HYPERSPECTRAL ANALYSIS OF DIRECT SHORTWAVE RADIATIVE FORCING OF DUST IN MOUNTAIN SNOWCOVER

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ABSTRACT: Springtime desert dust storms regularly deposit radiatively absorbing dust on the snow cover of the San Juan Mountains of southwestern Colorado. The dust reduces the albedo of snow in visible wavelengths, accelerates grain metamorphism, and increases grain size, significantly impacting the energy balance of the San Juan Mountains seasonal snowpack. The NASA/JPL Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) is of sufficient spectral resolution to quantitatively detect the radiative effects of dust upon the grain size and visible albedo of snow. AVIRIS detects upwelling radiance in 224 contiguous spectral channels within the wavelength range of 400-2500 nanometers, and is flown at ~5 km altitude in a Twin Otter aircraft. We analyze AVIRIS data collected over two energy balance monitoring sites in the alpine and sub alpine of Red Mountain Pass in the San Juan Mountains on May 19 and May 21 of 2004, and April 26, 2006. We used the software Atmospheric Correction Now (ACORN) to atmospherically correct the AVIRIS data to apparent surface reflectance and enhanced the reflectance retrieval with field spectra of a within scene calibration site. The Scaled Integral Dust Index model uses radiative transfer calculations of clean snow directional reflectance for snow of grain size inferred on a pixel by pixel basis from the AVIRIS data themselves. The scaled integral between the AVIRIS spectrum and the radiative transfer spectrum gives the direct measure of the surface shortwave forcing of dust in snow. The relationship between quantitative estimates of relative dust concentration and grain size is direct until a threshold dust concentration at which the relationship inverts. The absorption by large concentrations of dust appears to contaminate the scaled area of the 1030 nm ice absorption feature. We present here statistics of the spatial variation and persistence of dust radiative forcing in snow.

KEYWORDS: Snow, dust, radiative forcing, hyperspectral, remote sensing.

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