Aerosol Optical Properties at a Polluted Continental Site

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The optical properties of aerosol particles are one of the controlling factors in determining direct aerosol radiative forcing. These optical properties depend on the chemical composition and size distribution of the aerosol particles, which can change due to various processes during the particles' lifetime in the atmosphere. Here we present result from a study investigating how cloud-processing of atmospheric aerosol changed aerosol properties at a polluted continental site. Aerosol physical, chemical and optical properties were measured continuously at Holme Moss, UK in November 2006. Holme Moss is a hilltop site located between Manchester and Leeds which can experience air flow from either urban area as well as clean air coming off the north Atlantic. The site is frequently in cloud (150-200 hrs/month in autumn, based on long-term climatology provided by the University of Manchester). Thus the Holme Moss site provides an excellent location to investigate how cloud processing might influence polluted air.

While the aerosol light extinction (extinction = absorption + scattering) measured at Holme Moss was similar to that at other rural continental sites at which ESRL has made measurements, the single scattering albedo (SSA) at Holme Moss was significantly lower (see figure below). SSA is an indicator of the relative absorbing nature of the aerosol and is an important parameter in climate forcing calculations. The Holme Moss aerosol was very absorbing – median SSA was around 0.82 (rural continental values of SSA in the US tend to be 0.92-0.95). The aerosol absorption can likely be attributed to urban, industrial and diesel emissions upstream of the sampling site.

During the three week study, there were six cloud events which provided ample opportunity to study how this very polluted aerosol changed during cloud processing. During cloud events the SSA of the interstitial aerosol (the aerosol not in the cloud drops) was even lower than that observed during clear periods. Indicators of particle size showed that the interstitial aerosol was also smaller than the typical ambient aerosol. Measurements made downstream of a counterflow virtual impactor, a special inlet which sampled only cloud droplets, showed that the aerosol scavenged by cloud drops was larger in diameter and less absorbing than both the interstitial aerosol and the ambient aerosol observed during cloud free conditions. Both of these observations are consistent with the notion that larger, scattering aerosol is preferentially scavenged by cloud droplets because of its more hygroscopic nature.

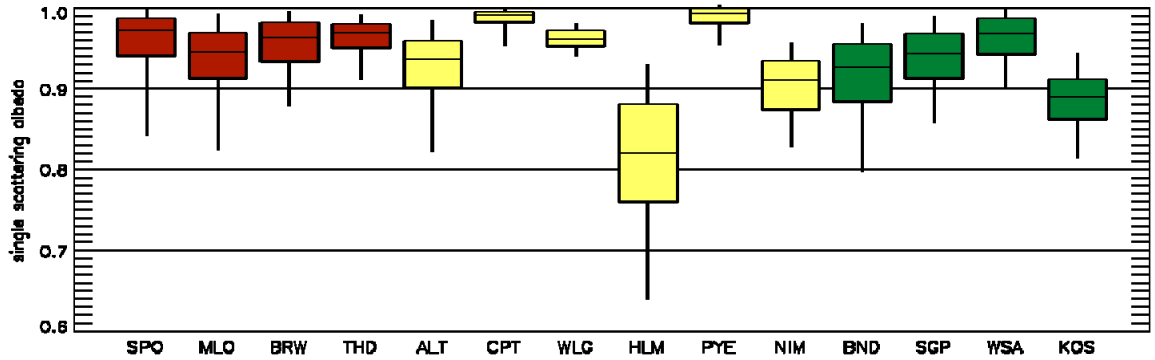

Figure 1. Comparison showing aerosol single scattering albedo for many sites; red sites are NOAA baseline stations, yellow sites are cooperative stations, and green sites are regional stations. SPO=South Pole, MLO=Mauna Loa, BRW=Barrow, THD=Trinidad Head, ALT=Alert, Canada, CPT=Cape Point, South Africa, WLG=Mt Waliguan, China, HLM=Holme Moss, UK, PYE=Point Reyes, NIM=Niamey, Niger, BND=Bondville, SGP=Southern Great Plains, WSA=Sable Island, Canada, KOS=Kosan, South Korea.