An assessment of the usefulness of SAR images to help better locating the Brazil Current surface inshore front

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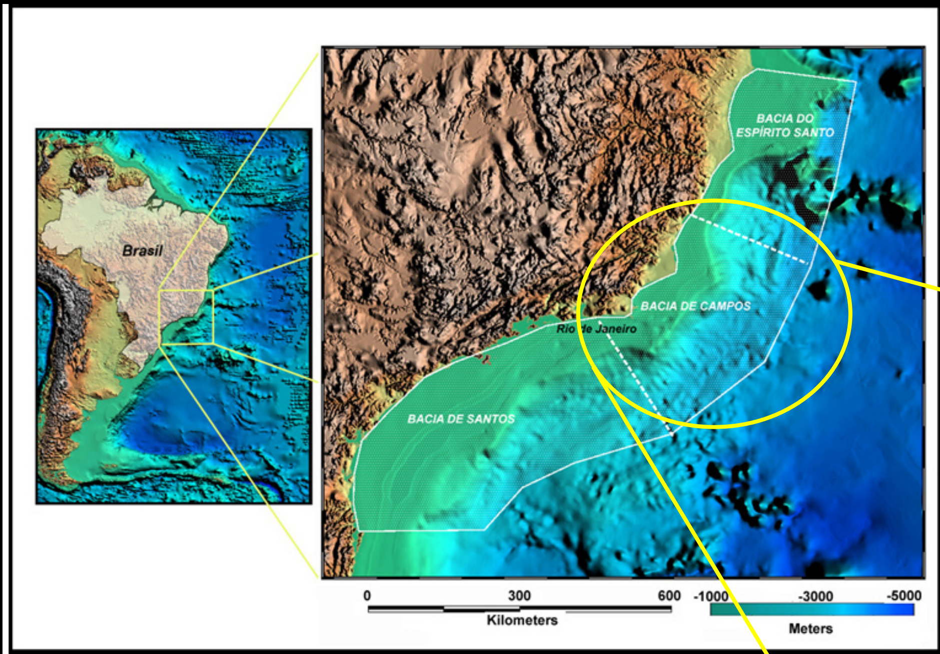
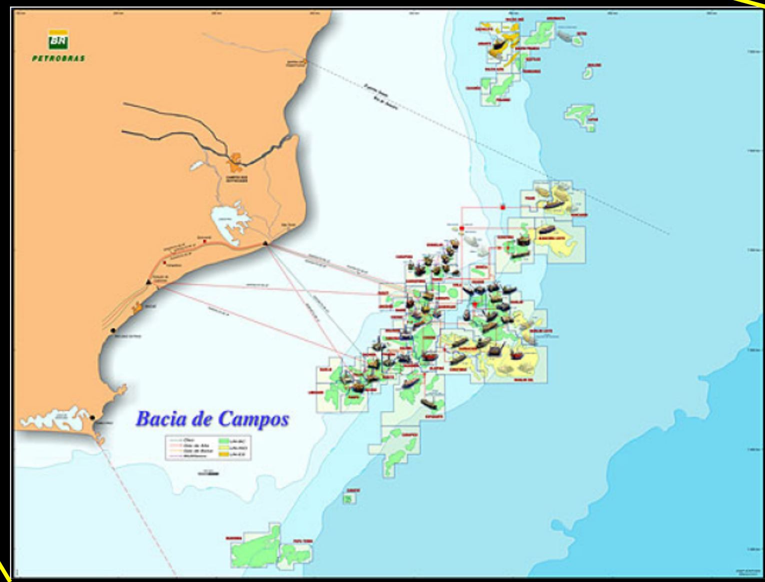
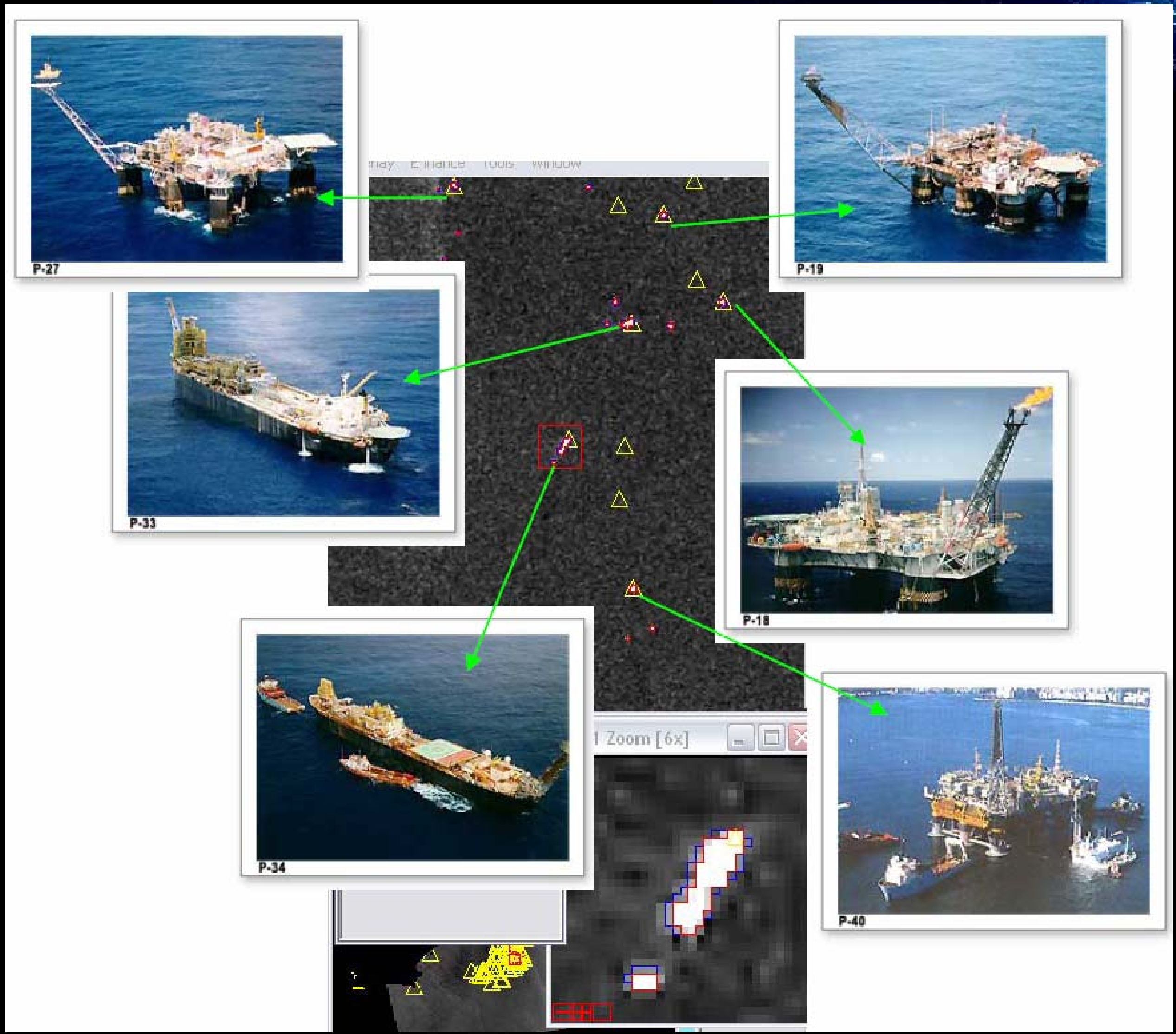
Campos Basin



- 100,000 sq km
- 64 production and drilling platforms,
- 89% of national oil production
- “Floating city” of about 40,000 people

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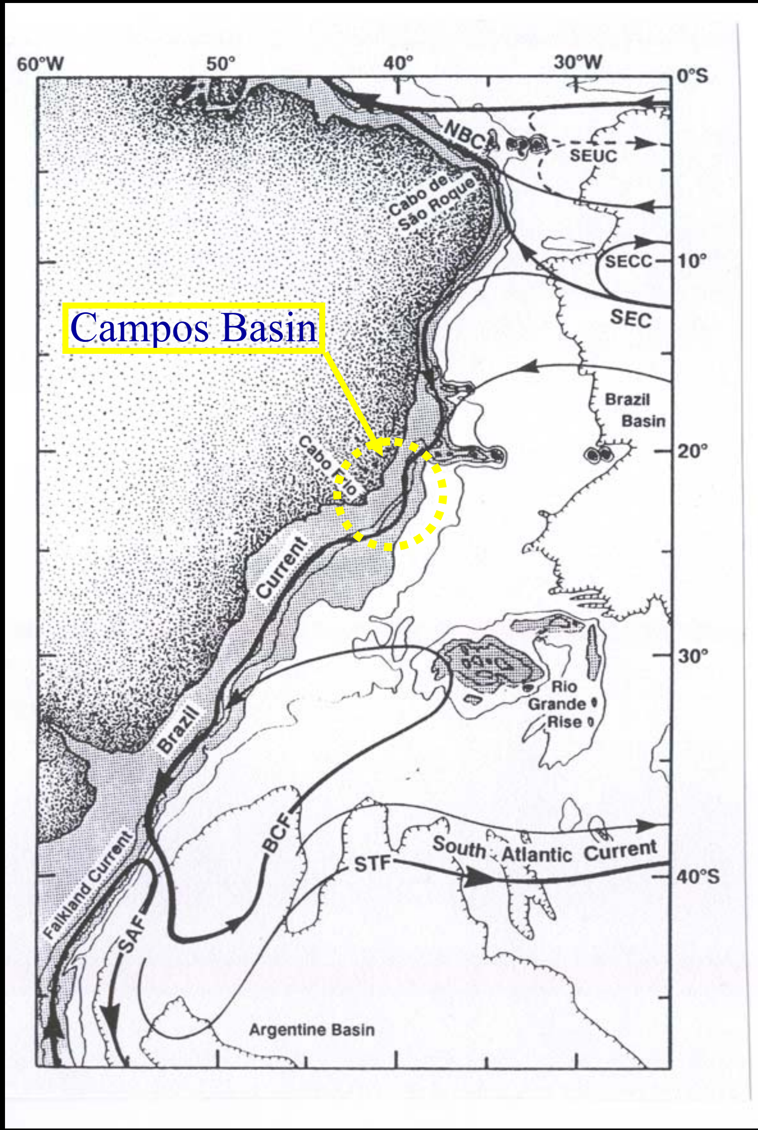
Zoom [6x]

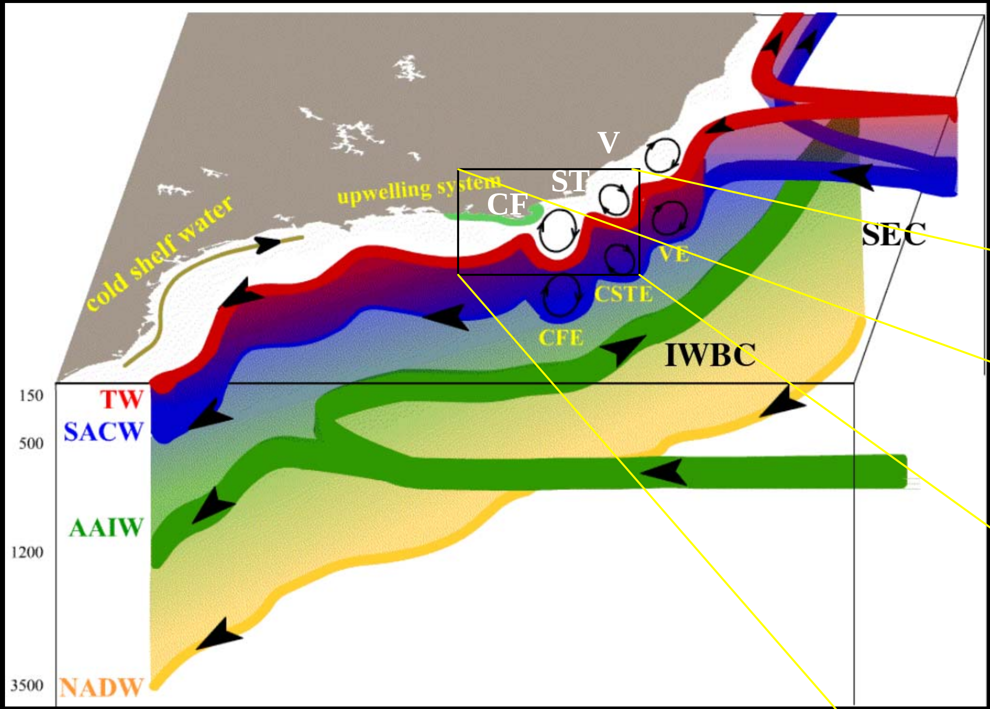


Mean surface circulation at SW South Atlantic

From: Peterson and Stramma, 1991

Conceptual display of Water Masses-Currents with mesoscale features for

SW South Atlantic



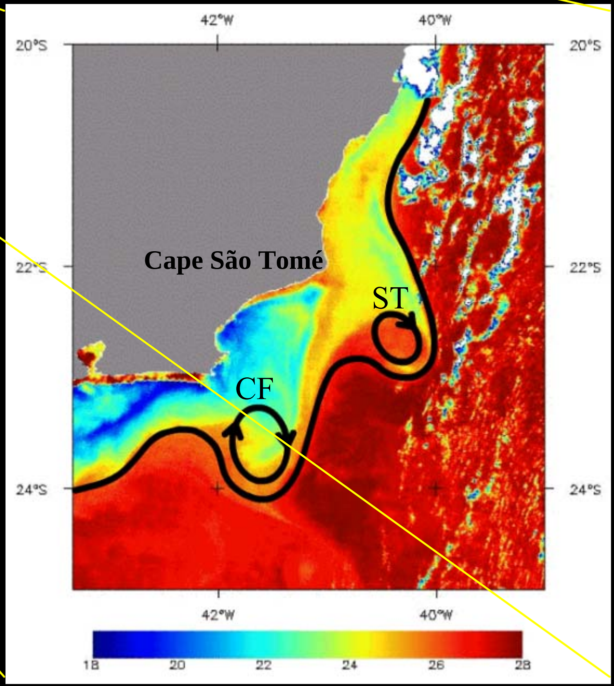
From: Silveira, I.C.A. (2004)

V – Vitória Eddy

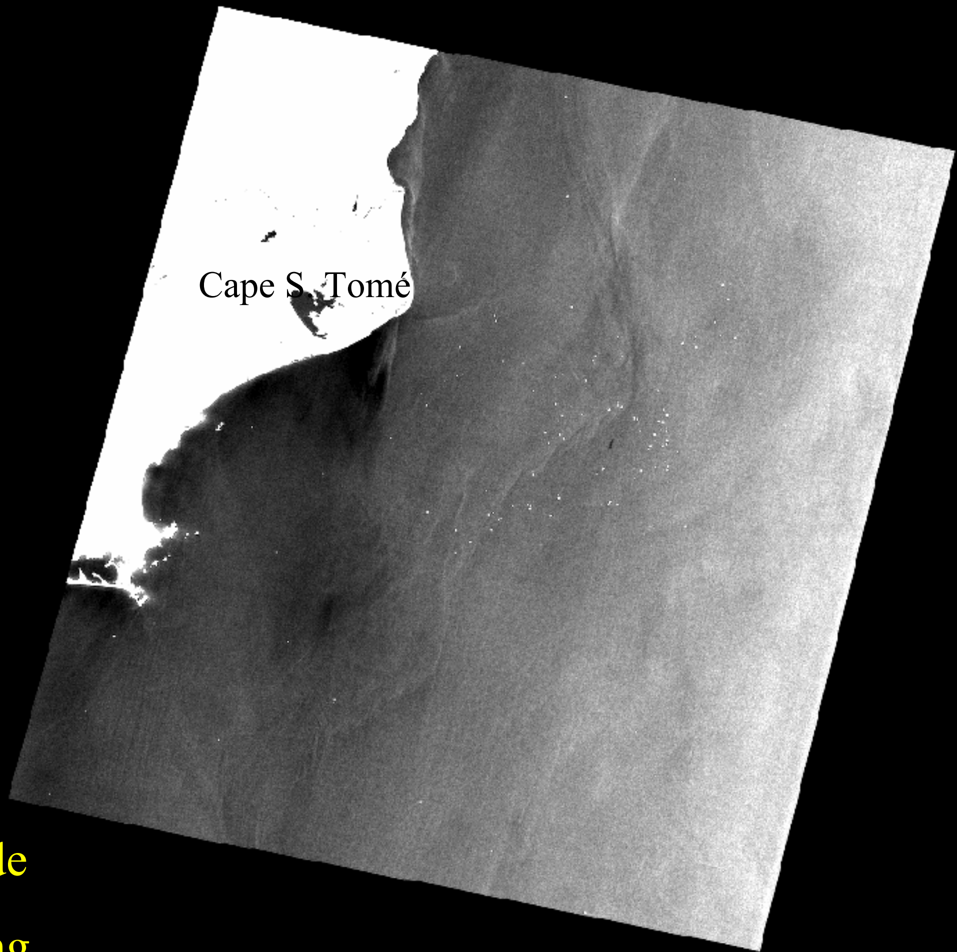
ST – São Tomé Eddy

CF – Cabo Frio Eddy

AVHRR SST



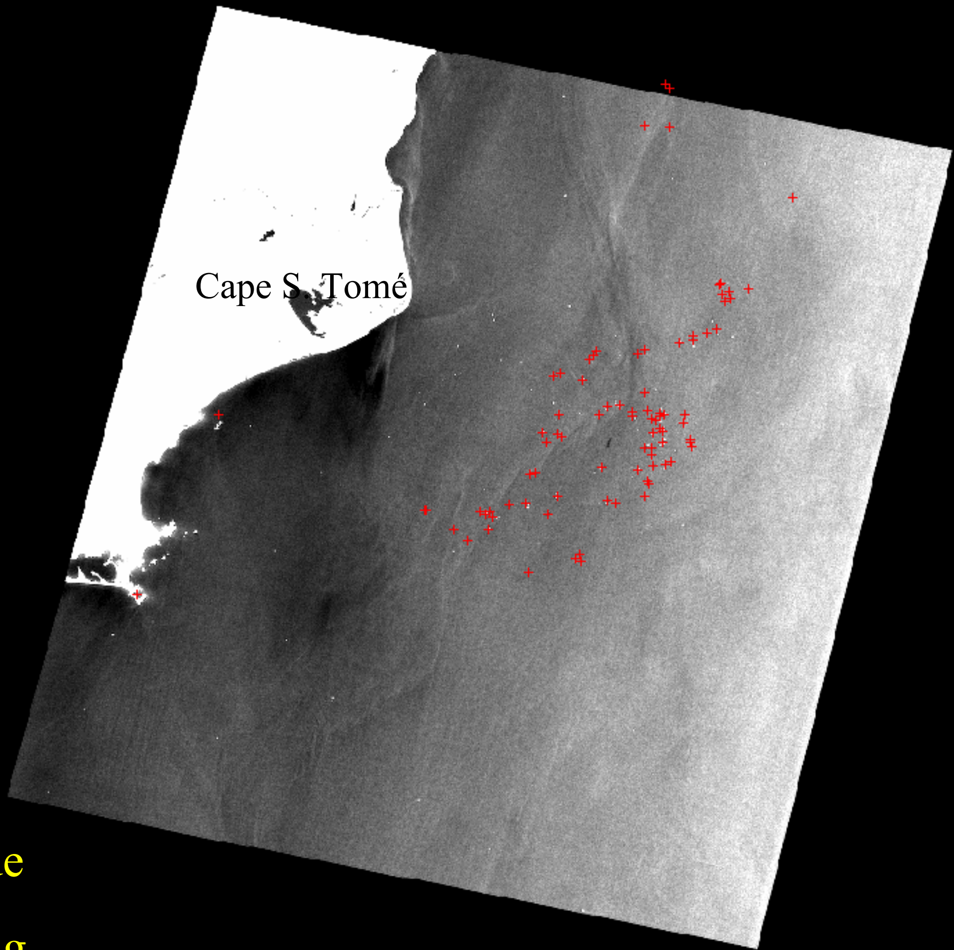
A SAR View of Campos Basin



Radarsat-1 ScanSAR Wide

Aug. 12, 2005, Descending

A SAR View of Campos Basin

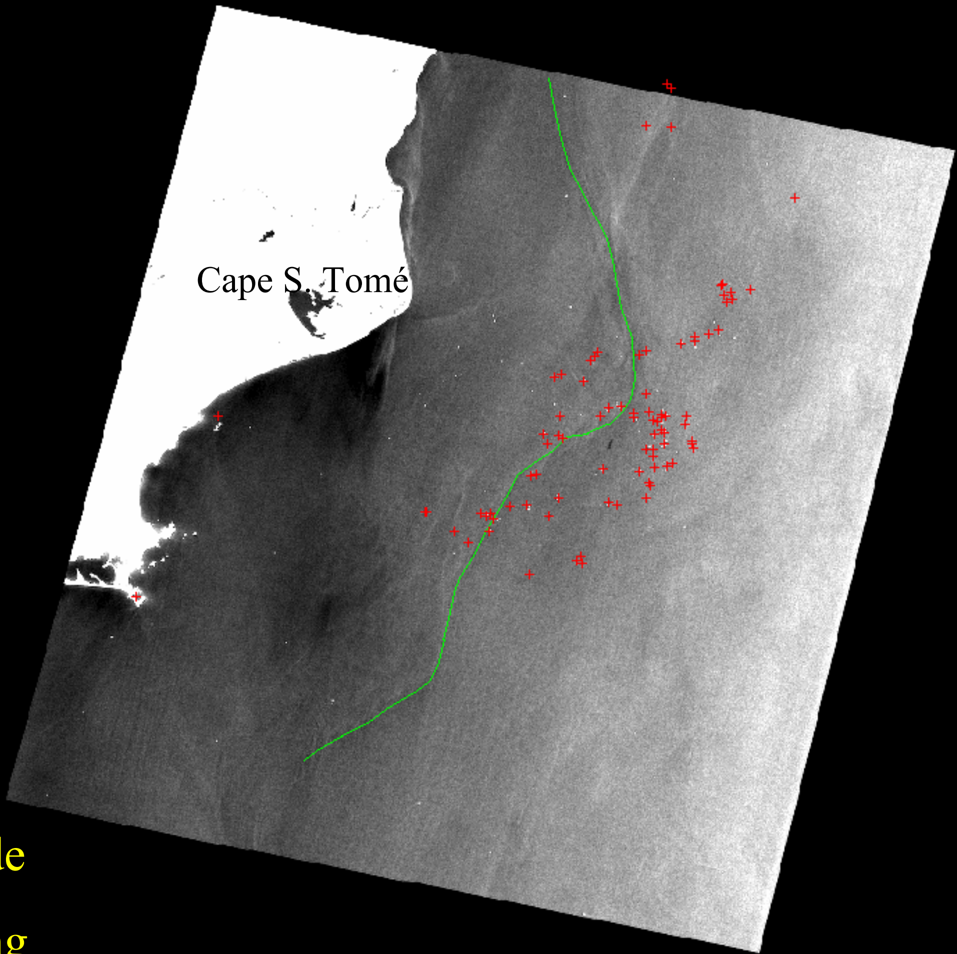


Red Crosses: Oil Platforms

Radarsat-1 ScanSAR Wide

Aug. 12, 2005, Descending

A SAR View of Campos Basin



Red Crosses: Oil Platforms

Green Line: Brazil Current Front

Radarsat-1 ScanSAR Wide

Aug. 12, 2005, Descending

Campos Basin Ocean Modelling Efforts

- The position of the BC front is a very important element in determining the flow field near the oil platforms in the Campos Basin;
- Initializing the model with a good position of the front will provide a much better prognostic forecast;
- Thermal IR SST images can provide a good estimate of frontal position in the absence of clouds;
- Problem with IR images for the region is the high cloud cover ; ▶ SACZ
- Possible solutions: a)IR/microwave blend SST images such as the GHRSST, b) GOES IR time composites; c) use of IR and microwave images together with SAR frontal mapping.

Campos Basin Ocean Modelling Efforts

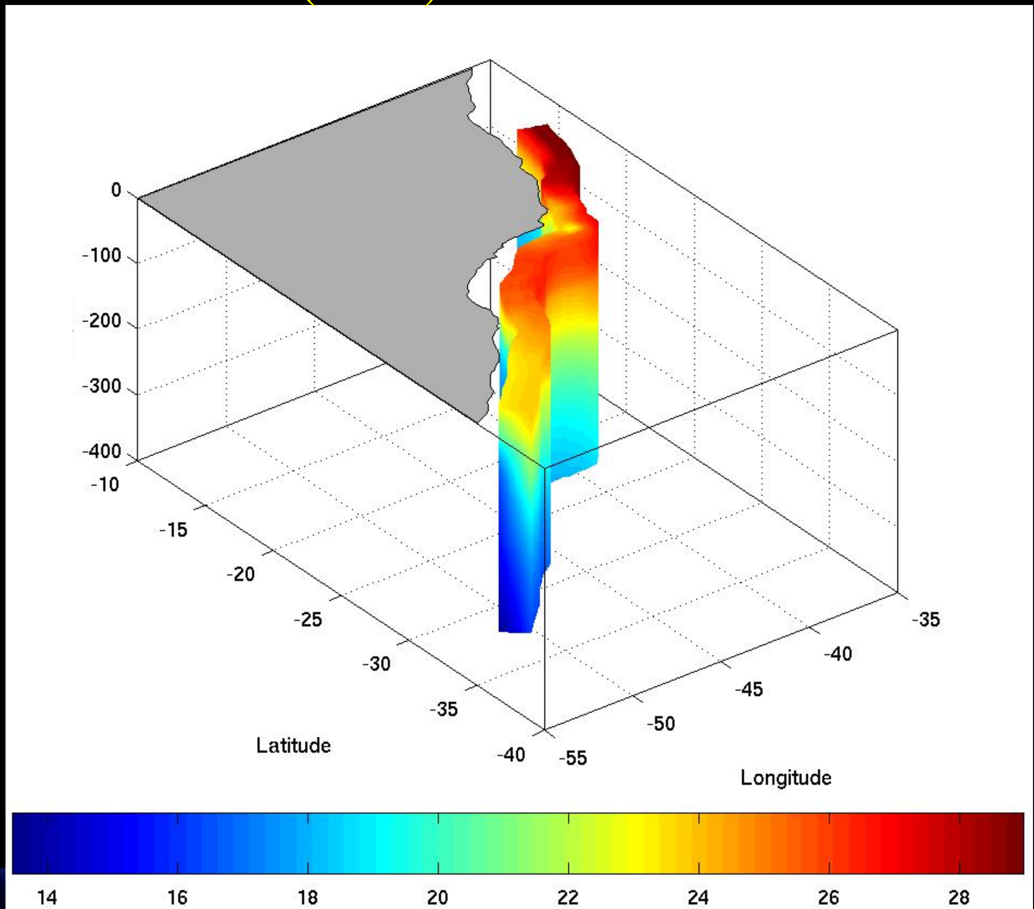
A possible methodology: the so-called "Feature Oriented Regional Model-FORM" that combines a previous knowledge of the main oceanic features present in the area with the development of parametric models of these features (Gangopadhay et al., 1997).

FORM Protocol:

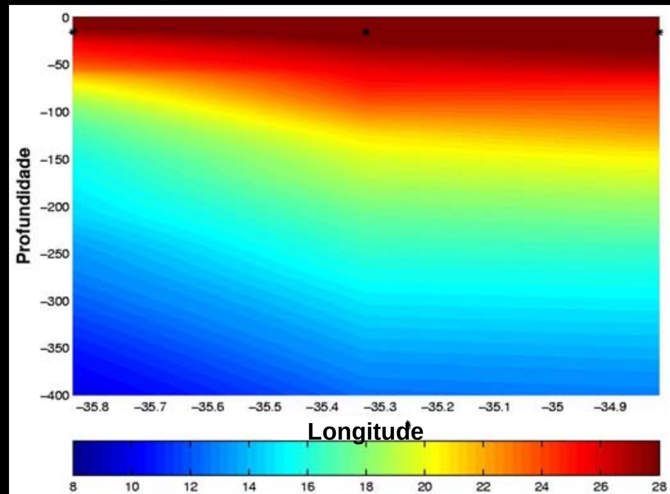
I – Identification of water masses and ocean features relevant for the regional dynamic;
II – Previous knowledge of the climatological regional circulation;
III – Collection of synoptic *in situ* and satellite data;
IV - Construction of the individual feature models (FM);
V – Interpolation/merging FMs with climatology using e.g. Multiple Scale Objective Analysis;
VI – Numerical Simulation.

Campos Basin Ocean Modelling Efforts

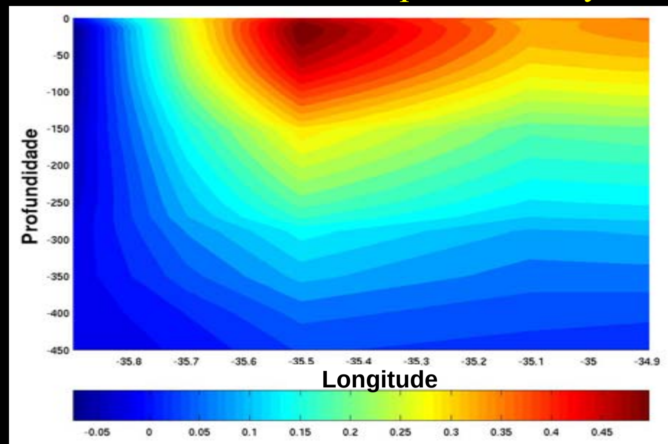
A Feature Model for Brazil Current from Calado (2006)



Temperature



Meridional Geostrophic Velocity



Sections at 24 S

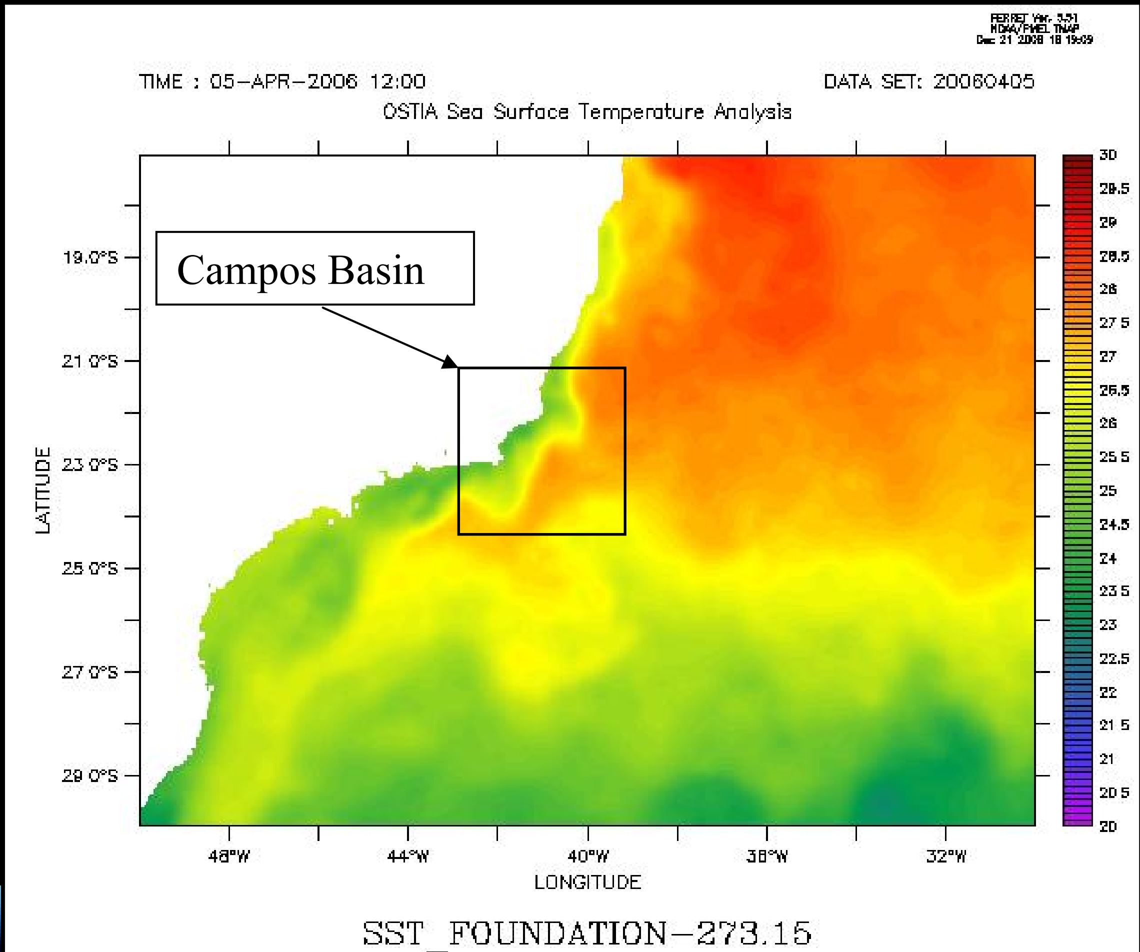
The GODAE High Resolution SST data set

GHRSST data were obtained from global OSTIA (*Operational Sea Surface Temperature and Sea Ice Analysis*) which uses Optimum Interpolation of data from different satellites and IR and microwave radiometers and *in situ* data.

Spatial resolution: 1/20° (aprox. 5.5 km)

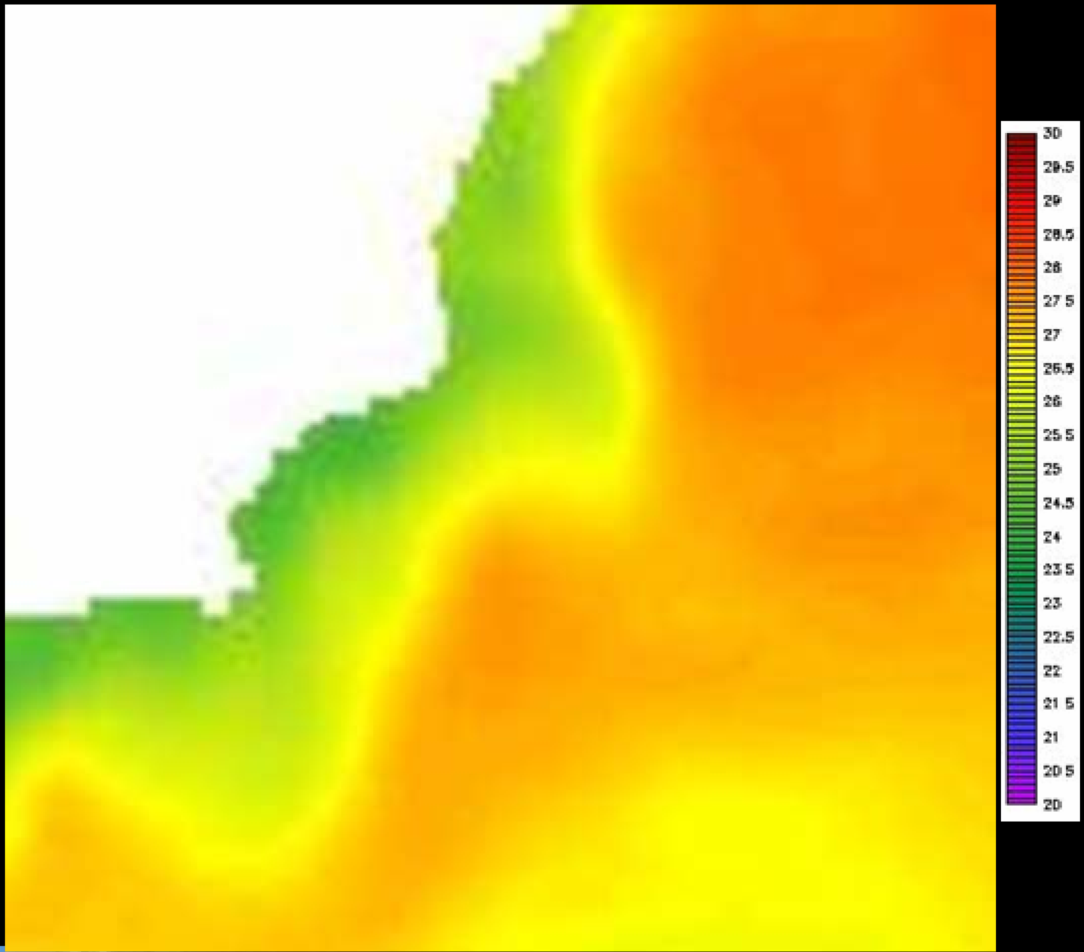
An example of GHRSST map for SW South Atlantic

April 05, 2006

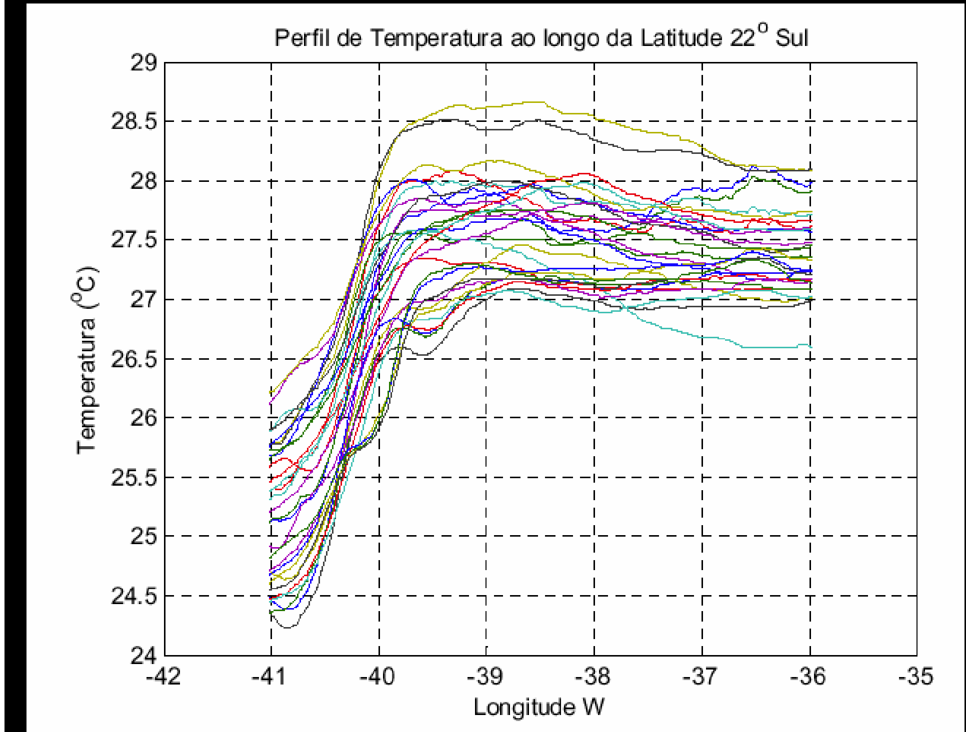


GHRSST map for Campos Basin (a zoom of previous slide)

April 05, 2006

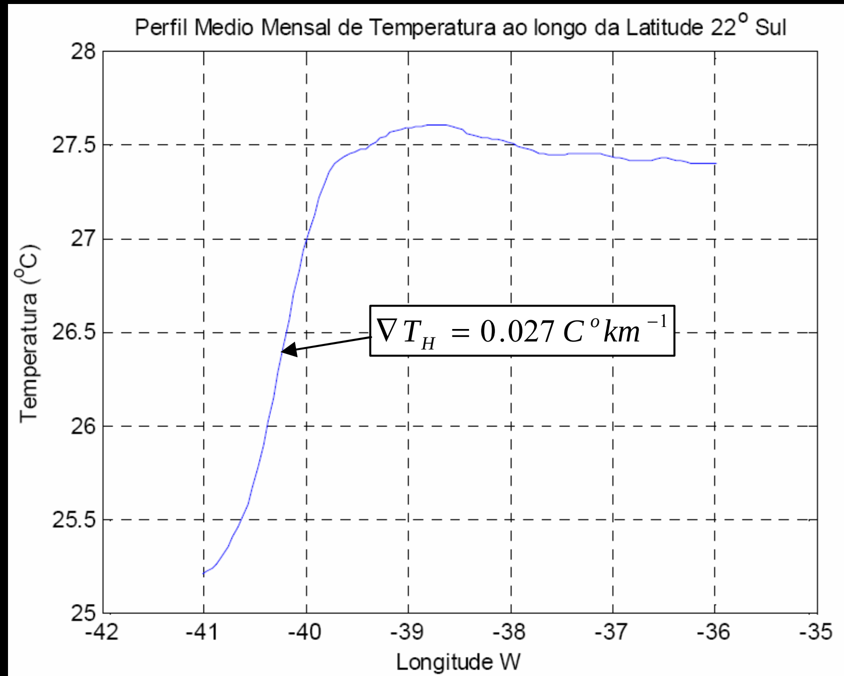


GHRSST



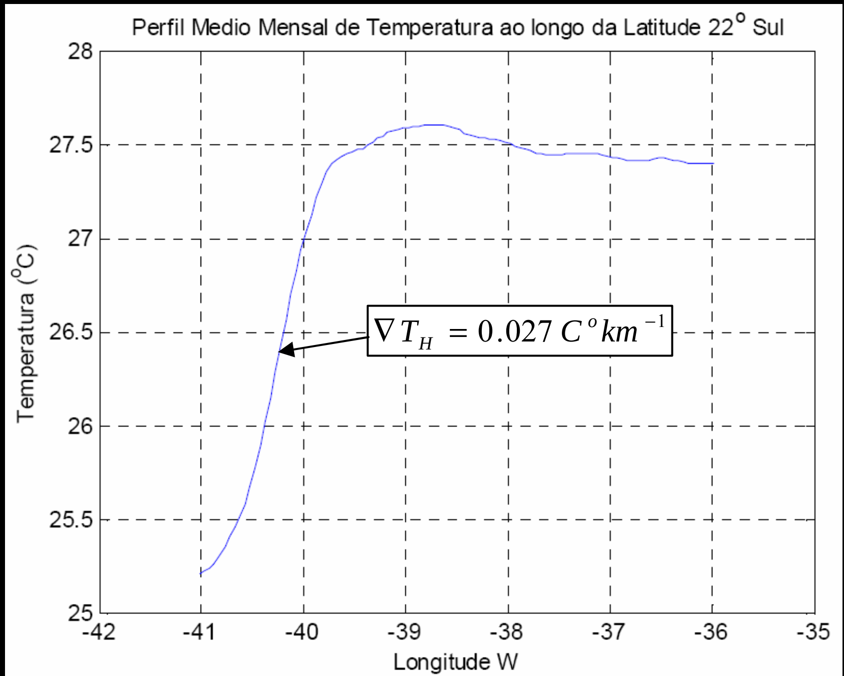
Longitudinal SST profiles at BC frontal region at 22ºS for April 2006 from the 5.5 km resolution GHRSST data set.

GHRSST



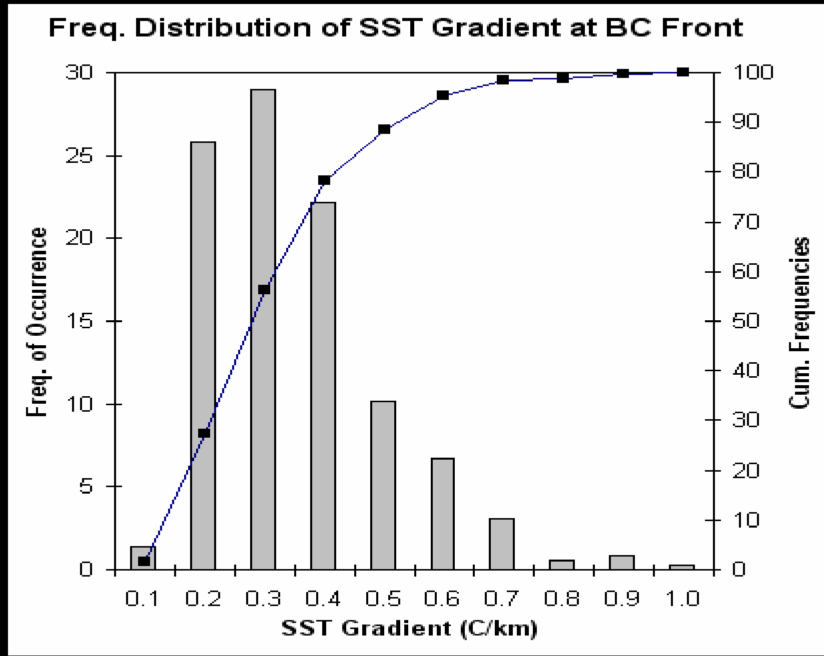
April 2006 monthly mean SST longitudinal profile of the BC frontal region at 22ºS

GHRSST



Mean SST longitudinal profile of the BC frontal region at 22°S for April 2006 from the 5.5 km resolution GHRSST data set.

AVHRR



SST gradient at BC frontal region in Campos Basin based on AVHRR data set from 2000 to 2002.

Frontal Detection in SAR Images

Physical Mechanisms Modulating Surface Roughness

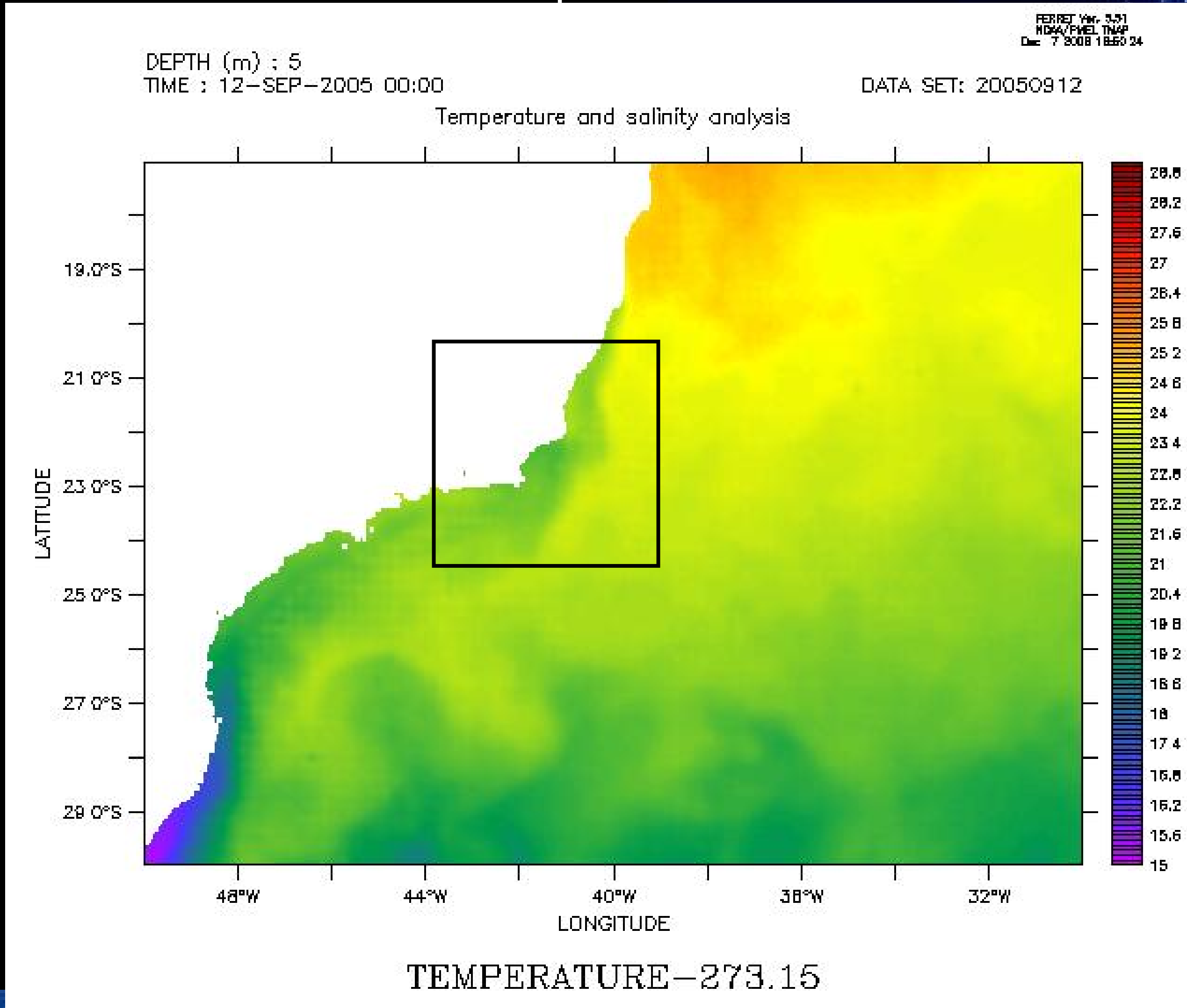
a) Accumulation of natural surfactants in regions of current convergence;

b) Interaction of short waves with surface current gradients;

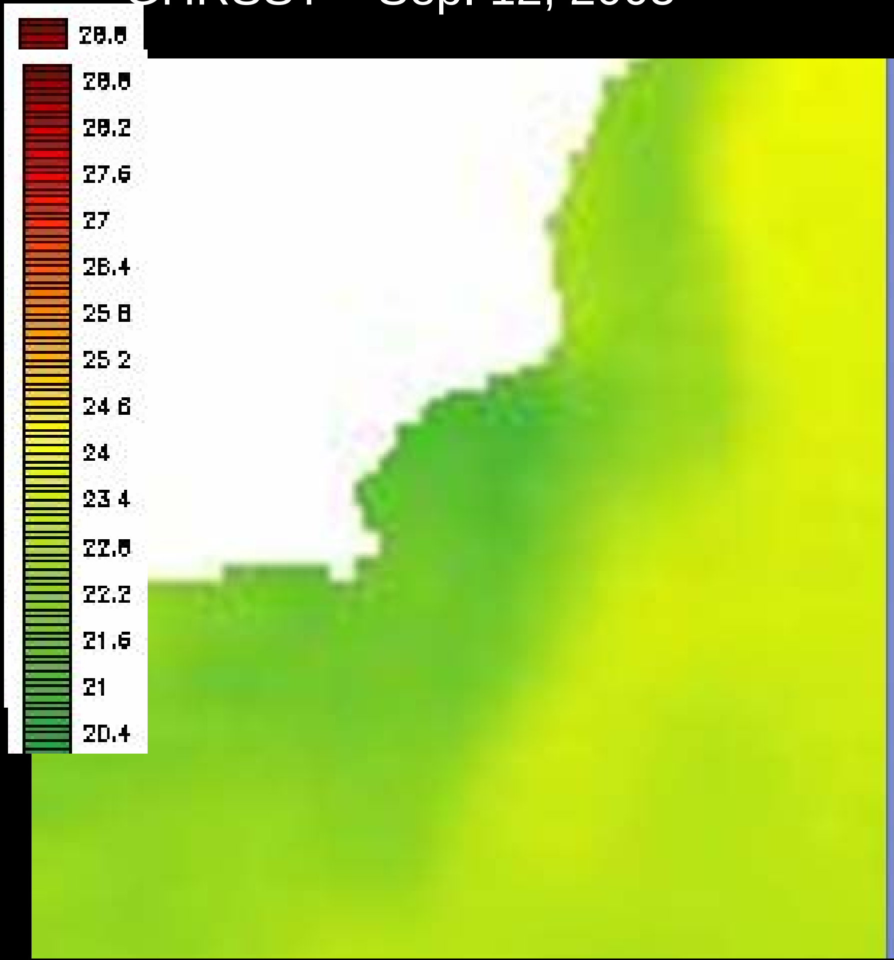
c) Wave breaking effects;

d) Changes in atmospheric stability associated to SST gradients

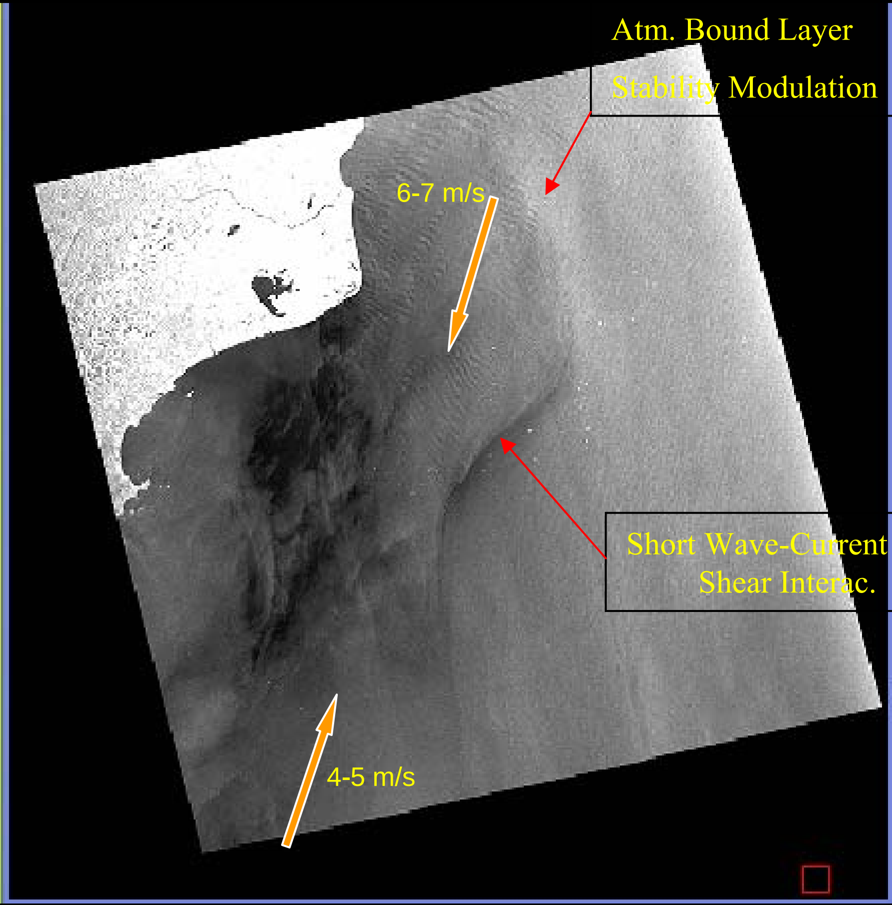
GHRSST – Sep. 12, 2005



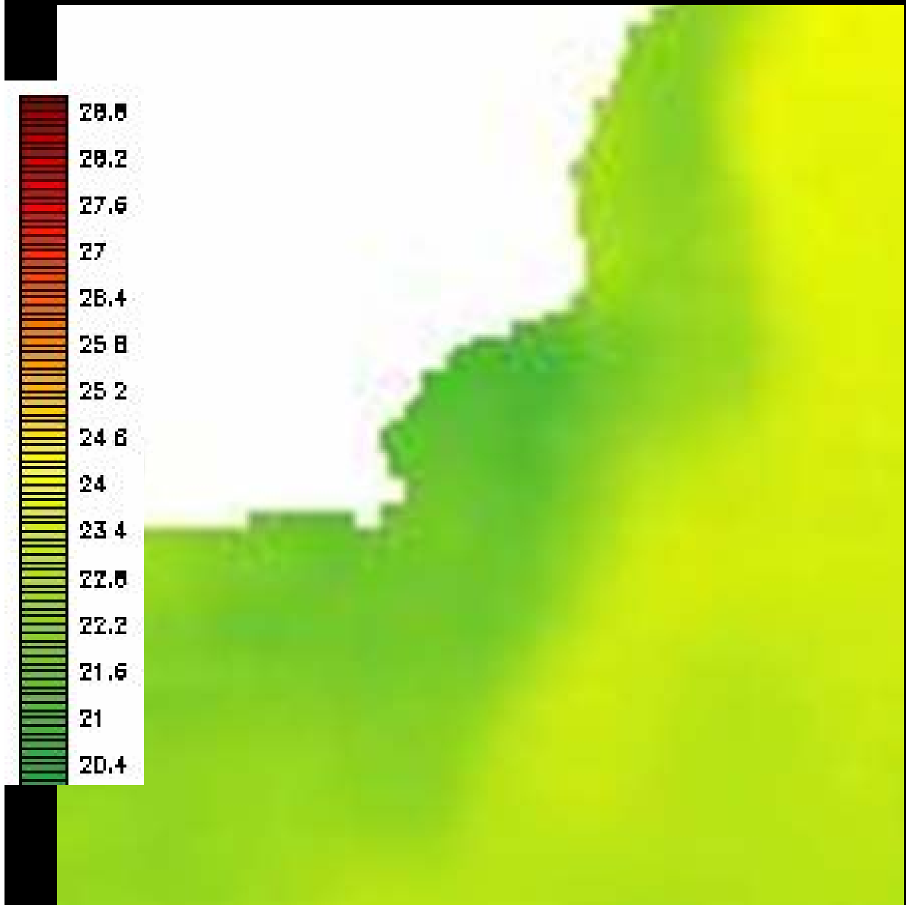
GHRSST – Sep. 12, 2005



Radarsat-1 ScanSAR Sep. 12, 2005



GHRSST – Sep. 12, 2005



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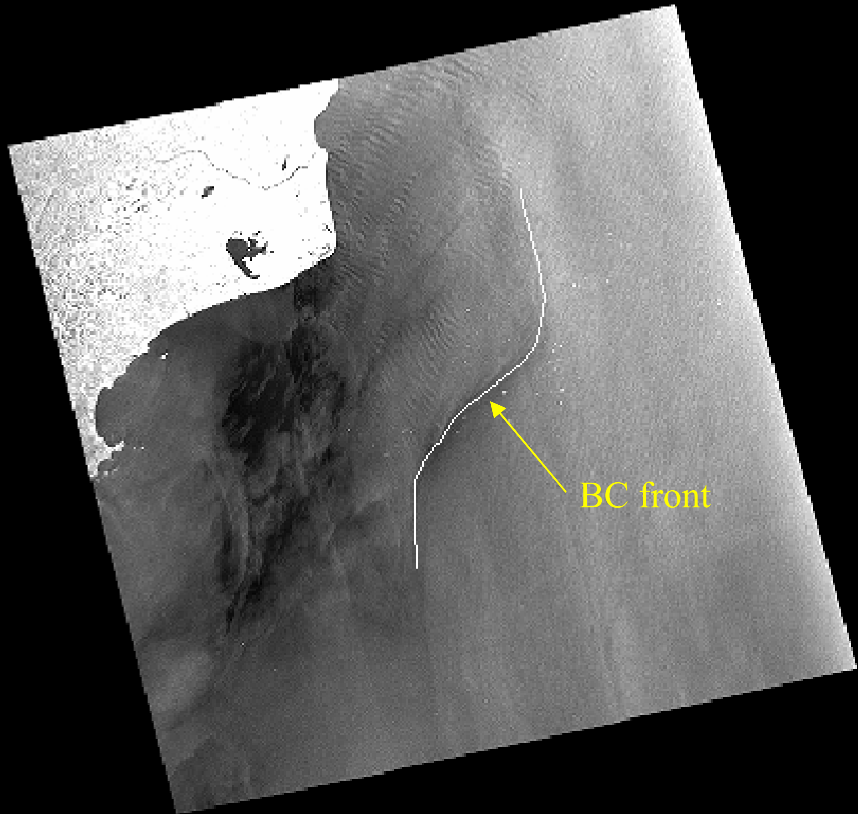
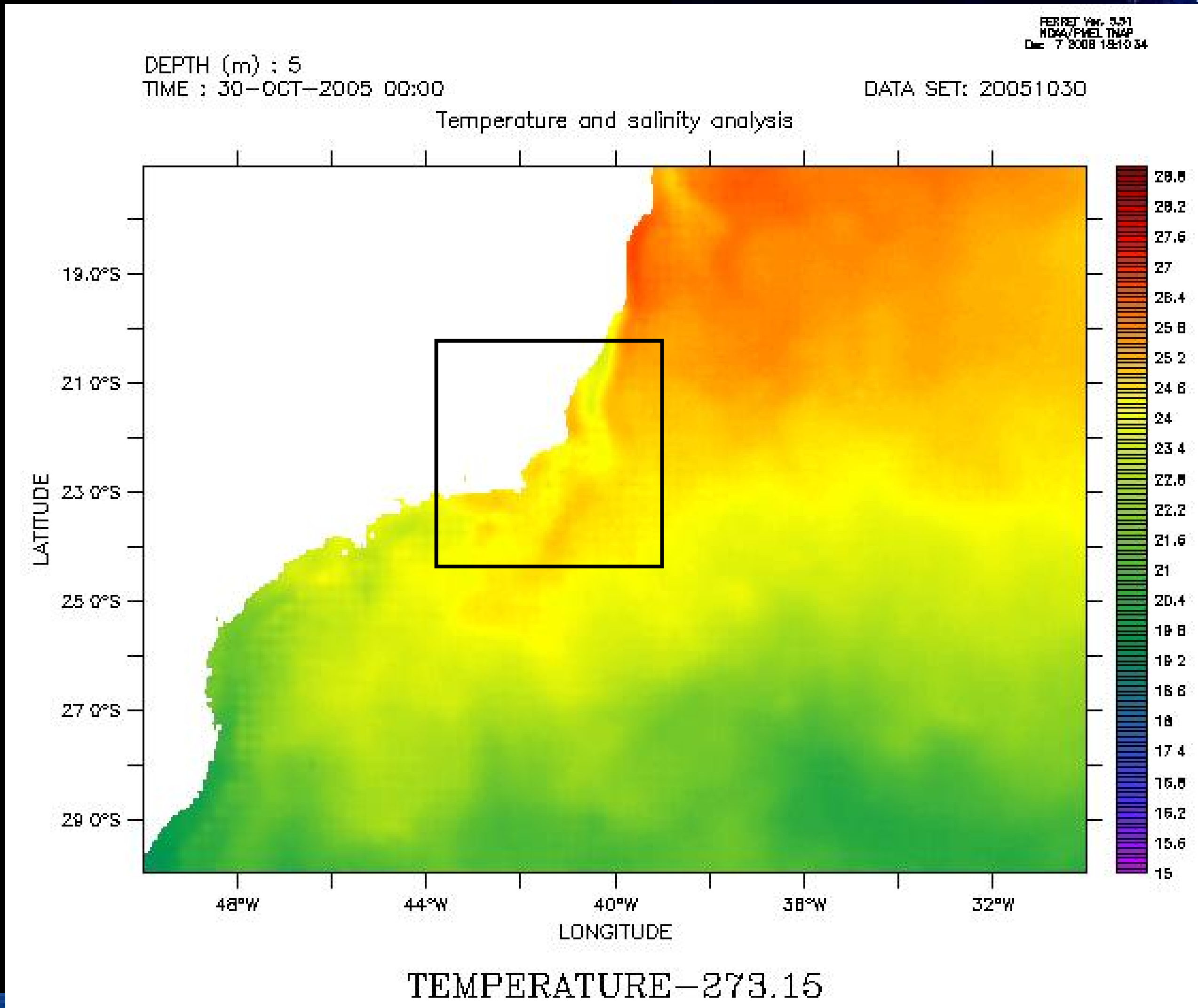
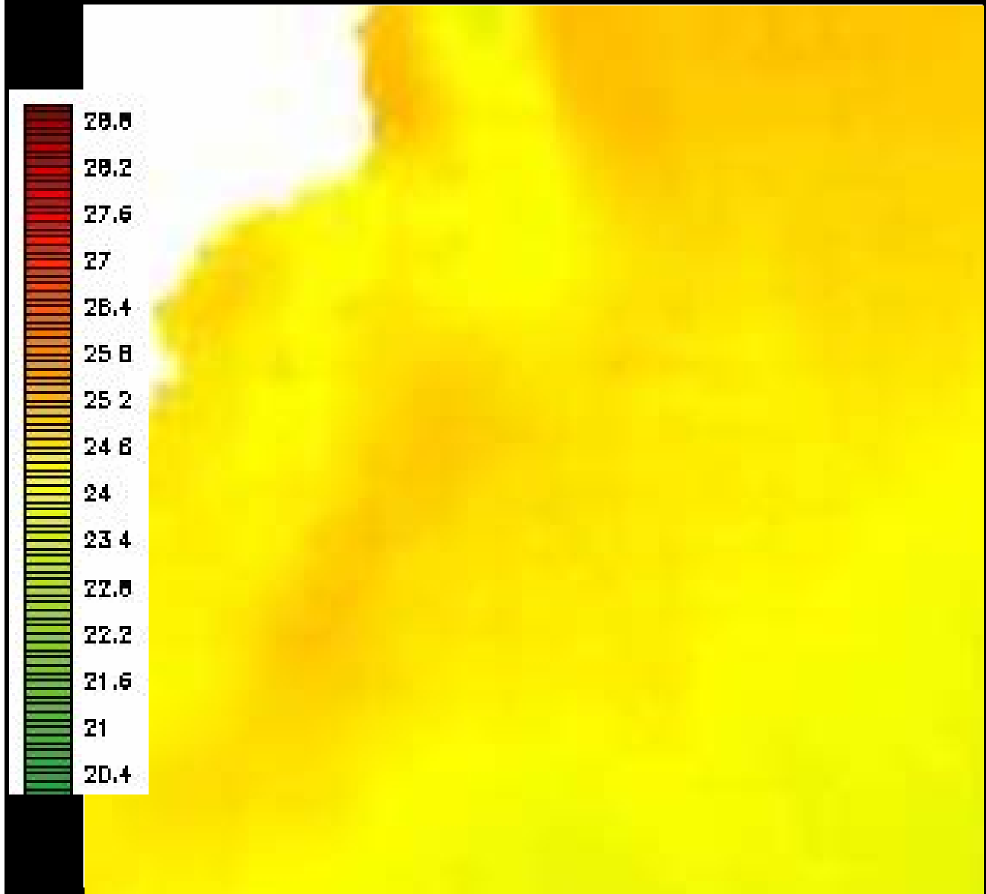


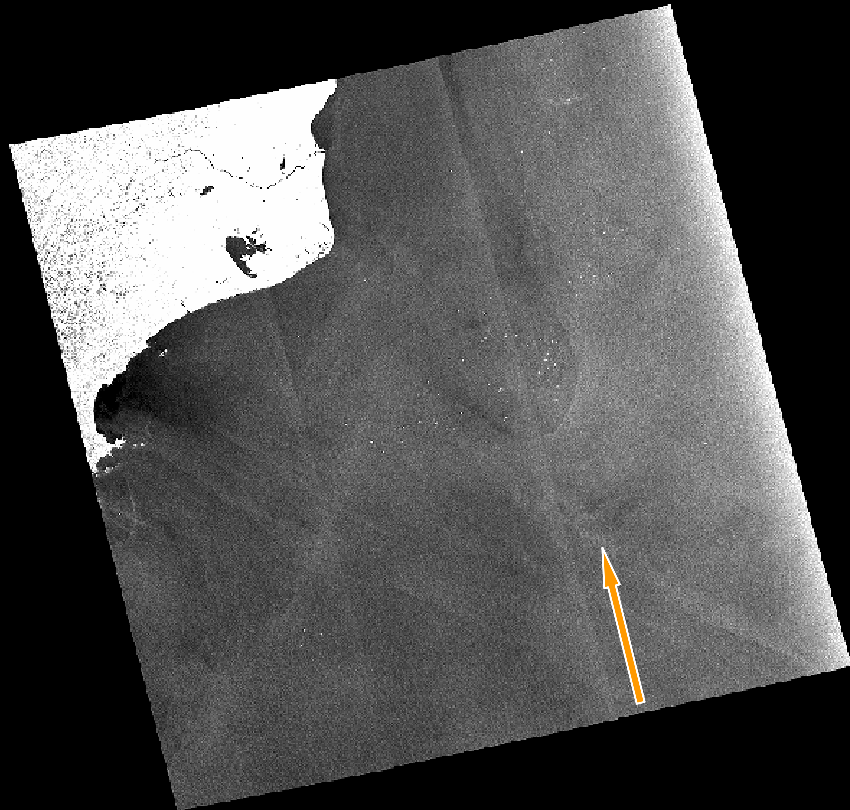
GHRSST – Oct. 30, 2005



GHRSST – Oct. 30, 2005



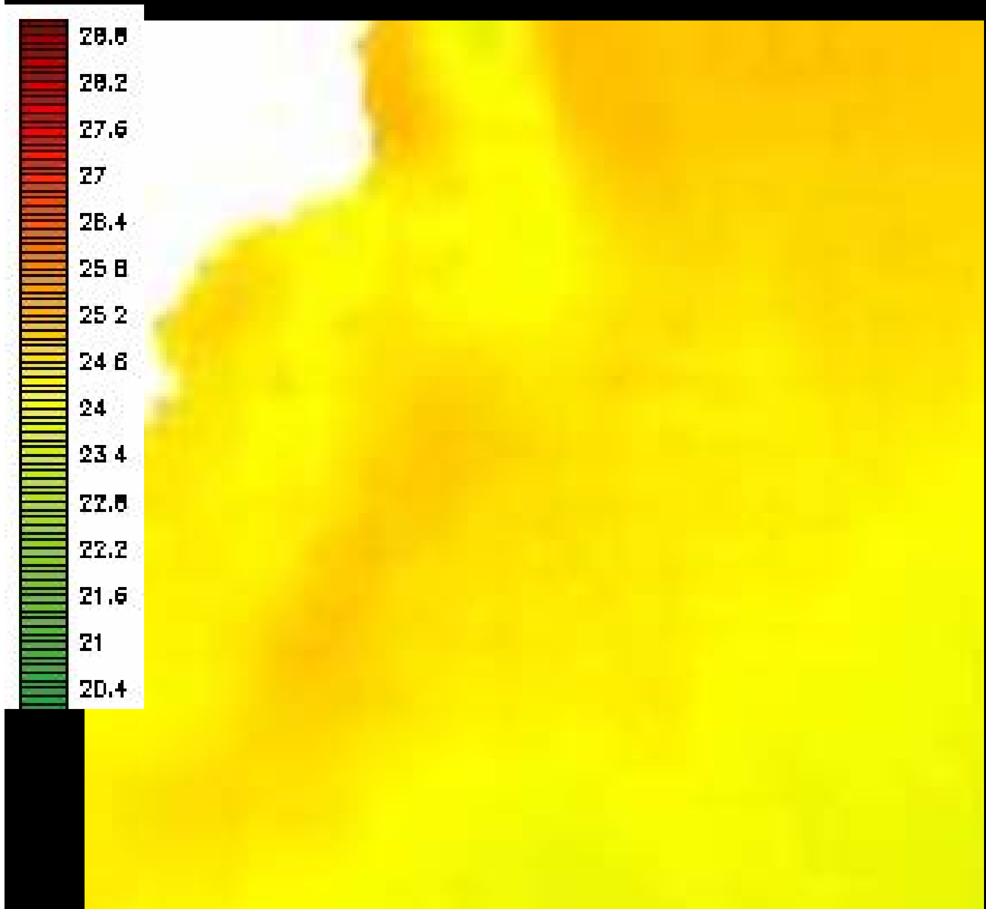
Radarsat-1 ScanSAR Oct. 30, 2005



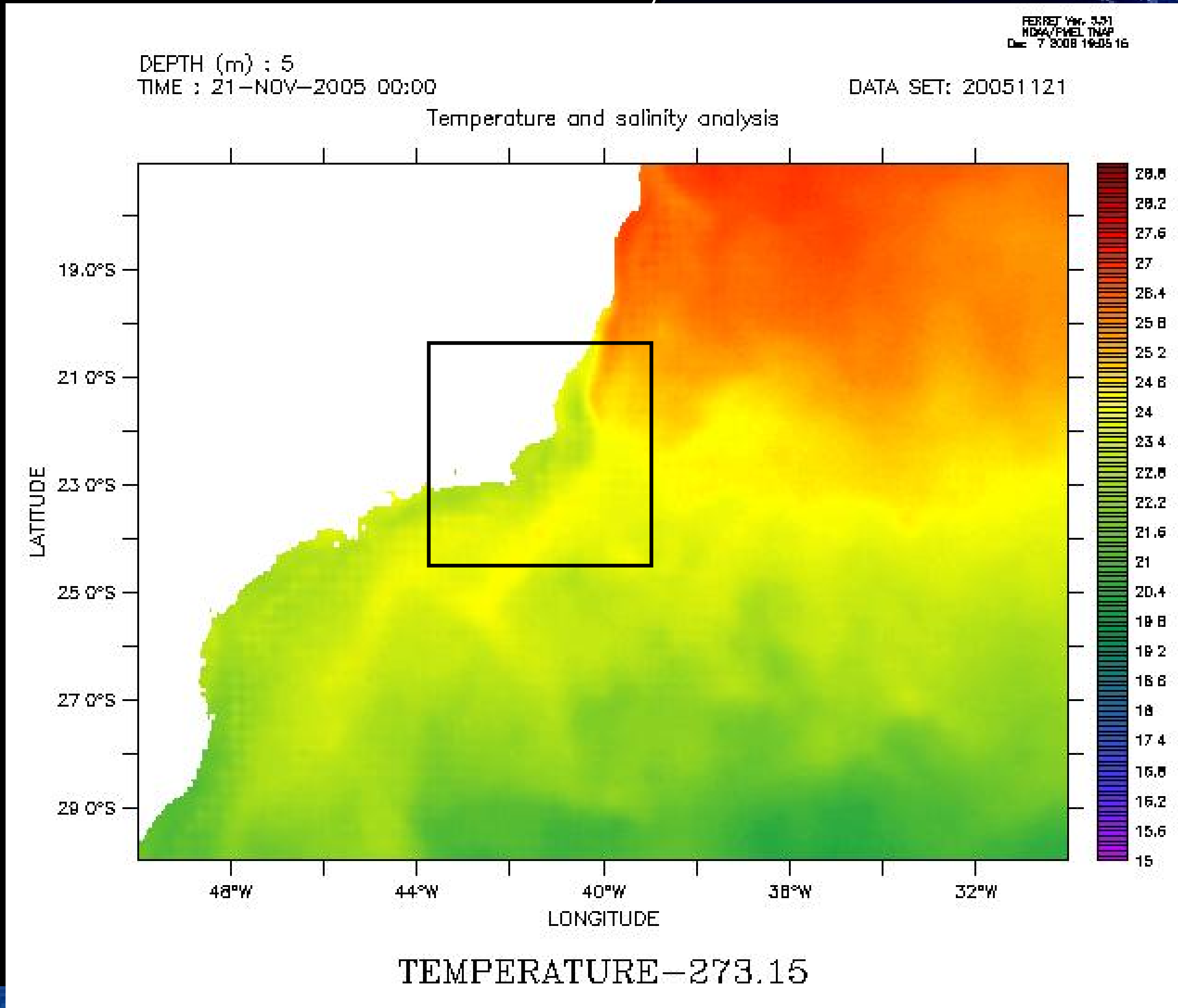
wind direction

GHRSST – Oct. 30, 2005

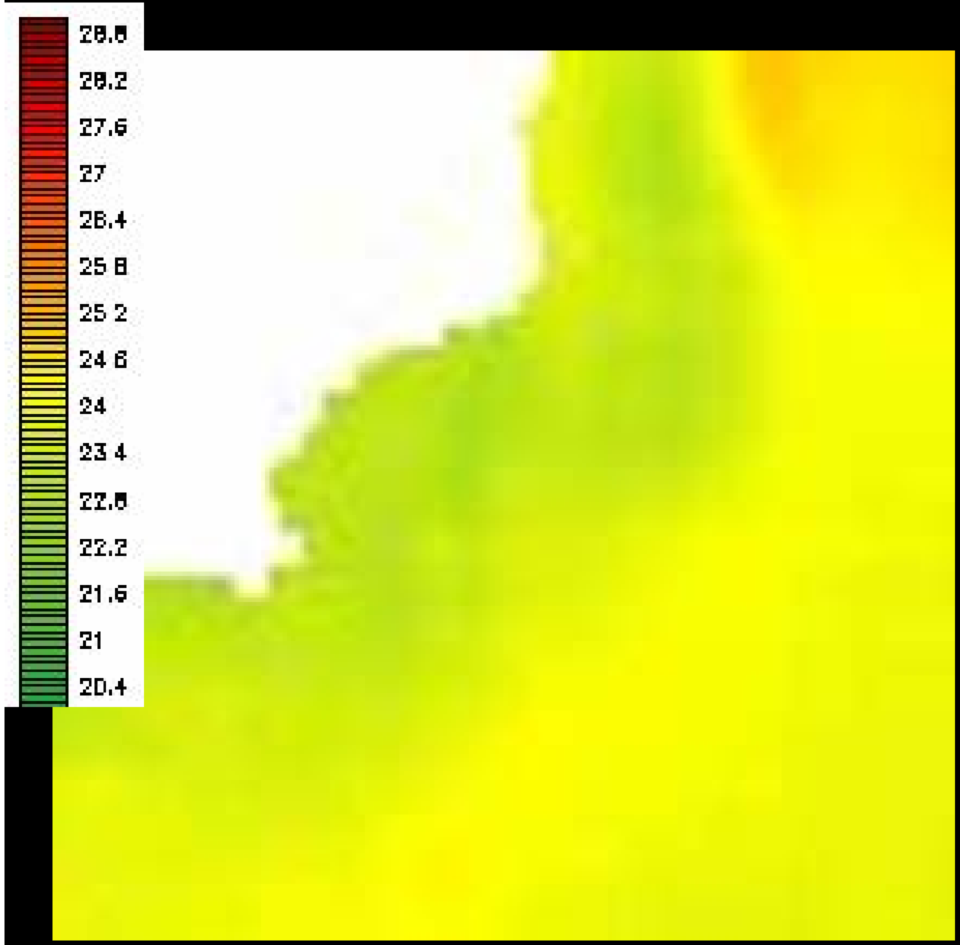
Radarsat-1 ScanSAR Oct. 30, 2005



GHRSST – Nov. 21, 2005



GHRSST – Nov. 21, 2005



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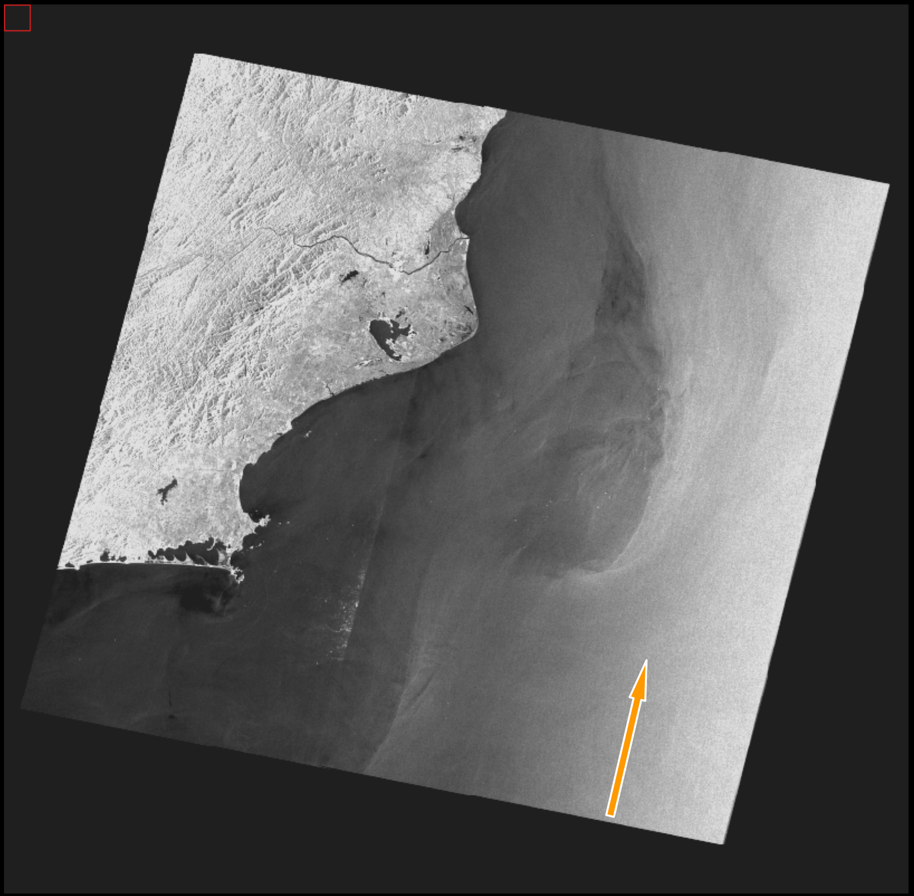
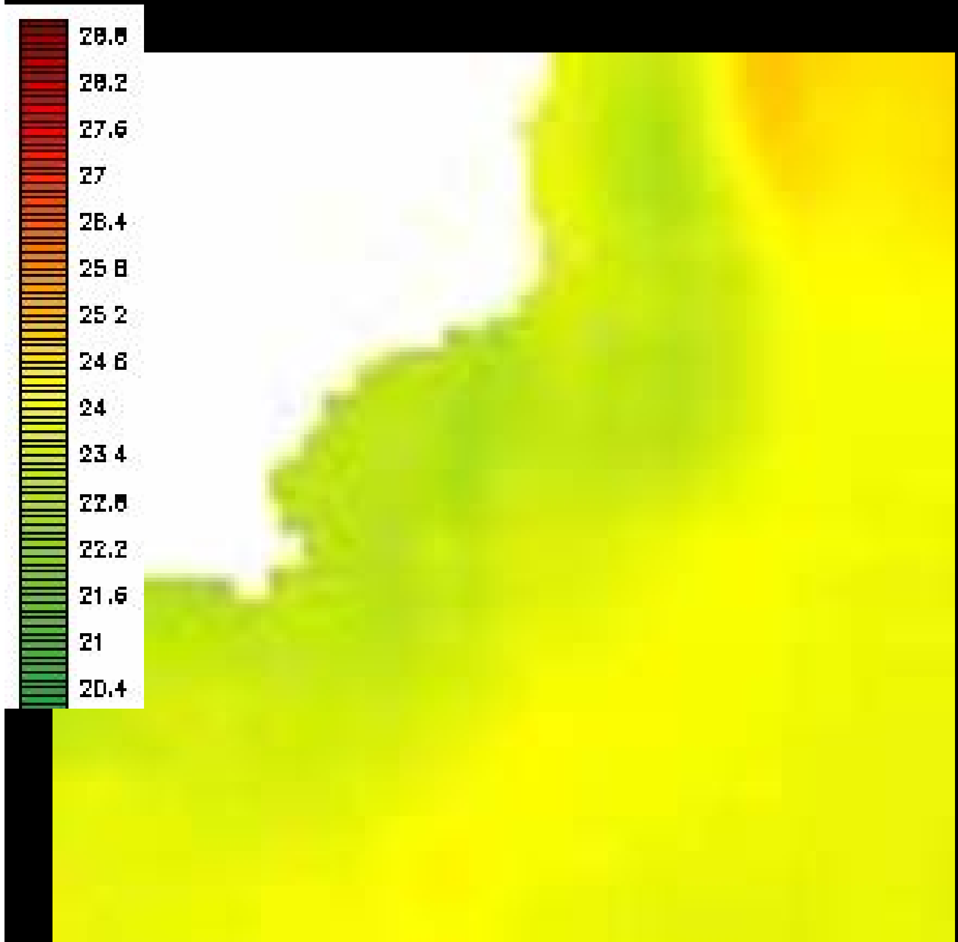


wind direction

GHRSST – Nov. 21, 2005

Radarsat-1 ScanSAR Nov. 21, 2005



Johannessen et al. (1996), using a development of Lyzenga (1991), presents the following expression for the perturbation of NRCS across an oceanic front caused by short wave/current gradients:

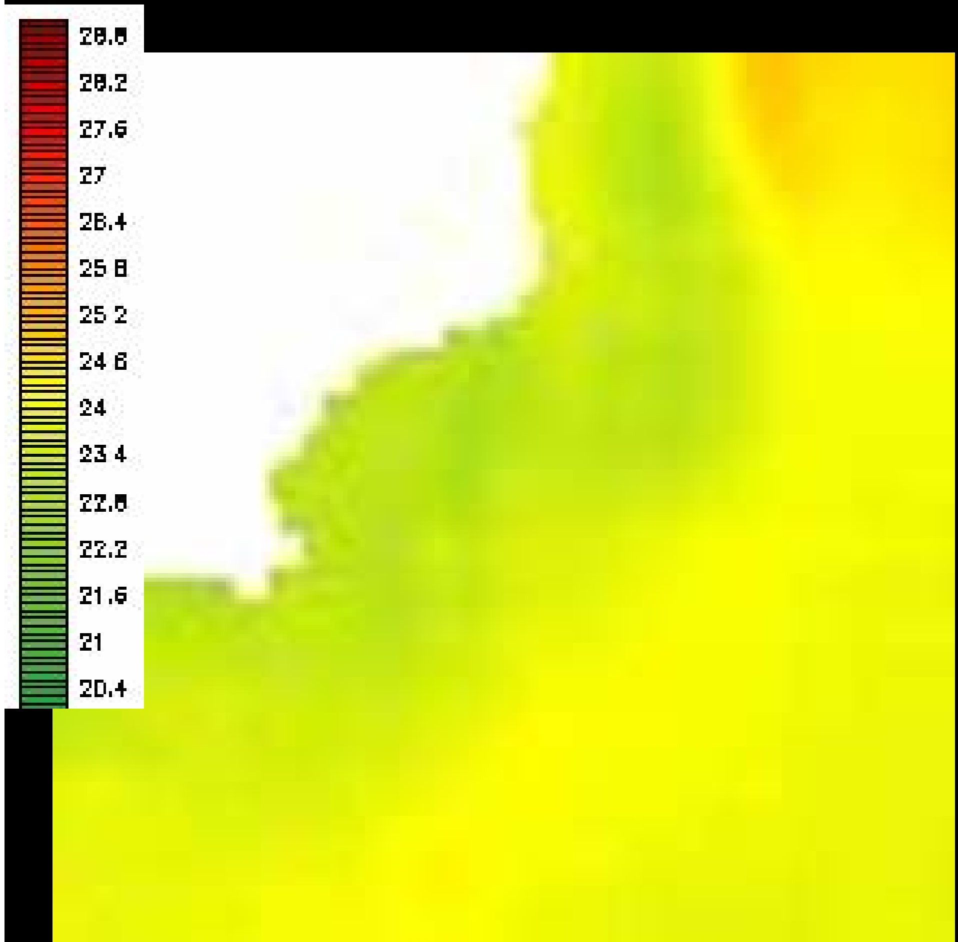
$$\Delta\sigma_0 = \left(\frac{\sqrt{(du/dx)^2 + (dv/dx)^2}}{\beta_r} \right) \cos(\phi - \psi)\, g(\phi, \phi_W)$$

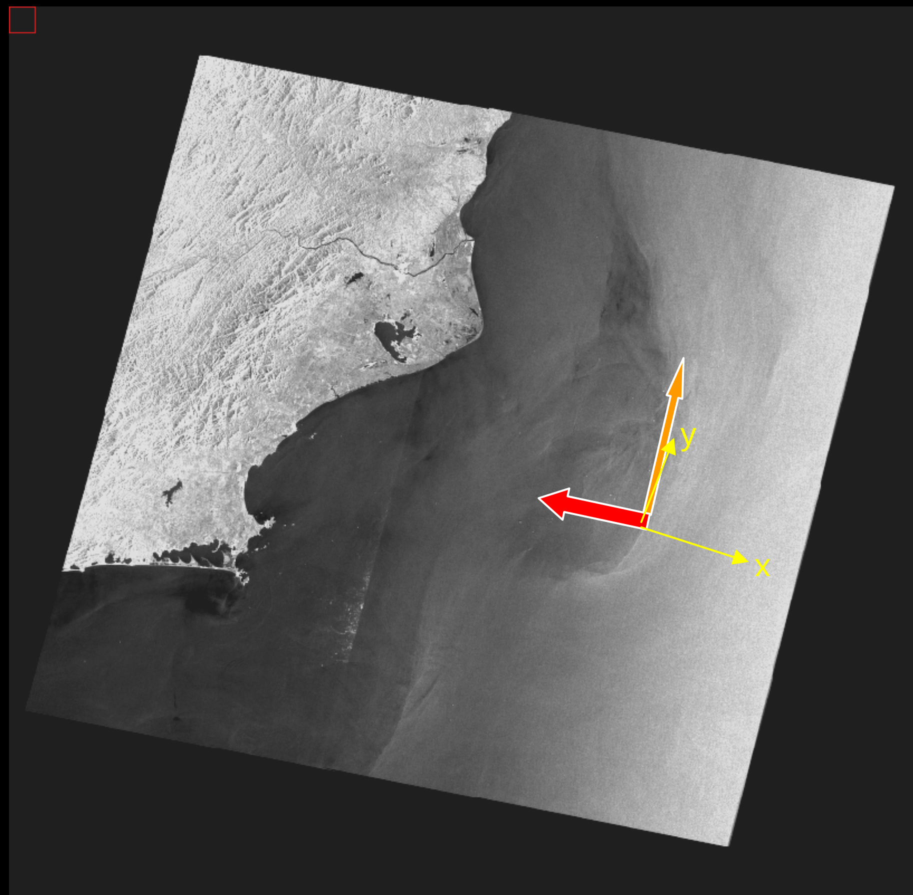
Where, Φ is the SAR look angle relative to the orientation of the front, and Ψ is parameter measuring the relative strength of shear versus convergence. β_r is the wave spectrum relaxation rate.

Function g depends on wind direction, ratio of group to phase velocity of short waves, p and n parameters that control wave spectrum falloff in k and azimuth.

GHRSST – Nov. 21, 2005

Radarsat-1 ScanSAR Nov. 21, 2005





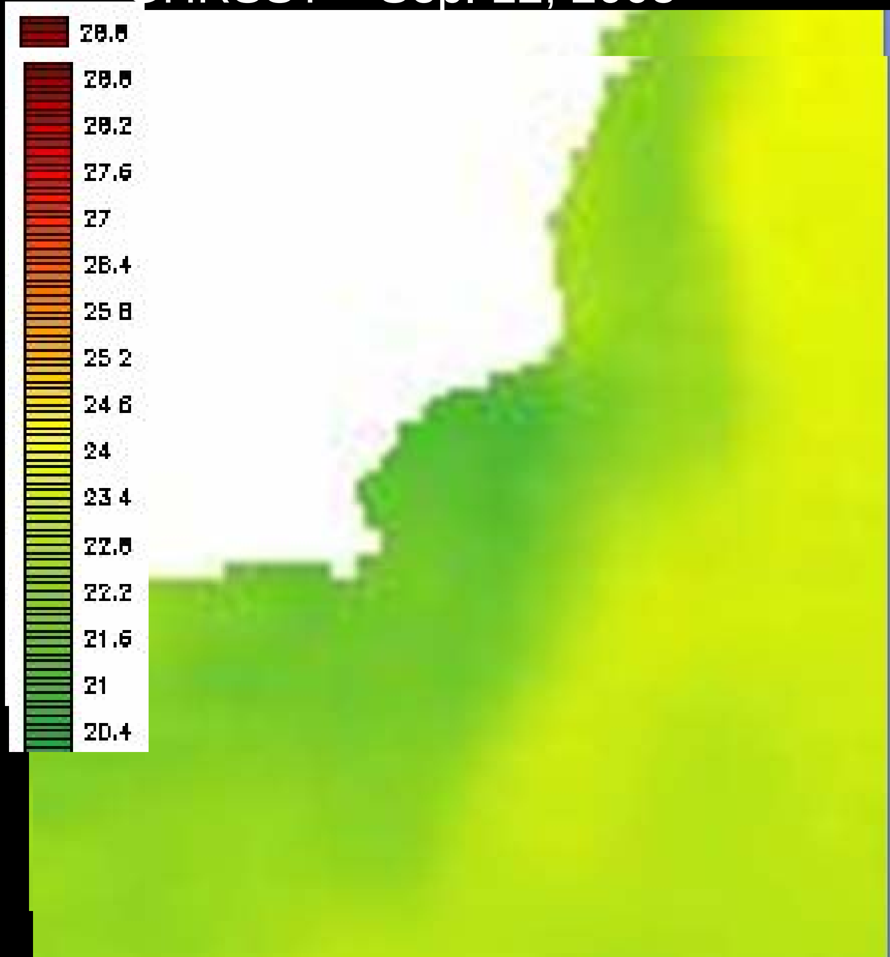
$$\phi_W = 95^0; \phi_R = 185^0; x_{rot} = -10^0$$

SAR look direction

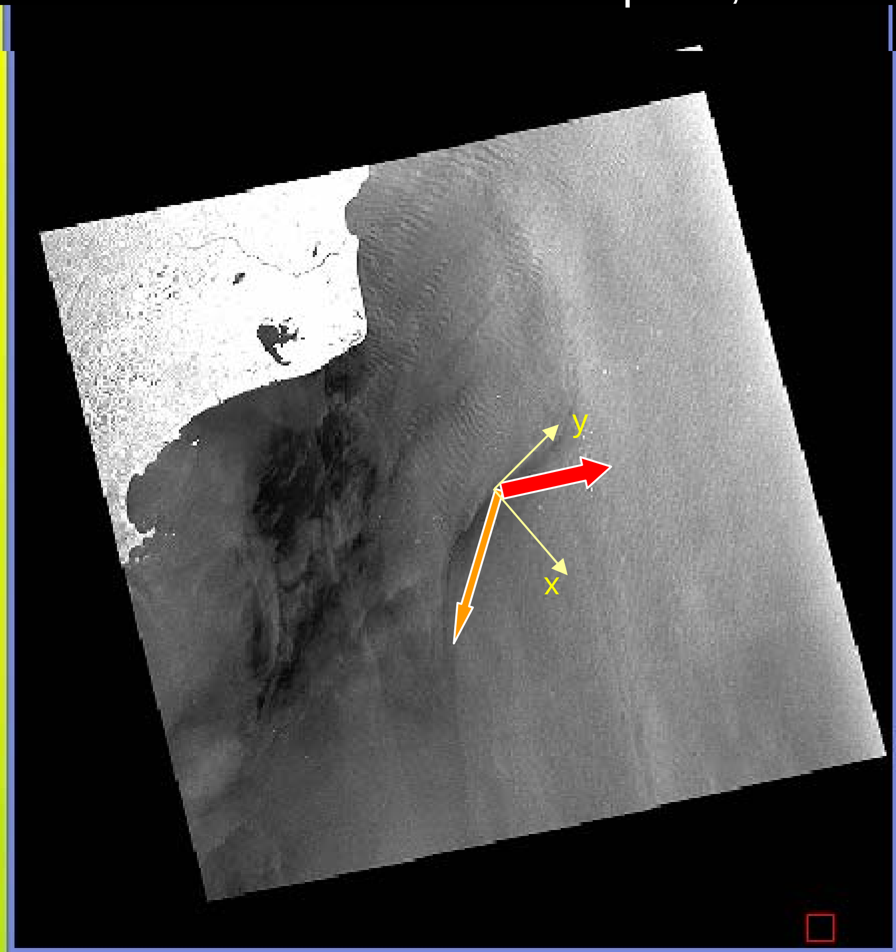
wind direction

$$\frac{\sigma_f - \sigma_0}{\sigma_0} < 0 (> 0) \;\; for \; \frac{\partial u}{\partial x} > 0 (< 0)$$

GHRSST – Sep. 12, 2005



Radarsat-1 ScanSAR Sep. 12, 2005



SAR look direction

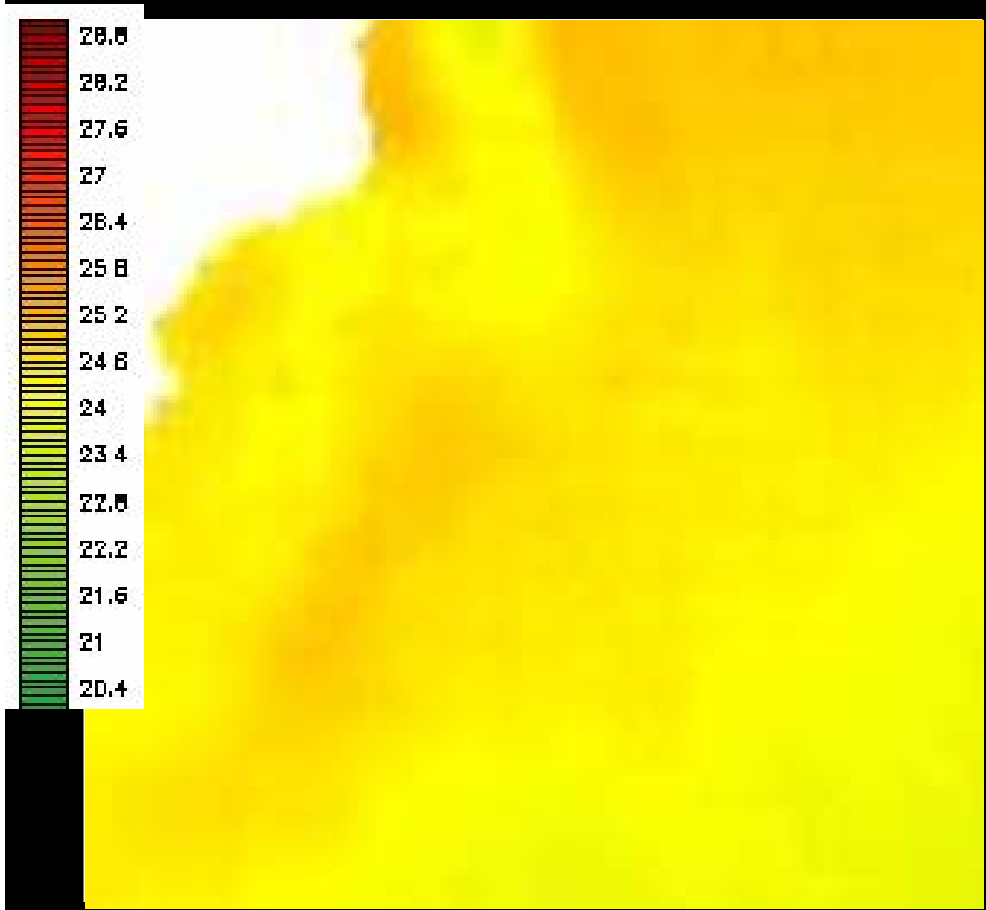
wind direction

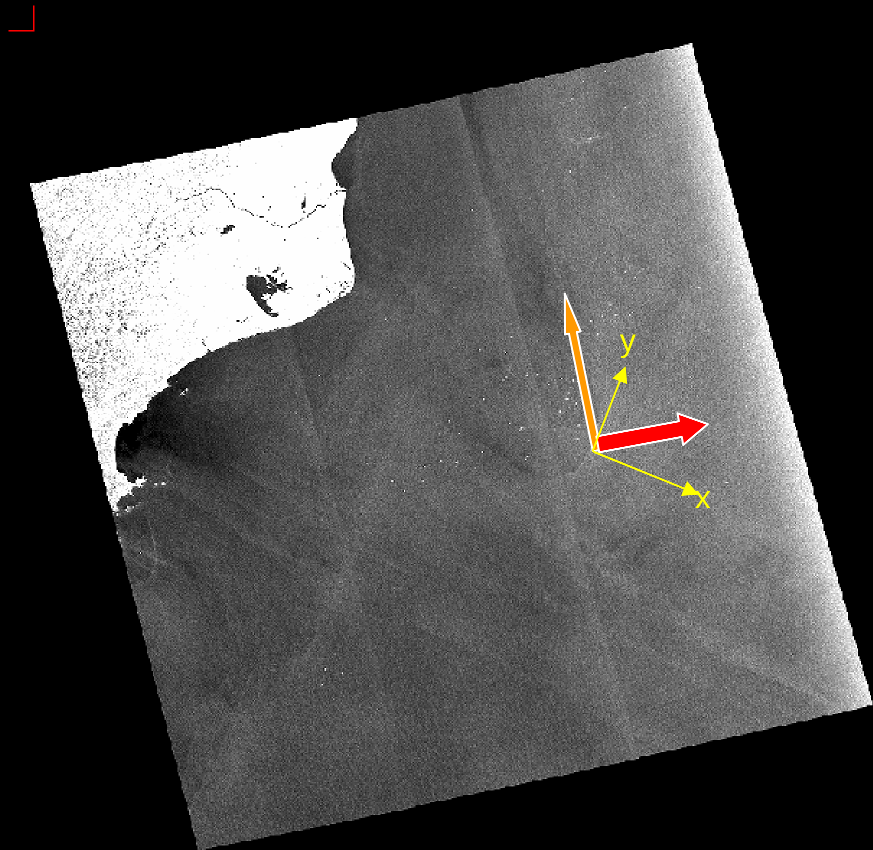
$$\phi_w = 300^0; \phi_r = 68^0; x_{rot} = -60^0$$

$$\frac{\sigma_f - \sigma_0}{\sigma_0} < 0\,(>0) \quad for\ \frac{\partial u}{\partial x} > 0\,(<0)$$

GHRSST – Oct. 30, 2005

Radarsat-1 ScanSAR Oct. 30, 2005





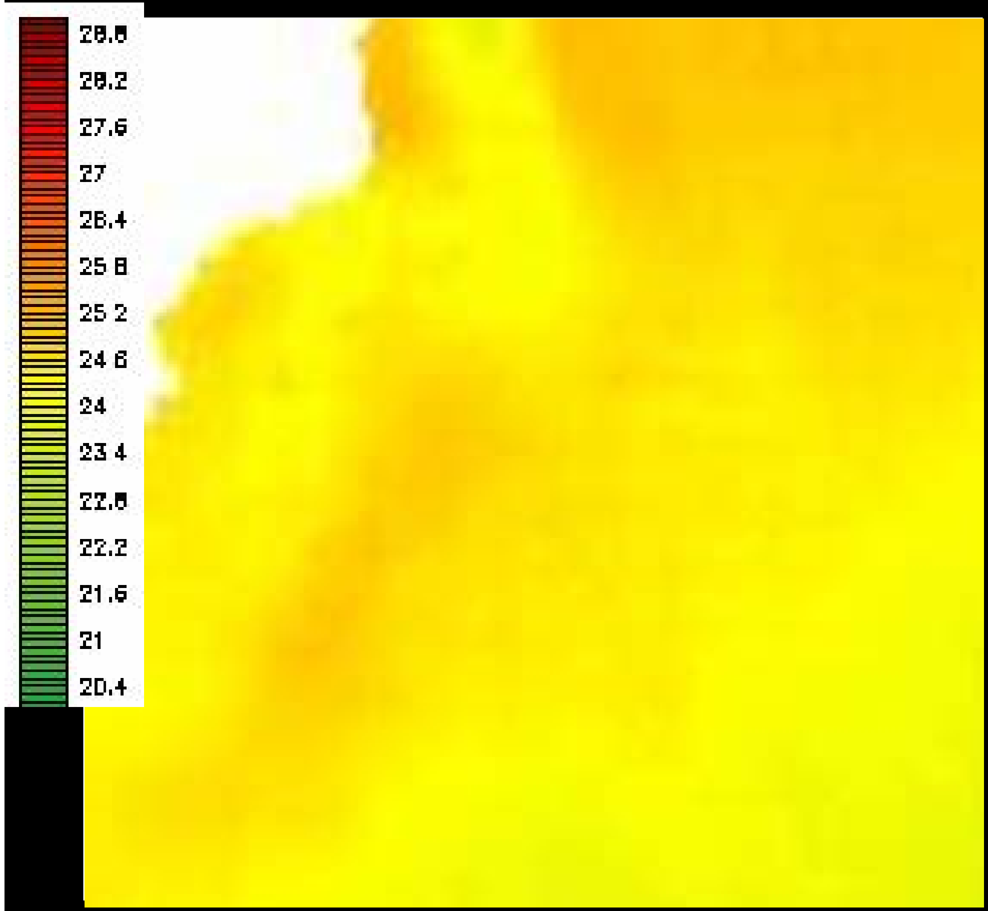
SAR look direction

wind direction

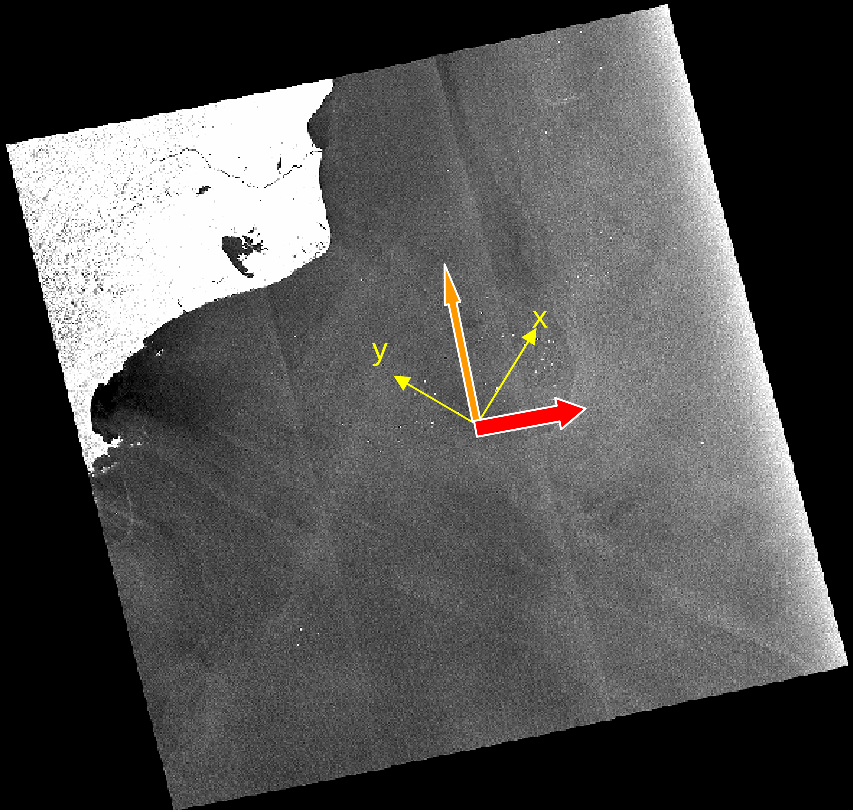
$$\phi_W = 128^0; \phi_R = 38^0; x_{rot} = -30^0$$

$$\frac{\sigma_f - \sigma_0}{\sigma_0} < 0 (> 0) \;\; for \; \frac{\partial u}{\partial x} > 0 (< 0)$$

GHRSST – Oct. 30, 2005



Radarsat-1 ScanSAR Oct. 30, 2005



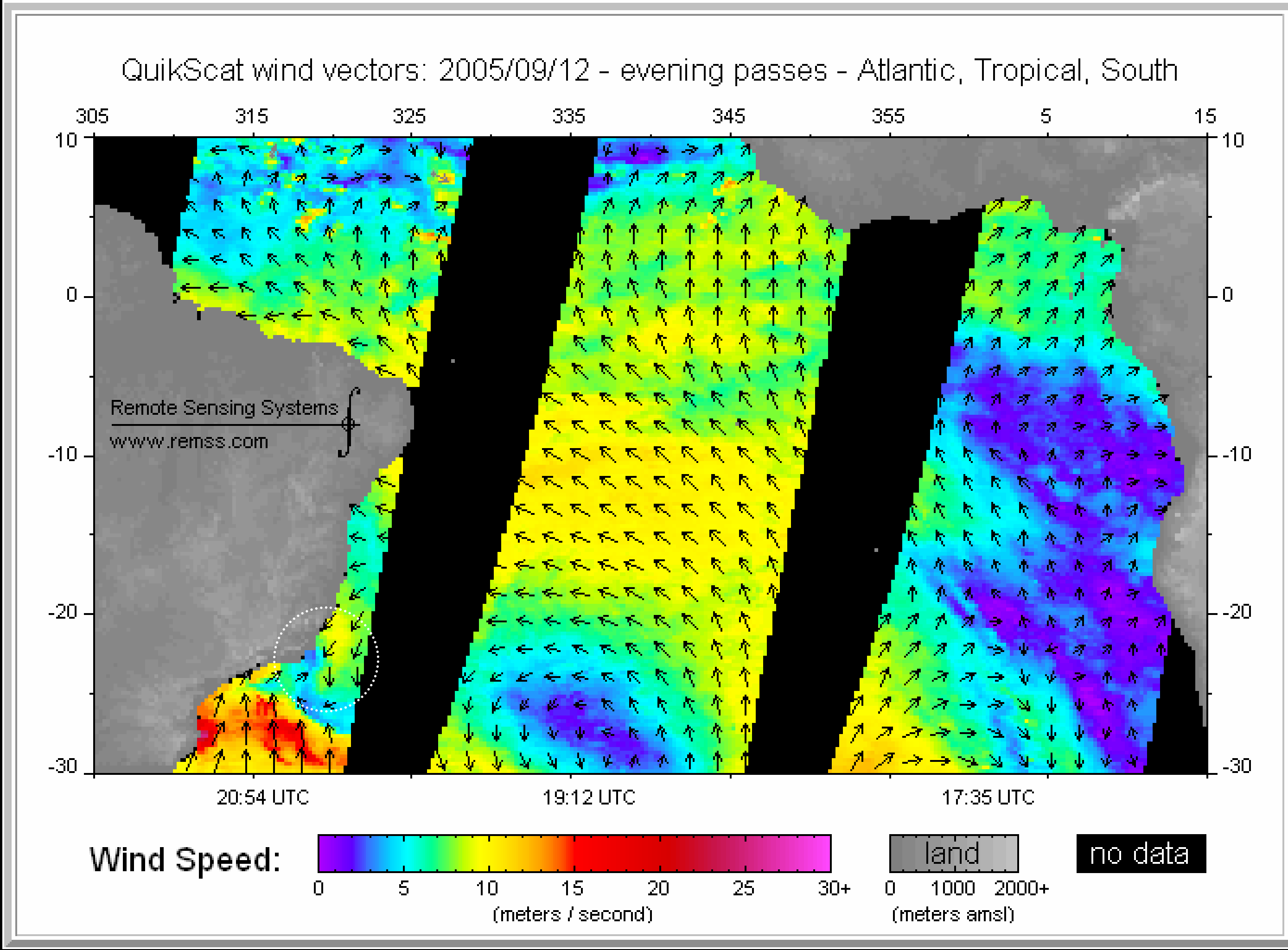
$\phi_W = 45^0; \phi_R = -45^0; x_{rot} = 50^0$

$\frac{\sigma_f - \sigma_0}{\sigma_0} < 0 (> 0) \;\; for \frac{\partial u}{\partial x} < 0 (> 0)$

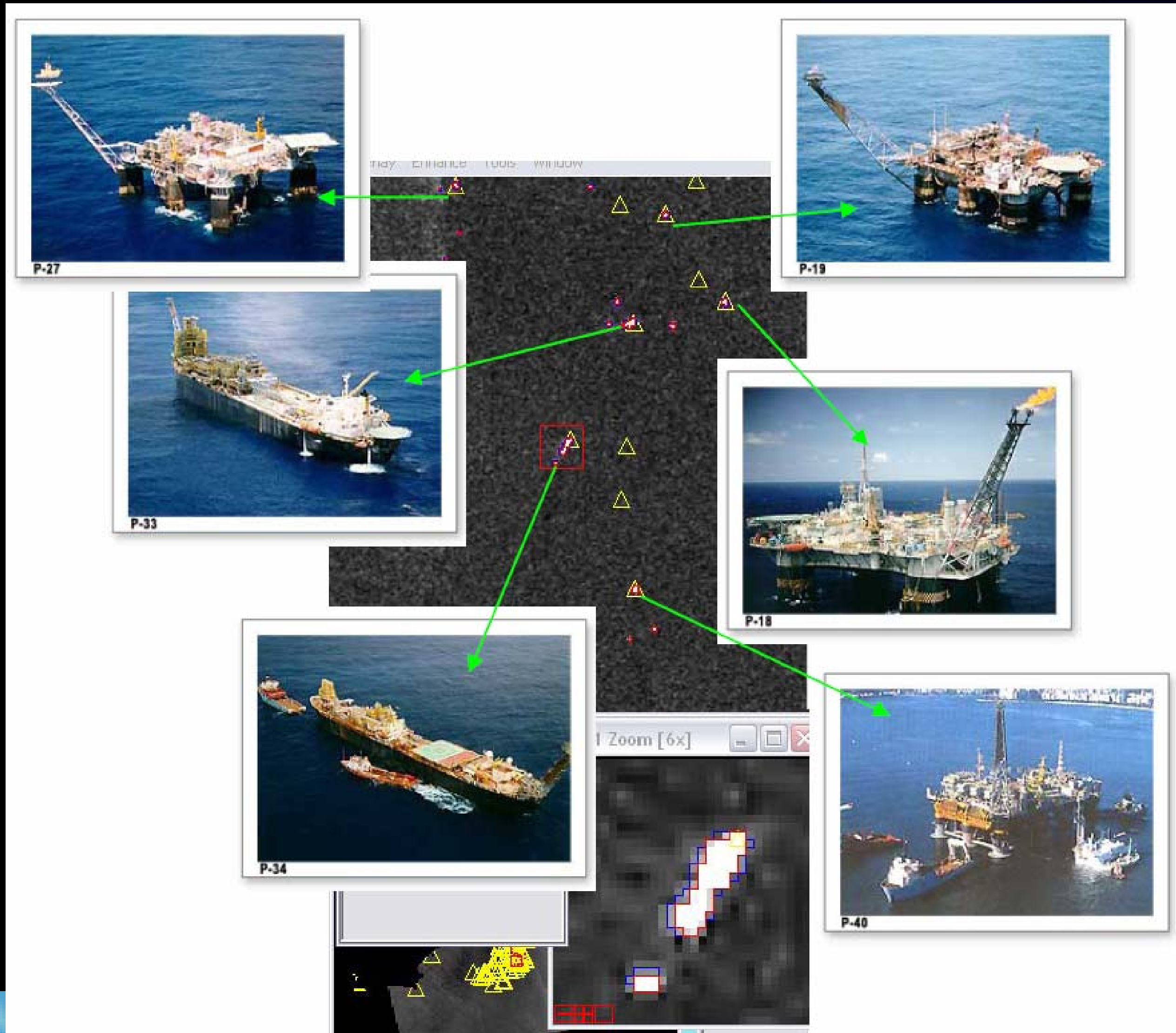
Conclusions

- ✓ SAR images can be used at Campos Basin for locating BC inshore frontal zone (not always but about 30-40% of the time). This would be particularly crucial during episodes of heavy or persistent cloud cover;
- ✓ Both, short wave-current gradients interaction or MBL stability modulation seem to be at play in making the frontal zone visible in the SAR images of the region;
- ✓ An implementation and better validation of a radar imaging model such as Lyzenga (1991), Johannessen et al. (1996), Romeiser et al. (1997), Kudryavtsev et al. (2005) could provide information about flow kinematics and MBL dynamics at the frontal zone;
- ✓ Johannessen et al. (1996) model used for presented SAR images produced very weak NRCS modulations at BC front;
- ✓ The use of SAR images for frontal extraction in the context of a modelling effort such as the FORM for a better initialization of a regional ocean model for the region seems promising methodology and is being investigated at moment.

THANKS



Remote Sensing Systems
www.remss.com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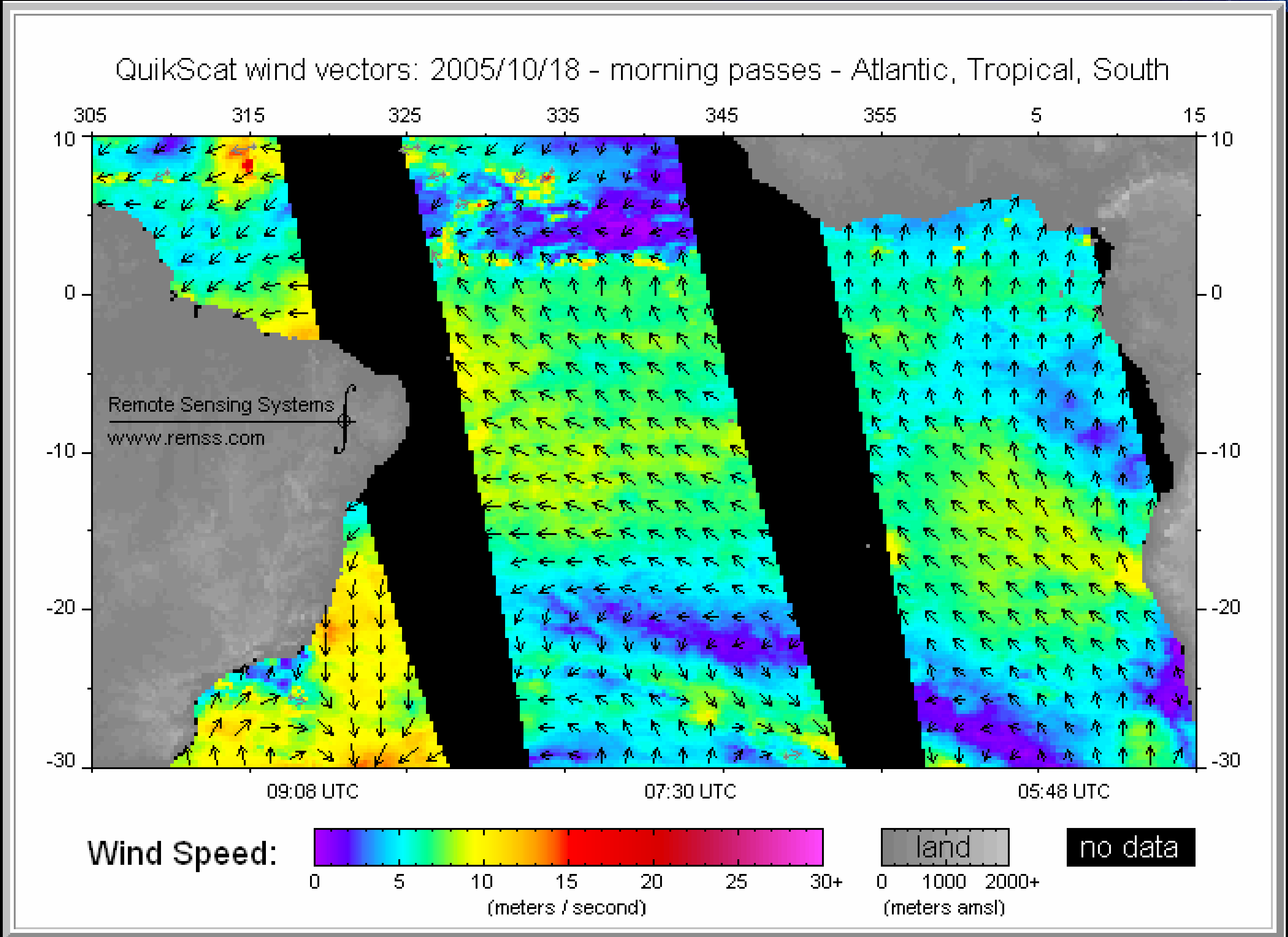

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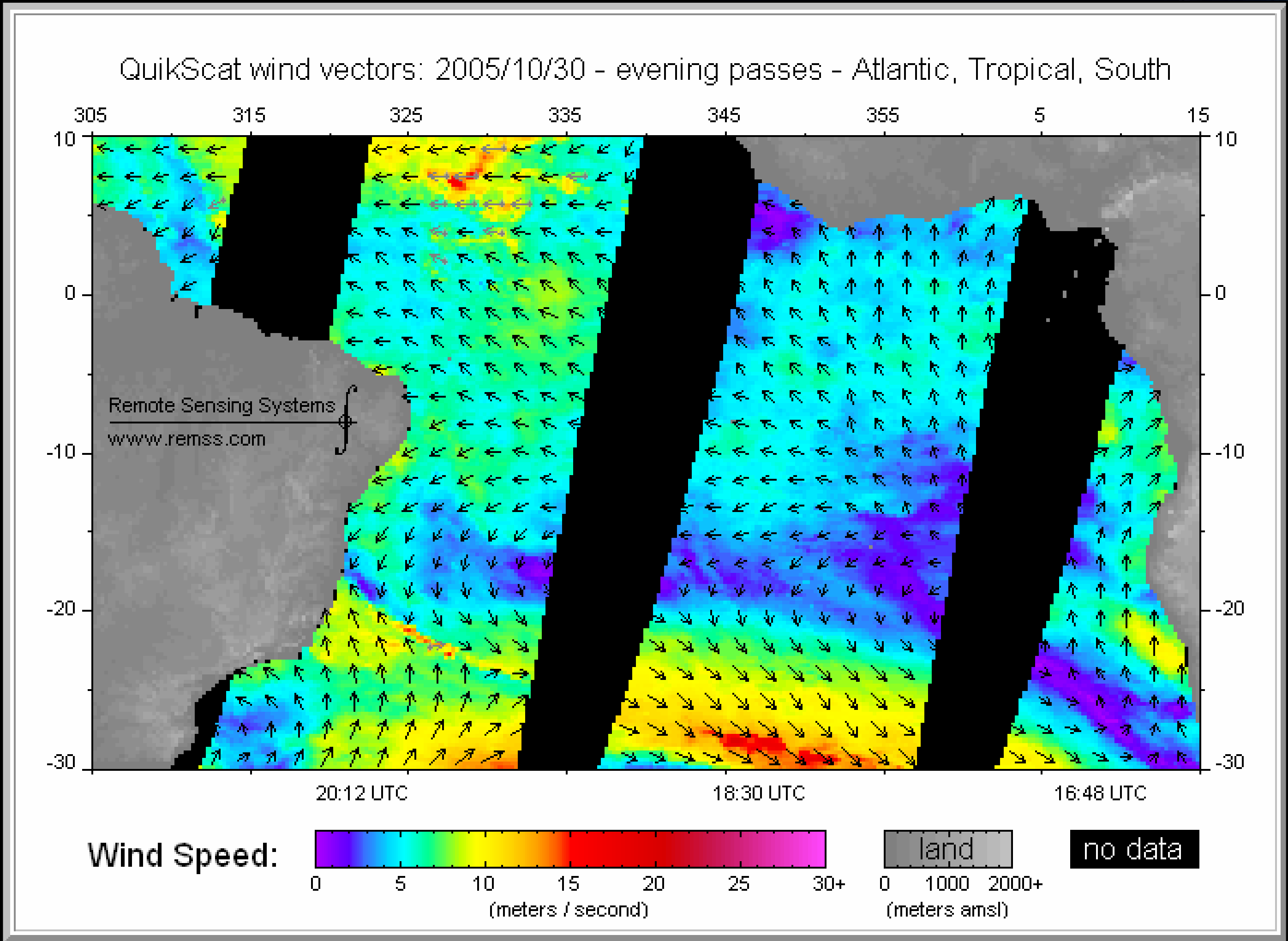
QuikScat wind vectors: 2005/10/30 - evening passes - Atlantic, Tropical, South
305
315
325
335
345
355
5
15
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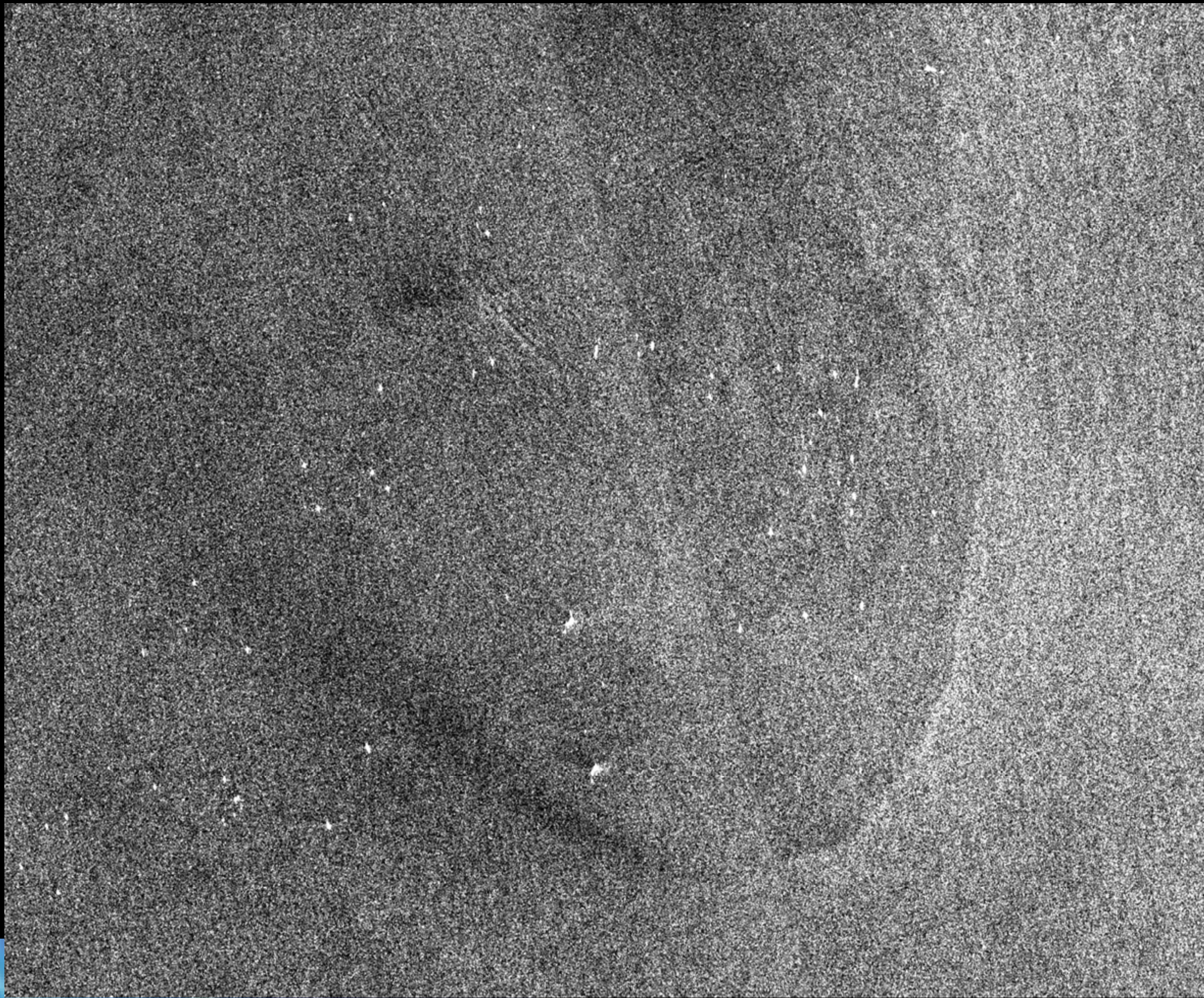
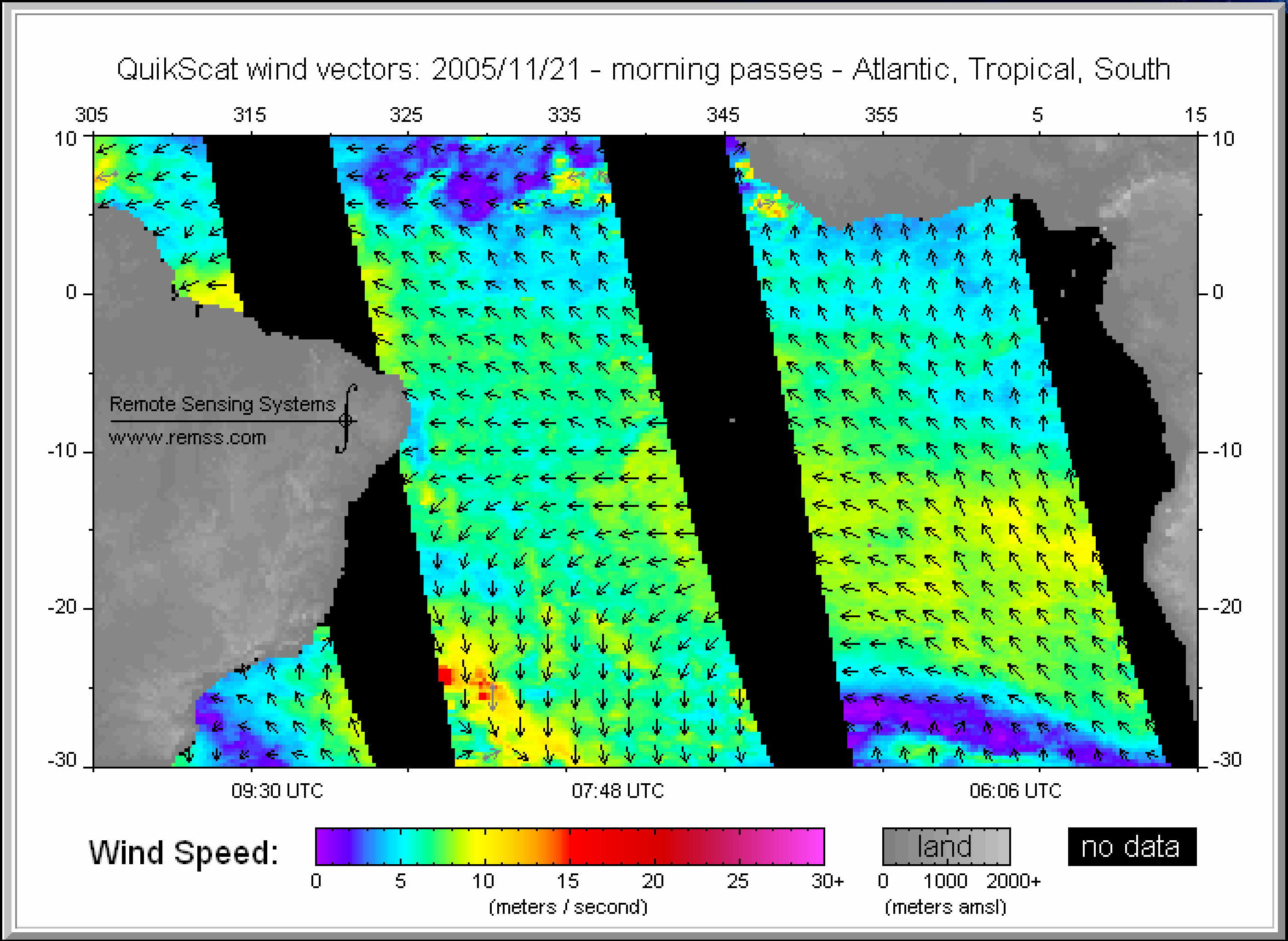
0
-10
-20
-30
Remote Sensing Systems
www.remss.com
20:12 UTC
18:30 UTC
16:48 UTC
Wind Speed:
0 5 10 15 20 25 30+
(meters / second)
land
0 1000 2000+
(meters amsl)
no data




QuikScat wind vectors: 2005/11/21 - morning passes - Atlantic, Tropical, South
305
315
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345
355
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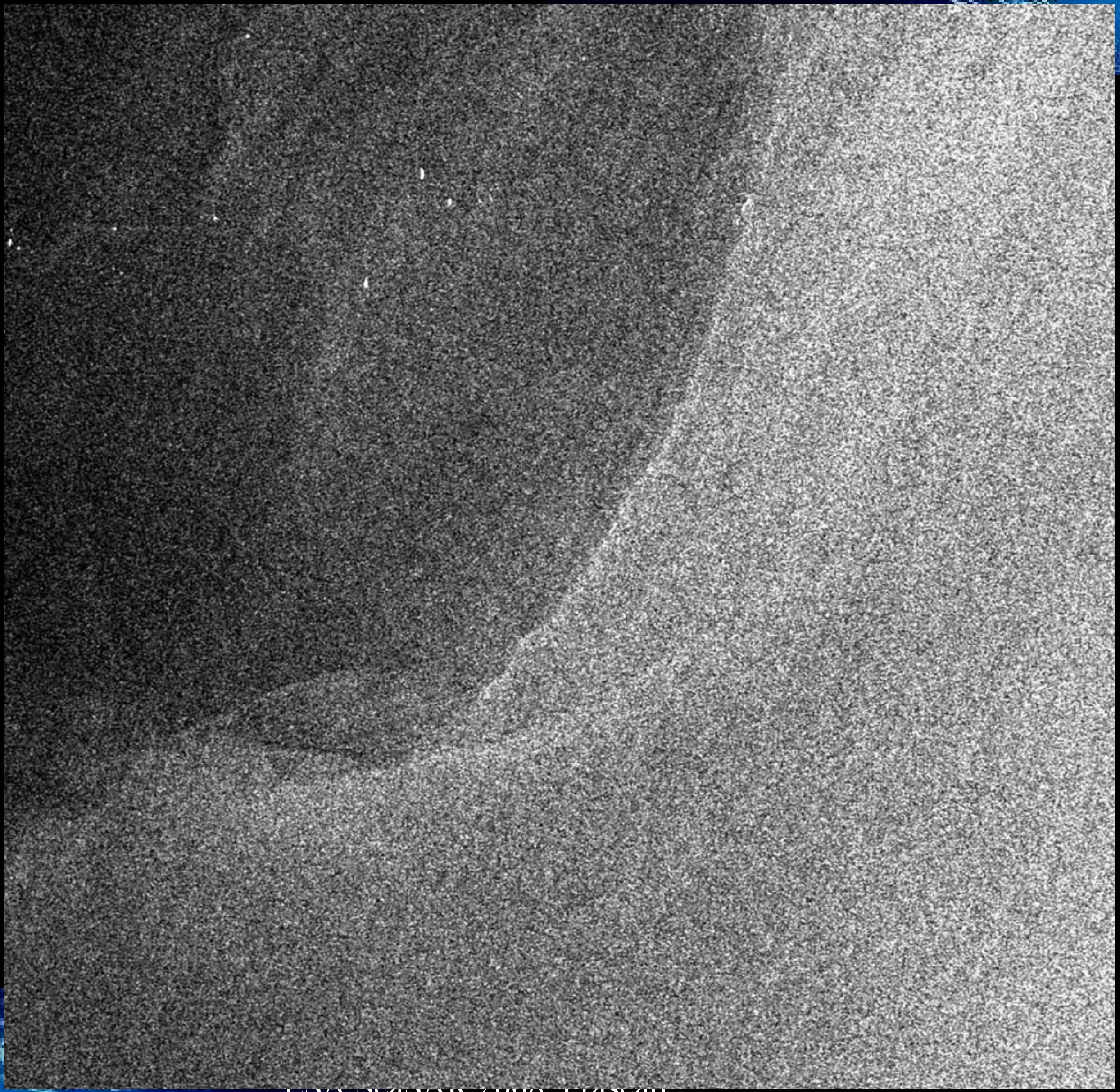
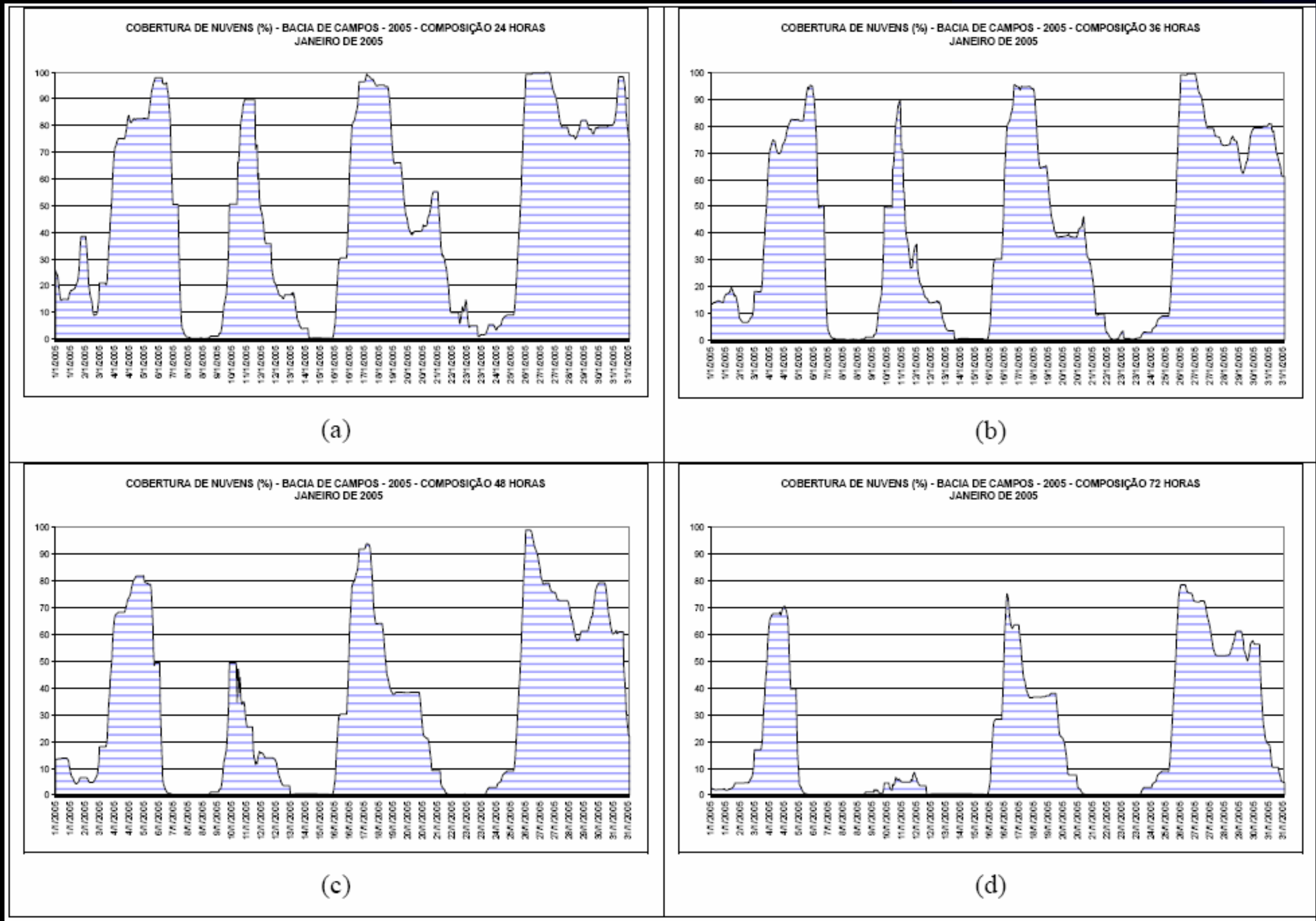
10
0
-10
-20
-30
Remote Sensing Systems
www.remss.com
09:30 UTC
07:48 UTC
06:06 UTC
Wind Speed:
0
5
10
15
20
25
30+
(meters / second)
land
0
1000
2000+
(meters amsl)
no data





Percent of cloud cover at Campos Basin for time compositing of GOES IR images: a) 24 h; b)48 h; c) 36 h and d) 72 h. January 2005.

South Atlantic Convergence Zone (SACZ) – Jan. 18, 2005