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TITLE: GIA around Vatnajökull ice cap, Iceland: InSAR data and finite element modeling

SESSION TYPE: Oral

SESSION TITLE: G21C. InSAR Applications for the Detection of Crustal Deformation I

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ABSTRACT BODY: Interferometric Synthetic Aperture Radar (InSAR) measurements have been used to study Glacio-Isostatic Adjustment (GIA) all around Vatnajökull ice cap in Iceland. It is the largest ice cap in Europe (area of 8100 km^2 and maximum thickness of 900 m) and has been retreating since the end of the Little Ice Age in 1890. Uplift due to this ongoing response to climate warming has induced significant rebound in the south-eastern Iceland. It has been mostly studied with GPS data in the past few years, which indicate an uplift of up to 20-25 mm/yr close to the edges of the ice cap.

InSAR is a phase differencing technique with a good spatial coverage, providing in our case more data to retrieve information about the Earth structure and ice model. Deformation observed at the surface is in Line-Of-Sight (LOS) direction, meaning that the signal is a combination of vertical and horizontal movements. Because the angle of incidence is small (~23° for ERS and Envisat), the signal is mostly dominated by vertical motion. The aim of the project is to increase the knowledge on the rheology of the Earth beneath Iceland. For that purpose, 150 InSAR images from both ERS 1 and ERS 2 (spanning 1992 to 2002) and Envisat (2004 to 2009) satellites were processed and time series and LOS velocity plots obtained. The whole ice cap and its surroundings are covered using both ascending and descending tracks. Finite element method is then applied to model the GIA process and find a best-fitting model.

The InSAR data reveal the full extent of the GIA pattern around the ice cap with greater details than observed before. The gained information close to the edge of Vatnajökull is valuable as it is where the numerical models are more sensitive to the Earth structure. We observe a significant difference in uplift velocities from neighboring outlet glaciers, attributed to a difference in melting rates, which couldn't be detected by other methods. The LOS velocity plots give uplift rates of ~13 mm/yr for the earlier period and ~17 mm/yr for the later. Other processes are affecting the results, such as glacial surges and volcanic intrusions/eruptions. Modeling is done with the Abaqus software, assuming a flat Earth, incompressible isotropic materials and two layers (an elastic crust underlain by a viscoelastic layer). The ice model assumes variable melting rate for Vatnajökull and a constant rate for the other ice caps in Iceland. Each model result is converted to the LOS geometry and compared with each InSAR scene. The fit is estimated using the chi-square method. First results show that models with a crust thickness between 10 to 20 km and a viscosity of 8 to 10x10^18 Pa s are in best agreement with the data. This is comparable

with what has been found in previous studies. Further modeling will look into non-linear rheology and crust thickness variation from the ridge axis outwards. The response would differ from east to west, as suggested by the InSAR results. We aim at refining both the Earth and ice models.

KEYWORDS: [1240] GEODESY AND GRAVITY / Satellite geodesy: results, [0720] CRYOSPHERE / Glaciers, [8159] TECTONOPHYSICS / Rheology: crust and lithosphere, [0545] COMPUTATIONAL GEOPHYSICS / Modeling.

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