A NEW BLENDED SNOW PRODUCT USING VISIBLE, MICROWAVE AND SCATTEROMETER SATELLITE DATA

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The ability to characterize snow storage more accurately at the drainage basin scale is crucial for improved water resource management. Snow-water equivalent (SWE), snow extent, and melt onset are important parameters for climate modeling and for the initialization of forecasts at daily and seasonal time scales. Snowmelt data are needed in hydrological models to improve flood control and irrigation management. In addition, knowledge of snowpack ripening is essential for natural-hazard applications such as flood prediction. Furthermore, data on snow depth and snowmelt are useful for assessing trafficability for military tactical operations Foster et. al., (in press).

A new, blended global snow product that utilizes Earth Observation System (EOS) Moderate Resolution Imaging Spectroradiometer (MODIS), Advanced Microwave Scanning Radiometer for EOS (AMSR-E) and QuikSCAT (QSCAT) scatterometer data has been developed jointly by the USAF and NASA. The initial blended-snow product includes snow cover extent, fractional snow cover, snow water equivalent (SWE), onset of snowmelt, and identification of actively melting snow cover at a 25-km resolution. These products have been evaluated using in situ data from the lower Great Lakes region of the U.S., from the Cold Lands Processes Experiment (CLPX) in Colorado, and from snow course data in Finland.

MODIS data have been used since early 2000 to produce validated, daily, global snow maps in an automated environment (http://modis-snow-ice.gsfc.nasa.gov). These maps, available at a variety of spatial resolutions – 500 m, 0.05° and 0.25° – provide snow extent, fractional-snow cover (FSC) and snow albedo (Hall et al., 2002; Klein and Stroeve, 2002; Salomonson and Appel, 2004; Riggs et al., 2006; Hall and Riggs, 2007) in both a sinusoidal projection and a latitude/longitude grid known as the climate-modeling grid (CMG). Validation activities for snow extent and FSC have been conducted by the data-product developers and also by other investigators (Hall and Riggs, 2007).

Passive microwave-derived methods to estimate regional to global snow depth or SWE use frequent and wide-swath-coverage observations from sensors on board several different satellites. There is a heritage of nearly 30 years of global-daily observations from such instruments (Chang et al., 1976 and 1987; Walker and Goodison, 2000). From

November 1978 to the present, the SMMR instrument on the Nimbus-7 satellite and the SSM/I on the Defense Meteorological Satellite Program (DMSP) series of satellites have acquired passive microwave data that can be used to estimate SWE. The SMMR instrument failed in 1987, the year the first SSM/I sensor was placed in orbit. The AMSR-E sensor, launched in 2002 on board the Aqua satellite, is the most recent addition to the passive microwave suite of instruments. AMSR-E snow products (Kelly et al., 2003, Kelly, in press) are archived and distributed through the National Snow and Ice Data Center, and are available in the Equal Area SSM/I Earth Grid (EASE-grid) projection (at a 25 km x 25 km pixel scale).

The sensitivity of spaceborne scatterometer data to snow parameters has been gaining more attention in recent years (e.g., Nghiem and Tsai 2001; Kimball et al. 2001; Hallikainen et al., 2004). Nghiem and Tsai (2001) indicate the potential of the scatterometer (QSCAT) data for applications to remote sensing of snow at the global scale by showing that Ku-band (14 GHz) backscatter is sensitive to snow properties. Moreover, the diurnal backscatter change method was developed to detect and map snowmelt areas using QSCAT data (Nghiem et al., 2001).

The confidence for mapping snow cover extent is greater with the MODIS product than with the microwave product when cloud-free MODIS observations are available. Therefore, the MODIS product is used as the default for detecting snow cover. The passive microwave product is used as the default only in those areas where MODIS data are not applicable due to the presence of clouds and darkness. Though the AMSR-E product is especially useful in detecting snow through clouds, passive microwave data often miss snow in those regions where the snow cover is thin, along the margins of the continental snowline, and on the lee side of the Rocky Mountains, for instance. In these regions, the MODIS product can reliably map shallow snow cover under cloud-free conditions. The AMSR-E snow product is used in association with the difference between ascending and descending satellite passes (Diurnal Amplitude Variations, DAV) to detect the onset of melt. In addition, a QSCAT product will be used to map areas of the snowpack that are actively melting.