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GNSS-VOD in conifer forests: Biogeophysical Drivers and Comparison with L-Band Radiometry

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Vegetation Optical Depth (VOD) has become an increasingly important biogeophysical variable, and has been used to estimate aboveground biomass (AGB) or vegetation water content (VWC). In recent years, GNSS transmissometry (GNSS-T) has been developed as a tool to estimate VOD continuously on plot-level (e.g. Humphrey & Frankenberg (2023)). Currently, observations of GNSS-VOD throughout the globe are being brought together within VODnet, aiming to, amongst others, serve the calibration/validation of satellite VOD products. (Brede et al. (2025)).

At the same time, we lack fundamental understanding of the drivers of temporal GNSS-VOD variability and their relative roles under different conditions, as well as the comparability with radiometry-based VOD. Here, we present (1) a detailed analysis of a 2.5-year record of low-cost (u-blox) GNSS-VOD observations from a dense Douglas fir forest in the Netherlands, including quantifying the biophysical drivers of temporal VOD dynamics (i.e. VWC, AGB, interception/dew, and temperature) and their relative importance, and (2) a cross-comparison of GNSS-VOD and L-band, upward-looking radiometer-based VOD measurements from a Scots pine forest in Switzerland.

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