Update on SHOM activities

On behalf of R. Baraille
and co.

Three configurations:

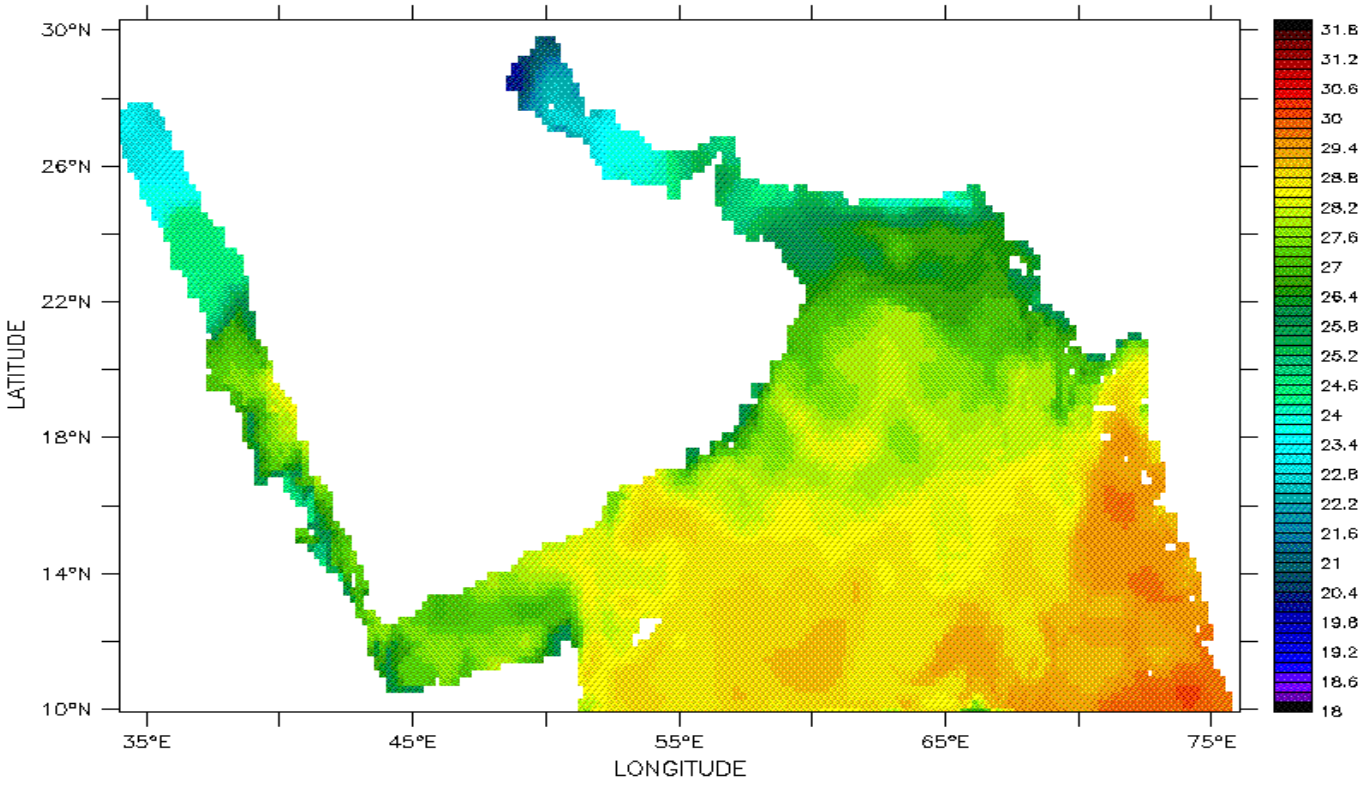
-Indian Ocean

-North Atlantic

-Bay of Biscay

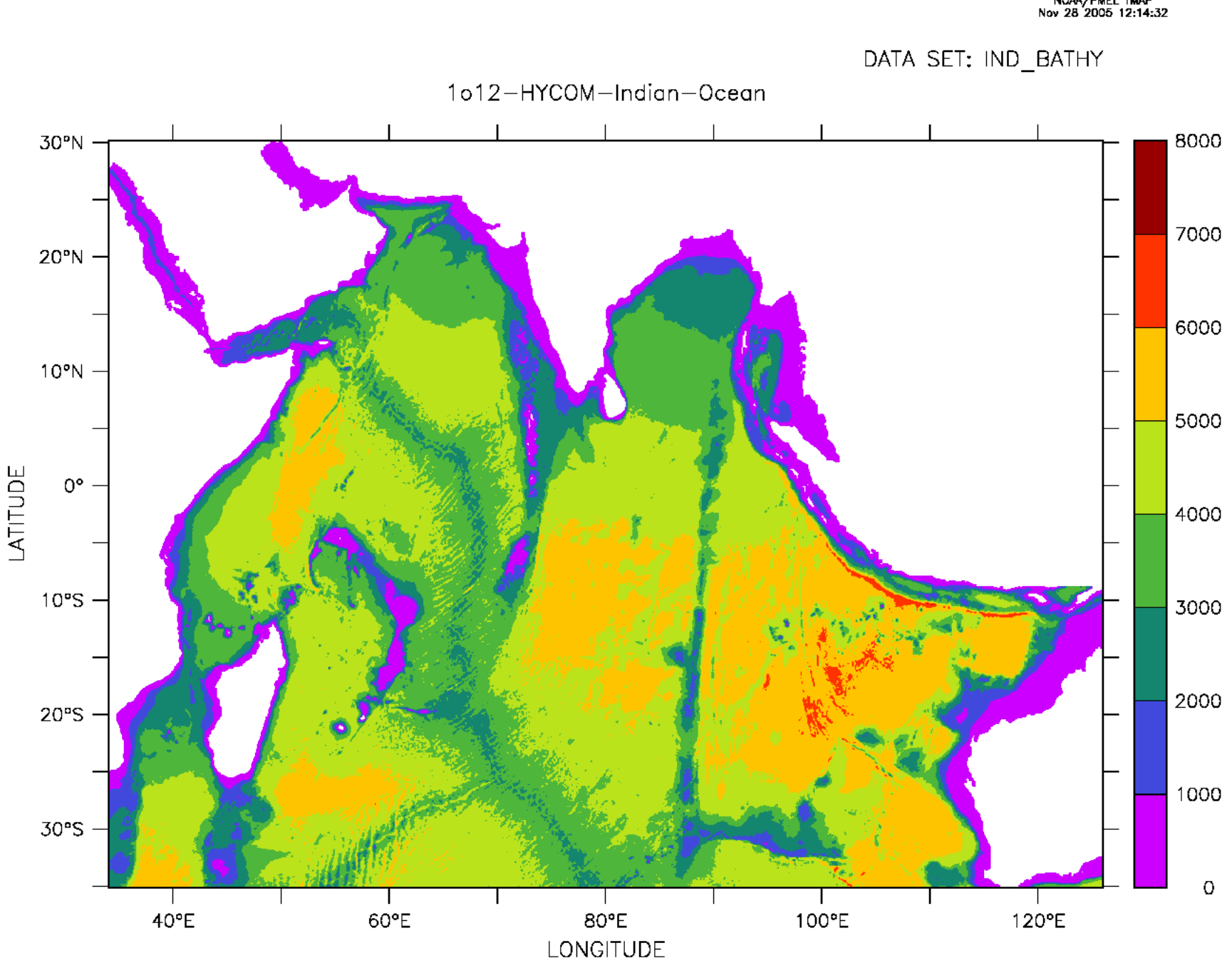
Indian Ocean

- present configuration «Arabiquart» at 1/4º
- runs operationally



Indian Ocean

- Increase of horizontal resolution to 1/12º and 1/24º
- Increase the domain size to cover the Arabian Sea
- Nesting within the global 1/12º HYCOM or the 1/12º Indian Ocean configuration (A. Srinivasan/J. Metzger)
- Refinement of topography in passages
- Implementation of same data assimilation technique as used in the North Atlantic



Indian Ocean Bathymetry (m)

Atlantic Ocean

- Older configuration ATN 1/3º (28ºS-70ºN) 421x403x26
- Runs in real time on demand
- Automatic scripts and generation of web
- Used as a platform to test :
  - parameterizations
  - numerical schemes
  - assimilation (in situ, adjoint, adaptive filter)

Atlantic Ocean

- Latest configuration ATN (1/12º 28ºS-70ºN) 1678x1609x28 (based on one of T. Townsend σ_2* configuration)
- Addition of external routines for visualisation, restart, and (visu, restarts, split,…), full sea surface height (*i.e.*, 1+η)

- Preliminary tests on 4,8,16,32,64 IBM processors

4 processors => 2h / 1 jour d'intégration

8 processors => 1h / 1 jour d'intégration

16 processors => 34' / 1 jour d'intégration

32 processors => 22' / 1 jour d'intégration

64 processors => 14' / 1 jour d'intégration

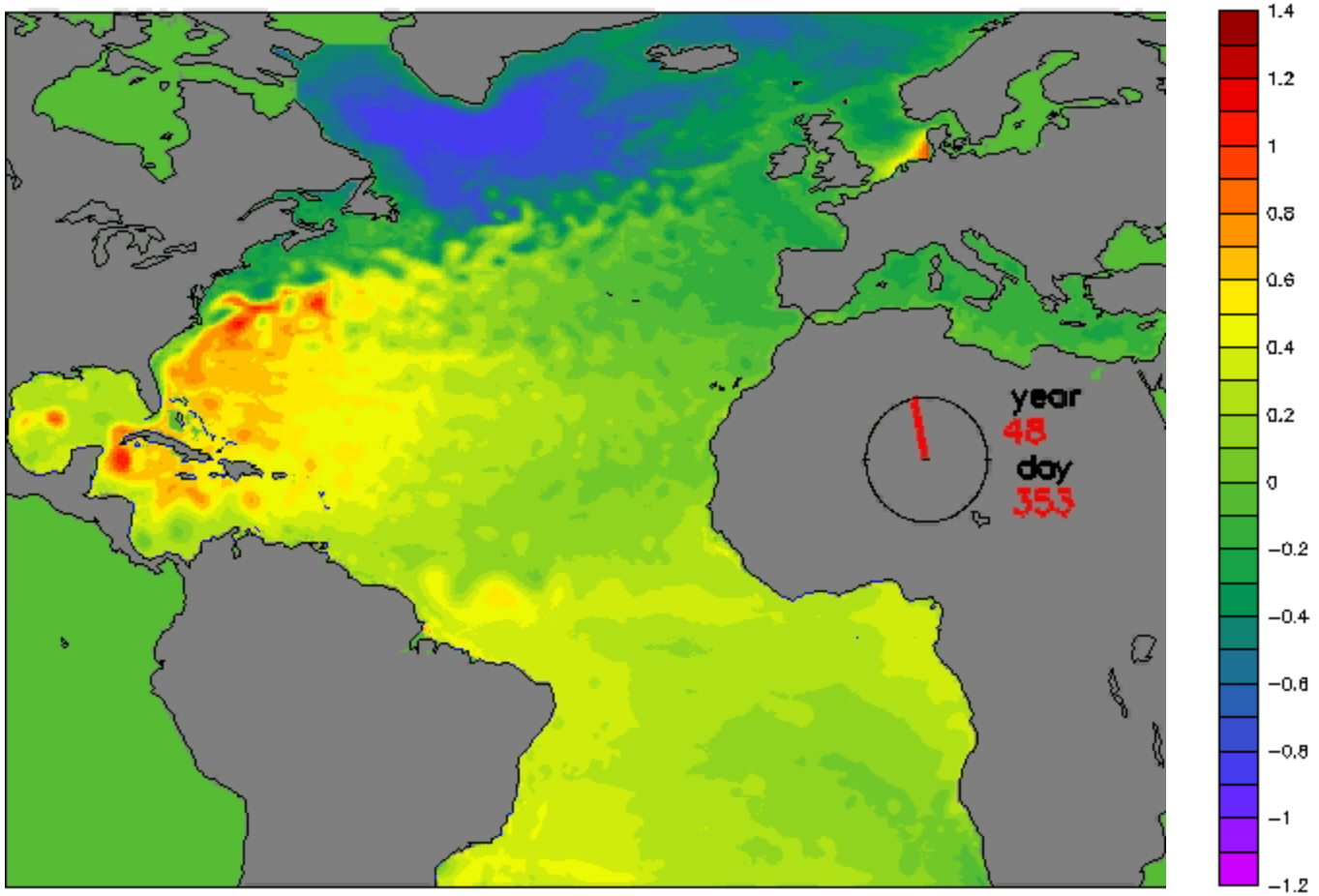
x 2

x 1,76

x 1,55

x 1,55

HYCOM 1/12º North Atlantic

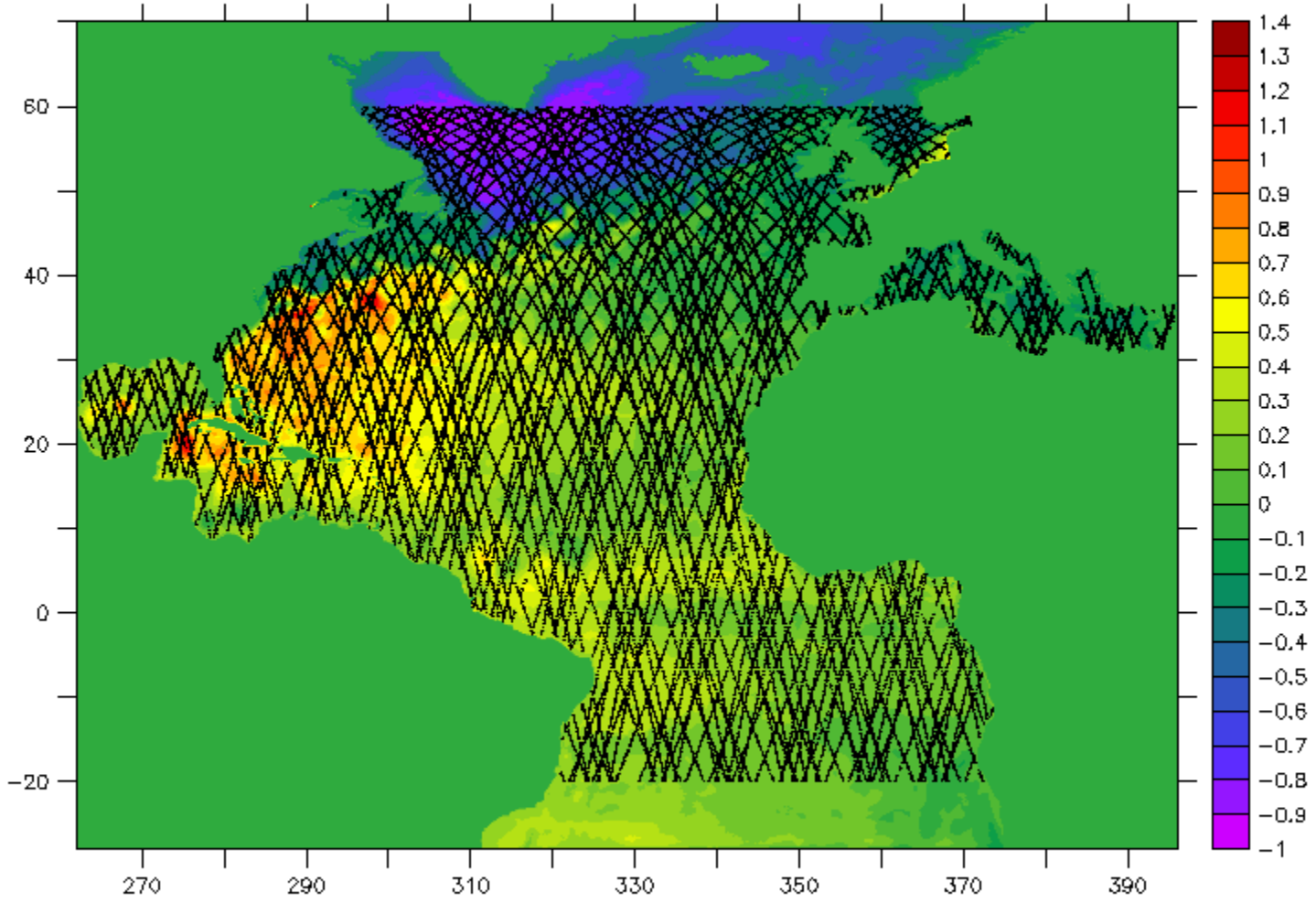


SSH

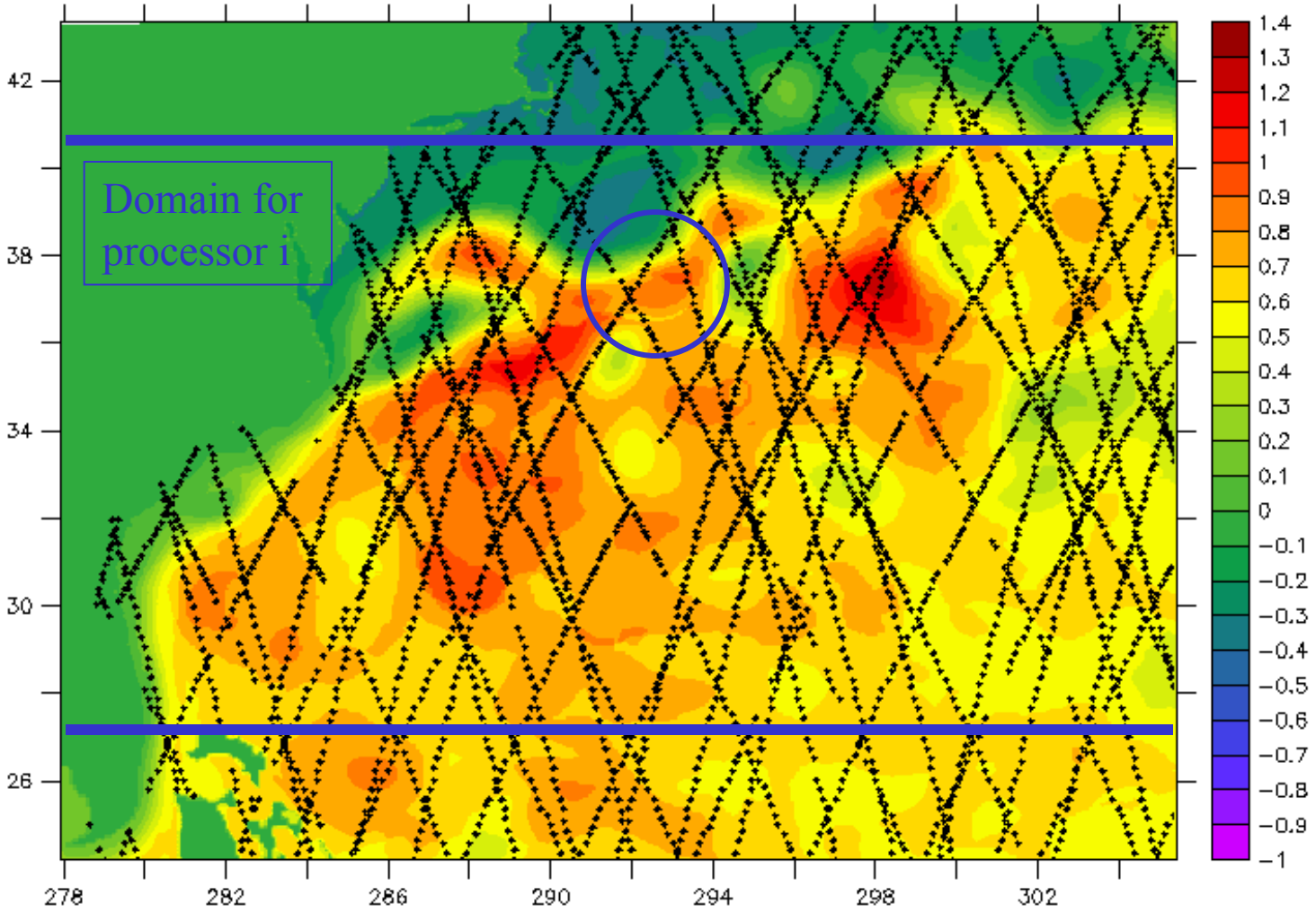
- Assimilation of SSH anomaly under the altimeter tracks
- 80000 observations in a 10-day
- The correction is computed as follows:

$$MH^T\left(HMH^T + R\right)^{-1}\zeta$$

- Takes a fair amount of memory and CPU time


60
40
20
0
−20
270
290
310
330
350
370
390
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
−1

Data selection



- Data acquisition in parallel
- Selection of data within the time window, removal of co-located data, etc.
- Algorithm gives

- Parallelization of two algorithms to compute

$$X=\left(HMH^T+R\right)^{-1}\zeta$$

Minimization of

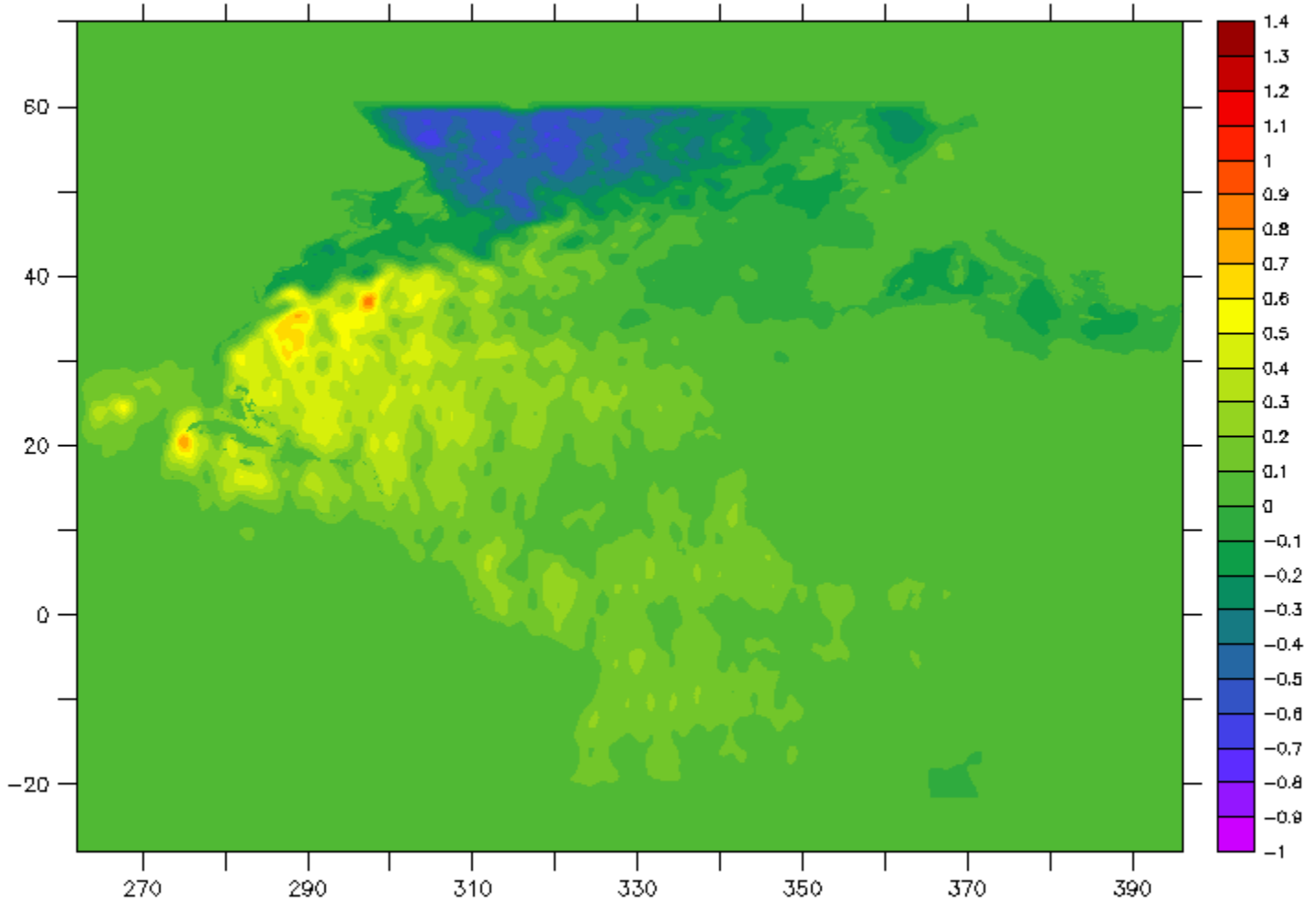
$$J(X)=\frac{1}{2}\left\langle\left(HMH^T+R\right)X,X\right\rangle-\left\langle\zeta,X\right\rangle$$

Limited memory
Quasi-Newton

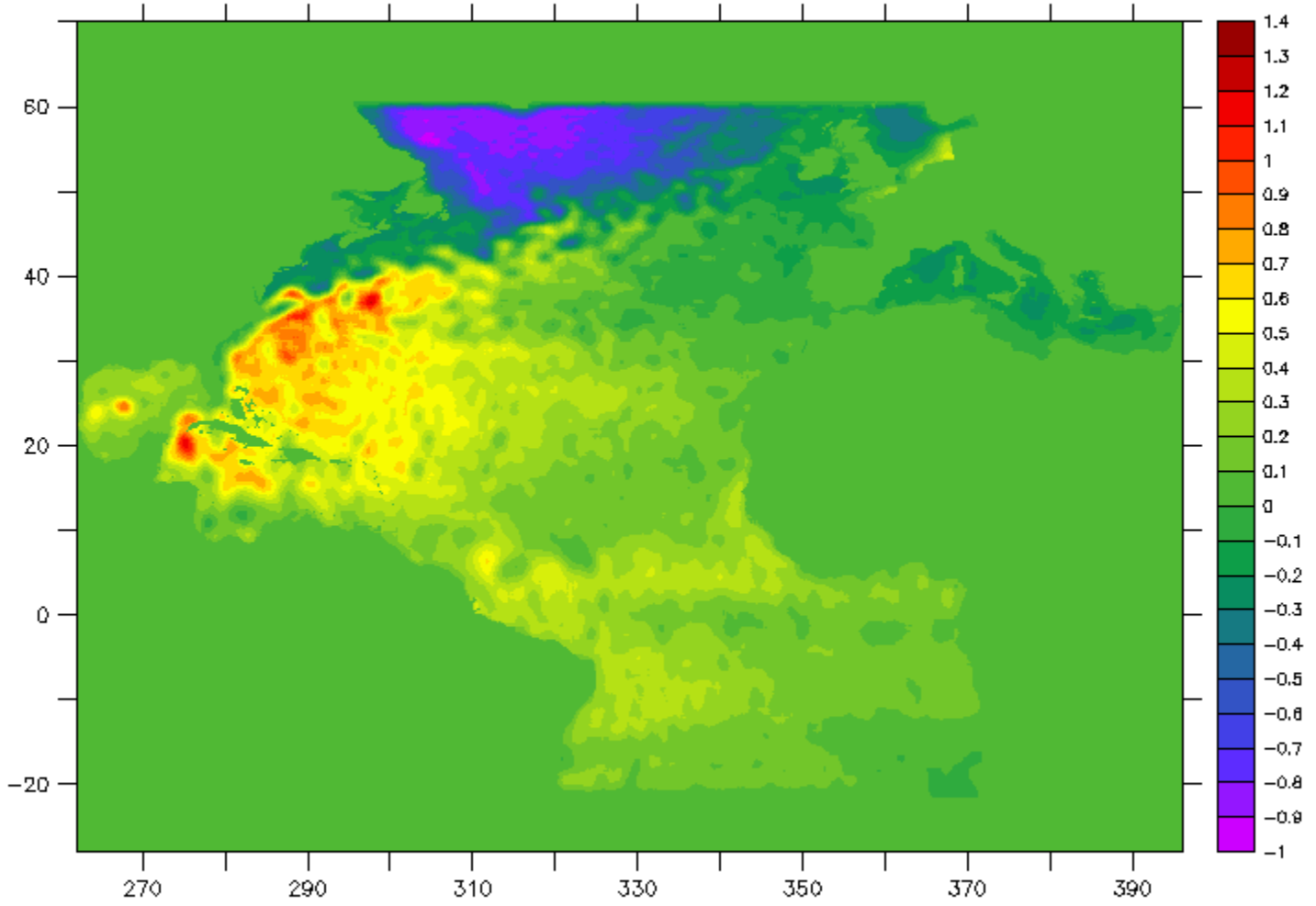
Solving for

$$\left(HMH^T+R\right)X=\zeta$$

Preconditioned conjugate gradient method



Quasi-Newton – Precision of 10^{-6} – Data within a circle of 200km
RMS error for observations: 12,5

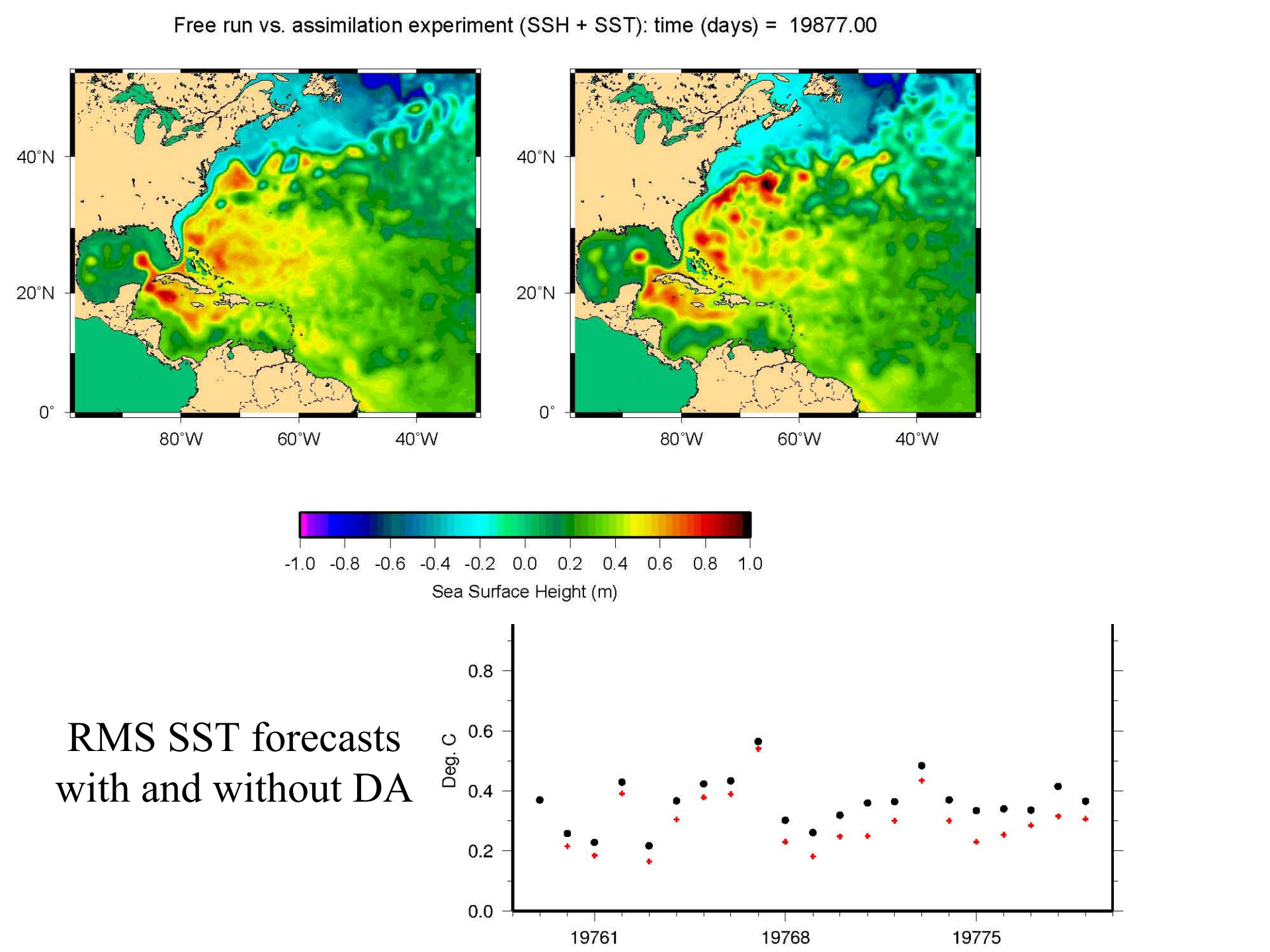


Gradient conjugate – Precision of 10^{-9} – Data within a circle of 200km
RMS error for observations: .75

Status of North Atlantic data assimilation

Reference level for cooper-Haines was chosen as function of the statification at the base of the thermocline.

The parameter that controls the layer thickness for downward projection was optimized.

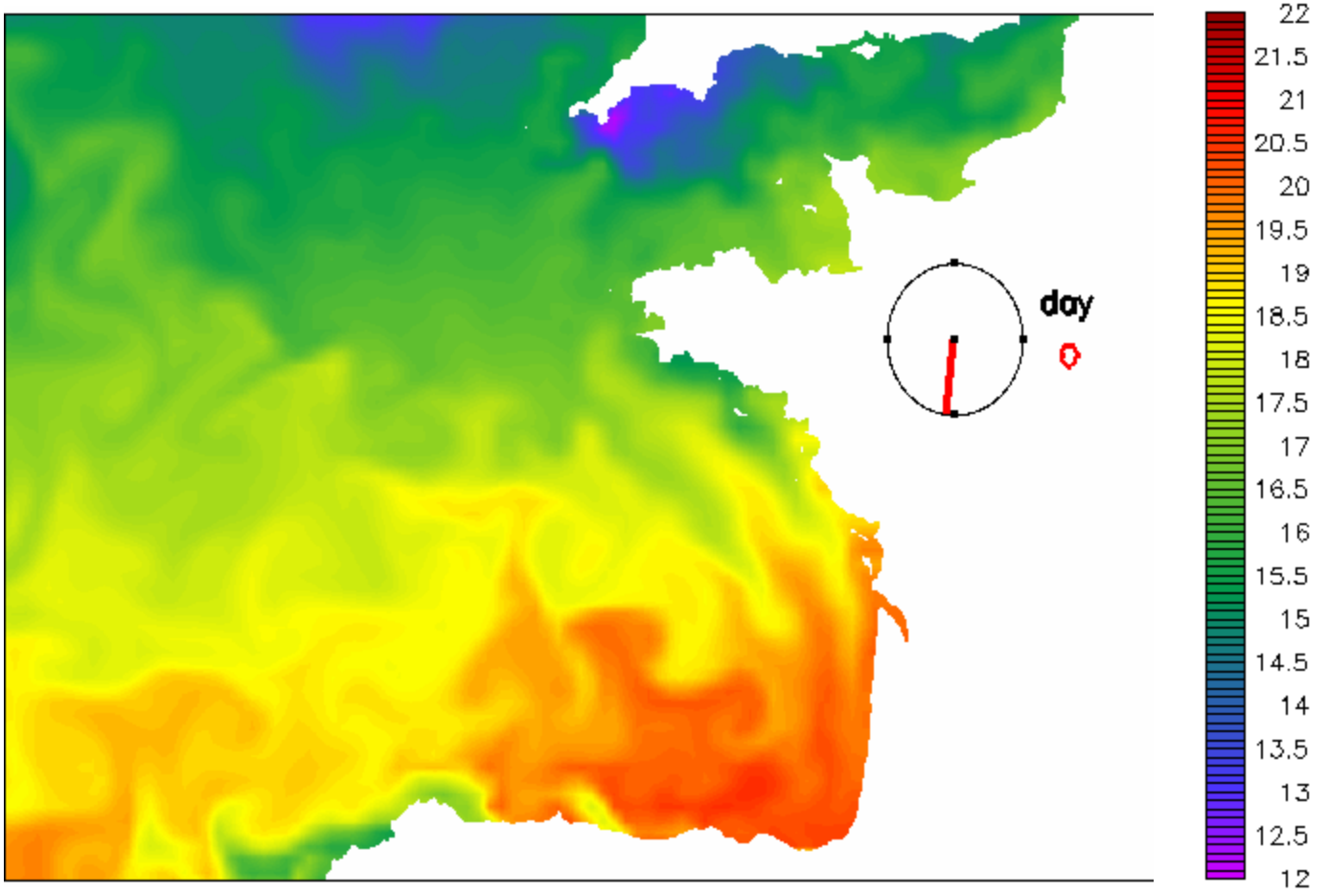


RMS SST forecasts with and without DA

Linear tangent and adjoint update

- Completed by N. Filatoff
- Will soon become available on the HYCOM web site as a tar file
- Ready for beta testing – we are looking for volunteers
- Based on HYCOM 1.0, but many updated routines – will soon be updated to latest HYCOM version
- Code includes CPP keys for ease of use

Bay of Biscay

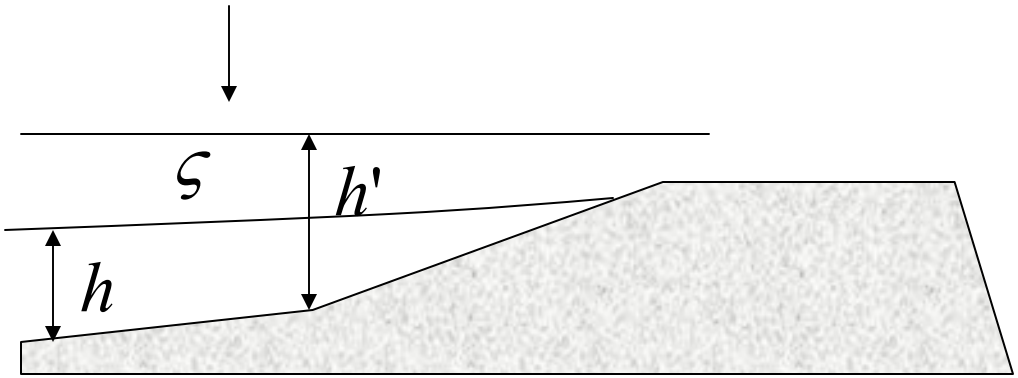


- Wetting and drying
- Tidal effects
- Regional zooms

- Modifications made to the barotropic solver to allow for zero layer thicknesses
- η does not have to be small in front of 1 anymore
- One needs to realize that η becomes equal to -1 when the layer thickness vanishes (even if dp non zero)

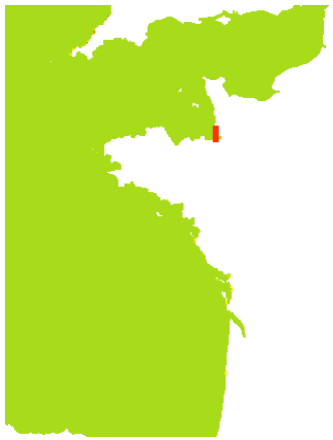
$$h=(1+\eta)h'$$

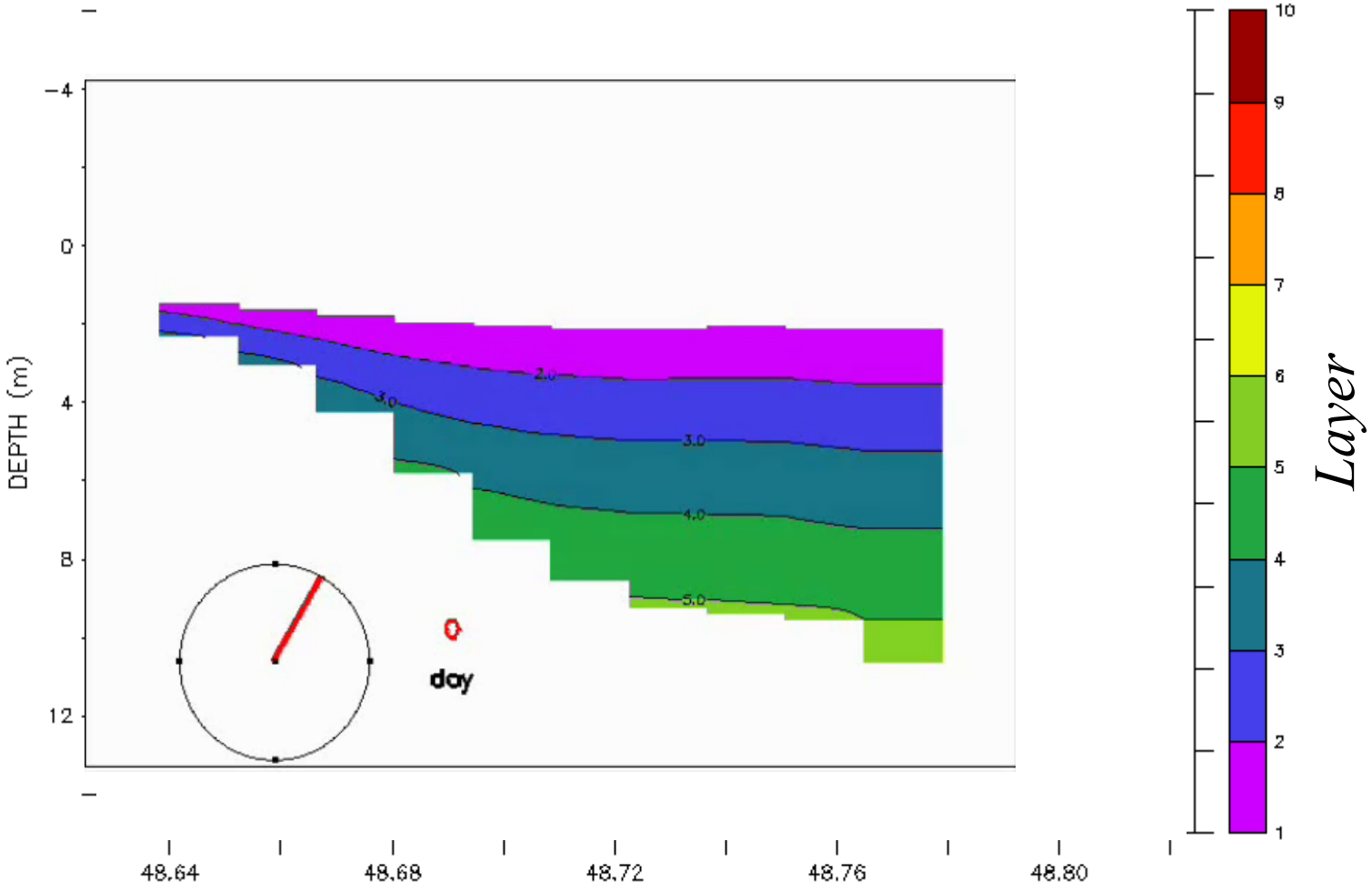
$$\eta=\frac{\varsigma}{h-\varsigma}$$



- One needs to thin in physical unsplit variables (layer thickness h, dp) instead of the split variables (h', dp').

Vertical section at 1.64°W in the bay of Mont S^{t} Michel



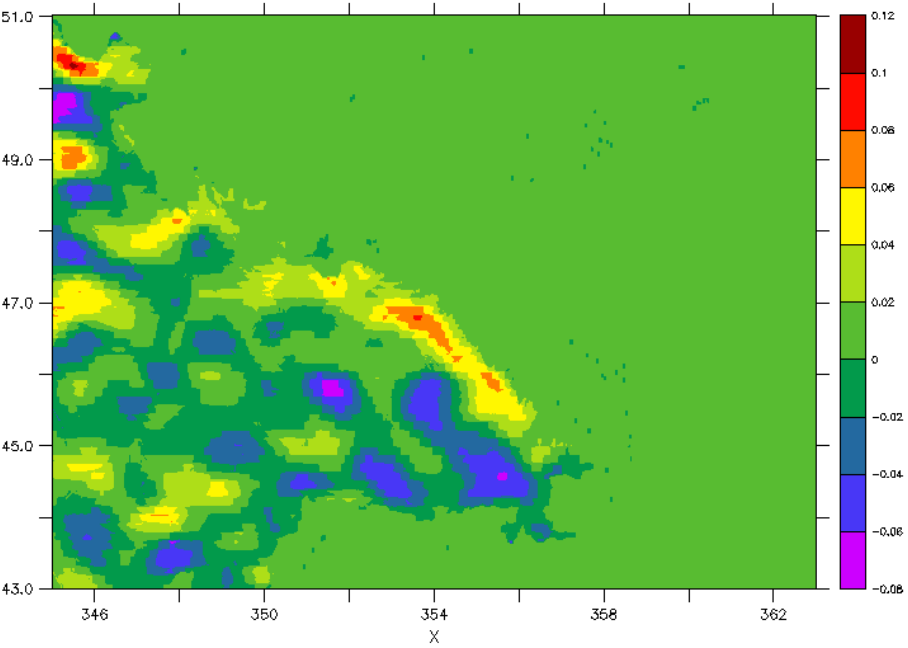


Layer thicknesses (in meters)

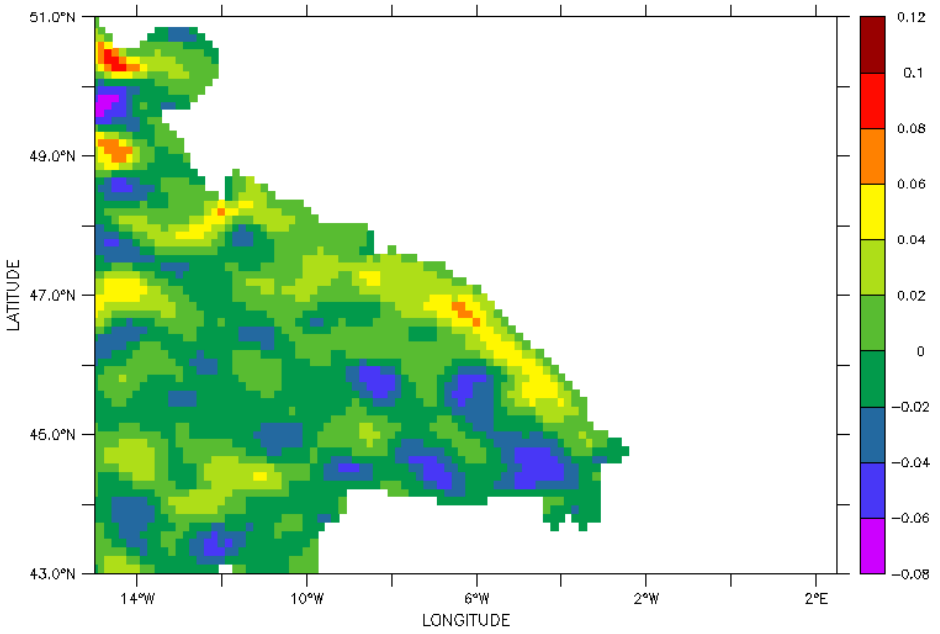
Bay of Biscay configuration

- Modification of open boundary conditions to
  - take into account the unsplit physical variables (*i.e.*, h instead of dp')
  - different update for tides and mesoscale features
- Initial and boundary conditions from MERCATOR

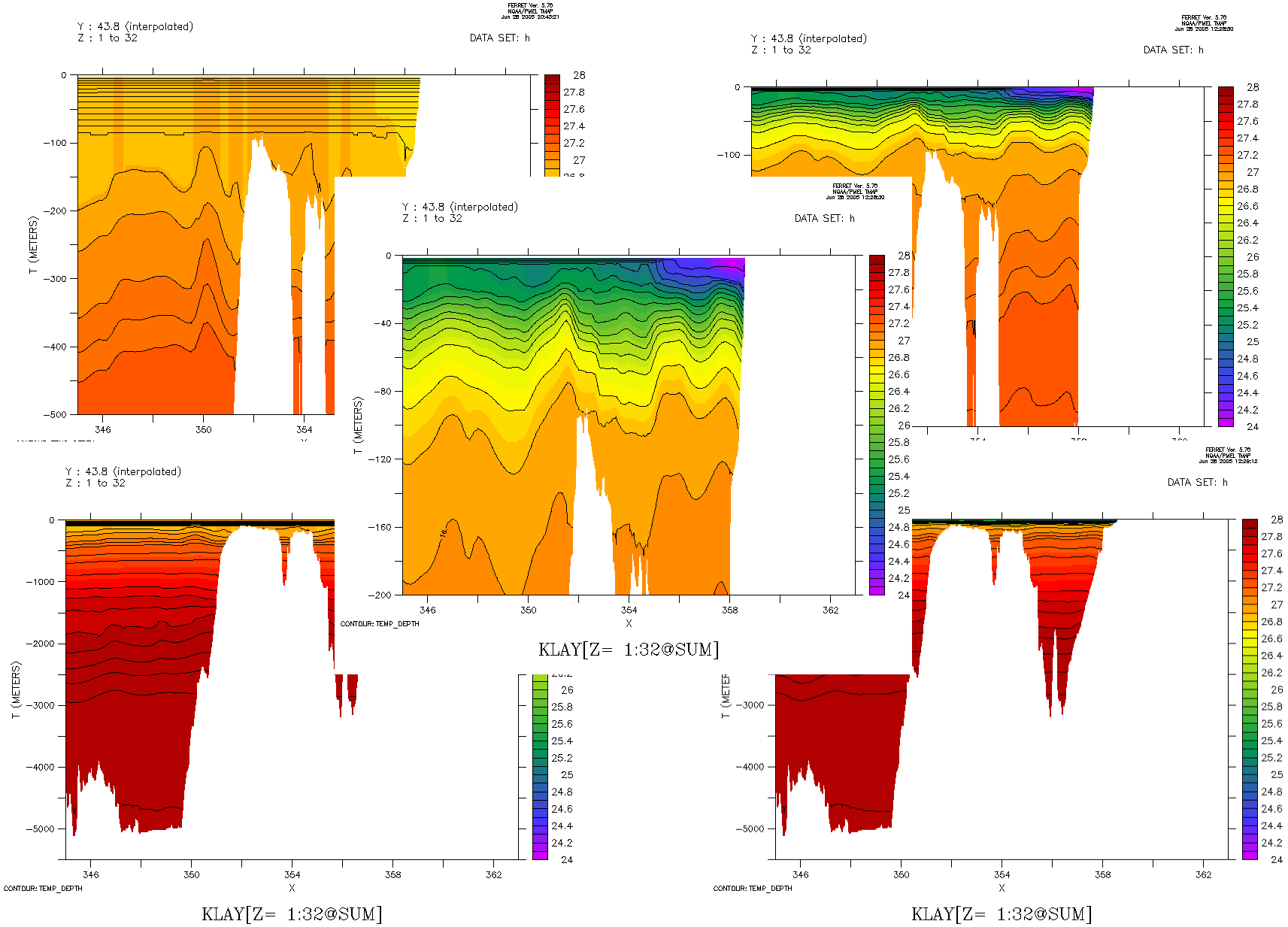
HYCOM geostrophic zonal velocity in layer 24 (2000 to 2400 meters



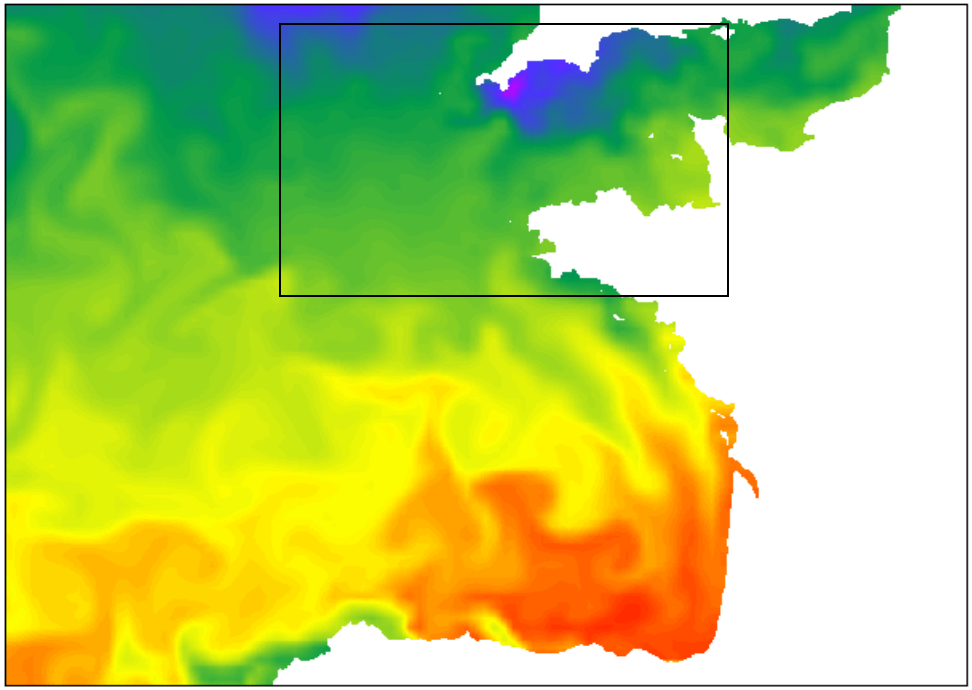
MERCATOR zonal velocity at 2250 m



Bay of Biscay configuration



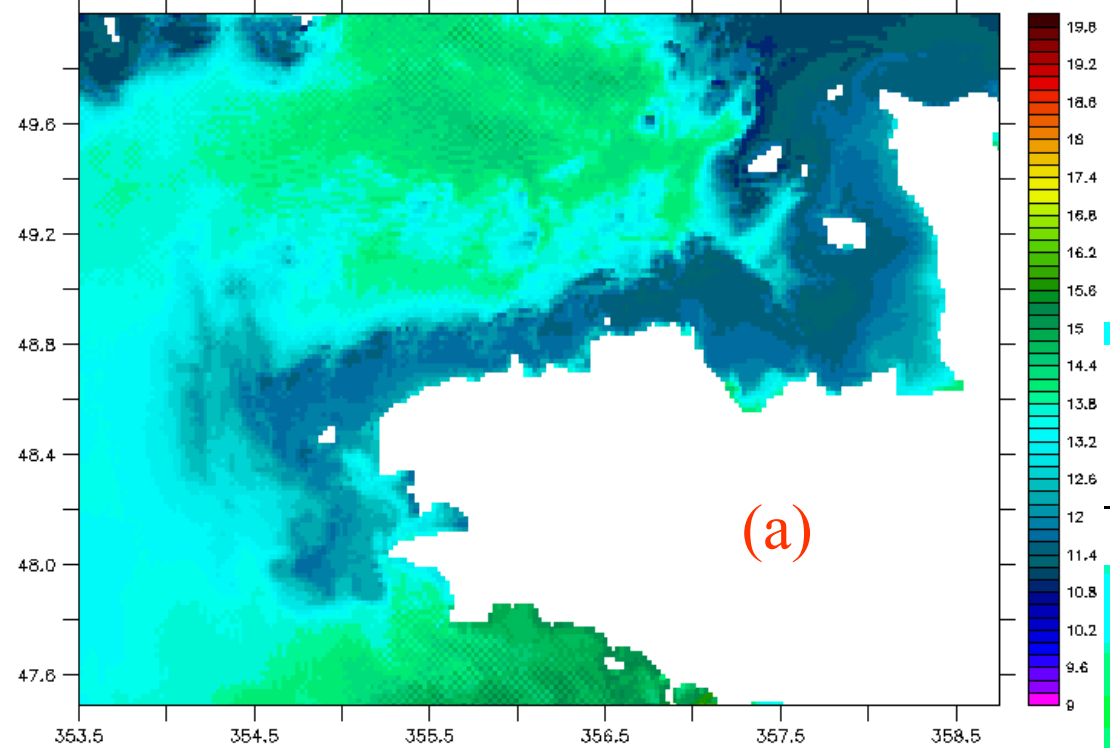
Regional zoom

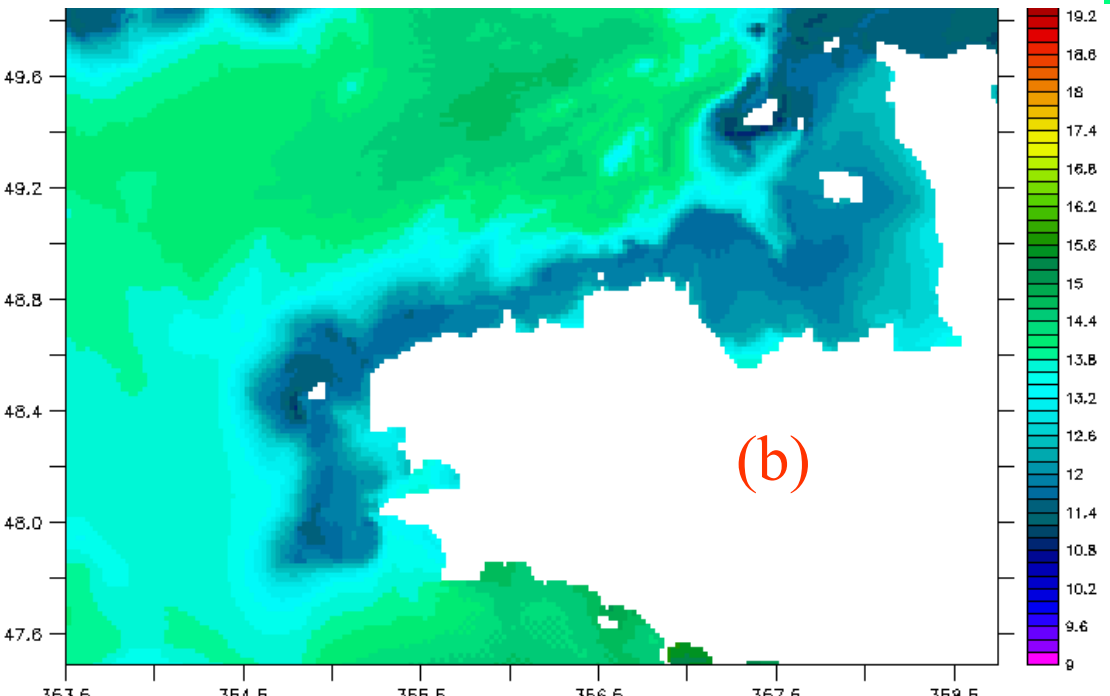


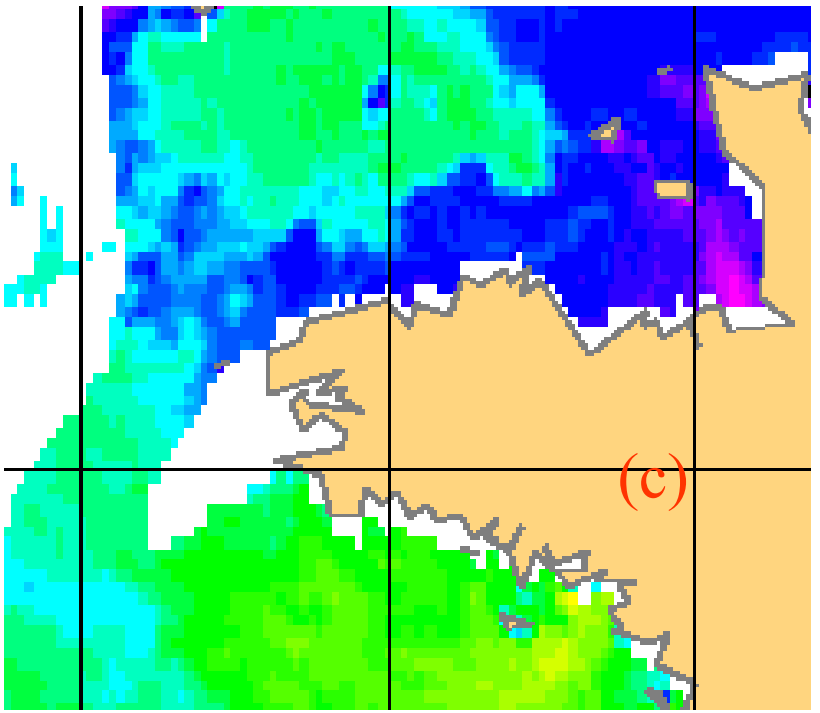
- same resolution

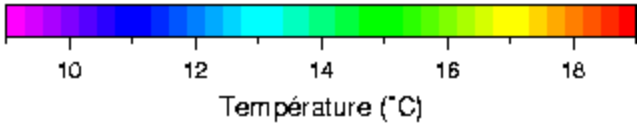
- investigation of various atmospheric forcing

- test of wetting and drying, open boundary conditions, tidal impact, etc.









Comparaison on 20/05/2004 between SST from HYCOM (regional configuration (a) and zoom (b)) and observations (c)