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Is Glacial Isostatic Adjustment continuing in Scotland? Insights from InSAR and GPS observations

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Understanding the effects of Glacial Isostatic Adjustment (GIA) in Scotland is essential for the assessment of past and future sea-level trends around the coast. Against the backdrop of climate change and the global rise of sea-levels caused by the ocean's thermal expansion and global melt-water influx, the question arises as to what are the modern rate and spatial distribution of GIA-related crustal uplift in Scotland. This is especially important, since the process of glacial rebound has generally slowed throughout the Holocene. If land uplift in Scotland is now outpaced by eustatic sea-level change, new concerns about the impact on Scottish coasts need to be addressed. Glacial rebound in Great Britain has been extensively examined in the past utilising a variety of measurement and modelling methods. This concerns the reconstruction of long-term Holocene relative sea-level change with geological evidence, which informed theoretical GIA models. Furthermore, modern rates of GIA have been measured with different geodetic techniques, mainly Continuous GPS (CGPS) and Absolute Gravimetry. The purpose of this study is to test the application of an Interferometric SAR (InSAR) time-series technique, the Small Baseline approach, in order to determine recent rates of GIA-induced vertical land motion with a high accuracy and precision (in the mm/yr level or better) and on a broader spatial scale than conventional geodetic techniques. The continuous two-dimensional monitoring capabilities of InSAR provide the advantage of measuring vertical land motion directly over large areas, in contrast to techniques that focus on single point measurements and spatial interpolation.
Different SAR sensors are utilized to cover a time frame of about 20 years, such as ESA's ERS-1/2, ESA's Envisat ASAR and JAXA's ALOS PALSAR. A range of possible error sources within the InSAR processing chain, that lead to orbital and atmospheric artefacts, require to be addressed in order to allow the extraction of any GIA deformation signal. To reduce orbit errors in the InSAR interferograms, an extended network correction technique has been tested with good results. In a next step, CGPS station coordinate time-series need to be integrated with the InSAR data to allow separation of vertical land motion and image artefacts.
Due to an engagement with Scottish Natural Heritage, this project also provides a platform for translating the results of the science into forms meaningful for agencies and land managers in order to inform future coastal planning purposes.