Characterizing Near-Nadir Ka-Band SAR Backscatter from Wet Surfaces and Diverse Land Covers

Jessica Fayne [1], Laurence C. Smith [2], Tien-Hao Liao [2], Lincoln Pitcher [2], Michael Denbina [2], Albert C. Chen [2], Marc Simard [2], Curtis W. Chen [2], and Brent A. Williams [2]

[1]University of California
[2]Affiliation not available

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Abstract

The forthcoming Surface Water and Ocean Topography (SWOT) satellite and AirSWOT airborne instrument are the first imaging radar-altimeters designed with near-nadir, 35.75 GHz Ka-band InSAR for mapping terrestrial water storage variability. Remotely sensed surface water extents are crucial for assessing such variability, but are confounded by emergent and inundated vegetation along shorelines. However, because SWOT-like measurements are novel, there remains some uncertainty in the ability to detect certain land and water classes. We study the likelihood of misclassification between 15 land cover types and develop the Ka-band Phenomenology Scattering (KaPS) scattering model to simulate changes to radar backscatter as a result of changing surface water fraction and roughness. Using a separability metric, we find that water is five times more distinct compared with dry land classes, but has the potential to be confused with littoral zone and wet soil cover types. The KaPS scattering model simulates AirSWOT backscatter for incidence angles 1-27°, identifying the conditions under which open water is likely to be confused with littoral zone and wet soil cover types. A comparison of KaPS simulated backscatter with AirSWOT observed backscatter shows good overall agreement across the 15 classes (median r^2=0.76). KaPS characterization of the sensitivity of near-nadir, Ka-band SAR to small changes in both wet area fraction and surface roughness enables more nuanced classification of inundation area. These results provide additional confidence in the ability of SWOT to classify water inundation extent, and open the door for novel hydrological and ecological applications of future Ka-band SAR missions.

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