University of Wyoming in situ aerosol measurements

The optical aerosol counters which have been used for balloon-borne measurements by the University of Wyoming since 1971 are based on the measurement of scattered light by individual particles passing through the instrument. The instruments were initially developed by Rosen [1964], and were most recently modified in 1989 to measure larger, more volatile particles, at lower concentrations [Hofmann and Deshler, 1991]. The most complete description of the instrument, including a discussion of 30 years of measurements at Laramie, Wyoming, is provided by Deshler et al. [2003].

The size is determined from measurements of the intensity of white light scattered at 40° from the forward direction using Mie theory and assuming spherical particles with an index of refraction of 1.45. The instruments provide in situ observations of integral number densities for particles with radii larger than 0.15 - 2.0 or 0.15 – 10.0 µm in twelve size classes with a sample flow rate of 10 liters/min. For condensation nuclei (CN), the particles are forced to grow to optically detectable sizes with a growth chamber using ethylene glycol vapor and the sample flow rate is 1 liter/min.

Concentration errors are controlled by Poisson counting statistics, while sizing errors are controlled by pulse width broadening of the photomultiplier tubes. For aerosol ≥ 0.15 µm radius the Poisson counting statistics for concentrations of 0.001 to 1.0 cm³ are 75 to 2%. For CN the uncertainties for concentrations of 1.0 to 10.0 cm³ are 8 to 3%. In practice the precision of the concentration measurement is about 10% based on laboratory comparisons of two counters. Pulse width broadening leads to sizing errors of about 10%, which increase towards smaller sizes. The minimum detectable concentration from these aerosol counters is 0.0006 cm³. An example profile from the most recent measurement in Laramie is shown in the figure below.

Present campaign, SCOUTO3 – AMMA, Niamey, Niger. Three flights are planned all using the 0.15 – 10.0 µm optical particle counter (OPC).

1) University of Wyoming sounding balloon (4000 or 8500 m3) including an OPC and CN counter and an ozonesonde. Fast ascent to approximately 30 km, fast descent. Aim is to sample aerosol/cirrus in UTLS, and stratospheric aerosol, to obtain an aerosol size distribution profile.

2) SCOUTO3 in situ tracers and particles (2 flights). One OPC flown together with micro Dirac and LABS. This flight includes collaboration with University of Manchester on the particle measurements. Aim is to sample UTLS looking for transport of particles/cirrus into lower stratosphere in the outflow region of large convection.


Figure. Left hand panel: Aerosol concentration in 12 size classes plus CN. The CN profile is off scale below 15 km. Right hand panel temperature in black, ozone mixing ratio in red. The measurements were completed on 6 May 2006 from Laramie, Wyoming, USA.