Realistic high resolution modeling of the Mediterranean Northern Current (NC) using the NEMO code : impact of model parameterization at lateral and open boundaries and validation with observations.

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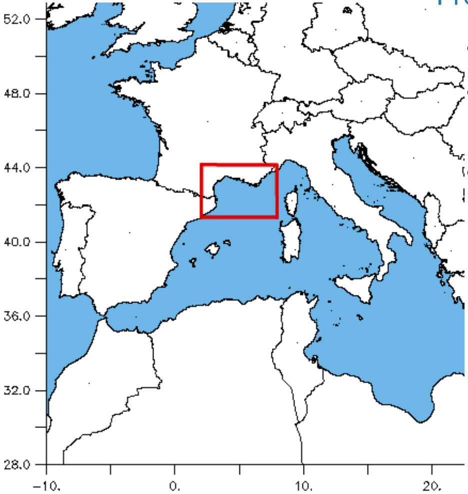
21-23 May 2012

Outline

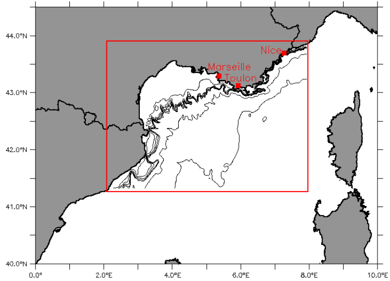
Outline

Geographic Situation and topography

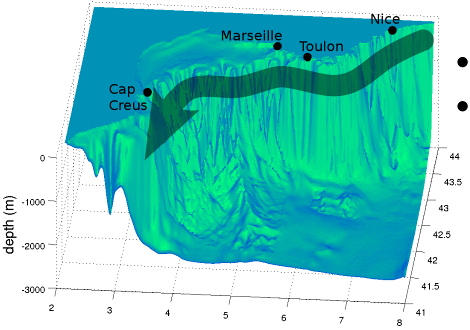


French Mediterranean Coast

- Very narrow shelf from Nice to Toulon
- Gulf of Lions shelf from Toulon to Spain
- Sharp shelf break

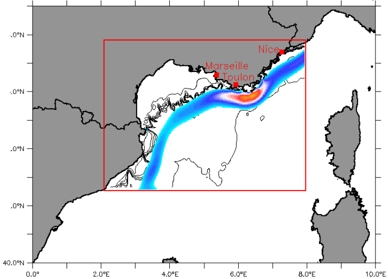


Circulation



Northern Current

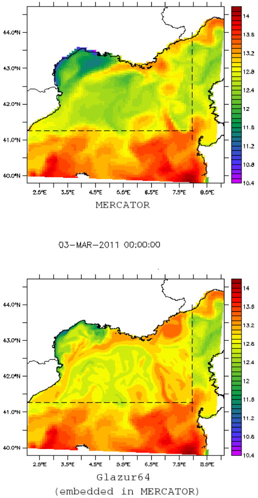
- Part of the general cyclonic circulation of the NW Mediterranean Sea
- Topographically guided
- 300m Depth, speeds up to $1\ \mathrm{m/s}$



GLazur64: NEMO downscaling at $1/64°$

Gulf of Lions and Côte d'AZUR at $1/64°$.

- NEMO code 3.2.1
- Horizontal resolution (377*170 pts) $\rightarrow 1/64°$ (≈ 1.5 km * 1.7 km).
- Vertical resolution $\rightarrow$ 130 levels (from 1 m at the surface to 30 m at the bottom).
- Standard parametrisation: Free surface, Partial steps, Bulk formulae.
- Specific parametrisation: OBC (Downscaling of $1/12°$) and runoff.
- Atmospheric forcings: ALADIN (Météo-France) - 3h, ≈ 10 km.



Simulations

Long-term simulation

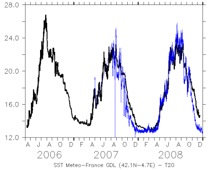
Simulation	Period	Lateral Forcing	Lateral Condition
T20	2006 - 2008	MED12	Freeslip
T21	2008	PSY2V3	Freeslip

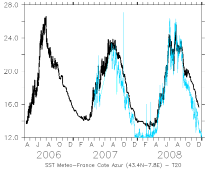
PHYOCE simulation

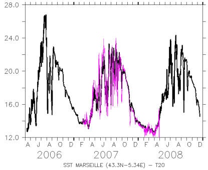
Simulation	Period	Lateral forcing	Lateral Condition
T24_freeslip	12/2010 - 05/2011	PSY2V4R1	Freeslip
T24_noslip	12/2010 - 05/2011	PSY2V4R1	Noslip

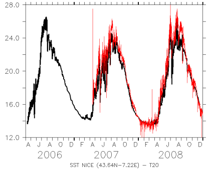
Outline

SST

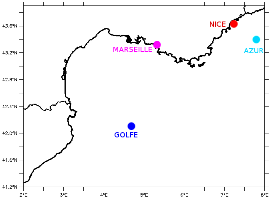








4 Buoys in GLazur64 region from 2006 to 2009: Validation of T20 simulation



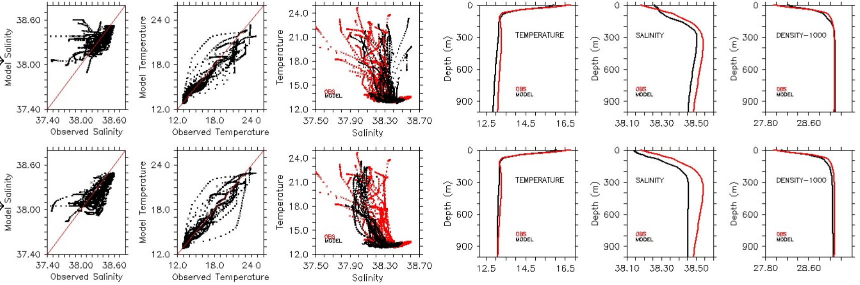
- Coastal area: good agreement between model and measurements (Nice and Marseille Moorings)
- Offshore : the model does not cool down fast enough in winter (Azur and Golfe Moorings)

$\Longrightarrow$ **Good parametrisation of surface flux.**

ARGO

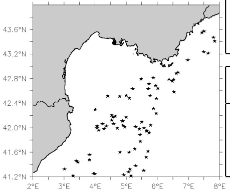
T20 →

T21 →



4 ARGO buoys in 2008 (→ 75 profils → 6119 points)

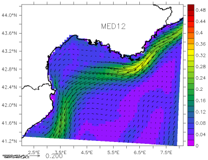
- T20: Bias in Salinity and Temperature, but water masses correctly reproduced
- T21: Correct in temperature, strong bias in salinity (no LIW)



RMSE	T20	T21
Salinity	0.121644	0.126603
Temperature	0.658192	0.54523

MRD	T20	T21
Salinity	0.000082	0.001652
Temperature	0.00987	0.00417

Mean circulation over 1 year and 150m



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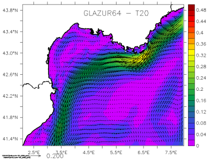
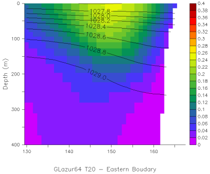
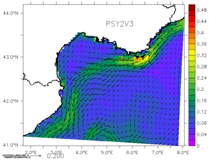


T20, forced by MED12: the NC is wider, 300m deep, too far from the coast.





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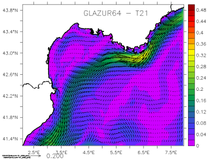
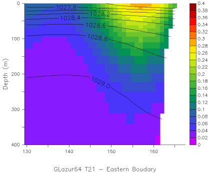
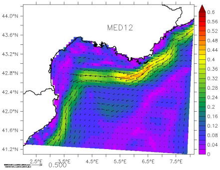


T21, forced by PSY2V3: the NC is narrower, 350m deep, closer to the coast.



- On the shelf → the dynamics is peculiar to GLazur64.
- Offshore → GLazur64 simulations inherit from the Open Boundaries datasets geostrophic dynamics.

Snapshot of circulation over 150m (2008/12/01)



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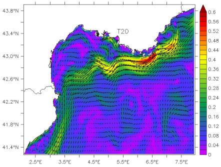
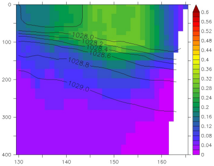
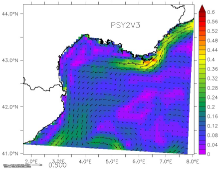


T20, forced by MED12 : Strong NC and many mesoscale processes.





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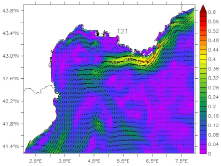
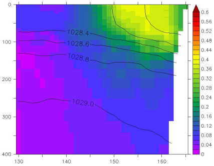
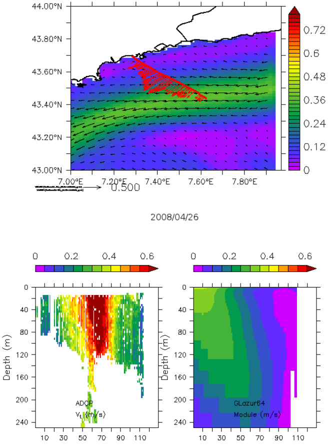


T21, forced by PSY2V3: the NC is slower but also many mesoscale processes.



GLazur64 recreates its own NC dynamics. Generation of many mesoscale processes (offshore and on the shelf)

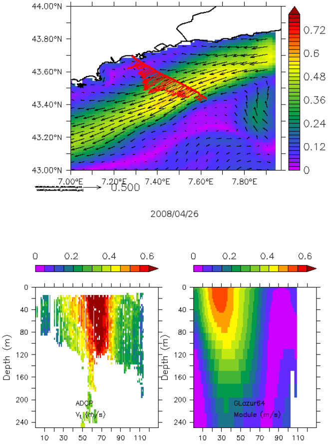
ADCP



T20, forced by MED12 (left): NC too far from the coast and too weak.

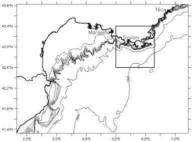
T21, forced by PSY2V3 (right): NC closer to the coast and stronger

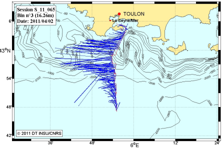
$\Longrightarrow$ **T21 is in good agreement with ADCP data, despite an underestimated intensity**



Outline

PHYOCE

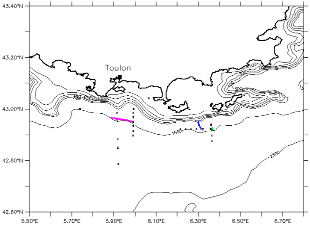


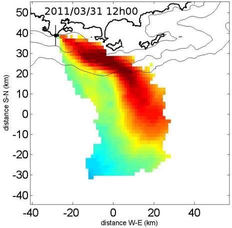


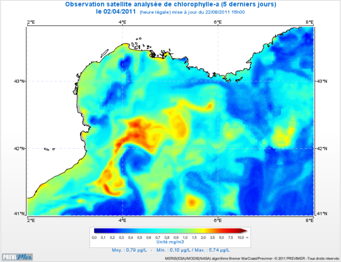
Scholar cruise off Toulon

Conjointly use of in-situ data (CTD, Drifters, ADCP, HF Radar), satellite and modeling

$\Longrightarrow$ Observation of a NC meander



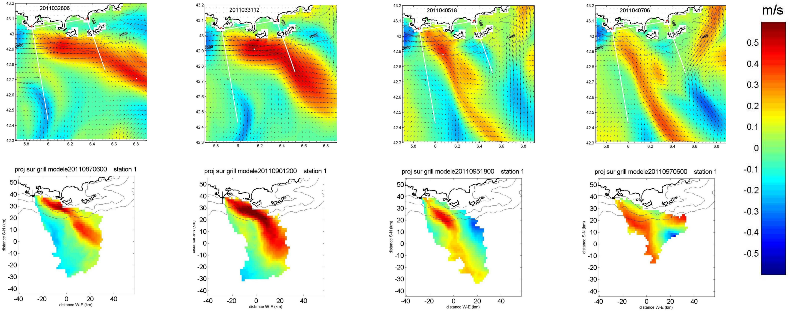




Comparison between HF radar and modeling

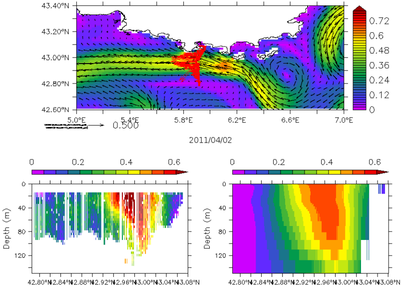
Model Radial velocity →

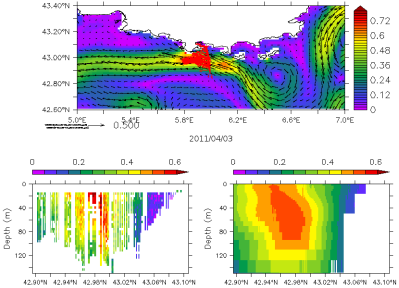
Radar Radial velocity →



1. 2011/03/28: The meander arrives in the radar area.
2. 2011/03/31: Strong meander, almost northwards.
3. 2011/04/05: The eddy can be observed in the radar field.
4. 2011/04/07: Radar: the eddy flows south and the Nc flows back along the coast. Model: The NC still meanders around the eddy.

Dynamical observation: ADCP

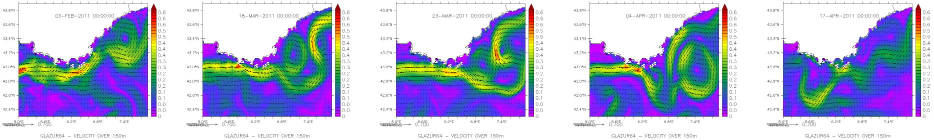




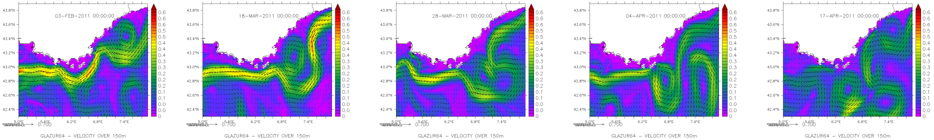
- NC Core well positionned.
- correct NC depth.
- But NC magnitude too weak.

Origin and history of the Meander: Freeslip vs Noslip

Freeslip run:

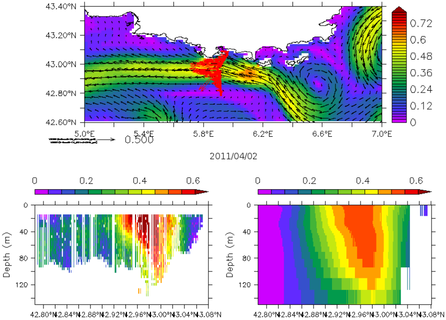


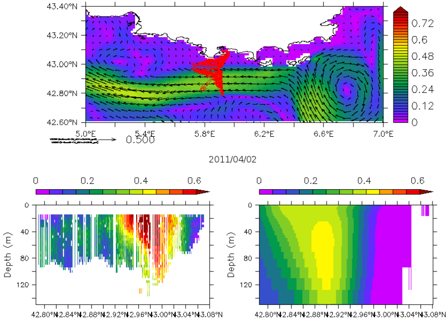
Noslip run:



- Before the PHYOCE experiment: both simulations agree.
- During the PHYOCE experiment: the meander exists in both simulations, but the NC have a different behaviour eastward.
- After the PHYOCE experiment: the simulations are very different.

Freeslip VS Noslip : ADCP validation





Freeslip case: Good position and width of the NC core, despite an underestimation of the intensity.

Noslip case: NC too far from the coast and too weak. Less realistic.

$\Longrightarrow$ **The freeslip simulation is more realistic**

Outline

Conclusion

Contribution of the High-resolution model

- Good assimilation of surface fluxes
- Water masses and geostrophic dynamics of the model generally in line with observations.
- The high-resolution model recreates its own mesoscale dynamics.

Problems encountered

1. NC magnitude generally underestimated
2. Some incertainties in the mesoscale dynamics:
   - ... inherited from the basin-scale model...
   - ... or intrinsic to GLazur64 ?

Perspectives

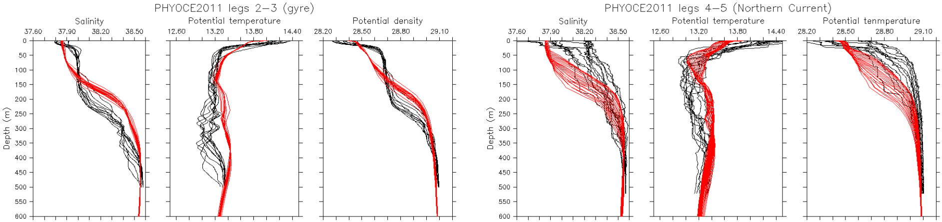
How to improve the model ?

1. NC magnitude generally underestimated
$\Longrightarrow$ **Increase of the vertical resolution on the intermediate layer (100-400m), to better reproduce the NC vertical structure.**

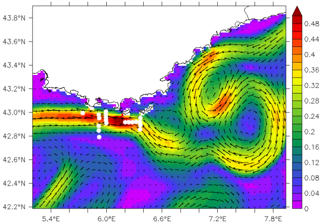
2. Some incertainties in the mesoscale dynamics:
   - ... inherited from the basin-scale model...
     $\Longrightarrow$ **Work on the OBC, in order to better control their impact ($\rightarrow$ tangential velocity)**
   - ... or intrinsic to GLazur64 ?
     $\Longrightarrow$ **Ongoing work on lateral friction ($\rightarrow$ viscosity, partial slip?)**

Thank you for your attention

Hydrological observation: CTD profiles

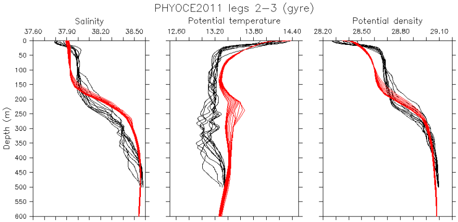


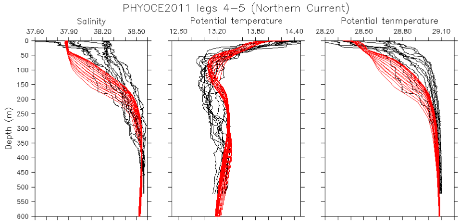
PHYOCE Period (30 March - 03 April)



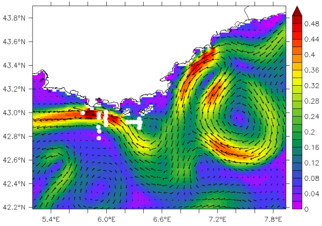
- In the gyre → desagreement between CTD and model salinity profiles
- In the NC → Halocline too deep in the model, but NC well positionned

Hydrological observation: CTD profiles





4 Days later (03 -07 April)



- In the gyre $\rightarrow$ Model salinity profil closer to CTD profils
- In the NC $\rightarrow$ Halocline less deep, closer to CTD profils

$\Longrightarrow$ The model represents with 4 days of delay the meander.

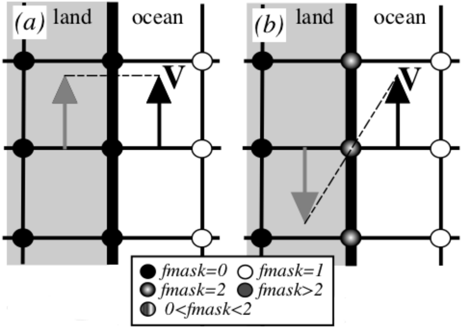
Boundary condition at the coast: Freeslip/Noslip case

Freeslip case (rn_shlat=0)

Normal velocity = 0
Tangential velocity = V
Vorticity = 0

Noslip case (rn_shlat=2)

Normal velocity = 0
Tangential velocity = 0
Vorticity $= 2(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y})$



From Madec2008