# A Preliminary Study of Optimal Multifrequency Radar Architectures for Simultaneous Retrievals of Vegetation and Soil Properties

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The 2017-2027 US National Academies Decadal Survey (DS'17) [1] has identified a number of targeted observables (TOs) that include soil moisture and vegetation properties. Additionally, the NASA Surface Topography and Vegetation (STV) incubation study, based on the DS'17, has identified several priority discipline areas, their associated data gaps, and priority observational product needs. Among these are products related to hydrology and vegetation structure, including shallow bathymetry, permafrost freeze/thaw, snow depth, vegetation canopy height, biomass, and canopy gap characteristics. In support of these observations, we are investigating a flexible-architecture distribute synthetic aperture radar (FlexDSAR) concept, which may include multiple frequencies and multiple acquisition modes for the distributed SAR system. In this paper, we present a range of possible system-level design scenarios with respect to frequency, polarization, and observation geometry, which may include monostatic and bistatic vantage points that can best address the science needs of STV. In particular, we present design scenarios that optimize retrieval products for vegetation height and/or water content, permafrost active layer freeze/thaw, and soil moisture. We focus on the simultaneous retrieval of vegetation and soil properties, which is a distinguishing factor between this work and much of what has been conventionally reported in the literature by retrieving either quantity by itself while assuming the other one is already known. We will show preliminary simulation results for both forward scattering scenarios and retrievals using P- and L-band observations under for barren, shrub, and forested landcover types. In each case, we will show the performance limits based on frequency, polarization, and observation mode.

1. National Academies of Sciences, Engineering, and Medicine 2018. Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space. Washington, DC: The National Academies Press. https://doi.org/10.17226/24938
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