PhD Studentship: Factors controlling hurricane intensity in high-resolution atmospheric models

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Tropical cyclones can cause devastating loss of human life and property. Although forecasts of tropical cyclone locations have improved greatly over the last 20 years, forecasts of their strength have shown relatively little improvement. Meanwhile, weather and climate models have steadily increased their horizontal resolution, allowing for the direct simulation of smaller-scale features such as rain bands, tightly-wrapped wind fields, and in some cases even individual columns of rising air. The key question for this project is: what physical processes are most important for the realistic simulation of tropical cyclone intensity? To address this question, the student will utilize state-of-the-art computer models at several different resolutions to simulate and analyse case studies of actual tropical cyclones as well as more idealised cases and longer global climate runs.

An outline for this project is:

Year one: Identification of model configurations yielding realistic simulations of tropical cyclones

The student will learn about tropical cyclone dynamics and the current state of model simulations, especially the UK Met Office Unified Model. In collaboration with the Met Office, the configuration of very high resolution simulations (~1 km grid length) leading to the most realistic storm intensities will be determined. Likewise, coarser resolution limited-area models will be run with different parameter settings focusing on key physical processes in order to find the most realistic configuration at these resolutions.

Year two: Investigation of processes that appear to be important in determining which of the simulations above have the most realistic tropical cyclone intensities.

Simulations will be analyzed using a range of tools to identify those processes that are most important in determining which simulations have the most realistic tropical cyclone intensities. Idealised simulations will be performed to test hypotheses stemming from this analysis.

Year three: Analysis of the effect of mechanisms important for better simulation of tropical cyclone intensity on large-scale climatology of storms.

Longer global simulations will be analysed. Do the statistics of tropical cyclone intensity improve? How are storm tracks, interannual variability, and environmental interaction affected? How do important processes found in models vary with storm intensity in observations and climate model runs?

Skills needed: The student should have (or be prepared to develop) a good understanding of atmospheric dynamics and thermodynamics. Strong computer skills will be needed, including knowledge of programming languages such as IDL and Fortran.