# Regional ultra high resolution sea surface temperature analysis

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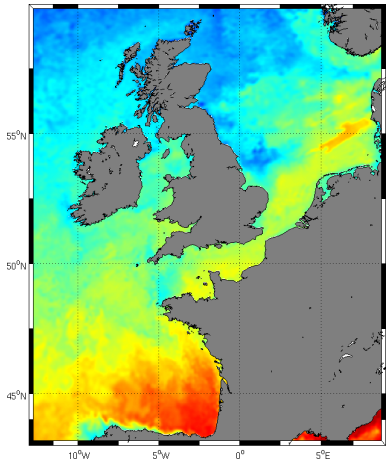
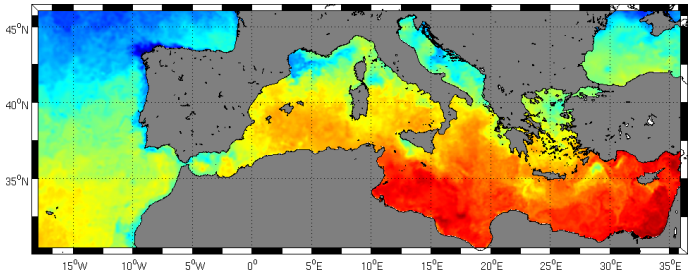
# *Regional UHR L4 from 2005 up to 2008*

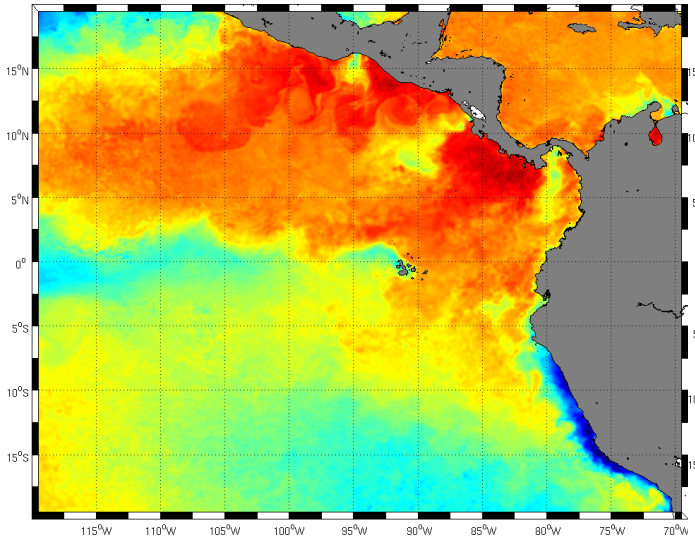
North West shelf



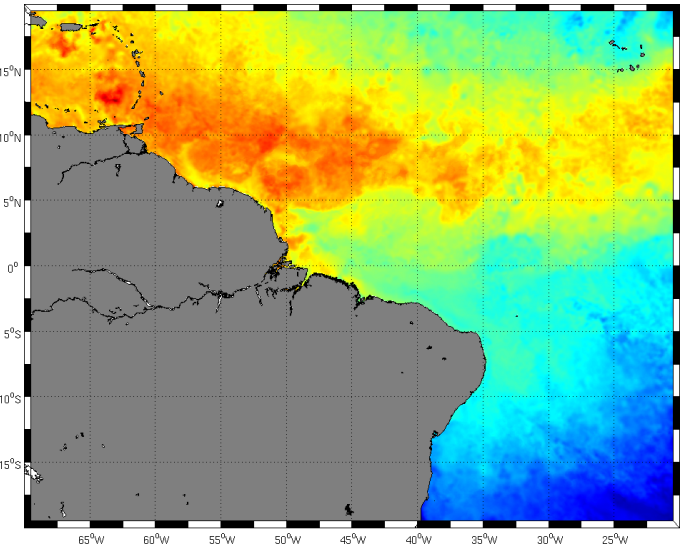




Mediterranean

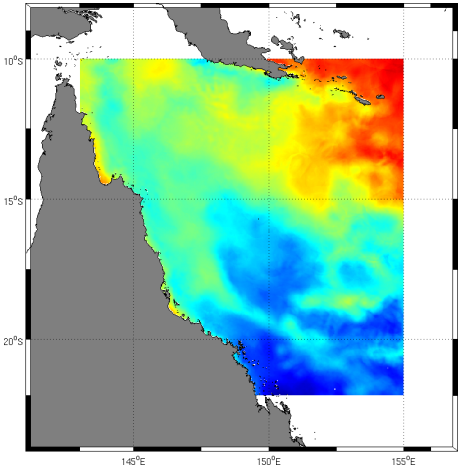
Galapagos




Brazil



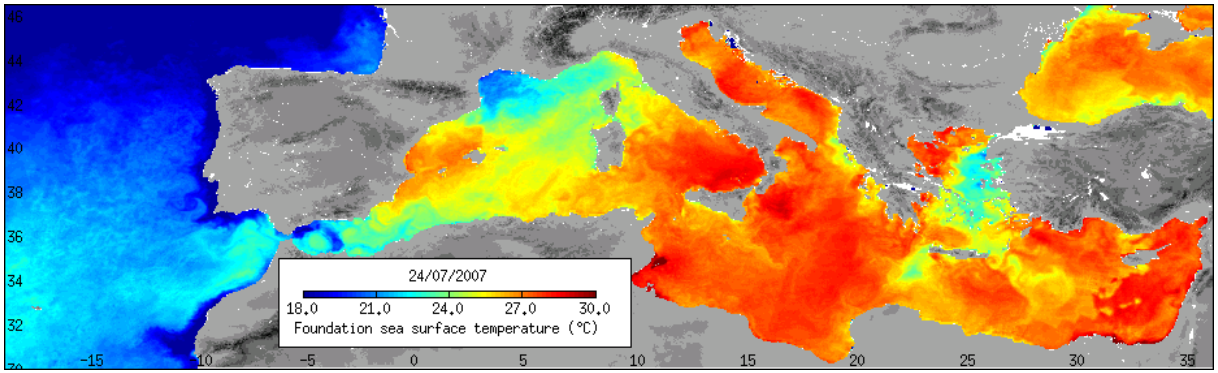

Great Bareer Reef



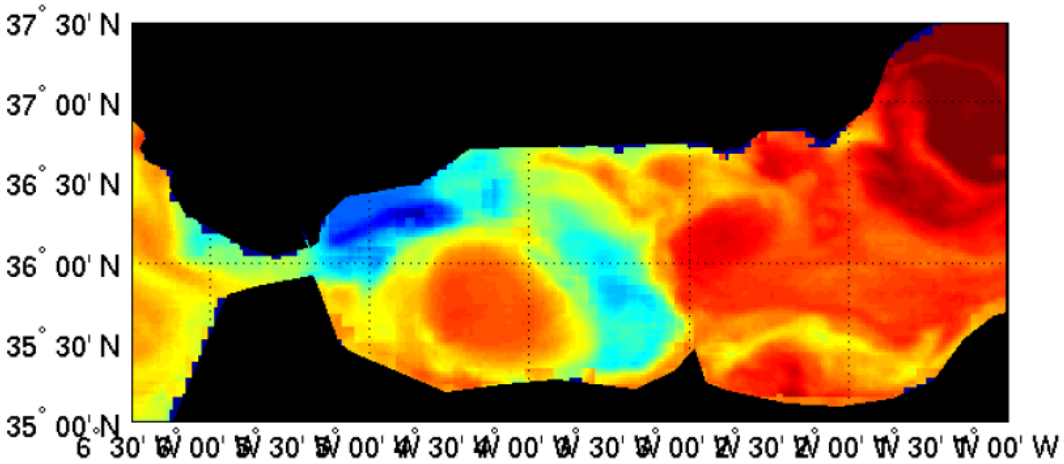
# *2006-2007 Mediterranean L4 fields*

- From Jan. 2006 up to Dec. 2007, the OI processing chain configuration over the Mediterranean had been stabilized:
  - Daily, 2km resolution, night-time data only
  - NAR17-18, Seviri, AATSR, AMSRE, TMI, AVHRR17-18 Gac and LAC
- Real time monitoring tools had been developed (www.medspiration.org/tools). They provide users or producers with visual tools qualitatively pointing out weak points or/and strong points
- Need for the SST time-series validation
  - to better quantify the OI scheme capability (oceanic structures or scales resolved, impact of the configuration on the results, ...)

# *2006-2007 Mediterranean L4 fields*



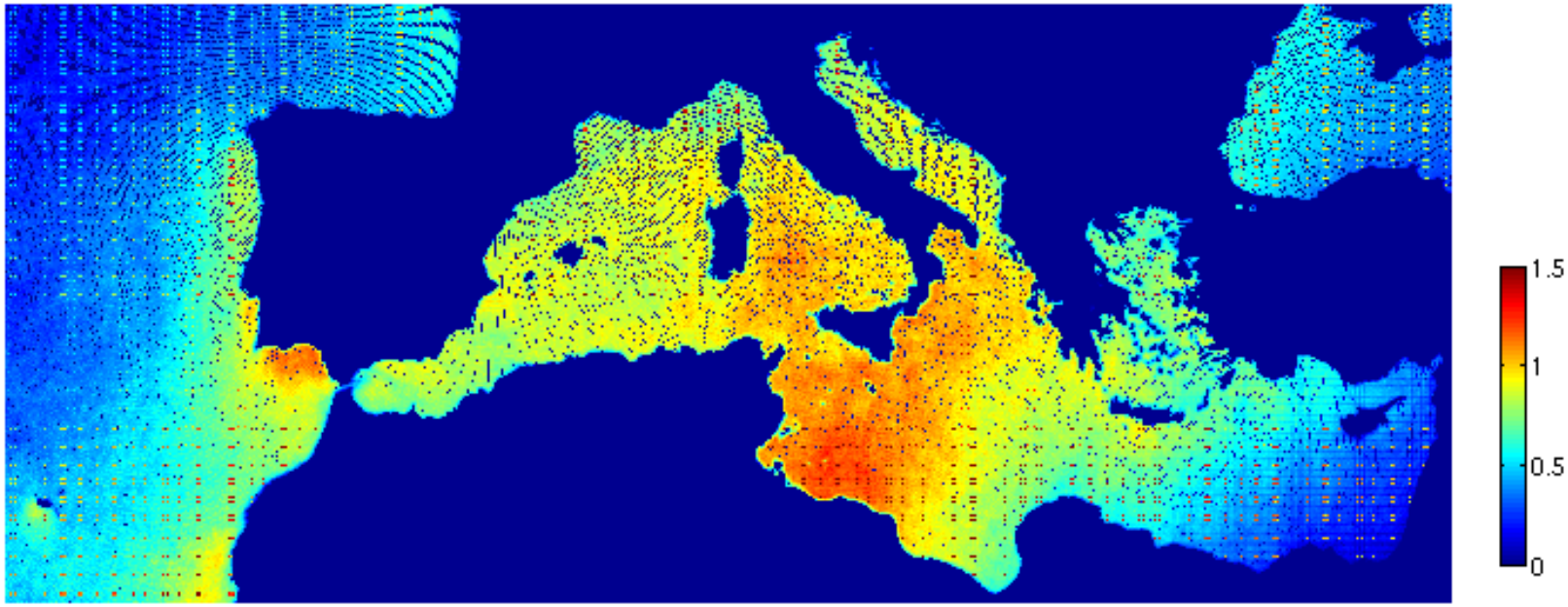

Medspiration L4 SST foundation (24/07/07), clearly shows that mesoscale oceanic features seem to be well preserved by the analysis and can clearly be identified. It is event clearer in the zoom of the field in the Alboran Sea where the Alboran eddy and Alboran front can be easily identified



# *2006-2007 Mediterranean L4 fields – 2006 assessment*

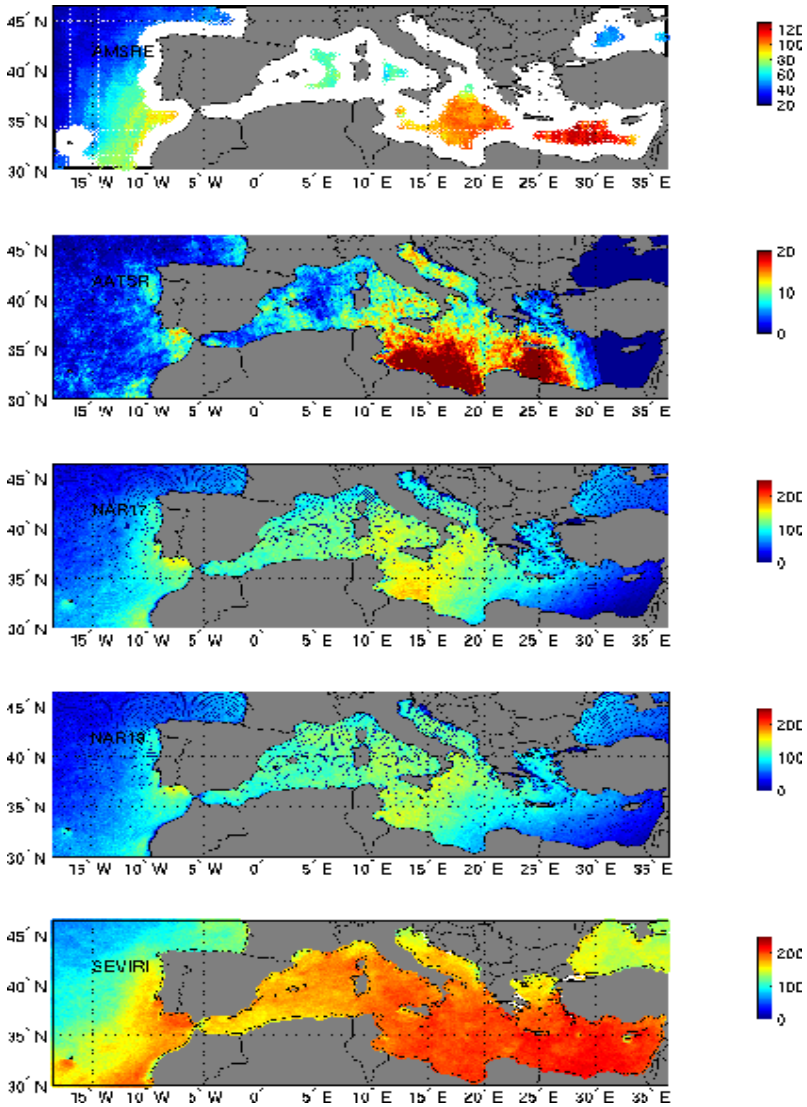
- Data set:
  - Because of the satellites sampling and cloud and aerosols coverages, the availability of SST data greatly varies over this Medspiration area.
  - 2006 data set: The central and western basins are well sampled with more than 1 L2P sample per day per L4 grid point whereas the near Atlantic , because of clouds, and eastern Mediterranean , mainly because of aerosols , are quite poorly covered with less than 0.5 sample per day.

Mean number of collated SST point per day



# *2006-2007 Mediterranean L4 fields – 2006 assessment*

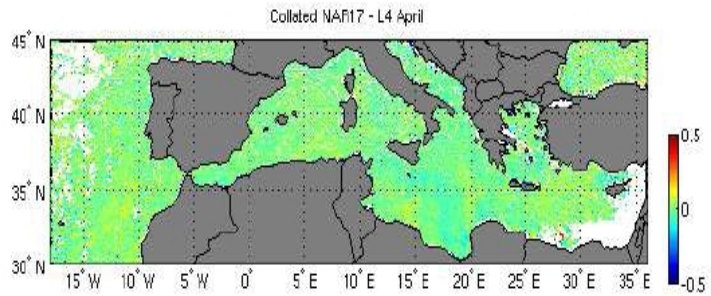
- Number of L2P samples available for 2006 from each data set . The most available L2P is MSG/SEVIRI. It is available between 75 days in the near Atlantic up to 200 days in the Eastern Med.
- AVHRR17-18 (NAR product) coverages present stronger regional variations and temporal sampling with poorly covered zones (less than 20 days) over the Atlantic and Eastern Med. And good availability in the central and western Med (more the 100 days).

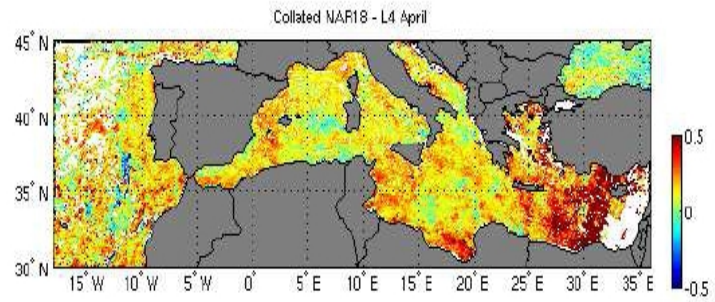


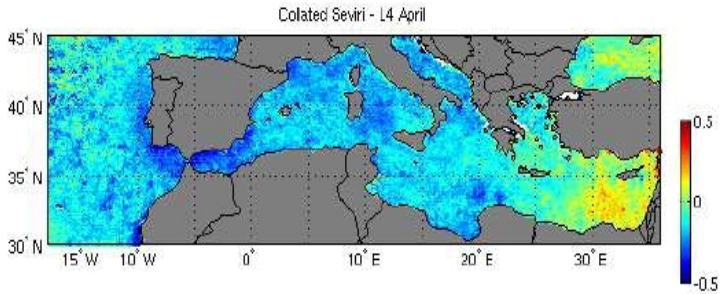
# *2006-2007 Mediterranean L4 fields – 2006 assessment*

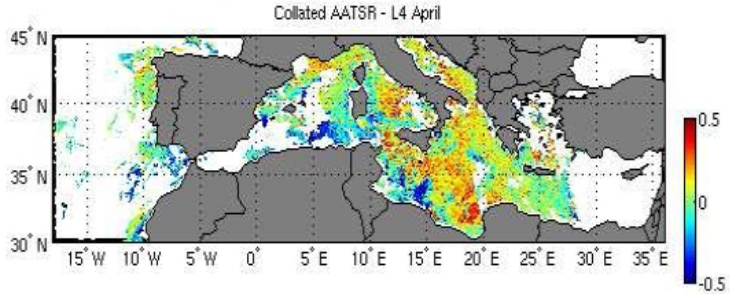
Difference between L2P and L4 for April 2006:

- NAR 17 has the largest weight in this version of OI processing chain
- Shows inter-calibration is essential



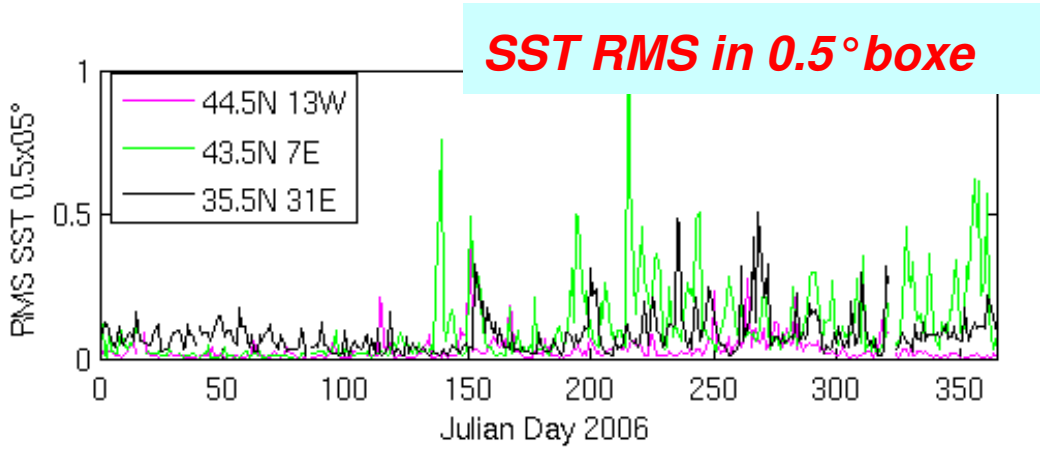
# 2006-2007 Mediterranean L4 fields – 2006 assessment

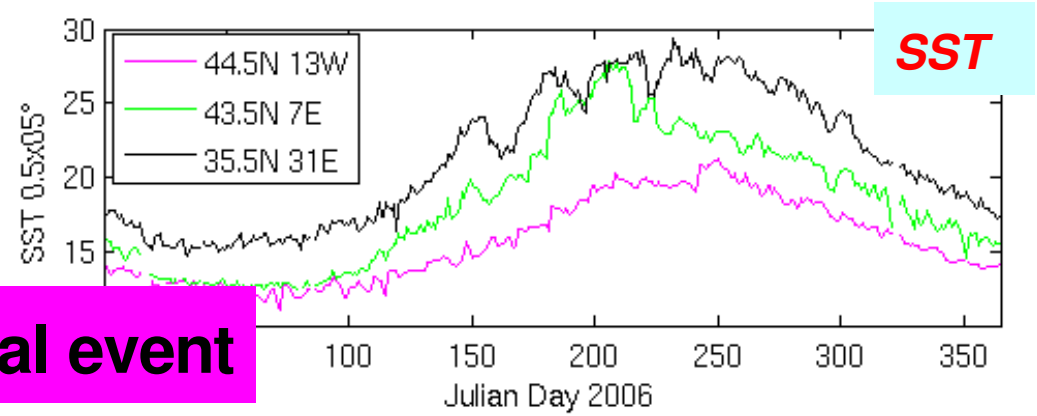
**Annual variation of SST for 3 locations**

**Near Atlantic**

**Gulf of Lions**

**Eastern Med**



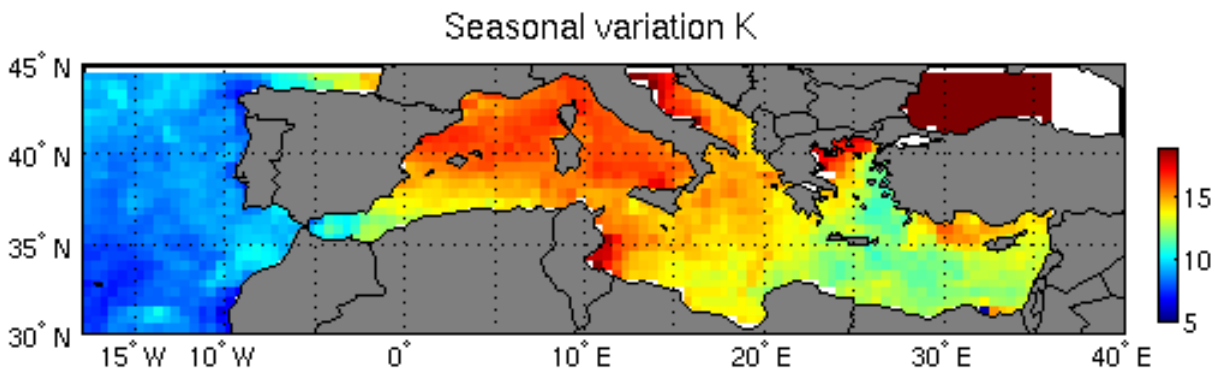




**Mistral event**

# 2006-2007 Mediterranean L4 fields – 2006 assessment

*Seasonal Cycle in the Med*

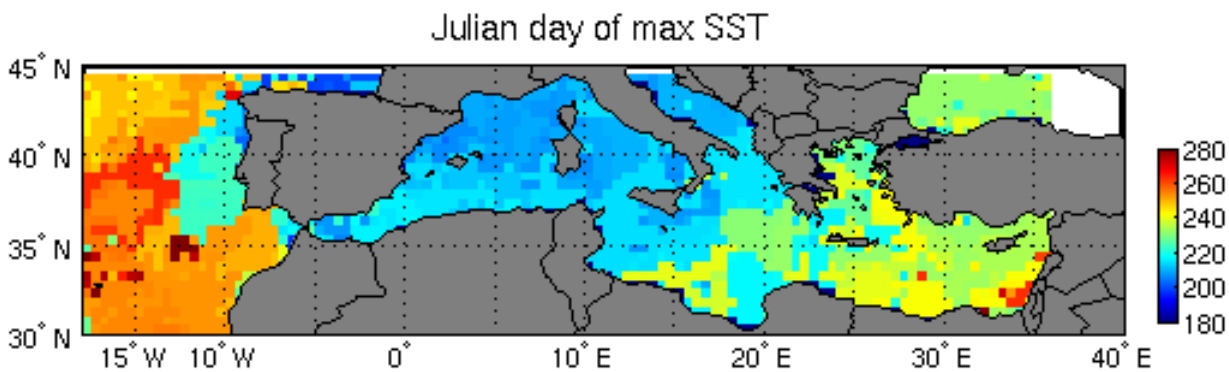
- Amplitude
- Day of maximum SST




***Weak cycle*** ***Strong cycle*** ***Medium cycle***

***Max at end of summer***

***Max at early August***



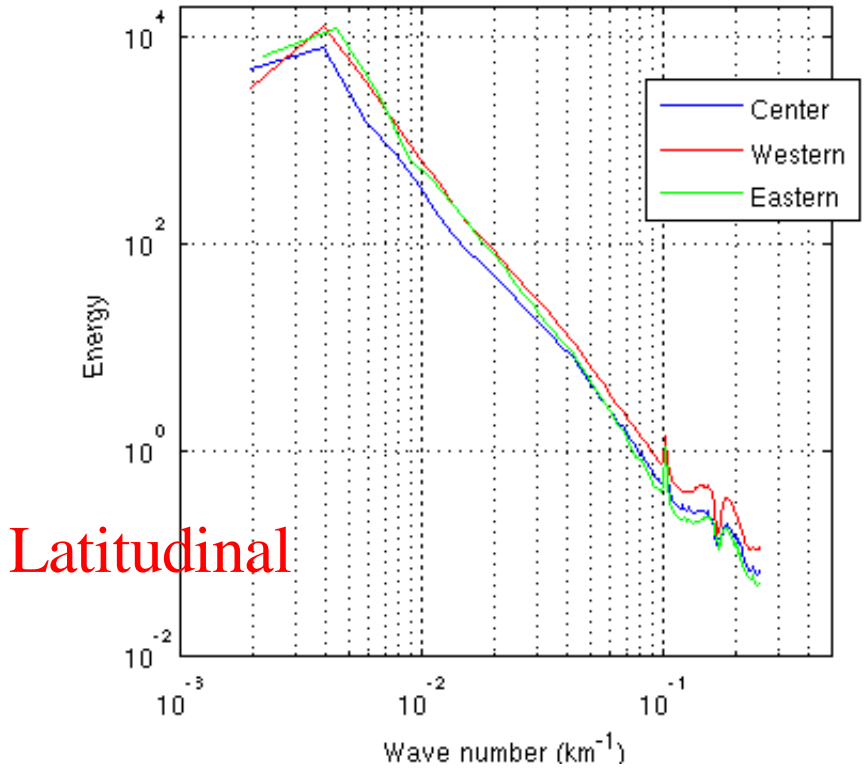

***Max at early september***

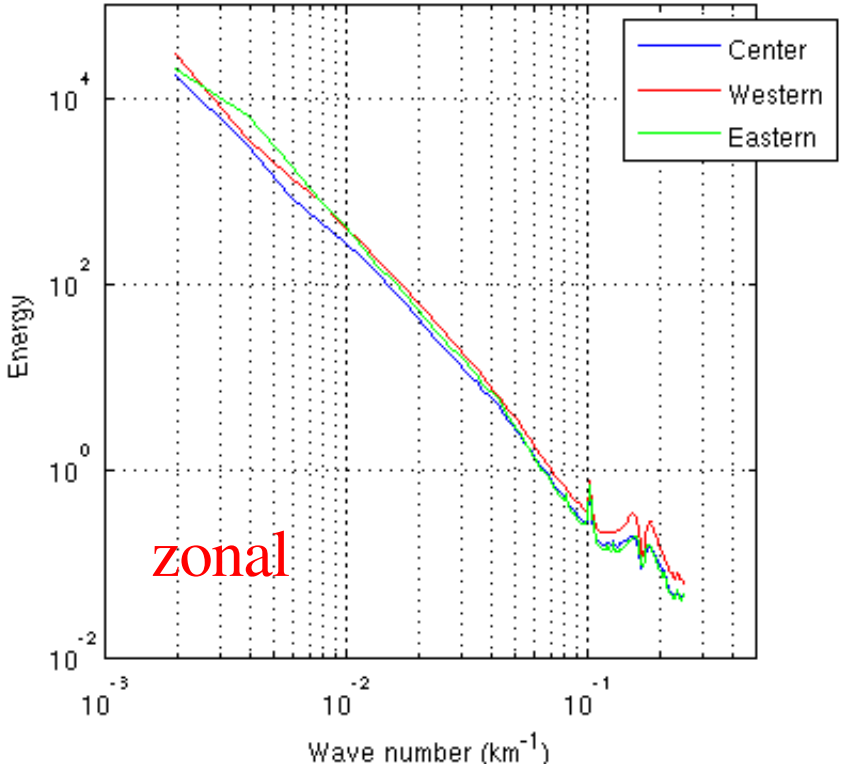
# 2006-2007 Mediterranean L4 fields – 2006 assessment

***Mean spectral behaviour of SST in the 3 basins***

***Different spectral slopes***

Difference of slope 10km Seviri spectral peak



# *Regional L4 from 2008*

- OI chain completely revised. 5 regional products generated by the ODYSSEA chain
  - METOP data taken into account
  - Changes in the processing steps (data selection)
  - Mainly new methods implemented to
    - inter-calibrate SST measurements using AATSR as a reference in order to help the construction of an homogeneous data set
    - To compute SSES (currently for AATSR)

# *SSES model – AATSR alternative SSES scheme*

## Issues & goals

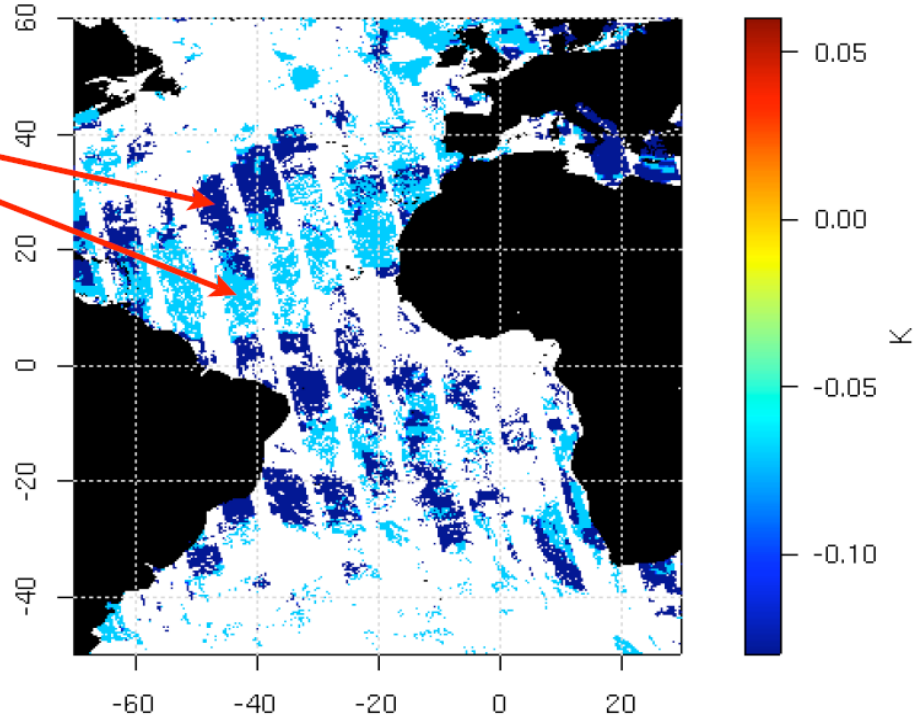
| **Issues** | **Goals** |
|---|---|
| <u>$SSES_{medspiration}$:</u><br><br>- discrete values (create artifact on L4 products) | <u>Compute $SSES_{ifremer}$:</u><br><br>- continuous values (including skin to subskin difference)<br>- to identity bias origin |

# *SSES model – AATSR alternative SSES scheme*

AATSR L3 products:
night-time measurements
best quality-pixel
24 h cumulated (24/05/08)

## Issues

2 discrete values




SSES$_{medspiration}$:

# *SSES model – AATSR alternative SSES scheme*

## Issues & goals

| **Issues** | **Goals** |
|---|---|
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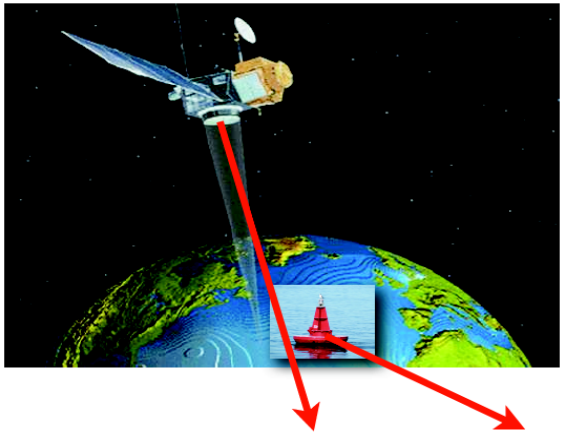
# *SSES model – AATSR alternative SSES scheme*

## AATSR
## Match-up Data Base



$$SSES_{ifremer} = SST_{dual} - SST_{buoys}$$

| Name | Source |
|---|---|
| Longitude | L2P |
| Latitude | L2P |
| Zenital solar angle | L2P |
| $SST_{dual}$ | L2P |
| $SST_{dual} - SST_{nadir}$ | L2P |
| Aerosol optical depth | NAAPS |
| Wind speed | ECMWF |
| Valid pixel in box | Ifremer |
| Sigma in box | Ifremer |

# *SSES model – AATSR alternative SSES scheme*

## AATSR
## Match-up Data Base

| | $SSES_{ifremer}$ | Covariates |
|---|---|---|
| 04/2005 ↓ 09/2007 | | 9 continuous variable |

n=25,384

- night-time co-located data
- best quality pixel
- time difference < 2h
- distance difference < 10 km

**Data sampling:**

# *SSES model – AATSR alternative SSES scheme*

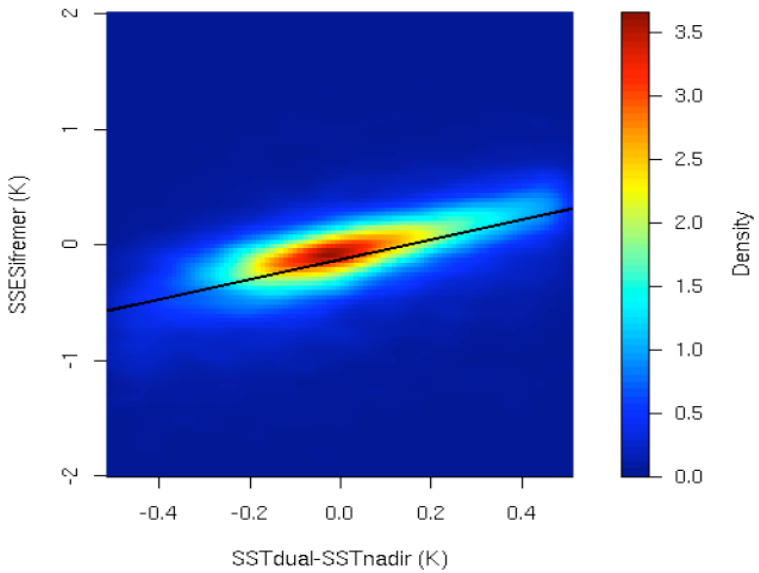
## SSESifremer model

Our aim is to deltaSST in real time, in order to adjust SST*dual* measurements.
=> find the effects of simultaneous covariates on the response variable deltaSST.
The analysis of the bi-dimensional pdf of deltaSST and SST*dual*-SST*nadir* shows that the relationship between the two variables is quite linear.
The pdf of deltaSST and other covariates present very similar features.
=>simple linear model (including skin to subskin adjustment)

An exhaustive search of the model with all covariates combinations has been done in accordance with criteria not detailed here.
Model selection shows that the interactions between the zenithal solar angle and SST*dual*-SST*nadir* is the most importance on deltaSST.

# *SSES model – AATSR alternative SSES scheme*

## $SSES_{ifremer}$ model




**Linear hypothesis:**

**Linear model formula:**

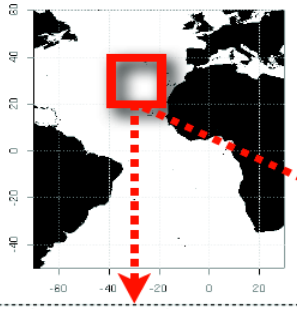
$$SSES_{ifremer} =$$

$\alpha^{(0)}$ → intercept

$+\sum_i \alpha^{(i)} X^{(i)}$ → principal effects

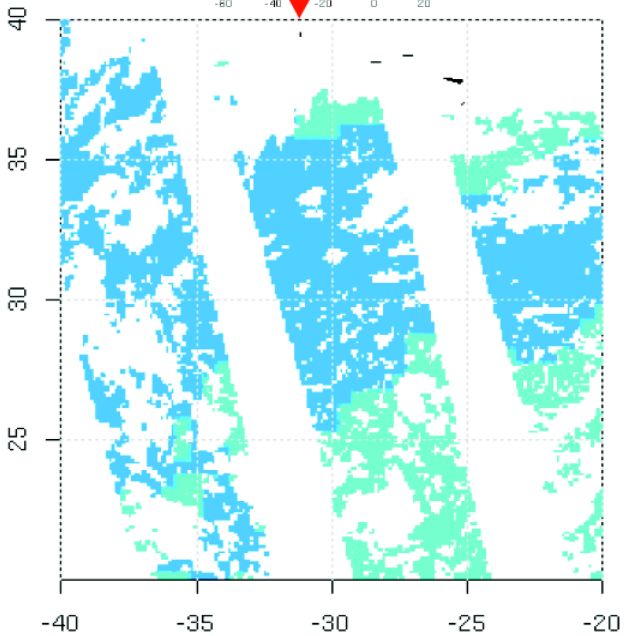
$+\sum_i \sum_j \beta^{(i:j)} X^{(i)} X^{(j)}$ → interaction effects

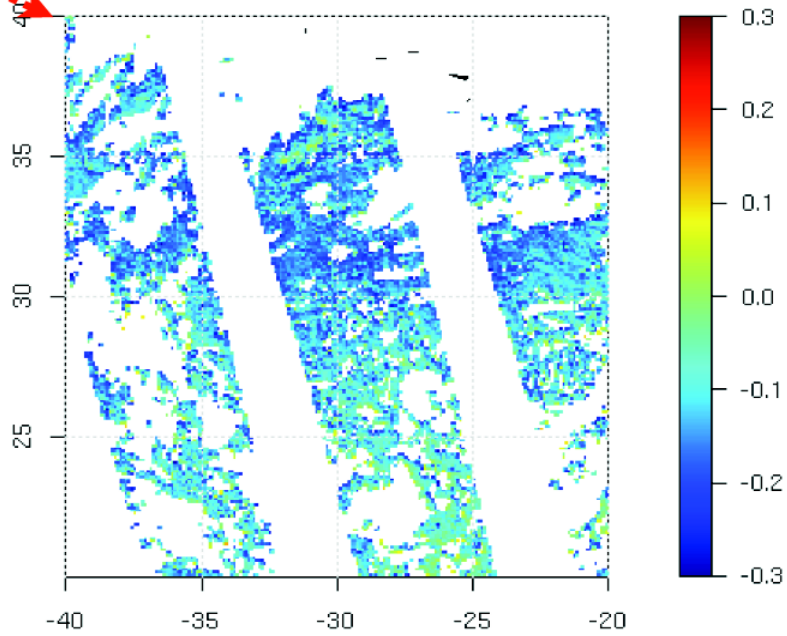
# *SSES model – AATSR alternative SSES scheme*



## Results

**AATSR L3 products:**
night-time measurements
best quality-pixel
24 h cumulated (24/05/08)




**SSES$_{medspiration}$:**

**SSES$_{ifremer}$:**

# *SSES model – AATSR alternative SSES scheme*

Results:

✗ Model used by ODYSSEA chain

✗ Work in progress:

- ✔Co-located data selection influence on model parameters
- ✔Model for other sensors

*A multivariate regression approach to adjust AATSR sea surface temperature to in situ measurements*, Tandeo P. and al., GRSL 2008

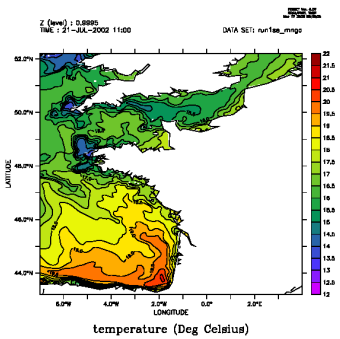
# *Advanced studies*

- Illustration of the need for ultra high resolution L3/L4 products:
  - Assimilation experiment : The MARS 3-D assimilative system
  - Surface velocities reconstruction from an SST field

# Applications: THE MARS-3D DATA ASSIMILATIVE SYSTEM

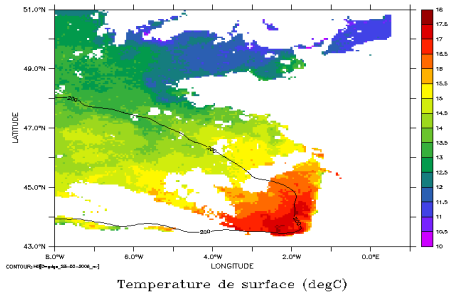
4 years R&D project (2008-2012), Previmer

Development and validation of a MARS-3D multivariate sequential data assimilation system based on Ensemble Kalman Filter (EnKF)

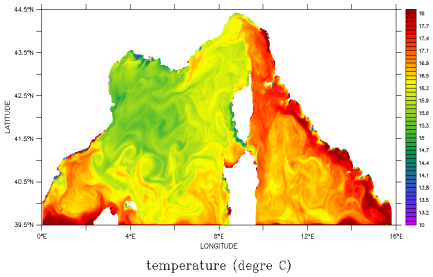



**BAY OF BISCAY & CHANNEL**

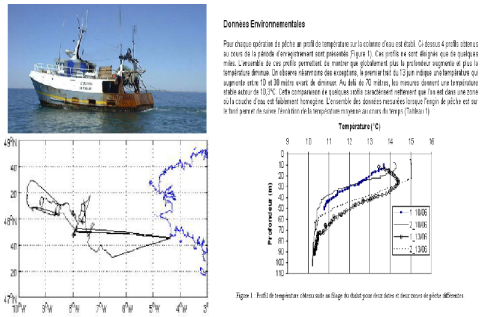
**SST (SEVIRI)**




North-Western Mediterranean Sea




In situ measurement (T-S)

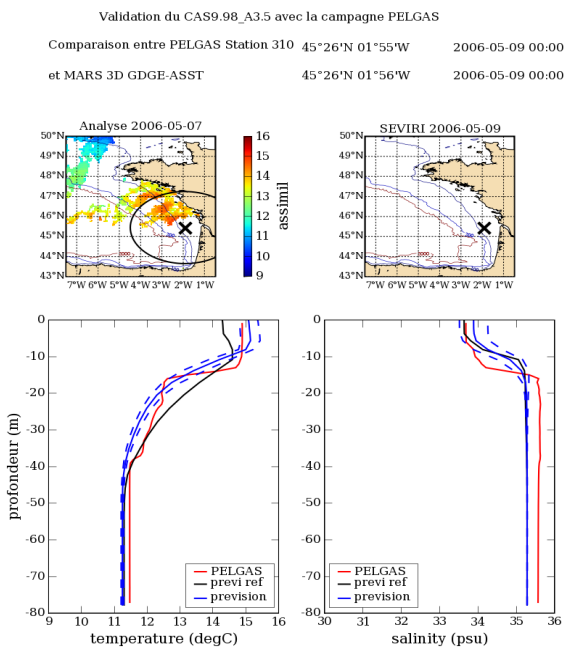


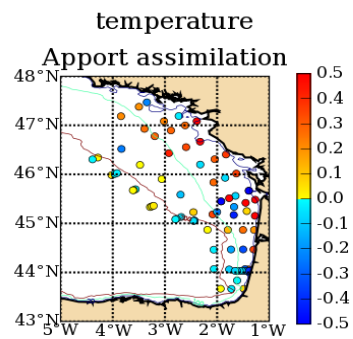

*P. Craneguy, P. Lazure, L. Bertino, V. Monbet et al*

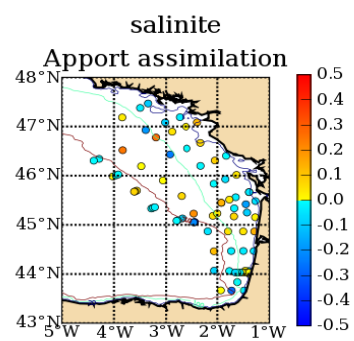
**Investigate the potential of sequential data assimilation of SST to improve T-S predictions over the Shelf**

The Data assimilative system provides significant error reduction for temperature over the shelf compared to the non assimilative one especially near the Loire and Gironde rivers plumes

Limitation due to periods of low SST availability



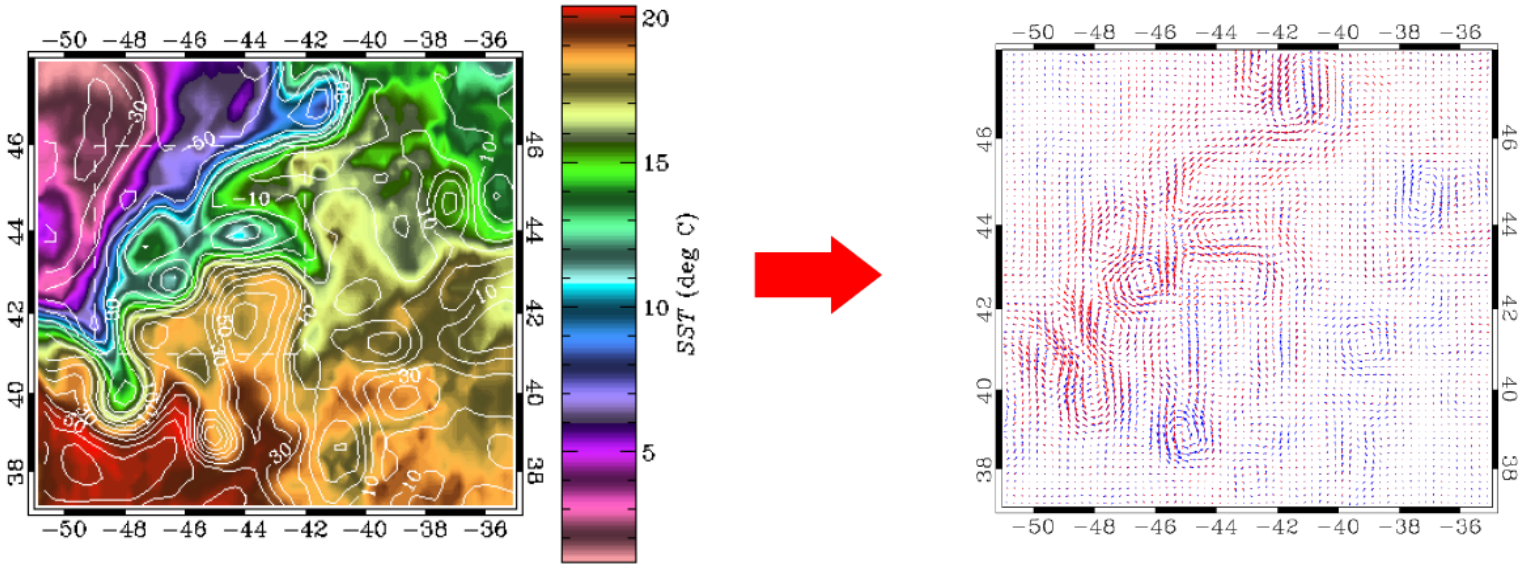




In progress:
tests with the regional multi-sensor L3 SST product

## Application : Surface velocities reconstruction from an SST snapshot

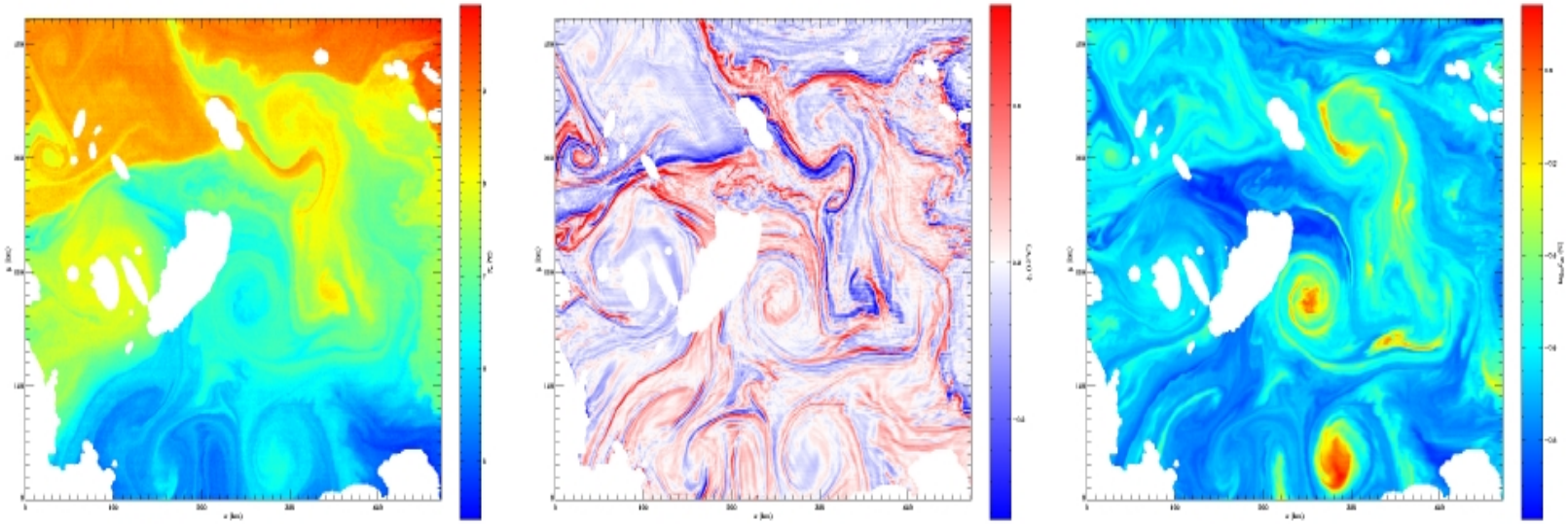
Surface velocities reconstruction from microwave SST




Using one SST field, surface velocities **at same resolution** can be reconstructed

(Isern-Fontanet et al. GRL 2006)

Surface velocities reconstruction from infra-red SST (Modis)



Brightness Temp  Deduced vorticity  Chl.

- Low resolution : validation with altimetry
- High resolution:
  - ✔ low noise needed to reconstruct high resolution velocities and vertical velocities
  - ✔ need for high resolution SST L4 product to validate the method

# *Conclusion (1)*

- UHR L4 products :
  - SST users interests
  - good data base to study the evolution and variability of SST at fine temporal and spatial scale
  - Work (short term):
    - Validation , evaluation of new regional products (spectral behaviours , ...)
    - Improvements and tune the configuration in the frame of the reanalysis
    - New method in test

# *Conclusion(2)*

Beyond the project frame :

- Improvements and new methods are needed in order to:
  - **exploit the huge end increasing quantity of informations (what is the percentage of measurements used ?)**
  - **Combine various data sources (SST, wind, AOD, sea ice concentration, ...)**
  - ➢ provide "the best SST" and coherent SST data sets
    - *Needed for assimilation*
  - ➢ provide ultra high resolution L4 products with low noise level, with an accurate location of fronts, of gradients values, geophysical spectra,...
    - *Such a product is needed to better unveil and quantify mesoscale structures of oceanic turbulence (primary production, climate applications, ...)*
  - ➢ Reconstruct homogeneous SST time series
    - *Climate applications*

  - => **New method (combination of statistical methods) is in test at Ifremer**