

Supporting Information for

Halt of ocean wave growth under tropical cyclone extremes

Tomoya Shimura¹, Nobuhito Mori¹, Daiki Ito², Satoshi Mitarai³, Takuya Miyashita¹

¹*Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan.*

²*Japan Fisheries Research and Education Agency, Kanagawa, Japan*

³*Okinawa Institute of Science and Technology, Okinawa, Japan*

Corresponding author: Tomoya Shimura (shimura.tomoya.2v@kyoto-u.ac.jp)

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Text S1. Swells during Representative TC Events

Figure 4 in the main text summarises all events from the summers of 2021 to 2024. Here, we focus on representative extreme events. Tropical cyclone (TC) events with lifetime minimum central pressures below 930 hPa, for which the simulation successfully reproduced the observed intensity, were selected. The four selected events were Typhoon Hinnamnor in 2022, Nanmadol in 2022, Bolaven in 2023, and Khanun in 2023. Their lifetime minimum central pressures were 920 hPa, 910 hPa, 930 hPa, and 905 hPa, respectively. A ± 2 -day period around the time of each lifetime minimum pressure was analysed.

Hinnamnor (2022): This TC translated westward during the analysis period (Figure S1a–c). Buoys were located around the track. Eighteen buoys detected swells, with a total of 200 observations. The median values of $\log_{10} \frac{E_{17 \text{ model}}}{E_{17 \text{ obs}}}$ within ± 0.25 (0.5) were recorded by 3 (9) buoys for CTRL and 9 (12) buoys for DragConst, respectively.

Nanmadol (2022): This TC translated north-westward during the analysis period (Figure S1d–f). Buoys were located surrounding the track. Twenty-six buoys detected swells, with a total of 1,216 observations. The simulated swell energy was generally overestimated. The median values of $\log_{10} \frac{E_{17 \text{ model}}}{E_{17 \text{ obs}}}$ within ± 0.25 (0.5) were obtained by 1 (3) buoys for CTRL and 1 (11) buoys for DragConst, respectively.

Bolaven (2023): This TC translated north-eastward during the analysis period (Figure S1g–i). Most buoys were located on the far left side of the track. Thirty-three buoys detected swells, with a total of 546 observations. The simulated swell energy was overestimated on the left-hand side of the track in the CTRL run. The median values of $\log_{10} \frac{E_{17 \text{ model}}}{E_{17 \text{ obs}}}$ within ± 0.25 (0.5) were obtained by 12 (18) and 26 (32) buoys for CTRL and DragConst, respectively.

Khanun (2023): This TC translated north-westward during the analysis period (Figure S1j–l). Two buoys were positioned directly along the track. Eighteen buoys detected swells, with a total of 508 observations. The simulated swell energy was overestimated on both sides of the track within approximately 1,000 km in the CTRL simulation. The median values of $\log_{10} \frac{E_{17 \text{ model}}}{E_{17 \text{ obs}}}$ within ± 0.25 (0.5) were obtained by 8 (11) and 10 (16) buoys for CTRL and DragConst, respectively.

Overall, across all representative TC events, the overestimations in swell energy by CTRL were clearly reduced in DragConst, supporting the halt of ocean wave growth under extreme tropical cyclone winds.

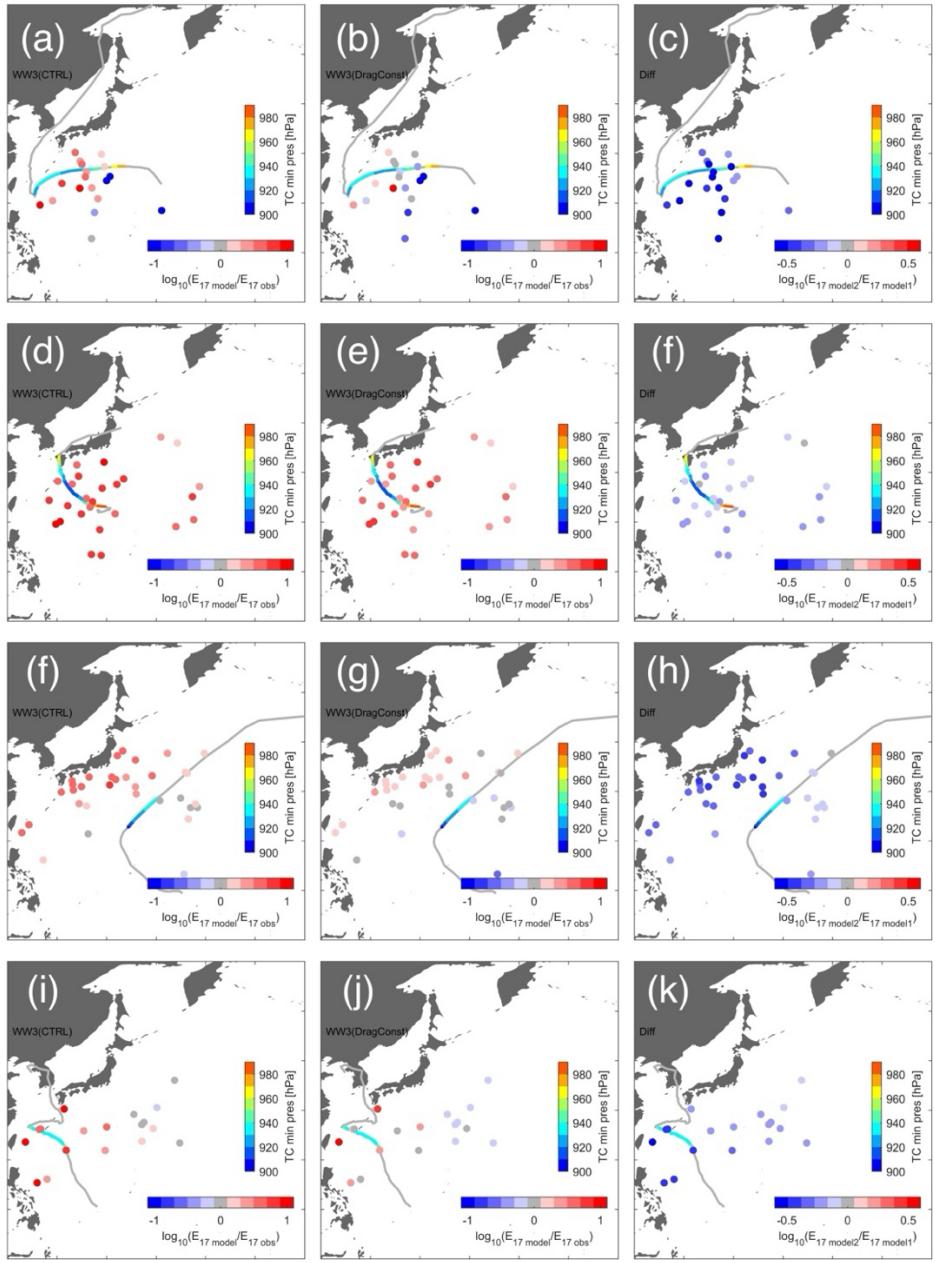


Figure S1. Differences in TC swell energies for representative extreme tropical cyclone events: Hinnamnor (2022) (top row), Nanmadol (2022) (second row), Khanun (2023) (third row), and Bolaven (2023) (fourth row). The left panels show the differences between WW3(CTRL) and observations, the middle panels show the differences between WW3(DragConst) and observations, and the right panels show the differences between WW3(DragConst) and WW3(CTRL). TC tracks within ± 2 days of the time corresponding to the lifetime minimum central pressure are coloured by central pressure; other periods are shown in grey.