Interannual Variability of Synoptic Scale Winds over the Northern West Florida Shelf from SeaWinds and ASCAT

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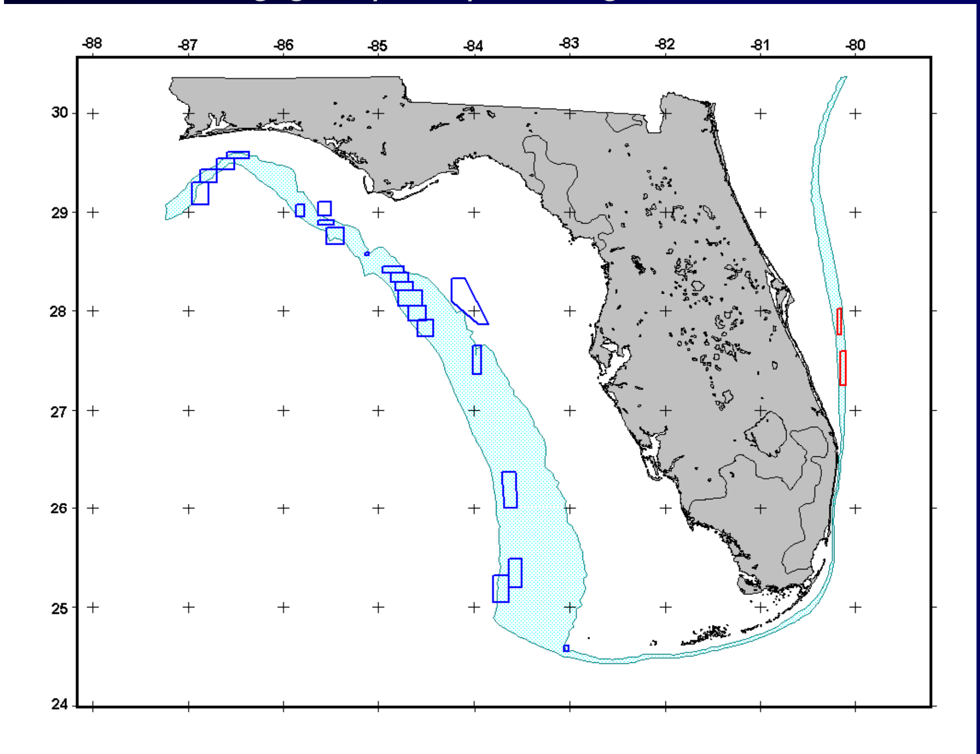
Motivation from a Biological Perspective

Gag grouper (*Mycteroperca Microlepis)* spawn along the outer shelf edge in winter through early spring.

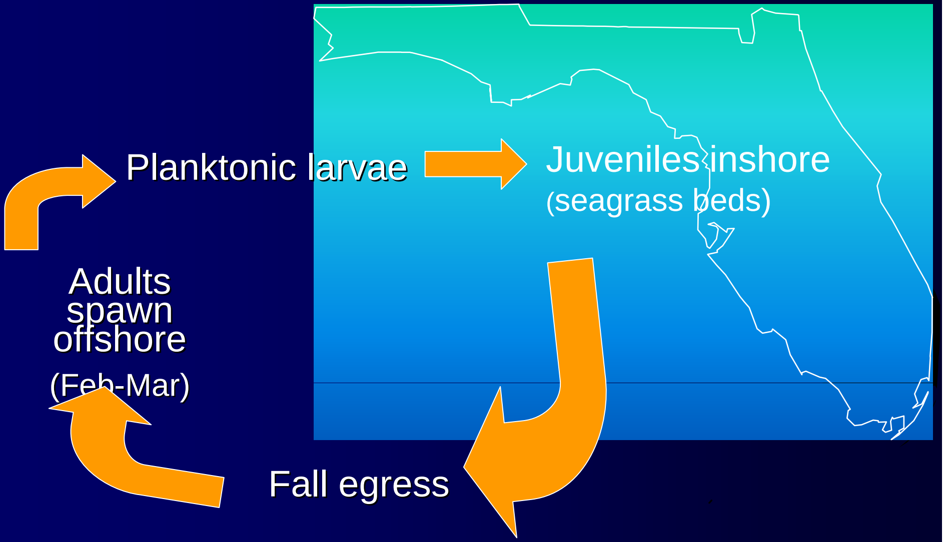
Larvae must reach nursery habitat (sea grass) in the coastal region for successful recruitment.

Grouper life history stages

Gag grouper spawning locations

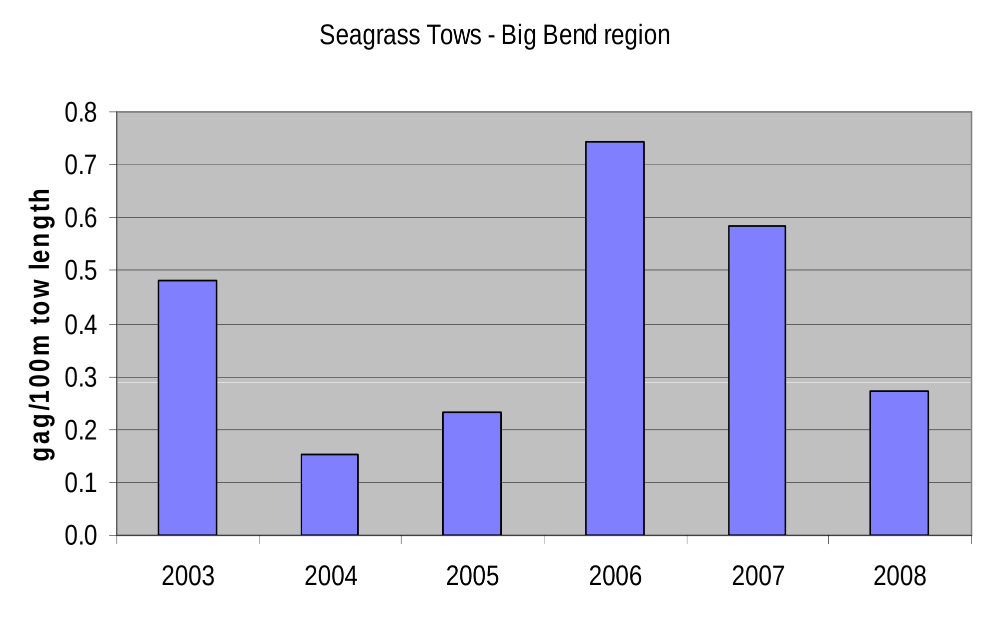


Courtesy C. Koenig, FSU



Recruitment Variability

Sea grass sampling and otolith surveys demonstrate large interannual variability in regional recruitment of Gag.



Sea grass tow data Courtesy C. Koenig

Multiple factors can influence this variability including:

Physical environmental stressors (temperature, salinity)

Biological stressors (harmful algal blooms, predation)

Food availability

Size of spawning stock

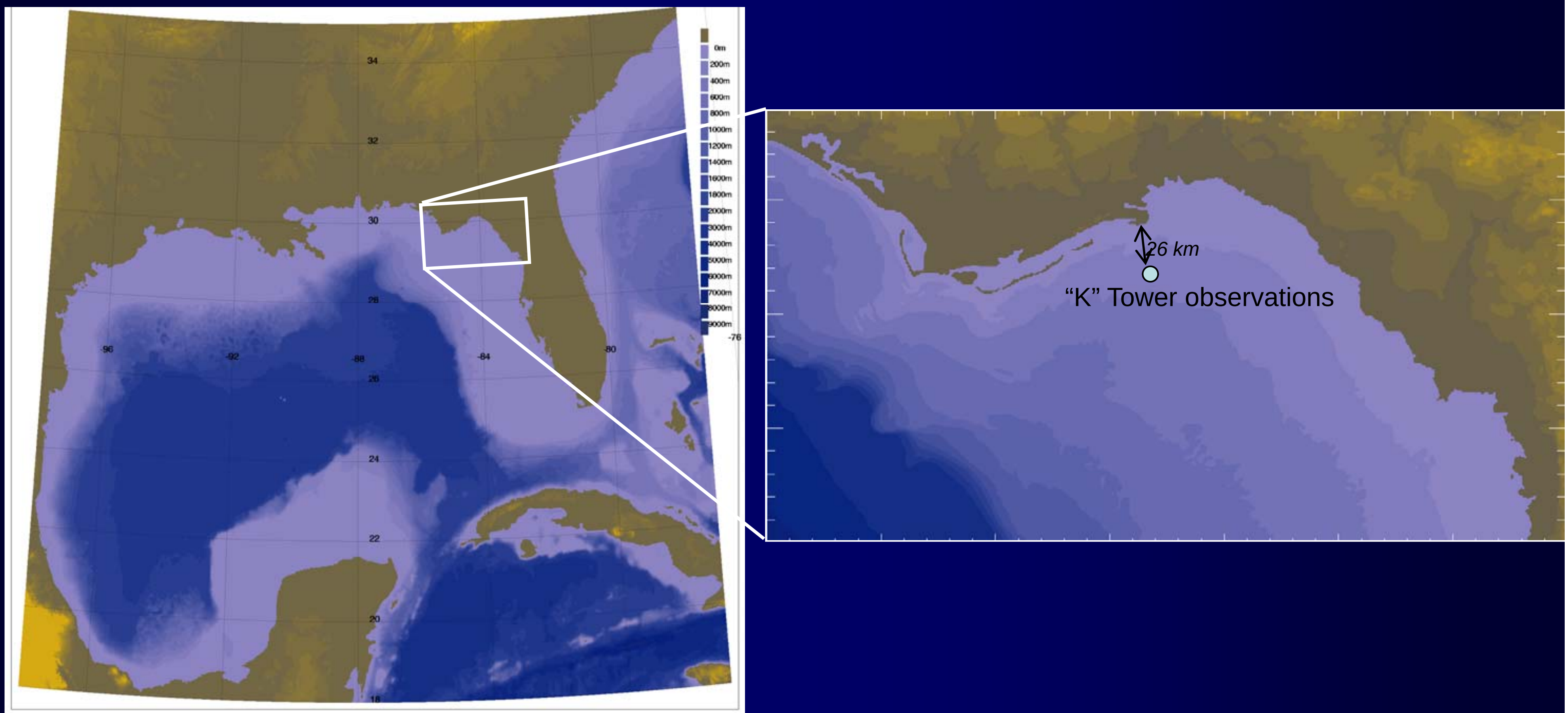
Favorable conditions for onshore transport of larvae

Numerical model studies

ROMS configured for the northern west Florida shelf

1/120° (~800m) horizontal resolution

20 terrain-following “S” coordinates



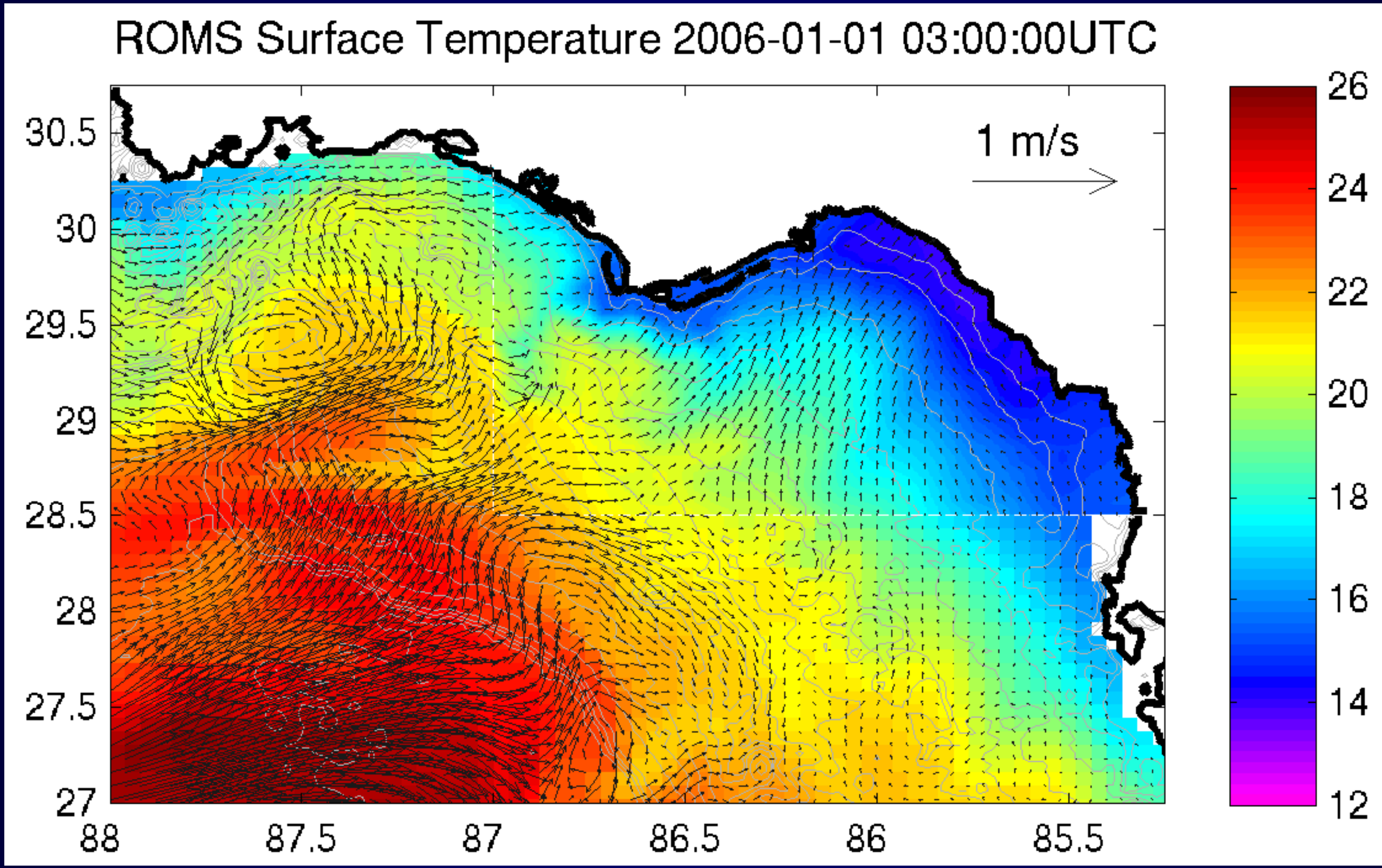
Numerical model studies

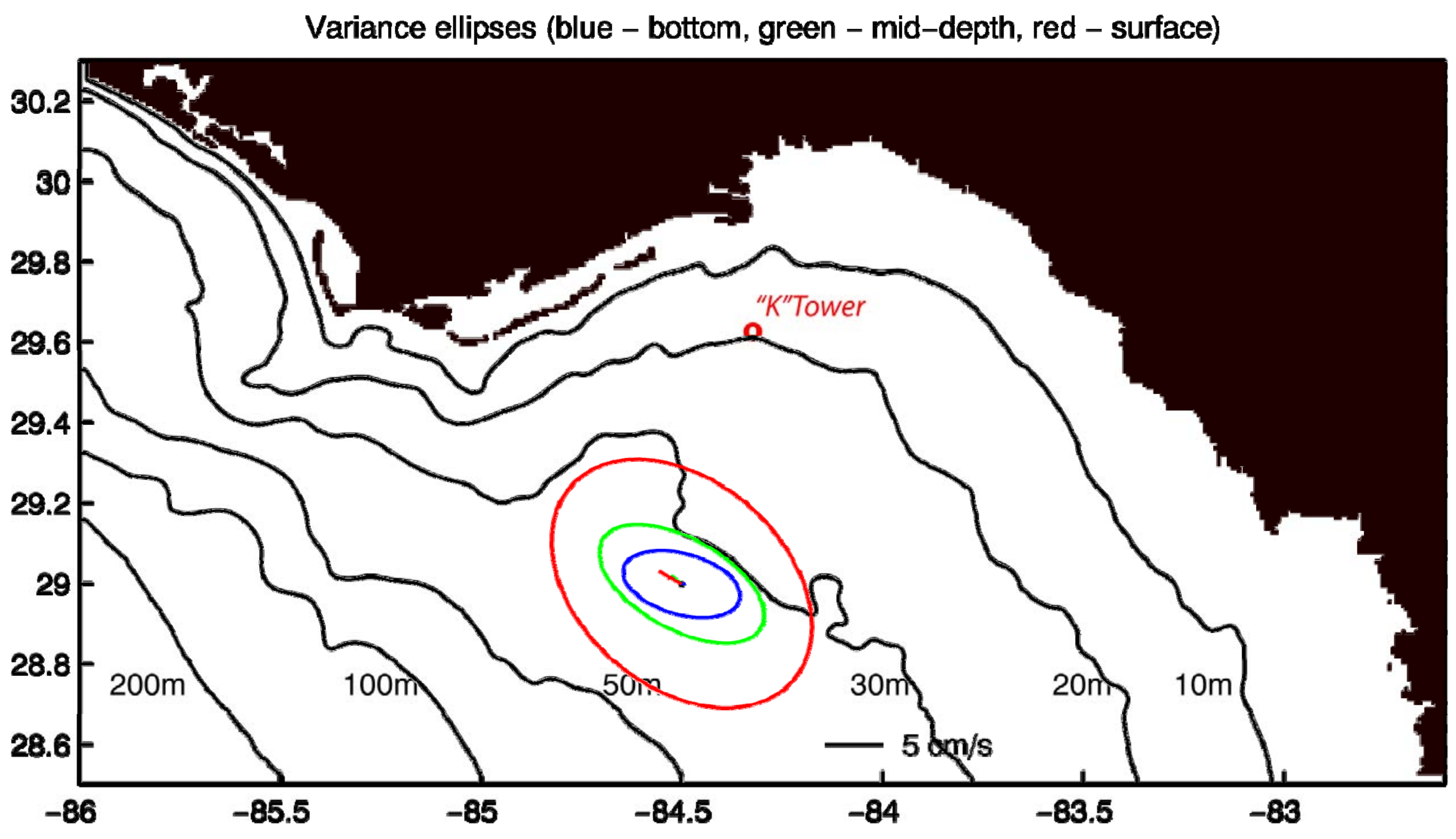
Numerical simulation run for 2004 – 2009 and forced by:

NARR (North American Regional Reanalysis) surface variables and COARE3.0 flux algorithm

GLOBAL HYCOM NCODA analysis lateral boundary conditions

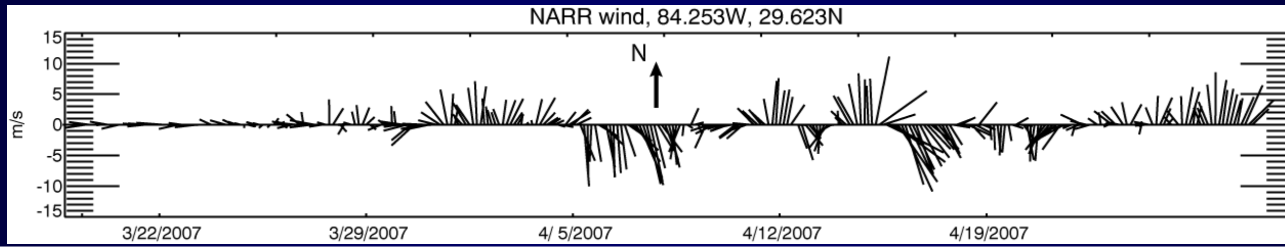
River discharge from 15 local sources

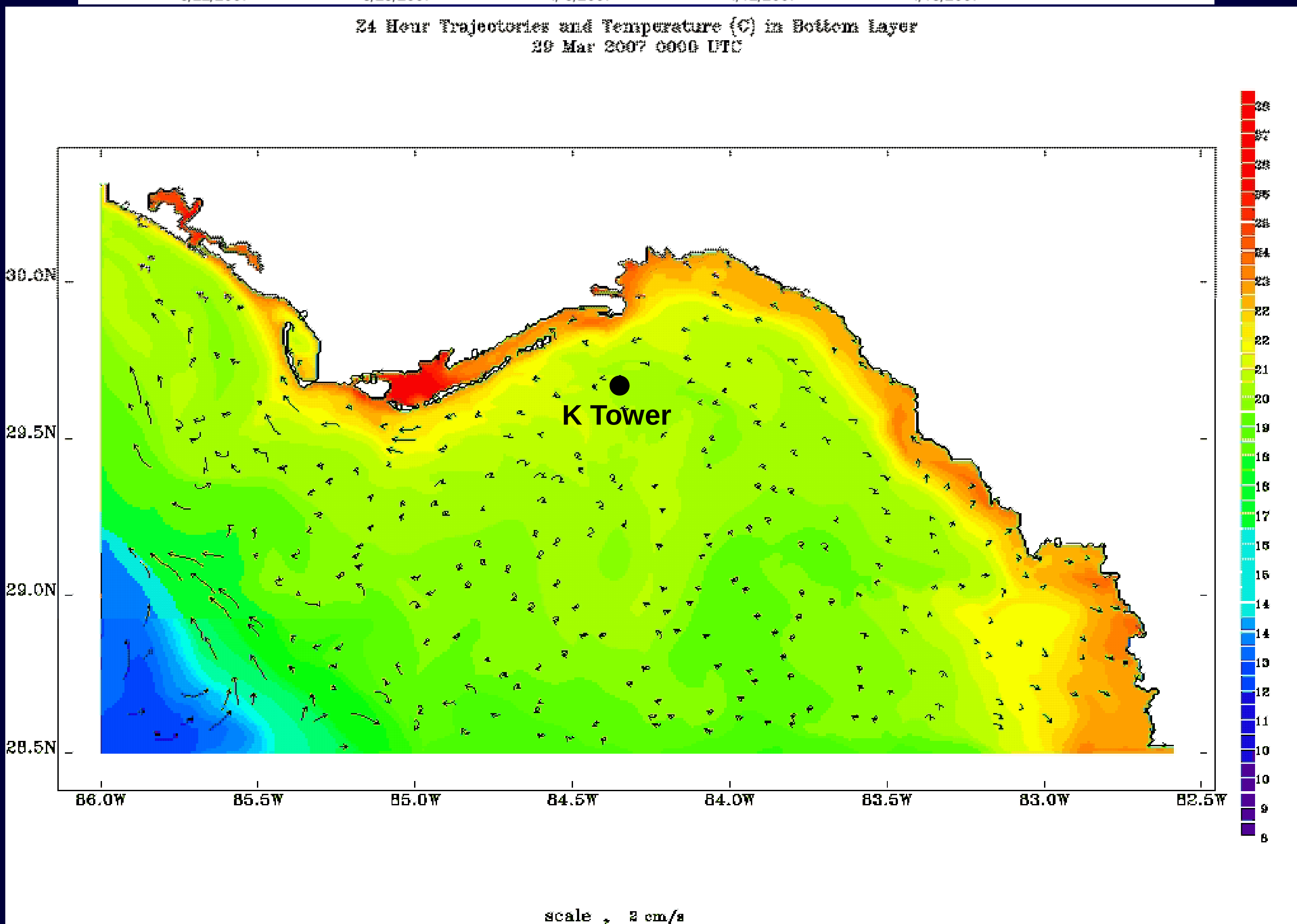


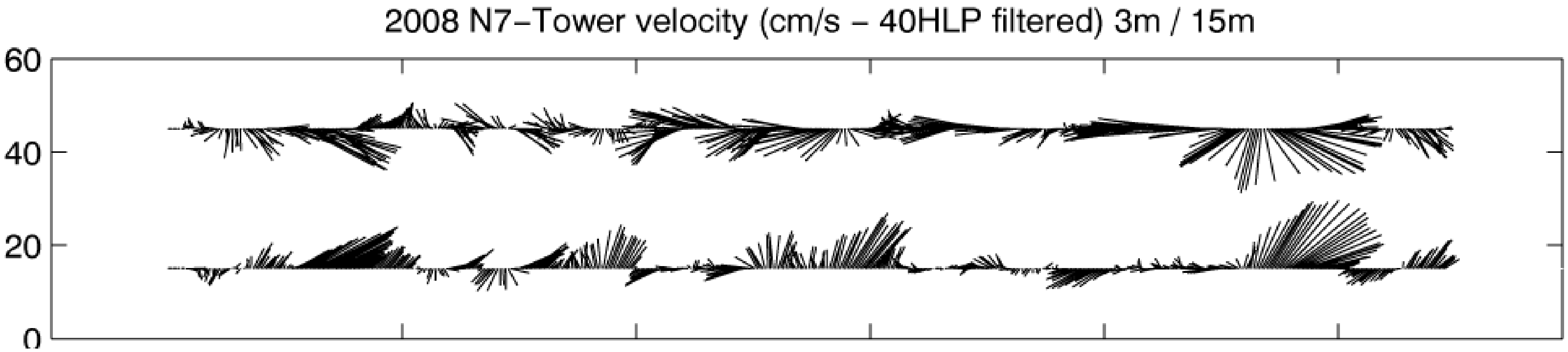


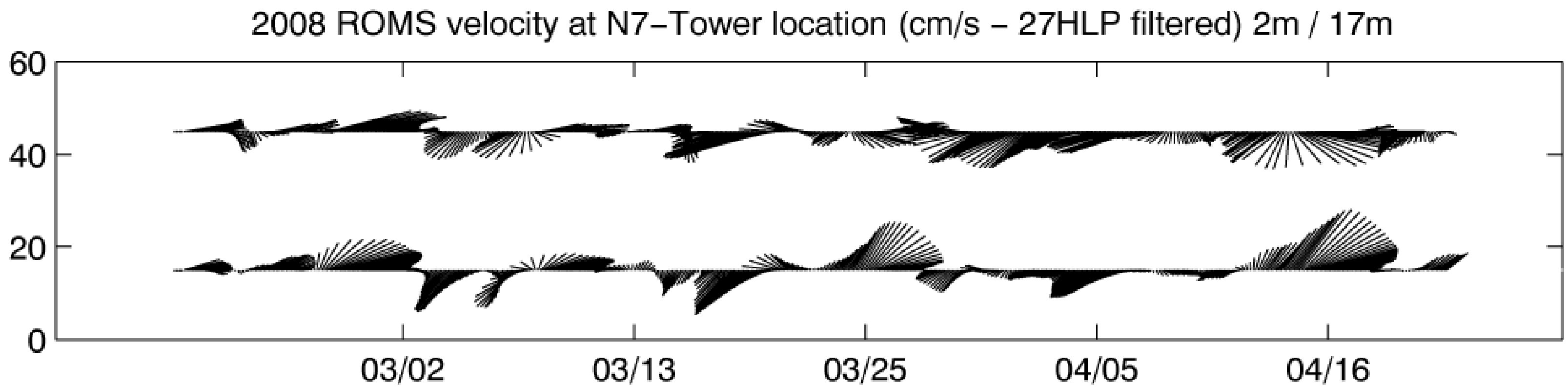
Variance ellipses (blue – bottom, green – mid–depth, red – surface)
"K"Tower
200m
100m
50m
30m
20m
10m
5 cm/s
30.2
30
29.8
29.6
29.4
29.2
29
28.8
28.6
−86
−85.5
−85
−84.5
−84
−83.5
−83

Strong onshore transport at the bottom linked with synoptic scale forcing

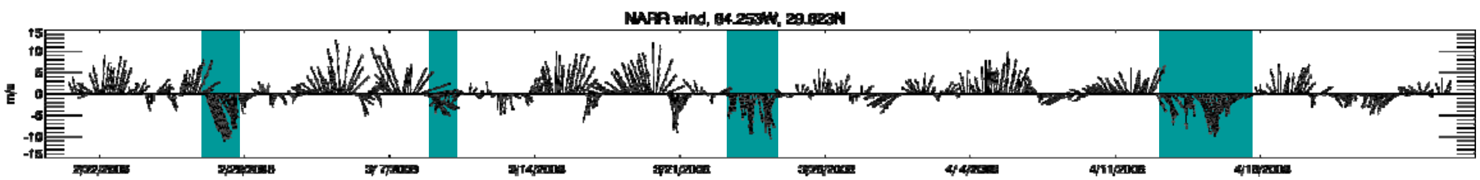


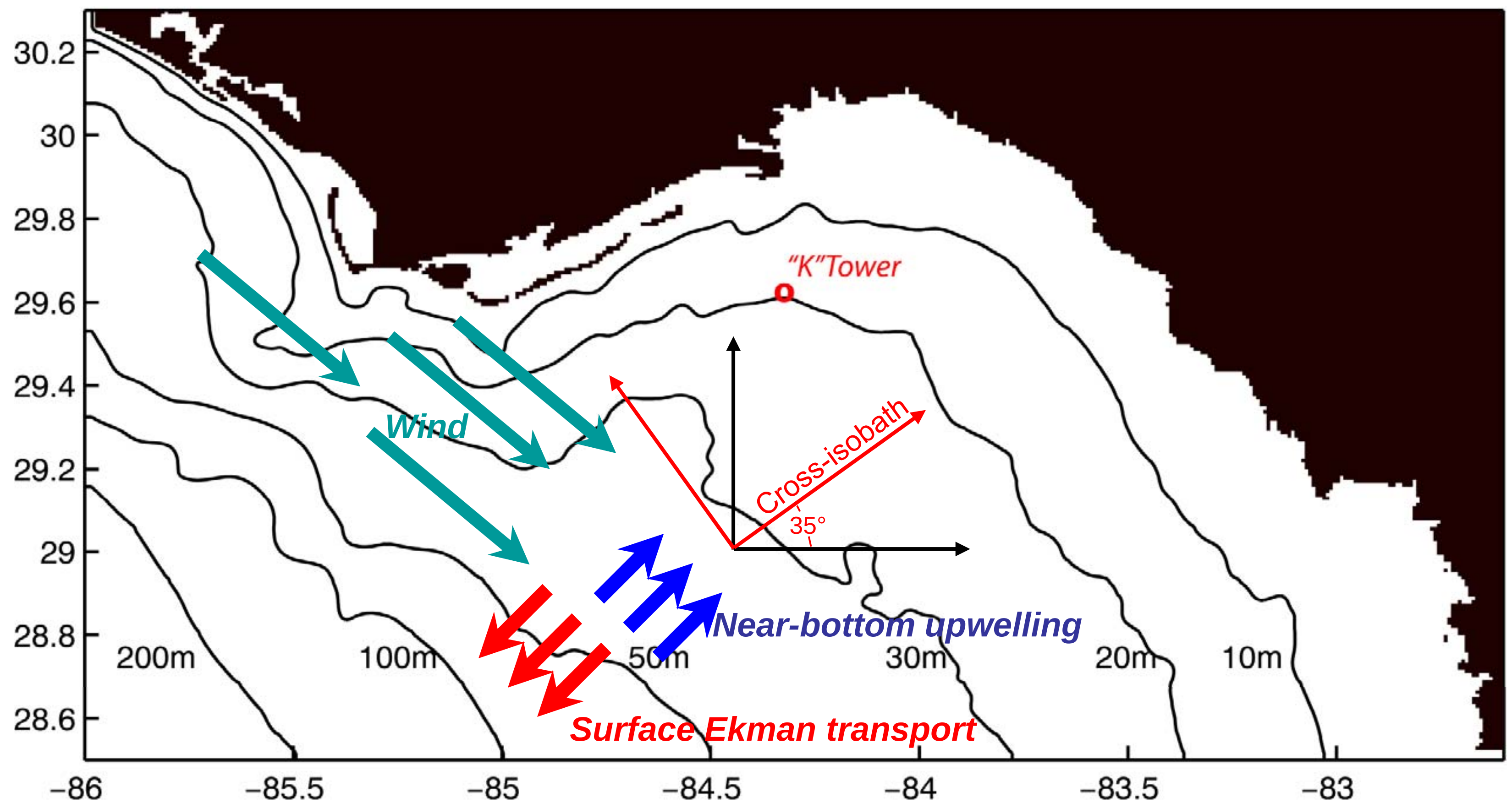



2008 N7−Tower velocity (cm/s − 40HLP filtered) 3m / 15m
60
40
20
0


2008 ROMS velocity at N7−Tower location (cm/s − 27HLP filtered) 2m / 17m
60
40
20
0
03/02
03/13
03/25
04/05
04/16

NARR winds

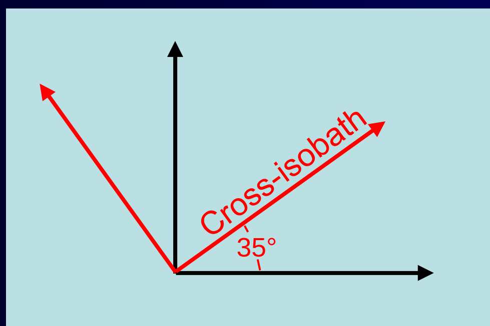

NARR wind, 84.253W, 29.823N
15
10
5
0
-5
-10
-15
m/s



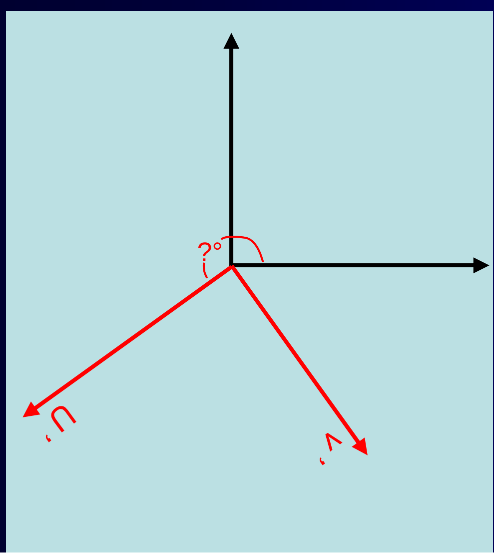
Given the curvature of the coast and isobaths, what is the most favorable wind direction for upwelling?

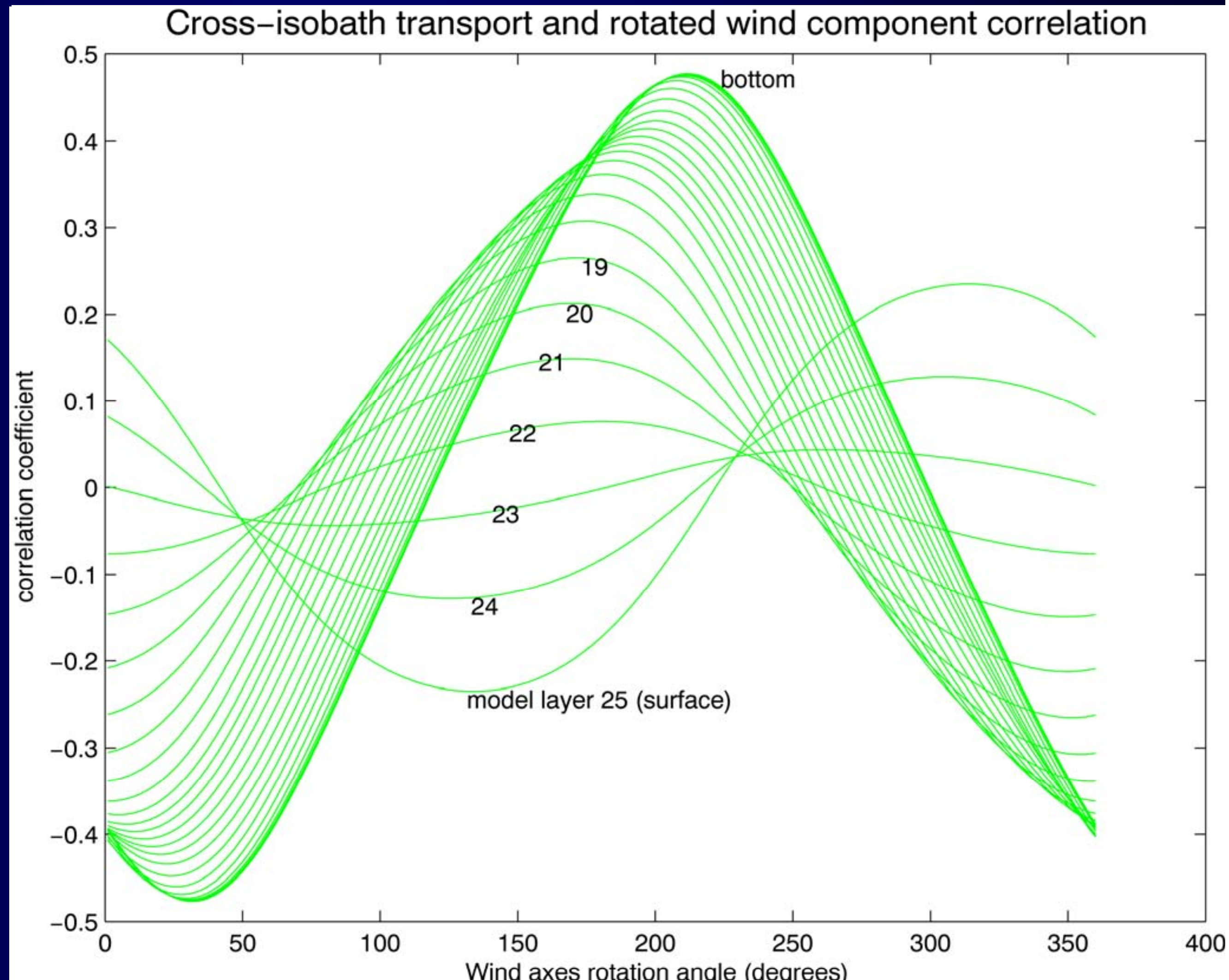
Local upwelling winds

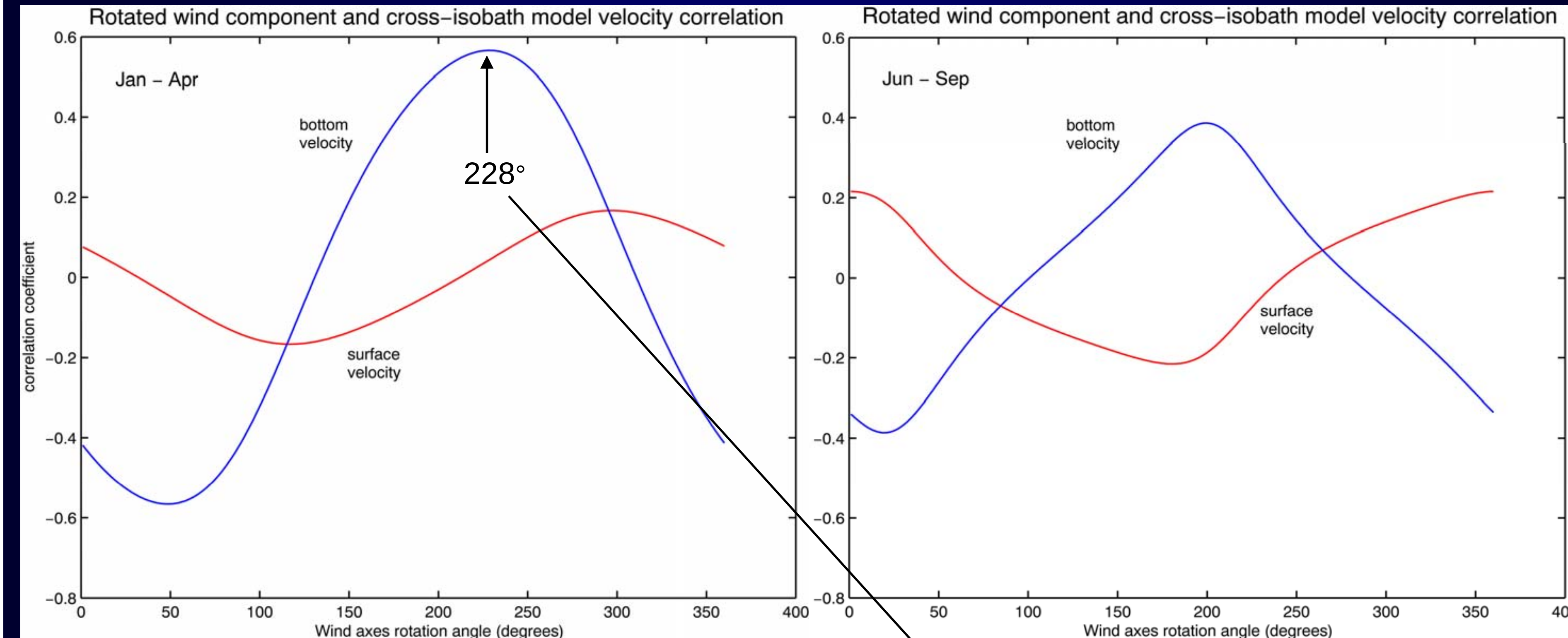
Correlation between cross-isobath velocity component …



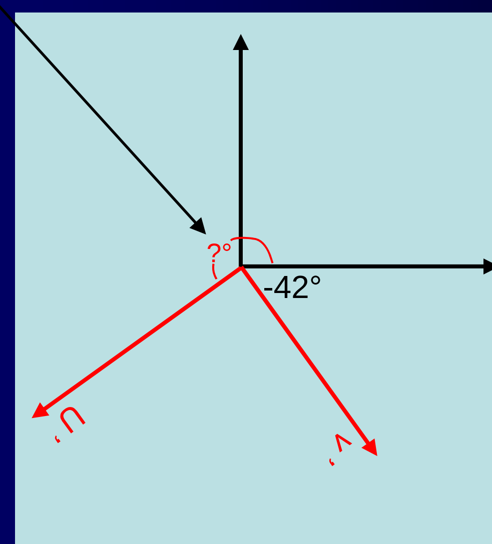
… with wind v' component projected onto rotated axes







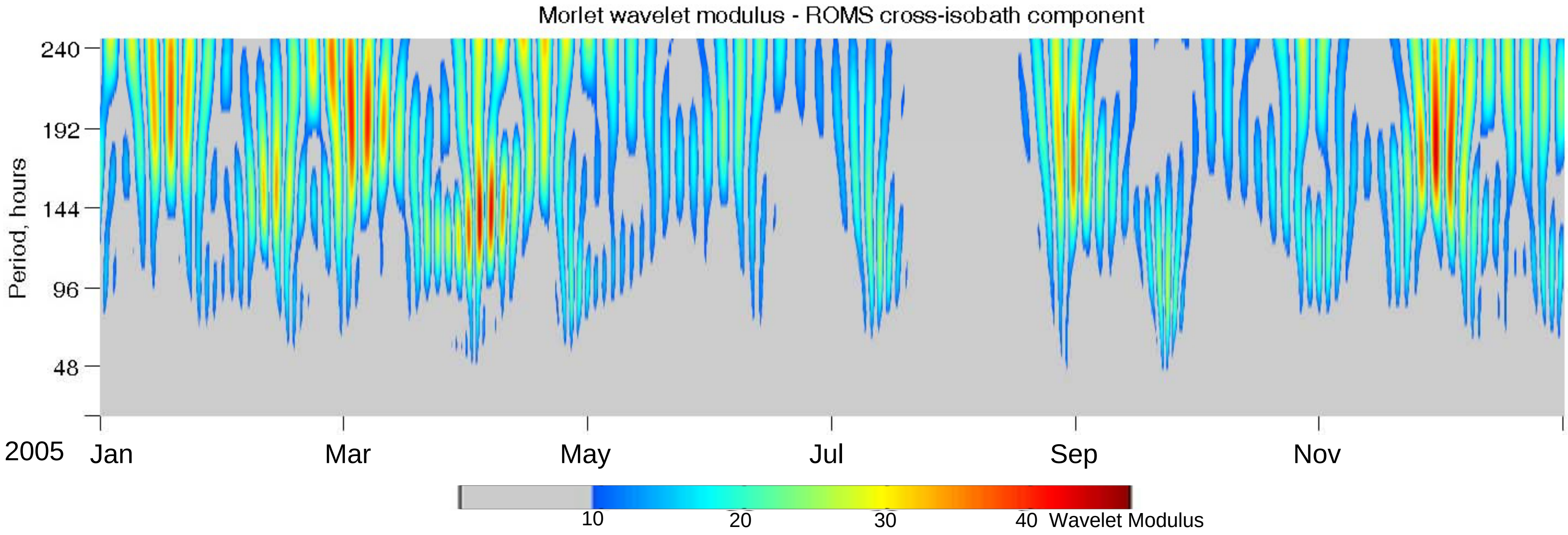
Highest correlation between near-bottom cross-isobath transport and wind vector v’ component of wind vector axes rotated 228° in winter – early spring months



What is the dominant time scale of the variability, and how does this change seasonally?

Morlet Wavelet Modulus

ROMS near-bottom cross-isobath velocity component

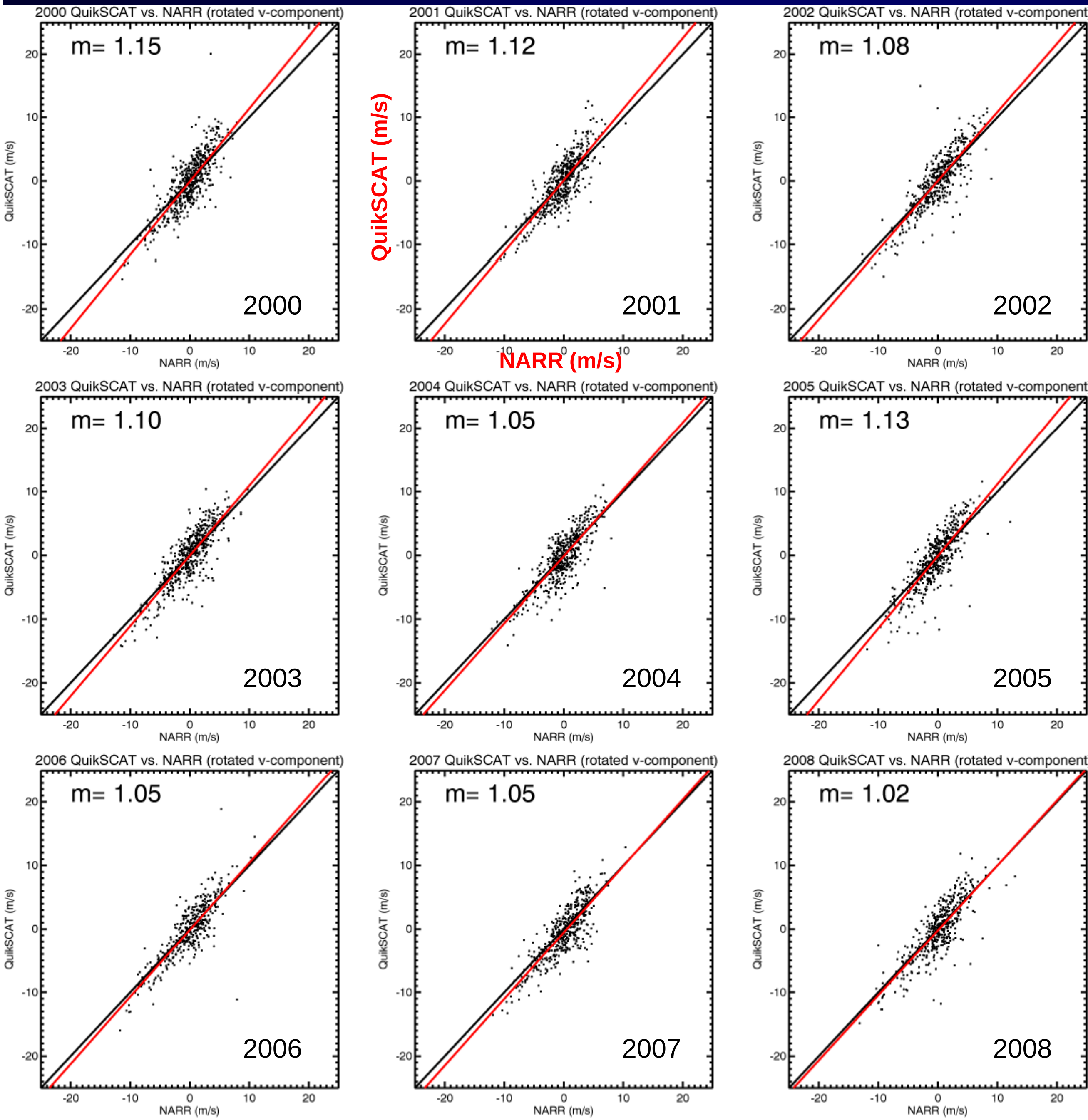


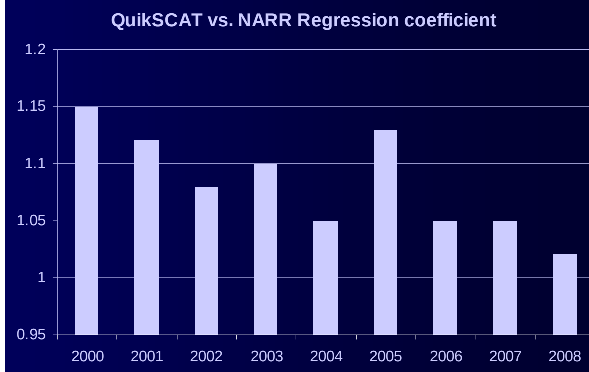
Cross-isobath benthic flow shows strong variability in the 3 to 10-day “weather” band from late fall through spring

This highlights the importance of synoptic scale wind forcing over the shelf for cross-shelf transport.

We want to explore the interannual variability of this onshore transport, so we need a wind record as long as possible that represents synoptic variability well.

Trends in the NARR wind speeds over the West Florida Shelf compared to QuikSCAT speeds

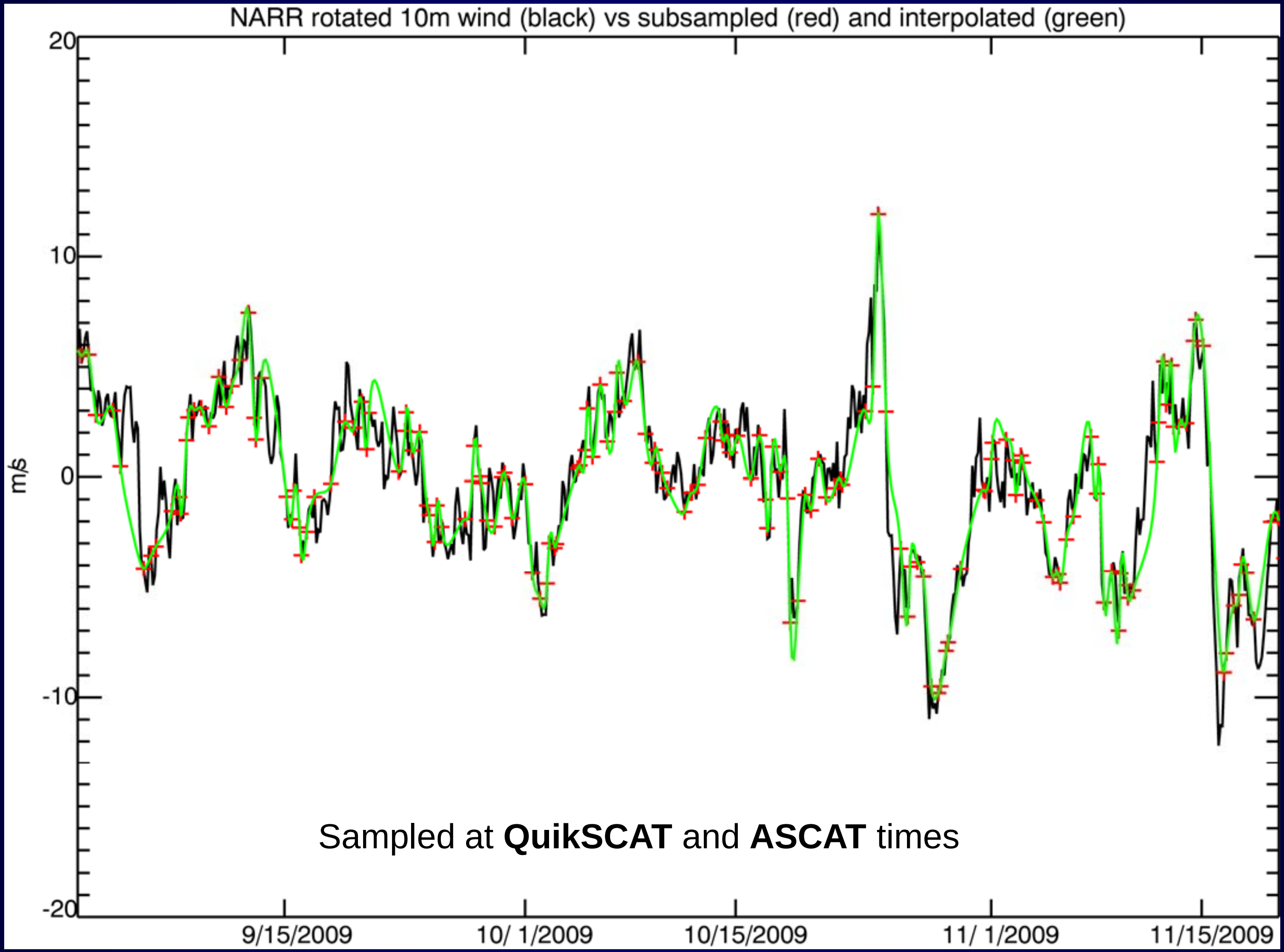




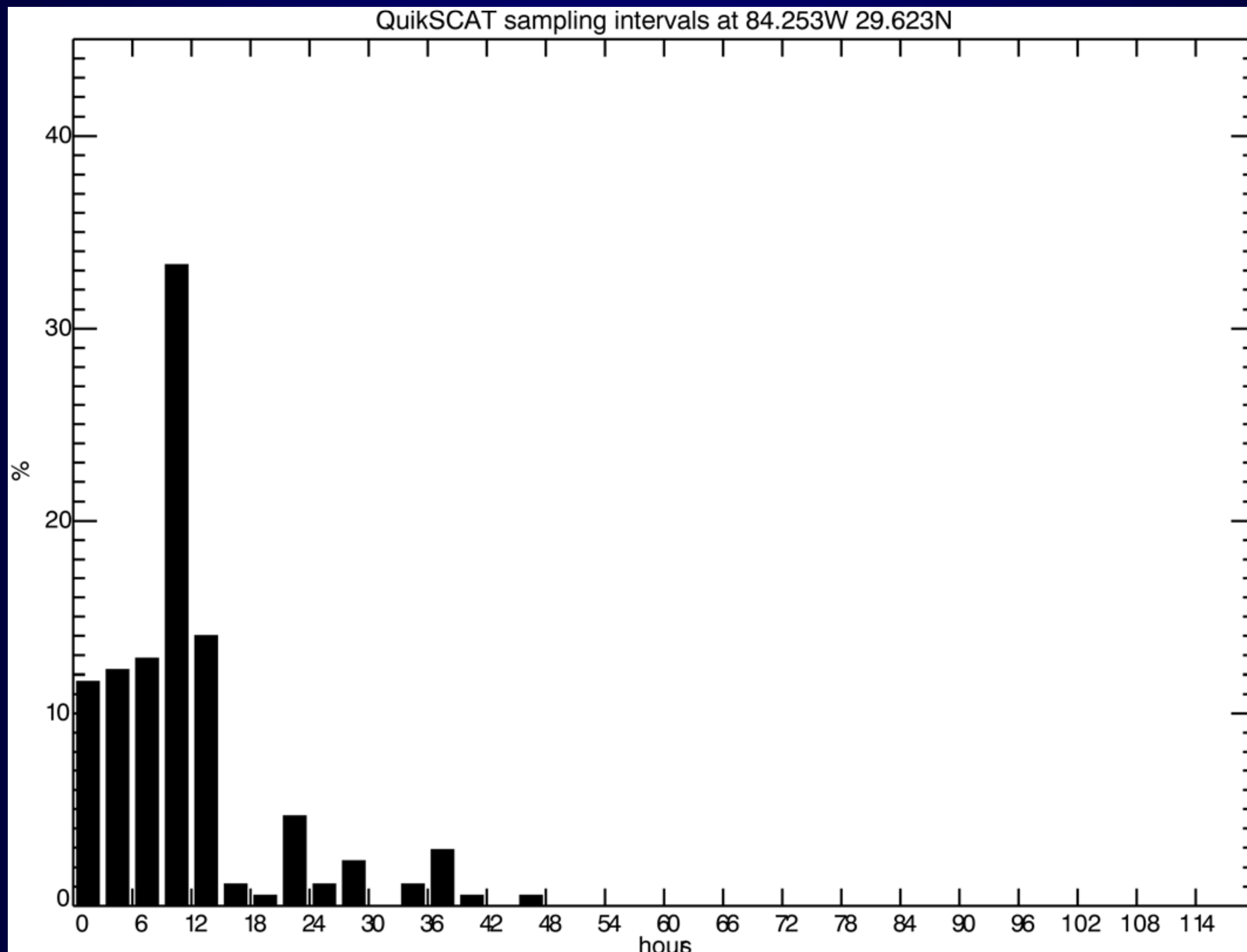
Decrease in magnitude of NARR bias over time indicates a non-stationary time series.

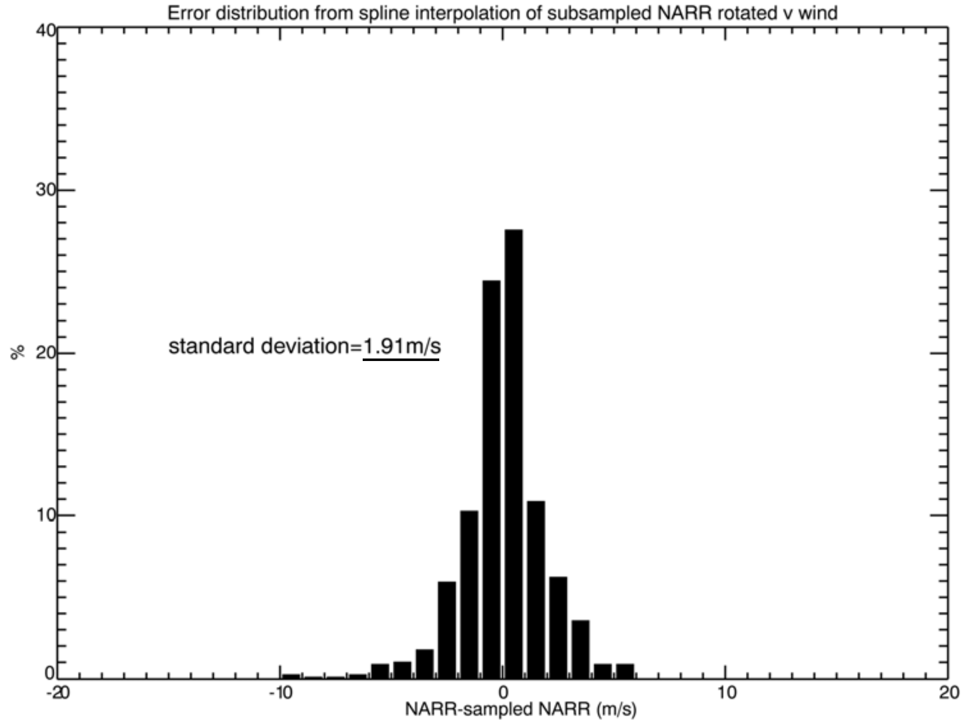
QuikSCAT winds could be useful for studying the interannual variability of synoptic winds in the region, but is the temporal sampling adequate?

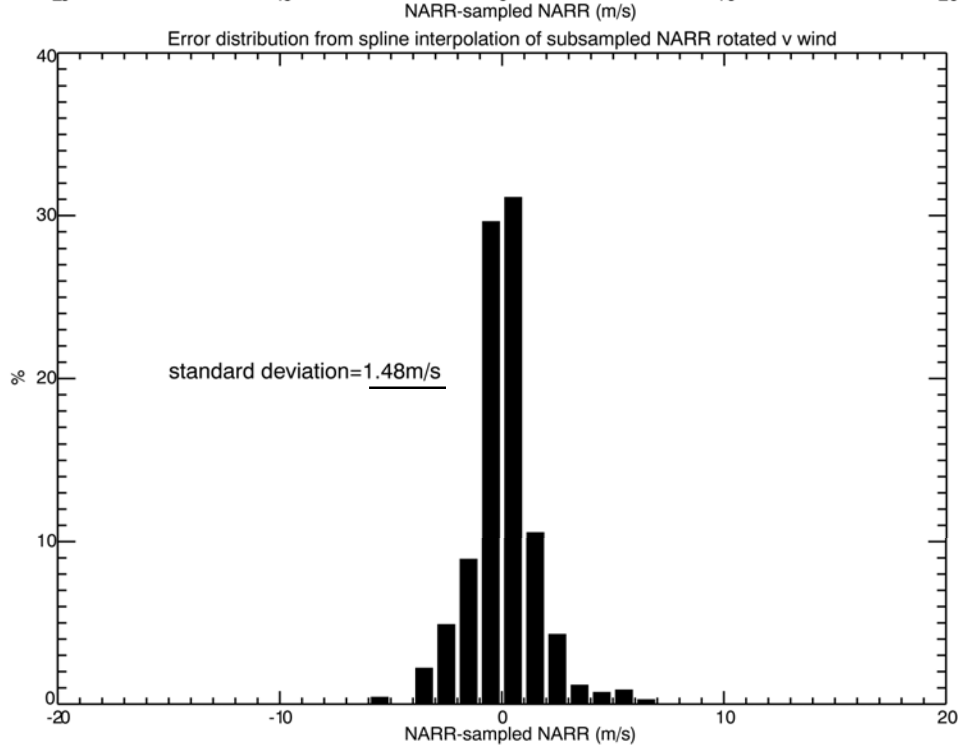
Synthetic Sampling of 3-hourly NARR upwelling wind component time series



Diurnal variability is not adequately sampled.
What are consequences of this aliasing?

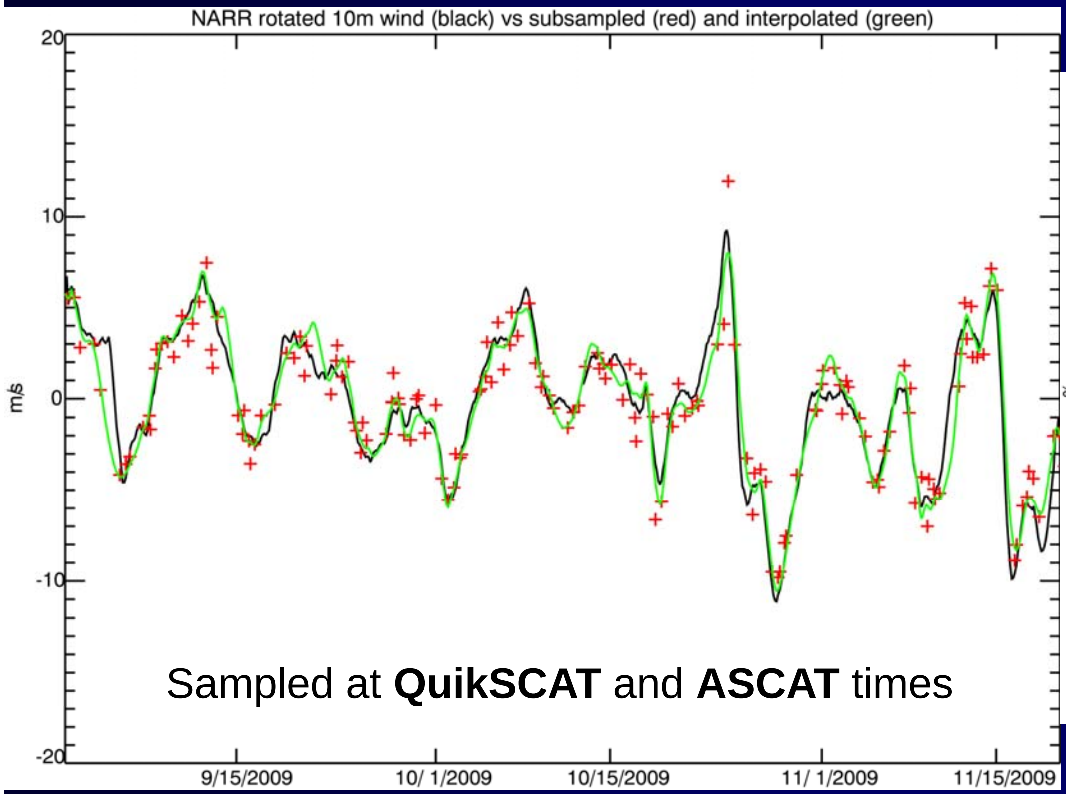

QuikSCAT sampling intervals at 84.253W 29.623N
%
0
10
20
30
40
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
hours

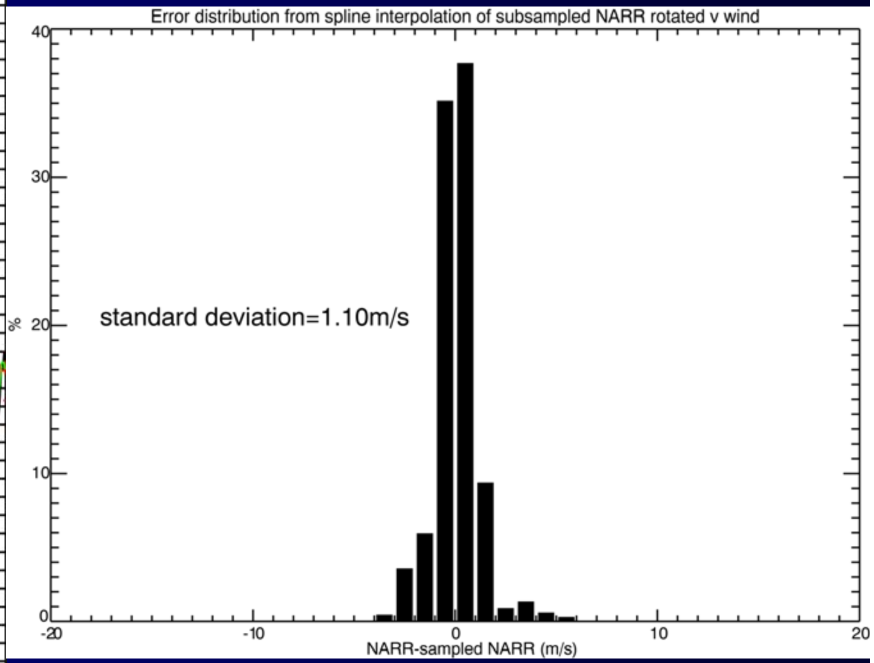

Error distribution from spline interpolation of subsampled NARR rotated v wind
standard deviation=1.91m/s
%
NARR-sampled NARR (m/s)
-20
-10
0
10
20
0
10
20
30
40


Error distribution from spline interpolation of subsampled NARR rotated v wind
standard deviation=1.48m/s
%
NARR-sampled NARR (m/s)
-20
-10
0
10
20
0
10
20
30
40

Synthetic Sampling of 3-hourly NARR upwelling wind component time series

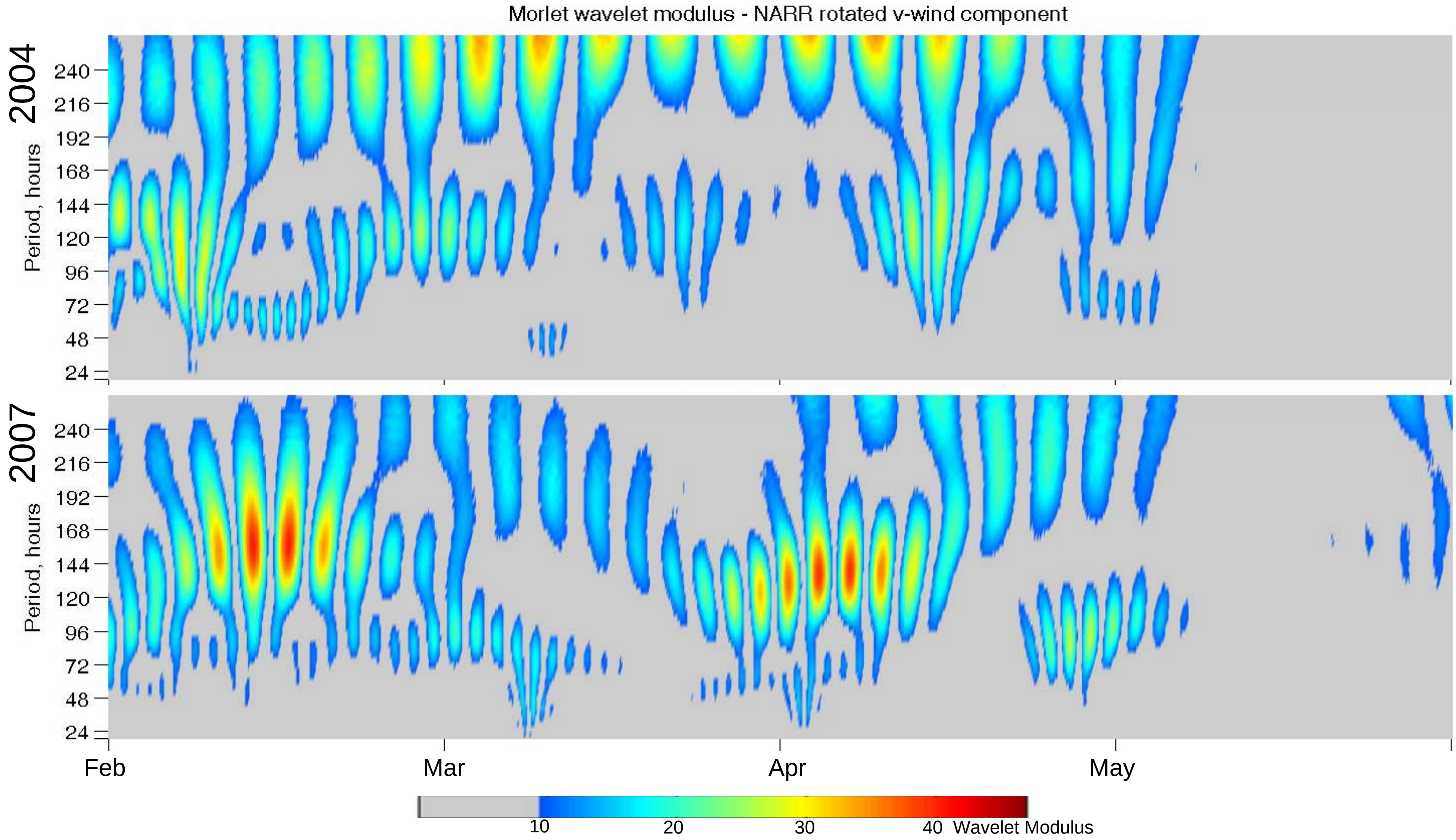
27-hour low-pass filter applied following sampling to remove diurnal variability





Is the QuikSCAT sampling suitable for exploring the interannual variability of synoptic scale winds in this region?

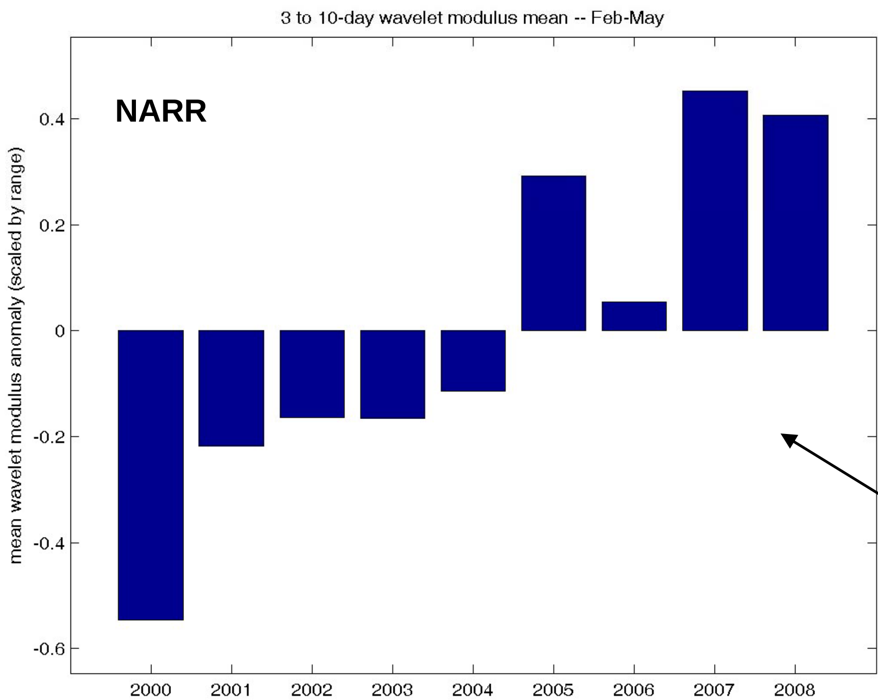
Morlet Wavelet Modulus –upwelling wind component Feb - May



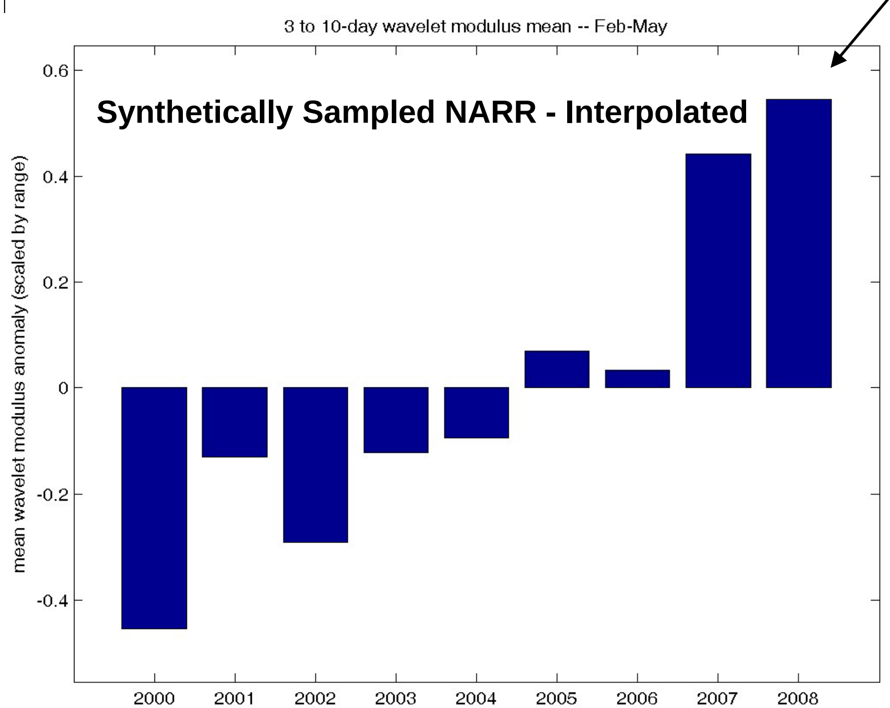
Mean of wavelet modulus (3 to 10 days)

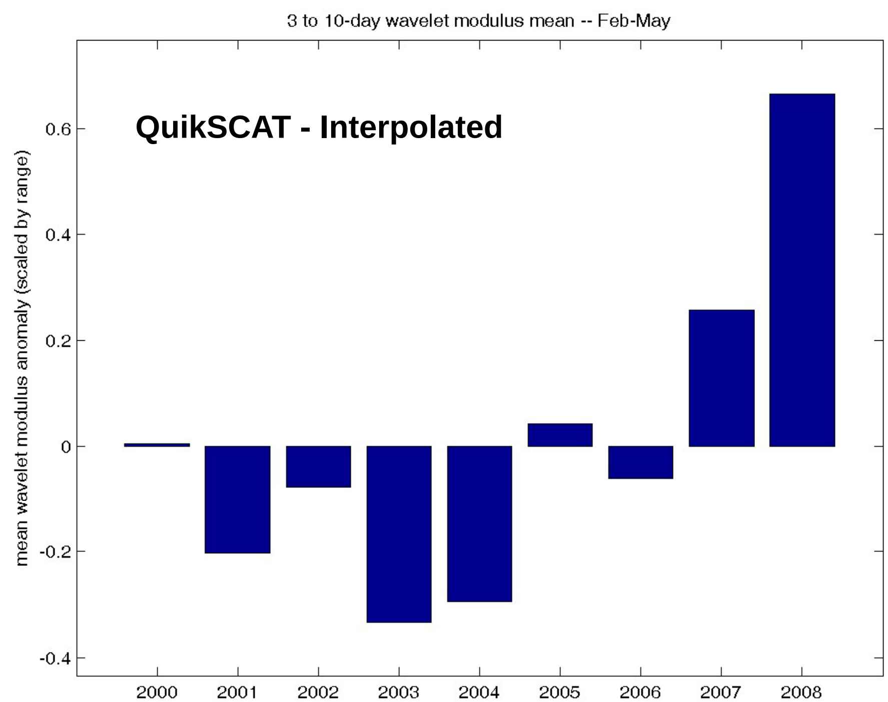
Anomaly scaled by range

February – May



Differences due to sampling





Summary

Cross-shelf transport responds to atmospheric forcing at synoptic scales

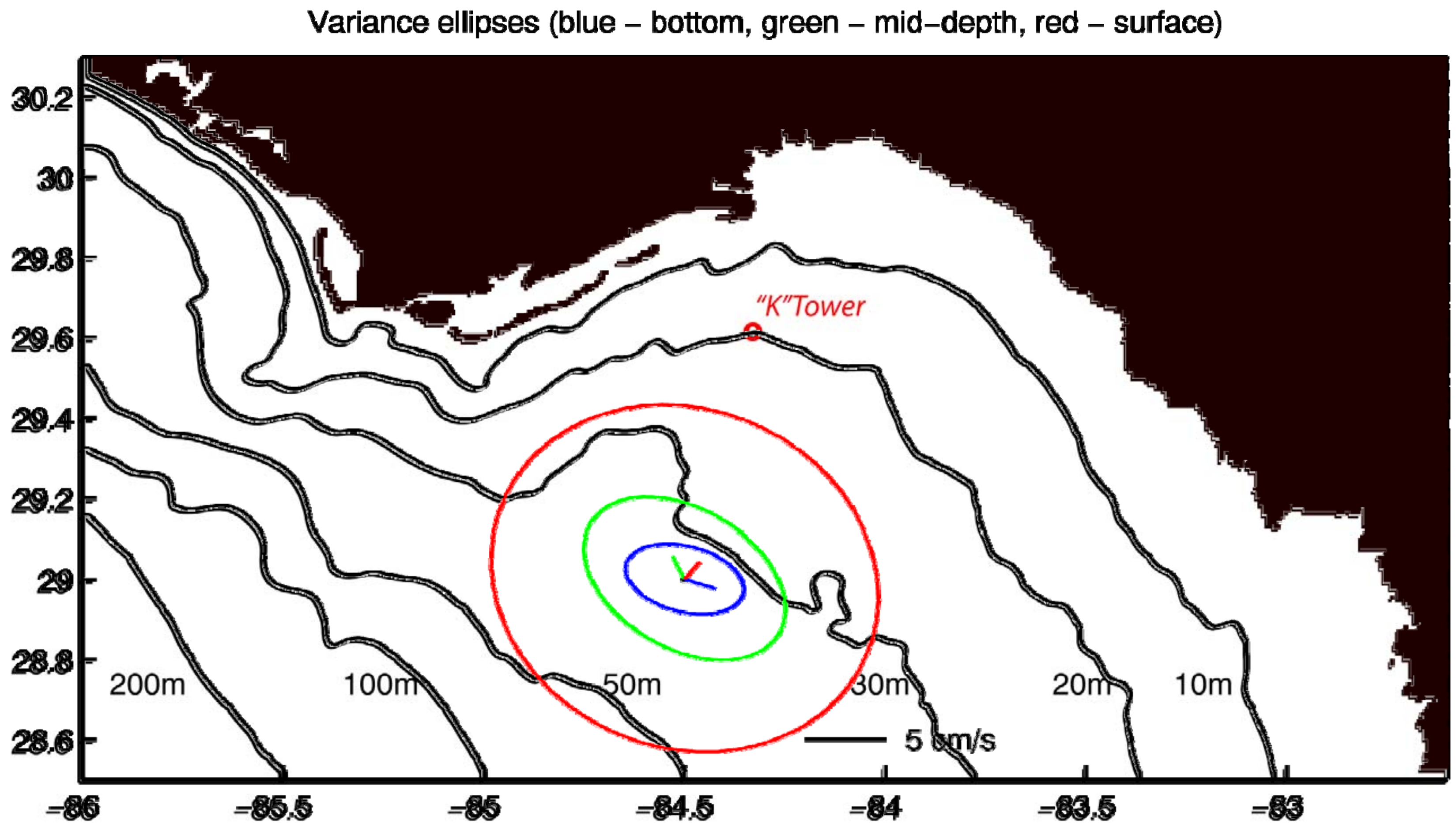
An objective method was applied to identify the most upwelling-favorable wind directional component – Useful technique for shelves with curvature.

Comparison of 10 years of QuikSCAT winds over the northern WFS to NARR reveals a trend

Temporal sampling of QuikSCAT over the region is marginally adequate for examining synoptic time scales (likely better at other latitudes)

Multiple satellite sampling (e.g. QuikSCAT and ASCAT) dramatically improves resolution of the synoptic time scale

Need to compare to in situ data and other reanalysis products


Variance ellipses (blue – bottom, green – mid–depth, red – surface)
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5 cm/s
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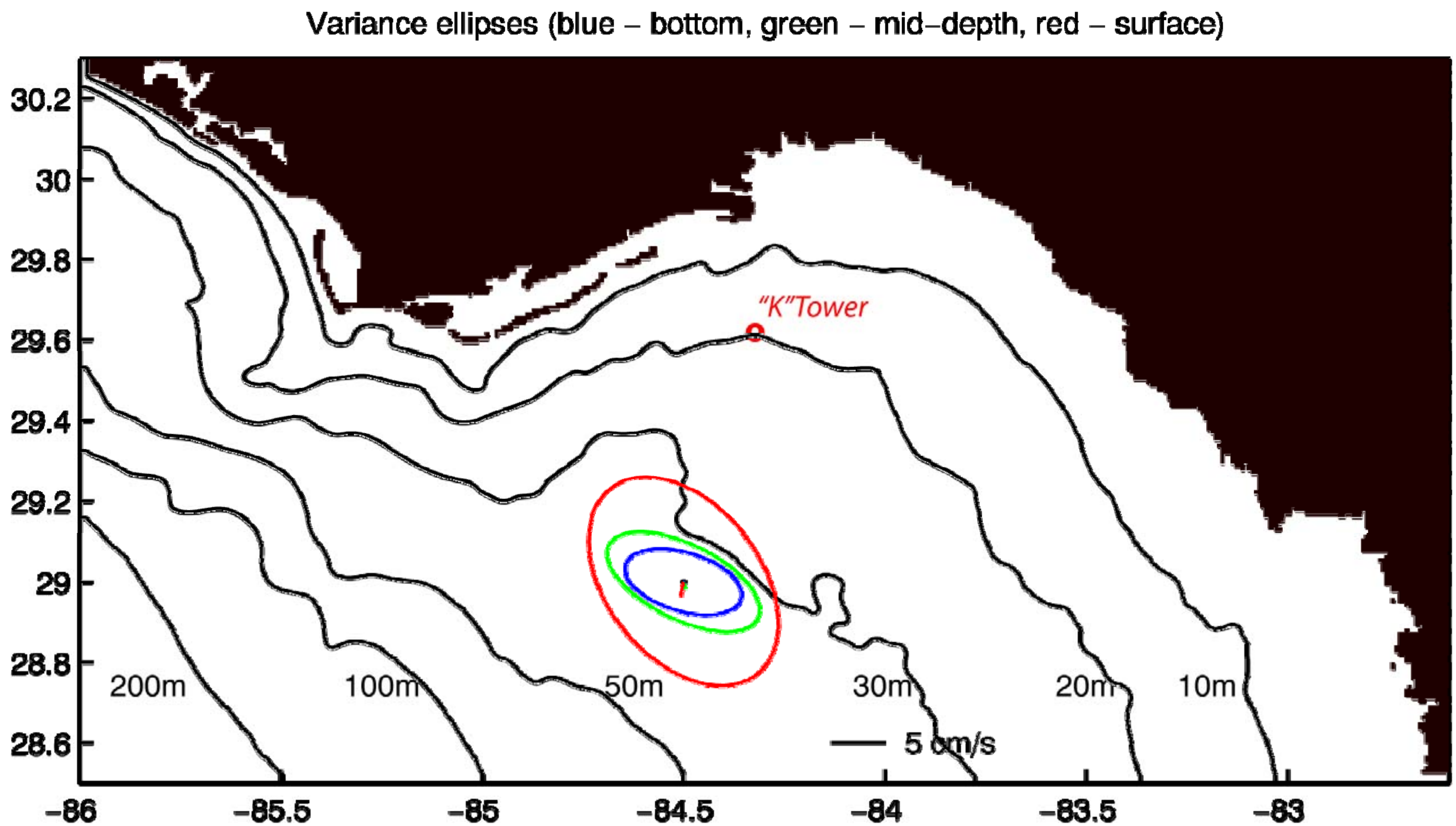
−83

June - August



January - March