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Comparison of seasonal evapotranspiration of temperate coniferous forests with Copernicus Sentinel-1 time series

Marlin Markus Mueller[1,2], Clémence Dubois[1], Thomas Jagdhuber[3,4], Carsten Pathe[1,2], and Christiane Schmullius[1]
[1]Department of Earth Observation, Institute of Geography, Friedrich-Schiller University, Jena, Germany (marlin.markus.mueller, clemence.dubois, carsten.pathe, c.schmullius)@uni-jena.de
[2]Institute of Data Science, German Aerospace Center, Jena, Germany
[3]Microwaves and Radar Institute, German Aerospace Center, Wesseling, Germany (thomas.jagdhuber@dlr.de)
[4]Institute of Geography, University of Augsburg, Augsburg, Germany

A changing climate accompanied by an increasing number of extreme weather events puts pressure on ecosystems around the globe. Evapotranspiration is one of the key metrics for understanding vegetation dynamics and changes in an ecosystem. Due to its complex nature, evapotranspiration is difficult to determine on a larger scale.
Existing approaches to correlate evapotranspiration measurements and radar backscatter signals were completed in boreal forests using ground-based scatterometers for short time series (several months) with much higher temporal resolution (multiple observations per hour) for small test sites. Our goal is to build upon this research to establish a broader understanding on the influences of evapotranspiration on the signal of the widely used Copernicus Sentinel-1 C-Band SAR for managed temperate coniferous forests. Variations of the observed backscatter signals (VV, VH) over several growing seasons and years (2016-2020) are investigated.
Besides wind, temperature or precipitation as some of the influencing parameters on the C-band SAR signal, we focus our analyses on the influence of evapotranspiration on the Sentinel-1 C-band signal. Therefore, we recorded long time series of Sentinel-1 data to investigate and estimate the correlation between forest evapotranspiration dynamics and SAR signal variations. For this purpose, Sentinel-1 and weather data from July 2016 to December 2020 were obtained for forested areas in the southeastern part of the Free State of Thuringia, central Germany.
We use four different weather station datasets with daily measurements to calculate evapotranspiration values following the Penman-Monteith approach and apply regression analyses to gain a better understanding about the influence on the SAR signal. To obtain regions with speckle-suppressed backscatter for in situ comparison, forest areas in a radius of five kilometers around the four weather stations are considered. For the analysis, radar datasets are differentiated in co- and cross-polarized data as well as descending and ascending flight directions. It seems also important to distinguish between frozen and no-frozen conditions as we discover strong changes in the C-band SAR signal but only minor changes in evapotranspiration values for temperatures below freezing level. Excluding frozen conditions, in situ evapotranspiration measurements and the SAR backscatter variations over four years directly

correlate with R2-values up to 0.48 without any parameterization or calibration on both sides (SAR & in situ). Currently we are investigating statistical methods for in-depth analysis of the correlation between the two datasets. As the SAR backscatter signal at C-band is not a direct and sole function of evapotranspiration, future work will combine the modelling of the different influence parameters of the environment on the SAR backscatter signal and aim at quantifying their respective influence on the signal to better understand the seasonal signal variations.