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Geoscientific Model Development Discussions

Interactive comment on "Equivalent sensor radiance generation and remote sensing from model parameters – Part 1: Equivalent sensor radiance formulation" *by* G. Wind et al.

Anonymous Referee #2

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Review

General comments

This manuscript is well written and presents an advanced satellite radiance simulator for multiple sensors from arbitrary climate or weather models. It should be published in GMD after improvement of some aspects.

Specific comments

The main aspects that must be improved are:

- There is no reference at all to previous studies concerned with the simulation of satellite radiances starting from weather/climate models. Such studies include but are not limited to Jonkheid et al. (2012); Bugliaro et al. (2011); Otkin et al. (2007). Furthermore, simulator suites for different sensors like the EarthCare Simulator ECSIM have not been mentioned neither. This should be corrected.
- Similarly, the new aspects addressed in this paper have not been adequately illustrated by the authors. This should be added to the introduction.
- Since the focus is on clouds, Sect. 2.3 is the key aspect of the paper. Here, references to previous studies (Venema et al., 2010; Bugliaro et al., 2011, and more) should be made and similarities/differences explained. Furthermore, one example (i.e. one Figure) of the generation of cloud fields at high spatial resolution starting from the model output would more intuitively sustain the explanation (especially the "clumping" procedure).
- **p. 4114 l. 5:** What is the meaning of "rank" in this context?
- **Entire Sect. 2.3:** One important point should be the consistency of the cloud downscaling with the model physics if one intends to use such simulations for model evaluation. How consistent is the procedure presented here with the model? Why don't you use the second procedure described in p. 4114 l. 14–27 since you say that it is 'very much akin to the internal GEOS-5 treatment of cloud overlap'?
- **p. 4115 l. 4 – p. 4116 l. 4:** Is it really necessary to explain this issue in this level of detail? Of course, the point you make here is essential for the correct generation of high resolution cloud fields with consistent optical properties but what's the point for this discussion? If you consider this part necessary, please integrate it in a better way into the manuscript.

- **p. 4113 l. 14:** Where do the effective radii in the model come from? Do you use one effective radius for all N cloudy subcolumns? Is this realistic enough? Are there vertical profiles of effective radii?
- **p. 4112 l. 12:** Even for the 1 km pixels internal variability is an issue (plane parallel error) that you neglect here. Couldn't you downscale the cloud field to even smaller scales to produce such variability? Why do you neglect this variability?
- Why do you compare retrieved cloud properties from real and simulated satellite scenes instead of comparing model clouds against clouds retrieved from real MODIS granules? Your procedure adds an additional degree of freedom since you have to apply the retrieval twice. This questions is related to the general strategy and future applications of the simulator. Please explain your motivation in the introduction **p. 4108 l. 22–26** in a more detailed way (retrieval validation against known truth is evident, but model validation is not).

Additional comments:

Title and manuscript: *equivalent sensor radiance* is not an established concept and needs a definition in the manuscript. It reminds of 'equivalent black body temperatures' in the thermal spectral range but has a specific meaning valid only in this paper. For this reason, I would also choose another title that does not make use twice of this concept like the current one.

p. 4106 l. 21–22: Please add a reference about the fact that high clouds (i.e. thin cirrus) have an overall net warming effect.

p. 4110 l. 19: What is the wavelength dependency of the LUT?

p. 4111 l. 27: Kratz's paper is for AVHRR channels. Have you applied this technique to MODIS channels? Can you apply it to new different sensors as well? If not, this will decrease the flexibility of your simulator. Please explain.

p. 4112 l. 8: Can you give a reference for this assertion?

p. 4116 l. 12: Disort is a 1D radiative transfer solver. Thus, you neglect 3D radiative effects. Please explain your choice.

p. 4116 l. 19: A large number of streams is important to reproduce details of the phase function like the rainbow and the backscatter glory (e.g. Mayer et al., 2004), for the accurate modelling of the forward peak additional effort is needed, as you describe below at l. 24. Please correct this.

p. 4118 l. 4–5: The incorrect location could come from a retrieval bug. How can you exclude this possibility?

p. 4118 l. 23–24: Please indicate the geographical area of this granule.

p. 4118 l. 27: Please explain *SWIR* here or refer to caption of Fig. 5.

p. 4119 l. 7–8: You are explaining the black stripe in Fig. 6, please refer explicitly to it in the text. Why is it visible only in the simulated data?

References

Bugliaro, L., Zinner, T., Keil, C., Mayer, B., Hollmann, R., Reuter, M., and Thomas, W.: Validation of cloud property retrievals with simulated satellite radiances: a case study for SEVIRI, Atmos. Chem. Phys., 11, 5603–5624, doi:10.5194/acp-11-5603-2011, 2011.

Jonkheid, B. J., Roebeling, R. A., and van Meijgaard, E.: A fast SEVIRI simulator for quantifying retrieval uncertainties in the CM SAF cloud physical property algorithm, Atmospheric Chemistry and Physics, 12, 10 957–10 969, doi:10.5194/acp-12-10957-2012, 2012.

Mayer, B., Schröder, M., Preusker, R., and Schüller, L.: Remote sensing of water cloud droplet size distributions using the backscatter glory: a case study, Atmos. Chem. Phys., 4, 1255–1263, 2004.

Otkin, J. A., Posselt, D. J., Olson, E. R., Huang, H.-L., Davies, J. E., Li, J., and Velden, C. S.: Mesoscale Numerical Weather Prediction Models Used in Support of Infrared Hyperspectral Measurement Simulation and Product Algorithm Development, Journal of Atmospheric and Oceanic Technology, 24, 585–601, doi:10.1175/JTECH1994.1, 2007.

Venema, V., Garcia, S. G., and Simmer, C.: A new algorithm for the downscaling of cloud fields, Quart. J. Roy. Meteor. Soc., 136, 91–106, doi:10.1002/qj.535, 2010.