

Interactive comment on “Development and basic evaluation of a prognostic aerosol scheme in the CNRM Climate Model” by M. Michou et al.

Anonymous Referee #2

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General comments

In this work, the authors incorporated a prognostic aerosol scheme in the CNRM climate model. This aerosol scheme is based on the MACC aerosol module in the ECMWF forecast model. They also added a new mineral dust emission parameterization, based on the works of Marticorena and Bergametti (1995) and Kok (2011), into the model and then studied its associated impacts. Simulated aerosol properties were validated with various observations such as the MACC aerosol reanalysis, the aerosol climatology of Kinne et al. (2013), AERONET ground-based observations, MODIS Aqua classic and Deep-Blue products, MISR products, and CALIOP products.

MACC aerosol module is a simple aerosol module developed by Morcrette et al. at 2009. The transformation of SO₂ into sulfate is done without any explicit chemistry.

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Nitrate and ammonium are not considered in the model. Lamarque et al. (2012) incorporated the online full chemistry scheme MOZART into the CESM model system. They used the Bulk Aerosol Model (BAM) coupling with MOZART to simulate sulfate, sea salt, dust, and carbonaceous species mass concentrations by considering major chemical and physical processes including emission, transport, gas phase chemistry, aqueous phase chemical reactions, dry deposition, and wet scavenging. Liu et al. (2012) introduced a modal aerosol module (MAM) in CESM which can be used to study aerosol size distribution and both internal and external mixing between aerosol components. Comparing to these previous works, the treatments of aerosol chemistry, mixing state, and scavenging in MACC aerosol module, which was incorporated in the CNRM climate model by this work, are too simple. When the authors calculate aerosol optical depth, how do they deal with particle growth caused by the uptake of nitrate, ammonium and aerosol water? And I do not find any new improvements to address these problems in this work.

The consideration of aerosol and climate interaction processes is important for the implementation of aerosol module in climate model. Based on current manuscript, I cannot obtain enough information to let me understand how the authors deal with aerosol and climate interactions. I would like the authors to provide more details about the treatments of aerosol direct and indirect effects in the manuscript. And what are the values of simulated aerosol radiative forcing and cloud radiative forcing in this study? Do the authors consider the impacts of aerosol on clouds and precipitation?

IMPROVE and EMEP have provided multi-year sulfate, BC, OC mass concentration measurements at numbers of sites over USA and Europe. I would like the authors to do the comparison of their model results with these aerosol mass observations.

In this work, the authors added a new mineral dust emission parameterization into the model. This new parameterization is based on the works of Marticorena and Bergametti (1995) and Kok (2011), As shown in Table 3, simulated dust emission by the new scheme is much higher than the values simulated by the old dust emission scheme in

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GEMS/MACC. What are the major reasons causing such differences of predicted dust emission? In additionally, the global averaged difference of the two scheme is more than a factor of 10. According to the authors understanding, which scheme is more realistic?

Based on current model validations provided by the authors, I think the incorporated MACC aerosol module in the CNRM climate model did not show good performances comparing to these observations/reanalysis. The validation of monthly mean global bin concentrations with MACC Reanalysis suggested the climate model simulation significantly underestimated mass concentrations of all the 3 sea salt bins, dust within the range of 0.03-0.5 micrometer, hydrophilic BC, and sulfate. The model significantly overestimated mass concentrations of dust within the range of 0.9-20 micrometer and hydrophobic BC. Simulated mean DJF 2003–2012 total AOD by this work is only half of the values from satellite retrievals, while simulated mean JJA 2003–2012 total AOD is about 60-70% of the values from satellite retrievals. The comparison of model simulation with AERONET observations also indicated that the model significantly underestimated AOD at numbers of sites.

Special comments

P6266, L3: Can the authors give some discussions about aerosol modeling in CESM, GISS, ECHAM, and UKCA?

P6268, L28: Please check the size information about dust bins.

P6269, L7: This kind of treatment cannot reflect the impact of boundary condition on dry deposition velocity which is important for tiny particles such as sulfate, BC, OC, and first bins of sea salt and dust.

P6269, L12: How do the authors deal with hydrophobic and hydrophilic species in wet scavenging. Does aerosol bin size impact wet scavenging?

P6269, L14: It is very questionable. How do the authors divide gas phase chemistry

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and aqueous phase chemistry in their study. The production rates of sulfate from the two different processes are quite different from each other.

P6272, L23: Without chemistry, how do DMS emission impact the authors' simulation. Do the authors trace DMS transport in their model?

P6273, L2: How do the authors deal with SOA in their model?

P6273, L22: Why do the authors rescale the sulfate precursor emissions?

P6273, L26: This kind of assumption is unreasonable to me. It may cover some potential problems in the authors' model simulation.

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