ALBOREX: an intensive multi-platform and multidisciplinary experiment in the Alboran Sea

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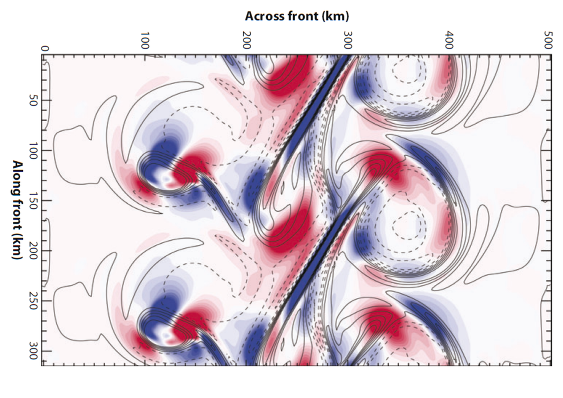
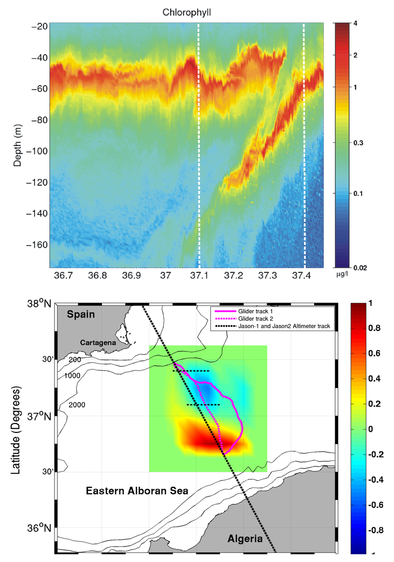
1. Motivation and field experiment

Scientific motivation: Capture the intense but transient vertical exchanges associated with mesoscale and submesoscale features, in order to fill gaps in our knowledge connecting physical process to ecosystem response.



Vertical velocities at 90 m from primitive equation simulations. Lévy et al. (2001); Klein & Lapeyre (2008)

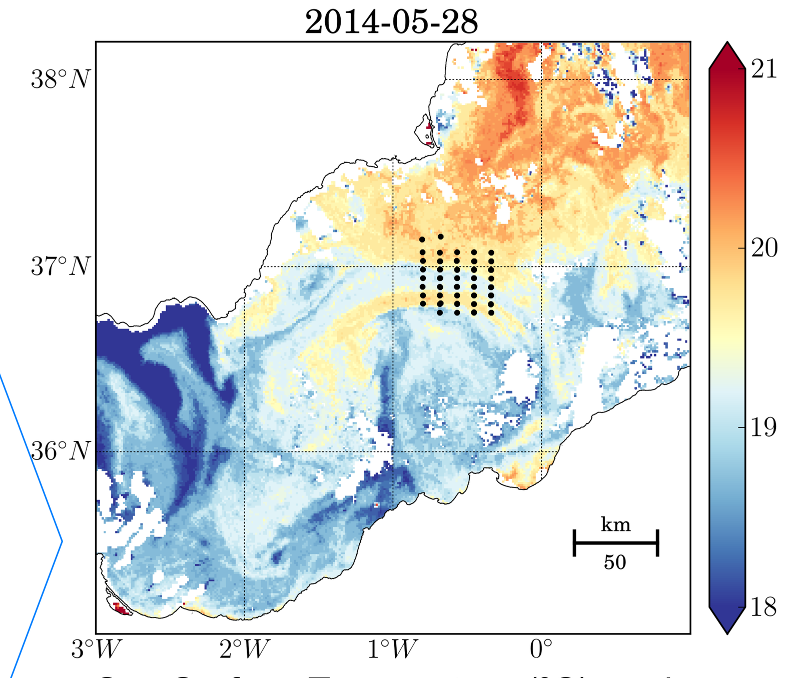


Top: Vertical section of chlorophyll from glider data. Bottom: Quasi-geostrophic vertical velocity at 75 m. Units are m day^{-1}. (Ruiz et al. 2009)

Need for high-resolution observations (both in situ and satellite) and multi-sensor approaches in synergy with numerical simulations

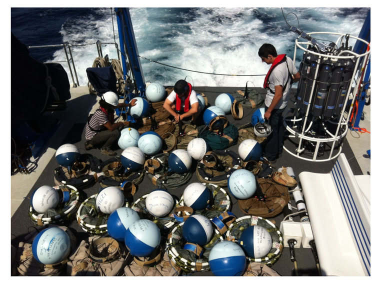
Advection and mixing associated with mesoscale and submesoscale oceanic features are of fundamental importance for the exchanges of properties between the surface and the ocean interior.

ALBOREX Experiment 25-30 May 2014 – Eastern Alboran Sea



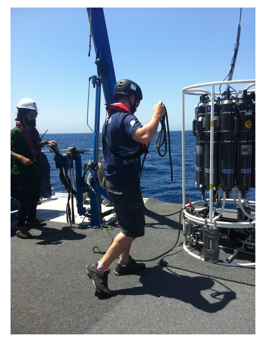
Sea Surface Temperature (ºC) and CTD stations (dots)

3 Argo floats



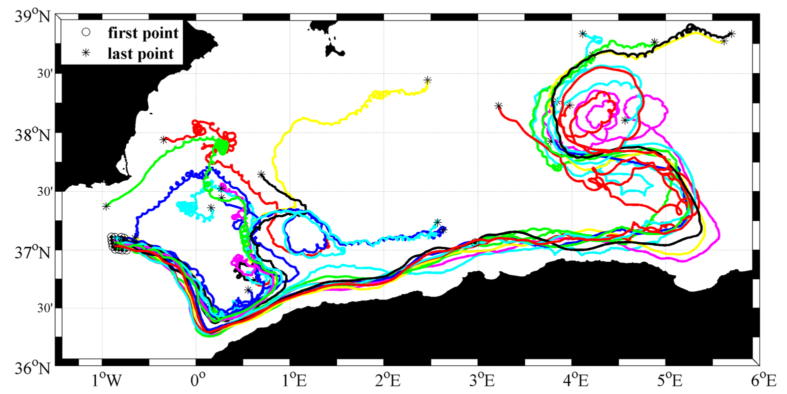
25 SVP drifters

Chl and nutrients



80 CTDs

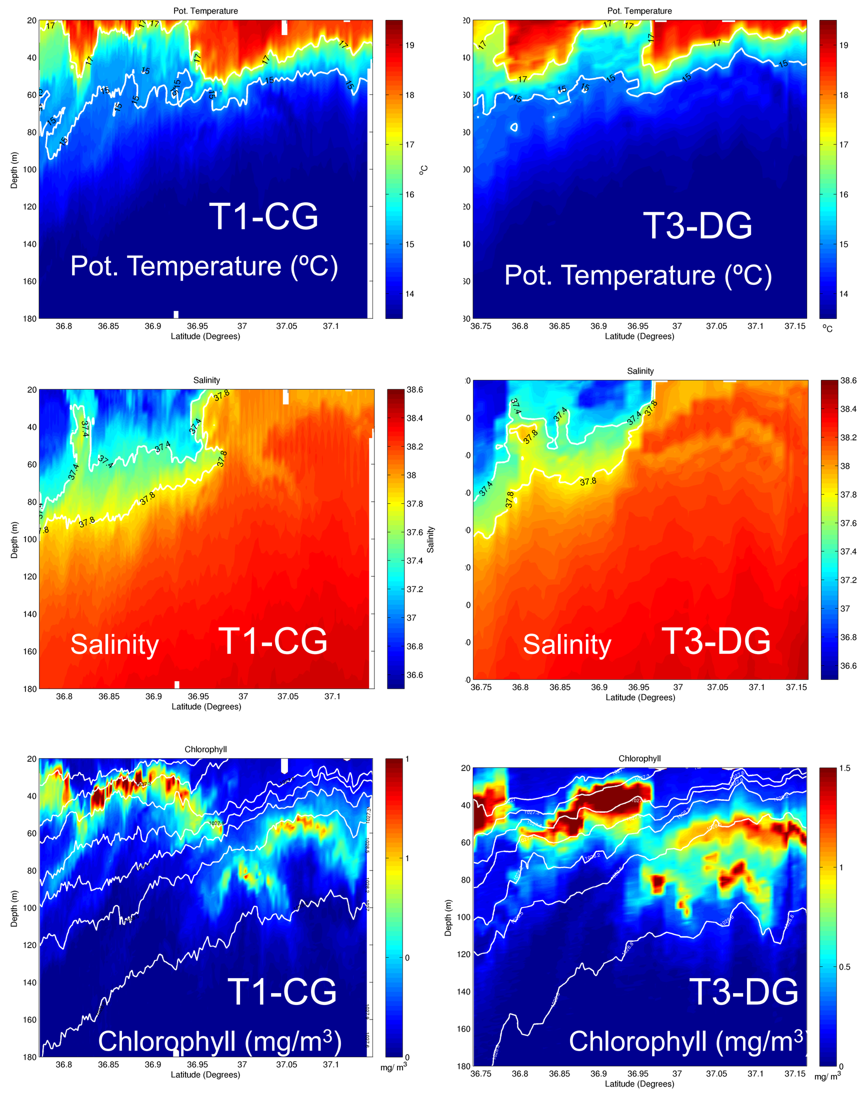
2 gliders



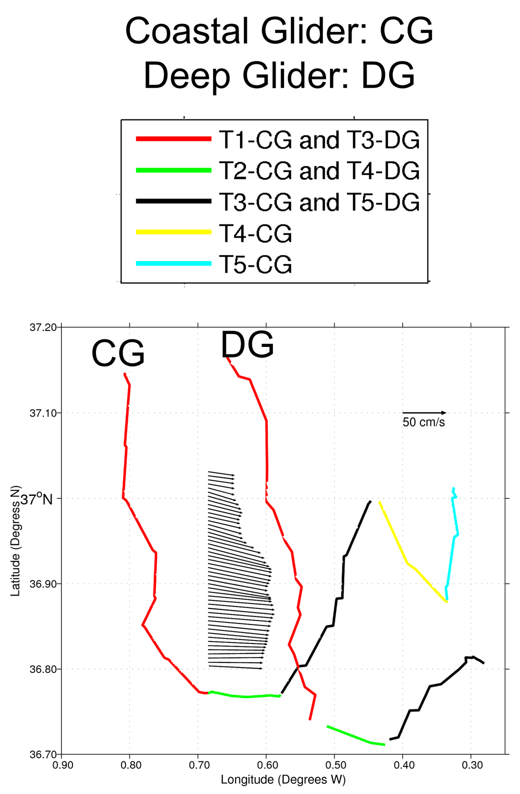
and VM-ADCP, Remote Sensing and Modelling

SVP drifter tracks between 25 May 2014 and 14 July 2014

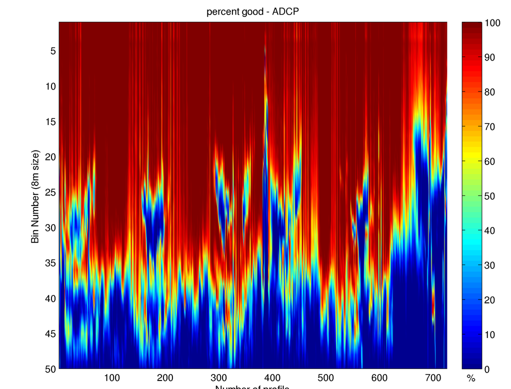
3. Results (II): High-resolution glider data, ADCP and numerical simulations



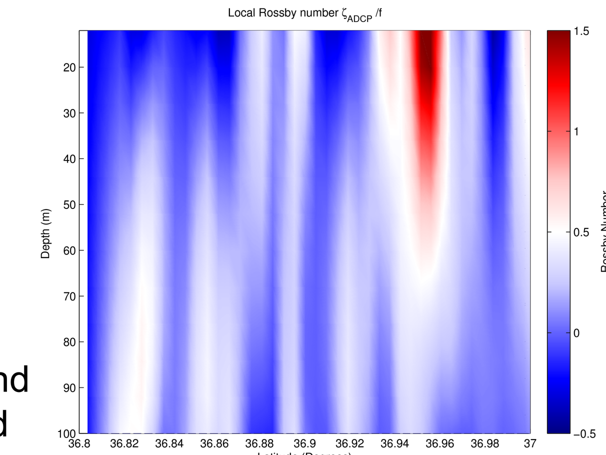
See also poster **Y181** (Olita et al.) for a deeper analysis on the deep chlorophyll maximum distribution.



Glider tracks. Vectors correspond to VM-ADCP data for a selected ADCP track.

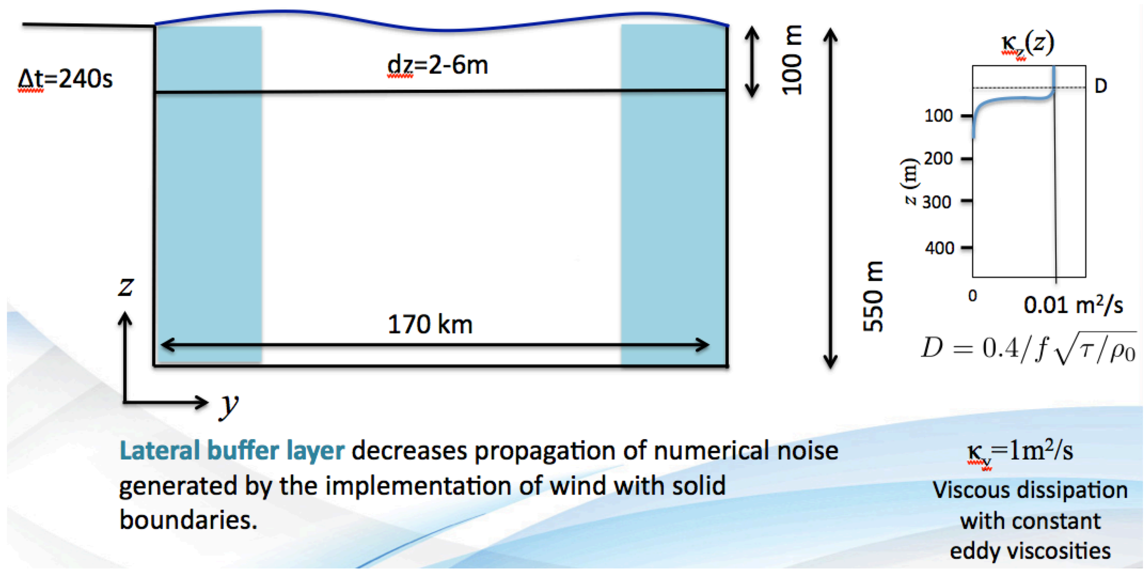


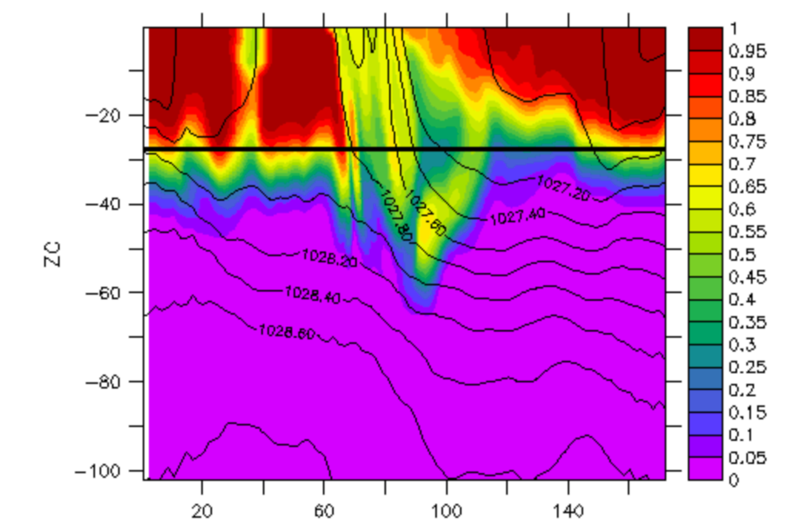
Percent good index for ADCP data. Bin size = 8m



Local Rossby number computed from VM-ADCP data. Note values > 1 around latitud 36.95ºN, coincident with the frontal zone.

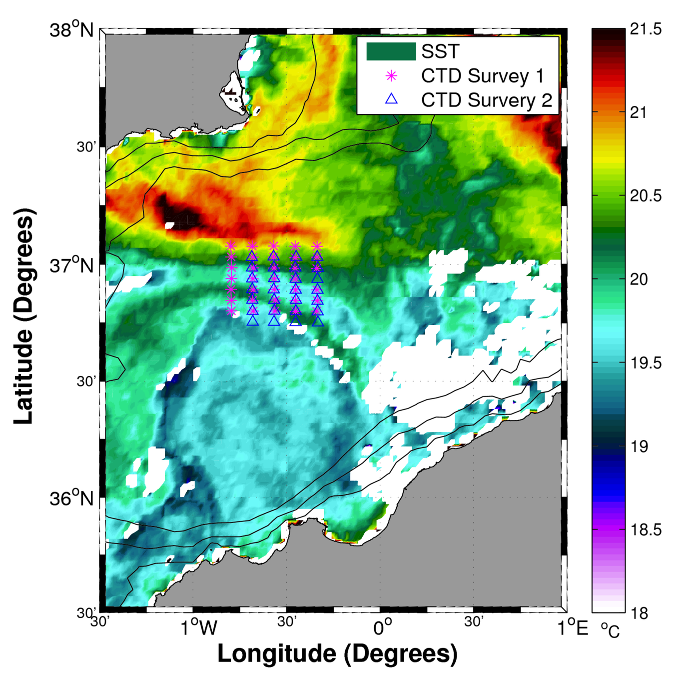
Ocean Process Study using a **non-hydrostatic** and **free-surface numerical** model that simulates the volume-preserving flow of a rotating and stratified fluid under the **Boussinesq** approximation (Mahadevan et al. 1996a,b).

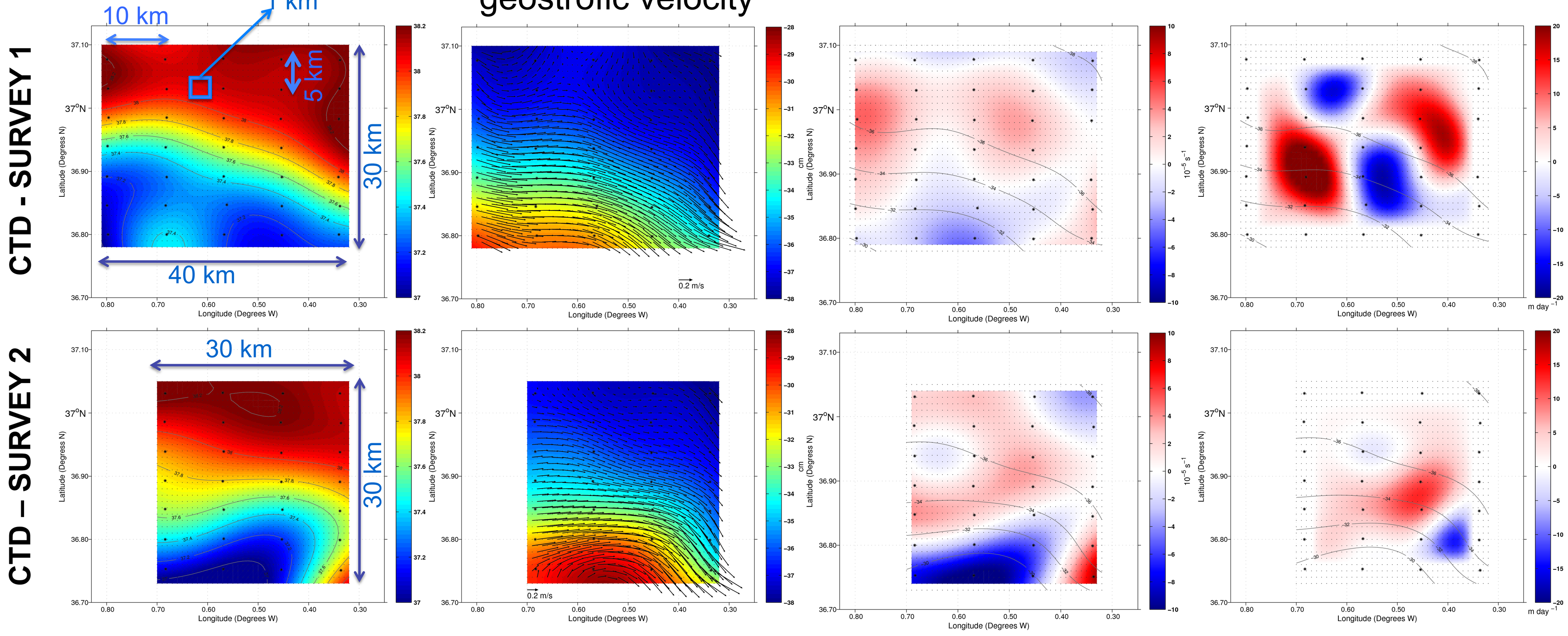




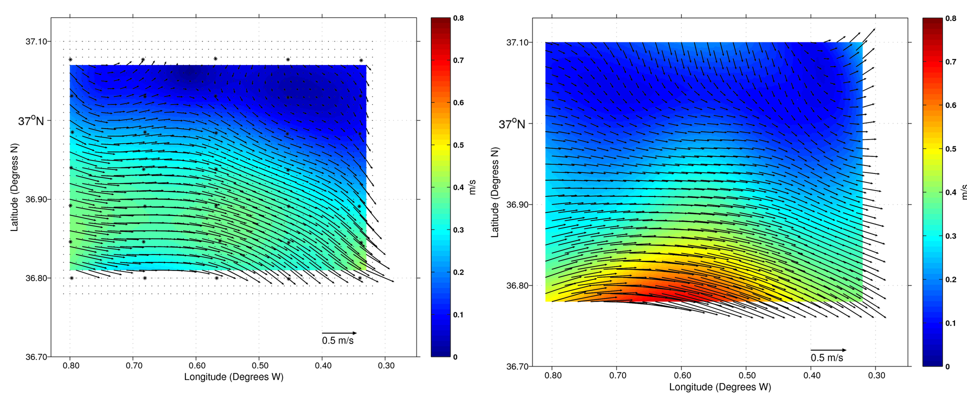
Color=tracer after 27 days of simulation, including winds. Contours correspond to isopycnals.

2. Results (I): CTD AND ADCP

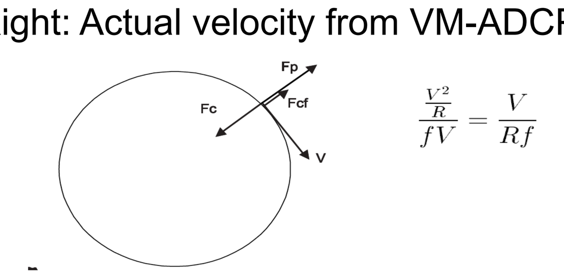




Salinity, dynamic height (cm), geostrohic velocity (cm/s, ref. lev 550 m), relative vorticity (10^{-5}s^{-1}) and quasi-geostrophic vertical velocity (m/day) for survey 1 (top) and survey 2 (bottom). Optimal Statistical Interpolation (OSI) scheme has been used for data interpolation (Gomis et al., 2001).



Left: Geostrophic velocity computed from CTD data (ref. lev. at 550 m)
Right: Actual velocity from VM-ADCP at 50 m depth



$$\frac{V^2/R}{fV} = \frac{V}{Rf}$$

Cyclostrophic component of the order of 15%

Potential mechanisms for vertical motion:

1. Quasi-geostrophic dynamics:

$$\nabla_h^2\left(N^2 w\right) + f^2\frac{\partial^2 w}{\partial z^2} = 2\nabla_h\cdot\vec{Q}$$

$$\vec{Q} = \left[f\left(\frac{\partial V}{\partial x}\frac{\partial U}{\partial z} + \frac{\partial V}{\partial y}\frac{\partial V}{\partial z}\right), -f\left(\frac{\partial U}{\partial x}\frac{\partial U}{\partial z} + \frac{\partial U}{\partial y}\frac{\partial V}{\partial z}\right)\right]$$

(U,V): geostrophic velocity components
N: Brunt-Vaisala frequency
F: the Coriolis parameter
L: characteristic scale

2. Ekman pumping (linear):

$$W_E = \frac{\nabla\times\tau}{\rho f} \qquad \tau = \rho C_D u_{rel}|u_{rel}| \qquad u_{rel} = u_a - u_o$$

Assuming u_a constant over the studied domain u_{rel} is proportional to relative vorticity with a change of sign and a factor scale (C_D ~10^{-3}, Gaube et al. (2013); Foreman and Emeis (2010)) **W_E= 0.5 m/day.**

4. Summary

- Detection and sampling of an intense frontal zone with differences in density of **1.5 kg/m^3** and evidences of vertical motions.

Potential mechanisms under investigation for understanding upward/downward motions:

- **Quasi-geostrophic theory: Vertical Velocity** of the order of **+/- 20 m/day** at 50 m depth.
- **Linear Ekman pumping theory:** Vertical velocity of **0.5 m/day.**
- **Frontogenesis:** Local Rossby number of **1.5** in the frontal zone. First numerical model results are coherent with the observed frontal zone and associated submesocales structures. This mechanisms needs to be investigated carefully: Further work is going on (**strain rate, frontogenetic tendency**). Additionally, implications of dynamics on biochemistry processes will be evaluated.

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For a complete list of references used in this poster, please contact first author.