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Calibration of EMI derived apparent electrical conductivity based on ERT measurements

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Soil electrical conductivity (ECa) is an indirect measure for various soil physical and chemical parameters. Among non-invasive geophysical methods, electromagnetic induction (EMI) appears to be the most efficient one that is able to measure ECa over large areas in short time. However, this method currently does not provide quantitative values of ECa due to calibration problems. In the calibration approach of Lavoué et al. (2010) inverted electrical conductivity data from a 120 m long ERT (electrical resistivity tomography) calibration transect were used as input parameter for an electromagnetic forward model to predict ECa measured with EMI. To further improve this calibration method we conducted a field survey within an agricultural field for crop breeding studies. The entire field (60x100 m) was mapped with the EM38-MK2 (Geonics, Ontario, Canada), an EMI system with multiple coil spacing which measures the weighted average of ECa over four depth ranges, immediately after the harvest of sugar beet. On the basis of high-resolution ECa distribution maps, an area with high contrast in ECa was selected for calibrating the EMI sensor with ERT. Along a 30 m long transect EMI measurements with two different internal calibration settings were carried out. A Syscal Pro System (IRIS Instruments, Orleans France) and 120 electrodes with an electrode spacing of 0.25 m were used to measure the apparent resistivity of soil. Post processed ERT measurements were inverted using the robust inversion method of the RES2DINV software. Quantitative EM inductions measurements were derived by linear regression between measured and predicted ECa measurements. The observed offset between the repeated EMI measurements could be removed successfully. Furthermore, shortening and focusing the ERT measurements to a specific area of interest could reduce the measurement time for calibration significantly. Prospectively, the application of a quantitative multi-layer inversion of multi-configuration EMI data will enable the detection of quantitative horizontal and vertical conductivity changes over large areas.