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DEVELOPING MORE ACCURATE MODELS OF TORNADOS

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ABSTRACT

Tornados are a major hazard and an ever-present threat around the world with the potential to cause wide scale loss of life and damage to infrastructure. There have been many attempts to model tornados by developing simulation techniques that allow a vortex to be generated for the purposes of understanding the characteristics of tornado maintenance and intensity. Traditionally, these models comprise an analysis of the wind field measurement data using Doppler radar collection, derivation of analytical tornado systems such as the Rankine vortex model, experimental modelling in a laboratory vortex chamber, or the more recent numerical simulation techniques. In the realm of wind engineering, these models tend to focus on the tornado vortex absent a parent storm and, as such, rely on artificial boundary conditions that lead to uniform, axially symmetric rotation of wind about a vertical axis centred in the model domain. This project aims to provide a quantitative assessment of the discrepancy between the velocities of wind-fields generated by the previous models with those of a physically realistic tornado spawned from a supercell in a meteorological numerical cloud model simulation at full-scale and able to freely form and dissipate in a large, yet well-resolved, domain. Further analysis will be performed to understand how the in-flow of wind at the simulation domain boundaries affects the mechanics of the simulated tornado and to determine the ideal ratio of the tornado radius to the size of its domain. Thus far, a novel method has been proposed to be used in tracking the precise centre of the tornado, upon which to base all subsequent analyses, and a comparison of the tangential velocity profiles of prior models have been shown to match that of the tornados analyzed in this work (when circumferentially-averaged). The non-averaged velocities of the tornado data analyzed here demonstrate high velocities in the wind-field in excess of 50% of the peak in the averaged profile, extending far from the core of the tornado. These findings indicate the need to incorporate the maximum tangential velocities in the analysis of tornado profiles and the potential dangers entailed in assuming the tornado does not freely form and move within its simulation domain and simply rotates symmetrically about a fixed, vertical axis. Finally, these findings outline to what extent current models of tornados underestimate their destructive potential and how they could be improved in future to provide superior results for engineering analysis.

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