GLOBAL RETRIEVALS OF SNOW PROPERTIES FROM IMAGING SPECTROSCOPY: HOW DO WE PREPARE FOR NASA'S SURFACE BIOLOGY AND GEOLOGY MISSION?

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Global patterns of snow darkening and melting, induced by grain metamorphism and the accumulation of small light-absorbing particles (LAPs), such as mineral dust, black carbon, volcanic ash, or algae cells, lead to an intensified radiative forcing and retreat of Earth's snow cover. Mapping and quantifying snow grain size, LAPs, and the associated albedo on both temporal and spatial scales is needed to improve the prediction of melt rates and their impacts on climate change. In particular, the retreat of polar glaciers and ice sheets amplifies global sea level rise, and reduced snow cover in mid-latitude mountains directly affects freshwater resources. It is therefore of particular importance to monitor the spatial and temporal changes in snow albedo on a global scale.

The U.S. National Academies' decadal survey clarifies a specific need for measurement of "albedo of subpixel snow […] at weekly intervals to an accuracy to estimate absorption of solar radiation to 10%." High-resolution visible-to-shortwave-infrared (VSWIR) imaging spectrometers herald a new era of passive spaceborne remote sensing, which will help to fulfill this objective. This technology provides measurements of reflected solar radiation in continuous spectral channels throughout the solar spectrum, allowing more accurate estimations of spectral and broadband albedo, as well as to detect narrow ice and LAP absorption bands. NASA's upcoming orbital Surface Biology and Geology (SBG) mission, which combines VSWIR and thermal infrared (TIR) instruments, will provide the required high-resolution observations of reflected solar radiation and surface temperature for almost all locations on Earth's land surface.

An accurate global snow albedo product requires independent retrieval algorithms that account for varying illumination conditions, fractional snow cover, topography, background reflectance, and optical properties of LAPs. However, we need to be careful in our decision about how to model snow within our inversion framework, since it varies in shape, size, and density, features different size distributions, and tends to induce subpixel roughness, as a quote from Jeff Dozier points out: "The left image looks in the direction toward the Sun, whereas in the right image the Sun is behind me. Forward scattering, based on a model like DISORT, should cause the left image to be brighter than the right, but the opposite is the case." In addition, we need to combine albedo products from different sensors with different spatiotemporal and spectral resolutions to close gaps in time series, caused by, e.g., cloud cover.

In this contribution, we will present the status of the SBG VSWIR snow and hydrology focus area with its community-guided plans and actions to achieve the objectives of the decadal survey. We will include the presentation of candidate retrieval algorithms and open-source tools such as GitHub repositories, and detail recommendations for improved product error budgets. Moreover, we will highlight the use of existing precursor missions, such as EMIT and ECOSTRESS, to particularly emphasize the importance of combining SBG VSWIR and TIR measurements to improve predictions from snow melt and runoff models. Finally, we will showcase the connection to NASA's Earth Science to Action program by outlining the needs of water resources applications for remotely sensed snow albedo, and how products from SBG will support decision makers.