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Re-examination of absolute gravity changes observed in Southeast Alaska

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Ground gravity measurement is one of the most effective methods to monitor mass variations due to glacial isostatic adjustment (GIA) and present-day ice melting (PDIM). Meanwhile, observed gravity data often contains environmental disturbances such as the effects of spatiotemporal mass variations associated with land water, atmosphere, and oceans, which should be corrected accurately to retrieve the GIA/PDIM gravity signals.

For example, the GIA/PDIM-derived linear gravity decrease of the maximum of -5.6 micro-Gal/year was found from absolute gravity data, obtained at Southeast Alaska every summer in 2006-2008 (Sun et al., 2010). However, the new gravity data measured at the same gravity sites in 2012-2013 was greater than expected from the regression lines of the linear gravity decrease suggested by Sun et al. (2010) by up to 20 micro-Gal (Kazama et al., 2013), because of the excess snow loading associated with the heavier-than-average snowfall in the wintertime of 2011-2012. Although Kazama et al. (2013) corrected the hydrological gravity disturbances (including the excess snow loading effect) from the observed gravity data using the synthetic ground gravity data created by the time series of satellite gravity (GRACE) and ground deformation (GPS), they did not take into account the atmospheric/oceanic gravity disturbances, which might distort their final results about the GIA/PDIM-derived gravity signal.

We were thus motivated to quantitatively evaluate the hydrological/atmospheric/oceanic gravity disturbances in the absolute gravity data measured at Southeast Alaska, in order to re-examine the gravity decrease rate due to GIA and PDIM. We first estimate the atmospheric/oceanic gravity disturbances using the global model AOD1B (Flechtner, 2007), and the hydrological disturbances using the satellite gravity time series collected by GRACE and some hydrological models (such as GLDAS (Rodell et al., 2004) and G-WATER [3D] (Kazama et al., 2015)). We then retrieve the GIA/PDIM-derived gravity changes in 2006-2013 from the observed absolute gravity data by correcting for the above gravity disturbances, and compare the retrieved gravity changes with those of the previous study (Sun et al., 2010).

Keywords: absolute gravity, Southeast Alaska, glacial isostatic adjustment, glacier, snow, soil moisture