A new global dataset of vertical land movement due to glacial isostatic adjustment

Plain language summary

Glacial isostatic adjustment (or GIA) is the ongoing response of the Earth's surface following the last ice age around 20,000 years ago. At this time, the weight of ice sheets deformed the land beneath them; a process which the Earth's crust continues to recover from today. Estimating and predicting GIA is difficult because of large uncertainties about exactly how much ice there was, where it was located, and the way in which the Earth's surface responds.

A global network of fixed Global Positioning System (GPS) stations record how the surface of the Earth moves up and down through time. These records include the effects of GIA but also measure other causes of vertical land motion – such as earthquakes and local land subsidence due to water extraction – which can obscure the underlying GIA signal.

In this study, a new method is developed to identify and remove non-GIA artefacts from GPS data. First, vertical land movement data from global GPS stations are processed for jumps (offsets in the measurements) and outliers (data points that are far outside the expected range of values). Second, results from a range of different GIA models are used to identify and exclude GPS stations which show rates of vertical land movement that are greater than can plausibly be explained from GIA alone. Finally, remaining GPS stations exhibiting local non-GIA effects (e.g. earthquakes or water extraction) are identified and removed by comparing the measured rate of vertical land movement with the average rate obtained from nearby stations.

Various corrections are also made to the GPS datasets to take into account other global geophysical processes which are known to affect GPS measurements, such as atmospheric pressure, the response of the Earth's surface to more recent changes in ice and oceans, and an eastward shift in the Earth's rotational pole.

This leaves a dataset of around 4,000 GPS stations, from which the records of vertical land movement are assumed to be dominated by GIA. The spatial pattern of GIA from this dataset is then compared with 13 global GIA models, with the largest discrepancies found for Antarctica and Greenland where GIA models are known to be most uncertain..

Full paper (open access): Schumacher M, King MA, Rougier J, Sha Z, Khan SA and Bamber JL (2018) A new global GPS dataset for testing and improving modelled GIA uplift rates, Geophysical Journal International ggy235 (DOI: 10.1093/gji/ggy235)

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Funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 694188

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