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

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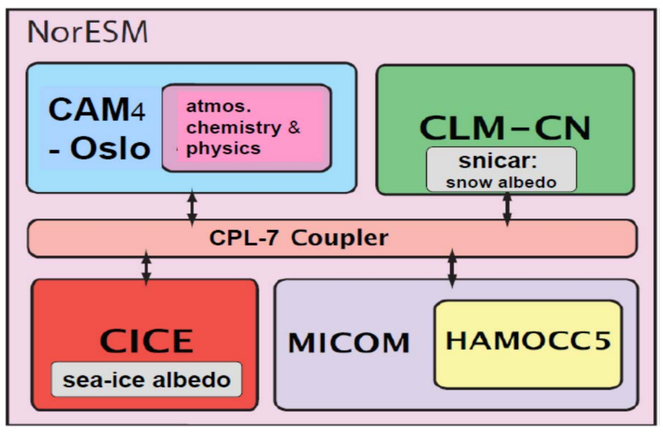
This poster presents

CMIP5 results from the Norwegian ESM version without carbon cycling (NorESM1-M), based on CCSM4, CAM4-Oslo and MICOM (BCCR-vs).

Climate effects of direct and indirect forcing by anthropogenic aerosols vs. GHG are emphasized.



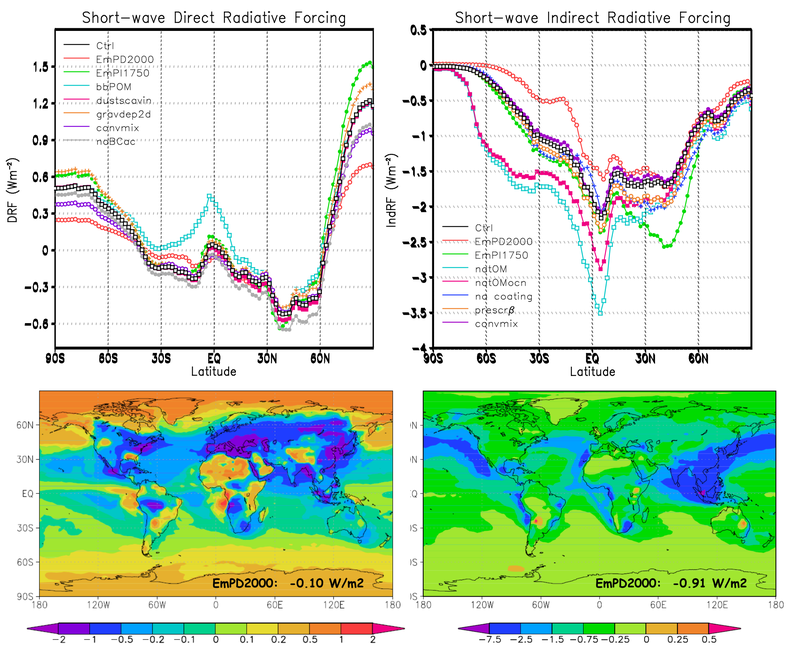
NorESM and CAM4-Oslo

is the Norwegian Climate Centre's numerical model for global climate and earth system studies (see GMDD – Special Issue for NorESM, 2012).

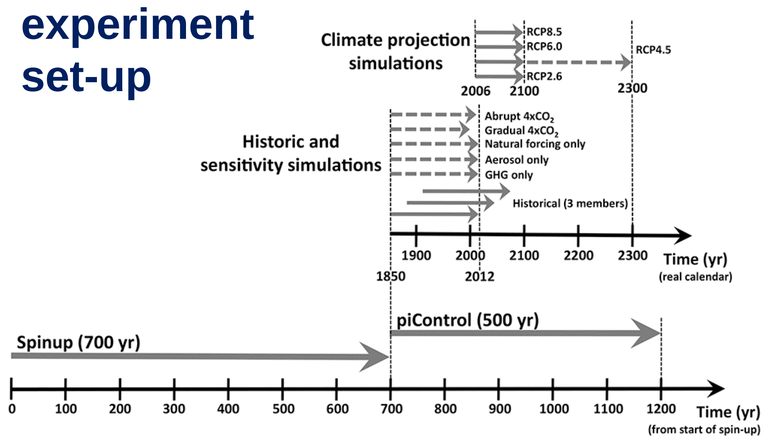
CPL, CLM, and CICE are from CCSM4.0. CAM4-Oslo is based on CAM4 but includes our own developed schemes for aerosols with cloud interactions, and has contributed to several AeroCom Phase II experiments. The ocean model is based on MICOM (and HAMOCC for ocean carbon cycling). Scripts, initialization files, and stratospheric volcanic aerosols are from CCSM4. Applied model grids: 1.9 x 2.5 degrees for atmosphere and land, and gx1v6 for ocean.

Fossil fuel and biomass burning emissions are from CMIP5. Additional aerosol emissions/yields: sea-salt, mineral dust, MSA, and extra OM as oceanic POM and SOA from land-based vegetation. The increased abundance of *natural* OM compared to the predecessor of CAM4-Oslo has contributed to a considerable decreased indirect (and total) radiative forcing by *anthropogenic* aerosols in the model.

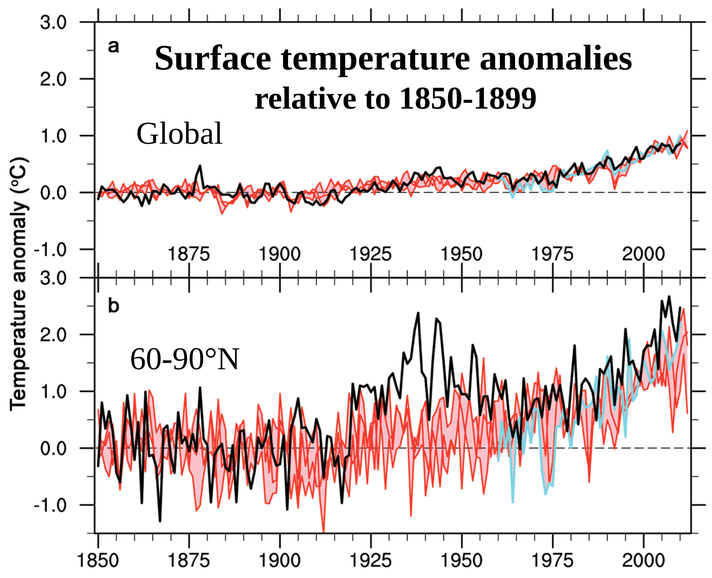
Aerosol radiative forcing at TOA



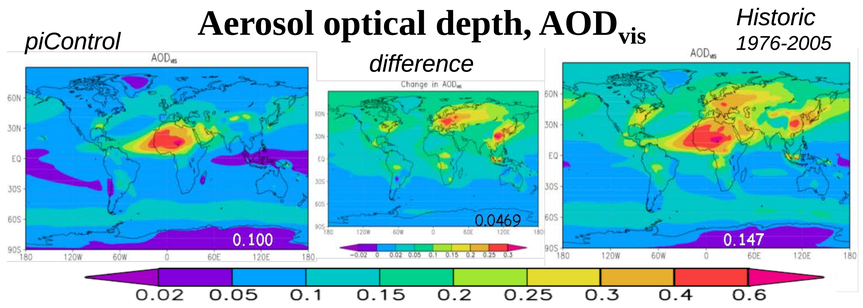
NorESM spin-up and CMIP5 experiment set-up



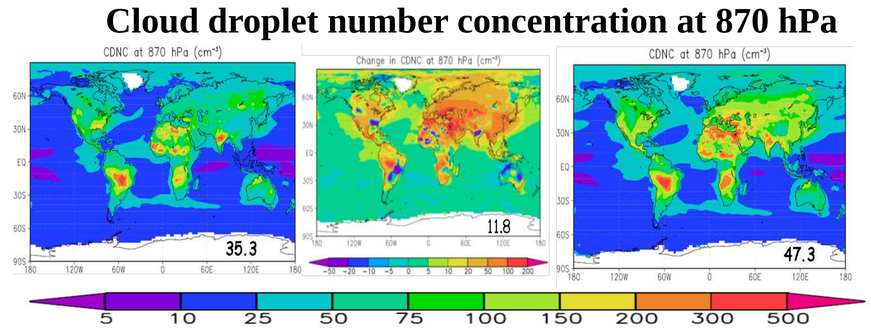
Historical Transient 1850-2005



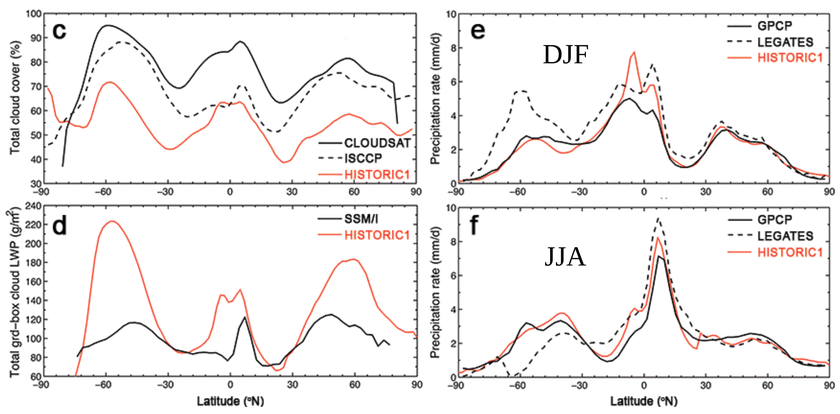
Aerosol optical depth, AOD_{vis}



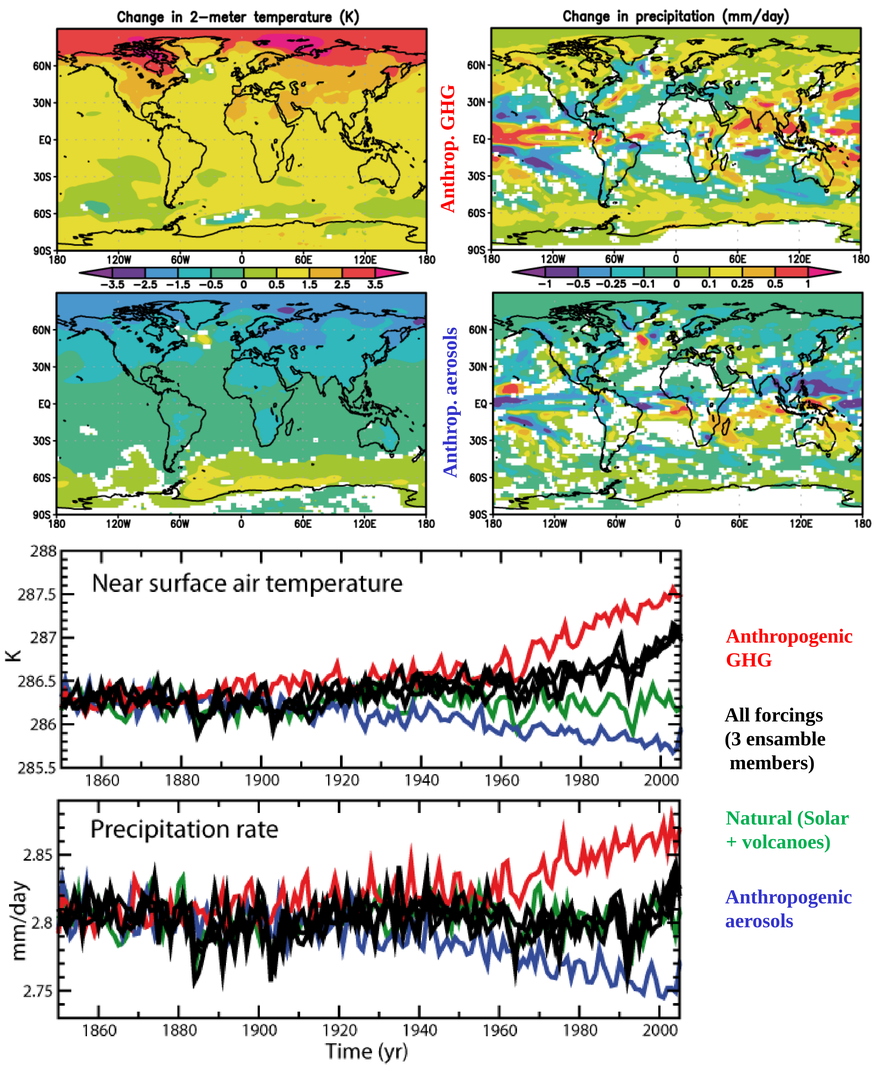
Cloud droplet number concentration at 870 hPa



Cloud fraction, liquid water path, and precipitation

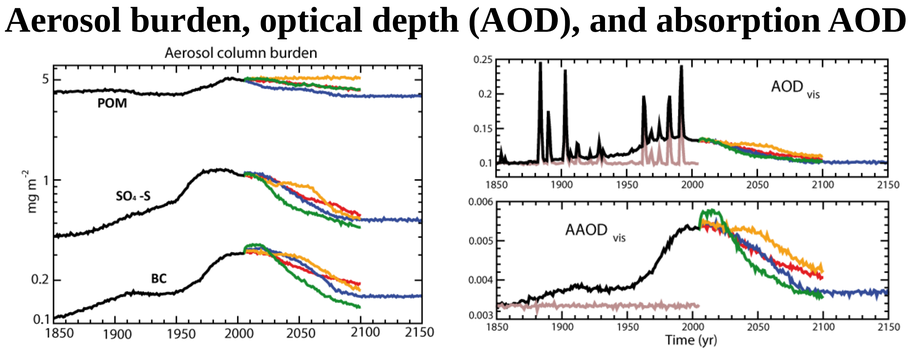


Surface air Temp. and Precip. response to forcings

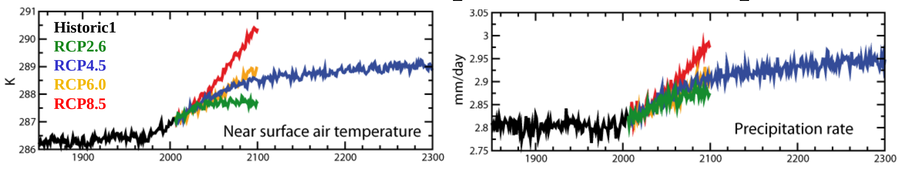


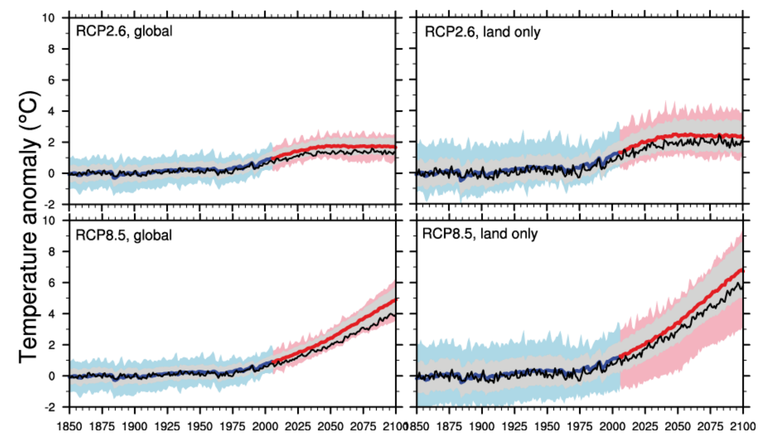
Scenarios

Aerosol burden, optical depth (AOD), and absorption AOD



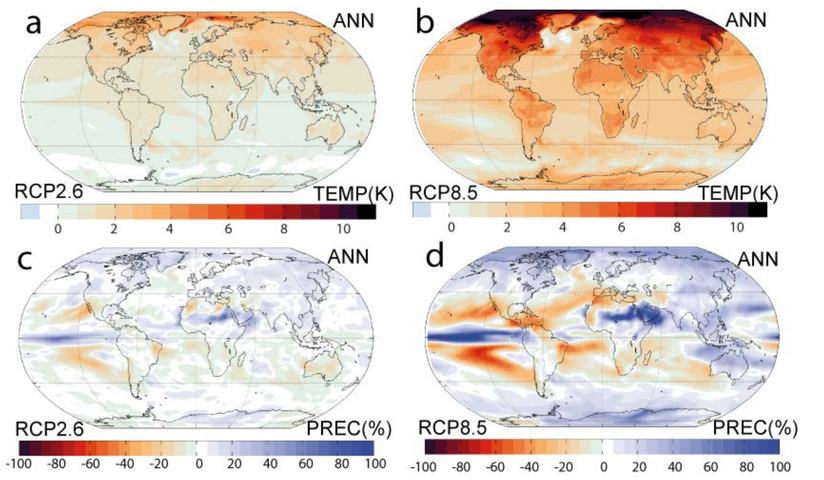
Global Surface air Temperature and Precipitation





Model calculated annual surface air temperature anomalies, relative to 1850-1899 for RCP2.6 and RCP8.5. Black lines: NorESM1-M; blue and red lines: ensemble mean over 15 other models contributing to CMIP5.

Change in mean Surf. air Temp. and Precip. from 1976-2005 to 2071-2100.



Summary

Global mean surface air temperature in NorESM is underestimated, more than in CCSM4, during the last few decades of the 20th century. The simulated temperature increase during the last 30-40 years is weaker and more realistic than in CCSM4, however. Although NorESM is diagnosed with a relatively low climate sensitivity, this is also due to the indirect effect of aerosols which is included in NorESM but not in CCSM4. None of the NorESM ensemble members simulate the early warming signal of the 1920s to the 1940s north of 60°N.

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.

"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 sub-tropical precipitation.

References: Bentsen et al. (2012), Iversen et al. (2012), Kirkevåg et al. (2012), in GMDD – Special Issue: The Norwegian Earth System Model: NorESM; basic development, validation, scientific analyses, and climate scenarios.

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