COMAPI :

NEW REGIONAL TIDE ATLASES AND HIGH FREQUENCY DYNAMICAL ATMOSPHERIC CORRECTION

M. Cancet[1], M. Lux[1], C. Pénard[1], F. Lyard[2], F. Birol[2],
L. Roblou[2], J. Lamouroux[1], S. Bourgogne[1], E. Bronner[3]

[1]NOVELTIS, Toulouse, France

[2]OMP/CNRS/LEGOS-CTOH, Toulouse, France

[3]CNES, Toulouse, France

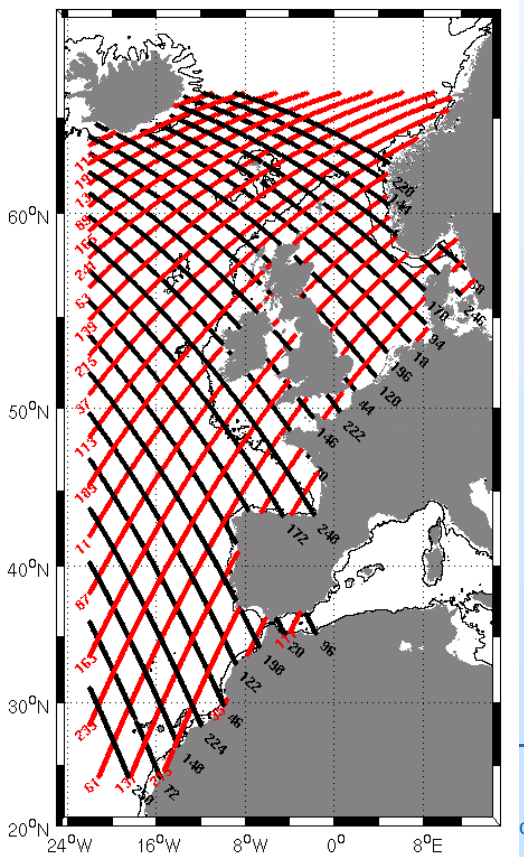
Introduction

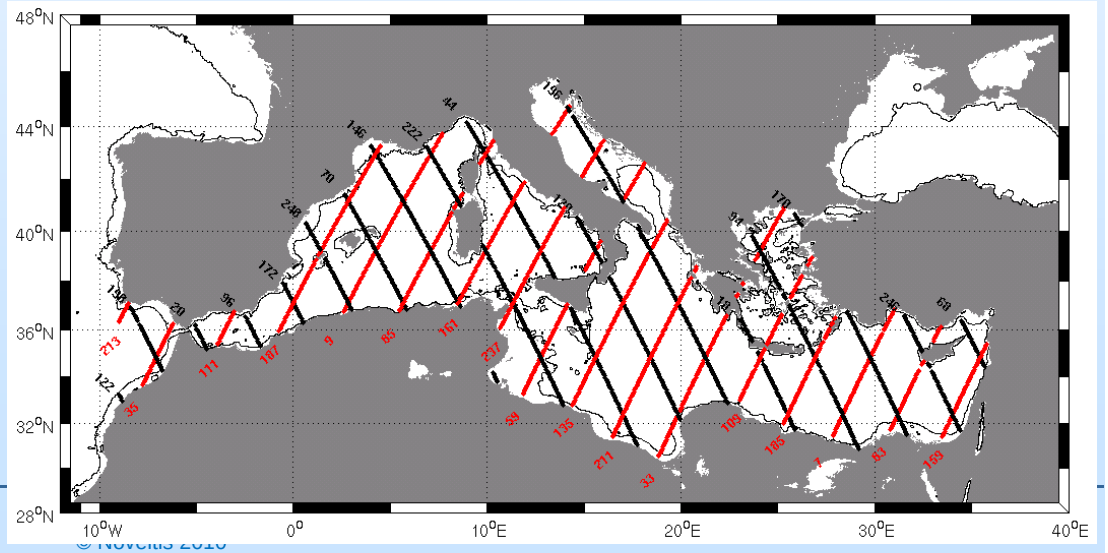
COMAPI: Coastal Modeling for Altimetry Product Improvement

- Global ocean models: not accurate enough to well represent the complex ocean dynamics and the high spatial variability of the process in the coastal zones
- Implementation of two regional dynamical atmospheric corrections for periods smaller than 20 days (high frequency) in:
  - The North East Atlantic Ocean
  - The Mediterranean Sea
- Development of two regional tide models with assimilation in the same zones
  - Better atlases for the "classical" waves
  - Extension to some of the non-linear waves

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional high frequency DAC in the North East Atlantic Ocean and in the Mediterranean Sea





Plots ©CTOH

© Noveltis 2010
cument est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional high frequency DAC: methodology

- TUGO 2D model (finite element model)
- Regional high resolution grids (NEA and MED)
- ECMWF 3h forcing fields
- Run period: Sept. 2008 – Dec. 2009

NOV-3717-SL-10180
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional HF DAC: Validation method

- **Comparison to a tide gauge database (MATROOS)**

- **Evaluation of the impact in the altimetry data:**
  - **X-TRACK Jason-2 SLA provided by the CTOH** *(see Birol et al presentation)*
  - **Several dynamical atmospheric corrections:**
    - COMAPI regional high frequency DAC (to be validated)
    - TUGO global high frequency DAC (high resolution grid, ECMWF 6h forcing fields)
  - **Evaluation of the temporal variability reduction at each observation point**

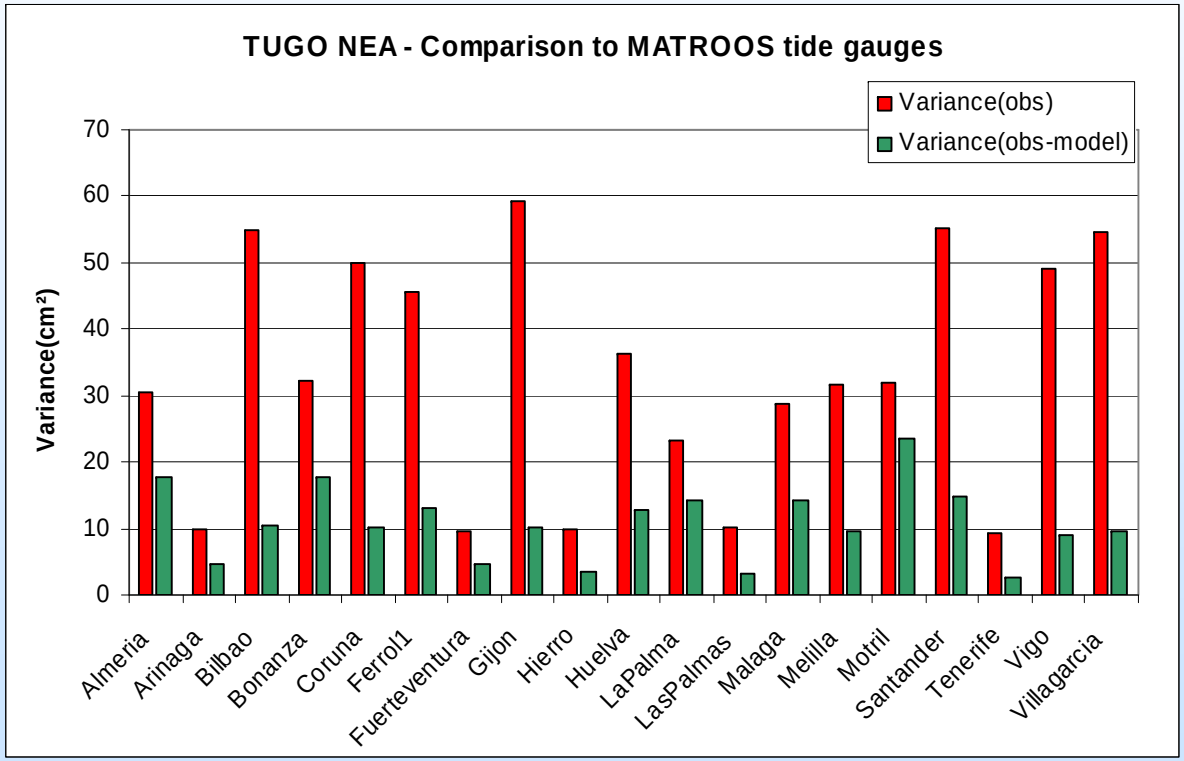
    ➔ Regional picture of the new high frequency DAC impacts

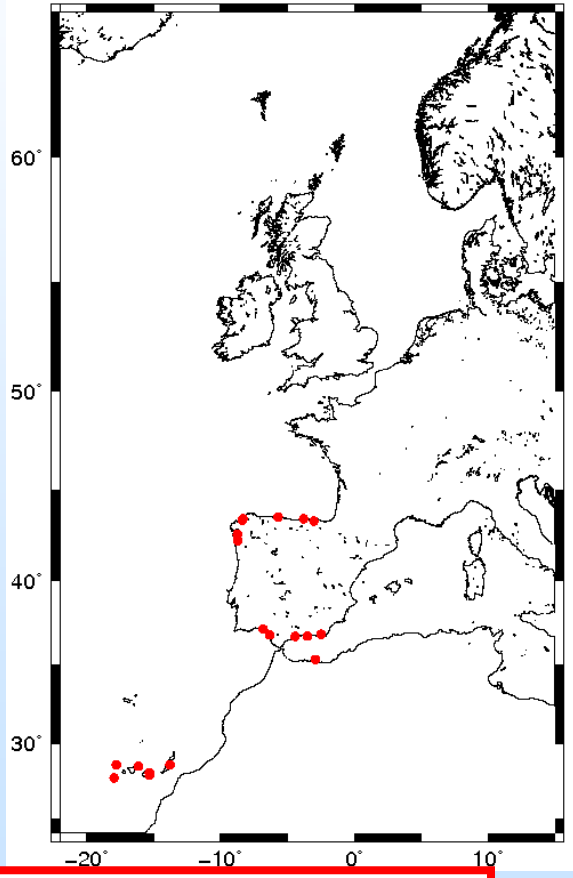
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional high frequency DAC: Validation in the NEA Ocean

Comparison to the MATROOS tide gauge dataset: detided SLA

Global performance score

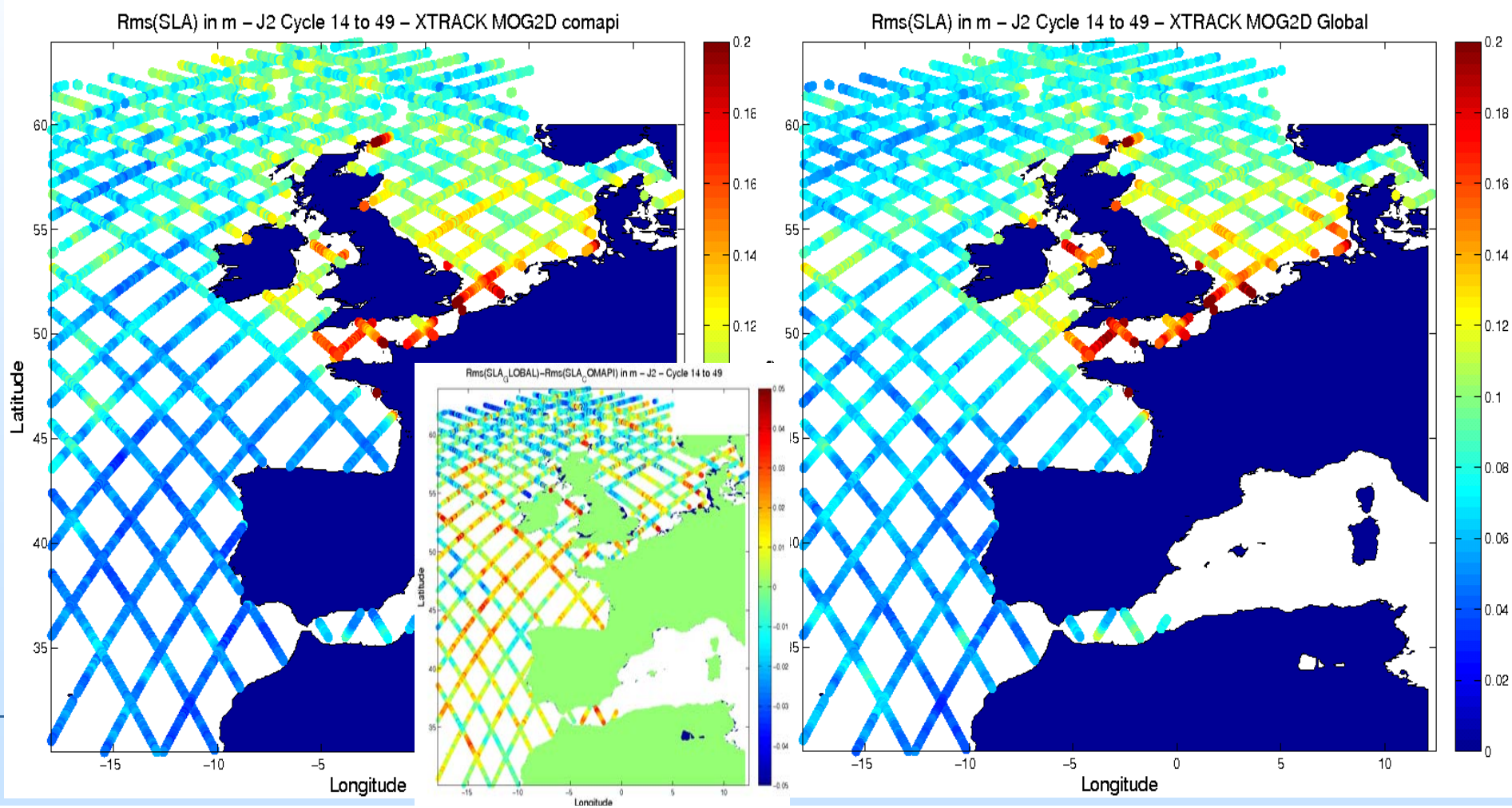




On average, reduction of more than 63% of the tide gauge SLA variance when using the COMAPI simulation.

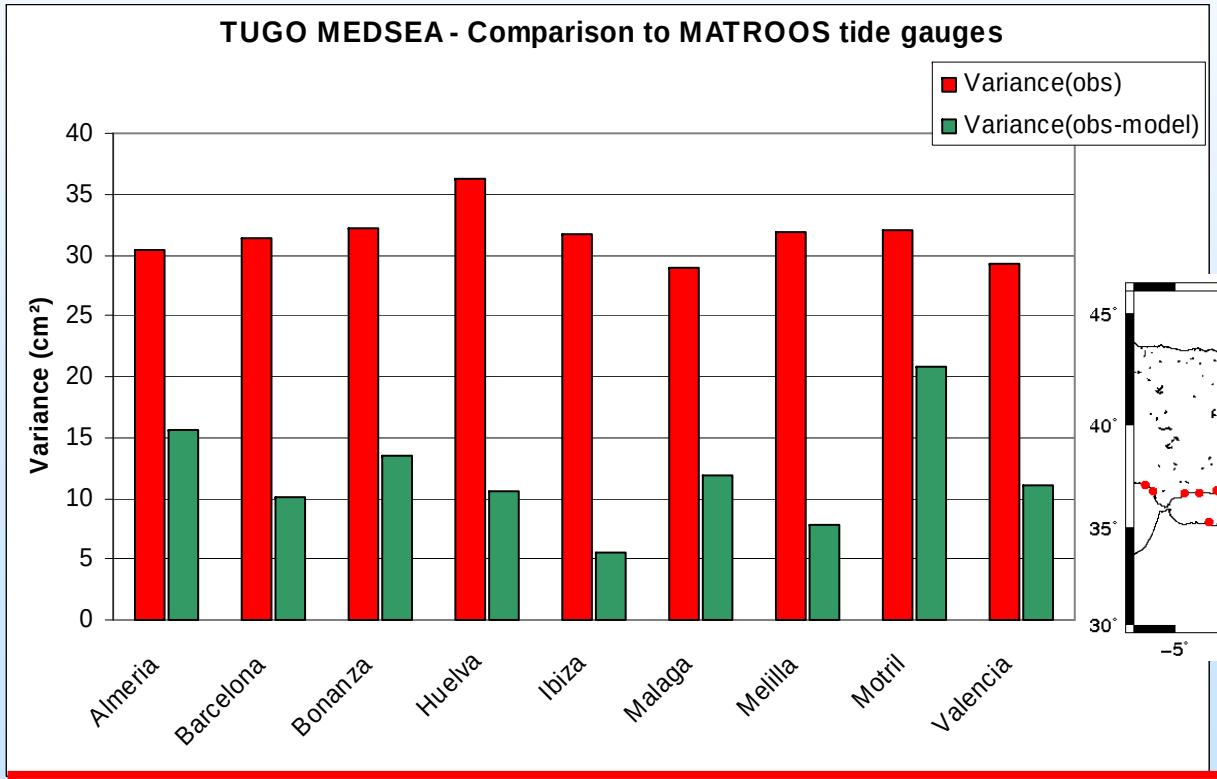
Regional HF DAC: Validation in the NEA Ocean

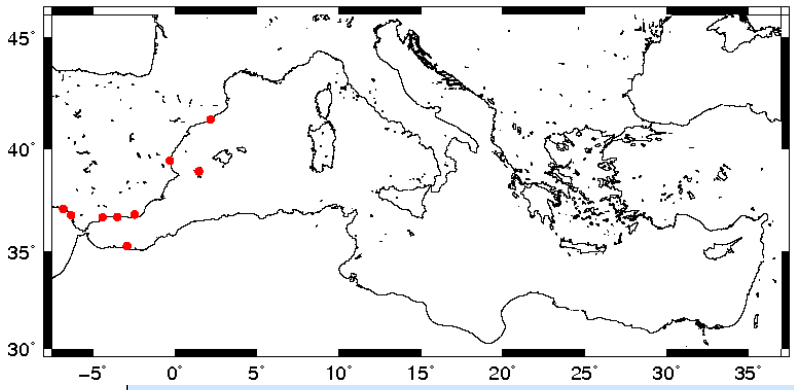
- **Impact on the Jason-2 SLA data provided by the CTOH**



Regional high frequency DAC: Validation in the MED Sea

- **Comparison to the MATROOS tide gauge dataset: detided SLA**
  - **Global performance score**





On average, reduction of more than 62% of the tide gauge SLA variance when using the COMAPI simulation.

Conclusions

- On-going validation work: preliminary results
- Choosing the most adapted ECMWF products to force the model is crucial.

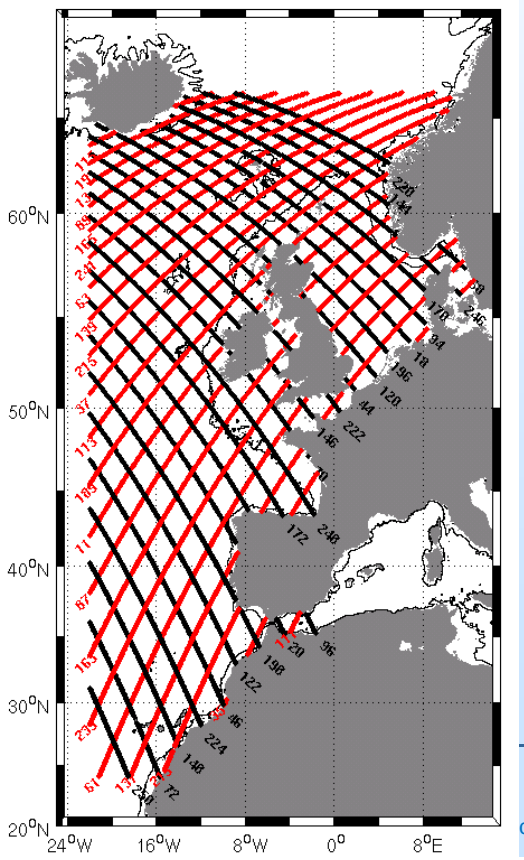
NOV-3717-SL-10180
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

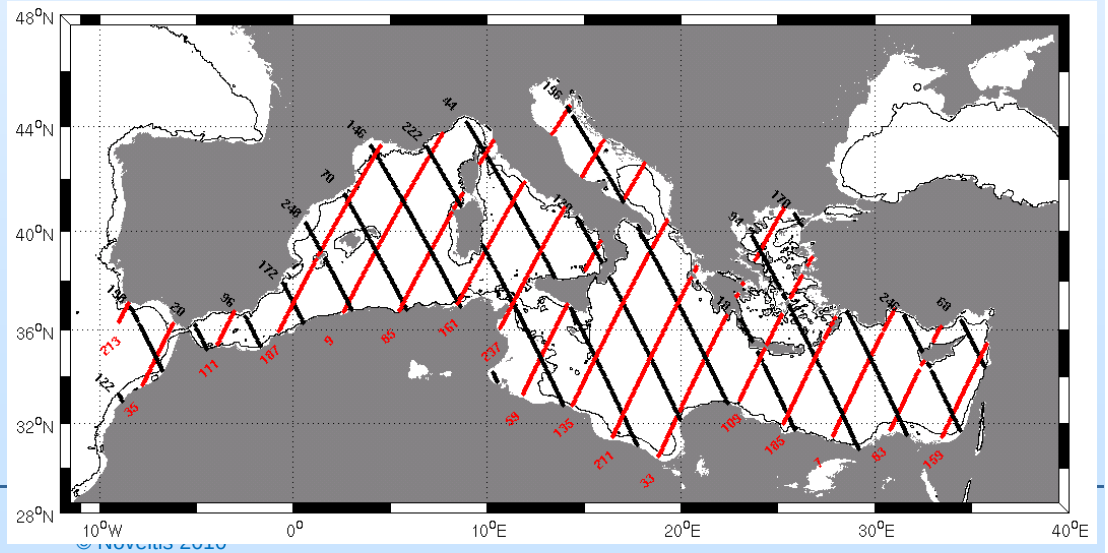
Perspectives

- Product intended to evoluate
- Increase the temporal resolution of the surface parameters: 1h atmospheric fields?
- Use regional atmospheric models to improve the forcings (MESO-NH, WRF)?

NOV-3717-SL-10180
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases in the North East Atlantic Ocean and in the Mediterranean Sea

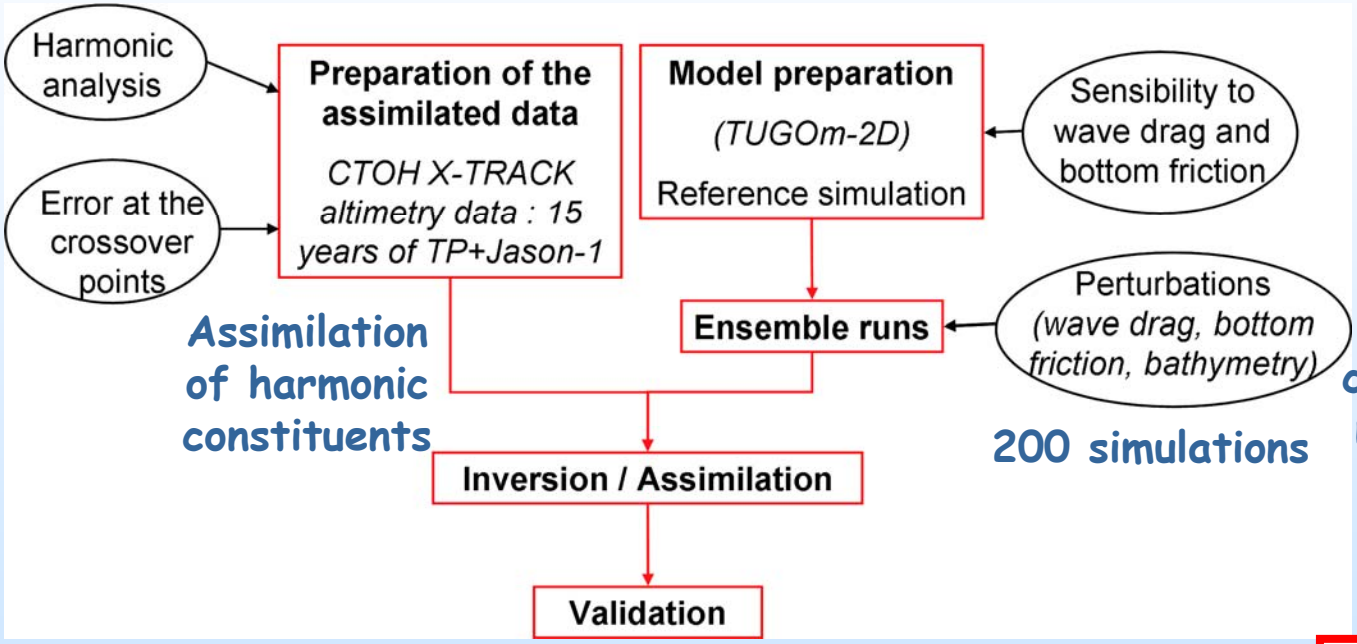




Plots ©CTOH

© Noveltis 2010
cument est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide models development: methodology



NEA: assimilation of altimetry data + coastal tide gauges

MED: assimilation of altimetry data

47-wave spectrum

15 assimilated waves

For each zone : 1 reference solution (no assim) + 1 assimilated solution

NOV-3717-SL-10180
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation method

- **Comparison to tide gauge datasets, wave by wave**

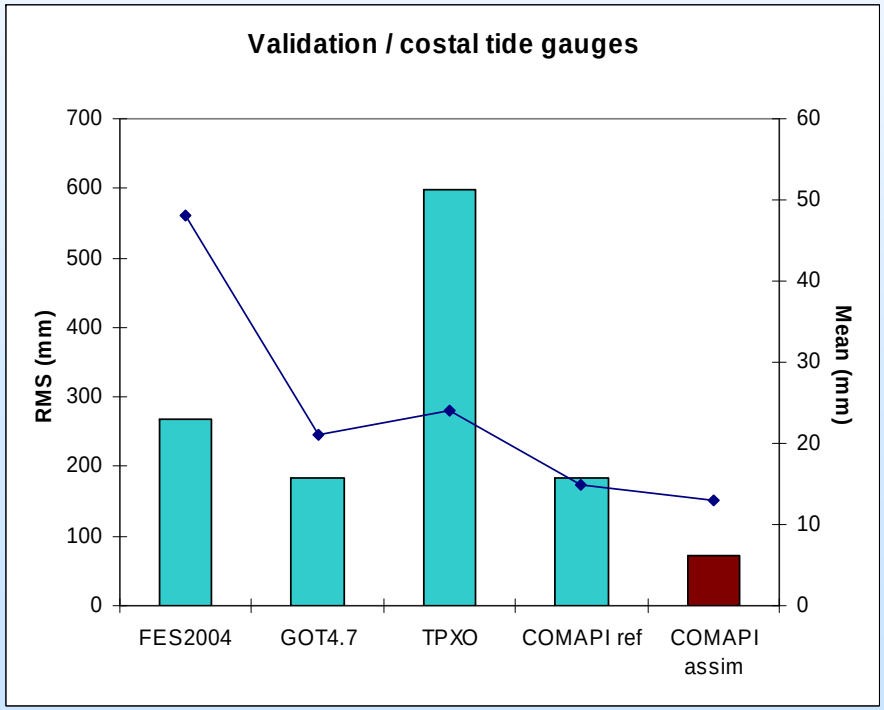
- **Evaluation of the impact in the altimetry data, compared to other tide models :**
  - **X-TRACK Jason-1 SLA provided by the CTOH**
  - **Several tide corrections:**
    - FES2004
    - GOT4.7
    - COMAPI reference solution (no assimilation)
    - COMAPI assimilated solution (to be validated)
  - **Evaluation of the temporal variability reduction at each observation point**

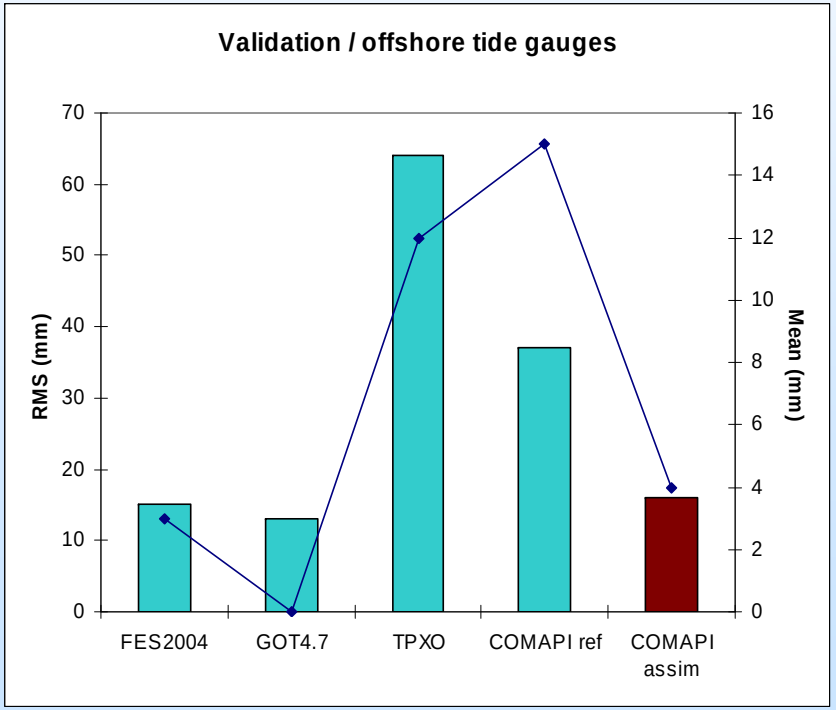
➔ Regional picture of the new tide solution impacts

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation in the NEA

- **Comparison to tide gauge datasets (wave by wave)**
  - **Global performance score: vector differences for M2**
  - **Comparison to global models (FES2004, GOT4.7, TPXO7.2)**





© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation in the NEA

- Comparison to tide gauge datasets (wave by wave)
  - Global performance score: vector differences for M2
  - Comparison to global models (FES2004, GOT4.7, TPXO7.2)

➢ Better scores with coastal tide gauges than with offshore ones

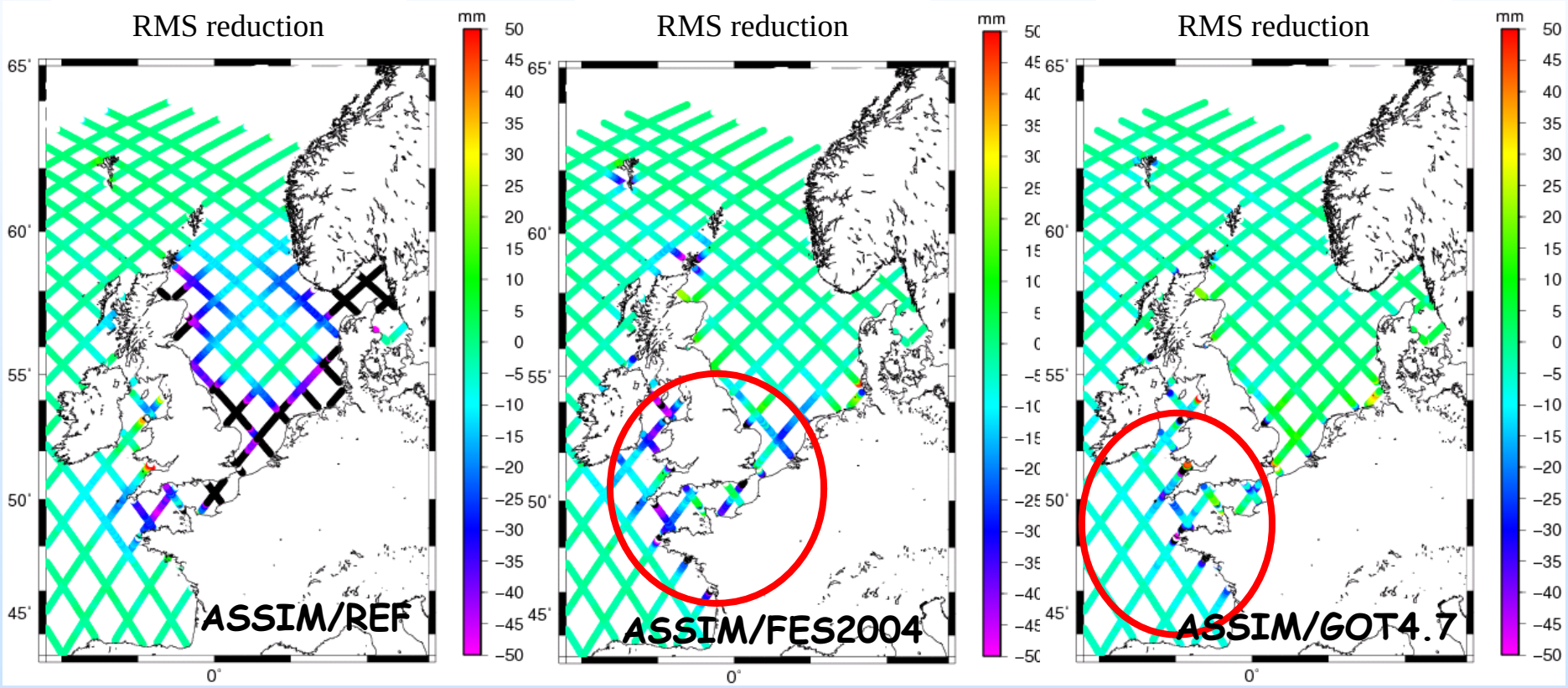
➢ Coastal tide gauges were assimilated, but same conclusion with a solution containing only altimetry data

➔ The altimetry data highly constrain the model.

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation in the NEA

Impact on the Jason-1 SLA data provided by the CTOH



© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation in the NEA

OFFSHORE: Better scores with the altimeter data than with the tide gauge ones.

It may be due to the load tide as:

- **Assimilated altimetry data were corrected from the global FES99 load tide** (1/4° spatial resolution for the load tide)
- **Load tide** highly variable near the coasts: **not well represented in the FES99 model.**
- **It induces some errors in the assimilated data and thus in the assimilated solution.**
- This error **vanishes when computing the geocentric tide**

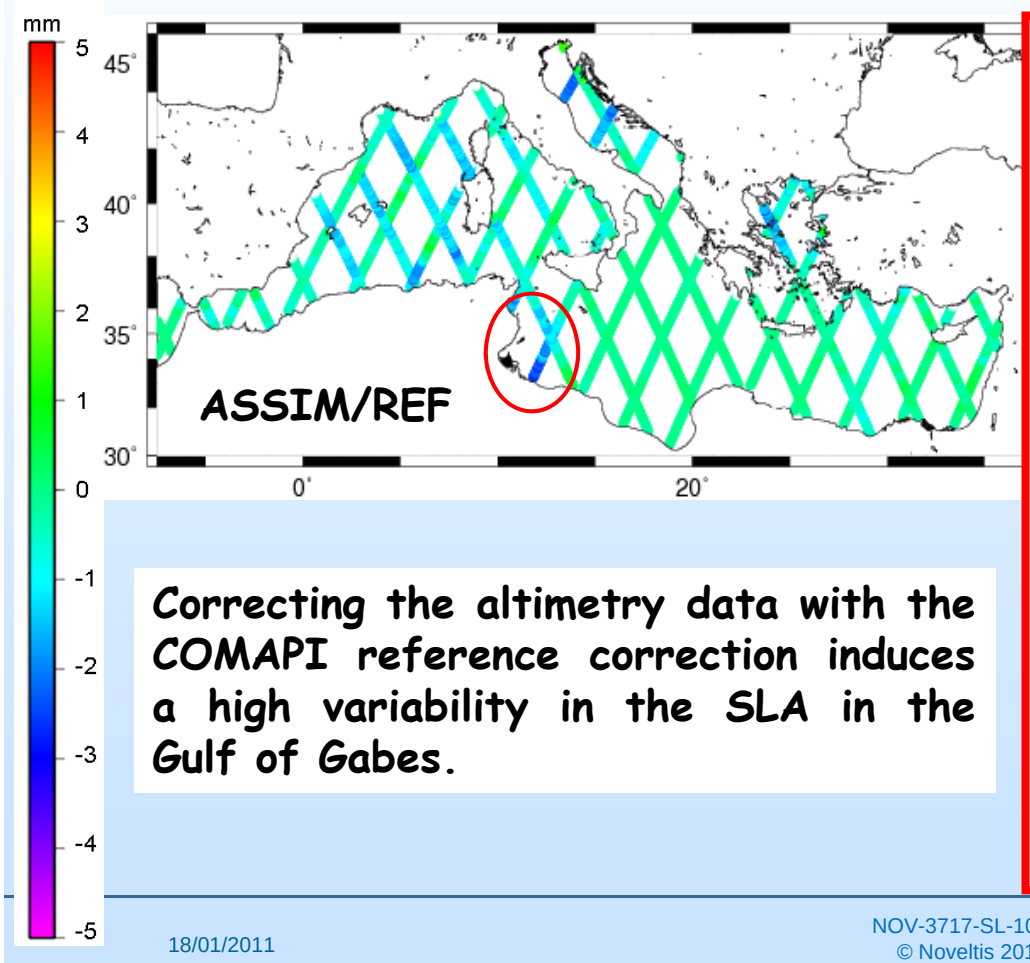
  ➔ **no impact in the altimetry data** as far as the same load tide correction is used

- On the contrary, **impacts the oceanic tide** and **degrades the comparison to the tide gauge harmonic constituents.**

An iteration to compute a load tide homogeneous with the COMAPI tide atlas would probably improve the results.

Regional tide atlases: Validation in the Mediterranean Sea

Impact on the Jason-1 SLA data provided by the CTOH



Correcting the altimetry data with the COMAPI reference correction induces a high variability in the SLA in the Gulf of Gabes.

- Probably due to a local bathymetry default
- The model bathymetry ensembles do not take this issue into account
- It induces non pertinent model error covariances which propagate in a large part of the basin
- To disconnect this zone from the others: limitation of the influence radius of the assimilated observations

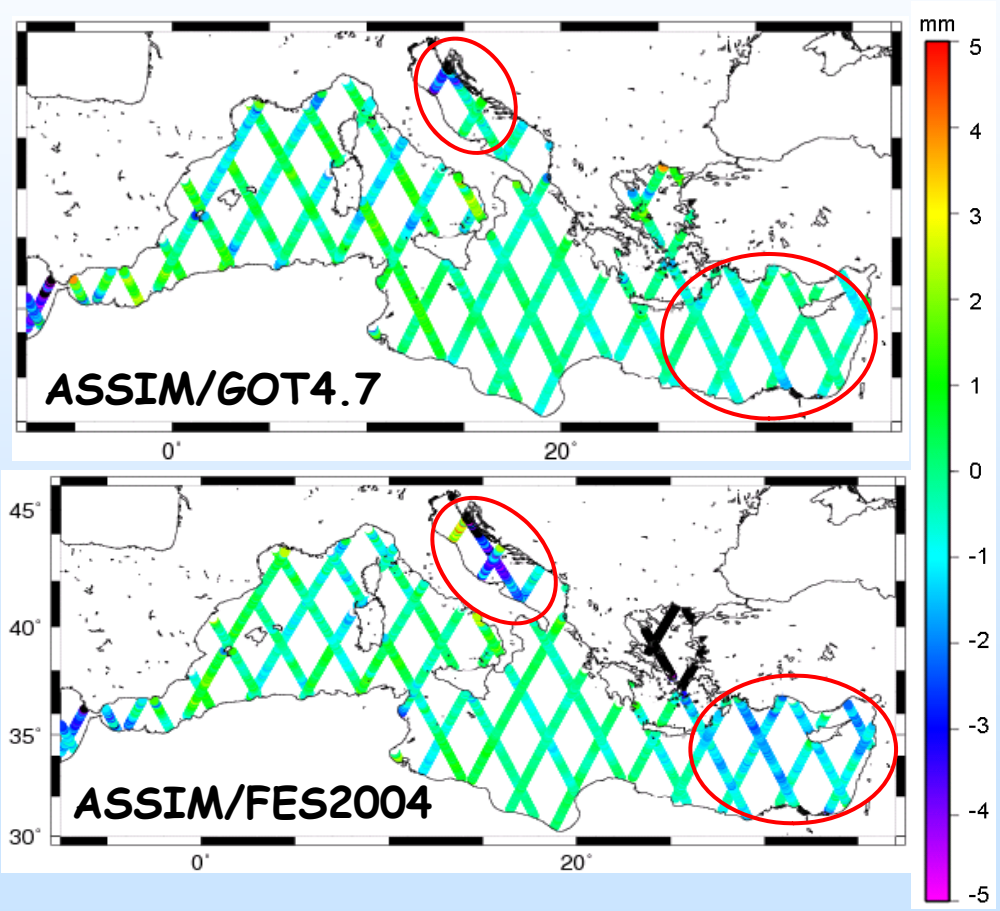
➔ The assimilation of altimetry data corrects this anomaly

➔A high quality bathymetry is crucial when modeling the tides

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Regional tide atlases: Validation in the Mediterranean Sea

- **Impact on the Jason-1 SLA data provided by the CTOH**



Reduction of the variability compared to the global models especially:

→ In the Levantine basin

→ In the Adriatic Sea

NOV-3717-SL-10180
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Conclusions on the tide atlases

Conclusions

- **Improvement of the tide atlases near the coasts:**
  - Decrease in the RMS of the altimetry SLA between 0.5cm and 5cm in the Channel and off Brittany, compared to GOT4.7 and the COMAPI reference solution (no assimilation)
  - Good coherency with the tide gauge harmonic constituents especially near the coasts
  - Offshore, better results with the altimetry data than with the tide gauges probably because of the load tide.
- **Necessity to compute an homogeneous load tide**
- **The definition of the bathymetry ensembles must be done carefully, maybe in two steps:**

  1) partitioning the zone a priori ➔ identification of bathymetry defaults

  2) new zoning to improve the assimilation

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

Conclusions on the tide atlases

Perspectives

- **These regional tide atlases will be patched in global models**

Today

- Boundary conditions ensembles were not used in the simulation

  ➔ can immediately be patched in FES2004

Next step

- There are still errors in the boundary conditions: the boundary conditions ensembles will be used in the ensembles runs
- Use of the boundary conditions to create a "buffer zone" between the global and the regional atlases.

  ➔ patch the regional model in any global one.

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

General conclusions and perspectives

General conclusions

- **Both validated products will be included in the PISTACH altimetry products**
- **The production of the atlases showed:**
  - Need for reliable bathymetry fields
  - Necessity to compute load tides homogeneous with the regional tide atlases

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

General conclusions and perspectives

Perspectives

- **Next priorities ?**
  - Artic Ocean
  - Indian Ocean
  - African coasts
  - Indonesian straits
  - Gulf of Mexico
  - Amazon shelf
  - … other suggestions ?
- **Bathymetry ?**
- **Regional altimetry datasets production ?**
- **Tide gauge time series availability ?**

© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

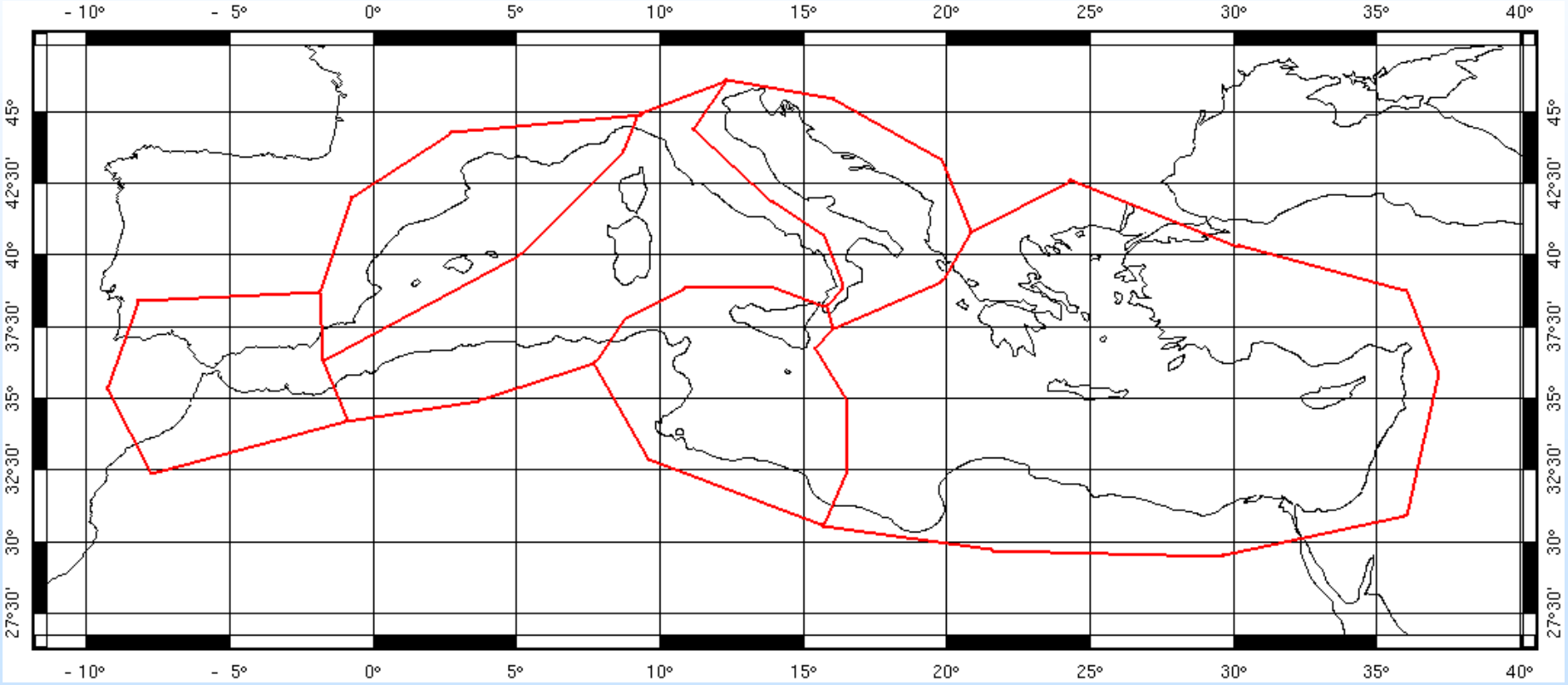
THANK YOU !

ANY QUESTIONS ?

Poster: COMAPI : A new low frequency DAC

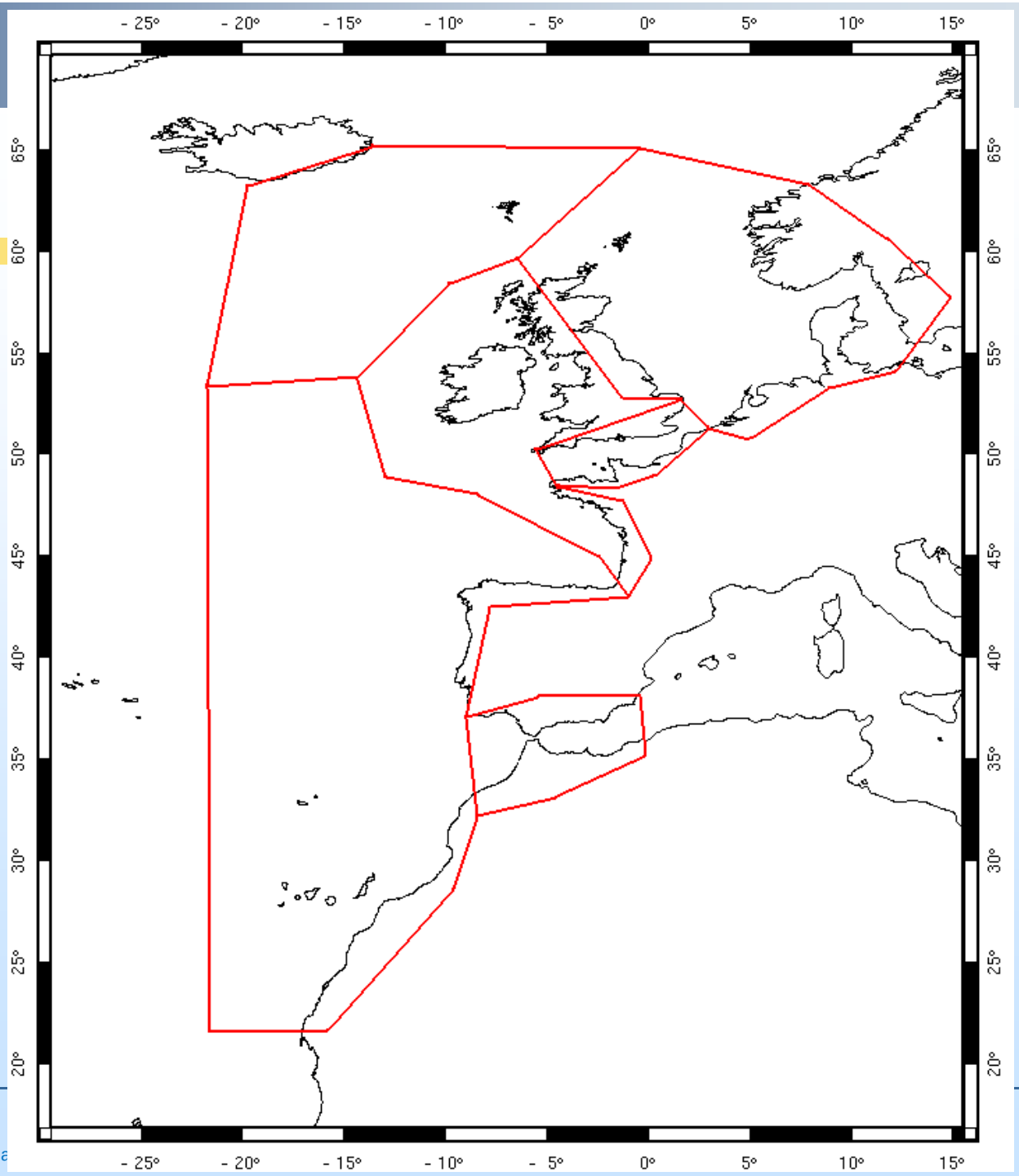
© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

MED Ensembles



© Noveltis 2010
Ce document est la propriété de Noveltis et ne peut être reproduit ou communiqué sans son autorisation.

- NEA Ensembles



Ce document est la