Geosci. Model Dev. Discuss., 6, C2479–C2483, 2014
www.geosci-model-dev-discuss.net/6/C2479/2014/

Geoscientific Model Development
Discussions
Open Access

Interactive comment on "Radiation sensitivity tests of the HARMONIE 37h1 NWP model" *by* K. P. Nielsen et al.

Anonymous Referee #1

Received and published: 30 January 2014

1 General comments

The paper presents a study on the sensitivity of shortwave radiation fluxes w.r.t. water vapor and ozone concentrations, aerosols, water clouds and ice clouds. Calculations of a single column version of the HARMONIE 37h1 NWP model (run in different configurations) are compared to DISORT calculations, which are taken as benchmark results. The atmospheric state, i.e. trace gas concentrations, liquid water content, ice water content, and cloud particle sizes, is the input to all models. The models then use different parameterizations to convert from these microphysical to optical properties which are required to solve the radiative transfer equation. As the authors mention in their introduction, their study includes these two steps: (1) conversion from microphysical

to optical properties and (2) solving the radiative transfer problem. The second step is solved more accurately with DISORT, which is a radiative transfer solver based on the discrete ordinate method whereas the NWP uses a a simple radiation schemes based on the delta-Eddington approximation. But the first step which is also very important may be even less accurate for the DISORT calculations. A major weakness of the paper is that the authors do not describe which parameterizations are used for the DISORT calculations to convert from microphysical to optical properties. LibRadtran offers a variety of different parameterizations, more and less accurate ones, and it is also possible to directly feed optical properties to DISORT. The standard settings of libRadtran are not the most accurate ones. For example, libRadtran includes the parameterization by Fu 1996 for ice clouds which is also optionally used in the NWP model. Therefore it is not surprising that the NWP model agrees best to DISORT when the Fu 1996 parameterization is used.

In my opinion the two steps need to be investigated separately. In order to test the radiation scheme itself, the models must use exactly the same optical properties as input. It should be possible to extract the optical properties from the NWP model and feed them to DISORT. The accuracy of the parameterizations to convert from microphysical to optical properties may also be investigated using the libRadtran package with the most accurate settings, for this part the libRadtran settings need to be described in detail. Currently the reader does not know on which parameterization the so called "benchmark results" are based. In several places it is obvious that the authors of the study have not used the most accurate settings. For these reasons I can not recommend to publish the study in its current status. The major revision of the study should include a comparison of DISORT and the NWP radiation schemes given the same optical properties and also a comparison of the various parameterizations (gas absorption, aerosol and clouds) where the most accurate settings of libRadtran should be compared to the various configurations of the NWP model.

2 Specific comments

Abstract

Please include some details about the NWP models, e.g. where in the HARMONIE NWP model used. Explain/expand the abbreviations IFS and hlradia. Also the benchmark results should be described more detailed, i.e. it should be clear that very accurate, state-of-the-art parameterizations are used.

Methods

p 6778, l. 25: Which absorption parameterization is used for DISORT calculations? 1 nm spectral resolution does not make much sense, because in order to obtain the integrated solar flux the most accurate parameterization in libRadtran is the correlated-k-distribution by Kato 1999.

Eq. 3-5, Table 2: How are the coefficients obtained? Are they fitted against detailed Mie calculations? This needs to be explained in detail.

p. 6780, l. 19: Explain "hybrid coordinates"

Results

p. 6782, l. 23: The authors say that the difference at TOA comes from differences in the downward component of the fluxes. The only source of discrepancy is here the extraterrestrial spectrum. Which one is used in IFS?

p. 6782, l 17ff.: "Detailed UVB/UVA estimations are not needed in general NWP computations and should be done separately by combining the modeled SW fluxes with the most recent ozone measurements." How should the modeled fluxes be combined with measurements? This is not at all clear.

p. 6784: The difference between the models for large solar zenith angles is explained by the fact that the IFS radiation scheme includes a correction for the sphericity of the

atmosphere whereas DISORT is a fully plane-parallel model. libRadtran includes also a pseudo-spherical version of DISORT. Why is this not used? It would be even better to use the fully spherical 1D Monte Carlo solver MYSTIC as benchmark, which is also freely available in the libRadtran package.

p. 6785: The aerosol experiment does not make much sense when different aerosol models, all of them not very accurate, are used. Here it is not clear, why DISORT with Shettle aerosol should produce more accurate results than the other models.

p. 6786ff: Which liquid cloud parameterization is used for DISORT calculations? Also in this section it is not clear whether discrepancies are due to different radiation schemes or different parameterizations to compute optical properties.

p. 6786, l.10: Explain "cloud SW inhomogeneity factor"

p. 6786, l.15: DISORT calculations were done for horizontally homogeneous clouds, therefore the cloud SW inhomogeneity factor in the NWP models was set to 1. In libRadtran it is also possible to use different cloud overlap assumptions, this could be compared to calculations with other cloud inhomogeneity factors.

p. 6791: Which ice cloud parameterization is used for DISORT calculations?

p. 6792, l25ff: "In both DISORT, IFS and hlradia cloud ice is considered to consist of hexagonal crystals. In reality, cloud ice particles come in multiple shapes (Baker and Lawson, 2006;Lawson et al., 2006). As shown by Kahnert et al. (2008), these shapes significantly affect the SW forcing of the cloud. ...". In libRadtran it is possible to select various shapes as well as shape mixtures. Why is this option not used to obtain a more realistic benchmark result?

Conclusions

p. 6793: "A new optical property parameterization for liquid clouds has been developed. We have shown that this is better than the parameterizations currently available in HARMONIE." This is not shown because the DISORT setup for the cloud simulations is not described and it is not clear whether the DISORT results are more accurate that the currently available parameterizations in HARMONIE.

p. 6794: "The SW cloud inhomogeneity factor should be changed from 0.7 (0.8) to 1.0 in all schemes applied in HARMONIE." It would be better to include a more accurate and fast radiation scheme, e.g. maximum random overlap.

"The hlradia gaseous transmission coefficients should be tuned to the DISORT clear sky results presented here." It is not shown in this study that the DISORT clear sky results are more accurate than hlradia.

Reference

- Kato, S., Ackerman, T. P., Mather, J. H., and Clothiaux, E.: The k–distribution method and correlated–k approximation for a shortwave radiative transfer model, J. Quant. Spectrosc. Radiat. Transfer, 62, 109–121, 1999.

Interactive comment on Geosci. Model Dev. Discuss., 6, 6775, 2013.