Spectral albedo and snow specific surface area at Summit, Greenland 2011

P. Wright[1], C. Carmagnola[2], F. Domine[2], J. Dibb[3] , and M. Bergin[4]

[1] Dept. of Earth and Atmospheric Science, University of Houston, Houston, TX
[2] CNRS, Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres, France
[3] EOS, University of New Hampshire, Durham, NH
[4] Dept. of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA

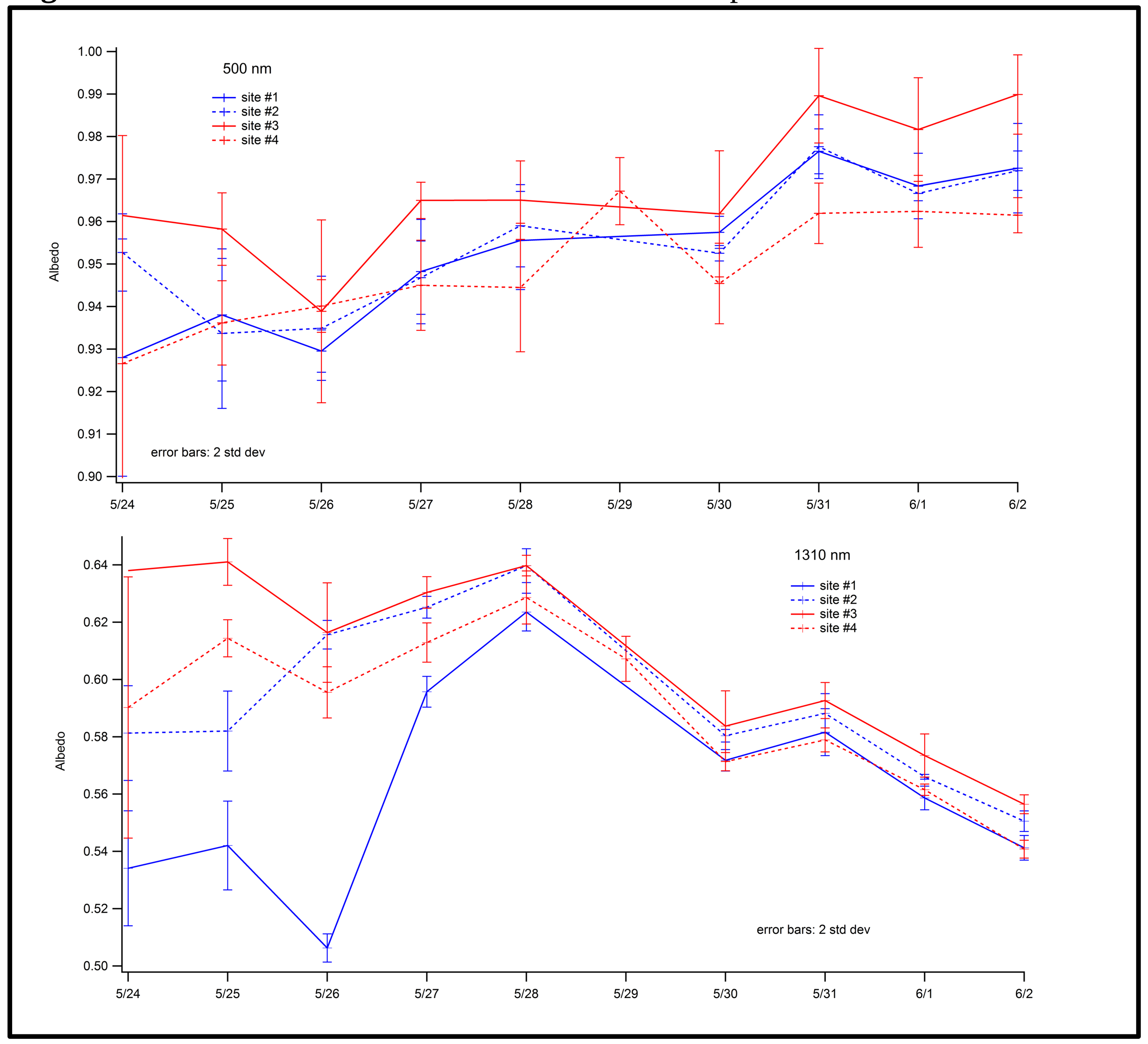
Introduction and Methods

Spectral albedo, physical snow properties, and snow chemistry are currently being measured at Summit, Greenland to investigate the effect of variation in snow albedo on direct aerosol radiative forcing. Spectral albedo is measured from 350-2500 nm with an ASD FieldSpec Pro spectroradiometer (Fig. 4) at a daily site, as well as in more intensive diurnal and spatial surveys. Snow specific surface area (SSA), the ratio of snow crystal surface area to mass, is measured with a Dual Frequency Integrating Sphere (DUFISSS) at 1310 nm and 1550 nm, as well as with samples collected for later stereology analysis.

The goal is to measure changes in spectral albedo, both spatially and temporally, and to correlate this with changes in scattering (physical properties) and/or absorption (snow chemistry). It will also be important to determine the spectral variation of these relationships.

Fig. 1 demonstrates the range of variability in spectral albedo, with an attempt to isolate the effect of variations in the snow surface. This ~1.5 km traverse was completed near solar noon on a clear sky day. Fig. 2 shows albedo at two wavelengths, measured daily at four fixed sites, each separated by 4 to 7 meters, and Fig. 3 represents data from a fifth site that rotates around these fixed sites, where albedo is measured and then SSA and density are measured in the same spot directly afterwards.

Fig. 2. Time evolution of albedo at four fixed sites. Top: 500 nm. Bottom: 1310 nm.



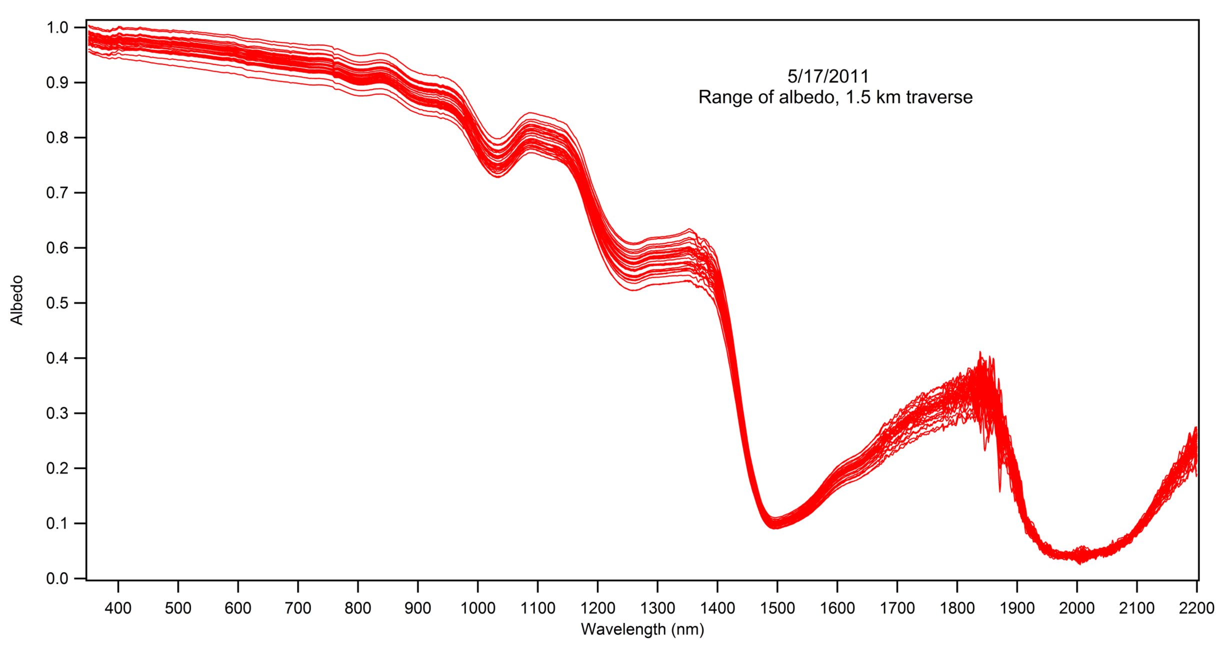


Fig. 1. Spectral albedo measured at 29 locations in ~50 m intervals along a ~1.5 km traverse.

Fig. 3. Time evolution of albedo and SSA measured in the same location. Top to bottom: 500 nm, 1100 nm, 1310 nm.

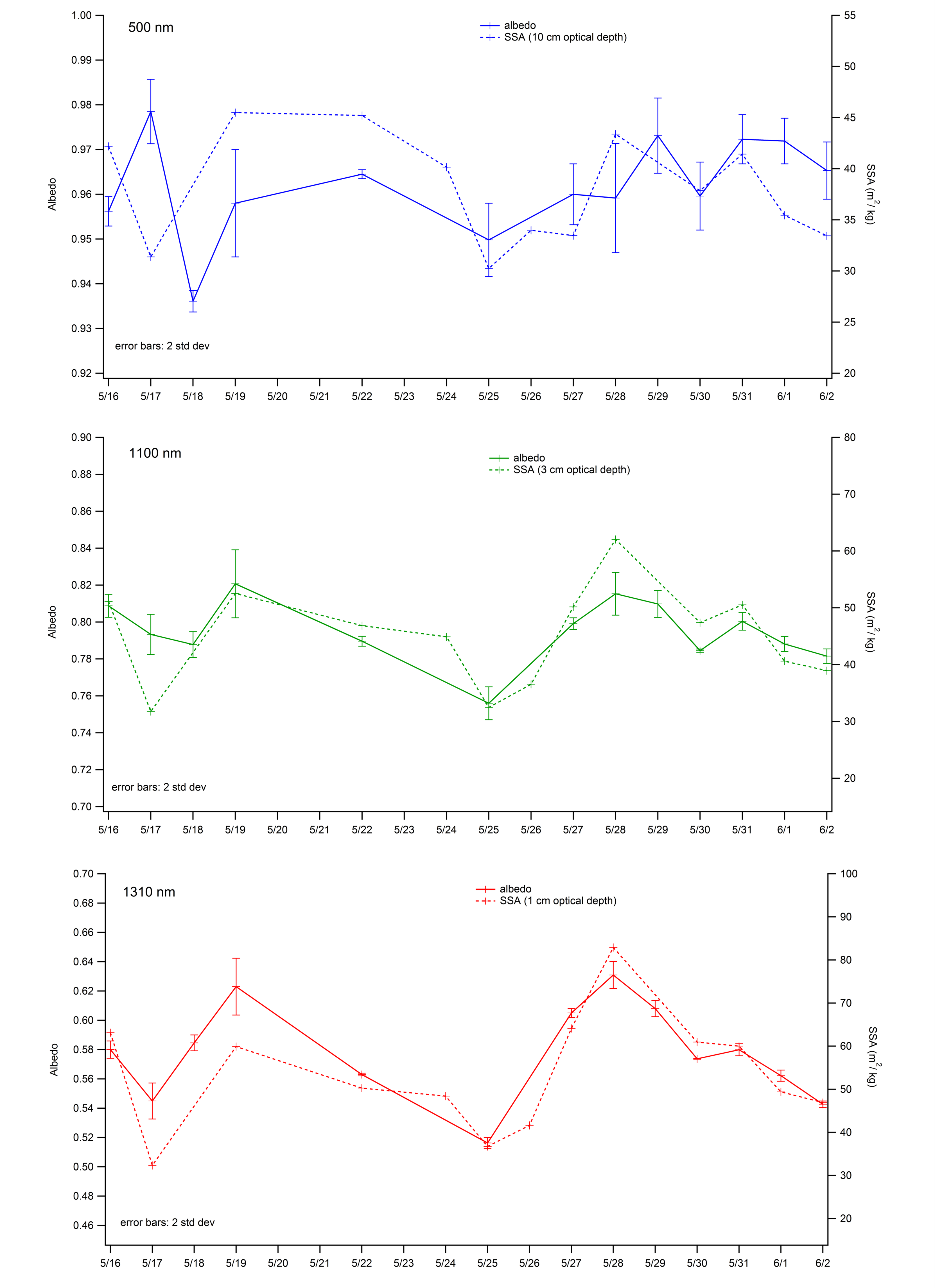


Fig. 4. Taking an upwelling measurement with the ASD FieldSpec Pro at Summit, May, 2011.

Results

Fig. 1 shows a range of 0.06 – 0.09 in spectral albedo as measured over a ~1.5 km distance. Although there is some effect of solar zenith angle during this time, this range likely represents variation due to the snow conditions present on this day, which were typical conditions seen at Summit.

Fig. 2 shows a range in albedo of ~0.04 at 500 nm, and a range of up to 1.5 at 1310 nm. The changes in these trends after May 26 are likely related to a change in weather conditions on this day, when blowing and drifting snow shifted to many days of stable weather.

Fig. 3 demonstrates a fundamental relationship between snow optical depth at different wavelengths, and the correlation to changes in albedo. In the UV/VIS, albedo has the weakest correlation to SSA, while in the SWIR correlation is strong, with an r^2 value of 0.76. Although optical depth (and albedo) are proportional to both SSA and density, at longer wavelengths the SSA alone clearly has a strong effect at Summit, where density is fairly consistent. In the UV/VIS, light absorbers such as soot will likely have a stronger effect than SSA.

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