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New DEMs of glaciers deduced from InSAR satellite data

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We use InSAR data from the ERS1/2 tandem mission to improve digital elevation model (DEM) of 400 km^2 area of Vatnajökull ice cap, Iceland. The existing model of this area, located in the accumulation area of S-Vatnajökull, is mostly based on maps since the 1930's. The phase signal in a topographically corrected InSAR scene consists of signal due to line of sight (los) displacement and residual topographic error in addition to errors caused by variable conditions in the atmosphere. By combining 4 or more InSAR scenes showing the same 3-dimensional velocity and topographic error we are able to derive a solution for the 3 velocity components, V_e, V_n and V_u, (the indices stand for east, north and up) plus the topographic error, dz. Using scenes from both ascending and descending orbits, with variable perpendicular baseline, V_e and dz should be accurately determined while V_n and V_u are poorly determined due to the unfavourable observation geometry. In our study we use 14 scenes from 1995 to 1997 and determine a smooth solution using Markov random field (MRF) regularization, optimized with simulated annealing. The dataset fulfils the above geometry condition and we use only scenes from winter in order to observe as constant velocity as possible. The 2 year time interval is short enough for the elevation change to be less than 5 m within the period in the accumulation area of the glacier. The derived correction for the DEM varies between -80 m and 65 m. Assuming that the residual error in each InSAR scene is less than half a fringe, the derived uncertainty for each pixel of the computed DEM is around 9 m. This appears to be rather generous estimate for the

slower part of the glacier, according to comparison with GPS-data and small elevation corrections in areas with elevation based on DEM from 1998. In contrast, we don't derive a reasonable solution for the fastest part of the glacier where the horizontal velocity is higher than 0.5 m/day, presumable due to variability in the flow rate. The method may have wider application for mapping remote glaciers in the Polar Regions.