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1. Introduction

1.1 Overview and History of Satellite Laser Ranging (SLR) Solutions

This document describes the latest in a series of Satellite Laser solutions, SL7.1, performed at NASA's Goddard Space Flight Center. Through the analysis of globally acquired satellite laser observations, the time-averaged three-dimensional coordinates of the tracking sites are determined for prescribed time intervals. To meaningfully measure tectonic motions of the tracking sites, knowledge of the orbiting LAser GEOdynamic Satellite (LAGEOS) trajectory is required at a level of accuracy approaching that of the laser ranges themselves: one centimeter. The SL7.1 analysis, which represents our fourth global solution, utilized the complete (through 1988) laser tracking data set and incorporates the latest (as of 1987) improvements in force and measurement models.

Starting with the experimental SL4 solution which took place in the early 1980s, the investigation entailed the estimation of *annual* station coordinates computed from laser tracking data sets then available. Although undocumented, the SL4 results demonstrated that the analysis concept was sound and viable given the status of the then-available hardware and software. When the GEM-L2 gravity model [*Lerch et al.*, 1985] became available (which, for its time, made major advances in the knowledge of the long-wavelength portion of the geopotential), the possibility of computing orbit trajectories of sufficient accuracy to resolve station motions due to plate tectonics was realized. The follow-on solution, SL5, made use of GEM-L2 and additionally, made use of laser *normal points* (discussed fully in Sect. 4.2) to provide data uniformity [*Smith et al.*, 1985]. Based on laser tracking data taken between 1979 and 1983, estimates of tectonic motion between five of the Earth's major plates were made and reported in *Christodoulidis et al.* [1985]. The SL5 solution provided the first Satellite Laser Ranging (SLR)-based geodetic confirmation that global plate tectonic motions were detectable and occurring in real time. Additional data, as well as improved models of Earth nutations and solid-Earth and ocean tides were included in subsequent solutions resulting in the SL6 solution [*Christodoulidis et al.*, 1986a]. The SL6 series of annual station coordinate solutions, based on tracking data spanning 1976-84, yielded estimates of horizontal velocities for a dozen sites. Many of these sites were centrally located on major tectonic plates and exhibited SLR-determined motions strongly resembling those predicted by the global tectonic model developed by *Minster and Jordan* [1978] from geologic and geophysical data.

The SL7.1 solution realizes, to date, the most dynamically consistent reference frame based on our analyses of LAGEOS ranging data. Nearly 13 years of LAGEOS tracking data have been analyzed to provide *quarterly* solutions spanning the time period from May 1976 (LAGEOS' launch date) to December 1988. This solution uses the GEM-T1 gravity model [*Marsh et al.*, 1988] within which the invariant and tidal parts of the geopotential were estimated simultaneously. The present work is intended to act as a companion volume to *Smith et al.* [1990b] which dealt more with the tectonic implications of the SL7.1 solution. This volume contains details regarding the data reduction, modeling, data and product evaluation steps taken, as well as the ancillary experiments and design decisions made during the analysis leading to the SL7.1 solution presented herein.

1.2 NASA's Role in the Development of Satellite Geodesy

Historically, the development of physical models to describe satellite tracking observations has provided a wealth of geophysical information. From the earliest measurements, using instruments which, at times, were no more sophisticated than binoculars and stopwatches (such as that used in the Smithsonian Astrophysical Observatory's project "Moonwatch" [*Mueller*, 1964, p. 236]), it soon became clear that satellite observations would both improve and change our understanding of the elements shaping our planet and its upper atmosphere. The earliest observed changes in orbits on the order of a few parts in a thousand quickly confirmed and refined the asymmetrical variations of the Earth's gravity field [*Merson and King-Hele*, 1958, and *O'Keefe et al.*, 1959]. These original determinations of global characteristics of the Earth through the application of space technologies initiated the growth of the subdiscipline of *satellite geodesy*. These early discoveries inspired developments in satellite tracking technology which have continued since the launch of Sputnik in 1957.

During the 1960s, NASA established the National Geodetic Satellite Program (NGSP) to advance and build a space geodesy program. The purpose of the early program was to establish a fiducial geocentric tracking station network which would unify the world's diverse regional geodetic datums into a single system [*Henriksen*, 1977]. To support the early requirements of precise orbit determination, constants were estimated and established to describe the central term (GM) and inhomogeneous portions of the Earth's gravitational field. The NGSP began as an effort to provide time-invariant positions of the participating tracking sites utilizing a variety of tracking technologies, such as optical, radio and electro-optical methods. As observational quality and physical models improved, the notion that estimates of crustal deformation and plate motions on global scales could be obtained via further technological refinement became more popular throughout the geodetic community. This led to the Williamstown Conference [*Kaula*, 1970] where plans were outlined to give direction towards achieving these goals.

Experiments utilizing satellite laser ranging began in the mid-1960s. From early experiences, improvements in the laser technologies led to the development of a second generation of tracking systems which offered 2-3 decimeter ranging accuracies, further encouraging the geodetic community to work towards the realization of more precise ranging systems. In 1972, an experiment began which was designed to test the capabilities of SLR to detect the effects of plate motion and deformation across California. This experiment, the San Andreas Fault Experiment (SAFE), sought to provide repeated measurements along a north-south, 896-km line straddling this complicated fault system [*Smith and Vonbun*, 1974]. The early success of SAFE, coupled with advances in the radio astronomic technology of Very Long Baseline Interferometry (VLBI), led NASA to increase the scope of its support for precise station positioning. The Earth and Ocean Dynamics Application Program (EODAP), formulated in 1972, specifically called for the development of centimeter-level VLBI and SLR systems to support geodynamic and oceanographic flight missions [*Geodynamics Program Office*, 1983, p. 7]. Details on the SLR system development and deployment can be found in *Degnan* [1985] and *Shawe and Adelman* [1985].

As an outgrowth of both the EODAP and the Earthquake Hazard Reduction Act of 1977, the NASA Crustal Dynamics Project (CDP) was founded in 1979 under the auspices of NASA's Geodynamics Program. The CDP was responsible for: (1) designing and developing space technology systems to acquire precise geodetic measurements for crustal dynamics investigations, (2) delineating measurement strategies enabling these investigations to proceed, (3) organizing and collecting the observations taken during the measurement program, and (4) supporting the analysis and interpretation of these results [*Geodynamics Program Office*, 1983, pp. 67-73]. CDP activities have sparked intense international interest in high-precision space-based point positioning. Through the participation and cooperation of over 30 countries, the capabilities of SLR and VLBI for geodetic monitoring of global tectonic processes continues to improve [*Coates et al.*, 1985 and *Flinn and Baltuck*, 1989]. Outlines for future developments promise improvements in scientific capabilities by expanding network coverage and by strengthening data acquisition strategies [*NASA Office of Space Science and Applications*, 1991].

1.3 The Laser Geodynamics Satellite - LAGEOS

The LAGEOS satellite was designed as a passive target for precise laser ranging. The satellite is a 60-cm-diameter sphere having a mass of 407 kg (Figure 1.1). The outer portion of the satellite is made of aluminum with 426 corner cube reflectors embedded within its surface. Of these, 422 reflectors are composed of fused silica with the remainder being composed of germanium. The satellite has a 175-kg cylindrical inner core made of brass. A complete description of the structural details of LAGEOS can be found in *Cohen and Smith* [1985].

LAGEOS was launched from the Western Test Range in California on May 4, 1976. It was placed into a high-altitude, near-circular orbit having an inclination of 109.8°. At an altitude of nearly 6000 km, LAGEOS experiences a minimal amount of atmospheric drag and is less apt to be perturbed by short-wavelength components of the Earth's gravitational and tidal fields. By minimizing the effects of non-conservative forces and higher frequency geopotential effects, LAGEOS acts as a target which has a highly predictable behavior; a quality that is necessary for the estimation of the motions of the tracking stations.

Through the global acquisition of high-precision laser tracking of LAGEOS, the data can be analyzed to yield information regarding geophysical parameters other than station positions and their ongoing motions. For example, improvements of the long-wavelength portion of the Earth's gravitational field from the analysis of LAGEOS data has been reported by *Lerch et al.* [1985] and *Marsh et al.* [1988]. Polar motion has been estimated [*Tapley et al.*, 1985] and high-frequency estimation of polar motion has been investigated and reported by *Pavlis et al.* [1988] and *Caporali et al.* [1990]. Tidal parameter estimation from LAGEOS data has been reported by *Christodoulidis et al.* [1986a]. Although not directly a geophysical parameter, a more physically appropriate model for general relativity and its effects on near-Earth satellites was studied and tested by *Martin et al.* [1985] and *Ries et al.* [1988]. Both studies concluded that within the noise limits of the laser measurement system, no significant effects were detectable. Ranging data to LAGEOS have provided a rich source of information from which advances in Earth science and physics have been and will continue to be made.

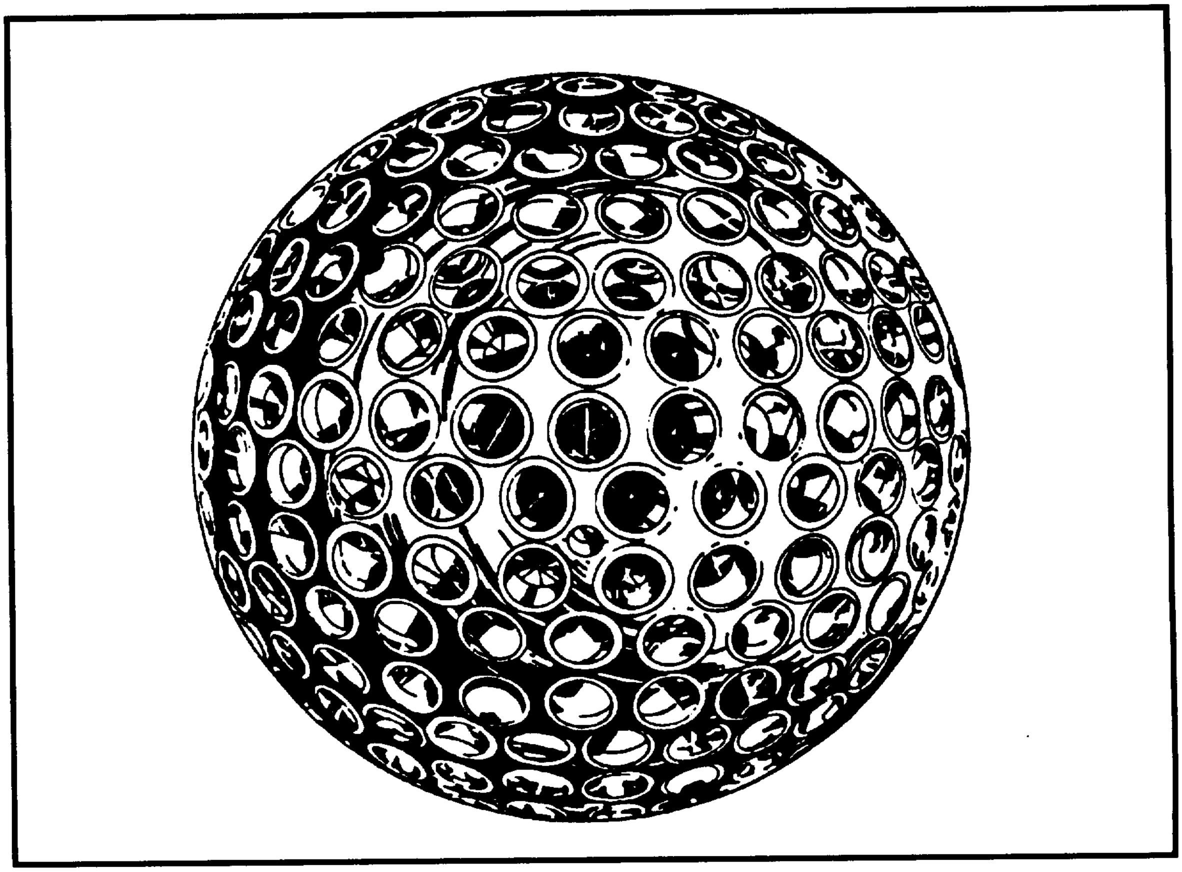


Figure 1.1 The LAGEOS laser reflecting geodynamic satellite launched by NASA.

2. Methodology, Definitions, and Rationale

2.1 Solution Strategies

2.1.1 *Introduction*

Satellite geodesy has traditionally been divided into two techniques; one based on geometric methods, and the other on dynamic methods. The geometric method utilizes the satellite simply as a high-flying target. Knowledge of the satellite's orbit is only required to locate the satellite during tracking. The dynamic method treats the satellite as a sensor as it passes through the Earth's gravitational field. Both methods have their merits and difficulties, but, as is explained below, the SL7.1 solution is based on the dynamic method.

2.1.2 *Dynamic Satellite Geodesy*

The theory behind the dynamic method has its roots in the works of various pioneers in the field of celestial mechanics. However, the specialized theory for close-Earth satellites did not emerge until the launch of Sputnik and the development of high-speed computing machines. Comprehensive texts of the theory have been made by *Mueller* [1964], *Kaula* [1966], and recently by *Schneider* [1988], although the latter is available only in German. Another book, by *Seeber* [1988] shares the same title as Schneider's book and is also in German, but its focus is not so much theoretical as technological.

The dynamic method relies on accurate modeling of the satellite's orbital behavior. The behavior of the class of satellite flown for geodetic purposes is largely dictated by the Earth's gravitational field. Additionally, for high-precision satellite tracking, known perturbing forces on the spacecraft, arising from non-gravitational sources, must be accurately modeled. Knowledge of the location of the satellite along its orbit and the orientation of the orbital plane with respect to the tracking station network, which rotates below on the Earth's surface, are required as a function of time. This provides the *dynamic* description of both the satellite's motion and orbital evolution and provides the connection to the Earth-based tracking system observing the satellite through time.

In the dynamic satellite approach, the solution parameters are estimated via least squares in an iterative manner until the parameters cease to improve (i.e., they have reached a prespecified level of convergence). The parameters which describe the physical situation for the tracking sites on the Earth (i.e. locations, polar motion, etc.), are estimated simultaneously with the parameters used to describe the orbit. In this scheme, the Earth orientation parameters are implicitly referenced to a system based on the LAGEOS orbit plane, and are directly relatable to the adopted model for the dynamical equator and equinox.

Other dynamic solution strategies have been used in various, primarily regional, investigations. For example, the work by *Klosko et al.*, [1990] utilized simultaneous LAGEOS tracking data in a technique dubbed "BEST" (Best Estimate from Simultaneous Tracking) [*Kolenkiewicz et al.*, 1985] to estimate baseline lengths in California and the Baja Peninsula averaged over 5 to 30 days. The technique is purely dynamic, but by using simultaneous data, the effects of orbit error are minimized. A similar technique called "translocation" was used by *Stolz et al.* [1989] to estimate the baseline rate between sites in California. The technique of "Pseudo Short-Arc" SLR analysis has been developed and used by *Sellers and Cross* [1990] to estimate baseline lengths in the northeastern Mediterranean. This technique is quite similar to the BEST technique but differs in that a consistent reference frame is maintained through the monthly arcs.

2.1.3 *The Geometric Approach*

The simplicity of the geometric approach, wherein the satellite dynamics are not required for the solution, must be tempered by the reality of whether sufficient tracking is likely to be available. The geometric method is based on triangulation or trilateration principles, or combinations thereof (see, for example, *Escobal et al.* [1973] and *Henriksen* [1977], Chapter 7, by H. Schmid) employing strictly simultaneous observations. Within the existing laser tracking data set, the choice of stations that qualify for mutual satellite inter-visibility is limited by deployment schedules and weather conditions which further restrict the overall size of the data set satisfying the condition of simultaneity, particularly for intercontinental station separations. Even when strong geometry is achieved, strictly geometric methods exhibit a strong sensitivity to data quality, both in (a): the ability to detect and separate unavoidable systematic errors and in (b): the difficult decisions for weighting of observations from instruments of differing precision. For these reasons the geometric approach could not be fruitfully applied in the global laser analyses for SL7.1.

2.2 Software Implementation

The software system utilized for the dynamic analysis of satellite laser ranging data is GEODYN II, which employs direct numerical integration of the satellite's equations of motion and variational equations in rectangular coordinates. Direct numerical models of a large number of satellite perturbing forces are evaluated at each integration step. Section 3 below describes the force modeling formulation, defines the adopted reference system, and details the measurement correction algorithms. The GEODYN System [*Henriksen*, 1977, Section 5.4.1, by B. Putney, *Putney et al.*, 1990 and *Eddy et al.*, 1990] is designed to apply a Bayesian weighted least squares algorithm but in practice, all *a priori* knowledge of the estimable parameters is relaxed so that *a priori* constraints are not generally applied to the estimated quantities, with rare exceptions.

In order to efficiently implement the required multi-arc capability for spanning many independent orbital arcs of data and for enabling a single simultaneous solution for orbit state vectors, station positions, Earth orientation parameters, tidal coefficients and other elements of the force model, the GEODYN system generates an intermediate data form (a matrix) consisting of a system of normal equations. These matrices are generated for each arc of data and are combined to yield a multi-arc solution in the SOLVE program [*Majer*, 1986] in which the full solution matrix is created by summing the selected rows and columns in the arc-normals and is inverted. The SL7 series are the first GSFC tectonic solutions to utilize the vector processing computer facility at Goddard: GEODYN II and SOLVE II were radically redesigned for operation on the CYBER 205 computer. The substantial improvement in resource utilization and details regarding program development can be found in Chapter 2 of *Marsh et al.* [1987].

2.3 The Role of Monthly, Quarterly, Annual and Global Solutions

The design of the software system allows considerable flexibility in choosing both the data time-span within which the analysis is to take place and the set of parameters to be adjusted in the solution. As was mentioned above, SOLVE can be directed to invert single-arc matrices as well as matrices formed by combining several subsequent arcs. In the course of the analysis, the arcs are combined in several different ways in order to provide a means to assess data quality and to estimate parameters which are dependent upon data continuous across time.

Initially, the raw range data to LAGEOS goes through a number of steps in order to prepare the data for full analysis (described in Chapter 4). The resulting data set is collected into data groups, called *arcs*, which accumulate all tracking data acquired over a specific time span. The time span chosen for the SL7.1 analysis is typically 30 or 35 days in duration. Error analysis studies indicated that this length of time was appropriate for the estimation of geodetic parameters. Arcs of this length have 180 continuous revolutions and several hundred passes of tracking making them quite stable. These *monthly arcs*, as processed in the form of matrices by GEODYN, provide the basic information for subsequent single- and multi-arc inversions by the SOLVE program. Each monthly arc is separately processed, evaluated, and qualified within GEODYN. If any data within an arc exhibits anomalous results, it undergoes further scrutiny via residual analyses to isolate the cause of the anomalous behavior.

Error analyses show that monthly arcs are capable of yielding precise station coordinates since perturbing forces acting on arcs of this length are well known. This capability is hampered by variations in local weather, system maintenance schedules, and other logistical and unforeseen operational problems. Since 1979, the tracking network has become well-distributed geographically and, for most months, yields accurate monthly positions for the stations having successful tracking campaigns. By combining several monthly arcs into a single solution, a more rigorous solution for all but the very weakest tracking sites can be made. We have chosen to make 3-month solutions, called *quarterly solutions*, to provide the principal means by which we estimate global tectonic motion for the tracking sites.

Just as monthly arcs are used to monitor individual station data quality, we also use *annual solutions* to assess global force model parameters such as the product of the gravitational constant with the Earth's mass (GM). The annual estimation of GM can yield important information about the variations in overall scale within the solution. However, the most accurate determination of global parameters such as GM, Earth orientation, and Earth and ocean tidal parameters is obtained by combining all monthly arcs into a single *global solution*. In this scheme, plate motion of the tracking stations is modeled in order to prevent a secular drift of the estimated pole which would occur due to the neglect of plate motion. This global solution yields a continuous Earth orientation series in a continuous reference system as well as a consistent monthly satellite ephemeris, simultaneously with the global geodetic parameters of interest.

In all these solutions, the parameters of chief importance include the tracking station locations in a center of mass system, the polar motion and UT1 variations of the Earth's rotation, and mean station tidal displacement terms. The gravity field and the Earth and ocean tidal modes affect our solution, as well as arc-dependent orbit vectors, radiation pressure coefficients, and along-track acceleration parameters which are used to empirically model a drag-like effect on LAGEOS. These quantities are either held fixed to values consistent with the most recently accepted models, or are estimated in the least-squares adjustment, as discussed individually in the next chapter.

3. Reference Frames, Constants, and Models

3.1 Reference Systems and Frames

The analysis of experimental data requires that one maintain the ability to compare the obtained results with those based on other observations or analysis procedures. It is implicit that a framework be defined which is adhered to by all analyzing the data and in all techniques. This provides the common ground on which we can base our comparisons and derive conclusions. This framework is termed the *reference system*.

For any given reference system it is possible to adopt various sets of numerical constants, mathematical models, and formalisms that will realize it, each with a different level of accuracy. Naturally, we are interested in adopting the most up-to-date and most accurate ones available. This adopted set of constants, models, etc., that realizes our preferred framework is known as the *reference frame*.

Not all of the required entities are preset to adopted values. Depending on the kind of data we are dealing with, we may find that these data are quite sensitive to certain parameters that enter the definition of our reference frame. In that case, the data themselves may actually determine improved values which are then more consistent with the data. For example, the LAGEOS laser ranging data can determine very accurately the value of the Earth's gravitational constant, GM. Although a reference value for this parameter has been adopted (through international accords), we have chosen to estimate it. This permits us to study its temporal variation and test the plausibility of theories as to the meaning and consequences of its variation.

The SL7.1 solution focuses on the temporal variation of several physical quantities which are of interest to a wide number of scientific disciplines. The experiments that we analyze are events in the space-time continuum in the sense of the general theory of relativity. We should point out, however, that the formalism adopted for the current analysis follows the classical Newtonian description rather than that of Einstein's geometro-dynamics.

Unlike the reference system which is a congregate of concepts alone, the reference frame comprises several categories of entities discussed below. Models for physical processes contain parameters set to adopted values and/or parameters which are estimated as part of the data analysis. The gravity field is an example of such a model. The central term of the field GM is estimated, but the remaining terms of the expansion are set to prescribed adopted values. The motion of the Earth's spin axis with respect to the crust is also amenable to different parameterizations. We have adopted the one that happens to be most commonly used, albeit not the only one possible.

Ancillary data sets are usually combinations of mathematical models and numerical values that complement our approximation of the natural environment where the observations take place. The Solar, Lunar and Planetary Ephemerides required in the integration of LAGEOS' orbit are a prime example for this category. We have chosen to use the ephemerides developed by the California Institute of Technology's Jet Propulsion Laboratory Development Ephemeris 200 and Lunar Ephemeris 200 (DE200/LE200) even though other ephemerides exist.

Finally, the way in which the data are analyzed is as important in defining the reference frame, as is the integrity of the data themselves. Dynamic satellite geodesy offers various options; the stability of the resulting reference frame in each case is different, and depending on the phenomena studied, one can have certain advantages over another. In the following subsections we describe the Reference System used in the present analysis of the LAGEOS data, and we discuss in summary the constants and numerical models that realize this system, i.e., the associated Reference Frame.

3.1.1 *Reference Systems*

In general, it suffices to use a single reference system within which we describe our experiment. Traditionally, and mostly for reasons of convenience, we use two such systems: one that is motionless with respect to the "fixed stars," the *Inertial System*, and one that is motionless with respect to the Earth's crust, the *Terrestrial System*.

The realization of these two systems is only an approximation of the actual concept of either of them. To stress this explicitly, it is common practice to refer to these as the *Conventional Inertial Reference System (CIRS)* and the *Conventional Terrestrial Reference System (CTRS)*, [*Kovalevsky and Mueller*, 1981]. The two systems are related to each other through three rotations which are functions of the fourth coordinate, time. We will not differentiate here between proper and coordinate time since, in the classical theory, they are assumed to be identical. The adopted free variable in the equations of motion is measured on the *Atomic Time* scale and the orientation of the Earth is specified in terms of the *Universal Time* scale. The first is chosen because of its uniformity, while the second is periodically stepped to keep it closer to the scale defined by the Earth's actual rotation. With the time coordinate defined, we proceed to the definition of the spatial coordinate system.

The international organization responsible for the definition of astrodynamical reference systems is the International Astronomical Union, (IAU). Our definitions follow as closely as possible those of the IAU. We have strived to maintain this parity by adopting their most recent recommendations every time a new cycle of analysis commences.

Traditionally, astronomers defined reference systems for their use by means of catalogs of repeatedly observed stars. When dynamical theories advanced and the contemporary instrumentation allowed it, the ephemerides of the planets, the Sun, and the Moon were realizations of the first dynamical reference system. The large distances between the bodies warranted that little attention be given to the issue of elaborate force modeling for the equations of motion. The very close approximation of the true motions by such simple point mass models was the main reason these ephemerides were used as stable frames of reference for a very long period of time.

The advent of satellite geodesy offered other options in the choice of the bodies whose orbits define the reference system. Precise tracking of artificial satellites provides an accurate measure of the observer's location relative to the spacecraft. However, the closer the satellite to the Earth, the stronger is the influence of the irregularities of the Earth's gravitational field and atmosphere on its trajectory. This is a drawback for the definition of a reference frame. The geopotential is not perfectly known, and the modeling of non-conservative forces such as atmospheric drag, Earth radiation, Solar radiation, etc., are in most cases incomplete at best. Therefore, the forces which perturb the orbit need to be estimated and they are undoubtedly of significant scientific importance. While this may improve the results, errors will still be present, for the model remains incomplete and imperfect. Clearly not all satellites are of equal use for the definition of a dynamical system despite the fact they may all be useful for other purposes.

The LAGEOS orbit can be determined through highly accurate laser ranging observations, thereby establishing a dynamical reference system which is directly accessible. When the results of the SL7.1 analysis are presented it will be clear that the goals set forth in the LAGEOS mission have been met and most of them surpassed by an order of magnitude. Nevertheless, the long term stability of the system is still limited due to unmodeled very long period perturbations, especially in the angular elements (node, inclination) which are yet to be fully modeled. As our modeling improves, we find that we more effectively use the satellite orbit as the means to define a dynamical reference system (even though imperfect), which we can access through direct observations from the Earth's crust.

This system is related to the astrodynamical reference systems defined through the planetary ephemerides by a weak link: the relatively small orbital perturbations that the rest of the solar system's bodies have on LAGEOS' trajectory. The astrodynamical system which is realized by these ephemerides is well studied [*Newhall et al.*, 1983, and *Lieske and Standish*, 1981]. The resulting system will, to a certain extent, violate one of the defining principles of a dynamical system based on the theory of the motion of some bodies in the solar system constructed in such a way that there remains no rotational term in the equations of motion. To reiterate, there are imperfections in the force modeling of LAGEOS' motion which may introduce frame distortions; our system will slowly rotate with respect to the inertial space, and the rate will be a function of the mis-modeled force effects.

Since we cannot define a truly inertial system, but rather a quasi-inertial one, we must associate a date with our definition. We use the IAU-adopted fundamental epoch of Noon January 1, 2000 Julian Ephemeris Date, designated by *J2000*. The first axis of the CIRS is defined as the intersection of two fundamental planes: the ecliptic and the mean celestial equator. By convention, the positive direction is that which points in the direction of the ascending node of the ecliptic on the equator, that is, the Mean Vernal Equinox of date. The third coordinate axis is perpendicular to the plane of the mean equator of J2000. Lastly, the second axis completes the orthogonal triad on the equator.

As we have already mentioned, the CIRS and the CTRS are related through three independent rotations which are functions of time. In order to study various phenomena that have vastly different origins or magnitudes, and because part of the total rotation is well represented by theoretical models, the total rotation is decomposed into several successive rotations which are all time-dependent. The mean places of the fundamental epoch are related to the mean places at the observation epoch through the *precessional* rotation. The short periodic (relatively speaking) variations of the Earth's orientation in space are modeled through the *nutational* rotation at the observation epoch. Both of these motions are forced and directly attributable to the gravitational torque of the solar system's bodies exerted on the Earth due to its oblateness. At this point, there are no other motions with respect to the inertial space. The interim system we have reached is what astronomers call the "true of date system" and for the sake of uniformity we shall call it the *Celestial Ephemeris Reference System (CERS).* It is described in Figure 3.1.

To relate this to the CTRS we must still define the rotations of the CERS with respect to the CTRS. These are: the orientation of the instantaneous equatorial plane, or equivalently, an axis perpendicular to it, the sidereal rotation, and the non-uniform rotation rate of the Earth on the Equator (see Figure 3.2). The sidereal diurnal rotation is modeled through a polynomial in time which describes at any instant the angular separation of the equinox and the conventionally adopted origin of longitudes on the Earth. The first two rotations account for the highly irregular polar motion while the last refers to the spin rate irregularities. Because these motions are "free" responses of Earth, polar motion and Earth rotation variations are, by and large, unpredictable to the required accuracy by any current theory. Therefore, they must be determined through observation. Their estimates orient the observer on the Earth's crust with respect to the CERS as materialized by the satellite's orbit. In fact, an accurate determination of these parameters is one of the goals of this analysis since their temporal variation can provide us with vital additional information about the inner structure and the elastic properties of the Earth.

The axis whose polar motion is "observed" by the various techniques must be uniquely defined and naturally "observable." The definition of this axis - the *Celestial Ephemeris Pole (CEP)* - has been a controversial issue since the 1970s, (cf. a historical review in [*Moritz and Mueller,* 1987]), and it is only recently (1984) that the issue has been settled. The IAU-adopted definition for the CEP is that it should have "no periodic diurnal motion relative to the crust (not the mantle) or the CIRS" [*Mueller,* 1981]. We should note that the CEP is the third axis of the CERS and it is the axis to which our nutation model refers. Since the nutation is derived from a model which is necessarily only an approximation of reality, it is important to choose a model that complies with it in order to conform with the above definition.

3.1.2 *Reference Frames*

The first international campaign to utilize laser ranging data for the definition of a dynamical system was ISAGEX, the International Satellite Geodesy Experiment. The accuracy of early-1970s ranging systems that participated was between 1 and 2 meters. Since the errors from the gravity field were large at the time, the resulting reference frame had an estimated accuracy of only about 5 meters. Instrumentation, however, has improved tremendously, and our

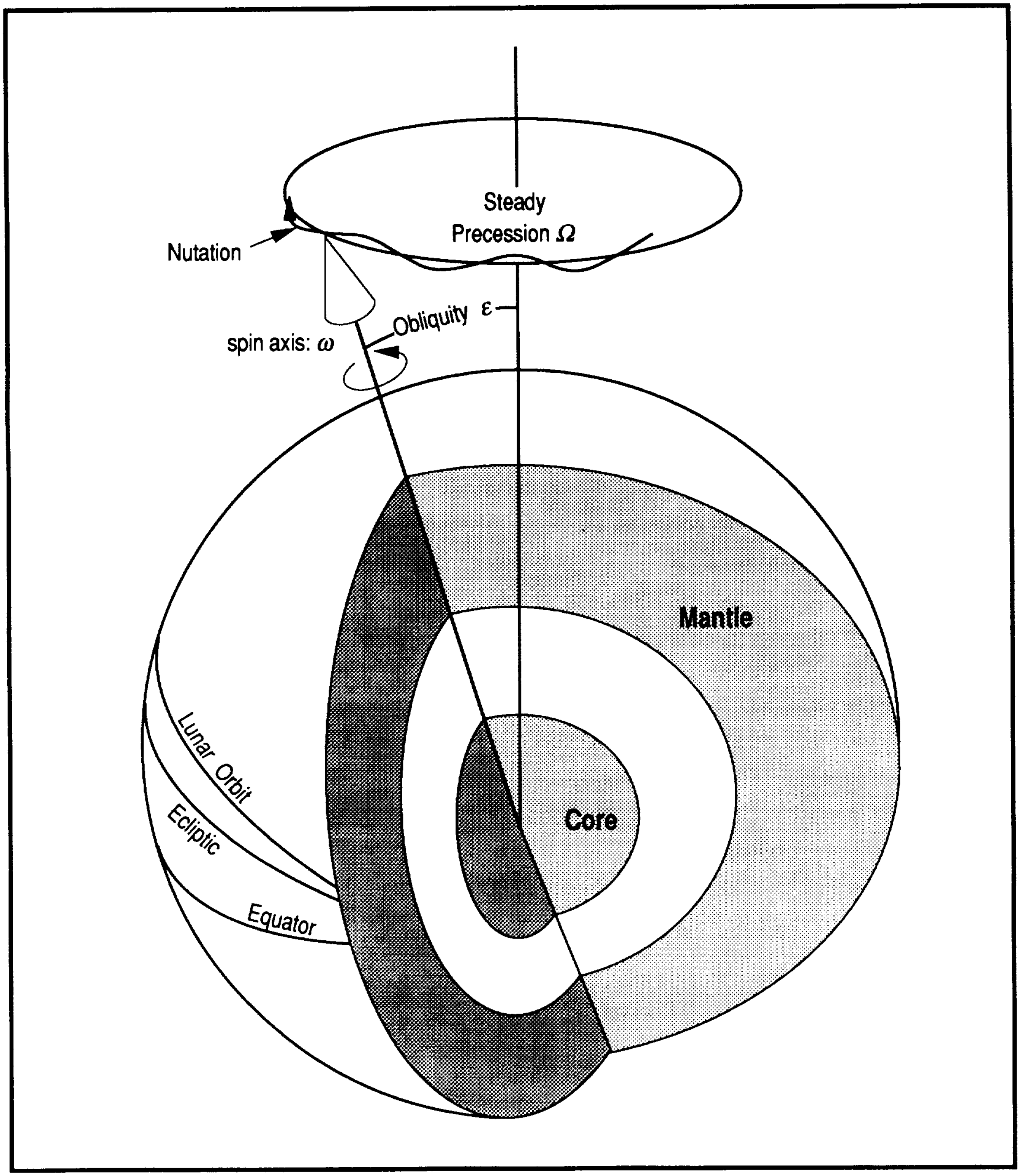


Figure 3.1 Earth rotation in inertial space: Precession and nutation.

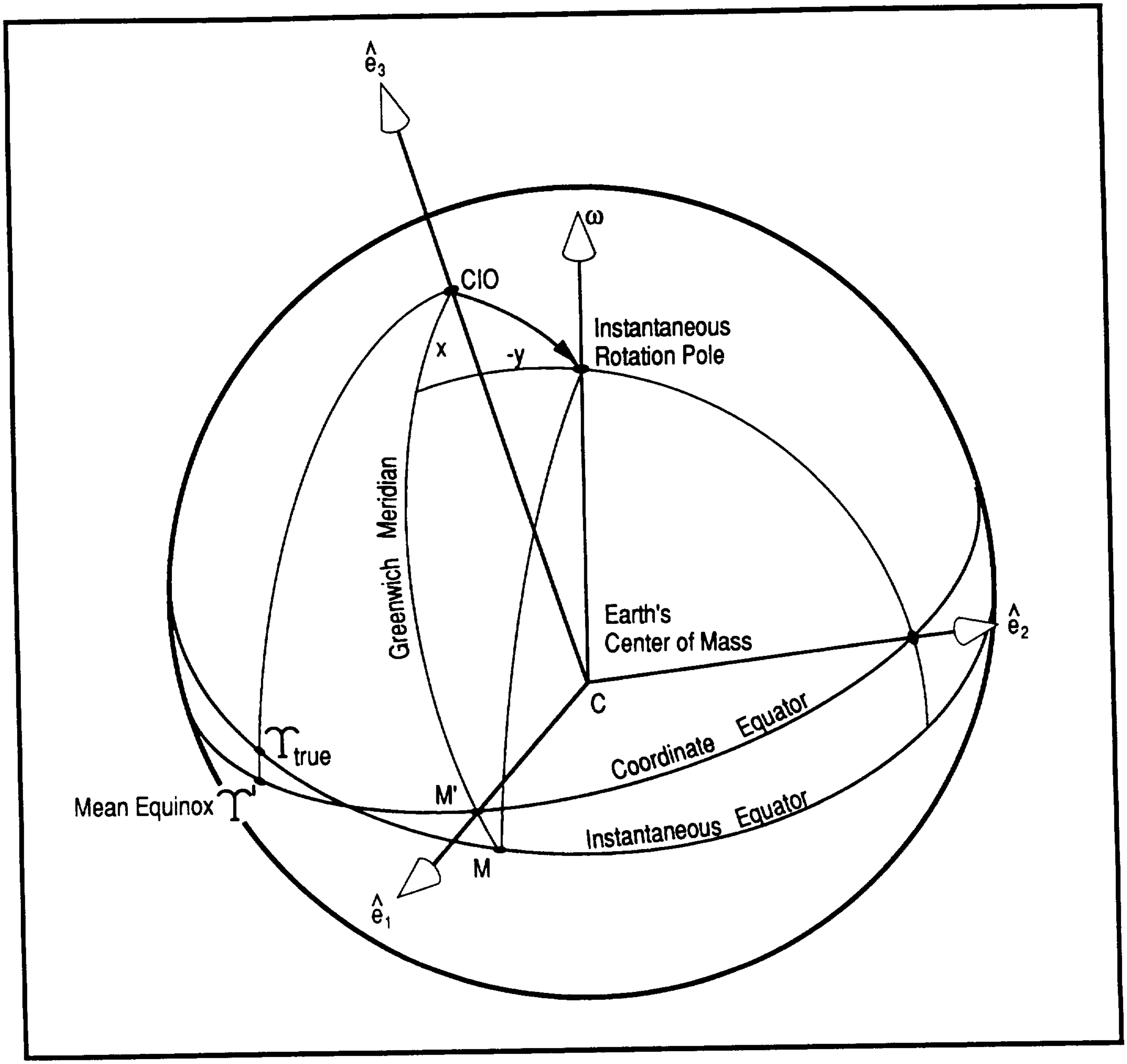


Figure 3.2 The terrestrial system: Polar motion and Earth rotation angles.

understanding and modeling of the gravity field and other forces acting on near-Earth satellites has advanced by orders of magnitude.

One of the most successful recent international campaigns organized for the purpose of studying Geodynamics was MERIT; it covered the period September 1983 through October 1984. MERIT was a program of international collaboration to Monitor Earth Rotation and to Intercompare the Techniques of observation and analysis, [*Mueller*, 1985]. Tracking of LAGEOS and the analysis of the collected data were main contributors to its success. Due to the high quality and abundance of data, and the variety of estimated geodynamic quantities, the MERIT campaign has had a major influence on subsequent international efforts in geodynamics.

As part of the preparation for this campaign the "MERIT Standards" [*Melbourne et al.*, 1983] were instituted and applied to a wide range of analyses. Therein one found a collection of constants, models, and formalisms that were used to define the reference frames associated with Project MERIT. Regardless of whether these Standards provided the most accurate or most popular values, their single most important contribution was bringing together in one document the entities one needed to adopt in the process of establishing a reference frame. In most cases, we only have to describe minor deviations from MERIT, rather than re-enumerate every single value required. To a great extent, this accurately describes the standards adopted for the SL7.

3.1.2.1 The Inertial Frame

The adopted definition for the CIRS is that of J2000. This frame is connected to the CERS frame at any instant through the IAU 1976 model for precession [*Lieske et al.*, 1977, and *Lieske*, 1979] and the nutations of the IAU 1980 model [*Wahr*, 1981]. The definition of the reference pole for Wahr's model happens to be such that it fulfills the CEP definition consistent with J2000. The obliquity of the ecliptic of date with respect to the reference ecliptic of J2000 is modeled through the IAU 1976 adopted formula [*Kaplan*, 1981], which is consistent with the adopted model for the precession. The adopted Solar, Lunar and Planetary ephemerides, JPL's DE200/LE200, are also consistent with J2000.

The connection of the CERS with the CTRS involves a model for the orientation of the first axis of one with respect to that of the other: the Greenwich Mean Sidereal Time, GMST. The formula that we have adopted is consistent with the IAU 1976 resolution [*Kaplan*, 1981, p. 8]. It complies with the definition of the Celestial Equator implied by the above-mentioned formula for the obliquity of the ecliptic as well as the definition of the CEP through Wahr's nutation model.

Application of the CIRS to the CERS transformation defines (as we already noted), an "instantaneously inertial" frame in which the orbit of the satellite is observed. This orbit is the "link" through which the aforementioned models effect the connection between the two frames. We know however, that there are no "bench marks" in space to define the CIRS and that today's adopted models are mere mathematical abstractions. If we were to reverse the argument about the "orbit link," we could see how the definition of the CIRS is realized indirectly through the dynamics of the satellite orbit. It is therefore clear why such a reference frame is termed a dynamical one.

3.1.2.2 The Terrestrial Frame

The connection of the CERS with the CTRS requires the knowledge of the Earth Orientation Parameters (EOP), namely the variation in the sidereal rotation and the polar motion coordinates. We have already mentioned that the systematic part of the first rotation is given by the GMST formula. To refer this angle to the true Equinox of date we must add to GMST the "Equation of the Equinox," which is the effect of the nutation on the mean Equinox. The resultant angle is the Greenwich Apparent Sidereal Time, GAST. The fact that the Earth rotates with a variable rate about an axis which has an irregular motion with respect to the crust, forces us to determine through observation the remaining portion of the three Eulerian angles.

The observatories which collect the tracking data are fixed on the Earth's crust. The polyhedron whose vertices are the observatories provides a crude approximation of the crust; the denser and more uniform the distribution of the observatories, the closer the approximation. Were the Earth's crust completely rigid, a few stations would suffice. Due to the motion associated with plate tectonics, this is not the case. Monitoring the magnitude and direction of these motions is currently an important task in geodynamics and is of chief interest in this study. Tectonic models exist to describe these motions, but are based mostly on geological data and make simplistic assumptions about the rigidity of the internal plate structure. These models can have large uncertainties associated with them and they reflect average behavior over several million years. Short-term variations can only be determined through direct observation and can provide us with vital information on precursory seismic events with obvious societal implications.

We are in a situation where we have no model demonstrably accurate enough to represent the global tectonic motions present in the tracking network, whose effects are large enough to affect the rest of the parameters that will define the CTRS station positions. The general rule in such cases is to estimate the effect from the data themselves. In fact, to help our solution converge faster, we have adopted as a first approximation the model AM0-2 of *Minster and Jordan* [1978]. The correction to the underlying model is made by allowing the observing station locations to adjust to new time-averaged positions over a prescribed interval of time. Depending on the purpose of the solution, this interval can be as short as a month or as long as a year, as described in Section 2.3. This procedure, along with the AM0-2 model, accounts for crustal motions within our analysis. We have thus reached the point where a set of piece-wise continuous station positions and an adopted model of crustal motion define our approximation of the Earth's crust.

The satellite dynamics are sensitive to the location of the observatory to the extent that the observatory's position can be determined from its observations along with the satellite trajectory. In particular, the analysis of ranging data to estimate tracking site positions is a problem which theoretically has only one singularity: the definition of the origin of longitudes. It is not necessary then to adopt positions for the "mean" places of the stations, we can simply estimate them from the data themselves. We only need to constrain the longitude of one station to remove the singularity (Figure 3.3). This would suffice for the solution to the definition of our CTRS if it were not for the simultaneous estimation of the Earth orientation parameters. An examination of the range equation in terms of this enlarged set of estimated parameters reveals that a change in the station position can be accommodated by an opposite change of the CTRS with no change in the observation residual itself. To remove this singularity, we need to define the location of the third axis on the already defined zeroth meridian. This can be accomplished through the adoption of the latitude of the already constrained station. One further constraint is required which will remove the rotational degree of freedom of the zeroth meridian plane about its equatorial axis. This can be effected in one of two ways : fixing the latitude of a station which is approximately on the same parallel and 90 degrees away in longitude (Figure 3.4), or fixing the longitude of a station nearly on the same meridian and about 90 degrees away in latitude (Figure 3.5).

We have used both approaches in different test solutions, considering in each case which of the two stations had stronger tracking. The nominally constrained stations adopted were: Greenbelt, Maryland, selected to serve as the primary station (fixing both latitude and longitude), and for the second station we had a choice between either Maui, Hawaii (fixing its latitude) or Arequipa, Peru (fixing its longitude). The applied constraints force these coordinates to change in time with a predefined tectonic motion provided by the AM0-2 model. It can be easily verified that these particular constraints are selected in such a way that the estimated changes in distance due to the tectonic motion between the constrained stations remain nearly unaffected over time.

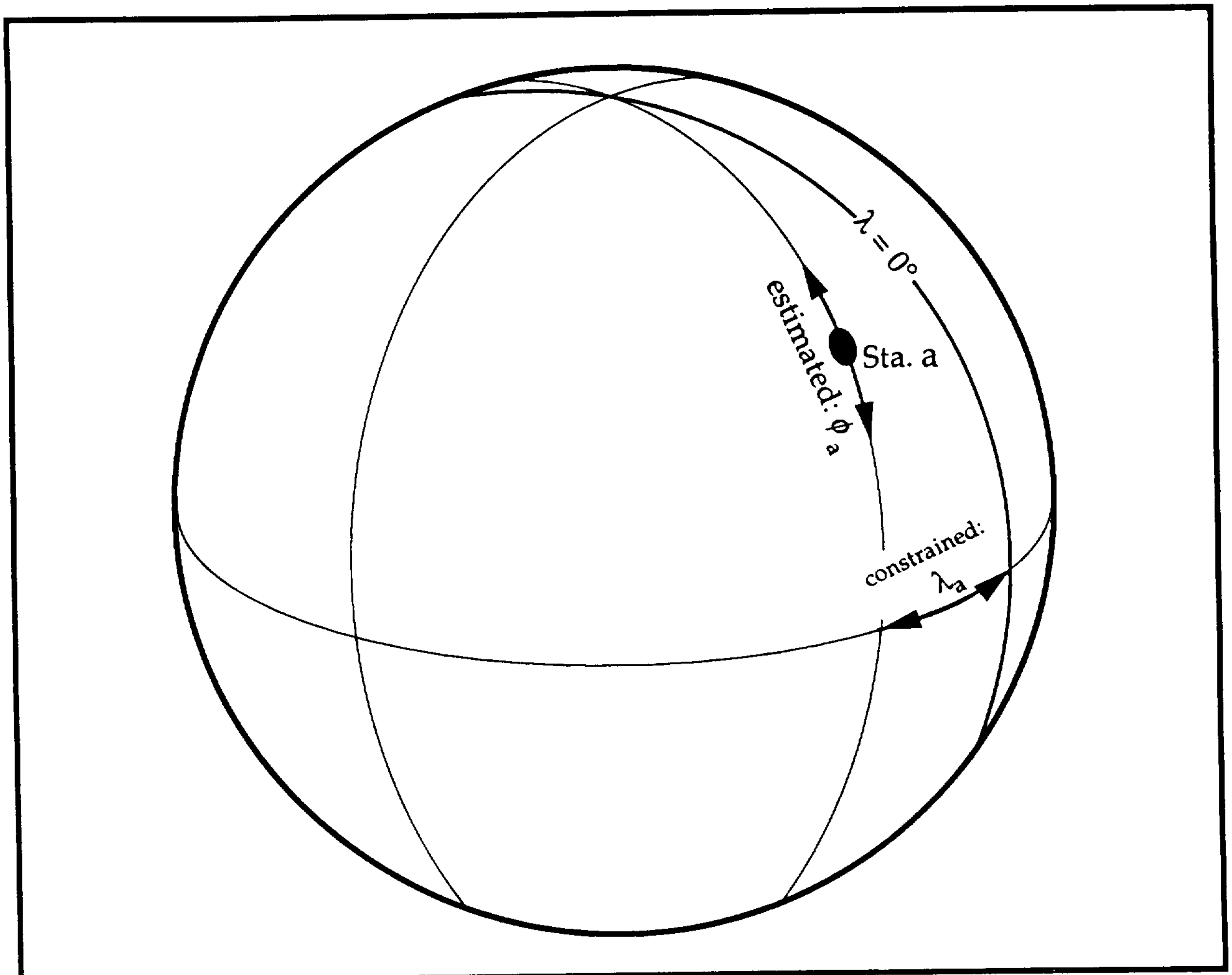


Figure 3.3 Minimal constraint required to establish a CTRS in a solution where Earth orientation parameters are not being estimated.

The initial approximate positions for the tracking stations were the result of the previous cycle of analysis, the SL6 solution. For stations that appeared after 1984, the values were obtained from preliminary solutions within the frame of the SL6 stations. The starting EOP set (the approximation for the estimates), was of mixed origin. For the 1976 through 1979 period we have used the values provided by BIH Circular D, and the same holds for the 1985-86 period. For the 1980-84 period, we have used the pole positions derived from the SL6 cycle of analysis. In all cases the BIH Circular D values were used for Earth rotation variations, described through the UT1-UTC.

The sequential application of the orthogonal rotations described in the last two subsections effects the connection of the CTRS to the CIRS, in other words, the observer's frame of reference to that of the inertial space as it is realized by the orbit of LAGEOS. The final solution which

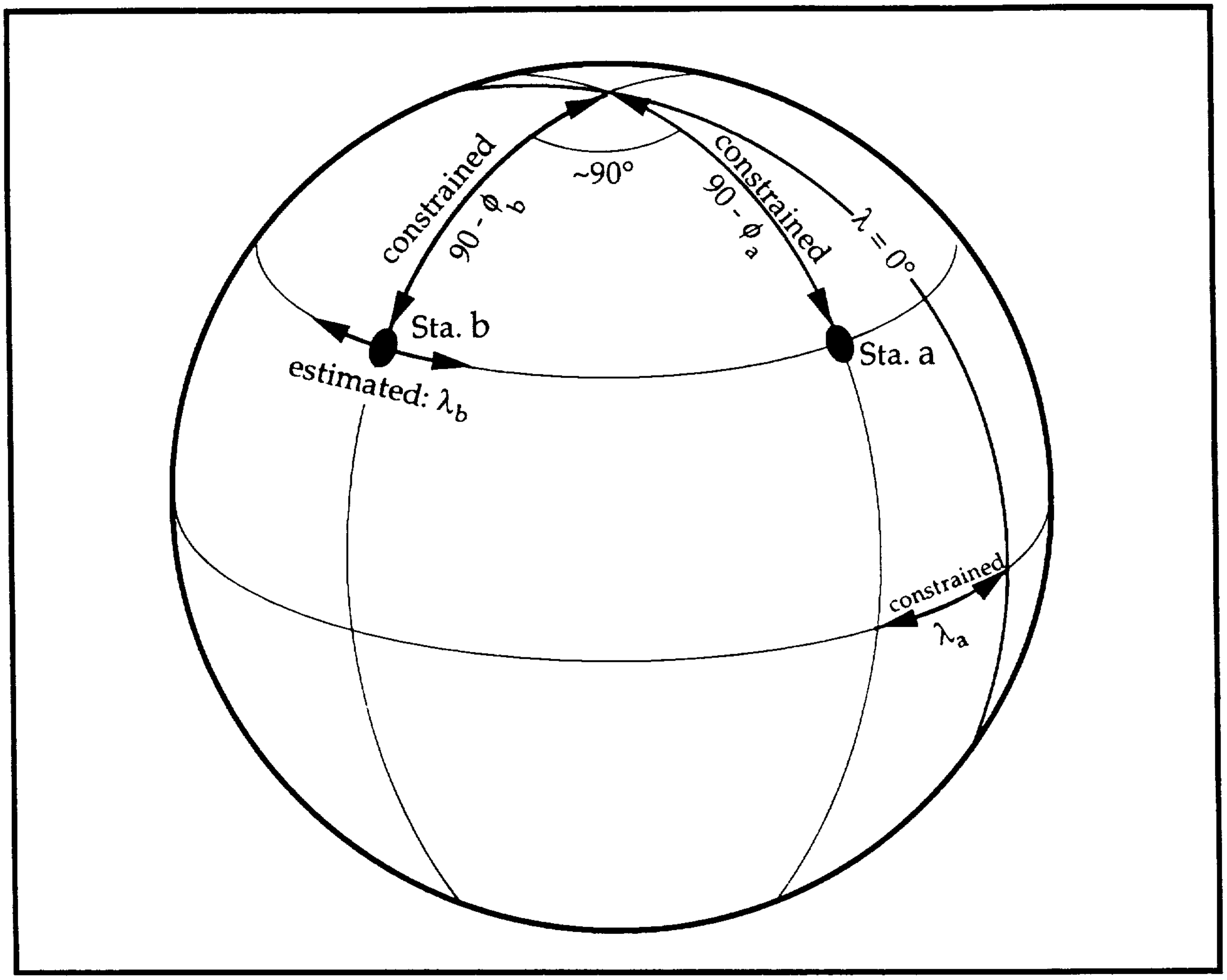


Figure 3.4 Minimal constraint required to establish a CTRS in a solution in which Earth orientation parameters are being estimated. Case 1: two stations on the same parallel.

is presented here, is the result of a second iteration to minimize non-linearity effects. As such, we must point out that these results have been based on using as *a priori*, information which has been derived from the previous iteration. This statement encompasses all of the adjusted parameters with the exception of the arc-dependent solar radiation pressure coefficients and the along-track acceleration series.

3.2 Adopted Constants

The following tables list the values adopted for constants that enter into the models used in the reduction of the observations. Only the more important ones have been included. We have

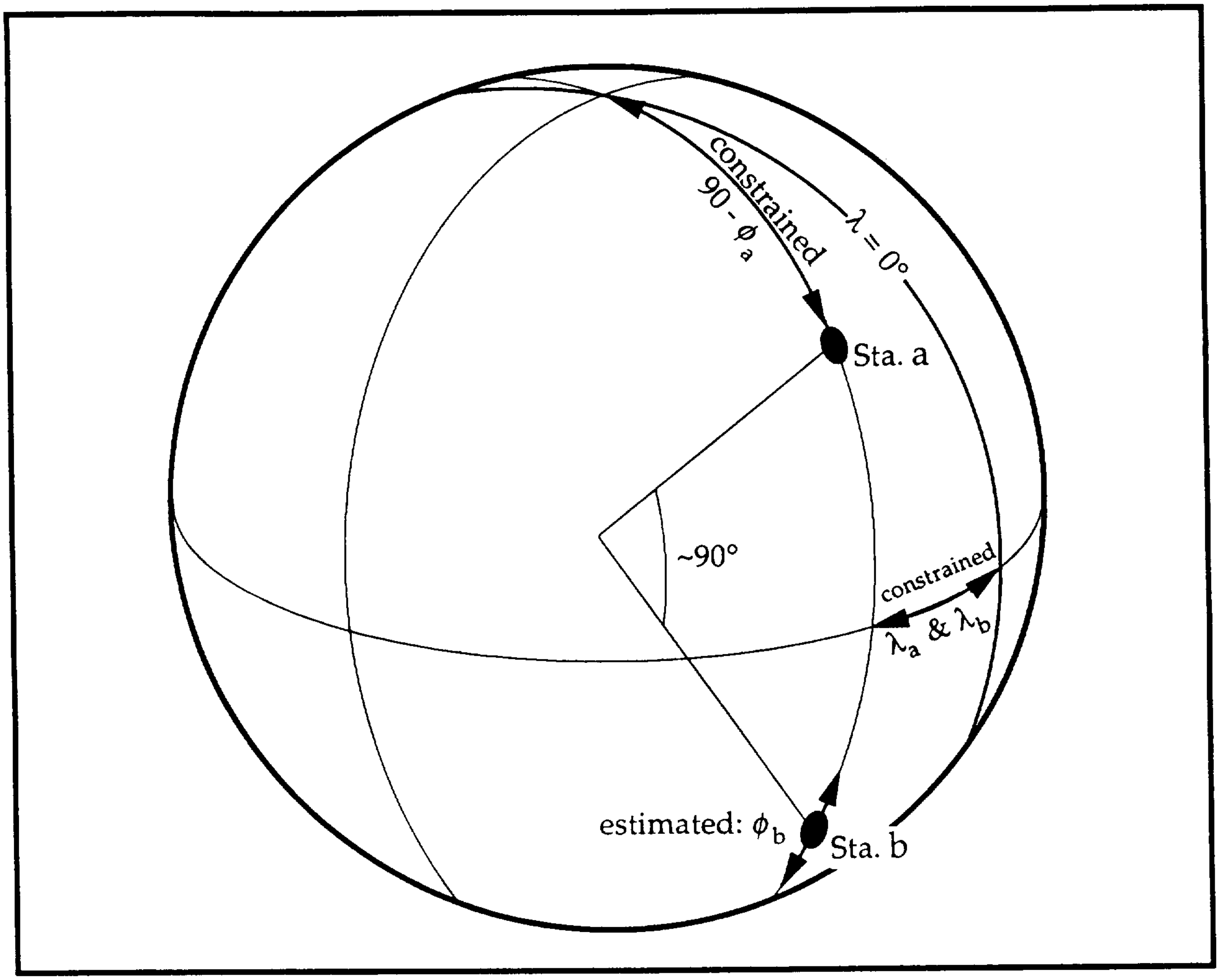


Figure 3.5 Minimal constraint required to establish a CTRS in a solution in which Earth orientation parameters are being estimated. Case 2: two stations on the same meridian.

also avoided repeating numbers which are implicitly embedded in standard models which we have adopted in the whole, e.g., the constants describing Wahr's nutation model, or Lieske's expressions for the precessional matrix.

3.2.1 *Astronomical Constants*

Speed of light	299792458 m/s
Equatorial radius of the Earth	6378137 m
Flattening of the Earth	1 / 298.257
Mean spin rate of the Earth	0.00007292115 rad/s
Geocentric gravitational constant	398600.440 km^3/s^2

Ratio of Earth to Moon mass	0.012300034
Ratio of Solar to Earth mass	332946.038
Astronomical unit	149597870660 m

3.2.2 *Dynamical Models*

Geopotential expansion	GEM - T1 (to degree and order 20)
Solid-Earth tides	Wahr model
Ocean tides	GEM - T1
Radiation pressure at 1 AU	0.0000045783 $kg/m/s^2$
Mass of LAGEOS	406.965 kg
LAGEOS cross-sectional area	0.28274 m^2
LAGEOS reflectance coefficient	1.13

3.2.3 *Measurement Model*

Troposphere	Marini-Murray model
Satellite center of mass correction	0.24 m
Station tidal displacements	Wahr model

3.2.4 *Reference System*

CIRS	J2000.0
Planetary Ephemeris	DE200/LE200
Terrestrial time scale	UTC(USNO)
Precession	IAU 1976 (Lieske model)
Nutation	IAU 1980 (Wahr model)
CTRS	Global Solution 11.7 y
Tidal variations in UT1	Yoder model
Tectonic motion model	Minster & Jordan AM0-2

3.3 Force Modeling

This section describes the force models of GEODYN and their specific application in the SL7.1 solution. The complete mathematical descriptions are found in *Eddy et al.* [1990].

The numerous forces which accelerate a satellite are naturally classified as conservative potential effects and non-conservative effects. The potential effects modeled include the geopotential due to the static mass distribution of the Earth and the temporally varying geopotential due to the deformation of the Earth by the gravitational forces of the Sun and Moon. The third body effects augment the conventional point mass potential to include the effect of Earth's dominant non-spherical component, C_{20}, that is, the "indirect oblateness" effect is modeled.

3.3.1 *Potential Effects*

The static geopotential is typically represented as a series of spherical harmonics by [*Heiskanen and Moritz*, 1967]:

$$U^s = \frac{GM}{r}\left[1 + \sum_{n=2}^{nmax}\sum_{m=0}^{n}\left(\frac{a_e}{r}\right)^n \overline{P}_{nm}(\sin\phi)\left(\overline{C}_{nm}\cos m\lambda + \overline{S}_{nm}\sin m\lambda\right)\right] \tag{3.1}$$

where GM is the gravitational constant of the Earth; r, ϕ and λ are the geocentric distance, latitude, and east longitude, respectively, at the point of evaluation; $\overline{P}_{nm}(\sin\varphi)$ are the associated Legendre functions of the first kind; and $\overline{C}_{nm}$ and $\overline{S}_{nm}$ are the geopotential coefficients, sometimes referred to as the Stokes' coefficients, which represent the inhomogeneous mass distribution of the Earth. The use of the normalized harmonics is indicated by the overbars. To completely represent the geopotential, $nmax$ should be very large. However, for the purposes of modeling satellite behavior, the series can be truncated with minimal loss of accuracy due to the gravitational attenuation with altitude. The evolution of LAGEOS' orbit and the forces acting upon LAGEOS at any one moment are predominantly influenced by the geopotential. The static geopotential model is further augmented with a model describing the dynamically varying indirect tidal potential, which may simply be regarded as the above model with the prescribed astronomic forcing.

The tidal potential adopted is split into two components; the solid body tide potential and the ocean tide potential. The body tide potential is modeled based on the frequency-dependent elastic response of the Earth [*Wahr*, 1981]. The ocean tide model is based upon the spherical harmonic expansion of a simple surface density layer model. Both of these potentials may be expressed in the standard spherical harmonic form given in equation 3.1, where the coefficients vary with time. However, tidal potentials are more conventionally expressed in terms of amplitude and phase, where the amplitudes are related to either surface tidal heights (ocean tides) or to their contribution to the elasticity parameter k_2 (for the solid-Earth tides).

The formulation for the tidal potentials in GEODYN is fully documented in *Christodoulidis et al.*, [1988]. The body tide potential is expressed as (for either the Sun or the Moon):

$$U^b = \sum_f k_{2,f} \overline{A}_f G_D \frac{3-m}{3} \left[\frac{a_e}{r} \right]^3 P_{2m}(\sin\phi) \cos\alpha_f^{SE} \tag{3.2}$$

and the ocean tide potential is similarly expressed as

$$U^o = \sum_f \sum_{l,q,\pm} 4\pi G_D a_e \rho_o \left(\frac{1+k_l'}{2l+1} \right) C_{lq,f}^{\pm} \left[\frac{a_e}{r} \right]^{l+1} P_{lq}(\sin\phi) \cos\alpha_{lq,f}^{\pm} \tag{3.3}$$

where

$\sum_f$	indicates summation over all tidal constituents f in the expression of the tide-generating potential.
$k_{2,f}$, $\delta_{2,f}$	are the second-degree Love number amplitude and phase respectively, which describe the body response of the Earth.
$\overline{A}_f$	is equivalent to the Doodson coefficient (given by equation A7 in *Christodoulidis et al.* [1988]).
G_D	equivalent of the Doodson Constant given by $G_D = 3\mu_m R^2 / \left(4a_m^3\right)$ where μ_m is the product of the gravitational constant with the mass of the Moon and a_m is the semi-major axis of the lunar orbit (likewise for the solar case), R is the mean radius of the Earth.
m	is the order associated with f which is 0 for the long-period tides, 1 for the diurnal tides, and 2 for the semi-diurnal tides.
ρ_o	average density of ocean water.
k_l'	load deformation coefficients.
$C_{lq}^{\pm}$, $\varepsilon_{lq,f}^{\pm}$	are the amplitude and phase of the $(l,q,\pm)$ subharmonic of the ocean tide generated by constituent f.

and where the angular arguments are:

$$\alpha_f^{SE} = (\mp)\left[(2-2h)\omega^* + (2-2h+j)M^* + k\Omega^*\right] + m\Theta_g + m\lambda + \pi - m\frac{\pi}{2} + \delta_{2,f} \tag{3.3a}$$

$$\alpha_{lq,f}^{\pm} = (\mp)\left[(2-2h)\omega^* + (2-2h+j)M^* + k\Omega^*\right] + m\Theta_g + q\lambda + \pi - m\frac{\pi}{2} + \varepsilon_{lq,f}^{\pm} \tag{3.3b}$$

and finally where

ω^*, M^*, Ω^*	are the traditional Keplerian elements for the disturbing body refered to the ecliptic, and the
$h, j, k, q, \pm$	are combinations of factors which map the six Doodson angular arguments into subscripts suitable for application with the Keplerian elements of the Moon and apparent Sun.
Θ_g	is the Greenwich sidereal hour angle.

The eccentricity and inclination of the osculating elements of the perturbing body are incorporated in the Doodson coefficient.

Each constituent f is associated with an unique frequency. It should be noted that if

$$k_{2,f} \equiv k_2$$
$$\delta_{2,f} \equiv \delta_2 \tag{3.4}$$

for all f (i.e., the solid-Earth Love number is frequency invariant) (including f=0, see comment below), then the total body tide potential may be simply computed in the time domain using the simple second-degree potential

$$U^b = \sum_d k_2 \frac{\mu_d a_e^2}{r_d^2}\left[\frac{a_e}{r}\right]^3 \left\{\frac{3}{2}\left[\frac{\bar{r}_d \cdot \bar{r}}{r_d r}\right]^2 - \frac{1}{2}\right\} \tag{3.5}$$

based on the point mass attraction of the third bodies and the Earth's deformation given by a constant Love number. Hence, $\bar{r}_d$ is the geocentric vector to the Sun or Moon, μ_d is the gravitational constant of the Sun or Moon and $\bar{r}$ is the position vector to the point of computation. For a more realistic frequency-dependent model for the Love numbers, most of the variations are concentrated in a single band (the diurnal). It is computationally efficient to use a simple frequency-invariant background model as a complete description of the solid Earth tides (as in equation 3.5) and correct select terms for which the Love numbers differ significantly from the background reference values. This procedure was adopted in our analysis.

Because terms with $f = 0$ were included in the tidal acceleration of the spacecraft, the resulting gravity field, its geoid etc., have all the permanent-body tidal deformation completely removed. In this way, they happen to be in agreement with earlier IAG resolutions on modeling the permanent tide and conflict with those which are most recent.

The tidal constituent f is uniquely identified by the Doodson argument number. Table 3.1 identifies the principal tidal frequencies and gives the (approximate) matching Darwinian symbol for each corresponding Doodson number. The frequencies are based upon the ecliptic constant element rates. Note that these same frequencies are also present in the ocean tide effects.

The direct potential effects of the other disturbing bodies are modeled as point mass effects:

$$U^d = \mu_d \left(\frac{1}{\rho} - \frac{\bar{r}_d \cdot \bar{r}}{r_d^3} \right) \tag{3.6}$$

where $\rho = |\bar{r}_d - \bar{r}|$ is the distance from the satellite to the disturbing third body. The second term refers the accelerations of the satellite to the center of the Earth.

In the case of the Earth-Moon system, the effect of the Earth's oblateness must be included in the precise computation of third-body accelerations. The effect of the Earth's gravity on the Moon is given by Equation. 3.1. As the force exerted on the Moon by the gravity of the Earth is matched by an equal and opposite force by the Moon on the Earth, the additional acceleration to be applied to the satellite radially and in latitude is:

$$\ddot{r} = \frac{-1.5\mu_m}{r_m^4} a_e^2 C_{20} (3\sin\phi_m - 1) \tag{3.7a}$$

$$\ddot{\phi} = 3\frac{\mu_m}{r_m^3} a_e^2 C_{20} \sin\phi \cos\phi_m \tag{3.7b}$$

where μ_m and r_m correspond to μ_d and r_d for the Moon and ϕ_m is the latitude of the Moon. The inclusion of this effect more precisely refers the accelerations of the satellite to the center of the Earth.

3.3.1.1 The *A Priori* Static Geopotential Model: GEM-T1

The *a priori* gravitational model adopted was the Goddard Earth Model - T1 (GEM-T1) using terms through degree and order 20. GEM-T1 resulted from a major new computation of the terrestrial gravitational field by the Geodynamics Branch of Goddard Space Flight Center.

Table 3.1. Principal Tidal Components

Darwinian Symbol	Doodson's Argument Number	Period (hr)	Description
M2	255.555	12.42	Principal lunar semidiurnal
S2	273.555	12.00	Principal solar semidiurnal
N2	245.655	12.66	Larger lunar elliptic semidiurnal
K2	275.555	11.97	Lunar/Solar semidiurnal
L2	265.455	12.19	Smaller lunar elliptic
K1	165.555	23.93	Lunar/Solar diurnal
O1	145.555	25.82	Principal lunar diurnal
P1	163.555	24.07	Principal solar diurnal
Mf	075.555	13.66d	Lunar fortnightly
Mm	065.455	27.55d	Lunar monthly
Ssa	057.555	188.62d	Solar semi-annual

A simultaneous solution was made for spherical harmonic parameters of both tidal and invariant parts of the gravitational field (*Marsh et al.*, 1988, *Christodoulidis et al.*, 1988).

The GEM-T1 model adopted the latest IAG reference constants and was solved in the J2000 Reference System. This gravitational model was based on modern ellipsoidal parameters (a_e=6378137m and 1/f=298.257) and the adopted speed of light (c=2999792.458 km sec^{-1}). It provided a simultaneous solution for a gravity model in spherical harmonics complete to degree and order 36; and a subset of 66 ocean tidal coefficients for the long wave-length components of 12 major tides. This adjustment was made in the presence of 550 other ocean tidal coefficients representing 32 major and minor tides and the Wahr frequency-dependent solid-Earth tidal model.

GEM-T1 was derived exclusively from satellite tracking data acquired on 17 different satellites whose inclinations ranged from 15 degrees to polar. In all, almost 800,000 observations were used, half of which were from third-generation laser systems. LAGEOS contributed nearly 5 years of observations to this solution. The calibration of the model accuracies performed for GEM-T1 show it to be a great improvement over all earlier GSFC "satellite-only" models for both orbital and geoidal modeling applications. For the longest wavelength portion of the geoid (to 8 x 8), GEM-T1 appears to be an improvement over all earlier GEM models, even those containing altimetry and surface gravimetry, including GEM-L2 [*Lerch et al.*, 1985] which was adopted by the MERIT Campaign for LAGEOS data analyses. Figure 3.6 compares the calibrated accuracy of the GEM-L2 and GEM-T1 potential models revealing the basis for its adoption for the SL7.1 analysis.

3.3.1.2 The *A Priori* Body Tide Model: Wahr

Table 3.2 gives the Love numbers computed by *Wahr* [1981], based upon the Earth Model 1066A of *Gilbert & Dziewonski* [1975]. Note that $\delta_{2,f}$ is zero for this elastic model, i.e., the model is free of dissipation. These Love numbers characterize the response of the 1066A Earth to the non-loading tide generating potential.

3.3.1.3 *A Priori* Ocean Tides Models: GEM-T1 Solution

The response of the oceans caused by the tide generating potential is a set of constituent tide heights

$$\xi_f(P) = A_f(P)\cos\left(\omega_f - \psi_f(P)\right) \tag{3.8}$$

where ω_f is the angular argument associated with constituent f and $A_f(P)$ and $\psi_f(P)$ are the tidal amplitude and phase, respectively, at point P. The amplitudes and phases are computed from numerical solutions of the Laplace Tide Equations. Such solutions involve a high computational burden and presently such models are available for only a limited number of tidal constituents.

The tidal heights are expanded into spherical harmonics by:

$$\xi_f(P) = \sum_{l,q,\pm} C^{\pm}_{lq,f} P_{lq}(\sin\phi)\cos\left(\sigma^{\pm}_{lq,f} \pm \varepsilon^{\pm}_{lq,f}\right) \tag{3.9}$$

Given the global tidal heights, the coefficients $C^{\pm}_{lq,f}$ and phases $\varepsilon^{\pm}_{lq,f}$ necessary for the evaluation of the potential can be computed.

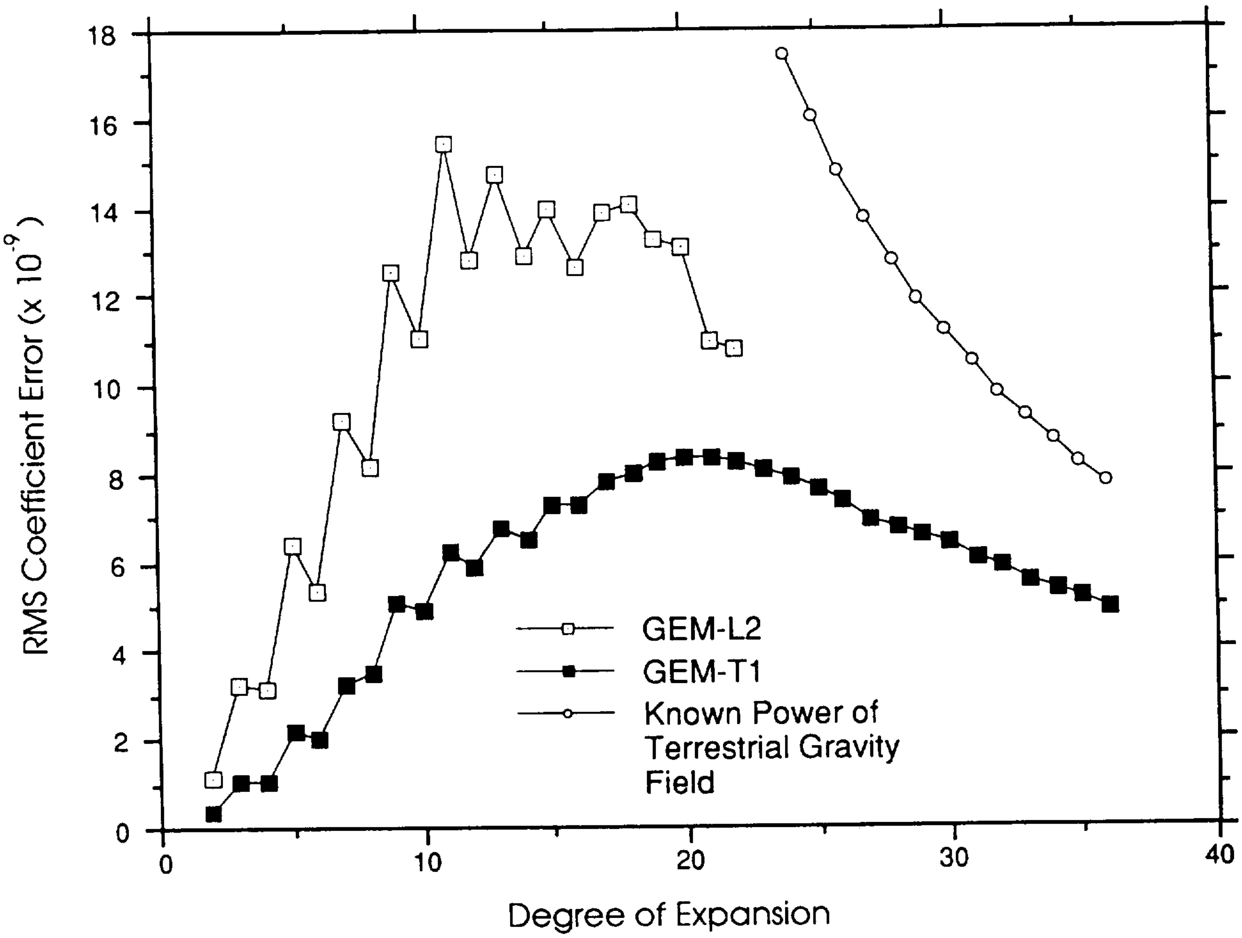


Figure 3.6 Gravity model RMS coefficient error by degree. The known power of the terrestrial fields is given by Kaula's rule which shows the approximate power of the field and gives a basis for estimating the percent accuracy of the harmonics of the field. Figure taken from *Marsh et al.* [1987].

Observed tide models for 11 major tide constituents in the semidiurnal, diurnal, and long-period bands have been computed on a 1° x 1° global grid by E.W. Schwiderski using an integration scheme which incorporates the available deep-sea tide gauge data. These tidal constituents typically account for over 90% of the total ocean tide amplitude at any point. However, numerous minor ocean tidal constituents, although small in amplitude, can have significant perturbing effects on satellite orbits. Models for these were developed using linear admittances from the oceanographic tide models [*Christodoulidis et al.*, 1986b].

With the advent of centimeter-level satellite geodesy and geodynamics, it is necessary to accurately model the tidal deformation of the Earth and its oceans, i.e., the dominant temporal variations of the geopotential. This is in part because the data distribution in time and space cannot be selected so that the effects of these temporal variations average out. All these tides

Table 3.2. Wahr Love Numbers for 1077A

Band	Tidal Line	$k_{2,f}$
Long Period	All	.299
Diurnal	145555 (O1)	.298
	163555 (P1)	.287
	165545	.259
	165555 (K1)	.256
	165565	.253
	166554 (PSI)	.466
Semi Diurnal	All	.302

have significant perturbations on all near-Earth satellites of geodetic interest. In fact, geodetic satellites form a sensitive measurement system for monitoring tidal effects. Table 3.3 shows the periods of the principal long-period tidal perturbations on the orbits of most of the laser satellites. The diurnal and semidiurnal perturbations are quite different in frequency than the corresponding periodicities of the tides on the Earth's surface, because it is the satellite's nodal precession with respect to the third bodies and not the Earth's rotation which defines these periodicities. The amplitude of the major tides on the orbital inclination and ascending node of Starlette, (a satellite similar in design to LAGEOS, but orbiting in a slightly eccentric orbit at 800-1200 km altitude), and LAGEOS are shown in Figures 3.7 and 3.8.

Dynamic values for select terms in the ocean tides which are most orbit sensitive were derived as part of the GEM-T1 gravity solution. The body tides were held fixed according to the Wahr values during this development as given in Section 3.3.1.2 and the adopted precession and nutation are the IAU 1980 models. Because the body tides are not separable from the ocean tides using orbital dynamics, only the ocean tides were adjusted in GEM-T1. The ocean tides which were recovered simultaneously in this model actually represent a determination of the total temporal variations of the geopotential exterior to the Earth's atmosphere in the presence of a fixed solid-Earth tidal model [*Marsh et al.,* 1987; *Christodoulidis et al.,* 1988] and thereby are an aggregate mass transport model.

Table 3.4 summarizes the ocean tidal terms which were modeled in the development of SL7.1 and indicates which were adjusted in the GEM-T1 solution. Due to attenuation by the distance

Table 3.3. Periods (Days) of Principal Long-Period Satellite Perturbations Due to Solid Earth and Ocean Tides For 12 Major Tide Constituents

	0	0	0	0	1	1	1	2	2	2	2	2
	5	5	6	7	4	6	6	4	5	7	7	7
	6	7	5	5	5	3	5	5	5	2	3	5
	.	.	.	.	.	.	.	.	.	.	.	.
	5	5	4	5	5	5	5	6	5	5	5	5
	5	5	5	5	5	5	5	5	5	5	5	5
	4	5	5	5	5	5	5	5	5	6	5	5
	5	5	5	5	5	5	5	5	5	5	5	5
SATELLITE	Sa	Ssa	Mm	Mf	01	P1	K1	N2	M2	T2	S2	K2
LAGEOS	365	183	27.6	13.7	13.8	221	1050	9.20	14.0	159	280	524
STARLETTE	365	183	27.6	13.7	11.9	60.8	91.0	7.61	10.5	33.1	36.4	45.5
GEOS-1	365	183	27.6	13.7	12.6	85.4	160	8.20	11.7	48.3	55.7	80.2
GEOS-2	365	183	27.6	13.7	14.4	629	257	9.83	15.3	2250	436	129
GEOS-3	365	183	27.6	13.7	15.2	482	132	10.6	17.2	145	104	66.2
BE-B	365	183	27.6	13.7	13.1	118	332	8.66	12.6	70.2	87.0	166
BE-C	365	183	27.6	13.7	11.8	57.9	84.8	7.51	10.3	31.5	34.4	42.4
SEASAT	365	183	27.6	13.7	14.8	7130	178	10.2	16.1	331	174	89.0
TELSTAR-1	365	183	27.6	13.7	12.8	93.9	193	8.34	12.0	53.9	63.2	96.7
ANNA	365	183	27.6	13.7	12.0	64.4	99.4	7.71	10.7	35.3	39.1	49.7
OSCAR	365	183	27.6	13.7	13.6	180	11700	9.12	13.6	119	177	5830

of the satellite from the oceans, the tidal model is only required to degree 6 in the SL7.1 solution development. Partial derivatives for the tides most significant on the evolution of the LAGEOS orbit were computed to add flexibility to the SL7.1 analysis.

3.3.2 *Non-Conservative Forces: Atmospheric Drag and Solar Radiation Pressure*

The non-conservative forces which are of concern in modeling the evolution of the LAGEOS orbit are the forces of an apparent "drag-like" effect and solar radiation pressure. We are presently not modeling Earth albedo: we believe we have minimized any unmodeled albedo effects by adjusting empirical coefficients.

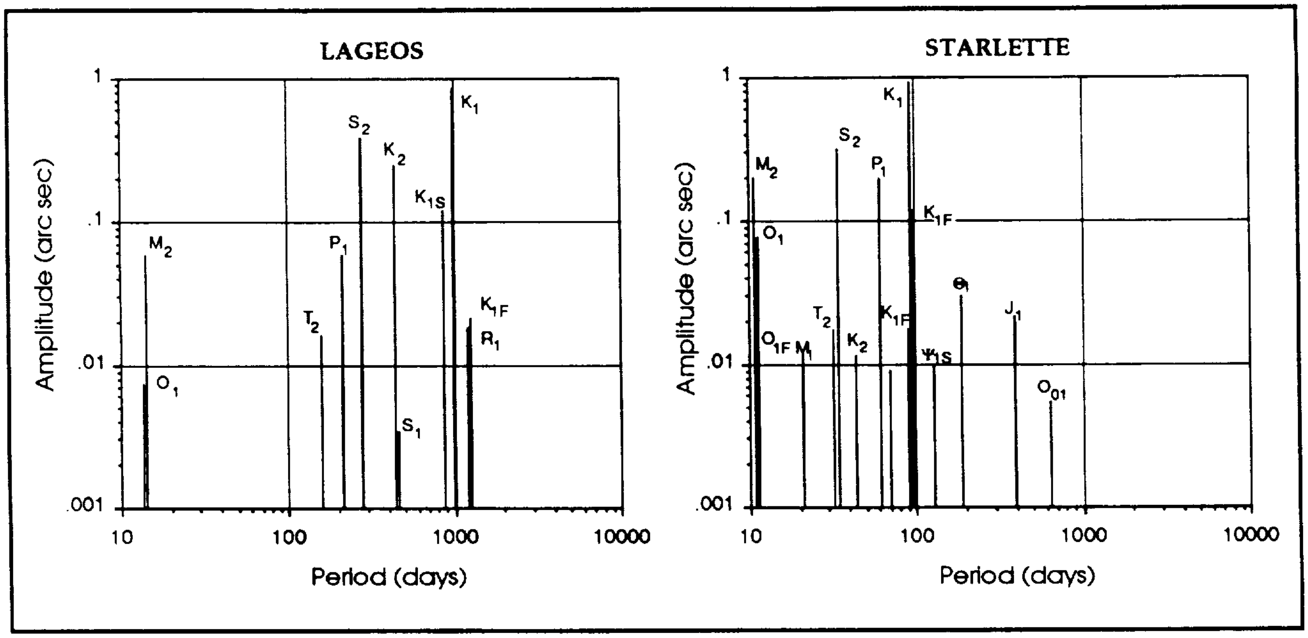


Figure 3.7 Effects of tidal perturbations on the inclinations of LAGEOS (left) and Starlette (right). Figure taken from *Marsh et al.* [1987].

3.3.2.1 Mathematical Formulation of the Models

The acceleration of an Earth orbiting satellite due to atmospheric drag is commonly expressed as

$$\overline{A}_D = -\frac{1}{2} C_D \left[\frac{A}{M}\right] \rho_D v_r \overline{v}_r \tag{3.10}$$

where C_D is the satellite drag coefficient, A is the effective cross-sectional area of the satellite, M is the mass of the satellite, ρ_D is the density of the atmosphere, $\overline{v}_r$ is the velocity vector of the satellite relative to the atmosphere and v_r is its modulus. The standard atmosphere model of *Jacchia* [1971] is used by GEODYN to provide atmospheric density values at satellite altitude. Jacchia's model is designed to give density values between 90 and 2500 km altitudes. Due to these limits, density values at LAGEOS altitude are unavailable. However, a "drag-like" decay of the LAGEOS orbit of ~1.3 mm/day in its semi-major axis is observed and a means to precisely model the decay is required. This is accomplished in the SL7.1 solution through the adjustment of along-track acceleration parameters within each monthly arc.

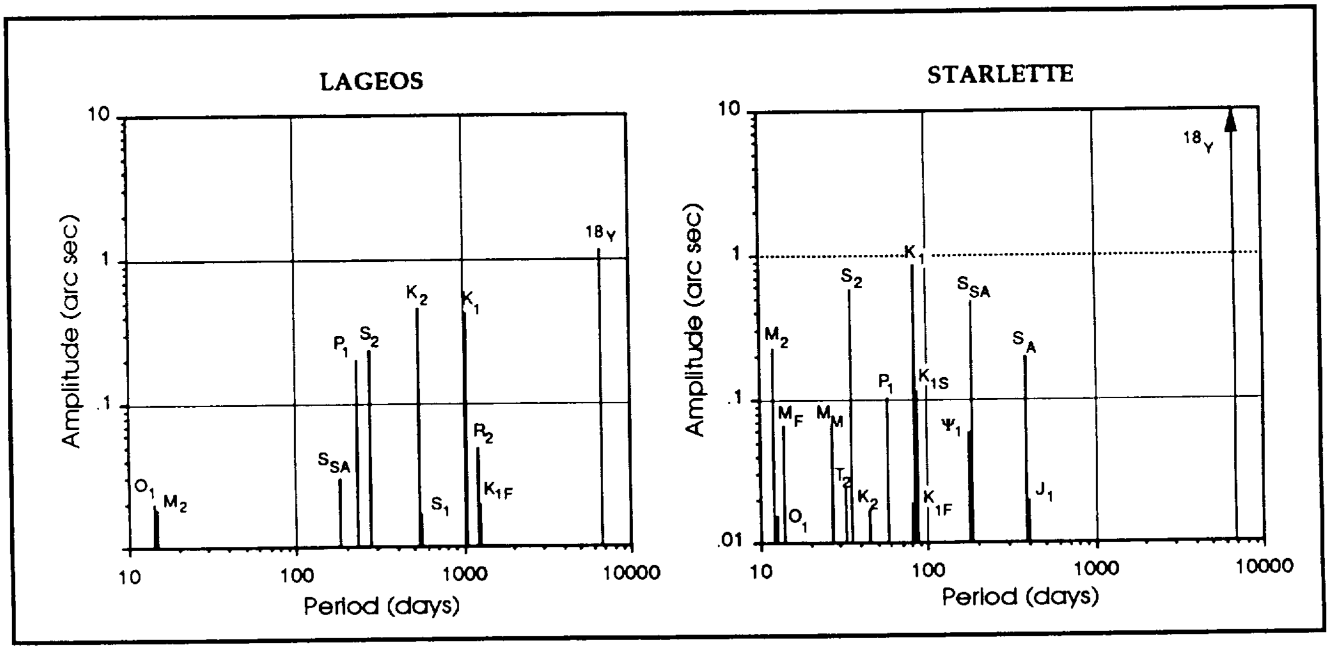


Figure 3.8 Effects of tidal perturbations on the right ascension of the ascending node of LAGEOS (left) and Starlette (right). Figure taken from *Marsh et al.* [1987].

General satellite accelerations can be modeled in GEODYN and have the form

$$\ddot{X} = \alpha \hat{u} \tag{3.11a}$$

where $\hat{u}$ is a unit vector defining the direction of the acceleration (specifiable within GEODYN) and α is the solved-for parameter. The direction of along-track acceleration is defined as

$$\hat{u} = \frac{\overline{v}}{|\overline{v}|} \tag{3.11b}$$

and is in the direction of the satellite's time of date velocity vector. After extensive experimentation, it was concluded that a single α-value for each 15-day period within a monthly orbit properly resolved this observed "drag-like" effect. Many authors have sought to provide the physical explanations for this observed effect. The results and discussion of our estimation of α within the context of the recent developments are given in Section 5.2.

The acceleration due to solar radiation pressure is given by

Table 3.4 Ocean Tide Modeling Within the GEM-T1 Solution Adopted for SL7.1 Taken from *Marsh et al.* [1987]

Doodson Number	Darwin Name	Modeled in SL7.1	Adjusted in GEM-T1 Solution
	Long Period Tides		
056.554	S_a	deg. 2→6	deg. 2
057.555	S_{sa}	prograde	deg. 2
058.554		only	none
065.455	M_m		deg. 2
075.555	M_f		deg. 2
075.565			none
	Diurnal		
135.655	Q_1	deg. 2→6	none
145.545		prograde	none
145.555	O_1	and	deg. 2,3,4
155.455		retrograde	none
155.655	M_1		none
162.556	Pl_1		none
163.555	P_1		deg. 2,3,4
164.556	S_1		none
165.545			none
165.555	K_1		deg. 2,3,4
165.555			none
166.554			none
167.555			none
175.455	S_1		none
185.555	OO_1		none
	Semi Diurnal		
245.655	N_2	deg. 2→6	deg. 2,3,4,5
255.545		prograde	none
255.555	M_2	and	deg. 2,3,4,5
265.455	L_2	retrograde	none
271.557			none
272.556	T_2		deg. 2,3,4,5
273.555	S_2		deg. 2,3,4,5
274.554	R_2		none
275.555	K_2		deg. 2,3,4,5
285.455			none
295.555			none

$$\overline{A}_R = -\nu C_R \left[\frac{A}{M}\right] P_s \hat{r}_s \qquad (3.12)$$

where ν is the eclipse factor accounting for shadowing of the satellite by the Earth or Moon, C_R is the satellite radiation pressure coefficient, A and M are as used in equation 3.10, P_s is the solar radiation pressure at the satellite, and $\hat{r}_s$ is the geocentric vector pointing toward the Sun. The quantity P_s is nominally specified by its mean value at 1 astronomical unit and corrected for the distance to the Sun through a term $\left(r_s / r_{1au}\right)^2$. The parameter $C_R = 1 + \rho_s$, where ρ_s, is the (specular) reflectivity of the satellite surface.

An assumption of this simple model is that the satellite is spherical; an assumption that is quite adequate for LAGEOS. Moreover, the adjustment of the along-track acceleration and/or radiation pressure coefficients accommodate much of the model error associated with errors arising in the non-conservative force modeling. This premise was tested in the simulation described below.

3.3.2.2 The Neglect of an Earth Albedo Model

Generally stated, an accurate model for both the diffuse and specularly reflecting Earth is still under development. In modeling the time history of the specular properties of the Earth *Rubincam and Weiss* [1986] have listed several complications which make modeling Earth albedo difficult. These include, among others, geographical variations in albedo, albedo variations in time due to meteorological changes, and reflection and scattering due to the atmosphere itself. Further investigations have been made to assess the magnitude of these effects of Earth albedo on LAGEOS' orbit (cf. Section 5.2).

One assessment of possible albedo effects was made in an experiment (performed courtesy of Richard Eanes at the University of Texas Center for Space Research) where a 15-day orbit of LAGEOS was integrated which included perturbations arising from an along-track drag effect, direct solar radiation pressure, and albedo re-radiative effects using a rather complete model developed by Philip Knocke (private communication). This trajectory was then converted into satellite positions in time which could be used as data for simulation purposes. These values were fit in a least-squares estimation process where the albedo model was no longer used, but one in which the along-track acceleration and solar radiation pressure coefficients were adjusted. The resulting orbit agreed with the original to within 1-cm RMS. This experiment, coupled with a worst-case scenario study by *Rubincam et al.* [1987], support the contention that neglecting an Earth albedo model does not significantly corrupt the SL7.1 solution within the scope of the non-conservative and empirical force models adopted here for our monthly arc lengths.

3.4 Station Motion Model Within the Terrestrial System

There are two distinct sources for temporal variations in the locations of tracking stations relative to the CTRS: the effects of the astronomic tides on the geosphere and the effects of plate motion. This section will describe the models used in SL7.1 and discuss planned improvements.

3.4.1 *Station Tidal Variations*

The tidal forces acting upon the Earth's surface cause the tracking stations to undergo periodic motions. This effect is conveniently modeled as the sum of the response of a spherical elastic Earth to the disturbing potentials of the Sun and Moon plus correction terms due to the frequency-dependent elastic response of a more realistic Earth. A convenient formulation for these motions was derived by *Diamante and Williamson* [1972] and has been implemented in GEODYN as well as having been adopted in the MERIT standards [*Melbourne et al.*, 1983] and subsequent IERS standards [*McCarthy et al.*, 1989].

For the simple elastic model, the vector displacement of the station to a precision of 1 cm is given by *Diamante and Williamson* [1972]:

$$\Delta\bar{r} = \sum_{d} \frac{\mu_d}{\mu} \frac{r_{sta}^4}{r_d^3} \left\{ \left(3l_2 \cos S\right) \frac{\bar{r}_d}{r_d} + \left[3\left(\frac{h_2}{2} - l_2\right) \cos^2 S - \frac{h_2}{2} \right] \frac{\bar{r}_{sta}}{r_{sta}} \right\} \tag{3.13}$$

where d indicates either the Sun or Moon as the disturbing body, $\bar{r}_d$ is the position vector of the disturbing body, $\bar{r}_{sta}$ is the station position vector, μ_d is the gravitational constant of the disturbing body, μ is the gravitational constant of the Earth, h_2 l_2 are the Love and Shida numbers, respectively, which characterize the Earth's elastic response, and

$$\cos S = \frac{\bar{r}_{sta} \cdot \bar{r}_d}{r_{sta} r_d} \tag{3.14}$$

Nominal values for the Love and Shida numbers are

$h_2 = .6090$ $\qquad\qquad$ $l_2 = .0852$

When a more realistic model of the Earth is used, the fluid interior of the Earth causes the deformation response to be frequency dependent. *Wahr* [1980] has shown that this effect in station position can be modeled to better than 5 mm by simply correcting the response of the simple elastic model for the differential response at the K_1 frequency. At this frequency, the Love number h from Wahr's theory is 0.5203. Only the radial displacement needs to be corrected at the 5-mm accuracy level. The additional radial correction, which is also specified by the MERIT and IERS Standards, is (in meters):

$$\overline{\Delta r_2} = -.0253 \sin\phi \cos\phi \sin\left(\theta_g + \lambda\right) \frac{\bar{r}_{sta}}{r_{sta}} \tag{3.15}$$

where ϕ is the station geocentric latitude, λ is the corresponding east longitude, and θ_g is the right ascension of Greenwich. At 45 degrees latitude, this effect reaches a maximum of 13 mm. The total correction vector is given by

$$\Delta\bar{r}_{sta} = \overline{\Delta r_1} + \overline{\Delta r_2} \tag{3.16}$$

For future solutions, an expanded frequency-dependent model including all terms to the millimeter level is anticipated. In addition, ocean and atmospheric loading should also be incorporated. It has been shown that ocean loading can have an effect as large as 17 mm in vertical displacement for locations in the middle of the North American Continent [*Pagiatakis*, 1990]. Ocean loading can be quite sizable (> 50 mm) at coastal sites. Atmospheric loading can cause vertical surface displacements as large as 20 mm and the oceanic response to atmospheric loading can additionally effect the vertical displacements for sites in coastal regions [*Van Dam and Wahr*, 1987].

3.4.2 *A Priori Station Plate Tectonic Motions*

As discussed in Section 3.1.2.2, it is difficult to adopt a completely satisfactory Earth-fixed reference frame due to the motion of the tectonic plates. While the relative location of points on the earth's surface are strictly deterministic, the absolute direction of the station motions are not easily defined in a system useful for geophysical and geological time frames. When confronting this problem, *Minster and Jordan* [1978] considered modeling tectonic motions within four distinct "absolute" systems. These were each developed under differing kinematical constraints: best fitting to hotspot data (mean mesospheric frame, AM1-2), African plate fixed

(AM2-2), Caribbean plate fixed (AM3-2), and a solution whereby the net rotation of the lithosphere is constrained to be zero (AM0-2).

The hot spot system, based on the traces of long-term (~10 million years) centers of mantle plume activity, was thought by *Minster and Jordan* [1978] to best represent an absolute frame. However, as they were aware, the resulting absolute motion model depended on the validity of the Wilson-Morgan fixed hot spot hypothesis which has recently received some challenge. *Molnar and Stock* [1987], and in summary by *Olson* [1987], have determined that the hot spots themselves are moving relative to one another with rates of at least 10 mm/yr and as much as 20 mm/yr. They therefore conclude that the hot spot traces do not define a fixed reference frame. The use of the hot spot frame is additionally complicated by an element of subjectivism with regard to the selection of the hot spots used to define the frame. Although *Minster and Jordan* [1978] were careful in their selection, an omission or addition of one or several hot spots traces could dramatically change the "absolute" motions of the plates.

Other alternatives to defining an "absolute" system include simply fixing one particular plate or applying a constraint which forces the net rotation of the plates to be zero. *Minster and Jordan* [1978] made two plate motion solutions where the African and Caribbean plates were each fixed, respectively, in accordance to certain hypotheses regarding these two plates. Unfortunately, the global data set used by Minster and Jordan was unable to completely support the frames defined by fixing these plates. The application of a no net rotation constraint to the solution yields a uniquely defined reference frame that is free from subjective choices. However, as pointed about by *Jurdy* [1990], this mean lithosphere reference frame is based solely on the plate geometry and velocities and any variation in the velocities will alter the definition of the frame.

As a practical matter, any of these systems would be satisfactory for implementation in SL7.1 for each yields an identical set of temporal changes for inter-station distance determinations. Since the relative tectonic motions of points on the Earth's surface are the principal observational products of the SL7.1 solution, adoption of a frame largely serves to define the directions by which the station network is deforming. Although a more recent and further refined tectonic model is now available, NUVEL-1 [*DeMets et al.*, 1990], we have, throughout the SL7.1 analysis, followed the MERIT standards (cf. Section 3.1.1) and use the AM0-2 model to provide the framework within which to make the solution.

Besides giving absolute reference to the observed tectonic motions of the SLR sites, an *a priori* tectonic motion model has additional application for the subset of quarterly solutions within SL7.1. For quarterly station coordinate determinations, sites located on fast moving plates may have perceptible motions within this averaging interval. Since the tracking data distribution is not consistent across time, the averaging taking place within such a solution may not be adequate for obtaining the location of the sites at their quarterly mid-point. Since earlier SLR results indicated that the relative motions predicted by AM0-2 were largely verified (e.g. *Christodoulidis et al.* [1985]), a more satisfactory result is achieved when the AM0-2 model is used to describe the *a priori* continuous motion of all sites. The quarterly solutions then correct the values for the station positions for the midpoint within each quarter, while simultaneously the change in location of the sites between the start and end of the quarter is modeled by AM0-2.

The mathematical implementation of an "absolute" plate motion model is found in *Melbourne et al.* [1983] as provided by Minster and Jordan. Briefly, let X_o, Y_o, Z_o at time, t_o, be the Cartesian location of a site on a known plate. The calculation of X, Y, Z at a new time, t, is obtained by:

$$\begin{aligned} X &= X_o + \left(\dot{Y} \cdot Z_o - \dot{Z} \cdot Y_o\right)(t - t_o) \\ Y &= Y_o + \left(\dot{Z} \cdot X_o - \dot{X} \cdot Z_o\right)(t - t_o) \\ Z &= Z_o + \left(\dot{X} \cdot Y_o - \dot{Y} \cdot X_o\right)(t - t_o) \end{aligned} \tag{3.17}$$

where the Cartesian velocities $\dot{X}, \dot{Y}, \dot{Z}$ per plate for the AM0-2 model are given in Table 3.5. This is the formulation used in GEODYN II.

Table 3.5. AM0-2 Cartesian Plate Velocities
(degrees/MY)*

Plate	$\dot{X}$	$\dot{Y}$	$\dot{Z}$
Pacific	-0.12276	0.31163	-0.65537
Cocos	-0.63726	-1.33142	0.72556
Nazca	-0.09086	-0.53281	0.63061
Caribbean	-0.02787	-0.05661	0.10780
South American	-0.05604	-0.10672	0.08642
Antarctic	-0.05286	-0.09492	0.21570
Austro-Indian	0.48372	0.25011	0.43132
African	0.05660	-0.19249	0.24016
Arabian	0.27885	-0.16744	0.37359
Eurasian	-0.03071	-0.15865	0.19605
North American	0.03299	-0.22828	-0.01427

* The values shown in above must be scaled by 1.7453292×10^{-8} to produce values in radians/yr before being used in equation (3.17).

4. Data Acquisition, Preparation and Processing

4.1 Laser System Description, Performance and Data Quality Control

Each laser tracking station consists of a variety of subsystems and instruments as illustrated in block form in Figure 4.1. The tracking system's laser and associated telescopes are aimed at a satellite using a target acquisition system which utilizes accurate orbit predictions. Laser pulses are emitted from the station, reflected by the target, and return to the receiving system where the pulses are detected and the elapsed travel time is measured. The detection system typically utilizes a predicted time-of-flight window (technically, a gated discriminator) to eliminate background noise in the returns, and uses filters tuned to the laser wavelength to further improve system sensitivity by rejecting undesired wavelengths. In many of the larger fixed systems, the transmitter optics are separate from the receiving optics, whereas the compact mounts of the transportable systems incorporate common transmit/receive paths. A separate timing system with good long-term stability is used to establish epoch time and is synchronized to a universal time standard using LORAN-C, the Global Positioning System (GPS) or a transportable atomic clock.

Much time and effort has been spent in developing laser tracking systems that minimize the effects from error sources and maximize output efficiency and ease of operation. Throughout the developmental process, all associated subsystems have been thoroughly scrutinized to guarantee successful operation and to insure that the goals set out by the CDP would be achieved. A detailed account of laser system development and the considerations and decisions made regarding the design or selection of each component is found in *Degnan* [1985]. A more recent account of the current (1991) status of the laser tracking system and its capabilities is found in *Murdoch and Decker* [1989]. Specific details on the designs and operations of many of the laser stations can be found in a variety of international laser ranging workshop proceedings. (Of recent note are proceedings from meetings held in 1986 at Antibes Juan-Les-Pins, France, [*Gaignebet and Baumont* , 1986] and in 1989 at Matera, Italy, [*Veillet* , 1990]).

4.1.1 *Laser Ranges, Corrections, and Calibration*

Knowledge regarding the entire ranging system, its relationship to fixed ground points, and certain satellite characteristics are required in order to link the measurements to ongoing

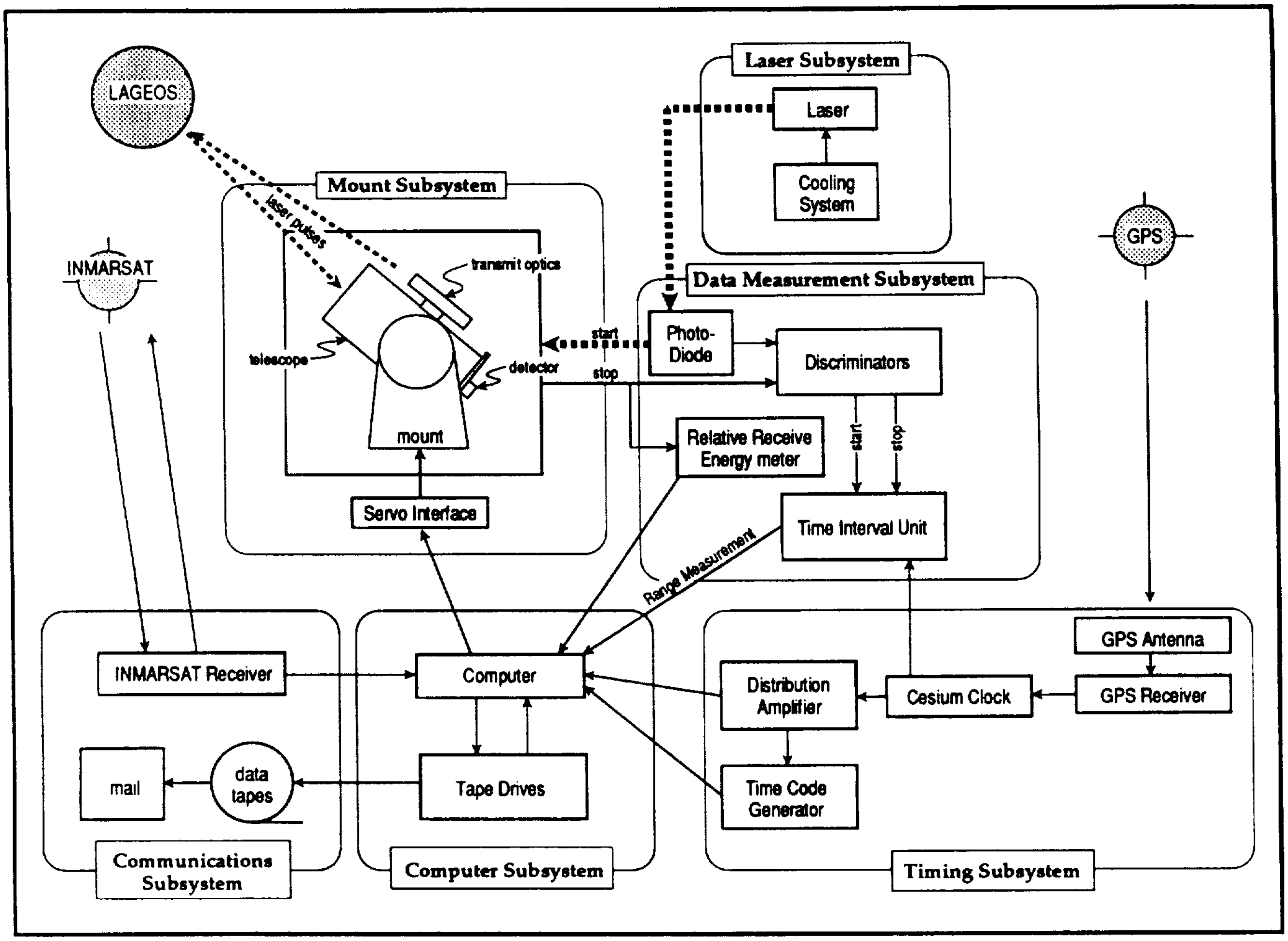


Figure 4.1 Laser tracking system block diagram (modified from *Murdoch and Decker* [1989]).

geophysical and tectonic processes. This knowledge constitutes the range measurement model and through calibration procedures we are able to confidently analyze and interpret the results. In this section we will summarize the elements which form and influence the laser range observations to LAGEOS.

The laser generates pulses of monochromatic, coherent light at repetition rates ranging from a few pulses per minute to 10 pulses per second (pps), and at power levels between 5 mJ and 1.5 J. The *range* between the station and the satellite is taken to be one-half of the product of the round-trip transit time of the laser pulse with the speed of light. The time tag of the measurement must be corrected to satellite reception time, taking into account the transit time of the pulse to reach the satellite (~20 msec for LAGEOS). Each range observation is corrected for the effects of atmospheric refraction with the Marini/Murray algorithm [*Marini and Murray*, 1973], which is based on locally measured meteorological readings taken coincidentally with the laser data at the tracking site. A correction for the offset of the satellite retroreflector from the center of mass of the spacecraft is also made which amounts to 24 cm for LAGEOS [*Fitzmaurice et al.*, 1977]. The fixed laser systems rest firmly on concrete pillars where, in many cases, the measurement reference point is defined by the optical center of the system and, except for instances of equipment upgrades, are considered to be invariant reference points. The mobile systems normally are parked and leveled on concrete pads and surveys are performed during each occupation to locate the optical center of the instrument to a nearby brass marker embedded in concrete. These offsets are known as *site eccentricities* and are crucial in the monitoring of the site's motion across time. These eccentricity offsets are listed by station and time in Appendix 1. At the mobile sites, the SL7.1 solution for station positions refers to the location of these brass markers which are directly constrained through the eccentricity values to the location of the optical centers of the laser for each site occupation.

The stations are calibrated regularly during field operations by tracking targets placed either external to or within the optical system at a known distance. A battery of system-level accuracy checks is routinely performed to ensure that the instruments are working within their specifications, specific details of which can be found in *Degnan* [1985]. Range observations are therefore transmitted from each site with a minimum of error. Further quality control checks are performed at the analysis centers to identify blunders, systematic biases, and registration errors that may be embedded in the data. These aspects are described in Section 4.1.4.

4.1.2 *Collocation Testing*

Each laser tracking system fielded by NASA undergoes a calibration against a fixed standard before it is deployed. The calibration compares, in a side-by-side or collocated fashion, the range measurements and the meteorological observations taken by the independent laser systems. These tests provide the opportunity to identify laser system range biases and to isolate system-dependent systematic error sources. Occasionally, collocation tests are conducted in the field, utilizing a mobile system which has, in turn, been collocated with the fixed standard (typically MOBLAS-7 at Greenbelt, MD). A list of collocation tests is given in Table 4.1, showing the names of systems compared. By regularly conducting these calibration experiments anomalous system behavior can be identified and accuracy at the specified level can be assured.

Table 4.1. Collocation Tests

Systems #1	#2	Location	Date
STALAS	ML01	GORF*	Nov 77
STALAS	ML03	GORF	Oct-Nov 77
STALAS	ML08	GORF	Feb-Mar 79
STALAS	ML05	GORF	Mar-Apr 79
STALAS	ML06	GORF	Feb-Apr 79
STALAS	ML07	GORF	Apr-May 79
STALAS	ML04	GORF	Mar-May 80
STALAS	TL01	GORF	Mar-May 80
STALAS	TL01	GORF	Sep-Oct 80
STALAS	ML07	GORF	Jul-Aug 81
ML07	ML04	GORF	Aug-Oct 81
HOLLAS	ML01	Hawaii	Sep 81-Jan 82
ML07	ML04	GORF	Jan-Apr 82
TL01	MLRS	Fort Davis, TX	Jul-Aug 82
ML07	ML06	GORF	Jul-Oct 82
ML07	TL02	GORF	Sep-Nov 82
ML07	ML04	GORF	May-Jun 83
ML08	TL01	Quincy, CA	Jul-Aug 83
ML04	TL01	Mon. Peak, CA	Oct 83
MT01	KOOLAS	Kootwijk, Neth.	Apr-May 84
ML08	TL01	Quincy, CA	Sep-Dec 84
ML04	TL01	Mon. Peak, CA	Jan-Jul 85
ML02	ML07	GORF	May-Jun 85
ML07	MT01	GORF	May-Jul 85
MT01	MATERA	Matera, Italy	Jan-Mar 86
MT02	MATERA	Matera, Italy	Jan-Mar 86
MT01	MT02	Matera, Italy	Jan-Mar 86
ML07	TL02	GORF	Nov 86 - May 87
ML07	TL01	GORF	Dec 86 - Jan 87
ML07	TL03	GORF	Oct 87 - Jan 88

* GORF: Goddard Optical Research Facility, Greenbelt, MD.

Typically, a collocation test involves a series of procedures and system check-outs. Strict control of the hardware and software set-up, or configuration, throughout the collocation experiment is required to ensure that the results will accurately describe unforeseen system discrepancies. Both systems in the collocation test go through a series of ground tests and satellite ranging tests. The ground tests check system stability parameters by measuring system delays and determining the delays due to any azimuthal and elevation dependence. For the TLRS-1 and MOBLAS-7 systems, these delays should meet a 20-mm performance goal. Both systems were shown to have easily achieved these goals in 1987 with the actual performance being measured at the 4 - 5 mm level [*Husson et al.* 1987]. In the satellite tests, the systems are run in two modes; calibration mode having a performance goal of 20 mm and satellite ranging mode having a performance goal of 30 mm. Again, TLRS-1 and MOBLAS-7 easily achieved these goals by a factor of 2 [*Husson et al.*, 1987]. Meteorological closure is assessed by differencing the meteorological data (e.g. temperature, humidity and barometric pressure) taken by each system during the course of the collocation. Typically these differences are quite small (e.g. < 1 mbar and < 1° C).

The chief assessment of system performance comes from an analysis of simultaneous laser tracking of geodetic satellites in a variety of categories; e.g. by quadrant, by ascending or descending passes, and in daylight passes. The analysis provides information from which detailed bias assessments can be made. These entail examining the data to determine the nature and extent of range biases, and their dependence on azimuth, range and elevation. For example, *Kolenkiewicz et al.* [1987] showed that between TLRS-1 and MOBLAS-7 a mean range bias of 2.7 ± 4.9 mm was measured based on 22 passes of simultaneous LAGEOS tracking.

4.1.3 *System Improvement Milestones*

The systems which were originally built and operated by the Smithsonian Astrophysical Observatory (SAO) underwent their upgrade programs simultaneously (M. Pearlman, private communication). At the time that LAGEOS was launched in May 1976, these stations, situated at Mount Hopkins, Arizona; Arequipa, Peru; Orroral, Australia; and Natal, Brazil were equipped with time digitizers which yielded range observations at a noise level of approximately one meter. Pulse choppers installed in 1978 narrowed the effective pulse length from 25 nanoseconds to 6 nanoseconds, producing a noise level improvement to about 30 cm. Improved shutters were installed in 1980 which further reduced the noise level to 15 cm for a transmitted signal of 3 nanoseconds, and analog detectors were introduced to handle an increased repetition rate from 15 per minute to 30 per minute.

Goddard Space Flight Center fielded a series of five similar laser systems in late 1979 to supplement the three different systems in operation at that time. After temporary deployment, these mobile laser systems settled at Monument Peak, California (MOBLAS-4); Yaragadee, Australia (5); Mazatlan, Mexico (6); Greenbelt, Maryland (7); and Quincy, California (8). The short-pulsed Quantel laser which was implemented in the systems at these locations was modified between 1982 and 1983 to increase the repetition rate from one pulse per second to 5 pps. In 1985 and 1986 the noise level of the systems was reduced from 2 or 3 cm through the installation of a high resolution photomultiplier (micro-channel plate), together with a low noise discriminator. The current noise level for LAGEOS observations taken by each system is for MOBLAS-4: 11 mm, MOBLAS-5: 9 mm, MOBLAS-6: 8 mm, MOBLAS-7: 8 mm and MOBLAS-8: 8 mm.

4.1.4 *Data Quality Control and Estimation of System Biases*

The control of the laser measurement quality is first exercised during the compression of the observations to normal points (details of which are described in Section 4.2). In the orbital fit to the full-rate data, only observations which fall within a 3-m residual window are considered for further analysis. The normal point generation step subsequently eliminates outliers that exceed three times the rms residual about a polynomial fitted to each pass. The normal points themselves are used in the final stage of data quality control. They are fitted to an orbit and their residuals are inspected for unusually high noise and for any systematic bias. Observations failing this quality control step are excluded from the final reduction of the data in which normal equations are generated.

A further quality control step can be taken during the geodetic analysis procedure. A subset global solution is made in which month-by-month range bias values for each station are estimated simultaneously with a single station position for the full mission lifetime. Stations providing concentrated observations over a long period of time can thus allow us to separate persistent systematic range errors from station position. Table 4.2 gives a list of stations exhibiting unusually high range bias estimates, which sometimes occur for only part of the station occupation. The full history of range bias values for the stronger stations is presented in Figures 4.2(a - o).

4.1.5 *Data Catalogs*

The results of the data quality control process are given in Appendix 2 which provides a summary of station characteristics for every monthly arc in which its observations were included. The number of observations, range RMS statistics, bias estimate and the number of passes available for each month are listed for each station. The nature of any corrections to the data used in the SL7.1 solution are listed in Table 4.3, and are the result of confirmed and correctable station anomalies, most of which were trapped by the data quality control procedure at an early stage.

Table 4.2. Stations Showing Significant Range Bias

Station	Number	Data Span (Partial Occupation)	Bias (cm)
McDonald	7086	(8506-8712)	-4 ± 3
Haystack	7091	7802-8011	30 ± 5
Mon. Peak	7110	(8307-8712)	4 ± 2
Platteville	7112	(8103-8308)	-10 ± 5
Goldstone	7115	7909-8104	-13 ± 5
Mazatlan	7122	8305-8712	3 ± 3
Maui	7210	8109-8712	5 ± 2
Zimmerwald	7810	8405-8705	10 ± 5
Kootwijk	7833	(7904-8005)	20 ± 5
Wettzell	7834	7807-8712	-3 ± 2
Simosato	7838	8204-8706	5 ± 4
Graz	7839	8309-8705	-3 ± 2
Orroral	7843	8505-8611	15 ± 10
Arequipa	7907	(8001-8604)	-7 ± 3
		(8605-8712)	-3 ± 3
Mt. Hopkins	7921	(7807-8203)	-35 ± 10
Natal	7929	(7807-8110)	-20 ± 10
Matera	7939	8309-8712	-3 ± 2
Orroral	7943	7904-8202	-35 ± 10

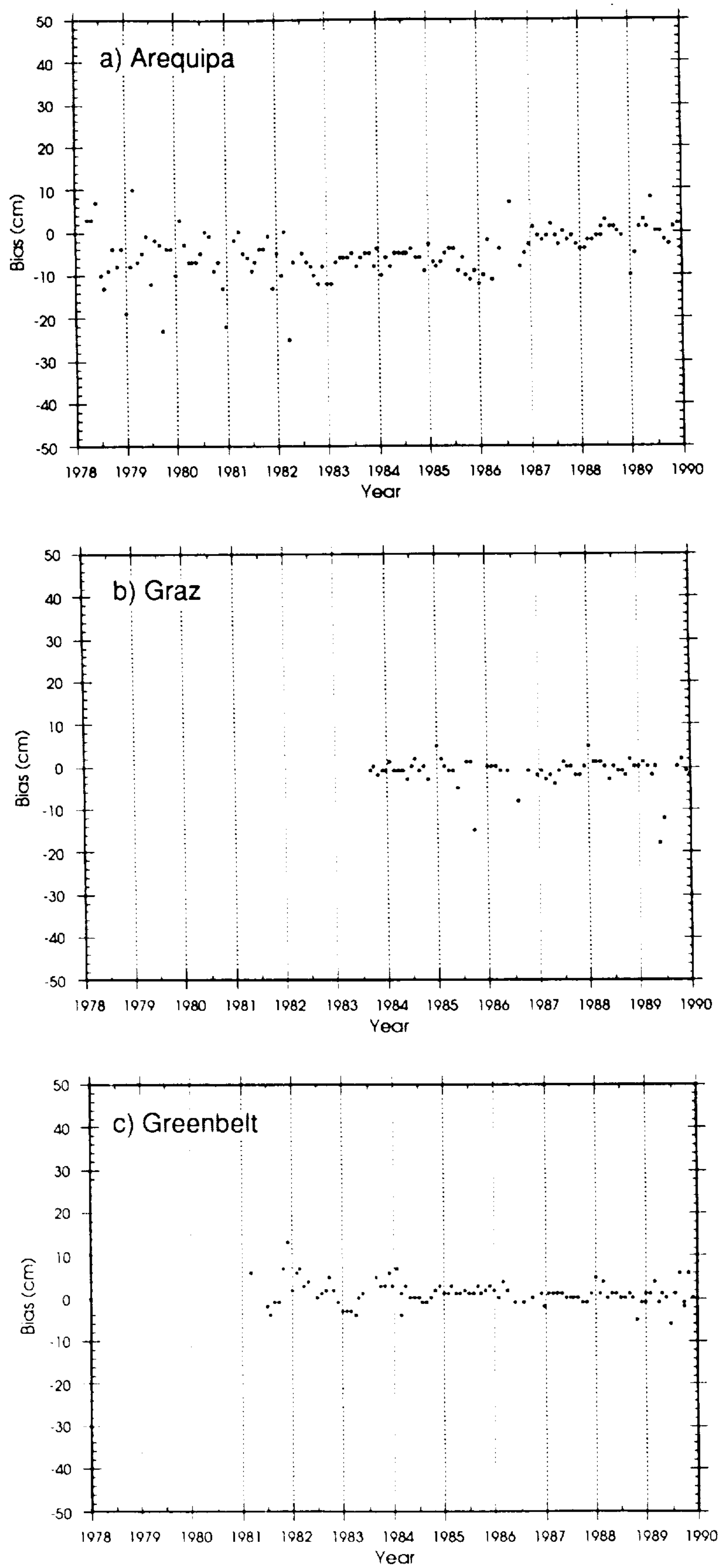


Figure 4.2 (a-c) SL7.1 estimates of monthly range bias values.

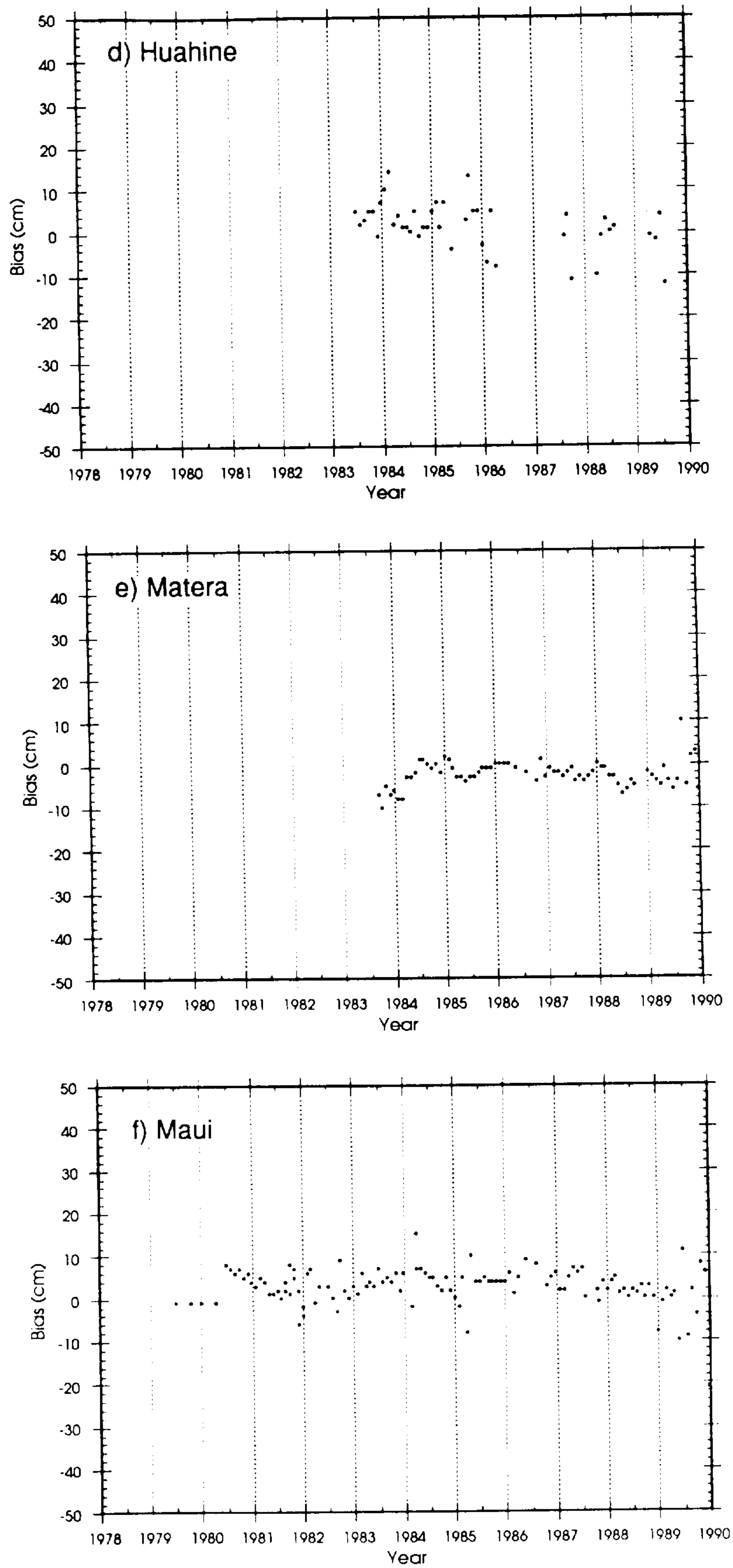


Figure 4.2 (d-f) SL7.1 estimates of monthly range bias values.

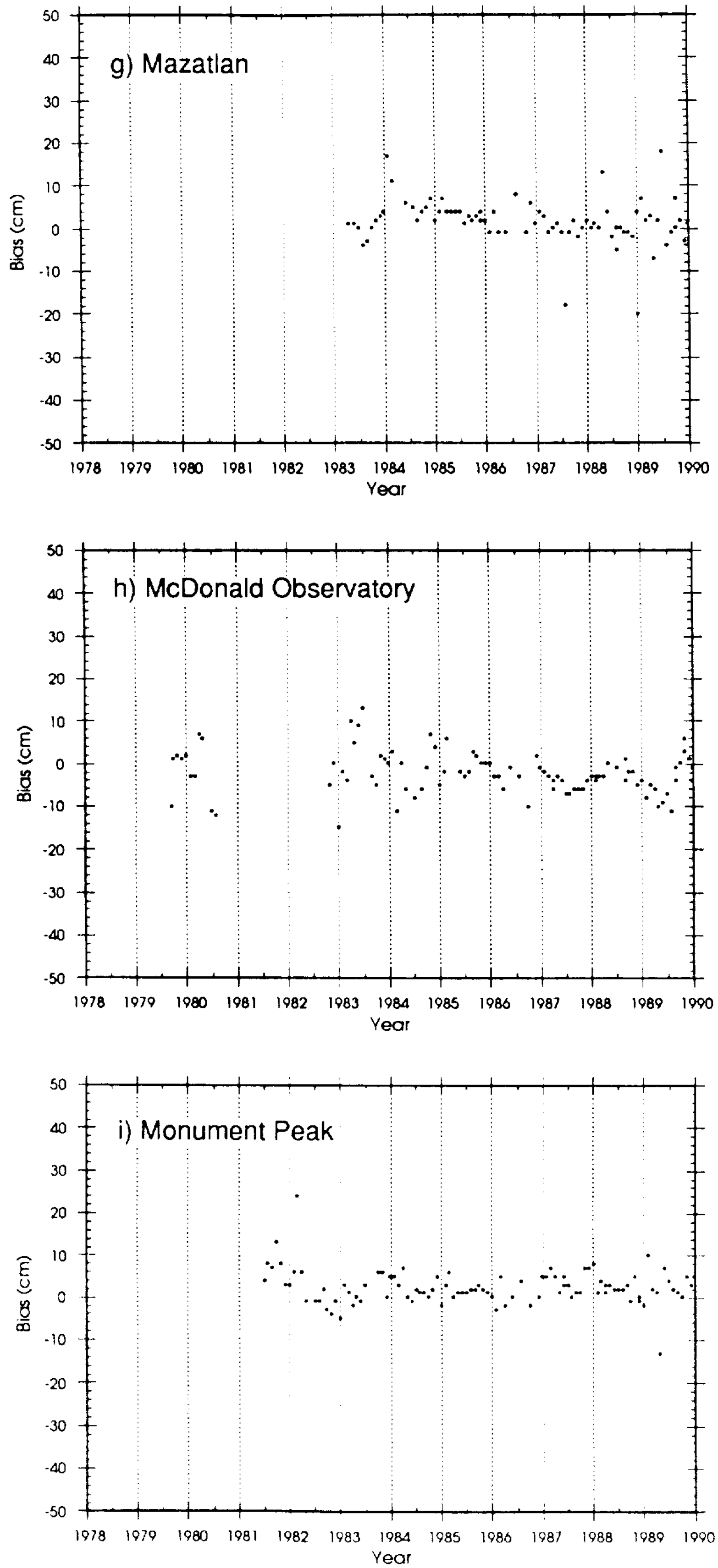


Figure 4.2 (g-i) SL7.1 estimates of monthly range bias values.

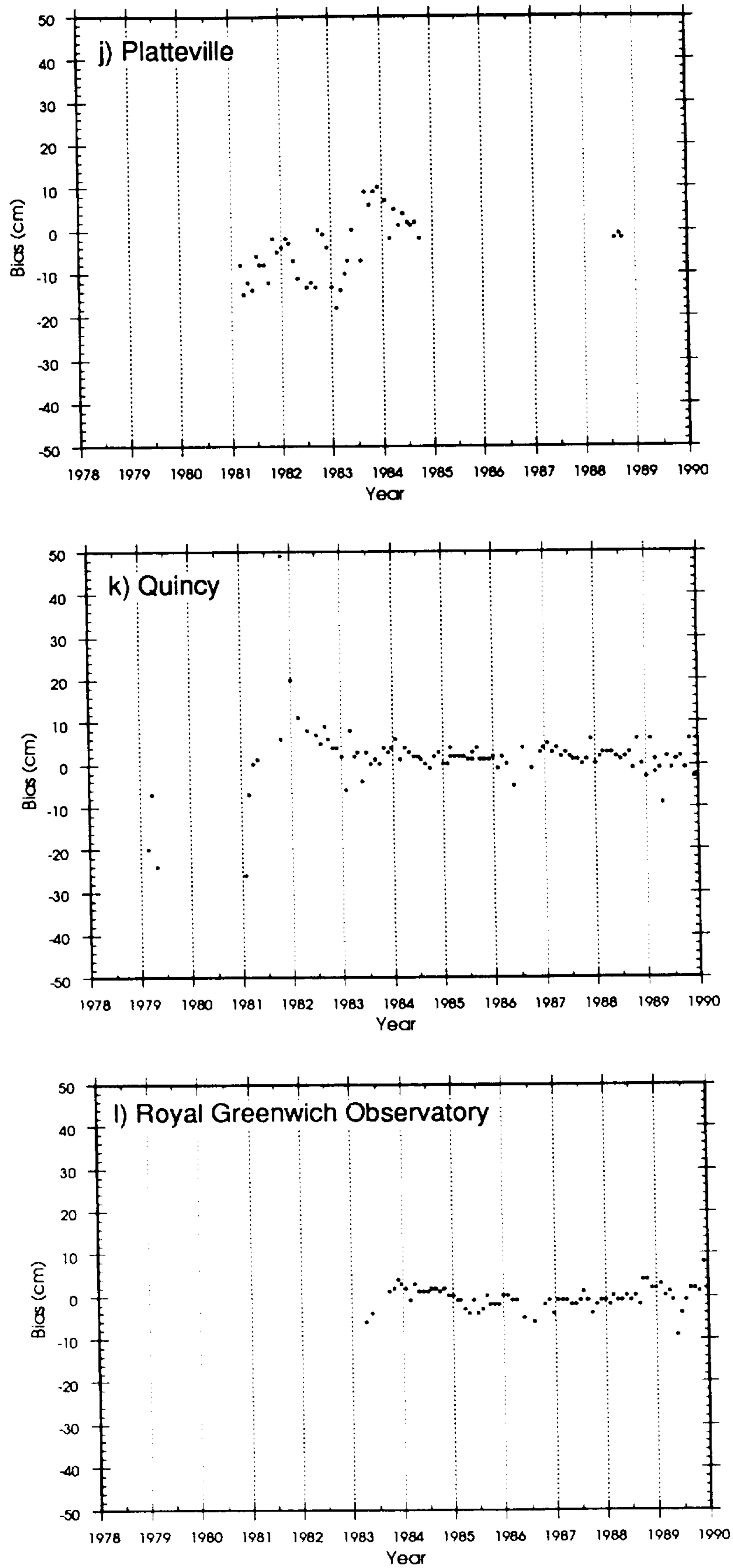


Figure 4.2 (j-l) SL7.1 estimates of monthly range bias values.

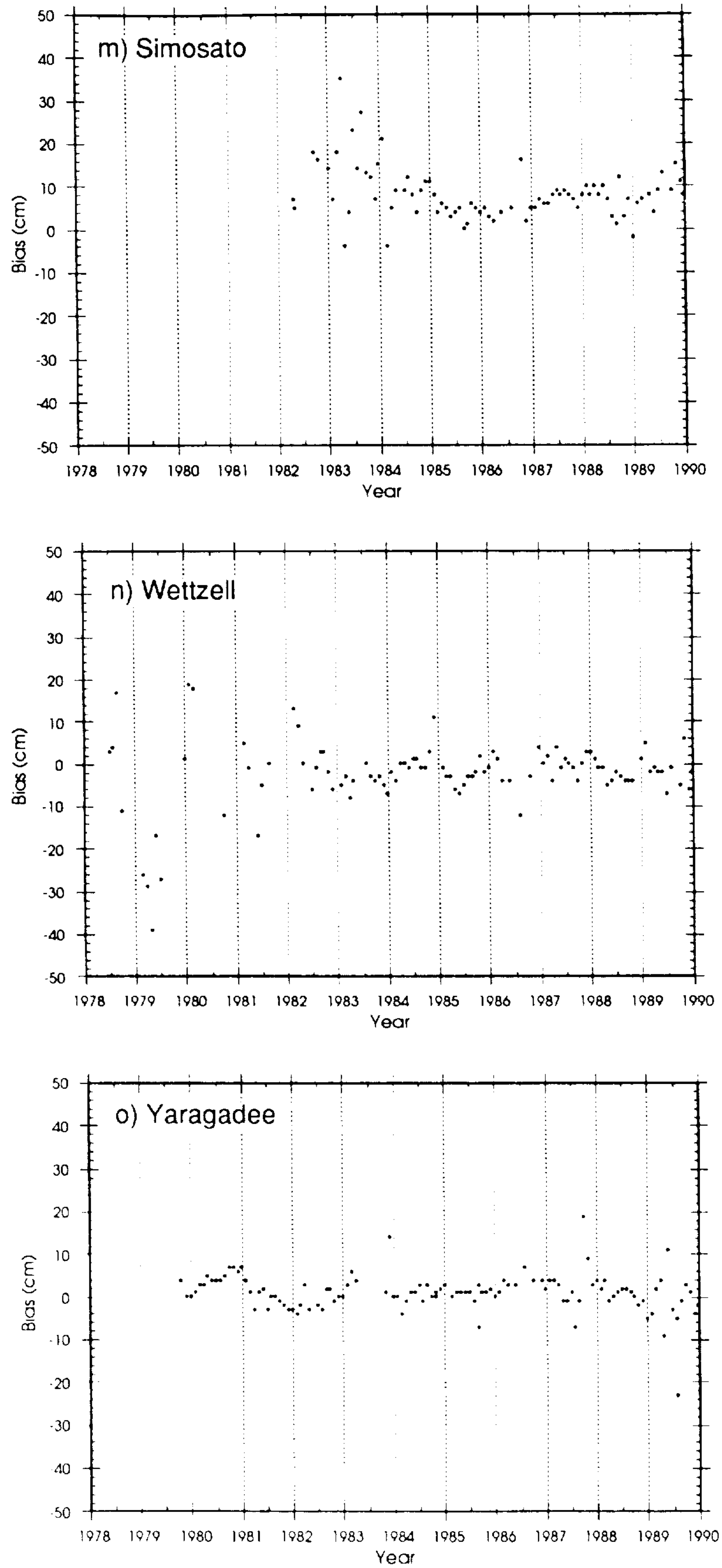


Figure 4.2 (m-o) SL7.1 estimates of monthly range bias values.

Table 4.3. Observation Correction Table

Station	Number	Date Start-End	Data Correction*
Orroral	7943	7609-8203	$\Delta R = -0.041$ m
			(Target Survey Error)
Orroral	7943	7806-7809	$\Delta R = -4.625-.00345\ (MJD-2443690)\times10^{-6}$ (m)
			(Counter Error)
Bear Lake	7082	7609-7611	$\Delta R = -.325$ m
			(Target Survey Error)
Wettzell	7834	7807-8308	$\Delta R = 7{*}10^{-9}\ R$ (m)
			(Oscillator Error)
Huahine	7121	8307-8308	$\Delta T = -194126\ \mu sec$
			(Clock Error)
RGO	7840	8305	$\Delta R = 14.937$ m., $WT = -62\ \mu sec$
		8307	$\Delta R = 16.290$ m., $WT = -367\ \mu sec$
			(Calibration Error)
RGO	7840	8310-8312	$\Delta T = -(21-(MJD-45608){*}0.209)(sec)$
			(Clock Error)
Simosato	7838	8204-8406	$\Delta T = +8\ \mu sec$
		8410-8501	(Clock Error)
Easter I.	7061	8305-8307	$\Delta T = -1$ msec.
		8404-8105	$\Delta T = 1$ msec.
		8406-8411	$\Delta T = 2$ msec
			(GPS Timing Error)

*ΔT: correction to a timing error. ΔR: correction to a range error.

4.2 Normal Point Processing

In order to efficiently utilize available computer resources, satellite laser ranging (SLR) data to the LAGEOS satellite have been compressed into *normal points*. Recently the SLR data has become so numerous, with current data rates of 1 to 10 points per second and almost thirty systems tracking worldwide, that an aggregation method has become desirable to avoid excessive costs in the analysis of the data. For a satellite such as LAGEOS, which is orbiting at nearly an earth's radius in altitude, the temporal density of information provided by the full rate data is approximately two orders of magnitude greater than that which is needed to fully monitor the perturbed motion of this satellite. While large data sets of independent observations reduce the influence of data noise on the calculated orbit, experience has shown that data noise is not a dominant error source for dynamic orbit modeling applications of these data. Statistical methods can be used applying the full data density to estimate and then filter out the noise contribution to the observations. The SLR data is then compressed using temporal sampling based upon the presence of some minimum number of data points in the sampling interval. This entire process is known as forming laser normal points.

Other groups, such as *Hauck and Lelgemann* [1982] and *Masters et al.* [1983], have adopted methods to thin the data while at the same time reducing noise in the data set. *Masters et al.* [1983] used successive differences in the second time derivative of the range to edit the data and Chebyshev polynomial fits to short spans (150 sec) of the edited data to produce laser normal points. These procedures were designed to accomplish three major objectives: (1) outlying differences were used to edit anomalistic points, (2) the noise over these short spans was reduced by being averaged over the empirical function, and (3) filtered data, absent this noise, were produced. We have adopted similar procedures to accomplish these same objectives [*Torrence et al.*, 1984]. Our approach was adopted to address not only the formation of normal points but also to assist with the assessment of the systematic stability of the laser systems, and to assess their relative performance with respect to the other laser systems.

4.2.1 *Normal Point Formulation*

Measurements inherently contain random errors or noise. Ideally, the normal points associated with a given set of laser range observations are representative of the same observations free from noise, i.e., the observations which would have been made if the measurement process were noise free. The normal point procedure is not designed to eliminate systematic errors in the data; such analysis normally requires an aggregate fit to the data from many tracking systems in an orbital reduction.

The observed laser range at time t may be expressed as

$$R_o(t) = R(t) + \varepsilon(t) \tag{4.1}$$

where $R(t)$ is the true range and $\varepsilon(t)$ is the observational noise. Optimally, the noise is minimized by averaging sufficient observations at time t so that the expected contribution of the random error to the average is insignificant. (for example, 0.1 mm). However, there is only one measurement at each time t, so the method must rely on having observations taken at a rapid rate over a short period of time, Δt. There must be sufficient observations during Δt so that the expected noise contribution is insignificant. It is also critical for the unmodeled signal in the observation during this Δt to have an insignificant contribution before forming a normal point.

Because the noise removal must be performed over a non-zero time span, the method requires the concept of an observation model and a noise model. The computed range to the satellite at any time $R_c(t)$, is the result of known modelable physical processes, as is done in GEODYN II. These models are capable of representing a range at all times within a pass, not just at the times of the observations, to the same general level of accuracy: it is deterministic, yielding a misclosure of observed vs. computed range on LAGEOS at the sub-decimeter level. While there are errors in our modeling of the "true" range, the model of the evolution of the range in time is correct for the first seven or so significant figures. This error in $R_c(t)$ is given by:

$$\delta R(t) = R(t) + \varepsilon(t) - R_c(t) \tag{4.2}$$

Note that $R(t)$ is the true noiseless range or the "normal" point range which is to be obtained.

Given a process for estimating $R(t)$, normal points can be produced for each observation time. This is a very dense set, with observations occurring far more often than is required to sense the physical phenomena influencing the satellite's orbit. Therefore, along with normal point creation (noise removal), the data are thinned. This desirable decimation is made by just selecting the observation closest in time to the $\Delta t/2$ point, which is the bin midpoint, and forming a normal point with this observation. This, in practice, also yields a uniform distribution of points across each pass.

Several considerations are involved in constructing normal points. First, the expected range as a function of time must be characterized. Through knowledge of the characteristics of the forces acting on a satellite, a "sampling" interval (bin) is determined which permits the reconstruction of all known "true" physical signals in the observed ranges from the thinned normal points. It is necessary to consider the behavior of δR within each bin. The spectra of δR must be known at short period (i.e., the bin width), to leave uncorrupted all meaningful longer periods from unmodeled orbit errors and modeled orbit effects. Harmonic analyses of the force-model error perturbations on LAGEOS show no perturbation greater than a centimeter for periods of less than 5 minutes. A numerical analysis of the order of the orbit integrator and the integration step size available in GEODYN II reveals that a good combination is a twelfth-order integrator coupled with a 150-second step size. Through the consideration of the spectra of the orbit perturbations and the numerical accuracy of GEODYN II, the choice was made to use 2-minute bins for forming normal points.

The orbit errors are found to be modeled adequately by a low-degree polynomial over a pass of residuals and, except for the rarest cases, vary linearly within a properly selected bin width. This is a result of using an accurate R_c. Therefore, the normal point $R_N(t)$ is

$$R_N(t) \equiv R(t) = f(\delta R(t)) + R_c(t) \tag{4.3}$$

where $f(\delta R(t))$ is some empirical function over the pass and bin used to correct the calculated range for the error in our physical models. The coefficients for this function are obtained from the signal left in the range residuals over the pass coupled with piecewise linear fits to the remaining residuals in the bin. The adopted procedure does both in succession.

Therefore, the procedural steps utilized for forming normal points are:

1. GEODYN II, based on our best knowledge of the forces, etc. produces a set of residuals from 15 days worth of global range data. This orbit fit produces a set of range residuals, $\delta R(t)$, representing the misclosure between the observations and the mathematical model of the satellite ephemeris.

$$\delta R(t) = R_o(t) - R_c(t)$$

2. A polynomial, $g(t)$, is fit to the residuals of a pass of data

$$\delta R(t) = g(t) + \xi(t)$$

Each residual is thus characterized in terms of signal and noise. Note that $\delta R(t)$ is distinct from the noise $\xi(t)$ according to the sufficiency of $g(t)$ to absorb the unmodeled signal in the original fitting process – A low-degree polynomial fit to $\delta R(t)$ effectually removes any residual signal. The remaining residual, $\delta r(t)$ is then

$$\delta r(t) = \delta R(t) - g(t)$$

The mean residual in the bin is then calculated

$$\delta \bar{r}_b = \langle \delta r(t) + \xi(t) \rangle$$

3. The expression for the "noiseless range" is given as:

$$R_p(T) = g(T) + R_c(T)$$

where T is mid-point time in the pass measured in uniform 2-minute intervals.

4. The normal point at time T is then:

$$R_B(T) = g(T) + R_c(T) + \delta \bar{r}_b$$

where T is defined as in 3 above, and $\delta \bar{r}_b$ is the "bin" correction. However, to avoid any error in the interpolation of range to an arbitrary time, we select the true observation closest to the bin mid-point to produce a normal point:

$$R_N(t') = R_c(t') + g(t') + \delta \bar{r}_b$$

or alternatively as:

$$R_N(t') = R_o(t') - (\delta r(t) - \delta \bar{r}_b)$$

where t' is the time of an observation closest to the mean observation time within the bin.

In summary, the normal point noise at a specific point is estimated from the residual mean "signal" over the bin width. The noise error at this point is estimated and removed from the original range. Note also that the normal point is at the time of a real observation. An estimate of the noise from this observation to form a "normal point" at the most centrally located observation time within each bin is removed. This is repeated providing one normal point for each 2-minute tracking span.

4.2.2 *Verification of the GSFC Normal Point Computations*

The normal point computation procedure has been verified using a segment of LAGEOS full-rate data. These data were used to verify that the normal points preserve the information content of the full rate data for calculating the orbit and for the recovery of station coordinates.

Two tests were performed to assess the performance of the normal points. In the first test, a common orbit is used as a reference for the determination of tracking station coordinates. The results based on the full-rate observation set are compared to those obtained using the normal points. In the second test, the orbit computed from the normal points is compared to that using the full-rate data with all other models and geodetic parameters held to be constant in the two cases. The differences which are obtained are compared to the formal errors of the parameter recoveries.

When the normal points were utilized, they were given individual observation weights:

$$w = \frac{1}{\sqrt{n}} \text{ meters} \tag{4.4}$$

where n is the number of full-rate points in the 2-minute bin used to compute the normal point. In contrast, each of the full-rate ranges was given a weight of 1 m. This preserved the data distribution variation as it is seen in the full-rate data.

Table 4.4 shows the difference obtained in a sampling of the adjusting orbit parameters. Shown is the difference in the inertial X position and velocity component, the along-track acceleration and the coefficient of solar radiation pressure for the normal point vs. full-rate orbit determination results. In each of the orbit parameters, the difference was insignificant

Table 4.4. Test of Orbit Adjustment: Four Stations, 3-Day Arc
Values shown are the difference between normal point and full-rate orbital solutions

ΔX (m)	$\Delta(X/t)$ (m/s)	Δ Accel 10^{-11} m/s^2	ΔC_r
0.004	-0.004	0.001	0.0000

when compared to the noise-only uncertainty obtained in the adjustment assuming 10-cm data noise.

Table 4.5 shows a comparison of the station adjustments obtained (taken with respect to the *a priori* coordinates used in the orbital arc) for the full rate vs. normal point determination. Again, the difference in the two adjustments is a small fraction of the noise-only uncertainty of the results. These tests confirm that the normal point process does not alter the fundamental geodetic signals contained within the full-rate ranging data.

Table 4.5. Test of Station Position Adjustment: Four Stations, 3-Day Arc
Values shown are from *a priori* for normal point and full-rate station coordinate solutions

	ΔX (m)	ΔY (m)	ΔZ (m)
Full rate data	-1.327	0.705	0.636
Normal point data	-1.358	0.727	0.652

5. Analysis of Estimated Parameters

5.1 Assessment of SL7.1 Solution Quality

Before presentation of the geodetic results from the SL7.1 solution, an appreciation of the quality of the solution across time is essential in order to assess the solution's strengths and its limitations. The amount of data entering into the solution as given by the number of LAGEOS normal points (1 normal point = 1 "observation" in the SL7.1 solution) is illustrated in Figure 5.1. It can be easily seen that a marked improvement in observational effort has been achieved during the history of LAGEOS tracking with an apparent seasonal variation in the number of normal points. Large troughs in the graph are probably associated with coincidental poor weather conditions across tracking stations as well as network-wide system upgrade programs (both fixed and mobile lasers) in which many sites experienced a considerable amount of down-time simultaneously (or lack of occupations for mobile sites – this was the case in 1986).

The monthly RMS orbital fit also provides a measure of solution quality for each of the monthly solutions and is shown in Figure 5.2. A dramatic improvement in solution quality is shown over the period of May 1976 to July 1989 whereby RMS orbital fits have dropped from ~30 cm to less than 5 cm. This improvement may not be entirely ascribable to system improvements since there appears to be some level of correlation between the number of normal points and the RMS fits as shown in Figure 5.3. It is well known in least-squares theory that as the number of observations increases, the solution uncertainties will decrease. However, in this case, system improvements most likely account for both the increased number of normal points (a measure of system reliability and more progressive measurement schedules) as well as lower RMS orbital fits as can be seen by distinguishing between pre-1980 data and post-1979 data. Since an obvious temporal grouping can be seen, we conclude that system improvements are more likely the cause for improved RMS orbital fits. This is especially the case for months of relatively few normal point observations (<2000) where even though they lack observations, the overall RMS orbital fit remains in the 5- to 15-cm level.

The SL7.1 solution, as assessed by these general measures, is of significantly lesser quality before 1980. Therefore, some of the analyses of the estimated parameters will disregard these results obtained from these early years of tracking. Between early 1980 and mid 1986, improvement in solution quality was slow but consistent, improving at a rate of ~2 cm/yr, in

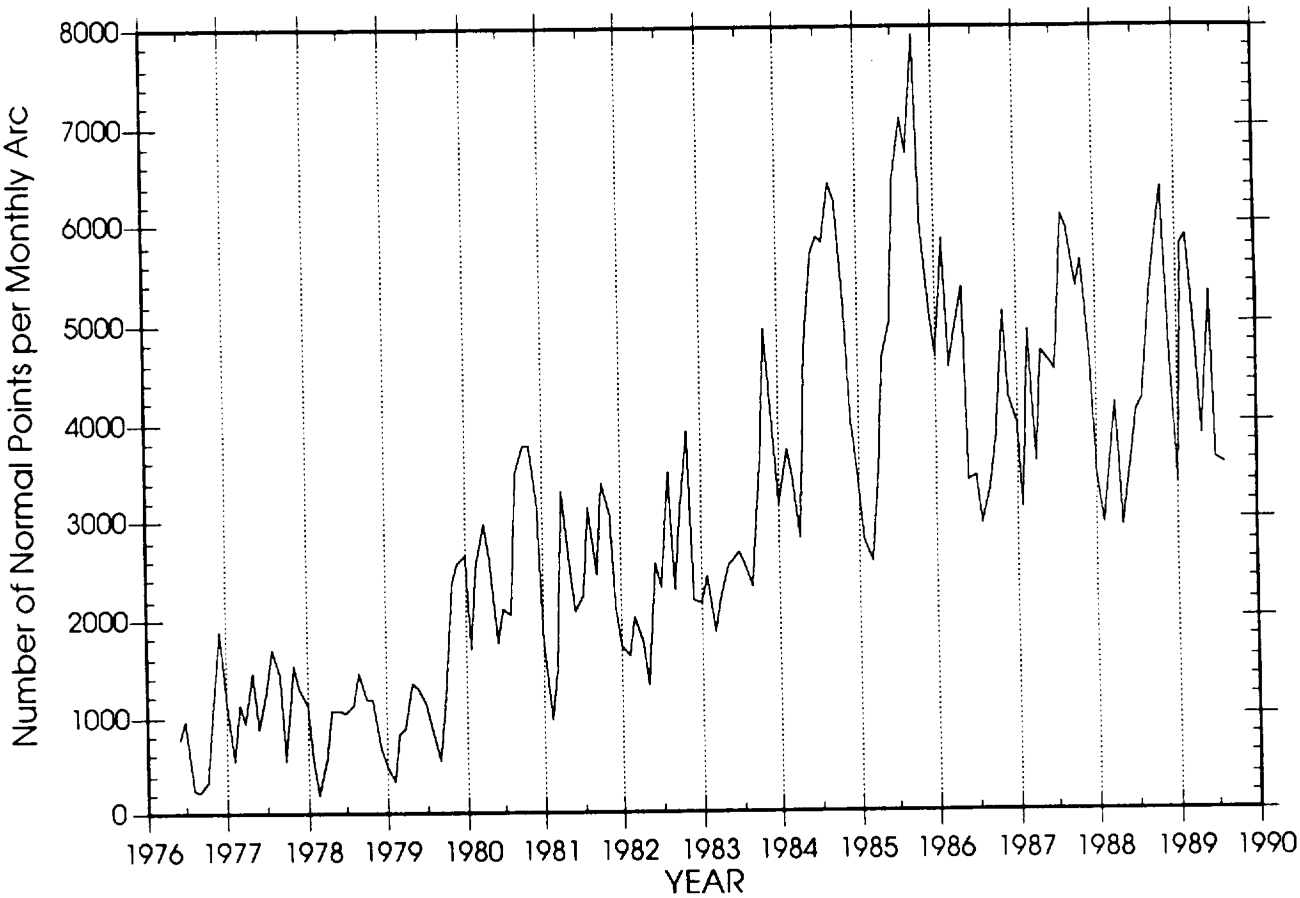


Figure 5.1 Number of monthly normal points utilized in the SL7.1 analysis.

terms of the RMS orbital fit. After 1986, the solution quality has remained rather constant at a level below 5 cm.

5.2 Non-Conservative Force Parameters: Estimation and Analysis

5.2.1 *Introduction*

In addition to the main products of the SL7.1 solution (i.e., station positions and Earth orientation parameters), other parameters related to the orbital environment of LAGEOS are also routinely estimated. These parameters (given in Appendix 3) provide useful information to characterize the evolutionary behavior of LAGEOS' orbit. Analyses of these parameters have proven to be useful in isolating remaining systematic behavior as well as providing information for theorists in their determination of physical models to further explain anomalous satellite behavior. In this section, the results and implications of these parameters are discussed and

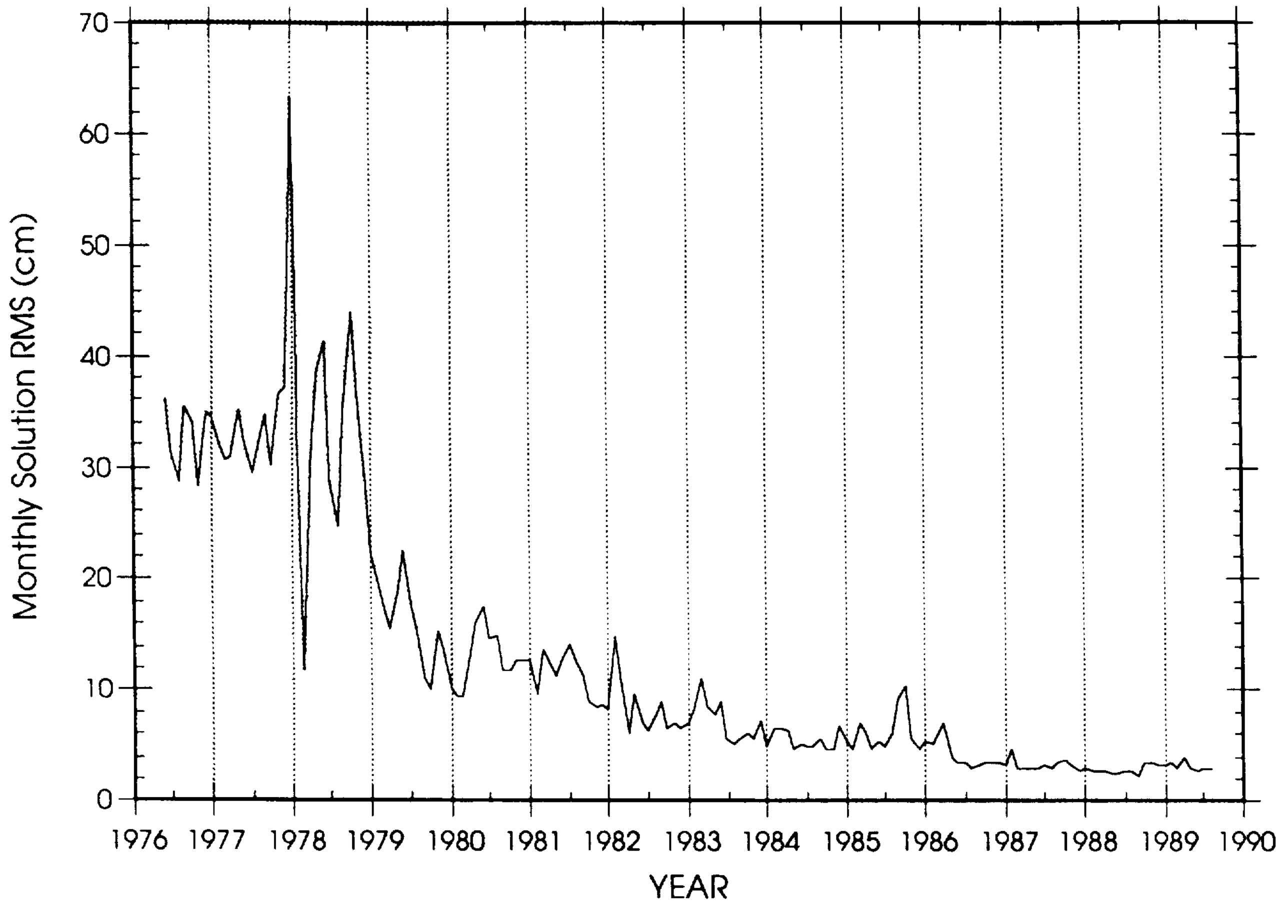


Figure 5.2 Monthly solution RMS orbital fits to LAGEOS. Only data taken after 1980 are used in subsequent spectral analyses of non-conservative force parameters due to the poorer orbital fits in earlier months (shown in the shaded region).

current theories and models are reviewed which, as of this writing, provide consistent explanations to describe a large portion of the systematic aspects that remain in LAGEOS' orbit.

The solar radiation pressure and along-track acceleration parameters are direct effects on LAGEOS which are estimated during the orbit estimation procedure. Fluctuations and trends in these parameters are due to unmodeled effects in the satellite environment which may be modelable or unmodelable, depending on the nature of the effect.

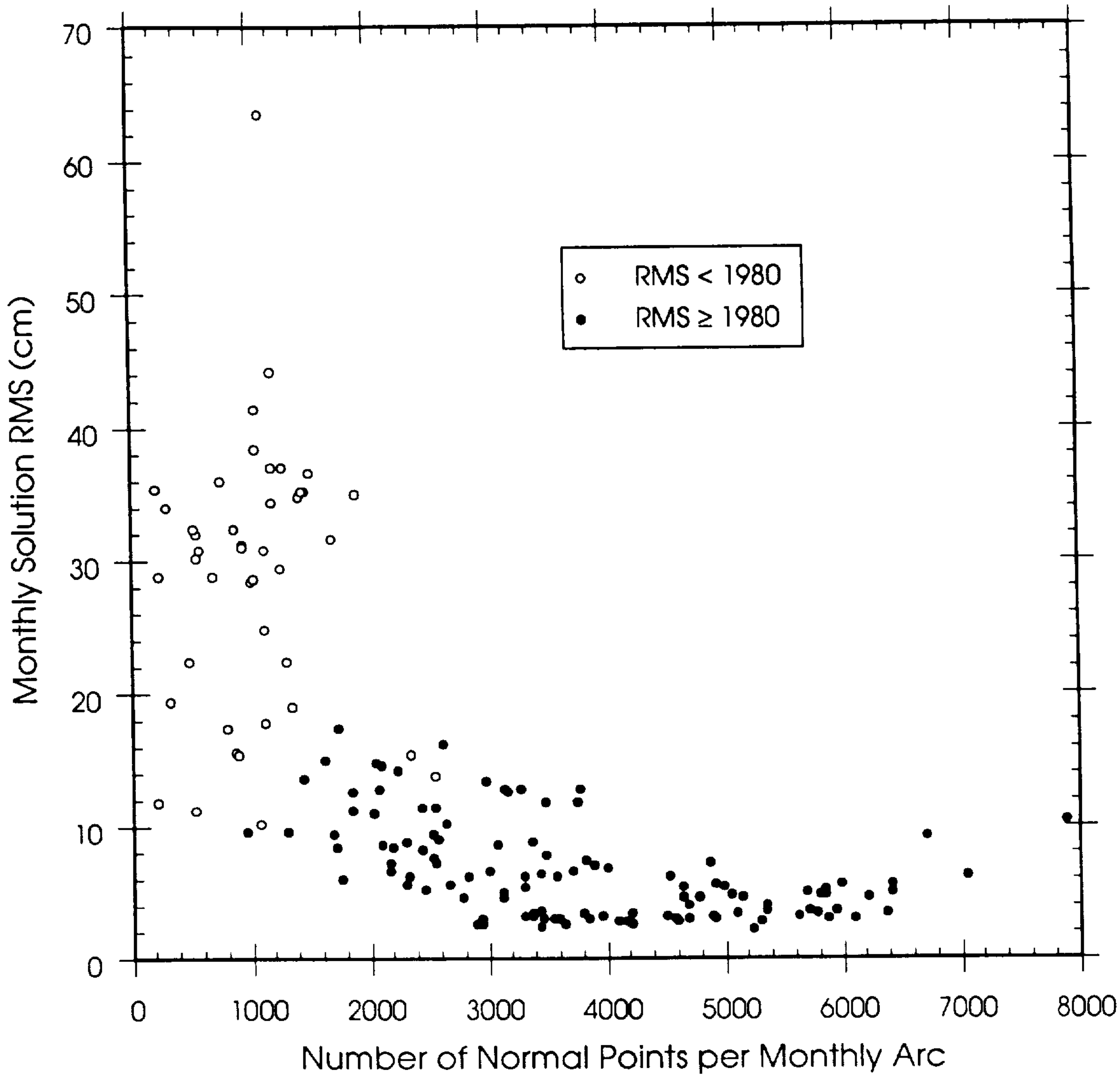


Figure 5.3 SL7.1 monthly solution RMS orbital fits correlated with the number of normal points. Open circles indicate arcs created with data acquired before 1980; blackened circles for arcs created with data acquired hence.

5.2.2 *Solar Radiation Pressure*

Bimonthly values for the solar radiation coefficient as shown by equation (3.12) have been recovered in each of the monthly solutions. The C_R parameter is estimated in these solutions because it has been shown that it helps reduce the overall solution RMS orbital fits by absorbing as yet unmodeled force parameters. By studying the variations in C_R , it may be possible to isolate remaining unmodeled phenomena.

Figure 5.4 presents the time evolution of the bimonthly recovered C_R parameters. LAGEOS' specular reflectivity coefficient ρ_s is quite small due to the brushed aluminum surface of the areas between corner cubes, therefore, C_R is not expected to be much larger than 1. In the figure, rather short-period variations occur primarily in the form of large dips of magnitude roughly 0.1 which appear to occur every 37 months. Interestingly enough, these correspond to the period of the node for LAGEOS.

The portion of the time series after 1979 has been spectrally analyzed producing the spectrum shown in Figure 5.5. The spectral decomposition is performed using a weighted least-squares spectral analysis algorithm of *Wells & Vanicek* [1978] where an average linear bias and slope have been removed. Significant peaks can be seen for periods of 1270 days and 550 days. Due to the broad character of the 1270-day peak, it is possible that this peak is associated with the nodal rate of 37 months (approximately 1120 days). The period at 550 days (nearly half of the nodal rate) also contains a considerable amount of power.

The implication of these results is that there remains some unmodeled force (or forces) which is in some way related to the nodal period. This variation in C_R is a variation in the non-conservative force directed outward from the Sun, and what we see is the least-squares accommodation of the unmodeled effect.

5.2.3 *Along-Track Acceleration*

The orbit of LAGEOS is perhaps the most accurately modeled of any artificial Earth-orbiting geodetic satellite. However, after modeling all of the known forces acting upon LAGEOS, there still remains a residual along-track acceleration that exhibits fluctuations and periodic behavior. Several investigators have reported on this residual acceleration with the general purpose of determining the phenomena that adequately explain the residual behavior, a review of which follows in the next section. By using the formulation explained in Section 3.3.2.1, bimonthly estimates of the along-track acceleration have been recovered in each of the monthly solutions.

The time series for the residual along-track acceleration is shown in Figure 5.6. It is immediately evident that the series is periodic in which a 37-month period is primary. The spectrum of the accelerations is illustrated in Figure 5.7 and exhibits similar character to that determined independently by *Barlier et al.* [1986]. As was the case for the solar radiation

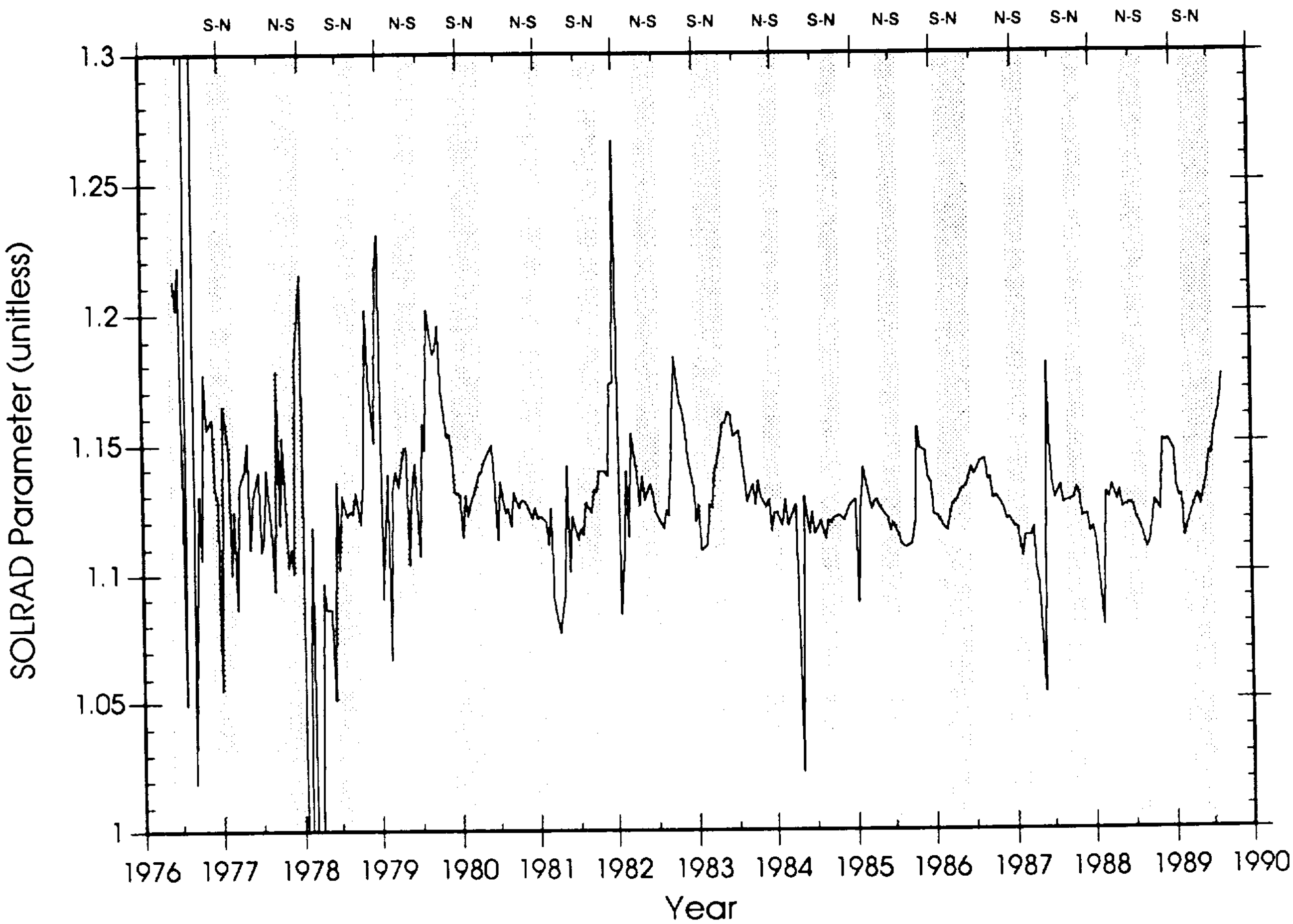


Figure 5.4 Time series of solar radiation pressure parameter (SOLRAD). The "N-S" and "S-N" refer to the orientation of the shadow entry and exit, respectively. Values estimated from 1980 onward were used in the subsequent spectral analysis.

pressure coefficient, two peaks dominate the spectrum. Again, the peak at 1060 days has a fairly broad character which is likely associated with the nodal period of 1120 days. The fact that the peak is skewed in the direction of the nodal period strengthens this conclusion. Again, the peak at 560 days (at half the nodal period) contains a considerable amount of power. The remaining spikes are most probably due to higher order harmonics (e.g., 280- and 140-day periods which correspond to multiples of the nodal frequency) and are probably influenced by the intrinsic noise of the data [*Barlier et al.*, 1986]. A comparison with the radiation pressure coefficient series reveals that the phase of the periodic signature of the along-track acceleration is orthogonal. The correlation diagram in Figure 5.8 shows this quite clearly. The cruciform shape seen in the diagram is a direct outcome of the orthogonal phase relationship. This relationship can be stated as follows: When the along-track acceleration undergoes an excursion away from its mean, the solar pressure coefficient remains at its mean and vice versa.

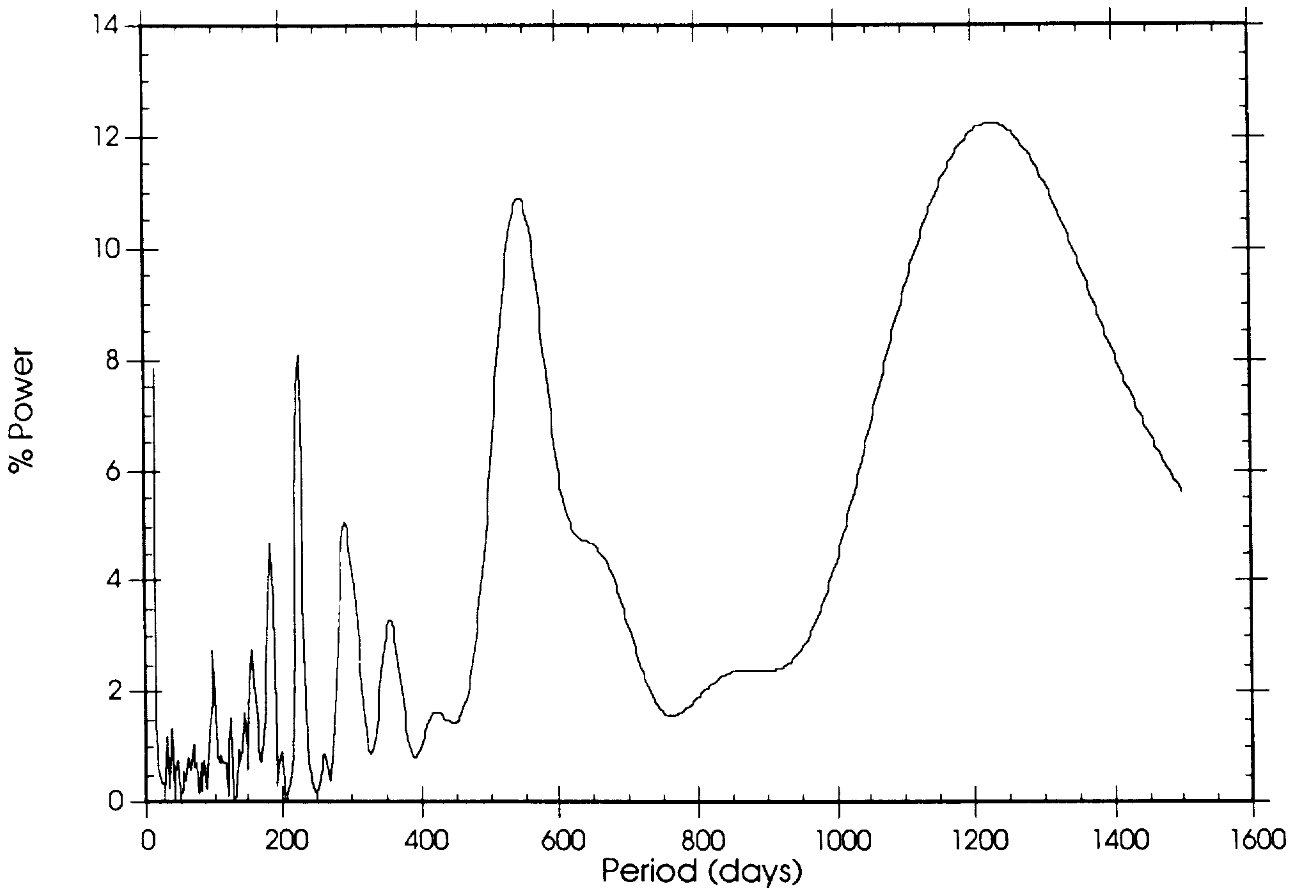


Figure 5.5 Spectral decomposition of the solar radiation pressure.

5.2.4 *Discussion*

From what has been shown, the parameters of the along-track accelerations and solar radiation pressure coefficients behave in a manner that is evidently correlated. Possible sources to explain the average and fluctuating portions of the along-track acceleration behavior were explored in the 1970s by many researchers; these were summarized in an early paper by *Rubincam* [1982]. Further refinements of these proposed models and better measurements to LAGEOS have brought a more complete description of the rather obscure non-conservative forces acting on LAGEOS. These improvements are summarized below.

5.2.4.1 Average Along-Track Acceleration

The average along-track acceleration of approximately -3.5 pms^{-2} was originally thought to be predominantly due to a combination of charged and neutral particle drag (e.g., *Afonso et al.* [1985] and earlier papers referenced therein). Neutral particle drag was shown to account for

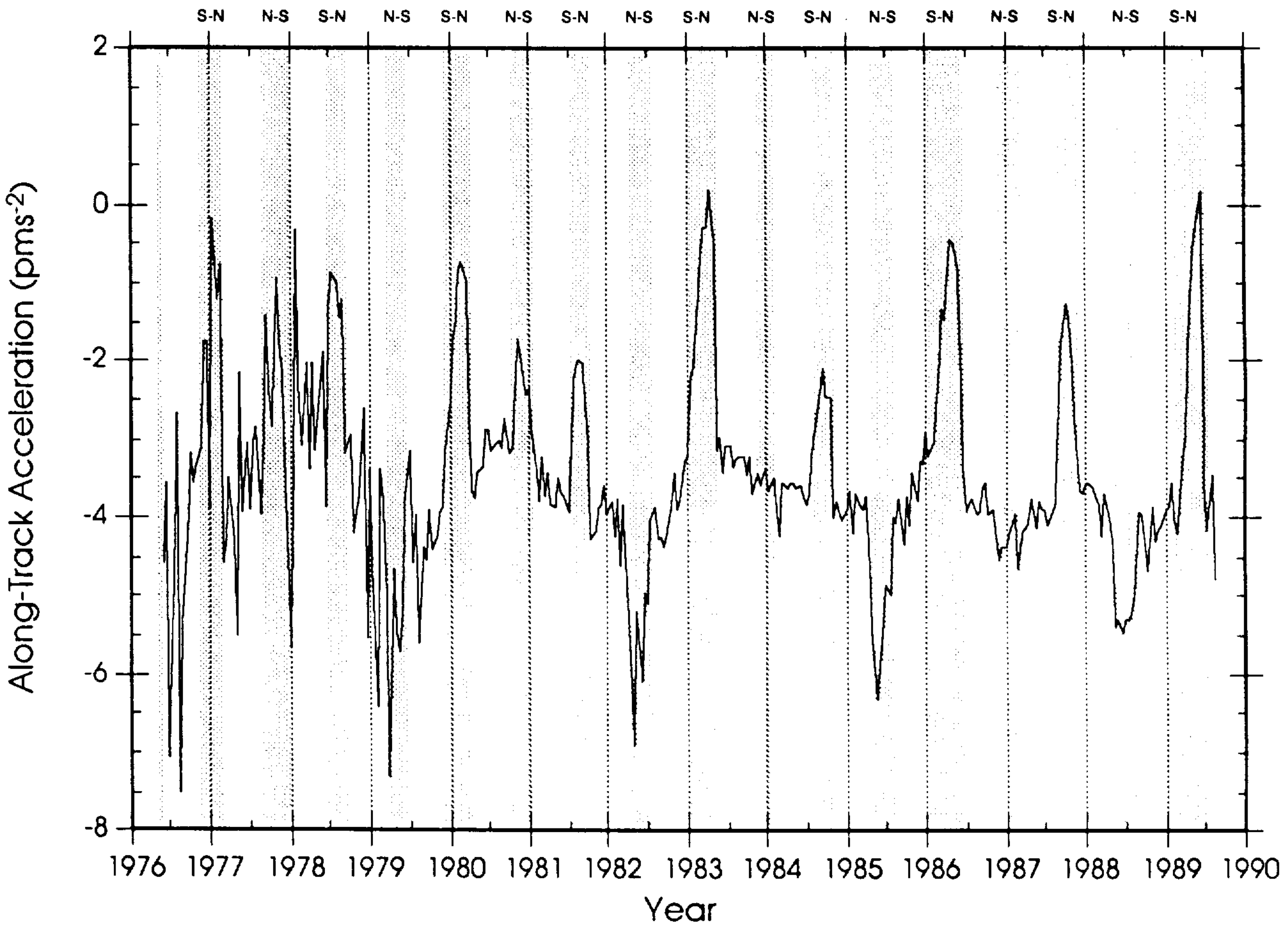


Figure 5.6 Time series of along-track acceleration as experienced by LAGEOS. The "N-S" and "S-N" refer to the orientation of the shadow entry and exit, respectively. Values estimated from 1980 onward were used in the subsequent spectral analysis.

only ~10% of the average along-track acceleration (*Rubincam* [1980] and *Afonso et al.* [1985]). A more recent analysis by *Rubincam* [1990a] indicates that neutral and charged-particle drag on LAGEOS are of similar magnitudes; -0.46 and -0.52 pms^{-2} for neutral and charged-particle drag respectively, accounting, in combination, for about 30% of the total along-track acceleration. In most models developed to date, it is typically assumed that these quantities are invariant, but, as pointed out by *Scharroo et al.* [1991], this is not completely true since it is well known that in the case of charged-particle drag, the drag from protons will vary slightly as the Sun/orbit geometry changes.

Rubincam [1987] proposed that the Yarkovsky thermal drag, or the asymmetric thermal response of LAGEOS upon Earth-emitted infrared radiation accounts for -3.33 pms^{-2} of the

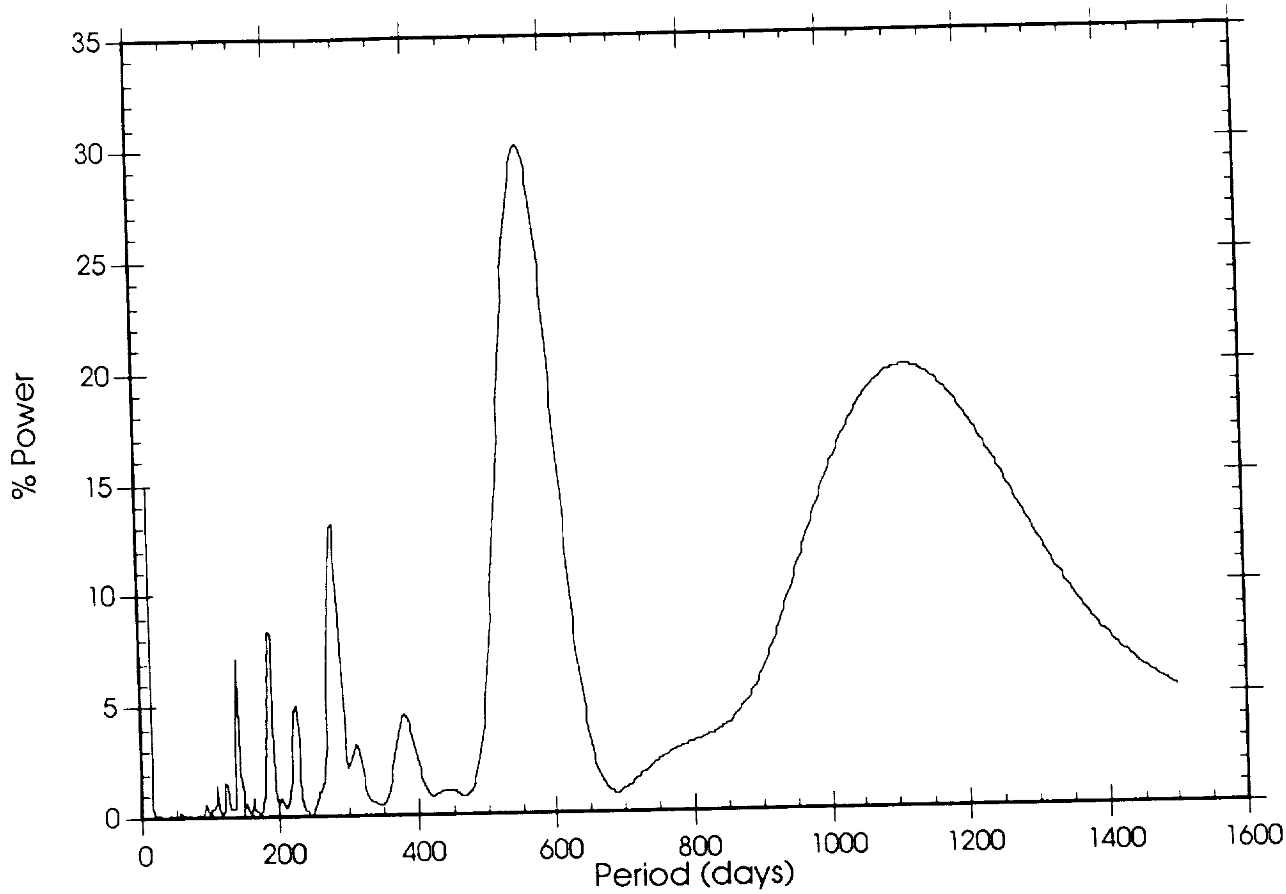


Figure 5.7 Spectral decomposition of the along-track acceleration.

average along-track acceleration observed to be occurring on LAGEOS. This value has since undergone some modification, largely due to refined considerations of the thermal behavior of the corner cubes on-board LAGEOS, to a generally accepted value of -3.08 pms^{-2} (*Rubincam* [1988] and *Scharroo et al.* [1991]). The Yarkovsky thermal drag is modeled through (*Rubincam* [1988])

$$S_{ytd} = \langle S_{\max} \rangle [1 - s_z^2 + \frac{1}{2}(3s_z^2 - 1)\sin^2 I + s_z \sin 2I(s_y \cos\Omega - s_x \sin\Omega) + \frac{1}{2}(s_x^2 - s_y^2)\sin^2 I \cos 2\Omega + s_x s_y \sin^2 I \sin 2\Omega] \quad (5.1)$$

Where $\langle S_{\max} \rangle$ = -3.08 pms^{-2}, I is the inclination of the orbit, Ω is the right ascension of the ascending node (a function of time, given by $\Omega = \Omega_o + \dot{\Omega}(t - t_o)$ where $\dot{\Omega}$ is the rate of change of the ascending node and Ω_o is the epoch position of the ascending node at time t_o). The

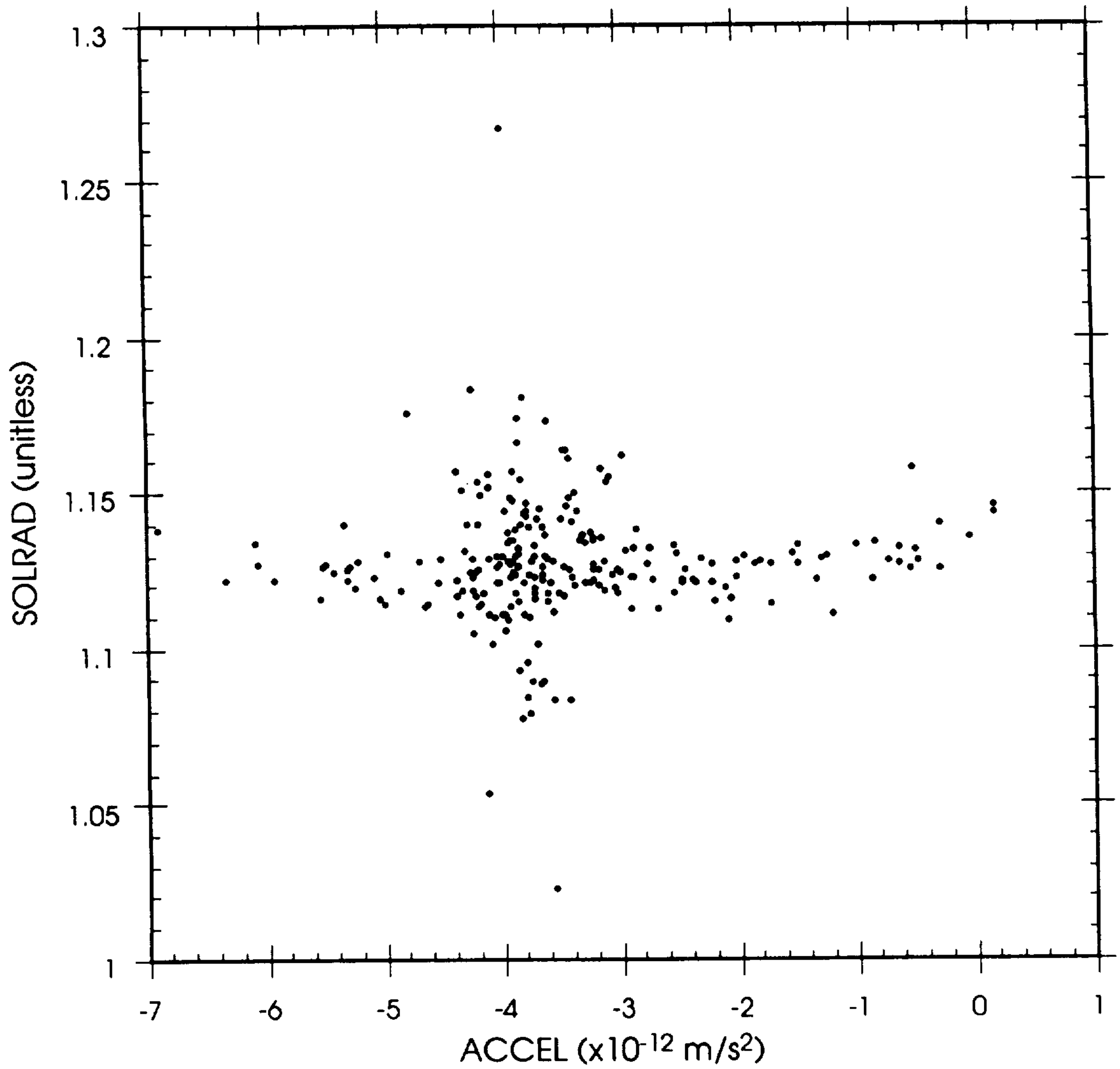


Figure 5.8 Correlation plot of SOLRAD vs. ACCEL.

s_x, s_y, s_z are the unit vector components of the spin axis of LAGEOS in an Earth-centered, celestial coordinate system, given by

$$
\begin{aligned}
s_x &= \sin\theta\cos\lambda \\
s_y &= \sin\theta\sin\lambda \\
s_z &= \cos\theta
\end{aligned}
\tag{5.2}
$$

where θ and λ are the co-latitude and right ascension of the direction of LAGEOS' spin axis. Originally, the angle θ was thought to be constant at ~22° with respect to the Earth's spin axis, but recently, assessments of magnetic and gravitational torques have shown that LAGEOS' spin axis has been changing as a function of time [*Rubincam*, 1990a]. In the work by *Scharroo et al.* [1991], they have made the assumption that the spin axis of LAGEOS is slowly aligning itself to the Earth's spin axis due to the magnetic torque experienced by LAGEOS' passage through the Earth's magnetic field. This has the effect of reducing the amplitude of the variation of the modeled effect. More recently, *Bertotti and Iess* [1991] have proposed that as the spin axis of LAGEOS comes into close alignment with the Earth's spin axis, gravitational torques will predominate over the forcing of the satellite's spin axis, sending LAGEOS into a chaotic tumbling state of spin. Their prediction is that LAGEOS will reach this chaotic state sometime in late-1991 or in 1992.

For the purposes of discussion here, the exponential progression of the alignment of LAGEOS' spin axis towards the Earth's spin axis has been adopted in a manner similar to that described by *Scharroo et al.* [1991] whereby the spin axis co-latitude decreases by 50% every 6 years; a value which has also been determined empirically by *Ries* [1991]. The combined effects of the Yarkovsky thermal drag and neutral and charged-particle drag are shown superimposed on the observed along-track acceleration in Figure 5.9a with the residual along-track acceleration after removing these effects being shown in Figure 5.9b. With the removal of the average along-track acceleration, the residual acceleration is now centered about zero but still contains excursions (or spikes) from the mean for which explanations have been proposed—discussed in the next paragraphs.

5.2.4.2 Along-Track Acceleration Spikes

Much effort has been spent by several researchers to understand the excursions that had been seen in the along-track acceleration parameter recovered from LAGEOS orbital analyses. Recently, *Scharroo et al.* [1991] have offered two models which reproduce the data remarkably well, at least for the time span from which their analysis was made as the prediction capability of their proposed algorithm appears to degrade after 1989.

The first model was put forth in detail by *Rubincam et al.* [1987] in which it was suggested that an asymmetry of the reflectivity of the satellite might cause the observed excursions in the along-track acceleration parameters. It has further been shown that even small differences in hemispheric reflectivity of LAGEOS could cause a portion of the observed spikes. The model is somewhat controversial because little pre-flight evidence exists that would indicate a variation in albedo on LAGEOS. The surface of the satellite was presumably manufactured in a uniform way and ground tests made on LAGEOS II indicate less than 2% hemispheric

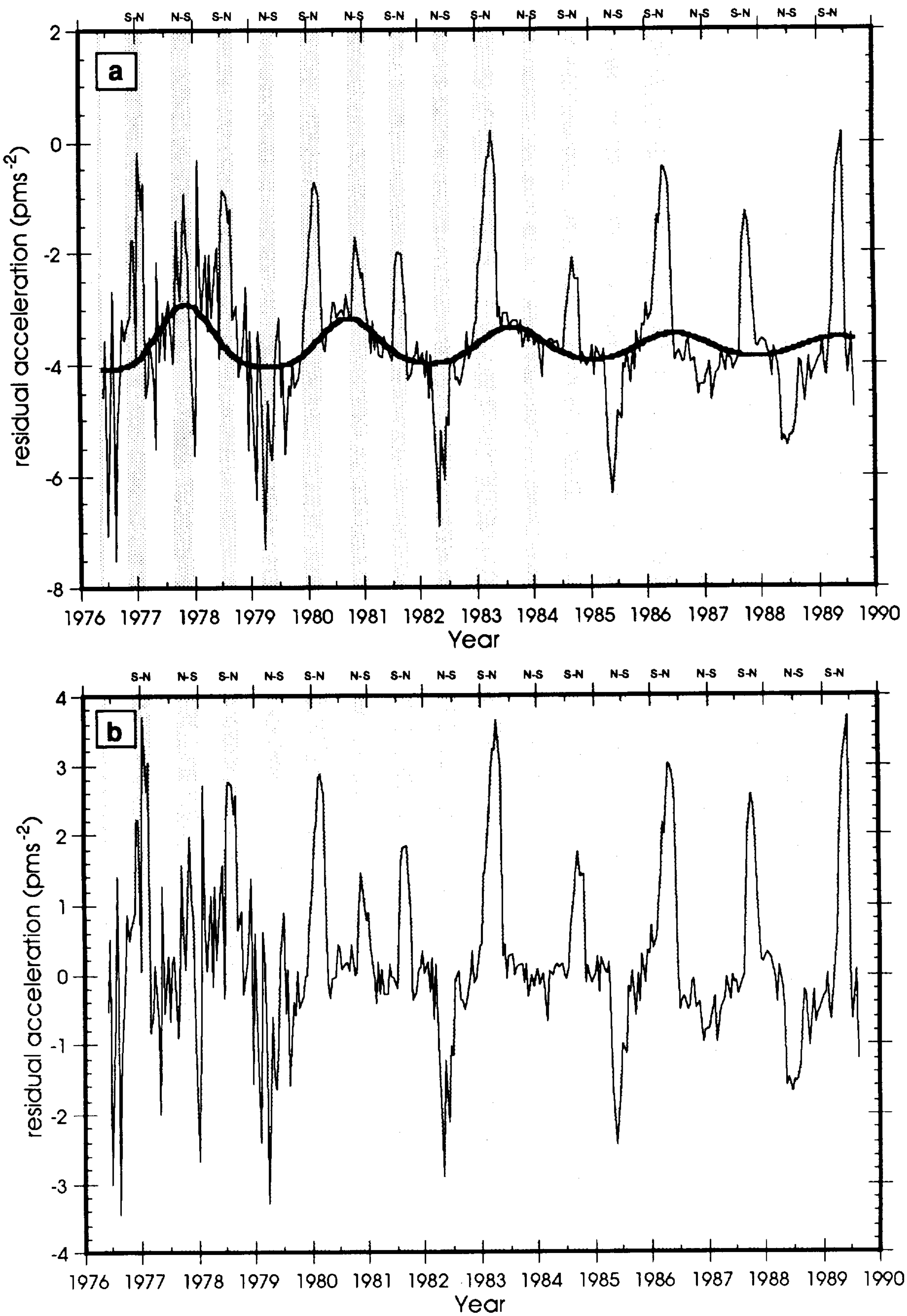


Figure 5.9 (a) Theoretical Yarkovsky thermal drag on LAGEOS shown (heavy line) superimposed on the total along-track acceleration determined by the SL7.1 analysis. (b) Residual along-track acceleration after removal of the Yarkovsky Thermal drag.

variation in reflectivity (*Rubincam*, [1990b]). Nonetheless, *Scharroo et al.* [1991] maintain that a hemispheric reflectivity variation of only 5% adequately explains the observed behavior, the source of which remains an intriguing mystery.

Anisotropic reflection of sunlight, assuming anisotropy exists on the satellite, will cause a recoil in the direction of the region or zone having the lower albedo, since fewer solar photons will rebound in this region. For a satellite having hemispheric variation in albedo and in the course of an orbit, this effect will largely cancel out if the satellite's orientation remains reasonably fixed in inertial space and if the orbit remains in full sunlight. When a portion of the orbit passes through the Earth's shadow, the recoil ceases, thereby causing an apparent force to act on the satellite and giving a net result which has all the appearances as that of an acceleration. Whether the effect takes form as a positive or negative acceleration is strictly a function of which satellite hemisphere enters the shadow zone first. The model takes a relatively simple form as outlined in *Rubincam et al.* [1987] and *Scharroo et al.* [1991]. (The formulation below is from the latter.)

$$S_{ani} = \frac{1}{2\pi}\ddot{s}_{\max}(A_1 - A_2)\sin^2\theta_r \tag{5.3}$$

where $\ddot{s}_{\max} = -12.1\ \mathrm{pms^{-2}}$, θ_r is the angle between the spin axis of LAGEOS and the Sun, A_1 and A_2 are LAGEOS' unit spin vector mapped onto the direction of the satellite radius vector from the Earth's center at moment (1) when the satellite enters the Earth's shadow and at moment (2) when the satellite exits the Earth's shadow. Once again, the spin axis of LAGEOS is assumed in this work, to be slowly re-aligning itself with the Earth's spin axis.

The second effect proposed by *Rubincam* [1982] and developed later in detail by several investigators is known as the Yarkovsky-Schach effect. This effect shares similar concepts with both the Yarkovsky Thermal Drag model and the anisotropic reflectivity models already mentioned. The Yarkovsky-Schach effect is again a consequence of photon thrust, but in this case we are concerned with solar-produced photons. The effect is similar to the anisotropic reflectivity model in the sense that both are due to the thrust (or recoil) ceasing during the time LAGEOS spends in the Earth's shadow. Again, borrowing from the derivation given in *Scharroo et al.* [1991], the Yarkovsky-Schach model is formulated as

$$S_{yse} = \ddot{s}_{\max}\frac{(A_1 - A_2) + u_o(B_1 - B_2)}{2\pi(1+u_o^2)}\cos\theta_r \tag{5.4}$$

where all values are defined as before with the exception that $\ddot{s}_{max}$ = -89.4 pms^{-2} , u_o = 1.45 rad, a constant expressing the thermal response time of a retroreflector, and B_1 and B_2 are like A_1 and A_2 except now the unit spin vector is mapped onto the along-track direction of the satellite at entry and exit points as the orbit passes through the Earth's shadow.

The sum of the anisotropic reflectivity and the Yarkovsky-Schach effects is shown in Figure 5.10a. The residual acceleration is fairly well modeled by these two effects, but some residual spikes can be seen in Figure 5.10b which seem to exhibit some amount of systematic behavior.

5.2.4.3 Along-Track Acceleration Modeling: Discussion

A substantial amount of the signal in the along-track acceleration can be accounted for by the combination of the four models; charged and neutral particle drag; Yarkovsky Thermal drag; anisotropic reflectivity of LAGEOS; and the Yarkovsky-Schach effect. With the exception of the charged and neutral particle drag, all models are dependent upon the direction of the spin axis of LAGEOS. Throughout the present discussion, it has been assumed that the spin axis is slowly realigning itself with the Earth's spin axis as suggested by *Scharroo et al.* [1991]. However, there is evidence that this simple behavior of the spin axis may not be entirely correct.

First, in carefully examining the behavior of the final residual acceleration (shown in Figure 5.10b), the amount of scatter seems to increase after early 1988. In follow-on GSFC solutions to SL7.1 and in the solution of *Ries* [1991], it has been noted that in early 1990, the along-track acceleration exhibits an unexpected positive excursion having an amplitude of ~2 pms^{-2}. The models, as presented here, fail to predict this spike which further raises questions regarding the orientation of LAGEOS' spin axis. If the prediction of *Bertotti and Iess* [1991] is valid, then it may be that the onset of a new spin axis dynamic, namely of a chaotic state, is the root cause of the 1990 spike. It is anticipated that if the spin axis begins to tumble in an uncontrolled fashion, the effects of the Yarkovsky thermal drag, the anisotropic reflectivity and Yarkovsky-Schach effect will be reduced, leaving approximately -1 pms^{-2} of along-track acceleration due to charged and neutral particle drag. In essence, the spiky nature of LAGEOS' along-track acceleration should be dramatically reduced as well as ~70% of the average along-track acceleration. The state of chaotic behavior is predicted to begin in late 1991 or 1992.

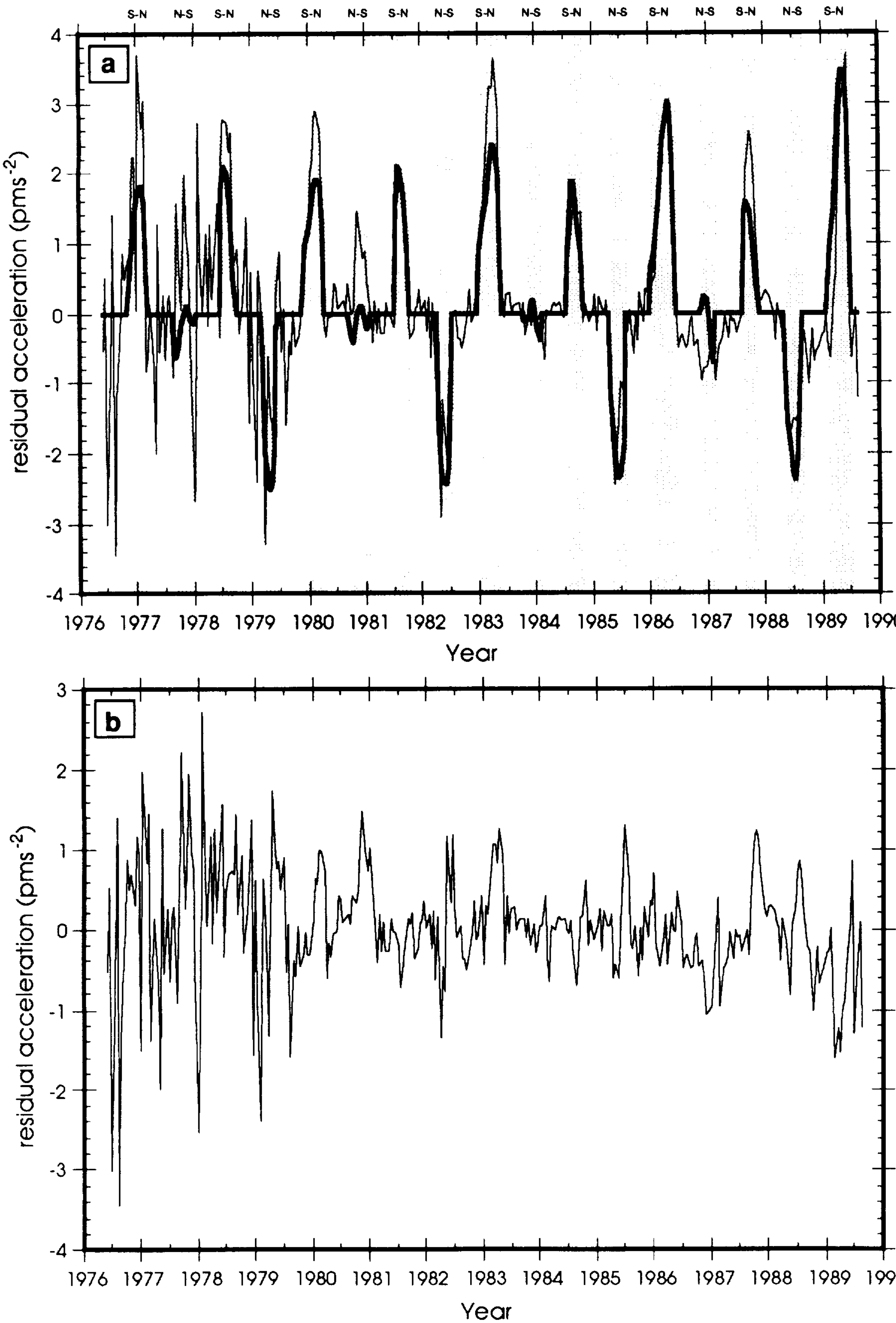


Figure 5.10 (a) Sum of theoretical anisotropic thermal response from Earth infrared radiation and Yarkovsky-Schach photon thrust (heavy line) superimposed on the residual acceleration shown in Figure 5.9b. (b) Residual acceleration after further removal of the anisotropic and Yarkovsky-Schach effects. In this chart, all proposed sources of acceleration variations have been removed.

Continued LAGEOS observations and analyses over this time period will clearly show whether or not the gravitational torque will become dominant, as expected by *Bertotti and Iess* [1991].

Finally, in Figure 5.11, the spectrum of the residual along-track acceleration (after 1979) is shown. Peaks at 885 and 140 days dominate the spectrum. The sources of the peaks remain unexplained. The lack of peaks at the nodal and half-nodal periods indicates that the models described here are effectively removing the signal at these periods.

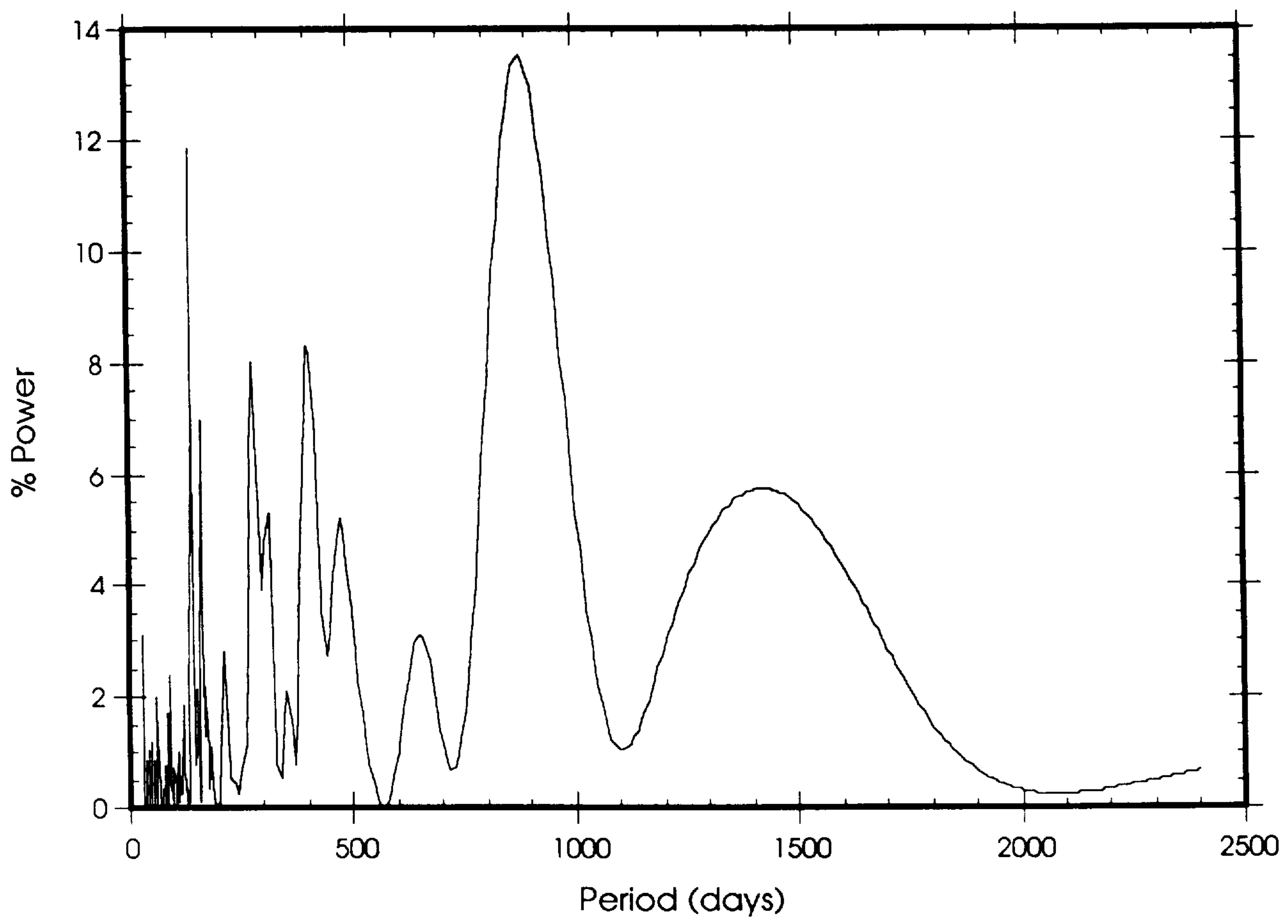


Figure 5.11 Spectral decomposition of the residual along-track acceleration after the effects of the four models have been removed. The five largest peaks are centered at 885, 140, 405, 283 and 163 days, respectively.

5.3 Orbit Evolution Studies

Analysis of LAGEOS' orbital evolution provides one means of assessing errors in the adopted models (gravitational, tidal, etc.) and errors entering into the solution from unmodeled sources. Several techniques have been devised to examine the long-term behavior of LAGEOS' orbital elements. In all of these techniques, it is desirable for the effects of the short-period variations to be minimized in order to understand the longer term fluctuations.

In our analysis, we have chosen to consider the Keplerian elements evaluated when the satellite arrives at a given position, rather than at a given time. Differences in the Kepler elements chosen in this manner from two differently computed osculating orbits reveal the long-period variations due to the different modeling. This enables the estimation of the Kepler element variations due to the errors in the adopted models. These variations must then be interpreted.

5.3.1 *Methodology*

The largest short-period perturbations are due to the Earth's oblateness (J_2). The effects of the Earth's oblateness on the Keplerian elements of a near-Earth satellite are given by *Merson* [1961]. Expressions for the departures δa, δe, δi, and $\delta\Omega$ from nodal conditions are presented in equations (35 - 38) from *Merson* [1961]:

$$\delta a = J_2 R^2 a^2 p^{-3}\left[(1 - e\cos v)^3(1 - 3fS^2) - (1 + e\cos\omega)^3\right] + O(J_2^2) \tag{5.5}$$

$$\begin{aligned}\delta e = 3J_2\left(\frac{R}{p}\right)^2 \Bigg[&\left(-\frac{1}{2}+\frac{f}{3}\right)\cos\omega - \frac{1}{4}e(1+\cos 2\omega) + \left(-\frac{1}{8}-\frac{f}{3}\right)e^2\cos\omega \\ &-\frac{1}{24}e^2\cos 3\omega - \frac{1}{2}feS^2 - \frac{3}{2}feS^2\cos^2 v + \frac{1}{2}e\cos^2 v \\ &+-\frac{1}{3}f(1-e^2)C\cos\omega + \frac{1}{2}\cos v - \left(\frac{7}{6}+\frac{1}{3}e^2\right)fS^2\cos v \\ &-\frac{1}{2}fe^2S^2\cos^3 v + \frac{1}{6}e^2\cos^3 v\Bigg] + O(J_2^2)\end{aligned} \tag{5.6}$$

$$\delta i = -3J_2\left(\frac{R}{p}\right)^2 \sin i\cos i\left[\frac{1}{2}S^2 + \frac{1}{3}e\cos\omega + \frac{1}{3}S^2 e\cos v - \frac{1}{3}Ce\cos\omega\right] + O(J_2^2) \tag{5.7}$$

$$\delta\Omega = -3J_2\left(\frac{R}{p}\right)^2 \cos i\left[\frac{u}{2}+\frac{2}{3}e\sin\omega-\frac{1}{2}SC+\frac{1}{3}S^2 e\sin v-\frac{2}{3}Ce\sin\omega\right]+O(J_2^2) \quad (5.8)$$

in which a, e, i, Ω, ω are the traditional Keplerian elements of the orbit and where:

J_2	$\approx 1.1 \times 10^{-3}$	u	$= \omega + v$
R	is the Earth's equatorial radius	S	$= \sin u$
p	$= a(1-e^2)$; the orbit's latus rectum	C	$= \cos u$

and f = $\sin^2 i$

By grouping terms that are scaled by e and its higher orders, equations (5.5) through (5.8) can be expressed as

$$\delta a = J_2 R^2 a^2 p^{-3}\left[-3fS^2 + e\Delta a\right] + O(J_2^2) \quad (5.9)$$

$$\delta e = 3J_2\left(\frac{R}{p}\right)^2\left[\left(-\frac{1}{2}+\frac{f}{3}-\frac{1}{2}fC\right)\cos\omega+\left(\frac{1}{2}-\frac{7}{6}f^2\right)\cos v + e\Delta e + O(e^2)\right]+O(J_2^2) \quad (5.10)$$

$$\delta i = -3J_2\left(\frac{R}{p}\right)^2 \sin i\cos i\left[\frac{1}{2}S^2 + e\Delta i\right]+O(J_2^2) \quad (5.11)$$

$$\delta\Omega = -3J_2\left(\frac{R}{p}\right)^2 \cos i\left[\frac{u}{2}+\frac{1}{2}SC+e\Delta\Omega\right]+O(J_2^2) \quad (5.12)$$

in which Δa, Δe, Δi, and $\Delta\Omega$ are functions of the arguments of the satellite's motion ($\omega + v$, which are rapidly changing during an orbit). Since e is small for LAGEOS, the major terms in each of the equations (5.9), (5.11) and (5.12) are only functions of the motion of the satellite projected on the Earth's surface and consequently contribute no variation in the differences of the elements when two differently computed osculating orbits are evaluated at the same argument of latitude (u). The eccentricity variation of equation (5.10) does not share this property, but, as it turns out, this element is affected by J_2 significantly less than are the other orbital elements.

As can be seen in the more general formulation of *Kaula* [1967] (equation 3.76), all of the short-period gravitational variations should similarly cancel. Using the same approach, it can also be shown that this is also approximately the case for third-body and non-conservative perturbations, especially if the satellite positions in the trajectories to be compared reach the same latitude at nearly the same time (i.e., the along-track difference between trajectories is not excessively large). The limitation of this approach is that the deviations in the mean orbits must not exceed the amounts describable by the first-order theory we have applied.

The elements of an orbit determined from a continuous data span (in this case, of 30 days duration) are evaluated at a given argument of latitude: we chose $u = 0$, the equator crossing (thereby causing $S = 0$ and $C = 1$ in the above equations), although previous analyses [*Smith and Dunn*, 1980 and *Dunn et al.*, 1973], have considered $u = \pi/2$ which is the point of maximum latitude. These "short arc" elements follow the real satellite orbit in the chosen "Equator crossing" space, but are averaged over the 30-day data interval. In our procedure, they are compared with Keplerian elements evaluated at the Equator crossing points from an orbit calculated over a time span of several years based on the May 1976 initial orbital state. The differences between the "short-arc" and "long-arc" elements shown in Figures 5.12 through 5.16 are measures of the effects of error in the force model used in the orbit determination process and errors introduced from unmodeled sources on Keplerian elements, but are significantly unaffected by short-period terms due to J_2. The differences are similar to those computed using mean elements but offer the advantage of direct evaluation during the data reduction process using GEODYN's versatile numerical integration scheme.

5.3.2 *Results and Discussion*

The slight downward trend observed in the semi-major axis residuals (Figure 5.12) suggests that the along-track acceleration value (-3.1 pms^{-2}) adopted in calculation of the long arc is slightly higher than the true average. This is indeed the case. The along-track acceleration was shown in the previous section (Figure 5.6), and its mean calculated from the bi-monthly estimates is -3.44 pms^{-2}. The excursions about a secular trend correspond to the data excursions in the along-track acceleration described in Section 5.2. The ± 0.2 ppm variations in the difference of the eccentricity (Figure 5.13) may be a result of error in the odd zonal terms of the geopotential and any seasonal variation in them, as well as by any Earth albedo effects and satellite thermal effects, which will additionally influence the length of the semi-major axis.

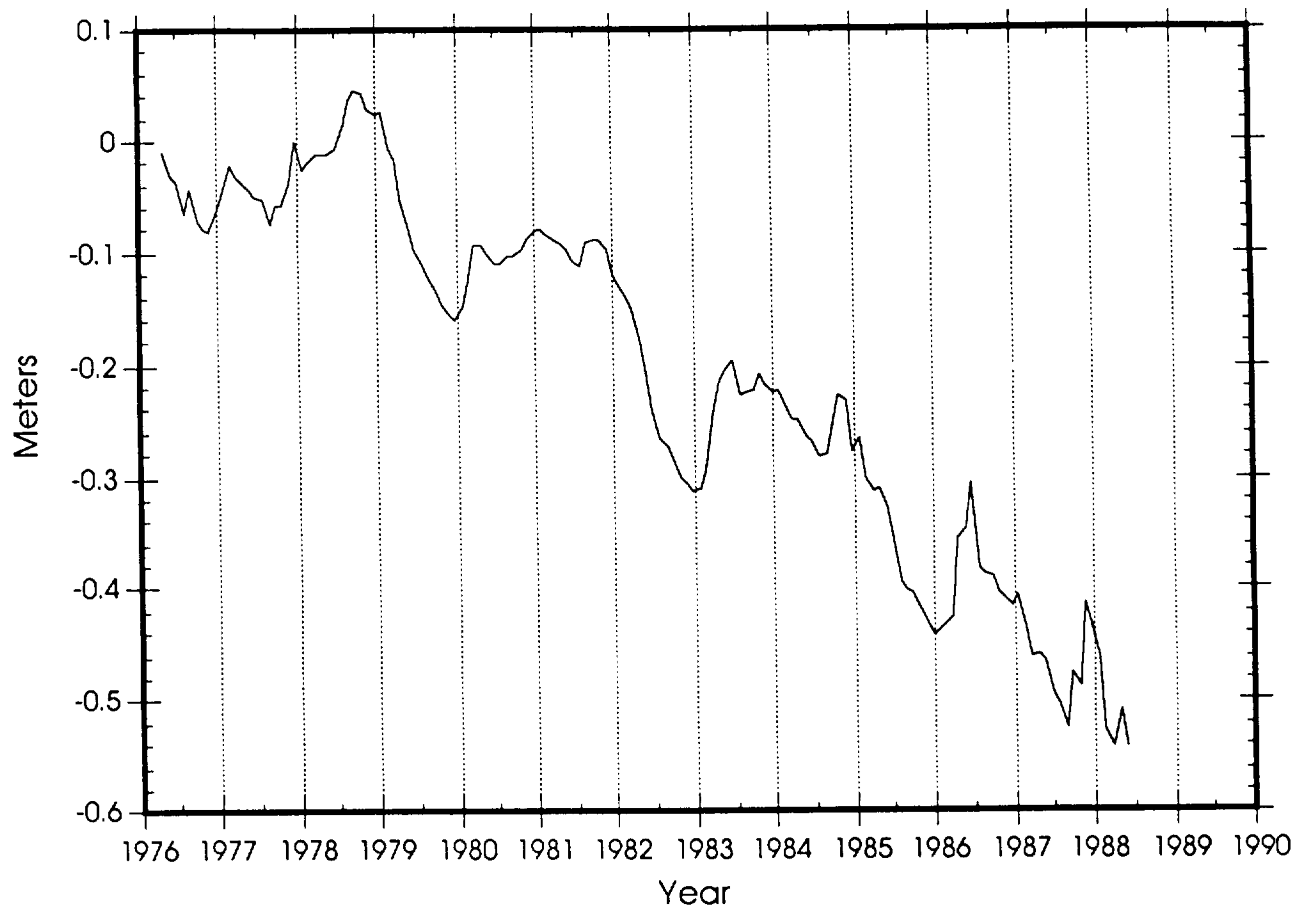


Figure 5.12 Monthly semi-major axis differences taken with respect to a single multi-year orbit calculated using identical force models beginning with the same initial conditions. An assumed average along-track acceleration of -3.1 pms^{-2} has been applied in this chart and in the next 4 figures. The remaining linear trend is due to the fact that the actual along-track acceleration is closer to -3.4 pms^{-2}.

A small upward trend in the inclination residuals (Figure 5.14) can also be attributed to the thermal drag effect described by *Rubincam* [1988] and *Farinella et al.* [1990], but the periodic effects are mainly caused by residual error in the tidal model and possibly by the Yarkovsky-Schach effect [*Farinella et al.*, 1990]. The Earth and ocean tidal errors will produce signatures in the node (Figure 5.15), among which would be included seasonal variations in the SA (annual) and SSA (semi-annual) tidal amplitude [*Smith and Dunn*, 1980]. The large secular effects in the node residuals are due to a combination of the effect of mis-modelling the 18.6-year zonal Earth tide by assuming that $k_{2,f}$ = .30 for this tide with zero phase and neglected ocean tides at this period and that of the rate of change of the second zonal harmonic caused by post-glacial rebound [*Rubincam*, 1984]. A few more years of tracking are required for the full

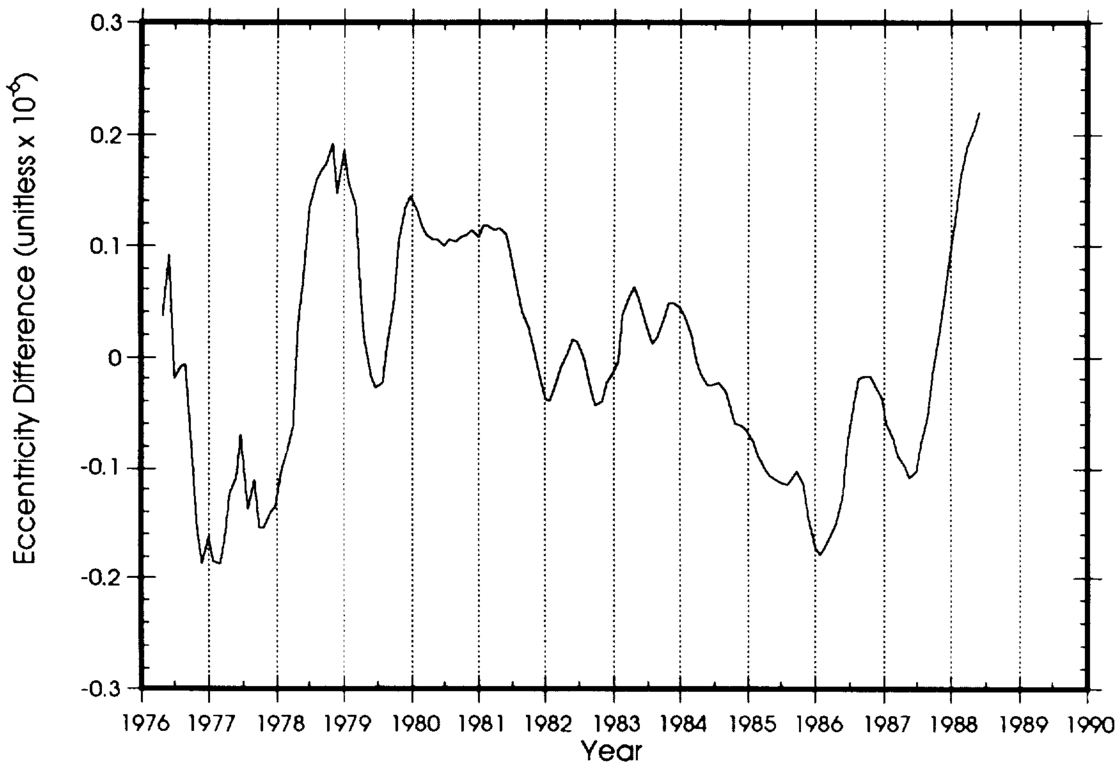


Figure 5.13 Monthly eccentricity differences taken with respect to a single multi-year orbit calculated using identical force models beginning with the same initial conditions.

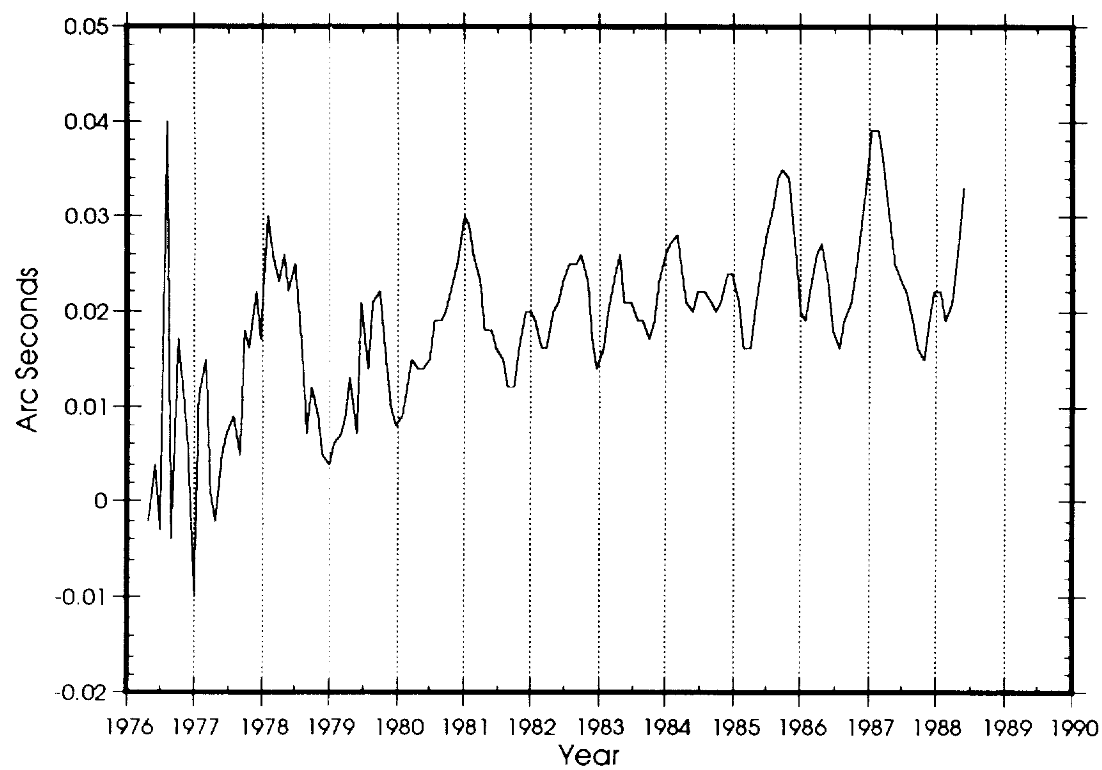


Figure 5.14 Monthly inclination differences taken with respect to a single multi-year orbit calculated using identical force models beginning with the same initial conditions.

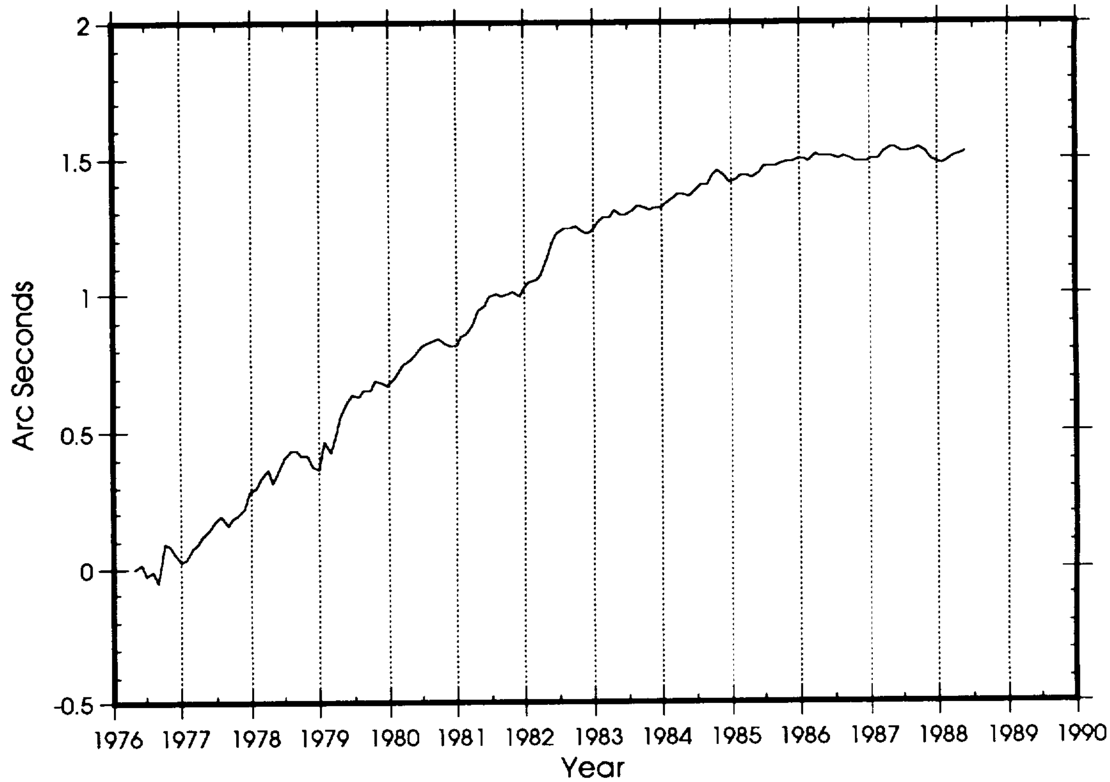


Figure 5.15 Monthly differences of the right ascension of the ascending node taken with respect to a single multi-year orbit calculated using identical force models beginning with the same initial conditions.

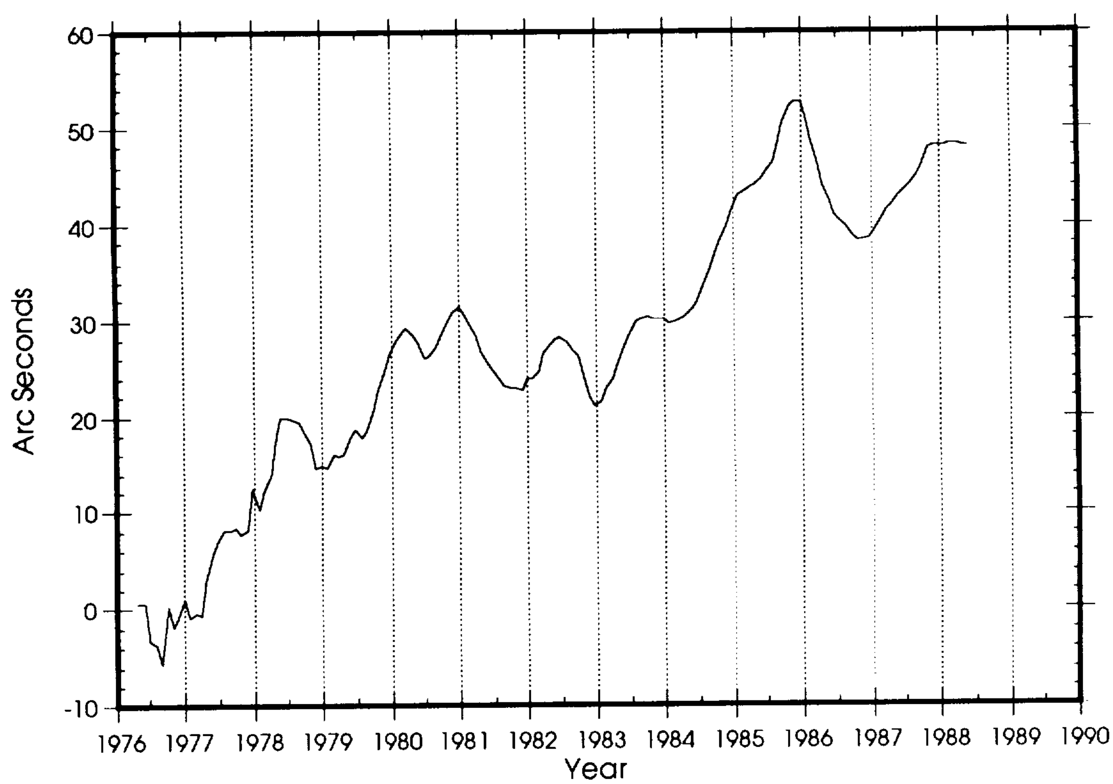


Figure 5.16 Monthly differences of the argument of perigee taken with respect to a single multi-year orbit calculated using identical force models beginning with the same initial conditions.

separation of these two effects. The argument of perigee variation (Figure 5.16) largely corresponds to excursions in the eccentricity.

5.4 Earth Orientation

It has already been discussed in the section on Reference Frames (Section 3.1) that polar motion and variations in the Earth's rotation rate must be determined through observation. In the discussion below, the polar motion and Earth orientation results obtained from the analysis of the LAGEOS laser ranging data is presented. The averaging intervals for the recovered Earth orientation parameters have been chosen for convenience to correspond to those of the BIH Circular D publication .

5.4.1 *The SL7.1 EOP Series*

The values of the SL7.1 recovered EOP series are given in Appendix 4. The series was obtained from a "global" solution (cf. Section 2.3) where all station motions were modeled with an adopted tectonic model; AM0-2 of *Minster and Jordan* [1978]. The horizontal position of Greenbelt, Maryland was unadjusted and constrained to move with AM0-2 motion as was the latitude of Maui, Hawaii. In addition to these, the first epoch estimate of A1-UT1R (the difference between atomic time (A1) and universal time regularized to account for tidal effects (UT1R)) was constrained in each arc, so that it could be decoupled from the node of LAGEOS.

Figures 5.17 through 5.20 graphically depict the estimated series of the coordinates of the pole in the usual conventional frame, the length-of-day, and its variations obtained by forward differencing of the estimated length-of-day (A1-UT1R) values. In Figures 5.21 through 5.23 are shown the standard deviations associated for each of the three components of the EOP series. It is remarkable how vividly the latter reflect the changes in the tracking network strength and the precision of the ranging instruments. Disregarding short transition periods in between major eras, one can clearly identify the existence of three such eras:

1976 - 80:	Weak network, low-precision instruments
1980 - 84:	Better network, higher precision instruments
1984 - 89:	Strong network, high-quality instruments

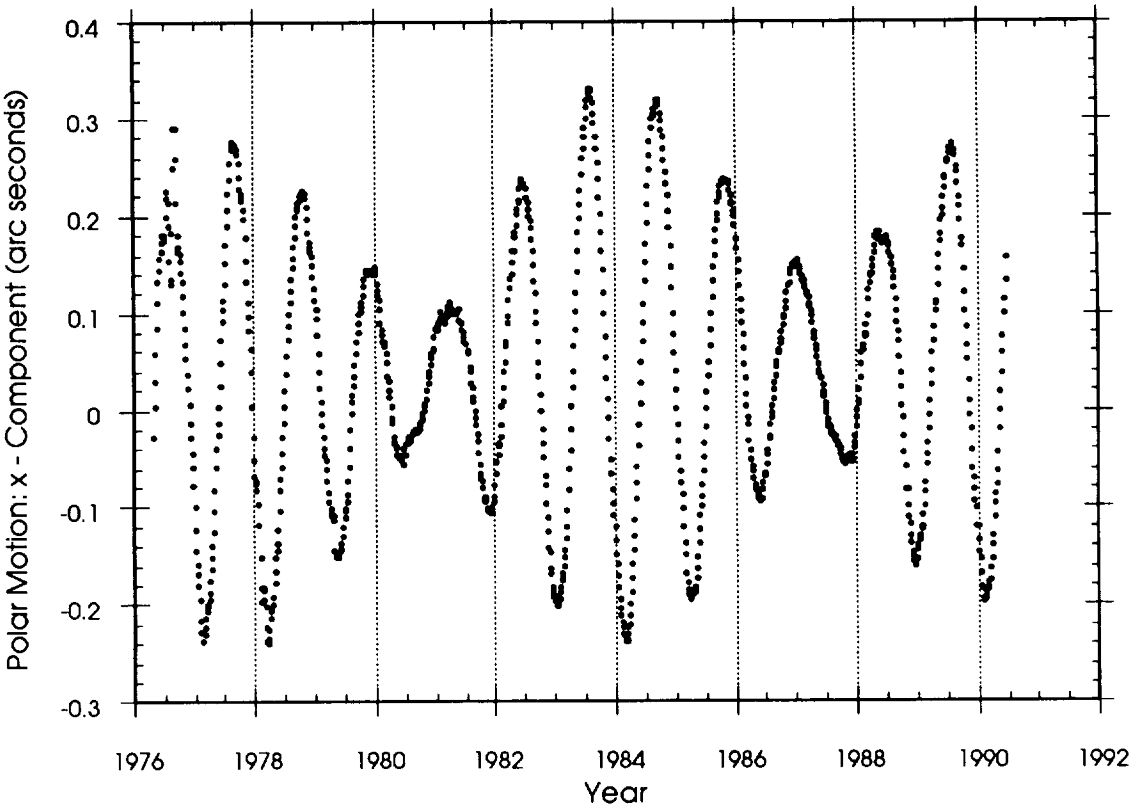


Figure 5.17 The x - component of the pole as recovered from the SL7.1 solution.

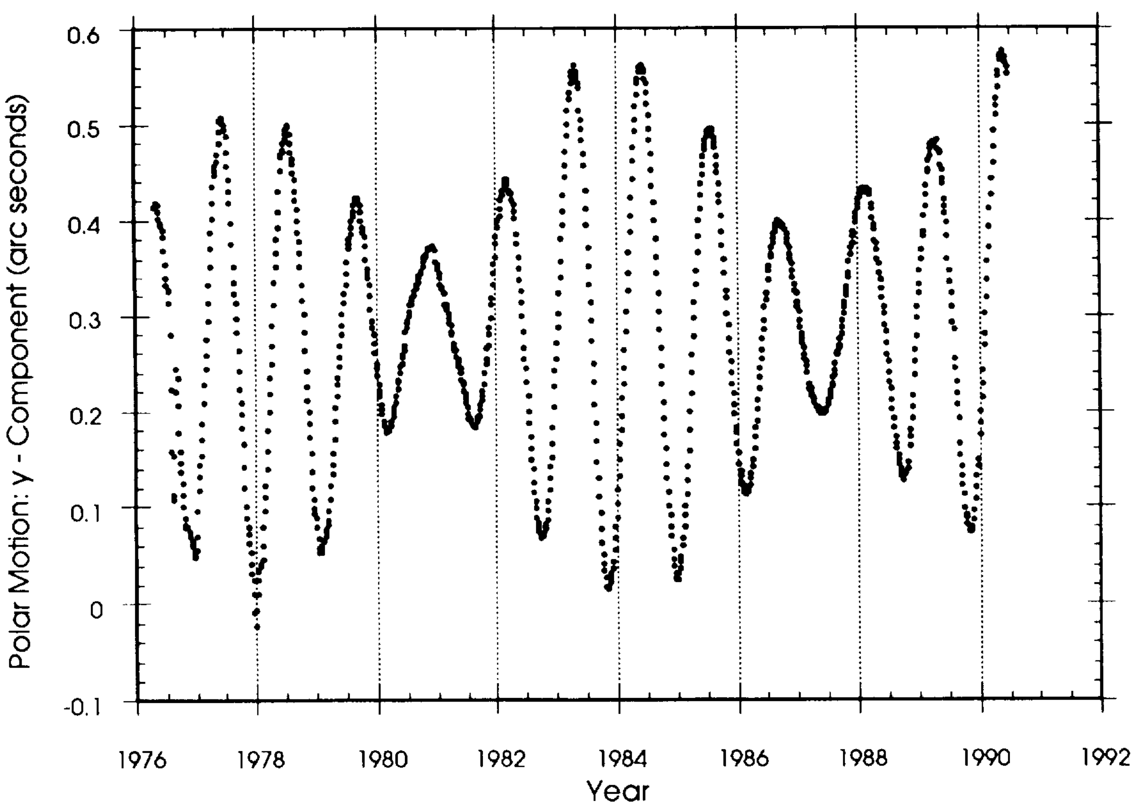


Figure 5.18 The y - component of the pole as recovered from the SL7.1 solution.

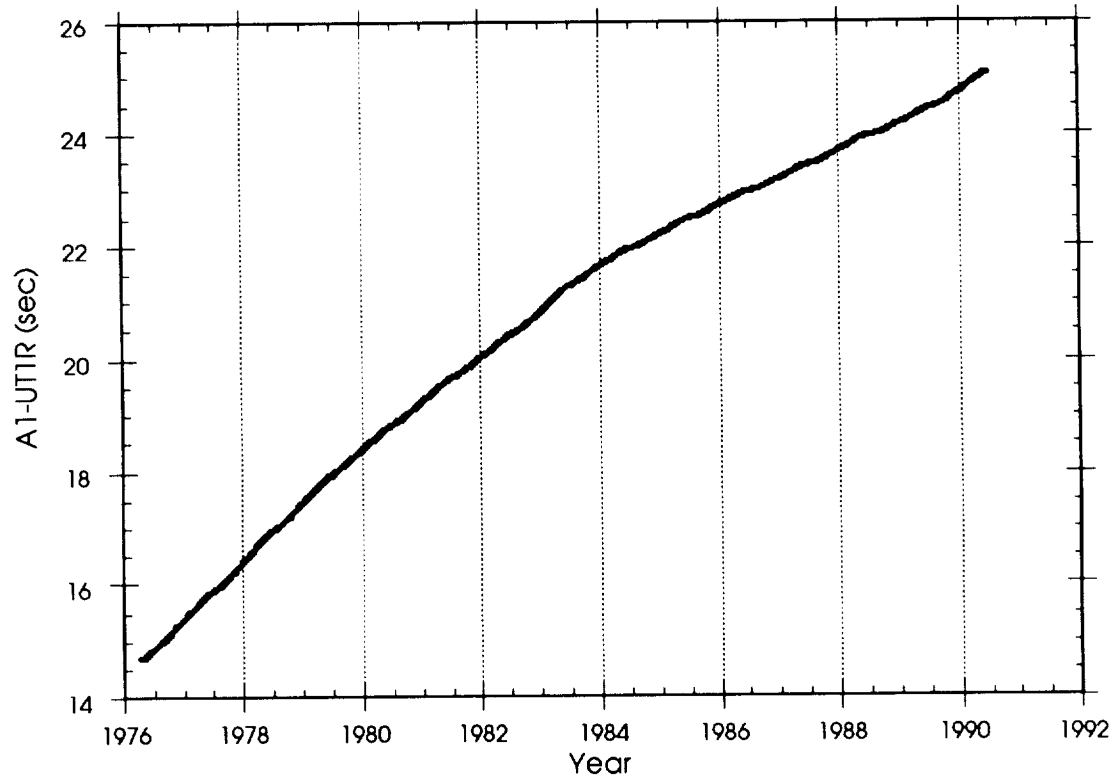


Figure 5.19 Length-of-day parameter (A1-UT1R) receovered by the SL7.1 solution.

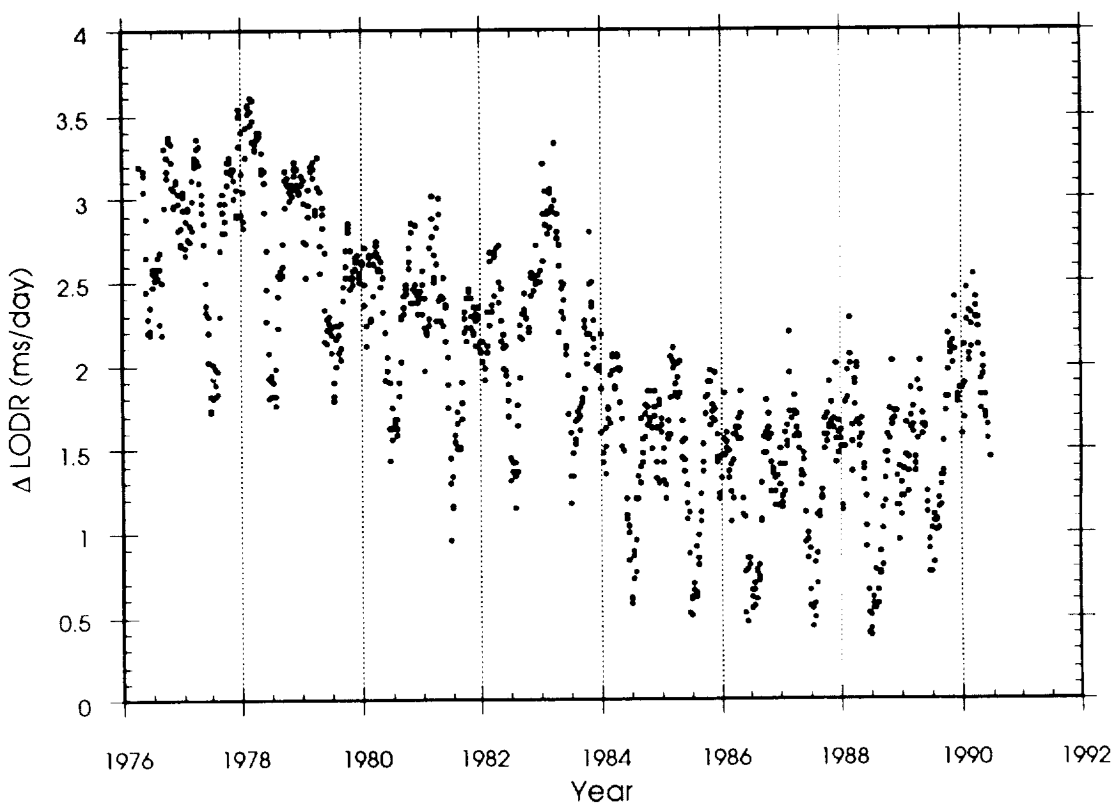


Figure 5.20 Change in the length of day as recovered by the SL7.1 solution.

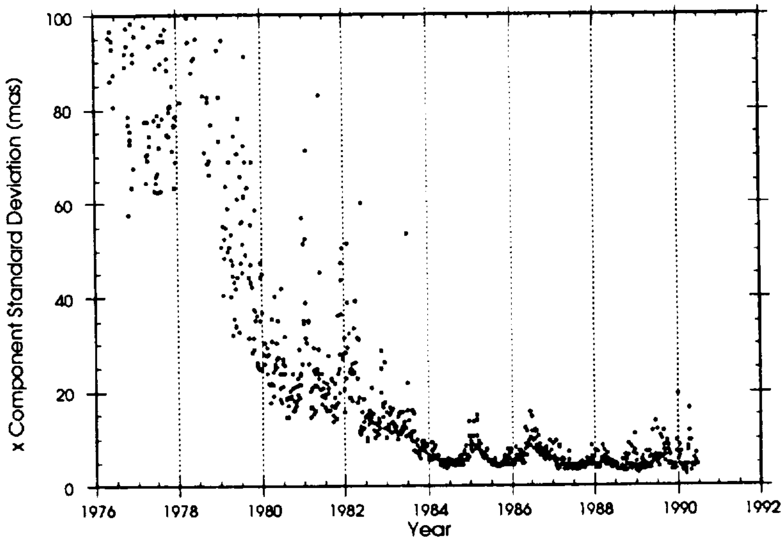


Figure 5.21 Standard deviations in the recovery of the x - component of polar motion.

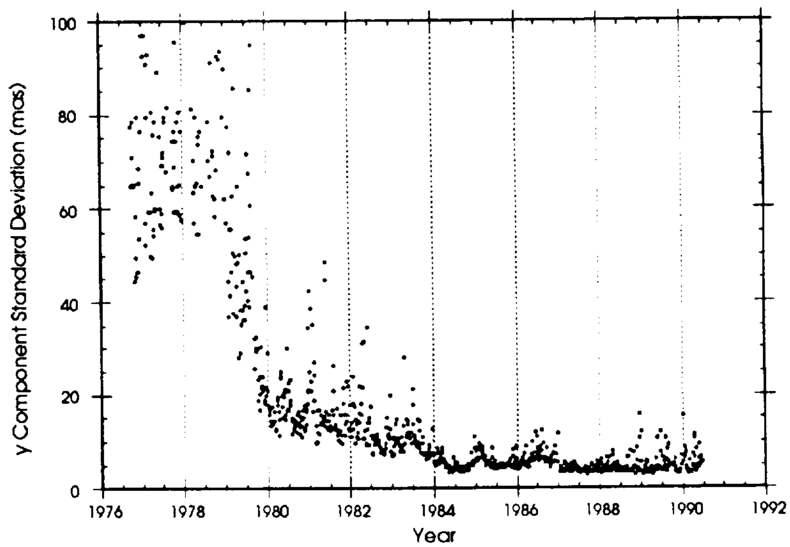


Figure 5.22 Standard deviations in the recovery of the y - component of polar motion.

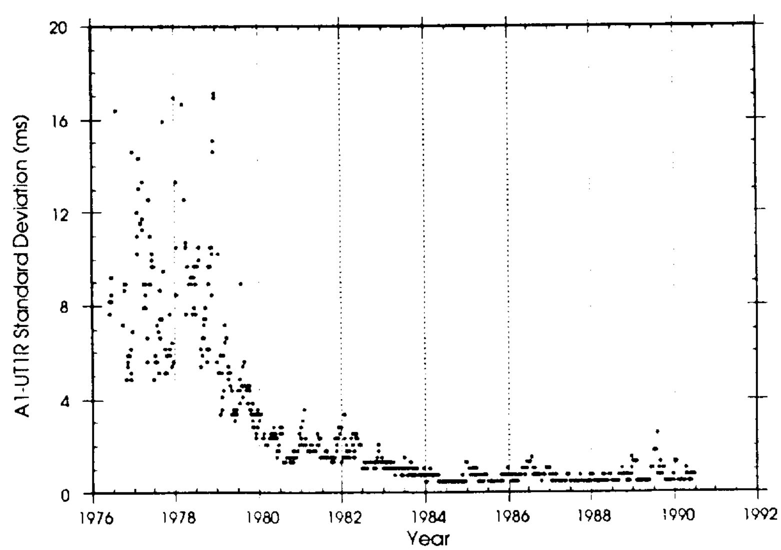


Figure 5.23 Standard deviations in the recovery of the length-of-day.

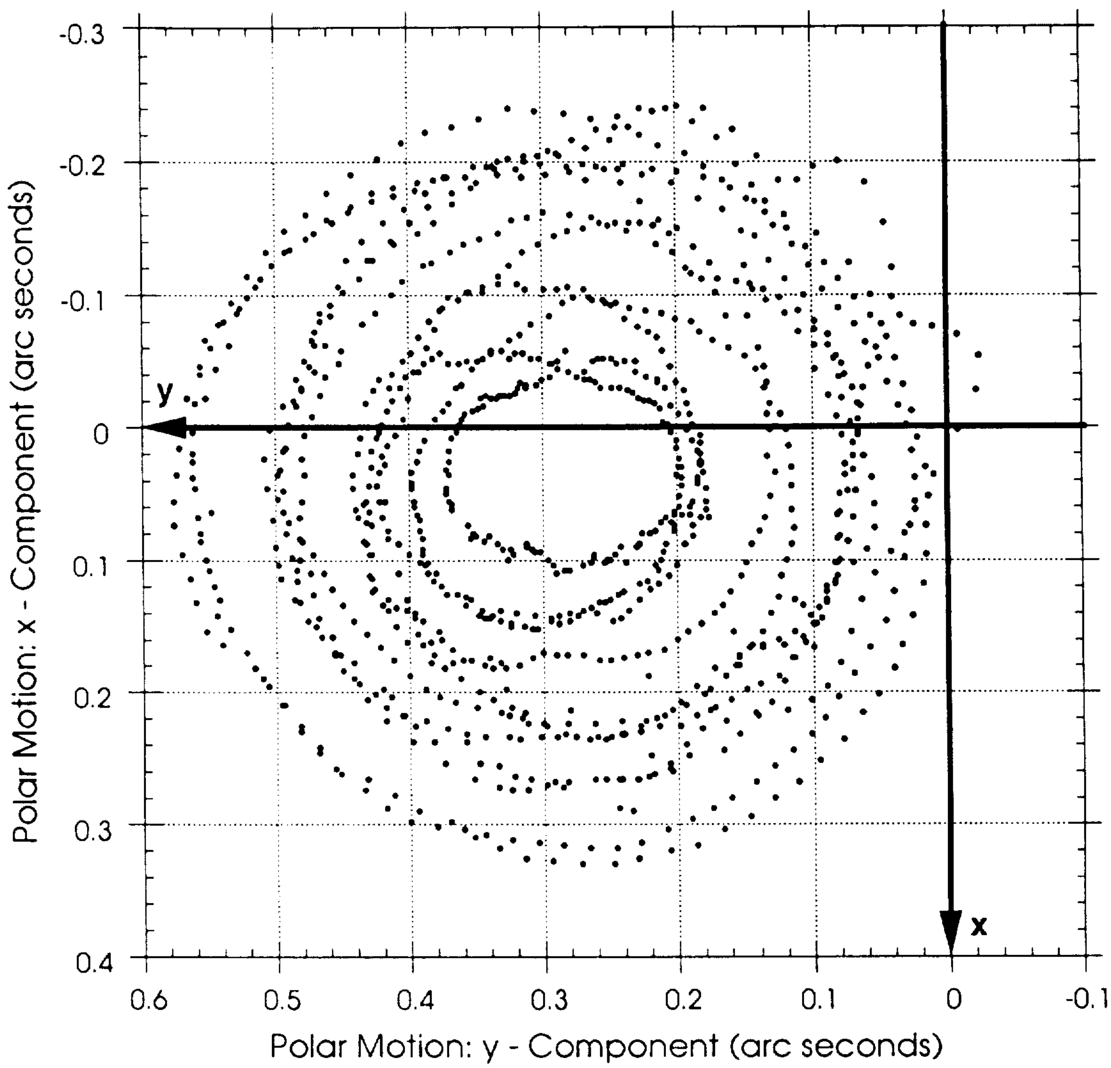


Figure 5.24 The polhode, or path of the pole, for the period May 1976 to July 1990 as recovered from the SL7.1 solution.

In Figure 5.24, there is shown a plot of the polhode, the actual trajectory of the Celestial Ephemeris Pole as determined in SL7.1, projected on a plane tangent to the Earth's surface at the Conventional International Origin (CIO).

5.4.2 *Uniformization of the EOP Solution*

The analysis of the SLR data produces a continuous series for polar motion (both components), and a discontinuous series of Earth rotation variations. The inability to separate the absolute magnitude of the Earth's angle of orientation in space from the satellite node requires us to

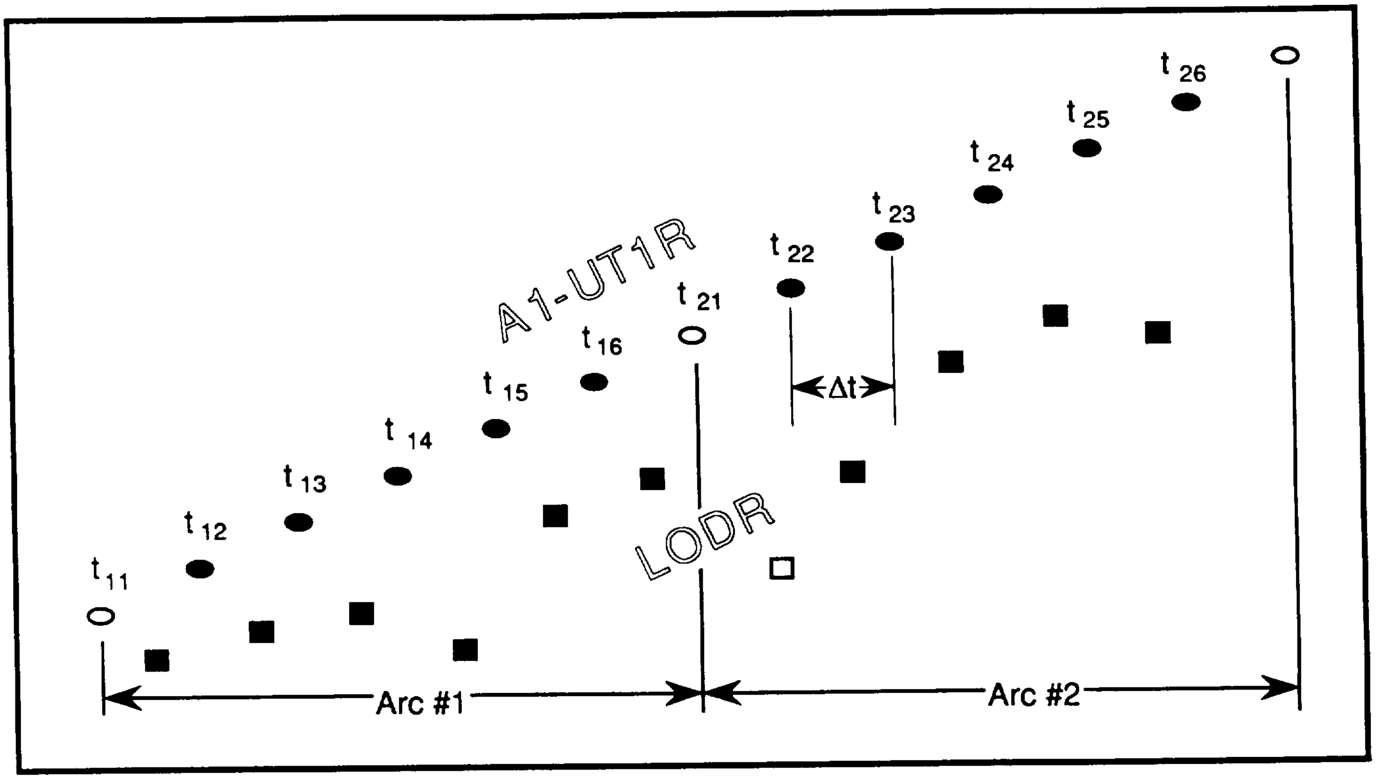


Figure 5.25 Method for uniformization of the estimated Earth orientation parameters. Two arcs are shown. The A1-UT1R series is depicted as ovals and the LODR series is depicted as rectangles. The open ovals indicate that A1-UT1R is constrained to BIH values. In the case of t_{11}, the BIH value is adopted to reference the uniform series. The solid ovals indicate values of A1-UT1R estimated in the solution. The solid rectangles indicate values of LODR determined from forward differencing of adjacent A1-UT1R values. The open rectangle indicates that LODR has been interpolated by cubic splines.

constrain the initial value of A1-UT1R in each of our independent arcs to its *a priori* value. If the constrained values are not consistent with the ensemble of values estimated, then the series will exhibit severe discontinuities at these nodal points.

Similar discontinuities exist in the derivative of the A1-UT1R parameter, the variation of the length of day, ΔLODR. Despite the fact that absolute orientation angles are not estimable from the data, their relative variations are. What we have done therefore, is to determine the ΔLODR series from the estimated A1-UT1R series and then determine, through spline interpolation, the missing values of ΔLODR at the nodes between arcs. Figure 5.25 illustrates these concepts. Once the ΔLODR series is rectified and complete, one only needs a starting value of A1-UT1R to reverse the forward difference procedure and integrate the ΔLODR series into a continuous A1-UT1R series

$$(A1-UT1R)_{unified}(t)=(A1-UT1R)_{unified}(t-\Delta t)+(\Delta t)\Delta LODR\left(t-\frac{\Delta t}{2}\right) \quad (5.13)$$

In applying this procedure we also smooth the final series using the Vondrák filter [*Vondrák*, 1977] with a weak smoothing parameter $\varepsilon = 10^{-4}$ which effectively suppresses the periods below 20-30 days. It is the rectified and smoothed series that was shown in the figures discussed above. This series is then in a form which can be used in comparison and time domain studies [cf. *Pavlis*, 1991].

The secular nature of the smoothed pole series was reported by *Pavlis* [1990] in which the secular trend of the pole was calculated from an 8-year span of polar motion data to be 3.3 mas/yr in x and 2.6 mas/yr in y giving a direction of approximately 38° E longitude with respect to the CIO.

5.5 Elastic Earth Parameters

In addition to the Earth orientation parameters, the global elastic parameters h_2 and l_2 (Love numbers) associated with the station tidal variations were estimated. The adjusted h_2 is 0.627 ± 0.004 as compared with the Wahr *a priori* of 0.609 and the adjusted l_2 is 0.0986 ± 0.002 as compared with the Wahr *a priori* of 0.0852. The standard deviations given are three times the formal standard deviation of the global solution. The differences from the *a priori* are formally significant: however, they represent variations in station positioning at the 1- to 5-mm level which could well be due to neglecting a model for the site dependent ocean loading. The discrepancies are at the 4% level for h_2 and the 16% level for l_2.

Previous recoveries of these parameters provide similar values for h_2 and l_2 : *Christodoulidis et al.* [1985] presented 0.608 ± 0.003 for h_2 and 0.0934 ± 0.002 for l_2 from analyses of the 1980-1983 LAGEOS tracking data. *Carter et al.* [1985], using VLBI data taken 1980-1984 determined values of 0.6135 ± 0.0054 and 0.0768 ± 0.0191 for h_2 and l_2, respectively. *Gendt and Dietrich* [1988] estimated h_2 and l_2 to have values of 0.610 ± 0.003 and 0.099 ± 0.002, respectively, based on their analysis of September 1983 to May 1985 LAGEOS tracking data. While none of these results are clearly inconsistent with the others, the values disagree by more than would be expected from their uncertainties; this behavior is more typical of model errors than geophysics.

Gendt and Dietrich [1988] have shed some light on this: they also evaluated h_2 and l_2 from their data on a station- by-station basis, recovering 0.598 ± 0.012 for h_2 and 0.092 ± 0.009 for l_2 as the respective means of their independent local determinations. The range of well-determined values was between 0.4 and 0.7 for h_2 and between 0.02 and 0.24 for l_2. The individual station recoveries provide estimates of h_2 and l_2 which are formally distinct from the global mean estimate by significant multiples of the formal error of determination. They are observing the same type of behavior we see in comparing the solutions of different investigators, and the implication is that the data do not fully conform to the model. We suspect that unmodeled ocean loading effects are strong candidates for being the major source of the model error here. This will be considered in future analyses.

6. The Estimation of Station Coordinates and Reference Frame Realization

In Section 3.1, reference systems were described and reference frames, as applied to the analysis of laser range data, were considered. One of the ultimate goals of the SL7.1 solution is to simultaneously realize the CTRS and determine the individual motions of the tracking stations. Ideally, the solution should be completely robust and all estimable quantities of interest (including those that vary with time) should be solved for in a singular, massive inversion. Due to software restrictions, the estimation of the station motions could only be achieved through a series of individual station position determinations spanning the tracking history of the network. In other words, the GEODYN/SOLVE analysis system was limited in its capability to directly estimate epoch positions while simultaneously estimating tracking site velocities.

Given the limitations of the software system, the procedure which was used can be outlined as follows. Within each solution period, the motion of each station was modeled according to the adopted tectonic model (AM0-2). It is important to try to keep the time span of each solution as short as possible so that the resulting station positions are not contaminated by errors in the underlying tectonic model. Additionally, if the solution period was made too long, the detection of episodic events and station hardware problems may become overly averaged and possibly go undetected. Once the series of station positions are available, their time histories of latitude, longitude, and height can be determined by weighted least-squares line fits to these quantities or, better, they can be estimated via a combined adjustment of the ensemble of interstation distance variations. A graphical outline of the data reduction process which was followed to estimate tracking site velocities is shown in Figure 6.1. The remaining sections of the chapter will describe the details of this process.

6.1 Requirements for High Temporal Resolution Analysis

The analysis of variations in the length of the distance between tracking sites provides the basis for the inference of station motions in SL7.1. Given the aforementioned software limitations, we chose to determine the motion of the stations based on the interstation distance rates. This approach was taken for primarily two reasons. The first is that interstation

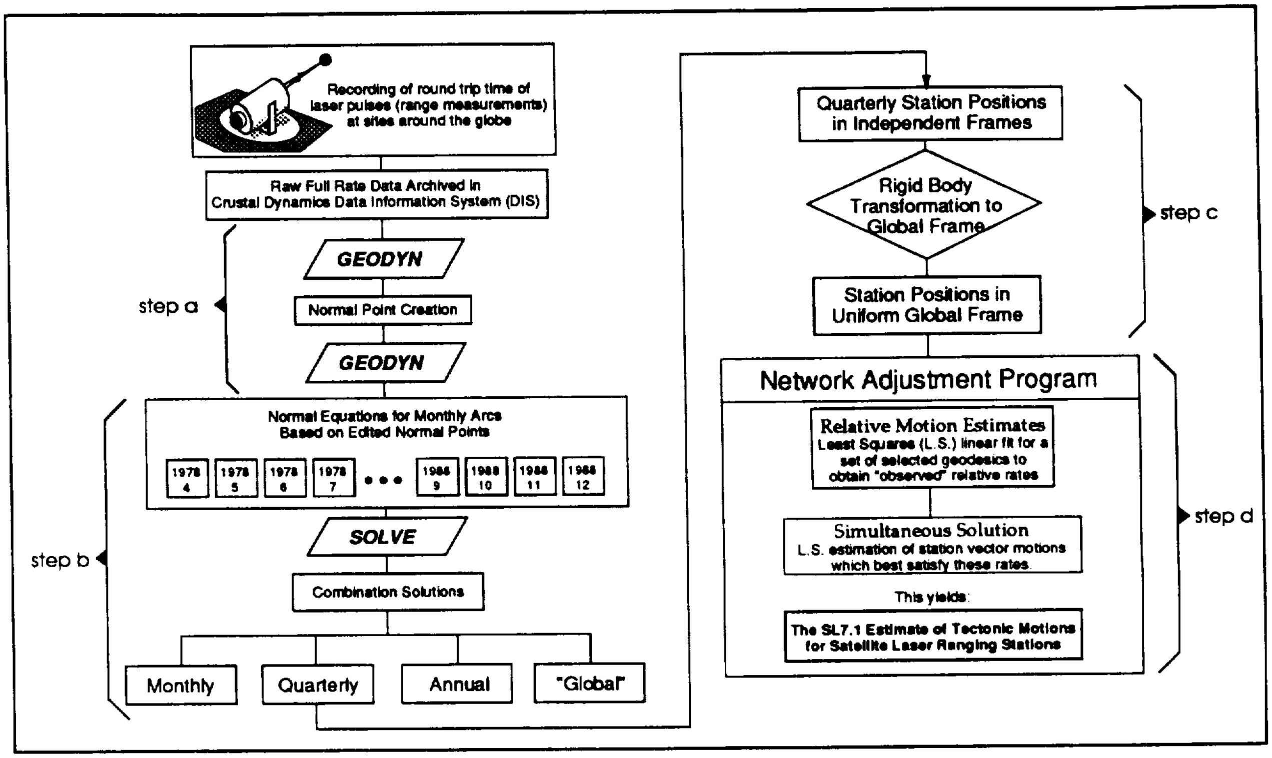


Figure 6.1 SL7.1 solution design. Step "a" on normal points was discussed in Section 4.2. The software system was described in Section 2.2. The various solution types were described in Section 2.3. The remainder of the present chapter will focus on steps "c" and "d."

distances are by and large uncorrelated, which then allows for the removal of off-diagonal terms within the covariance matrix without appreciable loss of accuracy. The second reason is due to the fact that the estimated station positions are directly dependent on the underlying reference frame. Since the reference frame from one estimation period (quarter) to the next is linked only through an *a priori* constraint, the stability of the reference frame is data dependent and therefore does not yield completely consistent station motion estimates based exclusively from the time histories of the geodetic coordinates themselves (this is discussed further in the next section).

Since the horizontal motion of the stations is of primary interest in assessing global tectonic behavior, it is required that all station positions be reduced to a common surface upon which distance computations are performed. A natural choice for the reference surface is an ellipsoid of revolution, such as is typically used for continental geodetic networks. The network computations are made with respect to the internationally accepted GRS-80 ellipsoid having a semi-major axis of 6378137m and a flattening of 1/298.257 [*Moritz*, 1988]. The last decision to be made is the "type" of interstation distance to be analyzed. Given the fact that the reference surface is an ellipsoid, there are two choices for a unique definition of interstation distance. These include the *spatial chord* connecting the projections of the two station positions on the ellipsoid, and the *geodesic line*, the curve on the ellipsoid's surface with the shortest length between the two projected positions.

The geodesic line, or shorter, the geodesic (sometimes called the geodetic line in some texts), was chosen since it can directly determine the horizontal components of the vector of motion which most closely approximates the natural one. This obviates the need to project the resulting motion vector components to the surface, since they are already determined directly with respect to it. Additionally, analysis of surface curves versus baselines or chord lengths overcomes the ill-conditioned case regarding motion between pairs of stations which are nearly antipodal (i.e., opposite sides of the world). Since the Earth's shape departs very little from that of an ellipsoid, the interstation chord or baseline between antipodal stations will contain only minimal information about the horizontal motion of the stations since it is essentially orthogonal to the local horizontal at each station. In these antipodal cases, baseline or chord rates, having typically a low signal-to-noise ratio, reduce the likelihood that one can derive any meaningful results regarding horizontal motion.

The disadvantage of using geodesic lines lies in the fact that unlike the spatial chords, geodesics are not independent of the reference frame realized by the estimated station positions. This stems from the fact that the reference surface, the ellipsoid, is attached to the coordinate axes of the reference frame centered at its origin. Any misalignment of the axes between solutions or any translations of the origin will directly affect the computed geodesic lengths and thereby their rate of variation. This in turn will propagate into the station position motion and result in biased estimates for them.

Without loss of generality, one can examine the special case of two stations lying on the same meridian. The situation is illustrated in Figure 6.2 for the case of an origin shift along the Z axis, and for that of a rotation $\Delta\psi$ about either the X or Y axis. As can be seen from these figures, the geodesic is less sensitive to rotations about X and Y (no changes for rotations about Z) but very sensitive to Z-axis translations. One can show that the sensitivity contrast between translations and rotations reaches a maximum when the ellipsoid degenerates to a sphere. At that point the geodesics degenerate into great circles and their length is, of course, independent of the orientation of the coordinate axes. For the spherical case, a change in a spherical

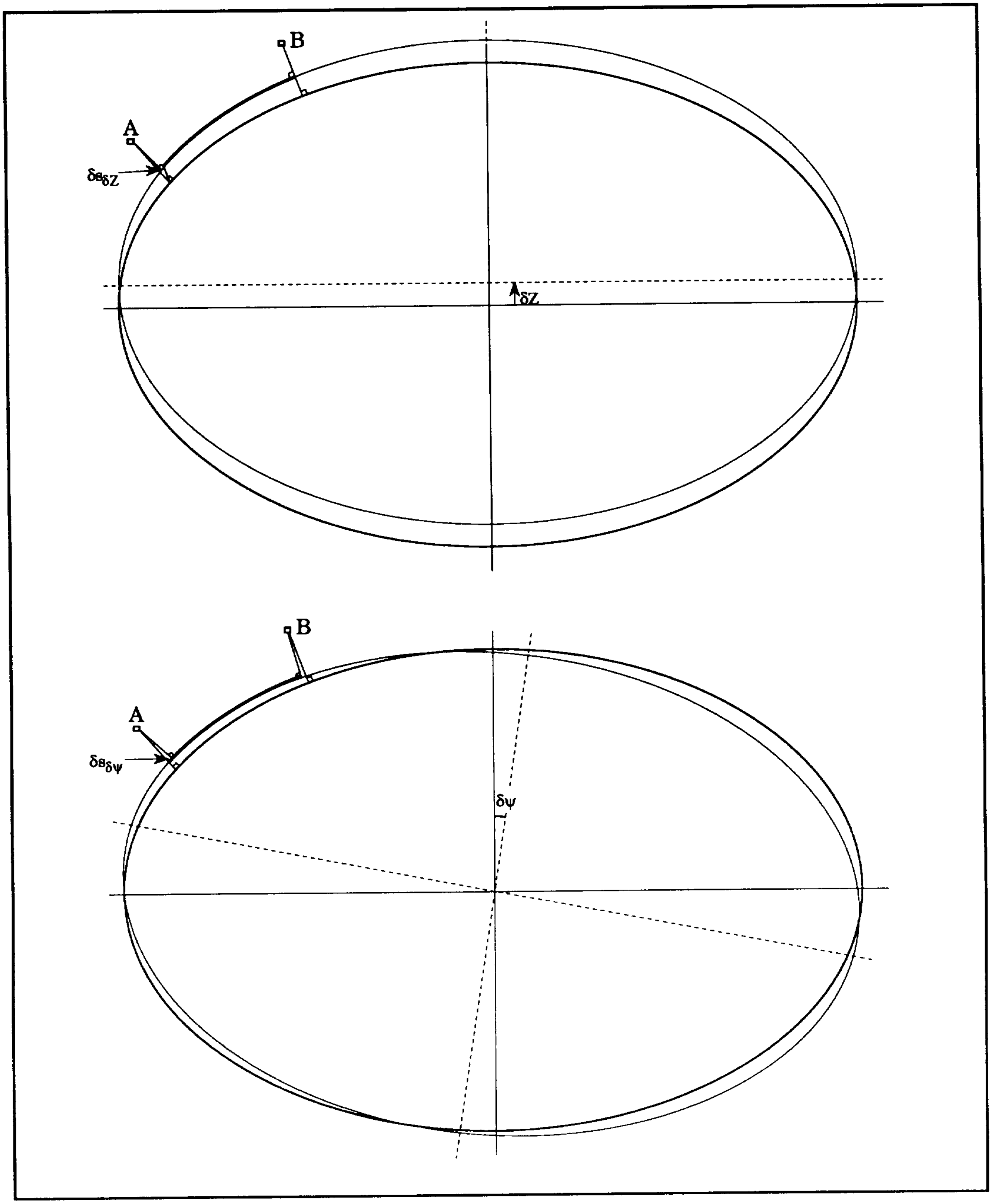


Figure 6.2 Changes in geodesic distances due to differential shift along the Z axis (top) and due to rotation about an axis lying in the equatorial plane (bottom). Points A and B represent tracking station locations which are projected to the ellipsoid for the purposes of computing geodesic distances. In both figures, the flattening of the ellipsoid is highly exaggerated compared to that of the real Earth.

distance (δs) between points projected onto the sphere at A and B due to a differential shift along the Z axis (δz) is given by

$$\delta s = -r_e\left(\frac{1}{\sqrt{1-u^2}}\right)\frac{du}{dz}\delta z \tag{6.1}$$

where

$$u = \sin\varphi_a \sin\varphi_b + \cos\varphi_a \cos\varphi_b \cos\Delta\lambda$$

$$\frac{du}{dz} = \sin\varphi_b \cos\varphi_a \frac{d\varphi_a}{dz} + \sin\varphi_a \cos\varphi_b \frac{d\varphi_b}{dz} - \cos\Delta\lambda\left\{\cos\varphi_b \sin\varphi_a \frac{d\varphi_a}{dz} + \cos\varphi_a \sin\varphi_b \frac{d\varphi_b}{dz}\right\}$$

$$\frac{d\varphi_i}{dz} = \frac{\sqrt{x_i^2 + y_i^2}}{r_i^2}$$

For the meridonal case as illustrated in Figure 6.2, the spherical approximation, formulated above, yields a family of curves describing the behavior of equation (6.1) which are illustrated in Figure 6.3. Shifts along the Z axis can cause variations of the spherical distance to have a ratio with respect to the Z shift as large as 2:1. The ellipsoidal case is not much different since the flattening of the ellipsoid departs from a sphere only by a small amount (~ 0.3 %).

6.2 Controlling the Stability of the Reference Frame

The results of the above analysis indicate that specific geodesics can attain magnification factors from Z axis translations as high as two. This means that to obtain geodesic rates free of any such biases and still claim accuracies of some millimeters per year, the reference frame must demonstrate comparable stability. This stability is a function of four major factors:

- the geometric strength of the network of observing stations,
- the variability of the station configuration between solutions,
- the time interval over which the stations define the reference frame, and,
- the orbital dynamics of the satellite(s) being tracked.

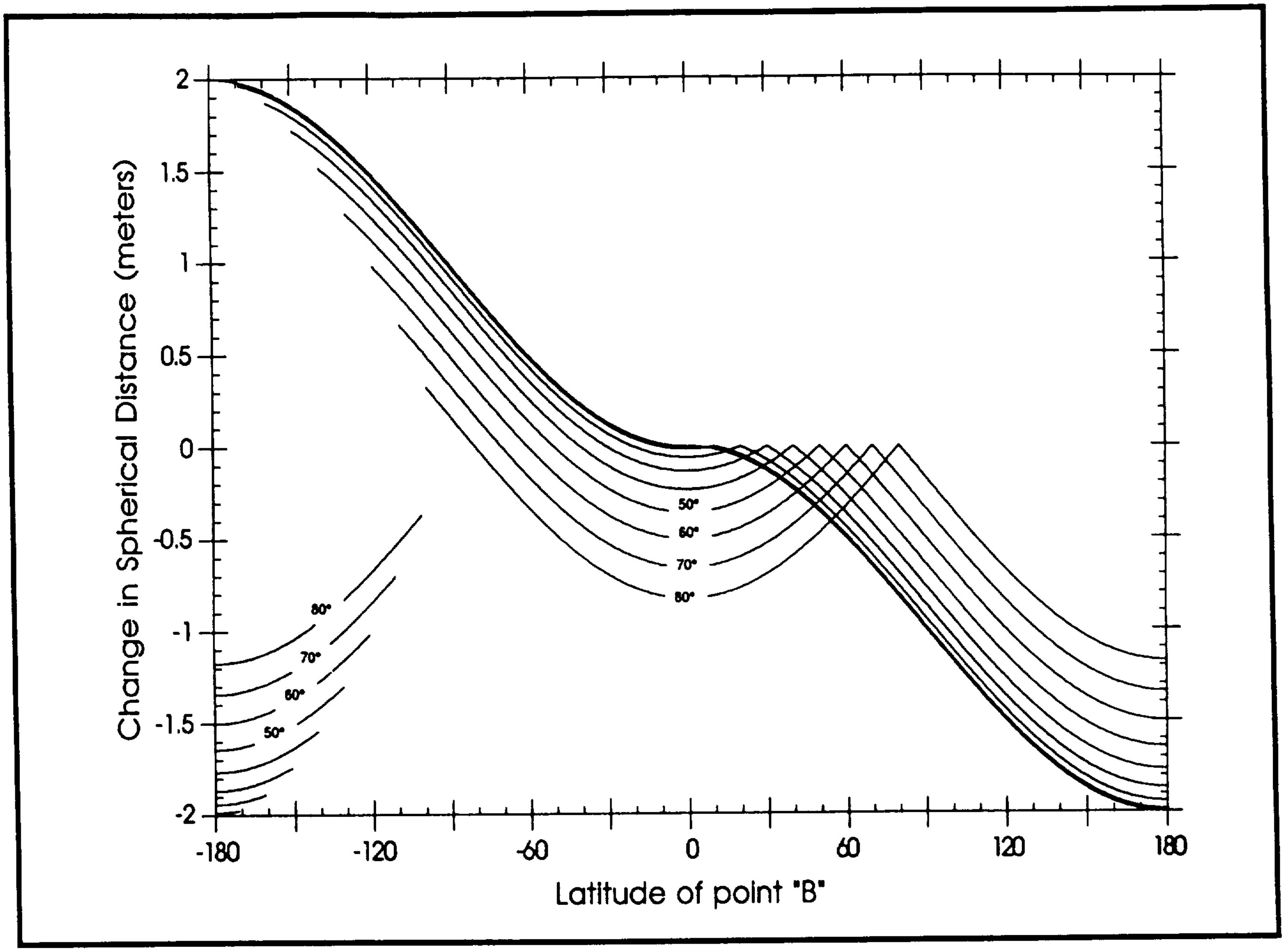


Figure 6.3 Behavior of meridonal spherical distances due to a 1-meter downward shift of the origin along the Z axis. Each curve represents the behavior of the spherical distance from point "A" to point "B". The latitude of point "A" is listed on each curve in 10° increments. The latitude of "B" goes beyond ±90° when "B" is in the opposite hemisphere. The curves are discontinuous at the antipodal point at which a singularity exists. Along meridonal sections, the largest spherical distance change occurs when points "A" and "B" lie near the Equator and can approach as much as twice the amount of the Z shift.

There is not much that can be done with respect to the first point, since in the case of SL7.1 the network is given de facto. As for the last point, the orbital evolution studies (Section 5.3) have not indicated any significant stability problems. LAGEOS constrains the origin of the coordinate system to an effective center of the Earth's attracting mass with great stability. Due to the extremely accurate force modeling possible for LAGEOS, the origin should be, to a very high degree of approximation, equivalent to the center of mass of the Earth.

The stability of the network configuration turns out to be very important because the tracking problems of particular stations and the effect of residual unmodeled forces on the orbit propagate through the highly accurate ranging data into the recovered station positions, Earth orientation, etc., in considerably different ways from one solution to the next. The solution time interval is very closely related to the network stability. The longer the interval which the solution spans, the more stable the frame it realizes. This is not only because of the increase in the collected observations, but also because of the natural averaging in the tracking configurations encountered. As the interval is lengthened, the impact of station drop-outs or new stations joining the network is minimized. It is extremely difficult to control this last factor since in most cases, drop-outs are to be blamed on unpredictable station malfunctions or prevailing climate conditions that are beyond our control. Nevertheless, one needs to develop a measure that reflects these changes in the network so that one can appropriately correct for them.

6.2.1 *Network Geometric Stability*

One way to quantify the two factors mentioned above is to monitor the changes in the geometric center of the tracking stations ensemble. We have done this for the case of the shortest span over which a set of data has been reduced (one month nominally) and for the station distribution over the triplets of the monthly subsets which define our basic solutions, the quarterlies, as presented herein.

We define the geometric center of the network as the point whose Cartesian coordinates are the average of those of the stations in the network:

$$\overline{X} = \frac{1}{N}\sum_{i=1}^{N} X_i \qquad \overline{Y} = \frac{1}{N}\sum_{i=1}^{N} Y_i \qquad \overline{Z} = \frac{1}{N}\sum_{i=1}^{N} Z_i \tag{6.2}$$

where N is the number of stations in the network. If the station configuration were to remain the same over the entire period of time, then the evaluation of the above would show no variations. On the other hand, the actual values would indicate how symmetrical the current station distribution is or, for that matter, how biased it is with respect to any one particular region. The results in Cartesian and spherical coordinates are shown in Figures 6.4 and 6.5.

The initial observation is that the geometric center of the network is located in the Northern Hemisphere as depicted in the graphs of the variation in Z (bottom of Figure 6.4) or in latitude

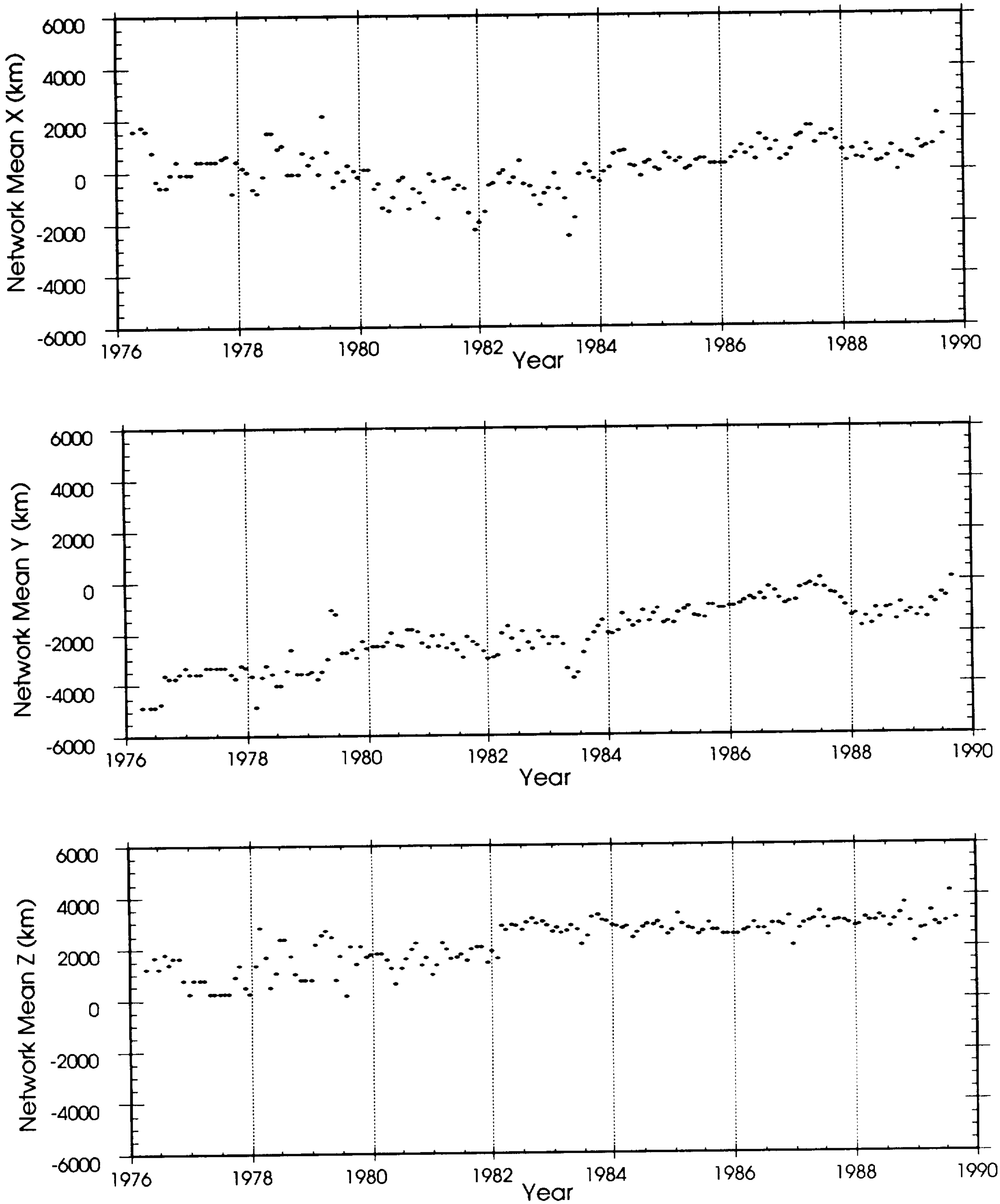


Figure 6.4 Monthly variations of the mean geometric center for the SLR network in terms of Cartesian coordinates.

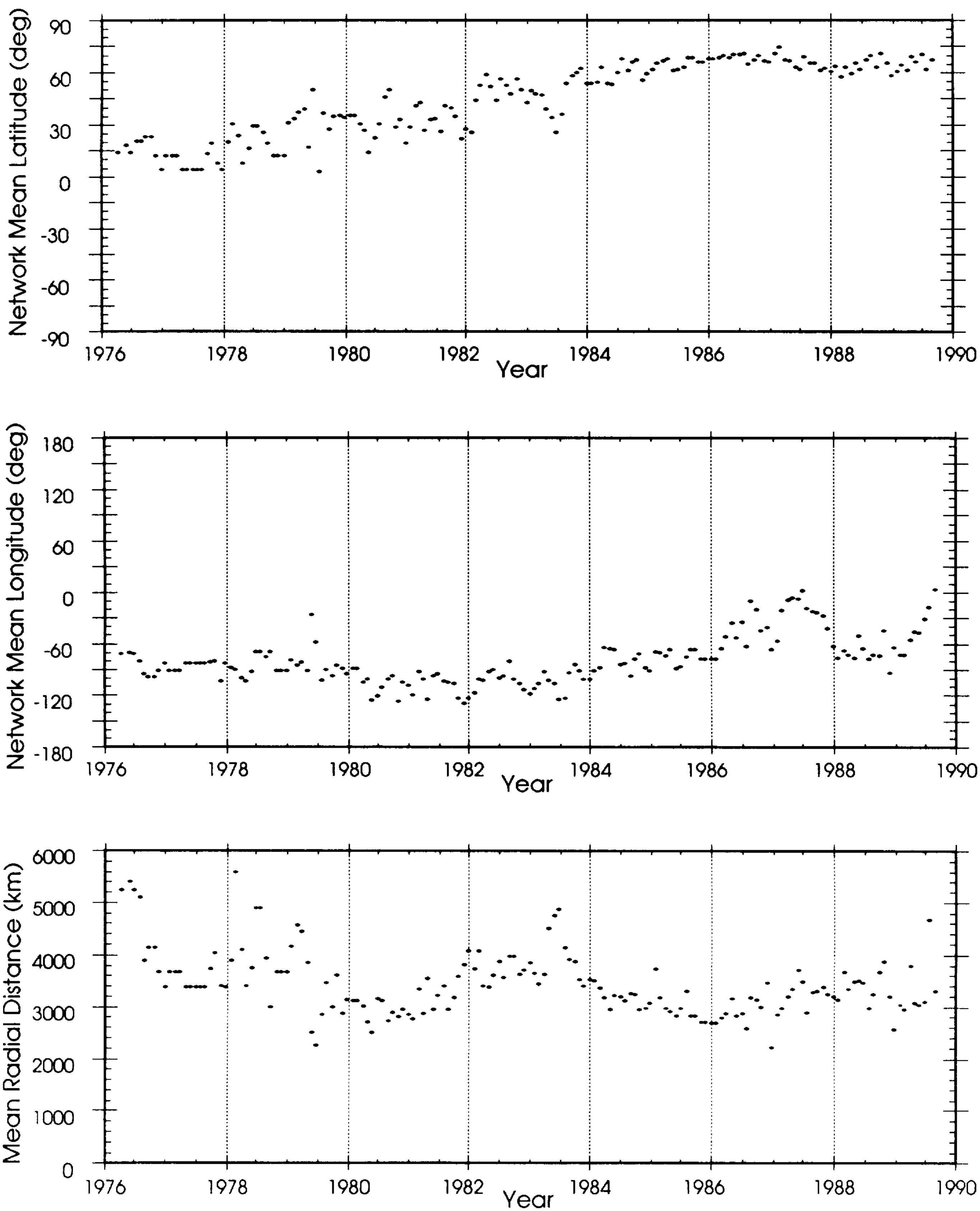


Figure 6.5 Monthly variations of the mean geometric center for the SLR network in terms of spherical coordinates.

(top of Figure 6.5). Secondly, the longitude of the mean geometric center is consistently close to 270 degrees indicating the strong influence of the stations located in the continental U.S. (middle graph of Figure 6.5). In terms of variations, one should note that the network center undergoes significant changes from one month to the next and, due to averaging, one can anticipate the variation across quarterly solutions to be smaller than that of the monthly ones.

The results of this analysis indicate that even with the extended solution period of 3 months, the network will continue to exhibit instabilities which may hinder the solution in achieving the accuracies required for answering geodynamically relevant questions. What therefore needs to be done is to devise a technique that would allow an increase in the resolution of the results without forcing a trade-off in their accuracy.

6.2.2 *The Global Solution as a Reference Standard*

If the length of the interval of analysis plays an important role in determining the stability of the reference frame, then the global solution should provide the most stable frame that can be established. As previously described, one of the main concerns in this "global" definition is the fact that the station motions are modeled through the adopted tectonic model rather than being estimated from the data. This, however, should not matter too much since the majority of the stations follow very closely the modeled motion anyway. What has been done, is to refer the estimated station positions from each quarter we analyzed to the frame realized by the globally estimated positions. To accomplish this, similarity (or rigid-body) transformation parameters (scale excluded) between each quarterly solution and the corresponding global positions from the global solution are determined. In order to avoid biases in the recovered transformation parameters, a time correction is made to bring the global positions from their reference epoch (January 1983) to the mid-epoch of each quarter. The geometry of the transformation is shown in Figure 6.6. Mathematically, the transformation can be written as

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{Global} = \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix} + \begin{bmatrix} 0 & \omega & -\psi \\ -\omega & 0 & \varepsilon \\ \psi & -\varepsilon & 0 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{Quarterly} \tag{6.3}$$

where the translational and rotational quantities are as shown in Figure 6.6. These parameters are estimated via a weighted least-squares inversion scheme. The results of this procedure are

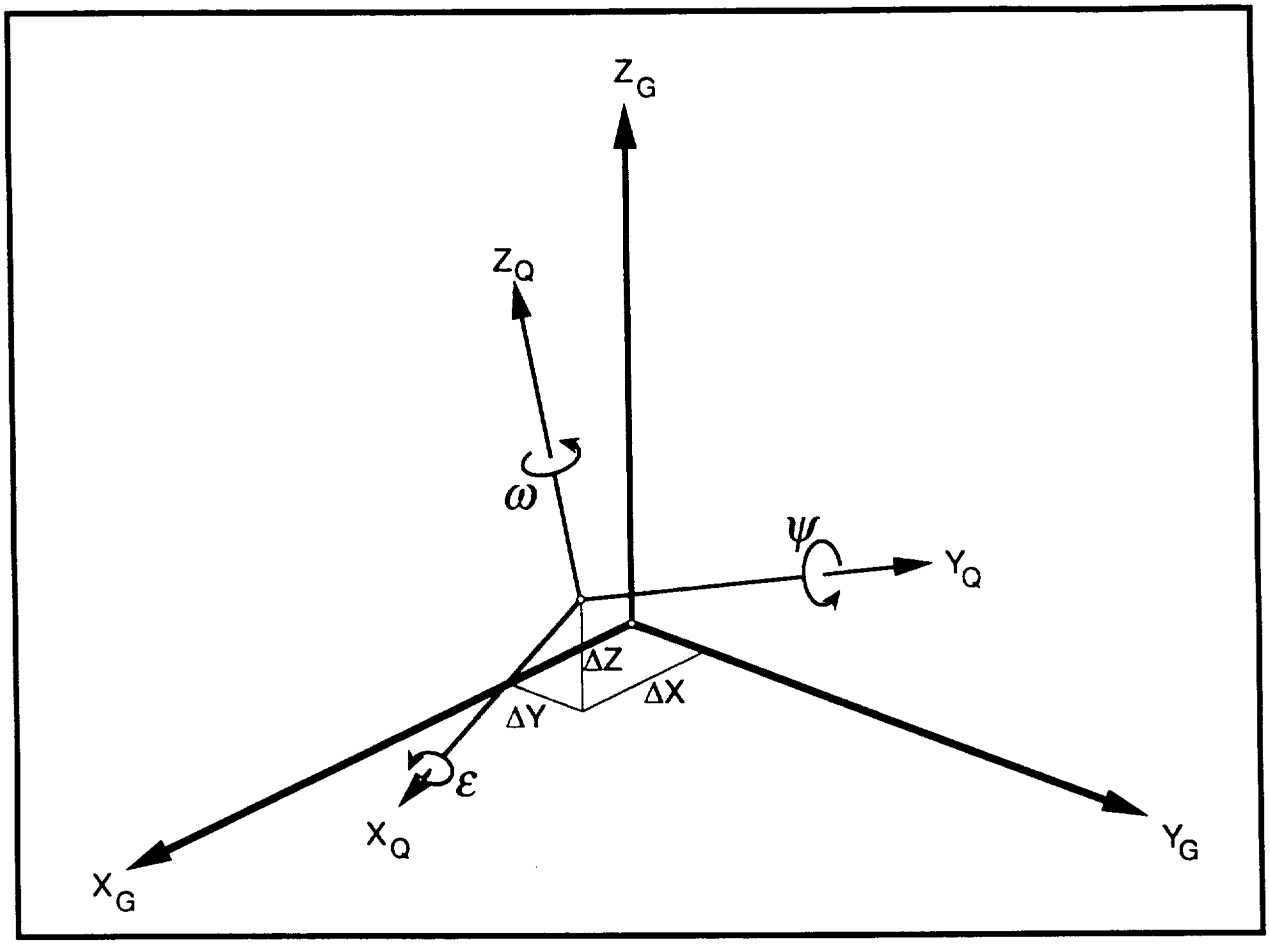


Figure 6.6 Similarity or rigid-body transformations. Nomenclature and geometry used to unify the quarterly realized reference frames into a more consistent "global" frame. The subscripts G and Q refer to the reference frames defined by the "Global" and "Quarterly" solutions, respectively.

summarized in Table 6.1 and are graphically displayed in Figure 6.7 for the translations and in Figure 6.8 for the rotations.

The poor station distribution in the tracking network prior to 1980 is quite evident in the magnitude as well as the quality of the estimates for those early years. In terms of translations, it seems that the Z-axis shift is the one which is consistently more significant than the other two. Yet, its root-mean-square variation for the quarters after 1980 is only 5.5 centimeters. The rotations are of even less significance, with rms variations of about one milliarcsecond in any one of them. What is more of interest here is the fact that the rotation about the Z-axis is very correlated with that about the X-axis, which in turn, is negatively correlated (strongly) with the rotation about the Y-axis. These estimates are based on the weighted estimates of the

Table 6.1 Transformation Parameters used to Place Station Coordinates into Uniform Reference Frame

Year	No. Sta.	ΔX (mm)	σ	ΔY (mm)	σ	ΔZ (mm)	σ	Scale (ppb)	σ	Rot X (mas)	σ	Rot Y (mas)	σ	Rot Z (mas)	σ
1978.25	7	123	120	26	98	-514	118	27	13.6	12	4.4	3	1.4	5	3.8
1978.50	9	157	66	105	62	212	73	11	8.8	-6	2.3	-1	0.8	7	2.2
1978.75	7	132	68	72	71	152	82	7	7.7	-4	2.8	-1	0.8	6	2.6
1979	14	-93	51	25	48	-458	57	5	6.4	10	1.8	1	0.7	-2	1.8
1979.25	15	-34	58	-41	52	-180	59	-4	7.2	5	2.0	0	0.7	0	1.9
1979.50	13	-38	62	21	56	351	67	-2	8.1	-8	2.1	-3	0.8	0	2.1
1979.75	14	48	30	-16	29	61	34	-3	3.8	0	1.0	0	0.4	2	1.1
1980	15	53	17	22	16	55	21	0	1.8	-1	0.5	0	0.3	2	0.7
1980.25	14	-18	16	17	13	22	21	1	1.8	0	0.5	-1	0.2	0	0.6
1980.50	18	16	10	8	10	29	13	5	1.1	0	0.4	0	0.2	0	0.5
1980.75	18	-16	13	51	12	53	14	2	1.3	-2	0.4	0	0.3	0	0.6
1981	15	17	19	-13	20	-67	24	3	2.1	2	0.7	-1	0.5	2	1.0
1981.25	15	18	37	0	31	-71	38	-2	3.2	2	1.2	-1	0.9	2	1.6
1981.50	15	-16	12	22	12	63	15	-4	1.4	-2	0.4	0	0.3	-1	0.6
1981.75	15	34	22	-19	20	80	27	-1	2.2	-1	0.7	2	0.6	0	1.1
1982	15	19	22	-10	24	69	32	-3	2.5	-1	0.9	1	0.6	0	1.3
1982.25	15	18	17	-6	18	66	21	-2	2.3	-1	0.6	1	0.4	0	0.8
1982.50	16	15	16	2	16	144	18	-9	2.0	-4	0.5	3	0.4	-2	0.7
1982.75	16	-5	15	40	15	45	18	-5	1.9	-2	0.5	0	0.4	0	0.7
1983	16	-12	21	70	19	-73	23	-1	2.4	0	0.7	-1	0.5	1	0.8
1983.25	17	-15	20	5	19	34	20	0	2.5	-1	0.6	0	0.5	-1	0.8
1983.50	19	-16	12	-10	15	73	12	0	1.9	-2	0.4	1	0.3	-2	0.4
1983.75	23	-36	10	10	10	62	11	0	1.3	-2	0.3	0	0.2	-2	0.4
1984	23	-11	10	-42	10	10	12	1	1.3	0	0.4	0	0.2	0	0.5
1984.25	23	-6	5	-2	6	-18	6	1	0.7	0	0.2	0	0.1	0	0.2
1984.50	21	14	6	13	7	-11	7	1	0.8	0	0.2	0	0.1	0	0.2
1984.75	23	9	8	5	8	53	9	0	0.9	-1	0.3	1	0.1	0	0.3
1985	18	1	7	7	7	-3	8	0	0.8	0	0.3	0	0.1	0	0.3
1985.25	18	-3	6	-1	6	-34	7	0	0.8	1	0.2	0	0.1	0	0.2
1985.50	20	-1	8	-2	8	60	9	-1	1.0	-1	0.3	1	0.2	-1	0.3
1985.75	20	-1	6	-1	6	46	7	-1	0.8	-1	0.2	0	0.1	0	0.2
1986	19	14	6	-7	6	-50	7	0	0.7	1	0.2	0	0.1	1	0.2
1986.25	21	-5	7	-8	7	-67	8	0	0.9	2	0.3	-1	0.1	1	0.3
1986.50	22	-1	4	15	4	-40	4	0	0.5	0	0.1	0	0.1	0	0.1
1986.75	21	-6	5	6	5	-29	5	2	0.6	0	0.2	0	0.1	0	0.2
1987	20	-19	7	-15	7	53	9	0	0.9	-1	0.2	0	0.2	-1	0.3
1987.25	27	-4	4	-5	5	-37	6	0	0.7	1	0.2	0	0.1	0	0.2
1987.50	27	8	7	-3	7	-97	8	2	1.0	3	0.2	-1	0.1	2	0.3
1987.75	24	-3	6	12	7	-99	8	1	0.9	2	0.2	-2	0.1	2	0.2
1988	20	10	17	13	15	-6	18	3	1.9	0	0.6	0	0.3	0	0.7
1988.25	21	4	13	-21	14	29	16	-2	1.8	0	0.5	0	0.3	0	0.6
1988.50	22	-4	12	-23	14	13	16	-1	1.7	0	0.5	0	0.3	0	0.6
1988.75	20	-10	23	22	27	112	30	-4	3.4	-3	0.9	1	0.6	-2	1.1

positions, so that the strongly determined stations dominate the solution, while the effect of the poorly determined ones is insignificant. The peculiarities of the recovered transformation parameters are therefore the result of an unbalanced distribution of quality tracking data rather than anything else. Despite the small magnitude of these individual constituents of the transformation, one should keep in mind that first it is the sum total that affects the solution, and second, in certain cases, as already shown, a geodesic can be affected by as much as twice that amount.

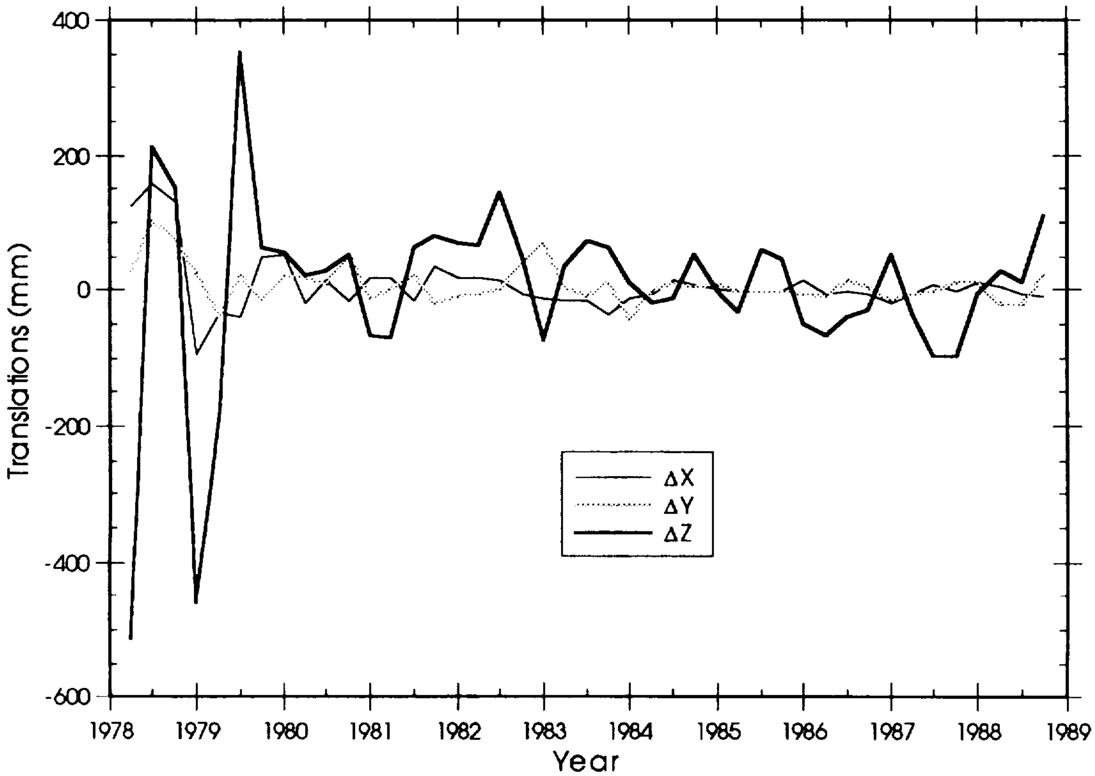


Figure 6.7 Rigid-body Transformations: Translations of the origin.

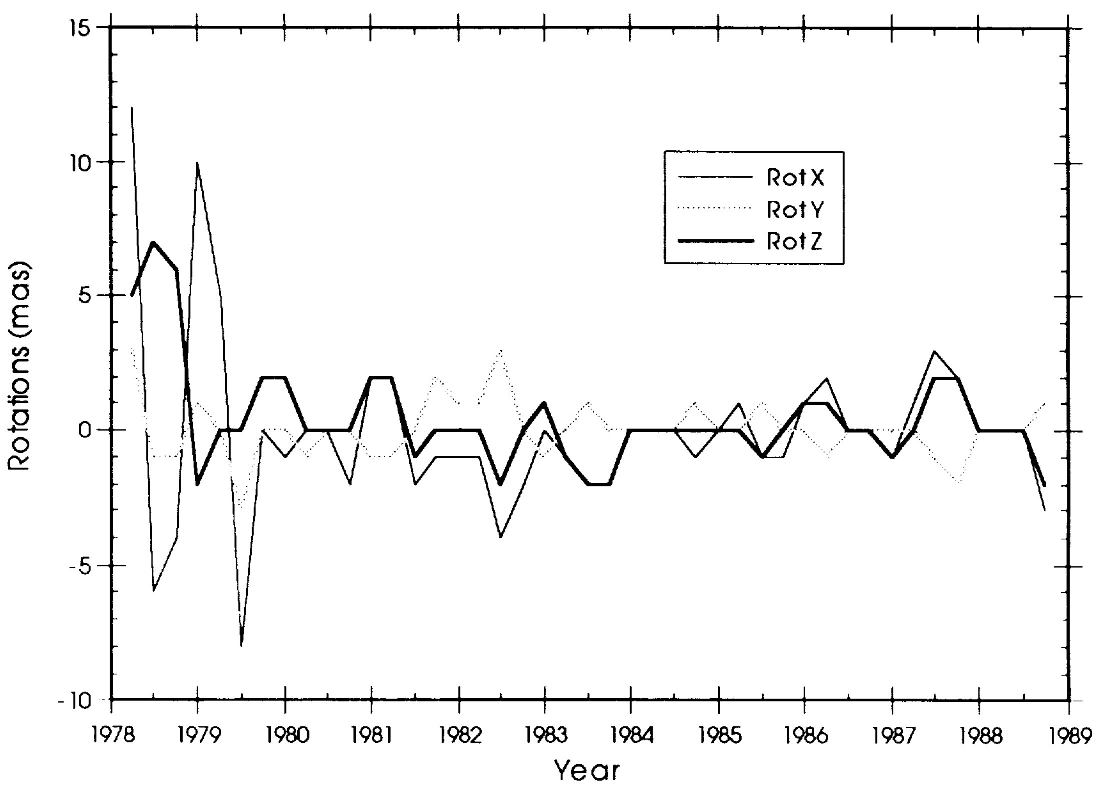


Figure 6.8 Rigid-body Transformations: Rotations about the origin.

The transformation parameters, as listed in Table 6.1, have been applied to all station positions within each quarter to produce a set of quarterly station positions in a globally consistent frame of reference. The resulting station positions used in the network adjustment are listed quarter-by-quarter in Appendix 6.

6.3 Geodesic Lines from the Transformed Quarterly Solution

The behavior of the recovered transformation parameters indicates a possible periodicity, perhaps varying with an annual period. The source of this effect may possibly be due to the seasonal nature of weather impediments thereby reducing the amount of tracking. However, such behavior is likely to introduce excessive variation in the behavior of the geodesics for reasons previously described. Our conjecture is that this variation should be grossly eliminated once we have accounted for the instability in the reference frame. Additionally, the reduction in the variation should be more prominent in the case of lines with greater extent, since short lines depart only slightly from their respective chords. This conjecture was tested by means of a comparison of the geodesic line lengths based on the station coordinates before having been transformed and those after applying the transformations. Weighted least squares estimates of best fitting lines were determined to yield the slopes of the observed geodesics between a set of twenty stations. We limited ourselves to this subset of stations, since they are the only ones with a significant number of determinations to recover meaningful estimates. The scatter about each line was the statistic under scrutiny. Histograms of the scatter were made for both sets of geodesics and for various subsets according to criteria based on the number of contributing determinations per line. The results for all cases examined are shown in Figure 6.9, for the lines with more than four determinations in Figure 6.10, and for our extremely robust lines with more than twelve determinations in Figure 6.11.

The obvious conclusion from these histograms is that the imposition of the global reference frame has resulted in a 30 - 40% decrease in the scatter of the line fits. That is to say the geodesic estimates are far more consistent between quarters after transforming the sites to a common origin. The original conjecture proves to be true then, and the increase in resolution is supported through this technique with a parallel increase in the consistency of the estimates.

Another way of examining the effect of the transformation is in the temporal stability of the quality of the line fits. Naturally, one expects that these quantities should follow the curve that describes the improvement in the quality of the ranging data on which they are based. We have computed the root mean square line fit scatter for each quarter in the solution and for the station subset which is nominally analyzed for the determination of the tectonic model implied by our geodesic rates between stations. The results for the pre- and after-transformation geodesic sets are shown in Figure 6.12. Even though the downward trend is expected, due to the improvement in the data, it is not nearly as clear in the case of the line fits determined on the

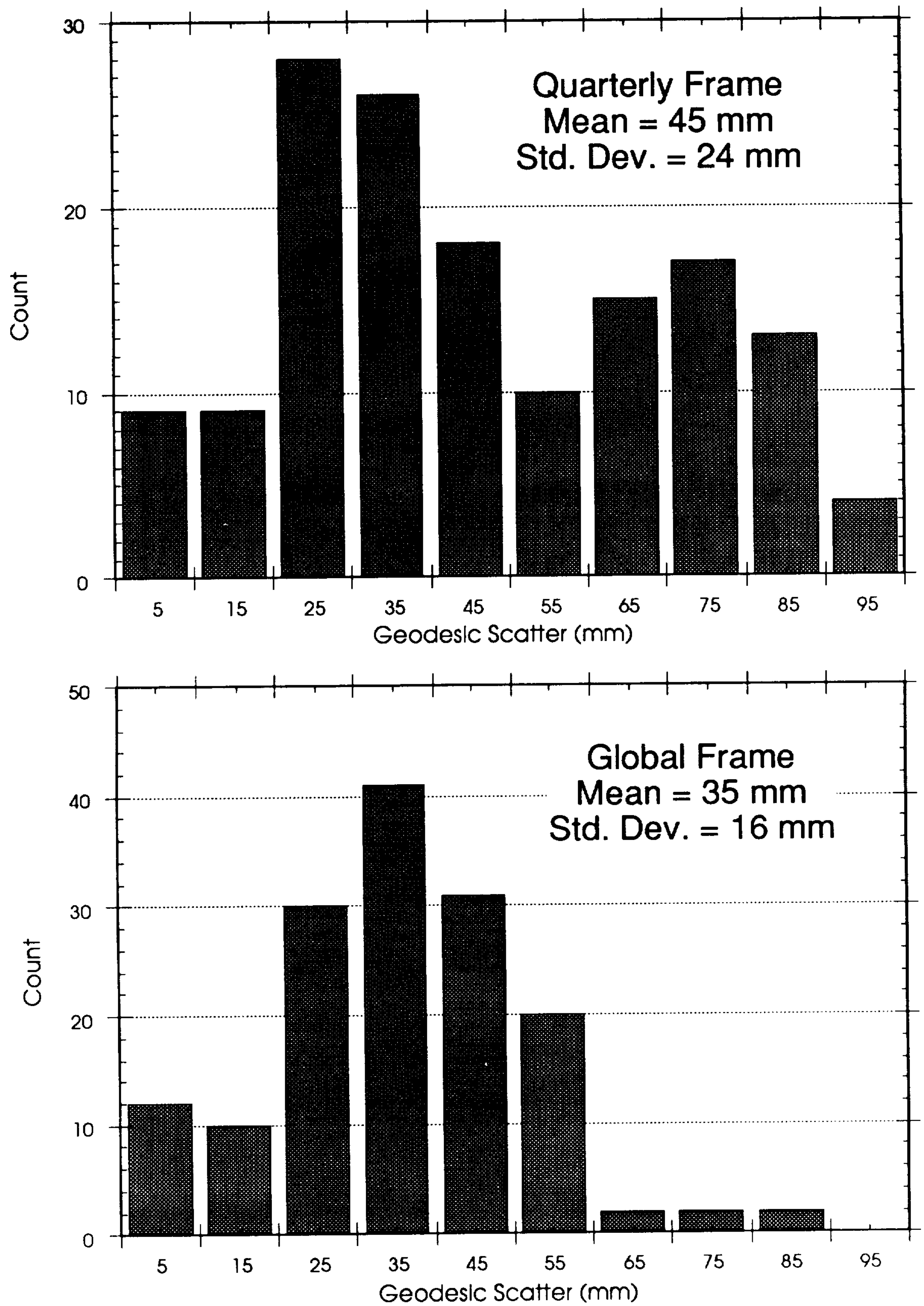


Figure 6.9 Geodesic line fit scatter distribution: Using all observed lines between 20 stations. Quarterly frame at top, global frame at bottom.

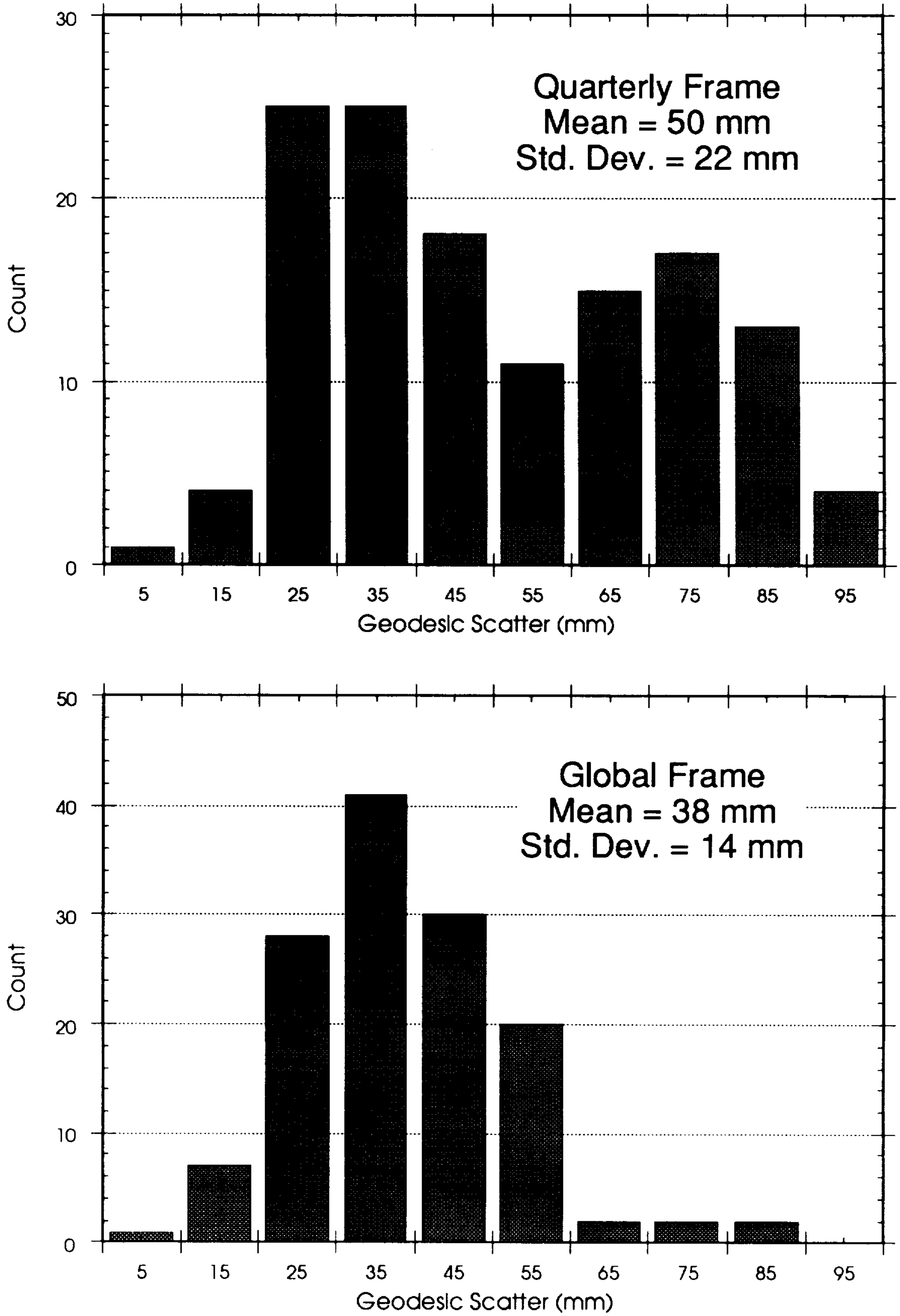


Figure 6.10 Geodesic line fit scatter distribution: Using lines with more than four determinations. Quarterly frame at top, global frame at bottom.

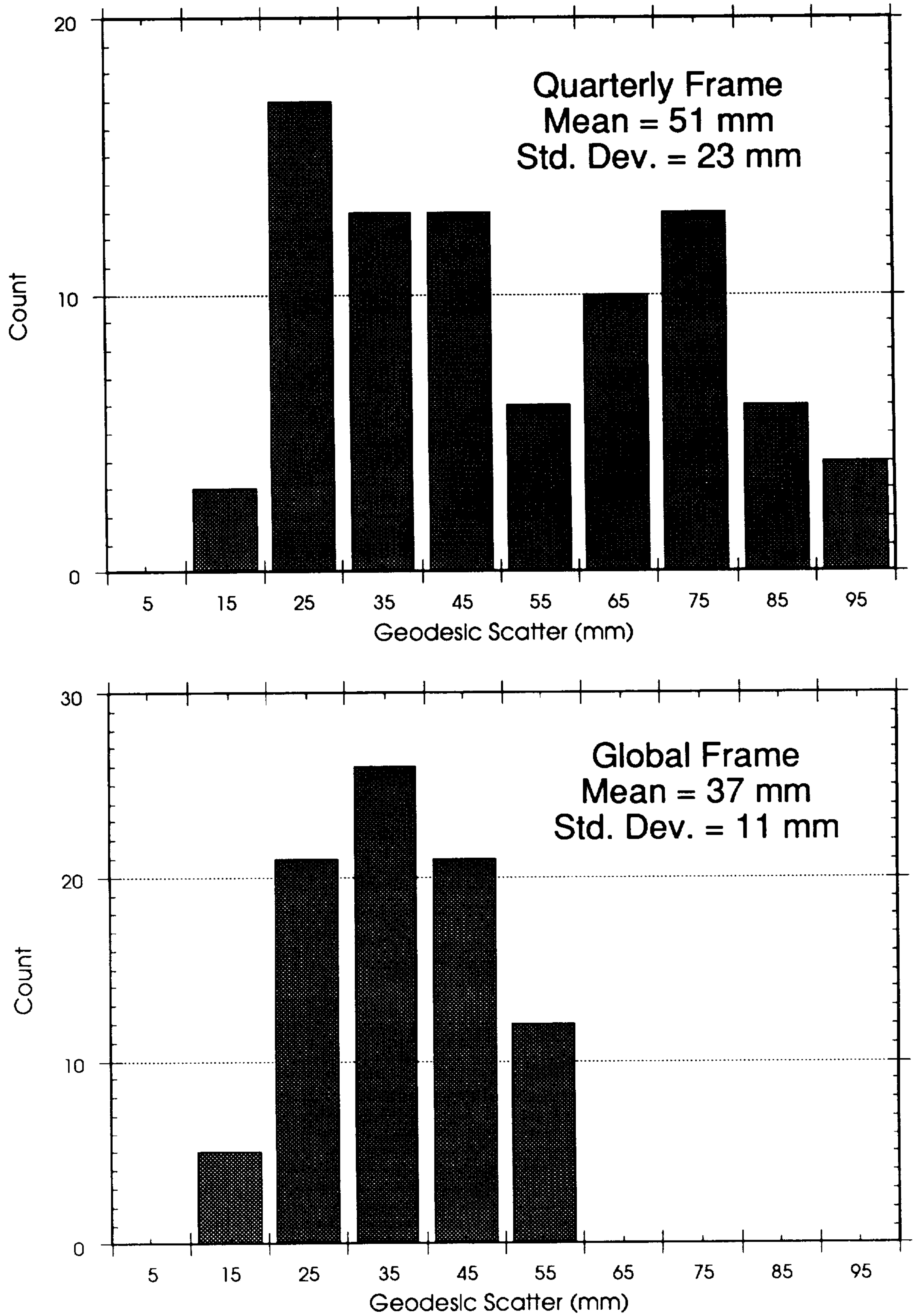


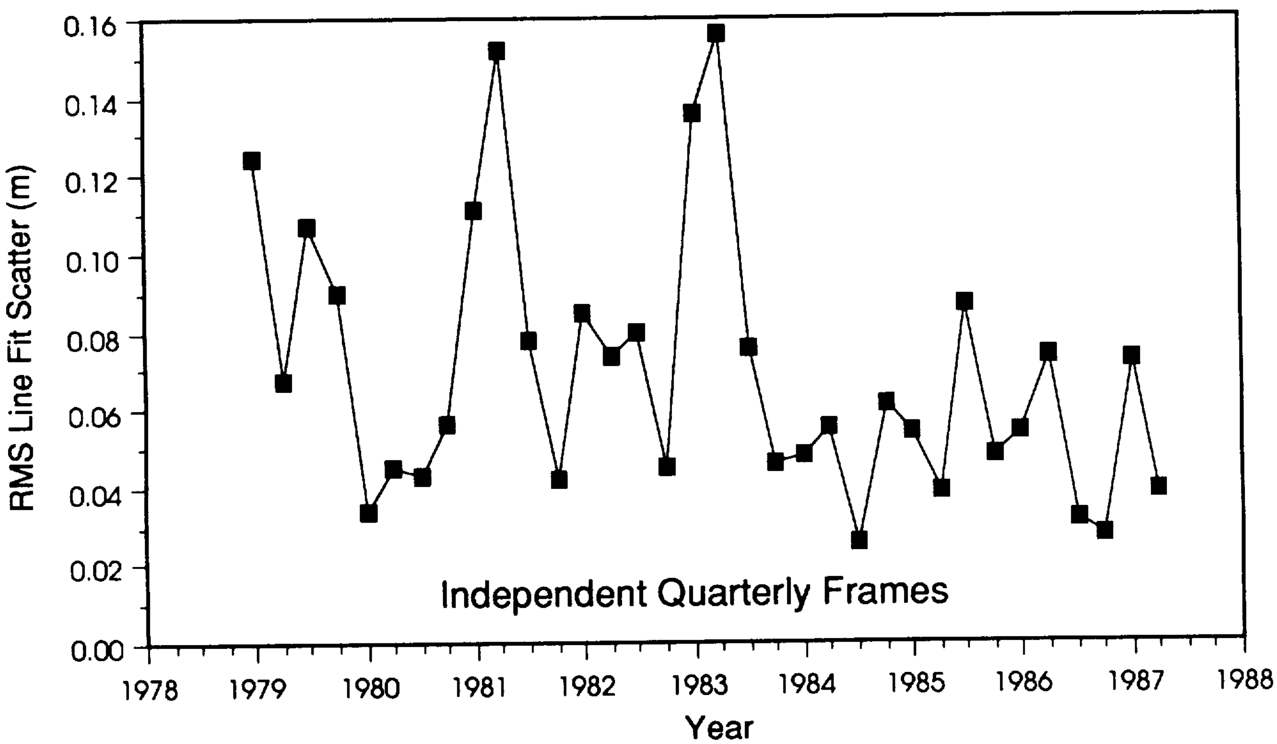
Figure 6.11 Geodesic line fit scatter distribution: Using lines with more than twelve determinations. Quarterly frame at top, global frame at bottom.

basis of quarterly determined stations in an independent frame. Not only does the trend become clearer, the rms of these scatters is now much more consistent for the entire period of time.

Finally, perhaps the best demonstration of the benefits resulting from the reference frame stabilization process is through the line fits themselves. Several examples of lines with typical fits as derived from station positions before and after the application of the transformation are shown in Figures 6.13 - 6.19. As expected, there is little to be gained in the case of short lines (e.g., Monument Peak to Quincy, Figure 6.13), but for long lines, the improved results are remarkable (e.g., Yaragadee to Arequipa (6.18) and Quincy to Matera (6.16)). An added benefit of this procedure is the fact that outliers are easier to detect, as is seen, for example, in the second and third quarter of 1983 determinations of the Quincy-to-Wettzell line (Figure 6.14).

6.4 Summary

In conclusion, the technique we have adopted allows for an increase in the temporal resolution of our estimates while still maintaining the same or even improved integrity of the results. It should be stressed here that this is an interim solution of the problem which we had to adopt due to software limitations. The results of the next cycle of analysis will be based on direct estimates of the station motions recovered in the global estimation procedure rather than through post-processing efforts.



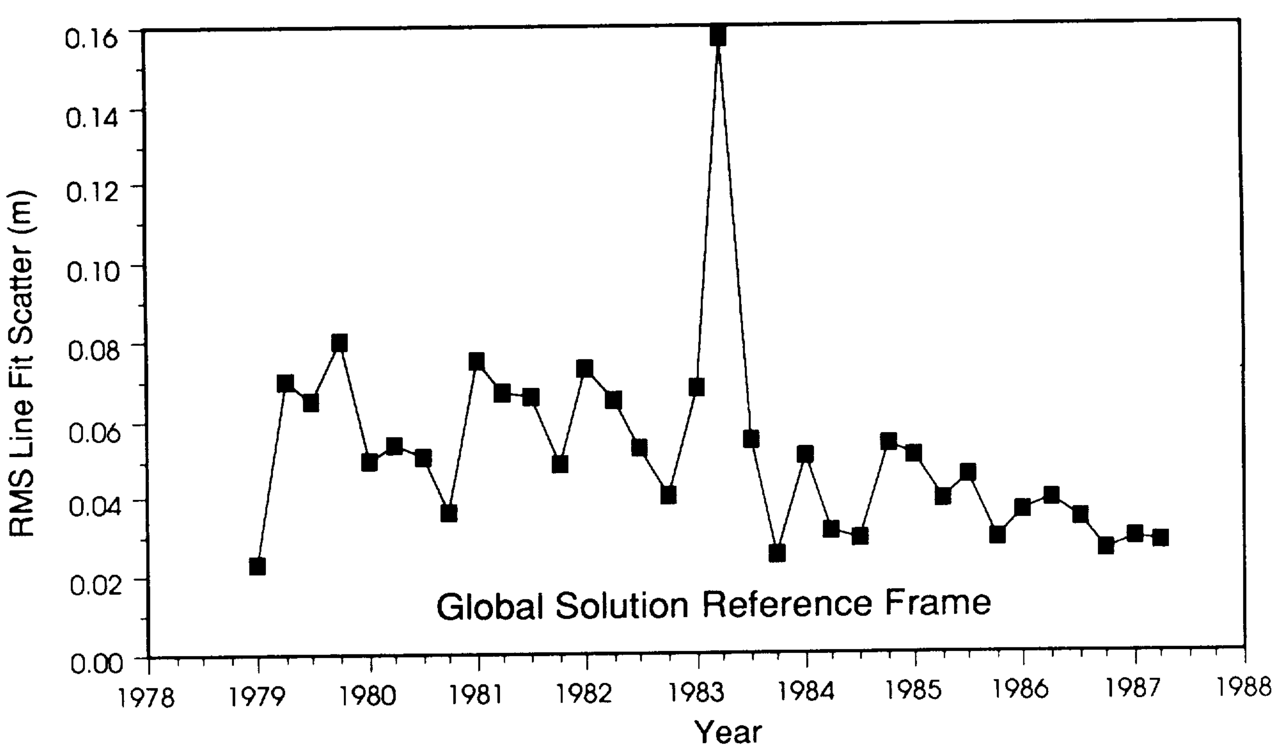
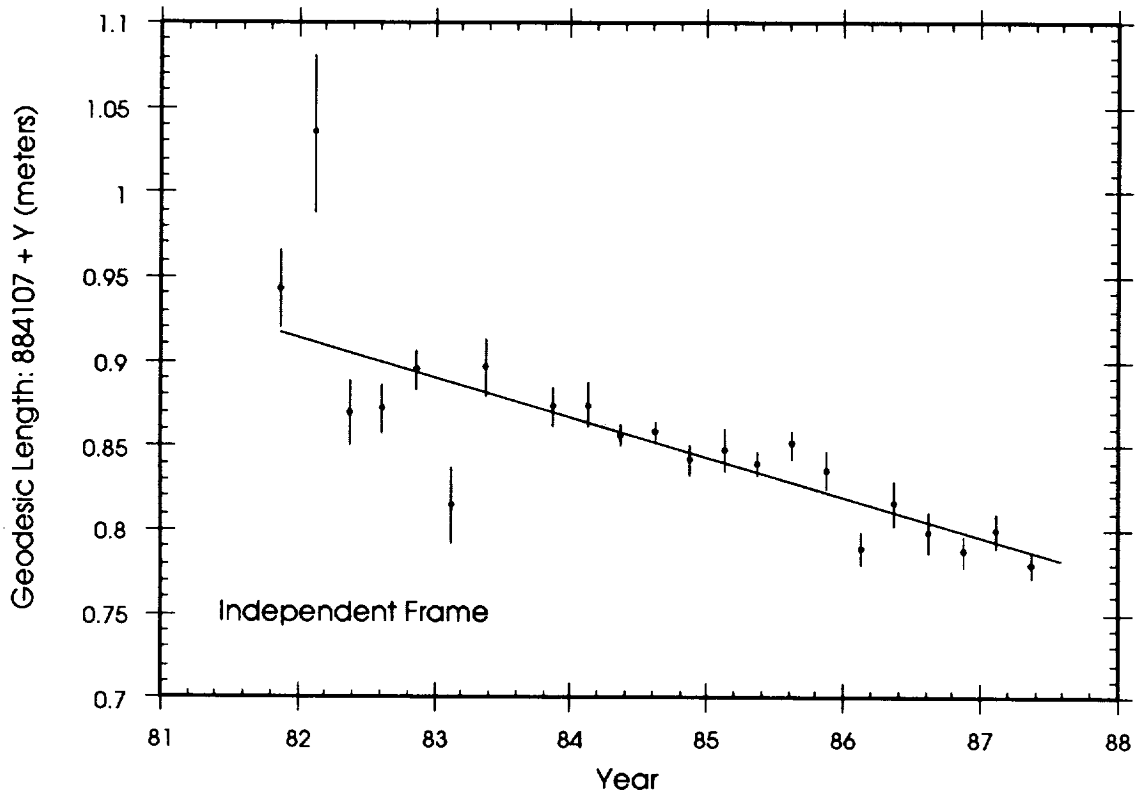


Figure 6.12 RMS line fit scatter by quarter: Before transformation at top, after transformation at bottom.



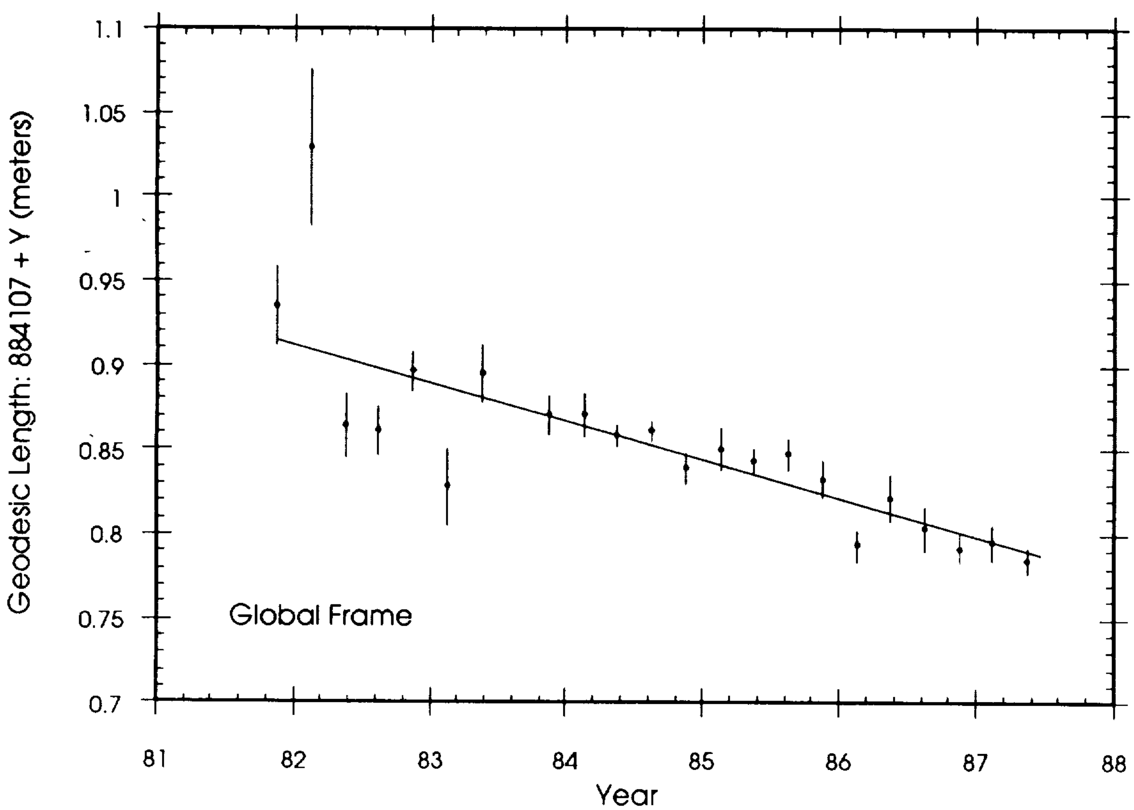
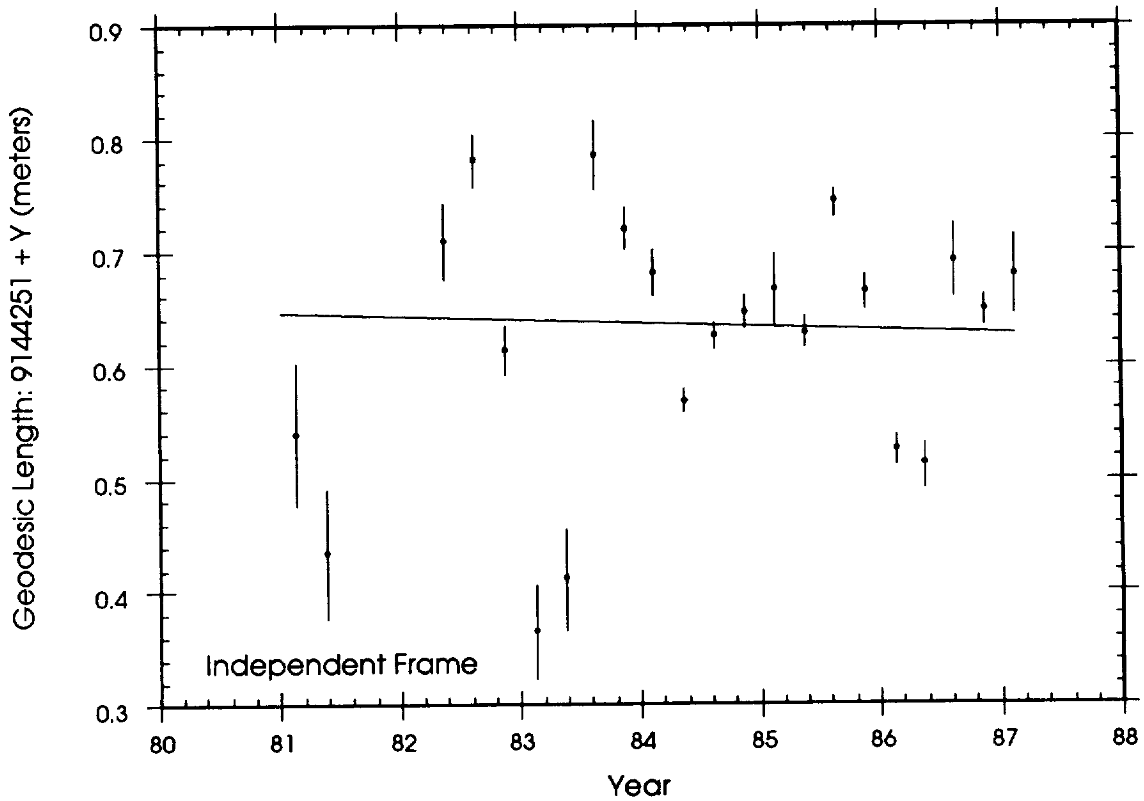


Figure 6.13 Comparison of the Monument Peak to Quincy geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.



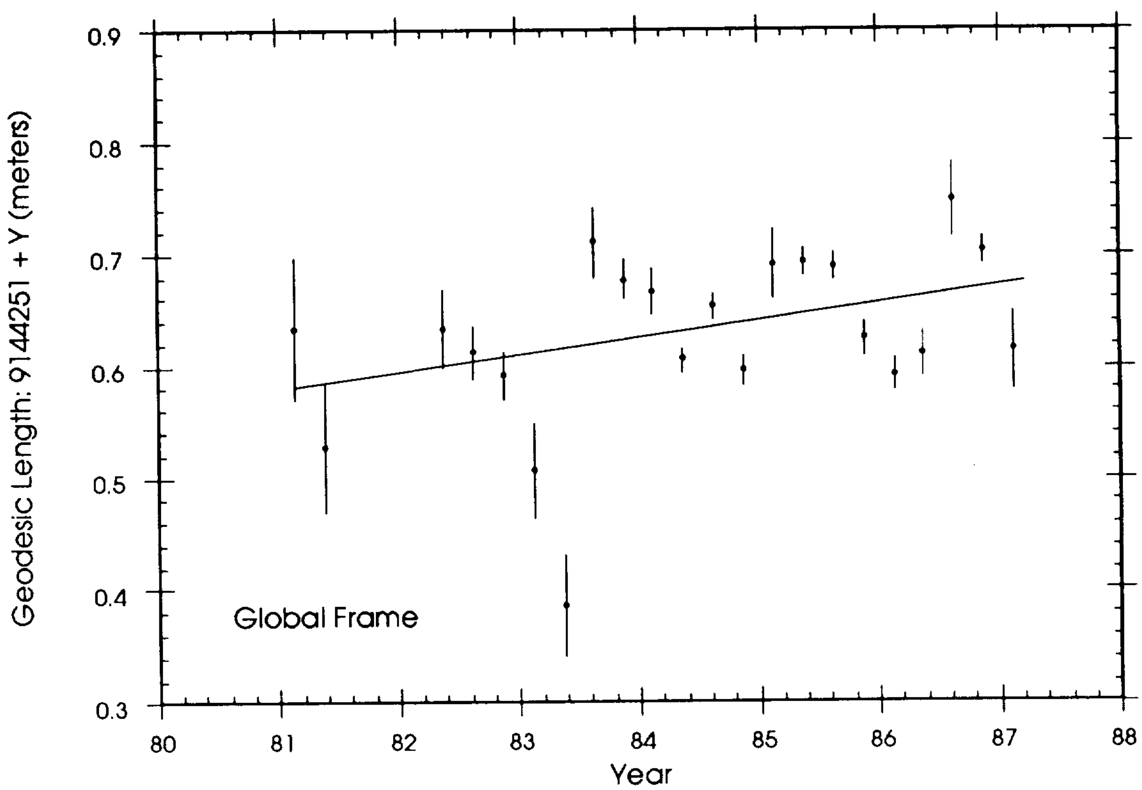


Figure 6.14 Comparison of the Quincy to Wettzell geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.

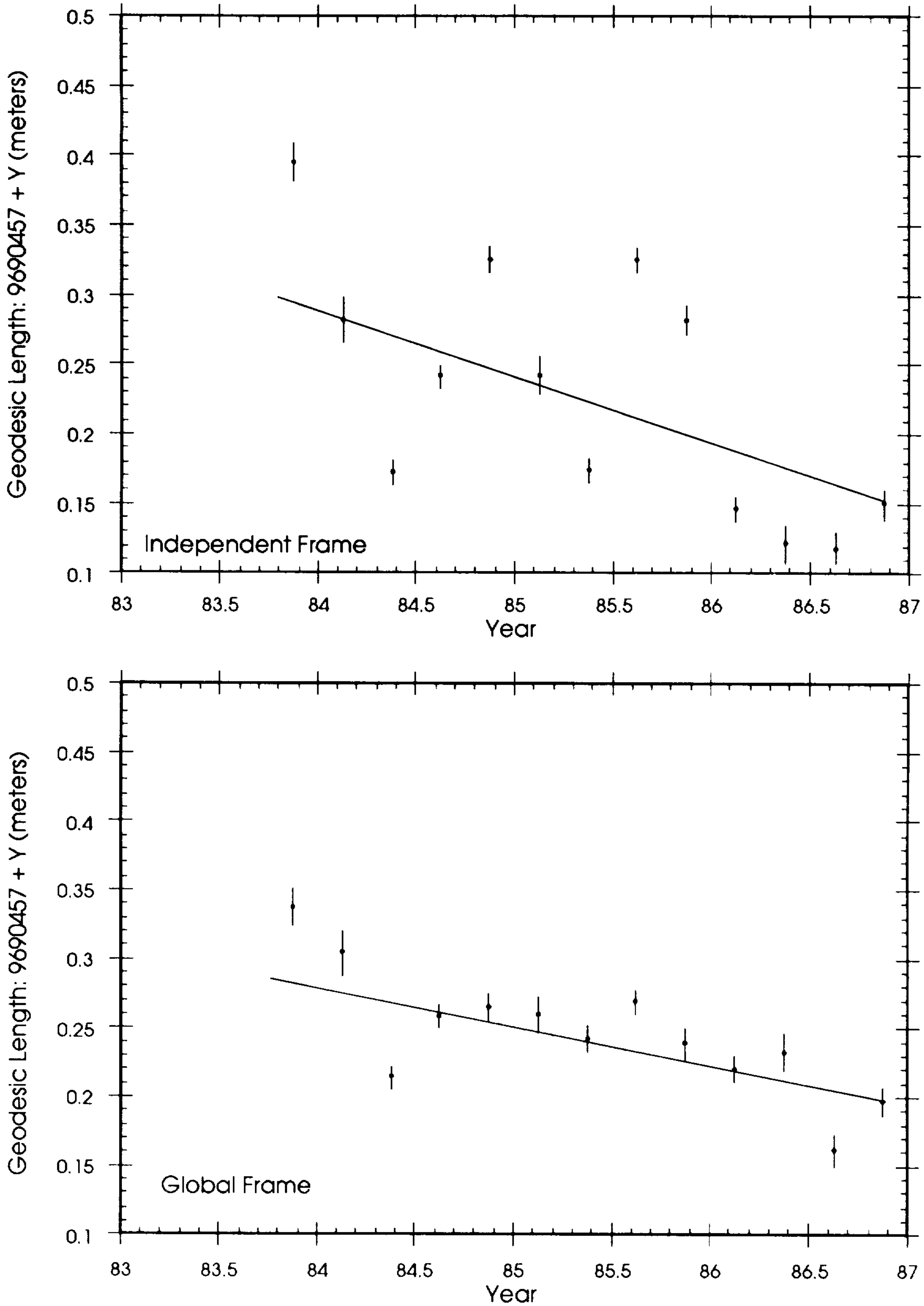


Figure 6.15 Comparison of the Simosato to RGO geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.

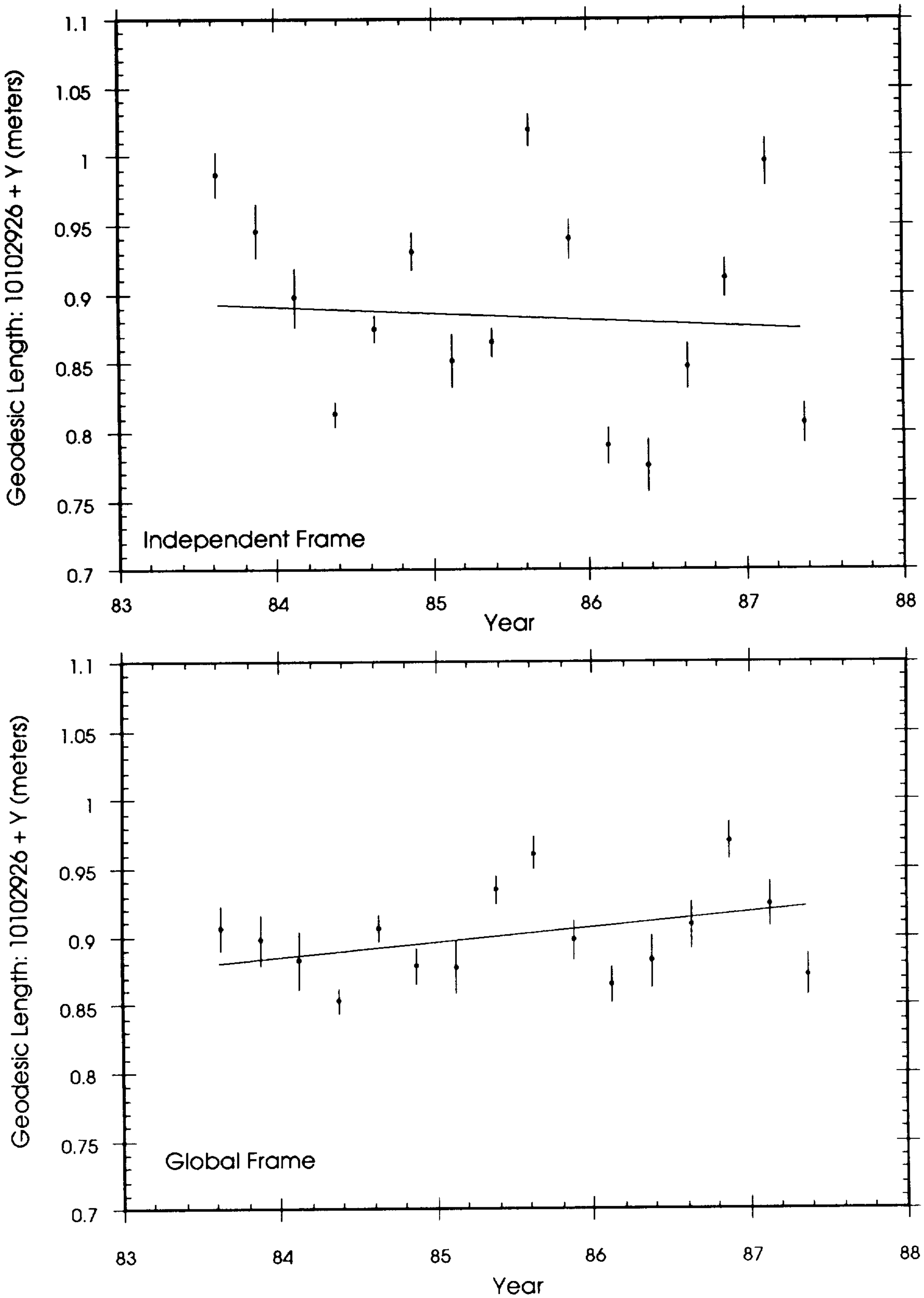
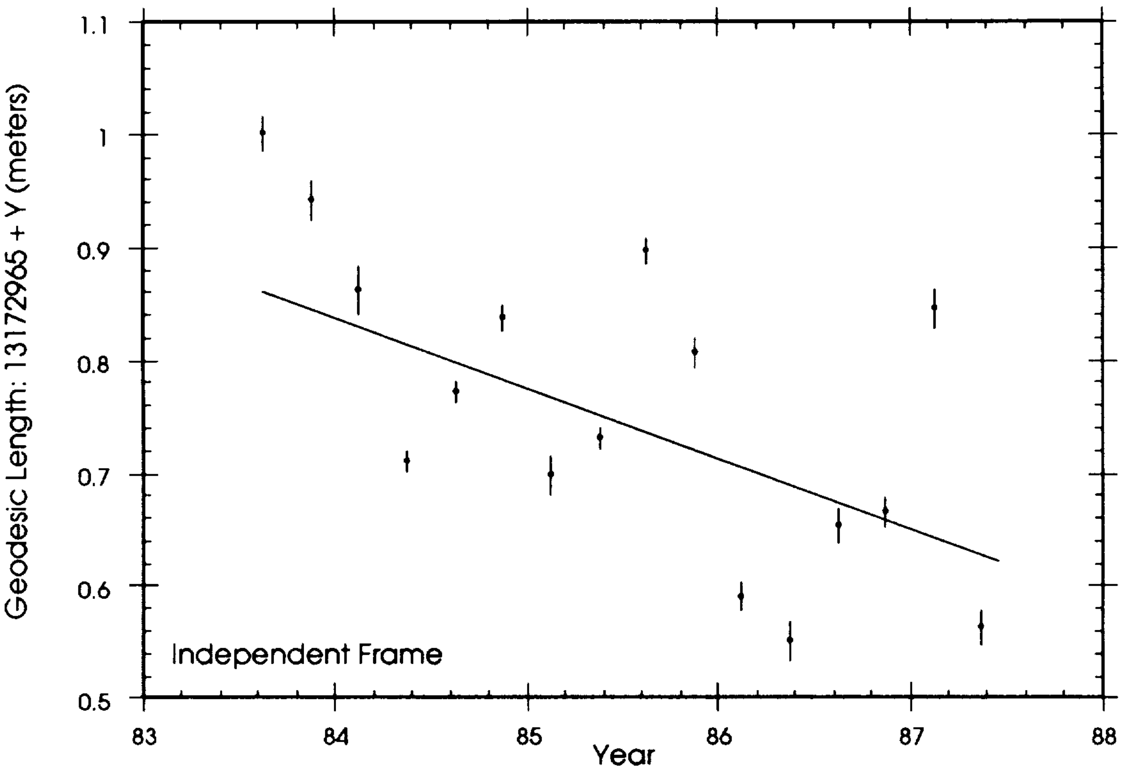


Figure 6.16 Comparison of the Quincy to Matera geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.



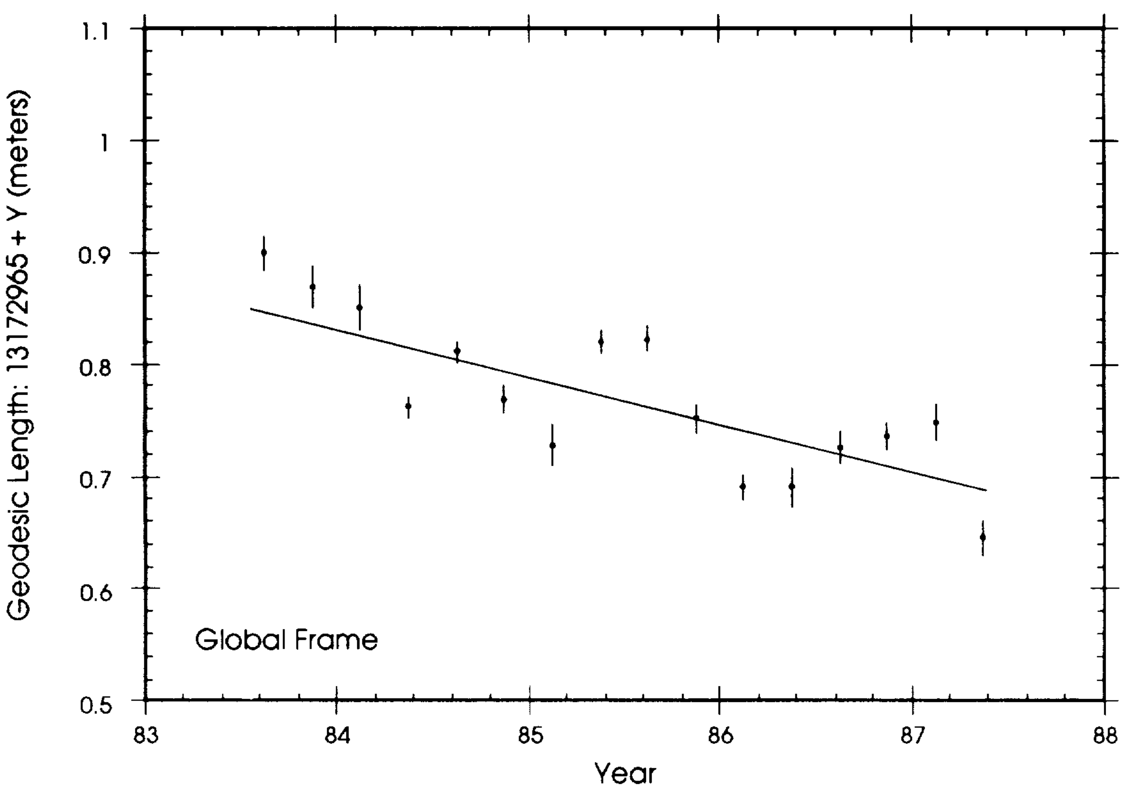
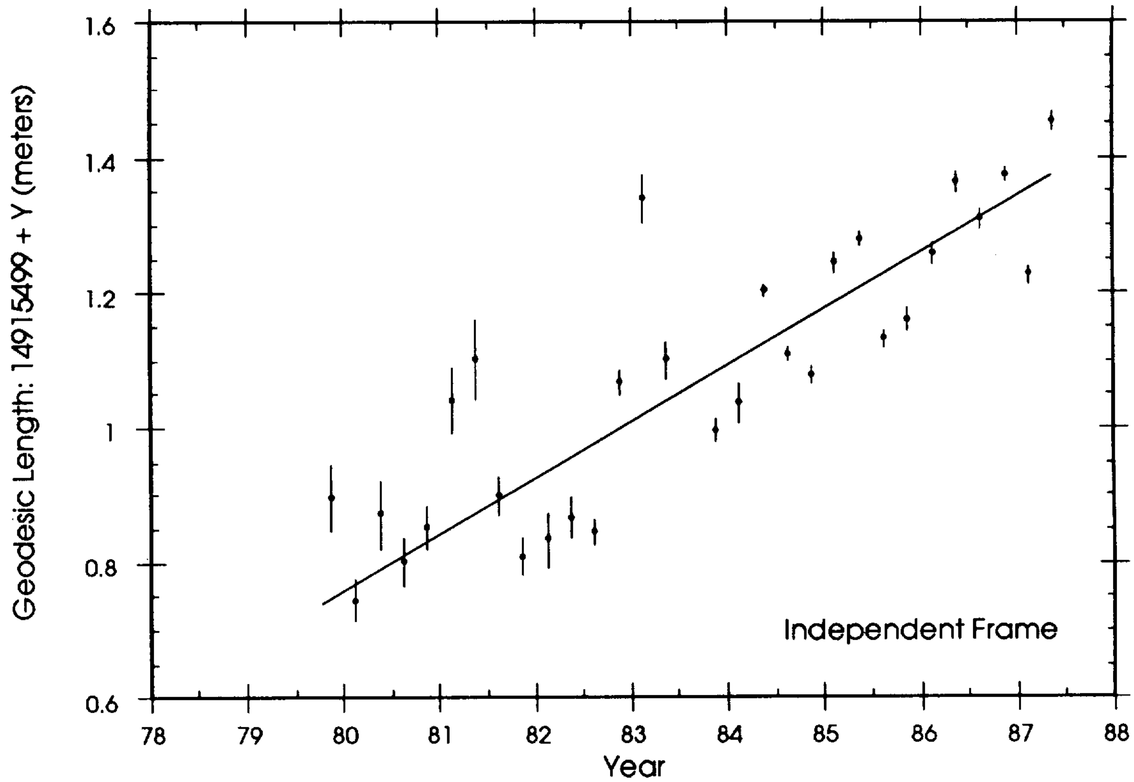


Figure 6.17 Comparison of the Maui to Matera geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.



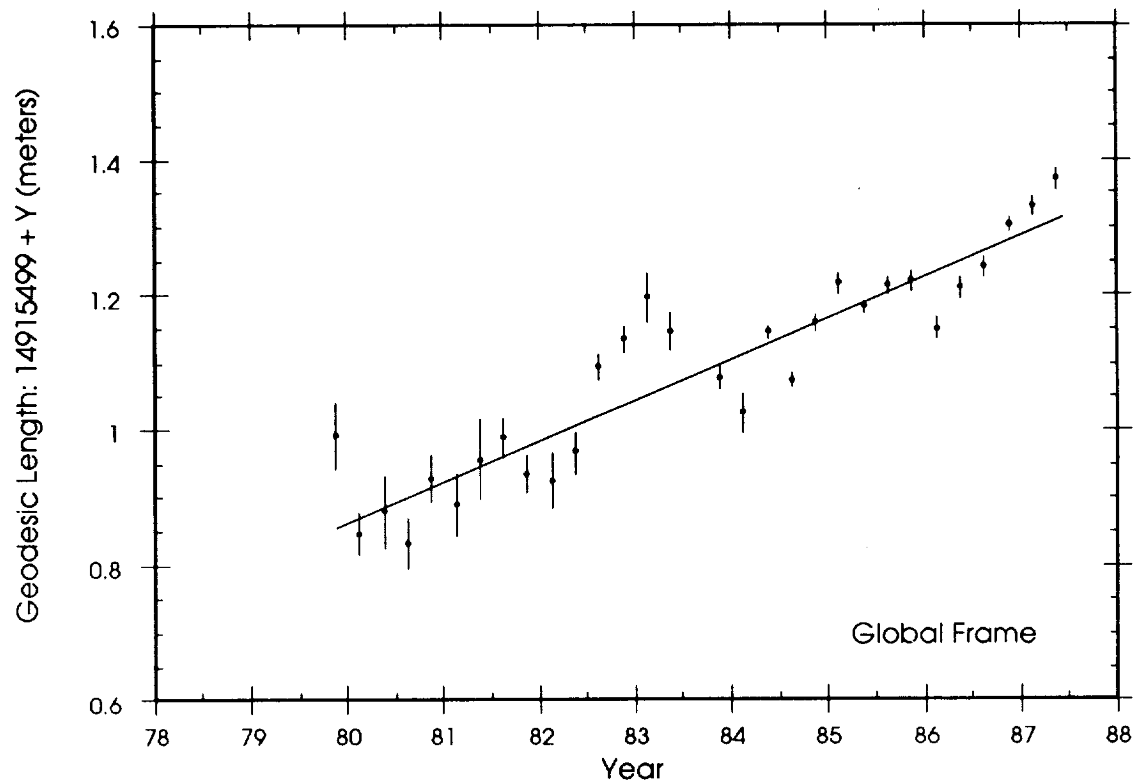
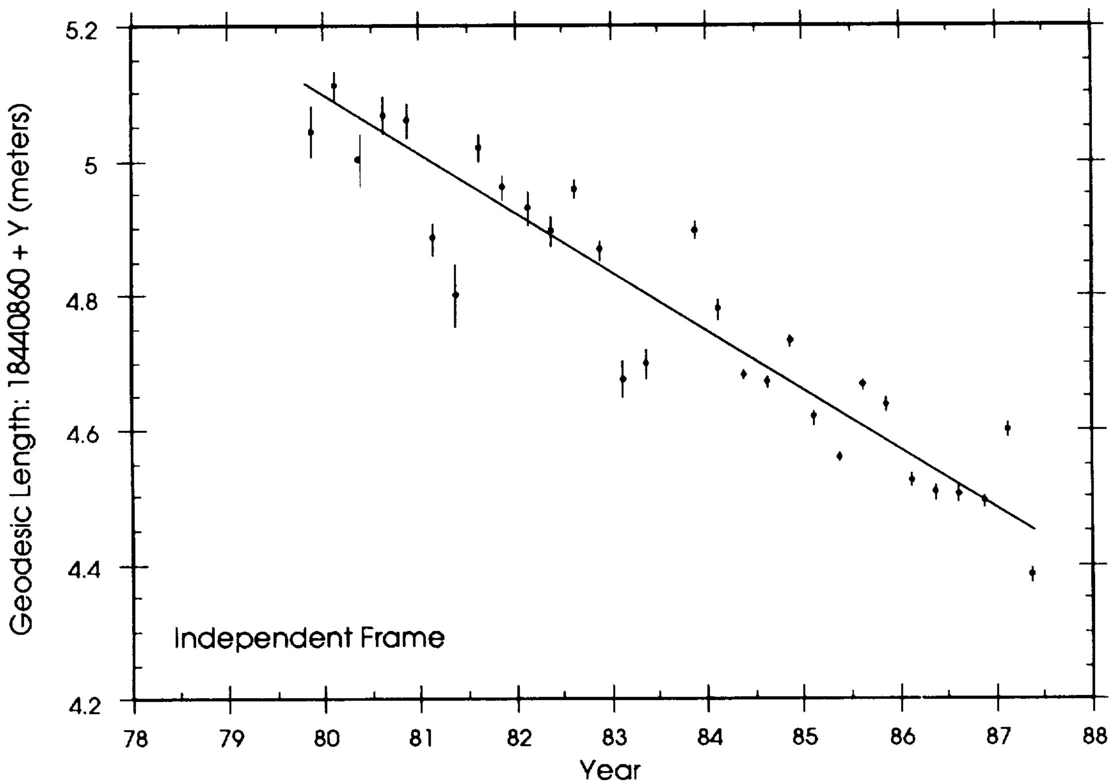


Figure 6.18 Comparison of the Yaragadee to Arequipa geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.



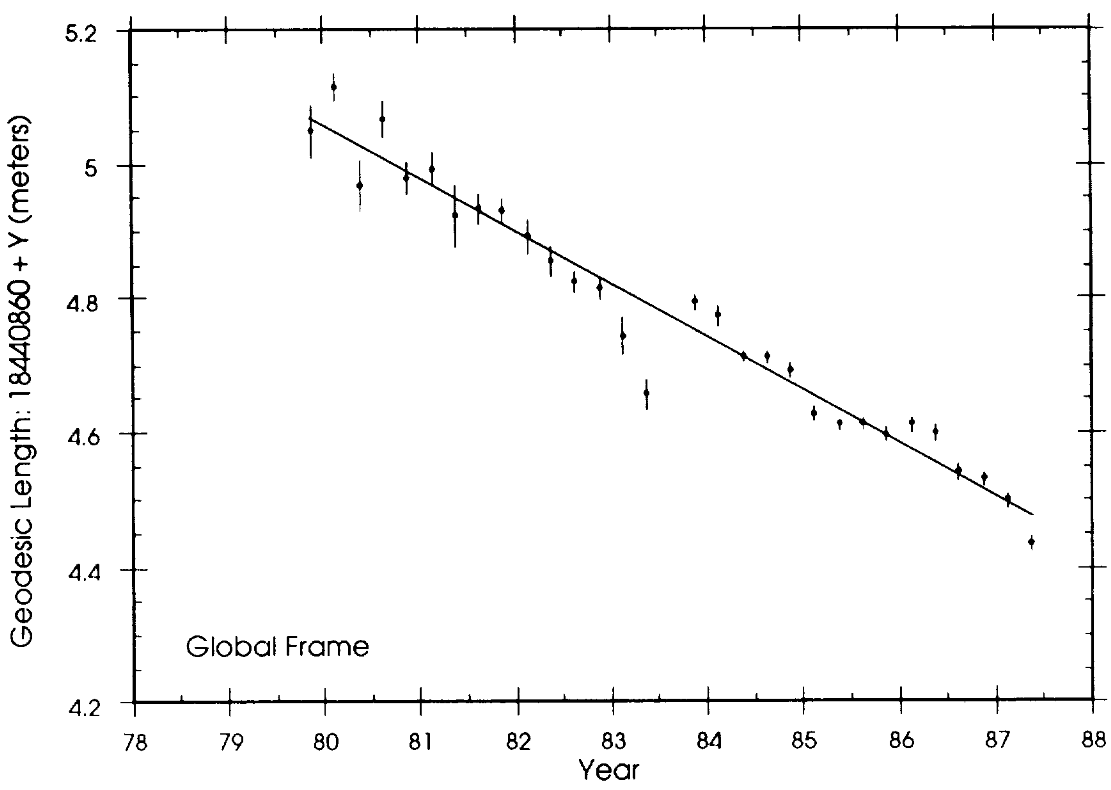


Figure 6.19 Comparison of the Yaragadee to Greenbelt geodesic line histories: Top - before transformation (independently determined reference frames) and bottom - after transformation (globally unified reference frame). This study was based on an earlier SL7 solution and therefore does not represent final station motion behavior.

7. Site Motion Estimation via Network Adjustment

7.1 Kinematic Reference Frames - Concepts

According to plate tectonic theory, all points on the Earth's surface are located on a continuously moving crust. To more easily understand the global tectonics determined by SLR and to understand regional deficiencies between the SLR results and the geologically based tectonic models (which assume rigid plate behavior), it is desirable to adopt a kinematic reference frame with respect to which we can define the linear horizontal motions of the individual SLR stations. We have elected to use the NUVEL-1 NNR (No Net Rotation) model of *Argus and Gordon* [1991] in the definition of the kinematic frame. NUVEL-1 NNR is based on the NUVEL-1 relative plate motion model published by *DeMets et al.* [1990]. This model updates the AM0-2 model of *Minster and Jordan* [1978], used throughout most of the SLR data reduction process. To determine the kinematic behavior of the SLR sites within this frame, standard network adjustment concepts have been applied. These concepts and the results thereof are described in the remainder of this chapter.

7.2 Interstation Geodesic Rates and Network Definitions

The transformed SL7.1 quarterly station coordinates are used in this, the final portion of the analysis. Geodesic distances between all possible tracking sites that have tracked LAGEOS in each quarter are computed via an algorithm derived by *Vincenty* [1975]. The uncertainty for each quarterly geodesic distance is calculated by propagating the formal station position uncertainty. The variation across time of the geodesic distances connecting pairs of stations provides the base information used to determine the north and east velocity components of the SLR sites. Linear changes in geodesic distances are computed using a weighted least-squares estimator. The uncertainty of each quarterly geodesic distance provides the weights used in the estimate of the slope. The algorithm yields a formal estimate of the uncertainty in the determined geodesic rate which is additionally scaled to reflect the fit of the geodesic distances to the linear model (i.e., $\chi^2=1$ criteria is assumed yielding an uncertainty of unit weight). These slopes, or geodesic rates, are used as the "observables" to determine the station motions in a least squares network adjustment described in the following section. Although for short interstation distances there is no significant difference between changes in the length of geodesics and the chord lengths, for long distances, changes in geodesics give a more meaningful description of the relative horizontal motion between stations. The geodesic rates are used to describe the relative changes in the positions of the stations along the ellipsoidal surface which is taken to be approximately equivalent to the Earth's surface. These rates are therefore independent of all station vertical motions and their associated height uncertainties. Thus, horizontal motions within the SLR network are effectively isolated.

Two networks of stations are defined in the adjustment procedure; an "external" network of strong stations which are used for the realization of a kinematic reference system and whose motions are assumed to be known; and an "internal" network of stations whose motions are to be determined. The motions of the internal stations are estimated within a kinematic reference frame defined by the motions of the external sites within the least-squares estimation procedure. Obviously, for satisfactory closure, the adopted motions for the external stations must be consistent relatively with that observed directly by SLR.

The definition of the kinematic reference frame within a geologically compatible context is provided by the NUVEL-1 NNR model. Two SLR sites are selected to define the external network which is constrained to move with NUVEL-1 NNR motions. As was used throughout the data reduction process, the tracking stations at Maui and Greenbelt were selected as the external reference stations. Use of these sites was viable, for the geologically predicted relative motion between these sites is consistent with that deduced by SLR (e.g., the SLR rate estimate between Greenbelt and Maui is 16 ± 2 mm/yr compared to the rate predicted by NUVEL-1 of 14 mm/yr). These two stations were also chosen for additional reasons, mainly having to do with the strength of the quality and quantity of laser data collected at these sites as well as both having been in continuous operation for at least 7 years and that each station is centrally located on a major tectonic plate. The motion constraint adopted in the network adjustment differs from that used in the laser data reduction in that both the north and east components of Maui's motion are constrained.

The tracking sites which make up the internal network are listed in Table 7.1 and shown in map form in Figure 7.1. These sites are distributed globally and represent the strongest stations with the longest tracking histories presently available from CDP SLR tracking campaigns. More importantly, each internal site has a resolvable geodesic rate with respect to almost all other internal and external stations used in the adjustment. A total of 230 geodesics can be constructed between the 22 tracking sites considered here. Of these, 214 actual geodesic rates can actually be calculated based on the available data. Two subsets of the geodesic rates are defined in the

Table 7.1. Internal Station Network

Site No.	Site Name	Plate
7109	Quincy, CA	No. American
7835	Owens Valley, CA	No. American
7086	McDonald Obs., TX	No. American
7122	Mazatlan, Mexico	No. American
7112	Platteville, CO	No. American
7110	Monument Pk, CA	Pacific
7035	Otay Mountain, CA	Pacific
7121	Huahine, French Polynesia	Pacific
7907	Arequipa, Peru	So. American
7097	Easter Island	Nazca
7090	Yaragadee, Australia	Indo-Australian
7843	Orroral, Australia	Indo-Australian
7834	Wettzell, Germany	Eurasian
7835	Grasse, France	Eurasian
7839	Graz, Austria	Eurasian
7810	Zimmerwald, Switzerland	Eurasian
1181	Potsdam, Germany	Eurasian
7840	Royal Greenwich Obs.,U. K.	Eurasian
7838	Simosato, Japan	Eurasian or North American
7939	Matera, Italy	African

adjustment procedure. One subset contains the geodesic rates between internal and external sites, and the other subset is made up of rates between the internal sites themselves.

7.3 Mathematical Description of the Network Adjustment

The algorithm used to estimate the velocities of the tracking sites is based on similar algorithms used to determine static positions based on distance measurements. In classical terrestrial surveying, the problem falls into the class of trilateration problems. In our application, we essentially solve the problem in the same manner, whereby we have substituted geodesic rates for distances and components of motion for components of location. In

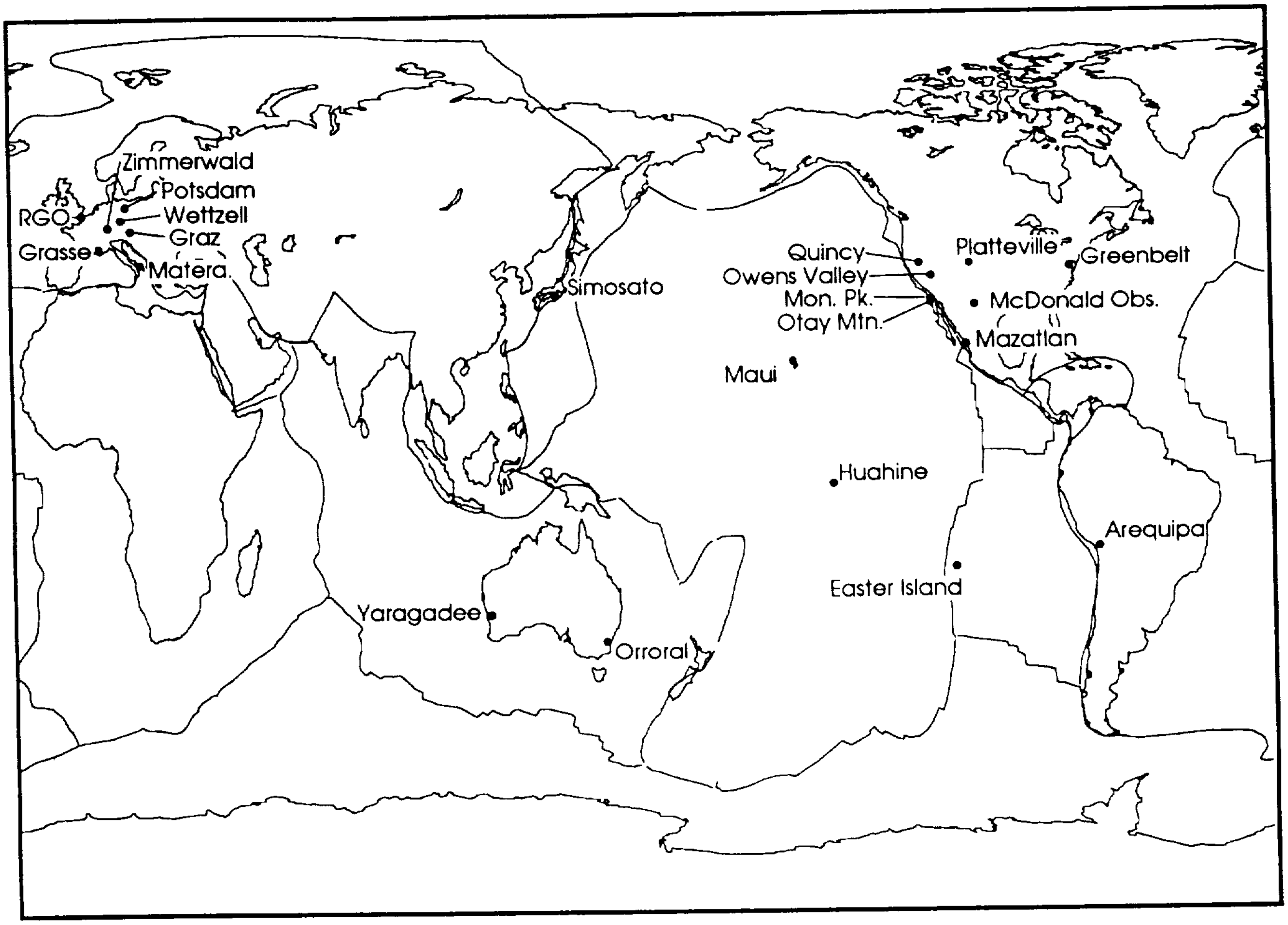


Figure 7.1 Locations of tracking sites contributing to the SL7.1 solution.

trilateration problems, the reference system is typically established by adopting a position of one of the nodes of the network and a direction toward one of the other nodes. In the same manner as described in the previous section, we have adopted the motion of two of the tracking sites. This is actually over-constraining the solution, but as mentioned above, as long as the SLR-determined motion between the constrained sites matches (to at least one standard deviation) that implied by the constraining model, the effects on the overall solution become negligible.

All geodesic rates between internal sites as well as those between internal to external sites are combined in a weighted least-squares solution which ultimately yields the unique motion vectors for each internal tracking site. Two kinds of observation equations can be written. For the external-to-internal lines the equation is written as:

$$C_{ij} = \left|\dot{X}_j\right| \cos\left(A_{xj} - A_{ji}\right) \tag{7.1}$$

where:

C_{ij} is the "observed" relative motion of the j^{th} internal site towards the i^{th} external station after the modeled motion of the external station has been removed, i.e., $C_{ij} = \dot{r}_{ij} - \dot{X}_i \cdot e_{ij}$ where $\dot{r}_{ij}$ is "observed" relative motion between external site i and internal site j, $\dot{X}_i$ is the constrained motion of the external site i, and e_{ij} is the unit vector at i toward j.

A_{xj} is the azimuth of the unknown motion vector $\dot{X}_j$.

A_{ji} is the azimuth from the internal site toward the external site.

These quantities are illustrated in Figure 7.2. The internal-to-internal lines have a somewhat similar observation equation of the form:

$$\dot{r}_{jk} = \left|\dot{X}_j\right| \cos\left(A_{xj} - A_{jk}\right) + \left|\dot{X}_k\right| \cos\left(A_{xk} - A_{kj}\right) \tag{7.2}$$

where:

$\dot{r}_{jk}$ is the observed relative geodesic rate between internal sites j and k

$\dot{X}_j, \dot{X}_k$ are the motion vectors being solved for at internal sites j and k

A_{xj}, A_{xk} are the azimuths of X_j and X_k, respectively, and

A_{jk}, A_{kj} are the azimuths of station j to k and k to j, respectively.

These terms are also illustrated in Figure 7.2.

7.4 Results from the Network Adjustment

The network adjustment is performed for 20 internal sites whereby estimates of their horizontal motions are relative to the constrained motions of the two external sites. In total, 214 geodesic distance rates (out of a possible 230) were used to determine the internal site velocities. The input geodesic rates between all pairs of stations are tabulated in Table 7.2 as well as those

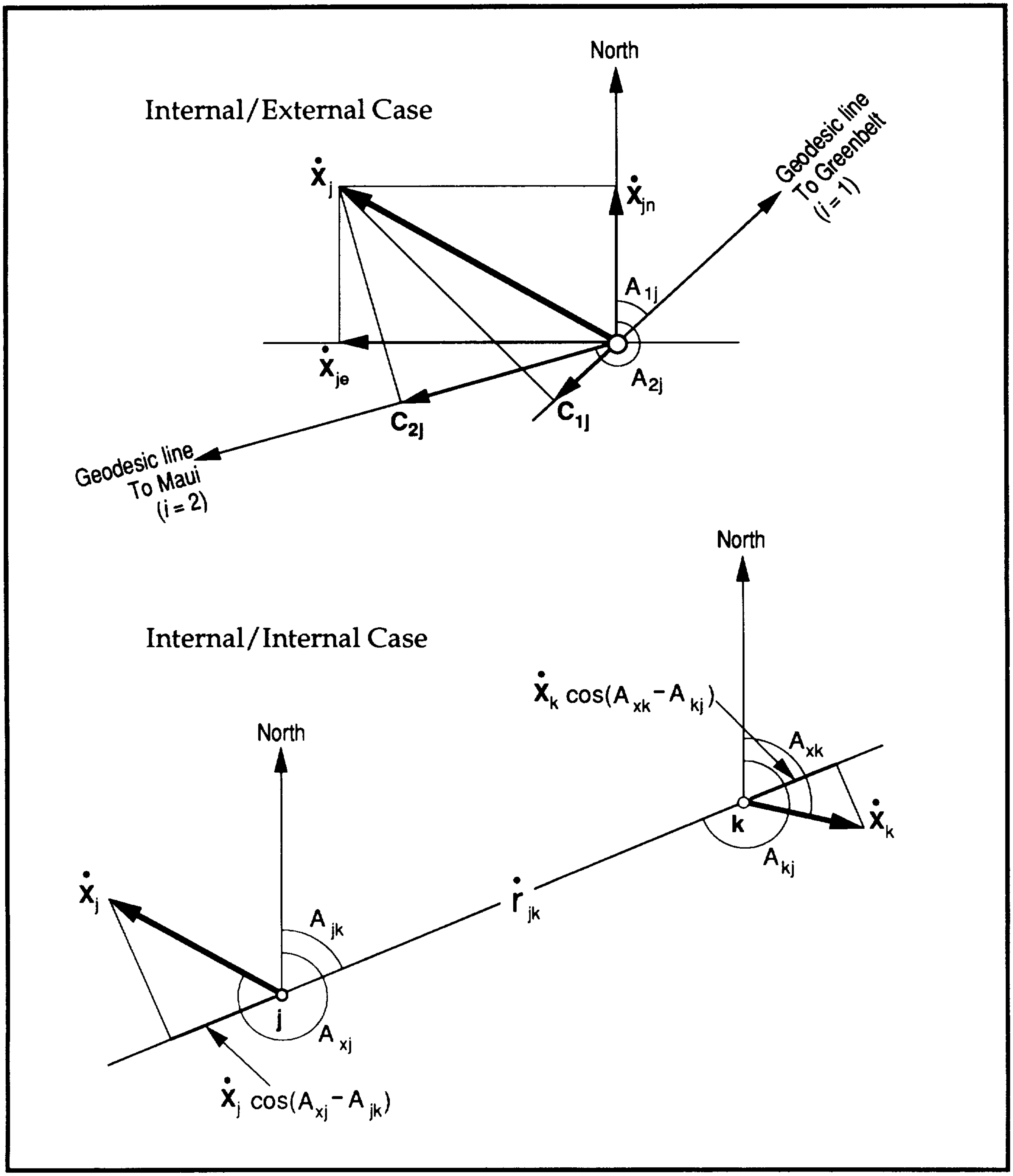


Figure 7.2 Network adjustment nomenclature used in equations (7.1) and (7.2). Top diagram illustrates the case between internal site j and the two external sites at Maui and Greenbelt. The bottom diagram illustrates the case between two internal sites, j and k.

inferred by the SL7.1 solved-for site velocities. Also shown on this table for reference, are the geodesic rates inferred by the geologic models NUVEL-1 and AM0-2.

The network adjustment provides estimates for the motions of the tracking sites as shown in Table 7.3. Actually, the estimated quantities are the site's northward and eastward velocity components, although in Table 7.3 we have elected to only show the direction and rate of the motions. Estimates of their errors in each component are also computed in the inversion and the error ellipse parameters are also given in the table. The overall weighted RMS of fit (or χ - squared statistic) for the complete solution is

$$WRMS = \left\{ \frac{\sum \left[\left(\dot{r}_{observed} - \dot{r}_{model} \right) / \sigma_{obs} \right]^2}{214} \right\}^{1/2} = 0.85 \qquad (7.3)$$

which indicates that the uncertainties quoted from the solution are optimistic (i.e., too large) and that good network closure has been achieved.

Geophysical interpretation of these results was the main focus of a companion paper of the present volume. The reader is advised to consult *Smith et al.* [1990b] for a comprehensive discussion of the tectonic results as well as regional anomalies and their implications with respect to current geophysical theories. Another recent global analysis of SLR-derived motions has been published by *Biancale et al.* [1991].

Table 7.2. Geodesic Rates Between SLR Sites

		Observed		NAP		NUVEL 1	AM0-2
From	To	Rate	σ	Rate	σ	Rate	Rate
Arequipa	Greenbelt	-7	2	-6	2	-4	-6
Arequipa	Maui	75	3	72	2	61	66
Arequipa	Easter Island	-62	7	-63	3	-80	-89
Arequipa	Grasse	8	7	3	3	20	22
Arequipa	Graz	5	6	4	3	20	21
Arequipa	Huahine	94	9	98	5	70	74
Arequipa	Matera	6	5	3	2	21	24
Arequipa	Mazatlan	3	5	4	2	-9	-12
Arequipa	McDonald	-2	3	-0	2	-8	-11
Arequipa	Monument Peak	36	3	36	2	38	42
Arequipa	Orroral	45	3	41	3	35	27
Arequipa	Otay Mountain	43	6	35	2	38	43
Arequipa	Owens Valley	-6	7	8	3	-8	-11
Arequipa	Platteville	0	9	-8	5	-7	-10
Arequipa	Potsdam	14	11	11	5	18	19
Arequipa	Quincy	7	3	7	2	-8	-11
Arequipa	RGO	5	5	4	3	17	19
Arequipa	Simosato	7	6	6	2	-20	-25
Arequipa	Wettzell	7	4	3	2	19	20
Arequipa	Yaragadee	59	4	62	2	64	62
Arequipa	Zimmerwald	0	16	5	6	19	21
Easter Island	Greenbelt	-21	7	-29	2	-33	-37
Easter Island	Maui	133	6	135	3	136	148
Easter Island	Grasse	-33	11	-42	3	-41	-46
Easter Island	Graz	-36	5	-37	2	-37	-43
Easter Island	Huahine	194	16	166	6	157	170
Easter Island	Matera	-48	1	-47	1	-47	-51
Easter Island	Mazatlan	-7	6	4	3	-5	-7
Easter Island	McDonald	7	16	-8	3	-8	-9
Easter Island	Monument Peak	42	6	39	3	48	54
Easter Island	Orroral	†	†	65	3	72	72
Easter Island	Otay Mountain	†	†	41	3	49	55
Easter Island	Owens Valley	†	†	20	4	10	9
Easter Island	Platteville	-7	54	-4	5	-5	-7
Easter Island	Potsdam	-23	11	-22	5	-32	-37
Easter Island	Quincy	18	4	21	3	12	12
Easter Island	RGO	-28	9	-33	2	-34	-39
Easter Island	Simosato	78	8	81	3	57	60
Easter Island	Wettzell	-30	11	-35	2	-35	-40
Easter Island	Yaragadee	48	4	59	2	67	67
Easter Island	Zimmerwald	†	†	-35	5	-38	-43
Grasse	Greenbelt	15	9	18	3	23	23
Grasse	Maui	-25	11	-28	4	-27	-31
Grasse	Graz	7	7	2	4	0	0
Grasse	Huahine	-11	25	15	4	6	3
Grasse	Matera	-2	4	-2	3	-6	-4
Grasse	Mazatlan	17	8	16	3	22	22
Grasse	McDonald	14	15	24	3	22	22
Grasse	Monument Peak	15	9	16	3	11	8
Grasse	Orroral	-18	29	-22	3	-31	-26

Table 7.2 (continued). Geodesic Rates Between SLR Sites

		Observed		NAP		NUVEL 1	AM0-2
From	To	Rate	σ	Rate	σ	Rate	Rate
Grasse	Otay Mountain	†	†	13	3	11	8
Grasse	Owens Valley	†	†	18	4	21	20
Grasse	Platteville	-20	*	16	4	22	21
Grasse	Potsdam	1	29	4	7	0	0
Grasse	Quincy	18	8	17	3	20	20
Grasse	RGO	2	7	2	3	0	0
Grasse	Simosato	-18	6	-19	3	0	0
Grasse	Wettzell	0	6	2	4	0	0
Grasse	Yaragadee	-15	7	-14	3	-21	-16
Grasse	Zimmerwald	5	15	-3	6	0	0
Graz	Greenbelt	16	5	17	2	22	21
Graz	Maui	-41	6	-40	3	-37	-43
Graz	Huahine	-14	12	-9	4	-16	-20
Graz	Matera	-2	3	-0	2	-8	-7
Graz	Mazatlan	12	4	14	2	21	21
Graz	McDonald	21	7	23	2	21	21
Graz	Monument Peak	8	5	10	2	4	0
Graz	Orroral	-29	24	-30	3	-38	-32
Graz	Otay Mountain	10	8	7	2	4	0
Graz	Owens Valley	†	†	14	3	20	19
Graz	Platteville	19	12	15	4	20	20
Graz	Potsdam	-12	19	-6	6	0	0
Graz	Quincy	13	4	14	2	19	18
Graz	RGO	0	5	-0	2	0	0
Graz	Simosato	-20	7	-21	3	0	0
Graz	Wettzell	-1	5	0	2	0	0
Graz	Yaragadee	-23	7	-21	2	-27	-23
Graz	Zimmerwald	-11	11	-2	5	0	0
Greenbelt	Maui	16	2	§	§	14	16
Huahine	Greenbelt	36	8	29	3	14	14
Huahine	Maui	16	10	3	5	0	0
Huahine	Matera	-10	10	-3	3	-17	-19
Huahine	Mazatlan	37	9	31	3	14	14
Huahine	McDonald	15	9	15	3	7	6
Huahine	Monument Peak	12	8	5	3	0	0
Huahine	Orroral	-64	21	-77	4	-59	-64
Huahine	Otay Mountain	-7	13	8	3	0	0
Huahine	Owens Valley	†	†	-3	4	-15	-18
Huahine	Platteville	-8	27	10	4	-5	-7
Huahine	Potsdam	-14	27	-5	6	-18	-23
Huahine	Quincy	0	9	-8	3	-21	-24
Huahine	RGO	12	11	10	3	2	-1
Huahine	Simosato	-88	11	-79	6	-98	-107
Huahine	Wettzell	-10	12	-7	3	-14	-18
Huahine	Yaragadee	-64	8	-77	4	-63	-69
Huahine	Zimmerwald	-12	36	13	5	-0	-4
Matera	Greenbelt	15	4	15	2	16	18
Matera	Maui	-42	7	-40	2	-45	-49
Matera	Mazatlan	12	5	13	2	15	17
Matera	McDonald	18	8	21	2	14	16

Table 7.2 (continued). Geodesic Rates Between SLR Sites

		Observed		NAP		NUVEL 1	AM0-2
From	To	Rate	σ	Rate	σ	Rate	Rate
Matera	Monument Peak	10	5	11	2	-0	-2
Matera	Orroral	-11	17	-15	3	-21	-18
Matera	Otay Mountain	13	2	8	1	-0	-2
Matera	Owens Valley	†	†	14	3	12	13
Matera	Platteville	24	15	14	4	13	15
Matera	Potsdam	-8	20	-6	6	-8	-7
Matera	Quincy	11	5	13	2	11	13
Matera	RGO	-2	4	-2	2	-8	-6
Matera	Simosato	-24	5	-20	3	-3	-3
Matera	Wettzell	-4	3	-0	2	-9	-7
Matera	Yaragadee	-13	6	-10	2	-14	-11
Matera	Zimmerwald	-0	14	-7	4	-8	-6
Mazatlan	Greenbelt	-0	3	-1	2	0	0
Mazatlan	Maui	40	4	39	2	43	48
Mazatlan	McDonald	-7	6	-9	2	0	0
Mazatlan	Monument Peak	35	3	32	2	47	55
Mazatlan	Orroral	-24	11	-43	2	-42	-45
Mazatlan	Otay Mountain	27	3	31	2	47	55
Mazatlan	Owens Valley	†	†	4	3	0	0
Mazatlan	Platteville	-15	12	-7	5	0	0
Mazatlan	Potsdam	22	16	22	5	21	20
Mazatlan	Quincy	4	4	3	2	0	0
Mazatlan	RGO	15	4	14	2	22	22
Mazatlan	Simosato	-1	6	-0	3	-10	-12
Mazatlan	Wettzell	14	6	13	2	21	21
Mazatlan	Yaragadee	-49	6	-51	2	-54	-58
Mazatlan	Zimmerwald	19	11	20	4	22	22
McDonald	Greenbelt	7	3	7	2	0	0
McDonald	Maui	18	4	23	2	30	34
McDonald	Monument Peak	24	4	27	2	35	41
McDonald	Orroral	-57	9	-57	3	-50	-52
McDonald	Otay Mountain	39	10	24	2	35	40
McDonald	Owens Valley	12	5	6	3	0	0
McDonald	Platteville	19	22	0	5	0	0
McDonald	Potsdam	34	17	31	5	20	20
McDonald	Quincy	5	4	6	2	0	0
McDonald	RGO	26	6	23	2	22	21
McDonald	Simosato	-1	8	0	3	-9	-11
McDonald	Wettzell	23	7	22	2	21	21
McDonald	Yaragadee	-67	6	-68	2	-67	-70
McDonald	Zimmerwald	11	15	29	4	22	22
Monument Peak	Greenbelt	19	2	18	1	14	16
Monument Peak	Maui	-0	3	-1	1	0	0
Monument Peak	Orroral	-74	10	-72	2	-67	-69
Monument Peak	Otay Mountain	-3	5	-3	2	0	0
Monument Peak	Owens Valley	-20	14	-24	3	-44	-51
Monument Peak	Platteville	11	7	8	3	-0	-2
Monument Peak	Potsdam	16	17	17	5	2	-2
Monument Peak	Quincy	-26	1	-27	1	-45	-53
Monument Peak	RGO	12	4	13	2	9	6

Table 7.2 (continued). Geodesic Rates Between SLR Sites

From	To	Observed Rate	Observed σ	NAP Rate	NAP σ	NUVEL 1 Rate	AM0-2 Rate
Monument Peak	Simosato	-33	5	-34	2	-55	-65
Monument Peak	Wettzell	13	5	9	2	5	0
Monument Peak	Yaragadee	-90	4	-91	2	-97	-103
Monument Peak	Zimmerwald	22	11	19	4	9	6
Orroral	Greenbelt	-63	5	-51	2	-51	-53
Orroral	Maui	-83	11	-65	2	-67	-67
Orroral	Otay Mountain	-65	2	-68	2	-67	-69
Orroral	Owens Valley	-65	55	-67	3	-62	-63
Orroral	Platteville	-34	138	-57	4	-61	-62
Orroral	Potsdam	-28	60	-49	6	-47	-42
Orroral	Quincy	-69	11	-69	2	-66	-66
Orroral	RGO	-42	15	-43	4	-49	-43
Orroral	Simosato	-14	15	-53	4	-71	-66
Orroral	Wettzell	-33	11	-34	3	-42	-36
Orroral	Yaragadee	12	4	3	2	0	0
Orroral	Zimmerwald	-41	31	-32	5	-38	-33
Otay Mountain	Greenbelt	22	5	15	2	14	16
Otay Mountain	Maui	19	10	2	2	0	0
Otay Mountain	Owens Valley	†	†	-24	3	-42	-50
Otay Mountain	Platteville	9	8	5	3	-0	-2
Otay Mountain	Potsdam	11	30	14	5	2	-2
Otay Mountain	Quincy	-24	4	-26	2	-45	-53
Otay Mountain	RGO	10	2	10	1	9	6
Otay Mountain	Simosato	-42	15	-33	3	-56	-65
Otay Mountain	Wettzell	5	1	7	1	4	0
Otay Mountain	Yaragadee	-98	3	-88	2	-97	-102
Otay Mountain	Zimmerwald	†	†	16	4	8	5
Owens Valley	Greenbelt	4	3	7	2	0	0
Owens Valley	Maui	34	17	7	2	14	17
Owens Valley	Platteville	20	50	10	4	0	0
Owens Valley	Potsdam	†	†	22	6	19	18
Owens Valley	Quincy	-7	6	-1	3	0	0
Owens Valley	RGO	†	†	16	3	20	20
Owens Valley	Simosato	-8	8	-7	3	-9	-11
Owens Valley	Wettzell	17	4	14	3	20	19
Owens Valley	Yaragadee	-87	7	-79	3	-78	-80
Owens Valley	Zimmerwald	†	†	22	5	20	20
Platteville	Greenbelt	-6	8	-4	3	0	0
Platteville	Maui	23	12	16	3	13	15
Platteville	Potsdam	22	25	24	6	20	20
Platteville	Quincy	10	7	11	4	0	0
Platteville	RGO	20	16	15	4	21	21
Platteville	Simosato	3	14	5	5	-8	-10
Platteville	Wettzell	23	10	15	4	20	20
Platteville	Yaragadee	-67	9	-69	4	-81	-83
Platteville	Zimmerwald	†	†	21	5	21	21
Potsdam	Greenbelt	26	13	26	5	21	20
Potsdam	Maui	-39	17	-33	6	-36	-42
Potsdam	Quincy	23	18	21	5	19	18
Potsdam	RGO	7	10	8	5	0	0

Table 7.2 (continued). Geodesic Rates Between SLR Sites

		Observed		NAP		NUVEL 1	AM0-2
From	To	Rate	σ	Rate	σ	Rate	Rate
Potsdam	Simosato	-23	12	-24	6	0	0
Potsdam	Wettzell	-3	18	-3	6	0	0
Potsdam	Yaragadee	-42	14	-37	5	-35	-30
Potsdam	Zimmerwald	-0	25	6	8	0	0
Quincy	Greenbelt	7	2	6	1	0	0
Quincy	Maui	3	2	1	1	7	8
Quincy	RGO	16	4	15	2	20	19
Quincy	Simosato	-5	5	-6	2	-9	-11
Quincy	Wettzell	16	4	14	2	19	18
Quincy	Yaragadee	-79	5	-80	2	-81	-82
Quincy	Zimmerwald	30	10	21	4	20	19
RGO	Greenbelt	16	4	17	2	22	22
RGO	Maui	-27	5	-28	2	-24	-28
RGO	Simosato	-19	5	-20	3	0	0
RGO	Wettzell	0	4	-0	2	0	0
RGO	Yaragadee	-28	5	-25	2	-31	-27
RGO	Zimmerwald	8	11	6	4	0	0
Simosato	Greenbelt	-2	5	-4	2	-5	-6
Simosato	Maui	-62	6	-64	3	-88	-99
Simosato	Wettzell	-19	4	-20	3	0	0
Simosato	Yaragadee	-72	6	-70	3	-80	-77
Simosato	Zimmerwald	-14	14	-18	6	0	0
Wettzell	Greenbelt	18	4	16	2	21	21
Wettzell	Maui	-35	5	-38	2	-35	-41
Wettzell	Yaragadee	-25	5	-23	2	-30	-26
Wettzell	Zimmerwald	-0	10	0	6	0	0
Yaragadee	Greenbelt	-77	3	-79	2	-88	-88
Yaragadee	Maui	-90	5	-90	2	-97	-103
Yaragadee	Zimmerwald	-20	18	-22	5	-26	-21
Zimmerwald	Greenbelt	16	11	22	4	22	22
Zimmerwald	Maui	-15	16	-26	5	-29	-34

† Indicates that no data exists to provide observed SLR rate.
* Indicates that rate is determined by only two points.
§ Indicates that the geodesic between the two stations is constrained within NAP.

Table 7.3. SL7.1 Tracking Site Velocities

Station Name	SLR Velocities Azimuth deg	SLR Velocities Rate mm/yr	Error Ellipse Parameters Semi-Major mm/yr	Error Ellipse Parameters Semi-Minor mm/yr	Error Ellipse Parameters Orient. deg	NUVEL-1 NNR Model Azimuth deg	NUVEL-1 NNR Model Rate mm/yr
Quincy	249	23	2.0	1.1	-15	224	20
Owens Valley	249	22	3.4	2.2	-11	226	19
McDonald	221	21	2.4	1.6	-12	239	15
Mazatlan	258	13	2.1	1.7	-28	230	13
Platteville	233	15	4.9	3.0	-20	244	18
Greenbelt	284	17	*	*	*	284	17
Monument Peak	287	44	2.1	1.2	-18	299	49
Otay Mountain	289	42	2.5	1.4	-40	299	49
Huahine	289	86	5.7	2.9	-51	297	74
Hawaii	299	70	*	*	*	299	70
Wettzell	47	22	3.1	1.5	42	56	25
RGO	38	23	3.5	1.5	32	49	24
Grasse	46	21	3.9	2.7	25	54	25
Zimmerwald	63	22	6.4	4.0	32	54	25
Graz	50	23	3.5	1.8	44	58	25
Potsdam	66	28	6.5	4.5	22	54	25
Simosato†	220	7	3.2	2.2	-51	127	26
Matera	46	21	3.1	1.5	43	43	29
Easter Island	99	81	3.3	2.2	-57	96	84
Arequipa	38	16	2.5	1.6	68	340	10
Orroral	21	57	3.7	1.9	-14	18	60
Yaragadee	34	65	2.4	1.6	-17	33	75

* Greenbelt and Hawaii are constrained to move with NUVEL 1 NNR motion.

† Although the plate upon which Simosato resides is under question, we have assumed Eurasian in our analysis.

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LAGEOS Geodetic Analysis - SL7.1

Appendix 1

Tracking Station Eccentricity Information

Site No.	Station Number	Occ. Name	Occ. System	Location	Plate	Start Date	End Date	Station north	Eccentricity east	up
1148	11480901	ONDLAS	OND. FIXED	ONDREJOV	EURASIAN	01-JAN-88	31-DEC-91	.000	.000	.000
1181	11813901	GDRLAS	GDR FIXED	POTSDAM, E	EURASIAN	01-JAN-74	31-DEC-91	.000	.000	.000
1863	18635101	MDNLAS	MDN. FIXED	MAIDANAK	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
1866	18665201	DNVLAS	DUN. FIXED	DUNAOVCY	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
1867	18675301	EVPLAS	EVP. FIXED	EVPATORIA	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
1873	18734901	SIMLAS	SIM. FIXED	SIMEIZ	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
1884	18844401	RGALAS	RGA FIXED	RIGA, USSR	EURASIAN	20-SEP-87	31-DEC-91	.000	.000	.000
1893	18931801	CRMLAS	CRIMEA FIX	KATZIVELY	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
1953	19532001	CUBLAS	CUBA FIXE	SANTIAGO D	NORTH AM	01-MAY-76	31-DEC-91	.000	.000	.000
7148	11480901	ONDLAS	OND. FIXED	ONDREJOV	EURASIAN	01-JAN-88	31-DEC-91	.000	.000	.000
7181	11813901	GDRLAS	GDR FIXED	POTSDAM, E	EURASIAN	01-JAN-74	31-DEC-91	.000	.000	.000
7863	18635101	MDNLAS	MDN. FIXED	MAIDANAK	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
7866	18665201	DNVLAS	DUN. FIXED	DUNAOVCY	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
7867	18675301	EVPLAS	EVP. FIXED	EVPATORIA	EURASIAN	01-JUL-90	31-DEC-91	.000	.000	.000
7873	18734901	SIMLAS	SIM. FIXED	SIMEIZ	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
7884	18844401	RGALAS	RGA FIXED	RIGA, USSR	EURASIAN	20-SEP-87	31-DEC-91	.000	.000	.000
7893	18931801	CRMLAS	CRIMEA FIX	KATZIVELY	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
7953	19532001	CUBLAS	CUBA FIXE	SANTIAGO D	NORTH AM	01-MAY-76	31-DEC-91	.000	.000	.000
7035	70351301	TL0306	TLRS-3	OTAY MOUNT	PACIFIC	24-JUN-88	31-DEC-88	N .006	E .017	2.587
7046	70461501	MT0127	MTLRS-1	BEAR LAKE	NORTH AM	03-AUG-90	31-DEC-90	N1.776	E1.946	1.335
7051	70510101	ML0102	MOBLAS-1	QUINCY, CA	NORTH AM	27-AUG-74	27-NOV-74	N .002	W .001	3.680
7051	70510202	ML0206	MOBLAS-2	QUINCY, CA	NORTH AM	09-JUL-76	30-NOV-76	S .005	W .003	3.604
7051	70510203	ML0210	MOBLAS-2	QUINCY, CA	NORTH AM	01-JAN-79	30-MAY-79	S .006	E .004	3.619
7051	70510804	ML0803	MOBLAS-8	QUINCY, CA	NORTH AM	01-FEB-81	21-MAY-81	S .022	E .023	3.279
7061	70611201	TL0202	TLRS-2	EASTER ISL	NAZCA	10-JAN-83	02-AUG-83	.000	.000	1.736
7061	70611202	TL0205	TLRS-2	EASTER ISL	NAZCA	19-MAR-84	12-DEC-84	.000	.000	1.735
7062	70620201	ML0202	MOBLAS-2	OTAY MOUNT	PACIFIC	28-AUG-74	14-DEC-74	S .005	.000	3.570
7062	70620302	ML0303	MOBLAS-3	OTAY MOUNT	PACIFIC	30-AUG-76	30-APR-77	.000	.000	3.615
7062	70620303	ML0306	MOBLAS-3	OTAY MOUNT	PACIFIC	29-JUN-78	30-MAY-79	S .011	W .010	3.568
7062	70621104	TL0115	TLRS-1	OTAY MOUNT	PACIFIC	04-OCT-81	09-JAN-82	N .031	W1.601	3.415
7062	70621205	TL0203	TLRS-2	OTAY MOUNT	PACIFIC	12-SEP-83	04-JAN-84	.000	.000	1.794
7063	70632101	STALAS	GSFC FIXED	GORF, GSFC	NORTH AM	01-MAY-76	29-AUG-81	.000	.000	3.036
7064	70640101	ML0101	MOBLAS-1	GORF, GSFC	NORTH AM	01-OCT-73	30-JUN-74	.000	.000	2.978
7064	70640102	ML0105	MOBLAS-1	GORF, GSFC	NORTH AM	21-OCT-77	30-NOV-77	N .002	E .002	2.966
7065	70650201	ML0201	MOBLAS-2	GORF, GSFC	NORTH AM	01-OCT-73	30-JUN-74	.000	.000	3.417
7065	70650203	ML0207	MOBLAS-2	GORF, GSFC	NORTH AM	17-OCT-77	21-NOV-77	S .013	E .002	3.468
7065	70650302	ML0302	MOBLAS-3	GORF, GSFC	NORTH AM	01-AUG-75	09-JUL-76	S .081	W .176	3.465
7066	70662701	WFCLAS	WAL. FIXED	WALLOPS IS	NORTH AM	01-MAY-76	01-JUN-79	.000	.000	9.080
7067	70670101	ML0103	MOBLAS-1	BERMUDA IS	NORTH AM	24-AUG-75	16-JUL-76	.000	.000	3.701
7067	70670102	ML0107	MOBLAS-1	BERMUDA IS	NORTH AM	26-JUN-78	09-NOV-78	S .005	W .008	3.689
7068	70680201	ML0204	MOBLAS-2	GRAND TURK	NORTH AM	19-APR-75	05-MAR-76	.000	E .005	3.578
7068	70680202	ML0209	MOBLAS-2	GRAND TURK	NORTH AM	30-JUL-78	07-NOV-78	N .009	W .029	3.678
7069	70692201	RAMLAS	PAFB FIXED	PATRICK AI	NORTH AM	01-MAY-76	30-SEP-80	.000	.000	3.436
7070	70700201	ML0203	MOBLAS-2	WALLOPS IS	NORTH AM	24-JAN-75	28-FEB-75	.000	.000	3.360
7080	70802401	MLRS07	MLRS	MCDONALD O	NORTH AM	10-FEB-88	03-JUN-88	N .004	E .005	1.756
7080	70802402	MLRS08	MLRS	MCDONALD O	NORTH AM	03-JUN-88	21-SEP-88	N .004	E .005	1.756
7080	70802403	MLRS09	MLRS	MCDONALD O	NORTH AM	21-SEP-88	12-SEP-89	N .004	E .005	1.756
7080	70802404	MLRS10	MLRS	MCDONALD	NORTH AM	12-SEP-89	28-SEP-89	N .004	E .005	1.756
7080	70802405	MLRS11	MLRS	MCDONALD	NORTH AM	27-SEP-89	18-NOV-89	N .004	E .005	1.756
7080	70802406	MLRS12	MLRS	MCDONALD	NORTH AM	18-NOV-89	15-JAN-90	N .004	E .005	1.756
7080	70802407	MLRS13	MLRS	MCDONALD	NORTH AM	15-JAN-90	25-JAN-90	N .004	E .005	1.756
7080	70802408	MLRS14	MLRS	MCDONALD	NORTH AM	25-JAN-90	03-APR-90	N .004	E .005	1.756
7080	70802409	MLRS15	MLRS	MCDONALD	NORTH AM	03-APR-90	29-APR-90	N .004	E .005	1.756
7080	70802410	MLRS16	MLRS	MCDONALD	NORTH AM	29-APR-90	06-JUN-90	N .004	E .005	1.756
7080	70802411	MLRS17	MLRS	MCDONALD	NORTH AM	06-JUN-90	25-SEP-90	N .004	E .005	1.756
7080	70802412	MLRS18	MLRS	MCDONALD	NORTH AM	25-SEP-90	01-DEC-90	N .004	E .005	1.756
7080	70802413	MLRS19	MLRS	MCDONALD	NORTH AM	01-DEC-90	09-APR-91	N .004	E .005	1.756
7080	70802414	MLRS20	MLRS	MCDONALD	NORTH AM	10-APR-91	31-DEC-91	N .004	E .005	1.756
7081	70810201	ML0205	MOBLAS-2	PATRICK AI	NORTH AM	12-APR-76	07-MAY-76	.000	.000	3.422
7082	70820101	ML0104	MOBLAS-1	BEAR LAKE,	NORTH AM	24-SEP-76	30-NOV-76	N .002	E .003	3.774
7082	70820102	ML0108	MOBLAS-1	BEAR LAKE,	NORTH AM	01-JAN-79	20-AUG-79	S .004	E .005	3.817
7082	70821103	TL0111	TLRS-1	BEAR LAKE,	NORTH AM	30-MAR-81	06-MAY-81	S1.087	E1.112	3.517
7082	70821104	TL0125	TLRS-1	BEAR LAKE,	NORTH AM	03-NOV-83	10-JAN-84	N .998	E1.207	3.521
7083	70830301	ML0301	MOBLAS-3	GORF, GSFC	NORTH AM	01-JAN-75	15-JUN-75	.000	.000	2.873
7084	70840201	ML0208	MOBLAS-2	OWENS VALL	NORTH AM	12-DEC-77	31-MAR-78	.000	.000	3.493
7085	70850101	ML0106	MOBLAS-1	GOLDSTONE,	NORTH AM	12-DEC-77	31-MAR-78	S .003	W .008	3.866
7086	70860101	ML0109	MOBLAS-1	MCDONALD O	NORTH AM	27-AUG-79	31-MAY-80	N .007	W .007	3.788
7086	70861102	TL0105	TLRS-1	MCDONALD O	NORTH AM	01-JUL-80	09-AUG-80	S1.580	W .140	3.536
7086	70862403	MLRS01	MLRS	MCDONALD O	NORTH AM	31-AUG-82	28-FEB-85	S5.315	E5.591	1.994
7086	70862404	MLRS02	MLRS	MCDONALD O	NORTH AM	01-MAR-85	17-OCT-86	S5.308	E5.590	1.977
7086	70862405	MLRS03	MLRS	MCDONALD O	NORTH AM	17-OCT-86	30-JUL-87	S5.308	E5.590	1.997
7086	70862406	MLRS04	MLRS	MCDONALD O	NORTH AM	30-JUL-87	01-FEB-88	S5.308	E5.590	1.977

Site No.	Station Number	Occ. Name	Occ. System	Location	Plate	Start Date	End Date	Station Eccentricity north	east	up
7090	70900501	ML0502	MOBLAS-5	YARAGADEE,	AUSTRALI	01-JUL-79	27-JUL-83	N .003	E .011	3.185
7090	70900502	ML0503	MOBLAS-5	YARAGADEE,	AUSTRALI	27-JUL-83	19-NOV-84	N .003	E .011	3.185
7090	70900503	ML0504	MOBLAS-5	YARAGADEE,	AUSTRALI	19-NOV-84	05-SEP-85	N .003	E .011	3.185
7090	70900504	ML0505	MOBLAS-5	YARAGADEE,	AUSTRALI	05-SEP-85	16-APR-87	N .003	E .011	3.185
7090	70900505	ML0506	MOBLAS-5	YARAGADEE,	AUSTRALI	23-APR-87	13-AUG-87	N .003	E .011	3.185
7090	70900506	ML0507	MOBLAS-5	YARAGADEE,	AUSTRALI	13-AUG-87	26-AUG-87	N .003	E .011	3.185
7090	70900507	ML0508	MOBLAS-5	YARAGADEE,	AUSTRALI	26-AUG-87	05-AUG-89	N .003	E .011	3.185
7090	70900508	ML0509	MOBLAS-5	YARAGADEE	AUSTRALI	05-AUG-89	31-DEC-91	N .003	E .010	3.177
7091	70910301	ML0305	MOBLAS-3	HAYSTACK O	NORTH AM	05-DEC-77	01-APR-78	.000	E .003	3.748
7091	70910702	ML0702	MOBLAS-7	HAYSTACK O	NORTH AM	10-JUN-79	14-NOV-80	S .016	W .003	3.381
7091	70911103	TL0147	TLRS-1	HAYSTACK O	NORTH AM	09-AUG-88	17-OCT-88	N1.556	E .121	3.476
7091	70911104	TL0156	TLRS-1	WESTFORD	NORTH AM	10-OCT-90	12-DEC-90	N1.550	E .059	3.497
7092	70920801	ML0802	MOBLAS-8	KWAJALEIN,	PACIFIC	15-AUG-79	01-NOV-80	S .015	E .045	3.142
7096	70960601	ML0602	MOBLAS-6	AMERICAN S	PACIFIC	10-JUN-79	14-NOV-80	.000	.000	3.198
7097	70971201	TL0210	TLRS-2	EASTER ISL	NAZCA	11-NOV-87	29-FEB-88	N .000	E .000	1.496
7097	70971202	TL0212	TLRS-2	EASTER ISL	NAZCA	22-SEP-88	31-DEC-89	N .000	E .000	1.474
7097	70971203	TL0214	TLRS-2	EASTER ISL	NAZCA	06-OCT-89	31-DEC-90	N .000	E .000	1.482
7100	71000301	ML0304	MOBLAS-3	GORF, GSFC	NORTH AM	16-AUG-77	18-NOV-77	.000	W .002	3.513
7100	71000402	ML0401	MOBLAS-4	GORF, GSFC	NORTH AM	01-MAR-78	13-OCT-78	N .005	E .021	3.191
7101	71010602	ML0603	MOBLAS-6	GORF, GSFC	NORTH AM	01-FEB-82	01-JUN-82	N .119	W .648	3.150
7101	71010801	ML0801	MOBLAS-8	GORF, GSFC	NORTH AM	01-AUG-78	30-MAY-79	N .168	W .691	3.133
7102	71020305	ML0309	MOBLAS-3	GORF, GSFC	NORTH AM	01-DEC-84	31-DEC-91	N .058	E .018	3.488
7102	71020402	ML0402	MOBLAS-4	GORF, GSFC	NORTH AM	15-MAY-79	15-NOV-82	S .002	W .004	3.205
7102	71020403	ML0403	MOBLAS-4	GORF, GSFC	NORTH AM	01-DEC-82	31-MAR-83	N .008	E .048	3.154
7102	71020404	ML0404	MOBLAS-4	GORF, GSFC	NORTH AM	01-APR-83	31-JUL-83	S .019	E .042	3.196
7102	71020501	ML0501	MOBLAS-5	GORF, GSFC	NORTH AM	01-APR-78	17-MAY-79	S .009	E .002	3.208
7102	71021106	TL0148	MOBLAS-5	GORF, GSFC	NORTH AM	21-OCT-88	01-JAN-89	N1.566	E .018	3.267
7102	71021107	TL0149	MOBLAS-5	GORF, GSFC	NORTH AM	02-JAN-89	06-MAR-89	N1.566	E .018	3.267
7103	71030601	ML0601	MOBLAS-6	GORF, GSFC	NORTH AM	15-MAY-78	10-MAY-79	.000	W .033	3.192
7103	71030602	ML0604	MOBLAS-6	GORF, GSFC	NORTH AM	08-JUN-82	02-NOV-82	S .046	W .006	3.166
7104	71040701	ML0701	MOBLAS-7	GORF, GSFC	NORTH AM	01-JUL-78	04-JUN-79	N .069	E .062	3.130
7105	71050701	ML0703	MOBLAS-7	GORF, GSFC	NORTH AM	01-JAN-81	15-JUN-81	N .016	W .026	3.149
7105	71050702	ML0704	MOBLAS-7	GORF, GSFC	NORTH AM	16-JUN-81	01-FEB-83	N .016	W .026	3.149
7105	71050703	ML0705	MOBLAS-7	GORF, GSFC	NORTH AM	01-FEB-83	22-AUG-83	N .017	E .031	3.168
7105	71050704	ML0706	MOBLAS-7	GORF, GSFC	NORTH AM	22-AUG-83	22-MAR-84	N .017	E .031	3.168
7105	71050705	ML0707	MOBLAS-7	GORF, GSFC	NORTH AM	22-MAR-84	07-MAY-85	N .017	E .031	3.168
7105	71050708	ML0708	MOBLAS-7	GORF, GSFC	NORTH AM	07-MAY-85	29-JUL-85	N .017	E .031	3.168
7105	71050709	ML0709	MOBLAS-7	GORF, GSFC	NORTH AM	29-JUL-85	27-MAR-86	N .017	E .031	3.168
7105	71050710	ML0710	MOBLAS-7	GORF, GSFC	NORTH AM	31-MAR-86	06-DEC-86	N .017	E .031	3.168
7105	71050711	ML0711	MOBLAS-7	GORF, GSFC	NORTH AM	06-DEC-86	27-JUL-88	N .017	E .031	3.168
7105	71050712	ML0712	MOBLAS-7	GORF, GSFC	NORTH AM	27-JUL-88	08-JAN-89	N .017	E .031	3.168
7105	71050713	ML0713	MOBLAS-7	GORF, GSFC	NORTH AM	09-JAN-89	14-JUN-89	N .017	E .031	3.168
7105	71050714	ML0714	MOBLAS-7	GREENBELT	NORTH AM	15-JUN-89	02-AUG-89	N .017	E .031	3.168
7105	71050715	ML0715	MOBLAS-7	GREENBELT	NORTH AM	03-AUG-89	12-OCT-89	N .017	E .031	3.168
7105	71050716	ML0716	MOBLAS-7	GREENBELT	NORTH AM	12-OCT-89	24-JUL-90	N .035	E .040	3.162
7105	71050717	ML0717	MOBLAS-7	GREENBELT	NORTH AM	25-JUL-90	31-AUG-90	N .014	E .033	3.153
7105	71050718	ML0718	MOBLAS-7	GREENBELT	NORTH AM	01-SEP-90	31-DEC-91	N .014	E .033	3.153
7109	71090801	ML0804	MOBLAS-8	QUINCY, CA	NORTH AM	01-OCT-81	29-JUL-82	N .012	E .011	3.225
7109	71090802	ML0805	MOBLAS-8	QUINCY, CA	NORTH AM	15-AUG-82	12-MAR-85	S .029	E .011	3.124
7109	71090803	ML0806	MOBLAS-8	QUINCY, CA	NORTH AM	12-MAR-85	15-AUG-85	S .029	E .011	3.124
7109	71090804	ML0807	MOBLAS-8	QUINCY, CA	NORTH AM	15-AUG-85	18-SEP-86	S .029	E .011	3.124
7109	71090805	ML0808	MOBLAS-8	QUINCY, CA	NORTH AM	26-SEP-86	12-DEC-88	S .029	E .011	3.124
7109	71090806	ML0809	MOBLAS-8	QUINCY, CA	NORTH AM	12-DEC-88	21-MAR-89	S .029	E .011	3.124
7109	71090807	ML0810	MOBLAS-8	QUINCY, CA	NORTH AM	21-MAR-89	31-DEC-91	S .029	E .011	3.124
7110	71100301	ML0308	MOBLAS-3	MOUNT LAGU	PACIFIC	13-JUL-81	03-JUL-83	S .007	W .003	3.520
7110	71100402	ML0405	MOBLAS-4	MOUNT LAGU	PACIFIC	15-AUG-83	12-NOV-86	S .033	W .015	3.209
7110	71100403	ML0406	MOBLAS-4	MOUNT LAGU	PACIFIC	19-NOV-86	30-APR-88	S .033	W .015	3.209
7110	71100404	ML0407	MOBLAS-4	MOUNT LAGU	PACIFIC	29-APR-88	15-JUN-88	S .033	W .015	3.209
7110	71100405	ML0408	MOBLAS-4	MOUNT LAGU	PACIFIC	15-JUN-88	12-DEC-88	S .033	W .015	3.209
7110	71100406	ML0409	MOBLAS-4	MOUNT LAGU	PACIFIC	13-DEC-88	31-DEC-91	S .033	W .015	3.209
7111	71111101	TL0117	TLRS-1	VANDENBERG	PACIFIC	28-APR-82	25-MAY-82	S1.162	W1.051	3.312
7112	71120201	ML0212	MOBLAS-2	PLATTEVILL	NORTH AM	04-MAR-81	13-OCT-84	N .005	W .002	3.511
7112	71121502	MT0116	MTLRS-1	PLATTEVILL	NORTH AM	30-JUL-88	30-SEP-88	S2.705	E .011	1.351
7112	71121403	TL0407	TLRS-4	PLATTEVILL	NORTH AM	26-JAN-90	23-FEB-90	N .007	E .022	2.628
7112	71121404	MT0128	MTLRS-1	PLATTEVILL	NORTH AM	25-SEP-90	31-DEC-90	N2.705	E .042	1.347
7114	71140201	ML0211	MOBLAS-2	OWENS VALL	NORTH AM	08-JUN-79	31-JAN-81	S .003	W .008	3.622
7114	71141102	TL0114	TLRS-1	OWENS VALL	NORTH AM	11-AUG-81	29-SEP-81	N1.512	W .442	3.466
7114	71141103	TL0120	TLRS-1	OWENS VALL	NORTH AM	03-NOV-82	22-JAN-83	N1.520	W .364	3.521
7115	71150301	ML0307	MOBLAS-3	GOLDSTONE,	NORTH AM	15-JUN-79	12-APR-81	N .007	W .029	3.615
7120	71200101	ML0110	MOBLAS-1	LURE OBS.,	PACIFIC	15-JUN-80	22-JAN-82	S .013	E .009	3.602
7121	71210101	ML0111	MOBLAS-1	HUAHINE, S	PACIFIC	01-FEB-83	13-APR-86	N .001	E .006	3.662
7122	71220601	ML0605	MOBLAS-6	MAZATLAN,	NORTH AM	01-MAR-83	16-MAR-84	N .001	W .007	3.182

Site No.	Station Number	Occ. Name	Occ. System	Location	Plate	Start Date	End Date	Station Eccentricity north	east	up
7122	71220602	ML0606	MOBLAS-6	MAZATLAN,	NORTH AM	27-MAY-84	15-DEC-85	N .001	W .007	3.182
7122	71220603	ML0607	MOBLAS-6	MAZATLAN,	NORTH AM	16-DEC-85	21-JAN-87	N .001	W .007	3.182
7122	71220604	ML0608	MOBLAS-6	MAZATLAN,	NORTH AM	28-JAN-87	17-AUG-88	N .001	W .007	3.182
7122	71220605	ML0609	MOBLAS-6	MAZATLAN,	NORTH AM	17-AUG-88	12-DEC-91	N .002	W .006	3.181
7122	71220606	ML0610	MOBLAS-6	MAZATLAN,	NORTH AM	13-JAN-89	22-JUN-89	N .002	W .006	3.181
7122	71220607	ML0611	MOBLAS-6	MAZATLAN	NORTH AM	23-JUN-89	03-OCT-89	N .002	E .006	3.181
7122	71220608	ML0612	MOBLAS-6	MAZATLAN	NORTH AM	04-OCT-89	31-DEC-91	N .002	E .006	3.181
7123	71231201	TL0209	TLRS-2	HUAHINE, S	PACIFIC	14-JUL-87	31-DEC-87	N .000	E .000	1.453
7123	71231202	TL0211	TLRS-2	HUAHINE, S	PACIFIC	16-MAR-88	01-SEP-88	N .000	E .000	1.437
7123	71231203	TL0213	TLRS-2	HUAHINE	PACIFIC	24-APR-89	03-SEP-89	N .000	E .000	1.482
7123	71231204	TL0215	TLRS-2	HUAHINE	PACIFIC	15-MAR-90	31-DEC-90	N .001	E .003	1.459
7125	71251501	MT0104	MTLRS-1	GORF, GSFC	NORTH AM	01-MAY-85	23-JUL-85	N .354	E2.118	1.338
7125	71251302	TL0304	TLRS-3	GREENBELT	NORTH AM	15-SEP-87	28-JAN-88	N .000	E .000	2.580
7130	71301201	TL0208	TLRS-2	GREENBELT	NORTH AM	06-NOV-85	19-MAY-87	N .000	E .000	2.486
7206	72062601	MCLAS1	2.7 METER	MCDONALD O	NORTH AM	01-MAY-76	29-JUN-85	S .810	W .041	5.328
7210	72102301	HOLLAS	HALEAKALA	LURE OBS.,	PACIFIC	01-MAY-76	31-MAR-84	N .752	.000	.848
7210	72102302	HOLLAS	HALEAKALA	LURE OBS.,	PACIFIC	01-APR-84	15-JUL-87	N .752	E .000	.848
7210	72102303	HOLLAS	HALEAKALA	LURE OBS.,	PACIFIC	16-JUL-87	04-AUG-89	N .752	E .000	.848
7210	72102304	HOLLAS	HALEAKALA	HALEAKALA	PACIFIC	04-AUG-89	31-DEC-91	N .753	E .001	.848
7220	72201101	TL0124	TLRS-1	MOUNT LAGU	PACIFIC	30-AUG-83	02-NOV-83	N1.439	E .656	3.248
7220	72201102	TL0132	TLRS-1	MOUNT LAGU	PACIFIC	28-DEC-84	10-JAN-85	.000	.000	.000
7220	72201103	TL0133	TLRS-1	MOUNT LAGU	PACIFIC	13-JAN-85	27-FEB-85	.000	.000	.000
7220	72201104	TL0134	TLRS-1	MOUNT LAGU	PACIFIC	03-MAR-85	23-MAR-85	.000	.000	.000
7220	72201105	TL0135	TLRS-1	MOUNT LAGU	PACIFIC	24-MAR-85	13-MAY-85	.000	.000	.000
7236	72362901	WUHLAS	WUH. FIXED	WUHAN	EURASIAN	01-JAN-88	31-DEC-91	.000	.000	.000
7265	72651101	TL0126	TLRS-1	BARSTOW, C	NORTH AM	18-JAN-84	06-MAR-84	N .470	W1.502	3.491
7274	72741101	TL0136	TLRS-1	MOUNT LAGU	PACIFIC	16-MAY-85	18-JUL-85	.000	.000	.000
7288	72881301	TL0305	TLRS-3	BARSTOW, C	NORTH AM	08-FEB-88	16-JUN-88	N .000	E .003	2.584
7288	72881402	TL0403	TLRS-3	BARSTOW, C	NORTH AM	23-JAN-89	19-APR-89	N .005	E .011	2.610
7288	72881403	TL0406	TLRS-4	MOJAVE	NORTH AM	21-OCT-89	31-JAN-90	N .013	E .004	2.617
7288	72881404	TL0410	TLRS-4	MOJAVE	NORTH AM	20-OCT-90	22-FEB-91	N .008	E .012	2.637
7295	72951501	MT0116	MTLRS-1	RICHMOND	NORTH AM	24-MAR-88	21-JUL-88	N2.611	E .196	1.341
7295	72951102	TL0157	TLRS-1	RICHMOND	NORTH AM	21-DEC-90	17-APR-91	N .166	E1.565	3.288
7300	73001701	HT0103	HTLRS-1	MINAMI TOR	EURASIAN	10-JAN-89	24-MAR-89	.000	.000	.000
7301	73011701	HT0104	HTLRS-1	OKINAWA	EURASIAN	03-AUG-89	04-SEP-89	.000	.000	.000
7302	73021701	HT0105	HTLRS-1	TUSIMA	EURASIAN	03-OCT-89	25-NOV-89	.000	.000	.000
7307	73071701	HT0102	HTLRS-1	ISIGAKI-SI	PACIFIC	18-JUL-88	17-SEP-88	.000	.000	.000
7308	73085001	CRLLAS	CRLLAS	TOKYO	PACIFIC	01-JAN-90	31-DEC-91	.000	.000	.000
7400	74001101	TL0127	TLRS-1	SANTIAGO,	SOUTH AM	07-MAR-84	10-MAY-84	.000	.000	.000
7401	74011101	TL0128	TLRS-1	CERRO TOLO	SOUTH AM	14-MAY-84	30-JUN-84	N1.580	E .119	3.309
7401	74011302	TL0311	TLRS-3	CERRO TOLO	SOUTH AM	08-JAN-90	02-JUN-90	N .022	E .009	2.699
7401	74011303	TL0313	TLRS-3	CERRO TOLO	SOUTH AM	11-NOV-90	13-MAR-91	N .017	E .004	2.701
7403	74031301	TL0312	TLRS-3	AREQUIPA	SOUTH AM	14-JUN-90	31-DEC-90	N .013	E .011	2.683
7510	75101501	MT0109	MTLRS-1	ASKITES, G	EURASIAN	21-MAY-86	22-JUL-86	N2.546	E .026	1.344
7510	75101602	MT0213	MTLRS-2	ASKITES	EURASIAN	25-MAY-87	29-AUG-87	N2.619	E .073	1.358
7510	75101603	MT0219	MTLRS-2	ASKITES	EURASIAN	05-AUG-89	02-NOV-89	N2.625	E .059	1.357
7510	75101504	MT0124	MTLRS-1	ASKITES	EURASIAN	03-NOV-89	31-DEC-89	N2.651	E .006	1.358
7512	75121501	MT0111	MTLRS-1	KATAVIA, R	EURASIAN	05-SEP-86	19-OCT-86	N2.558	E .073	1.340
7512	75121602	MT0212	MTLRS-2	KATAVIA, R	EURASIAN	19-MAR-87	15-MAY-87	N2.575	E .070	1.353
7512	75121503	MT0123	MTLRS-1	KATAVIA	EURASIAN	10-OCT-89	28-OCT-89	N2.678	E .075	1.344
7515	75151501	MT0110	MTLRS-1	DIONYSOS	EURASIAN	27-JUL-86	31-AUG-86	N2.577	E .014	1.328
7515	75151502	MT0114	MTLRS-1	DIONYSOS	EURASIAN	20-JUL-87	23-OCT-87	N2.622	E .003	1.329
7515	75151503	MT0125	MTLRS-1	DIONYSOS	EURASIAN	15-DEC-89	31-MAR-90	N2.616	E .028	1.333
7517	75171601	MT0208	MTLRS-2	ROUMELLI	EURASIAN	27-MAY-86	01-SEP-86	N2.592	E .058	1.360
7517	75171102	TL0143	TLRS-1	ROUMELLI	EURASIAN	20-JUL-87	28-AUG-87	N1.568	E .058	3.309
7517	75171503	MT0115	MTLRS-1	ROUMELLI	EURASIAN	22-OCT-87	11-DEC-87	N2.576	E .014	1.339
7517	75171104	TL0150	TLRS-1	ROUMELLI	EURASIAN	16-APR-89	27-JUN-89	N1.562	E .072	3.238
7520	75201501	MT0108	MTLRS-1	KARITSA	EURASIAN	18-MAR-86	14-MAY-86	N2.429	E .020	1.339
7520	75201502	MT0120	MTLRS-1	KARITSA	EURASIAN	07-JUN-89	08-AUG-89	N2.722	E .070	1.354
7525	75251601	MT0209	MTLRS-2	XRISOKALAR	EURASIAN	03-SEP-86	13-SEP-86	N2.572	E .103	1.370
7525	75251602	MT0210	MTLRS-2	XRISOKALAR	EURASIAN	14-SEP-86	15-SEP-86	N2.572	E .103	1.370
7525	75251603	MT0211	MTLRS-2	XRISOKALAR	EURASIAN	15-SEP-86	19-OCT-86	N2.572	E .103	1.371
7525	75251104	TL0144	TLRS-1	XRISOKALAR	EURASIAN	10-SEP-87	11-DEC-87	N1.573	E .078	3.263
7525	75251105	TL0153	TLRS-1	XRISOKALAR	EURASIAN	19-NOV-89	31-MAR-90	N1.568	E .018	3.260
7530	75300201	ML0214	MOBLAS-2	BAR GIYYOR	AFRICAN	02-AUG-85	07-AUG-89	N .000	E .579	2.024
7530	75300202	ML0215	MOBLAS-2	BAR GIYYOR	AFRICAN	08-AUG-89	31-DEC-91	N .000	E .579	2.024
7540	75401501	MT0106	MTLRS-1	MATERA, IT	EURASIAN	08-JAN-86	17-MAR-86	N2.654	E .022	1.321
7541	75411601	MT0206	MTLRS-2	MATERA, IT	EURASIAN	08-DEC-85	13-MAR-86	N2.640	E .115	1.336
7543	75431601	MT0222	MTLRS-2	NOTO	EURASIAN	22-OCT-90	13-DEC-90	N2.602	E .264	1.361
7544	75441601	MT0214	MTLRS-2	LAMPEDUSA,	AFRICAN	14-SEP-87	11-DEC-87	N2.651	E .016	1.363
7544	75441502	MT0119	MTLRS-1	LAMPEDUSA	AFRICAN	21-MAR-89	05-JUN-89	N2.686	E .038	1.346
7545	75451601	MT0205	MTLRS-2	PUNTA SA M	EURASIAN	19-OCT-85	07-DEC-85	N2.607	E .089	1.348

Site No.	Station Number	Occ. Name	Occ. System	Location	Plate	Start Date	End Date	Station Eccentricity north	east	up
7545	75451602	MT0215	MTLRS-2	PUNTA SA M	EURASIAN	08-JAN-88	24-MAR-88	N2.632	E .037	1.361
7545	75451103	MT0220	MTLRS-2	PUNTA SA M	EURASIAN	01-JAN-90	24-APR-90	N .038	E1.565	3.249
7546	75461601	MT0216	MTLRS-2	BOLOGNA, I	EURASIAN	28-MAR-88	04-JUN-88	N2.648	E .112	1.349
7550	75501601	MT0207	MTLRS-2	BASOVIZZA	EURASIAN	18-MAR-86	20-MAY-86	N2.062	E .552	1.346
7550	75501602	MT0218	MTLRS-2	BASOVIZZA	EURASIAN	23-MAY-89	26-JUL-89	N2.631	E .045	1.353
7575	75751501	MT0112	MTLRS-1	DIYARBAKIR	ARABIAN	23-MAR-87	15-MAY-87	N2.625	E .087	1.328
7575	75751502	MT0122	MTLRS-1	DIYARBAKIR	ARABIAN	07-SEP-89	29-SEP-89	N2.676	E .166	1.350
7580	75801101	TL0141	TLRS-1	MELENGICLI	EURASIAN	02-APR-87	16-MAY-87	N1.574	E .103	3.318
7580	75801102	TL0152	TLRS-1	MELENGICLI	EURASIAN	16-OCT-89	12-NOV-89	N1.555	E .230	3.245
7585	75851501	MT0113	MTLRS-1	YOZGAT	EURASIAN	25-MAY-87	03-JUL-87	N2.581	E .168	1.344
7585	75851502	MT0121	MTLRS-1	YOZGAT	EURASIAN	15-AUG-89	07-SEP-89	N2.603	E .153	1.342
7587	75871101	TL0142	TLRS-1	YIGILCA	EURASIAN	20-MAY-87	03-JUL-87	N1.576	E .036	3.307
7587	75871102	TL0151	TLRS-1	YIGILCA	EURASIAN	05-JUL-89	11-OCT-89	N1.559	E .198	3.273
7590	75901601	MT0204	MTLRS-2	MONTE GENE	EURASIAN	01-SEP-85	19-OCT-85	N2.307	E .513	1.132
7596	75961601	MT0202	MTLRS-2	WETTZELL,	EURASIAN	01-MAR-85	16-APR-85	N2.407	E .030	1.371
7596	75961502	MT0105	MTLRS-1	WETTZELL,	EURASIAN	07-AUG-85	31-DEC-85	N2.445	E .006	1.341
7597	75971501	MT0103	MTLRS-1	WETTZELL,	EURASIAN	01-FEB-85	23-MAR-85	N2.524	E .009	1.333
7597	75971502	MT0104	MTLRS-1	WETTZELL,	EURASIAN	29-MAR-85	03-APR-85	N2.585	E .001	1.324
7599	75991501	MT0102	MTLRS-1	WETTZELL,	EURASIAN	01-SEP-84	31-DEC-84	N2.304	E .055	1.368
7602	76021601	MT0221	MTLRS-2	TROMSOE	EURASIAN	05-AUG-90	01-OCT-90	N .792	E2.004	1.349
7805	78053301	FINLAS	FIN. FIXED	KIRKKONUM	EURASIAN	01-AUG-78	31-DEC-91	.000	.000	.000
7810	78104801	ZIMLAS	SWI. FIXED	BERN, SWIT	EURASIAN	01-MAY-84	31-DEC-91	.000	.000	.000
7811	78113801	POLLAS	POL. FIXED	BOROWIEC,	EURASIAN	01-JAN-83	31-DEC-87	.000	.000	.000
7811	78113802	POLLAS	POL. FIXED	BOROWIEC,	EURASIAN	01-JAN-88	31-DEC-91	.000	.000	.000
7824	78244501	SPNLAS	SPN. FIXED	SAN FERNAN	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
7831	78314601	HELLAS	EGY. FIXED	HELWAN, EG	AFRICAN	25-OCT-83	31-DEC-91	.000	.000	.000
7833	78333201	KOOLAS	NL. FIXED	KOOTWIJK O	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
7834	78343001	WETLAS	GER. FIXED	WETTZELL,	EURASIAN	01-MAY-76	31-DEC-91	.000	.000	.000
7835	78353101	GRASSE	FRA. FIXED	GRASSE, FR	EURASIAN	01-MAY-76	21-MAR-83	.000	.000	.000
7835	78353102	GRASSE	FRA. FIXED	GRASSE, FR	EURASIAN	23-DEC-83	31-DEC-91	.000	.000	.000
7837	78373701	CHILAS	SO FIXED	SHANGHAI	EURASIAN	01-AUG-83	31-DEC-91	N .000	E .000	.000
7838	78383601	SHOLAS	SHO FIXED	SIMOSATO H	EURASIAN	01-MAR-82	31-DEC-91	.000	.000	2.100
7839	78393401	AUSLAS	GRAZ FIXED	GRAZ, AUST	EURASIAN	01-SEP-83	31-JUL-88	.000	.000	.000
7839	78393402	AUSLAS	GRAZ FIXED	GRAZ, AUST	EURASIAN	31-JUL-88	31-DEC-91	.000	.000	.000
7840	78403501	RGOLAS	RGO FIXED	ROYAL GREE	EURASIAN	30-MAR-83	31-DEC-91	.000	.000	.000
7843	78432501	NATMAP	NLRS	ORRORAL VA	AUSTRALI	01-AUG-84	31-DEC-91	.000	.000	.000
7844	78441701	HT0101	HTLRS-1	TITISIMA	PACIFIC	01-JAN-88	31-MAR-88	.000	.000	.000
7853	78531501	MT0118	MTLRS-1	OWENS VALL	NORTH AM	01-OCT-88	30-NOV-88	S2.674	W .014	1.321
7853	78531502	MT0126	MTLRS-1	OWENS VALL	NORTH AM	25-JUN-90	31-DEC-90	N2.690	E .004	1.330
7882	78821201	TL0204	TLRS-2	CABO SAN L	PACIFIC	01-FEB-84	10-MAR-84	.000	.000	1.703
7882	78821102	TL0146	TLRS-1	CABO SAN L	PACIFIC	21-MAR-88	01-AUG-88	N .353	E1.525	3.254
7883	78831401	TL0404	TLRS-4	ENSENADA	PACIFIC	25-APR-89	13-JUL-89	N .006	E .006	2.626
7883	78831402	TL0405	TLRS-4	ENSENADA	PACIFIC	14-JUL-89	06-OCT-89	N .006	E .006	2.626
7885	78851101	TL0119	TLRS-1	MCDONALD O	NORTH AM	23-JUL-82	10-OCT-82	N1.469	E .543	3.571
7886	78861101	TL0123	TLRS-1	QUINCY, CA	NORTH AM	05-JUL-83	28-AUG-83	.000	.000	.000
7886	78861102	TL0129	TLRS-1	QUINCY, CA	NORTH AM	08-JUL-84	14-JUL-84	.000	.000	.000
7886	78861103	TL0130	TLRS-1	QUINCY, CA	NORTH AM	06-AUG-84	08-SEP-84	.000	.000	.000
7886	78861104	TL0131	TLRS-1	QUINCY, CA	NORTH AM	10-SEP-84	18-DEC-84	.000	.000	.000
7887	78871101	TL0121	TLRS-1	VANDENBERG	PACIFIC	25-JAN-83	21-FEB-83	S1.409	E .678	3.339
7888	78881101	TL0116	TLRS-1	MOUNT HOPK	NORTH AM	25-JAN-82	16-APR-82	S1.494	E .467	3.419
7889	78891201	TL0201	TLRS-2	GORF, GSFC	NORTH AM	01-MAY-82	20-DEC-82	.000	.000	1.720
7889	78891203	TL0207	TLRS-2	GORF, GSFC	NORTH AM	01-AUG-85	15-OCT-85	.000	.000	.000
7889	78891302	TL0301	TLRS-3	GORF, GSFC	NORTH AM	01-NOV-84	01-AUG-85	.000	.000	.000
7890	78901101	TL0103	TLRS-1	AUSTIN, TX	NORTH AM	21-FEB-80	23-FEB-80	S1.486	E .379	3.257
7890	78901102	TL0110	TLRS-1	AUSTIN, TX	NORTH AM	30-JAN-81	17-MAR-81	N .442	W1.510	3.301
7891	78911101	TL0113	TLRS-1	FLAGSTAFF,	NORTH AM	20-JUN-81	06-AUG-81	S .001	W1.574	3.384
7892	78921101	TL0112	TLRS-1	VERNAL, UT	NORTH AM	07-MAY-81	18-JUN-81	S .054	E1.562	3.358
7892	78921102	TL0118	TLRS-1	VERNAL, UT	NORTH AM	31-MAY-82	21-JUL-82	N .021	E1.570	3.332
7894	78941101	TL0122	TLRS-1	YUMA PROVI	NORTH AM	22-FEB-83	04-JUL-83	.000	.000	.000
7895	78951101	TL0109	TLRS-1	MOUNT WILS	NORTH AM	06-JAN-81	28-JAN-81	.000	.000	.000
7896	78961101	TL0108	TLRS-1	JET PROPUL	PACIFIC	24-OCT-80	06-JAN-81	N1.510	E .459	3.314
7897	78971101	TL0101	TLRS-1	MCDONALD O	NORTH AM	01-SEP-79	31-DEC-79	S1.583	E .102	3.197
7897	78971102	TL0102	TLRS-1	MCDONALD O	NORTH AM	01-JAN-80	13-FEB-80	S1.549	E .126	3.333
7899	78991101	TL0104	TLRS-1	GORF, GSFC	NORTH AM	29-FEB-80	21-MAY-80	N1.541	E .301	3.313
7899	78991102	TL0107	TLRS-1	GORF, GSFC	NORTH AM	18-AUG-80	10-OCT-80	N1.526	E .326	3.311
7907	79074001	SAO201	SAO-2	AREQUIPA,	SOUTH AM	01-SEP-70	15-JUN-88	.000	.000	.000
7907	79074002	SAO202	SAO-2	AREQUIPA,	SOUTH AM	15-JUN-88	31-DEC-91	.000	.000	.000
7917	79174201	SAO302	SAO-3	GORF, GSFC	NORTH AM	01-SEP-84	31-DEC-85	N .000	E .579	2.024
7918	79181301	TL0302	TLRS-3	GORF, GSFC	NORTH AM	22-AUG-85	08-JUL-86	N .005	E .001	2.464
7918	79181302	TL0303	TLRS-3	GORF, GSFC	NORTH AM	11-FEB-87	31-DEC-87	N .005	E .001	2.464
7918	79181403	TL0402	TLRS-4	GREENBELT	NORTH AM	01-FEB-88	23-DEC-88	N .009	E .006	2.603
7918	79181404	TL0408	TLRS-4	GREENBELT	NORTH AM	06-MAR-90	24-JUL-90	N .011	E .005	2.615

Site No.	Station Number	Occ. Name	Occ. System	Location	Plate	Start Date	End Date	Station Eccentricity north	east	up
7918	79181405	TL0409	TLRS-4	GREENBELT	NORTH AM	24-JUL-90	04-OCT-90	N .007	E .005	2.613
7919	79191401	TL0401	TLRS-4	GORF, GSFC	NORTH AM	18-NOV-85	02-APR-87	N .000	E .011	2.591
7920	79201101	TL0137	TLRS-1	GORF, GSFC	NORTH AM	29-JUL-85	15-JAN-86	N1.556	E .143	3.287
7920	79201102	TL0138	TLRS-1	GORF, GSFC	NORTH AM	16-JAN-86	19-DEC-86	N1.586	E .081	3.319
7920	79201103	TL0139	TLRS-1	GORF, GSFC	NORTH AM	21-DEC-86	20-JAN-87	N1.586	E .081	3.319
7920	79201104	TL0140	TLRS-1	GORF, GSFC	NORTH AM	21-JAN-87	06-FEB-87	N1.586	E .081	3.319
7920	79201105	TL0145	TLRS-1	GORF, GSFC	NORTH AM	03-FEB-88	08-MAR-88	N1.586	E .081	3.319
7920	79201306	TL0307	TLRS-3	GREENBELT	NORTH AM	03-OCT-88	15-FEB-89	N1.566	E .849	2.700
7920	79201307	TL0308	TLRS-3	GREENBELT	NORTH AM	16-FEB-89	18-JUN-89	N1.567	E .857	2.695
7920	79201308	TL0309	TLRS-3	GREENBELT	NORTH AM	19-JUN-89	12-OCT-89	N1.566	E .858	2.696
7920	79201309	TL0310	TLRS-3	GREENBELT	NORTH AM	12-OCT-89	16-NOV-89	N1.569	E .860	2.697
7920	79201110	TL0155	TLRS-1	GREENBELT	NORTH AM	04-SEP-90	31-DEC-90	N1.572	E .054	3.241
7921	79214301	SAO401	SAO-4	MOUNT HOPK	NORTH AM	10-FEB-68	06-MAR-82	.000	.000	.000
7929	79294101	SAO101	SAO-1	NATAL, BRA	SOUTH AM	31-OCT-70	01-OCT-81	.000	.000	.000
7939	79394101	SAO102	SAO-1	MATERA, IT	EURASIAN	01-MAY-83	31-JUL-91	.000	.000	.000
7940	79404701	GRELAS	GRE. FIXED	NATIONAL T	EURASIAN	01-MAY-84	31-DEC-91	.000	.000	.000
7943	79434201	SAO301	SAO-3	ORRORAL VA	AUSTRALI	15-JUN-76	10-MAR-82	.000	.000	.000
7999	79991101	TL0106	TLRS-1	MCDONALD O	NORTH AM	09-AUG-80	11-AUG-80	.000	.000	.000
8833	88331501	MT0101	MTLRS-1	KOOTWIJK O	EURASIAN	01-APR-84	31-MAY-84	.000	.000	.000
8833	88331602	MT0201	MTLRS-2	KOOTWIJK O	EURASIAN	15-NOV-84	28-FEB-85	.000	.000	.000
8833	88331603	MT0203	MTLRS-2	KOOTWIJK O	EURASIAN	18-APR-85	31-AUG-85	.000	.000	.000
8833	88331604	MT0217	MTLRS-2	KOOTWIJK O	EURASIAN	04-JUN-88	24-MAY-89	.000	.000	.000
8833	88331605	MT0220	MTLRS-2	KOOTWIJK O	EURASIAN	05-NOV-89	31-DEC-90	.000	.000	.000

LAGEOS Geodetic Analysis - SL7.1

Appendix 2

Monthly Tracking Summaries
by Station

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
1181	8309	2	15	15	15	17	32	16
1181	8310	7	45	34	34	8	26	10
1181	8311	6	64	64	64	-25	34	-25
1181	8312	10	71	67	67	-6	30	-12
1181	8401	12	96	52	52	-5	16	-14
1181	8402	10	58	39	39	4	22	-2
1181	8403	23	163	93	93	4	19	-2
1181	8404	9	55	36	36	5	16	2
1181	8405	5	37	22	22	16	24	8
1181	8406	5	41	28	28	0	16	-2
1181	8407	8	58	40	40	-12	19	-14
1181	8408	17	123	72	72	-18	36	-15
1181	8409	4	38	27	27	1	22	-4
1181	8410	7	64	33	33	-4	10	-7
1181	8411	10	110	34	34	4	14	-2
1181	8412	6	31	15	15	-1	16	-9
1181	8502	3	20	17	17	19	50	-1
1181	8503	2	16	11	11	-8	26	1
1181	8504	5	35	24	24	5	19	0
1181	8505	5	40	13	13	-5	12	-5
1181	8506	5	45	16	16	-37	40	-21
1181	8507	7	83	29	29	3	16	-5
1181	8509	11	99	34	34	10	17	7
1181	8510	11	76	15	15	2	10	-3
1181	8511	3	20	15	15	19	23	18
1181	8512	3	37	37	37	-3	32	-8
1181	8601	3	26	15	15	14	19	14
1181	8602	13	140	63	63	12	21	9
1181	8603	12	118	25	25	2	12	2
1181	8604	3	30	30	30	23	35	20
1181	8605	3	22	8	8	2	17	
1181	8606							3
1181	8609	1	14	9	9	-2	7	
1181	8610	5	38	13	13	-8	12	
1181	8611	4	44	24	24	9	13	
1181	8612	7	67	24	24	-5	10	
1181	8702	15	129	71	71	-24	35	-27
1181	8703	24	216	23	23	-7	9	-7
1181	8704	6	44	12	12	-6	11	-10
1181	8705	14	144	29	29	-3	8	-13
1181	8706	4	34	11	11	-1	8	-6
1181	8707	8	69	21	21	-2	8	-8
1181	8708	10	91	34	34	-5	12	-8
1181	8709	13	115	39	38	53	334	-6
1181	8710	14	116	44	44	2	11	-6
1181	8711	4	48	30	30	11	16	4
1181	8712	6	54	28	28	11	13	3
1181	8801	7	63	30	30	6	10	6
1181	8802	4	34	25	25	16	18	16
1181	8803	1	8					
1181	8804	5	61	36	36	11	14	12
1181	8805	5	61	23	23	7	11	5
1181	8806	2	11	10	10	14	18	4
1181	8807	7	42	7	7	11	15	6
1181	8808	9	93					
1181	8809	11	75	40	40	9	19	8
1181	8810	15	178	64	64	23	27	17
1181	8811	4	32	32	32	20	29	20
1181	8901	18	200	200	200	10	25	6
1181	8902	16	175	173	173	11	27	10
1181	8903	14	138	138	138	8	26	6
1181	8904	8	103	103	103	11	18	6
1181	8905	11	110	108	108	3	22	1
1181	8906	1	6	6	6	14	18	-3
1181	8907	3	23	22	22	6	16	-2
1181	8909	2	19	19	19	-6	18	0
1181	8910	3	29	29	29	-8	24	-8
1181	9001	4	25	25	25	24	33	15
1181	9002	17	185	182	182	-3	31	2
1181	9003	6	71	70	70	11	28	-3

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
1181	9004	1	13	13	13	-17	20	-18
1181	9006	7	57	56	56	17	31	12
1181	9007	15	164	164	163	10	75	
1181	9008	8	81	81	81	24	48	
1181	9009	1	3	3	3	29	113	
1181	9010	22	252	252	251	36	383	
1181	9012	4	42	42	41	158	1011	
1873	8907	1	3					
1873	8910	2	6					
1873	9003	2	2					
1873	9004	5	5					
1873	9009	1	7					
1873	9010	7	36					
1873	9011	6	43					
1884	8709	2	22					
1884	8710	19	142	142	125	128	535	246
1884	8711	8	68	30	0	1371	1490	-1
1884	8712	4	28					
1884	8801	4	28					
1884	8809	4	33					
1884	8810	34	336					
1884	8811	11	101	75	75	44	105	192
1884	8812	7	64	63	63	-86	118	56
1884	8901	2	23	23	15	-146	205	
1884	8902	17	245	245	245	-110	137	32
1884	8903	3	43	43	43	-78	106	51
1884	8905	12	175	175	175	-160	186	25
1884	8910	2	21	21	17	-98	134	51
1884	8911	4	30	30	24	-129	169	33
1884	8912	3	18	18	18	-64	92	63
1884	9003	12	127	127	127	-127	157	32
1884	9004	29	355	355	355	-138	165	31
1884	9005	16	195	195	195	-124	150	31
1893	8902	3	36	36	0	433	449	-1
1893	8903	2	19	19	0	465	483	-1
1893	8905	4	25	25	0	585	620	-1
1893	8906	1	11	11	0	502	532	-1
1893	9002	2	7	7	0	528	572	-1
1893	9003	6	64	64	0	465	477	-1
1893	9011	4	23	23	0	474	492	
1953	8803	2	14	5	5	14	17	-60
1953	8804	5	53	4	4	-31	36	-106
1953	8805	3	15	2	2	9	26	-115
1953	8810	12	138	37	37	34	53	-22
1953	8811	17	200	185	183	43	61	-24
1953	8812	8	84	84	84	21	48	-41
1953	8901	15	143	140	140	37	52	
1953	8902	15	93	76	76	5	35	-47
1953	8906	2	7	7	7	63	84	-1
1953	8911	12	107	107	106	43	59	-5
1953	8912	9	70	70	70	38	63	-19
1953	9001	4	19	19	19	57	61	
1953	9002	2	9	9	9	61	70	18
1953	9012	13	125	125	125	29	42	
7035	8808	26	362	278	278	3	4	2
7035	8809	30	451	345	345	4	10	3
7051	7604							6
7051	7605							-85
7051	7606							-16
7051	7607							-22
7051	7608	3	22	22	22	19	26	
7051	7609	2	4	4	4	-26	33	
7051	7610	5	20	20	20	13	40	
7051	7611	11	30	27	27	-9	33	
7051	7903	1	13	13	13	7	12	-20
7051	7904	7	66	65	65	-2	12	-7
7051	7905	5	62	61	61	-17	19	-24
7051	8102	2	34	34	34	-11	14	-26
7051	8103	20	387	387	387	-1	16	-7
7051	8104	45	686	668	668	6	17	0

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7051	8105	37	537	526	526	9	14	1
7061	8303	9	47	31	31	3	8	13
7061	8304	18	128	120	117	-1	13	6
7061	8305	23	263	257	248	-6	16	4
7061	8306	20	218	208	204	-1	17	5
7061	8307	1	7					
7061	8405	5	28	27	27	3	6	14
7061	8406	1	15	15	15	6	8	19
7061	8407	15	104	99	95	-4	150	15
7061	8408	2	11	11	11	2	19	19
7061	8409	5	22	20	20	10	12	20
7061	8410	8	51	50	50	8	11	16
7061	8411	7	25	25	25	3	9	12
7061	8412	3	23	22	22	1	6	14
7062	7606							-19
7062	7607							-3
7062	7608	1	16					9
7062	7610	5	45	42	42	-18	49	
7062	7611	49	508	494	490	1	34	
7062	7612	19	186	186	186	0	20	
7062	7702	17	220	217	217	-45	51	-45
7062	7703	16	192	164	164	-20	29	-42
7062	7704	14	162	156	156	-4	21	-16
7062	7807	7	65	64	64	5	20	-4
7062	7808	29	357	352	352	-3	11	-7
7062	7809	11	128	125	125	-8	22	7
7062	7811	3	34	34	22	64	122	14
7062	7812	5	32	32	32	-5	20	-8
7062	7901	3	18	18	18	6	38	5
7062	7902	10	118	118	112	13	33	5
7062	7903	7	63	63	63	-7	18	-19
7062	7904	22	256	254	254	-17	28	-14
7062	7905	10	110	109	109	-13	20	-14
7062	8110	14	113	105	102	-6	14	-2
7062	8111	20	156	156	156	1	10	7
7062	8112	18	151	151	151	5	14	14
7062	8201	2	9	9	9	7	9	18
7062	8309	5	57	57	54	9	10	14
7062	8310	12	129	111	108	9	10	11
7062	8311	4	70	70	69	6	7	13
7062	8312	2	14	4	4	13	15	11
7062	8401	4	27	27	23	15	17	18
7063	7602							-34
7063	7605	14	146	146	144	-31	46	-14
7063	7606	6	81	48	48	-47	60	
7063	7704	8	64	64	64	50	58	-26
7063	7705	1	14	14	14	61	69	-37
7063	7707	1	1	1	0	-14	0	-1
7063	7708	3	38	38	38	-37	45	-5
7063	7709	1	15	15	15	-16	91	-71
7063	7710	12	135	130	130	-21	28	-4
7063	7711	3	40	40	40	-12	14	19
7063	7712	2	30	30	30	9	15	-5
7063	7801	1	10	10	10	53	59	36
7063	7802	1	9	9	9	-13	14	-26
7063	7803	15	187	184	183	-7	14	-11
7063	7804	13	195	183	183	12	22	-15
7063	7807	5	59	55	55	12	23	7
7063	7808	8	91	89	89	2	6	-6
7063	7809	8	90	89	89	-4	12	7
7063	7812	2	21	21	21	25	34	12
7063	7901	1	2					
7063	7902	7	71	69	69	-3	24	-6
7063	7903	14	197	185	185	6	18	-3
7063	7904	12	182	177	177	7	13	-3
7063	7905	17	205	188	188	7	14	-4
7063	7909	22	262	245	245	-2	9	-4
7063	7910	33	488	483	483	1	12	-2
7063	7911	23	284	282	282	-6	18	-6
7063	7912	28	400	373	373	-4	14	-2

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7063	8001	16	123	101	101	3	10	-2
7063	8002	3	24	22	21	-10	16	-7
7063	8003	22	317	316	316	-2	6	-3
7063	8004	11	183	175	175	0	6	-5
7063	8005	11	159	115	115	-1	8	-3
7063	8007	5	51	42	42	3	6	0
7063	8008	13	131	102	102	2	7	-1
7063	8009	31	340	273	273	3	9	1
7063	8010	22	171	149	147	1	14	-3
7063	8012	9	114	114	114	0	8	1
7063	8101	2	36	36	36	3	9	6
7063	8102	9	140	140	140	2	15	1
7063	8103	33	536	536	508	1	124	1
7063	8104	4	27	25	25	15	23	2
7063	8105	8	70	58	58	-4	13	-4
7063	8106	3	26	21	21	3	10	-7
7063	8107	12	138	138	137	-3	14	-6
7063	8108	14	242	242	241	4	9	-2
7064	7711	1	5	5	5	-32	38	0
7067	7602							-44
7067	7606	2	9	2	2	-2	27	
7067	7806	1	9	9	9	32	36	16
7067	7807	7	40	37	37	12	23	-23
7067	7808	11	100	94	94	-1	9	-23
7067	7809	7	56	52	52	-4	16	1
7068	7809	4	26	24	24	-2	11	5
7069	7903	2	14	14	14	0	29	-70
7069	7904	4	27	19	19	30	33	-55
7069	7908	1	4					
7069	7909	1	2	1	1	6	0	-44
7069	7910	2	11	9	7	33	46	-45
7069	8001	1	6	6	5	-3	28	-65
7069	8002	3	19	18	16	-21	30	-86
7069	8003	3	14	14	14	-4	9	-78
7069	8004	1	5	5	5	-14	21	-89
7069	8008	1	3	3	3	-24	49	-89
7080	8802	16	233	199	199	-5	10	-3
7080	8803	49	716	624	624	-4	7	-3
7080	8804	28	377	282	282	-2	5	-3
7080	8805	20	257	18	18	-1	4	0
7080	8806	20	266					
7080	8807	19	250	33	33	-1	4	-1
7080	8808	6	64					
7080	8809	31	429	195	195	-4	6	-4
7080	8809			34	34	7	11	1
7080	8810	66	958	785	785	-2	13	-2
7080	8811	33	477	477	477	-1	16	-2
7080	8812	22	296	296	296	-5	10	-5
7080	8901	34	471	471	471	-5	14	-4
7080	8902	27	321	321	321	-9	17	-8
7080	8903	28	262	262	262	-4	12	-5
7080	8904	12	179	179	179	-5	9	-6
7080	8905	32	460	460	460	-10	18	-10
7080	8906	27	270	259	259	-8	15	-9
7080	8907	22	243	243	243	-7	35	-7
7080	8908	17	249	249	249	-18	29	-11
7080	8909	32	476	123	123	-4	6	-4
7080	8909			99	99	-2	18	-1
7080	8910	36	466	466	466	0	27	0
7080	8911	17	182	33	33	-1	5	6
7080	8911			149	149	-1	7	3
7080	8912	6	68	68	68	2	7	1
7080	9001	30	337	171	171	-1	6	-1
7080	9001			107	107	-6	7	-4
7080	9002	23	236	224	224	-11	15	-3
7080	9003	15	157	157	157	-7	16	-1
7080	9004	5	64	64	64	1	11	3
7080	9005	11	130	130	130	1	12	5
7080	9006	3	35	35	35	-6	15	2
7080	9007	4	43	43	43	1	10	

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7080	9008	2	16	16	16	2	5	
7080	9009	10	92	92	92	5	9	
7080	9010	12	119	119	119	-1	5	
7080	9011	25	229	229	229	3	13	
7080	9012	11	103	103	103	4	11	
7082	7605							-23
7082	7606							-1
7082	7607							-10
7082	7609	4	12	11	11	-19	25	
7082	7610	6	42	40	33	67	122	
7082	7611	31	323	307	306	0	30	
7082	7903	7	26	22	22	11	16	-14
7082	7904	8	73	70	70	1	16	-6
7082	7905	10	113	90	90	39	53	46
7082	7907	21	246	243	243	10	27	31
7082	7908	8	91	91	91	12	22	26
7082	8104	22	243	240	240	-10	16	-8
7082	8105	10	132	125	125	-6	11	-10
7082	8311	5	39	38	37	-6	11	-1
7082	8312	6	65	65	65	-5	11	-3
7082	8401	4	33	33	27	-12	14	-9
7084	7802	8	55	55	55	-3	50	8
7084	7803	14	162	127	127	28	38	15
7085	7803	21	196	162	162	-14	30	-8
7085	7804	2	3	3	3	12	20	2
7086	7909	1	22	22	22	-21	24	-10
7086	7910	19	236	228	228	0	13	1
7086	7911	24	305	301	301	3	16	2
7086	7912	32	379	377	377	1	12	1
7086	8001	26	284	283	283	4	10	2
7086	8002	27	394	387	387	-1	9	-3
7086	8003	24	340	322	321	-2	8	-3
7086	8004	18	305	296	296	8	15	7
7086	8005	8	108	108	108	5	10	6
7086	8007	8	52	52	52	-9	13	-11
7086	8008	9	87	73	72	-13	14	-12
7086	8209	7	79					
7086	8210	11	68	61	58	-7	22	
7086	8211	6	41	40	40	-7	14	-5
7086	8212	19	168	136	136	-11	15	0
7086	8301	21	93	68	67	-13	16	-15
7086	8302	16	99	95	95	0	12	-2
7086	8303	11	132	32	32	-4	13	-4
7086	8304	18	185	124	124	11	16	10
7086	8305	7	55	40	39	17	27	5
7086	8306	5	39	39	39	4	17	9
7086	8307	3	37	37	37	3	11	13
7086	8309	10	129	62	62	-1	9	-3
7086	8310	3	42	42	42	-5	7	-5
7086	8311	20	258	135	133	2	9	2
7086	8312	13	157	153	152	0	19	1
7086	8401	4	41	41	41	1	8	0
7086	8402	3	35	15	15	1	6	3
7086	8403	4	53	47	47	-11	13	-11
7086	8404	16	150	147	146	-1	12	0
7086	8405	14	165	142	139	-8	12	-6
7086	8406	10	99					
7086	8407	21	264	248	246	-9	13	-8
7086	8408	12	145					
7086	8409	12	153	140	139	0	10	-6
7086	8410	5	66	63	63	-3	9	-1
7086	8411	5	70	65	65	7	11	7
7086	8412	8	139	126	126	1	9	4
7086	8501	4	54	54	54	-5	9	-5
7086	8502	11	171	122	121	-1	17	-2
7086	8503	4	43	43	36	-7	137	6
7086	8504	11	145					
7086	8505	12	155					
7086	8506	10	134	132	132	1	11	-2
7086	8507	22	354	346	346	-4	9	-3

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7086	8508	31	385	380	380	-2	15	-2
7086	8509	20	192	186	186	0	13	3
7086	8510	26	340	321	321	3	13	2
7086	8511	37	551	537	537	-1	9	0
7086	8512	41	604	569	569	0	5	0
7086	8601	44	647	629	629	1	6	0
7086	8602	41	584	573	573	-1	9	-3
7086	8603	41	538	503	502	-3	9	-3
7086	8604	10	128	125	125	-3	9	-6
7086	8605	23	271	240	240	0	7	
7086	8606	4	61	54	54	-1	9	-1
7086	8607	7	99	83	83	-13	17	
7086	8608	3	33	33	33	10	12	-3
7086	8609	9	109	91	91	-5	11	
7086	8610	3	51	30	17	-23	26	-10
7086	8610			20	20	-6	7	
7086	8611	21	299	287	287	-3	8	
7086	8612	16	232	202	194	-5	12	2
7086	8701	20	253	165	165	3	8	-1
7086	8702	22	273	267	264	-8	17	-2
7086	8703	40	594	496	489	-4	9	-3
7086	8704	31	452	429	429	-6	11	-4
7086	8704							-6
7086	8705	18	214	195	188	-4	11	-3
7086	8706	22	322	291	285	-3	7	-4
7086	8707	33	412	396	393	-8	10	-7
7086	8708	17	212	212	212	-6	8	-7
7086	8709	15	195	168	157	-9	12	-6
7086	8710	38	544	429	427	-5	7	-6
7086	8711	35	461	392	392	-6	9	-6
7086	8712	49	567	270	270	-4	7	-4
7086	8801	27	349	259	259	-4	8	-3
7086	8802	3	30	29	26	0	15	-4
7090	7910	13	91	89	89	0	14	4
7090	7912	8	95	94	94	-1	14	0
7090	8001	15	227	227	227	1	10	0
7090	8002	48	649	640	639	-1	11	1
7090	8003	47	675	673	672	1	8	3
7090	8004	37	545	545	544	2	8	3
7090	8005	32	468	468	468	2	9	5
7090	8006	27	435	435	434	4	10	4
7090	8007	57	769	760	758	0	8	4
7090	8008	56	946	946	944	0	7	4
7090	8009	62	880	878	877	2	8	5
7090	8010	59	876	876	875	2	10	7
7090	8011	42	611	601	601	2	13	7
7090	8012	28	442	441	440	4	12	6
7090	8101	31	405	405	404	3	13	7
7090	8102	52	822	822	822	2	14	4
7090	8103	38	539	539	538	-2	10	1
7090	8104	27	377	376	376	-3	16	-3
7090	8105	38	559	549	548	-1	12	1
7090	8106	38	589	563	562	0	8	2
7090	8107	50	693	691	691	-3	12	-3
7090	8108	32	401	401	400	-1	9	0
7090	8109	48	770	765	763	-2	10	0
7090	8110	66	962	950	950	-2	9	-1
7090	8111	40	654	649	647	-3	11	-2
7090	8112	64	1007	973	971	-1	13	-3
7090	8201	60	941	938	937	-2	10	-3
7090	8202	61	969	969	967	-6	53	-4
7090	8203	49	786	786	784	-2	12	-2
7090	8204	9	150	150	150	5	19	3
7090	8205	27	404	374	373	-3	11	-3
7090	8206	21	302	214	212	-4	11	
7090	8207	23	429	425	424	-3	8	-2
7090	8208	26	473	426	426	1	9	-3
7090	8209	27	487	474	473	1	14	2
7090	8210	25	393	389	373	-4	22	2
7090	8211	9	125	125	125	-11	18	-1

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7090	8212	11	167	166	166	5	11	0
7090	8301	25	427	406	405	2	10	0
7090	8302	16	278	278	277	3	16	3
7090	8303	29	516	516	516	2	15	6
7090	8304	24	396	396	396	2	12	4
7090	8311	22	393	393	393	0	5	1
7090	8312	10	177	177	177	9	19	14
7090	8401	23	363	363	363	-2	5	0
7090	8402	12	235	235	235	-5	9	0
7090	8403	12	155	144	144	-10	16	-4
7090	8404	12	194	194	193	-1	7	-1
7090	8405	36	498	491	490	0	7	1
7090	8406	36	561	532	532	-2	6	1
7090	8407	22	396	396	396	2	7	3
7090	8408	19	313	310	310	-2	10	-1
7090	8409	38	618	617	617	1	8	3
7090	8410	36	632	632	632	-2	7	0
7090	8411	29	437	349	349	-1	7	0
7090	8411			88	88	0	4	1
7090	8412	32	444	439	438	0	7	2
7090	8501	39	571	571	568	0	37	3
7090	8503	64	893	893	892	0	8	0
7090	8504	58	821	821	821	0	8	1
7090	8505	54	736	736	735	-1	5	1
7090	8506	49	764	764	762	-1	6	1
7090	8507	29	432	432	429	-1	9	1
7090	8508	32	504	494	494	0	12	-1
7090	8509	39	645	162	159	-1	19	-7
7090	8509			483	483	0	10	3
7090	8510	36	517	517	513	-1	18	1
7090	8511	30	326	326	311	-3	16	1
7090	8512	29	348	348	340	1	8	2
7090	8601	34	494	494	481	-1	10	0
7090	8602	25	406	404	401	-5	13	1
7090	8603	36	519	503	502	4	11	4
7090	8604	44	637	628	619	3	10	3
7090	8605	27	454	300	294	1	7	
7090	8606	35	566	345	344	2	8	3
7090	8607	21	340	262	260	-1	10	
7090	8608	31	509	373	372	-1	6	7
7090	8609	20	328	320	313	-1	9	
7090	8610	28	487	465	459	0	7	4
7090	8611	21	274	232	231	4	7	
7090	8612	23	389	312	308	2	7	4
7090	8701	24	430	404	404	-2	11	2
7090	8702	25	452	452	451	-2	12	4
7090	8703	13	256	128	127	1	5	4
7090	8704	10	181	129	129	-1	4	3
7090	8705	21	306	254	254	-7	11	-1
7090	8706	4	42	38	34	-1	13	-1
7090	8707	12	173	165	165	-2	7	1
7090	8708	2	35	35	23	-9	19	-7
7090	8709	13	245	244	233	-5	13	-1
7090	8710	15	276	132	80	13	24	19
7090	8711	31	486	300	295	1	9	9
7090	8712	18	348	270	270	1	7	3
7090	8801	25	442	377	376	-2	8	4
7090	8802	32	528	324	319	0	9	2
7090	8803	22	367	276	256	2	8	4
7090	8804	13	231	194	194	-3	5	-1
7090	8805	12	154	128	128	-2	5	0
7090	8806	17	202	186	172	-1	8	1
7090	8807	23	424	372	325	-3	17	2
7090	8808	15	237	168	168	-1	5	2
7090	8809	9	118	33	31	4	10	1
7090	8810	18	230	61	52	-7	14	0
7090	8811	25	419	243	240	-1	12	-2
7090	8812	24	410	249	234	-5	12	-1
7090	8901	16	194	108	108	-5	9	-5
7090	8902	25	416	322	315	-6	12	-4

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7090	8903	25	445	410	410	0	8	2
7090	8904	25	466	299	297	1	8	4
7090	8905	19	337	222	210	-16	20	-9
7090	8906	24	432	82	82	3	9	11
7090	8907	19	341	110	109	-6	14	-3
7090	8908	31	571	195	181	0	14	-5
7090	8908			22	22	-14	19	-23
7090	8909	21	337	226	211	-3	8	-1
7090	8910	21	367	367	330	-4	9	3
7090	8911	28	521	484	477	-2	8	1
7090	8912	26	476	404	383	-6	12	-4
7090	9001	23	404	404	354	-4	17	-2
7090	9002	23	369	361	361	-3	8	0
7090	9003	25	478	478	478	-4	9	0
7090	9004	13	234	218	218	-1	8	0
7090	9005	16	244	244	243	-1	16	5
7090	9006	15	220	219	219	2	11	3
7090	9007	8	130	130	128	3	15	
7090	9008	13	219	219	218	2	10	
7090	9009	20	374	374	366	-2	11	
7090	9010	24	435	435	425	-40	757	
7090	9011	33	650	650	648	-3	12	
7090	9012	19	292	292	290	-6	16	
7091	7802	10	62	62	62	-12	25	8
7091	7803	20	137	121	121	-3	13	29
7091	7804	5	58	56	56	24	32	19
7091	7908	2	22	22	22	3	17	51
7091	7909	16	167	159	159	5	17	32
7091	7910	27	391	358	353	5	20	32
7091	7911	26	429	411	411	-4	20	23
7091	7912	21	333	333	333	-1	21	28
7091	8001	22	309	302	302	-1	13	25
7091	8002	42	554	482	482	2	13	29
7091	8003	11	148	125	122	10	21	40
7091	8004	6	25	25	25	0	16	29
7091	8005	3	21	19	19	28	34	56
7091	8006	4	52	52	52	-7	18	21
7091	8007	10	105	82	82	0	10	29
7091	8008	13	179	176	176	7	16	36
7091	8009	27	366	349	349	2	14	33
7091	8010	37	531	505	504	-2	15	25
7091	8011	21	280	280	280	-1	16	24
7091	8809	46	461	305	305	-4	10	20
7091	8810	17	177	126	126	-15	19	13
7091	9010	9	123	123	121	-74	570	
7091	9011	31	502	502	502	-8	15	
7091	9012	8	122	122	122	-10	12	
7092	8001	6	62	58	58	-4	17	-6
7092	8004	1	9	9	9	13	18	-3
7092	8006	11	140	138	138	-1	14	0
7092	8007	10	98	85	85	5	17	6
7092	8008	11	144	143	143	-3	21	2
7092	8009	9	124	120	120	-3	17	0
7092	8010	9	122	109	107	8	18	10
7092	8011	1	14	14	14	13	24	7
7096	7908	3	26	24	24	-20	25	-23
7096	7909	2	14	14	14	-23	25	-15
7096	7910	7	73	71	71	-13	17	-13
7096	7911	6	51	50	50	-24	27	-18
7096	7912	6	94	93	91	2	34	-11
7096	8002	5	45	44	44	-10	19	-9
7096	8003	20	231	208	208	-4	16	-5
7096	8004	11	143	143	143	6	14	7
7096	8005	5	59	54	54	1	13	4
7096	8006	11	122	122	122	5	14	1
7096	8007	12	107	101	101	13	21	9
7096	8008	11	106	105	105	4	16	2
7096	8009	6	62	58	57	-6	15	-6
7096	8010	13	129	127	127	0	9	1
7096	8011	9	94	94	94	10	17	4

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7097	8711	3	42	30	29	1	10	13
7097	8712	21	270	201	172	-14	17	-4
7097	8801	10	149	121	121	-9	11	2
7097	8802	18	273	260	244	-11	14	-2
7097	8810	2	15					
7097	8811	4	56	42	42	-23	35	-6
7097	8812	4	38	17	17	-25	89	13
7097	8901	12	157	144	143	-1	28	1
7097	8902	14	190	191	191	-16	32	-9
7097	8903	15	192	190	190	-8	17	0
7097	8910	2	28	63	63	-9	12	-1
7097	8911	8	93	93	93	-15	30	-5
7097	8912	10	132	132	132	-11	15	1
7097	9001	17	184	184	181	-12	64	-4
7097	9002	19	227	226	226	-14	26	-17
7097	9012	11	138	138	138	-15	17	
7100	7710	4	36	36	36	-46	52	-64
7100	7711	1	17	17	17	-39	44	-47
7101	7902	3	29	26	26	-17	22	-24
7101	7903	5	53	52	52	-19	24	-45
7101	8205	1	16	16	16	13	16	-1
7101	8206							0
7102	7903	9	128	123	123	2	20	0
7102	7904	2	21	21	21	18	20	1
7102	7911	15	170	156	156	20	32	23
7102	7912	20	279	251	244	15	31	21
7102	8001	4	29	14	13	-6	21	-7
7102	8002	2	16	16	13	3	41	-1
7102	8003	19	288	239	238	-4	13	-1
7102	8004	14	223	223	223	-9	16	-11
7102	8006	1	14	14	14	-5	7	2
7102	8007	3	14	10	10	3	5	0
7102	8009	8	110	99	99	6	13	9
7102	8010	16	139	134	134	-3	15	-1
7102	8011	2	8	8	8	11	16	-39
7102	8012	1	2	2	2	-3	4	13
7102	8101	3	25	25	25	-33	40	-45
7102	8102	1	9	9	9	19	26	14
7102	8103	4	29	29	27	-18	73	3
7102	8104	2	15					
7102	8106	1	6	6	6	16	20	6
7102	8107	3	36	36	36	-2	19	-3
7102	8108	2	17	17	17	1	9	3
7102	8109	7	86	85	85	-21	24	-18
7102	8110	18	256	256	256	-2	5	-1
7102	8111	3	25	25	25	-1	9	10
7102	8201	5	35	33	33	-1	5	2
7102	8202	4	25	25	20	8	408	1
7102	8203	7	86	86	82	17	162	7
7102	8204	14	235	235	234	-3	13	3
7102	8209	2	30	26	24	13	20	
7102	8210	5	75	72	72	3	11	16
7102	8211							6
7102	8305	6	101	101	101	-31	32	-29
7102	8306	26	294	286	286	6	16	5
7103	7902	3	16	13	13	1	14	-6
7103	7903	8	102	50	50	0	26	-11
7103	7904	7	94	87	87	6	17	-3
7103	8208	5	30	28	27	7	15	
7103	8209	5	35	35	35	0	10	5
7103	8210	32	566	541	540	-2	12	4
7103	8211							-1
7104	7902	1	17	16	16	7	18	14
7104	7904	10	136	134	134	-3	14	-5
7104	7905	2	13	13	13	2	20	-12
7105	8103	29	466	466	466	5	14	6
7105	8107	10	169	169	169	-3	8	-2
7105	8108	15	217	217	217	-1	5	-4
7105	8109	23	323	323	323	-1	8	-1
7105	8110	15	177	177	177	0	5	-1

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7105	8111	4	29	29	29	-2	7	7
7105	8112	1	19	19	19	14	15	13
7105	8201	8	116	116	116	3	8	2
7105	8202	19	242	242	240	0	12	6
7105	8203	14	218	218	218	2	10	7
7105	8204	14	220	220	219	0	13	3
7105	8205	15	235	235	232	1	14	4
7105	8206	7	133	133	132	-1	7	
7105	8207	22	369	369	367	0	7	0
7105	8208	22	357	337	337	0	7	1
7105	8209	22	288	288	287	2	8	2
7105	8210	32	484	484	484	1	12	5
7105	8211	22	369	369	369	0	11	2
7105	8212	13	140	138	136	-7	133	-1
7105	8301	9	140	140	140	2	6	-3
7105	8302	3	30	30	30	-10	11	-3
7105	8303	11	121	70	70	-2	6	-3
7105	8304	17	251	215	212	0	8	-4
7105	8305	20	279	278	278	-1	13	0
7105	8306	18	221	183	183	-1	15	1
7105	8309	16	231	229	228	3	8	5
7105	8310	26	438	438	438	2	7	3
7105	8311	20	320	319	319	1	4	3
7105	8312	16	226	226	226	0	8	6
7105	8401	13	200	200	200	4	8	3
7105	8402	8	151	150	150	1	6	7
7105	8403	7	131	89	89	1	7	-4
7105	8403			42	42	-3	4	1
7105	8404	13	158	158	158	4	8	3
7105	8405	41	602	588	587	-1	6	0
7105	8406	16	294	294	293	1	4	0
7105	8407	11	175	173	173	-6	7	0
7105	8408	21	313	312	312	-4	8	-1
7105	8409	19	289	289	289	-2	7	-1
7105	8410	7	64	64	64	0	3	0
7105	8411	10	181	181	181	-4	8	2
7105	8412	13	195	192	192	4	9	3
7105	8501	7	78	78	78	3	6	1
7105	8502	20	264	258	258	2	5	1
7105	8503	31	452	450	449	-3	6	3
7105	8504	26	408	408	408	2	9	1
7105	8505	22	354	330	330	0	5	1
7105	8505			24	24	-2	2	1
7105	8506	35	486	486	481	3	13	2
7105	8507	31	481	449	449	0	6	1
7105	8507			32	32	8	11	1
7105	8508	23	377	377	377	1	9	1
7105	8509	35	560	554	554	1	10	3
7105	8510	15	180	180	180	2	6	1
7105	8511	11	152	152	152	2	9	2
7105	8512	23	281	281	281	3	5	3
7105	8601	23	294	294	294	3	6	2
7105	8602	6	49	48	48	1	6	0
7105	8603	14	145	139	139	2	8	4
7105	8604	19	263	263	262	4	9	2
7105	8605	33	435	385	385	0	5	
7105	8606	29	322	186	186	1	7	-1
7105	8607	7	80	39	38	3	5	
7105	8608	14	101	87	87	-1	5	-1
7105	8609	14	156	155	155	3	7	
7105	8610	20	248	230	230	2	7	0
7105	8611	38	552	542	541	1	6	
7105	8612	23	412	293	293	1	5	1
7105	8612			79	79	-2	9	
7105	8701	22	316	300	300	-4	10	-2
7105	8702	22	383	383	383	-2	10	1
7105	8703	30	466	429	428	0	7	1
7105	8704	19	307	291	291	-2	6	1
7105	8705	34	487	482	482	0	8	1
7105	8706	21	281	278	278	-1	7	0

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7105	8707	30	401	396	395	0	5	0
7105	8708	26	393	376	376	1	5	0
7105	8708							-1
7105	8709	20	291	291	291	-1	5	0
7105	8710	36	545	519	519	0	6	-1
7105	8711	35	511	509	509	0	4	-1
7105	8712	21	296	289	289	0	7	1
7105	8801	10	139	118	117	7	10	5
7105	8802	12	147	119	119	0	9	1
7105	8803	13	144	105	105	3	4	4
7105	8804	18	258	242	242	0	5	0
7105	8805	7	109	109	109	1	5	1
7105	8806	19	289	289	289	1	5	1
7105	8807	8	114	109	100	-2	15	0
7105	8808	21	318	280	279	1	5	0
7105	8809	31	519	327	301	0	9	1
7105	8810	54	836	535	534	1	6	0
7105	8811	15	214	175	163	-7	14	-5
7105	8812	37	610	511	511	-3	8	-1
7105	8901	26	421	345	345	-1	6	-1
7105	8901			7	7	-10	14	1
7105	8902	25	360	360	359	-3	10	1
7105	8903	17	213	206	206	4	7	4
7105	8904	27	455	448	448	-2	6	-1
7105	8905	3	59	59	59	3	12	1
7105	8906	3	12	12	12	3	9	0
7105	8907	10	152	26	26	0	10	-6
7105	8908	9	113	65	53	-16	21	1
7105	8909	3	19	15	8	-13	15	6
7105	8910	19	255	161	161	-3	6	-2
7105	8910			94	82	2	15	-1
7105	8911	14	202	176	173	2	10	6
7105	8912	14	158	147	147	-3	8	0
7105	9008	2	40	40	40	1	3	
7105	9009	24	380	380	380	-3	6	
7105	9010	21	359	359	359	-3	11	
7105	9011	30	464	464	464	1	11	
7109	8110	15	232	231	231	5	11	6
7109	8111	1	6	6	6	18	26	49
7109	8201	4	49	31	29	11	32	20
7109	8202	3	37					
7109	8203	5	70	70	69	4	17	11
7109	8205	22	433	421	420	5	13	8
7109	8206	29	563	416	407	6	12	
7109	8207	18	354	306	294	6	16	7
7109	8208	8	84	84	83	6	8	5
7109	8209	29	547	547	519	0	8	9
7109	8210	32	531	531	512	2	11	6
7109	8211	18	303	303	298	1	10	4
7109	8212	10	148	148	148	4	7	4
7109	8301	21	302	302	302	3	6	2
7109	8302	3	45	45	45	-1	7	-6
7109	8303	6	96	96	96	4	8	8
7109	8304	16	244	244	244	1	7	2
7109	8305	19	268	268	268	3	7	3
7109	8306	5	41	39	31	-27	49	-4
7109	8307	49	720	719	718	-2	8	3
7109	8308	50	883	883	877	1	5	0
7109	8309	52	889	889	881	0	8	1
7109	8310	21	335	335	335	-1	7	0
7109	8311	3	26	26	26	1	6	4
7109	8312	5	62	62	62	-1	4	3
7109	8401	18	332	332	330	1	5	4
7109	8402	16	307	307	307	-1	5	6
7109	8403	13	222	222	221	-6	9	1
7109	8404	44	860	860	858	-1	8	4
7109	8405	60	1143	1143	1142	0	5	3
7109	8406	35	619	619	617	-1	6	2
7109	8407	51	962	959	956	-2	8	2
7109	8408	54	1064	1064	1063	-1	8	1

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7109	8409	41	816	816	815	-2	8	0
7109	8410	39	662	661	661	-2	6	-1
7109	8411	7	124	124	124	-3	8	2
7109	8412	13	210	210	210	-3	7	3
7109	8501	17	293	293	293	-1	8	0
7109	8502	13	234	234	234	0	5	0
7109	8503	17	315	55	55	-5	7	2
7109	8503			257	257	-1	6	4
7109	8504	24	464	458	458	0	5	2
7109	8505	40	786	781	780	-1	4	2
7109	8506	43	882	882	880	-1	6	2
7109	8507	43	802	781	780	-2	8	1
7109	8508	45	914	456	456	-6	13	1
7109	8508			420	420	5	8	3
7109	8509	31	596	596	596	2	12	4
7109	8510	25	456	449	448	1	7	1
7109	8511	25	436	436	436	1	7	1
7109	8512	25	466	466	465	0	4	1
7109	8601	11	159	159	159	-1	7	2
7109	8602	13	248	247	247	-1	9	-1
7109	8603	29	433	433	432	0	10	2
7109	8604	19	319	315	315	-2	9	0
7109	8605	21	341	23	23	-4	6	
7109	8606	37	734	628	608	4	11	-5
7109	8607	51	945	748	748	-3	7	
7109	8608	30	597	544	542	5	8	4
7109	8609	18	359	359	357	0	5	
7109	8610	32	545	529	525	-1	6	-1
7109	8611	23	408	408	408	0	5	
7109	8612	14	215	179	179	1	5	3
7109	8701	15	270	270	270	2	6	4
7109	8702	13	215	215	215	3	7	5
7109	8703	20	361	280	279	3	8	3
7109	8704	28	539	286	286	0	6	4
7109	8705	27	488	417	417	-2	8	2
7109	8706	37	673	671	670	0	6	3
7109	8707	36	613	612	612	-2	7	2
7109	8708	48	913	887	887	-2	6	1
7109	8709	27	501	501	500	-2	7	1
7109	8710	32	598	565	565	-2	6	0
7109	8711	15	222	145	145	-3	7	1
7109	8712	1	6	6	6	-1	2	6
7109	8801	8	121	119	119	-5	9	0
7109	8802	27	519	377	376	1	8	2
7109	8803	28	509	454	453	0	7	3
7109	8804	12	225	198	198	2	5	3
7109	8805	29	526	489	483	0	5	3
7109	8806	27	494	477	457	2	8	2
7109	8807	32	604	565	519	0	14	1
7109	8808	38	722	584	584	-1	5	2
7109	8809	44	865	579	561	0	8	3
7109	8810	46	760	561	512	-4	11	-1
7109	8811	15	262	173	168	2	12	6
7109	8812	16	295	78	78	-2	4	0
7109	8812			100	95	-7	11	0
7109	8901	23	419	395	394	-7	9	-3
7109	8902	20	314	300	300	-2	8	6
7109	8903	12	194	103	102	-3	9	1
7109	8903			78	78	-8	11	-2
7109	8904	35	610	605	605	-3	8	-1
7109	8905	13	202	132	132	-5	9	-9
7109	8906	19	256	118	118	10	26	2
7109	8907	51	907	510	510	-3	10	-1
7109	8908	39	650	386	386	-1	10	1
7109	8909	6	97	97	90	-2	7	2
7109	8910	26	395	418	382	-2	11	-1
7109	8911	10	147	147	121	5	17	6
7109	8912	18	264	264	264	-3	6	-3
7109	9001	6	105	105	105	6	12	6
7109	9002	8	146	146	146	-4	13	2

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7109	9003	26	469	469	469	5	15	3
7109	9004	2	41	41	41	-8	21	-3
7109	9005	19	342	342	342	-5	14	1
7109	9006	7	105	105	105	-3	7	-1
7109	9007	27	308	308	308	0	7	
7109	9008	6	94	94	94	3	6	
7109	9009	22	393	393	393	-3	7	
7109	9010	17	283	283	283	0	8	
7109	9011	19	239	239	239	-9	14	
7109	9012	7	37	37	37	8	10	
7110	7601	1	2					
7110	8107	5	36	36	36	-1	16	4
7110	8108	8	58	53	53	12	17	8
7110	8109	27	383	377	374	5	9	7
7110	8110	20	292	274	267	12	17	13
7110	8111	25	289	268	268	5	13	8
7110	8112	16	193	164	164	-3	14	3
7110	8201	6	84	83	83	-1	14	3
7110	8202	9	111	111	111	0	9	6
7110	8203	2	17	17	17	18	31	24
7110	8204	3	30	30	30	5	17	6
7110	8205	13	171	164	164	-4	12	-1
7110	8206	12	159	129	129	-2	7	
7110	8207	29	331	330	324	0	8	-1
7110	8208	6	74	64	63	-3	16	-1
7110	8209	20	168	168	166	-11	57	2
7110	8210	53	677	663	654	-6	12	-3
7110	8211	24	301	301	298	-1	14	-4
7110	8212	34	427	427	424	-2	6	-1
7110	8301	21	282	282	281	-3	7	-5
7110	8302	9	141	141	141	0	9	3
7110	8303	12	193	193	193	0	6	1
7110	8304	17	311	311	309	-3	8	-2
7110	8305	6	111	111	111	1	16	0
7110	8306	14	199	185	185	3	12	-1
7110	8307	4	48	48	46	-6	11	3
7110	8310	33	460	458	458	4	10	6
7110	8311	11	166	166	166	2	5	6
7110	8312	12	106	106	106	1	5	0
7110	8401	32	515	515	514	3	6	5
7110	8402	27	430	430	430	0	7	5
7110	8403	25	337	336	336	-2	9	3
7110	8404	33	525	486	484	2	10	7
7110	8405	24	361	361	361	-3	7	0
7110	8406	49	744	744	743	-1	5	-1
7110	8407	30	374	374	374	1	6	2
7110	8408	47	735	734	732	0	8	1
7110	8409	43	751	750	748	-1	8	1
7110	8410	28	472	472	470	-1	5	0
7110	8411	25	434	434	434	-2	7	2
7110	8412	8	137	137	136	2	13	5
7110	8501	15	266	266	265	-3	6	-2
7110	8502	28	449	446	446	2	6	3
7110	8503	24	413	411	410	0	8	6
7110	8504	61	992	989	984	-1	6	0
7110	8505	39	630	628	625	0	5	1
7110	8506	64	1108	1108	1105	0	5	1
7110	8507	47	793	792	790	-1	10	1
7110	8508	11	198	198	197	-8	17	2
7110	8509	23	414	414	414	0	11	2
7110	8510	7	121	121	121	3	11	3
7110	8511	38	631	630	630	4	8	2
7110	8512	23	404	403	401	0	6	1
7110	8601	31	557	557	556	0	6	0
7110	8602	22	287	287	287	-2	9	-3
7110	8603	34	528	523	520	3	11	5
7110	8604	34	559	559	558	-2	6	-2
7110	8605	30	398	385	385	0	5	
7110	8606	38	669	567	566	3	8	0
7110	8607	29	399	335	335	-3	7	

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7110	8608	7	108	107	107	3	8	4
7110	8609	29	442	435	432	-1	6	
7110	8610	37	615	612	611	1	6	-2
7110	8611	33	522	181	181	3	7	
7110	8611			341	339	-1	5	
7110	8612	16	225	211	210	-2	7	0
7110	8701	15	201	201	201	6	10	5
7110	8702	20	317	317	316	2	9	5
7110	8703	14	204	202	202	7	12	7
7110	8704	44	690	599	597	1	7	5
7110	8705	30	462	396	395	1	7	1
7110	8706	46	661	658	658	2	7	5
7110	8706							3
7110	8707	53	837	814	807	1	6	3
7110	8708	47	776	773	773	-1	5	0
7110	8709	35	457	455	455	0	6	1
7110	8710	31	465	445	445	1	5	1
7110	8711	22	339	314	312	4	8	7
7110	8712	13	157	157	157	6	9	7
7110	8801	13	189	186	186	5	7	8
7110	8802	31	390	286	286	-1	7	1
7110	8803	48	786	753	748	0	5	4
7110	8804	24	387	298	297	1	6	1
7110	8804			42	42	0	5	3
7110	8805	39	660	649	649	1	4	3
7110	8806	35	552	252	250	1	6	2
7110	8806			289	289	1	4	2
7110	8807	44	687	645	606	1	11	2
7110	8808	16	258	237	226	1	5	2
7110	8809	35	597	501	501	2	7	3
7110	8810	56	847	670	642	-1	9	-1
7110	8811	28	503	360	333	0	13	5
7110	8812	22	351	34	34	-1	5	-1
7110	8812			178	178	-7	11	0
7110	8901	22	350	344	343	-6	8	-2
7110	8902	7	120	120	120	7	16	10
7110	8903	34	556	502	502	-3	7	2
7110	8904	32	546	546	546	0	7	1
7110	8905	15	218	165	165	-7	11	-13
7110	8906	39	514	317	316	9	15	7
7110	8907	30	508	214	213	4	8	4
7110	8908	32	484	276	274	7	11	2
7110	8909	33	444	416	404	0	6	1
7110	8910	26	365	408	357	1	13	0
7110	8911	41	664	645	619	0	10	5
7110	8912	33	482	472	470	1	9	3
7110	9001	32	480	460	451	5	12	5
7110	9002	39	650	619	618	0	13	5
7110	9003	34	470	465	463	-1	15	2
7110	9004	12	192	171	168	12	18	9
7110	9005	41	634	590	586	7	18	3
7110	9006	44	676	641	636	3	11	3
7110	9007	35	499	499	498	4	11	
7110	9008	23	323	323	323	6	12	
7110	9009	25	422	422	422	1	6	
7110	9010	42	727	727	726	1	10	
7110	9011	35	622	622	619	1	13	
7110	9012	19	212	212	211	4	11	
7112	8103	3	57	57	57	-7	12	-8
7112	8104	10	135	135	135	-15	22	-15
7112	8105	19	264	264	264	-10	11	-12
7112	8106	12	126	126	126	-6	12	-14
7112	8107	33	309	286	285	-6	67	-6
7112	8108	27	275	211	207	0	126	-8
7112	8109	16	140	134	130	-5	17	-8
7112	8110	15	151	150	150	-7	11	-12
7112	8111	20	214	209	204	5	109	-2
7112	8112	5	74	74	74	-7	13	-5
7112	8201	10	80	67	66	-1	20	-4
7112	8202	11	136	136	133	-21	197	-2

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7112	8203	11	130	130	130	-6	11	-3
7112	8204	13	197	194	194	-3	9	-7
7112	8205	13	168	168	168	-11	14	-11
7112	8206	14	224	222	221	-10	12	
7112	8207	21	320	319	313	-7	88	-13
7112	8208	2	22	21	21	-12	14	-12
7112	8209	11	97	95	95	-5	16	-13
7112	8210	35	486	465	465	-2	11	0
7112	8211	30	488	486	485	-1	10	-1
7112	8212	10	131	131	131	-2	8	-4
7112	8301	5	59	59	49	-7	19	-13
7112	8302	5	57	57	57	-12	14	-18
7112	8303	13	178	171	170	-8	14	-14
7112	8304	5	47	46	46	-3	8	-10
7112	8305	2	27	27	27	9	24	-7
7112	8306	4	52	52	52	3	15	0
7112	8307	4	5					
7112	8308	2	10	7	7	-6	9	-7
7112	8309	12	140	110	109	6	26	9
7112	8310	15	232	206	205	11	14	6
7112	8311	12	153	152	150	13	37	9
7112	8312	4	17	11	10	55	169	10
7112	8401	1	1					
7112	8402	16	214	190	190	4	9	7
7112	8403	7	67	53	52	-8	43	-2
7112	8404	30	343	315	315	3	9	5
7112	8405	10	101	92	92	0	7	1
7112	8406	24	330	285	284	5	8	4
7112	8407	8	98	76	75	8	13	2
7112	8408	10	129	95	94	7	17	1
7112	8409	9	111	99	99	5	9	2
7112	8410	4	31	22	22	6	9	-2
7112	8808	16	238	217	216	2	6	-2
7112	8809	51	833	580	580	4	11	-1
7112	8810	5	78	64	64	-14	25	-2
7112	9009	2	17	17	17	-8	10	
7112	9010	23	336	336	332	10	16	
7114	7909	22	272	271	271	-2	12	0
7114	7910	43	601	578	576	-1	13	0
7114	7911	38	516	502	502	0	16	0
7114	7912	28	428	427	427	-5	14	-3
7114	8001	11	175	173	173	-2	9	0
7114	8002	25	428	427	427	-3	9	-4
7114	8003	31	367	339	338	-2	7	-1
7114	8004	14	173	158	157	-5	8	-4
7114	8005	8	85	84	84	-2	8	-2
7114	8006	1	5	5	5	0	3	-10
7114	8007	2	10	8	8	-1	6	4
7114	8008	15	149	107	107	1	10	1
7114	8009	16	163	159	158	-4	27	-1
7114	8010	11	128	114	114	-3	12	-2
7114	8011	32	498	493	492	-1	12	1
7114	8012	18	218	217	216	3	28	3
7114	8101	4	59	59	59	4	11	5
7114	8108	5	43	43	43	-3	12	-7
7114	8109	24	237	232	232	0	8	1
7114	8211	17	82	82	81	2	12	
7114	8212	20	162	162	162	5	8	1
7114	8301	28	232	232	225	2	11	4
7115	7909	1	4	4	4	-27	31	-23
7115	7910	23	326	320	320	-3	13	-12
7115	7911	44	653	644	642	-8	17	-19
7115	7912	31	380	379	379	-8	15	-17
7115	8001	24	297	297	297	-3	13	-16
7115	8002	21	279	279	279	-1	8	-14
7115	8003	20	267	261	261	-2	8	-13
7115	8004	15	210	210	210	5	11	-11
7115	8005	14	146	146	144	-4	12	-18
7115	8006	23	221	220	220	1	12	-12
7115	8007	1	20	20	20	0	5	-13

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7115	8008	13	158	132	132	-8	11	-18
7115	8009	16	213	213	213	-1	8	-13
7115	8010	20	255	255	255	-1	7	-12
7115	8011	33	294	291	291	-1	9	-11
7115	8012	14	128	128	128	2	11	-10
7115	8101	7	75	75	75	-3	8	-15
7115	8102	2	34	34	34	-14	19	-19
7115	8103	42	588	588	587	0	17	-12
7115	8104	18	230	229	228	2	11	-8
7120	8007	3	30	30	30	0	8	8
7120	8008	21	297	297	296	4	11	7
7120	8009	19	341	341	340	2	9	6
7120	8010	27	289	283	283	5	12	7
7120	8011	26	309	301	300	4	14	5
7120	8012	14	117	116	116	1	11	6
7120	8101	9	57	57	56	9	26	4
7120	8102	20	253	253	253	-2	16	3
7120	8103	32	400	400	400	2	10	5
7120	8104	22	229	226	225	4	15	4
7120	8105	13	86	86	85	-4	8	1
7120	8106	33	371	365	365	1	9	1
7120	8107	21	261	259	256	-4	13	2
7120	8108	24	391	391	387	0	9	0
7120	8109	29	466	463	461	1	10	2
7120	8110	30	546	546	546	-2	8	1
7120	8111	17	309	309	308	2	9	7
7120	8112	4	77	77	77	-8	13	-6
7120	8201	8	159	159	159	-2	13	-2
7121	8307	5	54	54	54	6	15	5
7121	8308	16	186	172	156	-6	22	2
7121	8309	6	106	106	106	0	5	3
7121	8310	14	176	173	173	2	7	5
7121	8311	9	74	74	74	2	7	5
7121	8312	13	136	131	131	-2	15	-1
7121	8401	1	21	21	21	4	7	7
7121	8402	11	83	79	73	3	18	10
7121	8403	12	148	144	143	13	17	14
7121	8404	16	192	158	157	2	14	2
7121	8405	15	142	137	136	0	8	4
7121	8406	14	170	148	144	-2	8	1
7121	8407	14	160	150	149	-1	7	1
7121	8408	7	81	80	79	-3	7	0
7121	8409	6	73	66	66	3	7	5
7121	8410	10	113	93	93	-4	8	-1
7121	8411	19	225	206	205	-3	8	1
7121	8412	14	163	136	135	-5	12	1
7121	8501	1	8	8	8	5	6	5
7121	8502	15	145	133	132	5	8	7
7121	8503	15	142	137	118	-4	205	1
7121	8504	8	49	49	32	-65	347	7
7121	8505	1	1					
7121	8506	2	24	16	16	-1	10	-4
7121	8509	3	25	21	20	-15	22	3
7121	8510	2	7	7	7	21	25	13
7121	8511	9	78	69	69	-8	17	5
7121	8512	7	97	87	87	2	8	5
7121	8601	3	52	49	49	-6	8	-3
7121	8602	11	96	88	88	-12	15	-7
7121	8603	9	74	40	40	1	13	5
7121	8604	13	177	152	151	-10	14	-8
7122	8305	7	102	87	87	2	8	1
7122	8306	11	184	172	172	-4	14	1
7122	8307	8	88	81	75	-14	20	0
7122	8308	4	63	54	54	-3	8	-4
7122	8309	4	69	69	63	-5	19	-3
7122	8310	20	275	273	273	-5	11	0
7122	8311	16	259	258	258	-4	8	2
7122	8312	7	98	97	97	-2	9	3
7122	8401	24	429	406	402	0	9	4
7122	8402	38	627	591	575	10	15	17

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7122	8403	15	266	250	250	6	14	11
7122	8406	11	143	143	142	0	5	6
7122	8408	12	155	153	149	3	13	5
7122	8409	14	185	179	179	-2	13	2
7122	8410	25	382	380	378	1	7	4
7122	8411	27	520	520	520	0	7	5
7122	8412	18	289	289	284	3	13	7
7122	8501	14	248	247	247	-1	5	2
7122	8502	17	293	292	292	1	6	4
7122	8503	22	382	378	378	-1	11	7
7122	8504	25	414	414	414	2	8	4
7122	8505	26	503	502	501	0	5	4
7122	8506	19	327	327	326	0	6	4
7122	8507	10	131	131	131	4	13	4
7122	8508	24	324	322	322	-1	8	1
7122	8509	22	328	328	328	-1	11	3
7122	8510	25	458	457	456	-1	9	2
7122	8511	24	397	397	397	6	10	3
7122	8512	15	213	95	95	3	6	2
7122	8512			118	102	-5	13	4
7122	8601	21	372	372	371	0	7	2
7122	8602	30	502	502	502	-5	8	-1
7122	8603	25	335	334	334	1	12	4
7122	8604	23	350	349	348	-4	7	-1
7122	8605	15	206	163	162	-2	7	
7122	8606	14	268	203	203	4	7	-1
7122	8607	14	181	141	140	-8	10	
7122	8608	12	126	63	63	7	9	8
7122	8609	18	266	265	265	-2	7	
7122	8610	20	378	378	378	1	5	-1
7122	8611	13	255	237	237	-1	8	
7122	8612	9	121	88	88	0	5	6
7122	8701	13	180	177	177	-6	13	1
7122	8702	27	480	480	480	-2	9	4
7122	8703	21	324	277	277	0	9	3
7122	8704	12	196	190	190	-8	15	-1
7122	8705	1	10	10	10	-1	3	0
7122	8706	19	318	317	316	-3	6	1
7122	8707	13	150	145	144	-5	9	-1
7122	8708	6	69	30	20	-13	18	-18
7122	8709	10	157	138	136	-5	9	-1
7122	8710	22	381	368	368	0	5	2
7122	8711	26	426	404	404	-6	8	-2
7122	8712	15	254	95	95	-3	10	0
7122	8801	23	322	256	256	-2	7	2
7122	8802	26	420	228	211	-5	13	0
7122	8803	17	250	202	202	-2	6	1
7122	8804	11	154	138	138	-3	5	0
7122	8805	2	14	5	1	27	34	13
7122	8806	3	8	4	4	-1	1	4
7122	8807	2	21	21	17	-15	24	-2
7122	8808	3	35	21	21	-6	6	0
7122	8808			3	3	-5	6	-5
7122	8809	9	88	71	71	2	5	0
7122	8810	34	404	354	333	-4	9	-1
7122	8811	14	188	148	146	-6	12	-1
7122	8812	3	26	24	24	-5	6	-2
7122	8901	10	124	79	79	0	5	4
7122	8901			8	8	-7	10	-20
7122	8902	14	245	233	233	3	7	7
7122	8903	10	139	138	137	0	9	2
7122	8904	25	351	237	237	0	9	3
7122	8905	11	155	125	125	-5	7	-7
7122	8906	15	202	84	84	7	12	2
7122	8907	5	60	9	9	21	23	18
7122	8908	5	43	33	25	-15	23	-4
7122	8909	12	172	172	165	-4	6	-1
7122	8910	21	296	29	18	11	19	7
7122	8910			234	232	-1	6	0
7122	8911	16	193	185	166	-3	14	2

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7122	8912	13	150	147	147	-3	6	-3
7122	9001	16	177	177	177	-5	7	1
7122	9002	9	123	118	118	-3	11	-11
7122	9003	21	259	259	251	-6	18	3
7122	9004	12	164	162	162	-6	13	-1
7122	9005	8	119	119	119	-2	10	-1
7122	9006	5	64	64	42	-25	31	1
7122	9007	2	21	21	21	0	6	
7122	9008	7	122	122	122	0	6	
7122	9010	8	116	116	112	-4	20	
7122	9011	19	258	258	243	1	17	
7122	9012	10	152	152	152	-3	8	
7123	7601	1	13					
7123	8707	2	9					
7123	8708	5	61	17	17	-7	8	-1
7123	8709	13	183	119	107	-1	15	4
7123	8710	4	60	56	41	-17	20	-11
7123	8804	1	11	11	11	-3	5	-10
7123	8805	11	112	110	110	-4	7	-1
7123	8806	9	111	60	60	-6	18	3
7123	8807	7	79	65	65	-8	21	0
7123	8808	8	84	62	62	-2	5	1
7123	8809	1	15					
7123	8905	7	99	99	99	-101	107	-1
7123	8906	12	197	197	196	-101	108	-2
7123	8907	16	215	215	215	-84	101	4
7123	8908	10	166	154	153	-100	107	-12
7123	9004	15	180	162	162	-2	14	0
7123	9005	10	135	134	134	-2	8	3
7123	9006	3	53	53	53	3	16	-2
7123	9007	10	121	121	109	46	115	
7123	9008	2	28	28	28	-8	11	
7125	8505	10	138	138	131	2	90	2
7125	8506	16	248	223	219	-6	50	-4
7125	8507	9	127	127	119	2	55	-1
7210	7905	2	3	1	1	-79	0	-87
7210	7907	4	4	2	0	102	146	-1
7210	7908	3	3					
7210	7911	4	4	4	0	142	681	-1
7210	7912	7	21					
7210	8001	2	3	1	0	53	0	-1
7210	8004	5	15					
7210	8005	2	2	1	0	-660	0	-1
7210	8109	7	79	79	79	0	16	4
7210	8110	1	19	19	19	2	3	8
7210	8111	19	284	284	284	-1	8	5
7210	8112	14	187	187	187	-1	11	2
7210	8201	6	83	83	83	-3	9	-4
7210	8202	9	100	100	98	16	92	6
7210	8203	9	153	153	153	-1	7	7
7210	8204	4	46	46	46	3	19	-1
7210	8205	22	326	326	326	0	10	3
7210	8206	25	409	329	329	-1	9	
7210	8207	25	390	388	388	-2	6	3
7210	8208	10	148	146	146	-10	16	0
7210	8209	11	150	150	150	4	10	-3
7210	8210	19	235	235	235	-6	12	9
7210	8211	7	83	83	83	1	11	2
7210	8212	21	304	301	301	2	6	0
7210	8301	32	460	460	460	1	5	3
7210	8302	29	488	488	488	-1	8	1
7210	8303	31	569	569	568	1	7	6
7210	8304	23	402	402	402	0	10	3
7210	8305	32	595	582	582	2	14	4
7210	8306	23	340	340	339	2	38	3
7210	8307	18	276	276	276	1	11	7
7210	8308	11	166	141	141	-1	4	4
7210	8309	34	460	454	454	0	8	5
7210	8310	30	400	396	396	1	8	4
7210	8311	26	382	381	381	0	4	6

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7210	8312	37	513	512	512	0	6	2
7210	8401	27	374	374	373	1	7	6
7210	8403	2	18	18	18	-7	8	-2
7210	8404	35	401	22	22	-4	12	15
7210	8404			378	378	2	8	7
7210	8405	52	600	563	563	3	7	7
7210	8406	45	616	606	605	1	6	6
7210	8407	23	302	301	301	2	7	5
7210	8408	22	266	264	264	0	8	5
7210	8409	33	436	435	435	-1	9	3
7210	8410	26	390	389	389	-1	6	2
7210	8411	17	262	261	261	0	9	5
7210	8412	16	200	200	198	-1	14	2
7210	8501	12	154	153	153	-3	6	0
7210	8502	3	25	25	25	-1	11	-2
7210	8503	7	35	31	30	-25	143	5
7210	8504	23	235	232	230	-10	74	-8
7210	8505	13	147	138	112	9	16	10
7210	8506	29	344	340	340	0	6	4
7210	8507	24	335	330	330	-1	11	4
7210	8508	31	430	426	423	1	12	5
7210	8509	23	353	353	353	-2	11	4
7210	8510	25	346	346	346	-1	9	4
7210	8511	20	279	278	277	1	10	4
7210	8512	21	301	298	297	0	6	4
7210	8601	21	330	330	330	2	7	4
7210	8602	24	317	317	317	3	10	6
7210	8603	18	297	296	296	-3	7	1
7210	8604	6	85	85	85	4	13	5
7210	8605	10	152	136	136	4	10	
7210	8606	11	140	125	125	2	5	9
7210	8607	18	232	163	163	-1	8	
7210	8608	15	159	145	145	-1	9	8
7210	8609	10	98	96	96	1	5	
7210	8610	14	220	218	218	2	4	3
7210	8611	11	107	105	105	2	7	
7210	8612	6	53	52	52	4	8	5
7210	8701	17	184	176	176	7	20	6
7210	8702	17	197	196	182	3	19	2
7210	8703	12	137	73	73	-8	10	2
7210	8704	22	288	154	154	1	6	5
7210	8705	28	416	332	332	4	8	7
7210	8706	25	321	282	277	0	7	6
7210	8707	19	267	36	36	1	8	7
7210	8707			198	198	3	6	7
7210	8708	16	239	197	192	-3	8	0
7210	8709	2	15					
7210	8710	22	311	249	249	-1	6	2
7210	8711	16	209	161	161	-7	9	-1
7210	8712	9	122	121	121	-2	6	4
7210	8801	25	331	183	183	-3	7	2
7210	8802	28	385	120	120	4	6	4
7210	8803	13	136	48	48	2	7	5
7210	8804	23	246	194	194	-2	4	1
7210	8805	22	250	223	223	-3	5	2
7210	8806	13	163	142	141	-5	6	0
7210	8807	37	480	392	360	-5	13	2
7210	8808	37	448	317	317	-4	5	1
7210	8809	19	220	122	122	-3	5	3
7210	8810	31	382	173	168	-4	9	0
7210	8811	8	107	21	20	-3	14	3
7210	8812	13	173	110	107	-3	10	0
7210	8901	8	141	54	47	-16	18	-8
7210	8902	11	147	96	96	-5	16	-1
7210	8903	10	151	137	137	-5	7	2
7210	8904	7	106	92	92	-6	8	0
7210	8905	11	355	135	135	-5	7	1
7210	8906	3	35	29	29	-26	27	-10
7210	8907	18	258	72	68	13	27	11
7210	8908	12	226	112	103	-11	22	-9

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7210	8909	11	179	179	179	-1	5	2
7210	8910	5	59	77	77	-7	9	-4
7210	8911	16	222	182	177	1	9	8
7210	8912	11	152	139	139	0	6	6
7210	9001	1	12	12	12	1	15	-21
7210	9002	10	105	70	70	-7	9	-3
7210	9003	21	229	206	206	-1	9	-2
7210	9004	14	143	108	108	-6	14	-4
7210	9005	12	196	123	123	2	16	-1
7210	9006	15	209	151	145	-5	11	3
7210	9007	13	128	128	128	2	11	
7210	9008	14	188	188	188	-4	9	
7210	9009	16	198	198	198	-3	8	
7210	9010	22	290	290	290	-3	8	
7210	9011	9	120	120	120	-1	11	
7210	9012	12	164	164	161	7	16	
7220	8309	33	408	399	396	0	10	3
7220	8310	39	465	463	452	2	20	2
7220	8311	5	36	35	35	-5	11	0
7265	8401	22	276	276	276	1	6	1
7265	8402	21	267	266	266	-5	10	3
7265	8403	8	86	86	86	1	9	5
7288	8803	12	143	102	102	-2	4	1
7288	8804	10	125	119	119	0	3	1
7288	8805	28	450	409	409	-2	4	1
7288	8806	15	211	206	206	0	14	1
7288	8902	11	156	156	156	-14	18	-4
7288	8903	4	54	54	54	-16	24	-7
7288	8904	13	186	186	186	-4	5	0
7288	8910	1	2	10	10	14	15	17
7288	8911	24	369	369	369	-2	10	4
7288	8912	18	343	343	343	-2	11	3
7288	9001	7	137	137	137	-11	16	-7
7288	9011	14	224	224	224	-5	12	
7288	9012	12	193	193	193	-4	10	
7295	8803	3	21	20	20	20	21	2
7295	8804	19	236	227	227	7	9	-3
7295	8805	2	14	11	11	6	8	-2
7295	8806	14	163	155	153	10	12	-2
7295	8807	14	160	138	138	10	14	0
7307	8809	7	83	83	83	3	20	14
7400	8403	8	90	89	89	-3	8	1
7400	8404	25	256	244	244	1	7	-3
7400	8405	10	120	120	120	-3	8	-4
7401	8405	13	180	177	177	1	7	-8
7401	8406	40	613	585	581	-1	9	-9
7401	9002	1	5	5	0	141	158	-1
7401	9003	25	398	398	92	65	110	9
7401	9004	14	251	251	251	6	26	7
7401	9005	20	341	341	341	7	18	7
7401	9006	2	23	23	23	-12	37	7
7401	9012	29	382	382	375	6	20	
7403	9007	26	450					
7403	9008	21	388					
7403	9009	24	413					
7403	9010	12	193					
7510	8606	30	387	302	298	-3	15	
7510	8607	30	305	213	213	2	17	
7510	8608							-6
7510	8610							-4
7510	8706	13	100	79	79	6	21	-8
7510	8707	63	571	496	495	5	15	-5
7510	8708	55	540	462	462	5	14	-5
7510	8910	13	80	80	80	10	22	1
7510	8911	43	625	626	623	7	103	-2
7510	8912	13	250	249	249	7	25	2
7512	8609	8	80	77	77	-5	11	
7512	8610	50	705	670	665	-2	16	
7512	8702							-4
7512	8703	6	49	42	42	9	15	1

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7512	8704	46	498	354	354	2	15	-3
7512	8705	9	119	105	105	-7	20	-6
7512	8910	58	808	803	786	-6	16	-6
7515	8608	42	603	532	532	3	63	
7515	8609	5	80	74	74	-9	72	
7515	8612							-4
7515	8702							-1
7515	8707	11	139	78	78	-4	41	-2
7515	8708	48	604	426	426	19	63	-1
7515	8709	56	749	436	436	-1	50	-1
7515	8710	40	488	383	383	4	63	-3
7515	8912	2	13	13	13	12	29	2
7515	9001	45	599	599	599	20	67	4
7517	8606	12	158	125	123	-1	16	
7517	8607	23	225	131	130	7	17	
7517	8608	33	301	228	227	1	11	-2
7517	8609	8	81	80	78	8	15	
7517	8610							-1
7517	8612							-3
7517	8702							-1
7517	8707	16	261	261	261	11	16	1
7517	8708	42	532	450	450	10	16	-1
7517	8710	8	104	46	46	9	17	4
7517	8711	33	514	390	390	7	15	-2
7517	8712	15	218	169	169	19	25	4
7517	8905	32	385	312	312	5	14	-3
7517	8906	18	298	260	260	-9	39	-5
7520	8604	37	541	518	511	0	7	4
7520	8605	9	130	119	117	3	7	
7520	8606							7
7520	8906	9	103	90	90	-16	31	-41
7520	8907	38	451	449	449	5	26	4
7520	8908	4	45	45	45	-11	36	16
7525	8609	22	252	175	175	13	25	
7525	8609			56	56	18	29	
7525	8610	3	26	26	26	-2	32	
7525	8702							0
7525	8702							0
7525	8704							1
7525	8709	4	50	50	50	16	26	5
7525	8710	29	444	370	370	17	32	3
7525	8711	21	293	220	220	18	30	3
7525	8712	13	203	141	141	16	36	6
7525	8911	5	34	31	30	9	77	1
7525	8912	9	94	92	92	5	36	2
7525	9001	37	474	474	467	18	75	-2
7530	8607	2	16	16	14	-22	24	
7530	8608	1	6	5	4	18	22	
7530	8609	6	72	60	59	15	17	
7530	8610	8	103	84	84	0	8	-5
7530	8611	13	167	137	137	-2	8	
7530	8612	11	137	81	75	10	13	-5
7530	8701	8	101	89	89	-2	11	3
7530	8702	10	90	55	55	-4	15	3
7530	8703	2	24	22	22	8	12	10
7530	8704	10	114	98	96	-6	16	-2
7530	8705	4	53	20	20	2	19	3
7530	8706	8	158	64	64	1	8	-2
7530	8707	12	171	126	126	0	7	2
7530	8708	4	54	26	26	-4	11	-5
7530	8709	14	253	142	142	2	16	5
7530	8710	10	130	81	81	-1	10	1
7530	8711	12	162	148	141	-1	12	2
7530	8909	2	26	26	9	-478	2174	6
7530	9001	1	16	16	16	9	12	-3
7530	9002	4	28	21	21	-11	22	-10
7530	9003	11	131	131	130	-9	19	-8
7530	9006	11	113	82	79	-22	26	-7
7541	8601	34	449	430	418	1	6	-1
7541	8602	21	226	76	76	3	9	-3

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7541	8603	6	50	49	49	1	6	-2
7543	9011	1	17	17	17	-11	19	
7543	9012	25	368	368	368	-5	15	
7544	8709	17	163					
7544	8710	43	417	314	308	16	22	1
7544	8711	16	125	85	85	9	22	0
7544	8712	11	83	62	62	13	28	6
7544	8903	1	14	14	14	14	16	5
7544	8904	1	7	7	7	45	49	6
7544	8905	41	533	530	530	14	21	1
7544	8906	1	11	11	11	10	22	2
7545	8511	22	333	319	319	1	7	-2
7545	8512	6	117	116	113	4	7	1
7545	8801	3	19	18	18	3	7	0
7545	8802	34	318	271	270	3	6	-2
7545	8803	21	170	140	140	3	7	-1
7545	9002	24	303	284	284	16	21	2
7545	9003	7	72	72	72	1	15	-4
7545	9004	18	201	189	189	-11	19	-1
7546	8804	1	1	1	1	5	0	9
7546	8805	7	41	39	39	4	12	4
7546	8806	4	37	37	37	7	22	6
7550	8604	5	44	44	44	0	11	16
7550	8605	24	256	247	247	-2	20	
7550	8606							14
7550	8906	15	59	58	58	-7	19	13
7550	8907	5	28	28	28	-26	37	3
7575	8704	5	44	37	37	29	33	2
7575	8705	27	261	209	209	14	18	-1
7575	8909	60	918	914	914	18	22	5
7580	8704	27	322	241	241	12	21	1
7580	8705	16	220	206	206	10	14	-3
7580	8910	32	430	451	449	7	42	0
7580	8911	18	243	243	243	4	19	0
7585	8706	27	251	225	225	10	17	11
7585	8707	10	65	14	14	7	28	4
7585	8908	45	478	456	456	-8	33	-10
7585	8909	12	175	172	172	21	41	19
7587	8706	34	457	397	397	-3	7	-2
7587	8707	9	133	114	114	-1	6	-1
7587	8907	1	10	10	10	7	9	2
7587	8908	20	245	220	220	-3	28	2
7587	8909	16	183	177	177	0	12	-1
7587	8910	14	196	195	195	3	22	4
7590	8509	19	351	345	332	8	13	4
7590	8510	26	548	531	509	-2	10	-2
7596	8503	4	37	37	19	198	222	107
7596	8504	1	6					
7602	9009	20	270	270	270	-1	10	
7805	8009	6	66	20	20	-43	53	-12
7805	8010	5	72	18	18	-55	79	-2
7805	8011	8	89	65	65	-158	197	-108
7805	8012	7	71	43	43	-127	193	-80
7805	8103	7	67	67	67	225	268	276
7805	8104	20	232	232	229	253	322	310
7805	8105	4	4	4	3	464	643	466
7805	8108	1	15	15	15	332	351	384
7805	8109	4	50	50	46	208	297	231
7805	8110	3	24	2	2	73	124	341
7805	8111	3	41	41	41	140	191	195
7805	8203	2	26	26	26	66	211	100
7805	8205	1	1					
7805	8208	6	74	74	73	-24	221	
7805	8209	11	143	143	141	-81	141	5
7805	8210	5	63					-25
7805	8211	7	94	90	90	-84	162	
7805	8212	3	38	28	26	-79	173	-40
7805	8301							-45
7805	8303	11	94	94	83	-193	1155	-62
7805	8304	3	24	24	24	-86	181	-36

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7805	8311	2	16	16	13	-170	273	-63
7805	8312	3	30	30	30	-103	190	-71
7805	8403	13	196	43	43	-20	78	17
7805	8404	3	31	4	4	20	88	-121
7805	8405	9	54	5	4	132	256	87
7805	8408	8	109	20	20	-30	61	4
7805	8409	7	117	8	8	-34	39	14
7805	8410	11	136	6	6	-33	42	25
7805	8411	1	18					
7805	8603	5	56	5	5	-61	70	1
7805	8612	5	15					
7805	8705	6	32	2	2	-27	40	-8
7805	8809	3	18					
7805	8904	3	20	20	20	-64	116	-3
7805	8905	1	5	5	5	-71	156	-150
7805	8910	1	4	4	2	350	2303	-8
7805	8912	3	30	25	25	-99	110	-54
7805	9003	7	47	47	47	-30	56	-9
7810	8405	1	9	9	8	11	16	6
7810	8406	5	64	64	64	-3	8	-1
7810	8407	14	177	170	169	-1	12	3
7810	8408	18	263	256	256	-3	12	2
7810	8409	10	134	100	100	3	9	0
7810	8410	12	117	100	100	-6	11	-1
7810	8411	4	65	65	64	4	12	4
7810	8509	14	173	154	154	12	17	4
7810	8510	22	238	223	223	0	11	-3
7810	8511	2	22	20	20	-7	19	-1
7810	8512	7	78	69	69	7	11	3
7810	8603	14	140	137	137	1	6	3
7810	8604	3	30	27	27	-4	14	-5
7810	8605	4	41	34	34	6	9	
7810	8606							-2
7810	8609	2	13	13	13	0	12	
7810	8610	1	11	11	11	-4	11	
7810	8611	12	182	172	171	0	10	
7810	8612	7	81	71	71	-2	10	
7810	8702							-4
7810	8703	2	29	23	19	-5	18	-12
7810	8704	22	298	195	191	10	16	1
7810	8705	11	136	131	131	0	7	-1
7810	8706	3	37	34	32	1	11	-4
7810	8707	5	42	40	36	9	14	4
7810	8708	14	174	166	151	7	13	3
7810	8709	25	347	327	325	4	12	1
7810	8710	11	112	109	101	4	13	-2
7810	8711	14	139	84	84	4	9	-2
7810	8803	2	23	23	18	-8	13	-2
7810	8804	6	73	73	70	-8	10	2
7810	8805	2	21	21	17	-6	11	2
7810	8806	14	192	107	107	0	8	5
7810	8807	16	190	170	170	3	11	4
7810	8808	30	418	377	338	5	10	5
7810	8809	33	449	238	227	2	10	4
7810	8810	4	57	38	30	-10	15	-6
7810	8811	30	444	342	336	2	11	5
7810	8812	20	308	157	150	8	13	5
7810	8901	44	637	455	444	8	12	5
7810	8902	41	562	499	499	11	14	11
7810	8903	7	75	72	72	7	13	9
7810	8904	9	87	56	55	15	19	12
7810	8905	16	242	207	207	3	12	3
7810	8906	9	119	103	103	4	12	-1
7810	8907	4	29	18	18	15	16	1
7810	8908	2	8	3	3	5	7	-1
7810	8909	1	4	3	3	3	12	-2
7810	8910	9	100	80	80	-10	14	0
7810	8911	12	176	117	117	-4	11	2
7810	8912	14	199	109	109	14	26	19
7810	9001	34	485	414	386	-8	15	-8

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7810	9002	29	414	340	324	-3	16	1
7810	9003	34	480	321	321	-11	15	-7
7810	9004	9	114	67	50	-26	31	-5
7810	9005	24	290	237	237	-6	11	-1
7810	9006	9	101	71	70	-9	16	-3
7810	9007	30	415	415	414	-4	10	
7810	9008	26	359	359	359	0	7	
7810	9010	19	248	248	248	1	9	
7810	9011	8	105	105	105	5	16	
7811	8805	2	19	10	10	17	71	-24
7811	8806	3	21	11	11	-16	20	-8
7811	8807	5	49	7	7	21	26	-31
7811	8808	7	79	17	17	43	77	-4
7811	8809	14	117	93	61	103	177	0
7811	8811	1	5	5	5	-8	60	1
7811	8905	11	136	134	134	98	141	11
7811	8906	2	23	23	23	90	117	-10
7811	9001	2	16	16	16	34	75	16
7811	9002	5	50	50	50	99	139	20
7811	9003	5	37	37	37	171	182	31
7811	9004	5	57	57	57	137	150	22
7811	9005	21	150	150	150	172	179	30
7811	9006	4	37	37	37	180	186	21
7811	9007	8	92	92	92	143	167	
7811	9008	9	94	94	85	166	182	
7811	9010	23	286	286	286	153	178	
7811	9011	5	54	54	54	127	159	
7811	9012	2	27	27	27	164	197	
7831	8310	1	6	6	6	-45	68	104
7831	8311	4	39	39	39	3	106	81
7831	8706	3	17	7	7	-32	36	14
7831	8707	30	276	101	101	-3	27	3
7831	8708	28	215	139	139	8	56	5
7831	8709	22	257	128	128	-18	44	3
7831	8906	12	92	92	92	19	72	7
7831	8907	16	129	124	124	5	64	-6
7831	8908	9	81	81	81	61	70	0
7831	8909	3	25	25	25	33	41	-19
7831	8910	12	133	133	133	-106	121	-2
7831	9006	9	75	75	75	-71	106	3
7831	9007	24	488	247	247	-90	109	
7831	9008	6	58	58	58	-86	101	
7833	7904	7	90	74	74	26	37	14
7833	7905	10	134	109	109	20	25	19
7833	7906	11	120	117	117	15	29	19
7833	7907	8	85	84	84	1	24	20
7833	7908	5	60					
7833	7909	8	66	56	56	33	36	27
7833	7910	22	234	183	183	12	22	23
7833	7911	3	22	13	13	33	41	24
7833	7912	6	73	44	44	12	24	22
7833	8002	6	21	13	13	12	15	17
7833	8003	2	18	13	13	33	39	28
7833	8004	3	5	1	1	61	0	63
7833	8005	2	29	29	29	23	26	33
7833	8008	2	24	20	20	-28	35	-29
7833	8009	6	99	89	89	-9	19	-4
7833	8010	4	64	59	59	-15	39	-11
7833	8204	8	76	56	56	-10	17	5
7833	8205	6	69	64	64	-4	18	3
7833	8206	9	112	77	77	-2	30	
7833	8207							7
7833	8209	8	86	66	66	6	31	
7833	8210	8	103	42	42	11	27	18
7833	8211	6	84	27	27	0	20	12
7833	8212	7	105	67	67	1	26	-4
7833	8301	2	28	27	27	2	23	5
7833	8302	10	163	163	163	-17	28	-13
7833	8303	3	45	45	45	7	21	3
7833	8304	2	17	17	17	-13	61	-16

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7833	8305	2	26	26	26	-2	24	30
7833	8309	3	30	30	30	-8	21	-2
7833	8310	8	76	30	30	3	22	11
7833	8403	4	37	33	33	5	16	6
7833	8404	25	301	234	234	-5	14	-1
7833	8405	10	127	104	104	17	20	20
7833	8406	7	68	45	45	4	12	12
7833	8407	5	47	42	42	9	15	9
7833	8408	6	83	56	56	1	14	3
7833	8410	3	41	33	33	3	14	9
7833	8411	4	56	39	39	-1	16	0
7833	8502							-6
7834	7807	4	30	30	30	-17	31	3
7834	7808	13	106	106	106	8	15	4
7834	7809	2	14	14	14	-1	29	17
7834	7810	9	62	62	62	-2	29	-11
7834	7902	3	7	7	7	-10	29	-80
7834	7903	2	9	9	9	-16	20	-26
7834	7904	1	3	3	3	13	15	-29
7834	7905	8	56	55	55	-18	25	-39
7834	7906	19	158	157	157	-2	20	-17
7834	7907	2	11	11	11	-19	22	-27
7834	8001	2	9	9	9	7	8	1
7834	8002	13	58	56	55	16	23	19
7834	8003	5	41	40	40	20	21	18
7834	8010	1	8	8	8	13	15	-12
7834	8103	8	47	47	47	7	23	5
7834	8104	14	112	112	111	-1	17	-1
7834	8106	6	28	28	28	-6	8	-17
7834	8107	2	8	8	8	-6	13	-5
7834	8109	7	29	29	29	5	12	0
7834	8203	5	21	21	21	5	12	13
7834	8204	23	154	123	123	3	10	9
7834	8205	19	121	93	93	-3	9	0
7834	8206	5	32	12	12	-7	12	
7834	8207	17	128	128	128	4	8	-6
7834	8208	18	117	117	117	3	10	-1
7834	8209	27	261	256	256	3	10	3
7834	8210	20	142	138	138	2	10	3
7834	8211	11	110	110	109	0	12	-2
7834	8212							-6
7834	8302	9	85	85	85	3	7	-5
7834	8303	5	32	32	32	3	10	-3
7834	8304	3	27	27	27	-3	9	-8
7834	8305	3	20	20	20	-1	5	-4
7834	8308	1	4	4	4	-1	2	0
7834	8309	5	36	36	36	-2	8	-3
7834	8310	20	236	236	236	1	6	-4
7834	8311	23	275	275	275	-1	5	-3
7834	8312	13	155	155	155	3	6	-5
7834	8401	8	93	91	91	0	8	-7
7834	8402	32	356	353	353	1	8	-2
7834	8403	42	419	363	363	6	9	-4
7834	8404	26	299	250	247	7	10	0
7834	8405	30	328	316	316	7	8	0
7834	8406	21	227	197	197	5	7	-1
7834	8407	28	323	308	308	2	8	1
7834	8408	31	383	350	350	5	10	1
7834	8409	20	175	156	156	6	10	-1
7834	8410	21	202	179	178	3	9	-1
7834	8411	24	291	283	283	7	9	3
7834	8412	4	49	31	31	10	12	11
7834	8502	3	21	15	15	11	12	-1
7834	8503	2	27	27	27	-9	12	-3
7834	8504	10	113	111	111	5	6	-3
7834	8505	6	56	55	55	-3	6	-6
7834	8506	11	120	113	113	-3	10	-7
7834	8507	27	432	430	430	1	7	-5
7834	8508	24	298	295	295	4	11	-3
7834	8509	37	490	489	489	4	11	-3

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7834	8510	40	497	486	486	3	10	-2
7834	8511	5	55	55	55	5	11	2
7834	8512	11	129	128	128	0	5	-2
7834	8601	7	71	71	71	1	7	-1
7834	8602	18	205	196	196	5	10	3
7834	8603	19	217	216	216	3	9	1
7834	8604	17	213	213	213	2	6	-4
7834	8605	10	124	95	94	0	8	
7834	8606	3	23	23	23	1	9	-4
7834	8607	2	18	18	16	-12	17	
7834	8608							-12
7834	8609	2	22	22	22	-4	6	
7834	8610	13	164	151	151	6	8	-3
7834	8611	16	203	194	194	7	8	
7834	8612	15	181	174	174	-2	7	
7834	8701	1	11	11	11	16	17	4
7834	8702	6	50	46	46	-3	3	0
7834	8703	8	64	61	61	11	13	2
7834	8704	5	39	38	38	0	6	-4
7834	8705	9	98	98	81	20	22	4
7834	8706	8	71	63	63	1	8	-1
7834	8707	29	309	306	306	8	10	1
7834	8708	20	206	206	206	7	8	0
7834	8709	25	221	215	215	6	8	-1
7834	8710	29	321	298	298	4	7	-4
7834	8711	19	205	186	186	8	12	0
7834	8712	6	34	34	34	11	12	3
7834	8801	5	56	56	56	5	6	3
7834	8802	5	37	34	34	8	11	1
7834	8803	1	5	5	5	11	13	-1
7834	8804	5	49	34	34	4	6	-1
7834	8805	3	29	29	29	0	5	-5
7834	8806	2	16	16	16	2	7	-4
7834	8807	11	120	81	81	5	11	-2
7834	8808	10	140	138	138	2	5	-3
7834	8809	12	146	93	93	0	5	-4
7834	8810	12	130	112	109	2	7	-4
7834	8811	16	166	113	112	1	10	-4
7834	8901	20	235	235	235	6	7	1
7834	8902	11	112	109	109	8	9	5
7834	8903	13	143	118	118	1	7	-2
7834	8904	16	176	143	143	5	8	-1
7834	8905	9	88	86	86	3	6	-2
7834	8906	9	94	65	65	1	10	-2
7834	8907	2	20	20	20	-2	12	-7
7834	8908	1	8	8	0	-48	53	-1
7834	8910	10	114	103	89	5	13	-5
7834	8911	9	102	67	67	8	11	6
7834	8912	4	58	58	58	-6	8	-6
7834	9001	3	42	41	35	9	16	-2
7834	9002	13	132	90	90	0	11	-1
7834	9003	31	347	286	286	3	9	-3
7834	9004	13	138	33	30	-1	16	-9
7834	9005	20	189	113	113	2	13	-2
7834	9006	5	30	8	8	-3	5	-3
7834	9007	20	202	202	201	15	240	
7834	9008	26	305	305	304	-2	21	
7834	9009	22	265	265	265	1	8	
7834	9010	22	198	198	198	5	10	
7834	9011	5	58	58	58	-7	15	
7834	9012	4	43	43	43	-3	9	
7835	7907	1	6	6	6	16	21	19
7835	7908	7	43					
7835	7909	6	73	57	57	29	33	16
7835	7911	2	27	20	20	34	39	23
7835	7912	2	23	23	23	-12	15	-12
7835	8009	10	105	55	55	1	24	-4
7835	8010	22	305	298	292	13	30	9
7835	8011	1	12	12	12	22	26	18
7835	8109	1	8	8	8	-26	29	-30

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7835	8110	2	20	20	20	-15	18	-18
7835	8205	5	67	67	59	-12	25	-20
7835	8206	9	122	96	90	-23	29	
7835	8207	7	58	46	46	-30	53	-22
7835	8208	9	145	131	123	-21	44	-27
7835	8209	16	296	296	275	-56	99	-22
7835	8210							-56
7835	8312	1	6	6	6	17	19	11
7835	8403	3	22					
7835	8404	11	89					
7835	8405	3	45					
7835	8406	14	146					
7835	8407	26	314					
7835	8408	8	86					
7835	8409	13	115					
7835	8410	21	264	135	135	2	5	1
7835	8411	11	129	128	125	7	11	4
7835	8412	14	214	207	204	6	9	3
7835	8501	7	70	70	69	4	7	2
7835	8502	7	118	118	113	4	8	4
7835	8503	8	130	130	127	-4	10	1
7835	8504	17	250	234	231	1	9	0
7835	8505	7	99	99	99	-1	5	-1
7835	8506	17	293	278	273	2	13	1
7835	8507	27	469	434	433	1	8	-4
7835	8508	30	577	576	566	3	10	-3
7835	8509	32	652	652	638	-6	13	-7
7835	8510	32	609					-6
7835	8511	15	238					-5
7835	8512	18	265					-5
7835	8601	4	61	11	11	-1	10	-9
7835	8602	1	16	16	16	2	8	-5
7835	8603	5	62	43	42	-6	11	-4
7835	8604	7	68	31	31	-6	9	-11
7835	8605	6	60	6	6	-9	10	
7835	8606	1	11	11	8	-4	6	-14
7835	8607	13	141	17	16	0	22	
7835	8608	4	66	13	13	-1	8	-5
7835	8609	7	115	68	66	8	10	
7835	8610	10	104	32	29	14	20	5
7835	8611	20	288	132	120	6	10	
7835	8612	28	611	561	471	4	10	3
7835	8701	10	209	209	175	7	14	2
7835	8702	24	443	393	340	5	13	3
7835	8703	19	321	240	222	1	6	0
7835	8704	28	522	317	301	10	13	4
7835	8705	23	372	331	301	16	19	7
7835	8706	14	210	185	176	7	10	2
7835	8707	6	100	100	94	11	12	3
7835	8708							-1
7835	8711	25	430	399	381	6	10	-1
7835	8712	48	812	656	614	-2	10	-5
7835	8801	36	752	532	471	6	16	-1
7835	8802	37	624	393	393	3	8	-4
7835	8803	67	1212	718	718	4	7	1
7835	8804	3	38	38	38	6	10	1
7835	8805	22	350	290	273	6	8	1
7835	8806	41	677	618	578	5	11	1
7835	8807	55	1021	887	797	7	12	0
7835	8808	71	1239	1177	1062	4	6	-1
7835	8809	71	1292	1252	1125	7	16	0
7835	8810	60	924	924	869	5	17	2
7835	8811	60	1170	1170	1012	5	14	4
7835	8812	60	1152	817	717	7	10	2
7835	8901	82	1603	1603	1434	4	13	2
7835	8902	67	1240	1240	1088	5	12	4
7835	8903	73	1292	1287	1181	3	14	0
7835	8904	18	268	268	251	7	13	3
7835	8905	58	865	865	825	6	14	2
7835	8906	51	699	699	660	11	24	2

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7835	8907	51	684	684	658	1	23	-6
7835	8908	37	508	502	485	-3	24	-1
7835	8909	45	592	592	568	8	16	5
7835	8910	71	1331	1342	1240	5	10	0
7835	8911	38	731	731	667	6	11	3
7835	8912	27	486	476	446	15	20	10
7835	9001	71	1257	1257	1120	483	13047	1
7835	9002	42	774	774	719	-2	16	3
7835	9003	41	631	631	604	5	16	0
7835	9004	34	608	608	561	7	25	7
7835	9005	53	863	863	818	3	17	3
7835	9006	64	965	965	928	3	14	4
7835	9007	75	1334	1334	1262	0	23	
7835	9008	69	1139	1139	1089	3	9	
7835	9009	59	1017	1017	947	6	12	
7835	9010	28	432	432	411	6	14	
7835	9011	57	953	953	898	9	56	
7835	9012	41	616	616	586	2	19	
7837	8311	3	19	6	6	-35	39	-52
7837	8312	7	17	15	15	4	19	-4
7837	8402	1	5	5	5	43	49	31
7837	8406	1	2	2	2	17	26	40
7837	8407	1	1					
7837	8408	6	18	15	15	-14	29	-21
7837	8409	1	3	2	2	29	46	-23
7837	8410	14	144	102	102	-1	16	-15
7837	8411	4	27	15	15	-2	22	-19
7837	8703	3	32	14	14	-18	23	-27
7837	8704	1	9	9	9	-24	26	-47
7837	8705	3	25	11	11	-27	30	-33
7837	8711	3	18					
7837	8712	12	77					
7837	8801	1	6					
7837	8804	1	3	3	3	-10	14	-41
7837	8805	1	15					
7837	8806	4	28	14	14	-6	13	-21
7837	8809	7	46	29	29	0	5	-18
7837	8810	6	45	34	34	25	34	4
7837	8811	11	86	86	86	-25	36	-28
7837	8812	6	34	37	34	-64	1097	-15
7837	8910	2	7	7	7	1	34	-28
7837	8911	10	82	82	82	2	12	-9
7837	8912	10	67	67	66	-14	56	-21
7837	9012	19	233	233	232	-9	65	
7838	8204	15	131	131	131	6	15	7
7838	8205	5	32	32	32	-1	10	5
7838	8206	1	3					
7838	8208	2	7	7	7	-7	13	
7838	8209							18
7838	8210	5	33	23	22	8	41	
7838	8211	2	3	3	3	-11	18	16
7838	8212	15	86	86	86	-3	10	-165
7838	8301	12	73	73	70	8	16	14
7838	8302	13	99	76	55	28	48	7
7838	8303	11	94	94	94	13	22	18
7838	8304	1	5	5	5	14	17	35
7838	8305	3	7	7	7	-5	18	-4
7838	8306	3	7	7	7	-6	10	4
7838	8307	1	3	3	3	15	20	23
7838	8308	11	66	66	65	13	16	14
7838	8309	3	17	17	17	19	21	27
7838	8310	23	168	168	168	3	11	13
7838	8311	24	203	201	201	4	8	12
7838	8312	33	290	290	290	5	9	7
7838	8401	11	72	69	68	9	13	15
7838	8402	18	110	96	96	7	14	21
7838	8403	30	269	214	212	-7	16	-4
7838	8404	11	71	71	70	-5	14	5
7838	8405	16	101	96	96	2	6	9
7838	8407	9	64	62	62	5	12	9

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7838	8408	28	202	189	188	2	11	12
7838	8409	21	251	243	243	2	11	8
7838	8410	23	329	312	309	-2	9	4
7838	8411	29	335	315	315	1	9	9
7838	8412	25	261	179	179	3	12	11
7838	8501	29	279	277	277	4	8	11
7838	8502	13	127	125	124	-1	11	8
7838	8503	4	35	31	31	-6	7	4
7838	8504	20	252	243	243	1	8	6
7838	8505	21	277	256	256	-2	7	5
7838	8506	3	45	44	44	-10	13	3
7838	8507	20	260	238	237	4	8	4
7838	8508	39	539	500	498	-2	12	5
7838	8509	25	422	402	400	-8	13	0
7838	8510	22	321	304	303	-5	17	1
7838	8511	48	731	683	682	0	10	6
7838	8512	52	805	741	726	-2	8	5
7838	8601	43	619	584	576	-1	9	4
7838	8602	35	511	466	465	0	9	5
7838	8603	28	506	463	462	-4	10	3
7838	8604	21	322	306	306	-4	9	2
7838	8605	13	216	172	172	-3	6	
7838	8606	5	74	44	44	-7	14	4
7838	8607	1	18	15	10	-25	28	
7838	8608	11	107	61	61	-7	13	5
7838	8609	11	113	101	97	0	11	
7838	8610	14	161	151	151	-3	9	16
7838	8611	15	188	161	161	-4	9	
7838	8612	30	501	394	379	2	9	2
7838	8701	18	306	267	267	-1	8	5
7838	8702	26	343	335	334	-4	15	5
7838	8703	14	194	70	70	2	8	7
7838	8704	4	59	35	35	-4	7	6
7838	8705	6	57	26	26	-9	11	6
7838	8706	10	87	63	62	1	8	8
7838	8707	7	85	76	73	6	11	9
7838	8708	12	119	97	97	1	6	8
7838	8709	13	174	133	128	4	9	9
7838	8710	14	177	138	136	4	8	8
7838	8711	5	56	48	46	2	14	7
7838	8712	30	496	383	382	-4	8	5
7838	8801	17	189	73	63	-7	15	8
7838	8802	18	191	94	94	1	5	10
7838	8803	4	57	43	41	8	10	8
7838	8804	6	91	70	69	7	10	10
7838	8805	4	67	58	55	4	8	8
7838	8806	4	47	42	42	5	7	10
7838	8807	6	85	62	52	9	21	7
7838	8808	8	93	71	62	-4	9	3
7838	8809	8	115	60	51	-9	17	1
7838	8810	10	168	86	68	3	15	12
7838	8811	11	183	119	113	-1	12	3
7838	8812	9	134	68	67	5	9	7
7838	8901	9	155	116	113	-6	11	-2
7838	8902	10	139	98	98	-2	9	6
7838	8903	9	113	82	82	3	8	7
7838	8905	7	135	63	63	0	11	8
7838	8906	7	135	57	57	-7	17	4
7838	8907	3	39	31	31	-6	8	9
7838	8908	5	64	31	31	-3	15	13
7838	8910	7	77	77	73	4	11	9
7838	8911	11	142	142	112	10	16	15
7838	8912	14	240	184	174	5	13	11
7838	9001	10	137	76	76	3	10	8
7838	9002	6	93	80	80	6	14	11
7839	8309	6	74	74	74	0	9	-1
7839	8310	26	313	313	273	-6	19	0
7839	8311	14	170	170	170	-4	6	-2
7839	8312	14	156	156	156	-1	5	-1
7839	8401	24	229	226	226	2	6	-1

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7839	8402	11	148	148	148	0	3	1
7839	8403	12	132	132	132	8	9	-1
7839	8404	11	137	137	137	0	4	-1
7839	8405	8	100	100	100	2	5	-1
7839	8406	11	142	142	142	-2	5	-3
7839	8407	19	201	201	201	-1	6	0
7839	8408	10	93	93	93	2	10	2
7839	8409	13	128	128	128	1	7	-1
7839	8410	4	32	32	32	8	11	0
7839	8411	1	11	11	11	-8	9	-3
7839	8501	1	7	7	7	-3	4	5
7839	8502	7	75	75	75	3	9	2
7839	8503	4	33	31	31	-5	6	0
7839	8504	10	135	135	135	2	8	-1
7839	8505	8	92	92	92	-3	5	-1
7839	8506	3	31	31	31	-12	13	-5
7839	8508	26	323	323	323	5	11	1
7839	8509	28	331	329	329	1	10	1
7839	8510	1	14	14	14	-19	20	-15
7839	8601	19	233	233	233	-1	5	0
7839	8602	10	103	103	103	4	9	0
7839	8603	10	130	130	130	4	8	0
7839	8604	17	222	222	222	1	7	-1
7839	8605	10	137	130	130	1	4	
7839	8606	4	31	29	29	-4	11	-1
7839	8607	1	8	8	8	-8	11	
7839	8608							-8
7839	8609	4	50	50	50	-2	4	
7839	8610	13	140	134	134	2	6	-1
7839	8611	15	215	201	201	2	5	
7839	8612	21	252	228	228	0	10	
7839	8701	15	188	186	186	-2	8	-2
7839	8702	32	362	361	361	-3	14	-1
7839	8703	25	351	225	225	-6	12	-3
7839	8704	22	235	198	198	6	10	-2
7839	8705	17	207	185	185	-7	11	-4
7839	8706	12	125	119	119	2	6	-1
7839	8707	29	319	319	319	4	6	1
7839	8708	14	201	201	201	3	4	0
7839	8709	25	327	325	325	2	5	0
7839	8710	10	143	129	129	3	6	-2
7839	8711	15	165	161	161	2	7	-2
7839	8712	11	150	133	133	0	6	0
7839	8801	14	229	221	216	3	10	5
7839	8802	6	82	63	63	5	10	1
7839	8803	5	52	52	52	-2	7	1
7839	8804	3	35	35	35	0	2	1
7839	8805	1	12					
7839	8806	5	53	41	41	-4	5	-3
7839	8807	13	180	171	163	4	11	0
7839	8808	21	341	300	300	0	4	-1
7839	8809	17	274	271	213	0	15	-1
7839	8810	21	343	259	216	-4	13	-2
7839	8811	15	255	122	122	1	8	2
7839	8812	31	550	408	408	3	8	0
7839	8901	14	230	230	222	-3	10	0
7839	8902	22	333	333	333	-5	12	1
7839	8903	16	218	218	218	-1	11	0
7839	8904	13	156	156	156	-2	8	-2
7839	8905	10	168	168	168	1	7	0
7839	8906	1	9	9	9	17	19	-18
7839	8907	1	8	8	8	-3	3	-12
7839	8910	17	251	191	191	1	6	0
7839	8911	15	214	149	149	-1	7	2
7839	8912	15	265	210	210	-4	9	-1
7839	9001	14	183	183	183	2	10	-2
7839	9002	21	338	315	315	6	12	3
7839	9003	17	204	192	192	2	9	0
7839	9004	1	9	9	9	20	24	9
7839	9005	15	250	242	242	-7	13	-3

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7839	9006	1	4	4	4	13	15	13
7839	9007	7	87	87	87	-4	7	
7839	9008	25	400	400	400	-3	6	
7839	9009	11	83	83	83	0	6	
7839	9010	23	259	259	259	-4	12	
7839	9011	14	173	173	173	2	11	
7839	9012	16	261	261	256	-2	14	
7840	8304	5	56	56	56	-3	9	-6
7840	8306	3	34	34	34	-4	13	-4
7840	8310	20	198	197	197	-1	7	1
7840	8311	14	161	160	159	0	8	2
7840	8312	14	187	187	187	3	8	4
7840	8401	16	184	184	181	6	10	3
7840	8402	30	360	353	353	-1	7	2
7840	8403	17	172	172	172	3	8	-1
7840	8404	36	374	369	369	3	7	3
7840	8405	10	96	94	94	3	7	1
7840	8406	26	268	254	254	1	5	1
7840	8407	50	611	586	585	1	9	1
7840	8408	30	399	390	390	3	8	2
7840	8409	34	416	377	377	3	8	2
7840	8410	40	550	546	545	1	8	1
7840	8411	38	489	483	483	-1	8	2
7840	8412	43	556	536	536	-2	9	0
7840	8501	36	506	506	506	1	7	0
7840	8502	43	541	527	526	0	8	-1
7840	8503	29	295	266	266	-2	8	-1
7840	8504	17	205	179	179	-1	5	-3
7840	8505	11	138	133	133	-1	6	-4
7840	8506	15	153	142	142	-3	9	-1
7840	8507	49	598	597	597	-4	8	-4
7840	8508	30	356	356	356	3	11	-3
7840	8509	52	728	709	709	-3	12	0
7840	8510	39	539	531	531	0	9	-2
7840	8511	37	498	492	492	-3	8	-2
7840	8512	18	253	251	251	-2	7	-2
7840	8601	49	737	732	732	0	7	0
7840	8602	36	503	482	482	-1	7	0
7840	8603	43	595	570	570	-1	7	-1
7840	8604	45	486	465	465	1	8	-1
7840	8605	38	432	331	331	0	6	
7840	8606	37	360	253	248	-1	8	-5
7840	8607	38	378	200	200	4	9	
7840	8608	46	568	510	510	1	5	-6
7840	8609	49	562	503	503	3	6	
7840	8610	43	517	477	477	2	6	-2
7840	8611	34	510	447	447	2	5	
7840	8612	50	715	597	597	2	7	-1
7840	8701	22	260	235	235	-4	8	-4
7840	8702	46	651	638	635	2	16	-1
7840	8703	38	565	499	499	0	5	-1
7840	8704	50	616	449	449	6	10	-1
7840	8705	54	762	643	643	1	7	-2
7840	8706	28	353	311	311	0	7	-2
7840	8707	49	579	306	306	1	6	-1
7840	8708	39	527	461	461	3	6	1
7840	8709	37	468	396	396	1	6	-1
7840	8710	32	365	283	283	0	5	-4
7840	8711	29	409	264	264	2	7	-2
7840	8712	28	368	246	244	1	8	-1
7840	8801	35	485	354	354	1	5	-1
7840	8802	58	823	705	705	-1	7	-2
7840	8803	35	430	367	367	1	5	0
7840	8804	40	487	342	337	-1	5	-1
7840	8805	25	283	236	236	0	4	-1
7840	8806	22	240	206	206	1	6	0
7840	8807	34	365	192	192	2	7	-1
7840	8808	49	563	358	358	1	4	0
7840	8809	36	433	291	291	-3	6	-2
7840	8810	61	734	425	420	4	9	4

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7840	8811	64	935	746	724	2	10	4
7840	8812	28	396	277	277	3	6	2
7840	8901	40	527	388	388	2	6	2
7840	8902	40	470	331	331	1	5	3
7840	8903	34	435	285	285	1	8	0
7840	8904	28	313	210	210	2	6	1
7840	8905	68	715	531	531	0	6	-1
7840	8906	59	647	327	327	-1	8	-9
7840	8907	75	761	410	410	0	6	-4
7840	8908	61	631	205	204	-3	9	-1
7840	8909	36	330	255	245	0	6	2
7840	8910	40	381	30	17	-2	20	2
7840	8911	57	745	662	656	1	7	1
7840	8912	9	86	56	56	6	10	8
7840	9001	17	150	111	111	7	10	2
7840	9002	40	450	277	277	-4	12	4
7840	9003	26	327	285	285	1	8	2
7840	9005	64	820	637	637	1	13	1
7840	9006	30	346	240	237	-5	12	0
7840	9007	69	874	874	874	-1	8	
7840	9008	56	732	732	731	-2	7	
7840	9009	47	470	470	466	0	11	
7840	9010	1	3	3	0	-111	230	
7840	9011	33	309	309	303	-17	126	
7843	8505	30	434	359	358	-3	8	7
7843	8506	52	628	596	596	-4	9	6
7843	8507	28	454	410	410	-3	11	8
7843	8509	15	198	176	176	-3	15	13
7843	8510	14	240					15
7843	8511	15	203					12
7843	8512	16	249					10
7843	8601	47	703	346	324	6	18	22
7843	8602	29	383	296	291	11	15	30
7843	8603	23	310	237	237	8	12	24
7843	8604	33	501	481	477	0	13	11
7843	8605	21	331	152	152	1	9	
7843	8606	46	704	212	206	3	13	13
7843	8607	39	662	261	261	-1	9	
7843	8608	34	763	327	327	4	8	14
7843	8609	30	469	395	381	7	11	
7843	8610	13	221	190	175	10	13	14
7843	8611	3	49	43	43	5	7	
7843	8612							18
7843	8701	17	259	247	247	-2	13	15
7843	8702	15	198	197	197	9	15	18
7843	8703	18	253	188	187	11	12	22
7843	8704	13	195	57	52	4	19	18
7843	8705	10	147	111	111	4	8	16
7843	8706							18
7843	8707	12	195	163	163	5	9	19
7843	8708	24	402	61	61	4	9	14
7843	8709	30	480	480	480	16	29	26
7843	8710	12	173	173	172	17	65	35
7843	8808	7	73	73	73	-4	7	11
7843	8809	33	436	32	32	2	12	14
7843	8810	45	604	539	539	-13	28	2
7843	8811	20	254	247	247	-3	27	3
7843	8812	22	275					
7843	8901	40	637	498	493	-8	33	-1
7843	8902	37	542	522	517	-4	15	8
7843	8903	13	201	151	150	-8	16	5
7843	8905	3	31	31	31	-16	17	1
7843	8906	3	41	27	27	-11	61	10
7843	8907	9	126	126	125	-12	34	-2
7843	8908	13	166	166	163	11	21	8
7843	8909	7	90	90	88	-10	17	0
7843	8910	2	40	54	54	-14	15	6
7843	8911	21	519	519	515	-10	17	1
7843	8912	17	416	416	416	-5	21	3
7843	9001	19	177	177	177	-17	28	-6

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7843	9003	12	170	170	168	-6	15	-5
7843	9004	24	277	277	276	-19	31	2
7843	9005	56	759	759	756	-12	25	4
7843	9006	22	296	296	294	-5	17	7
7843	9007	7	59	59	59	-5	15	
7843	9008	6	71	71	71	-9	18	
7843	9009	22	275	275	271	-7	14	
7843	9010	36	441	441	437	-14	24	
7843	9011	19	274	274	269	-23	30	
7844	8802	8	51	33	33	0	27	7
7844	8803	3	41	15	15	22	29	9
7853	8810	48	738	457	457	4	9	5
7853	8811	12	231	209	209	4	25	4
7882	8402	8	88	86	85	-3	9	16
7882	8403	8	66	59	59	8	13	22
7882	8805	12	165	165	156	25	770	-1
7882	8806	34	454	454	453	-5	255	-3
7882	8807	6	66	66	66	-18	39	-1
7883	8905	9	116	116	116	28	29	7
7883	8906	15	210	210	210	24	32	7
7883	8907	4	53	21	21	-7	12	-8
7883	8907			32	32	22	27	3
7883	8908	5	40	40	40	31	34	1
7883	8909	1	10	10	10	19	20	8
7885	8207	1	4	4	4	0	4	
7885	8208	25	235	224	224	1	6	-10
7885	8209	7	57	57	55	4	14	-1
7885	8210	3	7	7	7	-4	12	3
7885	8211							4
7886	8308	18	128	128	127	-3	9	3
7886	8407	4	49	48	48	3	5	6
7886	8408	37	583	577	577	-1	8	-3
7886	8409	28	387	274	271	-1	51	-1
7886	8409			113	113	7	12	0
7886	8410	19	198	194	194	1	5	1
7887	8302	3	10	10	10	3	22	85
7888	8202	13	104	104	104	0	11	-14
7888	8203	10	125	125	125	0	13	-12
7888	8204	8	80	80	80	-2	14	-16
7890	8103	2	25	25	25	1	14	61
7891	8106	11	141	141	141	-4	11	-7
7891	8107	28	278	256	256	-2	11	-5
7892	8105	11	109	106	105	-3	11	2
7892	8106	26	335	322	321	-4	9	-11
7892	8206	10	95	95	95	3	6	
7892	8207	22	172	172	169	2	12	4
7892	8208							3
7894	8303	3	11	9	9	1	9	10
7894	8304	15	101	101	100	-2	11	-4
7894	8305	3	13	13	13	-7	15	6
7894	8306	25	146	144	144	-3	20	3
7894	8307	5	23	23	22	11	25	6
7896	8010	6	55	55	55	3	11	-4
7896	8011	35	324	315	312	1	13	-6
7896	8012	30	370	354	349	-4	9	-10
7899	8008	1	1	1	1	-13	0	-27
7899	8009	25	219	191	191	-2	10	-12
7899	8010	7	45	45	42	-3	21	-7
7907	7602							-19
7907	7603							31
7907	7604							27
7907	7605	22	242	147	146	-10	49	3
7907	7605							28
7907	7606	23	335	186	185	-15	55	-10
7907	7607	17	216	134	133	-14	43	3
7907	7608	11	166	78	78	3	45	-1
7907	7609	2	24	15	15	0	46	
7907	7610	31	528	461	461	2	40	
7907	7611	31	549	464	461	6	52	
7907	7612	20	336	287	287	-5	46	

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7907	7701	15	211	154	153	-10	51	-8
7907	7702	9	127	97	97	-6	42	6
7907	7704	22	356	272	272	33	58	40
7907	7705	24	391	316	316	-10	50	-2
7907	7706	51	886	742	742	0	43	9
7907	7707	56	1007	713	712	-1	43	5
7907	7708	31	511	348	348	-9	48	-4
7907	7709	31	572	280	280	-15	45	-45
7907	7710	24	410	307	307	10	41	0
7907	7711	21	383	328	328	-1	45	0
7907	7712	21	405	343	343	7	48	2
7907	7804	17	300	250	250	27	49	3
7907	7805	29	512	408	408	22	51	3
7907	7806	28	451	380	380	15	50	7
7907	7807	50	1013	875	874	-1	34	-10
7907	7808	42	792	750	748	-1	34	-13
7907	7809	41	688	688	681	-2	48	-9
7907	7810	25	403	392	387	5	65	-4
7907	7811	12	158	158	156	11	53	-8
7907	7812	17	194	182	182	0	31	-4
7907	7901	11	101	87	87	-7	44	-19
7907	7902	18	214	184	184	-4	32	-8
7907	7903	11	91	79	79	-1	31	10
7907	7904	31	370	302	297	-2	36	-7
7907	7905	43	527	438	437	3	32	-5
7907	7906	43	683	605	594	2	32	-1
7907	7907	36	344	229	225	-4	30	-12
7907	7908	23	253	206	206	2	21	-2
7907	7909	23	256	209	201	6	26	-3
7907	7910	7	55	38	38	-10	26	-23
7907	7911	20	194	151	151	-1	27	-4
7907	7912	20	219	163	163	3	23	-4
7907	8001	20	247	178	174	-5	22	-10
7907	8002	11	65	36	30	7	38	3
7907	8003	7	71	42	40	5	24	-3
7907	8004	29	367	336	330	-5	25	-7
7907	8005	39	547	490	490	-3	25	-7
7907	8006	47	645	576	570	-2	25	-7
7907	8007	36	465	405	395	0	24	-5
7907	8008	51	698	639	621	4	27	0
7907	8009	35	457	358	348	4	25	-1
7907	8010	16	216	208	203	-5	22	-9
7907	8011	23	219	208	203	2	23	-7
7907	8012	24	250	215	203	-8	33	-13
7907	8101	5	28	28	26	-14	35	-22
7907	8103	12	95	95	95	9	33	-2
7907	8104	18	199	178	168	3	42	0
7907	8105	28	325	287	279	1	23	-5
7907	8106	42	551	497	491	-3	23	-6
7907	8107	53	842	801	792	-2	22	-9
7907	8108	39	677	656	590	-3	22	-7
7907	8109	41	700	636	518	-1	23	-4
7907	8110	24	363	342	274	-1	23	-4
7907	8111	23	191	120	113	1	20	-1
7907	8112	5	25	15	14	-9	30	-13
7907	8201	4	36	33	32	4	20	-5
7907	8202	7	55	55	55	-5	33	-10
7907	8203	14	126	126	116	7	36	0
7907	8204	4	66	64	61	-17	23	-25
7907	8205	39	876	802	619	0	18	-7
7907	8206	47	966	778	631	0	11	
7907	8207	64	1350	1323	1045	1	9	-5
7907	8208	42	822	784	667	-2	13	-7
7907	8209	32	587	587	488	-4	14	-8
7907	8210	23	390	383	307	-9	20	-10
7907	8211	16	216	207	175	-6	26	-12
7907	8212	28	418	418	395	-2	10	-8
7907	8301	29	448	448	420	-4	12	-12
7907	8302	28	446	446	423	-4	14	-12
7907	8303	22	272	272	266	-6	17	-7

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7907	8304	35	506	486	458	-2	17	-6
7907	8305	56	1029	981	782	-2	19	-6
7907	8306	61	1226	1226	996	-3	22	-6
7907	8307	76	1550	1550	1249	-1	12	-5
7907	8308	57	1103	1103	887	-2	9	-8
7907	8309	48	1016	1016	762	-3	9	-6
7907	8310	45	1038	985	787	-1	12	-5
7907	8311	43	931	914	777	-1	11	-5
7907	8312	30	512	500	457	-3	11	-8
7907	8401	1	16	16	16	2	7	-4
7907	8402	1	17	17	16	-3	8	-10
7907	8403	2	30	28	28	8	15	-6
7907	8404	25	414	403	366	-3	27	-8
7907	8405	38	646	612	528	-1	14	-5
7907	8406	37	601	581	572	0	9	-5
7907	8407	53	909	871	863	1	12	-5
7907	8408	48	763	743	742	-1	9	-5
7907	8409	51	841	831	829	0	10	-4
7907	8410	26	361	321	309	-1	19	-6
7907	8411	18	235	210	206	-1	11	-6
7907	8412	19	264	244	224	-6	19	-9
7907	8501	13	139	139	138	2	17	-3
7907	8502	6	59	59	59	-2	10	-7
7907	8503	10	109	93	93	-6	14	-8
7907	8504	20	190	134	134	-3	12	-7
7907	8505	40	552	490	487	0	9	-5
7907	8506	44	690	655	655	1	9	-4
7907	8507	51	792	777	771	1	13	-4
7907	8508	45	707	684	683	-1	14	-9
7907	8509	24	393	371	367	-2	18	-6
7907	8510	29	440	427	410	-3	19	-10
7907	8511	8	75	64	52	-2	26	-11
7907	8512	3	32	29	29	-6	11	-9
7907	8601	4	41	35	35	-3	9	-12
7907	8602	5	69	63	63	-6	12	-10
7907	8603	9	107	91	91	7	14	-2
7907	8604	21	225	129	128	-5	14	-11
7907	8605	31	459	234	233	-3	8	
7907	8606	33	588	226	223	8	13	-4
7907	8607	33	572	209	207	-5	11	
7907	8608	23	332	219	219	-6	10	7
7907	8609	20	306	251	250	2	10	
7907	8610	29	506	411	409	2	10	-8
7907	8611	27	387	262	262	0	8	
7907	8612	19	287	170	154	3	14	-5
7907	8701	7	99	80	80	1	11	-3
7907	8702	26	370	328	328	3	9	1
7907	8703	20	245	139	139	2	8	-1
7907	8704	23	314	194	194	3	11	-2
7907	8705	13	163	88	84	1	13	-1
7907	8706	9	89	41	40	3	8	2
7907	8707	22	376	235	235	2	9	-1
7907	8708	31	520	230	229	3	7	-3
7907	8709	36	614	271	265	5	9	0
7907	8710	29	542	151	140	2	11	-2
7907	8711	23	389	177	177	1	7	-1
7907	8712	21	290	156	156	4	9	-3
7907	8801	6	80	42	34	5	18	-4
7907	8802	3	51	20	20	0	10	-4
7907	8803	14	250	158	150	2	8	-2
7907	8804	16	271	223	218	4	8	-2
7907	8805	32	495	291	284	3	7	-1
7907	8806	31	509	159	120	7	15	-1
7907	8806			155	154	4	7	1
7907	8807	33	530	311	300	5	14	3
7907	8808	30	498	241	231	5	8	1
7907	8809	25	413	78	72	5	11	1
7907	8810	22	385	169	145	6	16	0
7907	8811	11	188	56	52	8	15	-1
7907	8812	1	13					

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7907	8901	1	12	12	6	-3	24	-10
7907	8902	5	76	76	72	-1	21	-5
7907	8903	7	103	103	98	9	15	1
7907	8904	14	217	217	209	7	17	3
7907	8905	31	481	481	456	4	20	1
7907	8906	28	457	457	439	5	32	8
7907	8907	31	511	109	109	4	11	0
7907	8908	16	245	91	74	11	32	0
7907	8909	17	249	249	155	-5	18	-2
7907	8910	17	219	219	151	4	78	-3
7907	8911	26	393	382	309	3	20	1
7907	8912	18	289	251	209	9	32	2
7907	9001	5	62	38	38	1	10	-4
7907	9002	9	133	41	38	2	19	-13
7907	9003	3	47	29	29	3	12	0
7907	9006	6	72	44	42	14	19	2
7907	9007	15	281	281	252	5	16	
7907	9008	14	251	251	226	4	16	
7907	9009	16	274	274	237	5	19	
7907	9010	16	205	205	198	-51	730	
7907	9011	1	13	13	12	1	24	
7918	8812	1	10					
7918	9004	14	185	185	63	-157	198	
7918	9005	10	154	154	151	5	14	
7918	9006	21	276	276	267	-4	12	
7918	9007	10	106	106	106	5	7	
7918	9008	6	74	74	74	1	3	
7918	9009	19	288					
7920	8811	6	96					
7920	8812	21	253					
7920	8908	1	13					
7920	8909	2	18					
7920	8910	8	101					
7920	9009	17	197					
7920	9010	1	19					
7921	7602							27
7921	7603							-6
7921	7604							5
7921	7605	36	587	386	384	11	50	24
7921	7605							57
7921	7606	48	730	451	446	4	56	16
7921	7607	3	25	17	16	-28	84	11
7921	7608	7	102	54	54	-7	64	1
7921	7609	27	334	194	194	23	73	
7921	7610	35	405	242	242	20	52	
7921	7611	46	598	379	378	19	57	
7921	7612	32	475	307	306	-1	50	
7921	7701	12	166	101	101	20	58	82
7921	7702	34	580	438	438	23	46	30
7921	7703	31	592	414	414	0	38	-12
7921	7704	16	247	206	206	-15	38	-51
7921	7705	4	60	48	48	5	41	-34
7921	7706	2	32	24	24	-10	52	-23
7921	7707	1	15	15	15	-62	73	-76
7921	7708	8	112	70	65	68	87	93
7921	7709	20	293	134	134	20	46	21
7921	7710	24	443	341	341	6	40	17
7921	7711	33	578	466	466	7	48	35
7921	7712	36	613	522	521	2	45	-8
7921	7801	20	307	307	306	-6	77	-21
7921	7802	3	61	61	61	-4	46	-3
7921	7804	32	445	331	331	-7	45	-14
7921	7805	28	478	379	378	-3	47	-23
7921	7806	40	697	541	541	0	49	-12
7921	7807	10	54	48	48	-6	34	-26
7921	7808	2	19	19	19	-39	49	-40
7921	7809	11	91	73	73	-9	36	-8
7921	7810	15	186	157	156	-30	52	-30
7921	7811	10	77	76	76	-35	55	-11
7921	7812	11	84	82	82	-22	41	-25

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7921	7901	5	35	32	32	-11	26	-34
7921	7902	8	58	47	47	-5	36	-21
7921	7903	8	47	38	38	-5	33	-21
7921	7904	14	70	53	52	-12	29	-28
7921	7905	9	65	61	61	-13	31	-18
7921	8112	1	15	8	8	-9	19	-40
7921	8201	1	16	8	8	-23	28	-10
7921	8202	8	105	105	92	-23	217	-30
7921	8203	2	27	27	27	-12	32	-19
7929	7602							-5
7929	7603							36
7929	7604							16
7929	7605	15	159	104	104	-14	57	9
7929	7605							70
7929	7606	25	363	278	275	-11	55	-18
7929	7607	10	142	98	98	14	42	2
7929	7608	12	138	70	69	22	63	31
7929	7609	10	117	58	58	45	86	
7929	7610	12	173	123	123	3	49	
7929	7611	16	225	140	138	23	65	
7929	7612	12	176	124	122	46	69	
7929	7701	5	33	29	28	25	72	-16
7929	7702	5	55	33	33	34	64	37
7929	7703	10	130	74	73	50	66	50
7929	7704	3	22	16	16	29	65	52
7929	7705	9	88	60	60	-24	90	-12
7929	7706	10	94	39	39	-1	72	13
7929	7707	9	77	47	43	22	79	6
7929	7708	13	134	94	87	23	95	-3
7929	7709	4	51	40	38	29	105	-30
7929	7710	9	78	45	32	72	133	-11
7929	7711	11	118	80	70	33	113	3
7929	7801	16	172	172	170	10	81	39
7929	7802	1	15	15	15	52	87	143
7929	7807	2	17	14	14	-17	62	-48
7929	7808	4	42	39	38	-10	37	-26
7929	7809	5	51	35	35	7	73	0
7929	7810	11	101	79	78	7	64	-13
7929	7811	10	87	64	64	-5	53	-13
7929	7812	2	23	17	14	-3	108	-9
7929	7901	6	31	26	26	2	26	-33
7929	7902	7	50	49	49	-22	30	-37
7929	7903	3	13	9	9	15	25	22
7929	7904	2	19	15	15	7	26	-34
7929	7905	1	4	4	4	-10	29	-45
7929	7906	2	13	8	8	-15	35	-29
7929	7908	5	15	10	10	-14	29	-9
7929	7910	2	8	4	4	9	15	-21
7929	7911	4	15	7	7	-37	46	-43
7929	7912	2	18	6	6	-20	27	-43
7929	8001	1	4	4	2	-49	83	-72
7929	8002	3	10	7	5	-7	39	-27
7929	8003	4	25	7	7	4	25	12
7929	8004	6	46	32	30	-12	38	-16
7929	8005	4	18	14	12	-1	73	-46
7929	8006	4	11	9	9	-5	29	-19
7929	8007	3	17	3	3	-32	42	-52
7929	8008	8	50	33	30	4	38	-15
7929	8009	4	19	16	16	2	17	-11
7929	8010	6	33	32	31	4	24	-15
7929	8011	12	81	78	75	-6	26	-16
7929	8012	7	37	36	34	-5	33	-14
7929	8101	9	47	47	45	7	30	-14
7929	8102	8	33	33	30	-18	42	-18
7929	8103	3	14	14	14	4	27	48
7929	8104	2	18	18	17	8	32	-8
7929	8106	8	93	93	83	-4	35	-16
7929	8107	19	175	164	155	-7	33	-23
7929	8108	15	140	136	136	-4	26	-23
7929	8109	17	146	138	133	-9	25	-23

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7929	8110	1	7	7	7	0	26	-21
7939	8309	19	378	378	300	-4	11	-7
7939	8310	25	455	401	325	-7	13	-10
7939	8311	12	226	115	96	-4	10	-5
7939	8312	16	309	302	237	-2	11	-7
7939	8401	30	635	610	511	-3	9	-6
7939	8402	9	164	152	114	-12	21	-8
7939	8403	14	211	200	181	-4	10	-8
7939	8404	24	435	415	352	1	15	-3
7939	8405	32	602	544	466	0	8	-3
7939	8406	38	699	669	604	-1	8	-2
7939	8407	50	830	768	735	-1	9	1
7939	8408	43	724	679	651	1	10	1
7939	8409	35	643	599	573	1	8	0
7939	8410	25	413	375	361	0	9	-1
7939	8411	13	219	190	185	1	9	0
7939	8412	25	418	339	291	-3	13	-2
7939	8501	11	148	123	97	5	15	2
7939	8502	9	129	106	99	-1	11	1
7939	8503	10	178	88	85	-3	9	-1
7939	8504	19	298	286	250	-1	64	-3
7939	8505	22	392	283	270	-1	8	-3
7939	8506	26	430	327	306	1	9	-4
7939	8507	49	1007	862	762	1	10	-3
7939	8508	58	1137	1024	926	-1	10	-3
7939	8509	78	1577	1338	1192	-1	13	-2
7939	8510	70	1354	1237	1108	1	12	-1
7939	8511	43	753	676	610	-2	10	-1
7939	8512	44	854	745	669	0	7	-1
7939	8601	41	704	640	568	0	8	0
7939	8602	26	444	351	333	-1	8	0
7939	8603	15	210	170	154	0	7	0
7939	8604	30	575	496	445	3	10	0
7939	8605	19	338	256	236	1	8	
7939	8606	16	248	169	158	-7	14	-1
7939	8607	15	215	117	112	-5	13	
7939	8608	10	128	86	68	0	11	-2
7939	8609	16	292	236	199	2	10	
7939	8610	20	420	384	337	0	7	-4
7939	8611	11	195	149	142	1	6	
7939	8612	28	538	421	391	-2	9	1
7939	8701	9	195	149	139	-5	9	-3
7939	8702	18	345	288	265	5	12	-1
7939	8703	23	397	193	182	1	6	-2
7939	8704	41	788	436	408	2	8	-2
7939	8705	37	648	392	362	0	7	-3
7939	8706	37	590	412	405	2	6	-2
7939	8707	57	830	615	607	2	6	-1
7939	8708	44	728	528	518	0	6	-4
7939	8709	44	816	580	546	-101	807	-3
7939	8710	28	453	324	317	0	6	-4
7939	8711	16	281	206	197	2	7	-3
7939	8712	17	267	131	131	0	8	-2
7939	8801	12	212	104	88	3	15	0
7939	8802	17	260	109	107	1	9	-1
7939	8803	14	253	127	118	-3	9	-1
7939	8804	16	259	128	127	0	7	-3
7939	8805	18	304	217	194	-2	6	-3
7939	8806	25	496	350	287	-1	10	-5
7939	8807	31	483	172	170	-3	8	-7
7939	8808	46	776	329	318	-4	7	-6
7939	8809	27	402	68	68	-2	4	-4
7939	8810	35	555	189	172	-1	9	-5
7939	8901	22	318	163	160	-1	6	-2
7939	8902	31	458	243	242	-5	10	-3
7939	8903	25	377	225	225	-4	8	-4
7939	8904	17	211	121	121	-2	7	-5
7939	8905	23	309	183	183	0	9	-1
7939	8906	10	154	62	62	-7	15	-4
7939	8907	11	171	110	104	-1	7	-6

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7939	8908	2	29	23	9	-34	43	-4
7939	8909	1	14	10	10	6	9	10
7939	8910	5	56	55	46	-3	16	-5
7939	8911	18	286	156	154	0	8	2
7939	8912	18	269	129	127	69	746	3
7939	9001	23	378	246	244	-2	7	-6
7939	9002	46	876	297	283	2	7	0
7939	9003	40	711	71	66	2	10	-2
7939	9004	2	37	36	20	-37	42	-14
7939	9005	22	359	291	287	-12	16	-4
7939	9006	24	300	102	97	-6	13	-3
7939	9007	18	219	219	213	-3	173	
7939	9008	8	120	120	118	0	8	
7939	9010	26	377	377	365	-71	901	
7939	9011	20	347	347	333	-7	188	
7939	9012	11	201	201	186	-6	18	
7940	7601	1	16					
7940	8406	6	42					
7943	7605							9
7943	7606							-27
7943	7607							-41
7943	7608							-41
7943	7609	3	47	43	43	6	35	
7943	7610	8	121	109	109	18	44	
7943	7611	8	109	104	104	-6	53	
7943	7612	22	340	298	298	-11	40	
7943	7701	21	322	278	278	2	40	-32
7943	7702	25	404	340	340	-3	36	-15
7943	7703	25	372	291	291	-5	38	-7
7943	7704	59	883	767	753	0	39	0
7943	7705	37	538	435	435	13	45	-6
7943	7706	40	599	494	465	16	53	-11
7943	7707	62	1251	1056	938	8	36	-11
7943	7708	62	1097	1023	898	-2	33	-27
7943	7709	15	279	97	88	-1	44	-38
7943	7710	39	843	757	682	-16	36	-41
7943	7711	21	427	412	370	-14	39	-40
7943	7712	15	276	267	248	-8	40	-27
7943	7801	3	65	65	57	0	51	-21
7943	7802	1	13	13	13	28	43	65
7943	7804	15	300	271	249	-9	39	-29
7943	7805	15	355	313	288	-18	51	-26
7943	7806	6	133	131	119	-29	56	-35
7943	7809	6	120	117	103	-8	40	-31
7943	7810	38	674	579	507	-10	47	-26
7943	7811	27	419	401	378	-5	39	-25
7943	7812	14	209	185	174	-5	44	-2
7943	7901	20	279	194	179	2	43	17
7943	7902	24	442	325	302	1	30	-8
7943	7903	23	392	250	223	4	33	8
7943	7904	9	126	88	84	-3	35	-29
7943	7905	12	193	188	176	-5	22	-31
7943	7906	20	286	269	254	-5	25	-20
7943	7907	23	388	356	341	2	19	-30
7943	7908	14	221	193	193	3	15	-20
7943	7909	5	65	53	52	-2	24	-18
7943	7910	2	22	20	19	0	27	-12
7943	7911	3	41	39	39	-3	23	-25
7943	7912	7	134	111	111	-7	19	-32
7943	8001	5	72	68	68	-2	16	-24
7943	8002	10	160	145	132	-1	21	-24
7943	8003	26	473	434	401	-5	18	-27
7943	8004	33	568	549	494	-5	22	-25
7943	8005	22	271	245	222	1	26	-17
7943	8006	40	651	597	553	-3	24	-27
7943	8007	44	586	526	475	2	26	-21
7943	8008	67	930	825	744	-3	24	-22
7943	8009	44	662	632	570	-2	21	-23
7943	8010	40	624	580	529	-4	24	-25
7943	8011	30	470	465	425	-8	27	-27

Station Number	Date	No. of Passes	Observ. Acquired	Obs. after Eng'r. Edit	Obs. after Dynam. Edit	Mean Residual (cm)	RMS of Residual (cm)	Bias Estimate (cm)
7943	8012	15	224	216	205	-3	23	-27
7943	8101	20	265	265	244	-1	24	-20
7943	8102	10	141	141	131	-4	24	-34
7943	8103	7	84	84	80	-4	30	-18
7943	8104	12	165	149	138	-1	28	-32
7943	8105	11	137	102	93	0	30	-29
7943	8106	10	121	108	94	2	39	-23
7943	8107	24	376	347	326	-3	25	-26
7943	8108	16	189	160	147	0	27	-22
7943	8109	21	268	227	206	-2	26	-24
7943	8110	13	117	90	77	-5	27	-31
7943	8111	6	55	34	32	-4	21	-33
7943	8112	9	71	61	57	-2	22	-35
7943	8201	14	98	89	75	3	33	-30
7943	8202	27	247	247	221	-8	37	-33
8833	8404	4	23	23	23	-1	5	10
8833	8405	8	130	130	130	3	7	2
8833	8412	7	97	93	93	-1	11	-6
8833	8501	6	40	40	40	1	7	
8833	8502	4	38	38	38	8	10	0
8833	8806	2	7	7	7	3	7	6
8833	8807	7	67	49	49	-2	9	-1
8833	8808	20	206	206	206	-2	8	0
8833	8809	24	284	284	283	-4	12	1
8833	9007	35	383	383	382	0	7	

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Appendix 3

Monthly LAGEOS Orbital Fits
and Estimates of Force Model Parameters

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
42930	778	36	1.2119	-4.5464
42945			1.2014	-3.5817
42960	956	31.1	1.1641	-6.0025
42975			1.0805	-4.0346
42991	247	28.8	1.8377	-2.6459
43006			1.8037	-7.44
43022	223	35.4	.9913	-5.1794
43037			1.1277	-4.1021
43052	325	33.9	1.1043	-3.1988
43067			1.1774	-3.5388
43083	1030	28.3	1.1555	-3.3535
43098			1.1602	-3.1257
43113	1904	34.9	1.1324	-1.7707
43128			1.1282	-1.6933
43144	1199	34.4	1.0556	-3.9379
43159			1.1664	-.1657
43175	560	31.9	1.1484	-1.215
43190			1.0997	-.753
43203	1125	30.7	1.124	-4.5884
43218			1.0861	-4.3162
43234	942	30.9	1.135	-3.5306
43249			1.1401	-4.2003
43264	1467	35.2	1.1456	-5.4863
43279			1.1066	-2.1732
43295	873	32.4	1.1288	-3.9015
43310			1.1381	-3.0441
43325	1270	29.4	1.1079	-3.8855
43340			1.1129	-3.0339
43356	1708	31.6	1.1392	-2.8198
43371			1.1129	-3.9677
43387	1436	34.7	1.0875	-3.0219
43402			1.1897	-1.1776
43417	555	30.2	1.1198	-2.4546
43432			1.1517	-2.8093
43448	1528	36.5	1.1015	-.9143
43463			1.1104	-1.8421
43478	1296	37	1.0996	-2.1358
43493			1.1835	-3.5831
43509	1142	63.4	1.2333	-5.1484
43524			1.0237	-3.6518
43540	543	32.3	.6026	3.032
43555			1.1763	-1.2907
43568	215	11.7	1.1102	-3.0922
43583			.9828	-2.0284
43599	593	30.7	.9743	-3.369
43614			1.0965	-2.1473
43629	1072	38.4	1.0848	-3.1293
43644			1.0875	-2.2875
43660	1074	41.3	1.0568	-1.921
43675			1.135	-3.8121
43690	1049	28.6	1.0932	-1.2848
43705			1.1285	-.7446
43721	1122	24.7	1.1236	-.952
43736			1.1267	-1.4589

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
43752	1446	35.1	1.1232	-1.236
43767			1.1312	-3.1879
43782	1196	44.1	1.1207	-2.9339
43797			1.136	-4.2142
43813	1190	36.9	1.2028	-3.961
43828			1.174	-3.7485
43843	696	28.8	1.1488	-2.5765
43858			1.2632	-5.5891
43874	505	22.3	1.2194	-3.492
43889			1.0833	-4.6632
43905	342	19.4	1.1381	-6.3809
43920			1.0676	-3.4201
43933	825	17.3	1.1329	-3.7948
43948			1.1395	-4.8523
43964	880	15.6	1.134	-7.2594
43979			1.1489	-4.6535
43994	1352	18.9	1.1471	-5.5038
44009			1.1054	-5.6283
44025	1304	22.4	1.1304	-5.1828
44040			1.1432	-3.7562
44055	1130	17.7	1.1072	-3.1239
44070			1.1573	-4.5634
44086	910	15.3	1.148	-3.9493
44101			1.2023	-5.5878
44117	546	11.1	1.1852	-4.3884
44132			1.1866	-4.5538
44147	1082	10.2	1.1967	-3.9152
44162			1.172	-4.3924
44178	2371	15.3	1.1484	-4.2313
44193			1.1515	-3.8966
44208	2574	13.7	1.1453	-3.852
44223			1.1325	-3.1536
44239	2665	10.2	1.1302	-2.5083
44254			1.1145	-1.7162
44270	1712	9.3	1.13	-1.5172
44285			1.1217	-.8456
44299	2543	9.3	1.1273	-.7127
44314			1.1331	-.9707
44330	2991	13.3	1.1389	-2.8289
44345			1.1378	-3.6897
44360	2642	16.1	1.1443	-3.7941
44375			1.1447	-3.4406
44391	1745	17.4	1.1495	-3.3603
44406			1.132	-2.8682
44421	2117	14.6	1.1116	-2.8943
44436			1.1346	-3.1474
44452	2061	14.8	1.123	-3.037
44467			1.1251	-3.0056
44483	3496	11.7	1.1179	-3.1242
44498			1.1316	-2.7381
44513	3775	11.8	1.1247	-3.1648
44528			1.1279	-3.1147
44544	3783	12.8	1.1286	-2.3152
44559			1.1268	-1.7136

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
44574	3172	12.6	1.1207	-2.1829
44589			1.1249	-2.4563
44605	1850	12.6	1.1215	-2.3513
44620			1.1221	-2.8965
44636	970	9.6	1.1201	-3.3725
44651			1.1104	-3.786
44664	1453	13.6	1.1248	-3.2154
44679			1.089	-3.729
44695	3298	12.7	1.0805	-3.422
44710			1.0767	-3.7933
44725	2560	11.4	1.0932	-3.8521
44740			1.1414	-3.4747
44756	2086	12.7	1.1012	-3.6846
44771			1.1222	-3.7148
44786	2238	14.2	1.1141	-3.9384
44801			1.1174	-3.0089
44817	3147	12.7	1.115	-2.1925
44832			1.1274	-1.9959
44848	2453	11.3	1.1228	-2.0094
44863			1.1324	-2.5319
44878	3387	8.8	1.1311	-2.9519
44893			1.1396	-4.2817
44909	3078	8.5	1.1398	-4.1678
44924			1.1376	-3.879
44939	2113	8.6	1.1736	-3.8434
44954			1.1727	-3.6026
44970	1722	8.3	1.2628	-3.9571
44985			1.0822	-3.8012
45001	1630	14.9	1.1044	-4.2307
45016			1.1376	-3.7779
45029	2041	11	1.1136	-4.6042
45044			1.1543	-3.8364
45060	1768	6	1.1397	-5.3286
45075			1.1267	-6.0256
45090	1324	9.6	1.1377	-6.8851
45105			1.1281	-5.202
45121	2566	7.1	1.134	-6.0658
45136			1.1304	-4.9549
45151	2335	6.2	1.1229	-5.0825
45166			1.1208	-4.0258
45182	3502	7.7	1.1173	-3.8776
45197			1.1244	-4.2585
45213	2314	8.8	1.1222	-4.2335
45228			1.1565	-4.3635
45243	3030	6.5	1.1835	-4.2287
45258			1.1661	-3.8493
45274	3909	6.9	1.1627	-3.426
45289			1.1553	-3.8944
45304	2183	6.6	1.1429	-3.7925
45319			1.1332	-3.2881
45335	2178	7.1	1.1203	-3.2176
45350			1.1265	-2.2157
45366	2446	8.1	1.1095	-2.0806
45381			1.1101	-1.1917

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
45394	1869	11.1	1.1265	-.602
45409			1.125	-.271
45425	2205	8.4	1.1393	-.2655
45440			1.1428	.1857
45455	2537	7.6	1.1574	-.5038
45470			1.1575	-3.1332
45486	2589	9	1.1611	-2.9613
45501			1.161	-3.4197
45516	2672	5.6	1.1527	-3.092
45531			1.1545	-3.0632
45547	2480	5.1	1.1441	-3.3554
45562			1.137	-3.2343
45578	2318	5.6	1.1271	-3.214
45593			1.1349	-3.1989
45608	3587	6.1	1.1258	-3.4637
45623			1.1351	-3.2198
45639	4936	5.5	1.1292	-3.6929
45654			1.125	-3.4116
45669	3841	7.3	1.1281	-3.5824
45684			1.1163	-3.4547
45700	3142	4.9	1.1226	-3.3891
45715			1.1232	-3.6416
45731	3715	6.5	1.1177	-3.5093
45746			1.1283	-3.9162
45760	3450	6.4	1.1187	-4.2225
45775			1.12	-3.5713
45791	2833	6.2	1.1264	-3.6294
45806			1.0832	-3.5639
45821	4793	4.5	1.0232	-3.5384
45836			1.129	-3.6068
45852	5702	5	1.1146	-3.6033
45867			1.1238	-3.7565
45882	5864	4.8	1.1145	-3.8422
45897			1.1172	-3.7066
45913	5818	4.8	1.1201	-3.1624
45928			1.1127	-2.6732
45944	6424	5.5	1.1203	-2.353
45959			1.1193	-2.0985
45974	6234	4.6	1.1207	-2.4637
45989			1.1216	-2.4499
46005	5159	4.6	1.1212	-4.0118
46020			1.1205	-3.7948
46035	4012	6.7	1.1227	-3.9216
46050			1.1256	-4.0359
46066	3314	5.4	1.128	-3.8881
46081			1.0876	-3.6712
46097	2800	4.6	1.1231	-4.1745
46112			1.1423	-3.686
46125	2574	7.1	1.1296	-3.8633
46140			1.1245	-3.8913
46156	3315	6.1	1.1274	-3.728
46171			1.1282	-4.5108
46186	4654	4.6	1.1255	-5.5091
46201			1.1217	-6.3306

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
46217	5001	5.3	1.1214	-5.911
46232			1.1158	-5.5183
46247	6437	4.9	1.1186	-4.8522
46262			1.1142	-4.9711
46278	7075	6.1	1.1108	-3.9831
46293			1.1096	-4.0532
46309	6716	9.1	1.1098	-3.7499
46324			1.1107	-4.3427
46339	7913	10.4	1.1191	-3.7191
46354			1.1558	-4.097
46370	5991	5.5	1.1482	-3.4171
46385			1.147	-3.7849
46400	5054	4.7	1.1368	-3.2954
46415			1.1343	-3.3324
46431	4659	5.4	1.1223	-2.895
46446			1.122	-3.1987
46462	5852	5.1	1.1186	-3.0303
46477			1.1174	-2.5206
46490	4551	6.1	1.1155	-2.0623
46505			1.122	-1.3313
46521	4883	7.1	1.1265	-1.4788
46536			1.1276	-.4626
46551	5362	3.9	1.1312	-.4773
46566			1.132	-.6038
46582	3385	3.3	1.1337	-.8318
46597			1.1409	-3.3955
46612	3446	3.5	1.137	-3.9451
46627			1.1397	-3.8253
46643	2954	2.9	1.1423	-3.7748
46658			1.144	-3.9511
46674	3310	3.1	1.1352	-3.92
46689			1.1361	-3.6052
46704	3818	3.4	1.1277	-3.5587
46719			1.1297	-3.9735
46735	5120	3.3	1.1267	-3.9104
46750			1.1243	-4.218
46765	4231	3.4	1.1203	-4.5314
46780			1.1212	-4.3632
46796	3967	3.2	1.1165	-4.3669
46811			1.1165	-4.2098
46827	3122	4.6	1.1105	-4.0998
46842			1.1058	-3.9666
46855	4923	2.9	1.1135	-4.635
46870			1.1138	-4.1636
46886	3580	3	1.1171	-4.1359
46901			1.101	-4.0771
46916	4691	3	1.0956	-3.7686
46931			1.0537	-4.1248
46947	4584	3	1.1804	-3.7953
46962			1.1482	-3.8995
46977	4509	3.2	1.1345	-3.8833
46992			1.1284	-4.1012
47008	6099	3	1.1335	-3.9268
47023			1.1261	-3.8328

Modified Julian Date	No. of Observations	RMS Orbital Fits (cm)	Solar Radiation	Along-Track Acceleration (pms^{-2})
47039	5961	3.5	1.1271	-2.7571
47054			1.1272	-1.8035
47069	5353	3.6	1.1283	-1.2671
47084			1.1323	-1.4784
47100	5627	3.2	1.1295	-1.9348
47115			1.1214	-2.7165
47130	4609	2.8	1.1217	-3.649
47145			1.1154	-3.7019
47161	3474	3	1.1169	-3.5981
47176			1.1126	-3.5492
47192	2947	2.6	1.0893	-3.6347
47207			1.079	-3.7639
47221	3644	2.6	1.1305	-3.837
47236			1.1282	-4.24
47252	4187	2.8	1.1332	-3.7016
47267			1.1272	-4.0004
47282	2916	2.5	1.1312	-4.2891
47297			1.1242	-5.4043
47313	3459	2.4	1.125	-5.2901
47328			1.1266	-5.4717
47343	4104	2.8	1.1255	-5.2868
47358			1.1214	-5.2904
47374	4217	2.6	1.1194	-5.2367
47389			1.1157	-5.0275
47405	5257	2.1	1.1091	-3.9358
47420			1.111	-3.9656
47435	5714	3.5	1.1183	-4.3256
47450			1.1276	-4.6788
47466	6376	3.3	1.1222	-3.8629
47481			1.1498	-4.3328
47496	4897	3.1	1.149	-4.174
47511			1.1513	-4.0852
47527	3374	3.2	1.147	-3.8852
47542			1.1321	-3.8618
47558	5795	3.3	1.1279	-3.5565
47573			1.1293	-4.016
47586	5874	2.9	1.1128	-4.187
47601			1.1207	-3.2773
47617	4702	4	1.1242	-2.9768
47632			1.127	-1.8453
47647	3865	2.9	1.1292	-1.2332
47662			1.1256	-.5245
47678	5315	2.8	1.1352	-.0379
47693			1.1459	.1708
47708	3602	3	1.1447	-3.6613
47723			1.1532	-4.1793
47739	3562	3	1.1628	-3.4679
47754			1.1754	-4.7764

LAGEOS Geodetic Analysis - SL7.1

Appendix 4

Polar Motion and
Earth Rotation Values

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
760506	-.029	.26394	.414	.44757	14.693	.00000	
760508.5							3.186
760511	.002	.22072	.416	.27852	14.709	.02148	
760513.5							3.166
760516	.030	.13069	.417	.25166	14.725	.02327	
760518.5							3.140
760521	.057	.09514	.417	.11739	14.741	.02276	
760523.5							3.040
760526	.085	.09642	.415	.12225	14.756	.02302	
760528.5							2.872
760531	.111	.08593	.408	.16036	14.770	.02302	
760533.5							2.648
760605	.131	.10716	.401	.13708	14.783	.00000	
760607.5							2.446
760610	.145	.09284	.396	.13708	14.796	.00818	
760612.5							2.284
760615	.156	.09437	.394	.14271	14.807	.00767	
760617.5							2.190
760620	.164	.08056	.390	.13171	14.818	.00818	
760622.5							2.182
760625	.173	.08721	.382	.12864	14.829	.00844	
760627.5							2.214
760630	.179	.15627	.368	.17008	14.840	.00921	
760632.5							2.342
760705	.176	.19719	.353	.68056	14.852	.00000	
760707.5							2.474
760710	.174	9.09620	.340	3.96040	14.864	.00000	
760712.5							2.552
760715	.179	.60435	.331	.52813	14.877	.03146	
760717.5							2.576
760720	.198	.45166	.328	.35473	14.890	.02634	
760722.5							2.584
760725	.219	.34246	.325	.23095	14.903	.02327	
760727.5							2.548
760730	.225	1.11990	.312	.39591	14.915	.00000	
760732.5							2.516
760804	.214	.55473	.279	.25166	14.928	.00000	
760806.5							2.526
760809	.189	.45166	.223	.27852	14.941	.01637	
760811.5							2.580
760814	.154	.00000	.158	.00000	14.954	.00000	
760816.5							2.644
760819	.130	1.31820	.112	1.84400	14.967	.00000	
760821.5							2.668
760824	.135	.33632	.107	.31560	14.980	.02762	
760826.5							2.580
760829	.181	.29079	.154	.32583	14.993	.03402	
760831.5							2.256
760903	.248	.45575	.220	.19258	15.004	.00000	
760905.5							2.182
760908	.289	.31560	.244	.17008	15.015	.02916	
760910.5							2.492
760913	.290	.88082	.234	.37340	15.028	.00000	
760915.5							2.950
760918	.258	1.47900	.206	.60230	15.042	.07494	
760920.5							3.306
760923	.214	.32174	.176	.19258	15.059	.04271	
760925.5							3.304
760928	.180	.08900	.157	.07724	15.075	.03785	
760930.5							3.160
761003	.167	.09182	.146	.10742	15.091	.00000	
761005.5							3.130
761008	.164	.12020	.137	.06471	15.107	.00716	
761010.5							3.252
761013	.161	.09719	.125	.06522	15.123	.00895	
761015.5							3.342
761018	.154	.09335	.112	.07084	15.140	.00895	
761020.5							3.374
761023	.142	.10205	.100	.07826	15.157	.00870	
761025.5							3.372
761028	.131	.07826	.089	.06522	15.174	.00895	
761030.5							3.334

Date YYMMDD	x (")	x sigma (")	y (")	y sigma (")	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
761102	.117	.07673	.082	.06471	15.190	.00000	
761104.5							3.224
761107	.102	.05780	.080	.04450	15.206	.00486	
761109.5							3.066
761112	.085	.07263	.080	.04962	15.222	.00537	
761114.5							2.946
761117	.068	.07366	.080	.04527	15.236	.00588	
761119.5							2.958
761122	.052	.07519	.079	.05831	15.251	.00563	
761124.5							3.056
761127	.037	.09821	.075	.07954	15.267	.00588	
761129.5							3.114
761202	.023	.06343	.069	.04629	15.282	.00000	
761204.5							3.102
761207	.005	.09182	.065	.06547	15.298	.00614	
761209.5							3.034
761212	-.014	.06752	.062	.05371	15.313	.00486	
761214.5							2.968
761217	-.029	.09003	.060	.06854	15.328	.00512	
761219.5							2.804
761222	-.044	.09540	.056	.07647	15.342	.00691	
761224.5							2.710
761227	-.059	.24143	.050	.10026	15.355	.01458	
761229.5							2.730
770101	-.077	.32788	.048	.56522	15.369	.00000	
770103.5							2.818
770106	-.099	.17391	.054	.11841	15.383	.03018	
770108.5							2.934
770111	-.123	.23939	.070	.12532	15.398	.03120	
770113.5							3.040
770116	-.144	.14783	.095	.09693	15.413	.02839	
770118.5							3.020
770121	-.159	.10563	.118	.09233	15.428	.02813	
770123.5							2.870
770126	-.169	.12430	.132	.11176	15.442	.02839	
770128.5							2.700
770131	-.180	.14834	.143	.11867	15.456	.00000	
770133.5							2.654
770205	-.196	.10921	.154	.09667	15.469	.01023	
770207.5							2.754
770210	-.216	.10972	.169	.05217	15.483	.01100	
770212.5							2.928
770215	-.229	.11535	.186	.05703	15.497	.01202	
770217.5							2.952
770220	-.238	.17008	.207	.07954	15.512	.01304	
770222.5							2.838
770225	-.238	.16164	.226	.09054	15.526	.01432	
770227.5							2.748
770302	-.232	.17826	.243	.09258	15.540	.00000	
770304.5							2.812
770307	-.223	.38977	.259	.19974	15.554	.02046	
770309.5							2.986
770312	-.214	.12711	.275	.05933	15.569	.01151	
770314.5							3.106
770317	-.207	.09744	.294	.04987	15.585	.01177	
770319.5							3.196
770322	-.202	.07724	.312	.05933	15.601	.01125	
770324.5							3.244
770327	-.199	.12481	.331	.13069	15.617	.01330	
770329.5							3.216
770401	-.195	.10384	.350	.08056	15.633	.00000	
770403.5							3.228
770406	-.187	.06445	.369	.04962	15.649	.00793	
770408.5							3.298
770411	-.175	.07008	.386	.06343	15.666	.00895	
770413.5							3.356
770416	-.163	.07059	.402	.05575	15.682	.00844	
770418.5							3.308
770421	-.152	.06931	.418	.05422	15.699	.00793	
770423.5							3.212
770426	-.139	.07724	.434	.07570	15.715	.00895	
770428.5							3.102

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
770501	-.125	.07442	.446	.05985	15.730	.00000	
770503.5							3.022
770506	-.104	.07212	.452	.06010	15.746	.00563	
770508.5							2.972
770511	-.082	.09335	.457	.07826	15.760	.00665	
770513.5							2.914
770516	-.060	1.18590	.461	1.63150	15.775	.00000	
770518.5							2.844
770521	-.040	.18645	.469	.27647	15.789	.01253	
770523.5							2.730
770526	-.026	.11662	.480	.14501	15.803	.01100	
770528.5							2.502
770531	-.014	.14348	.493	.12916	15.815	.00000	
770533.5							2.356
770605	.003	.13836	.503	.08900	15.827	.00895	
770607.5							2.324
770610	.025	.07775	.506	.05678	15.839	.00972	
770612.5							2.286
770615	.048	.06266	.504	.06010	15.850	.01023	
770617.5							2.190
770620	.072	.11151	.501	.07519	15.861	.00997	
770622.5							2.016
770625	.091	.06445	.499	.05601	15.871	.00972	
770627.5							1.820
770630	.104	.08875	.498	.06905	15.880	.00000	
770632.5							1.718
770705	.114	.06598	.495	.05908	15.889	.00486	
770707.5							1.726
770710	.130	.06650	.486	.07187	15.898	.00588	
770712.5							1.806
770715	.150	.07877	.470	.06931	15.907	.00563	
770717.5							1.922
770720	.171	.06240	.455	.07084	15.916	.00588	
770722.5							2.002
770725	.190	.09437	.441	.10051	15.926	.00716	
770727.5							1.974
770730	.207	.07187	.431	.07826	15.936	.00563	
770732.5							1.880
770804	.222	.07673	.417	.07928	15.945	.00000	
770806.5							1.818
770809	.238	.06266	.397	.06777	15.955	.00512	
770811.5							1.834
770814	.254	.08977	.374	.10384	15.964	.00691	
770816.5							1.960
770819	.267	.09591	.351	.13171	15.974	.00870	
770821.5							2.296
770824	.272	.07800	.334	.08159	15.985	.00665	
770826.5							2.684
770829	.275	.11151	.323	.12097	15.998	.00742	
770831.5							2.970
770903	.274	.09437	.312	.10844	16.013	.00000	
770905.5							3.032
770908	.271	.10921	.297	.11560	16.028	.00742	
770910.5							2.912
770913	.268	.85396	.281	.38977	16.043	.03581	
770915.5							2.792
770918	.267	.09693	.263	.21662	16.057	.00946	
770920.5							2.790
770923	.267	.20588	.242	.33632	16.071	.01586	
770925.5							2.864
770928	.264	.37340	.222	.28056	16.085	.01995	
770930.5							2.976
771003	.254	.09079	.207	.06419	16.100	.00000	
771005.5							3.082
771008	.240	.07468	.195	.06471	16.115	.00512	
771010.5							3.158
771013	.228	.08823	.182	.07417	16.131	.00614	
771015.5							3.222
771018	.222	.08056	.164	.05933	16.147	.00588	
771020.5							3.244
771023	.219	.07954	.141	.06880	16.164	.00588	
771025.5							3.224

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
771028	.215	.07417	.119	.07622	16.180	.00512	
771030.5							3.162
771102	.207	.08031	.101	.09540	16.196	.00000	
771104.5							3.146
771107	.196	.08082	.088	.07417	16.211	.00588	
771109.5							3.180
771112	.178	.09974	.078	.07826	16.227	.00767	
771114.5							3.184
771117	.154	.08491	.071	.05933	16.243	.00588	
771119.5							3.112
771122	.131	.07110	.063	.06496	16.259	.00614	
771124.5							3.002
771127	.111	.07673	.053	.08056	16.274	.00639	
771129.5							2.888
771202	.096	.06343	.041	.06522	16.288	.00000	
771204.5							2.900
771207	.081	.07647	.032	.05857	16.303	.00537	
771209.5							3.054
771212	.063	.06880	.023	.05780	16.318	.00563	
771214.5							3.318
771217	.038	.07826	.009	.07622	16.334	.00563	
771219.5							3.498
771222	.004	.34450	-.009	.20844	16.352	.00000	
771224.5							3.528
771227	-.027	.86215	-.023	.60026	16.370	.00000	
771229.5							3.396
780101	-.053	.55473	-.024	.16036	16.387	.00000	
780103.5							3.148
780106	-.068	.23504	-.008	.17980	16.402	.01688	
780108.5							2.900
780111	-.074	.17059	.010	.11790	16.417	.01049	
780113.5							2.828
780116	-.076	.12941	.024	.19386	16.431	.01330	
780118.5							2.870
780121	-.083	.12506	.034	.19565	16.445	.00844	
780123.5							3.038
780126	-.097	.08159	.039	.09949	16.461	.00000	
780128.5							3.246
780131	-.119	.15652	.040	.24143	16.477	.00000	
780133.5							3.426
780205	-.152	.82916	.046	.63529	16.494	.00000	
780207.5							3.540
780210	-.183	.00000	.059	.00000	16.512	.00000	
780212.5							3.566
780215	-.198	.50742	.078	.51969	16.529	.00000	
780217.5							3.506
780220	-.195	.53223	.096	.24143	16.547	.04245	
780222.5							3.434
780225	-.184	1.60690	.109	.48670	16.564	.09846	
780227.5							3.520
780302	-.185	.78184	.122	.32583	16.582	.00000	
780304.5							3.604
780307	-.203	.63734	.138	.29284	16.600	.05038	
780309.5							3.586
780312	-.223	.63120	.157	.21253	16.618	.02992	
780314.5							3.470
780317	-.239	.55473	.178	.16164	16.635	.01662	
780319.5							3.340
780322	-.241	.53223	.199	.17545	16.652	.01253	
780324.5							3.294
780327	-.236	.51355	.217	.17417	16.668	.00000	
780329.5							3.292
780401	-.225	.14118	.234	.08107	16.685	.00000	
780403.5							3.324
780406	-.215	.09412	.249	.06343	16.701	.00767	
780408.5							3.356
780411	-.208	.10921	.267	.07008	16.718	.01074	
780413.5							3.374
780416	-.204	.09923	.288	.05703	16.735	.01049	
780418.5							3.400
780421	-.199	.10614	.311	.06471	16.752	.00972	
780423.5							3.396

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
780426	-.192	.10051	.334	.07928	16.769	.00972	
780428.5							3.364
780501	-.179	.12813	.352	.10256	16.786	.00000	
780503.5							3.278
780506	-.166	.10077	.366	.06547	16.802	.00895	
780508.5							3.176
780511	-.153	.08747	.379	.05473	16.818	.00895	
780513.5							3.156
780516	-.145	.09028	.392	.05473	16.834	.00895	
780518.5							3.158
780521	-.137	.12251	.409	.07519	16.850	.00895	
780523.5							3.094
780526	-.124	.10486	.430	.07366	16.865	.00921	
780528.5							2.920
780531	-.104	.16471	.451	.18824	16.880	.00000	
780533.5							2.694
780605	-.084	.10716	.465	.11151	16.893	.00767	
780607.5							2.460
780610	-.071	.09079	.469	.07622	16.905	.00767	
780612.5							2.260
780615	-.060	.09489	.470	.06471	16.917	.00793	
780617.5							2.076
780620	-.045	.17954	.473	.11304	16.927	.00921	
780622.5							1.918
780625	-.029	.11253	.479	.10051	16.937	.00972	
780627.5							1.802
780630	-.014	.33836	.484	.21049	16.946	.00000	
780632.5							1.810
780705	.002	.10921	.489	.17621	16.955	.00767	
780707.5							1.908
780710	.020	.16803	.494	.16522	16.964	.00895	
780712.5							1.942
780715	.037	.16138	.498	.14987	16.974	.00972	
780717.5							1.896
780720	.055	.47033	.497	.21662	16.983	.00000	
780722.5							1.820
780725	.073	.19540	.490	.10614	16.993	.01049	
780727.5							1.764
780730	.087	.13683	.480	.15831	17.001	.00997	
780732.5							1.818
780804	.098	.10332	.471	.13785	17.010	.00000	
780806.5							1.982
780809	.110	.10051	.464	.10614	17.020	.00537	
780811.5							2.220
780814	.122	.10486	.458	.07826	17.031	.00614	
780816.5							2.418
780819	.135	.08286	.450	.07008	17.044	.00614	
780821.5							2.534
780824	.146	.07084	.441	.06675	17.056	.00588	
780826.5							2.564
780829	.157	.12379	.431	.10358	17.069	.00665	
780831.5							2.540
780903	.167	.14706	.421	.18568	17.082	.00000	
780905.5							2.524
780908	.177	.14859	.411	.16675	17.094	.00665	
780910.5							2.540
780913	.189	.13095	.400	.13811	17.107	.00716	
780915.5							2.590
780918	.198	.12302	.388	.09105	17.120	.00742	
780920.5							2.734
780923	.205	.06854	.377	.06292	17.134	.00742	
780925.5							2.940
780928	.208	.08235	.365	.07136	17.148	.00793	
780930.5							3.110
781003	.212	.08133	.350	.07238	17.164	.00000	
781005.5							3.166
781008	.216	.06624	.332	.06215	17.180	.00614	
781010.5							3.126
781013	.221	.06931	.315	.05831	17.195	.00563	
781015.5							3.076
781018	.224	.07673	.300	.06829	17.211	.00614	
781020.5							3.044

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
781023	.224	.12890	.282	.19488	17.226	.00972	
781025.5							2.984
781028	.224	.11483	.262	.11662	17.241	.00895	
781030.5							2.988
781102	.223	.11535	.242	.12737	17.256	.00000	
781104.5							3.016
781107	.223	.17315	.224	.14885	17.271	.01049	
781109.5							3.052
781112	.218	.12379	.210	.09233	17.286	.00972	
781114.5							3.086
781117	.208	.11176	.198	.09156	17.302	.00844	
781119.5							3.132
781122	.196	.11151	.187	.13555	17.317	.01049	
781124.5							3.180
781127	.183	.13887	.172	.13555	17.333	.01023	
781129.5							3.220
781202	.173	.44348	.155	.24143	17.349	.00000	
781204.5							3.178
781207	.167	.11202	.137	.09335	17.365	.01458	
781209.5							3.086
781212	.164	.11662	.120	.11176	17.381	.01509	
781214.5							3.050
781217	.159	.15550	.107	.15396	17.396	.01714	
781219.5							3.040
781222	.149	.09233	.098	.07954	17.411	.01688	
781224.5							3.024
781227	.136	.51355	.094	.33427	17.426	.02813	
781229.5							3.030
790101	.124	.07340	.089	.06215	17.441	.00000	
790103.5							3.082
790106	.113	.08261	.080	.08977	17.457	.00563	
790108.5							3.138
790111	.103	.05089	.068	.05703	17.472	.00512	
790113.5							3.116
790116	.093	.46419	.058	.76317	17.488	.04245	
790118.5							2.970
790121	.077	.11100	.053	.17008	17.503	.01023	
790123.5							2.744
790126	.059	.09437	.052	.07749	17.517	.00588	
790128.5							2.524
790131	.040	.05524	.055	.04450	17.529	.00000	
790133.5							2.530
790205	.023	.04066	.060	.03683	17.542	.00332	
790207.5							2.732
790210	.008	.04834	.064	.04118	17.555	.00358	
790212.5							2.894
790215	-.004	.05268	.064	.05550	17.570	.00512	
790217.5							2.966
790220	-.017	.13376	.065	.07187	17.585	.00409	
790222.5							3.056
790225	-.028	.05499	.069	.05550	17.600	.00435	
790227.5							3.158
790302	-.039	.13299	.074	.11662	17.616	.00000	
790304.5							3.190
790307	-.046	.06368	.077	.04629	17.632	.00588	
790309.5							3.162
790312	-.052	.05908	.081	.05064	17.648	.00716	
790314.5							3.176
790317	-.061	.10844	.086	.06266	17.663	.00716	
790319.5							3.220
790322	-.073	.04987	.096	.03760	17.680	.00639	
790324.5							3.122
790327	-.086	.05089	.108	.04987	17.695	.00665	
790329.5							2.936
790401	-.096	.06880	.123	.08568	17.710	.00000	
790403.5							2.906
790406	-.102	.05345	.135	.04322	17.724	.00512	
790408.5							3.066
790411	-.106	.04808	.144	.04808	17.740	.00537	
790413.5							3.240
790416	-.109	.04041	.155	.03683	17.756	.00486	
790418.5							3.242

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
790421	-.110	.03223	.169	.02813	17.772	.00460	
790423.5							3.042
790426	-.115	.04476	.188	.04859	17.787	.00512	
790428.5							2.556
790501	-.145	.04706	.204	.06471	17.800	.00000	
790503.5							2.712
790506	-.150	.07417	.216	.05013	17.814	.00435	
790508.5							2.826
790511	-.152	.04322	.226	.03836	17.828	.00332	
790513.5							2.950
790516	-.152	.03555	.235	.02890	17.843	.00332	
790518.5							2.910
790521	-.152	.03376	.245	.03504	17.857	.00358	
790523.5							2.672
790526	-.152	.04194	.256	.03836	17.871	.00358	
790528.5							2.336
790531	-.149	.03402	.268	.03529	17.882	.00000	
790533.5							2.136
790605	-.146	.07059	.280	.04425	17.893	.00332	
790607.5							2.132
790610	-.143	.06112	.290	.03836	17.904	.00307	
790612.5							2.206
790615	-.137	.04450	.301	.03632	17.915	.00307	
790617.5							2.276
790620	-.130	.07800	.313	.03939	17.926	.00358	
790622.5							2.286
790625	-.121	.03274	.323	.03632	17.937	.00332	
790627.5							2.252
790630	-.112	.04757	.332	.05371	17.949	.00000	
790632.5							2.224
790705	-.105	.05601	.343	.04245	17.960	.00435	
790707.5							2.186
790710	-.101	.06598	.356	.05038	17.971	.00435	
790712.5							2.070
790715	-.096	.04527	.369	.04655	17.981	.00384	
790717.5							1.894
790720	-.087	.05627	.376	.07161	17.990	.00486	
790722.5							1.786
790725	-.073	.05141	.380	.04041	17.999	.00435	
790727.5							1.814
790730	-.058	.06138	.385	.03887	18.008	.00460	
790732.5							1.986
790804	-.041	.06189	.392	.05396	18.018	.00000	
790806.5							2.152
790809	-.021	.07238	.399	.06752	18.029	.00895	
790811.5							2.234
790814	-.004	.06880	.404	.06061	18.040	.00460	
790816.5							2.234
790819	.007	.09105	.409	.08517	18.052	.00537	
790821.5							2.182
790824	.016	.04910	.415	.04629	18.062	.00409	
790826.5							2.078
790829	.024	.23095	.419	.09489	18.073	.00000	
790831.5							2.038
790903	.035	.29488	.422	.10102	18.083	.00000	
790905.5							2.104
790908	.046	.06343	.423	.04552	18.094	.00563	
790910.5							2.256
790913	.057	.04450	.422	.03223	18.105	.00460	
790915.5							2.394
790918	.069	.03146	.420	.02558	18.117	.00435	
790920.5							2.464
790923	.080	.05575	.415	.03248	18.129	.00384	
790925.5							2.524
790928	.090	.04348	.408	.02992	18.142	.00000	
790930.5							2.598
791003	.098	.04706	.399	.02941	18.155	.00000	
791005.5							2.694
791008	.102	.04220	.392	.02327	18.168	.00435	
791010.5							2.790
791013	.105	.06880	.388	.02992	18.182	.00460	
791015.5							2.848

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
791018	.110	.02839	.386	.01893	18.196	.00358	2.824
791020.5							
791023	.117	.02916	.381	.01662	18.210	.00332	2.692
791025.5							
791028	.126	.03760	.372	.02378	18.224	.00358	2.528
791030.5							
791102	.135	.03146	.358	.02020	18.237	.00000	2.454
791104.5							
791107	.142	.03529	.348	.02148	18.249	.00281	2.480
791109.5							
791112	.144	.05882	.343	.03044	18.261	.00384	2.526
791114.5							
791117	.142	.03734	.338	.02174	18.274	.00307	2.560
791119.5							
791122	.139	.03606	.331	.02174	18.287	.00332	2.578
791124.5							
791127	.140	.02634	.319	.02404	18.300	.00281	2.618
791129.5							
791202	.143	.02558	.305	.02097	18.313	.00000	2.650
791204.5							
791207	.145	.02506	.294	.01867	18.326	.00230	2.660
791209.5							
791212	.143	.02481	.287	.01816	18.339	.00256	2.624
791214.5							
791217	.140	.03504	.279	.02148	18.352	.00281	2.546
791219.5							
791222	.138	.04425	.270	.01969	18.365	.00332	2.494
791224.5							
791227	.140	.04757	.260	.03887	18.378	.00358	2.526
791229.5							
800101	.147	.04501	.249	.02890	18.390	.00000	2.606
800103.5							
800106	.145	.03683	.243	.02072	18.403	.00332	2.600
800108.5							
800111	.138	.02455	.236	.01790	18.416	.00307	2.620
800113.5							
800116	.130	.02609	.228	.01586	18.429	.00332	2.700
800118.5							
800121	.123	.02813	.220	.01739	18.443	.00332	2.480
800123.5							
800126	.118	.03044	.214	.01662	18.455	.00332	2.364
800128.5							
800131	.113	.02609	.206	.01432	18.467	.00000	2.116
800133.5							
800205	.104	.03044	.201	.01432	18.478	.00230	2.240
800207.5							
800210	.089	.02583	.195	.01330	18.489	.00230	2.240
800212.5							
800215	.083	.02941	.188	.01407	18.500	.00230	2.660
800217.5							
800220	.076	.02762	.188	.01355	18.513	.00256	2.640
800222.5							
800225	.069	.02404	.183	.01739	18.527	.00230	2.608
800227.5							
800301	.069	.02813	.177	.01637	18.540	.00000	2.272
800303.5							
800306	.064	.02200	.178	.01432	18.551	.00205	2.260
800308.5							
800311	.057	.02148	.179	.01228	18.562	.00205	2.420
800313.5							
800316	.048	.01790	.179	.01279	18.574	.00205	2.600
800318.5							
800321	.035	.02174	.180	.01279	18.587	.00205	2.660
800323.5							
800326	.030	.03069	.183	.01944	18.601	.00230	2.712
800328.5							
800331	.020	.03555	.185	.01867	18.614	.00000	2.668
800333.5							
800405	.012	.02200	.188	.01790	18.628	.00230	2.740
800407.5							
800410	.003	.01918	.193	.01125	18.641	.00256	2.560
800412.5							

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
800415	-.009	.02430	.199	.01458	18.654	.00256	
800417.5							2.580
800420	-.014	.02148	.204	.01637	18.667	.00230	
800422.5							2.640
800425	-.029	.02506	.208	.02353	18.680	.00256	
800427.5							2.566
800430	-.033	.04041	.214	.02506	18.693	.00000	
800432.5							2.474
800505	-.035	.02609	.215	.02404	18.705	.00230	
800507.5							2.620
800510	-.037	.02685	.222	.01509	18.718	.00256	
800512.5							2.520
800515	-.048	.03044	.230	.01969	18.731	.00281	
800517.5							2.320
800520	-.041	.02532	.231	.01739	18.743	.00230	
800522.5							2.320
800525	-.049	.03529	.239	.02046	18.754	.00256	
800527.5							2.192
800530	-.047	.02737	.245	.01944	18.765	.00000	
800532.5							1.908
800604	-.050	.01841	.249	.01483	18.775	.00153	
800606.5							2.040
800609	-.051	.02097	.255	.01560	18.785	.00179	
800611.5							2.040
800614	-.050	.02404	.258	.02123	18.795	.00230	
800616.5							1.960
800619	-.048	.01790	.263	.01688	18.805	.00179	
800621.5							1.900
800624	-.040	.02404	.268	.02072	18.814	.00205	
800626.5							1.622
800629	-.057	.04194	.281	.03018	18.823	.00000	
800631.5							1.438
800704	-.048	.02711	.287	.02251	18.830	.00256	
800706.5							1.740
800709	-.047	.02123	.291	.01662	18.838	.00256	
800711.5							1.620
800714	-.036	.02583	.293	.02072	18.847	.00281	
800716.5							1.560
800719	-.034	.02558	.299	.01790	18.854	.00281	
800721.5							1.640
800724	-.031	.02378	.304	.01867	18.862	.00256	
800726.5							1.680
800729	-.028	.03171	.311	.02327	18.871	.00281	
800731.5							1.656
800803	-.030	.01841	.311	.01509	18.879	.00000	
800805.5							1.584
800808	-.033	.01893	.315	.01432	18.887	.00128	
800810.5							1.620
800813	-.028	.01483	.317	.01151	18.895	.00128	
800815.5							1.680
800818	-.025	.01483	.319	.01279	18.904	.00128	
800820.5							1.820
800823	-.023	.01714	.324	.01458	18.913	.00128	
800825.5							1.900
800828	-.022	.01893	.328	.01330	18.922	.00153	
800830.5							2.012
800902	-.023	.02020	.329	.01381	18.932	.00000	
800904.5							2.288
800907	-.023	.01893	.331	.01432	18.944	.00153	
800909.5							2.280
800912	-.021	.01867	.334	.01202	18.955	.00153	
800914.5							2.340
800917	-.021	.01918	.338	.01355	18.967	.00153	
800919.5							2.300
800922	-.023	.01918	.341	.01560	18.978	.00153	
800924.5							2.420
800927	-.020	.01611	.345	.01381	18.990	.00128	
800929.5							2.430
801002	-.015	.02404	.344	.01637	19.003	.00000	
801004.5							2.450
801007	-.013	.02072	.347	.01407	19.015	.00153	
801009.5							2.480

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
801012	-.011	.01611	.352	.01304	19.027	.00153	
801014.5							2.620
801017	-.008	.01816	.357	.01534	19.040	.00153	
801019.5							2.580
801022	-.004	.01637	.360	.01177	19.053	.00153	
801024.5							2.700
801027	-.001	.02123	.361	.01483	19.067	.00179	
801029.5							2.794
801101	.002	.01816	.363	.01330	19.081	.00000	
801103.5							2.846
801106	.005	.01714	.364	.01100	19.095	.00128	
801108.5							2.380
801111	.010	.01944	.368	.01509	19.107	.00179	
801113.5							2.380
801116	.019	.02302	.369	.01662	19.119	.00153	
801118.5							2.460
801121	.027	.01867	.370	.01228	19.131	.00153	
801123.5							2.440
801126	.034	.02148	.371	.01279	19.143	.00153	
801128.5							2.486
801201	.038	.02916	.370	.01765	19.156	.00000	
801203.5							2.834
801206	.047	.02404	.371	.01637	19.170	.00179	
801208.5							2.420
801211	.052	.02148	.372	.01355	19.182	.00179	
801213.5							2.380
801216	.057	.02353	.370	.01714	19.194	.00179	
801218.5							2.300
801221	.063	.02583	.367	.01816	19.205	.00205	
801223.5							2.400
801226	.060	.05703	.368	.03453	19.217	.00256	
801228.5							2.436
801231	.075	.02609	.356	.02072	19.229	.00000	
801233.5							2.444
810105	.081	.03529	.352	.02506	19.242	.00230	
810107.5							2.300
810110	.085	.05166	.353	.04220	19.253	.00281	
810112.5							2.480
810115	.083	.03453	.349	.02072	19.266	.00230	
810117.5							2.560
810120	.087	.05243	.344	.03862	19.278	.00307	
810122.5							2.400
810125	.083	.03887	.340	.02302	19.290	.00205	
810127.5							2.230
810130	.090	.03146	.333	.02097	19.302	.00000	
810132.5							1.970
810204	.094	.03044	.329	.01637	19.311	.00205	
810206.5							2.180
810209	.100	.07136	.326	.03504	19.322	.00358	
810211.5							2.200
810214	.097	.03478	.322	.02430	19.333	.00230	
810216.5							2.280
810219	.094	.02609	.323	.02685	19.345	.00205	
810221.5							2.240
810224	.092	.03504	.311	.01867	19.356	.00230	
810226.5							2.696
810301	.089	.02020	.311	.01330	19.369	.00000	
810303.5							2.764
810306	.093	.01688	.308	.00997	19.383	.00179	
810308.5							3.020
810311	.095	.01483	.305	.00946	19.398	.00179	
810313.5							2.880
810316	.096	.01688	.301	.00997	19.413	.00179	
810318.5							2.660
810321	.100	.01688	.296	.01202	19.426	.00179	
810323.5							2.520
810326	.105	.02097	.292	.01688	19.439	.00179	
810328.5							2.496
810331	.110	.02941	.290	.01688	19.451	.00000	
810333.5							2.264
810405	.108	.02455	.283	.01662	19.462	.00205	
810407.5							2.600

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
810410	.108	.01534	.279	.01177	19.475	.00179	
810412.5							2.820
810415	.104	.01611	.270	.01407	19.490	.00205	
810417.5							3.000
810420	.103	.02148	.265	.01586	19.504	.00205	
810422.5							2.900
810425	.099	.02404	.263	.01355	19.519	.00205	
810427.5							2.390
810430	.098	.02123	.263	.01407	19.531	.00000	
810432.5							2.270
810505	.102	.02506	.255	.01534	19.542	.00179	
810507.5							2.420
810510	.100	.02302	.253	.01330	19.554	.00179	
810512.5							2.240
810515	.101	.02378	.250	.01534	19.566	.00179	
810517.5							2.400
810520	.098	.02916	.247	.01458	19.578	.00179	
810522.5							2.520
810525	.103	.08286	.238	.04834	19.590	.00256	
810527.5							2.354
810530	.092	.04527	.243	.04476	19.602	.00000	
810532.5							2.346
810604	.092	.02046	.231	.01637	19.614	.00205	
810606.5							2.140
810609	.089	.02378	.229	.01304	19.624	.00230	
810611.5							2.040
810614	.082	.01918	.227	.01432	19.635	.00230	
810616.5							1.880
810619	.081	.01739	.220	.01279	19.644	.00205	
810621.5							1.740
810624	.079	.02072	.217	.01279	19.653	.00230	
810626.5							1.440
810629	.074	.01918	.212	.01432	19.660	.00000	
810631.5							.960
810704	.069	.02225	.208	.01560	19.665	.00153	
810706.5							1.300
810709	.068	.01662	.203	.01228	19.671	.00153	
810711.5							1.140
810714	.068	.01867	.196	.01228	19.677	.00153	
810716.5							1.160
810719	.067	.01944	.191	.01330	19.683	.00153	
810721.5							1.340
810724	.061	.02174	.191	.01662	19.689	.00153	
810726.5							1.540
810729	.057	.01611	.188	.01279	19.697	.00153	
810731.5							1.588
810803	.044	.02762	.185	.02634	19.705	.00000	
810805.5							1.652
810808	.039	.02072	.185	.02097	19.713	.00153	
810810.5							1.720
810813	.028	.01969	.183	.01560	19.722	.00179	
810815.5							1.500
810818	.022	.01611	.183	.01304	19.729	.00153	
810820.5							1.520
810823	.013	.01611	.182	.01279	19.737	.00153	
810825.5							1.520
810828	.008	.01611	.182	.01355	19.745	.00179	
810830.5							1.502
810902	-.001	.02302	.188	.01125	19.752	.00000	
810904.5							1.778
810907	-.009	.02251	.190	.01714	19.761	.00153	
810909.5							1.680
810912	-.017	.01714	.193	.01228	19.769	.00153	
810914.5							1.900
810917	-.026	.01381	.194	.01023	19.779	.00153	
810919.5							2.200
810922	-.033	.01509	.200	.01151	19.790	.00153	
810924.5							2.320
810927	-.044	.01355	.205	.01023	19.802	.00153	
810929.5							2.274
811002	-.057	.02200	.210	.01586	19.813	.00000	
811004.5							2.146

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
811007	-.066	.01688	.214	.00997	19.824	.00128	
811009.5							2.220
811012	-.071	.01893	.220	.01228	19.835	.00153	
811014.5							2.400
811017	-.074	.01739	.228	.01125	19.847	.00153	
811019.5							2.440
811022	-.081	.01432	.238	.00946	19.859	.00128	
811024.5							2.460
811027	-.090	.03632	.248	.02148	19.871	.00230	
811029.5							2.406
811101	-.093	.02404	.253	.01816	19.883	.00000	
811103.5							2.294
811106	-.096	.01790	.264	.01560	19.895	.00153	
811108.5							2.220
811111	-.102	.01969	.268	.01125	19.906	.00179	
811113.5							2.340
811116	-.105	.02481	.279	.01560	19.917	.00205	
811118.5							2.180
811121	-.102	.02813	.287	.01355	19.928	.00205	
811123.5							2.200
811126	-.102	.04731	.297	.02276	19.939	.00281	
811128.5							2.114
811201	-.102	.04373	.311	.01432	19.950	.00000	
811203.5							2.266
811206	-.106	.03657	.318	.01560	19.961	.00230	
811208.5							2.300
811211	-.107	.05064	.332	.02200	19.973	.00281	
811213.5							2.280
811216	-.101	.02685	.343	.01279	19.984	.00256	
811218.5							2.340
811221	-.100	.02813	.353	.01279	19.996	.00256	
811223.5							2.120
811226	-.094	.03146	.361	.01765	20.007	.00281	
811228.5							2.090
811231	-.089	.02046	.374	.01228	20.017	.00000	
811233.5							2.070
820105	-.079	.01586	.383	.01100	20.027	.00128	
820107.5							2.140
820110	-.066	.02276	.391	.01100	20.038	.00153	
820112.5							2.140
820115	-.055	.02839	.398	.01407	20.049	.00153	
820117.5							2.020
820120	-.048	.05166	.403	.02378	20.059	.00332	
820122.5							1.980
820125	-.038	.03887	.411	.01816	20.069	.00230	
820127.5							1.914
820130	-.034	.02941	.421	.01253	20.078	.00000	
820132.5							1.906
820204	-.027	.01893	.426	.00972	20.088	.00153	
820206.5							2.080
820209	-.017	.02430	.431	.01458	20.098	.00179	
820211.5							2.120
820214	.002	.03248	.429	.01739	20.109	.00205	
820216.5							2.320
820219	.009	.01893	.435	.01100	20.120	.00153	
820221.5							2.240
820224	.021	.02404	.437	.01483	20.132	.00179	
820226.5							2.676
820301	.038	.02506	.442	.01381	20.145	.00000	
820303.5							2.624
820306	.048	.01816	.442	.01074	20.158	.00153	
820308.5							2.360
820311	.064	.02455	.439	.01202	20.170	.00179	
820313.5							2.320
820316	.070	.02609	.438	.01432	20.181	.00179	
820318.5							2.320
820321	.089	.03350	.431	.01611	20.193	.00230	
820323.5							2.420
820326	.097	.02430	.428	.02200	20.205	.00230	
820328.5							2.640
820331	.112	.02378	.430	.01407	20.218	.00000	
820333.5							2.680

Date YYMMDD	x (")	x sigma (")	y (")	y sigma (")	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
820405	.125	.03913	.428	.01816	20.232	.00256	
820407.5							2.700
820410	.134	.02634	.420	.01586	20.245	.00205	
820412.5							2.700
820415	.139	.01790	.415	.01074	20.259	.00153	
820417.5							2.500
820420	.150	.03146	.409	.03095	20.271	.00256	
820422.5							2.720
820425	.162	.02276	.401	.02148	20.285	.00179	
820427.5							2.374
820430	.163	.03120	.384	.03146	20.297	.00000	
820432.5							2.266
820505	.178	.01151	.384	.01049	20.308	.00230	
820507.5							2.460
820510	.182	.01867	.374	.01228	20.320	.00256	
820512.5							2.140
820515	.190	.01202	.361	.00946	20.331	.00230	
820517.5							2.100
820520	.201	.01100	.348	.00921	20.342	.00230	
820522.5							2.180
820525	.207	.01253	.337	.00921	20.353	.00230	
820527.5							1.980
820530	.213	.06010	.324	.03453	20.362	.00000	
820532.5							1.960
820604	.216	.01586	.314	.01279	20.372	.00205	
820606.5							2.120
820609	.227	.01202	.298	.01407	20.383	.00205	
820611.5							1.940
820614	.233	.01381	.283	.01407	20.392	.00205	
820616.5							1.880
820619	.236	.01841	.266	.01509	20.402	.00205	
820621.5							1.780
820624	.237	.01228	.254	.00921	20.411	.00205	
820626.5							1.690
820629	.233	.01483	.243	.01739	20.419	.00000	
820631.5							1.310
820704	.231	.01458	.229	.01125	20.426	.00102	
820706.5							1.440
820709	.227	.00972	.215	.00767	20.433	.00102	
820711.5							1.420
820714	.227	.01023	.198	.00716	20.440	.00102	
820716.5							1.420
820719	.219	.01509	.187	.01074	20.447	.00128	
820721.5							1.360
820724	.213	.01611	.173	.01023	20.454	.00128	
820726.5							1.420
820729	.206	.01304	.161	.00921	20.461	.00102	
820731.5							1.336
820803	.199	.01432	.149	.01125	20.468	.00000	
820805.5							1.144
820808	.194	.01611	.138	.01125	20.473	.00102	
820810.5							1.360
820813	.188	.01381	.125	.00972	20.480	.00102	
820815.5							1.640
820818	.174	.01586	.115	.00946	20.489	.00102	
820820.5							1.760
820823	.162	.02097	.105	.01151	20.497	.00128	
820825.5							1.920
820828	.148	.01458	.097	.01074	20.507	.00128	
820830.5							2.168
820902	.133	.01381	.089	.00946	20.518	.00000	
820904.5							2.232
820907	.119	.01534	.083	.00972	20.529	.00128	
820909.5							2.300
820912	.100	.01202	.079	.00895	20.540	.00128	
820914.5							2.160
820917	.088	.01330	.073	.01023	20.551	.00128	
820919.5							2.300
820922	.070	.01151	.068	.00870	20.563	.00128	
820924.5							2.300
820927	.049	.01330	.067	.00870	20.574	.00128	
820929.5							2.326

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
821002	.034	.01023	.069	.00742	20.586	.00000	
821004.5							2.434
821007	.014	.01151	.069	.00742	20.598	.00102	
821009.5							2.280
821012	-.002	.01304	.071	.00793	20.609	.00128	
821014.5							2.280
821017	-.021	.01432	.076	.00742	20.621	.00128	
821019.5							2.220
821022	-.036	.01100	.078	.00716	20.632	.00102	
821024.5							2.200
821027	-.050	.01330	.082	.00716	20.643	.00128	
821029.5							2.196
821101	-.068	.01228	.087	.00972	20.654	.00000	
821103.5							2.544
821106	-.078	.01355	.096	.00870	20.667	.00128	
821108.5							2.420
821111	-.098	.01355	.104	.01304	20.679	.00153	
821113.5							2.520
821116	-.111	.01969	.118	.01125	20.691	.00179	
821118.5							2.520
821121	-.125	.02865	.130	.01509	20.704	.00205	
821123.5							2.440
821126	-.143	.02481	.141	.01304	20.716	.00205	
821128.5							2.446
821201	-.147	.01739	.150	.01100	20.728	.00000	
821203.5							2.714
821206	-.163	.01688	.164	.01151	20.742	.00128	
821208.5							2.480
821211	-.170	.01483	.182	.01074	20.754	.00128	
821213.5							2.500
821216	-.182	.01228	.203	.00793	20.767	.00128	
821218.5							2.540
821221	-.188	.01765	.224	.01253	20.779	.00153	
821223.5							2.500
821226	-.193	.02634	.242	.01995	20.792	.00153	
821228.5							2.542
821231	-.193	.01560	.253	.01074	20.805	.00000	
821233.5							2.558
830105	-.197	.01023	.269	.00691	20.817	.00102	
830107.5							2.500
830110	-.202	.01304	.286	.00716	20.830	.00128	
830112.5							2.620
830115	-.203	.01202	.302	.00895	20.843	.00102	
830117.5							2.900
830120	-.201	.01228	.323	.01100	20.858	.00102	
830122.5							3.200
830125	-.194	.01509	.340	.00972	20.874	.00128	
830127.5							2.836
830130	-.187	.01688	.356	.01355	20.888	.00000	
830132.5							2.904
830204	-.184	.01151	.379	.00997	20.902	.00102	
830206.5							3.040
830209	-.177	.01586	.394	.00997	20.917	.00128	
830211.5							2.920
830214	-.173	.01330	.409	.01483	20.932	.00128	
830216.5							2.780
830219	-.168	.01125	.426	.01074	20.946	.00102	
830221.5							2.900
830224	-.161	.01381	.444	.00946	20.961	.00128	
830226.5							3.054
830301	-.153	.01637	.456	.00946	20.976	.00000	
830303.5							3.026
830306	-.145	.01355	.470	.01049	20.991	.00128	
830308.5							2.820
830311	-.132	.01304	.488	.00921	21.005	.00128	
830313.5							2.940
830316	-.121	.01151	.500	.00793	21.020	.00102	
830318.5							2.940
830321	-.105	.01253	.513	.00895	21.034	.00102	
830323.5							2.920
830326	-.084	.01279	.526	.01100	21.049	.00128	
830328.5							2.986

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
830331	-.061	.01151	.533	.00818	21.064	.00000	
830333.5							3.334
830405	-.042	.01458	.543	.01330	21.081	.00102	
830407.5							2.900
830410	-.020	.01100	.550	.00921	21.095	.00077	
830412.5							2.760
830415	.002	.00997	.555	.00793	21.109	.00077	
830417.5							2.800
830420	.021	.01534	.561	.00972	21.123	.00102	
830422.5							2.720
830425	.040	.01534	.561	.00946	21.136	.00102	
830427.5							2.586
830430	.066	.01586	.547	.02813	21.149	.00000	
830432.5							2.194
830505	.082	.01100	.554	.01483	21.160	.00102	
830507.5							2.320
830510	.100	.01151	.550	.01177	21.172	.00102	
830512.5							2.460
830515	.120	.01202	.545	.01100	21.184	.00102	
830517.5							2.500
830520	.142	.01177	.542	.01202	21.197	.00102	
830522.5							2.280
830525	.164	.01253	.538	.01381	21.208	.00102	
830527.5							2.478
830530	.183	.01560	.514	.01432	21.221	.00000	
830532.5							2.382
830604	.196	.01279	.505	.01074	21.233	.00077	
830606.5							2.100
830609	.210	.01355	.494	.01100	21.243	.00102	
830611.5							2.120
830614	.226	.01330	.482	.01100	21.254	.00102	
830616.5							2.060
830619	.242	.01228	.468	.01202	21.264	.00077	
830621.5							1.940
830624	.258	.01074	.455	.00972	21.274	.00077	
830626.5							1.706
830629	.267	.01611	.431	.01790	21.282	.00000	
830631.5							1.594
830704	.279	.02174	.411	.01355	21.290	.00102	
830706.5							1.340
830709	.290	.05371	.393	.02123	21.297	.00153	
830711.5							1.180
830714	.299	.01100	.370	.01049	21.303	.00102	
830716.5							1.340
830719	.311	.01407	.351	.01125	21.309	.00102	
830721.5							1.480
830724	.319	.01100	.333	.00997	21.317	.00102	
830726.5							1.480
830729	.326	.01023	.313	.00946	21.324	.00102	
830731.5							1.556
830803	.328	.01125	.293	.00997	21.332	.00000	
830805.5							1.524
830808	.330	.01074	.272	.00895	21.340	.00077	
830810.5							1.660
830813	.330	.01151	.249	.00997	21.348	.00077	
830815.5							1.680
830818	.327	.00972	.230	.00972	21.356	.00077	
830820.5							1.720
830823	.321	.01611	.206	.01458	21.365	.00102	
830825.5							1.720
830828	.316	.01534	.186	.01432	21.374	.00128	
830830.5							1.694
830902	.304	.01151	.167	.01228	21.382	.00000	
830904.5							1.606
830907	.294	.00767	.146	.00844	21.390	.00077	
830909.5							1.740
830912	.280	.00921	.128	.00946	21.399	.00102	
830914.5							1.800
830917	.268	.00716	.111	.00767	21.408	.00077	
830919.5							1.780
830922	.253	.00716	.094	.00716	21.417	.00077	
830924.5							1.860

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
830927	.236	.00870	.077	.00946	21.426	.00102	
830929.5							2.270
831002	.217	.00997	.063	.01100	21.437	.00000	
831004.5							2.230
831007	.202	.00639	.051	.00742	21.448	.00077	
831009.5							2.180
831012	.183	.00691	.040	.00742	21.459	.00102	
831014.5							2.060
831017	.164	.00742	.033	.00742	21.470	.00102	
831019.5							2.000
831022	.143	.00742	.026	.00742	21.480	.00102	
831024.5							2.180
831027	.119	.00588	.018	.00614	21.490	.00102	
831029.5							2.484
831101	.098	.00793	.016	.00691	21.503	.00000	
831103.5							2.796
831106	.075	.00972	.015	.00716	21.517	.00077	
831108.5							2.500
831111	.054	.00895	.014	.00665	21.529	.00077	
831113.5							2.380
831116	.031	.00818	.016	.00767	21.541	.00077	
831118.5							2.340
831121	.010	.00793	.021	.00665	21.553	.00077	
831123.5							2.260
831126	-.010	.00946	.026	.00921	21.564	.00077	
831128.5							2.162
831201	-.031	.00767	.032	.00870	21.575	.00000	
831203.5							2.098
831206	-.051	.00716	.037	.00716	21.586	.00077	
831208.5							1.980
831211	-.067	.00844	.044	.00742	21.596	.00077	
831213.5							1.980
831216	-.082	.00895	.055	.00716	21.605	.00077	
831218.5							1.960
831221	-.097	.00895	.066	.00767	21.615	.00077	
831223.5							1.960
831226	-.110	.00870	.078	.01279	21.625	.00102	
831228.5							1.994
831231	-.122	.00563	.088	.00716	21.635	.00000	
831233.5							2.186
840105	-.135	.00588	.102	.00588	21.646	.00051	
840107.5							1.860
840110	-.149	.00665	.117	.00537	21.655	.00077	
840112.5							1.600
840115	-.160	.00563	.132	.00563	21.663	.00077	
840117.5							1.480
840120	-.171	.00588	.147	.00486	21.671	.00051	
840122.5							1.480
840125	-.184	.00563	.164	.00588	21.678	.00077	
840127.5							1.424
840130	-.195	.00767	.179	.00742	21.685	.00000	
840132.5							1.356
840204	-.204	.00921	.193	.00844	21.692	.00077	
840206.5							1.520
840209	-.211	.00563	.212	.00537	21.699	.00077	
840211.5							1.620
840214	-.219	.00665	.226	.00767	21.708	.00102	
840216.5							1.680
840219	-.224	.00588	.244	.00512	21.716	.00077	
840221.5							1.740
840224	-.230	.00793	.263	.00588	21.725	.00077	
840226.5							1.730
840229	-.235	.00588	.282	.00588	21.733	.00000	
840231.5							1.650
840305	-.237	.00844	.303	.00639	21.742	.00077	
840307.5							1.940
840310	-.238	.00639	.324	.00844	21.751	.00077	
840312.5							1.960
840315	-.231	.00639	.345	.00742	21.761	.00077	
840317.5							2.040
840320	-.224	.00614	.366	.00614	21.771	.00077	
840322.5							2.060

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
840325	-.221	.00665	.386	.00588	21.782	.00077	
840327.5							2.054
840330	-.212	.00537	.404	.00614	21.792	.00000	
840332.5							1.866
840404	-.201	.00665	.422	.00563	21.801	.00077	
840406.5							1.860
840409	-.188	.00563	.441	.00512	21.810	.00077	
840411.5							1.980
840414	-.174	.00460	.460	.00435	21.820	.00077	
840416.5							2.040
840419	-.159	.00537	.475	.00563	21.831	.00077	
840421.5							2.060
840424	-.146	.00460	.491	.00460	21.841	.00077	
840426.5							1.982
840429	-.130	.00537	.504	.00486	21.851	.00000	
840431.5							1.958
840504	-.113	.00486	.518	.00435	21.861	.00051	
840506.5							1.780
840509	-.092	.00512	.530	.00486	21.869	.00051	
840511.5							1.680
840514	-.076	.00512	.541	.00460	21.878	.00051	
840516.5							1.520
840519	-.058	.00409	.547	.00358	21.885	.00051	
840521.5							1.520
840524	-.038	.00435	.554	.00358	21.893	.00051	
840526.5							1.488
840529	-.017	.00537	.558	.00435	21.901	.00000	
840531.5							1.492
840603	.005	.00384	.561	.00358	21.908	.00051	
840605.5							1.200
840608	.027	.00537	.560	.00409	21.914	.00051	
840610.5							1.100
840613	.048	.00460	.559	.00384	21.920	.00051	
840615.5							1.080
840618	.069	.00435	.557	.00409	21.925	.00051	
840620.5							1.040
840623	.088	.00588	.554	.00639	21.930	.00051	
840625.5							1.002
840628	.108	.00409	.548	.00384	21.935	.00000	
840630.5							.838
840703	.131	.00537	.541	.00563	21.939	.00051	
840705.5							.580
840708	.152	.00486	.532	.00486	21.942	.00051	
840710.5							.620
840713	.171	.00512	.521	.00409	21.945	.00051	
840715.5							.600
840718	.191	.00563	.509	.00460	21.948	.00051	
840720.5							.720
840723	.211	.00512	.495	.00435	21.952	.00051	
840725.5							.860
840728	.230	.00563	.482	.00537	21.956	.00051	
840730.5							.892
840802	.246	.00435	.468	.00384	21.961	.00000	
840804.5							.768
840807	.262	.00460	.452	.00435	21.965	.00051	
840809.5							.960
840812	.275	.00486	.434	.00409	21.969	.00051	
840814.5							1.200
840817	.289	.00512	.417	.00435	21.975	.00051	
840819.5							1.340
840822	.298	.00435	.399	.00358	21.982	.00051	
840824.5							1.200
840827	.302	.00563	.380	.00409	21.988	.00051	
840829.5							1.398
840901	.305	.00460	.360	.00435	21.995	.00000	
840903.5							1.682
840906	.309	.00460	.344	.00384	22.003	.00051	
840908.5							1.300
840911	.312	.00460	.323	.00384	22.010	.00051	
840913.5							1.420
840916	.314	.00537	.303	.00435	22.017	.00051	
840918.5							1.560

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
840921	.317	.00486	.285	.00358	22.025	.00051	
840923.5							1.480
840926	.319	.00512	.266	.00409	22.032	.00051	
840928.5							1.568
841001	.319	.00563	.247	.00460	22.040	.00000	
841003.5							1.712
841006	.314	.00614	.228	.00460	22.049	.00051	
841008.5							1.760
841011	.305	.00639	.209	.00435	22.057	.00051	
841013.5							1.740
841016	.296	.00460	.190	.00409	22.066	.00051	
841018.5							1.640
841021	.288	.00537	.175	.00460	22.074	.00051	
841023.5							1.840
841026	.281	.00460	.160	.00435	22.083	.00051	
841028.5							1.840
841031	.269	.00460	.143	.00384	22.093	.00000	
841033.5							1.660
841105	.257	.00537	.129	.00512	22.101	.00051	
841107.5							1.680
841110	.245	.00691	.114	.00512	22.109	.00051	
841112.5							1.500
841115	.232	.00767	.101	.00512	22.117	.00051	
841117.5							1.620
841120	.220	.00563	.091	.00512	22.125	.00051	
841122.5							1.740
841125	.204	.00844	.080	.00767	22.134	.00077	
841127.5							1.692
841130	.187	.00563	.069	.00486	22.142	.00000	
841132.5							1.848
841205	.167	.00588	.056	.00486	22.151	.00051	
841207.5							1.620
841210	.147	.00639	.046	.00588	22.160	.00051	
841212.5							1.420
841215	.124	.00563	.039	.00537	22.167	.00051	
841217.5							1.320
841220	.099	.00614	.032	.00537	22.173	.00051	
841222.5							1.300
841225	.076	.01049	.027	.01100	22.180	.00128	
841227.5							1.786
841230	.058	.01355	.024	.00870	22.189	.00000	
841232.5							1.754
850104	.040	.00844	.023	.00818	22.197	.00128	
850106.5							1.680
850109	.019	.00793	.025	.00614	22.206	.00128	
850111.5							1.640
850114	0.000	.00072	.030	.00793	22.214	.00128	
850116.5							1.600
850119	-.015	.00895	.035	.00639	22.222	.00102	
850121.5							1.500
850124	-.032	.00716	.043	.00588	22.229	.00102	
850126.5							1.424
850129	-.050	.01049	.049	.00870	22.237	.00000	
850131.5							1.316
850203	-.063	.01074	.059	.00972	22.243	.00077	
850205.5							1.200
850208	-.076	.01355	.067	.00870	22.249	.00102	
850210.5							1.280
850213	-.088	.00793	.079	.00639	22.256	.00077	
850215.5							1.560
850218	-.103	.00793	.090	.00793	22.263	.00102	
850220.5							1.660
850223	-.121	.00844	.100	.00818	22.272	.00077	
850225.5							1.578
850228	-.137	.01049	.113	.00895	22.280	.00000	
850230.5							1.582
850305	-.150	.01509	.127	.00742	22.288	.00102	
850307.5							1.800
850310	-.168	.01407	.141	.00870	22.296	.00102	
850312.5							2.040
850315	-.178	.00844	.158	.00588	22.307	.00077	
850317.5							2.100

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
850320	-.186	.00793	.179	.00614	22.317	.00077	
850322.5							2.020
850325	-.191	.00946	.199	.00691	22.327	.00102	
850327.5							1.980
850330	-.192	.00895	.217	.00691	22.337	.00102	
850332.5							1.824
850404	-.196	.00742	.239	.00486	22.346	.00000	
850406.5							1.876
850409	-.194	.00716	.258	.00537	22.356	.00077	
850411.5							1.820
850414	-.191	.00665	.278	.00512	22.365	.00051	
850416.5							2.000
850419	-.188	.00691	.295	.00588	22.375	.00051	
850421.5							1.920
850424	-.186	.00639	.313	.00512	22.384	.00051	
850426.5							1.800
850429	-.188	.00588	.331	.00537	22.393	.00077	
850431.5							1.826
850504	-.182	.00691	.347	.00588	22.403	.00000	
850506.5							2.014
850509	-.174	.00665	.365	.00512	22.413	.00051	
850511.5							1.660
850514	-.164	.00588	.383	.00460	22.421	.00051	
850516.5							1.540
850519	-.153	.00639	.398	.00486	22.429	.00051	
850521.5							1.440
850524	-.138	.00614	.411	.00486	22.436	.00051	
850526.5							1.360
850529	-.124	.00767	.425	.00639	22.443	.00077	
850531.5							1.438
850603	-.110	.00793	.436	.00870	22.450	.00000	
850605.5							1.562
850608	-.100	.00563	.447	.00512	22.458	.00077	
850610.5							1.280
850613	-.090	.00512	.457	.00409	22.464	.00077	
850615.5							1.180
850618	-.078	.00563	.465	.00435	22.470	.00077	
850620.5							1.080
850623	-.064	.00563	.472	.00435	22.475	.00077	
850625.5							1.120
850628	-.049	.00537	.478	.00435	22.481	.00077	
850630.5							.878
850703	-.034	.00563	.483	.00588	22.485	.00000	
850705.5							.522
850708	-.019	.00512	.486	.00486	22.488	.00051	
850710.5							.500
850713	0.000	.00060	.490	.00060	2.490	.00051	
850715.5							.600
850718	.017	.00460	.492	.00409	22.493	.00051	
850720.5							.620
850723	.034	.00460	.495	.00460	22.497	.00051	
850725.5							.660
850728	.049	.00486	.494	.00486	22.500	.00051	
850730.5							.692
850802	.065	.00512	.494	.00435	22.503	.00000	
850804.5							.908
850807	.081	.00588	.492	.00512	22.508	.00051	
850809.5							.620
850812	.099	.00486	.488	.00486	22.511	.00051	
850814.5							.640
850817	.116	.00460	.484	.00486	22.514	.00051	
850819.5							.800
850822	.132	.00409	.481	.00435	22.518	.00051	
850824.5							.840
850827	.146	.00460	.475	.00460	22.522	.00051	
850829.5							.976
850901	.159	.00435	.465	.00512	22.527	.00000	
850903.5							1.224
850906	.173	.00435	.456	.00460	22.533	.00051	
850908.5							1.060
850911	.185	.00409	.449	.00435	22.539	.00051	
850913.5							1.120

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
850916	.195	.00435	.438	.00486	22.544	.00051	
850918.5							1.360
850921	.202	.00409	.426	.00435	22.551	.00051	
850923.5							1.420
850926	.213	.00409	.417	.00460	22.558	.00051	
850928.5							1.534
851001	.219	.00435	.403	.00486	22.566	.00000	
851003.5							1.806
851006	.223	.00486	.388	.00486	22.575	.00051	
851008.5							1.700
851011	.229	.00435	.372	.00512	22.583	.00051	
851013.5							1.800
851016	.232	.00435	.358	.00486	22.592	.00051	
851018.5							1.820
851021	.234	.00512	.343	.00512	22.601	.00051	
851023.5							1.900
851026	.234	.00665	.325	.00614	22.611	.00077	
851028.5							1.898
851031	.237	.00665	.318	.00588	22.620	.00000	
851033.5							1.962
851105	.234	.00588	.301	.00486	22.630	.00051	
851107.5							1.640
851110	.235	.00435	.289	.00460	22.638	.00051	
851112.5							1.680
851115	.235	.00486	.275	.00486	22.647	.00077	
851117.5							1.720
851120	.234	.00614	.260	.00486	22.655	.00077	
851122.5							1.760
851125	.235	.00793	.250	.00691	22.664	.00077	
851127.5							1.726
851130	.232	.00537	.240	.00818	22.673	.00000	
851132.5							1.954
851205	.226	.00486	.228	.00486	22.683	.00077	
851207.5							1.660
851210	.220	.00691	.217	.00665	22.691	.00077	
851212.5							1.580
851215	.214	.00588	.205	.00563	22.699	.00077	
851217.5							1.440
851220	.210	.00435	.195	.00409	22.706	.00077	
851222.5							1.420
851225	.203	.00793	.181	.00895	22.713	.00102	
851227.5							1.222
851230	.199	.00767	.176	.00870	22.719	.00000	
851232.5							1.198
860104	.189	.00716	.164	.00614	22.725	.00077	
860106.5							1.200
860109	.175	.00512	.155	.00409	22.731	.00077	
860111.5							1.320
860114	.165	.00435	.144	.00512	22.738	.00077	
860116.5							1.460
860119	.154	.00486	.136	.00460	22.745	.00077	
860121.5							1.460
860124	.141	.00460	.131	.00409	22.752	.00077	
860126.5							1.556
860129	.128	.00563	.125	.00486	22.760	.00000	
860131.5							1.824
860203	.113	.00818	.122	.00588	22.769	.00077	
860205.5							1.600
860208	.101	.00639	.119	.00537	22.777	.00051	
860210.5							1.540
860213	.089	.00537	.115	.00537	22.785	.00051	
860215.5							1.500
860218	.077	.00588	.113	.00614	22.792	.00077	
860220.5							1.320
860223	.063	.00614	.114	.00639	22.799	.00077	
860225.5							1.490
860228	.045	.00537	.114	.00537	22.807	.00000	
860230.5							1.370
860305	.031	.00537	.114	.00486	22.813	.00051	
860307.5							1.400
860310	.016	.00742	.117	.00716	22.820	.00077	
860312.5							1.240

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
860315	.003	.00665	.119	.00742	22.827	.00077	
860317.5							1.060
860320	-.008	.00588	.122	.00563	22.832	.00051	
860322.5							1.200
860325	-.016	.00742	.130	.00512	22.838	.00051	
860327.5							1.436
860330	-.033	.00665	.133	.00895	22.845	.00000	
860332.5							1.584
860404	-.043	.00486	.140	.00486	22.853	.00077	
860406.5							1.580
860409	-.052	.00537	.149	.00435	22.861	.00077	
860411.5							1.620
860414	-.058	.00691	.161	.00563	22.869	.00077	
860416.5							1.680
860419	-.064	.00665	.173	.00614	22.877	.00077	
860421.5							1.560
860424	-.071	.00486	.182	.00435	22.885	.00077	
860426.5							1.620
860429	-.079	.01228	.188	.00716	22.893	.00000	
860431.5							1.840
860504	-.080	.00895	.200	.00588	22.903	.00102	
860506.5							1.700
860509	-.084	.00793	.210	.00588	22.911	.00102	
860511.5							1.560
860514	-.087	.00639	.222	.00588	22.919	.00102	
860516.5							1.200
860519	-.089	.00818	.234	.00639	22.925	.00102	
860521.5							1.200
860524	-.093	.01151	.244	.00997	22.931	.00102	
860526.5							1.112
860529	-.094	.00946	.254	.00767	22.936	.00000	
860531.5							1.088
860603	-.095	.00844	.262	.00588	22.942	.00077	
860605.5							.760
860608	-.096	.00844	.275	.00588	22.946	.00077	
860610.5							.520
860613	-.092	.00870	.284	.00639	22.948	.00102	
860615.5							.460
860618	-.082	.01023	.293	.00767	22.951	.00102	
860620.5							.840
860623	-.076	.01560	.307	.01202	22.955	.00128	
860625.5							.772
860628	-.069	.01458	.316	.01100	22.959	.00000	
860630.5							.848
860703	-.065	.01177	.323	.00870	22.963	.00128	
860705.5							.800
860708	-.057	.00997	.337	.00767	22.967	.00128	
860710.5							.660
860713	-.048	.00946	.347	.00691	22.970	.00128	
860715.5							.620
860718	-.043	.00793	.352	.00588	22.973	.00128	
860720.5							.540
860723	-.031	.01202	.360	.00818	22.976	.00153	
860725.5							.660
860728	-.029	.01151	.364	.00895	22.979	.00153	
860730.5							.560
860802	-.017	.00997	.369	.00793	22.982	.00000	
860804.5							.700
860807	-.010	.00716	.374	.00665	22.986	.00077	
860809.5							.780
860812	-.004	.00844	.379	.00793	22.989	.00077	
860814.5							.760
860817	.002	.01151	.385	.01228	22.993	.00102	
860819.5							.600
860822	.011	.01049	.387	.00972	22.996	.00102	
860824.5							.740
860827	.019	.00742	.392	.00614	23.000	.00077	
860829.5							.714
860901	.028	.00844	.394	.00614	23.003	.00000	
860903.5							.806
860906	.035	.00716	.397	.00665	23.007	.00077	
860908.5							1.060

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
860911	.043	.00665	.397	.00537	23.013	.00077	
860913.5							1.080
860916	.048	.00895	.398	.00665	23.018	.00077	
860918.5							1.300
860921	.057	.00793	.396	.00844	23.025	.00077	
860923.5							1.480
860926	.061	.00691	.395	.00614	23.032	.00077	
860928.5							1.574
861001	.067	.00691	.393	.00563	23.040	.00000	
861003.5							1.786
861006	.072	.00614	.392	.00588	23.049	.00077	
861008.5							1.600
861011	.079	.00614	.392	.00537	23.057	.00077	
861013.5							1.480
861016	.086	.00563	.389	.00460	23.064	.00051	
861018.5							1.560
861021	.094	.00614	.389	.00563	23.072	.00077	
861023.5							1.700
861026	.097	.00793	.389	.00614	23.081	.00077	
861028.5							1.622
861031	.103	.00818	.385	.00537	23.089	.00000	
861033.5							1.578
861105	.111	.00614	.380	.00512	23.097	.00077	
861107.5							1.240
861110	.120	.00716	.376	.00691	23.103	.00077	
861112.5							1.420
861115	.126	.00691	.371	.00742	23.110	.00077	
861117.5							1.380
861120	.127	.00691	.364	.00537	23.117	.00077	
861122.5							1.380
861125	.128	.00691	.358	.00742	23.124	.00077	
861127.5							1.356
861130	.130	.00972	.353	.00895	23.130	.00000	
861132.5							1.324
861205	.138	.00614	.346	.00588	23.137	.00102	
861207.5							1.240
861210	.144	.00563	.339	.00563	23.143	.00102	
861212.5							1.160
861215	.146	.00742	.331	.00563	23.149	.00102	
861217.5							1.160
861220	.148	.00742	.324	.00716	23.155	.00102	
861222.5							1.340
861225	.151	.00895	.323	.01177	23.162	.00102	
861227.5							1.402
861230	.151	.00588	.314	.00537	23.169	.00000	
861232.5							1.498
870104	.152	.00588	.308	.00537	23.176	.00077	
870106.5							1.280
870109	.153	.00512	.303	.00435	23.183	.00051	
870111.5							1.180
870114	.146	.00563	.294	.00332	23.188	.00051	
870116.5							1.140
870119	.148	.00614	.287	.00460	23.194	.00051	
870121.5							1.220
870124	.147	.00946	.280	.00460	23.200	.00077	
870126.5							1.242
870129	.143	.00409	.274	.00332	23.206	.00000	
870131.5							1.598
870203	.138	.00486	.270	.00358	23.214	.00051	
870205.5							1.400
870208	.136	.00409	.264	.00384	23.221	.00051	
870210.5							1.520
870213	.133	.00563	.259	.00332	23.229	.00051	
870215.5							1.540
870218	.132	.00358	.254	.00332	23.237	.00051	
870220.5							1.640
870223	.131	.00384	.251	.00358	23.245	.00051	
870225.5							1.948
870228	.126	.00870	.245	.00563	23.255	.00000	
870230.5							2.192
870305	.125	.00818	.240	.00512	23.266	.00077	
870307.5							1.720

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
870310	.119	.00537	.228	.00512	23.274	.00051	
870312.5							1.680
870315	.117	.00460	.223	.00409	23.283	.00051	
870317.5							1.680
870320	.116	.00460	.222	.00384	23.291	.00051	
870322.5							1.820
870325	.108	.00435	.214	.00460	23.300	.00051	
870327.5							1.714
870330	.105	.00588	.217	.00460	23.309	.00000	
870332.5							1.566
870404	.101	.00537	.212	.00409	23.316	.00051	
870406.5							1.700
870409	.096	.00332	.211	.00332	23.325	.00051	
870411.5							1.580
870414	.089	.00435	.208	.00384	23.333	.00051	
870416.5							1.620
870419	.079	.00409	.203	.00512	23.341	.00051	
870421.5							1.500
870424	.076	.00384	.202	.00460	23.348	.00051	
870426.5							1.564
870429	.073	.00460	.204	.00460	23.356	.00000	
870431.5							1.576
870504	.065	.00384	.202	.00332	23.364	.00051	
870506.5							1.360
870509	.061	.00332	.199	.00332	23.371	.00051	
870511.5							1.340
870514	.054	.00435	.199	.00384	23.378	.00051	
870516.5							1.280
870519	.046	.00435	.196	.00409	23.384	.00051	
870521.5							1.340
870524	.039	.00563	.196	.00537	23.391	.00051	
870526.5							1.430
870529	.037	.00716	.200	.00563	23.398	.00000	
870531.5							1.470
870603	.032	.00435	.197	.00486	23.405	.00077	
870605.5							.940
870608	.031	.00409	.199	.00409	23.410	.00077	
870610.5							1.120
870613	.025	.00358	.199	.00358	23.416	.00077	
870615.5							1.000
870618	.018	.00435	.200	.00332	23.421	.00077	
870620.5							.960
870623	.012	.00435	.201	.00435	23.425	.00077	
870625.5							.842
870628	.006	.00409	.205	.00409	23.430	.00000	
870630.5							.898
870703	0.000	.00060	.207	.00058	3.434	.00051	
870705.5							.660
870708	-.003	.00409	.210	.00332	23.437	.00051	
870710.5							.560
870713	-.012	.00384	.212	.00384	23.440	.00051	
870715.5							.540
870718	-.017	.00435	.216	.00358	23.443	.00051	
870720.5							.540
870723	-.018	.00358	.220	.00307	23.446	.00051	
870725.5							.440
870728	-.018	.00332	.225	.00358	23.448	.00051	
870730.5							.486
870802	-.021	.00384	.228	.00384	23.450	.00000	
870804.5							.814
870807	-.025	.00332	.233	.00332	23.454	.00026	
870809.5							.580
870812	-.026	.00358	.237	.00332	23.457	.00051	
870814.5							.700
870817	-.029	.00384	.242	.00358	23.461	.00051	
870819.5							.880
870822	-.029	.00435	.248	.00332	23.465	.00051	
870824.5							1.100
870827	-.029	.00486	.257	.00409	23.471	.00051	
870829.5							1.098
870901	-.033	.00435	.260	.00460	23.476	.00000	
870903.5							1.122

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
870906	-.035	.00512	.265	.00409	23.482	.00051	
870908.5							1.200
870911	-.034	.00384	.268	.00281	23.488	.00051	
870913.5							1.220
870916	-.037	.00384	.274	.00332	23.494	.00051	
870918.5							1.260
870921	-.040	.00384	.279	.00358	23.500	.00077	
870923.5							1.580
870926	-.042	.00486	.287	.00409	23.508	.00077	
870928.5							1.502
871001	-.047	.00384	.294	.00358	23.516	.00000	
871003.5							1.678
871006	-.050	.00409	.301	.00358	23.524	.00051	
871008.5							1.700
871011	-.051	.00384	.307	.00332	23.532	.00051	
871013.5							1.580
871016	-.054	.00435	.313	.00358	23.540	.00051	
871018.5							1.540
871021	-.055	.00435	.319	.00332	23.548	.00051	
871023.5							1.620
871026	-.051	.00588	.324	.00512	23.556	.00051	
871028.5							1.638
871031	-.057	.00486	.330	.00486	23.564	.00000	
871033.5							1.902
871105	-.055	.00435	.338	.00332	23.574	.00051	
871107.5							1.660
871110	-.051	.00512	.343	.00384	23.582	.00051	
871112.5							1.780
871115	-.049	.00460	.355	.00358	23.591	.00051	
871117.5							1.640
871120	-.046	.00512	.362	.00332	23.599	.00051	
871122.5							1.620
871125	-.047	.00537	.370	.00435	23.607	.00051	
871127.5							1.676
871130	-.054	.00844	.375	.00588	23.616	.00000	
871132.5							2.004
871205	-.051	.00614	.381	.00486	23.626	.00051	
871207.5							1.560
871210	-.046	.00435	.388	.00358	23.633	.00051	
871212.5							1.420
871215	-.040	.00512	.396	.00409	23.641	.00051	
871217.5							1.480
871220	-.036	.00512	.401	.00460	23.648	.00051	
871222.5							1.600
871225	-.029	.00537	.406	.00563	23.656	.00077	
871227.5							1.666
871230	-.018	.00767	.411	.00563	23.664	.00000	
871232.5							1.614
880104	-.010	.00614	.415	.00512	23.672	.00077	
880106.5							1.560
880109	-.001	.00435	.420	.00358	23.680	.00077	
880111.5							1.520
880114	.005	.00384	.422	.00307	23.688	.00077	
880116.5							1.520
880119	.009	.00716	.424	.00512	23.695	.00077	
880121.5							1.160
880124	.019	.00742	.427	.00614	23.701	.00077	
880126.5							1.130
880129	.032	.00716	.428	.00460	23.707	.00000	
880131.5							1.510
880203	.045	.00460	.429	.00384	23.714	.00051	
880205.5							1.520
880208	.057	.00435	.432	.00384	23.722	.00051	
880210.5							1.780
880213	.060	.00409	.433	.00332	23.731	.00051	
880215.5							1.800
880218	.065	.00384	.430	.00332	23.740	.00051	
880220.5							1.960
880223	.074	.00486	.431	.00486	23.750	.00051	
880225.5							2.280
880228	.076	.00588	.427	.00639	23.761	.00051	
880230.5							2.000

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
880304	.087	.00512	.433	.00460	23.771	.00051	
880306.5							2.060
880309	.097	.00537	.430	.00409	23.781	.00051	
880311.5							1.640
880314	.114	.00870	.427	.00537	23.790	.00051	
880316.5							1.360
880319	.122	.00537	.425	.00332	23.796	.00051	
880321.5							1.540
880324	.130	.00512	.415	.00358	23.804	.00051	
880326.5							1.760
880329	.137	.00614	.410	.00358	23.813	.00000	
880331.5							1.884
880403	.139	.00742	.401	.00639	23.822	.00000	
880405.5							1.916
880408	.140	.00537	.395	.00358	23.832	.00051	
880410.5							2.000
880413	.146	.00435	.389	.00384	23.842	.00051	
880415.5							1.980
880418	.154	.00588	.377	.00435	23.852	.00077	
880420.5							1.660
880423	.161	.00460	.376	.00409	23.860	.00051	
880425.5							1.560
880428	.168	.00588	.368	.00691	23.868	.00077	
880430.5							1.632
880503	.177	.00691	.359	.00793	23.876	.00000	
880505.5							1.508
880508	.176	.00537	.353	.00512	23.884	.00051	
880510.5							1.580
880513	.181	.00563	.344	.00486	23.892	.00051	
880515.5							1.680
880518	.183	.00409	.337	.00435	23.900	.00051	
880520.5							1.380
880523	.183	.00435	.328	.00409	23.907	.00051	
880525.5							1.400
880528	.181	.00435	.318	.00358	23.914	.00051	
880530.5							1.312
880602	.174	.00486	.308	.00537	23.920	.00000	
880604.5							1.208
880607	.171	.00512	.300	.00460	23.926	.00077	
880609.5							1.040
880612	.172	.00384	.289	.00358	23.932	.00077	
880614.5							.920
880617	.172	.00460	.281	.00460	23.936	.00077	
880619.5							.660
880622	.172	.00409	.270	.00332	23.940	.00077	
880624.5							.520
880627	.176	.00460	.259	.00460	23.942	.00077	
880629.5							.394
880702	.177	.00486	.251	.00384	23.944	.00000	
880704.5							.426
880707	.175	.00435	.240	.00358	23.946	.00051	
880709.5							.380
880712	.173	.00409	.230	.00384	23.948	.00051	
880714.5							.500
880717	.171	.00460	.222	.00409	23.951	.00051	
880719.5							.540
880722	.168	.00358	.211	.00332	23.953	.00051	
880724.5							.620
880727	.161	.00332	.201	.00332	23.956	.00051	
880729.5							.576
880801	.155	.00358	.192	.00358	23.959	.00000	
880803.5							.784
880806	.148	.00358	.182	.00409	23.963	.00051	
880808.5							.540
880811	.141	.00358	.173	.00358	23.966	.00051	
880813.5							.580
880816	.134	.00358	.166	.00358	23.969	.00051	
880818.5							.660
880821	.124	.00358	.161	.00409	23.972	.00051	
880823.5							.580
880826	.112	.00384	.152	.00435	23.975	.00051	
880828.5							.750

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
880831	.102	.00537	.149	.00639	23.979	.00000	
880833.5							.890
880905	.090	.00409	.144	.00460	23.983	.00077	
880907.5							.760
880910	.079	.00307	.139	.00332	23.987	.00077	
880912.5							.800
880915	.069	.00384	.135	.00358	23.991	.00077	
880917.5							1.020
880920	.054	.00563	.131	.00639	23.996	.00077	
880922.5							1.140
880925	.036	.00665	.127	.00793	24.002	.00102	
880927.5							1.190
880930	.023	.00537	.133	.00793	24.008	.00000	
880932.5							1.330
881005	.003	.00332	.131	.00332	24.014	.00077	
881007.5							1.480
881010	-.009	.00307	.133	.00332	24.022	.00077	
881012.5							1.580
881015	-.028	.00435	.135	.00332	24.030	.00077	
881017.5							1.420
881020	-.044	.00537	.134	.00384	24.037	.00077	
881022.5							1.480
881025	-.058	.00639	.139	.00460	24.044	.00077	
881027.5							1.560
881030	-.082	.00895	.146	.00767	24.052	.00077	
881032.5							1.736
881104	-.082	.00435	.163	.00435	24.061	.00000	
881106.5							2.024
881109	-.100	.00384	.171	.00281	24.071	.00051	
881111.5							1.660
881114	-.111	.00384	.180	.00460	24.079	.00077	
881116.5							1.640
881119	-.119	.00358	.192	.00409	24.087	.00077	
881121.5							1.720
881124	-.131	.00460	.203	.00588	24.096	.00077	
881126.5							1.720
881129	-.137	.00818	.214	.00870	24.104	.00077	
881131.5							1.680
881204	-.147	.00691	.237	.00409	24.113	.00000	
881206.5							1.720
881209	-.151	.00384	.250	.00332	24.122	.00051	
881211.5							1.340
881214	-.156	.00409	.263	.00332	24.128	.00051	
881216.5							1.160
881219	-.159	.00409	.278	.00563	24.134	.00077	
881221.5							1.160
881224	-.161	.01100	.297	.01049	24.140	.00102	
881226.5							.960
881229	-.157	.00742	.309	.01560	24.145	.00153	
881231.5							1.388
890103	-.154	.00639	.322	.01202	24.152	.00000	
890105.5							1.292
890108	-.145	.00512	.332	.00563	24.158	.00128	
890110.5							1.100
890113	-.141	.00307	.346	.00332	24.163	.00128	
890115.5							1.220
890118	-.136	.00281	.358	.00281	24.170	.00128	
890120.5							1.220
890123	-.130	.00409	.368	.00332	24.176	.00128	
890125.5							1.380
890128	-.123	.00358	.381	.00358	24.183	.00128	
890130.5							1.454
890202	-.120	.00332	.387	.00332	24.190	.00000	
890204.5							1.646
890207	-.109	.00307	.404	.00435	24.198	.00051	
890209.5							1.460
890212	-.099	.00332	.412	.00307	24.205	.00051	
890214.5							1.360
890217	-.085	.00435	.424	.00512	24.212	.00051	
890219.5							1.240
890222	-.076	.00563	.434	.00588	24.218	.00051	
890224.5							1.440

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
890227	-.057	.00614	.449	.00537	24.226	.00051	
890229.5							1.624
890304	-.046	.00537	.452	.00537	24.234	.00000	
890306.5							1.696
890309	-.036	.00460	.461	.00384	24.242	.00051	
890311.5							1.860
890314	-.022	.00358	.465	.00307	24.251	.00051	
890316.5							1.600
890319	-.007	.00486	.472	.00384	24.260	.00051	
890321.5							1.640
890324	.008	.00460	.478	.00384	24.268	.00051	
890326.5							1.740
890329	.025	.00435	.480	.00435	24.276	.00051	
890331.5							1.360
890403	.038	.00716	.477	.00460	24.283	.00000	
890405.5							1.400
890408	.057	.00384	.479	.00332	24.290	.00051	
890410.5							1.440
890413	.070	.00384	.481	.00281	24.297	.00051	
890415.5							1.560
890418	.085	.00460	.481	.00332	24.305	.00051	
890420.5							1.900
890423	.101	.00588	.482	.00358	24.315	.00051	
890425.5							2.020
890428	.108	.00588	.483	.00409	24.325	.00051	
890430.5							2.020
890503	.110	.00716	.473	.00409	24.335	.00000	
890505.5							1.840
890508	.127	.00460	.471	.00460	24.344	.00051	
890510.5							1.580
890513	.145	.00614	.467	.00614	24.352	.00051	
890515.5							1.640
890518	.158	.00384	.457	.00409	24.360	.00051	
890520.5							1.700
890523	.173	.00486	.451	.00384	24.369	.00051	
890525.5							1.640
890528	.179	.00486	.442	.00435	24.377	.00051	
890530.5							1.624
890602	.195	.01177	.437	.01049	24.385	.00000	
890604.5							1.636
890607	.198	.00614	.420	.00460	24.393	.00102	
890609.5							1.180
890612	.205	.00563	.414	.00435	24.399	.00102	
890614.5							1.240
890617	.218	.00588	.405	.00435	24.405	.00102	
890619.5							1.120
890622	.227	.00537	.396	.00384	24.411	.00102	
890624.5							.900
890627	.238	.00639	.381	.00742	24.415	.00102	
890629.5							.768
890702	.239	.01355	.358	.01202	24.419	.00000	
890704.5							.952
890707	.254	.01202	.347	.00665	24.424	.00179	
890709.5							.760
890712	.256	.00486	.334	.00384	24.428	.00179	
890714.5							1.020
890717	.264	.00409	.322	.00384	24.433	.00179	
890719.5							1.060
890722	.267	.00537	.309	.00460	24.438	.00179	
890724.5							1.100
890727	.269	.00639	.292	.00537	24.444	.00179	
890729.5							.820
890801	.272	.01049	.285	.01049	24.448	.00256	
890803.5							1.070
890806	.267	.01074	.254	.00614	24.453	.00000	
890808.5							1.010
890811	.266	.00614	.244	.00460	24.458	.00077	
890813.5							1.080
890816	.266	.00588	.230	.00358	24.464	.00077	
890818.5							1.200
890821	.262	.00614	.218	.00588	24.470	.00077	
890823.5							1.140

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
890826	.260	.00997	.205	.00818	24.475	.00102	
890828.5							1.020
890831	.248	.01177	.192	.00921	24.480	.00128	
890833.5							1.340
890905	.245	.00870	.166	.00537	24.487	.00000	
890907.5							1.280
890910	.232	.00742	.154	.00435	24.493	.00077	
890912.5							1.160
890915	.217	.00742	.142	.00486	24.499	.00077	
890917.5							1.340
890920	.208	.00512	.131	.00486	24.506	.00077	
890922.5							1.360
890925	.193	.00665	.121	.00486	24.513	.00077	
890927.5							1.540
890930	.174	.00972	.112	.00486	24.521	.00102	
890932.5							1.718
891005	.167	.00895	.098	.00486	24.529	.00000	
891007.5							1.802
891010	.145	.00870	.092	.00512	24.538	.00051	
891012.5							1.800
891015	.120	.00742	.089	.00512	24.547	.00051	
891017.5							1.960
891020	.102	.00460	.082	.00435	24.557	.00051	
891022.5							2.180
891025	.084	.00486	.079	.00358	24.568	.00051	
891027.5							2.100
891030	.066	.00639	.079	.00435	24.578	.00051	
891032.5							2.066
891104	.050	.00691	.073	.00614	24.589	.00000	
891106.5							2.114
891109	.029	.00460	.074	.00307	24.599	.00051	
891111.5							2.000
891114	.008	.00358	.076	.00332	24.609	.00051	
891116.5							2.140
891119	-.007	.00332	.080	.00332	24.620	.00051	
891121.5							2.140
891124	-.022	.00358	.087	.00332	24.631	.00051	
891126.5							2.400
891129	-.043	.00358	.096	.00307	24.643	.00051	
891131.5							2.274
891204	-.061	.00409	.096	.00358	24.654	.00000	
891206.5							2.086
891209	-.071	.00435	.108	.00384	24.664	.00051	
891211.5							1.820
891214	-.084	.00409	.119	.00307	24.674	.00051	
891216.5							1.780
891219	-.095	.00358	.132	.00307	24.682	.00051	
891221.5							1.800
891224	-.103	.00716	.142	.00486	24.691	.00051	
891226.5							1.860
891229	-.121	.00972	.149	.00691	24.701	.00077	
891231.5							1.862
900103	-.122	.01944	.175	.01534	24.710	.00000	
900105.5							1.858
900108	-.135	.00537	.186	.00537	24.719	.00128	
900110.5							1.580
900113	-.148	.00563	.199	.00537	24.727	.00128	
900115.5							1.580
900118	-.155	.00460	.212	.00691	24.735	.00128	
900120.5							1.680
900123	-.169	.00614	.227	.00665	24.743	.00128	
900125.5							1.880
900128	-.182	.00844	.241	.00844	24.753	.00128	
900130.5							2.110
900202	-.185	.00716	.267	.00742	24.763	.00000	
900204.5							2.270
900207	-.195	.00409	.279	.00435	24.775	.00051	
900209.5							2.460
900212	-.197	.00409	.300	.00384	24.787	.00051	
900214.5							2.460
900217	-.193	.00358	.318	.00384	24.799	.00051	
900219.5							2.320

Date YYMMDD	x (″)	x sigma (″)	y (″)	y sigma (″)	A1-UT1R (s)	A1-UT1R sigma (s)	ΔLOD (ms)
900222	-.195	.00307	.336	.00307	24.811	.00051	
900224.5							2.060
900227	-.187	.00384	.355	.00384	24.821	.00051	
900229.5							2.020
900304	-.186	.00460	.371	.00588	24.831	.00000	
900306.5							2.100
900309	-.183	.00358	.391	.00358	24.842	.00051	
900311.5							2.240
900314	-.178	.00307	.410	.00307	24.853	.00051	
900316.5							2.300
900319	-.175	.00256	.425	.00307	24.865	.00051	
900321.5							2.540
900324	-.164	.00358	.442	.00358	24.877	.00051	
900326.5							2.540
900329	-.155	.00767	.459	.00435	24.890	.00051	
900331.5							2.398
900403	-.141	.00460	.475	.00486	24.902	.00000	
900405.5							2.282
900408	-.130	.00818	.491	.00716	24.913	.00051	
900410.5							2.340
900413	-.111	.01151	.508	.01125	24.925	.00077	
900415.5							2.220
900418	-.097	.00946	.518	.00639	24.936	.00077	
900420.5							2.280
900423	-.088	.01637	.525	.01049	24.948	.00102	
900425.5							2.120
900428	-.078	.00972	.537	.00818	24.958	.00077	
900430.5							1.906
900503	-.064	.00307	.550	.00384	24.968	.00000	
900505.5							1.734
900508	-.044	.00307	.555	.00358	24.976	.00026	
900510.5							1.820
900513	-.020	.00460	.565	.00486	24.986	.00051	
900515.5							1.980
900518	-.001	.00409	.568	.00409	24.995	.00051	
900520.5							2.040
900523	.018	.00435	.570	.00409	25.006	.00051	
900525.5							1.940
900528	.037	.00409	.572	.00614	25.015	.00051	
900530.5							1.814
900602	.057	.00588	.575	.00921	25.024	.00000	
900604.5							1.706
900607	.075	.00435	.574	.00460	25.033	.00077	
900609.5							1.680
900612	.098	.00691	.568	.00639	25.041	.00077	
900614.5							1.640
900617	.114	.00512	.563	.00512	25.049	.00077	
900619.5							1.560
900622	.133	.00460	.558	.00537	25.057	.00077	
900624.5							1.440
900627	.155	.00055	.002	.00506	.767	.00000	
900629.5							.000

LAGEOS Geodetic Analysis - SL7.1

Appendix 5

Quarterly Station Coordinates

Station Name	Station Num.	Latitude (°)	Latitude (′)	Latitude (″)	Longitude (°)	Longitude (′)	Longitude (″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
April - June 78	**RMS.374+00**				**6378137.00**			**298.257**			
GORF70	7063	39	1	13.3754230	283	10	19.9493290	19.0982000	0.0000	0.0000	.0741
BERM70	7067	32	21	13.7601000	295	20	38.0212710	-22.7736000	.3257	.4484	7.7205
GOLD70	7085	35	25	28.0268010	243	6	49.1247780	965.2321000	.2294	.1499	1.2732
HAYS70	7091	42	37	21.7020270	288	30	44.4908810	91.6469000	.0041	.0063	.1201
AREQ79	7907	-16	27	56.6640620	288	30	24.7517330	2492.0584000	.0030	0.0000	.0524
MOUN79	7921	31	41	3.2305150	249	7	18.9822860	2352.5488000	.0036	.0039	.0606
ORRO79	7943	-35	37	29.7571420	148	57	17.2776140	949.0492000	.0069	.0051	.0759
July - September 78	**RMS.299+00**				**6378137.00**			**298.257**			
OTAY70	7062	32	36	2.6672790	243	9	32.9237730	988.4148000	.0025	.0022	.0519
GORF70	7063	39	1	13.3753980	283	10	19.9491400	19.0927000	0.0000	0.0000	.0643
BERM70	7067	32	21	13.7760250	295	20	38.0782730	-23.1123000	.0024	.0028	.0666
GRAN70	7068	21	27	37.7965910	288	52	5.1647030	-18.6289000	.0050	.0070	.1070
WETT78	7834	49	8	41.7609350	12	52	41.1294170	661.1274000	.0044	.0061	.0792
AREQ79	7907	-16	27	56.6840430	288	30	24.7516750	2492.2194000	.0020	0.0000	.0353
MOUN79	7921	31	41	3.2351180	249	7	18.9841540	2352.7991000	.0030	.0031	.0611
NATA79	7929	-5	55	40.1217100	324	50	7.3823630	39.5956000	.0036	.0027	.0544
ORRO79	7943	-35	37	29.7814900	148	57	17.2908480	948.7678000	.0064	.0043	.0774
October - December78	**RMS.396+00**				**6378137.00**			**298.257**			
OTAY70	7062	32	36	2.6917070	243	9	32.9585220	988.4432000	.0169	.0219	.0904
GORF70	7063	39	1	13.3754450	283	10	19.9489560	19.8241000	.0001	0.0000	.7007
WETT78	7834	49	8	41.7276800	12	52	41.1255280	661.0660000	.0244	.0161	.1321
AREQ79	7907	-16	27	56.6949790	288	30	24.7516220	2492.2470000	.0082	0.0000	.0400
MOUN79	7921	31	41	3.2428730	249	7	19.0134490	2352.6948000	.0144	.0190	.0983
NATA79	7929	-5	55	40.1581940	324	50	7.3753480	39.6561000	.0175	.0065	.0595
ORRO79	7943	-35	37	29.7434140	148	57	17.3103410	948.9819000	.0184	.0190	.0560
January - March 79	**RMS.201+00**				**6378137.00**			**298.257**			
QUIN70	7051	39	58	24.5766870	239	3	37.7013770	1059.8905000	.0027	.0109	.0998
OTAY70	7062	32	36	2.6698620	243	9	32.9258680	988.4840000	.0022	.0021	.0413
GORF70	7063	39	1	13.3757020	283	10	19.9487890	19.0928000	0.0000	0.0000	.0471
PATR70	7069	28	13	40.6312180	279	23	39.5423280	-23.3885000	.0101	.0240	.1543
BEAR70	7082	41	56	.9053530	248	34	45.6647520	1962.7708000	.0051	.0091	.1128
GORF71	7101	39	1	16.2044620	283	10	42.9998270	8.7036000	.0022	.0024	.0553
GORF71	7102	39	1	14.3920730	283	10	18.9472330	17.7902000	.0017	.0020	.0513
GORF71	7103	39	1	14.6159720	283	10	18.9427170	17.9188000	.0023	.0030	.0576
GORF71	7104	39	1	17.1332220	283	10	36.8791490	11.6082000	.0386	.1587	2.5067
WETT78	7834	49	8	41.7684780	12	52	41.1344820	661.3796000	.0059	.0187	.1017
AREQ79	7907	-16	27	56.6809290	288	30	24.7515660	2492.3213000	.0020	0.0000	.0306
MOUN79	7921	31	41	3.2386850	249	7	18.9841930	2352.8391000	.0026	.0023	.0494
NATA79	7929	-5	55	40.1293690	324	50	7.3800540	39.5647000	.0038	.0035	.0515
ORRO79	7943	-35	37	29.7717570	148	57	17.2841050	948.9454000	.0034	.0023	.0371
April - June 79	**RMS.198+00**				**6378137.00**			**298.257**			
QUIN70	7051	39	58	24.5783070	239	3	37.7019600	1060.0334000	.0017	.0023	.0472
OTAY70	7062	32	36	2.6656300	243	9	32.9338430	988.7272000	.0014	.0015	.0344
GORF70	7063	39	1	13.3756430	283	10	19.9485960	19.1878000	0.0000	0.0000	.0359
PATR70	7069	28	13	40.6689980	279	23	39.4648350	-23.9476000	.0051	.0076	.0617
BEAR70	7082	41	56	.9115390	248	34	45.6777520	1962.5837000	.0015	.0022	.0425
GORF71	7102	39	1	14.3961160	283	10	18.9417010	17.7596000	.0051	.0068	.1216
GORF71	7103	39	1	14.6204650	283	10	18.9461610	17.8773000	.0019	.0023	.0469
GORF71	7104	39	1	17.1008020	283	10	36.9951320	10.0145000	.0014	.0019	.0421
LURE72	7210	20	42	25.9563620	203	44	38.7377930	3068.3830000	.0024	.0032	.1968
KOOT78	7833	52	10	42.2319180	5	48	35.2723690	93.2646000	.0102	.0169	.1627
WETT78	7834	49	8	41.7628000	12	52	41.1218100	661.3984000	.0031	.0034	.0516
AREQ79	7907	-16	27	56.6793410	288	30	24.7515070	2492.2926000	.0013	0.0000	.0246
MOUN79	7921	31	41	3.2288970	249	7	18.9840040	2352.9692000	.0023	.0018	.0426
NATA79	7929	-5	55	40.1098180	324	50	7.3576410	39.8313000	.0044	.0035	.0535
ORRO79	7943	-35	37	29.7636500	148	57	17.2856990	949.0488000	.0031	.0021	.0350

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 79			**RMS.150+00**				**6378137.00**	**298.257**			
GORF70	7063	39	1	13.3756700	283	10	19.9484190	19.2931000	0.0000	0.0000	.0284
PATR70	7069	28	13	40.6764040	279	23	39.4589010	-23.5777000	.0006	.0083	.0328
BEAR70	7082	41	56	.9058890	248	34	45.6838360	1962.4753000	.0017	.0027	.0333
MCDO70	7086	30	40	37.3513690	255	59	2.6978250	1961.5488000	.0282	.0563	.1021
HAYS70	7091	42	37	21.6942310	288	30	44.5010830	92.0730000	.0013	.0018	.0360
AMER70	7096	-14	20	7.5093020	189	16	30.4922100	49.1495000	.0032	.0044	.0652
OWEN71	7114	37	13	57.2214800	241	42	22.3580470	1178.1455000	.0013	.0014	.0270
KOOT78	7833	52	10	42.2346960	5	48	35.2897610	93.1280000	.0110	.0175	.1782
WETT78	7834	49	8	41.7776130	12	52	41.1635400	660.9303000	.0062	.0153	.1151
GRAS78	7835	43	45	16.8744910	6	55	16.0146750	1322.5151000	.0171	.0233	.4680
AREQ79	7907	-16	27	56.6835910	288	30	24.7514550	2492.3154000	.0013	0.0000	.0250
NATA79	7929	-5	55	40.1067830	324	50	7.3803510	39.6377000	.0075	.0047	.0935
ORRO79	7943	-35	37	29.7654340	148	57	17.2842160	949.0874000	.0028	.0015	.0359
October - December 79			**RMS.137+00**				**6378137.00**	**298.257**			
GORF70	7063	39	1	13.3755960	283	10	19.9482380	19.3033000	0.0000	0.0000	.0121
PATR70	7069	28	13	40.6792000	279	23	39.4782960	-24.1048000	.0061	.0125	.1789
MCDO70	7086	30	40	37.3177620	255	59	2.6257510	1961.4405000	.0005	.0006	.0107
YARA70	7090	-29	2	47.4223580	115	20	48.2563040	241.3229000	.0015	.0010	.0169
HAYS70	7091	42	37	21.7023530	288	30	44.4970160	92.0016000	.0004	.0006	.0126
AMER70	7096	-14	20	7.5200280	189	16	30.5035860	49.1775000	.0012	.0010	.0143
GORF71	7102	39	1	14.3858230	283	10	18.9498540	17.8094000	.0006	.0008	.0213
OWEN71	7114	37	13	57.2251390	241	42	22.3568110	1178.0655000	.0006	.0006	.0112
GOLD71	7115	35	14	53.9136970	243	12	29.0912840	1038.6805000	.0006	.0006	.0113
KOOT78	7833	52	10	42.2339140	5	48	35.2689950	93.2487000	.0073	.0125	.1355
GRAS78	7835	43	45	16.8598400	6	55	16.0343990	1322.9725000	.0126	.0225	.3196
AREQ79	7907	-16	27	56.6793410	288	30	24.7513970	2492.3335000	.0007	0.0000	.0124
NATA79	7929	-5	55	40.1260580	324	50	7.3697900	40.0242000	.0039	.0026	.0547
ORRO79	7943	-35	37	29.7614600	148	57	17.2893160	948.9758000	.0014	.0013	.0222
January - March 80			**RMS.100+00**				**6378137.00**	**298.257**			
GORF70	7063	39	1	13.3756050	283	10	19.9480530	19.2617000	0.0000	0.0000	.0098
PATR70	7069	28	13	40.6745660	279	23	39.4599740	-23.6336000	.0033	.0044	.0267
MCDO70	7086	30	40	37.3163980	255	59	2.6281550	1961.4602000	.0005	.0005	.0068
YARA70	7090	-29	2	47.4240070	115	20	48.2542730	241.3522000	.0008	.0005	.0065
HAYS70	7091	42	37	21.6982200	288	30	44.4957870	91.9789000	.0005	.0007	.0080
KWAJ70	7092	9	23	37.6891420	167	28	32.6416210	33.0453000	.0013	.0011	.0221
AMER70	7096	-14	20	7.5127070	189	16	30.5097050	49.0880000	.0010	.0008	.0096
GORF71	7102	39	1	14.3956480	283	10	18.9485100	17.9648000	.0005	.0007	.0117
OWEN71	7114	37	13	57.2237370	241	42	22.3580480	1178.0597000	.0007	.0005	.0076
GOLD71	7115	35	14	53.9128220	243	12	29.0916680	1038.6001000	.0006	.0005	.0074
KOOT78	7833	52	10	42.2215930	5	48	35.2862380	93.3242000	.0260	.0604	.3791
WETT78	7834	49	8	41.7668780	12	52	41.1290450	660.9669000	.0013	.0017	.0164
AREQ79	7907	-16	27	56.6828770	288	30	24.7513450	2492.3151000	.0007	0.0000	.0117
NATA79	7929	-5	55	40.1219990	324	50	7.3912870	39.7872000	.0034	.0030	.0346
ORRO79	7943	-35	37	29.7639900	148	57	17.2806910	949.0370000	.0009	.0007	.0089
April - June 80			**RMS.158+00**				**6378137.00**	**298.257**			
GORF70	7063	39	1	13.3757120	283	10	19.9478780	19.2549000	0.0000	0.0000	.0198
PATR70	7069	28	13	40.6744900	279	23	39.4280710	-23.6794000	.0022	.0288	.1271
MCDO70	7086	30	40	37.3167380	255	59	2.6282480	1961.3492000	.0011	.0010	.0166
YARA70	7090	-29	2	47.4222850	115	20	48.2603810	241.3457000	.0015	.0009	.0102
HAYS70	7091	42	37	21.7006780	288	30	44.5021200	92.0621000	.0015	.0023	.0368
KWAJ70	7092	9	23	37.6800090	167	28	32.6334160	32.9667000	.0019	.0011	.0233
AMER70	7096	-14	20	7.5186520	189	16	30.5086840	48.9788000	.0016	.0008	.0141
GORF71	7102	39	1	14.3943840	283	10	18.9461870	18.0631000	.0010	.0014	.0199
OWEN71	7114	37	13	57.2222910	241	42	22.3575910	1178.0815000	.0013	.0013	.0205
GOLD71	7115	35	14	53.9090210	243	12	29.0916440	1038.5865000	.0011	.0010	.0138
KOOT78	7833	52	10	42.2377860	5	48	35.2954560	93.2756000	.0258	.0843	1.4876
AREQ79	7907	-16	27	56.6824090	288	30	24.7512840	2492.2912000	.0008	0.0000	.0084
NATA79	7929	-5	55	40.1228850	324	50	7.3603250	39.6853000	.0021	.0024	.0297
ORRO79	7943	-35	37	29.7652830	148	57	17.2836550	949.0520000	.0015	.0011	.0114

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 80	**RMS.139+00**				**6378137.00**			**298.257**			
GORF70	7063	39	1	13.3756880	283	10	19.9476950	19.2039000	0.0000	0.0000	.0136
PATR70	7069	28	13	40.6661810	279	23	39.4093900	-23.1883000	.0030	.0257	.1715
MCDO70	7086	30	40	37.3166390	255	59	2.6290680	1961.5875000	.0010	.0014	.0245
YARA70	7090	-29	2	47.4251120	115	20	48.2581720	241.3270000	.0010	.0008	.0068
HAYS70	7091	42	37	21.7010220	288	30	44.4933900	91.9149000	.0006	.0009	.0116
KWAJ70	7092	9	23	37.6814680	167	28	32.6293410	32.9305000	.0008	.0010	.0116
AMER70	7096	-14	20	7.5163650	189	16	30.5125770	48.9754000	.0008	.0011	.0133
GORF71	7102	39	1	14.3938880	283	10	18.9440090	17.8429000	.0011	.0013	.0218
OWEN71	7114	37	13	57.2215720	241	42	22.3552420	1178.0495000	.0007	.0013	.0157
GOLD71	7115	35	14	53.9095860	243	12	29.0939270	1038.6294000	.0007	.0011	.0123
LURE71	7120	20	42	27.3928830	203	44	38.2449540	3067.7111000	0.0000	.0010	.0095
KIRK78	7805	60	13	2.2552450	24	23	40.4266700	77.7391000	.0523	.1431	.9608
KOOT78	7833	52	10	42.2308070	5	48	35.2851020	93.5456000	.0128	.0287	.3521
GRAS78	7835	43	45	16.8650150	6	55	16.0232050	1322.8989000	.0154	.0248	.2288
GORF78	7899	39	1	15.3534550	283	10	48.1391280	10.0373000	.0008	.0011	.0179
AREQ79	7907	-16	27	56.6816350	288	30	24.7523430	2492.2452000	.0006	.0010	.0070
NATA79	7929	-5	55	40.1211520	324	50	7.3667270	39.7526000	.0015	.0021	.0332
ORRO79	7943	-35	37	29.7651100	148	57	17.2844010	949.0135000	.0007	.0009	.0086
October - December 80	**RMS.125+00**				**6378137.00**			**298.257**			
GORF70	7063	39	1	13.3757450	283	10	19.9475160	19.2079000	0.0000	0.0000	.0137
YARA70	7090	-29	2	47.4224310	115	20	48.2593630	241.3201000	.0008	.0009	.0060
HAYS70	7091	42	37	21.7002300	288	30	44.4918200	91.9777000	.0006	.0010	.0094
KWAJ70	7092	9	23	37.6778890	167	28	32.6366580	32.8915000	.0010	.0014	.0162
AMER70	7096	-14	20	7.5170240	189	16	30.5060500	49.0363000	.0008	.0012	.0150
GORF71	7102	39	1	14.3928220	283	10	18.9456060	17.9827000	.0009	.0012	.0185
OWEN71	7114	37	13	57.2219350	241	42	22.3568210	1178.0200000	.0005	.0010	.0093
GOLD71	7115	35	14	53.9098940	243	12	29.0913800	1038.5704000	.0006	.0010	.0092
LURE71	7120	20	42	27.3926000	203	44	38.2480650	3067.7572000	0.0000	.0011	.0105
KIRK78	7805	60	13	2.2809730	24	23	40.3799320	79.1077000	.0109	.0195	.1365
KOOT78	7833	52	10	42.2143130	5	48	35.3352060	93.5391000	.0191	.0363	.2058
WETT78	7834	49	8	41.7949040	12	52	41.1286990	660.6728000	.1111	.0609	2.4432
GRAS78	7835	43	45	16.8746250	6	55	16.0232030	1322.7246000	.0055	.0085	.0926
JPL 78	7896	34	12	19.9865670	241	49	39.8440400	441.6382000	.0005	.0010	.0103
GORF78	7899	39	1	15.3571850	283	10	48.1421610	9.8922000	.0017	.0016	.0441
AREQ79	7907	-16	27	56.6812320	288	30	24.7537180	2492.2912000	.0007	.0011	.0086
NATA79	7929	-5	55	40.1171480	324	50	7.3716610	39.6695000	.0012	.0013	.0193
ORRO79	7943	-35	37	29.7646020	148	57	17.2819960	949.0739000	.0006	.0009	.0078
January - March 81	**RMS.130+00**				**6378137.00**			**298.257**			
QUIN70	7051	39	58	24.5820290	239	3	37.6929870	1060.0080000	.0006	.0009	.0122
GORF70	7063	39	1	13.3757220	283	10	19.9473430	19.1953000	0.0000	0.0000	.0104
YARA70	7090	-29	2	47.4230230	115	20	48.2586400	241.3374000	.0008	.0007	.0072
GORF71	7102	39	1	14.3972400	283	10	18.9366710	17.9287000	.0014	.0022	.0307
GORF71	7105	39	1	14.1754970	283	10	20.3132710	19.0845000	.0005	.0008	.0128
PLAT71	7112	40	10	58.0097190	255	16	26.4861890	1501.6626000	.0013	.0018	.0343
OWEN71	7114	37	13	57.2184880	241	42	22.3552950	1177.9476000	.0018	.0025	.0616
GOLD71	7115	35	14	53.9095950	243	12	29.0918850	1038.6142000	.0005	.0008	.0110
LURE71	7120	20	42	27.3934870	203	44	38.2476610	3067.7538000	0.0000	.0008	.0087
KIRK78	7805	60	13	2.3165850	24	23	40.3379730	74.5956000	.0211	.0239	.2385
WETT78	7834	49	8	41.7637190	12	52	41.1229850	661.0547000	.0020	.0029	.0320
AUST78	7890	30	18	55.7909130	262	8	4.0203160	257.3139000	.0033	.0058	.0710
AREQ79	7907	-16	27	56.6815750	288	30	24.7514310	2492.3439000	.0012	.0010	.0214
NATA79	7929	-5	55	40.1221480	324	50	7.3717860	39.7370000	.0014	.0014	.0283
ORRO79	7943	-35	37	29.7629500	148	57	17.2797610	948.9755000	.0008	.0009	.0165

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
April - June 81			RMS.126+00			6378137.00		298.257			
QUIN70	7051	39	58	24.5790760	239	3	37.6964510	1059.9053000	.0008	.0016	.0090
GORF70	7063	39	1	13.3757360	283	10	19.9471620	19.1671000	0.0000	0.0000	.0291
BEAR70	7082	41	56	.9021160	248	34	45.6792710	1963.0171000	.0011	.0017	.0135
YARA70	7090	-29	2	47.4202860	115	20	48.2594240	241.3877000	.0014	.0018	.0067
GORF71	7102	39	1	14.0278790	283	10	18.6086360	25.7847000	.4182	.3830	9.0792
PLAT71	7112	40	10	58.0108550	255	16	26.4848050	1501.6465000	.0011	.0017	.0123
GOLD71	7115	35	14	53.9092580	243	12	29.0969140	1038.5335000	.0010	.0018	.0147
LURE71	7120	20	42	27.3938060	203	44	38.2484100	3067.7694000	0.0000	.0017	.0081
KIRK78	7805	60	13	2.2295400	24	23	40.3452120	74.7935000	.0119	.0122	.1362
WETT78	7834	49	8	41.7709720	12	52	41.1274880	661.1124000	.0013	.0033	.0178
FLAG78	7891	35	12	52.3431920	248	21	55.7646270	2144.3319000	.0012	.0019	.0225
VERN78	7892	40	19	36.6527250	250	25	45.0259120	1590.3606000	.0011	.0017	.0146
AREQ79	7907	-16	27	56.6822150	288	30	24.7503420	2492.3251000	.0013	.0019	.0089
NATA79	7929	-5	55	40.1270740	324	50	7.3653700	39.6969000	.0016	.0021	.0172
ORRO79	7943	-35	37	29.7564320	148	57	17.2875730	949.0420000	.0013	.0021	.0146
July - September 81			RMS.129+00			6378137.00		298.257			
GORF70	7063	39	1	13.3752320	283	10	19.9466320	19.2364000	.0006	.0008	.0136
YARA70	7090	-29	2	47.4212210	115	20	48.2595850	241.3977000	.0008	.0006	.0070
GORF71	7102	39	1	14.3885090	283	10	18.9408450	18.1584000	.0009	.0014	.0198
GORF71	7105	39	1	14.1757730	283	10	20.3097770	19.1885000	0.0000	0.0000	.0111
MOUN71	7110	32	53	30.2528800	243	34	38.4059440	1838.9250000	.0005	.0008	.0115
PLAT71	7112	40	10	58.0120240	255	16	26.4820920	1501.5778000	.0005	.0008	.0114
OWEN71	7114	37	13	57.2209980	241	42	22.3565510	1178.0679000	.0006	.0009	.0155
LURE71	7120	20	42	27.3935100	203	44	38.2452640	3067.8193000	0.0000	.0007	.0077
LURE72	7210	20	42	25.9699250	203	44	38.7466730	3067.5164000	.0013	.0012	.0237
KIRK78	7805	60	13	2.2825590	24	23	40.4895380	75.2702000	.0168	.0404	.2984
WETT78	7834	49	8	41.7708280	12	52	41.1242340	661.0912000	.0025	.0028	.0323
FLAG78	7891	35	12	52.3440780	248	21	55.7590000	2144.3305000	.0007	.0009	.0153
AREQ79	7907	-16	27	56.6799600	288	30	24.7498640	2492.3033000	.0005	.0008	.0069
NATA79	7929	-5	55	40.1198250	324	50	7.3666380	39.7624000	.0008	.0009	.0091
ORRO79	7943	-35	37	29.7630420	148	57	17.2862080	949.0432000	.0006	.0008	.0104
October - December 81			RMS.913-01			6378137.00		298.257			
OTAY70	7062	32	36	2.6683180	243	9	32.9250640	988.5222000	.0005	.0007	.0089
YARA70	7090	-29	2	47.4213830	115	20	48.2601350	241.3666000	.0007	.0007	.0047
GORF71	7102	39	1	14.3920720	283	10	18.9472830	17.9961000	.0005	.0008	.0105
GORF71	7105	39	1	14.1757390	283	10	20.3095990	19.2025000	0.0000	0.0000	.0122
QUIN71	7109	39	58	30.0121850	239	3	19.0931910	1106.2998000	.0006	.0009	.0105
MOUN71	7110	32	53	30.2536940	243	34	38.4055880	1838.9083000	.0004	.0007	.0068
PLAT71	7112	40	10	58.0119530	255	16	26.4824000	1501.5894000	.0005	.0008	.0081
LURE71	7120	20	42	27.3965040	203	44	38.2455520	3067.7932000	.0004	.0007	.0058
LURE72	7210	20	42	25.9757710	203	44	38.7481490	3067.5039000	0.0000	.0008	.0067
KIRK78	7805	60	13	2.2903800	24	23	40.4445790	76.0292000	.0134	.0297	.2033
GRAS78	7835	43	45	16.8721540	6	55	16.0126300	1323.1051000	.0226	.0408	.3159
AREQ79	7907	-16	27	56.6812820	288	30	24.7482290	2492.3166000	.0006	.0009	.0080
MOUN79	7921	31	41	3.2098900	249	7	18.9024500	2352.1017000	.1201	.3523	4.3699
NATA79	7929	-5	55	39.5742680	324	50	8.4082450	28.8656000	.1820	.3424	3.5606
ORRO79	7943	-35	37	29.7585810	148	57	17.2827400	949.0447000	.0008	.0010	.0138

Station		Latitude			Longitude			Height	Scaled Stnd. Deviations Lat.	Lon.	Ht.
Name	Num.	(°)	(′)	(″)	(°)	(′)	(″)	(m)	(″)	(″)	(m)
January - March 82				M S.123+00			6378137.00	298.257			
OTAY70	7062	32	36	2.6670560	243	9	32.9136040	988.5771000	.0028	.0086	.1439
YARA70	7090	-29	2	47.4196920	115	20	48.2598480	241.3784000	.0010	.0006	.0068
GORF71	7102	39	1	14.3914180	283	10	18.9422360	17.9885000	.0009	.0011	.0177
GORF71	7105	39	1	14.1757660	283	10	20.3094280	19.1772000	0.0000	0.0000	.0123
QUIN71	7109	39	58	30.0128040	239	3	19.0862730	1106.2504000	.0013	.0018	.0220
MOUN71	7110	32	53	30.2524860	243	34	38.4025100	1838.9459000	.0008	.0010	.0151
PLAT71	7112	40	10	58.0121250	255	16	26.4810360	1501.5824000	.0006	.0010	.0150
LURE71	7120	20	42	27.3981190	203	44	38.2459480	3067.8437000	.0010	.0011	.0173
LURE72	7210	20	42	25.9758160	203	44	38.7442730	3067.5228000	0.0000	.0009	.0117
KIRK78	7805	60	13	2.2964250	24	23	40.3281900	77.2882000	.0224	.0522	.4934
WETT78	7834	49	8	41.7634390	12	52	41.1407590	660.9418000	.0043	.0056	.0496
MOUN78	7888	31	41	6.3740810	249	7	18.6256820	2331.3272000	.0007	.0009	.0154
AREQ79	7907	-16	27	56.6832410	288	30	24.7507640	2492.2957000	.0008	.0012	.0142
MOUN79	7921	31	41	3.2360100	249	7	18.9805770	2353.0999000	.0009	.0011	.0208
ORRO79	7943	-35	37	29.7646970	148	57	17.2820800	949.0114000	.0010	.0010	.0169
April - June 82				M S.835-01			6378137.00	298.257			
YARA70	7090	-29	2	47.4176340	115	20	48.2588500	241.3738000	.0009	.0006	.0118
GORF71	7101	39	1	16.2029870	283	10	43.0092800	8.5404000	.0264	.0437	.2393
GORF71	7102	39	1	14.3915570	283	10	18.9445750	17.9988000	.0005	.0006	.0134
GORF71	7105	39	1	14.1757950	283	10	20.3092430	19.1779000	0.0000	0.0000	.0111
QUIN71	7109	39	58	30.0127900	239	3	19.0905660	1106.2624000	.0004	.0006	.0109
MOUN71	7110	32	53	30.2557490	243	34	38.4002830	1838.9987000	.0004	.0007	.0112
PLAT71	7112	40	10	58.0120120	255	16	26.4814980	1501.6498000	.0004	.0006	.0111
LURE72	7210	20	42	25.9760910	203	44	38.7451610	3067.5092000	0.0000	.0007	.0084
KOOT78	7833	52	10	42.2324500	5	48	35.2823960	93.4591000	.0059	.0115	.1068
WETT78	7834	49	8	41.7654370	12	52	41.1275490	661.1224000	.0012	.0010	.0169
GRAS78	7835	43	45	16.8691020	6	55	16.0217030	1323.1229000	.0045	.0092	.0972
SIMO78	7838	33	34	39.7058700	135	56	13.3353800	99.4217000	.0011	.0013	.0144
MOUN78	7888	31	41	6.3770380	249	7	18.6281720	2331.3667000	.0008	.0009	.0204
VERN78	7892	40	19	36.6534930	250	25	45.0217210	1590.2615000	.0007	.0010	.0187
AREQ79	7907	-16	27	56.6839920	288	30	24.7467960	2492.3222000	.0004	.0008	.0089
July - September 82				M S.797-01			6378137.00	298.257			
YARA70	7090	-29	2	47.4171030	115	20	48.2598170	241.3804000	.0006	.0004	.0074
GORF71	7102	39	1	14.3897820	283	10	18.9519150	17.8660000	.0023	.0021	.0778
GORF71	7103	39	1	14.6177450	283	10	18.9461440	17.9296000	.0007	.0012	.0162
GORF71	7105	39	1	14.1758020	283	10	20.3090560	19.2197000	0.0000	0.0000	.0074
QUIN71	7109	39	58	30.0126920	239	3	19.0883740	1106.3875000	.0003	.0005	.0072
MOUN71	7110	32	53	30.2572110	243	34	38.4015740	1839.0264000	.0003	.0005	.0080
PLAT71	7112	40	10	58.0143400	255	16	26.4768320	1501.6668000	.0003	.0005	.0089
LURE72	7210	20	42	25.9763480	203	44	38.7428100	3067.5823000	0.0000	.0005	.0063
KIRK78	7805	60	13	2.3306600	24	23	40.3863040	78.2979000	.0056	.0109	.0701
KOOT78	7833	52	10	42.2424020	5	48	35.2827090	93.3447000	.0115	.0204	.1362
WETT78	7834	49	8	41.7666270	12	52	41.1261620	661.1568000	.0008	.0007	.0088
GRAS78	7835	43	45	16.8816470	6	55	16.0168860	1323.4308000	.0027	.0044	.0608
SIMO78	7838	33	34	39.7144270	135	56	13.3704280	99.7821000	.0074	.0214	.2311
MCDO78	7885	30	40	37.3180790	255	59	2.6215600	1961.3972000	.0004	.0005	.0103
VERN78	7892	40	19	36.6570570	250	25	45.0212660	1590.2803000	.0005	.0007	.0138
AREQ79	7907	-16	27	56.6806310	288	30	24.7484530	2492.3501000	.0003	.0006	.0058

Station		Latitude			Longitude			Height	Scaled Stnd. Deviations		
Name	Num.	(°)	(′)	(″)	(°)	(′)	(″)	(m)	Lat. (″)	Lon. (″)	Ht. (m)
October - December 82		**M S.690-01**			**6378137.00**			**298.257**			
MCDO70	7086	30	40	37.3186920	255	59	2.6275920	1961.5450000	.0003	.0005	.0084
YARA70	7090	-29	2	47.4185750	115	20	48.2620640	241.3982000	.0005	.0004	.0060
GORF71	7102	39	1	14.3895110	283	10	18.9436210	17.9902000	.0008	.0010	.0242
GORF71	7103	39	1	14.6199340	283	10	18.9478750	17.9421000	.0003	.0004	.0071
GORF71	7105	39	1	14.1758440	283	10	20.3088690	19.1965000	0.0000	0.0000	.0062
QUIN71	7109	39	58	30.0131370	239	3	19.0895800	1106.3570000	.0003	.0004	.0060
MOUN71	7110	32	53	30.2558820	243	34	38.4015920	1839.0323000	.0002	.0004	.0047
PLAT71	7112	40	10	58.0135470	255	16	26.4819310	1501.5492000	.0002	.0003	.0058
OWEN71	7114	37	13	57.2236950	241	42	22.3555690	1177.9757000	.0003	.0005	.0091
LURE72	7210	20	42	25.9762840	203	44	38.7408480	3067.5320000	0.0000	.0005	.0049
KIRK78	7805	60	13	2.3299500	24	23	40.3388940	78.5693000	.0053	.0094	.0821
KOOT78	7833	52	10	42.2317780	5	48	35.2819070	93.4587000	.0047	.0080	.0826
WETT78	7834	49	8	41.7679670	12	52	41.1294340	661.2040000	.0007	.0008	.0084
SIMO78	7838	33	34	39.7029310	135	56	13.3306750	99.4950000	.0007	.0011	.0136
MCDO78	7885	30	40	37.3139940	255	59	2.6207000	1961.3496000	.0020	.0030	.0619
AREQ79	7907	-16	27	56.6775870	288	30	24.7504920	2492.3142000	.0003	.0005	.0058
January - March 83		**M S.931-01**			**6378137.00**			**298.257**			
EAST70	7061	-27	8	52.1462150	250	36	59.1450990	115.8103000	.0121	.0207	.4257
MCDO70	7086	30	40	37.3182160	255	59	2.6269010	1961.4638000	.0005	.0010	.0143
YARA70	7090	-29	2	47.4159670	115	20	48.2623630	241.3872000	.0010	.0008	.0115
GORF71	7105	39	1	14.1758730	283	10	20.3086980	19.2188000	0.0000	0.0000	.0168
QUIN71	7109	39	58	30.0134240	239	3	19.0911170	1106.3292000	.0005	.0009	.0129
MOUN71	7110	32	53	30.2575780	243	34	38.4006480	1838.9589000	.0004	.0008	.0109
PLAT71	7112	40	10	58.0156360	255	16	26.4837330	1501.6519000	.0006	.0009	.0136
OWEN71	7114	37	13	57.2218350	241	42	22.3554960	1177.9515000	.0005	.0009	.0154
LURE72	7210	20	42	25.9764630	203	44	38.7410920	3067.5054000	0.0000	.0008	.0080
KIRK78	7805	60	13	2.2993210	24	23	40.3493420	78.8335000	.0105	.0176	.1487
KOOT78	7833	52	10	42.2359400	5	48	35.2775530	93.6009000	.0053	.0082	.0902
WETT78	7834	49	8	41.7720330	12	52	41.1332390	661.1460000	.0013	.0018	.0189
SIMO78	7838	33	34	39.6996000	135	56	13.3327740	99.4509000	.0009	.0012	.0136
VAND78	7887	34	33	58.4099040	239	29	58.1026270	601.3928000	.0068	.0069	.1863
YUMA78	7894	32	56	20.9387400	245	47	48.7397950	241.6877000	.0029	.0044	.0651
AREQ79	7907	-16	27	56.6780130	288	30	24.7497010	2492.3005000	.0006	.0009	.0094
April - June 83		**M S.900-01**			**6378137.00**			**298.257**			
EAST70	7061	-27	8	52.1417770	250	36	59.1447620	115.9666000	.0023	.0029	.0552
MCDO70	7086	30	40	37.3115710	255	59	2.6229180	1961.2946000	.0005	.0007	.0113
YARA70	7090	-29	2	47.4155030	115	20	48.2665690	241.3349000	.0008	.0007	.0109
GORF71	7102	39	1	14.3910800	283	10	18.9460040	18.0442000	.0004	.0006	.0095
GORF71	7105	39	1	14.1759030	283	10	20.3085300	19.1649000	0.0000	0.0000	.0085
QUIN71	7109	39	58	30.0138060	239	3	19.0891190	1106.2977000	.0004	.0006	.0094
MOUN71	7110	32	53	30.2554590	243	34	38.3984240	1838.9916000	.0003	.0005	.0087
PLAT71	7112	40	10	58.0133060	255	16	26.4798300	1501.5551000	.0006	.0009	.0161
MAZA71	7122	23	20	34.2619280	253	32	27.3006120	30.8614000	.0004	.0007	.0094
LURE72	7210	20	42	25.9767180	203	44	38.7398910	3067.4888000	0.0000	.0006	.0062
KIRK78	7805	60	13	2.2218720	24	23	40.2820650	78.5045000	.0650	.1099	.2812
KOOT78	7833	52	10	42.2233470	5	48	35.2883520	93.3208000	.0118	.0207	.2018
WETT78	7834	49	8	41.7707920	12	52	41.1193490	661.0951000	.0014	.0019	.0207
SIMO78	7838	33	34	39.7100620	135	56	13.3379840	99.4500000	.0022	.0020	.0269
ROYA78	7840	50	52	2.5599490	0	20	10.0202870	75.4124000	.0011	.0020	.0158
YUMA78	7894	32	56	20.9388040	245	47	48.7436020	241.7964000	.0005	.0006	.0100
AREQ79	7907	-16	27	56.6798610	288	30	24.7492070	2492.2960000	.0003	.0006	.0052

July - September 83 M S.556-01 6378137.00 298.257

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
POTS11	1181	52	22	48.9393440	13	3	54.9972290	147.8504000	.0157	.0439	.3372
OTAY70	7062	32	36	2.6702570	243	9	32.9203440	988.4268000	.0005	.0009	.0115
MCDO70	7086	30	40	37.3175910	255	59	2.6255830	1961.4502000	.0004	.0008	.0093
GORF71	7105	39	1	14.1759240	283	10	20.3083400	19.1157000	0.0000	0.0000	.0066
QUIN71	7109	39	58	30.0125900	239	3	19.0873190	1106.3733000	.0002	.0005	.0036
MOUN71	7110	32	53	30.2570570	243	34	38.4027730	1839.1544000	.0008	.0011	.0287
PLAT71	7112	40	10	58.0132310	255	16	26.4837810	1501.3575000	.0005	.0011	.0156
HUAH71	7121	-16	44	.6694900	208	57	31.9268730	43.5892000	.0003	.0005	.0053
MAZA71	7122	23	20	34.2601420	253	32	27.2987140	30.9299000	.0003	.0006	.0066
LURE72	7210	20	42	25.9770060	203	44	38.7397690	3067.5062000	0.0000	.0005	.0037
MOUN72	7220	32	53	30.2371150	243	34	37.7881450	1838.8185000	.0003	.0005	.0055
KOOT78	7833	52	10	42.2321670	5	48	35.2864690	93.4462000	.0133	.0465	.3948
WETT78	7834	49	8	41.7651020	12	52	41.1299510	661.1000000	.0010	.0015	.0162
SIMO78	7838	33	34	39.7004520	135	56	13.3295900	99.3271000	.0006	.0008	.0105
GRAZ78	7839	47	4	1.6742550	15	29	36.0729770	539.4125000	.0007	.0010	.0122
QUIN78	7886	39	58	30.0298330	239	3	18.7620080	1109.6232000	.0004	.0007	.0093
YUMA78	7894	32	56	20.9363350	245	47	48.7434160	241.8301000	.0013	.0016	.0345
AREQ79	7907	-16	27	56.6797230	288	30	24.7467490	2492.2866000	.0003	.0005	.0020
MATE79	7939	40	38	55.7807620	16	42	16.8471180	535.8907000	.0005	.0006	.0073

October - December 83 M S.661-01 6378137.00 298.257

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
POTS11	1181	52	22	48.9312310	13	3	55.0209550	147.9949000	.0045	.0069	.0641
OTAY70	7062	32	36	2.6691940	243	9	32.9204900	988.4559000	.0004	.0005	.0079
BEAR70	7082	41	56	.9033020	248	34	45.6764070	1962.9621000	.0005	.0006	.0115
MCDO70	7086	30	40	37.3172640	255	59	2.6237780	1961.4321000	.0003	.0004	.0070
YARA70	7090	-29	2	47.4181370	115	20	48.2616950	241.3112000	.0005	.0004	.0058
GORF71	7105	39	1	14.1759610	283	10	20.3081650	19.1326000	0.0000	0.0000	.0056
QUIN71	7109	39	58	30.0120480	239	3	19.0883170	1106.3763000	.0003	.0004	.0072
MOUN71	7110	32	53	30.2554220	243	34	38.3995410	1838.9422000	.0002	.0004	.0056
PLAT71	7112	40	10	58.0123570	255	16	26.4803120	1501.4104000	.0003	.0004	.0069
HUAH71	7121	-16	44	.6698510	208	57	31.9277720	43.6264000	.0003	.0004	.0056
MAZA71	7122	23	20	34.2593520	253	32	27.3001240	30.8898000	.0002	.0004	.0053
LURE72	7210	20	42	25.9769520	203	44	38.7398930	3067.5261000	0.0000	.0004	.0040
MOUN72	7220	32	53	30.2364270	243	34	37.7886060	1838.8494000	.0002	.0004	.0064
KIRK78	7805	60	13	2.2827260	24	23	40.3835970	79.1331000	.0079	.0143	.1299
HELW78	7831	29	51	32.4003070	31	20	33.6603300	131.2880000	.0081	.0117	.1765
KOOT78	7833	52	10	42.2395460	5	48	35.2934190	93.2901000	.0110	.0202	.1920
WETT78	7834	49	8	41.7666590	12	52	41.1300430	661.1389000	.0006	.0005	.0065
SHAN78	7837	31	5	51.1349650	121	11	30.2396310	28.1460000	.0225	.0213	.3823
SIMO78	7838	33	34	39.7027910	135	56	13.3313590	99.4015000	.0004	.0006	.0056
GRAZ78	7839	47	4	1.6748220	15	29	36.0772310	539.4050000	.0006	.0004	.0065
ROYA78	7840	50	52	2.5556620	0	20	10.0272360	75.3453000	.0005	.0005	.0066
AREQ79	7907	-16	27	56.6797220	288	30	24.7484690	2492.2816000	.0002	.0005	.0034
MATE79	7939	40	38	55.7819560	16	42	16.8486120	535.9256000	.0006	.0004	.0062

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
January - March 84			M S.665-01			6378137.00		298.257			
POTS11	1181	52	22	48.9319550	13	3	55.0240150	147.8645000	.0044	.0070	.0677
OTAY70	7062	32	36	2.6688880	243	9	32.9226650	988.3429000	.0014	.0009	.0278
BEAR70	7082	41	56	.9056580	248	34	45.6759390	1963.0439000	.0015	.0013	.0476
MCDO70	7086	30	40	37.3175110	255	59	2.6269930	1961.5270000	.0005	.0007	.0105
YARA70	7090	-29	2	47.4199050	115	20	48.2644540	241.3767000	.0006	.0004	.0057
GORF71	7105	39	1	14.1759440	283	10	20.3079690	19.1722000	0.0000	0.0000	.0067
QUIN71	7109	39	58	30.0125320	239	3	19.0909380	1106.3503000	.0003	.0004	.0061
MOUN71	7110	32	53	30.2557190	243	34	38.4017080	1838.9657000	.0003	.0004	.0051
PLAT71	7112	40	10	58.0125410	255	16	26.4821370	1501.4634000	.0004	.0005	.0090
HUAH71	7121	-16	44	.6688980	208	57	31.9303870	43.5346000	.0004	.0006	.0076
MAZA71	7122	23	20	34.2589450	253	32	27.3011920	30.7865000	.0002	.0004	.0044
LURE72	7210	20	42	25.9776960	203	44	38.7413750	3067.5088000	0.0000	.0006	.0058
BARS72	7265	35	19	52.3812640	243	6	31.3637680	896.0064000	.0003	.0004	.0064
SANT74	7400	-33	8	58.7462730	289	19	52.9261660	725.4559000	.0007	.0014	.0153
KIRK78	7805	60	13	2.2606190	24	23	40.4311190	77.8189000	.0106	.0146	.1340
KOOT78	7833	52	10	42.2401410	5	48	35.2808880	93.2819000	.0184	.0148	.3247
WETT78	7834	49	8	41.7652010	12	52	41.1298160	661.1350000	.0007	.0006	.0070
SIMO78	7838	33	34	39.7013120	135	56	13.3278800	99.4150000	.0005	.0008	.0070
GRAZ78	7839	47	4	1.6738710	15	29	36.0779310	539.3733000	.0007	.0006	.0106
ROYA78	7840	50	52	2.5555290	0	20	10.0299310	75.3416000	.0006	.0006	.0070
CABO78	7882	22	55	3.1813490	250	8	8.0709590	111.2946000	.0004	.0006	.0094
AREQ79	7907	-16	27	56.6795590	288	30	24.7484710	2492.3395000	.0007	.0010	.0142
MATE79	7939	40	38	55.7816490	16	42	16.8506780	535.8787000	.0007	.0005	.0065
April - June 84			M S.543-01			6378137.00		298.257			
POTS11	1181	52	22	48.9327730	13	3	55.0176220	147.8401000	.0072	.0079	.0976
EAST70	7061	-27	8	52.1442000	250	36	59.1468210	115.8685000	.0062	.0070	.1251
MCDO70	7086	30	40	37.3172160	255	59	2.6262120	1961.4697000	.0002	.0003	.0072
YARA70	7090	-29	2	47.4163190	115	20	48.2634420	241.3671000	.0002	.0002	.0028
GORF71	7105	39	1	14.1759620	283	10	20.3077920	19.1814000	0.0000	0.0000	.0034
QUIN71	7109	39	58	30.0124140	239	3	19.0882570	1106.3414000	.0001	.0002	.0025
MOUN71	7110	32	53	30.2562350	243	34	38.3995540	1838.9621000	.0001	.0002	.0029
PLAT71	7112	40	10	58.0132610	255	16	26.4807100	1501.4232000	.0002	.0003	.0046
HUAH71	7121	-16	44	.6681990	208	57	31.9257630	43.6065000	.0002	.0003	.0039
MAZA71	7122	23	20	34.2595250	253	32	27.3013180	30.8246000	.0003	.0004	.0069
LURE72	7210	20	42	25.9780810	203	44	38.7397970	3067.4708000	0.0000	.0003	.0022
SANT74	7400	-33	8	58.7497370	289	19	52.9278710	725.4607000	.0002	.0004	.0054
CERR74	7401	-30	10	20.9166310	289	11	59.8743920	2158.7138000	.0002	.0003	.0036
KIRK78	7805	60	13	2.2927210	24	23	40.5053040	78.5685000	.0398	.0567	.8169
BERN78	7810	46	52	38.0156630	7	27	54.7587510	951.0621000	.0006	.0010	.0125
KOOT78	7833	52	10	42.2355960	5	48	35.2806990	93.4280000	.0033	.0037	.0592
WETT78	7834	49	8	41.7689300	12	52	41.1298900	661.1035000	.0003	.0004	.0046
SIMO78	7838	33	34	39.7039810	135	56	13.3310320	99.4372000	.0003	.0005	.0066
GRAZ78	7839	47	4	1.6764270	15	29	36.0786600	539.4089000	.0004	.0005	.0070
ROYA78	7840	50	52	2.5579870	0	20	10.0296830	75.3600000	.0003	.0004	.0038
AREQ79	7907	-16	27	56.6794770	288	30	24.7509160	2492.2987000	.0002	.0003	.0028
MATE79	7939	40	38	55.7845370	16	42	16.8515110	535.8314000	.0003	.0003	.0037
KOOT88	8833	52	10	41.4506330	5	48	36.5882440	88.6193000	.0004	.0007	.0073

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 84				**M S.519-01**			**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9338420	13	3	55.0219000	148.0231000	.0044	.0057	.0543
EAST70	7061	-27	8	52.1450100	250	36	59.1484250	115.8129000	.0031	.0044	.0644
MCDO70	7086	30	40	37.3142920	255	59	2.6266500	1961.5331000	.0002	.0003	.0053
YARA70	7090	-29	2	47.4164310	115	20	48.2633860	241.3517000	.0003	.0002	.0031
GORF71	7105	39	1	14.1759620	283	10	20.3076080	19.1737000	0.0000	0.0000	.0039
QUIN71	7109	39	58	30.0125160	239	3	19.0887780	1106.3396000	.0001	.0002	.0029
MOUN71	7110	32	53	30.2558190	243	34	38.3990430	1838.9558000	.0001	.0002	.0030
PLAT71	7112	40	10	58.0121850	255	16	26.4803240	1501.4444000	.0002	.0004	.0055
HUAH71	7121	-16	44	.6684640	208	57	31.9241580	43.6025000	.0002	.0003	.0048
MAZA71	7122	23	20	34.2607480	253	32	27.3009480	30.8232000	.0002	.0003	.0045
LURE72	7210	20	42	25.9787610	203	44	38.7384590	3067.4713000	0.0000	.0003	.0029
KIRK78	7805	60	13	2.2818730	24	23	40.4284720	78.0664000	.0162	.0232	.1678
BERN78	7810	46	52	38.0181440	7	27	54.7643830	951.0240000	.0003	.0004	.0043
KOOT78	7833	52	10	42.2364610	5	48	35.2907140	93.4091000	.0065	.0110	.0897
WETT78	7834	49	8	41.7677380	12	52	41.1321920	661.1117000	.0003	.0004	.0039
SHAN78	7837	31	5	51.1549520	121	11	30.2359770	27.8111000	.0104	.0122	.1624
SIMO78	7838	33	34	39.7029000	135	56	13.3305430	99.4139000	.0003	.0004	.0043
GRAZ78	7839	47	4	1.6740210	15	29	36.0776930	539.4113000	.0004	.0004	.0047
ROYA78	7840	50	52	2.5565530	0	20	10.0310280	75.3727000	.0003	.0004	.0036
AREQ79	7907	-16	27	56.6816440	288	30	24.7504280	2492.2882000	.0002	.0003	.0024
MATE79	7939	40	38	55.7824270	16	42	16.8521290	535.8222000	.0003	.0003	.0032
October - December 84				**M S.551-01**			**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9291670	13	3	55.0228310	147.9414000	.0066	.0106	.0738
EAST70	7061	-27	8	52.1451570	250	36	59.1466390	115.8546000	.0039	.0060	.0817
MCDO70	7086	30	40	37.3163960	255	59	2.6230480	1961.4027000	.0003	.0004	.0055
YARA70	7090	-29	2	47.4153260	115	20	48.2625750	241.3533000	.0003	.0003	.0033
GORF71	7105	39	1	14.1759860	283	10	20.3074300	19.1625000	0.0000	0.0000	.0047
QUIN71	7109	39	58	30.0120710	239	3	19.0882630	1106.3766000	.0002	.0003	.0040
MOUN71	7110	32	53	30.2561590	243	34	38.3984740	1838.9850000	.0002	.0003	.0036
PLAT71	7112	40	10	58.0078970	255	16	26.4757360	1501.5239000	.0013	.0022	.0198
HUAH71	7121	-16	44	.6680370	208	57	31.9235430	43.6235000	.0002	.0004	.0043
MAZA71	7122	23	20	34.2601020	253	32	27.3003510	30.8212000	.0002	.0003	.0031
LURE72	7210	20	42	25.9789820	203	44	38.7386580	3067.5082000	0.0000	.0004	.0032
KIRK78	7805	60	13	2.2929890	24	23	40.4358430	78.0593000	.0334	.0617	.3773
BERN78	7810	46	52	38.0199900	7	27	54.7618940	951.0570000	.0005	.0007	.0068
KOOT78	7833	52	10	42.2292670	5	48	35.2804070	93.4936000	.0062	.0097	.0882
WETT78	7834	49	8	41.7690300	12	52	41.1285430	661.1031000	.0004	.0005	.0047
GRAS78	7835	43	45	16.8754320	6	55	16.0215900	1322.8358000	.0004	.0005	.0046
SHAN78	7837	31	5	51.1483090	121	11	30.2355890	27.8506000	.0031	.0044	.0764
SIMO78	7838	33	34	39.7027680	135	56	13.3312570	99.4513000	.0003	.0005	.0038
GRAZ78	7839	47	4	1.6750560	15	29	36.0727590	539.3550000	.0011	.0014	.0303
ROYA78	7840	50	52	2.5577330	0	20	10.0286300	75.3887000	.0003	.0004	.0040
QUIN78	7886	39	58	30.0551300	239	3	18.6344670	1109.6495000	.0003	.0005	.0074
AREQ79	7907	-16	27	56.6801920	288	30	24.7501980	2492.3206000	.0002	.0004	.0037
MATE79	7939	40	38	55.7833420	16	42	16.8503320	535.8457000	.0004	.0004	.0040
KOOT88	8833	52	10	41.4412040	5	48	36.5936500	88.7166000	.0005	.0010	.0088

Station Name	Station Num.	Latitude (°)	Latitude (′)	Latitude (″)	Longitude (°)	Longitude (′)	Longitude (″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)

January - March 85   M S.633-01   6378137.00   298.257

Station Name	Num.	(°)	(′)	(″)	(°)	(′)	(″)	Height (m)	Lat. (″)	Lon. (″)	Ht. (m)
POTS11	1181	52	22	48.9665450	13	3	55.0075530	148.1179000	.0150	.0351	.3752
MCDO70	7086	30	40	37.3165840	255	59	2.6223130	1961.4674000	.0004	.0004	.0082
YARA70	7090	-29	2	47.4139690	115	20	48.2640360	241.3608000	.0004	.0003	.0033
GORF71	7105	39	1	14.1760140	283	10	20.3072580	19.1645000	0.0000	0.0000	.0047
QUIN71	7109	39	58	30.0118420	239	3	19.0874020	1106.3511000	.0003	.0003	.0049
MOUN71	7110	32	53	30.2557550	243	34	38.3981270	1838.9617000	.0003	.0003	.0042
HUAH71	7121	-16	44	.6706670	208	57	31.9256610	43.5744000	.0004	.0005	.0061
MAZA71	7122	23	20	34.2594310	253	32	27.3003520	30.8226000	.0002	.0003	.0039
LURE72	7210	20	42	25.9791110	203	44	38.7377940	3067.5309000	0.0000	.0005	.0067
WETT75	7596	49	8	39.0555080	12	52	43.2367870	657.3310000	.0028	.0056	.0341
WETT78	7834	49	8	41.7675560	12	52	41.1317150	661.1424000	.0011	.0011	.0153
GRAS78	7835	43	45	16.8763480	6	55	16.0240920	1322.8301000	.0006	.0005	.0073
SIMO78	7838	33	34	39.7033080	135	56	13.3332290	99.4104000	.0004	.0007	.0055
GRAZ78	7839	47	4	1.6753420	15	29	36.0724980	539.4801000	.0007	.0011	.0187
ROYA78	7840	50	52	2.5585750	0	20	10.0284130	75.3885000	.0005	.0004	.0047
AREQ79	7907	-16	27	56.6791500	288	30	24.7495590	2492.3428000	.0003	.0006	.0070
MATE79	7939	40	38	55.7849580	16	42	16.8520760	535.8126000	.0006	.0005	.0073
KOOT88	8833	52	10	41.4467900	5	48	36.5902470	88.6026000	.0008	.0012	.0118

April - June 85   M S.566-01   6378137.00   298.257

Station Name	Num.	(°)	(′)	(″)	(°)	(′)	(″)	Height (m)	Lat. (″)	Lon. (″)	Ht. (m)
POTS11	1181	52	22	48.9246460	13	3	55.0366060	147.7436000	.0099	.0178	.2578
MCDO70	7086	30	40	37.3142010	255	59	2.6232320	1961.4853000	.0003	.0004	.0078
YARA70	7090	-29	2	47.4144540	115	20	48.2659350	241.3839000	.0002	.0002	.0025
GORF71	7105	39	1	14.1760380	283	10	20.3070680	19.1569000	0.0000	0.0000	.0034
QUIN71	7109	39	58	30.0123530	239	3	19.0865520	1106.3427000	.0001	.0002	.0030
MOUN71	7110	32	53	30.2565450	243	34	38.3974280	1838.9882000	.0001	.0002	.0027
HUAH71	7121	-16	44	.6676890	208	57	31.9245080	43.5896000	.0005	.0006	.0157
MAZA71	7122	23	20	34.2593460	253	32	27.3006310	30.8347000	.0001	.0002	.0030
GORF71	7125	39	1	12.9664870	283	10	21.1960350	18.5279000	.0002	.0003	.0051
LURE72	7210	20	42	25.9793430	203	44	38.7352080	3067.5238000	0.0000	.0003	.0032
WETT78	7834	49	8	41.7665500	12	52	41.1296340	661.1666000	.0004	.0006	.0071
GRAS78	7835	43	45	16.8750050	6	55	16.0236290	1322.8432000	.0003	.0003	.0052
SIMO78	7838	33	34	39.7033200	135	56	13.3291540	99.4472000	.0003	.0004	.0042
GRAZ78	7839	47	4	1.6744130	15	29	36.0759840	539.4486000	.0004	.0005	.0085
ROYA78	7840	50	52	2.5562450	0	20	10.0314610	75.3933000	.0003	.0004	.0047
ORRO78	7843	-35	38	10.5223780	148	56	21.5134760	1349.9182000	.0002	.0003	.0036
AREQ79	7907	-16	27	56.6792940	288	30	24.7501230	2492.3032000	.0002	.0003	.0029
MATE79	7939	40	38	55.7820650	16	42	16.8503160	535.8457000	.0003	.0003	.0038

July - September 85   M S.728-01   6378137.00   298.257

Station Name	Num.	(°)	(′)	(″)	(°)	(′)	(″)	Height (m)	Lat. (″)	Lon. (″)	Ht. (m)
POTS11	1181	52	22	48.9330640	13	3	55.0212390	147.8415000	.0086	.0138	.1122
MCDO70	7086	30	40	37.3147480	255	59	2.6225650	1961.4902000	.0002	.0003	.0047
YARA70	7090	-29	2	47.4142860	115	20	48.2654650	241.3680000	.0003	.0003	.0033
GORF71	7105	39	1	14.1760320	283	10	20.3068750	19.1808000	0.0000	0.0000	.0044
QUIN71	7109	39	58	30.0132380	239	3	19.0859140	1106.3465000	.0002	.0003	.0036
MOUN71	7110	32	53	30.2569910	243	34	38.3960490	1838.9955000	.0002	.0003	.0040
HUAH71	7121	-16	44	.6749300	208	57	31.9194370	43.5827000	.0016	.0014	.0238
MAZA71	7122	23	20	34.2602900	253	32	27.3002450	30.8531000	.0002	.0003	.0045
GORF71	7125	39	1	12.9658160	283	10	21.1958590	18.5442000	.0005	.0007	.0123
LURE72	7210	20	42	25.9796750	203	44	38.7364970	3067.4987000	0.0000	.0003	.0035
MONT75	7590	45	55	39.2510290	9	1	3.9356440	1648.3807000	.0004	.0005	.0067
BERN78	7810	46	52	38.0125340	7	27	54.7755270	950.9841000	.0006	.0008	.0101
WETT78	7834	49	8	41.7675740	12	52	41.1332760	661.1468000	.0004	.0004	.0043
GRAS78	7835	43	45	16.8744330	6	55	16.0271180	1322.9135000	.0003	.0003	.0040
SIMO78	7838	33	34	39.7013410	135	56	13.3293830	99.4890000	.0003	.0004	.0040
GRAZ78	7839	47	4	1.6738200	15	29	36.0821200	539.3993000	.0004	.0005	.0066
ROYA78	7840	50	52	2.5573170	0	20	10.0314150	75.4033000	.0003	.0003	.0042
ORRO78	7843	-35	38	10.5219070	148	56	21.5138000	1349.8697000	.0003	.0004	.0051
AREQ79	7907	-16	27	56.6786070	288	30	24.7494450	2492.3144000	.0002	.0004	.0031
MATE79	7939	40	38	55.7816960	16	42	16.8531890	535.8504000	.0004	.0003	.0036

Station Name	Station Num.	Latitude (°)	Latitude (′)	Latitude (″)	Longitude (°)	Longitude (′)	Longitude (″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)

October - December 85 RMS.780-01 6378137.00 298.257

POTS11	1181	52	22	48.9321300	13	3	55.0257290	147.8831000	.0078	.0144	.1171
MCDO70	7086	30	40	37.3146010	255	59	2.6248010	1961.4573000	.0002	.0004	.0040
YARA70	7090	-29	2	47.4142510	115	20	48.2660300	241.3520000	.0004	.0004	.0041
GORF71	7105	39	1	14.1760540	283	10	20.3066980	19.1647000	0.0000	0.0000	.0060
QUIN71	7109	39	58	30.0128470	239	3	19.0871570	1106.3593000	.0002	.0004	.0044
MOUN71	7110	32	53	30.2571470	243	34	38.3973600	1838.9845000	.0002	.0004	.0045
HUAH71	7121	-16	44	.6651520	208	57	31.9224040	43.5680000	.0005	.0006	.0092
MAZA71	7122	23	20	34.2596780	253	32	27.3005630	30.8576000	.0002	.0004	.0043
LURE72	7210	20	42	25.9799730	203	44	38.7359820	3067.5045000	0.0000	.0004	.0041
PUNT75	7545	39	8	7.7747910	8	58	22.7409660	229.9782000	.0005	.0006	.0061
MONT75	7590	45	55	39.2525810	9	1	3.9351250	1648.4752000	.0004	.0006	.0061
BERN78	7810	46	52	38.0111160	7	27	54.7749460	951.0889000	.0005	.0007	.0076
WETT78	7834	49	8	41.7691200	12	52	41.1316260	661.1185000	.0005	.0006	.0058
GRAS78	7835	43	45	16.8766260	6	55	16.0258910	1322.9143000	.0004	.0005	.0051
SIMO78	7838	33	34	39.7018080	135	56	13.3307810	99.4765000	.0003	.0005	.0038
GRAZ78	7839	47	4	1.6720700	15	29	36.0831360	539.7217000	.0165	.0099	.4568
ROYA78	7840	50	52	2.5584670	0	20	10.0314000	75.4057000	.0004	.0005	.0046
ORRO78	7843	-35	38	10.5238670	148	56	21.5163020	1349.9882000	.0004	.0005	.0246
AREQ79	7907	-16	27	56.6788410	288	30	24.7521630	2492.3581000	.0004	.0005	.0063
MATE79	7939	40	38	55.7836120	16	42	16.8527100	535.8239000	.0004	.0004	.0039

January - March 86 RMS.589-01 6378137.00 298.257

POTS11	1181	52	22	48.9285970	13	3	55.0204990	147.8162000	.0056	.0090	.0914
MCDO70	7086	30	40	37.3145050	255	59	2.6233860	1961.4775000	.0002	.0003	.0032
YARA70	7090	-29	2	47.4137480	115	20	48.2640730	241.3433000	.0003	.0003	.0031
GORF71	7105	39	1	14.1760780	283	10	20.3065420	19.1416000	0.0000	0.0000	.0055
QUIN71	7109	39	58	30.0118830	239	3	19.0869220	1106.3479000	.0002	.0004	.0042
MOUN71	7110	32	53	30.2573610	243	34	38.3964830	1838.9722000	.0002	.0003	.0034
HUAH71	7121	-16	44	.6677880	208	57	31.9179430	43.6682000	.0003	.0005	.0060
MAZA71	7122	23	20	34.2597760	253	32	27.2993470	30.8655000	.0002	.0003	.0030
LURE72	7210	20	42	25.9805390	203	44	38.7345950	3067.4803000	0.0000	.0004	.0034
MATE75	7541	40	38	54.6942550	16	42	15.4159240	528.3682000	.0004	.0004	.0048
BERN78	7810	46	52	38.0103700	7	27	54.7697190	951.0454000	.0006	.0008	.0087
WETT78	7834	49	8	41.7702140	12	52	41.1288900	661.0828000	.0004	.0005	.0051
GRAS78	7835	43	45	16.8796550	6	55	16.0234050	1322.8930000	.0006	.0010	.0114
SIMO78	7838	33	34	39.7029840	135	56	13.3305610	99.4590000	.0003	.0004	.0032
GRAZ78	7839	47	4	1.6765960	15	29	36.0783200	539.4040000	.0004	.0005	.0062
ROYA78	7840	50	52	2.5585220	0	20	10.0295880	75.3903000	.0003	.0004	.0038
ORRO78	7843	-35	38	10.5199440	148	56	21.5108680	1349.9735000	.0003	.0004	.0152
AREQ79	7907	-16	27	56.6814230	288	30	24.7477520	2492.3117000	.0004	.0005	.0060
MATE79	7939	40	38	55.7848650	16	42	16.8505410	535.8044000	.0004	.0004	.0041

April - June 86 RMS.847-01 6378137.00 298.257

POTS11	1181	52	22	48.9360490	13	3	55.0167740	147.5723000	.0112	.0166	.2084
MCDO70	7086	30	40	37.3150710	255	59	2.6232900	1961.4601000	.0003	.0005	.0074
YARA70	7090	-29	2	47.4134390	115	20	48.2645880	241.3539000	.0004	.0003	.0043
GORF71	7105	39	1	14.1761070	283	10	20.3063600	19.1636000	0.0000	0.0000	.0052
QUIN71	7109	39	58	30.0117050	239	3	19.0856240	1106.3146000	.0003	.0004	.0049
MOUN71	7110	32	53	30.2565360	243	34	38.3961060	1838.9826000	.0003	.0004	.0044
HUAH71	7121	-16	44	.6664670	208	57	31.9187160	43.7692000	.0006	.0007	.0104
MAZA71	7122	23	20	34.2596580	253	32	27.2993830	30.8711000	.0003	.0004	.0050
LURE72	7210	20	42	25.9804980	203	44	38.7336450	3067.4442000	0.0000	.0006	.0065
ROUM75	7517	35	24	15.2723860	24	41	38.9918270	102.3862000	.0007	.0008	.0128
KARI75	7520	39	44	3.2968930	20	39	53.3892900	598.5863000	.0006	.0006	.0067
BASO75	7550	45	38	34.6311910	13	52	32.0104300	447.0707000	.0006	.0008	.0081
BERN78	7810	46	52	38.0129360	7	27	54.7723290	951.0961000	.0011	.0016	.0154
WETT78	7834	49	8	41.7702800	12	52	41.1287020	661.1313000	.0006	.0008	.0073
GRAS78	7835	43	45	16.8815960	6	55	16.0188500	1322.9256000	.0010	.0015	.0205
SIMO78	7838	33	34	39.7023200	135	56	13.3329390	99.4759000	.0004	.0007	.0059
GRAZ78	7839	47	4	1.6773150	15	29	36.0765640	539.3844000	.0006	.0007	.0075
ROYA78	7840	50	52	2.5600140	0	20	10.0298770	75.3988000	.0005	.0006	.0055
ORRO78	7843	-35	38	10.5230110	148	56	21.5126610	1349.9616000	.0004	.0004	.0133
AREQ79	7907	-16	27	56.6796600	288	30	24.7493670	2492.2807000	.0003	.0005	.0045
MATE79	7939	40	38	55.7852350	16	42	16.8508520	535.7893000	.0006	.0005	.0054

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 86			**S.359-01**			**6378137.00**		**298.257**			
MCDO70	7086	30	40	37.3149310	255	59	2.6218720	1961.5422000	.0002	.0003	.0045
YARA70	7090	-29	2	47.4111230	115	20	48.2666920	241.3429000	.0002	.0002	.0023
GORF71	7105	39	1	14.1761210	283	10	20.3061680	19.1488000	0.0000	0.0000	.0036
QUIN71	7109	39	58	30.0119760	239	3	19.0852780	1106.3257000	.0002	.0002	.0023
MOUN71	7110	32	53	30.2571770	243	34	38.3951500	1838.9820000	.0002	.0002	.0028
MAZA71	7122	23	20	34.2598910	253	32	27.2984750	30.8283000	.0002	.0003	.0030
LURE72	7210	20	42	25.9808650	203	44	38.7333980	3067.4857000	0.0000	.0003	.0030
ASKI75	7510	40	55	40.8638040	25	33	58.3775530	182.5806000	.0018	.0032	.0389
KATV75	7512	35	57	5.4668860	27	46	50.8750460	73.9358000	.0028	.0040	.0662
NTUA75	7515	38	4	42.9329380	23	55	56.8576750	510.5590000	.0010	.0014	.0241
ROUM75	7517	35	24	15.2725610	24	41	38.9906410	102.4207000	.0013	.0015	.0246
XRIS75	7525	36	47	29.2001720	21	52	39.4005610	476.2329000	.0017	.0022	.0325
BAR 75	7530	31	43	20.6100980	35	5	18.7483370	774.3873000	.0005	.0004	.0092
BERN78	7810	46	52	38.0117150	7	27	54.7602920	951.3579000	.0018	.0054	.1134
WETT78	7834	49	8	41.7692830	12	52	41.1293970	661.1301000	.0006	.0007	.0093
GRAS78	7835	43	45	16.8785190	6	55	16.0238270	1322.7925000	.0027	.0029	.0771
SIMO78	7838	33	34	39.7040430	135	56	13.3278650	99.4845000	.0003	.0004	.0043
GRAZ78	7839	47	4	1.6767110	15	29	36.0786460	539.3777000	.0005	.0006	.0100
ROYA78	7840	50	52	2.5587880	0	20	10.0315990	75.3718000	.0002	.0004	.0024
ORRO78	7843	-35	38	10.5209830	148	56	21.5136090	1349.9627000	.0002	.0003	.0083
AREQ79	7907	-16	27	56.6788470	288	30	24.7496350	2492.2947000	.0002	.0003	.0024
MATE79	7939	40	38	55.7841120	16	42	16.8504340	535.8156000	.0003	.0003	.0042
October - December 86			**S.452-01**			**6378137.00**		**298.257**			
POTS11	1181	52	22	48.9345090	13	3	55.0347710	147.7512000	.0056	.0095	.0871
MCDO70	7086	30	40	37.3150060	255	59	2.6218600	1961.5135000	.0002	.0003	.0051
YARA70	7090	-29	2	47.4113420	115	20	48.2657220	241.3274000	.0003	.0002	.0028
GORF71	7105	39	1	14.1761530	283	10	20.3059940	19.1577000	0.0000	0.0000	.0032
QUIN71	7109	39	58	30.0110530	239	3	19.0853110	1106.3243000	.0002	.0002	.0033
MOUN71	7110	32	53	30.2563410	243	34	38.3940090	1838.9606000	.0002	.0002	.0029
MAZA71	7122	23	20	34.2591300	253	32	27.2984770	30.8314000	.0002	.0002	.0030
LURE72	7210	20	42	25.9810870	203	44	38.7333230	3067.4884000	0.0000	.0003	.0036
KATV75	7512	35	57	5.4647590	27	46	50.8742290	73.9088000	.0011	.0016	.0279
XRIS75	7525	36	47	29.1980100	21	52	39.3980120	476.2277000	.0198	.0436	.2618
BAR 75	7530	31	43	20.6105750	35	5	18.7501730	774.3869000	.0004	.0004	.0041
KIRK78	7805	60	13	2.2791580	24	23	40.3095140	79.1765000	.0189	.1133	1.3183
BERN78	7810	46	52	38.0130580	7	27	54.7579200	951.1367000	.0007	.0024	.0202
WETT78	7834	49	8	41.7685370	12	52	41.1300040	661.1001000	.0004	.0004	.0040
GRAS78	7835	43	45	16.8769640	6	55	16.0245050	1322.8067000	.0004	.0003	.0040
SIMO78	7838	33	34	39.7028270	135	56	13.3287930	99.4620000	.0003	.0004	.0034
GRAZ78	7839	47	4	1.6758430	15	29	36.0766800	539.4003000	.0005	.0005	.0083
ROYA78	7840	50	52	2.5579610	0	20	10.0315760	75.3487000	.0003	.0003	.0041
ORRO78	7843	-35	38	10.5209190	148	56	21.5128460	1350.0293000	.0003	.0004	.0194
AREQ79	7907	-16	27	56.6787220	288	30	24.7507530	2492.2731000	.0002	.0003	.0030
MATE79	7939	40	38	55.7831340	16	42	16.8510020	535.8257000	.0004	.0003	.0039

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
January - March 87				RMS.395-01			6378137.00	298.257			
POTS11	1181	52	22	48.9346560	13	3	55.0289300	148.0603000	.0039	.0055	.0704
MCDO70	7086	30	40	37.3157390	255	59	2.6212440	1961.4991000	.0001	.0002	.0031
YARA70	7090	-29	2	47.4122590	115	20	48.2659490	241.3247000	.0003	.0002	.0030
GORF71	7105	39	1	14.1761560	283	10	20.3058170	19.1938000	0.0000	0.0000	.0033
QUIN71	7109	39	58	30.0126700	239	3	19.0854830	1106.3300000	.0002	.0002	.0035
MOUN71	7110	32	53	30.2577930	243	34	38.3941960	1838.9553000	.0002	.0002	.0033
MAZA71	7122	23	20	34.2603600	253	32	27.2984040	30.8674000	.0001	.0002	.0027
LURE72	7210	20	42	25.9811610	203	44	38.7336090	3067.5323000	0.0000	.0003	.0035
KATV75	7512	35	57	5.4575660	27	46	50.8748920	73.8637000	.0061	.0075	.0747
BAR 75	7530	31	43	20.6075080	35	5	18.7482000	774.3789000	.0025	.0028	.0393
BERN78	7810	46	52	38.0385520	7	27	54.7107520	951.2205000	.0096	.0211	.0125
WETT78	7834	49	8	41.7676200	12	52	41.1332310	661.0760000	.0005	.0006	.0086
GRAS78	7835	43	45	16.8742680	6	55	16.0258380	1322.8046000	.0009	.0013	.0235
SHAN78	7837	31	5	51.1517980	121	11	30.2388020	27.9356000	.0086	.0096	.1682
SIMO78	7838	33	34	39.7015500	135	56	13.3268080	99.4763000	.0003	.0004	.0034
GRAZ78	7839	47	4	1.6731500	15	29	36.0773310	539.4348000	.0011	.0016	.0208
ROYA78	7840	50	52	2.5572940	0	20	10.0328300	75.3820000	.0003	.0002	.0037
ORRO78	7843	-35	38	10.5194620	148	56	21.5158890	1349.9933000	.0016	.0019	.0962
AREQ79	7907	-16	27	56.6780470	288	30	24.7492180	2492.2531000	.0002	.0003	.0031
MATE79	7939	40	38	55.7830410	16	42	16.8527600	535.8125000	.0004	.0002	.0038
April - June 87				S.331-01			6378137.00	298.257			
POTS11	1181	52	22	48.9351690	13	3	55.0199330	147.9684000	.0051	.0066	.0956
MCDO70	7086	30	40	37.3152810	255	59	2.6232070	1961.5025000	.0001	.0002	.0025
YARA70	7090	-29	2	47.4103850	115	20	48.2690390	241.3875000	.0003	.0002	.0030
GORF71	7105	39	1	14.1761610	283	10	20.3056170	19.1734000	0.0000	0.0000	.0028
QUIN71	7109	39	58	30.0124110	239	3	19.0858130	1106.3246000	.0001	.0002	.0026
MOUN71	7110	32	53	30.2576650	243	34	38.3949670	1838.9562000	.0001	.0002	.0023
MAZA71	7122	23	20	34.2603610	253	32	27.3002750	30.8832000	.0001	.0002	.0026
LURE72	7210	20	42	25.9817140	203	44	38.7332000	3067.4807000	0.0000	.0002	.0021
ASKI75	7510	40	55	40.8630780	25	33	58.3778940	182.6459000	.0026	.0047	.0572
KATV75	7512	35	57	5.4640290	27	46	50.8736380	73.9192000	.0011	.0014	.0220
BAR 75	7530	31	43	20.6122410	35	5	18.7481060	774.4455000	.0004	.0003	.0039
DIYA75	7575	37	55	12.8494310	40	11	41.5816760	724.9863000	.0016	.0022	.0288
MELE75	7580	37	22	39.5766860	33	11	28.5011220	1357.7628000	.0010	.0015	.0298
YOZG75	7585	39	48	1.8927660	34	48	46.8350940	1677.1022000	.0017	.0023	.0468
YIGI75	7587	40	56	13.1758710	31	26	19.6567980	822.6839000	.0013	.0015	.0337
KIRK78	7805	60	13	2.2771380	24	23	40.3745970	77.5713000	.0253	.0907	.4479
BERN78	7810	46	52	38.0123440	7	27	54.7751230	951.0664000	.0003	.0003	.0044
HELW78	7831	29	51	32.3977710	31	20	33.6766380	131.5884000	.0028	.0450	.1490
WETT78	7834	49	8	41.7712770	12	52	41.1311000	661.0624000	.0004	.0004	.0073
GRAS78	7835	43	45	16.8774210	6	55	16.0261850	1322.7531000	.0010	.0011	.0264
SHAN78	7837	31	5	51.1398060	121	11	30.2515460	28.2503000	.0162	.0225	.3612
SIMO78	7838	33	34	39.7033500	135	56	13.3307940	99.4364000	.0003	.0004	.0053
GRAZ78	7839	47	4	1.6770410	15	29	36.0807700	539.4208000	.0003	.0002	.0037
ROYA78	7840	50	52	2.5585550	0	20	10.0326000	75.3911000	.0002	.0002	.0030
ORRO78	7843	-35	38	10.5205010	148	56	21.5158070	1350.0168000	.0003	.0004	.0182
AREQ79	7907	-16	27	56.6778000	288	30	24.7522430	2492.2689000	.0002	.0003	.0039
MATE79	7939	40	38	55.7854990	16	42	16.8520780	535.8166000	.0003	.0002	.0028

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 87				**S.345-01**			**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9352940	13	3	55.0262830	147.8964000	.0034	.0056	.0503
MCDO70	7086	30	40	37.3147010	255	59	2.6226520	1961.5134000	.0001	.0002	.0028
YARA70	7090	-29	2	47.4103740	115	20	48.2636150	241.4319000	.0003	.0002	.0035
GORF71	7105	39	1	14.1761830	283	10	20.3054370	19.1579000	0.0000	0.0000	.0027
QUIN71	7109	39	58	30.0115180	239	3	19.0857940	1106.3076000	.0001	.0002	.0024
MOUN71	7110	32	53	30.2569460	243	34	38.3941410	1838.9543000	.0001	.0002	.0022
MAZA71	7122	23	20	34.2589850	253	32	27.2993630	30.8944000	.0002	.0002	.0034
HUAH71	7123	-16	44	.6685260	208	57	31.9172790	45.2972000	.0003	.0003	.0055
LURE72	7210	20	42	25.9822540	203	44	38.7327150	3067.4703000	0.0000	.0002	.0026
ASKI75	7510	40	55	40.8670560	25	33	58.3795440	182.5744000	.0008	.0013	.0155
NTUA75	7515	38	4	42.9327290	23	55	56.8604020	510.5391000	.0008	.0012	.0164
ROUM75	7517	35	24	15.2739260	24	41	38.9934060	102.3683000	.0008	.0011	.0218
XRIS75	7525	36	47	29.1989100	21	52	39.4042730	476.1254000	.0027	.0048	.0799
BAR 75	7530	31	43	20.6119310	35	5	18.7522080	774.3838000	.0003	.0003	.0033
LAMP75	7544	35	31	3.9305170	12	34	2.7878800	111.8783000	.0024	.0030	.0477
YOZG75	7585	39	48	1.8880630	34	48	46.8338530	1677.2857000	.0065	.0129	.1907
YIGI75	7587	40	56	13.1751740	31	26	19.6561530	822.6676000	.0022	.0039	.0589
BERN78	7810	46	52	38.0137460	7	27	54.7753750	951.0202000	.0003	.0003	.0033
HELW78	7831	29	51	32.4131880	31	20	33.7192480	131.8324000	.0013	.0024	.0285
WETT78	7834	49	8	41.7702190	12	52	41.1330620	661.0889000	.0003	.0003	.0032
GRAS78	7835	43	45	16.8790030	6	55	16.0281780	1322.7394000	.0036	.0043	.1021
SIMO78	7838	33	34	39.7042400	135	56	13.3324800	99.3637000	.0002	.0004	.0036
GRAZ78	7839	47	4	1.6780510	15	29	36.0806610	539.3663000	.0003	.0003	.0033
ROYA78	7840	50	52	2.5595170	0	20	10.0323950	75.3644000	.0002	.0002	.0030
ORRO78	7843	-35	38	10.5201100	148	56	21.5128470	1349.9272000	.0002	.0003	.0157
AREQ79	7907	-16	27	56.6788200	288	30	24.7506450	2492.2545000	.0001	.0002	.0026
MATE79	7939	40	38	55.7865200	16	42	16.8526500	535.8081000	.0003	.0002	.0025
October - December 87				**RMS.363-01**			**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9349000	13	3	55.0244640	147.8518000	.0032	.0048	.0510
MCDO70	7086	30	40	37.3144480	255	59	2.6211760	1961.5033000	.0001	.0002	.0028
YARA70	7090	-29	2	47.4118440	115	20	48.2673770	241.3075000	.0003	.0002	.0037
EAST70	7097	-27	8	52.1459650	250	36	59.1557430	117.5281000	.0002	.0003	.0049
GORF71	7105	39	1	14.1762080	283	10	20.3052800	19.1600000	0.0000	0.0000	.0031
QUIN71	7109	39	58	30.0112370	239	3	19.0845670	1106.3291000	.0001	.0002	.0036
MOUN71	7110	32	53	30.2576280	243	34	38.3934010	1838.9217000	.0001	.0002	.0030
MAZA71	7122	23	20	34.2589700	253	32	27.2978380	30.8650000	.0001	.0002	.0027
HUAH71	7123	-16	44	.6603550	208	57	31.9130400	45.5819000	.0006	.0007	.0110
LURE72	7210	20	42	25.9823490	203	44	38.7303190	3067.5188000	0.0000	.0003	.0029
NTUA75	7515	38	4	42.9310810	23	55	56.8585720	510.5534000	.0013	.0019	.0280
ROUM75	7517	35	24	15.2728880	24	41	38.9937290	102.3779000	.0010	.0014	.0207
XRIS75	7525	36	47	29.1995530	21	52	39.4020030	476.1499000	.0009	.0012	.0210
BAR 75	7530	31	43	20.6132370	35	5	18.7501210	774.3862000	.0005	.0003	.0051
LAMP75	7544	35	31	3.9296790	12	34	2.7880250	111.8925000	.0012	.0017	.0237
BERN78	7810	46	52	38.0137090	7	27	54.7743310	951.0608000	.0004	.0004	.0055
WETT78	7834	49	8	41.7703010	12	52	41.1321460	661.0953000	.0003	.0003	.0041
GRAS78	7835	43	45	16.8779500	6	55	16.0268100	1322.8790000	.0008	.0011	.0174
SIMO78	7838	33	34	39.7018470	135	56	13.3291280	99.4344000	.0003	.0004	.0033
GRAZ78	7839	47	4	1.6781830	15	29	36.0790260	539.3916000	.0004	.0003	.0043
ROYA78	7840	50	52	2.5601100	0	20	10.0311880	75.3732000	.0003	.0002	.0039
ORRO78	7843	-35	38	10.5144140	148	56	21.4992200	1350.3110000	.0021	.0037	.1795
AREQ79	7907	-16	27	56.6798770	288	30	24.7494850	2492.2612000	.0001	.0002	.0035
MATE79	7939	40	38	55.7856530	16	42	16.8522080	535.8229000	.0004	.0002	.0035

Station Name	Station Num.	Latitude (°)	Latitude (′)	Latitude (″)	Longitude (°)	Longitude (′)	Longitude (″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)

January - March 88 RMS.307-01 6378137.00 298.257

POTS11	1181	52	22	48.9354770	13	3	55.0258290	147.7713000	.0039	.0057	.0609
CUBA19	1953	20	0	42.9998150	284	14	15.9783280	18.2278000	.0058	.0446	.4893
MLRS70	7080	30	40	48.9673170	255	59	5.2890420	2004.2926000	.0007	.0008	.0157
MCDO70	7086	30	40	37.3152100	255	59	2.6222500	1961.4811000	.0002	.0003	.0032
YARA70	7090	-29	2	47.4113380	115	20	48.2677780	241.3345000	.0002	.0002	.0023
EAST70	7097	-27	8	52.1445750	250	36	59.1564480	117.5087000	.0002	.0003	.0040
GORF71	7105	39	1	14.1762100	283	10	20.3051400	19.1258000	0.0000	0.0000	.0031
QUIN71	7109	39	58	30.0120800	239	3	19.0844240	1106.3160000	.0002	.0002	.0025
MOUN71	7110	32	53	30.2583760	243	34	38.3917760	1838.9413000	.0001	.0002	.0023
MAZA71	7122	23	20	34.2595060	253	32	27.2982320	30.8596000	.0002	.0002	.0022
LURE72	7210	20	42	25.9828000	203	44	38.7306000	3067.4912000	0.0000	.0003	.0027
BARS72	7288	35	19	52.4516500	243	6	30.5178940	896.1475000	.0021	.0032	.0594
RICH72	7295	25	36	48.0826960	279	36	57.1835890	-22.9296000	.0089	.0066	.1443
PUNT75	7545	39	8	7.7762980	8	58	22.7430330	229.9786000	.0011	.0016	.0200
BERN78	7810	46	52	38.0114550	7	27	54.7639020	951.2734000	.0013	.0043	.0819
WETT78	7834	49	8	41.7699100	12	52	41.1335110	661.0874000	.0004	.0005	.0049
GRAS78	7835	43	45	16.8769620	6	55	16.0261990	1322.8675000	.0006	.0007	.0123
SIMO78	7838	33	34	39.7009690	135	56	13.3290790	99.3896000	.0003	.0004	.0040
GRAZ78	7839	47	4	1.6769530	15	29	36.0803060	539.3584000	.0003	.0003	.0037
ROYA78	7840	50	52	2.5593550	0	20	10.0330090	75.3963000	.0002	.0003	.0027
UNKN78	7844	27	5	30.3754580	142	13	.3635160	262.8173000	.0037	.0050	.0804
AREQ79	7907	-16	27	56.6796810	288	30	24.7513360	2492.2460000	.0002	.0003	.0037
MATE79	7939	40	38	55.7852890	16	42	16.8533350	535.8233000	.0003	.0003	.0035

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POTS11	1181	52	22	48.9366240	13	3	55.0158090	147.8604000	.0035	.0115	.2038
CUBA19	1953	20	0	42.9398470	284	14	16.0068960	18.5921000	.0626	.0089	.2728
MLRS70	7080	30	40	48.9666650	255	59	5.2884530	2004.3162000	.0011	.0012	.0222
YARA70	7090	-29	2	47.4078380	115	20	48.2679600	241.3661000	.0003	.0002	.0034
GORF71	7105	39	1	14.1762350	283	10	20.3049670	19.1929000	0.0000	0.0000	.0031
QUIN71	7109	39	58	30.0122470	239	3	19.0837160	1106.3479000	.0001	.0002	.0030
MOUN71	7110	32	53	30.2583200	243	34	38.3919130	1838.9982000	.0001	.0002	.0026
MAZA71	7122	23	20	34.2582650	253	32	27.2985710	30.9126000	.0002	.0003	.0038
HUAH71	7123	-16	44	.6631090	208	57	31.9161460	45.3888000	.0013	.0014	.0337
LURE72	7210	20	42	25.9829810	203	44	38.7292100	3067.5506000	0.0000	.0002	.0025
BARS72	7288	35	19	52.4520690	243	6	30.5197690	896.1775000	.0007	.0010	.0147
RICH72	7295	25	36	48.0744720	279	36	57.1865670	-22.7375000	.0009	.0012	.0186
BOLO75	7546	44	31	12.1178980	11	38	47.3479640	49.4725000	.0024	.0044	.0373
BERN78	7810	46	52	38.0104610	7	27	54.7719100	951.0231000	.0003	.0004	.0064
BORO78	7811	52	16	37.1458270	17	4	28.4438520	123.6441000	.0093	.0177	.3584
WETT78	7834	49	8	41.7669070	12	52	41.1313360	661.1157000	.0004	.0005	.0081
GRAS78	7835	43	45	16.8750000	6	55	16.0242830	1322.8427000	.0006	.0010	.0140
SHAN78	7837	31	5	51.1429720	121	11	30.2305280	27.8711000	.0061	.0095	.0978
SIMO78	7838	33	34	39.7036560	135	56	13.3271160	99.4131000	.0003	.0004	.0053
GRAZ78	7839	47	4	1.6749650	15	29	36.0751560	539.5057000	.0004	.0006	.0157
ROYA78	7840	50	52	2.5579290	0	20	10.0302200	75.3939000	.0003	.0002	.0037
CABO78	7882	22	55	3.1846130	250	8	8.0619510	111.5571000	.0007	.0008	.0171
AREQ79	7907	-16	27	56.6783710	288	30	24.7492630	2492.2678000	.0001	.0003	.0026
MATE79	7939	40	38	55.7828380	16	42	16.8515280	535.8619000	.0003	.0002	.0034
KOOT88	8833	52	10	41.4413520	5	48	36.5967640	88.6341000	.0139	.0608	.1364

Station Name	Num.	Latitude (°)	(′)	(″)	Longitude (°)	(′)	(″)	Height (m)	Scaled Stnd. Deviations Lat. (″)	Lon. (″)	Ht. (m)
July - September 88			**RMS.265-01**				**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9330460	13	3	55.0257850	147.7627000	.0035	.0051	.0489
OTAY70	7035	32	36	2.4530180	243	9	32.9526340	988.6504000	.0006	.0009	.0185
MLRS70	7080	30	40	48.9660480	255	59	5.2883900	2004.3457000	.0013	.0012	.0317
YARA70	7090	-29	2	47.4085480	115	20	48.2687420	241.3340000	.0002	.0002	.0026
HAYS70	7091	42	37	21.7012720	288	30	44.4895350	92.0803000	.0010	.0016	.0271
GORF71	7105	39	1	14.1762740	283	10	20.3047460	19.1895000	0.0000	0.0000	.0027
QUIN71	7109	39	58	30.0122930	239	3	19.0838620	1106.3573000	.0001	.0002	.0024
MOUN71	7110	32	53	30.2587820	243	34	38.3914380	1839.0006000	.0001	.0002	.0022
PLAT71	7112	40	10	58.0122690	255	16	26.4776360	1501.5367000	.0006	.0009	.0136
MAZA71	7122	23	20	34.2614710	253	32	27.2965580	30.8957000	.0002	.0003	.0055
HUAH71	7123	-16	44	.6631990	208	57	31.9154850	45.3848000	.0017	.0022	.0317
LURE72	7210	20	42	25.9832250	203	44	38.7283410	3067.5453000	0.0000	.0002	.0021
RICH72	7295	25	36	48.0761510	279	36	57.1869080	-22.7734000	.0015	.0022	.0297
BERN78	7810	46	52	38.0105530	7	27	54.7742030	951.0087000	.0002	.0002	.0028
BORO78	7811	52	16	37.1204710	17	4	28.4632200	122.7768000	.0026	.0038	.0352
WETT78	7834	49	8	41.7675200	12	52	41.1327540	661.1346000	.0003	.0002	.0032
GRAS78	7835	43	45	16.8751620	6	55	16.0243960	1322.8502000	.0004	.0005	.0080
SHAN78	7837	31	5	51.1502870	121	11	30.2384810	27.8385000	.0051	.0037	.0696
SIMO78	7838	33	34	39.7031680	135	56	13.3274610	99.4613000	.0002	.0003	.0039
GRAZ78	7839	47	4	1.6750190	15	29	36.0787690	539.4095000	.0003	.0002	.0029
ROYA78	7840	50	52	2.5573790	0	20	10.0308200	75.3899000	.0002	.0002	.0029
ORRO78	7843	-35	38	10.5216730	148	56	21.5107020	1350.1112000	.0031	.0047	.2352
CABO78	7882	22	55	3.1863510	250	8	8.0599690	111.5382000	.0022	.0021	.0475
AREQ79	7907	-16	27	56.6781370	288	30	24.7487730	2492.2262000	.0001	.0002	.0024
MATE79	7939	40	38	55.7825550	16	42	16.8519230	535.8883000	.0003	.0002	.0028
KOOT88	8833	52	10	41.4406360	5	48	36.5896520	88.6900000	.0009	.0015	.0147
October - December 88			**RMS.376-01**				**6378137.00**	**298.257**			
POTS11	1181	52	22	48.9260460	13	3	55.0292540	147.7013000	.0038	.0062	.0699
RIGA18	1884	56	56	54.7684590	24	3	32.6535510	30.0543000	.0033	.0041	.0450
CUBA19	1953	20	0	42.9862560	284	14	16.0008180	17.8324000	.0018	.0015	.0319
MLRS70	7080	30	40	48.9663840	255	59	5.2894060	2004.3095000	.0006	.0008	.0142
YARA70	7090	-29	2	47.4061630	115	20	48.2683630	241.3819000	.0004	.0002	.0044
HAYS70	7091	42	37	21.6989740	288	30	44.4900800	92.1970000	.0021	.0039	.0599
EAST70	7097	-27	8	52.1887160	250	36	59.1112380	116.9922000	.0084	.0067	.2085
GORF71	7105	39	1	14.1762990	283	10	20.3045360	19.2024000	0.0000	0.0000	.0033
QUIN71	7109	39	58	30.0112670	239	3	19.0835690	1106.3936000	.0002	.0002	.0036
MOUN71	7110	32	53	30.2584270	243	34	38.3913710	1839.0424000	.0002	.0002	.0033
PLAT71	7112	40	10	58.0131990	255	16	26.4743760	1501.4940000	.0031	.0044	.0757
MAZA71	7122	23	20	34.2598680	253	32	27.2983780	30.9027000	.0002	.0002	.0036
LURE72	7210	20	42	25.9834380	203	44	38.7279770	3067.5682000	0.0000	.0003	.0037
BERN78	7810	46	52	38.0121330	7	27	54.7737590	951.0377000	.0004	.0003	.0044
BORO78	7811	52	16	37.1005420	17	4	28.2662940	125.7969000	.0283	.0590	.6765
WETT78	7834	49	8	41.7682100	12	52	41.1307190	661.1970000	.0004	.0004	.0053
GRAS78	7835	43	45	16.8767210	6	55	16.0257580	1322.8477000	.0006	.0007	.0120
SHAN78	7837	31	5	51.1578190	121	11	30.2382420	27.8123000	.0028	.0031	.0577
SIMO78	7838	33	34	39.7006420	135	56	13.3283190	99.4456000	.0004	.0006	.0057
GRAZ78	7839	47	4	1.6749240	15	29	36.0802120	539.4577000	.0004	.0003	.0040
ROYA78	7840	50	52	2.5583640	0	20	10.0307590	75.3773000	.0003	.0003	.0040
OWEN78	7853	37	13	57.3667550	241	42	22.3490490	1178.1509000	.0009	.0014	.0192
AREQ79	7907	-16	27	56.6780470	288	30	24.7478230	2492.1831000	.0002	.0004	.0051
MATE79	7939	40	38	55.7845630	16	42	16.8532570	535.9066000	.0004	.0003	.0055

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16. Abstract

Laser ranging measurements to the LAGEOS satellite from 1976 through 1989 are related via geodetic and orbital theories to a variety of geodetic and geodynamic parameters. This document explains the SL7.1 analyses of this data set including the estimation process for geodetic parameters such as the Earth's gravitational constant (GM), those describing the Earth's elasticity properties (Love numbers), and the temporally varying geodetic parameters such as Earth orientation (polar motion and ΔUT1) and tracking site horizontal tectonic motions. Descriptions of the reference systems, tectonic models, and adopted geodetic constants are provided; these are the framework within which the SL7.1 solution takes place. Estimates of temporal variations in non-conservative force parameters are included in these SL7.1 analyses as well as parameters describing the orbital states at monthly epochs. This information is useful in further refining models used to describe close-Earth satellite behavior. Estimates of intersite motions and individual tracking site motions computed through a network adjustment scheme are given. Tabulations of tracking site eccentricities, data summaries, estimated monthly orbital and force model parameters, polar motion, Earth rotation, and tracking station coordinate results are provided as appendices.

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