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Terrestrial Systems Research: Monitoring, Prediction & High Performance Computing

**Oral** presentation in Session:
**Patterns in soil-vegetation-atmosphere systems** or **Monitoring of terrestrial systems**

**Linking spatial and temporal Fluorescence patterns to soil and atmospheric properties in a heterogeneous agriculture landscape**

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There are strong interactions between soil properties, plant growth and atmosphere. We use sun-induced Fluorescence (F) to obtain information about the plant physiological status that can be linked to soil and atmospheric properties, improving our understanding of energy and matter flows.

F is a remote sensing signal closely related to the actual rate of photosynthesis and vegetation stress. It reflects functional limitations of the photosynthetic carbon gain and can be measured in solar and atmospheric absorption lines using high performance spectrometers.

We have collected data for spatial analyses using the high performance imaging spectrometer *HyPlant*, measuring in wavelength ranges 400 – 2500 nm and 670 – 780 nm with a spectral resolution of 0.26 nm. Data were recorded with a spatial resolution of 3 m per pixel for the entire region (ca. 14×14 km2) and with a 1 m resolution for the Selhausen area (ca. 1.5×5 km2) that was better characterized, in particular in terms of the land use classification, soil properties and had an Eddy Covariance (EC) tower.

The data was processed using iFLD (Improved Fraunhofer Line Discrimination) and SFM (Spectral Fitting Method). We investigated the within- and between-species variability of red and far-red fluorescence and vegetation indices. We have chosen fields with the same crop type and found the distributions of F for the main most active regional crops at the measurement time such as sugar beet, potato and corn. We have found that the variability of the red and far-red fluorescence, PRI and Simple Ratio vegetation indexes is normally distributed. Broader distributions are caused by structural effects (growing canopies) or canopy senescence.

For the first time we have shown that the within-field inhomogeneity of F caused by differences in plant performance is related to specific subsurface structures obtained by multi-coil EMI data inversions. The electrical conductivity of the ploughing layer showed minor correlation to fluorescence data, while the correlation between the subsoil conductivity and far-red fluorescence indicate a significant influence of the subsoil on the plant performance, especially during dry periods.

In addition to spatially resolved airborne data measured once per year, temporally-resolved passive measurements of F for the chosen crop (sugar beet) were performed in 2017 from the middle of June to the end of October using the hyperspectral field instrument FloxBox. The FloxBox was installed on the same location as the EC tower to allow linking the plant functioning and atmospheric changes.

A huge dataset collected and processed during the last years allows us performing deep analyses of interactions within the system soil-plant-atmosphere.