High-resolution Airborne Microwave Imaging of Snow Cover and Snow Water Equivalent (SWE) Retrieval

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Snowpack plays a critical role in the Earth's hydrologic cycle and has a significant impact on global weather and climate through modulation of the Earth's radiation budget, maintenance of stored greenhouse gases in frozen tundra, and moderation of boundary layer fluxes. Accurate measurement of snowpack properties using passive microwave observations requires detailed knowledge of the relationship between snowpack geophysical parameters and the upwelling polarimetric brightness signature. We examine the response of microwave brightness temperatures to snow water equivalent over a wide range of snowpack conditions observed during the NASA Cold Land Processes Experiment (CLPX) in 2002 and 2003. Spatially intensive measurements of snow were collected over the CLPX study areas within the Colorado Rocky Mountains. The NOAA Earth System Research Laboratory's Polarimetric Scanning Radiometer (PSR) was operated to obtain coincident high-resolution (150-500 m) multiband microwave imagery of the snowpack. We used the 30-m resolution USGS terrain elevation data to georegister and rotate the PSR V-pol and H-pol data with respect to the terrain facet. Together, a robust data set of over 2300 collocated in situ and remotely sensed observations were obtained for this analysis. For each point we modeled brightness temperatures using observed snow properties and the Helsinki University of Technology (HUT) snow emission model. Using observed and modeled data, we developed multiple regression algorithms to retrieve snow water equivalent (SWE). The algorithms use snow emissivity differences between 10.7, 18.7, and 21.5 GHz with 37 GHz and 89 GHz. Results show that the CLPX microwave data are consistent with a) historically established data and, b) after removal of cases with macro vegetation or possible wet snow, with theoretically derived curves for microwave dependence on SWE. Using the developed retrieval algorithm SWE was computed for the entire PSR-observed data set.