

U.S. regional tornado outbreaks and their links to spring ENSO phases and North Atlantic SST variability

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Key findings:

- 1) Historical U.S. regional tornado outbreaks are linked to sea surface temperature (SST) variations due to the El Niño / Southern Oscillation (ENSO) and the North Atlantic tripole mode. These SST signals induce atmospheric conditions conducive to U.S. outbreaks, such as increased wind shear and the convergence of warm moist air originating from the Gulf of Mexico.
- 2) El Niño events that persist into boreal spring, such as the 2015-16 event, are associated with a relatively mild risk of tornado outbreaks over most of the country, except along the Gulf Coast and central Florida in February. In contrast, weak early-terminating El Niño events tend to boost the likelihood of tornado outbreaks in the Upper Midwest by up to 50% in May.
- 3) La Niña events that resurge in boreal spring tend to enhance the likelihood of tornado outbreaks over widespread regions of the Ohio Valley, Southeast, and Upper Midwest by up to 57% in April. In contrast, a La Niña transitioning to El Niño in boreal spring boosts the likelihood of tornado outbreaks in the South, particularly Kansas and Oklahoma, by up to 50% in April.
- 4) Despite these connections, there remains a large element of chance: tornado outbreaks can occur in any season and almost anywhere in the U.S., regardless of the state of ENSO.

Relevance to NOAA science, and to society: Tornado outbreaks are one of nature's most destructive forces. The ability to predict tornado outbreaks a season or more in advance could help society to better prepare, potentially preventing significant losses of life and property.

Research overview & goals: Currently, the risk of regional tornado outbreaks is predictable only about a week ahead. The goal of the study was to explore the scientific basis for predictions of outbreaks a month or more in advance.

Unique aspects of the study: This study breaks new ground on a potential basis for seasonal predictability of tornado outbreak probability over the U.S. in boreal spring.

Methodology: Historical weather and climate records were examined for the period 1950-2014. An "outbreak month" is defined as when at least 12 weighted F1-F5 tornadoes occur within a 200 km radius of a given point over 5 consecutive days within the month (the weighting assigns an F1 tornado a 1, F5 a 5). The probability of outbreak in a given month, and the statistical significance of that probability, are then linked to global SST variations -- including the previously-identified main spatiotemporal "flavors" of ENSO (persistent El Niño, early-terminating El Niño, resurgent La Niña, and transitioning La Niña).

Future work: Future work is aimed at incorporating ENSO and other climate patterns into statistical and dynamical models, with the goal of reliably forecasting the likelihood of U.S. tornado outbreaks one to three months in advance.

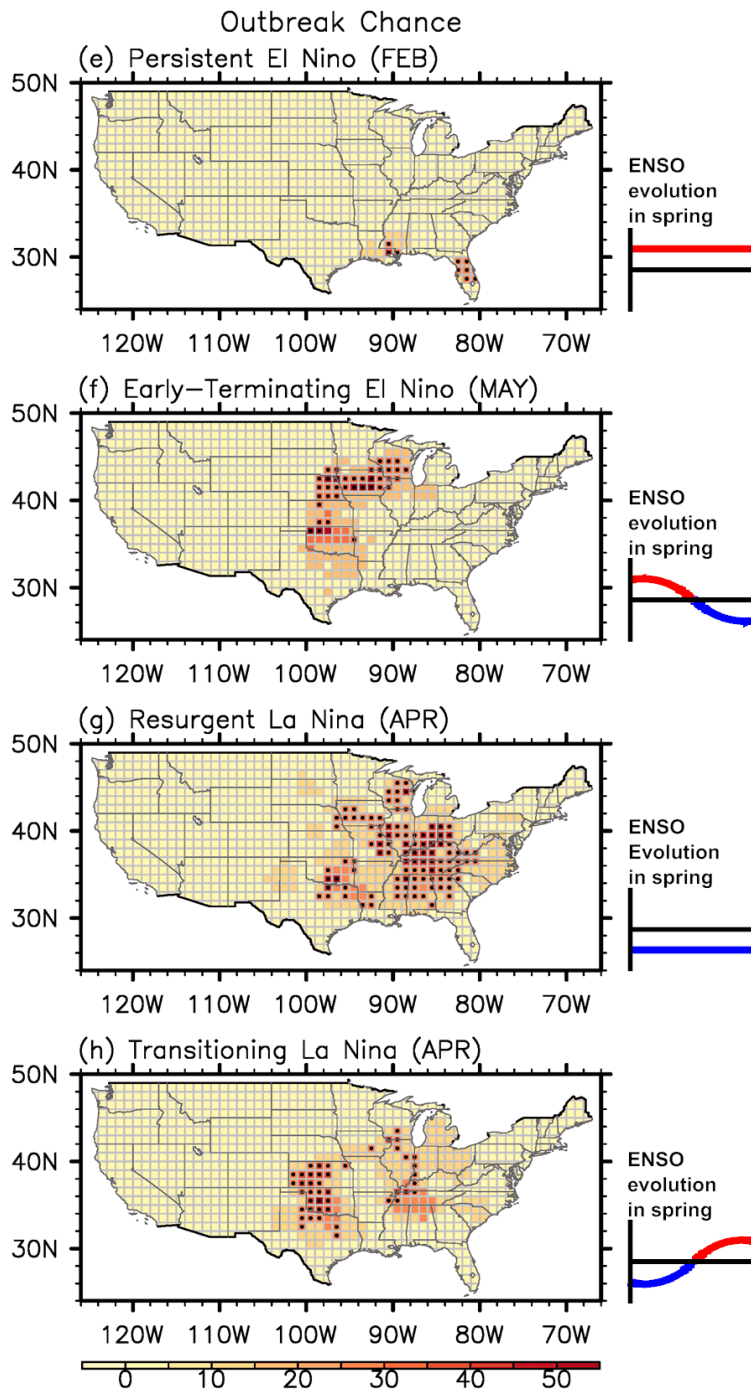


Figure 1: Probability (%) of U.S. regional tornado outbreaks linked to the four dominant springtime ENSO behaviors (illustrated at right), during the month in which each ENSO flavors has its strongest influence. Areas shaded yellow to red represent the probability during that month of a regional tornado outbreak, which occurs when at least 12 F-scale weighted tornadoes occur within 200 km of a given point during 5 consecutive days within the month. Black dots exceed the 90th percentile of local climatological outbreak probability, based on a binomial test.