



Ocean currents from altimetry

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Introduction

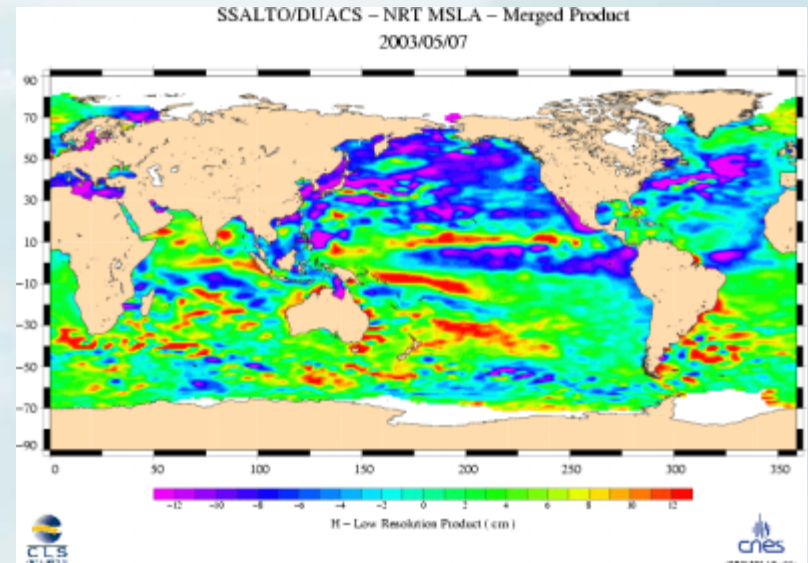
- Today:
 - information mainly comes from **in situ measurements**
 - **ocean observing satellites** are entering a new **operational era** and naturally occupy a major place in programs designed to **manage and predict ocean**
- Objectives of the presentation:
 - **overview** of CLS satellite data processing centres
 - **examples** of different products
 - **applications** and users



Maps of Sea Level Anomalies

- DUACS

- 3-year European project started in 1997
- demonstrates that altimeter data can be processed in near real time with sufficient accuracy to improve the skill of climate simulation

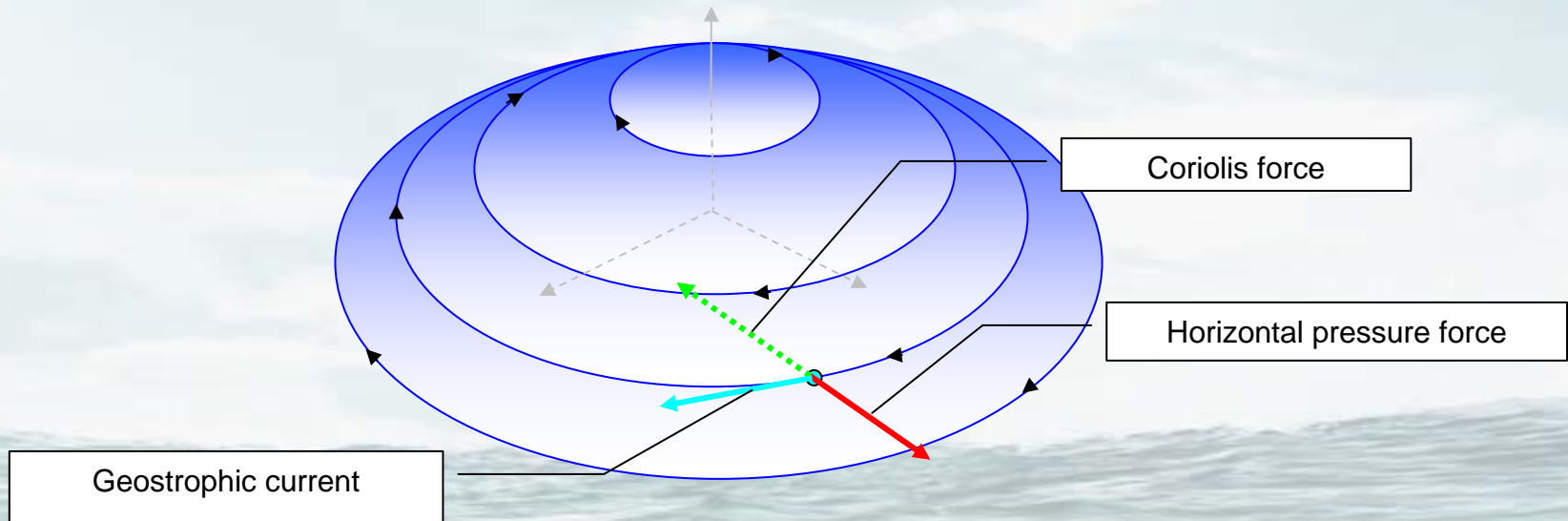


- Today, SSALTO/DUACS (CLS/CNES) is now in operational mode:

- combines merged measurements from the different operational missions (JASON, GFO and ERS-2)
- produces global maps of Sea Level Anomalies (SLA) in near real time (NRT)
- coverage is global in space and time (altimetry data are not affected by clouds)
- resolution is at the eddy scale

Ocean currents from maps of SLA

- Main long wavelength ocean currents are **geostrophic currents**:
 - **Coriolis force** balanced by **gradient of the horizontal pressure force** due to the slope of the sea surface (geostrophic equilibrium)
 - always perpendicular to the pressure gradient
- **Currents are deduced from the maps of SLA**
- Generation of geostrophic currents on an oceanic peak in the northern hemisphere



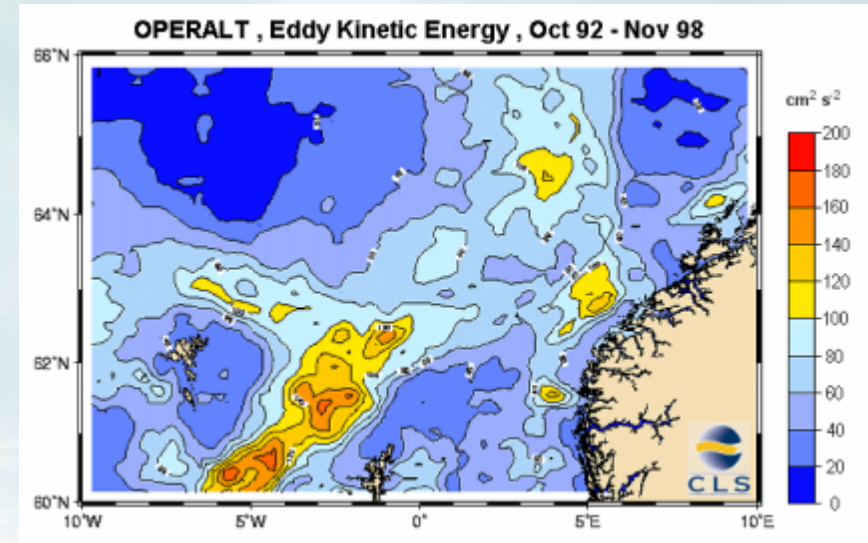
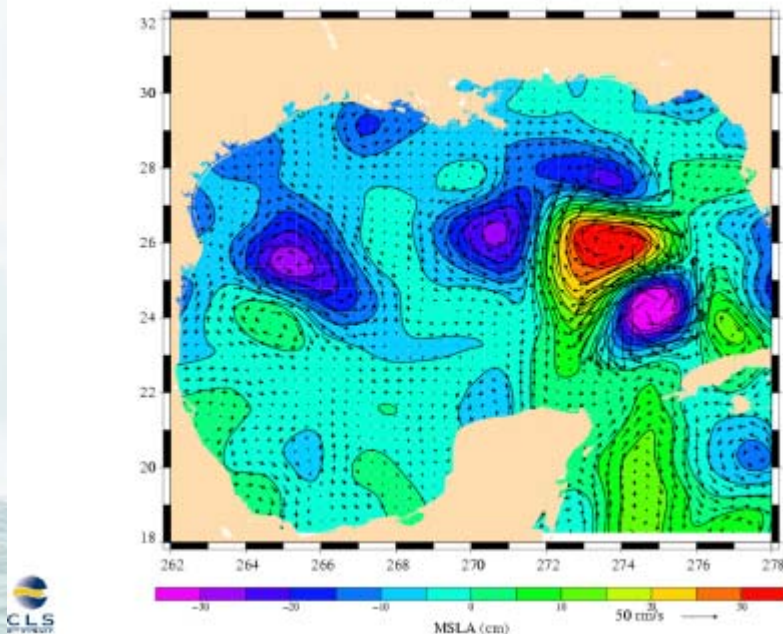
Operational modes of the DUACS products

- Near Real Time products (nowcast)
 - gridded products ($1/3^\circ$ Mercator projection)
 - global coverage at the eddy scale
 - updated twice a week with a time delay of 48 to 72h
 - used in operational oceanography systems
 - derived products such as current maps
- Historical products (hindcast)
 - gridded products ($1/3^\circ$ Mercator projection)
 - global coverage at the eddy scale
 - more than 10 years from now
 - available with a ~2 months delay
 - statistical view of the ocean features over the past
 - derived products such as ocean variability

Derived statistical products from altimeter data

- 7-day average map
 - SLA and geostrophic currents from Jason-1, GFO and ERS-2
 - synoptic view of ocean features
 - eddy scale represented

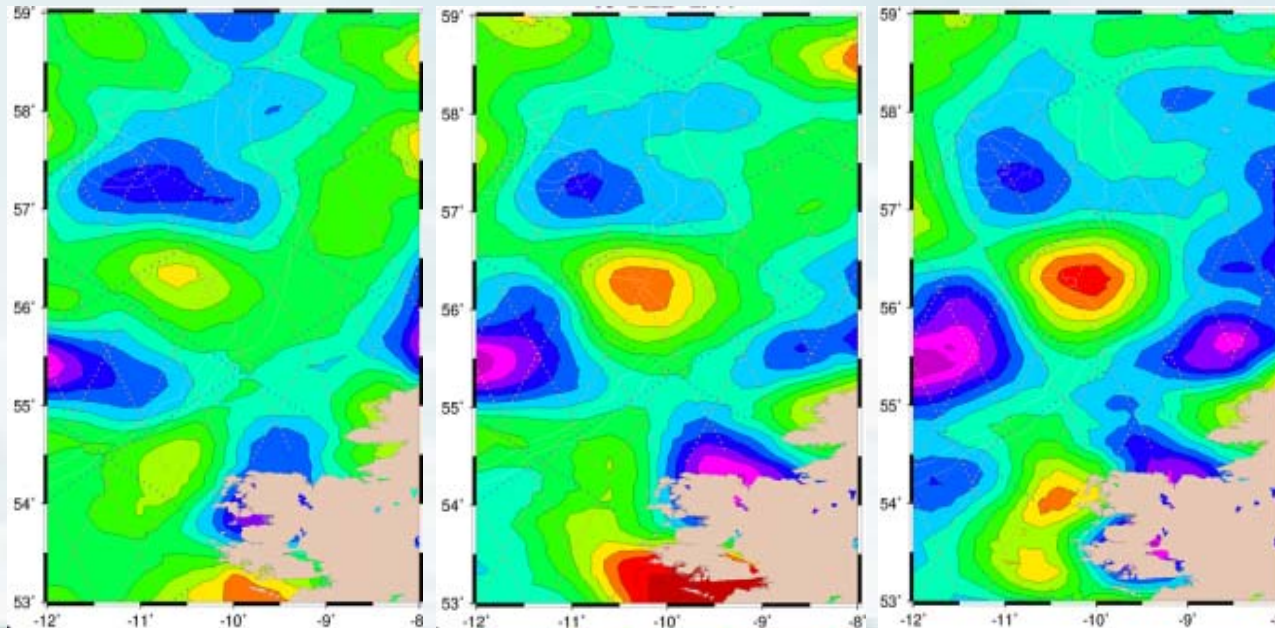
Mean Sea Level Anomalies and Geostrophic Velocities from DUACS (TP+ERS+GFO)
26-Feb-2003 (CNES day 19414)



- Eddy kinetic energy map
 - $EKE = 1/2 (\langle u^2 \rangle + \langle v^2 \rangle)$
 - on average over 6 years
 - to highlight the areas of strong currents over a period of time
 - also available for each season

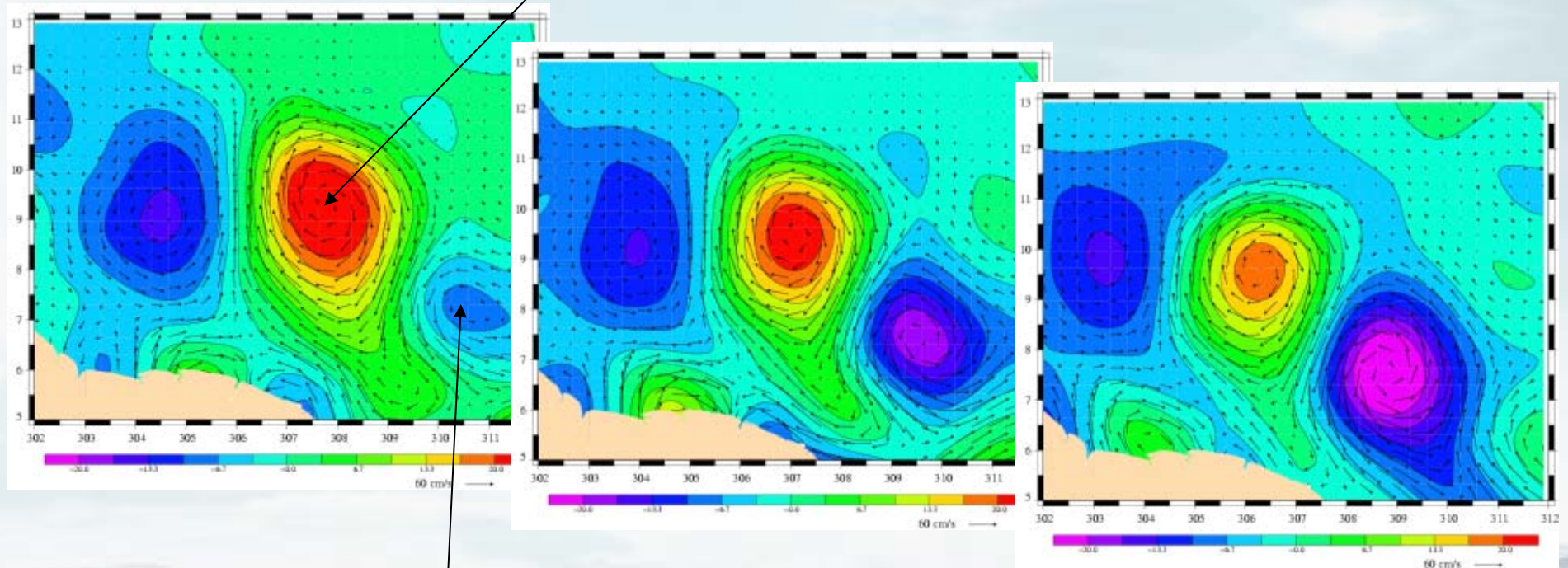
Eddy monitoring in the West of Ireland

- NRT monitoring of eddies:
 - to follow the trajectory of very energetic eddies
 - provide resolution which cannot be covered by moorings (high spatial density and time continuity)
- Specific study



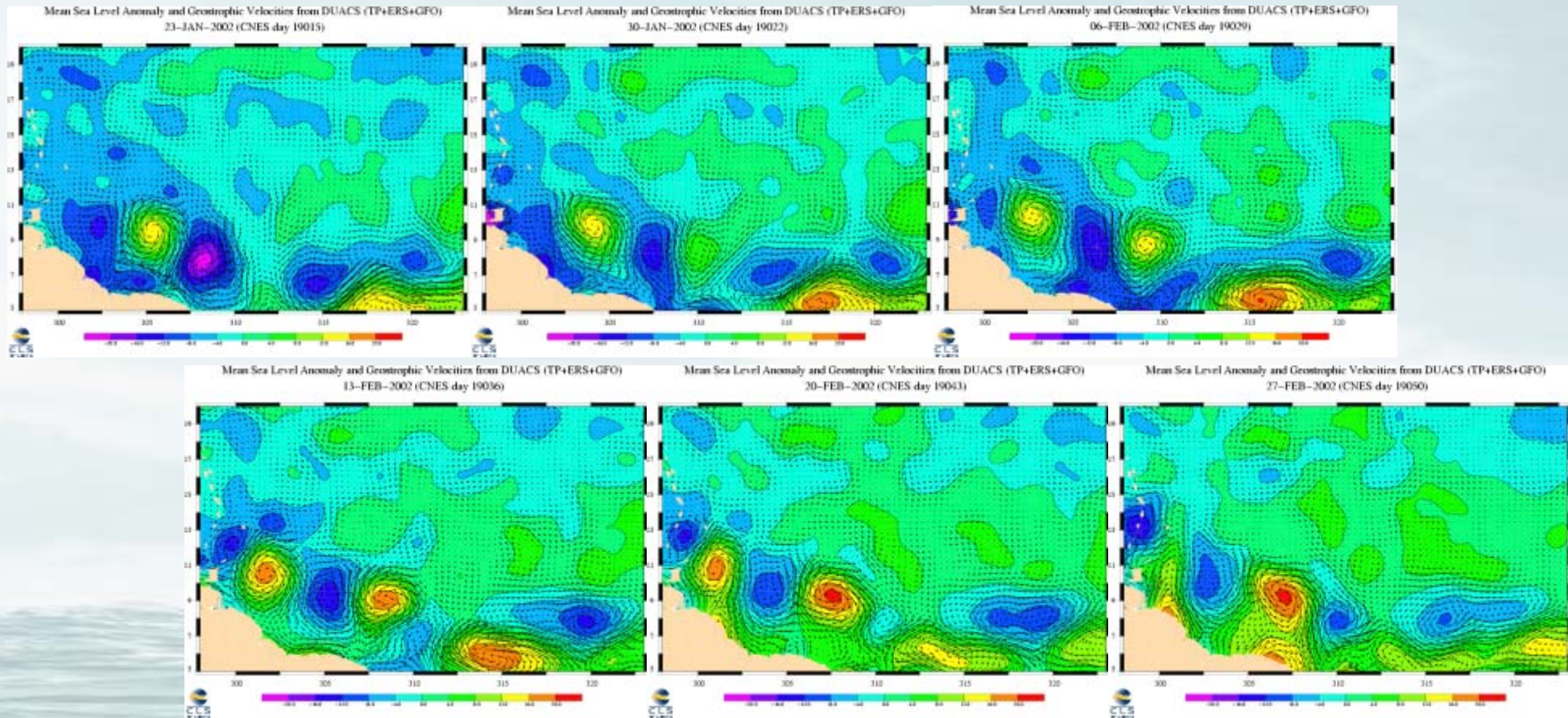
Eddy monitoring along the Venezuelan coast (Trinidad region)

- NRT monitoring of eddies
- A map each week



Real-time monitoring of North Brazil Current Rings

- Eddies visible with a map each 7 days
- Propagation westward

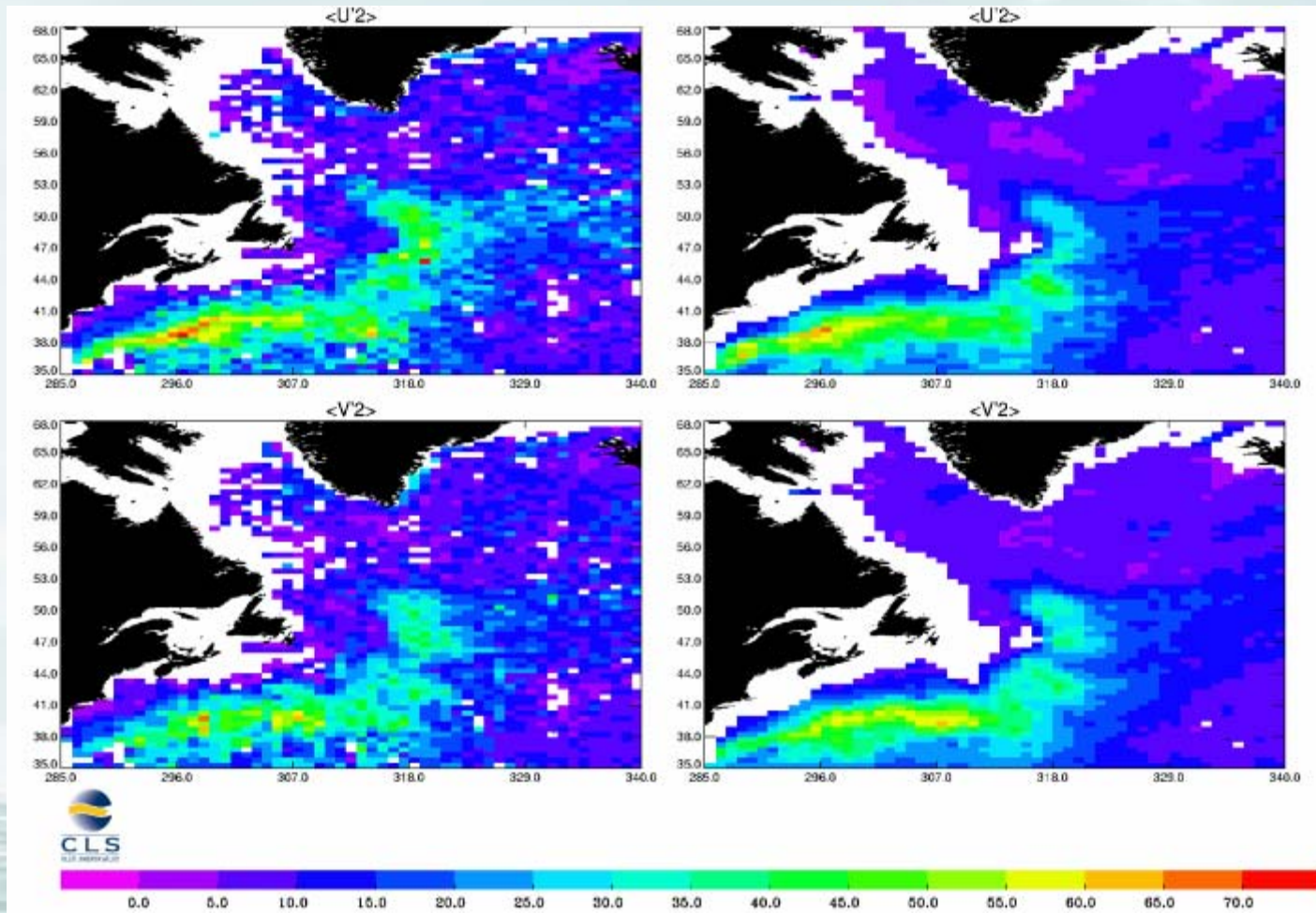


T/P + ERS mapping capabilities

- Comparisons studies made :
 - with maps generated with only two satellites
 - with in situ data and numerical models
- Computation of errors with “instantaneous” data:
 - SLA can be mapped with an accuracy of 5 to 10% of the signal variance
 - Ocean currents can be mapped with an accuracy of 20 to 30 % of the signal variance
- But a large part of the mapping errors is due to high frequency (<20 days): tides, atmospheric effects...
- Errors on 10-day averages data are much smaller (~twice smaller)

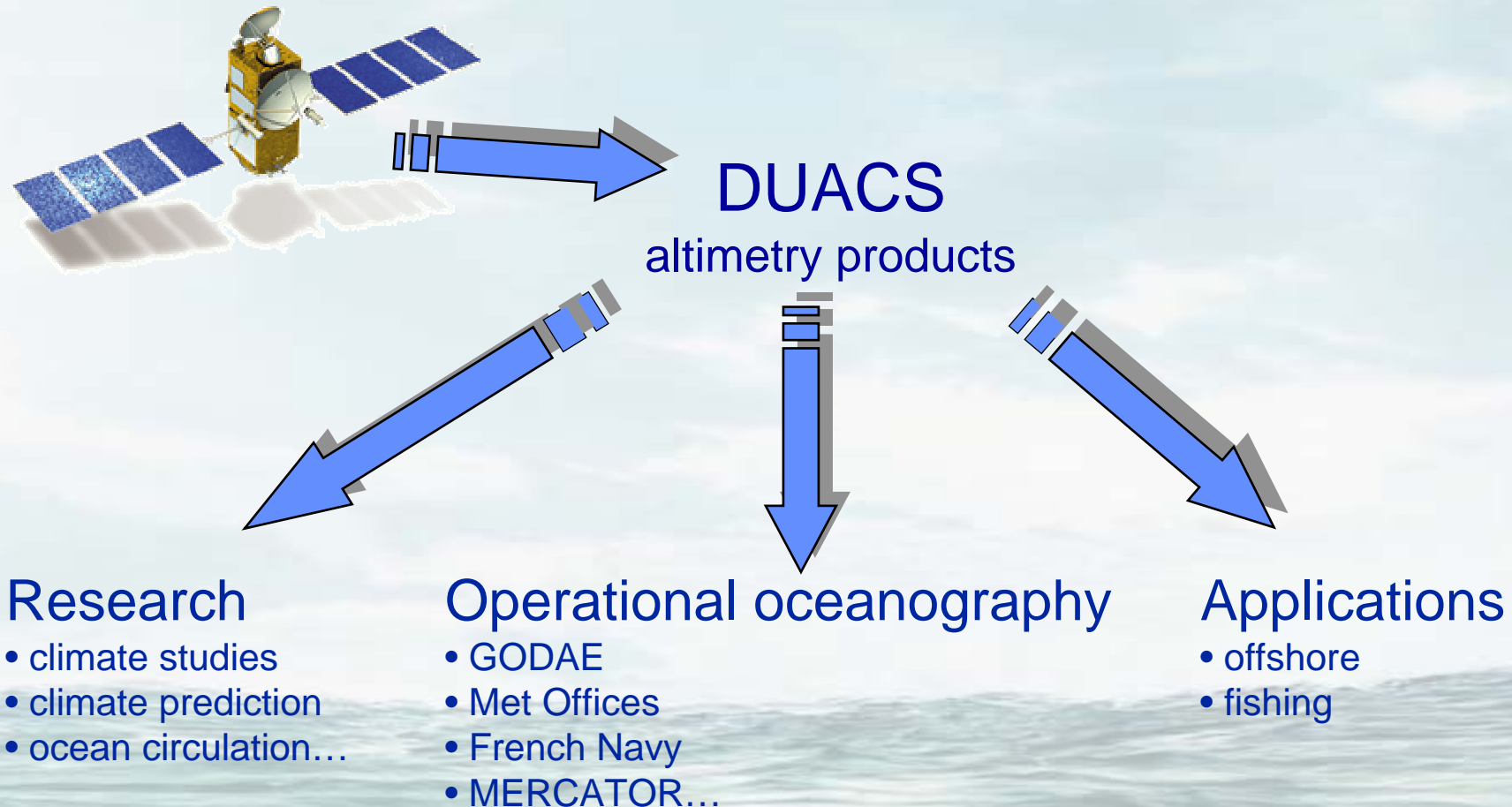
Reliability of ocean currents from maps of SLA

- RMS of velocity from drifters (left) and T/P+ERS (right) (Ducet et al., 2000)



Use of SSALTO/DUACS products

- Products directly useable for **scientific** and **operational** applications (climate and mesoscale)



Projects for offshore needs

- CLS was/is involved in 2 main projects which use altimetry for offshore needs

- **OPERALT** project

- 2-year European project started in 1998
- Objective:

assess the benefits and cost-effectiveness of the ocean current information provided by altimeter data analysis for applications by the offshore industry, both on a regional and the global scale



- **EMOFOR** project

- 3-year ESA project started in 2002
- Objective:

provide operational monitoring and forecasting service for the offshore industry

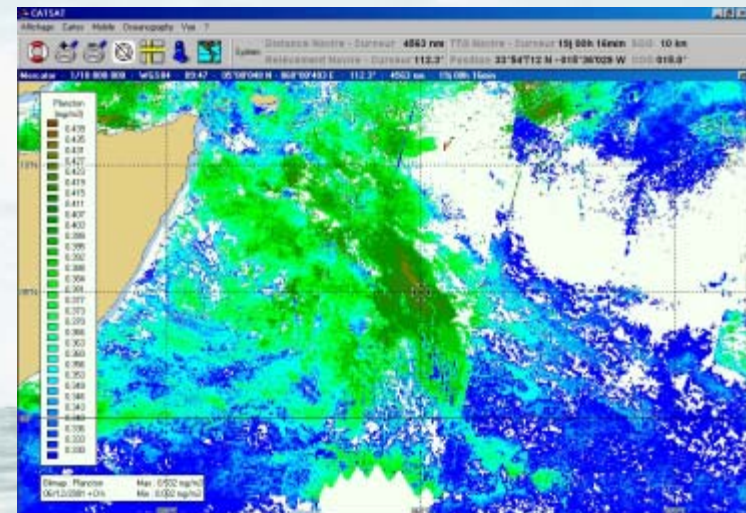
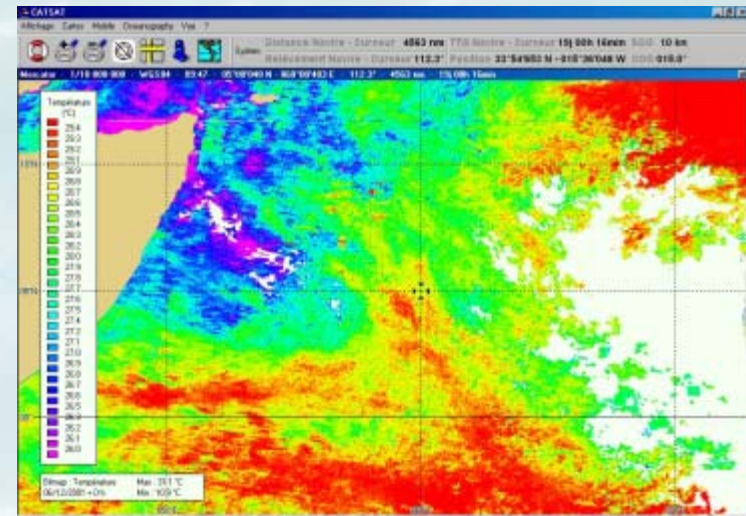


CLS operational products for fisheries

- To complement CLS expertise : CATSAT



- Objective: offer an easy-to-use, onboard oceanographic data service for the fishing community
- Data:
 - maps of SLA from DUACS
 - sea surface temperature maps from NOAA AVHRR
 - ocean color maps from SPOT
 - modeling forecasts from MERCATOR
 - weather forecast from Meteo FRANCE
- Can be adapted to offshore industry as an additional information to altimeter products



Conclusion

- CLS altimetric products supply:
 - a **statistical view** of the **ocean variability** over a long period of time (>10 years)
 - a bi-weekly **NRT snapshot** of the sea surface height of the ocean at the **eddy scale**
- Maps of **sea level anomalies** and derived maps of **ocean currents**:
 - worldwide
 - at the eddy scale
 - global coverage (no problem with cloud coverage)
 - weekly maps before mid-February 2003
 - now, twice a week
- CLS also operates a **NRT satellite oceanography data service**:
 - widely used by industrial fishermen
 - afford an additional information to altimetry with:
 - ocean color maps
 - sea surface temperature maps

More information

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