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Climate of the Past Discussions

Interactive comment on "Maintenance of polar stratospheric clouds in a moist stratosphere" *by* D. B. Kirk-Davidoff and J.-F. Lamarque

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1 Summary of results

The paper contains some sensitivity studies with a simple, parameterized model on the effects of lower stratospheric clouds in case of enhanced methane and enhanced stratospheric water vapor in the Eocene. The issue was also studied with a complex chemistry climate model with the conclusion that the radiative effect of 'polar stratospheric clouds' is too small to explain enhanced heating of the high latitude troposphere. To get significant effects, in the simplified model rather unrealistic properties of the polar stratospheric clouds (compared to recent observations) are needed.

2 Major controversial points

I wonder, however, if the simplified model is appropriate to tackle the stratosphere having most of its model layers in the troposphere and only 1 of about 67 in the region where the chemical conversion of CH_4 to H_2O and the meridional transport (Brewer Dobson circulation) takes place. Also in the PSC-region there are too few layers for a proper representation of sedimentation and other relevant processes. Already about 20 years ago there were several 2D-models available (e.g. at NCAR) which would have been more suitable.

What has been done with the local radiative heating by methane or the radiative effects of induced ozone changes? Following Lamarque et al, 2006, these effects can be large, but nothing is written on that in section 2 or 3. Is it neglected? A lot of clarifications and justifications are necessary to convince me that with such a study you can provide important new results on the issue of heating by stratospheric clouds compared to Lamarque et al, 2006, which are worth publication. I would vote against publication in CP now.

3 Detailed comments

What is the model top? Is most of the stratosphere just squeezed into one layer above 15hPa (page 939)? This is not quite clear from the given references but the figures therein also point to that. A linear pressure grid is not appropriate for stratospheric problems. Is it possible to redo the calculations with a better vertical resolution in the stratosphere? The term Q_{BD} is more often referenced as 'dynamical or adiabatic heating or cooling' and strongly altitude dependent.

Better cite standard textbooks for the stratospheric up- and downwelling (page 940,

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top, e.g. Holton).

An age of air of 3 years at the poles is too low (page 941), also compared to WACCM, check e.g. Eyring et al.(2006).

What has been assumed for CH_4 in the Eocene case (page 942)? This is also not given in the caption of Fig. 2. 15ppmv H_2O appear to be low since in case of 30 ppmv CH_4 one would expect more than 50 ppmv (above the PSCs) from chemical production. Was radiative heating by CH_4 included?

10 cm^{-3} particle density in PSCs is much larger than observed at present days (page 943). Also with somewhat bigger particles (and smaller N) at the high water vapor concentrations there should be PSC forcing. Is there an artifact in sedimentation from the coarse model resolution? Which temperatures are effected by PSC-forcing, the local ones or the ones in the troposphere or both?

The interpretation of the WACCM-results might be expanded (page 945).

Fig. 7: Caption and labels are inconsistent. Please use a log(pressure) axis or skip at least the lower and middle troposphere.

Fig. 10: A log(pressure) axis would be more appropriate.

The paper contains plenty of typographical errors.

References

[1] Eyring, V., Butchart, N., Waugh, D. W., Akiyoshi, H., Austin, J., Bekki, S., Bodeker, G. E., Boville, B. A., Brühl, C., Dameris, M., Deushi, M., Fioletov, V. E., Frith, S. M., Garcia, R. R., Gettelman, A., Giorgetta, M. A., Grewe, V., Jourdain, L., Kinnison, D. E., Mancini, E., Manzini, E., Marchand, M., Marsh, D. R., Nagashima, T., Newman, P. A., Nielsen, J. E., Pawson, S., Pitari, G., Plummer, D. A., Rozanov, E., Schraner, M.,

Shepherd, T. G., Shibata, K., Stolarski, R. S., Struthers, H., Tian, W., and Yoshiki, M.: Assessment of temperature, trace species, and ozone in chemistry-climate model simulations of the recent past, J.Geophys.Res., 111, D22308, 2006.

Interactive comment on Clim. Past Discuss., 3, 935, 2007.