Multi-Year Current and Surface Gravity Wave Observations Near Florida's Big Bend Coast

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Thursday, May 19, 8:45 – 10:15 AM

Objective:

Gag grouper, red tide, oil spills

Understand the subtidal currents (along- and cross-isobath) and how they may be influenced by:

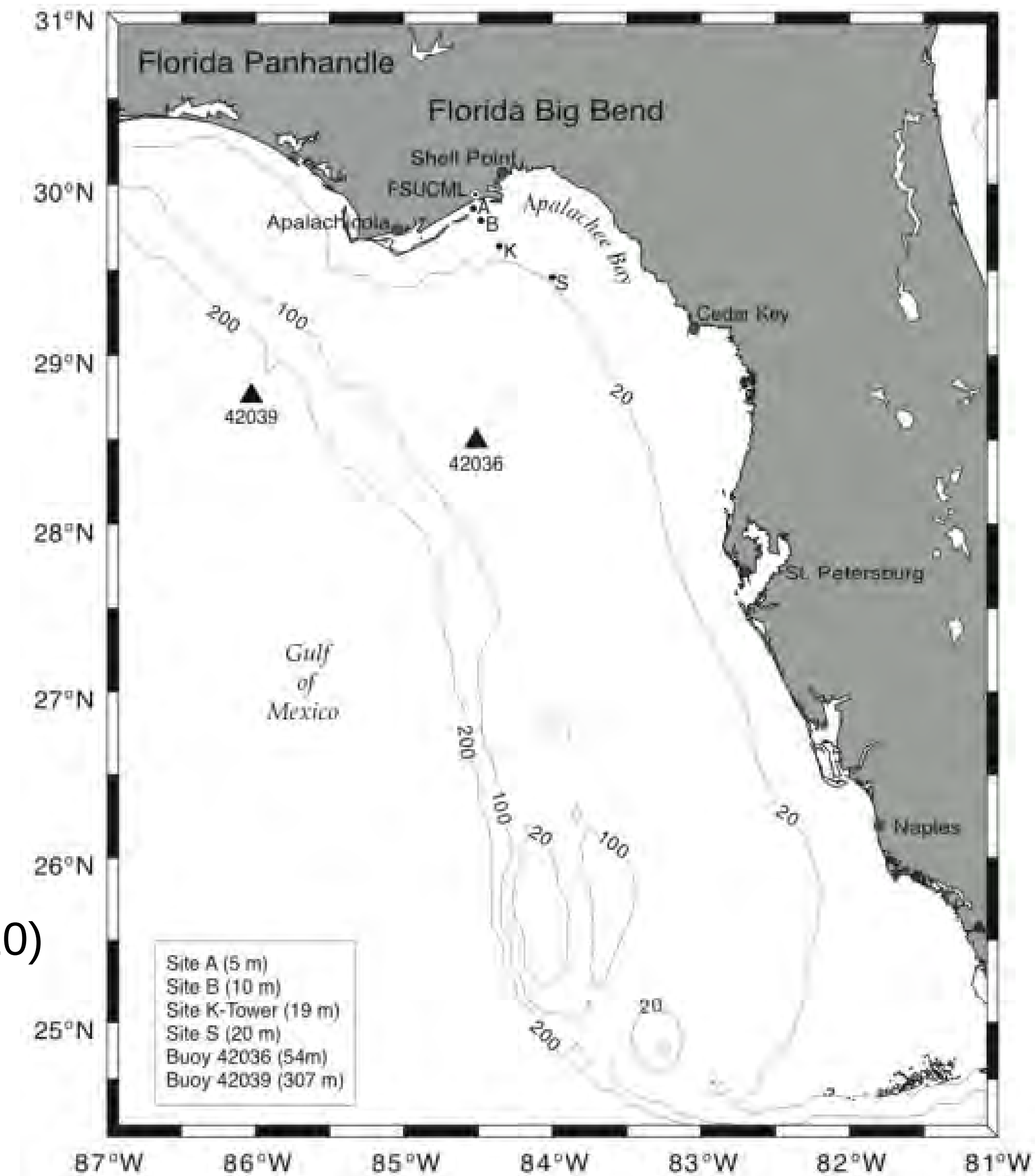
- The 90º bend in Florida's Big Bend Coast
- Wind (local and remote via long shelf waves)
- Vertical stratification (summer/winter)
- River discharge (horizontal density gradients)
- Surface gravity waves (Stokes' Drift)
- Water column depth

Study region:

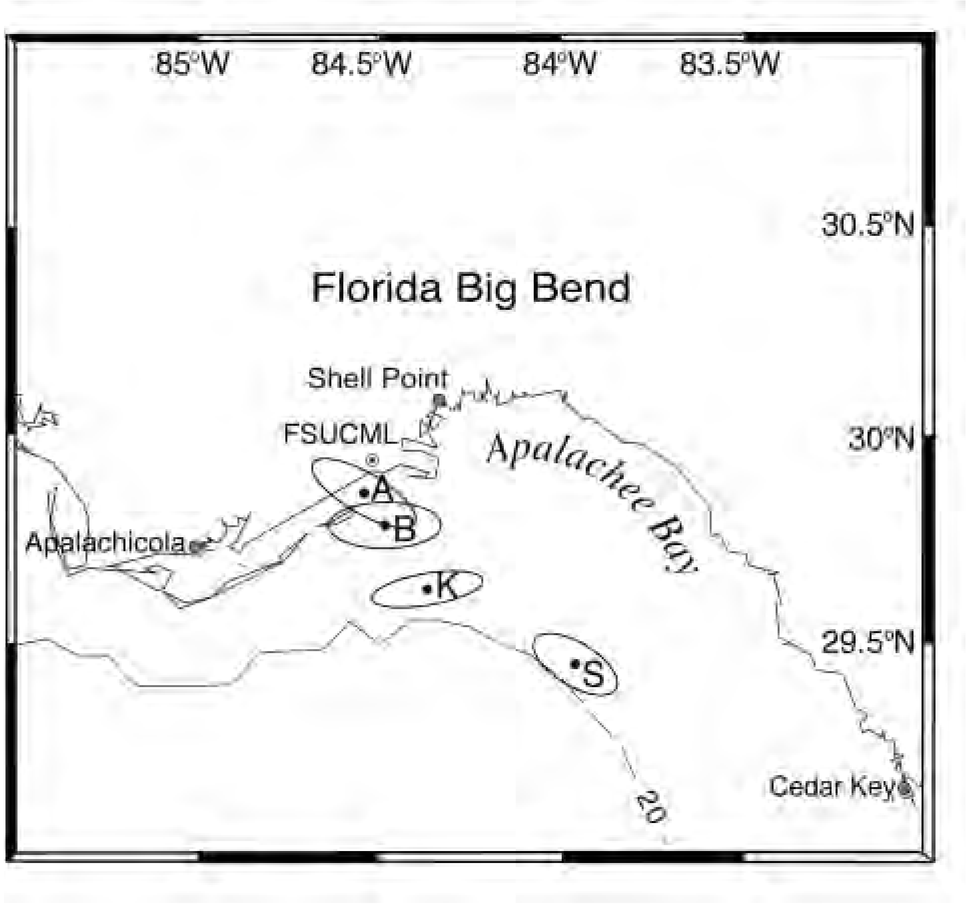
Florida Big Bend, where West Florida Shelf bends by 90º.

Never-before-analyzed ADCP current and surface gravity wave records at

K-Tower: ~4 yrs (2007-2010)
Site B: ~2 yrs(2008, 2009, 2010)
Site A: ~3 yrs (2008-2010)
Site S: ~1 yr (2009, 2010)



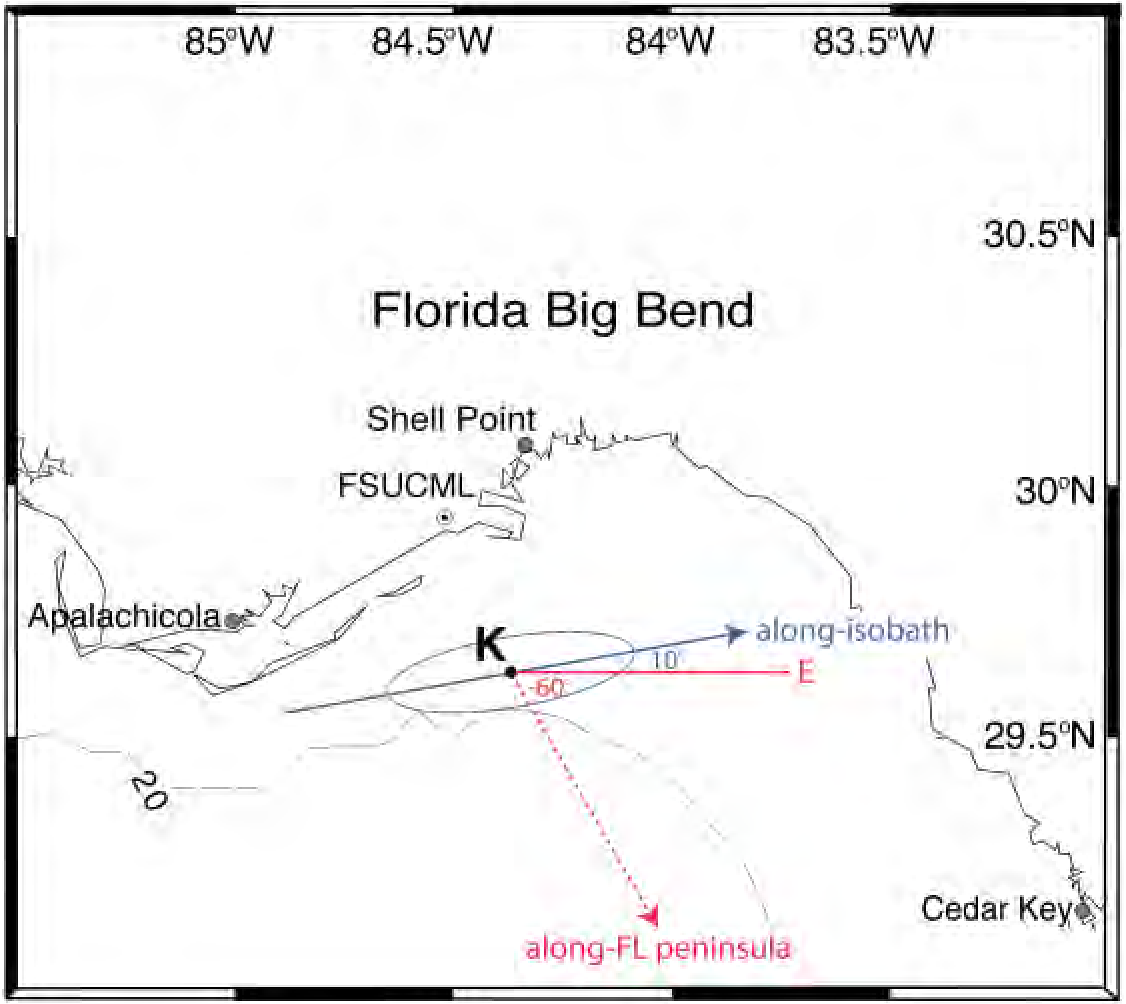
Big Bend Region with local major axis ellipses for currents



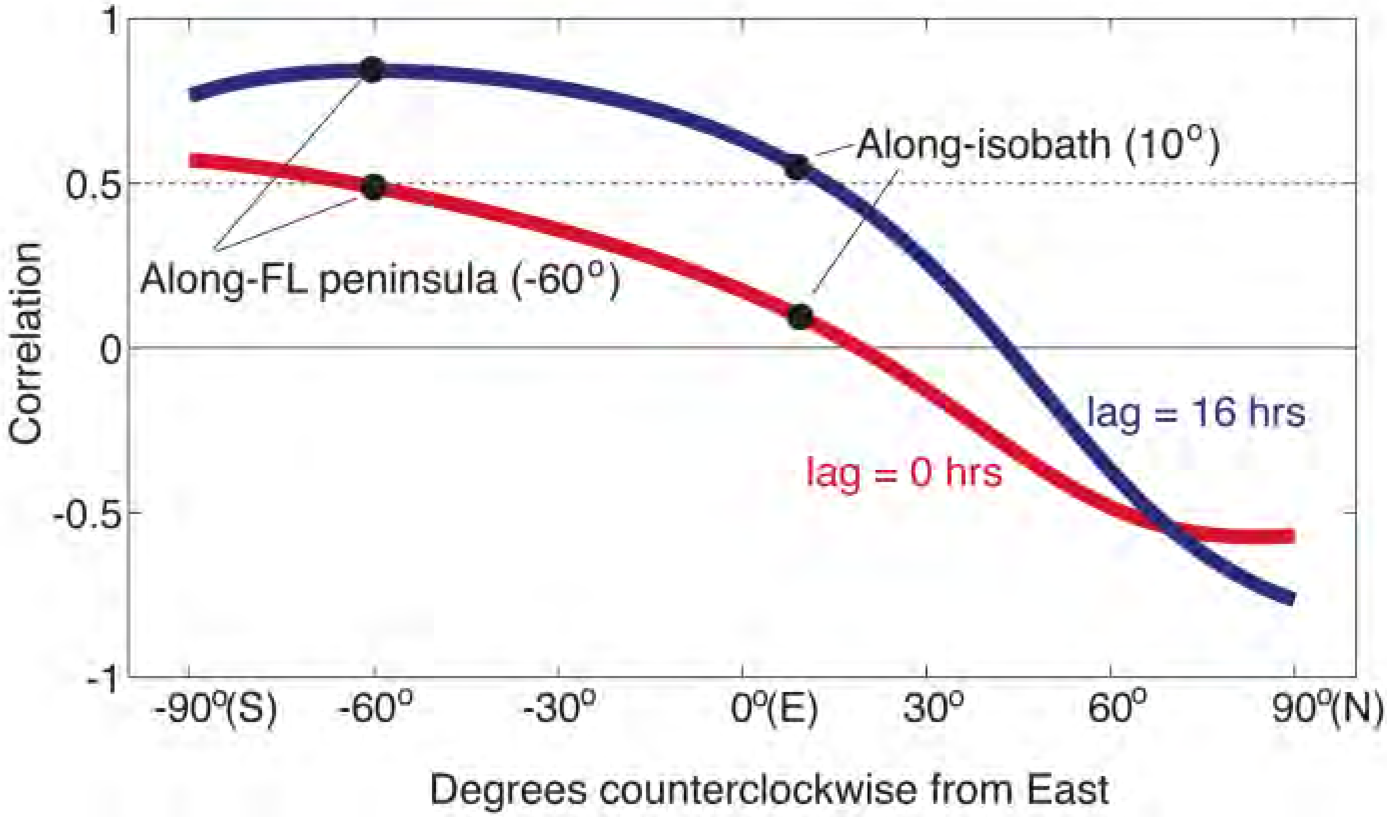
Along the major axis of variability the currents have the same sign at all depths. The depth-averaged flow is within about 10º of being along the local isobaths.

What is wind orientation for best correlation with the depth-averaged along-shelf flow?

What are the dynamical implications?

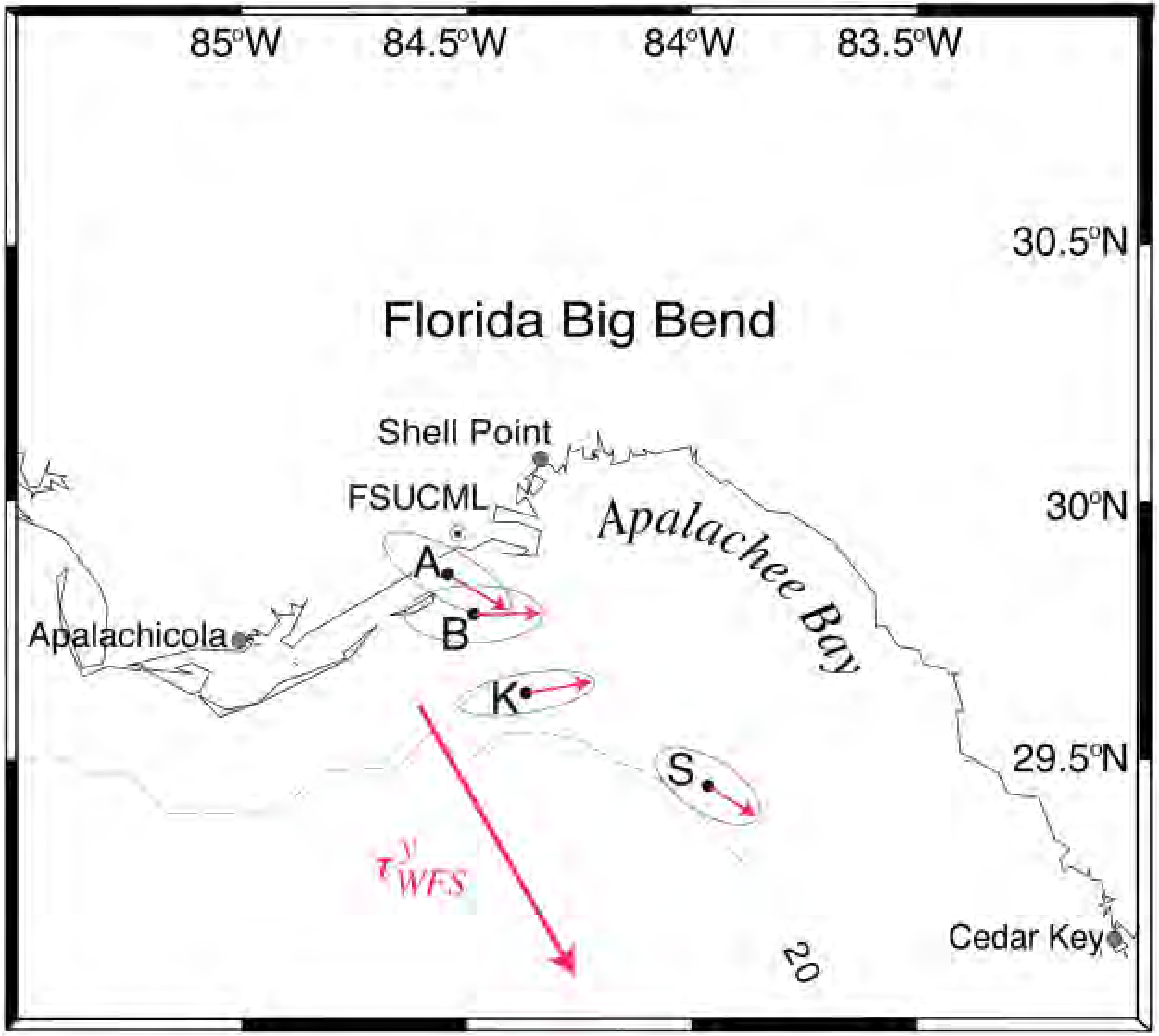


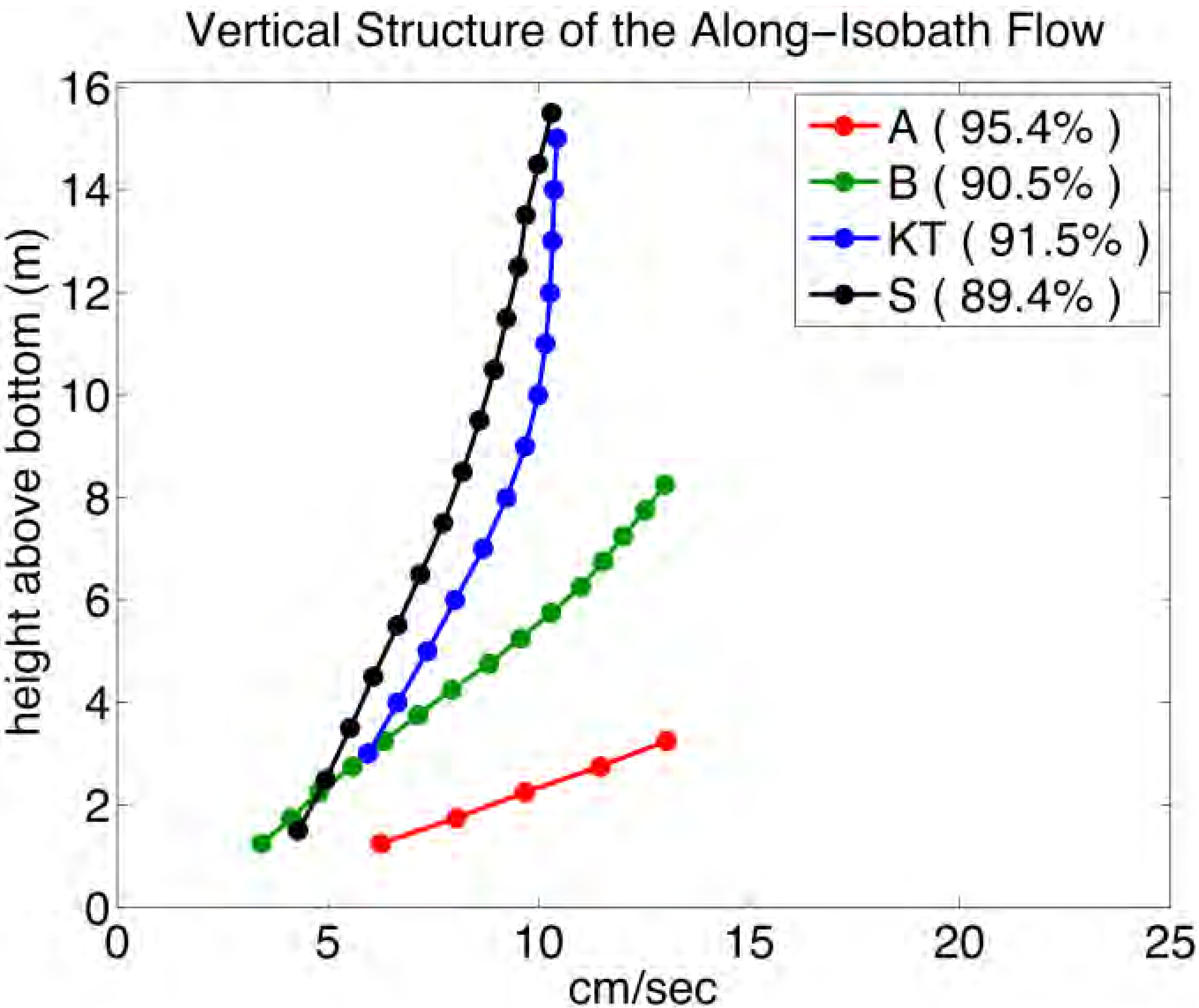
Correlation of along-isobath current at K-Tower and wind stress in all directions from southward (-90º) to northward (90º), winter 2009.



⇒ <u>**Remote**</u> forcing dominates in driving along-shelf currents near the Bend **=>**

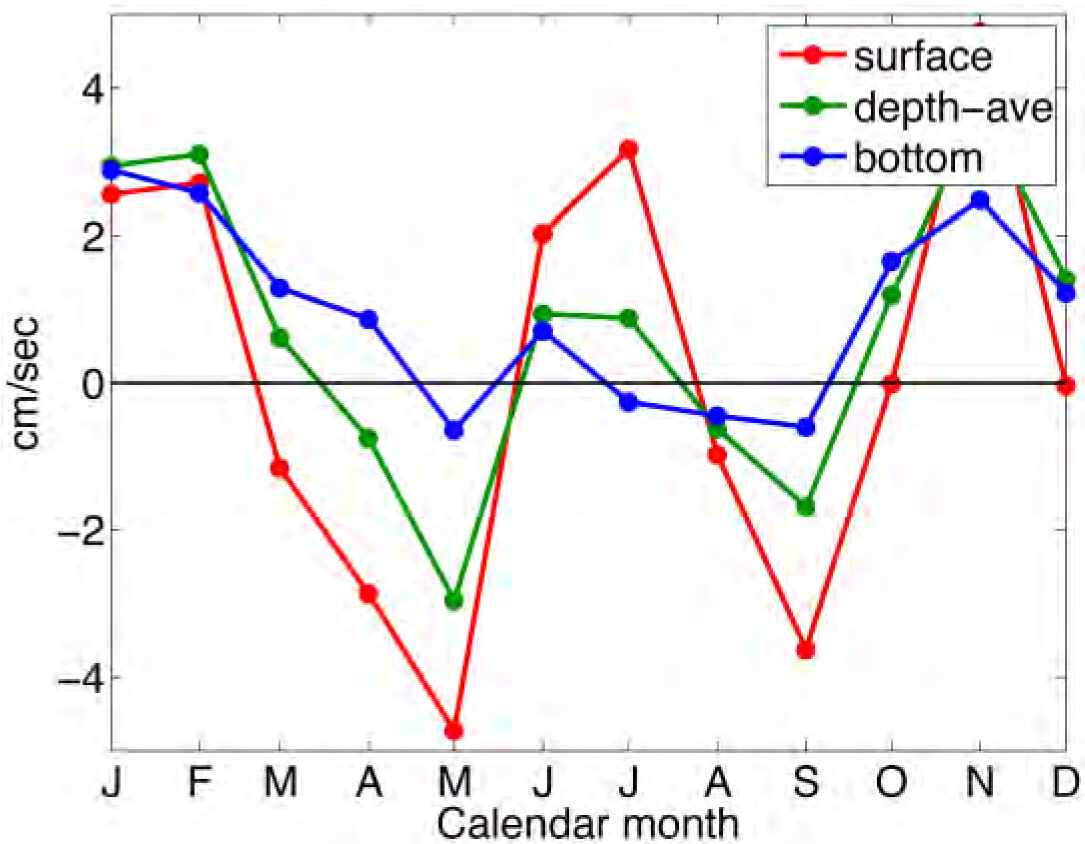
Low-frequency long shelf-trapped wave dynamics.

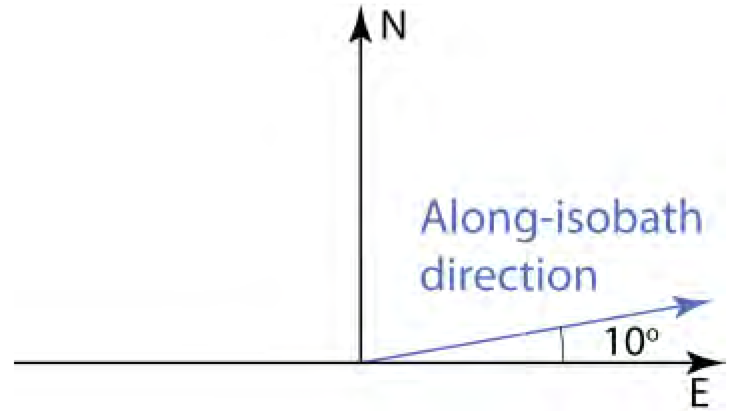

85°W
84.5°W
84°W
83.5°W
30.5°N
Florida Big Bend
Shell Point
FSUCML
Apalachee Bay
30°N
A
B
Apalachicola
K
29.5°N
S
τ^{y}_{WFS}
20
Cedar Key



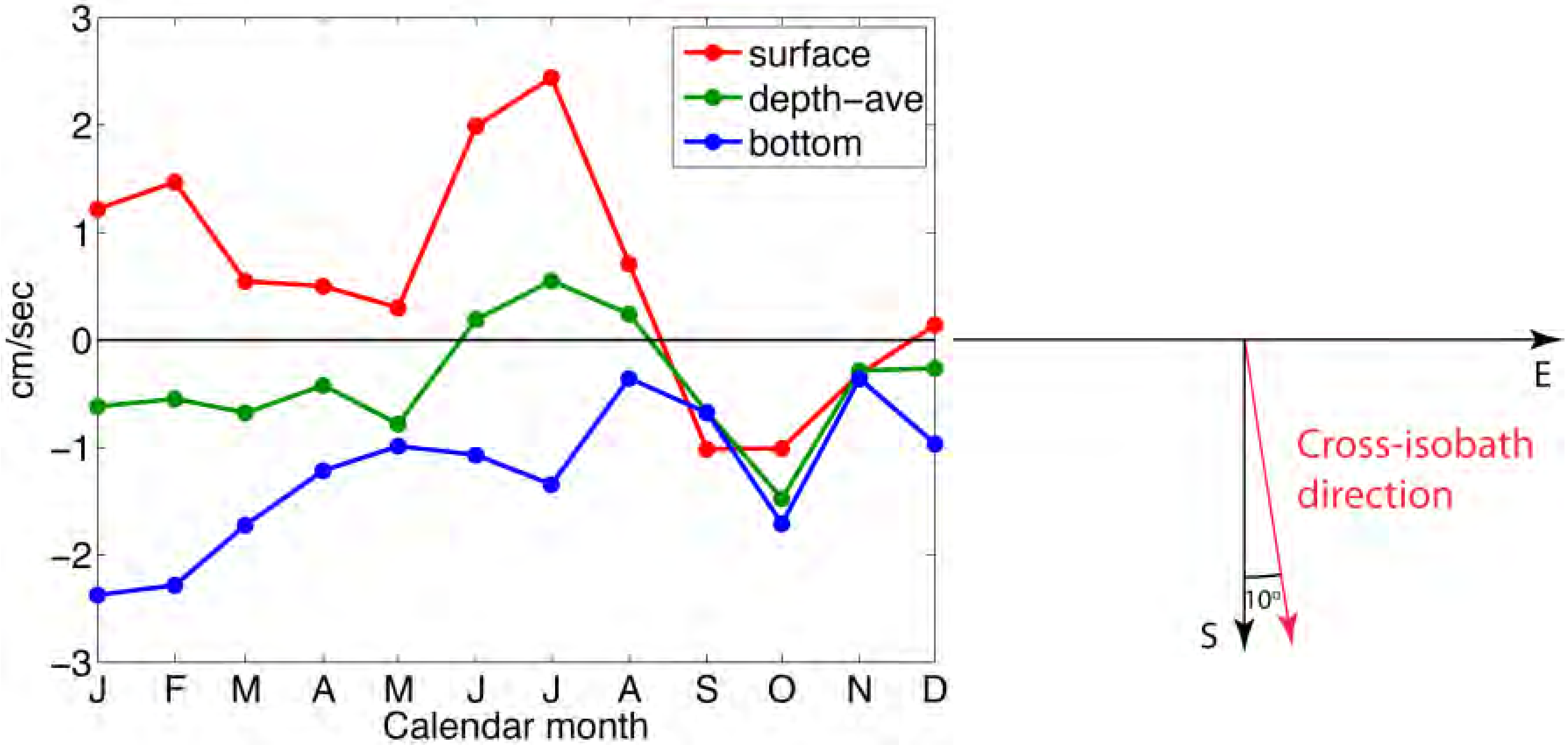
Vertical Structure of the Along−Isobath Flow
height above bottom (m)
cm/sec
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
A (95.4%)
B (90.5%)
KT (91.5%)
S (89.4%)

Along-isobath seasonal current at K-Tower

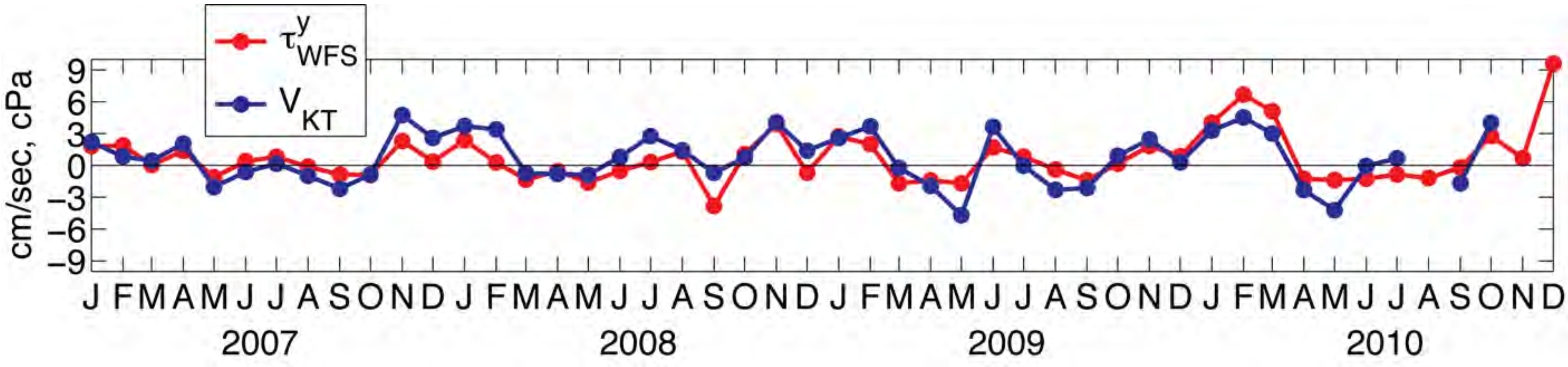




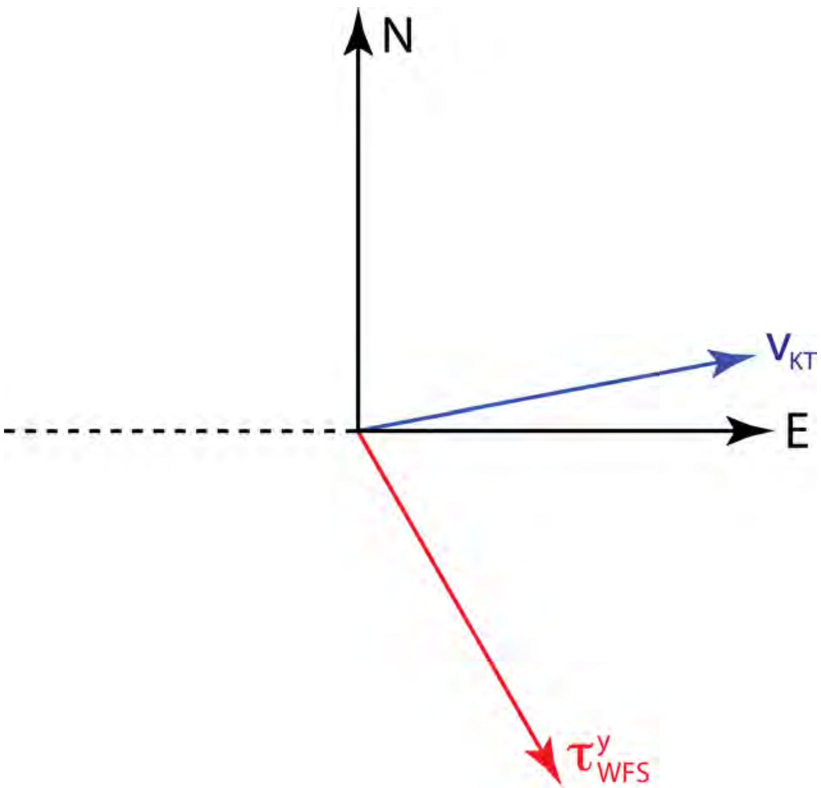
Cross-isobath seasonal current at K-Tower



Much of the along-isobath monthly flow is remotely wind-driven.

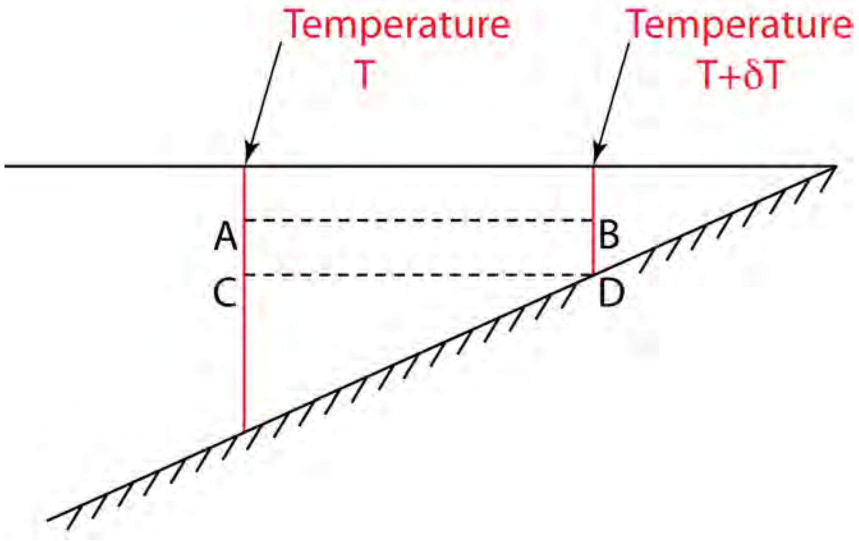


v_{KT} = depth-averaged along-isobath flow at K-Tower

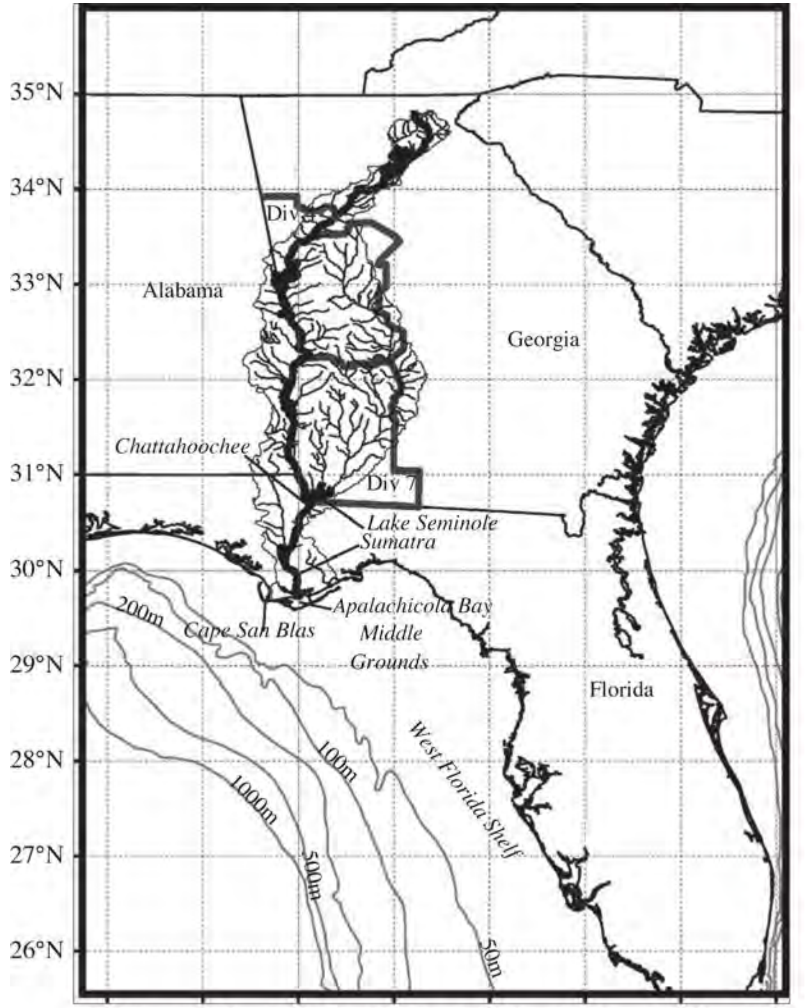


Seasonal flows driven by density gradients

- In shallow water same amount of heat goes into a smaller water depth; increased temperature in shallower water, lighter water, and hence there's a horizontal density and pressure gradient and current. Geostrophic current depends on depth.



Seasonal flows can also be driven by horizontal salinity gradients, mainly due to coastal fresh water from the Apalachicola River.



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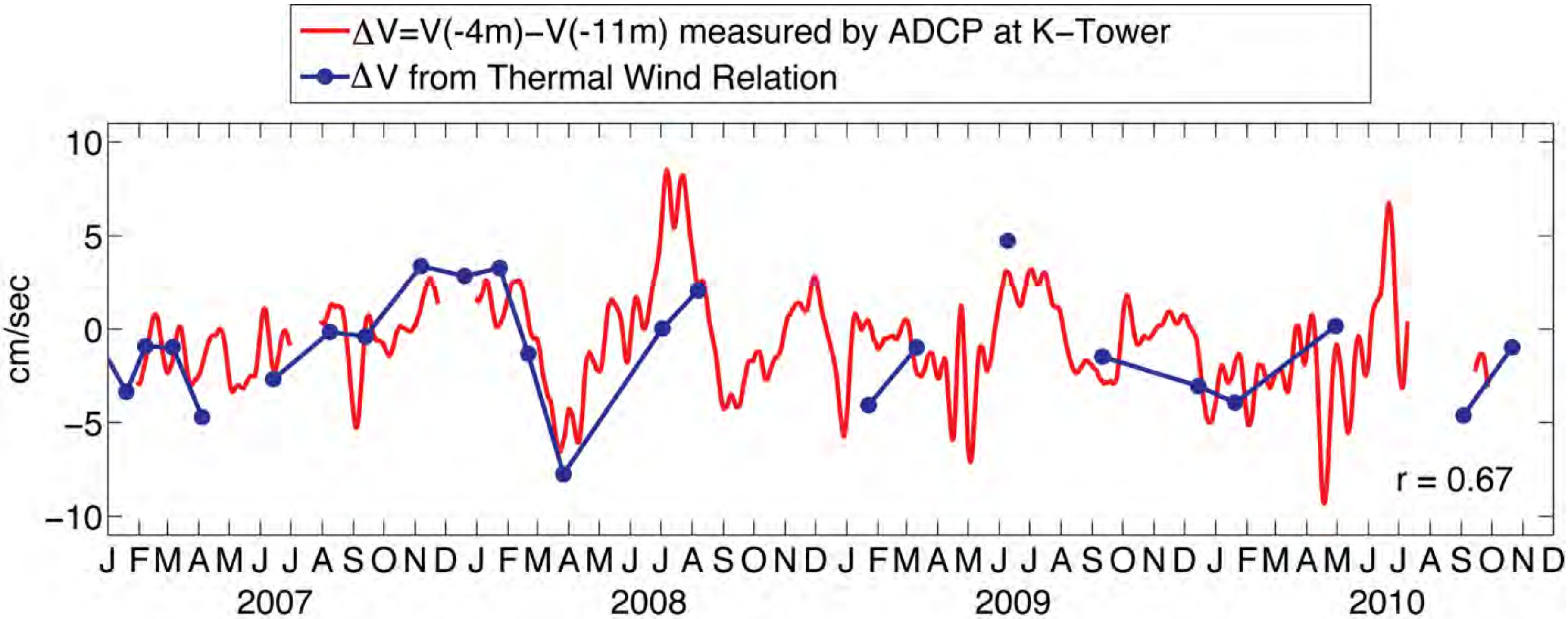
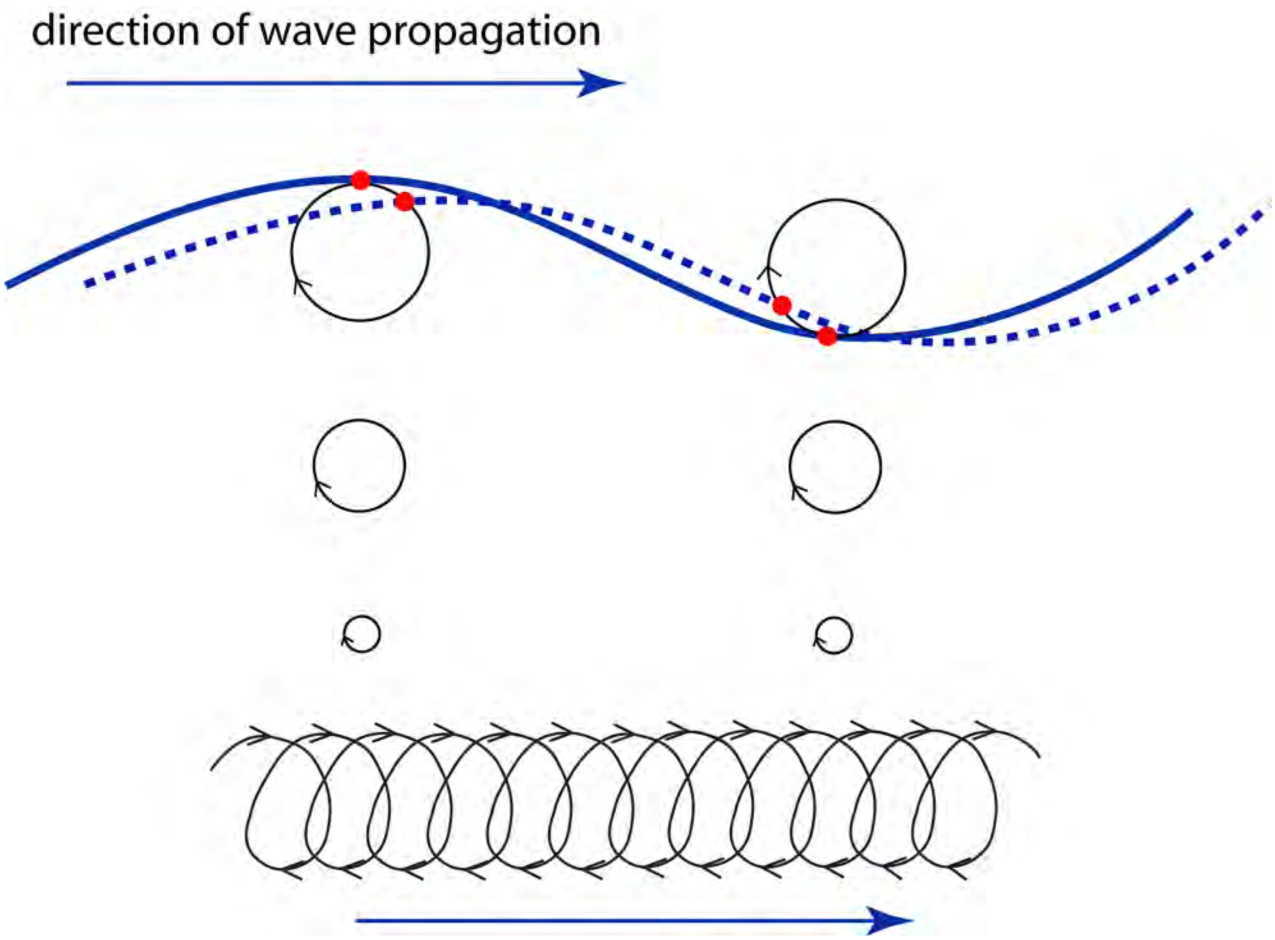
Actually, salinity mainly explains the density gradient.

$$v_z = -g\rho_x/(\rho f)$$

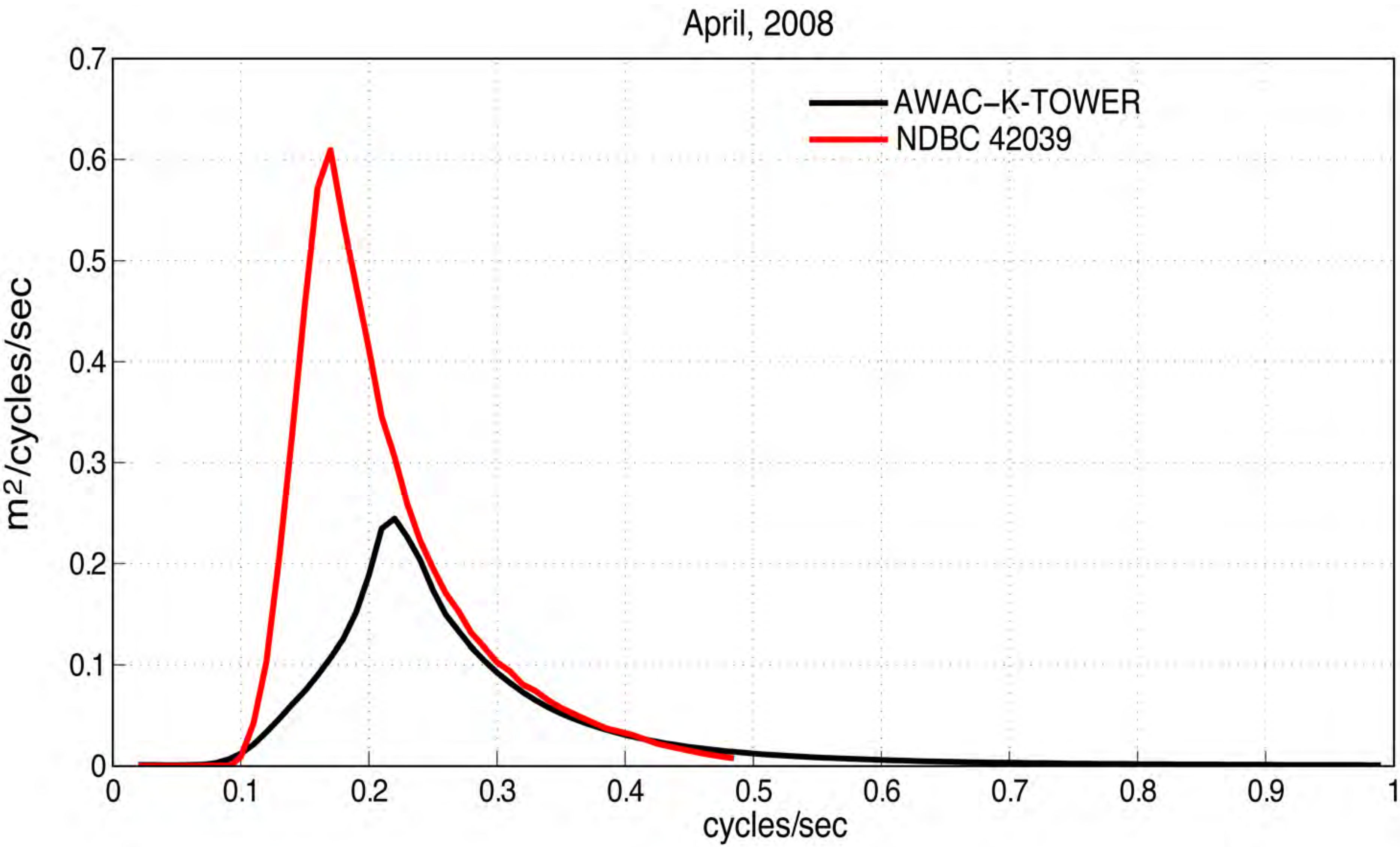
$$\Delta v = v(-4m) - v(-11m) = -g(\rho f)^{-1}\int_{-11m}^{-4m} \rho_x dz$$



Surface Waves & Stokes' Drift



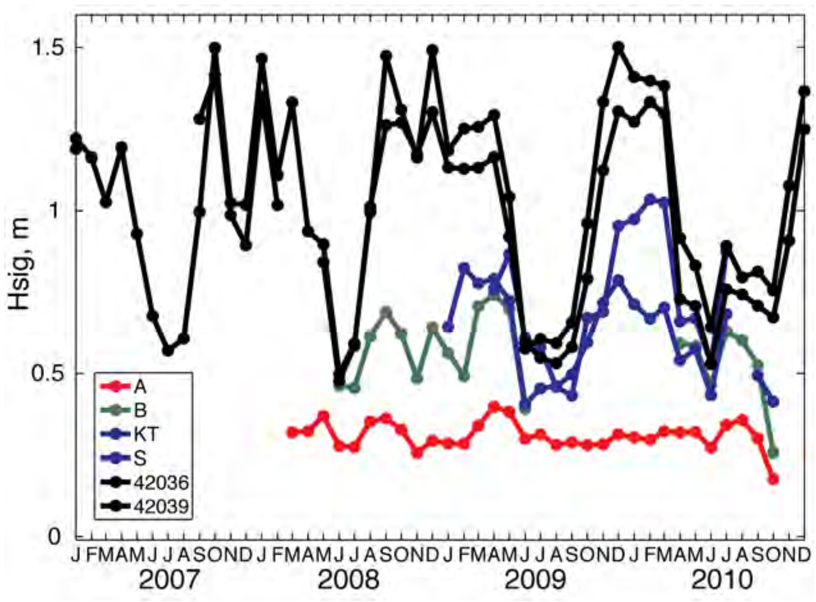
Stokes' drift



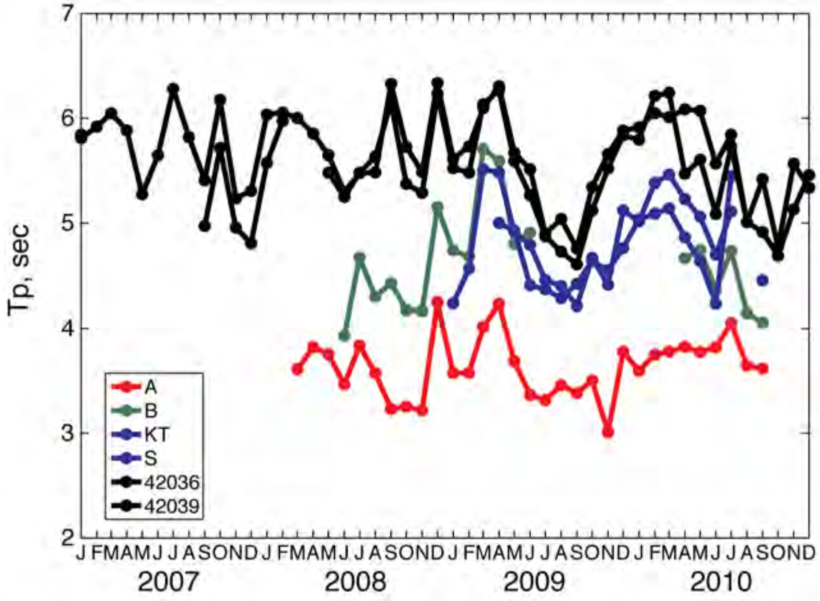
April, 2008
AWAC–K-TOWER
NDBC 42039
m2/cycles/sec
cycles/sec
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Wave characteristics

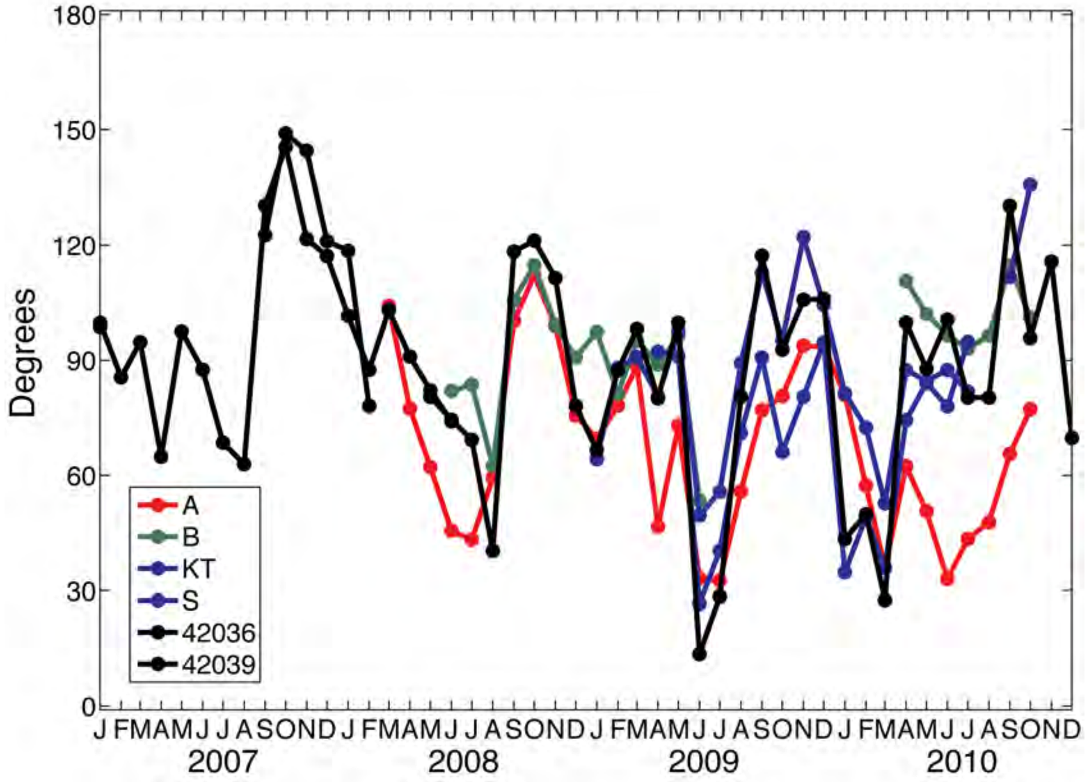
Significant wave height



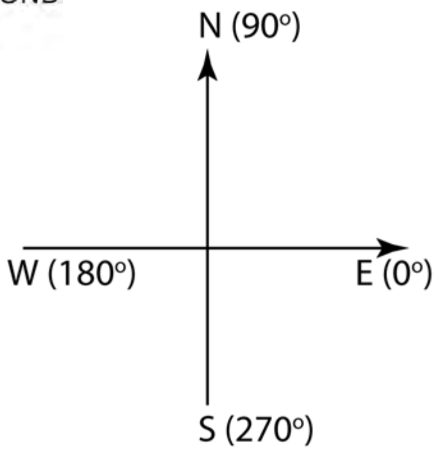
Period at the peak of the wave spectrum



Wave direction



90º means that the waves' direction is northward.



Stokes' drift should be "added on" to what we measure at a fixed site (e.g., K-Tower).

Stokes' drift at K-Tower is northward but is typically less than 0.5 cm/sec at the uppermost measurement 4 m beneath the surface. It's even smaller at the shallower sites.

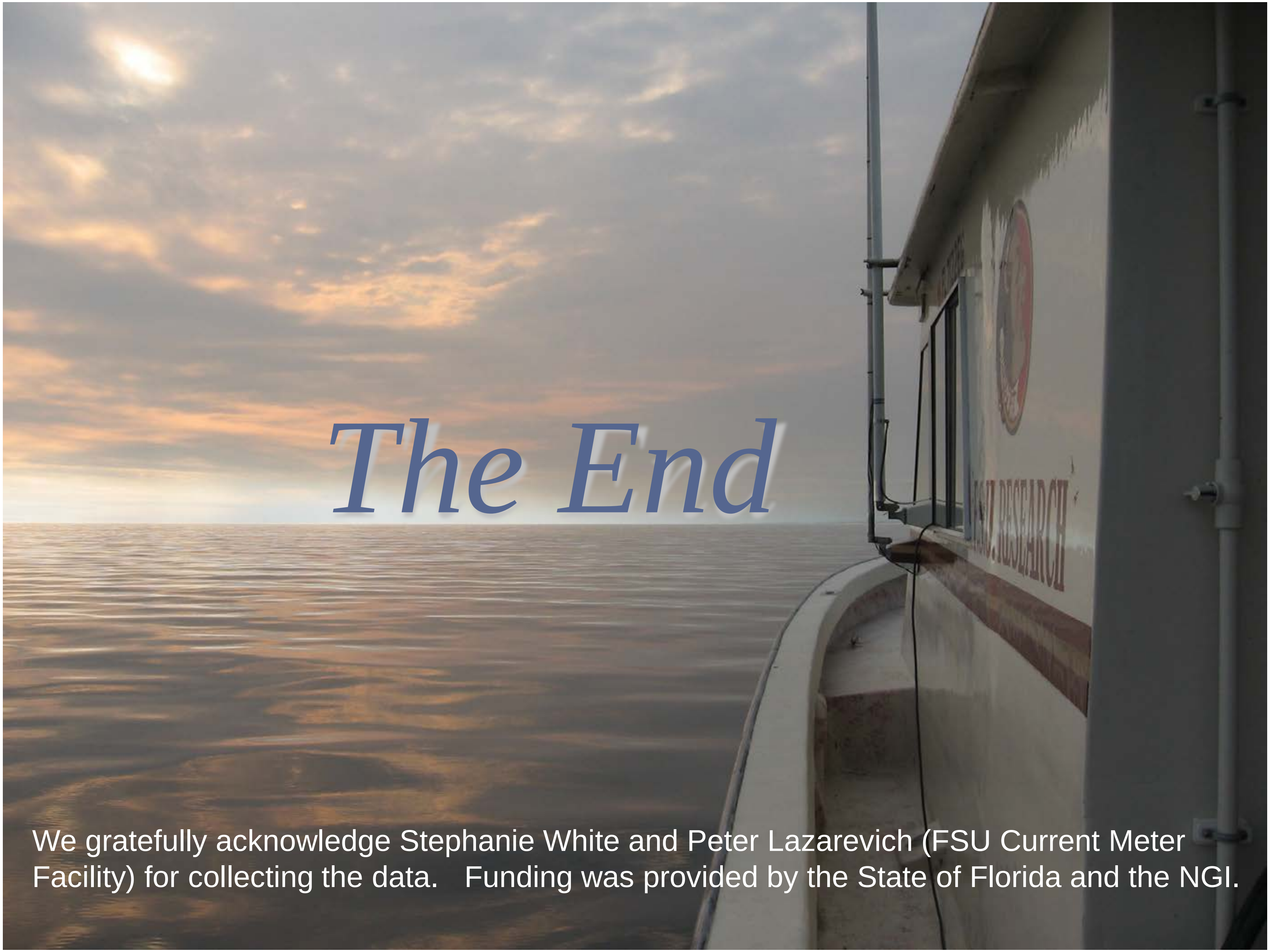
Summary

- Big Bend sub-tidal & seasonal currents are mainly along-isobath, approximately independent of depth and remotely driven by the alongshore winds on the West Florida Shelf to the south.

- Part of the seasonal flow is due to seasonal changes in density gradients perpendicular to the coast. The salinity gradient is mostly responsible for the density gradient.

- The Big Bend across shelf flow is directed mainly away from the coast at the surface and toward the coast nearer the bottom.

- Stokes' drift does not significantly change these results.



The End

We gratefully acknowledge Stephanie White and Peter Lazarevich (FSU Current Meter Facility) for collecting the data. Funding was provided by the State of Florida and the NGI.