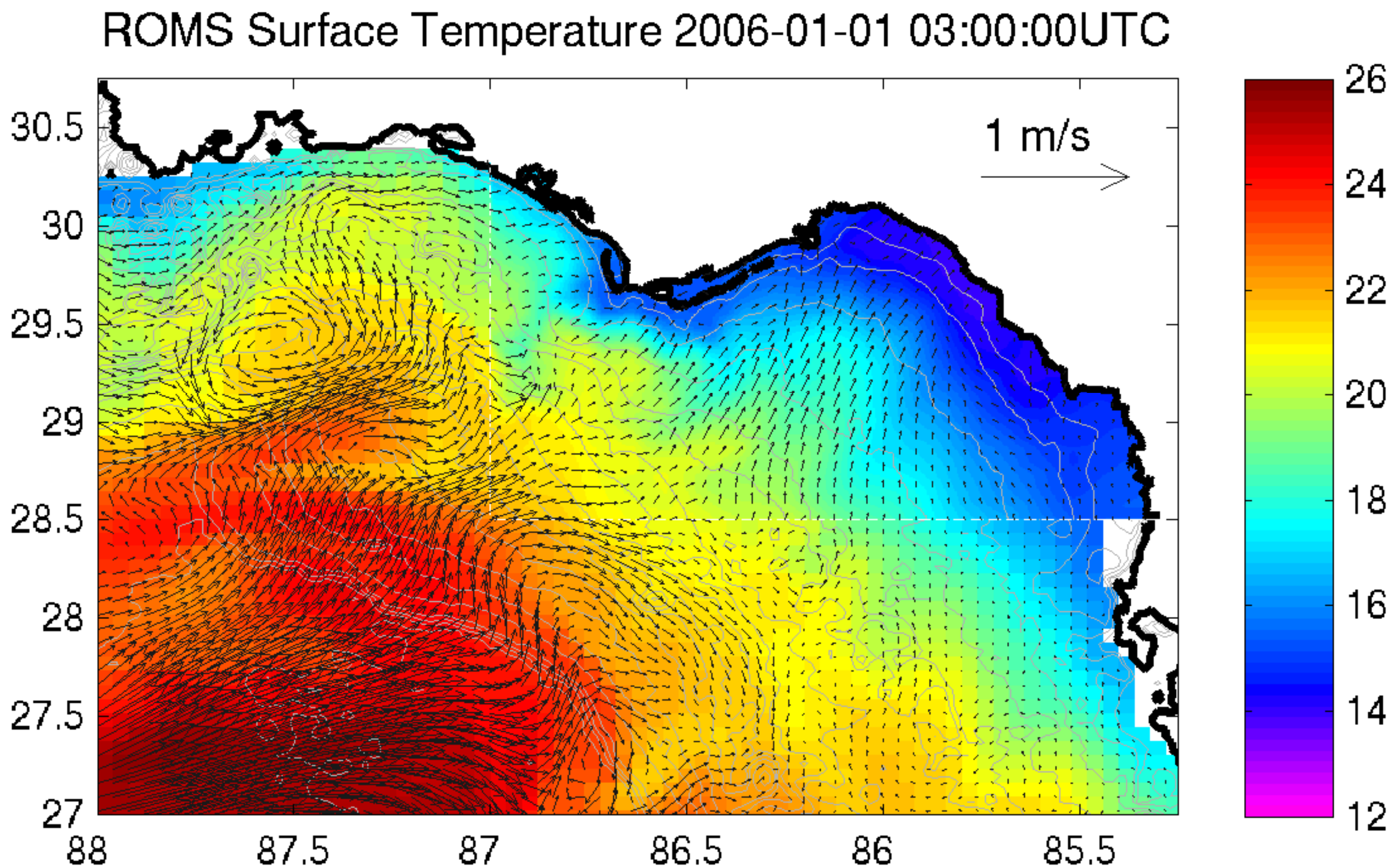
Applications and Future Requirements of Satellite Vector Winds for Coastal and Shelf Studies



Steve Morey, Dmitry Dukhovskoy, Austin Todd, Mark Bourassa

COAPS-FSU

Scales of Variability

- Inertial to atmospheric synoptic time scales important to shelf dynamics

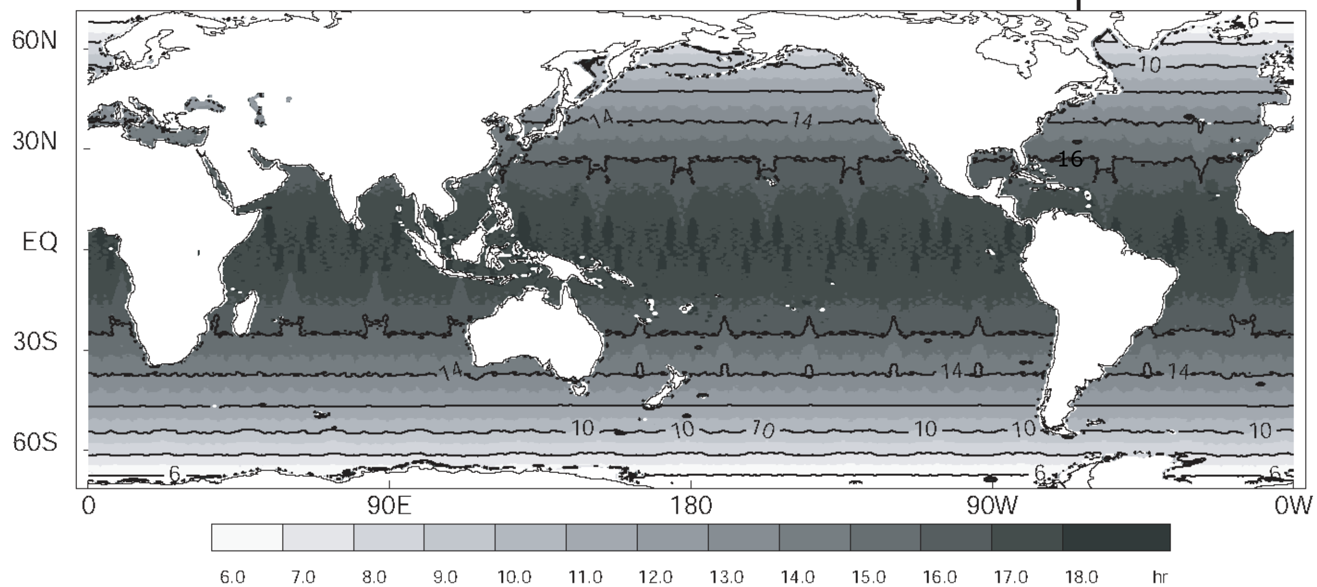
- Tropical cyclones – Storm surges, and modification of shelf thermal structure and currents

- Diurnal variability strong in coastal areas

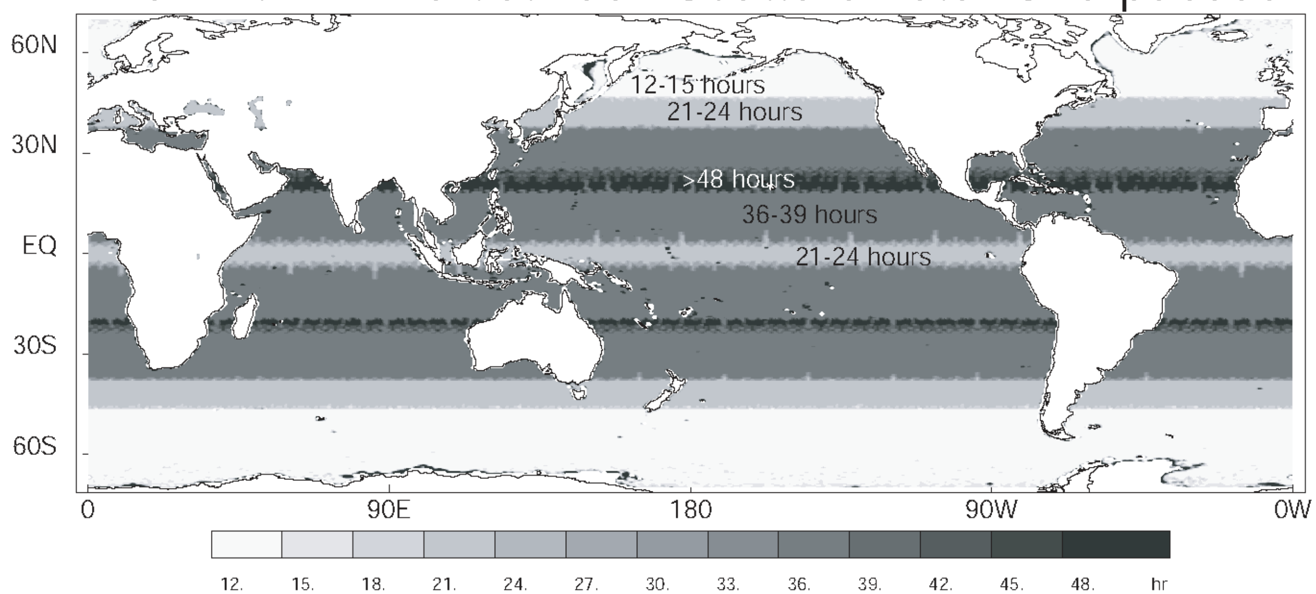
- Potentially large wind gradients in coastal areas due to SST gradients, orography, land/sea breeze

QuikSCAT Temporal Sampling

Mean Time between Scatterometer Overpasses



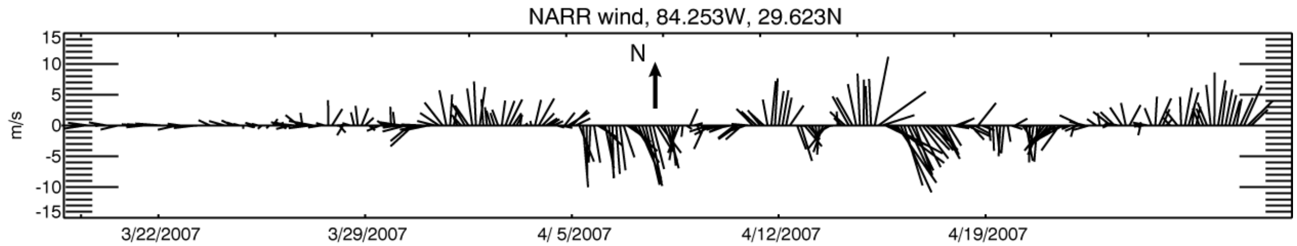
Maximum Time between Scatterometer Overpasses

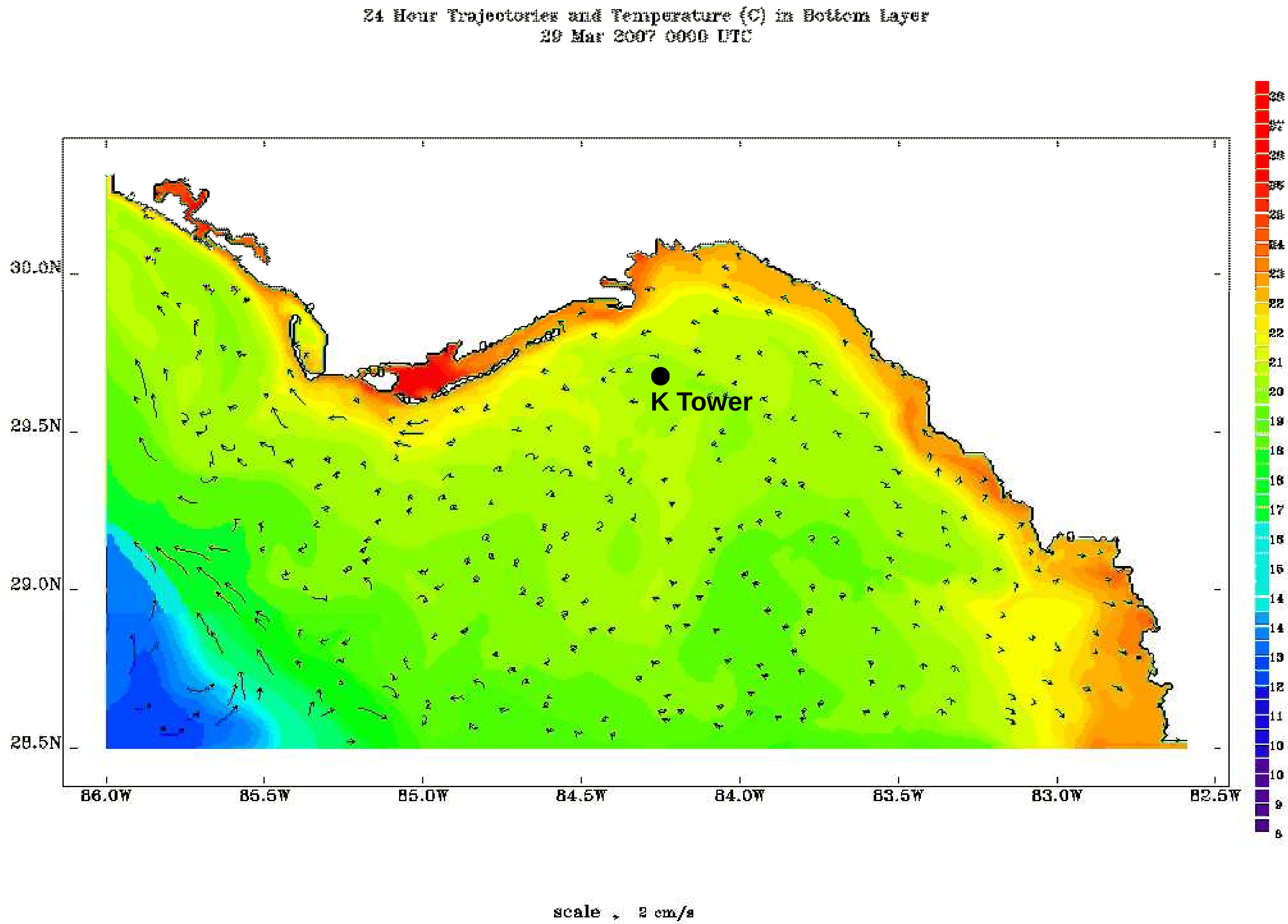


Synoptic Scale Variability of Forcing on the Shelf

- The 3-10 day weather band (sub-inertial frequencies) dominates variability on mid-latitude shelves.

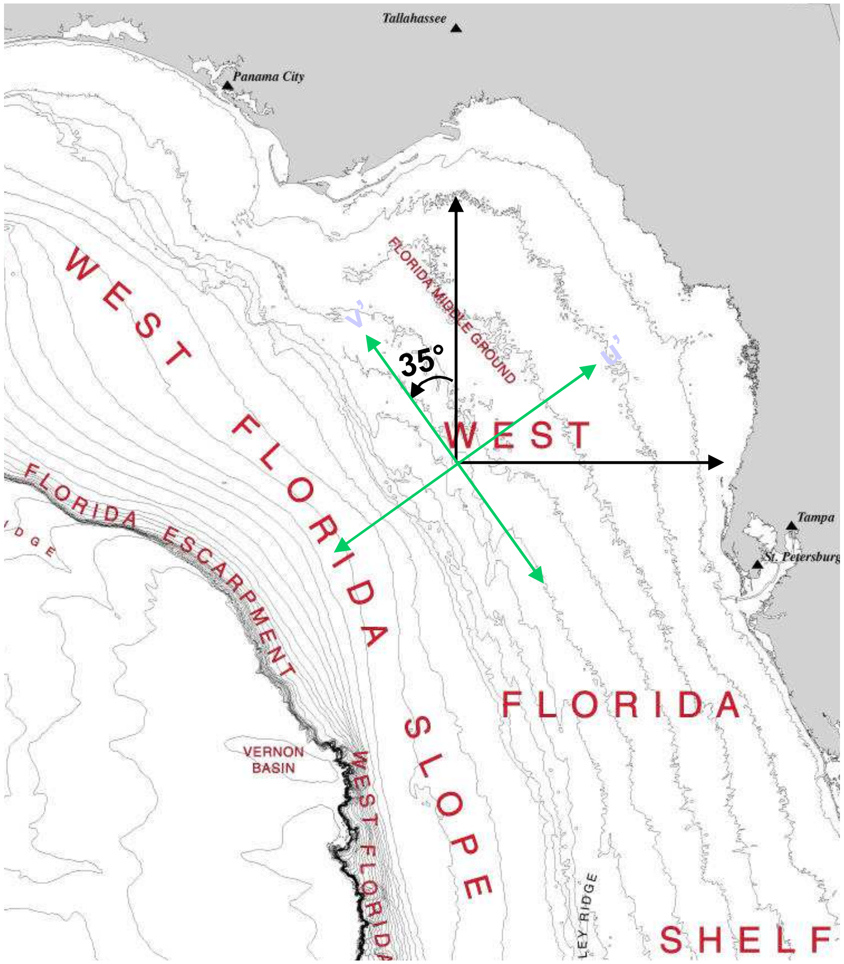
- Responses include
  - Upwelling/Downwelling
  - Shelf Waves
  - Coastal Jets


NARR wind, 84.253W, 29.623N
N
m/s
15
10
5
0
-5
-10
-15
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

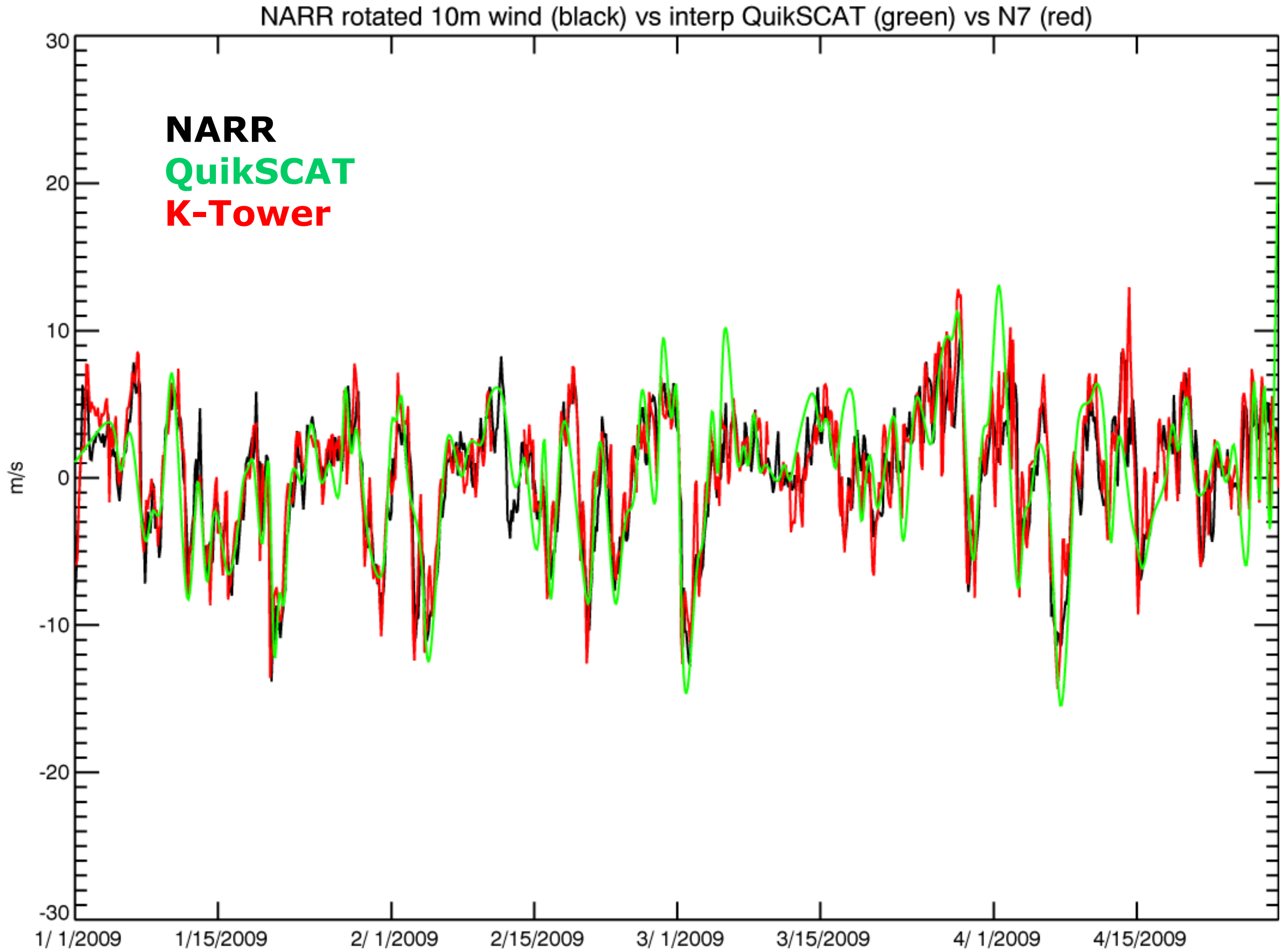
Wind (u,v) components are rotated 35° to the (u',v') axes, roughly along local isobaths.

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



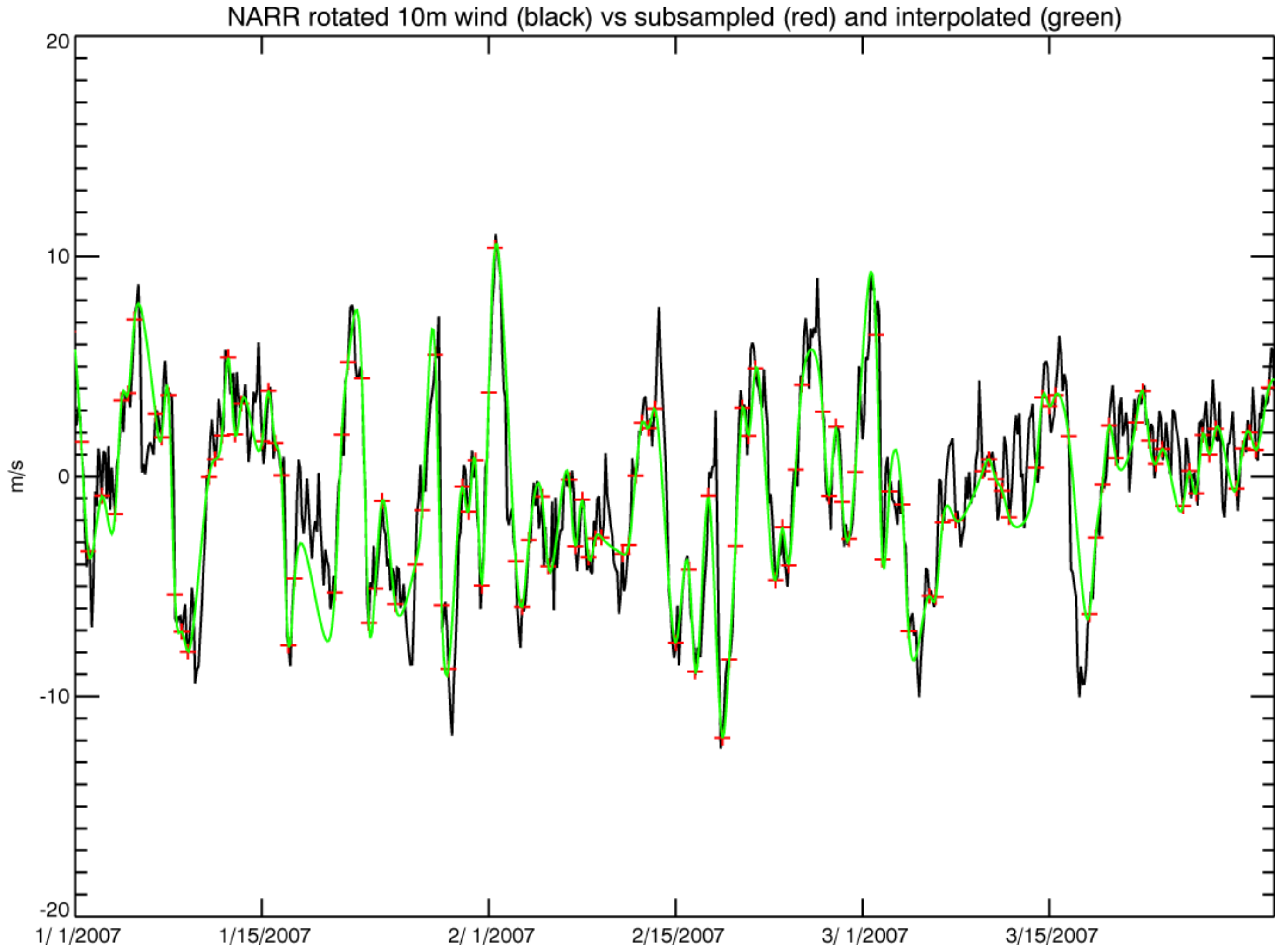
NARR wind – upwelling component

vs. spline interpolated QuikSCAT wind vs. K-Tower observations

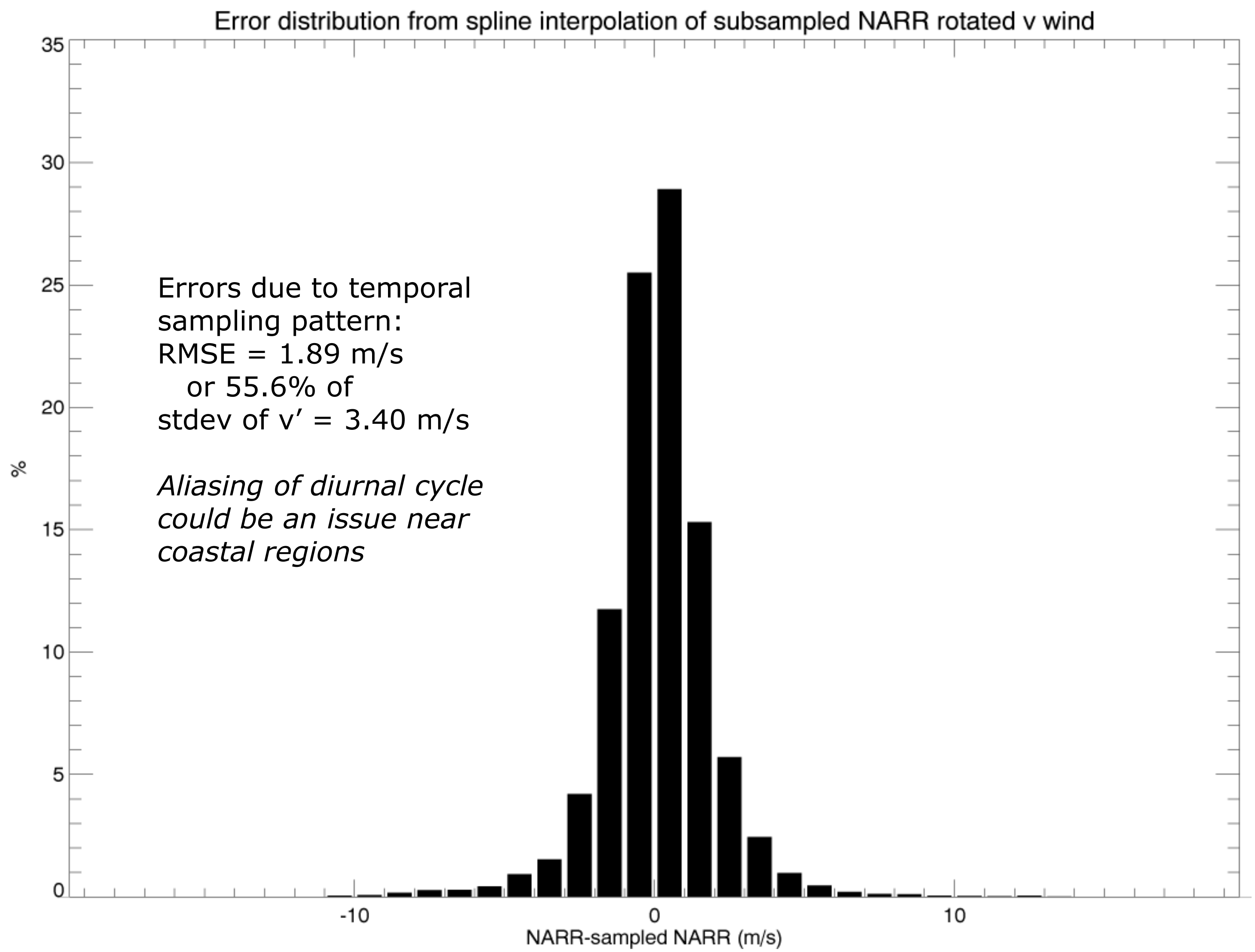


NARR wind – upwelling component

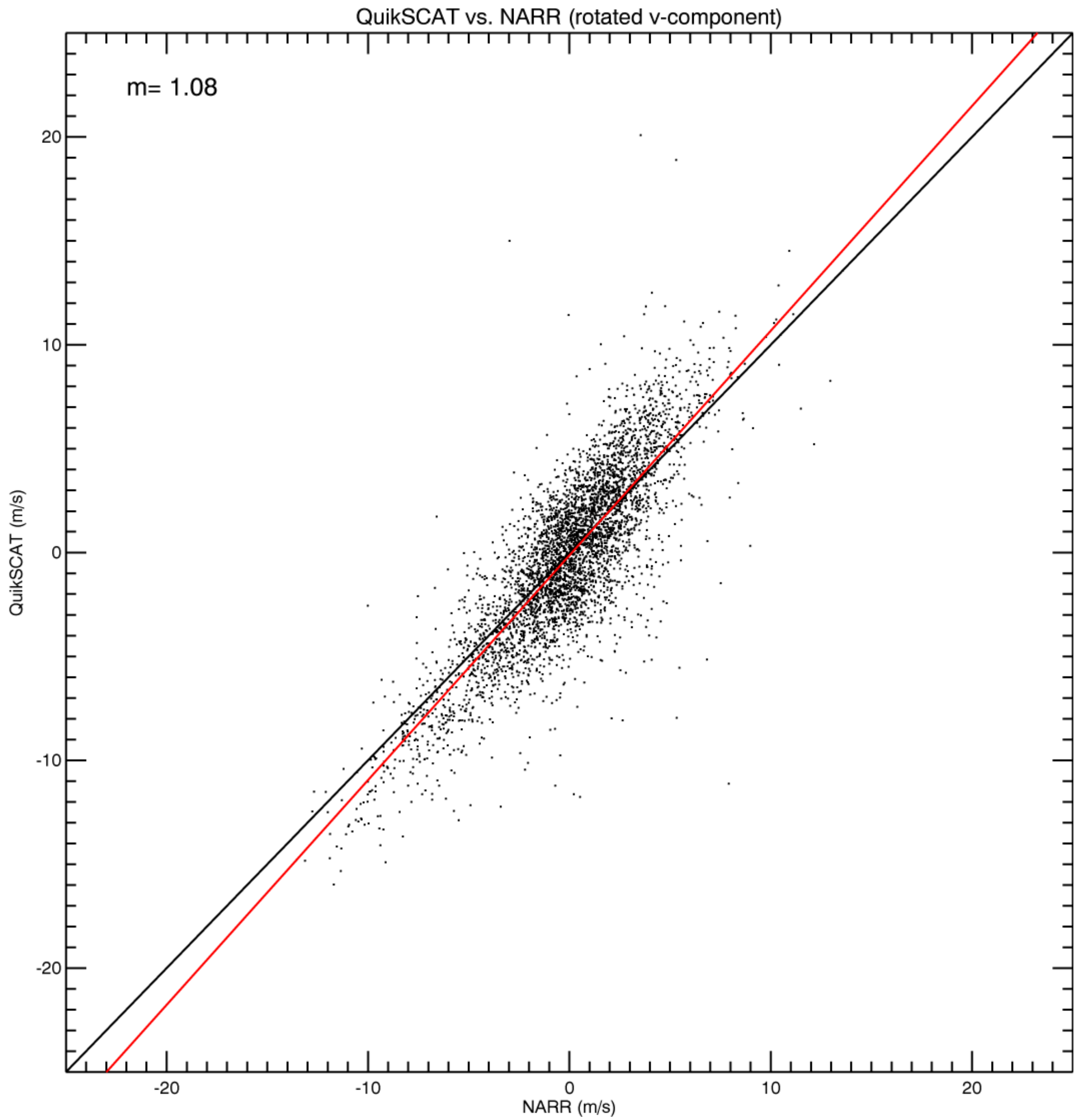
vs. subsampled and spline interpolated NARR wind

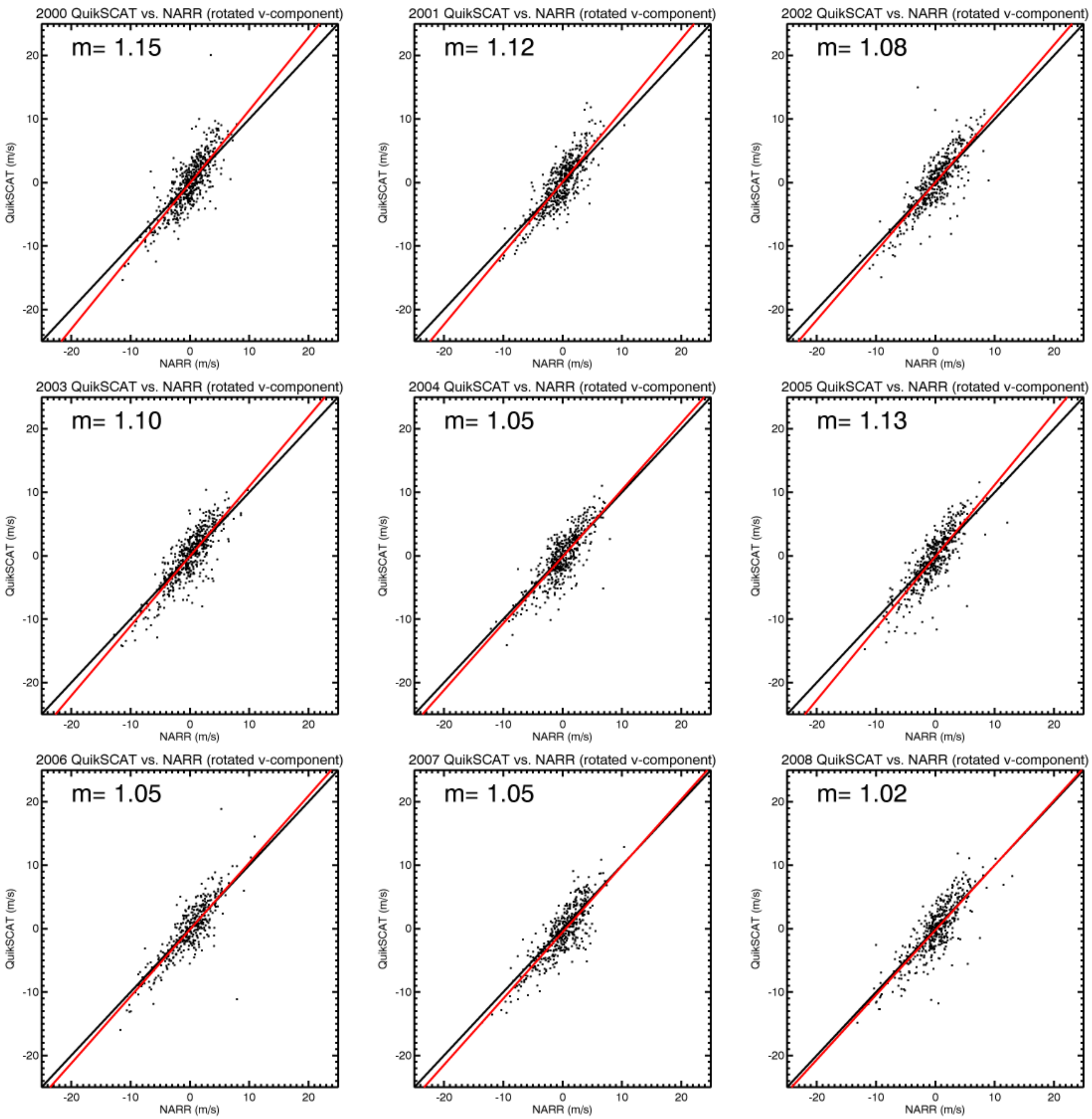


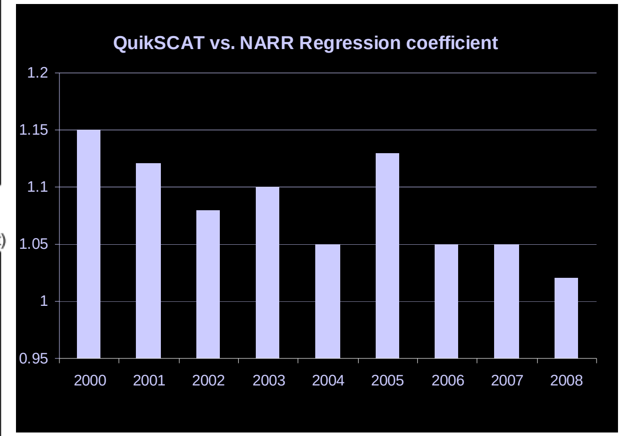
Differences between NARR wind (low-pass filtered) and subsampled/interpolated NARR wind – rotated v’ component



NARR has a low wind speed bias compared to QuikSCAT



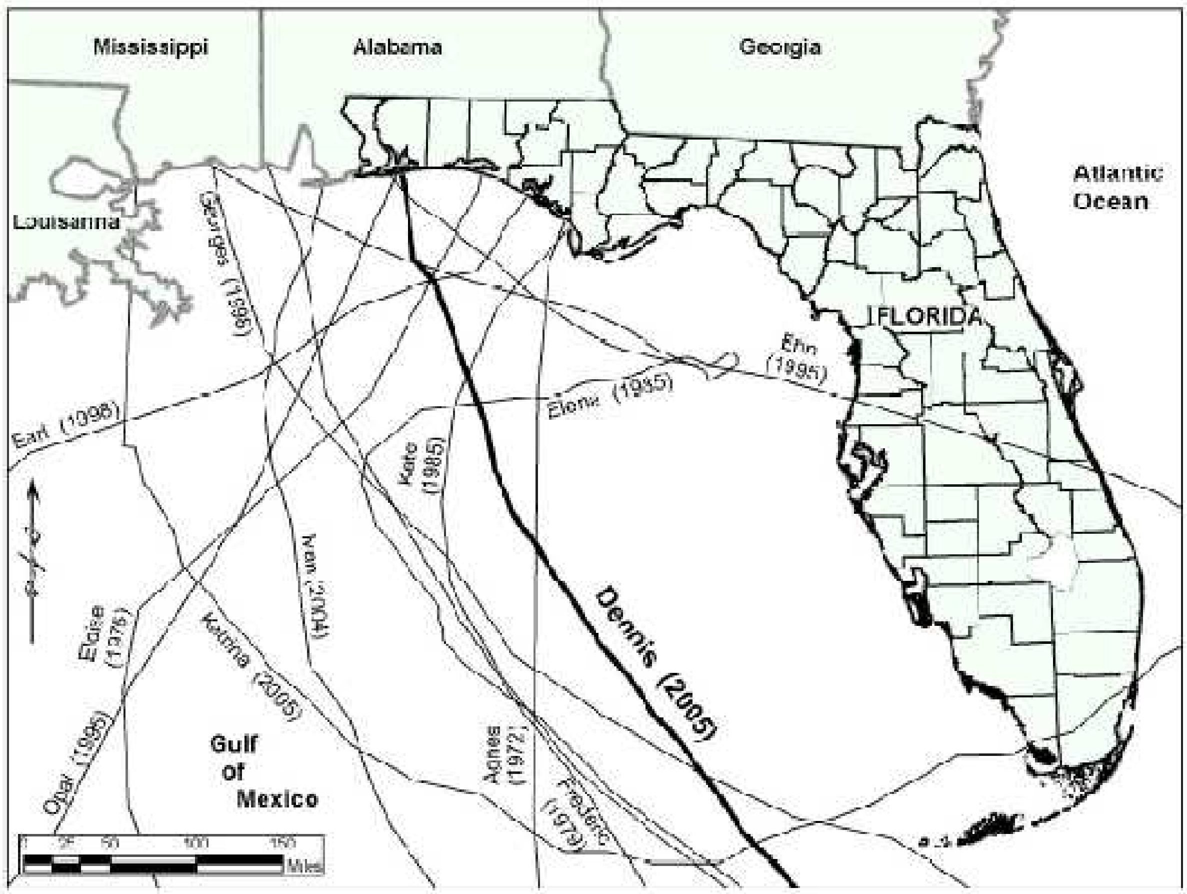




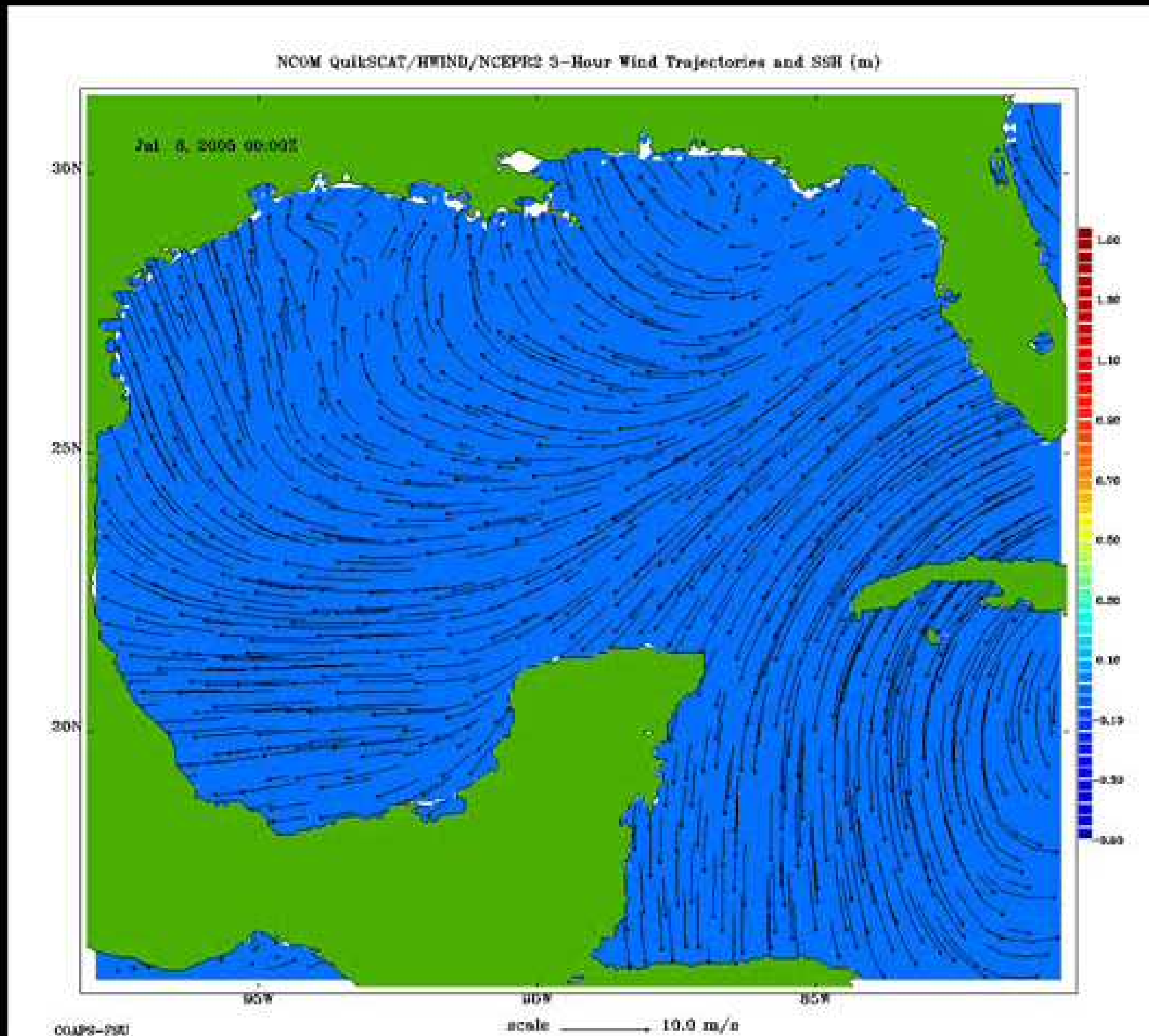
Decrease in NARR bias over time produces a non-stationary time series.

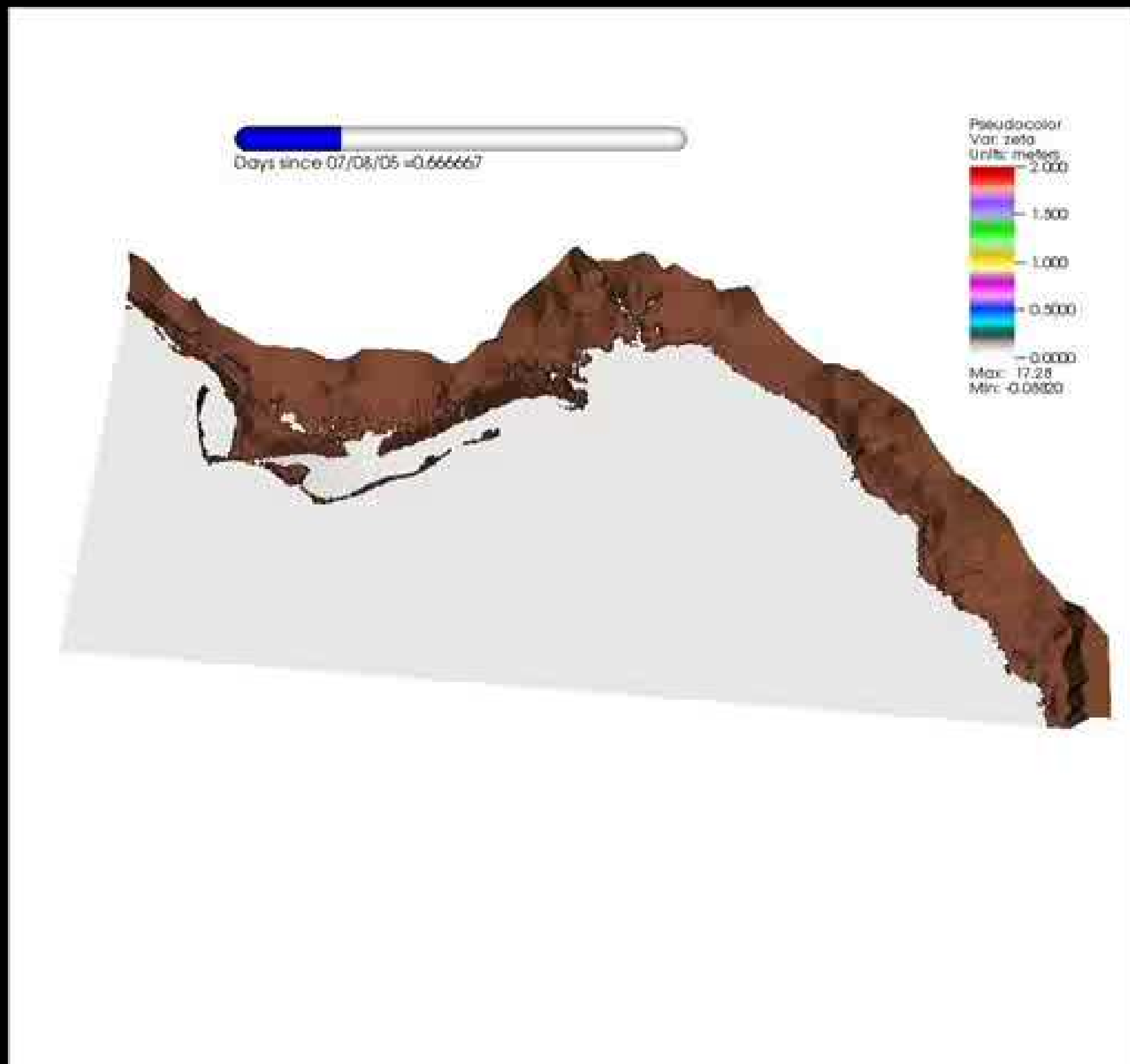
Tropical Cyclones and Storm Surge

- Storm surge popularly considered to occur on the scale of storm size, but significant localization occurs due to
  - Coastline geometry
  - Storm spatial structure
  - Storm track
  - Incidence angle



Hurricane Dennis, 2005




Days since 07/08/05 =0.666667
Pseudocolor
Var: zeta
Units: meters
2.000
1.500
1.000
0.5000
0.0000
Max: 17.28
Min: -0.08820

Hurricane Wind Fields for Storm Surge Simulation and Prediction

- QuikSCAT samples winds too coarsely in time to capture the storm’s movement when nearing the coast.
- Rain contamination and high wind speed retrieval issues cause difficulties in resolving the storm’s structure near the core
- NOAA HRD H*WIND surface wind analyses are widely used for storm surge simulations

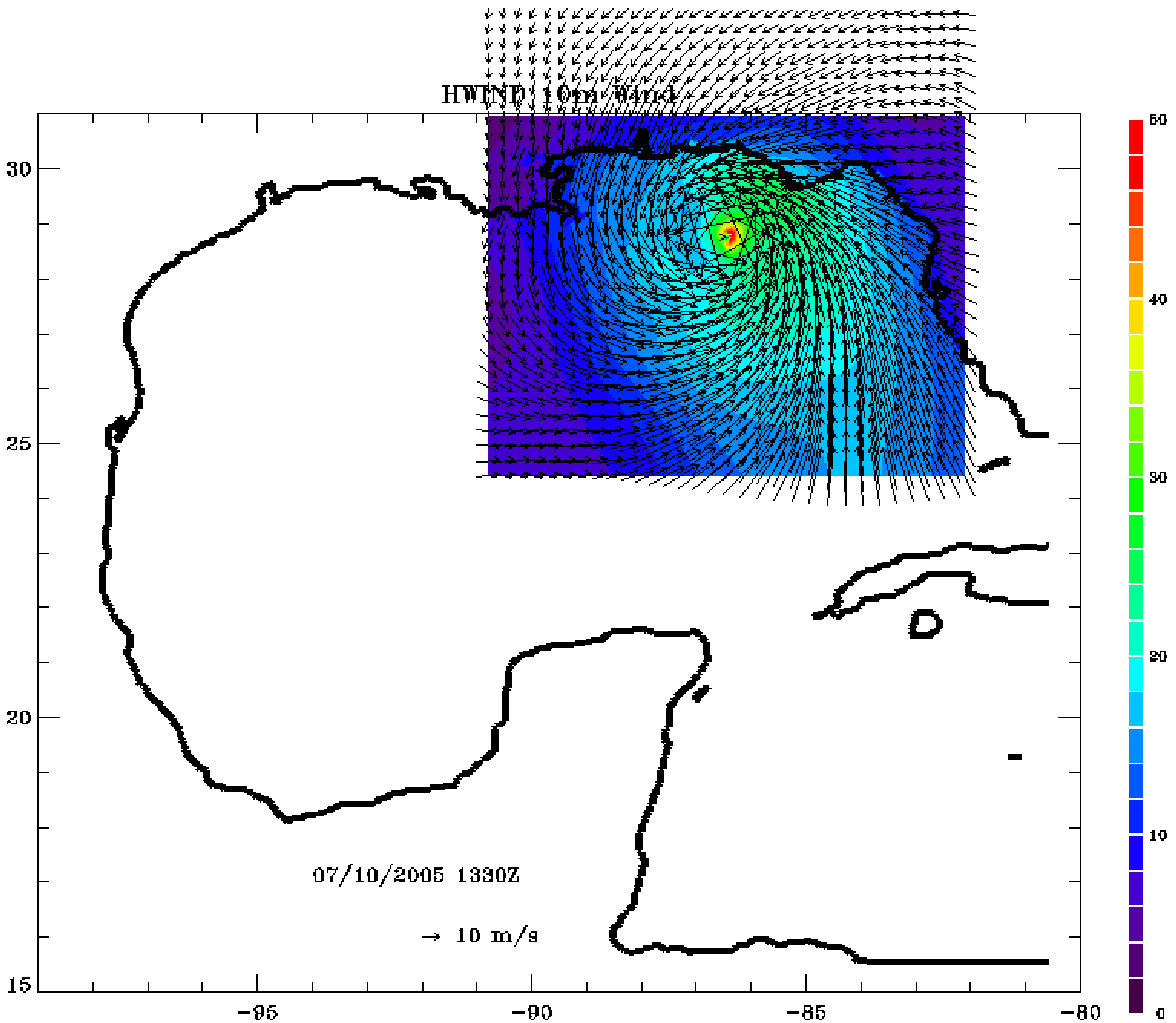
H*WIND Surface Wind Analyses

- Accumulates all available surface weather observations within the region (8° x 8°)
  - Ships, buoys, coastal platforms, surface aviation reports, reconnaissance aircraft data, and satellite data

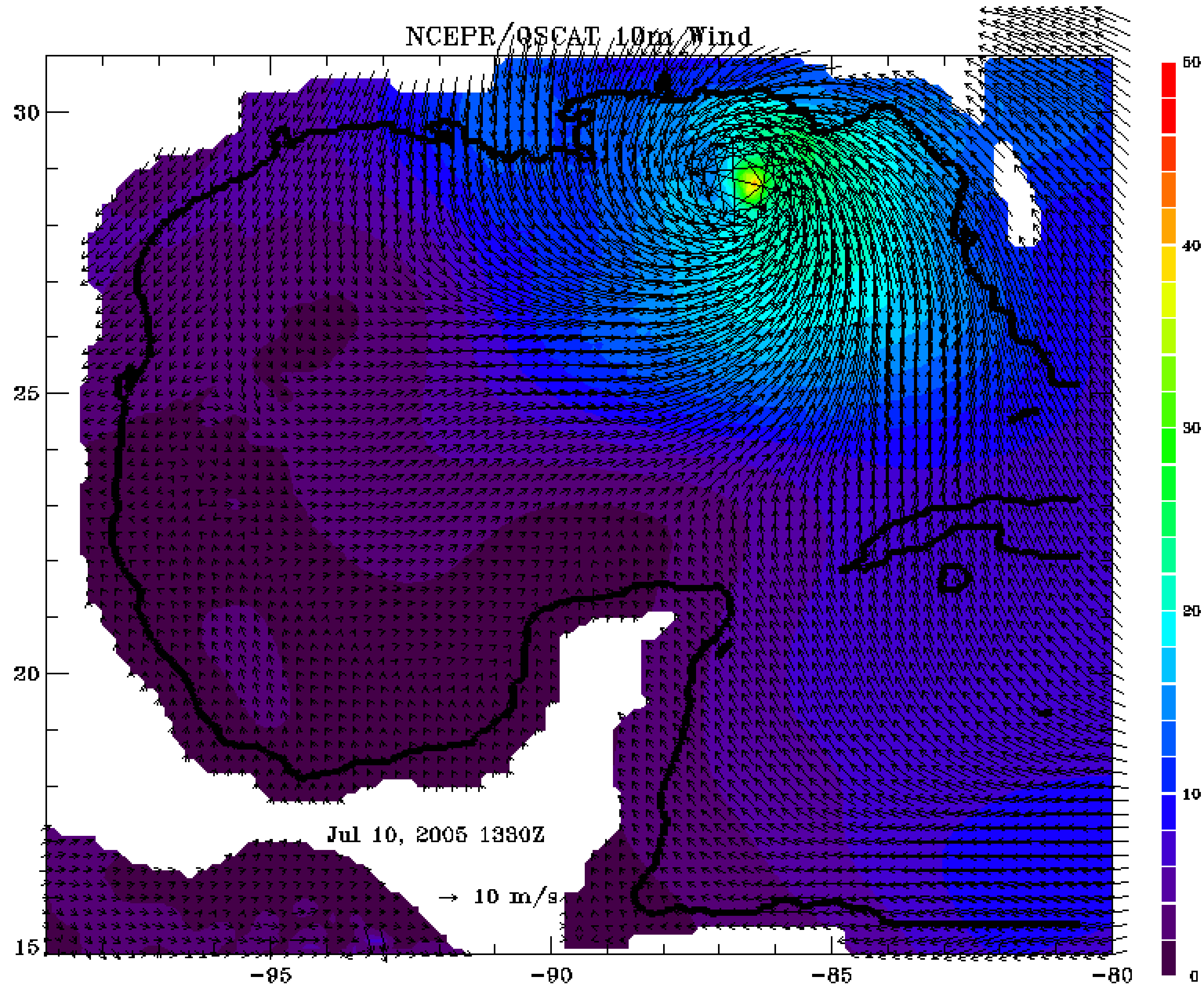
- Data composited over a 4-hour period, height adjusted, and converted to a maximum sustained 1-minute wind speed

- Data are assimilated into a surface wind field model

M. Powell, NOAA AOML HRD

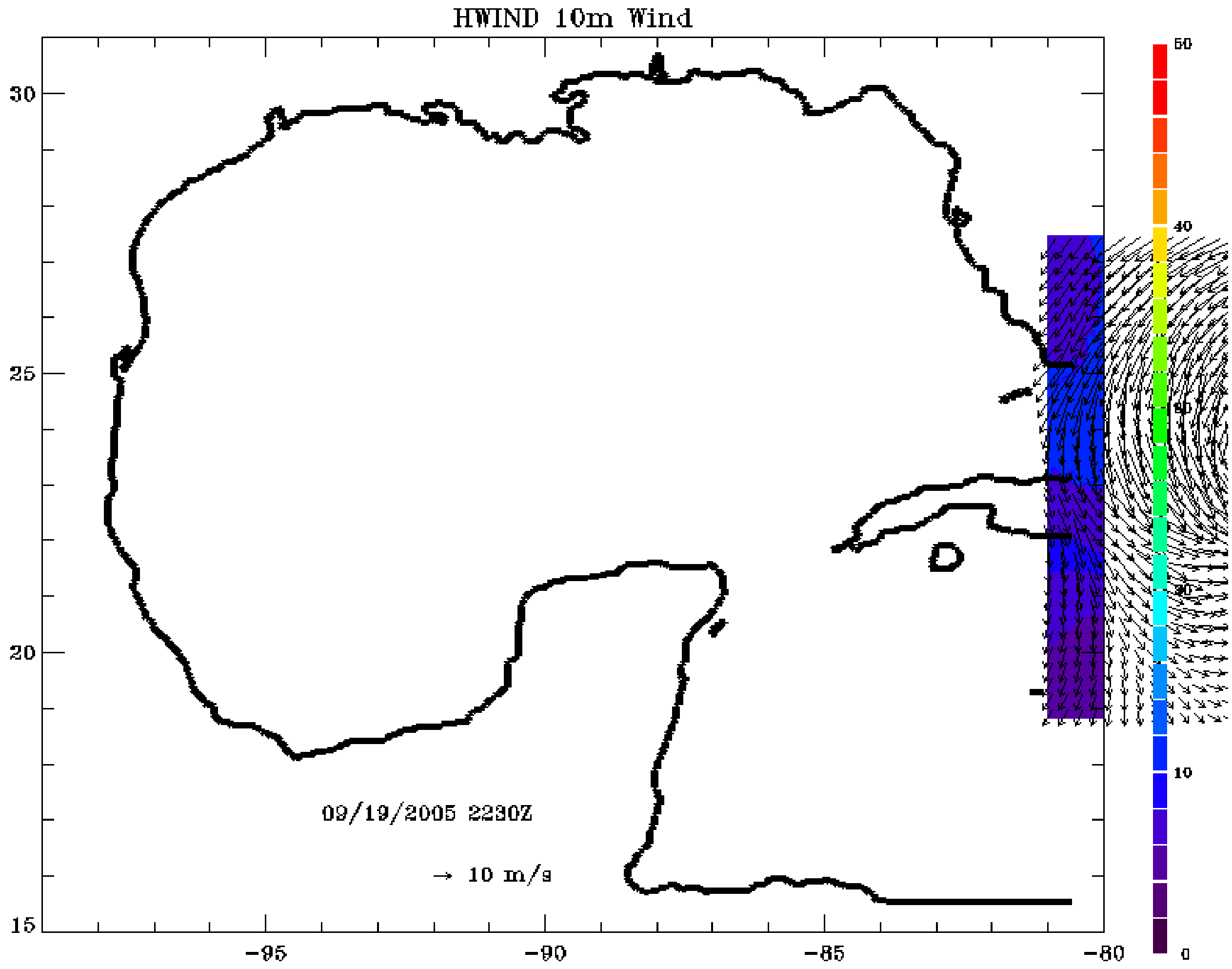


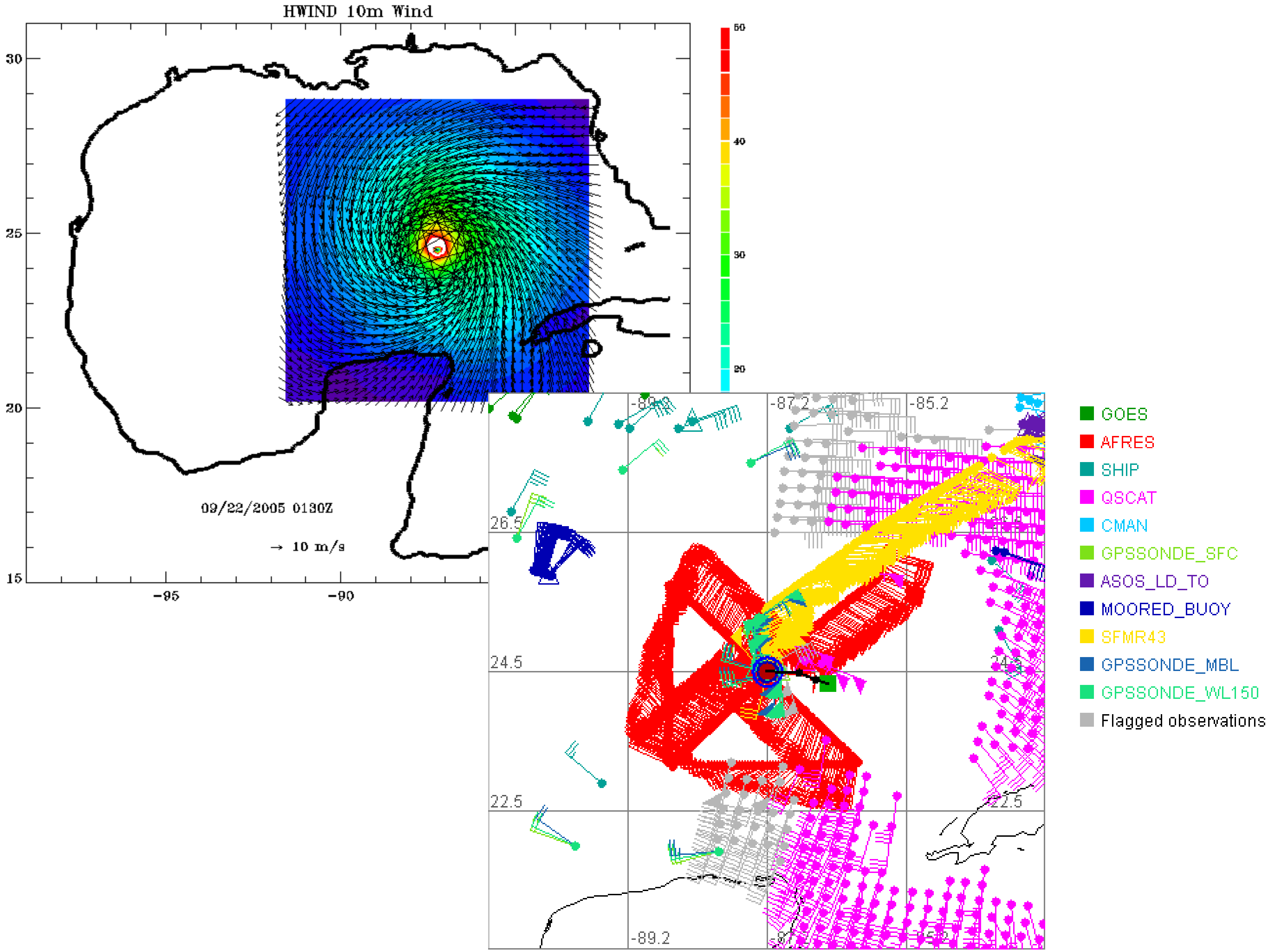
HWIND 10m Wind
30
25
20
15
-95
-90
-85
-80
07/10/2005 1330Z
→ 10 m/s
50
40
30
20
10
0



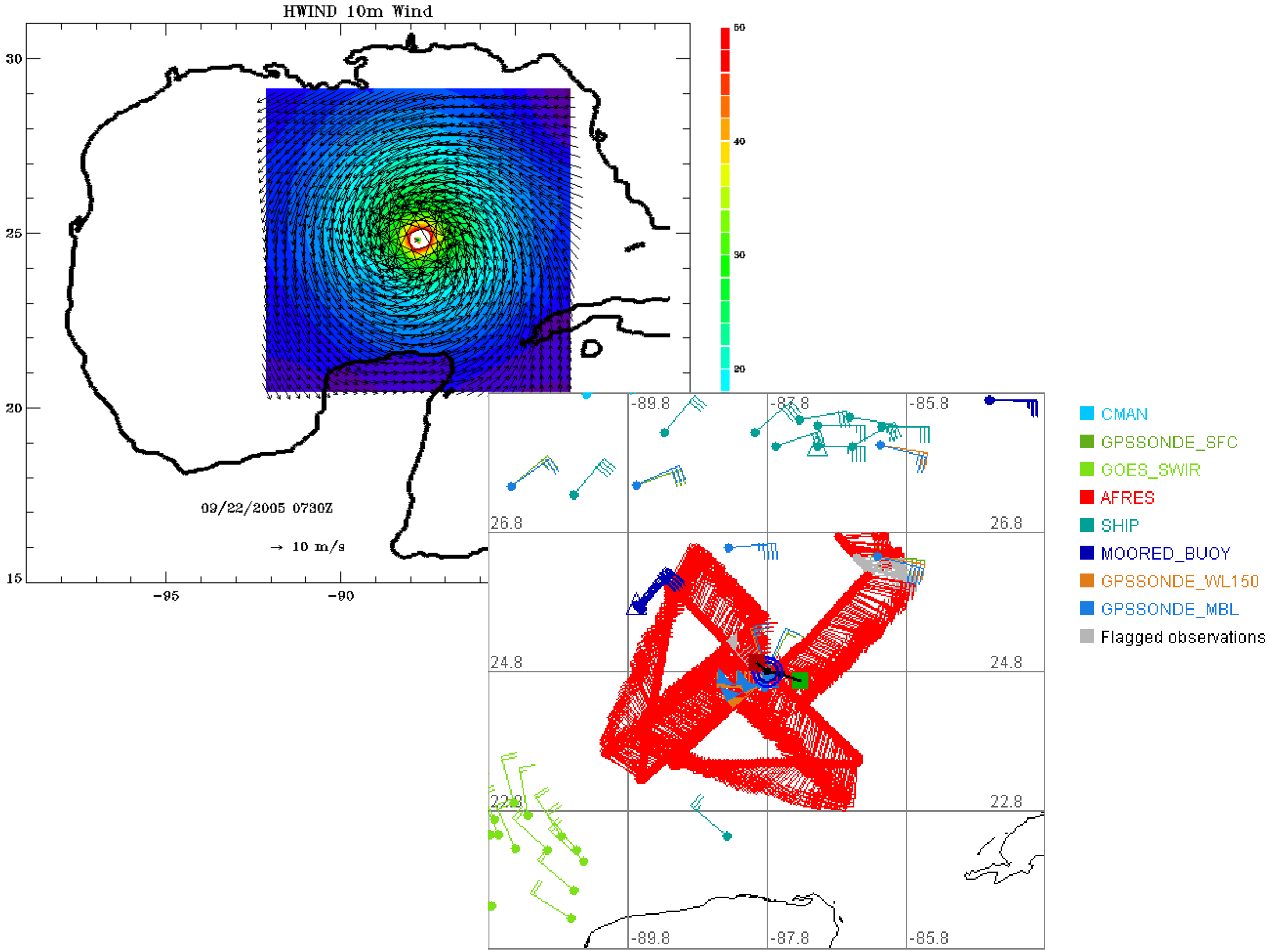
NCEPR/QSCAT 10m Wind
30
25
20
15
-95
-90
-85
-80
Jul 10, 2005 1330Z
→ 10 m/s
50
40
30
20
10
0

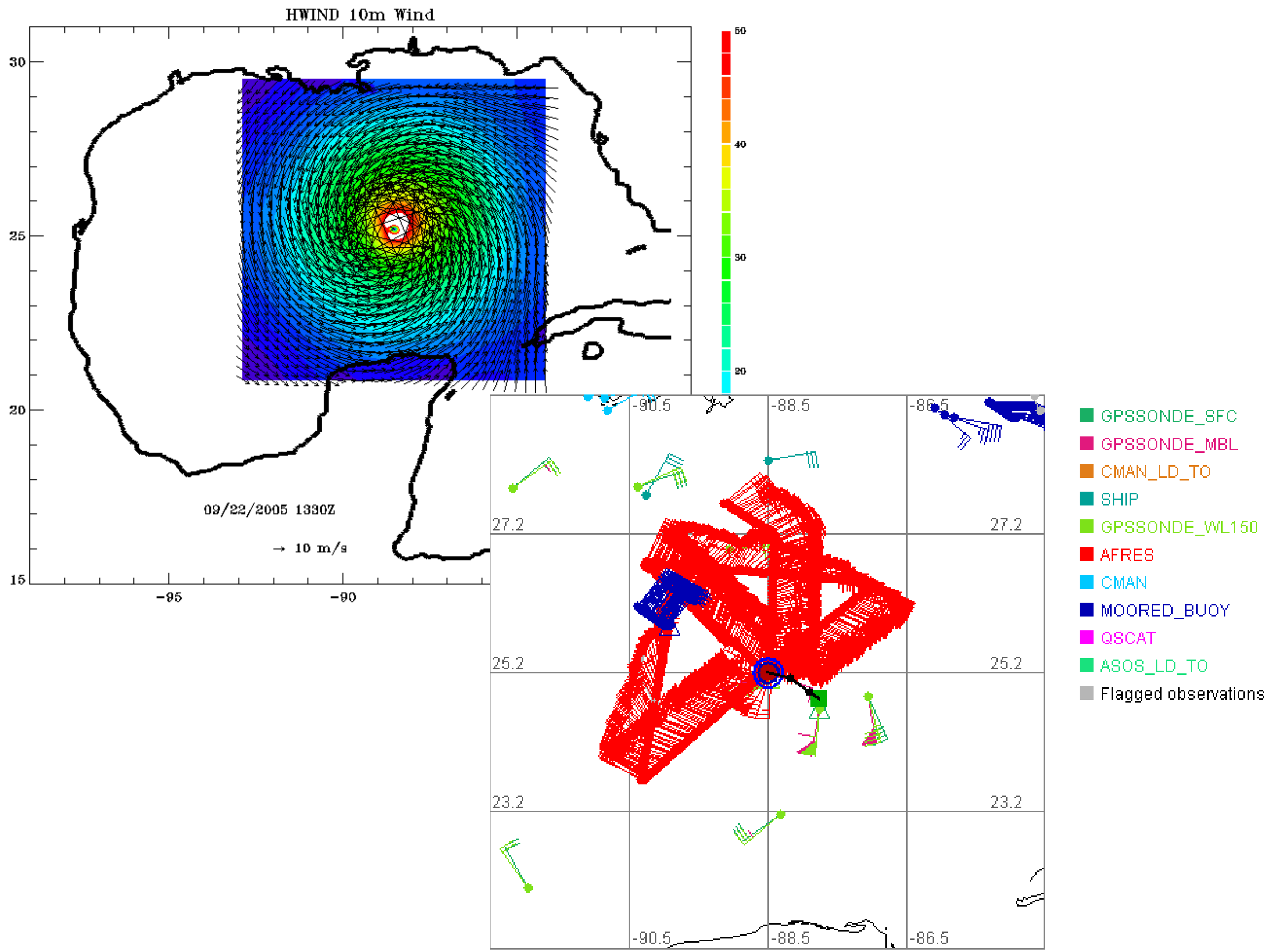
Hurricane Rita H*Wind Fields

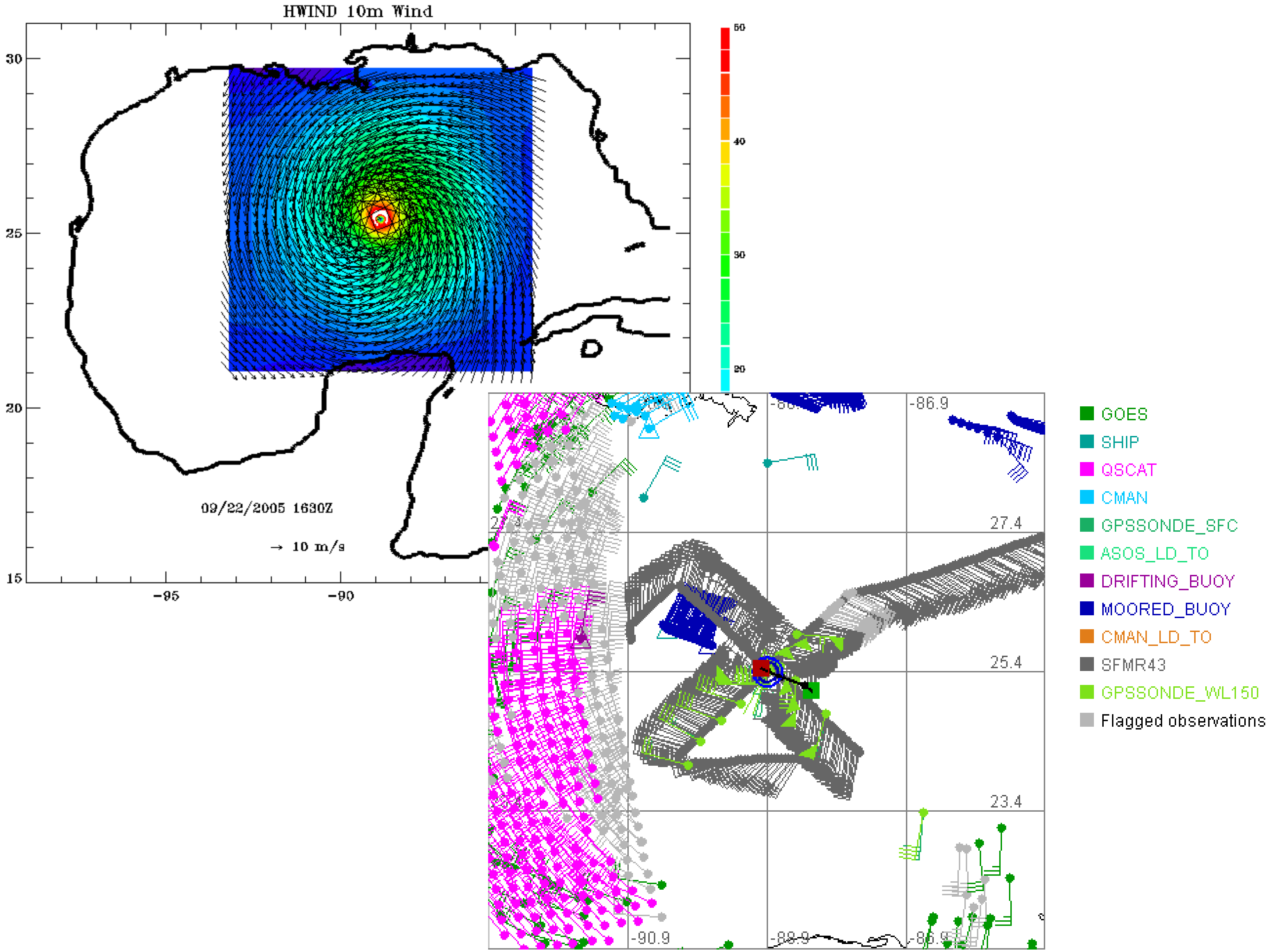




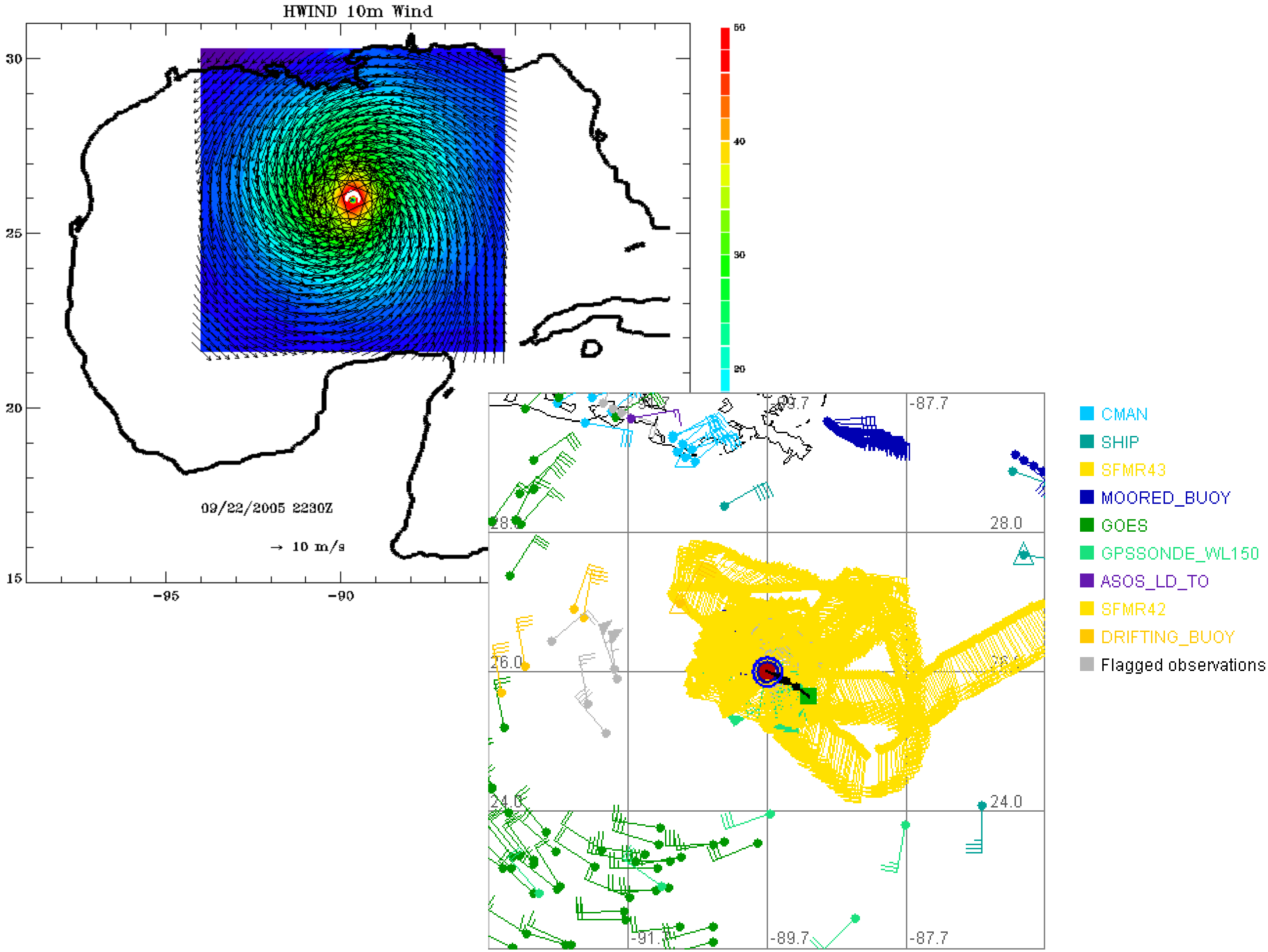
HWIND 10m Wind
30
25
20
15
-95
-90
09/22/2005 0130Z
→ 10 m/s
50
40
30
20
-89.2
-87.2
-85.2
26.5
24.5
22.5
GOES
AFRES
SHIP
QSCAT
CMAN
GPSSONDE_SFC
ASOS_LD_TO
MOORED_BUOY
SFMR43
GPSSONDE_MBL
GPSSONDE_WL150
Flagged observations

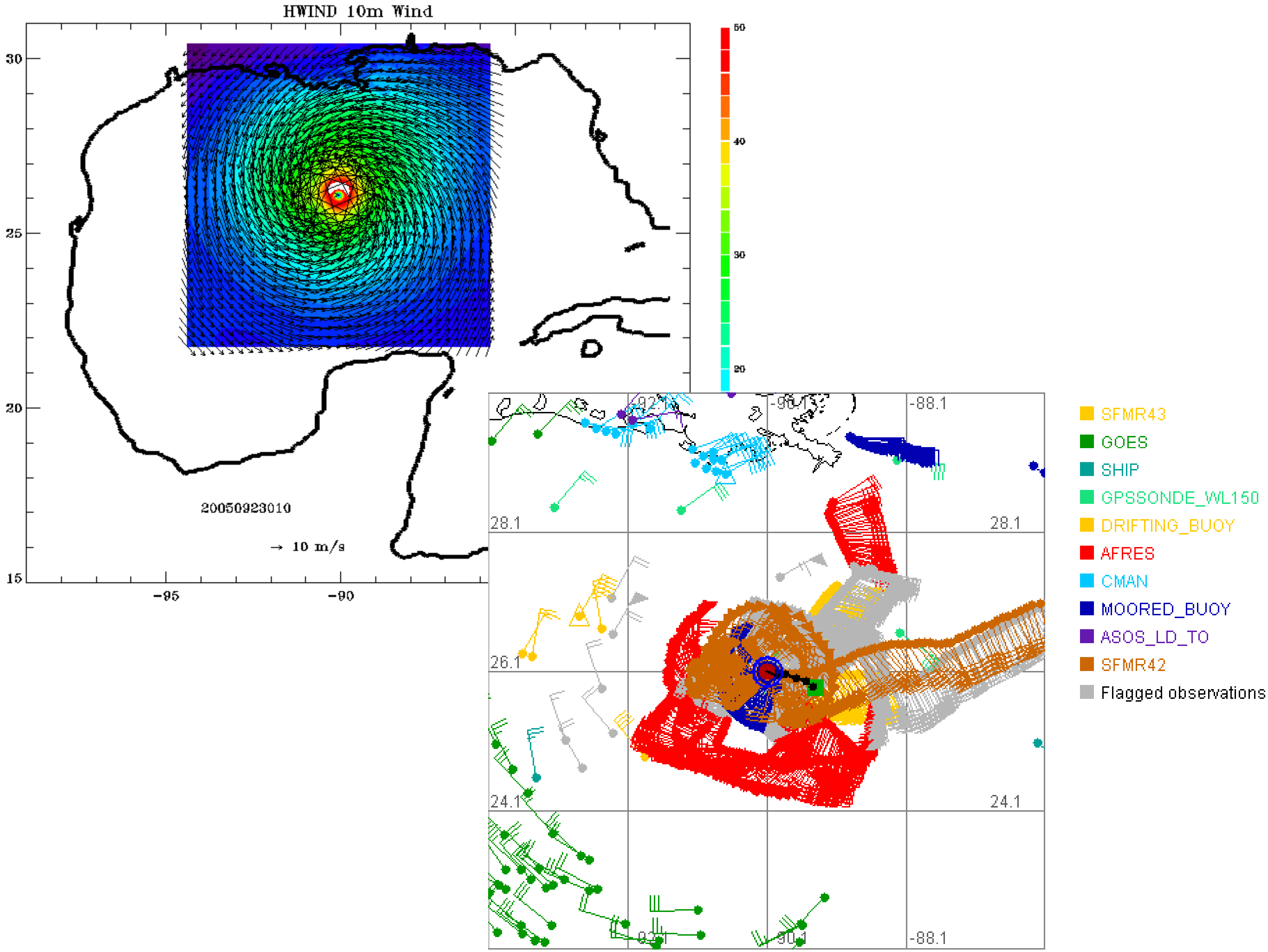

HWIND 10m Wind
30
25
20
15
-95
-90
09/22/2005 0730Z
→ 10 m/s
50
40
30
20
-89.8
-87.8
-85.8
26.8
24.8
22.8
CMAN
GPSSONDE_SFC
GOES_SWIR
AFRES
SHIP
MOORED_BUOY
GPSSONDE_WL150
GPSSONDE_MBL
Flagged observations


HWIND 10m Wind
09/22/2005 1330Z
→ 10 m/s
30
25
20
15
-95
-90
50
40
30
20
-90.5
-88.5
-86.5
27.2
25.2
23.2
GPSSONDE_SFC
GPSSONDE_MBL
CMAN_LD_TO
SHIP
GPSSONDE_WL150
AFRES
CMAN
MOORED_BUOY
QSCAT
ASOS_LD_TO
Flagged observations

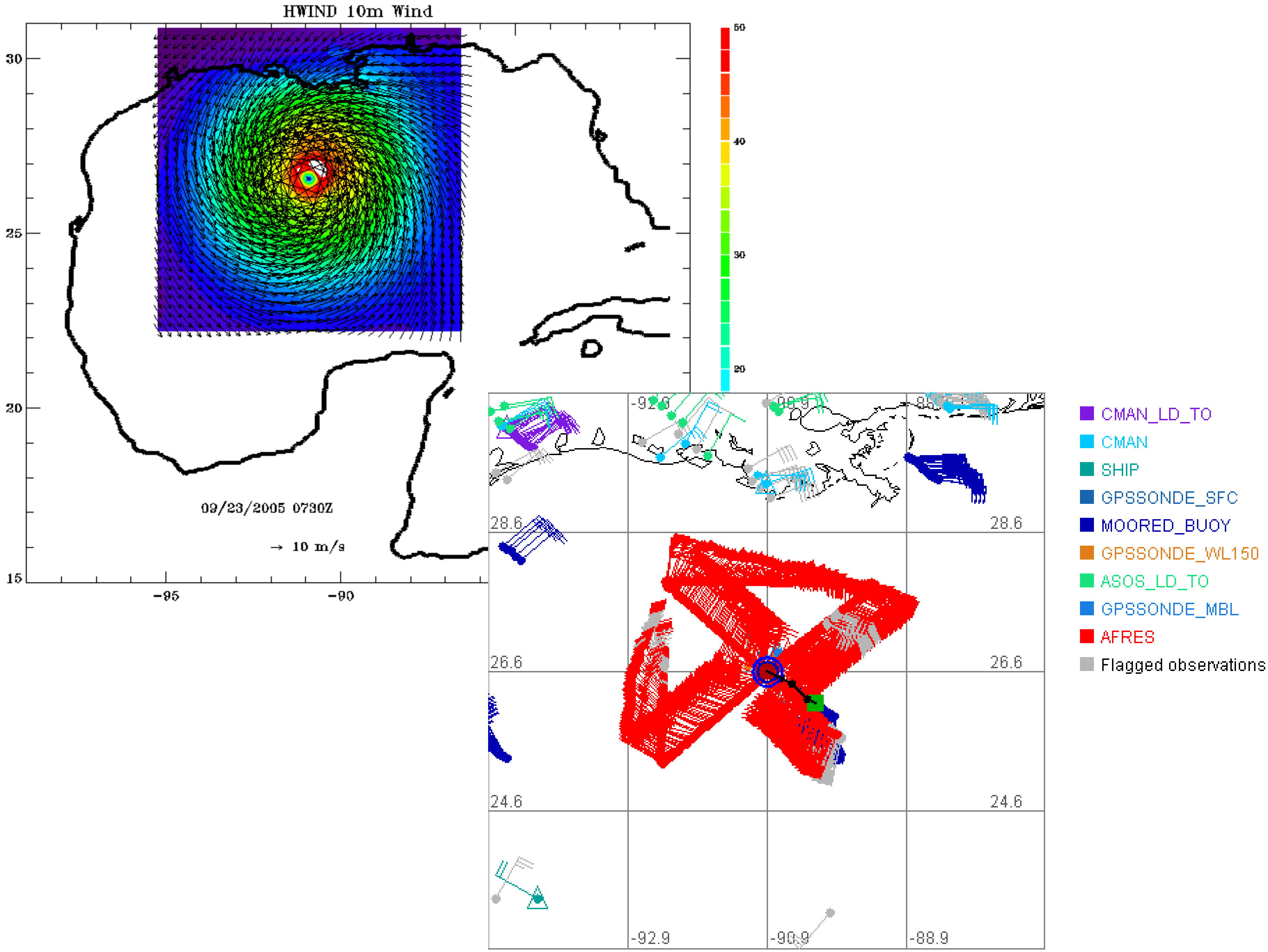


HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/22/2005 1630Z
→ 10 m/s
-86.9
27.4
25.4
23.4
-90.9
-88.9
-86.9
GOES
SHIP
QSCAT
CMAN
GPSSONDE_SFC
ASOS_LD_TO
DRIFTING_BUOY
MOORED_BUOY
CMAN_LD_TO
SFMR43
GPSSONDE_WL150
Flagged observations

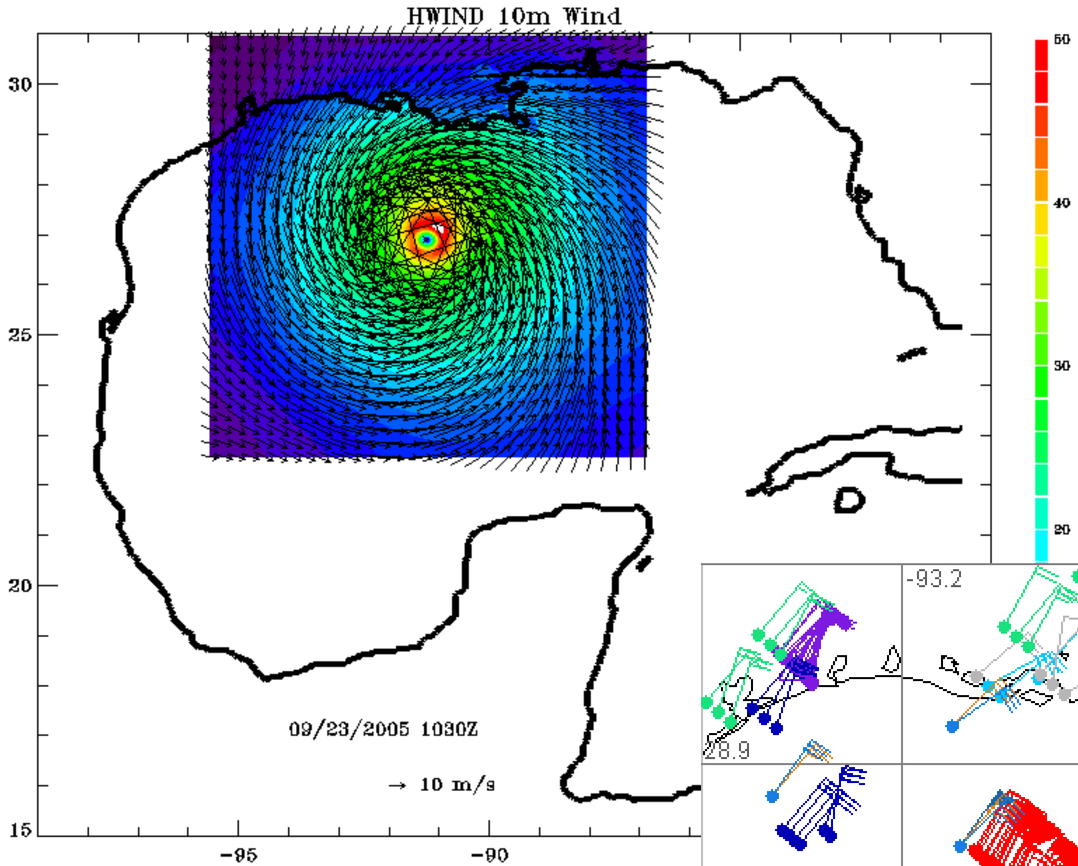

HWIND 10m Wind
30
25
20
15
-95
-90
09/22/2005 2230Z
→ 10 m/s
50
40
30
20
-89.7
-87.7
28.0
26.0
24.0
-91.7
CMAN
SHIP
SFMR43
MOORED_BUOY
GOES
GPSSONDE_WL150
ASOS_LD_TO
SFMR42
DRIFTING_BUOY
Flagged observations



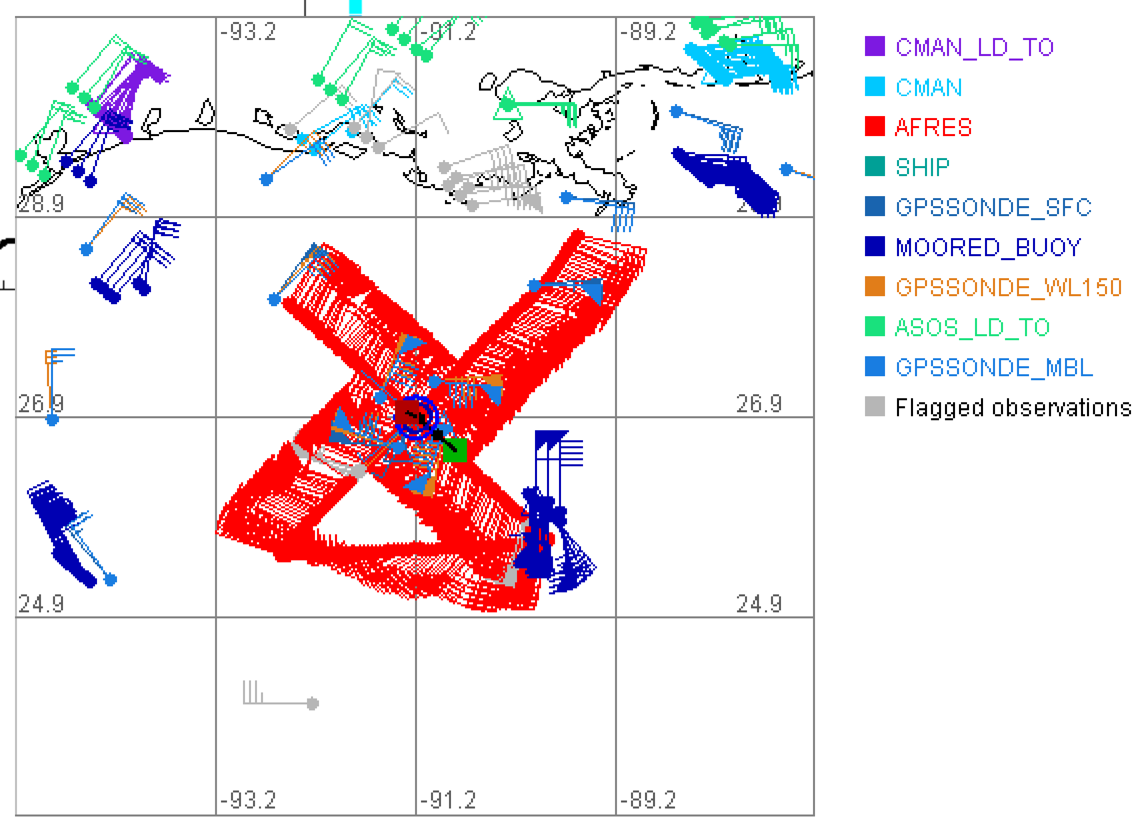
HWIND 10m Wind
30
25
20
15
-95
-90
20050923010
→ 10 m/s
50
40
30
20
28.1
26.1
24.1
-88.1
SFMR43
GOES
SHIP
GPSSONDE_WL150
DRIFTING_BUOY
AFRES
CMAN
MOORED_BUOY
ASOS_LD_TO
SFMR42
Flagged observations



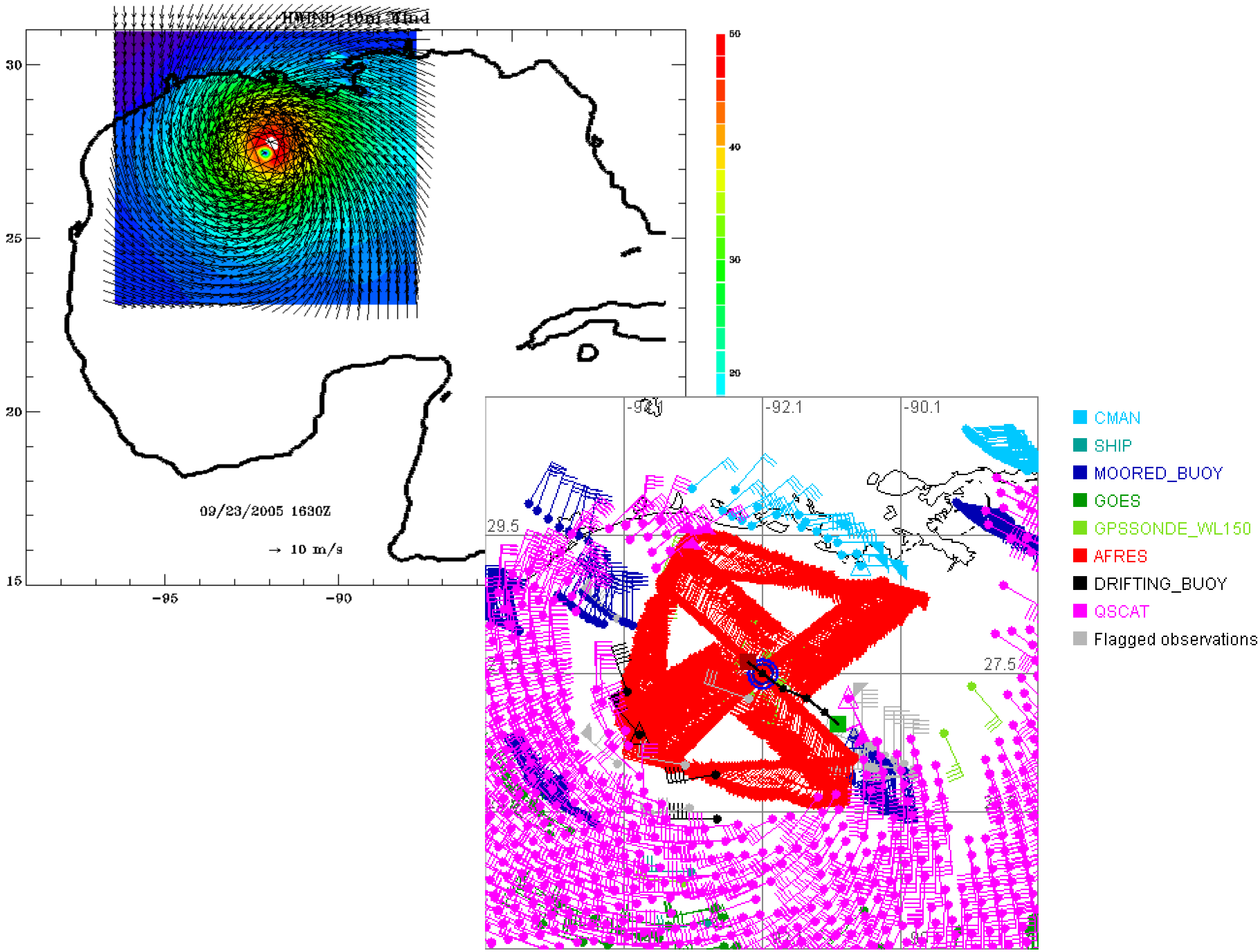
HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/23/2005 0730Z
→ 10 m/s
28.6
26.6
24.6
-92.9
-90.9
-88.9
CMAN_LD_TO
CMAN
SHIP
GPSSONDE_SFC
MOORED_BUOY
GPSSONDE_WL150
ASOS_LD_TO
GPSSONDE_MBL
AFRES
Flagged observations

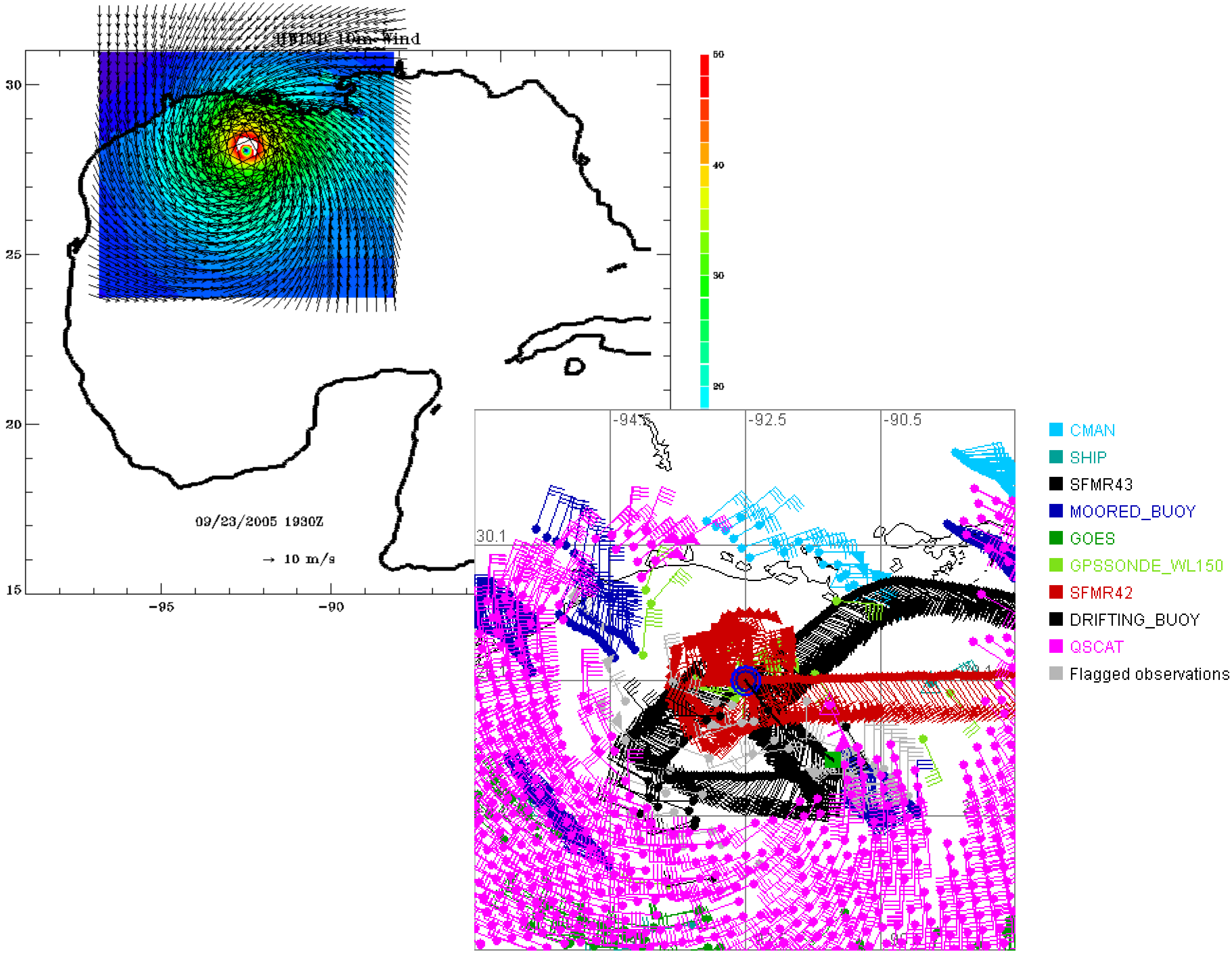


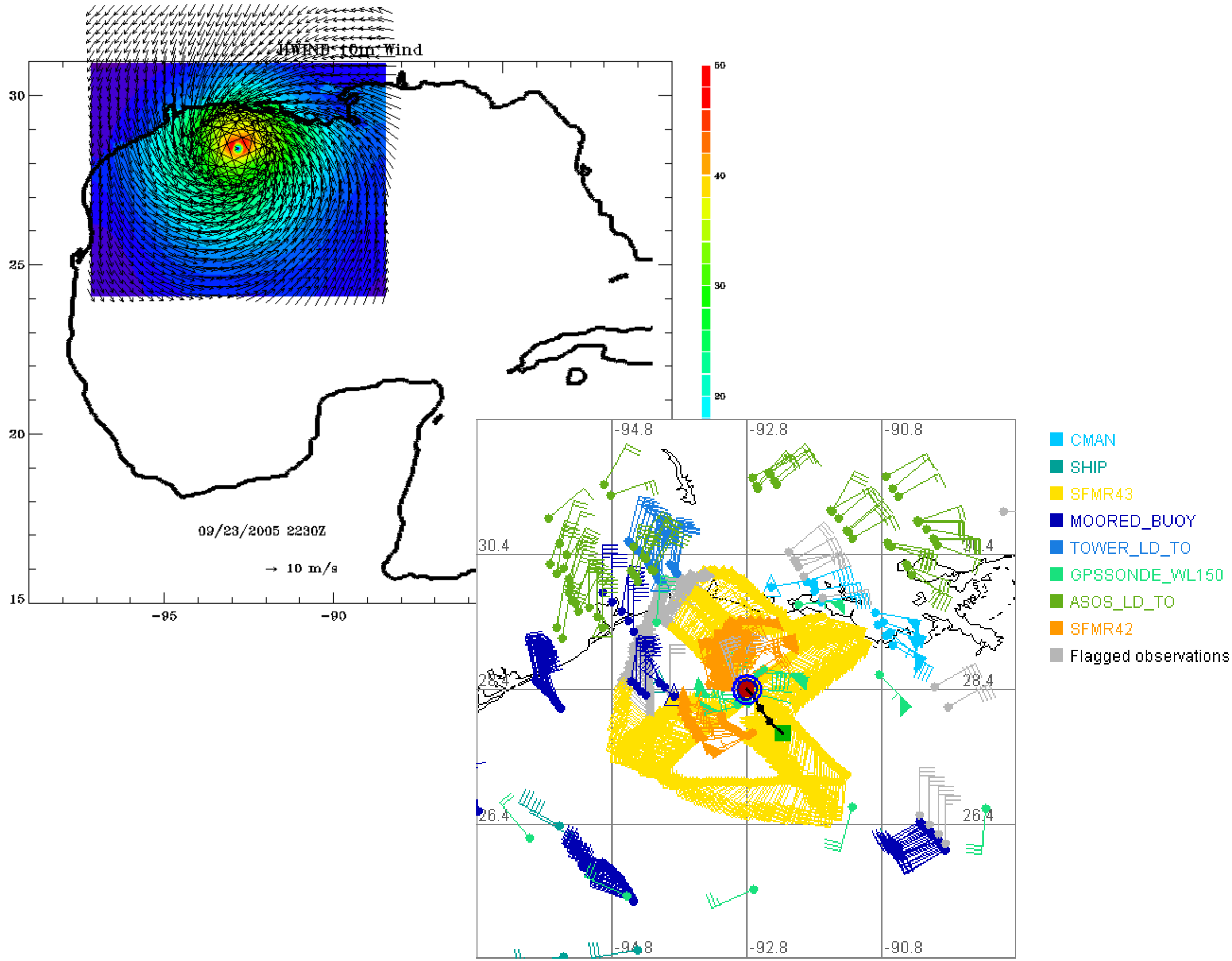
HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/23/2005 1030Z
→ 10 m/s



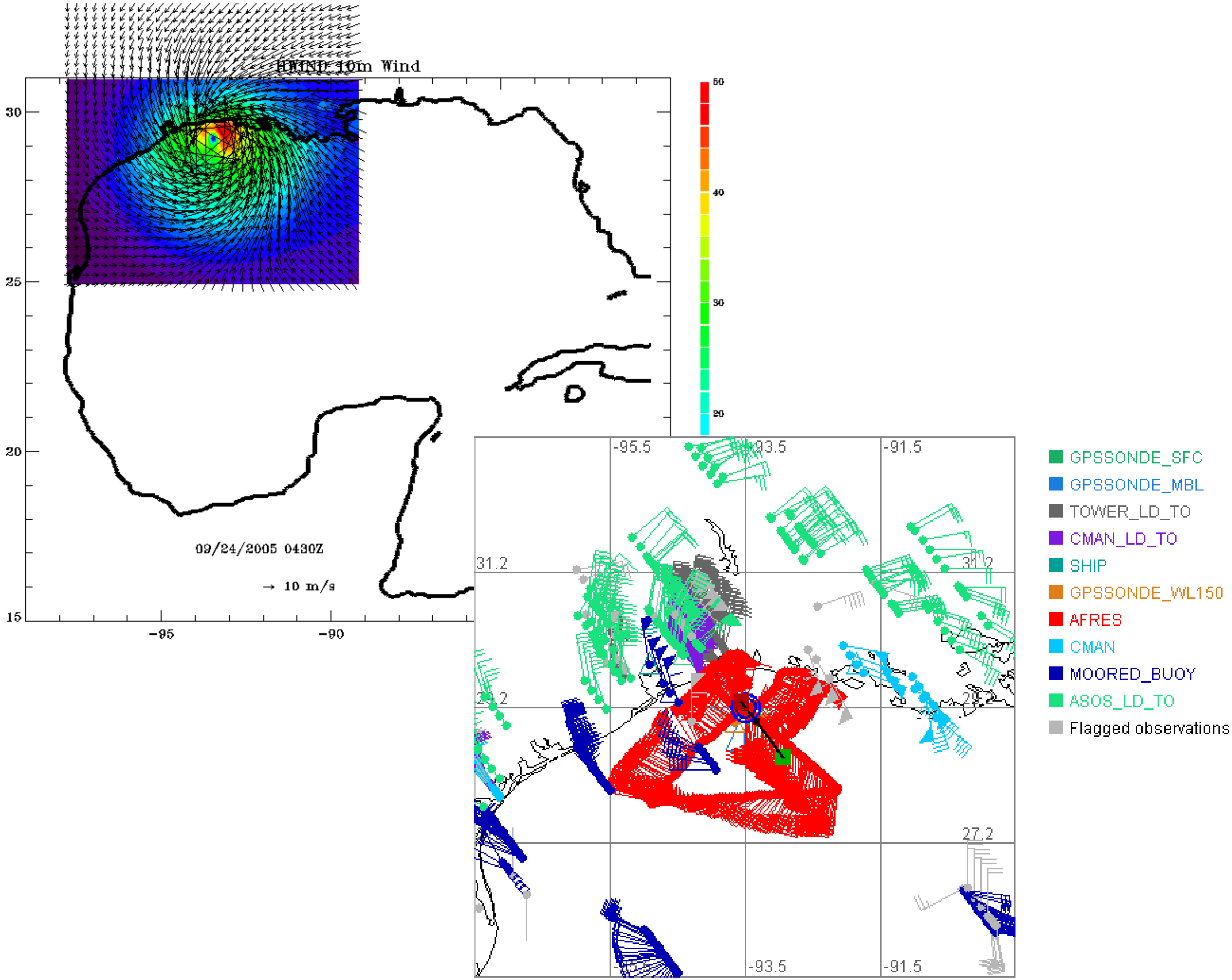
-93.2
-91.2
-89.2
28.9
26.9
24.9
CMAN_LD_TO
CMAN
AFRES
SHIP
GPSSONDE_SFC
MOORED_BUOY
GPSSONDE_WL150
ASOS_LD_TO
GPSSONDE_MBL
Flagged observations

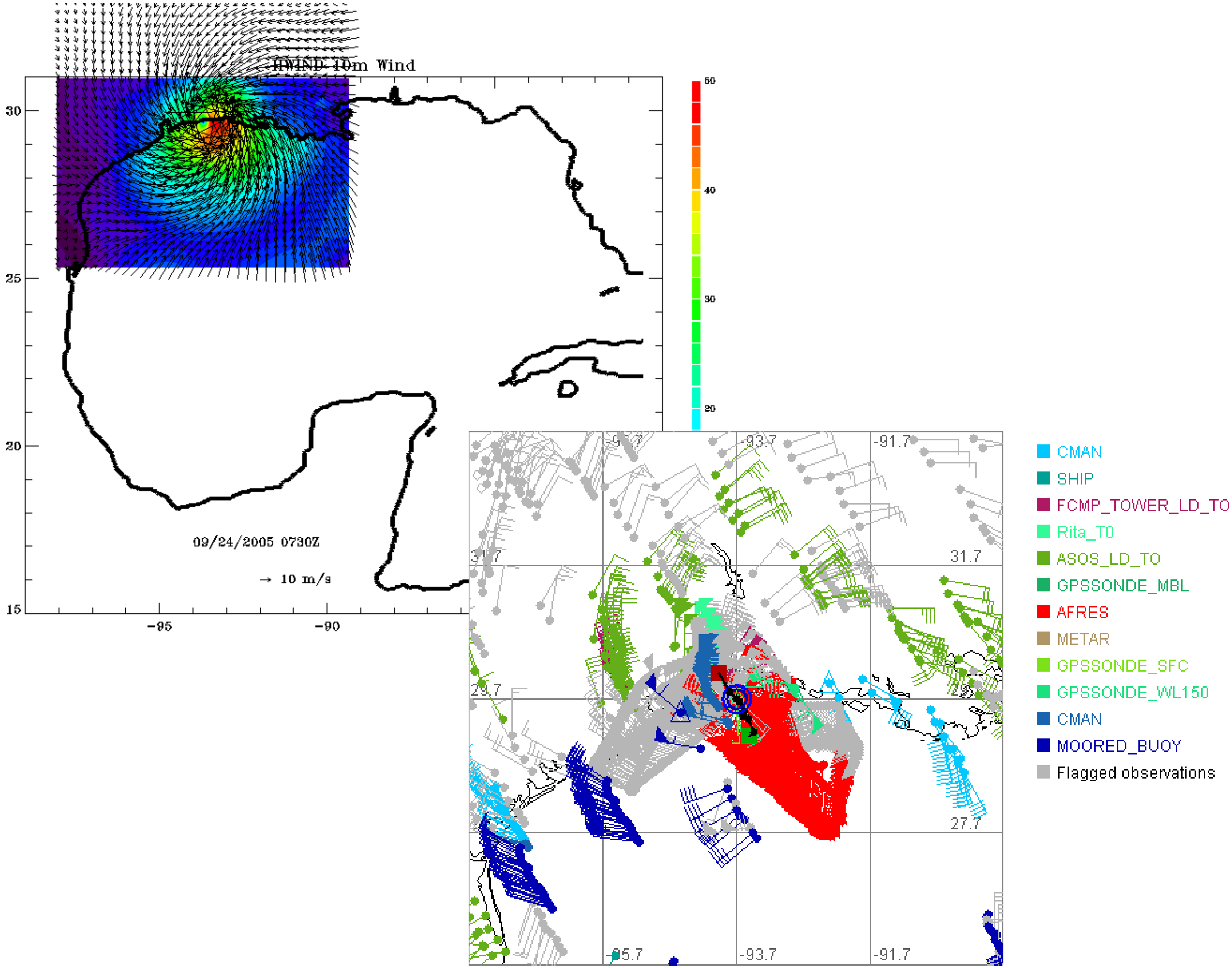

HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/23/2005 1630Z
→ 10 m/s
-92.1
-90.1
29.5
27.5
CMAN
SHIP
MOORED_BUOY
GOES
GPSSONDE_WL150
AFRES
DRIFTING_BUOY
QSCAT
Flagged observations


HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/23/2005 1930Z
→ 10 m/s
-94.5
-92.5
-90.5
30.1
CMAN
SHIP
SFMR43
MOORED_BUOY
GOES
GPSSONDE_WL150
SFMR42
DRIFTING_BUOY
QSCAT
Flagged observations

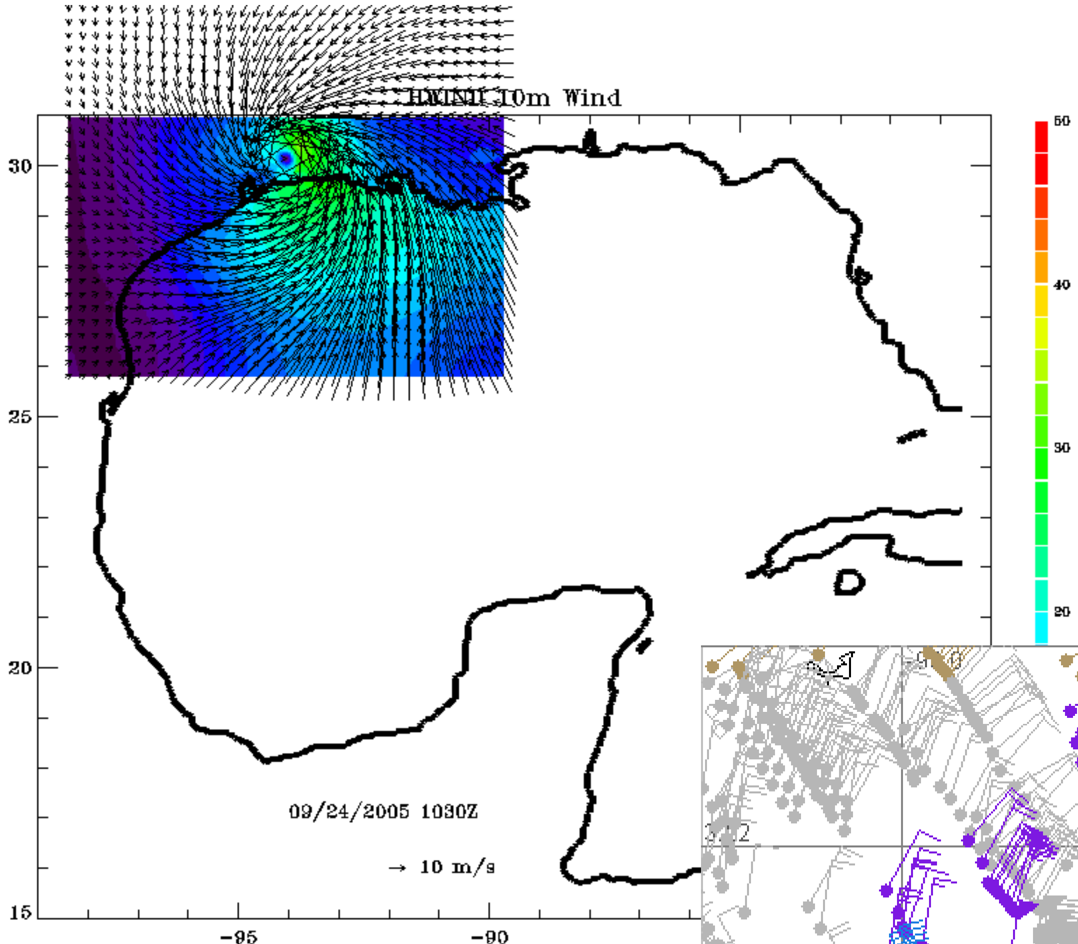


HWIND 10m Wind
30
25
20
15
-95
-90
09/23/2005 2230Z
→ 10 m/s
50
40
30
20
-94.8
-92.8
-90.8
30.4
28.4
26.4
CMAN
SHIP
SFMR43
MOORED_BUOY
TOWER_LD_TO
GPSSONDE_WL150
ASOS_LD_TO
SFMR42
Flagged observations

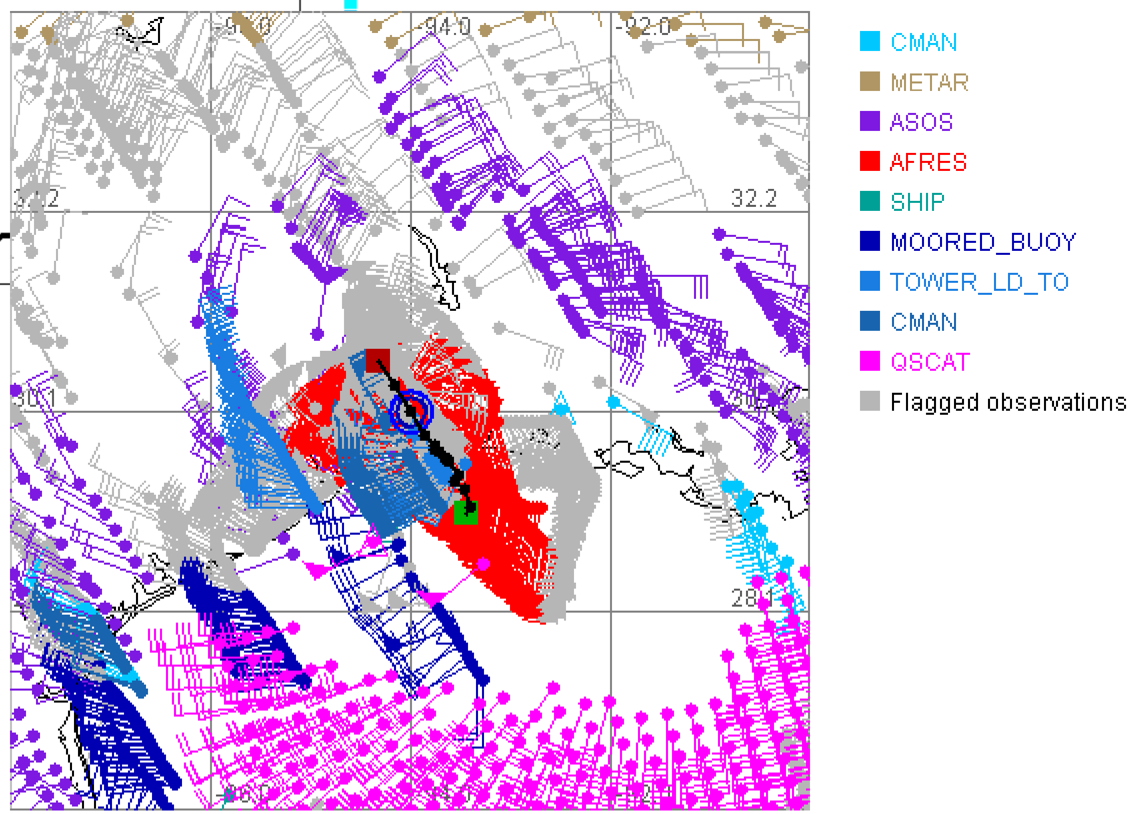

HWIND 10m Wind
30
25
20
15
-95
-90
50
40
30
20
09/24/2005 0430Z
→ 10 m/s
-95.5
-93.5
-91.5
31.2
27.2
GPSSONDE_SFC
GPSSONDE_MBL
TOWER_LD_TO
CMAN_LD_TO
SHIP
GPSSONDE_WL150
AFRES
CMAN
MOORED_BUOY
ASOS_LD_TO
Flagged observations



HWIND 10m Wind
09/24/2005 0730Z
→ 10 m/s
30
25
20
15
-95
-90
50
40
30
20
-93.7
-91.7
31.7
29.7
27.7
-95.7
CMAN
SHIP
FCMP_TOWER_LD_TO
Rita_T0
ASOS_LD_TO
GPSSONDE_MBL
AFRES
METAR
GPSSONDE_SFC
GPSSONDE_WL150
CMAN
MOORED_BUOY
Flagged observations



From 19 Sep 22:30 to 24 Sep 10:30, 22% of H*Wind Analyses for Rita contained QuikSCAT data.



Summary and Conclusions

- Shelf and coastal circulation and sea level have a strong response to inertial through synoptic period atmospheric forcing
- QuikSCAT temporal sampling pattern marginally adequate for sampling the synoptic variability at lower subtropical latitudes.
  - In the northern Gulf of Mexico shelf region, the sparse sampling leads to RMS error of about 1.9 m/s (aliasing of diurnal variability?)
  - Study of climate variability (interannual variability or trends) of "storminess" could potentially benefit from the stationarity of the scatterometer record compared to trends in the reanalysis products. But do the errors arising from sparse temporal sampling mask the trends?
- Scatterometer data are potentially valuable for tropical cyclone surface wind field analyses for storm surge modeling and prediction.
  - Rain contamination and high wind speed issues limit usefulness of data near the storm center
  - For Hurricane Rita (2005), only about 22% of H*WIND analyses contained scatterometer data
  - What is the value added by the scatterometer data?

Hurricane Bill
18 Aug 2009 07:30
H*WIND Analysis Data Coverage