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Monitoring vegetation dynamics using Sentinel-1 and Sentinel-2

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Information markets in the sectors of agriculture, forestry, water and environmental management require quantitative measurements of vegetation water content and biomass, all of which are not currently available as operational services on required scales (global, regional, field). There is a large potential to use microwave sensors for monitoring vegetation dynamics. Contrary to optical based remote sensing, microwave remote sensing monitoring has the advantage that it is not hindered by cloud cover, smoke, aerosol contamination and low solar illumination potentially. With the launch of Sentinel-1 co- and cross-polarization measurements are now available on a high spatial and temporal resolution, making it a valuable source of information for vegetation monitoring next to optical satellite systems. Studies have already shown the sensitivity of microwave indices to vegetation dynamics and specifically to changes in vegetation water content (VWC) and structure. However, the effect of vegetation structure on the microwave signal can hinder the monitoring of VWC dynamics. Therefore, combining both microwave and optical based satellite systems in a complementary manner could provide a better estimate on the water status of vegetation.

This study investigates the capacity of and synergies between Sentinel-1 and Sentinel-2 and the aim is to merge the strengths of both to monitor VWC dynamics. For the duration of a growing season, in situ samples of biomass, VWC and leaf area index were taken over 10 grass- and croplands in Austria and the United Kingdom and were used to validate indices and products retrieved from both Sentinel-1 and Sentinel-2. With Sentinel-1 promising results were obtained using a cross-ratio between VH and VV polarized data (CR). High correlations between CR and VWC are found in Austria in canola (R=0.70) and corn (R=0.66) and correlations are varying between 0.42 and 0.83 in wheat and barley. Although the Sentinel-2 time series followed the same pattern as in situ measured VWC, observations were limited due to the cloud cover over all test sites and reliable statistical metrics could not be calculated based on the available in situ data. This also emphasizes the importance of combining Sentinel-1 and Sentinel-2 to obtain reliable estimates of VWC. The large gaps in Sentinel-2 data causes challenges for merging datasets from both satellites, since for example multiple linear regression is not straight forward. Hence, alternative approaches, e.g. machine learning, will be tested and validated.