Interannual Variability of Wind Induced Onshore Transport over the Northern West Florida Shelf

Steve Morey
Austin Todd
Mark Bourassa

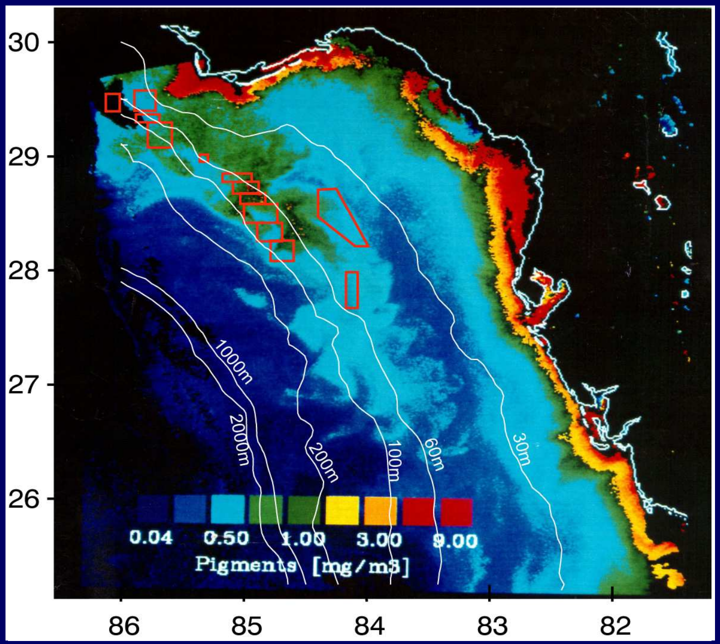
COAPS/FSU

Motivation

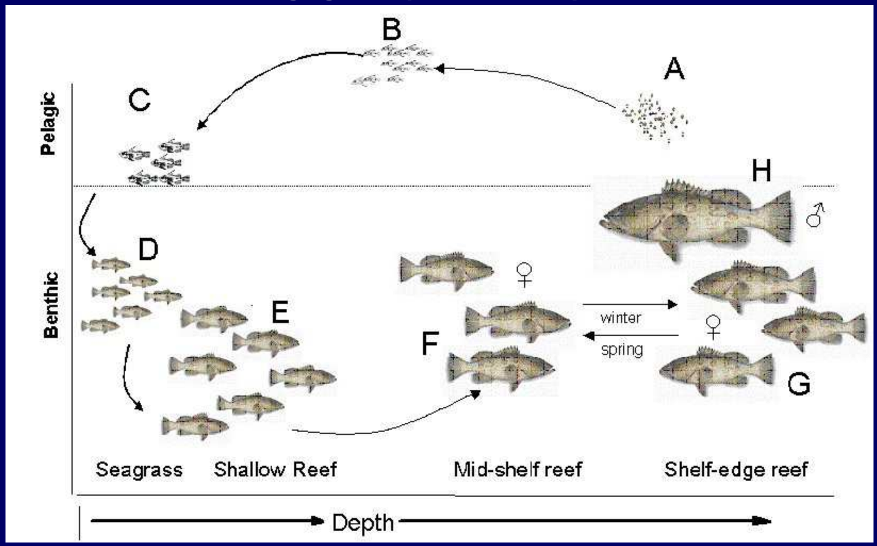
Understand the physical controls on regional Gag grouper populations, which support economically important recreational and commercial fisheries along the northeastern Gulf of Mexico.

Understand the variability of the system to aid in sustainable management of the resource.

Gag grouper spawning locations



Gag grouper life cycle

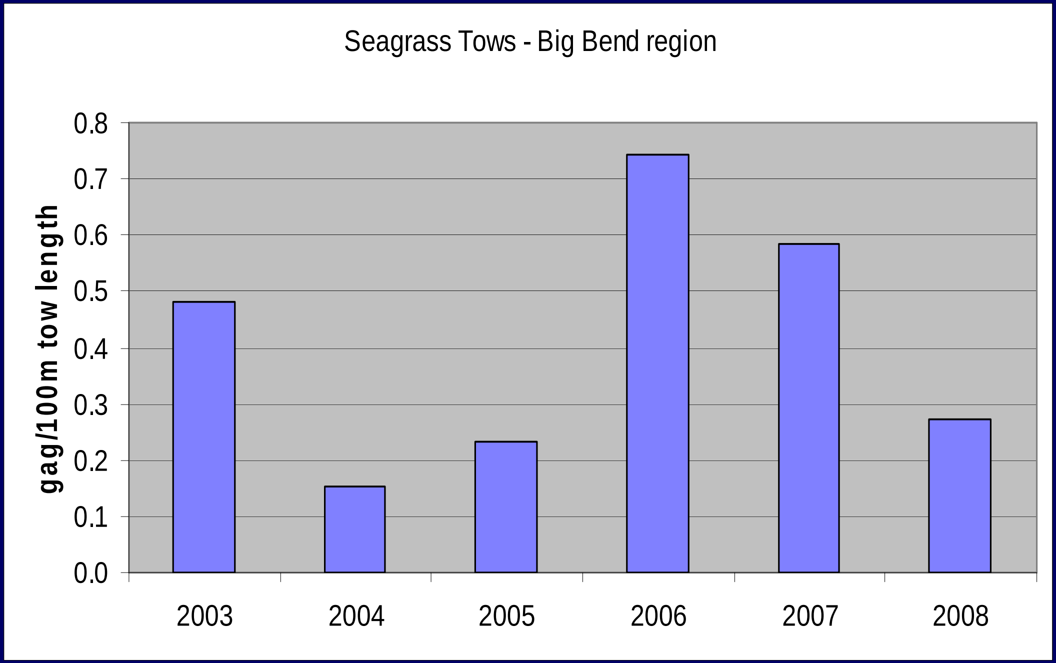


Gag spawn along the outer shelf edge in Feb-Apr.

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

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 stressors (temperature, salinity)

Biological stressors (harmful algal blooms, predation)

Food availability

Favorable conditions for transport of larvae to seagrass beds

Transport Mechanisms

Previous observational and modeling studies have failed to identify the mechanisms responsible for the onshore transport of the nearly immotile larvae.

A high-resolution (~800m) ROMS simulation of the region is being used for numerical experimentation.

Candidate physical transport mechanisms include:

- Bottom transport due to upwelling or Ekman flow
- Near surface transport including Stokes drift due to waves
- Vertical diel migration to take advantage of diurnal current variability

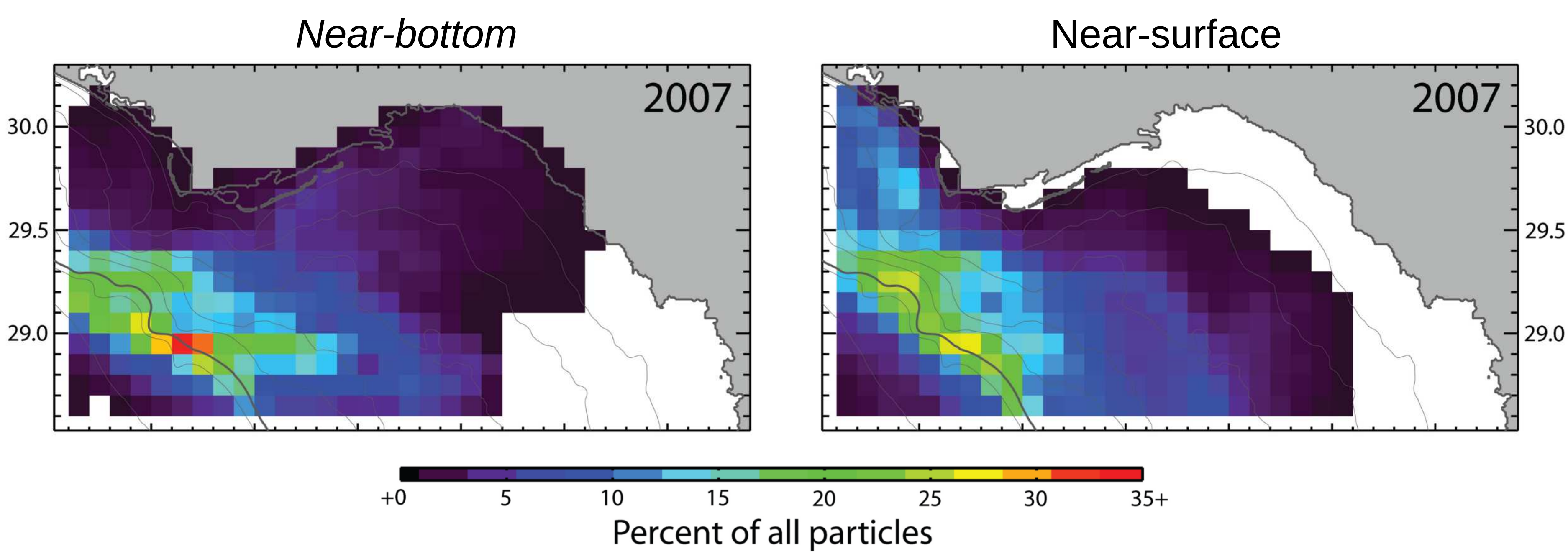
Discovery of likely transport mechanisms will aid in understanding larval behavior and targeted sampling strategies.

Lagrangian numerical studies

Numerical simulation run for 2004 – 2008 and forced by:

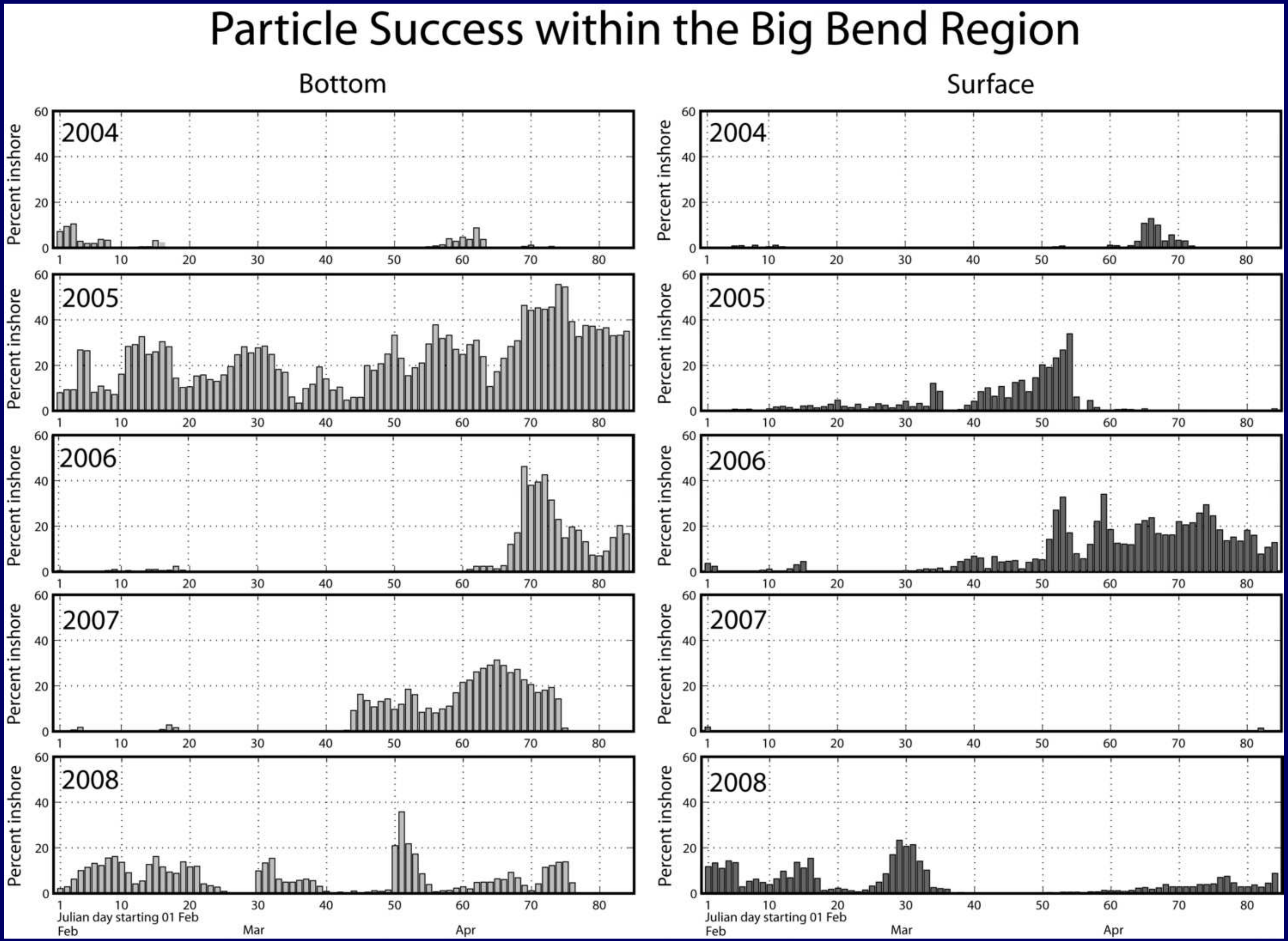
- NARR (North American Regional Reanalysis) surface variables and COARE3.0 flux algorithm
- GLOBAL HYCOM NCODA analysis lateral boundary conditions
- River discharge

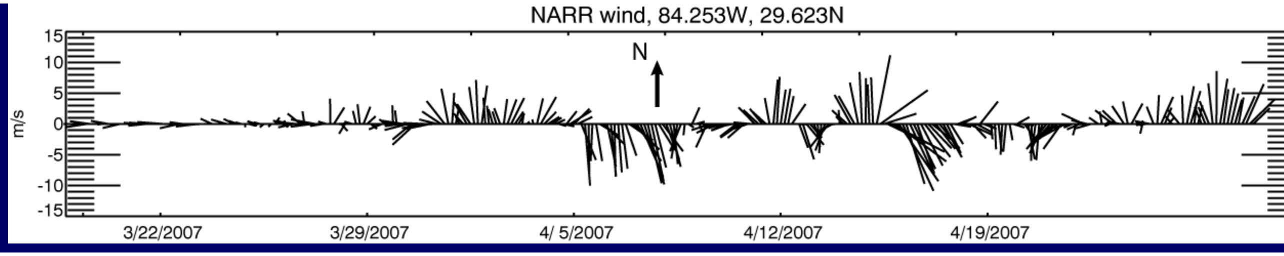
Simulated Lagrangian drifters are released along the ~80m isobath and tracked for 60 days in surface and bottom layers.

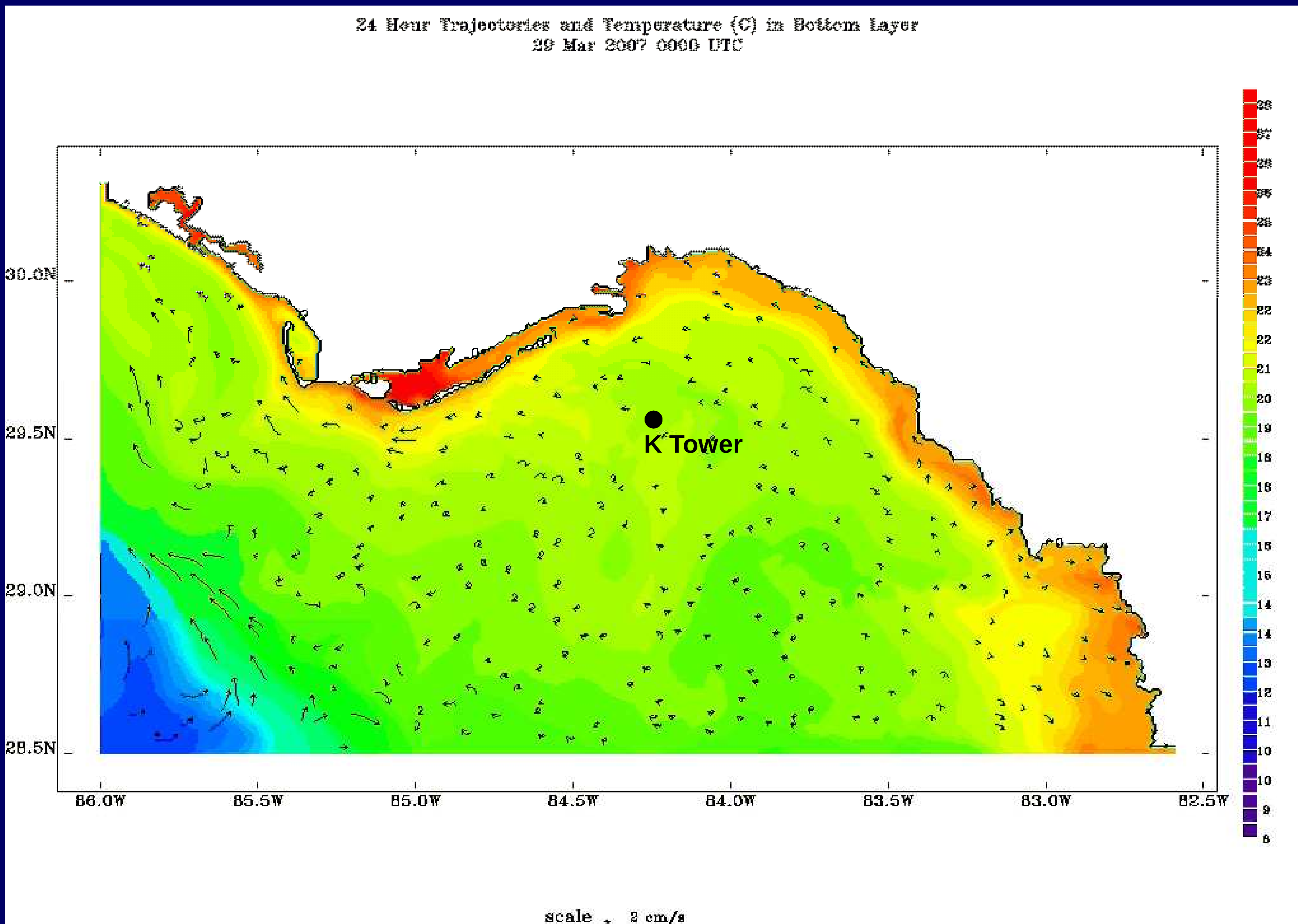


Lagrangian numerical studies

The number of particles that reach the 5m isobath east of Cape San Blas (prevalent seagrass habitat) are counted as "successful"




NARR wind, 84.253W, 29.623N
m/s
15
10
5
0
-5
-10
-15
N
3/22/2007
3/29/2007
4/ 5/2007
4/12/2007
4/19/2007


24 Hour Trajectories and Temperature (C) in Bottom Layer
29 Mar 2007 0000 UTC
K Tower
30.0N
29.5N
29.0N
28.5N
86.0W
85.5W
85.0W
84.5W
84.0W
83.5W
83.0W
82.5W
scale , 2 cm/s

Hypothesis: Interannual variability of synoptic scale atmospheric forcing influences the interannual variability of onshore transport during the winter-spring spawn.

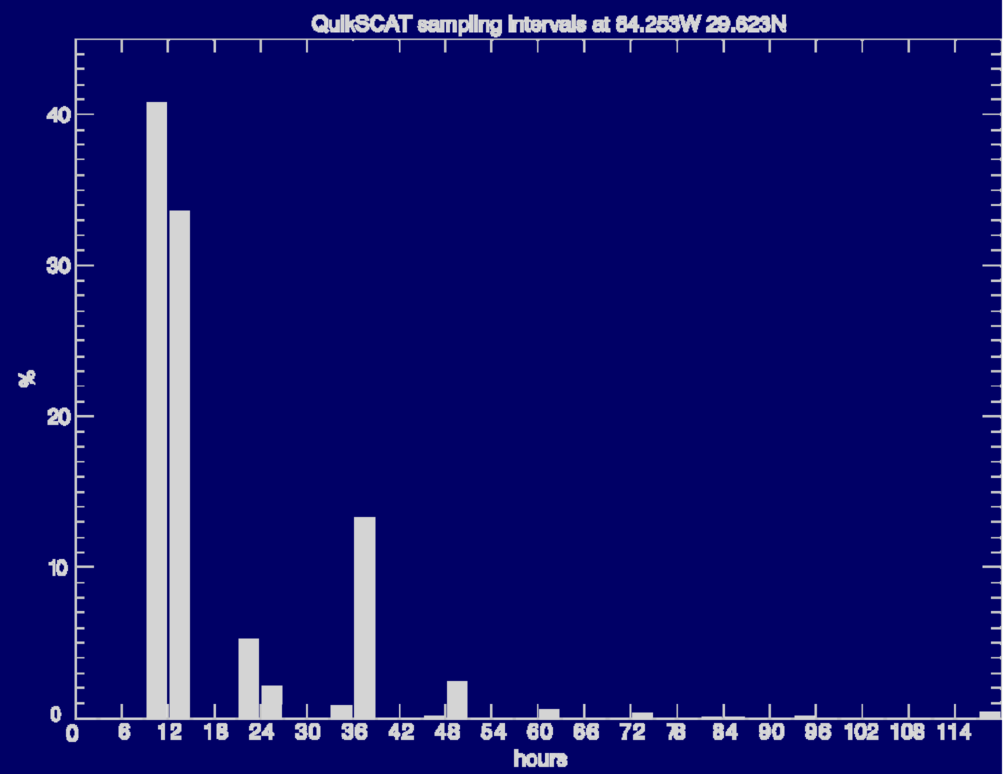
Problem: What data should we use to study interannual variability of winds over the northeastern Gulf of Mexico?

Operational NWP products are frequently changing

Reanalysis products have changes in data available for assimilation over the time record

In situ measurements are sparse and instrument technology changes over time

Satellite scatterometer data may be complicated by inhomogeneous and sparse temporal sampling



Objectives:

Compare the reanalysis product (NARR) against QuikSCAT to identify trends in the data.

Quantify the errors due to sparse temporal sampling of synoptic scale events over the Big Bend region of the West Florida Shelf.

Characterize the interannual variability of synoptic scale forcing over the northern West Florida Shelf.

Data:

QuikSCAT 10m wind time series extracted from Level 2B swath data

All data from a single track within a 50km x 50km bin about 84.253°W, 29.623°N are averaged, rejecting rain-contaminated cells

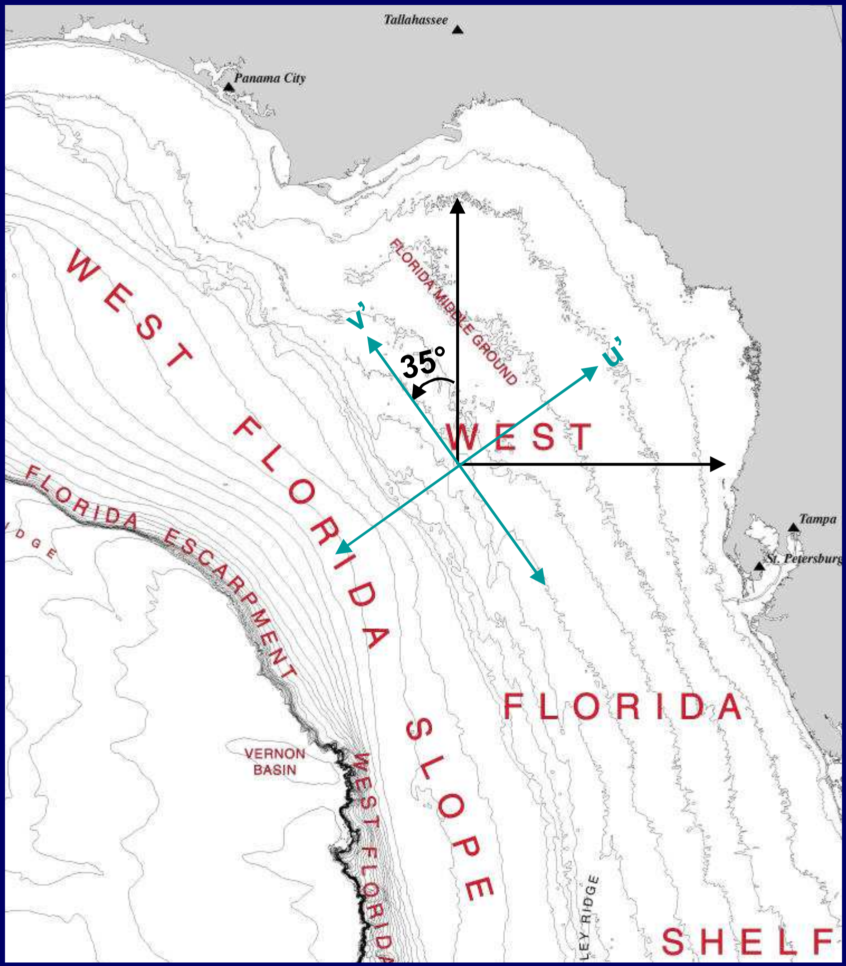
NCEP North American Regional Reanalysis

32 km reanalysis product with 3-hourly fields archived for 1979-

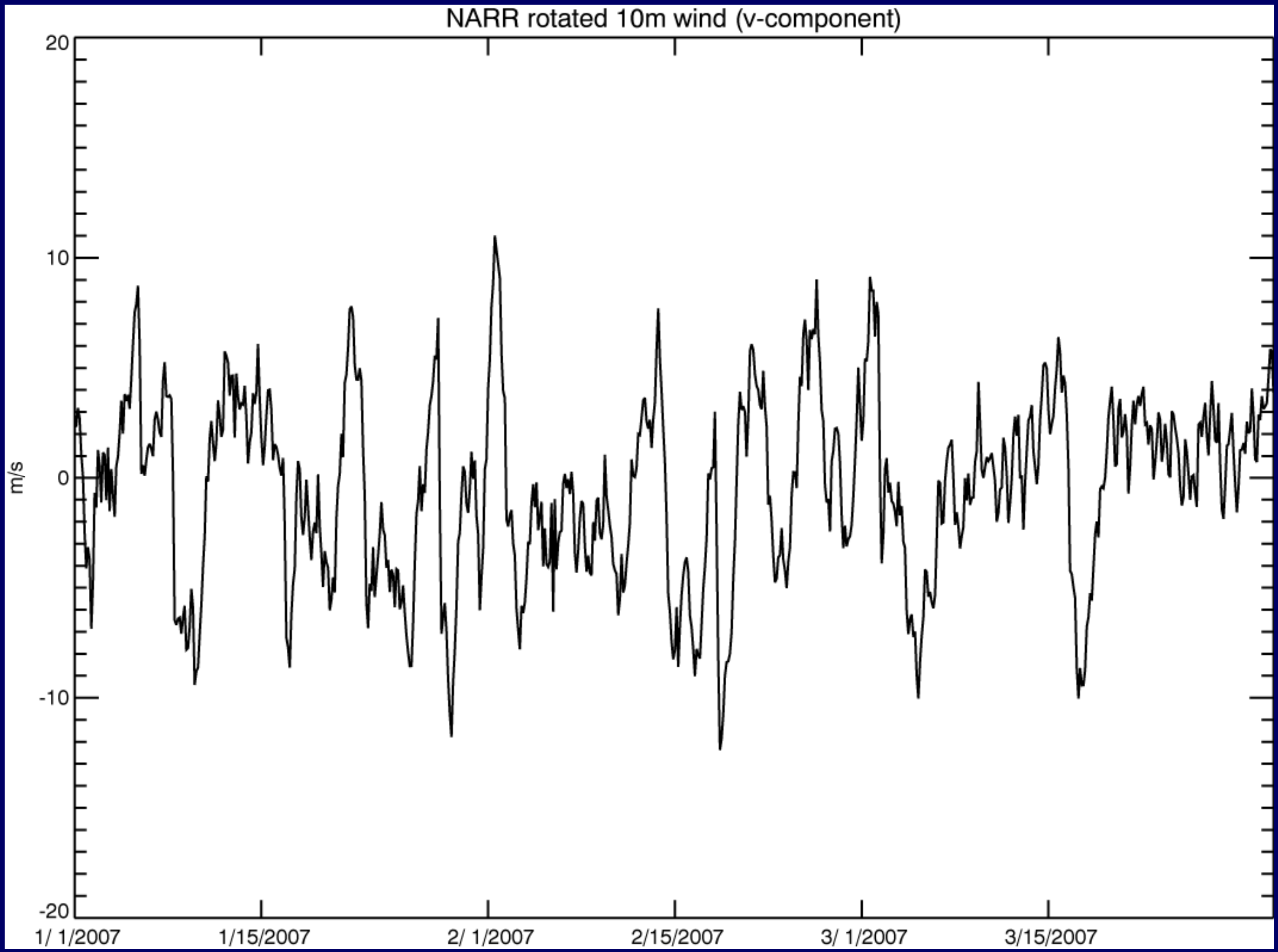
In situ observations from the FSU coastal observing station “K-Tower” (currently undergoing QA/QC)

Wind (u,v) components are rotated 35° to the (u’,v’) axes, roughly along local isobaths.

Winds are defined as upwelling when the rotated v’ component is negative.

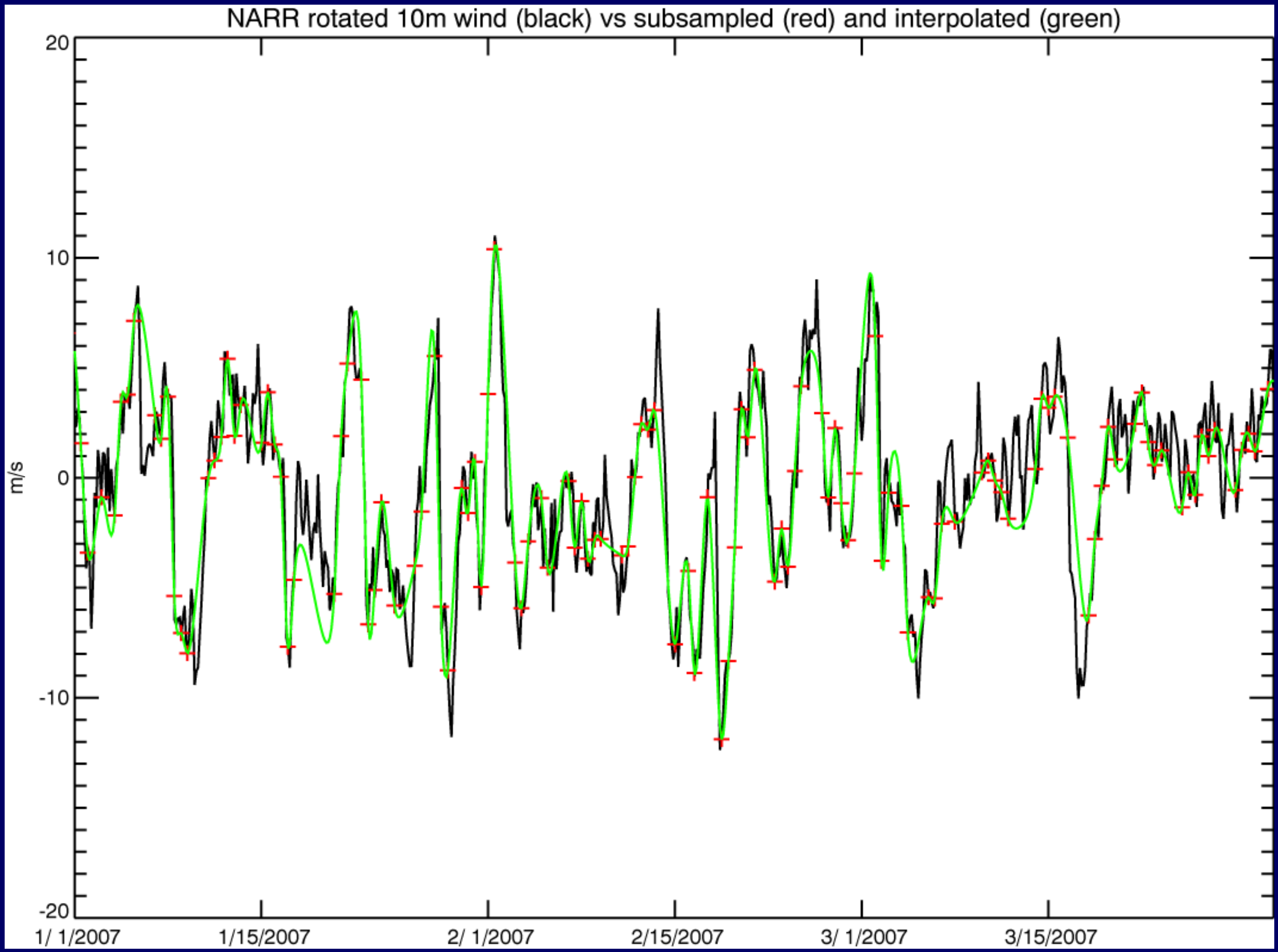


NARR wind – upwelling component



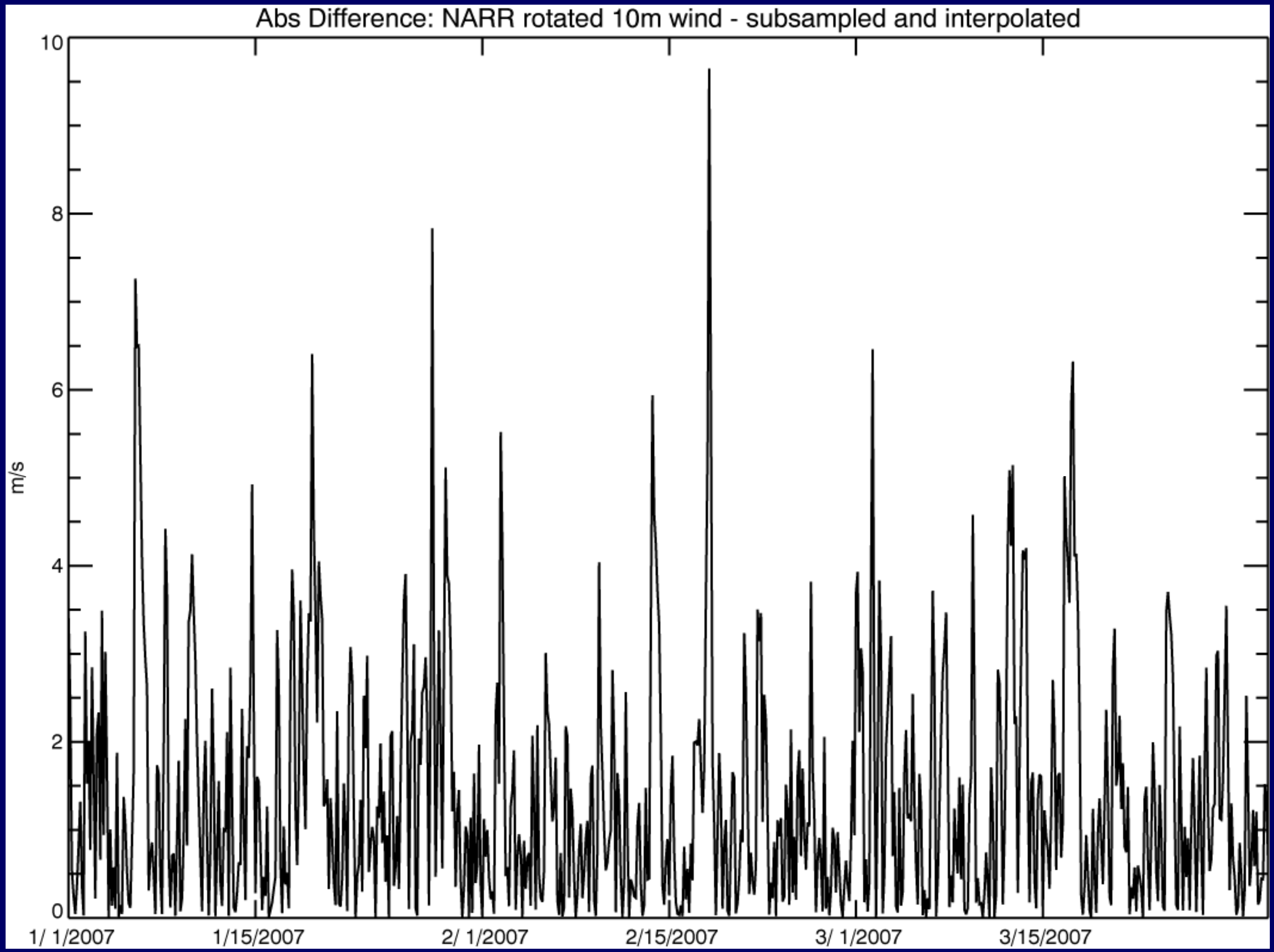
NARR wind – upwelling component

vs. subsampled and spline interpolated NARR wind



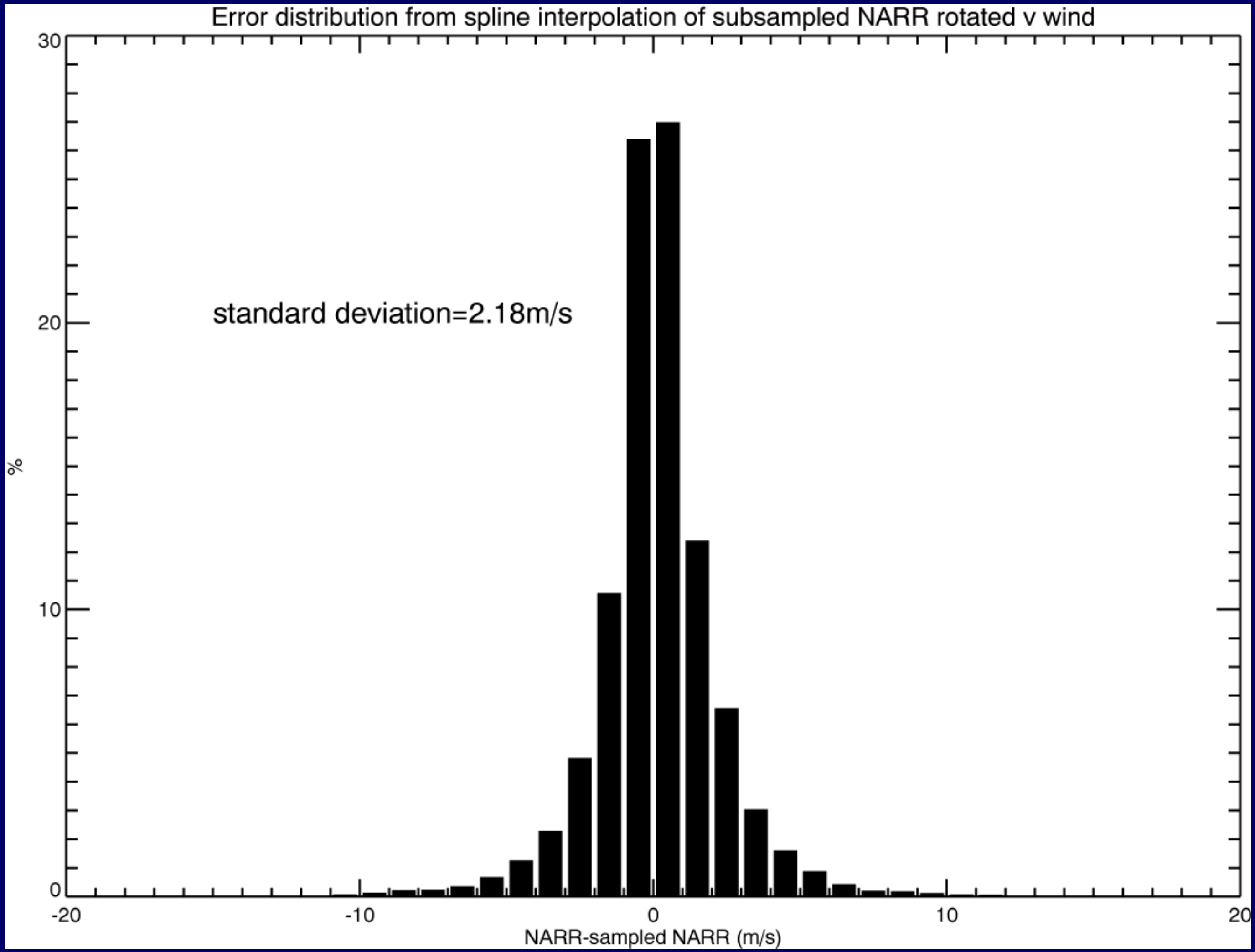
Magnitude of differences between NARR wind

and subsampled/interpolated NARR wind – rotated v’ component



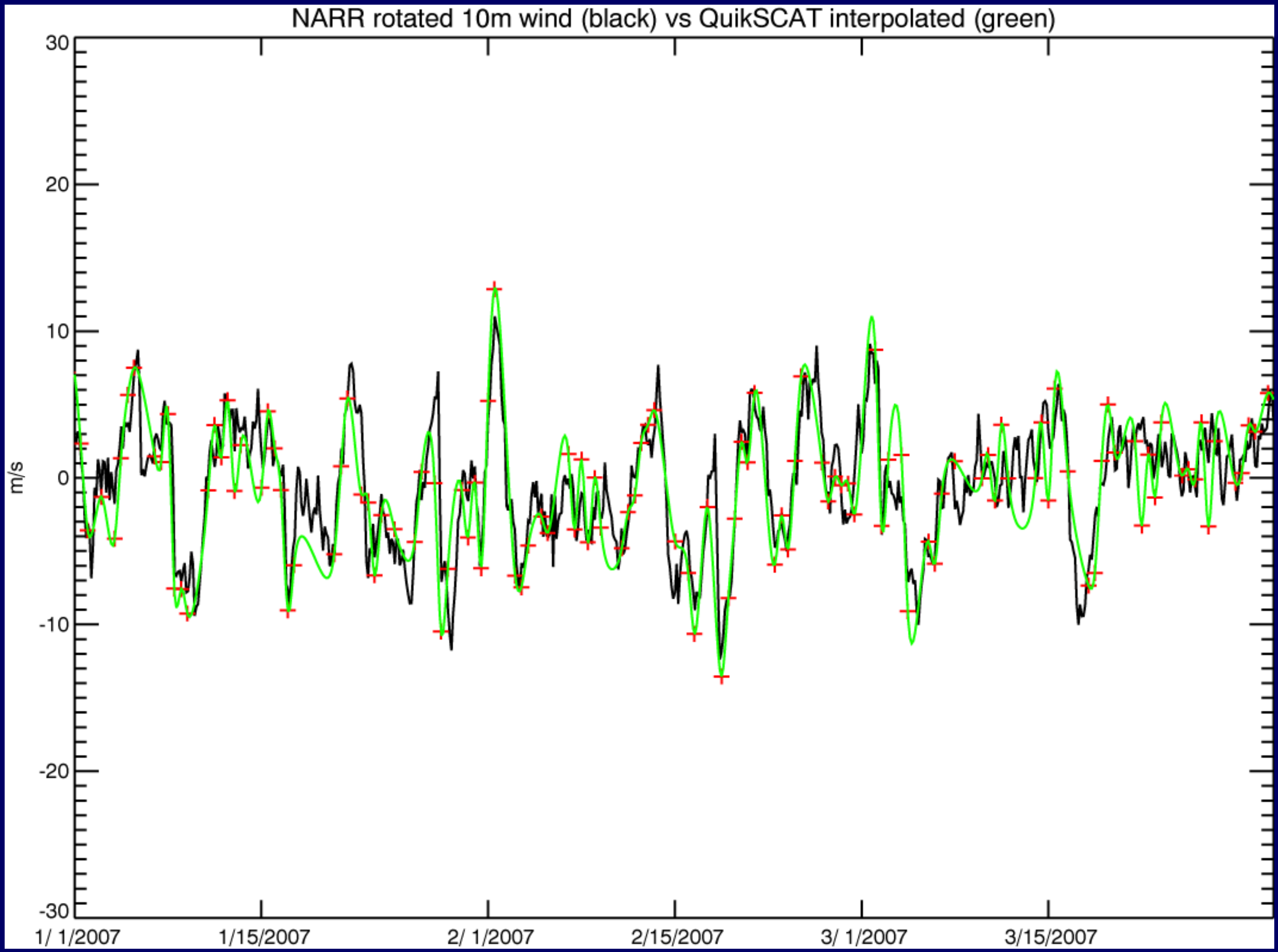
Differences between NARR wind

and subsampled/interpolated NARR wind – rotated v' component



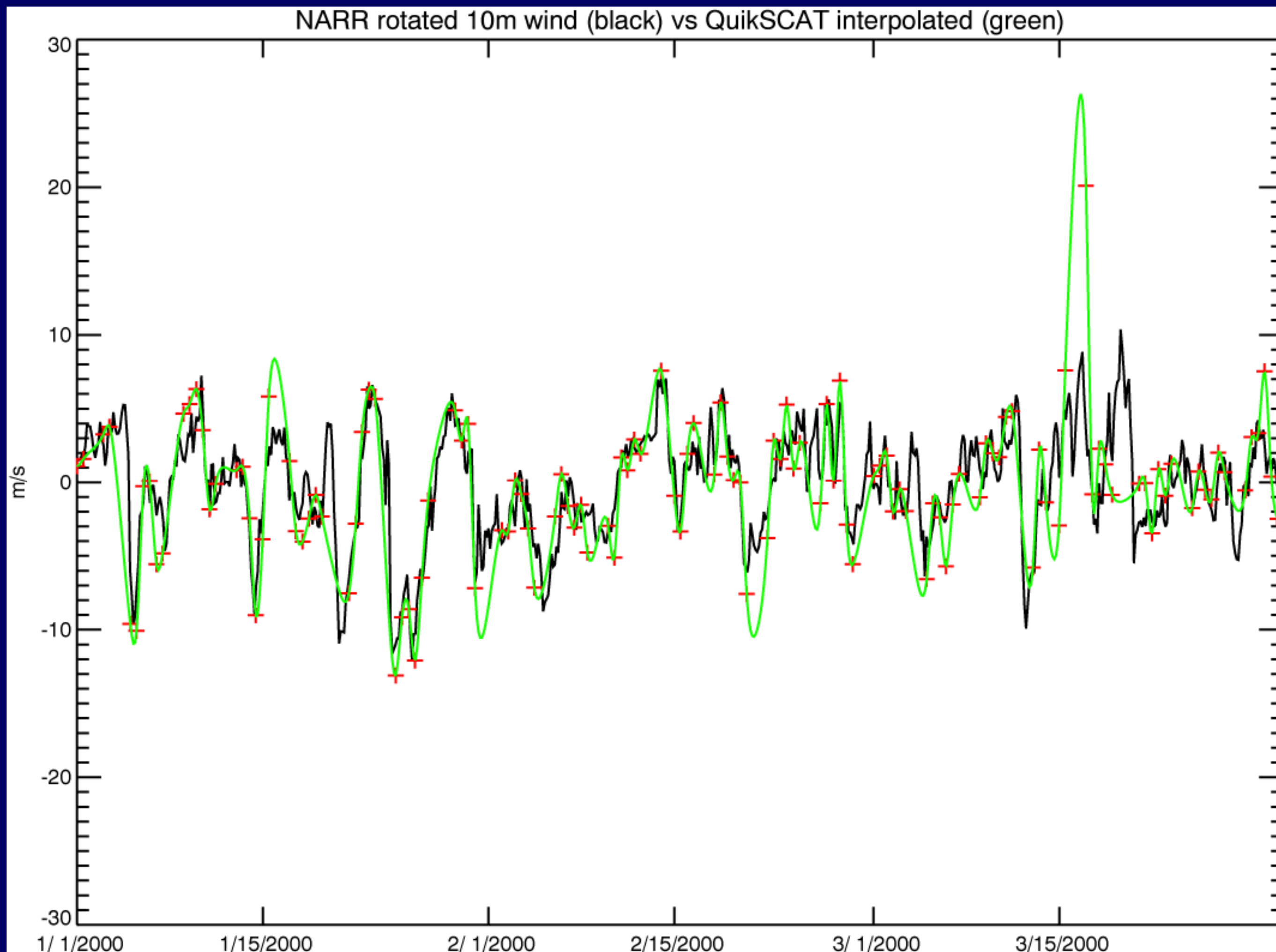
NARR wind vs. interpolated QuikSCAT – upwelling component

Jan-Mar 2007

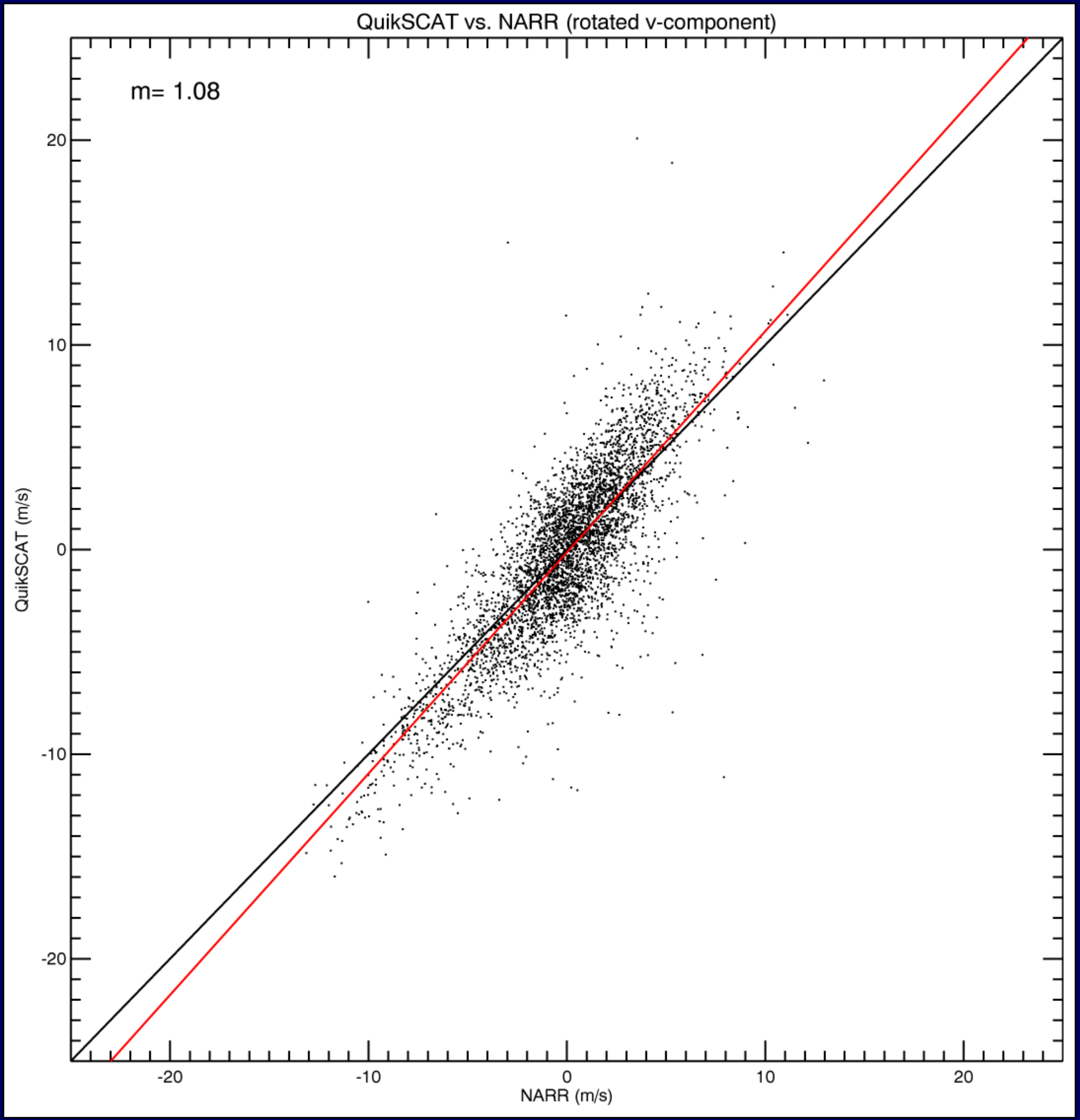


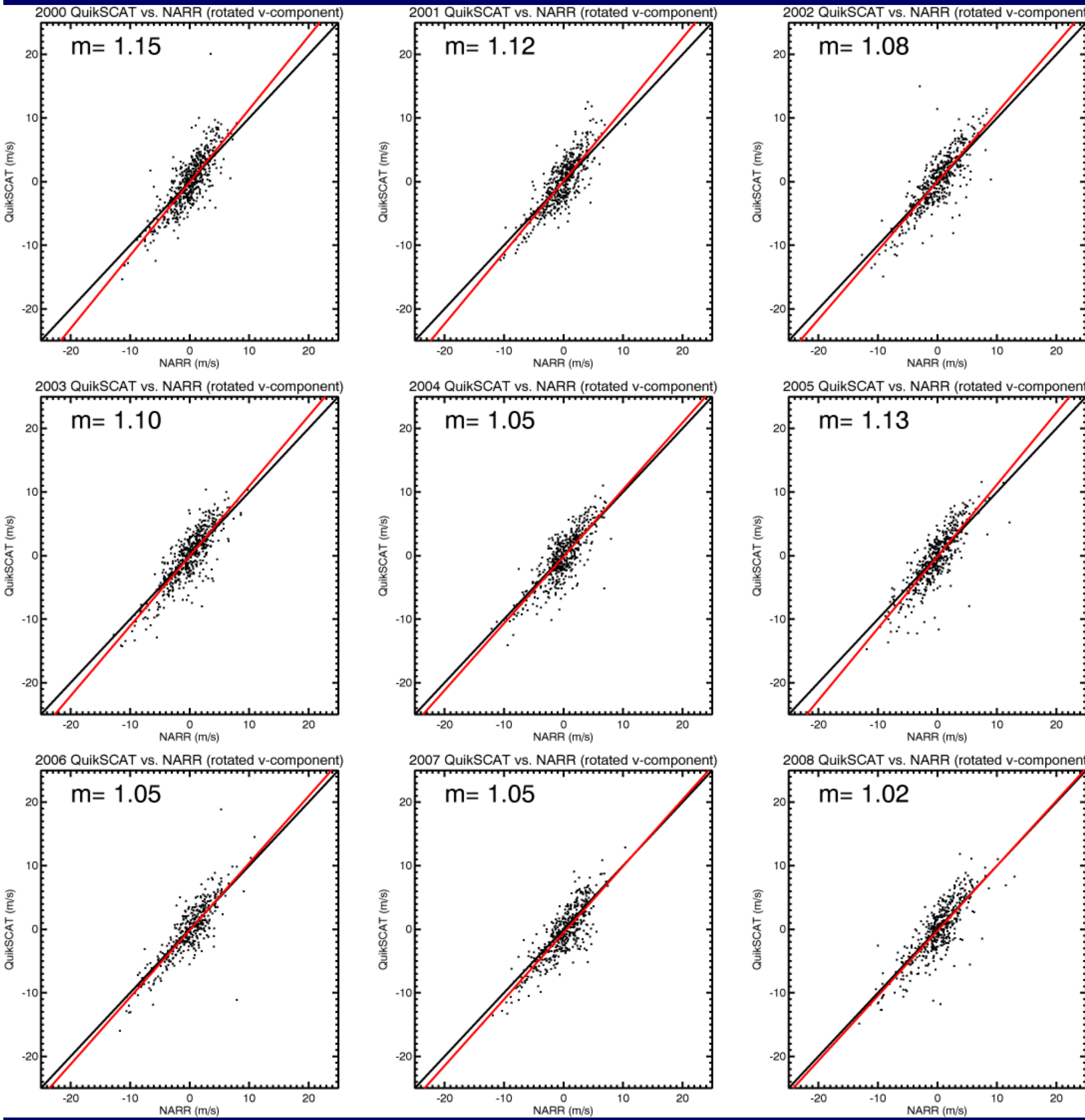
NARR wind vs. interpolated QuikSCAT – upwelling component

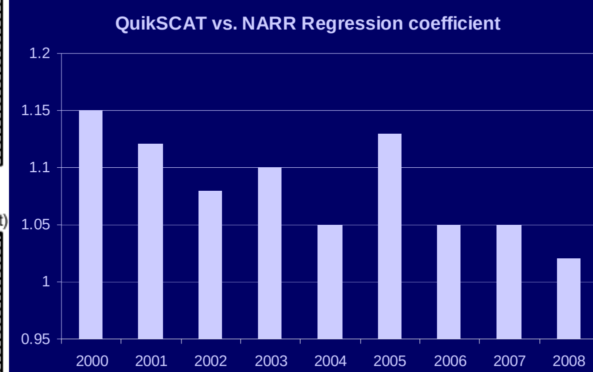
Jan-Mar 2000



NARR has a low wind speed bias compared to QuikSCAT







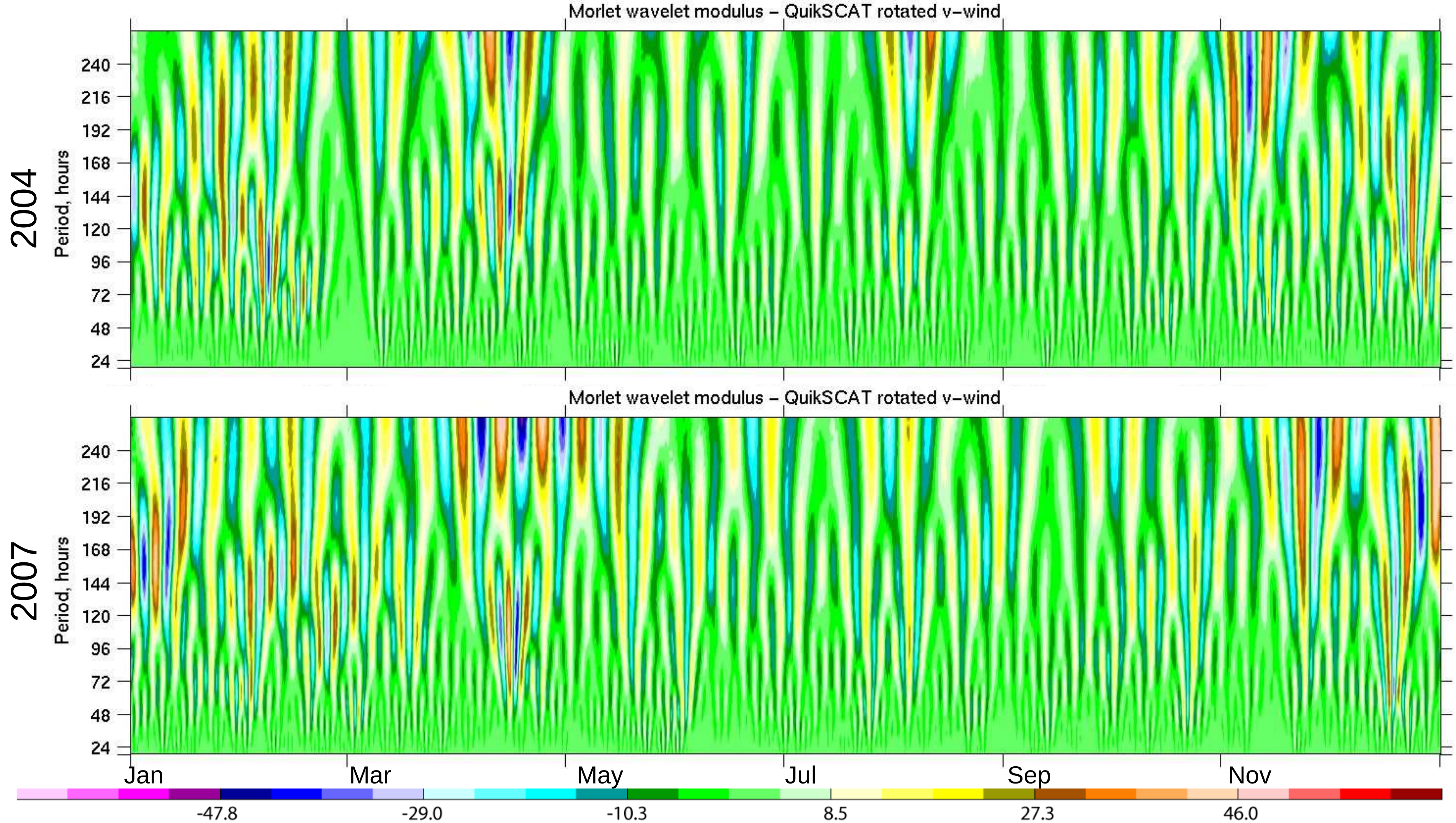
Decrease in NARR bias over time produces a non-stationary time series.

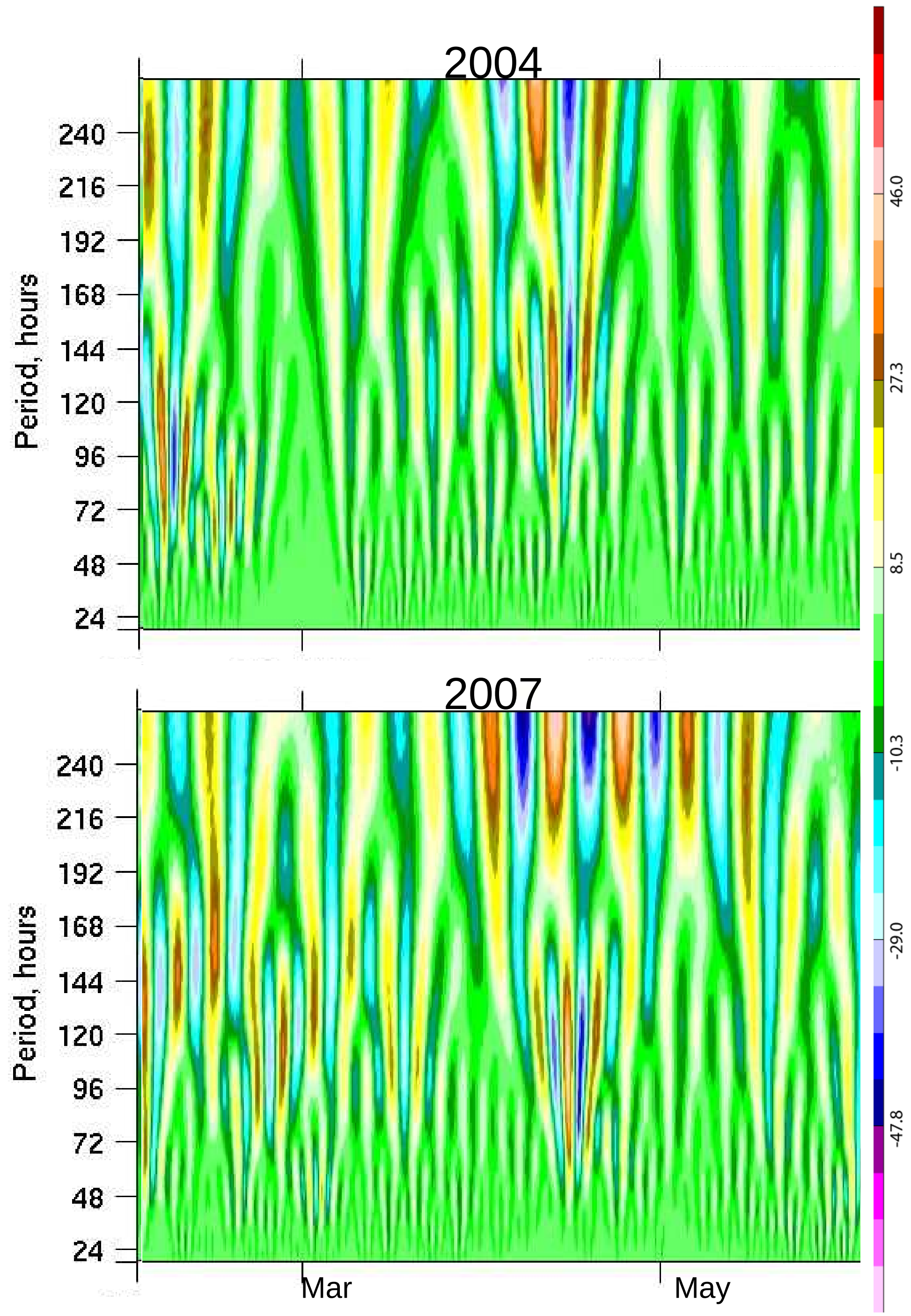
We will therefore use QuikSCAT to examine variability of winds over the region.

Morlet Wavelet Modulus

QuikSCAT rotated v’ time series interpolated (cubic spline) to 3-hour time step

10-day high-pass filter




2004
2007
Period, hours
240
216
192
168
144
120
96
72
48
24
Mar
May
46.0
27.3
8.5
-10.3
-29.0
-47.8

Summary

The NARR product has wind speed bias that evolves over time

- This is expected since the number and quality of observations assimilated changes over time.

QuikSCAT sampling intervals for the region seem adequate for capturing synoptic scale events of concern for this problem.

- Errors from interpolating via cubic spline to 3-hourly time steps for analysis have a estimated standard deviation of 2.18 m/s.
- In situ observations from the K-tower station can be used to better quantify the sampling errors

Interannual variability in the synoptic scale variability is evident

- This may be linked to the prevalence of upwelling-favorable winds following cold front passages
- Further research is needed to explain the dynamical response of the onshore transport to the wind variability, including duration and frequency of upwelling favorable wind events.