# ENVISAT contribution to the development of application and services, and future perspectives with the Sentinels

## With a focus on MERIS Marine applications

*Odile Hembise Fanton d'Andon*

# Waiting for ENVISAT to be launched 2001


ENVISAT

# Waiting for ENVISAT to be launched 2001


# ENVISAT- MERIS

# MERIS for what ?
# Science – Carbon cycle

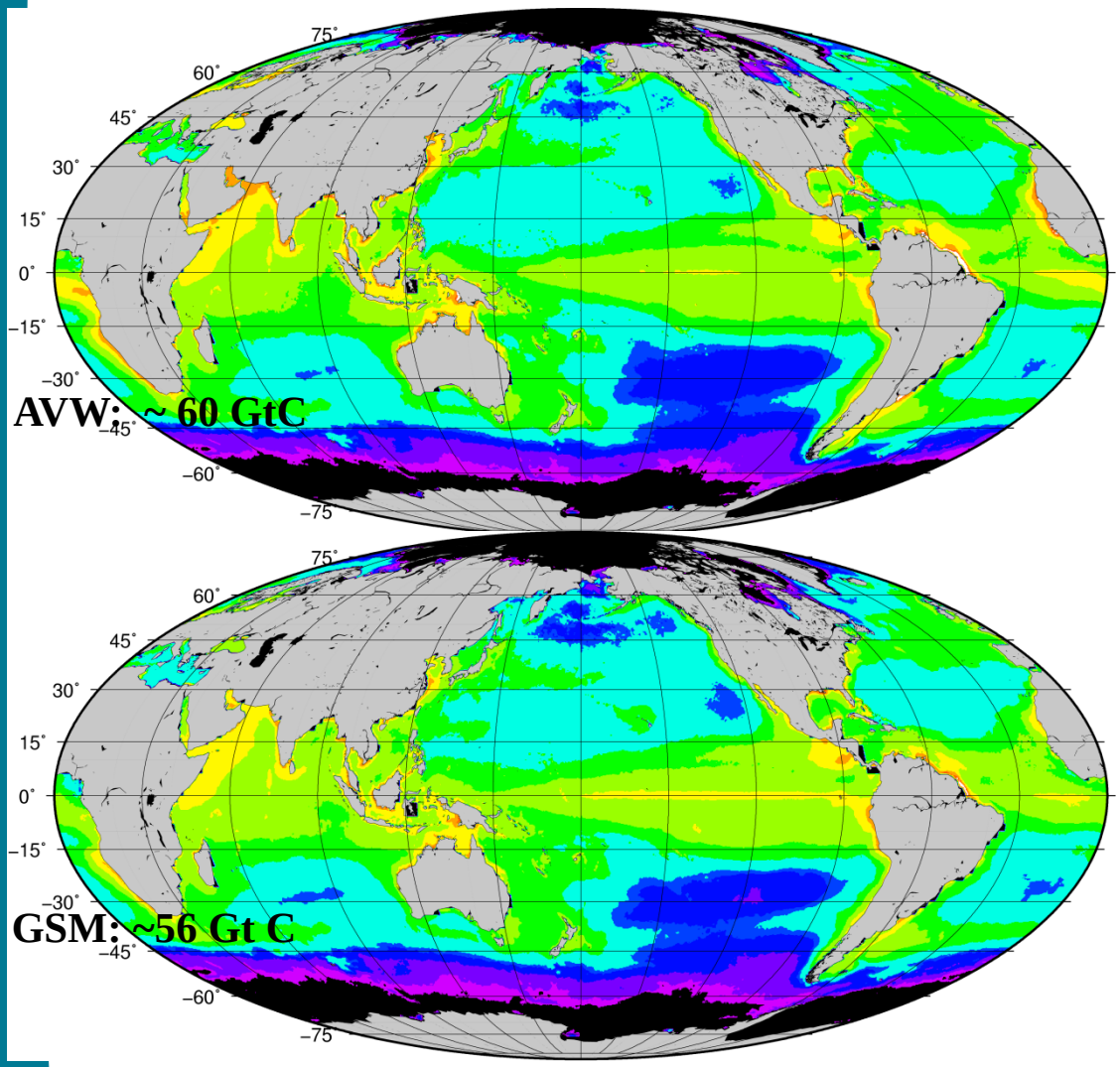



Table 2. Global annual phytoplankton primary production (Pg C $yr^{-1}$) calculated with the vertically generalized production model (VGPM), Laboratoire de Physique et Chimie Marines (LPCM) model (Antoine et al. 1996), Bedford production model (BPM) (Longhurst et al. 1995), and the Eppley and Peterson (1979) compilation (E&P). Annual production is also shown for the five major ocean basins defined by Antoine et al. (1996) (percentages of total production indicated in parentheses), as well as three trophic categories for the VGPM and LPCM models (subpolar plus global in brackets).

| | VGPM | LPCM* | BPM† | E&P‡ |
|---|---|---|---|---|
| Global total | 43.5 | 46.9 | $50.2^{+0.3}_{-4.7}$ | 27.1 |
| Pacific | 16.7(38.3) | 20.0(42.7) | $19.4^{+5.1}_{-1.8}$(38.6) | 9.1(33.7) |
| Atlantic§ | 11.9(27.5) | 11.3(24.0) | $13.7^{+1.7}_{-0.8}$(27.3) | 8.6(31.6) |
| Indian | 6.2(14.2) | 8.1(17.3) | $6.5^{+0.7}_{-0.2}$(13.0) | 6.0(22.0) |
| Arctic | 0.4(0.9) | 0.6(1.3) | 1.4(2.8) | 0.1(0.5) |
| Antarctic | 8.3(19.1) | 6.9(14.7) | 9.2(18.3) | 3.3(12.2) |
| Oligotrophic | 10.3[10.5]‖ | 16.2 | | |
| Mesotrophic | 22.0[26.4]‖ | 22.5 | | |
| Eutrophic | 3.6[6.6]‖ | 2.5 | | |

Previous results (Behrenfeld and Falkowski, 1997)

Average global value from more than 20 models, using SeaWiFS data for the year 1998, is of about 50 Gt C; uncertainty by about a factor of 2 (Carr et al., 2006)

# Waiting for ENVISAT to be launched 2001

Very first users community

# Then comes the launch … 2002

## MERIS applications & services - A brief history

| | *Event/stimuli* | *Applications* |
|---|---|---|
| … 2002 | MERIS in orbit | Science – Carbon cycle |
| | | Support to fish geolocation |
| | GSE-Coastwatch/Roses<br>Marcoast | Algal bloom monitoring |
| 2006 | | Environmental regulation – WFD |
| | DUE – Globcolour<br>Marcoast II<br>FP7 R&D support | Environmental monitoring |
| | OC missions merging | Fish resource assessment |
| 2010 | | Environmental regulation – MSFD |
| | Assimilation into biogeochemical models | Support to aquaculture |
| | … | Support to State of Climate assessment |
| | Bio-profilers | OC as an element of observation system |
| … 201x | Sentinel 3 in orbit<br>MCGS in operation | Multi-sensors services shall be deployed |

# The triggering event : MERIS in orbit

2002

Good preparation : everything goes well !

… 2002

*1st MERIS FR image*
*22 March 2002*
*Orbit number: 00306*

# ENVISAT MERIS People

**Expert Support Laboratory led by ACRI-ST – LOV, FUB, GKSS, LISE 1995 - 2002**

François Montagner, Ludovic Bourg, Vincent Fournier-Sicre, André Morel, David Antoine, Antoine Mangin, Roland Doerffer, Jurgen Fischer, Carsten Brockmann, Bernard Pinty, Nadine Gobron, Richard Santer, Marcel Babin, Gerald Moore, Steven Delwart, Jean-Paul Huot, Philippe Goryl, Guido Levrini, Odile Fanton d'Andon …

**Since 2002,**

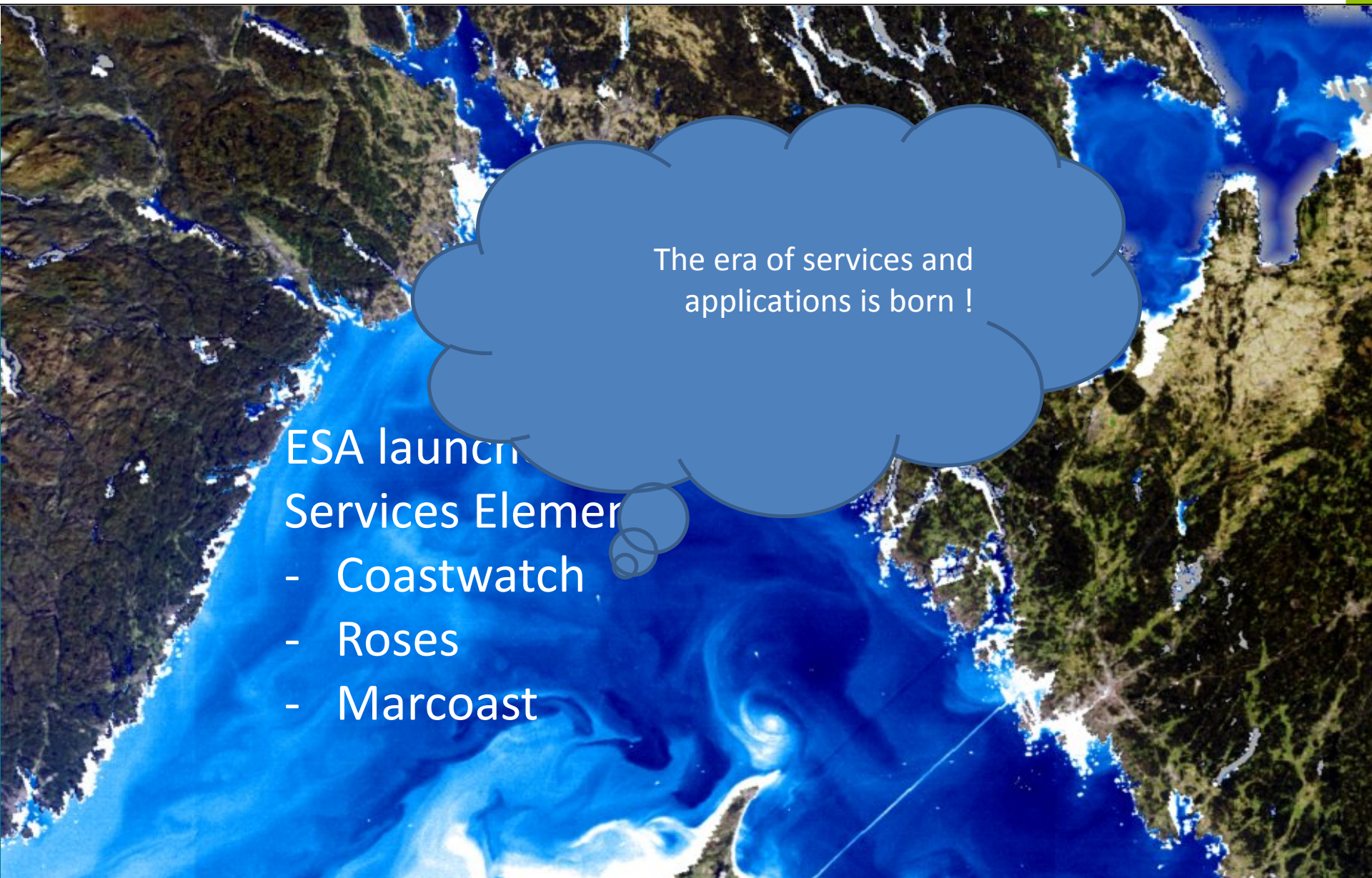
**Quality Working Group led by ACRI-ST**

- Monitoring health of the sensor and processing
- Propose / test evolutions of the processing – trigger reprocessing
- 21 members from 12 different institutions

**MERIS Validation team**

- More than 200 people
- An annual meeting oriented towards the data users.

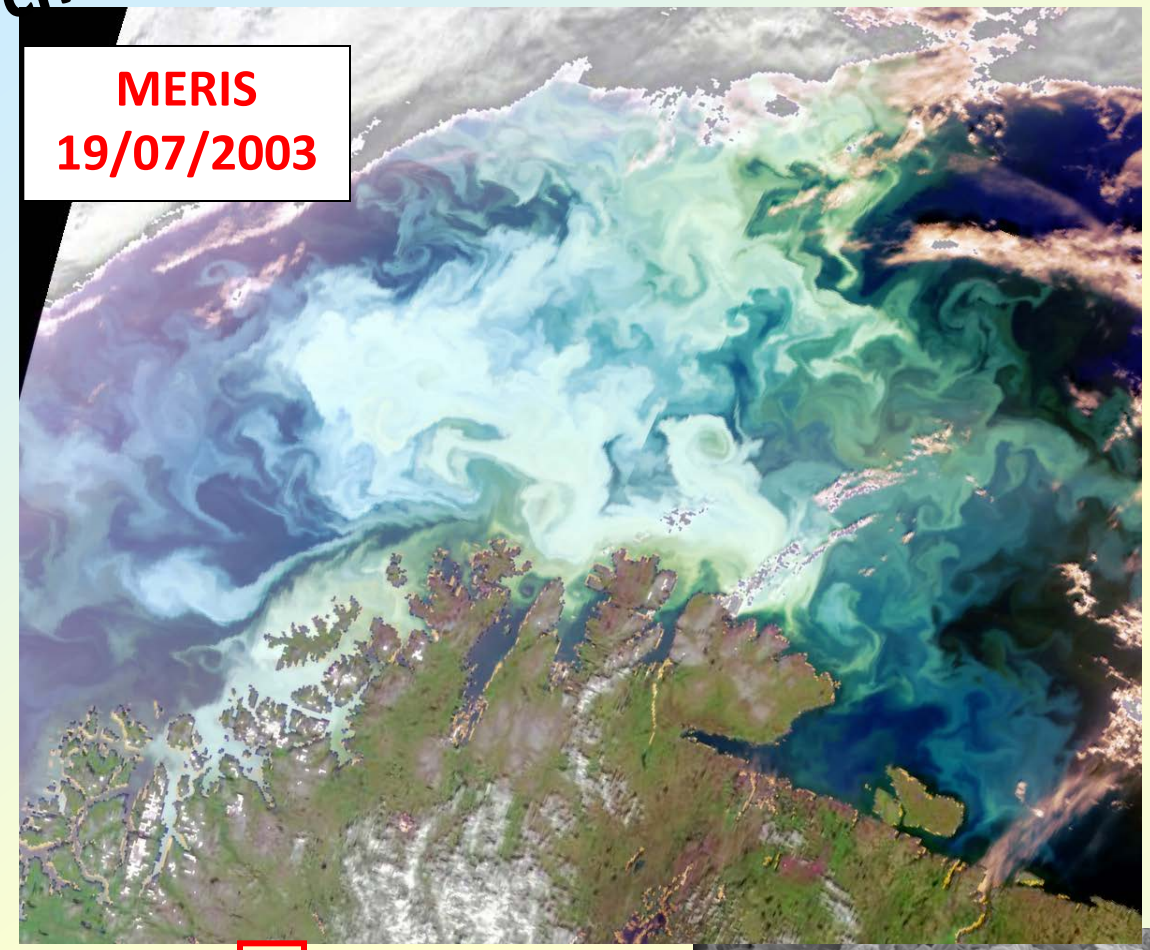
# The Second Stimuli 2003



Archive slide

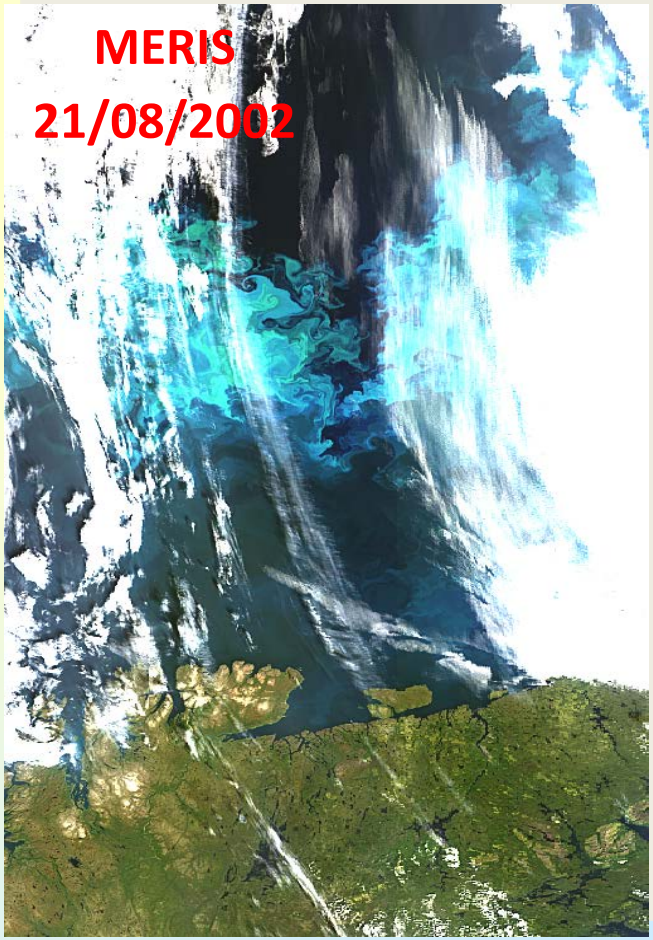
*Applications*

# GMES marine surveillance monitoring service



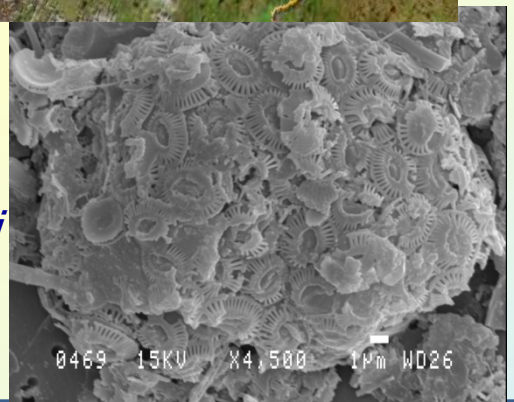

COAST WATCH

coastwatch@acri-st.fr





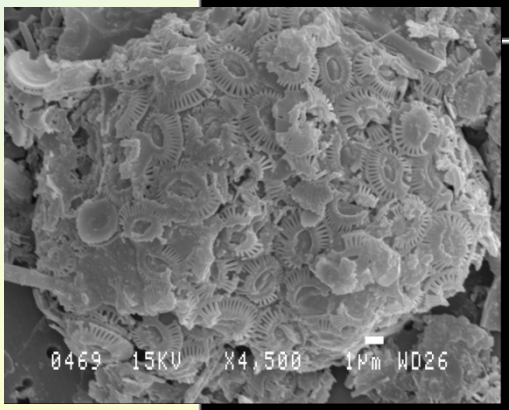
Barents sea
*Emiliania huxleyi*
Summer Bloom



# Archive slide

## Algal bloom monitoring in Barents Sea affecting Norwegian coastal seas - July, 2003

MERIS image
(morning)

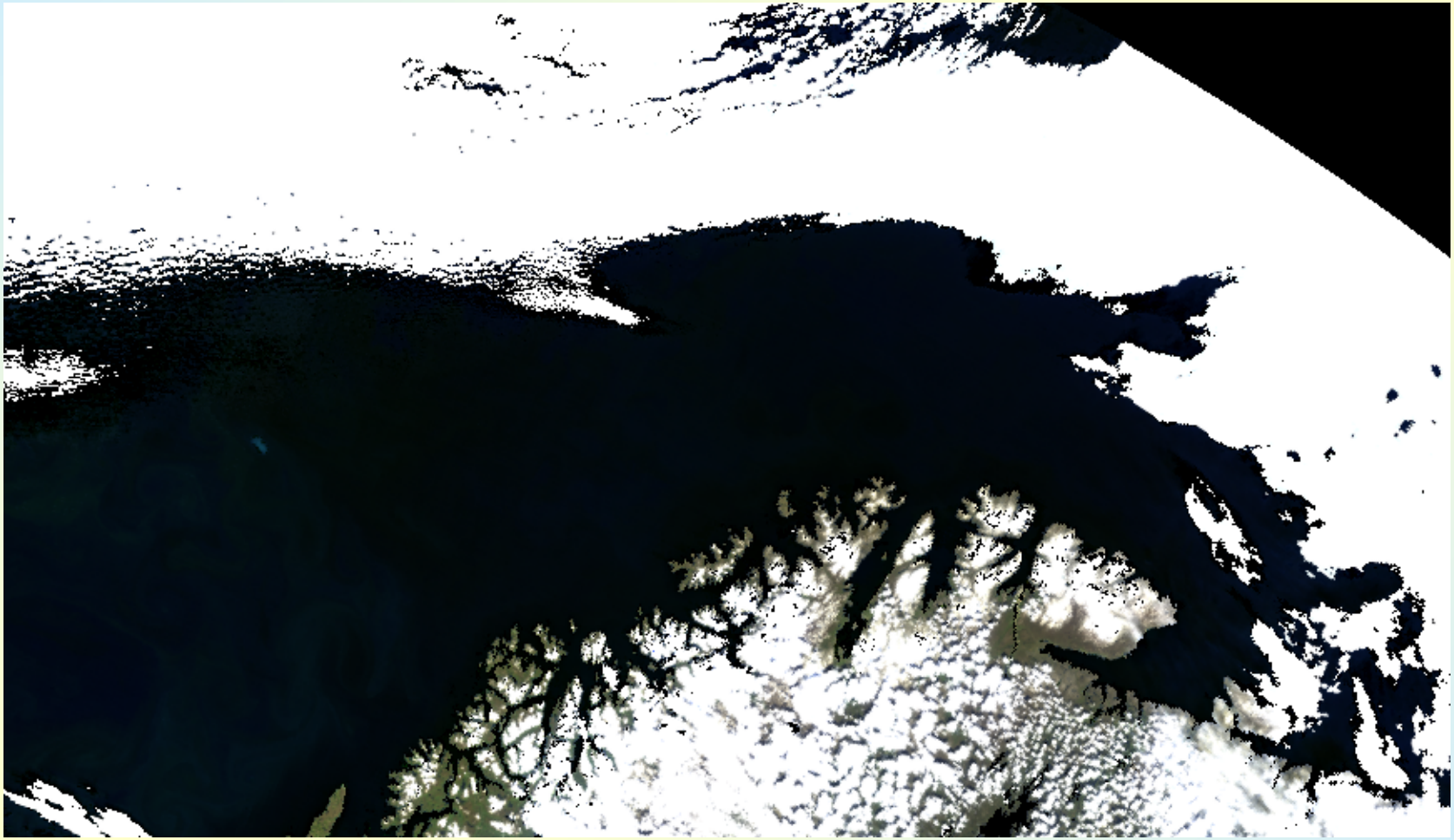



*Emiliania huxleyi*
Bloom

MERIS image
(afternoon)

COAST WATCH
coastwatch@acri-st.fr
http://www.coastwatch.info

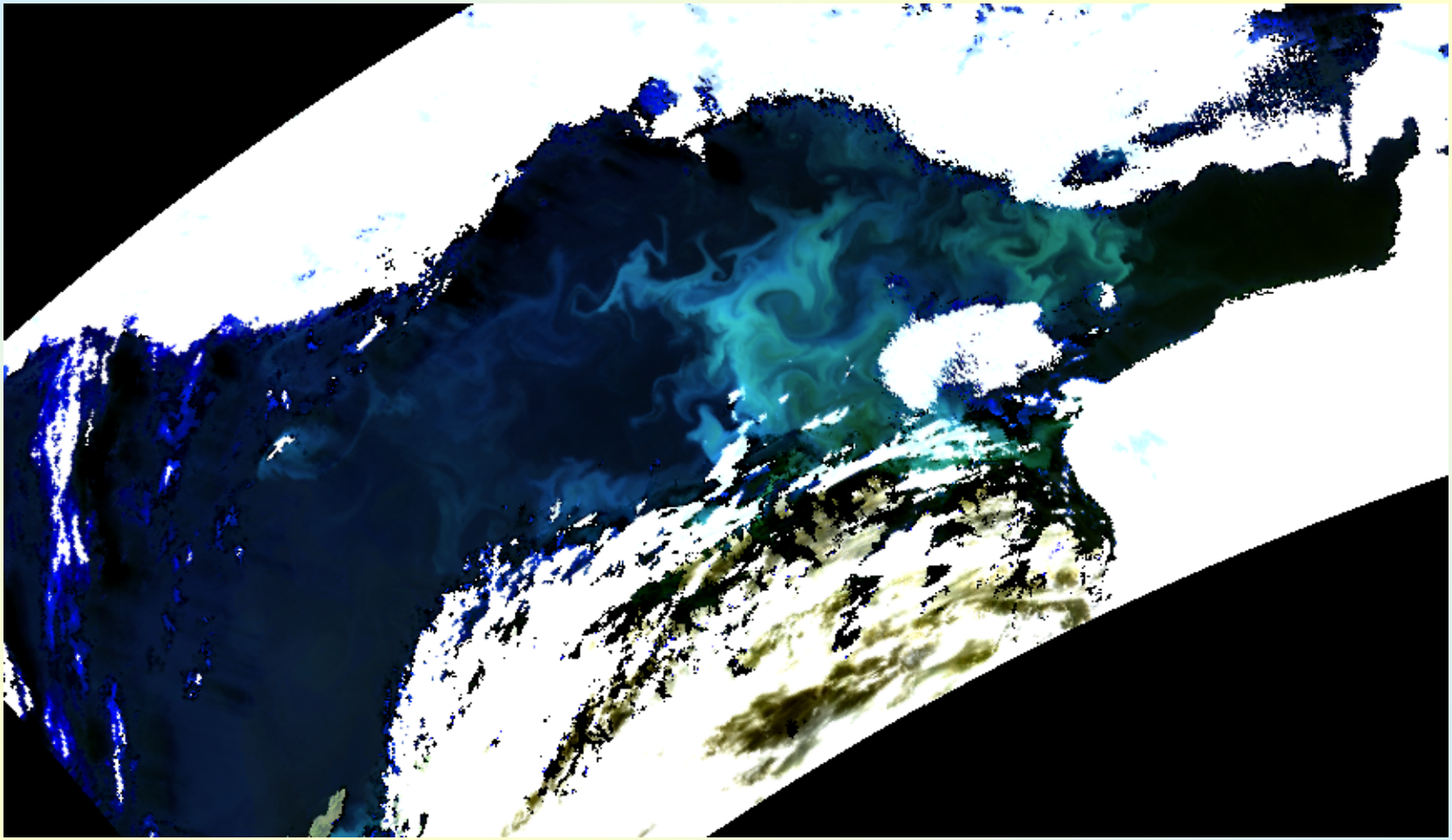
# Archive slide



MERIS RGB,  19 June 2003, 10H09

COAST WATCH

# Archive slide

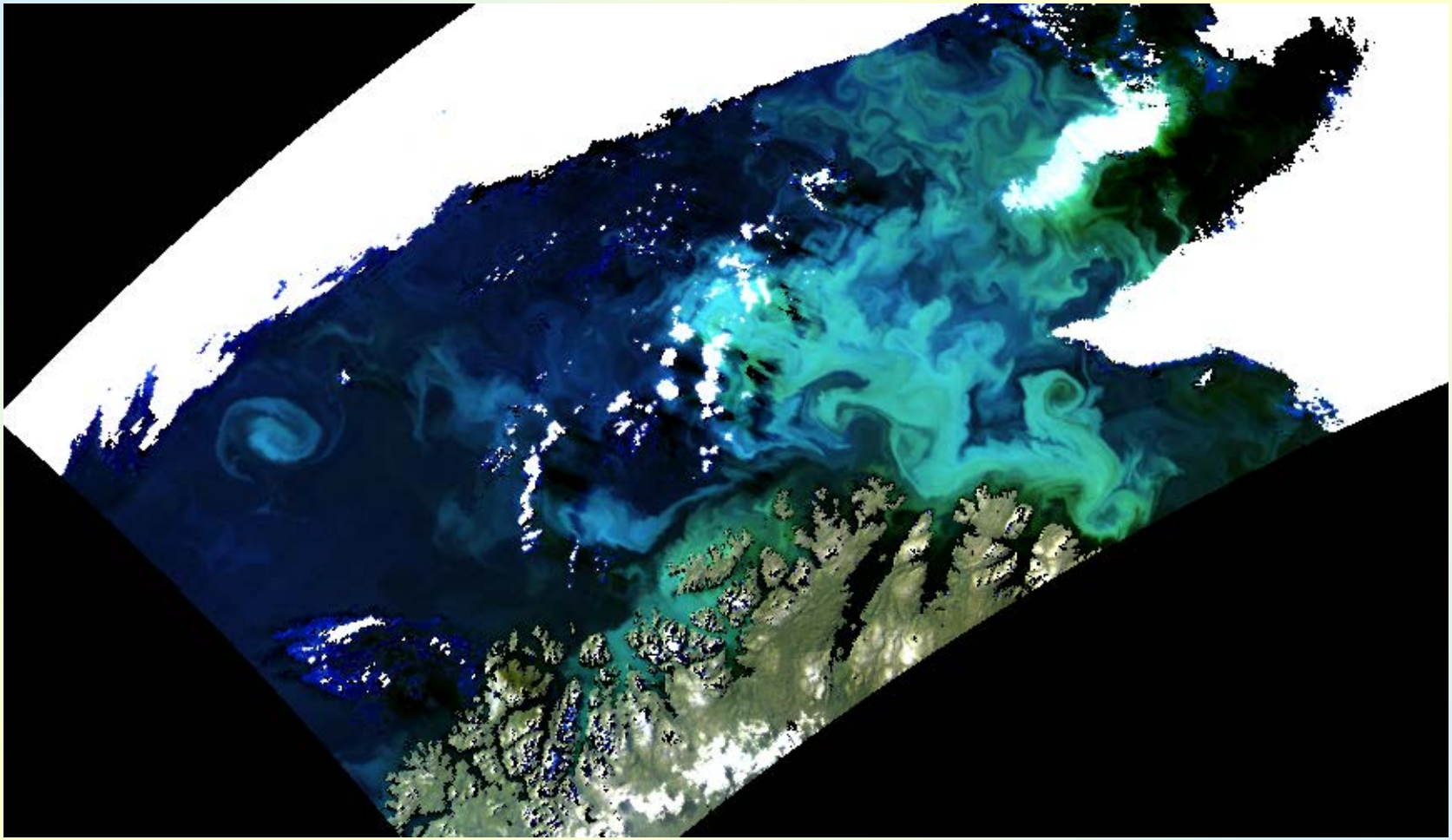


MERIS RGB, 11 July 2003, 10H09

COAST WATCH

coastwatch@acri-st.fr
http://www.coastwatch.info

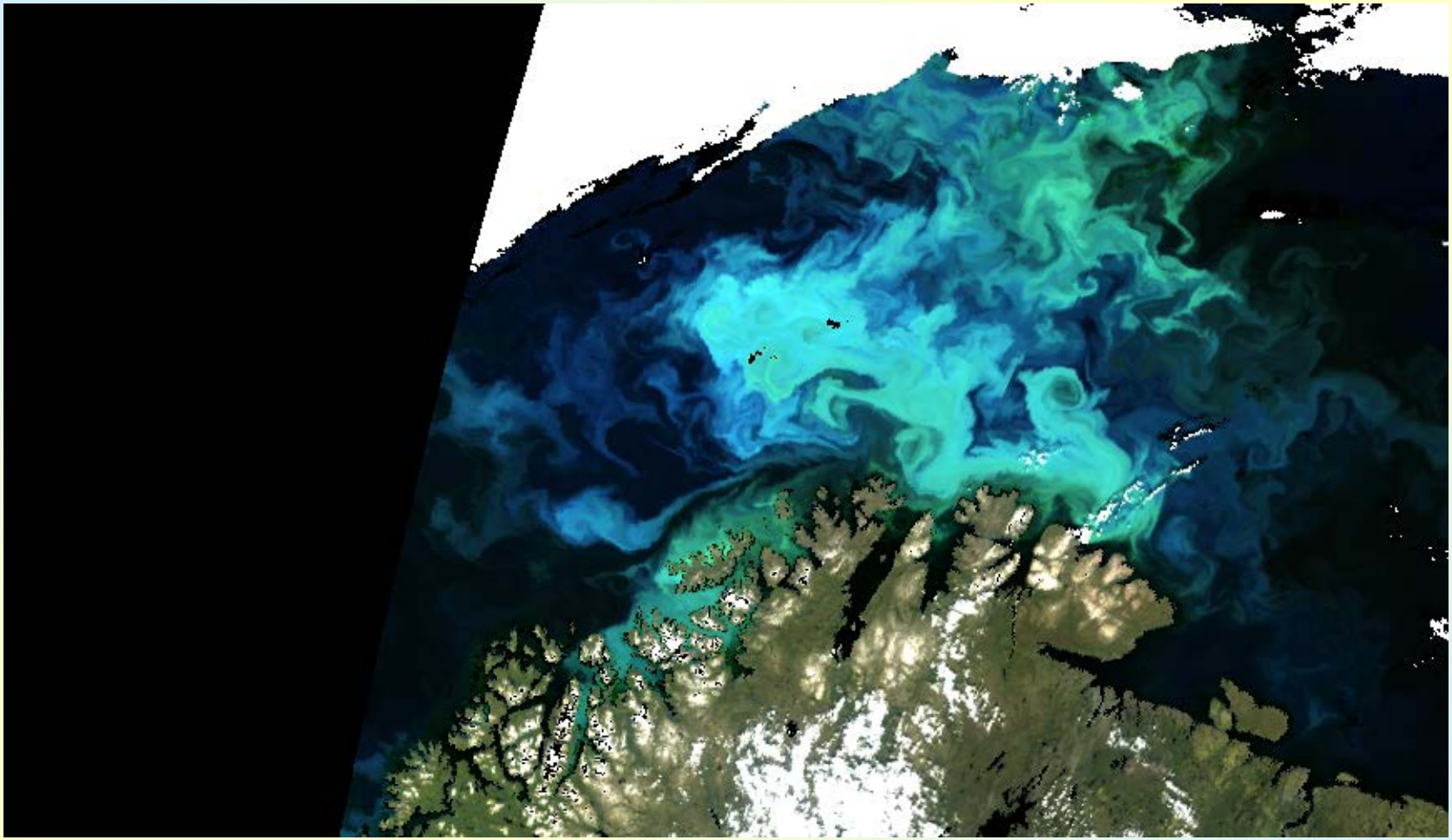
# Archive slide



MERIS RGB, 18 July 2003, 18H12

COAST WATCH

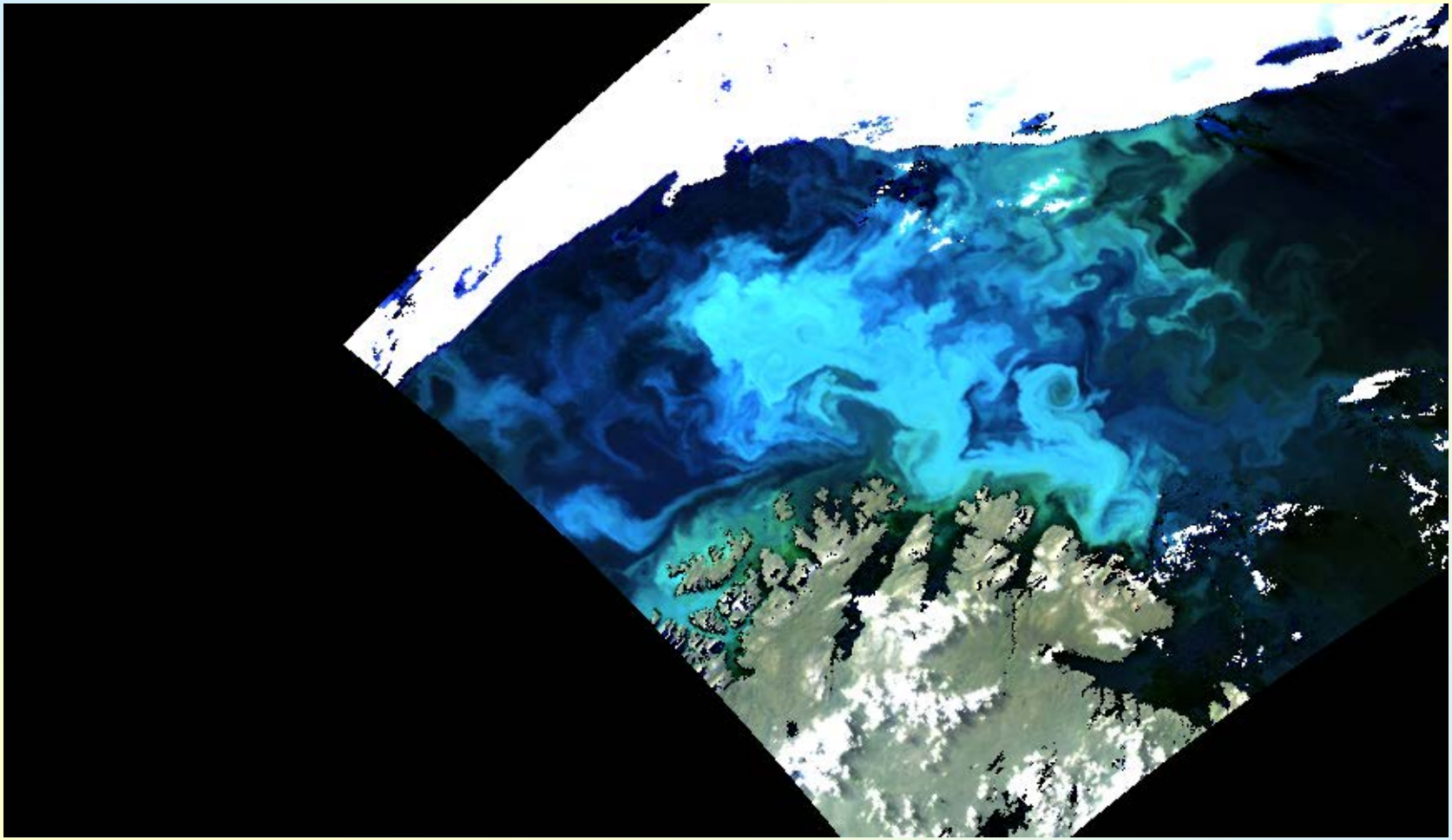
# Archive slide



MERIS RGB, 19 July 2003, 9H26

COAST WATCH

# Archive slide



MERIS RGB, 19 July 2003, 17H41

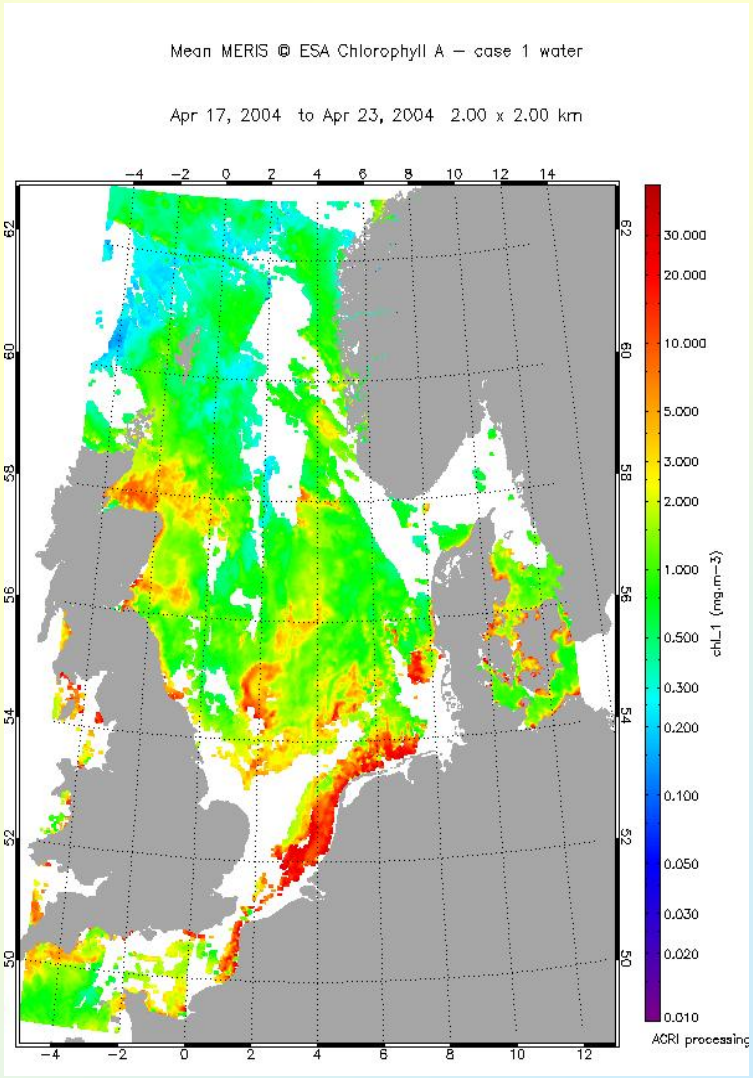
COAST WATCH

# Algae bloom monitoring (user : RIKZ)

**Archive slide**

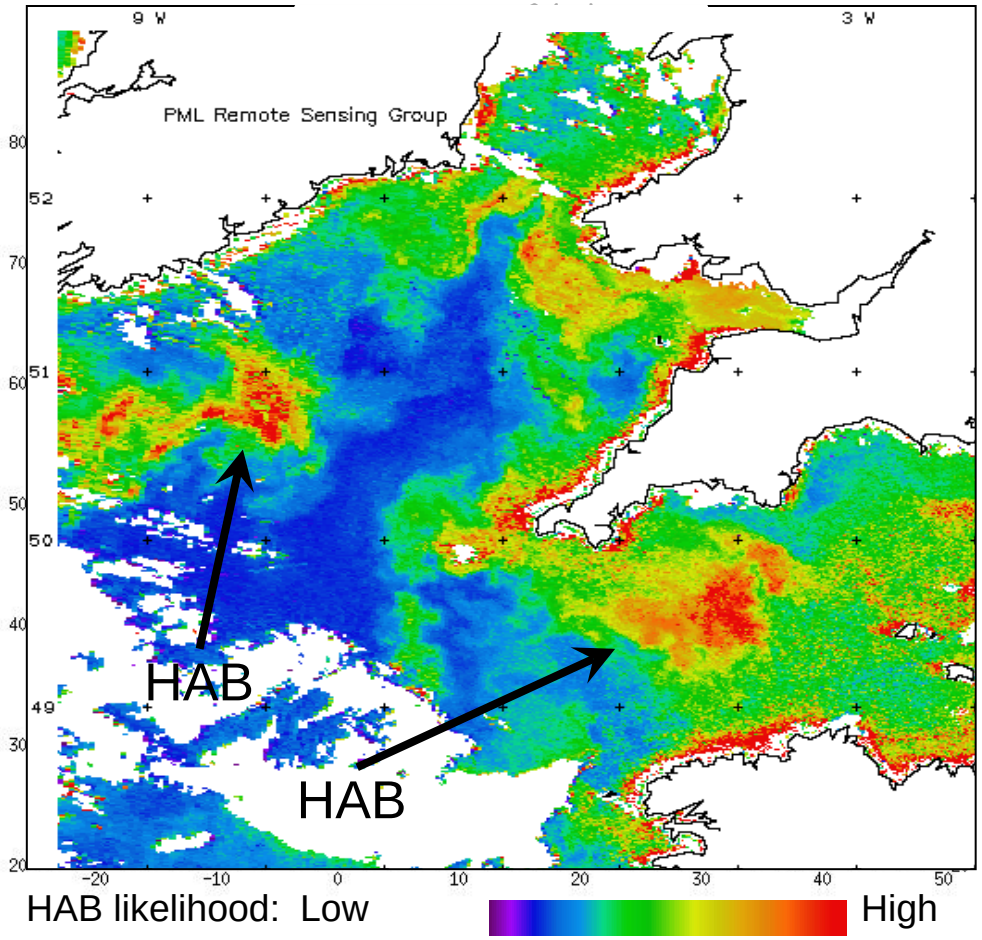
COAST WATCH

- In 2002 about 20M€ loss of mussel cultures in the River Scheldt area.
- Predicting of risk based on EO-data Chlorophyll and wave data.
- Decision support for closing dams to keep Harmful algae blooms outside the estuary.



# 10 years later
# Several algal bloom detection services 2012

**Algal blooms** are generally detected from Ocean Colour (mainly Chla), but




- Not all AB are **detectable**

- **Harmfulness** detection is an issue (excepted some species e.g. *Karenia Brevis*) – need for *in situ* truth when AB is triggered

- Some (H)AB (e.g. *Cyanobact., red/green tides)* can be detected from specific **spectral signature**

**Operational services** are operated on European waters (e.g. ESA-Marcoast 2, Algarisk, Plaagalgen-bulletin)

**Research** performed in FP7 Aquamar, Cobios, Azimuth…

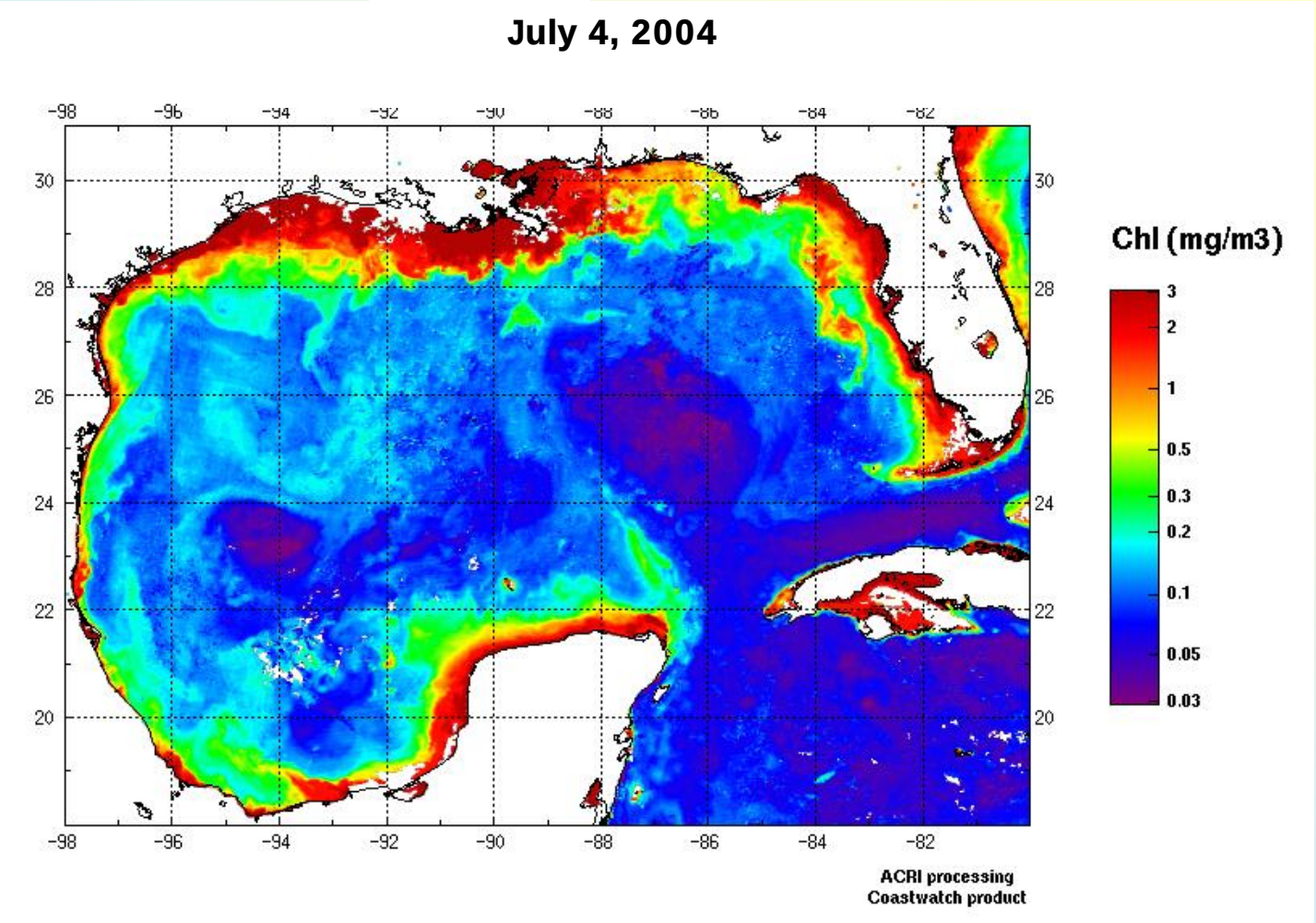
# Geophysical parameters

# Monitoring - chlorophyll

**Archive slide**

COAST WATCH

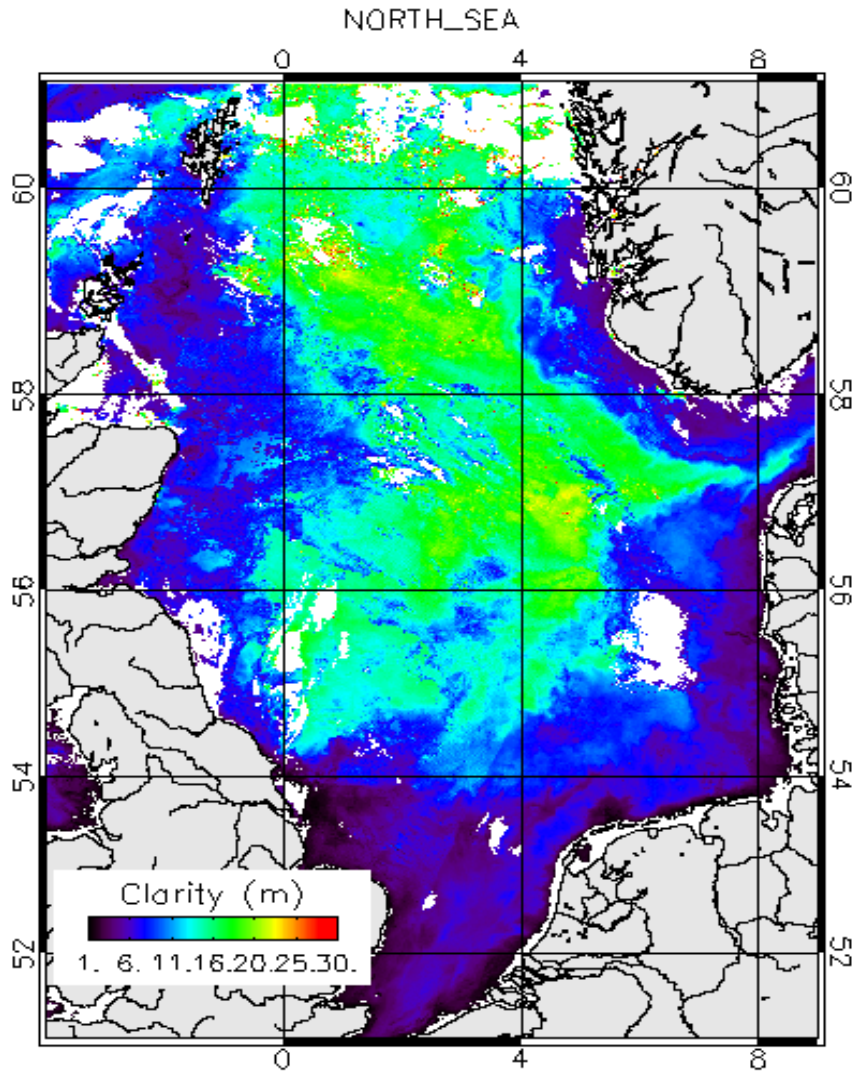
**Daily composite of ESA/ENVISAT/MERIS and NASA/AQUA/MODIS chlorophyll**

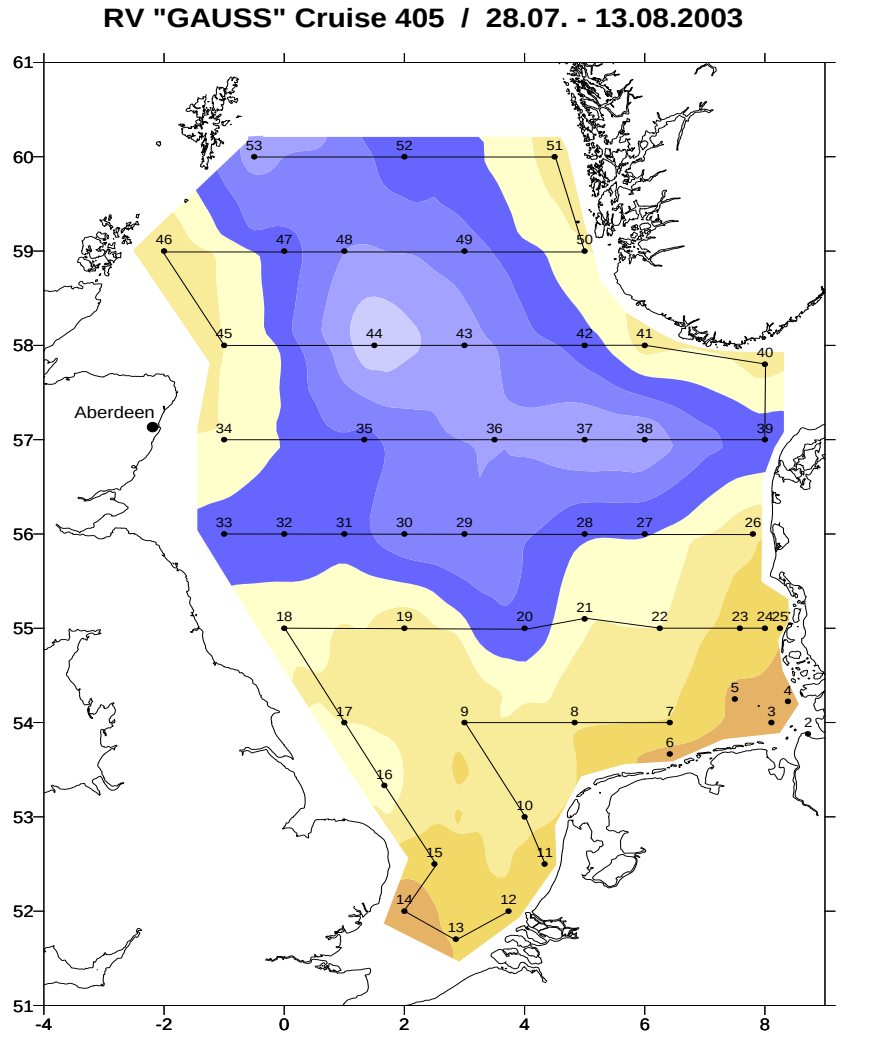


# Transparency
## (user : BSH) : Ship time reduced by 40%.

**Archive slide**

COAST WATCH



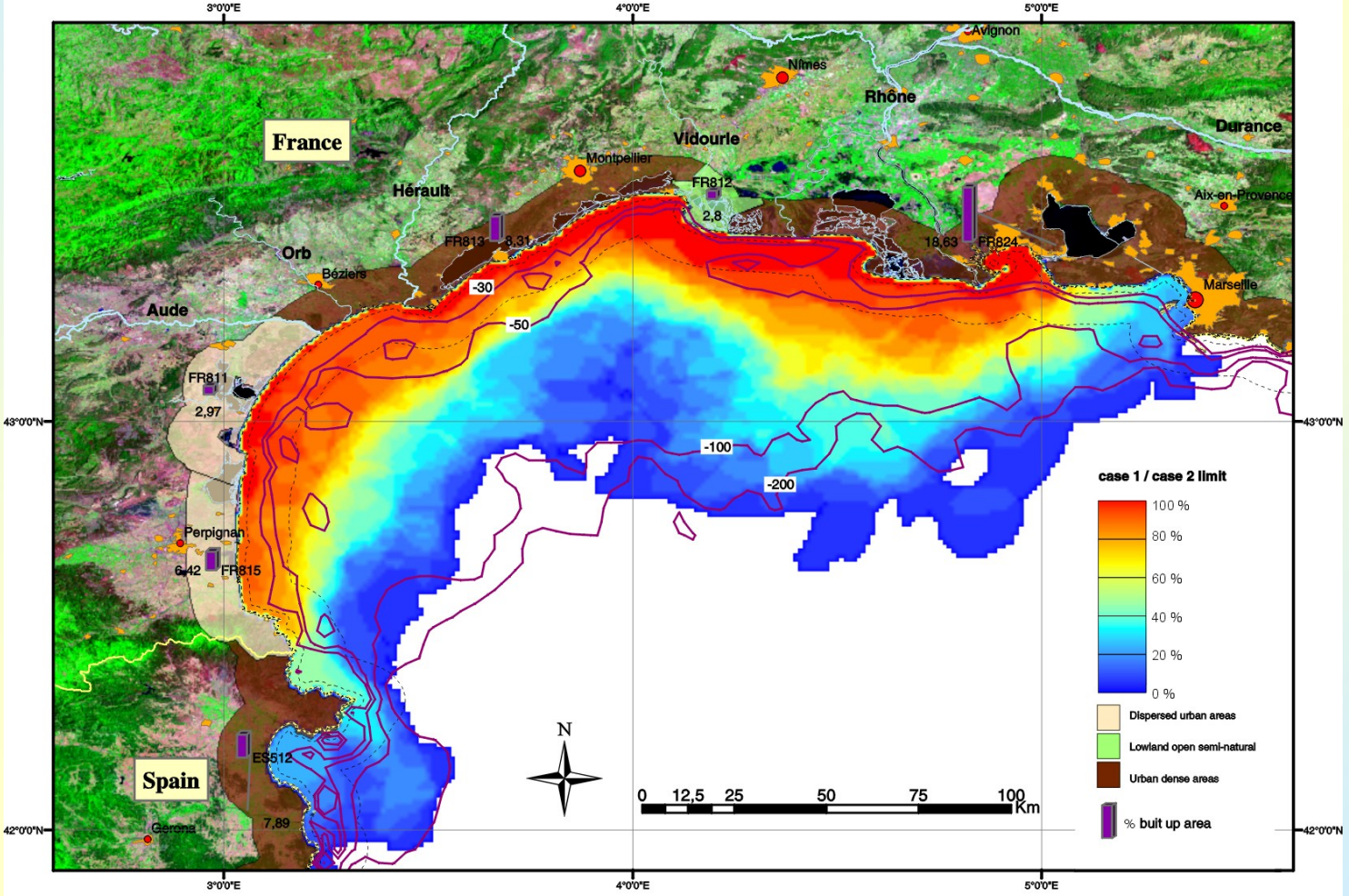



# Coastal indicators (user : EEA)

## Archive slide

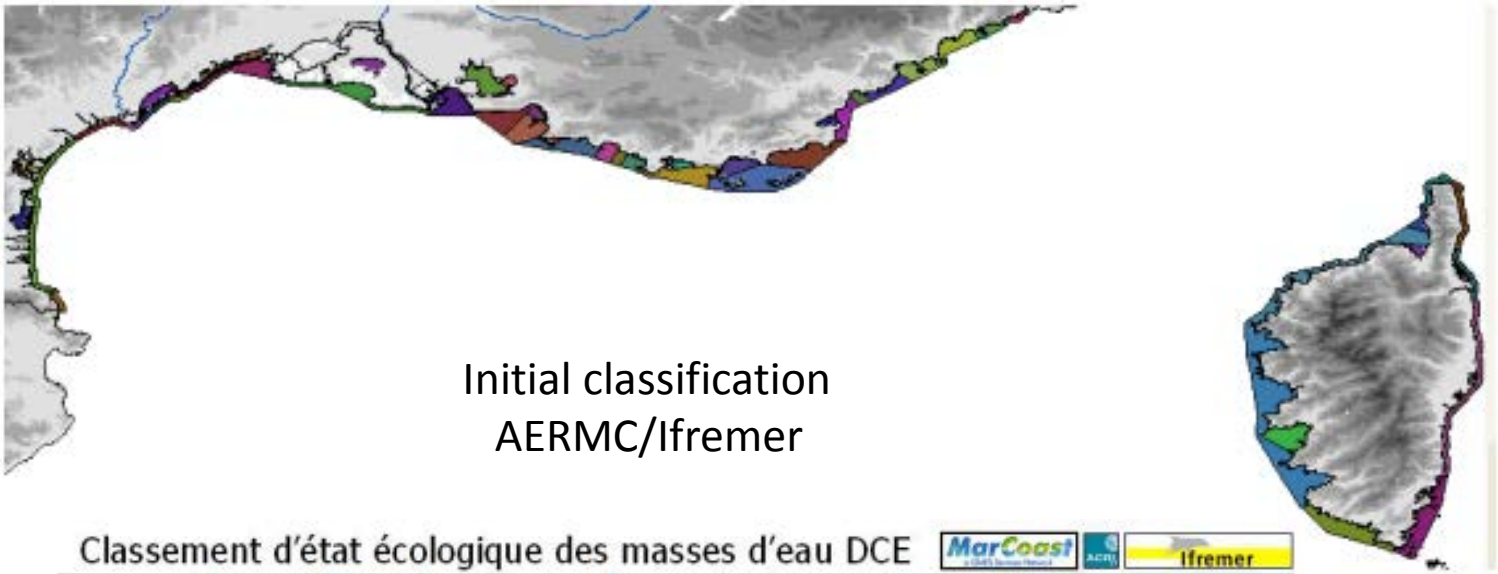
COAST WATCH

## Annual frequency of occurrence of turbid waters in the Gulf of Lions

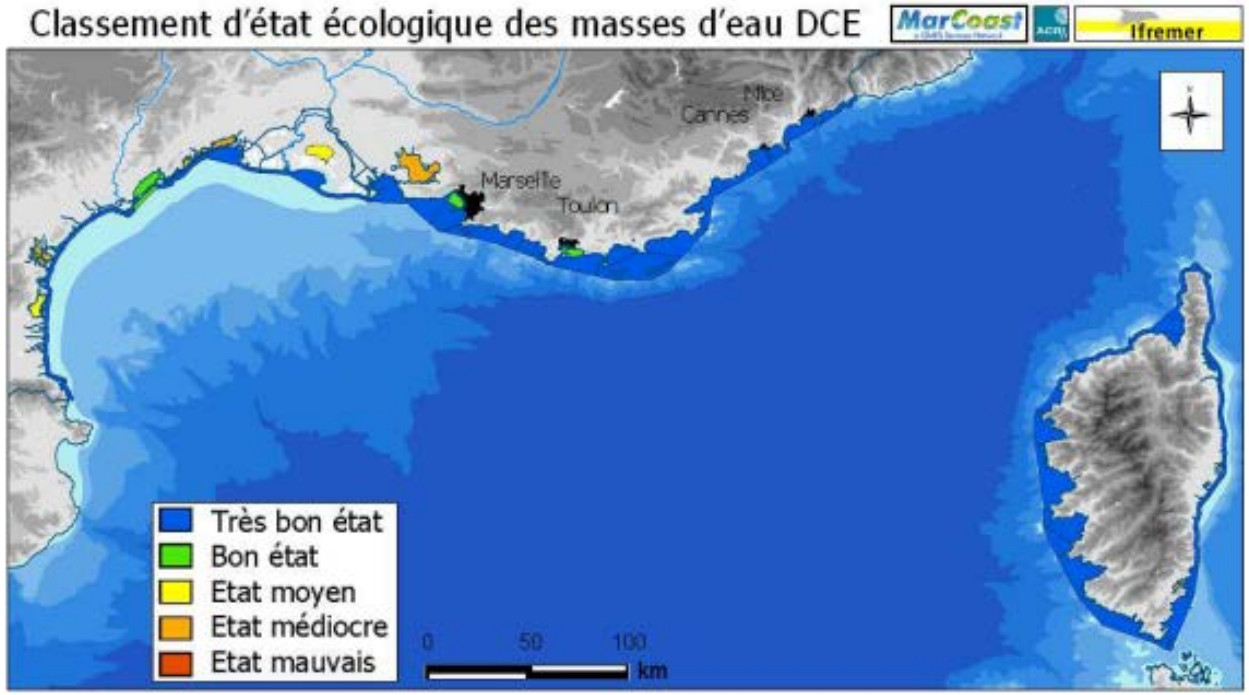



published in the state of environment report 2005

# MERIS contributes to the Water Framework Directive Since 2006

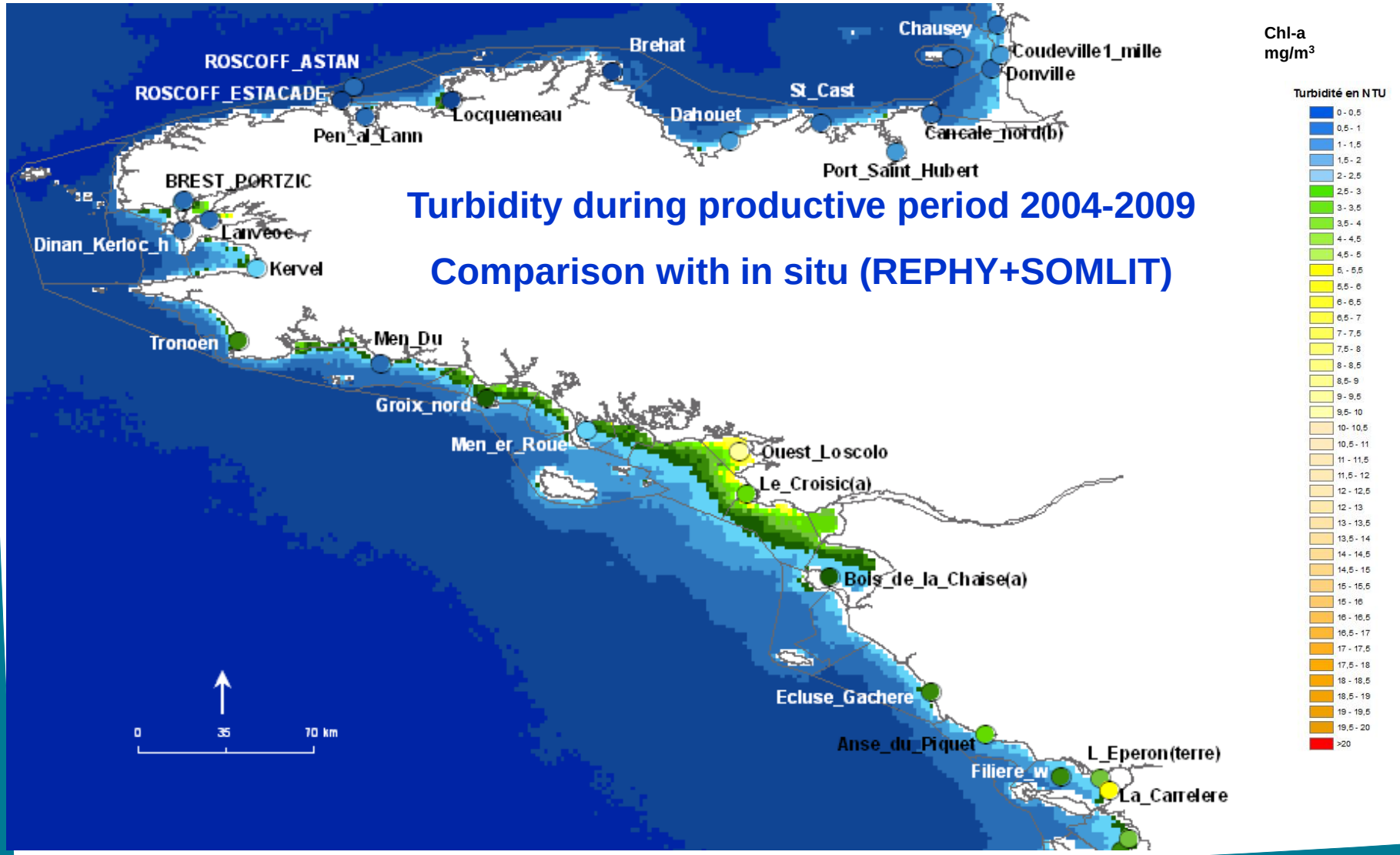


Initial classification
AERMC/Ifremer

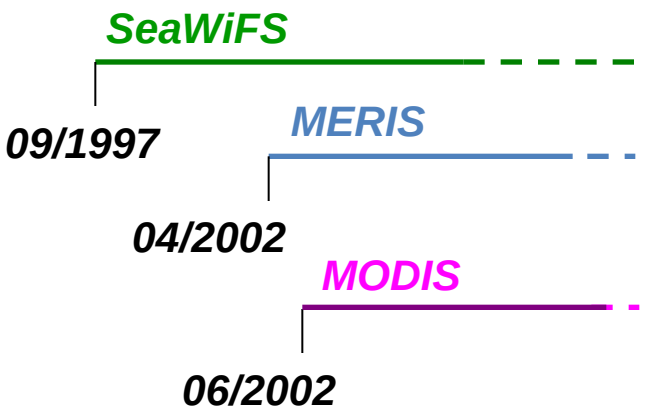



GES classification
obtained from MERIS FR

# Application MSFD/DCSMM : Initial state on continental shelf (from Gohin, 2012)



# The Global expansion 2005
# ESA DUE GlobColour



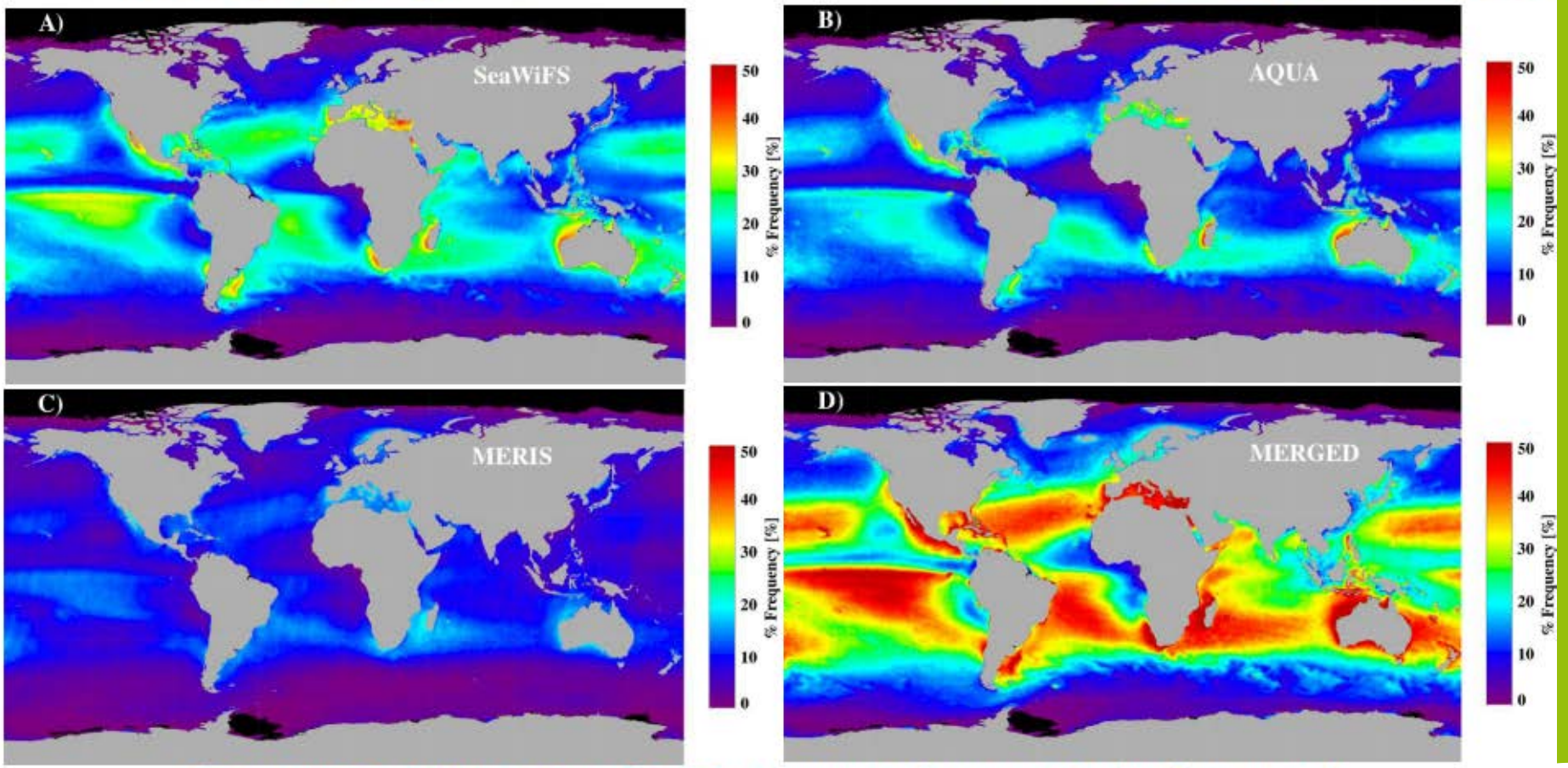

## The GlobColour Products

Merged and individual data set of 3 ocean-colour sensors
SeaWiFS (1997-> 2010), MERIS (2002->), MODIS (2002->)

- 19 official parameters + 4 demonstration parameters
  - Photosynthetic Available Radiation (PAR)
  - Depth of the Heated Layer (ZHL)
  - Secchi Disk Depth (ZSD)
  - Primary Production (PP)
- 4.6 km global maps (FPS)
- 1.0 km and 4.6 km local maps (fixed DDS and user defined ROI)
- Products contain: average value, flags and error estimates
- **More than 956,000 products (4.8 Tb)**

# Frequency

# Benefits



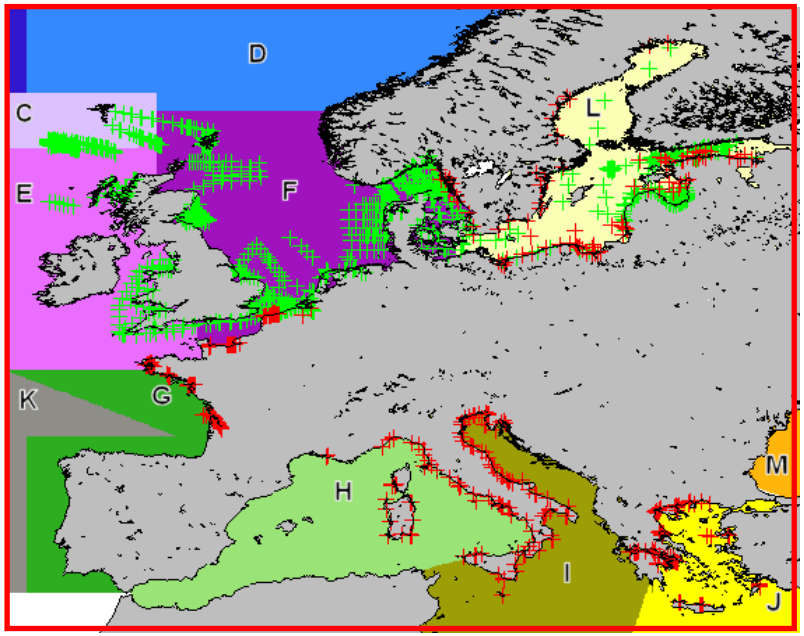

Geographic distribution of the frequency of coverage (in % in days) for the 2002-2009 period for A) SeaWiFS, B) MERIS, C) AQUA and D) when the three sensors are merged.

# MERIS contributes to : 2008

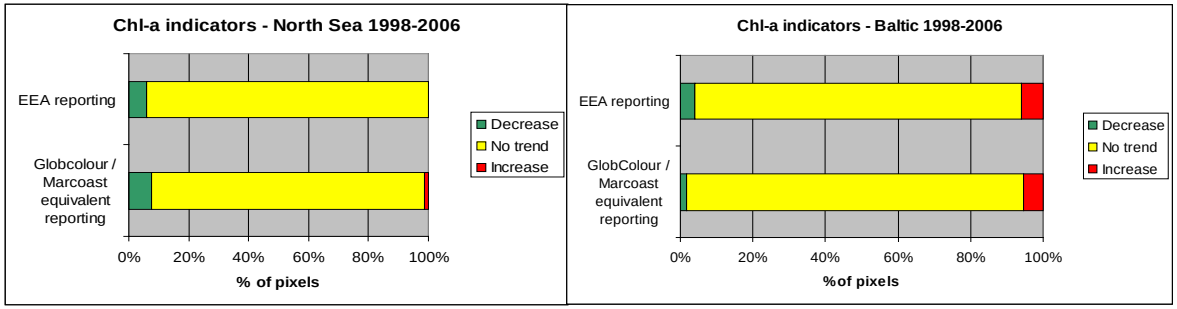
## EEA reporting

Exploitation of *in situ* database (ICES) for application of a non parametric analysis to detect trends of Chlorophyll indicators over each European eco-region

This analysis is part of the mandatory reporting of EEA

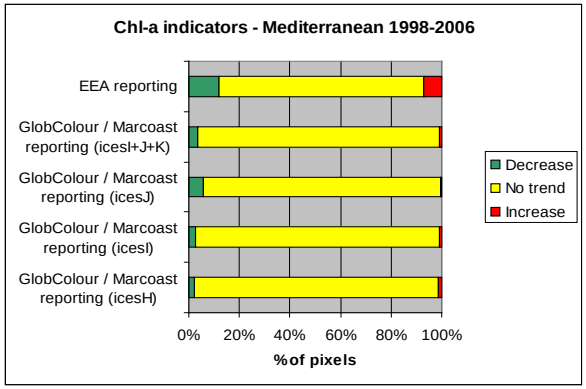



Successfull attempt to derive these indicators directly from ocean color









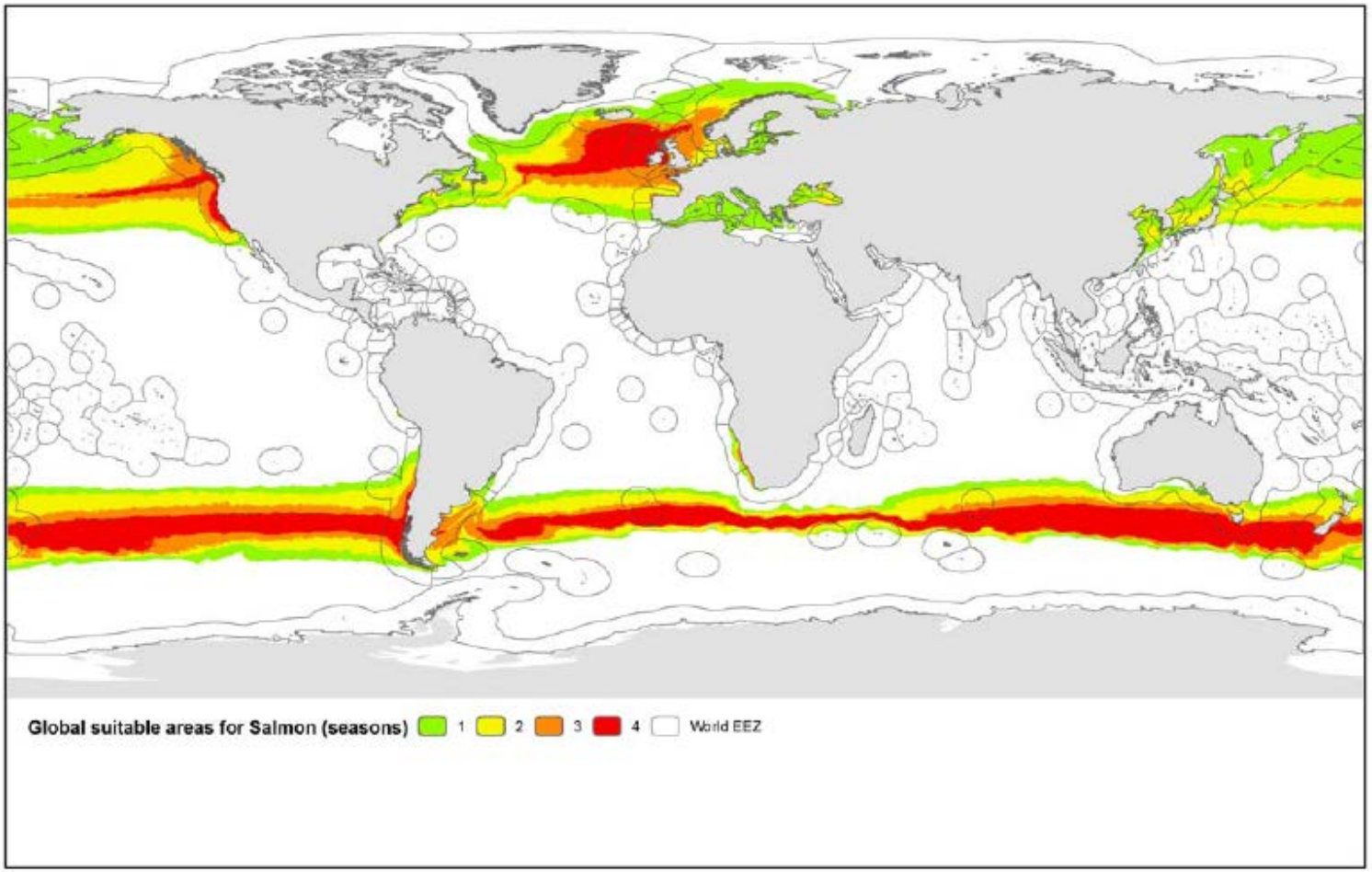

(EUROGOOS Conference 2008)

# Fish resource assessment

2009

Zoning of optimal zones for aquaculture (for FAO)

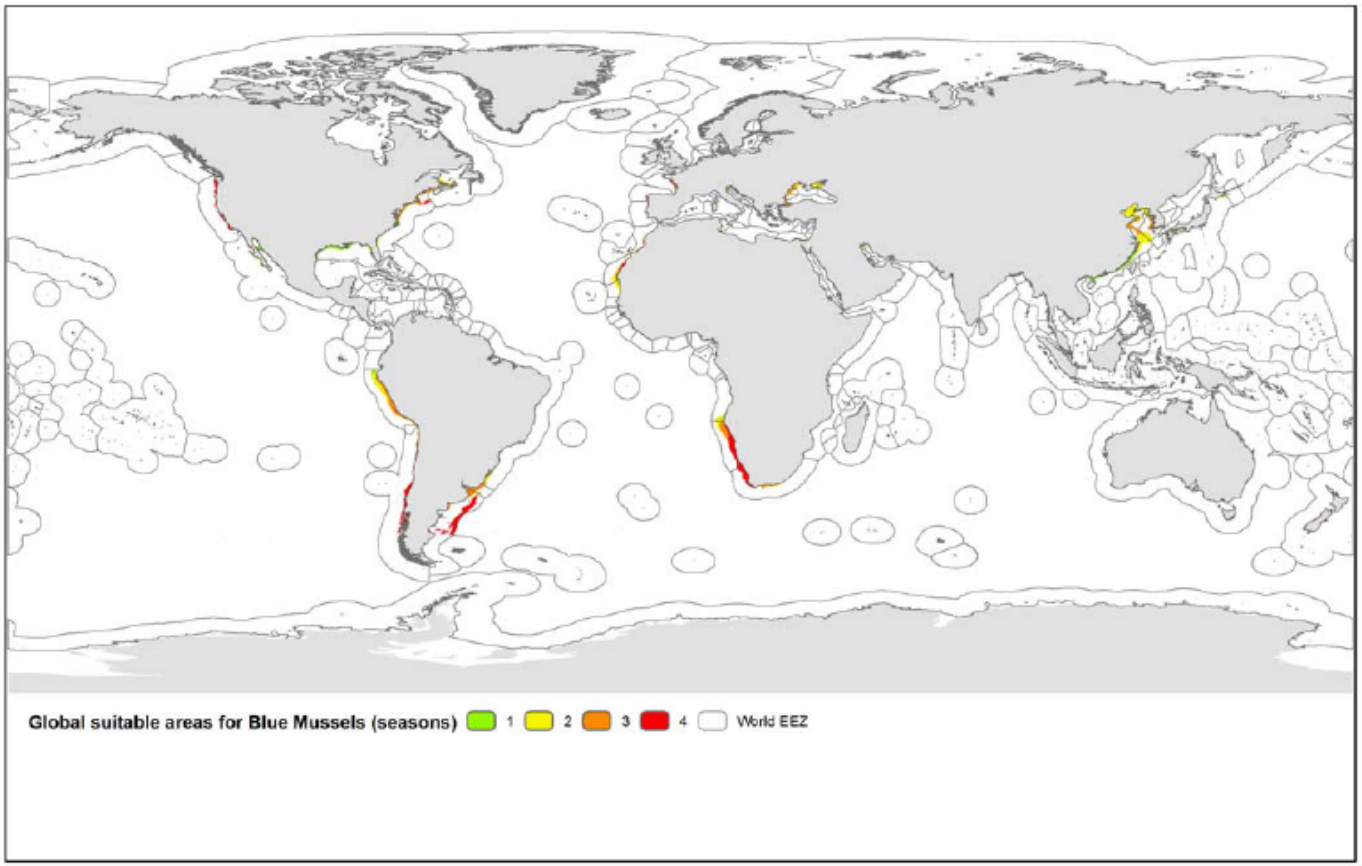
**Figure 5-2. Global area suitable for Atlantic Salmon (*Salmo salar*) based on SST 8 to 16 °C**



# **MERIS** contributes to : 2009

Zoning of optimal zones for some types of aquaculture (for FAO)

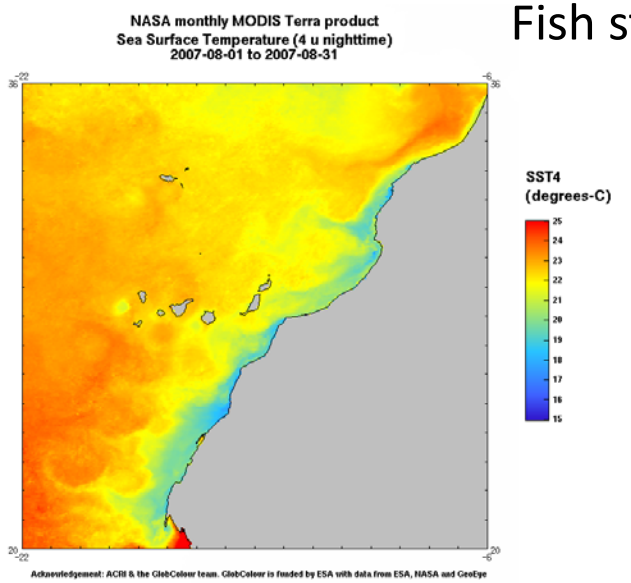
**Figure 5-3. Global area suitable for Blue Mussel (*Mytilus edulis*) based on SST 5 to 20 °C and chlorophyll concentration >1 mg/m$^3$**



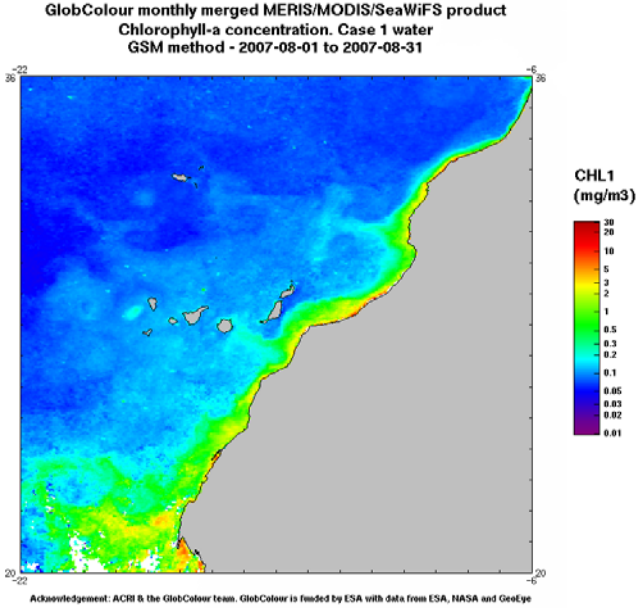
# **MERIS** contributes to :

2010

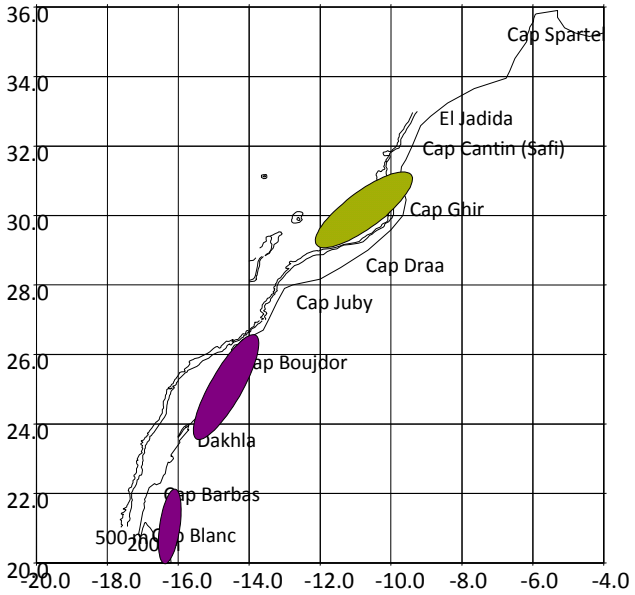
## Fish stocks assessment

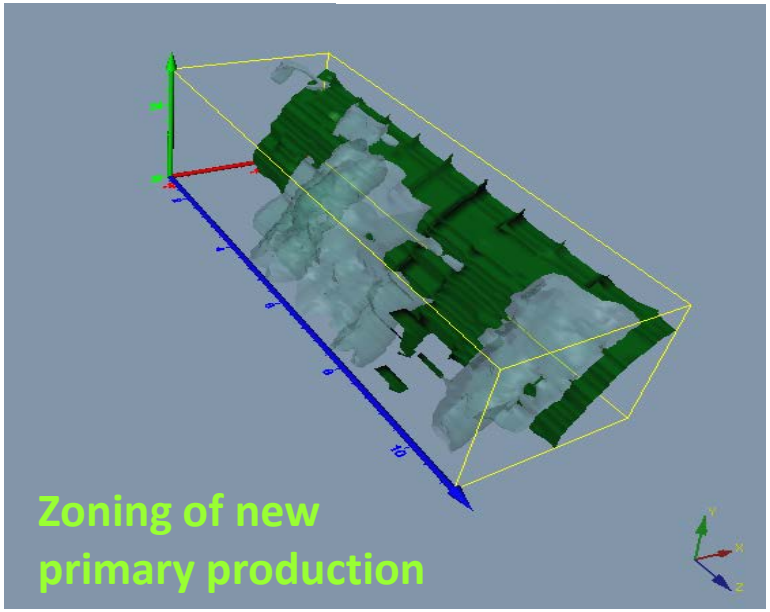



SST and Chla are used to determine New Primary Production and thus, combined with hydrodynamic export due to the upwelling allows assessment of pelagic recruitment

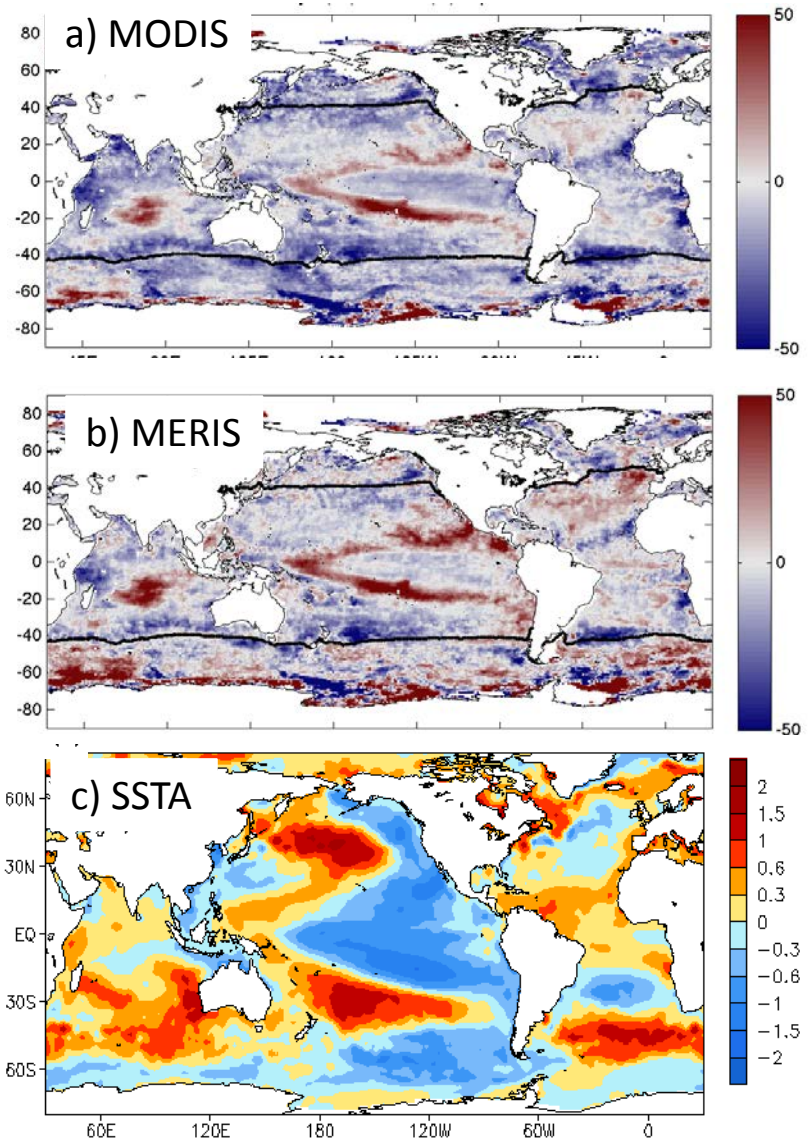



**Main spawning areas**



# MERIS contributes to 2012 State of Climate 2011 Report - Global Ocean Phytoplankton D. Siegel et al, 2012




*Both MODIS and MERIS chlorophyll values in 2011 show differences from the long-term mean that are greater than 40% in many areas.*

*The climate state of 2011 can be characterized by the development of a strong La Nina event during the second half of the year and a strong negative Pacific Decadal Oscillation. In fact, the "wishbone" shaped feature indicative of a La Nina transition can be seen in the log-transformed Chl distribution across the tropical Pacific.*

# One of the success of ESA/ENVISAT/MERIS and CNES User's awareness and interest in OC are growing

2012

MarCoast a GMES Services Network

EO for monitoring of water quality in Europe
65 users

GLOBCOLOUR

Creation of 14-yrs dataset of merged OC data
More than 700 users world-wide

Ocean Colour workshop – GIS COOC - January 2012
90 participants (French)

# Sentinels perspectives

2012






MCGS

## Marine Collaborative Ground Segment
## Segment Sol Collaboratif Maritime de GMES







MCGS

## MCGS set-up

### A sound set-up for contributing to the exploitation and promotion of the Sentinel investment

- First European initiative of a collaborative ground segment
- Partnership of 8 actors in space oceanography covering ocean radiometry, surface topography and surface roughness
- Support by 3 French "Pôles de compétitivité" (regional economic competitiveness clusters)
- Strong implication of the CNES for optimal national structuration and interface with ESA/EUMETSAT


- Strong collaboration with the GMES Space Component to be initiated (data flow, processing functions) in order to be part of the "ESA Collaborative Ground Segment" network

**R&D works to make the most of Sentinels' potential and added-value for economic return**

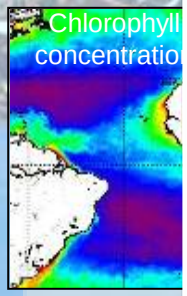
# ENVISAT 10 year MERIS mission

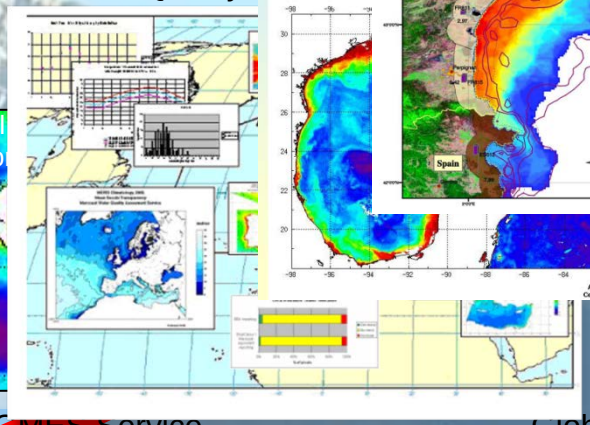
## MERIS products uptake and services development

Sentinel 3

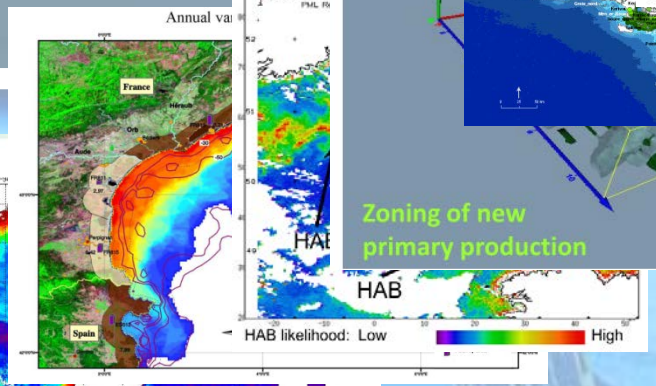
First images

Water Quality S



Environmental



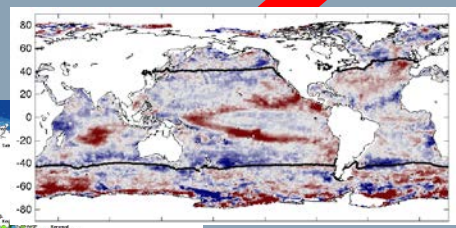







MSFD





Climate studies

MCGS

Bio-profilers

Assimilation of OC

FP7 – R&D parallel projects

Launch

GMES Service Element

GlobColour Marcoast 2

Mar 02

2010

2012

# Sentinels perspectives

2012

MCGS

## MCGS in the GMES framework