Geophysical Research Abstracts
Vol. 20, EGU2018-9051, 2018
EGU General Assembly 2018

Aerosol evaluation using a global synthesis of aircraft measurements

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Despite ongoing efforts (e.g. Kipling et al. 2016 and Koffi et al. 2016), the vertical distribution of aerosols globally is poorly constrained in many commonly used GCMs. This in turn leads to large uncertainties in the contributions of the direct and indirect aerosol forcing on climate (e.g. Samset et al. 2011). Using the GASSP database - the largest collection of in-situ aircraft observations currently available, with more than 1000 flights from 37 campaigns from around the world - we are investigating the vertical structure of aerosols across a wide range of regions and environments. These in-situ constraints are particularly valuable when investigating the dominant processes above or below clouds, where remote sensing data is limited.

The application of this unique dataset to assess the vertical distributions of cloud condensation nuclei and number size distribution in the global aerosol-climate model ECHAM-HAM reveals that the model underestimates larger particles in the upper troposphere. The processes underlying this discrepancy are explored by comparing the full aerosol distributions, clustered using k-means clustering, as a function of altitude against a Perturbed Parameter Ensemble (PPE).

We will also discuss an AeroCom Phase III experiment to use the GASSP database and a number of other aircraft campaigns to evaluate the vertical distribution of aerosol across AeroCom models. Some of the sampling issues associated with this kind of evaluation, the need for high frequency model output and tools we have developed to facilitate this will also be discussed.