Anonymous Referee #1

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This paper addresses the value of cloud-permitting grid sizes near 3 km on globalscale simulations that cover a large fraction of the globe except polar regions. This is compared with a lower resolution simulation at 45 km grid size that uses a cumulus parameterization. The simulations are run for 5 continuous months with only northern and southern boundary conditions provided by analyses. The paper is of value because it not only addresses the above questions but also addresses some of the additional hurdles presented by large simulations in especially the computational aspects and handling large amounts of data. This aspect is also of interest.
Furthermore the authors have used a variety of datasets to improve the input to the model such as surface datasets that are not part of the regular WRF package.

It is also impressive to see the wide range of verification techniques employed from looking at convective propagating features to large-scale waves, precipitation patterns and even EOF analysis. I think this paper is publishable but I will make some comments on how this work could be improved from my perspective. The authors should consider this even though it is some extra work.

The results are very good for the high-resolution almost-global simulation that is run so long and gives confidence for future studies of such applications. Noting that the tropics is hardly constrained at all, this is a real test of the model physics both at high and low resolution.

We thank Referee #1 for the positive feedback and the valuable comments to further enhance the quality of the manuscript.

General Comments

1. While results were shown for convective systems, precipitation, and large scale features, none were shown for thermal fields or precipitable water that would also be of value in determining how well such a long simulation captured the climatology. I would encourage addition of some of these.

Thank you for your valuable suggestion. We included an additional section 3.4 on page 8 starting at line 255 including new figures 8 and 9 to evaluate the 2-m temperatures for different synoptic time steps as well as an evaluation of the simulated and analyzed precipitable water (PW) content . Our results show that although a temperature bias is still present in the CP simulation in some areas, the temperature bias especially over the Oceans and South America is considerably reduced by applying a CP resolution. The mean PW content shows a general tendency of underestimation at both resolutions, with the CP simulation being much closer to the analyzed values in the Tropical West Pacific region and over Australia.

2. In the conclusions the authors have attributed much of the improvement to the higher resolution which includes not having to use a cumulus parameterization. However, it can also be argued that the chosen scheme had some deficiencies that can be attributed to that scheme alone, e.g. shallow cloud issues in South America, and probably some of the tropical convective behavior. I would strongly encourage a separate run with a different cumulus scheme at 45 km to see how many of these improvements still stand when a possibly better one is used (e.g. WRF has a Tiedtke option more similar to the one in the ECMWF model). Such an additional run may add robustness to the authors' conclusions.

At the time where this simulation was conducted, the GF was a very robust scheme while the “new” Tiedtke scheme underwent major updates in version 3.8.1 and especially in the later version 3.9.1 (where also the GF scheme has been updated).
As our computing resources are limited, we performed a short simulation for February 2015 at 50 km resolution using the new Tiedtke scheme. The precipitation along the tropics considerably reduced by 30-50 % as compared to the GF scheme, but the TOA OLR values along the tropics are far too high. Apparently, this is caused by an improper interaction of the Tiedtke scheme with the RRTMG scheme.
Also, while admitting that a coarse scale ensemble applying different convection parametrizations would show some more insight, we regret to say that this is beyond the scope of our study.

Additionally, we performed further literature research on this topic.

Fowler et al. (2016) performed an experiment where they investigated the performance of the Grell-Freitas (GF) scheme and briefly compared it with the Tiedtke scheme using the MPAS model. They found that applying the Tiedtke scheme on a resolution of 50 km yields even worse results in the tropics and extratropics as compared to the GF scheme. As the physics in WRF and MPAS are the same, we assume that these findings also apply for the WRF model.
Gbode et al. (2019) investigated the performance of 27 different combinations using WRF version 3.8.1 over western Africa. Their findings indeed show a superior performance of the new Tiedtke scheme as compared to the GF Freitas scheme. The application of the modified Tiedtke scheme apparently helps to reduce the precipitation to about 50 % (on a daily basis) but the location of the maximum precipitation amount was still incorrect.

A new sentence was added to the conclusions on page 10, line 327:

“While Fowler et al. (2016) found a superior performance of the GF cumulus parametrization when compared to the Tiedtke scheme (Tiedtke 1989) on a 50 km resolution, the application of a different cumulus parametrization can lead to a reduction of the precipitation bias while the weakness of an incorrect spatial distribution still remains (Gbode et al. 2019, e.g.). As computing resources were limited, an additional experiment with the new Tiedtke scheme (Zhang et al. 2011) was performed for February 2015 (not shown). Depending on the region, the precipitation bias is reduced but the OLR values are too high indicating an improper interaction with the applied RRTMG scheme.”

Minor Points

1. line 100 - "andas" sentence needs correction.

Thank you for detecting this spelling mistake. This is corrected now on page 3, line 100.

2. line 107 - "skin temperature" used for lakes. Is this at least a diurnal average? How is seasonal change handled for lakes unresolved by the SST.

For very small lakes, which are resolved neither by the ECMWF nor by the OSTIA data set, the analyzed surface temperature from ECMWF is applied in 6-h intervals to update lake temperatures. These lakes are treated like sea in the model. Although WRF offers the possibility of applying an additional lake model, we did not apply it as this is so far mostly validated for deep lakes like the Great Lakes area.

The term “skin temperature” has been changed to “surface temperature” and the paragraph on page 4, line 106 now reads:

“In case no SST from either ECMWF or OSTIA was available, the ECMWF surface temperature was considered instead and the lake SST was limited between 34°C and -2°C in order to avoid unrealistic surface fluxes over inland lakes.”

3. Figure 3. This is rotated making references to upper right, etc. confusing at first. Lettering the panels would resolve this.

Thank you for your valuable suggestion. Panel letters were applied in Figure 3 to make it more clear. “Upper right” etc. has been replaced by the letters throughout the whole manuscript to match the panel description.

4. Figure 3 caption. Refers to +/- 10 N which is really just +/- 10 degrees (N and S).

As shown in the individual figures, the averaging region is +/-15 ° latitude. In order to clarify, the figure caption for Figure 3 has been changed to:

“Wheeler-Kiladis diagrams of the TOA OLR averaged over the latitude belt of ±15° around the equator and sampled with a temporal resolution of 3 h over April-June 2015. (a) and (d): Results achieved with the CERES data, (b) and (e): CP simulations, (c) and (f): NCP resolution. (a)-(c) : antisymmetric spectra, (d)-(f): symmetric spectra.”

5. line 213 - "same holds" maybe means "reverse holds"?

Actually, our intention was different. The idea was to emphasize the good agreement of the cloud patterns over Africa and the Indian Ocean basin. To further clarify this sentence, it has been changed on page 6, line 212. It now reads:
“The same applies to the Indian Ocean basin, where the NCP simulation shows less OLR than observed.”

6. line 235 - should be Fig. 6b.

Thank you for detecting this typo error. It is corrected on page 7, line 235.

References

Fowler, Laura D.; Skamarock, William C.; Grell, Georg A.; Freitas, Saulo R.; Duda, Michael G. (2016): Analyzing the Grell–Freitas Convection Scheme from Hydrostatic to Nonhydrostatic Scales within a Global Model. In: *Mon. Wea. Rev.* 144 (6), S. 2285–2306. DOI: 10.1175/MWR-D-15-0311.1.

Gbode, Imoleayo E.; Dudhia, Jimy; Ogunjobi, Kehinde O.; Ajayi, Vincent O. (2019): Sensitivity of different physics schemes in the WRF model during a West African monsoon regime. In: *Theor Appl Climatol* 136 (1-2), S. 733–751. DOI: 10.1007/s00704-018-2538-x.

Tiedtke, M. (1989): A Comprehensive Mass Flux Scheme for Cumulus Parameterization in Large-Scale Models. In: *Mon. Wea. Rev.* 117 (8), S. 1779–1800. DOI: 10.1175/1520-0493(1989)117<1779:ACMFSF>2.0.CO;2.

Zhang, Chunxi; Wang, Yuqing; Hamilton, Kevin (2011): Improved Representation of Boundary Layer Clouds over the Southeast Pacific in ARW-WRF Using a Modified Tiedtke Cumulus Parameterization Scheme. In: *Mon. Wea. Rev.* 139 (11), S. 3489–3513. DOI: 10.1175/MWR-D-10-05091.1.