Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2016-31-RC1, 2016

Geoscientific Model Development Discussions

Interactive comment on "Numerical framework and performance of the new multiple phase cloud microphysics scheme in RegCM4.5: precipitation, cloud microphysics and cloud radiative effects" *by* Rita Nogherotto et al.

Anonymous Referee #1

Received and published: 5 April 2016

The paper describes the implementation of an improved cloud microphysics scheme for stratiform clouds within the RegCM4.5 model. The scheme introduces a prognostic representation of cloud water, ice, rain and snow in the model improving the physical basis for simulating mixed phase clouds and microphysical processes. The performance of the model is evaluated using the COSP simulator and comparing cloud radiative forcing to observational estimates. The paper is interesting and well written and requires only few changes. Since a few pieces of information are missing in the paper, prohibiting a comprehensive understanding of the results, I recommend major revisions.

Main comments:

1. It is not clear to me whether you have tuned the model after introducing the changes to the microphysical scheme. I assume that the original model was tuned with the SUBEX scheme to reproduce the radiative budget within the area covered. Could it be that the tuning forces the model to simulate a high amount of high clouds to balance a spurious heating in the model? And, in case you did not tune the model with the new microphysics scheme, you may allow the model to simulate a more realistic cloud field? Please give details on the model tuning and its implication for the results.

2. Why do you use random overlap? Most large scale models use maximum random overlap. Of course it depends on the layer thickness which overlap is more appropriate. How many of your 23 layers are in the troposphere and what is the resulting vertical resolution in the troposphere?

3. The differences between dX/dt and deltaX/delta t . . ..don't seem to be defined clearly enough – see comments further down (5. and 8.).

Minor comments:

1. You may want to give the full name for the SUBEX scheme when it is first mentioned.

2. Figure 1: What is the process that converts rain into cloud liquid or snow into cloud ice? You probably want to get rid of the arrow head pointing up. The arrow pointing from snow to water vapor should say sublimation and only point up. The evaporation arrow should only point up.

3. Equation 2: the sums should go from y=1 up to m and not from x=1.

4. Text before the equation after equation 2 (which is not equation 3!): You say it is an nxn matrix. But n is your time step! If you want to be consistent with equation 2 it should be an mxm matrix. It should also say 'm = 3 category system' instead of 'n=3'.

5. Equation 4: L should have an index x instead of x being in brackets. I think it

should be dT/dt instead of deltaT/deltat? Why do you subtract the source of q_x due to convective outflow and due to sedimentation from dq_x/dt? These sources of water/ice should be a sink in temperature in the same way as dq_x/dt. If there is a source of q_x due to sedimentation and convective detrainment, then dT_L/dt should not be =0.

6. Equation 5: Please give values/expressions for p, alpha and gamma.

7. Line 157-160: Not only do the time scales need to be fast but the ice crystal number needs to be high as well.

8. Equation 6: If the left hand side includes large scale advection already, then it is not clear to me why there is a second term on the right hand side.

9. Equation 8: this equation together with the diagnostic cloud scheme removes any supersaturation relative to ice. In line 177 you say 'condensation is a source of ice as homogeneous freezing takes place.' – it should say 'deposition' and the remainder of the sentence should be reformulated explaining that homogeneous freezing would only take place at high ice supersaturations but here in connection with the diagnostic cloud scheme deposition is handled just as condensation removing any supersaturation instantaneously.

10. Equation 11: You talk about evaporation due to turbulent mixing but you do not mention that by not resolving ice supersaturation you neglect the fact that there could be also an increase in ice mass due to turbulence.

11. Equation 12: The value of alpha does not seem to matter. The source term for any q_x is here D.

12. Equation 15: What are the values of b_1, P_loc and c_0 ?

13. Later on in the text you do not mention which autoconversion formulation you use. It is not clear to me why you need all 4 alternative formulations here in the paper if you (presumably) only use one.

14. Table 1: You probably want to list the ISCCP simulator in the last 2 lines as well.

15. Line 299: Please complete the information for this citation in the publication list.

16. Table 2: How large is the interannual variability in global mean total cloud fraction? Are the differences of the simulated coverage significantly different from the observations or could the simulations be a member of the distribution of observed cloud coverages? I assume you have quite a few years of data from the ISCCP observations and could easily check this. Similarly in table 4 you should be able to give an estimate for the variability of CRF. I assume that the differences in SW and LW fluxes are huge compared to the interannual variability but for CRF_tot it is not that obvious anylonger. Please note that the fourth row should say TOA CRF_SW . . .... and not LW.

17. Figure 4e should say MIC Medium JJA

18. Figure 7: In the CERES data, is the white in the very south in DJF and the very north in JJA missing values or really values close to zero.

Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2016-31, 2016.