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An Organic Molecular Approach towards the Reconstruction of Past Hurricane Activity

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The relationship between global warming and hurricane activity is the focus of considerable interest and intensive research. The available instrumental record, however, is still too short to document and understand the long term climatic controls on hurricane generation. Only by extending the records of past hurricane activity using paleo–data, can we capture the full range of natural variability in hurricane generation and investigate the climatic context in which such variability occurs.
Hurricane activity is partly related to sea surface temperatures (SST's) due to the temperature dependence of evaporation rates at the sea surface. When SST's lie below a critical threshold, insufficient moisture is generated to 'feed' a potential hurricane and it remains as a lower energy tropical storm. The reconstruction of SST's, precipitation and runoff over the past 300 years from the same core, will allow for a comparison between marine SST records and reconstructed hurricane activity. The core was recovered from Rookery Bay, a shallow, non-stratified, subtropical estuary on the western shelf of Florida and has already been studied using micropaleontological proxies for relative changes in runoff, habitat change and human impact [1]. The frequent hurricane impacts over the past 150 years are well documented, which makes Florida a suitable location for this research.
Due to their large convective cells, hurricanes fractionate water molecules several times more strongly than tropical storms, resulting in the depletion of deuterium (2H) in hurricane precipitation. This deuterium-depleted precipitation is then incorporated in the leaf waxes of plants. Compound specific hydrogen analyses on derivatives of leaf waxes, like long chain n-alkanes with a strong odd-over-even predominance, can therefore be used to reconstruct past changes in the isotopic composition of precipitation. Consequently, stable hydrogen isotope analyses can be used as a direct proxy for past hurricane precipitation intensity. Preliminary results indicate D values ranging between -130 and -150‰ vs. VSMOW indicating small changes in precipitation.
Hurricanes are associated with excessive rainfall and storm surges, both resulting in massive displacements of soil organic matter to the coastal environment. Another way to recognize past hurricane landfalls is thus by reconstructing periods with increased runoff. Since both terrestrial and marine GDGT's are present in high concentrations, the variable concentration of the terrestrial GDGT's (measured by the Branched and Isoprenoid Tetraether index (BIT)) [2] will be used as a proxy for runoff to reconstruct the frequency of storm surges in the bay. Preliminary results show a BIT-index with overall high values of (õ.7-0.8), indicating that soil derived organic matter is a major component of the sediment. This will be supported by comparison with the micropaleontological results, and by investigating the concentration of long chain n-alkanes, whose transport to the coring site is also sensitive to the magnitude of runoff. Concentrations of these n-alkanes are generally around 0.1-0.2µg/g sediment.
High alkenone concentrations in Rookery Bay allow for the parallel reconstruction of past sea surface temperatures using the UK'37 paleo-thermometer [3], indicating temperatures of õ7-28°C, with little fluctuations for the past 300 kyr. However, at high sea surface temperatures (>28°C), UK'37 is at its upper limit for reliable SST reconstructions. At these temperatures the TEX86 paleo-thermometer [4] is better suited. However, the high concentration of terrestrial GDGT's in this core renders the TEX86 paleo-thermometer unusable.

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