Mobile Wireless Sensor Networks for Ground Truthing Multispectral Remotely Sensed Data

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Motivation

Inferring conditions about the earth's surface using remotely sensed electro-optical measurements almost always requires the use of ground truth data. Due to the heterogeneity and diversity of the land cover, as well as the distinctions in spectral and geometric resolution of various remote sensing applications an adaptive ground-based reference system is required for an adequate calibration and validation of the data. Wireless sensor networks are a promising application for a sufficient solution of ground truthing multispectral remotely sensed data. Due to the quick installation and their self-organising behaviour iterative optimal sampling strategies can be performed straightforward. Especially the improvement of atmospheric corrections as well as resampling algorithms of single multispectral channels or derived vegetation indices are great potentials for the data quality management of remote sensing products.

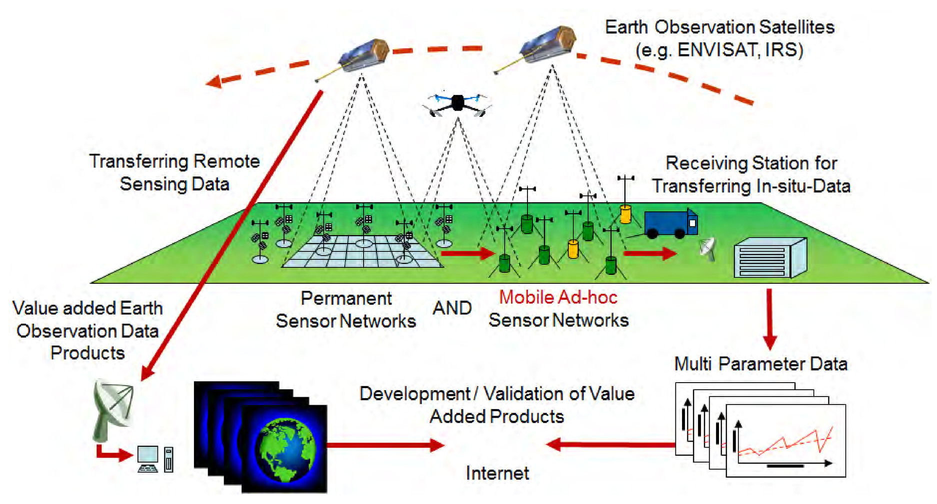

Figure 1: Automated sensor network (after Borg, 2013).

Test Sites and Experimental Setup

Bad Lauchstädt

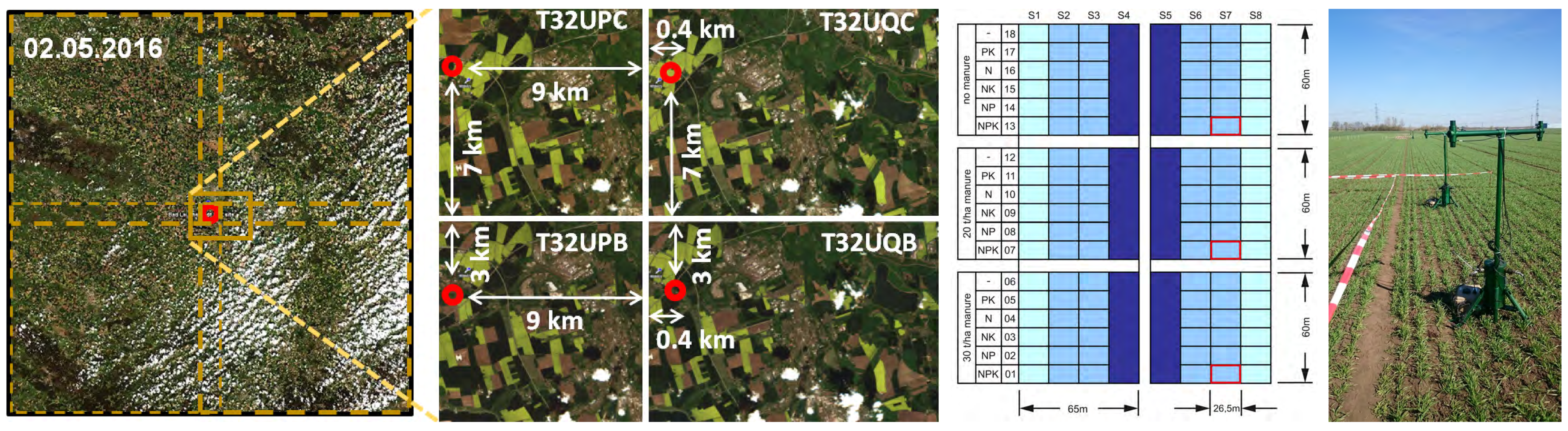

Figure 2: Left: Image of Sentinal 2a of the test site near Bad Lauchädt, Germany. Right: Scheme of the static fertilisation experiment structure at the test site and an image of the installed wireless sensor network. The detected wavelengths of the multichannel sensors during the experiment were 550, 665, 740 and 770 nanometres for calculating a Nitrogen Reflectance Index (NRI) for spring barley. In addition, full (400-2500 nm) reflectance spectra on plot and leaf level were recorded during Sentinel 2a flyovers.

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Figure 3: Left: Satellite image of the test site near Demmin, Germany. Right: Image of the wireless sensor network transect with increasing distance to the branch of the Peene river. The detected wavelengths of the multichannel sensors during the experiment were 665, 705, 740 and 865 nanometres for calculating a Normalized Difference Vegetation Index (NDVI) for canola.

Results

Bad Lauchstädt

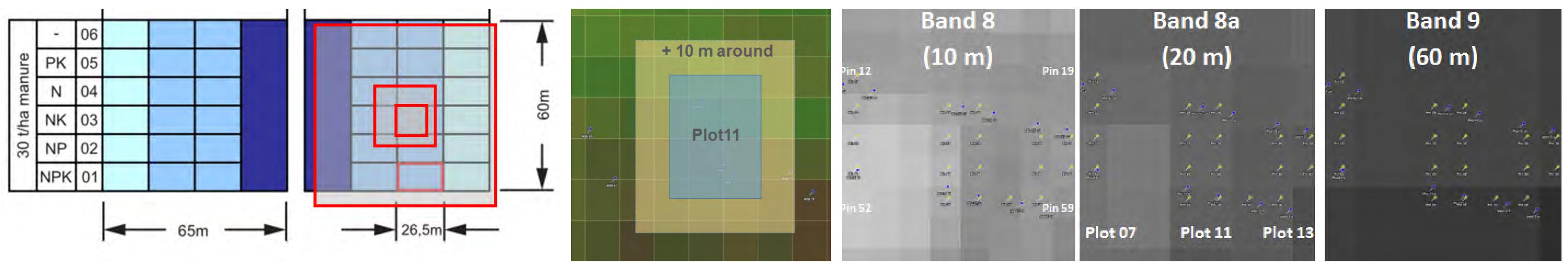

Figure 4: Left: Spatial matching of Sentinel 2a channels 8, 8a, 9 and the plots as well as the geolocation uncertainty. Right: Native spectra resolution for area of each 10 m-pixel within the given plot corner coordinates.

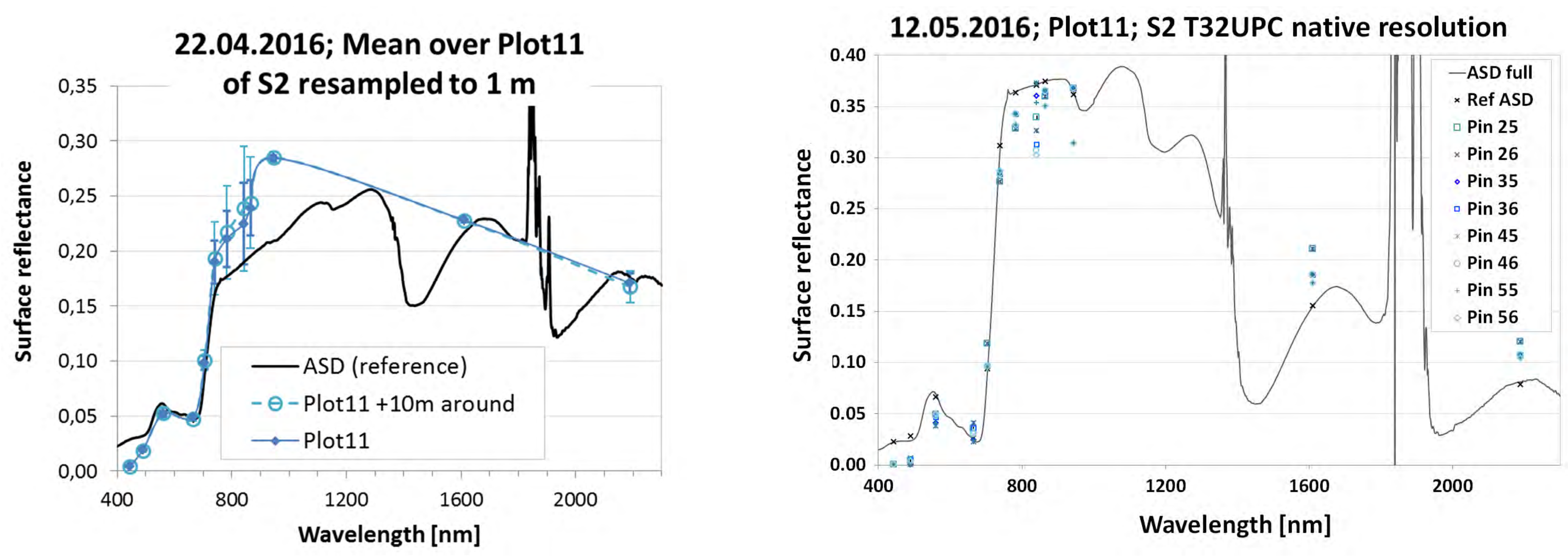

Figure 5: Left: Averaged reflectance of the whole area of plot 11 and extended averaged reflectance (12m in each direction to get SR variation) of resampled (1m) S2a-image in comparison with averaged in-situ spectra of the plot. Left: Best matching reference reflectance of 10m-native resolution spectrum of plot 11 in comparison to the averaged in-situ reflectance spectra for testing the ESA's Sen2Cor (atmospheric-, terrain and cirrus correction) processor.

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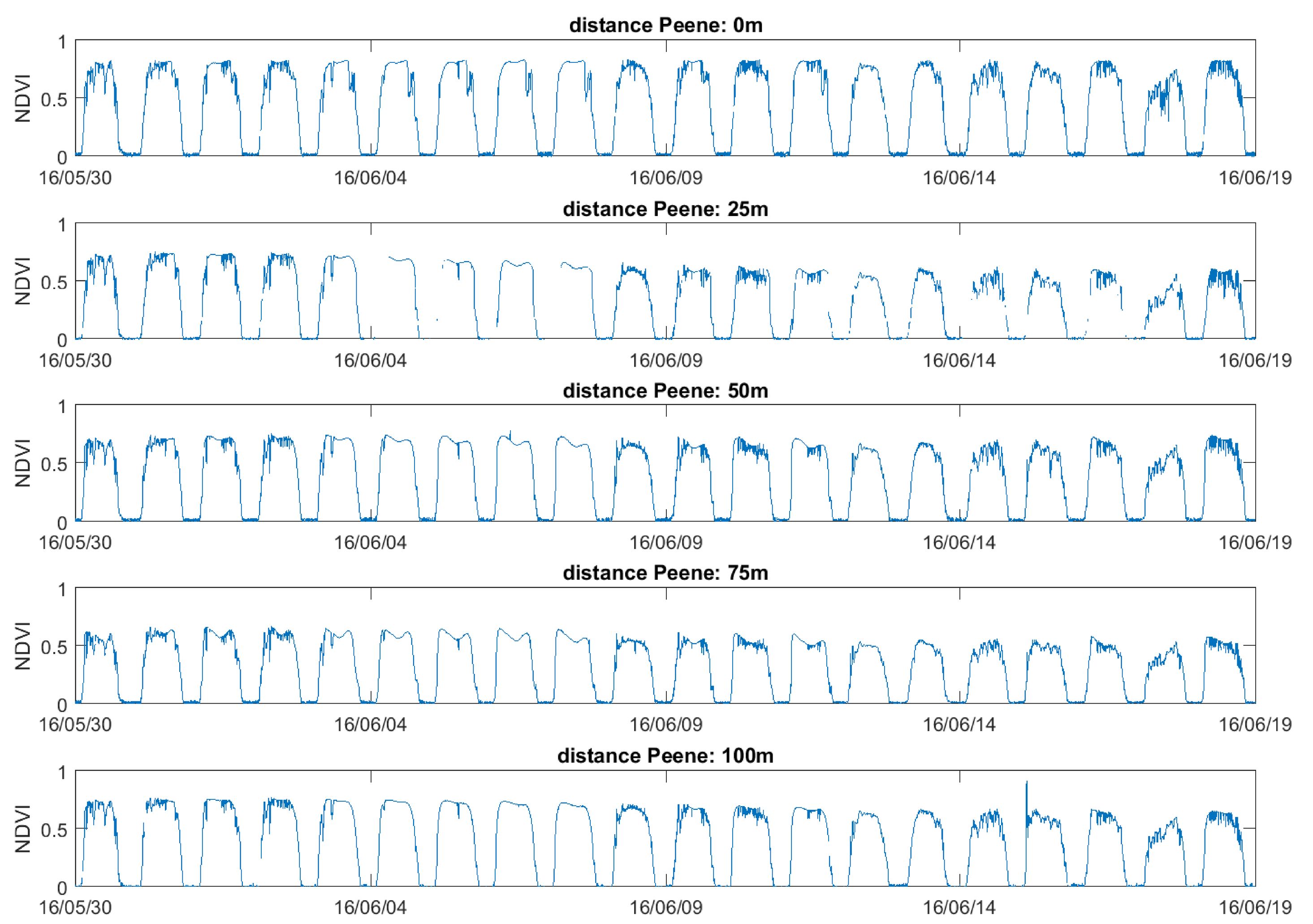

Figure 6: Calculated NDVI (5 minute sample periode) over 20 days for increasing distances to the branch of the Peene river of 5 sensor nodes of the wireless sensor network. Both possible local water vapour effects, which are not taken into account in the atmospheric corrections of satellite remote sensing products, can thus be prevented as well as the heterogeneity of the canola plot can be determined in the sub-pixel level.

References

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