Geophysical Research Abstracts
Vol. 20, EGU2018-7428, 2018
EGU General Assembly 2018

Developing emulator for subgrid-scale aerosol-cloud interactions in a global climate model

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Aerosol-cloud interactions are a significant source of uncertainty for global climate models. One reason for this is that aerosol-cloud interactions have a large impact on subgrid-scale process, which are typically described using relatively simple parameterizations. Shallow marine clouds have global relevance, but also depend heavily on subgrid-scale processes such as turbulence and the availability of aerosol to act as a Cloud Condensation Nuclei (CCN). These processes can be modelled by using high resolution models like UCLALES-SALSA, which is a Large Eddy Simulation (LES) model supplemented with an aerosol and cloud microphysics module (SALSA). High resolution models are computationally demanding, so coupling those with a global climate model such as ECHAM is not possible. However, using so-called emulator is a computationally efficient solution to the problem.

We have developed an emulator for describing subgrid-scale aerosol effects on shallow marine clouds in the ECHAM global climate model. Binary Space Partitioning (BSP) method was used to sample the representative meteorological and aerosol parameters from several cloudy ECHAM columns. UCLALES-SALSA simulations were made using these parameters as an input, and as a result we observed the tendency of cloud fraction. Cloud fraction is strongly dependent on meteorological constrains, but the aerosol effect is also observable. This cloud fraction data was used to the train the emulator, which means that it should be able to predict the tendency of cloud fraction based on ECHAM column properties. Current work has been focused on finding the best ECHAM column data sampling strategy, building a reasonable setup for UCLALES-SALSA based on limited inputs, and on training, testing and improving the emulator. The first results show that the accuracy of the developed emulator is reasonable. The next task will be testing it with the ECHAM model.