with the average (1.23 watts per meter per Kelvin) at the 10 'hard-ground' stations, reflecting the density difference between penetrated soft and hardened sediments.

Acknowledgments

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SECTION NEWS

Southwestern U.S. Drought Maps From Pinyon Tree-Ring Carbon Isotopes

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BIOGEOSCIENCES

Tree-ring widths have long been a useful North American drought proxy [e.g., *Cook et al.*, 1999, 2004]. A potentially rich, new tree-ring proxy associated with the tree's leaf-level moisture status is stable-carbon isotope composition ($\delta^{13}C = [^{13}C/^{12}C_{sample} \div {}^{13}C/^{12}C_{standard} - 1] \times 1000$), which is determined by both the rate of carbon assimilation and the rate of gas conductance through leaf stomata [*Farquhar et al.*, 1982]. In the U.S. Southwest, where evaporation exceeds precipitation, drought may be the dominant influence on plant $\delta^{13}C$ [*Warren et al.*, 2001], so measurements of tree-ring $\delta^{13}C$ in a network of southwestern sites has allowed for spatially mapping this ecophysiological indicator back to A.D. 1600.

Stomatal portals are the primary avenues of water loss and carbon gain in plants, providing carbon dioxide (CO_2) for photosynthesis, which tends to discriminate against fixation of $^{13}CO_2$ in favor of $^{12}CO_2$. In principle, under conditions of water stress the stomata close down and the reservoir of CO_2 available for continued photosynthesis is reduced, proportionally more $^{13}CO_2$ is fixed, and the $^{13}C/^{12}C$ ratio of sugars eventually incorporated into tree rings increases (i.e., $\delta^{13}C$ increases), and vice versa during moist conditions.

In a tree-ring $\delta^{13}C$ study about two decades ago [*Leavitt and Long,* 1989], pinyon pine trees (*Pinus edulis* and *Pinus monophylla*) at 14 sites in six southwestern U.S. states were sampled, and 5-year ring sequences were analyzed. The isotopic chronologies show a post-1800 $\delta^{13}C$ decline, attributed to fossil fuel and land-use change inputs of ^{13}C-depleted CO_2 to the atmosphere, and high-frequency fluctuations about the long-term trend. The chronologies were fit with spline curves to remove the long-term trends, and ratios of the measured $\delta^{13}C$ value to the respective spline $\delta^{13}C$ value at each pentad were calculated (isotopic index = $\delta^{13}C_{measured}/\delta^{13}C_{spline}$).

A 'del index' (= (isotopic index − 1) × 1000) was then computed such that positive values represent measured $\delta^{13}C$ values below the spline (lower than expected $^{13}C/^{12}C$ ratios) and negative values represent higher than expected $^{13}C/^{12}C$ ratios (moisture deficiency). Comparisons of del index with instrumental drought and precipitation records [*Leavitt and Long,* 1989] showed good correspondence, and contour drought maps of del index at the 14 sites for 1900–1904 and 1950–1954 matched well instrumental drought maps and ring-width reconstructions.

The del indices have since been arbitrarily rescaled to 'drought indices' (= del index ÷ 10), which puts virtually all original values into the range of −6 to +6, like the common range of the Palmer drought indices (http://www.drought.unl.edu/whatis/indices.htm#pdsi). Additionally, all sites were recently resampled to extend the isotope chronologies through the twentieth century. The $\delta^{13}C$ analysis from 1985 to 1999 was on

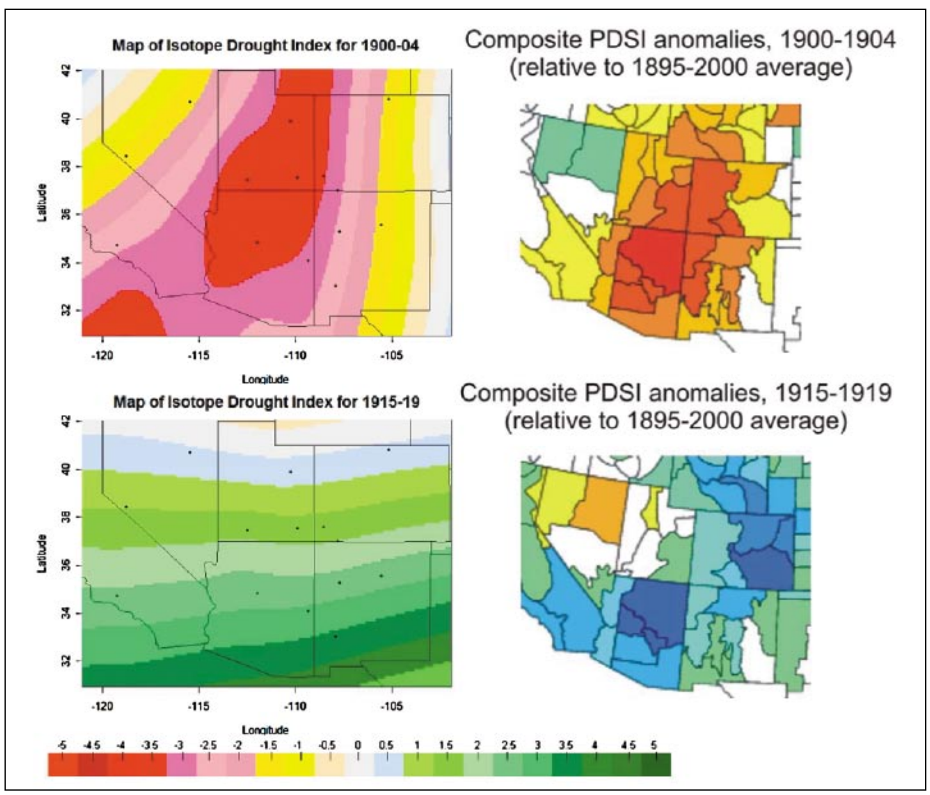

Fig. 1. Examples of pinyon pine tree-ring isotope drought index maps (color contour scale at bottom), for a widespread dry pentad (1900–1904, where $^{13}C/^{12}C$ ratios tended to be above the long-term trend throughout the region, i.e., negative indices) and for a moist pentad (1915–1919, $^{13}C/^{12}C$ ratios tended to be below average). For comparison, the Palmer Drought Severity Index anomalies for those pentads are shown, with progressively drier areas in darker red and wetter areas in darker blue (source: http://www.cdc.noaa.gov/USclimate/USclimdivs.html).

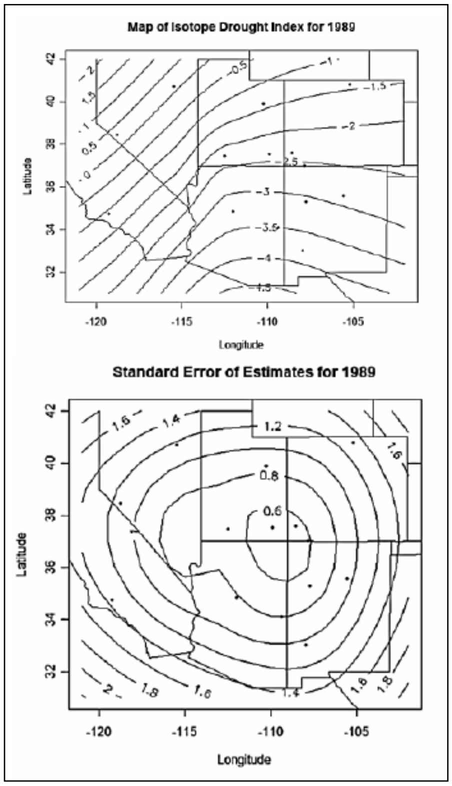

Fig. 2. From annual isotope drought maps: (top) example of widespread dry year in the U.S. Southwest (1989) and (bottom) a map of the standard error of the estimate associated with each grid point.

individual rings, so drought indices for three pentads (1985–1989, 1990–1994, and 1995–1999) have been added to the original record, as have annual drought indices from 1985 to 1999 calculated using a straight-line fit to those δ^{13}C data of each site.

Now, a complete set of contour maps of isotope drought indices has been generated by gridded interpolation methods. For example, the maps for the 1900–1904 and 1915–1919 pentads (Figure 1) appear to follow southwestern moisture variation. The map for 1989 (Figure 2) illustrates a single-year, linear contour map of a particularly dry year, as well as its corresponding error map, both of which are available for all pentads and years. These maps offer a new perspective for looking at past southwestern environment, through the lens of processes affecting stable-carbon isotopes in tree rings (likely dominated by moisture). As such, these drought indices may provide important new insight into the ecophysiological activity of trees over the past several centuries, and may be useful to better understanding both the water cycle and carbon cycle in the Southwest.

These pentad δ^{13}C and isotope drought index data sets, maps that date back to 1600–1604 as both linear contours and color-shaded fields, and all of the interpolated gridded (1° × 1°) data tables are now available at http://www.ncdc.noaa.gov/paleo/treering/isotope/iso-drought.html, along with a more complete description of the data source and interpolation methods.

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In Memoriam

Andrew W. Berg, 80, 12 February 2006; Seismology, 1994.
Robert H. Clark, 85, 1 January 2007; Hydrology, 1951.
Dick Duffey, 89, 10 November 2006; retired member, Volcanology, Geochemistry, and Petrology, 1970.
Llody C. Fowler, 81, 2 September 2006; Hydrology, 1952.
Nathan L. Green, 58, 1 October 2006; Volcanology, Geochemistry, and Petrology, 1982.
Helen Neugebauer, 73, 7 April 2006; Technophysics, 1983.
Howard W. Oliver, 79, 28 August 2006; life member, Geodesy, 1951.
James Luhr, 53, 1 January 2007; Volcanology, Geochemistry, and Petrology, 1984.
J. S. Prasad; Magnetospheric Physics, 1970.
Laurie Wirt, 47, 26 February 2006; Hydrology, 1991.

Honors

Neil Gehrels and the team of scientists working on NASA's Swift Gamma-Ray Burst Explorer mission have been awarded the Bruno Rossi Prize, the top award from the High Energy Astrophysics Division of the American Astronomical Society. Swift, launched in 2004, was designed to rapidly detect, locate, and observe gamma-ray bursts, powerful cosmic explosions that astronomers believe are the birth cries of black holes.