SOLID EARTH DEFORMATION MONITORING USING SATELLITE ALTIMETRY IN SOUTHWESTERN COASTS IN TAIWAN

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1. INTRODUCTION

The southwestern coasts of Taiwan have been experiencing a significant solid earth deformation: A land subsidence in the rate of ~8 cm/year, due to, in part, the excess extraction of the underground water [1]. In order to accurately monitor the land subsidence rate, several first-order leveling networks and GPS control points from campaigns have been established for this purpose. However, for continuous monitoring of the land subsidence, repeated campaigns are required despite the fact that such repeated campaigns are labor-intensive and time-consuming. In this study, we proposed to use waveform retracked data from satellite altimetry to monitor the land subsidence of this area, where 2 groundtracks of TOPEX/Poseidon (T/P) passes. This area is part of the Chia-Nan Plain of Taiwan and the main vegetation is rice paddy so it is relatively flat and may reflect the radar signal more favorable than that does the rugged terrains. These unique factors presents a good opportunity for us to use T/P for land subsidence observations. By taking full advantage of T/P 10-day repeated orbit, the land surface height change can be repeatedly monitored every 10 days. The subsidence rate estimated with leveling [2] and the T/P groundtracks are illustrated in Figure 1.

2. PRINCIPLE OF SATELLITE ALTIMETRY AND WAVEFORM RETRACKING

Satellite altimetry is an operational observing system for synoptic oceanic measurements, including the sea surface height, wind speed, and, waves [3]. Its principle is shown in Figure 2. The satellite altitude above the reference ellipsoid is provided from methods of precise orbit determination. The range from the satellite to the instantaneous sea surface height is calculated based on half of the travel time of the radar pulse as it is bounced back to the satellite from the sea surface. Hence, the surface height is inferred by subtracting the range from the altitude. Since the radar pulse passes through the atmosphere, several range corrections, including troposphere, ionosphere, tides, atmospheric loading, and instruments, are applied. Due to the surface property, the use of satellite altimeters on land requires an additional waveform retracking procedure. Several algorithms, such as Offset Center of Gravity (OCOG) [4] , β-parameter [5], threshold [6] and others, have been developed in order to accurately account for this. Hence, in this study, we compare the land

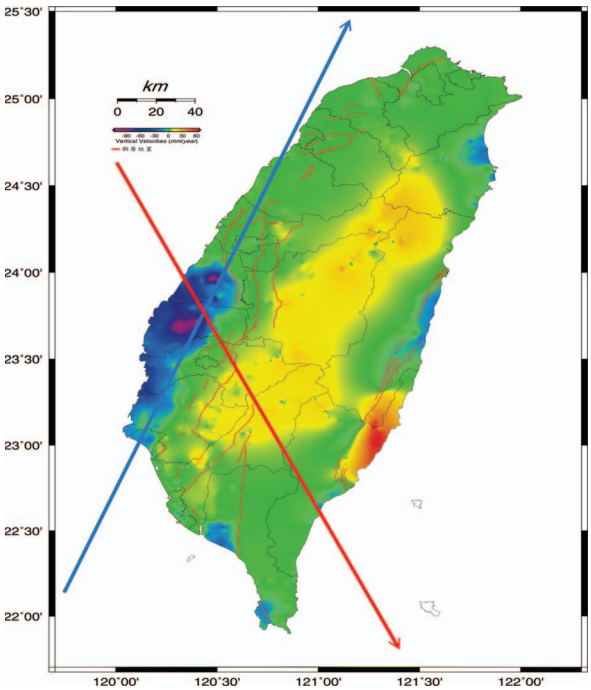

Figure 1. The ground tracks of T/P near Taiwan. The area experiences significant land subsidence is in purple and is thus selected as the study area. The ascending pass (Pass #051, in blue) is used in this study. The background color represents the rate of land subsidence estimated by the leveling network [2].

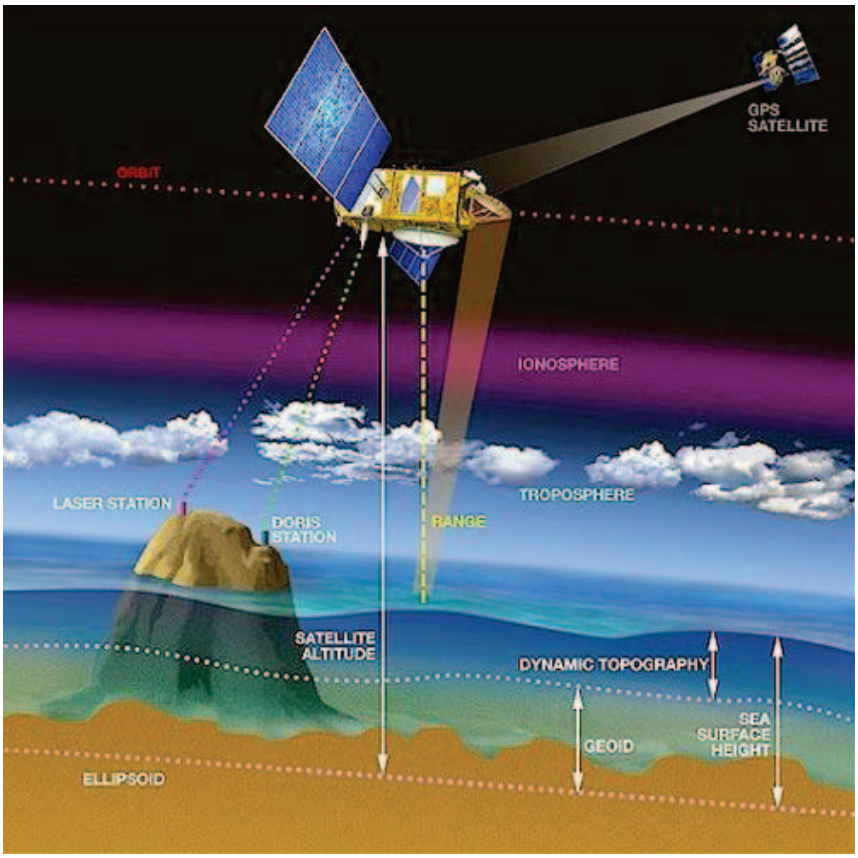

Figure 2. Principle of satellite altimetry (courtesy AVISO)

subsidence rate derived from leveling to that estimated by T/P waveform retracked results using different retracking algorithms, or retrackers. One of the objectives of this study is to find the most suitable retracker for this area.

3. PRELIMINARY RESULTS

Figure 3 presents the land subsidence rate estimated by the leveling conducted by the Industrial Technology Research Institute (ITRI) of Taiwan and the locations where T/P groundtrack passes. There are ~ 200 nominal geographic areas, or namely *Bins*, defined along the groundtrack. The size of each Bin is approximately 600 by 200 m in the along- and cross-track directions, respectively. The choice of the Bin size is based on the 10 Hz T/P high-rate sampling. As a result, a time series of the surface height can be estimated in each Bin by using waveform retracked T/P sensor data (Cycles 2–364, which corresponds to 1992–2002). Different retrackers such as 50% threshold, 10% threshold, and OGOC were tested and the results are summarized in Figure 4. This preliminary results, except for OCOG, exhibits good agreement between Bins 117–124 with the subsidence rate of 3–5 cm/year. The result shows that it is possible to monitor land subsidence in this area with satellite altimetry provided that suitable retracker is chosen.

4. REFERENCES

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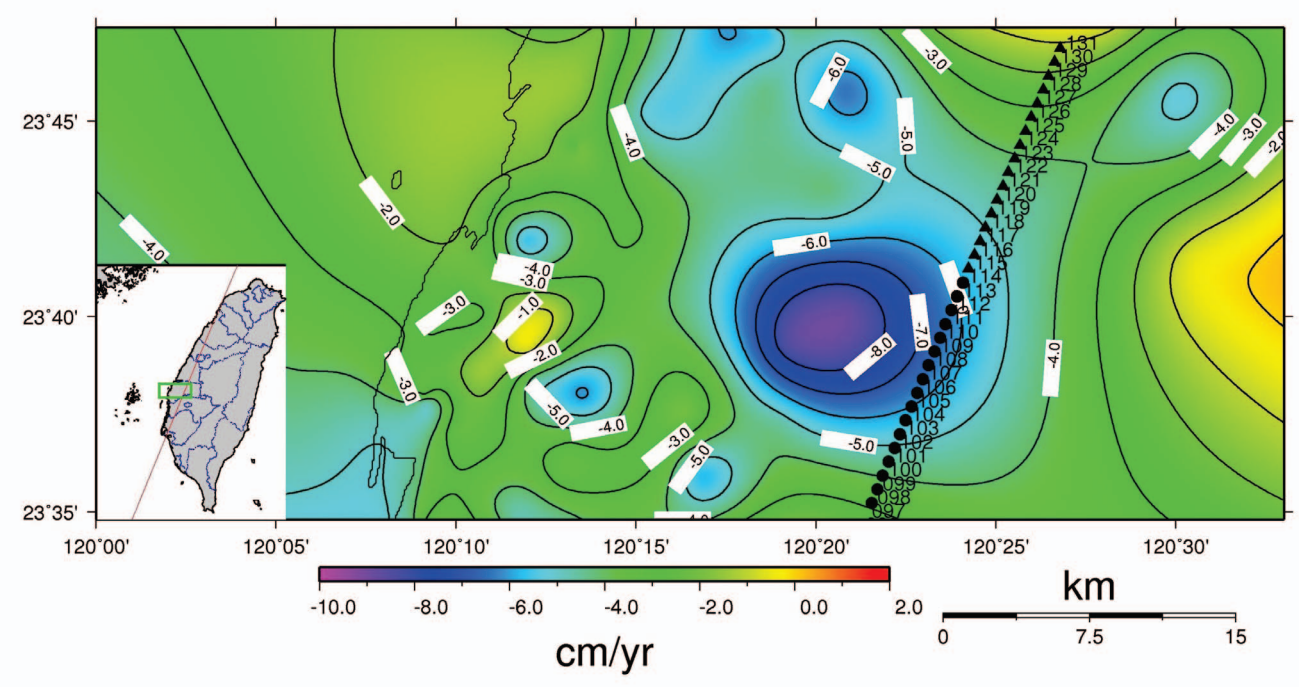

Figure 3. The subsidence rate estimated by leveling provided by Industrial Technology Research Institute (ITRI) of Taiwan and the definition of each bin (black circles and triangles) along the T/P groundtrack.

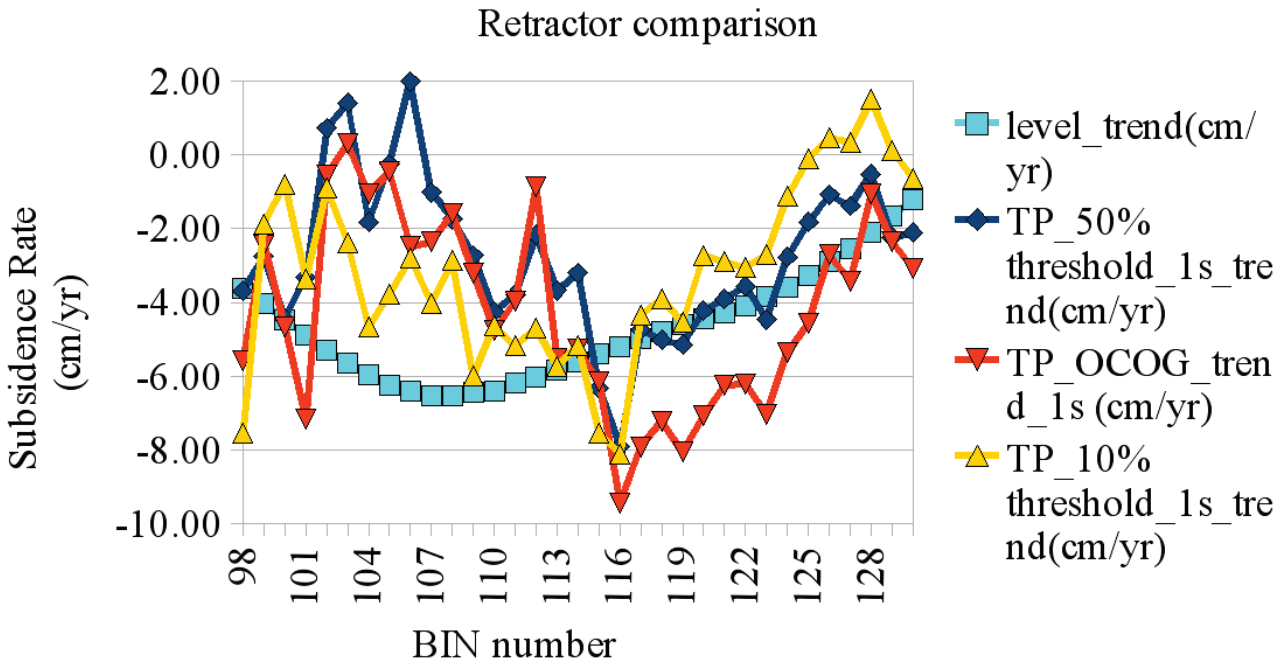

Figure 4. Comparison of different retrackters to the trend estimated by leveling. A Bin is a small nominal location along the T/P groundtrack, in which the subsidence rate is estimated.