

## ***Interactive comment on “The implementation of NEMS GFS Aerosol Component (NGAC) Version 2.0 for global multispecies forecasting at NOAA/NCEP: Part I Model Descriptions” by Jun Wang et al.***

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General comments:

This paper describes a substantial revision of NGAC, from a dust-only model to one including the usual fuller set of aerosol species (adding sea-salt, sulfate, black carbon and organic matter). Although there are no particularly novel scientific features compared to existing aerosol schemes, this paper serves to document the development of a well-used operational system. It is a well-written model description paper, and more

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extensive evaluation is provided in the companion paper (which is subject of a separate review). I would recommend publication in GMD subject to the following minor comments.

The comments and suggestions from the referee #2 are greatly appreciated. The specific comments have been addressed and point-to-point response is provided here

p.2, lines 3–4: “sea salt particles tend to reflect all the sunlight they encounter” – this is a rather simplistic description of their scattering behaviour.

- Response: The manuscript has been revised (page 2, lines 4-6). Page2, lines 4-6: “Sea salt particles scatter the incoming solar radiation and absorb the outgoing terrestrial radiation, with short and long wave radiation approximately the same order of magnitude, but in opposite sign (Lundgren, 2013).”

p.2, lines 10–12: “Polluted air. . . leads to a weak hydrological cycle” – please clarify the limited conditions or scales for which this is true, since in general precipitation will be constrained by surface evaporation.

- Response: it is true that the general precipitation is constrained by surface evaporation. However, the regional cooling aerosol radiation effect can result in lower evaporation, changing regional circulation and modifying the microphysics to reduce the rain. But there is uncertainty on general conclusion of aerosol impact on hydrological cycle. Manuscript is modified (page 2, lines 13-16). Page 2, lines 13-16: “Polluted air with an increased amount of aerosols tends to generate bright clouds reducing precipitation efficiently, which then leads to a weak regional hydrological cycle that affects the quality of fresh water over the tropics and the subtropics, especially in the Asian region which has the large tropical and subtropical aerosol emission sources (Ramanathan et al. 2001).”

p.2, lines 16–17: I would suggest “aerosols may have significant impact” as the magnitude of such impacts outside idealised scenarios remains quite uncertain.

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- Response: Suggested change is made in the manuscript (page 2, line 19-20).

p.4, line 25: "full aerosols" would suggest that e.g. nitrate aerosol is included; perhaps "a wider range of aerosols"?

- Response: the suggested change is made in the manuscript. (page 5, line 31- page 6, line 1). Page 5, line 31- page 6, line 1: "In NGACv2 the GOCART module is updated and the suite of aerosol components is turned on to predict a wider range of aerosols."

p.5, line 14: it would help to specify the actual resolution of this Gaussian grid rather than the spectral truncation, for those unfamiliar with the particular spectral gridpoint mapping used.

- Response: The Gaussian grid resolution 100 km is added in the manuscript (Page 5, lines 23-24). Page 5, lines 23-24: "Emissions datasets are re-gridded to the native model grid (i.e., T126 Gaussian grid, about 100km horizontal resolution)."

p.5, lines 17–18: which AeroCom emissions dataset? There have been several recommendations for different phases of experiments – a specific link or reference would be helpful.

- Response: AeroCom Phase II (HCA0 v1, Diehl T. 2012) emissions are used. Reference is added in the manuscript. Section 2.3 has been revised to provide additional information on emissions (Page 5, lines 28-29). Page 5, lines 28-29: "For anthropogenic emissions of primary sulfate, the AeroCom Phase II dataset (HCA0 v1, Diehl et al., 2012) is used."

p.5, line 21: "Organic carbon has Terpene emission" – more detail on this rather terse statement would be welcome. Are terpenes emitted directly as organic carbon aerosol? Or emitted in the gas phase and subsequently converted to aerosol? From what inventory are these emissions derived, covering what sectors?

- Response: Ten percent of the Terpene emission is converted to organic carbon aerosols through the oxidation of gas-phase precursors following Chin et al (2002).

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The emission is from IGAC-GEIA 1990 inventory (Guenther et al. 1995); it includes isoprene, monoterpenes, other reactive VOC (ORVOC), and other VOC (OVOC) emissions. Manuscript is revised (page 6, lines 9-11). Page 6, lines 9-11: "Emissions of terpene from vegetation are oxidized to produce OC aerosols. Biogenic emissions are treated following Chin et al. (2002) using a monthly varying Global Emissions Inventories Activity (GEIA) inventory (Guenther et al. 10 1995)"

p.6, lines 30–31: "NGACv2 is closer to GEOS-4" – but does that mean it is closer to truth or observations?

- Response: this statement does not mean that NGACv2 is closer to truth or observations. We only compare NGACv2 with GEOS-4 and AeroCom model suite. Following explanation is added to manuscript (page 7, line 30 – page 8, line 2). Page 7, line 30 – page 8, line 2: "It is worth noting that the NGAC emissions, budget, and lifetime presented here are in the context of the AeroCom model suite. Evaluation of aerosol budget, emissions, and lifetime using observations is beyond the scope of this study."

p.7, lines 26–29: These plots compare results from CMAQ using NGACv2 vs GEOS-5 monthly boundary conditions, but observations should also be included to give some indication of which is performing better (as is done for the next example); otherwise the statement which follows that the forecast is improved is not justified.

- Response: The Figure 4 (Figure 3 before manuscript modification) is updated to show the impact of providing lateral boundary from NGACv2 to CMAQ forecast. Observations of PM<sub>2.5</sub>, (cycled dots) and synoptic condition (wind vector and pressure) are added in the plots of CMAQ forecast with NGACv2 as lateral boundary condition (plots in the middle column). This figure shows that the CMAQ forecast with NGACv2 as lateral boundary condition matches observations better compared to BASE CMAQ forecast. The manuscript has been revised (page 9, lines 6-8). page 9, lines 6-8: "The middle panel is the PM<sub>2.5</sub> forecast from CMAQ during the same period using NGACv2 multi-species aerosols as the lateral boundary condition. PM<sub>2.5</sub> observations (cycled

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dots) and synoptic condition (wind vector and pressure) are also shown in this panel to compare CMAQ forecast with observations.”

p.8, line 9: although the run using NGACv2 is closer to observations here, it is worth noting that the values are still too low.

- Response: The comment has been added in the manuscript (page 9, lines 19-20). Page 9, lines 19-20: “It is clear that the run with the NGACv2 forecast is closer to observations than the runs from the other experiments even though the peak of PM2.5 in this run is still lower than the observations”

p.8, line 14: please define CRTM.

- Response: The definition of CRTM is added in the manuscript as “Community Radiative Transfer Model” (page 9, line 25).

p.8, lines 14–15: please explain what is meant by the term “aerosol column density”.

- Response: Because there is no direct derivation of aerosol retrieval in current SST retrieval algorithm, the three dimensional NGACv2 aerosol information is added in CRTM model, the Jacobian values for all aerosols and all altitude levels calculated from CRTM output are integrated as the aerosol retrieval. The aerosol column density of all aerosols is the single Jacobian value representing the derivative of radiation transfer equation with respect to a single variable. Manuscript is revised (page 9, lines 26-28). Page 9, lines 26-28: “Aerosol column density (ACD) of all aerosols is represented by the single Jacobian value that are calculated in CRTM representing the derivative of radiation transfer equation with respect to a single variable, the ACD is then included in the state vector for the MODIS-Aqua SST retrieval.”

p.8, line 23: there appear to be two section 5.2s.

- Response: the section of “Insolation on the earth surface estimation” is changed to section 5.3.

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p.8, line 32: each of the different experiments presented here should be properly described.

- Response: Manuscript is modified to add description of the experiments. Page 10, lines 14-23: “Figure 7b (Figure 6b before manuscript modification) shows aerosol impact on the mean bias error (MBE) of Global Horizontal Irradiance (GHI) from Perez Model. The GHI is computed from Perez Model with AOD and water vapor from different sources. Five sets of experiments were conducted to show the MBE. “GHI” is the control experiment with monthly averaged AOD from NASA Earth Observations (NEO) and water vapor from NEO or GFS. Validation are performed on two sets of sites, one set is validated against GOES eastern US satellite (GOES-13), the other against GOES western US satellite (GOES-15). “GHI\_our” experiment is using the monthly averaged AOD from ASRC. “GHI GM” is using Gueymard AOD (Gueymard, 2008). GHI with NGACv2 AOD at 550nm and GHI with NGACv2 AOD at 660nm are also shown. It is found that GHI MBE is the smallest for the experiment using NGAC AOD at 660nm for the 2016 spring period. The results indicate potential improvement in the operational insolation estimate using NGAC AOD at 660nm.”

p.9, line 25: should “GFSC” here be “GSFC” instead? Otherwise it should be defined.

- Response: The future work section has been revised to emphasize near term work of transitioning NGAC to FV3GFS based system. This sentence is removed.

p.9, line 25–26: The MAM aerosol scheme and MG cloud microphysics don’t appear elsewhere in the paper – if their use is to be mentioned in the conclusions as more than a possibility for the future, more detail should be given at an appropriate point in the body of the paper.

- Response: There is some uncertainty on the time line of implementing the MAM aerosol schemes and MG cloud microphysics due to the transition to FV3 based atmospheric system. The two lines are removed.

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Table 2: This is quite confusing with a lot of numbers, and I would consider finding a more accessible way to present the data (perhaps with the aid of a bar chart)

- Response: Table 2 is presented as a bar chart (Figure 2, see attached figure); the manuscript is revised (page 21). Following is the caption for Figure 2: Figure 2: Global annual total aerosol emissions and annual average aerosol burdens, lifetimes, and loss frequencies in NGACv2, AeroCom models, GOES4 and NGACv1 (dust only). For AeroCom models, the red vertical lines show the maximal and minimal values, and the bar shows the mean value. The first column is for dust, the second column is for sea salt aerosols, the third column is for black carbon, the fourth column is for organic carbon and the first column is for sulfate. Sulfate is for sulfur amount only. 5 (Colarco, P. et al, J. Geophys. Res., 2010).

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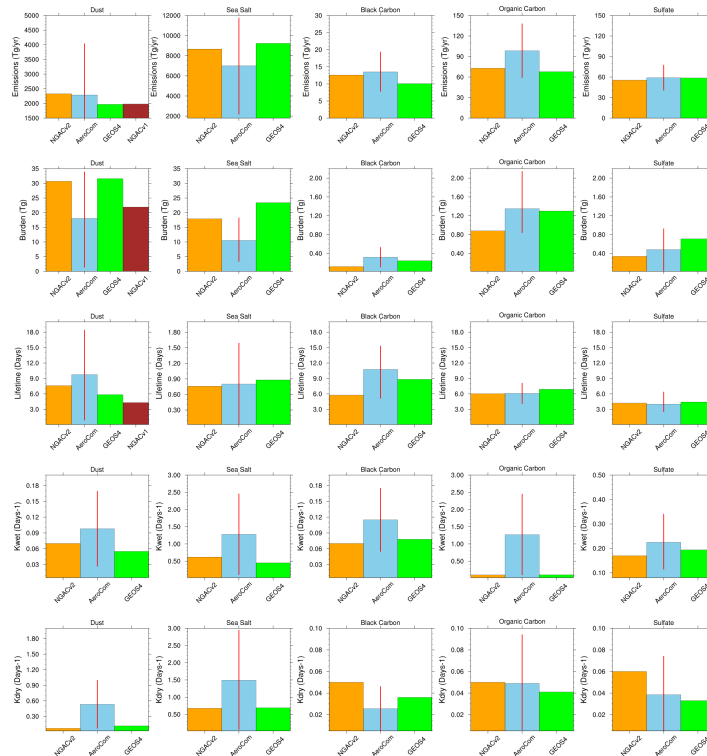


Fig. 1. Figure 2 (previous table 1)

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