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STUDY OF THE TIME EVOLUTION

OF THE LITHOSPHERE

Grant NAG 5-150

Semi-Annual Progress Report No. 1

For the period 1 March through 31 August 1981

Principal Investigator

Dr. Micheline C. Roufosse

Prepared for
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

November 1981

Smithsonian Institution
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Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
and the Harvard College Observatory
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The work performed during this reporting period falls into three categories.

1. A three-dimensional geoid of all oceanic regions has been obtained in collaboration with Dr. B. Parsons (M.I.T.) and Dr. D. Mckenzie (University of Cambridge, U.K.). To construct that geoid, we have used the first data set derived from the GEOS-3 radar altimeter and we have applied the corrections for bias and trend calculated by Dr. R. Rapp (Ohio State University). We have further removed from the data the long wavelengths (>4000km) by subtracting a reference geoid of degree and order 10 and the very short wavelengths (<100km) by filtering with a Gaussian filter. The filtered values are finally projected onto a square mesh and these grid values are machine contoured. Results obtained in the Pacific Ocean for both geoid and bathymetry (McKenzie, Watts, Parsons and Roufosse, Nature, 288, 442, 1980) can be seen in Figure 1. That work has enabled us to obtain a very detailed geoid over most oceanic areas and has identified quite clearly the areas that will be the best candidates for future investigation with both the SEASAT and GEOS-3 data sets. Among those, we have selected the South West Atlantic Ocean for which very little data has been collected during the GEOS-3 experiment.

2. We have recently received the complete SEASAT Geophysical data set and we have presently almost completed its editing and organization.

Several criteria have been used to edit the data: all data points of geoid heights larger than +/- 150 m have been rejected as well as all geoid heights which differed by more than 15 m from the 3 preceding and 3 following points. Furthermore, several passes have been chosen at random and the observed and calculated geoids have been plotted (see Figures 2 and 3) to check the efficacy of the rejection criteria and to strengthen them if necessary. So far, the data have proven to be of excellent quality except at the borderline between continents and oceans.

In order to obtain data files of manageable size we have divided the oceans of the world into 7 regions as follows:

North Atlantic Ocean

South Atlantic Ocean

Indian Ocean

North Pacific Ocean I and II

South Pacific Ocean I and II

Each satellite pass has been divided into these 7 regions. Within each area, all the files are organized by increasing revolution number and for each file, we provide the following information: latitude, longitude, standard deviation, observed geoid, reference geoid (up to degree and order 10), residual geoid and the position along pass in each region. The data will thus be in a format compatible with that used for GEOS-3 and will permit simultaneous use of the two data sets.

The data have not as yet been adjusted into a coherent network for bias and trend corrections, but the crossover errors observed so far are at the 60 cm level. When these corrections for bias and trend become available, we shall use them.

3. We have then selected from the South Atlantic Ocean region obtained for the SEASAT experiment a subset of the data in the geographical area located between 25 and 35 degrees South and between 320 and 335 degrees East, around the Rio Grande Rise. That area is of particular interest to us because it was created concomitantly with the Walvis Ridge, on the Mid-Atlantic Ridge; these two features have now moved away from the ridge because of the plate motion. The Walvis Ridge is presently located on the East and the Rio Grande Rise on the West of the Mid-Atlantic Ridge. The Walvis Ridge has been studied extensively using the GEOS-3 data (Roufosse, in preparation) and has been found to consist of three segments formed at different periods by a migrating hot spot. Preliminary results obtained over the Rio Grande Rise using the few available GEOS-3 data indicate that the geoid signals in that area resemble those obtained over the Eastern section of the Walvis Ridge and thus we tentatively conclude that these two features should have been formed simultaneously. However, because of the poor coverage available so far (2 Geos-3 satellite passes), we are in the process of further investigating that area using the SEASAT data. So far, 6 SEASAT passes have been retrieved and their interpretation will be the object of our future work.

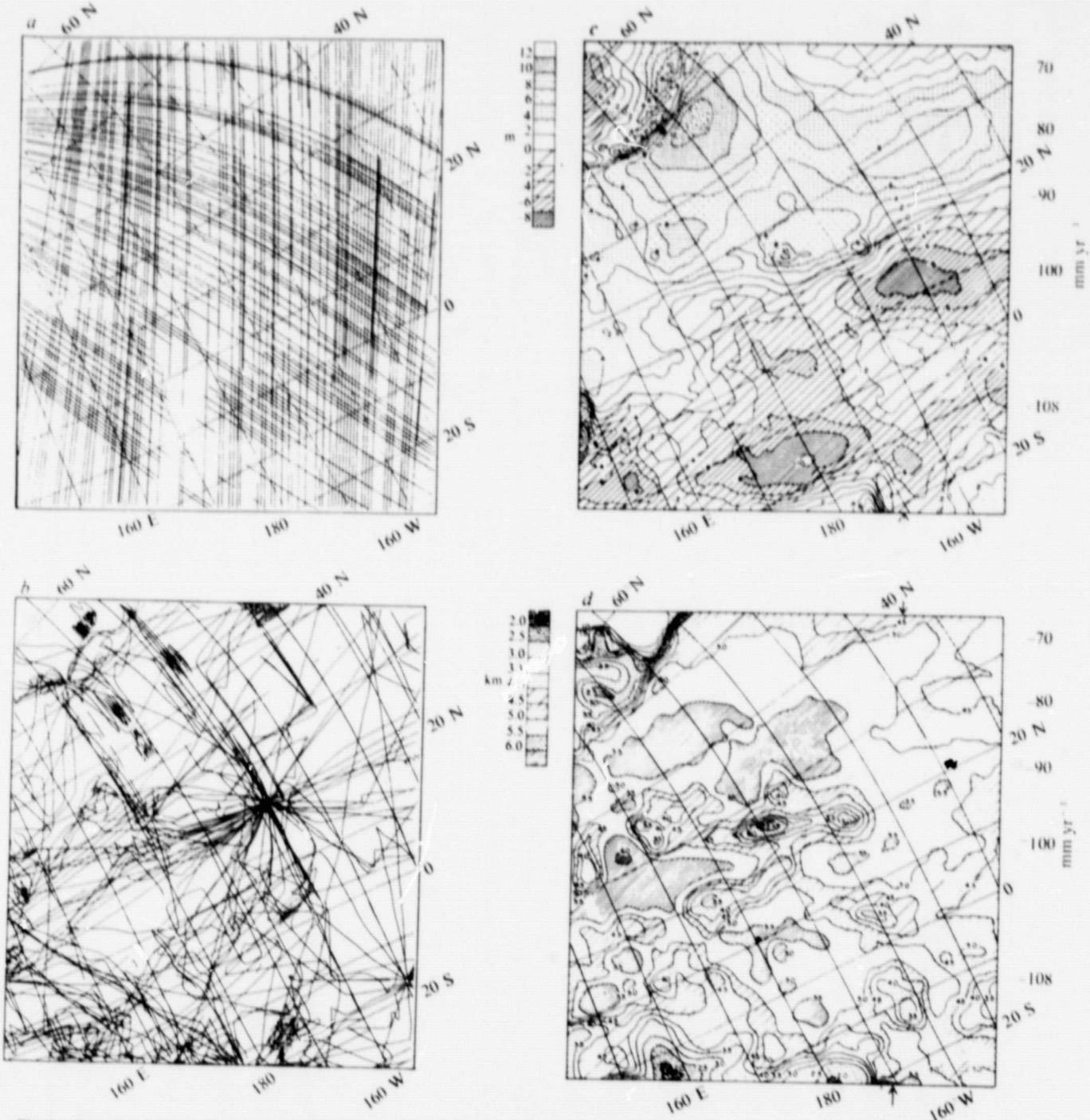

Fig. 1 Satellite altimeter (*a*) and ship (*b*) tracks used to obtain contour maps of geoid (*c*) and bathymetry (*d*) in the North and Central Pacific. The projection is an oblique mercator projection with axis 61.7°N, −82.8°E. Contour intervals are 2 m for (*c*) and 0.5 km for (*d*). The grid spacing in both cases is 100 km at the equator of the projection, and the gaussian half width for interpolation is 110 km for (*c*), 150 km for (*d*). The velocities shown on the right of (*c*) are those of the Pacific plate, moving from right to left, relative to the hot spot frame[15], and is 108 mm yr^{-1} at the equator of the projection.

Figure 2.

Observed and calculated geoid heights using SEASAT data, reduction number 954.

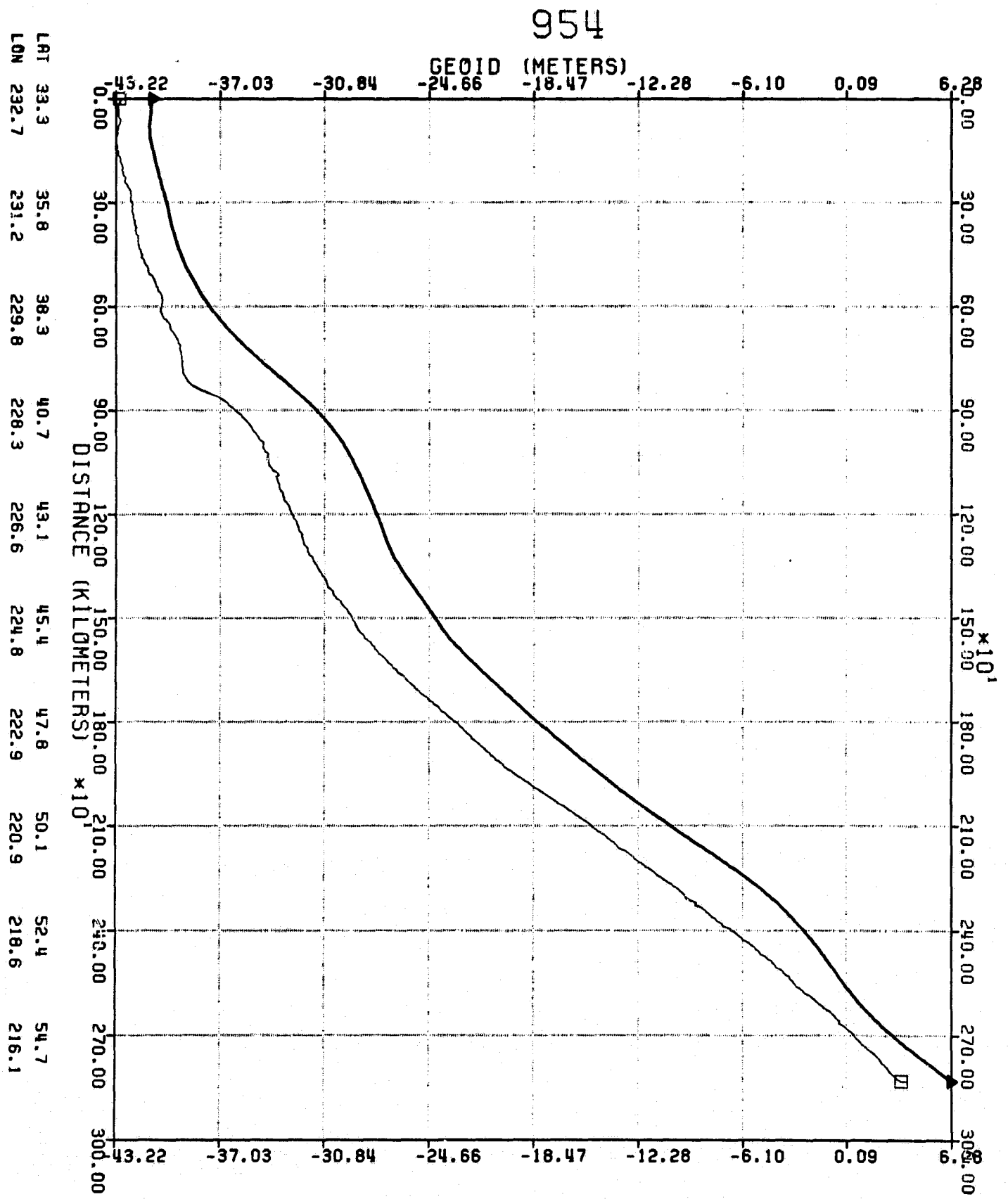

Figure 3.
Observed and calculated geoid heights using SEASAT data, reduction number 1016.