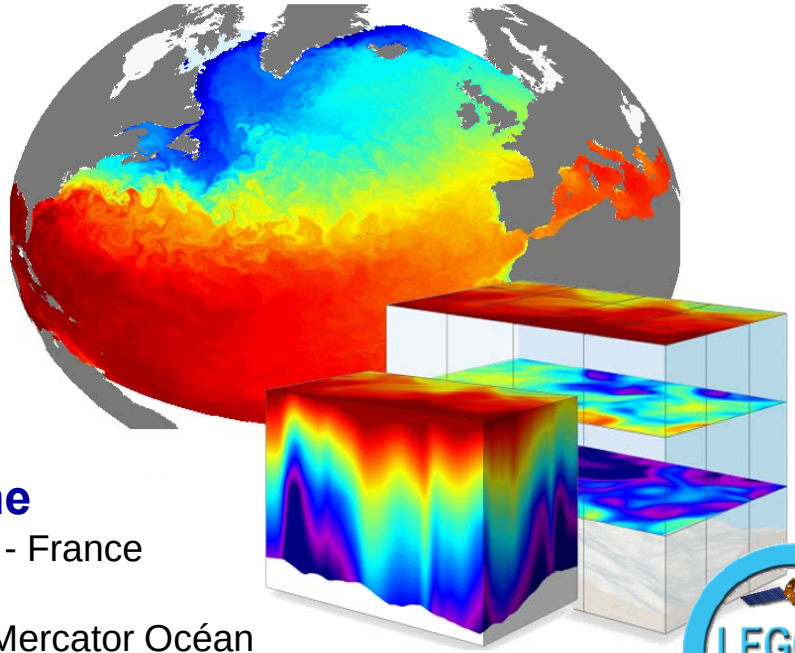
Uncertainties in drift modeling



Stéphane Law Chune
Mercator Océan - Toulouse - France
slaw@mercator-ocean.fr
Advisors: ***Yann Drillet*** - Mercator Océan
Pierre Daniel - Météo France
Pierre De Mey - Legos Cnrs

Applicative context

- SAR operations: Météo France → Mothy: operational drift model
  - uses **weather forecasts (6h ECMWF)** as primary input data (surface current fast response to wind, windage)
  - More recently: **ocean forecasts (daily Mercator)** as background current (general circulation)

→ The quality of forecasts depend on

- Current forecasts accuracy
- Wind forecasts accuracy
- Knowledge about the drifting material

(initial conditions in time and space, behavior on sea, etc.)

Sensitive studies over benchmarked scenarios
→ modeling tools + case studies

Modeling tools

- 1 OGCM model (Nemo 2.3) → **Regional configurations**

= ***several oceanic outputs of different qualities feeding…***

- 2 particles fate models

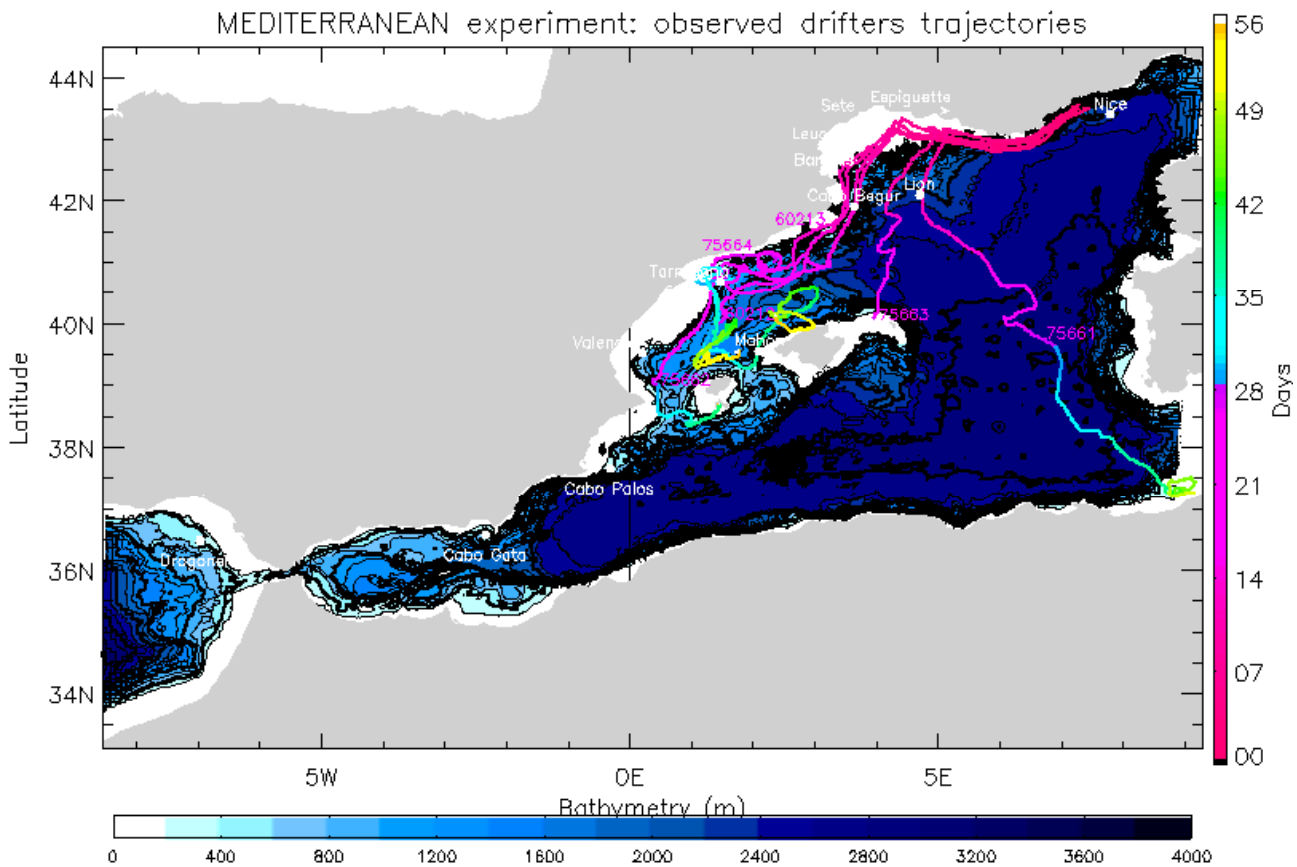
→ **Mothy** (Daniel, 1996)**:** OGCM as background of a wind response oceanic model

→ **Ariane** (Blanke, 1997): flexible offline lagrangian tool using direct OGCM outputs

Regional Imbricated configuration	Modeling options
Spatial resolution	- **1/36°** - 1/12°
Atm. Forcing Frequency (ECMWF)	- **3 h** - Daily
Vertical mixing scheme	- **GLS** - TKE 2
Additional physical processes	- **Open boundaries for rivers** - **Diurnal cycle** - Tide - **Parametrized waves mixing**
Data assim	Deprived but forced with operational at boundaries

Case studies

- 2 case studies:
- **Western Mediterranean Basin**
- Angola offshore zone

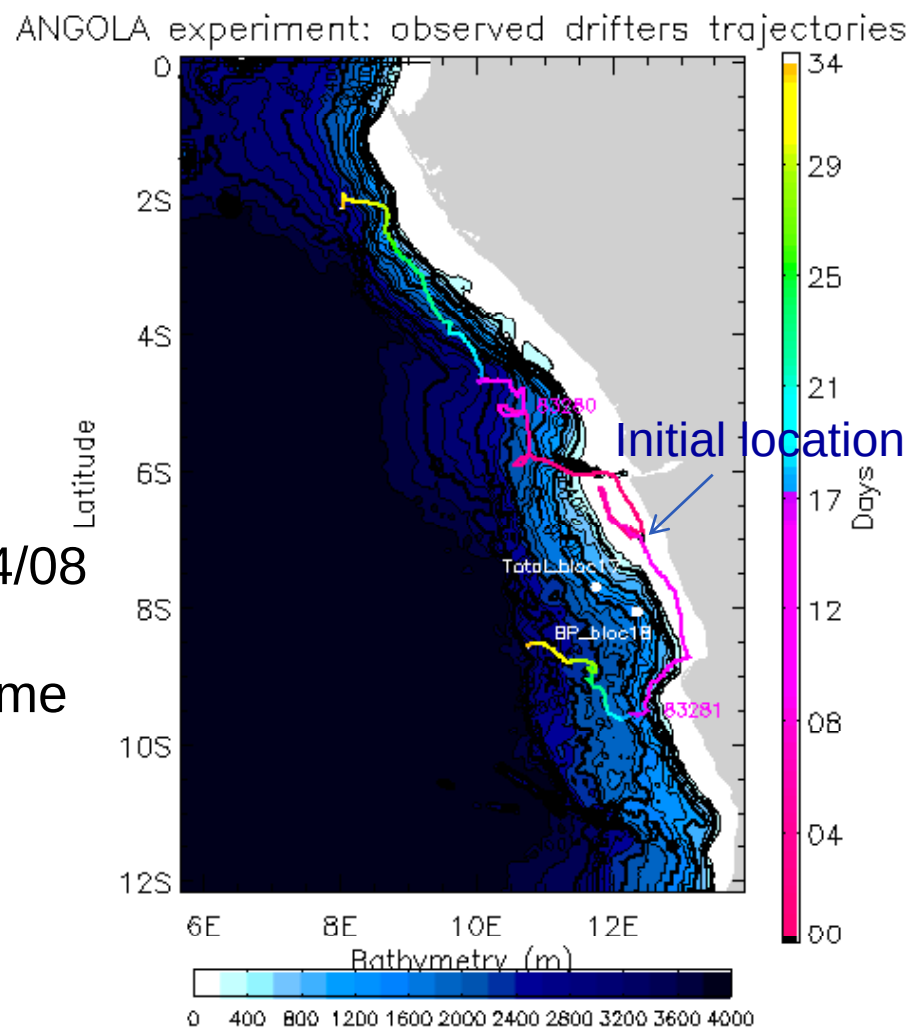


- 6 surface drifters
- 2 months of data 10/10/07 → 06/12/07
- Ligurian current advection + meso-scale activity
- Winter wind conditions (Mistral, Tramontane)

Case studies

- 2 case studies:
  - Western Mediterranean Basin
  - **Angola offshore zone**

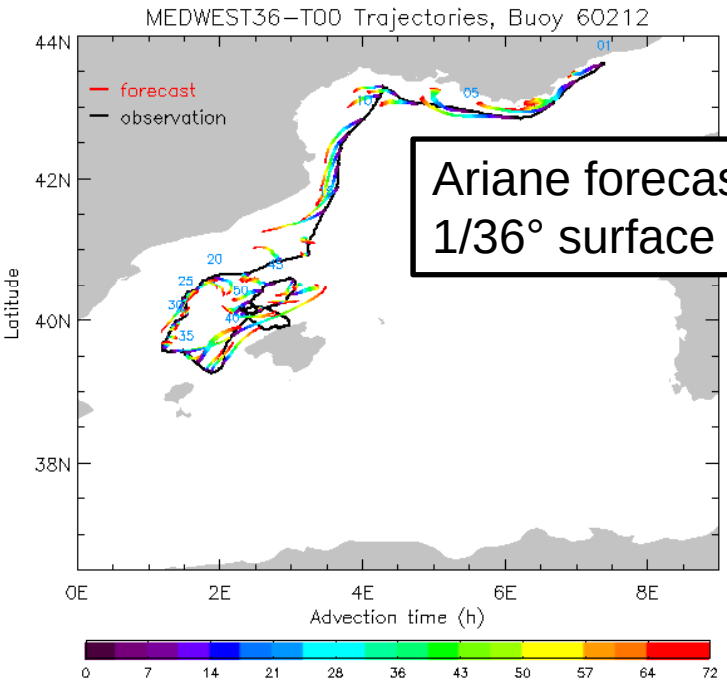
- 2 buoys
- 1 month of data: 01/03/08 →06/04/08
- Interaction with Congo's river plume
- Weak winds conditions



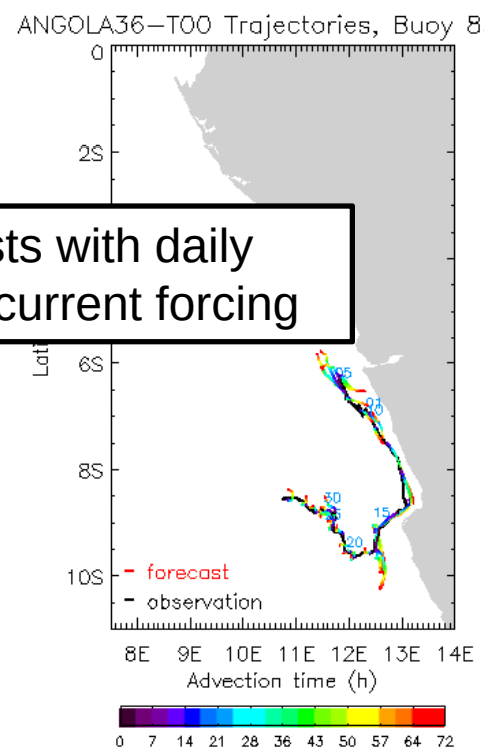
Protocols

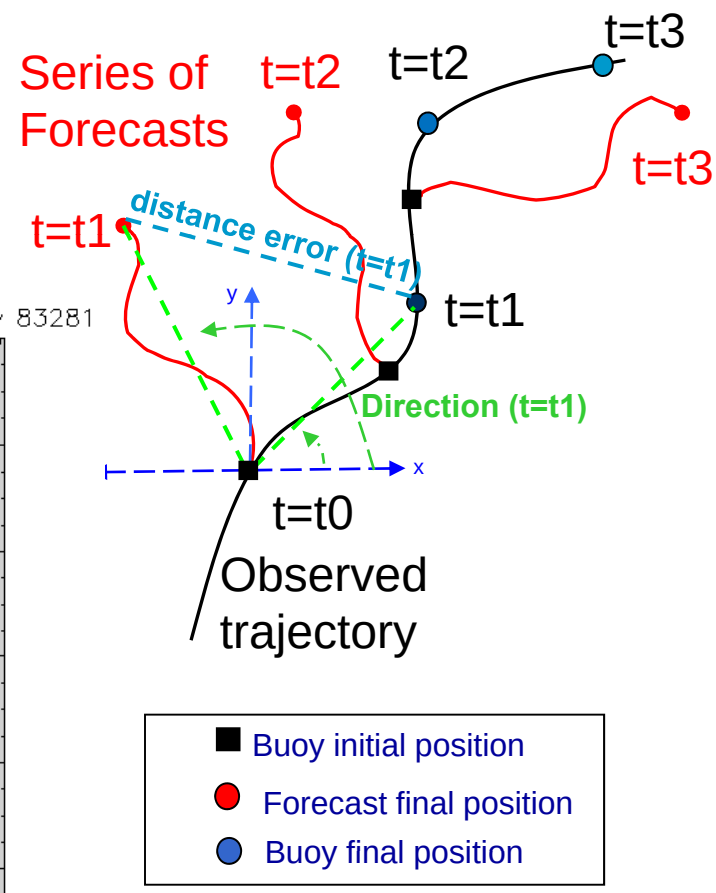
- Each day a drift forecast: 3600 particles seeding on one drifter's real position
- 3-days advections with OGCM outputs

→ Med = 252 simulations
→ Angola = 68 simulations



Ariane forecasts with daily 1/36° surface current forcing

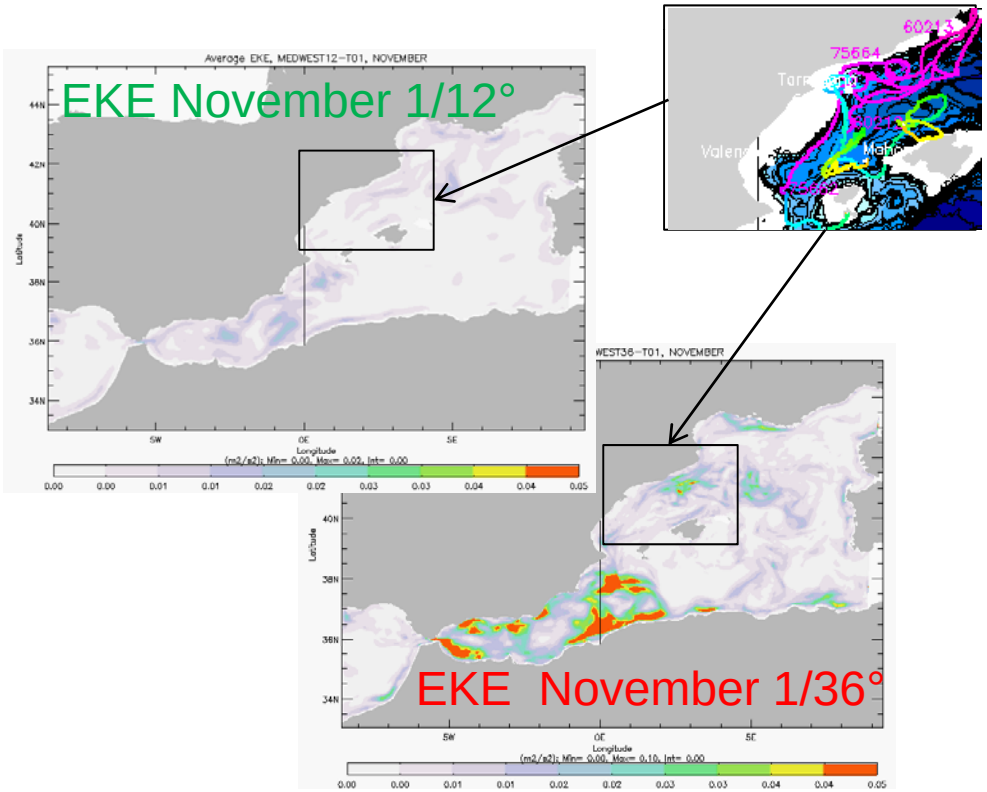


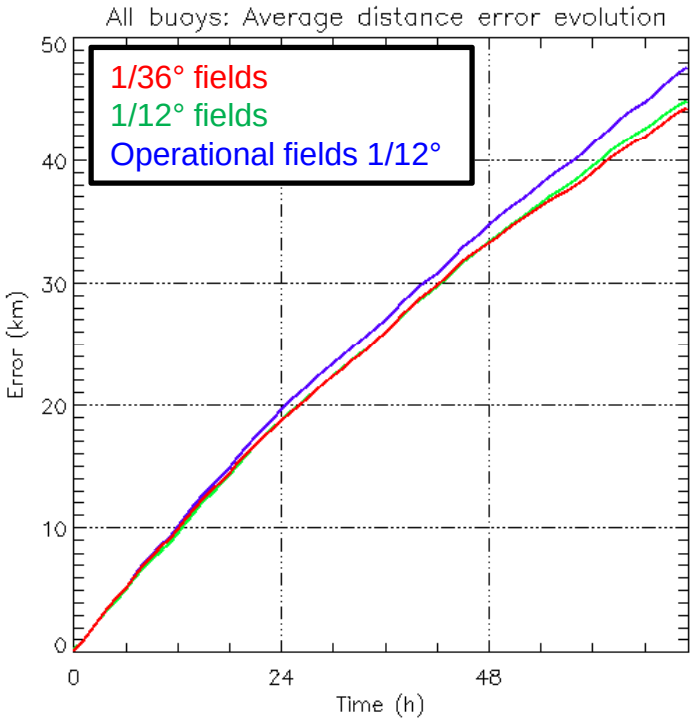


Sensitivity to current (1)

- Resolved scales ?
- meso-scale is critical for oceanic drift

→ The control of resolution





→ Increasing resolution doesn't necessarily improve results much

→ Well described LF circulation vs miss-described HF short scales

Sensitivity to current (2)

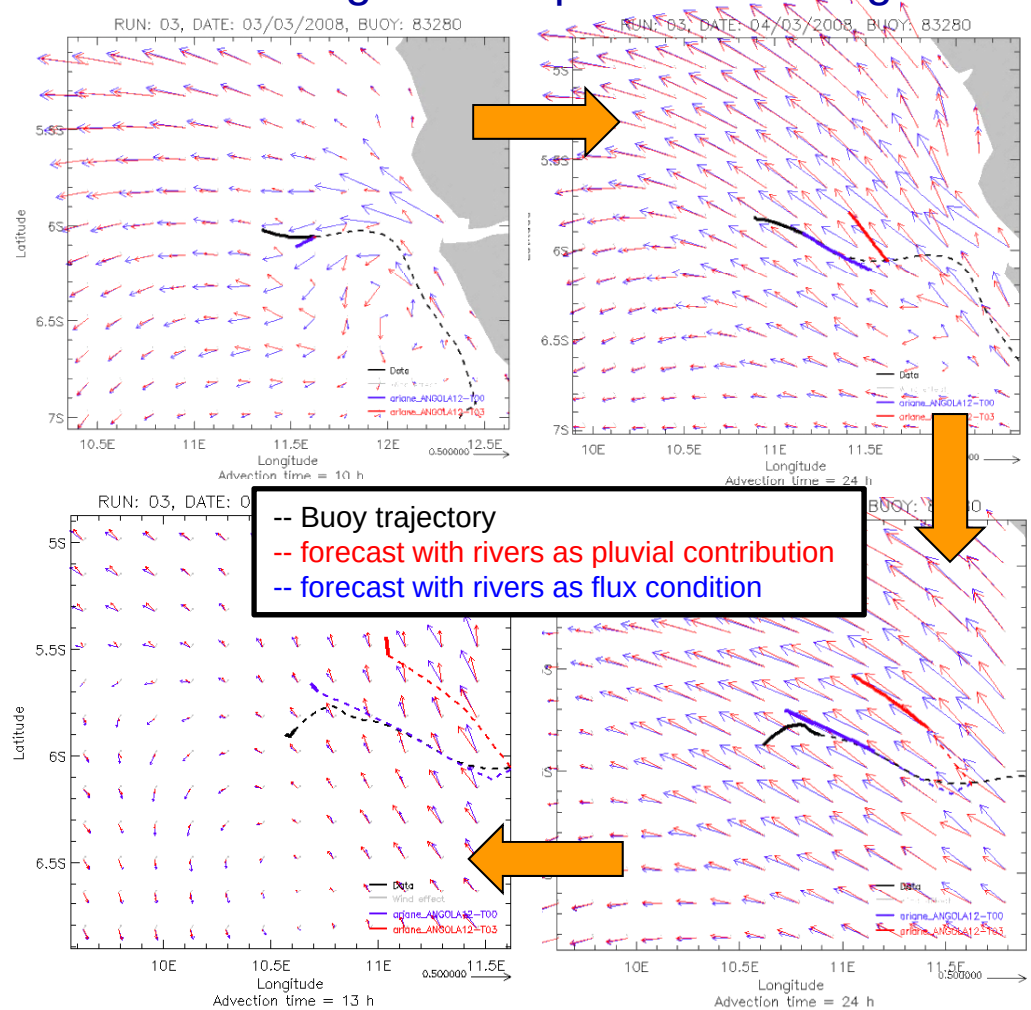
- Modeling strategy

  - A regional modeling trend

  ie: Fronts, shelf mixing, river plumes, etc.

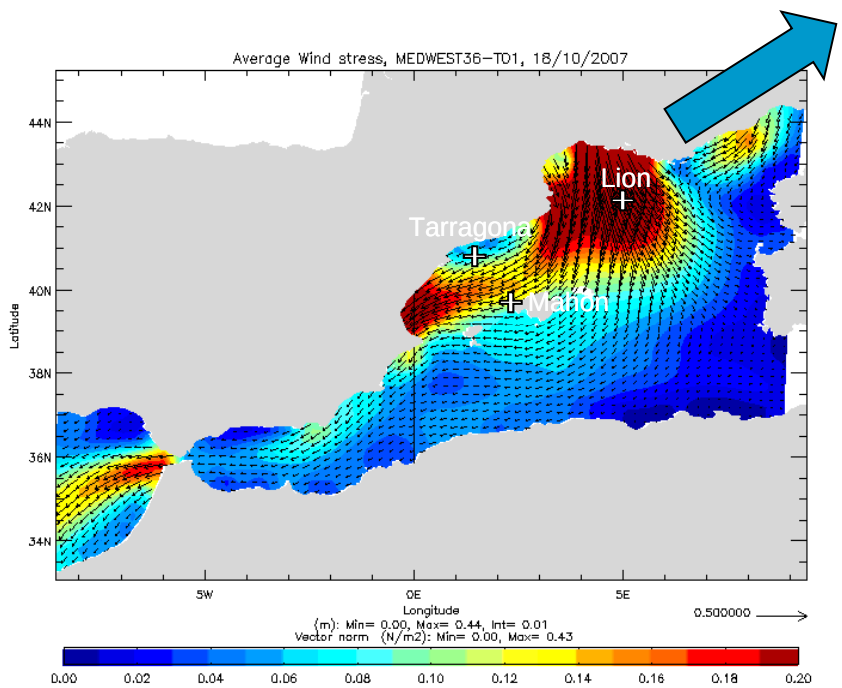
  → Local processes have strong impact

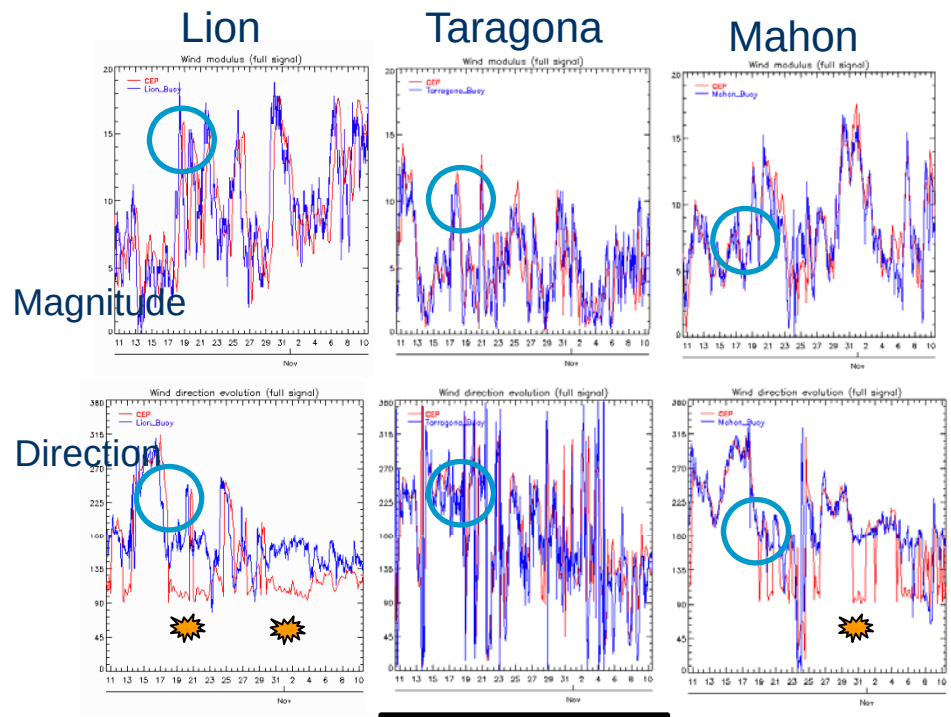
- Ex: Congo river's plume modeling



Uncertainties on the wind (1)

- Wind forcing
  - Critical for the surface current (drag, mixing, etc.)
  - Validation: ECMWF forecasts vs instrumented buoys



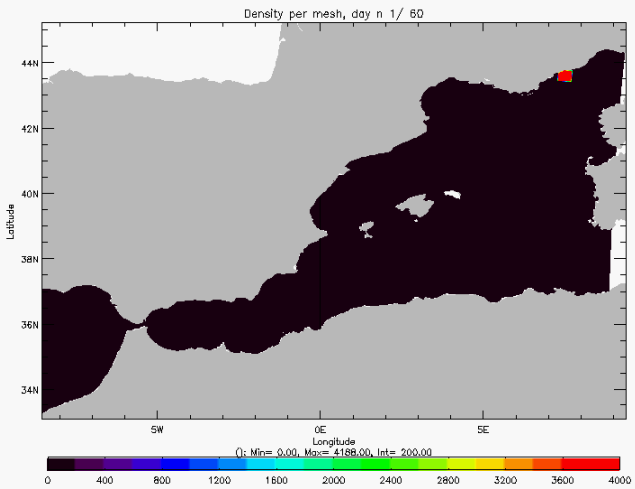


ECMWF vs Data

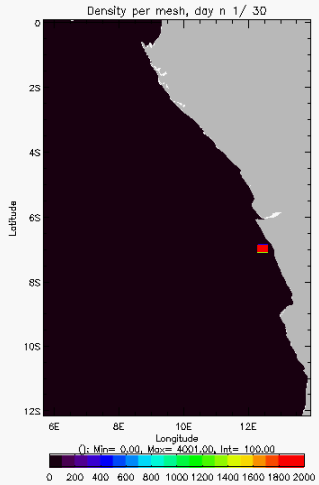
→ Good agreement in magnitude
→ Some discrepancy in direction when wind blows occur
→ Impact ?

Initial position sensitivity

- Statistical experiments

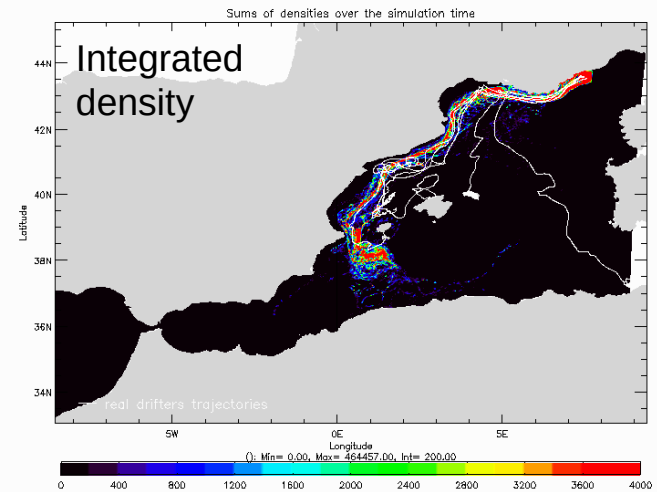


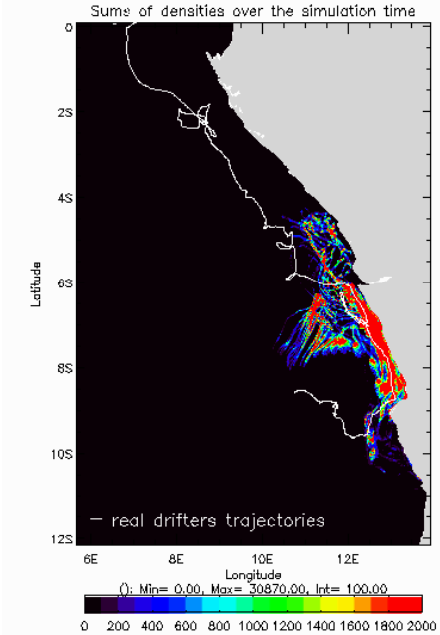
Density of particles per mesh



- High number of particles seeding to explore the model dispersion
- Initial box of ~ 1 million particles
- Box dimension: +/- 0.25 ° on drifters initial positions
- Full time advection over the scenarios (30/60 days)

- Map of integrated density ~ preferred advective paths





Conclusion

Conclusions

- The efforts go toward controlling short and rapid scales movement (wind and ocean) → high resolution models and high frequency forcings.
- The local physic's importance
- Statistical studies are interesting for drift applications → ensemble forecasts

Works in progress

- Ensemble forecast with perturbed currents or combined currents
- Impact of the forcing frequency
- The Stokes drift

Mercator Ocean
Ocean Forecasters

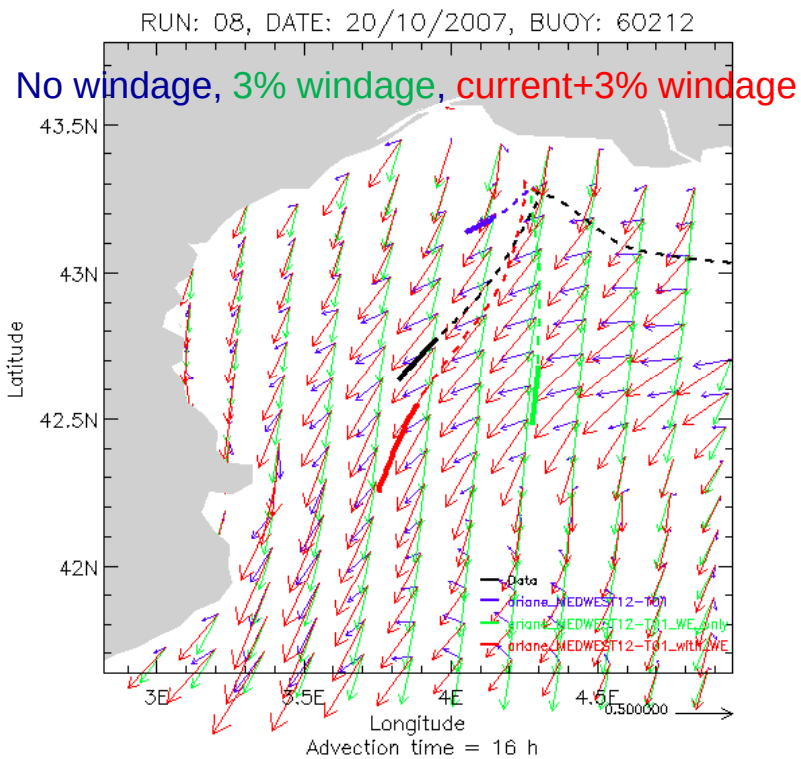
Thank you !

Uncertainties on the wind (2)

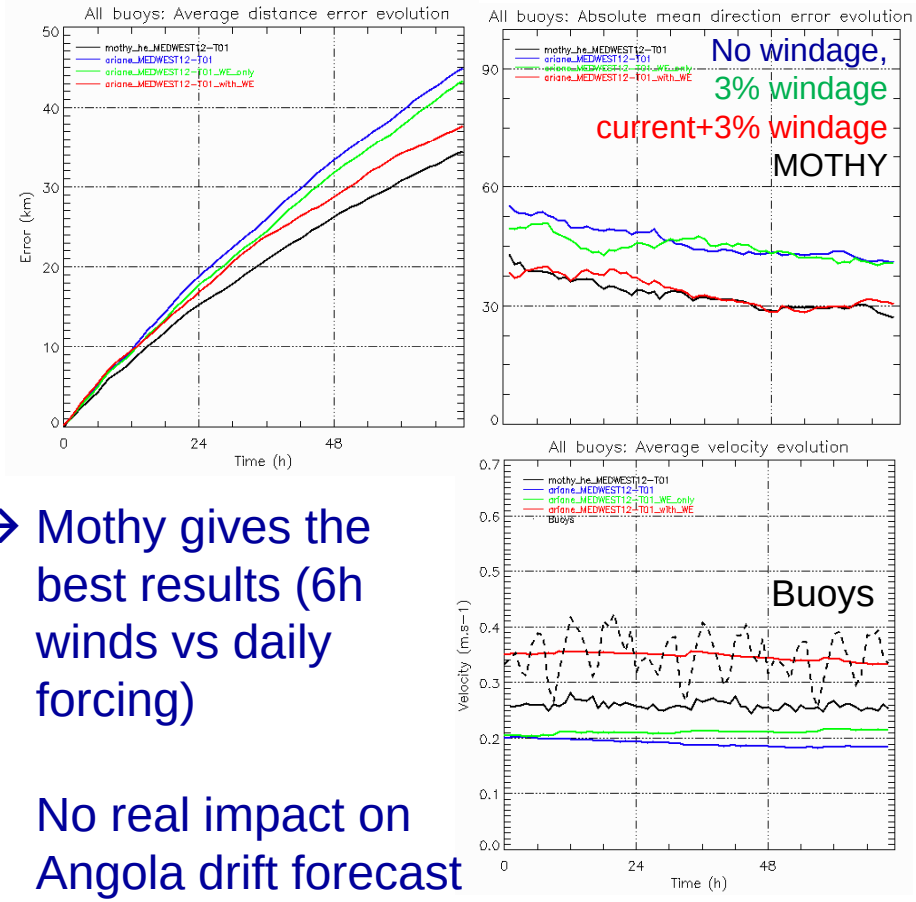
Wind effect

- Drift forecasts not enough southward during the mistral blow episode…

→ possible windage ?



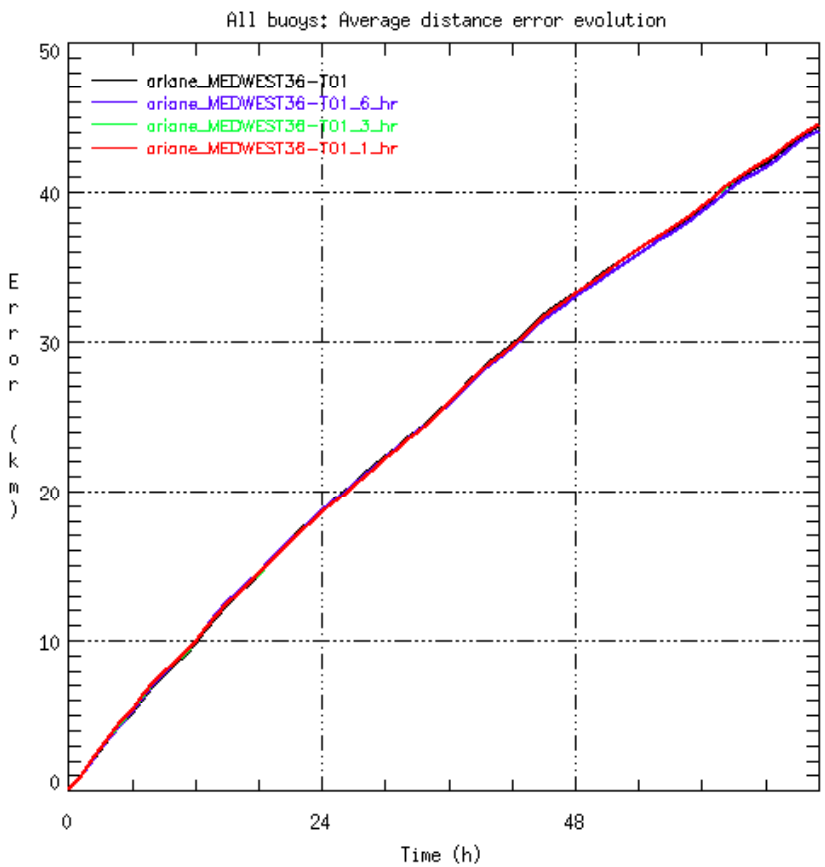
- Is the effect of wind on the ocean correctly represented in daily current fields ?

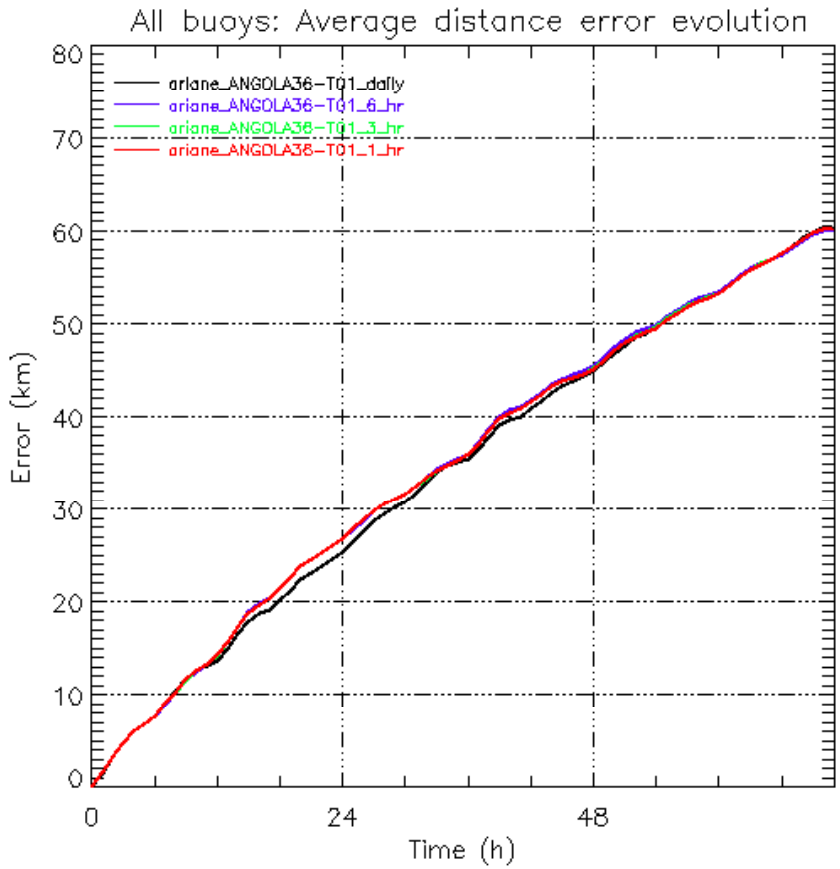


→ Mothy gives the best results (6h winds vs daily forcing)

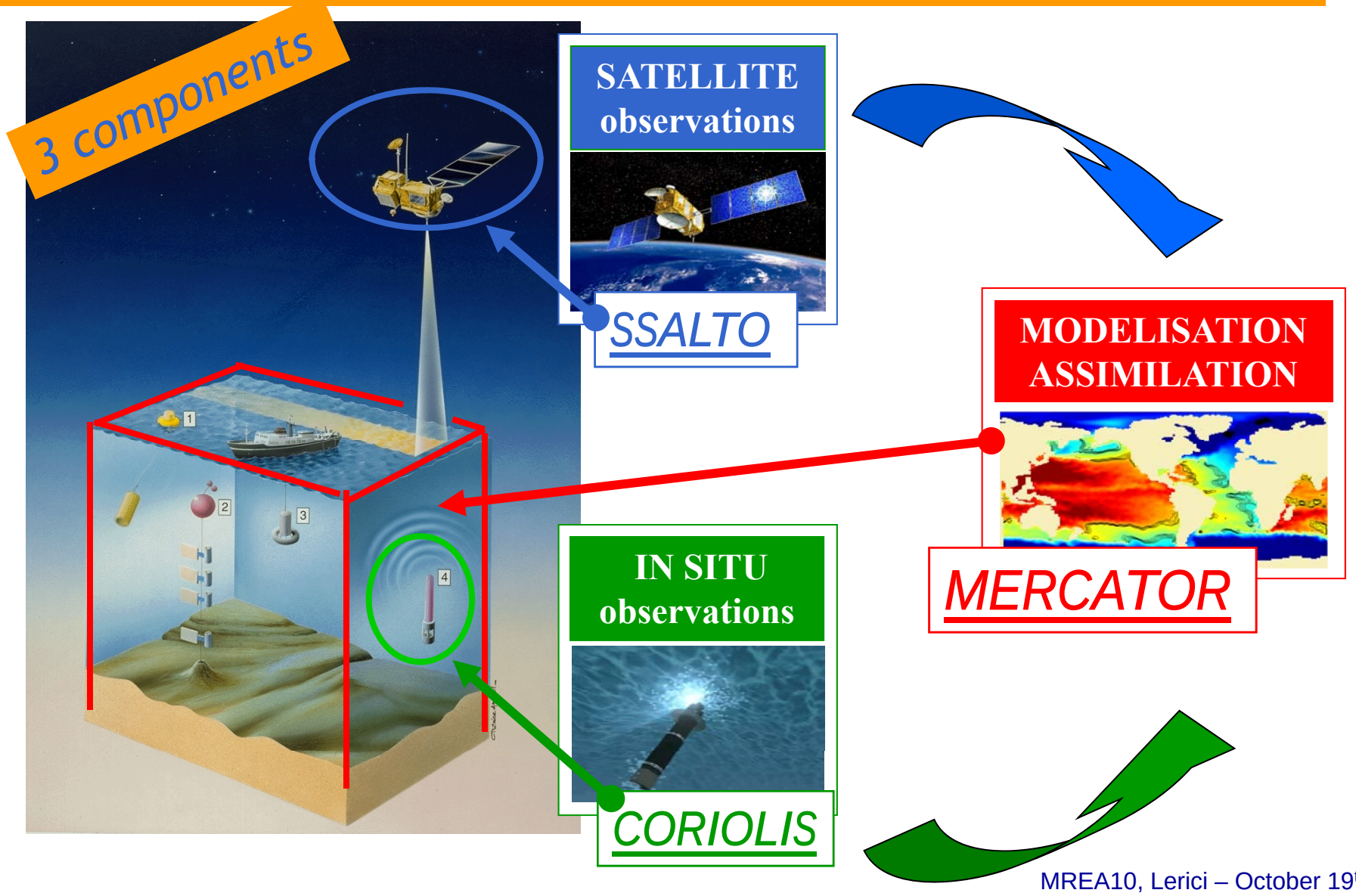
- No real impact on Angola drift forecast

High frequency forcing on curents





Mercator, integrated system



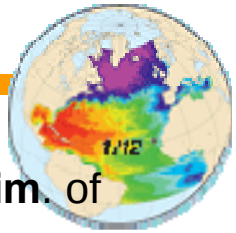
The system

Mercator target system:
Global Ocean
and High Resolution

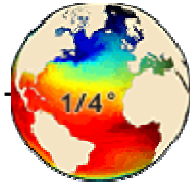
Assimilation :

Altimetry	Altimetry + SST + T(z) + S(z)

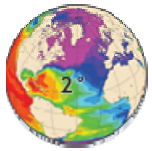
Analysis and Forecast System



- **Regional eddy resolving** (2002→ now)
  - North Atlantic + Mediterranean **1/12°** (6.5 km at 45°N), **NEMO/LIM, SEEK assim**. of alti, T/S and SST, daily fcst
  - Target: mesoscale upper ocean, downscaling to smaller regional and coastal regions, …



- **Global eddy permitting** (09/2005 → now)
  - Global, ocean and sea ice **1/4°** (25 km at eq), **NEMO/LIM**, **SEEK assim**. of alti, T/S and SST
  - Target: global ocean climate monitoring, biology, sea ice, reanalysis, …
  - Configuration used to produce GLORYS1 reanalysis (2002-2008)



- **Global low resolution** (05/2004 → now)
  - Today: **2°, OPA8, SEEK assim** of alti, T/S and SST
  - Target: oceanic initial conditions for coupled seasonal prediction, reanalysis

- ***Global eddy resolving***
  - ***NEMO/LIM 1/12° + SEEK***
    - *Has been demonstrated in April 2008 → operational at the end of MyOcean*
  - *Target: Global Marine Core Service and downscaling to European regions*
- ***Northeastern Atlantic high resolution***
  - ***NEMO 1/36° + SEEK + Tidal free surface*** *→ operational at the end of MyOcean*
  - *Target: IBIROOS Marine Core Service → Boundary data to coastal systems*

CONTACT

MERCATOR OCEAN

email: products@mercator-ocean.fr
URL://www.mercator-ocean.fr

MYOCEAN

email: servicedesk@myocean.eu.org
URL://www.myocean.eu.org