Decadal-scale variations in the coupling between sea level along the Florida Atlantic coast and the strength of the Florida Current

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Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida

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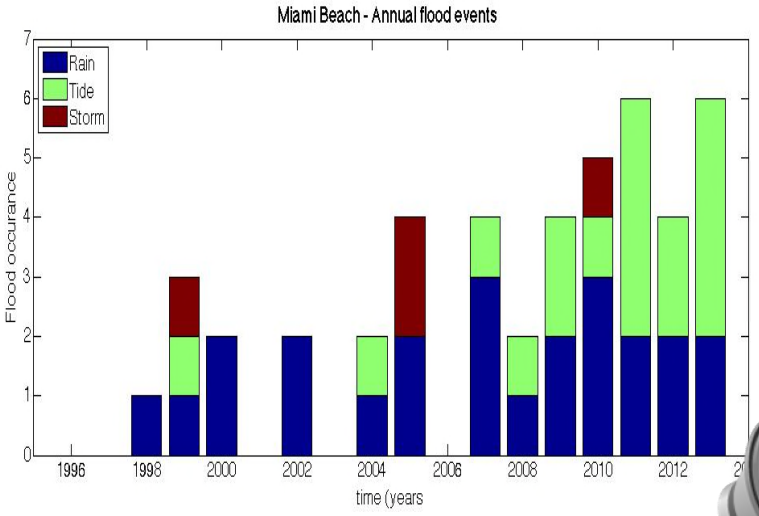
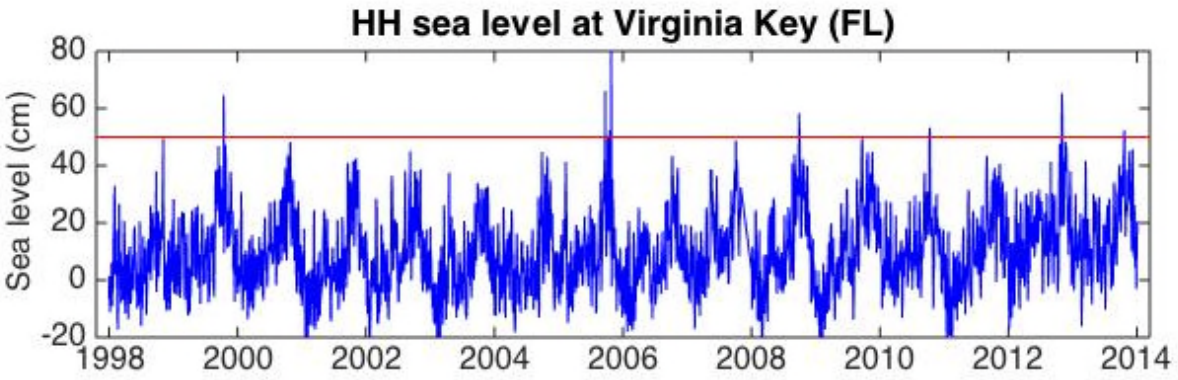
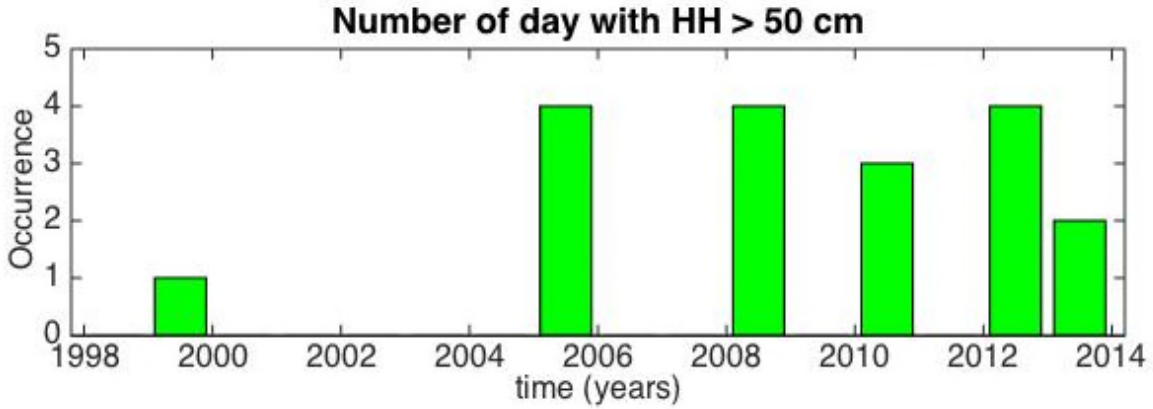
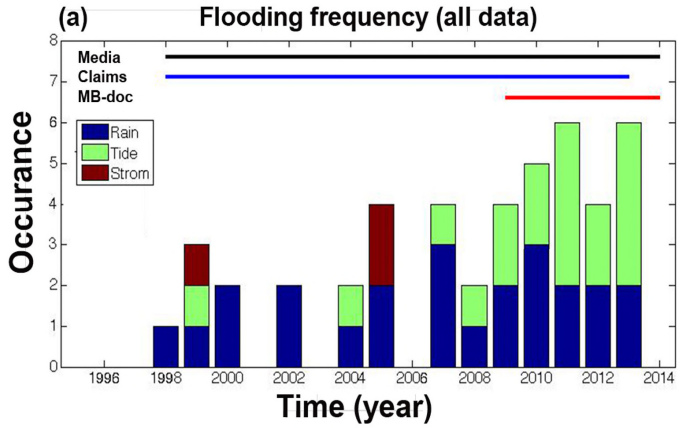


Flooding frequency from TG record



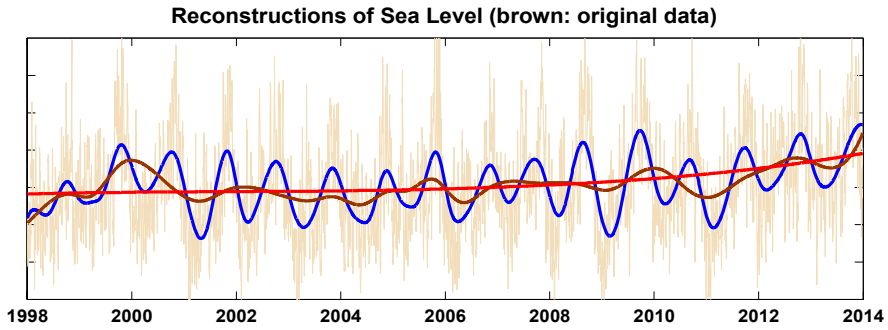


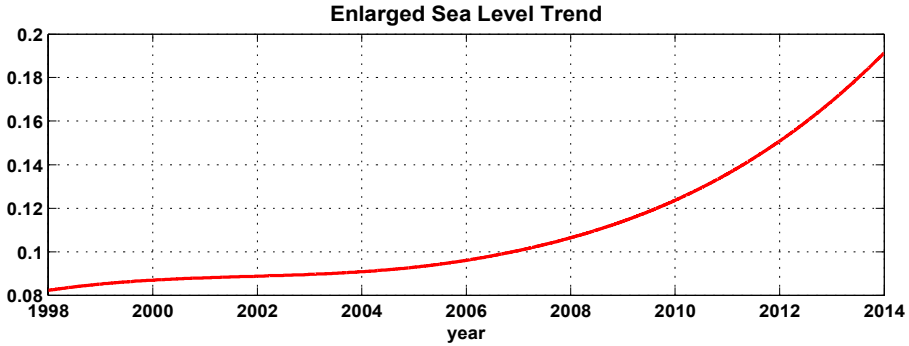


Flooding frequency – significant increase since 2006

- Tide + Storm – Increase from 5 events prior to 2006 to 15 events after 2007 (3x increase)

Sea Level Change in SE Florida

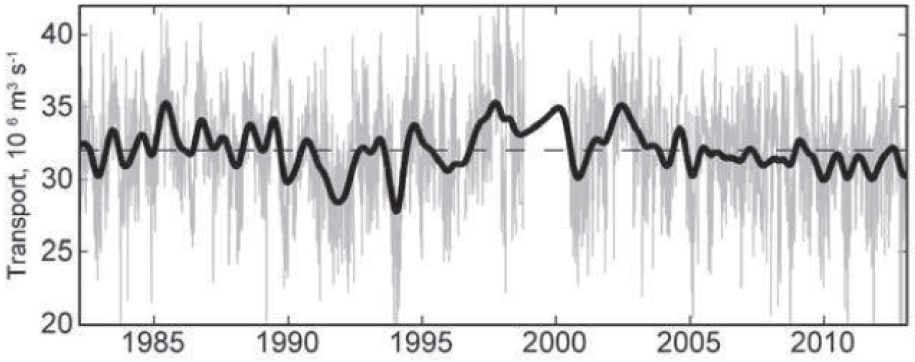




Wdowinski et al. (2016)

EEMD analysis of the Virginia Key tide gauge reveals:

- Acceleration of SLR since 2006
- Total trend increase since 2006 – 10 cm

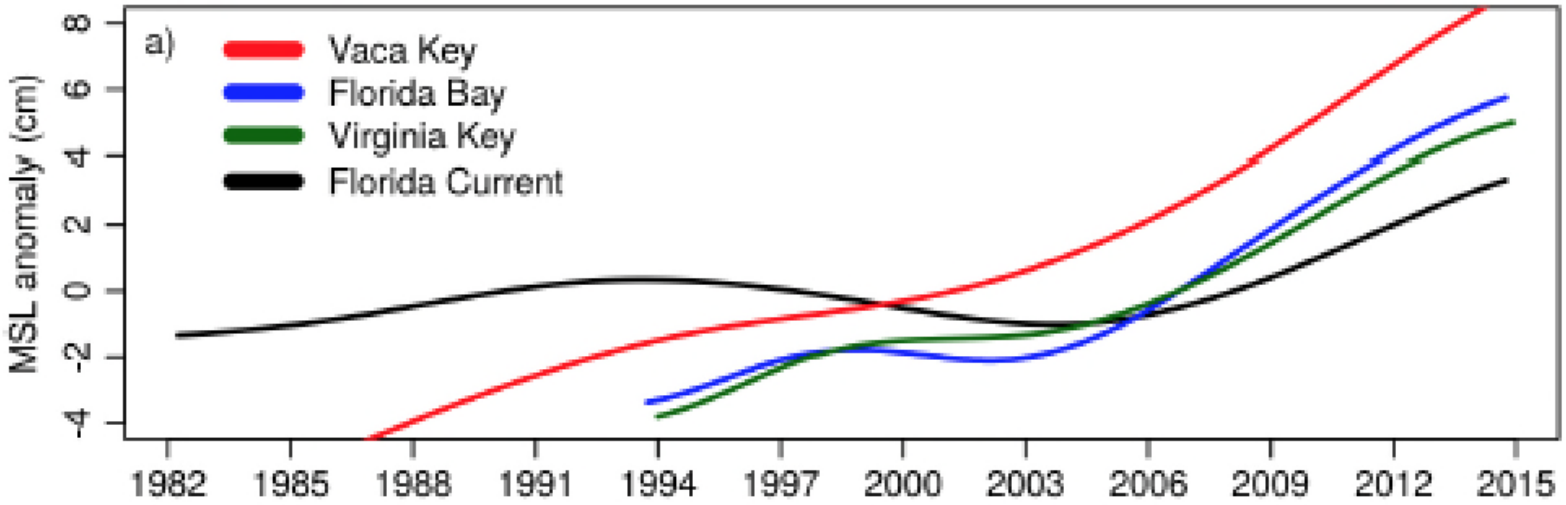


Baringer et al. (2013)

Daily estimates of the FC transport (light gray), a smoothed version of transport (heavy black line).

- gradual transport decline since ~2000.

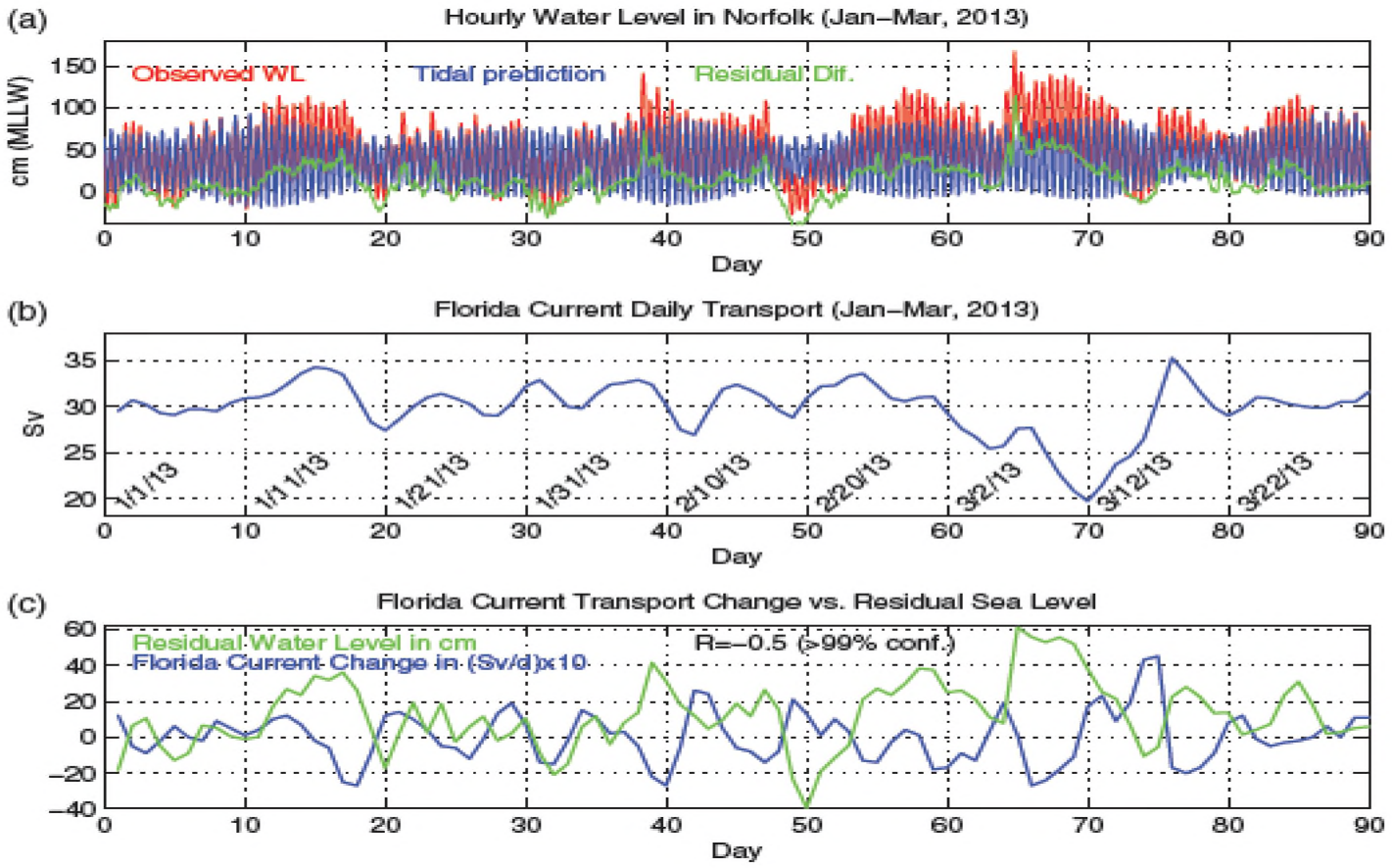
Sea Level Change in SE Florida



Park and Sweet (2015) analyzed tide gauge and FC transport data using an EMD analysis and showed:

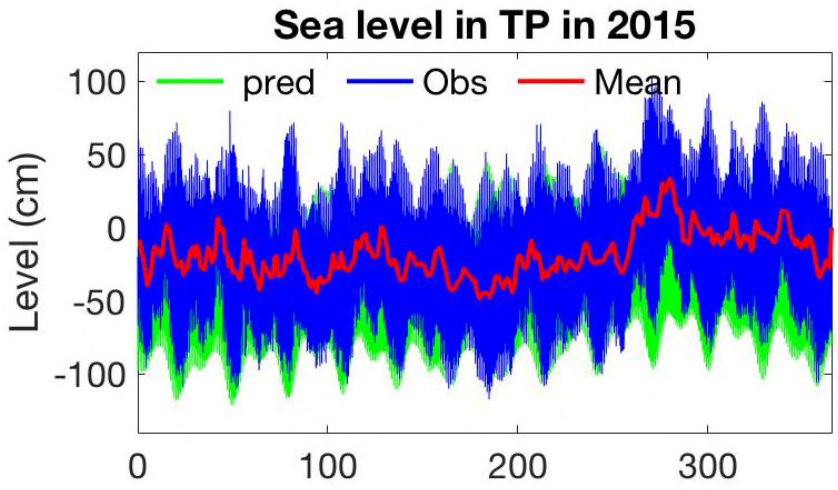
- Accelerating rates in SE Florida began after 2003
- The accelerating SLR rates correlate with anomalous behavior (weakening) of the Florida current

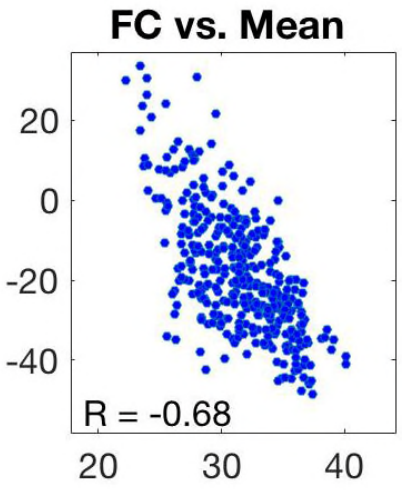
Short-term correlation between coastal flooding and the strength of the Florida Current

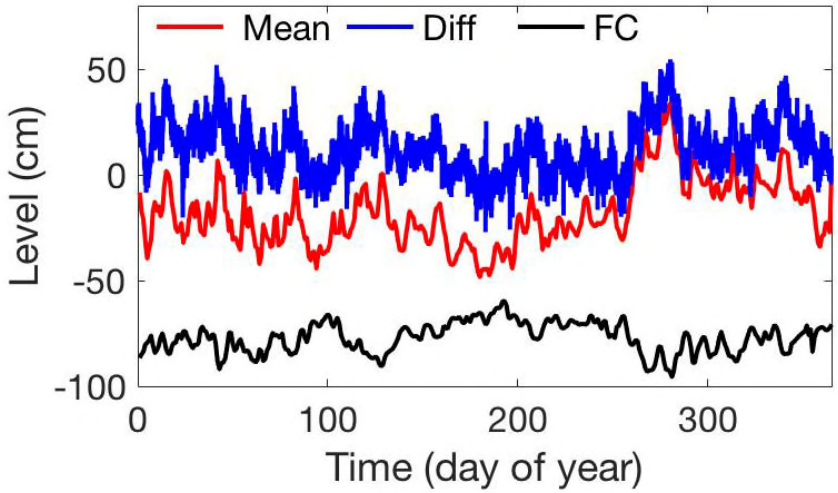


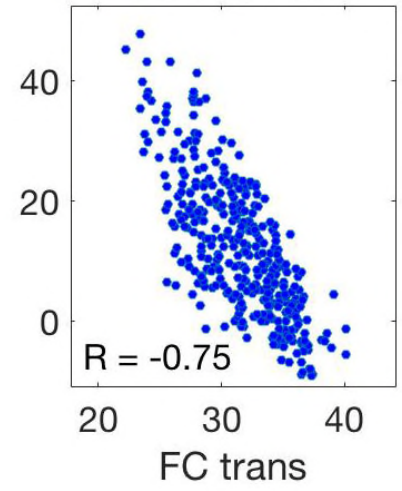
Ezer and Atkinson (2014)

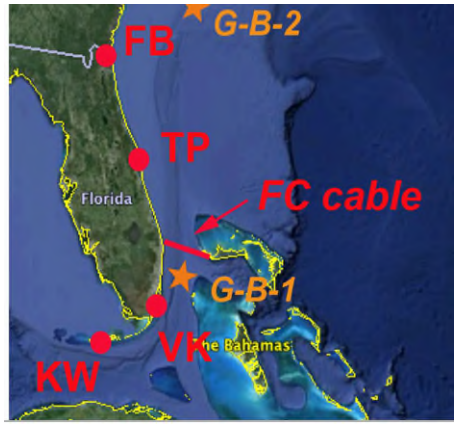
Yearly correlations between excess water and the strength of the FC



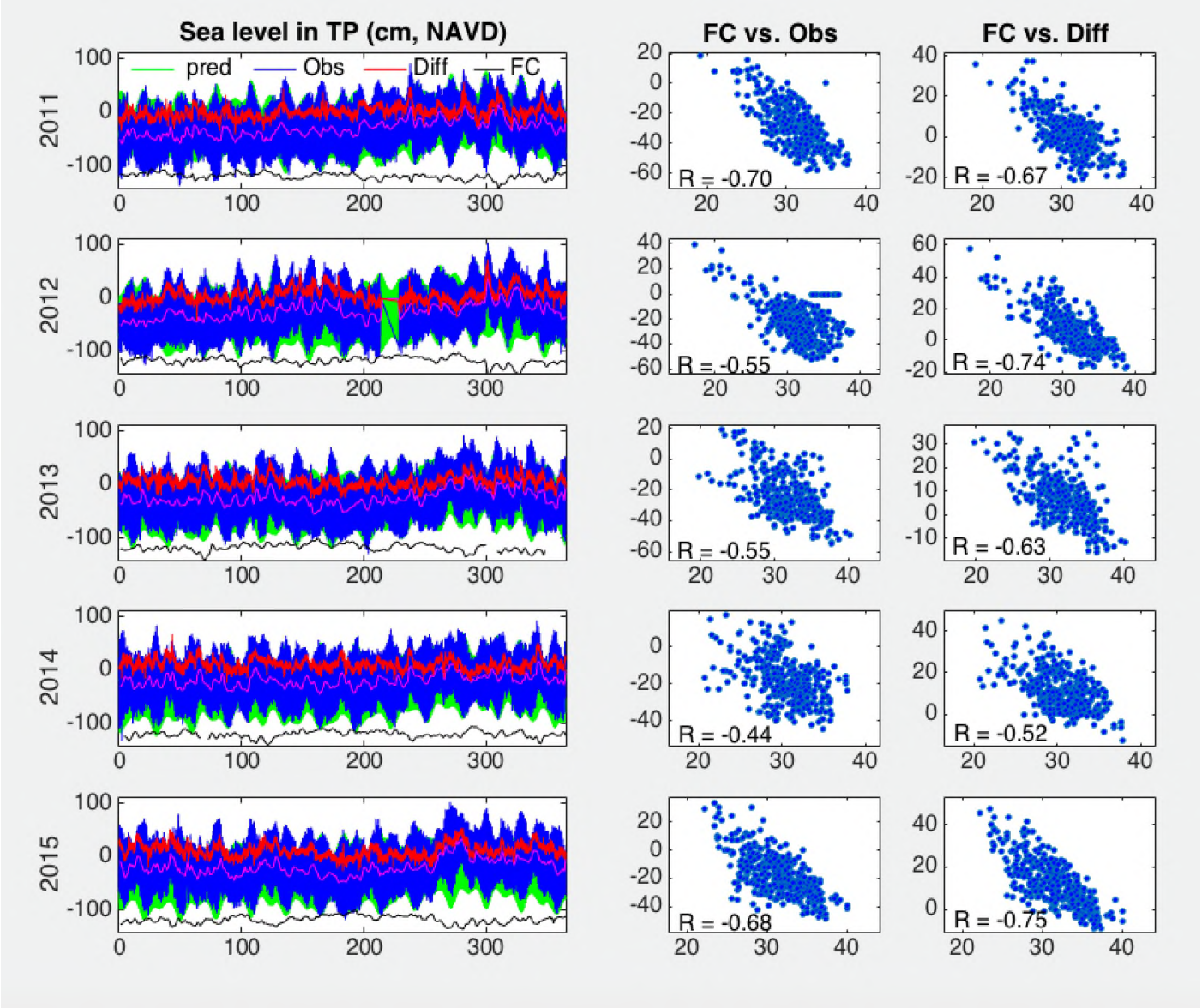




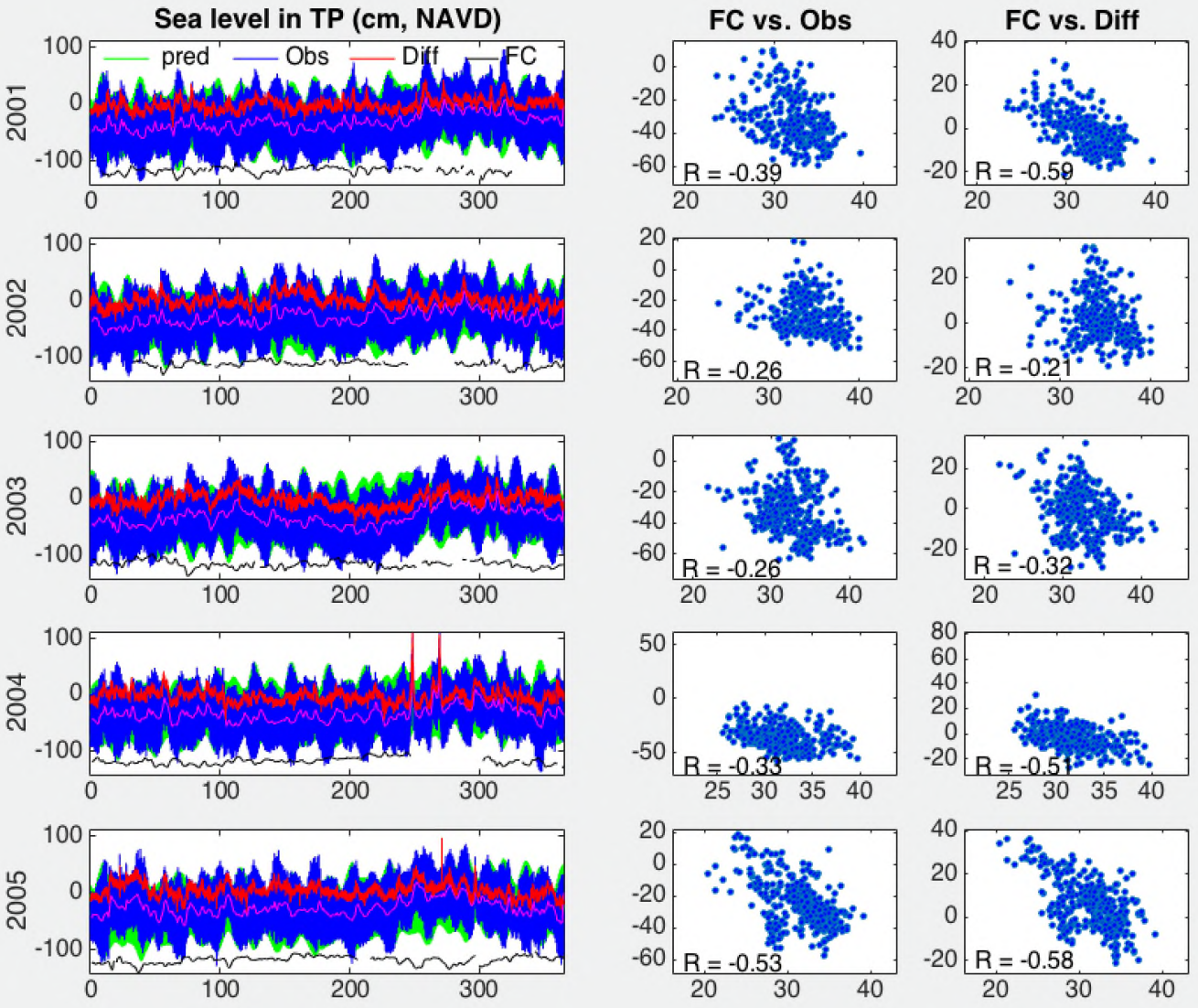




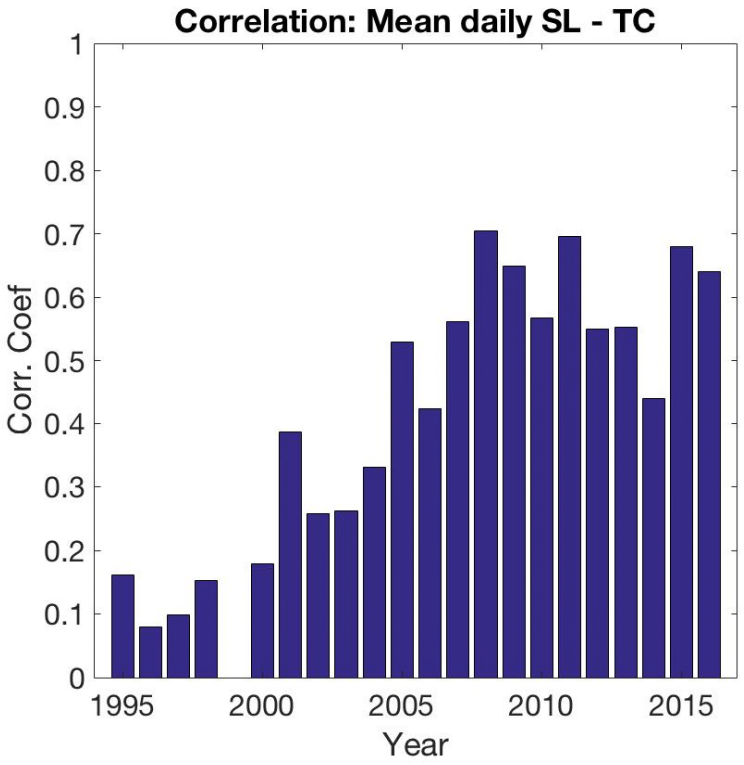
Yearly correlations between excess water and the strength of the FC

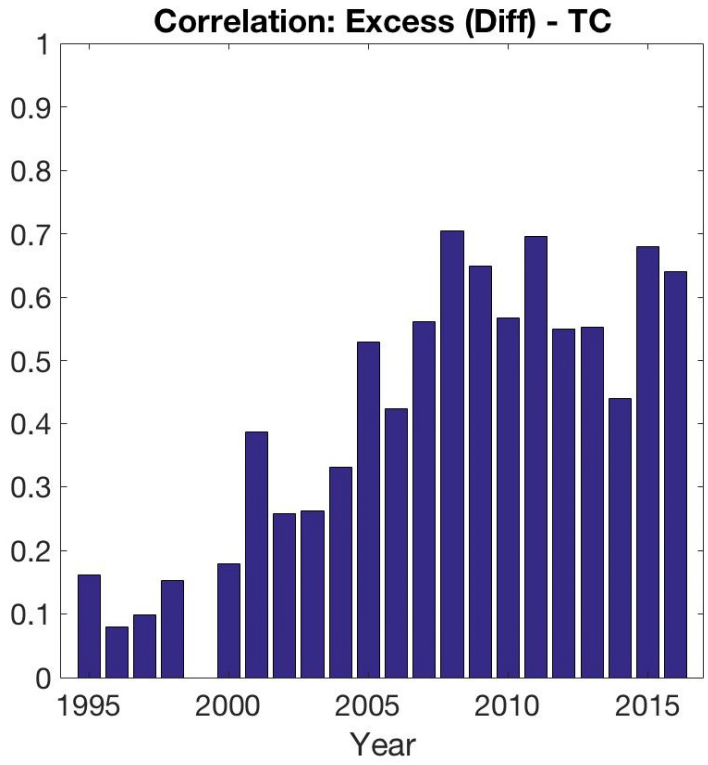


Yearly correlations between excess water and the strength of the FC



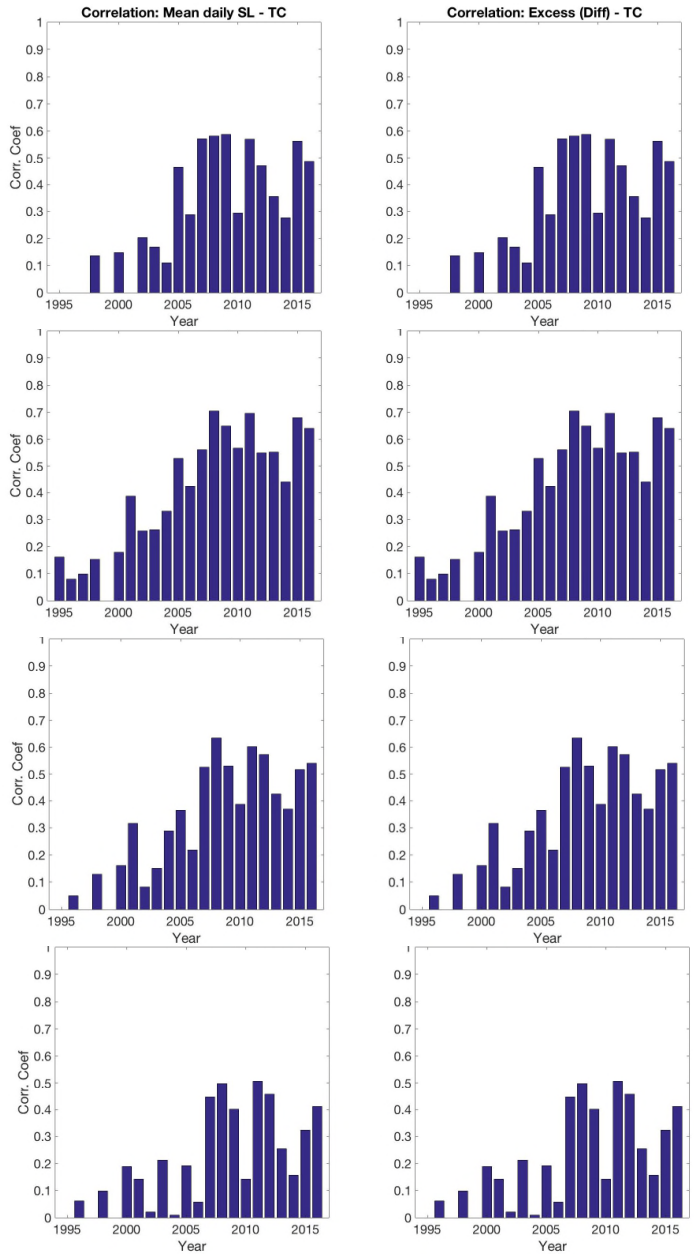
Yearly correlations - Trident Pier (TP)





Strong correlation (> 0.5) began around 2005

Yearly correlations

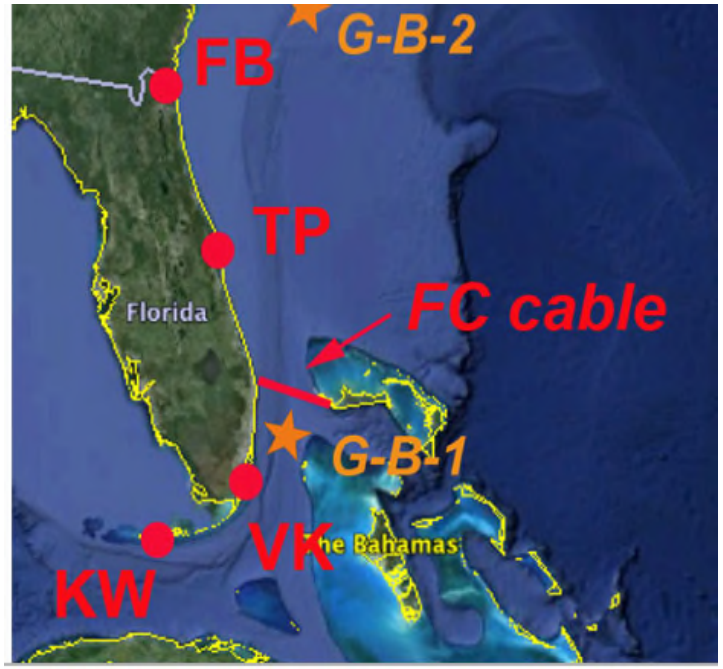


FB

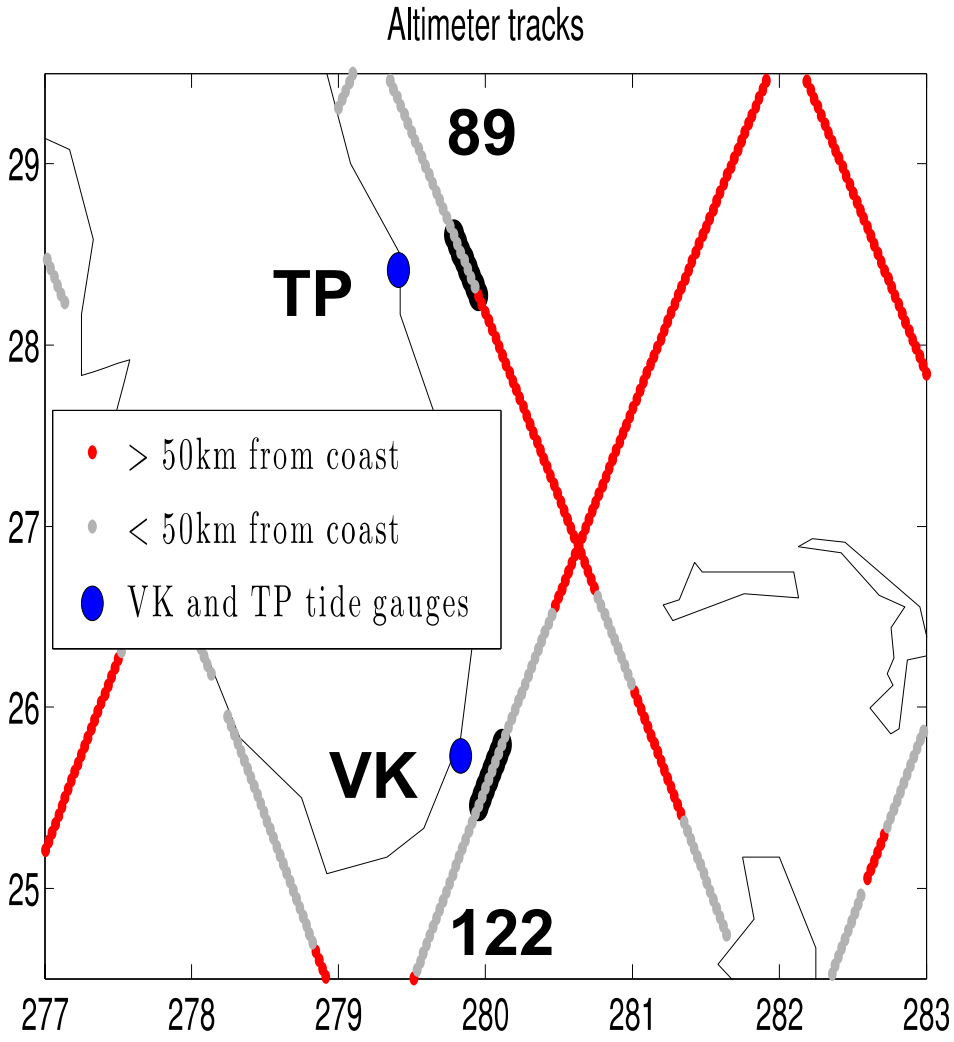
TP

VK

KW

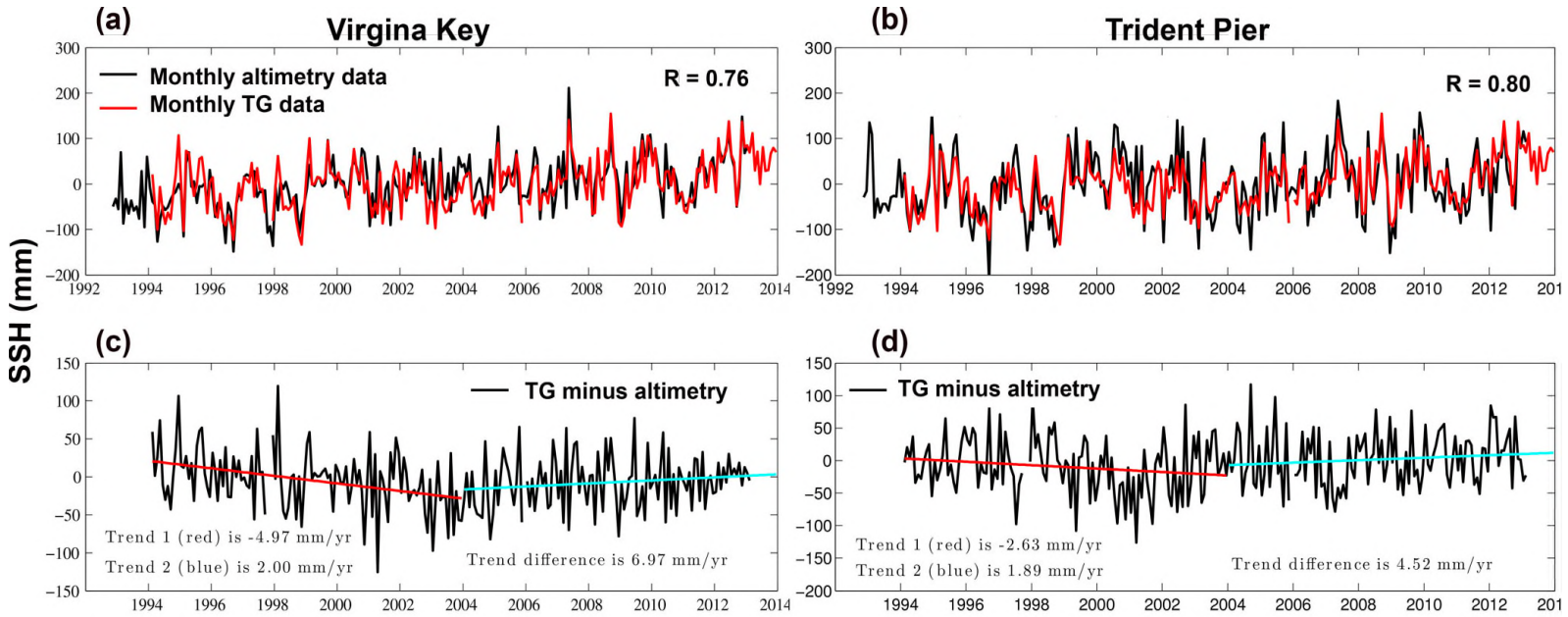


Coastal altimetry



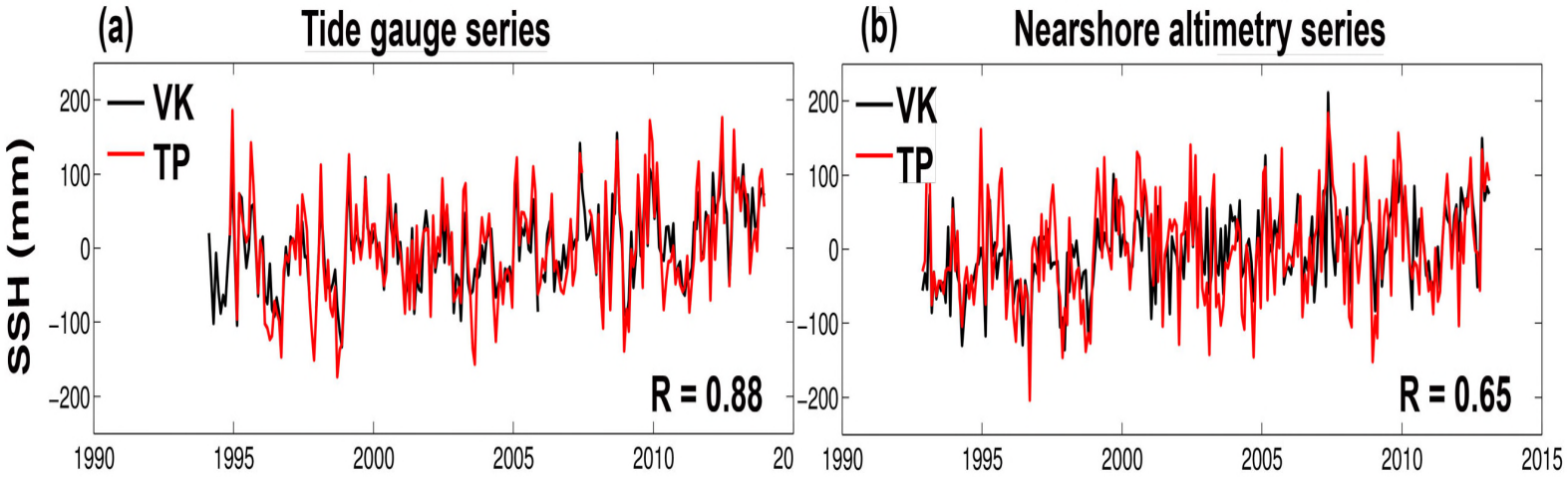
- Location of two satellite altimetry tracks.
- Location of the Trident Pier (TP) and Virginia Key (VK) tide gauges.
- Thick black line – Location of 7 points along the tracks used for calculating SSH time series near- and off-shore the gauge stations.
- Altimeter locations within 50km of the coast are shown in grey, while open-ocean locations are shown in red.

Coastal altimetry



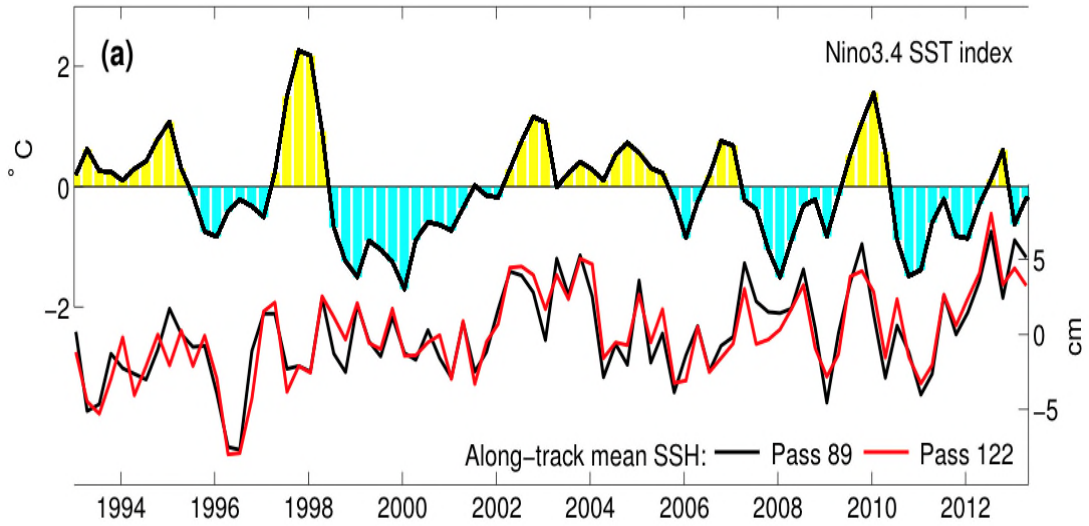
- Comparison between tide gauge and altimetry monthly averaged SSH time series for Virginia Key (a) and Trident Pier (b).
- The difference between the tide gauge and altimetry values reveals a decadal-scale slope change, after 2004, which is more pronounced in the Virginia Key residual plot (c)

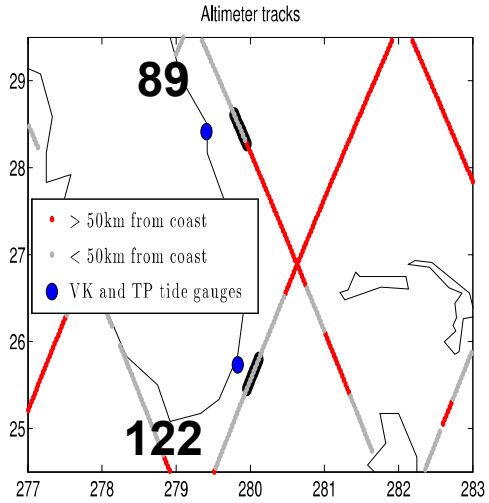
Coastal altimetry



- Comparison between tide gauge time series (a) and the two nearshore altimetry time series (b).
- The tide gauge record indicates a stronger correlation between the two series (R=0.88) than those of the nearshore series (R=0.65).

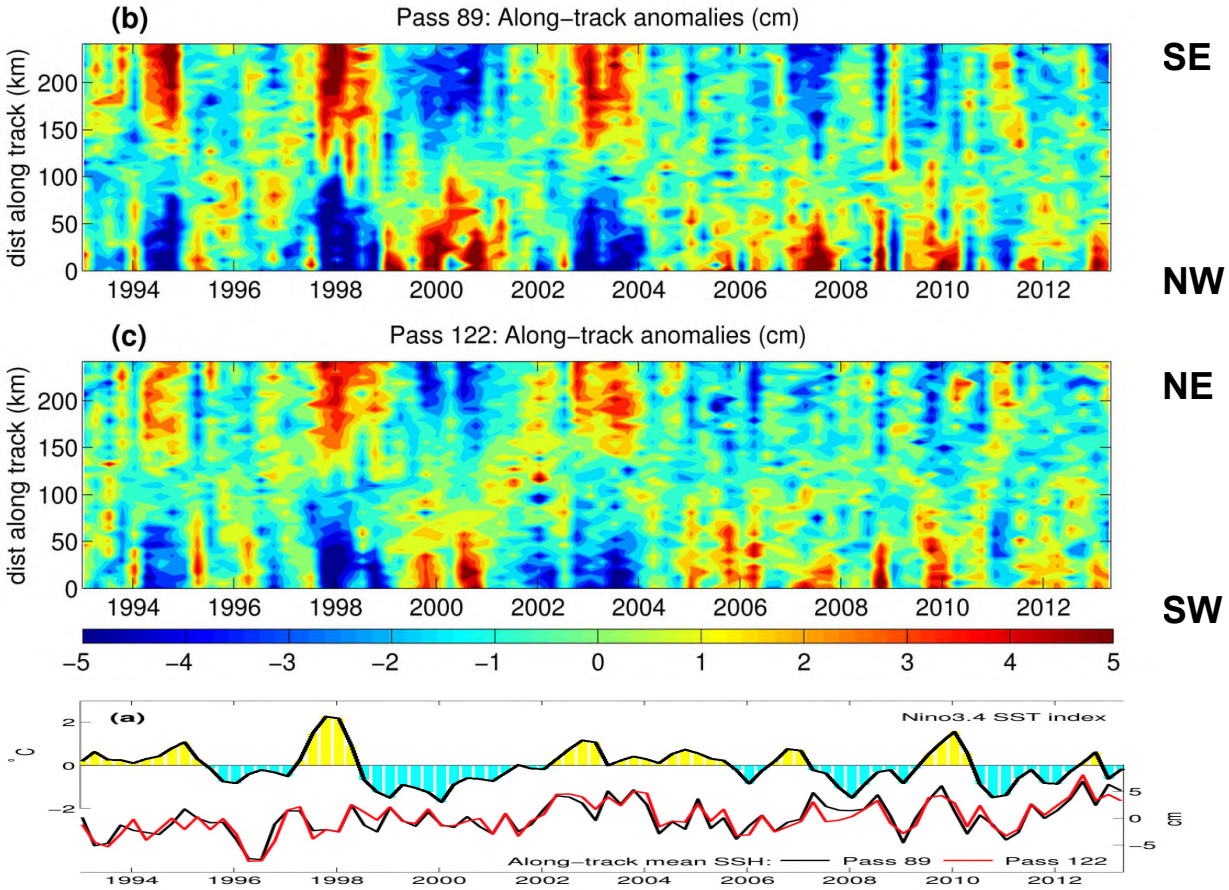
Coastal altimetry





- SST index from the Nino3.4 region
- Along-track mean SSH between 280ºE and 281ºE for passes 89 and 122.

Coastal altimetry

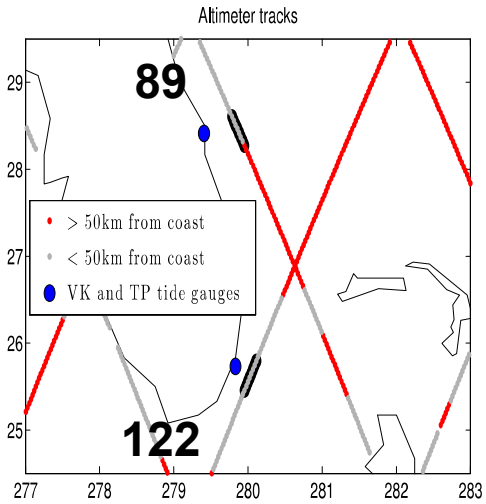


SE

NW

NE

SW

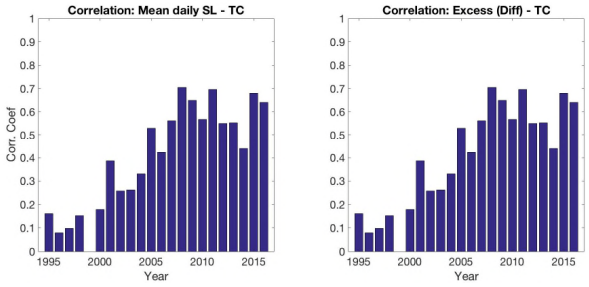


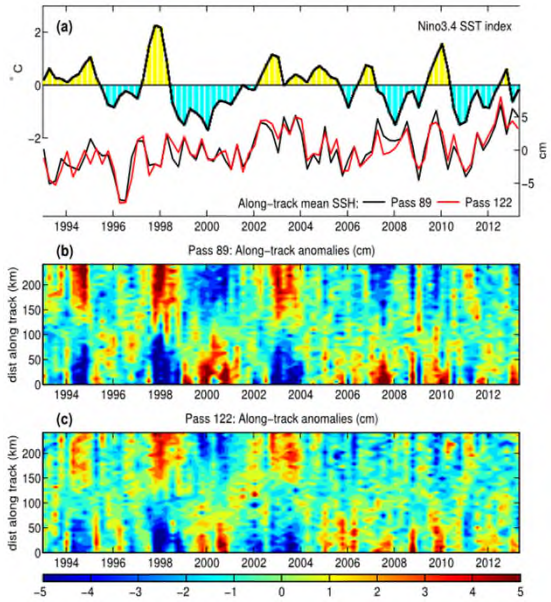
SW, NW – Near shore
SE, NE - Offshore

- Along-track SSH anomalies (SSH minus the mean values). Values represent seasonal averages (DJF, MAM, JJA, SON).
- Decadal-scale changes in differential SSH along the Florida coast. Prior to 2004 – large differential SSH (tilt) during El Nino events. After 2004 – Limited level of differential SSH.

Summary

- The observed strong coupling between sea level changes along the Florida coast and the strength of the Florida Current has affected coastal flooding since mid-2000's.
- The change in coupling coincides with decadal-scale changes in differential SSH along the Florida coast.
  - Prior to 2004 – large differential SSH (tilt) during El Nino events.
  - After 2004 – Limited level of differential SSH.
- Forecasts of coastal flooding based on the strength of the Florida Current need to take into consideration that the coupling between the two processes may change over decadal time scales.





Acknowledgements

- **Tide gauge data** - NOAA
- **Florida Current data** - NOAA
- **Altimetry data** - JPL PODAAC

Questions?

Questions and Comments

Please send email to:

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