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Does Your Optical Particle Counter Measure What You Think it Does? Calibration and Refractive Index Correction Methods.

Phil Rosenberg (1), Angela Dean (2), Paul Williams (3,4), James Dorsey (3,4), Andreas Minikin (5), Martyn Pickering (6), and Andreas Petzold (7)

(1) School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK, (2) Facility of Airborne Atmospheric Research, Cranfield, MK43 0AL, UK, (3) School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK, (4) National Centre for Atmospheric Science, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK, (5) Institute of Atmospheric Physics, DLR, Wessling, 82234, Germany, (6) Met Office, Exeter, EX1 3PB, UK, (7) Forschungszentrum Jülich, Jülich, 52425, Germany

Optical Particle Counters (OPCs) are the de-facto standard for in-situ measurements of airborne aerosol size distributions and small cloud particles over a wide size range. This is particularly the case on airborne platforms where fast response is important. OPCs measure scattered light from individual particles and generally bin particles according to the measured peak amount of light scattered (the OPC’s response).

Most manufacturers provide a table along with their instrument which indicates the particle diameters which represent the edges of each bin. It is important to correct the particle size reported by OPCs for the refractive index of the particles being measured, which is often not the same as for those used during calibration. However, the OPC’s response is not a monotonic function of particle diameter and obvious problems occur when refractive index corrections are attempted, but multiple diameters correspond to the same OPC response.

Here we recommend that OPCs are calibrated in terms of particle scattering cross section as this is a monotonic (usually linear) function of an OPC’s response. We present a method for converting a bin’s boundaries in terms of scattering cross section into a bin centre and bin width in terms of diameter for any aerosol species for which the scattering properties are known. The relationship between diameter and scattering cross section can be arbitrarily complex and does not need to be monotonic; it can be based on Mie-Lorenz theory or any other scattering theory. Software has been provided on the Sourceforge open source repository for scientific users to implement such methods in their own measurement and calibration routines.

As a case study data is presented showing data from Passive Cavity Aerosol Spectrometer Probe (PCASP) and a Cloud Droplet Probe (CDP) calibrated using polystyrene latex spheres and glass beads before being deployed as part of the Fennec project to measure airborne dust in the inaccessible regions of the Sahara.