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Geoscientific Model Development Discussions

Interactive comment on "The implementation of NEMS GFS Aerosol Component (NGAC) Version 1.0 for global dust forecasting at NOAA/NCEP" *by* C.-H. Lu et al.

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Lu et al.: The implementation of NEMS GFS aerosol component (NGAC) version 1.0 for global dust forecasting at NOAA/NCEP

The comments and suggestions from the Referee #2 are greatly appreciated. Please see detailed response below.

Specific Comment:

The validation part is good, but I do recommend including more AERONET stations. In fact, what I wish the authors would have done is a validation effort similar in extent to what has been presented in Huneeus et al 2011. As far as I know, they even developed

a tool that is straight-forwardly applicable. In doing so, the authors could test the model performance in all regions of the globe rather than at just two AERONET stations next to the main Saharan desert dust sources (which, arguably, are the most important sources). In addition, as pointed out above, they can highlight the model skill in the context of other - presumably less performant - models. In any case, I would kindly ask the authors to defend their minimalistic choice and to justify why they did not use more or omit other AERONET stations. The same is true for the choice of satellite remote sensing products. MISR, MSG Seviri or OMI are other data set available for comparison.

Response: The Referee is correct that this manuscript only presents concise descriptions of model performance.

There are very limited, if any, peer-reviewed publications on NCEP's ongoing NEMS development and on NCEP's emerging global aerosol modeling capability. This paper, therefore, seeks to present the aerosol modeling capability in the programmatic aspects (such as the rationale, the NCEP-GSFC collaborative approach, and aerosol-related applications) rather than providing an extensive model evaluation/validation.

During the development phase, we compared NGAC V1 dust results with other models (ICAP MME and GSFC's GEOS-5), in-situ observations at multiple (> 2) AERONET sites, and aerosol retrievals from satellites (MODIS, VIIRS, and CALIPSO). This paper, however, only provides brief descriptions of NGAC V1 evaluation. Such choice, by no means, trivializes the importance of model evaluation and validation. Efforts are ongoing at NCEP to evaluate and validate parallel NGAC V2 (with dust, sea salt, OC/BC, and sulfate). The references on the approach for AeroCom and NMMB/BSC-dust model are greatly appreciated and will certainly provide valuable guidance on how to put NGAC V2 performance in better context with other aerosol models. We have included additional sites (Sede Boker, Ilorin, Banizoumbou, and La Parguera sites) for Figure 6c-6f in Section 4.

Minor comments:

* Section 2.1, p.7, line 4ff: Not sure it is relevant to mention the future development of WAM in this context. Unless it takes any bearing on the further development of the aerosol module, you may as well leave it out in order to avoid confusion.

Response: The WAM-related discussions have been removed to avoid confusion.

* Section 2.2, p.7/8: You are referring to the on-line capability of the model here. Later in section 2.3, p.9, line 19ff, you provide more details on how the on-line approach works. Are you talking about the same thing here? Please try to make the text more coherent and merge the bits that belong together.

Response: The manuscript has been revised. The discussions on the on-line capability in p.9 line 19 have been moved to Section 1. The end of 4th paragraph in Section 1 (p.4) is changed from "The NGAC consists of two key modeling components: (1) the GFS within the NEMS architecture (NEMS GFS) and (2) the on-line aerosol module based on Goddard Chemistry Aerosol Radiation and Transport (GOCART) model" to "NGAC is the first on-line (interactive) atmospheric aerosol forecast system at NCEP. It consists of two key modeling components: (1) the GFS within the NEMS architecture (NEMS GFS) and (2) the on-line aerosol module based on Goddard Chemistry Aerosol Radiation and Transport (GOCART) model. The advantages for taking the so-called on-line approach include: (1) consistency: no spatial–temporal interpolation and the use of the same physics parameterization, (2) efficiency: lower overall CPU costs and easier data management, and (3) interaction: allows for aerosol feedback to meteorology."

* Section 2.2, p.8, line 13ff: Which dust emission scheme you are using? Also, which moisture correction and surface roughness correction scheme you are using? Have you done any sensitivity experiments in order to tune the model, e.g. wrt soil moisture, or did you just tune the emission budget? As a side note: Ginoux's topographical dust source function happens to be very suitable for representing the major dust sources as

they are linked to wind channelling effects due to said orography.

Response: Ginoux's topographical dust source function is used, and the only tuning is for dust emission budget. One paragraph is added at the end of section 2.3 (p.9):

"GOCART in GEOS-4/5 has been implemented in NEMS GFS 'as is' except for emission budget. As in GEOS-4/5 (Colarco et al., 2010), the spatial distribution and intensity of dust sources in NGAC V1 follows from Ginoux et al. (2001). Owing to differences in the GEOS-4/5 meteorology and resolution relative to NEMS GFS, the global scaling constant for dust emissions (see equation (2) in Ginoux et al. (2001)) has been adjusted from C = 0.375 μg s2 m-5 as in GEOS-4/5 to C = 1 μg s2 m-5 in NGAC. This adjustment is determined from sensitivity experiments, allowing NGAC V2 to obtain dust emission budget comparable to GEOS-4/5."

* Section 3, p.10, line 8: NCEP begins → NCEP has begun

Response: The technical correction has been made.

* In the next line, you mention that dust forecasts are available online. On p.11, line 3, you do actually provide an online resource which appears to be linked to these forecasts. I recommend merging the two separated statements, which presumably, refer to the same thing.

Response: The two statements (in 2nd and 5th paragraphs, respectively) have been merged. The 2nd paragraph now mentions the link for EMC NGAC webpage. The discussions on how NGAC is initialized has been moved from 2nd paragraph to the end of section 3.

* Section 3, p.10, line 27: I don't quite understand this sentence: "This aerosol-radiation decoupled configuration that GOCART aerosols are not radiatively coupled to the AGCM is intended [. . .]". Please rephrase!

Response: The phrase has been modified as such "Note the interaction of GOCART aerosol fields and GFS's radiation package has been disabled in NGAC V1.0. This

configuration that aerosols are not radiatively coupled to AGCM is intended to facilitate aerosol modeling development in the near term. Once the prognostic aerosol capability reaches desired maturity level, this aerosol-radiation decoupled configuration will be changed allowing the aerosol direct and semidirect radiative effects to be accounted for."

* Section 4.2, p.12, line 16ff: Why did you only compare with MODIS? What about OMI, MISR, MSG Seviri? In Fig 5: Why only monthly AOD means rather than seasonal means? At least it has to be consistent! Text and Figure capture say different things.

Response: This manuscript aims to provide a high-level description of NGAC from the programmatic aspects, so does not cover detailed model evaluation/validation.

For Fig.5, the text has been revised from "Figure 5 shows seasonal dust distributions over the subtropical Atlantic region." to "Figure 5 shows monthly-mean dust distributions over the subtropical Atlantic region at different seasons."

* Section 4.2, p.13, line 9ff: As highlighted in the specific comment, I would kindly ask you to either justify the choice of only two AERONET stations for comparison, or provide a more comprehensive analysis. While the performance at the two stations shown in Fig 6 is really good, it may well just be by chance. I'd rather know the model performing not so well in some regions as opposed to not knowing at all. Also, what about Lidar observations? How do you know the model is able to represent the vertical structure of the dust plume away from sources? EARLINET and CALIOP are the tools to go with. Again, please justify why you didn't use either of those.

Response: Four additional sites are added. The discussions in section 4.2 (p.13) are modified to "Among the six stations included in the comparison, three sites are located in dust-prone Sahara-Sahel region (Dakar, Ilorin, and Banizoumbou), one site is located in dust-prone Middle East area (Sede Boker), and two sites are located in tropical Atlantic Ocean region (Cape Verde and La Parguera). The Dakar site is located in Senegal, North Africa near the dust source region. The Ilorin site, located in Guinea

Savanna zone, experiences dust and episodic smoke aerosols. The Banizoumhou site, located in the Sahel region, is influenced predominantly by dust transport from the Sahara. For the two ocean sites, Cape Verde is influenced by dust outflow from Saharan sources while La Parguera is influenced by long-range transport of Saharan dust. The Middle East site, Sede Boker, is located in the Negev desert of Israel and experiences mainly dust and urban aerosols. At these sites except for Ilorin, NGAC V1.0 simulations are found to capture the seasonal variability in the dust loading. Overall, NGAC V1.0 shows similar seasonal variability to and is well correlated with the AERONET observations."

To justify why only concise model evaluation is presented, the last paragraph in Section 4.2 (p.13) is moved to Section 4 (p.11).

In the original manuscript, the last paragraph in Section 4.2: "NCEP is currently working toward the phase-two NGAC implementation (i.e., full-suite of aerosols including dust, sea salt, sulfate, and carbonaceous aerosols using near-real-time smoke emissions from satellite fire products). The planned NGAC upgrade will produce total AOD, allowing us to evaluate NGAC results beyond dust- dominated regions."

In the revised version, the 1st paragraph in Section 4 becomes: "In this section, the results of operational NGAC V1.0 forecasts are presented. Note NCEP is currently working toward the phase-two NGAC implementation (Lu et al., 2016). The NGAC V2 includes full-suite of aerosols using near-real-time smoke emissions from satellite fire products. The NGAC upgrade will produce total AOD, allowing us to evaluate NGAC results beyond dust-dominated regions. Efforts are underway to evaluate experimental NGAC V2 with other models (ICAP MME and GSFC's GEOS-5), in-situ observations at AERONET sites throughout the globe, and aerosol retrievals from multiple satellites, including MODIS, Visible Infrared Imaging Radiometer Suite (VIIRS) and Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP). In this paper, only concise model results are presented as the paper mainly provides the programmatic aspects of NGAC development and implementation."

* Section 5.1, p.15, line 2ff: Fig 8 does not seem to add any extra value. Unless you compare NGAS with ICAP directly, rather than showing the average of all ICAP models (MME), I don't see any benefit of putting the Figure and suggest to take it out.

Response: Figure 8, showing the dust AOD regional ensemble products from the WMO SDS-WAS regional center at BSC, has been removed. The text has been revised accordingly: (1) 2nd paragraph in Section 5.1 is shorten as the reference to Figure 8 (WMO SDS-WAS regional MME) is removed, (2) 2nd and 3rd paragraphs are merged into one paragraphs, and (3) CMAQ results (previously Figure 9) is now Figure 8.

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