Assessing the 'Full Spectral' Potential Radiative Impact of Arctic Aerosols: Dust, Smoke, Haze

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Measurements of aerosol overburden at the NOAA ESRL Barrow site are part of the suite of ongoing long-term records. Typically, the particle size distribution is derived from measurements of local shortwave spectral Aerosol Optical Depth (AOD), along with Surface Net Flux Measurements. The fundamental inferred values of Extinction, Absorption, and Asymmetry Parameters can then be inserted into a 'single column' Radiative Transfer (RT) code (e.g. such as Moderate Resolution Transmittance radiative transfer model, MODTRAN®5) to predict radiance at all altitudes, along with fluxes and cooling rates. The agreement (or lack thereof) between measured surface fluxes and RT-code predictions attests to the closure within this system. This methodology has already been applied to the shortwave Direct Aerosol Radiative Forcing (DARF), the change in net shortwave irradiance per unit of AOD, associated with an incursion of Asian dust observed at Barrow during spring, 2002, and boreal smoke during summer, 2004; both analyses reproduced the measurements to within 5%. These studies are now being extended into the longwave, where a spectral cooling response is expected. Initial results (cooling rate plots) for a light dust layer over snow are depicted below. Smoke, over snow or tundra, shows a similar result, but the Longwave spectral response of haze has yet to be established.

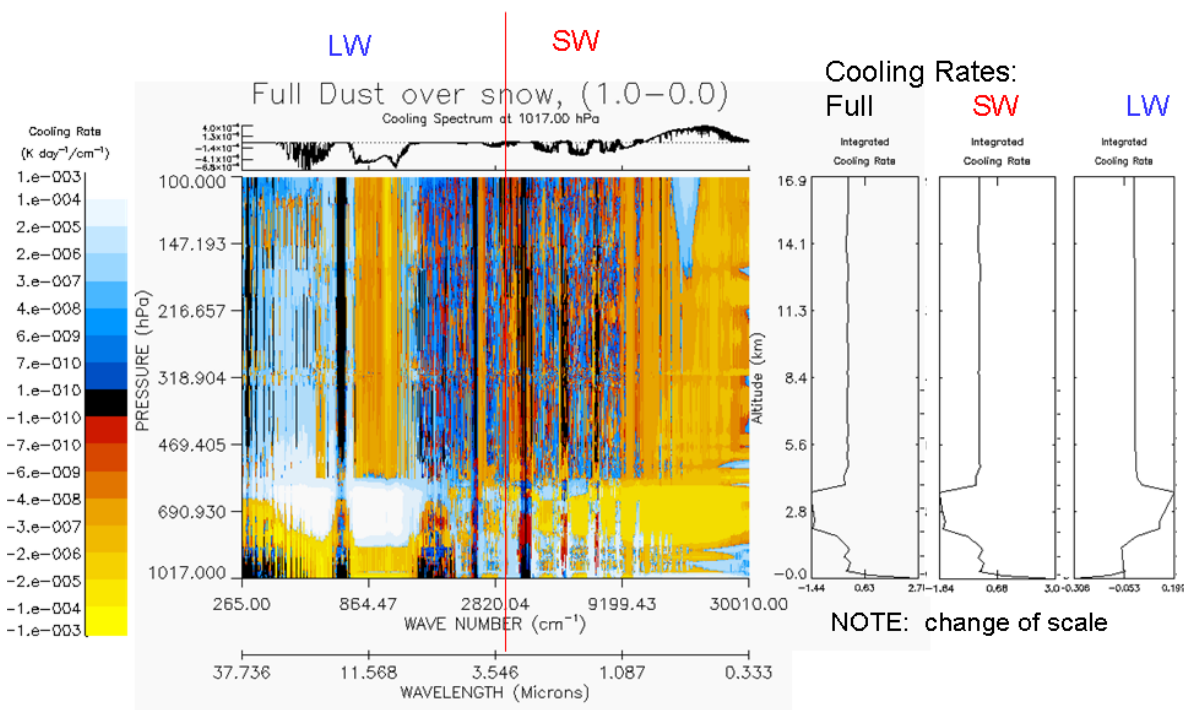

Figure 1. Full spectral (~0.3- 40 μm) cooling rate 'difference' plot of calculation employing a 'dust aerosol layer' – 'clean background'; NOTE: The sign reversal: negative cooling = positive heating. The dust aerosol resides between 2-4 km, has an AOD (550nm) ~ 0.4, and provides a net heating within the layer: -1.64K cooling rate °K/day. It also provides a net cooling at the surface, ~2.7°K/day. The cooling profiles for Shortwave (SW) and Longwave (LW) allocate the contributions from each spectral range. The LW cools in the layer and heats at the surface.