
A21D-1749 The Effects of Boundary Layer Dynamics and Intensity Improvements on Hydro-Meteorological Forecasts of Hurricanes

 Tuesday, 10 December 2024

 08:30 - 12:20

 *Hall B-C (Poster Hall) (Convention Center)*

Abstract

Hurricanes can cause billions of dollars in damage each year due to their high winds and floods. While hurricane dynamics can significantly impact the amount and spatial extent of rainfall, our understanding of the impacts of hurricane intensity on precipitation patterns is limited. The primary objective of this study is to address this knowledge gap by conducting real hurricane simulations using the Weather Research and Forecasting (WRF) model.

We will show that the current Planetary Boundary Layer (PBL) schemes of WRF are overly diffusive for major hurricane forecasts mainly since they do not consider turbulence suppression effects caused by strong rotation (Romdhani et al. 2022; Matak & Momen 2023). By reducing the vertical diffusion, we improved the hurricane intensity forecasts by $\sim 40\%$ on average compared to the default models in four considered major hurricanes. These intensified hurricanes generated more intense and localized precipitation forcing as the attached figure shows (compare improved model precipitation extent and peaks with the default model). The intensification altered the size of hurricanes and consequently the rainfall patterns. When we coupled WRF with the WRF hydrological model, this enhancement in intensity led to $\sim 16\%$ and $\sim 34\%$ improvements on average in hurricane streamflow bias and correlation forecasts, respectively, in three coastal regions in the US (Khondaker & Momen 2024). This research provides notable insights into the impacts of hurricane dynamics on precipitation and flood forecasts. The findings can be helpful in

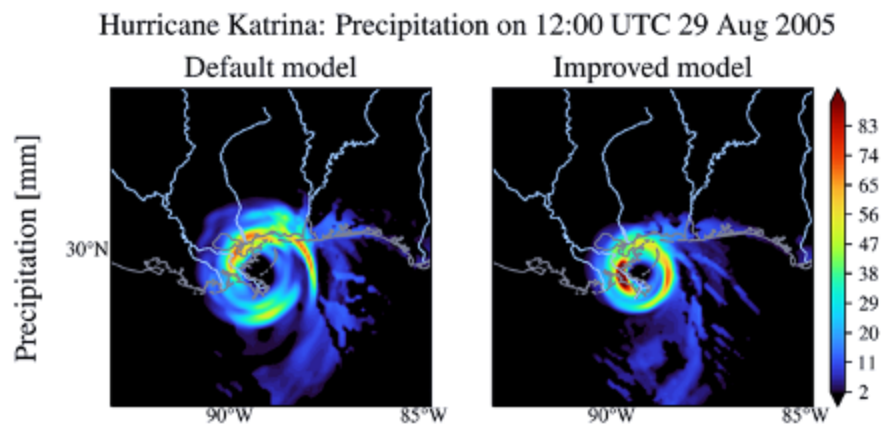
improving operational hurricane flood forecasting models to aid in mitigating some damages of these extreme weather events.

References

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Matak L, Momen M (2023) The role of vertical diffusion parameterizations in the dynamics and accuracy of simulated intensifying hurricanes . Boun. Lay. Met. <https://doi.org/10.1007/s10546-023-00818-w>

Romdhani O, Zhang JA, Momen M (2022) Characterizing the impacts of turbulence closures on real hurricane forecasts. J Adv Model Earth Syst. <https://doi.org/10.1029/2021MS002796>



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