Geoscientific Model Development Discussions

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Comment on gmd-2020-441

Anonymous Referee #3

Referee comment on "WRF-GC (v2.0): online two-way coupling of WRF (v3.9.1.1) and GEOS-Chem (v12.7.2) for modeling regional atmospheric chemistry-meteorology interactions" by Xu Feng et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-441-RC3, 2021

The paper presents a new online two-way coupled model WRF-GC v2.0 based on WRF meteorological model coupled with the GEOS-Chem chemical model including aerosol-radiation interactions (ARI) and aerosol-cloud interactions (ACI) based on bulk aerosol mass and composition, and nesting capability for high-resolution simulations. The authors also analyze chemical feedbacks to meteorology considering ARI and ACI mechanisms.
The paper is interesting and can be suitable for publication, but several comments need to be improved and clarified.
The coupling structure modular, which allows the two parent models to be run off-line or online. This is definitely an advantage. However, it is difficult to classify this model as online-integrated coupled model. According to the definitions (Baklanov et al., 2014) it is still online-access coupling model, like WFR-CMAQ, because the equations of the meteo and chemical transport parts are solved separately, not on the same grid, not simulteneously in each grid-cell and not on each time step (at least it is not clear from the model description). So, in such way of coupling it is difficult to guarantee the consistency and mass-conservation. Besides, most probably the convection numerical schemes are different and not consistent in WRF and GEOS-Chem models.
From other side, the model uses a coupler for data transfer from one model to other. Transfer of 3D data on each time step for each grid-cell will take a lot of time, that makes the modelling system substantially slower in comparison with the fully online integrating approach. For example, ECMWF demonstrated that when they switched from the online-access version IFS-MOZART to the online integrated C-IFS (Huijnen et al., 2010), the modeling system became much faster.
So, it would be important to demonstrate the consistency tests and the effectiveness of the suggested way of the coupling.