

Second Review of “*Regional evaluation of the performance of the global CAMS chemical modeling system over the United States (IFS cycle 47r1)*” submitted by Jason E. Williams et al. to Geoscientific Model Development

The authors made great efforts to address my comments and concerns from their initial submission and the manuscript is greatly improved. I have a few technical edits listed below, and once addressed I recommend this paper for publication.

**Comments:**

Line 61: The NAQFC has a comma after it, as if the authors were going to note something else. What I found lacking was the acknowledgement of NOAA with NAQFC and recommend adding it here.

Line 61: There is also a period and comma missing in “(e.g., Chai et al., 2013”.

Line 63: I find the wording “The model is regional meaning” awkward and recommend changing this to something like

“This system is a regional model configuration, therefore, it requires lateral and chemical boundary conditions from a global model to account for effects of long-range transport.”

Line 64-67: Thank you for the acknowledgement of the NASA GEOS-CF system. I suggest changing “One other” to “Another notable system” since there are other global models (e.g., the Finish SILAM, NCAR’s WACCM) and regional models (e.g., ECCO, NCAR’s WRF-Chem and NOAA’s RAP-Chem) which also forecast over the US. I’d hesitate to say that GEOS-CF is “similar to CAMS” unless you say specifically that they are both CCMMs (coupled chemistry and meteorology models) as here the GEOS-CF uses GEOS instead of the IFS and GEOS-Chem is not an option in the IFS as far as I am aware. Note there is a missing period after et al. in the Keller et al. reference. Also, we are no longer referring to GEOS by its version number so I recommend removing the (v5). Altogether, I suggest changing this sentence to something like:

“Another notable system for AQF is the NASA GEOS Composition Forecast system (GEOS-CF v1.0; Keller et al., 2021); it is a global coupled chemistry and meteorology model like CAMS but uses the GEOS atmospheric circulation model coupled to the GEOS-Chem chemistry module and run at the global resolution of 0.25° x 0.25° on 72 vertical layers.”

Line 87: It is likely fine, but the radicals OH and HO2 were not defined at first use (hydroxyl radical and hydroperoxyl radical). I only note it here because in line 111 the authors define the “hydroxyl radical (OH)” so it should likely be done here at first use.

Line 166-168: I still find this sentence awkward. I think it is the “is computed” that is throwing me off. I suggest something like this:

“In the MBA, the radiative transfer calculation is performed with a two-stream solver using the absorption and scattering components introduced by gases, aerosols and clouds which are computed online for each of the predefined band intervals.”

Line 240: The SOG was defined already at line 214 (and SOA defined earlier on Line 181). Is there a reason the authors have redefined it here?

Line 270: In response to one of my comments on the initial draft, the authors changed BENZENE to Benzene, but TOLUENE and XYLENE have been reduced simply to TOL and XYL with no explanation, instead of using lower case letters. This current version is confusing as “TOL” in the line above refers to a lumped aromatic. Can these also be changed to toluene and xylene?

Line 309: Add a comma after “Huijnen et al. (2019),”

Line 325: State in this first paragraph that Yarmouth is in Canada and given its close proximity to the US it is a good proxy for New England and that is why you have included it in your study of US air quality.

Line 330, Figure 1 caption: GMDL is not defined in the paper. In line 340, “NOAA ESRL Global Monitoring Laboratory” is written. This needs to be better defined in the main text and matched in the figure caption. Also, was it a choice not to add dots for the AirNow CO stations that would match with the Table 5 count of stations?

Line 338-342: The three sites THD, BAO and NWR used for O<sub>3</sub> are part of the NOAA ESRL GML, so the Niwot Ridge does not need to be redefined in line 342 unless it really is at a different longitude. Also, it may be good to move up the definition of BAO and THD from line 472-473 here to be closer to the Figure 1 where we see they are used to label the ozonesonde locations.

Line 380: I think you caught most of the region updates throughout but double check as here I see the use of “Col” instead of “COL” and “TX” instead of “SC” as given in Table 4.

Line 400, Table 5: Some of the regional domains still included latitude or longitude bands that would include Canada. Particularly, in New England, 65 °W is further east than necessary if US only, as this box should mark out the region for AirNow observations and does not need to include Yarmouth, Nova Scotia. For North/South Dakota and Pacific Northwest, both go up to 50 °N in the table but the US border stops at 49° and the boxes in Figure 1 were reduced to reflect that. What concerns me is the number of total stations has not changed, which leads me to wonder if the analysis included any of the Canadian stations in the initial submission or not. This should be confirmed so the authors are confident that only the US stations are included in the analysis in the final version. There were only a few that were likely included in the Pacific NorthWest, but it looks like half the O<sub>3</sub> red dots that were once in the New England region were removed when the Canadian sites were removed.

Line 456-457: Here the authors refer to ozonesondes composites “located across the US” which is not correct with Yarmouth in Canada. This is why there needs to be a statement at Line 325 that Yarmouth is being used as a proxy for New England so that it is appropriate for the authors to write “Yarmouth (east coast)”. I do appreciate that Figure 3 caption was updated to have “across the US/Canada”.

Line 466, Figure 3: The authors could add here “Note, x-axis and y-axis scales vary.” or something to that effect.

Line 491, Figure 4: The legend was removed from the left panel and should be added in as per the figure caption. However, the THD panel is very busy, so I recommend adding it back in to the bottom left corner of the NWR (middle) panel.

Line 508: I recommend changing this to:

“During the first few months of 2014, a significant mean positive bias exists for more northerly regions across the chemical modules, with IFS(CBA) biases up to  $20 \text{ ug m}^{-3}$  and IFS(MOZ) biases as high as  $40\text{-}60 \text{ ug m}^{-3}$ .”

Line 553: VOC should be plural: VOCs

Line 687: I made a similar comment in the Conclusion section of the initial draft which was addressed. Here “Western US” refers to a portion of the USA while “Eastern US” is one of your defined regions. It would likely help to change Western to lowercase “western US” and could add in brackets the regions from Table 8 that the authors associate with the lower biases (e.g., Colorado, California/Nevada).

Line 715: This is a sentence where you could add the brackets to help with brevity

“Low (high) values for S are indicative of an equilibrium which favors O<sub>3</sub> production (destruction).”

I do like this way of writing. In the earlier cases, I found the double parentheses with the model names hard to read.

Line 808, Figure 18: There is one site in Canada. Similar to Figure 3 caption, I suggest this is changed to “across the US/Canada for”

Line 890-938: I mentioned this on the first draft, it took me by surprise that the full names of the chemical modules were written out instead of the short names used throughout the paper. It may be a conscious choice, but I remember finding this made the conclusion feel separate from the rest of the paper.

Line 974: ozone-sonde still needs the hyphen removed.