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Sentinel-1 backscatter dynamics for vegetation monitoring: Synergies and discordances with Vegetation Optical Depth

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Vegetation is a highly dynamic land surface parameter and plays an important role in regional and global hydrological-, energy- and carbon cycles. Because of the crucial role of vegetation in the Earth's system, there is an urgent need to monitor and improve our understanding of vegetation dynamics and its response to climate change. Classically, studies use visible near infrared based satellite products, e.g. Normalized Difference Vegetation Index or Leaf Area Index, to monitor vegetation. Microwave remote sensing provides a complementary source of data to monitor vegetation especially in crucial areas with extensive cloud cover, such as the tropics and high latitudes. Often Vegetation Optical Depth (VOD) is retrieved from microwave observations which is assumed to be sensitive to the water content in the total above ground biomass. However, until recently the disadvantage of microwave remote sensing has been the low spatial resolution of microwave observations compared to visible near infrared based remote sensing. Sentinel-1 (S-1) provides for the first time microwave observations at a spatio-temporal resolution suitable for vegetation monitoring. Co- and cross-polarized backscatter from the C-band SAR instruments is available at 5 x 20 m resolution. Studies have already shown that, for selected test fields, a ratio of co- and cross-polarized S-1 backscatter (CR) is sensitive to vegetation dynamics (Vreugdenhil et al., 2018). However, the sensitivity of CR to vegetation dynamics has still not been assessed over larger areas and different land cover types and is urgent in order to use S-1 for vegetation monitoring.

Here we will present the results of a comparison between S-1 based CR and VOD derived from the Advanced SCATterometer on-board Metop. By assessing the similarities and discordances between CR and VOD derived at C-band we can assess the sensitivity of CR to vegetation dynamics and explore the potential of S-1 CR to improve our vegetation monitoring capabilities at high spatial resolution. First, to investigate the sensitivity of CR to vegetation dynamics, S-1 CR is aggregated to the spatial resolution of Metop ASCAT at 25 km and temporal correspondence with ASCAT VOD is quantified using Spearman rank correlation analysis. In addition, regression parameters between the resampled CR and VOD are calculated. The results are analysed per land cover type at the coarse scale. A further assessment to identify in which land cover types S-1 CR can be reliably used as a proxy for VOD is performed at high resolution. Here a correlation layer is calculated between CR at 1 km resolution and coarse resolution VOD to identify land cover types and areas where CR is sensitive to vegetation dynamics and can reliably be used for vegetation monitoring. The results will be the first step towards a high resolution vegetation monitoring product based on microwave observations from S-1.

Vreugdenhil, M., Wagner, W., Bauer-Marschallinger, B., Pfeil, I., Teubner, I., Rüdiger, C., Strauss, P., 2018. Sensitivity of Sentinel-1 Backscatter to Vegetation Dynamics: An Austrian Case Study. Remote Sensing 10, 1396. https://doi.org/10.3390/rs10091396