→ 4th ESA ADVANCED TRAINING
ON OCEAN REMOTE SENSING

Synergy between Optical, Infrared and Microwave Sensors for Ocean Remote Sensing Applications

7–11 September 2015 | IFREMER | Brest, France

Sensor Synergy

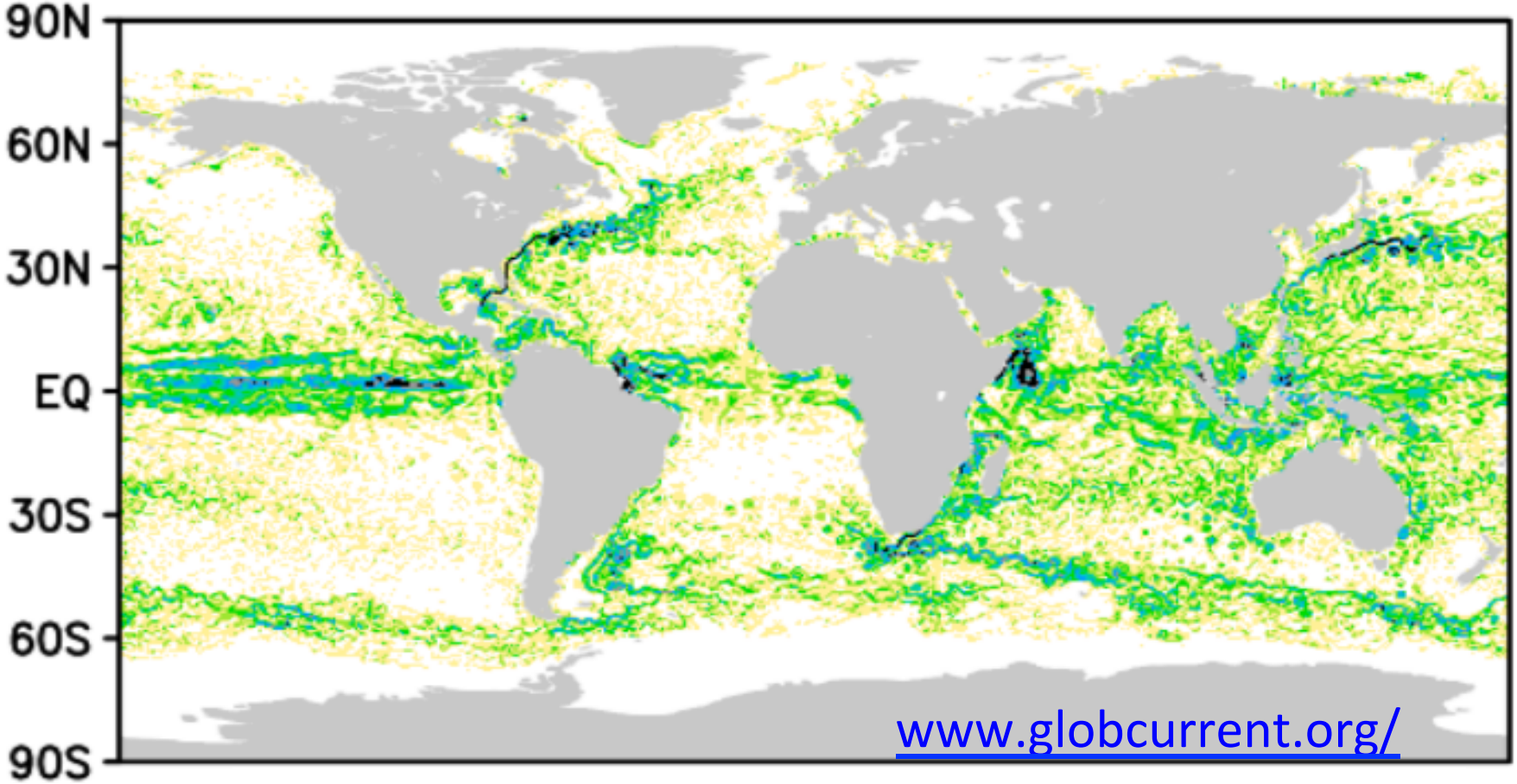
What do different satellite sensors have in common?

They have

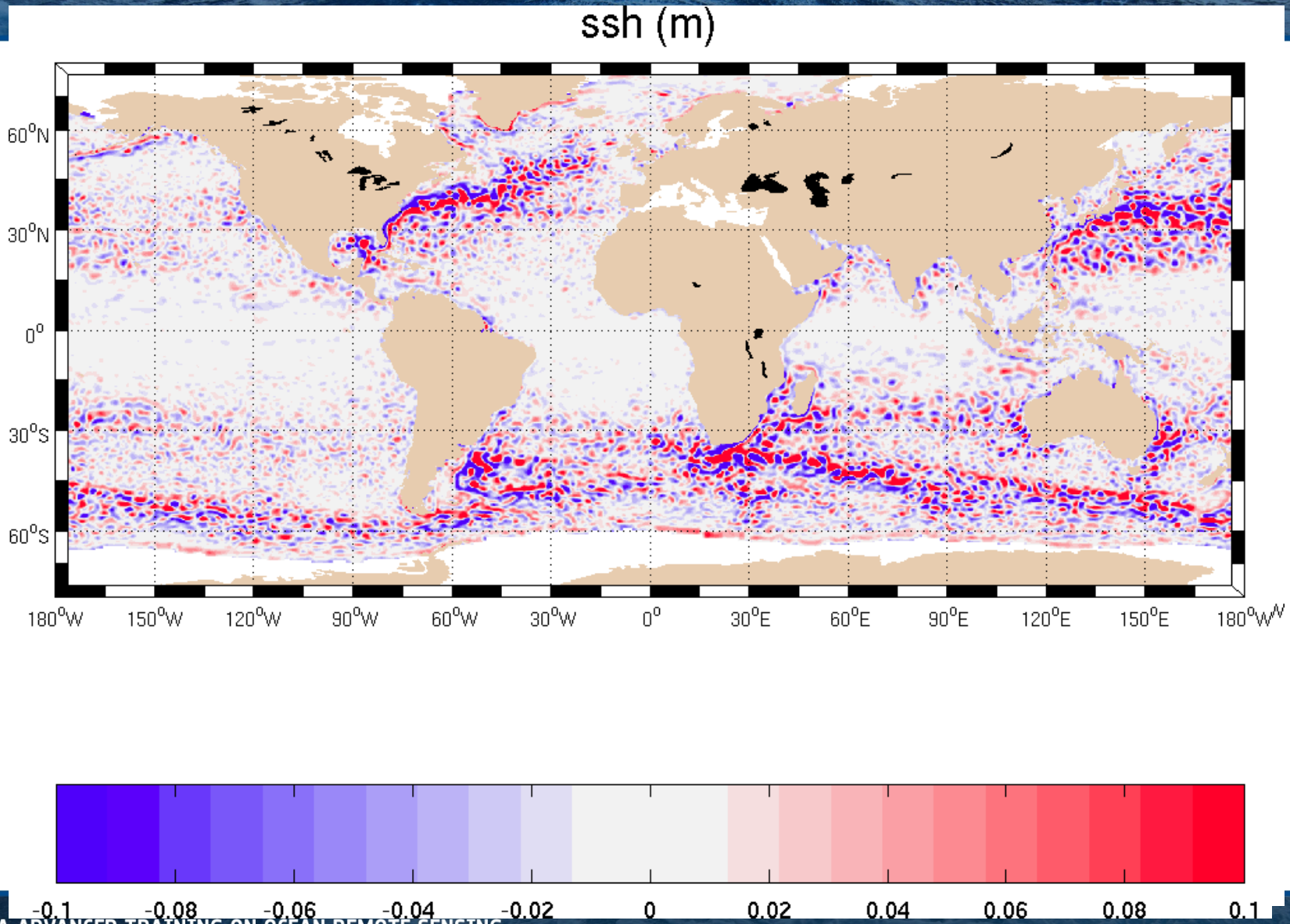
- fronts
- eddies
- meandering currents

IR, Spectrometers, Altimeters, SAR, Scatterometers, PM detect and manifests these features through the gradients and anomalies in the SST, OC, sunglint anomalies, SSH, NRCS and range Doppler, near surface wind and SSS

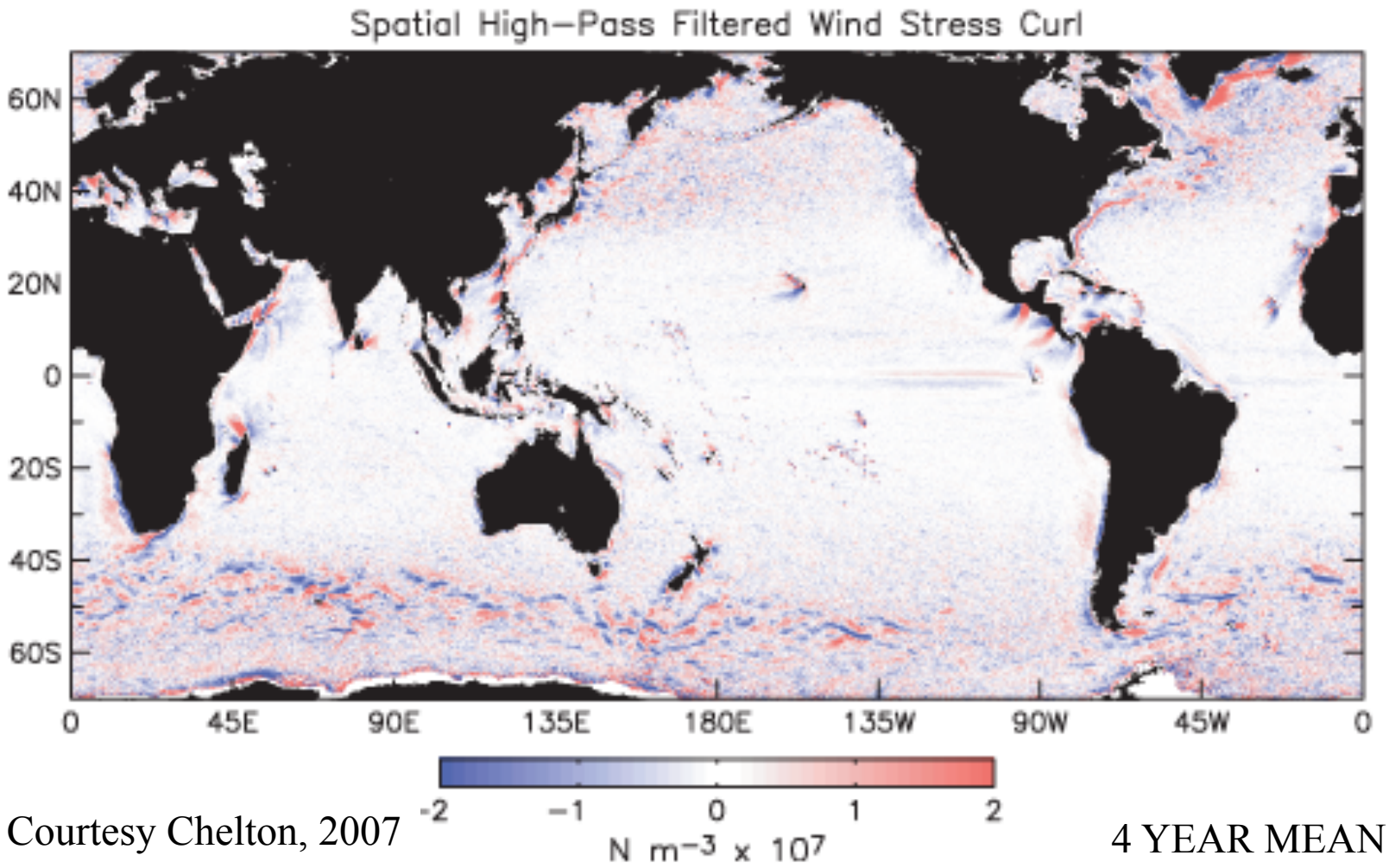
Global Surface Geostrophic Current Product



Example SST and SSH gradients DISPLAY CURRENT FRONTS (global scale)

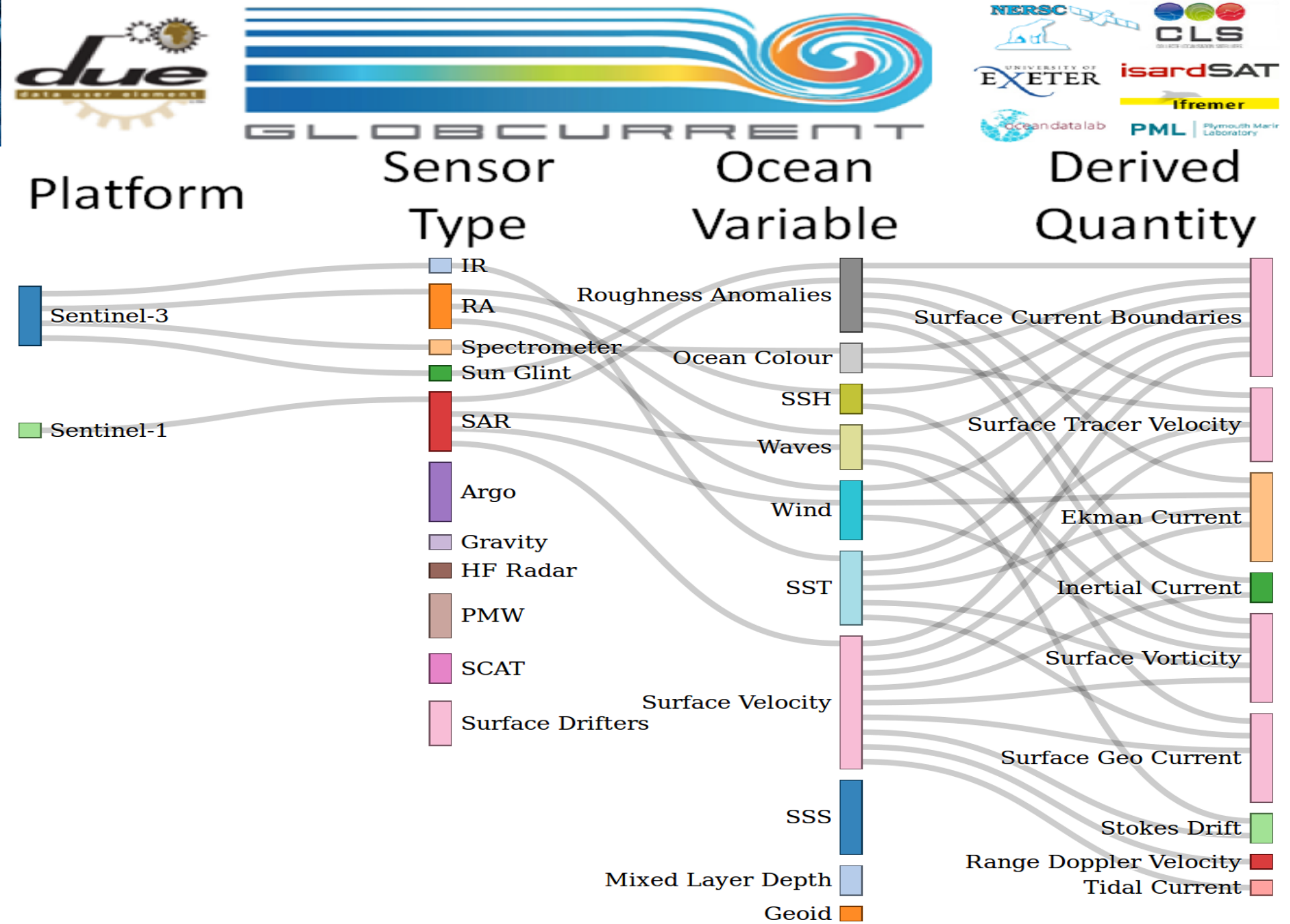


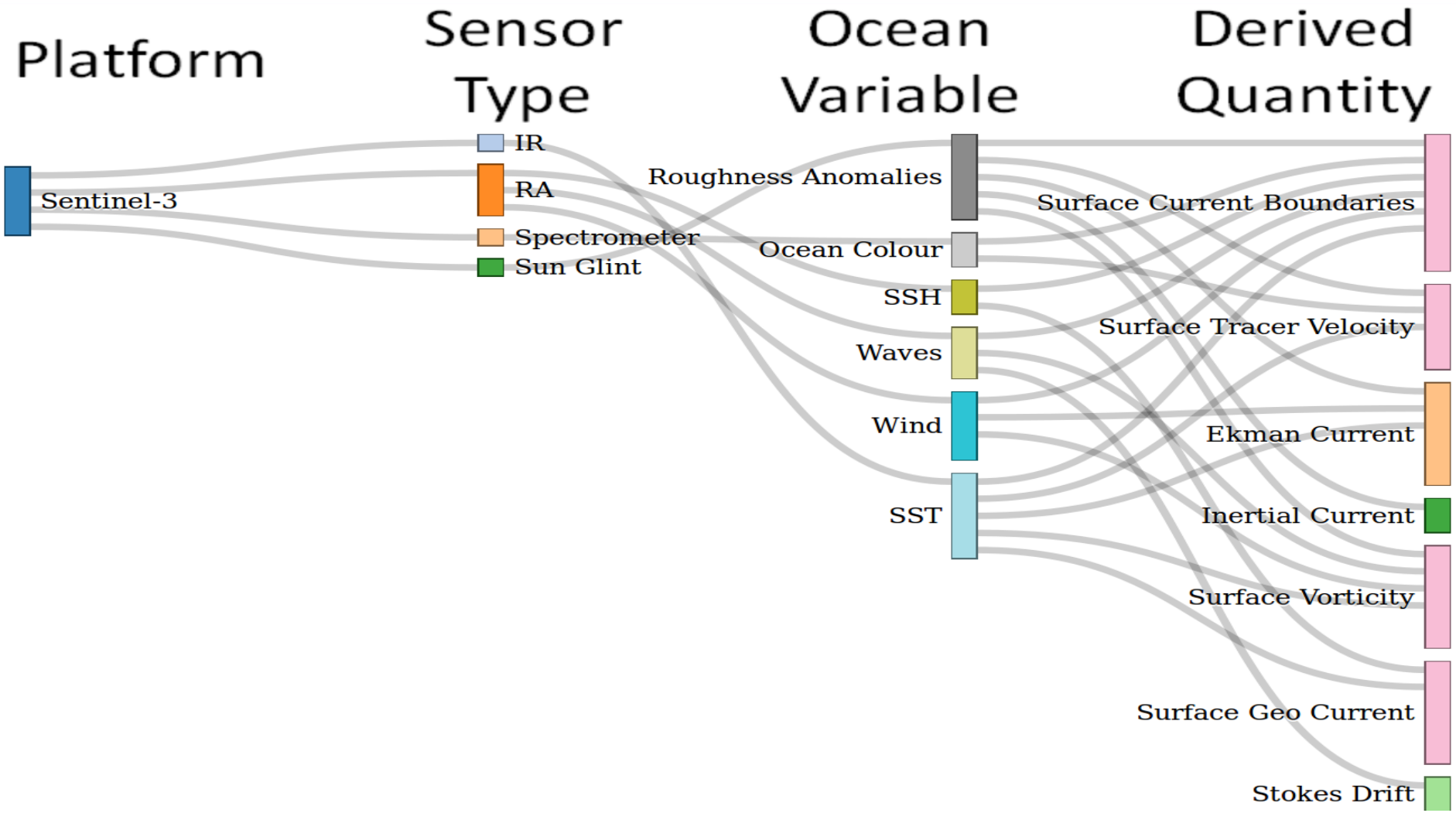
LINKS BETWEEN WIND STRESS CURL AND BIG CURRENT FRONT (SCALE > 100 KM)



Courtesy Chelton, 2007

4 YEAR MEAN


Platform
Sensor Type
Ocean Variable
Derived Quantity
Sentinel-3
Sentinel-1
IR
RA
Spectrometer
Sun Glint
SAR
Argo
Gravity
HF Radar
PMW
SCAT
Surface Drifters
Roughness Anomalies
Ocean Colour
SSH
Waves
Wind
SST
Surface Velocity
SSS
Mixed Layer Depth
Geoid
Surface Current Boundaries
Surface Tracer Velocity
Ekman Current
Inertial Current
Surface Vorticity
Surface Geo Current
Stokes Drift
Range Doppler Velocity
Tidal Current


Platform
Sensor Type
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Sentinel-3
IR
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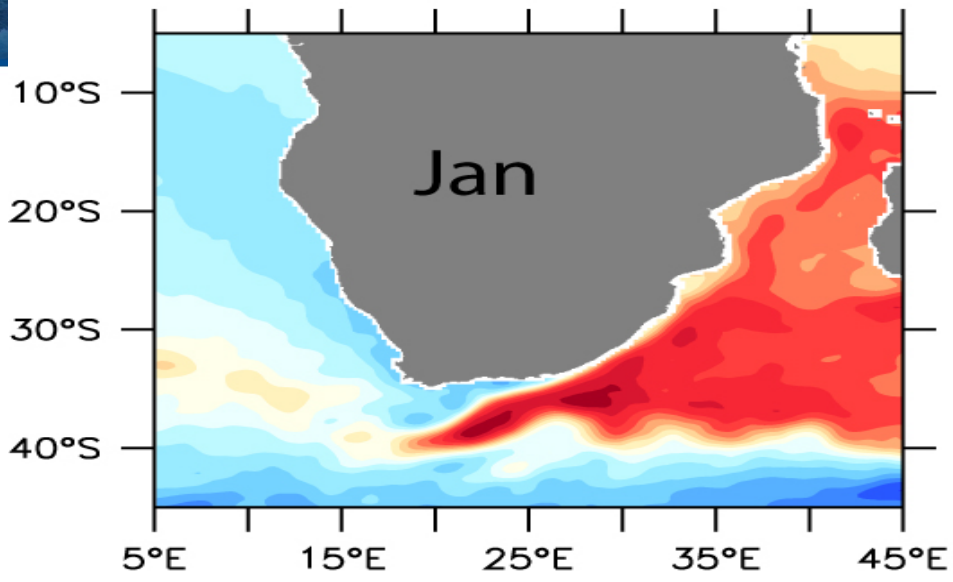
Spectrometer
Sun Glint
Roughness Anomalies
Ocean Colour
SSH
Waves
Wind
SST
Surface Current Boundaries
Surface Tracer Velocity
Ekman Current
Inertial Current
Surface Vorticity
Surface Geo Current
Stokes Drift

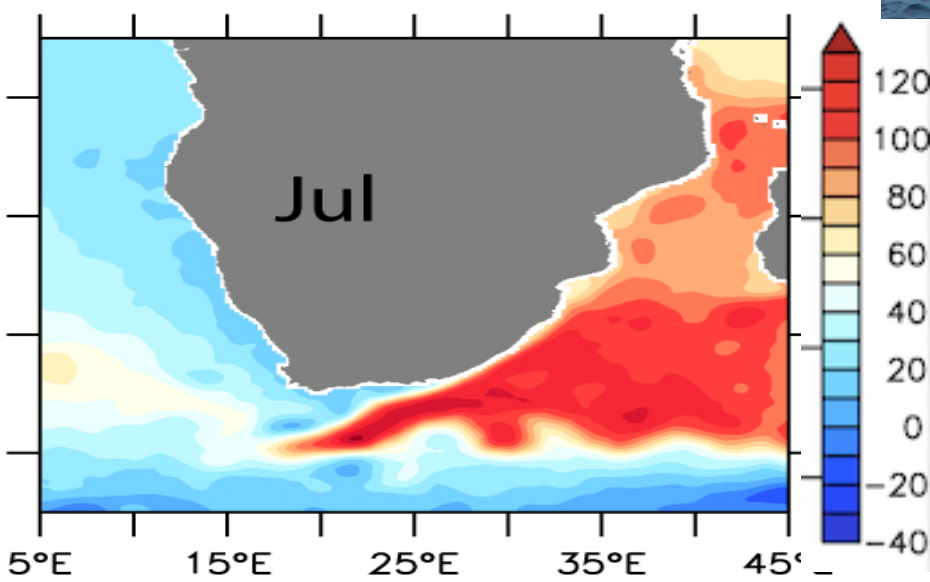
Sensor Synergy

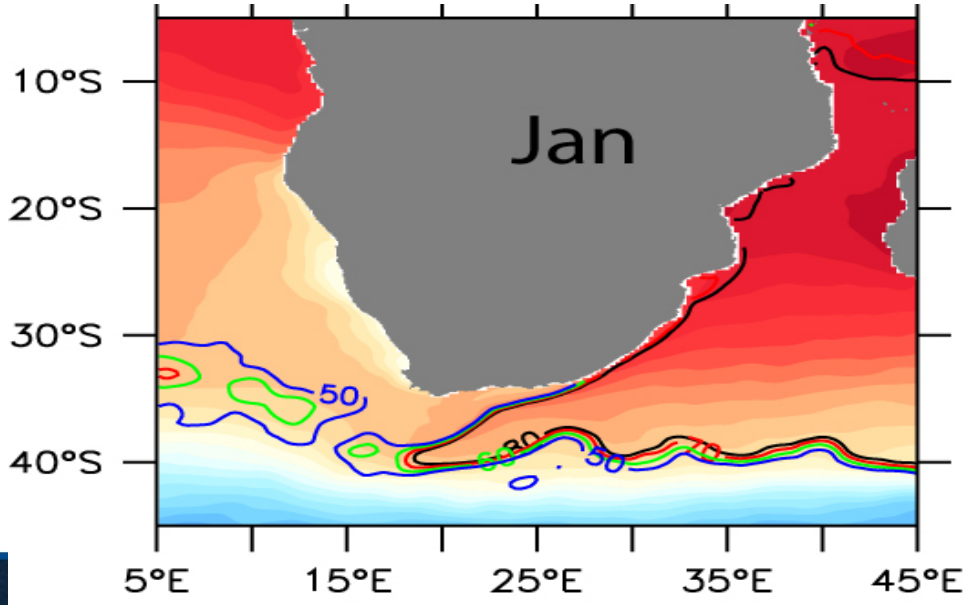
What spatial scales are valid when we look for these common features?

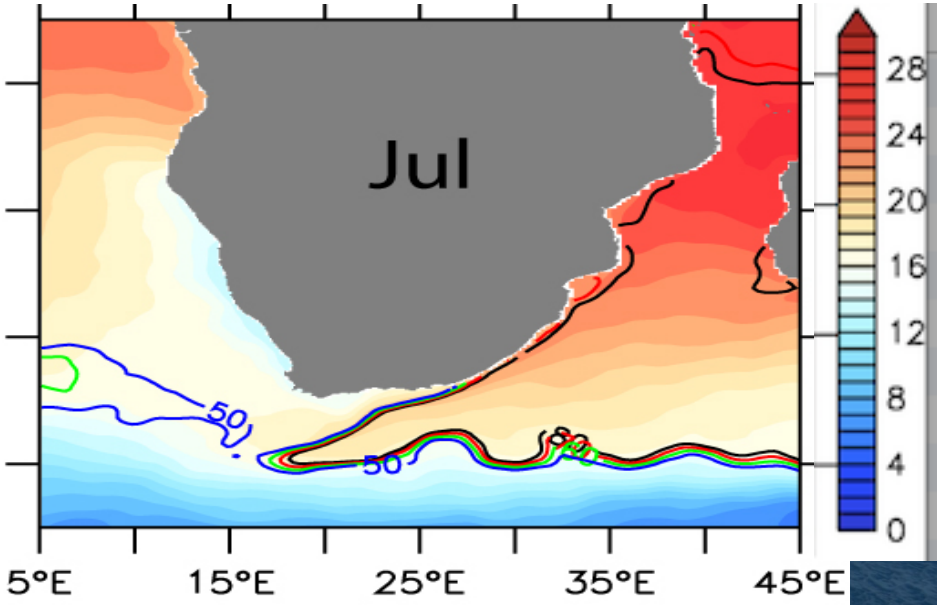
- Global, large scale at >100-200 km
  (SST, SSH, SSS, wind stress curl)
- Regional mesoscale at 30-100 km (low latitude)
  (SAR, range Doppler, SST, SSS, OC, sunglint, SSH)
- Regional mesoscale at 10-30 km (high latitude)
  (SAR, range Doppler, SST, OC, sunglint)
- Regional to local submesoscale at 1-10 km
  (SAR, range Doppler, SST, OC, sunglint)

CLIMATOLOGY OF SSH AND SST (regional scale, 1993-2012)

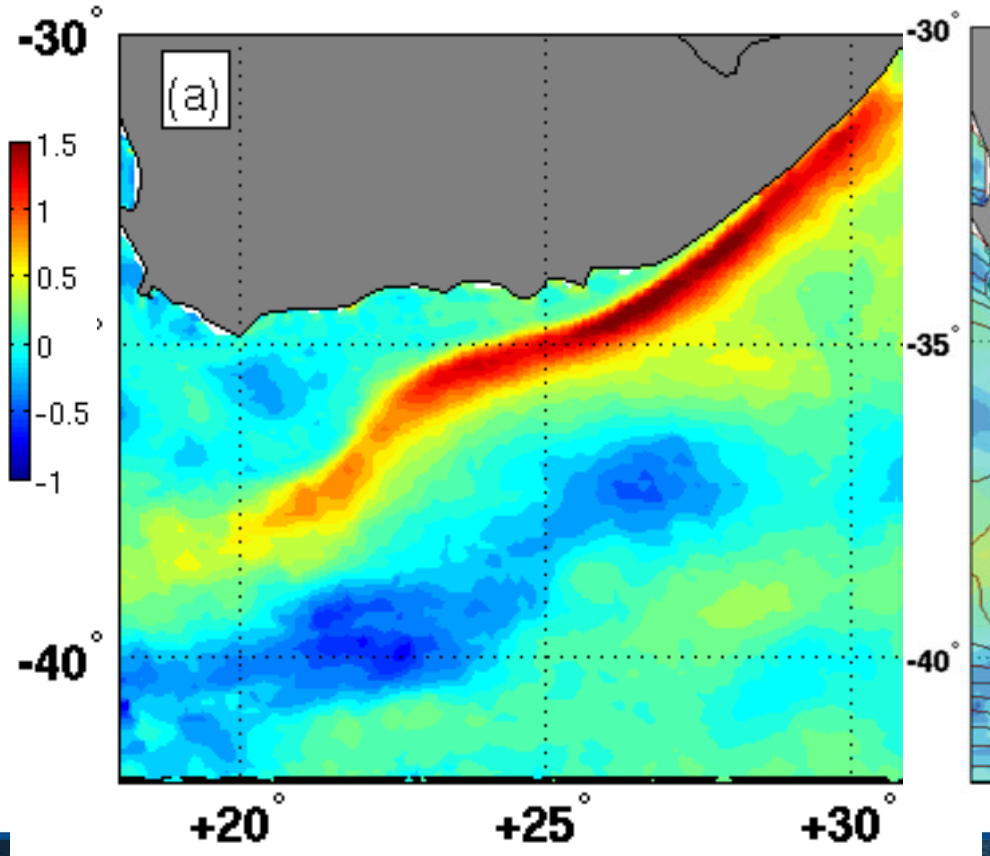


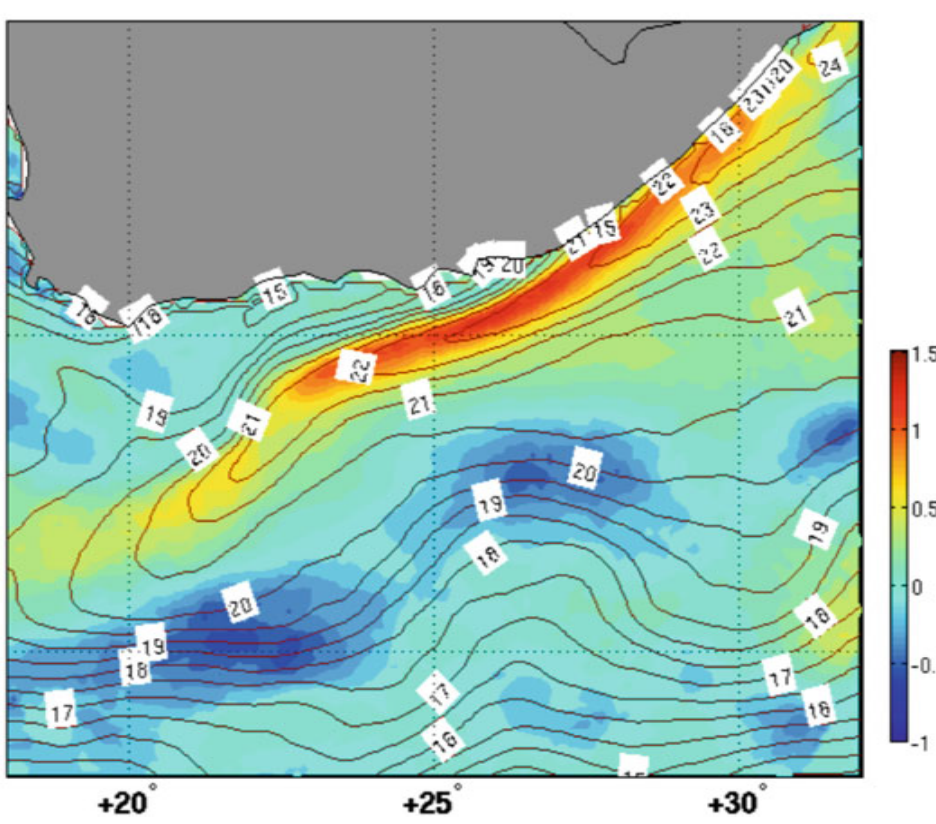




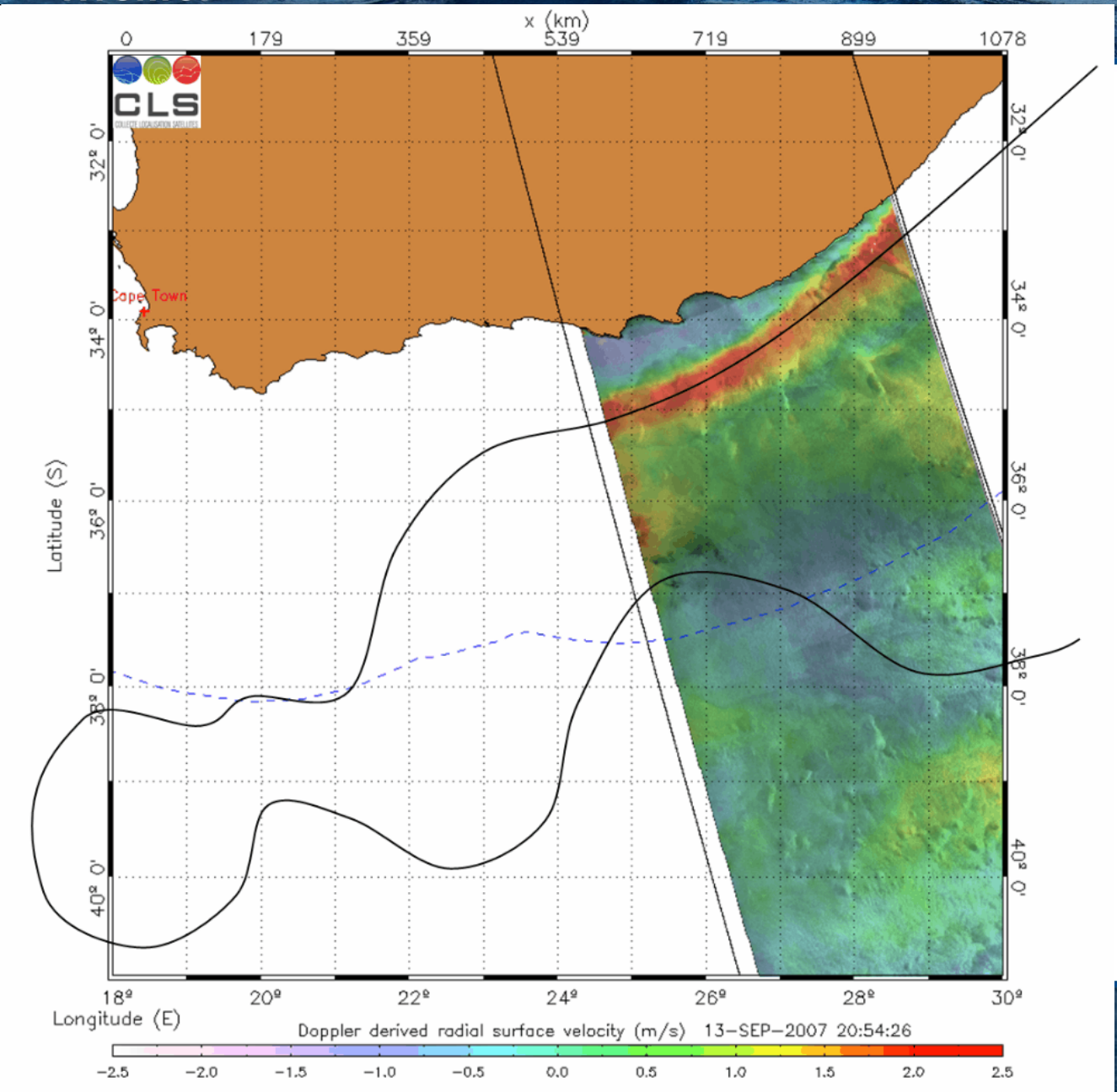


Mean Range Doppler velocity and SST for 2007-20012





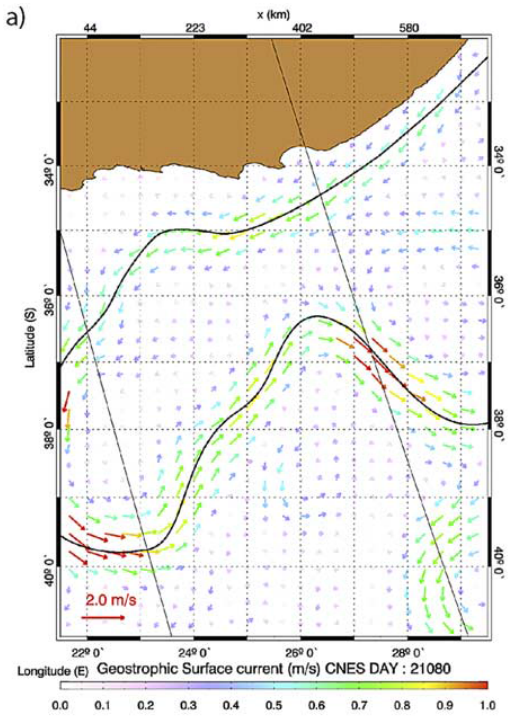
Johannessen et al., 2014

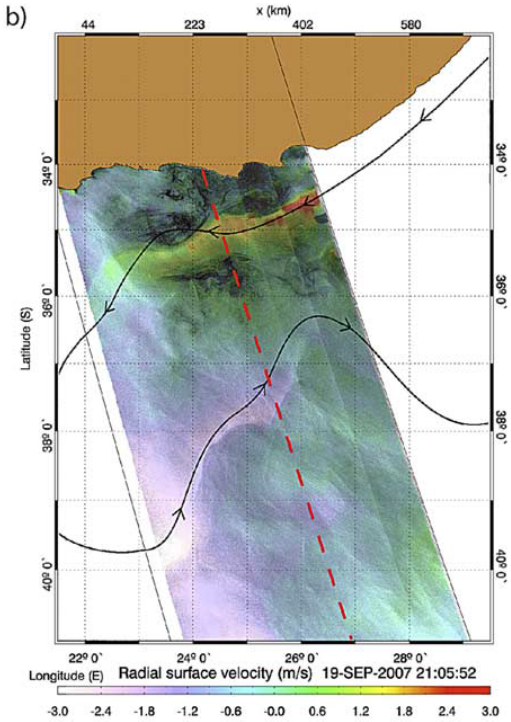


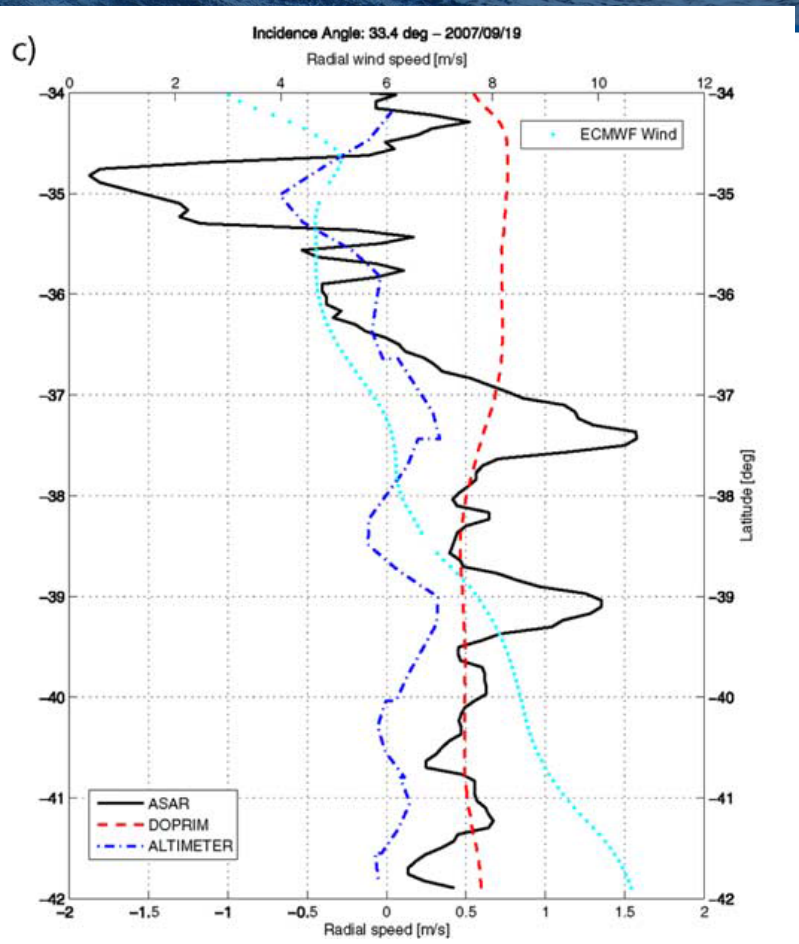
SAR Radial Surface velocity products from 13, 16, 18, 19 and 22 September 2007

Accuracy around 5 Hz or ~25 cm/s at 30 degree incidence angle

Johannessen et al., 2008

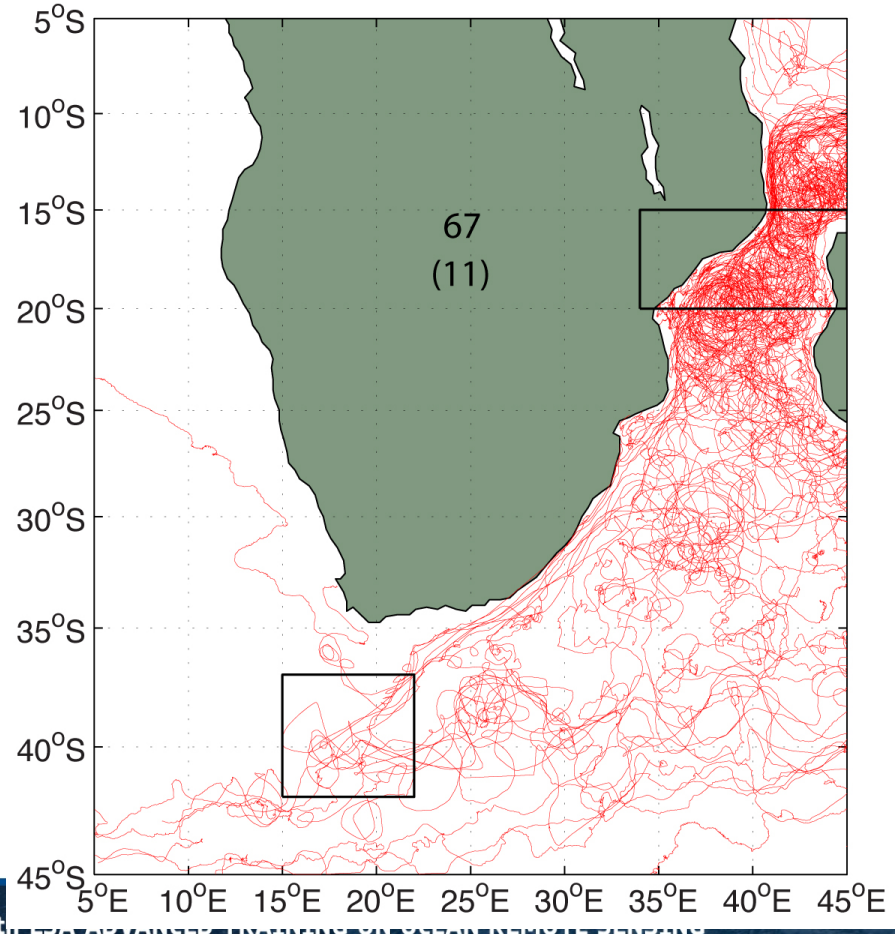


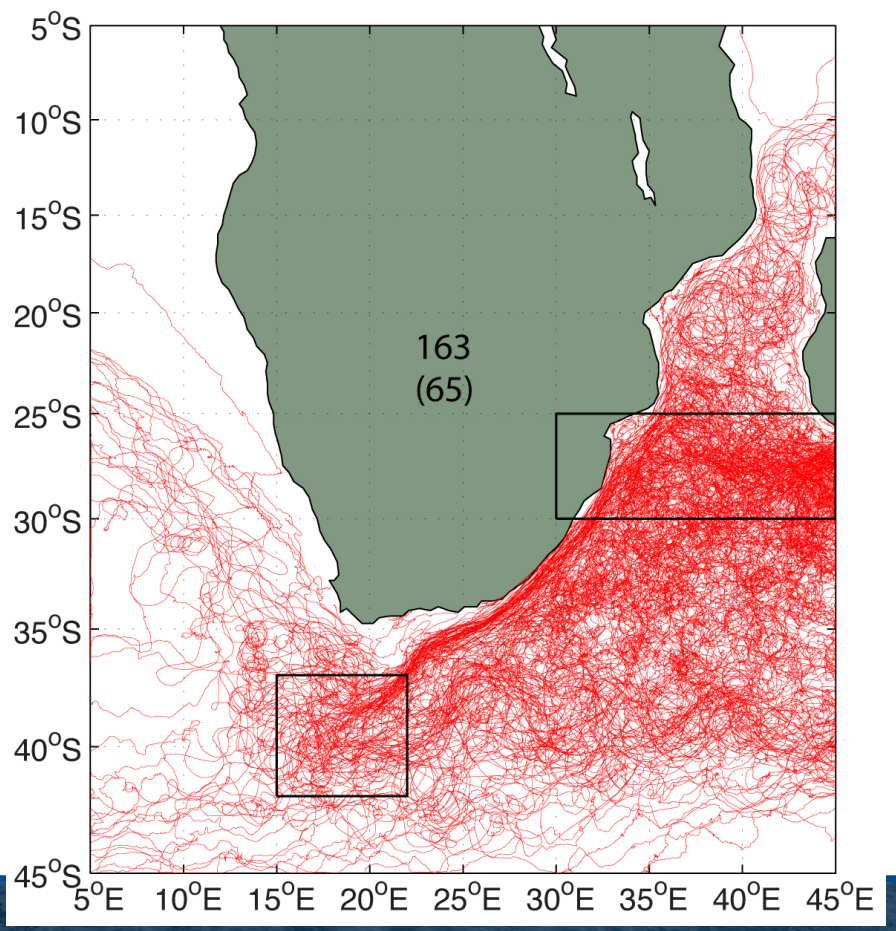




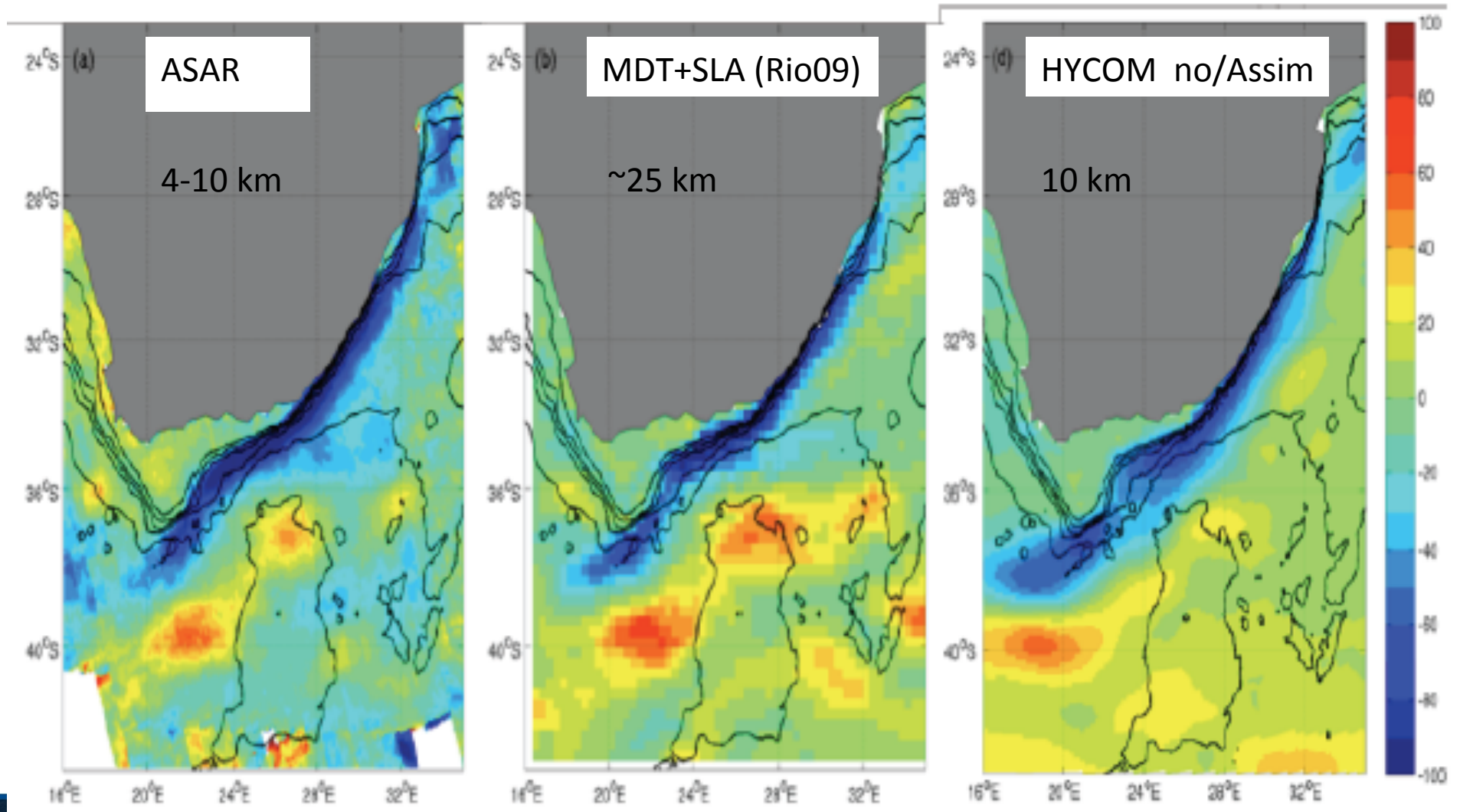
Johannessen et al., 2008

Validation: Surface drifter velocity 1992-2014

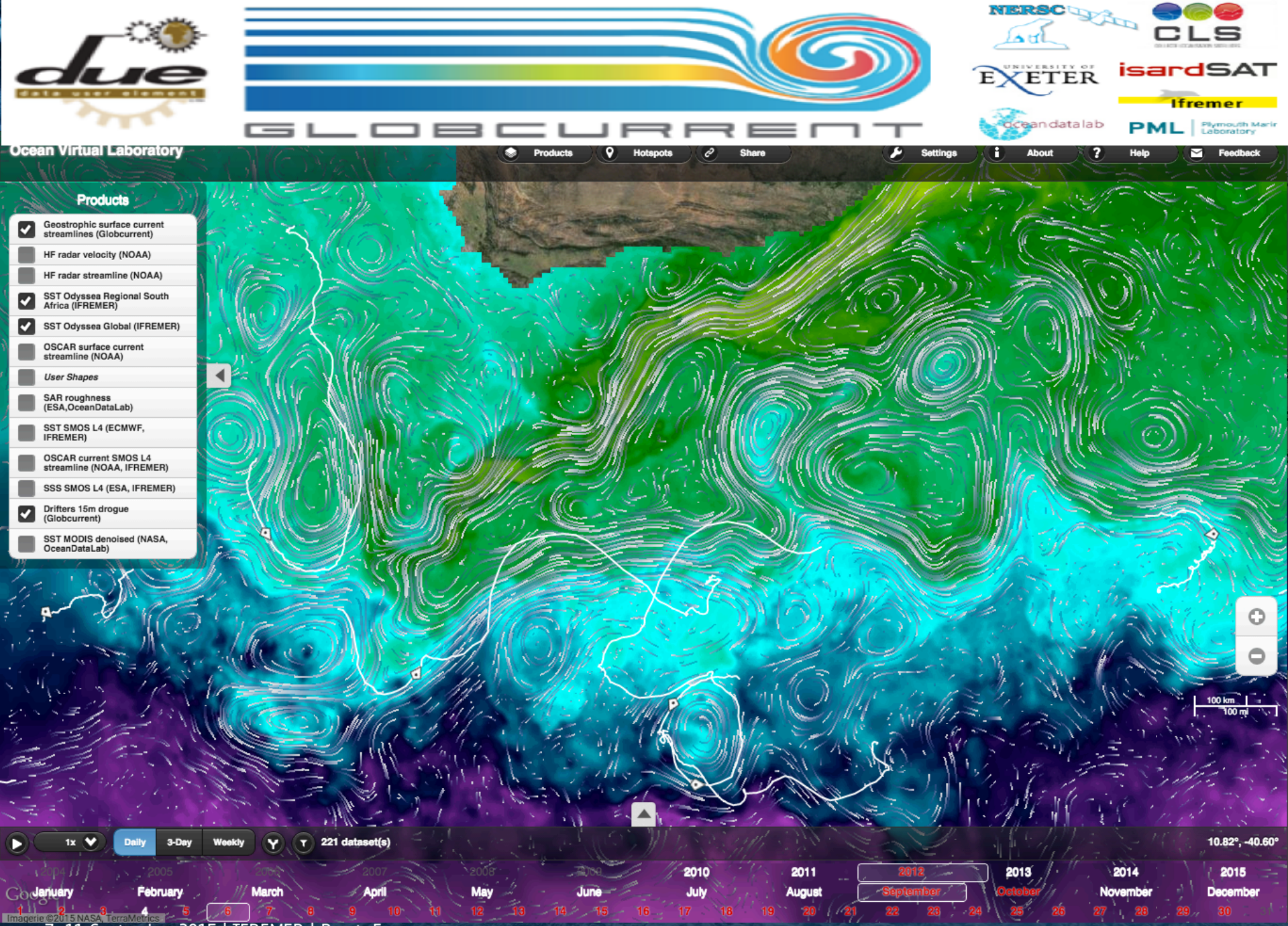




Agulhas Surface Current Climatology 2007-2009



Johannessen et al 2014



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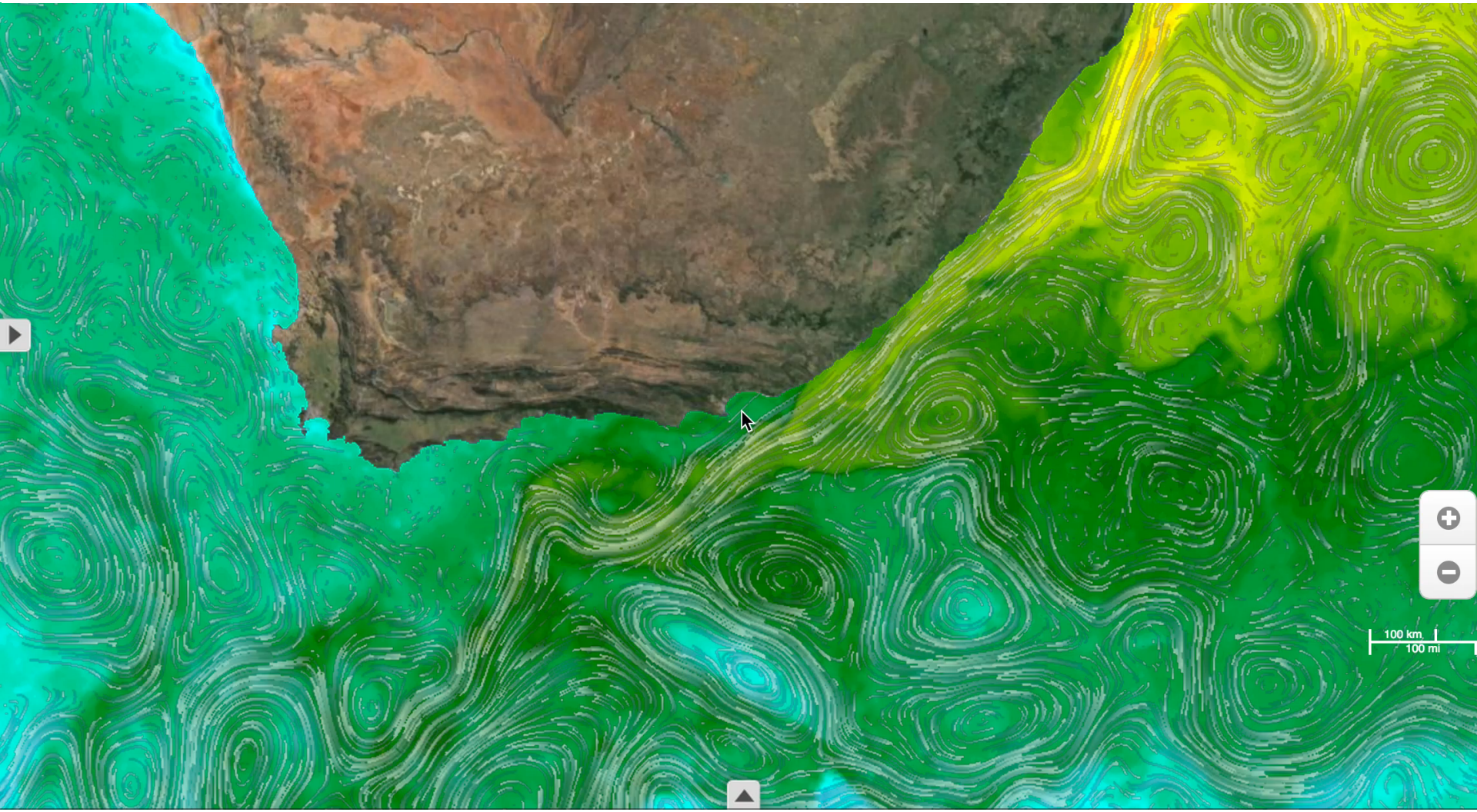
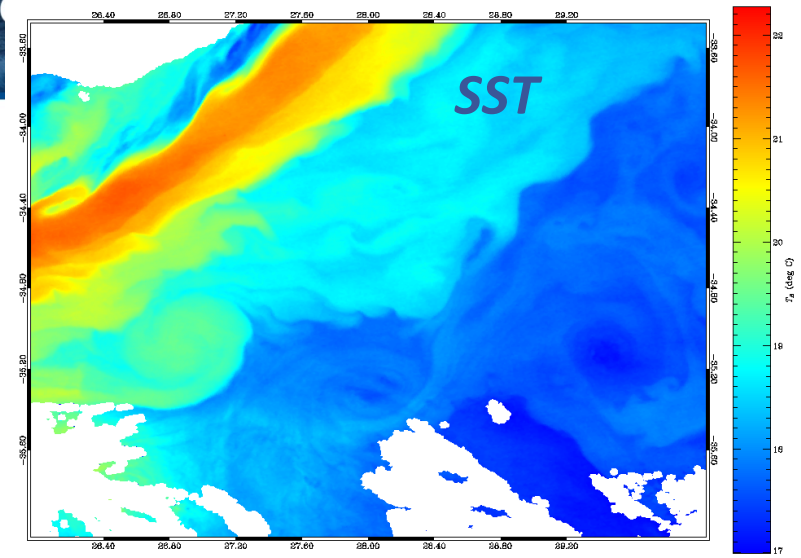
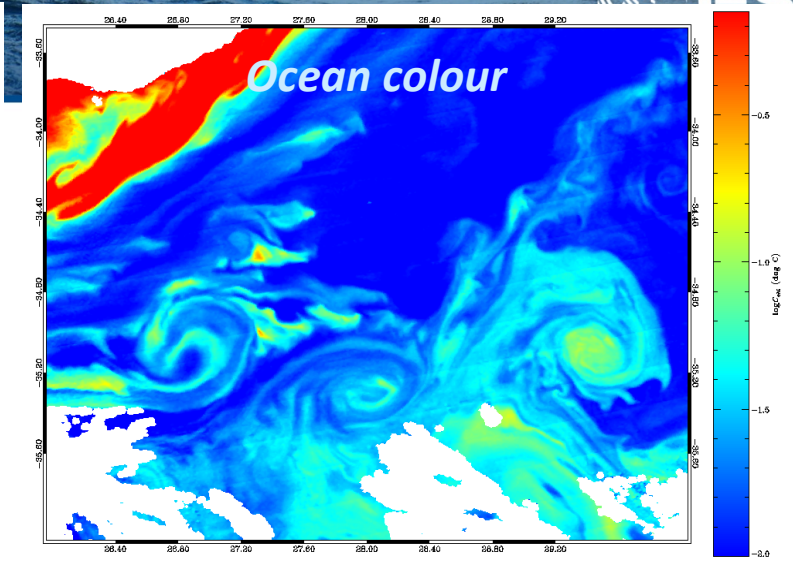
SNAPSHOT 6 SEPTEMBER 2012

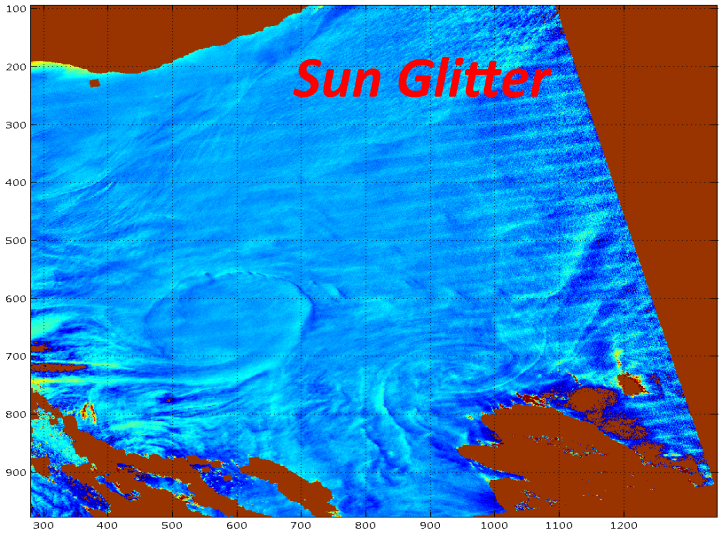
Lido, Venice, Italy, 2-6 June 2015

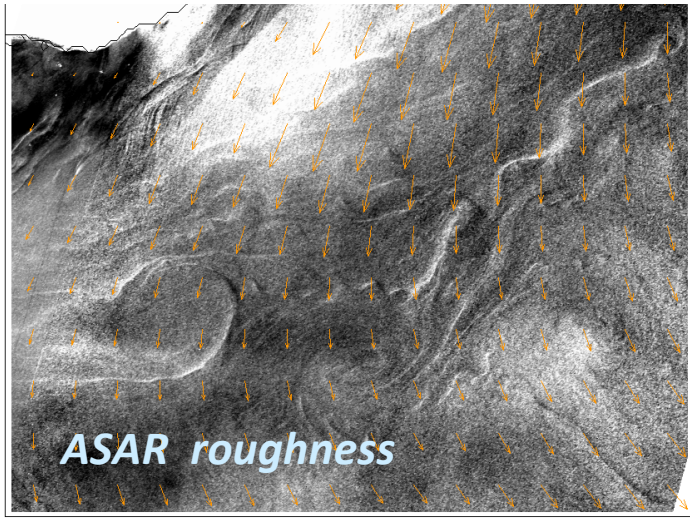

100 km
100 mi

Challenges at the mesoscale (Synergy)

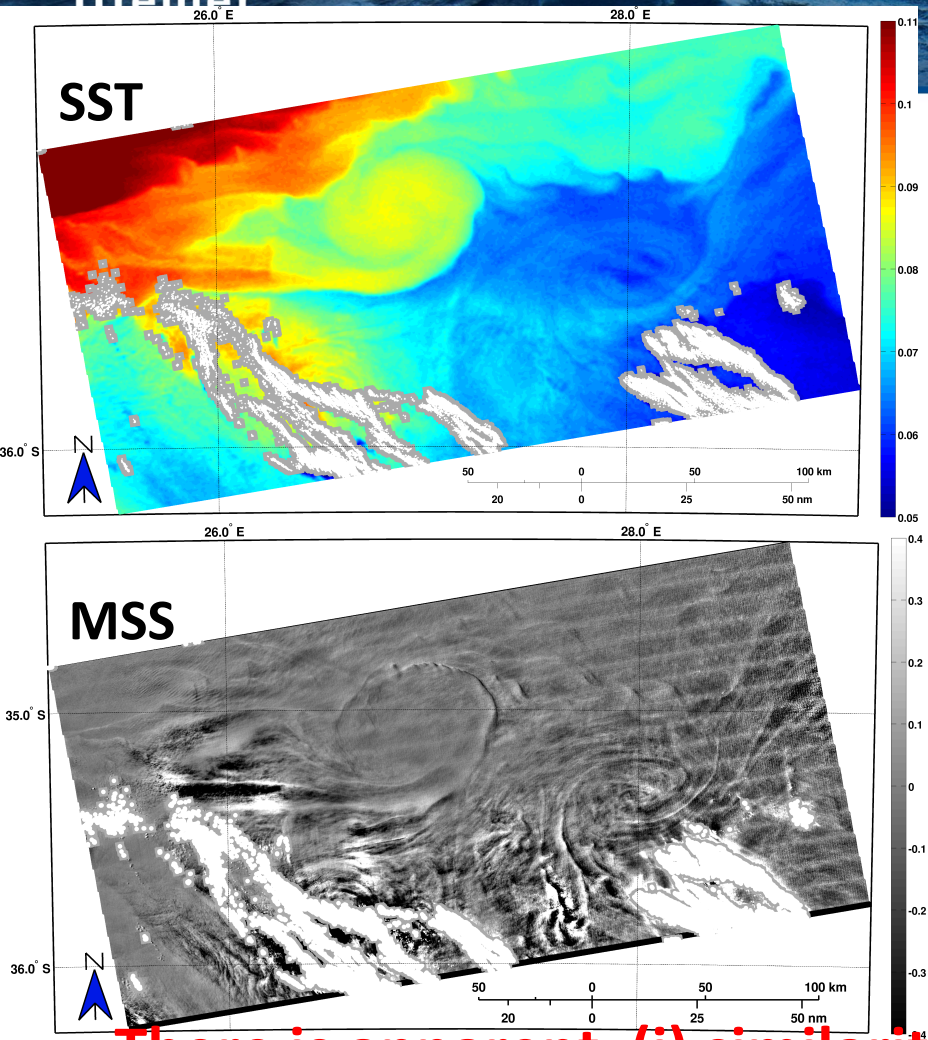


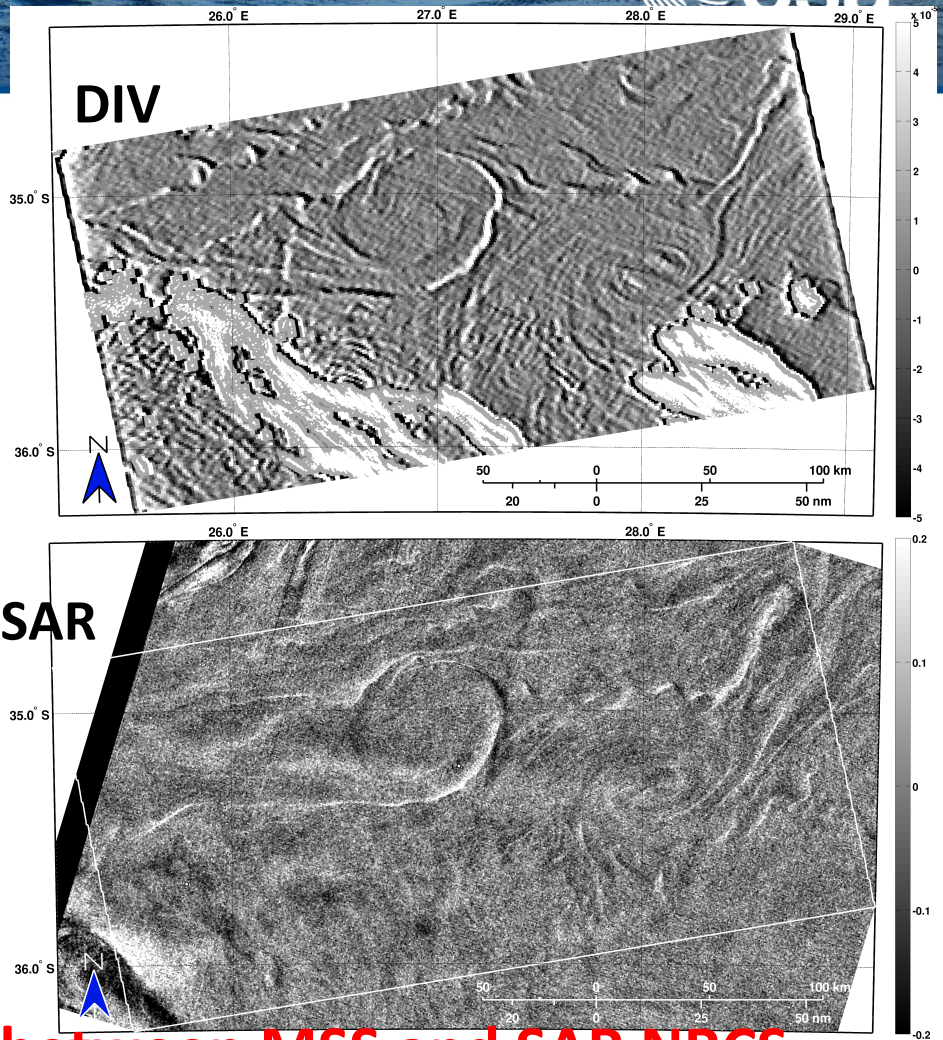






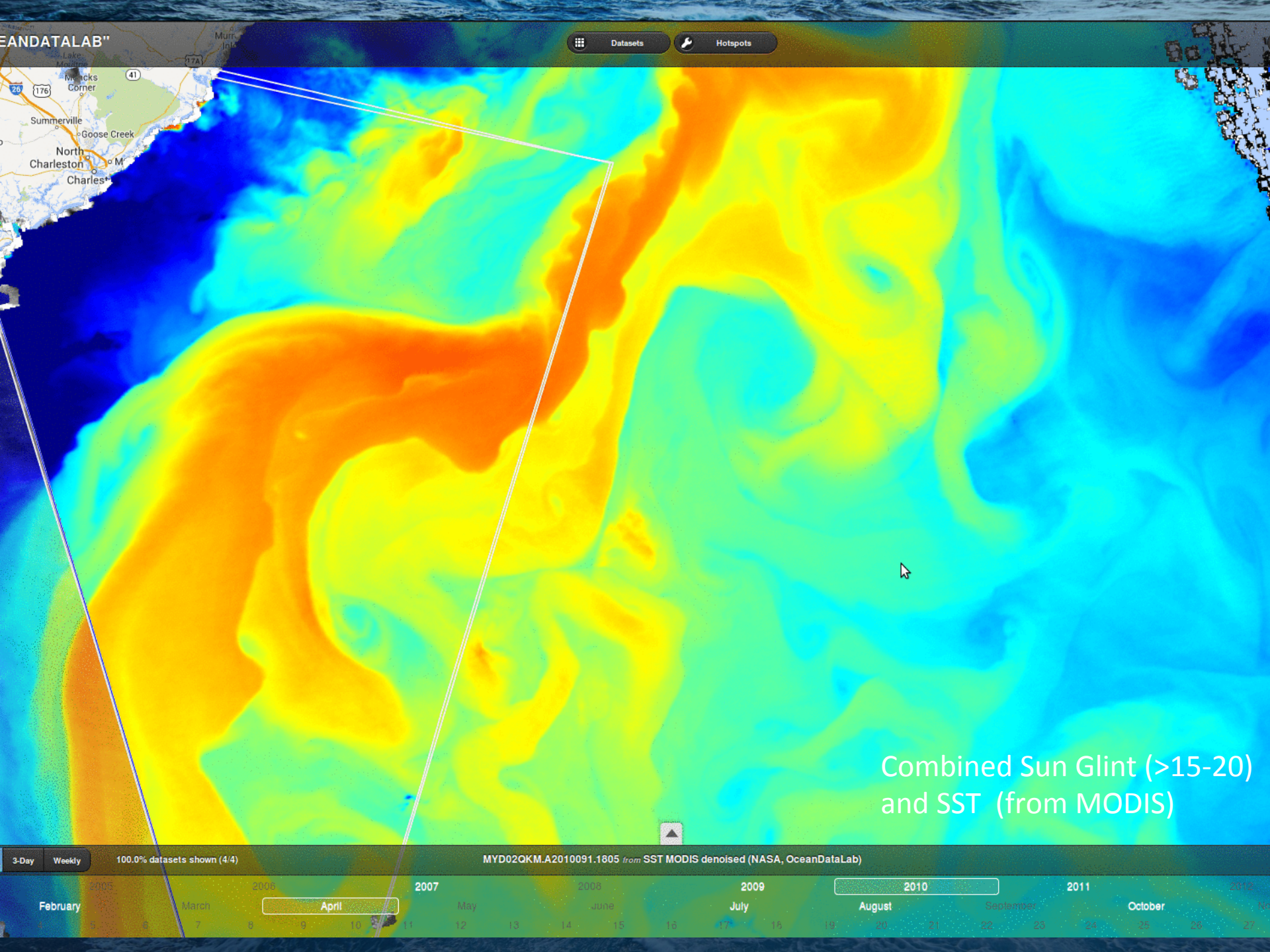
Kudryavtsev, A. Myasoedov, B. Chapron, J.A. Johannessen, F. Collard, JGR; 2012



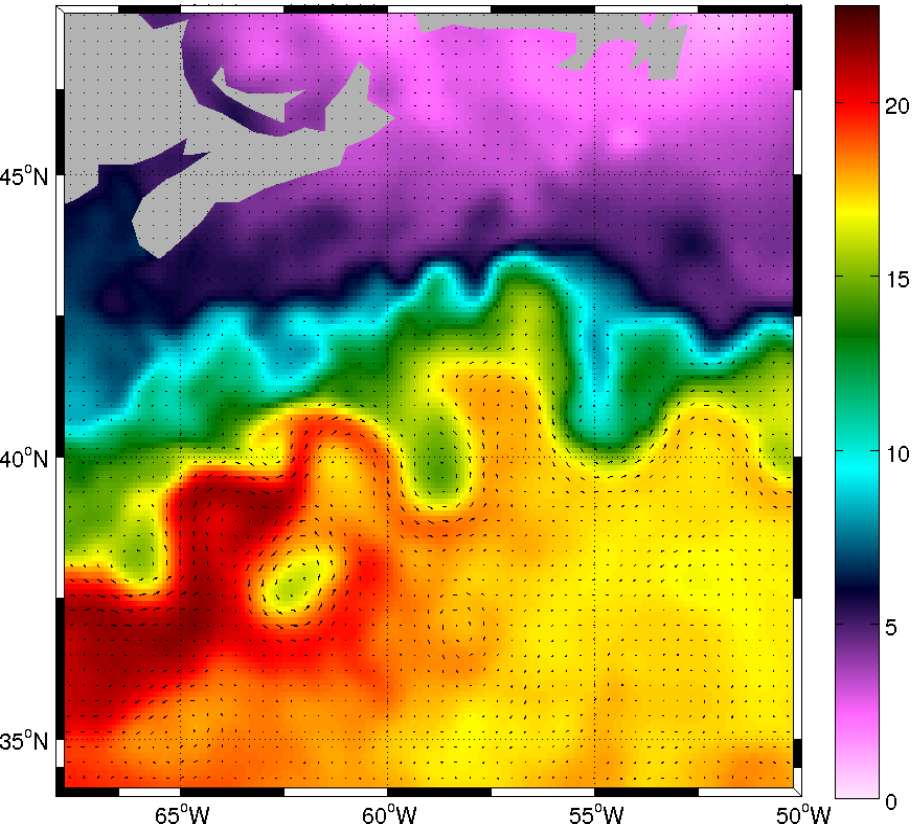


There is apparent (i) similarity between MSS and SAR NRCS signatures, and (ii) correlation with surface current convergence

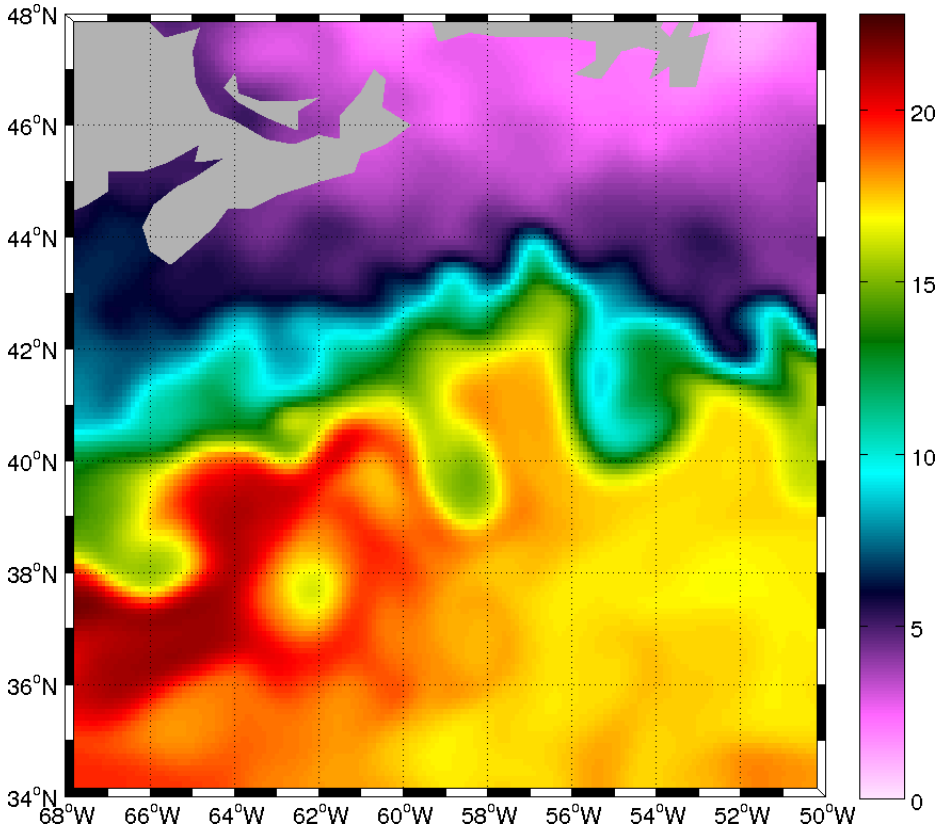
Kudryavtsev et al, 2012


EANDATALAB"
Datasets
Hotspots
Summerville
Goose Creek
North Charleston
Combined Sun Glint (>15-20)
and SST (from MODIS)
3-Day
Weekly
100.0% datasets shown (4/4)
MYD02QKM.A2010091.1805 from SST MODIS denoised (NASA, OceanDataLab)
2005
2006
2007
2008
2009
2010
2011
February
March
April
May
June
July
August
September
October

Forward Lagrangian Advection from 02/05 to 06/05 2010

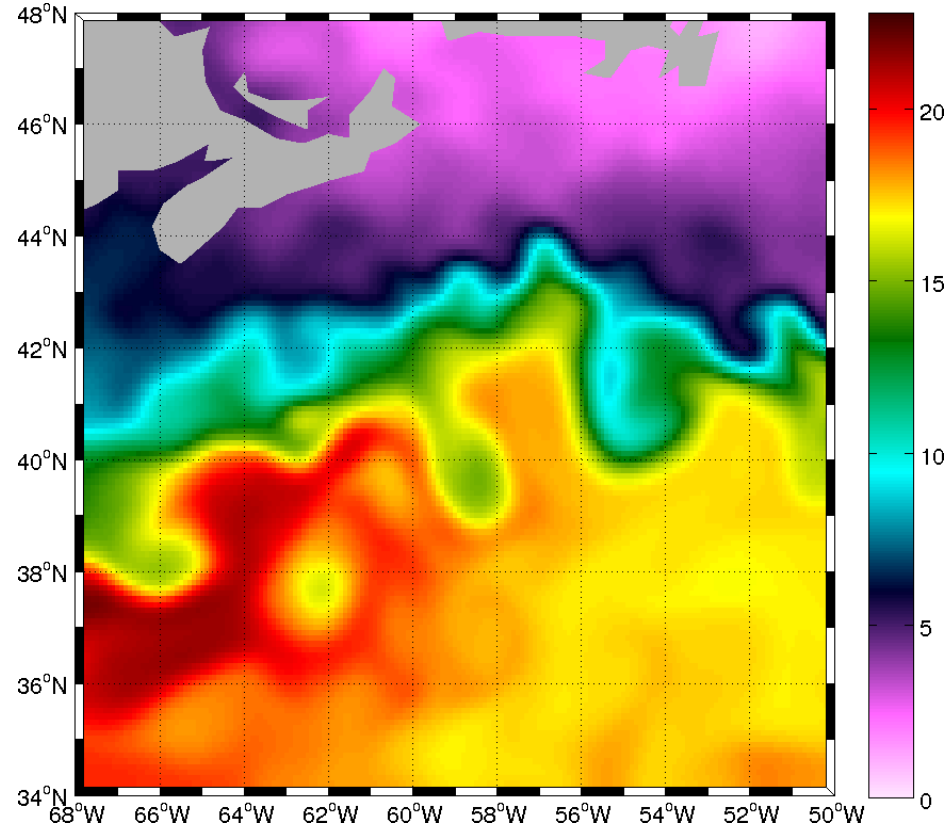


SST and AVISO Current Vectors at 25 km resolution (02/05/2010)

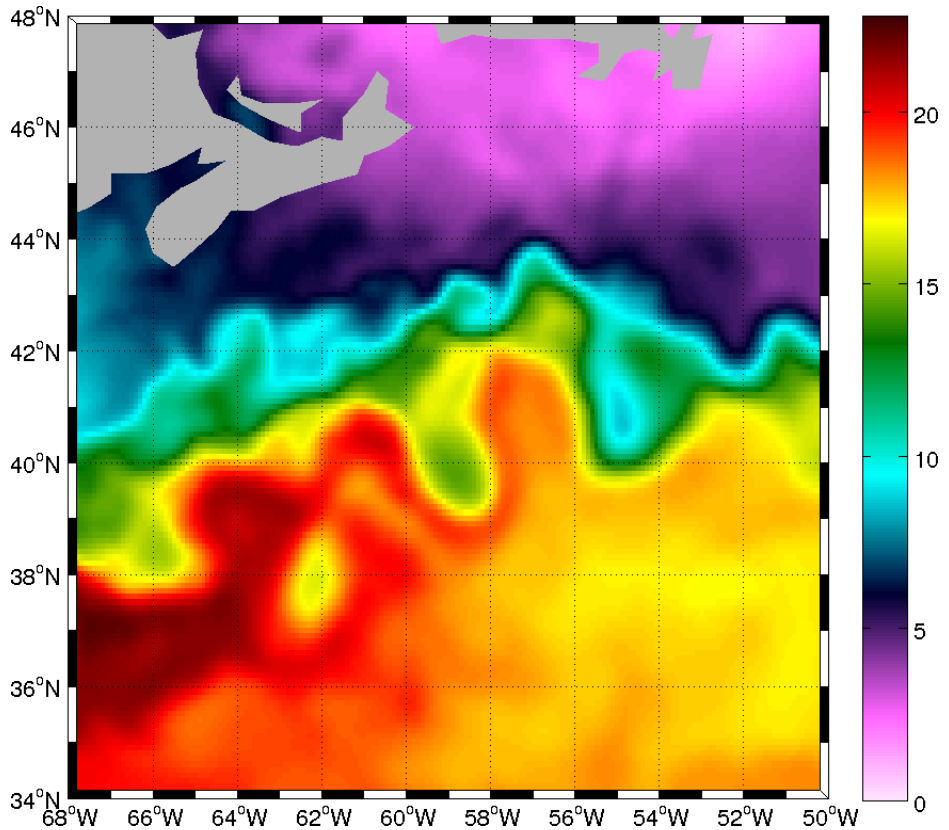


06/05/2010 - « smoothed » advected SST (4 days)

Forward Lagrangian Advection from 02/05 to 06/05 2010

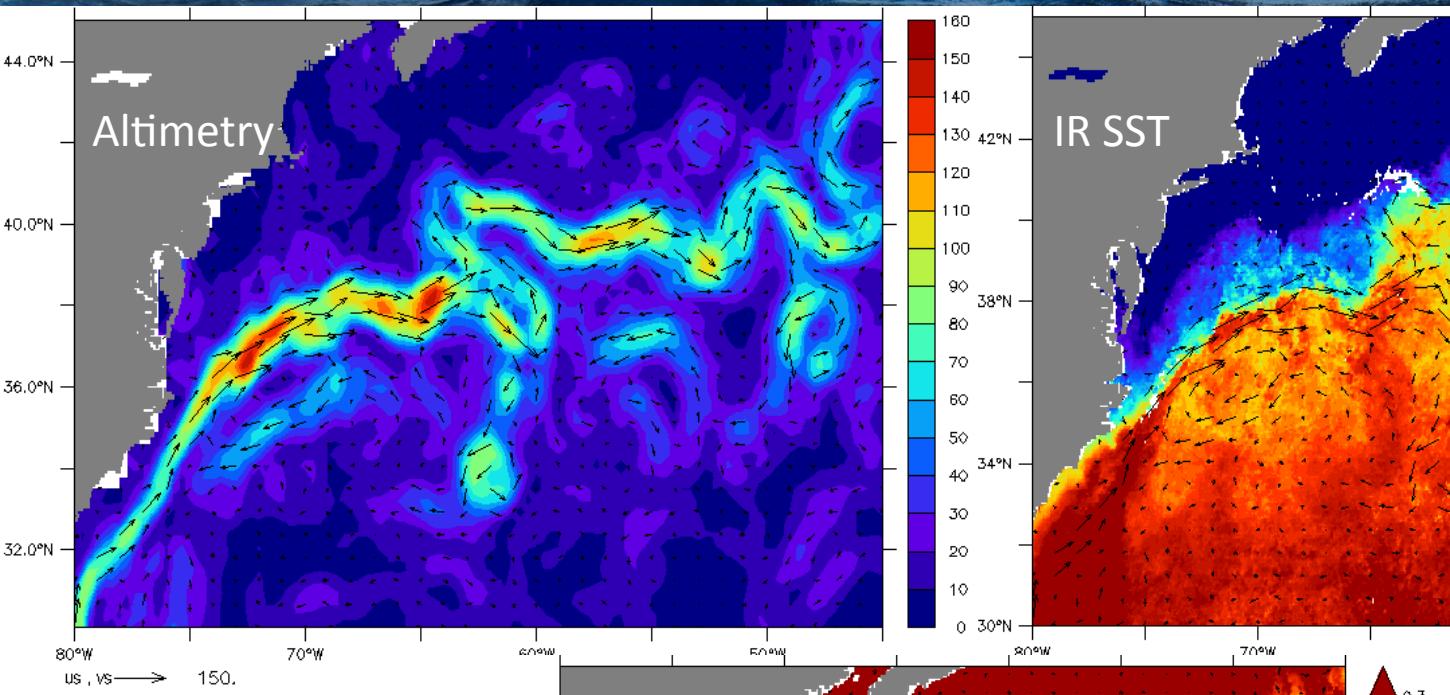


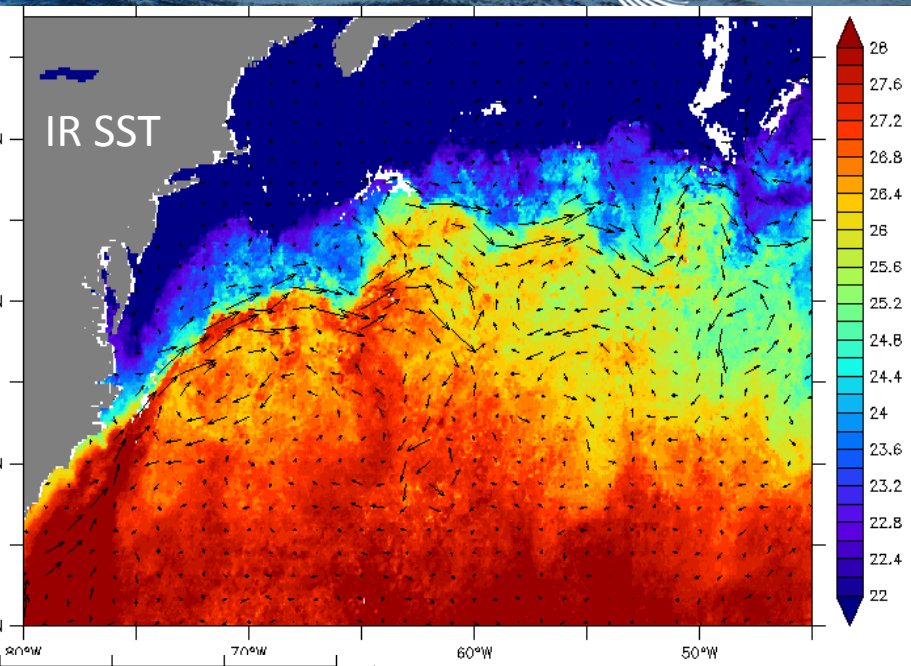
06/05/2010 - « smoothed » advected SST (4 days)

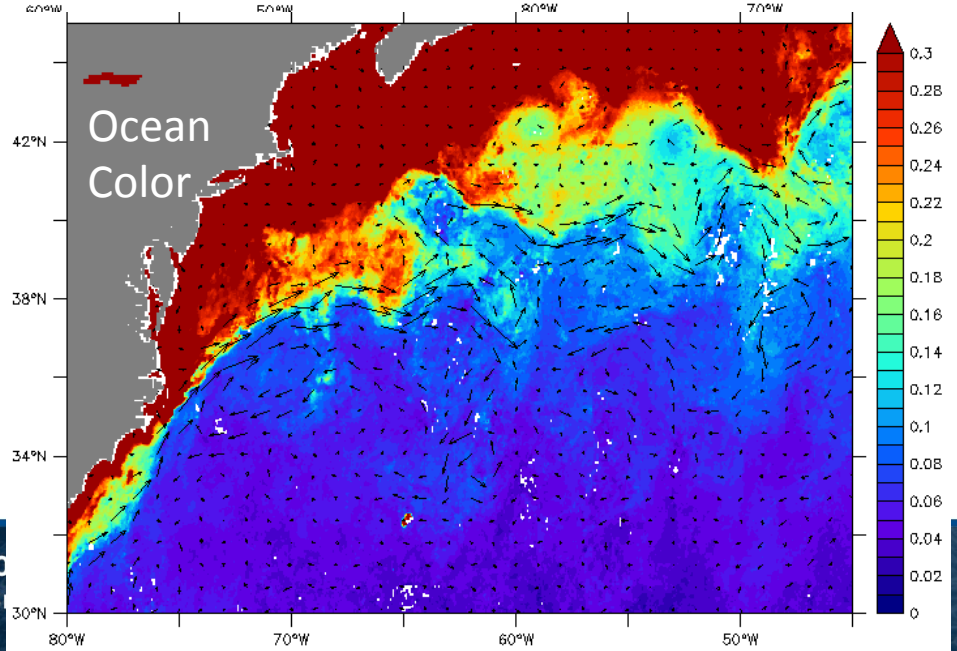


06/05/2010 – Observed SST

SSH , SST, OC

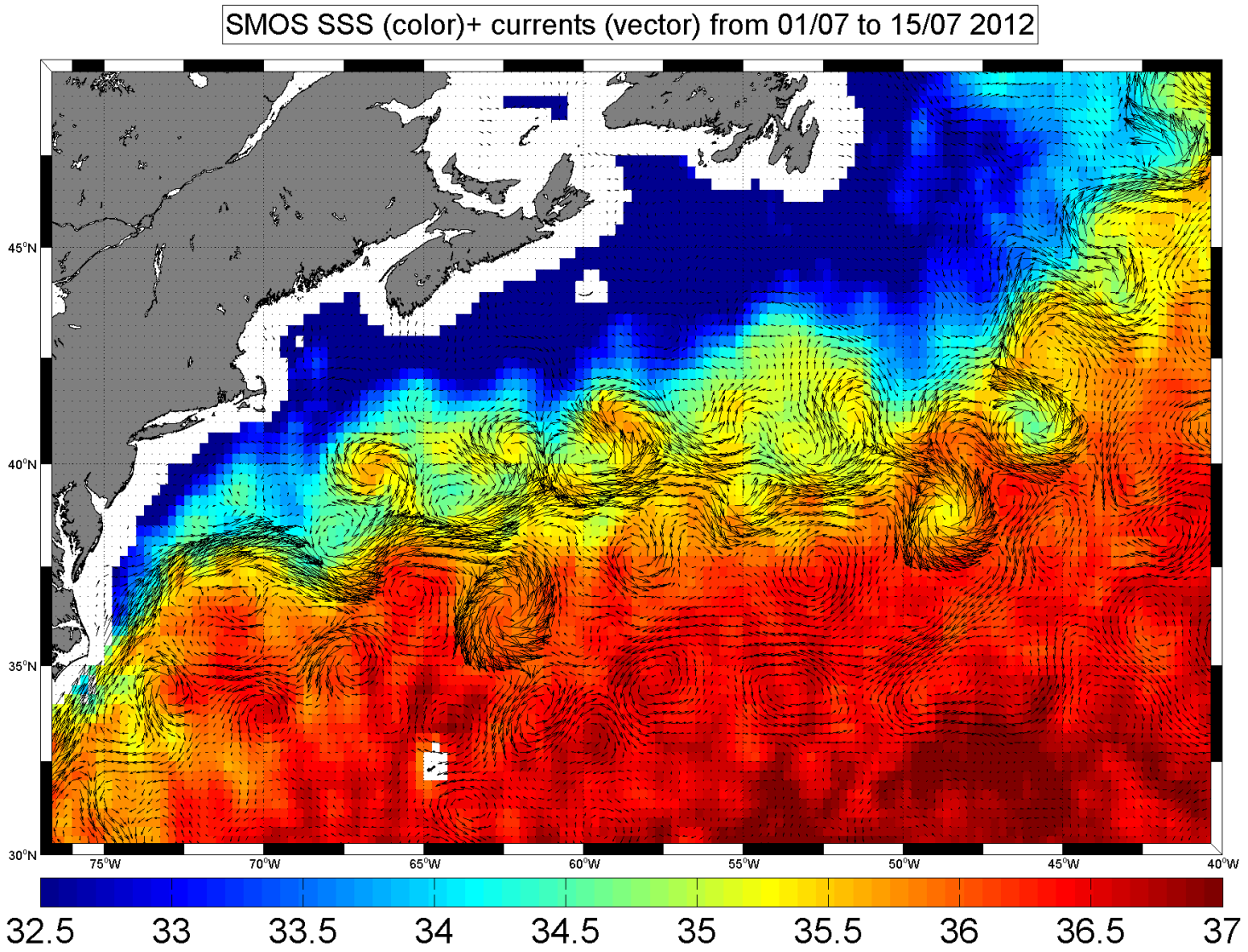




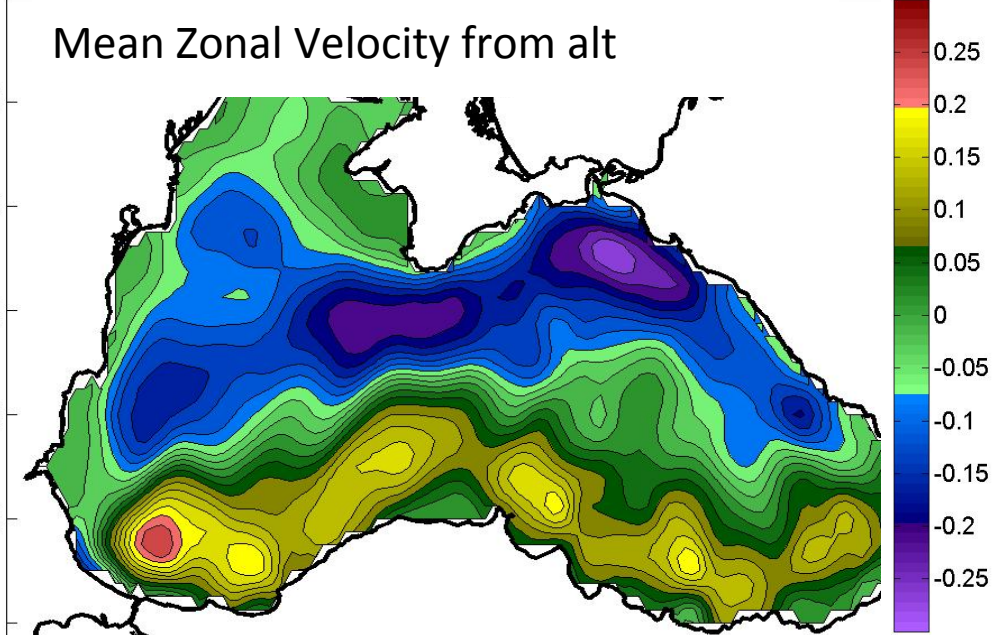


September mean 2009

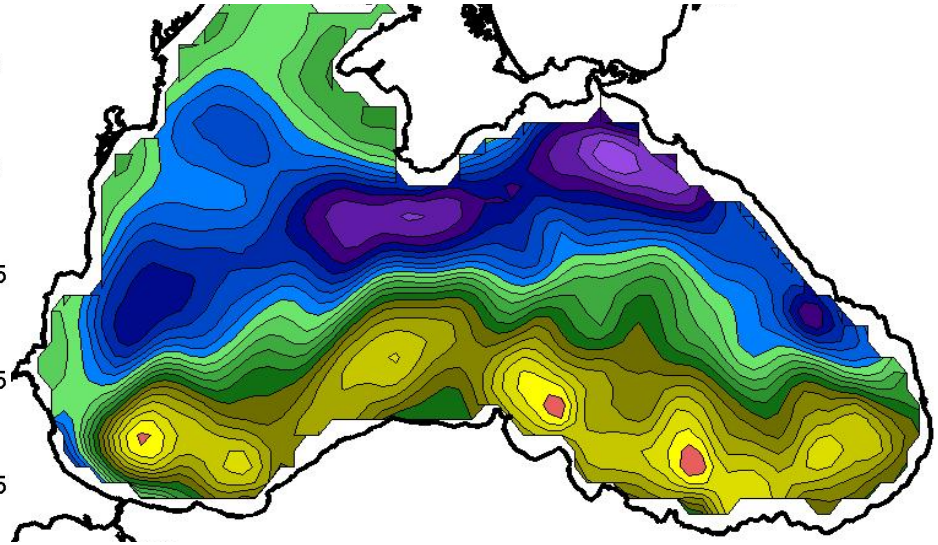
SSS and Geostrophic Current



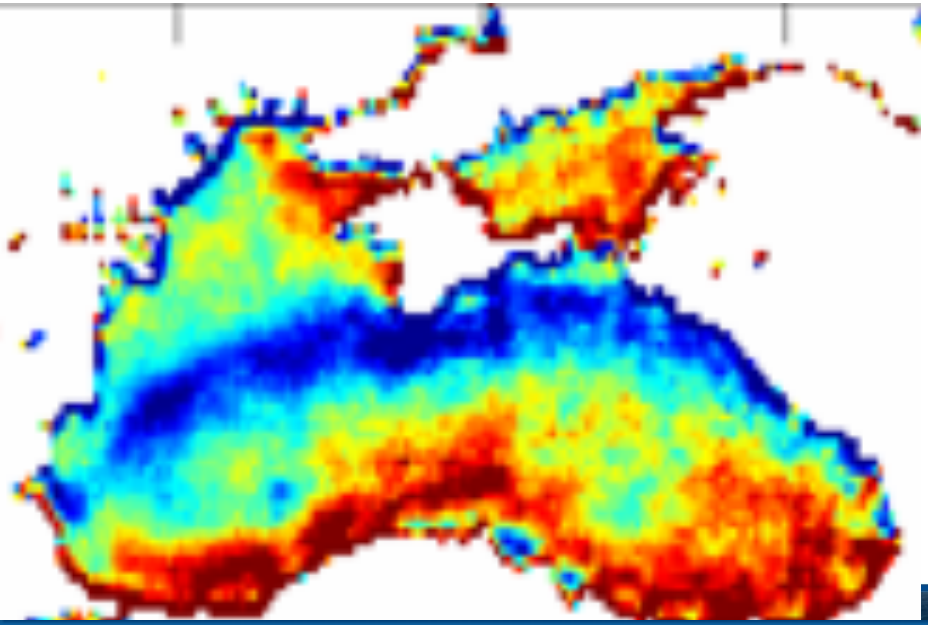
Mean Zonal Velocity from alt



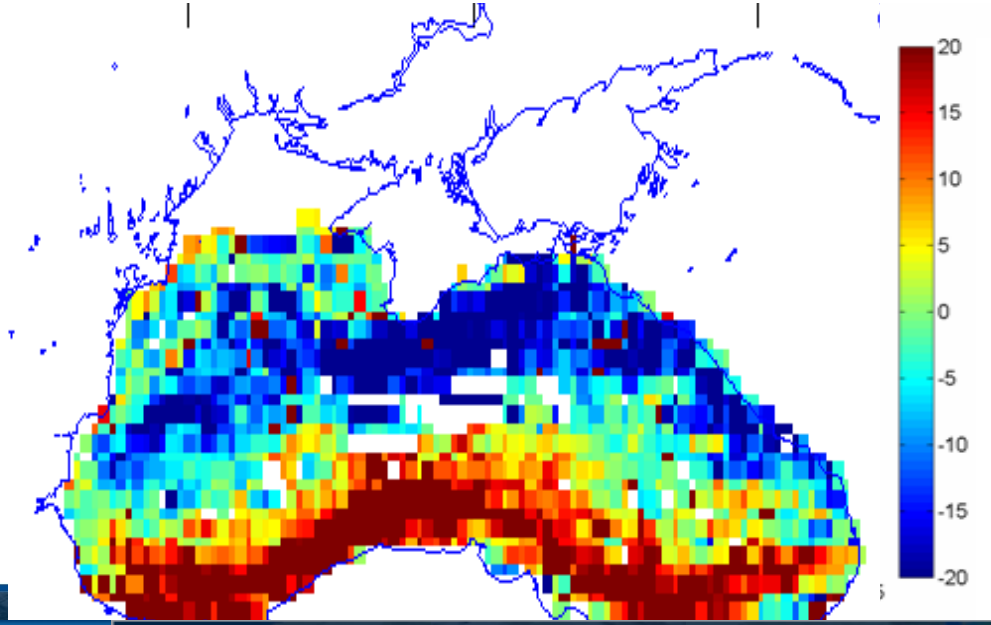
Mean Zonal Velocity from MM5

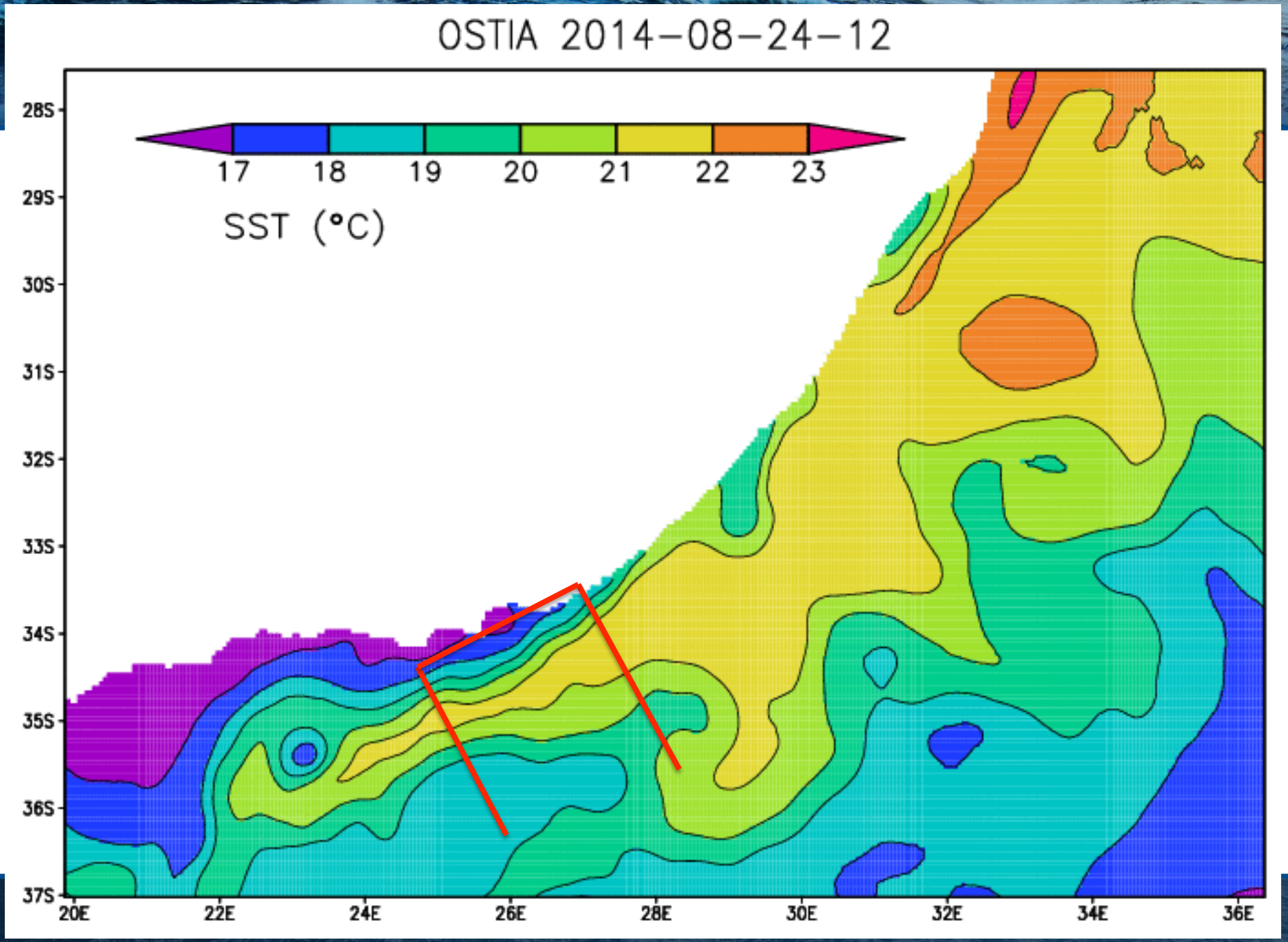


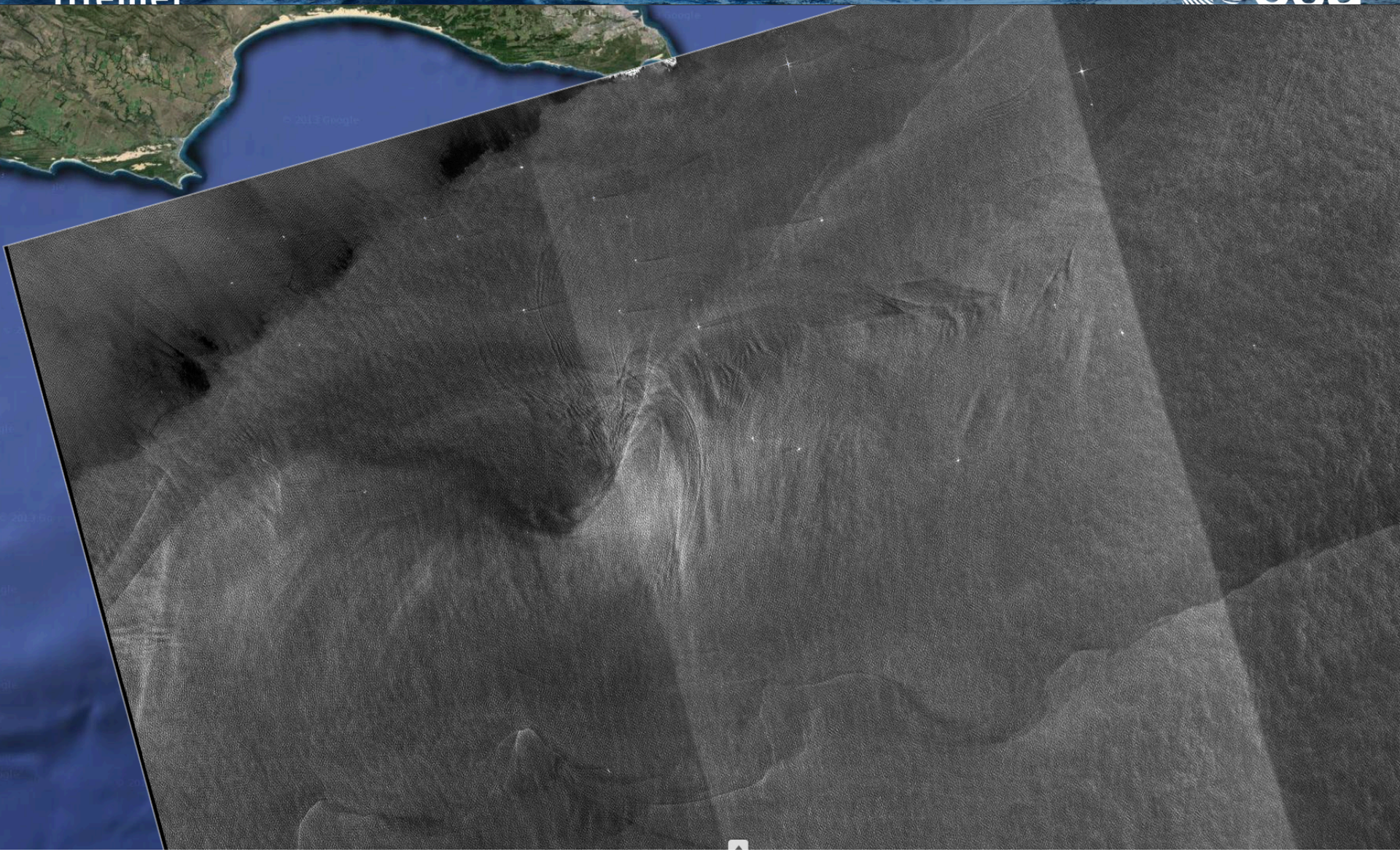
ASAR Mean Zonal Velocity



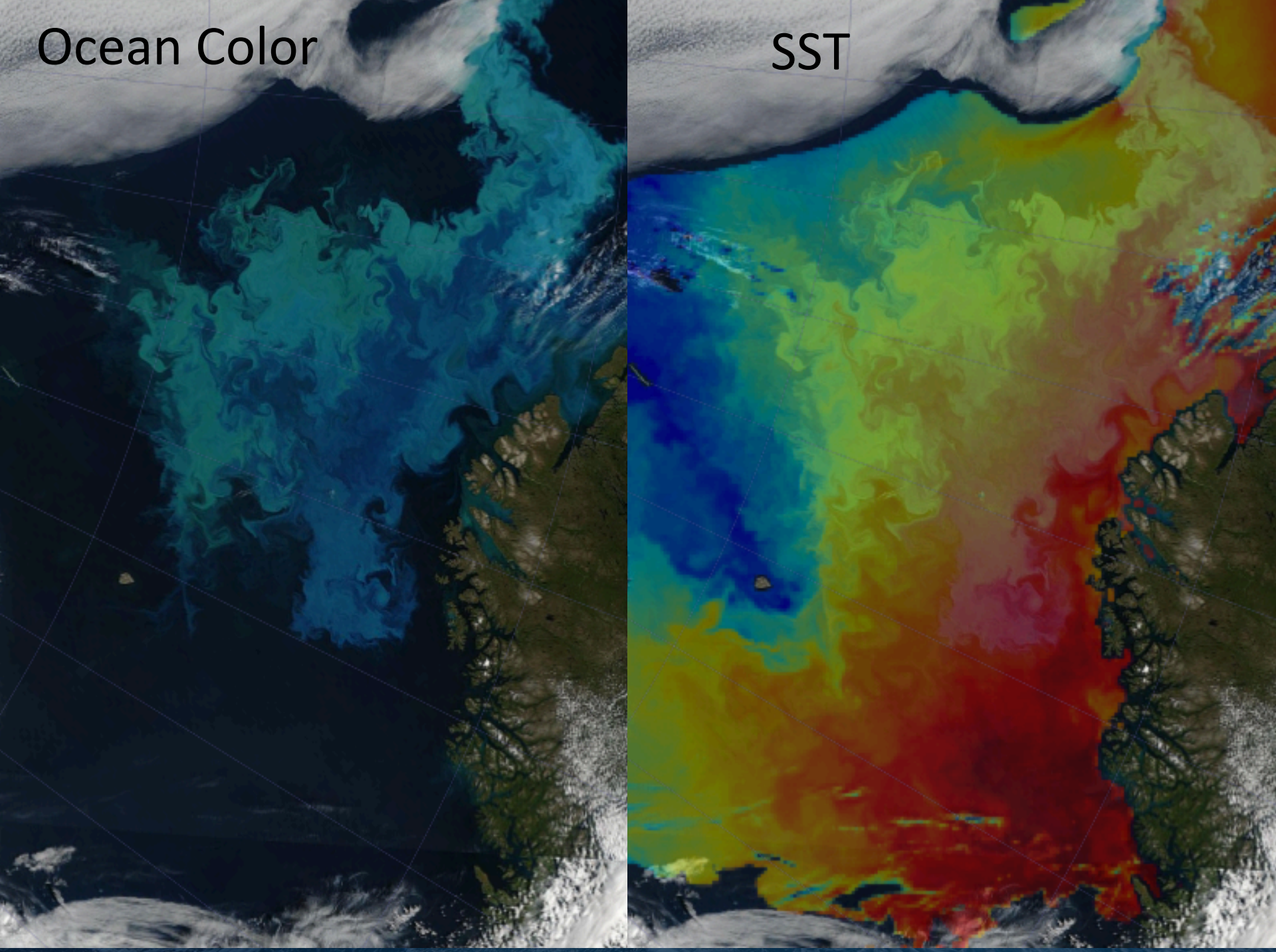
Drifter Mean Zonal Velocity



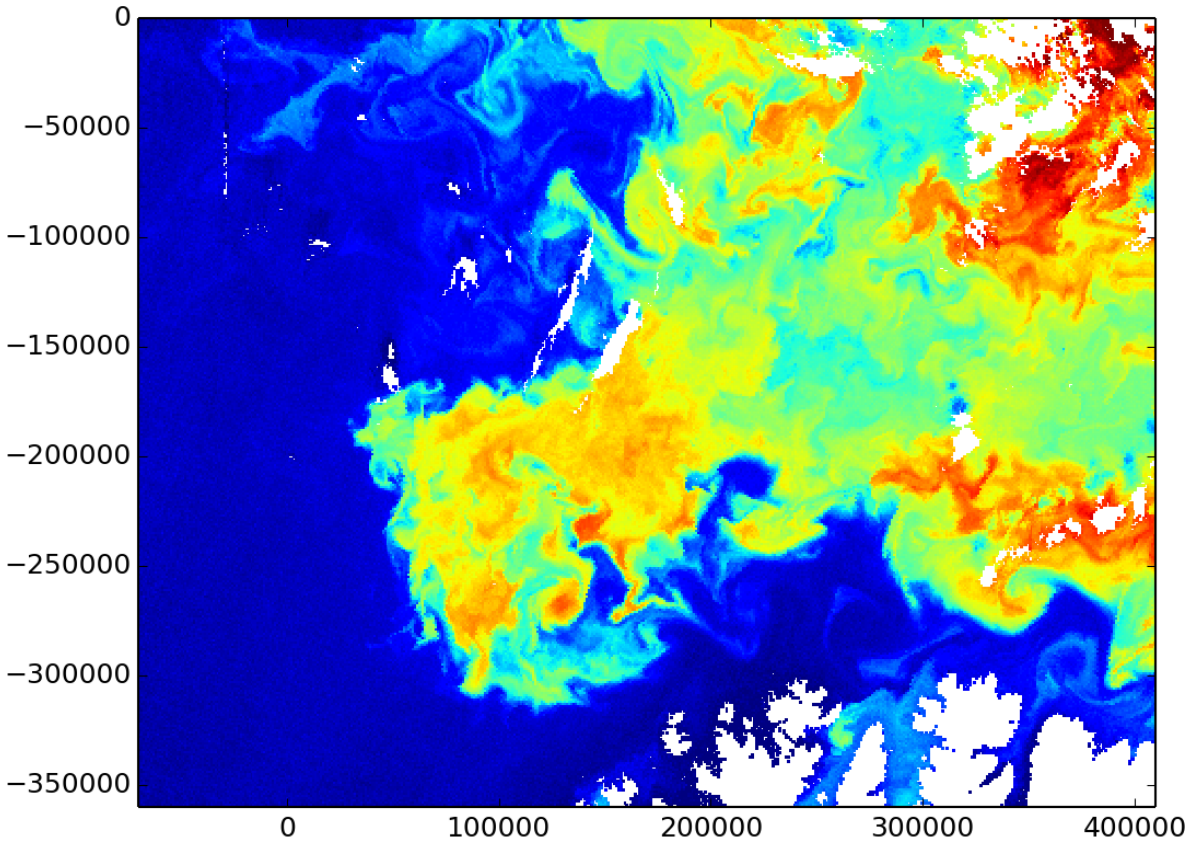

OSTIA 2014-08-24-12
17
18
19
20
21
22
23
SST (°C)
28S
29S
30S
31S
32S
33S
34S
35S
36S
37S
20E
22E
24E
26E
28E
30E
32E
34E
36E



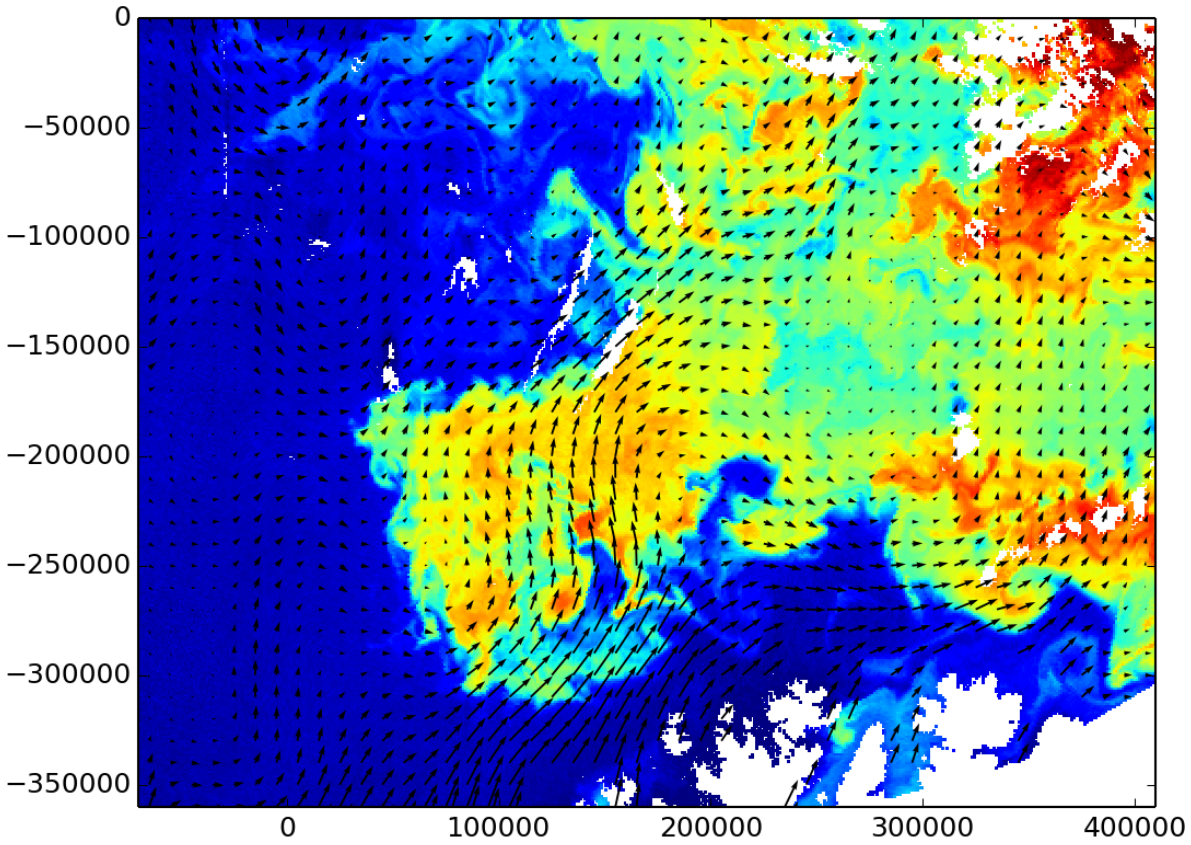
Sentinel-1 acquisition 24 August 2014


Ocean Color
SST

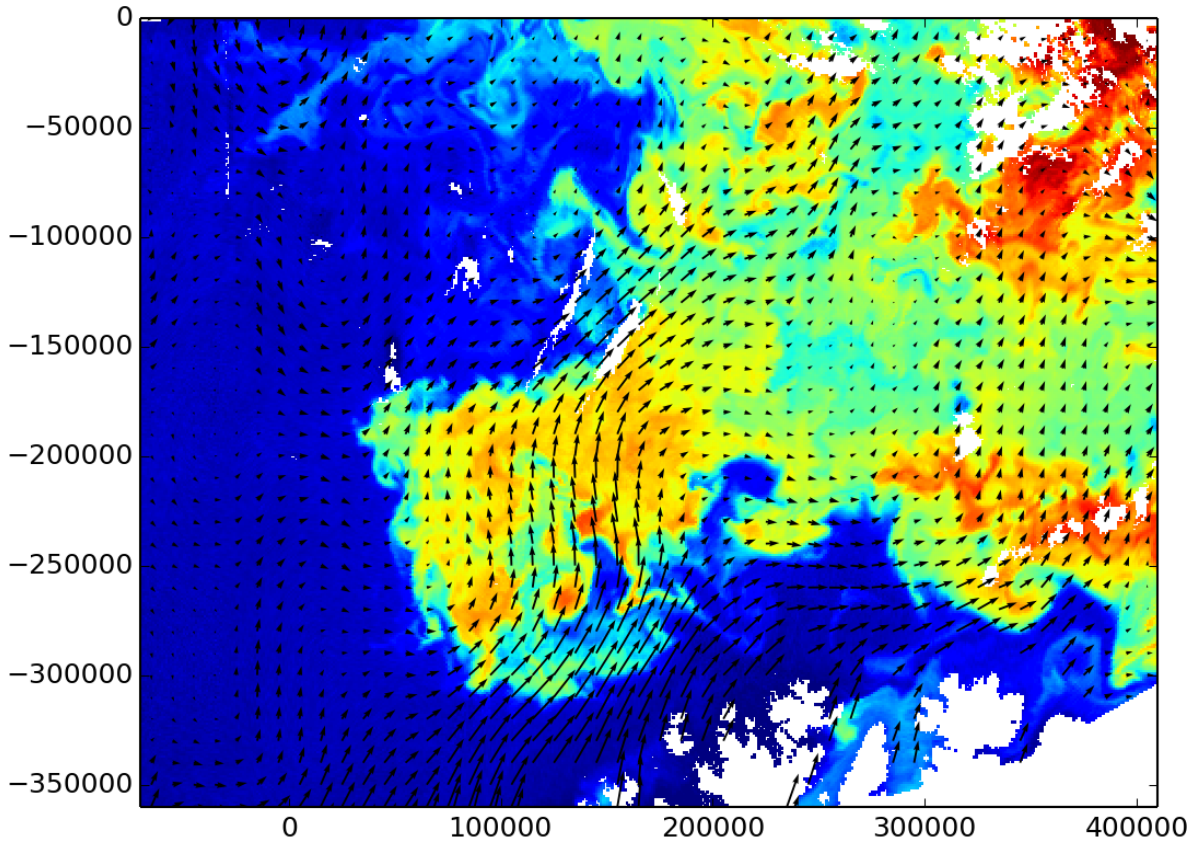
2012-08-17 12:00



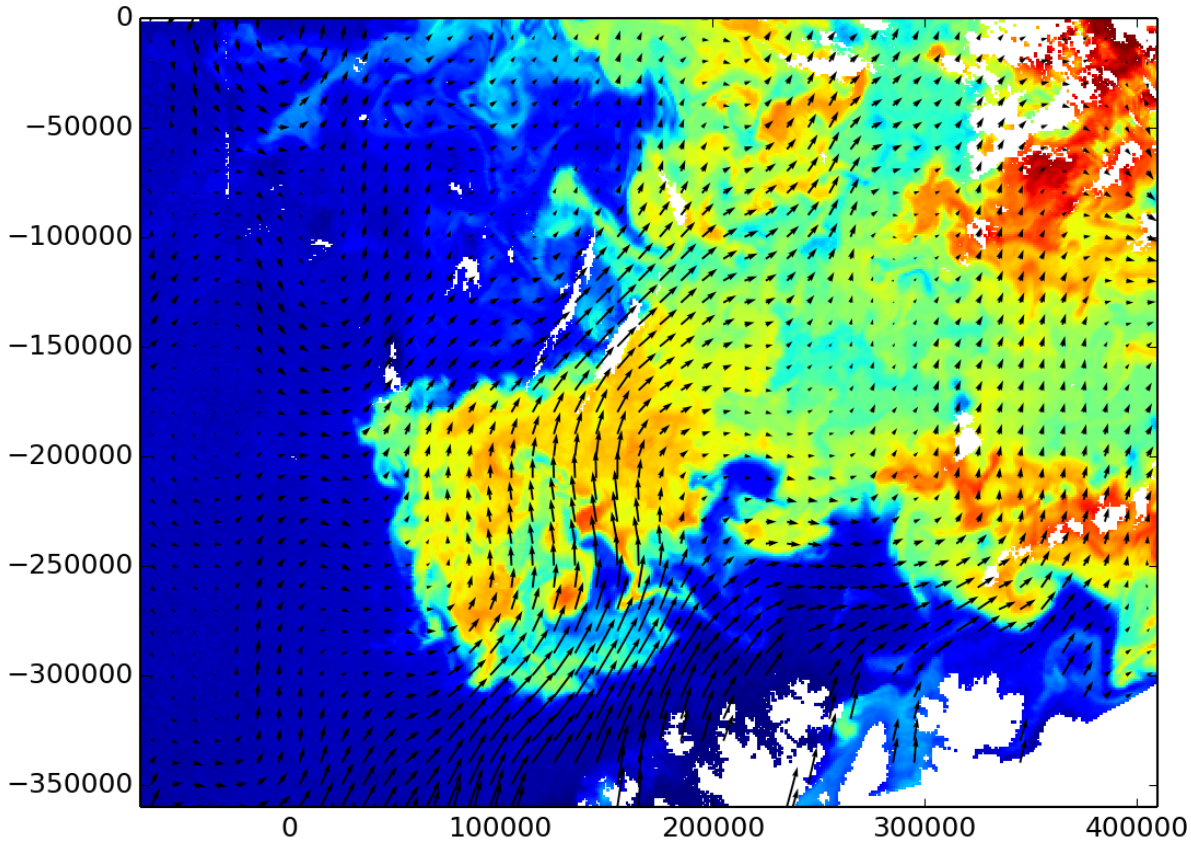
2012-08-17 15:00



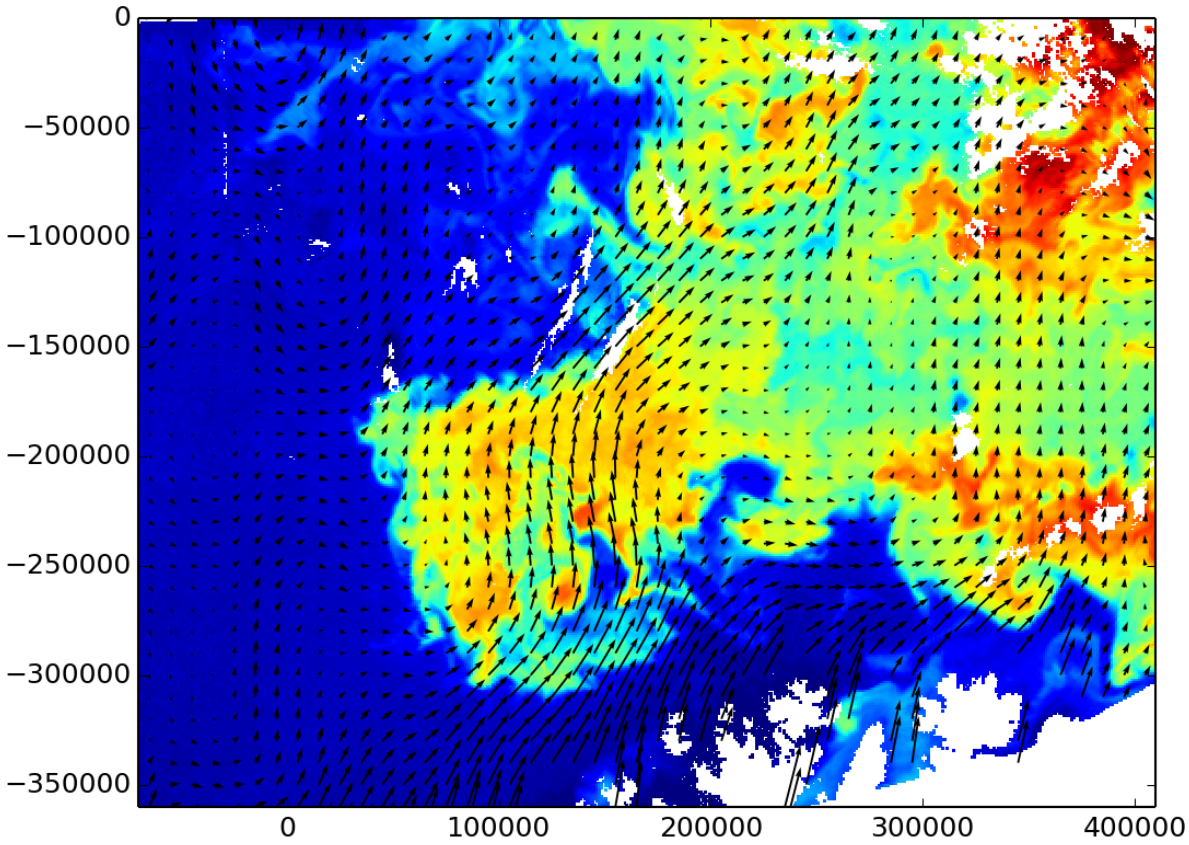
2012-08-17 18:00



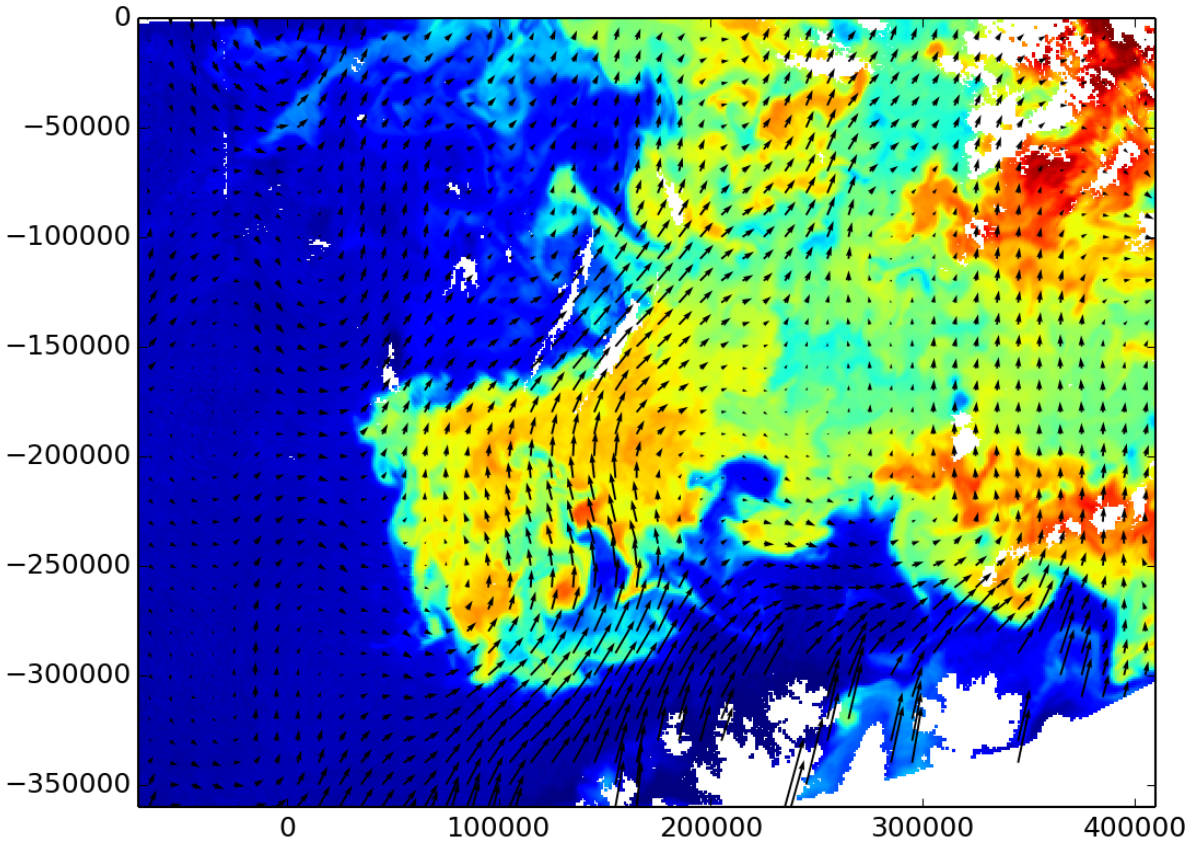
2012-08-17 21:00



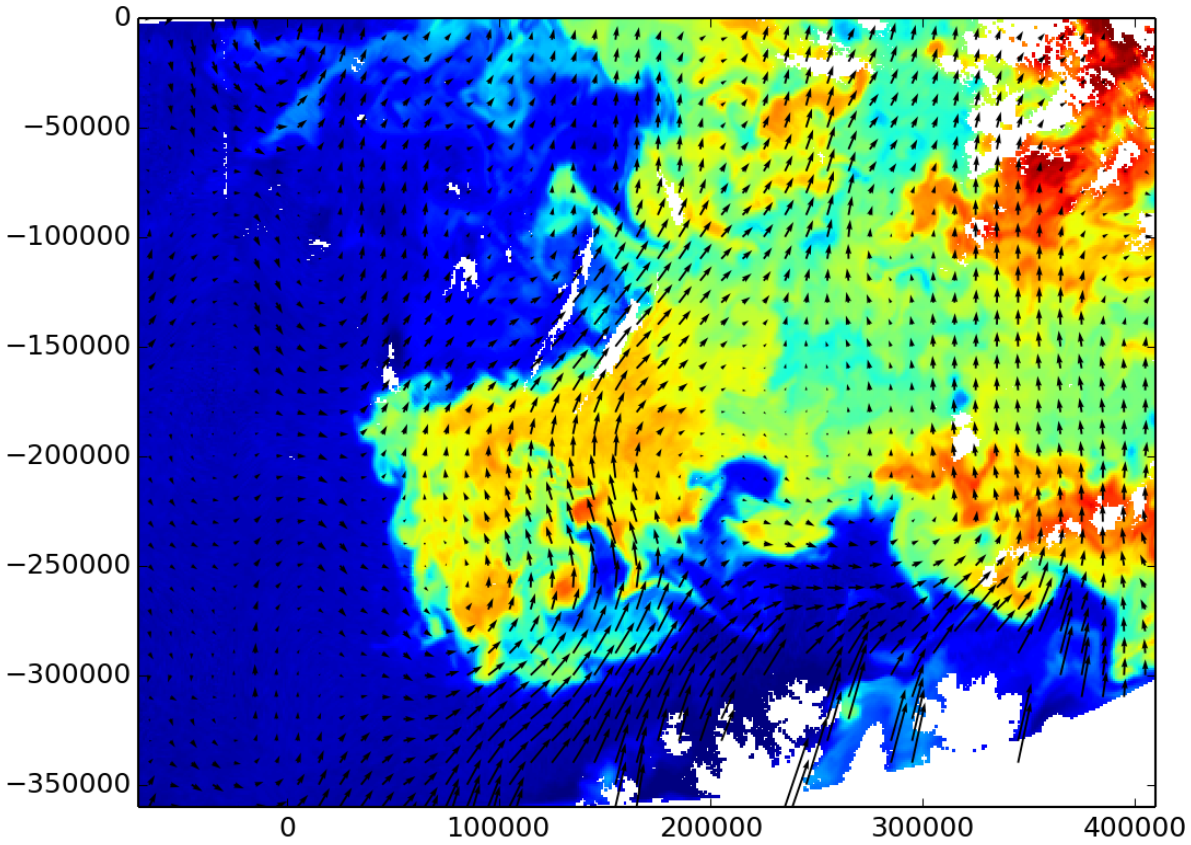
2012-08-18 00:00



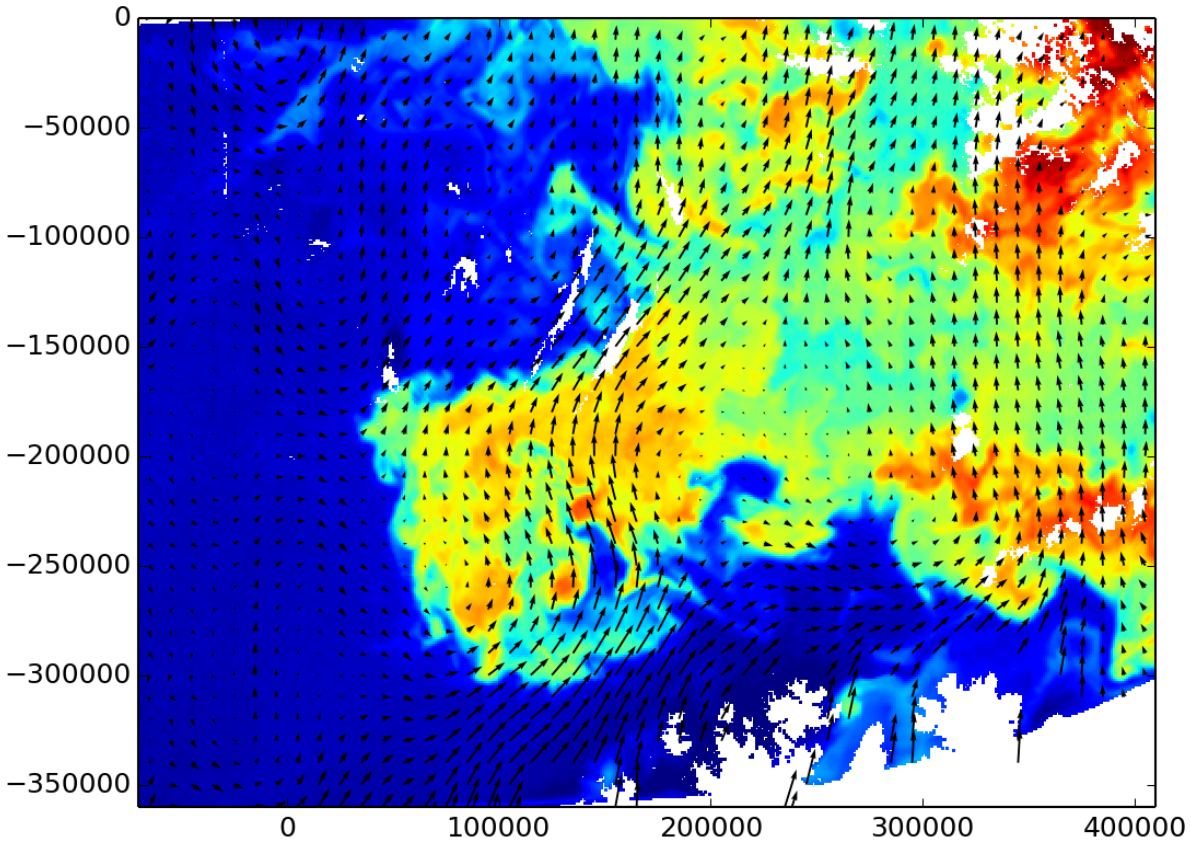
2012-08-18 03:00



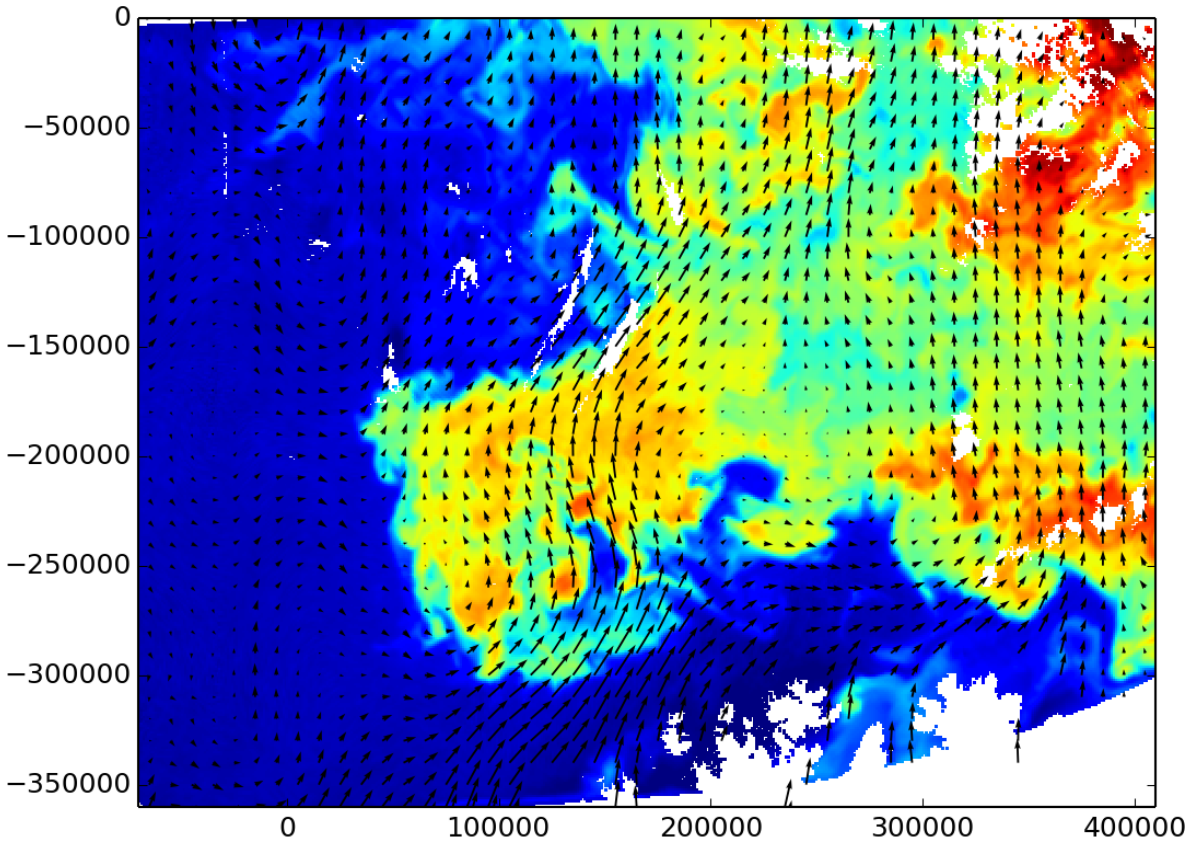
2012-08-18 06:00



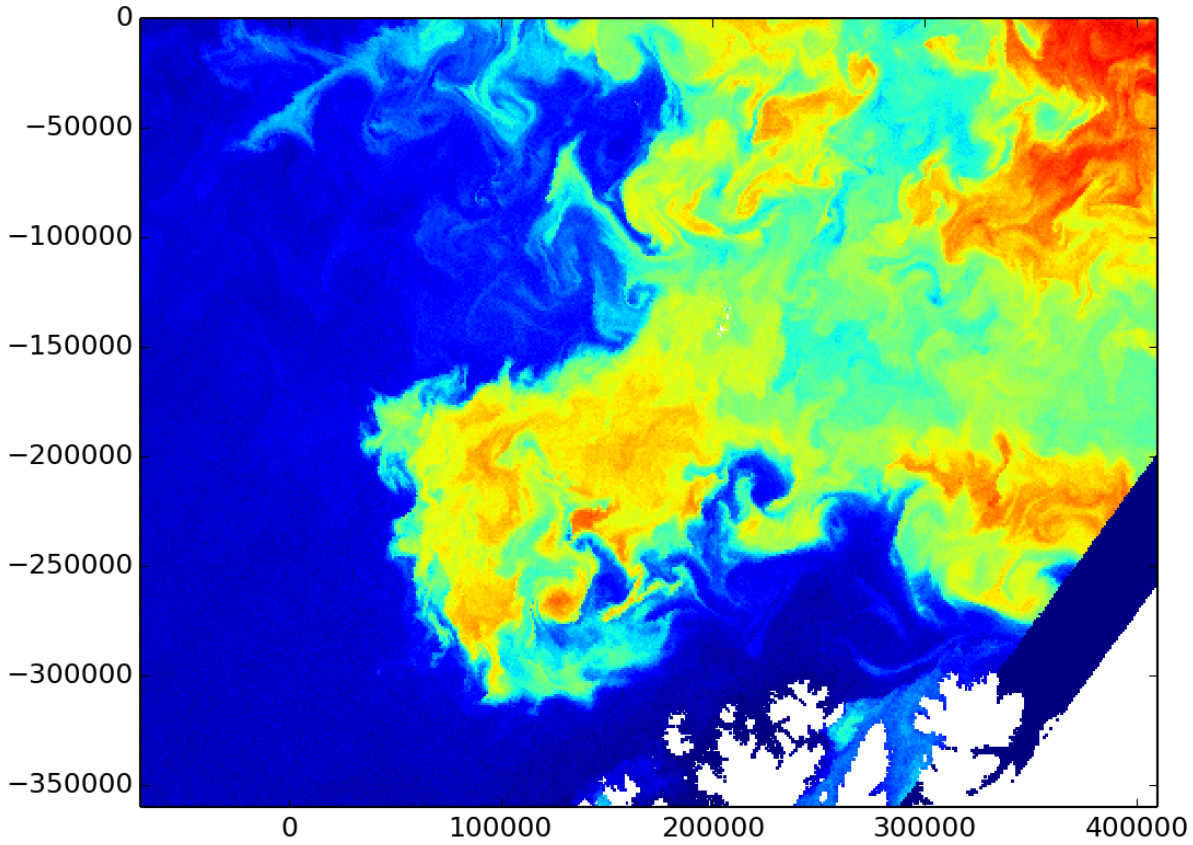
2012-08-18 09:00



2012-08-18 12:00

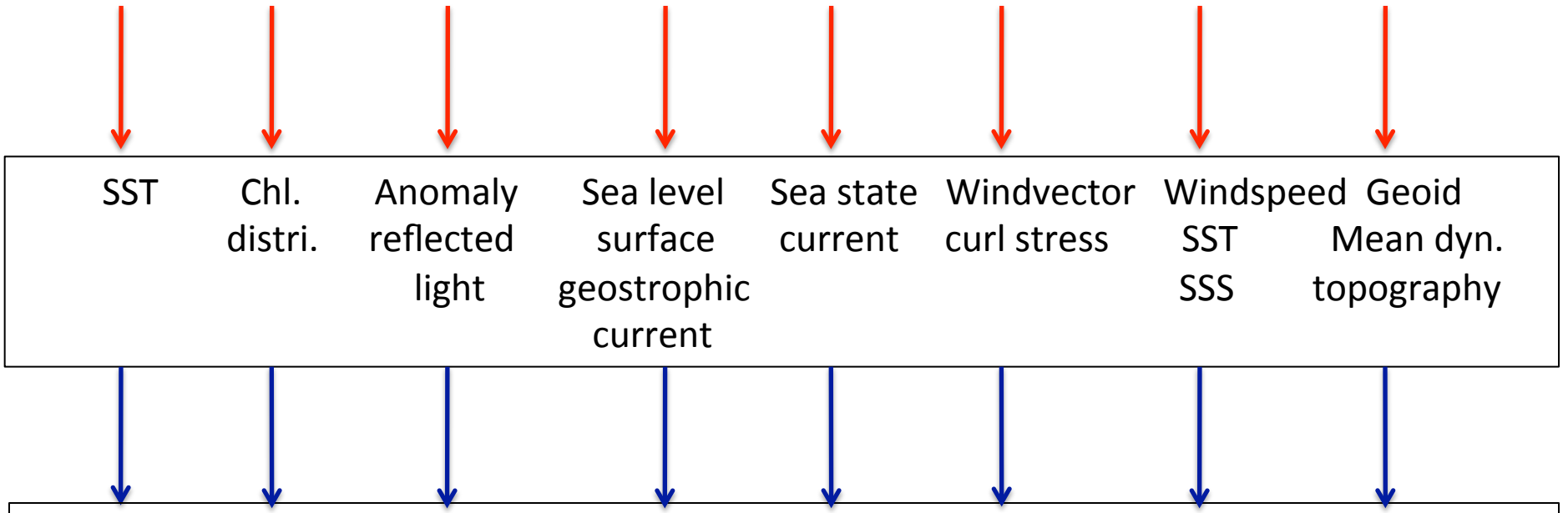


2012-08-18 12:00



Satellite Sensor Synergy

Infrared, Visible, Microwaves (passive, radars), Accelerometers



RANGE OF TWO DIMENSIONAL SURFACE EXPRESSIONS WHICH OFTEN HAVE ONE THING IN COMMON – NOTABLY RELATED TO THE OCEAN SURFACE DYNAMICS

Outlook

- A new framework for satellite sensor synergy is now emerging that can advance studies of the upper ocean (~ 100 m) dynamics. Towards the end of the year the global data base will be extended to cover 2002-2015. Will be available at www.globcurrent.org/

- The goal is to ensure simple and easy access and use of the framework

- A User Consultation Meeting will take place at IFREMER, Brest 4-6 November following an ESA science conference on future current