NorESM in CMIP5: selected results with emphasis on climate response by aerosols vs. GHG.

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Abstract:

We present selected results from response simulations with the Norwegian Earth System Model, NorESM (Bentsen et al., 2012; Iversen et al., 2012), based on scenarios defined in the fifth phase of the Coupled Model Inter-comparison Project (CMIP5). The main focus is on impacts of aerosols and greenhouse gases (GHG) on surface temperature and precipitation.

NorESM is to a large degree based on CCSM4 from NCAR (USA). While the land and sea-ice modules of CCMS4 have been retained with only small modifications, the ocean model has been replaced by an updated version of the isopycnic ocean model MICOM. Furthermore, the atmospheric component in NorESM, CAM4-Oslo (Kirkevåg et al., 2012), is a modified version of CAM4 (of CCSM4) with updated versions of aerosol and aerosol-cloud interaction schemes originally developed for CAM-Oslo. The most important changes with respect to anthropogenic impacts on climate, compared to CAM-Oslo, are the inclusion of biogenic primary organics and methane sulfonic acid from oceans, as well as a nearly doubled production of land-based biogenic secondary organic aerosols. This increased abundance of *natural* organic matter (OM) has contributed to a considerable decrease of the indirect radiative forcing at top of the atmosphere (IndRF) by *anthropogenic* aerosols in the model. The new IndRF estimate of -0.91 W m^{-2} for the period 1850-2000 is closer to the IPCC AR4 estimates than previous estimates with CAM-Oslo. Direct radiative forcing is estimated at -0.10 W m^{-2} for the same time period. CAM4-Oslo is participating in AeroCom with a range of Phase II experiments.

The simulated global mean near surface air temperature in NorESM is lower than in CCSM4 during the last few decades of the 20th century, and temperature increase during the last 30-40 years is more realistic in NorESM. Although NorESM is diagnosed with relatively low climate sensitivity, this is also due to the indirect effect of aerosols which is included in NorESM but not in CCSM4. The magnitude of the indirect forcing in NorESM is moderate, however. The projected increase in global mean surface air temperature based on RCP scenarios is considerably lower than a 15-model CMIP5 average. Precipitation is projected to increase in the tropics and in most of the extra-tropics, whilst decreases are prominent in the sub-tropics, and in southern parts of the northern extra-tropics during summer.

“Single-forcing” experiments indicate that aerosols and greenhouse gases produce similar geographical patterns of response for near surface temperature and precipitation. These patterns tend to have opposite sign, with important exceptions for precipitation at low latitudes. The asymmetric aerosol effects between the two hemispheres lead to a southward displacement of ITCZ. Both forcing agents thus tend to reduce northern hemispheric subtropical precipitation.