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Distinguishing between hurricane and tsunami deposition using modern analogues from Anegada, British Virgin Islands (BVI)

Jessica Pilarczyk[1], Michaela Spiske[2,3], and Stephen Mitchell[4]

[1]Simon Fraser University, Department of Earth Sciences, Burnaby, Canada (jessica_pilarczyk@sfu.ca)
[2]Universität Basel, Departement für Umweltwissenschaften, Basel, Switzerland (michaela.spiske@unibas.ch)
[3]State Museum of Natural History, Section Geology, Karlsruhe, Germany (michaela.spiske@unibas.ch)
[4]Division of Marine Science, School of Ocean Science and Engineering, University of Southern Mississippi, Stennis Space Center, MS, USA (Stephen.Mitchell@usm.edu)

Tsunamis and land-falling hurricanes pose an economic and environmental hazard to coastlines of the Caribbean and Gulf of Mexico. Patterns of their frequency and intensity remain unclear in part because detailed long-term records are limited to only a few locations, but also because of uncertainties associated with interpreting the geologic record (e.g., preservation/erosion of older deposits, distinguishing between storm and tsunami deposition). The seemingly unprecedented generation of four intense storms during the 2017 hurricane season highlights the uncertainty surrounding the geographic and temporal controls on hurricanes in the Atlantic region. Similarly, the historical record and recent modeling studies indicate that the region is susceptible to both far-field (e.g., 1755 Lisbon tsunami) and near-field (e.g., originating from the Puerto Rico trench) tsunamis. We improve upon this uncertainty by comparing the sedimentological characteristics of two modern analogues from Anegada, BVI: sediments deposited by the 1755 Lisbon tsunami and those deposited in 2017 by Hurricane Irma. The 1755 Lisbon tsunami sediments were collected from hypersaline ponds via trenching and shovel cores. The Hurricane Irma sediments were collected during a post-event survey of Anegada four months after the storm tracked 35 km south of the BVI as a Category 5 system. During this survey, we investigated the coastal areas affected by Hurricane Irma in an effort to: (1) document the storm surge parameters and associated sedimentary deposits of a known Category 5 hurricane; (2) assess the depth of scour and distance of sediment transport by storm surge; and (3) use the Hurricane Irma deposit as a basis for comparison with older overwash records, including a series of inferred tsunami deposits (e.g., 1755 Lisbon tsunami) preserved within coastal ponds.

The Lisbon tsunami deposited a laterally-extensive graded shell-rich layer composed of medium to coarse sand and abundant Homotrema, an easily recognisable foraminifer with a defined provenance in the reef. Hurricane Irma's storm surge reached a maximum flow depth of up to 3 m and deposition was limited to thin (<40 cm) lobes of sand consisting of well-sorted fine to medium Homotrema-bearing carbonate sand. Homotrema is a red organism that bleaches and rounds predictably following detachment from the reef. Intertidal mollusks were observed in lobate sediment fans deposited by Hurricane Irma on the southern side of the island, whereas

sand sheets with faint laminations were found in trenches along the northern and western coastlines. While similar in terms of composition, the tsunami and hurricane deposit were slightly different in terms of Homotrema taphonomy (preservation state of individual Homotrema fragments). The 1755 Lisbon deposit contains high abundances of Homotrema that are generally large (250-500 μm) and vibrantly coloured, suggesting scouring and transport by tsunami, followed by rapid burial on the coast. In contrast, the Hurricane Irma deposit contains bleached and non-bleached Homotrema in near equal proportions, suggesting that the sediment was sourced from the fringing reef to the north of the island as well as the reef flat. Constraining the origin of overwash deposits at this location is essential to the establishment of effective coastal hazard mitigation policies.