## Title:

Inference of impurity radiative forcing in snow from multispectral to hyperspectral imagers

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## Conference Theme:

Remote sensing applications to hydrology, carbon cycle, biochemical and –physical cycles, plant ecology, ecosystems, snow, soil moisture, agriculture, natural ecosystems, etc.

## Abstract:

The inference of the radiative forcing of soot and dust in snow has taken on importance in recent years because of the realization of the climate effects that they have (Hansen and Nazarenko, 2004). To date, there is no operational remote sensing product that allows us to determine the presence of impurities in snow. The change in snow hemispherical-conical reflectance factor due to change in impurity concentration can be small in absolute reflectance but the relative change in absorption is large.  However, clean snow with nonspherical grains can appear to have non-zero impurity concentration under the assumption of spherical grains.  In this work, we present an analysis of the sensitivity of snow HCRF to snow impurities, snow morphology, and snow texture.  We also present a model for impurity concentration from imaging spectrometer and multispectral imager data.

We investigate the sensitivity of snow HCRF with a radiative transfer model that accounts for single scattering of nonspherical particles and external and internal inclusions of dust and soot.  From these analyses, we can then understand the uncertainties inherent in remote sensing of snow impurity radiative effects.  Springtime desert dust storms regularly deposit radiatively absorbing dust on the snow cover of the San Juan Mountains of southwestern Colorado, USA. With data collected with an Analytical Spectral Devices FieldSpec Spectroradiometer (350-2500 nm with 3-10 nm spectral resolution), the NASA/JPL Airborne Visible/Infrared Imaging Spectrometer (AVIRIS, 400-2500 nanometers with 10 nm spectral resolution and 2 m spatial resolution), and the Moderate Resolution Imaging Spectroradiometer (MODIS – multispectral optical), we investigate the spatial distribution of dust radiative forcing in the mountain snow cover near two energy balance monitoring sites in the alpine and sub alpine of Red Mountain Pass in the San Juan Mountains. 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 model is then applied to MODIS surface reflectance data through incorporation of digital elevation data.