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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Towards a better representation of the solar cycle in general circulation models" *by* K. M. Nissen et al.

K. M. Nissen et al.

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Reply to Referee #4:

General comments:

The Referee suggests a comparison of the ECHAM5-MESSy simulations using the FUBRad scheme with other GCM or CCM simulations. This is however beyond the scope of this paper. A radiation code intercomparison is going to be performed within the CCMVal activity. FUBRad will participate in this intercomparison.

The Referee is right when stating that other GCMs/CCMs exist that use spectrally resolved SW radiation codes. However the ECHAM5 radiation code is still in widespread use, also for the analysis of solar variability. It is the purpose of our paper to attract the attention of the GCM/CCM community to the fact that the interpretation of the solar

impact resulting from these simulations is limited and should be carried out with care.

The question of solar impact on ozone and the treatment of solar induced ozone changes in the model (either prescribed or interactively calculated) has been deliberately excluded from the discussion. Our focus is on the quality of the radiation schemes used for solar cycle studies, and not on the physical/chemical processes leading to the solar signal.

Specific comments:

p47 l09: We summarise here results of a study by Shibata and Kodera (2005) in which they performed sensitivity experiments to test the separate effects of UV and ozone forcing due to solar variability. In our view, their statements do not suggest that interactive ozone is not necessary.

p48 l11: "additional" was added

p48 l09: See general comments to all Referees "general comment" in seperate file; the text has been modified.

p49: We agree that given the current model setup the calculation of total heating rates is energetically consistent. Therefore total heating rates are displayed in the revised version. The only energy loss considered is due to airglow.

p51: Yes, as indicated in the manuscript we used the disort solver by Stamnes et al (1988) which is a plane-parallel model. We did some sensitivity studies with the pseudo-spherical version of disort, sdisort, to confirm that the sphericity has negligible influence on the diurnal averages presented in the paper. Rayleigh scattering was included; we used the well-accepted cross section of Bodhaine et al, Journal of Atmospheric and Oceanic Technology, 1999.

p51 third paragraph: Thank you for pointing at the slight scale shift in the figures. This has been corrected. We performed a detailed comparison of FUBRad and the reference model, for different solar zenith angles as well as for daily means. The overall

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agreement is very good.

p51 l17: see above

p51 l20: We thank the reviewer for this comment. Careful checking of the code revealed a bug in the Chappuis band code in FUBRad. After removing it, the agreement between FUBRad and the line-by-line model improved considerably in the altitude range of 20 to 30km (see new Figure 1).

p35 fig4: We have checked the results. The strength of the Lyman-alpha response is not so surprising when looking at the fluxes suggested by Lean (2000). Variations between maximum and minimum are of the same order of magnitude as the fluxes themselves (solmax: 8.06*10-3 W/m**2, solmin: 4.65*10-3 W/m**2).

Figure 4 for Schumann-Runge bands and continuum includes total heating rates now.

p 53 paragraph Temperature response: Yes, NIR has been included in the online calculations.

p53 l14: For the differences between perpetual season and annual cycle solar simulations see our reply to Referee 1. We anticipate that the results of Matthes et al. (2004) would be modified in the mesosphere as this region is primarily affected by FUBRad extensions.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 45, 2007.