The SARSense campaign: A dataset for comparing C- and L-band SAR backscattering behaviour to changes of soil and plant parameters in agricultural areas

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With the upcoming L-band Synthetic Aperture Radar (SAR) satellite mission Radar Observing System for Europe at L-band (ROSE-L) and its combination with existing C-band satellite missions such as Sentinel-1, multi-frequency SAR observations with high temporal and spatial resolution will become available. To investigate the potential for estimating soil and plant parameters, the SARSense campaign was conducted between June and August 2019 at the agricultural test site Selhausen in Germany. In this regard, we introduce a new publicly available, extensive SAR dataset and present a first analysis of C- and L-band co- and cross-polarized backscattering signals regarding their sensitivity to soil and plant parameters. The analysis includes C- and L-band airborne recordings as well as Sentinel-1 and ALOS-2 acquisitions, accompanied by in-situ soil moisture measurements and plant samplings. In addition, soil moisture was measured using cosmic-ray neutron sensing as well as unmanned aerial system (UAS) based multispectral and temperature measurements were taken during the campaign period. First analysis of the dataset revealed, that due to misalignments of corner reflectors during the SAR acquisition, temporal consistency of airborne SAR data is not given. In this regard, a scene-based, spatial analysis of backscatter behaviour from airborne SAR data was conducted, while the spaceborne SAR data enabled the analysis of temporal changes in backscatter behaviour. Focusing on root crops with radial canopy structure (sugar beet and potato) and cereal crops with elongated canopy structure (wheat, barley), the lowest correlations can be observed between backscattering signal and soil moisture, with $R^2$ values ranging below 0.35 at C-band and below 0.36 at L-band. Higher correlations can be observed focusing on vegetation water content, with $R^2$ values ranging between 0.12 and 0.64 at C-band and 0.06 and 0.64 at L-band. Regarding plant height, at C-band higher correlations with $R^2$ up to 0.55 can be seen compared to $R^2$ up to 0.36 at L-band. Looking at the individual agricultural corps in more detail, in almost all cases, the backscatter signals of C- and L-band contain a different amount of information about the soil and plant parameters, indicating that a multi-frequency approach is envisaged to disentangle soil and plant contributions to the signal and to identify specific scattering mechanisms related to the crop type, especially related to the different characteristics of root crops and cereals.

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