Potential Geomorphic Consequences of Wave Climate Alterations on Cuspate Coastlines

Jennifer Johnson
Laura J. Moore, Kenneth Ells, A. Brad Murray
GSA-Southeast, San Juan, PR
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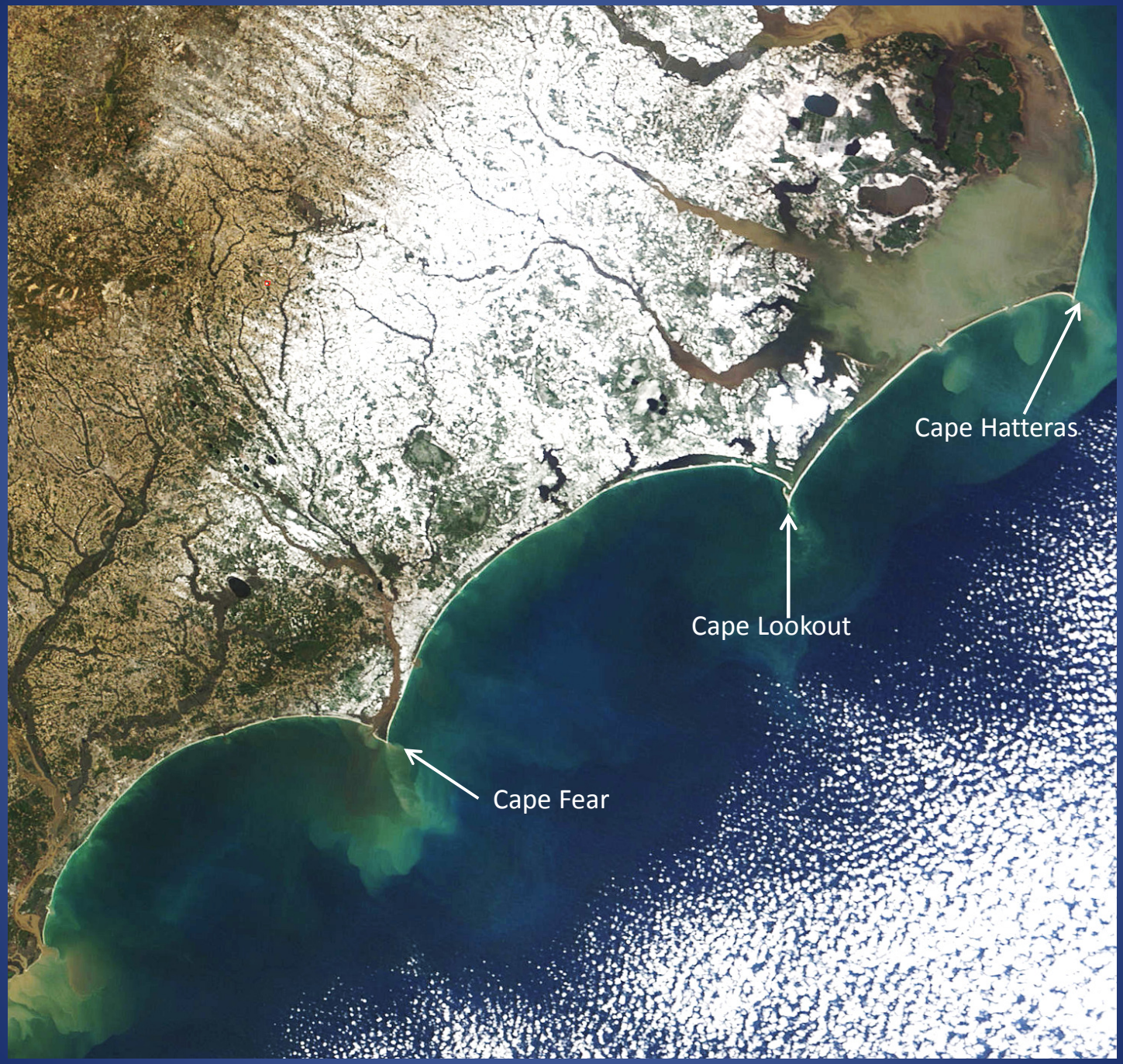


Image Courtesy NASA

Wave Climate Changes

- Komar & Allan (2008) - Increases in summer significant wave heights (Hs) since 1975
  - 0.7m increase over 30 years (Cape Hatteras, NC)
  - Along Eastern U.S.
  - Decreasing effect to North
  - Coincides with increasing tropical storm activity (Emanuel, 2005)

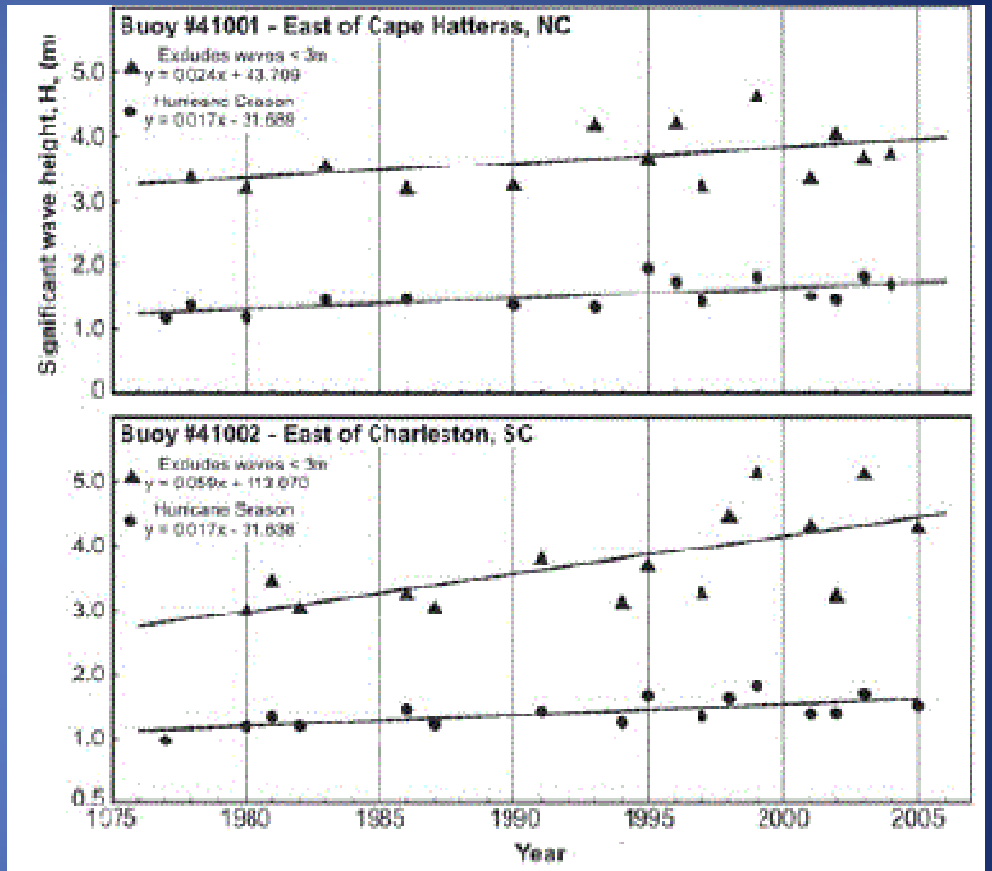
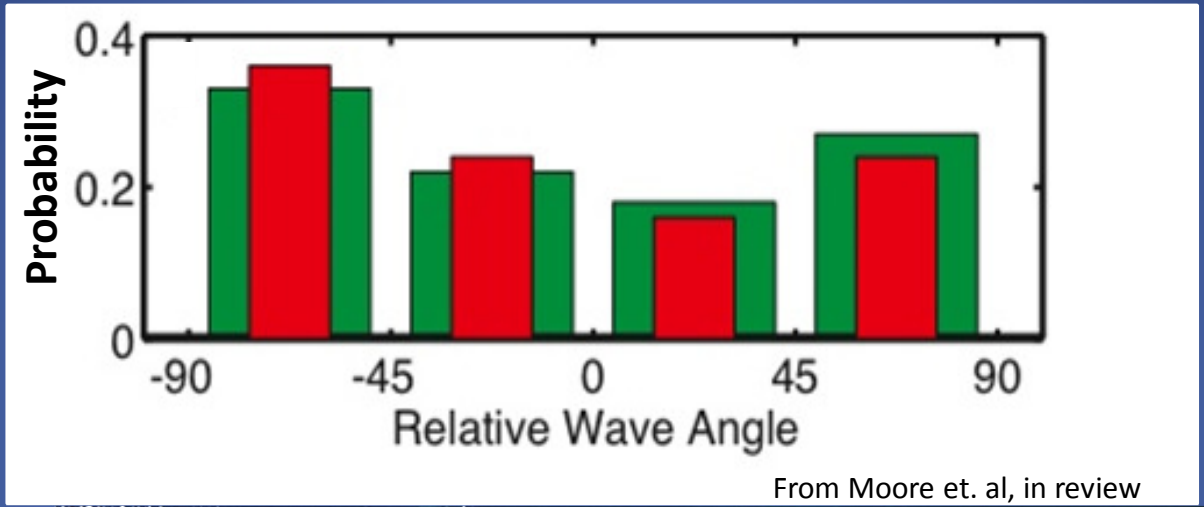


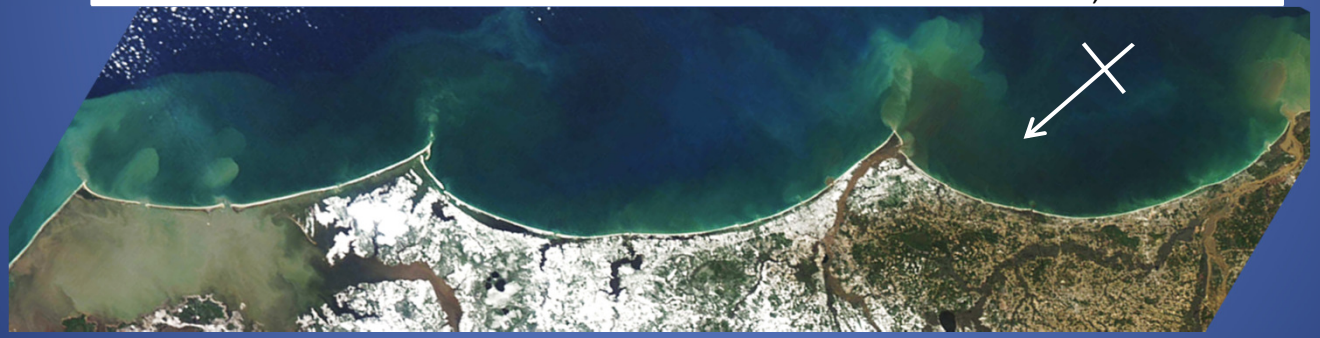
Figure 5. Trends in annual averages of the significant wave heights higher than 3 m, those generated by hurricanes and recorded by the East Coast buoys.

From Komar & Allan, 2008

NC Wave Climate Change



From Moore et. al, in review



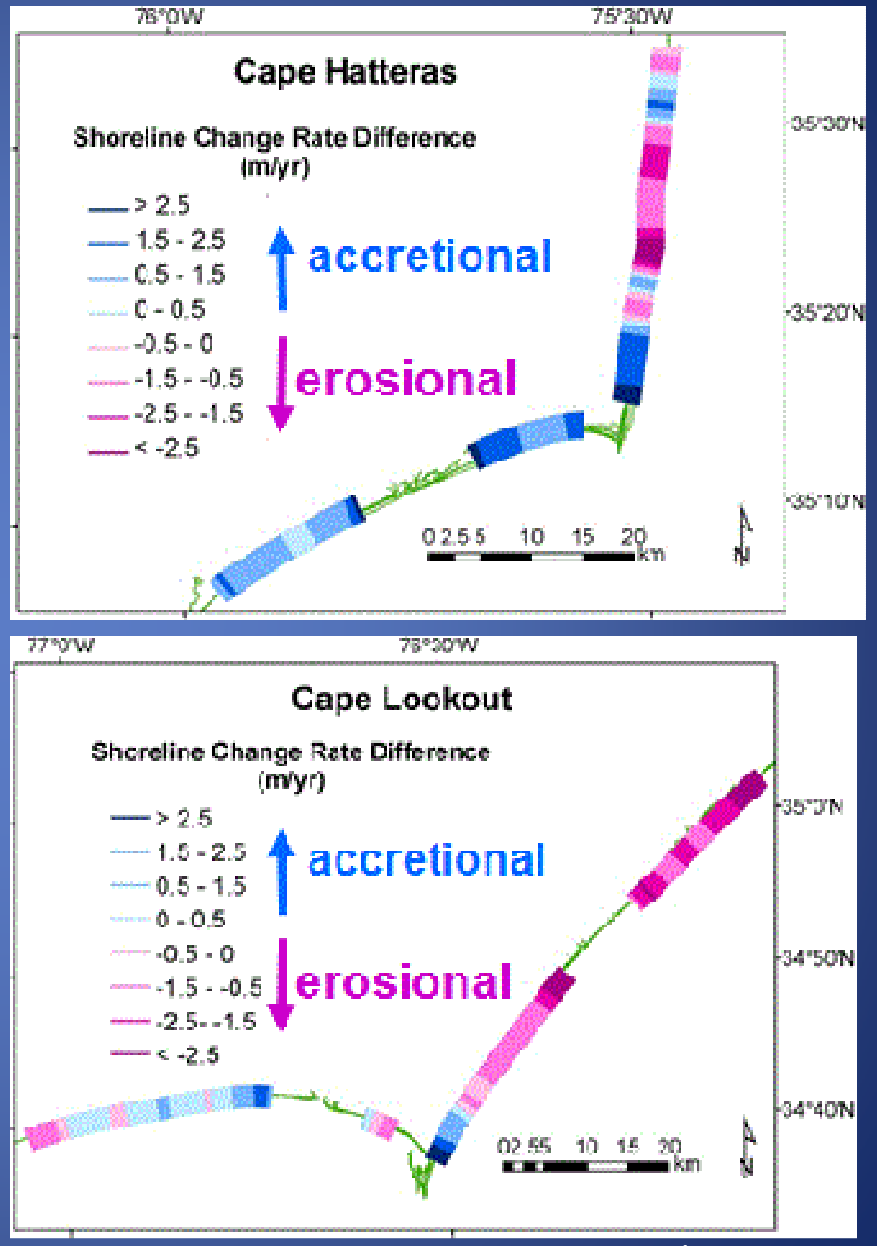
In NC, more large waves from the <u>east</u> & <u>northeast</u> which leads to an increasingly asymmetric, high-angle (>45°) wave climate (McNamara et. al, 2011).

Increasing Asymmetry

- Cape Hatteras & Cape Lookout
  - Shifts in areas of erosion/accretion since 1975
  - Increasing asymmetry

Shoreline Change Rate Difference

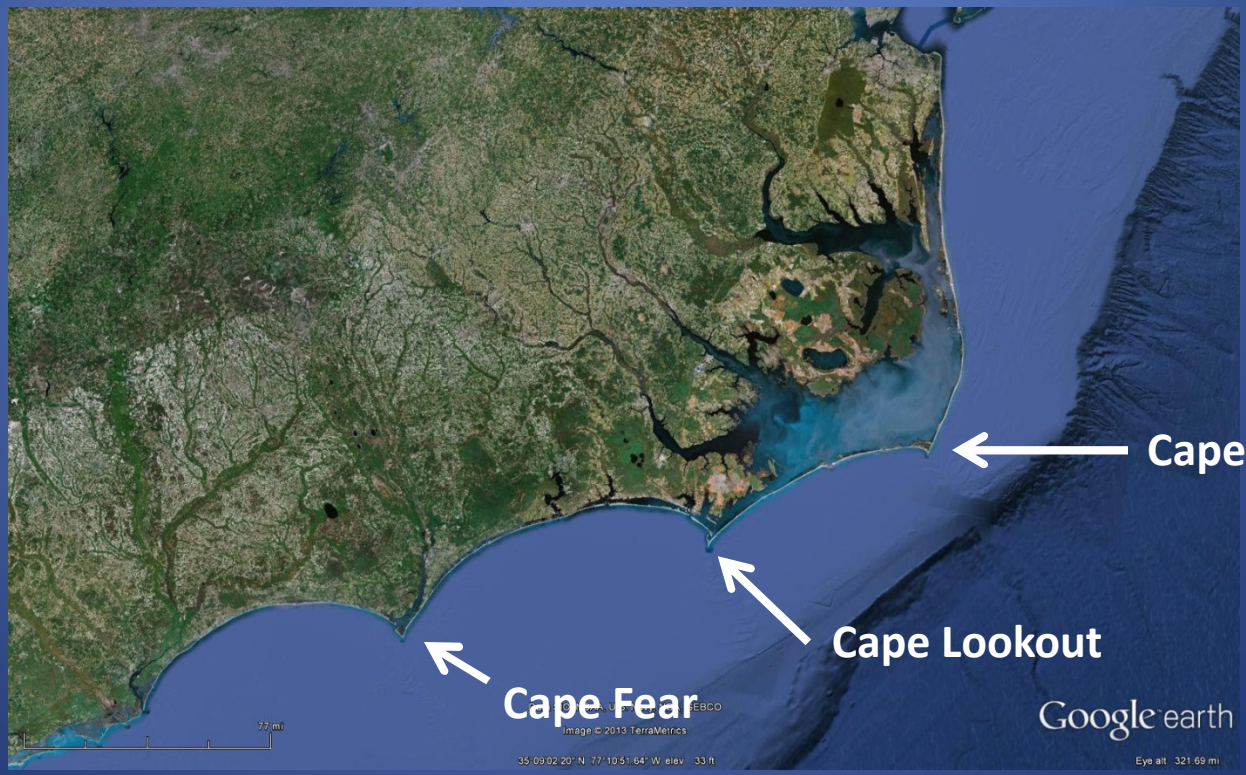
Rr (post 1975) - Rh (pre-1975)

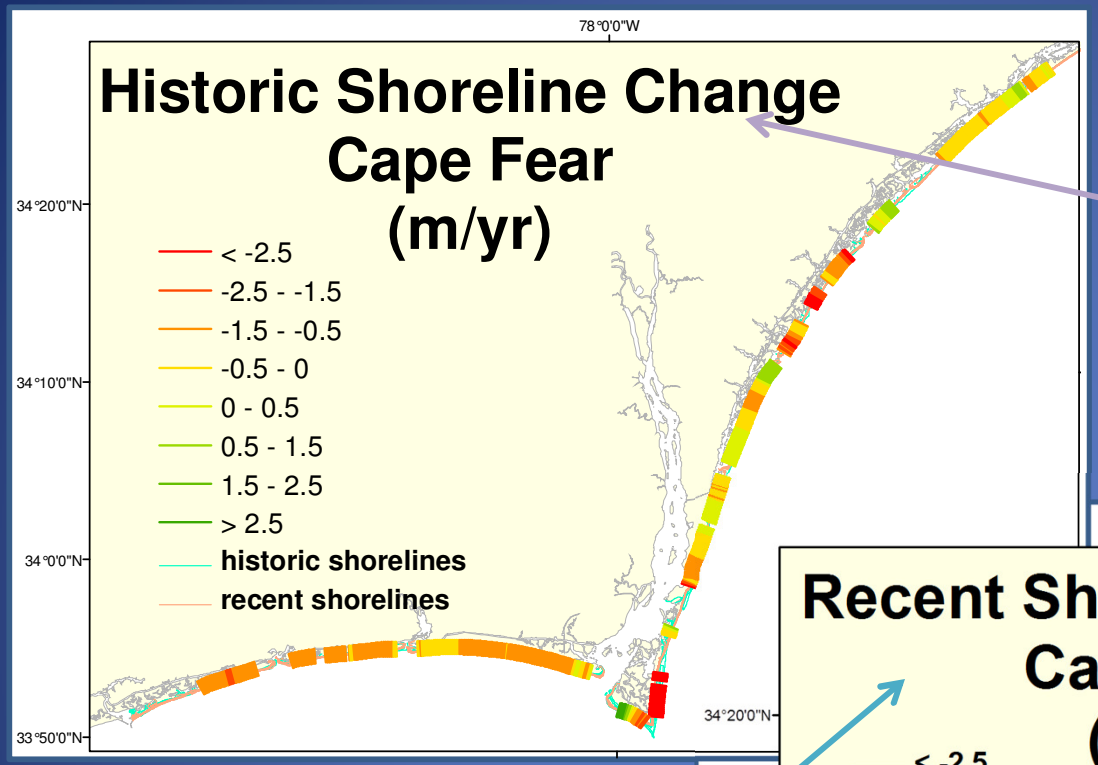


From Moore et al., in review

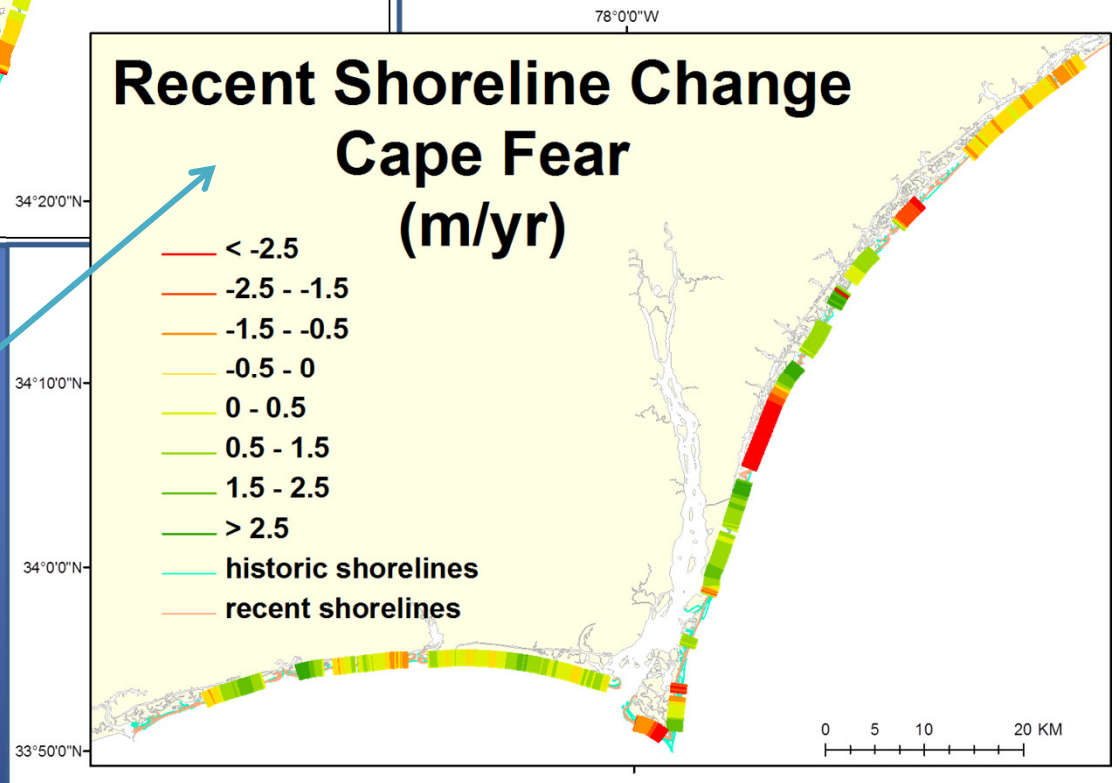
Cape Fear, NC

- Morphologically similar to Cape Hatteras and Cape Lookout
- Likely same degree of wave climate alteration
- More human influence

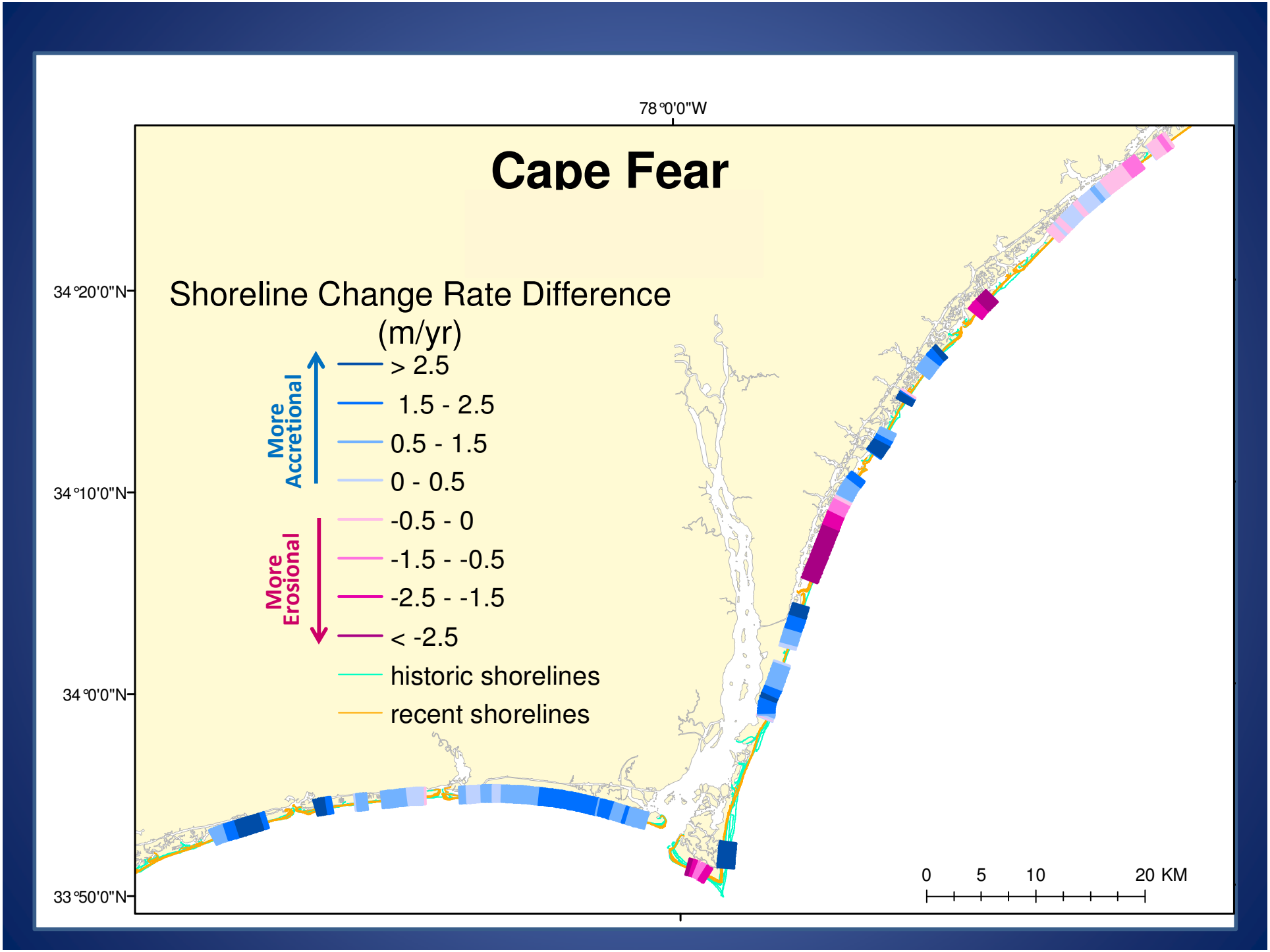




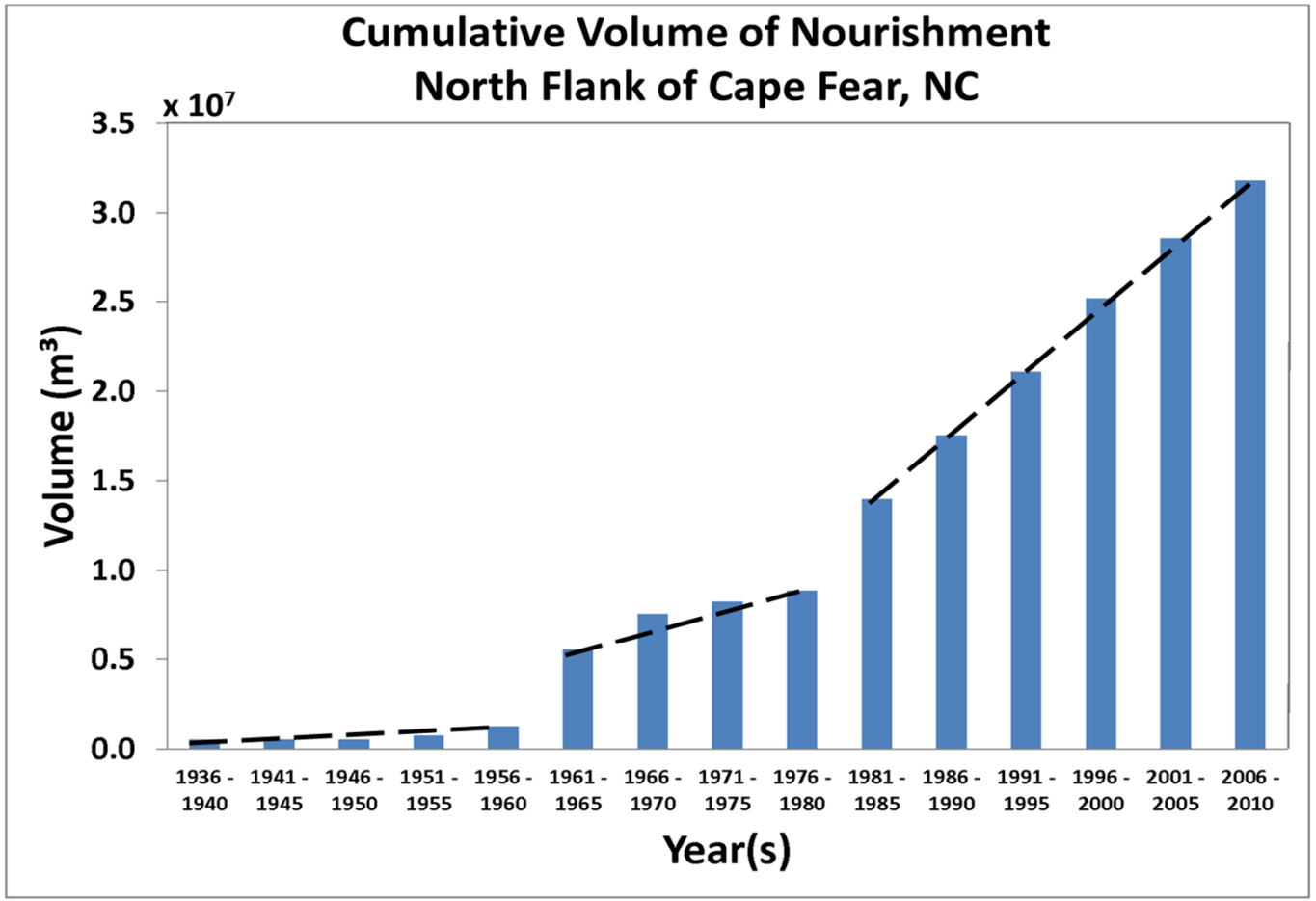
Historic Shoreline Change Rates
R_h
1850-1970



Recent Shoreline Change Rates
R_r
1970-2004


Cape Fear
78°0'0"W
34°20'0"N
34°10'0"N
34°0'0"N
33°50'0"N
Shoreline Change Rate Difference
(m/yr)
More Accretional
More Erosional
> 2.5
1.5 - 2.5
0.5 - 1.5
0 - 0.5
-0.5 - 0
-1.5 - -0.5
-2.5 - -1.5
< -2.5
historic shorelines
recent shorelines
0 5 10 20 KM

Nourishment Graph

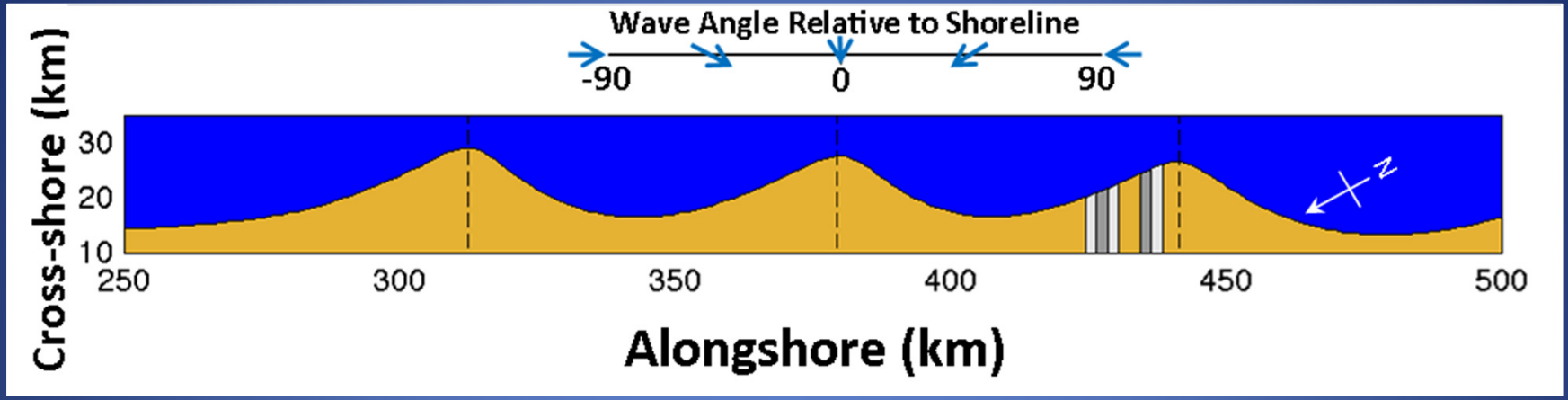


Data from PSDS

Coastline Evolution Model

- Uses PDF to select daily offshore wave angle.
- Starting in 1970 - linear increase in waves approaching from left (east/northeast)
- Assumes refraction over shore parallel bathymetric contours

Coastline Evolution Model Set-up

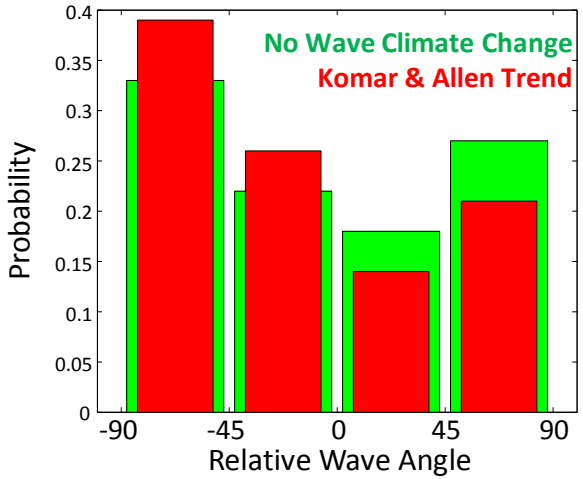


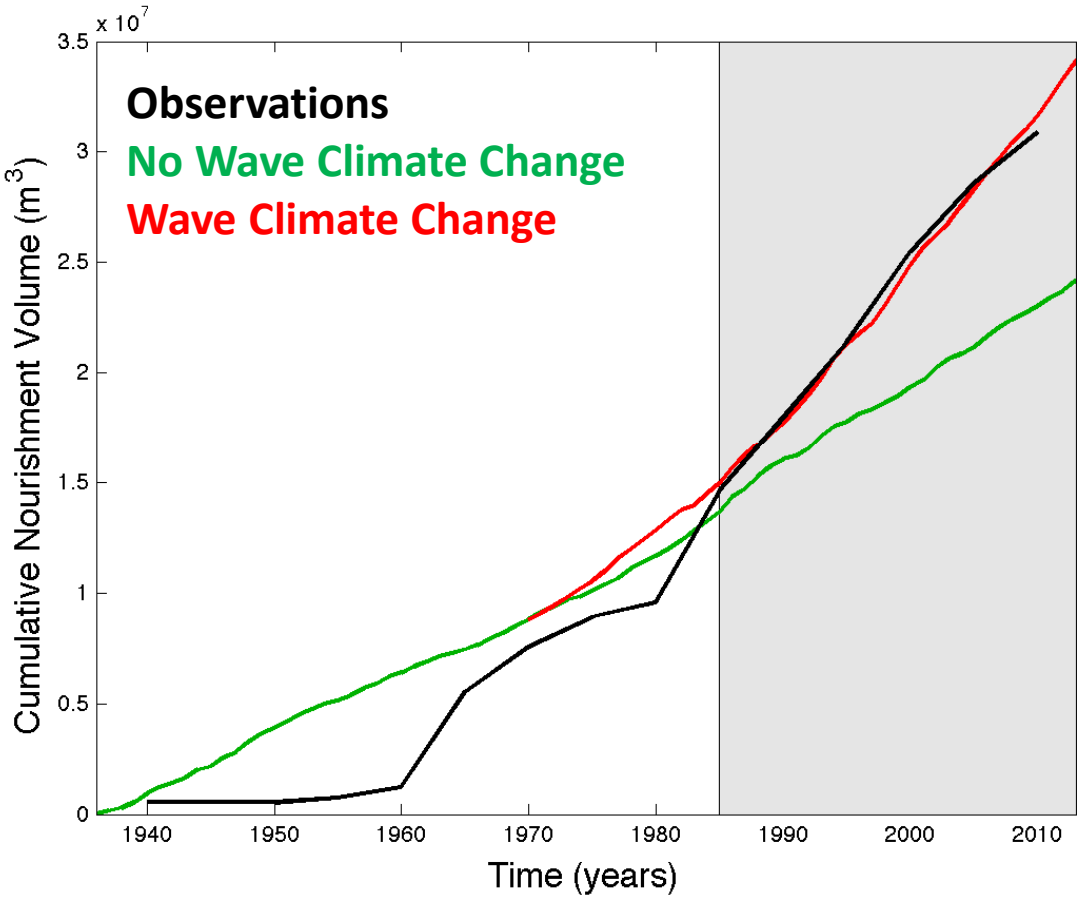
Areas nourished in the model approximate locations of high-volume nourishment.

Nourishment from 1940 – 1980 limited to dark grey bars

Nourishment expanded in 1980 to reflect observations (light grey bars).

Results


No Wave Climate Change
Komar & Allen Trend
Probability
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-90
-45
0
45
90
Relative Wave Angle


x 10^7
Observations
No Wave Climate Change
Wave Climate Change
Cumulative Nourishment Volume (m^3)
3.5
3
2.5
2
1.5
1
0.5
0
1940
1950
1960
1970
1980
1990
2000
2010
Time (years)

Conclusions

- Cape Fear shoreline change observations don't reflect the geomorphic signature of an increasingly asymmetric wave climate.
- Rates of nourishment increase ~ 1970, coinciding with changes in wave climate.
- Effects of wave climate change are discernible in patterns of shoreline stabilization.

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THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL