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Barletta, Valentina Roberta; Spada, G.

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Assessment of errors and uncertainty patterns in GIA modeling

BARLETTA V.R.[(1)], **SPADA G.**[(2)]

(1) DTU Space, Technical University of Denmark, Copenhagen, Denmark,
v.r.barletta@gmail.com **or** vrba@space.dtu.dk

(2) Dipartimento di Scienze di Base e Fondamenti, Urbino University "Carlo Bo", Italy,
giorgio.spada@gmail.com

ABSTRACT

During the last decade many efforts have been devoted to the assessment of global sea level rise and to the determination of the mass balance of continental ice sheets. In this context, the important role of glacial-isostatic adjustment (GIA) has been clearly recognized. Yet, in many cases only one "preferred" GIA model has been used, without any consideration of the possible errors involved. Lacking a rigorous assessment of systematic errors in GIA modeling, the reliability of the results is uncertain. GIA sensitivity and uncertainties associated with the viscosity models have been explored in the literature. However, at least two major sources of errors remain. The first is associated with the ice models, spatial distribution of ice and history of melting (this is especially the case of Antarctica), the second with the numerical implementation of model features relevant to sea level modeling, such as time-evolving shorelines and paleo-coastlines.

In this study we quantify these uncertainties and their propagation in GIA response using a Monte Carlo approach to obtain spatio-temporal patterns of GIA errors. A direct application is the error estimates in ice mass balance in Antarctica and Greenland due to GIA.

GIA errors are also important in the far field of previously glaciated areas and in the time evolution of global indicators. In this regard we also account for other possible errors sources which can impact global indicators like the sea level history related to GIA.

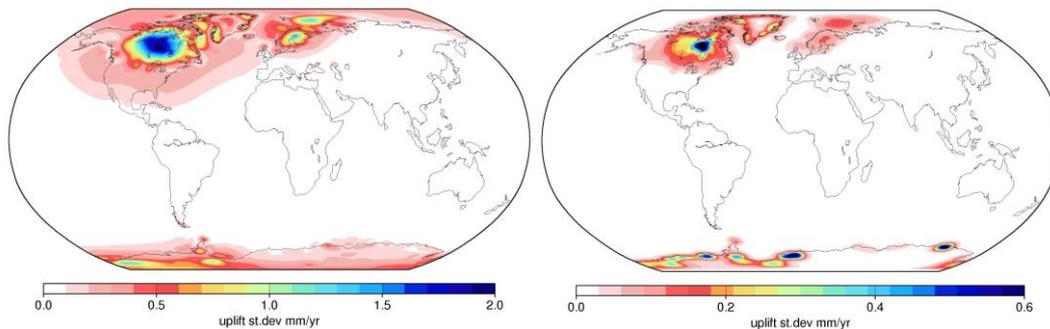Keywords: Glacial Isostatic Adjustment, ice mass balance, sea level rise.

Figure 1: Example of standard deviation of Uplift rate obtained by varying Earth model (left) and Ice model (right). GIA errors shows a sensitivity to different modeling parameters, and with a highly variable geographic distribution that can be exploited to select the most suitable sites to be used for comparison with geodetic data at specific points., i.e. GPS and relative sea level histories, in order to constrain GIA modeling.