REPORTS OF THE DEPARTMENT OF GEODETIC SCIENCE

REPORT NO. 199

GLOBAL SATELLITE TRIANGULATION AND TRILATERATION FOR THE NATIONAL GEODETIC SATELLITE PROGRAM (SOLUTIONS WN 12, 14 AND 16)

by

Ivan L. Mueller
and
M. Kumar, J. P. Reilly, N. Saxena, T. Soler

Prepared for the
National Aeronautics and Space Administration
Washington, D.C.

Grant No. NGR 35-008-093
OSURF Project No. 2514

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Research Foundation
Columbus, Ohio 43214

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Project staff with significant contributions is listed in the table on the next page. The proportion of their individual contributions is reflected in a general way by the length of stay and/or by the issue numbers in the Report Series of the Department of Geodetic Science to which the individual contributed most. In a university environment where there are important interactions between the students themselves and the instructional staff, it is generally difficult to separate out individual contributions from the team work. Thus the Report numbers listed reflect, in most cases, responsibilities in a given area rather than "individual" contributions. Exceptions to this are theoretical studies contained in Reports No. 114, 147, 150, 177, 185, where very little input came from students other than the authors.
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Those students receiving financial assistance (travel, etc.), other than direct fellowships, have asterisks next to their names. In addition to those listed in the table, fifteen students also carried short-term appointments for various generally nonprofessional responsibilities.

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<td>107</td>
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<tr>
<td>5.1-2</td>
<td>Determination of scale</td>
<td>111</td>
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<tr>
<td>5.4-1</td>
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<td>182</td>
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<tr>
<td>5.4-2</td>
<td>Dynamic pole positions relative to the WN14 pole</td>
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</tr>
<tr>
<td>5.5-1</td>
<td>Major geodetic datum blocks</td>
<td>185</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

In 1965 the Department of Geodetic Science at The Ohio State University had been requested to submit a proposal to the National Aeronautics and Space Administration for a multi-year study and analysis of data from satellites launched specifically for geodetic purposes and from other satellites useful in geodetic studies. The program of work included theoretical studies and analysis for the geometric determination of station positions derived from photographic observations of both passive and active satellites and from range observations. This paper examines the current status of data analysis, processing and results. Various theoretical studies have been described in the Report series of the Department of Geodetic Science (Nos. 106, 110, 114, 118, 139, 147, 150, 177, 185, and 191) and are not repeated here.

The ultimate goal of the data analysis was to obtain an improved global net combining all participating tracking stations in a single worldwide coordinate system. In deriving these results OSU representatives were to work with other universities and government agencies to prepare a handbook containing the best geodetic data from satellite observations available at the time. This report condenses the OSU contribution to the above enterprise.

The work performed during the grant period included, but was not limited to, the following:

(1) Deriving the necessary mathematical formulations, programming and testing the same.
Making use of the observational data as they became available to determine the relative positions of the tracking stations in an arbitrary Cartesian coordinate system.

Estimating the position of this coordinate system with respect to an absolute (geocentric) system and also with respect to coordinate systems used by the other agencies.

Participating in working groups and other planning meetings to establish desirable operational procedures, including tracking procedures, data format, analysis procedures, etc.

Providing advice to NASA on various aspects of the National Geodetic Satellite Program.

Thus, the primary objective of the OSU investigation was the geometric analysis of geodetic satellite data. The analysis was to be accomplished in three steps:

1. The establishment of a primary network where station positions are known to an internal consistency of 10 meters or better to serve the following purposes: (a) to establish the relative relationships between the various geodetic datums in use around the world; (b) connect isolated tracking stations, islands, navigational beacons and other points of interest.

   In fulfilling the requirement of (a) a minimum of three tracking stations were to be used on any given datum.

2. Establishment of a densification network where station positions are known to an internal consistency of three meters or better to serve the following purposes: (a) improve the internal quality of existing geodetic networks (triangulation, etc.) by establishing "super" control
points in sufficient numbers; (b) to provide control for mapping to scales as large as 1:25,000 in areas where no primary geodetic control exists.

(3) Establishment of a set of scientific reference stations where positions are known to an internal consistency of one meter or better for advanced (earth and ocean physics) applications.

This report contains results in connection with (1). The goals of items (2) and (3) still need to be fulfilled when the quality of the observational material and/or the distribution of tracking stations will become better than those made available for this study. Since the National Geodetic Satellite Program is no longer funded, it is only hoped that these goals will be incorporated in the Earth and Ocean Physics Application (EOPAP) or in the GEOS-C Programs.

This report is in six sections. Following the brief section on instrumentation, section 3 contains material on observational and survey data as provided to The Ohio State University by the various data collecting agencies. After describing the theory in section 4, the results of the least squares adjustment are given in section 5. This section also contains the comparison of these results with various dynamic solutions and survey data. In section 6 conclusions are presented with some recommendations for future work. Numbers in brackets after the section captions refer to the appropriate Department of Geodetic Science Report where more detailed information on the content of the section may be found.
2. INSTRUMENTATION

The Ohio State University used data provided by other groups and did not make any observations of its own. It did not develop or use any instruments or equipment which were unique to OSU's work, and the instruments used in getting the data used by OSU are described in [American Geophysical Union, in press].
Table 2-1
Index to Descriptions of Instruments Used in Producing Data for OSU Work

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Responsible Group</th>
<th>Location Chapter</th>
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<tr>
<td>RCS</td>
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<td></td>
</tr>
<tr>
<td>Relay 1</td>
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<tr>
<td>SECOR (EGRS)</td>
<td>DOD/DMA</td>
<td>III</td>
</tr>
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<td>IX</td>
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<td>DOD</td>
<td>III</td>
</tr>
</tbody>
</table>

1 in [American Geophysical Union, in press]
3. DATA

Details of the data used by OSU and obtained from various agencies are presented in the tables of section 3.1, 3.21 and 3.3. Before reaching OSU the data was subjected to reductions considered necessary by the respective agencies [Gross, 1968; Hotter, 1967]. Most of the obtained data needed some kind of additional treatment before it could be used for analysis; the more important details of this treatment (preprocessing) are given in section 3.22.

3.1 Satellites and Observation Stations [71]

Data used for OSU investigations was obtained by observing the satellites listed in Table 3.1-1. Orbital and other information on these satellites is tabulated in [Girnius and Joughin, 1968; King-Hele et al., 1970].

Survey information regarding the observation stations is summarized in Tables 3.1-2 to 3.1-4.

Table 3.1-1

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<td>Teledyne 1</td>
<td>62 20 1</td>
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Table 3.1-2
Survey Information of Observation Stations

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<th>TYPE</th>
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<td>84° 4.9'</td>
<td>21.0</td>
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<td>48° 10.7'</td>
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<td>MDT 40</td>
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* INSUFFICIENT DATA
1 REFER TO TABLE 3.1-3
2 GEODETIC COORDINATES OF THE INSTRUMENTAL REFERENCE POINT (OPTICAL/ELECTRONIC CENTER, ETC.) ON THE LOCAL GEODETIC DATUM
3 MEAN SEA LEVEL HEIGHT OF THE INSTRUMENTAL REFERENCE POINT
4 HEIGHT OF INSTRUMENTAL REFERENCE POINT ABOVE SURVEY MONUMENT
5 REFER TO TABLE 3.1-4

NOTE: A ZERO IN THE LAST DIGIT MAY INDICATE THAT THE DIGIT IS UNKNOWN.
## Table 3.1-3

### Geodetic Datums

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<th>Longitude</th>
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<td>Station 75 ADISDA</td>
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<td>31°29'21.608</td>
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<tr>
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<td>Clarke 1886</td>
<td>Raffelton</td>
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<td>3</td>
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<td>Cape Town</td>
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<td>Station 038</td>
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<td>Bessel</td>
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<td>Krassowsky</td>
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<td>ASTRO 1952</td>
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<td>Clarke 1880</td>
<td>YOF ASTRO 1967</td>
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<td>International</td>
<td>Belle Vue IGH</td>
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<td>168°20'32.280</td>
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*Local datums of special purpose, based on NAD 1927 values for the origin stations.*
Table 3.1-4
Summary of Source Information

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<th>Source</th>
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<td>[CSC, 1972/73]</td>
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<td>3</td>
<td>[Huber, 1971]</td>
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<td>4</td>
<td>[Gaposchkin et al., 1973]</td>
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3.2 Satellite Observational Data and Its Handling

3.21 Satellite Observational Data [187, 188, 193, 195, 196]

Data used in the four OSU partial solutions (networks) reported earlier, namely, MPS, BC, SECOR, and SA, and in the current combined solutions designated WN, is summarized in Table 3.2-1. These networks are shown in Figs. 3.2-1 through 3.2-7. Various statistical information on the solutions are provided in Tables 3.2-2 and 3.2-3.
### Table 3.2-1

Basic Information on the OSU Solutions (Networks)

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<th>OSU Solution (Network)</th>
<th>No. of Stations</th>
<th>No. of Observations</th>
<th>No. of Constraints Used</th>
<th>$\sigma_0$</th>
<th>$\text{Ref.}$</th>
<th>Fig.</th>
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1. MPS includes 14 PC-1000 stations, 15 MOTS-40 stations, 1 PTH-100 station, 7 C-Band stations, 6 European stations (8000 series), and 23 SAO stations (9000 series).

2. BC includes all 49 stations of BC-4 Worldwide Geometric Satellite Network.

3. SECOR includes 37 SECOR stations of the Equatorial Network and 13 collocated BC-4 camera stations.

4. SA includes 9 PC-1000 stations of South American Densification Net and 5 BC-4 stations.

5. WN includes all the above-mentioned four networks, namely, MPS (less one C-Band station: 4742), BC, SECOR, and SA.


7. OSU Department of Geodetic Science Report No.
Fig. 3.2-1 MPS stations in North America.
Fig. 3.2-2 MPS stations in Europe.
Fig. 3.2-3  SAO and C-Band stations in the MPS net.
Fig. 3.2-4  BC-4 Worldwide Geometric Satellite Network.
Fig. 3.2-5 SECOR Equatorial Network.
Fig. 3.2-6 South American densification net.
Fig. 3.2-7  OSU Geometric Satellite Network (WN)
Table 3.2-2

Summary of Observation Types

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<th>Instrument</th>
<th>NASA Series No.</th>
<th>Satellite Observed</th>
<th>OSU Network Where Used</th>
<th>Data Source*</th>
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<td>GEOS-I</td>
<td>MPS</td>
<td>NSSDC</td>
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<td>PC-1000</td>
<td>3000</td>
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<td>MPS</td>
<td>NSSDC</td>
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<td>3000</td>
<td>Echo I,II, PAGEOS, GEOS-II</td>
<td>SA</td>
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<td>GEOS-II</td>
<td>MPS</td>
<td>NASA/Wallops Isl.</td>
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<td>PAGEOS</td>
<td>BC, SA</td>
<td>NGS, NSSDC</td>
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<td>GEOS I</td>
<td>MPS</td>
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<td>SAO</td>
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<td>MPS</td>
<td>SAO</td>
</tr>
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</table>

*OMA Defense Mapping Agency
NGS National Geodetic Survey
NSSDC National Space Science Data Center
SAO Smithsonian Astrophysical Observatory
Table 3.2-3a
Summary of Simultaneous Observations by Line (MPS Network)

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<th>Line Station-Station</th>
<th>No. of Pairs</th>
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<td>3406-3477</td>
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Table 3.2-3d
Summary of SECOR Observations by Quadrangle

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<thead>
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<th>Quad Stations Involved</th>
<th>No. of Observations</th>
<th>Quad Stations Involved</th>
<th>No. of Observations</th>
</tr>
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<td>644</td>
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<td>5726-5933-5934-5935</td>
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<td>1008</td>
<td>5931-5726-5934-5935</td>
<td>1144</td>
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<td>5734-5410-5411-5201</td>
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<td>5734-5730-5411-5201</td>
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<td>5715-5736-5717-5744</td>
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</tr>
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</tr>
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<td></td>
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<td>5931-5930-5726-5933</td>
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<td></td>
</tr>
<tr>
<td>5723-5930-5726-5933</td>
<td>652</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.22 Data Handling

3.221 Preprocessing. [70, 82, 93, 100, 106, 110, 195]

The term preprocessing covers any treatment (reductions, corrections, etc.) necessary to be applied to the observed data prior to its analysis for the purpose of removing systematic errors burdening the observations. From the point of view of the investigator who has not participated in the actual observations preprocessing can be considered as consisting of two parts, namely,

(1) Reductions and corrections of observed data by the respective agencies responsible for the observations prior to sending the data either to the National Space Science Data Center or to the individual investigator. This part of the preprocessing is dealt with by Hotter [1967] and by Gross [1968].

(2) Additional corrections to the reduced data, or homogenization of the data obtained from various agencies, screening of data for blunders and ambiguities are the parts of the preprocessing procedure to be done by the investigator.

Fig. 3.2-8 is a self-explanatory summary of both types of preprocessing for optical observations as handled in practice. The shaded blocks represent the portion of the work performed at OSU. For more details see [Hotter, 1967].

Fig. 3.2-9 is a summary of preprocessing applied to the SECOR data. For more details see [Gross, 1968].

No preprocessing was applied to the C-Band radar data [Mueller and Whiting, 1972].
<table>
<thead>
<tr>
<th>Camera</th>
<th>Name</th>
<th>DMA</th>
<th>NGS</th>
<th>NASA/GSFC</th>
<th>SAO</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>PC-1000</td>
<td>BC-1(ASY)</td>
<td>BC-4(COSMO)</td>
<td>MOTS 24</td>
</tr>
<tr>
<td>Catalog</td>
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<td>SAO</td>
<td>SAO</td>
<td>SAO</td>
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<tr>
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<td></td>
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<td>PHOTO</td>
<td>PHOTO</td>
<td>ASTRO</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>-</td>
<td>-</td>
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<td>Yes</td>
<td>No</td>
<td>-</td>
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<tr>
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<td>Portable Clock &amp; VLF</td>
<td>Active Sat Only</td>
<td>Portable Clock &amp; VLF</td>
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</tr>
<tr>
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<td>Satellite</td>
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<td>M</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
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<td>M/C</td>
<td>M</td>
<td>M</td>
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<td>C</td>
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<td>C</td>
<td>C</td>
<td>C</td>
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</tr>
<tr>
<td>Diurnal Aberration</td>
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<td>Astro Refraction</td>
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<td>(Garkinkel) with Adj Coeff</td>
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<td>Parallax Refraction</td>
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<td>-</td>
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</tr>
<tr>
<td>Sat Aberration</td>
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<td>C</td>
<td>C</td>
<td>C</td>
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</tr>
<tr>
<td>(Light Time)</td>
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</tr>
<tr>
<td>UTC = UT1</td>
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<td>C</td>
<td>C</td>
<td>C</td>
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<tr>
<td>UTC = ST</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>AS = UT1</td>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Phase (Passive Only)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3.2-8 Optical data preprocessing procedure summary for major U.S. agencies.
\[ R_{\text{obs}} = \text{observed range measurement} \]
\[ C_{\text{HF}}, C_{\text{LF}} = \text{observed frequency channel calibration correction (high and low frequency)} \]
\[ \text{DI-DC} = \text{given ionospheric correction for each range} \]
\[ A_{\text{HF}}, A_{\text{LF}} = \text{given ambiguities (initial and new sets)} \]
\[ \Delta R_{\text{ION}} = -0.7125 \left[ (\text{DI-IC}) + A_{\text{LF}}^{i} + A_{\text{LF}}^{n} + (C_{\text{LF}} - C_{\text{HF}}) \right] \]
\[ \Delta S = .98 \frac{R_{\text{obs}}}{10^6} \]
\[ R_{I} = R_{\text{obs}} + \Delta R_{\text{ION}} + A_{\text{HF}}^{i} + A_{\text{HF}}^{n} + C_{\text{HF}} + \Delta S \]

Fig. 3.2-9 Scheme of SECOR preprocessing procedure at OSU.
\[
\sin a = \sin \delta \sin \phi + \cos \delta \cos(h + \lambda) \cos \phi
\]

\( \phi, \lambda \) station coordinates

\( h, \delta \) topocentric Greenwich hour angle and declination

\[
TROPO = \frac{k_1(1 - e)}{\sin a + k_2 \cos a}
\]

where

- \( k_1 = 2.7 \)
- \( k_2 = 0.0236 \)
- \( Z = 1.7000 \)
- \( a \) elevation angle

\[
r = R_1 - TROPO
\]

Print out (OSUGOP format)
3.222 Detection of Blunders and Rejection.* [86]

A. Optical Data. Blunders in the observed declinations and right ascensions and/or observing ground station coordinates are detected during the formation of the normal equations. The procedure used is to test the variance of unit weight that would result from a preliminary least squares adjustment of each simultaneous event. In this adjustment the ground stations are held fixed. The residuals on the \( ij \)th observed \( \alpha, \delta \) pair from such a preliminary adjustment are the first two elements of the 3 x 1 vector

\[
V_{ij} = B_{ij}^{-1} (X_i - \hat{X}_j^0) \hat{X}_j^0 = (\sum M_{ij}^{-1})^{-1} \{ \sum M_{ij}^{-1} X_i \}
\]

(The third element is the range to the preliminary adjusted satellite position.) And, therefore,

\[
\sum V_{ij}^T P_{ij} V_{ij} = \sum (X_i - \hat{X}_j^0)^T M_{ij}^{-1} (X_i - \hat{X}_j^0)
\]

since the third element is dispensed within the product

\[
P_{ij} B_{ij}^{-1} (X_i - \hat{X}_j^0)
\]

(see equation 4.2-16). Therefore, the variance of unit weight is computed from

\[
\sigma_0^2 = \frac{\sum_{\text{event}} (X_i - \hat{X}_j^0)^T M_{ij}^{-1} (X_i - \hat{X}_j^0)}{2n - 3}
\]

where the numerator can be shown to be the sum square of the weighted residuals (arc seconds squared) of all the observed declinations and right ascensions in the event; \( n \) is the number of ground stations in the event.

If a number of rejected simultaneous events repeatedly contain a particular ground station, it is probably due to a blunder in the coordinates.

*To appreciate this section the reader is advised to study section 4 first.
of the particular ground station rather than in the observed quantities. In this case, the preliminary coordinates of that ground station should be verified.

B. Range Data. Blunders in the observed topocentric ranges and/or ground station coordinates are detected during the formation of the normal equations. The procedure used is to test the variance of unit weight (equation 3.2-10) arising from a preliminary least squares adjustment of each simultaneous event.

The preliminary adjustment is basically an iterative adjustment for the $u_j$, $v_j$, $w_j$ rectangular coordinates of the satellite position by fixing the ground stations and applying the residuals of the adjustment to the observed ranges. The approximation to the parameters $u_j$, $v_j$, $w_j$ is obtained by converting the so-called approximate geodetic coordinates of the satellite into rectangular coordinates by use of equation 4.2-18. The approximate geodetic coordinates of the satellite are obtained by averaging the latitudes and longitudes of the ground stations involved in the simultaneous event and estimating the ellipsoidal height of the satellite. The idea that the above is crude is immediately rejected upon the knowledge that at most four iterations (to a tolerance of 1 cm in $u_j$, $v_j$, $w_j$) are required and that the electronic computers perform these iterations more quickly than the time necessary to solve the corresponding simultaneous, exact, second-order equations.

The equation giving the mathematical structure of this preliminary adjustment is identical to equation 4.3-1, the mathematical structure for the main range adjustment. Since only three parameters are involved, the linearized form of the mathematical structure for $n$ ground stations in one
simultaneous event becomes

\[ AX - \bar{V} + W = 0 \]  

where the coefficient matrix

\[
A = \begin{bmatrix}
u_j^0 - u_1^0 & v_j^0 - v_1^0 & w_j^0 - w_1^0 \\
u_j^0 & v_j^0 & w_j^0 \\
u_j^0 - u_2^0 & v_j^0 - v_2^0 & w_j^0 - w_2^0 \\
\vdots & \ddots & \vdots \\
u_j^0 - u_k^0 & v_j^0 - v_k^0 & w_j^0 - w_k^0 \\
\vdots & \ddots & \vdots \\
u_j^0 - u_m^0 & v_j^0 - v_m^0 & w_j^0 - w_m^0 \\
r_j^0 & r_j^0 & r_j^0 \\
r_j^0 & r_j^0 & r_j^0 \\
r_j^0 & r_j^0 & r_j^0 \\
r_m^0 & r_m^0 & r_m^0
\end{bmatrix}
\]

the correction vector for the satellite coordinates

\[
X = \begin{bmatrix}du_j \\
dv_j \\
dw_j
\end{bmatrix}
\]

the residual vector for the ranges

\[
\bar{V} = \begin{bmatrix}v_{1j} \\
v_{2j} \\
\vdots \\
v_{kj} \\
v_{mj}
\end{bmatrix}
\]

and the constant vector
The normal equations
\[ \mathbf{d} = \mathbf{N} \mathbf{X} + \mathbf{U} = 0 \]
where
\[ \mathbf{N} = \mathbf{A}' \mathbf{P} \mathbf{A} \]
and
\[ \mathbf{U} = \mathbf{A}' \mathbf{P} \mathbf{L} \]
are solved for \( \mathbf{X} \) by iteration until the elements of the vector \( \mathbf{X} \) are less than 1 cm. At this point, \( \mathbf{X} \) is entered into equations 3.2 - 2 and the vector of residuals \( \mathbf{V} \) is determined; the variance of unit weight is then computed according to
\[ \sigma_0^2 = \frac{\mathbf{V}' \mathbf{p} \mathbf{V}}{n - 3} \]

The complete set of data for the simultaneous event is printed out for evaluation in the case that the particular \( \sigma_0^2 \) is greater than a chosen input value. At the same time, no contribution is made to the normal equations by the rejected event.

### 3.3 Constraints

For the explanation of the type of constraints used in the solution, see section 4.5. Only the data used in applying the various constraints is summarized here in Tables 3.3-1 to 3.3-4.
### Table 3.3-1

**Summary of Constraint-Types with the Source Information**

<table>
<thead>
<tr>
<th>Code</th>
<th>Constraint Type</th>
<th>Source (Agency)*</th>
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<td>1</td>
<td>BC-4 - Baker-Nunn</td>
<td>SAO, NGS</td>
</tr>
<tr>
<td>2</td>
<td>BC-4 - SECOR</td>
<td>DMA/TC</td>
</tr>
<tr>
<td>3</td>
<td>BC-4 - BC-4</td>
<td>NGS</td>
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<td>4</td>
<td>Others</td>
<td>OSU</td>
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<td></td>
<td><strong>Height</strong></td>
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</tr>
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<td>5</td>
<td>MSL (mean sea level heights)</td>
<td>CSC, NGS, NWL</td>
</tr>
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<td>6</td>
<td>Geoidal undulations</td>
<td>OSU [Rapp, 1973]</td>
</tr>
<tr>
<td></td>
<td><strong>Length (Chord)</strong></td>
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</tr>
<tr>
<td>7</td>
<td>North America</td>
<td>NGS</td>
</tr>
<tr>
<td>8</td>
<td>Europe</td>
<td>NGS, DGFI</td>
</tr>
<tr>
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<td>Africa</td>
<td>NGS</td>
</tr>
<tr>
<td>10</td>
<td>Australia</td>
<td>NGS, DNP</td>
</tr>
<tr>
<td>11</td>
<td>C-Band</td>
<td>NASA/Wallops Isl.</td>
</tr>
</tbody>
</table>

*CSC  Computer Sciences Corporation  
DGFI  Deutsche Geodätisches Forschungsinstitut  
DMA/TC Defense Mapping Agency Topographic Center  
DNP  Division of National Mapping, Dept. of National Development, Australia  
NGS  National Geodetic Survey  
NWL  Naval Weapons Laboratory  
SAO  Smithsonian Astrophysical Observatory
# Table 3.3-2

Relative Position Constraints

<table>
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<tr>
<th>STATIONS</th>
<th>RELATIVE</th>
<th>COORDINATES (METERS)</th>
<th>WEIGHTS</th>
<th>SOURCE</th>
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<td>$\Delta v$</td>
<td>$\Delta w$</td>
<td>$1/\sigma^2$</td>
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<th>(%_{HCONSTR} )</th>
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1 FROM [RAPP, 1973 ]
2 HCONSTR = MSL - NREF + \(\Delta N\) (SEE SECTION 5.1)
3 USED IN COMPUTING THE WEIGHTS OF THE HEIGHT CONSTRAINTS
Table 3.3-4

Chord Constraints

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<th>Station-Station</th>
<th>Chord Distance (meters)</th>
<th>$\sigma \times 10^6$</th>
<th>Source Code</th>
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<td>6003-6111</td>
<td>1 425 876.452</td>
<td>1.11</td>
<td>7</td>
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<td>6006-6065</td>
<td>2 457 765.810</td>
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<td>8</td>
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<td>6016-6065</td>
<td>1 194 793.601</td>
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<td>8</td>
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<td>6063-6064</td>
<td>3 485 550.755</td>
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<td>9</td>
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1 Used in computing the weights.

2 Refer to Table 3.3-1.
4. THEORY AND MATHEMATICAL MODELS [86, 150, 185, 191]

This section presents almost the complete theory used in transforming the observational data (section 3) into geodetic results. Left out of this section and given in section 3 instead is that part of the theory which concerns the preprocessing procedure of the observed data where systematic errors in the observed data are removed, detected, and eliminated, or where generally the necessary corrections to the observed data are made before inserting them into the method of least squares adjustment.

4.1 Definitions and Coordinate Systems [86]

4.1.1 Basic Concepts and Statement of the Problem

A theory proceeds from a set of known facts or assumptions called the data, and by manipulating these according to accepted rules called theory, produces certain conclusions called results. This process is started in response to the posing of a problem. The problem in this case can be stated as follows:

Given are the approximate coordinates of a number of points (stations) on the surface of the earth, which are assumed to be in error by unknown amounts. Also given are measured distances and/or directions from these points to other points on and also above the surface of the earth (artificial satellites); the observations occur in sets with all observations within a given set being made at the same time. The problem is then to find the most probable values for the unknown errors in the coordinates of points (stations) on the earth's surface.

Thus in this "space triangulation (trilateration)" method satellites are observed simultaneously from groups of known and unknown ground
stations, permitting a purely geometric solution. The main characteristic of this method is that orbital elements are not required. If the satellite positions are needed they can be computed from the preliminary coordinates of the ground stations and the observations themselves.

The method used to get a solution is therefore (1) to set up the equations giving the observations (angle or distance) in terms of observer and satellites coordinates; (2) linearize these equations to give observation residuals in terms of observer and satellites coordinate errors; (3) select from the data available those which can be put into simultaneity sets; (4) using known and assumed statistical properties of the observations, solve the equations of (2) using the data of (4).

Since the method is geometric and involves coordinates of earth surface points and of points in "inertial" space, transformation between coordinate systems occurs frequently. The systems used and their interrelation are described in 4.12 and 4.13 respectively.

4.12 Coordinate Systems

The optical observations after preprocessing (section 3.22) are assumed to be in the true topocentric celestial system, while the preprocessed topocentric ranging data is independent of the coordinate system used.

Two distinct types of coordinate systems have been used here:

(a) the terrestrial (average and instantaneous) system,
(b) the celestial (true) system.

The following summary of these systems assumes right-handed rectangular coordinates with axes numbered according to Fig. 4.1-1. Generally the
origin of the coordinate system coincides with or is near to the center of gravity of the earth.

Fig. 4.1-1 Numbering of coordinate axes.

**Average Terrestrial (X)**

(a) 3-axis directed toward the average north terrestrial pole as defined by the International Polar Motion Service (IPMS), commonly known as the Conventional International Origin (CIO) [Mueller, 1969, p. 351].

(b) 1-3 plane parallel to the mean Greenwich astronomic meridian as defined by the Bureau International de l'Heure (BIH) [Mueller, 1969, p. 343].

This system is the geodetic (terrestrial) coordinate system later also referred to as the u,v,w system.
Instantaneous Terrestrial (Y)

(a) 3-axis directed toward the instantaneous rotation axis of the earth (true celestial pole), the coordinates of which are given by the IPMS or by the BIH with respect to the CIO.

(b) 1-3 plane contains the point where the mean Greenwich astronomic meridian intersects the true equator of date.

This coordinate system is used as the intermediate connection between the terrestrial and celestial coordinate systems.

True Celestial (Z)

(a) 3-axis equivalent to 3-axis of instantaneous terrestrial system (true celestial pole).

(b) 1-axis directed toward the true vernal equinox of date.

These and still other coordinate systems are discussed in detail in [Veis, 1963; Mueller, 1969].

4.13 Transformations of Coordinate Systems

Transformation between terrestrial and celestial coordinate systems becomes necessary in the case that topocentric directions to satellites are obtained by photographing the satellite against a background of stars. After corrections for the physical effects such as differential refraction and aberration, shimmer, etc. [Mueller, 1964, pp. 309-317; Hotter, 1967] have been applied, the resulting topocentric right ascension and declination form the purely geometric ground-to-satellite direction. In terms of the corresponding direction cosines, $\mathbf{Z}$ can be expressed by the column vector

$$\mathbf{Z} = \begin{bmatrix} \cos\delta & \cos\alpha & \sin\delta \\ \cos\delta & \sin\alpha & \sin\delta \end{bmatrix} \mathbf{Z}_1 \begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \end{bmatrix} \quad \text{(4.1 - 1)} \.$$
In order to transform \( \mathbf{Z} \) from the celestial to the average terrestrial system (in which the mathematical model for the adjustment is expressed), rotations about the coordinate axes are required.

\[
Z_3 \equiv Y_3
\]

![Fig. 4.1-2 True celestial and instantaneous terrestrial coordinate systems.](image)

Transformation is first made into the instantaneous terrestrial system (see Fig. 4.1-2). This transformation is a function of a single finite rotation through the Greenwich apparent sidereal time (GAST). A vector \( \mathbf{Z} \) in the true celestial system is transformed into the instantaneous terrestrial system by the following equation:

\[
\mathbf{Y} = R_3 \text{(GAST)} \mathbf{Z}
\]

where \( \mathbf{Y} \) is the resulting vector in the instantaneous terrestrial system and \( R_3 \text{(GAST)} \) is a 3 x 3 matrix that expresses a counterclockwise rotation, as viewed from the positive end of the 3 axis, by the amount GAST, namely:
\[
R_3(\text{GAST}) = \begin{bmatrix}
    \cos(\text{GAST}) & \sin(\text{GAST}) & 0 \\
    -\sin(\text{GAST}) & \cos(\text{GAST}) & 0 \\
    0 & 0 & 1
\end{bmatrix}
\]

4.1 - 3

Next the vector \( \hat{y} \) in the instantaneous terrestrial system (Y) is transformed to the average terrestrial (X) system (see Fig. 4.1-3). This transformation is a function of two rotations through the x and y coordinates of the instantaneous terrestrial pole.

Fig. 4.1-3 Instantaneous and average terrestrial coordinate systems.
where \( \hat{x} \) is the resulting vector in the average terrestrial coordinate system; \( R_1(-y) \) and \( R_2(-x) \) are 1-axis and 2-axis rotations through \(-y\) and \(-x\). Since the \( x \) and \( y \) values are differentially small, the finite rotations may be replaced by differential rotations and equation 4.1-4 is reduced to

\[
\begin{bmatrix}
1 & 0 & x \\
0 & 1 & -y \\
-x & y & 1
\end{bmatrix}
\]

by omitting the products of \( x \) and \( y \). Thus the transformation from the true celestial to the average terrestrial coordinate system is achieved by combining the rotations expressed in equations 4.1-2 and 4.1-4, namely:

\[
\hat{X} = R_2(-x) R_1(-y) R_3(GAST) \hat{Z}
\]

and after considering equation 4.1-5, the matrix form is

\[
\hat{X} = S \hat{Z}
\]

where

\[
S = \begin{bmatrix}
\cos(GAST) & \sin(GAST) & x \\
-x \cos(GAST) - y \sin(GAST) & -x \sin(GAST) + y \cos(GAST) & 1
\end{bmatrix}
\]

The quantities \( x \), \( y \) and \( GAST \) in the above equation are obtained as described in [Mueller, 1969, pp. 80, 153, 337].
4.2 The Direction Adjustment

4.21 Uncorrelated Events  [86]

4.211 The Mathematical Model.

The adjustment method is by least squares, where the parameters are
the three-dimensional rectangular coordinates of the ground stations and
satellite positions,* while the observables are the topocentric range,*
and topocentric declination and right ascension of the satellite.

The mathematical structure relating the parameters and the observables
is a function of three vectors. The three vectors as depicted in Fig. 4.2-1
are (the arrow over the symbol will be reserved for those vectors which
have a finite magnitude as opposed to, say, vectors containing differential
corrections):

1. \( \hat{X}_i \), the coordinate-system-origin to ground station vector,
2. \( \hat{X}_j \), the coordinate-system-origin to satellite position vector,
3. \( \hat{X}_{ij} \), the ground station \( i \) to satellite position \( j \) vector.

Thus
\[
\hat{X}_j - \hat{X}_i = \hat{X}_{ij} \tag{4.2-1}
\]
or
\[
F_{ij} = \hat{X}_j - \hat{X}_i - \hat{X}_{ij} = 0 \tag{4.2-2}
\]
where
\[
\hat{X}_j = \begin{bmatrix}
    u_j \\
    v_j \\
    w_j 
\end{bmatrix} \tag{4.2-3}
\]

*Needed in the algebraic derivation but, in fact, in the numerical computa-
tion, they are either not needed, or obtained to a sufficient accuracy
from the observed quantities.
Fig. 4.2-1 The adjustment coordinate system.

is a vector composed of the rectangular coordinates of an arbitrary satellite position;

\[
\dot{x}_i = \begin{bmatrix} u_i \\ v_i \\ w_i \end{bmatrix}
\]

4.2 - 3(a)
is a vector composed of the rectangular coordinates of an arbitrary ground station;

\[
\hat{x}_{ij} = S \begin{bmatrix}
    r_{ij} \cos \delta_{ij} \cos \alpha_{ij} \\
    r_{ij} \cos \delta_{ij} \sin \alpha_{ij} \\
    r_{ij} \sin \delta_{ij}
\end{bmatrix}
\]

4.2 - 4

\(r_{ij}, \delta_{ij}, \alpha_{ij}\) being the topocentric range, true declination and right ascension from \(i\) to \(j\), respectively, while \(S\) is the matrix which transforms the vector from the true celestial to the average terrestrial coordinate system (section 4.13).

The point-by-point build-up of the network can be visualized in the following way. Given the components of the vectors \(\hat{x}_i\) and \(\hat{x}_{ij}\), \(\hat{x}_j\) is computed. Then with this position \(j\) as known, and a known vector from an unknown \(k\) station to \(j\), the coordinates of the unknown station \(\hat{x}_k\) are computed (see Fig. 4.2-1). This is extended to include many unknown and known stations, along with many redundant observations thereby necessitating an adjustment.

Strictly speaking, pure optical or range data does not permit such a procedure to be literally followed; however, the adjustment framework (a form of collinearity) remains applicable.

The mathematical structure (equation 4.2 - 2) is linearized by a Taylor series expansion about the preliminary values of the ground stations and satellite positions, and the observed topocentric values of the range, declination and right ascension. The result is the following matrix equation

\[ A\hat{x} + BV + W = 0 \]

4.2 - 5

which represents the general linearized mathematical model.
In this equation, the design matrix $A$ is composed of submatrices of the form

$$A_{ij} = \frac{\partial F_{ij}}{\partial X_j \partial X_1} = \begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 \end{bmatrix} = [I_3 | -I_3] \quad 4.2 - 6$$

and the unknown $X$ vector is composed of subvectors of the form

$$X_{ij} = \begin{bmatrix} x_j \\ \ldots \\ x_1 \end{bmatrix} \quad 4.2 - 7$$

where

$$X_j = \begin{bmatrix} du_j \\ dv_j \\ dw_j \end{bmatrix}, \quad X_i = \begin{bmatrix} du_i \\ dv_i \\ dw_i \end{bmatrix} \quad 4.2 - 8$$

are corrections to the preliminary values of the satellite positions and ground stations respectively. The design matrix $B$ is composed of 3 x 3 submatrices of the form

$$B_{ij} = \frac{\partial F_{ij}}{\partial \delta_{ij}, \partial \alpha_{ij}, \partial \gamma_{ij}} = S R_3(-\alpha_{ij}) R_2(-90^\circ + \delta_{ij}) \begin{bmatrix} 1 & 0 & 0 \\ 0 & -\cos \delta_{ij} & 0 \\ 0 & 0 & -1 \end{bmatrix} \quad 4.2 - 10$$

where $S$ is defined by equation 4.1 - 8; $R_3$ and $R_2$ are rotation matrices.

The matrix

$$\begin{bmatrix} r_{ij} & 0 & 0 \\ 0 & r_{ij} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

is omitted from the expression for $B_{ij}$ since it is multiplied into the vector of residuals $V$ composed of the subvectors.
These are the residuals of the adjustment in units of meters ($\delta r_{ij}$ and $\kappa_{ij}$ are in radians). Observe that $\delta r_{ij}$ is measured on the circle of radius $r_{ij}$, while $\kappa_{ij}$ is measured on the circle of radius of $r_{ij} \cos \delta_{ij}$.

Finally, the misclosure vector $W$ is composed of the subvectors

$$W_{ij} = x_{i}^{b} - x_{j}^{b} - x_{ij}^{b}$$

where "o" designates "evaluated at preliminary values" and "b" designates "evaluated at observed values."

4.212 Weighting of Observations.

The observed quantities in the optical case are considered as the topocentric declinations ($\delta$) and right ascensions ($\alpha$). The corresponding accuracy estimates resulting from a photographic plate adjustment or some other a priori estimate are $\sigma_{\delta}$ and $\sigma_{\alpha}$, the variances, and $\sigma_{\alpha \delta} = \sigma_{\delta \alpha}$, the covariance. All units are arc seconds squared.

It is important to note that the weighting of the declinations and right ascensions is made on the basis of the estimates of variances of
\( \delta \) and \( \alpha \) obtained from the plate adjustments and that it is assumed that the variance of \( \delta \) and \( \alpha \) do not vary according to the distance of the satellite from the particular observing ground station.

On the other hand, the weighted sum of squares of the residuals is conveniently chosen to have units of arc seconds squared; thus the weights are to have units of \((\text{arc sec})^2 \text{ m}^{-2}\) since the units of the residuals have been stipulated (equation 4.2 - 11) to be meters. Therefore, it is necessary to transform \( \sigma_\delta^2 \), \( \sigma_\alpha^2 \), and \( \sigma_{\delta \alpha} \) into linear units (meters) by the following formulas:

\[
\frac{\sigma_\delta^2}{r} = \frac{\sigma_\delta^2}{\rho} \quad 4.2 - 13
\]

\[
\frac{\sigma_\alpha^2}{r} = \frac{\sigma_\alpha^2}{\rho} \cos^2 \delta \quad 4.2 - 14
\]

\[
\sigma_{\delta \alpha} = \frac{r^2 \sigma_{\delta \alpha}}{(\rho \cos \delta)^2} \quad 4.2 - 15
\]

where \( r \) is the approximate topocentric range and

\[
\rho = \frac{1}{\sin \theta}
\]

With the estimated accuracy in linear units the following variance-covariance matrix is formulated:

\[
\Sigma_{\delta, \alpha, r} = \begin{bmatrix}
\sigma_\delta^2 & \sigma_{\delta \alpha} & \sigma_{\delta r} \\
\sigma_{\delta \alpha} & \sigma_\alpha^2 & \sigma_{\alpha r} \\
\sigma_{\delta r} & \sigma_{\alpha r} & \sigma_r^2
\end{bmatrix}
\]

same as above as above diagonal
where the new quantities $\sigma^2_r$, $\sigma_{\delta r}$, and $\sigma_{\alpha r}$ are the variance of the range, the covariance between the declination and range, and the covariance between the right ascension and range respectively. If the correlation coefficients

\[
\rho_{\delta r} = \frac{\sigma_{\delta r}}{\sigma_\delta \sigma_r} = 0
\]

\[
\rho_{\alpha r} = \frac{\sigma_{\alpha r}}{\sigma_\alpha \sigma_r} = 0
\]

and

\[
\sigma_r = \infty
\]

the weight matrix for a single direction is

\[
P_{ij} = \sigma_0^2 \begin{bmatrix} \sigma^2_\delta & \sigma_{\delta \alpha} & 0 \\ \sigma_{\alpha \delta} & \sigma^2_\alpha & 0 \\ 0 & 0 & 0 \end{bmatrix}^{-1}
\]

4.2 - 16

where $\sigma_0^2$ is the a priori variance of unit weight.

Corresponding to $P_{ij}$, $P$ denotes the weight matrix for the observed topocentric directions of the adjustment. $P$ has the characteristic of containing non-zero 3 x 3 matrices only along the diagonal since the individual directions are assumed to be independent.

The topocentric range is needed in equations 4.2 - 13 to 4.2 - 15 to convert the estimated accuracy of the directions from arc units into linear (meters) units. Four significant figures are required in the topocentric range. Equation 4.2 - 13 shows that the range need have no more significant figures than $\sigma_\delta$ or $\sigma_\alpha$.

The topocentric range from an arbitrary ground station $i$ in a given simultaneous event $j$ is computed from
\[ r_{ij} = \left( (u_j^0 - u_i^0)^2 + (v_j^0 - v_i^0)^2 + (w_j^0 - w_i^0)^2 \right)^{\frac{1}{2}} \]

\( i = 1, 2, \ldots, m \) (number of stations in the event). \( u_i^0, v_i^0, w_i^0 \) are the preliminary rectangular coordinates of the \( i^{th} \) ground station and are computed from

\[ \begin{bmatrix} u_i^0 \\ v_i^0 \\ w_i^0 \end{bmatrix} = \begin{bmatrix} (N+H) \cos \phi \cos \lambda \\ (N+H) \cos \phi \sin \lambda \\ [N(1-e^2) + H] \sin \phi \end{bmatrix} \]

\( \phi, \lambda, H, N \), being the geodetic latitude and longitude, the ellipsoidal height, and prime vertical radius of curvature at point \( i \), respectively, while \( e \) is the eccentricity of the reference ellipsoid. \( u_j^0, v_j^0, w_j^0 \) are the preliminary rectangular coordinates of the \( j^{th} \) satellite position and are computed (note that these are needed only for the purpose of getting the approximate topocentric range) as follows:

1. The ground vector \( \hat{x}_{ik} \) between the first two stations listed in the particular simultaneous event

\[ \hat{x}_{ik} = \begin{bmatrix} u_k - u_i \\ v_k - v_i \\ w_k - w_i \end{bmatrix} \]

2. The unit vector (direction) \( \hat{x}_{ij} \) from the ground station \( i \) to the satellite position \( j \) is computed from

\[ \hat{x}_{ij} = S \begin{bmatrix} \cos \delta_{ij} \cos \alpha_{ij} \\ \cos \delta_{ij} \sin \alpha_{ij} \\ \sin \delta_{ij} \end{bmatrix} \]

where \( S \) is the transformation matrix of the true celestial to the average terrestrial coordinate systems (section 4.13).
(3) In the same way the direction $\mathbf{x}_{kj}$ is computed.

(4) The angle $A_k$ at ground station $k$ is computed from

$$\cos A_k = \frac{\mathbf{x}_{kj} \cdot \mathbf{x}_{kj}}{|\mathbf{x}_{kj}| |\mathbf{x}_{kj}|} \quad 4.2 - 21$$

(5) The angle $A_j$ at the satellite position is computed from

$$\cos A_j = \frac{\mathbf{x}_{ij} \cdot \mathbf{x}_{jk}}{|\mathbf{x}_{ij}| |\mathbf{x}_{jk}|} \quad 4.2 - 22$$

(6) Finally, the satellite position vector $\mathbf{x}_j^o$ to be used in equation 4.2 - 17 is computed from (see Fig. 4.2-1)

$$\mathbf{x}_j^o = \mathbf{x}_i^o + r_{ij} \mathbf{x}_{ij} = \begin{bmatrix} u_j^o \\ v_j^o \\ w_j^o \end{bmatrix} \quad 4.2 - 23$$

where

$$r_{ij} = \frac{|\mathbf{x}_{ik}|}{\sin A_k} \frac{\sin A_j}{\sin A_j} \quad 4.2 - 24$$

Fig. 4.2-2 The approximate satellite vector.
4.213 The Normal Equations.

The normal equations are derived by minimizing the quadratic form

$$ V'PV + X'P_XX $$

subject to the relation (equation 4.2 - 5)

$$ AX + BV + W = 0 $$

Upon introduction of Lagrange multipliers $K$, the variation function is

$$ \phi = V'PV + X'P_XX - 2K'(AX + BV + W) \quad 4.2 - 25 $$

where

- $V$ is the vector of residuals corresponding to the $\alpha$'s and $\delta$'s
- $X$ is the vector of corrections to the preliminary ground and satellite positions
- $P$ is the weight matrix for the $\alpha$'s and $\delta$'s
- $P_X$ is the weight matrix for the ground and satellite positions

As described in section 4.211 $A$ and $B$ are the design matrices

and $W$ is the constant vector.

Upon the differentiation of equation 4.2 - 25 for the minimum condition [Uotila, 1967, p. 81], the expanded form of the normal equations becomes

$$ \begin{bmatrix} -P_X & 0 & A' \\ 0 & -P & B' \\ A & B & 0 \end{bmatrix} \begin{bmatrix} X \\ V \\ K \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ W \end{bmatrix} = 0 \quad 4.2 - 26 $$

By a row and column transformation, the residual vector $V$ is eliminated and the normal equations become

$$ \begin{bmatrix} 8P^{-1}B' & A \\ A' & -P_X \end{bmatrix} \begin{bmatrix} K \\ X \end{bmatrix} + \begin{bmatrix} W \\ 0 \end{bmatrix} = 0 \quad 4.2 - 27 $$

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Next, the correlates are eliminated resulting in

$$[A' (BP^{-1} B')^{-1} A + P_x]X + A' (PR^{-1} R')^{-1} W = 0$$

The following summation form of the non-zero 3 x 3 submatrices of the above equation is found by replacing the A, B, and P matrices with their expanded forms in terms of 3 x 3 submatrices (equations 4.2 - 6, 4.2 - 10, and 4.2 - 16):

$$\begin{bmatrix}
\sum_i (B_{ij} P^{-1}_{ij} B'_{ij})^{-1} + P_j & -(B_{ij} P^{-1}_{ij} B'_{ij})^{-1} \\
-(B_{ij} P^{-1}_{ij} B'_{ij})^{-1} & \sum_j (B_{ij} P^{-1}_{ij} B'_{ij})^{-1} + P_i
\end{bmatrix}
\begin{bmatrix}
X_j \\
X_i
\end{bmatrix}
+ 
\begin{bmatrix}
U_j = \sum_i (B_{ij} P^{-1}_{ij} B'_{ij})^{-1} W_{ij} \\
U_i = -\sum_j (B_{ij} P^{-1}_{ij} B'_{ij})^{-1} W_{ij}
\end{bmatrix}
= 0
$$

where the non-zero 3 x 3 submatrices occur only on the diagonal and those
ij 3 x 3 positions corresponding to a ground-to-satellite observation; $\sum_i$ indicates a summation over all ground stations observing satellite position j; $\sum_j$ indicates a summation over all satellite positions observed from ground station i. All summations contain only 3 x 3 or 3 x 1 matrices.

Elimination of $X_j$, the corrections to the satellite positions, from
the above yields the following reduced normal equations:

$$NX + U = 0$$

in which the $X$ vector will always represent the unknown corrections to the preliminary rectangular coordinates of the ground stations only; $U$ is the constant vector; $N$ is the coefficient matrix.
The coefficient matrix \( N \) is made up of 3 x 3 matrices. By letting

\[
M^{-1}_{ij} = (B_{ij}^{-1} B_{ij}')^{-1} \quad 4.2 - 31
\]

\[
= (B_{ij}')^{-1} P_{ij} B_{ij}^{-1} \quad 4.2 - 32
\]

in equation 4.2 - 29, the expression for the 3 x 3 diagonal matrix corresponding to the \( k \)th ground station is given by [Krakiwsky and Pope, 1967]

\[
N_{kk} = \frac{1}{3} M^{-1}_{kj} - \frac{1}{3} (M^{-1}_{k} (\bar{c}_{k} M^{-1}_{i})^{-1} M_{k}^{-1}) + P_{k} \quad 4.2 - 33
\]

Note the weight, \( P_{j} \), for the \( j \)th satellite position has been dropped in the second term of the above equation. The expression for the off-diagonal 3 x 3 matrix corresponding to the \( k \)th and the \( l \)th ground stations is

\[
N_{kl} = -\frac{1}{3} \{M^{-1}_{k} (\bar{c}_{k} M^{-1}_{j})^{-1} M_{k}^{-1}\} \quad 4.2 - 34
\]

where the summation \( \bar{c}_{j} \) is performed over all satellite events observed simultaneously from both ground stations \( k \) and \( l \).

The constant vector of the normal equations (equation 4.2 - 30) is made up of 3 x 1 vectors corresponding to each ground station. The vector \( U_{k} \) for the \( k \)th ground station is given by

\[
U_{k} = -(\bar{c}_{k} M^{-1}_{k} W_{k}) + \frac{1}{3} \{M^{-1}_{k} (\bar{c}_{k} M^{-1}_{i})^{-1} (\bar{c}_{i} M^{-1}_{i} W_{i})\} \quad 4.2 - 35
\]

where, according to equation 4.2 - 12,

\[
W_{ij} = \hat{\chi}_{j}^{\alpha} - \hat{\chi}_{i}^{\alpha} - \hat{\chi}_{ij}^{b} \quad 4.2 - 36
\]

or

\[
W_{kj} = \hat{\chi}_{j}^{\alpha} - \hat{\chi}_{k}^{\alpha} - \hat{\chi}_{kj}^{b} \quad 4.2 - 37
\]

At first sight it seems that the preliminary coordinates of each satellite position are required; however, substitution of equations 4.2 - 36 and 4.2 - 37 into equation 4.2 - 35 results in the cancellation or dropping out of terms containing \( \hat{\chi}_{ij}^{b} \) and the observed vector \( \hat{\chi}_{ij}^{b} \) or \( \hat{\chi}_{kj}^{b} \). Specifically,
\[
U_k = -\sum_j (M_k^{-1}) \left( \tilde{x}_j^o - \tilde{x}_k^o - \tilde{x}_k^b \right) + \\
+ \sum_j (M_k^{-1}) (\sum_i (M_i^{-1})^{-1} \left[ \sum_i (M_i^{-1}) (\tilde{x}_j^o - \tilde{x}_k^o - \tilde{x}_k^b) \right] ) 
\]

4.2 - 38

\[
= -\sum_j (M_k^{-1}) \tilde{x}_j^o + (\sum_j (M_k^{-1}) \tilde{x}_k^o + \sum_j (M_k^{-1}) \tilde{x}_k^b) + \\
+ \sum_j (M_k^{-1}) (\sum_i (M_i^{-1})^{-1} (\sum_i (M_i^{-1}) \tilde{x}_j^o)) - \\
- \sum_j (M_k^{-1}) (\sum_i (M_i^{-1})^{-1} (\sum_i (M_i^{-1}) \tilde{x}_j^o)) - \\
- \sum_j (M_k^{-1}) (\sum_i (M_i^{-1})^{-1} (\sum_i (M_i^{-1}) \tilde{x}_k^b)) 
\]

4.2 - 39

Terms 1 and 4 in the above expression cancel (i.e., \( \tilde{x}_j^o \) satellite coordinates drop out) because \( \tilde{x}_j^o \) can be factored out of \( \tilde{x} \) in term 4, i.e.,

\[
\tilde{x} (M_k^{-1}) (\sum_i (M_i^{-1})^{-1} (\sum_i (M_i^{-1}) \tilde{x}_j^o)) = (\sum_j (M_k^{-1}) \tilde{x}_j^o) 
\]

4.2 - 40

which has an opposite sign to that of term 1. Terms 3 and 6 drop out because they are identically zero. This happens because both terms contain products like

\[
B_{ij}^{-1} \tilde{x}_j^b \text{ or } B_{ij}^{-1} \tilde{x}_j^b 
\]

where (taking into consideration the orthogonality property of the rotation matrices and \( S \))

\[
B_{ij}^{-1} = \begin{bmatrix}
1 & 0 & 0 \\
0 & -1/\cos\beta_{ij} & 0 \\
0 & 0 & -1
\end{bmatrix} R_2(90^\circ - \gamma_{ij}) R_3(\alpha_{ij}) S^t
\]

and after elementary matrix operations we have

67
Since in the optical adjustment, \( P_{ij} \) has the form
\[
\begin{bmatrix}
\ast & \ast \\
\ast & \ast \\
0 & 0 & 0
\end{bmatrix}
\]
and using 4.2 - 32
\[
M^{-1}_{ij} \mathbf{r}^b_{ij} = 0
\]
the final expression for the constant column becomes
\[
U_k = \sum_j M^{-1}_{kj} \mathbf{x}^0_k - (\sum_i M^{-1}_{ij})^{-1} (\sum_i M^{-1}_{ij} \mathbf{x}^0_i)
\]
In summary, the normal equations in the optical adjustment are formed by equations 4.2 - 33, 4.2 - 36, and 4.2 - 42.

4.22 Correlated Events [193]

4.221 The Mathematical Model.

The theory and the mathematical model for a generalized least squares adjustment for simultaneous directions without correlation has been described (section 4.21). In that case each simultaneously observed satellite image was taken as an independent event, thus the correlation between satellite directions on the same plate was not considered. The following is a description of how the mathematical model is manipulated to take care of possible correlations between directions, such as in the case of the NGS BC-4 Type II data, where each given event consists of 7 fictitious directions (Greenwich hour angle \( h \) and declination \( \delta \) relative to the 1900-1905 CIO mean pole) per station and the full 14 x 14 variance-covariance matrix associated with the set.
The basic geometric figure to begin the mathematical development is that of a single ground station observing one satellite position shown in Fig. 4.2-1. Using vector notation, the mathematical model as we know can be written

\[ F_{ijm} = \vec{x}_{jm} - \vec{x}_i + \vec{x}_{ijm} = 0 \quad 4.2 - 43 \]

where now \( m \) will identify a fictitious satellite image within the event \( j \), i.e., \( m = 1, 2 \ldots m_x \) (generally \( 4 \leq m_x \leq 7 \)).

The vector \( \vec{x}_{ijm} \) with this type of data takes the form

\[ X_{ijm} = \begin{bmatrix} r_{ijm} \cos^2_{ijm} \cos h_{ijm} \\ -r_{ijm} \cos_{ijm} \sin h_{ijm} \\ r_{ijm} \sin h_{ijm} \end{bmatrix} \quad 4.2 - 44 \]

The linearized mathematical model can be written as follows

\[ [A_1i; A_2j; \ldots; X_j] + RV + W = 0 \quad 4.2 - 45 \]

Since all the observations from one station to all fictitious satellite directions on a given plate are correlated, it is necessary to build up the model using all these satellite directions. Thus the design matrix \( A \) is divided in submatrices of the form

\[ A_{ijm} = \frac{\partial F_{ijm}}{\partial x_{ijm}} = [A_{ijm}; A_{2ijm}] = \begin{bmatrix} I_{3m} & -I_3 \\ -I_3 & I_{3m} \\ 3m_x & 3m_x \end{bmatrix} \quad 4.2 - 46 \]
and the design matrix $B$ is of the form:

$$B_{ijm} = \begin{bmatrix}
3x3 \\
3x3 \\
3x3 \\
3x3
\end{bmatrix}$$

(3m x 3m)

$$\begin{bmatrix}
0 \\
\vdots \\
\vdots \\
0
\end{bmatrix}$$

(3x3)

After minimizing $Y'PV$ under the condition 4.2 - 45, the vector of Lagrangian multipliers can be expressed as

$$K = -(RP^{-1}B')^{-1}(A_1X_j + A_2X_1 + W)$$

4.2 - 48

and the normal equations will take the form:

$$\begin{bmatrix}
A_1'(BP^{-1}B')^{-1}A_1 \\
A_1'(BP^{-1}B')^{-1}A_2
\end{bmatrix}X_j + \begin{bmatrix}
A_1'(BP^{-1}B')^{-1}W \\
A_2'(BP^{-1}B')^{-1}W
\end{bmatrix} = 0$$

4.2 - 49


Before proceeding further, it is necessary to explain how the above equations (4.2 - 48) are actually solved. For a particular station $i$ and event $j$, the $B$ matrix is dimensioned (21 x 21), but the original given $P^{-1}$ matrix is (14 x 14). The $P^{-1}$ matrix refers only to the actual observed quantities which are the Greenwich hour angle ($h$) and the declinations ($\delta$) and therefore it has to be modified before it is substituted in equation 4.2 - 48. The easiest way to explain this is to look only at that part of $B_{ij}$ that corresponds to observations on the first satellite position only:

$$B_{ij1} = B_1 = \begin{bmatrix}
\frac{\partial F_1}{\partial h_1} & \frac{\partial F_1}{\partial \delta_1} & \frac{\partial F_1}{\partial r_1} \\
\frac{\partial F_2}{\partial h_1} & \frac{\partial F_2}{\partial \delta_1} & \frac{\partial F_2}{\partial r_1} \\
\frac{\partial F_3}{\partial h_1} & \frac{\partial F_3}{\partial \delta_1} & \frac{\partial F_3}{\partial r_1}
\end{bmatrix}$$

4.2 - 50
The matrix $P_1$ (not $P_1^{-1}$) would have to be of the form

$$ P_{ij} = P_1 = \begin{bmatrix} \sigma_{h_1}^2 & \sigma_{h_1} \delta_1 & \sigma_{h_1} r_1 \\ \sigma_{h_1} \delta_1 & \sigma_1^2 & \sigma_1 r_1 \\ \sigma_{h_1} r_1 & \sigma_1 r_1 & \sigma_r^1 \end{bmatrix}^{-1} \quad 4.2 - 51 $$

and for a single satellite image using 4.2 - 16 we can write

$$ P_1 = \begin{bmatrix} \sigma_{h_1}^2 & \sigma_{h_1} \delta_1 & 0 \\ \sigma_{h_1} \delta_1 & \sigma_1^2 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad 4.2 - 52 $$

What is really needed is $(B_1 P_1^{-1} B_1^t)^{-1}$, but $B_1 P_1^{-1} B_1^t$ is singular. However, the matrix $B_1$ is square and nonsingular. Knowing this, $(B_1 P_1^{-1} B_1^t)^{-1}$ can be rearranged as follows:

$$ (B_1 P_1^{-1} B_1^t)^{-1} = (B_1^t)^{-1} P_1 B_1^{-1} = (B_1^{-1})^t P_1 B_1^{-1} \quad 4.2 - 53 $$

where $P_1$ is defined by equation 4.2 - 52.

The preceding description applies to the case of one satellite position $j_1$. For the seven satellite positions the dimension of the $P_1^{-1}$ matrix is $(14 \times 14)$. The matrix $P_1$ in equation 4.2 - 53 has to be of dimensions $(21 \times 21)$ and of the form of equation 4.2 - 52. The matrix $P_{ij}$ for the BC-4 observations can be written as follows:
ith P defined considering 4.2 - 55, the matrix $M^{-1}$ can be formed using the technique shown in equation 4.2 - 53.

$$M^{-1} = (B P^{-1} B')^{-1} (B^{-1})' P B^{-1}$$  \hspace{1cm} 4.2 - 56

4.2.23 The Reduced Normal Equations.

Equation 4.2 - 49 can be referred to as the conventional normal equation, where the satellite position $X_j$ is among the parameters. Since the satellite position is of no interest, it is eliminated from the solution. This is done by solving for $X_j$ in terms of the other parameters and substituting this into the remaining equations. After elimination of $X_j$ from 4.2 - 49, we will obtain the reduced normal equations. The $(3 \times 3)$ and $(3 \times 1)$ block elements
of the coefficient matrix and constant vector respectively can be obtained by expressions similar to equations 4.2 - 33, 4.2 - 34 and 4.2 - 35. The only difference being that now the term \( P_k \) in equation 4.2 - 33 will drop out because now we are only minimizing \( V'PV \).

4.3 The Range Adjustment [86, 140]

4.3.1 The Mathematical Model

Fig. 4.3-1 shows the average terrestrial coordinate system \( uvw \) (section 4.12) with a ground station \( i \) and a satellite position \( j \). The observed quantity is the topocentric range \( r_{ij} \) from ground station \( i \) to satellite position \( j \). The parameters \( u_i, v_i, w_i \) and \( u_j, v_j, w_j \) are the Cartesian coordinates of the ground station \( i \) and the satellite position \( j \) respectively.

From Fig. 4.3-1 it can easily be seen that the mathematical model can be written as

\[
\begin{align*}
  r_{ij} &= \left[ (u_j - u_i)^2 + (v_j - v_i)^2 + (w_j - w_i)^2 \right]^{\frac{1}{2}} \quad 4.3 - 1
\end{align*}
\]

or

\[
\begin{align*}
  F_{ij} &= \left[ (u_j - u_i)^2 + (v_j - v_i)^2 + (w_j - w_i)^2 \right]^{\frac{1}{2}} - r_{ij} = 0 \quad 4.3 - 2
\end{align*}
\]

The basic mathematical model above is extended to include simultaneous ranges from three or more ground stations. By increasing the number of simultaneous events along with the number of known and unknown ground stations, an adjustment is necessary.

The mathematical model (equation 4.3 - 2) is linearized by a Taylor series expansion about the preliminary values of the ground stations and satellite positions and the observed value of the topocentric range. The expression for the linearized mathematical model as in the optical case has the form

\[
AX + BV + W = 0 \quad 4.3 - 3
\]
where now the design matrix $B$ is a negative unit matrix and the design matrix $A$ is formed by submatrices of the form

$$
 A_{ij} = \frac{\partial F_{ij}}{\partial x_i^0, \partial x_j^0} = \begin{bmatrix}
 u_j^0 - u_i^0 & v_j^0 - v_i^0 & w_j^0 - w_i^0 \\
 r_{ij}^0 & r_{ij}^0 & r_{ij}^0 \\
 r_{ij}^0 & r_{ij}^0 & r_{ij}^0
\end{bmatrix}
$$

$$
= [a_{ij}; -a_{ij}] \quad 4.3 - 4
$$

where $r_{ij}^0$ is computed from 4.3-1 using the initial approximate values for the station and satellite coordinates, the latest coordinates resulting from a preliminary least squares adjustment (for each event $j$) with the coobserving stations held fixed.
The unknown vector $X$ is made up of subvectors

$$X_{ij} = \begin{bmatrix} X_j \\ X_i \end{bmatrix}$$

where

$$X_i = \begin{bmatrix} du_i \\ dv_i \\ dw_i \end{bmatrix}$$

and

$$X_j = \begin{bmatrix} du_j \\ dv_j \\ dw_j \end{bmatrix}$$

The misclosure vector $W$ is formed by the individual differences

$$W_{ij} = r_{ij}^0 \text{(computed)} - r_{ij}^b \text{(observed)}$$

The residual vector $V$ is composed of the individual residuals $V_{ij}$ (in meters) corresponding to the observed ranges $r_{ij}^b$.

Giving consideration to the characteristic of the design matrices, the final equation for the linearized model in the range adjustment can be written as

$$AX - V + W = 0$$

4.32 Weighting of Observed Ranges

The weighting of the observed topocentric range from ground station $i$ to satellite position $j$ is achieved by the following:

$$p_{ij} = \frac{\sigma_i^2}{\sigma_{ij}^2}$$

where $\sigma_0^2$ is the variance of unit weight and $\sigma_{ij}^2$ is the variance of the observed range in meters squared. $P$ will denote the diagonal weight matrix containing all the independent weights $p_{ij}$ to be considered in the adjustment.
4.33 The Normal Equations

The variation function for the range adjustment is similar to the optical case, namely,

\[ \phi = V'PV + X'P_{x}X - 2K'(AX - V + W) \]  

4.3 - 11

where

- \( V \) is the vector of residuals corresponding to the range observations
- \( X \) is the vector of corrections to the preliminary ground and satellite positions*
- \( P \) is the weight matrix for the ranges
- \( P_{x} \) is the weight matrix for the ground and satellite positions
- \( K \) is the vector of correlates

The differentiation of equation 4.3 - 11 for the minimum condition results in the following expanded form of the normal equations:

\[
\begin{bmatrix}
-P_{x} & 0 & A' \\
0 & -P & -I \\
A & -I & 0 \\
\end{bmatrix}
\begin{bmatrix}
X \\
V \\
K \\
\end{bmatrix}
+
\begin{bmatrix}
0 \\
0 \\
W \\
\end{bmatrix}
= 0
\]  

4.3 - 12

After the elimination of the correlates and residuals and the expansion of the \( A \) and \( P \) matrices, the following expression results

\[
\begin{bmatrix}
\sum a^{i}_{ij}p_{ij}a^{a}_{ij} + p_{j} \\
-a^{a}_{ij}p_{ij}a^{a}_{ij} \\
-a^{a}_{ij}p_{ij}a^{a}_{ij} + \sum a^{i}_{ij}p_{ij}a^{a}_{ij} + p_{j} \\
\end{bmatrix}
\begin{bmatrix}
X_{j} \\
U_{j} \\
V_{j} \\
\end{bmatrix}
+
\begin{bmatrix}
U_{j} = \sum a^{i}_{ij}p_{ij}a^{a}_{ij} \\
V_{j} = -\sum a^{i}_{ij}p_{ij}a^{a}_{ij} \\
\end{bmatrix}
= 0
\]  

4.3 - 13

*As in the case of the optical adjustment, satellite positions will be considered "nuisance" parameters and therefore eliminated from the solution.
Elimination of the corrections to the preliminary coordinates of the satellite position, namely \( X_j \) from equation 4.3 - 13, results in the following three expressions: The 3 x 3 diagonal matrix corresponding to the \( k \)th ground station is given by

\[
N_{kk} = (\sum_j a'_i p_{kj} a_k) - (\sum_j a'_i p_{kj} a_k (\sum_i a'_i p_{ij} a_{ij})^{-1} a'_i p_{kj} a_k) + p_k
\]

4.3 - 14

The 3 x 3 off-diagonal matrix corresponding to the \( k \)th and the \( r \)th ground stations is given by

\[
N_{kr} = - (\sum_j a'_i p_{kj} \dot{a}_k) + (\sum_j a'_i p_{kj} \dot{a}_k (\sum_i a'_i p_{ij} a_{ij})^{-1} a'_i p_{kj} \dot{a}_k
\]

4.3 - 15

where the main summation \( \sum_j \) is performed over all satellite positions observed simultaneously from both ground stations \( k \) and \( r \); the constant vector of the \( k \)th ground station is

\[
U_k = -(\sum_j a'_i p_{kj} \dot{w}_k) + (\sum_j a'_i p_{kj} \dot{a}_k (\sum_i a'_i p_{ij} a_{ij})^{-1} a'_i p_{kj} \dot{a}_k
\]

4.3 - 16

In the above expressions, the weight matrix \( P_j \) of each satellite position was set equal to zero as there is no independent external source from which to get a priori variance estimates which could be used to derive weights.

The equivalent expression for the constant column \( U_k \) can be shown to have the following form:

\[
U_k = - (\sum_j a'_i p_{kj} \dot{w}_k)
\]

4.3 - 17
where \( \bar{v}_{kj} \) is the residual of the particular observed range \( r_{kj} \) arising from a least squares adjustment of one simultaneous event with ground stations held fixed.

The quantities \( a_{kj} \) and \( \bar{v}_{kj} \) needed in the formation of the reduced normal equations (equations 4.3 - 14, 4.3 - 15 and 4.3 - 17) are a side product of the preliminary adjustment of each simultaneous event. Specifically, \( a_{kj} \) is contained in the A matrix given by equation 3.2 - 3, and \( \bar{v}_{kj} \) is an element of the \( \bar{V} \) vector of equation 3.2 - 5.

4.4 Addition of Normal Equations

Independent sets of normal equations formed from two or more batches of optical and/or range data can be added together. The basic idea of the combination of the normal equations is simply the algebraic addition of their corresponding terms. Letting \( n \) sets of normal equations be represented by

\[
\begin{align*}
N_1X + U_1 &= 0 \\
N_2X + U_2 &= 0 \\
&\vdots \\
N_nX + U_n &= 0
\end{align*}
\]

and their corresponding variances of unit weight as \( \sigma_1^2, \sigma_2^2, \ldots, \sigma_n^2 \); the addition is

\[
\left( N_1 + p_{12}N_2 + \ldots + p_{1n}N_n \right)X + \left( U_1 + p_{12}U_2 + \ldots + p_{1n}U_n \right) = 0
\]

4.4 - 2

In the above, the weights may be obtained as follows:

\[
\begin{align*}
p_{12} &= \frac{\sigma_1^2}{\sigma_2^2} \\
&\quad \vdots \\
p_{1n} &= \frac{\sigma_1^2}{\sigma_n^2}
\end{align*}
\]

4.4 - 3
where \( \sigma_1^2, \sigma_2^2, \ldots, \sigma_n^2 \) must have the same a priori variance of unit weight (see sections 4.212 and 4.32).

The advantage of the above is obvious, namely, batches of observed data may be adjusted separately or as a part of a combined adjustment. The same holds for the addition of two or more independent sets of range normal equations and for the addition of optical and range normal equations to each other.

The weighing of the two or more different sets of normal equations (e.g., \( N_{11}, U_{11}, \) and \( N_{22}, U_{22} \)) is a function of the goodness of the observations involved and the geometry existing between the unknown parameters and the respective observables. The first item is taken care of by proper weighting as a function of the estimated variance-covariance matrix of the observations, and this weighting is reflected in the quantities \( N_{11}, N_{22}, U_{11}, \) and \( U_{22} \). The geometry aspect is implicit in the coefficient matrices \( A \) and \( B \) which enter into \( N_{11} \), and so forth.

4.5 Constraints' Contributions to the Normal Equations [86, 140, 148]

4.5.1 General

Since the coefficient matrix of normal equations is singular, a unique least squares solution is not possible. A minimal set of constraints to the normal equations provides a unique solution [Blaha, 1971].

Two alternative definitions exist for the term "constraints:" the absolute constraints represent certain conditions which have to be fulfilled exactly and with no uncertainties. The relative constraints (or weighted constraints) have the same characteristics as the observations.

In general the contribution of the functional constraint equation

\[ G(\gamma, L_\xi) = 0 \]
to the reduced normal equations $\bar{N}X + \bar{U} = 0$ can be found by bordering the normal equation matrix

$$\begin{bmatrix} N & C' \\ C & -P^{-1}C \end{bmatrix} \begin{bmatrix} X \\ W \end{bmatrix} + \begin{bmatrix} \bar{U} \\ WC \end{bmatrix} = 0$$

where

$$C = \frac{\partial G}{\partial X_i}$$

After elimination of $K_C$

$$K_C = -P_C CX + WC$$

It is easy to find

$$[\bar{N} + C'P_C C] X + \bar{U} + WC = 0$$

or

$$[\bar{N} + N^C] X + \bar{U} + U^C = 0$$

where $N^C$ and $U^C$ are the contributions to the coefficient matrix and constant vector of the normal equation due to the application of constraints. The quantities $\bar{N}$ and $\bar{U}$ represent the original normal equations (without constraints).

After the constraints are added the normal equations will take the usual form

$$N X + U = 0$$

and we are in the position to obtain the contribution from a new set of constraints.

Constraints can be applied between two stations $k$ and $l$ or to a single station. The contribution of these constraints to the matrix ($3 \times 3$ blocks) and $U$ ($3 \times 1$ blocks) can be schematically expressed in two different ways.
(a) Contribution to the normals due to the constraint applied to station $k$

\[
N_{kk}^c = C_k^t P_c C_k \quad \text{4.5 - 2a}
\]

\[
U_k^c = C_k^t P_c W^c
\]

(b) Contribution to the normals due to the constraint between stations $k$ and $z$

\[
N_{kk}^c = C_k^t P_c C_k; \quad N_{zz}^c = C_z^t P_c C_z
\]

\[
U_k^c = C_k^t P_c W^c; \quad U_z^c = C_z^t P_z W^c \quad \text{4.5 - 2b}
\]

These blocks obtained as indicated above for the corresponding case will be the only ones computed and added to the original normal equations as expressed by formula 4.5 - 1.
4.52 Relative Position Constraints

Relative position constraints are used in order to combine the normal equations obtained from various satellite nets and to constrain "double" stations or closely situated stations of the same net. The expression for the combination of normals can be written as follows.

\[
\begin{bmatrix}
\bar{N} + N^R
\end{bmatrix} x + \bar{U} + u^R = 0
\]

where \(N^R\) and \(U^R\), computed from 4.5 - 2a, 4.5 - 2b, are the contribution to the original combined normal equations \((\bar{N}X + \bar{U} = 0)\).

If the relative position \((\Delta u^o, \Delta v^o, \Delta w^o)\) of two stations is known, along with the standard deviation of these relative positions, the constraints can be formed. In this case the functional constraint equations are

\[
\begin{align*}
\frac{u^o_k - u^o_k}{\sigma_u} &= \Delta u^o \\
\frac{v^o_k - v^o_k}{\sigma_v} &= \Delta v^o \\
\frac{w^o_k - w^o_k}{\sigma_w} &= \Delta w^o
\end{align*}
\]

Therefore

\[
C_k \begin{bmatrix} R \\ \bar{U} \end{bmatrix} = I \quad ; \quad C_{\bar{U}} \begin{bmatrix} R \\ \bar{U} \end{bmatrix} = -I
\]

\[
\begin{bmatrix} R \\ \bar{U} \end{bmatrix} = \begin{bmatrix} 3 \times 3 \\ 3 \times 1 \end{bmatrix} \quad ; \quad \begin{bmatrix} R \\ \bar{U} \end{bmatrix} = \begin{bmatrix} 3 \times 3 \\ 3 \times 1 \end{bmatrix}
\]

and

\[
\begin{bmatrix} R \\ \bar{U} \end{bmatrix} = 0 \quad ; \quad \begin{bmatrix} R \\ \bar{U} \end{bmatrix} = 0 \quad \text{because} \quad W^R = g^R(x^o, L^o) = 0
\]

where

\[
P_R = \begin{bmatrix}
\frac{1}{\sigma_u} & 0 & 0 \\
0 & \frac{1}{\sigma_v} & 0 \\
0 & 0 & \frac{1}{\sigma_w}
\end{bmatrix}
\]
and

\[
\begin{align*}
N_{k\bar{k}} & = N_{\bar{k}k} = I \begin{bmatrix} P_R & I \end{bmatrix} \begin{bmatrix} 0 & 0; P_R \end{bmatrix} = -P_R \\
3 \times 3 & \quad 3 \times 3
\end{align*}
\]

Thus, the diagonal elements of \( P_R \) are added to each element of the diagonal of the blocks \( k\bar{k} \) and \( \bar{k} k \) of the coefficient matrix of the combined normals \( \bar{N} \), and subtracted from the diagonal elements of the blocks \( k\bar{k} \) and \( \bar{k} k \) of \( \bar{N} \).

There is no contribution to the vector \( \bar{U} \).

4.53 **Length (Chord) Constraints**

Chord constraints are introduced when scalar information is available between ground stations (e.g., distances determined through high precision geodimeter traversing). The functional constraint equation in this case is

\[
G^C(x, L_C) = 0
\]

or

\[
\left( (u_k - u_{\bar{k}})^2 + (v_k - v_{\bar{k}})^2 + (w_k - w_{\bar{k}})^2 \right)^{1/2} = D_{k\bar{k}}
\]

4.5 - 3

\[
C_k = \begin{bmatrix} u_k - u_{\bar{k}} \over D_{k\bar{k}} & v_k - v_{\bar{k}} \over D_{k\bar{k}} & w_k - w_{\bar{k}} \over D_{k\bar{k}} \end{bmatrix}
\]

and

\[
C_\bar{k} = \begin{bmatrix} u_{\bar{k}} - u_k \over D_{k\bar{k}} & v_{\bar{k}} - v_k \over D_{k\bar{k}} & w_{\bar{k}} - w_k \over D_{k\bar{k}} \end{bmatrix}
\]

and

\[
P_C = \frac{\sigma^2}{\sigma^2} = \frac{\text{a priori variance of unit weight}}{\text{a priori variance of the chord}}
\]

Then the contribution to the normals are obtained by applying 4.5 - 2a and 4.5 - 2b.
The first three expressions in the above are added respectively to
the blocks $\bar{N}_{kk}$, $\bar{N}_{k\ell}$ and $\bar{N}_{k\ell}$ of $\bar{N}$; the last two expressions are added
respectively to the constant subvectors $\bar{U}_k$ and $\bar{U}_k$ of $\bar{U}$.

4.54 Station Position Constraint

Station position constraint is used for the purpose of defining the
origin of the coordinate system. If the station coordinates $(u^0, v^0, w^0)$ of
station $k$ are to be constrained and if the computed (known) variances of
its approximate coordinates are $\sigma_k^2$, $\sigma_k^2$, $\sigma_k^2$, then the equations given in
section 4.52 are valid by merely deleting the terms with index $r$, then

$$\Delta u^0 = u_k^0, \Delta v^0 = v_k^0, \Delta w^0 = w_k^0.$$  

Then

$$N_{kk}^C = \begin{bmatrix} C_k^C \end{bmatrix}' P_C C_k^C$$

$$N_{k\ell}^C = \begin{bmatrix} C_{k\ell}^C \end{bmatrix}' P_C C_{k\ell}^C$$

$$N_{k\ell}^C = \begin{bmatrix} C_{k\ell}^C \end{bmatrix}' P_C C_{k\ell}^C$$

$$U_k^C = \begin{bmatrix} C_k^C \end{bmatrix}' P_C W^C$$

$$U_k^C = \begin{bmatrix} C_k^C \end{bmatrix}' P_C W^C$$

$$U_k^C = \begin{bmatrix} C_k^C \end{bmatrix}' P_C W^C$$

The equations given in section 4.52 are valid by merely deleting the terms with index $r$, then

$$\Delta u^0 = u_k^0, \Delta v^0 = v_k^0, \Delta w^0 = w_k^0.$$  

Then

$$N_{kk}^S = I P_S I = P_S$$

where

$$P_S = \begin{bmatrix} \frac{1}{\sigma_k^2} & 0 & 0 \\
0 & \frac{1}{\sigma_k^2} & 0 \\
0 & 0 & \frac{1}{\sigma_k^2} \end{bmatrix}$$
4.55 Height Constraints

If the geodetic (ellipsoidal) height of the station $k$ is to be constrained, then

$$ N_{kk}^H = (C_k^H)' P_H C_k^H $$

where

$$ C_k^H = [\cos \phi_k^o \cos \lambda_k^o, \cos \phi_k^o \sin \lambda_k^o, \sin \phi_k^o] $$

and

$$ P_H = \frac{1}{\sigma_k^2} $$

where $\phi_k^o$ and $\lambda_k^o$ are the approximate geodetic coordinates and $\sigma_k^2$ is the variance of the height for station $k$.

The constant vector $U_k^H$ can be computed from

$$ U_k^H = (C_k^H)' P_H W^H $$

where

$$ W^H = H_k - H_k^c $$

4.56 Directional Constraints

Directional constraints are introduced when the orientation of the coordinate system is not defined through the observations (e.g., in the case of a ranging network).

The directional constraint between two stations $k$ and $l$ is accomplished by applying weights to two angles $\alpha^o$ and $\beta^o$ defining the direction between them and computed from the approximate $(u^o, v^o, w^o)$ coordinates of the two stations as follows:

$$ \alpha^o = \tan^{-1} \frac{\Delta v^o}{\Delta u^o} $$

$$ \beta^o = \tan^{-1} \frac{\Delta w^o}{R^o} $$
where

\[ \Delta u^o = u_{0}^o - u_{k}^o \]
\[ \Delta v^o = v_{0}^o - v_{k}^o \]
\[ \Delta w^o = w_{0}^o - w_{k}^o \]

and

\[ R^o = (\Delta u^o)^2 + (\Delta v^o)^2 \]

The matrix \( C^D \) of partial derivatives is then formed

\[
C_k^D = \begin{bmatrix}
\frac{\partial \sigma^o}{\partial u^o} & \frac{\partial \alpha^o}{\partial u^o} & \frac{\partial \Delta \alpha^o}{\partial u^o} & \frac{\partial \Delta \alpha^o}{\partial v^o} & \frac{\partial \Delta \alpha^o}{\partial w^o} \\
\frac{\partial \alpha^o}{\partial u^o} & \frac{\partial \delta^o}{\partial u^o} & \frac{\partial \Delta \delta^o}{\partial u^o} & \frac{\partial \Delta \delta^o}{\partial v^o} & \frac{\partial \Delta \delta^o}{\partial w^o} \\
\frac{\partial \delta^o}{\partial u^o} & \frac{\partial \Delta \delta^o}{\partial u^o} & \frac{\partial \Delta \delta^o}{\partial v^o} & \frac{\partial \Delta \delta^o}{\partial w^o} & \frac{\partial \Delta \delta^o}{\partial w^o} \\
\end{bmatrix}
\]

where

\[ \frac{\partial \alpha^o}{\partial u^o} = \cos^2 \alpha^o \tan^2 \alpha^o / \Delta u^o \]
\[ \frac{\partial \alpha^o}{\partial v^o} = -\cos^2 \alpha^o / \Delta u^o \]
\[ \frac{\partial \delta^o}{\partial u^o} = 0 \]
\[ \frac{\partial \delta^o}{\partial v^o} = \Delta u^o \cos^2 \beta^o \tan^2 \beta^o / R^o \]
\[ \frac{\partial \delta^o}{\partial w^o} = \frac{\partial \delta^o}{\partial u^o} \tan \alpha^o \]
\[ \frac{\partial \delta^o}{\partial w^o} = -\cos^2 \beta^o / R^o \]

end clearly \( C_k^D = -C_k^D \).

Then the matrix

\[ N^D = (C^D)' P_D C^D \]

is formed according to 4.5 - 2b where \( P_D \) is the weight matrix estimated from the statistics of \( \alpha^o \) and \( \beta^o \) in the customary way

\[ P_D = \begin{bmatrix} \sigma^2_{\alpha^o} & \sigma_{\alpha^o \beta^o} \\ \sigma_{\alpha^o \beta^o} & \sigma^2_{\beta^o} \end{bmatrix}^{-1} \]

The matrix \( N^D \) is then added to the block elements of the reduced normal equations which correspond to each of the ground stations, i.e., its
diagonal blocks will be added to $\bar{N}_{kk}$ and $\bar{N}_{\ell \ell}$ and subtracted from the off-diagonal elements $\bar{N}_{k \ell}$ and $\bar{N}_{\ell k}$.

4.57 Inner Constraints (Free Adjustment)

Even though the selection of a coordinate system is arbitrary in the case of a minimum constraint adjustment, e.g., in the case of ranging, the selection of the six coordinates (at more than two stations) to be constrained is very critical, since one set of constraints would give a different solution than another set. The "best" solution is arrived at in a coordinate system defined through the use of a set of constraint equations called "inner" constraints [Rinner et al., 1967]. In this sense, "best" means resulting in the smallest covariance matrix for the unknowns. Covariance matrices may be compared by means of their traces, and the inner constraint equations are characterized by the property that the trace of the covariance matrix obtained with their use is a minimum among those obtained by adjusting a given set of observations augmented by a minimal set of constraint equations. This property also implies that the mean square uncertainty of the unknowns is smaller when the inner adjustment equations are used. The resulting adjustment is called a "free" one. The functional inner constraints equations can be written as

$$C^I X = 0$$

where $X$ is the set of corrections of the approximate coordinates of the unknown points and in the most general application when the "best" origin, orientation and scale are sought.
The symbol, \((u_i^0, v_i^0, w_i^0)\) denote the approximate coordinates of the \(i^{th}\) unknown point where both the ground points and the satellite positions are considered.

It is also possible to design a set of constraints that will result in the "best" solution for only a subset of the points. In the adjustments reported here we were only interested in the ground station unknowns implying that the trace of only that portion of the covariance matrix corresponding to the ground station unknowns should be minimized, while the variances of the satellite position unknowns should not be included in the minimum sum. The constraint equations that will produce such a solution have the same form as those producing the "best" solution for all the points; however, 3 x 3 blocks of zeros are inserted into those positions of \(C_i^I\) which correspond to unknowns whose variances are not to be included in the minimum sum.

The inner adjustment constraint equations can be given a geometrical interpretation that appeals to intuition. Let \(X_i^o\) denote the set of approximate coordinates of the \(i^{th}\) unknown point, \(dX_i\) denote the corrections to these coordinates, and \(X_i^a\) denote the adjusted coordinates, i.e.,

\[
X_i^a = X_i^o + dX_i
\]

The first set of constraint equations, \(C_i^I X = 0\), is then equivalent to the set of conditions

\[
\frac{1}{2} dX_i = 0
\]
The geometrical interpretation of these conditions is that the center of gravity of all the points will not change after adjustment, i.e.,

\[ \sum_{i} x_{i}^{a} = \sum_{i} x_{i}^{o} \]

The second set of constraint equations, \( C_{2}^{\top} X = 0 \), corresponds to the conditions

\[ \sum_{i} x_{i}^{o} \times dX_{i} = 0 \]

If the center of the system remains fixed, then the cross products \( x_{i}^{o} \times dX_{i} \) reflect rotations of the points around the fixed center. These constraint equations insure that the sums of the rotations around all three coordinate axes are zero. The corresponding geometrical interpretation is that the mean orientation of the system of points will not change after adjustment either.

Thus, the respective equations \( C_{1}^{I} X = 0 \) and \( C_{2}^{I} X = 0 \) effectively specify the origin and the orientation of the adjustment coordinate system. A seventh "inner adjustment" equation \( C_{3}^{I} X = 0 \) specifies the scale of the system. However, this scale equation is only used when the observations themselves do not determine the scale.

A more complete description of the inner adjustment is described in [Blaha, 1971].

In summary, if the normal equations with the contribution of all the constraints (except inner constraints) are represented by

\[
\begin{bmatrix}
N + R + C + S + H + D
\end{bmatrix} X + \bar{U} + U + U' + U' + U + U' = 0
\]

or

\[ NX + U = 0 \]

then the inner adjustment can be obtained by bordering the coefficient matrix \( N \) of the normal equations as...
Upon the addition of any kind of constraint to the normal equations, it becomes necessary to consider also its contribution to \( zV'Pv \). The degrees of freedom change as well. In order to compute the proper variance of unit weight the latter must be taken into consideration.

4.6 Solution of Normal Equations and Formation of the Inverse Weight Matrix [86]

4.61 Introduction

The normal equations for the optical and range adjustments are given in the previous section. The general form of the normal equations is

\[
N X + U = 0
\]

where \( N \) is the coefficient matrix, \( X \) is the vector of unknowns, and \( U \) is the constant vector.

The adjusted values of the Cartesian coordinates of the observing ground stations are obtained by adding the corrections \( X \) to the preliminary values \( X^0 \), namely,

\[
X^a = X^0 + X
\]

Section 4.7 deals with obtaining the precision estimate of \( X^a \) through the inverse matrix \( N^{-1} \). For this reason the method of formation of \( N^{-1} \) will be dealt with in section 4.64 along with the method of solving for \( X \).

The procedure used to solve the normal equations is a Gauss reduction (section 4.62) and back solution (section 4.63) and computation of the inverse by the method established by Banachiewicz (section 4.64).
Two features which are peculiar to the specific procedure used here are:

1. The coefficient matrix $N$ is broken down into $3 \times 3$ submatrices, and similarly the $U$ vector is treated as composed of $3 \times 1$ vectors.

2. The coefficient matrix $N$ is compacted so that $3 \times 3$ zero submatrices are neither stored nor used in the computation.

The first feature is achieved rather naturally; it is because of the form of the expressions given in sections 4.2 - 4.6 which are used to build up $N$ and $U$. On the other hand, the second feature is achieved through programming logic. Specifically, a first matrix $L$ is used to tag each $3 \times 3$ nonzero submatrix of $N$ with a row and column number. A second matrix $F$ with a one-to-one correspondence to the first is then employed to tag the storage assigned to the particular $3 \times 3$ submatrix. The individual elements of the $3 \times 3$ submatrices are all stored in one large linear array $E$.

The reduced elements of $N$ are stored in the locations previously created for elements in $N$. During reduction additional $3 \times 3$ matrices arise in locations where there were none originally in $N$; thus "drag storage" must be assigned. In doing so the guide matrix $L$ and the storage tagging matrix $F$ are updated to account for these additional matrices. Similar "drag storage" is also determined during the formation of the inverse $N^{-1}$.

Once the "drag storage" is determined, the reduction, back solution and inverse determinations are guided by $L$, the storage located by $F$, and the elements to be used in the computation found in $E$.

### 4.6 Reduction

The coefficient matrix of the normal equations is written as

$$N = SR$$

4.6 - 3
where $S$ is a lower triangular matrix with $3 \times 3$ identity matrices along the diagonal, and $R$ is an upper triangular matrix. All matrices and vectors presented in this discussion are stipulated to be composed of $3 \times 3$ submatrices and $3 \times 1$ subvectors respectively.

The reduction is accomplished by computing

$$S = I - T$$

from

$$N = R - TR$$

or

$$R = N + TR$$

where $R$ and $T$ (thus $S$) are built up simultaneously. The augmented matrix

$$[N,U] = \begin{bmatrix}
n_{011} & n_{012} & n_{013} & \cdots & n_{01n} & u_0 \\
n_{012} & n_{022} & n_{023} & \cdots & n_{02n} & u_2 \\
n_{013} & n_{023} & n_{033} & \cdots & n_{03n} & u_3 \\
n_{014} & \cdots & \cdots & \cdots & u_n \\
n_{01n} & \cdots & \cdots & \cdots & n_{0nn} & u_n
\end{bmatrix}$$

is first reduced according to the algorithms

$$n_{k,i,j} = n_{k-1,i,j} - n_{k-1,k,i} n_{k-1,k,j} n_{k-1,k,k}^{-1}$$

$k = 1, 2, \ldots, n - 1$

$i = k+1, k+2, \ldots, n$

$j = i, i+1, \ldots, n$

defining

$$R = \begin{bmatrix}
n_{011} & n_{012} & \cdots & \cdots & n_{01n} \\
n_{012} & n_{122} & n_{123} & \cdots & n_{12n} \\
\text{zeros} & \cdots & \cdots & \cdots & \text{zeros} \\
\text{below} & \text{diagonal} & \cdots & \cdots & n_{n-1,n,n}
\end{bmatrix}$$
and

\[ u_{k,i} = u_{k-1,i} - n_{k-1,k,k-1}^{-1} n_{k-1,k,k} u_{k-1,k} \]

\[ k = 1, 2, \ldots, n-1 \]

\[ i = k+1, \ldots, n \]

defining

\[
\tilde{C} = \begin{bmatrix}
  u_{01} \\
  u_{12} \\
  \vdots \\
  u_{n-1,n}
\end{bmatrix}
\]

A second algorithm (performed as part of equation 4.6 - 8) namely,

\[ \tilde{n}_{k-1,k,j} = n_{k-1,k,k}^{-1} n_{k-1,k,j} \]

\[ \tilde{n}_{k-1,k,k} = I \]

\[ \tilde{u}_{k-1,k} = n_{k-1,k,k}^{-1} u_{k-1,k} \]

\[ j = k+1, k+2, \ldots, n \]

\[ k = 1, 2, \ldots, n-1 \]

results in the following reduced matrices:

\[
S' = \begin{bmatrix}
  I & \tilde{n}_{012} & \tilde{n}_{013} & \cdots & \tilde{n}_{01n} \\
  0 & I & \tilde{n}_{123} & \tilde{n}_{12n} \\
  0 & 0 & I \\
  \vdots & \vdots & \vdots & \ddots & \vdots \\
  0 & 0 & 0 & 0 & I
\end{bmatrix}
\]

\[
-\bar{\alpha} = \begin{bmatrix}
  \bar{u}_{01} \\
  \bar{u}_{12} \\
  \bar{u}_{23} \\
  \vdots \\
  \bar{u}_{n-1,n}
\end{bmatrix}
\]

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(S' and D are used to obtain solution vector X—section 4.63)

\[
R^{-1} = \begin{bmatrix}
    n_{011}^{-1} & n_{122}^{-1} & \cdots & n_{n-1,n,n}^{-1} \\
    0 & n_{122}^{-1} & \cdots & 0 \\
    \vdots & \vdots & \ddots & \vdots \\
    0 & 0 & \cdots & n_{n-1,n,n}^{-1}
\end{bmatrix}
\]

4.63 Back Solution

The back solution involves the determination of the unknown vector X from elements of the reduced matrices S' and D. Without derivation [Uotila, 1967, p. 28],

\[
X = T'X - D
\]

recall

\[
T = I - S'
\]
or in summation form

\[
X_i = \sum_{j=1+1}^{n} n_{i-1,i,j} X_j + \bar{u}_{i-1,i}
\]

4.64 Formation of Inverse

The inverse matrix N^{-1} will be computed by the method associated with the name of Banachiewicz [Uotila, 1967, p. 31]. According to equation 4.6 - 3, N^{-1} can be computed from

\[
N^{-1} = R^{-1} S^{-1}
\]

However, it turns out that N^{-1} can be formed without the aid of S^{-1} and further only the diagonal elements of R^{-1} are needed.

The diagonal elements of R^{-1} are readily available since the inverse of an upper triangular matrix has as its diagonal elements the reciprocal of the diagonal elements of the triangular matrix itself and the same result holds if "elements" is taken to mean 3 x 3. The diagonal elements of
\( R^{-1} \) are computed by inverting the 3 x 3 diagonal matrices of \( R \) and for computer space saving reasons are stored along the diagonal of \( S' \) (equation 4.6 - 13).

From equation 4.6 - 18
\[
R^{-1} = N^{-1}S
\]
and further substituting in for \( S \) from equation 4.6 - 4
\[
R^{-1} = N^{-1}(I - T) \quad 4.6 - 20
\]
\[
= N^{-1} - N^{-1}T \quad 4.6 - 21
\]
and finally
\[
N^{-1} = R^{-1} + N^{-1}T \quad 4.6 - 22
\]
The corresponding summation equation for computing any 3 x 3 matrix of \( N^{-1} \) is
\[
n_{ij} = \sum_{k=1}^{n} \tilde{n}_{i-1,k} n_{k,j} \delta_{ij} n_{i-1,i,i}^{-1} \quad 4.6 - 23
\]
where \( \delta_{ij} \) is the Kronecker delta defined by
\[
\delta_{ij} = \begin{cases} 
1 & i = j \\
0 & i \neq j
\end{cases} \quad 4.6 - 24
\]
and
\[
n_{ij} = (n_{ji})' \quad 4.6 - 25
\]

4.7 Statistical Evaluation (Precision of Ground Stations After Adjustment) \[86\]

4.7.1 Variance of Unit Weight

The variance of unit weight for the total adjustment is given by the following expression:
\[
\sigma_0^2 = \frac{V'PV}{df} \quad 4.7 - 1
\]
where \( V'PV \) is the sum of the squares of the weighted residuals of all
observed quantities and df is the number of degrees of freedom in the least squares adjustment.

4.711 Optical Adjustment.

Equation 4.7 - 1 will now be considered for the optical adjustment. The linearized mathematical structure according to section 4.2 was shown to be of the form

\[ AX + BV + W = 0 \]

The general expression for the computation of \( V'PV \) is

\[ V'PV = -W'K - \sum (W^C)'K_C \]

where the first term is the contribution from equation 4.7 - 2 and the second term is the contribution from the \( c \) constraints applied. Without taking into consideration the constraints' contribution

\[ V'PV = -W'K \]

and considering an expression for \( K \) and \( X \) from equations 4.2 - 27 and 4.2 - 28 respectively,

\[ V'PV = W'(BP^{-1}B')^{-1}(AX + W) \]

and

\[ X = -(A'M^{-1}A + P_x)^{-1}A'M^{-1}W \]

Denoting

\[ M = BP^{-1}B' \]

equation 4.7 - 5 with equations 4.2 - 29 and 4.7 - 6a gives

\[ V'PV = W'M^{-1}W - [U_j U'_i] \begin{bmatrix} X_j \\ X'_i \end{bmatrix} \]

Let the partitioning of equation 4.2 - 29 be denoted as

\[
\begin{bmatrix}
N_{11} & N_{12} \\
N_{21} & N_{22}
\end{bmatrix}
\begin{bmatrix}
X_j \\
X'_i
\end{bmatrix}
+
\begin{bmatrix}
U_j \\
U'_i
\end{bmatrix}
= 0
\]

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Then, using
\[
\begin{bmatrix}
N_{11} & N_{12} \\
N_{21} & N_{22}
\end{bmatrix}^{-1} =
\begin{bmatrix}
Q_{11} & Q_{12} \\
Q_{21} & Q_{22}
\end{bmatrix} =
\begin{bmatrix}
N_{11}^{-1} + N_{11}^{-1}N_{12}E N_{21}N_{11}^{-1} & -N_{11}^{-1}N_{12}E \\
-E N_{21}N_{11}^{-1} & E
\end{bmatrix}
\]
where
\[
E = (N_{22} - N_{21}N_{11}^{-1}N_{12})^{-1}
\]
equation 4.7 - 7 becomes
\[
V'PV = W'M^{-1}W - [U'_i U'_j] \begin{bmatrix}
Q_{11}U'_j + Q_{12}U'_i \\
Q_{21}U'_j + Q_{22}U'_i
\end{bmatrix}
\]
and after substituting the values from equation 4.7 - 9 and simplifying
\[
V'PV = W'M^{-1}W - U'_iN_{11}^{-1}U'_i + (U_i - N_{21}N_{11}^{-1}U_j)' E(U_i - N_{21}N_{11}^{-1}U_j)
\]
but by elimination of \(X_i\) from 4.7 - 8 we get
\[
X_i = -[N_{22} - N_{21}N_{11}^{-1}N_{12}]^{-1} [U_i - N_{21}N_{11}^{-1}U_j]
\]
or, using the notation of 4.6 - 1,
\[
X = -N^{-1} U
\]
Thus we see that
\[
E = N^{-1}
\]
and
\[
U = U_i - N_{21}N_{11}^{-1}U_j
\]
and finally
\[
V'PV = W'M^{-1}W - U'_iN_{11}^{-1}U'_j + U'X
\]
Denoting
\[
Q = W'M^{-1}W - U'_iN_{11}^{-1}U'_j
\]
and considering equation 4.2 - 31 this becomes
\[
Q = \sum_{i,j} W_{i1}M_{i1}^{-1}W_{i1} - \sum_{i} (\sum_{j} M_{i1}^{-1}W_{ij})' (\sum_{j} M_{i1}^{-1})^{-1} (\sum_{j} M_{i1}^{-1}W_{ij})
\]
Now using equations 4.2 - 38, 4.2 - 42 and factorization and cancellation analogous to that in equations 4.2 - 41 to 4.2 - 42, this becomes
\[
Q = \sum_{i,j} X_{i}M_{i1}^{-1}X_{i} - \sum_{i} (\sum_{j} M_{i1}^{-1}X_{i})' (\sum_{j} M_{i1}^{-1})^{-1} (\sum_{j} M_{i1}^{-1}X_{i})
\]
which is easily shown to be identically equal to

\[ Q = \sum_{ij} (\hat{x}_i - \hat{x}_j)'^* M_{ij}^{-1} (\hat{x}_i - \hat{x}_j) \]

with

\[ \hat{x}_j = (\sum_i M_{ij}^{-1})^{-1} (\sum_i M_{ij} x_i) \]

so that finally after the constraints are taken into consideration

\[ V_c' P_c V_c = \sum_{ij} (\hat{x}_i - \hat{x}_j)' M_{ij}^{-1} (\hat{x}_i - \hat{x}_j) + U'X - \sum (W_c)' C_c \]

Note that the first term in the above is the quadratic form of all the residuals arising from all simultaneous event adjustments with ground stations held fixed and is computed and summed for each event by means of equation 3.2 - 1 for the purpose of blunder detection (section 3.222); the second term is found from

\[ U'X = \bar{D}' \bar{C} \]

where the vectors \( \bar{D}' \) and \( \bar{C} \), a byproduct in the solution of the normal equations, are defined by equations 4.6 - 14 and 4.6 - 9 respectively. \( K_c \) is obtained from 4.5 - 1 where \( X \) is the solution of equation 4.5 - 6.

The total number of degrees of freedom, \( df \), to be used in equation 4.7 - 1 is

\[ df = \text{number of equations} - \text{number of unknowns} \]

\[ df = (\sum_j 2n + n_c) - (3s + 3g) \]

where \( 2n \) is the number of equations resulting from one simultaneous event (\( n = \text{number of ground stations in a particular event} \) and the summation is performed over all simultaneous events; \( n_c \) is the number of constraint equations; \( 3s \) is the number of unknowns due to \( s \) number of satellite positions; \( 3g \) is the number of unknowns due to \( g \) number of unknown ground stations.)
In conclusion the "a posteriori" variance of unit weight for the optical adjustment will be

\[ \sigma_0^2 = \frac{V^T P V}{\text{df}} \]  

4.7.12 Range Adjustment.

Equations 4.7 - 1 will now be discussed in the light of the range adjustment. Firstly, the expression for computing \( V^T P V \) by an analogous argument to the optical case is

\[ V^T P V = \overline{V^T P V} - X'U \]  

where \( \overline{V^T P V} \) is the quadratic form of the residuals arising from the adjustment of simultaneous events--holding the ground stations fixed. The second term

\[ X'U = D'C \]  

is computed according to equations 4.6 - 14 and 4.6 - 9 respectively.

The degrees of freedom, \( \text{df} \), in the range adjustment is as usual

\[ \text{df} = \text{number of equations} - \text{number of unknowns} \]

\[ \sum_{i=1}^{n} (x_i - \bar{x})^2 \]

where \( n \) is the number of ground stations, thus observed ranges, in a particular simultaneous event and the summation is performed over all simultaneous events; \( n_r \) again is the number of constraint equations in the range adjustment; \( 3s \) and \( 3g \) are the number of unknowns due to \( s \) number of satellite positions and \( g \) number of unknown ground stations respectively.

In summary,

\[ \sigma_0^2 = \frac{V^T P V}{\text{df}} \]  

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4.72 Variiances and Covariances of Ground Stations

4.721 Cartesian Coordinates.

The variance-covariance matrix giving the accuracy of the adjusted rectangular ground station coordinates is

\[ \Sigma = \sigma^2_0 \mathbf{N}^{-1} \]  \hspace{1cm} 4.7 - 23

where \( \sigma^2_0 \) is the variance of unit weight arising from the adjustment (section 4.71) and \( \mathbf{N}^{-1} \) is the coefficient matrix discussed in section 4.64.

The units for the variance-covariance matrix for the optical and range adjustments are meters squared.

The square root of the diagonal elements of the variance-covariance matrix yields the corresponding standard deviations in meters.
4.722 Geodetic (Curvilinear) Coordinates.

The propagation of variances and covariances from curvilinear coordinates (geodetic latitude $\phi$ and longitude $\lambda$ and ellipsoidal height $H$) in meters to three dimensional rectangular coordinates $(u, v, w)$ is achieved by the following matrix equation

$$
\Sigma = G \Sigma \phi \lambda H G' \quad 4.7 - 24
$$

where

$$
G = \begin{bmatrix}
-sin\phi \cos \lambda & -\cos \phi \sin \lambda & \cos \phi \cos \lambda \\
-sin\phi \sin \lambda & \cos \phi \cos \lambda & \cos \phi \sin \lambda \\
\cos \phi & 0 & \sin \phi
\end{bmatrix}
$$

Reversing the transformation depicted by equation 4.7 - 24, the 3 x 3 variance-covariance matrix corresponding to $\phi, \lambda, H$ is

$$
\Sigma = G^{-1} \Sigma \phi \lambda H (G')^{-1}
$$

all in meters.

In order to obtain the units

$$
\begin{align*}
\sigma_{\phi}^2 &= (\text{arc sec})^2 \\
\sigma_{\lambda}^2 &= " \\
\sigma_{\phi \lambda}^2 &= " \\
\sigma_{\phi H}^2 &= " \\
\sigma_{\lambda H}^2 &= m^2 \\
\sigma_{H}^2 &= " \quad 4.7 - 27
\end{align*}
$$

$\phi H \equiv \sigma_{\phi H}^2; \quad \sigma_{\lambda H} \equiv \sigma_{\lambda H}^2$ \quad \text{arc sec} \times \text{meters}
the elements of equation 4.7 - 26 require the following modifications:

\[ \sigma_\phi^2 = \left( \frac{\rho''}{R + H} \right)^2 \]

\[ \sigma_\lambda^2 = \left( \frac{\rho''}{R + H} \sigma_\lambda \right)^2 \]

\[ \sigma_\phi \sigma_\lambda = \left( \frac{\rho''}{R + H} \right)^2 \sigma_\phi \sigma_\lambda \]

\[ \sigma_H^2 = \frac{\rho''}{R + H} \sigma_H \]

\[ \sigma_H = \frac{\rho''}{R + H} \sigma_H \]

where

\[ \rho'' = \frac{1}{\sin \phi''} \]

\[ R = 6,370,000 \text{ m} \]

(Note: R replaces the radius of curvature N in the prime vertical plane in the rigorous case--justification for simplification is given by the fact that only three significant figures are meaningful in propagation of variances whose magnitudes in m² or (arc sec)² are in the units place.)

4.73 Correlation Between Ground Stations

The amount of correlation between the adjusted ground station coordinates is described in terms of the correlation coefficient. The correlation coefficient is defined as

\[ \rho_{ij} = \frac{\sigma_{ij}}{\sigma_i \sigma_j} \]

where i and j represent any two quantities associated with a variance-covariance matrix such as that of equation 4.7 - 23; \( \sigma_{ij} \) is the covariance, namely, the off-diagonal term of equation 4.7 - 23; \( \sigma_i \) and \( \sigma_j \) are the
standard deviations or square root of the $i^{th}$ and $j^{th}$ variances (diagonal terms) respectively.

4.74 Error Ellipsoid Computation

Error ellipsoid computation is made for each observing ground station considered as an unknown in the adjustment. The eigenvalues and eigenvectors are computed in a topocentric three-dimensional rectangular coordinate system with its origin at the particular ground station and its axes parallel to the mean terrestrial coordinate system (section 4.12). For each point there corresponds one eigenvalue ($\lambda_{ij}$) for each of the three mutually perpendicular axes of the ellipsoid; the direction of these three axes is given by their corresponding eigenvector ($\mathbf{T}_i$).

The actual computation is as follows. The particular $3 \times 3$ on-diagonal variance-covariance matrix $\Sigma$ of equation 4.7-23 is subjected to an orthogonal transformation

$$\mathbf{T}'\Sigma\mathbf{T} = \Lambda$$  \hspace{1cm} 4.7-30

where $\Lambda$ is a diagonal matrix and $\mathbf{T}$ is the orthogonal transformation matrix to be found which diagonalizes $\Sigma$. The transformation results in three homogeneous linear equations, namely,

$$[\Sigma - \lambda_{ij}I] \mathbf{T}_i = 0$$  \hspace{1cm} 4.7-31

which has a solution only if the determinant of the coefficient vanishes, i.e.,

$$|\Sigma - \lambda_{ij}I| = 0$$

or

$$\begin{vmatrix} \sigma_{11} - \lambda_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} - \lambda_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} - \lambda_{33} \end{vmatrix} = 0$$  \hspace{1cm} 4.7-32

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Once the eigenvalues are obtained from equation $4.7 - 32$, their corresponding eigenvectors are obtained from equation $4.7 - 31$ after substitution of $\lambda_{ij}$.

The length of the axes of the error ellipsoid are the square-roots of the corresponding eigenvalues. The spherical coordinates (spherical latitude $\theta$ and longitude $\lambda$) which give the direction of each ellipsoidal axis are obtained from the components of the eigenvector

$$
T^i = \begin{bmatrix} t_1 \\ t_2 \\ t_3 \end{bmatrix}
$$

namely

$$
\tan \theta = \frac{t_3}{\sqrt{t_1^2 + t_2^2 + t_3^2}} \quad 4.7 - 33
$$

and

$$
\tan \lambda = \frac{t_2}{t_1} \quad 4.7 - 34
$$

These angles can easily be converted to altitude and azimuth if so desired.

4.8 Computer Programming [87, 88, 190, 193]

Computer programs related to section 4 may be found in [Reilly et al., 1972] and in [Mueller et al., 1973a].
5. RESULTS (SOLUTION WN14) [187, 188, 193, 195, 196]

5.1 Reference Ellipsoid, Origin, Orientation and Scale

The least squares adjustment of the observations listed in Tables 3.2-3 is performed in terms of the Cartesian coordinates of the tracking stations. The results are also converted into geodetic coordinates (latitude, longitude, height) referenced to a rotational ellipsoid of the following parameters:

\[
\begin{align*}
a &= 6378155.00 \text{ m} \\
b &= 6356769.70 \text{ m}
\end{align*}
\]

The corresponding flattening is

\[
f = \frac{1}{298.2494985} = 0.003352897507
\]

The origin of the coordinate system (or the center of the above reference ellipsoid) is free as determined through the "inner" constraints explained in section 4.57. The orientation of the system is inherent in the optical observations, through the star positions in the SAO catalog (referenced to the FK4 system) updated to their apparent positions at the epoch of the observation, and through UT1, x and y (coordinates of the true pole with respect to the C10) as derived by the BIH. Thus the positive end of the axis u is in the direction of the Greenwich Mean Astronomical Meridian (and the zero geodetic meridian of the reference ellipsoid); the positive w axis passes through the Conventional International Origin (and coincides with the minor axis of the reference ellipsoid). The axis v completes the right-handed coordinate system in the direction of the 90°(E) meridian, and with the u axis defines the plane of the average terrestrial (geodetic) equator.
The scale in the solution is defined through the dominating nearly 30,000 SECOR range observations, through the lengths of eight EDM (Geodimeter or Tellurometer) and three C-Band baselines, and also through a special procedure using constrained ellipsoidal heights.

The SECOR observations have an a posteriori standard deviation of ±4.1 m or approximately one part per million [Mueller et al., 1973b]. The scale is propagated into the network through thirteen optical stations whose relative positions with respect to the nearby SECOR stations are maintained in the adjustment with their survey coordinate-differences entered as weighted constraints (see Table 3.3-2).

The available EDM and C-Band baselines are listed in Table 3.3-4. The chord distances shown are entered in the adjustment as weighted constraints with weights computed from their estimated a priori standard deviations as listed in the table. The reasons for rejecting the east-west Australian tellurometer line (6032-6060) are explained in [Mueller et al., 1973a]. Three C-Band lines were also rejected because of suspected errors in the survey coordinates of the terminal stations (Kauai (4742) in Hawaii and Pretoria (4050) in South Africa) needed to tie them to the nearest optical stations (9012 and 9002, respectively). Though these four lines were not constrained, at the end of the analysis two of them (6032-6060 and 4082-4050) compared well with the lengths computed from the adjusted coordinates (see Table 5.3-1). Thus the only station with survey coordinates in definite error is Kauai.

The use of geodetic (ellipsoidal) heights as weighted constraints as a contribution to the scale requires a more detailed explanation (Fig. 5.1-1). The height (H) above a geocentric reference ellipsoid has two
Fig. 5.1-1 Height components.

main components: the orthometric (mean sea level) height (MSL) and the geoid undulation (N). In this geocentric case, N consists of a long-wave-length component $N_{REF}$, a short-wave-length term $\delta N$, and an additive part $\Delta a$. The term $N_{REF}$ generally corresponds to regional gravitational effects and can be computed, e.g., from a truncated spherical harmonic series. The short-wave-length part $\delta N$ corresponds to local gravity or mass disturbances and is generally not contained in the spherical harmonic representation. The additive part $\Delta a$ is the so-called zero-degree term which may exist due to the fact that the ellipsoid may not be of the same size (though it is of the same flattening) as the "best" (mean earth) level ellipsoid to which the undulation, $N_{REF}$, are referenced. Since the $N_{REF}$ undulations are, within reasonable limits, insensitive to the semidiameter of the level ellipsoid, it is difficult to define a correct value for $\Delta a$.

If the reference ellipsoid is nongeocentric, as is the case in this solution, an additional height term ($dH$) arises due to the "shift" of the origin (ellipsoidal center) with respect to the geocenter.
Thus the geodetic height may have the following components:

\[ H = \text{MSL} + N \]  \hspace{1cm} 5.1 - 1

\[ N = N + \Delta N + \Delta N_{\text{REF}} \]  \hspace{1cm} 5.1 - 2

where [Heiskanen and Moritz, 1967, p. 207]

\[ \Delta N = \Delta a + dH = \Delta a + u_o \cos \phi \cos \lambda + v_o \cos \phi \sin \lambda + w_o \sin \phi \]  \hspace{1cm} 5.1-3

\[ \Delta a = a \text{ (level ellipsoid)} - a \text{ (reference ellipsoid)} \]

\[ u_o, v_o, w_o \] are the coordinates of the geocenter with respect to the center of the reference ellipsoid (origin)

\[ \phi, \lambda \] are the geodetic coordinates of the station to which \( H \) refers

In practice at most satellite tracking stations, the quantity \( \text{MSL} + N_{\text{REF}} \) is well known, and generally it constitutes the largest portion of the total height above the level ellipsoid. The additive + shift term, \( \Delta N \), can be determined empirically through an iterative interpolation procedure as described later. Since \( \text{MSL} + N_{\text{REF}} + \Delta N \) constitute the largest portion of the total height above the reference ellipsoid, it seems reasonable not to ignore this, admittedly partial, information on the height of the station and to include it in the adjustment as a constraint \( (H_{\text{CONSTR}} = \text{MSL} + N_{\text{REF}} + \Delta N) \) with such a weight that the adjustment should be able to "pull out" the only remaining component, the short-wave-length term, \( \Delta N \), together with possible errors in \( H_{\text{CONSTR}} \). In this solution the standard deviations used in computing the weights vary from \( \pm 2.5 \) m to \( \pm 8 \) m depending mostly on the location of the station, from the point of view of the extent of the available surface gravity observations in the area which
was included in the spherical harmonic expansion for $N_{\text{REF}}$ [Rapp, 1973].

Table 3.3-3 lists these standard deviations and the quantities $H_{\text{CONSTR}}$ for all the stations.

In trying to determine the "best" scale for the solution or, which is the same, the "best" additive term $\Delta a$, the first step is to establish the relationship between them. This problem differently stated is the determination of the relationship between the additive term and the semi-diameter of the "best" level ellipsoid to which the quantity $N_{\text{REF}}$ refers. The meaning of the term "best" will be elaborated on later in this section.

This is accomplished empirically from a set of solutions with height constraints containing different additive terms, from $\Delta a = 0$ to 30 m. The shift term $dH$ initially is estimated from comparisons with various dynamic solutions, resulting in the coordinates $u_o, v_o$ and $w_o$ needed in equations 5.1-3. These solutions result in sets of geodetic heights ($H_{\text{WNi}}$) above the reference ellipsoid and also in sets of undulations after subtracting the MSL:

$$N_{\text{WNi}} = H_{\text{WNi}} - \text{MSL}$$

These undulations thus refer to the reference ellipsoid of $a = 6378155$ m, whose origin is set by the inner constraint. Disregarding the short-wavelength term, the relationship between the undulations $N_{\text{WNi}}$ and $N_{\text{REF}}$ is given by equations 5.1-2 and 5.1-3, from where, for any station and for the solution $WNi$:

$$(N_{\text{WNi}} - N_{\text{REF}}) - (\Delta a_i + u_{oi} \cos\phi \cos\lambda + v_{oi} \cos\phi \sin\lambda + w_{oi} \sin\phi) = 0$$
Since the quantity \( (N_{WNi} - N_{REF}) \) is known at all stations, the parameters \( \Delta a_i, u_{0i}, v_{0i}, w_{0i} \) can be calculated (iterated) from least squares adjustments for each set "i." This is the same as determining the size (scale) and the origin of the level ellipsoid which fits best the geoid defined for a given set by the undulations \( N_{WNi} \). Its size is

\[
a_i = 6378155 + \Delta a_i
\]

and its origin with respect to the origin of the reference ellipsoid is defined by the coordinates \( u_{0i}, v_{0i} \) and \( w_{0i} \). After some iterations these coordinates hardly change from solution (set) to solution (set), regardless of the initial selection of \( \Delta a \); thus the relationship between the input additive term and the resulting semidiameter, \( a = f(\Delta a) \), becomes straightforward and linear.

This empirically determined relationship is shown in Fig. 5.1-2, as the dashed line drawn from the lower left corner towards the upper right. The corresponding ordinate is on the right-hand side of the diagram. The line now allows either to pick the correct initial additive term which when used in the height constraints would result in an a priori defined semidiameter (scale), or to determine which semidiameter (scale) would correspond to an a priori defined additive term. As an example, if the semidiameter of the level ellipsoid best fitting the geoid was to be 6378142 m, the WN solution would require height constraints computed with an additive term of -15 m.

The next question, of course, is just how big should this desired semidiameter be. Putting it differently, what criterion should be used to select the "best" scale? If the scale was to be determined only from the EDM and C-Band baselines and/or the SECOR observations, these questions would not arise since the scale would be inherently defined.
Fig. 5.1-2 Determination of scale.
The use of weighted height constraints, as explained above, provides a unique tool to select the scale to fit some criterion. There could be several noninclusive criteria, e.g.,

1. The lengths of the EDM baselines as computed from the adjusted coordinates of the terminal stations should be (a) exactly the same as the given lengths in Table 3.3-4, or (b) their differences should be within the limit of one (average) standard deviation, or (c) within a certain limit, e.g., 1:1,000,000, etc.

2. Same as (1) but for the C-Band baselines.

3. The scale difference as determined from the station coordinates of the WN solution and from the same coordinates of some dynamic solution should be (a) exactly zero, (b) within the limit of one standard deviation of the scale difference factor, (c) within 1:1,000,000, etc.

4. The scale difference as determined in (3) should be within a certain limit with respect to all the dynamic solutions.

5. The scale difference should be within a certain limit with respect to all the dynamic solutions and the EDM and C-Band baselines.

In order to be able to enforce any of the above criteria, first the relationship between the scale difference factor and the semidiameter has to be established. This is accomplished again empirically by determining the scale differences between the different WNi solutions (used to determine the function $a = f(\Delta a)$) and the EDM and C-Band baselines and the dynamic solutions NWL-9D [Anderle, 1973], SAO III [Gaposchkin et al., 1973], GEM 4 [Lerch et al., 1972], GSFC 73 [Marsh et al., 1973]. The method of calculating the scale-difference factor is described in [Kumar, 1972], and
the results are shown in Fig. 5.1-2 where, with the ordinate on the left-hand side, the scale differences are plotted against the semidiameters corresponding to the various $\Delta a$'s used in the height constraints. The numbers on the lines indicate relative weights based on the uncertainties of the scale-difference determinations. It can be seen that the lines representing the geometric (EDM and C-Band) scale differences are much less well determined than the dynamic ones. As an example, the scale-difference factor, between the WNI solution computed with $\Delta a = -15$ m ($a = 6\,378\,142$ m), and the solutions NWL-9D is $-0.18 \times 10^{-6}$; the GEM 4 is $-0.68 \times 10^{-6}$ (the dynamic scales are larger). Also, the lengths of the EDM baselines from the adjustment differ from their directly measured values by $1.38 \times 10^{-6}$ (the measured values are smaller).

The diagram is used by recognising the importance of the various intersection points, marked by numbers. For example, point 1 illustrates the fact that if the semidiameter of the level ellipsoid was $6\,378\,125$ m, the difference between the adjusted chord lengths and their given values would be zero; point 4 shows that with an $a = 6\,378\,143$ m there would be no scale difference between WNI and NWL-9D. Fourteen similar intersection points are listed in Table 5.1-1 with weights and interpretation.

From the table it is immediately clear that taking the weighted mean of the intersection points from the "geometric" scalars (points 1 and 2), the "best" semidiameter is $6\,378\,125.8$ m, while from the "dynamic" lines (points 3 - 6) it is $6\,378\,142.0$ m. The difference of some 16 m, or about 2.5 parts in a million, seems to be real but unexplained at this time. The combined weighted mean from points 1 - 6 is $6\,378\,141.7$ m; while from all the points (1 - 14), it is $6\,378\,142.7$ m.
Table 5.1-1

Determination of Scale

<table>
<thead>
<tr>
<th>Point</th>
<th>Interpretation</th>
<th>Weight</th>
<th>( a ) (m)</th>
<th>Weighted Mean ( a ) (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WN = EDM</td>
<td>10</td>
<td>6 378 125.0</td>
<td>6 378 125.8 (from points 1 and 2)</td>
</tr>
<tr>
<td>2</td>
<td>WN = C-Band</td>
<td>1</td>
<td>6 378 133.7</td>
<td>6 378 141.7 (from points 1 - 6)</td>
</tr>
<tr>
<td>3</td>
<td>WN = SAO III</td>
<td>278</td>
<td>6 378 140.8</td>
<td>6 378 142.0 (from points 3 - 6)</td>
</tr>
<tr>
<td>4</td>
<td>WN = NWL 9D</td>
<td>69</td>
<td>6 378 143.0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>WN = GSFC 73</td>
<td>66</td>
<td>6 378 144.9</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>WN = GEM 4</td>
<td>48</td>
<td>6 378 144.1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>C-Band = SAO III</td>
<td>1</td>
<td>6 378 143.6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>C-Band = GSFC 73</td>
<td>1</td>
<td>6 378 146.8</td>
<td></td>
</tr>
<tr>
<td>9</td>
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<td>9</td>
<td>6 378 160.5</td>
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</tbody>
</table>

For the solution reported here (WN14), the criterion for the scale is (5) above, i.e., that the scale should correspond well to all geometric and dynamic information available at present. Based on the above numbers and on previously published parameters, \( a = 6 378 142 \text{ m} \) was selected. This then requires an adjustment in which the scale is defined, in addition to the SECOR, EDM and C-Band observations, through height constraints with the initial additive constant \( \Delta a = -15 \text{ m} \). As can be seen from Fig. 5.1-2,
at this semidiameter the maximum scale difference expected between WN14 and any of the dynamic solutions is about 0.8 x 10^-6, and with respect to the EDM about 1.4 x 10^-6 or 1:700,000 which is about the average standard deviation of the EDM baselines. Using this scale the resulting geoid undulations

\[ N = H_{WN14} - MSL - \Delta N \]  

5.1 - 4

with

\[ \Delta N \text{ (meters)} = -13 - 23.2 \cos \phi \cos \lambda - 2.9 \cos \phi \sin \lambda + 2.7 \sin \phi \]

are consistent with dynamically computed ones when the following set of constants defining the gravity field of the level ellipsoid are used [Heiskanen and Moritz, 1967, p. 64]:

\[ \begin{align*} 
  f &= 1/298.25 \quad \text{(flattening)} \\
  \omega &= 0.72921151467 \times 10^{-4} \text{rad. sec}^{-1} \quad \text{(rotational velocity)} \\
  a &= 6378142 \text{ m} \\
  W_o &= 6263688.00 \text{ kgal m} \quad \text{(geopotential on the geoid)}
\end{align*} \]

Derived from these are the following parameters:

\[ \begin{align*} 
  k^2M &= 3.98600922 \times 10^{14} \text{ m}^3 \text{ sec}^{-2} \quad \text{(gravitational constant x earth mass)} \\
  \gamma_c &= 978.03226 \text{ cm sec}^{-2} \quad \text{(equatorial normal gravity)} \\
  J_2 &= 1082.6863 \times 10^{-6} \quad \text{(second-degree harmonic)}
\end{align*} \]

All the above constants are in good agreement with their current best estimates. The parameters in equation 5.1 - 4 (\( \Delta a = -13 \pm 0.7 \text{ m} \), \( u_0 = -23.2 \pm 0.9 \text{ m} \), \( v_0 = -2.9 \pm 0.8 \text{ m} \), \( W_o = 2.7 \pm 1.2 \text{ m} \)) are the result of fitting an ellipsoid to the WN14 geoid as explained earlier in this section, and they represent the size and the position of the best fitting level ellipsoid with respect to the reference ellipsoid (of the same flattening). In case of a good global station distribution the center of this level
ellipsoid is the "geometric" center of the geoid. If this point is assumed to be identical with the center of mass than the above coordinates may be viewed as its coordinates with respect to the origin of the reference ellipsoid, and with opposite signs they can be used to shift the W14 coordinates to the geocenter:

\[
\begin{align*}
u \text{ (geocentric)} &= u_{\text{W14}} + 23.2 \text{ m} \\
v \text{ (geocentric)} &= v_{\text{W14}} + 2.9 \text{ m} \\
w \text{ (geocentric)} &= w_{\text{W14}} - 2.7 \text{ m}
\end{align*}
\]

5.2 Cartesian and Geodetic Coordinates

The Cartesian and geodetic coordinates resulting from the W14 solution are listed in Table 5.2-2. Standard deviations of both types of coordinates are also given together with the parameters of the error ellipsoid (see section 4.74). The first page of the table explains the format and the units used. Table 5.2-1 is a summary of the average standard deviations. The values are also broken down to the constituent networks. The notation is explained on the first page of Table 5.2-2, except for the average standard deviation which is \( \sigma = \sqrt{(\sigma_u^2 + \sigma_v^2 + \sigma_w^2)/3} \). As can be seen, the weakest portion of the network is the MPS, and the strongest is the SECOR. The average standard deviation in a Cartesian coordinate is ±3.9 m. See Table 5.3-2 for comparison with solutions without the weighted height constraints.

The full variance-covariance matrix cannot be presented here due to lack of space; however, the correlation coefficients \( \rho_{ij} \) (see equation 4.7 - 29) between the u,v,w coordinates of stations i and j (the off-diagonal 3 x 3 matrices) are listed in Table 5.2-3 when \( \rho_{ij} > 0.75 \).
Table 5.2-1

Average Standard Deviations (Solution WN14)

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<th>Constituent Networks</th>
<th>WN14</th>
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<td>$\sigma_\lambda$ (arcsec)</td>
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<td>$\sigma$ (m)</td>
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</table>

The 3 x 3 correlation coefficient matrices with any element greater than 0.925 are marked by asterisks. Comparison with Table 3.3-2 reveals that all of these station pairs have their relative positions constrained; thus such correlations are expected. Table 5.2-4 contains the correlation coefficients between the $u,v,w$ coordinates of a given station, i.e., the 3 x 3 matrices along the diagonal of the full correlation coefficient matrix.
Table 5.2-2
Cartesian and Geodetic Coordinates
(Solution WNI4)

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- Cartesian coordinates in meters (Orientation: \( u = \) the Greenwich meridian as defined by the B.I.H.; \( v = \lambda = 90^\circ \) (E); \( w = \) Conventional International Origin).

- \( \phi, \lambda \) Geodetic latitude and longitude in angular units (degrees, minutes and seconds of arc) computed from the Cartesian coordinates and referred to a rotational ellipsoid of \( a = 6378155.00 \) m and \( b = 6356769.70 \) m.

- \( H \) Geodetic (ellipsoidal) height in meters referred to the same ellipsoid.

- \( \sigma_u, \sigma_v, \sigma_w \) Standard deviations of the Cartesian coordinates in meters.

- \( \sigma_\phi, \sigma_\lambda \) Standard deviations of the geodetic coordinates in seconds of arc.

- \( \sigma_H \) Standard deviations of the geodetic height in meters.

- \( a, A_a, r_a \) Altitude (elevation angle), azimuth and magnitude of the major semi axis of the error ellipsoid, respectively. Angles in degrees, magnitude in meters. Altitude is positive above the horizon. Azimuth is positive east reckoned from the north (see section 4.74).

- \( a_b, A_b, r_b \) Same as above for the mean axis of the error ellipsoid.

- \( a_c, A_c, r_c \) Same as above for the minor axis of the error ellipsoid.
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119
Table 5.2-2 (cont'd)

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Table 5.2-2 (cont'd)

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<td>-0.512  0.999  0.187</td>
<td>-0.708  0.933  0.191</td>
</tr>
<tr>
<td>0.157  0.187  0.999</td>
<td>0.159  0.195  0.946</td>
</tr>
<tr>
<td>STA.NO.6134 WITH STA.NO.9425</td>
<td>STA.NO.7072 WITH STA.NO.9010</td>
</tr>
<tr>
<td>0.953  -0.304  0.158</td>
<td>0.964  0.034  -0.140</td>
</tr>
<tr>
<td>-0.308  0.932  0.191</td>
<td>0.053  0.828  0.156</td>
</tr>
<tr>
<td>0.159  0.195  0.945</td>
<td>-0.141  0.157  0.947</td>
</tr>
<tr>
<td>STA.NO.8009 WITH STA.NO.8010</td>
<td>STA.NO.8009 WITH STA.NO.8015</td>
</tr>
<tr>
<td>0.619  0.149  -0.610</td>
<td>0.565  0.182  0.545</td>
</tr>
<tr>
<td>-0.047  0.794  -0.168</td>
<td>0.095  0.778  -0.236</td>
</tr>
<tr>
<td>-0.593  -0.217  0.602</td>
<td>-0.532  -0.242  0.559</td>
</tr>
<tr>
<td>STA.NO.8009 WITH STA.NO.8019</td>
<td>STA.NO.8010 WITH STA.NO.8015</td>
</tr>
<tr>
<td>0.551  0.173  -0.550</td>
<td>0.717  0.093  -0.679</td>
</tr>
<tr>
<td>0.092  0.777  -0.242</td>
<td>0.083  0.931  -0.296</td>
</tr>
<tr>
<td>-0.537  -0.232  0.564</td>
<td>-0.695  -0.268  0.762</td>
</tr>
<tr>
<td>STA.NO.6010 WITH STA.NO.8019</td>
<td>STA.NO.8015 WITH STA.NO.9004</td>
</tr>
<tr>
<td>0.726  0.085  -0.682</td>
<td>0.593  0.366  -0.335</td>
</tr>
<tr>
<td>0.079  0.036  -0.303</td>
<td>0.059  0.788  -0.313</td>
</tr>
<tr>
<td>-0.701  -0.261  0.768</td>
<td>-0.436  -0.532  0.556</td>
</tr>
<tr>
<td>STA.NO.8015 WITH STA.NO.8030</td>
<td>STA.NO.8019 WITH STA.NO.9004</td>
</tr>
<tr>
<td>0.591  0.125  -0.561</td>
<td>0.615  0.391  -0.328</td>
</tr>
<tr>
<td>0.124  0.787  -0.186</td>
<td>0.064  0.786  -0.322</td>
</tr>
<tr>
<td>-0.560  -0.273  0.592</td>
<td>-0.437  -0.540  0.581</td>
</tr>
<tr>
<td>STA.NO.6019 WITH STA.NO.8030</td>
<td>STA.NO.9004 WITH STA.NO.9001</td>
</tr>
<tr>
<td>0.578  0.123  -0.551</td>
<td>0.555  0.196  -0.521</td>
</tr>
<tr>
<td>0.118  0.079  -0.179</td>
<td>0.307  0.137  -0.225</td>
</tr>
<tr>
<td>-0.375  -0.433  0.812</td>
<td>-0.264  -0.433  0.818</td>
</tr>
<tr>
<td>STA.NO.9004 WITH STA.NO.9426</td>
<td>STA.NO.9007 WITH STA.NO.9011</td>
</tr>
<tr>
<td>0.322  -0.003  0.267</td>
<td>0.752  -0.080  0.167</td>
</tr>
<tr>
<td>0.466  0.081  -0.538</td>
<td>-0.006  0.376  -0.049</td>
</tr>
<tr>
<td>-0.054  -0.131  0.277</td>
<td>0.050  0.152  0.512</td>
</tr>
<tr>
<td>STA.NO.9051 WITH STA.NO.9091</td>
<td>STA.NO.9051 WITH STA.NO.9431</td>
</tr>
<tr>
<td>0.490  -0.299  0.208</td>
<td>0.540  -0.152  0.528</td>
</tr>
<tr>
<td>-0.301  0.998  -0.383</td>
<td>-0.523  0.826  0.283</td>
</tr>
<tr>
<td>-0.207  -0.381  0.991</td>
<td>-0.102  -0.354  0.250</td>
</tr>
<tr>
<td>STA.NO.9051 WITH STA.NO.9432</td>
<td>STA.NO.9091 WITH STA.NO.9431</td>
</tr>
<tr>
<td>0.598  -0.196  -0.530</td>
<td>0.543  -0.152  -0.531</td>
</tr>
<tr>
<td>-0.370  0.047</td>
<td>-0.523  0.828  0.283</td>
</tr>
<tr>
<td>-0.151  -0.334  0.371</td>
<td>-0.103  -0.355  0.252</td>
</tr>
<tr>
<td>STA.NO.9091 WITH STA.NO.9432</td>
<td>STA.NO.9431 WITH STA.NO.9432</td>
</tr>
<tr>
<td>0.602  -0.196  -0.533</td>
<td>0.808  -0.451 -0.617</td>
</tr>
<tr>
<td>-0.471  0.810  0.047</td>
<td>-0.373  0.847 -0.085</td>
</tr>
<tr>
<td>-0.152  -0.335  0.374</td>
<td>-0.750  0.180  0.721</td>
</tr>
</tbody>
</table>
### Table 5.2-4

Station Correlation Coefficients $\rho_{ij} \geq 0.75$

(Solution WN14)

<table>
<thead>
<tr>
<th>STA.NO.1032</th>
<th>1.000</th>
<th>0.967</th>
<th>0.779</th>
<th>STA.NO.3478</th>
<th>1.000</th>
<th>0.875</th>
<th>-0.919</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.967</td>
<td>1.000</td>
<td>0.880</td>
<td>1.000</td>
<td>0.875</td>
<td>1.000</td>
<td>0.837</td>
<td></td>
</tr>
<tr>
<td>0.779</td>
<td>0.880</td>
<td>1.000</td>
<td>-0.919</td>
<td>-0.837</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA.NO.3902</td>
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<td>-0.155</td>
<td>0.087</td>
<td>STA.NO.8010</td>
<td>1.000</td>
<td>0.027</td>
<td>-0.817</td>
</tr>
<tr>
<td>-0.155</td>
<td>1.000</td>
<td>0.813</td>
<td>0.027</td>
<td>1.000</td>
<td>-0.206</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>0.087</td>
<td>0.813</td>
<td>1.000</td>
<td>-0.817</td>
<td>-0.206</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA.NO.9011</td>
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<td>0.408</td>
<td>-0.752</td>
<td>STA.NO.8030</td>
<td>1.000</td>
<td>0.139</td>
<td>-0.845</td>
</tr>
<tr>
<td>0.408</td>
<td>1.000</td>
<td>-0.382</td>
<td>0.139</td>
<td>1.000</td>
<td>-0.241</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>-0.752</td>
<td>-0.382</td>
<td>1.000</td>
<td>-0.845</td>
<td>-0.241</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA.NO.6426</td>
<td>1.000</td>
<td>0.230</td>
<td>-0.857</td>
<td>STA.NO.9427</td>
<td>1.000</td>
<td>-0.858</td>
<td>0.636</td>
</tr>
<tr>
<td>0.230</td>
<td>1.000</td>
<td>-0.353</td>
<td>-0.858</td>
<td>1.000</td>
<td>-0.813</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>-0.857</td>
<td>-0.353</td>
<td>1.000</td>
<td>0.636</td>
<td>-0.813</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA.NO.5431</td>
<td>1.000</td>
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<td>-0.870</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.441</td>
<td>1.000</td>
<td>0.129</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.870</td>
<td>0.129</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $\rho_{ij} > 0.925$
5.3 Comparisons with Geometric Information

In addition to solution WN14, two other adjustments were also performed with the same data. The only differences were that in one of them (WN12) the weighted height constraints were not applied; thus the scale is defined through the SECOR, EDM and C-Band data. In the other (WN16), the EDM and C-Band lengths were not entered as weighted constraints; thus the scale is through the SECOR and the weighted height constraints. Coordinates from solution WN16 are not given, only some revealing information in a summary form which can be compared to the WN14 results.

Table 5.3-1 contains the differences between the adjusted and given chord lengths (Table 3.3-4) from the three solutions. The lines originating

Table 5.3-1
Chord Length Comparisons (Solutions WN12, 14 and 16)

<table>
<thead>
<tr>
<th>Type</th>
<th>Line</th>
<th>Adjusted - Given Length</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WN12</td>
<td>WN14</td>
<td>WN16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>m</td>
<td>ppm</td>
<td>m</td>
<td>ppm</td>
</tr>
<tr>
<td>EDM</td>
<td>6002 - 6003</td>
<td>8.3 ± 2.5</td>
<td>2.58</td>
<td>2.7 ± 2.3</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>6003 - 6111</td>
<td>2.7 ± 1.4</td>
<td>1.90</td>
<td>2.3 ± 1.4</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>6006 - 6005</td>
<td>7.7 ± 2.1</td>
<td>3.13</td>
<td>6.1 ± 2.0</td>
<td>2.47</td>
</tr>
<tr>
<td></td>
<td>6016 - 6016</td>
<td>-2.0 ± 1.3</td>
<td>2.30</td>
<td>-2.9 ± 1.3</td>
<td>2.47</td>
</tr>
<tr>
<td></td>
<td>6003 - 6004</td>
<td>2.7 ± 2.2</td>
<td>0.77</td>
<td>1.3 ± 2.1</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>6029 - 6000</td>
<td>7.9 ± 3.1</td>
<td>3.42</td>
<td>5.9 ± 3.0</td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td>6002 - 6060</td>
<td>-2.4 ± 3.9</td>
<td>0.76</td>
<td>-4.5 ± 3.6</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>5861 - 7043</td>
<td>2.2 ± 1.6</td>
<td>1.44</td>
<td>1.5 ± 1.8</td>
<td>0.99</td>
</tr>
<tr>
<td>C-Band</td>
<td>4002 - 4009</td>
<td>26.5 ± 6.9</td>
<td>2.42</td>
<td>-5.2 ± 3.9</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>4002 - 4740</td>
<td>2.0 ± 2.7</td>
<td>1.25</td>
<td>1.3 ± 2.7</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>4002 - 4061</td>
<td>2.0 ± 2.3</td>
<td>0.90</td>
<td>2.3 ± 2.3</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>4002 - 4061</td>
<td>-0.4 ± 3.6</td>
<td>0.19</td>
<td>-1.5 ± 2.6</td>
<td>0.65</td>
</tr>
<tr>
<td>Average</td>
<td>EDM</td>
<td>2.52</td>
<td>1.74</td>
<td>2.54</td>
<td>1.36</td>
</tr>
<tr>
<td></td>
<td>C-Band</td>
<td>1.56</td>
<td>0.96</td>
<td>1.57</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>2.02</td>
<td>1.50</td>
<td>2.02</td>
<td>1.50</td>
</tr>
</tbody>
</table>

*Not constrained in WN12 and WN14.
from Sta. 4742 (Kauai) are not listed for reasons explained earlier. Comparing solutions WN14 and WN12 the effect of including the heights is not very significant. The average length discrepancy decreases $0.48 \times 10^{-6}$ in case of the EDM, and $0.60 \times 10^{-6}$ in the C-Band case, both numbers being within the noise level. At first glance the difference between WN14 and WN16 seems to be significant since the average length discrepancy increases by about $4 \times 10^{-6}$ or $1:250,000$ for both types of observations. Close inspection, however, reveals that though the inclusion of the EDM and C-Band chords in the solution improves the positions of stations 6111 (Wrightwood), 6065 (H. Peissenberg) and 4081 (Grand Turk), it does not otherwise contribute to the overall scale determination significantly. If the above-mentioned stations are left out from the comparison, the average length discrepancies in the WN16 solution decrease to $2.76 \times 10^{-6}$ for the EDM and $1.81 \times 10^{-6}$ for the C-Band, both within noise level from WN14 (about $1 \times 10^{-6}$).

The above conclusion is also strengthened by the content of Table 5.3-2 where the average standard deviations of the coordinates and the heights

Table 5.3-2

Standard Deviation Comparisons
(Solutions WN12, 14 and 16)

<table>
<thead>
<tr>
<th>Solution</th>
<th>Constituent Networks</th>
<th>WNj</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BC</td>
<td>SECOR</td>
</tr>
<tr>
<td></td>
<td>$\sigma$</td>
<td>$\sigma_H$</td>
</tr>
<tr>
<td>WN12</td>
<td>4.4</td>
<td>5.0</td>
</tr>
<tr>
<td>WN14</td>
<td>3.5</td>
<td>3.2</td>
</tr>
<tr>
<td>WN16</td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

All units in meters.
are compared from the three solutions. It is seen that while the inclusion of the weighted heights decreases the standard deviations significantly, the exclusion of the geometric scalars hardly changes the results.

Table 5.3-3 shows the results of a coordinate transformation between solutions WN14 and WN16. Inspection of the residuals on the second and third pages of the table shows that they are insignificant except probably at the stations already mentioned, though even there the discrepancies are within or near the noise level. The fact that the chords 6003-6111 and 6016-6065 improve the positions of stations 6111 and 6065 (while the other chords have very little effect on their terminal stations) is not surprising once it is recognized that these lines are too short to be determined well from observations on PAGEOS.

Table 5.3-4 contains the results of the transformation between WN14 and WN12. The effect of the missing height constraints is well recognizable both in the scale and in the residuals.

In the tables the rotations $\omega$, $\psi$ and $\epsilon$ are about the $w$, $v$ and $u$ axes respectively. The unit in the variance-covariance matrix, for the elements corresponding to the rotations, is radian squared.
### Table 5.3-3

**Transformation: WN16 - WN14**

**SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS**

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>METERS</td>
<td>METERS</td>
<td>METERS (x10^-6)</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td></td>
</tr>
<tr>
<td>0.08</td>
<td>0.57</td>
<td>0.04</td>
<td>0.06</td>
<td>0.00</td>
<td>-0.00</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

**VARIANCE - COVARIANCE MATRIX**

\[ \sigma_v^2 = 0.22 \]

<table>
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<tr>
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<th>0.6470-01</th>
<th>0.3790-04</th>
<th>-0.1180-03</th>
<th>-0.1160-10</th>
<th>0.6330-10</th>
<th>0.1860-09</th>
<th>-0.3560-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3990-04</td>
<td>0.6450-01</td>
<td>0.1940-03</td>
<td>0.1590-10</td>
<td>0.7280-10</td>
<td>-0.3610-11</td>
<td>-0.1940-00</td>
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</tr>
<tr>
<td>-0.1180-03</td>
<td>0.1940-03</td>
<td>0.9300-01</td>
<td>-0.2190-10</td>
<td>0.6820-11</td>
<td>-0.1020-09</td>
<td>-0.1470-00</td>
<td></td>
</tr>
<tr>
<td>-0.1160-10</td>
<td>0.1590-10</td>
<td>-0.2190-10</td>
<td>0.1410-16</td>
<td>0.6380-20</td>
<td>-0.5830-20</td>
<td>0.2720-19</td>
<td></td>
</tr>
<tr>
<td>0.6330-10</td>
<td>0.7280-10</td>
<td>0.6820-11</td>
<td>0.6380-20</td>
<td>0.9930-16</td>
<td>-0.1140-16</td>
<td>0.1550-17</td>
<td></td>
</tr>
<tr>
<td>0.1860-09</td>
<td>-0.3610-11</td>
<td>-0.1020-09</td>
<td>-0.5830-20</td>
<td>-0.1140-16</td>
<td>0.1400-15</td>
<td>-0.3430-17</td>
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</tr>
<tr>
<td>-0.3560-11</td>
<td>-0.1940-09</td>
<td>-0.1470-09</td>
<td>0.2720-19</td>
<td>0.1550-17</td>
<td>-0.3430-17</td>
<td>0.1340-15</td>
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</tr>
</tbody>
</table>

**COEFFICIENTS OF CORRELATION**

<table>
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<th>0.1000+01</th>
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<th>-0.1270-01</th>
<th>0.2510-01</th>
<th>0.6210-01</th>
<th>-0.1210-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6190-03</td>
<td>0.1000+01</td>
<td>0.2500-02</td>
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<td>0.2880-01</td>
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<td>-0.6590-01</td>
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</tr>
<tr>
<td>-0.1530-02</td>
<td>0.2500-02</td>
<td>0.1000+01</td>
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<td>0.2240-02</td>
<td>-0.2820-01</td>
<td>-0.4160-01</td>
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</tr>
<tr>
<td>-0.1270-01</td>
<td>0.1670-01</td>
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<td>0.1000+01</td>
<td>0.1700-03</td>
<td>-0.1310-03</td>
<td>0.6230-03</td>
<td></td>
</tr>
<tr>
<td>0.2510-01</td>
<td>0.2880-01</td>
<td>0.2240-02</td>
<td>0.1700-03</td>
<td>0.1000+01</td>
<td>-0.9620-01</td>
<td>0.1340-01</td>
<td></td>
</tr>
<tr>
<td>0.6210-01</td>
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<td>-0.2820-01</td>
<td>-0.1310-03</td>
<td>-0.9620-01</td>
<td>0.1000+01</td>
<td>-0.2490-01</td>
<td></td>
</tr>
<tr>
<td>-0.1210-02</td>
<td>-0.6590-01</td>
<td>-0.4160-01</td>
<td>0.6230-03</td>
<td>0.1340-01</td>
<td>-0.2490-01</td>
<td>0.1000+01</td>
<td></td>
</tr>
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Transformation: W12 - W14

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

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VARIANCE - COVARIANCE MATRIX

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Table 5.3-4 (cont’d)

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Table 5.3-5 is a height analysis computed for the purpose of inspecting the height residuals from solution WN14 which, according to the explanation offered in section 5.1, are mostly the short-wave-length components ($\Delta N$) of the geoid undulation. In the table, NOSUGC denotes the quantity $H_{WN14} - MSL - dH$, where $dH$ is computed with $u_0 = -23.2 \text{ m}$, $v_0 = -2.9 \text{ m}$ and $w_0 = 2.7 \text{ m}$. In case of a uniform global station distribution, the average value of NOSUGC - $N_{\text{REF}}$ should be equal to the additive terms from the best fit, $\Delta a = -13 \text{ m}$. As it is seen on the last page of the table, this number is $-12.94 \text{ m}$. The root mean square value of the residuals is $\pm 6.42 \text{ m}$. The respective numbers from the WN12 solution (no weighted height constraints) are $-1.24$ and $+13.45 \text{ m}$. From this it seems that the semidiameter of the level ellipsoid best fitting the geoid (defined through the $N_{WN12}$ undulations) is $6378153.8 \pm 13.5 \text{ m}$, opposed to the WN14 solution's $6378142.1 \pm 6.4 \text{ m}$. The proximity of these values and their noise level are only indications that the "best" semidiameter of the level ellipsoid still needs to be determined; at the present time it can only be defined to fit some criteria as in section 5.1.

Table 5.3-6 contains the results of an independent height comparison where undulations ($N$) from the WN14 solution referenced to the defined level ellipsoid are compared with those from [Vincent et al., 1972] ($N_v$). The quantity

$$N = H_{WN14} - MSL - \Delta N = \text{NOSUGC} - \Delta a$$

The average difference $N - N_v$ taken over the stations where $N_v$ is available is $-0.3 \text{ m}$, and the rms of the residuals is $\pm 6.1 \text{ m}$. Similar comparisons with the WN12 solution show an average difference of $-0.2 \text{ m}$ and the rms of the residuals of $\pm 16.1 \text{ m}$.
### Table 5.3-5

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**AVERAGE**

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**SEMI-MAJOR AXIS**

6378147.06
Table 5.3-6
Undulation Comparison (Solution WN14)
Sta

.

mff.


Table 5.3-6 (cont'd)

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5.4 Comparisons with Dynamic Solutions

Table 5.4-1 is a compilation of transformation parameters between the WN coordinates and those from the dynamic solutions NWL-9D, SAO III, GEM-4 and GSFC-73. The method of computing the parameters is described in [Kumar, 1972]. In the table the positive angles $\omega$, $\psi$ and $\epsilon$ are counterclockwise rotations about the $w$, $v$ and $u$ axes respectively, as viewed from the end of the positive axis. The scale difference factor $\Delta$ is in units of ppM. In the transformations the variances of both sets of the coordinates are taken into account. Taking the variances of the WN solutions as standard, those of the dynamic solutions are scaled by the weight factors indicated. These numbers are also indicative of the overoptimism over the quality of some of the published solutions. For example, a weight factor of 25 would indicate that the published standard deviations of a given solution need to be multiplied by $\sqrt{25} = 5$.

Tables 5.4-2 to 5.4-5 contain the variance-covariance matrices, the correlation coefficients, and the residuals after transformation for the solutions mentioned above.

It can be observed that there is a good agreement between the translation elements $\Delta w$, $\Delta v$-s and $\Delta u$-s of the main (all stations inclusive) dynamic solutions and a discrepancy of about $8.5 \pm 1.7$ m with respect to the geometric values (see equation 5.1-5). The largest discrepancy occurs in the $\Delta w$ components, where there seems to be a $12.3 \pm 2.1$ m difference between the SAO III and the GEM-4 solutions. Eliminating the SAO III value, all $\Delta w$-s, including the geometric one, are within the noise level. The weighted mean shifts from the main dynamic solutions (excluding $\Delta w$ from SAO III), or the coordinates of the geocenter
Table 5.4-i

Relationships Between Various Dynamic and the WN Systems
('Dynamic-WN14')

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<td>$\Delta (10^8)$</td>
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<td>$\omega (\cdot)$</td>
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<td>$\psi (\cdot)$</td>
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*Weight Factor = $\sigma_\delta^2 / \sigma_{\delta m14}^2$

**See p. 118 for references.
Table 5.4-2
Transformation: NWL 9D - WN14

**Solution Flr 2 Translation, 1 Scale and 3 Rotation Parameters**

(Using Variances Only)

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**Variance - Covariance Matrix**

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-0.9120 & 0.9550 & 0.1270 & -0.1040 & -0.8770 & -0.2480 & -0.6030 \\
-0.1130 & 0.1270 & 0.1120 & 0.2030 & -0.2050 & -0.2070 & -0.1960 \\
-0.0956 & -0.1040 & 0.1850 & -0.3460 & -0.2770 & -0.5300 & -0.1960 \\
-0.1510 & -0.8770 & -0.2050 & 0.2850 & -0.5920 & -0.6460 & -0.1670 \\
-0.0537 & -0.2480 & -0.2070 & 0.2770 & -0.5920 & -0.7890 & -0.1670 \\
-0.5025 & -0.6030 & -0.5300 & -0.5300 & 0.4460 & 0.1670 & 0.3940 \\
\end{bmatrix}
\]

**Coefficients of Corelation**

\[
\begin{bmatrix}
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-0.4590 & 0.1000 & 0.1230 & 0.2600 & -0.1680 & -0.4720 & -0.983 \\
-0.1290 & 0.1230 & 0.1000 & -0.6460 & -0.2630 & -0.1250 & -0.2960 \\
-0.2290 & 0.2600 & -0.6460 & 0.1000 & -0.1900 & -0.1200 & -0.1660 \\
-0.2890 & -0.1680 & -0.2630 & -0.1900 & 0.1000 & -0.2070 & -0.1339 \\
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-0.1570 & -0.983 & -0.2960 & -0.1200 & -0.1660 & 0.4940 & 0.1000 \\
\end{bmatrix}
\]
### Table 5.4-2 (cont'd)

#### RESIDUALS V

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Table 5.4-3

Transformation: SAO III - WN14

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

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<th>OMEGA SECONDS</th>
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VARIANCE-COVARIANCE MATRIX

\[ \sigma^2 = 1.14 \]

\[
\begin{array}{cccccccc}
0.1550+01 & -0.2470-04 & -0.1800-03 & -0.3820-08 & 0.3570+08 & 0.3550+08 & 0.3100+09 \\
-0.2470-04 & 0.1670+01 & 0.1180-02 & 0.2880-08 & 0.4730-08 & 0.5799-09 & 0.5240-08 \\
-0.1800-03 & 0.1180-02 & 0.1670+01 & -0.3000-08 & 0.3420-09 & -0.5840-08 & -0.6210-08 \\
-0.3820-08 & 0.2880-08 & -0.3000-08 & 0.1900-14 & -0.6930-12 & -0.1000-17 & 0.3010-17 \\
0.3570+08 & 0.4730-08 & 0.3420-09 & -0.6930-18 & 0.2740-14 & -0.1570-15 & -0.4740-16 \\
0.3550+08 & 0.5790+09 & -0.5840-08 & -0.1000-17 & -0.1520-15 & 0.3000+14 & 0.3040+15 \\
0.3100+09 & -0.3290-08 & -0.4910-08 & 0.3010-17 & -0.4740-16 & 0.3040+15 & 0.3040+14 \\
\end{array}
\]

COEFFICIENTS OF CORRELATION

\[
\begin{array}{cccccccc}
0.1000+01 & -0.1530-04 & -0.5090-03 & -0.7040-01 & 0.5480-01 & 0.5210-01 & 0.4500-02 \\
-0.1530-04 & 0.1000+01 & 0.7050-03 & 0.5110-01 & 0.6990-01 & -0.8190-02 & -0.4590-01 \\
-0.5090-03 & 0.7050-03 & 0.1000+01 & -0.5340-01 & 0.5070-02 & -0.8760-01 & -0.6680-01 \\
-0.7040-01 & 0.5110-01 & -0.5340-01 & 0.1000+01 & -0.3040-03 & -0.4210-03 & 0.1250-02 \\
0.5480-01 & 0.6990-01 & 0.5070-02 & -0.3040-03 & 0.1000+01 & -0.5300-01 & -0.1640-01 \\
0.5210-01 & -0.8190-02 & -0.8260-01 & -0.4210-03 & -0.5300-01 & 0.1000+01 & 0.1000+00 \\
0.4500-02 & -0.4590-01 & -0.6880-01 & 0.1250-02 & -0.1640-01 & 0.1000+00 & 0.1000+01 \\
\end{array}
\]

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### Table 5.4-3 (cont'd)

**RESIDUALS V**

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Table 5.4-3 (cont'd)
Table 5.4-4
Transformation: GEM 4 - WN14

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 2 ROTATION PARAMETERS

(USING VARIANCES ONLY)

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VARIANCE-COVARIANCE MATRIX

\[ \sigma^2 = 1.11 \]

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-0.3780 & 0.2510 & 0.7610 & 0.3640 & 0.7030 & 0.1100 & -0.3450 & 0.07 \\
-0.1160 & 0.7610 & 0.2910 & -0.3050 & 0.6120 & -0.7120 & -0.3950 & 0.07 \\
-0.9320 & 0.3640 & -0.3050 & 0.1110 & -0.4370 & -0.5360 & 0.4020 & 0.14 \\
0.2350 & 0.7030 & 0.4120 & -0.4370 & 0.9990 & -0.2040 & -0.1660 & 0.14 \\
0.3920 & -0.1100 & -0.2120 & -0.5360 & -0.2040 & 0.1760 & -0.3870 & 0.14 \\
0.5100 & -0.3450 & 0.3950 & 0.4020 & 0.1660 & 0.3870 & 0.1270 & 0.13 \\
0.1000 & -0.1460 & -0.4140 & -0.5400 & 0.1440 & 0.1800 & 0.2770 & 0.01 \\
0.1460 & 0.1000 & 0.2820 & 0.4180 & 0.4480 & -0.5270 & -0.1630 & 0.00 \\
0.4140 & -0.4180 & 0.4100 & 0.1000 & -0.1700 & 0.3500 & -0.9390 & -0.2050 & 0.00 \\
0.5400 & 0.2180 & 0.1700 & 0.1000 & 0.1500 & -0.1540 & 0.3370 & 0.02 \\
0.1440 & 0.4480 & 0.4150 & 0.1500 & 0.1000 & 0.1540 & 0.3370 & 0.02 \\
0.1800 & -0.5230 & -0.9390 & -0.3840 & -0.1540 & 0.1000 & 0.1000 & 0.00 \\
0.2770 & -0.1930 & -0.2050 & 0.3380 & -0.1470 & 0.2590 & 0.1000 & 0.01
\]

COEFFICIENTS OF CORRELATION
Table 5.4-4 (cont'd)

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<td>-1.1</td>
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<td>1.7</td>
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<td>-0.4</td>
<td>-0.6</td>
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<td>0.9</td>
<td>-0.9</td>
<td>-0.3</td>
</tr>
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<td>1.5</td>
<td>0.8</td>
<td>-1.3</td>
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<td>9021</td>
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<td>-1.6</td>
</tr>
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<td>-0.2</td>
<td>0.3</td>
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<td>-5.6</td>
<td>1.8</td>
<td>-7.0</td>
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<td>-2.4</td>
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<tr>
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<td>0.4</td>
<td>-0.6</td>
</tr>
<tr>
<td>9427</td>
<td>2.1</td>
<td>-32.0</td>
<td>2.2</td>
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Table 5.4-5
Transformation: GSFC 73 - WN14

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

<table>
<thead>
<tr>
<th>DU METERS</th>
<th>DV METERS</th>
<th>DW METERS (X1D+6)</th>
<th>DELTA SECONDS</th>
<th>OMEGA SECONDS</th>
<th>PSI SECONDS</th>
<th>EPSILON SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.73</td>
<td>12.86</td>
<td>-1.70</td>
<td>0.96</td>
<td>-0.30</td>
<td>0.10</td>
<td>0.24</td>
</tr>
</tbody>
</table>

\[ \sigma_0^2 = 1.00 \]

\[
\begin{array}{cccccccc}
0.218D+01 & -0.646D-01 & -0.166D-01 & -0.125D-07 & 0.265D-07 & 0.500D-07 & 0.679D-08 \\
-0.646D-01 & 0.203D+01 & 0.449D-01 & 0.508D-07 & 0.113D-07 & -0.106D-07 & -0.642D-07 \\
-0.166D-01 & 0.449D-01 & 0.367D+01 & -0.269D-07 & 0.132D-07 & -0.243D-07 & -0.648D-07 \\
-0.125D-07 & 0.508D-07 & -0.369D-07 & 0.127D-13 & -0.133D-15 & -0.537D-16 & 0.172D-15 \\
0.265D-07 & 0.113D-07 & 0.132D-07 & -0.133D-15 & 0.111D-12 & -0.320D-14 & -0.306D-14 \\
0.500D-07 & -0.190D-07 & -0.343D-07 & -0.437D-16 & -0.390D-14 & 0.223D-13 & 0.546D-14 \\
0.629D-08 & -0.542D-07 & -0.648D-07 & 0.132D-15 & -0.306D-14 & 0.594D-14 & 0.179D-13 \\
\end{array}
\]

VARIANCE - COVARIANCE MATRIX

\[
0.100D+01 & -0.308D-01 & -0.597D-07 & -0.761D-01 & 0.170D+00 & 0.227D+00 & 0.315D+01 \\
-0.308D-01 & 0.100D+01 & 0.166D+01 & 0.321D+00 & 0.755D+01 & -0.894D+01 & -0.184D+00 \\
-0.597D-07 & 0.166D+01 & 0.117D+01 & -0.174D+00 & 0.660D+01 & -0.121D+00 & -0.254D+00 \\
-0.761D-01 & 0.321D+00 & -0.174D+00 & 0.100D+01 & -0.113D+00 & -0.705D-07 & -0.589D+00 \\
0.170D+00 & 0.755D+01 & -0.113D+01 & 0.100D+01 & 0.241D+00 & -0.218D+00 & 0.227D+00 \\
0.227D+00 & -0.894D+01 & -0.121D+00 & -0.323D+00 & -0.241D+00 & 0.100D+01 & 0.297D+00 \\
0.315D+01 & -0.184D+00 & -0.254D+00 & -0.705D-07 & -0.589D+00 & 0.297D+00 & 0.100D+01 \\
\]

COEFFICIENTS OF CORRELATION

\[
0.100D+01 & -0.308D-01 & -0.597D-07 & -0.761D-01 & 0.170D+00 & 0.227D+00 & 0.315D+01 \\
-0.308D-01 & 0.100D+01 & 0.166D+01 & 0.321D+00 & 0.755D+01 & -0.894D+01 & -0.184D+00 \\
-0.597D-07 & 0.166D+01 & 0.117D+01 & -0.174D+00 & 0.660D+01 & -0.121D+00 & -0.254D+00 \\
-0.761D-01 & 0.321D+00 & -0.174D+00 & 0.100D+01 & -0.113D+00 & -0.705D-07 & -0.589D+00 \\
0.170D+00 & 0.755D+01 & -0.113D+01 & 0.100D+01 & 0.241D+00 & -0.218D+00 & 0.227D+00 \\
0.227D+00 & -0.894D+01 & -0.121D+00 & -0.323D+00 & -0.241D+00 & 0.100D+01 & 0.297D+00 \\
0.315D+01 & -0.184D+00 & -0.254D+00 & -0.705D-07 & -0.589D+00 & 0.297D+00 & 0.100D+01 \\
\]
### Table 5.4-5 (cont’d)

#### RESIDUALS V

<table>
<thead>
<tr>
<th>V11 (WN141)</th>
<th>V21 (GSFC 73)</th>
<th>V11 - V21</th>
</tr>
</thead>
<tbody>
<tr>
<td>1021 0.2</td>
<td>1021 -1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>1022 0.9</td>
<td>1022 -3.8</td>
<td>4.7</td>
</tr>
<tr>
<td>1030 -0.7</td>
<td>1030 2.7</td>
<td>-7.4</td>
</tr>
<tr>
<td>1034 -1.1</td>
<td>1034 2.5</td>
<td>-3.6</td>
</tr>
<tr>
<td>1042 -3.7</td>
<td>1042 -10.0</td>
<td>13.7</td>
</tr>
<tr>
<td>7036 -2.9</td>
<td>7036 6.7</td>
<td>-9.1</td>
</tr>
<tr>
<td>7037 0.2</td>
<td>7037 -0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>7039 0.2</td>
<td>7039 -0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>7040 0.6</td>
<td>7040 -1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>7046 -3.9</td>
<td>7046 4.7</td>
<td>-8.7</td>
</tr>
<tr>
<td>7072 0.7</td>
<td>7072 -7.9</td>
<td>8.6</td>
</tr>
<tr>
<td>7075 -2.0</td>
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</tr>
<tr>
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<td>7076 7.5</td>
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</tr>
<tr>
<td>9001 -2.0</td>
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<td>-5.7</td>
</tr>
<tr>
<td>9002 1.1</td>
<td>9002 -1.9</td>
<td>3.0</td>
</tr>
<tr>
<td>9004 -1.8</td>
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<td>-3.5</td>
</tr>
<tr>
<td>9005 5.9</td>
<td>9005 -11.2</td>
<td>17.0</td>
</tr>
<tr>
<td>9006 11.1</td>
<td>9006 -17.7</td>
<td>28.8</td>
</tr>
<tr>
<td>9008 -2.2</td>
<td>9008 1.3</td>
<td>-3.5</td>
</tr>
<tr>
<td>9009 0.6</td>
<td>9009 -17.2</td>
<td>17.8</td>
</tr>
<tr>
<td>9012 1.6</td>
<td>9012 -5.7</td>
<td>7.2</td>
</tr>
<tr>
<td>9021 2.1</td>
<td>9021 -1.6</td>
<td>3.7</td>
</tr>
<tr>
<td>9028 0.6</td>
<td>9028 -0.7</td>
<td>10.7</td>
</tr>
<tr>
<td>9031 -9.8</td>
<td>9031 9.0</td>
<td>-18.8</td>
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</tr>
<tr>
<td>9425 -0.0</td>
<td>9425 0.4</td>
<td>-0.4</td>
</tr>
</tbody>
</table>

179
with respect to the WN14 origin, are listed in Table 5.4-6.

Table 5.4-6

Shifts to the Geocenter (Solution WN14)

<table>
<thead>
<tr>
<th>Source</th>
<th>u₀ (m)</th>
<th>v₀ (m)</th>
<th>w₀ (m)</th>
<th>r₀ (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dynamic Comparison</td>
<td>14.8 ±1.4</td>
<td>11.8 ±1.3</td>
<td>-1.8 ±1.6</td>
<td>18.9 ±1.9</td>
</tr>
<tr>
<td>2. Geometric Fit (section 5.1)</td>
<td>23.2 ±0.9</td>
<td>2.9 ±0.8</td>
<td>-2.7 ±1.2</td>
<td>23.4 ±1.2</td>
</tr>
<tr>
<td>3. Weighted Mean of 1 &amp; 2</td>
<td>20.7 ±1.2</td>
<td>5.3 ±1.1</td>
<td>-2.4 ±1.4</td>
<td>21.4 ±1.6</td>
</tr>
<tr>
<td>4. JPL/DSN</td>
<td></td>
<td></td>
<td></td>
<td>25.9 ±2.5</td>
</tr>
</tbody>
</table>

The quantity \( r₀ = \sqrt{u₀^2 + v₀^2} \) is distance of the WN14 origin from the rotation axis of the earth. Calculating the same number from the JPL-LS 37 coordinates of the Deep Space Network (stations DSN1 = 4711, DSN2 = 4712, DSN4 = 4714, DSN6 = 4742 and DSN7 = 4751) as published in [Gaposchkin et al., 1973], one gets \( r₀ = 25.9 ±2.5 \) m, which value is nearest to the one calculated from the geometric fit.

The differences in scale between the dynamic solutions are significant (see Fig. 5.1-2 for comparison). The largest discrepancy is between the SAO III and GSFC-73 with \( \Delta = (1.13 ±0.12) \times 10^{-6} \), which is larger than what one would expect from the noise. The other dynamic scales are within near noise level and, on the average, differ from the scale of the WN14 solution by

\[
\Delta = (0.12 ±0.08) \times 10^{-6}
\]

or about one part in 8.3 million.
The largest discrepancies occur in the orientation of the various
dynamic systems with respect to each other and to WN14. In the rotation
about the w axis (ω), the largest difference occurs between the NWL-9D and
the GSFC-73 solutions, where ω = 1°1, or about 34 m on the equator (Fig.
5.4-1). The other differences are smaller but are significant. These
rotations may be partly due to the definition of the zero meridian in the
case of purely electronic systems (e.g., Doppler), partly to the various
definitions of the vernal equinox in the star catalogs used, and also to
its motion with respect to inertial space, in case of optical observations.
The latter alone requires a correction to the FK4 right ascensions amount-
ing to +0°65 at 1960.0, changing with a rate of +1°36 per century [Martin
and Van Flandern, 1970].

The rotations about the axes u and v are even more confusing. Fig.
5.4-2 illustrates the situation at the pole. The weighted means of the
dynamic solutions are ψ = 0°02 ±0°02 and ε = -0°04 ±0°02. The discrepancy
between the poles as determined separately from the SAO III 6000 stations
and then from the 9000 stations is unexplained at this time. It is
interesting to note that the weighted mean pole and zero meridian positions
computed from the dynamic solutions hardly differ from those of the WN14
solution.

The only general conclusion that one can draw from the rotation param-
eters is that the coordinate systems used in the dynamic solutions need to
be more carefully defined and conditions enforcing these definitions more
strongly applied than evidenced from the solutions discussed.
Fig. 5.4-1 Dynamic zero meridians relative to the WN14 zero meridian.

Fig. 5.4-2 Dynamic pole positions relative to the WN14 pole.
5.5 Comparisons with Geodetic Datums

In a planning document prepared in 1966 it was shown that the various countries in the world use or have used 90 different geodetic datums in their mapping activities [Mueller, 1966]. Since many of these datums have been tied together with ground survey, it is possible to combine them into about 20 large and/or independent datum blocks (Fig. 5.5-1). The original OSU goal, outlined in section 1, called for at least three well-distributed tracking stations on each of these datum blocks. As of the writing of this report this goal has been accomplished only on the following datums:

- Australian (3 stations)
- European 50 (16 stations but marginal accuracy)
- North American 1927 (21 stations)
- South American 1969 (10 stations)

On the Tokyo Datum there are also several stations, but only one of them is independently determined in the WN14 solution. In order to meet the original requirement additional stations or observations will have to be included in future solutions in the following general areas in order of preference: Europe, Soviet Union, India, Japan, Philippines, Cape (South Africa), Madagascar, New Zealand, North Africa. Observations have already been taken and will become available within reasonable time in Europe and North Africa.

Relationships between the geodetic datums and the WN14 coordinate system, as reflected from the data included, are summarized in Table 5.5-1. Coordinates given only to the nearest meter represent estimated values, while the other parameters are the results of regular seven parameter transformations. In order to reduce the correlations between these parameters, the rotations and the scale are determined first from respective direction cosines and chord distances, and then independent of the translation parameters.
and from each other. In a subsequent adjustment, the translations are calculated while the rotations and scale are constrained at their previously determined values with weights corresponding to their variances. For details of this procedure see [Kumar, 1972].

If the geodetic coordinates referred to any of the datums listed are to be shifted to the "best" geocenter, subtract from the Cartesian datum coordinates the values $\Delta u$, $\Delta v$, $\Delta w$ listed and add 21 m, 5 m and -2 m (or other value from Table 5.4-6) respectively.

The variance-covariance matrix, the coefficients of correlation and the residuals after adjustment for those datum blocks where three or more stations are available are shown in Tables 5.5-2 to 5.5-8. The datum with the poorest fit is the European 50, followed by the South American 1969.
Fig. 5.5-1 Major geodetic datum blocks.
Table 5.5-1

Relationship Between Various Geodetic Datums and the WN System (Datum - WN14)

<table>
<thead>
<tr>
<th>Datum No.</th>
<th>Datum Name</th>
<th>Δu (m)*</th>
<th>Δv (m)*</th>
<th>Δw (m)*</th>
<th>ω (°)**</th>
<th>φ (°)**</th>
<th>ξ (°)**</th>
<th>Δ (×10^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adindan (Ethiopia)</td>
<td>164 ±19</td>
<td>21 ±11</td>
<td>-200 ±6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>American Samoa</td>
<td>119 ± 8</td>
<td>-105 ± 8</td>
<td>-413 ±10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cape (South Africa)</td>
<td>152 ± 7</td>
<td>126 ± 7</td>
<td>298 ±10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ascension Island</td>
<td>227 ± 7</td>
<td>-92 ± 7</td>
<td>-58 ± 8</td>
<td>1.03±0.18</td>
<td>0.99±0.18</td>
<td>-0.23±0.22</td>
<td>-1.20±0.71</td>
</tr>
<tr>
<td>5</td>
<td>Australian Geodetic</td>
<td>11.2±5.0</td>
<td>41.1±6.2</td>
<td>-121.0±6.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Camp Area Astro 1961</td>
<td>111 ±10</td>
<td>148 ± 9</td>
<td>-238 ±10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Christmas Island Astro 1967</td>
<td>-116 ± 9</td>
<td>-224 ±12</td>
<td>529 ± 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Easter Island Astro 1967</td>
<td>-182 ±10</td>
<td>-138 ±10</td>
<td>-128 ±11</td>
<td>-1.76±0.38</td>
<td>0.01±0.31</td>
<td>-0.38±0.44</td>
<td>-7.39±1.14</td>
</tr>
<tr>
<td>9</td>
<td>European-50 (Wy)</td>
<td>133.3±9.5</td>
<td>114.2±15.9</td>
<td>152.2±9.2</td>
<td>-1.76±0.38</td>
<td>0.01±0.31</td>
<td>-0.38±0.44</td>
<td>-7.39±1.14</td>
</tr>
<tr>
<td>10</td>
<td>European-50 (All stations)</td>
<td>114.3±9.1</td>
<td>152.7±8.0</td>
<td>144.6±8.8</td>
<td>-0.41±0.20</td>
<td>0.27±0.30</td>
<td>-0.51±0.22</td>
<td>-7.24±0.88</td>
</tr>
<tr>
<td>11</td>
<td>Graciosa Island (Azores)</td>
<td>123 ±17</td>
<td>-147 ± 9</td>
<td>37 ±17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Heard Astro 1969</td>
<td>162 ±12</td>
<td>56 ±12</td>
<td>-114 ±14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Island</td>
<td>165 ±17</td>
<td>-711 ±10</td>
<td>-228 ±11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Isla Socora Astro</td>
<td>154 ±12</td>
<td>-206 ± 7</td>
<td>593 ± 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Johnston Island</td>
<td>-161 ±13</td>
<td>51 ±25</td>
<td>211 ±13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Luzon 1911 (Philippines)</td>
<td>151 ±10</td>
<td>51 ± 7</td>
<td>111 ± 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Midway Astro 1961</td>
<td>-377 ± 7</td>
<td>84 ± 7</td>
<td>-279 ± 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*if (Datum - Geocenter) is sought add to the tabulated values of Δu, Δv, Δw the respective quantities -21m, -5m, 2m (see Table 5.4-6).
**ω, φ, ξ when positive, represent counterclockwise rotations about the respective w, v, u axes, as viewed from the end of the positive axis.
Table 5.5-1 (cont'd)

<table>
<thead>
<tr>
<th>Datum Name</th>
<th>( \Delta u ) (m)</th>
<th>( \Delta v ) (m)</th>
<th>( \Delta w ) (m)</th>
<th>( \omega ) (')</th>
<th>( \phi ) (')</th>
<th>( \epsilon ) (')</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand 1949</td>
<td>1 - 61 ± 6</td>
<td>41 ± 9</td>
<td>-192 ± 9</td>
<td>0.21±0.20</td>
<td>0.59±0.21</td>
<td>-0.45±0.23</td>
</tr>
<tr>
<td>North American 1927 (W)</td>
<td>6 30.8± 7.3</td>
<td>-170.3± 4.5</td>
<td>-134.9± 8.8</td>
<td>0.01±0.19</td>
<td>0.01±0.16</td>
<td>-0.54±0.14</td>
</tr>
<tr>
<td>North American 1927 (E)</td>
<td>13 56.4± 6.9</td>
<td>-144.6± 4.4</td>
<td>-196.4± 4.3</td>
<td>0.86±0.06</td>
<td>0.33±0.06</td>
<td>2.15±0.62</td>
</tr>
<tr>
<td>North American (All Stations)</td>
<td>21 57.1± 2.2</td>
<td>-147.9± 2.6</td>
<td>-187.5± 2.9</td>
<td>0.03±0.11</td>
<td>0.50±0.27</td>
<td></td>
</tr>
<tr>
<td>Pitcairn Island Astro</td>
<td>1 -167 ±12</td>
<td>-168 ±11</td>
<td>-60 ±11</td>
<td>0.04±0.12</td>
<td>0.17±0.13</td>
<td>6.67±0.59</td>
</tr>
<tr>
<td>Provisional South Chile 1963</td>
<td>1 0 ± 8</td>
<td>-196 ± 8</td>
<td>-93 ± 9</td>
<td>-0.12±0.13</td>
<td>0.03±0.13</td>
<td></td>
</tr>
<tr>
<td>South American 1960</td>
<td>10 54.4± 6.5</td>
<td>30.0± 4.8</td>
<td>42.9± 4.9</td>
<td>0.03±0.17</td>
<td>0.17±0.13</td>
<td>6.67±0.59</td>
</tr>
<tr>
<td>Southeast Island (Mahe)</td>
<td>1 54 ± 8</td>
<td>186 ± 8</td>
<td>272 ± 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Georgia Astro</td>
<td>1 820 ± 8</td>
<td>-104 ±11</td>
<td>291 ±11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tokyo</td>
<td>1 183 ±10</td>
<td>-506 ± 9</td>
<td>-686 ± 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tristan Astro 1968</td>
<td>1 054 ±14</td>
<td>-420 ±11</td>
<td>622 ±13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wake Island Astronomic 1952</td>
<td>1 -280 ± 7</td>
<td>67 ±12</td>
<td>-140 ± 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yof Astro 1967 (Dunker)</td>
<td>1 55 ± 6</td>
<td>-143 ± 7</td>
<td>-95 ± 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmer Astro 1969</td>
<td>1 -218 ± 9</td>
<td>- 8 ±12</td>
<td>-226 ±12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If (Datum - Geocenter) is sought add to the tabulated values of \( \Delta u \), \( \Delta v \), \( \Delta w \) the respective quantities -21m, -5m, 2m (see Table 5.4-8).

**\( \omega \), \( \phi \), \( \epsilon \) when positive, represent counterclockwise rotations about the respective \( w \), \( v \), \( u \) axes, as viewed from the end of the positive axis.
Table 5.5-1 (cont'd)

1 See Table 3.1-3 for datum description and other related information.

2 Stations included are Tromso (8006), Catania (8016), Hohenpeissenberg (8066), Wippolder (8009), Zimmerwald (8010), Haute Provence (8015), Nice (8018), Meudon (8030), San Fernando (9004), Dionysos (9091) and Haestua (9426).

3 Stations included are as in #2 and Mashhad (8015), Malvern (5011), Naini Tal (8006), Shiraz (8008) and Riga (9431).


5 Stations included are Coldstone (1030), Colorado Springs (3400), Vandenberg AFB (4280), Wrightwood II (8134), Moses Lake (8003), Edinburg (7036), Denver (7044) and Organ Pass (8001).

6 Stations included are Blossom Point (1021), Fort Myers (1022), E. Grand Forks (1034), Rosman (1042), Bedford (1043), Semmes (1402), Hunter AFB (3648), Aberdeen (3657), Homestead (3681), Bridgeville (6002), Greenbelt (7043), Jupiter (7072) and Sudbury (7075).

7 Stations included are as in #4 and #5 above.

8 Stations included are Brasilia (3414), Asuncion (3431), Bogota (3477), Paramaribo (6003), Quito (6009), Villa Dolores (6019), Natal (8067), Arequipa (9007), Curacao (9009) and Comodoro Rivadavia (9031).
Table 5.5-2

Transformation: Australian Datum - WN14

SCALE FACTOR AND ROTATION PARAMETERS CONSTRAINED

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU METERS</th>
<th>DV METERS</th>
<th>DW METERS</th>
<th>DELTA (x10^6)</th>
<th>OMEGA SECONDS</th>
<th>PSI SECONDS</th>
<th>EPSILON SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>118.16</td>
<td>41.14</td>
<td>-120.05</td>
<td>-1.20</td>
<td>1.03</td>
<td>0.99</td>
<td>-0.25</td>
</tr>
</tbody>
</table>

\[
\sigma_b^2 = 0.48
\]

\[
\begin{array}{cccccccc}
0.2500+02 & 0.3750+01 & 0.1870+01 & 0.2070-05 & -0.2540-05 & -0.1410-05 & 0.5760-06 \\
0.3750+01 & 0.3910+02 & 0.1800+02 & -0.1970-05 & -0.4140-05 & 0.1620-06 & 0.4570-05 \\
0.1870+01 & 0.1800+02 & 0.4740+02 & 0.1240-05 & -0.2140-05 & 0.4420-05 & 0.5880-06 \\
0.2070-05 & -0.1970-05 & 0.1240-05 & 0.3550-14 & -0.1560-13 & -0.4570-14 & \\
-0.2540-05 & -0.4140-05 & -0.2140-05 & 0.3350-14 & 0.7650-12 & -0.1410-12 & -0.4090-17 \\
-0.1410-05 & 0.1620-05 & 0.4420-05 & -0.1550-13 & -0.1480-12 & 0.7490-12 & 0.3790-12 \\
0.5740-06 & 0.4570-05 & 0.5880-05 & -0.4570-14 & -0.4090-12 & 0.3790-12 & 0.1140-11 \\
\end{array}
\]

VARIANCE - COVARIANCE MATRIX

\[
\begin{array}{cccccccc}
0.1000+01 & 0.1200+00 & 0.5420-01 & 0.5820+00 & -0.5800+00 & -0.3260+00 & 0.1070+00 \\
0.1200+00 & 0.1000+01 & 0.4380+00 & -0.4430+00 & -0.7570+00 & 0.3000+00 & 0.6820+00 \\
0.5420-01 & 0.4380+00 & 0.1000+01 & 0.2520+00 & -0.3560+00 & 0.7490+00 & 0.7980+00 \\
0.5820+00 & -0.4430+00 & 0.2520+00 & 0.1000+01 & 0.5390-02 & -0.2520-01 & -0.6000-02 \\
-0.5800+00 & -0.7570+00 & -0.3560+00 & 0.5390-02 & 0.1000+01 & -0.1960+00 & -0.4360+00 \\
-0.3260+00 & 0.3000+00 & 0.7430+00 & -0.2520-01 & -0.1960+00 & 0.1000+01 & 0.4100+00 \\
0.1070+00 & 0.6830+00 & 0.7980+00 & -0.6000-07 & -0.4360+00 & 0.4100+00 & 0.1000+01 \\
\end{array}
\]

COEFFICIENTS OF CORRELATION

189
Table 5.5-2 (cont'd)

<table>
<thead>
<tr>
<th>V1 ( W414 )</th>
<th>V2 ( AUST. )</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6073</td>
<td>0.9 -0.4 -3.0</td>
<td>6023 -0.8 0.4 1.9</td>
</tr>
<tr>
<td>6032</td>
<td>1.0 1.2 0.7</td>
<td>6032 -0.9 -1.1 -0.5</td>
</tr>
<tr>
<td>6060</td>
<td>-1.9 -0.8 1.9</td>
<td>6060 1.7 0.7 -1.4</td>
</tr>
</tbody>
</table>
Table 5.5-3

Transformation: European 50 Datum (W) - WN14

SCALE FACTOR AND ROTATION PARAMETERS

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>METERS</td>
<td>METERS</td>
<td>METERS</td>
<td>(X1.0+6)</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td>SECONDS</td>
</tr>
<tr>
<td>133.27</td>
<td>114.18</td>
<td>152.20</td>
<td>-7.30</td>
<td>-1.76</td>
<td>0.01</td>
<td>-0.30</td>
</tr>
</tbody>
</table>

VARIANCE - COVARIANCE MATRIX

\[ \sigma^2 = 0.64 \]

\[
\begin{bmatrix}
0.8950E+02 & -0.1470E+02 & -0.1720E+02 & -0.5550E-05 & -0.2810E-05 & 0.1050E-04 & 0.1460E-05 \\
-0.1470E+02 & 0.2530E+03 & -0.1250E+02 & -0.5590E-06 & 0.2380E-04 & -0.6060E-06 & -0.2030E-04 \\
-0.1720E+02 & -0.1250E+02 & 0.8510E+02 & -0.6100E-05 & -0.8510E-06 & 0.9390E-06 & 0.2810E-05 \\
-0.5550E-05 & -0.6100E-05 & -0.5390E-06 & 0.1320E-11 & 0.4200E-14 & 0.6840E-15 & -0.2000E-14 \\
-0.2810E-05 & 0.2380E-04 & -0.8510E-06 & 0.4200E-14 & 0.3440E-11 & -0.1210E-12 & -0.2070E-11 \\
0.1050E-04 & -0.6060E-06 & -0.9380E-05 & 0.9840E-15 & -0.1210E-12 & 0.2240E-11 & 0.2790E-13 \\
0.1460E-05 & -0.2930E-04 & 0.2810E-05 & -0.2990E-14 & -0.2070E-11 & 0.2290E-13 & 0.4470E-11
\]

COEFFICIENTS OF CORRELATION

\[
\begin{bmatrix}
0.1000E+01 & -0.9790E-01 & -0.1970E+00 & -0.5660E+00 & -0.1600E+00 & 0.7300E+00 & 0.7300E-01 \\
-0.9790E-01 & 0.1000E+01 & -0.8540E+01 & -0.4590E+01 & 0.8040E+00 & -0.2530E-01 & -0.8710E+00 \\
-0.1970E+00 & -0.8540E+01 & 0.1000E+01 & -0.5760E+00 & -0.4970E+01 & -0.6760E+00 & 0.1440E+00 \\
-0.5060E+00 & 0.4590E+01 & -0.5760E+00 & 0.1000E+01 & 0.1970E-02 & 0.8700E-03 & -0.1730E+02 \\
-0.1600E+00 & 0.8060E+00 & -0.4970E+01 & -0.1970E-02 & 0.1000E+01 & 0.4340E+01 & -0.5270E+00 \\
0.7300E+00 & -0.2530E-01 & 0.6760E+00 & 0.5700E-03 & 0.4340E+01 & 0.1000E+01 & 0.7100E+02 \\
0.7300E+00 & 0.1970E+00 & -0.4590E+01 & -0.5760E+00 & -0.2530E-02 & 0.5270E+00 & 0.7100E-02
\]

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<table>
<thead>
<tr>
<th></th>
<th>V1 (WN14)</th>
<th>V2 (EU-50W)</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6006</td>
<td>0.0</td>
<td>-0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>6016</td>
<td>0.2</td>
<td>-0.8</td>
<td>-0.0</td>
</tr>
<tr>
<td>6065</td>
<td>0.1</td>
<td>-0.4</td>
<td>-0.1</td>
</tr>
<tr>
<td>8009</td>
<td>-3.2</td>
<td>0.0</td>
<td>0.3</td>
</tr>
<tr>
<td>8010</td>
<td>-1.3</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>8015</td>
<td>-0.1</td>
<td>7.6</td>
<td>-0.1</td>
</tr>
<tr>
<td>8019</td>
<td>-0.0</td>
<td>3.0</td>
<td>-0.1</td>
</tr>
<tr>
<td>8030</td>
<td>-1.5</td>
<td>4.7</td>
<td>0.2</td>
</tr>
<tr>
<td>9004</td>
<td>0.0</td>
<td>3.8</td>
<td>0.0</td>
</tr>
<tr>
<td>9091</td>
<td>0.3</td>
<td>7.7</td>
<td>-0.5</td>
</tr>
<tr>
<td>9426</td>
<td>-0.6</td>
<td>3.9</td>
<td>-9.7</td>
</tr>
</tbody>
</table>

Table 5.5-3 (cont'd)
Table 5.5-4

Transformation: European 50 Datum - WN14

Scale Factor and Rotation Parameters Constraint

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>METERS</td>
<td>METERS</td>
<td>METERS</td>
<td>(X1.5+6) SECONDS</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td></td>
</tr>
<tr>
<td>134.32</td>
<td>152.68</td>
<td>144.60</td>
<td>-7.24</td>
<td>-0.41</td>
<td>0.27</td>
<td>-0.51</td>
</tr>
</tbody>
</table>

Variance - Covariance Matrix

$\sigma^2 = 1.06$

\[
\begin{bmatrix}
0.8360 & 0.5480 & -0.7890 & -0.3080 & -0.2650 & -0.2100 & 0.7270 & -0.2750 \\
0.5480 & 0.6410 & -0.6510 & -0.7940 & 0.3720 & 0.1280 & -0.4340 & -0.1500 \\
-0.7890 & -0.6510 & 0.7690 & -0.2570 & 0.1500 & -0.9110 & -0.3490 & 0.1300 \\
-0.3080 & -0.7940 & 0.3570 & -0.7160 & -0.1310 & 0.4290 & -0.2730 & -0.1500 \\
-0.2650 & -0.2570 & -0.1500 & 0.5100 & -0.8800 & -0.5770 & -0.3900 & -0.1500 \\
-0.2100 & 0.1280 & -0.9110 & 0.4290 & -0.3720 & 0.2100 & -0.5940 & -0.1100 \\
0.7270 & -0.8800 & -0.5770 & -0.3900 & -0.3720 & 0.3080 & -0.5940 & -0.1100 \\
-0.2750 & -0.5770 & -0.3900 & -0.3720 & -0.5940 & 0.1100 & -0.1100 & 0.1100
\end{bmatrix}
\]

Coefficients of Correlation

\[
\begin{bmatrix}
0.1000 & 0.7640 & -0.3600 & -0.3830 & -0.2910 & -0.2100 & -0.7760 & -0.2750 \\
0.7640 & 0.1000 & -0.9270 & -0.1130 & 0.4670 & 0.1090 & 0.6120 & 0.1100 \\
-0.3600 & -0.9270 & 0.1000 & -0.4620 & 0.1720 & -0.7060 & 0.3650 & 0.1000 \\
-0.3830 & -0.1130 & 0.4620 & 0.1000 & -0.1400 & -0.3940 & -0.2840 & 0.1100 \\
-0.2910 & -0.7060 & -0.7060 & -0.1400 & 0.1000 & -0.2550 & -0.2840 & -0.1100 \\
0.2910 & 0.3650 & -0.3940 & -0.2840 & 0.2840 & -0.2720 & 0.1000 & 0.1000 \\
0.7760 & -0.2840 & -0.2550 & -0.2840 & -0.2720 & 0.1000 & -0.1100 & 0.1100 \\
-0.2750 & -0.2840 & -0.2550 & -0.2840 & -0.2720 & 0.1000 & -0.1100 & 0.1100
\end{bmatrix}
\]
Table 5.5-4 (cont'd)

<table>
<thead>
<tr>
<th>\text{RESIDUALS V}</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{V1 ( WN14 )}</td>
</tr>
<tr>
<td>V1</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>6006</td>
</tr>
<tr>
<td>6015</td>
</tr>
<tr>
<td>6016</td>
</tr>
<tr>
<td>6065</td>
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<tr>
<td>8019</td>
</tr>
<tr>
<td>8030</td>
</tr>
<tr>
<td>9004</td>
</tr>
<tr>
<td>9006</td>
</tr>
<tr>
<td>9008</td>
</tr>
<tr>
<td>9091</td>
</tr>
<tr>
<td>9426</td>
</tr>
<tr>
<td>9431</td>
</tr>
</tbody>
</table>

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Table 5.5-5
Transformation: NAD 1927 (W) - WN14

SCALE FACTOR AND ROTATION PARAMETERS CONstrained

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMIGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>METERS</td>
<td>METERS</td>
<td>METERS</td>
<td>(X1,0+6)</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td>SECONDS</td>
</tr>
<tr>
<td>30.60</td>
<td>-170.28</td>
<td>-134.88</td>
<td>-7.91</td>
<td>0.21</td>
<td>0.59</td>
<td>-0.45</td>
</tr>
</tbody>
</table>

VARIANCE = COVARIANCE MATRIX

\[ \begin{bmatrix} 0.531D+02 & 0.528D+01 & 0.276D+02 & 0.285D-06 & 0.596D-05 & 0.565D-05 & -0.292D-05 \\ 0.528D+01 & 0.707D+02 & 0.164D+02 & 0.985D-06 & -0.251D-06 & 0.137D-05 & -0.372D-05 \\ 0.276D+02 & 0.164D+02 & 0.441D+02 & -0.820D-06 & 0.293D-04 & 0.442D-04 & -0.601D-04 \\ 0.285D-06 & 0.985D-06 & -0.830D-06 & 0.207D-12 & -0.639D-14 & 0.198D-14 & 0.102D-12 \\ 0.596D-05 & -0.751D-06 & 0.253D-05 & -0.639D-14 & 0.920D-12 & 0.205D-12 & -0.382D-12 \\ 0.565D-05 & 0.137D-05 & 0.442D-05 & -0.580D-14 & 0.395D-12 & 0.106D-11 & -0.570D-12 \\ -0.292D-05 & -0.372D-05 & -0.691D-05 & 0.102D-12 & -0.362D-12 & -0.570D-12 & 0.123D-11 \end{bmatrix} \]

COEFFICIENTS OF CORRELATION

\[ \begin{bmatrix} 0.100D+01 & 0.159D+00 & 0.557D+00 & 0.861D-01 & 0.868D+00 & 0.761D+00 & -0.485D+00 \\ 0.159D+00 & 0.100D+01 & 0.532D+00 & 0.475D+00 & -0.573D-01 & 0.206D+00 & -0.736D+00 \\ 0.557D+00 & 0.532D+00 & 0.100D+01 & -0.524D+00 & 0.287D+00 & 0.664D+00 & -0.918D+00 \\ 0.861D-01 & 0.475D+00 & -0.269D+00 & 0.100D+01 & -0.146D-01 & -0.126D-01 & 0.201D-01 \\ 0.868D+00 & -0.573D-01 & 0.287D+00 & -0.146D-01 & 0.100D+01 & 0.206D+00 & -0.356D+00 \\ 0.761D+00 & 0.284D+00 & 0.664D+00 & 0.124D-01 & 0.289D+00 & 0.106D+01 & -0.508D+00 \\ -0.485D+00 & 0.918D+00 & -0.201D-01 & -0.356D+00 & 0.100D+00 & 0.206D+00 & 0.508D+00 \\ -0.356D+00 & -0.918D+00 & 0.201D-01 & 0.356D+00 & -0.106D+00 & 0.206D+00 & -0.508D+00 \end{bmatrix} \]
Table 5.5-5 (cont'd)

<table>
<thead>
<tr>
<th>V1 (W14)</th>
<th>V2 (W40-27W)</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1030.0</td>
<td>4.5</td>
<td>-1.4</td>
</tr>
<tr>
<td>3600</td>
<td>2.2</td>
<td>0.5</td>
</tr>
<tr>
<td>4280.0</td>
<td>0.1</td>
<td>-0.7</td>
</tr>
<tr>
<td>6003</td>
<td>0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>6134</td>
<td>0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>7036</td>
<td>-0.1</td>
<td>-0.2</td>
</tr>
<tr>
<td>7045</td>
<td>-1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>9001</td>
<td>-0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Table 5.5-6

Transformation: NAD 1927 (E) - WN14

SCALE FACTOR AND ROTATION PARAMETERS CONSTRAINED

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

(USING VARIANCES ONLY)

<table>
<thead>
<tr>
<th>DU METERS</th>
<th>DV METERS</th>
<th>DW METERS</th>
<th>DELTA X10^6</th>
<th>OMEGA SECONDS</th>
<th>PSI SECONDS</th>
<th>EPSILON SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.37</td>
<td>-144.64</td>
<td>-196.45</td>
<td>2.15</td>
<td>1.01</td>
<td>-0.01</td>
<td>0.54</td>
</tr>
</tbody>
</table>

VARIANCE - COVARIANCE MATRIX

\[ \Phi = 0.76 \]

\[
\begin{pmatrix}
0.4750+02 & 0.5870+01 & 0.1360+01 & -0.2880-06 & 0.5010-05 & 0.4270-05 & -0.7570-06 \\
0.5870+01 & 0.1910+02 & 0.1160+01 & 0.1930-05 & 0.1060-05 & 0.5450-06 & -0.1760-05 \\
0.1360+01 & 0.1160+01 & 0.1880+02 & -0.1420-05 & 0.1770-06 & -0.1630-06 & -0.2240-05 \\
-0.2880-06 & 0.1930-05 & -0.1420-05 & 0.3790-12 & 0.1300-14 & -0.1940-14 & 0.2070-15 \\
0.5810-05 & 0.1060-05 & 0.1770-06 & 0.1300-14 & 0.8660-17 & 0.3970-17 & -0.1010-12 \\
0.4270-05 & 0.5450-06 & -0.1630-06 & -0.1940-14 & 0.3920-12 & 0.6180-12 & -0.6740-13 \\
-0.7570-06 & -0.1760-05 & -0.2260-05 & 0.2070-15 & -0.1010-12 & -0.6740-13 & 0.6470-12 \\
\end{pmatrix}
\]

COEFFICIENTS OF CORRELATION

\[
\begin{pmatrix}
0.1000+01 & 0.1950+00 & 0.4550+01 & -0.6790-01 & 0.9050+00 & 0.7890+00 & -0.1420+00 \\
0.1950+00 & 0.1000+01 & 0.6100+01 & 0.7170+00 & 0.2600+00 & 0.1590+00 & 0.5920+00 \\
0.4550+01 & 0.6100+01 & 0.1000+01 & -0.5300+00 & 0.4390-01 & -0.4770-01 & -0.7640+00 \\
-0.6790-01 & 0.7170+00 & -0.5300+00 & 0.1000+01 & 0.2270-02 & -0.4400-02 & 0.6950-03 \\
0.9050+00 & 0.7600+00 & 0.4390-01 & 0.7270-02 & 0.1000+01 & 0.5350+00 & -0.1590+00 \\
0.7880+00 & 0.1590+00 & -0.4770-01 & -0.4400-02 & 0.5350+00 & 0.1000+01 & -0.1760+00 \\
-0.1420+00 & 0.5920+00 & -0.7640+00 & 0.4490-03 & -0.1590+00 & -0.1260+00 & 0.1000+01 \\
\end{pmatrix}
\]

197
Table 5.5-6 (cont'd)

RFSIDUALS V

<table>
<thead>
<tr>
<th>V1( WH14 )</th>
<th>V2(4AD-27E )</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1021</td>
<td>0.6</td>
<td>-2.5</td>
</tr>
<tr>
<td>1022</td>
<td>0.1</td>
<td>-0.6</td>
</tr>
<tr>
<td>1034</td>
<td>-3.2</td>
<td>8.8</td>
</tr>
<tr>
<td>1042</td>
<td>2.4</td>
<td>-7.2</td>
</tr>
<tr>
<td>3401</td>
<td>1.6</td>
<td>-0.7</td>
</tr>
<tr>
<td>3402</td>
<td>0.5</td>
<td>-1.0</td>
</tr>
<tr>
<td>3402</td>
<td>-0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>3649</td>
<td>-1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>3657</td>
<td>2.0</td>
<td>-7.2</td>
</tr>
<tr>
<td>3861</td>
<td>-1.4</td>
<td>4.4</td>
</tr>
<tr>
<td>3861</td>
<td>-0.2</td>
<td>-0.6</td>
</tr>
<tr>
<td>3861</td>
<td>-0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>3861</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>3861</td>
<td>-0.4</td>
<td>-1.2</td>
</tr>
</tbody>
</table>
Table 5.5-7
Transformation: NAD 1927 - WN14

SCALF FACTOR AND ROTATION PARAMETERS CONSTRAINED

SOLUTION FOR 3 TRANSLATION, 1 SCALE AND 3 ROTATION PARAMETERS

<table>
<thead>
<tr>
<th>DU</th>
<th>DW</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>METERS</td>
<td>MFTPS</td>
<td>METERS</td>
<td>(X1.0=6)</td>
<td>SECONDS</td>
<td>SECONDS</td>
<td>SECONDS</td>
</tr>
<tr>
<td>57.13</td>
<td>-147.90</td>
<td>-187.52</td>
<td>0.80</td>
<td>0.86</td>
<td>0.23</td>
<td>0.32</td>
</tr>
</tbody>
</table>

VARIANCE - COVARIANCE MATRIX

\[ e_0^2 = 0.76 \]

\[
\begin{array}{cccccccc}
0.4980 & 0.5290 & 0.8240 & -0.1940 & 0.4210 & -0.3040 & -0.1580 & -0.0660 \\
0.5290 & 0.6530 & 0.2940 & 0.3690 & 0.4490 & 0.1040 & -0.8760 & -0.0660 \\
0.8240 & 0.2940 & 0.8360 & -0.7750 & 0.4930 & -0.1340 & 0.1190 & 0.0530 \\
-0.1940 & 0.3680 & -0.2750 & 0.7340 & -0.2000 & -0.1910 & 0.2620 & -0.1530 \\
0.4210 & -0.2000 & 0.7710 & -0.9540 & -0.1000 & -0.1220 & 0.2600 & -0.1530 \\
0.3040 & -0.1380 & 0.1910 & -0.9540 & 0.6930 & -0.2930 & 0.3200 & -0.1330 \\
-0.1580 & -0.8760 & -0.1190 & 0.2620 & -0.1000 & -0.2930 & 0.7420 & -0.1210 \\
\end{array}
\]

COEFFICIENTS OF CORRELATION

\[
\begin{array}{cccccccc}
0.1000 & 0.9270 & 0.1280 & -0.3200 & 0.6790 & 0.5170 & -0.1460 & 0.0000 \\
0.9270 & 0.1000 & 0.2980 & 0.5320 & 0.6330 & 0.1600 & 0.6970 & 0.0000 \\
0.1280 & 0.2980 & 0.1000 & -0.3510 & 0.6140 & 0.1810 & 0.6300 & 0.0000 \\
-0.3200 & 0.5320 & -0.3510 & 0.1000 & -0.2660 & 0.2670 & 0.1970 & 0.0000 \\
0.6790 & 0.6330 & 0.6140 & -0.2660 & 0.1000 & 0.1310 & -0.7239 & 0.0000 \\
0.5170 & 0.1600 & 0.1810 & 0.2670 & -0.7239 & 0.1310 & 0.1000 & -0.7760 & 0.0000 \\
-0.1460 & -0.2660 & 0.6970 & -0.3200 & 0.1000 & 0.1310 & 0.1000 & -0.2260 & 0.0000 \\
\end{array}
\]
### RESIDUALS V

<table>
<thead>
<tr>
<th>V1 [WM14]</th>
<th>V2 [NAD-27]</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1021 0.9  0.2 1.3</td>
<td>1021 -3.7 -1.0 -3.8</td>
<td>4.6 1.2 5.1</td>
</tr>
<tr>
<td>1022 0.0  0.6 0.5</td>
<td>1022 -0.2 -3.3 -3.5</td>
<td>0.2 3.9 2.4</td>
</tr>
<tr>
<td>1023 -0.5 -0.6 1.5</td>
<td>1023 2.4 1.3 -2.2</td>
<td>-3.9 1.7 2.7</td>
</tr>
<tr>
<td>1034 -3.9  1.7 1.2</td>
<td>1034 5.4 -5.0 -3.9</td>
<td>10.4 6.7 5.0</td>
</tr>
<tr>
<td>1042 2.5  0.3 1.1</td>
<td>1042 -7.5 -0.9 -6.0</td>
<td>10.1 1.1 4.1</td>
</tr>
<tr>
<td>3400 0.5  0.5 2.2</td>
<td>3400 -1.6 -2.9 -4.1</td>
<td>2.2 3.4 7.2</td>
</tr>
<tr>
<td>3401 2.1  0.0 1.1</td>
<td>3401 -8.0  3.0 3.1</td>
<td>11.0 -5.0 -4.2</td>
</tr>
<tr>
<td>3402 0.2  0.7 0.7</td>
<td>3402 0.4  2.2 -1.6</td>
<td>0.6 2.9 2.3</td>
</tr>
<tr>
<td>3648 -1.1  0.2 1.5</td>
<td>3648 2.6 -1.0 -2.7</td>
<td>-3.7 1.3 4.2</td>
</tr>
<tr>
<td>3657 2.4  0.6 -0.4</td>
<td>3657 -8.6 -2.5 -1.1</td>
<td>11.1 -3.1 -1.4</td>
</tr>
<tr>
<td>3961 -1.5  0.7 -0.2</td>
<td>3961 4.7  3.0 0.6</td>
<td>-6.2 3.7 -2.8</td>
</tr>
<tr>
<td>4280 1.0  1.1 -0.5</td>
<td>4280 -4.7  4.6 0.0</td>
<td>10.7 4.7 5.0</td>
</tr>
<tr>
<td>6002 0.0  0.5 -0.6</td>
<td>6002 0.3  0.7 0.6</td>
<td>0.4 -6.2 -7.5</td>
</tr>
<tr>
<td>6003 0.0  0.3 -0.9</td>
<td>6003 -0.7  4.4 4.8</td>
<td>0.7 -19.0 -7.6</td>
</tr>
<tr>
<td>6134 0.5 -0.5 -0.6</td>
<td>6134 5.0  4.0 4.2</td>
<td>14.4 3.4 -6.8</td>
</tr>
<tr>
<td>7036 -2.1  2.2 0.2</td>
<td>7036 4.3  4.6 -0.7</td>
<td>-6.4 11.6 0.8</td>
</tr>
<tr>
<td>7043 0.0  0.6 -0.9</td>
<td>7043 -0.3  5.8 6.4</td>
<td>0.3 -6.3 -7.4</td>
</tr>
<tr>
<td>7045 -3.5  0.5 -0.6</td>
<td>7045 7.4 -1.6 0.0</td>
<td>-10.9 2.1 2.6</td>
</tr>
<tr>
<td>7072 0.4  0.2 0.4</td>
<td>7072 -4.1 -2.9 -6.7</td>
<td>4.5 3.1 5.1</td>
</tr>
<tr>
<td>7075 -2.8  2.5 -0.1</td>
<td>7075 -6.4  2.5 0.2</td>
<td>-9.2 3.6 -3.3</td>
</tr>
<tr>
<td>9001 -0.3  0.4 0.6</td>
<td>9001 4.9 -6.6 -6.2</td>
<td>-5.3 6.5 6.8</td>
</tr>
</tbody>
</table>
Table 5.5-8
Transformation: South American 1969 Datum - WN14

**SCALE FACTOR AND ROTATION PARAMETERS**

<table>
<thead>
<tr>
<th>(USING VARIANCES ONLY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DU</td>
</tr>
<tr>
<td>METERS</td>
</tr>
<tr>
<td>54.37</td>
</tr>
</tbody>
</table>

**VARIANCE - COVARIANCE MATRIX**

\[ \sigma^2 = 0.07 \]

<table>
<thead>
<tr>
<th></th>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>DU</td>
<td>0.2980+02</td>
<td>0.4770+01</td>
<td>0.1880+01</td>
<td>-0.9900-06</td>
<td>0.3480-05</td>
<td>-0.9060-06</td>
<td>-0.4730-07</td>
</tr>
<tr>
<td>DV</td>
<td>0.4770+01</td>
<td>0.2280+02</td>
<td>0.2620+00</td>
<td>0.1820-05</td>
<td>0.1800-05</td>
<td>-0.2250-06</td>
<td>0.4210-06</td>
</tr>
<tr>
<td>DW</td>
<td>0.1880+01</td>
<td>0.2620+00</td>
<td>0.2360+07</td>
<td>0.3270-06</td>
<td>0.2750-06</td>
<td>-0.1780-05</td>
<td>-0.2080-05</td>
</tr>
<tr>
<td>DELTA</td>
<td>0.9900-06</td>
<td>0.1820-05</td>
<td>0.3270-06</td>
<td>0.3520-12</td>
<td>0.1280-14</td>
<td>0.1590-14</td>
<td>0.2520-14</td>
</tr>
<tr>
<td>OMEGA</td>
<td>0.3480-05</td>
<td>0.1880-05</td>
<td>0.2750-06</td>
<td>0.1280-14</td>
<td>0.6570-12</td>
<td>-0.1030-12</td>
<td>0.4630-14</td>
</tr>
<tr>
<td>PSI</td>
<td>0.9060-06</td>
<td>-0.2250-06</td>
<td>0.1280-05</td>
<td>0.1590-14</td>
<td>-0.1030-12</td>
<td>0.3490-17</td>
<td>0.5850-12</td>
</tr>
<tr>
<td>EPSILON</td>
<td>0.4730-07</td>
<td>0.4210-06</td>
<td>-0.2080-05</td>
<td>0.2520-14</td>
<td>0.6430-14</td>
<td>0.5850-13</td>
<td>0.9720-12</td>
</tr>
</tbody>
</table>

**COEFFICIENTS OF CORRELATION**

<table>
<thead>
<tr>
<th></th>
<th>DU</th>
<th>DV</th>
<th>DW</th>
<th>DELTA</th>
<th>OMEGA</th>
<th>PSI</th>
<th>EPSILON</th>
</tr>
</thead>
<tbody>
<tr>
<td>DU</td>
<td>0.1000+01</td>
<td>0.1830+00</td>
<td>0.7080-01</td>
<td>-0.3060+00</td>
<td>0.7870+00</td>
<td>-0.2850+00</td>
<td>-0.1470-01</td>
</tr>
<tr>
<td>DV</td>
<td>0.1830+00</td>
<td>0.1000+01</td>
<td>0.1130-01</td>
<td>0.4410+00</td>
<td>0.4870+00</td>
<td>-0.6070-01</td>
<td>0.1640+00</td>
</tr>
<tr>
<td>DW</td>
<td>0.7080-01</td>
<td>0.1130-01</td>
<td>0.1000+01</td>
<td>0.1140+00</td>
<td>0.6080-01</td>
<td>-0.4500+00</td>
<td>-0.7020+00</td>
</tr>
<tr>
<td>DELTA</td>
<td>-0.3060+00</td>
<td>0.6410+00</td>
<td>0.1140+00</td>
<td>0.1000+01</td>
<td>0.2640-02</td>
<td>0.4580-02</td>
<td>0.6900-02</td>
</tr>
<tr>
<td>OMEGA</td>
<td>0.7870+00</td>
<td>0.4870+00</td>
<td>0.4980-01</td>
<td>0.2660-02</td>
<td>0.1000+01</td>
<td>-0.2190+00</td>
<td>0.9340-02</td>
</tr>
<tr>
<td>PSI</td>
<td>-0.2850-00</td>
<td>-0.6070-01</td>
<td>-0.4500+00</td>
<td>0.4580-02</td>
<td>-0.7140+00</td>
<td>0.1000+01</td>
<td>0.1640+00</td>
</tr>
<tr>
<td>EPSILON</td>
<td>0.1420-01</td>
<td>0.1440+00</td>
<td>-0.7020+00</td>
<td>0.6960-02</td>
<td>0.9340+02</td>
<td>0.1640+00</td>
<td>0.1000+01</td>
</tr>
</tbody>
</table>

201
**Table 5.5-8 (cont'd)**

**RESIDUALS V**

<table>
<thead>
<tr>
<th></th>
<th>V11 (W114)</th>
<th>V2 (SA-196G)</th>
<th>V1 - V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3414</td>
<td>3.0 -1.1 6.0</td>
<td>3414 -1.7 0.7 -2.8</td>
<td>5.6 -1.3 5.9</td>
</tr>
<tr>
<td>3431</td>
<td>-1.3 2.5 0.0</td>
<td>3421 1.4 -3.3 -0.0</td>
<td>-2.7 6.7 0.1</td>
</tr>
<tr>
<td>3477</td>
<td>16.8 2.2 14.1</td>
<td>3477 -10.2 -3.2 -0.9</td>
<td>27.1 5.6 26.1</td>
</tr>
<tr>
<td>6008</td>
<td>0.1 0.3 1.9</td>
<td>6006 -1.0 -5.1 -14.4</td>
<td>1.0 5.4 14.4</td>
</tr>
<tr>
<td>6009</td>
<td>-3.0 -1.0 -1.8</td>
<td>6006 9.5 5.7 6.7</td>
<td>-11.2 -6.7 -5.6</td>
</tr>
<tr>
<td>6019</td>
<td>-0.2 -0.2 -0.6</td>
<td>6019 2.2 2.0 2.6</td>
<td>-2.5 -2.5 -2.4</td>
</tr>
<tr>
<td>6067</td>
<td>-0.2 -0.5 -0.9</td>
<td>6067 7.0 7.0 8.2</td>
<td>-3.1 -7.6 -9.1</td>
</tr>
<tr>
<td>9007</td>
<td>1.0 0.4 -1.1</td>
<td>9007 -10.6 -2.6 -7.7</td>
<td>11.6 7.1 4.4</td>
</tr>
<tr>
<td>9009</td>
<td>-0.4 0.0 -1.0</td>
<td>9009 -4.6 -0.4 10.8</td>
<td>-4.2 0.4 -12.8</td>
</tr>
<tr>
<td>9031</td>
<td>-5.7 1.6 2.4</td>
<td>9031 5.3 -1.3 -1.3</td>
<td>-11.0 2.6 3.7</td>
</tr>
</tbody>
</table>
6. SUMMARY AND CONCLUSIONS

The OSU WN14 solution is a geometric adjustment for the coordinates of 158 tracking stations.

The coordinate system in which the coordinates are presented is oriented towards the Greenwich Mean Astronomical Meridian (u axis) and the Conventional International Origin (w axis), as both defined by the Bureau International de l'Heure. The v axis forms a right-handed system with u and w, and with the former defines the average geodetic equator. The coordinates of the origin with respect to the geocenter are suggested to be \( u^o_{WN14} = -21 \) m, \( v^o_{WN14} = -5 \) m, \( w^o_{WN14} = 2 \) m.

The scale in the solution is defined through SECOR observations and weighted height constraints. Chord distances derived from C-Band radar observations and from electronic distance measurements (geodimeter and tellurometer) are also included as weighted constraints, but they seem to have very little or no effect. The main reason that the SECOR observations are successfully utilized (perhaps for the first time) is that the ill-conditioning arising in quadrilateration when the four stations lie near a plane (which is always the case with SECOR) is eliminated by "pinning down" the stations to the geoid through the height constraints and the directions defined by the optical observations from the collocated stations.

The scale in the solution is such that when the coordinates are transformed to a geocentric rotational ellipsoid of \( a = 6378142 \) m and \( 1/f = 298.25 \), they produce geoid undulations consistent with dynamically determined ones with \( k^2M = 3.9860092 \times 10^{14} \text{m}^3 \text{sec}^{-2} \) and \( \gamma_e = 978.0326 \text{cm sec}^{-2} \).
The consistency of the solution is represented by the average standard deviation in a Cartesian coordinate of \(\pm 3.9\) m, and in height of \(\pm 2.9\) m. The correlations between the coordinates of a given station and those between different stations are low, except at those nearby stations where the relative positions are maintained at the surveyed values with weighted constraints.

Comparisons with the EDM chords show an average agreement of 1:575,000, with 1:2,700,000 at best and 1:330,000 at worst. The average agreement with the C-Band chords is 1:1,000,000, varying between 1:2,100,000 and 1:525,000. The scale agreement with the dynamic solutions on the average is 1:3,600,000, with 1:1,000,000 at worst and 1:5,900,000 at best.

Comparisons with coordinates from dynamic satellite solutions show significant inconsistencies in the orientation of the coordinate systems which need to be resolved. The residuals after transformation are all within the noise level.

Table 6.1 is a summary of the Cartesian coordinates from solutions WN12 and WN14. As mentioned earlier the former differs from the latter only in that in it the heights are not constrained. The scale in WN12 is such that when the coordinates are transformed to a geocentric rotational ellipsoid of \(a = 6 378 154\) m and \(1/f = 238.25\), they produce geoid undulations consistent with dynamically determined ones with \(k^2M = 3.9860099 \times 10^{14}\) m\(^2\) sec\(^{-2}\) and \(\gamma_c = 978.0285\) cm sec\(^{-2}\). For various comparisons between solutions WN12 and WN14 see Tables 5.3-1, 5.3-2 and 5.3-4.

Comparisons with geoid undulations from satellite and surface gravimetric solutions in case of the WN14 solution show an rms residual of \(\pm 6.1\), with
an average of only -0.3 m. Similar comparison with the WN12 solution, where the heights are not constrained, shows that the rms of the residuals is -16.1 m, and the average -0.2 m.

Comparisons with survey coordinates result in satisfactory transformation parameters for the NAD-1927, the Australian and the South American 1969 datums, and marginal ones for the European 1950 datum. In order to fulfill the "three station per datum" general requirement for the other major datum blocks, additional observations are needed from Europe, the Soviet Union, India, Japan, the Philippines, South Africa, Madagascar, New Zealand and North Africa, in order of preference.
<table>
<thead>
<tr>
<th>STATION</th>
<th>SOLUTION WN12</th>
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REFERENCES


Hotter, Frank D. (1967). "Preprocessing Optical Satellite Observations." Reports of the Department of Geodetic Science, No. 82. The Ohio State University, Columbus.


Kumar, Muneendra. (1972). "Coordinate Transformation by Minimizing Correlations Between Parameters." Reports of the Department of Geodetic Science, No. 104, The Ohio State University, Columbus.


Mueller, Ivan I. (1967). "Data Analysis in Connection with the National Geodetic Satellite Program." Reports of the Department of Geodetic Science, No. 93, The Ohio State University, Columbus.


Mueller, Ivan I. and M.C. Whiting. (1972). "Free Adjustment of a Geometric Global Satellite Network (Solution MPS-7)." Reports of the Department of Geodetic Science, No. 188, The Ohio State University, Columbus.


Saxena, Narendra K. (1972). "Improvement of a Geodetic Triangulation Through Control Points Established by Means of Satellite or Precision Traversing." Reports of the Department of Geodetic Science, No. 177, The Ohio State University, Columbus.


Uotila, U.A. (1967). "Introduction to Adjustment Computations with Matrices." Lecture notes, Department of Geodetic Science, The Ohio State University, Columbus.


APPENDIX

Solution WN12 (Heights not Constrained)

Information pertinent to the WN12 solution may be found in sections 5.3 and 6.

Tables corresponding to those in the Appendix, but for the solution WN14 (heights constrained), are 5.2-2, 3 and 4, on pp. 124 - 157.

Coordinates and statistical information for solution WN16 (no EDM and C-Band scalars) are not given. For various comparisons with solutions WN12 and WN14 see section 5.3.
### Table A - 1

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(Solution WN12, Heights not Constrained)

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- $u, v, w$ Cartesian coordinates in meters (Orientation: $u$ = the Greenwich meridian as defined by the B.I.H.; $v - \lambda = 90^\circ$ (E); $w$ = Conventional International Origin).

- $\phi, \lambda$ Geodetic latitude and longitude in angular units (degrees, minutes and seconds of arc) computed from the Cartesian coordinates and referred to a rotational ellipsoid of $a = 6378155.00$ m and $b = 6356769.70$ m.

- $H$ Geodetic (ellipsoidal) height in meters referred to the same ellipsoid.

- $\sigma_u, \sigma_v, \sigma_w$ Standard deviations of the Cartesian coordinates in meters.

- $\sigma_\phi, \sigma_\lambda$ Standard deviations of the geodetic coordinates in seconds of arc.

- $\sigma_H$ Standard deviations of the geodetic height in meters.

- $a_a, A_a, r_a$ Altitude (elevation angle), azimuth and magnitude of the major semi axis of the error ellipsoid, respectively. Angles in degrees, magnitude in meters. Altitude is positive above the horizon. Azimuth is positive east reckoned from the north (see section 4.74).

- $a_b, A_b, r_b$ Same as above for the mean axis of the error ellipsoid.

- $a_c, A_c, r_c$ Same as above for the minor axis of the error ellipsoid.
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Station to Station Correlation Coefficients \( r_{ij} > 0.75 \)
(Solution WN12)

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Table A - 3
Station Correlation Coefficients \( \rho_{ij} > 0.75 \) (Solution WN12)