THE ARCUATE GEOMETRY OF ONSLOW BAY, NORTH CAROLINA, ITS INFLUENCE ON HURRICANE-INDUCED MICROSEISMS, AND POTENTIAL RELATIONS TO COASTAL PROCESSES

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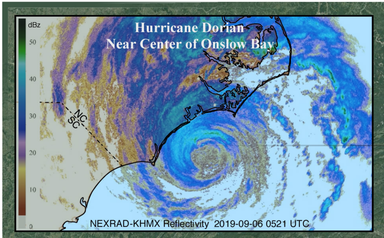
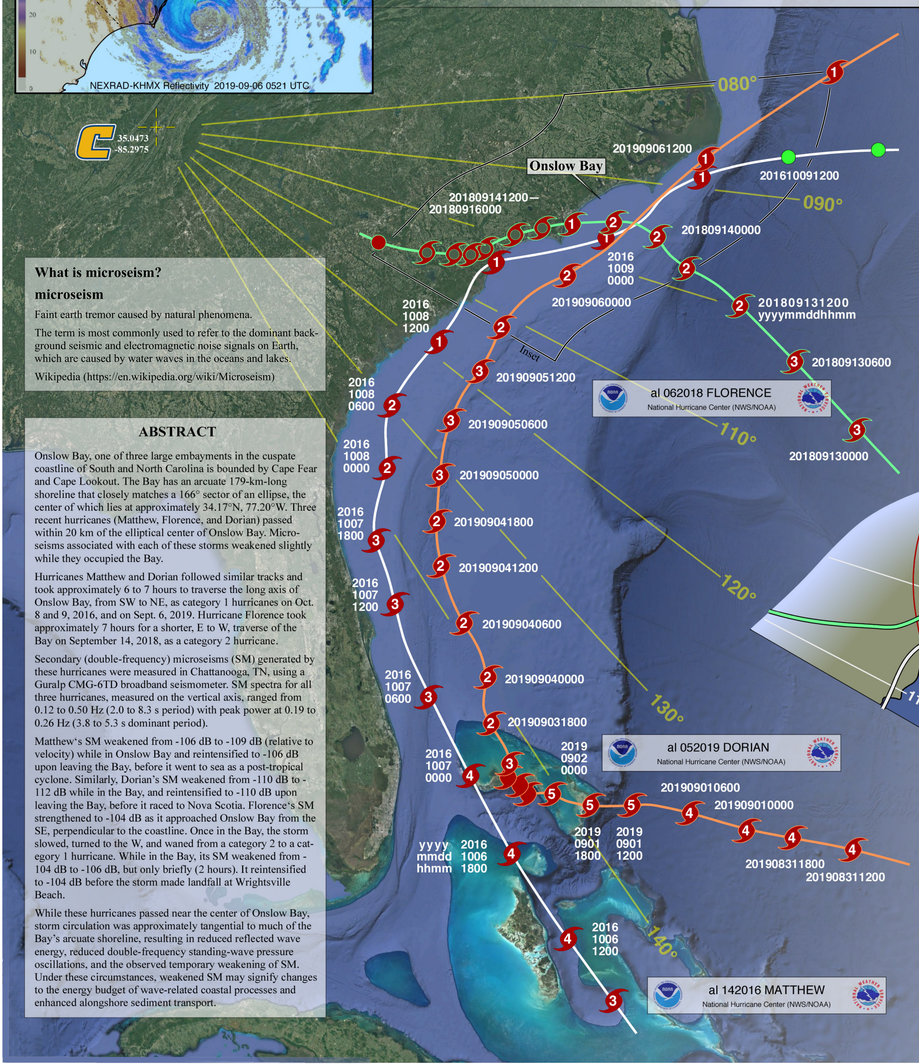




What is microseism?

microseism

Faint earth tremor caused by natural phenomena.

The term is most commonly used to refer to the dominant background seismic and electromagnetic noise signals on Earth, which are caused by water waves in the oceans and lakes.

Wikipedia (https://en.wikipedia.org/wiki/Microseism)

ABSTRACT

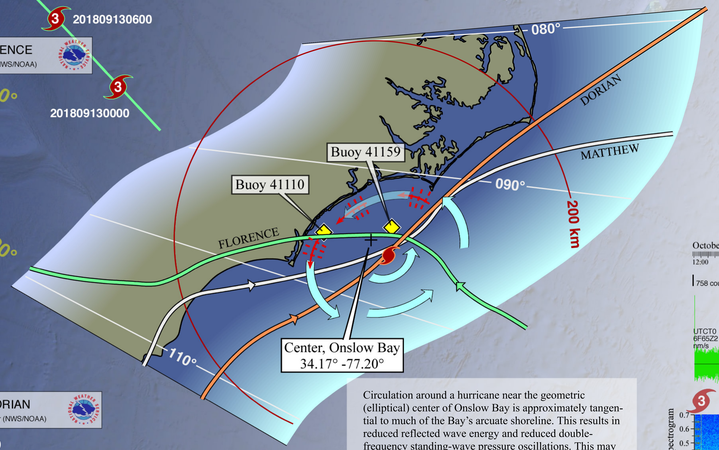
Onslow Bay, one of three large embayments in the cuspate coastline of South and North Carolina is bounded by Cape Fear and Cape Lookout. The Bay has an arcuate 179-km-long shoreline that closely matches a 166° sector of an ellipse, the center of which lies at approximately 34.17°N, 77.20°W. Three recent hurricanes (Matthew, Florence, and Dorian) passed within 20 km of the elliptical center of Onslow Bay. Microseisms associated with each of these storms weakened slightly while they occupied the Bay.

Hurricanes Matthew and Dorian followed similar tracks and took approximately 6 to 7 hours to traverse the long axis of Onslow Bay, from SW to NE, as category 1 hurricanes on Oct. 8 and 9, 2016, and on Sept. 6, 2019. Hurricane Florence took approximately 7 hours for a shorter, E to W, traverse of the Bay on September 14, 2018, as a category 2 hurricane.

Secondary (double-frequency) microseisms (SM) generated by these hurricanes were measured in Chattanooga, TN, using a Guralp CMG-6TD broadband seismometer. SM spectra for all three hurricanes, measured on the vertical axis, ranged from 0.12 to 0.50 Hz (2.0 to 8.3 s period) with peak power at 0.19 to 0.26 Hz (3.8 to 5.3 s dominant period).

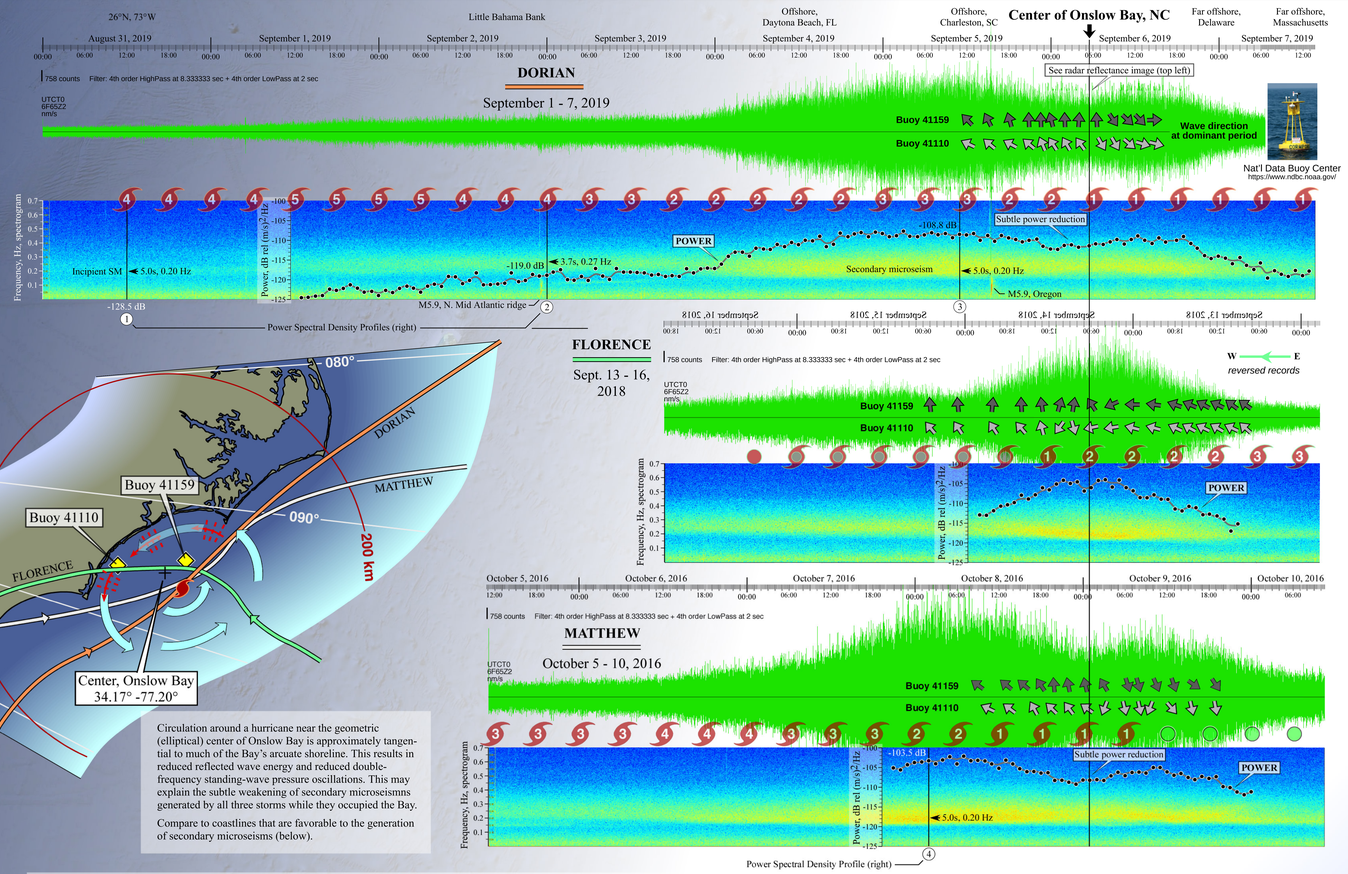
Matthew's SM weakened from -106 dB to -109 dB (relative to velocity) while in Onslow Bay and reintensified to -106 dB upon leaving the Bay, before it went to sea as a post-tropical cyclone. Similarly, Dorian's SM weakened from -110 dB to -112 dB while in the Bay, and reintensified to -110 dB upon leaving the Bay, before it raced to Nova Scotia. Florence's SM strengthened to -104 dB as it approached Onslow Bay from the SE, perpendicular to the coastline. Once in the Bay, the storm slowed, turned to the W, and waned from a category 2 to a category 1 hurricane. While in the Bay, its SM weakened from -104 dB to -106 dB, but only briefly (2 hours). It reintensified to -104 dB before the storm made landfall at Wrightsville Beach.

While these hurricanes passed near the center of Onslow Bay, storm circulation was approximately tangential to much of the Bay's arcuate shoreline, resulting in reduced reflected wave energy, reduced double-frequency standing-wave pressure oscillations, and the observed temporary weakening of SM. Under these circumstances, weakened SM may signify changes to the energy budget of wave-related coastal processes and enhanced alongshore sediment transport.



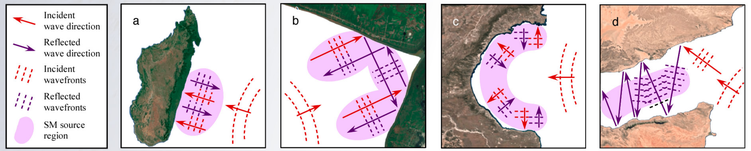
Circulation around a hurricane near the geometric (elliptical) center of Onslow Bay is approximately tangential to much of the Bay's arcuate shoreline. This results in reduced reflected wave energy and reduced double-frequency standing-wave pressure oscillations. This may explain the subtle weakening of secondary microseismns generated by all three storms while they occupied the Bay.

Compare to coastlines that are favorable to the generation of secondary microseisms (below).

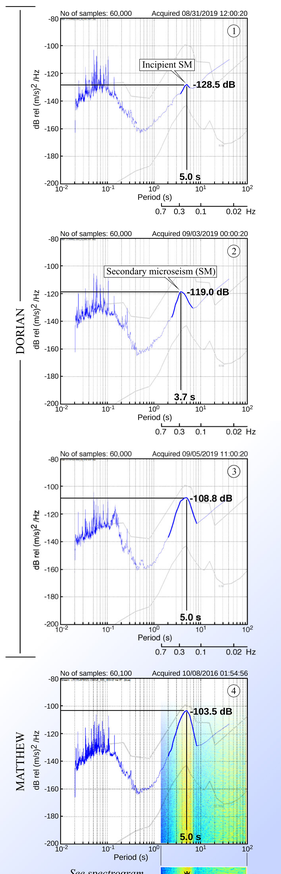


Secondary microseisms result from double-frequency standing-wave pressure oscillations, due to interference of incident and reflected ocean waves having nearly opposite propagation directions and similar periods.

Examples of coastlines that are favorable to the generation of secondary microseisms (*a* through *d*, right). Modified from Lin *et al*. (2018).



POWER SPECTRAL DENSITY (PSD) OF GROUND MOTION (VELOCITY)



See spectrogram for Matthew, PSD profile #4

Acknowledgments

Seismograms, spectrograms, and PSDs plotted with *SCREAM* (**S**eismometer **C**onfiguration **RE**al-time **A**cquisition and **M**onitoring, Guralp Systems, Ltd.).

Backdrop image of the coastal southeastern United States is due to *Google Earth*.

References

Lin, J., Fang, S., Li, X., Wu, R, and Zheng, H., 2018, Seismological observations of ocean swells induced by typhoon Megi using dispersive microseisms recorded in coastal areas: Remote Sensing, v. 10, 1437 doi:10.3390/rs10091437.