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Test study: Can power-line emissions be used for subsurface exploration?

Motivation

The motivation of this study is to test, if power-line signals can be used as a source for electromagnetic investigations. To test this recordings of the power-line and some electric/magnetic field measurements were

obtained.

The measurements was operated with an optical pumped magnetometer suspended below an UAS around 50 Meters away from the power-line. A base station was placed 150 m away from the power-line.

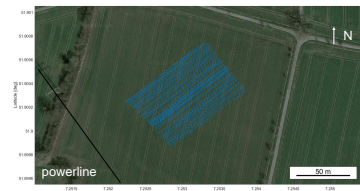


Figure 1: 2nd measurement: investigation field with flight lines and power-line

Electricity grid

In Western Europe 110 kV power-lines are operated with AC. The fundamental frequency is 50 Hz. Most commonly used power pole in Europe for 110 kV power-lines is the Donaumast. The pole has six cables, three on each side. It has a three-phase current on each side of the pole.

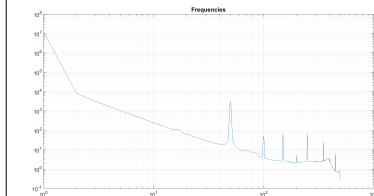


Figure 4: Frequency spectrum of the data

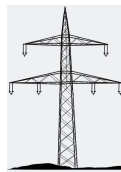


Figure 3: Schematics of a Donaumast

Electromagnetic field:

- Composed of its fundamental frequency and a range of harmonics
- strength depends on strength of the electrical currents in the cable
- strength of the currents depends on the height of instantaneous energy consumption
- Penetrate the conductive earth and induce eddy currents that are associated with the secondary electric and magnetic field



Figure 2: UAS with magnetometer

Data examples

- Variations of the total magnetic intensity were sampled at 1000 Hz.
- We calculated spectrograms with a window length of 1 s.
- Here we show the decay of 50 Hz and harmonics Fourier-coefficient away from the power-line.
- They are composed for a 100 Ωm homogeny half-space

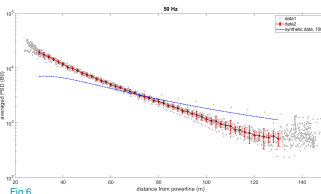


Fig.6

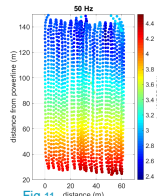


Fig.11

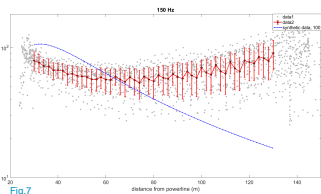


Fig.7

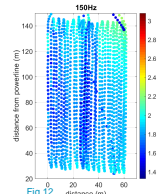


Figure 11-15: Spectral map for different frequencies

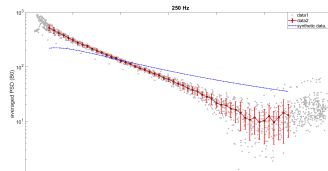


Fig.8

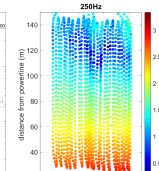


Fig.13

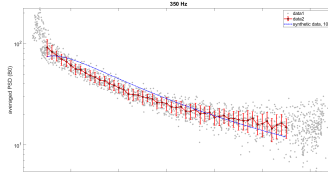


Fig.9

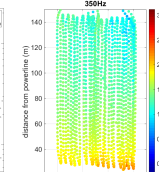


Fig.14

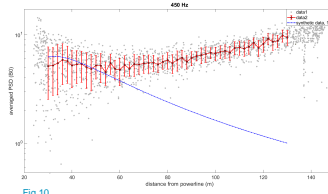


Fig.10

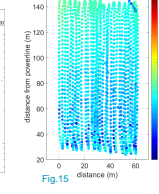


Fig.15

Conclusion

- It is possible to map the 50 Hz and its harmonics
- At the moment its not possible to draw conclusions about the ground resistivities
- The power-line could be too close to the investigation field

Outlook

- Measurements further away from the power-line
- Compare power-line data with base station data