INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH

Paleotempestology of the Caribbean region: a multi-proxy, multi-site study of the spatial and temporal variability of Caribbean hurricane activity (SGP-CRA 2050)

The pan-Caribbean region, which includes Central America, the Caribbean islands, and the U.S. Gulf coast, is one of the most hurricane-ridden regions of the world. In spite of the enormous damage hurricanes often inflict when making landfall, it is poorly understood how hurricane activity in this region has varied over various timescales and what controls this variability both spatially and temporally. This project analyzes the long-term variability of Caribbean hurricane activity using paleotempestology, the study of past hurricane activities, by generating and analyzing 'proxy data' from coastal lagoon sediments, as well as isotopic records from stalagmites, tree-rings, and corals. Recently the geographical scope of this project has been expanded to include the Pacific coast of Mexico, a region where no paleotempestology study had been done. The addition of this new study region opens the door for a comparative study in hurricane activity between two major tropical cyclone basins—the Atlantic basin and the Eastern North Pacific basin.

The map shows for the first time how many people in the U.S. coastal states live in areas below 3 meters (red areas) or below 6 meters (yellow areas) above sea level.

Goals

- Produce proxy records of past hurricane activity in the Caribbean region and the Pacific coast of Mexico
- Understand the climate mechanisms that affect Caribbean hurricane activity by analyzing and modeling historical hurricane records and modern climate data
- Use past records to assess the risk of future hurricanes

Taking sediment cores

First results

- A new coral-based proxy record of Atlantic sea surface temperatures for the period AD 1552-1991, the longest-ever established, shows that higher hurricane activity before 1550 and after 1750 coincides with warmer sea surfaces. When the Atlantic surface was cooler, there were fewer storms in the Caribbean.
- Caribbean hurricane activity varies following climate patterns such as the Atlantic Multidecadal Oscillation (AMO) and El Niño-Southern Oscillation (ENSO). Proxy data and modeling reveal peaks in Atlantic hurricane activity during Medieval times (AD 900-1100), and again since 1980, can be explained by the prevalence of warmer sea surface temperatures and La Niña-like conditions.
- New proxy records from Nicaragua and Belize reveal an anti-phase relationship in hurricane landfall activity between Central America and the eastern Caribbean and U.S. East coast, suggesting that shifting positions of the ITCZ (inter-tropical convergence zone) and the subtropical anticyclone and the resultant changes in steering patterns may be important factors affecting coastal hurricane risks in the western Atlantic.
- Air mass circulations in the Intra-Americas Sea are dominated by the Low-Level Jet (IALLJ). A re-analysis of the Jet shows that it critically affects sea surface temperatures and moisture advection – important factors for hurricane strength and storm damage.
- Geographical and demographic (2006) data show approximately 19 million people living within vulnerable areas less than 1 km from the coast line in the conterminous U.S. and 12 million people live within three-meter elevation along the coast.

A sediment core taken from a coastal lagoon in Sian Kaan, Mexico, containing a clastic layer probably deposited by a hurricane (Photo credit: J. Donnelly)

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Project web page: http://www.rsgis.envs.lsu.edu/crn/default.asp

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