ICON-HAM-lite 1.0: simulating the earth system with interactive aerosols at kilometer scales by P. Weiss et al.

Strengths

Interesting concept for detailed aerosol representations in km scale global modeling
Simulations for an entire year for detailed examination for strengths and limitations

Weaknesses

Transitions from emission and processing to accumulation and coarse mode is unclear.
Some emission inputs (e.g. biomass burning) are too coarse for km-scale modeling.
Fixed sizes seem too simple for interactions with ambient humidity (sulfate, seasalt).

General

For applications in km-scale global modeling, standard complex aerosol modules (i.e. M7 in ICON/ECHAM) are (at least currently) computationally too demanding. Thus, with the ability to actually simulate most dynamics simplifications to aerosol modules are needed.

The paper is an initial attempt to simplify with only 4 different (radiatively active) components, although the limitations to 4 sizes may be too simple (i.e. to include processing under changing ambient relative humidity). While important aerosol processing methods (e.g. sedimentation, dry deposition and wet deposition) are nicely summarized, is it not quite clear how bottom-up processing from emissions (without nucleation and Aitken modes) would work.

Results highlight a few cases, where aerosol component dynamics is examined and there are immediate applications for aerosol-cloud interaction / processing. On the other hand radiative forcing applications have to wait for better AOD (annual) maps (carbonaceous AOD and mineral dust AOD are very low) and for satisfactory values for aerosol absorption.

I see this paper as a useful first step, which should be improved over time, as forseen by the authors. While the 4 selected compositions (fine-mode carbon, fine-mode scattering aerosol, coarse mode sea-salt and coarse-mode dust) seem sufficient, I would also consider size variations for scattering fine-mode and seasalt, and for coarse-mode dust sizes (to improve an AAODc representation).

Details

60 / 74 is it unclear how humidity (via kappa) come into play, if size is fixed

92 interesting … that no convection scheme/parameterization is needed

107 emissions data are relatively coarse for km-scale models …. ?

135 / 155 why distributing the formulas on two lines ?

191 displaying the reff (effective radii) would be better, as it includes the width information) … there seems a size inconsistency to the MACv2 reference, as number mode radii are picked for the two coarse modes, while (larger) effective radii are picked for the fine-mode. The kappa approach (values are reasonable) might be useful for CCN estimates in the context of ambient rel. humidity but are they actually used? Densities are reasonable but on the high side for carbon and sulfate, and those might become smaller with increased aerosol water.

236 great to have a simulations done for an entire year

238 is there a difference of Table 4 data between HAM and HAM-lite ?

252 the comparison to AeroCom median are quite interesting. Here also the optical depth data of the top-down approach of the MAC climatology can be added (see below). I also provide access to data so that in assessment annual and even monthly component spatial distributions differences can be examined. While global averages for seasalt and sulfate seem ok, global averages for dust and carbonaceous aerosol are ca factor 2.5 too low. Hereby the low dust AOD bias is not helped by the relatively small coarse dust size.

257 the vertical component distributions in Figure 5 look reasonable. And biomass (or carbonaceous) aerosol is often above dust (i.e. off west Africa)

267 MODIS overestimates AOD, especially at low AOD values. In addition, listed global average might even on the low side as the applied dark-target data-set has no data over deserts. I suggest to use for MODIS data comparisons a combined dark-target/deep blue data set.

291 if aerosol modulate the intensity of cyclones is unclear … and highly unlikely by sea-salt, as this type stays a low altitudes.

299 the local feature associated with dust look impressive

302 what are the prescribed mean radii and std.dev s (incomplete in Table 2)
303 one ‘the’ too many

324 … are blown off continents … not just Africa

330+ I like most of the ideas for future work, in particular studies involving aerosol cloud interactions. For aerosol forcing, however, a better representation of AOD components and also a validation of assumed absorption (AAODf / AAODc) will be needed

Resources for more detailed comparisons

(here to annual data of the MACve3 aerosol climatology)

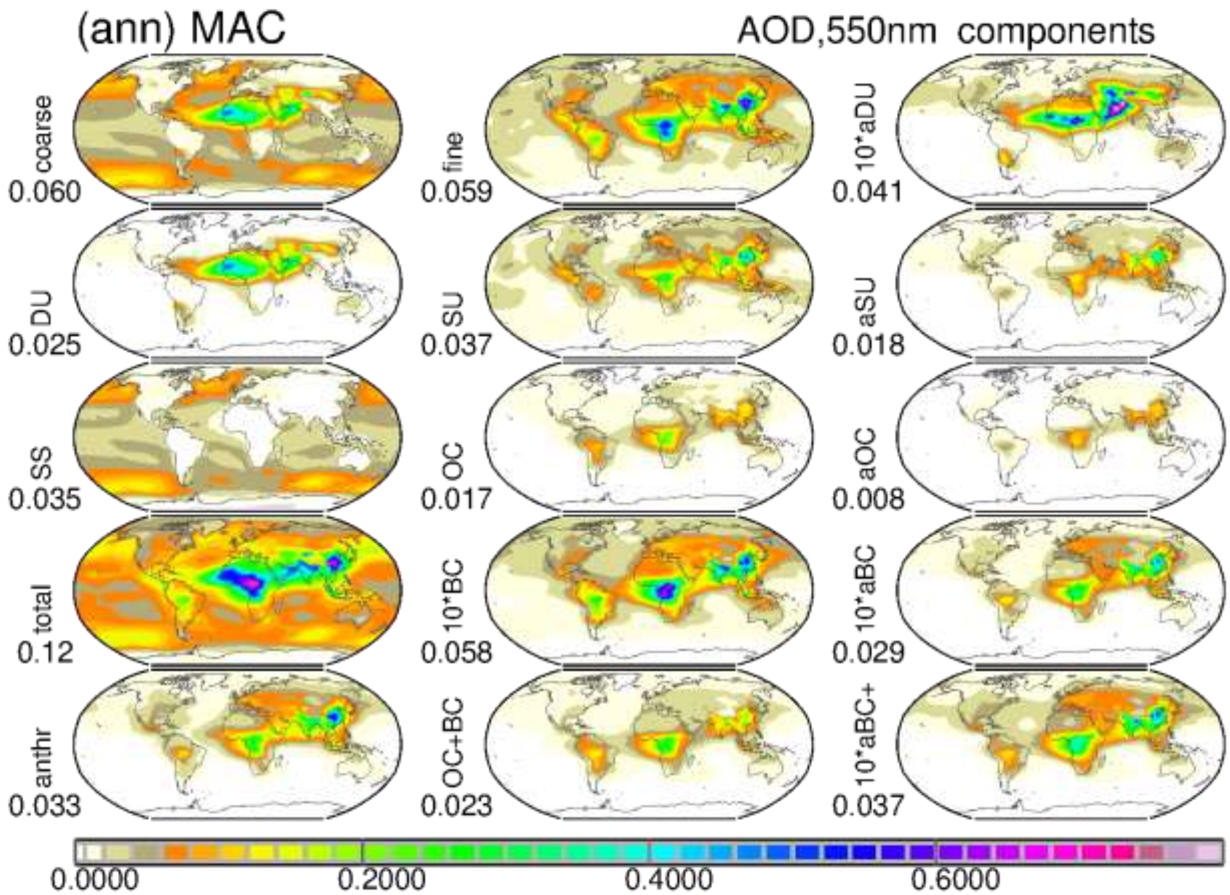

***Figure**. annual average mid-visible AOD distributions of the MACv3 climatology. Total AOD (total: col1, row4) is split in AODc (coarse: col1, row1) and AODf (fine: col2, row1). In a 'top down' approach (mainly relying on complementary AAOD data) in turn AODc is split into AOD contributions from mineral dust (DU: col1, row2) and seasalt (SS: col1, row3). And AODf is separated into contributions by scattering aerosol (SU: col2, row2), organic carbon (OC: col2, row3) and soot (BC: col2, row4 – 10 times). Combined carbon (OC+BC: col2, row5) data are also presented. In addition (with the help from 'bottom-up' global modeling), current (ca year 2015) anthropogenic AOD fields are offered for total aerosol (anthr: col1, row5) and component contributions by coarse-mode dust (aDU: col3, row1 – 10 times) and by fine-mode contributions of scattering aerosol (aSU: col3, row2), organic carbon (aOC: col3, row3), soot (aBC: col3, row4 -10 times) and for an alternate soot (BC+: col3, row5 – 10 times) using a higher anthropogenic fine-mode fraction. Values to the lower left of each images indicate global average mid-visible AOD.*

for direct comparisons are global monthly maps of the MACv3 climatology in netcdf format are on anonymous ftp

ftp-projects.mpimet.mpg.de/aerocom/climatology/MACv3_2022/MACv3_550

gt_aodTO_550.nc   total aerosol
gt_aodFI_550.nc   fine-mode aerosol
gt_aodCO_550.nc   coarse-mode aerosol
gt_aodDU_550.nc   total aerosol
gt_aodCA_550.nc   total carbon aerosol (mainly assuming heevily OC coated BC)
gt_aodSS_550.nc   coarse-mode seasalt aerosol
gt_aodSU_550.nc   fine-mode scattering aerosol (mainly sulfate and Nitrate but also small DU and SS …
I   …and even volcanic aerosol)

gt_ref_DU_CO.nc   coarse-mode effective radii
gt_ref_SU_FI.nc   fine-mode scattering effective radii

gt_ta_0550mn.nc   total absorption at 550nm
gt_fa_0550mn.nc   fine-mode absorption at 550nm
gt_ca_0550mn.nc   coarse-mode absorption at 550nm

… and many more data