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Glacial isostatic adjustment using GNSS permanent stations and GIA modelling tools

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Glacial Isostatic Adjustment (GIA) affects the Earth's mantle in areas which were once ice covered and the process is still ongoing. In this contribution we focus on GIA processes in Fennoscandian and North American uplift regions. In this contribution we use horizontal and vertical uplift rates from Global Navigation Satellite System (GNSS) permanent stations. For Fennoscandia the BIFROST dataset (Lidberg, 2010) and North America the dataset from Sella, 2007 were used respectively. We perform GIA modelling with the SELEN program (Spada and Stocchi, 2007) and we vary ice model parameters in space in order to find ice model which suits best with uplift values obtained from GNSS time series analysis. In the GIA modelling, the ice models ICE-5G (Peltier, 2004) and the ice model denoted as ANU05 ((Fleming and Lambeck, 2004) and references therein) were used. As reference, the velocity field from GNSS permanent station time series was used for both target areas. Firstly the sensitivity to the harmonic degree was tested in order to reduce the computation time. In the test, nominal viscosity values and pre-defined lithosphere thicknesses models were used, varying maximum harmonic degree values. Main criteria for choosing the suitable harmonic degree was chi-square fit - if the error measure does not differ more than 10%, then one might use as well lower harmonic degree value. From this test, maximum harmonic degree of 72 was chosen to perform calculations, as the larger value did not significantly modify the results obtained, as well the computational time for observations was kept reasonable. Secondly the GIA computations were performed to find the model, which could fit with highest probability to the GNSS-based velocity field in the target areas. In order to find best fitting Earth viscosity parameters, different viscosity profiles for the Earth models were tested and their impact on horizontal and vertical velocity rates from GIA modelling was studied. For every tested model the chi-square misfit for horizontal, vertical and three-dimensional velocity rates from the reference model was found (Milne, 2001). Finally, the best fitting models from GIA modelling were compared with rates obtained from GNSS data.

Keywords: Fennoscandia, North America, land uplift, glacial isostatic adjustment, visco-elastic modelling, BIFROST.

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