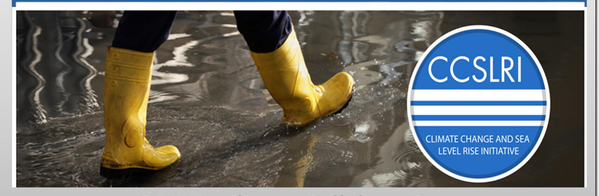
On the impact on coastal sea level from the combined effect of hurricanes and the Gulf Stream

Tal Ezer (tezer@odu.edu), Old Dominion University, Norfolk, VA

Old Dominion University
Center for Coastal Physical Oceanography
Dept. of Ocean, Earth & Atmospheric Sciences

ODU Climate Change and Sea Level Rise Initiative



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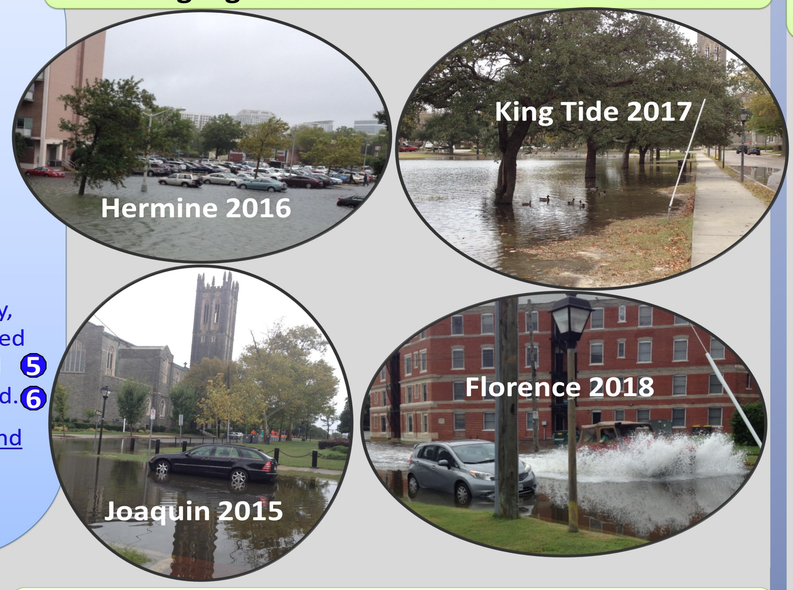
SUMMARY

- Minor flooding and frequency of storm surges are accelerating along the U.S. East Coast. (1) (2) (3)

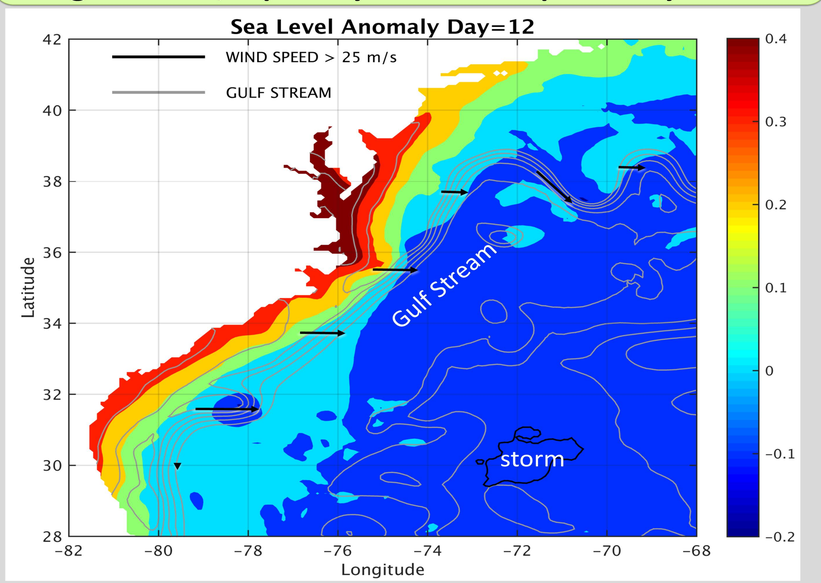
Important factors: global sea level rise, local land subsidence and slowdown of the Gulf Stream flow (long-term and short-term)

- Hurricanes and tropical storms cause flooding in different ways:
  1. Precipitation (not considered here)
  2. Wind-driven storm surge (short term, few hours)
  3. Indirect impact by disruption of the Gulf Stream flow (4) (longer impact of several days to weeks)
- New findings: hurricanes that do not make landfall in Virginia (e.g., Sandy, 2012; Joaquin, 2015; Hermine & Matthew, 2016; Florence, 2018) disrupted the flow of the Gulf Stream and when the current slowed down sea level raised, causing "clear day" tidal flooding long after the storm disappeared. (5) (6)
- Better understanding of the relation between coastal sea level, storms and ocean dynamics can improve flood prediction and help mitigation, adaptation and resilience efforts.

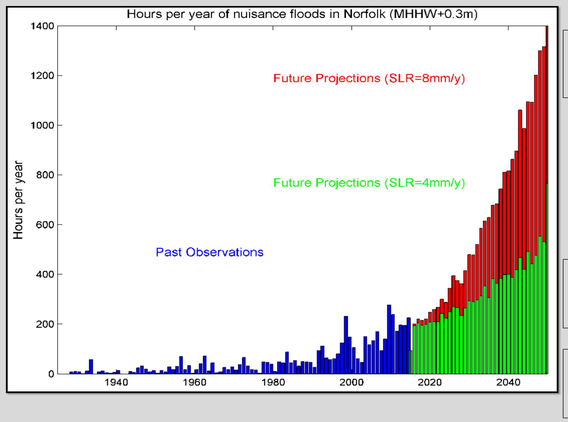
(3) "Clear-Day" minor tidal flooding in Norfolk, VA, during high-tides and remote Atlantic storms



(5) Model simulations of sea level anomaly 12 days after Hurricane Matthew. Note that water level remained high along the coast, especially in the Chesapeake Bay



(1) Sea Level Rise Increases Minor Flooding

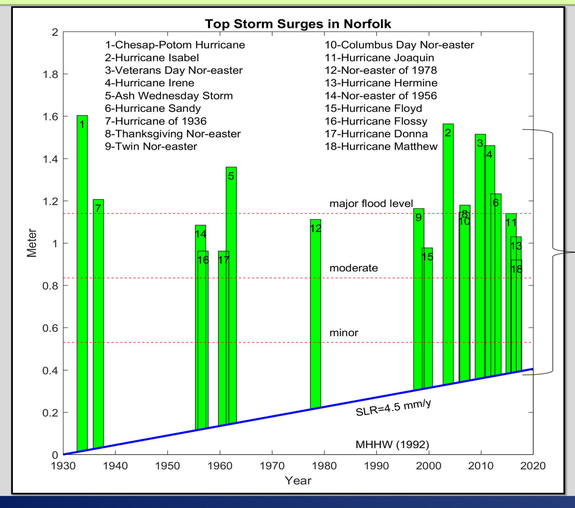


~60 flood days per year by 2050

~10 flood days per year today

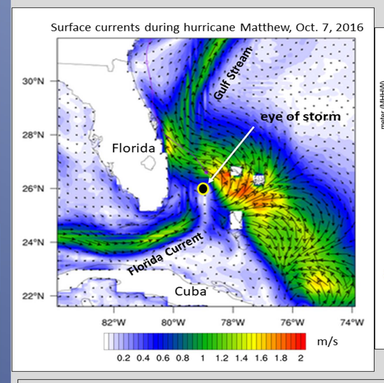
~2 flood days per year 1930-1990

(2) Sea Level Rise Increases Storm Surges

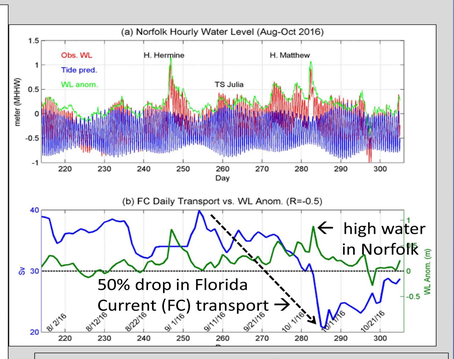


More storms reach flood level now than before

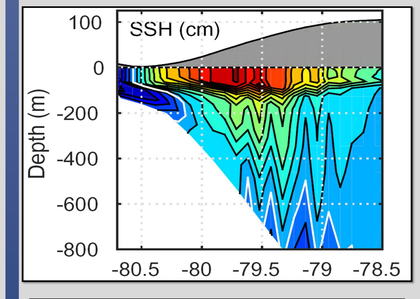
(4) Disruption of the Gulf Stream flow during Hurricane Matthew (2016) elevated coastal sea level.



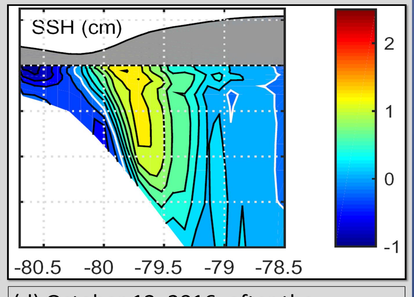
(a) Simulated surface currents when the hurricane was near south Florida (from NOAA's HWRF-POM model).



(b) Water level in Norfolk (top) is elevated when the flow of the Florida Current (blue line; bottom) is weakening (cable observation across Florida straits).

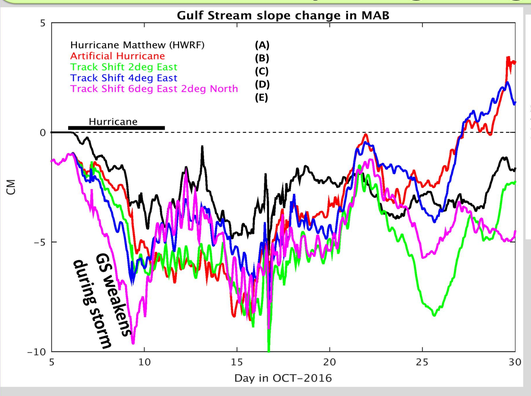


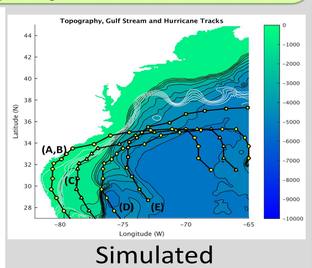
(c) Simulated northward currents (m/s) and sea level at 29N on October 8, 2016, when the hurricane was near the coast of south Florida.



(d) October 12, 2016: after the hurricane dissipated and moved away from the coast, the current was weaker, deeper and coastal sea level was elevated.

(6) Simulations with different tracks show that the Gulf Stream remains weaker than normal for several weeks after the storm moved away- a long-lasting impact on the coast.





Simulated hurricane tracks

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