Peculiarities from the frequency analysis of geomagnetic data at COBS

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A frequency analysis of geomagnetic time series measured at the Conrad Observatory is performed in order to identify artificial disturbing signal contributions. These disturbances are characterized by periods of 900s and corresponding harmonics, which can be associated with trading intervals of the power grid. Variations of power consumption during the first COVID-19 lockdown and at weekends might cause strong (electro)magnetic signals with a period of 75s.

Frequency analysis tools facilitate the study and isolation of distinct periodic contributions to a recorded signal. The identification of recurring electromagnetic disturbances is crucial in order to guarantee very accurate and precise monitoring of the geomagnetic field. Therefore, time series of geomagnetic field components X (North-component), Y (East-component) and Z (Vertical-component) measured in 2020 at the Conrad Observatory with a LEMI 36 magnetometer (LEMI036_1_0002_0002) have been evaluated using the Fast Fourier Transform technique (Fig. 1).

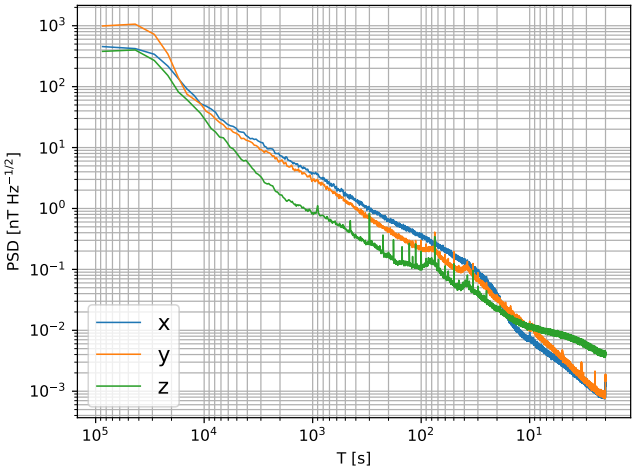

Figure 1: Median of daily power spectral densities for components X, Y and Z.

The medians of power spectral densities (PSD) determined for each day of the year 2020 reveal remarkable features for components Y and Z. Pronounced peaks in the PSD for Z are observed starting from a period T of 900s along with higher harmonics (i.e. multiples of the fundamental frequency f_0=1/900 Hz). The peak at T=75s also strongly stands out in the PSD of Y.

Trading intervals of 15 minutes (=900s) in the European power grid (Schäfer et al., 2018, https://doi.org/10.1038/s41560-017-0058-z) can be conceivable sources of detected (electro)magnetic variations. The exact physical processes – i.e. do disturbances originate directly from the power supply or from stray currents – are subject of ongoing research.

The temporal evolution of PSD Z values at T=75s over the year 2020 reveals further peculiarities (Fig. 2). In spring a steep increase of values is followed by a period of a constant high level, which is then terminated by a sudden decrease. These variations roughly coincide with the phases of the first lockdown due to the COVID-19 pandemic in Austria and might correlate with (public) power consumption. This hypothesis is supported by the fact that other peak values are often observed at weekends. However, the reason for the lack of significant effects during the lockdown phases in November and December remains open.

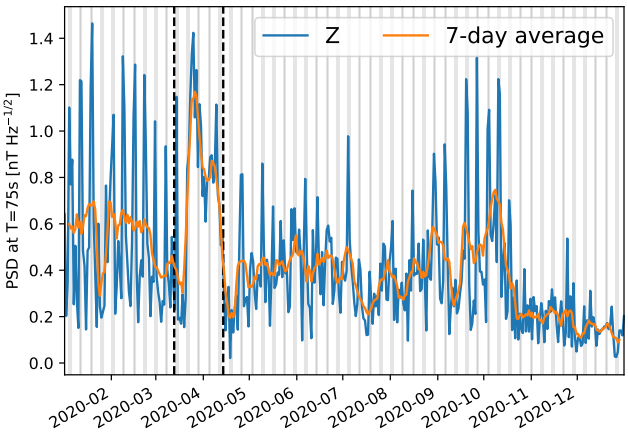

Figure 2: Temporal evolution of PSD values at T=75s over the year 2020. Dashed lines give the period of the first lockdown, while grey areas depict weekends.

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