Historical Analysis of Geomagnetic Storm Scales in Austria

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Geomagnetically induced currents (GICs) can affect power transmission grids in the form of power operation problems in mild cases and power blackouts in extreme cases. To quantify the risk for Austria, we carried out an analysis of historical geomagnetic field measurements from recent years - since the Conrad Observatory only spans the past five years, this was extended to 25 years by using the data from nearby Fürstenfeldbruck in Germany. Using a model of GICs validated using Conrad Observatory data and GIC measurements, we can estimate the scales of GICs during larger geomagnetic storms.

As a mid-latitude country, Austrian is not expected to suffer greatly during geomagnetic storms as many countries in higher latitudes do. Regardless, geomagnetically induced currents have been found to affect the Austrian power grid and studies are being carried out on the kinds of scales that can be expected during rare and powerful geomagnetic events.

Measurements from the Conrad Observatory over the past years have been used to build and validate a model of geomagnetically induced currents in the Austrian power grid. This model takes geomagnetic variations and computes the geoelectric field induced in the Earth, which is represented by a 1D layered half-space reaching into the ground. The geoelectric field is then fed into a virtual model of the power network, and the currents at each network node (i.e. transformer) are calculated. It has been possible to validate this model by comparing the results to measurements of DC in transformers across Austria.

However, the past years have been relatively quiet with regards to geomagnetic activity and our modelling does not provide estimates of the GICs that would occur during larger and potentially damaging storms. For this, we need a dataset that reaches back further into the past. The data at the Fürstenfeldbruck (FUR) observatory has a high correlation (>0.9 in dB/dt) with that at the Conrad Observatory due to the similar latitudes of the two locations. With minute data reaching back to 1995, it is a useful proxy for the variations we would have expected to see in Austria.

An analysis carried out on FUR geomagnetic data shows that there were dB/dt values of up to 180 nT/min in the East-West direction and 90 nT/min in the North-South direction. As a result, power grid substations susceptible to variations in the East-West direction can be expected to suffer from larger GICs. The largest geomagnetic event of the past 25 years was the 2003 Halloween storm, and with FUR data we were able to model the GICs that likely occurred during that storm, plotted in Fig. 1. At a station near Vienna, the values reach 25 A (middle panel). Generally, DC above 10 A is expected to affect transformer operation. The sum of minute-value GICs over consecutive half-hour periods (lower panel) are around 200 A early on the 29th and late on the 30th of October, showing that there were times of sustained GICs that could lead to eventual overheating problems.

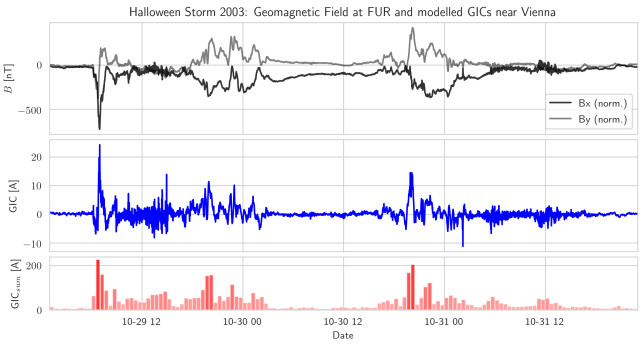

Figure 1: The 2003 Halloween storm (2003-10-29 till 2003-10-31) geomagnetic field variations at Fürsternfeldbruck (top), along with the GIC values computed at one substation transformer in Austria in values over time (middle) and the cumulative GICs over half-hour sections (bottom).

Using the estimates from the past 25 years, we can extrapolate to larger geomagnetic storms such as the Carrington event, where GICs in Austria would be estimated to reach up to a few hundred ampere. What effect currents of this size would have on power operations is a topic that will be investigated in the next years.

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