

# Comparison of Surface Layer Currents Determined by Satellite Tracked Drifters and *in situ* Anchored Current Meters off Southeast Brazil

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## ABSTRACT

Trajectories from satellite tracked drifters are compared with data series for the same time intervals from a current meter anchored in 200m depth on the continental platform off SE Brazil. The field measurements were obtained as part of Project COROAS, Brazil's contribution to the World Ocean Circulation Experiment (WOCE). Autocorrelation series generated from a 140 day long drifter series were used to determine a decorrelation time scale of about 23 days, 7 days longer than most of the series used in this report. Mean current speeds and directions for southbound flow for the drifters and current meter were 31cm/s toward 219° and 43 cm/s toward 201°, respectively. Current meter velocities were, on the average 17° to the left of the drifter trajectories and faster than the drifters by about 8 cm/s. Standard deviations for both data sets were about the same, suggesting that the two data sets are of about the same quality and can be compared when necessary.

## INTRODUCTION

Project COROAS (Oceanic Circulation in the Western Region of the South Atlantic) represents Brazil's participation in the World Ocean Circulation Experiment (WOCE). COROAS is multi-institutional with researchers participating from the Oceanographic Institute of the University of São Paulo (IO-USP), the National Institute for Space Research (INPE) and the Federal University at Rio Grande (FURG). COROAS consists of 6 component projects, among them the study of the influence

of mesoscale vortices (eddies) on the Brazil Current using drifting buoys by researchers at INPE and the study of the transport of mass and heat by the Brazil Current on the continental shelf, off SE Brazil using current meters, by scientists at IO-USP. Some preliminary results describing characteristics of circulation in the Project COROAS region have been published (Campos et al, 1995; Stevenson 1996).

Direct measurements of currents are made with anchored current meters (moorings) and by satellite tracked drifters or buoys. Both methods

are considered to provide accurate and useful indications of current speed and direction. The current meters, however, measure the current passing by at a fixed location in time, while the drifters are considered to accompany a parcel of water along its course. When current measurements are made in a region where the horizontal circulation is reasonably uniform, the methods are expected to provide very similar data. A comparison of such paired data was made by Collin et al (1968). A comparison of drifter and moored current meter measurements, based on theoretical considerations was made by White (1986).

On the continental platform off SE Brazil, however, the presence and interaction of vortices with the Brazil Current result in a complex circulation that is still poorly understood. It is important therefore, to know to what extent the velocities of ocean currents measured by anchored current meters and by drifting buoys in COROAS are similar, and when necessary can be substituted for one another. The objective of this report is to make a preliminary comparison of the surface layer ocean current data obtained from satellite tracked drifters with data from an anchored current meter located in the same region.

### STUDY AREA

In order to maximize results from different research components of COROAS, most of the field work was done within the area delimited by 23.6°S, 44.8° W; 25.1° S, 43.1° W; 26.8° S, 45.2° W; and 25.1° S, 47.0° W (Fig. 1).

### DRIFTER DATA

Positional and sea surface temperature data were obtained from 15 WOCE standard, low cost drifters (LCDs) launched in groups of 5, in the vicinity of 24.8°S, 44.3°W, in February and July 1993 and January 1994. The drifters were set to measure the current at 15m depth. The drifters used ARGOS compatible data collection platforms (DCP's) and transmitted

their data via CLS ARGOS equipment aboard NOAA-11 and NOAA-12 satellites. Data were subsequently obtained via telephone modem and PC computer from Service ARGOS, Toulouse, France. Data time series from the drifters were limited to those portions of the time when the drifters were within the previously defined area of study (Fig. 1). For this report data sets were limited to series from the first set of 5 drifters (LCDs 3178-82). Initially all of the drifters spent some of their time within the study area, while some months later several drifters passed to the NE on a return course through the western part of the study area.

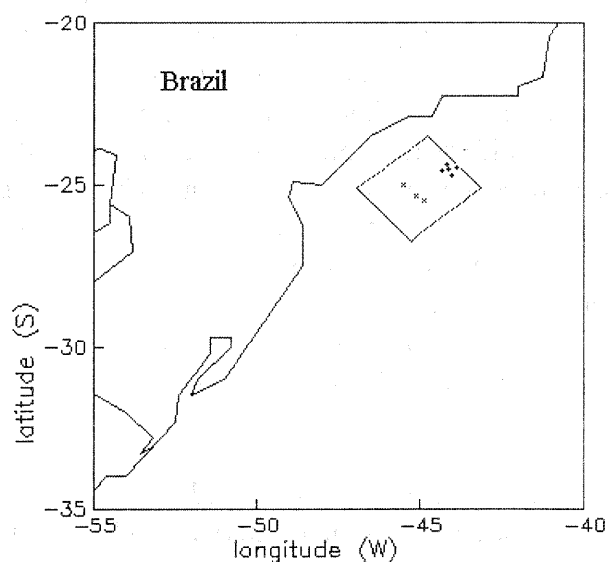


Figure. 1. Drifter launch positions (+) and location of current meter moorings (x).

Latitudinal and longitudinal data series were first split into shorter series corresponding to those time intervals when the drifters were within the study area. Mean current speed and direction were then determined for these series. After the individual mean currents were computed, the general mean current and its standard deviation were determined. Because some of the series indicated currents to the north and others indicated currents to the south, the series were separated by current direction and the northerly and southerly mean currents

and their standard deviations were also computed.

In order to determine to what extent the two type of current measurements might be compared, the decorrelation scale for one of the LCD 3178 series was determined. The autocorrelation series were computed for the two component series after each series was detrended.

CURRENT METER DATA

The three current meter (CM) moorings used in COROAS were located at about 25.0°S, 45.5°W; 25.4°S, 45.1° W; and 25.5°S, 44.9°W, in 100m (C100), 200m (C200) and 1000m (C1000) water depths, respectively (Fig. 1). While each mooring contained current meters set at different depths, only data from the shallowest current meter (32m) at each mooring was used. Data time series from the three current meters were limited to the same time intervals used for the drifter trajectories. For this study the analysis was limited to the current meter at 32m depth (CM32) at the C200 mooring.

Measurements of current speed and direction were made at 15 minute intervals and the data were averaged to obtain hourly current velocities. In order to obtain a visual indication of the similarity between the drifter and current meter data, the velocity values for LCD 3178 were converted in the usual manner to a progressive vector diagram (PVD). The origin for this PVD was adjusted to be the position of the C200 mooring.

Mean velocities were computed for each of the CM series. Because the currents moved to the north in some series and to the south in other series, the series were separated into two groups and the means and their standard deviations for the two groups were determined.

RESULTS

The autocorrelation time series for LCD 3178 are shown in Figure 2.

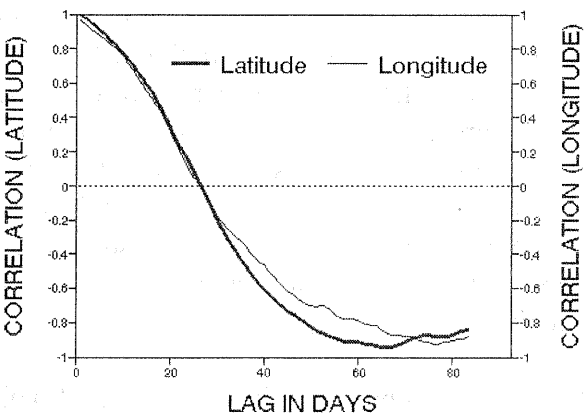


Figure 2. Decorrelation of the drifter with time is shown by the decrease in coefficients with increasing time lags. After about 23 days there is essentially no correlation between the earlier and later parts of the series.

The correlation coefficients decrease from a maximum of 1 at zero time lag to a correlation of zero after about 23 days. We consider then the decorrelation scale to be about 23 days in the locale of the drifter trajectory. Most drifter and current meter time series used in this report were less than 15 days. Such series are expected to show reasonable similarity.

The similarity between the LCD 3178 trajectory and the current meter PVD is seen in Figure ? Both trajectories begin with a current direction toward the east, followed by a change towards the southwest. The longer PVD indicates that the current speed measured by the current meter was greater than the equivalent speed determined by the drifter.

Mean speeds and current directions for LCDs 3178-3182 and (CM32) current meter time series at C200 were computed and are shown in Table 1. Analysis of the drifter trajectories and current meter velocities show a complicated surface circulation, with eddies frequently

present or passing through the study area (Fig. 2). The mean surface circulation in the eastern half of the study area ( $\geq 200\text{m}$  water depth) was found to flow to be toward the SW. Inshore of the C200 mooring, the surface currents were sometimes to the NE, particularly during the winter months.

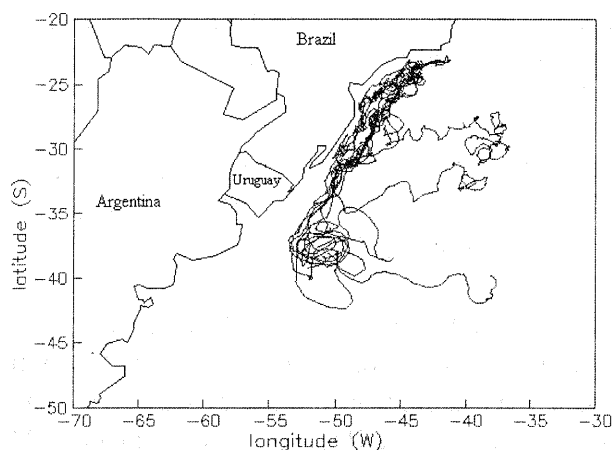


Figure 3. Displacement trajectories for satellite tracked drifters.

Average current velocity for the southbound flow at CM32 was  $43\text{ cm/s}$  toward  $201^\circ$ . The corresponding mean current velocity measured by the 5 drifters was  $31\text{ cm/s}$  toward  $219^\circ$ . The two forms of measurement shows the drifter data to be about  $8\text{ cm/s}$  slower than the current meter measurements. Current directions were also different, with the current meter data showing the currents to be about  $17^\circ$  to the left of the drifter currents. The variability in the measurements is best seen from their standard deviations. The overall standard deviations for the data are almost equal:  $\pm 21\text{ cm/s}$  for current speed and about  $\pm 72^\circ$  for the current directions. For the individual northbound and southbound grouping of data, the standard deviations for the CM data are slightly smaller than for the drifter data sets. The analysis shows a good correspondence for the two velocity fields as determined from the drifter trajectories and the current meter, especially when considering the presence of eddies in the study area.

During 8 March (Julian Day 67,23-.99) the LCD 3178 passed in very close proximity to the 200m current meter mooring (Fig. 4). Positional data from the LCD3178 and the current meter for the time interval 67.23-68.0 were used to determine the mean velocity for both the drifter and current meter (see Table 1). The mean speeds and directions for the LCD and current meter were  $66\text{ cm/s}$  and  $60\text{ cm/s}$  toward  $200^\circ$  and  $204^\circ$ , respectively, considered to be very similar to each other.

## CONCLUSIONS

Both satellite tracked drifters and *in situ* moored current meters were used to measure currents on the continental platform off SE Brazil for Project COROAS. In order to determine whether these different forms of measurement could provide similar results, an autocorrelation series of a 140 day long drifter series was computed and found to determine a decorrelation time scale of 23 days for the locale. Since most of the time series were less than 15 days, the comparisons were considered to be reliable indicators of the similarity of the two data sets.

The mean current speed and direction for the southbound flow indicated by the 5 drifters (set for 15 m depth) used in the study was  $31\text{ cm/s}$  toward  $219^\circ$  and  $43\text{ cm/s}$  toward  $201^\circ$  for the 32m deep current meter located at the 200 m depth mooring. Analysis of standard deviations for both sets of data show the variation to be essentially the same for speed and direction indicating that the two data sets are of about the same quality. Mean current meter velocities were on the average  $17^\circ$  to the left of the drifter velocities and  $8\text{ cm/s}$  faster. A combination of small scale non-uniformities in the velocity field and the fact that the currents were measured at 15m depth by the drifters and at 32m depth by the current meter are considered the principal reasons for the observed differences between the two forms of measurements. The results of this study strongly support the view that WOCE standard, drifters

tracked by satellite are suitable for intercomparison with *in situ* current meters and produce about the same variations in the data series.

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Table 1. Comparison of drifter and current meter velocities

LCD	JDay <sub>i</sub>	JDay <sub>f</sub>	ΔJDay	V (cm/s)	θ (°)	V <sub>32</sub> (cm/s)	θ <sub>32</sub> (°)	V-V <sub>32</sub> (cm/s)	θ-θ <sub>32</sub> (°)
3178	48.75	69.20	20.55	8.7	218.2	26.8	201.6	-18.2	16.6
3178	67.23*	67.99	0.76	65.9	200.2	59.9	203.6	6.0	-3.4
3179	8.72	53.00	4.28	8.9	060.8	11.4	058.0	-2.5	2.8
3179	58.23	64.25	6.02	54.7	213.0	43.3	203.6	11.4	9.4
3180	48.88	49.98	1.10	22.9	081.4	17.9	040.4	5.0	41.0
3180	56.25	71.01	14.76	20.5	216.7	44.9	209.5	-24.5	7.2
3181	48.88	60.29	11.41	23.2	224.5	14.2	182.2	9.0	42.3
3182	49.23	55.32	6.09	5.6	083.5	10.4	083.5	-4.8	0.0
3182	62.40	75.48	13.08	13.1	239.8	67.0	206.9	-53.9	32.9
GenM <sup>1</sup>				24.8	170.9	32.9	154.4	-8.1	16.5
GSDev <sup>1</sup>				±21.3	±72.8	±21.6	±71.5	±21.1	±17.8
Means <sup>2</sup>				31.0 12.5	218.7 075.2	42.7 13.2	201.2 60.6	-11.7 -0.8	17.5 14.6
Std Devs <sup>2</sup>				±23.5 ±9.2	±13.1 ±12.5	±19.8 ±4.1	±9.7 ±21.7	±25.5 ±5.1	±17.1 ±22.9

\*Values determined when LCD passed in close proximity to current meter (32) mooring.  
<sup>1</sup> Means and standard deviations determined for sets of 9 measurements.  
<sup>2</sup> Means and standard deviations determined for sets of northbound and southbound currents.

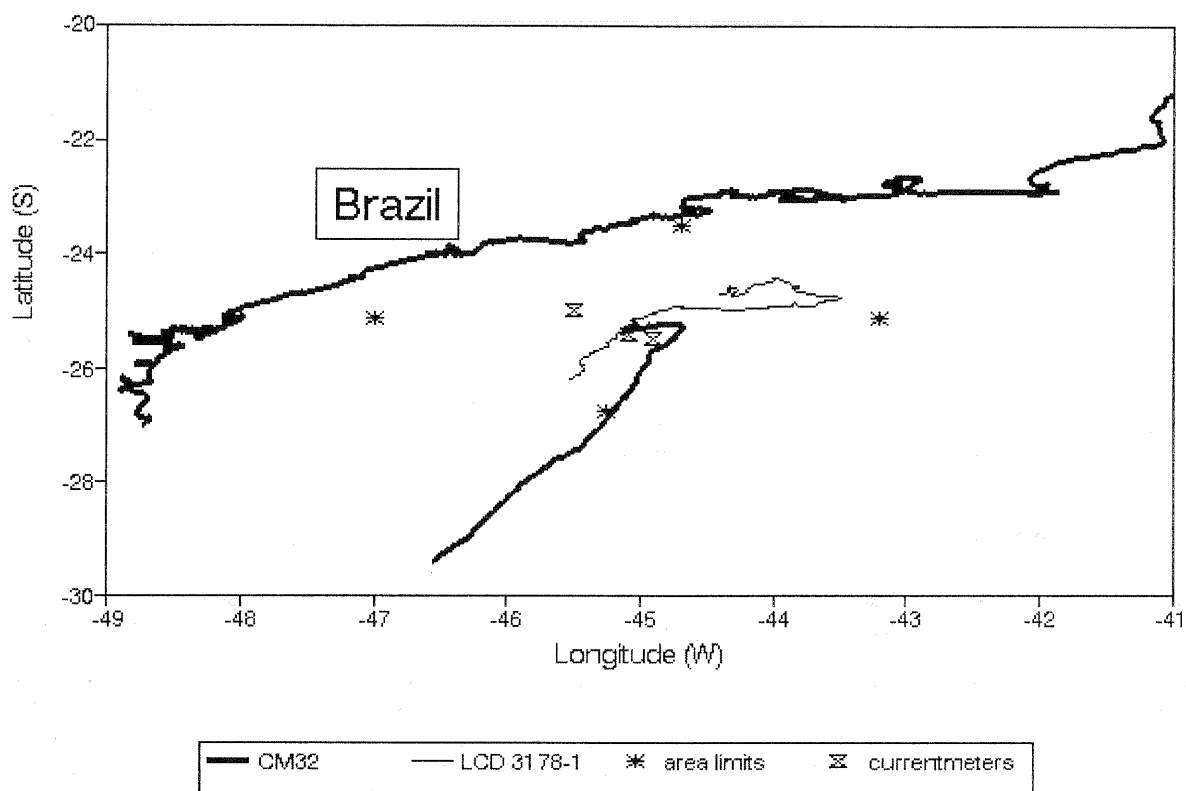


Figure 4. Drifter (LCD3178) trajectory during the first 20.6 days of the data series. The equivalent trajectory for the current meter series is shown as a progressive vector diagram (CM32) centered at the location of the current meter.