EGU2020-6244
https://doi.org/10.5194/egusphere-egu2020-6244
EGU General Assembly 2020

Regional modelling of aerosol interaction with deep convection and the effect on new particle formation over Amazonia

Xuemei Wang[1], Daniel Grosvenor[1], Hamish Gordon[2], Meinrat O. Andreae[3], and Ken Carslaw[1]
[1]University of Leeds, Institute for Climate and Atmospheric Science, United Kingdom of Great Britain and Northern Ireland (earxw@leeds.ac.uk)
[2]Carnegie Mellon University, Engineering Research Accelerator and the Center for Atmospheric Particle Studies, 5000 Forbes Ave, Pittsburgh, PA 15213, United States
[3]Max Planck Institute for Chemistry, Hahn-Meitner-Weg 1, 55128 Mainz, Germany

It has been estimated that over 50% of the present-day global low-level cloud condensation nuclei (CCN) are formed from new particle formation (NPF), and that this process has a substantial effect on the radiative properties of shallow clouds (Gordon et al. 2017). In contrast, we have a very limited understanding of how NPF affects deep convective clouds. Deep clouds could interact strongly with NPF because they extend into the high free troposphere where most new particles are formed, and they are responsible for most of the vertical transport of the nucleating vapours. Andreae et al. (2018) hypothesised from ACRIDICON-CHUVA campaign that organic gas molecules are transported by deep convection to the upper troposphere where they are oxidised and produce new particles, which are then be entrained into the boundary layer and grow to CCN-relevent sizes.

Here we study the interaction of deep convection and NPF using the United Kingdom Chemistry and Aerosols (UKCA) model coupled with the Cloud-AeroSol Interacting Microphyics (CASIM) embedded in the regional configuration of UK Met Office Hadley Centre Global Environment Model (HadGEM3). We simulate several days over a 1000 km region of the Amazon at 4 km resolution. We then compare the regional model, which resolves cloud up- and downdrafts, with the global model with parameterised convection and low resolution.

Our simulations highlight three findings. Firstly, solely using a binary H_2SO_4-H_2O nucleation mechanism strongly underestimates total aerosol concentrations compared to observations by a factor of 1.5-8 below 3 km over the Amazon. This points to the potential role of an additional nucleation mechanism, most likely involving biogenic compounds that occurs throughout more of the free troposphere. Secondly, deep convection transports insoluble gases such as DMS and monoterpenes vertically but not SO_2 or H_2SO_4. The time scale for DMS oxidation (~ 1 day) is much longer than for monoterpene (1-2 hours), which points to the importance of simulating biogenic nucleation over the Amazon in a cloud-resolving model, while lower-resolution global models may adequately capture DMS effects on H_2SO_4 nucleation. Finally, we also examine the Andreae et al (2018) hypothesis of aerosol supply to the boundary layer by quantifying cloud-free and cloudy up- and downdraft transport. The transport of newly formed aerosols into the boundary layer is 8

times greater in cloud-free regions than in the clouds, but these transport processes are of similar magnitude for large aerosols.