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Simultaneous assessment of debris trajectories to determine characteristics of the July 1, 2023 Didsbury, Alberta, Canada EF4 tornado

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The Enhanced Fujita scale is a useful assessment tool to determine wind speeds in tornadoes in Canada, the United States of America, and Japan. However, it is a damage-based assessment which relies on the tornado hitting damage indicators whose wind loads have been well-documented and researched (such as houses, mobile homes, and trees). Additionally, the Enhanced Fujita scale is unable to determine any additional characteristics of the tornado such as the ratio of wind speeds (swirl ratio), or the dimension of the core radius.

In a previous study, the authors of this abstract developed a forensic tool to analyse the trajectories of large compact objects (vehicles, farming equipment, trailers, haybales, etc) identified during damage surveys. By combining analytical tornado wind field models with debris equations, the lofting wind speeds required to recreate these observed trajectories can be estimated. This was achieved by utilizing a Monte Carlo simulation to randomly select parameters and plotting cumulative distribution functions to depict the likelihood of lofting at various wind speeds. Analyzing debris trajectories from several documented tornadoes in Canada revealed that this method yields threshold lofting wind speeds comparable to those estimated by other approaches. However, incorporating trajectories resulted in higher estimated lofting wind speeds than the EF-scale ratings derived from ground survey assessments based on structural damage.

All of the debris trajectories examined in the previous study were analysed as single independent instances. For example, in the EF4 Didsbury, AB tornado, although the focus was on a single combine harvester, there were multiple other large compact objects in the same area that were not analysed in the study. Additionally, the effect of the relative location of the object to the centre of the tornado was not considered.

The goal of this paper is to continue the development of a forensic tool for debris trajectories of large compact objects by analyzing the trajectories of multiple debris objects simultaneously. Analyzing multiple debris simultaneously narrows the range of possible tornadic parameters, which provides more insight to the characteristics of a tornado. Data from the EF4 Didsbury, AB tornado are applied as a case study to test this forensic tool.