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Interactive comment on "Global simulation of tropospheric chemistry at 12.5 km resolution: performance and evaluation of the GEOS-Chem chemical module (v10-1) within the NASA GEOS Earth System Model (GEOS-5 ESM)" *by* Lu Hu et al.

Anonymous Referee #1

Received and published: 7 June 2018

General Comments:

This paper presents an online version of the GEOS-chem chemistry module with an aim of simulating tropospheric chemistry at very high horizontal resolution for a global model (appox. 12.5km). More imporantly the authors have developed a consistency between the GEOS-chem CTM and the online ESM which enables the ESM to keep up with the state of the art science. The main aim is to serve observing simulation experi-

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ments for satellite monitoring systems but also has the added advantage of being able to simulate high-resolution impacts of climate change on air quality. The high resolution of the output will also be of interest to the health and vegetation impacts communities. The paper is very well written and easy to follow and will be of great interest to the wider atmospheric science community. Therefore I recommend publication in GMD after the following relatively minor comments are addressed.

Specific Comments:

Page 5, Line 9: You mention that the model has 72 vertical levels here up to a height of 0.01hPa. Would you be able to clarify what the spacing of the lower vertical model levels are, specifically in the boundary layer region? This will be important if one of the intended uses of the model is for air quality simulations as can have important implications for the rise of emissions plumes, mixing of emissions throughout the BL and ultimately concentrations of key secondary species such as ozone. Further to this the spacing of vertical layers near to the surface can also impact which height emissions are injected at which could have implications for ozone destruction pathways (E.g. NOx titration) and thus concentrations. This could be one of the potential reasons why the model is failing to capture the surface concentrations in Europe (although it is doing a reasonably good job at present). I think the discussion of model performance could benefit further from some extra discussion in relation to this matter.

Page 5, Line 25: Please provide a brief summary of the VOCs included. From an air quality perspective it would be interesting to know the most reactive VOCs from an ozone formation potential. Higher reactive VOCs (E.g. Butanes and aromatics) are important for looking at air quality issues over highly polluted regions such as northern China where models with more basic chemistry schemes struggle to reproduce high levels of O3.

Page 5, Line 26: Which aerosol microphysics scheme is being used?

Page 5, Line 27: Is Fast-JX fully coupled to cloud and aerosol species, to simulate

feedbacks? This could have implications on chemical processes. This is especially important given that the focus of evaluation is ozone.

Technical corrections:

Page 3, Line 22: Double period at the end of the sentence please remove.

Page 4: Lines 32-33: Which boundary layer scheme is being used here? Please provide some detail.

Page 7, Lines 23 and 24: The observed/literature values for O3 are shown in the text and Table 1 but the values for CO and OH are only shown in Table 1. Please be consistent and either refer to all observed values in the text or remove the mention to the O3 values in the text and refer to Table 1.

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