



OCEAN MONITORING A CHALLENGE FOR SPACE SYSTEMS

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with contribution from Pierre Bahurel, GIP MERCATOR OCEAN



Few figures to characterize ocean

- 70 % of earth surface
- 96 % of total available water
- 3,8 km depth in average



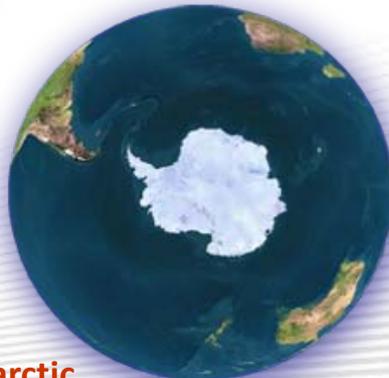
Atlantic



Pacific



Arctic



Antarctic



Indian

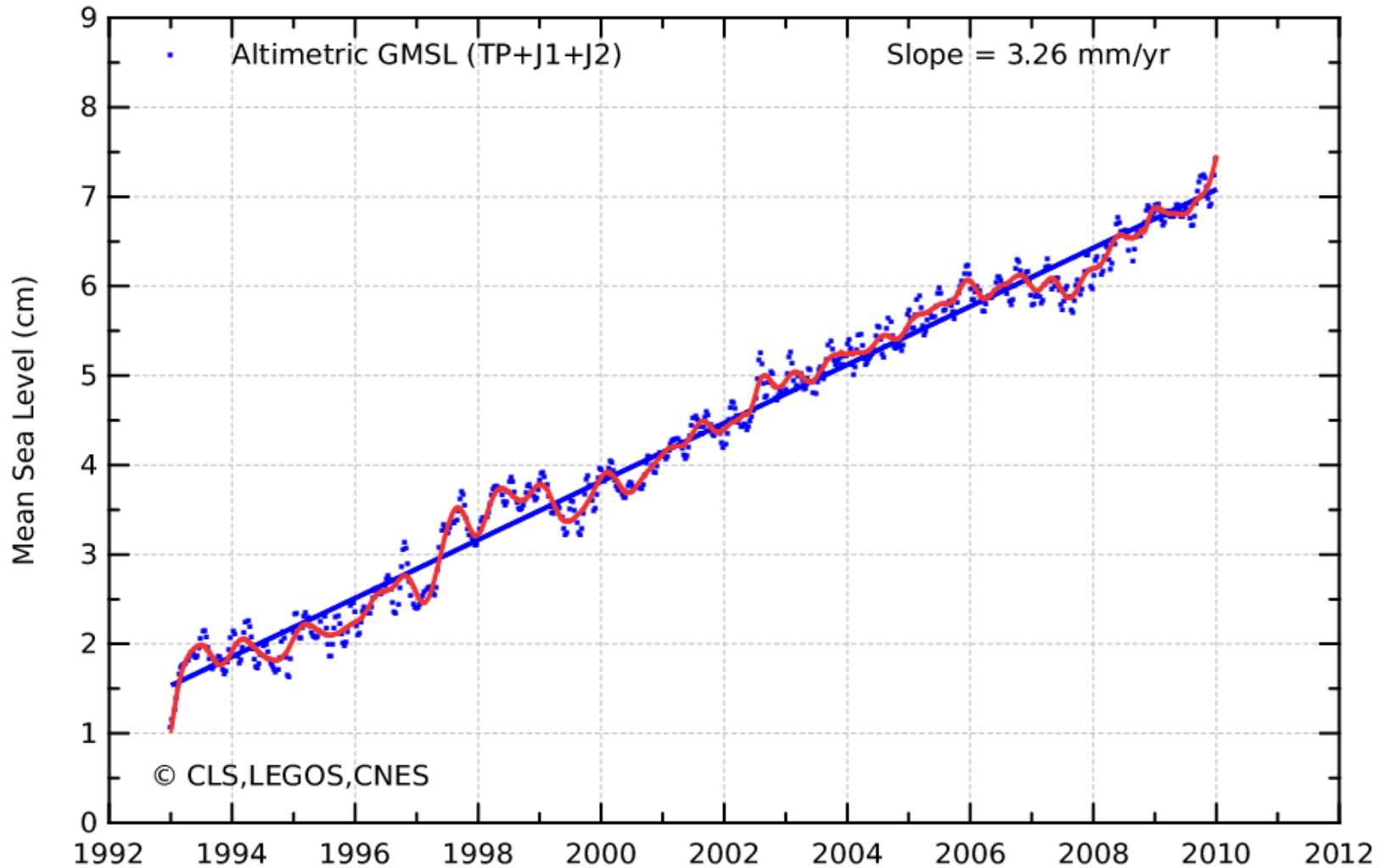
■ Climate regulation role:

- ◆ Heat storage and transport
- ◆ Contribution to CO₂ storage
- ◆ Slower dynamic than atmosphere

- 300 times heavier than atmosphere
- 3 first meters store the same amount of heat than all the atmosphere

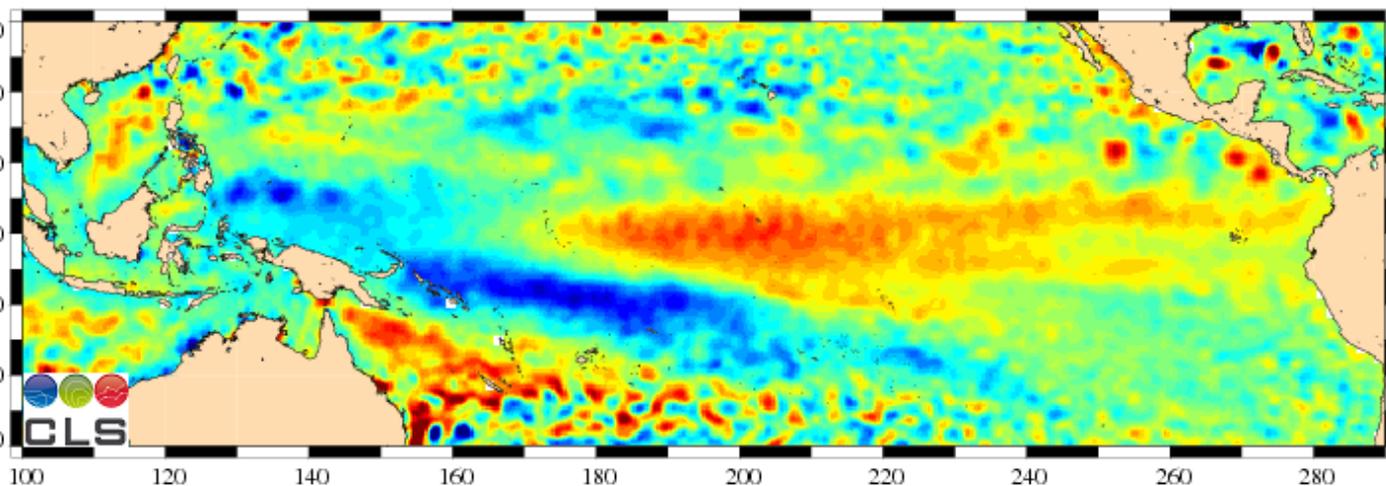
Climate monitoring : secular effects

Mean sea level rise

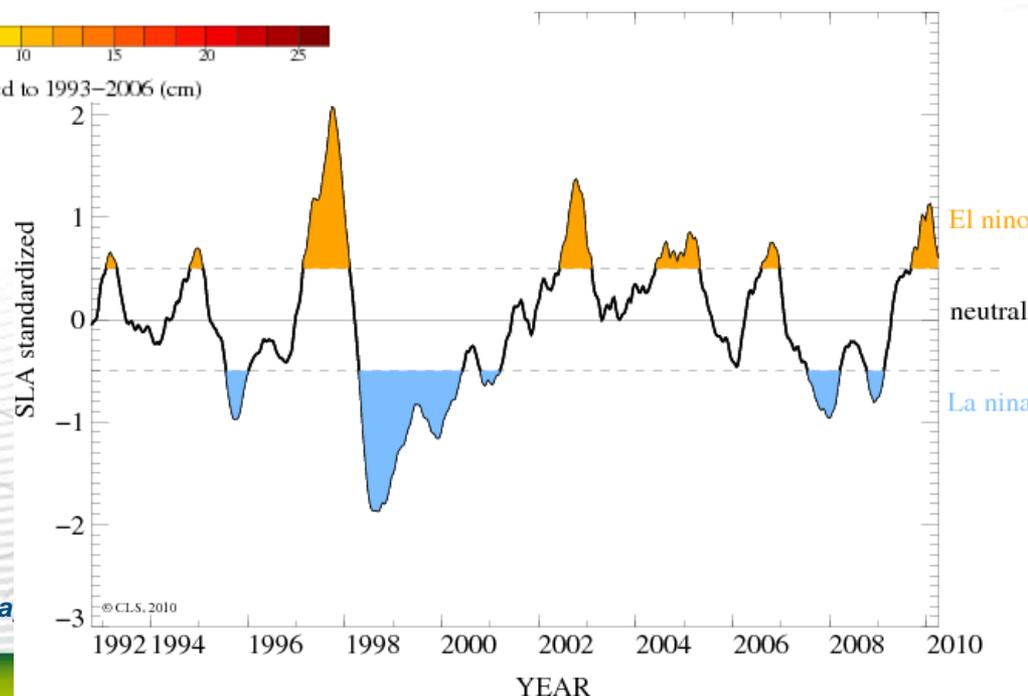


Climate monitoring : interannual effects

February 2010 **El Niño**

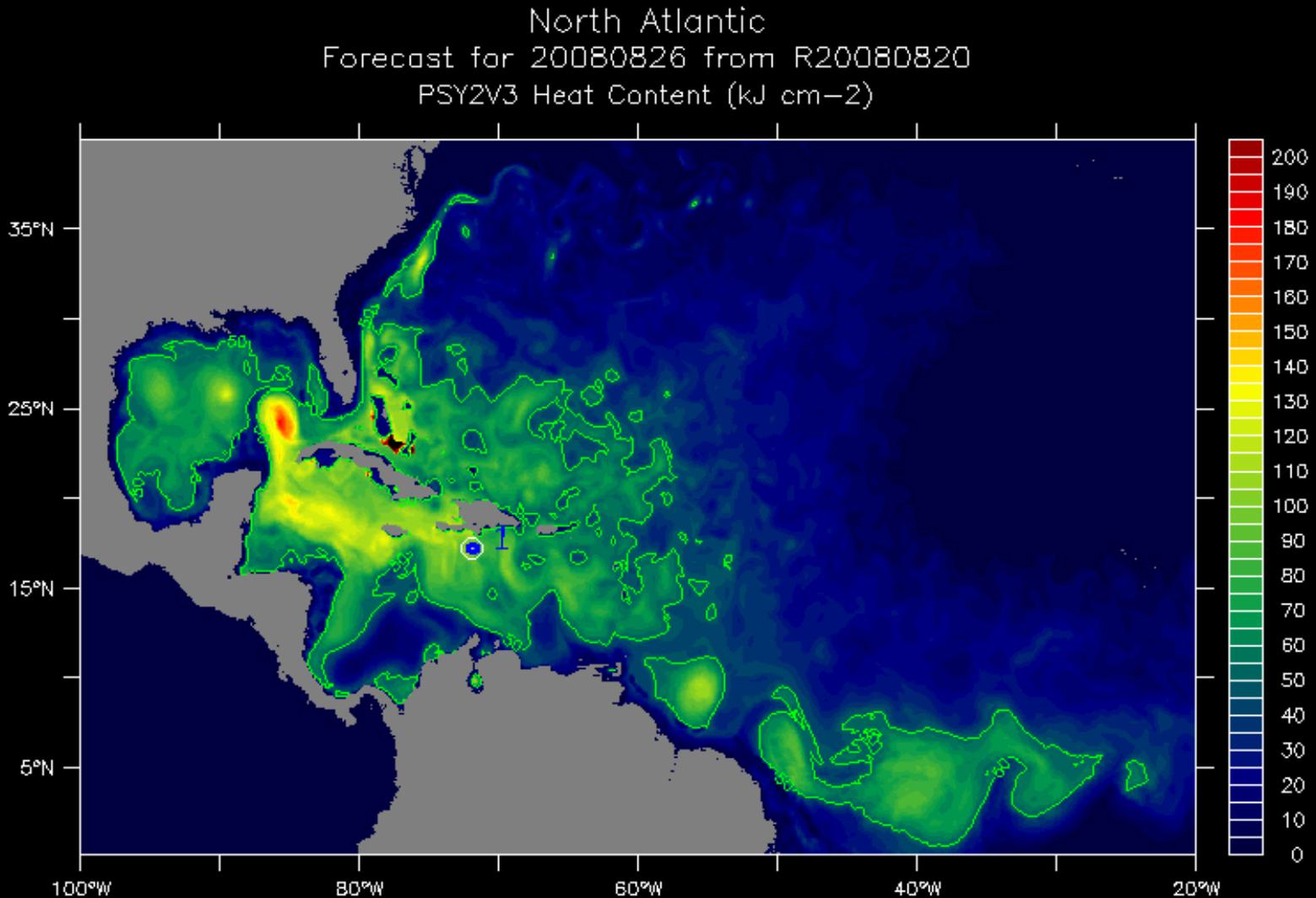


SLA monthly mean (seasonal cycle removed) referenced to 1993–2006 (cm)



Climate monitoring : extreme events

Ocean total Heat content

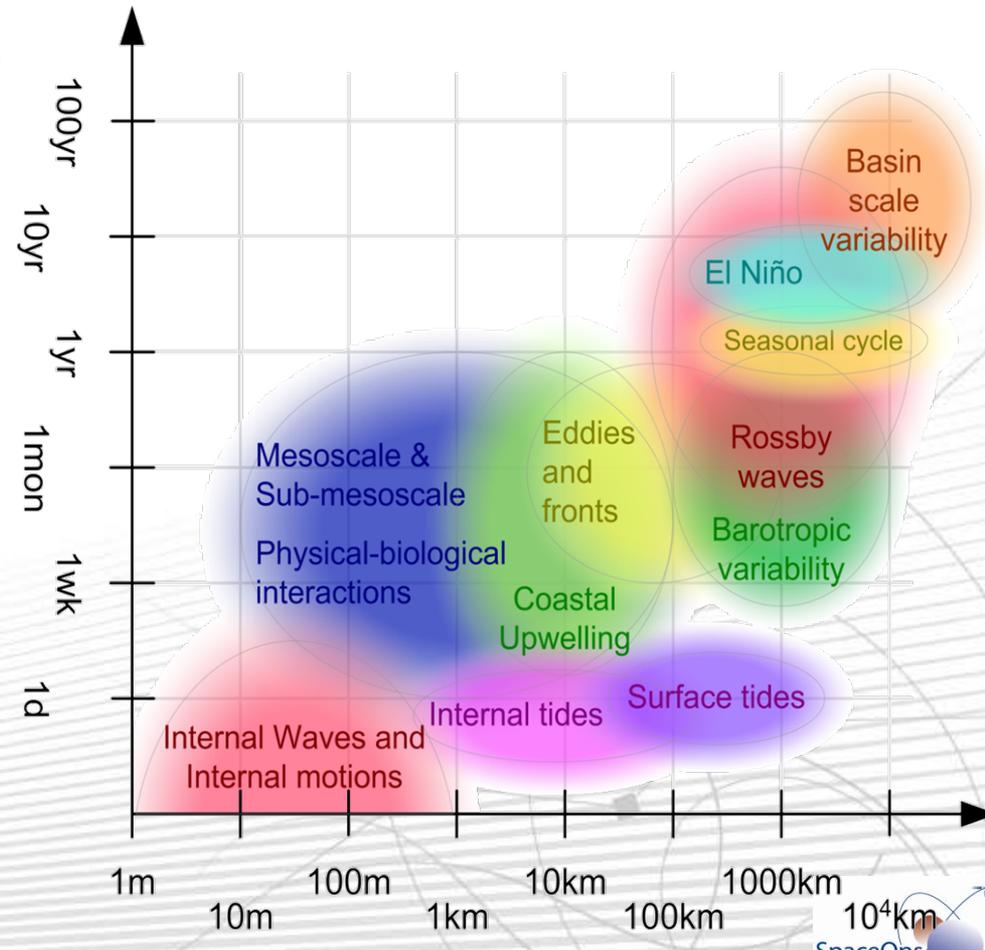


GUSTAV (from 26th Aug to 1st Sep 2008)
From GIP Mercator Ocean

TAV

- Remote area, difficult access,
- Multiple scales of ocean dynamics,
- “Opacity” of ocean surface,
- Key components :
 - Direct space measurements
 - Global coverage
 - Consistency
 - In Situ measurements
 - 3D information
 - Calval

Data collect through space
 - Models
 - Global 3D analysis
 - Forecast

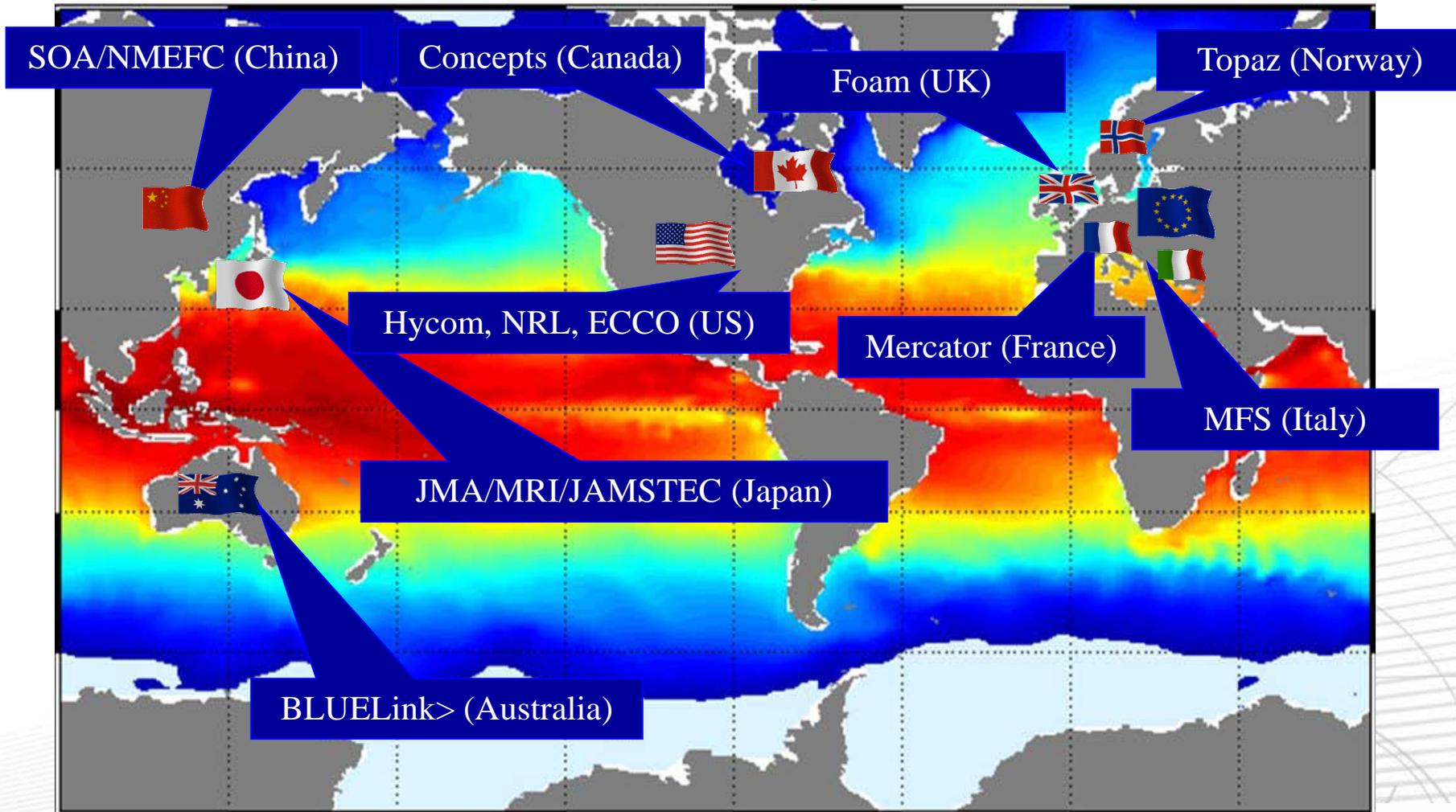


Multi-sensors, Multi-Agencies :

- Surface Topography : ocean circulation :
TOPEX/POSEIDON, ERS, GFO, ENVISAT, JASON-1, JASON-2
CRYOSAT-2, HY-2, JASON-3, GFO2, SWOT, SENTINEL-3
- Surface winds :
ERS, WINDSAT, SEAWINDS/ADEOS-2
METOP-1, OVWM, OCEANSAT-2, NPOESS...
- Sea Surface Temperature :
ERS, (ADEOS 1), ADEOS-2, ENVISAT
Meteorological Satellites
- Significant wave Heights and wave spectra :
ERS, ENVISAT, RADARSAT (-1, -2, -3)
TerraSAR (-L), Cosmo, CFOSAT,
- Ocean Surface Color:
SeaWIFS, MODIS, ADEOS-2, ENVISAT, OCEANSAT, HY-1
NPOESS
- Geoid :
CHAMP, GRACE, GOCE
- Salinity:
SMOS, SMAP ...
- + **Data Collect System**
ARGOS, Iridium,...

Ocean Monitoring and Forecasting

Global International Cooperation : GODAE



The GODAE Ocean View program: see <http://www.godae.org>

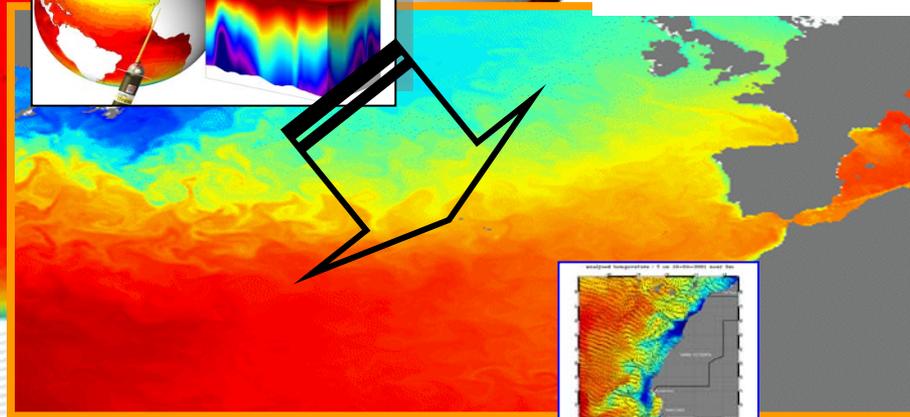
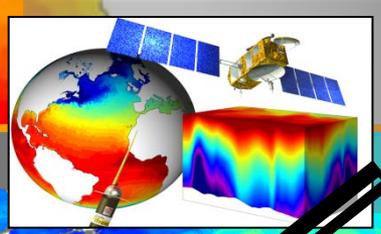
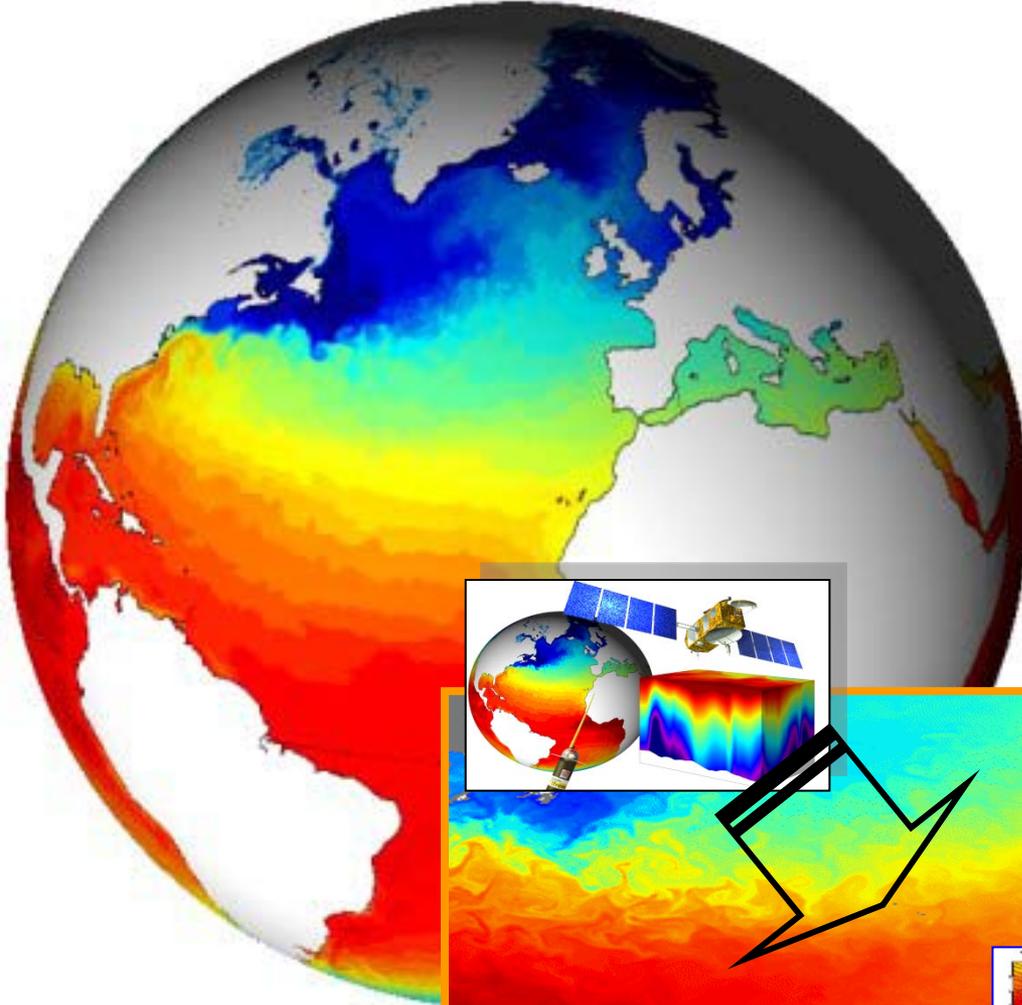
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Marine Core Service in Europe, EU GMES initiative (Global Monitoring for Environment and Security)

The MyOcean offer : A core information on the ocean

- Physical state of the ocean, primary ecosystem
- Global ocean, and main European basins and seas
- Large and basin scale, mesoscale physics
- Hindcast, Nowcast, Forecast
- Data, Assimilation and Models

Information
and Quality
Assessment



The 4 areas of benefit driving the MyOcean service definition



- The users, their requirements, their assessment

Area 1

« MARINE SAFETY »

(marine operations,
oil spill drift, ship routing,
defense, search & rescue, ...)



Area 3

« MARINE AND COASTAL ENVIRONMENT »

(water quality, pollution,
coastal activities, ...)



Area 2

« MARINE RESSOURCES »

(fish stock management,
ICES, FAO, ...)



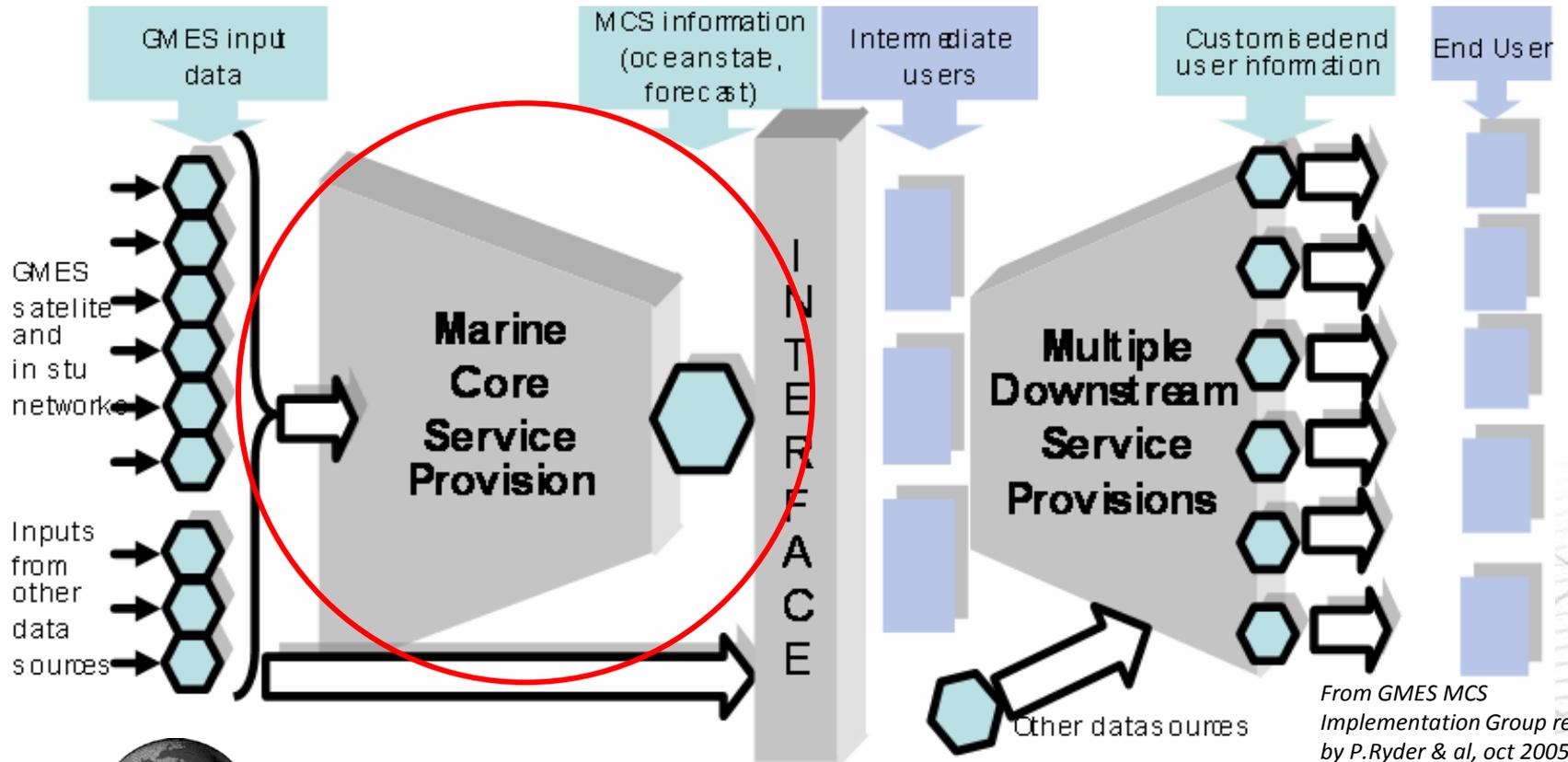
Area 4

« CLIMATE & SEASONAL FORECASTING »

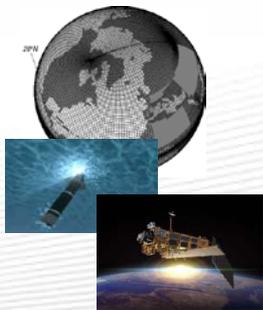
(climate monitoring, IPY,
seasonal forecasting, ..)



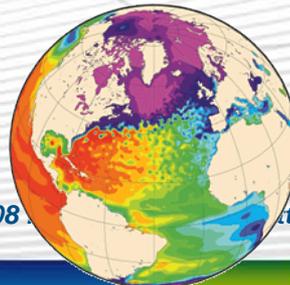
MyOcean : Marine Core Service in Europe



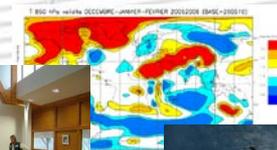
From GMES MCS Implementation Group report by P. Ryder & al, oct 2005



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Ocean Monitoring Operations in Europe



- **500 000**

observations per day, coming from satellites and in situ, entering the MyOcean systems

- **700 000**

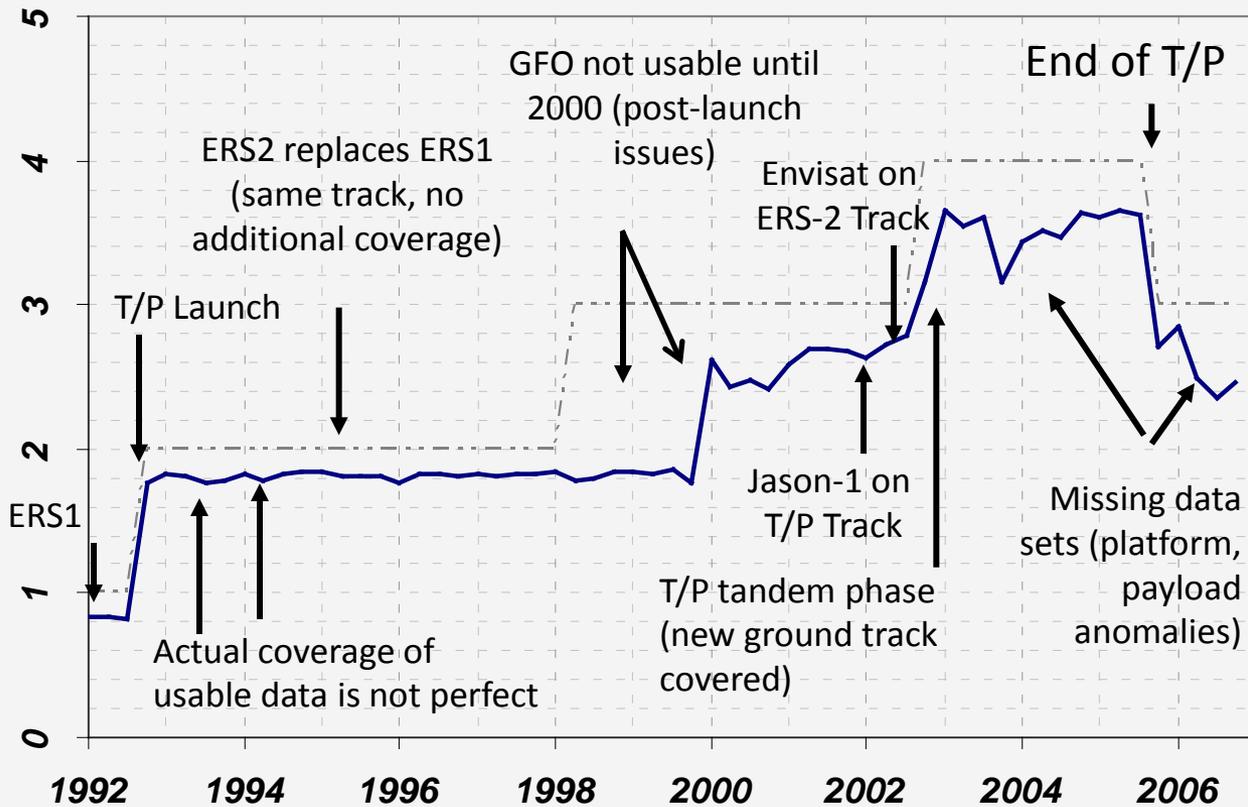
BILLIONS of operations per day on supercomputing facilities to run data assimilative models

- **500** Gb of new real-time products per MyOcean bulletin, a growing number of products

and services but **1** service desk, single access point to the ocean, open and free



- **350** persons throughout **29** countries



Downstream requirement for ocean mesoscale monitoring

- 1 sat available :
Insufficient for meso-scale monitoring
- 2 sats available :
Minimum for off-line meso-scale monitoring
- 3 sats available :
Robust for off-line meso-scale monitoring
- 4 sats available :
Robust for real time mesoscale applications

Altimetry example : Number of satellites available for downstream applications since 1992 (monthly averaged)

Key Issues for Space Operations to support ocean climate monitoring

- Data Continuity
 - Long term monitoring with adequate space and time sampling
 - Past missions have demonstrated the importance of interannual variability
- CalVal
 - Initial Calval to measure system biases wrt previous mission and ensure data continuity between missions
 - Continuous Calval to monitor system drifts
 - Information on mission events to explain discontinuities
- Long term archive and data reprocessing
 - Continuous progress on data processing algorithms
 - Availability of improved auxiliary data sets
 - Reanalysis of past data key element of climate models initialization and tuning