Supplementary Table 1. Tornado-related number of fatalities and injuries and property and crop damages (in million US dollars) in the U.S. during 2005-2014, reproduced from the U.S. Natural Hazard Statistics (http://www.nws.noaa.gov/om/hazstats.shtml).

Year	Fatalities	Injuries	Property & crop damages
2005	38	537	503.9
2006	64	990	759.0
2007	81	659	1,407.5
2008	**126**	**1,714**	**1,865.6**
2009	21	351	584.9
2010	45	699	1,134.6
2011	**553**	**5,483**	**9,493.0**
2012	70	822	1,649.7
2013	55	756	3,648.7
2014	47	641	635.7
Total	**1,100**	**12,652**	**21,682.6**

Supplementary Table 2. List of the four most frequently recurring patterns of ENSO evolution (7 persistent El Niño, 6 early-terminating El Niño, 7 resurgent La Niña and 8 transitioning La Niña cases) identified based on the sign and amplitude of the normalized principal components of El Niño and La Niña variability during 1949 - 2014 [17]. The selected ENSO events have the normalized principal components larger than or equal to 0.5, and are listed by their onset-decay years (that is, year (0) - year (+1)).
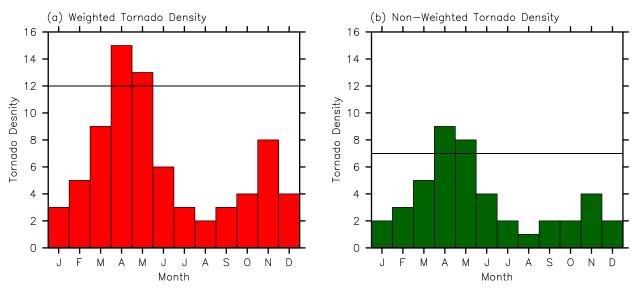
Persistent El Niño	Early-Terminating El Niño	Resurgent La Niña	Transitioning La Niña
1957 - 1958	1953 - 1954	1954 - 1955	1950 - 1951
1968 - 1969	1958 - 1959	1970 - 1971	1956 - 1957
1982 - 1983	1963 - 1964	1973 - 1974	1964 - 1965
1986 - 1987	1969 - 1970	1983 - 1984	1971 - 1972
1991 - 1992	1977 - 1978	1998 - 1999	1975 - 1976
1997 - 1998	1987 - 1988	2010 - 2011	2000 - 2001
2002 - 2003		1950 - 1951	2005 - 2006
			2011 - 2012

Supplementary Table 3. List of 10 most active and 10 least active U.S. tornado years based on the total number of F1-F5 tornados in the U.S. during March-May. The corresponding ENSO phase for each case is also shown. Note that the decaying phase of La Niña in 2008 cannot be described using the leading mode of observed La Niña variability; thus it is referred to as decaying La Niña. Similarly, the decaying phase of El Niño in 2003 is referred to as decaying El Niño as in the case of 1952 and 2005. The transitioning of 1972-1973 El Niño to 1973-1974 La Niña can be described only by the 2nd leading mode of observed El Niño variability; thus it is referred to as transitioning El Niño [17]. The onset of El Niño in 1982 occurred from ENSO neural condition; thus it is referred to as developing El Niño as in cases of 1991 and 2002.

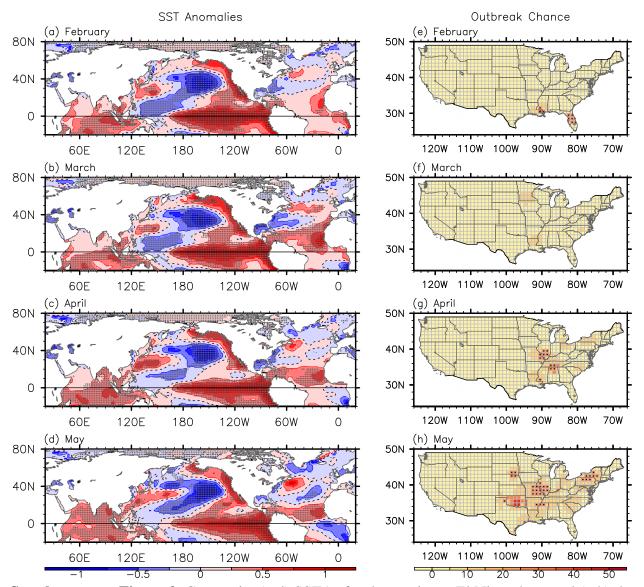| 10 Most Active U.S. Tornado Years		10 Least Active U.S. Tornado Years	
Year (Number)	**ENSO phases**	**Year (Number)**	**ENSO phases**
2011 (690)	Resurgent La Niña	1951 (67)	Transition La Niña
1973 (412)	Transition El Niño	1987 (80)	Persistent El Niño
1974 (390)	Resurgent La Niña	1950 (89)	Resurgent La Niña
2008 (359)	Decaying La Niña	2005 (89)	Decaying El Niño
1982 (342)	Developing El Niño	1952 (93)	Decaying El Nino
1976 (325)	Transition La Niña	1992 (102)	Persistent El Niño
1957 (317)	Transition La Niña	1958 (113)	Persistent El Niño
2003 (306)	Decaying El Niño	2002 (125)	Developing El Niño
1991 (302)	Developing El Niño	1993 (129)	ENSO neutral
1965 (301)	Transition La Niña	1969 (130)	Persistent El Niño

Supplementary Table 4. List of 16 negative (below lower quartile) and 16 positive (above upper quartile) phases of North Atlantic SST tripole mode in MAM during 1949-2014, derived from the leading EOF mode of the North Atlantic SSTAs in MAM. For each case of the positive and negative phase of North Atlantic SST tripole mode, the corresponding springtime ENSO phase is also listed. Note that the decaying phase of La Niña in 1985 cannot be described using the leading mode of observed La Niña variability; thus it is referred to as decaying La Niña as in the case of 1989. Similarly, the decaying phase of El Niño in 2005 is referred to as decaying El Niño. The transitioning of 2009-2010 El Niño to 2010-2011 La Niña, which can be described only by the 2nd leading mode of observed El Niño variability, is referred to as transitioning El Niño [17]. Similarly, the resurgence of La Niña in 1975 following 1973-1974 and 1973-1974 La Niña events is referred to as 2nd resurgent La Niña. The onset of El Niño in 1986 occurred from ENSO neural condition; thus it is referred to as developing El Niño as in cases of 1991, 1994 and 2009.

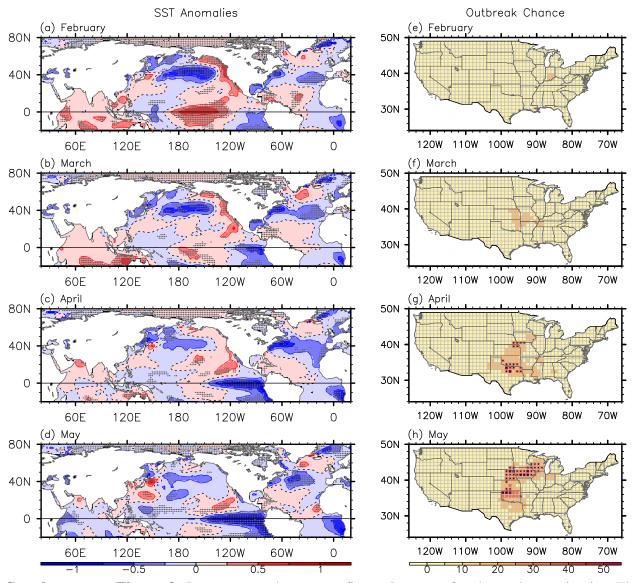| Negative phase of North Atlantic SST tripole (March-May)		Positive phase of North Atlantic SST tripole (March-May)	
Year	ENSO phases	Year	ENSO phases
1950	Resurgent La Niña	1951	Transition La Niña
1957	Transition La Niña	1958	Persistent El Niño
1959	Early-Term El Niño	1962	ENSO neutral
1971	Resurgent La Niña	1966	Decaying El Niño
1972	Transition La Niña	1969	Persistent El Niño
1974	Resurgent La Niña	1970	Early-Term El Niño
1975	2nd resurgent La Niña	1979	ENSO neutral
1976	Transition La Niña	1980	ENSO neutral
1985	Decaying La Niña	1981	ENSO neutral
1986	Developing El Niño	1983	Persistent El Niño
1989	Decaying La Niña	1988	Early-Term El Niño
1991	Developing El Niño	1998	Persistent El Niño
1994	Developing El Niño	2005	Decaying El Niño
2003	Persistent El Niño	2006	Transition La Niña
2009	Developing El Niño	2010	Transition El Niño
2014	ENSO neutral	2013	ENSO neutral

99th Percentiles of Tornado Density in the Central and Eastern U.S.

(a) Weighted Tornado Density

(b) Non−Weighted Tornado Density

Supplementary Figure 1. The 99th percentiles of (a) weighted and (b) non-weighted tornado density values averaged over the central and eastern U.S. region, frequently affected by intense tornadoes (30° - 40°N and 100° - 80°W). The horizontal lines in (a) and (b) indicate the March-May averages of the weighted and non-weighted tornado density values, respectively. The outbreak threshold in this study is set to a uniform value of 12, which is the March-May average of the weighted tornado density values over the central and eastern U.S. region. See section 2 for more details about how these fields are derived.
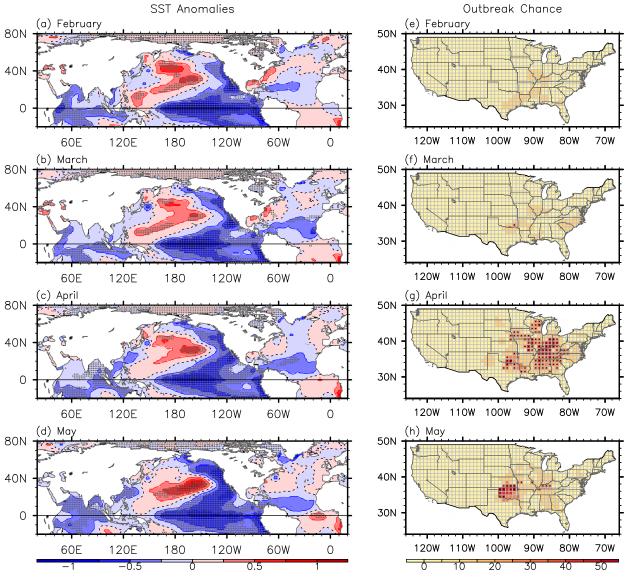
Supplementary Figure 2. Composite (a-d) SSTAs for the persistent El Niño phase and (e-h) the corresponding probability of U.S. regional tornado outbreaks in (top row) February (+1), (upper middle row) March (+1), (lower middle row) April (+1) and (bottom row) May (+1). The gray dots in panels a-d indicate that the SSTAs are statistically significant at the 10% level based on a Student's *t*-test. The black dots in panels e-h indicate that the probability of tornado outbreaks is statistically significant at the 10% level based on a binomial test. The units are in °C for the SSTAs and in % for the probability of tornado outbreaks.
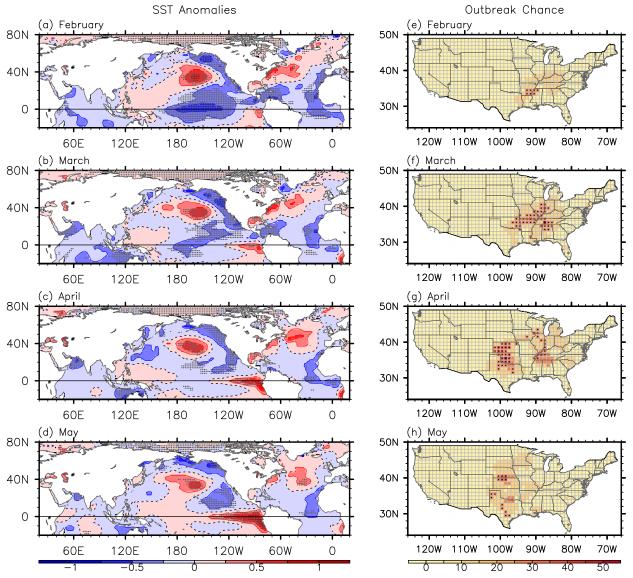
Early−Terminating El Nino [+1] Year: SSTA and Probability of Tornado Outbreak

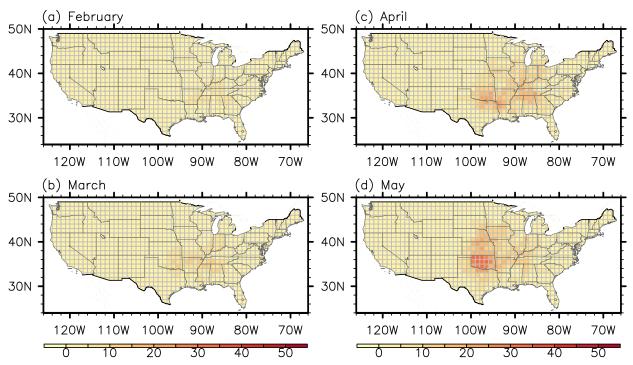**Supplementary Figure 3**. Same as supplementary figure 2 except for the early-terminating El Niño phase.

Resurgent La Nina [+1] Year: SSTA and Probability of Tornado Outbreak

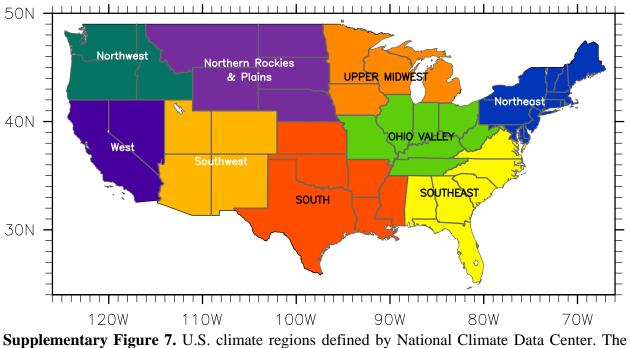**Supplementary Figure 4.** Same as supplementary figure 2 except for the resurgent La Niña phase.

Transitioning La Nina [+1] Year: SSTA and Probability of Tornado Outbreak

SST Anomalies

(a) February

(b) March

(c) April

(d) May

Outbreak Chance

(e) February

(f) March

(g) April

(h) May

Supplementary Figure 5. Same as supplementary figure 2 except for the transitioning La Niña phase.
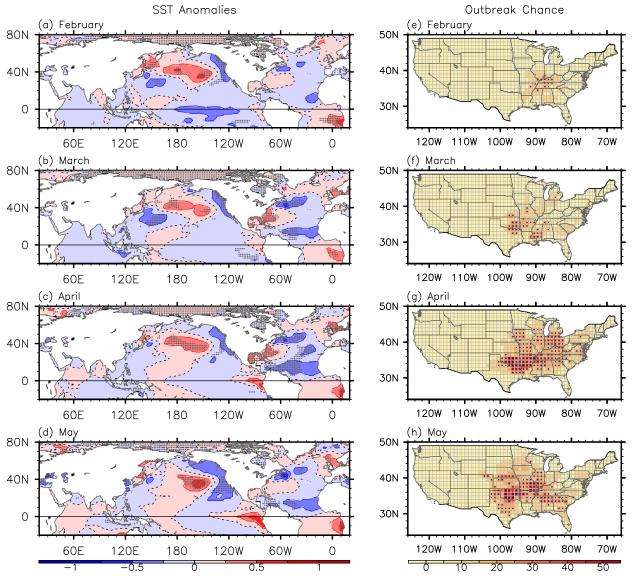
Climatology: Probability of Tornado Outbreak

Supplementary Figure 6. Climatological probability of U.S. regional tornado outbreaks in (a) February, (b) March, (c) April and (d) May. The units are in %.
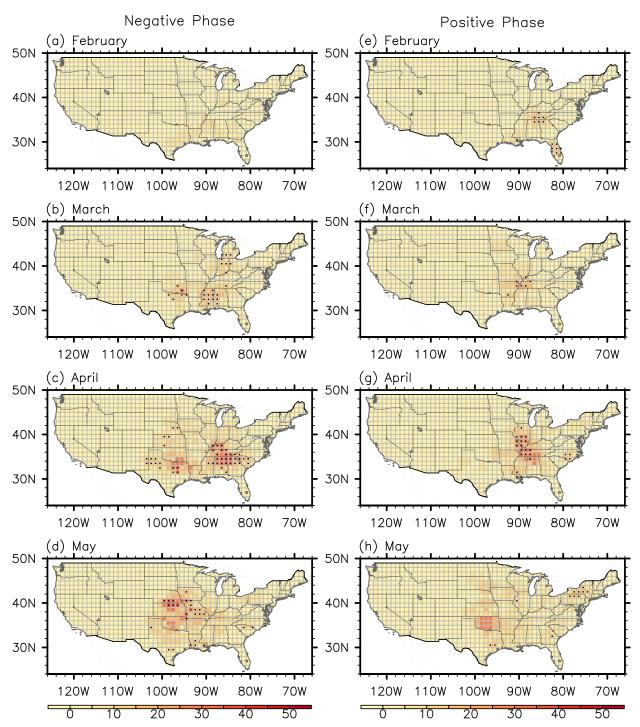
U.S. Climate Regions defined by NCDC

Supplementary Figure 7. U.S. climate regions defined by National Climate Data Center. The four regions, namely the South, Ohio Valley, Southeast and Upper Midwest, are frequently referred in the main text to describe the probability of U.S. regional tornado outbreaks.
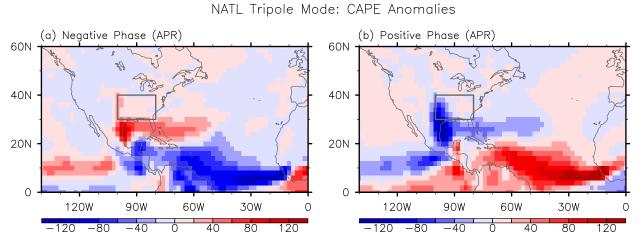
Active US Tornado Years: SSTA and Probability of Tornado Outbreak

Supplementary Figure 8. Same as supplementary figure 2 except for the 10 most active U.S. tornado years.

Supplementary Figure 9. Probability of U.S. regional tornado outbreaks for (a-d) the negative and (e-h) positive North Atlantic SST tripole in (top row) February, (upper middle row) March, (lower middle row) April and (bottom row) May. The black dots indicate that the probability of tornado outbreaks is statistically significant at the 10% level based on a binomial test. The units are in %.

NATL Tripole Mode: CAPE Anomalies

(a) Negative Phase (APR) (b) Positive Phase (APR)

Supplementary Figure 10. Anomalous CAPE in April for (a) the negative and (b) positive North Atlantic SST tripole. The units are in J kg^{-1}. The small boxes indicate the central and eastern U.S. region frequently affected by intense tornadoes (30°-40°N, 100°-80°W).