Title: Comment on: “Impact of changes in the formulation of cloud-related processes on model biases and climate feedbacks” by Carlo Lacagnina, Frank Selten and A. Pier Siebesma (2014; 6(4): 1224-1243)

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Comment on:

"Impact of changes in the formulation of cloud-related processes on model biases and climate feedbacks" by Carlo Lacagnina, Frank Selten and A. Pier Siebesma (J. Adv. Mod. Earth Syst. 2014; 6(4): 1224-1243)

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1 Introduction

The following comment has previously been submitted to the AGU journal: "*Journal of Advanced in Modeling Earth Systems*." The chief editor Robert Pincus and an anonymous associate editor rejected it for publication and replied:

> "Your central point, that the CIF used in the Lacagnina et al. paper is unrealistically low, is entirely valid. But the unphysical nature of the CIF has been known since the 1990s and pointing out one dubious choice in one model doesn't do much to advance the field or to interpret the previous work. You may suspect that this "bias correction" impacts the results reported by Lacagnina et al.; if so I would encourage you to submit a manuscript in which you make this point and support it with evidence."

This is all reasonable, but we have no plans for running tests with the EC-EARTH model used by Lacagnina et al. and nevertheless think that our comment is relevant for the scientific community. Therefore, we publish it here.

2 Comment

Recently, we published a paper (Nielsen et al., 2014) on detailed testing of the shortwave (SW) radiation physics in the HARMONIE cycle 37h numerical weather prediction (NWP) model that included testing of the cloud optical property and radiative transfer parametrizations. The default radiation scheme in this version of HARMONIE is based on the Integrated Forecast System (IFS) cycle 25r1 (ECMWF, 2002; Mascart and Bougeault, 2011). This is the same radiation scheme that was used in the version of the EC-Earth model runs included in the recent study by Lacagnina et al. (2014).

Using HARMONIE we showed that the default SW cloud inhomogeneity factor (CIF) of 0.7 has a large impact on the cloud radiative forcing. The impact as a function of the cloud water load is illustrated in Fig. 1 for a solar zenith angle (SZA) of 56° and standard atmospheric conditions as described by Nielsen et al. (2014). Liquid cloud droplets with effective radii of 10 μm are assumed.

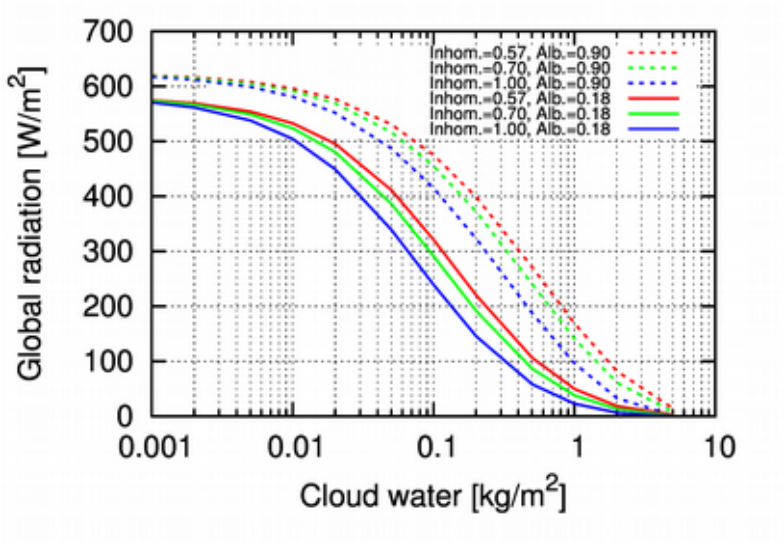

Figure 1. *Global shortwave radiation at the surface as a function of cloud water load for three different cloud inhomogeneity factor settings: 0.57 (red lines), 0.7 (green lines) and 1.0 (blue lines), and for two different surface albedos: 0.18 (solid lines) and 0.9 (dashed lines).*

Lacagnina et al. (2014) state that they reduced the CIF further in order to achieve radiative balance at the top of the atmosphere. They do not give the actual value of the factor. From the EC-Earth source code, we find this to be 0.57. The effect of having a SW CIF that is further reduced from 0.7 to 0.57 is also illustrated in Fig. 1. The effect is almost a 100 W/m^2 increase in the SW irradiance transmitted through clouds with ~ 0.1 kg/m^2 cloud water compared to the transmittance through homogeneous clouds. This large effect is not surprising since the physical implication of using the CIF is to factorize the entire cloud water load before performing the radiation calculations. In the simulations of Lacagnina et al. (2014) 43% of all cloud water has thus been removed before the radiation calculations. Certainly this is important for the cloud feedbacks studied in the paper, and it is important for future investigators to be aware of this when they read the paper. The values of CIF for both SW and LW irradiances ought to have been specified in the paper, which is why we write this comment. Assumptions about CIF in general are important for understanding differences in irradiance fluxes from different atmospheric models, as described for instance by Oreopoulos et al. (2012).

Cloud inhomogeneity is an issue that can be physically quantified (Oreopoulos and Davies, 1998; Oreopoulos and Cahalan, 2005; Shonk et al., 2010, 2012) and thus ought not be used as a tuning factor to achieve radiative balance. As noted by Lacagnina et al. (2014) the next versions of EC-EARTH will not use CIF. In stead the McICA parametrization (Pincus et al., 2003) will be used.

3 References

References ECMWF (2002), IFS documentation CY25r1, http://old.ecmwf.int/research/ifsdocs/-CY25r1/index.html, Accessed: 2015-03-16.

Lacagnina, C., F. Selten, and A. P. Siebesma (2014), Impact of changes in the formulation of cloud-related processes on model biases and climate feedbacks, J. Adv. Mod. Earth Syst., 6 (4), 1224–1243, doi:10.1002/2014MS000341.

Mascart, P. J., and P. Bougeault (2011), The Meso-NH atmospheric simulation system: Scientific documentation, Tech. rep., Meteo France, Toulouse, France.

Nielsen, K. P., E. Gleeson, and L. Rontu (2014), Radiation sensitivity tests of the harmonie 37h1 nwp model, Geosci. Model Dev., 7, 1433–1449, doi:10.5194/gmd-7-1433-2014.

Oreopoulos, L., and R. F. Cahalan (2005), Cloud inhomogeneity from MODIS, J. Climate, 18, 51105124, doi:10.1175/JCLI3591.1.

Oreopoulos, L., and R. Davies (1998), Plane parallel albedo biases from satellite observations. Part II: Parameterizations for bias removal, J. Climate, 11, 933–944.

Oreopoulos, L., E. Mlawer, J. Delamere, T. Shippert, J. Cole, B. Fomin, M. Iacono, Z. Jin, J. Li, J. Manners, P. R¨ais¨anen, F. Rose, Y. Zhang, M. J. Wilson, and W. B. Rossow (2012), The continual intercomparison of radiation codes: Results from phase I, J. Geophys. Res., 117, D06,118, doi:10.1029/2011JD016821.

Pincus, R., H. W. Barker, and J.-J. Morcrette (2003), A fast, flexible, approximate technique for computing radiative transfer in inhomogeneous cloud fields, J. Geophys. Res., 108 (D13), 4376, doi:10.1029/2002JD003322.

Shonk, J. K. P., R. J. Hogan, J. M. Edwards, and G. G. Mace (2010), Effect of improving representation of horizontal and vertical cloud structure on the Earths global radiation budget. Part I: Review and parametrization, Q. J. R. Meteorol. Soc., 136, 1191–1204, doi:10.1002/qj.647.

Shonk, J. K. P., R. J. Hogan, and J. Manners (2012), Impact of improved representation of horizontal and vertical cloud structure in a climate model, Clim. Dyn., 38, 2365–2376, doi:10.1007/s00382-011-1174-2.