Geosci. Model Dev. Discuss., 3, C23–C25, 2010
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Interactive comment on "A fast stratospheric chemistry solver: the E4CHEM submodel for the atmospheric chemistry global circulation model EMAC" *by* A. J. G. Baumgaertner et al.

Anonymous Referee #2

Received and published: 14 April 2010

General Comments: The paper, "A fast stratospheric chemistry solver: the E4CHEM submodel for the atmospheric chemistry global circulation model EMAC" is appropriate for publication in Geosci. Model Dev. Discussions. This paper documents the chemistry and solver used for future studies in the EMAC model. The main purpose for using this solver seems to be an improved computational efficiency over the EMAC/MECCA framework. However, there is no science shown in this study - only model documentation. My only reservation regarding publishing this work is that the E4CHEM submodel doesn't include a representation of bromine chemistry. This, in my opinion, would limit its scientific usefulness.

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Specific Comments: Abstract: Page 182, Lines 6-7: "In a model setup with E4CHEM, EMAC is now also suitable for simulations of longer time scales." - This has already been accomplished by EMAC/MECCA. Why not say what the difference in the computational cost are in the abstract since this seem to be the main reason why one would use E4CHEM. You state this in section 3.1.

Page 182, Lines 14-16: The following statement seems too obvious: "For some species the steady state in the box model differs by up to 100% when compared to results from CAABA/MECCA due different reaction rates". Isn't the point to have the same reaction rates!?

Introduction: Page 183, Line 5. You should add the following reference (since the EMAC model participated in this report): SPARC CCMVal, SPARC CCMVal Report on the Evaluation of Chemistry-Climate Models, V. Eyring, T. G. Shepherd, D. W. Waugh (Eds.), SPARC Report No. 5, WCRP-X, WMO/TD-No. X,Âăhttp://www.atmosp.physics.utoronto.ca/SPARC, 2010.

Page 184, Lines 10-15. "The sedimentation velocity of NAT and ice is considered to be identical if ice is present, otherwise sedimentation is neglected. The stokes velocity of ice particles is calculated every timestep according to the changing radius due to condensation or evaporation of water vapour. This scheme may underestimate denitrification in the Arctic but is well suitable for the Antarctic lower stratosphere where ice particles occur frequently." Question: I believe you are saying that you do not sediment NAT, correct? If so, and as you point out there is less water-ice in the northern hemisphere, you "would" not "may" underestimate denitrification in the Arctic, correct?

Page 186, Lines 19-21. "The submodels PSC and HETCHEM, needed for EMAC simulations with MECCA, can be switched off if E4CHEM is used, since E4CHEM already contains heterogeneous chemistry on sulphate aerosols and polar stratospheric clouds." Please define what is meant by PSC in E4CHEM. E.g., does the E4CHEM model include a supercooled ternary solution (STS) representation for sulfate based

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PSC.

Page 188, Lines 6-9.

"The here applied MECCA mechanism, which is equivalent to the E4CHEM chemistry, contains the reactions labelled for the stratosphere, however, bromine, iodine and mercury containing reactions have to be excluded (thus the selection string is (St && !Br && !I && !Hg))." I would delete the formating structure for you chemistry pre-processor. I also do not understand why you would not include bromine chemistry in a model that is attempting to represent the stratosphere!? The EMAC/MECCA model includes bromine chemistry - why would EMAC/E4CHEM leave it out? The reason for the exclusion of organic and inorganic bromine chemistry needs to be stated in this paper.

Interactive comment on Geosci. Model Dev. Discuss., 3, 181, 2010.

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