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Estimating the Impacts of DEM Uncertainty on Ice Sheet Model Results

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Ice sheet model results have been shown to be susceptible to DEM uncertainties of various sources. Resampling of DEMs to resolutions suitable for ISM input as well as errors inherent in the DEM data itself create uncertainties that effect model outcomes despite the relative low resolutions of the order of 5-20km many ISM are running on. Sensitivity analysis and error propagation tests can be performed in order to assess the impact of DEM uncertainty on ISM models. However, for realistic and sensible sensitivity testing, information on the properties of the uncertainties, including magnitude and frequencies, as well as spatial distributions are necessary. Commonly, DEM data products are distributed with limited information on error or uncertainty, such as global RMSE or standard deviation values for large areas. Where no higher accuracy reference data is available, these global values often result in unrealistic and unverifiable assumptions about the distribution and spatial autocorrelation of the modelled uncertainty. Using SRTM as a set of higher accuracy reference data provides an opportunity to test ISM runs previously conducted using older, but widely distributed and less accurate DEM data such as GLOBE and GTOPO30. However, as SRTM is only available up to 61deg N, many areas used in cryosphere modelling are not covered. Therefore, in order to test the impact of GLOBE DEM uncertainty on an ice sheet simulation over Fennoscandia using the GLIMMER ISM, uncertainty surfaces with sensible values and distributions of simulated error had to be constructed without available reference data. We approached this problem by assessing GLOBE error properties for regions with elevation distributions analogous to the Fennoscandian region, where SRTM data was available to be used as ground truth. In this way, GLOBE error surfaces for a range of regions were derived and correlated with a suite of terrain properties, landscape indices and data sources. These analyses resulted in the formulation of an uncertainty model using linear regression which reproduces the amount and

spatial distribution of GLOBE uncertainty using deterministic as well as stochastic elements, and thus producing uncertainty surfaces suitable for sensitivity testing using Monte Carlo Simulation. Using the new uncertainty model, a suite of uncertainty surfaces have been produced for Fennoscandia and added to the original topography. These surfaces are currently used as input for the GLIMMER ISM, conducting sensitivity tests using different climate scenarios.

The developed uncertainty model thus enables realistic modelling of uncertainty for GLOBE DEM data without use of higher accuracy reference data. The error model can thus also be applied to analyse the impact of DEM uncertainty on previous ISM runs for other regions.