Raytheon

NASA TECHNICAL MANAGEMENT REPORT (533Q)

CONTRACT NO. NAS5-32352

For Period Ending April 30, 2001

Submitted May 15, 2001

mc1c

NASA Task 00-920-02: Satellite Laser Ranging Planning and Support

--WORK PLAN--

GSFC ATR: J. Bosworth

Raytheon Task Leader: Peter Dunn
Raytheon Task Number: 128

The objective of this task is analytical support of the NASA Satellite Laser Ranging (SLR) program in the areas of SLR data analysis, software development, assessment of SLR station performance, development of improved models for atmospheric propagation and interpretation of station calibration techniques, and science coordination and analysis functions for the NASA led Central Bureau of the International Laser Ranging Service (ILRS). The contractor shall in each year of the five year contract:

1. *Provide software development and analysis support to the NASA SLR program and the ILRS. Attend and make analysis reports at the monthly meetings of the Central Bureau of the ILRS covering data received during the previous period. Provide support to the Analysis Working Group of the ILRS including special tiger teams that are established to handle unique analysis problems. Support the updating of the SLR Bibliography contained on the ILRS web site.*
2. *Perform special assessments of SLR station performance from available data to determine unique biases and technical problems at the station.*
3. *Develop improvements to models of atmospheric propagation and for handling pre- and post-pass calibration data provided by global network stations.*
4. *Provide review presentation of overall ILRS network data results at one major scientific meeting per year*
5. *Contribute to and support the publication of NASA SLR and ILRS reports highlighting the results of SLR analysis activity.*

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Peter Dunn	15%	Task leadership, science results
Mark Torrence	15%	Orbit analysis, science results
Steve Klosko	15%	Science Coordination

Spread charges for infrastructure support will be incurred from:

Program Management

Administrative Support

Cost Control

Courier

MILESTONES AND METRICS

This task is research-oriented and requires timely reporting of new results in Laser Ranging analysis at scientific meetings and collaboration with GSFC staff in publicizing the results.

Task performance metrics include:

1. Oral reports of analysis shall be presented at the monthly meetings of the ILRS Central Bureau.
2. Written special reports on SLR station performance shall be delivered within 15 working days of initiation of request.
3. Approaches/algorithms for improvements to models shall be delivered within 90 working days of initiation of request.

WORK PLANNED FOR NEXT REPORTING PERIOD

Assistance to the GSFC MOLA team will continue. MOLA processing will stop when MOLA is powered off, and the automatic processing will be reinitialized at power on.

Analysis assistance will continue to be provided for the estimation of the location of Mars' rotation pole and rotation rate from a combination of Doppler range and range rate observations from the DSN and MOLA data. The analysis will on focus on results from reformed normal equations for mid 1999 through mid 2000, and then will be extended into 2001.

Simultaneous gravity and topographic analysis activities using DSN and NLR data from NEAR will continue. Oribit files in spk format and reprocessed NLR files based upon the NEAR NLR393 solution will be prepared and submitted to the PDS.

Development of GEODYN and other analysis software will continue, with particular attention to merging the MGS and NEAR versions of GEODYN.

Scientfic and NEAR, NLR, and MOLA project related meetings will be attended as necessary.

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None

WORK PERFORMED

Unix cron jobs have processed MOLA data during this reporting period with little intervention required (see http://ltpwww.gsfc.nasa.gov/tharsis/processing_info/). The failures of the automatic process were due to unforeseen file system anomalies on the processing computer, and were fixed quickly. A web based tour of the Mars topography as derived from MOLA was placed at http://ltpwww.gsfc.nasa.gov/tharsis/Mars_topography_from_MOLA/.

Staff continued to assist GSFC personnel with analysis of Mars' rotational dynamics as determined from deep space network (DSN) tracking of the MGS spacecraft. Staff analyzed results for results derived from normal equations made with the mgm1004d gravity model from February 1999 through December 2000 (see http://ltpwww.gsfc.nasa.gov/tharsis/QQQ/). After developing software to reformat the MOLA pedr data and the Mars topography from netCDF grid files, orbit determination tests for MGS in February, and July 1999, and April 2000 utilizing direct MOLA observations included with the DSN data were begun. Several studies were done to determine the effect of using 1/01, and 1/32 x 1/64 of degree surface representations of the Mars topography. GEODYN was modified to perform surface interpolation on a rectangular grid.

Staff processed the last files of NLR data through the end of the NEAR mission and posted the information on the tharsis web site (see http://ltpwww.gsfc.nasa.gov/tharsis/NLR). Staff attended several meetings on end of mission and archiving activities to be completed by the summer of 2001. Example files of processed NLR data and calculated NEAR orbits were delivered to the Geophysics Node of the Planetary Data System.

New information about the magnitude, duration and mass expended during NEAR maneuvers were obtained from APL and incorporated into the NEAR analyses. DSN tracking data through the end of the mission were retrieved from JPL, and the data through January 27, 2001 were incorporated into the development of solution NLR393. Orbit analyses and estimations of dynamic and kinematic parameters can be found at http://magus.stx.com/NEAR.

Regular meetings were held with the ATR.

Example files of NLR products were delivered to the Geophysics Node of the PDS.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

NASA Task 00-920-01: Simulation & Analysis of Extra-terrestrial Missions

--WORK PLAN--

GSFC ATR: Dr. D. Smith

Raytheon Task Leader: Mark Torrence
Raytheon Task Number: 178

The objective of this task is to provide analytical, simulation, and data and error analysis support for planetary and interplanetary missions. To facilitate exchange of information among researchers, postings of results will be made to the web. The GEODYN and SOLVE programs will be used to estimate dynamic and kinematic parameters of scientific interest for the particular mission under consideration. Accurate orbit determination for existing extra-terrestrial spacecraft missions will performed. Orbital characteristics and spatial and temporal data density will be examined to help satisfy the scientific objectives of each mission. Simulated data will be generated and used in GEODYN to form normal equations for relevant parameters. The SOLVE program will be employed to manipulate and invert the normal equations to test parameter estimability and sensitivity. Existing data production and analysis procedures on computer workstations will be enhanced as the need arises. Automation of repetitive components within data production efforts will be implemented.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Mark Torrence	60%	Task Leadership, orbit and data analyses; solution design
Peter Dunn	55%	Orbit and data analyses, solution design
John McCarthy	25%	GEODYN and SOLVE software modification and evaluation

Spread charges for infrastructure support will be incurred from:

Program Management

Administrative Support

Cost Control

Courier

MILESTONES AND METRICS

This research task requires frequent reports, meetings, and discussions of new results with GSFC staff. Quality assurance is achieved through free and open exchange of results within and outside the GSFC community, and through the peer review of publications.

Spacecraft orbits will be produced for each of the existing missions.

Material will be developed for each task year to support presentations at two science meetings and the publication of one peer reviewed journal paper per year.

Results will be thoroughly documented using WWW-based methods to keep the Science Team apprised of developments, performance of new models, and new data availability. This will be achieved with bi-weekly updates to the appropriate WWW-pages supporting this project.

In addition, the contract performance metrics are:

The milestones are as follows for this task:

- Precision orbits: Period one: Data delivery plus 8 weeks
- Precision orbits: Period two, three and four: Completion of period one analysis plus 6 weeks
- Precision orbits: Monthly period: TBD
- Terra/TDRS POD report: One week after the completion of each period's analysis
- Report on Monthly period: TBD

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None

WORK PERFORMED

The three sets of TP/TDRSS/TERRA 72-byte tracking data have been acquired and preprocessed. These data sets cover the 4 arc periods defined by the task. Preliminary orbits have been made for the first arc. Verification and further editing of the data is required and is progressing. The orbit products for the first arc are very near delivery. The second arc processing is at the point where the TERRA data is being added to the fixed TDRSS orbit. The entire process will be repeated more quickly with the 3rd and 4th arcs with the knowledge collected and experience gained in the process.

PROBLEM AREAS

A Y2K fix is necessary to an old piece of software, GODIVA, to work on 2000 data. This software is used to write delete cards easily and would make editing the data faster and easier.

The noise produced by the fix to the air flow disturbed some people in the nearby offices, so the problem of excessive heat in the afternoons still exists. It has been proposed to replace some, if not all, of the antiquated equipment in the building.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Refine the orbit for the first arc period and deliver to the customer.

Continue with the processing of the second, third and fourth arc periods.

NASA Task 00-572-01: Simulation & Analysis of Extra-terrestrial Missions

--WORK PLAN--

GSFC ATR: C. Gramling

Raytheon Task Leader: Shelley Rowton
Raytheon Task Number: 183

This task will focus on the precise determination of the Terra and TDRS spacecraft to verify the orbital accuracy routinely being produced operationally by this mission. The task will require orbits to be determined using an approach developed in Code 926 which uses TOPEX to aid in the positioning of TDRS; this improved TDRS positioning is then leveraged to produce highly precise orbits for spacecraft tracked by the TDRS constellation. In all, 4 time periods, each being 3-days in length, will be investigated from the data now available operationally. In addition, a 1-month period in the future will be evaluated. Precision orbit files will be delivered for comparison with operational trajectories, and we will assist in the evaluation and characterization of errors in the operational products.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Shelley Rowton	20%	data analysis and data reductions

Spread charges for infrastructure support will be incurred from:

Program Management

Administrative Support

Cost Control

Courier

MILESTONES AND METRICS

The four periods to be investigated include:

- Period one: March 3 to 6, 2000: the nominal case
- Period two: March 20 to 23, 2000: contains an MO frequency adjustment
- Period three: April 11 to 14: drag make-up maneuver case
- Period four: April 5 to 8: large solar storm case (and also contains an MO frequency adjustment)

The TDRSS tracking data from Terra will be provided by the Multi-Mission Flight Dynamics Team and/or the Terra TONS Team. We will be required to develop the reduction strategies, develop Terra specific models and setups, and process the TOPEX/TDRS and TDRS/Terra orbits during these timeframes. The accuracy goals are on the order of 2 meters or less for the resulting TDRS orbits, and 1 meter or less, for Terra.

These orbits will be delivered in standard ephemeris file formats for each spacecraft covering these time periods. We will also be required to document the modeling utilized and our own accuracy assessments for these trajectories.

Improved models will be uploaded to Terra for TONS operations. A one-month period will be selected and independent orbits will be produced by our group, which can be used to assess improvements in the operational scenario for Terra orbit determination.

4. Review presentation of ILRS network data shall be made at one major scientific meeting per year.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL REPORTS AND DOCUMENTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Staff attended several meetings of the ILRS Central Bureau with HS Center for Astrophysics, HTSI, and GSFC personnel, and conducted a comparison of positioning solutions as part of the Analysis Working Group Pilot Project.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Results in data analysis, network operations and scientific research will be reviewed at regular meetings of the Central Bureau of the International Laser Ranging Service. Development will continue on a bibliography of scientific results derived from SLR analysis. Any data anomalies in the stations of the Global Laser Tracking Network that affect the scientific measurements will be investigated.

NASA Task 00-920-03: SLR2000 and 48-inch Telescope

--WORK PLAN--

GSFC ATR: J. McGarry

Raytheon Task Leader: Jack Cheek
Raytheon Task Number: 124

This task is for the development and testing of software for the new totally automated Satellite Laser Ranging (SLR) system called SLR2000, and for the continued software and system maintenance and support at NASA's 48 Inch Telescope System at the Goddard Geophysical and Astronomical Observatory (GGAO).

Raytheon is responsible for (i) development and testing of the operational Pseudo-Operator (POP) code for SLR2000, development and testing of the realtime weather interface and the weather simulation code, and development of the software interface for the optical subsystem (camera, focus control, filters); (ii) development and testing of the POP interface software for SLR2000 Mount Field Testing; (iii) interface and system level testing of all SLR2000 computer systems, including POP, DAN (Data Analysis Computer), RAT (Remote Access Terminal), ICC (Interface and Control Computer), and the DCS (Dome Control System); (iv)support of instrument system testing during Mount Field Testing, Star Calibrations, Ground Calibrations, and Satellite Ranging Passes; (v) maintenance of the SLR2000 computer directories for all of the source and documentation (for ISO compliance); (vi) system administration for all SLR2000 computers and all 920.3 48 Inch Telescope computers, including backup, upgrades/patches for all OS, security awareness and security monitoring; (vii) maintenance for all 48 Inch Telescope Servo Control software, and provide system and operational support when required by 920.3 experiments, including support for special user experiments when required, including software modifications and training; (viii)ongoing support for the GGAO LAN, including troubleshooting problems, interface with GSFC CNE for the GGAO connection to GSFC, and being the GGAO point-of-contract for all GGAO computer networking problems; and (ix) maintain the Star Calibration software for the NASA SLR Network (MOBLAS and TLRS systems).

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE %	Responsibilities
Jack Cheek	100	Task leadership, development and testing of POP code, POP interface for Mount Field Testing, system level testing of all computer systems, maintenance of software directories, system administration for UNIX machines and the network, maintenance of the 48-inch telescope servo control software, support for users of the 48-inch, and maintenance of Star Cal software.
Tony Mallama	25/50*	Development and testing of weather interface and simulation code, and support for the optical subsystem to be used for field acceptance testing of the telescope mount.
David Poole	25	System administration for Windows machines, including backups.

* *FY00 vs FY01*

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

There are four major elements of this task:

1) SLR2000 software development and testing. This includes development and testing of the operational POP code, development and testing of the real time weather interface and the weather simulation code, and development of the software interface for the optical subsystem (camera, focus control, filters); development and testing of the POP interface software for SLR2000 Mount Field Testing; interface and system level testing of all SLR2000 computer systems, including POP, DAN, RAT, ICC, and the DCS; support of instrument system testing during Mount Field Testing, Star Calibrations, Ground Calibrations, and Satellite Ranging Passes; maintenance of the SLR2000 computer directories for all of the source and documentation.
2) Support for the 48-inch telescope. This includes maintenance for all 48 Inch Telescope Servo Control software, and system and operational support when required by 920.3 experiments, including support for special user experiments when required, software modifications and training.
3) System administration and network support. This includes system administration for all SLR2000 computers and all 920.3 48 Inch Telescope computers, including backup, upgrades/patches for all OS, security awareness and security monitoring; and ongoing support for the GGAO LAN, including troubleshooting problems, interface with GSFC CNE for the GGAO connection to GSFC, and being the GGAO point-of-contract for all GGAO computer networking problems.
4) Star Cal support. Maintenance of the Star Calibration software for the NASA SLR Network (MOBLAS and TLRS systems).

Milestone	Due Data
Install ISO compliant source directory for all SLR2000 software/documentation	September 2000
Deliver weather instrumentation test software	September 2000
Deliver mount field testing software	December 2000
Provide report on Mount Field Testing	April 2001
Deliver preliminary version of operational software (POP and weather)	June 2001
Deliver preliminary version of SLR2000 Operational Handbook	December 2001
Provide report of Star Calibration Testing	December 2001
Deliver version 2 of the operational software (POP and weather)	July 2002

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.
b) Cost control: adherence to CTR estimated cost to within a 10% variance.

The following milestones were met:

- Installation of ISO compliant source directory for all SLR2000 software/documentation.
- Delivery of weather instrumentation test software.

TECHNICAL REPORTS AND DOCUMENTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

SLR2000 Software Development and Testing

Various problems were discovered and corrected involving the Dome Control System (DCS) simulator, involving RS232 synchronization, shutdowns and restarts. Displays were designed and added to the DCS simulator and the POP software itself, these displays aid in debugging and testing. Testing was conducted with the actual Dome Control System, and some modifications are being conducted

Signal processing was added into the POP software. A satellite search routine was added. Use of the cloud map developed by a task member was discussed and was integrated into the star calibration code. It still needs to be added to the satellite tracking portions.

In March, a week of full testing was conducted and a number of problems were discovered among those were simulation times were not working correctly, no search routines were included for ground calibrations and schedule overrides were not being handled at all. Simulation times were corrected and search routines were added for the ground calibrations.

A new process was added to POP, which handles maintenance tasks and is directed by POP via a maintenance thread to determine which tasks to run and when to run them. Two maintenance tasks have been written , one to copy the real-time schedule and another to remove files more than 10 days old, those files would be message files, log files, image files, etc.

A fair amount of testing has been conducted overall and requires that no modification be made during this testing. Whenever a problem is discovered and then corrected it requires that the testing be completely redone.

Problems were corrected where the ICC appeared to be attempting to track stars before a star was even selected. Additional star calibration testing was conducted, it appeared that biases were not being applied and was discovered that a flag was not being set which is required to apply the biases. A problem was also discovered when the star calibration distribution was not even. It would keep trying the same star over and over again to attempt to make the distribution even. This was corrected and will now abandon the star calibration after retrying all stars 1 time if the distribution is still uneven it will abandon the calibration.

In support of SkyCamera software development a task member ported all the required code from the Met PC to the DAN workstation. Since DAN cannot receive data from the camera over RS-232 yet, testing involved simulation of incoming data using files of sky thermograms acquired on the MetPC. Raytheon also worked with Honeywell personnel at the request of the customer to generate 'requests for quotes' for the SkyCamera mirror mandrel and quantities of one and ten mirrors. Those quotes have been received and are being evaluated. Additionally, the task person assisted Honeywell in ordering a new thermal sensor camera for outdoor use.

Work is underway on developing code for Sun avoidance. The CIRCBUF and PREDICT functions have been studied, including their data structures. The Fortran software developed by D. O'Gara at the University of Hawaii was converted to C and a simulation program was written to graphically display telescope pointing according to this kinematical algorithm. Dynamical constraints are also being studied, since kinematical calculations by themselves are not sufficient for commanding the telescope in such a way to that Sun exposure can be avoided.

Several changes were made to the DLOG program so that its output would be compatible with the input requirements for the corresponding analysis program.

Support for the 48 Inch Telescope

A quote was received from U.S. Logic on the new machine, some additional questions were asked of the vendor and I have gotten no reply from either my phone call or my emails. The last three star calibrations were gathered for the ATR for analysis of the problem with the mount dragging. There were no significant problems seen.

System Administration and Network Support

Problems were corrected concerning kernel patches for 48screamer.

The following is a list of unauthorized attempts to gain access to 48screamer which were reported to GSFC IT Security:

02/17/01 20:21:49 ftpd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/21/01 09:31:59 telnetd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/21/01 09:32:12 telnetd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/24/01 15:18:09 ftpd refused access to beta.cefetpr-unedcp.br (200.250.18.178)

03/15/01 02:03:36 ftpd refused access to 216.167.77.98

03/15/01 13:55:44 ftpd refused access to 213.51.21.227

03/15/01 19:57:19 ftpd refused access to 213.51.21.227

03/27/01 04:04:37 ftpd refused access to test2.allocine.fr (195.68.112.243)

04/09/01 00:48:06 ftpd refused access to proxy.mlstern.com (207.218.36.8)

04/12/01 19:44:55 ftpd refused access to 212.24.188.11

04/22/01 16:04:57 ftpd refused access to 24.27.86.208

04/24/01 11:50:03 ftpd refused access to p3E9EDE94.dip.tdialin.net

04/25/01 13:42:38 ftpd refused access to 217.58.10.68

05/03/01 13:16:03 ftpd refused access to 165.21.101.92

The following is a list of unauthorized attempts to gain access to S2KPOP which were reported to GSFC IT Security:

02/17/01 20:14:58 ftpd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/27/01 06:17:35 ftpd refused access to C-3ec870d5.010-86-7374gf23.cust.bredbandsbolaget.se (213.112.200.62)

03/15/01 01:57:39 ftpd refused access to 216.167.77.98

03/15/01 01:50:15 ftpd refused access to 213.51.21.227

03/15/01 19:51:42 ftpd refused access to 213.51.21.227

04/09/01 00:42:47 ftpd refused access to proxy.mlstern.com (207.218.36.8)

04/12/01 19:39:18 ftpd refused access to 212.24.188.11

04/22/01 15:59:43 ftpd refused access to 24.27.86.208

05/03/01 13:12:30 ftpd refused access to 165.21.101.92

The following is a list of unauthorized attempts to gain access to S2KDAN which were reported to GSFC IT Security:

02/17/01 20:15:00 ftpd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/27/01 06:17:27 ftpd refused access to C-3ec870d5.010-86-7374gf23.cust.bredbandsbolaget.se (213.112.200.62)

03/15/01 01:57:12 ftpd refused access to 216.167.77.98

03/15/01 13:49:24 ftpd refused access to 213.51.21.227

03/15/01 19:51:24 ftpd refused access to 213.51.21.227

04/09/01 00:42:02 ftpd refused access to proxy.mlstern.com (207.218.36.8)

04/22/01 15:59:00 ftpd refused access to 24.27.86.208

04/24/01 11:44:42 ftpd refused access to 62.158.222.148

05/03/01 13:11:45 ftpd refused access to 165.21.101.92

The following is a list of unauthorized attempts to gain access to 48ntserver which were reported to GSFC IT Security:

02/03/01 05:01:59 ftpd refused access to 212.171.38.117

02/17/01 20:09:55 ftpd refused access to p3E9D5378.dip.t-dialin.net (62.157.83.120)

02/27/01 06:12:01 ftpd refused access to C-3ec870d5.010-86-7374gf23.cust.bredbandsbolaget.se (213.112.200.62)

03/15/01 01:50:15 ftpd refused access to 216.167.77.98

03/15/01 13:42:24 ftpd refused access to 213.51.21.227

03/15/01 19:44:34 ftpd refused access to 213.51.21.227

03/27/01 03:50:41 ftpd refused access to test2.allocine.fr (195.68.112.243)

04/22/01 15:50:25 ftpd refused access to 24.27.86.208

04/24/01 11:35:27 ftpd refused access to 62.158.222.148

04/25/01 13:42:38 ftpd refused access to 217.58.10.68

05/02/01 17:22:16 ftpd refused access to 194.145.112.1

05/03/01 13:03:04 ftpd refused access to 165.21.101.92

The following is a list of patches applied to 48screamer, running Red Hat Linux 6.2:

xemacs-21.1.14-2.62.i386.rpm

xemacs-el-21.1.14-2.62.i386.rpm

xemacs-info-21.1.14-2.62.i386.rpm

micq-0.4.6-1.i386.rpm

inetd-0.16-7.i386.rpm

NASA SLR Network Star Calibration Support.

A problem was discovered at MOBLAS 8 in Tahiti. The field for the RMS in the coefficient file was not wide enough for the RMS on that system. It was actually never anticipated that the RMS would ever exceed the original size, however they were having major problems with their mount and the star calibration was producing very high RMS's. The problem has been corrected.

SCHEDULE CONFORMANCE

Work is proceeding according to schedule.

WORK PLANNED FOR NEXT REPORTING PERIOD

We will continue work on the SLR 2000 POP software. We will continue testing the systems data logging capabilities by varying the amount of data being produced by the simulator. We will assist with reracking the SLR 2000 computers and producing cable diagrams. The schedule overrides by the RAT computer will be addressed, coded and tested. A final round of full up software testing will occur in June and will end with the preliminary version of the POP software completed. We will also complete the definition of

NASA Task 00-920-04: MicroAltimeter Data Analysis and Display

--WORK PLAN--

GSFC ATR: J. McGarry

Raytheon Task Leader: Jairo Santana
Raytheon Task Number: 179

This task is for the development of data analysis and display software for the MicroAltimeter project, a project funded under the Instrument Incubator Program. The MicroAltimeter instrument is a high repetition rate (multi-kilohertz), low power (milli-Joule) laser altimeter, which uses a small aperture (10 centimeters) telescope. Aircraft flights will demonstrate proof of concept.

The task involves two parts: (1) modification of existing NASA software, called GRAPES, for display, and (2) development of data analysis software (algorithms to be supplied by NASA).

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Jairo Santana	50%	Task Leadership, IDL support for the display and analysis of MicroAltimeter data.
Samuel Ohring	50%	Fortran programming support for data analysis
Anita Brenner	5%	Technical oversight

Spread charges for infrastructure support will be incurred from:

Program Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

The objectives of this task are:

- Development of an IDL software package to read the ranging log format and display range and signal processing information to the screen.
- Development of a software package to generate footprint location and terrain heights from experimental data sets which consist of logged ranging information, post-processed differential GPS aircraft position, raw aircraft attitude information, and scanning wedge angle orientation with respect to aircraft body.
- Analysis and comparison of a dataset generated from previous objective with an existing Digital Elevation Model (DEM) of the same location. Contractor will be responsible for finding an appropriate DEM for this task. The results of the comparison should be a data file of differences, and a report which indicates statistical nature of the comparison, as well as the particulars of the DEM chose, and any other relevant information.
- Modification of an existing IDL GRAPES software package for the display of Microaltimeter data, and the generation of a 3-D data display of Microaltimeter data against the comparison DEM data.

Metrics that meet these Objectives:

- Deliver IDL ranging display software by November 2000
- Deliver terrain height software package, preliminary version, by March 2001.
- Deliver 3-D software package, preliminary version, by July 2001.
- Deliver terrain height software package, final version, by October 2001
- Deliver comparison data set, report, software and DEM by November 2001
- Deliver terrain height software package User's Guide by December 2001
- Deliver 3-D software final version and User's Guide by December 2001

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

Preliminary version of post-processing software was delivered.

WORK PERFORMED

1. Added new options to the IDL ranging display software:
   - Display ranging data only for those channels selected by the user.
   - Continuous display of Microaltimeter data, in addition to one-second displays.
2. Modified/corrected IDL display software after it was installed on an NT computer by the NASA ATR (NT computer is attached to the rest of the Microaltimeter's hardware). The IDL software will then be tested at the beginning of May in a few tests flights over the Ocean City and Wallops Island region.
3. Continued working on the three-dimensional display of Ocean City DEM provided by Bea Csatho. Calibrated data from the post-processing software, of the same region, in the form of latitudes, longitudes, and heights will be plotted over the DEM.
4. Finished coding post-processing software program. This program computes and outputs geodetic latitude, longitude, terrain height and channel number, respectively, of the point where the laser strikes the Earth for each laser shot (up to 16 channels and 10,000 laser shots) fired by an instrument on board an aircraft

This post-processor program includes geometrical calculations involving the GPS and Attitude (roll, pitch and heading) of the aircraft and scan and wedge angles of the laser instrument. Cubic interpolation is used to obtain the GPS and attitude values for each laser shot.

Contractor successfully and completely process three datasets obtained from flights at 11,500 ft., 17,500 ft. and 22,500 ft using the post-processing software. The results looked reasonable in that the Latitude and Longitude don't vary significantly and the terrain heights on the order of -0.01km to -0.06km. (The Geo-model used has the Del-MarVa peninsula little below sea level.).

PROBLEM AREAS

None

SCHEDULE CONFORMANCE

Work is proceeding according to schedule.

WORK PLANNED FOR NEXT REPORTING PERIOD

1. Continue working on the three-dimensional display of the Ocean City DEM. Once the data (output from post-processing software) is plotted over this DEM, contractor to make profile plots of pre-selected paths.
2. Will make a comparison between DEM of Ocean City and Microaltimeter data.

NASA Task 00-921-01: Geomagnetism Investigations

--WORK PLAN--

GSFC ATR: Dr. Herb Frey

Raytheon Task Leaders: Mike Purucker/Terry Sabaka
Raytheon Task Number: 114

Contractor shall provide geomagnetic infrastructure support in the areas of main field modeling, crustal field separation, magnetic data base management and distribution, and magnetic field mission support. Continuing work includes maintenance of a geomagnetic data base, publication of the current comprehensive field model, investigation of the sources of crustal magnetic anomalies, and support for the Orsted mission. New work includes calibration support for the SAC-C mission magnetometers, parameterized modeling of external sources, studies of the crustal magnetic anomalies on Mars in comparison with remnant anomalies on the Earth, and development of mission concepts for tethered and free-flying spacecraft and lower altitude craft for studies of the magnetic fields of both Earth and Mars.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Mike Purucker	67	Task Leadership, Crustal field separation and modeling, mission support and development.
Terry Sabaka	100	Task Leadership, Main field and Comprehensive field models, Mission support and development
Katia Nazarova	50	Magnetic data base management and distribution

Spread charges for infrastructure support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

Main field and Comprehensive field models: Submission of the present comprehensive field model for publication in a peer-reviewed journal. Extension of the comprehensive field model to include improved parameterization of external sources. Inclusion of Oersted data in a main field and comprehensive field model. Submission of candidate IGRF models and/or a manuscript on inclusion of Oersted data in the comprehensive field model.

Crustal field separation and modeling: Generation of improved crustal field models based on updated comprehensive field models for the Earth and on equivalent source or other methods for Mars. Submission of a paper to a peer-reviewed journal on Mars lithospheric anomalies. Investigation of likely sources of crustal anomalies using both forward and inverse modeling approaches.

Mission support and development: Continuation of calibration studies for Oersted and collaboration in reduction and analyses of Oersted data. Magnetometer calibration and data reduction support for SAC-C and other missions as required. Where required, simulation studies of possible future missions.

Milestone	Due Date
Submission of comprehensive field model paper to a peer-reviewed journal	Jan 1, 2001
Submission of a paper on Mars lithospheric anomalies to a peer-reviewed journal	Apr 1, 2001
Completion of Oersted magnetometer calibration	June 1, 2001

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None

WORK PERFORMED

Purucker is a participant in the NASA Solid Earth Science Working Group on Geomagnetism. A meeting is being held at Scripps on May 16 to discuss future initiatives in geomagnetism.

Purucker was the first author on two submitted abstracts to the Spring AGU meeting in Boston. The titles of the abstracts were 1) 'Global lithospheric magnetization model validated and refined using new satellite observations' by Purucker, Langlais, Hulot, Mandea, and Olsen and 2) 'Terrestrial and Martian magnetizations of lithospheric origin: Comparative Planetology', by Purucker, Langlais, and Mandea. The first abstract above is being prepared for submission as a Science manuscript. Purucker is a member of the Program Committee for the Spring meeting and was also responsible for scheduling the papers in Geomagnetism and Paleomagnetism.

Work continued on the calibration of the magnetometer data from SAC-C/Orsted-2.

Sabaka continued work on comprehensive model revisions of a paper submitted to Geophysical Journal Internaltion (GJI).

Sabaka further developed a method to estimate surface fluid velocity patterns at the Core-Mantle boundary and initial magnetic field states directly from magnetic field measurements, where the fluid velocity is consistent with the motional-induction equation.

Purucker presented an oral talk at the 32nd Lunar and Planetary Science Conference entitled 'Interpretation of a magnetic map of the Valles Marineris region, Mars'. His coauthors were B. Langlais and M. Mandea of IPG-Paris.

Sabaka and co-convenors organized a session for the IAGA August 2001 meeting in Hanoi, Vietnam entitled "Main Magnetic Field and Secular Variation Modeling at the Earth's Surface and Core-Mantle Boundary".

Sabaka and Purucker were involved in a Mars Scout Proposal to JPL on which Frey and Taylor were the PI's. The proposed mission to be studied would involve magnetic gradiometry from orbit and balloon.

Purucker was involved with Jeff Wynn (USGS) in another Mars Scout Proposal to JPL. The proposed mission to be studied involves the use of active and passive EM for water/conductivity contrast from a balloon dragging an instrumented guiderope.

A manuscript on the Martian magnetic field, and its interaction with the solar wind, was submitted by J. Luhmann (Berkeley) to the Spreiter Memorial Magnetosheath issue of Planetary and Space Science. Purucker is as a coauthor.

Purucker was a coauthor on two poster presentations at the 2nd Netlander Symposium in Nantes, France from April 2-4. N. Olsen (DSRI) was the first author of one of the posters, entitled 'The Space-Time structure of magnetic variations and their use for Electromagnetic Induction studies'. B. Langlais (IPGP) was the first author on the other poster, entitled 'The Martian Magnetic Field: From Mars Global Surveyor to Netlander'.

Nazarova completed the non-interactive versions of the webpages representing the work and interests of the Geomagnetics Lab, as well as other Goddard investigators involved in geomagnetism. These pages will be accessible from the Code 921 Branch website.

Purucker contributed a color map of the Martian magnetic field in the Terra Sirenum region for a review paper by David Stevenson entitled 'Mars Core and Magnetism'. The paper is scheduled to appear in Nature.

A new student, David Benveniste, began work in April on a project with Purucker that will examine whether the fractures associated with the Pavonis Centre on Mars are actually intrusive dikes. Benveniste is from the Ecole Polytechnique in Paris.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue previous month's work.

NASA Task 00-921-02: Digital Elevation Studies

-- QUATERLY REPORT--

GSFC ATR: Dr. David J. Harding **Raytheon Task Leader: Claudia C. Carabajal**

Raytheon Task Number: 163

The contractor will investigate digital elevation data sets acquired using laser altimeter (SLICER, Bigfoot, ATM, commercial airborne laser altimeters, SLA-01 and SLA-02, ICESat, VCL) and interferometric SAR (TOPSAR, SIR-C/X-SAR, ERS, SRTM) sensors aboard aircraft and spaceborne platforms, to improve characterization of land surface topography and vegetation cover. Analysis of laser altimeter data sets in comparison to SRTM and land cover products will be used to establish the quality of SRTM topography data and assess its utility in studies of geodynamic and surface processes. Analysis of laser altimeter waveforms in comparison to high-resolution elevation data acquired by airborne mapping laser altimeters will be used to establish appropriate waveform processing procedures for retrieval of land elevation and vegetation cover parameters.

Work to be performed includes:

(a) Merging of range and waveform data sets for SLA-01 observation periods previously processed to enhanced data product level.

(b) Documentation of geolocation accuracy for SLA-01 enhanced observations and all SLA-02 geolocated observations by elevation differencing with respect to DTED Level 1.

(c) Development of an IDL software tool for quantifying systematic and random errors in the global SRTM elevation data. Quantification will be based on empirical relationships between lidar data and the SRTM elevation and error estimate products established as a function of geographic region, land cover type, slope, radar incidence angle, backscatter amplitude, and coherence. Lidar data is to include waveform profiles (SLICER, SLA, VCL, ICESat) and mapping laser altimeters (ATM, commercial systems).

(d) Assessment of western Washington State SRTM product to be delivered by JPL using tools of (c).

(e) Establish optimal acquisition and waveform processing parameters for ICESat land data by testing processing on SLA, SLICER, and Bigfoot waveforms and simulations of waveforms produced using ICESat 3-D simulator applied to high-resolution airborne mapping laser altimeter data.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001, the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Claudia Carabajal	100%	Task leadership, processing and analysis, documentation, waveform processing, data processing algorithms design and development, testing, quality assurance and calibration, validation.

Spread charges for infrastructure support will be incurred from:

Program Management

Cost control

Administrative support

Courier

MILESTONES AND METRICS

Contract performance metrics include:

1) Weekly/biweekly meetings with task leader and ATR to discuss progress, determine new deliverables required and ways to proceed.

2) Due to the dynamic nature of the task, schedules and deliverables are defined by the ATR as new issues arise

during processing. In principle, the following schedule applies:

Milestone	Due date
a) Merging of range and waveforms for SLA-01 enhanced geolocated observations.	11/01/2000
b) Documentation of geolocation accuracy.	11/01/2000
e) Establish optimal acquisition and waveform processing algorithms for ICESat	02/01/2001
c) IDL software tool for quantifying systematic and random errors in the global SRTM elevation data.	05/01/2001
d) Assessment of western Washington State SRTM product	07/31/2001

3) Scientific results will be presented at science team meetings and scientific conferences.

In addition, the contract performance metrics are:

a) Prompt quarterly reporting of task status. The previous quarter report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL REPORTS AND DOCUMENTS DELIVERED THIS REPORTING PERIOD

Paper submitted to the Special Issue of Journal of Geodynamics on Laser Altimetry: "Enhanced Geolocation of Spaceborne Laser Altimeter Surface Returns: Parameter Calibration from the Simultaneous Reduction of Altimeter Range and Navigation Tracking Data", by S.B. Luthcke, C.C. Carabajal, and D.D. Rowlands.

WORK PERFORMED

- Ran the codes for all enhanced geolocation files for all enhanced geolocated files for areas in Hawaii, Zagros, Sudan, North Africa, South America, Saudi Arabia, Pakistan, and India. Compared the results for the TDRSS based solutions for the shuttle orbits and only a-priori roll and pitch biases, TDRSS orbits and altimetry only pointing solutions, and the combined TDRSS tracking and altimetry solutions for a full attitude model. A definite improvement in the match is seen for the solutions for which pointing is recovered from the residuals with the ocean surface. Documented the statistics of the comparisons for every case, and tabulated the results.
- A new SLA-02 data structure and codes are being developed to merge and distribute the four observation periods re-processed for enhanced geolocation.
- Finishing implementation of Z-shifting addition to altimetry profile comparisons against DEMs. Also, made modifications to the stored parameters that were needed, as requested by the ATR, to save various parameters and processing outputs for archiving.
- Continued support to the ICESat Cal./Val. Group. Participated in meetings to discuss activities related to the ICESat Cal./Val. Plan and attended ICESat Science Team meeting in San Diego. Wrote codes to derive an ocean islands mask from the Global Ecosystems Landcover classification file. This was to be added to the continental mask to be used on-board by ICESat in selecting shot processing schemes.
- Selected SLA-02 data segments intercepting the Patagonian Ice fields, and searched literature regarding geological, geophysical and glaciological background. Only SDP-V2 products were available for this region. Visually inspected data to see how it can be used for ICESat science. Selected SLA-02 data segments intercepting the Puget Sound, WA area. Only observations 9 and 11 contain data crossing this region. Will browse waveforms to see how they represent the surfaces. Once simulator is working, will check waveforms

against simulations.

- Deviced procedures to convert Arc Info interchange files distributed by Terrapoint for first and last return surfaces from the survey at the Puget Sound region. Files were converted into ENVI grids and associated projection and header files. Documentation of the procedures was developed. Assisted K. Still in becoming familiar with the conversion procedures to process remaining files for ATR.
- Investigated Big Foot Data sets collected in 1993 and 1994 with Jeanne Sauber. Reviewed documentation, inspected available files, visually inspected variations in the waveforms when intercepting various surfaces for the1994 data set. Data was not geolocated. The 1993 geolocated data set was not available from D. Rabine, so no further action has been taken regarding these data.
- Developed codes to convert the SLA-02 data structure into the format specified for the SLICER data sets, so these data can then be ingested into the SLICER browser developed by the ATR, allowing easy inspection of waveforms. Some modifications to the SLICER browser were needed to account for the changing starting bin for the waveform signal in the SLA-02 data sets, and the choice of filter width used.
- Re-ran tests of the GLAS simulator in collaboration with J. Saba (RITSS). Some problems were encountered in the testing runs, and J. Saba worked on modifying some of the codes to continue with testing. Now the contractor has taken over the modifications needed. At present the contractor is working on the GLAS waveform simulator to get it to work taking a surface terrain file as input from which the elevation profile will be extracted.
- Finished contributions to revisions to the accepted publication submitted to Surveys of Geophysics: "Improvements in Spaceborne Laser Altimeter Geolocation", by S.B. Luthcke, C.C. Carabajal, D.D. Rowlands, and D.E. Pavlis.
- Completed contribution to the paper submitted to the Special Issue of Journal of Geodynamics on Laser Altimetry: "Enhanced Geolocation of Spaceborne Laser Altimeter Surface Returns: Parameter Calibration from the Simultaneous Reduction of Altimeter Range and Navigation Tracking Data", by S.B. Luthcke, C.C. Carabajal, and D.D. Rowlands.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Milestones to be reached this reporting period have been completed:

IDL software tool for quantifying systematic and random errors in the global SRTM elevation data has been developed. Since no SRTM data has been made available to date, evaluation of SRTM data accuracy is to be performed utilizing the developed procedures as data can be accessed, and appropriate procedures for data ingestion will be developed as well.

WORK PLANNED FOR NEXT REPORTING PERIOD

Support ATR and ICESat cal./val. group's efforts. Develop appropriate means for testing and implementing modifications to ICESat 3-D waveform simulator.

NASA Task 00-922-01: CDDIS Support

--WORK PLAN--

GSFC ATR: C. Noll

Raytheon Task Leader: M. Dube
Raytheon Task Number: 105

Raytheon will support the Crustal Dynamics Data Information System (CDDIS), managed by the Terrestrial Information Systems Branch, Code 922. The CDDIS staff is tasked by the geodynamics community to assist investigators with their data requirements. The data services of the CDDIS consist primarily of receiving and archiving geodynamics and geophysics-related data on-line and to archive media (e.g., magnetic tape, CD-ROM) and cataloging these data in the CDDIS data base. The CDDIS is responsible for the dissemination of these data to authorized NASA investigators and scientists participating in other global space geodesy programs.

A majority of the data processing efforts, including data verification, distribution, reformatting, and special requests, will be performed on the CDDIS AlphaServer 4000; a small subset of activities will continue to be performed on the CDDIS VAX system. These processes include special programs to read received data, summarize their contents, validate data contents, reformat the data if required, and archive the data to the appropriate disk area and backup media.

The CDDIS operationally supports many international programs such as the International GPS Service (IGS), International Laser Ranging Service (ILRS), International VLBI Service (IVS), International Earth Rotation Service (IERS), the International GLONASS Service – Pilot Experiment (IGLOS-PP), and the DORIS Pilot Experiment (DPE). The support of these programs requires timely availability of data holdings, typically within hours, and sometimes minutes, of receipt.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Maury Dube	100	Task leadership, overall responsibility for processing and archiving data, maintenance of the ORACLE data base, applications programming, and attendance at space geodesy meetings.
Ruth Kennard	100	Support space geodesy investigators in accessing CDDIS, assist in processing and archiving data and in maintenance of the ORACLE database, and other duties as assigned.
Laurie Batchelor	100	Operation of the CDDIS pre-mastering and writing facility for CD-ROM media, distribution of the CDDIS bulletin, and other duties as assigned.

Spread charges for infrastructure support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

Raytheon will:

a. Provide data products on a routine basis (daily) and per request basis (~five per week) to space geodesy investigators including GPS and GLONASS data, satellite and lunar laser ranging (SLR and LLR) data, VLBI data base experiments, DORIS data, and analyzed data.

b. Maintain and verify the CDDIS data base using query language and pre-programmed screen forms of the ORACLE Relational Data Base Management System (RDBMS).

c. Process all GPS and GLONASS data (observation, navigation, meteorological files) received via network transmission, including data compression and decompression where required, data formatting to RINEX if necessary, data archiving to magnetic and optical disk, tape and CD-ROM, quality checking, data summarization, and loading of summary information into CDDIS data base. Data must be made available to the user community during normal working hours within an hour of receipt for daily data files and five minutes for hourly data files.

d. Process all SLR data (full-rate, field-generated normal points) received from cooperating institutions (European Data Center) and the NASA SLR support contractor (currently Honeywell Technical Services, Inc.). Process the other data products received for archive in CDDIS. Provide data quality and summary information for all data processed.

e. Migrate and maintain the data archiving and processing software from the CDDIS VAX/VMS facility to the AlphaServer 4000 system running UNIX. Develop the new automated routines to support the archiving and distribution of data sets in this environment.

f. Operate the CD-ROM pre-mastering and writing facility. Test and operate a separate computer facility designed to pre-master data for writing to CD-ROM media in approved standards. CDDIS data sets, particularly GPS data, will then routinely be written to CD-ROM for archive and distribution.

g. Provide programs for the reformatting and analysis of data products.

h. Continue to maintain the CDDIS archive (both tape, CD-ROM, and in the data base) by archiving and backing data up to tape or CD-ROM. Migrate data on 9-track tapes to on-line and/or new media. Maintain all software used to generate and verify CDDIS tape products. Incorporate enhancement software as required. Archive backup tapes for the CDDIS computer facilities.

i. Load data and summary information into the CDDIS ORACLE data base and validate submitted data products.

j. Revise and enhance the CDDIS Standard Operating Procedures (SOP) manual yearly to contain up-to-date instructions for tasks performed by the CDDIS support staff.

k. Generate monthly reports for CDDIS data management and users describing the data activity of the project.

l. Provide support to space geodesy investigators in accessing CDDIS (~five requests per week).

m. Distribute the bimonthly CDDIS Bulletin and other hardcopy documentation.

n. Document all programs, procedures, and CDDIS system activities.

o. Attend one domestic and one international space geodesy-related meetings per year for the purpose of coordinating data products from the analysis groups to the CDDIS and its users.

p. Apprise CDDIS government staff daily of any problems in data, processing of data, or with the various computer systems accessed by the support staff.

All programs and scripts written to support CDDIS activities will contain appropriate documentation within the code to aid in readability and use by other staff members or the ATR.

Below are performance standards for selected CDDIS activities:

a. Mean time to fill special requests (based upon notification by ATR or directly by user)

   i. one week or more fair

ii. 3 to 4 days good
iii. 1 to 2 days very good
iv. within 1 day excellent

b. Timeliness of CDDIS Bulletin distribution
i. more than 8 days fair
ii. 6 to 8 days good
iii. 5 days very good
iv. less than 5 days excellent

c. Timeliness of creation of CD-ROMs of GPS data
i. 1/week fair
ii. 2/week good
iii. 4/week very good
iv. 5 or more/week excellent

d. Migration of data from 9-track tape to other media or on-line availability
i. 1 tape/week fair
ii. 2 tapes/week good
iii. 3 tapes/week very good
iv. 4 tapes/week excellent

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

SLR

CDDIS continues to receive and process SLR Quicklook data from the following satellites: AJISAI, STARLETTE, LAGEOS, LAGEOS-2, ERS-2, ETALON-1 and –2 TOPEX, STELLA, GPS35, GPS36, BE-C, WESTPAC, CHAMP and the Earth's moon. CDDIS continues to process SLR quicklook data for the GLONASS72, 75, 76, 77, 80, 81, 82, and 84 satellites in support of the International Glonass Experiment (IGEX'98) campaign. From the daily ALLSAT Quicklook data files, merged monthly Quicklook data files (sorted by time) were generated for each of the satellites, the corresponding summaries were also generated, and summary information loaded into the CDDIS database. CDDIS continues to receive daily SLR full-rate data files from HTSI for 2001. Each SLR data file contains data for tracking one satellite per station and per day.

Work to generate the August 1997 SLR monthly merged data set is continuing.

RITSS continues to archive hourly SLR Quicklook data in Allsat data files.

RITSS worked on several special requests of SLR data.

Attended the 4th Annual Raytheon Science Data Centers Symposium, Pasadena, California, 26-28 March 2001; presented the CDDIS Data Center Poster paper at the Symposium.

Prepared four SLR data sets for the pos+eop pilot project to be analyzed by the various SLR analysis groups. These four data sets cover 4 weeks of data from April 1-28, 2001, and are from the four satellites: Lageos-1, Lageos-2, Etalon-1, and Etalon-2.

RITSS continues to migrate older archived SLR full-rate data from 9-track magnetic tapes to computer disks on cddisa. Some of the recent data copied to disk include Jan-Dec 1992-1994 Ajisai, Topex, Stella, Starlette, Ers1, Etalon1,2, Gps35,36, Meteor3, and the Glonass satellite data.

GPS

RITSS continues to process incoming GPS data for the IGS.

RITSS continued to process GPS data for the GSAC (GPS Seamless Archive Center).

CDDIS continues to receive and process GLONASS data in support of the IGLOS-PP (International Glonass Service Pilot Project).

RITSS continues to convert VLBI meteorological data to RINEX V2 format, and make this data available to the IGS community.

RITSS continues the work on archiving the hourly GPS data from JPL, ESA, NRCan, GFZ, PGC, NOAA, BKG, and IGN.

RITSS has begun to process GPS ground data from JPL in support of the LEO (Low Earth Orbit) project. This is 1-sec data arriving in 15-min (4 per hour) data files.

RITSS processed solar max GPS data for days 113-119, 2001. This is 1-sec data that arrived in hourly data files from the various IGS data centers. This campaign is to study the ionospheric behavior during the current solar maximum.

RITSS worked on several special requests of GPS data.

VLBI

There was no work for VLBI data during this quarter.

DORIS (TOPEX AND SPOT)

CDDIS continues to receive new TOPEX and SPOT-2 DORIS data, which were summarized and loaded into the CDDIS database in support of the TOPEX project. During this quarter, TOPEX data for the 10-day cycles of 306 through 315, and SPOT-2 data for cycles 361 through 375 were processed.

For this quarter, cycles 116 through 131 have been processed for SPOT-4 data.

LLR (Lunar Laser Ranging)

There was no work for LLR data during this quarter.

Miscellaneous

RITSS prepared over 800 CDDIS Bulletins for mailing to U.S. and International sites.

RITSS generated CDROMs for GPS weeks 0659 to 0678 (GPS data for days 136-366, 1992).

Data catalog information was loaded into the CDDIS database.

Routine system maintenance and regular system backups were performed.

Computer Utilization

14 hours	Micro-Vax
252 hours	DEC Alpha

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding according to schedule.

WORK PLANNED FOR NEXT REPORTING PERIOD

Project support will continue.

The processing and archiving of quicklook and full-rate daily and monthly SLR data will continue on a regular basis.

TOPEX, SPOT-2 and SPOT-4 DORIS data will continue to be archived and processed.

Work will also continue on the processing of GPS data for the IGS.

Work will also continue on the processing of GPS data for the GSAC.

Work will also continue on the processing of GLONASS data for IGLOS-PP.

RITSS will continue to convert VLBI meteorological data to RINEX V2 format.

RITSS will begin to merge the May 1999 full-rate data.

RITSS will continue to merge the August 1997 full-rate data.

RITSS will continue to work on the new DEC ALPHA computer system.

RITSS will continue to generate new CDROMs containing GPS data.

RITSS will continue to migrate older archived data (mostly SLR full-rate data) off the 9-track magnetic tapes to computer disks on cddisa.

NASA Task: 00-924-01 Geoscience Laser Altimeter Support

-- Work Plan --

GSFC ATR: P. Millar

Raytheon Task Leaders: Marcos Sirota/Steve Klosko
Raytheon Task Number: 170

Provide optical and systems support to the GeoScience Laser Altimeter System (GLAS) and various other Code 924 laser remote sensing projects, including the Geoscience Laser Altimeter System (GLAS) and as well as other 924 proposals for the GLAS follow-on and Laser Sounder for Orbital Measurements of CO2 and CH4 (of Earth's Atmosphere).

STAFFING PROFILE

For August 1, 2000 through July 31, 2002 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Marcos Sirota	90%	SRS systems engineering
Severine Tournois	100%	SRS systems engineering
Peter Dogoda	100%	Optical systems engineering
Joe Marzouk	90%	Optical systems engineering
Robert Reely	100%	Mechanical Design engineer
Richard Porter	20%	Mechanical design
Richard DiSorbo	100%	Senior Design Engineer
Haris Riris	100%	Systems Engineer
Steve Schmidt	50%	Mechanical Engineer
Damon Douglas	10%	Administrative support
Laila Marzouk	10%	Administrative support

Spread charges for infrastructure support will be incurred from:

Program management

Cost Control

Administrative Support

MILESTONES AND METRICS

In overview, the milestones for this Task will coincide with those of the GLAS project, i.e

1) Major reviews
2) Project milestones.

Deliverable elements will be:

1) Interim and major milestone reports
2) Configuration control documents

3) Performance and test reports

4) Schedule and assembly plans

5) Optical test reports

NOTE: Several of these elements will be delivered directly to the Project, and will not be attached to these status reports.

Milestone Schedule:

1. Operate the Code 924 optical laboratory. This lab is presently occupied by the GLAS project, however there may be requests by other projects to perform various optical tests. Period of performance from 8/1/00 – 6/30/02. Optical testing to be performed on an as needed basis, test data report shall be provided within one week of performing the tests. Appropriate milestones and schedule will be provided with all newly requested work.

2. Support the Geoscience Laser Altimeter System: These dates are based on an April 23rd 2001 delivery of the instrument to the observatory, Ball Aerospace in Boulder Colorado and a launch date of 12/31/01 at Vandenburg, CA. If these dates slip due to impact of other subsystems not covered by this task these dates will be extended. It should also be noted that this flight project is on a tight and compressed schedule and the dates listed do not account for any hardware failures or problems. Therefore, this schedule has a fair amount of risk, and there are many elements affecting schedule that is beyond the scope of this task. The ATR will judge if schedule compliance has been achieved in the face of these difficulties. The following shows the detailed schedule for this effort.

- Lead the Assembly, integration, alignment, & test of the Altimetry receiver path. This includes the 1-meter telescope and 1064 nm receiver optics. 8/1/00 – 6/30/02 (this date may be extended if GLAS launch date moves beyond this date)
    a. flight unit assembly and testing completed by 1/31/01
    b. pre-shipment test report due 5/23/01
    c. post-shipment testing at observatory, 5/25/01 – 6/2/01, (Travel required, Boulder CO)
    d. post-ship test report due 6/9/01
    e. support thermal vacuum testing at observatory, 6/23 – 6/30/01 (Travel required, Boulder CO)
    f. support instrument – spacecraft integration at launch site, 4 days in 12/01 TBD (Travel required to Vandenburg CA)

- Provide systems engineering support for assembly, testing and performance assessment of the SRS flight hardware for, test, and assess performance of the SRS. 8/1/00-12/31/01.
    a. support flight unit integration and preliminary alignment to flight bench due 9/30/00
    b. assemble, align and test SRS BCE by 12/31/00
    c. functional testing report by 1/30/00
    d. calibration report by 4/30/01
    e. pre-shipment test report due 5/23/01
    g. support post-shipment testing at observatory, 5/25/01 – 6/2/01 (Travel required, Boulder CO)
    h. post-ship test report due 6/9/01
    i. support thermal vacuum testing at observatory, 6/23 – 6/30/01 (Travel required, Boulder CO)
    j. support instrument – spacecraft integration at launch site, 4 days in 12/01 TBD (Travel required to Vandenburg CA)

- Lead the Fabrication, Assembly and Testing of the GLAS BCE which includes the Altimeter Laser Test System (ATS), Lidar Test System (LdrTS), GPS and Timing System, BCE Controller, Laser Test System (LsrTS) & Boresight Control, and Power System. Each subsystem is verified with flight components in validation reporting. Expected period of performance 8/1/00-6/30/01
    a. Power system validation report 10/1/00

b. ATS validation report 10/22/00
c. Lidar Test System validation report 11/2/00
d. Complete orbit simulation s/w for GPS & timing system 11/30/00
e. Integrate BCE Controller with GPS and timing system 12/9/00
f. BCE thermal vacuum test report, 12/1/00
g. Support Integration of BCE with instrument in thermal vacuum chamber 2/22/01
k. Support thermal vacuum testing at observatory, 6/23 – 6/30/01 (Travel required, Boulder CO)

- Mechanical design, fabrication and testing Support for Integration and test of the GLAS instrument
  a. Responsible for leading the mechanical engineering effort for the GLAS instrument aft optics. Expected period of performance 4/30/01
     - Delivery of Lidar Beam Splitter Mounts for bonding - 8/10/00
     - Delivery of Lidar Fold Mirror Mounts for bonding - 8/10/00
     - Delivery of Lidar Detector Box - 8/15/00
     - Vibration testing of Altimeter Tower - 9/15/00
     - Vibration testing of Lidar Detector Box Assay - 10/15
     - Write mechanical procedures, conduct mechanical interface checks, support GLAS mechanical integration activities through instrument delivery 4/30/01
  b. General support engineering: Expected period of performance 8/1/00 - 10/31/00
     - Produce mechanical drawings in support of the GLAS instrument Update and maintain the GLAS mechanical IDEAS drawing database; weekly through 10/31/00
     - Produce and update top level assembly drawings:
     - Thermal Installation Assembly: 8/31/00
     - Instrument Assembly: 9/31/00
     - Electrical Assembly: 10/30/00
  c. Thermal support engineering: Expected period of performance 8/1/00 through 8/31/00
     - Produce mechanical drawings in support of the GLAS instrument Sunshade assembly: 8/15/00
     - Telescope thermal assembly: 8/10/00
     - Other Thermal hardware assemblies: 8/31/00
- Post flight calibration of the 1.5 arcsecond accurate laser pointing knowledge of the SRS. Lead planning and GSFC development of post-launch testing of GLAS for:
  a. White Sands Verification Overpasses
     - develop the airborne lidar components in collaboration with U of Texas at Austin effort. Support engineering flights, 6/01.
  b. On orbit monitoring of SRS and pointing performance, for the first 6 months after satellite is launched, (this period of performance may be extended)
  c. Post launch test report due 6/30/02.

3. Support 924 Laser Remote Sensing proposals, level of effort is expected to be one man-week per proposal.
   1. Laser Sounder for Orbital Measurements of CO2 and CH4 (of Earth's Atmosphere), 12/15/00.
   2. GLAS follow-on for an instrument concept study in inertially referenced laser pointing, 4/02.

In addition, there are general contract performance metrics which include:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

During this reporting period, various tasks were performed in support of the GLAS program. This support included designing and drawing of parts, testing, inspections, report preparation, procedure preparations, supervision, instruction, assembly, updating, collection of data and analyzing of results.

February 2001

GLAS BCE

General

BCE is now set up outside the SCA - alignment is not a problem. ATS was up and running in two hours after we got the OK from laser safety. TVAC re-scheduled. Blankets are ready and will be baked out. Received the fibers for the outside and the inside (tvac). Preparing for TVAC test. Worked on new budget. LdrTS is up and running. Submitted TVAC test plan. Revised BCE laser operating procedures.

ATS & LdrTS

Tracking down an ATS software issue. Checking new set up with diode laser for flight software testing. Checked Main Target transmission of 5 ns laser - inadequate power. Checked the PSD's with the TVAC harness. Fiber bake out finished. Awaiting the arrival of additional laser curtain. Writing TVAC test plan. Tests with showerhead on the Main Target show good correlation between input power and monitor. Stability of TVAC splitters OK - instabilities has been traced to showerheads.

Main Target

Risley and shutter re-calibration using autocollimator in progress. New feedthrough plate installed on Main Target. Thermocouple and heater placement started. TVAC splitters installed on the Main Target. Position Sensitive Detector (PSD) has been tested in the SCA with TVAC harness. Most of the thermocouples are on the Main Target. Radiometry tests showed that the 5ns laser has insufficient power to do some of the TVAC tests - we will use the 30 ns laser.

Mini Target

Most parts are finished. Thermal control of Mini Target is in progress. Blankets and heaters have been purchased. Design complete with the exception of thermal issue with filters. Thermal model of Mini Target in progress.

LsrTS

SW mod for Energy monitors will be in place and tested successfully. 660 nm laser for PSD is working nicely. Pressure transducers software for flight lasers finished.

DHDS

DHDS system is ready for data storage and has be tested with BCE controller.

Data Analysis

IST is in place and tested with DHDS.

Timing & GPS

GPS antenna in B7 installed successfully and GPS is working.

GLAS Optical

Worked on GLAS flight fiber box.

Power Meter - Fiber adaptor design.

Inspection of GLAS flight optical.

GLAS SRS Fiber Feedthrough Bonding.

GLAS Spare fiber splitter assembly and test.

Bonded five pieces GLAS dummy cubes.

Inspection of GLAS BCE color filters.

GLAS flight Etalon re-assembly.

Thermal testing of GLAS laser pick-off.

Bonded another ten pieces Lidar Box dummy cubes.

Assembly and test of GLAS flight Fiber Box.

Fit checked the EM LSM assembly. Alignment verification of Laser s/n 2 (determined angle wrt bench).

Revised optical integration flow.

Continued assembly procedure for the lidar components.

Supported laser operations in the SCA.

SRS Tasks

Lead the assembly, integration, alignment, & testing of the SRS and provide general systems engineering support for assembly, testing and performance assessment of the SRS BCE and I&T.

Temporary (non-optimized) alignment completed.

SRS BCE and Main Target BCE benches scheduled to go into TVAC for thermal balance testing.

SRS BCE will be optimized after the TVAC test.

Switch out of the lens corrector mount and the fiber array mount on the SRS BCE bench and final alignment scheduled.

Tests began on the BCE camera and fiber source to do some preliminary checkouts.

The BCE camera was mounted on the bench and images of the fiber array were obtained and saved.

Discussed the optical layout of SRS-BCE, alignment method, components, parabola, and the calibration procedure with new technician.

Reconsidered the coordinate transformation between LRS frame and star tracker coordinate frame.

Reconsidered the measurement method of the absolute offsets between the LRS frame and the LPA frame.

Work on the measurement method of the absolute angular offsets of the GLAS laser.

Developed a Zemax model to help future alignment of the lens corrector after TVAC test.

LPA (Laser Profile Camera) data acquisition procedure has been studied by GLAS

LPA GSE Data Acquisition System Operating Notes of Space Power Electronics, Inc. The phase mask image will be acquired and stored by a commercial software package.

Measured GLAS flight Zenith LTR 6-inch pre-temperature cycle and pre-vibe,

Tested LTR beam deviation.

Tested Dihedral and facet wavefront error (with Zygo).

Supervised LRS and ST integration on flight bench using NTGSE.

Discussed with Ball personnel integration of LRS, ST and Gyro using ITOC>

Directed data acquisition in BCE system to test stability and S/N limitations of the system.

Compiled data from LRS and ST deliveries, to prepare IDR for both cameras.

Worked on troubleshooting plan for CRS lens thermal failure with vendor and mechanical personnel.

Generated a table summarizing the specs for the fiber array mount and updated the specs for the lens corrector mount (tool: Zemax).

Writing a text document summarizing the main steps of the SRS BCE alignment.

Writing a document summarizing the analysis on tolerances for the SRS BCE.

Discovered why there were difficulties aligning the lens corrector (tilt and decenter).

Developed Zemax models simulating the alignment set-up.

Proposed solution to fix the problem: calculate new position of the theodolite.

The final alignment will start as soon as the SRS BCE is back from the TVAC thermal balance testing.

Performed a fit check of the SRS BCE bench cover to the SRS BCE bench.

Three sides of the cover are being modified.

Began writing the preliminary version of the SRS BCE star generator plate scale calibration and data analysis procedure.

Studied Young's interference method.

Checked the data analysis method by the image process software.

Worked on oscillator long-term test set up.

GLAS Mechanical

Continued work on alignment device.

Assisted in Clean Room.

Oversaw design of GLAS telescope light plug.

Began research on GLAS-SRS BCE alignment adjustable mount.

Reviewed SCA delivery schedule.

Completed initial design and modeling of SRS BCE alignment devices.

Etalon

Pushed spiders and end caps thru QA for final release.

Fit checked and cleaned.

Modified closeout tubes.

Inspected spider damaged during assembly and reassembled with second spider.

Lidar Detector Assembly

Designed Lidar Box cover with light blocking ports used during alignment.

Began custom interface adaptor.

SRS CRS

Inspected broken CRS lens.

Reviewed mechanical design with lead mechanical engineer.

Met with structural analyst to begin stress model of CRS lens.

Reviewed bonded risley stress numbers.

Derived equations for radial bond stress, radial deflection during vibe, and deflection due to inconsistent bond line thickness.

March 2001

GLAS BCE

General

Main Target with MLI, heaters, fibers, etc. installed on BAP. Addressed testing requirements. BCE moved in front of TVAC. Alignment and set up were done. BCE TVAC Testing completed and data gathered. Preliminary data shows the Main Target behaved as expected. Received okay to send instruments for calibration. Preparing for 4/13/01 testing. Reviewed budget.

ATS & LdrTS

Software trouble was resolved. Prepared for dry run with target in SCA. Checked TVAC set up with LdrTS and ATS transmitters. Exploring alternative alignment scheme to the partitions in front of TVAC.

Main Target

Target is 95% ready.

Mini Target

Design is complete with the exception of mini target beam dump. A coarse Thermal model of the Mini Target is in progress.

LsrTS

Ready for dry run. Questions regarding the Risley motor heat dissipation will be addressed during the TVAC test.

DHDS

DHDS is ready and will store data during TVAC test.

Data Analysis

IST is in place and tested with DHDS.

Timing & GPS

GPS is working great.

GLAS Optical

Completed the measurement of the ETU laser alignment relative to the GLAS main bench.

Completed the installation and the alignment of the laser pick-off box.

Worked to resolve the Blanket issues on the telescope. Buttons were added to the telescope and the blanket was modified.

Located and brought a blanket liaison consultant on board to assist with the integration of the instrument.

Completed and delivered the GLAS flight fiber box test.

Bonded seven pieces of GLAS spare lidar beam splitter cubes.

Worked on GLAS SRS BCE Risley bonding.

Bonded GLAS spare Etalon wedge.

Completed the Laser pick-off box integration and checkout. Verified that the signal levels were within expected ranges.

Improved fiber routing scheme from laser pick-off which minimizes fiber length as well as the possibility for damage.

Completed collimator verification.

Worked to resolve implications of the e-box failure and transmit optics questions.

Inspected four pieces of GLAS fiber splitter b/s cubes. Worked on the alignment, focus, and vacuum defocus test of GLAS lidar box.

Designed a collimating lens for the GLAS SRS CRS system.

Performed Zemax analysis and proposed specifications for a custom made silica lens. Current analysis shows that the spherical aberration is significantly reduced with such a lens.

Assisted in the integration of the GLAS instrument.

Resolved some optical issues regarding blankets and the telescope.

Completed and submitted hit list action item.

Conducted GLAS flight Lidar box Thermal testing and Vibe test.

Updated the procedure that will be used for the SRS BCE final alignment.

SRS Tasks

Lead the assembly, integration, alignment, & testing of the SRS and provide general systems engineering support for assembly, testing and performance assessment of the SRS BCE and I&T.

Supervised SRS BCE data acquisition in preparation for T-Vac.

Thermally cycled first fold mount and approved post-test optical measurements results.

Analyzed LTR issues with mechanical team.

Worked with designers and machinists of GRC camera enclosure to resolve leak issues.

Analyzed options for CRC lenses, optical issues, and stability issues.

Finished the preliminary version of the SRS BCE star generator plate scale calibration and data analysis procedure. The second version of the plate scale calibration procedure has been submitted.

Made new image-processing program. An ideal picture of the multimode fiber star array has been simulated.

Tested GLAS LTR Nadir 10.7" Post-Vibe Beam deviation testing.

Tested GLAS LTR Zenith 6" Pre-Vibe Beam deviation testing.

Tested GLAS LTR CRS 4" Pre-Vibe Beam deviation testing.

Tested GLAS Flight First Fold.

Supervised removal and replacement of first fold and second fold.

Performed LPA check through flight harness.

New program being considered to resolve problem for a high fitting resolution.

Reviewed vendor specifications and measurements for coatings of new optics.

Recommended responsivity test of LPA over whole CCD area, since current laser spot is in different area than previous.

Recommended polarization measurement of ETU laser.

Continued T-Vac testing of SRS BCE. Took continuous data runs to compare to discontinuous files. Found very good system stability using this method.

Examining centroiding routines to assure accuracy.

Discussed integration plan for Inertial Reference Unit. Suggested integration strategy to minimize Helium contamination. Requested permanent purge using stainless steel flex lines.

Analyzed LPA signal problem and requested new second fold optics as back up solution.

Finished the SRS BCE T-Vac data acquisition.

Finished the general calibration procedure of the SRS LRS including the procedure, data volume calculation, measurement time estimation, and the reduction method of time and data volume.

GLAS Mechanical

Completed detail drawings of individual parts. Assembly drawings remain after final approval of design.

Modified custom parts and revised drawings as needed.

Initiated manufacturing process.

Met with SPCM lead and machinist to measure detectors for adaptor interface.

Performed fit check.

Assembled SPCM and interface for initial focus measurements.

Worked with verification engineers for SPCM bake-out.

Troubleshot assembly cover.

Mounted Etalon assembly to invar plate.

Set up thermal survival test.

Worked on heat-treating issues of alignment cover.

Conducted Vibration test of Etalon Assembly.

Qualified Etalon and Spider design.

Updated WOA binder and certification logs for assembly.

Designed shims for Lidar box cover.

Assisted in the assembly and alignment of the box.

Assembled cages onto the flight spare beam splitters.

Began thermal cycling.

Completed assembly of Spare Lidar cube cages.

Thermal cycled spare Lidar cubes and fold mirrors.

Oversaw repair of SPCM high-voltage connector.

Successfully conducted Vibration test of Lidar Detector Box assembly.

Supported LSM arm redesign.

April 2001

GLAS BCE

General

Analyzed the last group of data files. Collaborated on refinement of centroiding algorithms. Requested complete archive for final analysis. Removed the system from vacuum chamber. Coordinated the transport to optics laboratory and necessary successive steps for its calibration and realignment. Redefined the plan for realignment. Coordinated repair and refurbishing of 24-inch and 17-inch LTR's with the manufacturer. Sent twenty-five instruments for calibration. Continued troubleshooting of non-uniform responsivity in LPA. Assembled a testing

station using a 1064nm laser. Found that the CCD was not centered on the optical axis of the LPA. Analyzed the data taken during the T-Vac. Requested thermal testing of star generator parabola. Discussed analysis of fringe data for plate-scale calibration. Suggested Fourier transform methods. Began final alignment following the new procedure GLAS-551-PROC-020-REV A. Measured the wedge of the star generator beam splitter. Obtained the ZYGO measurements of the star generator beamsplitter, star generator fold, camera side beamsplitter, and camera side fold. Obtained the ZYGO measurements of the 6-inch parabola with temperature changes, using a heat gun. Performed black light checks. Cleaned the Target thoroughly. Final alignment is in progress, 21 of 40 tasks involved in the final alignment have been completed. Replaced a theodolite. Aligned four theodolites and established the optical axis.

BCE TVAC

Testing data analysis in progress. Temperature loop performed well and the laser test signals were stable. Addressed testing requirements in several meetings. Began writing the BCE procedure. Remaining analysis: TOF Start Pulse amplitude PSD.

Mini Target

Held meeting to discuss beam dump thermal issue. Did radiometry for the Mini Target. Set up equipment in front of SCA. Addressing safety issues. That would make it easier to align the Transmitters in front of TVAC. Writing several procedures and interface control document.

Minor design change to the Mini Target beam dump because of additional requirements to serve as beam close out box without the Mini Target. Tested AOM with HP pulse generator. The LdrTS and the ATS software are being integrated as much as possible without the HW. DEM and orbit simulation software is in place.

GLAS Optical

Made inquiries about the CRS lens: Generating manufacturing drawing and description of the lens surface profile (aspheric equation and sag table). Finalizing some tolerances.

Measured the transmittance of five filters (GLAS SRS Main Beam Flight Filters) at 1064nm.

Worked on the GLAS flight Lidar box final testing and delivery.

Worked on the GLAS flight Fiber Splitter assembly.

Completed the bake out of the flight and flight spare etalons.

Completed the TCS installation and the GSE heater installation on the flight etalon.

Received the Lidar detector box for integration onto the instrument.

Blanket fit check was completed.

CCHP hardware dry installed for blanket fitting.

TCS instrumentation is to be installed.

Prepared the Lidar path integration.

Completed necessary work orders.

Worked with the mechanisms group to develop a more accurate test for the fixed fold analysis. Built and set GLAS flight OTS.

Troubleshot GLAS flight Fiber splitter.

Built and aligned GLAS spare Lidar box.

Worked on GLAS fixed mirrors.

Completed the installation and the alignment of the GLAS etalon assembly onto the GLAS instrument.

Completed the fit check of the GLAS Lidar detector box.

Coordinated the preparation for the integration of the assembly onto the instrument.

Worked on the GLAS fiber splitter and I&T support.

Measured beam deviation of flight zenith LTR and flight nadir LTR at ambient temperature and with temperature changes using a heat gun.

Completed the alignment and mechanical integration of the etalon.

Completed the alignment and mechanical integration of the Lidar detector assembly.

Completed the revisions to the Lidar detector integration to protect the detectors.

Developed a test plan for the fixture beam dump.

Attended the light close out meeting.

Worked on GLAS SCA collimator.

Performed measurement of GLAS flight fixed Laser fold mirrors.

Installed GLAS flight Lidar box.

Performed measurement of GSA fibers for Lidar box testing.

SRS Tasks

Lead the assembly, integration, alignment, & testing of the SRS and provide general systems engineering support for assembly, testing and performance assessment of the SRS BCE and I&T.

Performed LPA troubleshooting through scanning of laser beam across FOV. Found anomalous behavior. Removed LPA from flight bench for further diagnosis. Recommended an upgrade of flight spare unit to flight condition. Contacted the manufacturer for replacement of defective units.

Coordinated the IRU integration with Integration Team.

Coordinated the sealing of the enclosure.

Supervised He determination and elimination techniques.

Selected bonding technique for CRS lens to eliminate thermal stress issue.

Produced performance analysis based on CTE of materials and bonding thickness.

Worked on refinement of timing scheme for ground testing and other data analysis issues with Data Handling Group.

Made progress on Young's interference pattern fitting.

Made a program to generate the fringe pattern.

Began consideration of a 3D data fitting.

Created the theoretical image file and prepared to do some data-fitting tests.

Conducted first calibration run. Obtained excellent fringes for interference of single mode fibers.

Working on MATLAB 3D real-time data fitting program and the graphics. This requires a real time data fitting with the repetition rate of 10-40HZ. So a complete new data-fitting program should be made for that purpose.

Analyzed the completeness of software databases for flight with a science team member and systems engineer. Determined the need for implementation of emergency command library in order to be ready for flight troubleshooting, if necessary.

Determined that Flight LPA had anomalous responsivity in the focal plane. Tested ETU LPA and found uniform response. Took both units to manufacturer for troubleshooting.

Discussed possible solutions to chip decentering with engineers.

Performed thermal testing of LTR's with flight mounts.

Devised a method for testing thermal chamber.

Working on image processing of experimental data of the interference fringe pattern. The data files have been loaded into the MATLAB program successfully.

Displaying techniques for different format image files have been studied.

Began to study the procedure of the functional verification of LRS performance with laser and BCE.

Continued work on the 3D real time data-fitting program and the graphics for the laser beam divergence measurement.

Studied the laser beam diagnostics theory and program.

Supervised the LTR assembly operations.

Different kinds of image data files have been processed, including 80x80 images and the 488x652 images. One new 90-degree full-size (488x652) image file has been processed.

Worked on the MATLAB program and function test. The program can now import jpeg image files, image profile plot along any angle in the image array, perform averaging along any angle, Fourier Transformation, Inverse FFT, and simple gate filter.

GLAS Mechanical

Prepared for and supported the Lidar detector box assembly IDR.

Updated Lidar paper work for WOA close out.

Coordinated the final thermal cycling of spare dichroic beam splitter.

Worked with blanket shop on design and issues.

Installed heat pipes and heat straps and addressed issues.

Designed lifting cradle for installation.

Black light testing on Etalon.

Mounting pads and shims were measured and assemble.

Installed Etalon onto the instrument.

Aligned to better than 1mrad.

Worked on heat strap issues.

Supported TCS installation.

Supported blanket fit checks.

Black lighted Lidar and cleaned for blanket installation.

Supported blanket installation.

Installed Lidar onto instrument for Lidar optical path determination.

Fit checked Lidar and worked out installation issues.

Made final preparations for assembly of 5-Axis adjustable mount.

Wrote assembly procedure.

Had all available parts cleaned.

Ordered and received the last of the required fasteners.

Performed all necessary tasks to have the 10.7-inch LTR modified and assembled.

Delivered the Flight 10.7-inch LTR for vibration testing.

Began fabrication on the 4-inch and 6-inch LTR shims and had the 6-inch LTR brushing coated.

Began work on removing the main SRS filters and Risley's from the flight bench (the Risley's are to be further tested and the filter mount is to be modified).

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue work of previous period.

NASA Task 00-924-02: VCL Support Task

-- WORK PLAN --

GSFC ATR: J. Blair

Raytheon Task Leader: Terry Williams
Raytheon Task Number: 167

This task is comprised of several work items supporting the Vegetation Canopy Lidar (VCL) project in the areas of algorithm development, measurement modeling, mission and systems design and engineering, and scientific data processing and research. The individual work items are summarized below. A detailed description of each work item is provided in the Milestones and Metrics section.

A. Coordinate and complete the development, testing and delivery of the VCL Precision Geolocation System (VPGS).

B. Provide algorithm research and development in the areas of instrument parameter calibration and validation.

C. Provide mission/systems engineering and analysis to "flow" VCL sensor and sub-system performance to final science data product accuracies and to analyze various mission and system trades.

D. Provide algorithm research and development for aircraft laser altimeter data processing.

E. Provide VCL on-orbit support.

STAFFING PLAN

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Terry Williams	80%	Task leadership, VPGS system software design and development, analysis and implementation
Eric Winter	100%	Algorithm design and development for aircraft laser altimeter
Shelley Rowten	20%	Support of shuttle altimeter laser analysis, testing of the VPGS

Spread charges for infrastructure support will be incurred from:

Program Management

Cost Control

Administrative Support

Courier

MILESTONES AND METRICS

METRICS

Each work item is detailed below along with specific "high-level" requirements to be met. In addition to meeting the "high-level" requirements outlined, a set of metrics is specified for each work item.

Work Item Functional Description / Requirements:

A. Coordinate and complete the development, testing and delivery of the VCL Precision Geolocation System (VPGS). The VPGS is a highly automated system that will operationally produce the VCL geolocated data products at the best accuracies possible given the final VCL sensor configuration. The VPGS processes shall be capable of running within the VCL Data Center (VDC) DAAC and running "stand-alone" without the DAAC. The VPGS shall operate within a SUN workstation environment, but the software shall be written such that it can be easily ported to other UNIX workstation environments. The system shall be comprised

of individual processes that perform various functions. Each process shall be self-contained and capable of running on its own as a UNIX command. Each process shall be self-documented and provide the user with both a "batch" and "analyst" mode of operation. The VPGS is comprised of 3 major sub-systems: (1) Precison Orbit Determination System (PODS), (2) Altimeter Range Processing System (ARPS), (3) Precision Attitude Determination System (PADS). While both the PODS and ARPS depend on the attitude solution from the PADS, the PADS is being developed under a separate UMD task. The PODS and ARPS developed under this task must properly accommodate the PADS system and products. Specific elements/ capabilities of the VPGS are described below:

- VPGS will operationally perform POD, instrument parameter calibration (pointing, ranging, timing), geophysical model/correction (body tides, pole tide, atm. Refrac., ocean loading, ocean tides, etc...), final surface return geolocation.
- The VPGS will meet the requirements outlined by the VCL SMRD (Science and Mission Requirements Document).
- The PODS and ARPS sub-systems are based on the GEODYN software system. Modifications of the GEODYN software will be necessary for model/capablility development, tuning, and maintenance and efficiency improvements.
- The PODS shall be capable of operationally: (1) processing both IGS ground network data and SP3 orbit solutions to produce IGS "caliber" precision orbits for the GPS satellites for a user selected arc and ground network. (2) processing spacecraft/user GPS receiver data to produce highly accurate user orbits, (3) processing SLR ground network data to contribute to user orbit solutions, (4) process laser altimeter range data to contribute to user orbit solutions, (5) processing GPS receiver navigation solutions to produce a quick-look orbit ephermeris prediction product for ground control system operations and science planning. The PODS shall be highly automated and requires a detailed set of analysis software to be developed, improved and maintained. The analysis software shall have significant visualization capabilities and run in both a "batch" and analyst mode. These analysis software include: residual analysis, orbit delta analysis, telemetry analysis, and recovered parameter analysis. An automated performance summary capability shall be implemented for final product quality assurance. Several capabilities are required to automate the POD processing of the above GPS and SLR data. These capabilities include, but are not limited to: automated BIH and flux table production, IGS and SLR ground network performance analysis, GPS satellite performance analysis and automated station position, eccentricity and antenna phase center data processing.
- The ARPS shall be capable of operationally processing the laser altimeter range data from AREAS for: (1) instrument parameter calibration from: ocean sweep calibration maneuvers, land calibration sites and dynamic cross-overs; (2) quicklook and final high-fidelity surface return geolocation including the appropriate geophysical corrections as mentioned above. The calibration aspect of the sub-system shall be based on the GEODYN software. Measurement model algorithms for classic geolocation, ocean and land direct altimetry and dynamic cross-over altimeter data processing shall be implemented, refined and maintained within GEODYN. The sub-system shall be capable of simultaneously processing spacecraft tracking, attitude and laser altimeter range data to provide a simultaneous solution of orbit and instrument parameters. The GEODYN laser altimeter measurement model algorithms shall be CPU and storage optimized to handle the large amounts of VCL data (~20M laser shots/day). A High-Speed-Geolocator (HSGEO) system shall be developed which will combine orbit solution data, instrument parameter solution data, attitude data and range data along with computing detailed geophysical corrections to produce the VCL geolocation product for each altimeter observation. The HSGEO must be highly optimized to handle the large amounts of VCL data.

B. Provide algorithm research and development in the areas of instrument parameter calibration and validation. This includes detailed simulations and pre-launch error analyses to quantify the performance of various algorithms, techniques and methodologies. It also includes processing of existing similar data sets (eg. SLA) to

operationally test the algorithms and quantify their performance. Provide algorithm and measurement model development, improvement, and enhancements so that the VGPS will meet VCL science product requirements for accuracy, resource efficiency, and schedule.

C. Provide systems engineering and analysis to "flow" VCL sensor and sub-system performance to final science data product accuracies and to analyze various system trades including competing sensor analysis. This includes detailed simulation and error analyses combining sub-system and sensor performance estimates to quantify final science data product accuracies based on various VCL sensor and sub-system configurations. The results of these analyses will be used to make significant VCL development and implementation decisions.

D. Provide algorithm research and development for aircraft laser altimeter data processing. This includes the implementation of existing formal spaceborne laser altimeter range processing algorithms for aircraft data processing.

E. Provide VCL on-orbit support including instrument parameter calibration analysis, geolocation error analysis and accuracy assessment, geolocation accuracy improvement and model/algorithm tuning and refinement, and operational geolocation production and quality assurance.

Work Item Metrics:

A. While this work item has some algorithm research oriented aspects, it is for the most part a development work item. Therefore, the following metrics will be used to assess the performance:

- Delivery schedule conformance as outlined in the *Milestones and Deliverables* section and as dictated and agreed upon by the ATR as the project continues to evolve.
- Meeting required functionality and providing the necessary capabilities.
- Flexibility of design.
- Responsiveness to change in requirements.
- Trouble shooting and problem solving.
- System performance as tested with real or simulated data.
- Regular communication of progress through informal communication, monthly reports and formal project reviews.
- Efficiency in the use of resources.

B. This work item is research oriented and the performance assessment relies on the ATR's subjective assessment of the quality of the research. Criteria to be considered includes:

- Use of innovation and creativity for problem definition and solving methodology
- Quantifiable improvement made with new algorithms or algorithm refinement
- Depth and completeness of analysis
- Articulation and written/oral presentation of results
- Resource savings

C. This work item is research and analysis oriented and is similar to the above item. Performance assessment criteria to be considered include:

- Depth and completeness of analyses
- Responsiveness in completing analysis and addressing changes
- Articulation and written/oral presentation of results

D. This work item is research oriented and the performance assessment relies on the ATR's subjective assessment of the quality of the research. Criteria to be considered includes:

- Use of innovation and creativity for problem definition and solving methodology
- Quantifiable improvement made with new algorithms or algorithm refinement
- Depth and completeness of analysis
- Articulation and written/oral presentation of results
- Resource savings if applicable

E. This work item consists of both production and analysis/research. Performance assessment criteria to be considered include:

- Depth and completeness of analyses.
- Timeliness of analysis and detail of results.
- Quantifiable improvement made with new algorithms, model tuning and refinement.
- Articulation and written/oral presentation of results
- Use of innovation and creativity
- Efficiency and timeliness of production processing.
- Quality of production products.
- Improvement of overall accuracy and efficiency.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

MILESTONES & DELIVERABLES

The VPGS delivery schedule is highly dependent on the evolving VCL mission timeline. Therefore, some flexibility in delivery must be maintained. Certain aspects of the VPGS can not be sufficiently completed until the VCL system is in a very mature state. This mostly applies to raw data ingest and preprocessing but also applies to specific data processing algorithms depending on types of sensors (eg. GPS receiver or star tracker). In developing the VPGS a level of effort must be commensurate with the mission timeline to ensure the most efficient allocation of resources in developing the system as it matures. However, a broad deliverable schedule can be outlined below. It should be noted that since the VPGS is modular, each module will be delivered and tested sequentially. Therefore, many of the capabilities will be delivered and tested long before the full system delivery date.

- Launch-11 mo. Delivery of V0 VPGS system.
- Launch-9 mo. Full integration of V0 VPGS within VDC DAAC.
- Launch-5 mo. Full integration of V1 VPGS within VDC DAAC.
- Launch-3 mo. Final I&T
- Launch-3 mo. System launch ready.
- Launch-1 mo. Operator training
- Launch+1 mo. System testing, extensive cal/val, model tuning

- Launch+7 mo. 1st three mo. of data processed and geolocation delivered
- Launch+10 mo. 2nd three mo. of data processed and geolocation delivered
- Launch+11 mo. start of monthly geolocation delivery – 3 mo. latency
- Mission completion + 4 mo. All geolocation delivered

All research and analysis oriented deliverables will be provided in a timely fashion to meet the schedule of the mission and the ATRs requirements. The deliverable schedule for each specific research and analysis task will be discussed and outlined on a case by case basis as needed.

Task documentation and deliverables:

- Maintain and update *Geolocation Algorithm Theoretical Basis Document.*
- Document research results and algorithm performance through oral presentation and major scientific/engineering conferences and through written refereed journal articles.
- Maintain internal software documentation and continue to provide function documentation through user initialized "man pages".
- Contribute (where appropriate) to VCL mission documents including: SMRD, various ICDs, and VDC/ground system documents.
- Document mission/systems engineering analyses and trade studies results through VCL email and technical memorandums.
- Provide regular quarterly progress and planning reports.
- Present progress and results at VCL mission reviews.
- Maintain development plan and schedule on VDC website
- On-orbit: provide timely cal/val and adhere to operational delivery schedule.
- Deliver VPGS on schedule as detailed below.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

The VCL task supports the Vegetation Canopy Lidar (VCL) project in several areas. These areas include algorithm development, measurement modeling, mission and system design and engineering, and scientific data processing and research. The VCL Precision Geolocation System (VPGS), which is comprised of all the above areas, is a highly automated system developed to produce VCL geolocated data products to the best possible accuracy given the final VCL sensor configuration. The delivery schedule for the system is dependent on the actual mission launch.

The majority of the effort has been concentrated on the development and testing of the highly automated Precision Orbit Determination System (PODS) of the VPGS. Raytheon staff has completed design and development of the processing of spacecraft/user GPS receiver data. Data from both GFO and CHAMP were used to test the setup and processing. Five sets of two-30 hour arcs with an overlap of 6 hours were selected from available GFO arcs processed with slr, tranet and altimeter data during January and February 2000. S. Luthcke and F. Lemoine are currently performing analysis of these runs to make improvements in the determination of the GPS user satellite's or-

bit.

Raytheon Staff implemented and automated processing improvements in the setup of GPS, SLR and DORIS sites within GEODYN. System development included creating station position-velocity options for GEODYN input based upon the newly released ITRF2000 SINEX file. In addition, software modules were written to automate the importation of SLR and DORIS data as well as site ancillary data.

VPGS Version 1 was created and released to the ATR. The released version includes all system development up to date and the final 1999 delivery of the VMSI software.

Raytheon Staff has also provided support to the LVIS aircraft laser altimeter data processing system.

Design and development of the first version of the laser shot geolocation software prototype has continued. The prototype includes libraries developed to perform computation of Earth orientation parameters, transformation matrices and aircraft rotations.

Performed background study of laser bounce point geolocation, GPS (Global Positioning System) theory and practice, and IERS conventions. In the course of this study, identified and corrected errors in the study text which significantly impacted results.

Developed a suite of software for analyzing satellite ground track and power usage data from simulated VCL orbits. Suite includes software for data extraction, preprocessing (including selective target extraction), analysis and report generation, and plotting of coverage maps and ground tracks on a map of the Earth. With this software, a serious power shortage was identified in the planned operation of VCL, which will require orbital redesign or sacrifice of some science data.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR Quarter

- Continue VPGS development and system testing.
- Continue processing SLA and GFO data to test the VPGS capabilities.
- Develop LVIS data geolocation / calibration processing system

NASA Task 00-926-01: Data Analysis For Geodynamics

--WORK PLAN--

GSFC ATR: R. Kolenkiewicz

Raytheon Task Leader: Peter Dunn
Raytheon Task Number: 133

LAGEOS I, LAGEOS II, ETALON I and ETALON II observations collected by the global laser ranging network will be analyzed to determine the rates of change of horizontal position at all major stations in the network, together with the stability of these rates. In the first phase of this task, the horizontal positions and heights of the major laser stations above a reference surface will be simultaneously estimated using LAGEOS I data collected up to Jan 1,2000, and the significance of any variations will be studied. A subsequent phase will extend the analysis to polar motion and length of day to be determined from LAGEOS I and II data at intervals of one day prior to the launch of LAGEOS II (October 1992) and thereafter the EOP series will be determined at sub-daily intervals. In the final phase of this task, data from four satellites will be analyzed to provide estimates of GM (the product of the Earth's mass and the universal gravitational constant) at regular intervals since LAGEOS I was launched in 1976. This re-analysis of LAGEOS data since launch will be conducted with improved force models. The analysis of laser ranging observations for the study of tectonic plate motion and regional deformation will build on the evolving improvements in instrument accuracy, and will take advantage of the latest developments in gravity, station and satellite motion modeling.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Peter Dunn	10%	Task leadership, solution design, science results
Mark Torrence	10%	Orbit analysis, SOLVE solution design and execution, science results
Ron Williamson	2%	Orbit analysis and force modeling assessment

Spread charges for infrastructure support will be incurred from:

Program Management

Cost Control

Administrative Support

Courier

MILESTONES AND METRICS

This work plan addresses Phase 1 of this effort, and will concentrate on resolving vertical station motion. This task is research-oriented and requires timely reporting of new results at scientific meetings and collaboration with GSFC staff in preparing the results for publication. The work includes the incorporation of recently acquired measurements from the CDDIS into the analysis, and the design of optimal techniques for reducing the measurements.

Task performance metrics include:

1. Incorporation of new SLR tracking measurements on a schedule appropriate to the analysis.
2. Effective and timely execution of solution strategies defined and approved by the ATR
3. Reporting of new results at one science meeting per year
4. Preparation of one publishable manuscript per year on new results from this investigation

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL REPORTS AND DOCUMENTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Staff extended an analysis of the vertical motion of SLR sites located near the boundary of the Fenno-Scandian ice sheet coverage. Discussions with the IERS about how an uncompromised multi-year tracking site position, velocity and EOP solution can be used in the ITRF 2000 determination continued.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

During the next reporting period, new observations contributing to global, annual, monthly and more frequent estimates of station location in the *LAGEOS* network will be assessed. Stabilizing transformations will be applied to facilitate subsequent analysis of interstation baseline rates. Vertical position variations will be monitored in a reference system for which values of polar motion and length of day were estimated, and the Earth Orientation Parameters will be compared with previous results.

NASA Task 00-926-02: Venus Gravity Modeling

--WORK PLAN--

GSFC ATR: Dr. F. Lemoine

Raytheon Task Leader: Chris Cox
Raytheon Task Number: 181

This task supports analysis of tracking data from Magellan and Pioneer Venus Orbiter, including data reductions using improved orbit modeling, creation of normal equations, and estimation of geopotential solutions. The K_2 Love number and planetary orientation parameters will be estimated. The Lerch method of subset solutions will be used to calibrate the geopotential solutions. The solutions will be evaluated in terms of orbit performance, and compared with solutions developed by other investigators.

STAFFING PLAN

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

NAME	FTE%	RESPONSIBILITY
Chris Cox	20%	Task leader, responsible for general task technical performance. Develop new Geodyn models and solution strategy for processing the PVO and Magellan tracking data. Develop code and Evaluate constraint techniques. Develop gravity model solutions.
Jennifer Beall	40%	Responsible for PVO and Magellan tracking data processing and editing, using models and code provided by the task leader. Also responsible for generation of the gravity Emats once the basic setup and strategy has been determined by the task leader and ATR.

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONE AND METRICS

There are three major elements of this task:

1. Spatial constraint techniques evaluation: This effort requires software coding and evaluate the spatial gravity model constraint techniques using terrestrial TDRSS data. All reference gravity solutions and emats that are needed already exist from the EGM96 and subsequent efforts.
2. GEODYN drag model development for Venus. The low altitude drag models developed for processing the TRMM data will be used to process the Magellan and PVO data. Some coding effort is required to verify the correct functioning of the models in the new GEODYN versions, and to hook the new drag modeling into the Venus atmosphere density model.
3. High degree (to degree 180) gravity model development. Solutions will be developed out to a maximum spherical harmonic degree of 180. This will either be done by piecing the solutions (e.g. by completing a first solution complete to degree 100 with high order terms to degree 180, then completing a fill in model), or if practical, by direct recovery of the entire solution. Solution calibration will be performed using the method of subsets.

To monitor this effort, the following milestones and metrics are proposed:

- Complete data reprocessing using new drag models and data edtis (11/00)
- Complete spatial constraint technique evaluation (01/01)
- Prepare presentation and paper on the spatial constraint evaluation (02/01)
- Complete emat generation pass 1, if pieced solution used (02/01)
- Complete initial gravity model (low degree ~120) (03/01)
- Complete emat generation for complete degree 180 model (04/01)
- Complete degree 180 gravity model (05/01)
- Prepare presentation and paper on the gravity model solution performance (6/31)

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Data cleanup and processing with the improved PVO and MGN, and drag models is progressing.

- Daily PVO arcs have been generated for all periods not already reduced using long arcs.
- Almost all the available data has been utilized.
- A portion of late 1978 remains to be processed, and some cleanup issues remain in the other periods.
- MGN cycle 4 data has been entirely processed and cleaned up using the new drag models and daily arcs.
- MGN cycle 5/6 is mostly complete, with only a small portion remaining to be checked.
- One-cycle-per-rev accelerations were required for the C5/^ data cleanup, however, once the cleanup is completed, the emats will not be generated using estimated 1-cpr terms.
- Biased tracking passes have been identified for both periods, and all editing has been turned into GEODYN DELETE cards to prevent the need for reediting later.
- Both MGN time periods will need to be rerun using longer data spans (~2-4 days for C4, and 2-3 days for C5/6), however no data cleanup is anticipated to be needed.

A proposal for the 2001 Planetary Geodesy and Geophysics portion of the Office of Space Science NRA is being investigated.

- The focus will be determination of Time Variable Gravity for Venus.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR THE NEXT REPORTING PERIOD

Submit proposal to OSS NRA.

Finish PVO processing.

Generate MGN long-arcs using existing modeling.

Include MGN hide modeling and improved macro model and rerun.

Begin emat generation.

NASA Task 00-926-03: GFO POD

--WORK PLAN--

GSFC ATR: Dr. F. Lemoine **Raytheon Task Leader: Nikita Zelensky**
Raytheon Task Number: 161

Nominal Medium precision Orbit Ephemeris (MOE) SLR-based orbits for the GEOSAT Follow-On (GFO) radar altimeter satellite will be determined each workday and shall be made available together with a Quality Assurance (QA) report less than 36 hours after the end of the data arc The science investigation for this task will focus on how to determine the best possible GFO orbits by accurate measurement modeling and force modeling using GEODYN. Changes that would facilitate GFO processing will be recommended to the GEODYN group; also precise orbits for the calibration/validation periods based on the best available models will be provided to the GFO CalVal team and user community . The final products of the science investigation will be a "macro" model " (representing surface forces acting on the spacecraft) and gravity model tuned with GFO tracking data, and specifications for optimal arc length, parameterization, and data weighting. The tracking complement consists of on-board GPS receivers, a laser retroreflector, and Doppler beacon. Since the GPS receivers have returned only limited data, the Precision Orbit Determination (POD) effort is anticipated to continue to depend primarily on SLR and altimeter crossover data. This task will require timely reporting of results at professional meetings and in publications.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Nikita Zelensky	30%	Task leadership, solution design, orbit and data analysis, science results
Neader Chandler	30%	data analysis
Doug Chinn	10%	orbit and data analysis, science results

Spread charges for infrastructure support will be incurred from:

Program Management

Cost control

Administrative support

Courier

MILESTONES AND METRICS

Under nominal tracking and satellite event conditions, an MOE and QA report will be produced each workday with a lag time of 36 hours or less following the end of the data arc.

Three coordinated and clearly defined activities will be pursued to meet the stated scientific objectives: 1) Evaluate all available tracking data types, including SLR, Doppler, GPS, GFO-GFO altimeter crossovers, and TOPEX-GFO altimeter crossovers. Antenna/measurement offsets for SLR, GPS, Doppler, and altimeter measurements may have to be determined. Also confirmation that the Doppler station positions are transformed properly into the ITRF will be necessary. 2) Evaluate tracking data combinations, optimal arc length, data weighting, solution parameterization, and compile metrics for guaging orbit accuracy and improvements in the tuned models. 3) Produce normal equation sets and tune the macromodel and gravity models using GFO tracking data. Of particular interest will be the inclusion of the TOPEX-GFO altimeter crossover data. Tuning of the macro and gravity models will proceed in several interative steps. Improvements in the models and orbits is evaluated with a number of indices including fits to tracking and altimeter data, orbit overlap consistency, direct orbit differences, changes in the estimated model coefficients and coefficient uncertainties, and orbit error covariance projections. This task will require timely reporting of results at professional meetings and in publications.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

- Of the 62 workdays, 63 orbits plus QA reports were delivered on time.
- Delivered special orbit so that SLR could re-acquire GFO following maneuver.
- Participate in e-mail discussions concerned with refining the GDR product.
- Completed EGS 2001 presentation, ILRS 2000 paper, and FMS 2001 paper
- Evaluate tuned force models and the reduced-dynamic approach with altimeter crossover data.
- GFO GPS data processing is under investigation
- Improvement of GFO altimeter corrections such as the ionosphere is under investigation.
- EGS 2000 paper in progress, and a paper is to be prepared for publication (Journal of Spacecraft and Rockets)

Technical Issues:

- Consolidate GFO orbit POE and MOE production using SLR+Doppler+ altimeter crossover data under new Sun work-station.

Other Issues:

- MOE and POE production cost will be shared by NASA and NOAA over one year, however additional funding may be available through the Navy
- Neader Chandler is planning to retire June 30, 2001; she is willing to work from home, but we must insure she is setup to be able to.

PROBLEM AREAS

None

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Altimeter crossovers constructed from both GFO and TOPEX will be evaluated and used to calibrate the GFO altimeter measurement model, and further tune the macromodel and gravity field.

NASA Task 00-926-04: MGS and NEAR Orbit Analysis

--WORK PLAN--

GSFC ATR: F. Lemoine

Raytheon Task Leader: D. Chinn
Raytheon Task Number: 132

The purpose of this task is to compute and deliver the best possible orbits for the Mars Global Surveyor (MGS) and the Near Earth Asteroid Rendezvous (NEAR) spacecraft. Both spacecraft carry laser altimeters and are tracked at X Band by the antennae of the Deep Space Network (DSN). Prime missions for both spacecraft are the estimation of high resolution topographic models, as well as models of the geopotential. For this purpose, the best possible orbits must be computed and delivered on a routine basis. To improve the orbit determination modeling, the macromodel or non-conservative force model of each spacecraft may need to be estimated from tracking data, and the best possible geopotential models must be used. Preparation and reformatting of external attitude files for use by GEODYN may be necessary to obtain the best possible OD modeling. Geopotential models and other geodetic parameters must be estimated from the tracking data to satisfy the missions' science objectives. Analysis will be required to verify the quality of the orbits.

Normal equations must be prepared and their labels verified prior to use by SOLVE. SOLVE will be used to estimate parameter solutions. Geopotential solutions will be calibrated using the subset technique of calibration. Error analyses will be performed using various covariance analysis and utility programs to assess the quality and performance of the SOLVE solutions. Solution results and calibrations will be documented.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Doug Chinn	30	Task leadership, and running GEODYN and SOLVE.

Spread charges for infrastructure support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

The primary deliverables will be the completed SOLVE runs, and the output from the covariance analysis and utility programs, as well as summaries of the calibration results and estimates of geodetic parameters of interest using different data sets and data weights. The secondary deliverables may be reformatted normal equations, if for examples parameter labels need to be made compatible with SOLVE input specifications.

The primary performance milestones are those associated with preparation of progress reports to be presented at science meetings such as the MGS/MOLA or MGS Radio Science Team Meetings or meetings such as AGU, EGS or LPSC. Results will be prepared supporting the publication of at least one peer reviewed journal article per year.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

The major accomplishments of this task during the past quarter were estimating the high gain antenna azimuth and elevation angles, and estimating the quaternions for the solar array when data gaps occur. These data files are obtained from JPL on a daily basis. However, data gaps from several minutes to several hours regularly occur in the files. But because the MGS satellite is suppose to be steered in a predictable and repeating pattern for each orbit, missing data can be estimated from interpolation programs. Indeed, for the high gain antenna, this estimation process has proceeded smoothly. However, for the solar array quaternions, the repeating patterns have not been stable.

There have been 3 different patterns for the month of April. All of these patterns differ from the pattern in March. Unless JPL can stabilize the repeating pattern for the solar array, this work will have to be discontinued, as it is very labor intensive to change the estimation programs each time the pattern is changed.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue to process MGS and NEAR tracking data as requested. New mars gravity field models will be computed if any MGS emats with new data are available. Planetary body tides and orientation parameters may also be estimated. Finally, the MGS macro-model may be tuned.

NASA Task 00-926-05: Tide Model Refinement

--WORK PLAN--

GSFC ATR: R. Ray

Raytheon Task Leader: Yan Ming Wang
Raytheon Task Number: 177

The objective of the work is to improve estimates of Earth-system tidal variations, especially those of the oceans, but also those of the atmosphere and the solid Earth. The estimates are to be deduced from various types of space-geodetic and in situ measurements and models. The space-geodetic estimates will rely primarily on data from altimeter satellites such as Topex/Poseidon, Geosat, ERS-1/2, and Jason-1, and on tracking data from various geodetic satellites such as Lageos and on other spacecraft. Atmospheric tidal estimates will rely on both measurements by the Topex altimeter and follow-on dual frequency altimeters as well as on analysis of the outputs of numerical weather centers. Ocean tidal estimates will rely on altimeter data, on tide-gauge and other in situ data, and on hydrodynamic modeling.

STAFFING PROFILE

For August 1, 2000 through, July 31, 2001, the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Dr. Yan Ming Wang	50%	Task Leadership and all subsidiary efforts

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

This task is research in its character: Improved accuracy in the low degree and order tidal spherical harmonics will necessarily come from improving upon the existing tide model recovery. This improvement may be found in elimination of errors of commission and omission. Improved and modeling and re-processing of the altimeter to account for various non-tidal signals will be undertaken in hopes that subtle aliasing effects can be reduced or eliminated.

Thorough evaluation of tide modeling changes and possible improvements will be documented in a timely fashion. For example, initial work will be undertaken to assess whether improved modeling of the ionospheric path delay in the altimeter measurements will improve tidal models produced from these data. Since it is unclear whether unrelated effects alias the tidal models, studies like this have uncertain gains. These investigations are highly important for errors in forward modeling tidal signals can contaminate other oceanographic signals arising from climatological and or circulation origins. Therefore, results must be clearly demonstrated, and material prepared for publication and dissemination to the wider oceanographic community.
In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

To model the ionosphere using the TOPEX observations, various tests were made. The following two models have been tested thoroughly:

Spherical harmonic model

This model is based on the IRI2000. The residual IO correction (difference between the TOPEX observation and IRI2000) in every 3 hours is fit to spherical harmonic functions up to degree and order 5. This time series covers the time span of 7 years of TOPEX data. In every 3 hours, there are only 3 TOPEX passes available. Therefore, data of previous and after the current day at the same local time are used. The weights used for the data of previous and after the current day are 10 time smaller that the weight used for the current day.

Mean IO scale model

The TOPEX data from cycle 1 to 300 are averaged into a 3-hourly block mean that represents an averaged surface. The cell size is 1 degree in latitude and 1 degree in longitude. There are 8 sets of the mean surfaces. The instantaneous TEC is calculated by scaling the mean surface. The scale factor is determined in 3-hour time span and in the least square sense.

The correlation between the TEC and the geomagnetic indices is also explored. This study is still going on.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue work of last quarter.

NASA Task 00-926-06: TOPEX Precision Orbit Determination Production System (PODPS)

--WORK PLAN--

GSFC ATR: D. Rowlands

Raytheon Task Leader: Nikita Zelensky
Raytheon Task Number: 143

PODPS routinely produces and delivers the Precision Orbit Ephemeris (POE) to the TOPEX Project at JPL where it is incorporated in the science data product – the altimeter GDR – for the TOPEX mission. The object of this task is to operate and maintain the TOPEX PODPS, and perform scientific analysis permitting an increase in the POE accuracy. The task also includes the enhancement of the PODPS process to include improved interfaces, enhanced automation, and improved verification of the POE and supporting models.

STAFFING PLAN

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

NAME	FTE%	RESPONSIBILITY
Subtask 1 & 3: TOPEX Precision Orbit Determination Improvements and Science Investigations		
Nikita Zelensky	50%	Section Leader; improved reduction techniques
Rowton, Shelley	10%	WWW support, documentation
Subtask 2: PODPS Operations		
Nikita Zelensky	30%	Section Leader; team leader for POD
Doug Chinn	70%	Orbit analysis; WWW page development
Neader Chandler	70%	Senior orbit process lead
Yero Radway	100%	Junior orbit processor

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONE AND METRICS

PODPS operations will routinely deliver to JPL the SLR-based Precision Orbit Ephemeris (POE) for TOPEX (spanning about 10 days), and the associated Quality Assurance (QA) Report containing scores of objective orbit tests, 22 working days after the laser data is available. DORIS data, when available, will be used in the POE determination; they will be verified and the results included in the QA report. Altimeter data will be used for POE verification. This is an inflexible schedule that allows very accurate oceanographic information to be placed into the hands of the science community routinely. Meeting this schedule and delivering orbits of consistent 2-3 cm ra-

dial RMS quality are major metrics of this project. Performance metrics, under normal conditions, will include the timely export of POEs, whose QA score shall not exceed two standard deviations of the norm.

The PODPS operations and expert systems will be maintained, and Y2K compliance and back-up capabilities insured. The data required by PODPS will continue to be managed and archived. As directed by the ATR, improvements will be made to PODPS. The operations system and procedures will be improved using those elements of the open systems development methodology desired by the ATR. System maintenance and modification will be performed following ATR and TOPEX Project approved configuration control procedures. All modifications to the system will be verified using the benchmark test suite which will be maintained. Both in-line and report documentation describing PODPS operation and evolution will be maintained. The PODPS Web site, which has proven very useful, will be maintained.

Scientific analysis will continue with the goal of increasing POE accuracy. In concurrence with the Science Working Team, existing cycles will be reprocessed using upgraded models and exported. Scientific investigation into the nature of POE orbit error, methods to better detect it, and to reduce it will continue. This includes efforts to:

- Process GPS data alone and in combination with SLR, DORIS, TDRSS, and altimeter crossover data.
- Investigate methods to refine DORIS and GPS measurement modeling.
- Investigate reduced-dynamic approach using the denser tracking combinations and refined GPS measurement modeling.
- Investigate non-conservative forces acting on T/P and enhance those models as the analysis suggests.
- Investigate application of more recent developments in gravity and tidal modeling, reference frame definitions, improved station weighting, and treatment of biases.
- Investigate metrics for better detecting orbit error. Compare various orbit products and understand differences.

Attend at least one meeting per year to report on precision orbit determination improvements.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

All 9 POE cycles (305-313) plus QA reports were delivered on schedule; all 9 QA scores were well under the 2.44 2-sigma score criteria.

Reduced dynamic approach including altimeter crossover data is being investigated. Preliminary results indicate orbit accuracy of 1.5 cm achievable prior to model improvement.

ILRS 2001 SLR and DORIS positions/velocities will be evaluated

SLR and DORIS data from 72 cycles selected from 1997 through 1999 has been processed using Dan Kubichek's solar array warp model to generate 72 emats in preparation for further gravity and macromodel tuning. Additional emats will be generated using altimeter crossover data.

Altimeter dynamic crossover differences from both the GDR and MGDR are being investigated to further improve altimeter data processing and editing.

Investigation continues to improve DORIS measurement modeling and to become a DORIS Analysis Center.

Technical Issues:

CSR crossover difference of about 5.5cm are better than the 6.2 cm we see due to altimeter data processing/editing, and not to the orbit. Deleting only about 150 points out of 5000 will reduce our crossover rms to 5.5 cm. However no legitimate criteria were found to directly delete these points. Closer comparison with CSR differences will be made following an upgrade to PODPS with the GEODYN dynamic crossover capability.

Other Issues:

Neader Chandler is planning to retire June 30, 2001.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR THE NEXT REPORTING PERIOD

- Raytheon staff will continue to evaluate altimeter data processing.
- Raytheon staff will begin re-tuning the macro and gravity models.
- Raytheon staff will continue to evaluate the new GEODYN dynamic crossover capability.
- Raytheon staff is evaluating enhancing DORIS data POD capabilities by possibly improving the current modeling of the DORIS ambiguity bias and troposphere bias.

NASA Task 00-926-07: GEODYN Maintenance

--WORK PLAN--

GSFC ATR: D. Rowlands

Raytheon Task Leader: Despina Pavlis
Raytheon Task Number: 151

This task provides general maintenance support for the GEODYN orbit determination and geodetic parameter estimation software for the Space Geodesy Branch of GSFC. Support includes: incorporation and code merging of new capabilities and fixes; executable, object, and source code creation; software archiving and distribution; testing and verification; maintaining supporting programs (Table Update Program, GEODYN Pre-Processor); BIH/Flux and planetary ephemeris file maintenance; software documentation maintenance. This task will also include developing ICESAT-specific modeling capabilities in GEODYN and building a largely automated system to support the calibration and validation of the pointing and range biases for this laser altimeter mission.

The new algorithms developed for and put into GEODYN will be designed starting from general descriptions of desired capabilities in many cases. Capabilities introduced into GEODYN generally are conceived, given a preliminary proof of concept, tested, and finally implemented within a six-month period. In some cases a potential capability may not be of general use and it is therefore useful to "patch-in" a limited form of a capability so that testing can be done before further development is approved or for a limited experiment to proceed. .

GEODYN requires several support programs. The purpose of these support programs is to prepare unformatted (binary) input files for GEODYN. These programs include the BIH TABLES program, CONOGB and CONCAR. The BIH TABLE program converts ASCII punched values of Earth orientation parameters (polar motion and UT1 - UTC) and solar and magnetic flux to a more compact file. CONOGB converts binary tracking data files to ASCII files and CONCAR converts the ASCII files back to binary input files (these are useful for porting files). All of these support programs will be maintained and enhanced as needed.

The Space Geodesy Branch uses work stations for most applications. Hewlett Packard 700 series and C series work stations (UNIX operating system) are currently in use. Sun Ultra series work stations (also UNIX operating system) may be phased in. Cray J90 processors linked together in shared memory machines are used for supercomputing (again the UNIX operating system). The program will be maintained on this broad range of platforms.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001, the staffing profile is (as percentage of FTE):

Name	FTE%	Responsibilities
Despina Pavlis	90%	Task Leadership, GEODYN development, User Support
Susan Poulose	50%	GEODYN maintenance, Table Updates, User Support
Shelley Rowton	50%	GEODYN documentation, Web Support, ICESat system development support
Terry Williams	20%	ICESat System development

Spread charges for infrastructure support will be incurred from:

Program Management

Cost Control

Administrative Support

Courier

MILESTONES AND METRICS

New versions of GEODYN must be made:

1. Whenever verifiable problems are found (and fixed).
2. Other than (1) above, about 3 times a year to incorporate Earth orientation files must be created about once a month in order to incorporate nearly current values of Earth Orientation parameters.

The changes made to make a new version of GEODYN (differences between new and previous version) must be documented and kept in electronic form. When a new capability is added which requires a change in user "card" input, the GEODYN User's Guide (Volume 3 of documentation) must be updated. When a new version requires a change in any of the other inputs or outputs, the File Description Documentation (Volume 1) must be updated.

The GEODYN source code for each version must be kept in a machine independent format so that upon running it through a text-editing program, a FORTRAN source can be obtained for any of the computing platforms used by the Space Geodesy Branch. The Space Geodesy Branch uses a text-editing program called "the GPP" for this purpose.

A second requirement is the timely creation of Earth Orientation Files (BIH tables) required by GEODYN.

A third requirement is support of new missions. Generally, GEODYN requires some modifications and tailoring to meet the needs of new data types or orbital characteristics encountered when supporting new missions. These changes can range from simple satellite form and attitude rules to quite complex, for example, introducing the capability to determine the orbit of a satellite orbiting an asteroid. This requires scientific knowledge in satellite orbit determination and statistical estimation, programming knowledge in FORTRAN and familiarity with the GEODYN program structure and engineering.

Priorities in the software development area are determined by the ATR and will be reviewed weekly.

Specific performance metrics include:

a) Organizing, maintaining and storing the code for all the TDF and GEODYN versions. Documenting code modifications between versions in a timely fashion.

b) Creating, testing and maintaining TDF and GEODYN executables on three platforms (HP, SUN, and Cray). This procedure is required every time a formal or a special version of GEODYN is produced. Conveying information about new versions to all GEODYN users.

c) Creating, testing and maintaining ancillary data files (BIH and flux Tables) approximately every month on two platforms (HP and Cray)

d) Thoroughly benchmarking new TDF and GEODYN executables before releasing them to the customer

e) Write, maintain, update and distribute GEODYN related documentation. The GEODYN documentation must be updated at the same time of a new GEODYN version release.

Milestones for Program Maintenance include:

a) Create new Earth orientation and Flux Tables for the HP and the Cray:

b) Update the GEODYN benchmarks

c) Update the GEODYN documentation Volume 3 sample GEODYN setups.

Milestones for User Support include:

a) Problem Resolution. Problems always take first priority in this task, unless otherwise specified by the ATR. For efficiency purposes, problem resolution is assigned to the group member who is most familiar with the subject. Investigation, correction of the problem, validation tests and providing the analyst with

the appropriate solution must follow each problem report. Problem reports, their resolution, and preventative steps to diminish their reoccurrence will be given to the ATR monthly.

b) Special GEODYN versions: The customer or analysts might request Creation and testing of Special GEODYN versions. The criteria for providing special deliverables are mission dependency, time limitations, investigation of new parameters effectiveness etc.

c) Assistance in using the GEODYN program.

Milestones associated with progress reporting include:

a) Weekly progress reports are required every Wednesday: Completion date: Wednesday of every week.

b) GEODYN executables must be benchmarked independently by GSFC personnel prior to their release. GEODYN documentation updates must accompany all GEODYN versions (if applicable)

c) Special GEODYN deliverables according to the needs of the project.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

WORK PERFORMED

NEW GEODYN VERSIONS

GEODYN version 0101 was created, benchmarked and released on all the applicable platforms. GEODYN 0104 features the following new options: LINK: An option to allow the users to link any two parameters in a constrained solution in GEODY by using input specifications. A new EMAT (Normal Matrix) labeling scheme to accommodate the increasing needs for new arc parameters in GEODYN. The web documentation on the GEODYN web site has been updated to reflect new information about the above features.

GEODYN version 0104 was created, benchmarked and released on all the applicable platforms. GEODYN 0104.0 features the new option of application and estimation of Earth Orientation parameters and the new Mendez Refraction model for Laser data. The web GEODYN documentation has been updated to reflect the new GEODYN options. A new point version 0104.01 was created, benchmarked, and released on all the applicable platforms suppressing the capability of using Proudman functions for ocean tides and sea surface topography. This suppressed option may be added easily any time in the future. GEODYN 0104.01 may be exported protecting the rights to the analysts of code 926.

GEODYN DEVELOPMENT

The GEODYN group has been working primarily in the development and implementation of accelerometer data options in the program. The new accelerometer options include geometric and dynamic models in the GEODYN code. The geometric models include the capability of reading accelerometer data as new measurement types and reduce them by using GEODYN computed accelerations (geometric mode). The dynamic models include the creation and ingestion of an external accelerometer file where the accelerations will replace the GEODYN computed, integrator values according to users request (dynamic mode). New parameters with geometric and force model biases have been added to GEODYN and the code has been modified to view the attitude parameters as force model parameters when in dynamic mode.

A first release of one-day accelerometer CHAMP data has helped test GEODYN. At the same time the GEODYN group has developed external stand-alone programs to create and interpret CHAMP data, external accelerometer files and other auxiliary conversion programs.

The one-day data have been used in extensive tests to understand the behavior of the data and create appropriate models. A first attempt to solve for constant geometric biases gave values almost identical to those recovered independently by CNES analysts.

At the same time with the accelerometer data options development, a separate effort of incorporating in GEODYN the capability of multi-rate integration took place at GSFC (D. Rowlands). The GEODYN group has brought all the above options together in one updated version. This version will be the next GEODYN point version (0107).

Development and testing of highly automated Precision Orbit Determination System (PODS) of PGSLA system continues. RAYTHEON Staff has completed design and development of the processing of S/C- user GPS receiver data. Data from GFO and CHAMP have been used to test the setup and processing. Five sets of two 30-hour arcs with an overlap of six hours were selected from available GFO arcs processed with SLR, TRANET and altimeter data during January and February 2000. RAYTHEON Staff implemented and automated processing improvements in the setup of GPS, SLR and DORIS sites within GEODYN. System development included creating station position/ velocity options for GEODYN input based upon the newly released ITRF2000 SINEX file. In addition software modules were written to automate importing SLA and DORIS data as well as site data.

USER SUPPORT

The GEODYN group has been supporting the following tasks: GFO, TOPEX, TERRA and ILRS during the last 5 months.

ANCILLARY DATA FILES

Earth orientation and Flux files have been created, tested and released by RAYTHEON Staff during the months of December, January, February, March, and April. The tables are being created on the HP geodesy2. Since January 1st 2001 the GEODYN tables contain 5-day pole data.

DOCUMENTATION

Preliminary documentation for volumes III and IV of the GEODYN documentation has been created along the development of the accelerometer data options.

PROBLEM AREAS

To be reported quarterly.

SCHEDULE CONFORMANCE

To be reported quarterly.

WORK PLANNED FOR NEXT REPORTING PERIOD

Staff will continue to support the production of new GEODYN versions and BIH/FLUX tables.

Staff will continue to update GEODYN documentation and ensure its proper distribution.

Staff will continue working on the implementation of all new GEODYN capabilities. Supplementary ephemeris, Crossover related options, GPS related options.

Staff will continue the support of many missions as far as software. (VCL, MGS, NEAR)

Staff will continue to field user problems and software errors as its highest priority.

NASA Task 00-926-08: SOLVE and ERODYN

--WORK PLAN--

GSFC ATR: D. Rowlands

Raytheon Task Leader: J. McCarthy
Raytheon Task Number: 103

This task provides general maintenance support for the SOLVE and ERODYN software for the Space Geodesy Branch of GSFC. Support includes: incorporation and code merging of new capabilities and fixes; executable, object, and source code creation; software archiving and distribution; testing and verification; user support; code maintenance; software documentation maintenance.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as percentage of FTE):

Name	FTE%	Responsibilities
John McCarthy	40%	Task Leadership, SOLVE and ERODYN development, User Support

Spread charges for program management and infrastructure support will be incurred from:

Program Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

1. Scientific Software Development: This requires scientific knowledge in satellite orbit determination, matrix manipulation and inversion techniques, and statistical estimation, programming knowledge in FORTRAN and familiarity with the SOLVE and ERODYN program structure and engineering. Priorities in the software development area are determined by the ATR and are reviewed monthly.

   MILESTONES IN SOFTWARE DEVELOPMENT WOULD INCLUDE:

   a) The task leader meeting all the deadlines set during last month's report.

   b) The quality of support provided for the Time Variable Gravity group (priority)

   c) The quality of support provided for the NEAR Laser Altimeter Group

2. SOLVE and ERODYN Maintenance: This responsibility may be broken into the following sub-tasks:

   - Organizing, maintaining and storing the code for all the SOLVE and ERODYN versions. Documenting code modifications between versions.
   - Creating, testing and maintaining SOLVE and ERODYN executables on three platforms (HP , SUN, and Cray). This procedure is required every time a formal or a special version of SOLVE or ERODYN is produced. Conveying information about new versions to all SOLVE and ERODYN users.
   - Thoroughly benchmarking new SOLVE and ERODYN executables before releasing them to the customer
   - Write, maintain, update and distribute SOLVE and ERODYN related documentation. The SOLVE and ERODYN documentation must be updated at the same time of a new SOLVE or ERODYN version release.

MILESTONES IN MAINTENANCE OF THESE SYSTEMS WOULD INCLUDE:

a) Updating the SOLVE and ERODYN benchmarks as required

b) Updating the SOLVE and ERODYN documentation as required.

3. User Support: This responsibility may be described as:

- Problem Resolution. Problems always take first priority in this task, unless otherwise specified by the ATR. Investigation, correction of the problem, validation tests and providing the analyst with the appropriate solution must follow each problem report.
- Special SOLVE or ERODYN versions: The customer or analysts might request creation and testing of special SOLVE or ERODYN versions. The criteria for providing special deliverables are mission dependency, time limitations, investigation of new parameters effectiveness etc.
- Assistance in using the SOLVE and ERODYN programs.

MILESTONES IN USER SUPPORT (which always has a high priority with respect to other activities) WOULD INCLUDE:

a) Providing timely and effective problem resolution and user assistance. Since the nature of problems are hard to predict, the ATR will need to assess the effectiveness of the problem resolution effort. Assistance can also require unpredictable efforts depending on the complexity of the request and the amount of work required to implement new capabilities in these codes.

4. Documentation and Configuration Maintenance includes the following activities:

- Monthly progress reports are required and delivered in a timely manner.
- SOLVE and ERODYN executables must be benchmarked prior to their release. SOLVE and ERODYN documentation updates must accompany all SOLVE and ERODYN versions (if applicable)
- Special SOLVE and ERODYN deliverables according to the needs of the project.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL REPORTS AND DOCUMENTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

SOLVE and ERODYN DEVELOPMENT

New modifications to GEODYN were implemented which require major changes in the SOLVE program. New labels are needed for many new GEODYN arc parameters and there is currently no room in the existing emat label sequence for these new labels. The SOLVE task leader suggested the following solution to this problem: an offset of N * 1.0E13, where N = 1, 2, 3..., will be added to the global parameter emat labels, and the space from 5E13 to 6E13 will be used for new arc parameter labels. The value of the offset will be written in the emat header for use in the SOLVE program. The GEODYN ATR adopted this suggestion.

A first version of SOLVE using the new GEODYN arc parameter numbering is complete, and was made available to users. The capability to use new setups with the new labels needs to be added. The present version uses the existing setups with the old global labels.

These new GEODYN modifications also affect the ERODYN program. Because the structure of ERODYN is much different from that of SOLVE, the changes required for the new labels to work in ERODYN are much more numerous and extensive than those needed in SOLVE.

The new ERODYN using the new GEODYN arc parameter numbering has been completed. The task leader had to modify the format of the covariance matrix header to include a flag indicating the label offset for the covariance matrix. This will also necessitate a change in SOLVE, which has not yet been done. For the case of a covariance matrix without a label offset word (i.e. existing covariance matrices), it will be assumed that the label offset for the covariance matrix is the same as that for the ematrix.

The task leader debugged the latest version of ERODYN using the GEODYN ERODYN benchmark. The new ERODYN version was given to S. Poulose to try, and she found that it gave the same results for the GEODYN ERODYN benchmark, as did the old version.

In addition to new SOLVE modifications required by this new emat labeling scheme, the matrix scan program had to be modified, and a program to convert the current format emats to the new label format was needed. The task leader has completed the modifications to the matrix scan program. The task leader also completed writing a new program to convert existing emats to the new format with a user-specified emat label offset.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

To be reported quarterly.

WORK PLANNED FOR NEXT REPORTING PERIOD

The task leader will continue to support the production of new SOLVE and ERODYN versions.

The task leader will continue to update SOLVE and ERODYN documentation and ensure its proper distribution.

The task leader will continue working on the implementation of all new SOLVE and ERODYN capabilities.

The task leader will continue to support all missions which use SOLVE or ERODYN software. (TVG, NEAR)

The task leader will continue to field user problems and software errors as its highest priority.

The task leader will continue modifications needed to implement the new GEODYN emat label system.

NASA Task 00-926-09: Simulation & Analysis of Future Missions

--WORK PLAN--

GSFC ATR: D. Rowlands

Raytheon Task Leader: Susan Fricke
Raytheon Task Number: 131

The purpose of this task is to provide assistance to members of the Space Geodesy Branch in running analysis softwares and with handling the data sets needed by and created by these softwares. Typically, those working on this task will be contacted by analysts and asked to make series of computer runs associated with the reduction of tracking data. This task is also responsible for making the bench mark runs for the GEODYN task.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Susan Fricke	100	Task leadership, running GEODYN and SOLVE.
Linda Gehrmann	100	Support for TOPEX/GPS and LAGEOS.
Susan Poulose	50	Applications programming and GEODYN benchmarking.

Spread charges for infrastructure support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

The performance schedule is dictated by the needs of the NASA scientists and analysts. Typically the analysts will need to see results in the timeframe of a few days. In many cases, it will be self evident if the softwares have been run successfully. Other times the quality of the computer runs will be made evident only after the NASA analysts applies the results of the runs in a different investigative setting. Raytheon will assist in the process to determine whether solutions have been executed correctly and in the assessment of the quality of the results. Unsatisfactory runs will be evaluated, corrected, and resubmitted. The ATR and other NASA scientists will return runs with suggested modifications, parametric variations, and/or corrections, and these new solutions will be executed in a timely fashion. As is often the case in this type of effort, preliminary solutions define later solutions, and complexity increases as the investigation develops improved understanding of the physical models and data being assessed. The contractor will assist in this effort throughout this investigative progression.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Raytheon continued to run new MGS arcs for F. Lemoine (code 926) as well as 5-Day arcs for D. Smith (code 920) with the MGM1004D gravity model. Once the orbits are converged the Unit 30 GEODYN II outputs are converted into a transfer file for further analysis by F. Lemoine and Greg Neumann (code 920). Once the 5-Day orbits for a months worth of data are converged;setup and created new E-matrices/C-matrices. SOLVE runs were then setup and submitted to adjust/suppress parameters. Outputs from both GEODYN II and SOLVE are edited and condensed and then emailed to Dr. Smith for further analysis. (The full outputs are also put out on a Raytheon web page by Mark Torrence for further analysis.)

In support of D. Rubincam (code 921), several runs of the following programs were submitted:

1. Jobs were submitted for the study of TRITON's global temperature.
2. 50 runs of the Range_Kutta sphere program, a program which calculates the change in rotation speed and obliquity of asteroids.
3. 6 runs were submitted in support of the Pluto studies.

Jobs were submitted as requested and modifications were made as required. In support of Oscar Colombo's experiment to generate orbits from GPS data set up programs and submitted a series of runs to convert orbit files to PCE format, TDF to convert it to Geodyn binary format, DELTA to compare the orbit files generated with TOPEX POE and then to convert the orbits to earth_fixed ASCII format.

A routine was developed to put together in ematrix format (generating header, labels, apriori, ...), the normals Dave Rowlands generated from GRACE data for initial state and (120,120) gravity field

Before a new version of geodyn is released 20 benchmark runs each are submitted on both the CRAY and HP computer systems to ensure that the original capabilities are still operational. Version 0104 was tested, ouput of the runs were were compared with the previous version and results reported.

Continued with modifying and testing software for conversion of data to and from SINEX (Solution INdependent EXchange) format and SOLVE matrix formats. SINEX data format is still being modified and so input and output requirements are continually changing and so is the program.

In the program that generates SINEX data, a few lines of code was copied instead of moving it, which resulted in a multiplication being done twice. Once we realized it and corrected it, a set of runs had to be redone

RITSS continued work on the Lageos I and Lageos II Laser data for Dr. Pavlis (Code 926). Presently have a working system that produces weekly orbit determinations on a weekly basis. This includes weekly data imports, and preparing the data and a setup file for the GEODYN software. This task is also in the stage of being current and completed through April 2001.

RITSS's support of the GPS task involves the analysis of small data sets for orbit determination purposes with regard to various missions. At present, this activity focuses on the analysis of the GPS data for the year 2000 through the present software. Starting in 2001, GPS data will be using the VPGS software on the CANOPY system. The member of RITSS is presently familiarizing herself with the new process of GPS.

NASA Task 00-926-10: Influence of Global Geophysical Fluids on Geodynamics
--WORK PLAN--

GSFC ATR: Dr. B. Chao

Raytheon Task Leaders: Chris Cox/Andy Au
Raytheon Task Number: 148

The objective of this task is to study the influence of global geophysical fluids (e.g., the Earth's atmosphere and wind fields, hydrology, and nontidal oceanographic) effects on geodynamical variables such as the earth orientation parameters, time-varying low-degree gravity coefficients, and geocenter motion.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Chris Cox	40%	Co-Task Leadership, time-varying gravitational signals, Software development, science results
Andy Au	50%	Co-Task Leadership, earth orientation parameters, low-degree gravity coefficients, geocenter motion, software development, science results
Jennifer Beall	30%	Data analysis and programming support for orbital reductions

Spread charges for infrastructure support will be incurred from:

Program Management

Administrative Support

Cost Control

Courier

MILESTONES AND METRICS

This task is research in character and requires timely reporting of new results at various professional meetings and the preparation of material, in collaboration with GSFC staff, for publication of results in appropriate journals. The task has two specific thrusts. The first is to recover and qualify (through rigorous error analyses) parameters related to changes in the gravity field and Earth rotational dynamics due to the redistribution of mass associated with movements of fluids within the Earth's systems. The second goal is to use complementary data available from a wide range of investigations and interpret them in the context of the mass that is being transported and predict the resulting changes in the geogravity field and rotational effects. The work proceeds on three threads: (a) the timely analysis and incorporation of new data into the study; (b) solution design, evaluation, diagnostic and experimental efforts to understand the geophysical significance of the derived signals from global geophysical fluids, and (c) the finalization of results.

Element (a) can be schedule driven. Pertinent metrics include:

1) incorporation of all new reanalysis data from the National Centers for Environmental Prediction (NCEP) into the study;
2) incorporation of all other new and/or existing climatic data sources such as the reanalysis data from the GSFC Data Assimilation Office (DAO) and the Global Soil Wetness Project (GSWP),

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

To be reported quarterly.

WORK PLANNED FOR NEXT REPORTING PERIOD

Setup and execute GEODYN II and SOLVE runs in support of the Mars Global Surveyor project.

Provide support to the Near Earth Asteroid Rendezvous project.

Provide support to the Geosat Follow On project.

Execute TOPEX/GPS assignments.

Support the LAGEOS Spin-Axis Task.

NASA Task 00-926-11: Studies of the Earth Gravity Field

--QUARTERLY REPORT--

GSFC ATR: F. Lemoine

Raytheon Task Leader: Nikos Pavlis
Raytheon Task Number: 157

The objective of this task is to develop normal equations from satellite altimeter data, in a way that will enable their rigorous combination with corresponding normal equations that could be formed from CHAMP, GRACE, and GOCE data, whenever such data may become available. The specific focus of this task is to prepare for the most rigorous static gravity field and DOT recovery, from the combination of the most suitable (and currently available) altimeter data with tracking data from existing and future satellite missions, as well as with surface gravity information. The global, comprehensive solutions that are anticipated will be of general purpose, i.e., will aim to satisfy various application requirements (orbit determination, marine and land geoid modeling), in the best overall sense.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Nikos Pavlis	30%	Task leadership, altimeter data pre-processing and verification, normal equation formation design.
Chris Cox	40%	Programming support, GEODYN and SOLVE verification, production of E-mats (including appropriate handling of orbit-related parameters).
Jarir Saleh	100%	Altimeter data processing. Production of normal point and crossover databases, archival and documentation of related files.
Prof Richard Rapp	5%	Consultant

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES

t0 ==> Task initiation.

t0+ 3 months ==> TOPEX, ERS-1, and ERS-2 altimeter data pre-processing software is ready, tested, and verified. Selection of time periods of data to be used is completed.

t0+ 4 months ==> GEODYN and SOLVE maximum capabilities are established and verified. This will permit accurate projections of the total computer time (CPU and turnaround) required to complete all necessary runs.

t0+ 6 months ==> Altimeter databases (deliverable 1) are ready.

t0+12 months ==> The maximum number of E-mats that could be formed given the available computer resources

is delivered. This completes the contractor's deliverable requirements.

PERFORMANCE METRICS

1. Effectiveness of quality control in the preparation of altimeter databases.
2. Completeness of documentation (database development and GEODYN/SOLVE runs). This includes the preparation of presentations and/or publications.
3. Capability to devise innovative and cost effective solutions to technical problems, without significant occupation of ATR's time (accounts also for the ATR's absence during the first 4 months of this task's performance period).
4. Timely preparation of deliverables and of monthly reports (the previous month's report will be delivered to GSFC within 15 working days of the end of the month being reported above).
5. Responsiveness to ATR's task-related requests.
6. Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

At the ATR's request prepared a detailed "roadmap" describing a possible scenario for the testing of an alternative-weighting scheme for altimeter data that accounts for the merging of the ground-track at high latitudes. This was e-mailed to the ATR on 2/8/01.

Provided Thomas Gruber (GFZ) with detailed explanations regarding some questions and comments that he had with respect to the results of the model evaluation work that was presented at the Miami SWT meeting. These explanations and numerical results were e-mailed to T. Gruber in several e-mails during the middle to end of Feb. 2001.

Prepared and gave a presentation at the EGS2001 meeting in Nice, France, 3/25-3/30, 2001. This presentation was received well and generated interest and requests for copies from several colleagues.

Worked closely with J. Saleh on the development of corrections accounting for the time-varying part of the DOT.

Worked in the preparation of a journal article describing PGM2000A.

Developed the software and performed numerous tests for the development of corrections accounting for the time-varying part of the DOT. This involved tests related to the estimation of the amplitudes and phases of 12 harmonic waves (1 cpy to 12 cpy) plus a constant offset term. These are estimated at T/P ground-track locations, and then gridded to a regular grid that is suitable for the efficient computation of these corrections for other satellites too (e.g., ERS-1 and -2). Numerous tests and their associated validation were run, and the fields of interest were plotted geographically and inspected carefully. An optimal estimation and gridding procedure has been designed and is in the final testing stages.

3) incorporation of existing satellite laser ranging and DORIS satellite data, data acquired by the upcoming GRACE and CHAMP Missions when available, and the incorporation of new SLR, DORIS, and other new data in the gravity rate determinations, to extract time-varying gravitational signals for the study. We will also investigate whether absolute gravimetry measurements of local geopotential changes can be applied in this analysis.

Element (b) requires:

1) exploration of new techniques and development of new software packages, on an as-needed basis, to further the understanding of the influence of global geophysical fluids on geodynamical variables and the temporal variations of the gravity field

2) reporting of new results at scientific meetings

Element (c) requires:

1) preparation of publishable manuscripts for scientific journals

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Based on EOF analysis of NCEP surface pressure field from 1958 through 2000, it is observed that the North Atlantic Oscillation (NAO) and the North Pacific Oscillation (NPO) are correlated with high statistical significance, in contrary to conventional wisdom in the meteorological community. In fact, both the NAO and the NPO can be considered as part of the Northern Hemisphere Annular Mode (NAM). A paper title "Correlation between North Atlantic Oscillation and North Pacific Oscillation: Evidence for a Combined Mode" co-authored with Raytheon personnel has been submitted to Geophysical Research Letters.

It is also observed that by virtue of EOF decomposition, the traveling pattern of the El Nino at the tropical Pacific may be decomposed into two eigenmodes of standing waves, with a phase lag as much as 15 months. Extensive simulation runs with traveling waves of low-order spherical harmonics confirmed the aforementioned speculation. Further study on the feasibility of developing a statistical scheme to predict an upcoming El Nino event some 15 months in advance is warranted.

EOF analysis of ocean bottom pressure derived from POCM-4B is in progress. The results will be combined with that from NCEP atmospheric pressure data and TOPEX sea surface height for a global comparison with observed time-varying low-order gravity coefficients derived from laser ranging.

Evaluation of the variations in the geopotential continued. Two 30-day resolution time series were estimated using the SLR and DORIS tracking for 1992-2000. One series was complete through spherical harmonic degree 4, and the other was complete through degree 5. The series complete through degree 4 was compared to the atmosphere, continental hydrology, snow coverage, and oceans, including two sets of steric corrections to the T/P altimetry im-

plied gravity series. The continental hydrology component was calculated from the NCEP reanalysis data. The match to the atmosphere series, which is expected to be the dominant term, was excellent. However, the total of all the modeled was not a good match, indicating that some of the models are not accurate, or that some components of the Earth's fluid envelop are missing.

The C2,0 series showed a distinct interannual signal, with a change in the sign of the slope occurring ca. 1997. This agrees well with results obtained for the long term gravity rates, presented at the IAG meeting in Banff Canada in August 1000, and with updated results prepared for the 2001 EGS meeting in France. There is a temporal correlation with a change in the Mean Sea Level rate. An oral presentation was given at the EGS 2001 meeting on the time series, and a poster was presented on the long-term rates, their interpretation, and the impact of the recent changes in the C2,0 rate. Efforts are underway to prepare GRL and JGR papers on the gravity series analysis. In support of this effort, the gravity time series is being correlated with as many geophysical time series as possible. In addition, efforts are underway to extend the series back to 1986 using constraints to permit the recovery of terms higher than degree 2. We have currently established that interannual signal change does not appear to be atmospheric in origin. There is already the aforementioned correlation with the MSL. There is a reasonable possibility that there is a correlation with changes in the ice thickness of Antarctica and Greenland. We have meet with the GSFC Ice branch and are currently going over their data.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue EOF analysis.

Continue Gravity series analysis, and prepare to manuscripts.

Prepare for the IAG meeting in Budapest in September.

Prepare and submit and unsolicited proposal to NASA HQ Code YS, Physical Oceanography on the analysis of the ocean, ice, and gravity data.

NASA Task 00-971-01: Ice Penetrating Radar Data Analysis

--WORK PLAN--

GSFC ATR: Dr. Waleed Abdalati **Raytheon Task Leader: Wei Li Wang**

Raytheon Task Number: 180

The focus of this task is to analyze continuous layers within the ice sheet as detected by the ice-penetrating radio echo sound. This radar was developed at University of Kansas and flown on NASA P-3 aircraft over most of the Greenland ice sheet.

Primary objectives are to support the following activities:

a) Identify and trace continuous layers (isochrons) within the ice sheet along each flight line

b) Determine the 3-dimensional surface of each layer based on interpolation of surface-fitting algorithms

c) Examine ice core records to estimate the date of each surface

d) Draw conclusions on past conditions and flow characteristics of the ice sheet based on the layers characteristics

For this purpose, the contractor will:

e) Maintain and modify existing and develop new signal processing software.

f) Analyze all available ice sheet radio-echosounder data for Greenland

g) Develop digital elevation maps for each traced layer

h) Estimate the age of each layer from comparisons to known age/depth data in the publicly available ice core record from Greenland's summit.

The contractor shall deliver the following conforming to the deadlines outlined in the Milestones section:

i) Latest version analysis software

j) Data files containing location along flight line, depth of layer successfully traced

k) Digital Elevation Models for each traced layer

l) Age estimates for each layer traced

STAFFING PROFILE

For August 1, 2000 through September 30, 2001 the staffing profile is (as a percentage of FTE):

Name:	**FTE%**	**Responsibilities:**
Wei Li Wang	100%	Task leader, software development, data analysis and science products.

Spread charges for infrastructure support will be incurred from:

Program Management

Cost control

Administrative support

Courier

MILESTONES AND METRICS

Performance period is from August 1 to September 30,2001 with the following schedule:

1. Aug.1, 2000 – Dec.31, 2000:

Completed the testing of SOLVE for the combination and inversion of one ERS-1 test Emat, containing geopotential and DOT terms complete to degree and order 130 for both fields.

Made some minor modification to the altimeter data pre-processing s/w, and provided JS with some test data necessary for the testing of the time-varying DOT corrections.

Begun preparing the setups necessary to test the alternative weighting scheme for the altimeter data.

Reviewed an existing s/w developed by E.J.O. Schrama, and provided it to JS.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue work.

NASA Task 00-971-02: Ocean Science Support

--WORK PLAN--

GSFC ATR: C. Koblinsky

Raytheon Task Leader: Brian Beckley
Raytheon Task Number: 140

Altimeter observations are to be analyzed to determine oceanographic models of dynamic topography, improve the correction and processing algorithms applied to these data, and develop improved methodologies for using altimetry to study long-term climatological processes. Analysis of in-situ and other types of ancillary data will be performed for intercomparison with the spacecraft measurements and ocean model estimates. An online database for the altimetry data is to be maintained and upgraded as needed to make optimal use of the current computer technology available.

STAFFING PLAN

For January 1 through December 31, 2000, the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities
Brian Beckley	25	Task Leadership, process ocean altimetry, science results
Scott Bringen	25	Computer systems administration
Yan Ming Wang	10	Mean sea surface development, altimetry analysis

Spread charges for infrastructure and project management support will be incurred from:

Project management

Technical Support

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

This task involves oceanographic research and altimetric product development and dissemination requiring timely reporting of new results at various professional meetings and preparation of material, in collaboration with GSFC staff, for publication of results in appropriate journals. The focus of this task will be to provide an integrated approach to measure the basin scale near surface ocean circulation from satellite measurements and in-situ networks. The work is comprised of two complimentary objectives. The first objective is the reprocessing of current and historical altimetry employing the latest set of improved algorithms, based on the results of the TOPEX/Poseidon mission, providing a geodetically consistent data set for oceanographic and climate research. The second objective involves the analysis of satellite altimeter observations in conjunction with in-situ and other types of ancillary data to determine ocean circulation and its relationship to climactic processes.

Pertinent metrics relevant to the activity include:

1) Reprocess altimetry with a consistent set of environmental algorithms and geodetic reference.
2) Validate reprocessed data with accepted statistical procedures and direct comparison against extensive tide gauge network.

a) Improve and maintain existing signal processing software
b) Complete the layer trace for 1999, 1998 and 1997

2. Jan. 1, 2001 – March 31, 2001

a) Develop software in Matlab to identify the layers traced from different files.
b) Combine the identified layers together to produce a digital elevation map
c) Products: digital elevation maps for each layer over Greenland

3. April 1, 2001 – September 30, 2001

a) Compare the depth to known age/depth data
b) Incorporate age/depth data into a flow model

4. Support ATR in the development of scientific papers

5. Technical Files and Documents to be developed include:

a) Final version of the trace layer software and all other software developed for this task will be documented
b) Digital elevation maps for each ice-layer over Greenland
c) All of the traced ice-layer's files
d) Age/depth files

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

No work was performed this period.

PROBLEM AREA

The problem with the MATLAB license has been solved by ATR.

SCHEDULE CONFORMANCE

The task is proceeding as planned

WORK PLANNED FOR NEXT REPORTING PERIOD

No work is anticipated.

ionosphere climatology. The evaluation and subsequent IRI model improvements are being monitored to eventually update single frequency altimeter observations from ERS and GFO.

Software has been developed to adjust ERS altimetry into the TOPEX reference by utilizing a time constraint on the crossovers from the coincident observations thus preserving the time dependent oceanographic signals. Production of an adjusted ERS-1 and ERS-2 dataset is underway.

Presentation material was generated for ATR for NASA headquarters site review.

Ocean Circulation

An investigation is ongoing to examine the potential for estimating the time dependent circulation with TOPEX along track altimetry, and evaluate the impact of ERS altimeter data on the solution. Preliminary results have been generated for the entire Pacific. TOPEX/POSEIDON and ERS-2 altimeter crossings with drifting buoy tracks were computed. For each drifter crossing an altimeter track, the altimeter sea surface height anomaly profile was saved for 150 km on either side of the crossing point. A mean dynamic height field interpolated from the World Ocean Atlas (Levitus and Boyer, 1998) was also saved at each crossing. A database was generated for the altimeter/drifter crossings to enable the routine conversion of altimeter sea surface height slopes to geostrophic velocitiy estimates for comparison against the drifter velocity normal to the altimeter track. Software has been developed to augment the database records with various wind fields, the EGM-96 geoid, and high resolution sea surface height anomalies computed by CLS.

Preliminary analysis of various orbit configurations were conducted in support of a proposed mission to measure salinity remotely. Maps were generated of the along-track sampling of POCM salinity fields and a crossover database of the push-broom orbit geometry was computed to provide tools to examine sampling strategies.

PROBLEM AREAS

None.

SCHEDULE PERFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Augment database records containing altimetry and drifting buoy information with wind, geoid, and high resolution sea surface height observations.

Installation procedures will continue to integrate an HP J7000 workstation with the project computer resources. A one half terra byte disk tower has been received and will be integrated in to the system.

Generate an adjusted ERS altimetry dataset for computing high resolution sea surface height anomaly grids. Develop software to produce similar dataset for GFO observations for subsequent blending into merged ERS and TOPEX product.

Investigate correlations of ionosphere model indices with TOPEX dual frequency observations to tune IRI predictive model.

Develop software to generate geo-referenced database for GFO altimetry.

Release new updated versions of TOPEX and ERS-2 collinear altimetry. Generate sea surface height anomaly maps and update project web site.

3) Develop and maintain an on-line direct access database of georeferenced altimeter observationsand in-situ data that takes full advantage of the most current computer resources..
4) Maintenance of anonymous ftp site and project web site.
5) Documentation preparation of data processing and validation procedures.
6) Scheduled version updates of reprocessed altimeter data sets.
7) Development of higher order products.
8) Product dissemination via CDROM and ftp access.
9) Reporting of new results/products at one science meeting per year.
10) Maintenance and upgrade of computer hardware and peripherals.
11) Compute gridded T/P sea surface height anomaly fields for various temporal scales.
12) Evaluate accuracy and impact of individual correction algorithms to altimeter range measurement
13) Evaluation of ocean circulation from T/P using coupled mode analysis with other relevant physical parameters.
14) Compute global and regional ocean current fields and compare against buoy and drifter network.
15) Provide altimetry data sets for mean sea level monitoring, ocean tide model and geoid model research.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Altimetry Analysis

The TOPEX/Poseidon geo-referenced database has been updated through cycle 313 (03/23/2001). High order sea surface height anomaly data sets have been generated and made available to the scientific community via the project web site. Revised correction algorithms include the updated ocean tide model GOT99.3 with consistent ocean loading. As part of calibration/validation procedures, variations in global mean sea level were computed for monitoring the long term rate of sea level change. A correction algorithm was developed to correct for the drift in TOPEX Alt A measurements based on an independent study comparing significant wave height measurements from TOPEX against ERS-2 and buoy observations. The correction algorithm was verified with an independent tide gauge validation showing good correlation between TOPEX and POSEIDON drift estimates. These results were presented at the TOPEX Science Working Team (SWT) meeting.

The ERS-2 geo-referenced database has been updated through cycle 57 (10/30/2001). As with T/P, high order sea surface height anomaly data sets have been generated and made available to the scientific community via the project web site. Revised correction algorithms include the updated ocean tide model GOT99.3 with consistent ocean loading, and an improved range correction based on new estimates of SPTR biases, and updated orbits computed by Delft with a new atmospheric model to better resolve solar drag during the period of solar maximum. As part of calibration/validation procedures, variations in global mean sea level were computed for monitoring the long term rate of sea level change.

A preliminary ionosphere model was developed based on measurements from the TOPEX dual-frequency altimeter observations. Further analysis was conducted comparing various solar and magnetic flux indices to the TOPEX

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

The aero-referenced database software updates the database daily as new PEDR files are added. The logs were reviewed daily.

PROBLEM AREAS

None

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Continue to monitor the data processing.

Data analysis if and when requested.

NASA Task 00-971-03: MOLA Laser Altimetry

--WORK PLAN--

GSFC ATR: Dr. J. Zwally

Raytheon Task Leader: J. Saba
Raytheon Task Number: 176

This task provides general programming and analysis support for data processing and scientific investigations of the Mars Orbiter Laser Altimetry data.

STAFFING PROFILE

For August 1, 2000 through July 31, 2001 the staffing profile is (as a percentage of FTE):

Name	FTE%	Responsibilities:
Jack Saba	20%	Task Leadership, science results, software and algorithm support
Louis Kouvaris	10%	Science results, software and algorithm support

Spread charges for infrastructure support will be incurred from:

Program Management

Cost Control

Administrative Support

Courier

MILESTONES AND METRICS

This task has two goals:

1) Create level 3 and 4 datasets over the Martian polar ice caps.

2) Provide meaningful analysis of the data.

The first goal is schedule driven. The metrics are

1) Generation of aero-referenced database files within two weeks of the time the data are provided to us in PEDR format.

1) Production of maps of the polar ice cap elevation, slope, and driving stress (North pole only) within 2 weeks of receipt of updated polar grids from MOLA project.

The second goal is research driven. The metrics are:

2) Reporting of new results at one scientific conference per year.

3) Preparation of research papers as required by the ATR.

In addition, the contract performance metrics are:

a) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter.

b) Cost control: adherence to CTR estimated cost to within a 10% variance.

John Shepherd	95	System administration of GLAS workstations and ClearCase administrator
Jack Saba	80	Contribute to elevation and waveform algorithm development, work on instrument algorithm development team
Donghui Yi	100	Contribute to elevation and waveform algorithm development, work on instrument algorithm development team, test waveform algorithms.
Suneel Bhardwaj	100	Lead GLAS SDP for elevation processing, contribute to QA and browser software
Steven McLaughlin	100	Program Optical Depth algorithms for LIDAR processing
Jeff Guerber	100	Develop SCF support code for GLAS data selection and visualization
Mark Sherman	30	ISIPS data management and processing design and development
Brad Boyd	100	ISIPS data management and processing development
John Bay	100	ISIPS data management development
Stephanie Faison	100	ISIPS DBA
Wayne Warren	65	SCF visualization
Matt Beckley	100	Data analysis and supporting programming
Stephen Fiegles	95	System Administration support for PCs and SCF
Mario Giovinetto	100	Glaciological research
Li Jun	100	Glaciological research
WeiLi Wang	100	Glaciological research
Margaret Russell	50	SDMS operations support

Spread charges for infrastructure and project management support will be incurred from:

Project Management

Administrative Support

Courier

Cost Control

MILESTONES AND METRICS

Deliver operational Science Data Management System – Oct 2001 changed with concurrence of ATR due to launch slip

Deliver operational Science processing code – Oct 2001 changed with concurrence of ATR due to launch slip

Provide updates as per science team instruction for science operational and testing code within 4 mos after new algorithms are received throughout life of contract

Have GSFC GLAS SCF operating for GLAS end to end testing – July 2001 changed with concurrence of ATR due to launch slip

Have GSFC GLAS SCF operating for production – Oct 2001 changed with concurrence of ATR due to launch slip

Provide access to data to GLAS science team within 1 week of receipt at GSFC GLAS SCF – projected time from cal/val period through end of mission (Feb 2002-Aug 2005)

Produce topographic map from first full repeat of GLAS 183-day repeat data – 2 mos after receipt of data – projected date Dec 2002

Produce paper comparing GLAS data with other altimetry data sets within 6 mos after cal/val period – projected date – Nov 2002

NASA Task 00-971-04: GLAS Ice-Laser Altimetry

--WORK PLAN--

GSFC ATR: J. Zwally

Raytheon Task Leader: Anita Brenner
Raytheon Task Number: 158

The objectives of this work are to 1) develop algorithms for processing and analyzing satellite laser altimeter and atmospheric lidar data, 2) develop and/or modify numerical simulators of satellite data, 3) provide systems support for the ICESAT/GLAS Science Computing Facility (SCF), 4) analyze and maintain libraries of altimeter data and various satellite and ancillary data sets, 5) assist members of the GLAS Science Team in accessing data and software on the SCF, 6) review and write data formats and develop algorithms and processing software for processing various levels of ICESAT/GLAS satellite data, and 7) develop and apply numerical models for analysis and interpretation of observed ice sheet elevation changes.

Technical Requirements

1. *Develop, modify, and maintain the software for the activities listed in 2- 7 below. This software shall process data, merge input data, apply corrections, plot data, grid data, create special data bases and catalogs, interactively access on-line data, archive and back-up data bases, and analyze data for quality validation and scientific studies.*
2. *Provide software for GLAS level 1b and above processing and the Science Data Management System (SDMS)*
3. *Operate the Goddard GLAS SCF and provide assistance in maintaining the remote GLAS SCFs at the GLAS Principle Investigator's institutions.*
4. *Create and maintain records and documentation on data sets and program versions used in various stages of this activity.*
5. *Produce topographic maps, elevation profiles, map of surface slopes and flow directions, ice boundaries, and statistical distribution of ice parameters for Antarctica and Greenland and altimeter performance characteristics (for ICESAT and the radar altimeter satellites GEOSAT, ERS 1 and 2, and ENVISAT.*
6. *Develop a GLAS data simulation and evaluate laser altimeter performance over ice surfaces and clouds.*
7. *Develop a numerical model for analysis and interpretation of observed ice sheet elevation changes, including models of the ice sheet surface mass balance, flow dynamics, and surface energy balance for Antarctica and Greenland.*
8. *Develop or acquire, archive, and analyze ancillary data sets for interpretation of observed ice sheet elevation changes*

STAFFING PROFILE

The current staffing profile (as a percentage of FTE)

Name	FTE %	Responsibilities
Anita Brenner	96	Task leadership, lead GLAS waveform algorithm team, lead GLAS ice sheet elevation algorithm team, contribute to corresponding ATBD, coordinate science input to the GLAS instrument algorithm team and contribute to team, contribute to GLAS processing software development, contribute to proposal for PI processing and implementation of it, contribute to SCF plan.
Zipora Sidel	100	Manage and develop GLAS SCF support software
Sam Ohring	50	Check out GLAS on-board instrument software
LeeAnne Roberts	100	Contribute to GLAS SDP software development, work on GLAS analysis software development
Kristine Barbieri	100	Lead GLAS SDP for LIDAR processing, contribute to QA and browser software
John DiMarzio	95	Lead GLAS SDP control and library functions, contribute system engineering expertise to SCF planning, contribute to elevation and waveform algorithm development
Helen Cornejo	100	Science support and data analysis of radar altimetry crossovers as part of elevation change history in support of GLAS

- The detailed design document, the user's guide, and version release notes are being revised for version 2
- Simulated level 0 data for 25 hours was created for all APIDs required for algorithm processing for testing

Work continued on the support utilities required for Science algorithm processing

- A utility to create the reference track ascending node file and calculate the granule stop and stop times from the predicted orbit was tested and delivered
- Work continued on the IDL utility to create browse products (jpeg files) from quality assurance, QAP, files. We can now create browse products for GLA02 and GLA07.

Work continued on development of GLAS visualization and data base management software

- A version of the data request GUI that processes special requests and subscriptions was finished
- The data request software was tested and scripts to run it from the visualization front end were written and checked out.
- Bulletin Board software was found to be used as a forum for science team feedback and interaction
- A web page was started with access to browse products
- IDL Readers for version 1 products for GLA01, GLA02, GLA05, GLA06, GLA07-9 were written and tested
- IDL Readers for version 2 products for GLA01 and GLA02 were written
- Modifications were finished to put the data request GUI as a front end to the visualization software.
- Modifications to the visualization software were completed to allow
    - Ground tracks of all passes selected on a world map
    - Thumbnails of decimated elevation profiles for all passes selected
    - Clicking on an elevation profile, highlights the associated ground track, and brings up the plot set menu for that profile, Two elevation plotsets are currently working
        - DEM, surface elevation and geoid from GLA06
        - Correction plot sets with tidal values and atmospheric corrections from GLA06
    - All plotsets have the following capabilities
        - show 1 or more of the available curves at the user's request as a fn of time
        - interconnect with the ground track plot to highlight the portion of the pass in the plotset
        - have difference plots showing differences between any two parameters in the plotset
        - zoom capability to produce a zoomed plot set that has all the capabilities of the parent
    - The elevation plotsets interconnect with the waveform thumbnails created from GLA01 and GLA05 so one clicks on a point on the profile and the waveform thumbnails for the data at that point are displayed. As one goes back and forth through the waveform thumbnails, an asterick is plotted on the profile showing where one is

Science Support

- Four papers were submitted to the IGS special remote sensing symposium to be held in College Park in June.
- Software has been written to create a georeferenced data set or all of Greenland so we can compare repeat track data for GLAS

Incorporate GLAS data into numerical model within 3 mos of receipt of one full repeat of mission data – projected date – Jan 2003

Produce papers for conferences and refereed journal with using GLAS results and ancillary data sets at the rate of 1/yr after 1st 183-day repeat Dec 2002 and every year thereafter

Additional contract metrics include:

1) Prompt reporting quarterly of task status. The previous quarter's report will be delivered to GSFC within 15 working days of the end of the quarter being reported upon.
2) Cost control: adherence to CTR estimated cost to within a 10% variance.

WORK PERFORMED

Work continued on SDMS – the GLAS Science Data Management System based on the DAAC V0 software. Version 2 was delivered in April. The delivery included:

Startup/Shutdown

- SDMS startup/shutdown including Archer (*does not include revisions for dual-host environment*).

External Interfaces

- Script to pre-populate database for NCEP MET data granules and files.
- Met data ingest includes renaming of files from NCEP to ISIPS convention (based on current understanding of NCEP convention).
- Functional EDOS interface; automatic population of database for GLA00 granules and files; ingest of GLA00 (does not include logic to check for presence of all required *APIDs*).
- Simulated UTCSR interface; automatic population of database for Level 1A and Level 2 granules and files; ingest of predicted orbit file (*based on possibly unwarranted assumptions about the protocols used for the UTCSR interface).*

Data Management

- Archer (may not allow import/export of tapes; families are not set up in final form)
- Data Server–Archer interface

Planning

- Planning of GL0P jobs.
- Planning job populates granule and file_info tables for ANC06 for each production job where appropriate.

Work continued on– the GLAS Science Algorithm Software –version 2

- Level 0 processing module, GL0P, was delivered
- Level 1a and 1b algorithm modules are in unit testing
    - This creates GLA01, GLA02, GLA05, and GLA07 that could be used in actual processing with associated QAP files
    - GLA03 and GLA04 functional code will be delivered in version 2+ or version 3
- Level 2 algorithms modules are in coding

NASA Task 00-971-05: Ice Altimetry

--WORK PLAN--

GSFC ATR: J. Zwally

Raytheon ITSS Task Leader: A. Brenner
Raytheon ITSS Task Number: 136

The objectives of this task are to produce and archive data sets of ice elevations and radar reflections, which are processed in a consistent manner using the best available models and algorithms, and to make the data readily available to the scientific community. This task also provides analysis support for scientific investigations of polar ice sheet topography and changes in elevation.

STAFFING PROFILE

For January 1 through December 31,1999 the staffing profile (as a percentage of FTE):

Name	FTE%	Responsibilities
John DiMarzio	15%	Task Leader, Altimetry data processing, algorithm support, science results.
Anita Brenner	10%	Science results, algorithm support.
John Shepherd	50%	Unix systems administration.
Jairo Santana	75%	Data processing, software development and maintenance.
Margaret Russell	100%	Data processing, software development and maintenance.

Spread charges for infrastructure support will be incurred from:

Cost Control

Administrative Support

Courier

MILESTONES AND METRICS

The goals of this task are twofold. The first is to process and reprocess radar altimetry data taken over the Greenland and Antarctic ice sheets. The data from Seasat, Geosat, TOPEX, ERS-1, and ERS-2 are processed in a consistent manner using the best available correction models and archived and staged for distribution to the scientific community. The second goal is to provide meaningful analyses of the data including topographic maps, crossover analyses, change studies, ice margin mapping and general analyses.

The first of these goals is schedule driven. Pertinent metrics include:

1) Incorporation of new data from ERS-2 into the near-line database within 1 month of receipt.
2) Distribution of the data in a timely manner via an on-line data browsing and selection account.
3) Maintenance of a World Wide Web home page, which gives the latest information about the on-line data and corrections, gives data formats, and provides a gateway to the on-line data distribution account and off-line data request form.
4) Reprocessing of the on-line data within 2 months of updates to the data correction software and/or models.
5) Creation of crossover files from the latest on-line data within 3 months of updates to the on-line data.
6) Creation of level 3 and 4 (georeferenced databases and topographic grids) within 3 months of updates to the on-line data.
7) Have no more than 3 days per month of downtime for the on-line database.
8) Bi-monthly reporting of the data processing status.

- Staff attended the ICESat science team meeting in San Diego and made several presentations
- Staff attended the HQ review for land ice and made 4 presentations
- Cooperative efforts are ongoing with MSSL (Wingham and others) to investigate the affect of backscatter on ERS-1 and ERS-2 elevation change measurements.
- Cooperative efforts are ongoing with Australian glaciologists to create a 3-D modeling capability for ice sheets

Systems Support

- All our systems have been upgraded to HP11.x except for the old 700 systems which cannot be upgraded and are being phased out.
- Staff purchased hardware for the remote SCFs, installed the operating system and are awaiting final shipping paper signoff to send them to the PIs
- Staff purchased a second L server for ISIPS to be used as the primary data base server and is installing the 64 bit version of ORACLE on it
- Staff is preparing for a major Clearcase upgrade

WORK PLANNED FOR NEXT REPORTING PERIOD.

Deliver V2 of GSAS, GLAS Science Algorithm Software that will produce functional products for GLA01, GLA02, GLA05 – GLA15.

Write display GUIs for the SDMS planner

Continue adding to the planner design to automate processing everything in the GSAS version 2

Test Archer with two robots

Continue writing other required utilities for ISIPS

Continue prototyping and developing GLAS visualization and data selection software.

- Add capability to show LIDAR cloud image thumbnails
- Add LIDAR plotsets and interconnect with GLA02 and GLA07 backscatter profiles
- Add plotsets for level 2 products
- Modify readers to read version 2 GSAS products

Continue flow line, accumulation, and dhdt analysis.

Continue work on ice sheet modeling

Continue work on software for using GLAS repeat cycle data for elevation change studies

Support science team meetings

None.

SCHEDULE CONFORMANCE

Work is proceeding as planned.

WORK PLANNED FOR NEXT REPORTING PERIOD

Staff will continue to retrack and *ERS-2* data from the *UK-PAF* files.

Staff will continue to create Version 4 Antarctica ERS1/2 Crossover files.

Staff will continue to process GFO data as received.

Staff will continue to update the *HTML* homepage and *user* documentation.

The second goal is research driven and metrics include:

1) Reporting of new results at one scientific conference per year.
2) Preparation of research papers as required by the ATR.
3) Bi-monthly reporting of the data processing status.

Additionally, contract performance metrics include:

1) Prompt reporting monthly of task status. The previous month's report will be delivered to GSFC within 15 working days of the end of the month being reported upon
2) Cost control: adherence to CTR estimated cost to within a 10% variance.

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

None.

WORK PERFORMED

Ice Altimetry Processing

Staff completed processing ERS-2 data for Greenland and Antarctica through April 2000. All newly received tapes have been copied to DLT in preparation for retracking.

Staff continued processing ERS-2/ERS-2 Antarctica crossovers for analysis. The continent has been broken up into 10 degree longitude sections. To date the all of the sections from 190-360 degrees east have been processed.

Staff continued processing ERS-1/ERS-2 Antarctica crossovers for analysis. The continent has been broken up into 10 degree longitude sections. To date the all of the sections from 70-360 degrees east have been processed.

Staff continued processing ERS-1/ERS-1 Antarctica crossovers for analysis. To date the all of the sections from 100-360 degrees east have been processed.

Staff completed processing of GFO data through March 2001.

Staff completed processing all ERS-2 arctic sea ice data from Nov96-Nov98 as a special request from Ron Kwok at JPL.

Staff ordered and received all year 2000 meteorological data from NCAR for calculating tropospheric refraction corrections for the ERS-2 data.

Analysis

Staff began writing software to read and retrack ENVISAT altimetry. The retracking function least squares algorithm has been updated to handle the 128 sample (as opposed to 64 for all heretofore altimeters). We are awaiting some documentation and more sample data from ESA to complete this software.

Staff presented a status report at the NASA HQ annual site review.

PROBLEM AREAS

6) review of mission and design requirements with the customer within one-week after identification of the need for electronic engineering support

A key issue in achieving the milestones is to make certain that all the processes are automated to the extent possible, and they are carried out under controlled conditions to minimize variability in the performance assessment.

Additionally, contract performance metrics include:

1) prompt reporting monthly of task status. The previous month's report will be delivered to GSFC within 15 working days of the end of the month being reported upon
2) cost control: adherence to CTR estimated cost to within a 10% variance.

REPORTING PERIOD

February 1, 2001 through April 30, 2001

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS PERIOD

Paper "Assessment of the cycle-by-cycle TOPEX altimeter noise level by high-pass filtering 1-Hz data', April 2001, N. Tran/Raytheon, D.W. Hancock III/NASA, G.S. Hayne/NASA, D.W. Lockwood/Raytheon, D. Vandemark/NASA.

Paper "The dependence of nadir ocean surface emissivity on wind vector as measured with TMR", April 2001, N. Tran/Raytheon, D. Vandemark/NASA, C. Ruf/Univ. of Michigan, B. Chapron/Centre de Brest, prepared for submission in IEEE Transactions on Geoscience and Remote Sensing.

WORK PERFORMED

TOPEX SUPPORT

Investigated and provided analysis on 7 autonomous-recovery and 3 manual-recovery SEU's.

Provided data and data analysis support for ABCAL #54.

Provided data and data analysis support for each monthly Calibration Sweep (CalSweep).

Continued testing of the creation of the GDR Database using ORACLE and sample reports reflecting the addition of new variables. Loaded side A GDR's to ORACLE database and tested reports. This completes the reloading all the GDR's.

Provided support and data analysis for the AGC Cal Leakage test and Transmit test.

Reviewed the IMIU clock rollover at JPL.

Completed analysis on the sensibility of the sea surface emissivity with respect to the wind speed and wind direction. The paper presenting these results is completed and has been submitted to IEEE Transactions on Geoscience and Remote Sensing journal for publication.

Started an analysis of altimeter noise by using a high-pass filter algorithm from a study by Driscoll and Sailor [2001]. Wrote a routine which worked on a cycle-by-cycle basis. Applied algorithm to TOPEX and Poseidon altimeter data.

NASA Task 00-972-01: Radar Altimeter Performance Analysis Support

--WORK PLAN--

GSFC ATR: David Hancock

Raytheon Task Leader: Dennis Lockwood
Raytheon Task Number: 172

The objective of this task is to provide radar altimeter instrument performance analysis for current and future projects. Provide GFO project support in algorithm verification elements assigned to the Wallops Flight Facility, producing project specific documentation using appropriate style and layouts, and coordinating reproduction as required. Provide support for the engineering assessments of the radar altimeter performance which fall under the responsibility of the WFF. Develop altimeter engineering assessment reports. Provide TOPEX project support for a long-term trend analysis of the instrument and the various data products and with instrument engineering data to provide calibrations to the project at JPL Provide software and algorithm maintenance support for TOPEX Radar Altimeter. Additionally, support is provided for the system software maintenance related to the OSB computing and a range of engineering expertise related to branch remote sensing instrumentation.

STAFFING PLAN

For August 1, 2000 through July 31, 2005, the staffing profile is (as a percentage of FTE):

NAME	FTE%	RESPONSIBILITY
Dennis Lockwood	90%	Task Leadership, software development, generation of special products
Jeff Lee	20%	Systems administration, software development
Ron Brooks	20%	Data analysis, performance assessment, command generation
Carol Purdy	65%	Data and software librarian, documentation
Lisa Brittingham	50%	Systems administration, database maintenance
Gregg Twigg	25%	Database software development
Ngan Tran	100%	Data Analyst
Gerry McIntire	100%	Sensor design/operation, circuit board fabrication

Spread charges for infrastructure support will be incurred from:

Cost Control

Administrative Support

MILESTONES AND METRICS

This task depends on the timely analysis and incorporation of new data into the WFF TOPEX database.

Pertinent metrics include:

1) incorporation of 24-hour datafiles on a daily basis, and daily reporting of instrument internal calibrations
2) production of cycle summaries within one week after the end of each cycle
3) production of monthly launch-to-date summaries
4) production of a yearly update of the Engineering Assessment Report
5) maintenance and upgrading of supporting computer systems

GFO

Continue support on the analysis and plotting of GFO data.

Continue to collect, distribute, and archive data.

SYSTEM

Continue to provide support to users on an as-needed basis.

Implement product updates as needed, specifically e-mail and operating system and virus software.

Continue to keep current Windows Documentation on the OSB website.

Continue to keep the ISO 9001 website current.

Continue to update user account request forms and information.

TECHNICAL SERVICES

Continue support with 972 Property Management.

Continue support of Bldg. N-159 operations.

Continue logistical and technical support to TRMM.

Provide support when needed to AOL.

Upgrade of hardware and modifications of Radar system on the SRA project. Support deployment to Tampa, FL for the installation on the NOAA P-3 in preparation for the 2001 hurricane season.

Completing the upgrade of the circuit board for interfacing radar to HARLLIE control system. Support summer deployment.

Continued support for ISO. Particularly in the area of the ESD bench and specifying new certified equipment.

GFO SUPPORT

Provided support in the analysis of the processed data since acceptance.

Provide a daily analysis of CAL/VAL products and quick response of ground processing problems with the data. Maintaining 'Ground Processing Problem Log'.

SYSTEM SUPPORT

Provided computer technical support to users on a daily/as-needed basis.

Added new foreign national user, and two local users, filled out all paperwork accordingly.

Changed all TCP/IP information to accommodate installation of firewall.

Update three users with new operating systems.

Assisted two users in the setup of new computer systems.

Placed several calls to ODIN for port activation.

TECHNICAL SERVICES SUPPORT

Completed directive to identify users of equipment and made proper changes in support of 972 property management.

Supported Scanning Raman Lidar with the redesign, proto-typing and testing of a interface circuit between a Marine Radar and the HARLIIE Lidar.

Supported the branch ESD bench with upgrades and maintaining inspections and logs.

Provided logistical and technical support for the TRMM, AOL and SRA project.

PROBLEM AREAS

None.

SCHEDULE CONFORMANCE

Work is processing on schedule.

WORK PLANNED FOR NEXT REPORTING PERIOD

TOPEX

Continue the analysis and plotting of altimeter data for various TOPEX assessments, as initiated under the SWDT Request system.

Support the monthly Cal Sweeps and ABCAL #55.

Complete yearly update of the Engineering Assessment Report for 2000.

Complete the comparison of the noise of GFO, TOPEX and Poseidon altimeters and write a paper presenting this comparison.

Start a new work related to using the TOPEX pathfinder to look at direct sea state bias determination.

REPORTING PERIOD

February 1, 2001 through April 30, 2001

TECHNICAL DOCUMENTS AND REPORTS DELIVERED THIS REPORTING PERIOD

ICESat Science Investigator-led Processing System (ISIPS) and Software Support Science Data Centers Symposium; Pasadena, CA; March 26-28, 2001

GLAS Quality Assurance Plan, March 27-28, 2001.

ICESat SIPS Science Team Meeting, February 14-15, 2001.

WORK PERFORMED

Continued general coding/support efforts for GLAS Science Algorithm Software.

Completed implementation of common_flags.

Completed integration GLOP into the new GLAS_L0proc design. Incorporated major design changes into GLAS_L0proc. Completed initial GLAS_L0proc integration test.

Completed integration of GLA00 v3.0+ APID formats

Began GLA04 product coding. Began work on L_Att.

Begin implementation of shot_time calculation.

Implemented V2 of L_Alt and completed unit test. Began implementation of L_Alt QA.

Updated L1A Algorithm Theoretical Basis Document.

Began revision of GSAS documentation to incorporate V2 software changes.

Completed revisions to the GLAS Development database.

Completed interface between the GLAS test data archive and the GLAS ground test data processing system for the GLAS Bench Checkout Equipment (BCE) data.

Integrated all ground test data processing routines into one system that is executed using a GUI.

Collected additional requirements for the post-processing of the GLAS ground test data.

Worked details of the interface between the ICESat MOC and the GLAS Instrument Support Facility.

Received the GLAS Instrument Support Terminal (IST) from the ICESat MOC. The GLAS IST was installed in the ISF. Spacecraft data during TVAC testing was received at the IST from the MOC and was displayed using OASIS.

Continued support of MOLA mission operations.

PROBLEM AREAS

None.

NASA Task 00-972-02: Code 972 Laser Altimeter Performance Analysis Support

--WORK PLAN--

GSFC ATR: David Hancock

Raytheon Task Leader: Jeffrey Lee
Raytheon Task Number: 171

The objective of this task to provide software and processing related to space flight laser altimeter projects within the Observational Science Branch. (Code 972) of the Laboratory for Hydrospheric Processes (Code 970). This task will support the ICESat and Mars Orbiter Laser Altimeter (MOLA2) projects. ICESat support will be focused on design, development, and implementation of software for the ground data system of the Geoscience Laser Altimeter System (GLAS) and post-launch operations and maintenance. MOLA2 support is based on command-generation and data and health monitoring for the MOLA2 instrument onboard the on-orbit Mars Global Surveyor spacecraft.

STAFFING PLAN

For August 1, 2000 through July 31, 2005, the staffing profile is (as a percentage of FTE):

NAME	FTE%	RESPONSIBILITY
Peggy Jester	100%	Group Leadership, software design, software development
Jeff Lee	80%	Task Leadership, software lead, systems administration
Dennis Lockwood	10%	Software development, testing
Carol Purdy	35%	Software librarian, documentation specialist
Lisa Brittingham	50%	Software development, database administration
Hwa-Ja Rhee	100%	Software development
James Golder	100%	Software development
Greg Twigg	75%	Software development

Spread charges for infrastructure support will be incurred from:

Cost Control

Administrative Support

Note: Hwa-Ja Rhee left the project in Mid-March 2001 and was replaced by James Golder on April 1, 2001.

MILESTONES AND METRICS

The GLAS ground data system is divided into two systems: the ICESat Science Investigator-led Processing System (I-SIPS) and the Instrument Support system. Delivery milestones are required to assure that for each respective data system, software will be completely developed and installed 3 months prior to the start-of-mission. Additional milestones will be required for post-launch software maintenance and updates.

MOLA support metrics are the accuracy of data and health monitoring and the timeliness of command generation.

Additionally, contract performance metrics include:

1) Prompt reporting monthly of task status. The previous month's report will be delivered to GSFC within 15 working days of the end of the month being reported upon
2) Cost control: adherence to CTR estimated cost to within a 10% variance.

SCHEDULE CONFORMANCE

Work is proceeding such that GSAS will be completely developed and installed within the scheduled "3 months prior to the start-of-mission" window.

WORK PLANNED FOR THE NEXT REPORTING PERIOD

Deliver Version 2 of GSAS and its delivery documentation.

Deliver schedule for V2+ versions of GSAS.

Deliver ground test data processing software and support instrument ground testing at GSFC.

Continue development of ISF interfaces. Receive the full up FASTCOPY software and test receiving playback data from the Central SAFS.

Complete next version of the ISF External ICD.

For MOLA2, continue to monitor instrument temperatures, review sequences, and attend weekly planning and status meetings and quarterly Science Data Validation Team meeting via telephone.