Computation of uplift rate caused by present-day ice melting in Southeast Alaska

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Crustal uplift caused by ice melting is observed in glacial areas such as Antarctica, Greenland and Alaska.This uplift consists of elastic and viscoelastic effects, which are called post glacial rebound (PGR) and present-day ice melting (PDIM), respectively.By dividing these effects from observed geodetic data, geophysical parameters such as mantle viscosity can be estimated.
In Southeast Alaska, for example, many geodesists have studied spatiotemporal characteristics of the crustal uplift due to ice melting.Sun et al. (2010) collected absolute gravity values in Southeast Alaska once a year from 2006 to 2008, and calculated the rate of the uplift due to PDIM (dΔ/dt) from the absolute gravity and GPS data.They also estimated the dΔ/dt values by the spatial integral of a PDIM model, showing the spatial distribution of the ice melting rate around Southeast Alaska.However, the amplitudes of the dΔ/dt values were not consistent with each other, possibly because Sun et al. (2010) simplified the conditions of their model calculation, especially about the distance between glaciers and each gravity site.
We were thus motivated to accurately estimate the rate of the PDIM-derived uplift at six absolute gravity sites in Southeast Alaska using PDIM models and observed geodetic data (dΔ/dt(obs) and dΔ/dt(cal), respectively).We first calculated dΔ/dt(cal) by the spatial integral of the UAF07 PDIM model (Larsen et al., 2007) using a response function of crustal deformation to a disk load (Farrell, 1972).We also calculated dΔ/dt(obs) from the rates of the GPS uplift and absolute gravity change from 2006 to 2013 (Kazama et al., 2015) using equations based on Wahr et al. (1995).
The average value of dΔ/dt(obs) at six gravity sites was calculated to be 14.7 +/- 2.2 mm/year, and its standard deviation is smaller than that of Sun et al. (2010) (10.7 +/- 7.3 mm/year) because we utilized the precise values of the gravity variation rates by Kazama et al. (2015), who considered the absolute gravity data newly obtained in 2012 and 2013.In addition, the average value of dΔ/dt(cal) was estimated to be 10.3 +/- 1.4 mm/year, which corresponded to 70 % of dΔ/dt(obs) in this study.Our dΔ/dt(cal) value reproduced the dΔ/dt(obs) value more than that of Sun et al. (2010) (5.5 +/- 3.2 mm/year; 50 % of their dΔ/dt(obs) value), because we considered realistic distributions of glaciers and gravity sites in estimating dΔ/dt(cal) from the PDIM model.The dΔ/dt(cal) value in this study still differs with dΔ/dt(obs) by about 30 %, which implies that more realistic conditions should be considered in the model calculation, such as the curvature, topography or internal structure of the Earth, and/or updated PDIM models.

Keywords: load deformation, ice sheet melting, gravity change, crustal uplift, Alaska

