SST DECREASE ON THE SAN MATIAS GULF COAST, ARGENTINA. POSSIBLE UPWELLING EVENTS

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INTRODUCTION

The San Matías Gulf (SMG) is the second largest gulf in the Argentinian Patagonian Shelf (Fig.1). It is one of the more productive regions of the Argentinian coast, and an outstanding foraging and breeding area for many species of birds, marine mammals and commercially valuable resources. A part of this region lies within the World Heritage area declared by UNESCO in 1999.

Figure 1

Based on *in-situ* data and remote sensing, thermal frontal systems have been previously identified (Fig. 2) and related to the areas where primary productivity is highest. Some of these frontal systems are spatially and temporally persistent and they are attributed to tidal vertical mixing and the inflow of shelf waters through the southeast. Other frontal areas located near the west coast of SMG, are more intermittent and are believed to be caused by upwelling favorable (N) wind events.

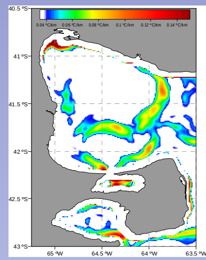

Figure 2: SST gradients climatology from NOAA-AVHRR. February (2000 – 2007).

Figures 3 and 4 show the barotropic response to wind forcing in the SMG using the Regional Ocean Model System (Tonini, 2010). Nonlinear effects generate upwelling or downwelling under different wind conditions. Figure 3c shows the northerly wind case which produces an Ekman transport to the east in southern hemisphere, decreasing sea level on the west coast and favoring the upwelling generation. This is shown in Figure 4c by mean of vertical velocities. On the other hand Fig 3d arises from southerly winds which cause a surface elevation on the west coast which lead to downwelling, as shown in Figure 4d.

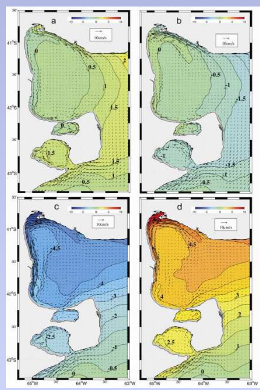

Figure 3: Mean flow and surface elevations. a) West wind, b) East wind, c) North Wind and d) South wind.

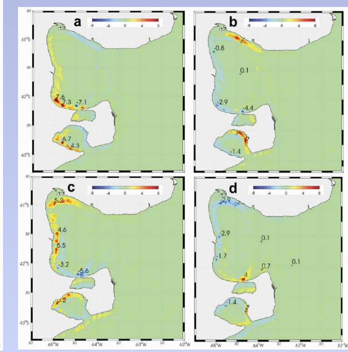

Figure 4: Vertical velocity (10^{-4} m.s^{-1}) in the bottom layer. a) West wind, b) East wind, c) North Wind and d) South wind.

DATA

- SST images from NOAA-AVHRR at 1.1 km resolution.
- Winds data from QuikSCAT scatterometer and consist in two images per day at 25 km of spatial resolution.

SST images show a well-know frontal area near the mouth and centre of the Gulf generated by tidal friction and the inflow of shelf waters at the south-east corner (Fig. 2), however in some cases, there are strong SST gradients (in some cases > 0.1ºC/km) on the west coast of SMG, as shown in Fig. 5.

These images were selected based on the observation of mean northerly wind exceeding 5 m s^{-1} for three consecutive days.

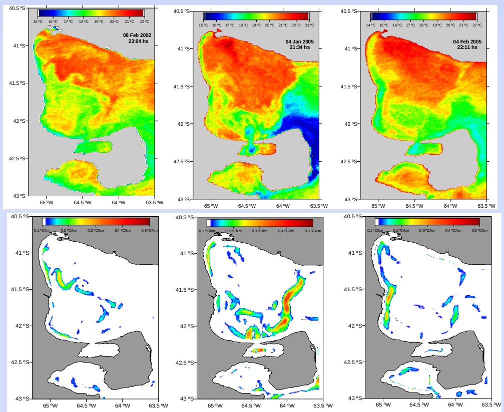

Figure 5: SST AVHRR images (upper panel) showing cold surface waters in the west coast of SMG. The scales are different to highlight the SST contrast. Horizontal gradients (lower panel) from SST images showing relative high values near the west coast.

Simple theoretical framework of upwelling in the SMG

Zonal transport:

$$M_x = \frac{\tau_y \hat{t}}{\rho \cdot f}$$

ρ = water density
f = Coriolis parameter

Considering the meridional mean wind stress τ_y) of the previous three days to the images of Figure 4, the zonal transport is given by: $M_x = 0.7\ m^2\ s^{-1}$

Assuming that the mixed layer depth (MLD, where transport occurs, *h*) is 20 meters and the area where upwelling is produced has 15 km width, then:

- Vertical velocity:

$$w = \frac{M_x}{width} = 4.67\ 10^{-5}\ m\ s^{-1}$$

- Zonal velocity:

$$u = \frac{M_x}{h} = 0.035\ m\ s^{-1}$$

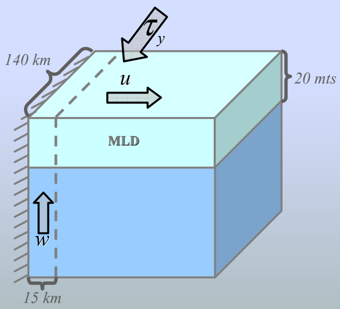

Figure 6: Simple scheme of the upwelling generation mechanism.

CONCLUSIONS

- Satellite images reveal relatively cold SST values in the west coast of SMG in agreement with upwelling favorable wind and numerical simulations.
- However, there are few cases in which the images present a band of cold water along the western shores but the winds are not upwelling favorable. On the other hand, after several days of upwelling favorable winds, it is not always possible to identify a cold coastal band in the SST images (not shown here).
- Overall, both, ROMS and Ekman theory seem to be in relatively good agreement.
- The velocity components derived from Ekman theory are not very different from those predicted from ROMS.

REFERENCES

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