

## ***Reply to anonymous referee #2***

### **General comments:**

The authors developed the GEFS-Aerosols component in the Unified Forecast System coupled with Chemistry (UFS-Chem) for the Global Ensemble Forecast System (GEFS). The GEFS-Aerosols component incorporated improvements to anthropogenic and biomass burning emissions, aerosol optical depth calculations, as well as inline aerosol radiative feedback, inline large-scale wet deposition, and updated dust scheme. The UFS-Chem performance with respect to weather and subseasonal predictions are evaluated against MERRA-2 reanalysis, ground-based measurements, and satellite observations. The authors quantified the relative impacts of aerosol radiative and indirect feedback on weather and subseasonal predictions. The results are very helpful in terms of understanding of how aerosol–radiation–cloud interactions affect model forecast skills. The paper is well organized and very well written. I recommend acceptance for publication with minor revisions.

**Reply:** We sincerely thank the reviewer for the positive and encouraging comments. We greatly appreciate your recognition of the significance of this work and your recommendation for publication with minor revisions. We have carefully addressed all of the comments as follows and revised the manuscript accordingly. Thank you for your valuable feedback.

### **Specific comments:**

L75-78: “Notable examples include the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model (Chin et al., 2000), which provided one of the first global representations of aerosol processes, and the subsequent development of National Aeronautics and Space Administration (NASA)’s Goddard Earth Observing System Composition Forecast (GEOS-CF) system, which delivers global operational forecasts of aerosols and atmospheric composition (Colarco et al., 2010; Keller et al., 2021).”

I suggest including the GEOS-FP system first and then GEOS-CF here (see <https://gmao.gsfc.nasa.gov/gmao-products/>) with additional references for GEOS-FP.

**Reply:** We thank the reviewer for this very helpful suggestion. We have revised the text to introduce the GEOS-FP system before GEOS-CF and added the corresponding references for GEOS-FP as recommended: “*Notable examples include the National Aeronautics and Space Administration (NASA)’s Goddard Chemistry Aerosol Radiation and Transport (GOCART) model (Chin et al., 2000), which provided one of the first global representations of aerosol processes, and Goddard Earth Observing System Forward Processing (GEOS-FP), a global meteorological analysis and forecasting system that provides the weather fields supporting aerosol and atmospheric composition modeling (Rienecker et al., 2008; Molod et al., 2015). Building upon the GEOS-FP framework, the Goddard Earth Observing System Composition Forecast (GEOS-CF) system was subsequently developed to integrate comprehensive atmospheric chemistry and delivers global operational forecasts of aerosols and atmospheric composition (Colarco et al., 2010; Keller et al., 2021).*”

L181: remove “. The MODIS Collection 6.1... from the Aqua satellite”, and change it to “, which is available...”

**Reply:** Revised.

L242-245: Large-scale wet deposition is mentioned here. How about convective scavenging?

**Reply:** We thank the reviewer for pointing this out, we have revised the manuscript by adding the following sentence: “*Convective scavenging and convective transport continue to be handled by SAS convection scheme.*”

L361-363: edits - “(e.g., large-scale precipitation)”. The statement needs some references.

**Reply:** Added.

L396: “Table 2, and no indirect feedback”

**Reply:** Revised.

L397-398: Are “CYC\_OWR” and “SUB\_OWR” defined at this point?

**Reply:** We thank the reviewer for pointing this out, we have added: “*The CYC\_OWR and CYC\_IWR experiments represent the 24-h cycling runs with offline and inline large-scale wet removal, respectively, whereas the SUB\_OWR and SUB\_IWR experiments represent the subseasonal free runs with offline and inline large-scale wet removal, respectively*” in the revised manuscript.

L504: remove “of”

**Reply:** Removed.

Table 1: typos – “Molde”, “COCART”, “CDES” (3 places). Indicate L65 and L127 are vertical levels.

**Reply:** Revised.

Table 2: typo – “Subseanal”, “Subseanal”. Explain Experiment names.

**Reply:** Revised and explained the experiment names.

Figure 1: GOCART is an aerosol module – why is it called “GOCART chemistry” (2 places)? Also, “Chemistry is GOCART and AM4.1” – do you mean “Chemistry is AM4.1”?

**Reply:** We thank the reviewer for pointing this out. We have revised Fig. 1 for clarity by correcting the labeling of GOCART as an aerosol module and clarifying that the chemistry component is based on AM4.1.

Figure 2 caption: indicate the region (North America).

**Reply:** Revised.

Figure 4 caption: define the experiment acronyms.

**Reply:** Defined.

Figure 5 caption: explain NIFA, NWFA etc. in the caption.

**Reply:** Revised.

Figure 10: TOA net radiative flux bias relative to CERES...

**Reply:** Revised.

There are a lot of acronyms in this paper. Perhaps consider including a list in the Supplement.

**Reply:** We thank the reviewer for this helpful suggestion. We have added **Table A1**, which provides a list of acronyms, abbreviations, and experiment names used in this study, to the Appendix to improve the readability of the manuscript.