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Title

Estimating vegetation productivity from microwave satellite observations

Abstract

Vegetation optical depth (VOD) from microwave remote sensing observations has been increasingly used for large-scale monitoring of vegetation dynamics in recent years. Since VOD is sensitive to the vegetation water content, and microwave observations at lower frequencies are not affected by cloud cover (Woodhouse, 2005), VOD holds additional information on the vegetation layer than optical remote sensing data. To which extent the VOD signal can be used to derive certain vegetation properties, however, is still focus of ongoing research. In this PhD thesis, the relationship between VOD and gross primary production (GPP) is analyzed for the purpose of deriving a conceptual model for estimating GPP based on VOD (VOD-GPP model).

For assessing the potential of VOD for estimating GPP, VOD observations from different microwave frequencies, from active and passive sensors and from single sensor or merged products were analyzed and compared with state-of-the-art global remote sensing data sets and in situ GPP estimates. Accordingly, the VOD-GPP model was derived, which represents a carbon sink-driven approach. It consists of a combination of bulk VOD and change in VOD for describing the temporal dynamic and the grid-cell median VOD as a static component representing differences in vegetation cover. Results showed in general good agreement between VOD-based GPP and other GPP estimates. Differences were observed between frequencies, yielding overall best performance with X-band VOD for this application. Results further demonstrated that VOD-based GPP estimates tend to overestimate GPP compared with other global data sets. This behavior was assumed to be related to the lack of

temperature dependence of autotrophic respiration in the model formulation. The addition of temperature as further model input could partly reduce the GPP overestimation. An analysis of the impact of water availability demonstrated, however, that the VOD-based GPP estimates are not significantly related to varying conditions of dryness and wetness in large parts of the world, and thus further supports the applicability of the VOD-GPP model.

To conclude, the VOD-GPP model provides an independent, remote sensing based GPP data set that is capable of monitoring vegetation dynamics. Through its sink-driven perspective, it further offers complementary information on carbon related vegetation dynamics than commonly used source-driven approaches. The VOD-GPP model may thus contribute to further our understanding of large-scale responses of vegetation to environmental changes.

Cited references

Woodhouse, I. *Introduction to Microwave Remote Sensing*. CRC Press, 2005. ISBN 978-0-203-64652-6.