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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global distribution of sea salt aerosols: new constraints from in situ and remote sensing observations" *by* L. Jaeglé et al.

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(1) The modification and adjustment of sea salt emission are completely based on the performance of a particular model, GEOS-Chem, therefore the application of the new empirical formula to other models may be limited. Also, because of the non-linearity of wind-dependence of sea salt emissions, the emission and the resulting sea salt concentrations and optical depth are unfortunately dependent on model spatial resolutions. Other factors such as the boundary layer mixing schemes (as the authors pointed out the differences between GEOS-4 and GEOS-5 driven simulations) and dry deposition schemes will also affect the model bias, even though the other processes such as wet deposition and transport can be less important for coarse mode sea salt. Therefore, while the finding of the necessity of including SST in emission is general, the actual

parameters are "tuned" to the current GEOS-Chem conïňĄguration and performance. The authors should clearly state the limitations here.

We do agree that our parameters for the SST dependence of sea salt emissions are tuned by design to the GEOS-Chem model configuration. Using a different model might indeed yield a different empirical parameterization. This limitation is now discussed in the revised version of the manuscript: "While our finding of a SST-dependence to SS emissions is robust, the actual parameters in Eq. (4) are likely to be model dependent to some degree as our approach in deriving these parameters was to fit the model discrepancy. If the same analysis were to be carried out with a different model using different meteorological fields, dry deposition scheme, or boundary layer mixing scheme, then the parameters might be somewhat different. We note that Tsigaridis et al. (2010) recently implemented our SST parameterization in the GISS model, finding improved agreement with sea salt observations compared to a number of other parameterizations they examined." We examined the impact of spatial resolution on sea salt emissions, but found little dependence. This is elaborated on further below.

(2) Considering SST as a controlling factor of sea salt emission makes a good sense, and inclusion of such a factor seems to resolve the "long-standing" problems of model underestimating AOD in the tropical and subtropical Pacific Ocean, since the MODEL-SST run agrees with MODIS AOD much better than the MODEL-STD. However, one should take into account that MODIS is likely to overestimate the AOD in that region when compared with the AOD measurements from the Maritime Aerosol Network (from many research ship cruises, coordinated by AERONET, see Smirnov et al. GRL 2006). I strongly suggest the authors use the MAN data, which also contain fine mode and coarse mode AODs.

Following this reviewer's suggestion, we have added in Figure 10 a comparison of MODEL-STD to Maritime Aerosol Network AOD observations for 2006-2008. The dependence of model bias on SST is similar to that observed for AERONET

ACPD

10, C13337–C13342, 2011

and MODIS observations, providing further evidence for a SST dependence to sea salt emissions.

Some detailed comments: - The term "SSA" is in general reserved for "single scattering albedo", not "sea salt aerosol". I suggest not use this acronym here for sea salt aerosols.

We have replaced SSA with SS as an acronym for sea salt aerosols.

- Page 25689, line 21-23, large discrepancies of sea salt aerosols in the AeroCom models have a lot to do with different size ranges in different models.

The sea salt emissions in the AeroCom models do indeed show a very high diversity (199%) as a result of different size ranges assumed. However, as noted by Textor et al. (2006), the diversity of the burden of sea salt aerosols is smaller (54%) because models with very high emissions (and large sea salt particles) predict shorter residence times due to the assumed large sizes. Thus when looking at sea salt burden, the divergent assumptions about size ranges are partially offset by the resulting changes in lifetimes.

- Page 25690, line 15-16, "large diameters" – need to be more quantitative. How large is "large"?

In the context of this sentence, we define large as diameters between 2 and 20 μm. This has been added to the text.

- Page 25691, line 18: GEOS-4 has 1.25 deg longitude resolution.

This has been corrected in the text.

- Page 25691, line 23: Given the high non-linearity of wind-speed dependence of sea salt emission, something should be said here about the effects on degrading spatial resolution.

We find little dependence (less than a 2-4% difference) of sea salt emissions on

ACPD

10, C13337–C13342, 2011

the assumed resolution (2x2.5, 1x1, 0.5x0.667) of daily wind fields. This has now been added to the text: "We also examined the impact of degrading our horizontal resolution by comparing the SS emission potential at different resolutions for QuikSCAT (2x2.5 and 1x1) and GEOS-5 (2°x2.5° and 0.5x0.667). We found that horizontal resolution has minimal impact, affecting our daily SS emission potential by less than 4% and annual mean SS emissions potential by less than 2%."

- Page 25694, line 8-11: Are all these wind comparisons at 2x2.5 deg resolution?

Yes, we have clarified this in the revised manuscript.

- Bottom of page 25694 to top of page 25695, comparing winds: Does GEOS-4 assimilate the 10-m QuickScat winds? The reason of GEOS-4 having higher 10-m winds due to its thicker lowermost layer should be explained better because readers wouldn't necessarily know why the thickness of the lowermost model layer would affect the 10-m wind speed, especially if it is from the reanalysis.

Yes, both GEOS-4 and GEOS-5 assimilate QuikSCAT winds as well as other observations of surface winds. However, the improved vertical resolution, turbulence model, and observation operator for scatterometer winds in GEOS-5 has led to improvements in the 10-m winds in the analyses over GEOS-4. This has been clarified in the text:"Both GEOS-4 and GEOS-5 do assimilate QuikSCAT as well as other surface wind observations from other satellites, ships, and buoys. However, the improved vertical resolution, turbulence model, and observation operator for scatterometer winds in GEOS-5 has led to improvements in the 10-m winds in the analyses over GEOS-4 (S. Pawson and A. Molod, personal communication, 2011)."

- Page 25695, paragraph starting with "Another difference": This is not really the difference between GEOS-4 and GEOS-5, but the difference in GEOS-Chem's choice of BL mixing schemes. Also, I would think that too much vertical mixing in the BL would lower

ACPD

10, C13337–C13342, 2011

the surface concentrations, even though the dry deposition could be less efïňĄcient. What is the budget from the GEOS-Chem model using two different schemes/met ïňĄelds?

After re-examining this issue in more detail, we found that the difference between GEOS-4 and GEOS-5 surface mass concentrations is almost entirely due to the overestimate in emissions because of the wind speed overestimate in GEOS-4. Differences in vertical mixing appear to have very little impact. This has now been corrected in the revised manuscript.

- Page 25696, line 1-2: It would be more appropriate to sample the model output at the closest time and location of measurements, not every 30 min, in order to have a fair comparison.

We are indeed sampling the model at the time and location of measurements. The sampling is done every 30 minutes along the cruise track in order to compare to the meteorological observations and be able to average over the appropriate sampling time for the sea salt observations (which are done at varying intervals ranging from 2-24 hours). This has been clarified in the text:"The model is sampled every 30 minutes at the closest time and location along the cruise track. The modelled SS concentrations are then averaged over the measurement sampling times, which range from 2 hours to 24 hours."

- Page 25696, line 5: add "and AOD" after "concentrations".

Done.

- Page 25699, 2nd paragraph: Do you sample the model output that matches the MODIS observation time and condition (i.e. cloud free)? Do you use MODIS Terra or Aqua or both?

Yes, we do sample the model at the MODIS Aqua observation time and under cloud free conditions. This has now been clarified in the text. In our analysis we

ACPD

10, C13337–C13342, 2011

only use MODIS Aqua and not Terra, although as noted in the text using MODIS Terra yields the same results.

- Page 25701, line 10-12: If the model error in wet dep cannot explain the poor model performance, how about errors in dry dep and/or settling?

We address this point in our answers to Reviewer 2 (see "dry vs wet deposition")

- Page 25701, 2nd paragraph: The winds are not from GEOS-Chem. Therefore it should say GEOS-4 or GEOS-5, not "the model" to avoid confusion.

Done.

- Page 25710, line 12-13: This should be topical/subtropical PaciïňĄc Oceans. AOD over the tropical Atlantic is dominated by dust with high values.

Done.

- Page 25713, line 3: Should be more quantitative than just saying "generally good agreement", which sounds subjective.

We have added that the mean normalized model bias is +2.6% for annual mean RH.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 25687, 2010.