

Meso and submeso scale processes in the upwelling system off Southern Peru as observed from glider data

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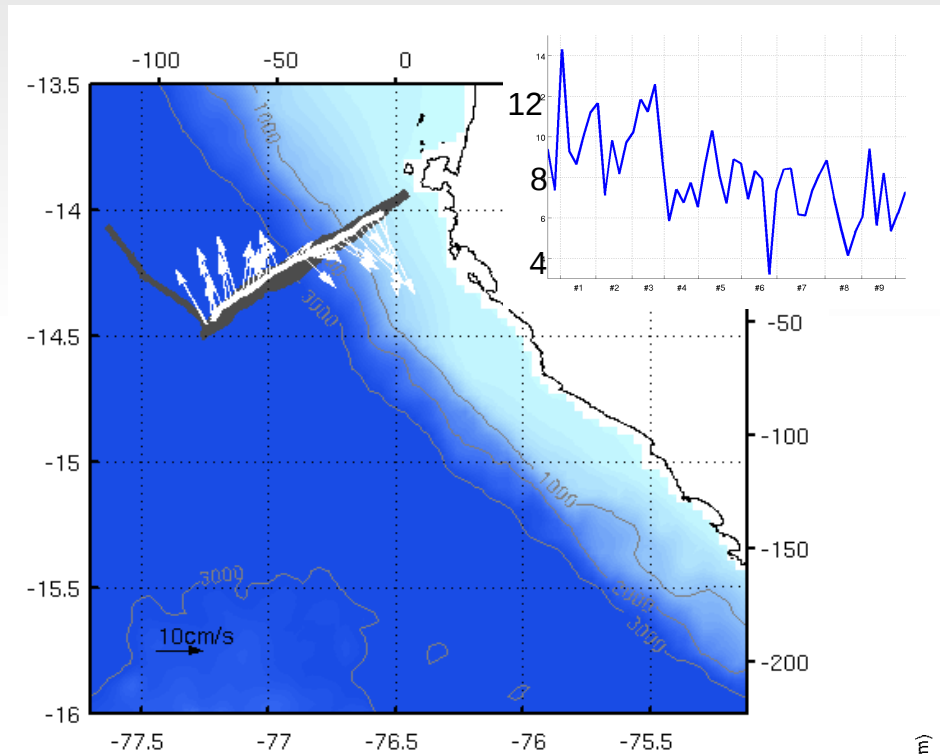
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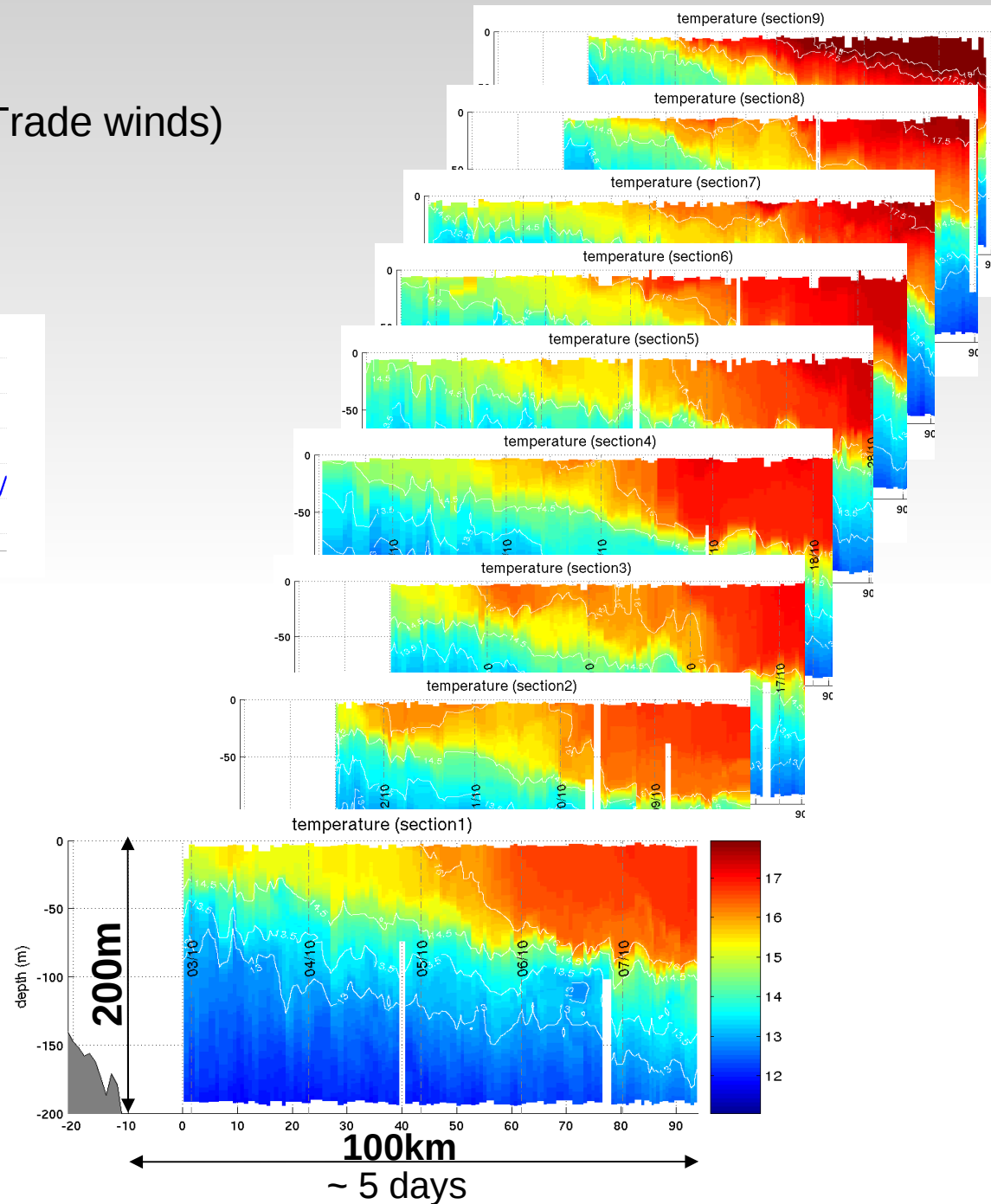
Thanks to L. Beguery and K. Bernardet

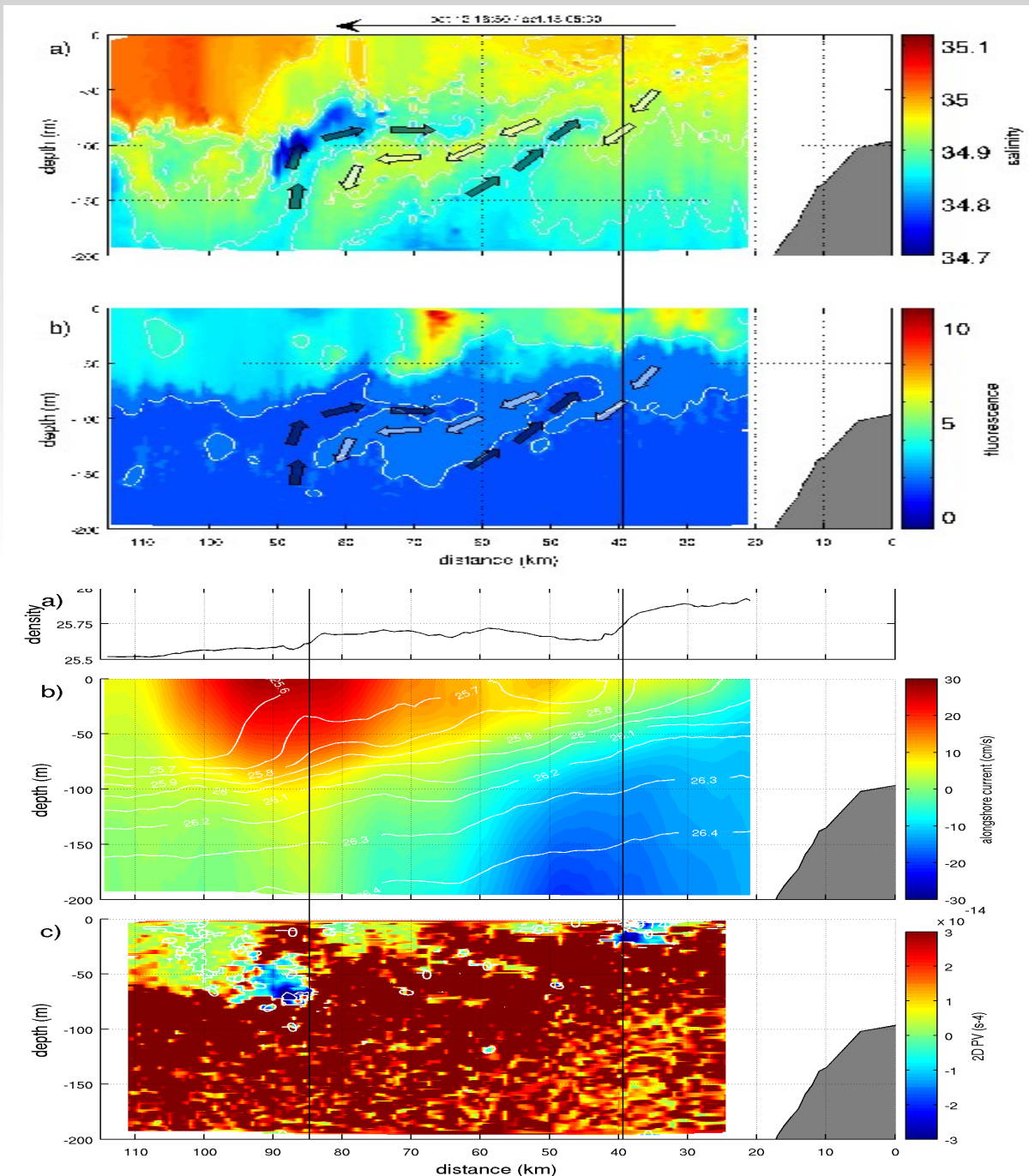
Pisco (14°S, Peru) :

- Year long Equatorward coastal winds (Trade winds)
- Strong upwelling cell



9 across shore sections
200m deep / 100km long / ~ 5 days





Wind driven ageostrophic secondary circulations due to inertial instability :

2D Potential Vorticity :

$$q = f \left(N^2 \left(f + \frac{\partial v}{\partial x} \right) - \frac{\partial v}{\partial z} \frac{\partial b}{\partial x} \right)$$

negative PV due to horizontal density gradient and vertical shear

- Horizontal scale :

$$q_{ml} \approx [-1.10^{-14} - 3.10^{-14}] s^{-4}$$

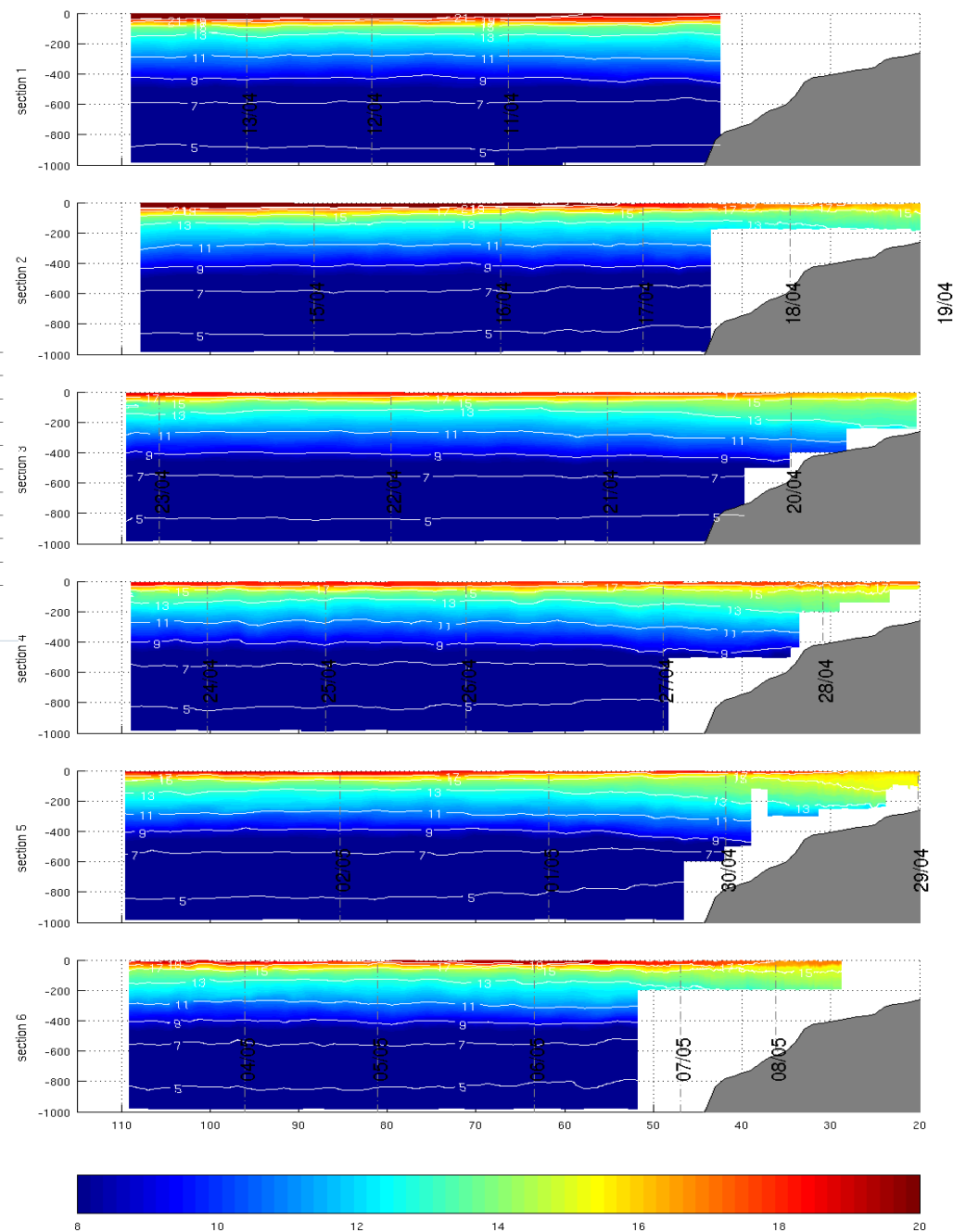
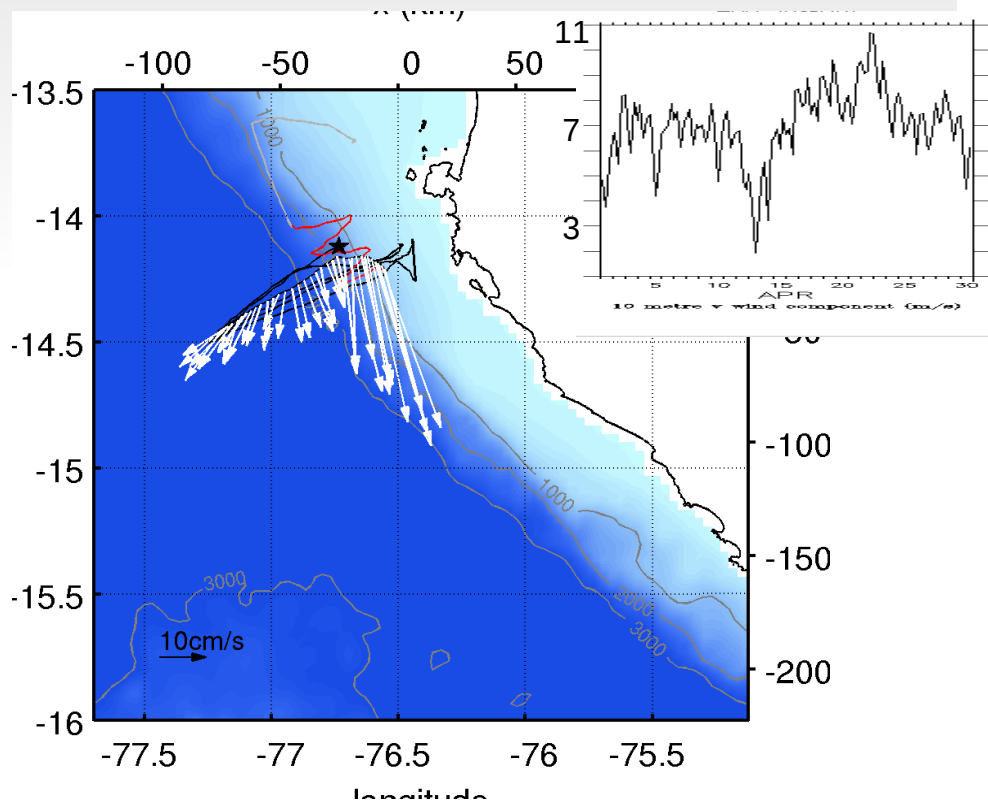
$$L_0 \approx [15 - 30] km$$

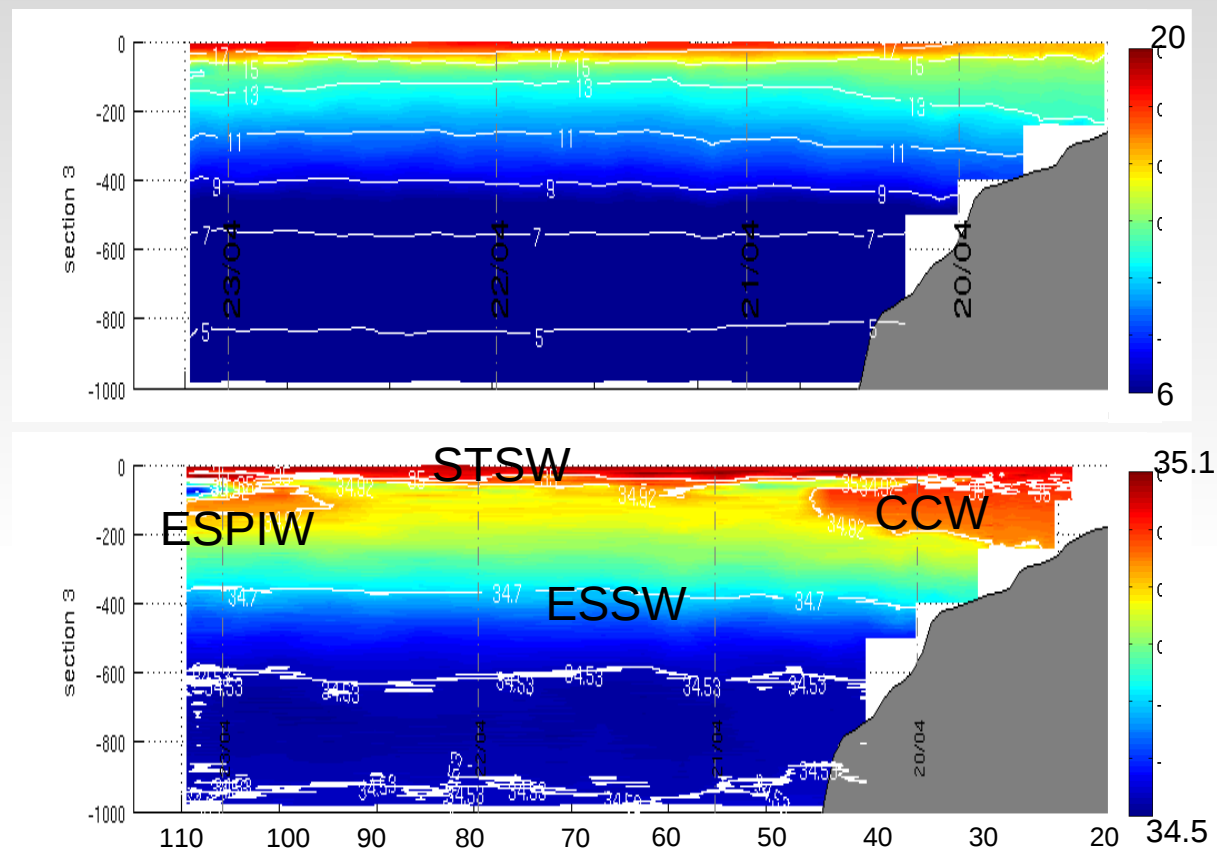
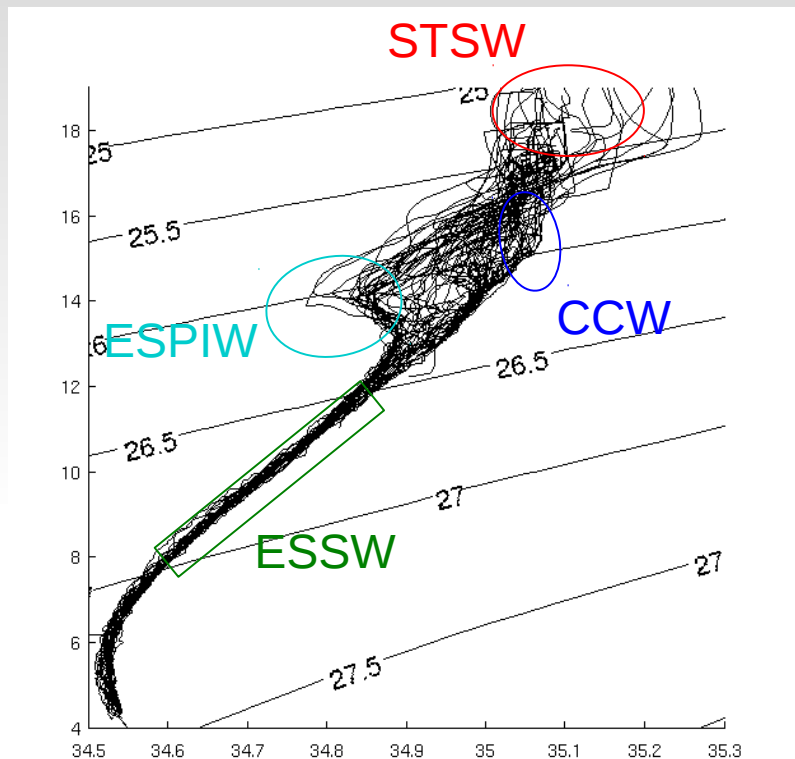
- Vertical velocity scale:

$$w = \frac{F_{eff}^B}{N^2 H} \approx 60 m / jour$$

Nearchos: Apr 11th – Mai 15th 2010

- 6 across shore sections
- 1000m deep / 100km long / ~ 5 days
- 5 short sections
- 1000m deep / 20km long / ~ 1 day





Water masses :

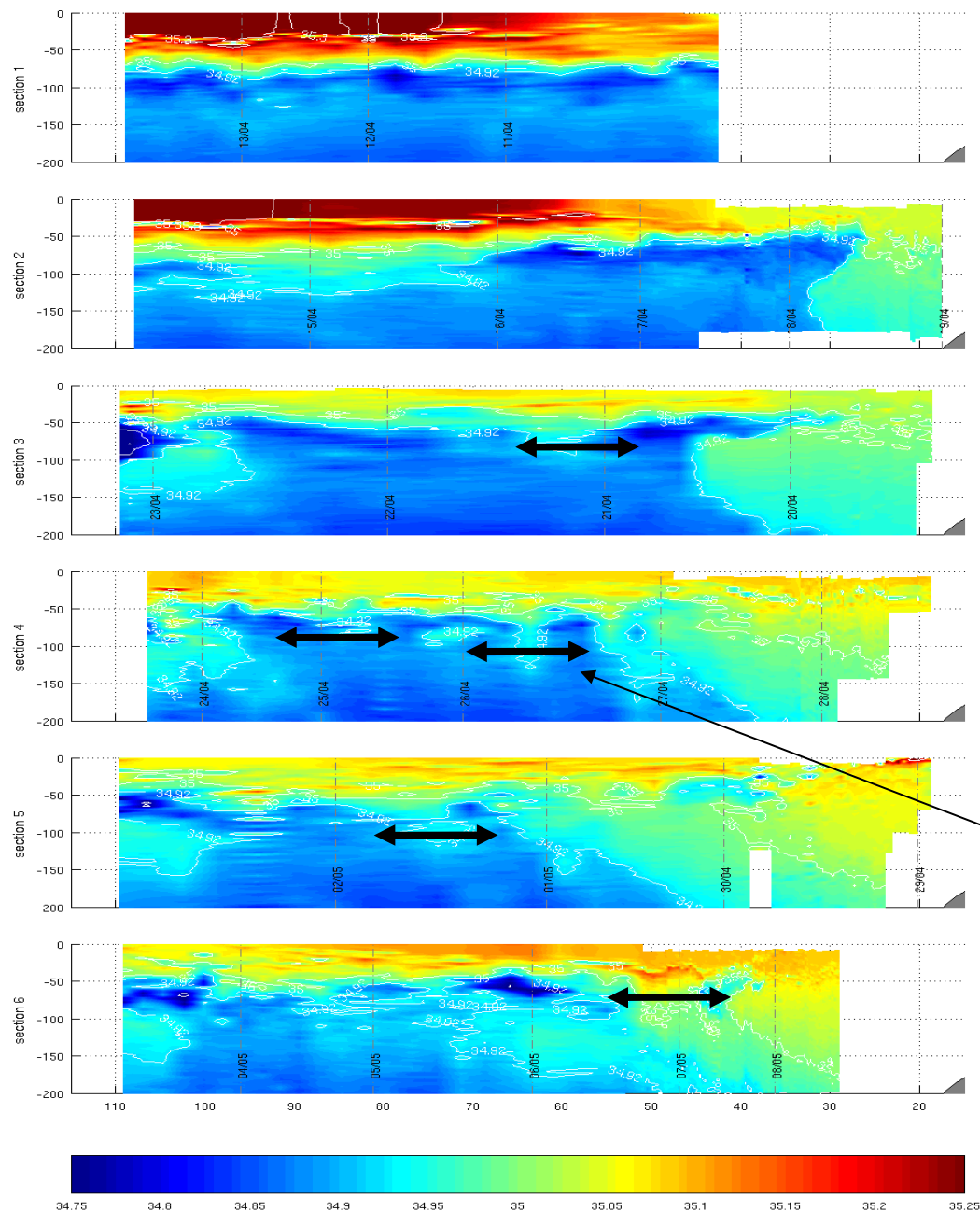
CCW : cold coastal water

STSW : SubTropical Coastal Water

ESPIW : Eastern South Pacific Intermediate Water

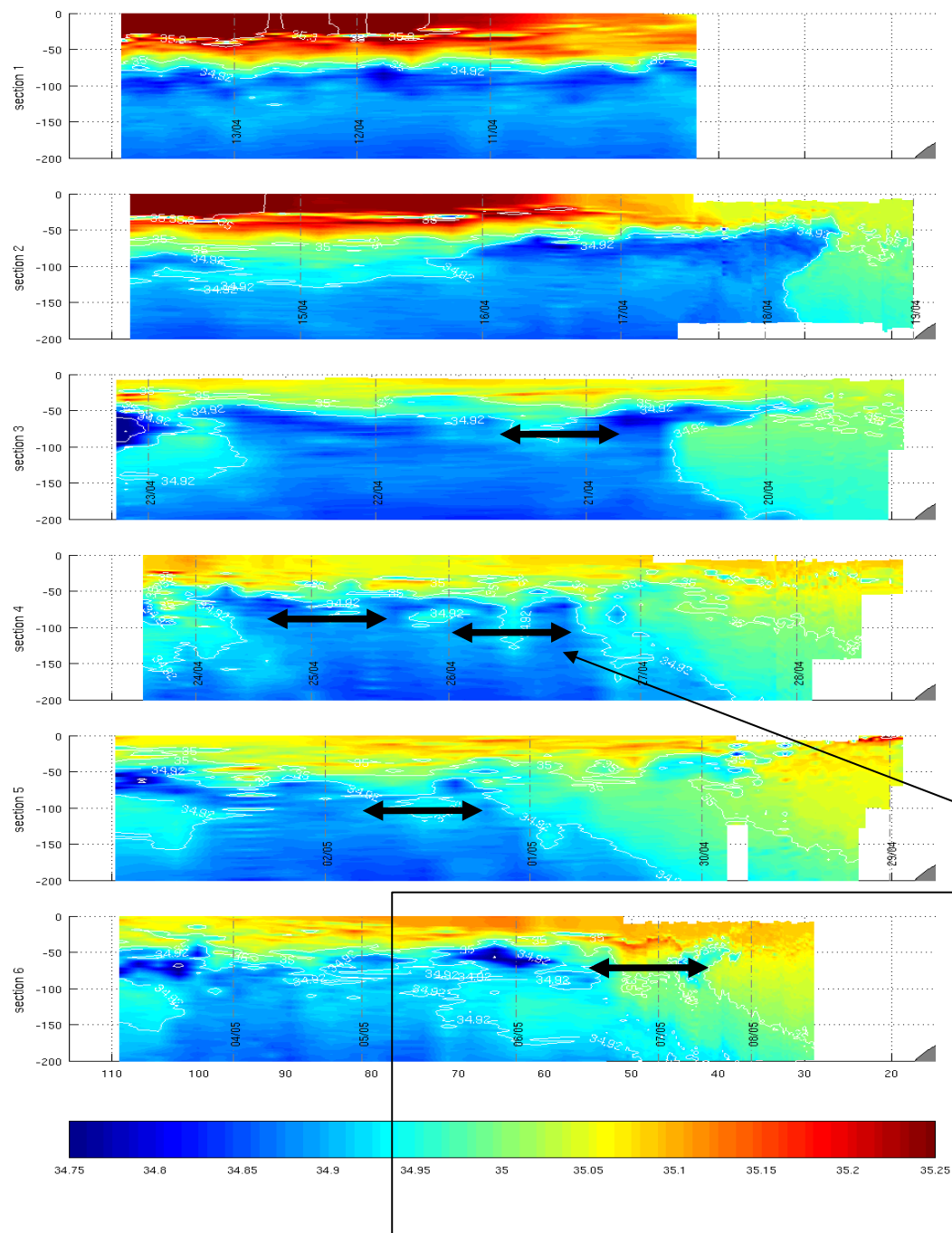
ESSW : Equatorial Sub Surface Water

Glider section #3 : Apr 19th - Apr 23th

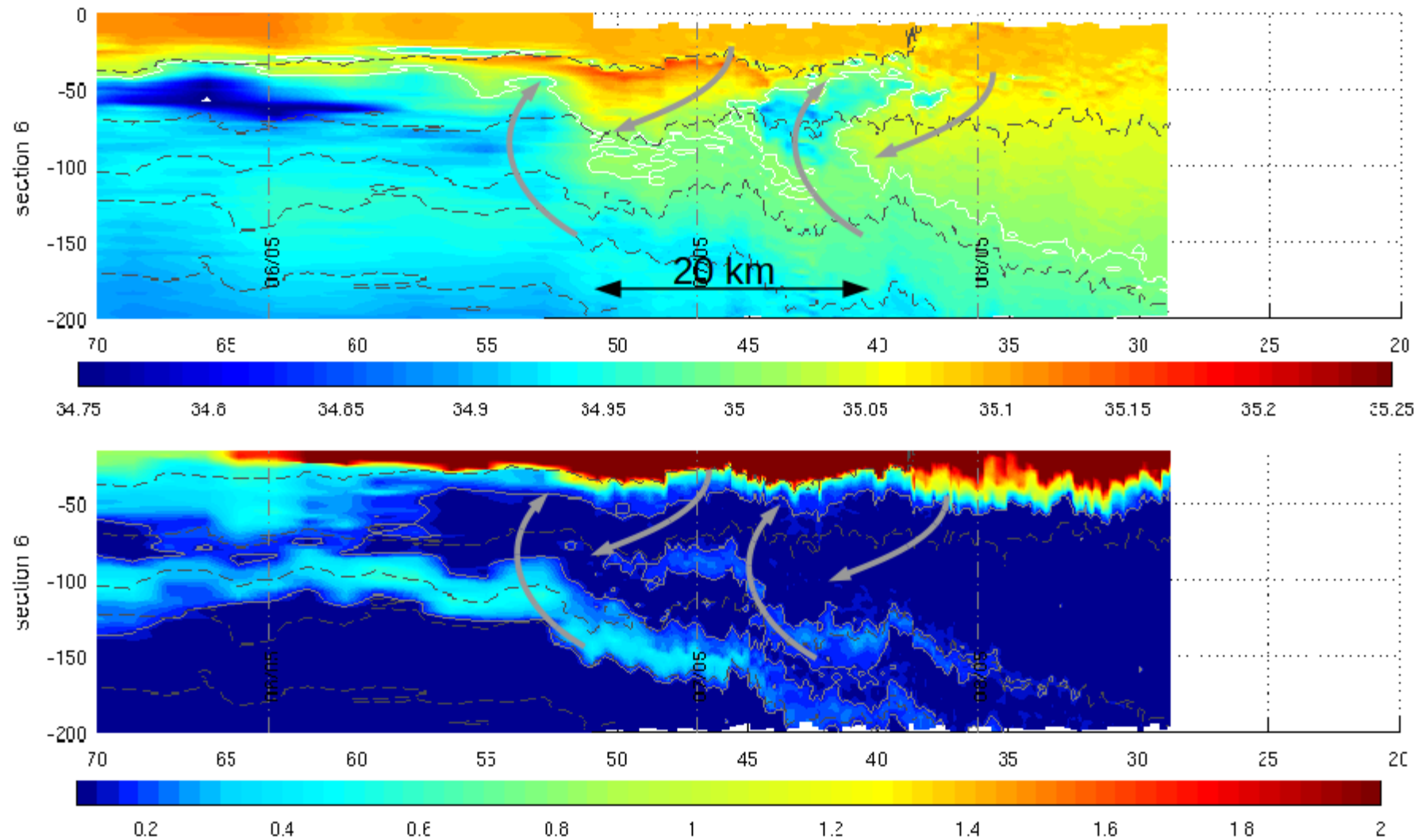


➤ Submesoscale processes with an horizontal scale of ~15-20 km

15-20 km

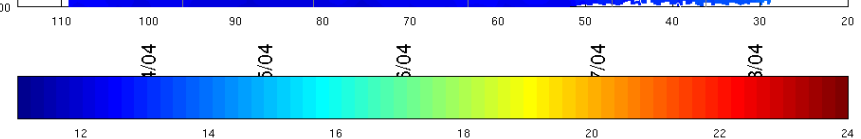
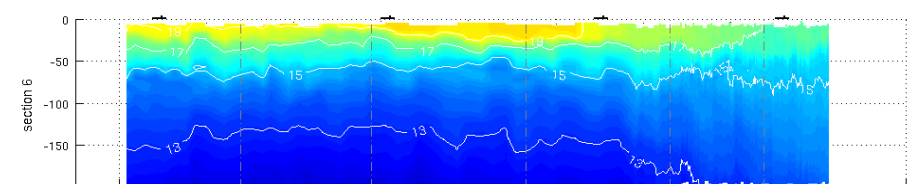
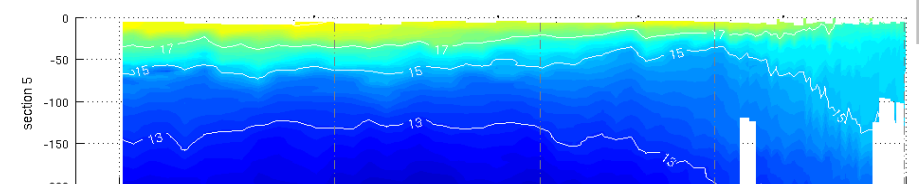
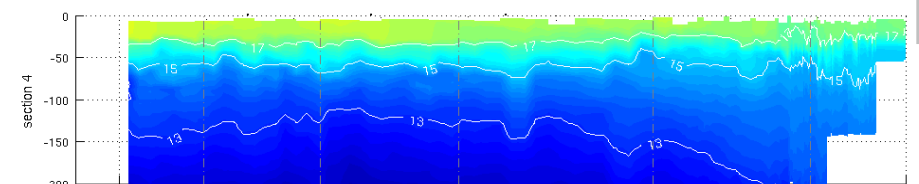
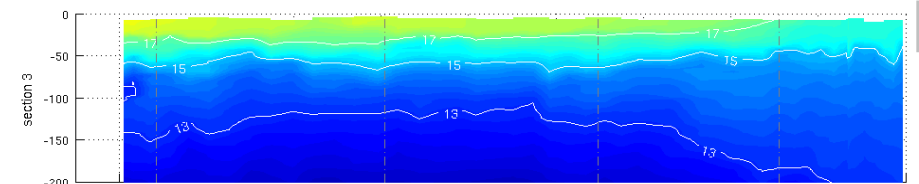
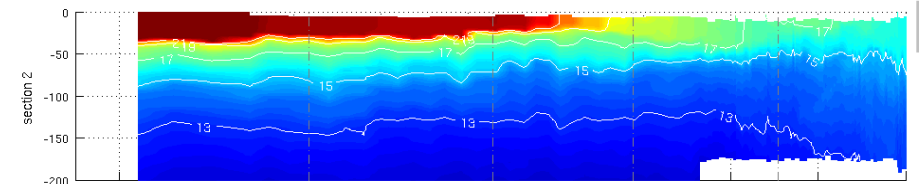
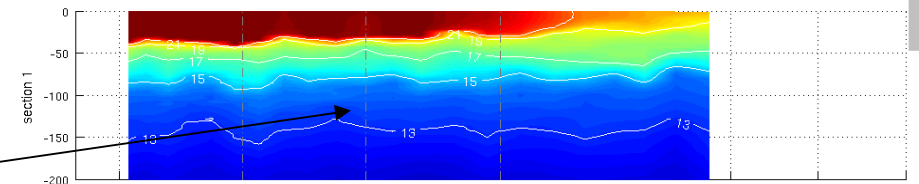
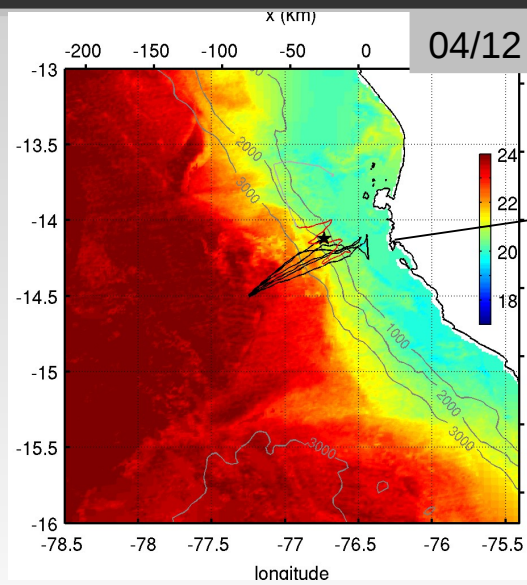


- Submesoscale processes with an horizontal scale of ~15-20 km
- Less visible than in oct/nev 2008

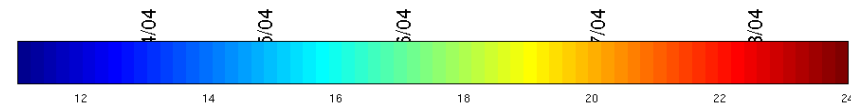
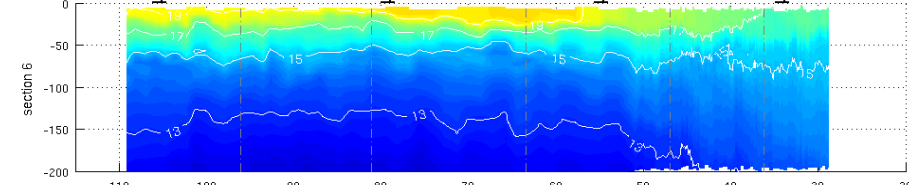
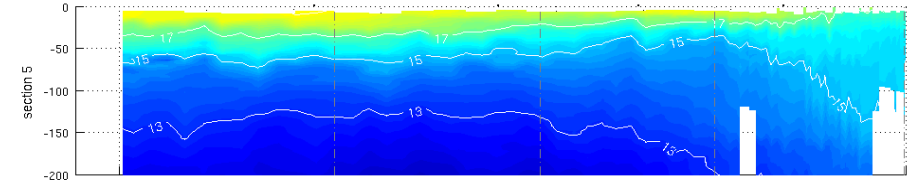
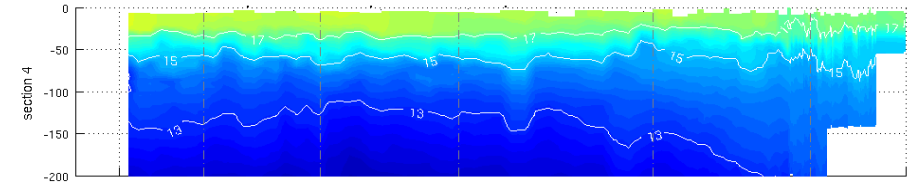
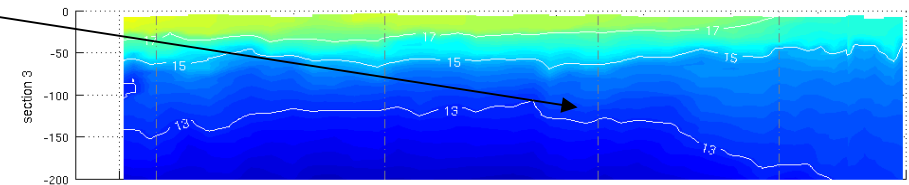
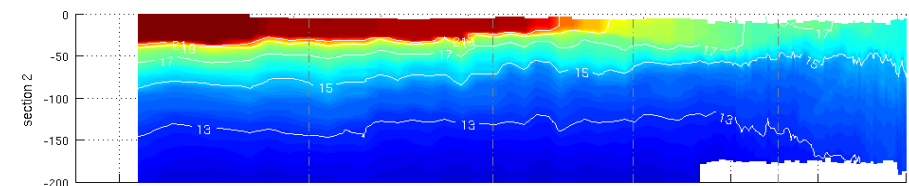
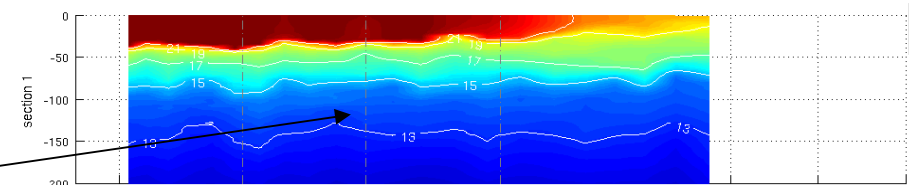
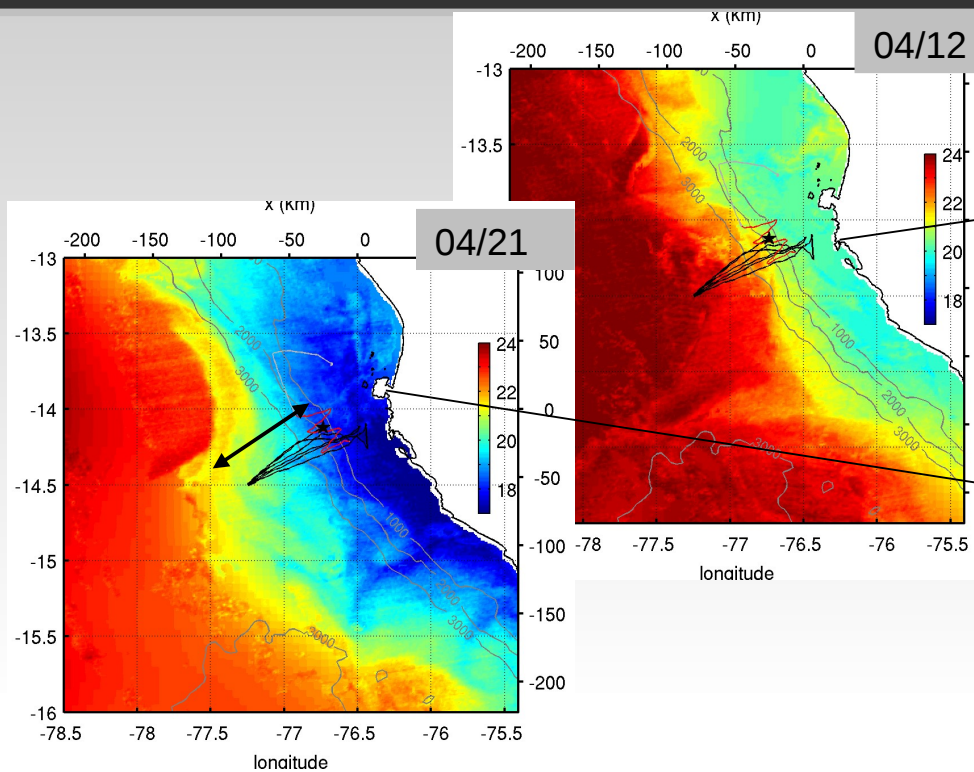


- Cross-isopycnal processes
- Deepening of the isopycnal close to the coast

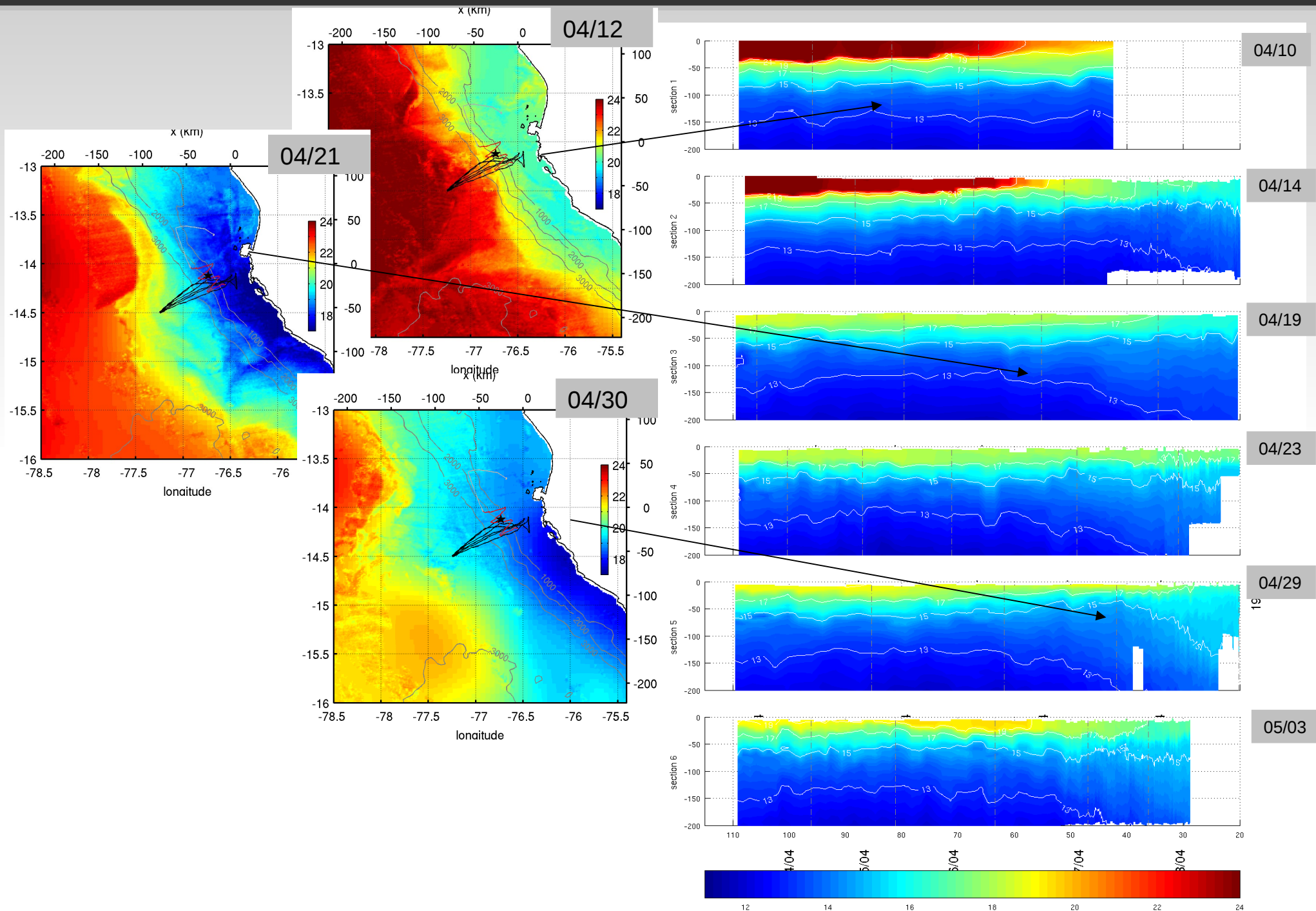
Nearchos : Apr/May 2010



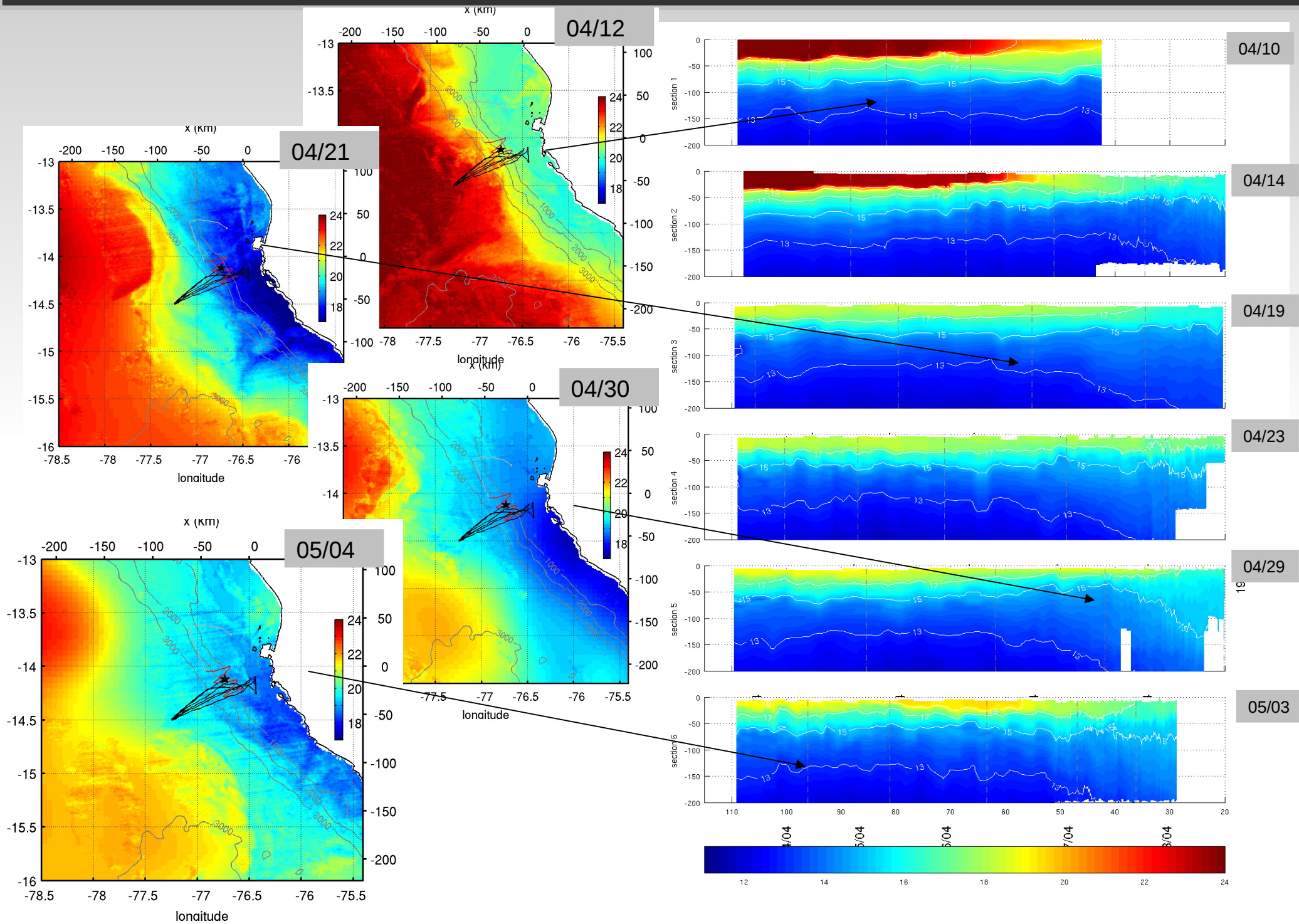
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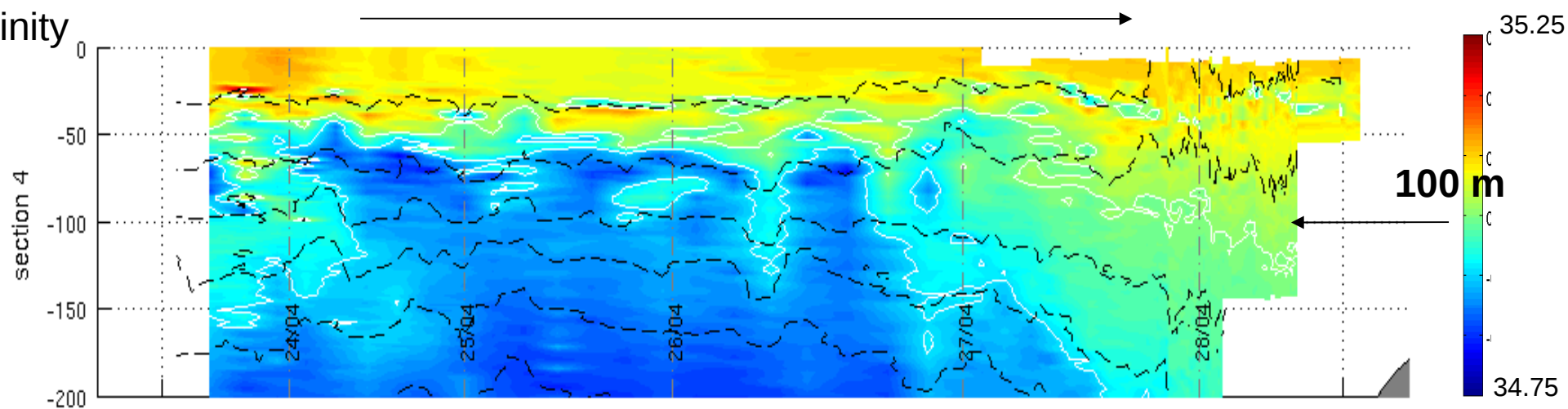


Nearchos : Apr/May 2010

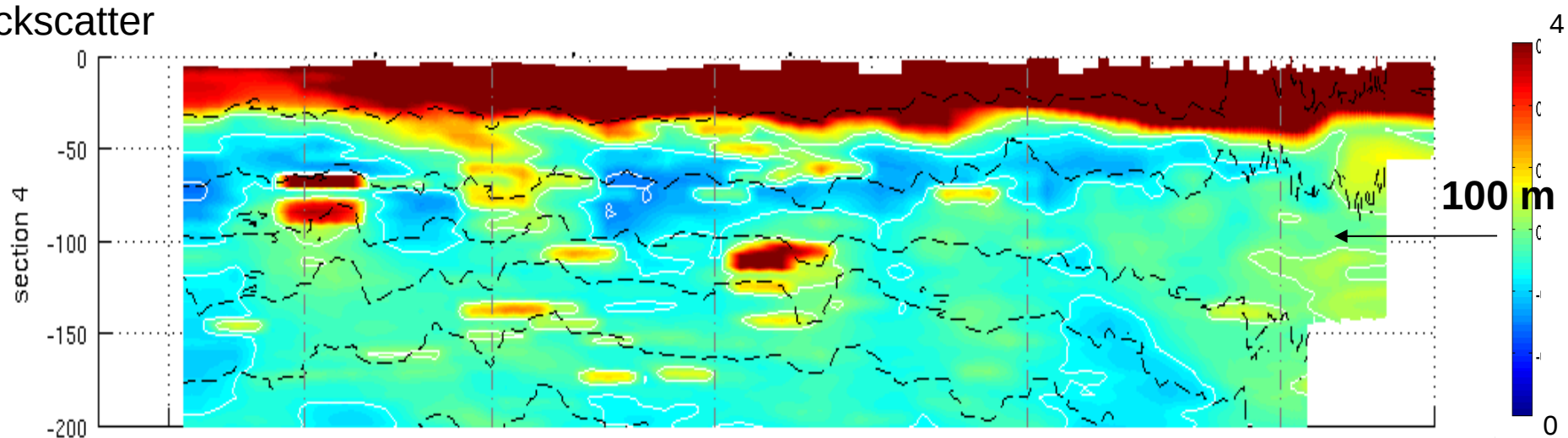


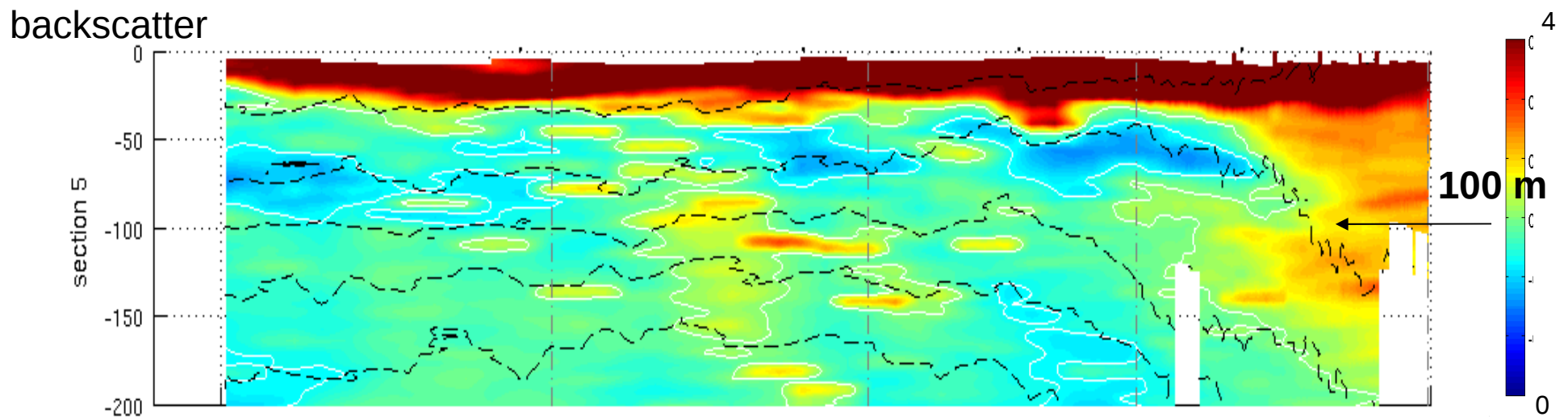
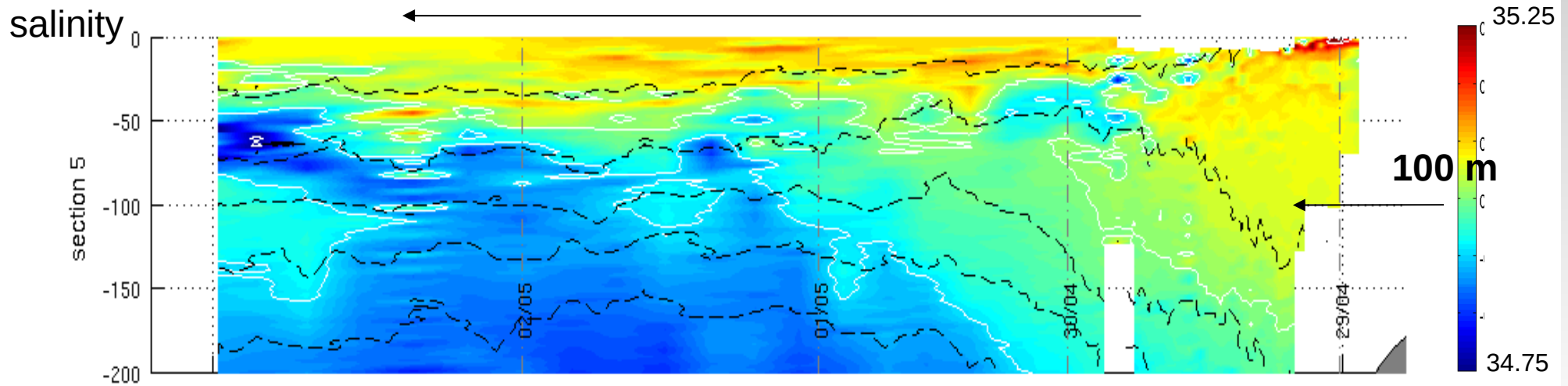
Nearchos : Apr/May 2010

salinity



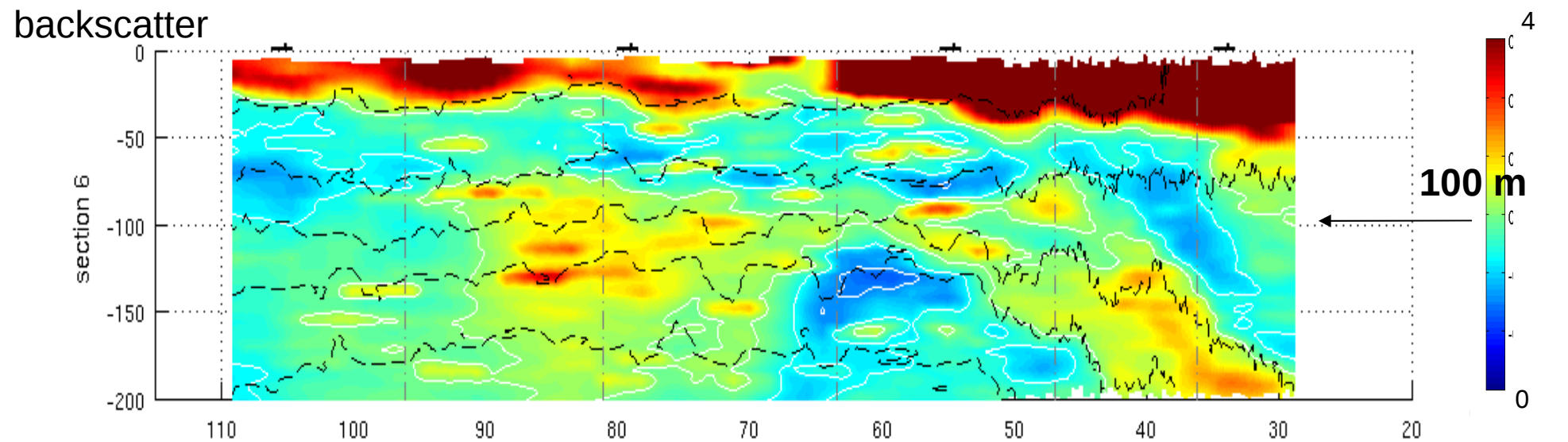
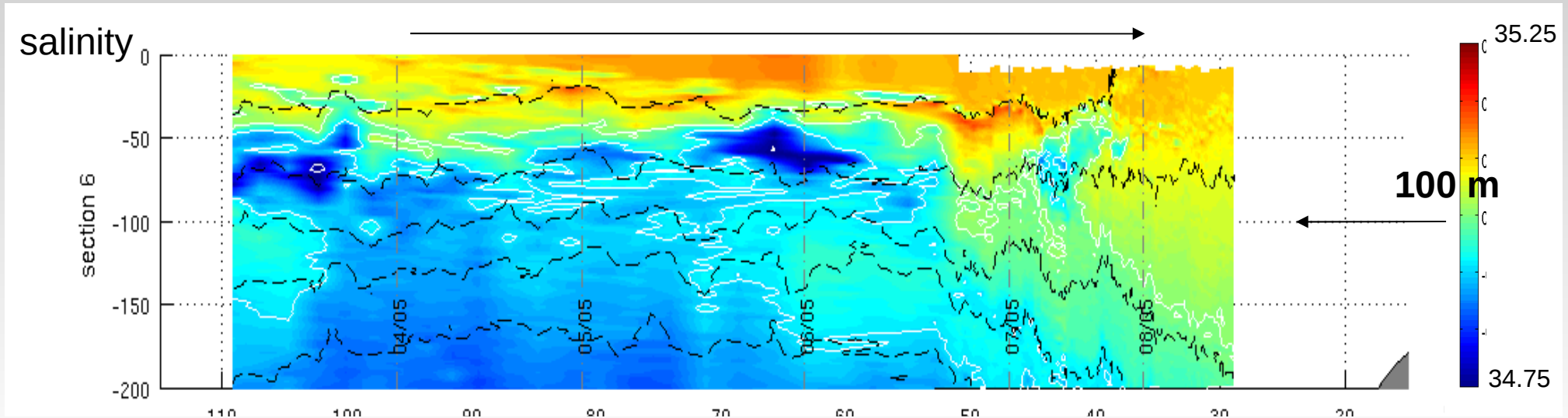
backscatter





Diving of the isopycnal 26 : **more than 50m in few hours**
Associated with high values from the backscatter and elevated salinity

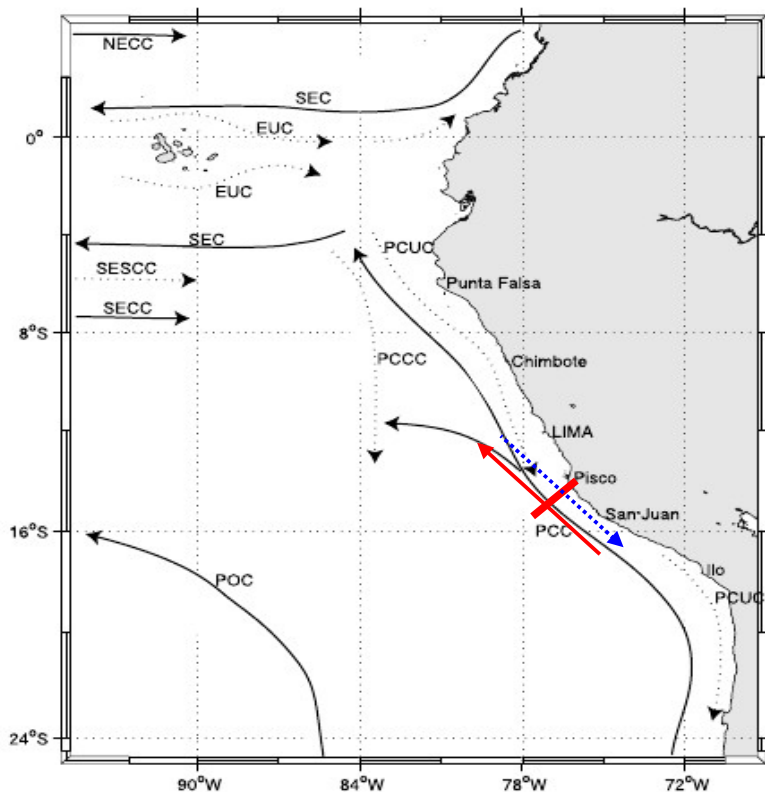
Nearchos : Apr/May 2010



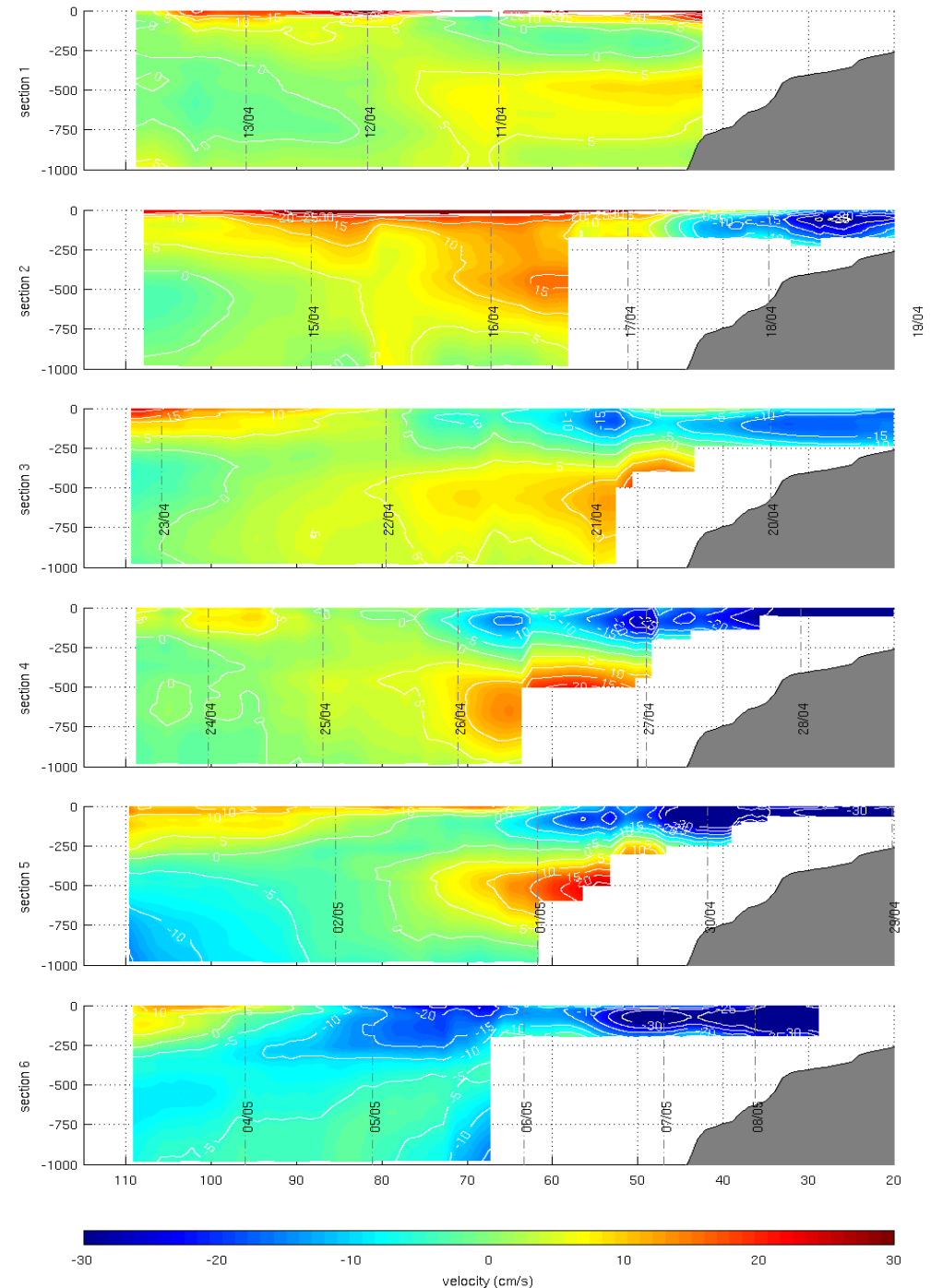
rising of the isopycnal 26 in less than 10 days

"Absolute" geostrophic velocities :

- filtered density
- thermal wind balance
- depth integrated currents from the glider as a reference velocity

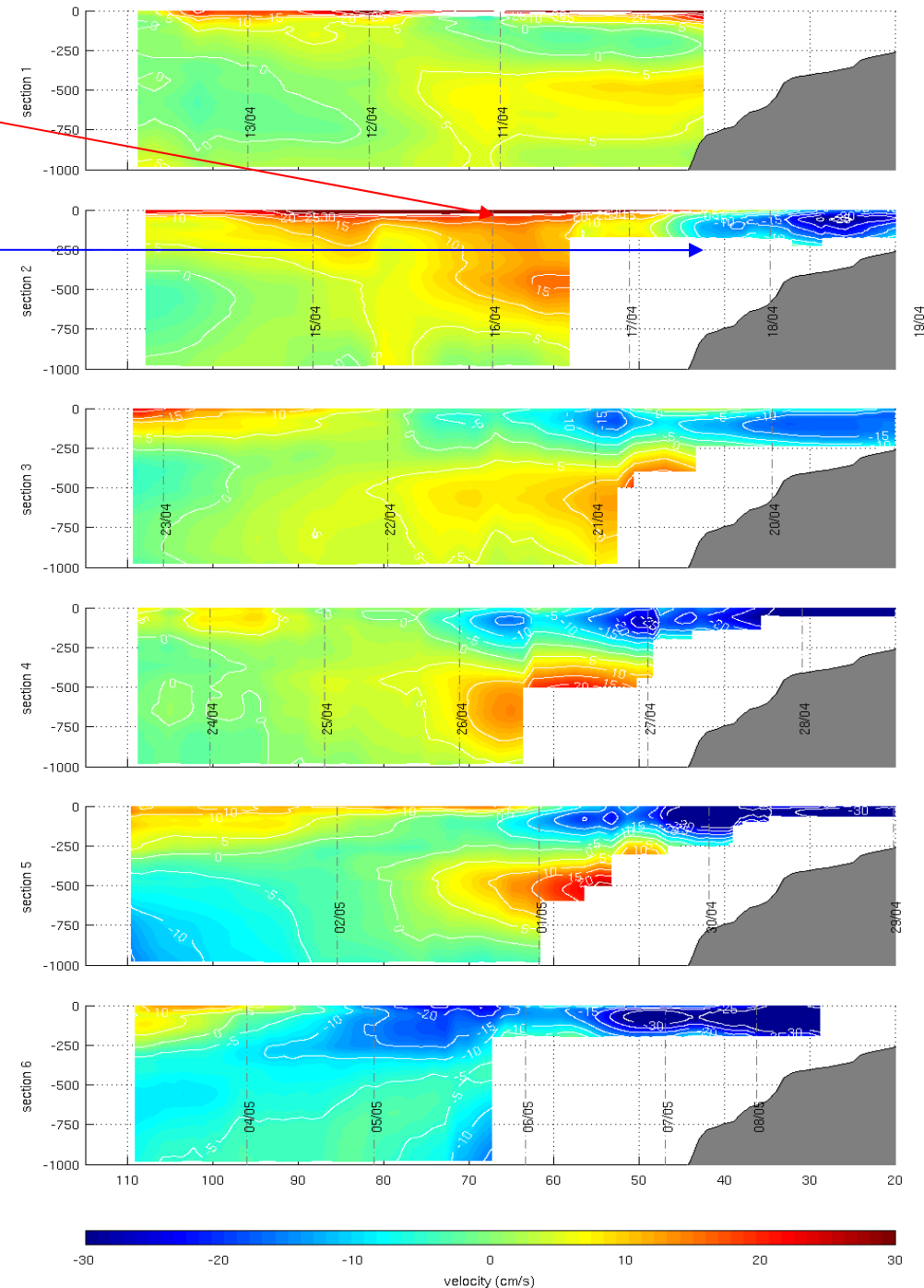
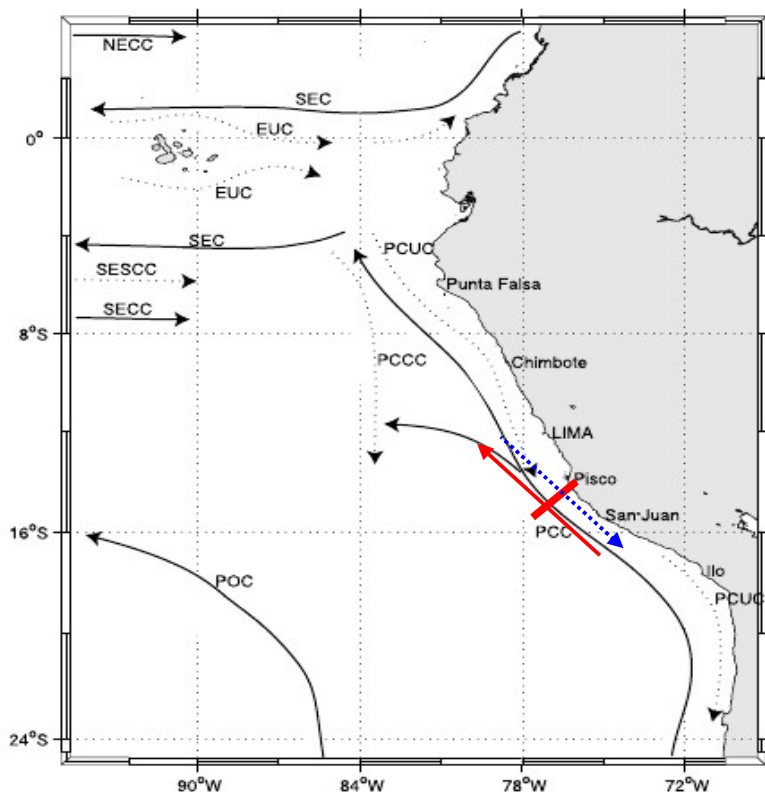


Penven et al, 2005 : monitoring the Peru current system



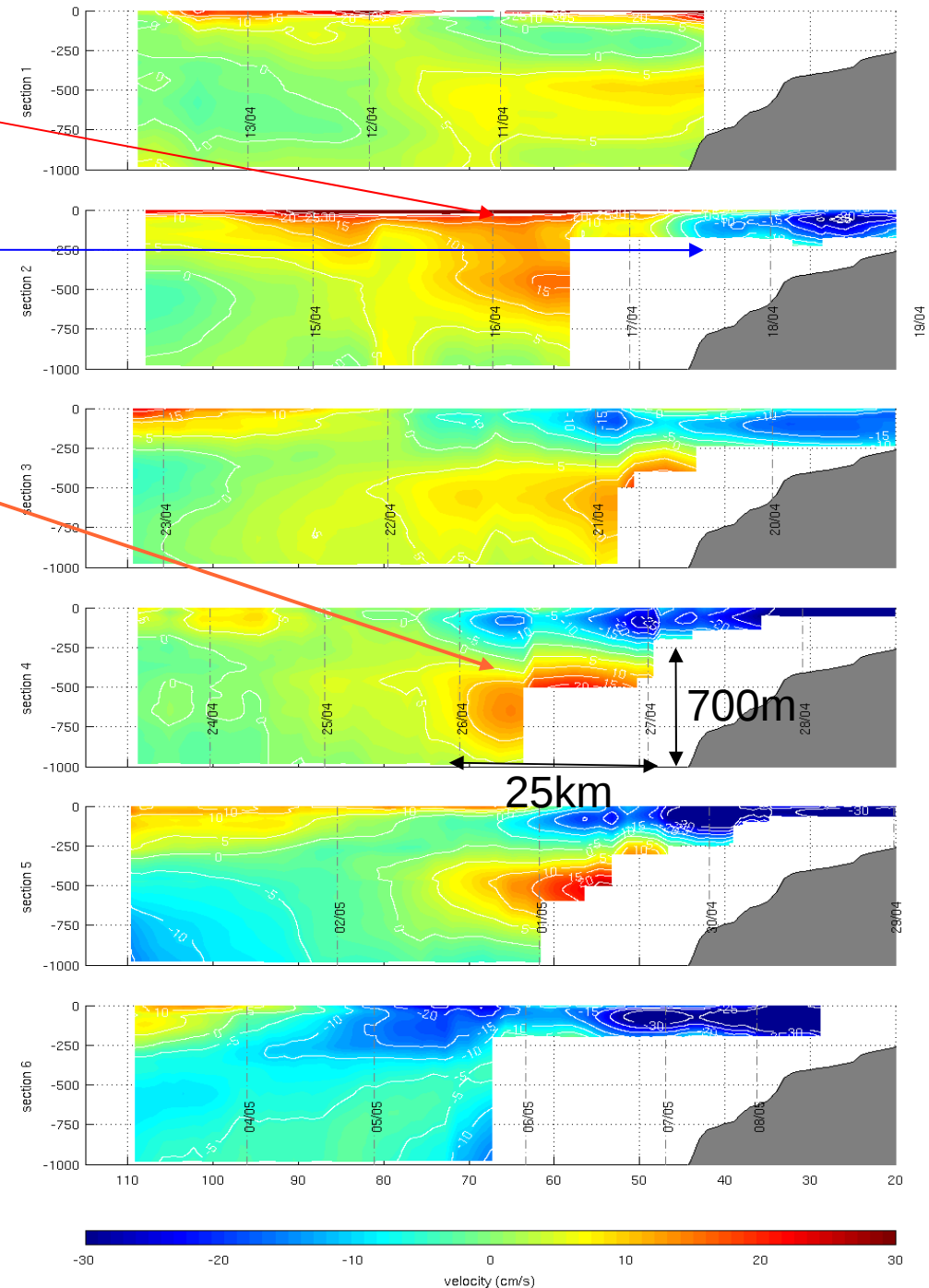
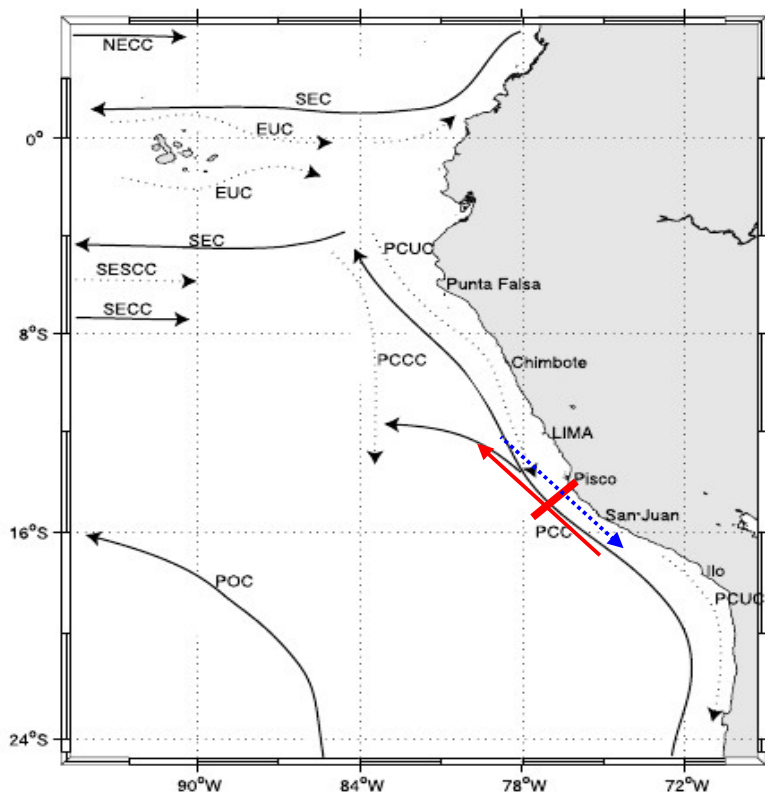
Nearchos : Apr/May 2010

- **PCC** : Peru Chile current (equatorward – max : 30cm/s)
- **PCCC** : Peru Chile counter current (poleward – max : 30 cm/s)
- Undercurrent ?



Nearchos : Apr/May 2010

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- Transient phenomenon :

+/- 25 days

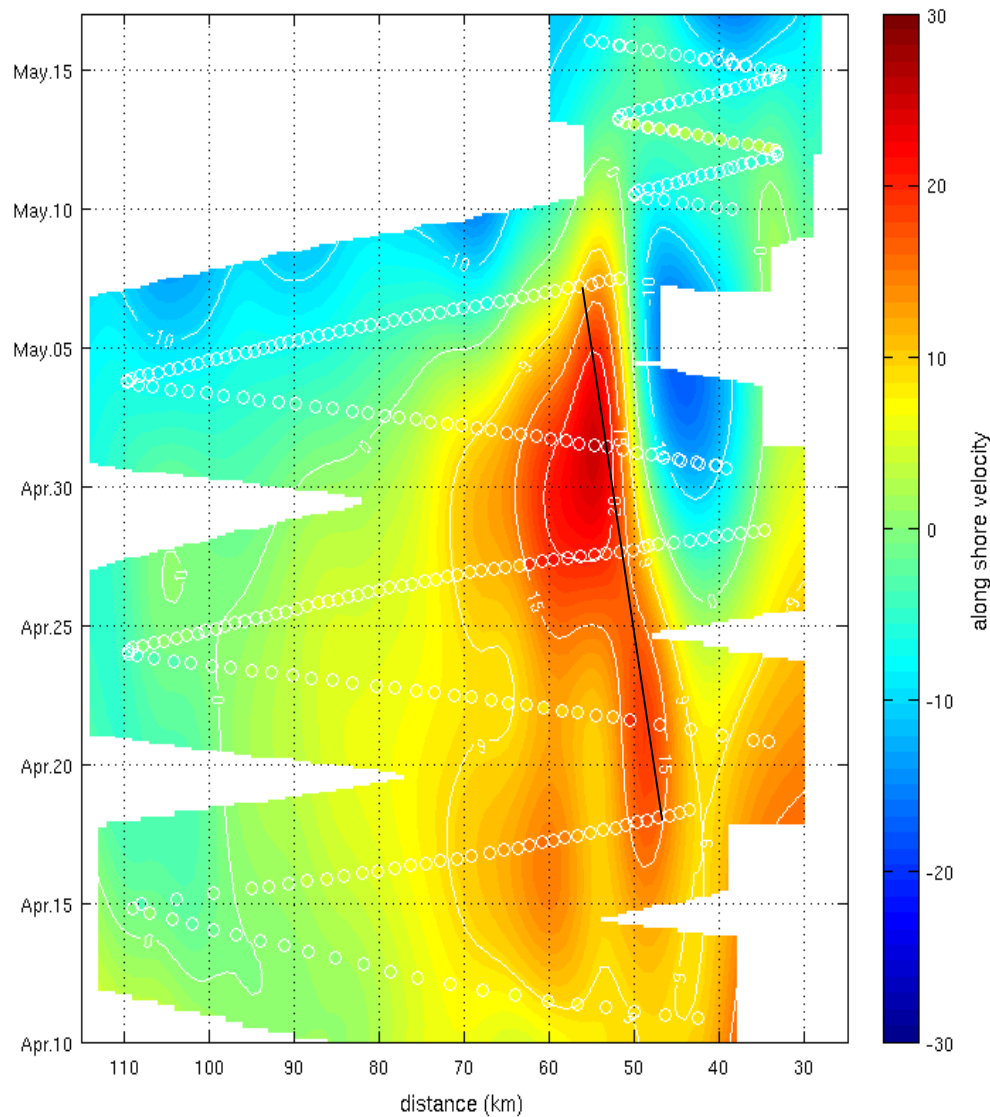
- Eastern propagation :
10km / 17 jours

Hypothesis :

➤ Wave

➤ Eddy

➤ Adjustment to the wind
and the upwelling episode



Hovmuller diagram of the alongshore
velocity at 500m deep

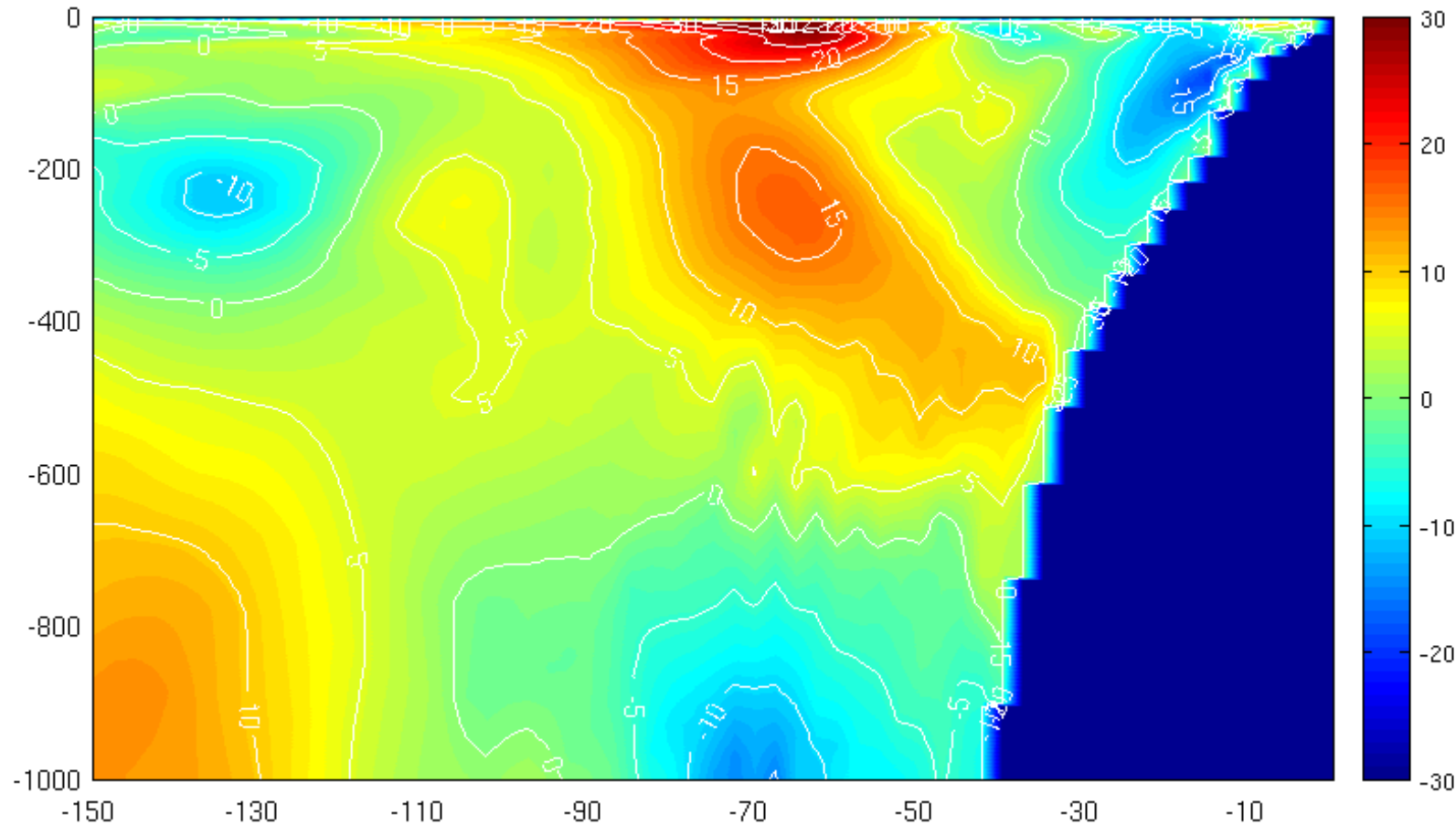
High resolution realistic model ROMS

Embedded model, forced at lateral boundaries by SODA (0.5° horiz. Res.)

Horizontal resolution of ~2km

Simulation by F. Colas

Along shore velocity



Conclusions and prospects

- Unique sets of fine scale measurements in the region
- In Apr/May 2010 remnants of **vertical circulations** seen in Oct/Nov 2008
 - To my knowledge first time an **equatorward “under current”** has been observed
 - Work in progress:
 - Wave ?
 - Eddy ?
 - Adjustment to the upwelling event ?
- Need for a sustained endurance line in the region to monitor current and biogeochemical parameters

