APPLICATION OF PRECISE ALTIMETRY TO THE STUDY OF THE EARTH'S GRAVITY FIELD IN THE WESTERN PACIFIC REGION AND EARTH DYNAMICS

Y. Fukuda
(Graduate School of Science, Kyoto, Japan)

This article outlines the research plan proposed by one of the Japanese groups of T/P investigators for solid earth dynamics studies. Our plan comprises four major research items:

1. **Determining the marine gravity field and its time variations.**
2. **Monitoring sea level change by combining satellite altimetry and precise geodetic measurements.**
3. **Ocean tides and oceanic effect on solid earth dynamics.**
4. **SLR tracking of TOPEX/POSEIDON satellite in the western Pacific region.**

Determining the marine gravity field and its time variations

Studying the marine gravity field is a long-established and important application of satellite altimeter data. One of the objectives of our investigation is to estimate underground structures in the north-western Pacific region, where there are subduction zones of the Pacific plate and Philippine plate and many marginal seas assumed to have been generated by subducting plates.

Although T/P data have lower spatial resolution than ERS-1/2 or recently declassified Geosat Geodetic mission data, the very accurate T/P data play an important role in calibrating other satellite altimeter data. Altimetric gravity anomalies, as well as derived bathymetry, are expected to contribute to geological and geophysical studies in the region. Improved geoid modeling is one of the major objectives of the geodetic studies; it will also help in oceanographic applications. Since satellite altimeter data, as is well known, can not provide the actual geoid, some investigators have recently tried to extract geoid signals using in-situ observations. Around Japan is also an area where gravity surveys have been made densely, especially over the continental shelves. The Geographical Survey Institute of Japan is now undertaking to determine a very precise land geoid to combine a gravimetric geoid with GPS leveling surveys. This should therefore be an opportunity to determine a detailed precise geoid in and around Japan by combining gravity data, geoid data and T/P and other altimeter data with in situ observations.

Another challenging study using T/P data is to reveal potential changes after major earthquakes. An estimation shows that geoid height changes may reach cm order magnitude.

Although the expected signal is very small, it is a step-like change in the time domain so that the signal, if it exists, should be revealed by T/P or future altimeter missions.

Monitoring sea level change by combining satellite altimetry and precise geodetic measurements

In relation to global warming, monitoring of the regional and global sea level changes is one of the most important objectives of the TOPEX/POSEIDON Extended Mission (TPEM). If vertical crustal movements can be accurately determined at tide gauge stations, tide gauge data directly provide sea level changes. At present, geocentric positions (referred to ITRF) of tide gauges can be directly obtained by GPS , SLR and/or VLBI measurements. The biggest problem in monitoring long-term sea level changes may be irregular sea level variations due to ocean currents, especially in coastal regions. Although it is difficult to combine open sea altimeter data and land geodetic measurements, careful analyses of along track T/P data should afford useful results.

Ocean tides and oceanic effect on the solid earth dynamics

One of the successful results of the T/P mission is the improvement of global ocean tide models. Although existing ocean tide models are much better than those before T/P data were available, they are still insufficient for some of the solid earth studies, e.g., the study of the free-core nutation mechanism, considered to cause liquid core resonance by the effect of diurnal components of the load exerted by oceanic tide. Efforts to improve ocean tide models using T/P data will be continued, especially in the marginal seas. Like the influence of ocean tides, non-tidal variations in sea surface topography affect geodetic observations on land, to a greater or lesser extent. An estimation shows, for instance, that the gravity change owing to non-tidal ocean variation may reach micro-gal order magnitude. This order of gravity change can not be ignored in the recent precise gravity measurements using superconducting gravity meters or absolute gravity meters. Satellite altimetry may be the only tool at present to reveal such effects. T/P-type data are very necessary.

SLR tracking of TOPEX/POSEIDON satellite in the western Pacific region

The Hydrographic Department of Japan has been tracking the T/P satellite by a fixed-type SLR station at the Simosato Hydrographic Observatory since the launch of T/P. The tracking data have contributed to determining the precise orbit of the satellite. A transportable SLR station, called the HTLRS, has been deployed at four major Japanese islands, Titi Sima, Isigaki Sima, Minamitori Sima and Wakkanai, once a year since 1996. Consequently, the SLR observation at Simosato and by the HTLRS will be continued during the extended mission. Besides such practical benefits, SLR observations at Simosato and transportable sites provide absolute geocentric sea surface heights near Japan. Tide gauges near the SLR sites will be connected to the SLR stations using GPS . These data should work effectively, like the calibration of sea level monitoring in the western Pacific region described previously.