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Investigation and modelling of the influence of soil moisture content and soil temperature on apparent electrical conductivity

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Time-lapse shallow ground-based electromagnetic induction (EMI) measurements are often applied to monitor the dynamics of vadose zone soil water content. However, the relationship between the measured apparent electrical conductivity (ECa) and soil water content is not straightforward. First, apparent ECa reflects a depth-weighted value of the ground's electrical conductivity distribution. Linking it directly to a water content value down to a specific depth is therefore not possible. Secondly, the electrical conductivity of the bulk soil depends on the influence of several factors. The major contribution to a change in electrical conductivity is known to be caused by the amount of dissolved ions in the pore fluid, variations in soil water content and soil temperature. In addition, electrical conductivity depends on clay content. There exists no universal petrophysical relationship that relates the sum of all these parameters to electrical conductivity. The separation of the different influences remains challenging since EMI devices are applied in a non-destructive manner and profile information about soil textural properties, soil water content, soil temperature and the soil electrical conductivity is usually not accessible.
We use a time series of TDR-measured soil water contents and soil electrical conductivities together with soil temperature data measured at various depths of a soil profile at the Grenzhof test site to investigate the influence of soil water content and temperature on the soil's electrical conductivity. Subsequently, we apply forward modelling of electrical conductivity to estimate the response of the EMI device on temperature-corrected and uncorrected electrical conductivity profiles. Preliminary results show, that the influence of a change in soil water content on apparent electrical conductivity conducts only few mS/m and is often influenced by simultaneous occurring changes in soil temperature.