



Glacial isostatic adjustment in NW Europe: Constraints provided by InSAR and GPS observations

Zhenhong Li* and Paul Bishop
*Zhenhong.Li@ges.gla.ac.uk

Glacial isostatic adjustment (GIA) is the response of the solid Earth to the large-scale changes in surface mass load brought about by the glaciation and deglaciation of the planetary surface. As an example, the present GIA deformation rate in Fennoscandia is more than 10 mm/yr in the vertical direction whilst the horizontal displacements are about 1-3 mm/yr. It is believed that GIA deformation maps provide insight into (1) the viscosity structure of the mantle, (2) the space-time geometry of Late Pleistocene glaciation, (3) global or regional sea level trends and (4) regional seismic hazards. GPS has been proved to be a powerful space geodesy technique to map first-order features of regional GIA deformation, but it is usually limited by the spatial coverage and density of existing regional GPS networks.

Interferometric SAR (InSAR) can also be used to map changes in the Earth's surface from space, utilizing the phase differences in complex (magnitude and phase) Synthetic Aperture Radar (SAR) images acquired in similar geometric conditions, but at two different epochs, to measure range changes in the radar line of sight to the satellite. This can be done with sub-centimetre precision and tens-of metres horizontal spatial resolution over large regions (e.g. 100 km × 100 km). With its global coverage and all-weather imaging capability, InSAR is revolutionizing our ability to image the Earth's surface and the evolution of its shape over time. In turn, this has led to many new insights into geophysical and engineering processes, including volcanoes, earthquakes, landslides and mining activity.

As a space geodetic technique, conventional InSAR is limited by two major factors: (a) decorrelation and (b) atmospheric effects. There have been two broad categories of InSAR time series techniques to address these two limitations: (a) Small baseline subset InSAR (SBAS) and (b) Permanent Scatterers InSAR (PSI). In the University of Glasgow, a SBAS-based InSAR Time Series with Atmospheric Estimation Model technique (InSAR TS + AEM) has been developed with two notable features: (1) partially coherent pixels are explored in time series analyses, together with fully coherent pixels over time; (2) no deformation model is required to separate deformation signals from atmospheric effects, as the latter are estimated based on their turbulence and (partly) topography-dependent features.

What the project involves. The principal aims of this project are:

- (1) to develop InSAR TS + AEM further to combine both SBAS and PS approaches to extract deformation signals at more coherent points;
- (2) to optimize time series algorithms to make it possible to process multiple images with a wide coverage (if necessary by integrating InSAR with continuous GPS observations);
- (3) to correct tide gauge records by comparing with InSAR/GPS solutions so as to determine present-day sea level trends in the study region.

Training. The student will receive training in space geodesy techniques, in particular the handling of satellite radar and GPS data, and in modelling the mechanics of glacial isostatic adjustment. Training in a wide range of generic skills to prepare the

student for life as a PhD student and afterwards is provided by the Faculty of Physical Sciences Graduate School. The student will join the Department's Earth Systems Research Group, be an affiliated member of Scottish Alliance for Geoscience, Environment and Society (SAGES), and a member of the Dynamic Earth and Geohazards research group in the UK's National Centre for Earth Observation. S/he will thus benefit from the shared expertise of Geosciences staff in several university departments, and will attend regular meetings where the research of these various groups is presented and discussed.

Application procedure and deadlines

To be considered for PhD studentships to be held in the School of Geographical and Earth Sciences (GES), suitably qualified candidates should apply via the website of the College of Science and Engineering (<http://www.gla.ac.uk/colleges/scienceengineering/graduateschool/prospectivestudents/essentialinformation/>). Closing dates for University and research council funded studentships will be in early in the new year, as stated on the GES studentships page: (<http://web2.ges.gla.ac.uk/~mlee/GES%202010%20studentships>).

Non- English speakers must meet the University's English language requirements. Candidates for NERC studentships should also meet the NERC's requirements for both academic qualifications and residential eligibility. For more information go to <http://www.nerc.ac.uk/funding/application/studentships> and please note that *non-UK European Union citizens will be awarded fees only by NERC.*

For informal enquiries about the research projects please contact the relevant supervisors. Information on the GES graduate school and the application process can be obtained from Mrs Jean McPartland, the assistant to head of the School (Jean.McPartland@glasgow.ac.uk), or Professor Susan Waldron (Susan.Waldron@Glasgow.ac.uk), the head of the GES graduate school.