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Impact of L-band Vegetation Optical Depth Temporal Variation on Soil Moisture Retrieval

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Forests are one of the most essential components of the Earth system. They account for a large part of the total global photosynthetic activity, store a significant amount of the total carbon, and provide a habitat for countless species. At the same time, they offer critical resources to anthropogenic activities, such as timber, food, and firewood. Soil moisture (SM) plays a pivotal role in the processes governing all these functions. Low-frequency remote sensing is the only way to acquire a large spatial distribution of the forest SM because of its ability to carry the signal from the forest floor through the forest canopy to the satellite. Studies have shown that NASA's SMAP (Soil Moisture Active Passive) mission, measuring brightness temperature at 1.4 GHz (L-band), is sensitive to SM changes in forests despite the interference by the forest canopy. The challenge is to accurately account for the attenuation, scattering, and emission by the canopy. The SMAP Validation Experiment 2019-2022 (SMAPVEX19-22) in the temperate forests of the northeast US collected a vast amount of in situ and other experimental data to improve SMAP's SM and L-band vegetation optical depth (L-VOD) retrievals in forested areas. The results from the experiment have shown that the transmissivity is substantially higher in the spring no-leaf conditions than later in the season, suggesting that the seasonal water content changes and phenology significantly affect L-band TB. While the effect is seasonal, substantial changes in the L-VOD response occurred within days as the water content and phenological changes occurred harmoniously across the large SMAP footprint (tens of km). Moreover, the frozen season effect on the tree permittivity affected

the SMAP L-VOD at daily timescales as the trees within the SMAP footprint underwent changes between frozen and thawed states. The results underline the need for the SM and L-VOD retrieval algorithms to account for the short-timescale changes.