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Interactive comment on "Gas-phase chemistry in the online multiscale NMMB/BSC Chemical Transport Model: Description and evaluation at global scale" *by* Alba Badia et al.

Anonymous Referee #1

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The authors present a detailed description and evaluation of the tropospheric chemistry transport model NMMB/BSC-CTM. This model domain has been expanded from regional to global. The focus of their evaluation is gas-phase chemistry with emphasis on tropospheric ozone and its precursors. Several ground-based, aircraft and satellite data are used to show model strengths and weaknesses. The paper is well-written and is within the scope of the journal. I would recommend the publication of this paper after my minor comments below have been addressed:

Page 2, line 15: replace "fed by emission inventories" with "emissions of chemical species".

Page 2, Line 31: Define NMMB/BSC here.

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Discussion paper

Page 3, line 19: replace “main reactions occurring in the atmosphere by” with “atmospheric composition”. It would be helpful to give a motivation for choosing year 2004 for evaluation.

Page 3, line 28: Insert “direct” before radiative effect.

Page 5, line 10: A reference is needed here.

Page 5, line 17: 1.85 ppm is too high for this year of simulation. Can you please provide a justification for using this number? Also, is the CH4 concentration constant throughout the troposphere in the model or only at the surface?

Page 8, section 2.2.6: Where does the MEGAN model implemented in this CTM derive the leaf-area index needed to calculate biogenic emissions?

Page 8, line 29: Need a period after “parameters”.

Page 9, section 3: What is the size of the bottom-most layer in the model? Also provide an estimate of the time it takes to run a year’s simulation.

Page 9, lines 12-13: Since emissions after year 2000 were not prvided by Lamarque et al., which projection (RCP?) was used for 2010 emissions to perform linear interpolation?

Page 10, line 25: Any particular reason why only two aircraft campaigns were used for the evaluation instead of several others available in Emmons et al. (2000).

Page 12, section 5.1: What is the simulated tropospheric lifetime of methane in the model and how does it compare with that from multi-model studies (e.g., Naik et al 2013a)? How does the simulated OH interhemispheric ratio compare with other studies (Naik et al., 2013a; Patra et al., 2014). Lightning NOx emissions have been shown to contribute significantly to tropospheric OH concentrations (Murray et al., 2013). Lightning NOx emissions are not considered in the current model set-up. Please explain how the simulated OH concentrations match closely with those of other modeling stud-

ies that include lightning NOx emissions.

Page 12, line 28: Need a reference for aerosol influence on OH. Also, a larger oxidizing capacity would be simulated if lightning NOx emissions were included in these simulations.

Page 13, line 9-10: Please give the reason why there were low CO concentrations in 2004 despite large Alaskan and Canadian wildfires.

Page 13, 11-15: Other modeling studies suggest even lower CO burden (e.g., Naik et al., 2013b). Could higher CH4 concentration prescribed in the model play a role in the simulated high CO burden?

Page 13, last paragraph: the role of seasonal CO emissions in explaining the low northern hemisphere wintertime bias has been highlighted by Stein et al., (2014), which should be noted here.

Page 15, line 25: Give the lifetime of NOx.

Page 18, line 13-18: How do the calculated dry deposition estimates compare with those from more recent chemistry-climate model simulations (e.g., Naik et al., 2013b).

Page 19: What fraction of model O3 biases could be related to biases in the simulated meteorological fields (e.g., temperature)?

Map figures: Please remove the grey background on the maps as this makes it difficult to read the colours.

Figure 6, 10: Colour bar text is too small to read.

References: Murray LT, et al. (2013) Interannual variability in tropical tropospheric ozone and OH: The role of lightning. J Geophys Res Atmos 118(19):11,468–11,480, doi:10.1002/jgrd.50857. Naik et al., (2013a), Preindustrial to present day changes in tropospheric hydroxyl radical and methane lifetime from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), Atmos. Chem. Phys., 13,

5277-5298, doi:10.5194/acp-13-5277-2013. Naik et al., 2013b, Impact of preindustrial to present day changes in short-lived pollutant emissions on atmospheric composition and climate forcing, J. Geophys. Res., doi: 10.1002/jgrd.50608. Patra et al., (2014), Observational evidence interhemispheric hydroxyl-radical parity, Nature, doi:10.1038/nature13721. Stein et al., (2014) On the wintertime low bias of Northern Hemisphere carbon monoxide found in global model simulations, Atmos. Chem. Phys., 14, 9295-9316, doi:10.5194/acp-14-9295-2014.

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