Subgrid variability of CCN sized aerosol

A. Asmi[1], R. Väänänen[1] and R. Kredji[1,2], A. Minikin[3], and airborne aerosol data providers

[1]Department of Physics, University of Helsinki, FI-00014, Finland
[2] Department of Applied Environmental Science (ITM), Stockholm University, S-10691, Sweden
[3] Institute of Atmospheric Physics, German Aerospace Center (DLR), 82234 Oberpfaffenhofen-Wessling, Germany
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Presenting author email: ari.asmi@helsinki.fi

General Circulation Models (GCMs) are the key method to figure out the impacts of atmospheric aerosol to climate system. Unfortunately, the computational limitations require such models to use relatively large grid sizes, typically of kilometres. Many clouds are much smaller than this, and such parameterizations are already used to approach the subgrid scale cloud formation for e.g. convective clouds (see e.g. Lohmann et al, 2007). However, the subgrid scale variation of cloud condensation nuclei (CCN) sized aerosol is far less studied.

We approach this issue by analysing the spatial variability of CCN sized aerosol from several aircraft campaigns around the world, mainly from EUCAARI LONGREX, ATAR, INCA, INDOEX, CLAIRE and several national aircraft campaigns in Finland. The aim is to find out the typical distribution shapes and usable mean parameters to describe such distributions. These values could then be used to parameterize such variability in GCMs, or at least diagnose potential variability in the results from this variation.

Analysing the aerosol measurements in the aircraft data shows a clear lognormal distribution of values, although with variable and location dependent modal parameters. The shape of the distribution is maintained in smaller scales (representing finer resolution models), but naturally with smaller geometric standard deviations as the variability is reduced. Figure 1 shows an example of gained coefficients of variation calculated from EUCAARI Falcon OPC datasets during 2008 LONGREX experiments (Hamburger et al., 2012).

The modelled grid box concentration is often assumed to be arithmetic mean value of the concentrations within the grid-box. Using such mean value (if correctly modelled, of course) could then significantly vary from the true number concentration of CCN sized particles on the most cases where the cloud activation would happen in the grid box. Thus, there might be a bias in aerosol-cloud interactions in GCMs and Chemical Transport Models (CTMs) related to the representation of aerosol number concentration spatial variability.

We will also evaluate the possibility to include Eulerian (fixed station) measurements to approximate spatial variability. This approach, if found feasible, will increase the temporal coverage significantly from individual aircraft campaigns to decades.

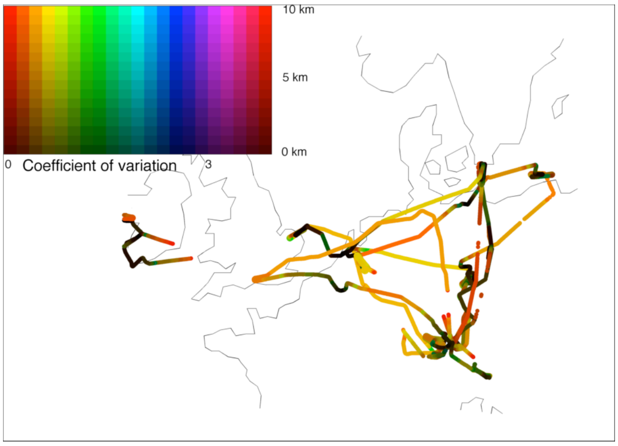

Figure 1. Example of spatial scale dependent differences around Europe, based on EUCAARI DLR Falcon measurements. Plotted is the coefficient of variation (CV=STD(x)/MEAN(x)) of the OPC aerosol concentrations (approx.. 250 nm to 1.1 μm), corrected to STP conditions, from 100 km spatial and 1 km vertical distance from each measurement point. The hue gives CV values, and the colour brightness is related to altitude. Only cloud-free data is shown.

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