Hurricane Intensity Changes associated with the Gulf of Mexico Loop Current and Eddies using GOES Sea Surface Temperatures and Satellite Altimetry

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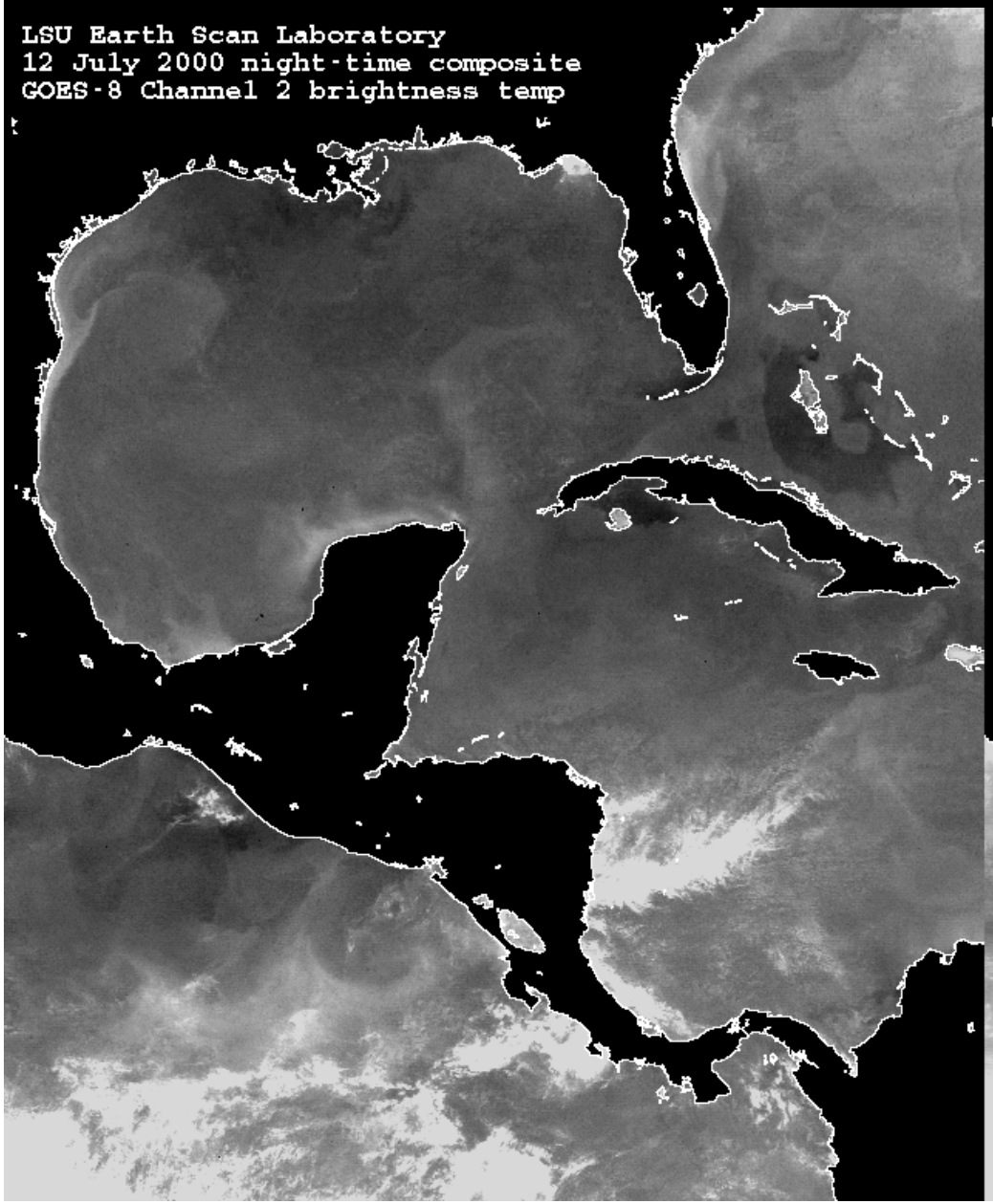
GOES User's Conference, AMS Meeting, New Orleans, 24 January 2008

Satellite Data and Methods

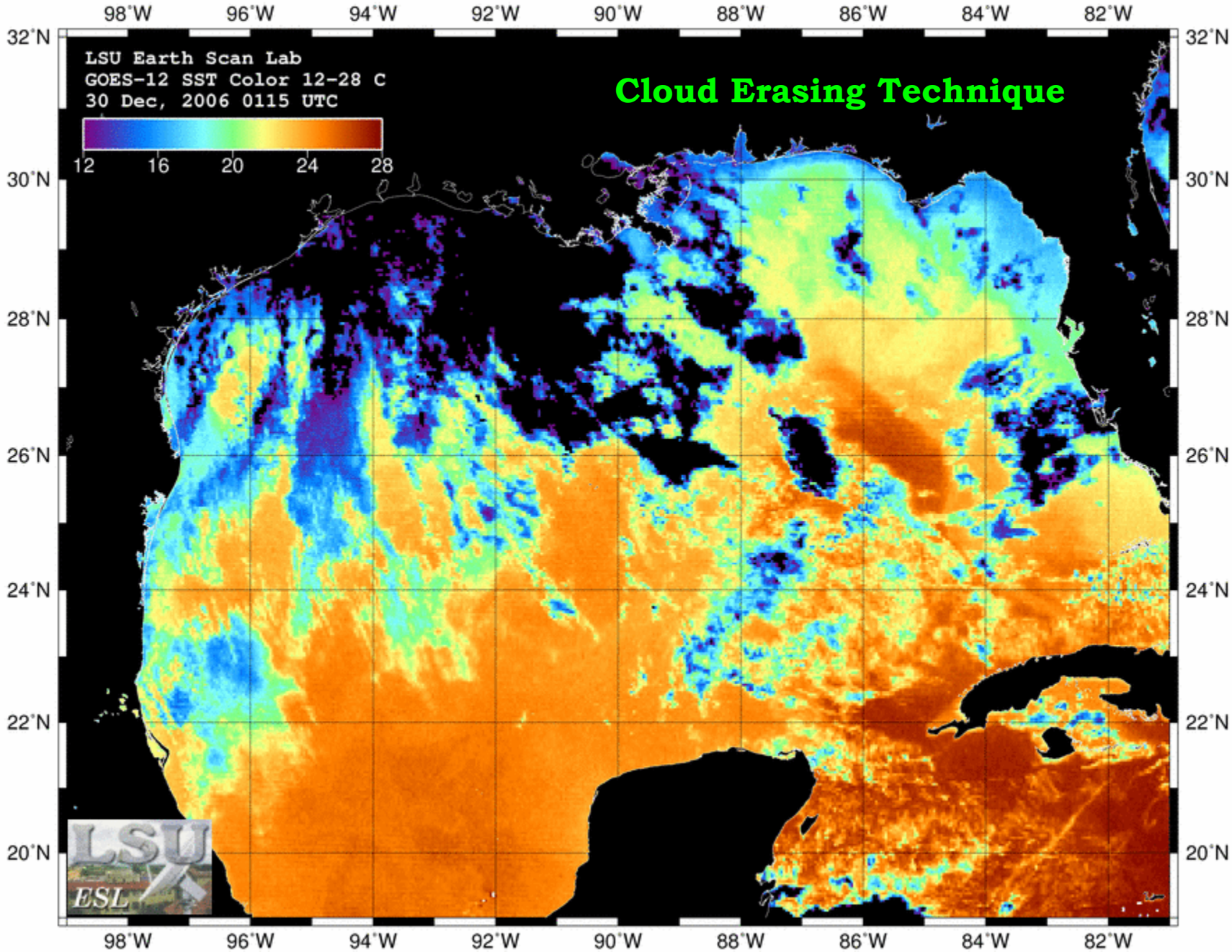
LSU GOES-East de-clouded night-time SST composites
(updated nightly, synoptic)

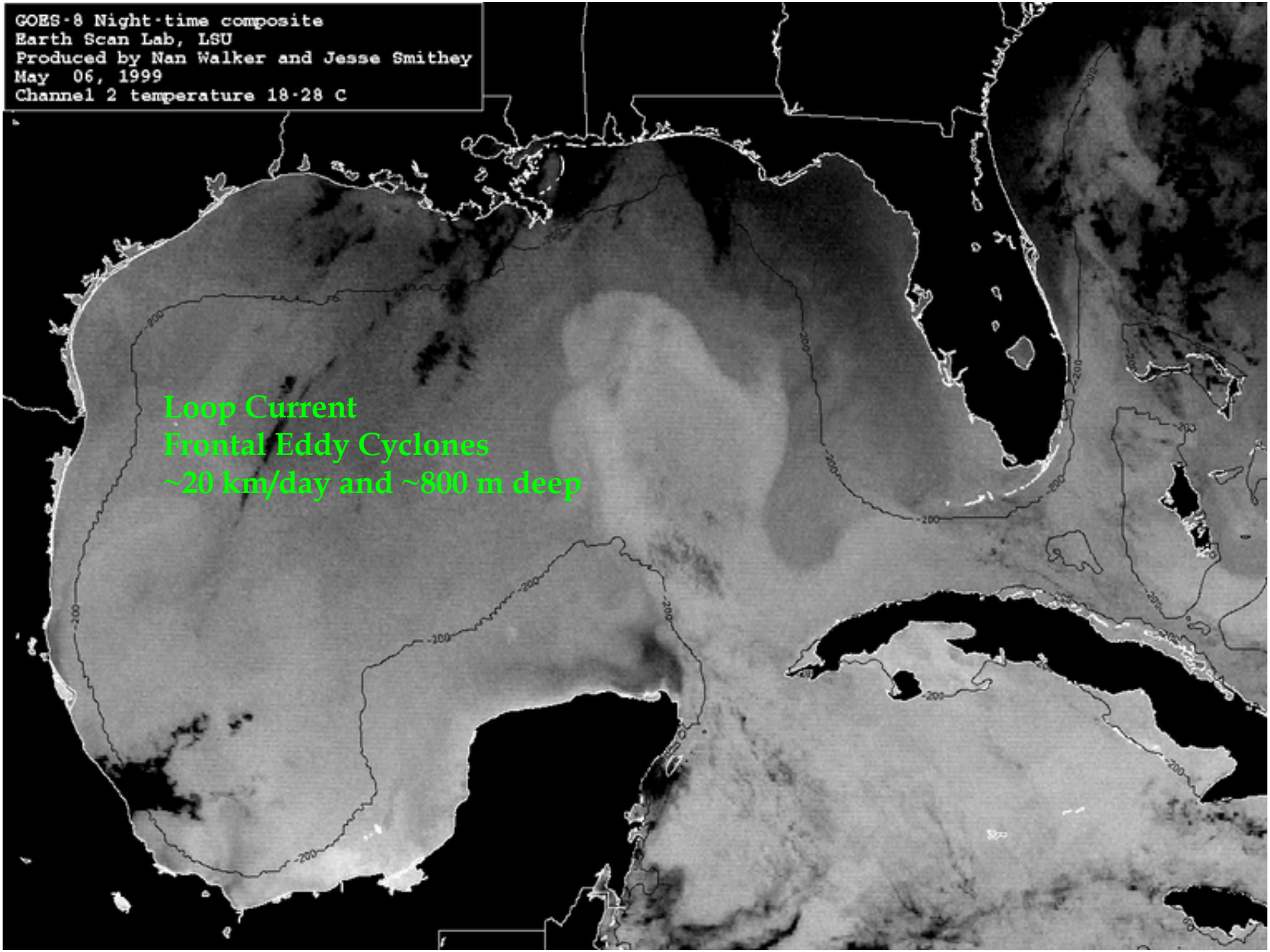
CCAR sea surface height measurements
(interpolated and gridded product, updated daily, not synoptic)
(Sensors: Jason, Topex-Poseidon, Geosat Follow-on)

GOES GVAR Ch2 3.9 µm
SST RMS < 0.5° C

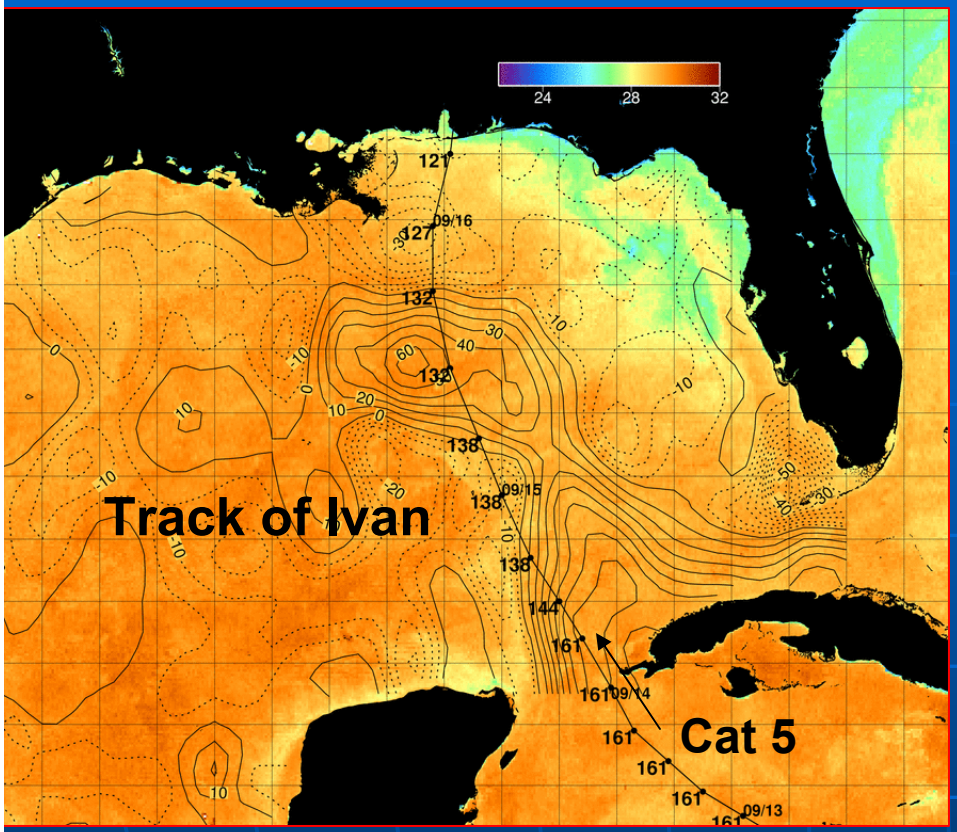


GVAR GOES Ch 4 11 µm


LSU Earth Scan Lab
GOES-12 SST Color 12-28 C
30 Dec, 2006 0115 UTC
12
16
20
24
28
Cloud Erasing Technique
98°W
96°W
94°W
92°W
90°W
88°W
86°W
84°W
82°W
32°N
30°N
28°N
26°N
24°N
22°N
20°N
LSU
ESL

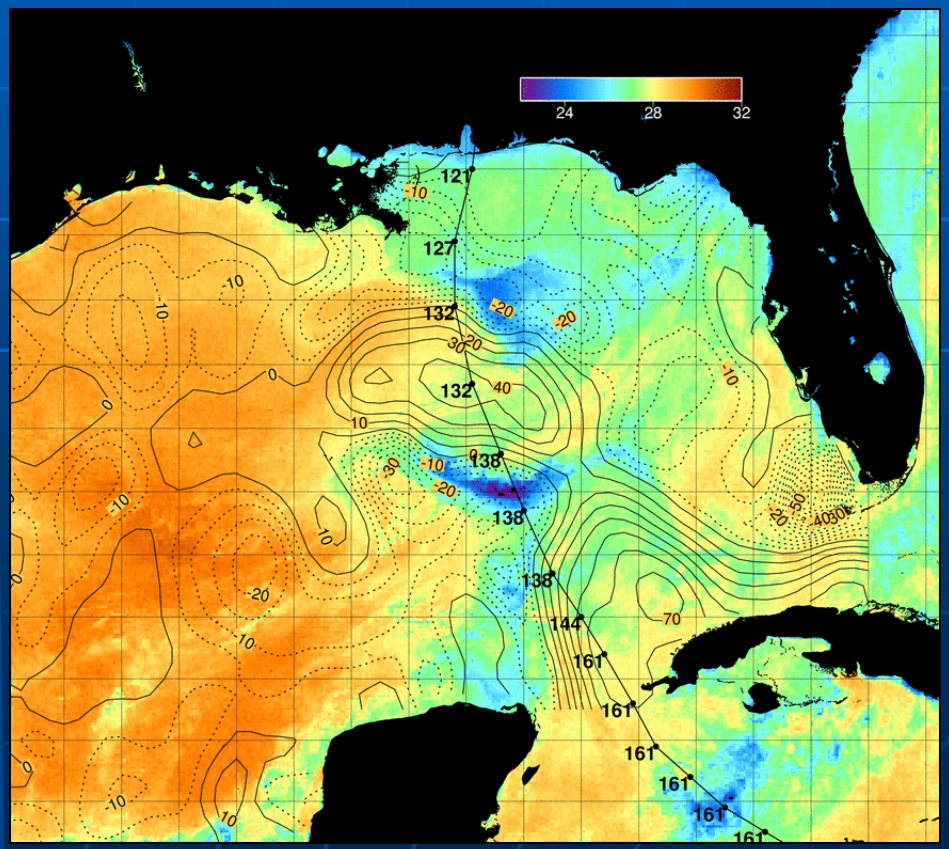

GOES-8 Night-time composite
Earth Scan Lab, LSU
Produced by Nan Walker and Jesse Smithey
May 06, 1999
Channel 2 temperature 18-28 C
Loop Current
Frontal Eddy Cyclones
~20 km/day and ~800 m deep

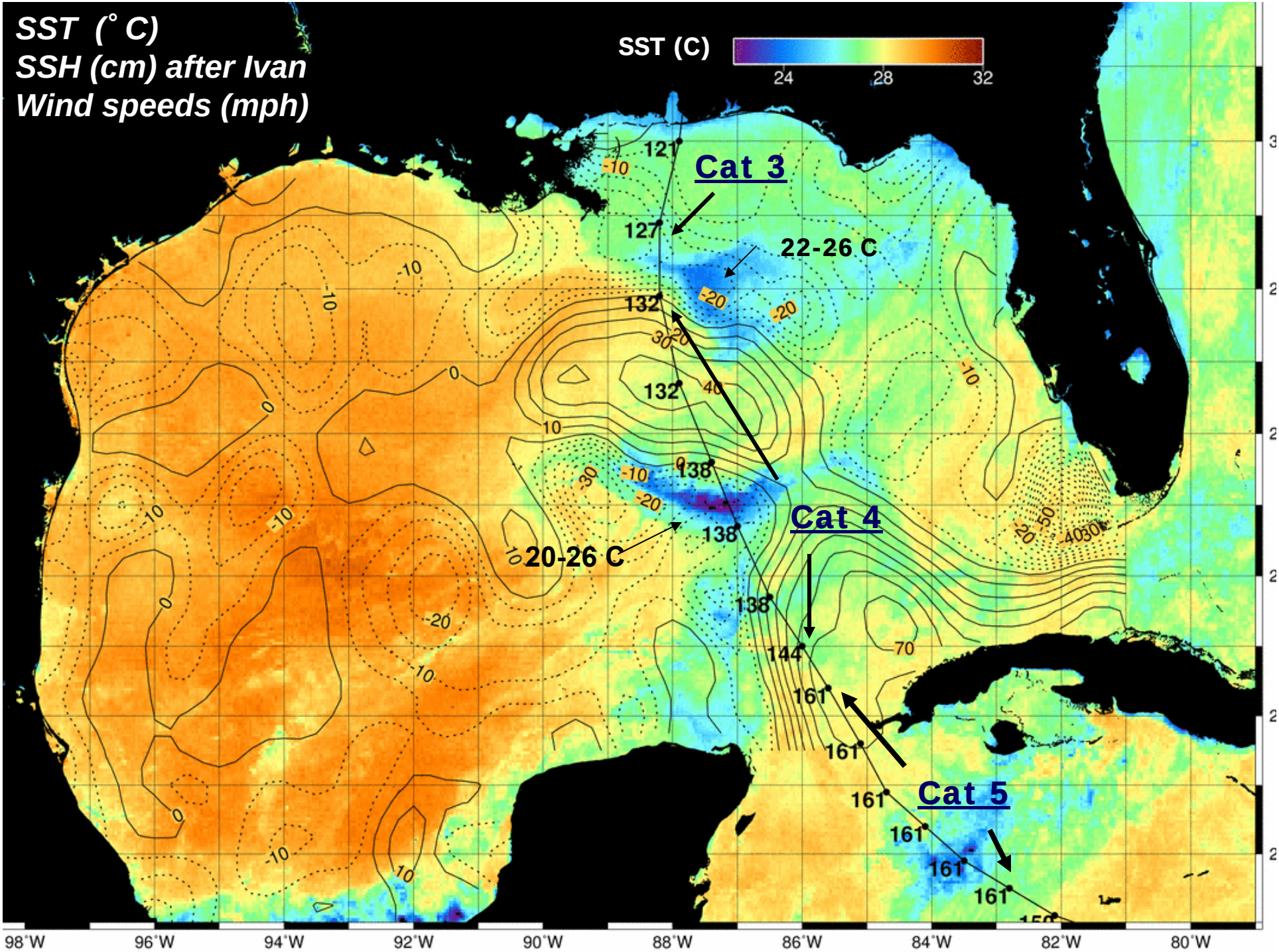
SST and SSH pre-Ivan



September 2004

SST and SSH post-Ivan




SST (°C)
SSH (cm) after Ivan
Wind speeds (mph)
SST (C)
24
28
32
Cat 3
22-26 C
Cat 4
20-26 C
Cat 5
98°W
96°W
94°W
92°W
90°W
88°W
86°W
84°W
82°W
80°W

Wind-forced Upwelling in Cyclones (Walker et al., GRL, 2005)

SST cooling:

* 3-7° C over 38,000 km^2

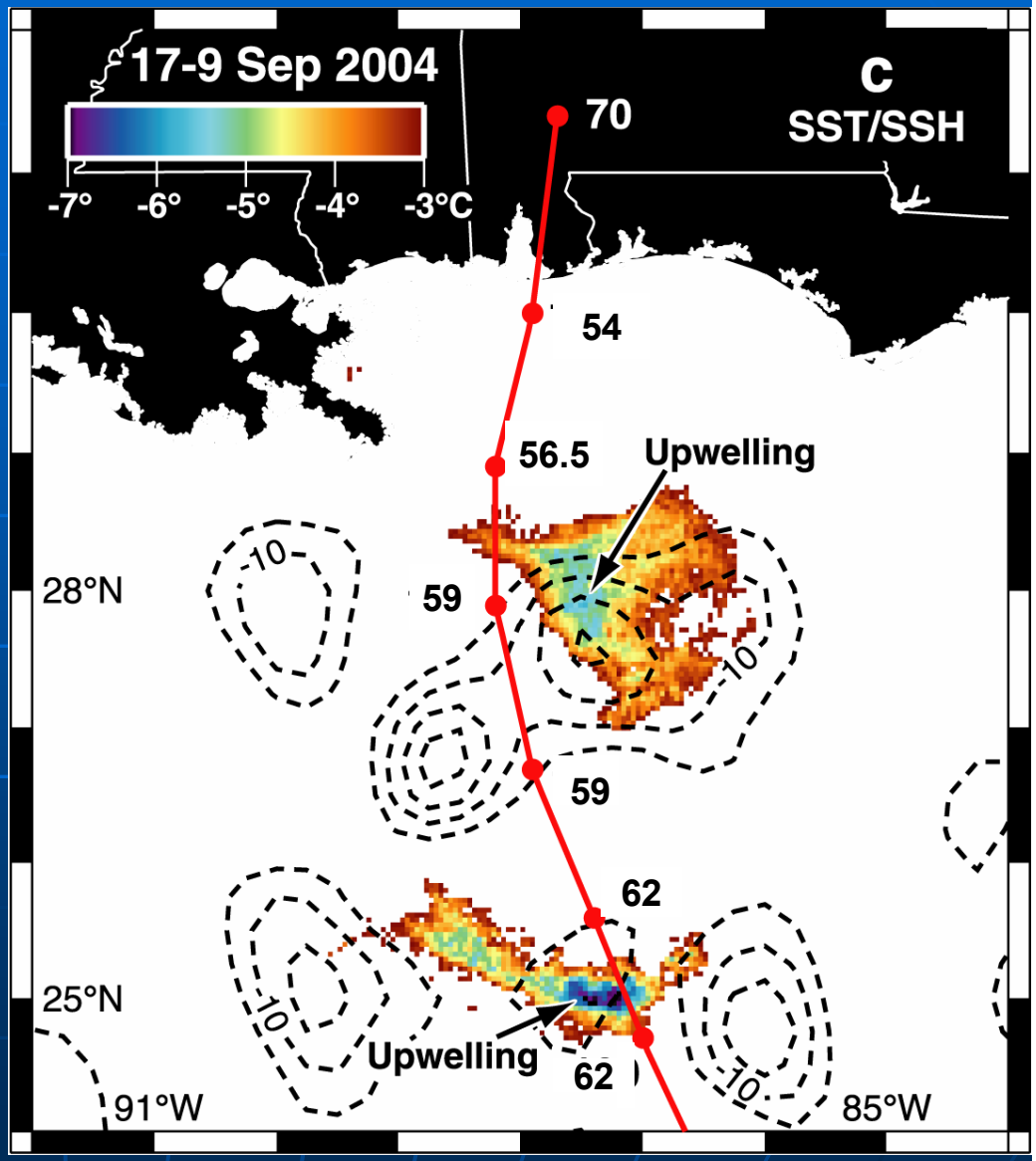
*Max wind speed: 59-62 m s^{-1}
*Wind induced upwelling 53-62m from :

$\eta = \tau / \rho f U_h$; where τ is wind stress, ρ is water density, f is the Coriolis force, and U_h is hurricane transit speed of 5.4 m/s
(after Price et al., 1994)

SSH change:

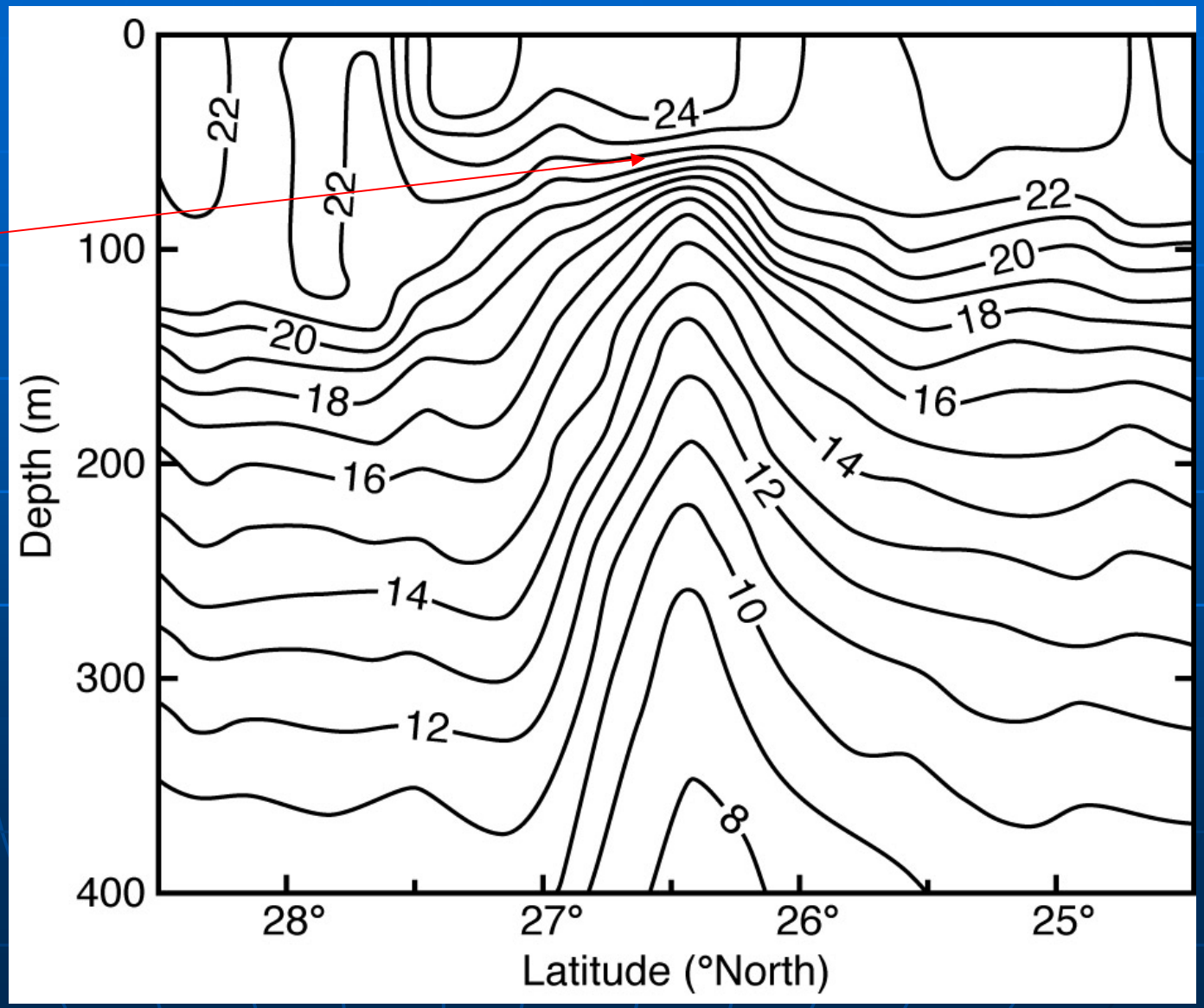
* -15 to -20 cm

*Isothermal displacement of 50-65m based on SSH changes and reduced gravity approximation (after Shay et al., 2000)

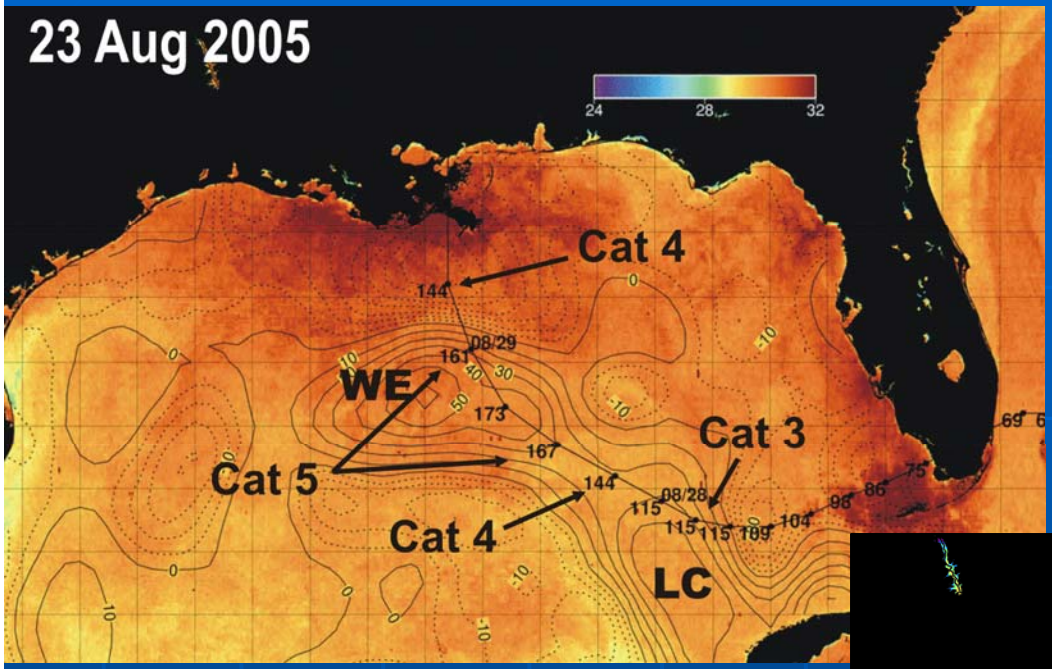


Vertical Temperature Structure Across Cold-core Cyclone

Upward displacement of thermocline within cyclone

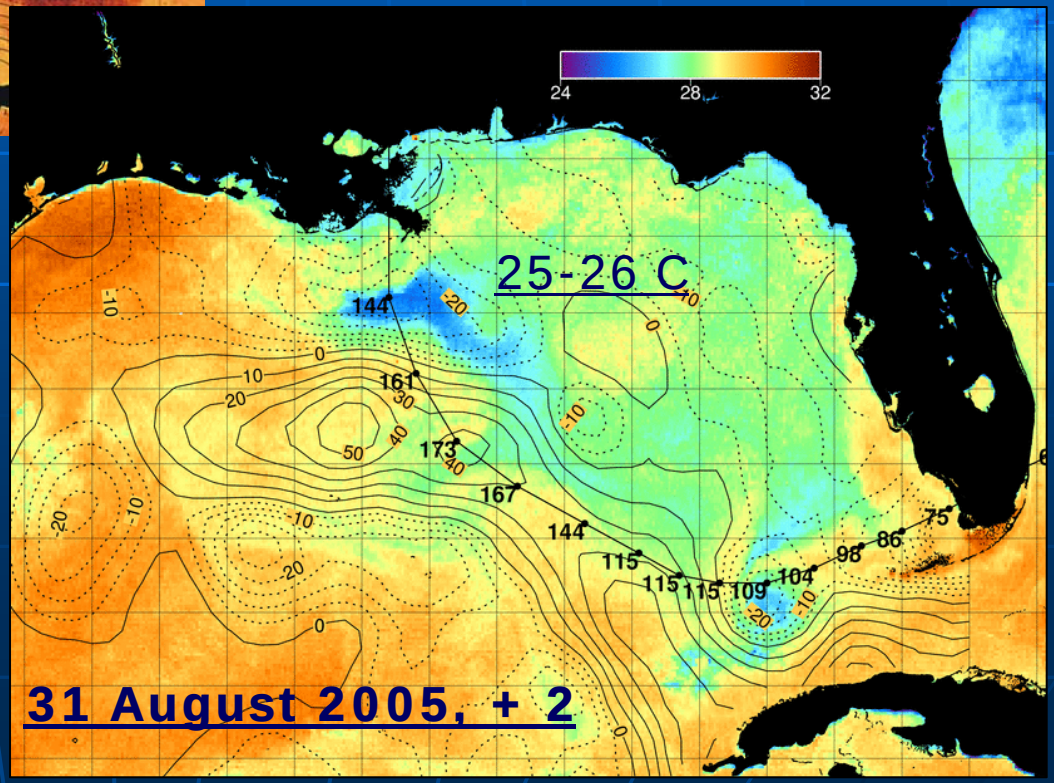


SST and SSH – pre-Katrina

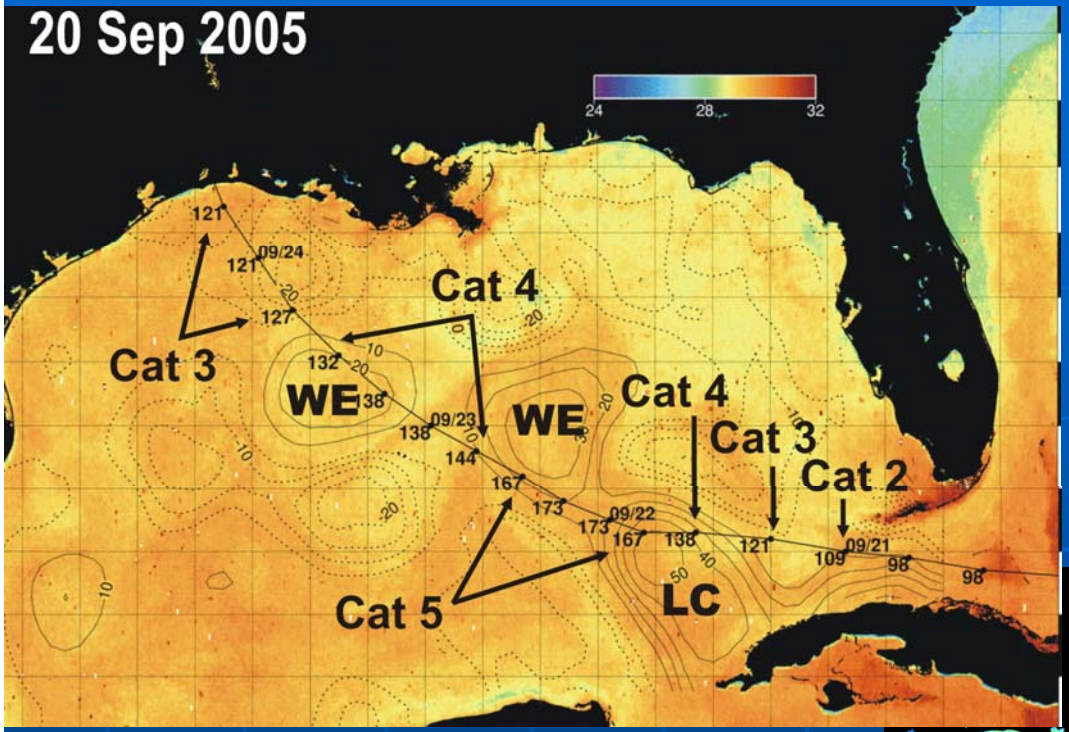


August 2005

SST and SSH post Katrina

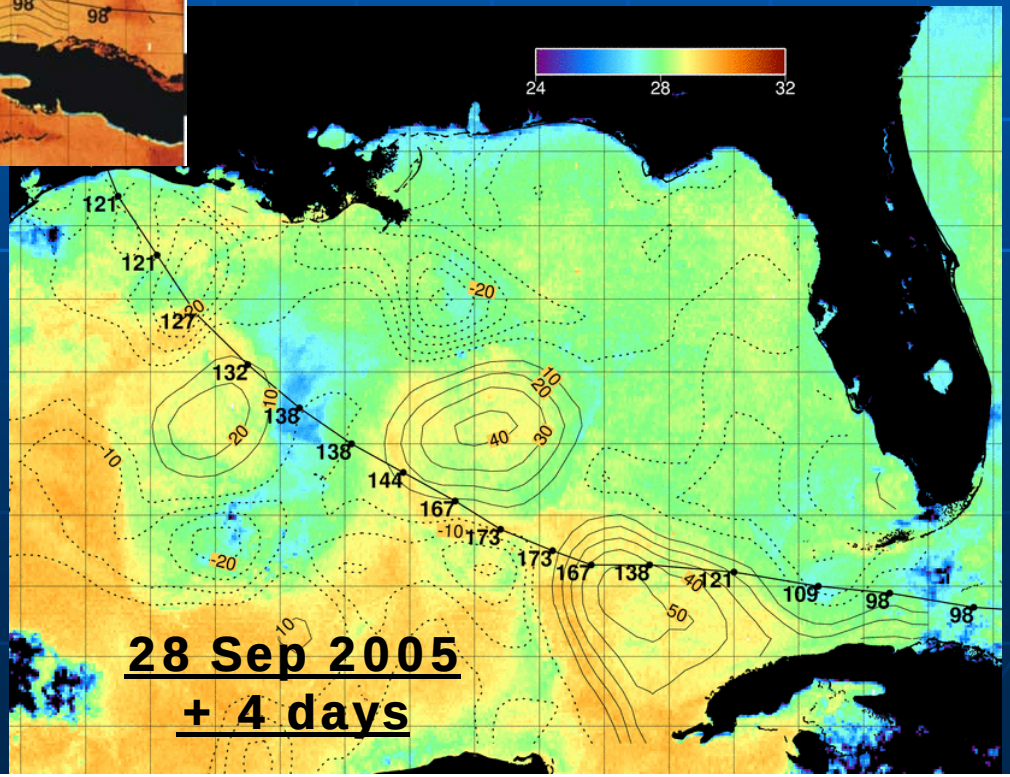


SST and SSH pre-Rita

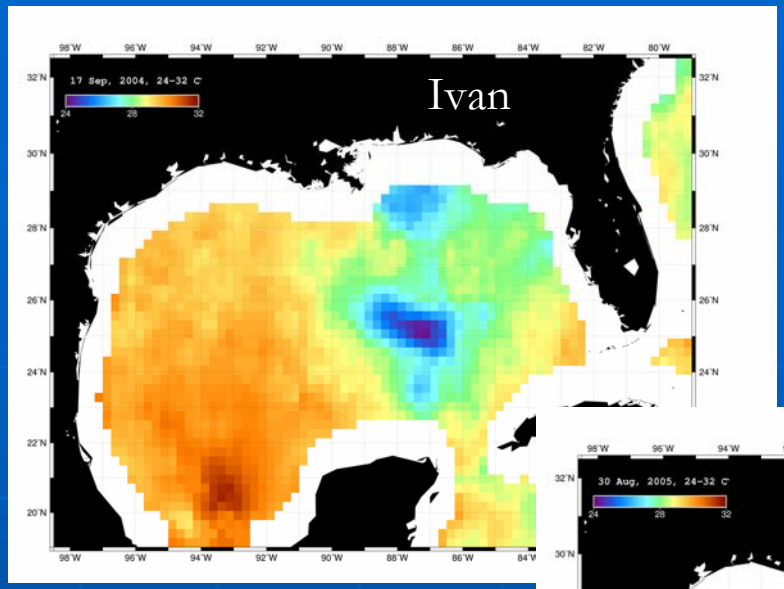


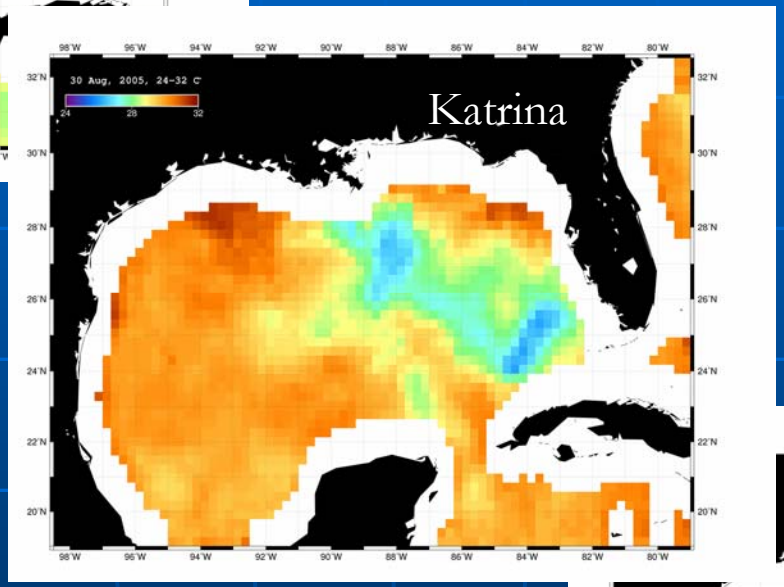
September 2005

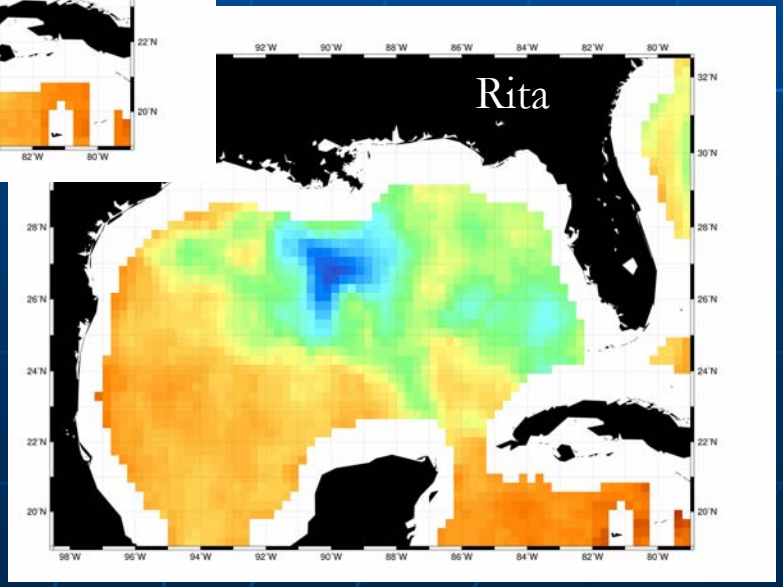
SST and SSH post-Rita



Cool Wakes from Microwave Measurements (C. Gentemann, www.remss.com)







SST (C)

Observed Hurricane Intensity Changes

For Ivan: no intensification over warm eddy, rather negative feedback from two large cool features 20- 26º C

For Katrina: rapid intensification over Loop Current and warm eddy

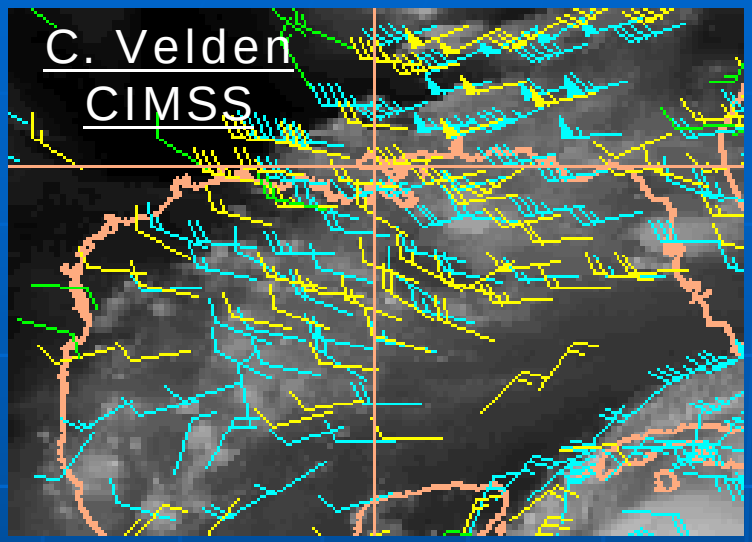
For Rita: rapid intensification over Loop Current, weakening before and after warm eddy

Why the disparity in the ocean impacts?

What can we learn from satellites about the atmospheric conditions over the Gulf?

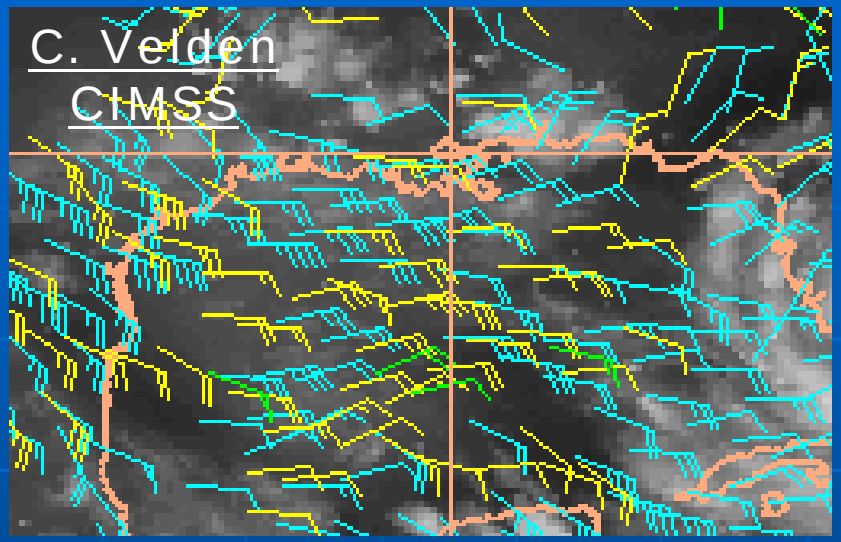
Ivan (wind shear!)

mid and upper winds from west



Katrina (no wind shear)

mid and upper winds from east



Preliminary Conclusions

- Atmosphere appears to be the main control valve
- Ocean effects (positive and negative) secondary but important
- Potential for strengthening over warm pools
- Potential for weakening over cold pools (ocean cyclones)
- Real-time tracking of Gulf water masses essential
- Incorporation of more accurate ocean feature information could improve predictions of hurricane intensity changes