Quantifying the Latitudinal Extent of the Aurorae During Large Geomagnetic Storms

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As geomagnetic storms grow larger, the extent of the auroral ovals can be seen to travel further towards the equator. During the famous Carrington event for example, the aurora was reportedly seen as far South as Cuba. Accompanying the auroras are large electric currents in the ionosphere. The magnetic signature of these ionospheric currents can be detected on the ground in magnetic observatories around the world in the form of increased magnetic variations. These variations can lead to large local geoelectric fields, posing a risk to the operation of power networks around the world.

It is therefore necessary to estimate the extent of the aurora and accompanying geoelectric fields during infrequent and large-scale (1-in-100 year) events. Using three decades of historical geomagnetic data from around the world, we have developed a method to detect and quantify the extent of the auroral oval (or latitude threshold) using ground-based data. We use this to statistically estimate the southernmost extent for storms with Dst values < -600 nT, as well as the geoelectric field strengths at these latitude thresholds.

In addition, building on the work by Ngwira et al. (2014) by using magnetospheric and ionospheric magnetohydrodynamic simulations, we simulate 'worst-case' scenario superstorms of different magnitudes. Applying our threshold detecion to the magnetic field outputs of these simulations enable us to estimate the latitude thresholds for storms of magnitudes not seen in the modern era.

Keywords: Aurora, Geomagnetism, Geostorms

