Variations of observed correlations between satellite altimetry and tide gauge data along the U.S. east coast

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Outline

- Motivation
- Data

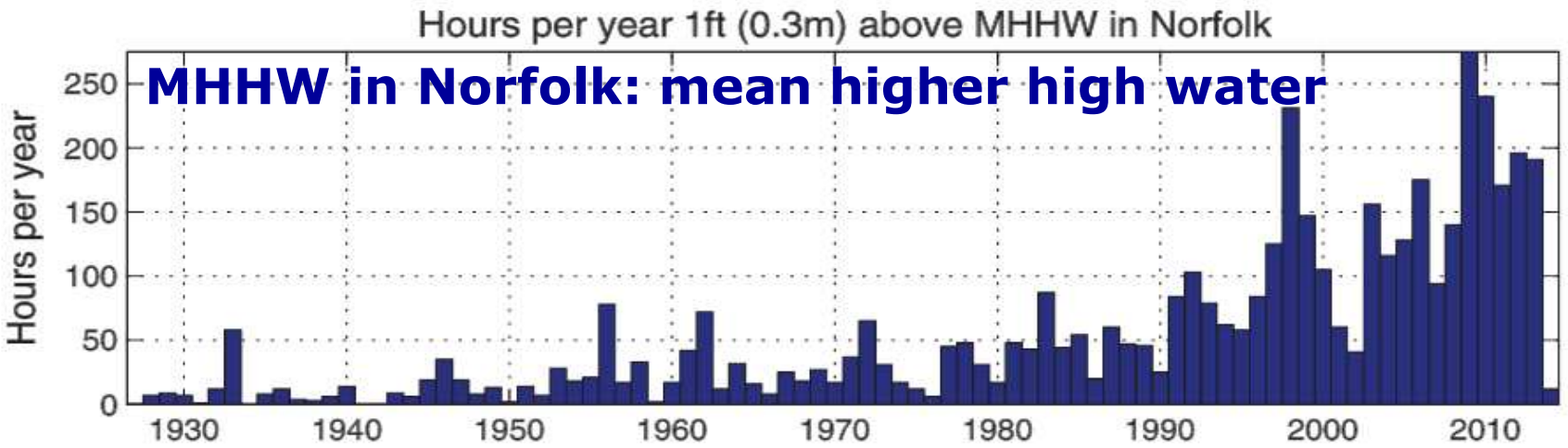
Tide gauge (PSMSL), satellite altimetry (ADT from AVISO), ECCO2 (http://ecco2.jpl.nasa.gov/)

- Method

CSEOF(Cyclostationary Empirical Orthogonal Function, *Hamlington et al., 2011a, 2011b*), EMD (empirical mode decomposition, T > ~ 5 years, *Ezer, 2013*)

- Spatial-temporal correlations
- Summary

Motivation

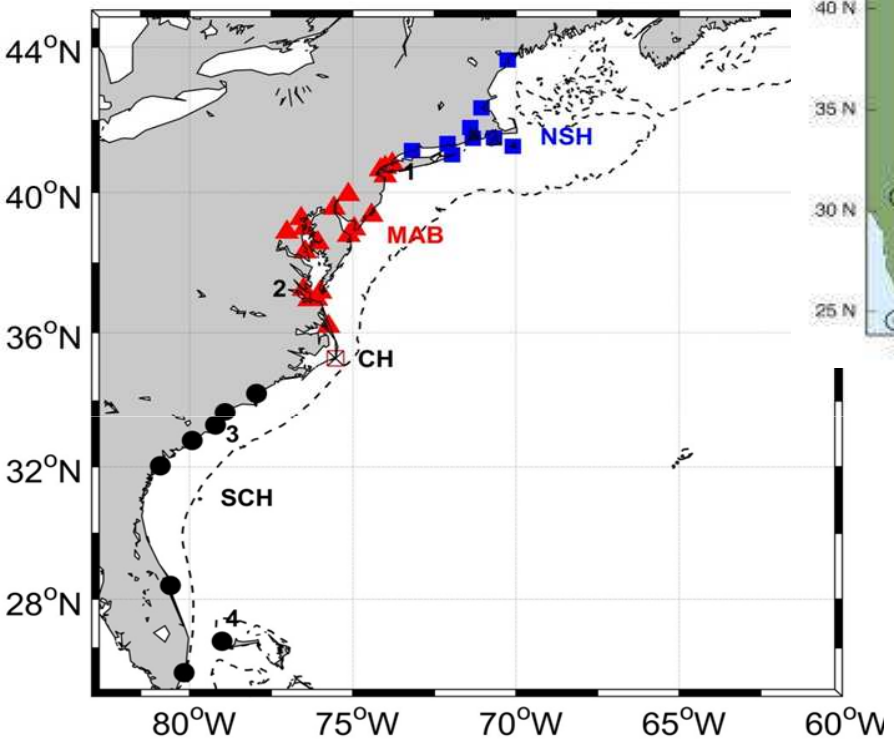


(Ezer and Atkinson, 2014)

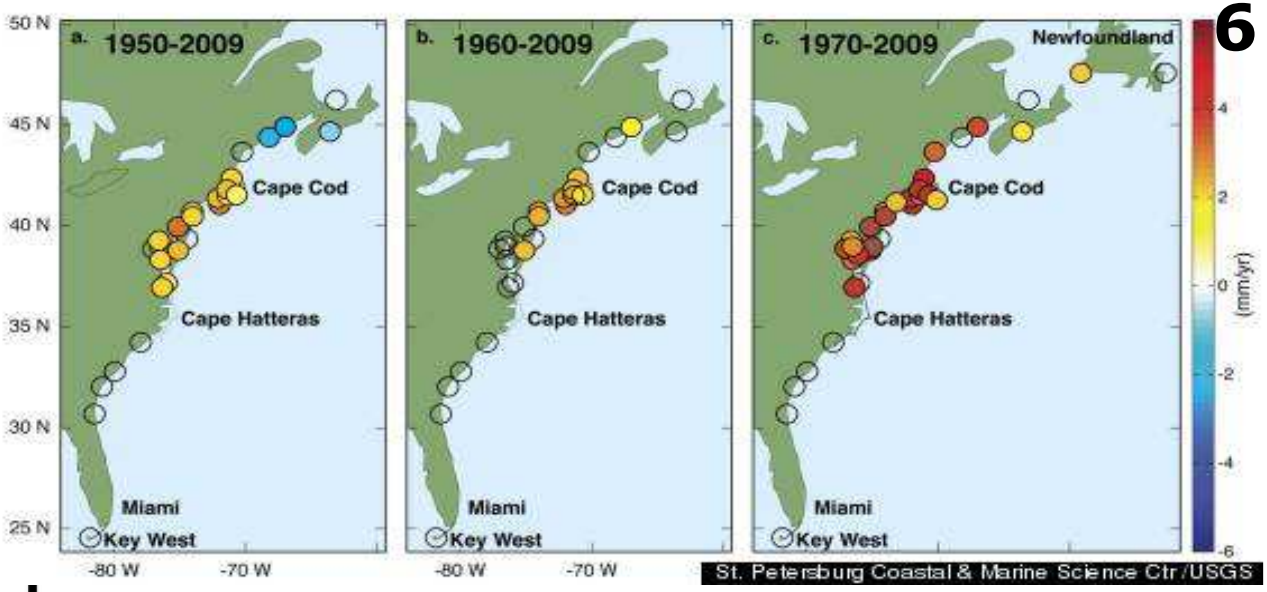
[October 2, 2015] ***Persistent north-easterly winds combine with large tides***

http://www.mari.odu.edu/information/impactsdoc/floodings.php

Motivation



NSH: North of Sandy Hook
MAB: Middle Atlantic bight
CH: Cape Hatteras
SCH: South of Cape Hatteras



Each circle represents a gauge location and is colour-coded to reflect sea level rise difference. Circles with no colour fill are not statistically different from zero. Confidence limits are $\pm 1\sigma$ and account for serial correlation. More gauges were available for plots that show results from shorter time series. **a**, 1950–2009. **b**, 1960–2009.**c**, 1970–2009.[*Asbury H. Sallenger Jr et al., 2012, Nature*]

Cyclostationary Empirical Orthogonal Function

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- In contrast to **EOFs** (sum of a set of individual modes composed of a single spatial pattern and a corresponding amplitude time series), **CSEOFs** have time-dependent LVs (loading vectors).

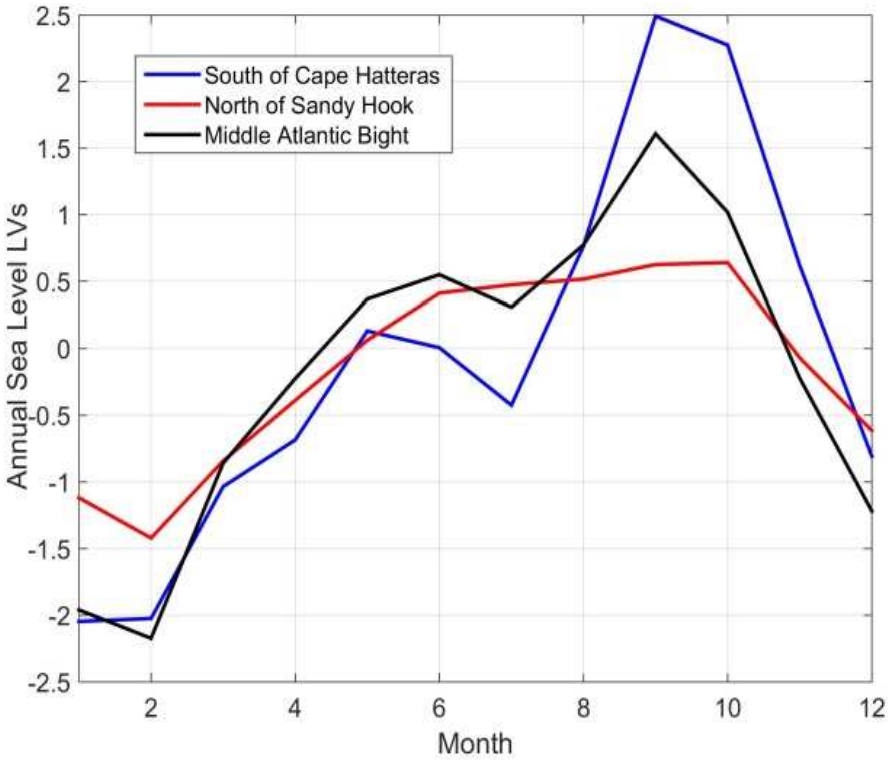
$$T(r,t) = \sum_n P_n(t) LV_n(r,t)$$

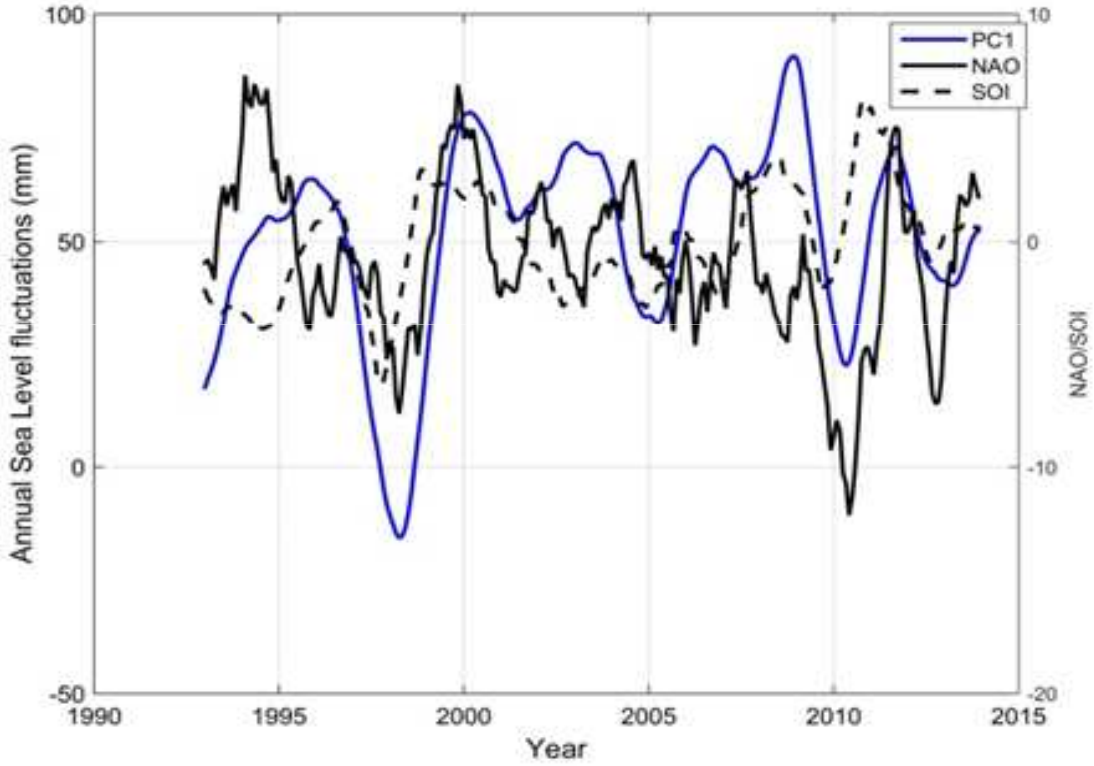
$$LV_n(r,t) = LV_n(r,t+d)$$

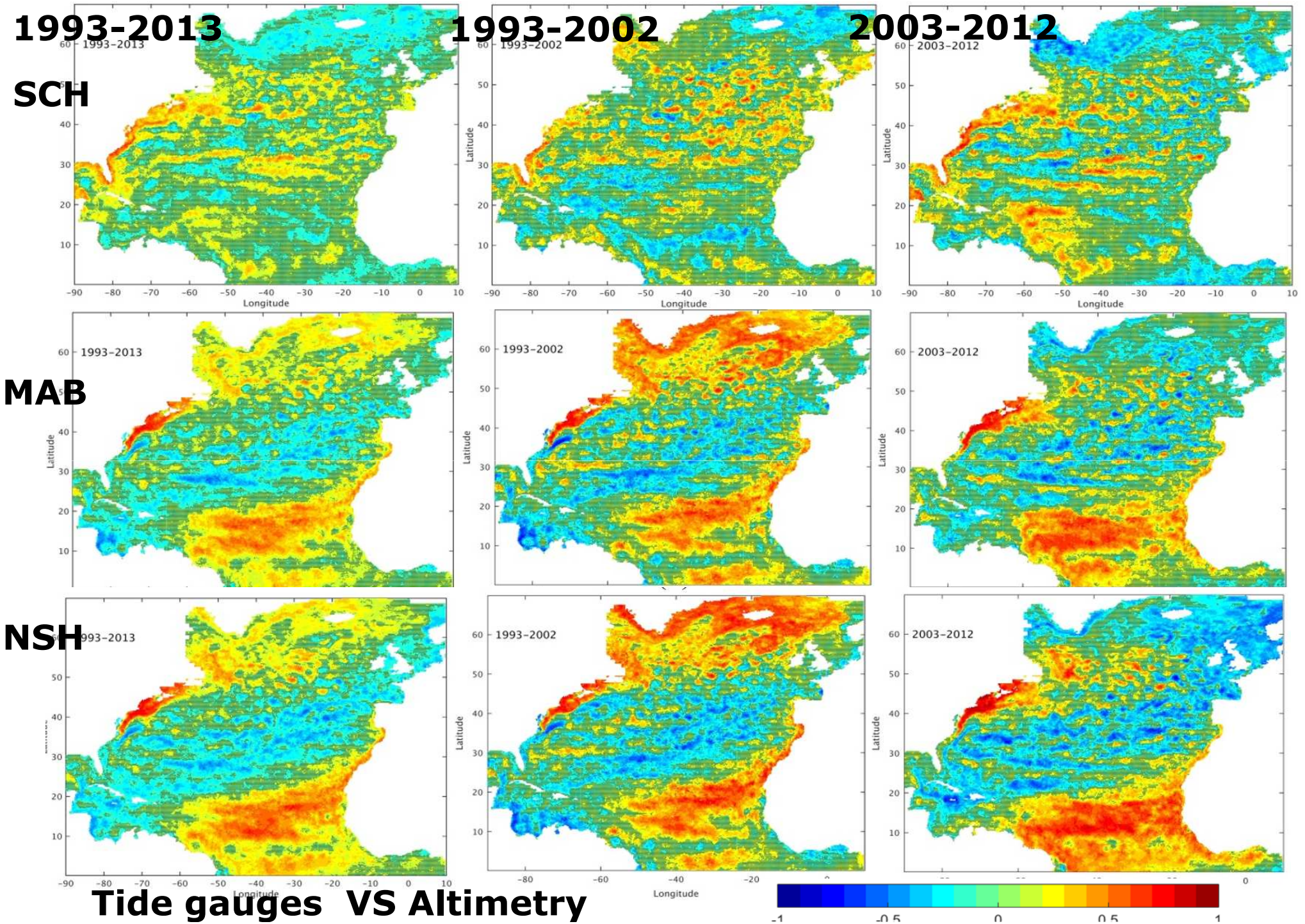
  - The temporal evolution of the spatial pattern of the CSEOF LVs is constrained to be periodic with a "nested period".
  - When studying the annual cycle, for example, the LVs would represent the one-year nested periodicity, while the PC time series would describe the change in amplitude of the annual cycle over time.

Hamlington et al. (2011, JGR, 2011, Journal of Climate)

Cyclostationary Empirical Orthogonal Function





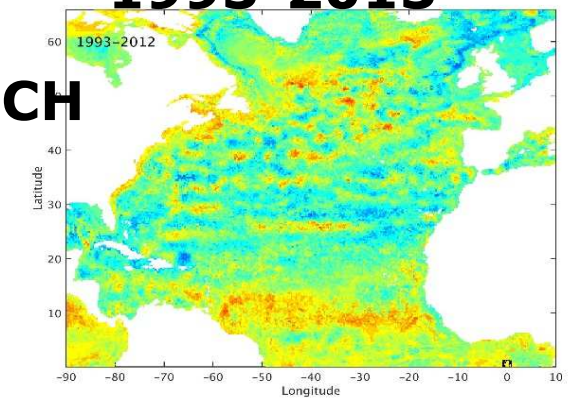

1993-2013
1993-2002
2003-2012
SCH
MAB
NSH
Latitude
Longitude
Tide gauges VS Altimetry

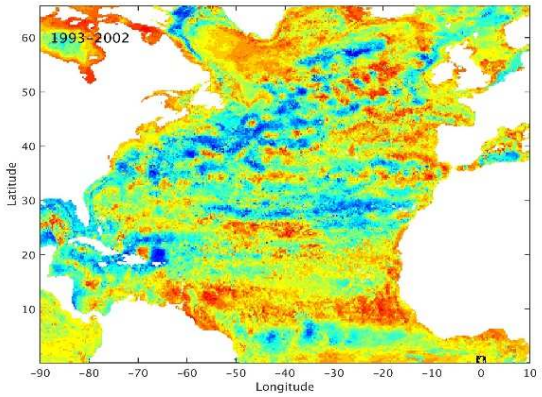
1993-2013

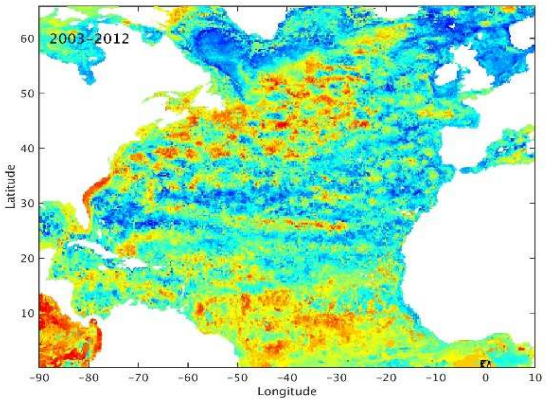
1993-2002

2003-2012

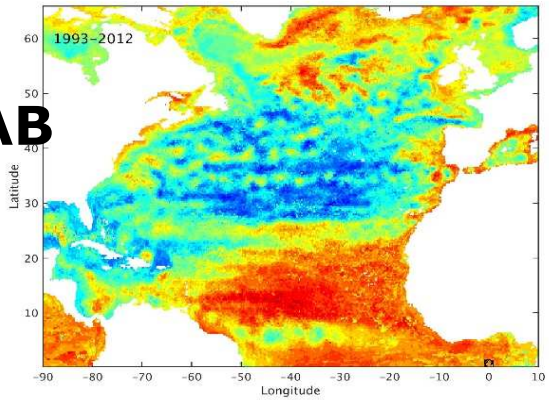
SCH

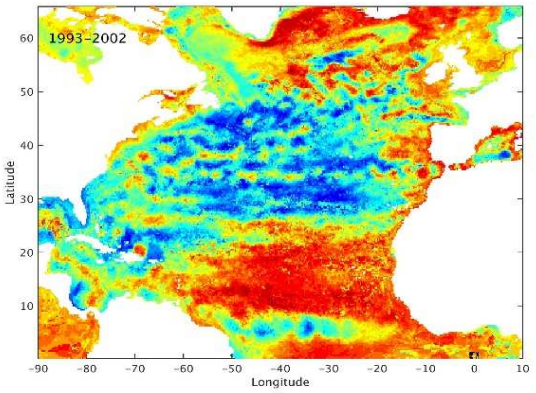


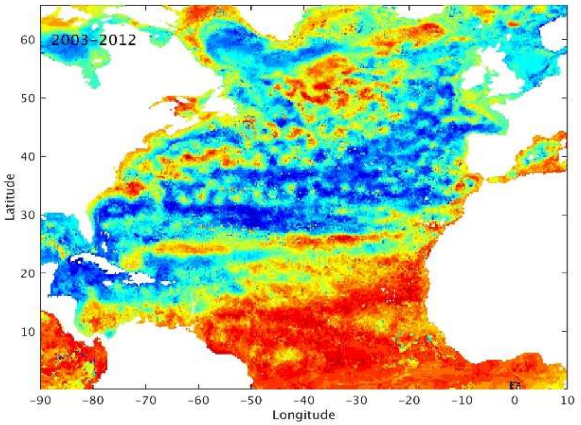




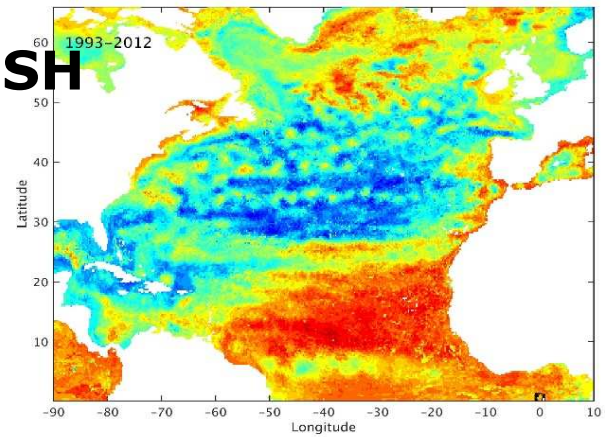
MAB

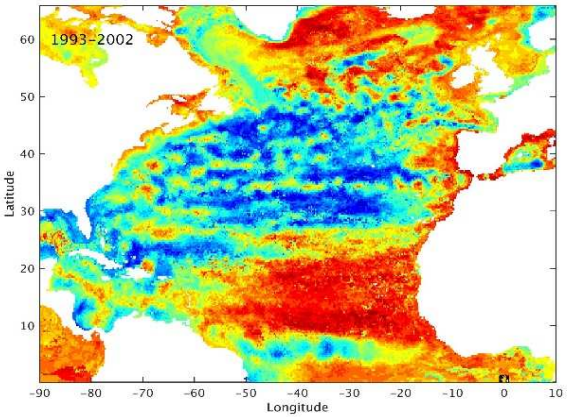


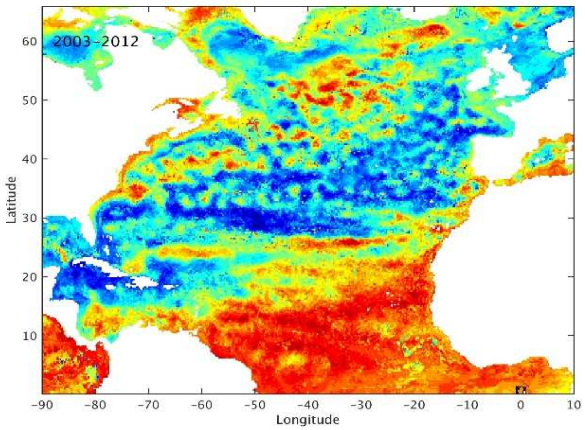




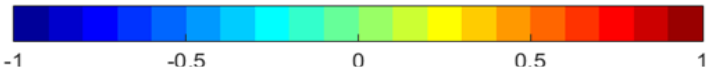
NSH







Tide gauges VS ECCO2



Cross correlation

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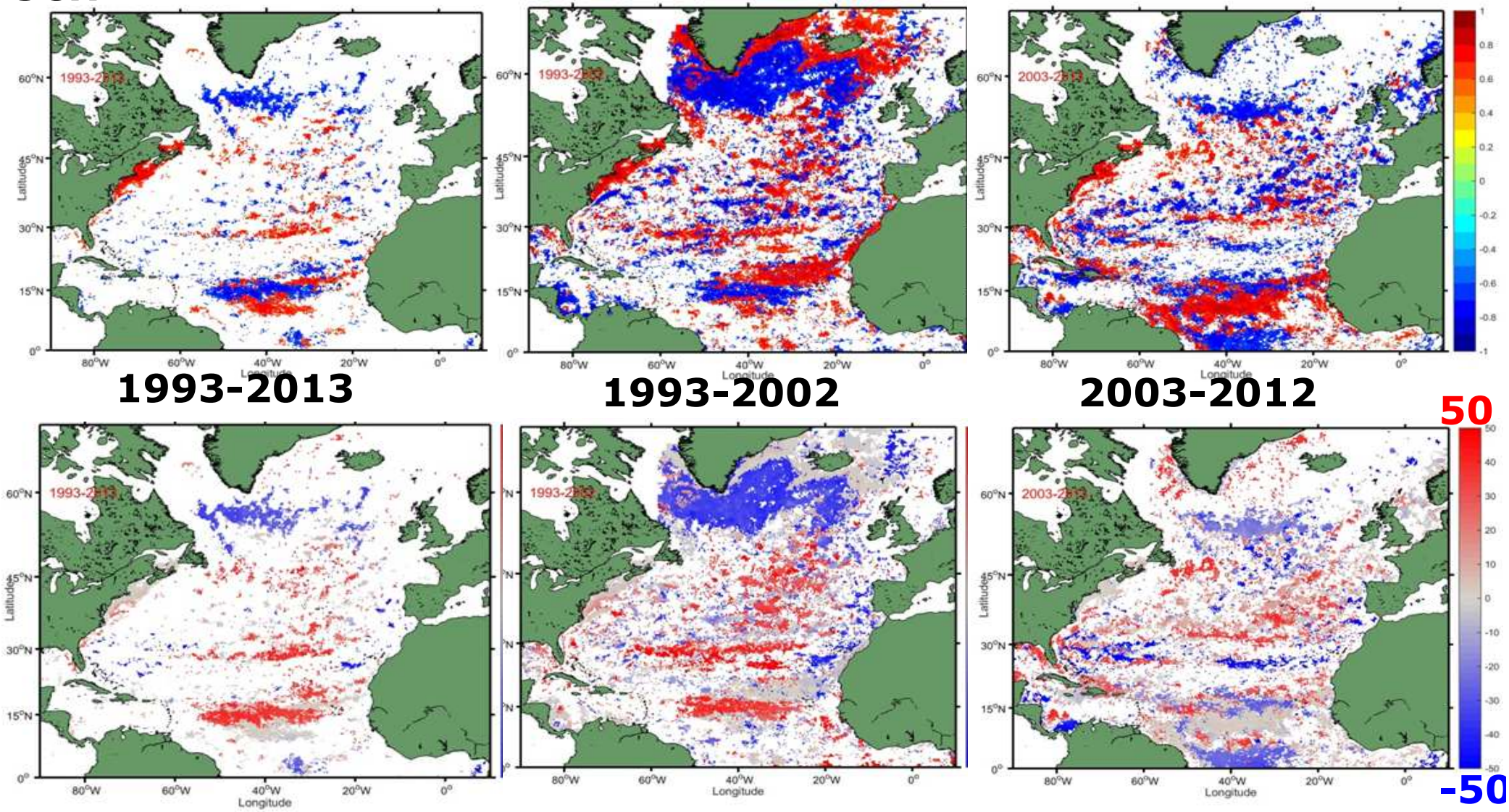
SCH



NSH: Tide gauges VS Altimetry

Cross correlation

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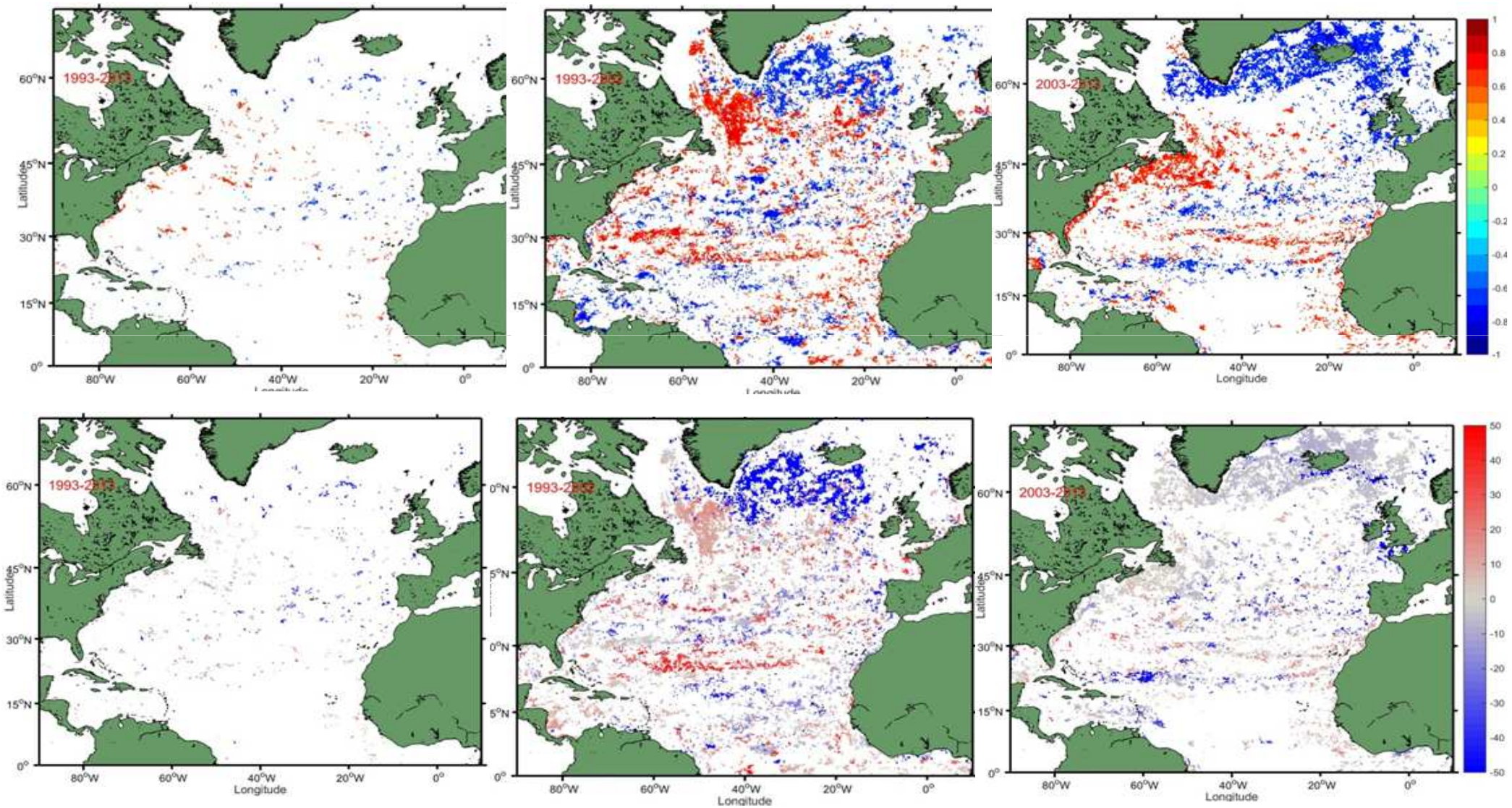
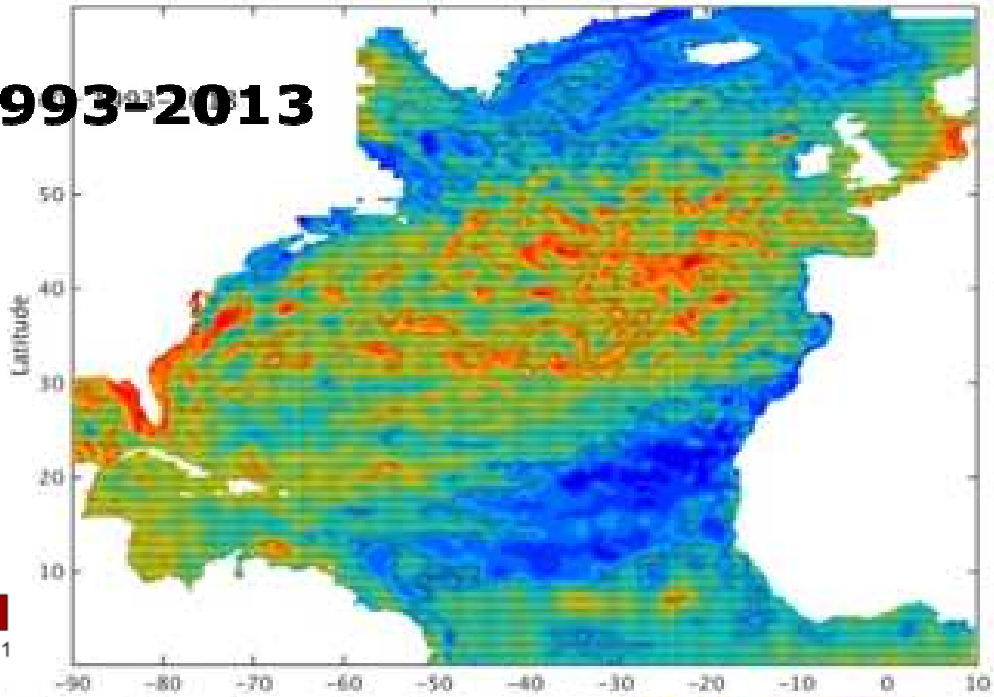
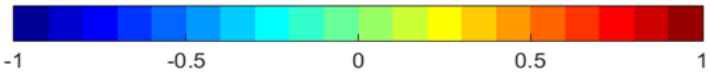
NCH

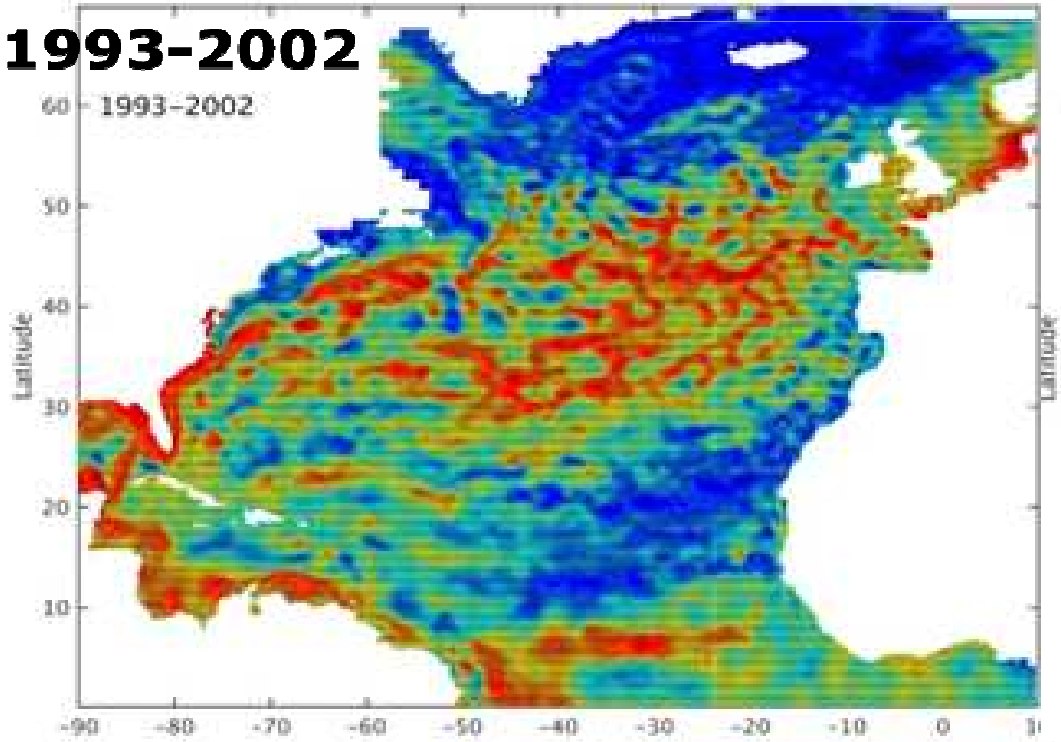


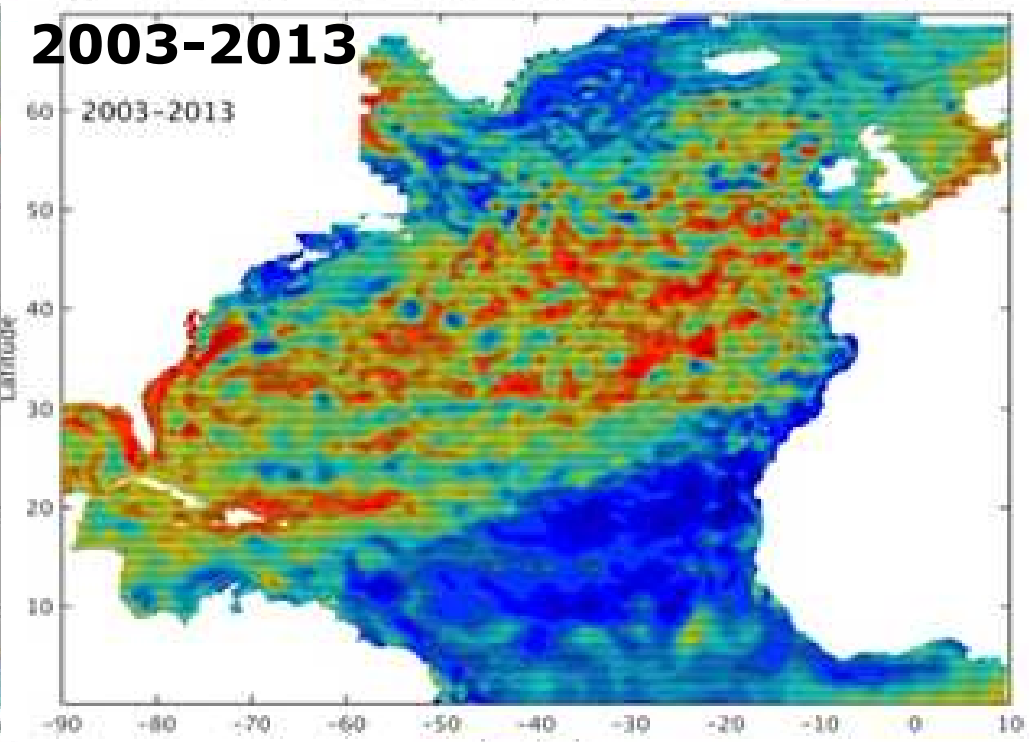
Spatial temporal correlation

Tide gauges *VS*
Hurrell Winter NAO index



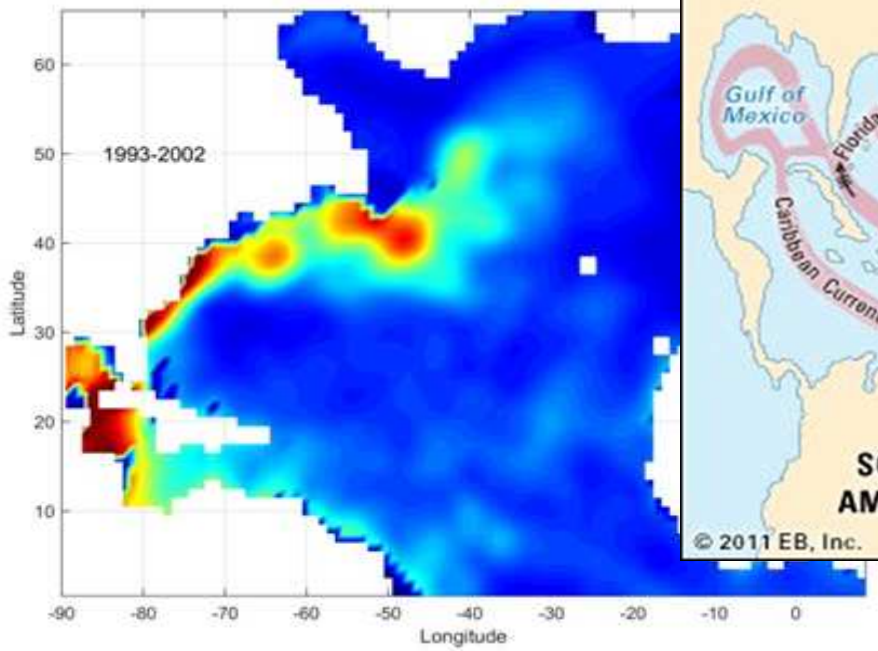


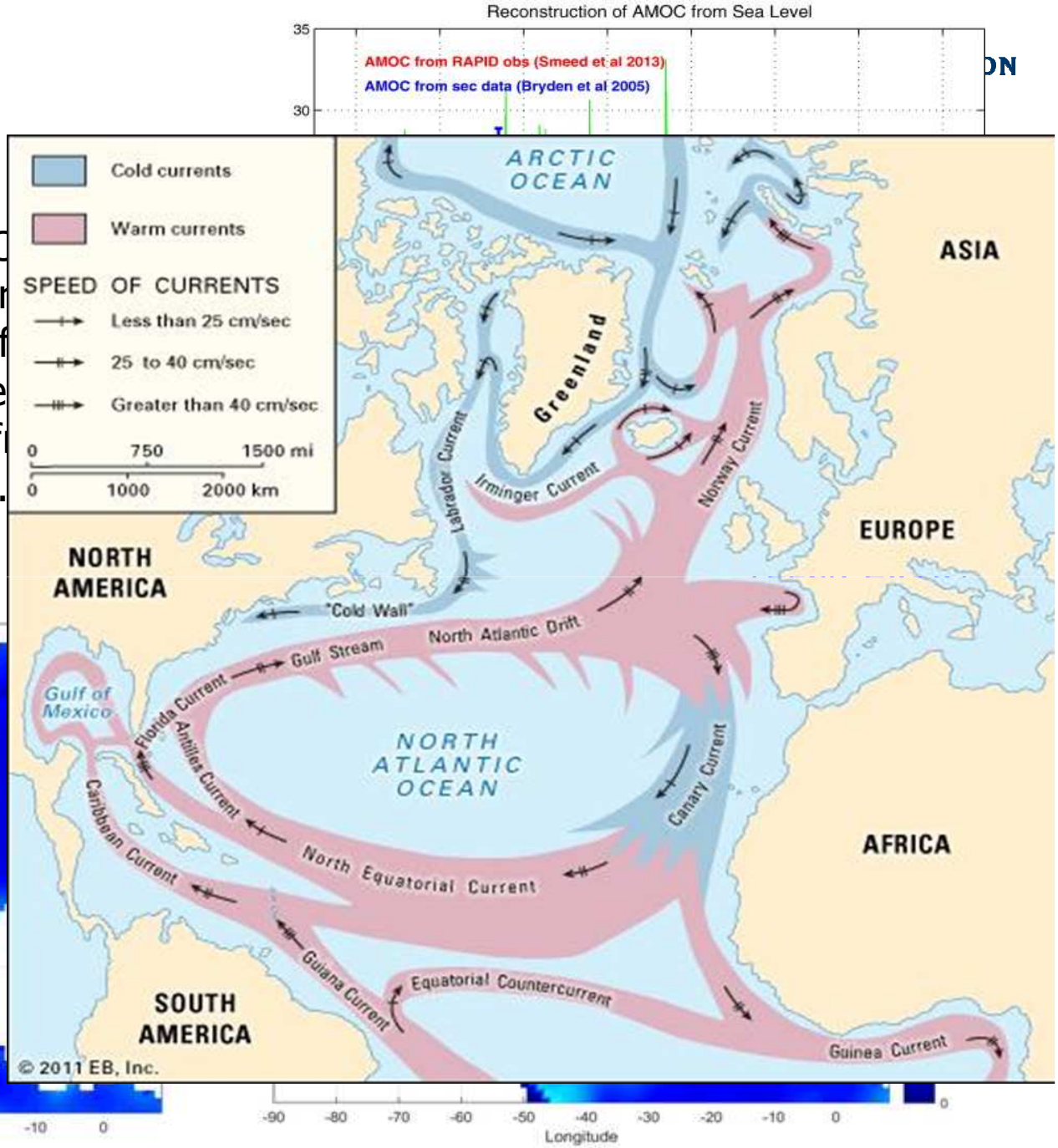




AMOC weaking

Reconstruction of monthly AMOC
1935 (green line), using the corr
sea level with observed AMOC af
(red line). Blue lines represent e
AMOC transport and error bars f
data across 25° N (Bryden et al.
Trend: Sv/dec.





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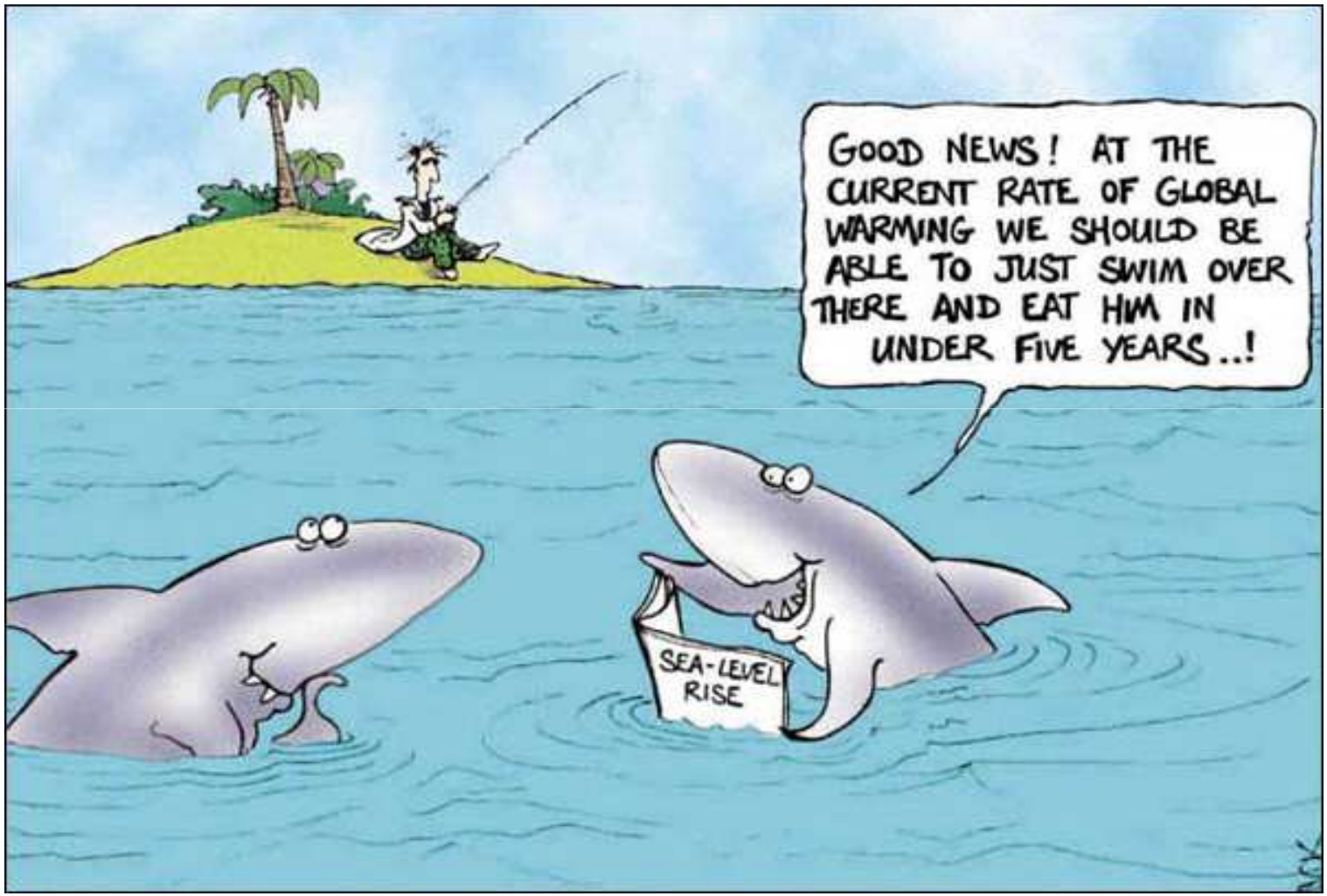
Summary

- 1.Significant correlations and the correlation variations between tide gauge data north of Cape Hatteras and altimeter data in the subpolar and tropical North Atlantic Ocean are observed in the last two decades.
- 2. The sea level variations in the Labrador Sea are highly correlated to local sea level variations north of Cape Hatteras with phase leading of about 3 years over 1993-2002 time period.
- 3. The spatial distribution characteristics of the correlation variations are linked to the slowing down of AMOC and the variations of NAO winter, atmospheric forcing and Ocean Heat Content in the North Atlantic Ocean.

Thanks for your attention.



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