Temporal Geoid of a Rebounding and Currently Deglaciating Antarctica and the Potential for Geodetic Measurement

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Both postglacial rebound and present-day ice mass balance of Antarctica and Greenland are forward modeled in order to provide minimum and maximum estimates of the combined solid Earth-related geoid change and crustal motion at present-day. The forward models are tested against secular polar motion, time-varying low-order field and center-of-mass center-of-figure offset data to tighten the bounds on rebound models (load history plus mantle viscosity structure). As revealed in several global solutions (e.g., James and Ivins, 1997; Johnston and Lambeck, 1999; Cox et al., 2001) present-day Antarctic deglaciation seems to fit these data with greater self-consistency than either zero or positive mass balance. (A typical solution is $+0.5 \pm 0.4$ mm/yr equivalent contribution to eustatic sea-level rise). The odd-harmonic signatures derived from passive satellite laser ranging data are most crucial to the later inference. However, data obtained from glacial flow patterns, SAR interferometry, radar altimetry, local sedimentary records and numerical models suggest a moderately paced, but continuous, retreat of the west Antarctic ice sheet over the past 3000 years. It is this feature of the new modeling, using a variety of assumptions about mantle viscosity, that is highlighted in this work, as it complicates the parameterizations necessary for the retrieval of present-day ice balances with GRACE, IceSat and GPS data combinations. The combined solid Earth and ice change-related geoid signatures are generally larger that in our previously reported estimates (IAG Meeting, 2000 July 31 - Aug. 4, Banff) that did not consider glacial history over the last 2000 yr. Revised maximum geoid change estimates are of order 0.5-1.5 mm/yr throughout several regions of west Antarctica.