ELEVENTH PROGRESS REPORT

on

CALIBRATION AND EVALUATION OF SKYLAB ALTIMETRY FOR GEODETIC DETERMINATION OF THE GEOID (Contract NAS9-13276, EPN 440), January 1 to January 31, 1974

to

NASA Johnson Space Center
Principal Investigation Management Office
Houston, Texas 77058

from

BATTELLE
Columbus Laboratories

February 18, 1974

Prepared by: D. M. J. Fubara (Co-Investigator)

A. G. Mourad (Principal Investigator)
Z. H. Byrns, Code TR6 - NASA/JSC Technical Monitor

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PROGRESS

The main work efforts for this period are the following:

(1) We have completed the extraction and transcription of data relevant to our task from data tapes S071-1 of SL-2 and generated new data tapes as required for our investigation.

(2) As previously reported,the various data we are processing involve three different geodetic reference datums. We have completed and incorporated into our computer programs the mathematical formulations required for implementing the transformations necessary to reduce all computations and results to a single geodetic reference ellipsoid of semi-major axis, a = 6,378,142 m,and flattening, f = 1/298·255. Translatory and rotational transformations have not been performed because all three geodetic datums are supposed to

have been made geocentric in addition to achieving parallelity between the semi-minor axis of the reference ellipsoid and the mean rotational axis of the earth, and the semi-major axis and the mean terrestrial equator of the earth. If, in future, it were established that the geocentering and parallelity conditions were not satisfactorily achieved and that significant rectifications for datum translation and rotation are required, the necessary mathematical formulations will have to be derived and incorporated into our computer program.

(3) New data sets for both the altimeter ranges and the orbit ephemeris for SL-2 EREP pass #9 have been received from NASA/Wallops. These and the corresponding data sets from NASA/JSC, Houston, have been processed for geodetic calibration, evaluation and determination of the geoid. Analysis and intercomparison of the results are in progress and are being incorporated into a formal write-up of a paper showing significant results. This paper will be submitted in the next period.

(4) Following our review of the data from NASA/Wallops and consultations with Dr. Dean Norris (NASA/JSC) and Mr. Clifford Leitao (NASA/Wallops), we have been advised by NASA/JSC to accept the altimeter ranges (as currently being corrected for systems calibration, biases and refraction) from NASA/Wallops as the set of data required for our task. As required by NASA/Wallops and approved by NASA/JSC, we have shipped our six NASA/JSC S071-1 data tapes back to NASA/Wallops along with a formal request and specifications for them to furnish us S-193 altimeter and associated data to be recorded on those tapes.

(5) The results of our data processing and analysis so far are showing such encouraging precision that we are continuing to investigate the possible implications for oceanographic and geophysical studies and applications.

(6) Documents and data records received and reviewed during this period are listed in Appendix A.

DATA PROCESSING RESULTS

Significant data processing results and comparative analyses to date are currently being compiled into a formal paper. This will be submitted in the next reporting period. Our computer program modifications for corrections due to differences in geodetic reference ellipsoidal parameters are effective.

The current results indicated that

(1) our analytical data handling procedure effectively recovers biases and sysematic errors in the altimeter and associated data. This we proved by processing (a) the Wallops' data which incorporated corrections for internal systems calibration, pulse width/band width and refraction, and (b) the Houston data which did not include corrections for these sytematic errors. The supporting data results and analysis will be furnished in the formal paper to be submitted later;

(2) the rate of change of radial errors in Skylab heights as computed from the ephemeris is about 0.5 m. per 2 minutes of time for the Wallops ephemeris and over 3 m. per 2 minutes for the Houston Skybet. Based on this and the earth gravity model involved in either orbit computation, it would appear that the Wallops orbit is more consistent, precision wise. However, in terms of absolute accuracy relative to geocenter, our judegement will await future analysis of various EREP passes in different parts of the world. Further technical discussions on the comparative analysis of both orbits will be in the forthcoming paper.

(3) based on the Wallops orbit, the geoid segment computed from SL-2 EREP pass 9 exceptionally matches the corresponding geoid segment from Vincent and Marsh geoid of 1973, after corrections for geodetic reference datum differences and the geodetic calibration constant we deduced analytically. This does not prove that the

orbit and/or the Vincent and Marsh geoid are very accurate because both depend on identical geopotential coefficients of the earth's gravity model and are therefore highly correlated. However, this close matching is an indicator of the consistency of altimeter data from Mode 5 of SL-2 EREP pass 9. The Mode 3 data for the same pass are, on the contrary, very bad and unsuitable for our task. The reason for this is not known yet.

(4) for the Mode 5 data of SL-2 EREP pass 9 in combination with Wallops' orbit, the geodetic calibration constant deduced, based on a reference ellipsoid of a = 6,378,142 m. and f = 1/298·255 is less than 25 m. However, this geodetic constant increases in magnitude away from the U.S. east coast and island tracking stations. This increase is probably a reflection of growth in radial errors of the orbit rather than instability in the altimeter. This preliminary assumption can be confirmed or negated later as more data are processed and analyzed.

CONCLUSION

Most of the technical conclusions have been given above as part of the discussions on data processing results.

We feel very strongly encouraged by current data processing results. However, the discussions have also identified several implicit problems. Such problems must either be resolved or effectively analyzed in order to (a) arrive at a reliable overall assessment of S-193 altimeter sensor performance evaluation, and (b) indicate the actual contributions toward future satellite altimeter design and programs for earth and ocean physics applications. The achievement of these and similar goals requires the processing and analyses of S-193 altimeter data from all other world sites besides the two test areas involved in our current task.

PROBLEMS

There are no new problems that merit being reported. We do look forward to expedited action from NASA/Wallops in sending us the requested data from SL-2. We are currently behind our milestone plan because of having to wait for the receipt of data required for our investigation.

RECOMMENDATIONS

Based on the brief discussion under conclusion and previous status reports, we strongly recommend that the S-193 altimeter data from various oceans be processed and analyzed as we are currently doing. Without comparative analysis of results from our test areas and these other worldwide data acquisition sites, a complete reliable evaluation and assessment of S-193 altimeter performance and contributions to future programs cannot be obtained. All previous recommendations that have not been implemented remain valid.

NEXT PERIOD AND SUMMARY OUTLOOK

During the next period, we plan to

(1) submit a paper on the significant results from our processing and analysis of SL-2 data, pass #9,

(2) continue the investigation of the possible contributions of the Skylab altimeter experiment to studies in earth and ocean physics applications, and

(3) continue processing and analysis of the remaining data from SL-2 mission.

TRAVEL

No travel was undertaken in this period and none is currently planned for the next period.

APPENDIX A

REPORTS AND DATA RECEIVED

	Title	Date	Identification Number	No. of Copies
(1)	Earth Resources Production Processing Requirements for EREP Electronic Sensors	January 3, 1974	PHO-TR524 Rev.A, Ch. 1	2
(2)	Earth Resources Experiment Package, Sensor Performance Report Volume II (S191)	October 22, 1973	MSC-05528 (SL2)	1
(3)	Earth Resources Experiment Package, Sensor Performance Report Volume I (S190A)	November 5, 1973	MSC-05528 (SL2)	1
(4)	Description of S191 Infrared Spectrometer and Discussion of the Sensor Products	January 18, 1974		1
(5)	Earth Resources Experiment Package, Sensor Performance Vol. V (S193 ALT))Engineering (Engineering Baseline)	July 31, 1973	NAS8-24000 Amendment JSC-14S	1