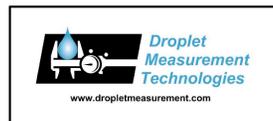


Black carbon measurements over Seattle and Mexico City: Results with the Single Particle Soot Photometer (SP2)



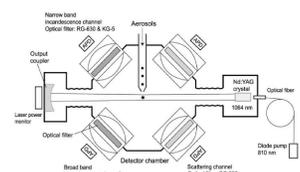
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Introduction

Black carbon plays an important role in aerosol radiative forcing by absorbing light and warming the atmosphere. Recent studies have shown that the absorption efficiency of coated black carbon particles could be 1.5 times that of uncoated BC (Bond et al. 2006).

The DMT single particle soot photometer (SP2) measures black carbon mass on a particle-by-particle basis, and can also provide information on the mixing state of BC. The instrument was used on board the NSF C130 (MILAGRO and INTEX-B) and DOE G-1 aircraft (MIRAGE). Here we describe the operational principles of the SP2 and present preliminary results from the C130.

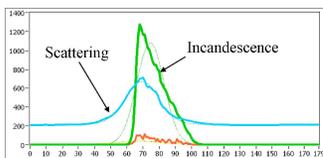
The Single Particle Soot Photometer (SP2)



The SP2 employs laser incandescence to detect BC mass and light scattering to determine particle size (Stephens et al. 2003). A schematic diagram of the instrument, from Moteki and Kondo (2007), is shown at left. The

sample stream (~ 2 cc/min) is introduced into a cavity with a Nd-YAG laser (1064 nm). All particles scatter light, while only BC absorbs light and incandesces. The scattering signal is detected over 30°-60° and 120°-150°, and the particle diameter is estimated by classical Mie theory.

The incandescence signal is detected by two broadband detectors (400-800 nm and 600-800 nm). The intensity of the incandescence signal is a function of the incandescing mass. The ratio



of the incandescence signals over two wavelengths is a function of the incandescence temperature, which is a characteristic of the incandescing material. Thus, the SP2 is highly specific for BC and gives us a direct measure of the BC mass in each particle.

Assuming the remaining particle mass as sulfate, we can estimate the fraction of BC per particle mass and thus the mixing state of the particle (Baumgardner et al. 2007). The SP2 is calibrated using monodisperse polystyrene latex spheres and size-selected glassy carbon spheres. Currently, we can detect BC particles as small as 0.1 μm diameter.

MILAGRO

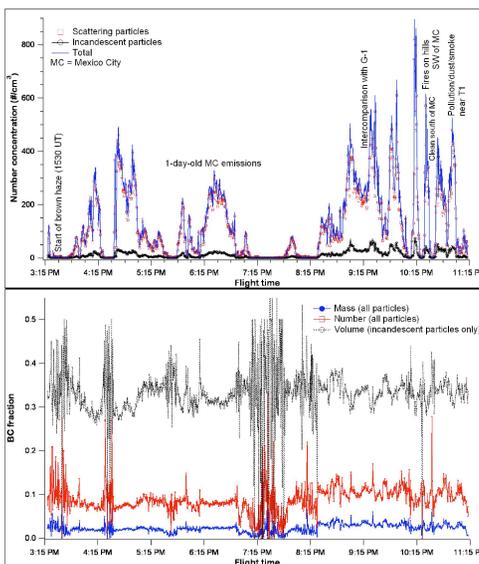
During MILAGRO, the SP2 flew on both the NSF/NCAR C130 and the DOE G1 aircraft. Samples were collected on all eleven C130 flights, and on eight of the G-1 flights. An inter-comparison of the two aircrafts was conducted on March 18, 2006. The flight path of the C-130 for this day is shown above (Google Earth flight path from NCAR/EOL).



As per the mission summary, during this flight the C130 sampled brown haze, one-day-old emissions, Mexico City (fires on the SE/SW hills, hazy north), clean areas over Apan, and a heavy haze (possibly dust) at high altitudes.

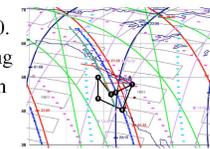
Results from MILAGRO C-130 flight on 3/18/2006

Preliminary results from a portion of this flight are shown below. The number concentrations are not corrected to STP or for altitude. Note that BC concentrations are for particles ~0.1 μm or bigger (mass equivalent diameter), while scattering particle concentrations are for particles ~0.2 μm or bigger. The instrument is not yet optimized for scattering measurements.



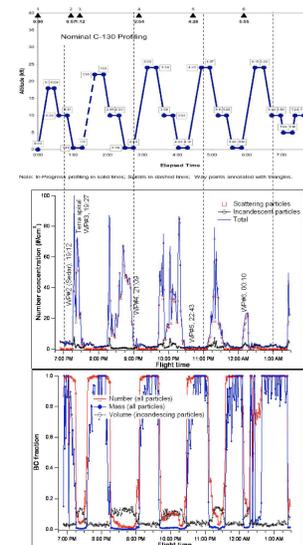
INTEX-B

We have SP2 data for 13 flights with the C130. One of the flights was on May 1, 2006. During this flight, the aircraft sampled Asian pollution characterized by high sulfate and low organic aerosol loadings (based on AMS results from the flight summary). Further, the aircraft did a series of vertical profiles, as shown in the flight plan details obtained from the INTEX-B website.



Results from INTEX-B C-130 flight on 5/1/2006

Preliminary results from the C-130 flight are shown below. The observed number concentrations are much lower than seen in the MILAGRO flights. The high (~100%) values for the BC number and mass fraction are associated with very low aerosol loadings, seen at high altitudes (note that these data are not corrected for altitudinal volume changes). For the periods with reasonably high aerosol loadings, the BC volume fraction for the incandescing particles is low compared to the Mexico City aerosol. This corresponds well with the AMS-reported results of aerosol with high sulfate and low organic matter loadings. However, these conclusions are tentative pending further data analysis.



Acknowledgments

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