

Evidence of Cyclonic Recirculation off SW Iberia from ARGO and Altimetry data

Luísa A.S. Lamas

Instituto de Oceanografia – Faculdade de Ciências
da Universidade de Lisboa

β plume theory

Özgokmen(2001); Kida(2006)

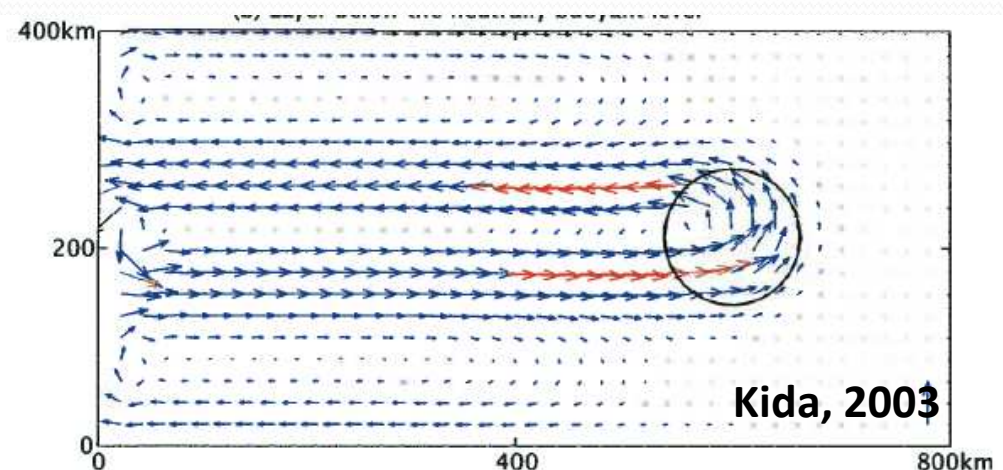
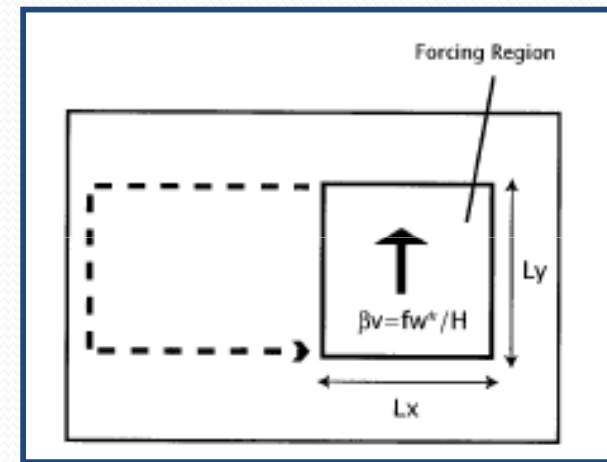
- Large scale horizontal circulation produced by a disturbance of potential vorticity caused by a source or sink of mass.
- **Linear vorticity Balance**

Equation :

$$\beta v = \frac{f_0 w^*}{H} + D$$

Local mass sink induces bidirectional zonal flows:

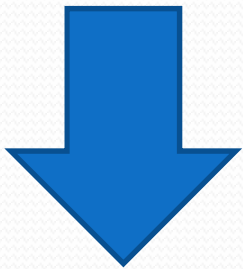
- Eastward to the south of sink
- Westward to the north



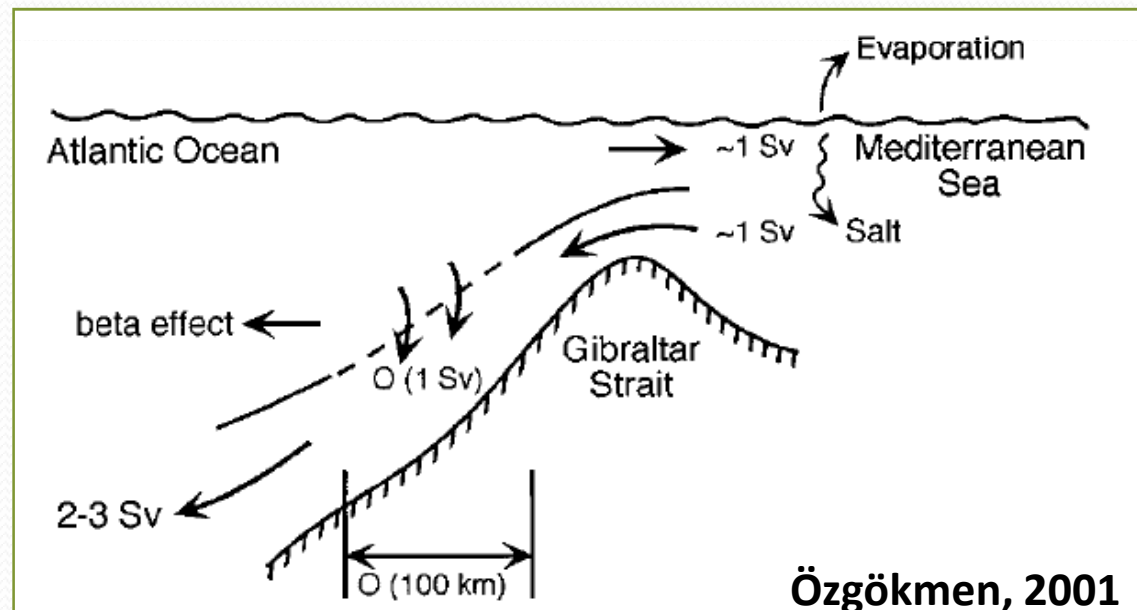
Gulf of Cadiz

Özgökmen(2001)

- Entrainment of Central waters by the Mediterranean outflow causes a local mass sink



Can generate a β plume type circulation



β plume in the Gulf of Cadiz

Özgokmen(2001); Kida(2006); Peliz(2007)

- Bidirectional zonal flows – Azores current and Countercurrent
- Vertical to horizontal transport ratio:

$$\frac{V}{W} = \frac{f_0}{\beta L_y}$$



Zonal transports may be 2 orders of magnitude larger than that of the sink

UNREALISTIC for the
Azores Current case

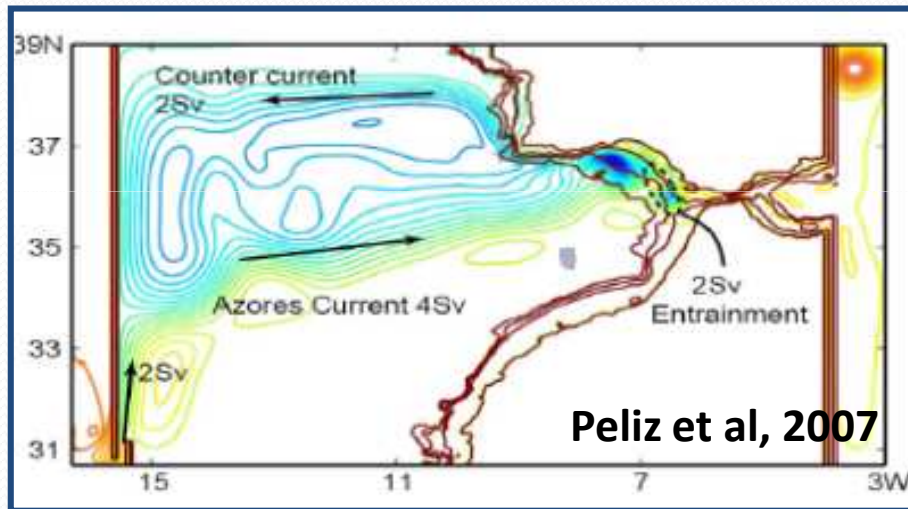
β plume in the Gulf of Cadiz

Özgokmen(2001); Kida(2006); Peliz(2007)

- Topographic β plume



Decrease in
transport ratio

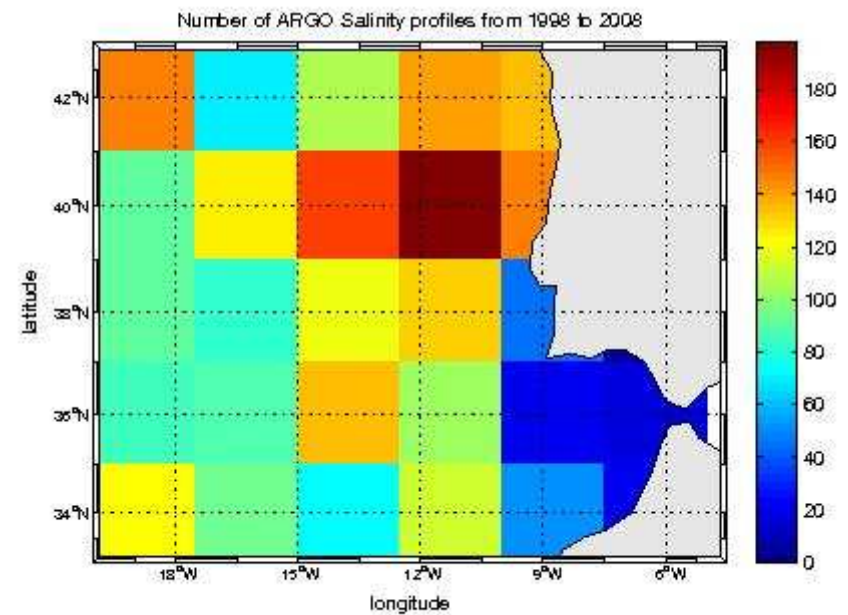
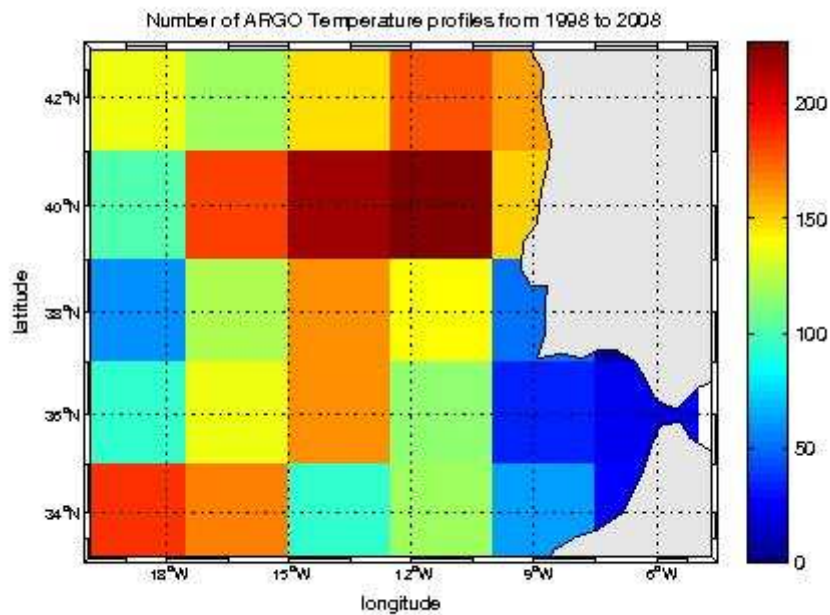


**More realistic scaling
for the GoC case**

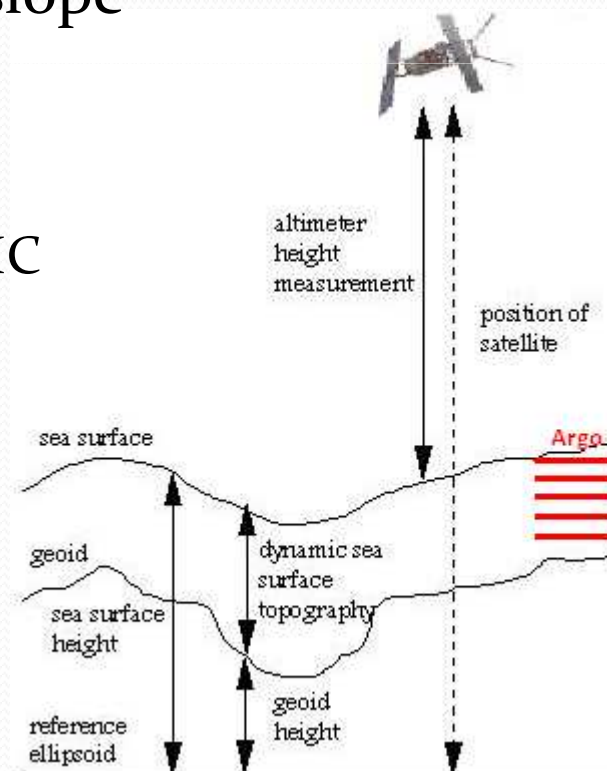
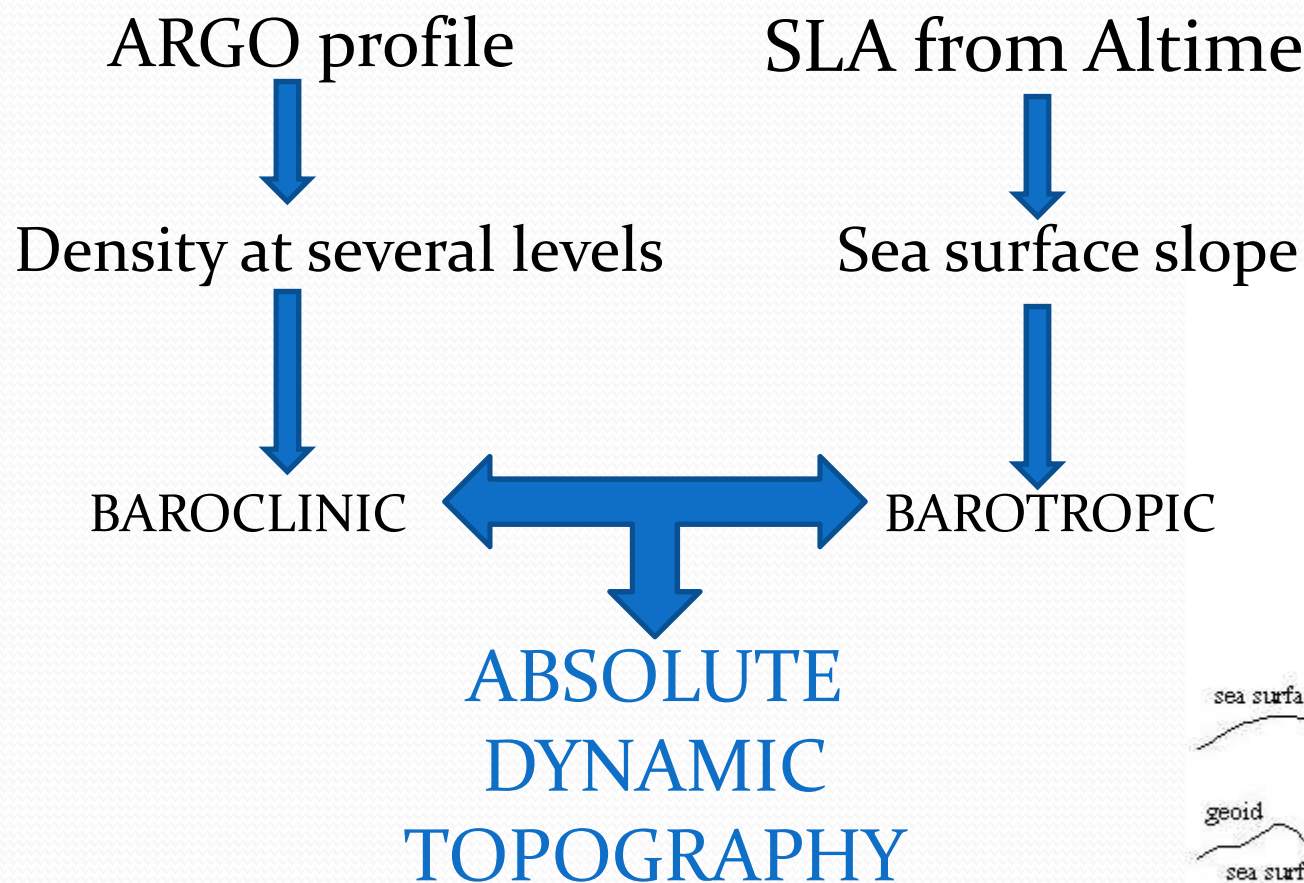
- Frictional boundary \rightarrow D large \rightarrow recirculation flows diminish
- Averaging for periods longer than mesoscale is necessary

DATA coverage - ARGO

1998 – 2008



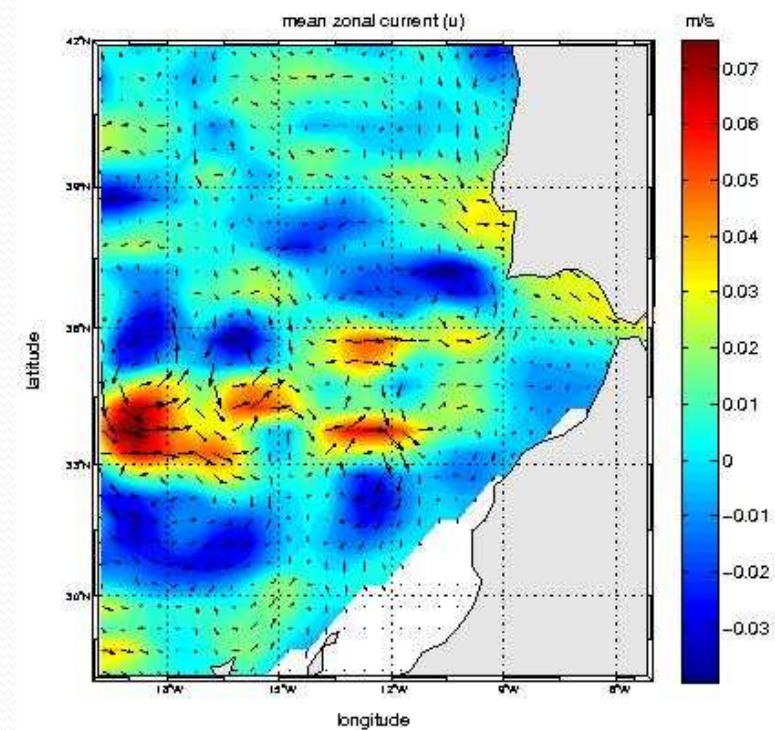
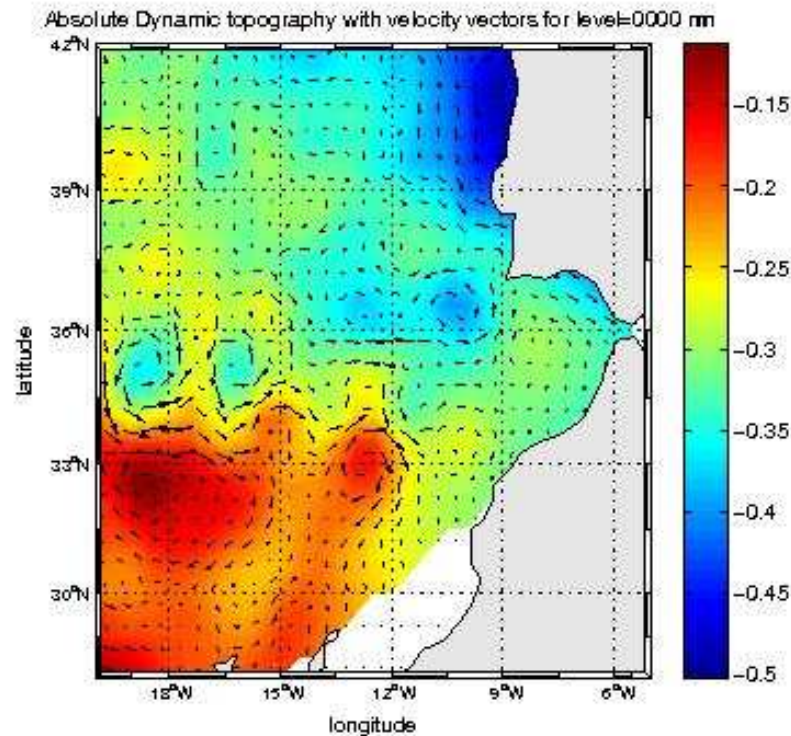
ADT from Argo + Altimetry



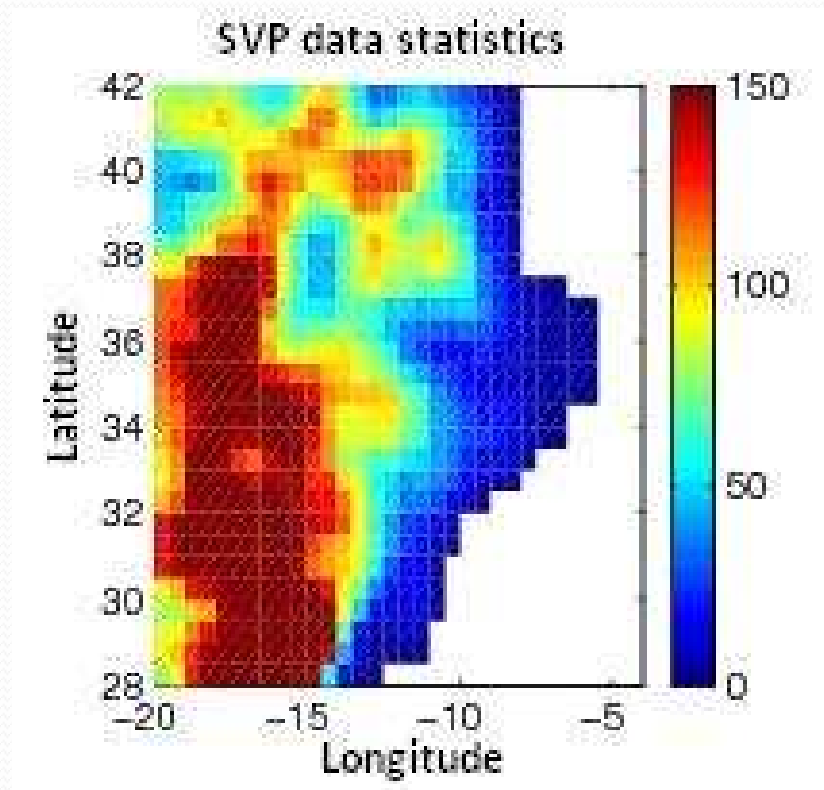
Absolute Geostrophic Surface Velocity

$$\longrightarrow \quad f v = g \frac{\partial \zeta}{\partial x} \quad f u = -g \frac{\partial \zeta}{\partial y}$$

Azores Current 33°N - 35° N



DATA coverage – SVP drifter buoys

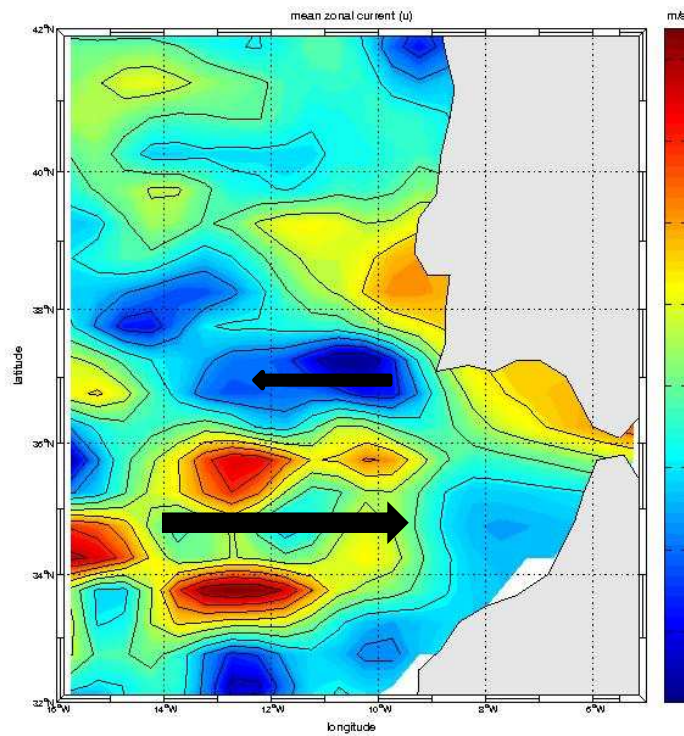


1993 - 2005

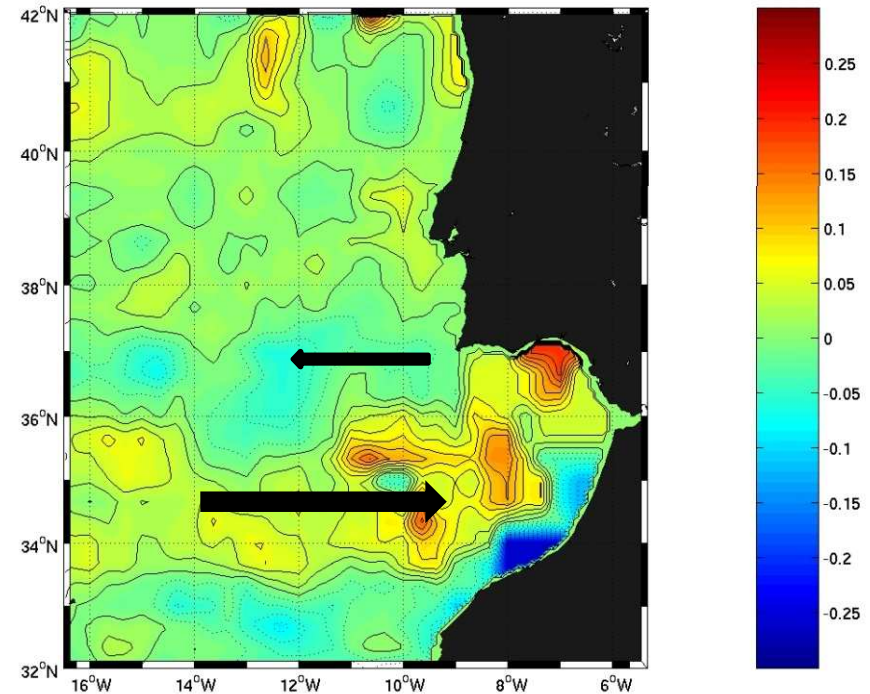
Global drifter Program
www.aoml.noaa.gov/phod/dac/gpd_drifter.html

Evidence of Cyclonic Recirculation Mean Surface Velocity

ARGO

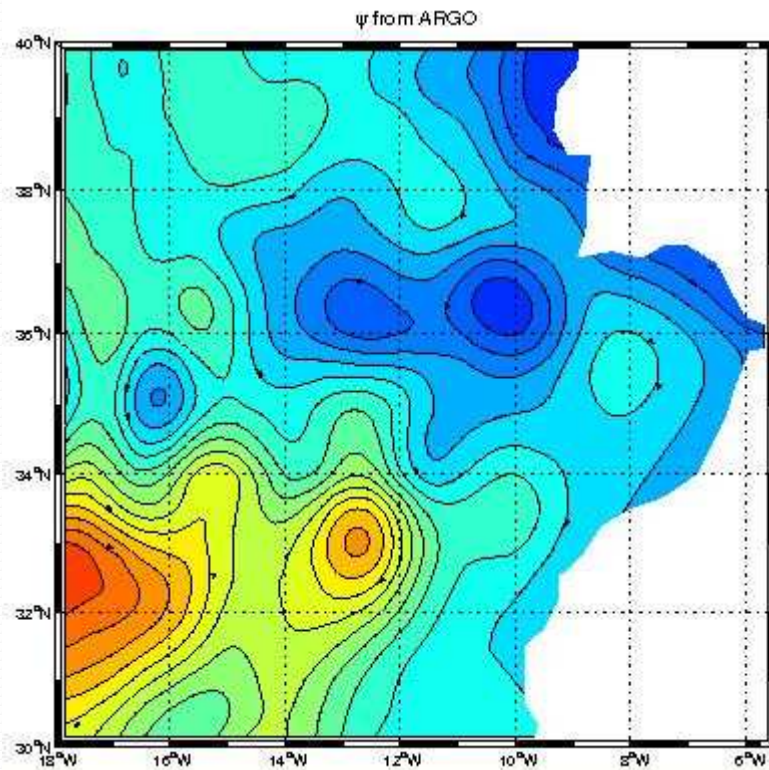


SVP

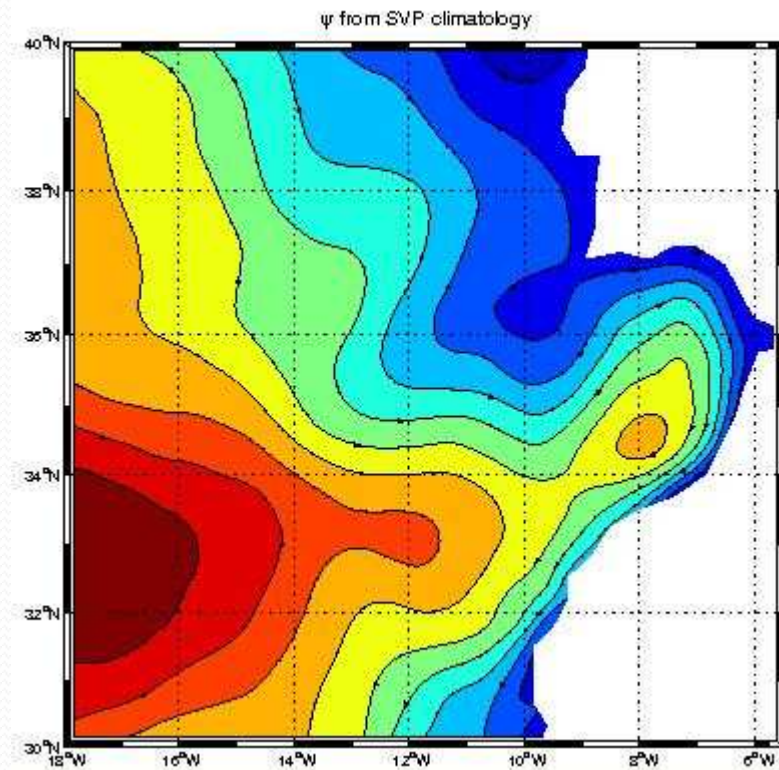


Stream function

ARGO



SVP



**CYCLONIC
RECIRCULATION**



Conclusions

- First observational evidence of β plume – as predicted by models
- Velocity fields calculated with SVP drifters data and ADT from Argo and Altimetry data showed a cyclonic recirculation in the GoC – as predicted by models
- Increasing number of data in past 10 years – crucial to reach such a result
- Data coverage still low



Acknowledgments

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References

- Kida, S. (2003), Eddy dynamics of β -plumes; Woods Hole Oceanogr. Inst./Mass. Inst. of Technology.
- Kida, S. (2006), Overflows and upper ocean interaction: A mechanism for the Azores Current, Ph.D. thesis, Woods Hole Oceanogr. Inst./Mass. Inst. of Technol., Cambridge, Mass.
- Jia, Y. (2000), Formation of an Azores Current due to Mediterranean overflow in a modelling study of the North Atlantic, *J. Phys. Oceanogr.*, 30, pp. 2341 -2358
- Özgökmen, T. and F. Crisciani,(2001), On the dynamics of β plumes; *Notes and Correspondence*, 31, pp. 3569-3580
- Özgökmen, T. , E. P. Chassignet, and C. G. H. Rooth (2001); On the Connection between the Mediterranean outflow and Azores Current, *J. Phys. Oceanogr.*, 31, pp. 461-480
- Peliz, A., J. Dubert, P. Marchesiello, and A. Teles-Machado (2007), Surface circulation in the Gulf of Cadiz: Model and mean flow structure, *J. of Geophysical Research*, 112, C11015.
- <http://apdrdc.soest.hawaii.edu> (Atlantic – Pacific Data Research Center)
- www.aoml.noaa.gov/phod/dac/gpd_drifter.html (Global Drifter Program)