Developing a Microfossil-Based Approach to Estimate Paleo-Hurricane Activity

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The manner in which tropical cyclone activity and climate interact has critical implications for society and is not well understood. Meterological records of the number, track and intensity of hurricanes in the Atlantic extend back to the mid-19th century, although debate exists over whether trends in storm observations genuinely reflect changes in Atlantic hurricanes or if advances in storm detection and observation prevent the attribution of these trends to changes in storm climate. Moreover, the brief observational record is inadequate for characterizing natural variability in hurricane activity occurring on longer than multi-decadal timescales.

In an effort to extend the hurricane record further into the past, a number of paleo-hurricane proxies are being developed by scientists. One such proxy uses sediment cores to identify tropical cyclones. The cores are collected in areas away from the coastline. The overwash from storms that surge into these areas creates distinctive layers in the core samples which can be analyzed and dated.

While sediment-based proxies have yielded much longer records reaching back several millennia, low sediment accumulation rates and high flooding thresholds at most sites studied have resulted in low resolution records of high magnitude events. For these reasons, paleo-hurricane frequency in existing sediment records has usually averaged less than one storm per century.

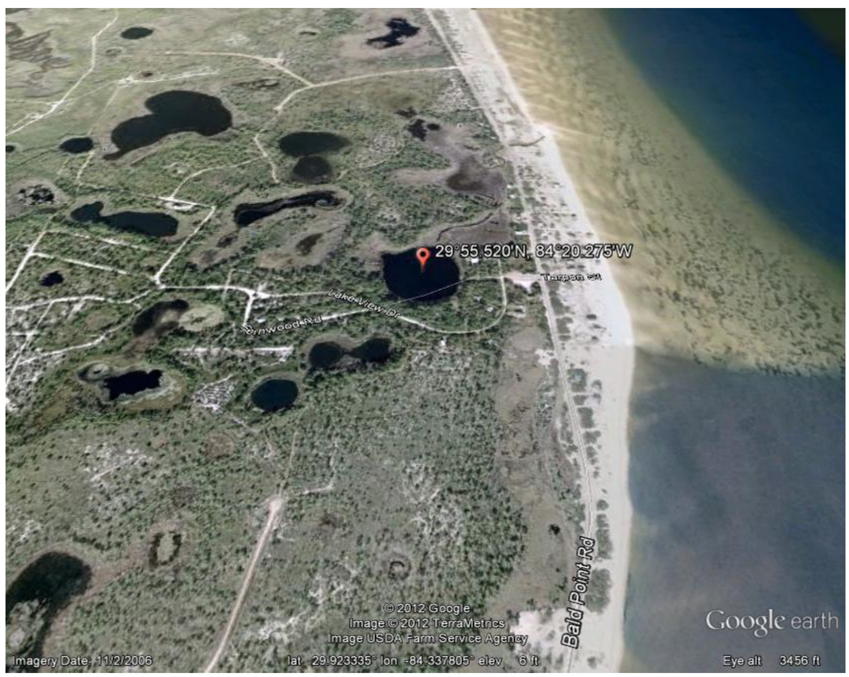

Figure 1: Mullet Pond, a nearly circular 200-meter-diameter sinkhole located on Bald Point, near Apalachee Bay, Florida.

With support from The Gratia Houghton Rinehart Coastal Research Endowed Fund, we developed a 4,500-year record of hurricane storm surges impacting Bald Point, Florida. This area, a roughly 40-km^2 peninsula near Apalachee Bay, is perforated by dozens of sinkholes. Our record was developed from the sedimentary archive preserved in one of these sinkholes called Mullet Pond (Figure 1). Our sediment core samples, on which we conducted radiocarbon dating, provided temporal resolution for as many as 177 hurricane deposits in the last 4,500 years with at least 8 storms occurring in the historic period since 1851. The resolution of the data from this sediment record was sub-decadal (less than 10 years) and is the first produced from this type of depositional environment. The average event frequency of 3.9 storms per century, greater than that of any published paleo-hurricane record, allowed us to objectively identify intervals with significantly elevated storm frequency as well as to determine abnormally inactive periods in the Northeastern Gulf of Mexico.

In our study, we also found offshore foraminifera preserved in some storm induced layers. Foraminifera are amoebas that build shells, or tests, around themselves. These shells contain evidence of seawater conditions when the foraminifera were living and building their shells. When a foraminifer dies, it sinks to the seafloor. During intense storms, these organisms are carried by the storm surge and re-deposited landward, where they become part of the sinkhole sediments. The depth from which the foraminifera are excavated and distance traveled provide valuable insight on past storm conditions and variability over time.

We analyzed hundreds of samples. Offshore foraminifera found in a handful of deposits suggest that, in some instances, storms have been much more intense that those that have been documented in the historic and instrumental record. In conjunction with this project, a regional study with similar goals has been undertaken in New England with the hopes of utilizing the offshore benthic foraminifera in the same manner. The New England project is almost complete and data looks positive for using foraminifera to identify intense storms. The development of regional records using this method will allow us to evaluate the link between changing climate conditions and the frequency and intensity of storms. This, in turn, will enable forecasters to prepare and plan for present and future storm scenarios.

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