

EGU2020-9957

<https://doi.org/10.5194/egusphere-egu2020-9957>

EGU General Assembly 2020

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## Denoising Swarm Geomagnetic Virtual Observatories using principal component analysis

Grace Cox<sup>1</sup>, Will Brown<sup>1</sup>, Ciaran Beggan<sup>1</sup>, Magnus Hammer<sup>2</sup>, and Chris Finlay<sup>2</sup>

<sup>1</sup>British Geological Survey, Geomagnetism, United Kingdom of Great Britain and Northern Ireland (gcox@bgs.ac.uk)

<sup>2</sup>Technical University of Denmark, National Space Institute, Denmark

Geomagnetic Virtual Observatories (GVOs) use satellite measurements to provide estimates of the mean internally-generated magnetic field (MF) over a specified period (usually one or four months) at a fixed location in space, mimicking the mean values obtained at ground-based observatories (GOs). These permit secular variation (SV) estimates anywhere on the globe, thereby mitigating the effects of uneven GO coverage. Current GVO estimates suffer from two key contamination sources: first, local time sampling biases due to satellite orbital dynamics, and second, MFs generated in regions external to the Earth such as the magnetosphere and ionosphere. Current methods to alleviate this contamination have drawbacks: Averaging over four months removes the local time sampling bias at the cost of reduced temporal resolution

- Stringent data selection criteria such as night-time, quiet-time only data greatly reduce, but do not entirely remove, external MF contamination and result in a small subset (<5%) of the available data being used
- Removing model predictions for external MFs from the measurements also reduces noise, however such parameterisations cannot fully describe these physical systems and some of their signal remains in the data.

Here we present an alternative approach to denoising GVOs that uses principal component analysis (PCA). This method retains monthly resolution, uses all available vector satellite data and removes contamination from orbital effects and external MFs. We present an application of PCA, implemented in an open-source Python package called MagPySV, to new GVOs calculated as part of a Swarm DISC project. The denoised data will be incorporated into a new GVO data set that will be available to the geomagnetism community as an official Swarm product.