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A system for the impaction and automatic optical sizing of giant aerosol particles

J. Jensen (1), S. Beaton (1), D. Rogers (1) and J. Stith
(1) National Center for Atmospheric Research, Boulder, Colorado, USA

Giant aerosol particles (dry radius larger than 1 mum) are thought to be critical for warm rain formation. However, they are not well characterised in the atmosphere due to the difficulty of obtaining statistically significant measurements. The reason is partly that giant aerosol particles occur in low concentrations and partly that analysis has in the past been very labour intensive. In this study we present a high-volume impaction system, and we develop an advanced automated microscope-based system for analysis of the impacted particles.

The glass slides are exposed from an aircraft using a rod that is extended into the free airstream. The glass are then analyzed in the laboratory using in a humidity-controlled glass chamber; this allows for particles to be analysed under a wide range of relative humidity conditions. An optical microscope with an attached digital camera is used to acquire images of the giant aerosol particles. A threshold-based system is used to determine the perimeter of giant aerosol particles. Salt particles will at high relative humidity form spherical cap solution drops; these appear as nearly circular particles on the image, and the salt mass in each giant aerosol particle is determined by assuming a NaCl composition. Irregular particles, presumably mineral dust and biological material, are sized using a 64-angle Fourier technique in order to simplify the shape classification.

For glass slides of 20 mm times 6.35 mm, the system has a sample volume of about 1 m3 in one minute at normal aircraft speeds. For salt particles, the measurement range is from 1 mum dry radius to hundreds of micrometers, with a resolution of 0.5 mum dry radius. The lower detection limit is somewhat higher for irregular particles. The sizing accuracy was tested using glass beads and salt particles of known size.

Examples of size distributions are presented from the recent RICO experiement which

focused on warm rain formation over the Atlantic Ocean east of Antigua. Typically tens of thousands of aerosol particles are sized on each glass slide, and this allows for measurement of the aerosol particles in cloud inflow and out flow air. The measurements are expected to be critical for the determination of the processes responsible for warm rain formation.