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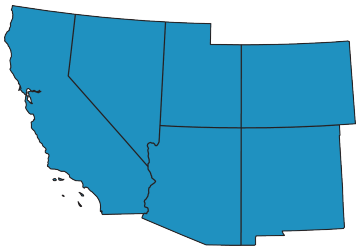


Regional Climate Trends and Scenarios: The Southwest U.S.

This document provides a brief overview of the observed changes in the climate of the Southwest[1] United States as well as possible future climate conditions as simulated by climate models, based on two scenarios of future greenhouse gas emissions. It summarizes the detailed findings presented in one of nine regional and national climate descriptions created by the National Oceanic and Atmospheric Administration (NOAA) in support of the National Climate Assessment (NCA). It is also hoped that these findings are of direct benefit to decision makers and communities seeking to develop adaptation plans. The full Regional Climate Trends and Scenarios report is available at http://scenarios.globalchange.gov/regions/southwest, and should be cited as:

Kunkel, K.E, L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K.T. Redmond, and J.G. Dobson, 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 5. Climate of the Southwest U.S., NOAA Technical Report NESDIS 142-5, 79 pp.

Observed Regional Climate Trends

This section summarizes the observed climate trends of the Southwest U.S., focusing mainly on temperature and precipitation, as well as other climate features, including heat waves and extreme precipitation. These historical data are primarily from the National Weather Service's Cooperative Observer Network (COOP), which has been in operation since 1895.

Temperature

- Average annual temperature in the Southwest has generally increased over the past 115 years. Daytime temperatures resemble the mean temperature time series, while nighttime temperatures show a somewhat steadier increase.
- Temperature trends for the region are upward and statistically significant (at the 95% confidence level) for each season, as well as for the year as a whole.
- The length of the freeze-free season in the Southwest has increased substantially and now averages about two weeks longer than during the 1960s and 1970s, and a whole month longer than in the early part of the 20th century.

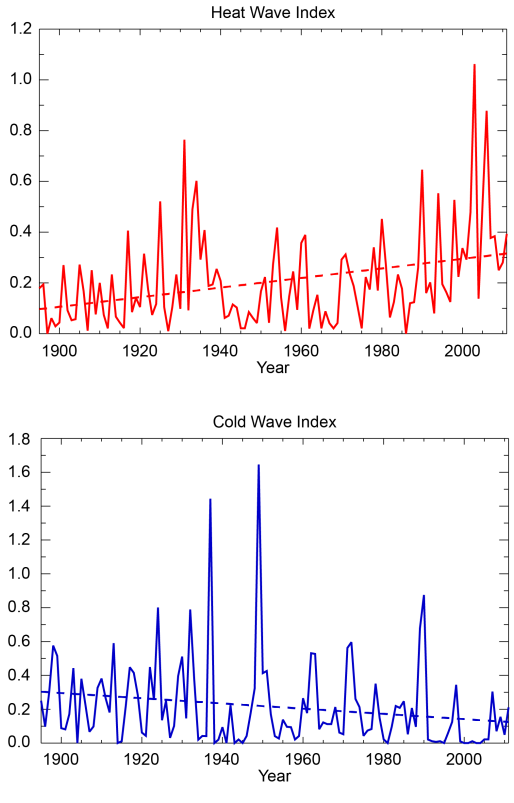
Precipitation

- Precipitation does not exhibit any obvious long-term trends for the Southwest U.S., except for fall, which shows a slight upward trend. Trends are not statistically significant for any season.
- The region experienced its wettest conditions in the 1980s and 1990s (coinciding with a shift in Pacific climate in 1976, after which El Niño became much more frequent), but has dried in the last decade.

Extremes

- The frequency of heat waves has generally been increasing in recent decades, with a statistically significant upward trend. There is an overall downward trend in the occurrence of cold waves that is also statistically significant (see figure).
- There is not a statistically significant trend in the occurrence of extreme precipitation events in the Southwest.

Mean Annual Heat Wave (top) and Cold Wave (bottom) Index for the Southwest U.S.
(Occurance of 4-day, 1 in 5-year events)



[1] California, Nevada, Utah, Arizona, Colorado, and New Mexico.

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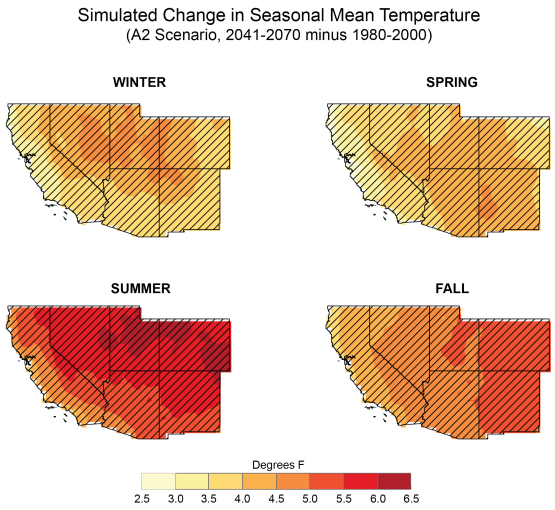
Future Regional Climate Scenarios

This section describes simulated future climate conditions based on climate models using two emissions scenarios generated by the Intergovernmental Panel on Climate Change: the high (A2) scenario, in which emissions of heat-trapping gases continue to rise, and the low (B1) scenario, where emissions peak in the mid-21st century and decline substantially thereafter. These scenarios were chosen because they incorporate much of the range of potential future human impacts on the climate system, and are used in a large body of literature. These simulations use data from the WCRP's Coupled Model Intercomparison Project 3 (CMIP3), as well as from statistically- and dynamically-downscaled data sets, including North American Regional Climate Change Assessment Program (NARCCAP) data (for A2, mid-century only).

Temperature

- CMIP3 models simulate increases in annual mean temperature across the Southwest, with these increases being statistically significant everywhere (for all future time periods and both emissions scenarios). Spatial variations are relatively small, with changes along coastal areas simulated to be smaller than those in inland areas. Warming is simulated to be slightly larger in the northern portion of the region.
- Seasonal temperature changes show greater spatial variability. The greatest warming is seen in summer with a localized maximum in central Utah (see figure).
- There is uncertainty within the range of model-simulated temperature changes, but for each model simulation, the warming is unequivocal and large compared to historical temperature variations.



- Increases in the number of hot days (maximum temperature of more than 95°F) are simulated by the NARCCAP models throughout the region, with the largest increases in southern and eastern areas. Statistically significant decreases in the number of days below freezing are simulated throughout the Southwest.

Precipitation

- The far southern portions of the Southwest U.S. are simulated to experience the largest decreases in annual mean precipitation, while slight increases are indicated for far northern areas (see figure). Statistically significant changes are simulated by most CMIP3 models late in the 21st century and under the high emissions scenario. However, while the models agree on drying in the south, they are in disagreement about the sign of the changes in the northern part of the region.
- The range of model-simulated precipitation changes is considerably larger than the multi-model mean change for both the high and low emissions scenarios, meaning that there is great uncertainty associated with precipitation changes in these scenarios.
- Parts of the Southwest that are already prone to little precipitation are simulated by the NARCCAP models to see an increase in the number of dry days (precipitation of less than 0.1 inches). These decreases are statistically significant over most of the region.