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Extending the North Atlantic Hurricane Record using Seismic Noise

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An ongoing debate within the climatological community centers on whether rising North Atlantic sea-surface temperatures attributed to anthropogenic global warming are changing the frequency or energy of hurricanes. A short and incomplete observational record makes it difficult to answer this question. Since North Atlantic hurricane records were based entirely on ship logs and land observations before aircraft reconnaissance began in 1944, it is possible that hurricanes may have gone unobserved before then. Even after the initiation of regular aircraft observation, not all areas were monitored. Hence the potential for sampling problems exists up until the advent of satellite-based observation in the mid-1960's, implying that an undercount in the historical record is likely.

To address this issue, we are developing methodology to improve the record of the number of North Atlantic hurricanes through the analysis of their signals recorded on decades of historical seismograms. Ambient seismic noise–signals derived from natural sources not related to earthquakes–is generated by atmospheric energy and so has been used as a proxy for oceanic wave climate and an indication of decadal-scale climate variability. Hence ambient seismic noise should be usable to detect hurricanes that may have gone unobserved. As a first step in developing such a methodology, we are using digital data from the HRV (Harvard, Massachusetts, USA) and SJG (San Juan, Puerto Rico, USA) seismic stations to calibrate seismic noise signals correlated with maximum wind speeds of well-characterized North Atlantic hurricanes, and investigate the development of a hurricane discriminant.

Although a hurricane signature is not apparent in raw HRV power data, filtering of data recorded during hurricane Andrew (August 1992) in the 5-7 second passband retrieves a signal correlatable with Andrew's maximum wind speed. An empirical hurricane discriminant based on power amplitudes in this passband demonstrates that hurricanes over the ocean can be identified seismically using data recorded at distances of up to several thousand kilometers from the storm. Because local storms also generate signals in this passband, we are investigating a discrimination algorithm combining data from the two distant stations.