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Forecasts of tropical cyclones in the Bay of Bengal in a regional convection-permitting atmosphere-ocean coupled model

Jennifer Saxby[1], Julia Crook[1], Cathryn Birch[1], Chris Holloway[2], Huw Lewis[3], Simon Peatman[1], and Juliane Schwendike[1]
[1]University of Leeds, ICAS, Earth and Environment, United Kingdom of Great Britain – England, Scotland, Wales (j.saxby@leeds.ac.uk)
[2]University of Reading, Meteorology, United Kingdom
[3]Met Office, United Kingdom

Tropical cyclones (TCs) forming over the Bay of Bengal can cause devastation when they make landfall in India and Bangladesh; accurate prediction of their track and intensity is essential for disaster management. TC intensity is moderated by heat, momentum and moisture exchanges between the atmosphere and ocean. In recent years there have been significant improvements in the skill of TC forecasts due to the implementation of coupled atmosphere-ocean models and high-resolution models capable of explicitly resolving small-scale physical processes influencing storm development.

This study evaluates the representation of six TCs in the Bay of Bengal from 2016 to 2019, using both a Met Office Unified Model atmosphere-only configuration (ATM) with 4.4 km grid spacing, and coupled to a 2.2 km resolution NEMO (Nucleus for European Models of the Ocean) ocean model (CPL). To determine the impact of coupling on wind-driven mixing and ocean-atmosphere heat exchange, forecast sea surface temperature (SST) is compared to observations. The impact of coupling on track position and storm intensity is evaluated using predictions of minimum sea level pressure (MSLP) and 10 m maximum sustained winds (MSW). Representation of TC dynamics is assessed by analysing storm structure, using radius of maximum winds and rain rate asymmetry.

Results from the three most intense TC case studies (Fani, Titli, and Vardah) show that SSTs in ATM are too high, while SSTs in CPL are slightly too low, with an overestimation of the cooling response in TC wakes. TC track position errors are small, but intensity error metrics for MSLP and MSW show biases relative to observations. Peak intensity is overestimated for Titli and Vardah in the ATM model configuration; the CPL model configuration generally produces weaker storms than the ATM model configuration. Wind speeds outside the storm centre are high compared to observations, with a greater bias in the ATM model configuration. Both model configurations produce accurate predictions of radius of maximum winds and rain rate asymmetry, suggesting a

good representation of TC dynamics. Much of the variation in rain rate asymmetry in the forecasts can be explained by variations in wind shear.