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Identifying characteristics of ice history models using the relation between rates of change of deformation and gravity

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The Glacial Isostatic Adjustment (GIA) process leads among others to deformation and gravity changes. With help of GIA models, the relation between the rates of change of the absolute vertical deformation (uplift $\dot{h}$) and the terrestrial gravity field ($\dot{g}$) was found to be almost constant within a particular GIA-affected region (Olsson et al., 2015). For Fennoscandia, the linear relation $\dot{g} = a * \dot{h} + b$ with a = –0.163±0.016 μGal/mm and b = 0.030±0.007 mm was determined (Olsson et al., 2015). This relation is valid for reliable and commonly used Earth models in GIA studies for Fennoscandia and appears to be independent from the ice history model.

Olsson et al. (2015) used a small number of GIA models (6) though to arrive at the conclusions above, therefore for verification we tested a much larger range of Earth (441) and ice history models (33) and calculated the linear relation of uplift change to gravity rate change for more than 14500 ice-Earth model combinations.

Our results confirm within the given uncertainties the results by Olsson et al. (2015) for reliable Earth models. A careful analysis of parameter b however shows that one can distinguish two groups of ice history models.

Our presentation will introduce the characteristics of the two ice model groups, highlight how the linear relation can be used for their identification, and discuss the capability of current deformation and terrestrial gravity measurements to determine the linear relation so precisely that certain ice sheet characteristics could be identified.

Reference

Olsson, P.-A., G. Milne, H.-G. Scherneck, and J. Ågren (2015). The relation between gravity rate of change and vertical displacement in previously glaciated areas. J. Geodyn. 83, 76-84.