Aerosol measurements at South Pole: Impact of local contamination events

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The Amundsen-Scott Station at the South Pole (SPO), sitting high on the Antarctic Plateau, is one of the most remote locations on the planet. Persistent katabatic winds routinely bring free tropospheric air to the station. Atmospheric composition measurements made in the station's Clean Air Sector (CAS) have long been regarded as global baseline values that represent the cleanest air on earth. Aerosol measurements, in particular, show the lowest aerosol concentrations routinely measured at the earth's surface (Bodhaine, 1983).

Aerosol measurements have been conducted at SPO by the National Oceanic and Atmospheric Administration Earth System Research Laboratory and its predecessor organizations continuously since 1974. Despite the remote environment, early studies showed episodes of local contamination with carbon soot observed in the snowpack downwind of SPO (Warren and Clarke, 1990). Fortunately, contamination of snowpack and atmosphere in the CAS is thought to be rare since the katabatic winds blow 95-98% of the time, with local sources downwind of the measurements at these times (Bodhaine *et al*, 1986; Bodhaine, 1995). Some of the early measurements were, however, influenced by the local sources and these data were removed from the clean data archive. In these cases, wind sector screening is vital; without this, single short-term events can dominate a parmeter's average that is collected over a much longer period (Hansen *et al*., 1988).

Knowing that contamination events were observed in the early SPO aerosol data, we asked to what extent human activity may have influenced the aerosol measurements in more recent years. In the decade of the 2000's two large multiyear construction projects occurred that brought additional people and increased local pollution to the South Pole. These were the construction of the New South Pole Station (1999-2003) and the development of the IceCube Solar Neutrino Observatory (2004-2010). The new station was necessary in part to house the extra construction workers and scientists that were to be working on the IceCube project. In addition to these long duration projects, there were individual events that had the potential to skew long-term trends if not properly identified as local pollution and removed from the clean data archive. An example of one of these events was the demolition of the Old Pole Station (i.e., The Dome) in a series of three explosions in December 2010.

In this study, markers of human activity over the years at South Pole have been analysed and compared with the long-term aerosol record. These markers include metrics such as station population, number of cargo flights, and station fuel consumption. Figure 1 shows one such comparison. The human activity markers all peak in the period 2005.5-2007, shown by the 'MAX' bar on the upper panel. There is no corresponding bump in the long term records during this period (particle number concentration is shown) as might be expected if increased local pollution was contaminating the measurements. The trend line is very slightly increasing over this period but over the longer term is flat. From comparisons such as these we conclude that increased activity at SPO during the mid-2000's did not appreciably affect the aerosol measurements being made there. Data are presented that show discrete events that did contaminate the CAS for extended periods of time. These events were relatively rare, however, and were removed from the clean data archive so as not to affect the long-term trends.

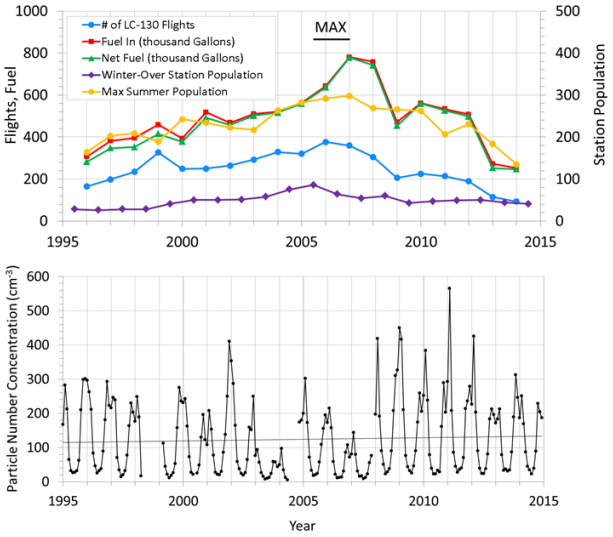

Figure 1. Times series of human activity markers and aerosol measurements at SPO over the last 20 years.

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