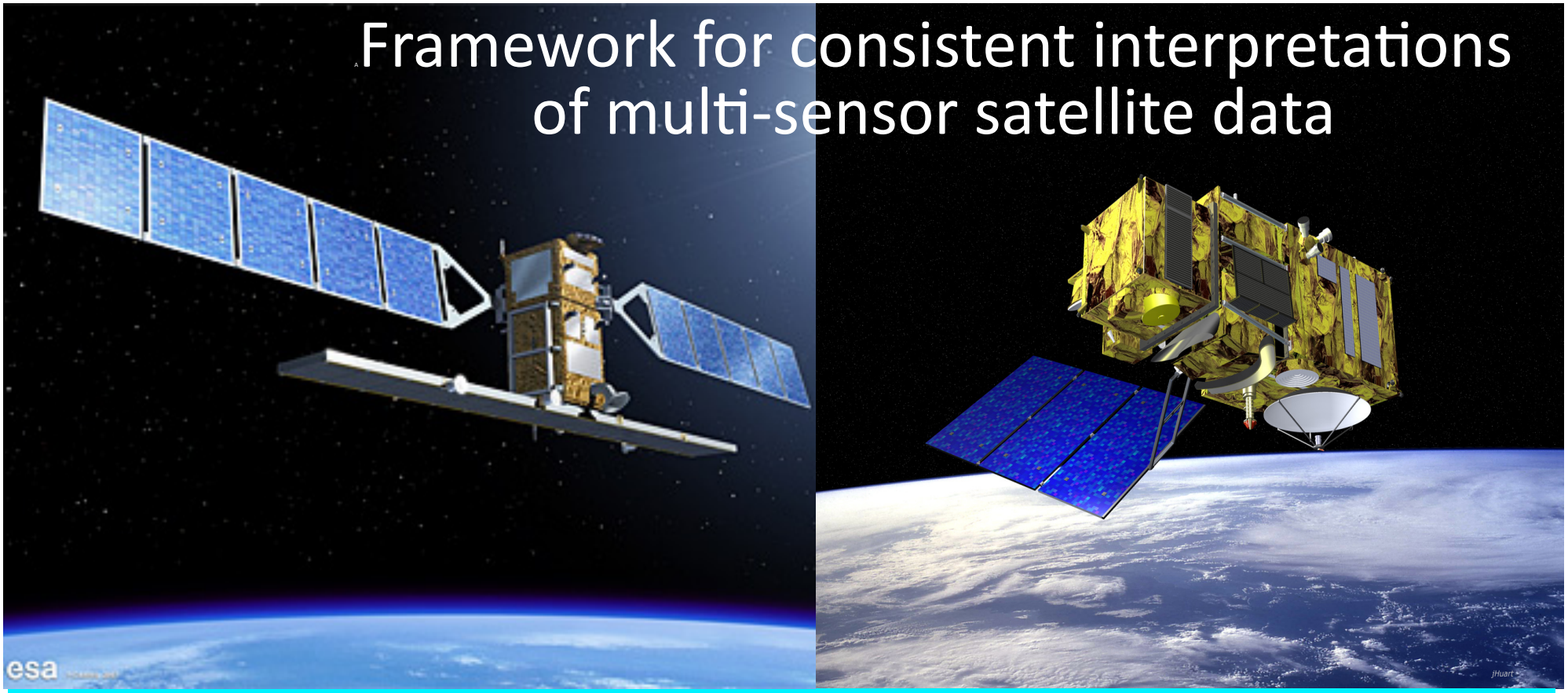
Ocean Prediction Networking



J.A.Johannessen, B. Chapron, F. Collard, and V. Kudryavtsev

OPNet Final Seminar, met.no, Oslo, 11-12 May 2011.

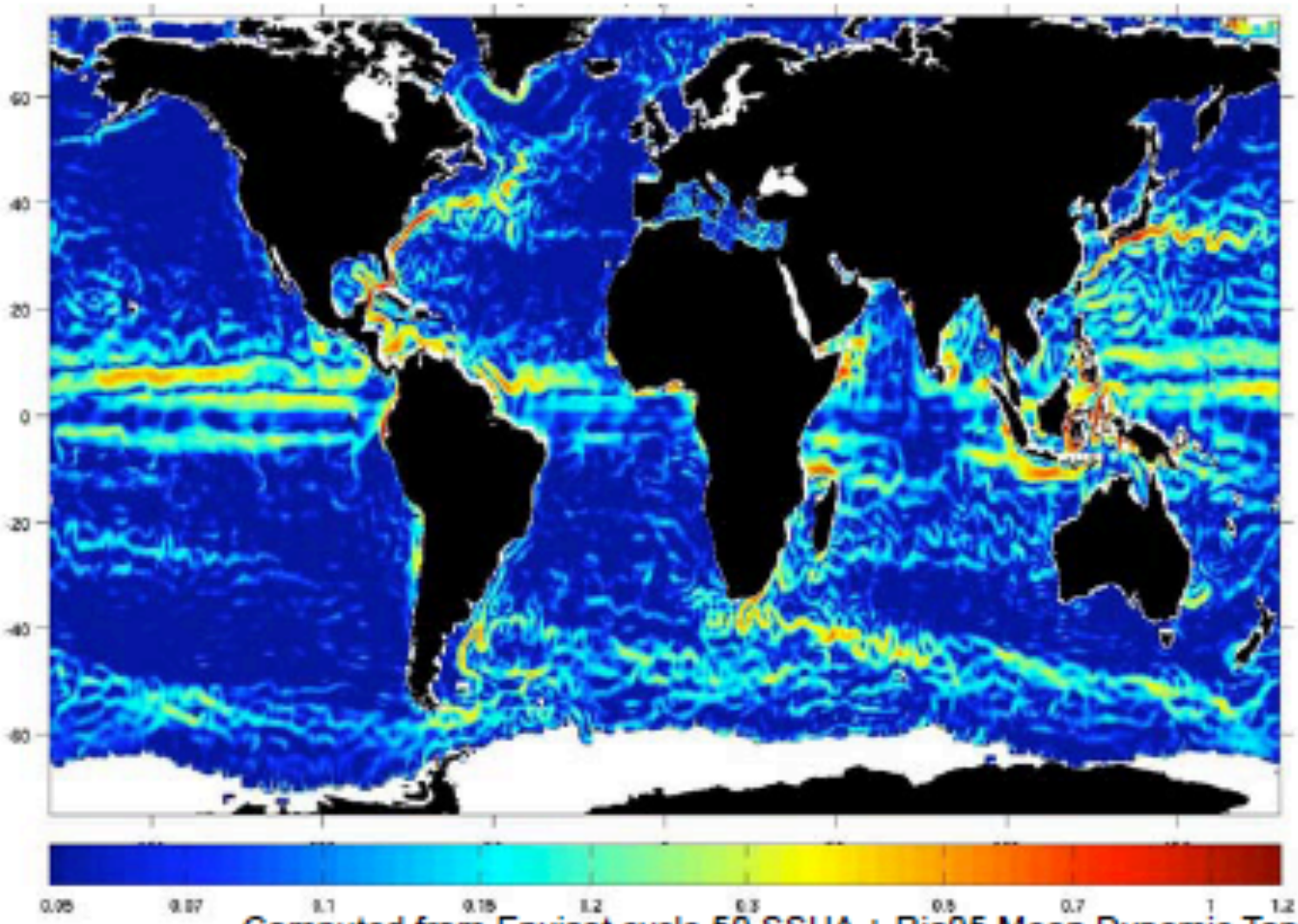
Ocean Prediction Networking

Challenges in Ocean Prediction

- Motions at sub-mesoscale to mesoscale scales (order 100 m to 10´s km) are key ingredients of the upper ocean dynamics. It also interact with dynamics at scales > 100 -200 km.
- Poorly sampled with in-situ observing systems
- The accuracy of high resolution (~ 5-10 km) model simulations of upper ocean dynamics is not adequately assessed and validated.
- 2D surface expressions in satellite data is a mixture of horizontal motions and vertical motions.
- We need to create a framework for connecting the 2D expression with upper layer 3D mesoscale to submesoscale ocean dynamics.

Ocean Prediction Networking

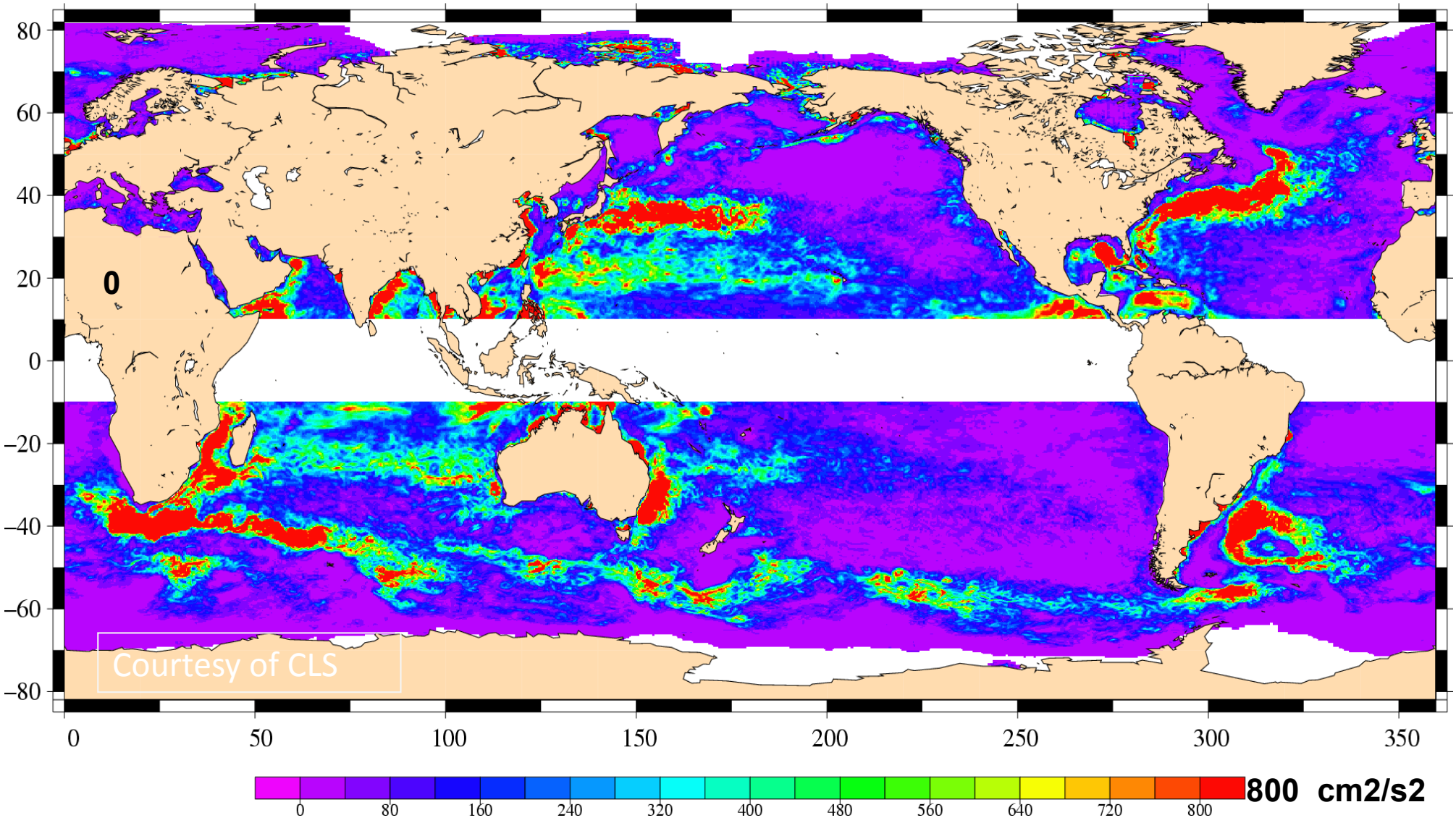
Major Global Current Fronts



Computed from Envisat cycle 50 SSHA + Rio05 Mean Dynamic Topography

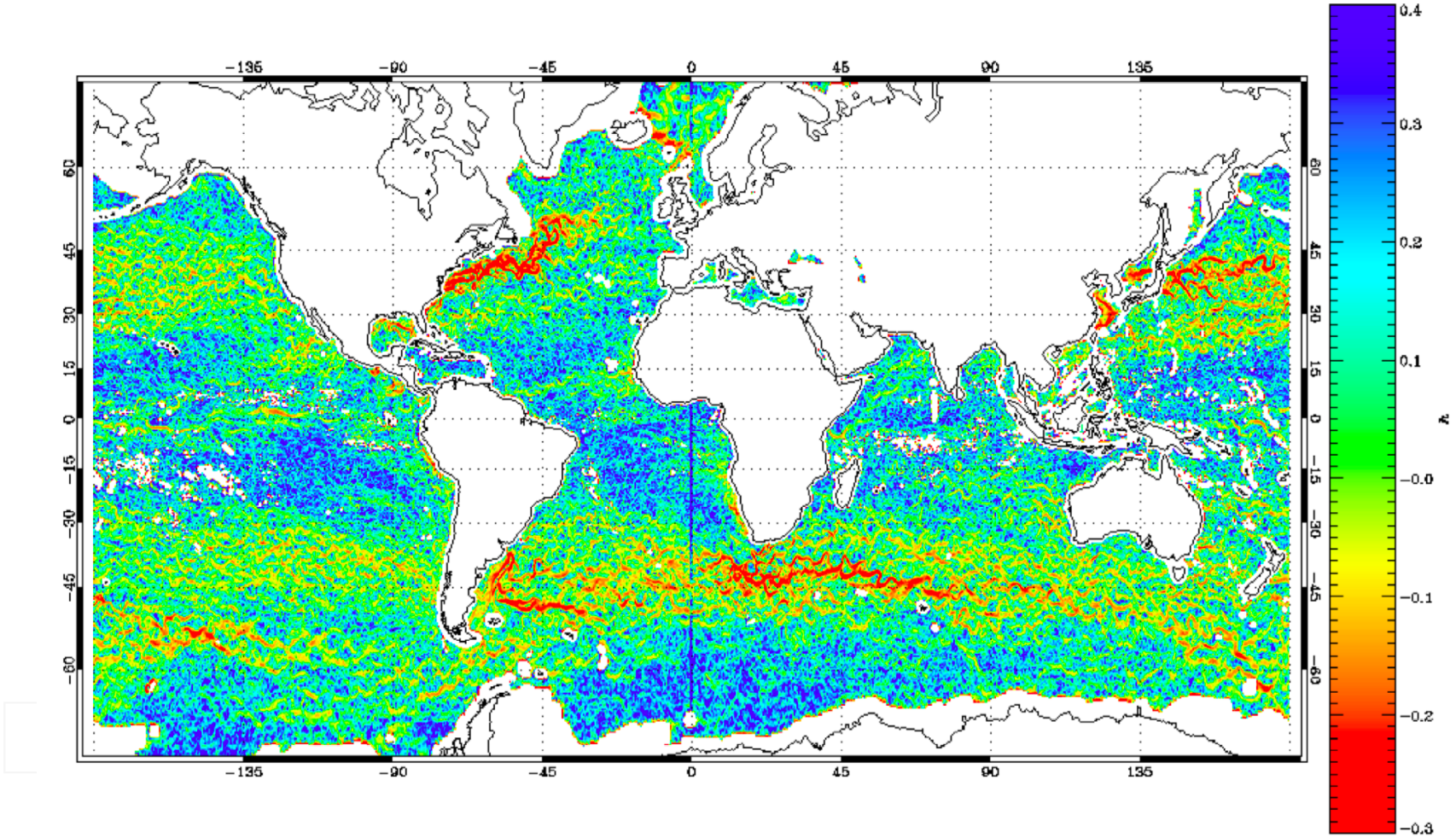
Ocean Prediction Networking

EKE - IMPORTANCE OF MAPPING FREQUENCY AND COVERAGE (4 ALT) – SCALE > 100 KM



Ocean Prediction Networking

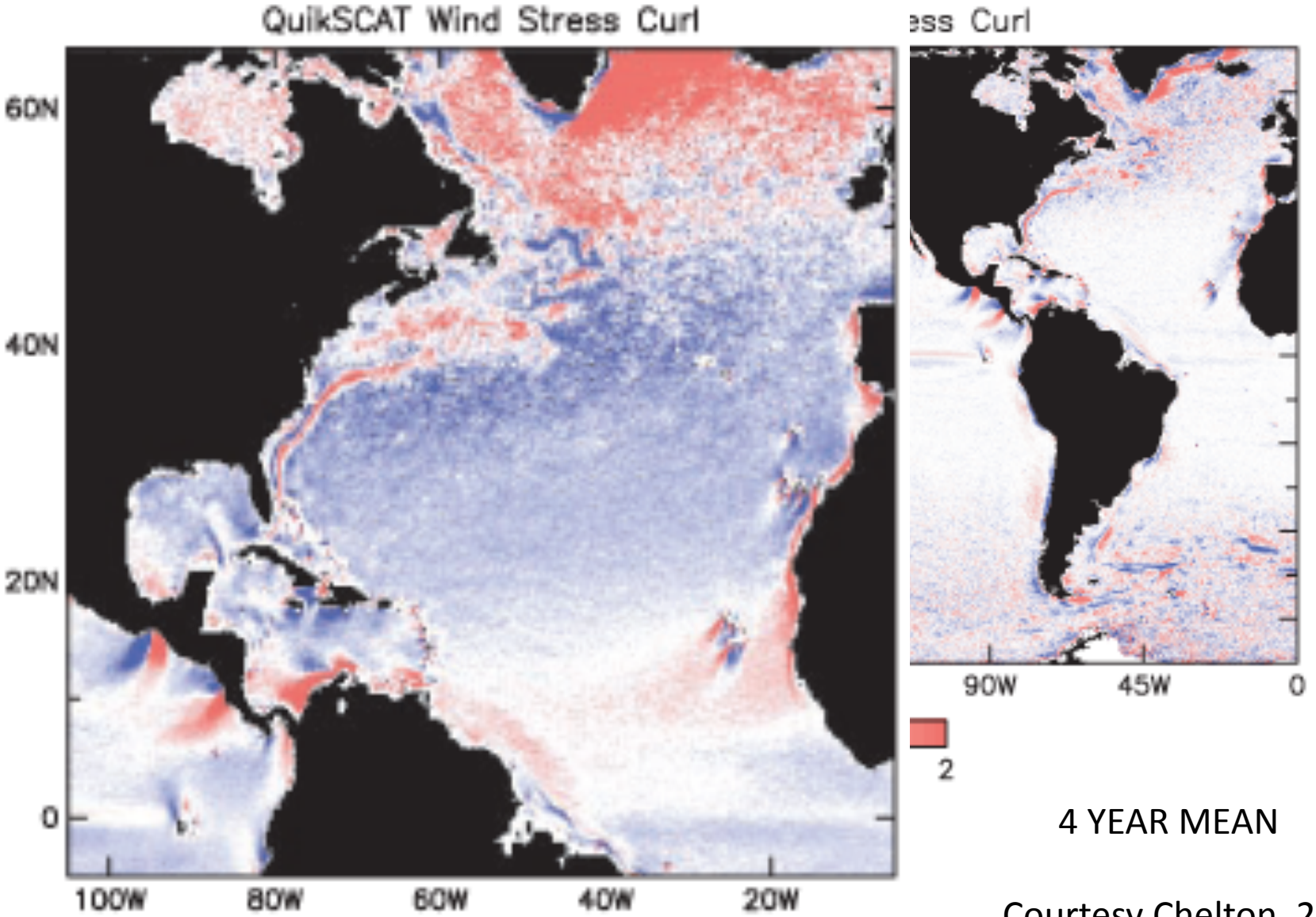
LINKS BETWEEN EKE AND SST GRADIENTS (SCALE > 100 KM)



Courtesy Turiel et al

Ocean Prediction Networking

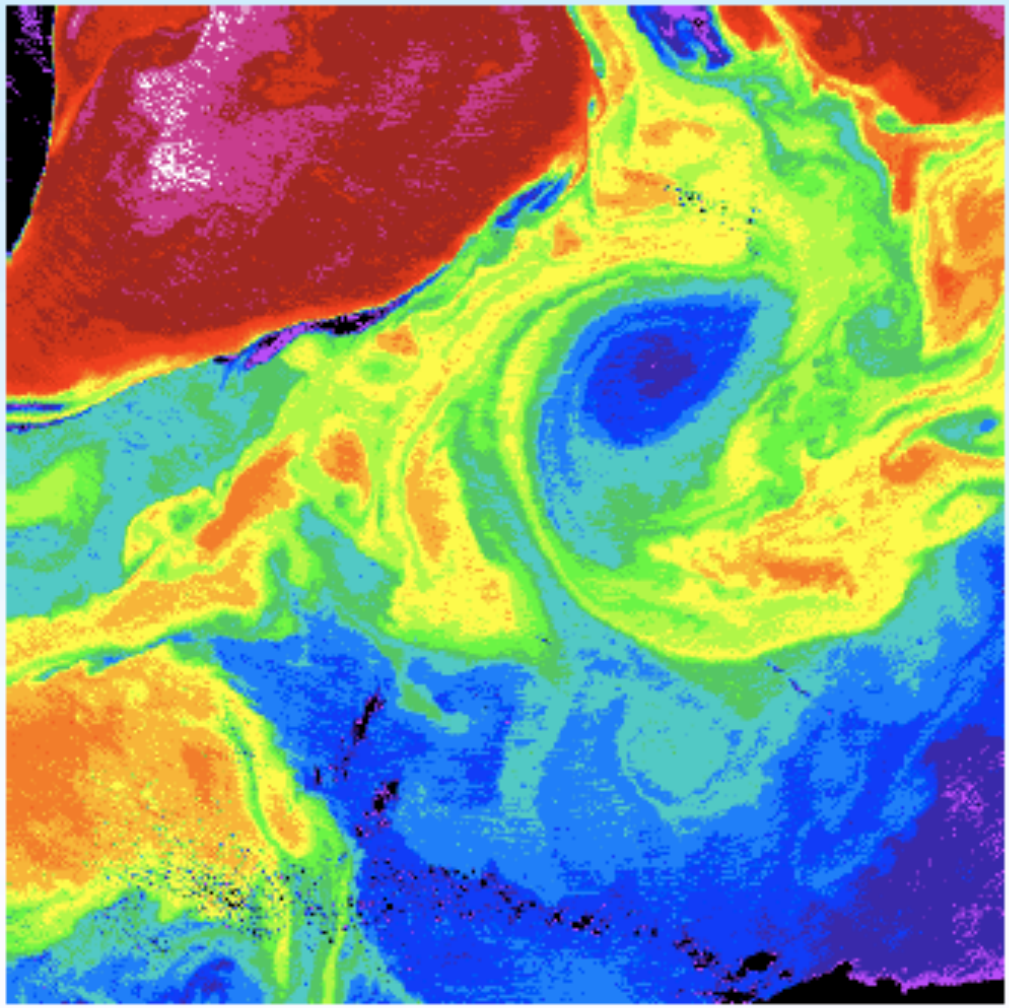
LINKS BETWEEN WIND STRESS CURL AND BIG CURRENT FRONT (SCALE > 100 KM)



4 YEAR MEAN

Courtesy Chelton, 2007

MESOSCALE VARIABILITY IN SST IMAGES (SCALES > 5 KM)



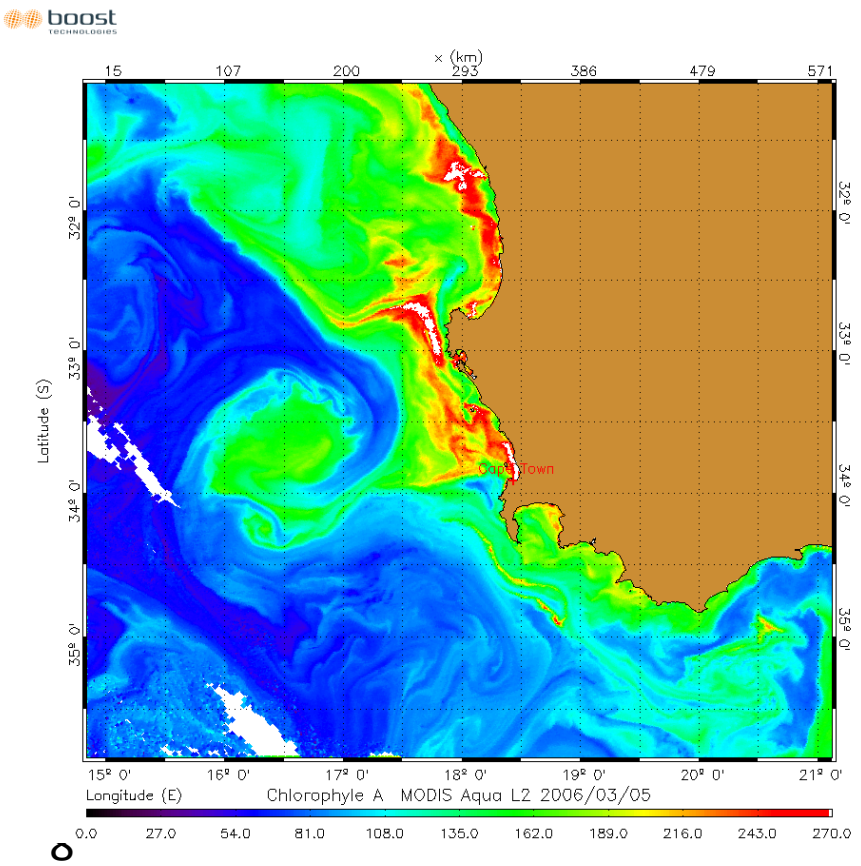
This ATSR image speaks for itself!

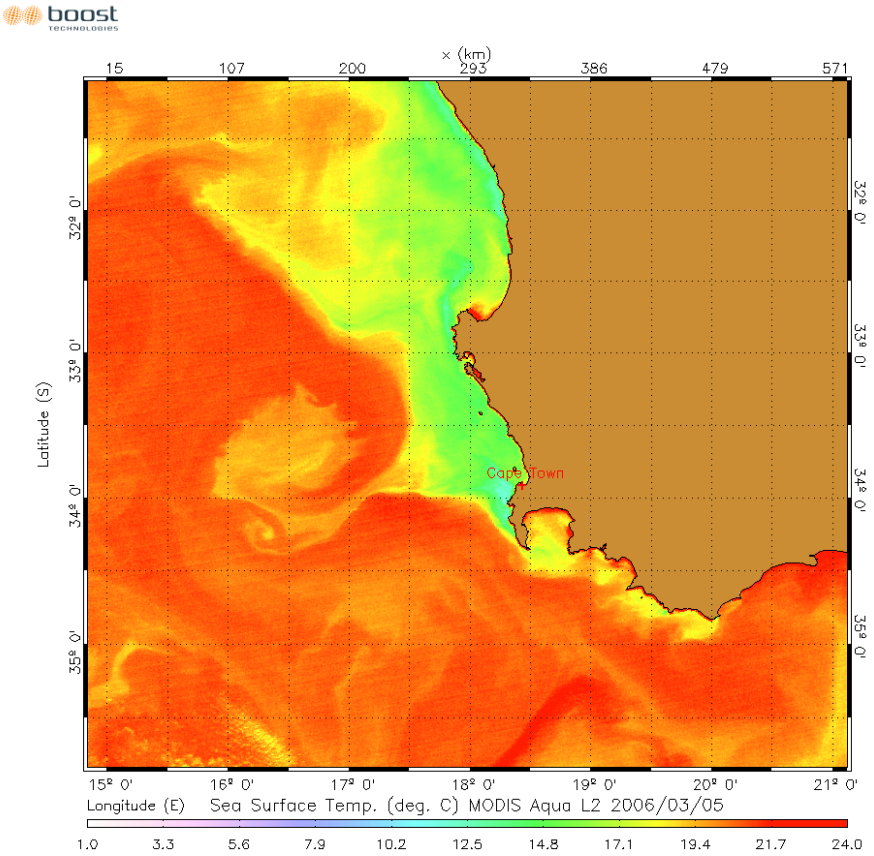
- A beautiful picture
- ¼ million precise temperature measurements
- Data source for a detailed oceanographic study of mesoscale variability

Llewellyn-Jones !

Chla-SST anti-corelation

- Vertical motion detector? (geostrophic circulation, spiraling eddy trapping, upwelling)

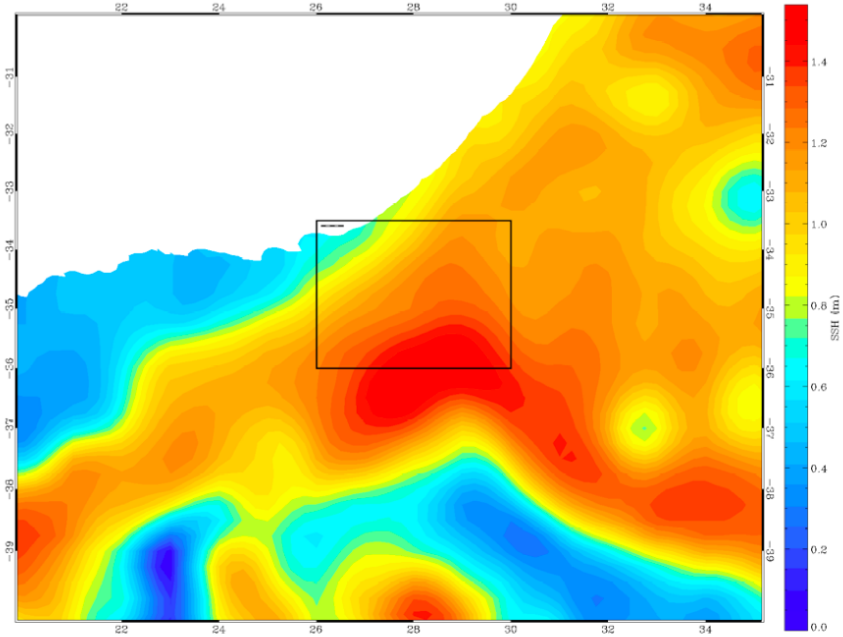




Ocean Prediction Networking

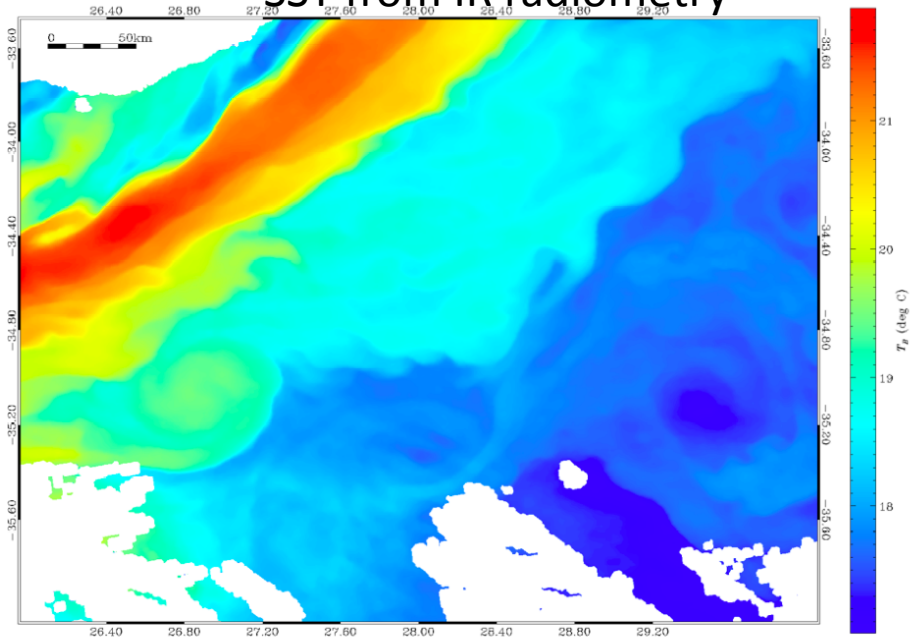
Supersite Agulhas Current: The mesoscale (single SST)

SSH from altimetry



SSH of the Agulhas Current regime from temporal and spatial integration of Altimeters. Resolution of about 100 km.

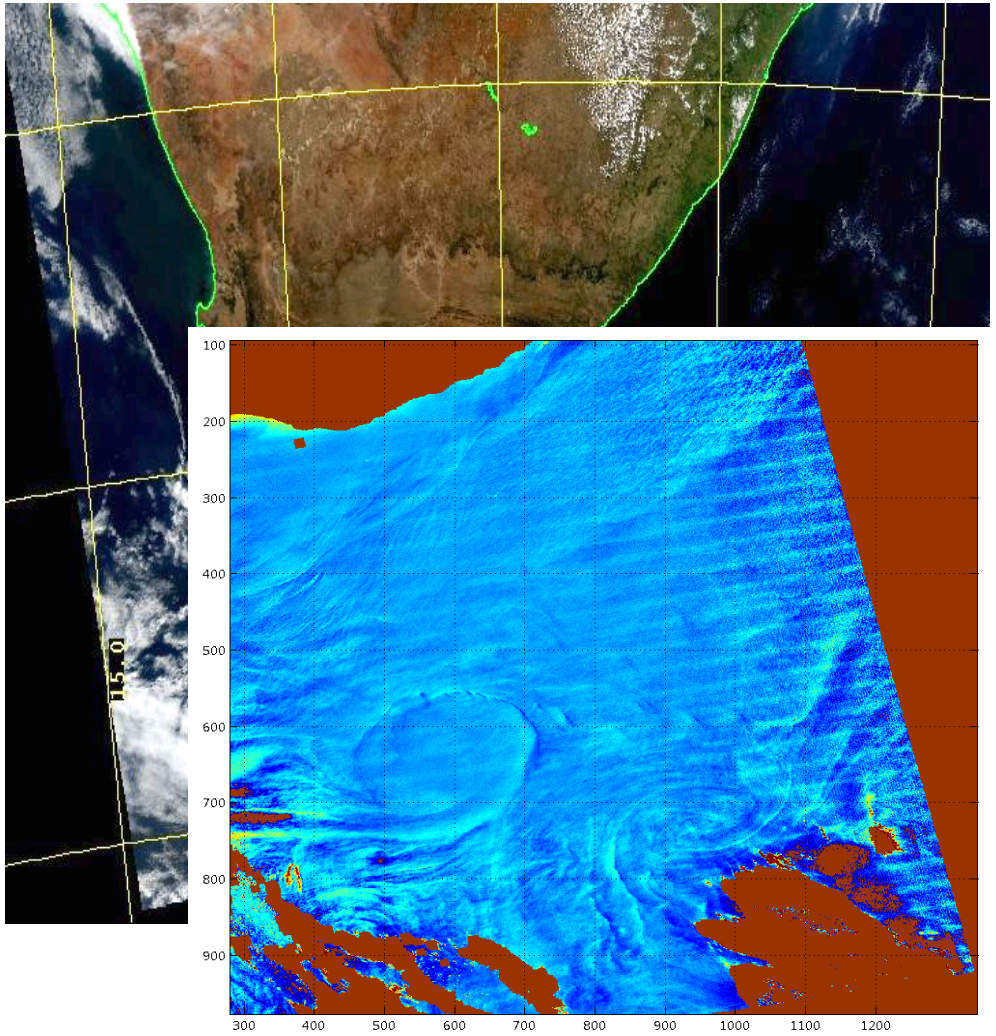
SST from IR radiometry



High resolution snap-shot SST field from the MODIS IR radiometer in the region marked with black box at a resolution of order km.

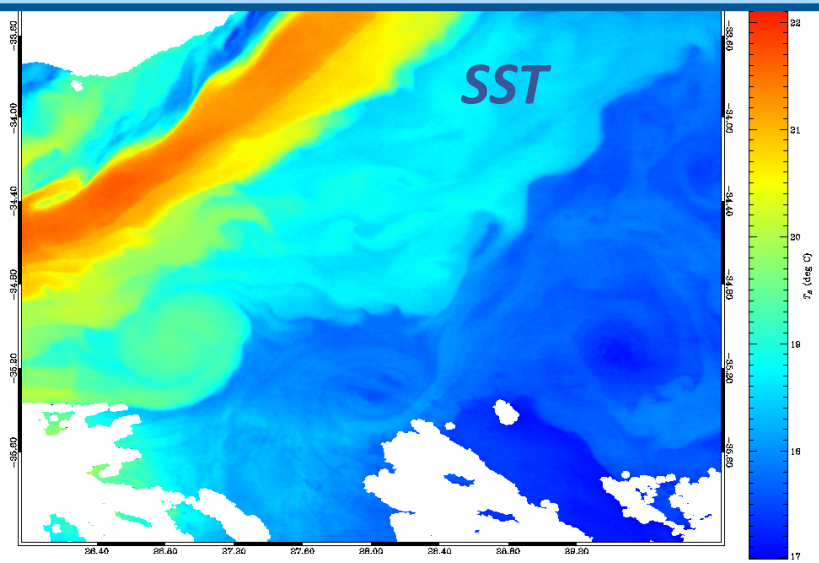
Ocean Prediction Networking

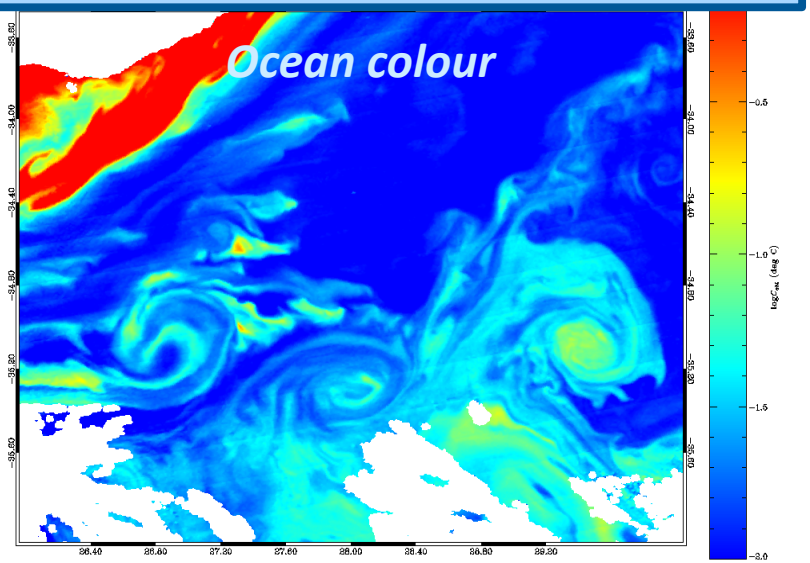
Taking advantage of the sunglint!

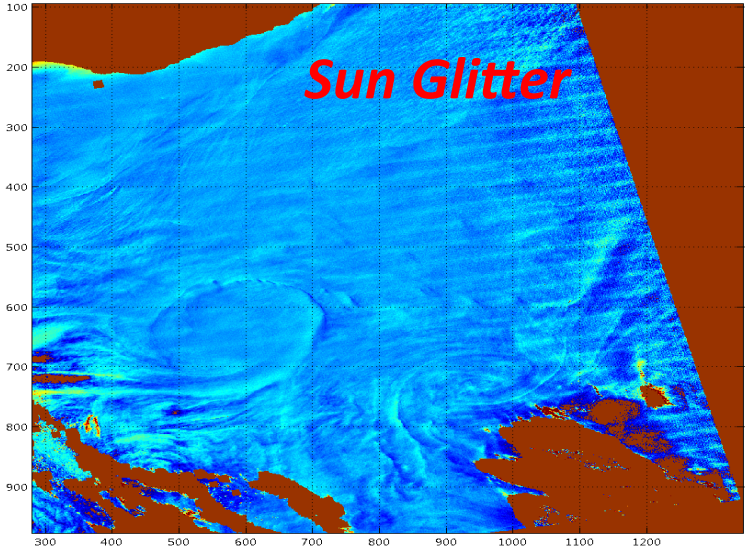


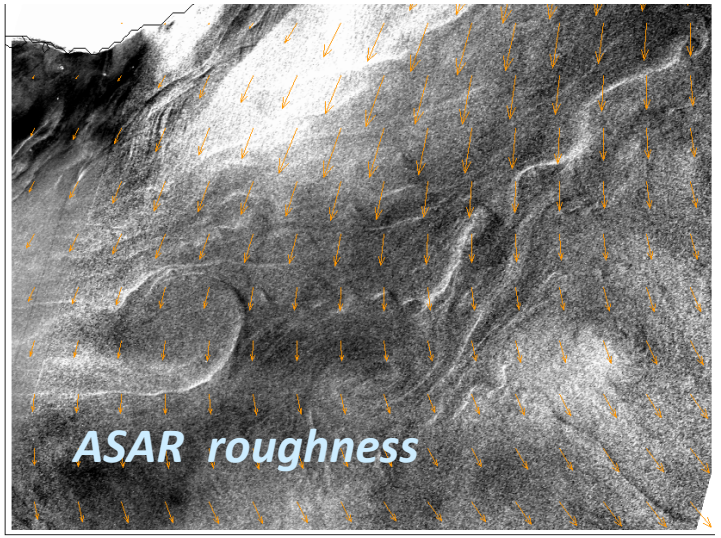
Ocean Prediction Networking

Challenges at the mesoscale (Synergy)









Reconstruction of Surface Currents from SST

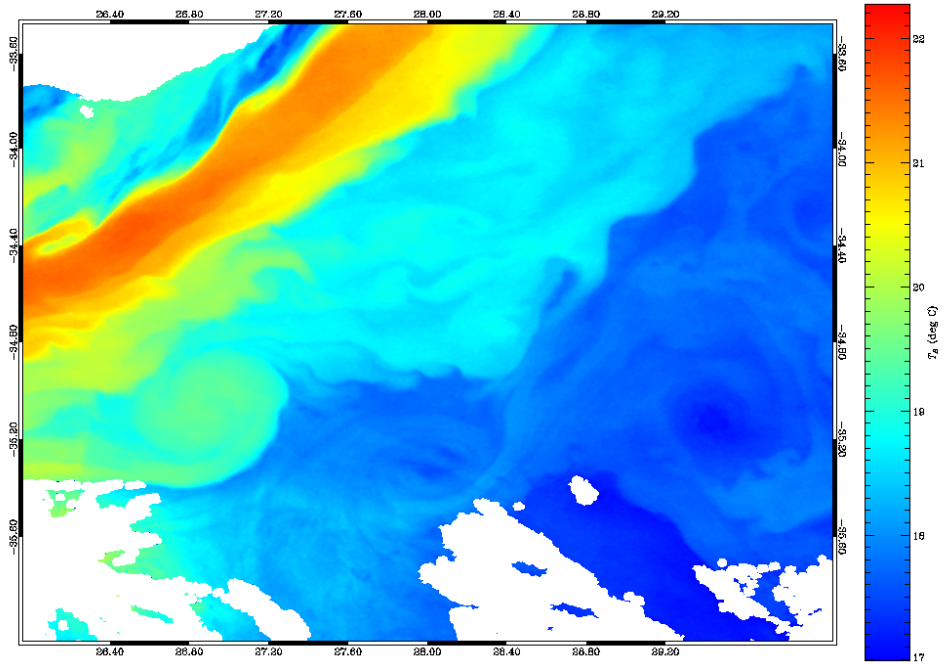
1. Surface Quasi – Geostrophy fields

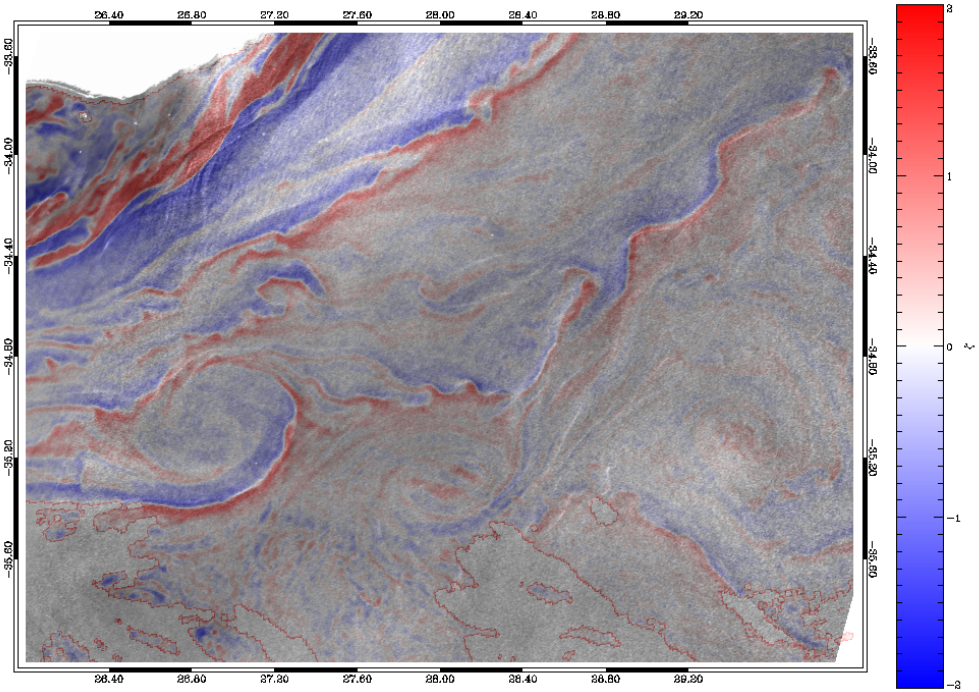
QG Stream-function

$$\mathbf{SST}\,(\widehat{T}_s) \;\rightarrow\; \widehat{\psi}(\boldsymbol{k},z) = \frac{g\alpha \widehat{T}_s(\boldsymbol{k})}{f\,\eta_\beta\,k}\exp(n_0 kz)$$

Vorticity of the surface QG current

$$\widehat{\Omega}_z(\boldsymbol{k}) = k^2\widehat{\psi}(\boldsymbol{k}) = \frac{g\alpha}{f\,\eta_\beta\,k}k^2\widehat{T}_s(\boldsymbol{k})$$





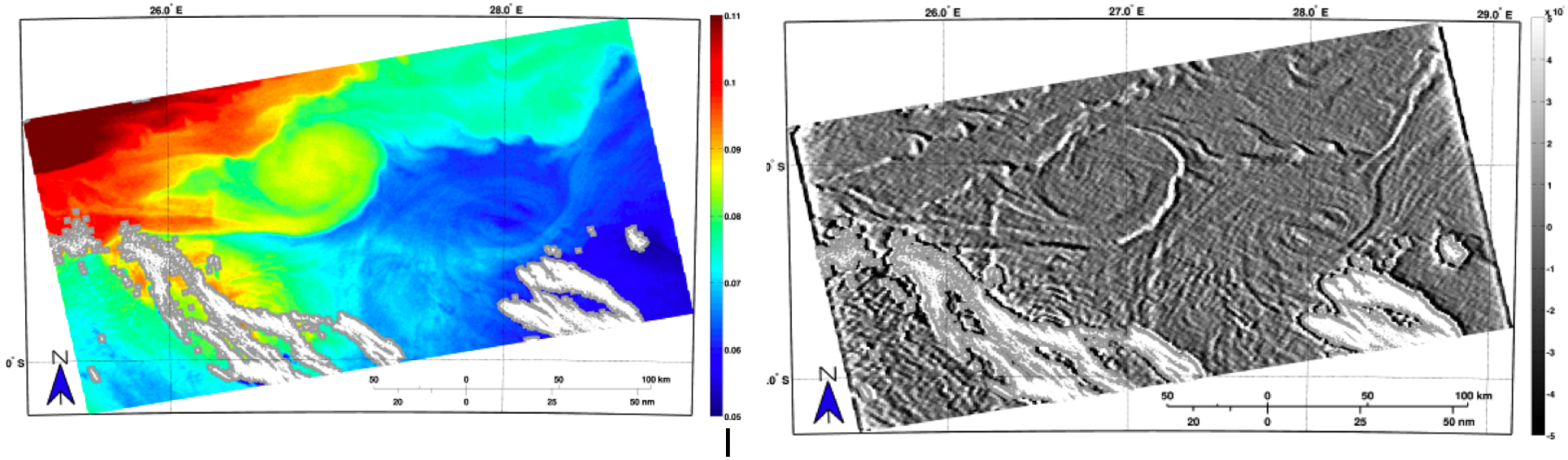
Reconstruction of Surface Currents from SST

2. Interactions Ekman and SQG currents (after Klein and Hua, 1990)

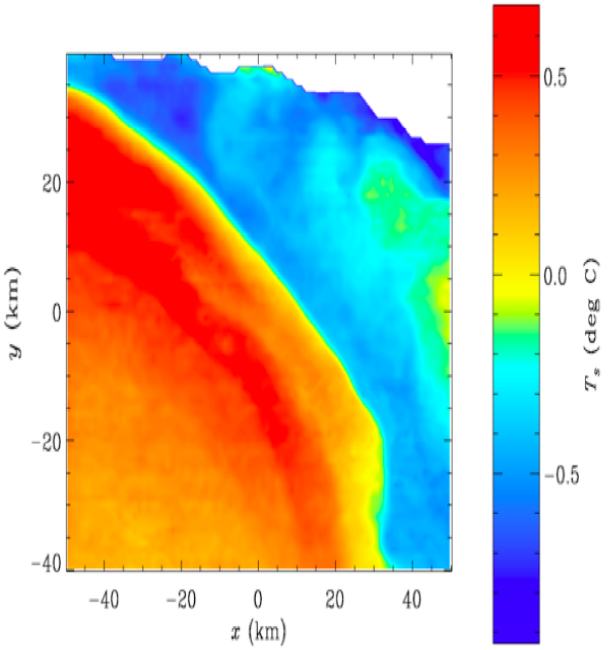
$$\tilde{u}_1 = -f^{-1}\overline{u}_j \frac{\partial U_2}{\partial x_j}, \quad \tilde{u}_2 = f^{-1}\overline{u}_j \frac{\partial U_1}{\partial x_j}$$

3. Generation of vertical pumping (convergence/divergence)

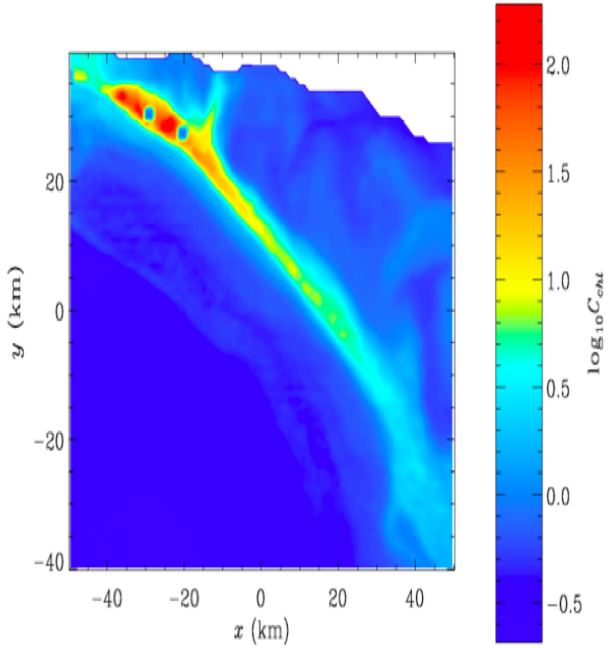
$$\nabla \cdot \boldsymbol{V} = -f^{-1}\overline{u}_j \frac{\partial}{\partial x_j}\Omega_z$$



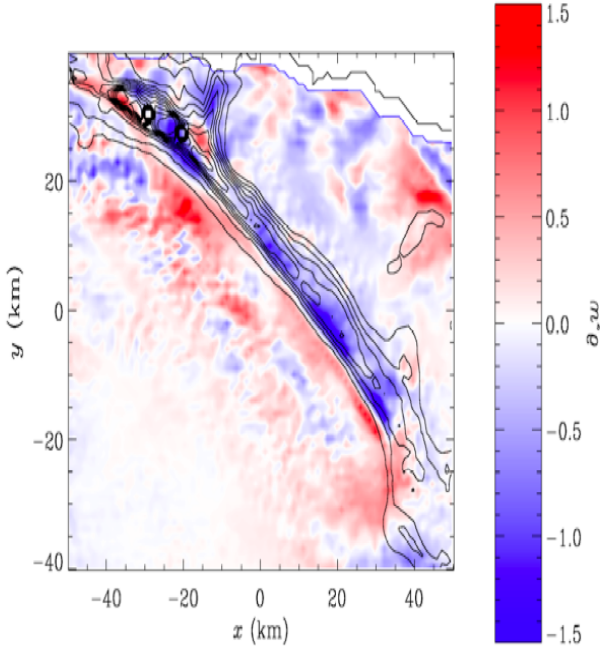
Synergy: Mesoscale Processes



SST



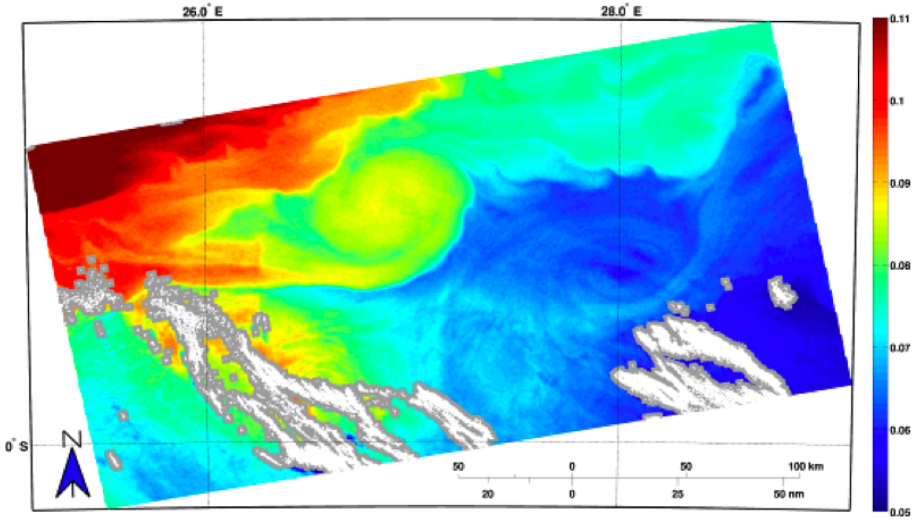
Chlorophyll

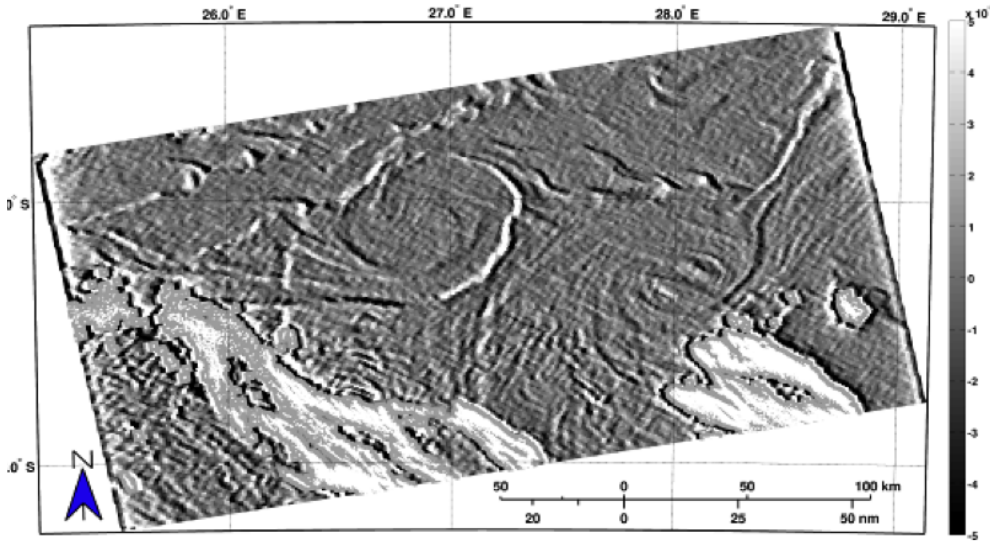


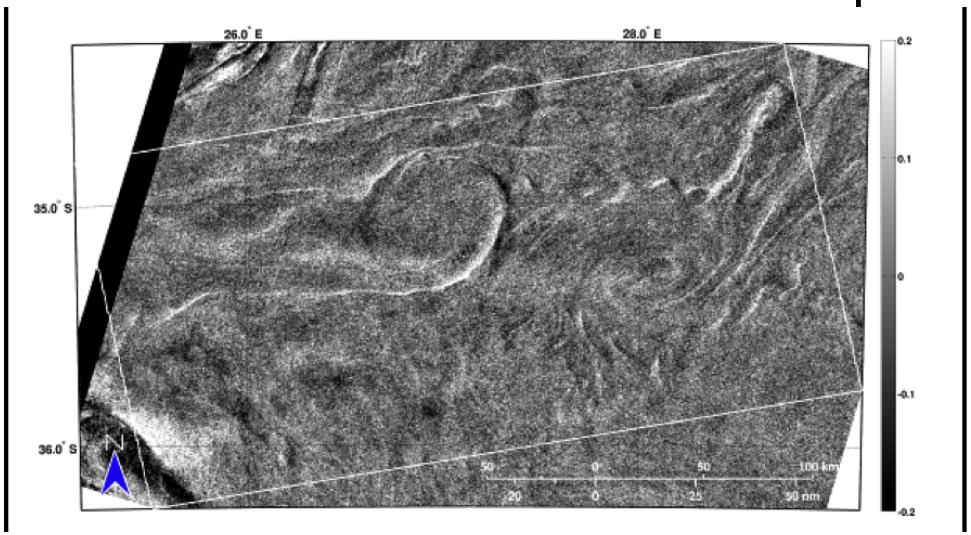
Divergence from SST

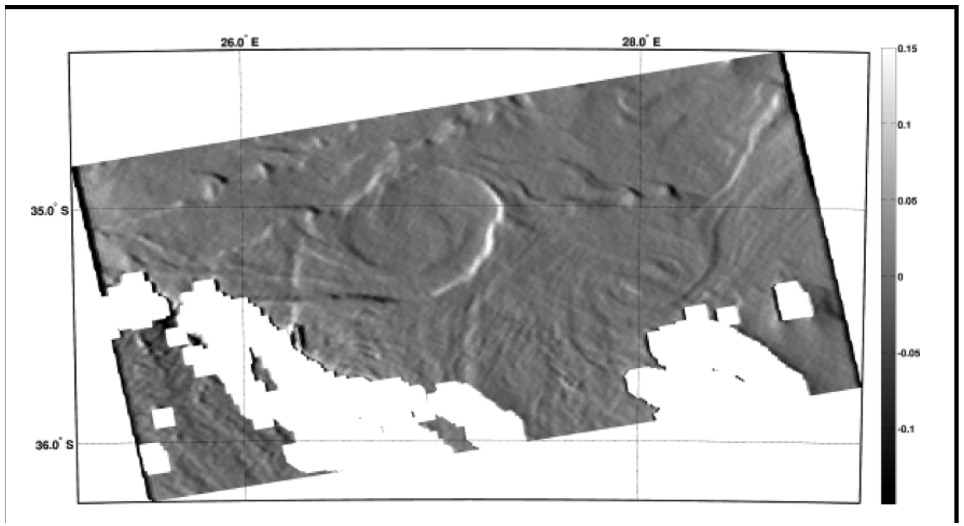
Preliminary reconstruction of the velocities from satellite data. (left) SST from MODIS; (center) corresponding chlorophyll concentration from the same MODIS image; and (right) surface divergence derived from SST using the SQG approach with chlorophyll contours overlaid. Blue patches indicate upwelling regions.

Reconstruction of Surface Currents from SST







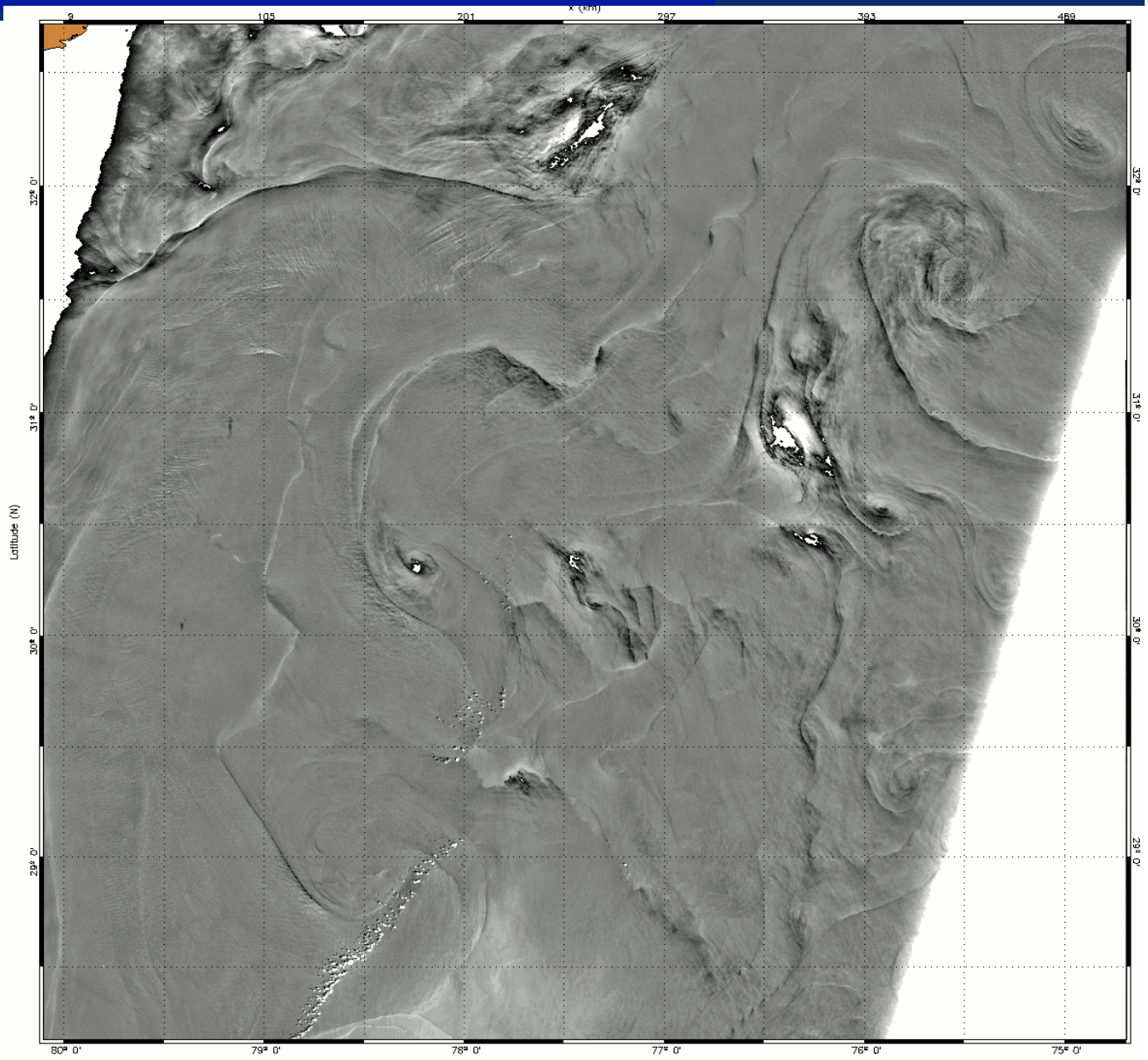


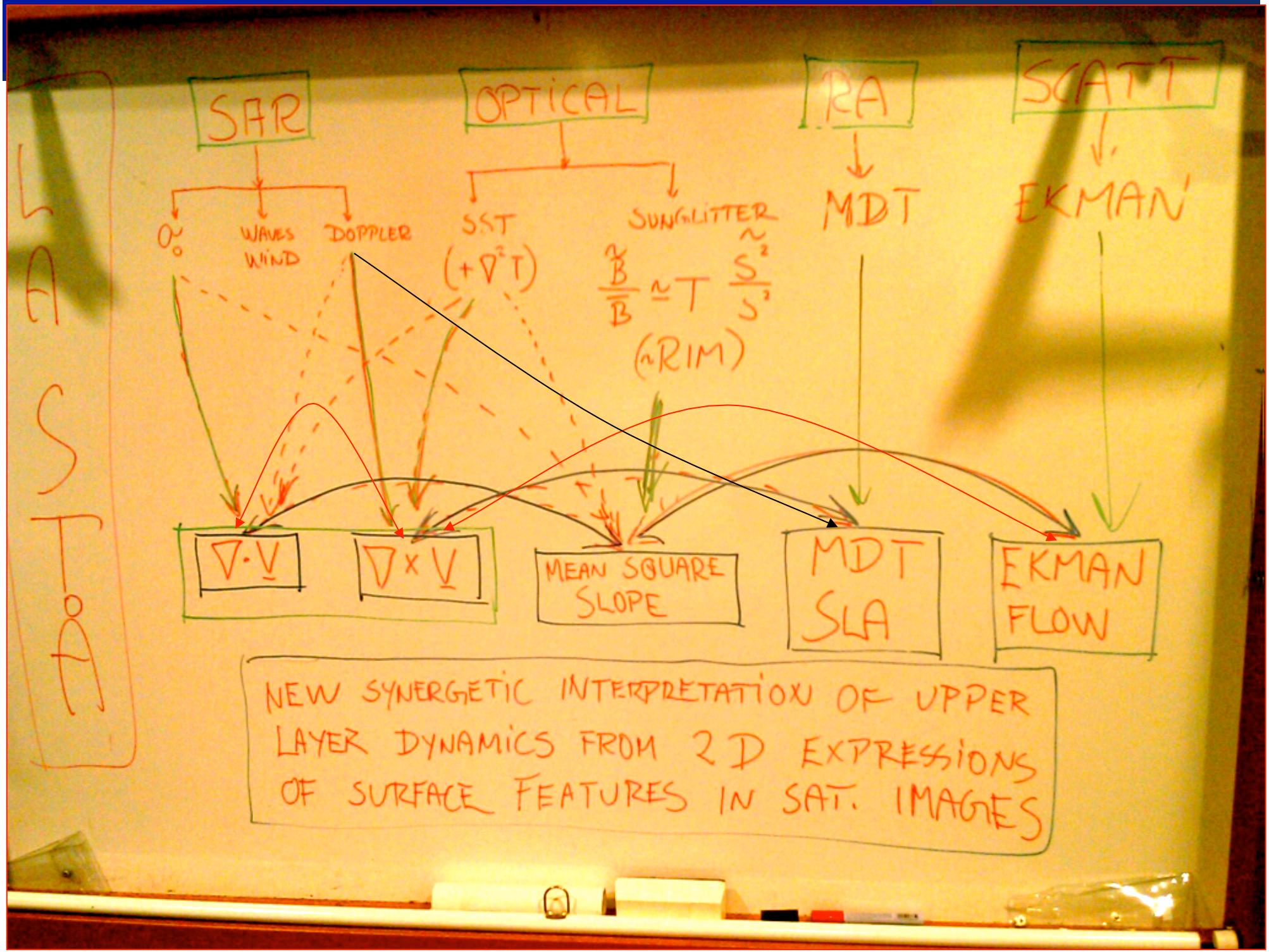
Ocean Prediction Networking

Another One!

Ocean Prediction Networking

AVHRR SST
AND
SUNGLINT




SAR
OPTICAL
RA
SCATT
LASTOA
WAVES WIND
DOPPLER
SST
(+∇²T)
SUNGLITTER
(nRIM)
MDT
EKMAN
∇·V
∇×V
MEAN SQUARE SLOPE
MDT SLA
EKMAN FLOW
NEW SYNERGETIC INTERPRETATION OF UPPER LAYER DYNAMICS FROM 2D EXPRESSIONS OF SURFACE FEATURES IN SAT. IMAGES