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Ocean tide loading effects observed by GPS in southeastern Alaska

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A joint Japan-US research called International geodetic project in southeast Alaska (ISEA, Miura et al., 2006) for crustal deformation caused by the recent deglaciation is being carried out since 20 06. Because of complicated shorelines forming typical fjord in this region, tidal amplitude and phase are strongly varied from place to place. And this region show a large tidal amplitude in general. For example, in Juneau, which is the state capital located in this region, the peak to peak amplitude is about 8 m at the maximum. Therefore, the ocean tide loading (OTL) effect in the observed earth tide is significant. To improve the accuracy of tidal correction in geodetic observations such as gravity and displacement measurements, studies on precise ocean tide modeling have been carried out (e.g., Sato et al., 2008; Inazu et al., 2009). In this study, we perform tidal analysis using continuous GPS data to verify the validity of OTL correction with the regional ocean tide models.
We use GPS data obtained at Eldred Rock (ELDC), which is one of the new continuous GPS sites established by ISEA and located at Lynn Cannal, which is a narrow cannal of about 150 km long and about 10 km wide. As ELDC is a small island with a size of 50 m by 200 m, OTL effects are dominant. Therefore the data is thought to be suitable for this study. We used GPS tools ver 0.6.4 (Takasu, 2009) for data analyses. We estimate site coordinates at each epoch using the kinematic precise point positioning (K-PPP) strategy. As the code uses the Kalman filter for parameter estimation, we must give a process noise (PN) as an a priori constraint. In the previous studies, PN was decided empirically in the most of the cases. In this study, however, we try to find an objective way to determine the optimum value of PN for tidal analyses. We estimated the amplitudes of the O1 constituent for each PN value by using BAYTAP-G (Tamura et al,. 1991), and found the optimum PN of 5 mm/s^0.5 giving the maximum amplitude.If PN is too small, the short period noise is reduced together with tidal amplitude, and if PN is too large, the estimated tidal amplitude is also small because of larger short period noise and resultant law S/N.
We carry out K-PPP analysis with ELDC data using the optimum PN, and compare the obtained amplitude and phase of the M2 constituent, which is the most sensitive to OTL, with those estimated using GOTIC (Sato and Hanada, 1984). The observed and calculated amplitude and phase agree within the range of 4~5 % and 3~4 degree,respectively, when we use the regional ocean tide model developed by Inazu et al. (2009).

Keywords: Earth tide, ocean tide loading, GPS, Alaska