ANALYZING TROPICAL CYCLONE-CLIMATE INTERACTIONS USING THE HIGH RESOLUTION COMMUNITY EARTH SYSTEM MODEL

Research Challenge
Research has shown that tropical cyclones (TCs) are both influenced by and have a significant impact on the Earth’s climate, particularly through their interactions with the upper ocean. Understanding these interactions is of great importance to obtaining a better knowledge of the Earth’s climate system and constraining uncertainty in climate projections. To this end, the team sought to characterize their climate model’s self-generated TCs, analyze the sensitivity of these simulated TCs to ocean coupling, and to diagnose the impact of the model’s self-generated TCs on the global ocean within the modeled climate.

Methods & Codes
In this project, the team analyzed the interactions between TCs and climate using a high-resolution configuration of the CESM (Community Earth System Model). First, they performed a 30-year fully coupled high-resolution simulation for use as a control. They then ran an atmosphere-only simulation to examine the sensitivity of modeled TCs to ocean coupling. And finally they investigated the impact of TCs on the global ocean using a set of ocean-only simulations with and without TC forcing.

Results & Impact
Results from the atmosphere-only simulation revealed that ocean coupling is essential to capturing realistic TC intensity and intensification, influencing the simulated annual TC number, spatial distribution, and storm intensity. Results from the ocean-only simulations revealed that TCs can influence global ocean temperature patterns, ocean energetics, and ocean heat transport. They also observed that TCs can strengthen certain ocean circulations, but the influence of such circulation changes appeared to be fairly small on a global scale.

Why Blue Waters
TC–climate research falls at the interface between weather and climate modeling, requiring high-resolution grid spacing to resolve weather-scale TC features, as well as global-scale coverage and decades of integration time. Blue Waters has the unique capability to handle the computational demand associated with running the model at ultra-high resolutions, including scalability to over 15,000 cores, high frequency input and output, and post-processing and visualization of model results.