Using a Collaborative Robot to Simulate How Topography Impacts Tornado Intensity

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How does topography impact the formation, size and strength of a tornado? In order to better understand how a tornado changes when it travels across different land masses a small-scale tornado simulator was constructed. Since it is easier to measure and observe changes in water versus changes in air, water was used as the experimental medium. A vortex was generated inside a large aquarium and mock topographies (plains, mountains and valleys) were created inside the aquarium using sand and rocks. Changes in vortex height, vortex width and vortex rotational speed were measured using a 2D laser and the vortex was moved over each artificial landform using a collaborative robot. The simulated data was analyzed and used to model and predict what would happen in real life as a tornado passes through valleys, over mountains, and across plains. In order to quantify and prove or disprove the hypothesis that there is a direct relationship between varying topographies and tornado strength, the concepts of Conservation of Angular Momentum and Conservation of Energy were applied. Based on the changes in Angular Momentum and calculated Total Energy the impact of various landforms was quantified. Through the specific application of Rankine's Vortex formula, Kelvin's Theorem on Circulation, and the formula for Kinetic Energy it was shown that a direct relationship exists between the strength of a tornado and the land mass it travels across.

Awards Won:

American Meteorological Society: Certificate of Honorable Mention