# Microfossils Show Promise In Prospecting Climate History

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In 2004 and now in 2005, the hurricane seasons have been horrifyingly intense – so how bad is the long-range forecast?
Based on a century of data, meteorologists currently believe that a 30-year lull in hurricane activity is over and we are at the beginning of a new multi-decade period of larger and more frequent storms.

However, there is other data that suggests we may also be coming to the end of a thousand year period of greatly diminished hurricane activity, making the outlook even worse.

Or not -- Finding the answer may depend on the research of University of North Carolina at Charlotte environmental micropaleontologist Scott Hippensteel -- and on microscopic shells, barrier marshes and fiddler crabs.

The answer may be critical not just in weather forecasting, but in adjusting insurance rates, in preparing for future disasters and in guiding future environmental policy. Since climate science cannot yet accurately predict the future, the best way we can find these answers is to look at history (or "prehistory"). But how much history is there for us to look at?

"Is the frequency of big storms going on now natural and should we expect this in the future?" Hippensteel said. "How much of this is anthropogenic? In trying to answer questions like these, what data do we have to compare our recent records to?

"We have 400 years of historical records, and about a century of real weather records. If you look at the coastal area that I'm doing research on, we've had one major hurricane – a category 4 or 5 – in the last 100 years. How do you adjust insurance rates based on one storm in 100 years? What we need is a much more extensive record -- maybe about 5,000 years worth of data."

There is, Hippensteel points out, a geological feature that records the past occurrence of major storms along the coasts – the sediments left behind by massive tidal surges that wash, tsunami-like over the land. The trick, of course, is to find places where surge-caused layers of coastal sedimentation are consistently preserved and then to identify distinguishing details in the hurricane-caused layers.

One place where such preservation may have occurred are the back-barrier marshes off South Carolina's barrier islands – low islands that protect these lowlands from regular erosion from the sea, yet also allow the ocean and its sand in when major storm events occur. In intervening times, the settling of sediment in the marsh lays down other protective layers.

In order to "read" the layers of marsh sediment and to distinguish between those laid down by normal weather cycles, Hippensteel uses foraminifera deposits -- a paleontological tool that in the past has been heavily used by geologists involved in oil exploration.

Foraminifera are single-celled organisms that produce easily identifiable shells, which are preserved in vast quantities in ocean and shore sediments. These organisms are very diverse and the populations of species are highly specific to the time and place in which they lived, leaving a clear marker in undisturbed sediments of the time period and locale of deposition.

Hippensteel reasoned that he could use the geological marking information offered by foraminifera deposits and apply it to a unique characteristic of powerful hurricanes – their ability to dredge up off-shore ocean deposits.

In a study funded by the National Science Foundation, Hippensteel and University of Delaware geologist Ronald E. Martin analyzed sediment cores taken from a South Carolina back-barrier marsh and indeed found numerous layers that contained foraminifera that originated in off-shore water (results published in Topics in Geobiology, Vol. 15, 2000).

"At Folly Island, South Carolina we found storm deposits that were interbedded with regular marsh muds. We knew that the deposits were left by hurricanes because they contain forams that only live in the off-shore environments," Hippensteel noted.

"There is only one way that you could get layers of sand enriched with these forams, and that is a big hurricane dredges them up and throws them in the back barrier marshes. We used fossils as a tracer to prove the mode of deposition."

The foraminifera that Hippensteel found in the deposits include modern off-shore species and also species that were known to live off-shore in the Oligo-Miocene period (25-30 million years ago) and are known to be present in sediment deposits on the Carolinas continental shelf.

Hippensteel found the highest percentage of off-shore species in the thickest sandy layers of suspected storm sediment, which is consistent with the supposition that the biggest storms would both carry the most sand and also churn more of it from deeper water.

When the big storm layers were thus isolated in the Folly Island sediment cores, the results had disturbing implications.

"The record indicates that big storms have been less frequent in the last 1000 years than in the previous 2000 years before that," Hippensteel said.

Recent layers contained far fewer layers of sand and very few layers containing significant numbers of off-shore foraminifera, compared with numerous such layers in the previous millennia.

Hippensteel cautions, however, that other environmental effects could be coloring this data. One big possible factor could be sediment-disturbing fiddler crabs, that might have only recently entered the area because of rising sea levels.

"Fiddler crabs mix the surface layers of sediment," he said. "If the sea level has been rising through time, we know that it is probable that our marshes have been getting muddier and muddier with more and more crabs. So if you think about it through time, the mixing is becoming more and more intense. The rising water may be making the recent record less certain."

The results shown in the foraminifera storm record are thus tantalizing but still uncertain, Hippensteel notes, and more work need to be done to verify the accuracy of the more recent layers.

"Our records seem to show that we have been in a thousand year period of relative calm, but that result doesn't consider the possible destruction of the storm layers," he said. "Hurricanes may have been far more frequent before a thousand years ago… but we really don't know yet. We need more data."