Why hasn't spring warmed?

John Abatzoglou (jabatzoglou@uidaho.edu) UI, David Rupp OSU, and Philip Mote OSU

Agriculture is a seasonal endeavor. Weather accrued during each season can profoundly impact farmers and the crops they produce. Variations in weather patterns and seasonal temperatures can affect cropping decisions, timing of field operations (e.g., planting or spraying), and pest cycles. As a result, weather is a daily conversation topic for farmers, who are constantly trying to guess what it's going to do so they know what they should do next.

IMPACT

Seasonal climatic cycles can greatly impact the management decisions that farmers have to make. Better understanding of current weather patterns and seasonal variability could help prepare farmers to adapt to climate changes in the region.

Weather is expected to become even more unpredictable as the global climate changes, and some understanding of current weather patterns and seasonal variability could help prepare farmers to adapt to changes in the region. REACCH scientists at the University of Idaho and Oregon State University are providing some new insights on how and why seasonal climate has changed over the past century in the Pacific Northwest. Examining regional temperature changes based on seasons, instead of just annual changes, makes for a complex, but interesting, story.

The regional annual average temperature has increased by nearly 1.3°F over the past century. This overall warming trend has been apparent in all seasons over the past century, with the general rate of warming increasing more in recent decades (Figure 1). Although it contains substantially more year-to-year variability, the upward trajectory of temperature change for the Pacific Northwest mirrors that of the global mean temperature. However, spring temperatures have cooled slightly over the past 3 decades, most notably since the early 1990s. Why is this?

Many factors influence the global climate, including volcanic eruptions, solar output (the total radiation coming from the sun), natural climate variability (such as El Niño and the lesser known Pacific North American pattern), and human-caused change (the factor most prominently associated with global climate change). Analyzing these factors suggests that the observed spring cooling is largely the result of natural climate cycles that temper the pace of regional anthropogenic warming.

The influence of natural climate variability is most pronounced during the winter and spring in the Pacific Northwest. Temperature trends during these seasons over the past several decades were strongly influenced by these factors. For example, approximately 40% of winter warming since 1950 seems to be linked to atmospheric circulation that favored the movement of warmer air masses into the region. Conversely, circulation patterns have contributed to a significant cooling of spring temperatures since 1980, thereby masking warming contributed by anthropogenic factors. In the absence of these cycles, spring warming of approximately 0.8°F over a 30-year span likely would have occurred.

Despite the recent cooling observed in spring temperatures, longer term trends show that spring temperatures have increased, with the decades of the 1980s, 1990s, and 2000s being the second, first, and fourth warmest decades since 1900 across the region. Prior to the 1980s, the 1930s was the warmest decade on record.

Spring temperature cycles are clearly observable in Figure 2, showing mean spring temperatures in Pomeroy, Washington. The mean springtime temperature for the entire time period (1930–2013) was 46.5°F, and departures from that mean can be observed for each year (red bars when mean temperature exceeded 46.5°F, blue bars when mean temperature was below 46.5°F). The black line shows the 11-year running mean and makes the cycles evident by illustrating that periods with cooler-than-average spring temperatures are followed by periods with warmer-than-average temperatures.

Research also documented the lengthening of the freeze-free season across the Pacific Northwest by nearly 2 weeks. Also, the coldest night of the year has warmed by an average of 5°F since the mid 20th century. Although the last spring freeze has not shown any change over the past 3 decades, coincident with the

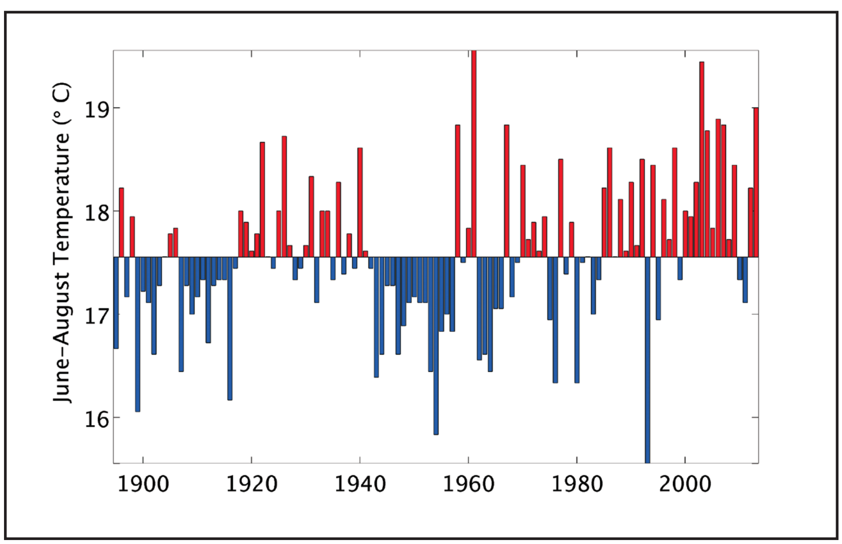

Figure 2. *Spring (March–May) mean temperature (1930–2013) for the Pomeroy, Washington United States Historical Climate Network station acquired using the WestWide Drought Tracker. Red and blue bars show anomalies from the 1981–2010 base period, and the black line shows the 11-year moving average.*

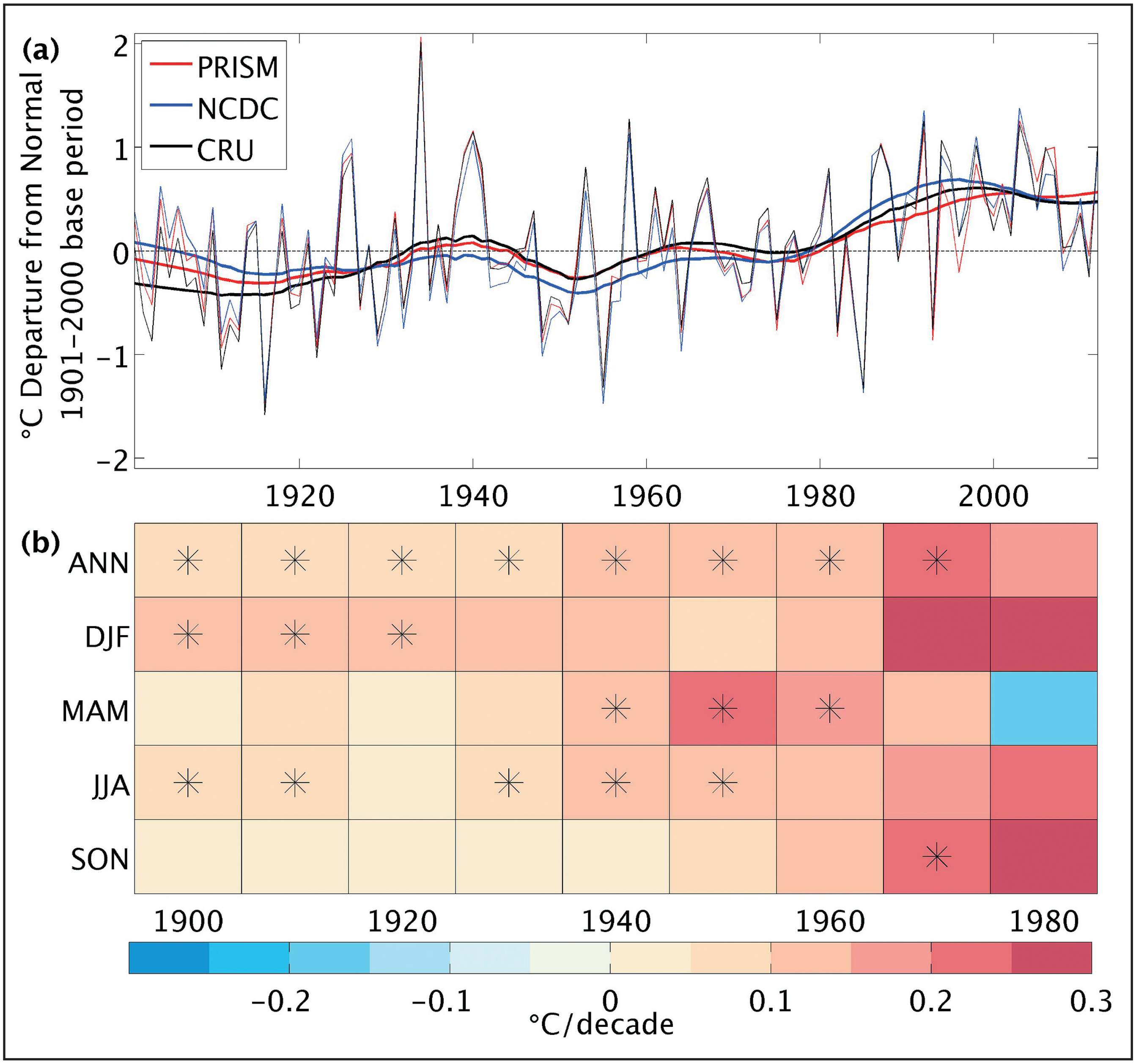

Figure 1. *(a) Annual regional mean temperature anomaly derived from three different data sources: PRISM (red), NCDC divisional data (blue), and CRU (black), 1901–2012. Anomalies are taken with respect to the 1901–2000 period. Thin lines show annual data, and bold lines show a local weighted regression. (b) Linear least squares trend in regional mean temperature (°C) per decade. Mean temperature is averaged over the calendar year and for each season for the time interval beginning with the year on the bottom axis through 2012. An average of the anomalies computed for the three different data sets is used in (a). Statistically significant ($p < 0.05$) trends are denoted by *.*

lack of springtime warming, the first autumn freeze has been delayed by around 1 week across the Pacific Northwest since 1980.

Longer freeze-free seasons and a lack of extremely cold winter temperatures may be advantageous to agricultural productivity and pests alike. Decreased winter mortality rates with warmer winter temperatures may increase insect populations. Likewise, a longer freeze-free season may allow for additional generations, which might require additional control measures to capitalize on any potential agricultural benefits of warming.

Better understanding of these climate cycles, and the combined impact of multiple drivers on seasonal climate, is of critical importance to agricultural producers, particularly in light of a changing climate. The natural factors that have resulted in cooler springs are not likely to continue indefinitely. Instead, it is likely that when these processes reverse, and large-scale natural factors and human-caused greenhouse forcing are acting in the same direction, we will see significant seasonal warming.