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Constraining plant water dynamics in land surface model by assimilating ASCAT dynamic vegetation parameters

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Previous studies have shown that Advanced Scatterometer (ASCAT) C-band microwave normalized backscatter (σ_{40}^{o}), slope (σ') and curvature (σ'') provide a valuable insight into vegetation water dynamics. However, currently there are limited studies focusing on the observation operator linking land surface models to ASCAT observables to allow for their assimilation. In this study, an observation operator is developed based on a Deep Neural Network (DNN). It is trained using simulated land surface variables over France from 2007 to 2016. A version of the ISBA land surface model, operated by CNRM is used to produce these variables. This ISBA model version is able to simulate leaf area index (LAI) in addition to soil moisture. The ISBA simulations are forced by surface atmospheric variables from the ECMWF ERA5 atmospheric reanalysis. The performance of DNN is validated using independent data from 2017 to 2019. Model performance yields a near-zero bias in the estimation of σ_{40}^{o} and σ'. The sensitivity of the DNN is also investigated using the Normalized Sensitivity Coefficient. The analysis shows that the model estimates are physically plausible. ASCAT σ_{40}^{o} is sensitive to modeled surface soil moisture and LAI. Generally, the sensitivities vary as a function of season and land cover types. σ' is shown to be most sensitive to LAI. This is in agreement with earlier studies that concluded that σ' is a measure of vegetation density. In spring, water availability in root zone contributes the spring peak of σ', which is identified as the time of maximum branch water content in a previous study (Pfeil et al., 2021). Our results show that the DNN-based model is suitable for use as an observation operator in a follow-on data assimilation study to constrain plant water transport processes in the land surface model.