Geosci. Model Dev. Discuss., 3, C41–C43, 2010
www.geosci-model-dev-discuss.net/3/C41/2010/

**Geoscientific
Model Development
Discussions**

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.

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Received and published: 12 May 2010

The authors are grateful for the valuable comments by the referee. A main concern of the referee is the fact that CHEM does not contain bromine chemistry. As indicated in the manuscript, an extension of the chemical algorithm is currently under development. For the meantime, we have optionally included a parameterisation of ozone depletion by bromine, see Rex et al. (2003) and Stenke et al. (2009). The motivation for this manuscript was merely to document (and evaluate the performance of) the modifications of CHEM (available for ECHAM4) for the new ECHAM5 based EMAC system, or in other words to show that during the transition the algorithms are not deteriorated and

that the results of the new system are in sufficient agreement with the alternative, more complex (but more flexible) approach of MECCA. We completely agree that scientific production simulations should not be performed without Br-Chemistry. However, additional evaluations of E4CHEM extensions are beyond the scope of this manuscript. We will include these arguments this in the revised manuscript.

We believe that in his/her comment the referee refers to "MECCA" when he/she write "MESSy". Just to clarify: MECCA is the submodel for photochemical kinetics, MESSy is the overall model infrastructure.

The NMHC extensions of CHEM would be a second step once the bromine chemistry is included in the mechanism. The reviewer correctly points out that this extension is neither straightforward nor is the computational efficiency known. We will indicate this in the revised manuscript. Nevertheless some basic estimates on NMHC concerning computational costs and achievable efficiency can be made. Currently a reduced scheme based on the newly developed Isoprene/NMHC chemistry of Taraborrelli et et al. (2009) is under development, which covers approximately 100 reactions of about 50 species, of which approx. 25 would be advected. Assuming that the coding of the newly reduced NMHC is at least as efficient as in the existing E4CHEM, the additional computational cost will be largely dominated by the advection of the additional species. Furthermore it can be assumed that the integration of the additional NMHC-reactions is substantially easier to realize since tropospheric chemistry is numerically less stiff than stratospheric chemistry and the estimated doubling of the computational costs of E4CHEM might be regarded as a conservative estimate.

The referee expressed the thought that a comparison between old and new kinetics could be an interesting study. In principle we agree that this could be a interesting and relevant study. However, the authors feel that for such a study to be useful this would require a significant analysis effort of the effects and therefore be a study of its own. This would be beyond the scope of this GMD paper. In addition, this could potentially be done with any chemistry package e.g., MECCA (where it would be much more

straightforward, since MECCA is much more flexible) and is therefore not specific to E4CHEM. Here we only want to point out that the differences arising from the reaction coefficient updates in E4CHEM are larger than the results of E4CHEM and MECCA, if the latter is setup with the same photochemical mechanism (and the same reaction coefficients) as E4CHEM. This is an important results which shows that we did not deteriorate the numerical integration in the new implementation.

Finally, the reviewer asks if load balancing exploits the fact that E4CHEM operates reduced nighttime chemistry. The load imbalance arises from the parallel domain decomposition of the base model, in our case ECHAM5, which differs from that of ECHAM4 (in which CHEM was applied). This load imbalance, which also occurs for MECCA, is currently under investigation and improvements of ECHAM5 in this respect are on the way.

References:

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