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Identifying the link between microwave vegetation optical depth and gross primary production

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Large-scale estimation of gross primary production (GPP) is commonly derived from optical remote sensing data. Microwave remote sensing, which is not affected by cloud cover, can complement optical data in tracking vegetation dynamics. Here, we assess the potential of microwave vegetation optical depth (VOD), a parameter that is sensitive to the water content of the vegetation layer, to serve as a proxy for GPP.
For this purpose, we compared VOD data from different frequencies (L-, C-, and X-band) and from both active and passive microwave sensors against global GPP estimates. The VOD data sets comprise data from the Advanced Scatterometer (ASCAT), the Soil Moisture Ocean Salinity (SMOS) mission, the Advanced Microwave Scanning Radiometer for Earth Observation System (AMSR-E) and a merged multi-sensor passive microwave VOD product. We compared these VOD products against FLUXCOM GPP and Solar-Induced chlorophyll Fluorescence (SIF) from the Global Ozone Monitoring Experiment-2 (GOME-2).
Global correlations between VOD and GPP showed widespread positive correlations both for time series data and anomalies with some negative correlations occurring in very dry or very wet regions depending on the sensor type. For a more in-depth assessment of the potential of VOD for estimating GPP, we analyzed three variables: original VOD time series, temporal changes in VOD, and positive changes in VOD. All three variables showed mainly positive correlations with GPP that varied in magnitude between land cover types. The relationship between VOD and GPP or SIF suggests that a combination of both original VOD time series and changes in VOD can be used to estimate GPP across biomes.
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