



Interactive comment on “Coupling a new turbulence parametrization to RegCM adds realistic stratocumulus clouds” by T. A. O’Brien et al.

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We thank Referee 1 for helpful suggestions. The comments have improved the depth of the background material presented in the manuscript. We have responded to each of the referee’s comments below (our comments are italicized), and we have revised the manuscript accordingly.

The improvement of turbulence parameterization scheme on the modelling of the diurnal and annual cycles of stratocumulus clouds is more understandable. However, it

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is not so sure about the physical reasons for improving the modelling of such clouds in interannual and decadal cycles. What contributes to the interannual and decadal cycles in the first place? When we know the responsible physical processes, then we could briefly discuss how the UW scheme contributes towards better representing such processes, and thus better modelling results could be obtained.

Adding a brief literature review of the interannual variability of stratocumulus is an excellent suggestion. We have added references to studies by Norris et al (1994), Norris (2000), and Clement (2000), which indicate that long-term variability in MSc (including interannual and decadal) is related to SST variability and possibly to variability in the midlatitude storm tracks. It is not clear from this review, however, why the UW model is successful at modeling long-term stratocumulus variability; we suggest in the manuscript that this is a good topic for a future study.

We changed the last paragraph of the “Time Evolution” subsection to cover this discussion (please forgive the bibtex reference notation):

“Norris and Levoy (1994), Norris (2000), and Clement et al. (2009) use ship- and satellite-based observations to show that the long-term variability (interannual and longer) of low clouds in the Pacific is related to variability in SSTs and possibility to variability in the position of the mid-latitude storm track. Though the trend is not statistically significant, the sign of the modeled trend in low cloud amount is consistent with the results from Clement et al. (2009), which show that low cloud amount in this region declined steadily over the last half of the century. This result hints that RegCM-UW exhibits the positive low-cloud climatological feedback shown by Clement et al. (2009). The modest success of RegCM-UW in simulating the long-term variability of MSc cloud amount suggests that it captures these relationships, though the exact mechanism through which SSTs and other climatological forcing affect long-term MSc variability in RegCM-UW is unclear. A future study that examines the causal relationships between MSc and climatological forcing can hopefully reveal the nature of long-term MSc variability in the real world.”

Apart from the field experimental data, which are limited in spatial and temporal availability, it is suggested to compare the modelling results with other sources of data, such as SYNOP reports of cloud base and radiosonde measurements of boundary layer inversion strength, water vapour mixing in cloud top, cloud base height, inversion height, etc. The longer and routine availability of such data could serve to test the robustness of UW scheme for many years over larger areas.

This would be an interesting validation of the UW parameterization. However, we feel that such an analysis is outside the scope of this study because of the amount of effort it would require to prepare the model output in a way that is comparable radiosonde measurements; we would have to write an analysis package to extract radiosonde-like output from the model, and this package would have to parse through 1TB of data. Additionally, since radiosondes do not directly detect clouds, an ad hoc method must be applied to estimate cloud presence (e.g. Wang and Rossow (1995; J. App. Met.)); this method has a large uncertainty and low resolution due to the time-lag of the humidity sensors commonly used in radiosondes. Therefore, it is not clear whether the significant effort required to do such a comparison would yield useful information about RegCM-UW.

The lead author is presently working on deriving a long-term climatology of low-cloud height and temperature from the high-resolution ISCCP DX data for the purpose of creating a dataset with much more extensive spatial and temporal range than the data used in this study. We anticipate submitting a manuscript on this dataset, including validation of these simulations against this dataset, in the next few months.

Specific comments p.3446, line 13 and 14 – there are two “sources”

We fixed this in the revised manuscript

Figures 6 to 8– the diagrams are too small to be legible to the wearing eyes

This is an artifact of the GMDD manuscript style. In the standard 8.5x11” format used

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by GMD, the figures are significantly larger (Figures 7 and 8 are full-page figures in the GMD-formatted version).

Are there any previous studies on the under-estimation of the modelled liquid water for similar turbulence parameterization scheme? More detailed discussion of this point would be welcome.

We have added a reference to the study by Wyant (2010), which shows CAM-UW (essentially the same boundary layer parameterization) with a low bias in liquid water path. We added discussion of this to the discussion section: “Wyant et al. (2010) show that CAM with the UW model also simulates stratocumulus with systematically low LWP, so this LWP bias may be associated with some aspect of the UW model (e.g. the entrainment parameterization), with the relatively low vertical resolution, or some combination of these factors.”

Interactive comment on Geosci. Model Dev. Discuss., 4, 3437, 2011.

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