Geophysical Research Abstracts
Vol. 14, EGU2012-9682-1, 2012
EGU General Assembly 2012


# Aerosols-cloud-climate -interactions in the Norwegian Earth System Model (NorESM). Importance of biogenic particles for cloud properties and anthropogenic indirect effect.

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According to the 4th assessment report of IPCC, major sources of uncertainty in anthropogenic climate change projections are inaccurate model description and weak knowledge of aerosols and their interactions with radiation and clouds, as well as the cloud feedback to radiative forcing.

One important aspect of the associated uncertainty is the natural atmosphere. Anthropogenic climate change is an increment caused by anthropogenic emissions relative to the properties of the climate system untouched by man. This is crucial for the direct and indirect effects of aerosols, since the amount, size and physical properties of natural background particles strongly influence the same properties of the anthropogenic aerosol components.

In many climate models where CDNC is calculated explicitly, CDNC is constrained by prescribing a lower bound below which calculated values are not allowed. This is done in order to keep the aerosol in-direct effect within estimated values. The rationale for using such a lower bound is to keep the aerosol radiative forcing constrained by the forcing of green-house gases and 20th century climate.We hypothesize this lower bound can be removed or made less strict by including aerosols of biogenic origin. We will present results and sensitivity studies from simulations with the NorESM where we have added contributions from organic carbon of natural origin both from vegetation and oceanic sources. By including aerosols of biogenic origin we obtain close to the median indirect radiative forcing reported by IPCC AR4, as well as reproducing the temperature increase in the 20th century.

NorESM is based on the Earth system model CCSM4.0 from NCAR, but is using CAM4-Oslo instead of CAM4 as atmosphere model and an updated version of MICOM from the Bergen Climate Model (BCM) instead of the ocean model POP2. The aerosol module includes sea-salt, dust, sulphate, black carbon (BC) and particulate organic matter (OM). Primary aerosol size-distributions are modified by condensation, coagulation, and wet-phase processes. Aerosol optics and size distributions for calculation of cloud droplet activation use look-up tables constructed from first
principles.
The model is used for CMIP5 simulations.