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Calibration of EMI data based on different electrical methods

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The advantages of the electromagnetic induction (EMI)-method have been known to soil scientists for many years. Thus it is used for many soil investigations, ranging from salinity measurements over water content monitoring to classification of different soil types. There are several companies that provide instruments for each type of investigation. However, a major disadvantage of the method is that measurements obtained under different conditions (e.g. with different instruments, or at different times or field sites) are not easily comparable. Data values yielded when using the instruments are not absolute, which is an important prerequisite for the correct application of EMI, especially at the landscape scale. Furthermore drifts can occur, potentially caused by weather conditions or instrument errors and subsequently give results with variations in conductivities, which are not actually reflective of actual test results. With the help of reference lines and repeated measurements, drifts can be detected and eliminated. Different measurements (spatial and temporal) are more comparable, but the final corrected values are still not absolute.

The best solution that allows for absolute values to be obtained is to calibrate the EMI-Data with the help of a known conductivity from other electrical methods. In a series of test measurements, we studied which electrical method is most feasible for a calibration of EMI-data. The chosen field site is situated at the floodplain of the river Mulde in Saxony (Germany). We chose a profile 100 meters in length which is very heterogeneous and crosses a buried back water channel. Results show a significant variance of conductivities. Several EMI-instruments were tested. Among these are EM38DD and EM31 devices from Geonics. These instruments are capable of investigating the subsurface to a depth of up to six meters. For the calibration process, we chose electrical resistivity tomography (ERT), Vertical Electrical Sounding (VES), and vertical insitu resistivity measurements.

A model of the subsurface is derived from each of the electrical methods. The models are used with a 1D-EMI-modelling program. Finally, theoretical and real EMI-measurements are compared and adapted (if applicable).

The focus is the comparison of these methods according to their accuracy and applicability to derive true subsurface models.

As a result we could show that all method are suitable for this calibration, however resistivity-logs are slightly advantaged in accuracy, because they offer high resolution models while ERT measurement are easier to accomplish but deliver ambiguous models. A decision which method to use is dependent on demand and technical requirements.