

Effects of Horizontal Resolution and Air–Sea Flux Parameterization on the Intensity and Structure of simulated Typhoon Haiyan (2013)

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Response to referee 1

Dear Referee,

We have performed an additional experiment for providing more evidence about the impact of the cumulus parameterization on the simulation with 1 km resolution. Please find our responses to your questions and comments below. The questions and comments are given in italics, and our responses are in blue.

GENERAL COMMENTS:

In the reply, the author claimed that the simulations with and without cumulus parameterization produced overall similar simulated storm intensity. Is it means that the cumulus parameterization may not play a role in the fine resolution (3 km) simulation? The authors should provide more evidence about the impact of the cumulus parameterization on the simulation in this case with 1 km resolution. Why must the cumulus parameterization be used in the 1 km resolution? I hope the author could perform the experiments in 1km resolution with and without cumulus parameterization and show the differences between the two tests.

We have carried out an additional experiment of 1 km resolution without cumulus parameterization in response to your specific comment. The additional experiment used the same configuration as 1kmF0, but with the cumulus parameterization turned off, hereafter 1kmF0_noCU. The result indicates that the use of a cumulus parameterization in such a high resolution (1 km) simulation does not exert considerable influence on the typhoon intensity, track, and structure. For this additional experiment, we have conducted the same analysis as that for those experiments presented in this manuscript. There are very little difference between 1kmF0 and 1kmF0_noCU in terms of the minimum central pressure and track (cf. Fig 4), surface fields (cf. Figs. 6, 8, and 9), vertical structure (cf. Figs. 10 and 11), upper layer warming (cf. Fig 12), CFADs for simulated reflectivity and vertical motion (cf. Figs. 13, 14, 15), and also the KE spectra (cf. Fig. 16). Specifically, we compared the result of 1kmF0_noCU to that of

1kmF0, 1kmF2 (and also 1kmF1), and 3kmF0. The comparison reveals that, results of 1kmF2 (and 1kmF1) and 3kmF0 are apparently different from 1kmF0_noCU (so as 1kmF0). This is to say, the use of different flux options (1kmF1 & 1kmF2) and spatial resolution (3kmF0) can exert large impact on the simulation of typhoon Haiyan, but the cumulus parameterization does not play a role in such a fine resolution (1 km) simulation. Therefore, in this manuscript, we used the cumulus parameterization for all resolution to keep consistency among all cases.

In this revision, we added a supplemental figure to show the simulated minimum central pressures and tracks of 1kmF0_noCU and 1kmF0. We did not put all the other plots for 1kmF0_noCU therein because we do not want to overemphasize the use of cumulus parameterization in this article.

In page 9, lines 17-25, we added the following sentences:

In this study, the cumulus parameterization was used for all resolutions. This is because we intend to keep consistency among all cases. Results from an additional simulation of the 1kmF0 with the cumulus parameterization turned off revealed that the simulated Haiyan intensity and structure are overall similar. The minimum central pressure and storm track of the 1kmF0 without cumulus parameterization follow almost the same evolutions as that of 1kmF0 (supplemental figure Fig. S3). In our case, the use of a cumulus parameterization in high resolution (1 km) simulation does not exert considerable influence on the typhoon intensity, track, and structure. Some studies have also revealed that the activation of cumulus parameterization for simulation with grid spacings of 2-3 km produced overall similar simulated storm as in the simulation with explicit convection (e.g., Yu et al. 2011; Li et al. 2018; On et al. 2018).

Below is the supplemental figure for your reference:

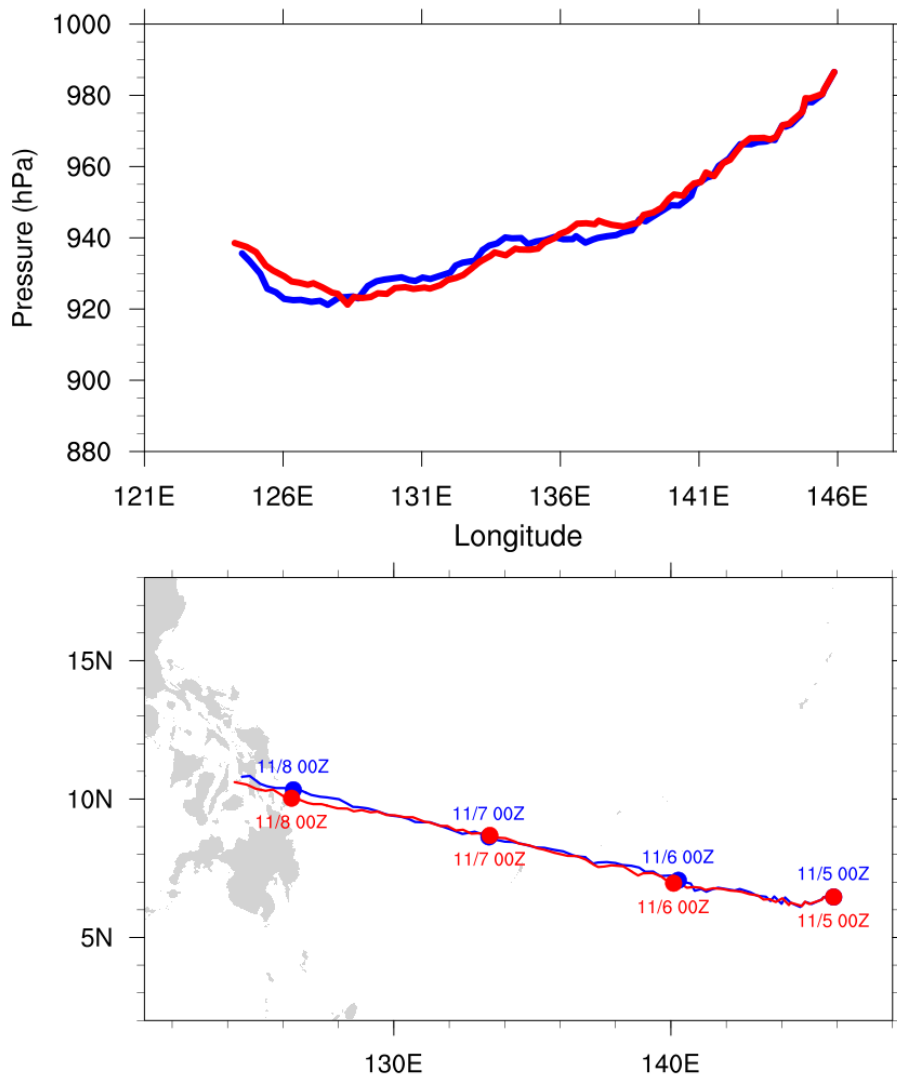


Fig. S3. The simulated minimum central pressures (hPa) and tracks during the period from 0000UTC 5 November 2013 through 0600UTC 8 November 2013. The experiment 1kmF0 is denoted in blue, and the additional experiment for simulation with 1 km resolution (and F0) but without cumulus parameterization is denoted in red. The evolutions of the simulated minimum central pressures (top panel) are shown in relation to longitude. The simulated tracks (bottom panel) were derived from the 1-hourly simulation results. The simulated position at each 0000UTC is denoted by a dot.