Documentation - Understanding soil and plant interaction by combining ground-based quantitative electromagnetic induction and airborne hyperspectral data, doi:10.1029/2018GL078658

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Files:	Data: Following data correspond to ground-based apparent electrical conductivity (ECa): F13_EMI_ECa_HCPs35.dat F13_EMI_ECa_HCPs50.dat F13_EMI_ECa_HCPs71.dat F13_EMI_ECa_HCPs135.dat F13_EMI_ECa_HCPs180.dat F13_EMI_ECa_VCPs32.dat F13_EMI_ECa_VCPs71.dat F13_EMI_ECa_VCPs118.dat Following data correspond to depth-specific inverted electrical conductivity layers: F13_EMI_Inversion_Layer1_Sigma.dat F13_EMI_Inversion_Layer2_Sigma.dat F13_EMI_Inversion_Layer3_Sigma.dat F13_EMI_Inversion_Layer1_Thickness.dat F13_EMI_Inversion_Layer2_Thickness.dat Video showing the quasi-3D EMI inversion results: 2018GL078658_F13_3LayerInversion.avi Following data correspond to airborne plant performance F13_PlantData_F760.dat F13_PlantData_F687.dat F13_PlantData_NDVI.dat Six figures that show the approximate linear regressions between soil information (electrical conductivity property) and plant performance. Documentation: this file Additions_to_2018GL078658_and_Data.pdf
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Description:	The study site (~ 1.4 ha large agricultural field, termed F13, with south-western corner coordinate E: 320683, N: 5638407 in UTM Zone 32N) is close to Selhausen (Germany) and is part of the area of interest in teh Transregional Collaborative Research Center on Patterns in the Soil–Vegetation–Atmosphere System (SFB-TR32) (Simmer et al., 2015). The ground-based electromagnetic induction (EMI) measurements were performed using the three-coil CMD-MiniExplorer used with vertical coplanar (VCP) coils with separations (s) of 32, 71, and 118 cm and the six-coil CMD-MiniExplorer Special Edition used with horizontal coplanar (HCP) coils with s = 35, 50, 71, 97, 135, and 180 cm, see additions to documentation. Both instruments are manufactured by GF-Instruments (Brno, Czech Republic). A single frequency GPS delivered spatial coordinates with low accuracy (meter range) but good precision. The recorded high resolution georeferenced ECa values of the nine coil configurations were processed as follows (see also additions to documentation). A user-defined min-max filter was applied, following the histogram filter (von Hebel et al., 2014), and a rapid change filter. Remaining outliers were visually removed. Filtered data were smoothed. A nearest neighbor interpolation regridded the qualitative ECa to maps with a spatial resolution of 1x1 m and 10609 regular nodes. The ECa maps were calibrated to obtain quantitative EMI data. We used inverted vertical electrical sounding data to predict ECa and linear regression with measured ECa obtained calibration factors. These turned the qualitative data into quantitative EMI data for inversion. The HCPs97 data contained few negative data and were not considered. To invert, we used the Maxwell-based full physical electromagnetic induction forward model (Keller & Frischknecht, 1966; Wait, 1951) in the shuffled complex evolution algorithm (Duan et al., 1993). The misfit between modeled and real data was evaluated using the L1-norm without smoothing or damping. The parallelized horizontally layered quasi-3D three-layer inversion scheme (von Hebel et al., 2014) ran on the JURECA supercomputer (Krause & Thörnig, 2016). The airborne HyPlant push-broom spectrometer (Rascher et al. 2015) passively measures sun-induced fluorescence (F) data with 1x1 m spatial resolution. The DUAL module measures radiance from 380 nm to 2500 nm. The resolution is 3 nm and 10 nm in the VIS/NIR and SWIR region for this module, respectively. The highly accurate FLUO module measures radiance from 670 nm to 780 nm with 0.25 nm resolution. To obtain quantitative maps of F at wavelength 687nm and 760 nm, we used the improved Fraunhofer line depth (iFLD) approach (Wieneke et al., 2016), a modification of the 3FLD approach (Maier et al., 2003) further developed by Damm et al. (2015). After F retrieval a 2D digital (disk) filter that uses 2D convolution was applied to reduce noise, see additions to documentation. Additionally, we calculated NDVI.

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