Geoscientific Model Development Discussions

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Comment on gmd-2021-111

Anonymous Referee #2

Referee comment on "Inline coupling of simple and complex chemistry modules within the global weather forecast model FIM (FIM-Chem v1)" by Li Zhang et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-111-RC2, 2021

The manuscript "Inline Coupling of Simple and Complex Chemistry Modules within the Global Weather Forecast model FIM (FIM-Chem v1)" discusses global chemical weather forecast (aerosol and gas phase) using three chemistry schemes from simple to complex and evaluates its result against aircraft measurement over parts of the globe. The study is valuable to understand the merits of these schemes as well as to understand some of the biases/issues that are present in inline couple chemistry transport model. The manuscript needs major revision to improve from its present status and Authors need to address the following comments outlined here:

- 3 difference chemistry schemes discussed in the mansucript , GOCART, GOCART-RACM and advanced RACM_SOA_VBS here. However it is not very clear how these three differs in terms of number of species advected, chemical reactions and computational expense from each other (both aerosol and gas phase). Authors should include that in the page 6 after describing each of the these schemes.
- Include full form of HTAP in Page 6, line 23.
- Is biomass burning emission (3BEM) used in the study have any day lag input in the model, like model forecast for today uses day -1 or -2 emission etc. Also whether same settings for all these 3 schemes were used in PRER-Chem step ? It should be included in the text.
- Include with some references ow much error is associated with PALMS for different species, Page 8.Anticipating it to be small, but Authors should include it.
- Comparing Figure 2 for total pm2.5, dust and seasalt sources are identical between GOCART and GOCART-RACM, which is expected to be the case. Looking into sulfate, particularly in the difference plot, it seems GOCART-RACM reduced sulfate emission quite a bit over land (with explicit oxidants simulations in its scheme). But why there is so much overprediction over the ocean all over the globe for sulfate in the different plot ? In Fig 2b, GOCART-RACM, over the coast of Africa and Europe and over East Asia there is reduction in sulfate but in the immediate part of the ocean there is a big surge in sulfate is simulated. What is the cause of this surge ? Chemical transport ? Authors should explain this in the text.
- Also is sulfate conc in Fig 2 is at the surface or total column ? Include that in the caption and text

- Include units in Figure 3.
- As we are investigating the reason for decrease in GOCART-RACM simulated oxidants, Authors should consider adding 12z figure for OH in figure 3, it will show the reduction over Africa, India and Asia between the two schemes.
- Line 15-19, Page 9, difference in terms of H2O2 and NO3 impacted over land areas only in Figure 3, GOCART-RACM largely reduced near biomass burning regions. However, NO3 conc is less and impact is smaller. OH difference with valid values over the globe will help to understand the issues.
- Include whether OH, H2O2 and NO3 are at the surface conc or total column in the figure caption and test.
- Add unit in the figure 4 caption.
- As there is no verification with any satellite data provided, Line 26, page 9 it is hard to compare GOCART-RACM simulation. I suspect much underprediction in surface O3 predicted over East China. Over middle-east and Mediterranean much of surface O3 present in the summer, but it is very less over the corresponding Ocean position. Authors can comment whether that is related to transport or due to intensity of surface O3.
- Again add unit in Figure 5 caption.
- Add SOA simulation by GOCART-RACM for the same time as in the Figure 5 for VOC to understand the difference between GOCART-RACM and RACM_SOA_VBS to understand the impact of the later. Add a description in the text, line 12, page 10.
- EC is not defined before in the text, how its relation to OC and BC aerosol of GOCART needs to be explained.
- It is confusing to understand what flight data used for Figure 6 and 7, in the test it is mentioned 15th and 17th August, but caption within Figure 6 mentioned only 15th Based on Figure 1, it is aircraft data from S. America to Europe combining 15th and 17th August of ATOM dataset. Remove all captions within the figure in Fig 6.
- As mentioned in line 30, Page 10, is hydrophilic BC and OC only has biomass burning origin?
- In the figure 6, CO near the surface over the tropics simulated by both GOCART-RACM and RACM_SOA_VBS is very high compare to ATOM. However O3 profiles matches closely with the observation and in the figure 7 OH shows underestimation by the model near the tropics. Something not adding up. Is it possible to include VOC and NOx comparisons in this figure if they are measured by the aircraft to understand a possible pathway. Add them in the text as well.
- In the figure 10, surprised to see GOCART with prescribed climatological oxidants simulating sulfate conc above 4km closely with ATOM rather than two other schemes which simulates explicit oxidant fields. Is it possible to add H202,OH and NO3 comparison for Continental USA case to understand difference between the schemes that gives such result.