

International Summer School of  
Oceanography

“An Integrated View of Oceanography :  
Ocean Weather Forecasting in the 21st Century”

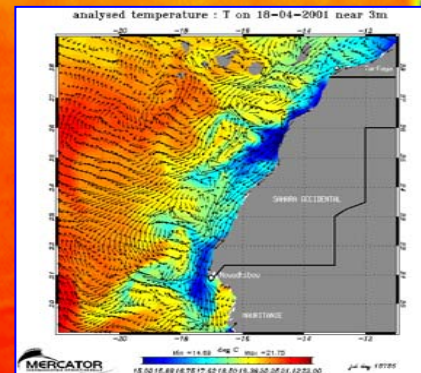
Ocean Monitoring and Forecasting : the **SYSTEMS**



# MERCATOR, Global to Regional Ocean Monitoring and Forecasting System

Pierre BAHUREL,  
MERCATOR OCEAN

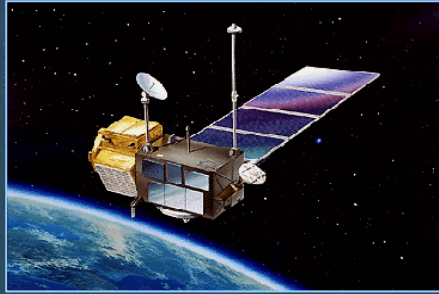
*Mercator SST 2-week  
forecast, 21 June 2003*



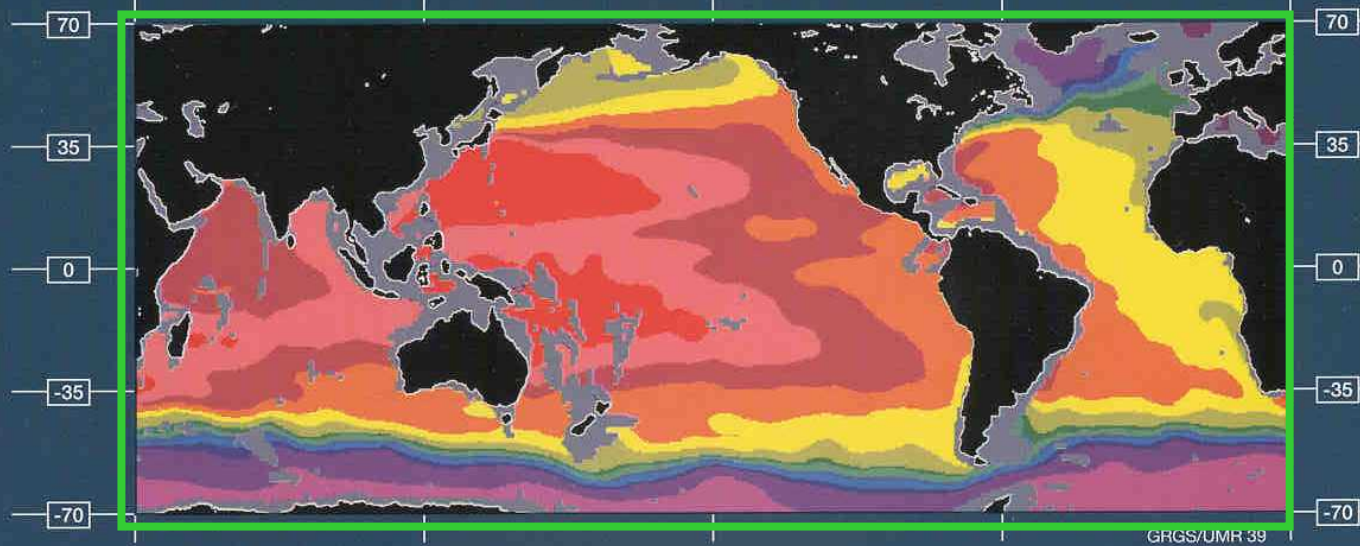
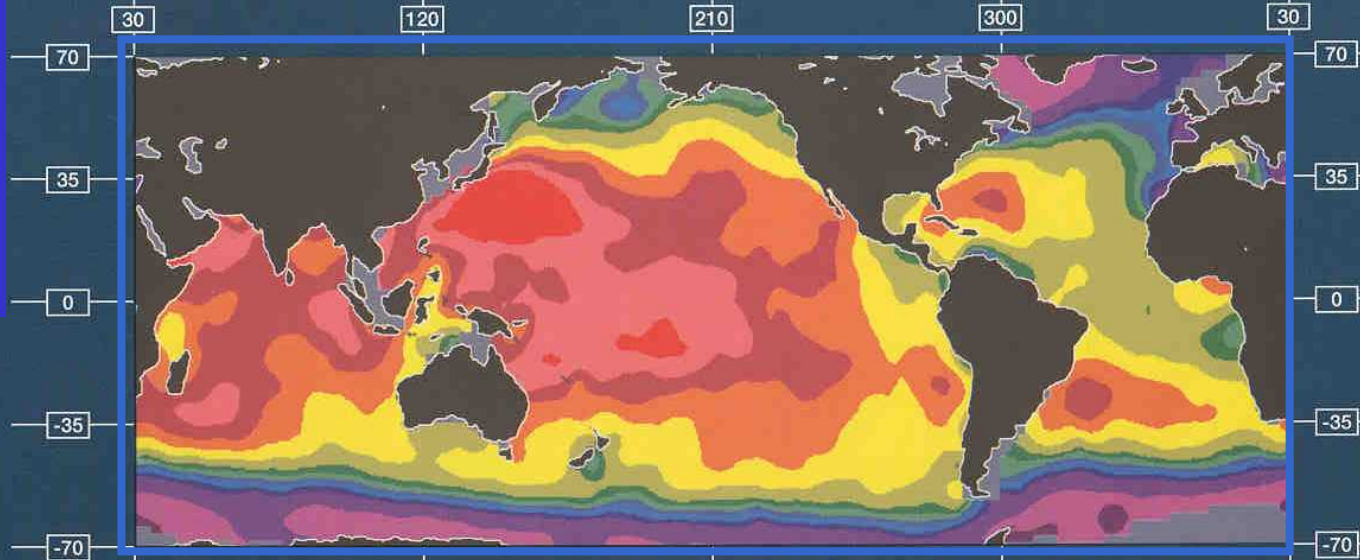
Lalonde  
Les Maures  
20 Sept 2004

# Sea Surface Height

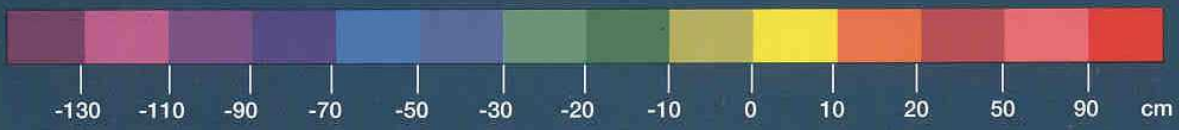
10 days of  
T/P satellite altimetry,  
compared to  
100 years of in situ  
measurements

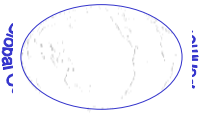


(1992)



GRGS/UMR 39

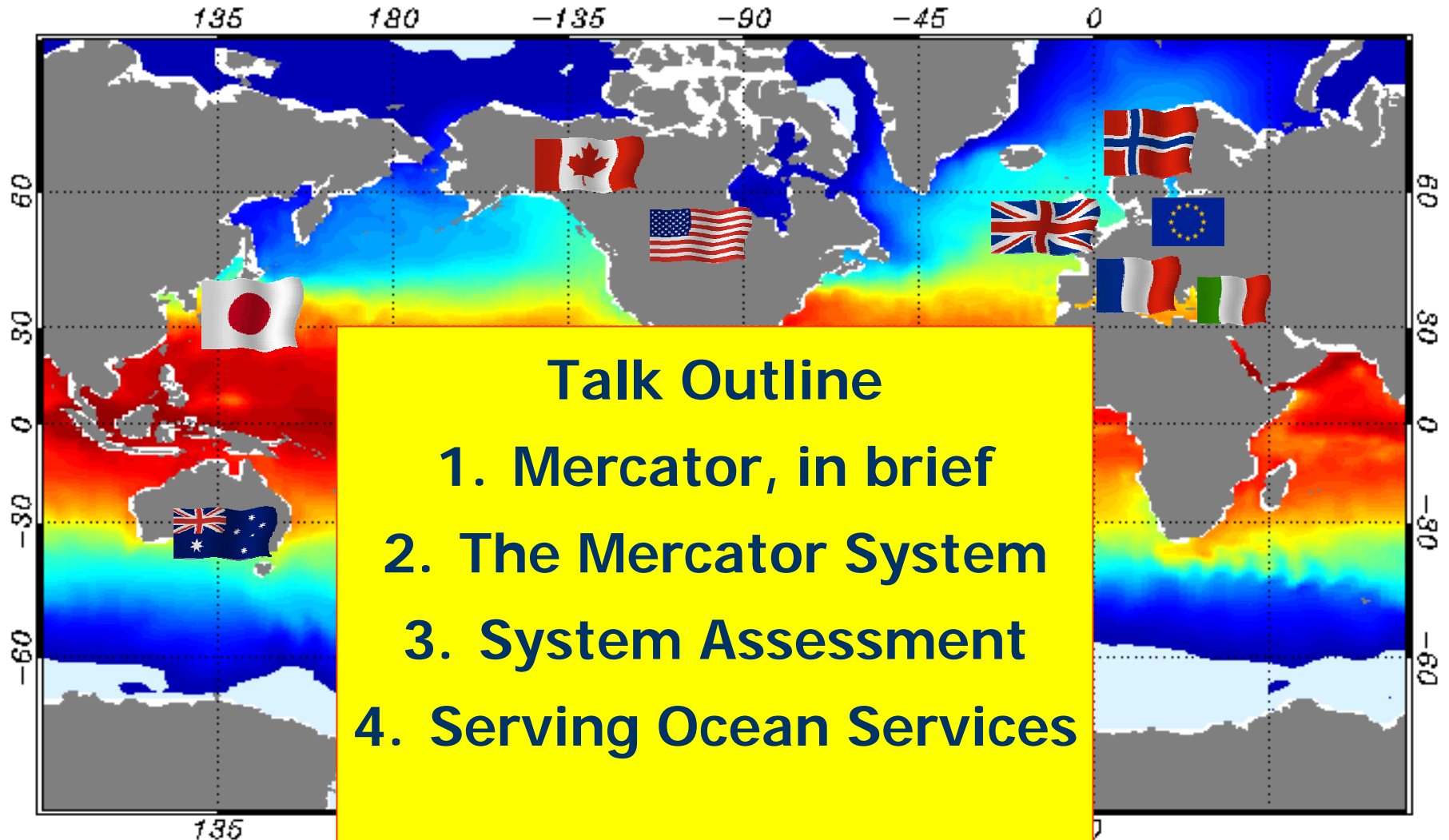




# The GODAE new « big bang » map

GODAE Modelling/Assimilation Centers

*initialised temperature : T on 16-06-2004 near 0 m*



Min = -1.91 deg C Max = 31.05



# MERCATOR, In Brief

**Mercator Ocean Centre**  
Ramonville St Agne  
Toulouse, France

# MERCATOR, Building a new Ocean Service

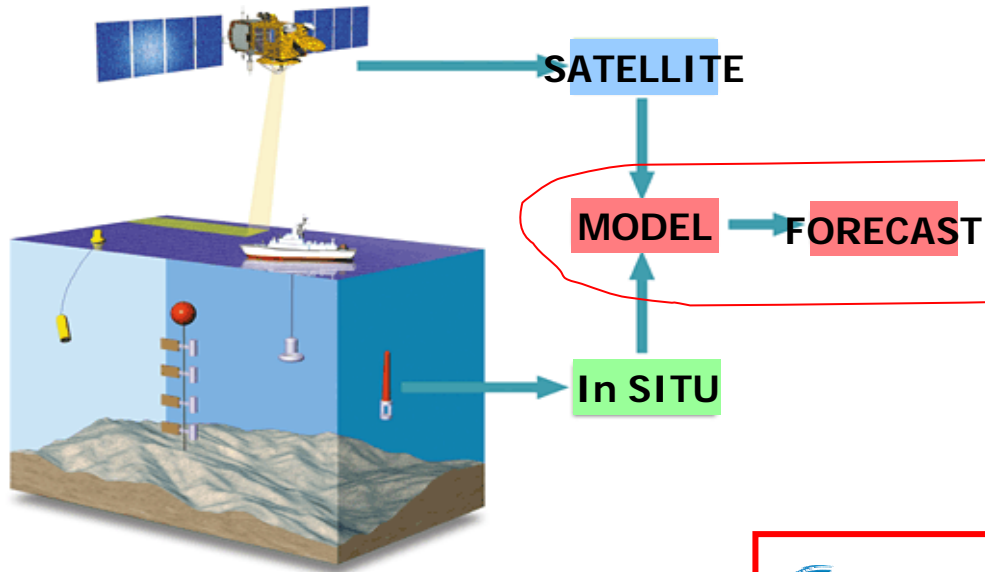
- Joint initiative of French agencies for Global/Regional Operational Ocean Monitoring and Forecasting.
- Supported by French institutes
- Conducted by **MERCATOR OCEAN**, with involvement of CLS & CERFACS
- A real-time and continuous Ocean Service (ocean forecasts) since January 2001, serving today more than 150 referenced users.



## Diary

- 1995 : the **idea** of global/regional operational oceanography in France
- 1996 : a joint **project** of 6 agencies
- 1997 : an **international** experiment, GODAE
- 1998 : a **science** plan and team for the foundations
- 1999 : a **development** plan and team for the forecasting systems
- 2000 : the first Mercator **system** in place
- 2001 : the first Mercator **ocean forecasting bulletin**
- 2002 : a consortium **company** - Mercator Ocean - to prepare op. phase
- 2003 : a new system for solid **user** applications
- 2004 : a **European** framework through Mersea, ... and a GODAE school

# Integrated Oceanography

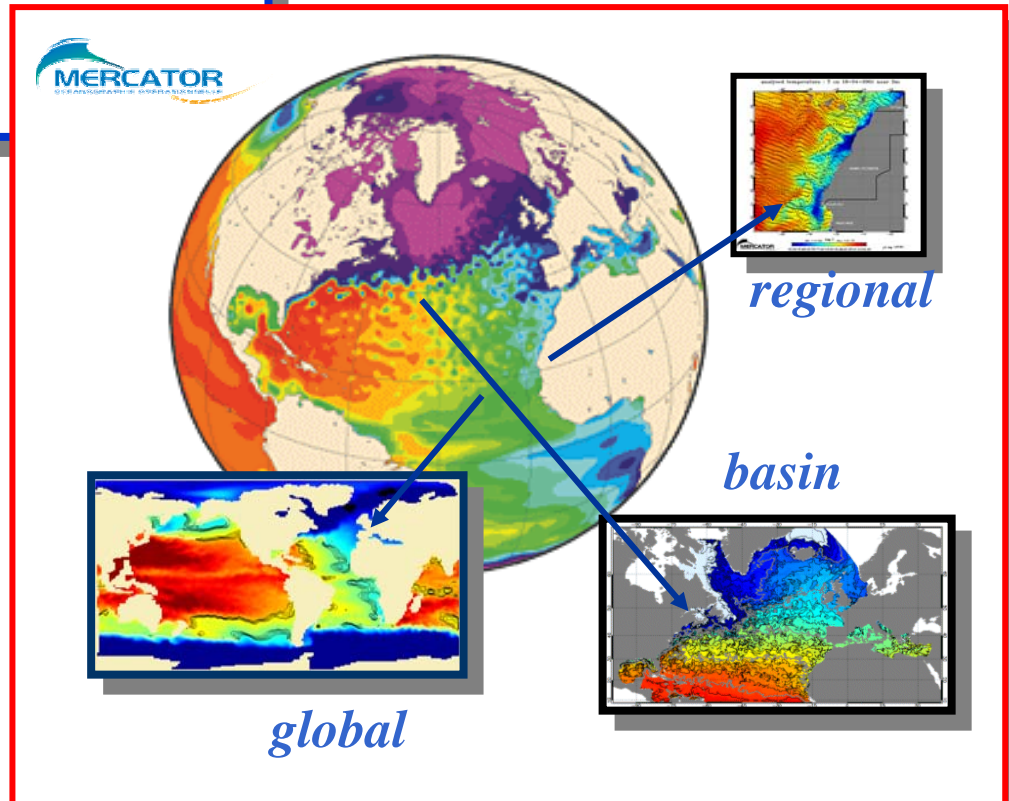


JASON, ...

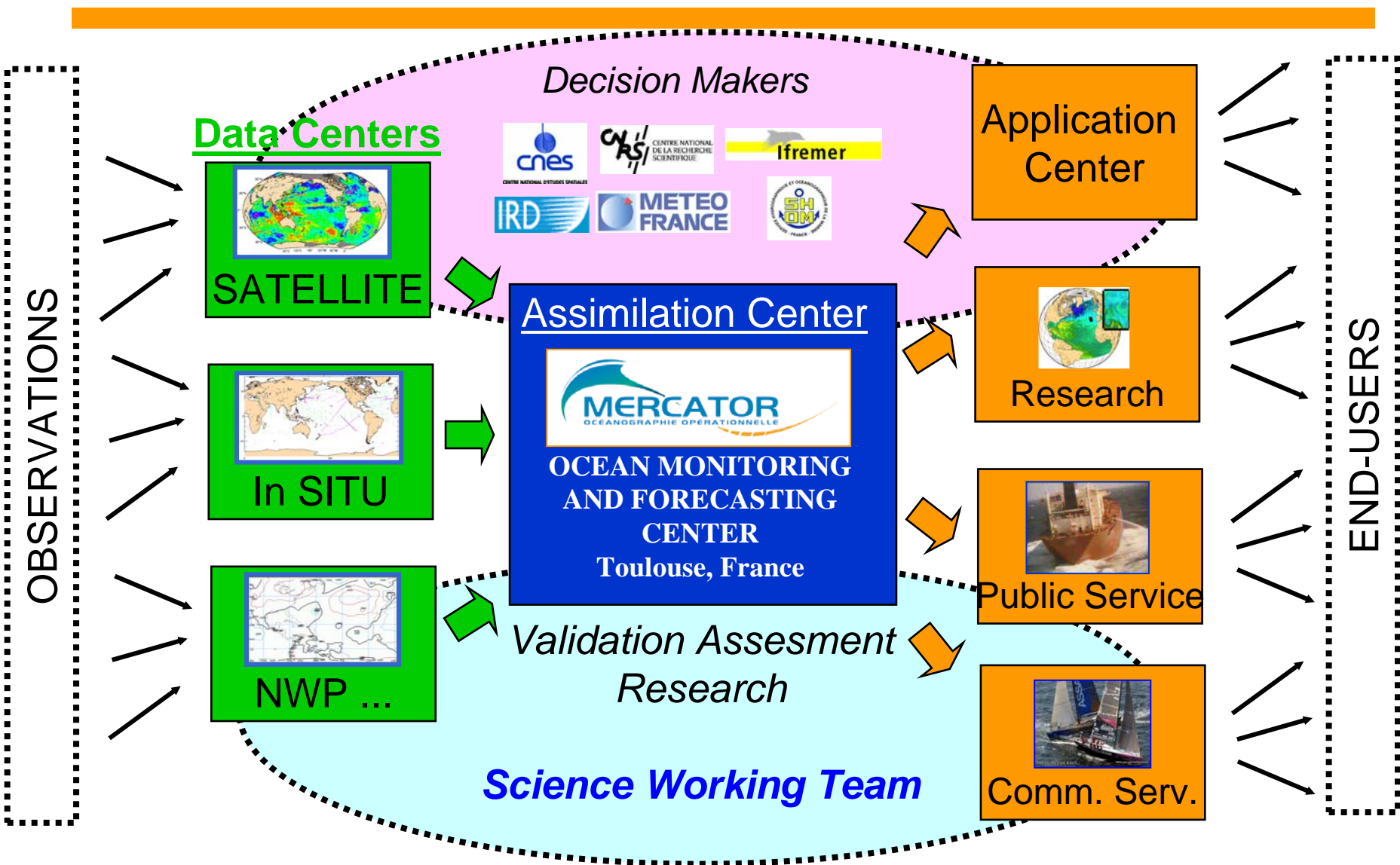
MERCATOR

CORIOLIS

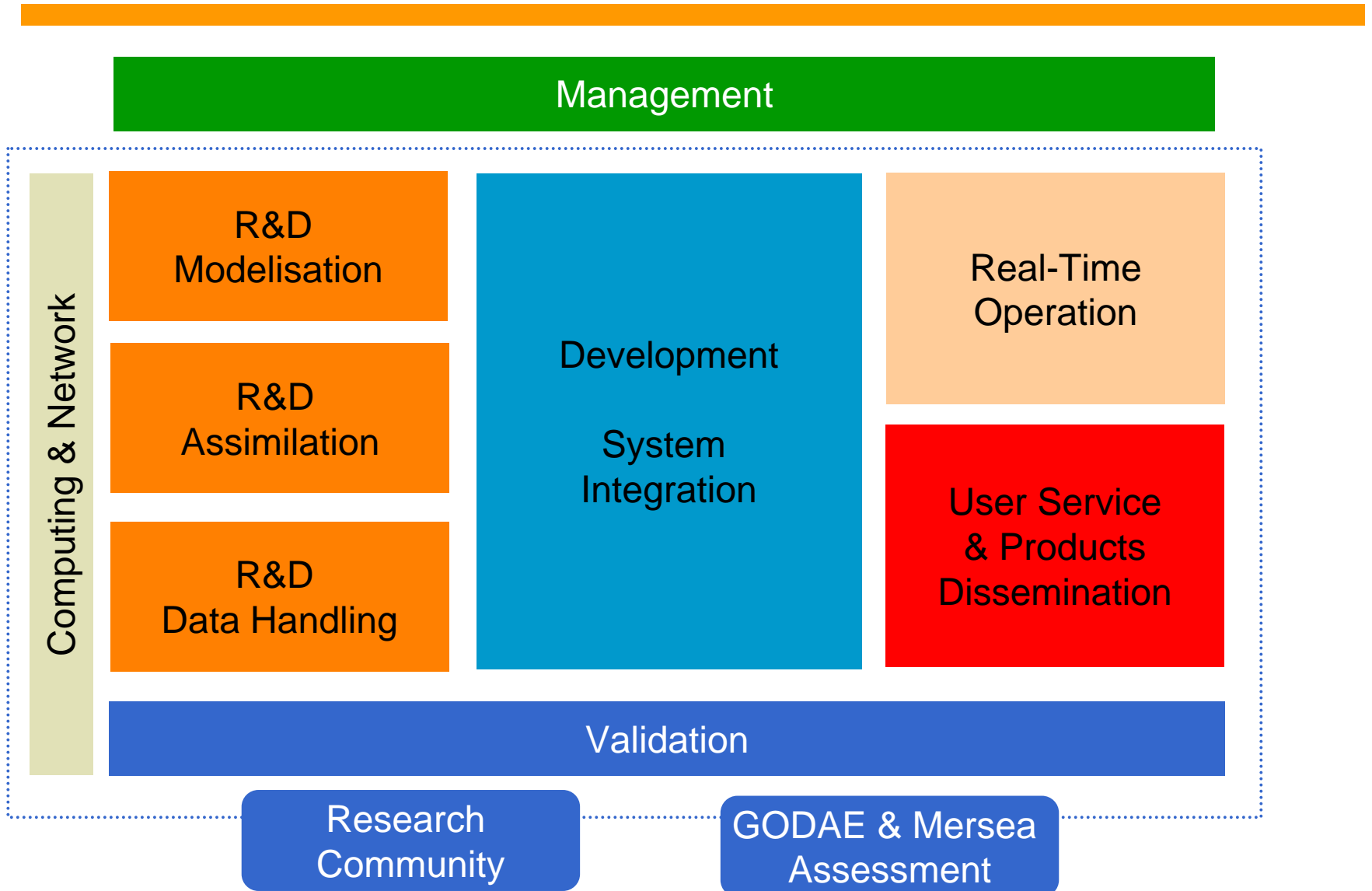
- High Resolution Global to Regional Ocean Monitoring and Forecasting
- Operational Assimilation of Satellite and In Situ Ocean Observations
- Serving **research**, **state** (military and civilian) service, and **commercial** needs



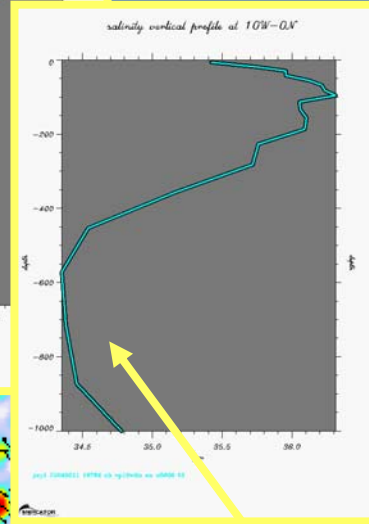
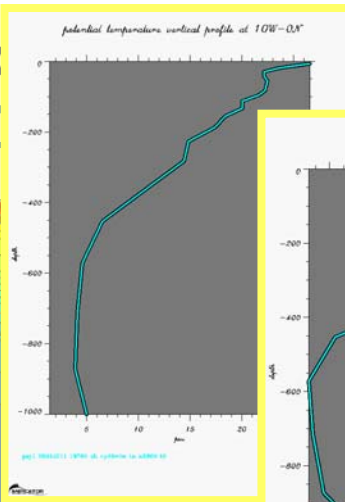
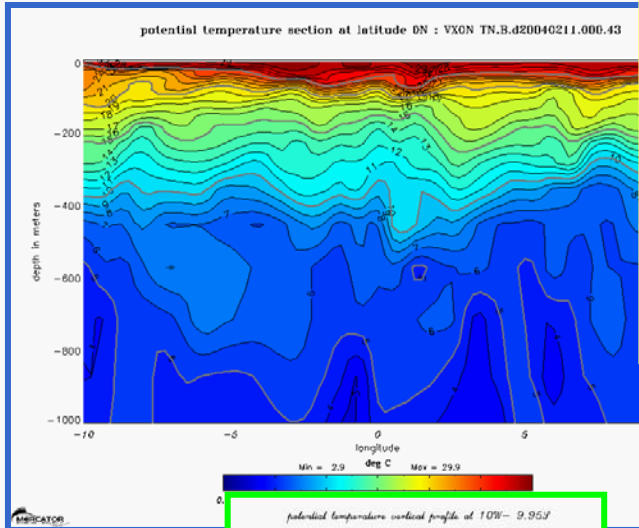
# MERCATOR, Ocean Forecasting Centre



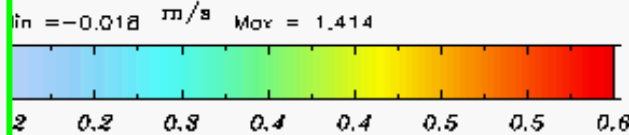
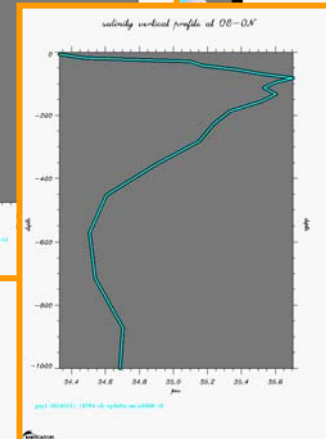
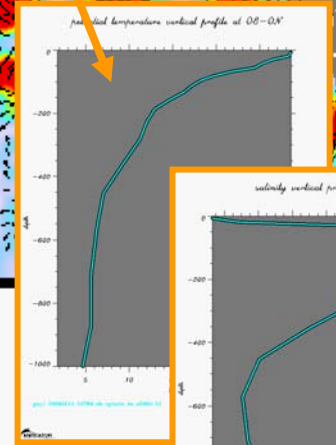
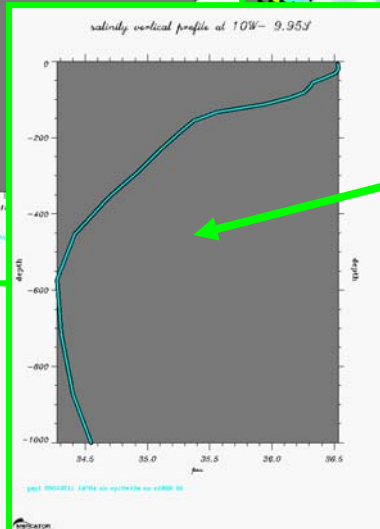
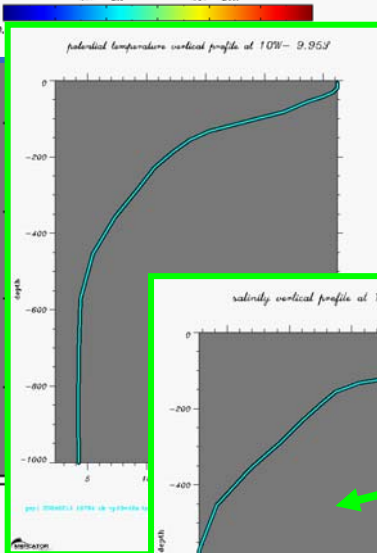
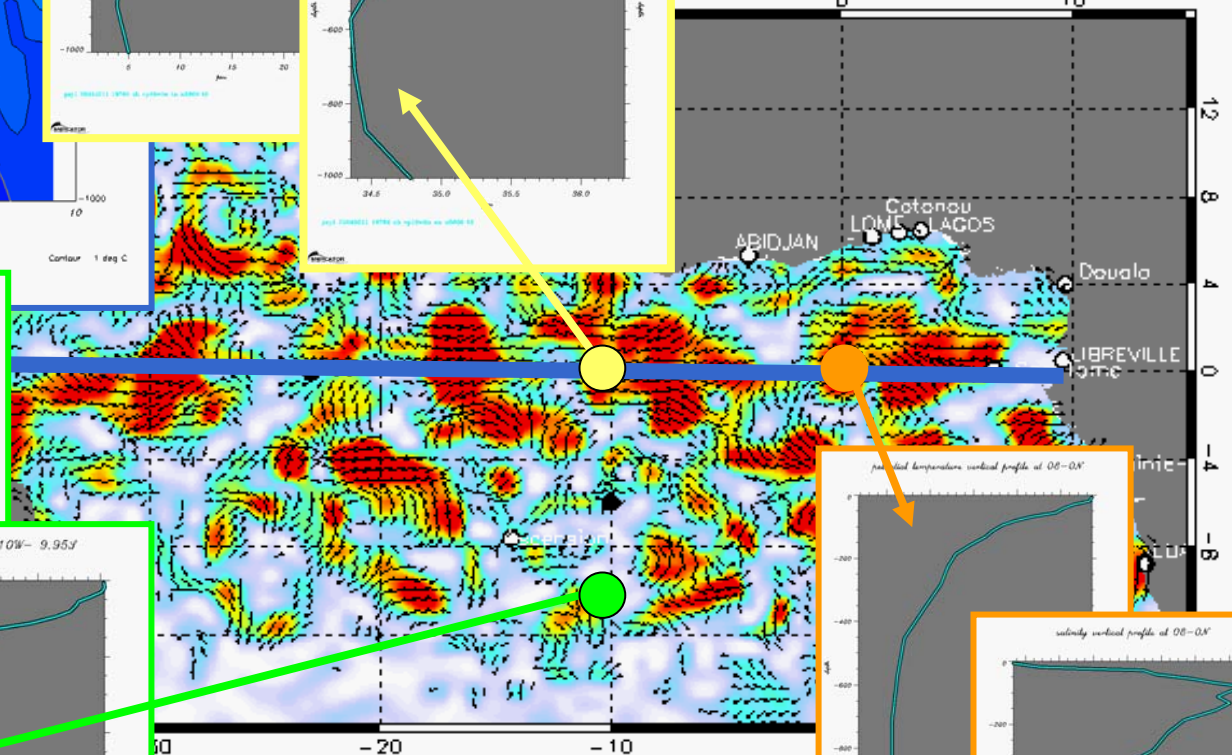
# The MERCATOR Team





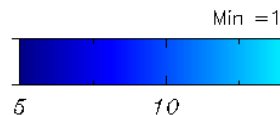
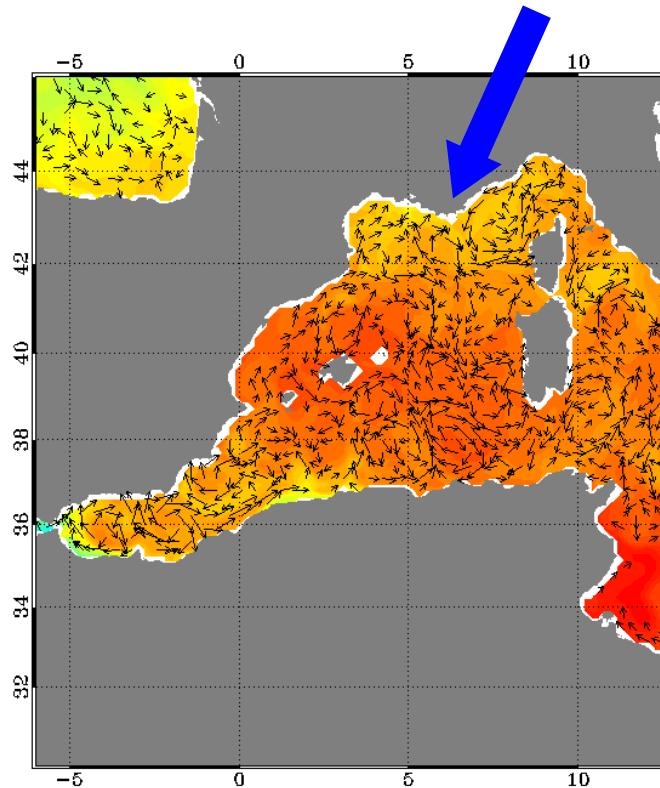


6m

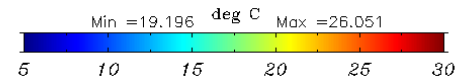
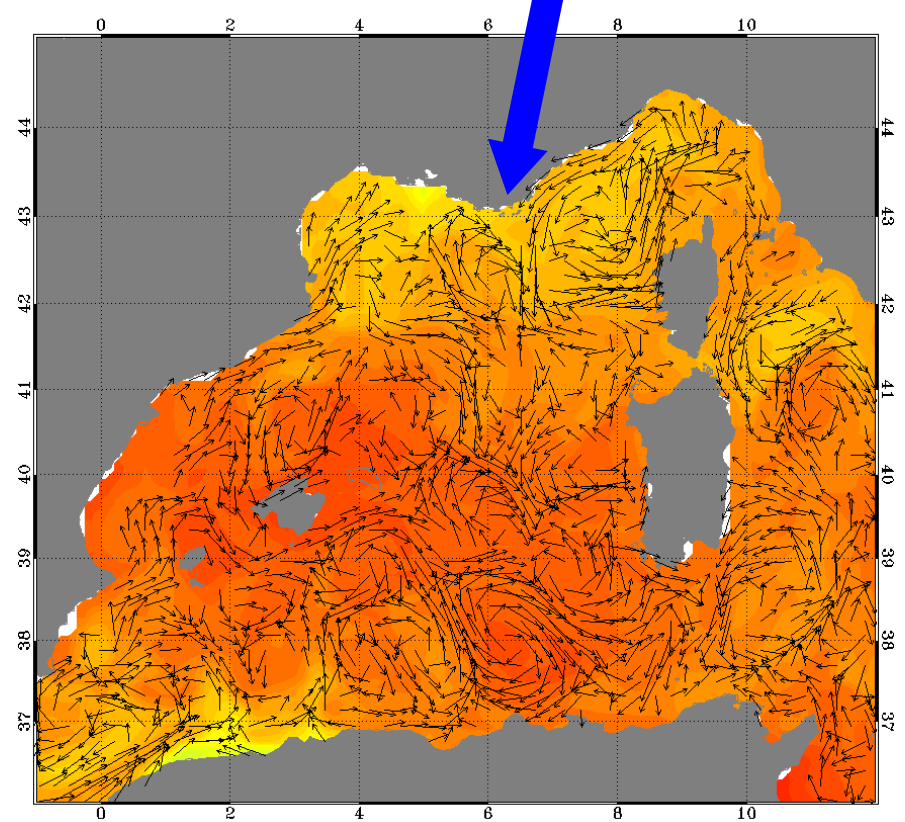


# Mercator Forecast : Lalonde Les Maures SST for the 29/09/2004

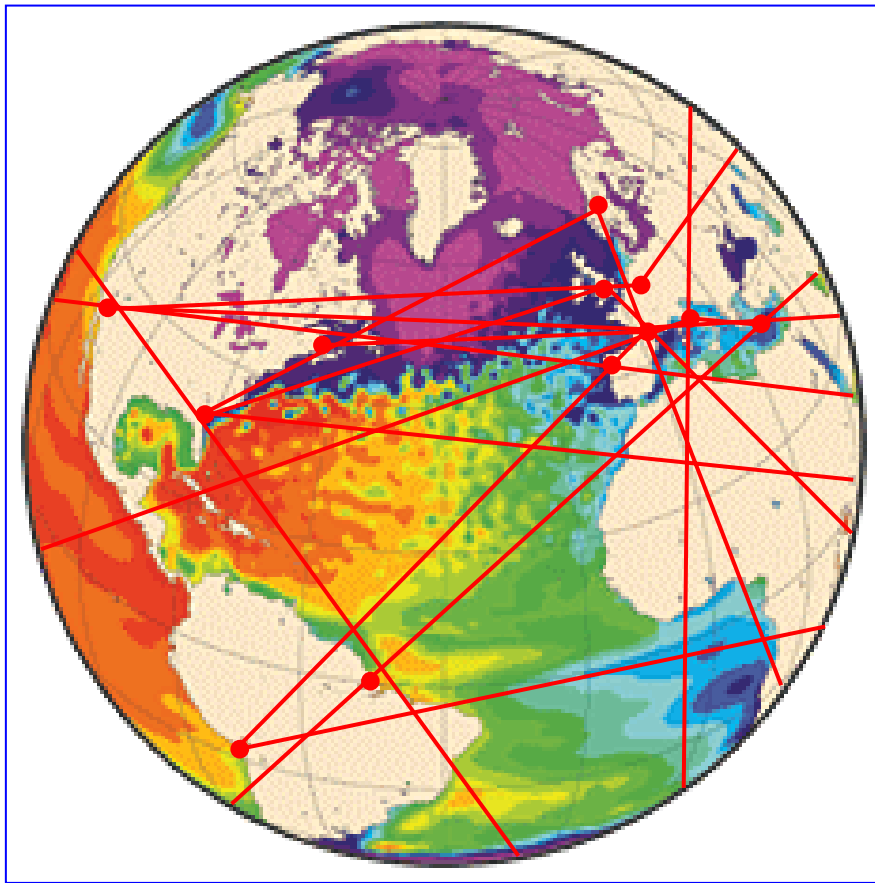
2 weeks forecast potential temperature : T on 29-09-2004 near 3m



2 weeks forecast potential temperature : T on 29-09-2004 near 3m



# Partnerships



- *International Global Ocean Data Assimilation Experiment* (**GODAE**)

GODAE



- *European Global Monitoring for Environment and Security program* (**GMES**)

- ROSES (ESA)
- MERSEA Strand 1 (EC/FP5)
- **MERSEA IP** (EC/FP6)



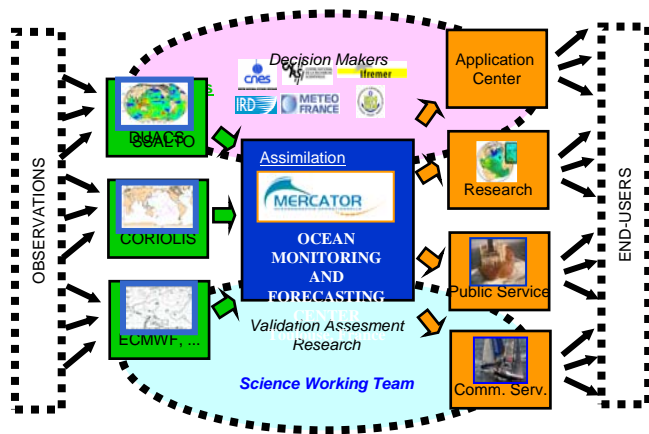
- *European Global Ocean Observing System program* (**EuroGOOS**)



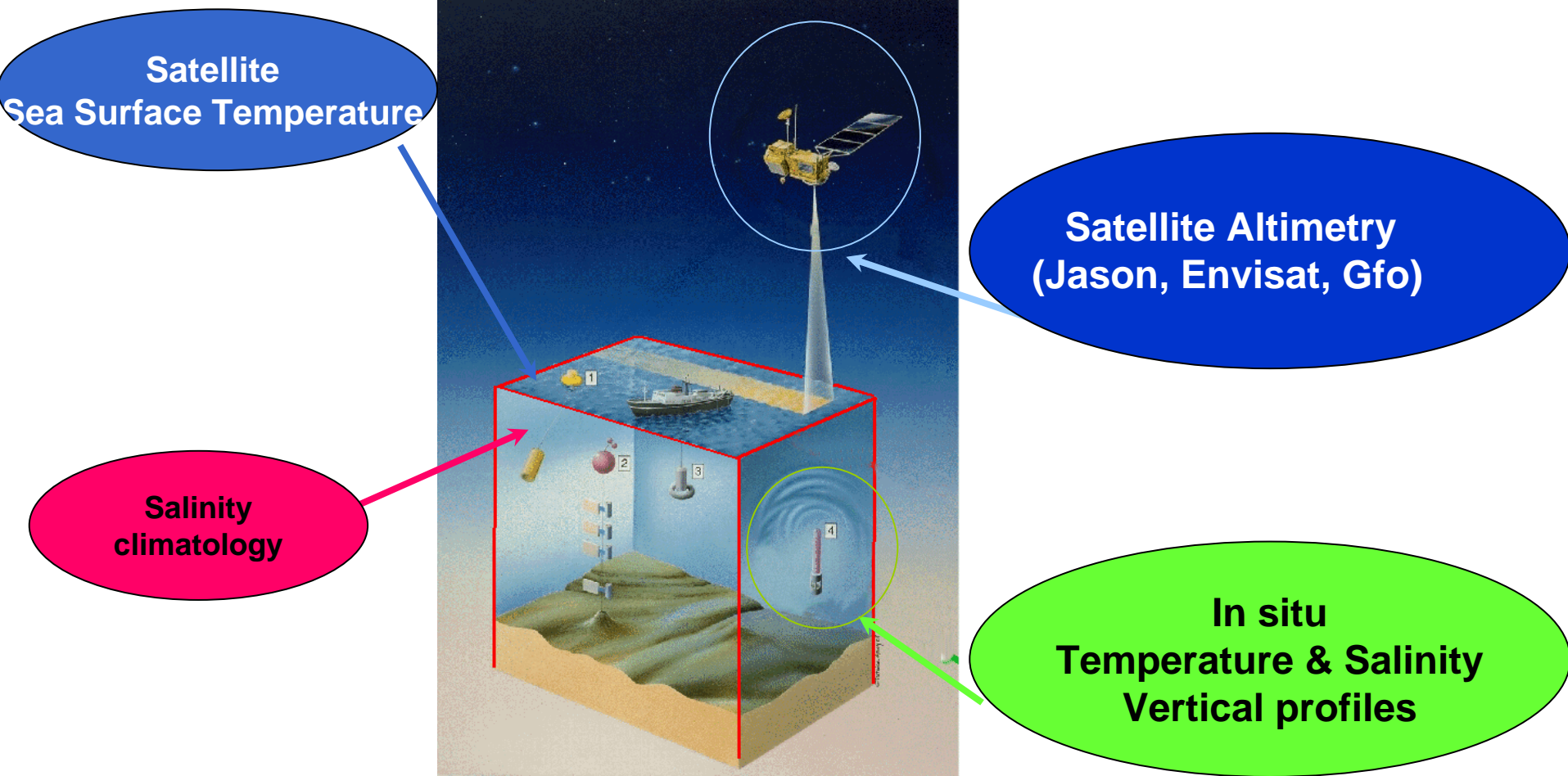
- *Med Sea Agreement with INGV* (**MOON**)



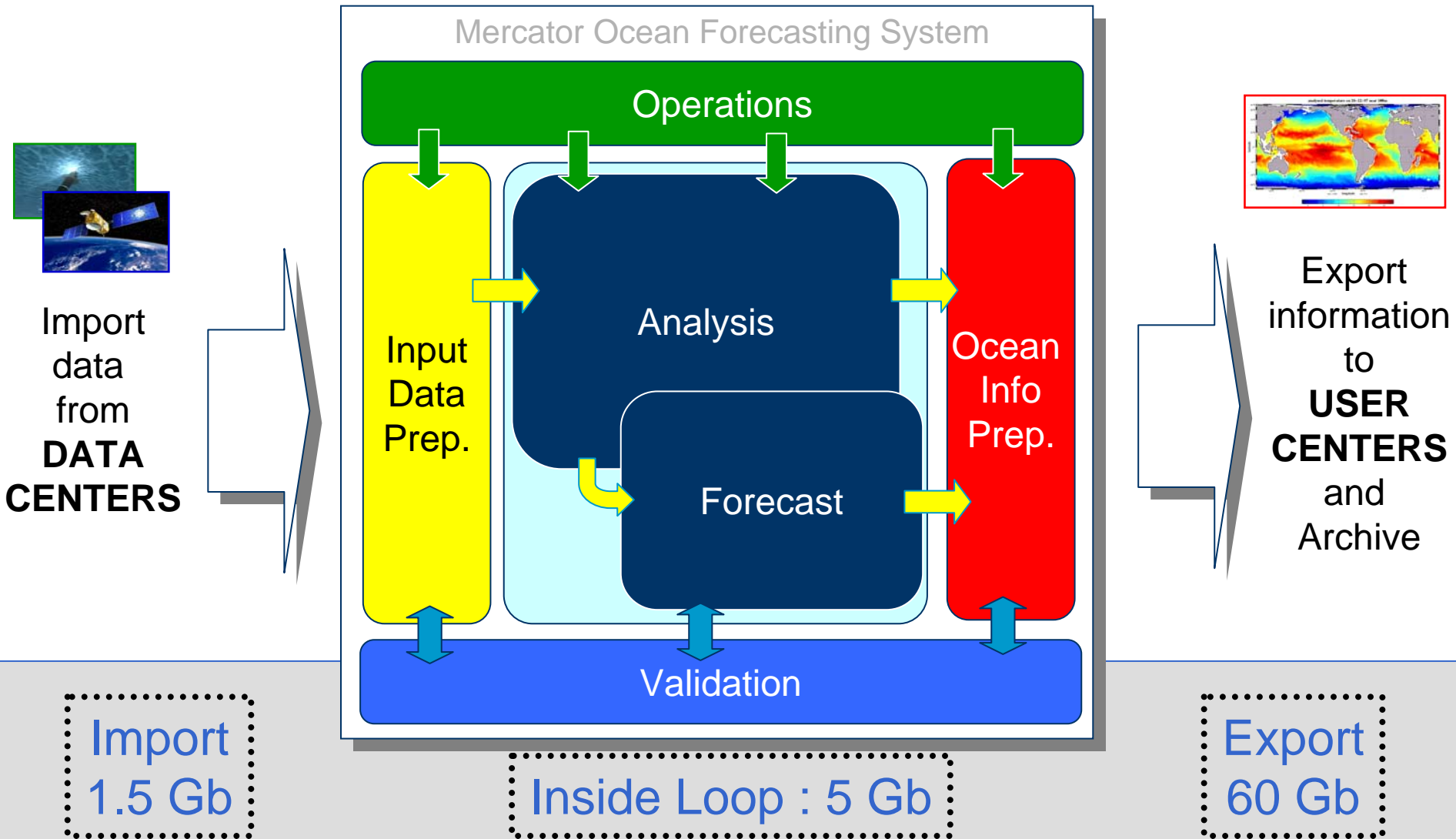
# The MERCATOR Ocean monitoring and forecasting system



# A 4D operational depiction of the ocean, coherent with satellite and in situ observations



# System and Components



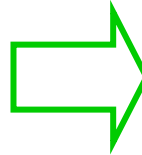
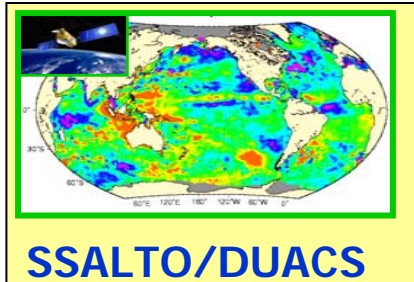
Example : Weekly operations for a 1/4° Global Ocean Bulletin

# IMPORT Input Data

FROM DATA ASSEMBLY CENTERS

## Altimetry

Topex/Poseidon,  
ERS-2, GFO,  
**Jason-1**, Envisat

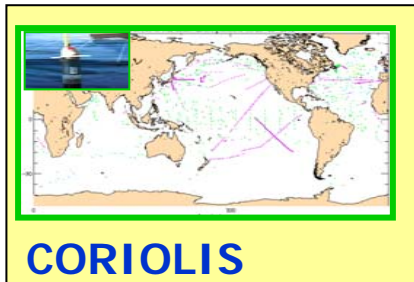


## MERCATOR Assimilation Center

- near-real-time : weekly retrieval of intercalibrated Along-Track Sea Level Anomalies
- delayed mode : off-line retrieval of fully validated data set

## In Situ

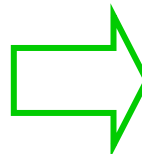
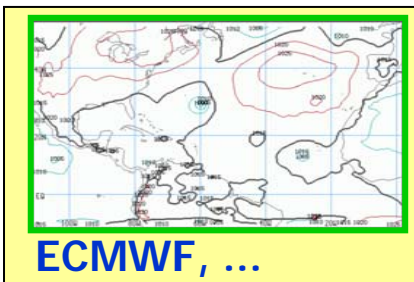
**ARGO** data,  
XBT/CTD, buoys,  
moorings, ...



- near-real-time : weekly retrieval of XBT, CTD, buoys, etc
- delayed mode : off-line retrieval of fully validated data set

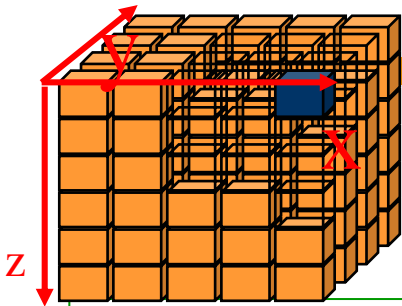
## NWP

wind stress, heat  
fluxes, E-P :  
atm. model outputs



- real-time : weekly retrieval of operational ECMWF 6 hour analyses, and 10 day forecasts ; Reynolds SST
- delayed mode : reanalysis

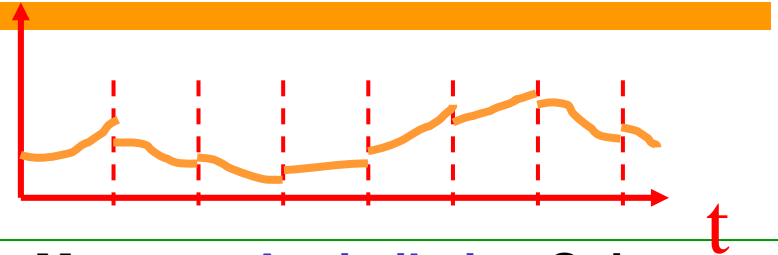
# Model/Assimilation CORE components



## Mercator Model Configurations

- **BASIN** (North Atlantic and Med sea)
  - **1/3°** North & Tropical Atlantic ; 43 levels
  - **1/15°** North Atlantic + **1/16°** Med Sea ; 43 levels
- **GLOBAL** Ocean
  - **2°** Global Ocean ; 30 levels
  - **1/4°** Global Ocean ; 46 levels

*based on the OPA-NEMO code*



## Mercator Assimilation Suite (SAM)

- **SAM1** (**ROOI-SOFA** type)
  - **V1** : O.I. - univariate analysis / altimeter data
  - **V2** : O.I. - multivariate analysis / alti. + STT+ in-situ data
- **SAM2** (**SEEK** type)
- **SAM3** (**3D/4DVar** type)

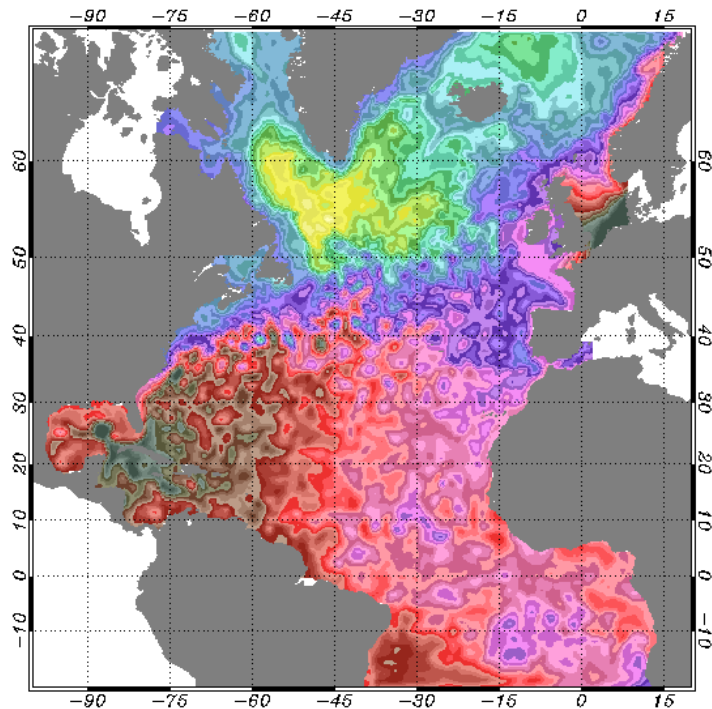
*using the PALM coupler*



JAN.2001  
(v2. Jan.2004)

# Line 1 : Basin-Scale Eddy Permitting « 1/3° North & Tropical Atlantic »

initial sea surface height : SSH on 02-04-2003 near 0m



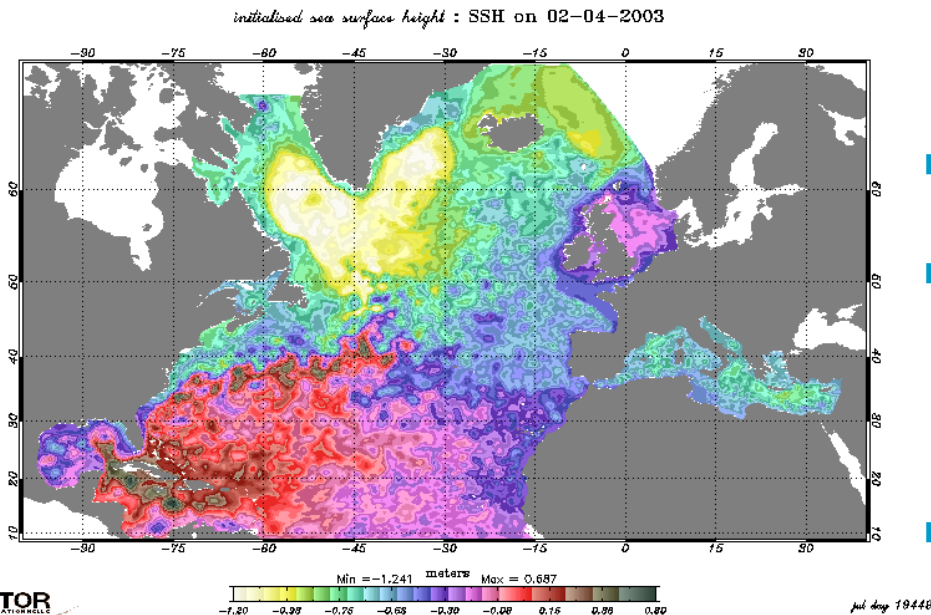
PSY 1

Goal : « Demo and Testbed »

- **Area and Resolution**
  - N.Atlantic + Tropical Band (20°S)
  - Horiz. 1/3° ; Vertical 43 levels
- **Model code : OPA-NEMO**
  - Rigid lid, z-coordinate
- **Assimilation tool : SAM1**
  - v2 multivariate (altimetry, SST, in situ T&S)
- **NRT Operations : weekly**
  - Start : 17/01/2001
  - 192 ocean bulletins (1 per week since 17/01/2001)
- **Simulations**
  - Reference simulations in NRT conditions available from 1993 to now (univariate) or 2003 to Now (multivariate)
  - 11 year reanalysis (1993-2004) with multivariate assimilation in preparation

JAN.2003

# Line 2 : Basin-Scale Eddy Resolving « 1/15° N.Atlantic & 1/16° Med. Sea »



PSY 2

- **Area and Resolution**
  - N.Atlantic (9°N) + Med Sea
  - Horiz. 5-7 km ; Vertical 43 levels
- **Model code : OPA-NEMO**
  - Rigid lid, z-coordinate
- **Assimilation tool : SAM1**
  - v1 univariate (17/01/2001)
  - v2 multivariate (in prep. 01/2005)
- **NRT Operations : weekly**
  - Start : 08/01/2003
  - 89 ocean bulletins (1 per week)
- **Simulations**
  - Reference simulations in NRT conditions available from 1999 to now (univariate)

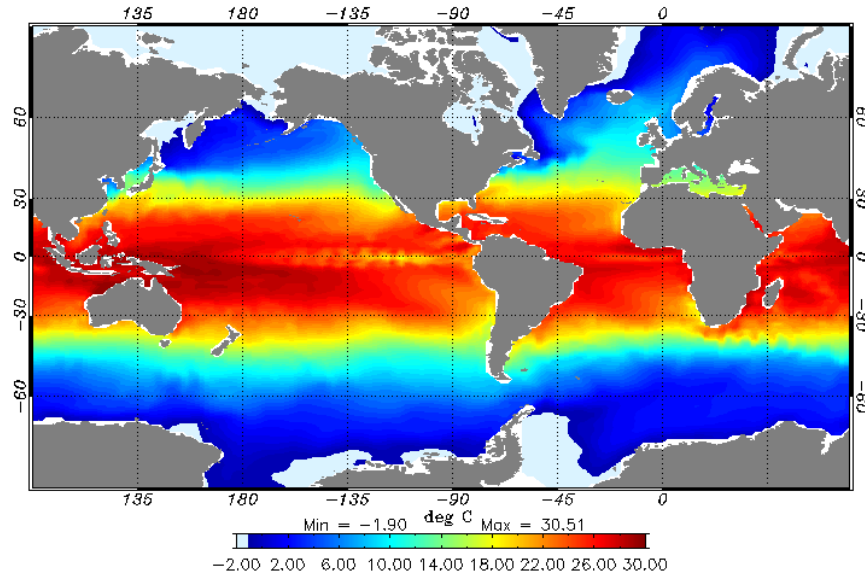
Goal : « Mesoscale Europ. Users »

JUL.2003

Line 3 : Global Ocean, Low resolution

## « 2°Global Ocean »

Analyzed : Temperature on 11-02-2004 near 0 m

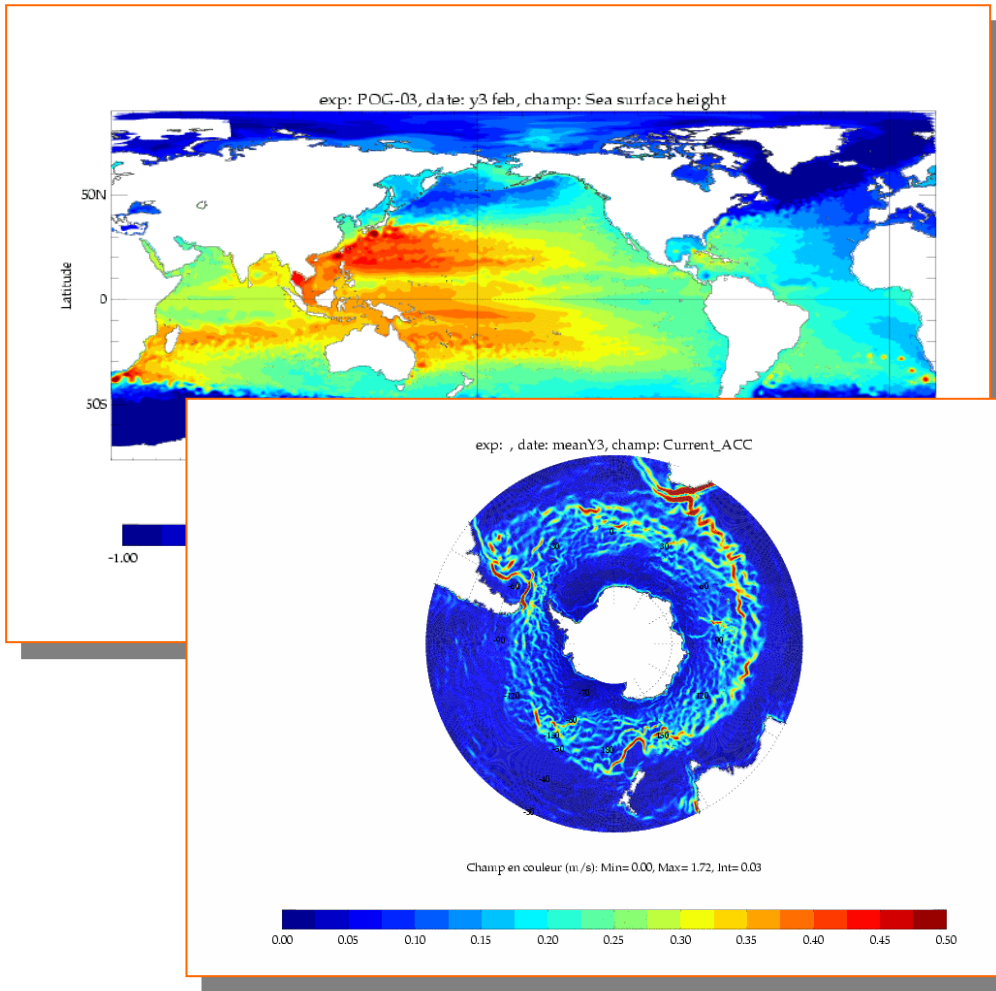


- **Area and Resolution**
  - Global Ocean
  - Horiz. 2° ; Vertical 30 levels
- **Model code : OPA-NEMO**
  - Free Surface, z-coordinate
- **Assimilation tool : SAM1**
  - v1 univariate (altimetry)
- **NRT Operations : weekly**
  - Start : 17/07/2003
  - 62 ocean bulletins (1 per week)
- **Simulations**
  - Reference simulations in NRT conditions available from 1999 to now (univariate)
  - 11 year reanalysis (1993-2004) with univariate assimilation, available

Goal : « Seasonal Forecasting »

2005  
(planned)

# Line 4 : Global Ocean, Eddy Permitting « 1/4° Global Ocean »

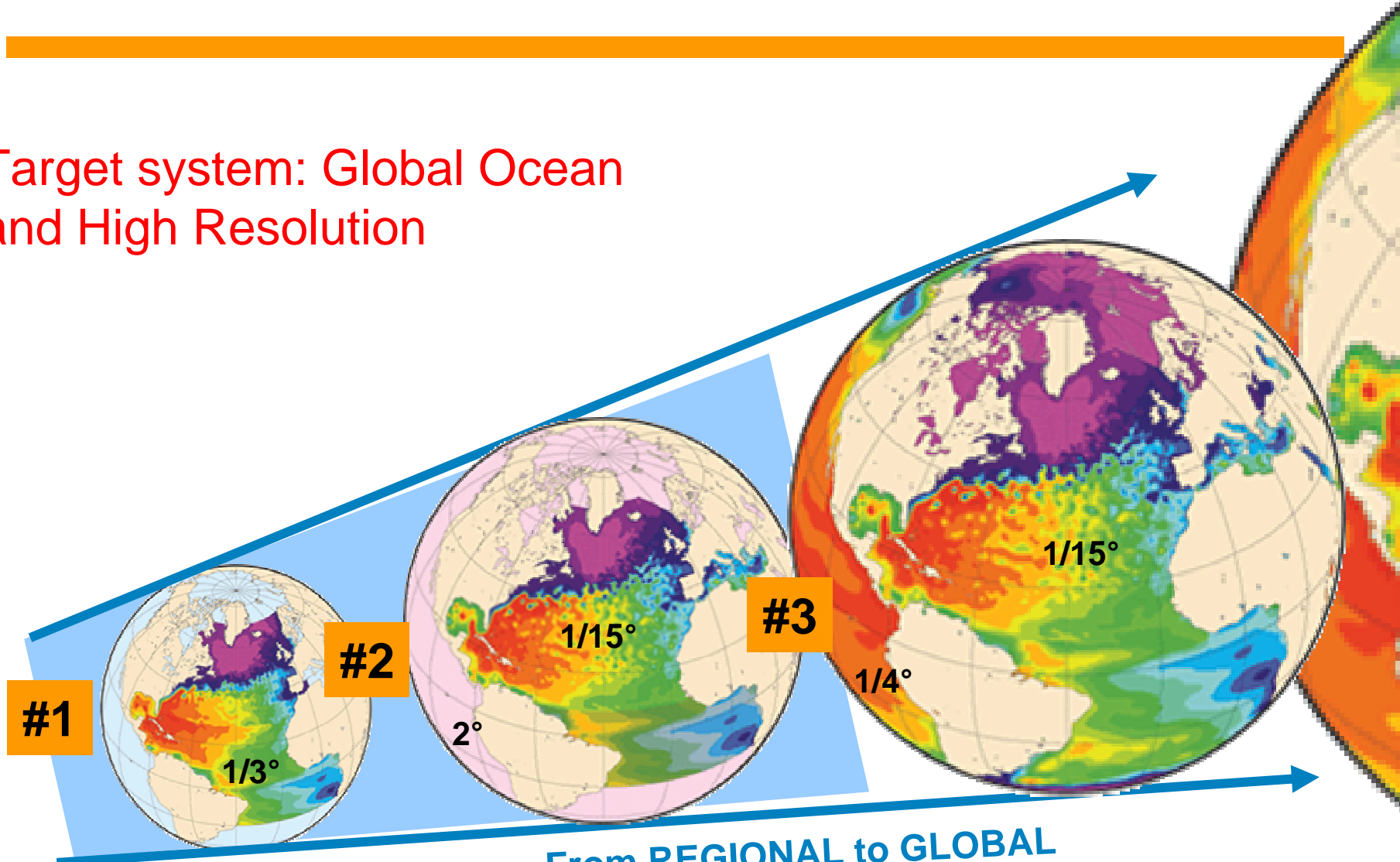


- **Area and Resolution**
  - Global Ocean
  - Horiz. 1/4° ; Vertical 46 levels
- **Model code : OPA-NEMO**
  - Free Surface, z-coordinate
- **Assimilation tool : SAM1**
  - v1 univariate (altimetry) and then v2 multivariate (alti, SST, in situ)
- **NRT Operations : weekly**
  - Start : planned Summer 2005
- **Simulations**
  - Various multiyear reference simulations (free model)

**Goal : « Global Ocean Mesoscale extension »**

# Incremental Development

Target system: Global Ocean  
and High Resolution



#1

$1/3^\circ$

#2

$2^\circ$

#3

$1/15^\circ$

$1/4^\circ$

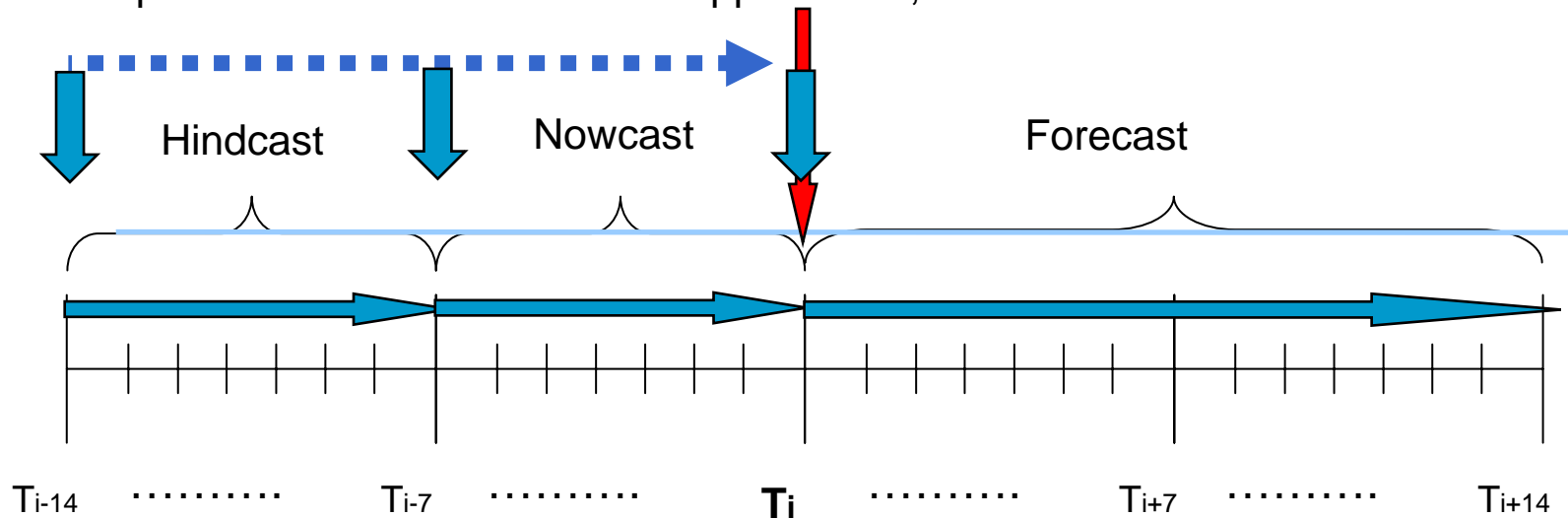
$1/15^\circ$

Strategy:

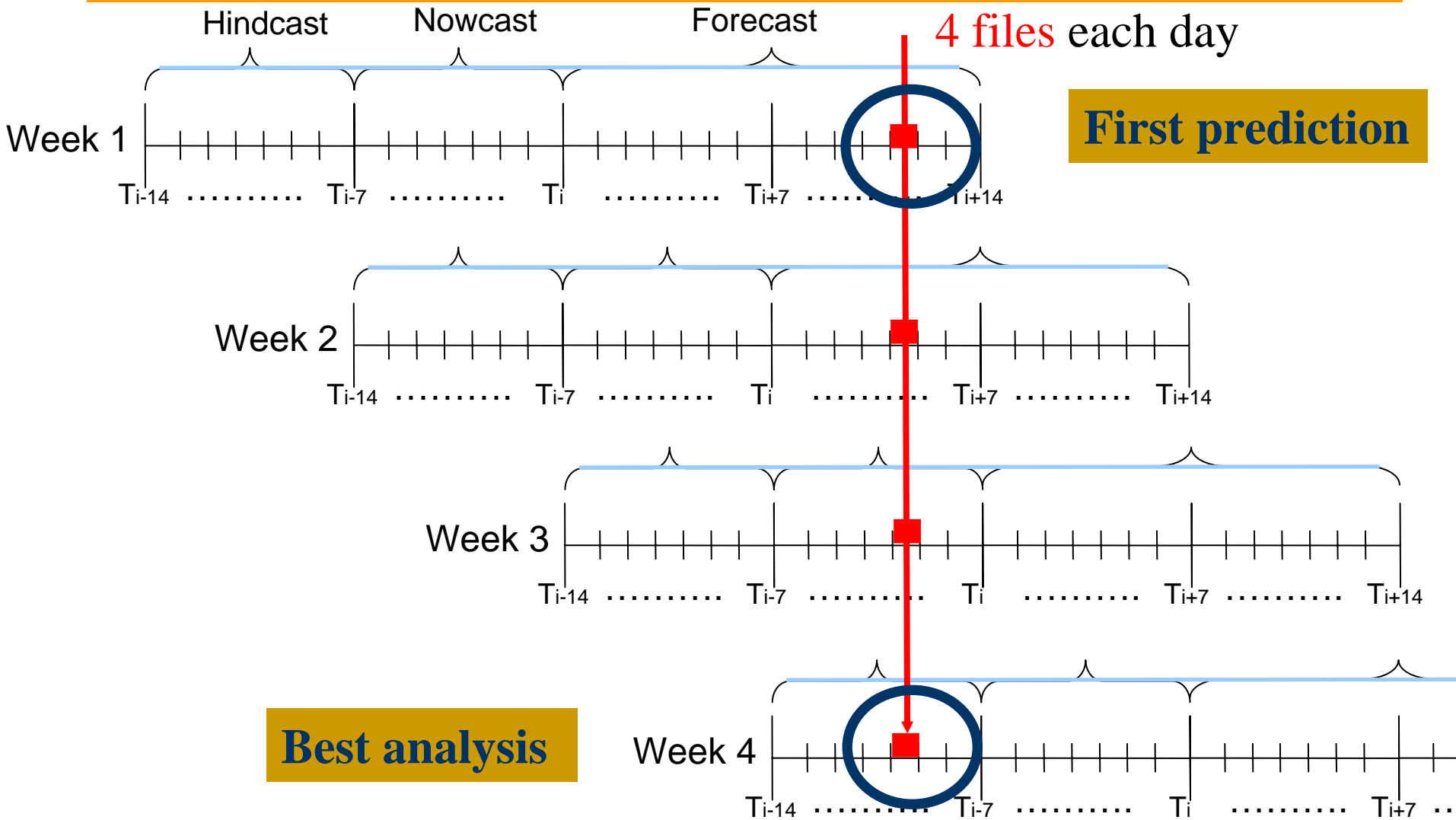
From REGIONAL to GLOBAL  
From R&D to OPERATIONAL  
From Altimetry to MultiData

# How does it work ?

- Every week on Tuesday night / Wednesday morning:
  - Assimilation data are acquired (SSALTO/DUACS & CORIOLIS)
  - Forcing fields are acquired (ECMWF gaussian grids)
  - We go 2 weeks back in time and perform a run from  $T_0-14$  to  $T_0$ 
    - Hindcast: forecast the past, perform analysis at  $T_0-7$ :
      - best MERCATOR estimate from  $T_0-14$  to  $T_0-7$
    - Nowcast: forecast the present, perform analysis at  $T_0$ :
      - Temporary results (not all the obs available), will be updated next week
  - We perform a 2-week forecast -> applications, ...



# Files created by MERCATOR: full fields - daily



# An example: the birth of an anticyclonic Eddy in the Gulf of Mexico in April 2002

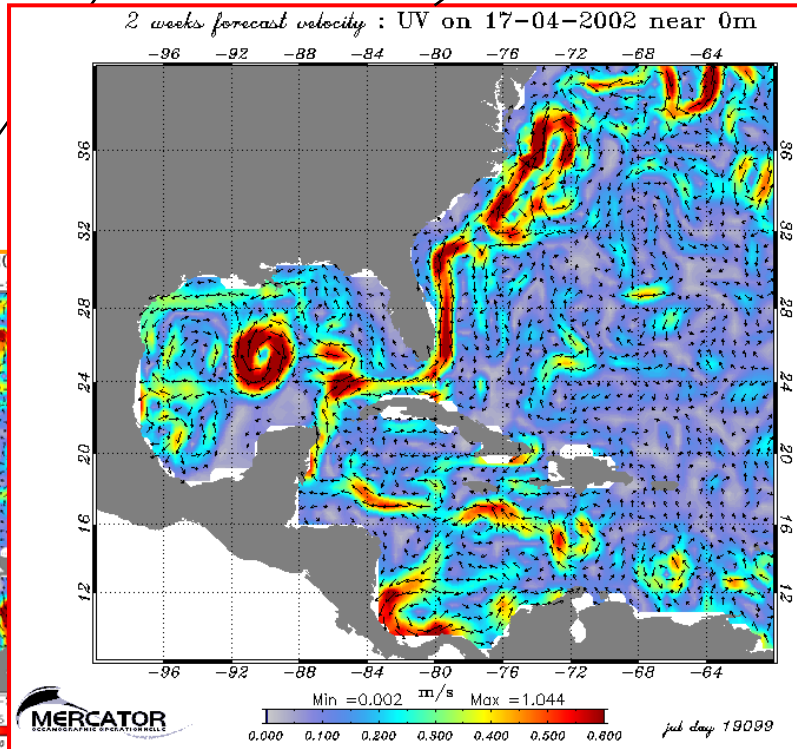
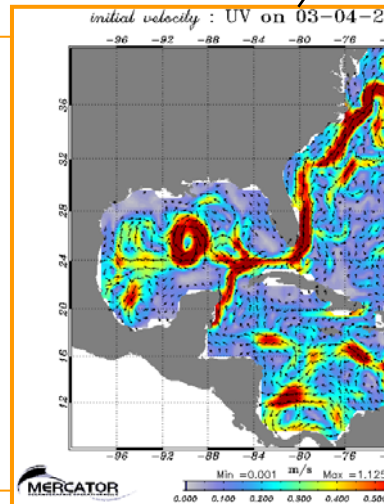
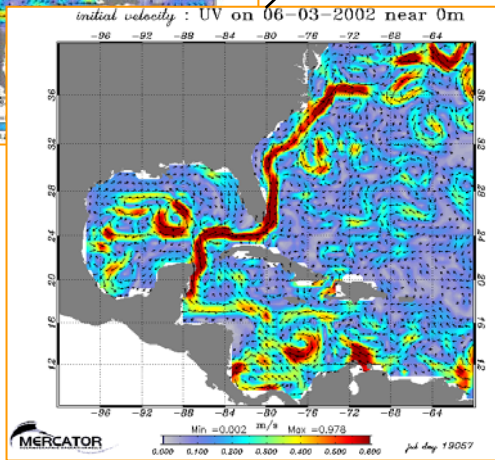
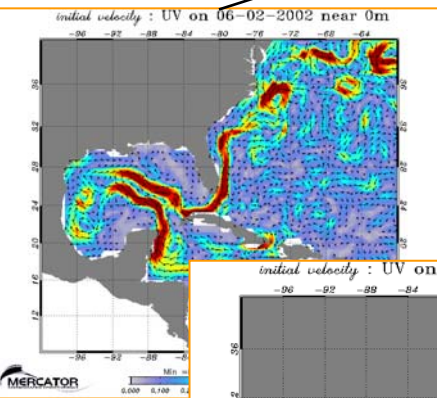


hindcast  
06 Feb 2002

hindcast  
06 Mar 2002

Nowcast  
03 Apr 2002

Forecast  
17 Apr 2002

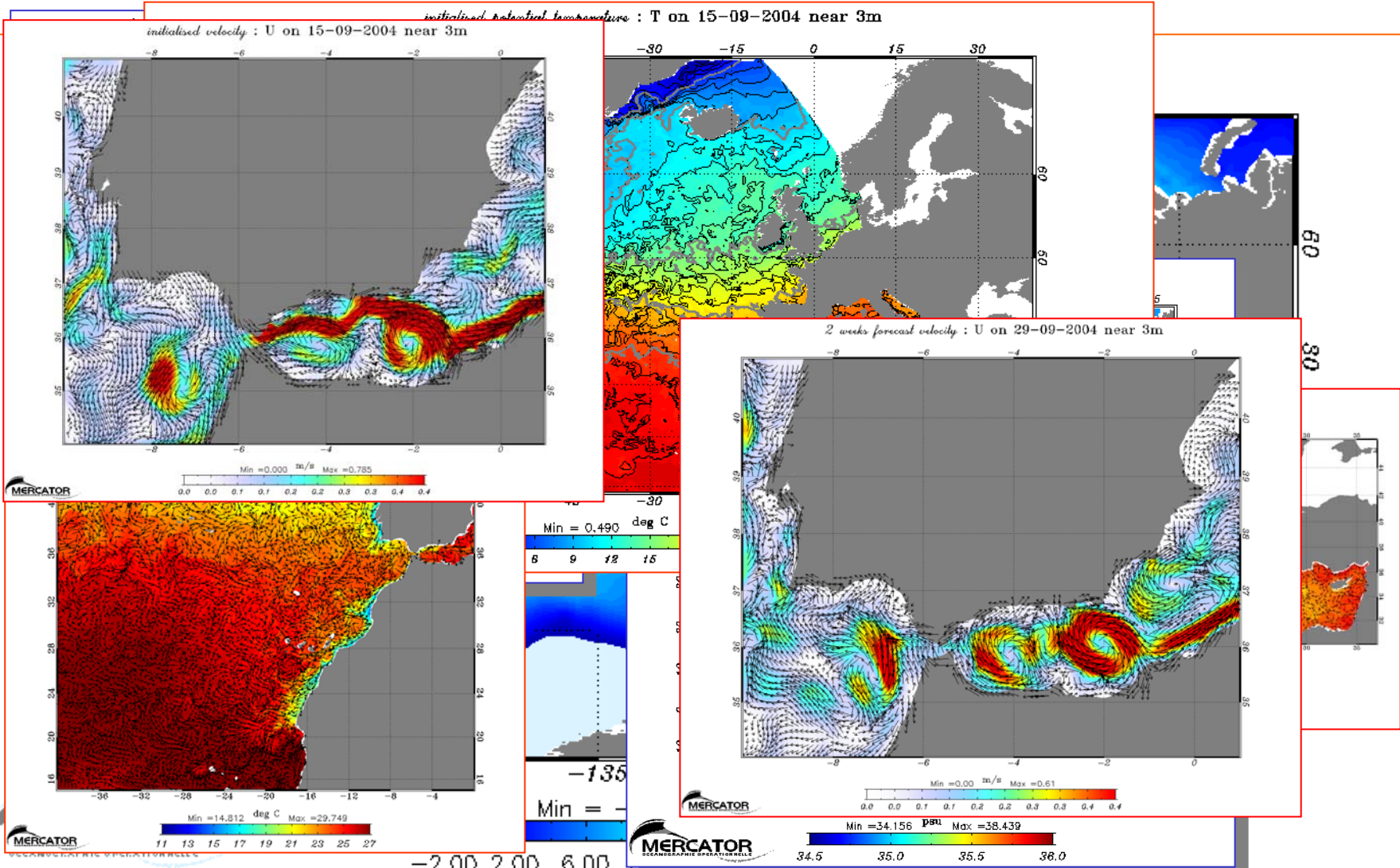




# Mercator Ocean system outputs

Information available on 15/09/04 (last bulletin).

EXPORT INFO



# Products Line

(see [www.mercator.eu.org](http://www.mercator.eu.org) ; <mailto:products@mercator-ocean.fr>)

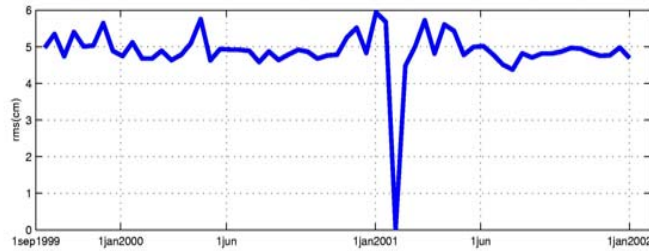
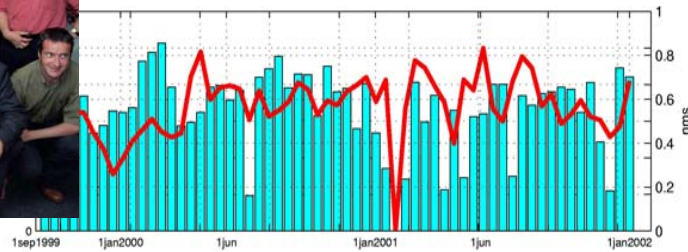
## EXPORT INFO

The screenshot shows a web browser window displaying the MERCATOR website. The page title is "PSY1 analysis and prediction bulletins". The main content area features a map titled "North atlantic Sea level anomaly on May 29, 2002 (T0)". The map shows a color-coded sea level anomaly over the North Atlantic region. To the right of the map is a "Bulletin Choice" section with a dropdown menu showing various date ranges, and a "Geographic Areas" section with links for "North Atlantic", "Sections", "Moorings", "Zonal mappings", and "Technical assimilation bulletin". The website footer includes "Contact us", "Subscribe", "Search", "Site map", and "Français Project group MERCATOR website".

- Dynamic access on MERCATOR web site to 2000 predefined maps fully describing the ocean from surface to bottom (pre-defined depth-levels).
- List of all MERCATOR products available and conditions for access and use.
- Free access to the numerical data products : ocean parameters and assimilation fields.
- OpenDap / LAS server operational (Mersea Strand 1 heritage)

150 referenced users,  
sept 2004

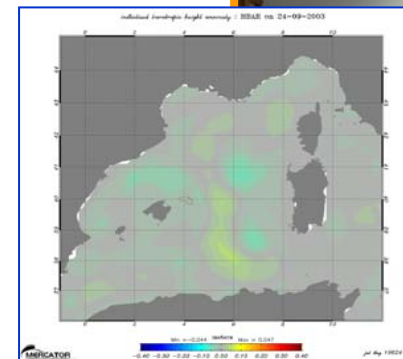
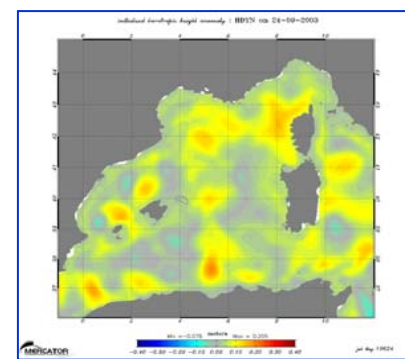
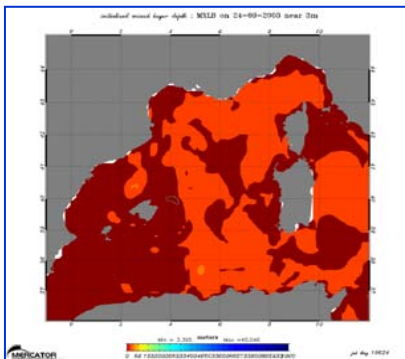
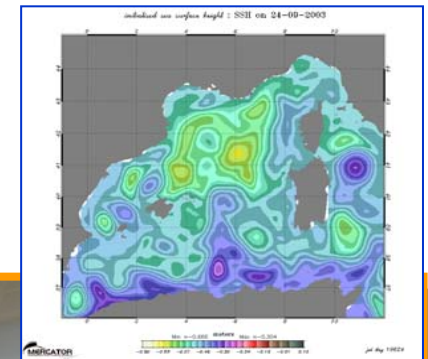
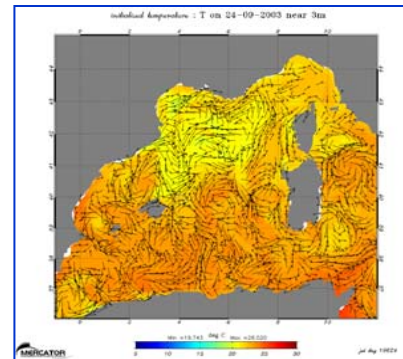
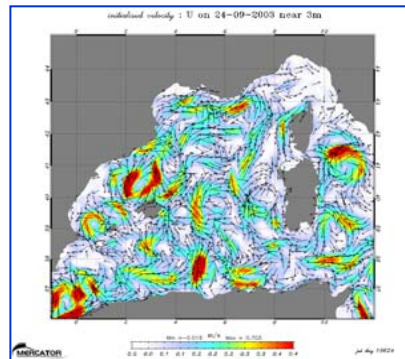
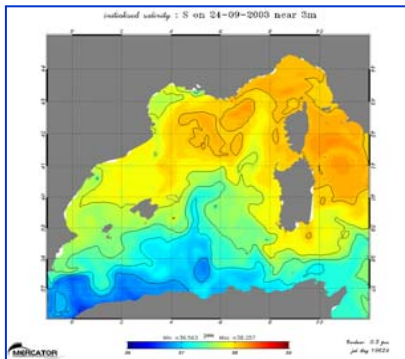
# MERCATOR, System ASSESSMENT



# A team of Ocean forecasters

## ROUND 1 : SHORT LOOP

- Monitoring the system outputs
- Elaborating Routine Ocean bulletin
- Customizing information for dedicated user team and dedicated experiment
- Ensuring relay and feedback to the R&D Mercator team



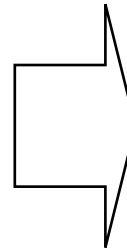
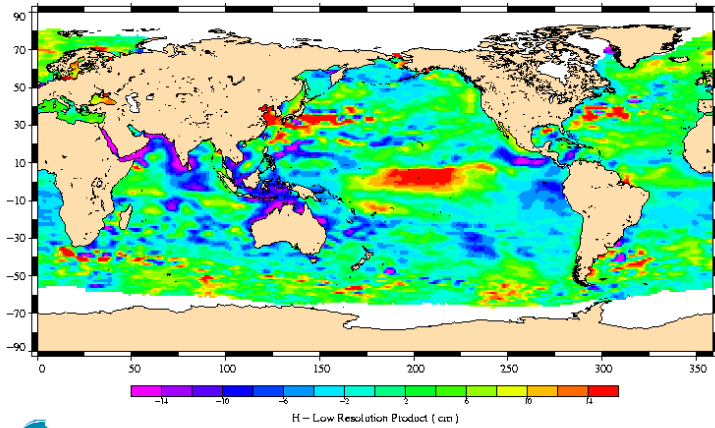
# Input Data Validation

ROUND 1 : SHORT LOOP

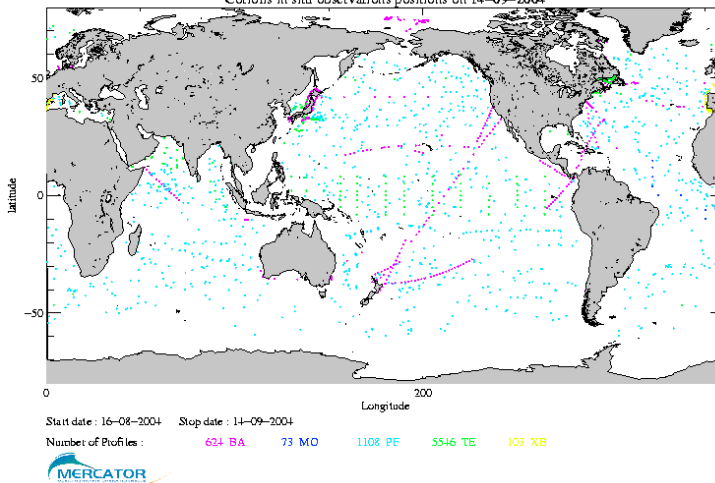
## Altimetry / In Situ Cross-comparison

ARMOR ; 14 Sept 2004

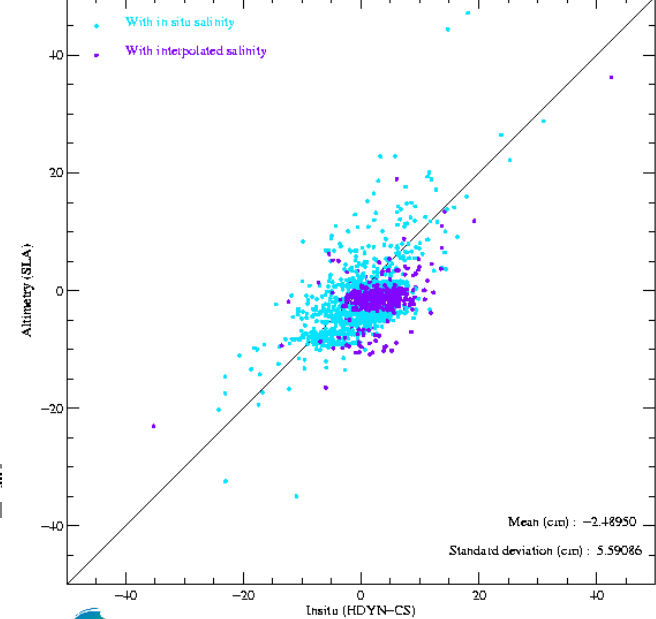
SSALTO/DUACS – NRT MSLA – Merged Product on 08–09–2004



Coriolis in situ observations positions on 14–09–2004



In Situ Altimetry scatter plot on 14–09–2004



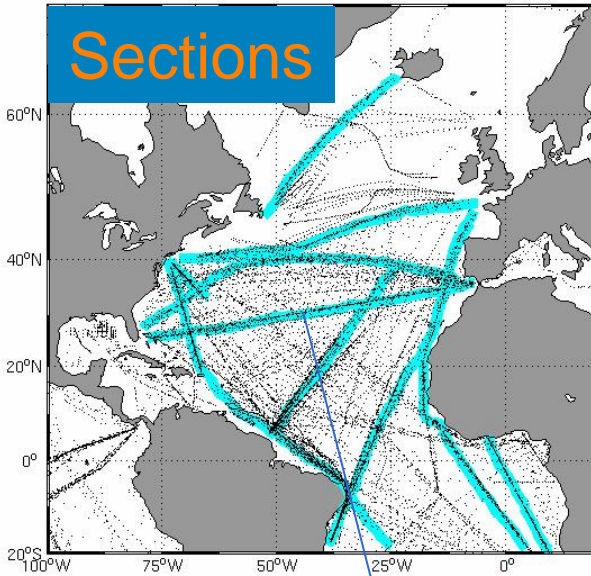
**IN SITU / ALTIMETRY DispersionPlot ;  
Mean : -2.4 cm ; St.Dev : 5.6 cm**

*discuss details with Stéphanie !*

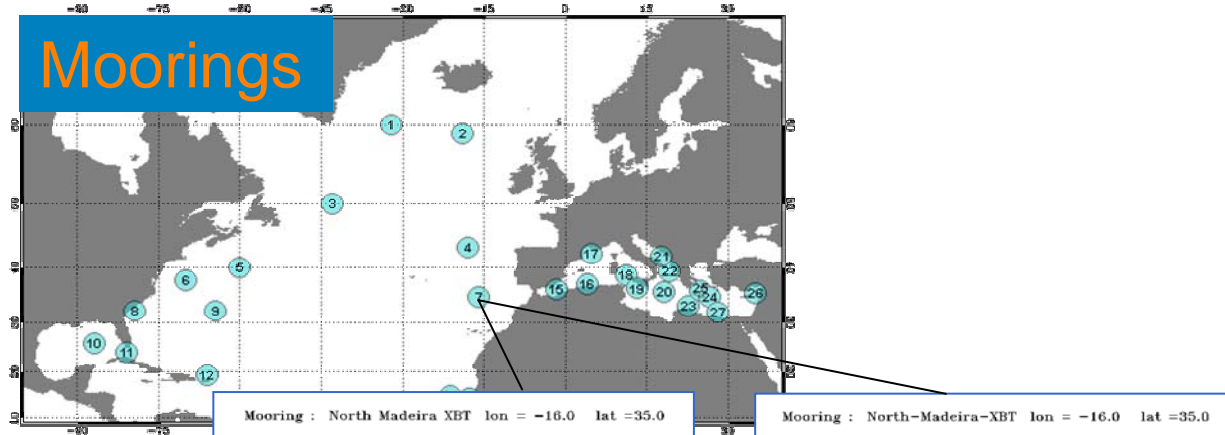
# Validation and Quality Control

## ROUND 1 : SHORT LOOP

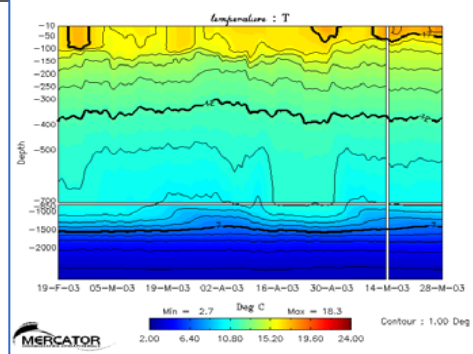
### Sections



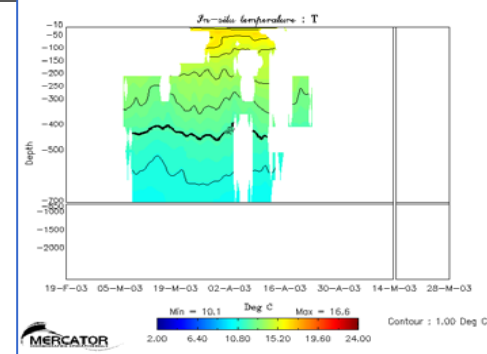
### Moorings



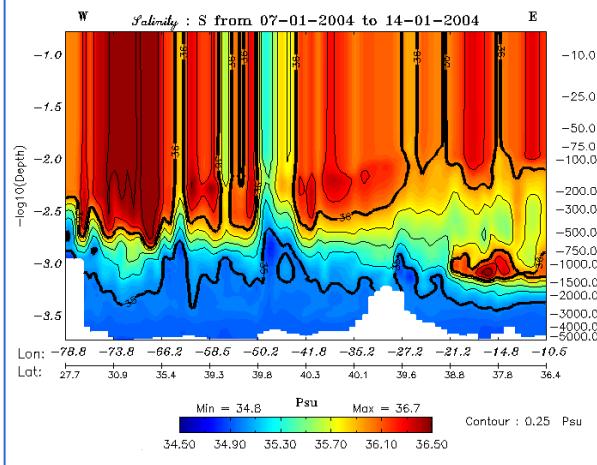
Mooring : North Madeira XBT Ion = -16.0 lat =35.0



Mooring : North-Madeira-XBT Ion = -16.0 lat =35.0



Section : Florida-Portugal

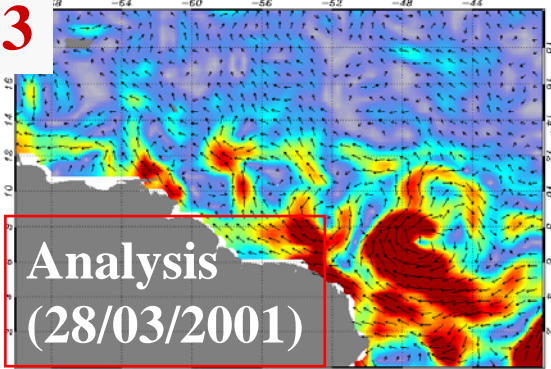


# Analysis/Forecast

## ROUND 1 : SHORT LOOP

13

initial velocity : UV on 28-03-2001 near 0m

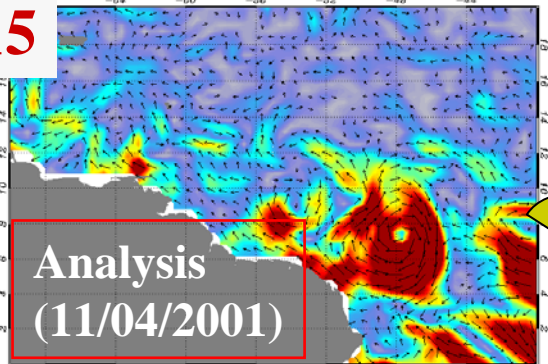


on 11-04-2001 near 0m

-48 -44

15

initial velocity : UV on 11-04-2001 near 0m

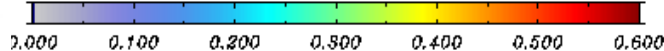


15\*\*

2 week  
FORECAST  
(11/04/2001)

Surface currents

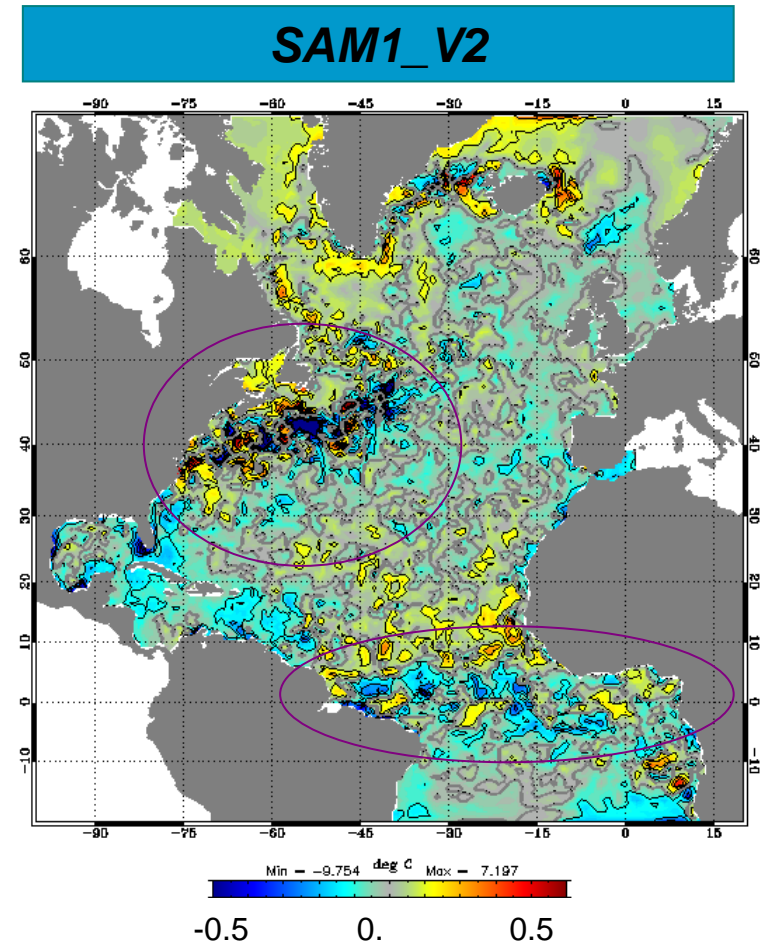
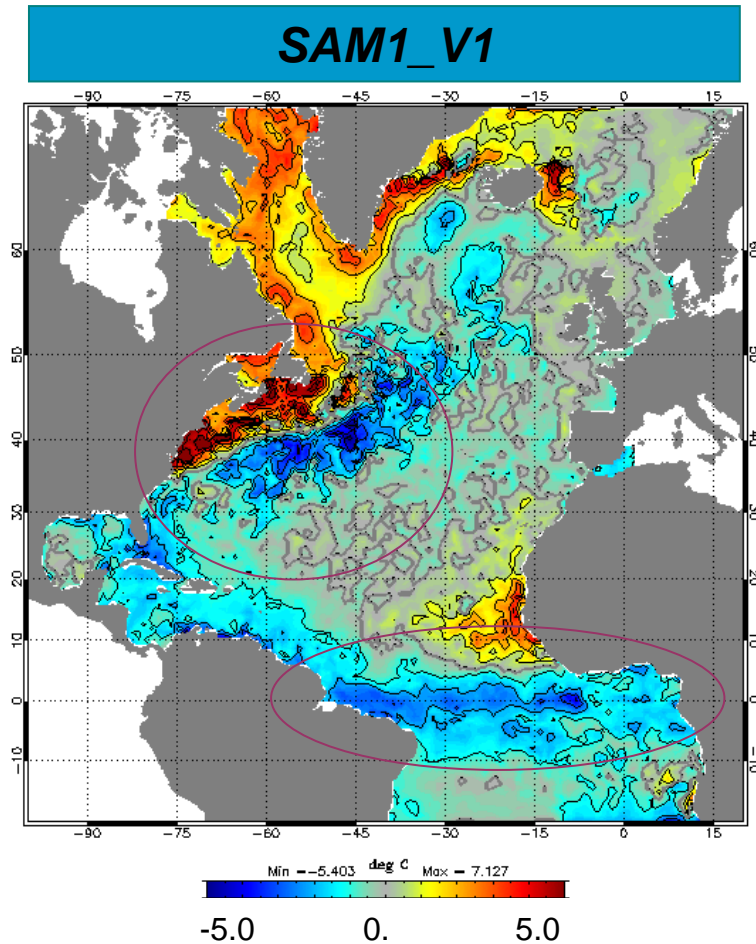
Min = 0.001 m/s Max = 1.096



jul day 18728

# ... assessing System upgrades (assimilation)

ROUND 2 : R&D LOOP



**Mercator SST minus Reynolds SST ; 12/06/2002**

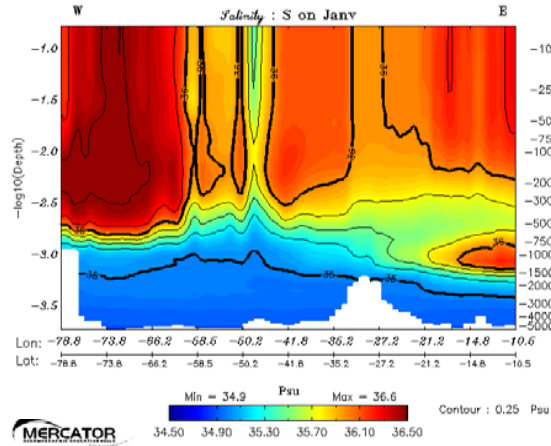


# High Resolution / Univariate *versus* Middle Resolution / Multivariate

**DATA LOOP**

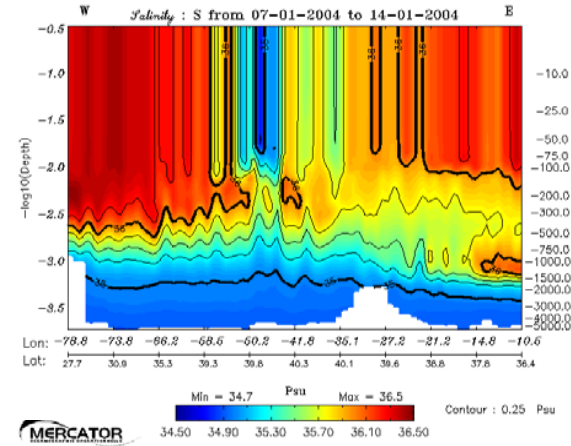
## Salinity section Florida-Portugal

Section : Florida-Portugal



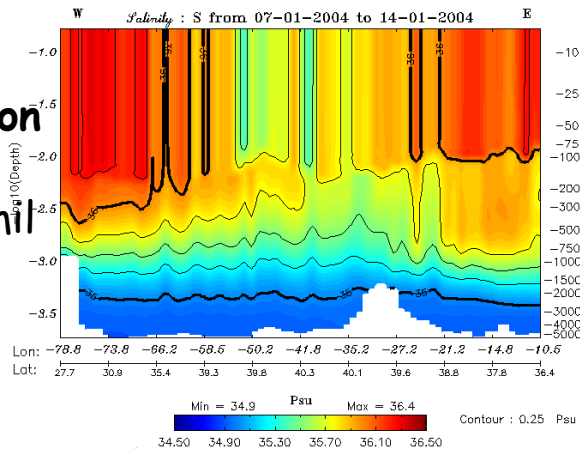
**Climatology**

Section : Florida-Portugal



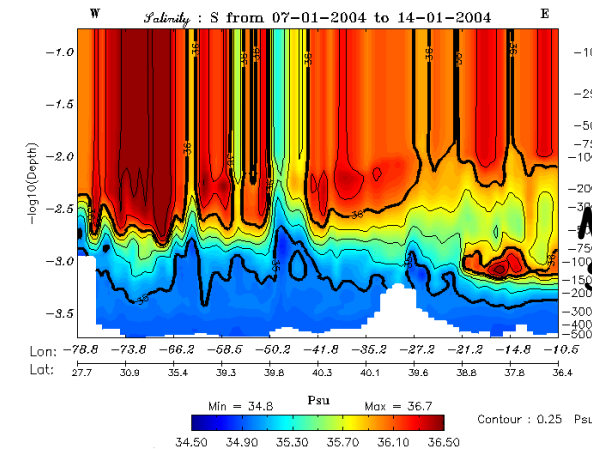
**High Resolution  
1/15°  
Univariate assimil  
SLA**

Section : Florida-Portugal

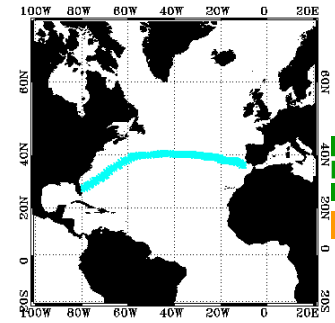


**Middle Resolution  
1/3°  
Univariate assimil  
SLA**

Section : Florida-Portugal



**Middle Resolution  
1/3°  
Multivariate assimi  
SLA + SST + T/S(z)**



# Systematic InterComparisons Lively Access to Products

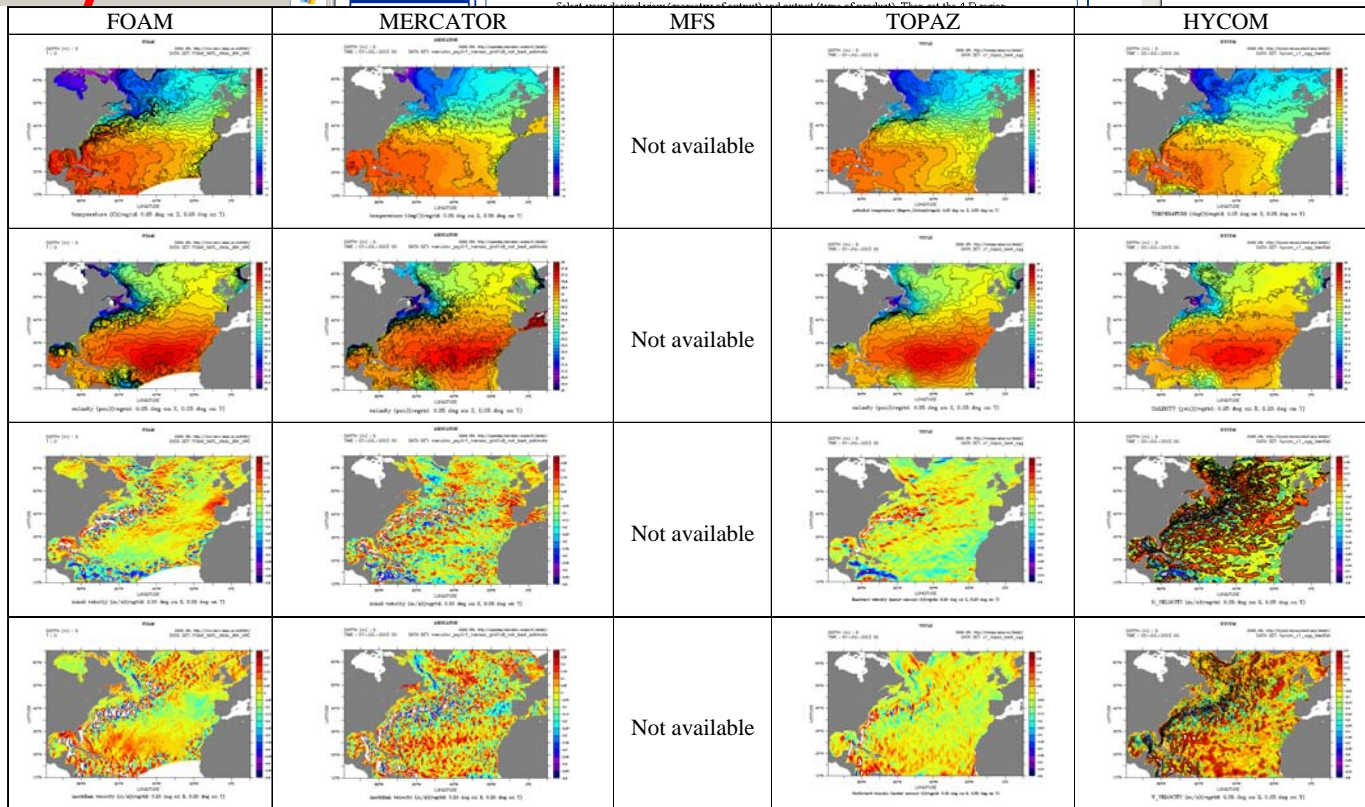
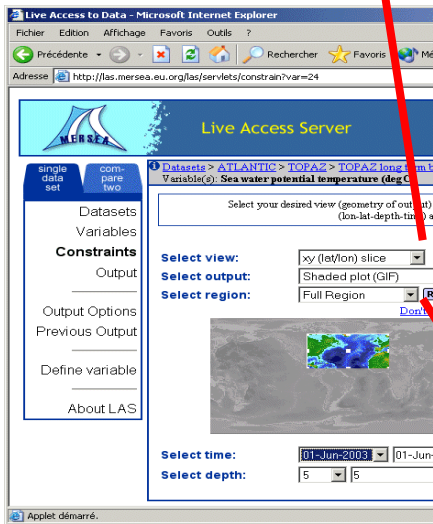
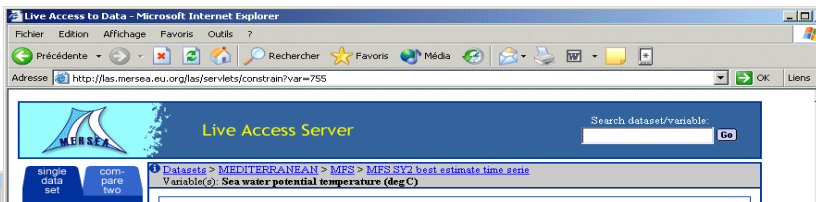
## ROUND 3 : INTERCOMPARISON



*Wait for Laurence presentation!*

- xy (lat/lon) slice
- xy (lat/lon) slice
- xz (lon/depth) slice
- xt (Hovmoller) slice
- yz (lat/depth) slice
- yt (lat/time) slice
- zt (depth/time) slice
- x line
- y line
- z line
- t line
- xyz volume
- xyt volume
- xyt volume
- xzt volume
- xyzt volume

- Shaded plot (GIF)
- Shaded plot (PostScript)
- Quick inspection (text)
- NetCDF
- Tab separated (text)
- Comma separated (csv)
- FORTRAN formatted (text)
- ArcView gnddied
- Fort script

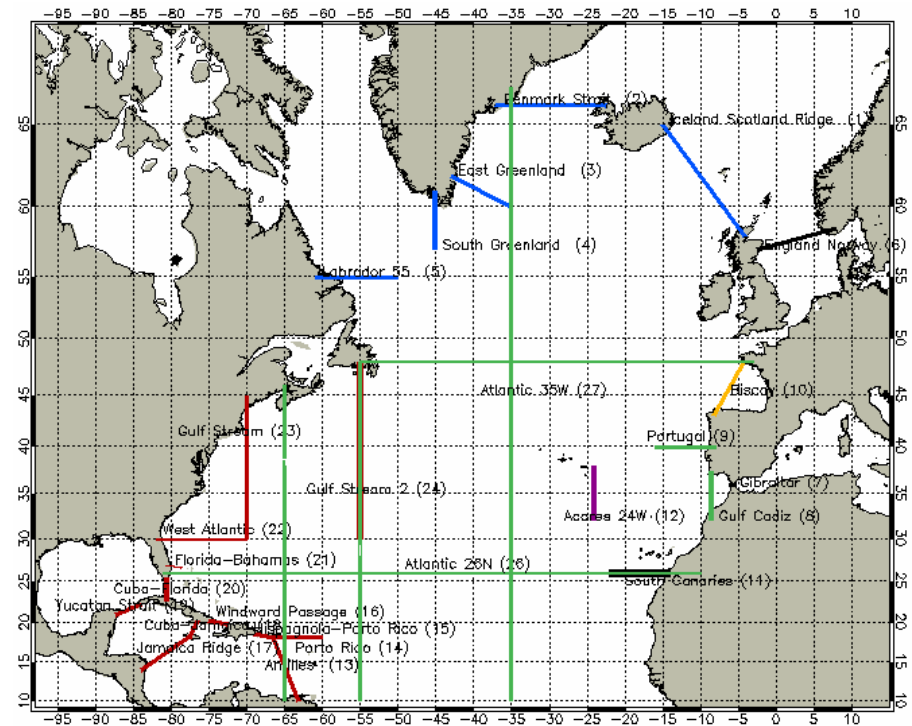
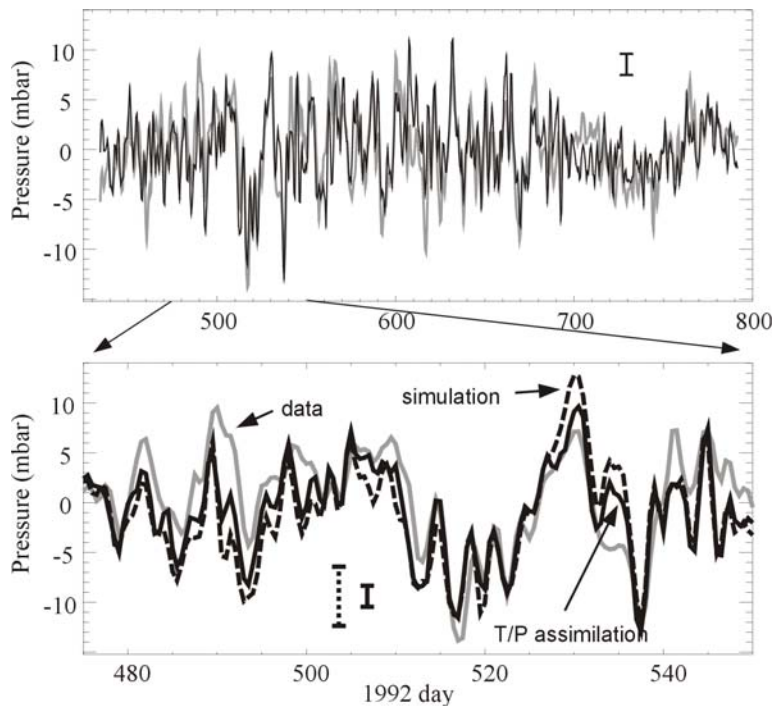


The Atlantic  
Case

# « metrics »

## ROUND 3 : INTERCOMPARISON

- **Definition of common metrics (e.g. transports,...) (model and assimilation)**
- **Agree on common formats/grids and fields to be compare (e.g. SST, T, S)**
- **Use of Live Access Server to facilitate the intercomparison,**
- **EC “MERSEA Strand 1” pilot project with prototype systems (North Atlantic and Med Sea)**

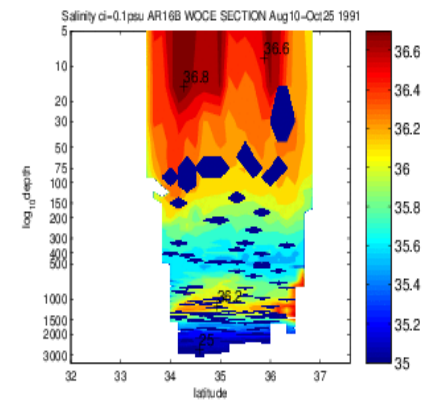
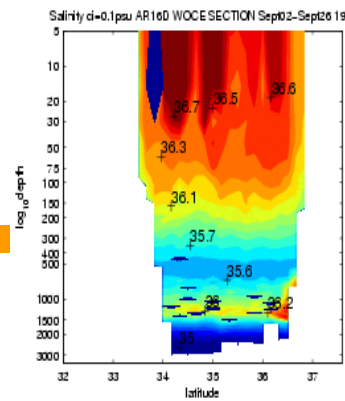


## ROUND 3 : INTERCOMPARISON

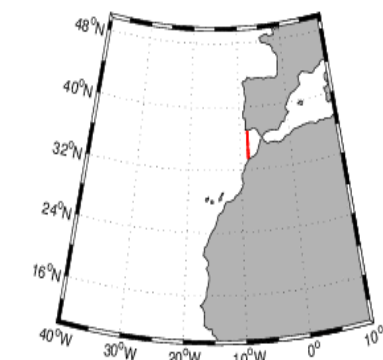
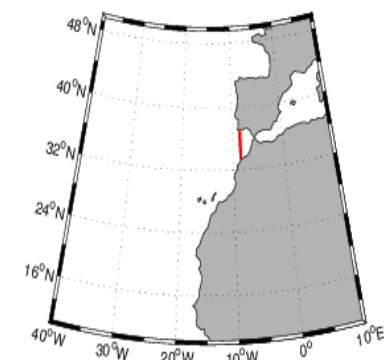
# Metrics Class2 : example

## Gulf Cadiz Section 9°W

### Salinity



WOCE

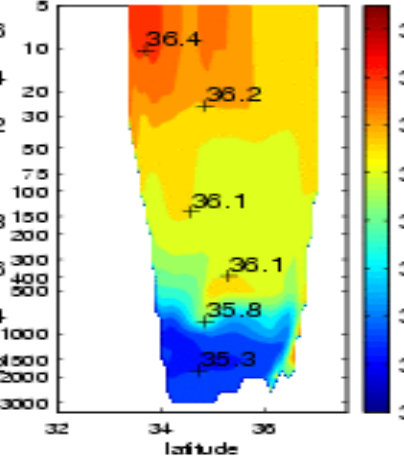
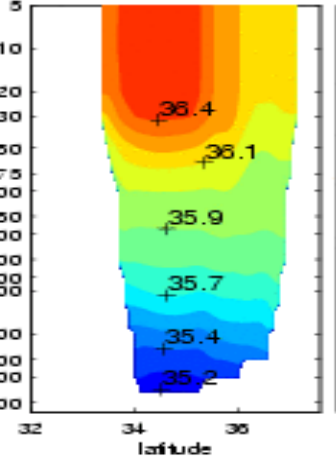
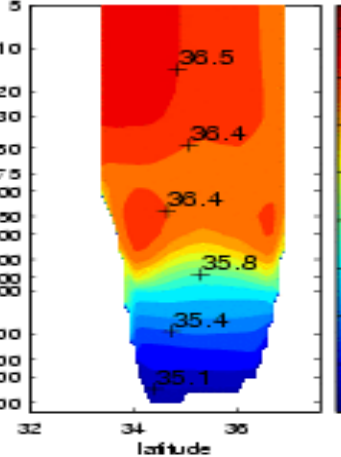
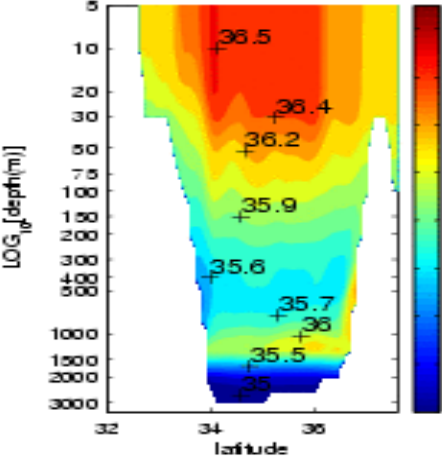


Sec9 MERCATOR Sal(d=0.1psu) OCT03

Sec9 TOPAZ Sal(d=0.1psu) OCT03

Sec9 FOAM Sal(d=0.1psu) OCT03

Sec9 HYCOM-US Sal(d=0.1psu) OCT03



MERCATOR

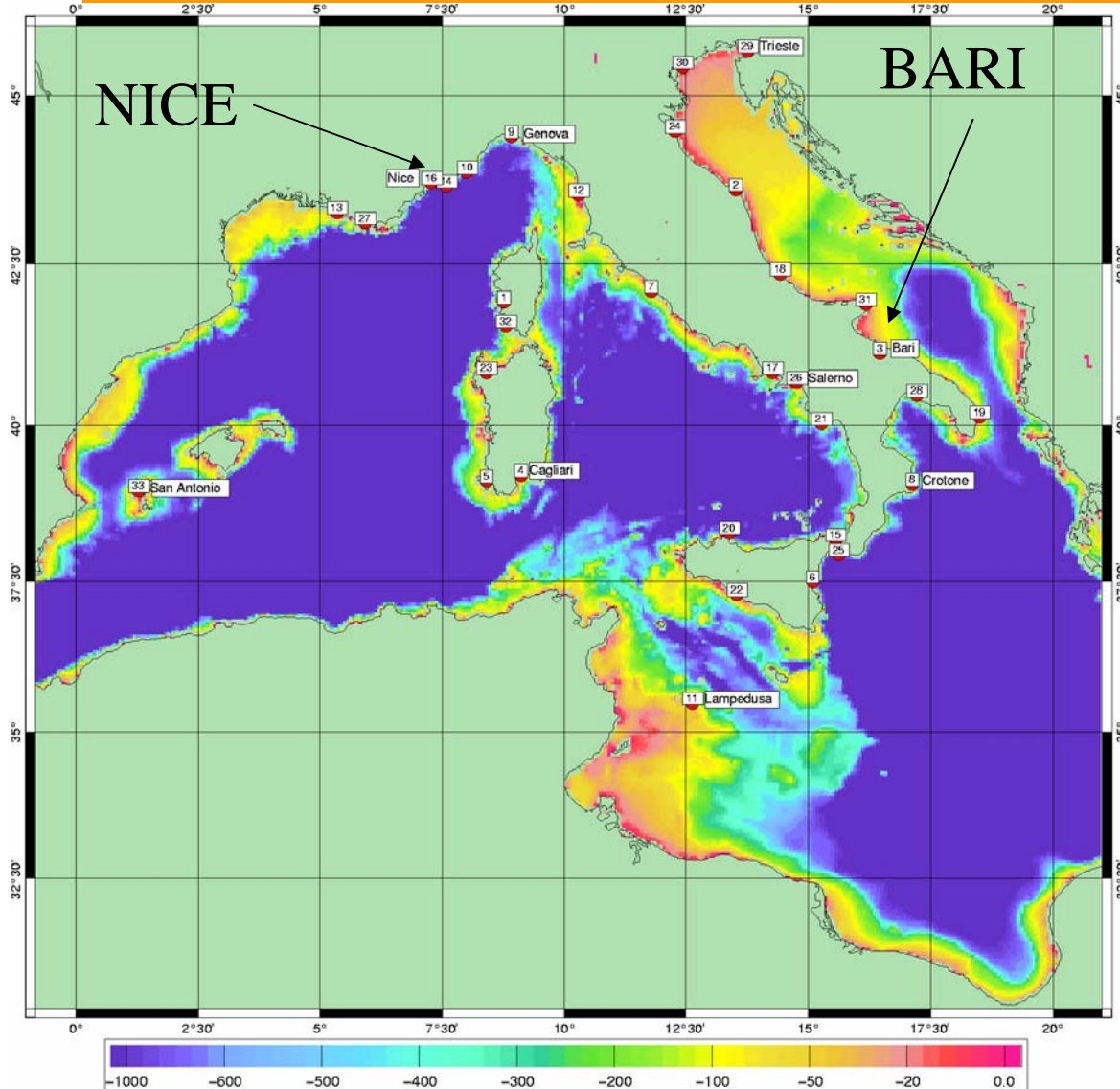
TOPAZ

FOAM

HYCOM-US

# ... using Mercator outputs in scientific applications

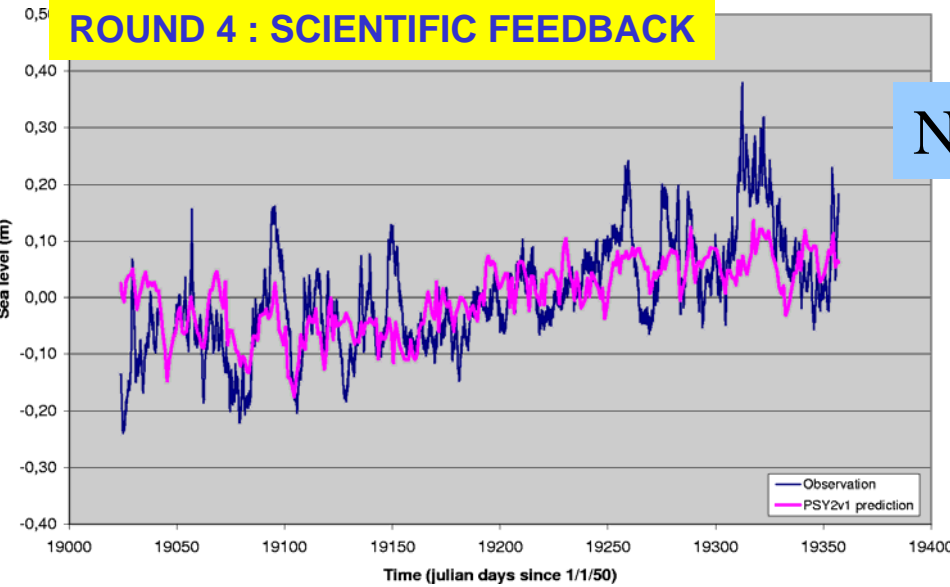
## ROUND 4 : SCIENTIFIC FEEDBACK



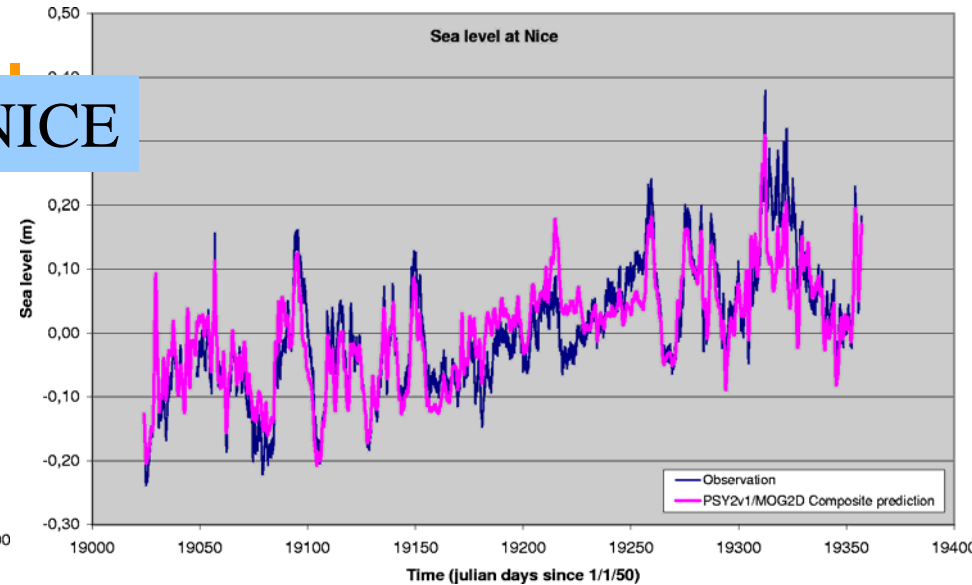
- **Sea Level** estimated through MERCATOR PSY2 and Mog2D models
- Comparison to Tidal gauges
- From F.Lyard (LEGOS) published in Mercator Newsletter #10

# Sea Level in Mercator (F.Lyard, LEGOS)

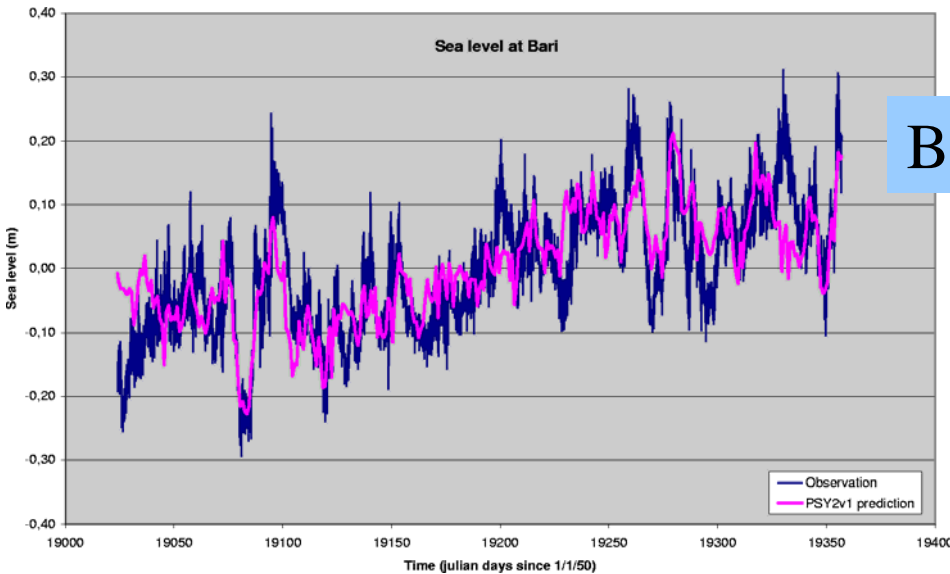
ROUND 4 : SCIENTIFIC FEEDBACK



NICE

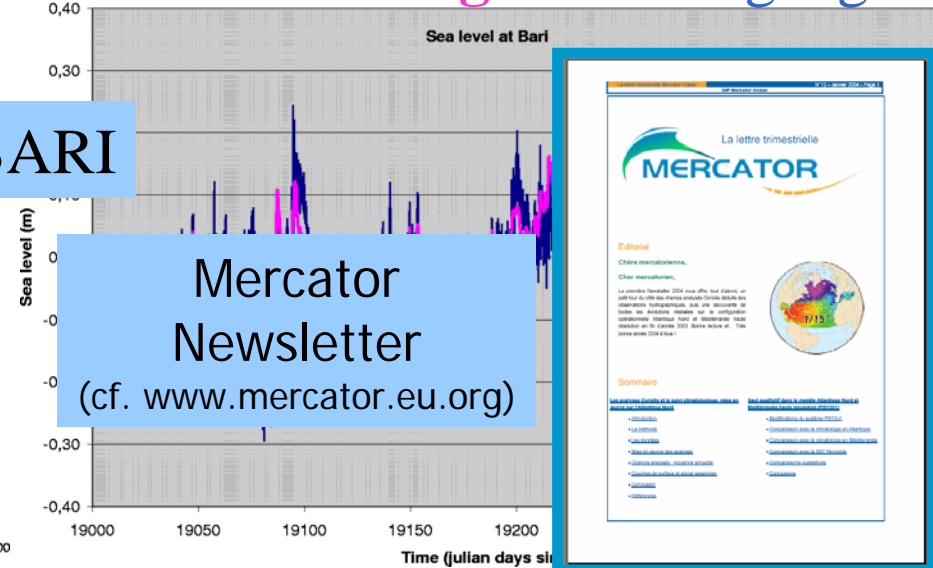


Mercator / tidal gauges



BARI

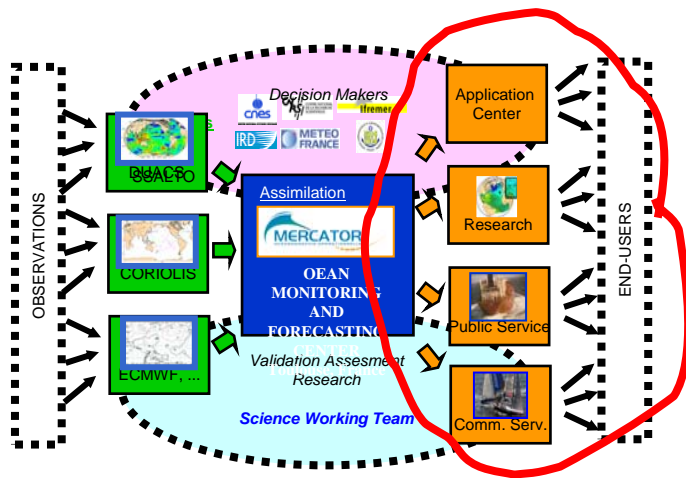
Mercator+Mog2D / tidal gauges



Mercator  
Newsletter  
(cf. [www.mercator.eu.org](http://www.mercator.eu.org))

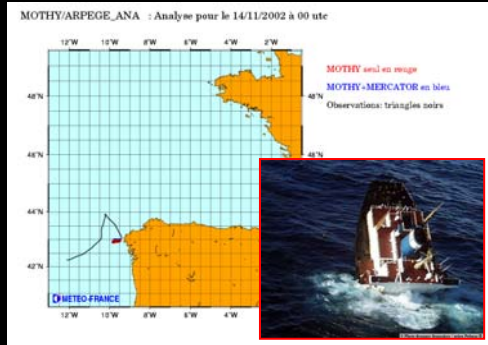
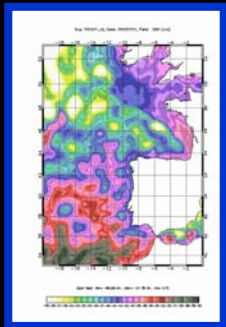


# MERCATOR, Serving Ocean services

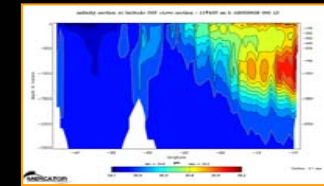
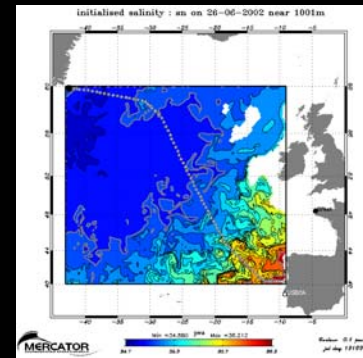


# Mercator Ocean services

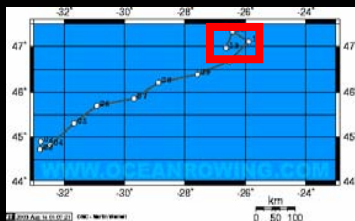
## Operational Institutional Applications



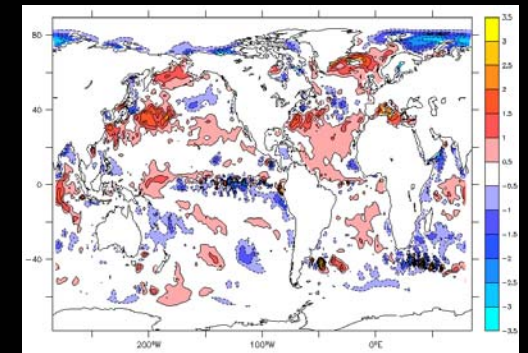
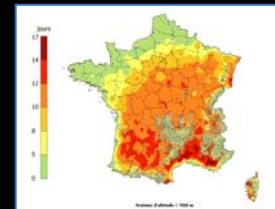
## Research



## Operational Recreational & Commercial Applications



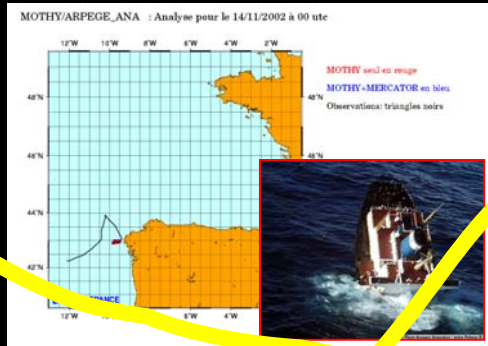
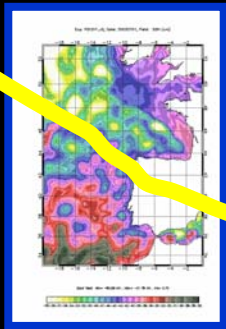
## Policy Makers Information



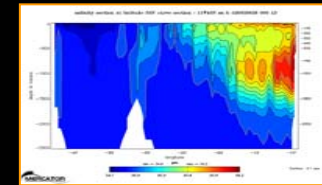
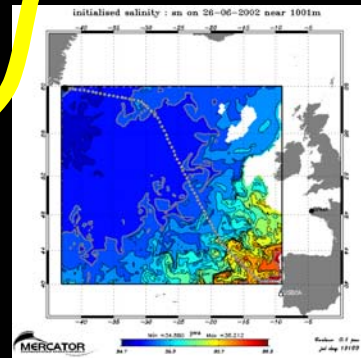


# Mercator Ocean services

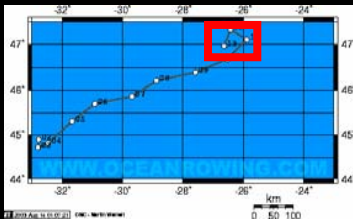
## Operational Institutional Applications



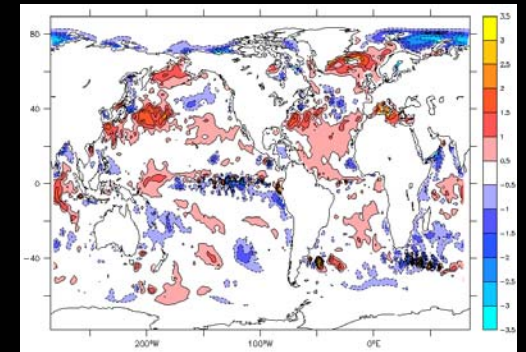
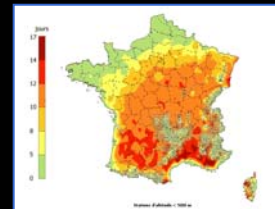
## Research



## Operational Recreational & Commercial Applications



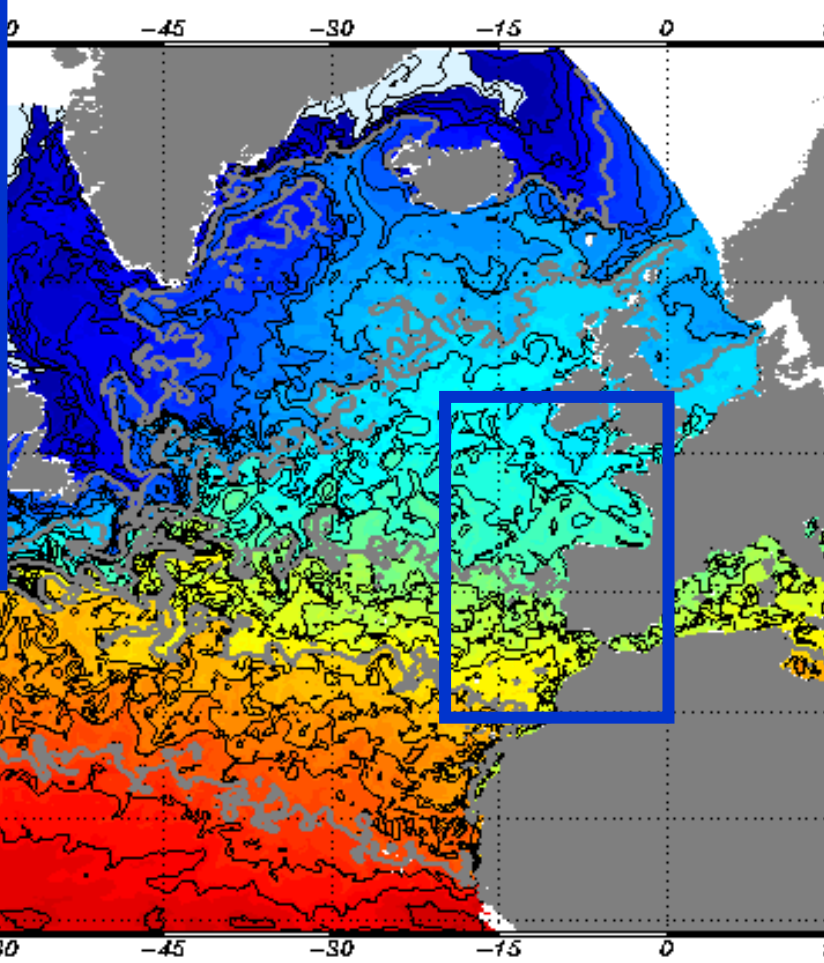
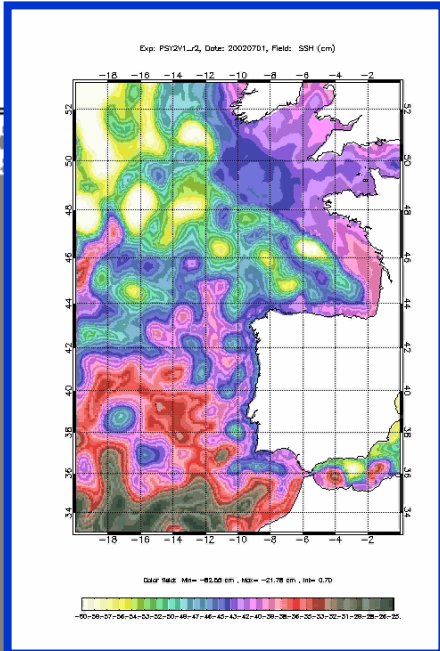
## Policy Makers Information



# ... operations against Oil Pollution

(serving Météo-France, ...)

forecast temperature : T on 03-12-2003 near 3m



## Forecaster's Bulletin

- Courants Mercator pour la zone 43°N-45°N et 6°W-1°W
- Analyse du 11/12/02
- Dans la zone située au sud entre les côtes de la Galice espagnol, les courants portent au NW en se renforçant à la Santander. Les vitesses moyennes sont de 0,2 m/s, avec renforcement principalement près de Santander. Le long du littoral français, le courant est extrêmement inférieur à 0,08 m/s. Il se renforce en mer large, pour des vitesses supérieures à 0,2 m/s à l'est de 4°W.
- Prévisions à une semaine du 15/12
- Près des côtes espagnoles, les courants portent en direction NW, à 0,05 à 0,17 m/s jusqu'au 14/12 puis porte au NW à 0,10 m/s pour des vitesses supérieures à 0,10 m/s atteignant localement 0,25 m/s près de la côte. Le courant portera le 16/12, SE à ESE 0,25 m/s [.

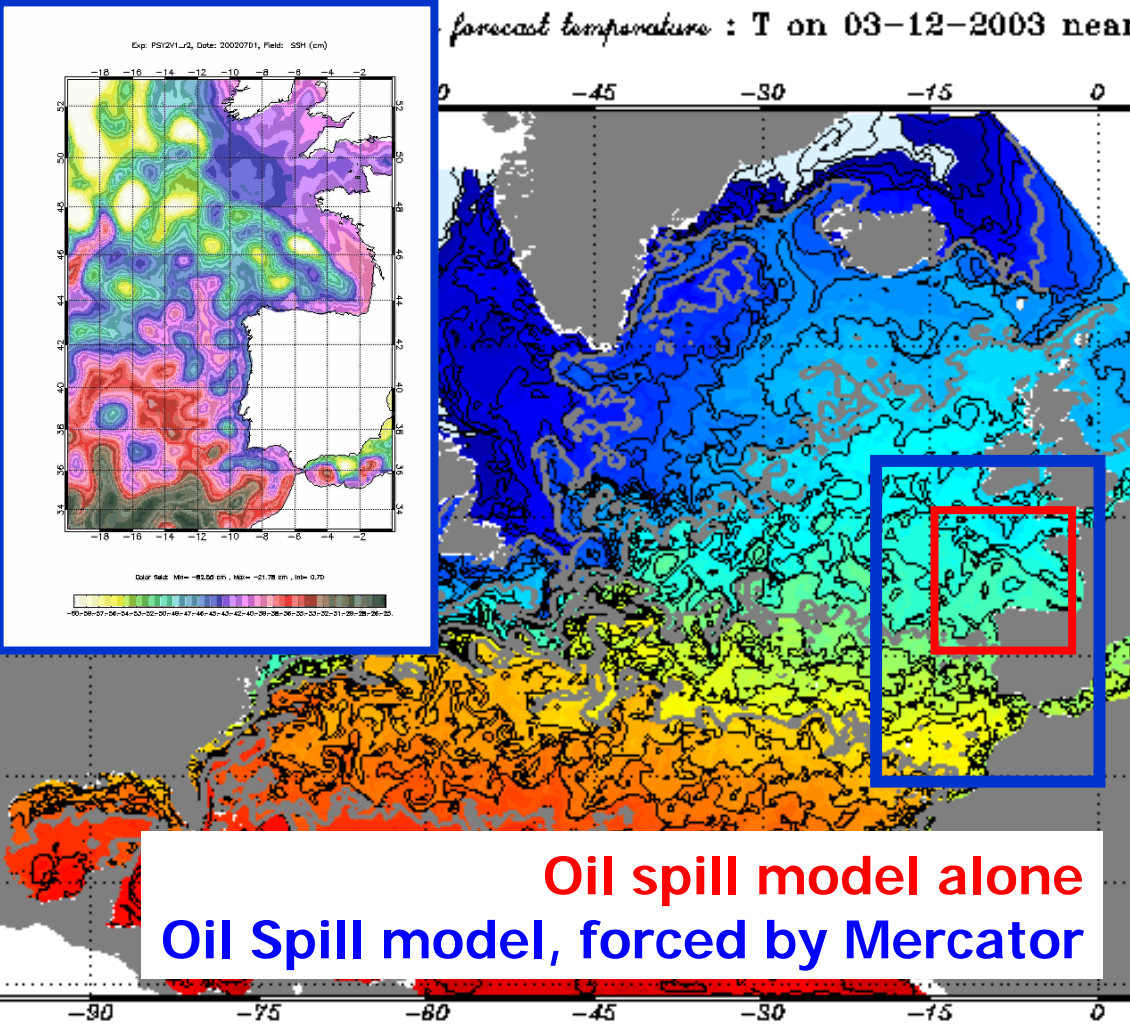
10-20% les courants  
jusqu'à 1969/4

# ... operations against Oil Pollution

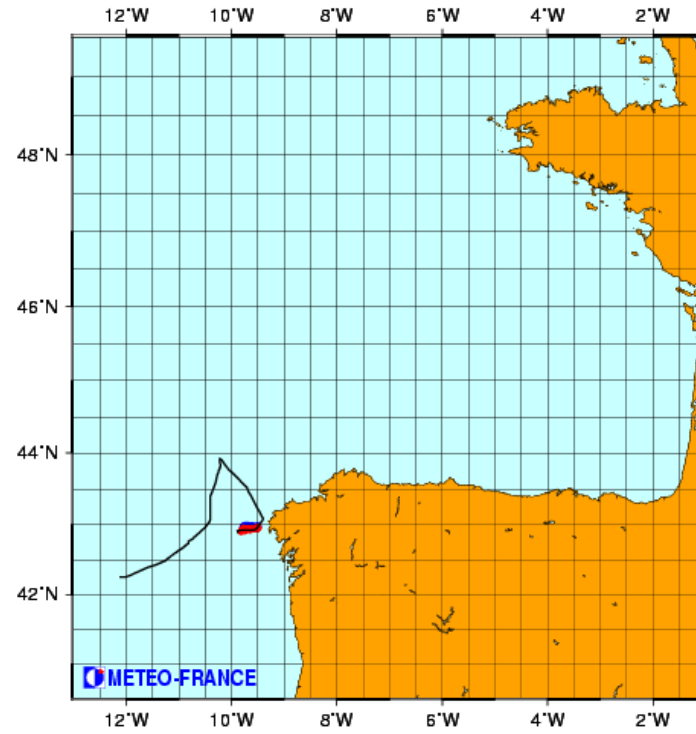
(serving Météo-France, ...)

4D Ocean Inputs

MOTHY/ARPEGE\_ANA : Analyse pour le 14/11/2002



Oil spill model alone  
Oil Spill model, forced by Mercator

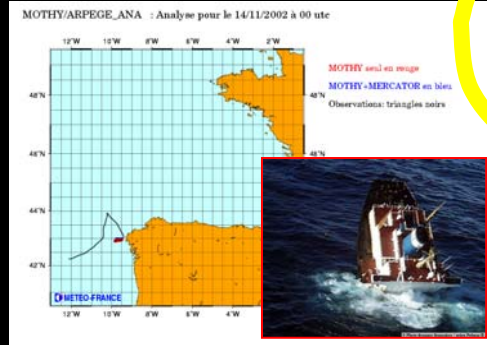
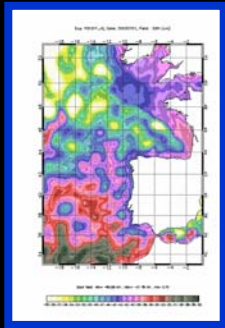


Météo-France Oil Drift Forecast  
(courtesy of P.Daniel)

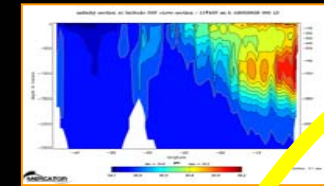
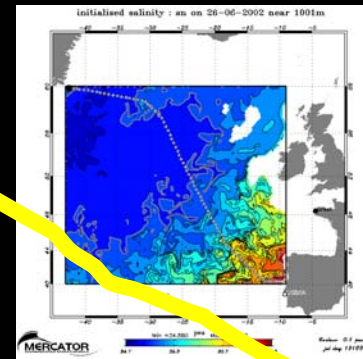
10-20% les coasts  
jul dec 19694

# Mercator Ocean services

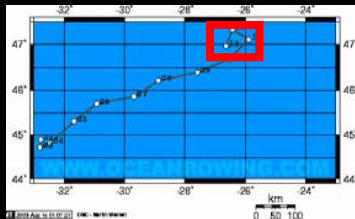
## Operational Institutional Applications



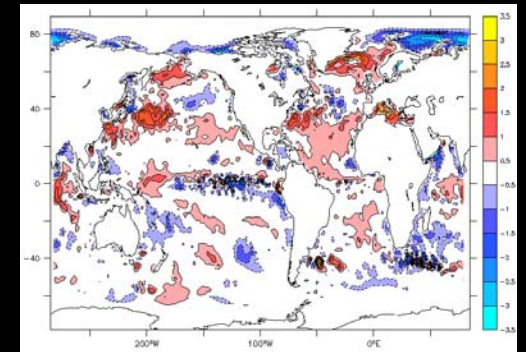
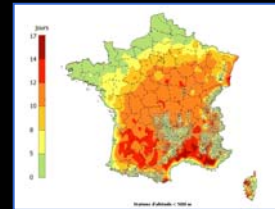
## Research



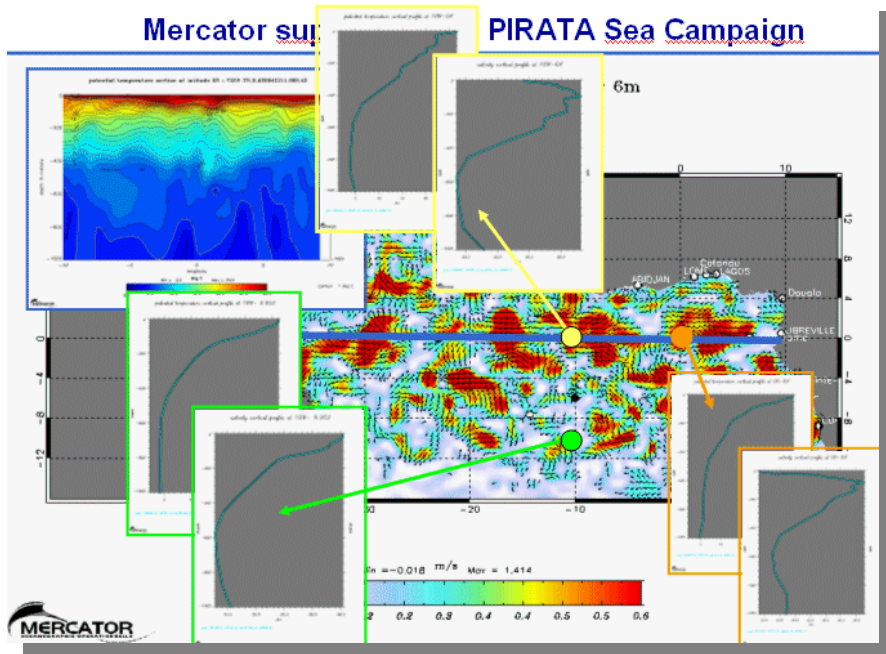
## Operational Recreational & Commercial Applications



## Policy Makers Information



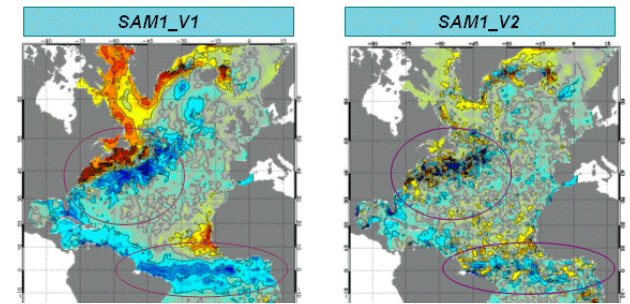
# ... providing valuable « raw matter » to research teams



- Science Working Team
- First users ; strong feedback
- Ocean physics : assess and improve
- Explore new fields : ecosystem and coastal coupling

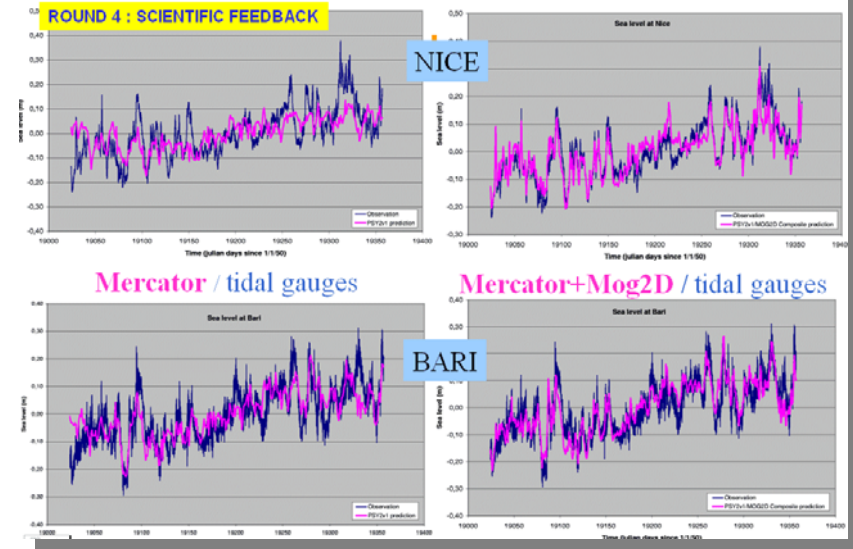
## ... assessing System upgrades (assimilation)

ROUND 2 : R&D LOOP



Sea Level in Mercator (F.Lyard, LEGOS)

ROUND 4 : SCIENTIFIC FEEDBACK

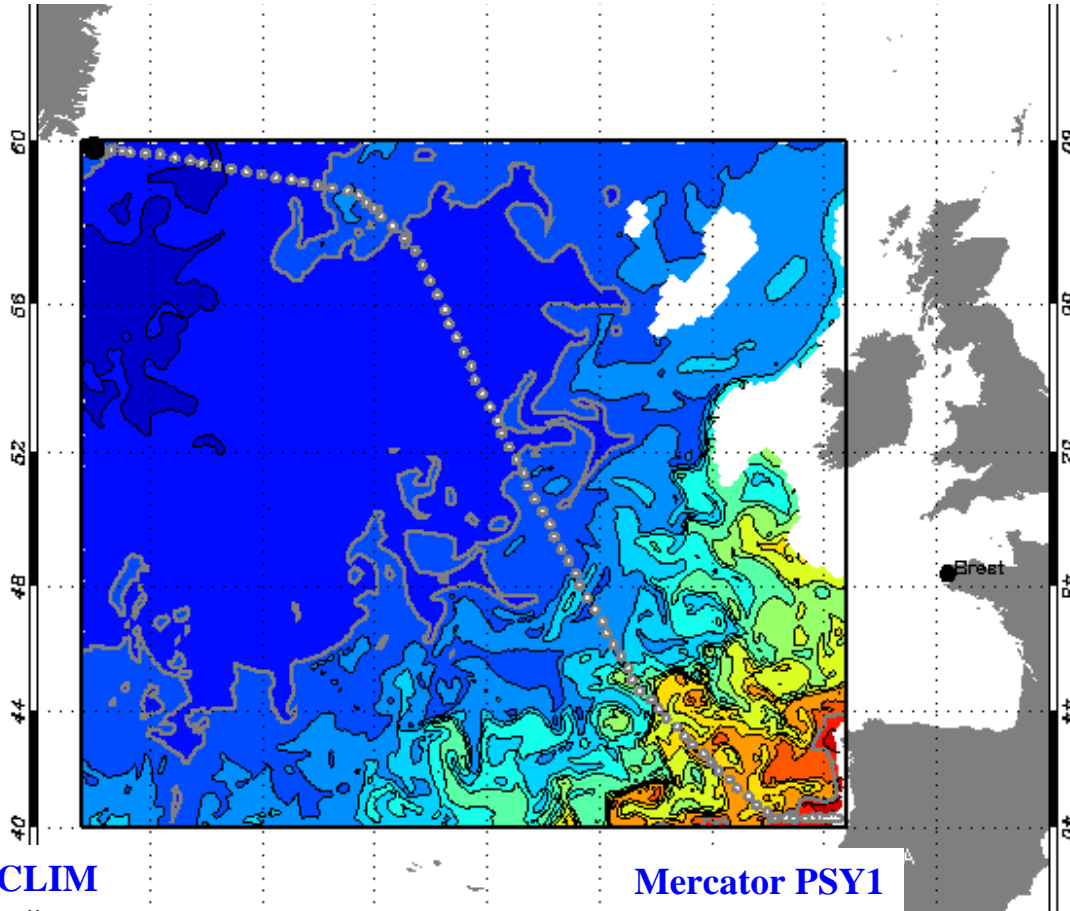


# ... supporting Sea campaigns

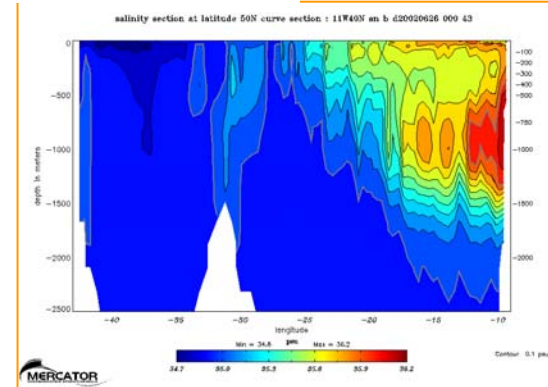
June 2002

Scientific Cruise (OVIDE)

Salinity Field

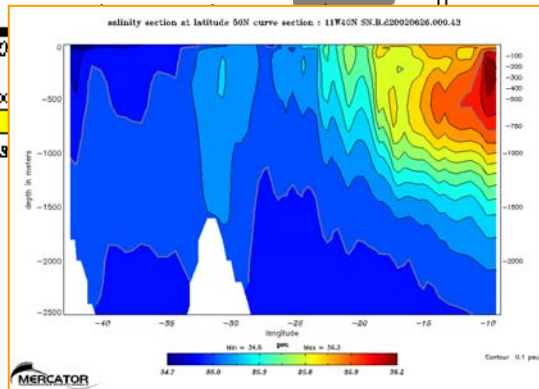
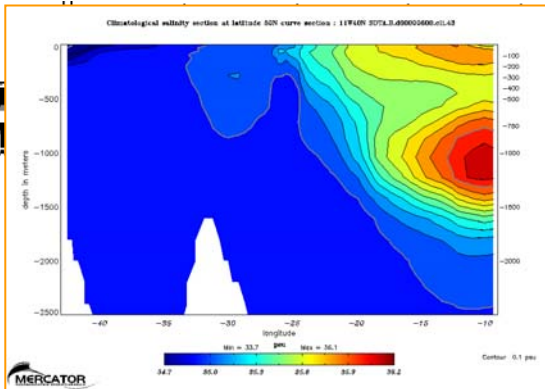


Mercator PSY2

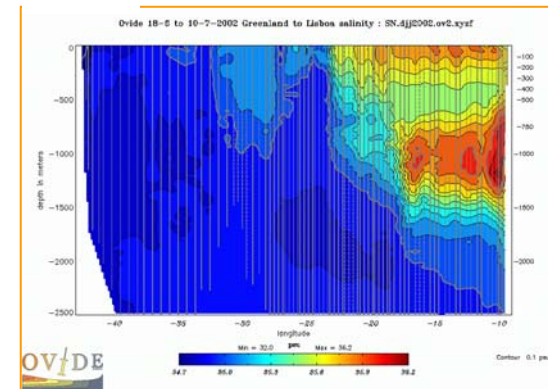


CLIM

Mercator PSY1

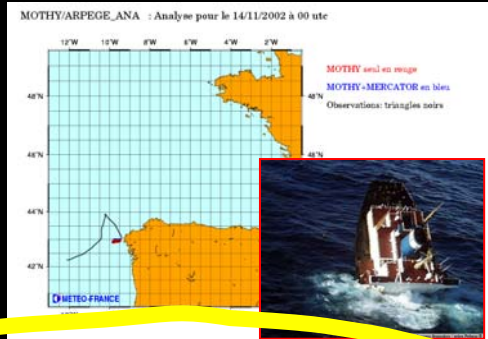
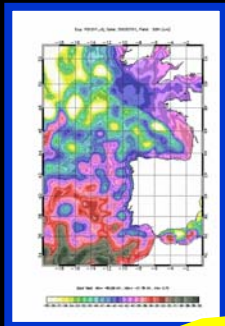


CTD

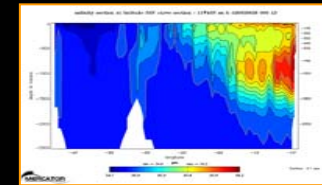
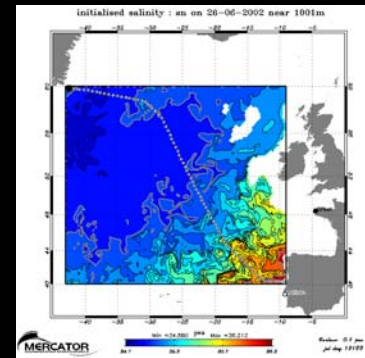


# Mercator Ocean services

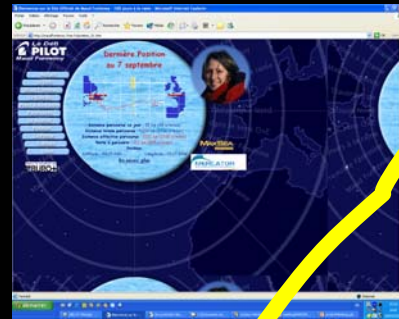
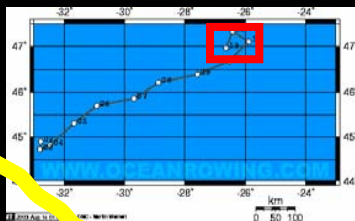
## Operational Institutional Applications



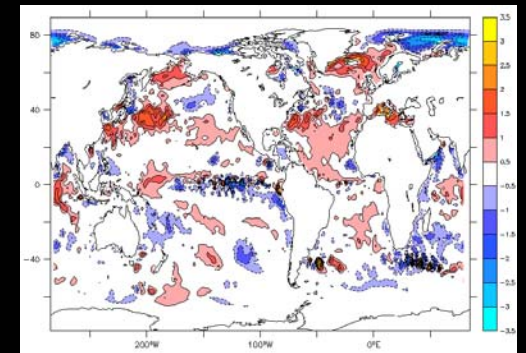
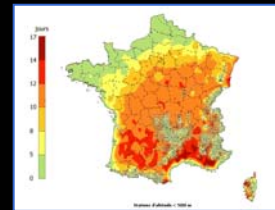
## Research



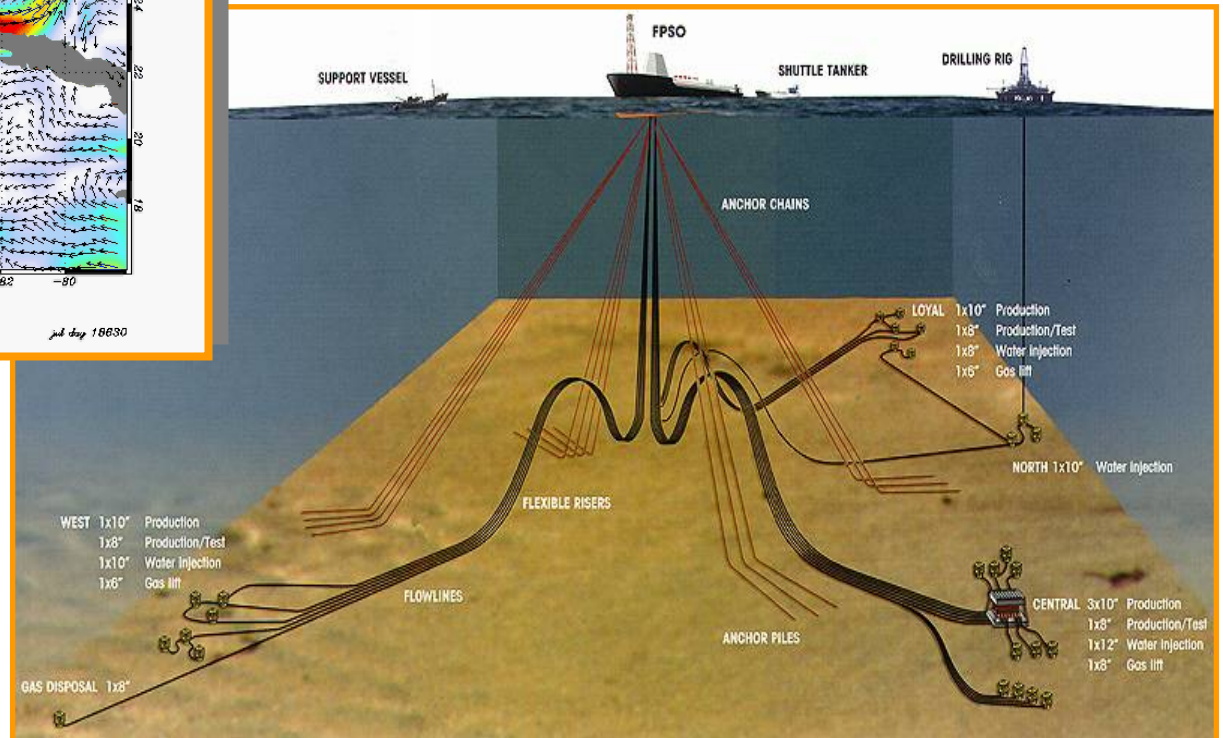
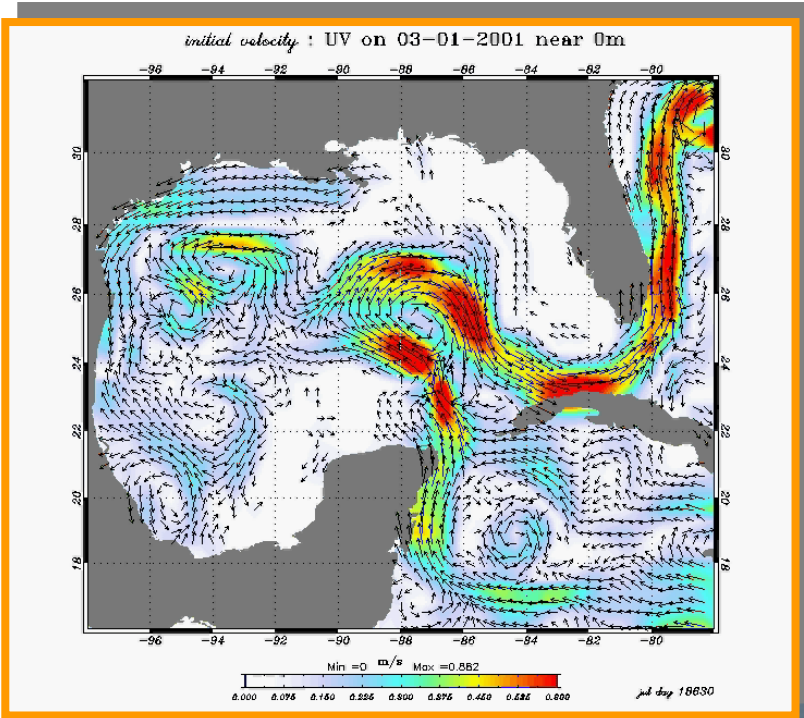
## Operational Recreational & Commercial Applications



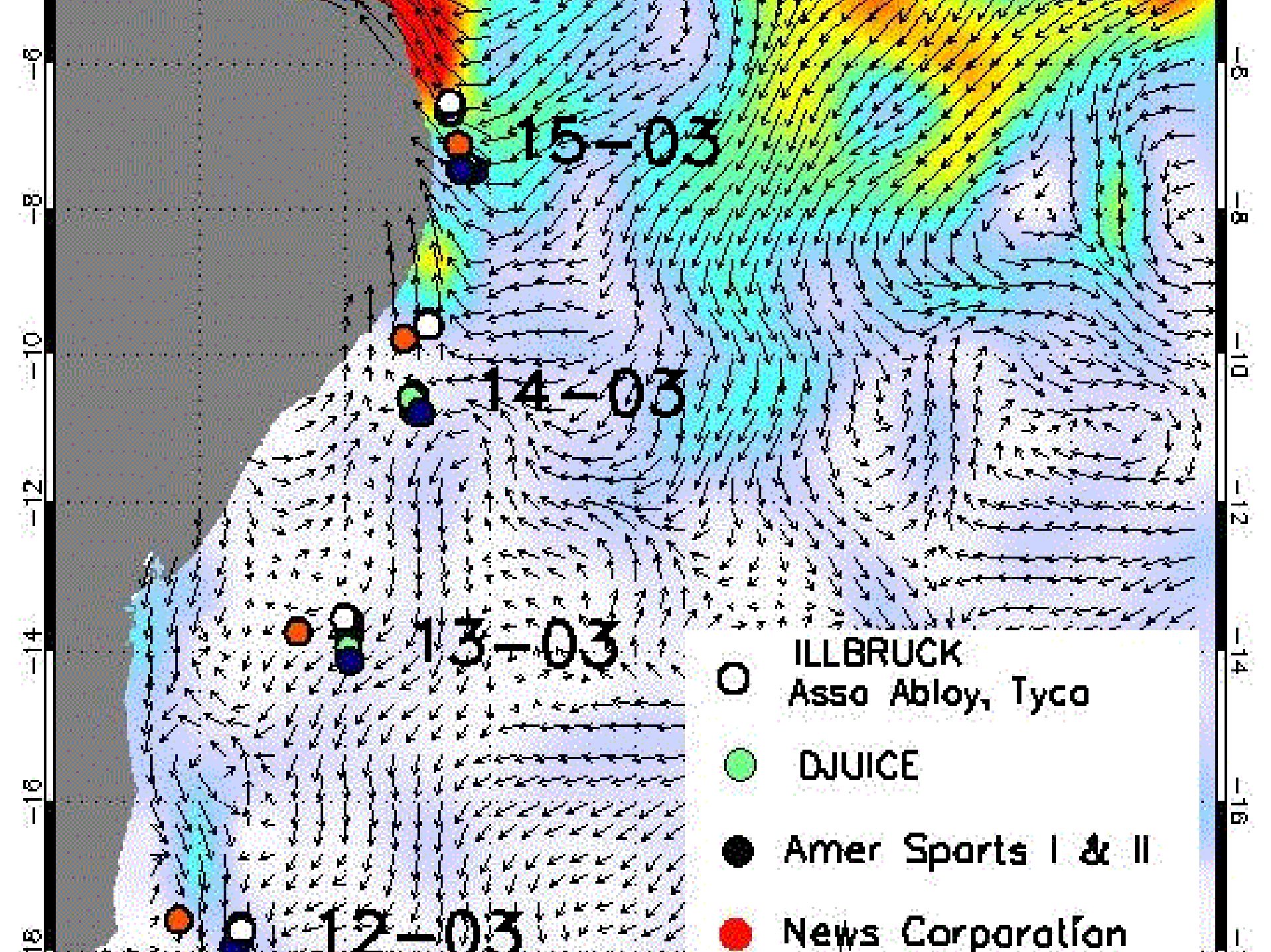
## Policy Makers Information



# ... preventing accidents in Offshore operations

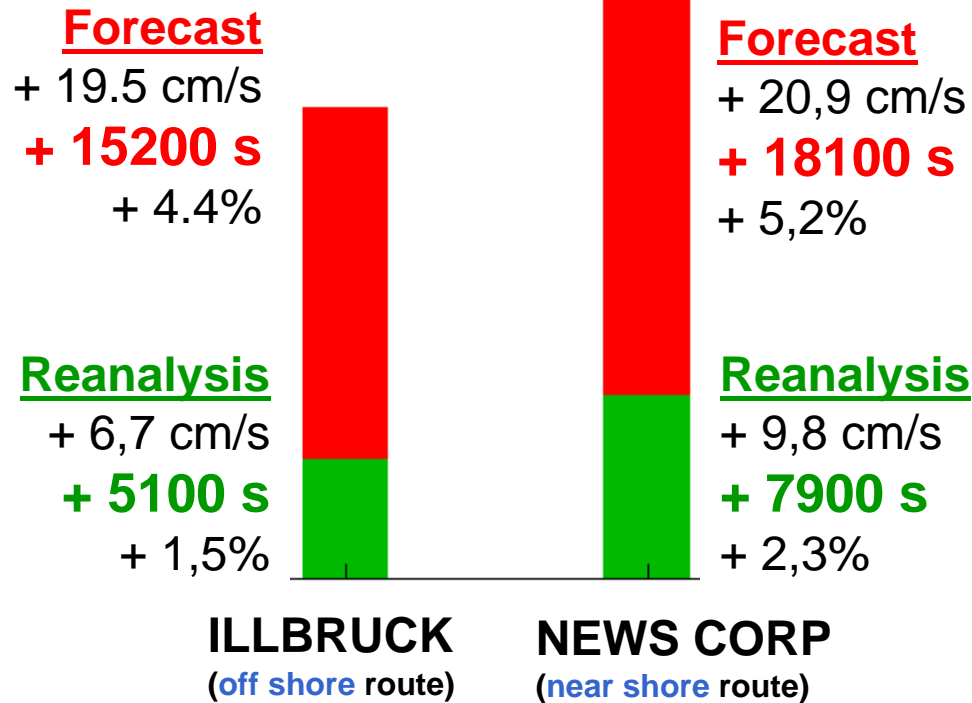






# Impact of Ocean Currents

Impact of the ocean current  
(in seconds)

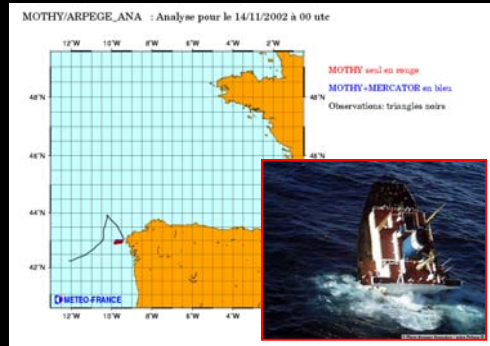
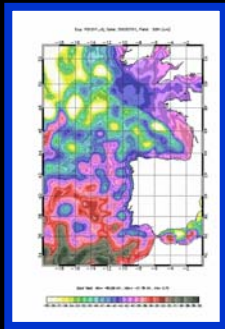


- The impact of ocean current is significative :
- from 1 to 5 % in a race where the difference of time between two boats can be less than 0.1 % !

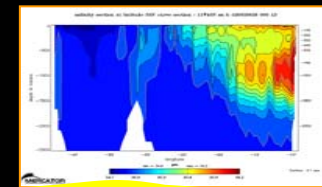
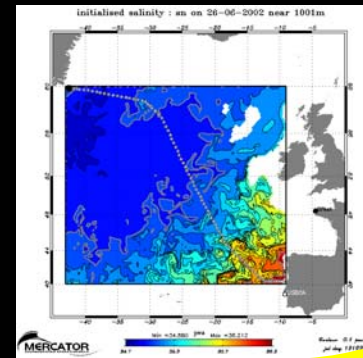
*discuss details with Marc !*

# Mercator Ocean services

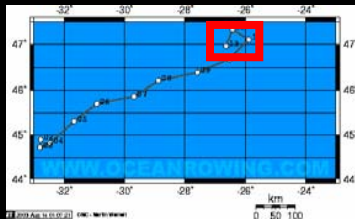
## Operational Institutional Applications



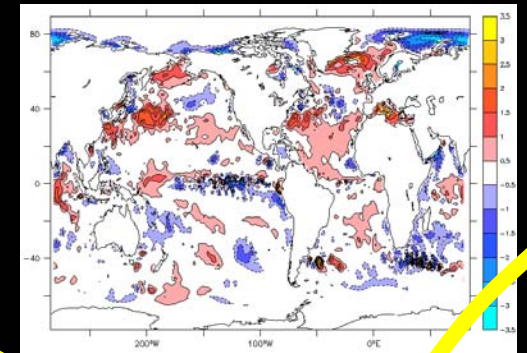
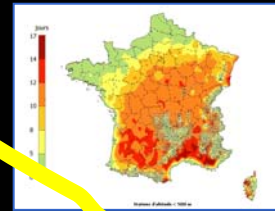
## Research



## Operational Recreational & Commercial Applications

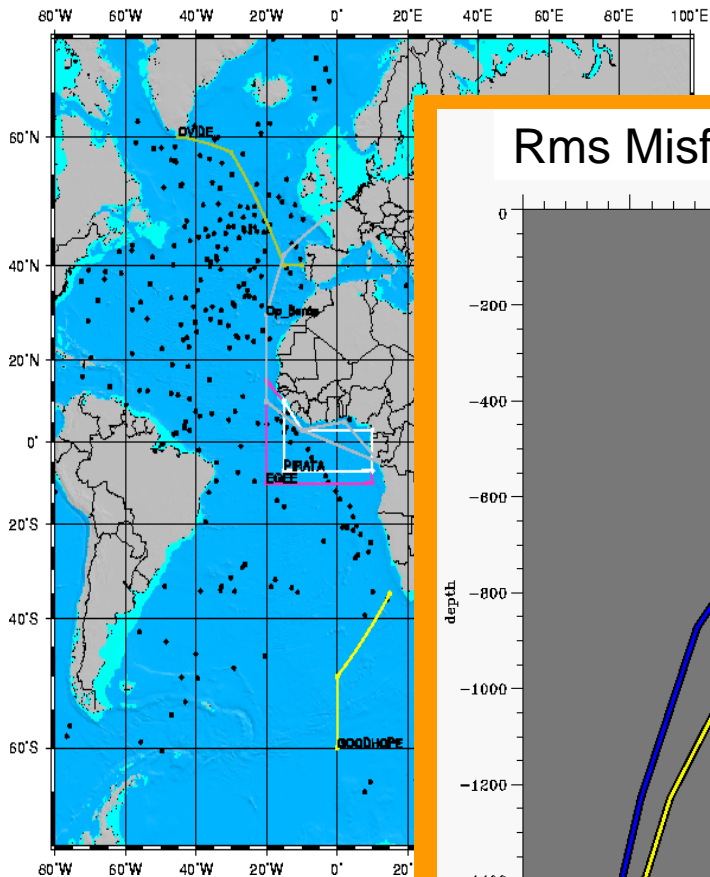


## Policy Makers Information

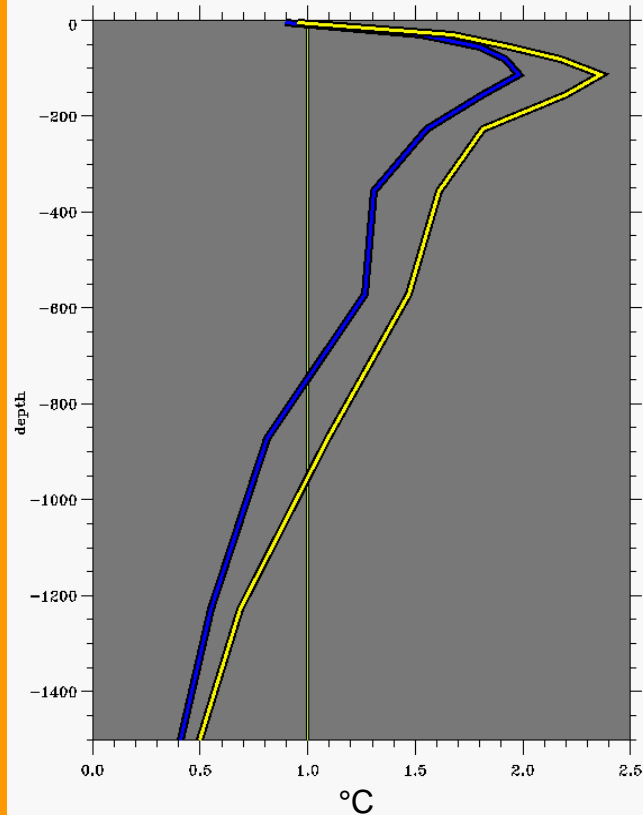


# ... organizing feedback to Space and In Situ Networks requirements

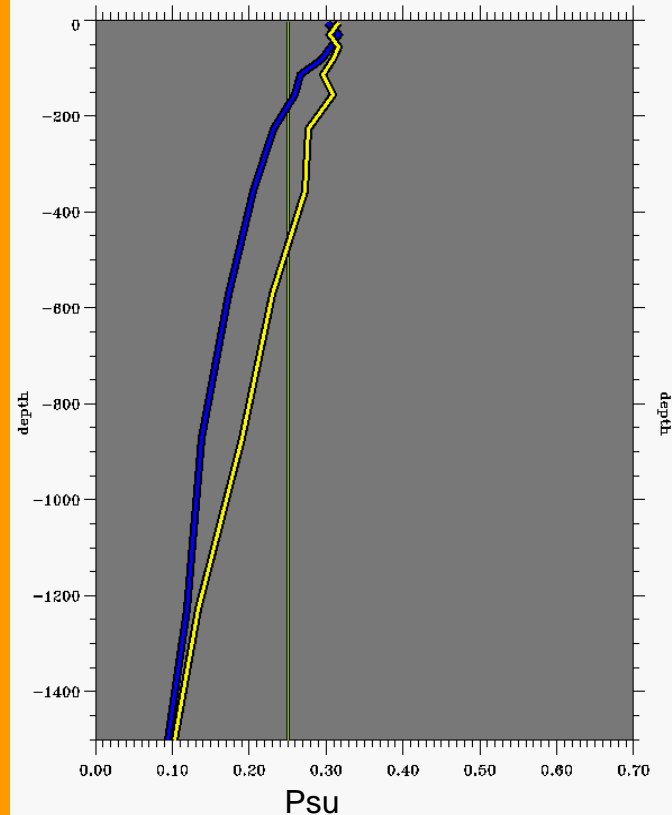
Assimilation of Altimetry and SST, with or without In Situ T & S profiles



### Rms Misfit (Temperature)



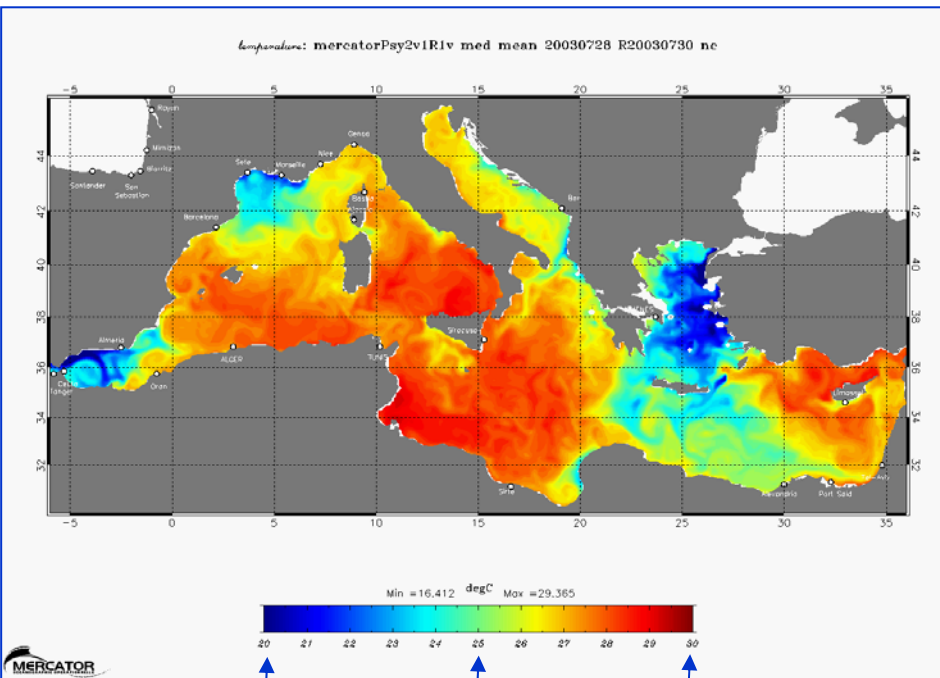
### Rms Misfit (Salinity)



— All Data  
— No in Situ

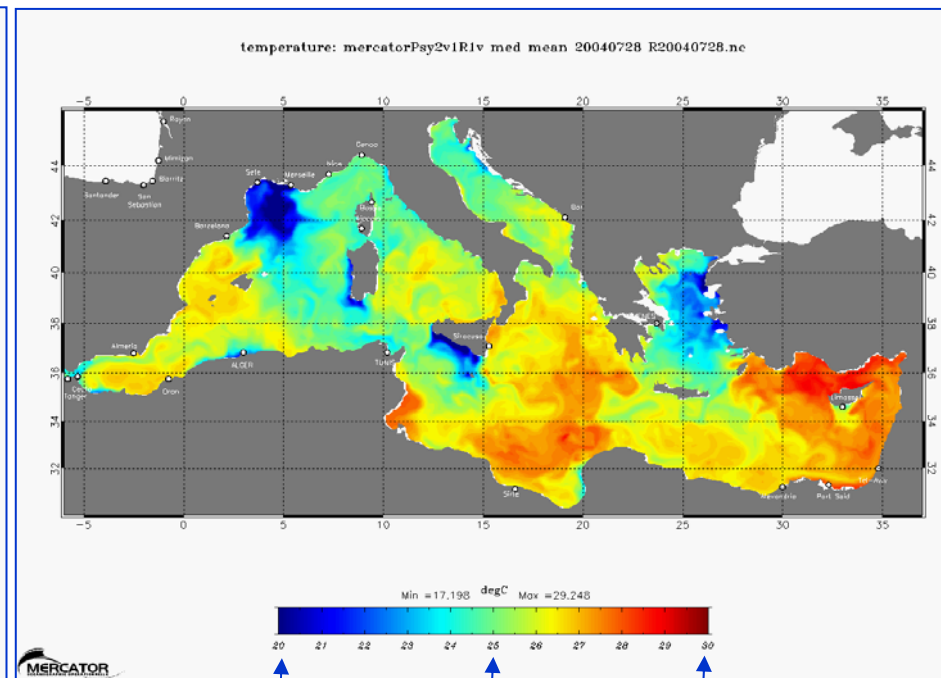
# ... monitoring « ocean climate » and looking back to extreme events

- hot weather event during summer 2003



20°      25°      30°

Mercator SST  
(reanalysis PSY2)  
28 July 2003



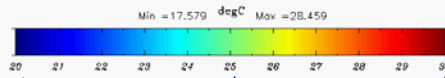
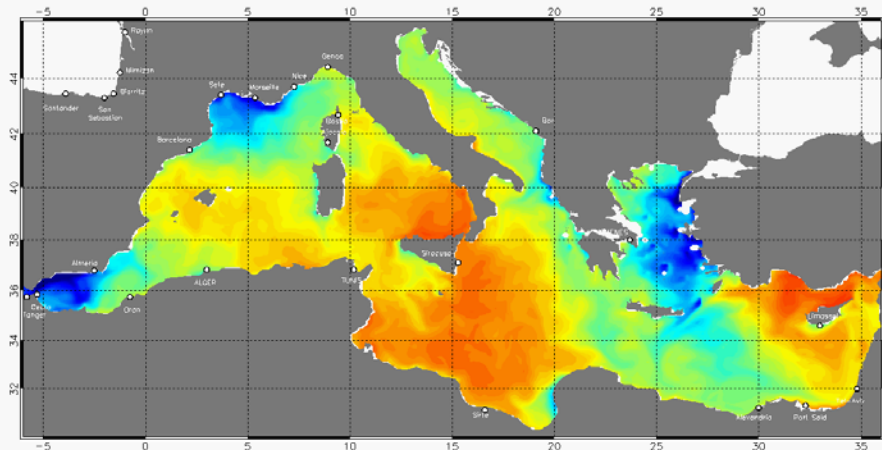
20°      25°      30°

Mercator SST  
(real time PSY2)  
28 July 2004

# ... monitoring « ocean climate » and looking back to extreme events

- hot weather event during summer 2003

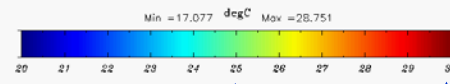
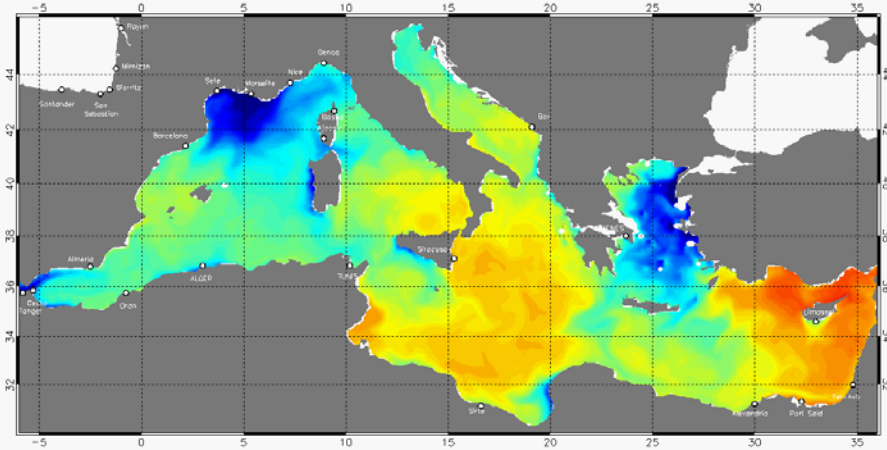
temperature: MOYMENS med 200307.nc



20° 25° 30°

Mercator Mean SST  
(reanalysis PSY2)  
July 2003

temperature: MOYMENS med 200407.nc



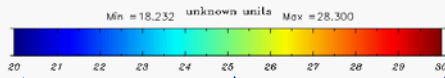
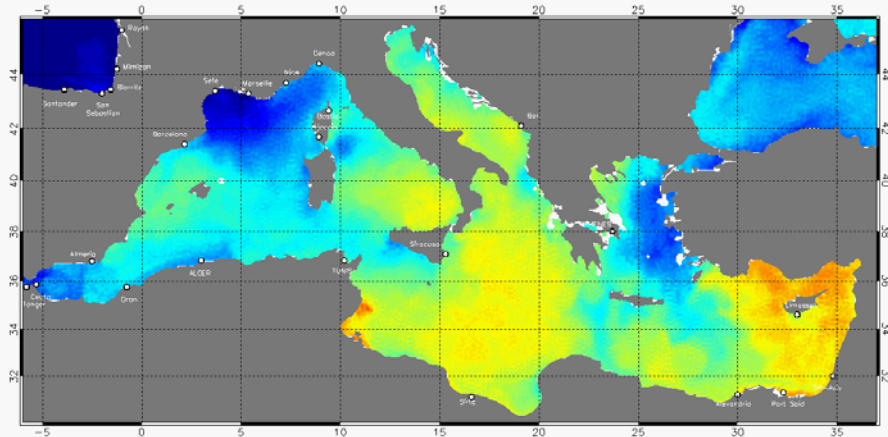
20° 25° 30°

Mercator Mean SST  
(real time PSY2)  
July 2004

# ... monitoring « ocean climate » and looking back to extreme events

- hot weather event during summer 2003

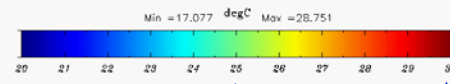
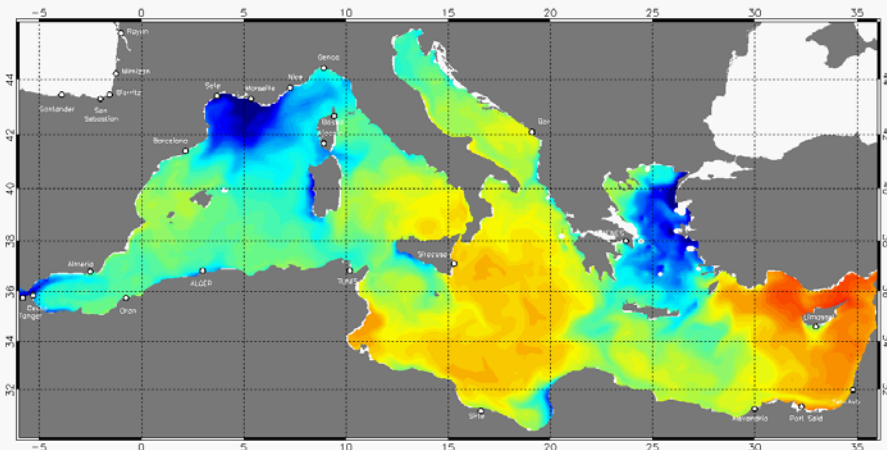
unknown choice: MOYMENS 200407.nc



20° 25° 30°

Satellite **Mean SST**  
(SAFO, Eumetsat/MF)  
**July 2004**

temperature: MOYMENS med 200407.nc

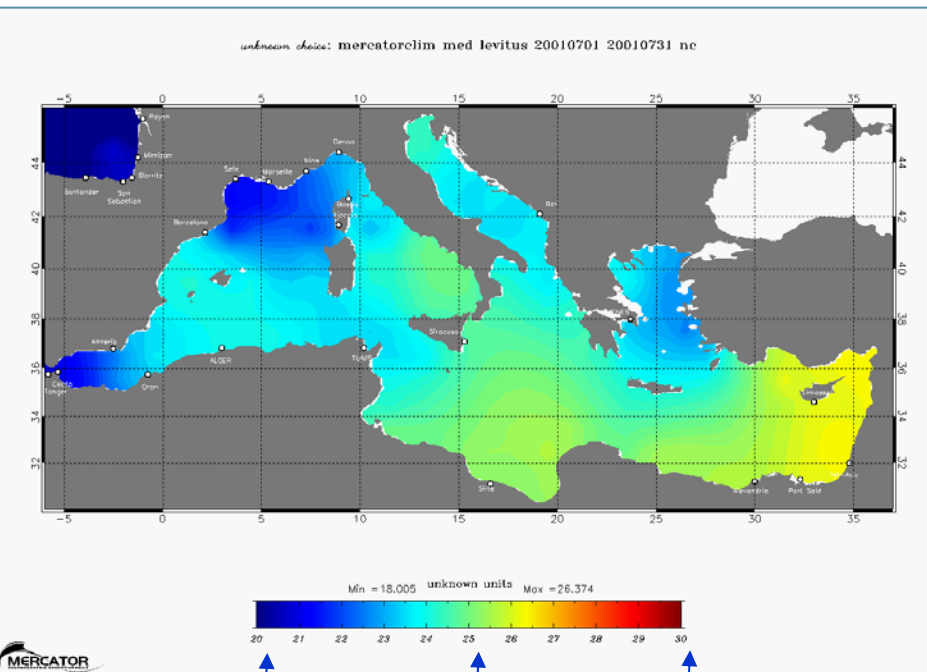


20° 25° 30°

Mercator **Mean SST**  
(real time PSY2)  
**July 2004**

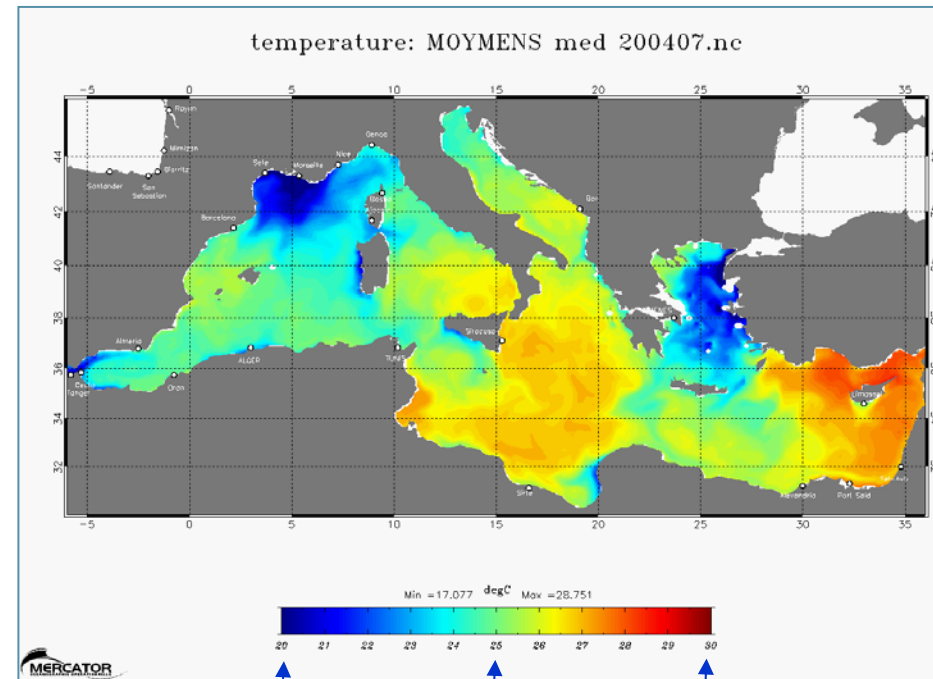
# ... monitoring « ocean climate » and looking back to extreme events

- hot weather event during summer 2003



20° 25° 30°

In Situ **Mean SST**  
(Levitus)  
**July**



20° 25° 30°

Mercator **Mean SST**  
(real time PSY2)  
**July 2004**



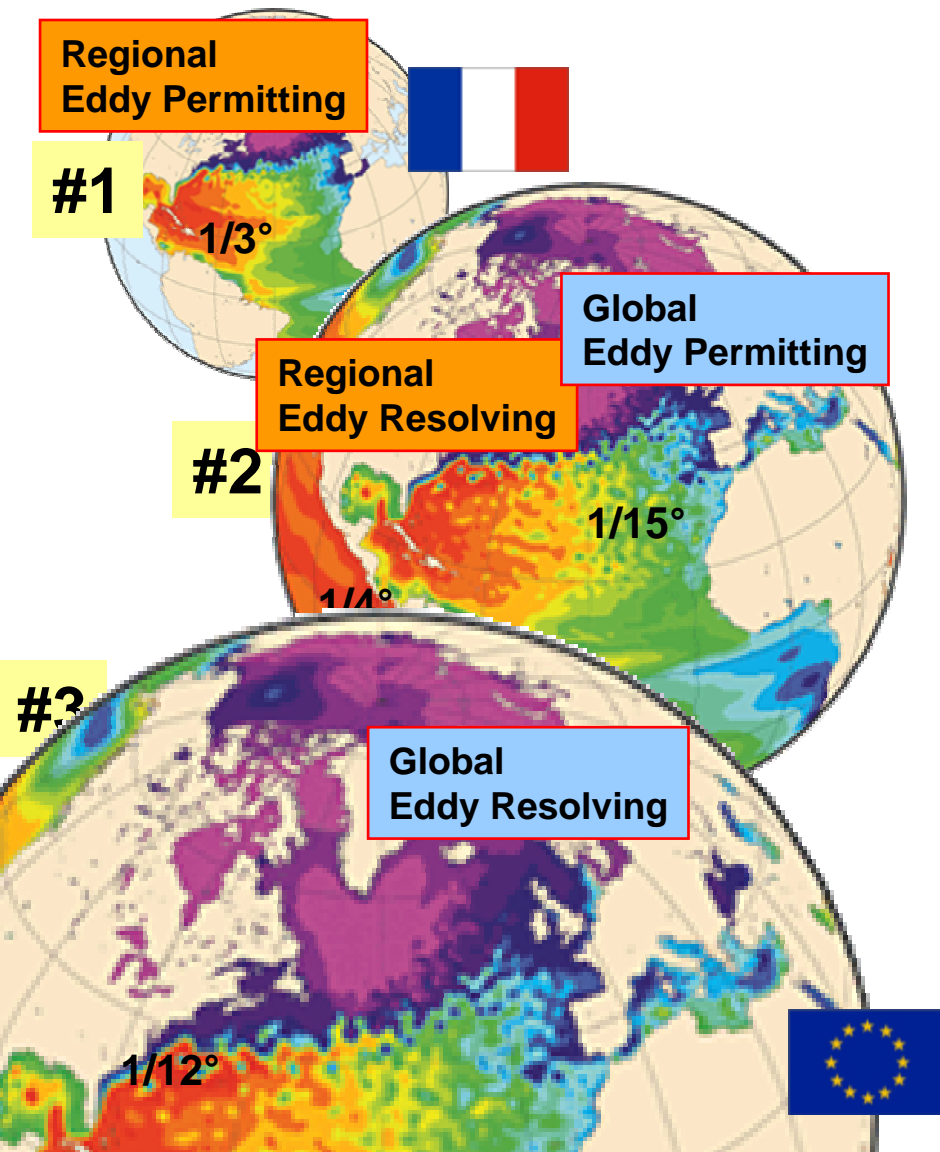


# Conclusions

## GoDAE



# Mercator ocean forecasting, Plans



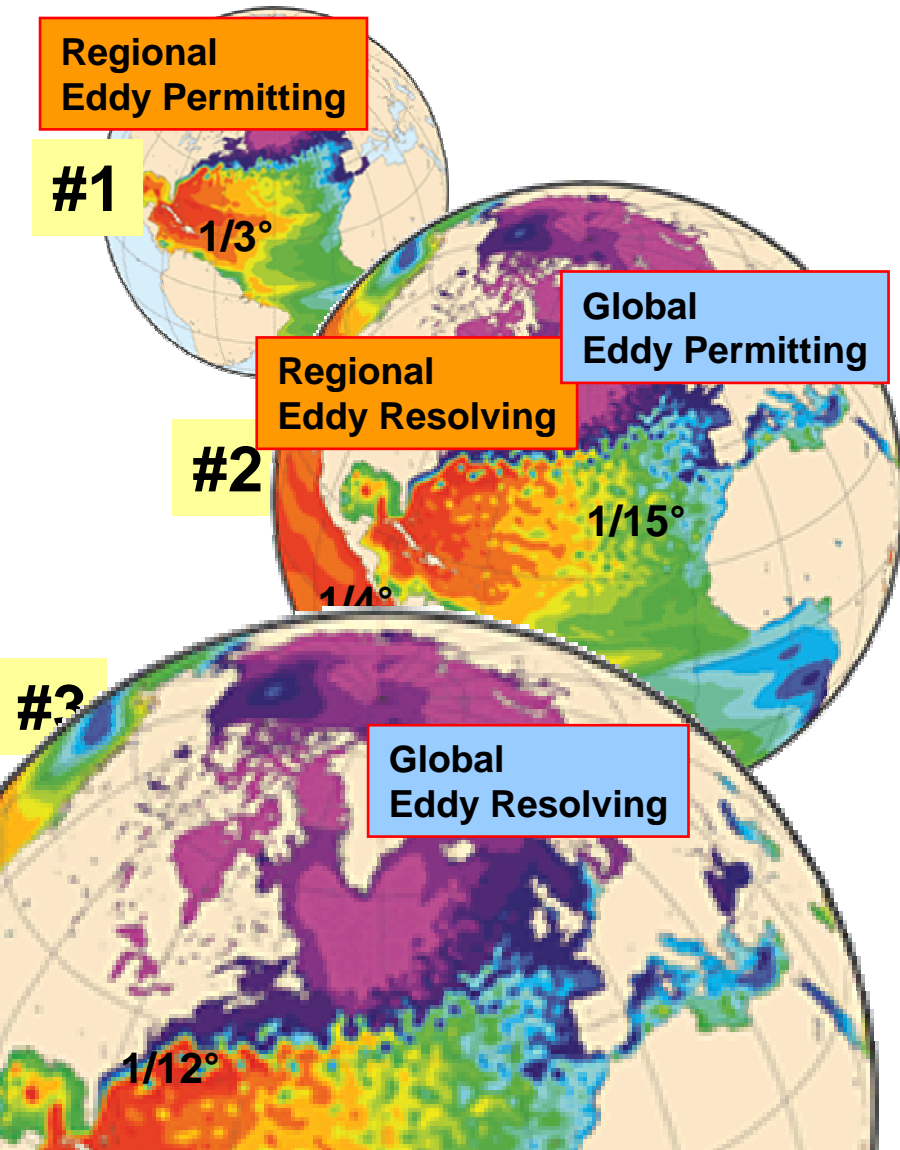
Mercator Ocean Centre :

- Jan 2005 : Eddy-resolving N.Atl / Med assimilation system upgrade (multivariate)
- Summer 2005 : Global Ocean  $\frac{1}{4}^\circ$  forecasting system ready for NRT operations
  - is the MERSEA Global Ocean initial component

Mersea

- 2008 : Global Ocean  $\frac{1}{12}^\circ$  system, with a demonstrator on European areas in 2007

# Challenges (1)



- [global ocean] reach the GODAE target : high resolution Global Ocean monitoring and forecasting ; and improve systems again and again (data/model/assimil, intercomparisons, ecosystems, ...)

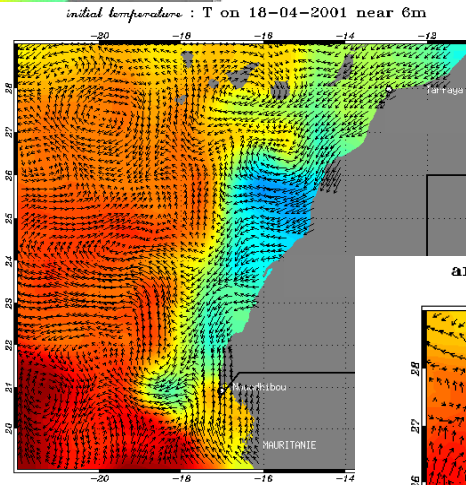
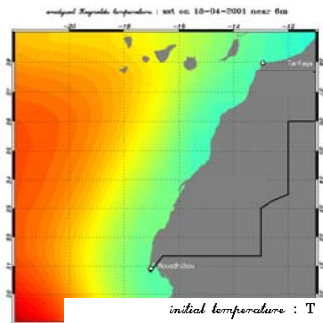
# Challenges (2)

Satellite  
data  
(AVHRR,  
mean)

Sea Surface  
Temperature  
Western  
Africa  
Upwelling

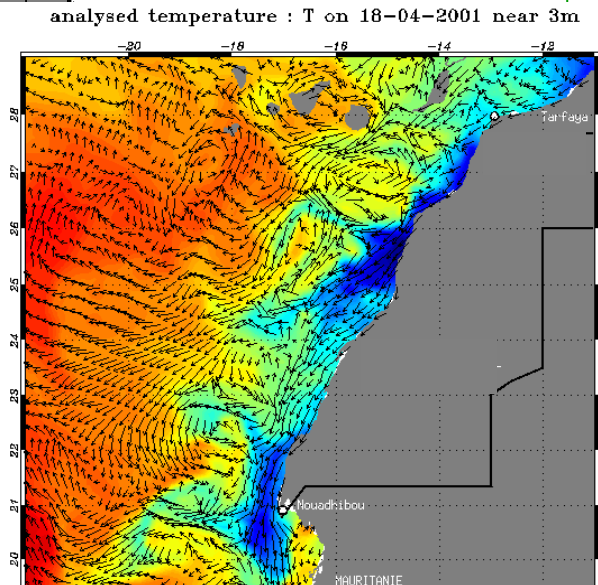
18 April 2001

- [downscaling] reach the shelves and develop nesting capacities to provide large scale inputs to coastal zones



MERCATOR  
15.00 15.88 16.76 17.62 18.50 19.38 20.26 21.12 22.38

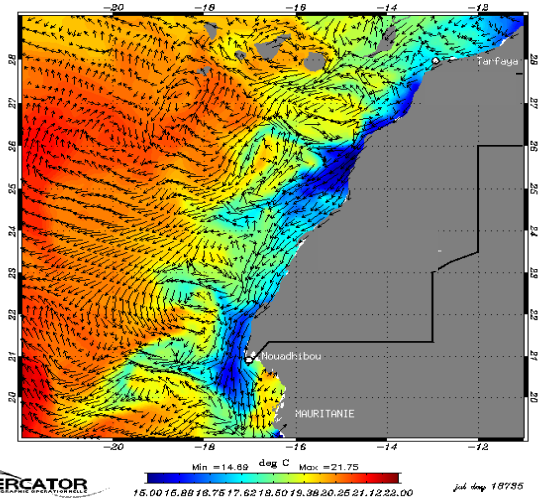
Mercator 1/3°  
Analysis  
(altimeter assimilation)



Mercator 1/15°  
Analysis  
(altimeter assimilation :  
T/P+ERS+GFO)

# Challenges (3)

analysed temperature : T on 18-04-2001 near 3m

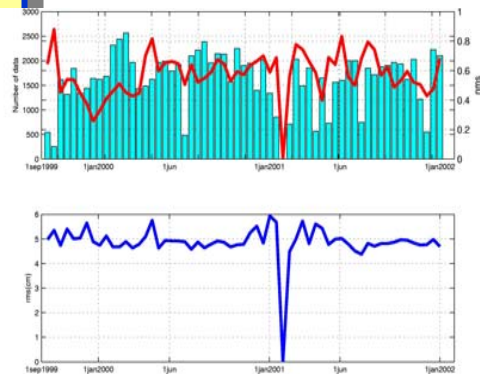
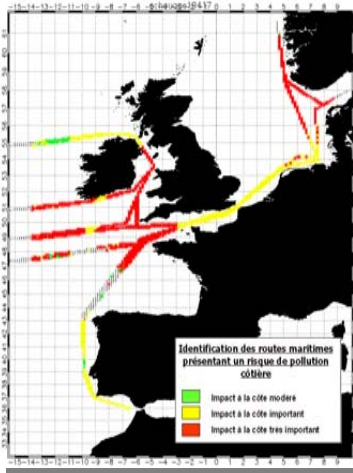


ur la zone  
45°N et 6°W-1°W

au sud de 43,5°N,  
côtes de la Galice  
pagnol, les  
courants portent à l'ouest puis au NW  
en se renforçant à la hauteur de  
Santander. Les vitesses moyennes sont  
de 0,1 à 0,2 m/s, avec renforcement  
de 0,25 m/s, principalement près  
der.  
du littoral français, à l'est  
le courant est extrêmement  
nul, inférieur à 0,08 m/s. I  
ce vers le large, pour des  
souvent supérieures à 0,2 m/  
le 4°W.

is à une semaine du 12/12 au  
côtes espagnoles, courant  
en direction, 0,05 à  
SE dominant, jusqu'au 14/12  
e au SE à ESE à partir du  
r des vitesses supérieures à  
atteignant localement 0,20 à  
près de la côte. Le courant  
ce le 16/12, SE à ESE

- [service] translate ocean system outputs into information for your users

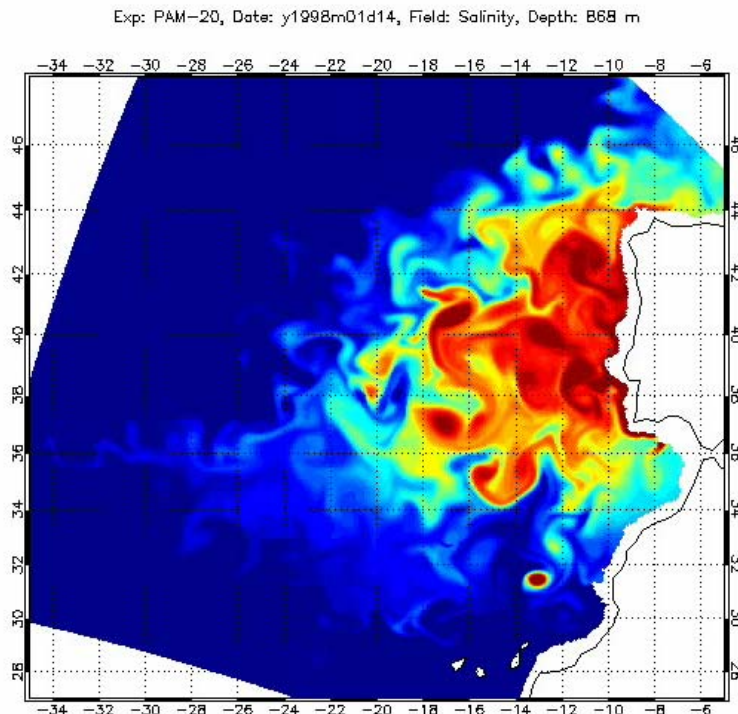


# Challenges (4)

**Modern operational ocean monitoring and forecasting systems are highly dependent on real time, high resolution, and accurate altimeter data.**

Today : JASON-1 + ENVISAT + GFO

We're running towards a **critical situation** by 2007 : risk of altimeter gap in 2007 (transition JASON-1 / JASON-2) and a low resolution situation afterwards (JASON-2 only).

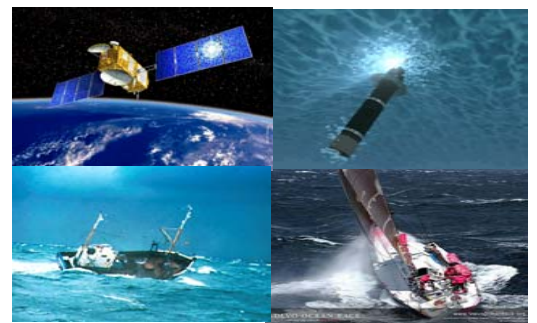
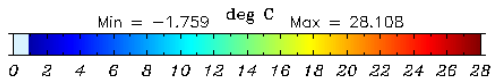
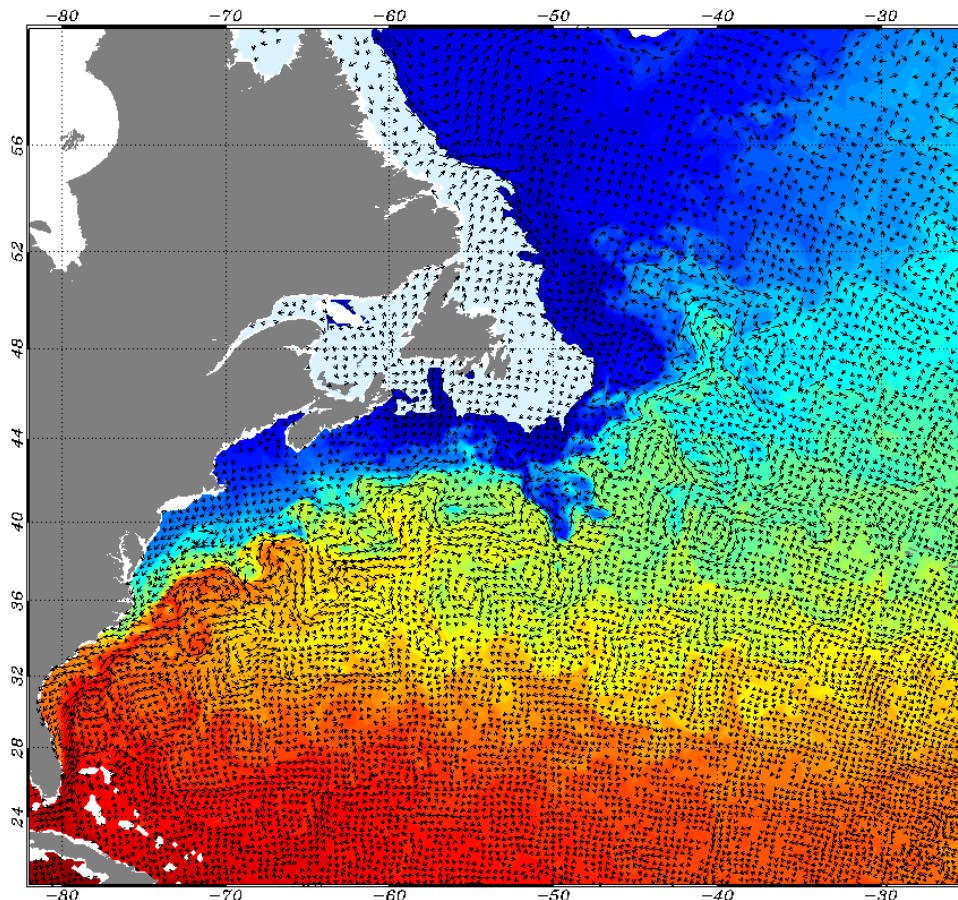


Realistic depiction of 1000 m depth salinity field.

Mercator System,  
3 altimeter assimilation

- [observations] ensure operational and continuous high resolution ocean observation network, to feed operational models, and meet users' demands for increased resolution.

2 weeks forecast temperature : T on 16-04-2003 near 3m



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Products request : <mailto://products@mercator-ocean.fr>