SOURCE EFFECTS CAUSING NON-STATIONARITY IN LONG-TERM MID-LATITUDE MAGNETOTELLURIC DATA

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Magnetotellurics (MT) works on the condition that the natural source signals exploited for it are homogeneous, i.e., that the so called far-field condition is met by the source signals. This assumption is not always fulfilled since some natural source signals are not homogeneous. In this case, so called source effects appear in transfer functions (TFs) derived from inappropriate signals leading to distorted results and possibly erroneous interpretation of the subsurface electrical structure. Unlike suggested in the older literature such source effects are not limited to polar regions and equatorial electrojet regions. Newer literature shows that such effects are visible in other locations too for example mid-latitude regions. The most obvious way to recognize source effects is that they produce temporal changes in transfer functions which cannot be explained by subsurface conductivity changes. Hence to observe them one needs long-term monitoring magnetotelluric data.

Magnetotelluric Measurements:

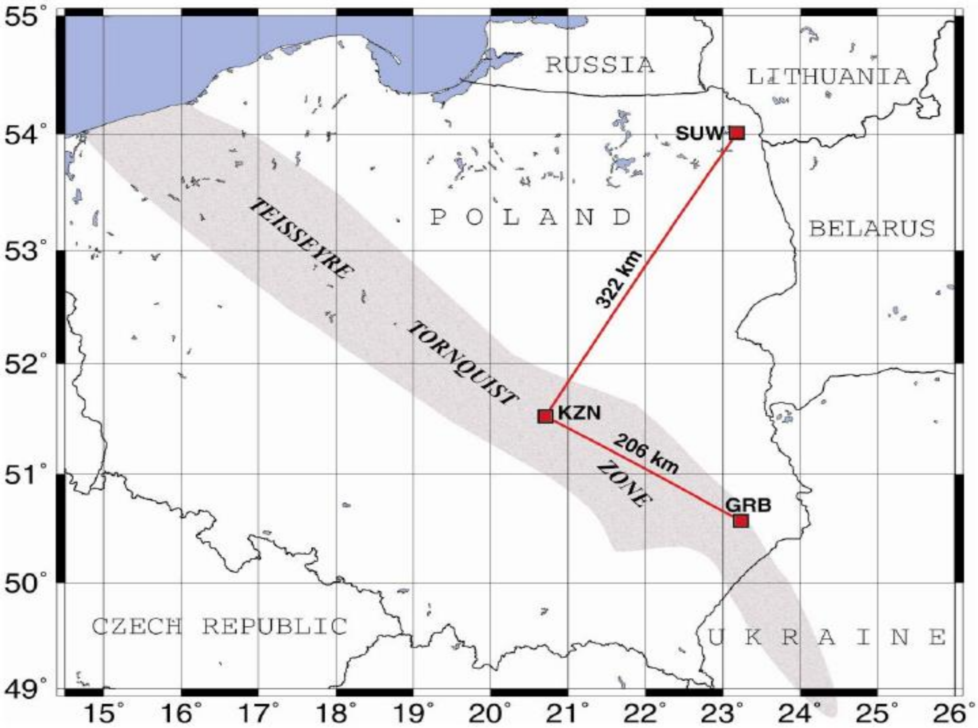

Figure 1: Location of GRB and SUW stations

Here we considered two long-term data sets from Poland of more than two years length to investigate the source effects. The two stations are Grabnik (GRB) and Suwałki (SUW). GRB is located at $50^0$34' latitude and $23^0$14' longitude. SUW is located at $54^0$01'latitude and $23^0$11' longitude as shown in Figure1. We have data starting from 25th November 2015 to 2nd April 2018 approximately, with some gaps. The data quality of both stations is quite good compared to the general noise level in Poland since sites located far from larger settlements have been chosen.

Sounding curves:

The two long-term magnetotelluric time series data have been divided into smaller pieces. Each fragment consists of 14 days long time series data. These fragments are further processed with Egbert's processing and least square processing. The remote reference technique has been applied as well. Transfer functions for each fragment have been calculated. Now the time-dependent set of sounding curves are produced. Figure2 represents the sounding curves of April 2017.

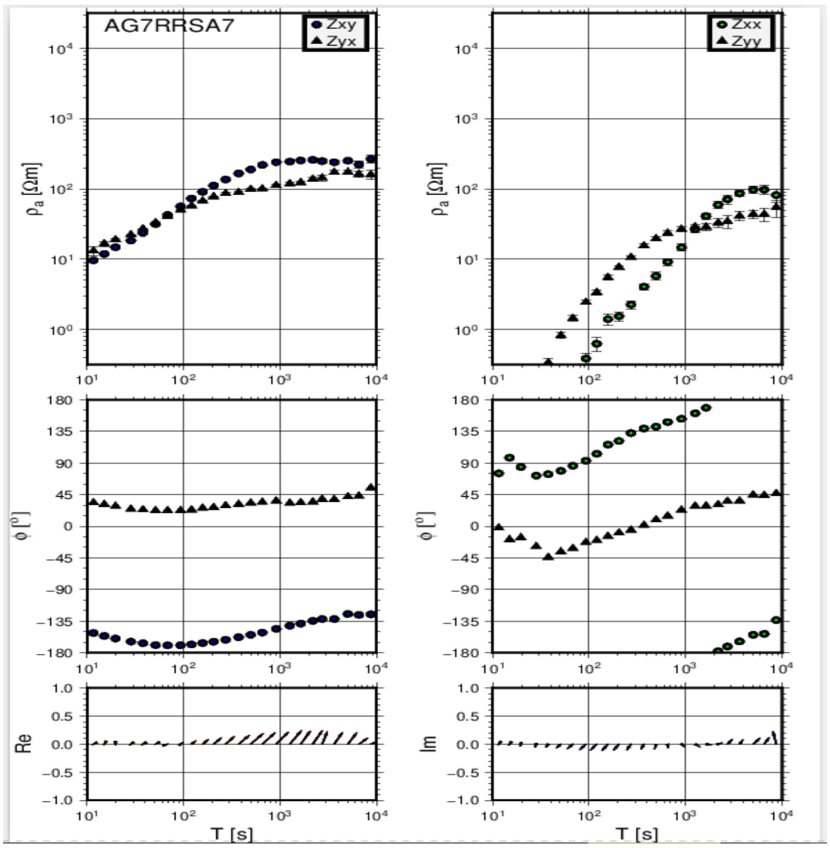

Figure2: The sounding curves shown are of GRB station for April 2017 with SUW as remote reference (Egbert's processing) (2).

Time-dependent transfer functions:

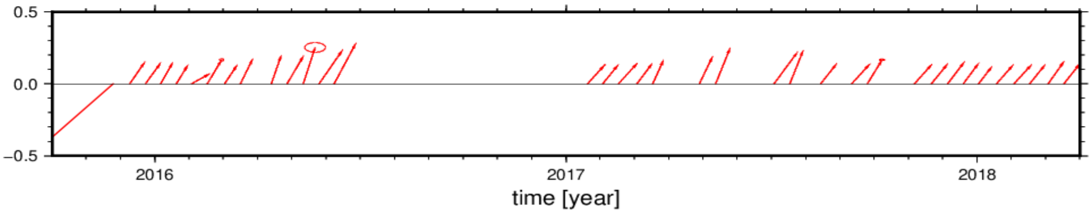

Figure 3: GRB real induction arrows (4000s)

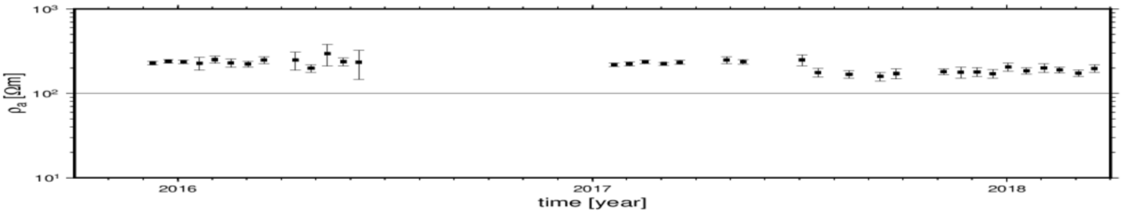

Figure 4: GRB XY components of apparent resistivity (4000s)

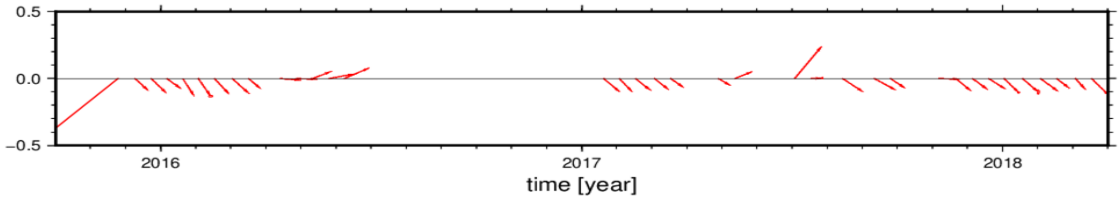

Figure 5: SUW real induction arrows (4000s)

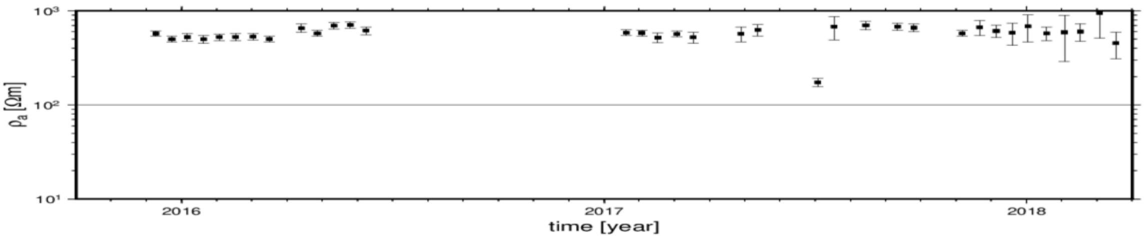

Figure 6: SUW YX components of apparent resistivity (4000s)

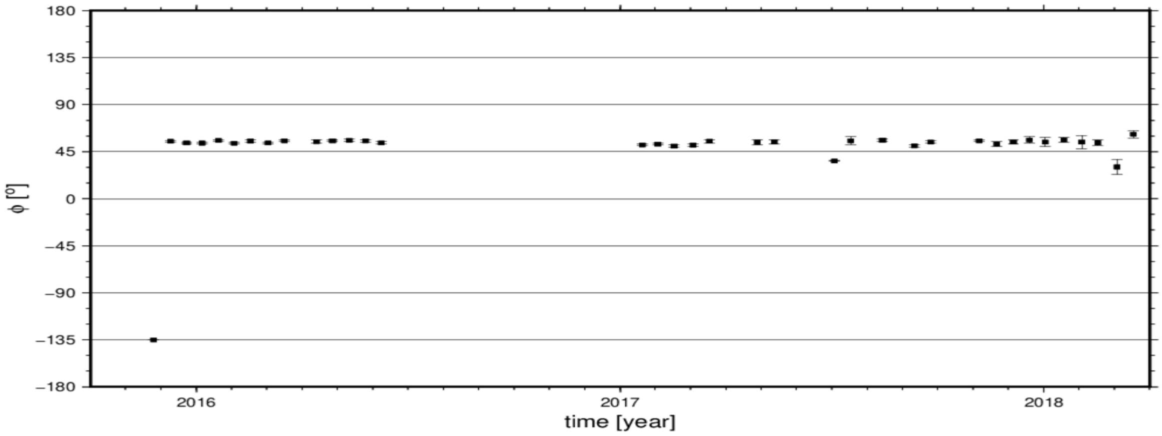

Figure 7: SUW YX components of Phase (4000s)

Here we have considered 4000s in both GRB and SUW stations for analyzing source effects. At longer periods(>1000s) the seasonal changes are visible clearly, which is why we have considered 4000s.

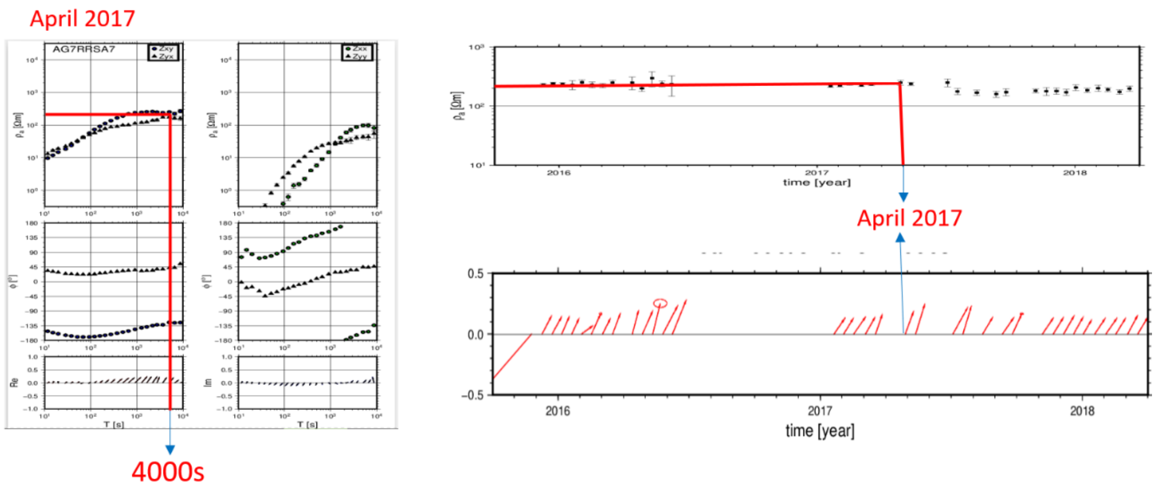

Figure 8: Picking one data point from sounding curves

The time-dependent transfer functions (Figures 3,4,5,6,7) shown are plotted by picking one data point from each fragment against time(year). Figure 8 explains the selection of one such data point at 4000s from the sounding curves of April 2017. Likewise, the data points which correspond to 4000s from all the sounding curves of GRB are plotted against time(year). In Figure3 we can see clear seasonality in induction arrows with larger north components during the summer season in 2016 and 2017 which is known from the newer literature (1,3,4).

In Figure4 we can also see a drop in GRB apparent resistivity in summer 2017 which, however, is most probably caused by instrumental effects, since it appears in all periods. In Figure6 SUW apparent resistivities there is visible (even if not very clearly) a seasonal effect similar to in induction arrows (Figure5) with larger values in the summer season. There is no clear effect in phases (Figure7).

Conclusion & Outlook:

The seasonal changes are visible in induction arrows as expected from recent literature and in apparent resistivities. However, one has to be careful with interpretation since instrumental effects may interfere in long-term MT data. We would further investigate and try to find the reason behind these seasonal changes.

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References:

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