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**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.

Anonymous Referee #1

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The present paper is about coupling the chemistry-climate model EMAC to a well-known stratospheric chemistry package (CHEM). EMAC is coupling the ECHAM5 GCM to the MESSy submodel for Earth System aspects including chemistry. The standard chemistry in EMAC (MESSy) is too computationally intensive to allow for long integrations. Older versions of ECHAM used to be coupled to the CHEM scheme, which is an efficient family formulation of stratospheric chemistry. CHEM has been technically modernized and now optionally replaces MESSy for stratospheric chemistry, leading to a significant speed-up of the model. The authors show that the simplifying assumptions made in CHEM compare generally well, in most respects, with the same chemistry calculated within the non-family MECCA system. This is a reassuring but unsurprising re-

sult, meaning that the more restrictive assumptions made in CHEM are well-founded. The authors suggest that the new coupled model E4CHEM is suitable for long integrations. Technically, I have no doubt that E4CHEM can be used for this purpose. I would however strongly encourage the authors not to use CHEM for this purpose until bromine chemistry is included too. The E39CA model (ECHAM4+CHEM) was the version of ECHAM to use CHEM in the recent CCMVal-2 model intercomparison exercise. In this activity, E39CA was the only model not to explicitly include bromine chemistry; considering the importance of bromine particularly for Antarctic ozone depletion, this is a distinctive shortcoming of CHEM. In E39CA, a parameterization for bromine chemistry is used (Stenke et al., 2009, not referenced here). I could not discern from the manuscript whether this parameterization is used in E4CHEM or not. In any case, there is no reason, other than modest computational savings, not to explicitly include bromine in the chemistry. The authors mention that this is planned; I imagine that this will greatly help in convincing reviewers in the future about the quality of results produced by E4CHEM. The other modifications also envisaged (NMHC chemistry, sulphur cycle) are also timely and useful extensions of the CHEM package. It may well mean that if these additional features are included in CHEM, a lot of the computational advantage of CHEM over MECCA will be eroded. I also doubt that for such a complicated chemistry package, a hard-coded, manually generated representation of chemistry is particularly practical to implement and maintain.

To give this paper a somewhat more scientific edge, more could be made of the differences between old and new revisions of kinetics. In CCMVal-2, a lot of models do not use updated kinetics, which contributes to the inter-model spread of results. Here, these differences are found in a very controlled environment, possibly allowing for conclusions that would not be possible when comparing two models that differ in many ways, not just kinetics.

On a technical note: E4CHEM operates reduced nighttime chemistry to save computational cost. This would particularly pay off if – in a parallel environment – load balancing

was used. Is this the case?

Reference:

Stenke, A., et al., Implications of Lagrangian transport for coupled chemistry-climate simulations, Atmos. Chem. Phys, 9, 5489-5504, 2009.

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