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Interactive comment on "Upgrading photolysis in the p-TOMCAT CTM: model validation and assessment of the role of clouds" *by* A. Voulgarakis et al.

Anonymous Referee #1

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This paper presents results from the Fast-JX photolysis scheme as implemented in the p-TOMCAT CTM. The Fast-J family is used in a variety of chemistry climate models and chemistry transport models, and as such it is useful to have a paper documenting this scheme. Although this paper isn't strictly a documentation of Fast-JX, more an evaluation of its impact on aspects of the p-TOMCAT chemistry simulations.

I have concern that to some extent Fast-JX is being compared against an unrealistic straw man. 2D prescribed photolysis rates have not been used by many other 3D tropospheric chemistry models, and would not be expected to be very realistic. Even the first generation of 3D chemisty models either used on-line two-stream schemes

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(e.g. Roelofs et al. 1995), or look-up tables based on cloud-cover and solar zenith angle (e.g. Muller and Brasseur 1995), to account for the horizontal and temporal variablity in clouds. It is not surprising that Fast-JX performs better than a 2D lookup table. What would have been more interesting would have been to show how the new generation of photolysis codes compares for example to an online two-stream approach.

Specific Comments: Introduction: p347, l21. The original Fast-J paper compared against (simple) photolysis schemes. This study compares only against a 2D lookup table. It would be more useful to know how the global model performance compares between Fast-JX and simple schemes.

P347, l28. For this study to act as a useful "reference work" for the new model set up, section 4.2 would need to be extended considerably.

p351, l12. The actinic flux should decrease exponentially with optical depth rather than being proportional to it.

Section 3.1 Since a different ozone column is used compared to Liu et al. we don't know whether differences in the results are due to the ozone or to differences in the model. I suggest removing this section or re-running with the Liu et al. ozone column.

Section 3.2 This presents a useful new comparison against observational datasets. However it is not quite clear whether the standard scheme simply uses the 2D lookup tables, or uses the underlying two-stream code with appropriate cloud data for the observing period.

Section 4.1 p357, l20. I didn't quite understand the reference to panel (c). Fig 5 currently doesn't include results from the AVG simulation (could these be added?) so doesn't provide any information on seasonal vs instantaneous clouds. On this same point, it is not made clear whether the climatology in AVG is zonally as well as seasonally averaged. Are the clouds used to drive OLD and AVG exactly the same? The

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reason this is important is that the interesting science is how FAST-JX performs against the two-stream code for the same clouds, not whether instantaneous 3D clouds are better than seasonally and zonally averaged ones.

Section 4.2 This section seems to contain the central finding of the paper - that although the new photolysis doesn't improve the absolute concentrations, it does improve the correlation with measurements. Hence I think this section needs expanding. For instance with more measurements and with some figures and/or tables backing up the discussion in the text of a difference in sensitivity between the N and S hemispheres and the tropics.

The Mace Head CO results are particularly disapointing, do other NH stations show more improvement? It looks as if Fast-JX significantly overestimates OH in the winter compared to the summer, with almost no seasonal cycle. I don't believe this can be blamed on European outflow. It is not generally true that there is more European outflow in the winter, rather there is more zonal flow in winter than summer. Note that Mace-Head observations are filtered to exclude European influence.

p-TOMCAT was an outlier in the ACCENT model intercomparison (Stevenson et al. 2006). Does the incorporation of Fast-JX improve the ozone budget and methane lifetime?

Interactive comment on Geosci. Model Dev. Discuss., 1, 345, 2008.

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