Multi-Decadal to Century-Scale Climate Variability in the Gulf of Mexico Region: Links Between Continental and Marine Records

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Better documentation of change in the climate of the southwestern United States (U.S.) during the current interglacial interval is needed to understand the natural variability of the current climate system, identify possible climate forcing, and thus help anticipate future changes. Historical records demonstrate that precipitation in the southwestern U.S. is quite variable. Several decades-long droughts have occurred in the recent past, and severity of fires has been linked to variability in amount and seasonal distribution of precipitation (e.g., Grissino-Mayer and Swetnam, 2000). Terrestrial paleoclimate records from the southwestern U.S. indicate significant climate variability has occurred during the current interglacial interval or Holocene (last 10,000 years) (e.g., Benson et al., 2002), but the pre-instrumental record of the wet southwest monsoon is poorly known (Meko and Baisan, 2001). Studies based on tree rings can provide highly resolved records of past conditions, but separating temperature and precipitation signals can be difficult, and determining seasonality of precipitation is challenging. In addition, tree-ring records usually represent short intervals of the Holocene, and they often reflect local conditions. Studies of pollen in lake sediments, lake shoreline deposits, and vegetation in packrat middens are available, but these records are often discontinuous, many are difficult to date, and they are sometimes contradictory (e.g., see summaries in Betancourt et al., 1993; Metcalfe et al., 2000; and Thompson et al., 1993).

Comparison of abundance variations in the planktic foraminifer *Globigerinoides sacculifer* in marine cores from the western and northern Gulf of Mexico (GOM) with terrestrial proxy records of precipitation (tree-ring width and packrat-midden occurrences) from the southwestern United States indicate that variations in *G. sacculifer* abundance are a proxy for the average position of the Intertropical Convergence Zone (ITCZ) and the intensity of the southwest monsoon on millennial and sub-millennial time scales. Northward migration of the ITCZ results in increased presence of warm tropical waters in the northern and western GOM and a stronger southwest monsoon; southward migration of the ITCZ results in decreased presence of warm tropical waters in the northern and southern GOM and a weaker southwest monsoon.

The marine record confirms the presence of a severe multi-century drought centered at ~1600 calendar years BP, as well as several multi-decadal droughts that have been identified in a long tree-ring record from west-central New Mexico spanning the last 2000 calendar years. The marine record further suggests that monsoon circulation, and thus summer rainfall, was enhanced in the mid-Holocene (~ 6500 to 4500 ^{14}C yrs BP; ~6980 to 4710 calendar years BP).

Spectral analyses of G. sacculifer abundance variations in Gulf of Mexico cores and tree-ring precipitation records from New Mexico reveal periodicities that are similar to the periodicities observed in proxy records of solar luminosity. The GOM and New Mexico proxy records suggest that the average position of the ITCZ and changes in intensity of the southwest monsoon are linked to solar variability.

References

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