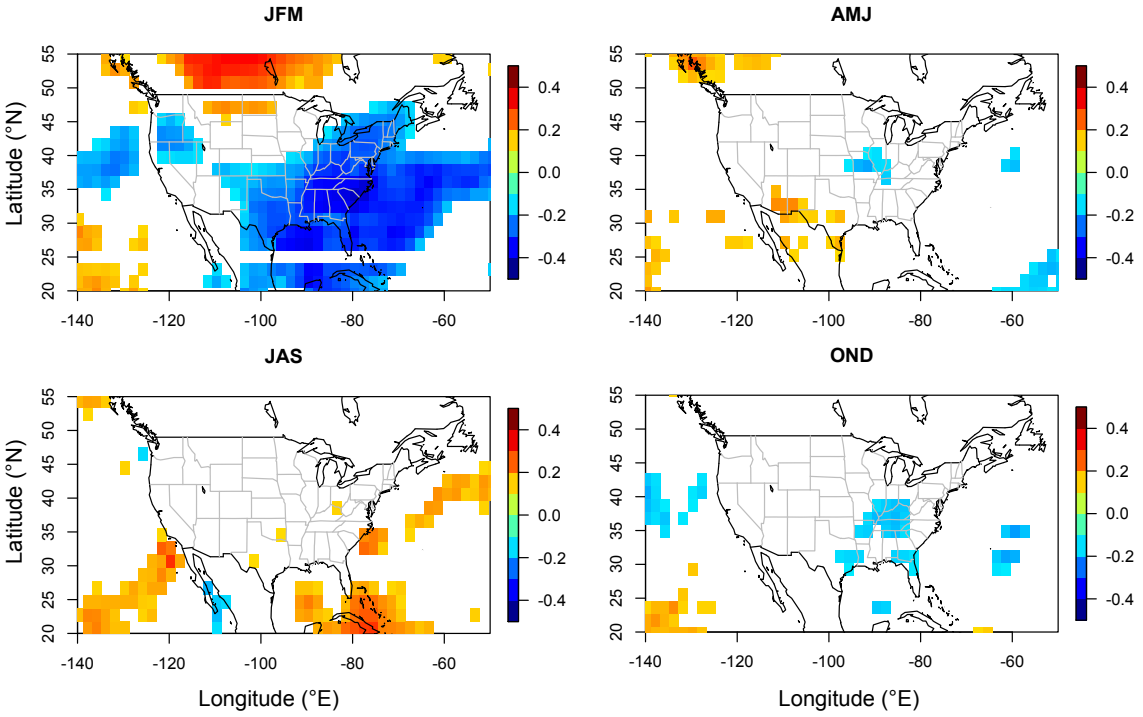
Supplementary Information

Modern ENSO $\delta^{18}O_{precip}$ Signals

While we incorporate over 10,000 separate weekly measurements of isotopes in precipitation in our analysis of modern ENSO signals, the time interval of observations is only 6 years and does not include large El Niño events such as took place in 1997-8. In order to validate these observed signals as features of ENSO teleconnections, we analyze model output of $\delta^{18}O$ from the Stable Water Isotope Intercomparison Group (SWING) publically available on their website (http://atoc.colorado.edu/~dcn/SWING/database.php). We use data from the Echam4 results of the S1b Experiment in which the model is forced with varying SST from the HadlSST data set.

Seasonal correlation coefficients between $\delta^{18}O_{precip}$ and the Niño 3.4 Index from 1950-2003 that are statistically significant at the 95% confidence interval are shown in SFIG 1. In the winter (JFM), negative correlations extend across the Pacific Northwest, Gulf Coast, and East Coast. These correlations match observed signals in the Pacific Northwest and East Coast. The modeled isotopic change, however, is significantly stronger surrounding the Gulf Coast including the Great Plains and is concentrated farther north on the West Coast as compared to observations. In the spring (AMJ), the model shows strong positive correlation in the Southwest, in good agreement with observations. Also similar to observations, the model shows little significant correlation across the US during the summer (JAS). Finally, in the fall (OND), negative correlation is modeled around the Gulf Coast area. This negative correlation extends west into the Great Plains including the Meade, KS locality, though this signal is only significant at the 88% confidence interval (not shown). Modeled results do not show the strong negative signal observed in the Southwest during the fall.

While there are some discrepancies between observed and modeled signals, there is very good agreement on the isotopic changes relevant to our discussion based on seasonality of carbonate formation at each locality (see discussion in main text). Therefore, we regard the isotopic anomalies observed in modern precipitation used in our analysis to be a robust feature of modern ENSO teleconnections.



Supplementary Figure 1. Seasonal correlation coefficients of modeled $\delta^{18}O_{precip}$ and the Niño 3.4 Index from 1950-2003. Isotope data taken from Stable Water Isotope Intercomparison Group (SWING) [reference in text]. Plots show only correlations statistically significant at the 95% confidence interval.