April 30, 2014

Longer periods of tornado activity are most likely to spawn the worst events, but they may also be more predictable

WEST LAFAYETTE, Ind. - Significant tornado outbreaks and especially strong tornadoes are more likely occur within periods of activity lasting three or more days, according to a Purdue University tornado expert.

Jeff Trapp, a professor of earth, atmospheric and planetary sciences, examined 30 years of U.S. weather records and found that an outbreak of 20 or more reported tornadoes had a 74 percent probability of occurring during a period of tornado activity lasting three or more days. During those same periods, a tornado rated 3 or higher on the Enhanced Fujita scale had a 60 percent probability of hitting.

The Enhanced Fujita scale rates tornadoes from EF0 to EF5 with damage rated as "light," including broken branches and windblown signs, to "incredible," including leveling of strong-frame houses.

"Two extreme tornado events last year led to 32 deaths, injured more than 377 and cost $2 billion in damage and inspired this study," Trapp said. "Unfortunately, the devastating tornadoes these past few days, tragically, seem to be bearing out the results."

Tornadoes swept through Arkansas, Oklahoma, Kansas, Missouri, Nebraska, Iowa and Mississippi on Sunday (April 27); Mississippi, Alabama and Tennessee on Monday (April 28); and North Carolina on Tuesday (April 29). The National Weather Service received 100 preliminary tornado reports for April 27 and 28, and multiple deaths have been attributed to the violent storm system.

Trapp also found the multiple-day periods were more likely to occur during the warm months of April through July.

"The encouraging news is that the larger, more slowly evolving and moving systems that appear to contribute to multiple-day tornado periods may be more predictable," he said. "The weather system responsible for the tornadoes this week falls in this category and was

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revealed in the forecast models at least five days in advance with good fidelity."

Trapp examined tornado activity entered into the National Oceanic and Atmospheric Administration's historical record of tornadoes in the United States from 1983-2012, which included 3,129 tornado days and 1,406 unique periods of tornado activity. Multiple-day periods made up 24 percent of the unique periods of activity.

A paper detailing his study and the results was published in the April issue of the journal *Monthly Weather Review* and is available online.

The idea for the research began while Trapp was participating as a lead investigator in the National Science Foundation's Mesoscale Predictability Experiment (MPEX), a national field project to improve predictions of severe weather.

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ABSTRACT

On the Significance of Multiple Consecutive Days of Tornado Activity

Robert J. Trapp

Motivated by the temporal behavior of recent high-end tornado events, a 30-year historical record of tornadoes in the United States is examined for multiple-day periods of tornado activity. Comprising the 3,129 tornado days during 1983-2012 are 1,406 unique, nonoverlapping periods. Only 24% of these periods have lengths of 3 or more days. However, the conditional probability of such a multiday period given an outbreak day (OB; one with 20 or more tornado reports) is 74%, and give a significant tornado day [SIGTOR; one rated Fujita /enhanced Fujita (F/EF) $\geqslant$ 3] is 60%. Alternative ways of expressing these conditional probabilities all lead to the conclusion that SIGTORs and/or OBs are more likely to be contained within multiday periods of tornadoes than within 1-2 day periods. Two additional conclusions are offered: 1) SIGTORs and OBs have a relatively higher

likelihood of occurrence during the latter half of the multiday periods, and 2) SIGTORs and OBs have a relatively higher likelihood of occurrence during the warm months of April-July. A hypothesized connection, illustrated using reanalysis data from 2013, is proposed between such behaviors and the characteristics of the larger-scale meteorological forcing. Some speculations are made about possible relationships between multiday periods of tornado activity and convective feedbacks, extended predictability, and modes of internal climate variability