Dear referees,

Thank you for your useful comments, corrections and suggestions.

To Boris Fomin:

To try a method that is described in Fomin and Correa (2005)

Certainly, it would be interestingto try the method presented in your paper. However, since our paper is dedicated to the radiation schemes used in ECHAM GCMs we will not include analysis of your scheme into this paper, but we will contact you separately concerning this topic.

To Anonymous Referee #2:

Comments on page C231

The authors should include the answers to the following question into their revised manuscript: How is the temperature climatology affected by the additional heating introduced for all periods except for the predefined 'grand minimum'.

and page C234

The statement on page 1346, line 4-6: "... the inclusion of these parametrizations does not change much the absolute values of the heating rates and therefore does not require any retuning of the original codes." Even an increase in heating rates less than 1 K/day can lead to significant temperature changes locally, but also non-locally through wave mean flow interactions and feedbacks on the temperatures. This is also claimed by the authors in their introduction. Have the updated versions of the E5 and E6 SW radiation parametrizations been tested online in the respective ECHAM models? Results from such simulations would be helpful to support the cited statement. The method presented in this paper to add the 11-year solar cycle to the heating rates, introduces extra heating rates for all months except for the predefined 'grand minimum' month. This extra heating has the potential to change the climatology of the climate model.

The considered codes overestimate the total heating rate in absolute values both during minimum and maximum solar conditions compare to libRadtran and this is the feature of the original schemes. However, the difference between libRadtran and E5 or E6 in case of solar minimum is bigger than in case of solar maximum, because in case of solar maximum the result of E5 or E6 is also influenced by the lack of variability representation. And by adding our extra heating we just fix the problem and don't introduce any heating over the existing difference in case of solar minimum. Here is an example:

The difference between libRadtran and E5at 44 km in solar minimum is ~1.6 K/day

The difference between libRadtran and E5 at 44 km in solar maximum is ~1.44 K/day

The difference between two above values is ~0.16

The extra heating added at this altitude is also ~0.16

Therefore we only make this delta (E5 or E6 minus libRadtran) constant in time. Of course, the mean delta over the whole modelling time will be greater with extra heating than without extra heating, however the second one is less only because of the bad representation of the

solar signal, and the first one will be equal the delta in the "grand minimum" and will be constant in time.

This is a tricky part and we will rewrite it in more details.

Regarding the online testing of parameterizations we should note that this was not our goal in this particular paper to analyze the temperature climatology, which depends on many processes besides short-wave heating that have to be also taken into account in the analysis, what makes the question highly model dependent. Also this extra heating is less than 1% from the absolute values and does not exceed natural variability and uncertainty of the observed temperature, therefore it will not introduce dramatic changes. The extra heating was applied in SOCOL 3.0, which is under evaluation in the framework of CCMI, also in three papers by Anet et al., similar approach (E4+) was tested by Egorova et al., (2004), showing no extraordinary result in temperature climatology.

The abstract announces the evaluation of three different generations of ECHAM radiation schemes (E4, E5, and E6). But the evaluation of the E4 radiation scheme is completely missing in the paper. Also there is no evaluation of the original standard E5 radiation scheme included, instead an updated version of the original scheme is used, that uses the 6-band SW radiation parametrization of the ECMWF (Cagnazzo et al., 2007). The abstract should reflect the analysis contained in the paper. C231

Here it would be interesting to see the behaviour of the original E5 SW radiation scheme (4-band) for the UV and visible band from 250–690 nm in comparison to the libRadtran line-by-line reference model in the same wavelength range. This analysis should be included in the revised manuscript. C233

ECHAM4 and the original ECHAM5 schemes are the same in the UV and have a negligible solar signal, what was already analyzed before several times. Therefore we didn't include its analysis into the paper. However, in terms of absolute values it can be interesting, as you pointed, and we will include this part for the more complete picture of the ECHAM radiation codes family.

The description of the ECHAM SW radiation parametrization is rather unorganized. C232

Although the study is only concerned with the UV-visible part of the spectrum, the authors should consider to expand their table 1 by some information about the other bands of the SW parametrizations. The authors should give a new label to the upgraded version of the E5 SW radiation scheme, as the original E5 SW radiation scheme is the 4-band Fouquart and Bonnel scheme. C232

The description and the labeling of the schemes are reconsidered and rewritten. The table 1 is extended by the information about the other bands.

The description of the approach by Nissen et al. (2007) is not correct and can be misleading. C231

This part is carefully reformulated in conformity with the cited paper.

The results of the validation presented in figure 2 are not adequately discussed.

Some statements concerning the discussion of figure 2 have to be sorted clearly, depending on whether referring to the absolute heating rates or the solar signal in heating rates between solar maximum and minimum. C233

This part is reformulated

On page 1343 (line 17) the authors give a reference to the SPARC CCMVal (2010) report for the updated E5 code, but this radiation code did not participate in that initiative. The updated E5 code participated only in the Forster et al. (2011) study. C233

The updated E5 code participated in chapter 3 of the SPARC CCMVal (2010) report as ECHAM5

The scaling coefficients should be tabulated for both radiation codes (E5 and E6) C233

The information about the wavelength ranges of the additional bands is not included (only for the Huggins bands). An additional table with these bandwidth informations should be included. C234

The scaling coefficients are presented as well as the bandwidth information of the extra heating parameterizations.

The statement on page 1345, line 5-6: "... parametrizations for HAR and HUG are in a good agreement with libRadtran." The results from figure 2 clearly show the discrepancy between the heating rates calculated with the line-by-line model and the heating rates within the wavelength ranges 250–440 nm (E5) or 263–345 nm (E6), it is therefore not correct to state a good agreement with libRadtran.

The statement "...parametrizations for HAR and HUG are in a good agreement with libRadtran" refers to the extra heating parameterizations and not to the figure 2. The picture with the comparison of the extra heating parameterisations and libRadtran was not included to the paper, but we will also include it.

Special thanks for technical corrections!