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Mapping Earth's Changing Surface and Overlying Vegetation Structure using a Novel Observing Strategy (NOS)

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Earth's geologic surface and overlying vegetation change due to a variety of processes. Past processes may be written in the landscape. NASA's Surface Topography and Vegetation (STV) observable addresses several science and applications needs and asks the overarching question: *How does Earth's changing surface structure inform us about climate change, natural hazards, ecosystem habitats, and water availability?* Separating the bare Earth topography from the overlying vegetation structure is key to understanding past, present, and future processes related to the solid Earth, vegetation structure, the cryosphere, hydrology, coastal geomorphology, and applications. Lidar, stereo imaging, and radar each contribute unique and complementary measurements for separating bare Earth topography from vegetation structure. Lidar measurements are excellent at determining a digital surface model and finding ground returns but can be sparse. Stereo imaging measurements cover a broad area and produce an excellent digital surface model, though canopy height can be underestimated as tree crowns narrow below the image pixel size. Lidar and stereo imaging observe the surface if not obstructed by clouds. Radar measurements provide broad area coverage while penetrating clouds. Single-frequency radar can penetrate vegetation and, when combined with multi-baseline radar, can provide tomograms of vegetation density profiles. Multi-frequency radar may improve tomograms of vegetation density distribution. Measurement of surface topography and vegetation and change over time would be best met with a variety of orbital and suborbital assets with the observing characteristics tailored to each technology and science or application need. An STV observing system requires a scalable architecture and smart tasking strategies, standardizing processing workflows and outputs, and fusing data into higher-level products. An NOS could integrate with tasking systems already available from commercial providers and suborbital platforms for event response or smaller, rapidly changing regions, while the core STV satellites perform mapping to guarantee systematic global coverage at a temporal cadence that meets the needs for measuring seasonal variations and other slower processes.

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