

Interactive comment on “Pan-spectral observing system simulation experiments of shortwave reflectance and longwave radiance for climate model evaluation” by D. R. Feldman and W. D. Collins

Anonymous Referee #2

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This paper presents a numeric simulator that is designed to simulate pan-spectral (shortwave + longwave) high-resolution radiance spectra from IPCC climate model outputs, which may facilitate the comparison between the models and satellite observations at the radiance level. This paper is well written, addresses an important research need faced by the community, and suits the journal very well. The hyperspectral simulator brought about by the authors may become a very powerful and widely used tool for integrating satellite observations and GCMs in climate research. I recommend acceptance of this paper for publication after addressing the following questions:

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1) On the use of monthly profiles

The simulations presented are based on monthly profiles. So is the validation, which is done by comparing to the radiation fluxes re-computed using GCM radiation codes and monthly profiles. It is understandable that long-term, multi-model, global, pan-spectral simulation at daily or hourly frequency is not affordable. However, it is important to recognize that the radiation fields that are associated and consistent with other aspects (e.g., surface temperature, precipitation, etc) of the GCM simulation are those averaged from instantaneous results, while those simulated from the monthly profiles may have a bias.

On the other hand, the simulator package should not be limited to the use of monthly profiles.

So I suggest the authors test the simulator with instantaneous profiles of some GCM for relatively short periods and validate the simulation by comparing to the original radiation field (e.g., OLR and reflected solar radiation flux) directly output by the GCM. Such comparison will offer valuable (and necessary) assessment on the consistency between the offline-simulation by the simulator and the online simulation of the GCM, concerning both the climatology and trend. And it is worth discussing whether the use of monthly profiles may obscure the climate change signal. Note a longwave assessment was done by Huang and Ramaswamy (2009, J. Clim.), but not the shortwave.

2) Simulation configuration

On page 3652, many details are described about the configuration of the radiative transfer simulation. However, it is not clear whether these aspects are kept consistent in the spectral simulator as compared to those in the GCM. And is the simulator flexible to adapt to different configurations of different GCMs, e.g., with regard to cloud optical property parameterization (grey body is used here) and overlap treatment (not mentioned).

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Page 3657, line 20. "model-reported" means GCM direct output? Given monthly profiles are used, the bias reported here looks surprisingly small.

Given the nature of the journal, it may be worth presenting some benchmarking computation times under different configurations of the simulator, e.g., how many seconds on average for simulating a LW and SW spectrum respectively from each atmospheric profile, how does it vary with number of vertical level, cloud overlapping schemes, expected saving of time using different RT codes (MODTRAN, PCRTM, GCM code), etc.

3) Advantage of pan-spectrum

Page 3658 Line 12. Huang et al. (2010, JGR) specifically noted that longwave-only fingerprinting is subject to the degeneracy of the signals of low clouds and surface temperature. We can expect this to be greatly improved by combining shortwave signals with the longwave.

Figure 4 (f). A great benefit (but sometimes not fully appreciated) of using spectrally resolved radiance data in climate simulation validation and climate change detection is that it is not subject to spectral compensation. Huang and Ramaswamy (2009) showed how LW spectral measurements can disclose detailed climate change signals that would otherwise hide in the broadband flux. The result here appears to show such spectral compensation may occur in the SW as well. It is worth emphasizing this obvious advantage of spectral climate monitoring here.

References

Huang, Y. and V. Ramaswamy (2009), Evolution and trend of the outgoing longwave radiation spectrum. *J. Climate*, 22, 4637-4651, doi:10.1175/2009JCLI2874.1.

Huang, Y., S. Leroy, J. Gero, J. Dykema, and J. Anderson (2010), Separation of longwave climate feedbacks from spectral observations. *J. Geophys. Res.*, 115, D07104, doi:10.1029/2009JD012766.

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