# Poleward front of upwelling filaments generates subsurface anticyclonic eddies (FEDDY): a CAIBEX Project contribution

**Sangrà P. (1), J. Aristegui (1), C. Troupin (2), E.D. Barton (3)**

(1) Facultad de Ciencias. Universidad de las Palmas de Gran Canaria. Campus de Tafira. 35017 Las Palmas de Gran Canaria. Spain (psangra@dfis.ulpgc.es)
(2) GHER. Université de Liège. Belgium. (ctroupin@ulg.ac.be)
(3)Departamento de Oceanografía. Instituto de Investigaciones Marinas (CSIC).Vigo Spain, (e.d.barton@iim.csic.es)

## 1) The Cape Ghir Filament survey

In the framework of CAIBEX project, from August to September 2009 we conduct an interdisciplinary survey of the Cape Ghir Upwelling Filament (CGUF). The CPGUF is located at the Northwest African Coast and is a cuasi-permanent structure (Figure 1). Among other measurements, during the survey the filament was sampled at mesoscale/submesoscale range using SEASOR and a high resolution (5 nautical miles) CTD transect. Sampling strategy was based on the location of the SST signature of the filament as revealed by satellite images.

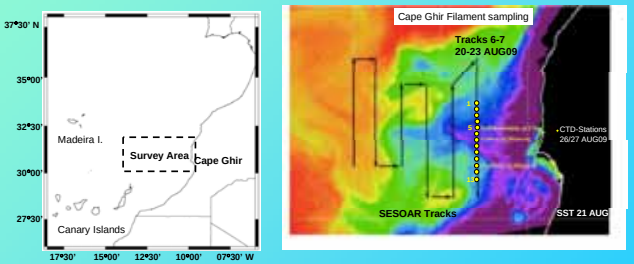


Figure 1. Survey area and SEASOR/CTD sampling of the Caper Ghir filament superposed to 21 of August 2009 SST Image. Notice the signature of the Filament by a cold tongue of upwelled water oriented zonally

## 2) Subsurface anticyclonic eddy and Chlorophyll-a chimney

Figure 2 show temperature and fluorescence section along the eastward SEASOR meridional track conducted first on 20 of August 2009 (Track 6) and the repeated on 23 of August 2009 (Track 7). Temperature sections show the signature of the filament at the upper levels by the doming of the isotherms. Below the poleward front of the filament located at 30.95 °N there is a clear downwelling of the isotherms being the signal of a subsurface anticyclonic eddy about 50 km diameter. Fluorescence shows a Clorophyll-a Chimney from the surface until at least 400 metres coinciding with the poleward front of the filament and the subsurface anticyclone. Fluorescence sections must only be viewed qualitatively because the fluormeter was misscalibrated, this caused that data were not recorded in a continuous way with jumps of 0.4 units as shown in Figure 3.

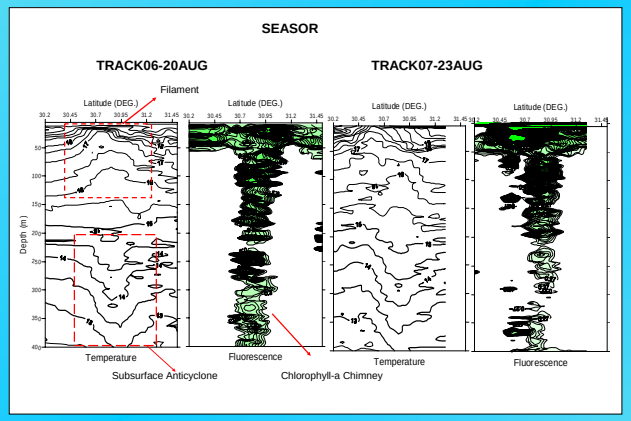


Figure 1. Temperature and fluorescence section along the SEASOR eastward track (see figure 1). The signal of the filament and subsurface anticyclones eddy was highlighted by a red frame on Track 6 temperature section these structures are located approximately at the same depth/latitude on Track 7. A chlorophyll-a chimney occupying the whole depth range is also clearly visible on florescence sections.

**SEASOR-Fluormeter misscalibration**

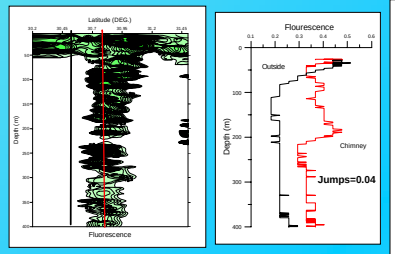


Figure 3. Fluorescence profiles inside a outside the chimney showing a staircase pattern related with the misscalibration of the SEASOR fluormeter that generated jumps of 0.04 units.

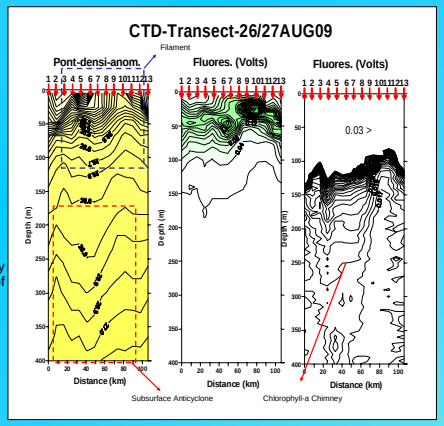


Figure 4. Temperature and fluorescence (high values middle, low values right) section of high resolution CTD Section (see Figure 1).

The SEASOR eastward track was repeated with a high resolution CTD section (see Figure 1). As illustrated in figure 4 CTD density section shows also a clear signal of the subsurface anticylone just below the poleward front of the filament located at CTD station 6. The depth range of the anticyclone is between 200 and 400 m. Location and intensity of this eddy is very similar as those observed one weak later on SEASOR Track 6 suggesting that is a near stationary filament related structure. On the right panel o figure 4 we have plot the CTD flourmeter section corresponding to the lowest values. Although the values of fluorescence values small, there are significant and, as in the case of the SEASOR, they reveal a subducting chimney of chlorophyll-a related with the poleward front of the filament and the subsurface eddy.

## 3) Proposed mechanisms

Significant values of fluorescence, associated with the chlorophyll-a chimney, well below the euphotic layer suggest a downward flux. Our hypothesis is that this flux is related with surface flow convergence at the poleward front of the filament and he secondary circulation inside the anticyclonic subsurface eddy (see right panel Figure 5). Convergences and divergences of this downward flux could explain the local concentration/dilution of chlorophyll-a observed on SEASOR florescence section. On the other had our hypothesis for the subsurface anticyclonic eddy generation is that this is related to the downward flux which causes the compression of planetary vorticity tubes and then injecting anticylconic relative vorticity to the fluid (see left panel of Figure 5).

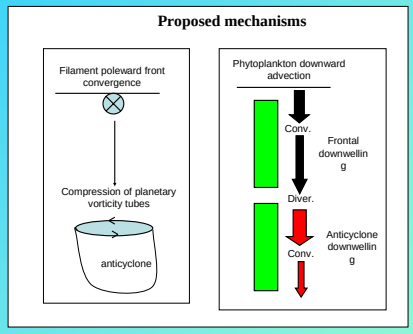


Figure 5. Proposed mechanisms for the generation of the subsurface anticyclonic eddy and chlorophyll-a chimney (sea details on text).

## Acknowledgements

We express our gratitude to the captain and crew of R/V Sarmiento de Gamboa and to the technicians of UTM-CSIC for supporting our work at sea. We also want to thank the Plymouth Marine Laboratory for providing satellites images. This work has been supported by the Spanish government through the projects CAIBEX (CMT2007-66408-CO2-O2/MAR),