A new global Gross Primary Production (GPP) dataset based on microwave Vegetation Optical Depth Climate Archive (VODCA)

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Gross Primary Production (GPP) describes the uptake of CO₂ by plants through photosynthesis and is essential to monitor and analyze ecosystem dynamics. Teubner et al.¹ developed a carbon sink-driven approach to estimate GPP on a global scale using Vegetation Optical Depth (VOD), derived from active and passive microwave observations. This allows to analyze GPP variability, complementing existing optical GPP products which are more affected by weather conditions. The short operation time of the individual microwave sensors and the bias between them prohibit analyzing GPP variability. This issue can potentially be overcome by using the Vegetation Optical Depth Climate Archive (VODCA) developed by Moesinger et al.², which merges multiple VOD products into a single data record. However, the use of a long-running VOD composite for estimating global GPP is challenging because the implications of the VOD aggregation process on the modelling of GPP are difficult to identify a priori.

Here, we present the results of applying the carbon sink-driven GPP estimation approach on the VODCA datasets. As model input for each pixel we used raw VOD from VODCA as well as changes in VOD and median VOD, the latter serves as proxy for vegetation cover. In order to analyze the performance of the carbon sink-driven approach when using VODCA as input, the model is cross-validated against single-sensor (AMSR-E) VOD estimates and commonly used carbon source-driven estimates (MODIS/FLUXCOM). We assessed the ability to model GPP based on single-frequency VODCA (C-, X- and Ku-band) as well as using multiple frequencies as model input.

Overall, the results show that single-band as well as multi-band VODCA performs slightly better in predicting GPP than single-sensor based VOD. Especially in the tropical regions multi-frequency VODCA GPP outperforms single-sensor based estimates. Compared to source-driven approaches, VOD based GPP estimates are higher than FLUXCOM and MODIS GPP. The spatial patterns, however, show good correspondence with the carbon source-driven GPP products, confirming that VODCA can be used to extend the GPP estimates to the past three decades.


²Moesinger, L., Dorigo, W., de Jeu, R., van der Schalie, R., Scanlon, T., Teubner, I., and Forkel, M.: