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Winter wheat growth dynamics and their relationship with the field productivity using Sentinel-1 SAR polarimetry

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Synthetic Aperture Radar (SAR) is sensitive to the surface structure as well as dielectric properties, so can be used to quantify the canopy characteristics and surface moisture. High temporal frequency SAR backscatter data are useful in terms of quantifying crop phenological development, growth and yield formation. The aim of this research is to identify the growth dynamics of winter wheat from SAR at field scale, validated using farm sites with different productivity between two years (2018-2019). We identify and explore the parameters which characterize crop performance from SAR temporal curves and use these to improve and automate the monitoring of wheat fields. Our novel methodology includes the extraction of crop indicators using the VH/VV ratio temporal curve from Sentinel-1. Sigmoid curve fitting is used to simulate the VH/VV response and the extracted parameters are related to the field development. The results show that specific indicators, such as the duration of the high vegetation (stem elongation to dough development) as well as the timing of the booting stage of wheat significantly correlate with the final yield. Other indicators can provide information about the canopy characteristics of wheat (e.g. above ground biomass and plant water content). The combination of selected indicators can provide a more robust analysis of the fields. These results demonstrate the potential of SAR to remotely quantify yield without using any management data from the farm.