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Tracking the Leaf Emergence in Deciduous Broadleaf Trees Using Microwave Remote Sensing

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The emergence of leaves on deciduous broadleaf (DB) trees marks the start of the growing season in temperate forests. While the timing of this event affects the carbon, water and energy exchange between the vegetation and the atmosphere, its shift is also an indicator of climate change, which makes the monitoring of this variable highly valuable (Buermann et al., 2018). Observing vegetation phenology, including leaf-out of deciduous trees, has a long tradition in many European countries. Since 2004, two reference datasets of phenological observations have been established: COST725 and its successor, the Pan European Phenology project (PEP725), which is used in this study (Templ et al., 2018). The PEP725 database provides leaf-out dates for different DB species all over Europe, including observations dating back to the 1950s. However, a drawback of combining observations from a number of different phenological networks is the fact that the quality of the different datasets and consequently of the PEP725 database varies widely.

Satellite remote sensing provides a tool to observe different variables of the Earth system globally under the same measuring conditions. In the context of monitoring vegetation dynamics, it has been shown that the Advanced Scatterometer (ASCAT) on-board the Metop-A satellite is sensitive to seasonal changes in the structure and water content of crops (Vreugdenhil et al., 2017). In this study, we show the sensitivity of ASCAT to the phenology of deciduous trees by comparing ASCAT to PEP725 observations over Austria.

A comprehensive validation of leaf-out dates derived from ASCAT is carried out for a period of 10 years over regions with different climatological and topographical conditions. The median absolute difference between the leaf-out dates derived from ASCAT and the PEP725 database is less than 10 days when including all 188 sites available in Austria. Moreover, we found that the order in which different tree species leaf-out is constant: the silver birch (Betula pendula) is always the first and the common oak (Quercus robur) the last species to leaf-out, with a period of 1-2 weeks in between. The leaf-out event derived from ASCAT is found between those two species in most years.

This study shows how microwave remote sensing can complement in situ observations of vegetation phenology and thus support current efforts in quantifying effects of climate change on DB forests and consequently the global carbon cycle.

References:

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