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Removing the auroral oval 'noise' from the crustal field 'signal' in satellite magnetic data

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Satellites in Low Earth Orbit measure a superposition of magnetic fields from many different sources. Separating the sources to estimate the contribution of each is difficult, as the individual sources have different spatio-temporal signals. In particular, the magnetic fields driven and produced by external sources (e.g. space weather) are both highly variable on short periods (seconds to days) and difficult to predict over wide areas. After removing a core field model, data taken at satellite altitudes are dominated by these contributions at high latitudes, masking small signals from the quasi-static crustal field. However, long time-series of data from repeated measurements can be used to isolate the steady crustal source.

We explore strategies for determining accurate models of the crustal field for the polar regions in particular, as these areas are most contaminated by the strong disturbance caused by field-aligned currents (FAC) and auroral electrojets (AEJ). We examine the role of data selection using activity indices and solar wind conditions in relation to the driving factors of FAC/AEJ activity to remove the impact of the external field in crustal models. There are seasonal and solar cycle modulations of the baseline activity in the AEJ, as well as hemispheric asymmetries, which cause biases in satellite datasets and hence are detrimental to internal field modelling. Using data from the current Swarm mission, we assess the accuracy of contemporary crustal field models and suggest future strategies for overcoming the external field biases at high latitude.