

An international coastal ocean technological observatory in the Balearic Islands

the relevance of
improved altimeter products
for regional applications

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J. Tintoré

A coastal observatory in the Balearic Islands

<http://www.imedea.uib.es/goifis/OPERACIONAL/EN/>

OPERATIONAL RESOURCES

Forecasting

- Western Mediterranean
 - Currents - ESEEO
 - Currents - MFS
- Balearic Sea**
 - High Resolution Model
 - Long Waves
 - Rissagues
- Coasts and Beaches
 - Waves and Currents
- Oil Spill Forecasting
 - Forecasting data(GNOME)
- Genetic Algorithms

Observation

- Satellites
 - Sea Surface Temp. (SST)
 - Altimetry
- Gliders
 - Current Status
 - Mission Archive
- Moorings
 - Received Data
 - Location
- Rapid Envir. Assessm.
 - CTD Profiles
 - Cruises
- Cameras - Beaches
 - Data
 - Images

Data Management

- GIS + Database
 - Cartographic Viewer
 - Metadata Search
 - Google Earth Data

Oceanographic Observation, Forecast

SATELLITES MOORINGS R.E. OIL SPILL

New Marine Technologies

- AUV - CORMORAN**
Autonomous underwater vehicle for study of coastal waters.
- ROV - ALBATROS** (Albatros Marine Technology)
Simple, remotely operated underwater observation.
- DRIFTER - ALBATROS**
Lagrangian drift buoy that records its location and filtered data via the GSM mobile phone network.

NEWS

- European Gliding Observatory (October 2007) and International (November 2nd) at IMEDEA/Calandula (Spain).
- The Status of European Coastal Observing Systems, International workshop organised and sponsored by NERC (UK), 22nd to 24th October 2007, Hotel Formentor, Mallorca (Spain)

SISTEMA DE PREDICCIÓN DE VERTIDOS DE HIDROCARBUROS

Inicio
Descripción
Predicciones (Variables superficiales)

Temp	Salt	Sigma	u,v
-24 h	-24 h	-24 h	-24 h
0 h	0 h	0 h	0 h
+24 h	+24 h	+24 h	+24 h
+48 h	+48 h	+48 h	+48 h
+72 h	+72 h	+72 h	+72 h

GNOME
DON PEDRO

Enlaces
Contactos

Corrientes Superficiales

Previsión del modelo HOPS para corrientes superficiales, válida para el día 04/10/2007 00:00 UTC

Previsión realizada el día 05 de octubre de 2007

2196 visitas desde 14/11/2006

A coastal observatory in the Balearic Islands

<http://www.imedea.uib.es/goifis/OPERACIONAL/EN/>

RESEARCH & TECHNOLOGY FOR SCIENCE BASED
OPERATIONAL OCEANOGRAPHY

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OPERATIONAL RESOURCES

Forecasting

Western Mediterranean

- Currents - ESEOO
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Balearic Sea

- High Resolution Model

Long Waves

- Rissagues

Coasts and beaches

- Waves and Currents

Oil Spill Forecasting

- Forecasting data (GNOMON)

Genetic Algorithms

Oceanographic Observation, Forecasting and Management

SATELLITES

CAMERAS

MOORINGS

FORECASTING

REAL TIME DATA

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Untitled Document

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← → ↺ ↻ 🏠 http://www.imedea.uib.es/goifis/donpedro/localitaques.html

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Conselleria d'Interior

MENU PRINCIPAL

- Característiques del vessament
- Observacions
- Prediccions
- Vulnerabilitat de la costa (ASA)
- Informes Interns
- Referències

SISTEMA DE PREDICCIÓN DE VERTIDOS DE HIDROCARBUROS

>Direcció General d'Emergències

Don Pedro

Inici

A coastal observatory in the Balearic Islands

<http://www.imedea.uib.es/goifis/OPERACIONAL/EN/>

The image shows a composite of two web pages. On the left is the I-M-E-D-E-A website, and on the right is a Firefox browser window displaying the Gliders website.

I-M-E-D-E-A Website (Left):

- Logo: I-M-E-D-E-A Institut Mediterrani d'Estudis Avançats
- Navigation: START, GOIFIS, PUBLICATIONS, PROJECTS
- Operational Resources:
 - Forecasting:
 - Western Mediterranean: Currents - ESEO, Currents - MFS
 - Balearic Sea: High Resolution Model
 - Long Waves: Rissagues
 - Coasts and Beaches: Waves and Currents
 - Oil Spill Forecasting: Forecasting data(GNOME)
 - Genetic Algorithms
 - Observation:
 - Satellites: Sea Surface Temp. (SST), Altimetry
 - Gliders** (circled in red): Current Status, Mission Archive
 - Moorings: Received Data, Location
 - Rapid Envir. Assessm.: CTD Profiles, Cruises
 - Cameras - Beaches: Data, Images
 - Data Management:
 - GIS + Database: Cartographic Viewer, Metadata Search, Google Earth Data
- New Marine Technology:
 - AUV - CORMORA: Autonomous underwater vehicle of coastal waters.
 - ROV - ALBATROS: Simple, remote observation.
 - DRIFTER - ALBATROS: Lagrangian drift observation, filtered data via the internet.

Firefox Browser Window (Right):

- Page Title: Gliders - Mozilla Firefox
- Address Bar: http://www.imedea.uib.es/~glider/index.php?op_menu=datos
- Page Content:
 - Logo: MERSEA G-O-I-F-I-S
 - Section: **Gliders** Planeadores submarinos autónomos
 - Warning: ATENCIÓN: Web en fase de pruebas
 - Time: 14:44:47 UTC
 - Buttons: Inicio, Estado actual, Archivo de misiones
 - Text: Características, Galería de imágenes, Documentos, Enlaces
 - Image: MAYA -UNIT 50-
 - Table:

Glider:	Deployment:
maya	From 2006-12-05 11:06:26 to 2006-12-11 11:06:35
	From 2006-11-28 10:10:00 to 2006-12-04 11:08:30
 - Section: Mapa
 - Map: A map showing the glider's path (yellow line with arrows) in the southern part of the Bay of Palma. The map includes a scale bar (0-5 km) and a legend.
 - Text: Descripción del estado del glider, Misión al sur de la Bahía de Palma en espera de recogida
 - Footer: 5 October 2007 - 16:42 local, 8361 visitas desde 9/11/2006

A coastal observatory in the Balearic Islands

<http://www.imedea.uib.es/goifis/OPERACIONAL/EN/>

Servicio de teledetección - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.imedea.uib.es/~ias/color.php

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Servicio de Teledetección

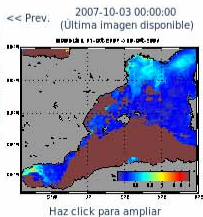
COLOR DEL OCEANO

Los sensores ópticos que operan en la banda visible del espectro electromagnético proporcionan información del color del océano y, de forma indirecta de la clorofila y phytoplankton.

IMAGENES

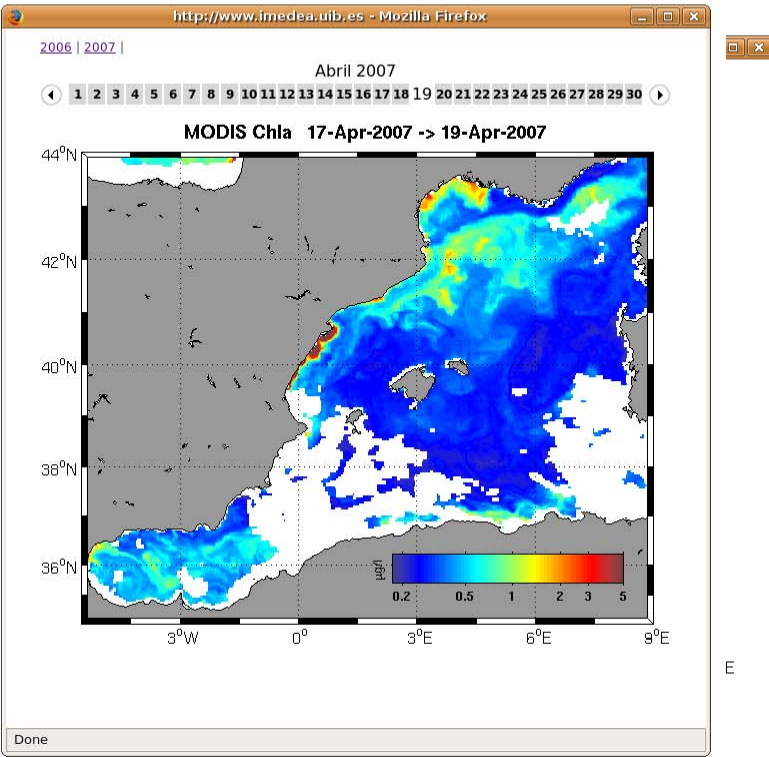
En esta página se utilizan los datos de MODIS-Aqua de la NASA. En particular, se utiliza el producto Nivel-3 (Level-3 binned) que consiste en la acumulación de todos los datos de Nivel-2, correspondiente al periodo de los tres 3 días anteriores. La resolución temporal es diaria pero la distribución de los datos se hace con 2 días de demora. Ejemplo: el día 20 de marzo está disponible la imagen del 18 de marzo que se ha obtenido combinando datos del 16, 17 y 18 de marzo. La resolución espacial de las imágenes es de 4.6x4.6 km.

Para más información:
http://oceancolor.gsfc.nasa.gov/DOCS/MODISA_processing.html



2007-10-03 00:00:00 (Última imagen disponible)

Haz click para ampliar



2006 | 2007 |

Abril 2007

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

MODIS Chla 17-Apr-2007 -> 19-Apr-2007

44°N
42°N
40°N
38°N
36°N

3°W 0° 3°E 6°E 9°E

µg/l
0.2 0.5 1 2 3 5

Done

(el centro de la Tierra, o una superficie regular que se aproxime a su forma real, el elipsoide de referencia). El nivel del mar (SSH) medido por el altímetro se descompone en: $SSH = G + h + h' + E$

Donde **G** es el geoido (la superficie equipotencial sobre la que el océano estaría en caso de no existir corrientes oceánicas); **h** es la topografía dinámica promedio (variaciones del nivel del mar asociadas a señales oceanográficas permanentes); **h'** es la topografía dinámica variable (variaciones del nivel del mar asociados a señales oceanográficas no permanentes) y **E** son errores tanto de órbita (el error dominante en los altímetros) como otro tipo de errores debido a correcciones geofísicas (troposfera húmeda, ionosfera, ...).

Topografía dinámica absoluta:

Para obtener la topografía dinámica la mejor manera sería eliminando **G** de la ecuación previa, pero el problema es que todavía no se conoce el geoido con suficiente precisión. La solución utilizada normalmente

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OPERACIONAL

RESEARCH & TECHNOLOGY FOR SCIENCE BASED

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Boya oceano-meteorológica Ba

START GOIFIS PUBLICATIONS PROJECTS

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 - Microgliders
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Oceanographic Observat

SATELLITES

CAMERAS

FORECAST

New Marine Technologies

- AUV - CORMORAN
 - Autonomous underwater of coastal waters.
- ROV - ALBATROS (All
 - Simple, remotely c observation.
- DRIFTER - ALBATROS
 - Lagrangian drift buoy filtered data via the G

15:13:01 UTC

Inicio

Características

Datos recientes

Datos históricos

Localización

Calidad

Agradecimientos

BOYA ENDERROCAT (IMEDEA)

Posicion: LAT=N39 29,936 LON=E2 42,138

Variable: Atmospheric pressure(hPa)

Periodo: de 2007-10-04 00:00:00 a 2007-10-05 00:00:00

Boya Océano-meteorológica BAHÍA DE PALMA

Nueva consulta

1019.0

1018.5

1018.0

1017.5

1017.0

1016.5

1016.0

1015.5

1015.0

1014.5

1014.0

1013.5

1013.0

2007-10-04 00:20:00

2007-10-04 01:30:00

2007-10-04 02:40:00

2007-10-04 03:50:00

2007-10-04 05:00:00

2007-10-04 06:10:00

2007-10-04 07:20:00

2007-10-04 08:30:00

2007-10-04 09:40:00

2007-10-04 10:50:00

2007-10-04 12:00:00

2007-10-04 13:10:00

2007-10-04 14:20:00

2007-10-04 15:30:00

2007-10-04 16:40:00

2007-10-04 17:50:00

2007-10-04 19:00:00

2007-10-04 20:10:00

2007-10-04 21:20:00

2007-10-04 22:30:00

EQUIPO EN FUNCIONAMIENTO GRACIAS A LA FINANCIACION DE:

Govern de les Illes Balears

Conselleria de Economia, Hisenda i Innovacio

Contacto

I-M-E-D-E-A Institut Mediterrani d'Estudis Avançats

October 5th, 2007 - 17:10 local

5951 visitas desde 25/05/2006

Viento medio (m/s)

20

15

10

5

0

02/10/07 12:00

03/10/07 12:00

04/10/07 12:00

05/10/07 12:00

A coastal observatory in the Balearic Islands

<http://www.imedea.uib.es/goifis/OPERACIONAL/EN/>

IMEDEA RESEARCH & TECHNOLOGY FOR SCIENCE BASED OPERATIONAL OCEANOGRAPHY

U16 Institut Mediterrani d'Estudis Avançats CSIC

MOON

START GOIFIS PUBLICATIONS PROJECTS DISSEMINATION WIKI STAFF LINKS

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Oceanographic Observation, Forecasting and Management

SATELLITES MOORINGS DRIFTERS GLIDERS

CAMERAS FORECASTING OIL SPILLS GIS

REAL TIME DATA

SST

Altimetry

New Marine Technologies

- AUV - CORMORAN**
Autonomous underwater vehicle for small scale variability monitoring of coastal waters.
- ROV - ALBATROS** (Albatros Marine Technologies)
Simple, remotely operated underwater vehicle for underwater observation.
- DRIFTER - ALBATROS**
Lagrangian drift buoy that records its GPS position and transmits the filtered data via the GSM mobile phone network.

NEWS

- European Gliding Observatory (EGO), 2nd Workshop (25-26 october 2007) and International Glider School (29 october, november 2nd) at IMEDEA/Calanova marine facilities, Mallorca (Spain).
- The Status of European Coastal Observing and Forecasting Systems, International workshop organised and sponsored by NERC (UK), 22nd to 24th October 2007, Hotel Formentor, Mallorca (Spain)

Enderrocot Mooring

Location

Air Temp. :22.8°C
Atm. Pres. :1016.7hPa
Sea Temp. :23.5°C
Wind Dir. :193.4º
Wind Speed :4.2m/s
Wave Height :0.4m
Date: 5/10/2007 15: 0
Connection via **WAP**

Glider MAYA

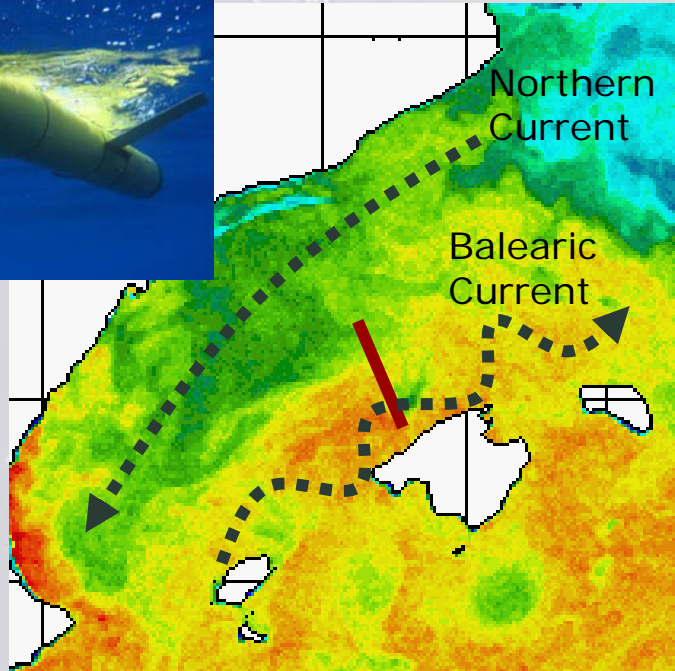
Location

Water Temp :xx °C
Salinity :xx psu
Date

ARGO Float IMEDEA

Location

REA: ongoing observational experiment (Jul-Dec 07)



Glider mission along Envisat track 773 every 35 days

1st sampling: 6-13 July 2007

2nd sampling: 14-17 September 2007

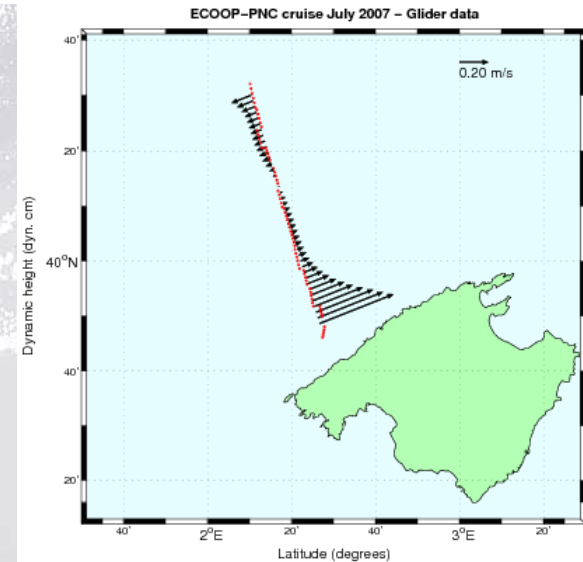
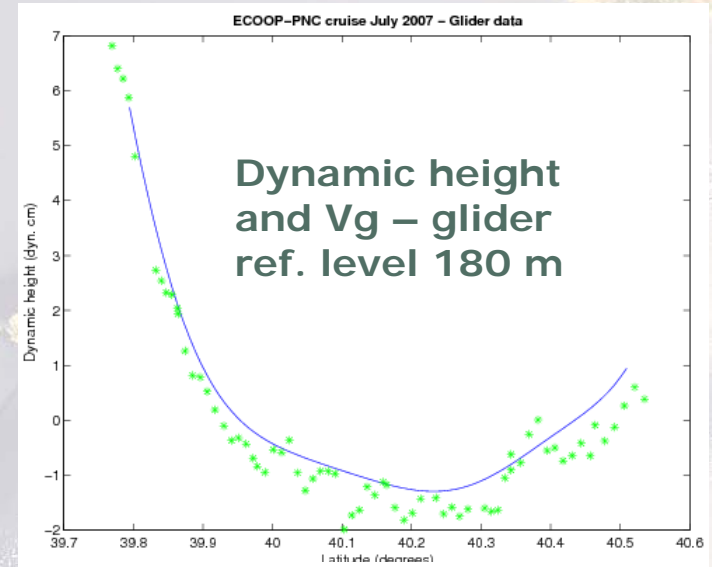
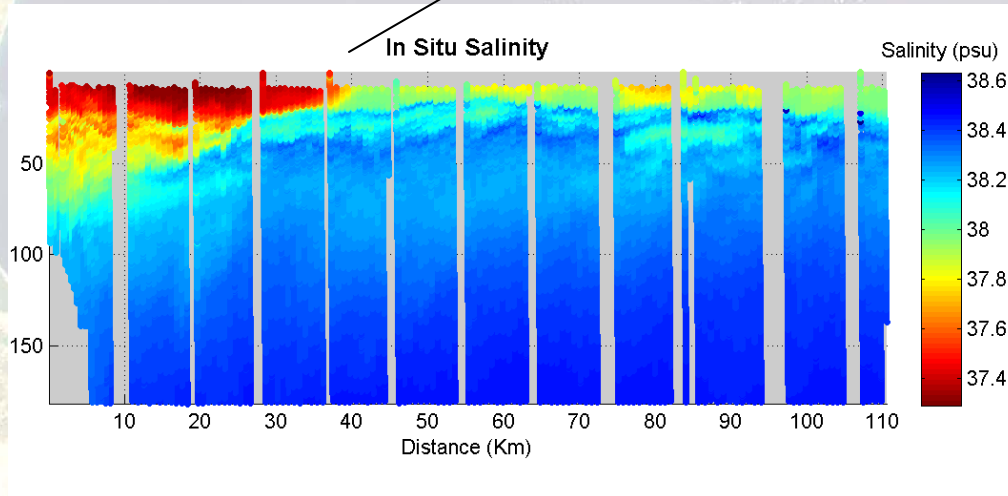
OBJECTIVES

- To characterize the Balearic front with new technologies
- To explore the use and limitations of altimetry data in the coastal area

REA programme: glider data (1st sampling)



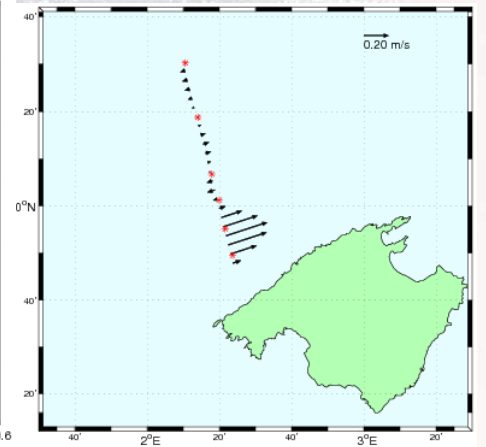
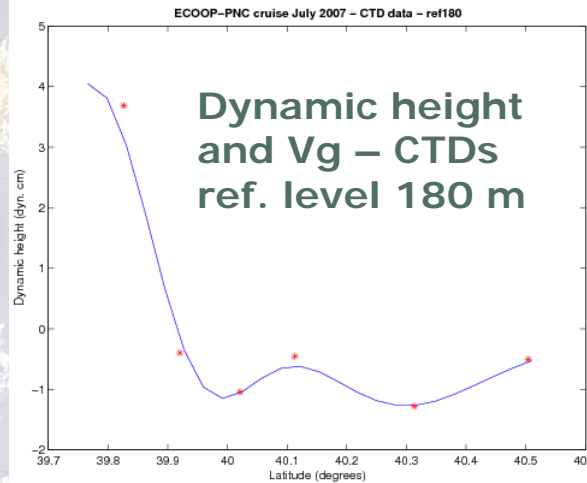
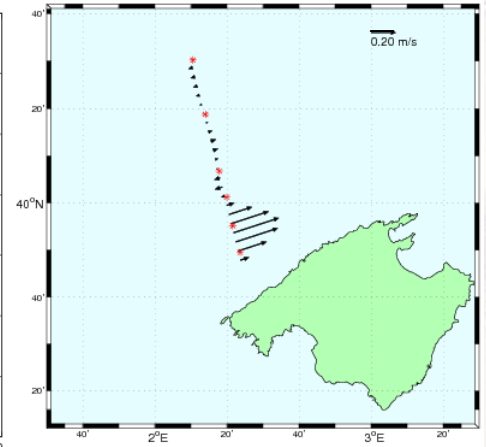
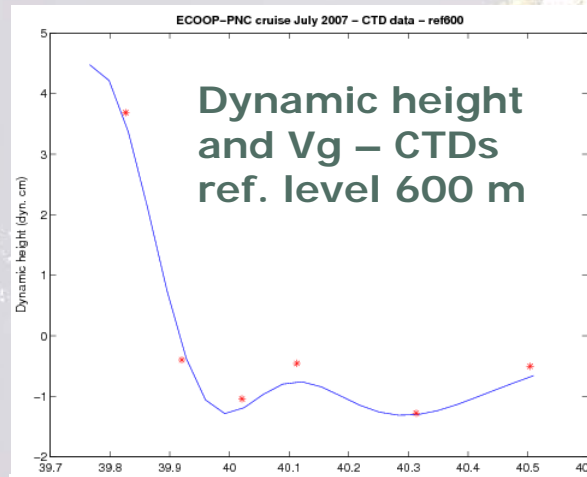
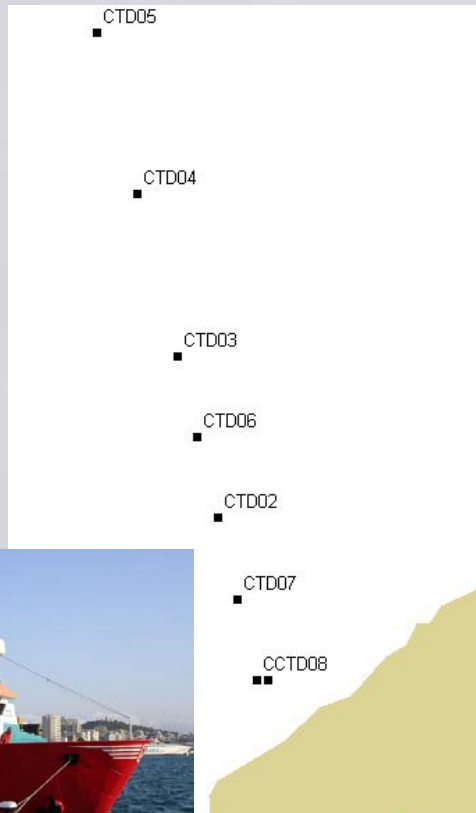
Balearic front



45-50 cm/s flowing Northeastwards

REA programme : CTD data (1st sampling)

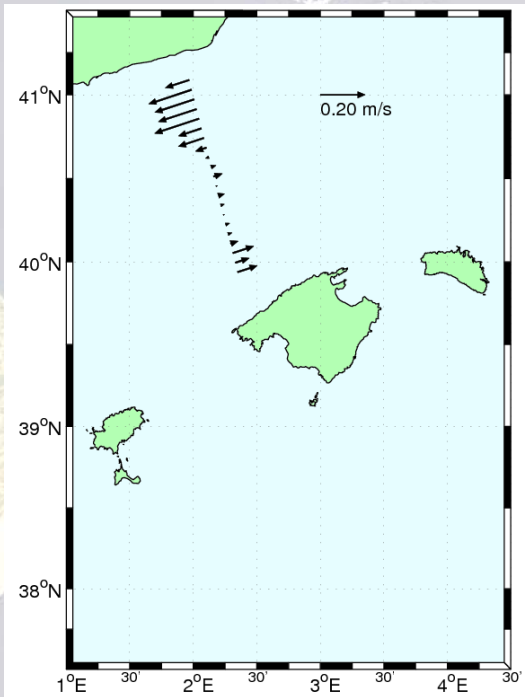
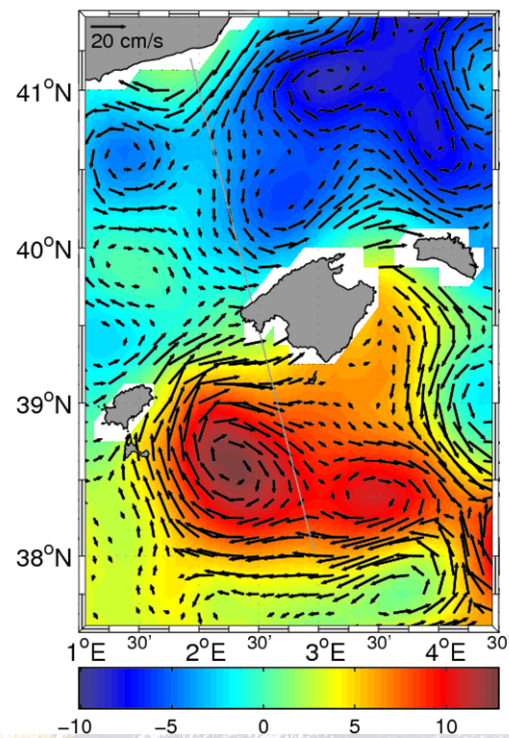
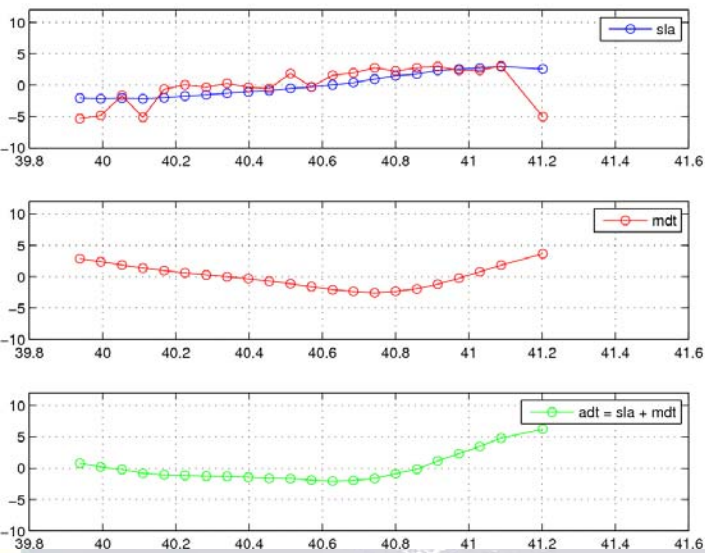
Simultaneous measurements with R/V Garcia del Cid
(conventional cruise): 9 – 12 July 2007
Following the 773 Envisat track



CTD stations

Small sensitivity to the ref. level.
Coherence pattern with glider data (40-45 cm/s)

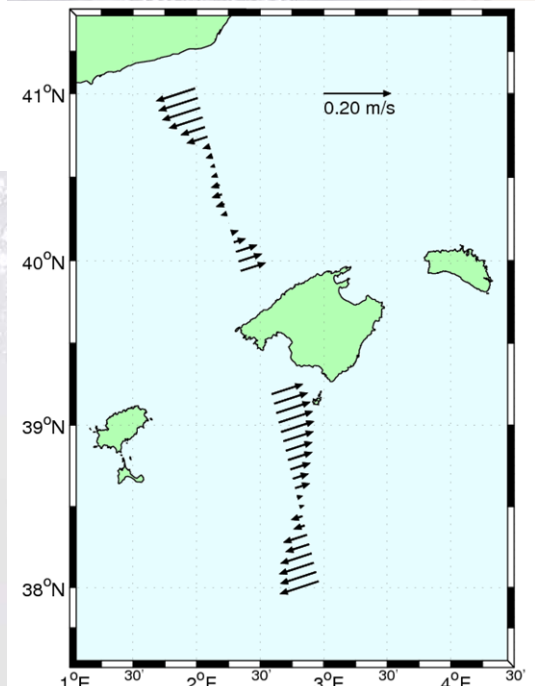
REA programme : altimetry data (1st sampling)



Present work in collaboration with CLS:

Improvement of Corrections:

- MOG2D HR
- Wet troposphere
- Tidal model
- Mean profile



Correcting HF signals in altimetry

- High frequency barotropic motions have important implications in altimetric measurements.

OBJECTIVES OF THIS STUDY

- To examine the sea level output of two barotropic ocean models (MOG2D and HAMSOM) over the Mediterranean Sea and NE Atlantic Ocean.
- To perform a skill assessment of the models on the basis of tide gauge and altimeter observations.

Data and methods

Model data

	HAMSOM	MOG2D*
Spatial Resolution	1/6° latitude 1/4° longitude	Finite elements 20-400 km
Temporal Resolution	1 h	6 h
Period	1958-2001	1993-present
Region	Med/NEAtl	Global
Atmospheric Forcing	REMO 1 h	ECMWF 6 h

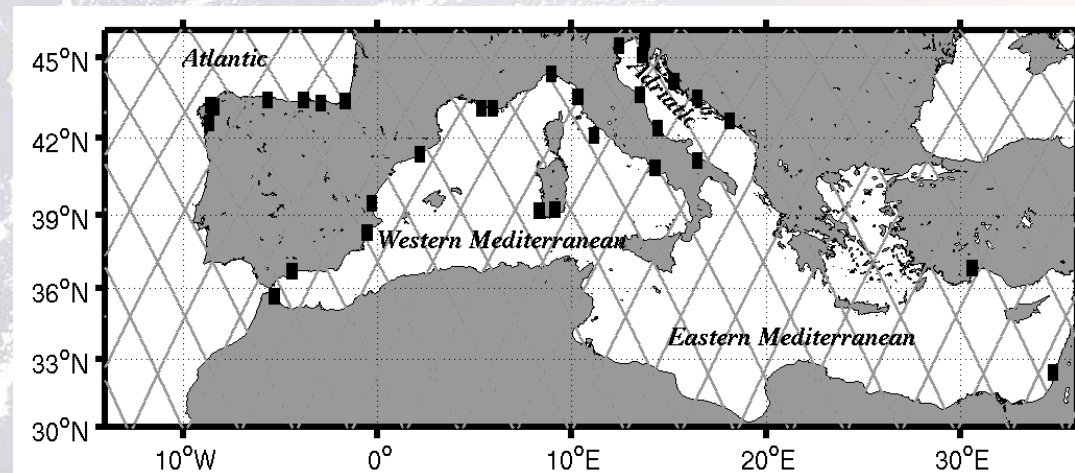
* Combined MOG2D. For frequencies lower than 20d the Inverse Barometer correction is applied.

Tide gauge data

- Hourly data
- Period: 1993-2001
- Filtering of tides
- Application of atmospheric correction (IB/MOG2D/HAMSOM)

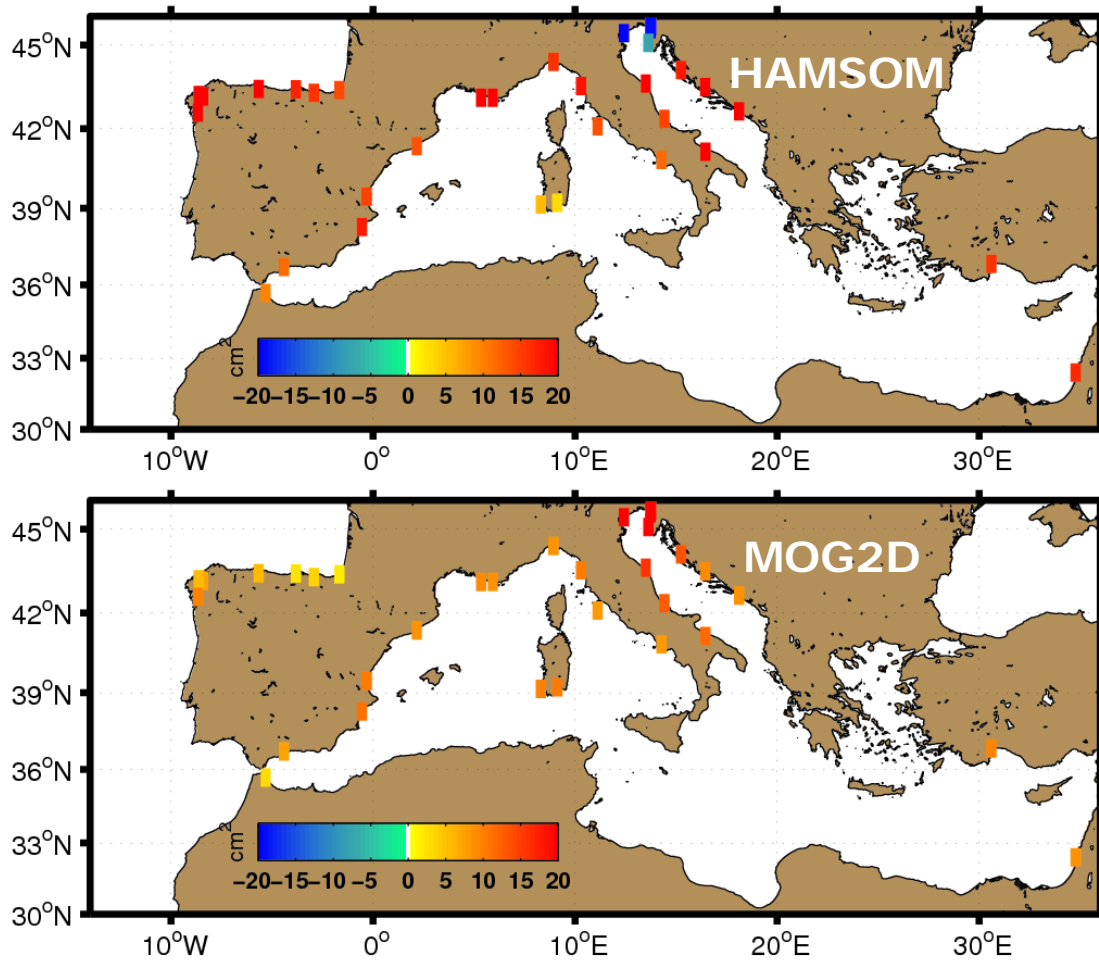
Altimeter data

- Along-track T/P data
- Period: 1993-2001
- Application of atmospheric correction (IB/MOG2D/HAMSOM)
- Usual other corrections



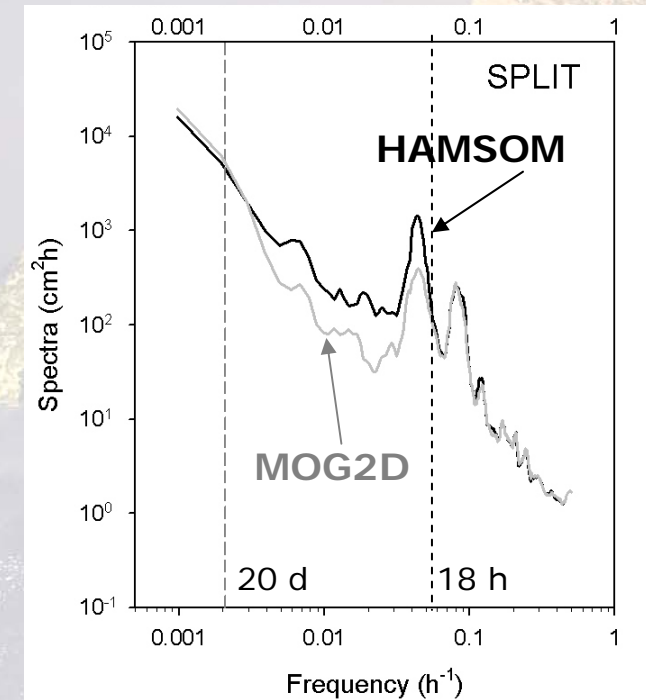
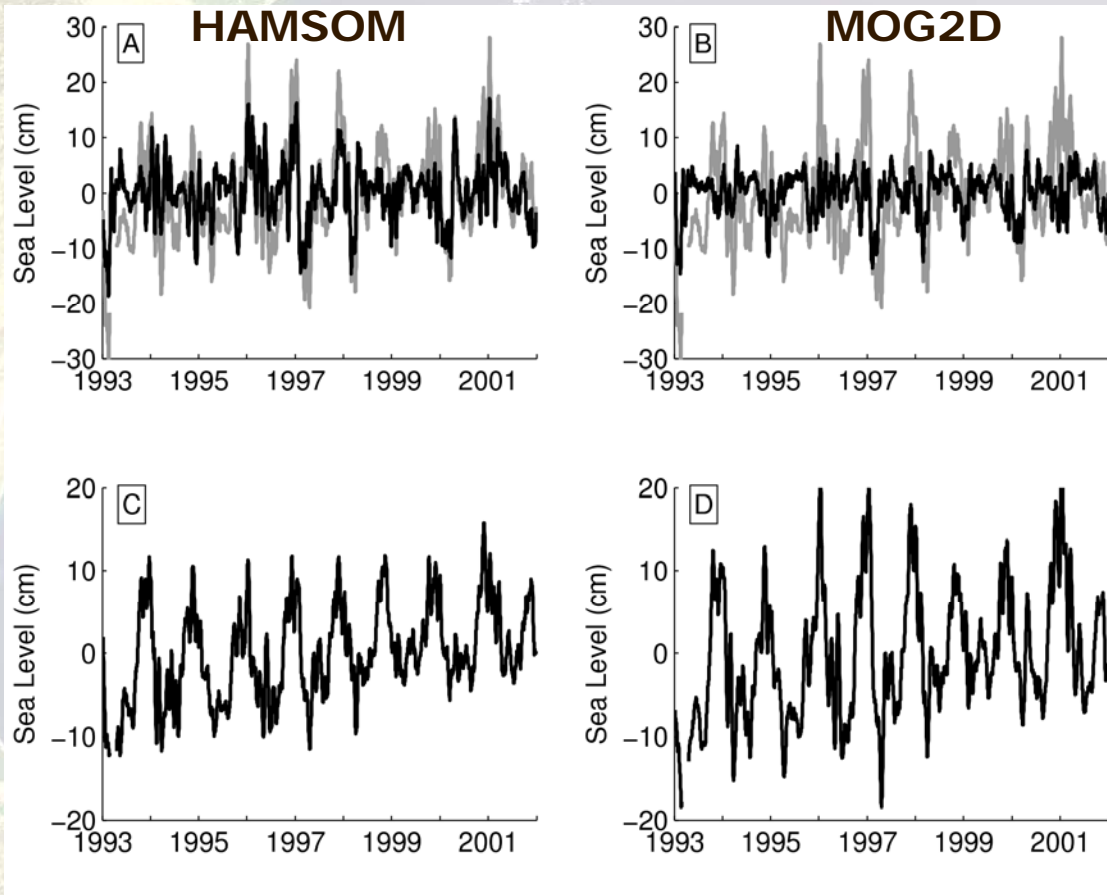
Validation with tide gauges

$\text{Var}(\text{TG-IB}) - \text{Var}(\text{TG} - \text{model})$



Difference between the variance of TG data corrected by the IB response and the variance of TG data corrected by the atmospheric models. The top panel is for HAMSOM and the bottom one is for MOG2D. Units are cm².

An illustration at SPLIT TG



Power spectral density (cm^2h) of the residual TG sea level corrected by MOG2D (grey curve) and HAMSOM (black curve) .

Comparison between model (black) and TG (grey) sea level time series at Split site (Adriatic). The lower panels show the difference between the two series of each upper panel. A 20 days low pass filter has been applied to all the time series.

Averaged values

$[\text{Var}(\text{TG-IB}) - \text{Var}(\text{TG-model})] / \text{Var}(\text{TG-IB})$

	<i>HAMSOM</i>	<i>MOG2D</i>
<i>ALL</i>	20.2%	12.3%
<i>ATLANTIC</i>	31.5%	7.1%
<i>WEST. MED</i>	22.9%	14.4%
<i>ADRIATIC</i>	8.3%	12.7%
Low Frequency	<i>HAMSOM</i>	<i>MOG2D</i>
<i>ALL</i>	23.9 %	0.56%
<i>ATLANTIC</i>	34.3%	3.4%
<i>WEST. MED</i>	31.3%	6.0%
<i>ADRIATIC</i>	8.4%	-9.9%
Hi Frequency	<i>HAMSOM</i>	<i>MOG2D</i>
<i>ALL</i>	20.1%	22.9%
<i>ATLANTIC</i>	30.1%	10.8%
<i>WEST. MED</i>	28.1%	34.0%
<i>ADRIATIC</i>	0.7%	13.4%

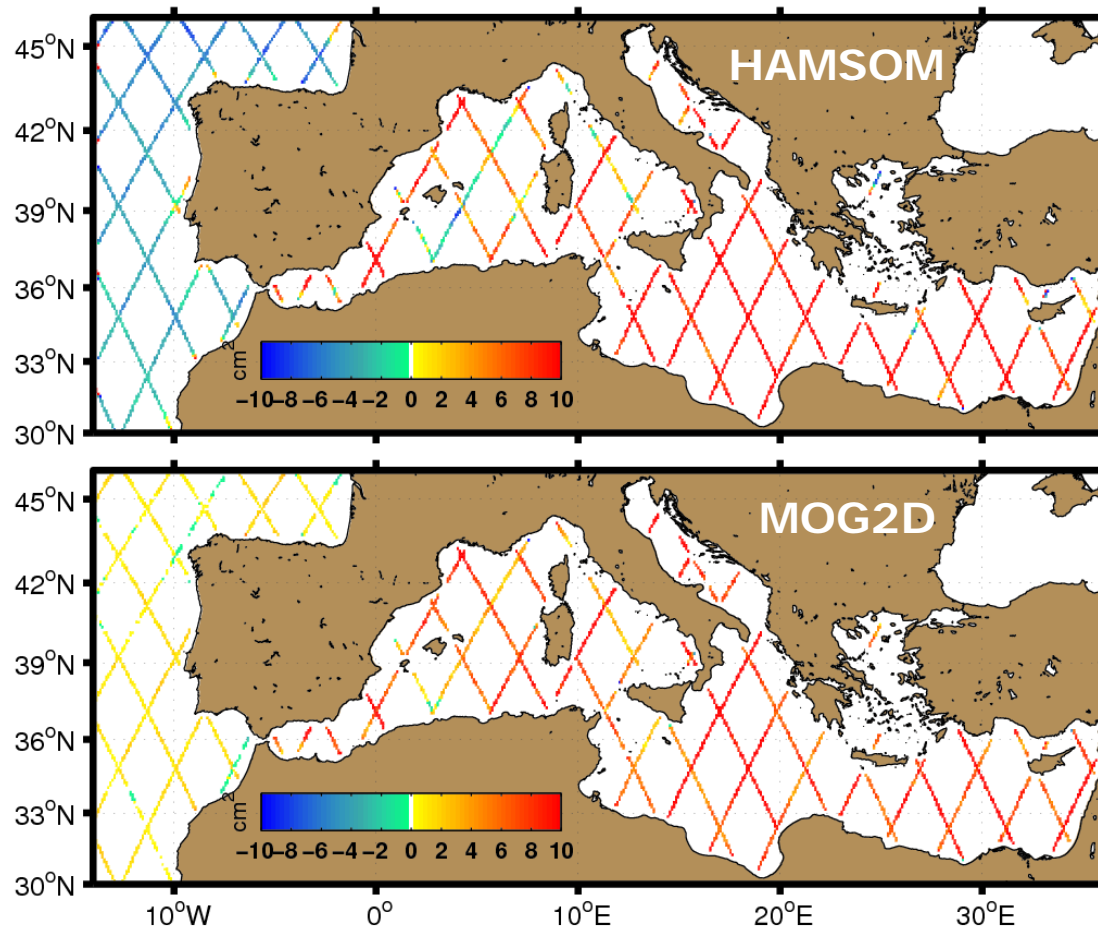
Variance reduction with respect IB.

Low frequency:
HAMSOM reduces more variance.

High frequency:
MOG2D reduces more variance.

Validation with altimetry

$\text{Var}(\text{TP-IB}) - \text{Var}(\text{TP-model})$



	<i>HAMSOM</i>	<i>MOG2D</i>
<i>ALL</i>	7.57 %	8.04%
<i>ATLANTIC</i>	-8.84%	2.74%
<i>WEST MED</i>	8.56 %	8.98%
<i>EAST MED</i>	13.16 %	9.45%

Variance reduction with respect IB.

SUMMARY:

MOG2D is slightly better than HAMSOM with the exception of the Eastern Med.

Summary

- The research and technological activities ongoing at IMEDEA as a basis for operational oceanography have been presented. These activities are carried out in the frame of European, National and Regional funded projects (MERSEA, ECOOP, COOL, UGIZC, etc.).
- The presently existing system includes gliders, moorings, drifting buoys, and satellite data on the observational side, and different types of high resolution forecasting systems on the modeling side, from beach to sub-basin scale.
- In the second part of the talk, we have focused on the impact of geophysical corrections applied to altimetry, which is crucial for regional and coastal applications.
- Other issues such as the impact of merging several altimeter missions (Pascual et al. GRL 2006; Pascual et al. JMS 2007) and the quality of real time altimeter products (Pascual et al. JTECH accept.) have not been discussed here but may be relevant for GODAE Coastal and Shelf Seas Working Group.

Altimeter products for regional applications

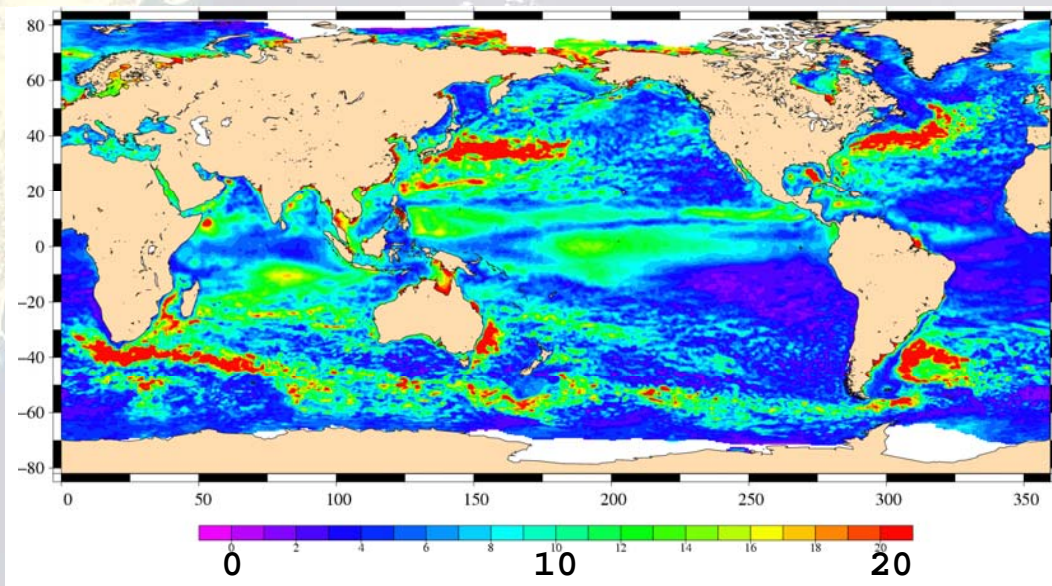
- Satellite altimetry provides a unique contribution to the global observation of eddy variability (Le Traon and Morrow, 2001).
- Two altimeters give an improved view of the mesoscale (Ducet et al., 2000; Fu et al., 2003).
- However, theoretical studies (Chelton and Schlax, 2003) have concluded that two altimeters are far from an optimal recovery of the mesoscale.

Objectives of this work



1. To merge up to 4 altimeter missions
2. To evaluate the impact in the representation of mesoscale variability

SLA variability

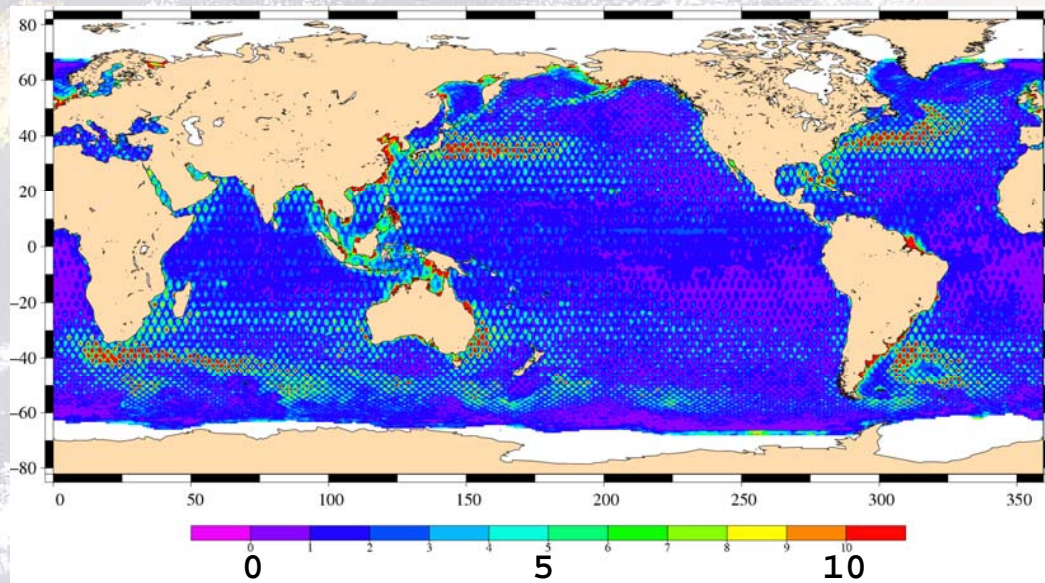


RMS of SLA
estimated with 4 satellites
missions
(Jason-1, T/P, ERS-
2/ENVISAT, GFO)

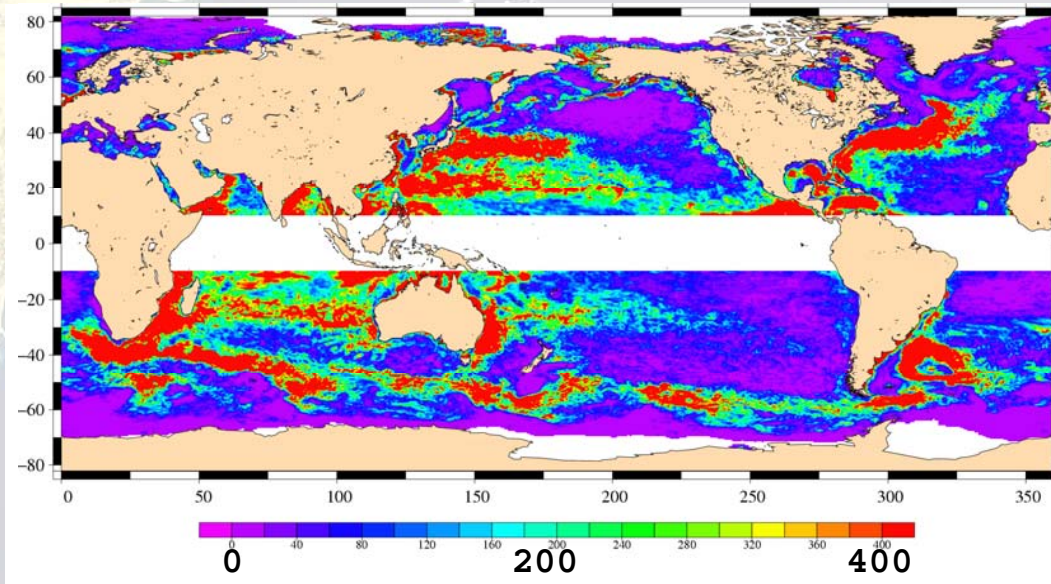
Units are in cm

RMS of SLA
differences
between 4 and 2
(Jason-1 + ERS-
2/ENVISAT)
missions

Units are in cm



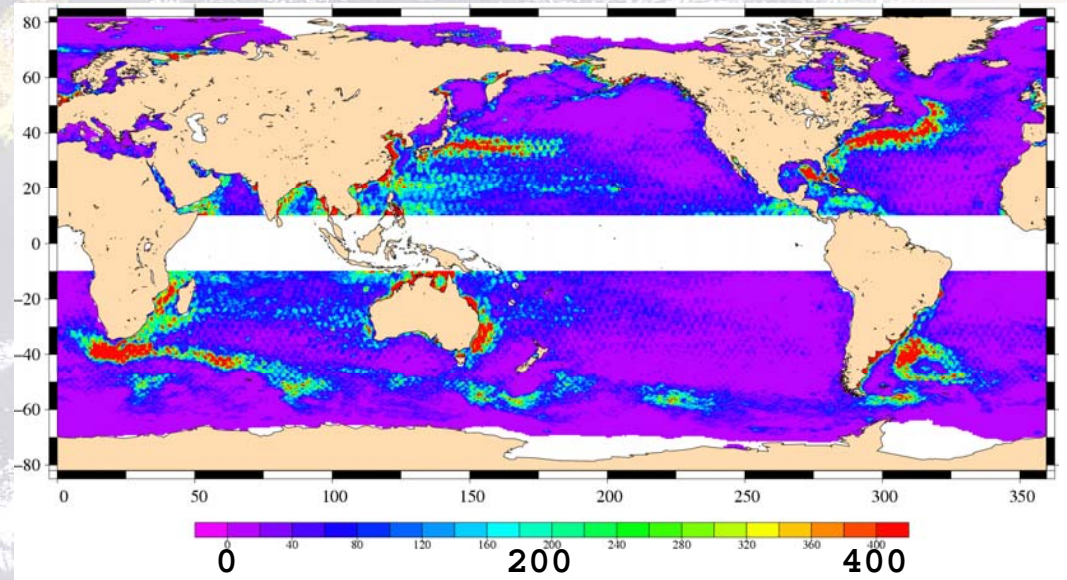
EKE variability



EKE
estimated with 4 satellites
missions
(Jason-1, T/P, ERS-
2/ENVISAT, GFO)

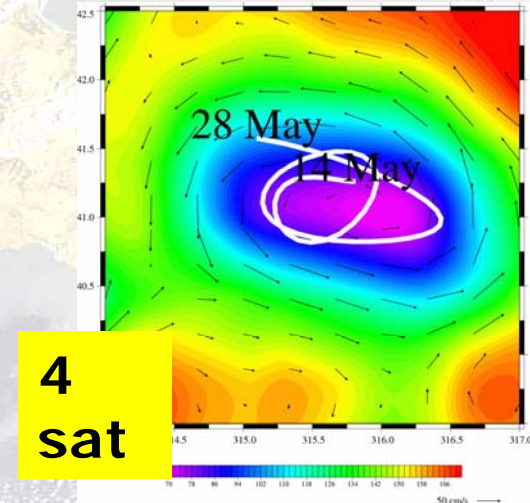
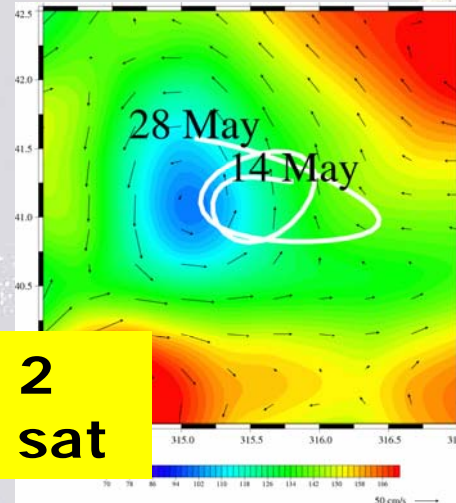
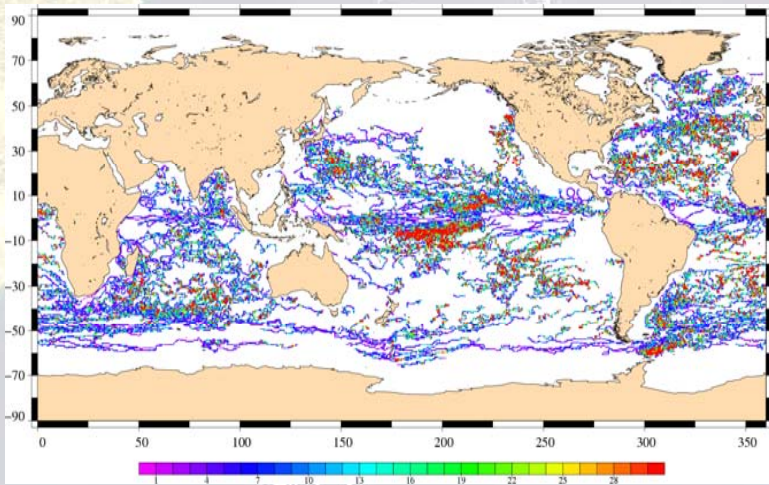
Units are in cm²/s²

EKE
differences
Between 4 and 2
satellite missions
Units are in cm²/s²



Comparison with surface drifters

Data : provided by AOML center
673000 measures (3 days low pass filter)

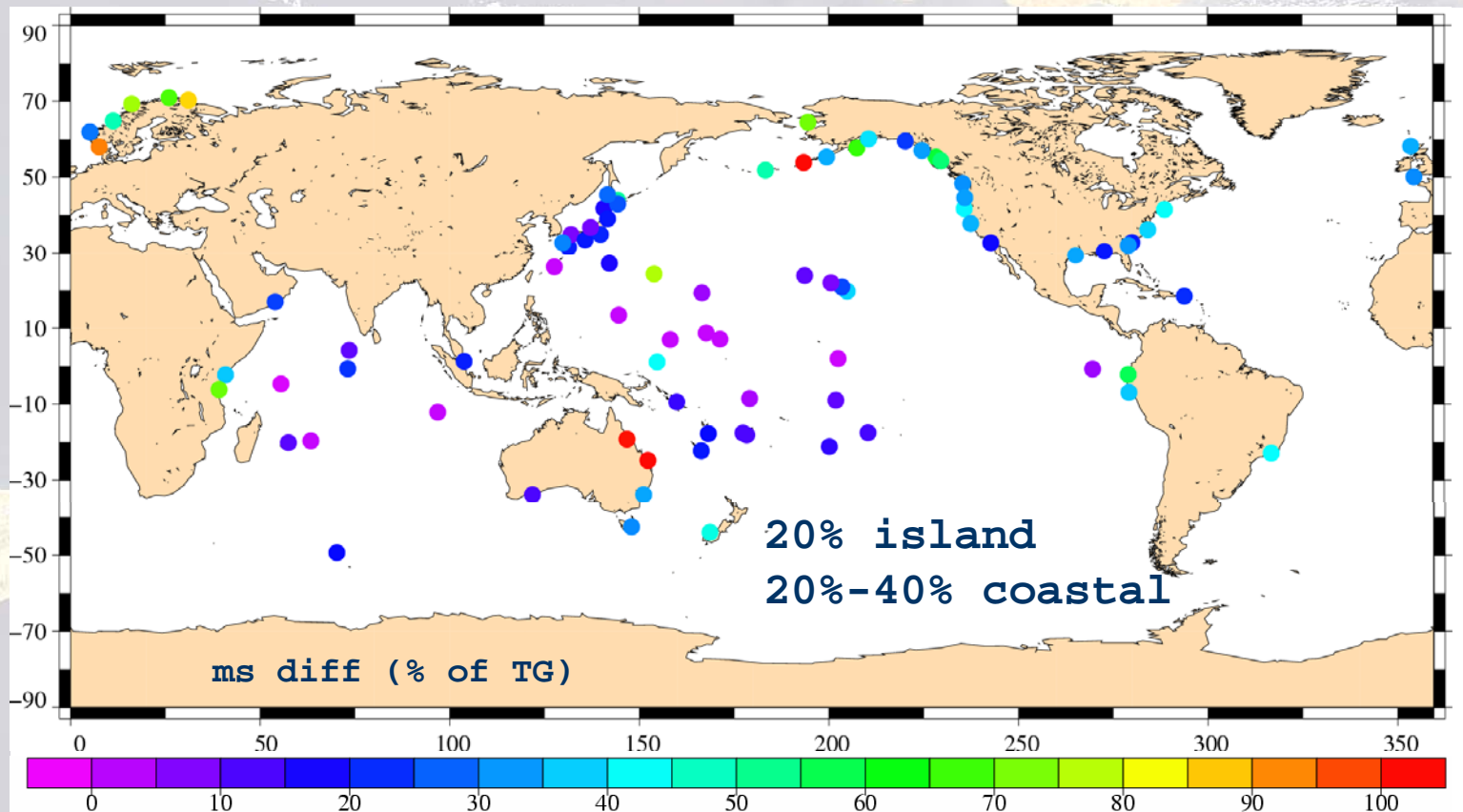


	Geostrophic Velocity Anomalies	Absolute Geostrophic Velocity	Absolute Velocity (+Ekman component)	Improvement using 4 sat missions
U	59.6%	34.2%	24.3%	9%
V	39.2%	32.1%	28.4%	15%

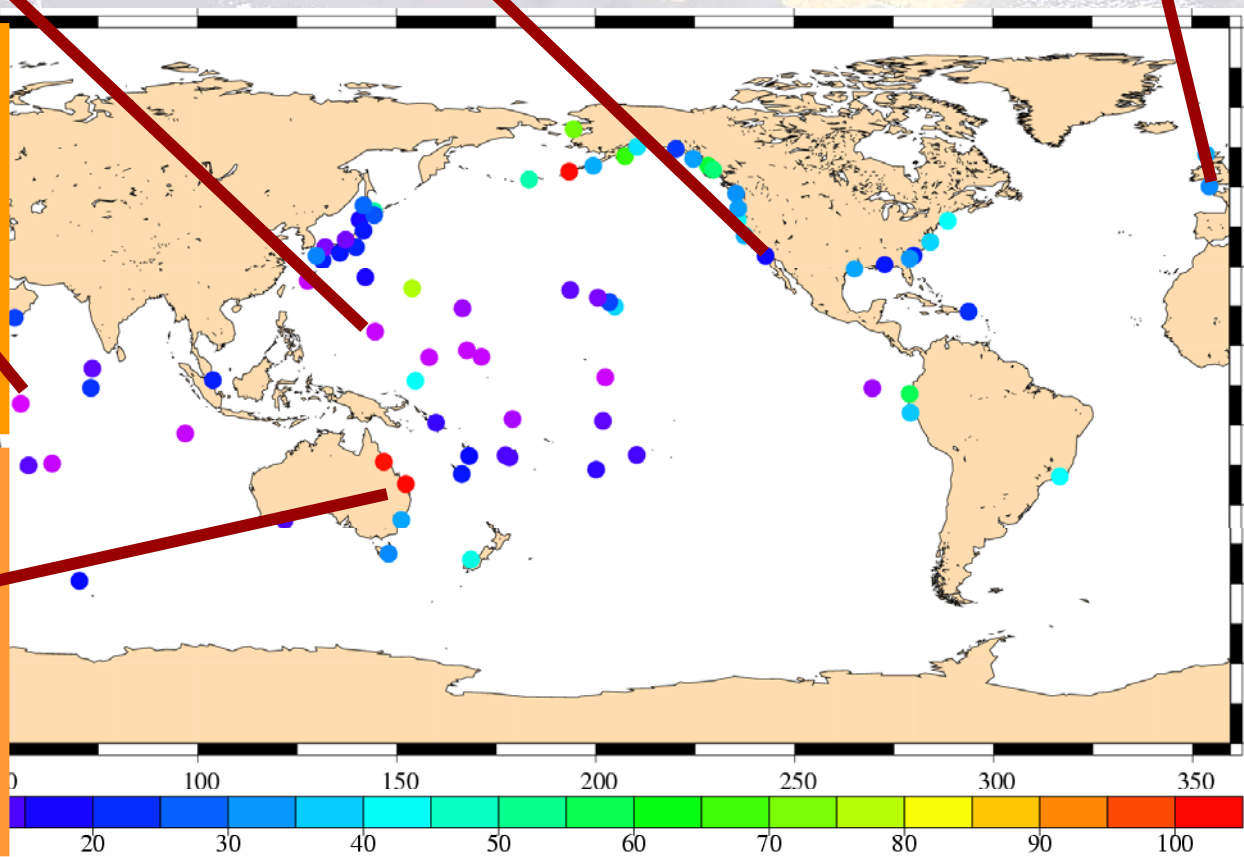
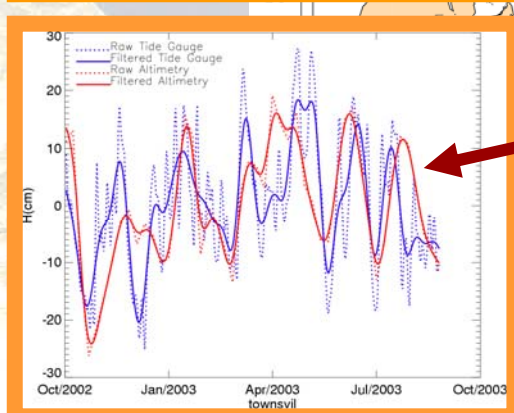
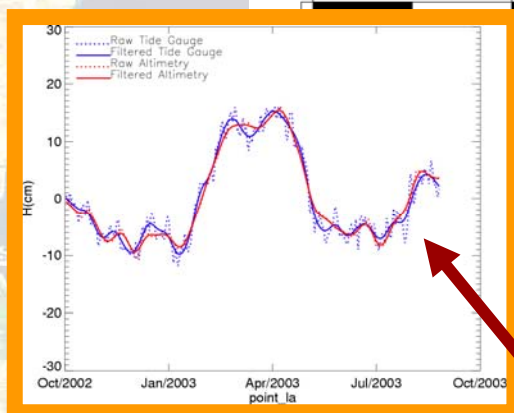
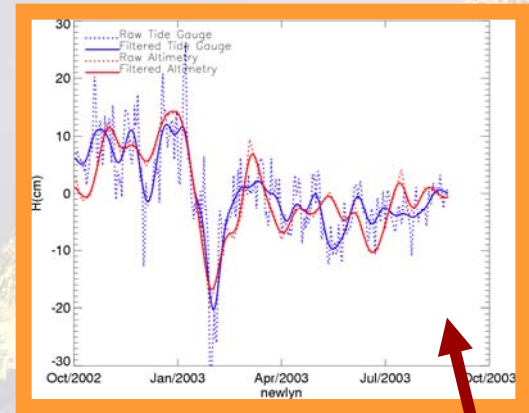
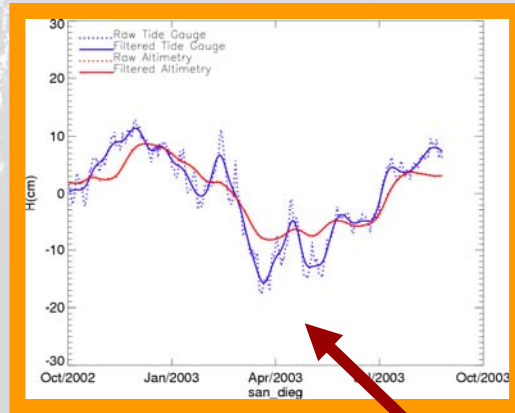
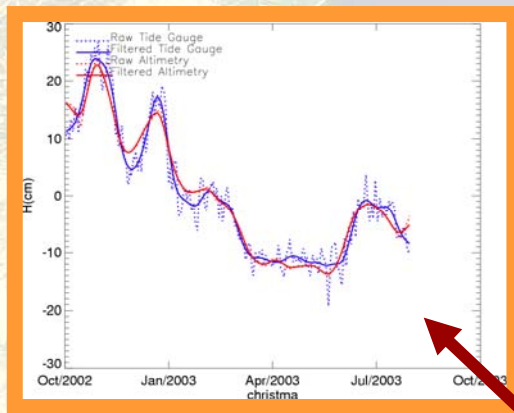
Comparison with tide gauge data

- 86 tide gauge stations from GLOSS/CLIVAR data base.
- Filter at 20 days to remove all signal aliased by altimetry.

2 missions	4 missions
46.7 %	35.3 %



Comparison with tide gauge data



Quality of real time products

Comparison with drifters data

	Delayed Time		Real Time	
	2 missions	4 missions	2 missions	4 missions
U	26.6	24.2	31.0	26.9
V	33.1	28.1	41.2	33.4

Mean square differences between drifter and altimeter velocities. Units are % of drifter variance.

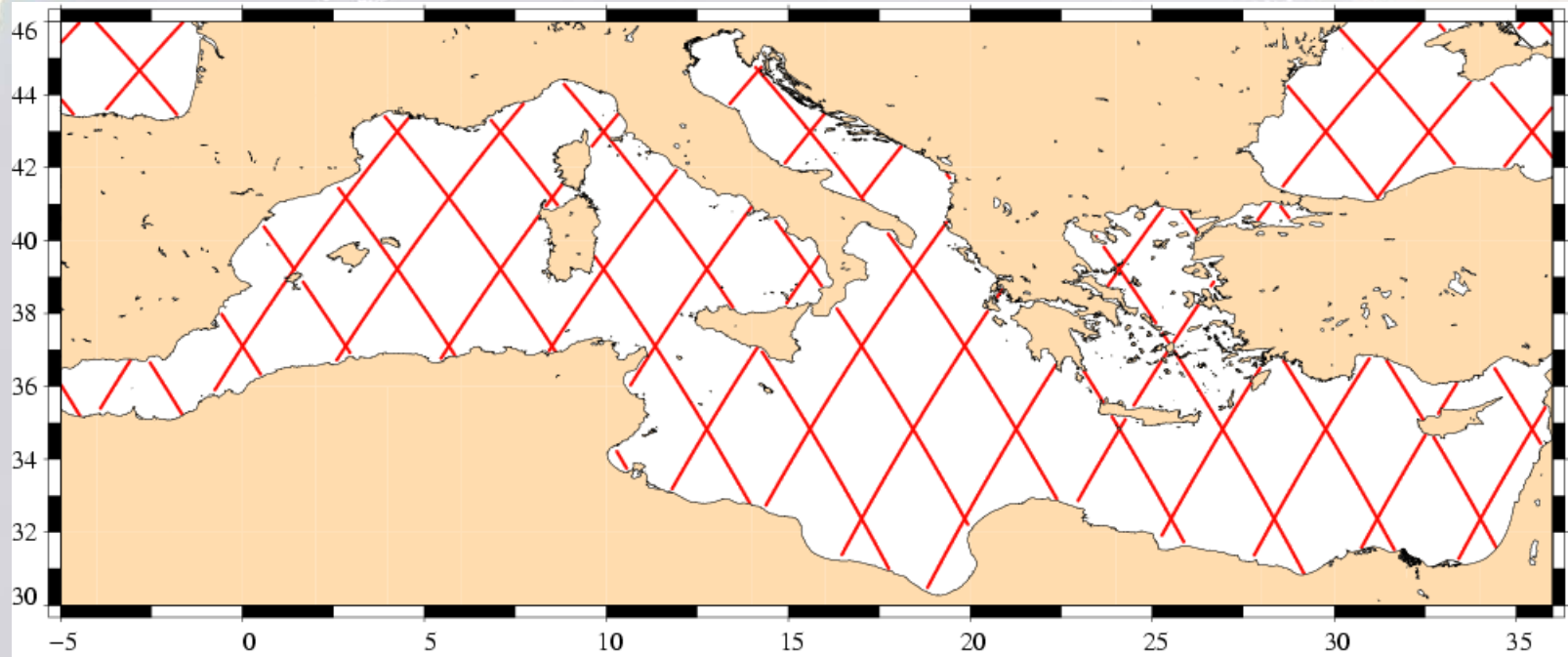
Comparison with tide gauge data

	2 missions	4 missions
Delayed time Old corrections (GOT99+IB)	46.7	35.3
Delayed time new corrections (GOT00+MOG2 D)	36.7	29.7
Real time Orbit error No-centering	45.2	37.1

Mean square differences between tide gauge and altimeter sea level. Units are % of tide gauge variance.

- 4 NRT missions give same results as 2 DT missions
- Continue improving of the processing

The impact of merging 4 altimeters

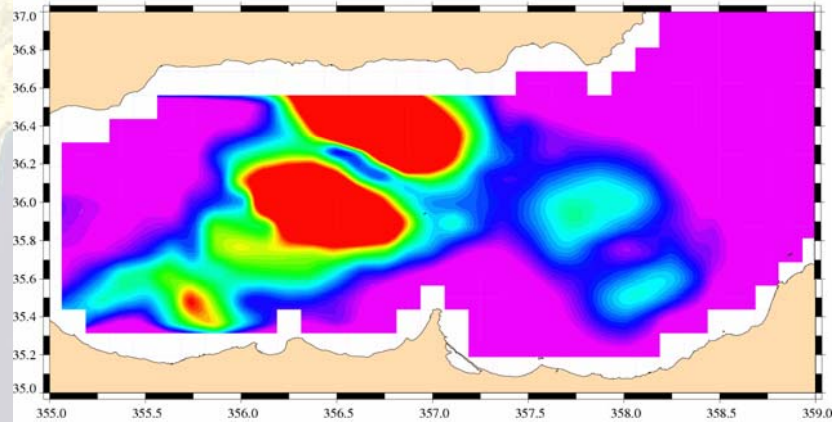


Track selection for 4-19 Nov 2002

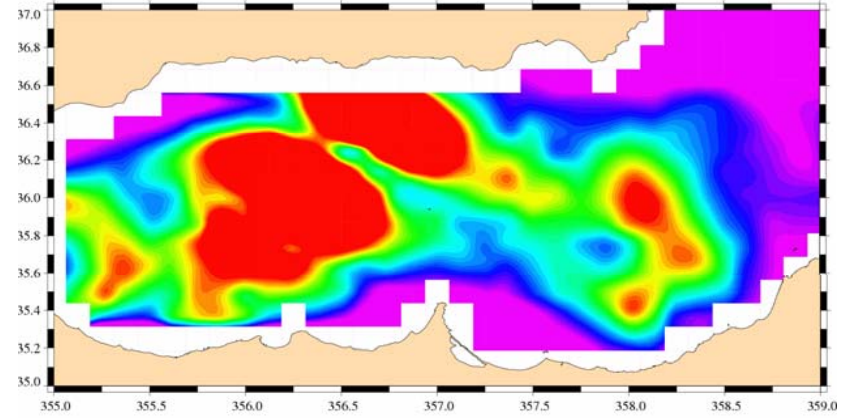


Eddy kinetic energy

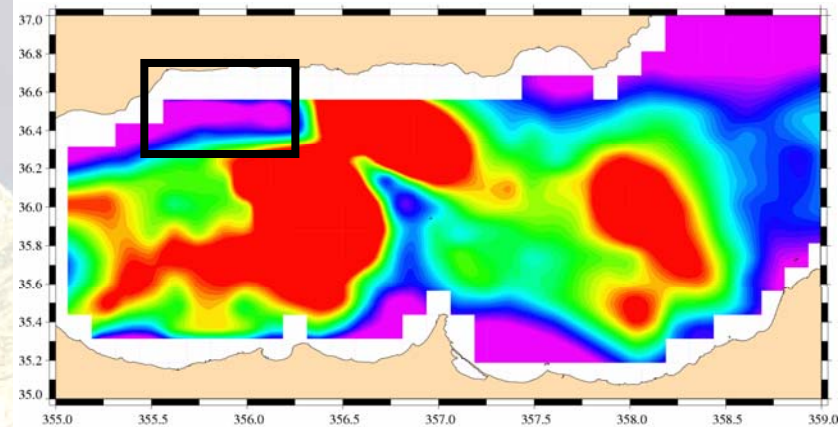
J1



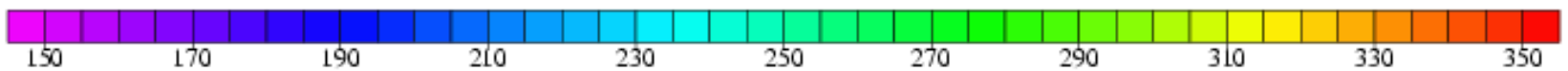
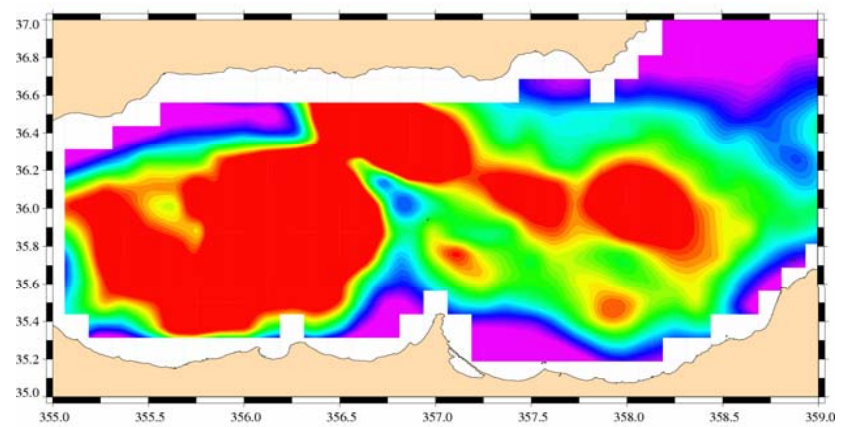
J1E2



J1E2TP



J1E2TPG2

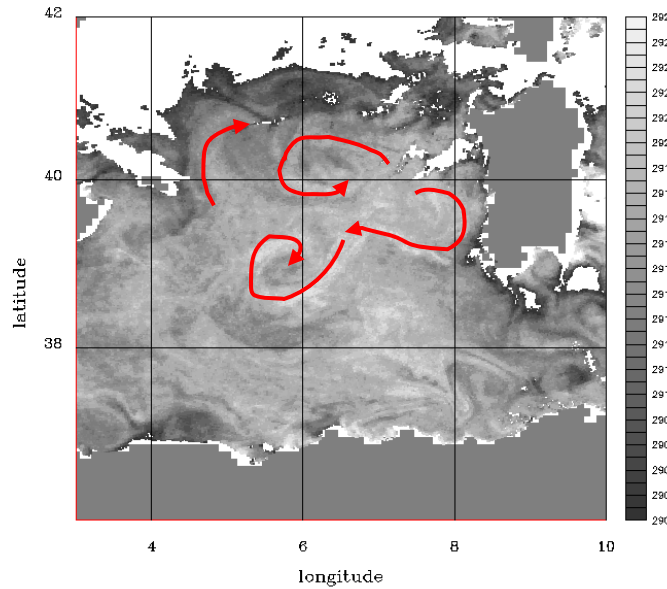


Mean EKE (cm²/s²)

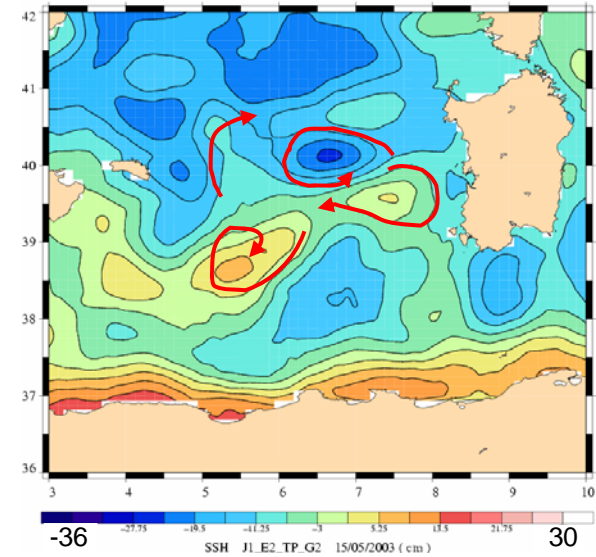
Altimetry vs SST: Algerian Basin

SST image from CMS. <http://www.ifremer.fr/las/>

15 May 2003



SLA (J1E2TPG2) +MDT



21 May 2003

