Climatology and Synoptic Patterns of Persistent Positive Temperature Anomalies for the Contiguous United States

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A statistical climatology of Persistent Positive Temperature Anomalies (PPTAs or heatwaves) was developed using a new method of defining PPTAs. This measure is based on the statistical deviation of daily maximum temperatures from their true means for calendar dates. Persistence is defined as runs of C days with C deviation. This study demonstrates that the method is flexible and is useful for the calculation of PPTA normals. A high station density and long (1950-1995) period of record permits the creation of high quality maps of the U.S. frequency, intensity, duration, and area of impact of PPTAs. The method has the added advantage of permitting direct, uniform comparisons of PPTAs across all seasons and regions.

The primary differences in long-lived PPTAs, i.e., those with long runs of consecutive, high deviation days, involve the season of occurrence: PPTAs in the central and eastern U.S. generally occur in the warm season, while western PPTAs occur in the cool season. Extreme summer PPTAs are centered in the Arkansas/Oklahoma region, while winter PPTAs are centered on the Nevada/Arizona region. The longest PPTA in the period of record (POR) occurred at Brownsville, TX (41 days) from 12 June 1980 to 22 July 1980; and one of the most intense PPTAs (>2.0 standard deviation) occurred at Pocahontas, AR for the period, July 6-17, 1980. Most (94%) of the record high temperatures which occurred in summer occurred within PPTAs, as did 91% of record "Z" (high deviation) events, but, they are found in every season.

An idealized synoptic pattern favorable for long-lived PPTAs was warm air-masses that were driven by southerly flows or formed by a stagnant, blocking upper-level ridge. A distinguishing feature of the 1954 summer PPTA is excessive daytime heat initiated by pre-existing widespread soil moisture deficits. An unusual warm-low typed thermal structure was sustained for this PPTA. The 1988 PPTA was more closely tied to upper-level forcing mechanisms than surface conditions. The peak of the 1988 summer PPTA occurred after the anticyclogenesis weakened. Synergistic warming effects of advected warm air and adiabatic heating result in significant winter PPTAs in the western U.S. Surface forcing mechanisms do not appear to be significant. Sudden increases of daily maximum temperature are primarily characterized by temporary, brief incursions of a largely northward-displaced polar jet streak. Accompanying intense quasi-geostrophic adiabatic subsidence heating and horizontal warm air advection play significant roles in inducing very intense PPTAs at the surface.