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Ocean Science
Discussions

Interactive comment on “Malvinas-slope water intrusions on the northern Patagonia continental shelf” *by* A. R. Piola et al.

A. R. Piola et al.

apiola@hidro.gov.ar

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We thank Rev#2 for the thorough review of our manuscript. Below we address the reviewer′s comments and suggestions:

1) “I am a bit concerned about linking SST and CC anomalies which are estimated for the sea surface to a process occurring close to the shelf break bottom. The authors lack to present strong evidences linking sub-surface to bottom temperature anomalies to SST anomalies in the study region.” This is a valid point which requires some clarification. We argue that during the slope water intrusions the surface temperature and chlorophyll anomalies are linked to variability throughout the water column because the vertical stratification is relatively weak. The barotropic nature of the flow ties bottom features to surface dynamics and, presumably, alters the productivity of the sur-

face layer. Subsurface information is derived from hydrographic observations. In the revised manuscript we include synoptic distributions of near-bottom temperature and salinity (see Fig. R2-1). Close to 41.5°S the near bottom distributions present inshore excursions of isotherms and isohalines similar to the ones observed near the surface, supporting the statement that the intrusions extend throughout the water column. This is also suggested by the T-S diagram of stn. 527 (Fig. 3).

2) “Fig 10 of the paper presents a clear trajectory of a drifter (showed in red) flowing in the continental shelf. It looks like to me that the Malvinas Current is totally affected by the f/H contour at 41_ S but, after a while, turns back towards the shelf break. The trajectory (as well as the others) gives to clue on how long this process was (days?).” The time spent by each drifter on the continental shelf is given in Table 2. These times range between 20 and 53 days. Though the drifters have a temperature sensor, the along track temperatures alone do not provide evidence of the spatial pattern of the SST field, which is derived from satellite observations only. Details of the cloud elimination procedures are given in Mariano and Brown (1992).

3) “Data description lacks the temporal frame” The periods of the observations used were stated in sections 3 (hydrographic data, from 1969), 4.1 (SST, 1985-1999) and 4.4 (chlorophyll, 1998-2007). We will include also this information in section 2 in the revised manuscript.

4) “Drifter data lacks description of having (or having lost) their drogues as well as measuring SST” Only drogued drifters were used, this is now stated in the revised manuscript.

5) “SST images are said to be 2 day composites but no mention on how long (and to which period) the series is (related); no mention is made to cloud coverage or to possible (anomaly) errors related to this that can exist close to 41_ S; CC images are monthly images but again I cannot see the length of the time series.” Details of the cloud elimination procedures are given in Mariano and Brown (1992).

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6) “Seasonal cooling at site “A” may be computed yearly from the SST data used by the authors: a plot similar to Fig 6 may be added to this figure showing the SST time series at this site as well as the SST anomaly, . . .” The SSTa time series at site A has been added to Fig. 6.

7) “May be also prudent to mention sea-air fluxes computed for the vicinity of the study region by Pezzi et al (2009). In Page 2947 the authors also finished the first paragraph concluding that “Thus, it seems unlikely that sea-air heat exchanges can explain the intense temperature drops at site A relative to the surrounding area. New evidences reported by Pezzi et al. (2009) and other (under review at JGR) results of Acevedo et al. (2010) show that the Fairall et al. (1996) parametrization generally used for computing the sea-air fluxes may not apply to the Southwestern Atlantic Ocean”. The article by Pezzi et al. discusses the effects of the strong SST gradients across the Brazil/Malvinas Confluence (BMC) over the atmospheric boundary layer (ABL). They show that the sharp thermal front modulates the surface wind field, pressure and vertical stability in the lower atmosphere. Of particular interest is the stabilizing effect of cold surface waters (in the cold side of the front), which tend to decouple the upper and lower ABL. These effects however tend to be somewhat obscured when strong large circulation features dominate (e.g. OP25 in Pezzi et al. 2009). Pezzi et al. further show that these cross frontal variations can induce sharp changes in the net sea-air heat flux, with larger fluxes observed on the warm side of the Confluence (their Fig. 6). Though Pezzi et al. clearly document the effects of the BMC on the ABL it is difficult to determine to what extent the above described processes might impact the flux estimates at site A derived from the OAFlux dataset [which uses the Fariall et al. (1996) and Bradley et al (14th AMS Symp., 2000) parameterizations, Yu and Weller, BAMS, 2007]. Site A is located west of the cold wedge produced by the northward penetration of the MC along the continental slope, and about 300 km SW from the climatological location of the BMC (see Fig. 1). The OAFlux distributions of wind speed and heat flux present sharp transitions across the BMC (e.g. http://oaflux.whoi.edu/data/figmmean/fig_ave_ws_jul.jpg and http://oaflux.whoi.edu/data/figmmean/fig_ave_lh_jul.jpg. To further illustrate this

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Fig. R2-2 presents the net heat flux in December and June 1987. The climatological SSTs, also shown in Fig. R2-2, display the location of the BMC in close agreement with the sharp heat flux transition described by Pezzi et al. (2009). Though the spatial resolution of OAFlux is too crude to capture the details of the cross front scales associated with the BMC, it is clear that OAFlux heat flux reflects the strong signal associated with the BMC and that site A is distant from the transition. To the best of our knowledge OAFlux provides the best available estimates to evaluate the net sea air heat flux during the intense cooling events observed at site A.

8) "EOF analysis may be briefly described in methods before showing up in the results section." A reference to the EOF analysis has been added in Section 2: Data and Methods.

9) "2nd paragraph's reference to 123 CTD stations in Fig 7: the figure needs to be better made for the stations are very difficult to be seen. I think Fig. 7 could also display the 100 m level as to better support Page's 2949 affirmation that "in winter the surface inshore intrusions extend vertically throughout the water column"."

Please refer to point 1 above.

10) "last lines of the conclusion: I guess that, although the physical mechanisms leading to the temporal variability of the cold intrusions at 41° S are still unknown, the authors are well aware of the possible presence of shelf-break eddies and smallscale mixing caused by current sheering (in this case the slow Patagonian and the fast Malvinas currents) – good references to this process at lower latitudes at the south American continental break region are stated in the last paragraph of Page 2941. I would like to know why these process was not investigated by the authors using the available 2-day SST image composites or at least why a mention to future work on this subject was not considered." The drifter tracks along the slope and the along the core of the Malvinas Current are remarkably linear, presenting very low eddy kinetic energy per unit mass (<265 cm2.s-2) and high kinetic energy of the mean flow ($\sim$ 103 cm2.s-2,

Oliveira et al., JGR, 2009, their Fig. 6). This is in agreement with the low rms sea surface height variability derived from altimeter observations and numerical simulations (< 10 cm, Goni and Wainer, JGR, 2001; Palma et al., JGR, 2008). This appears to be in sharp contrast with the observations further north, where a variety of eddy scales seem to be effective in promoting cross slope exchanges and impact the shelf ecosystem. Nevertheless, high resolution color images suggest that small scale eddies and filaments, not readily detected by low resolution SST and SSH observations and the somewhat smoothed drifter trajectories, might be ubiquitous on the slope region. It is difficult to assess to what extent the onshore intrusions documented in this study may be connected to eddy variability, however, this possibility is included at the end of Section 5.2: Genesis of slope water intrusions.

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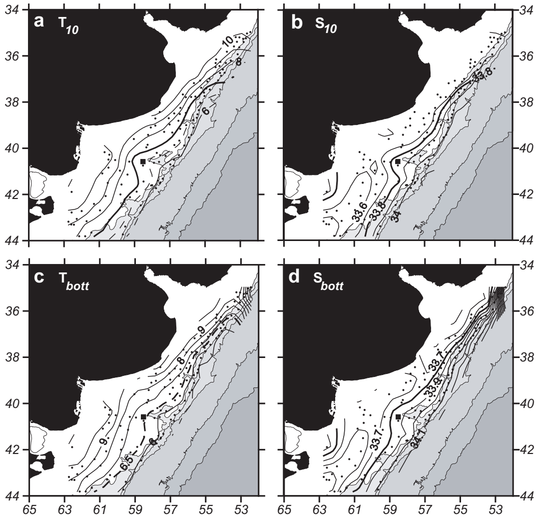

Figure R2-1 (Figure 7):
Temperature (left) and salinity (right) distributions at 10 depth (upper panels) and bottom (lower panels) from hydrographic data collected in July 1996. The station locations are indicated, station 527 with a large square. The background shading are the 100, 200, 1000, 3000 and 5000 m isobaths.

Fig. 1.

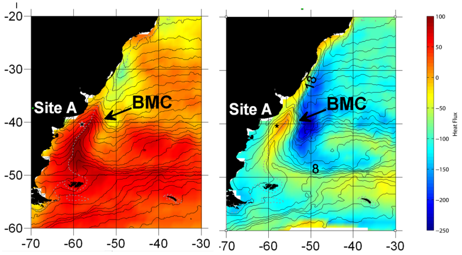

Figure R2-2: The background colors show the net heat flux through the sea surface in December (left) and June (right) 1987, from http://oaflux.whoi.edu/. Contours are climatological SST from Casey and Cornillion (J. Climate,12, 1999). The star indicates the location of site A and the dashed line the 200m isobath.

Fig. 2.