Western Boundary Currents in front of French Guiana

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I. Introduction

The main objectives of the NOE programme ("Nord Ouest Equatoriale" experiment) conducted by the ORSTOM Center of Cayenne is to study the seasonal variability of the mass and heat transports along the portion of the western boundary located in front of French Guiana. This country presents a particular geographical position for the exchanges between both hemispheres.

Here are presented the preliminary results got in 1989 in front of Cayenne during the four cruises carried out for the first three by the N.O. "Andre NIZERY" (ORSTOM) in May (12-22), June (2-12), July (4-12) and for the last one by the N.O. "Malcolm Baldridge" (NOAA) in August (27) - September (17).

II. Surface wind distribution (fig. 1)

The first two cruises were under the Northeast trade winds regime; the winds were strong ; a mean wind speed of 20-25 knots was currently observed on board (the anemometer of the ship is located at 12 m above sea level). In July, on the contrary, due to the Northward displacement of the Inter Tropical Convergence Zone (ITCZ) the winds were weaker and variable in direction. The offshore wind observations are of good agreement with the wind speed and wind direction measured at the rocket basis (Centre Spatial Guyanais) located at Kourou (60 kms North of Cayenne). A comparison with the monthly mean values computed at that location over a ten year period (1976-1985) shows the anormality of the 1989 year particularly in may and june during which the winds were north easterly instead of Southeasterly. In September 1989, the situation was not statistically different from the mean for the direction but the mean wind speed was a little bit higher.

III. Currents

III.1 at the surface (fig.2)

The surface current distribution (without reference) present many interesting features : i) in May, the currents are strong along the coast particularly over the continental shelf ; the arrows show anticyclonic gyres along the two legs (see fig. 1) ; ii) in June, the currents are strong both on and off the shelf, the maximum speed is observed at the shelf break ; iii) in July, the currents are weaker and the vectors exhibit now a tendancy for cyclonic senses. In all three cases, the observed currents at the surface (Ekman drift) are consistent offshore with the winds observations ; this is particularly obvious in May and June periods during which the winds are strong. These surface current distributions are consistent with the surface currents deduced from shipdrifts and the 3-D non linear model of GFDL (Richardson and Philander (J.G.R., 92, CI, 1987)).

III.2 Subsurface and deep currents (fig.3 et 4)

The currents at 50 m depth cannot be described, as at the surface, in a simple manner. For each period of observations, a succession of gyres of apposite senses appear : cyclonic at the coast and beyond 7°N but anticyclonic between the shelf break and 7°N. These current distributions as we shall see later on, are consistent with the 20°C isotherm topography. Currents at the surface and at 50 m depth are of opposite direction.

Deeper, in the 200-300 m layer, the currents are still very strong, particularly in June and along the shelf break ; they flow to the Southeast direction with speeds up to 100cm/s ! In September, PEGASUS profile got at four stations located in front of Cayenne (bottom depths of respectively 4230 m, 4100 m, 3750 m and 3000 m) still show the presence offshore of this Southeast current : speeds ago to 190cm/s have been measured between 200 and 300 m deep (!) at stations 1 and 2 (fig. 5). Closed to the shelf-break (station 4), the current is now to the Northwest and not to the Southeast as in June. Below 1 000 m depth which corresponds at that time to a level of no motion, strong currents appear again but are of opposite direction. We now observe a Southeast current with a speed up to 100 cm/s at 2 000 m deep (!) and a Northwestward current at station 1 from 1 500 m to 4 200 m depth (!). The mean transport computed for the Southeast current (deep werstern boundary current) corresponds, for that period of time, to about 100 sverdrup ! These deep equatorward (shelf-break) and poleward (open sea) flows have been reported further north from geostrophic computations ; they are both associated with maxima of F-11 (Fine and Molinari, DSR,35,1988).

IV. Temperature

IV.1 At the surface (fig.5)

The monthly variability of the Sea Surface Temperature (SST) is weak in the (< 2°C) west compared to the one observed in the eastern equatorial area (≃ 6-7°C) during the same period of the year. For the three first cruises : i) the SST minima are located on and off the shelf ; the absolute minimum is at the coast in May and June but at the shelf-break in July ; ii) the two minima are separeted by a SST maximum which appears as a tongue in May and June but through a frontal zone in July, oriented in a direction parallel to the coast ; this feature suggests the presence of an anticyclonic gyre Southeast of Cayenne.

IV.2 20°C isotherm (fig.6)

The topography of the 20°C isotherm, identified as the central part of the thermoclim, exhibits in May and July as the SST distribution, the presence of two minima separated by a relative maximum. In June, the Southeast leg, a second maximum appears. Compared with the surface current map the deepening (cropping up) of the thermoclim is associated with anticyclonic (cyclonic) gyres. Along the shelf-break and on the shelf, the tilt of the isotherms are closely linked to the strong coastal Northwesward surface current.

V. Salinity

V.1 At the surface (fig.7)

The Sea Surface Salinity (SSS) is, in the West, a good indicator of the coastal circulation, at the surface. In May, the Amazone fresh waters (S<30 ‰) are observed on the shelf but closed to the coast. In June, in connection with the surface currents, these fresh waters

In June, in connection with the surface currents, these fresh waters spread to the east ; salinity values of less than 15 ‰ are then seen beyond the continental shelf break. This is the situation which allows the amazone river waters to reach directly, following the coast, their Northest position.

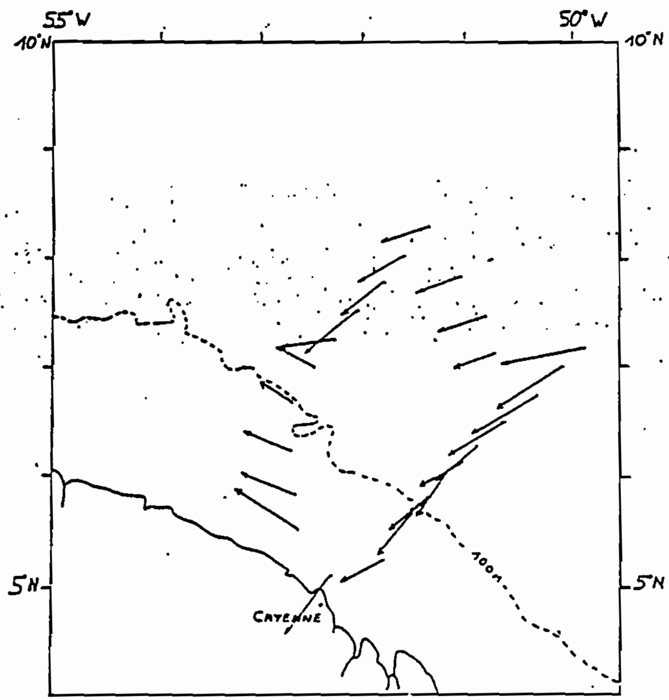
V.2 Salinity maxima (fig. 9)

The salinity structure is often characterized, as shown in figure 9, by two maxima separated by a relative minimum. The closest to (farest of) the coast corresponds to the South (North) Atlantic Central Water. In september the same feature occurs but with maximum values slightly lower than the ones observed from May to July. The depth of the salinity maxima decreases from May to July in front of Cayenne. This feature doesn't appear on the monthly community model computations of the meridionnal salinity sections along 53°W further observations are needed..

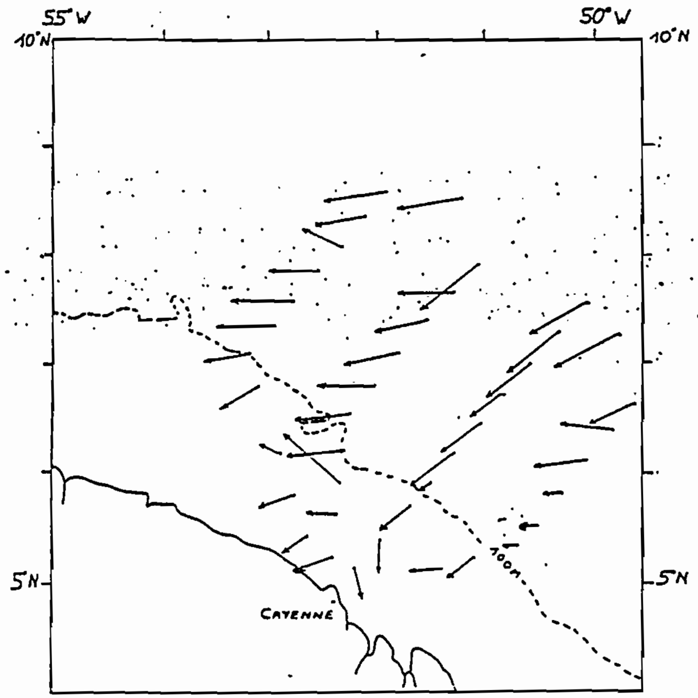
VI. CONCLUSIONS

The preliminary results got during the NOE cruises exhibit very interesting features either at the surface or in the subsurface and deep layers. We have now to go on in order to achieve the main scientific objective which is the seasonal variability of their dynamics. Cruises with the N.O. NIZERY (January, February, March, October, November) and the NOAA ships (January, August (?)) are scheduled in 1990 to complete the study. A french subsurface mooring will be deployed (bottom depth 2500 m) in March 1990 for at least one year to fulfil these objectives.

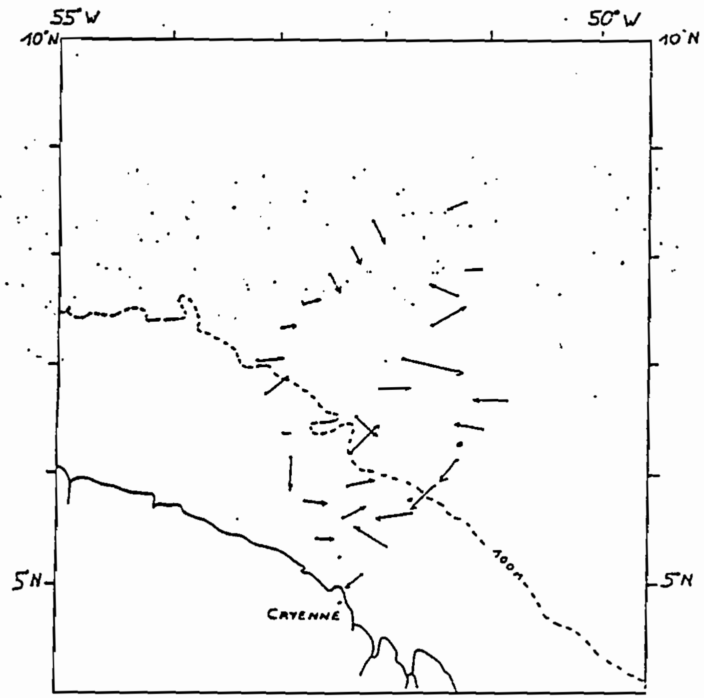
VENT DE SURFACE



NOE-1 12-22 Mai 1989



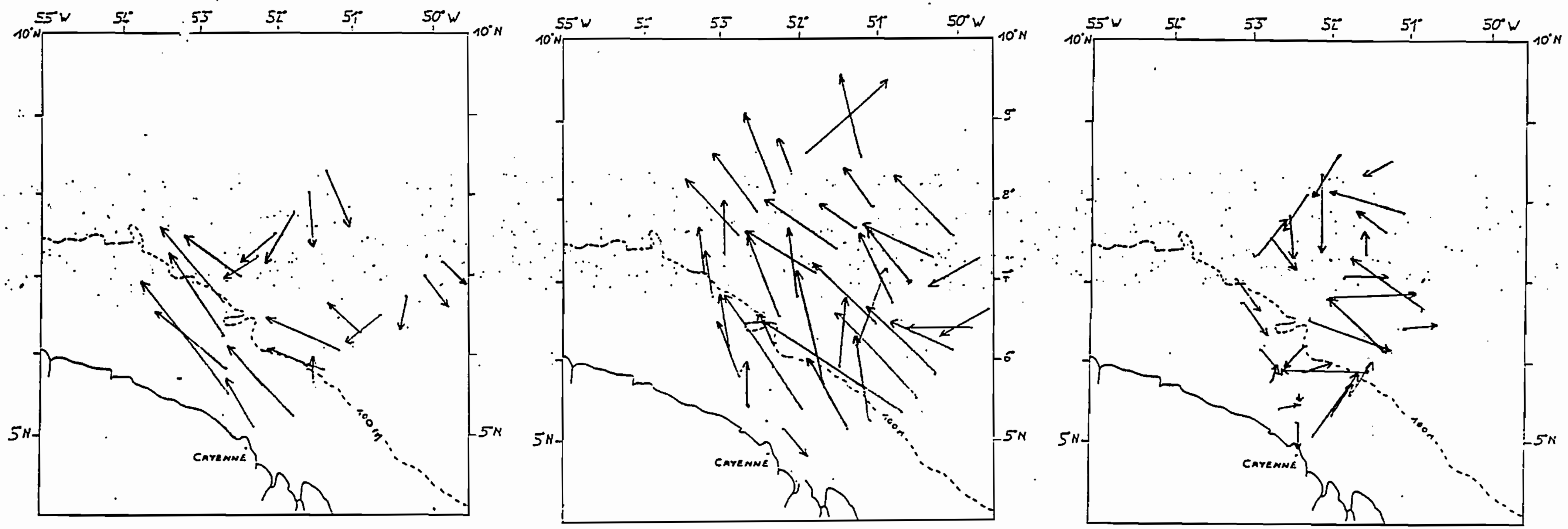
NOE-2 2-12 Juin 1989



NOE-3 4-12 Juillet 1989

fig. 1

COURANT DE SURFACE



NOE-1 12-22 Mai 1989

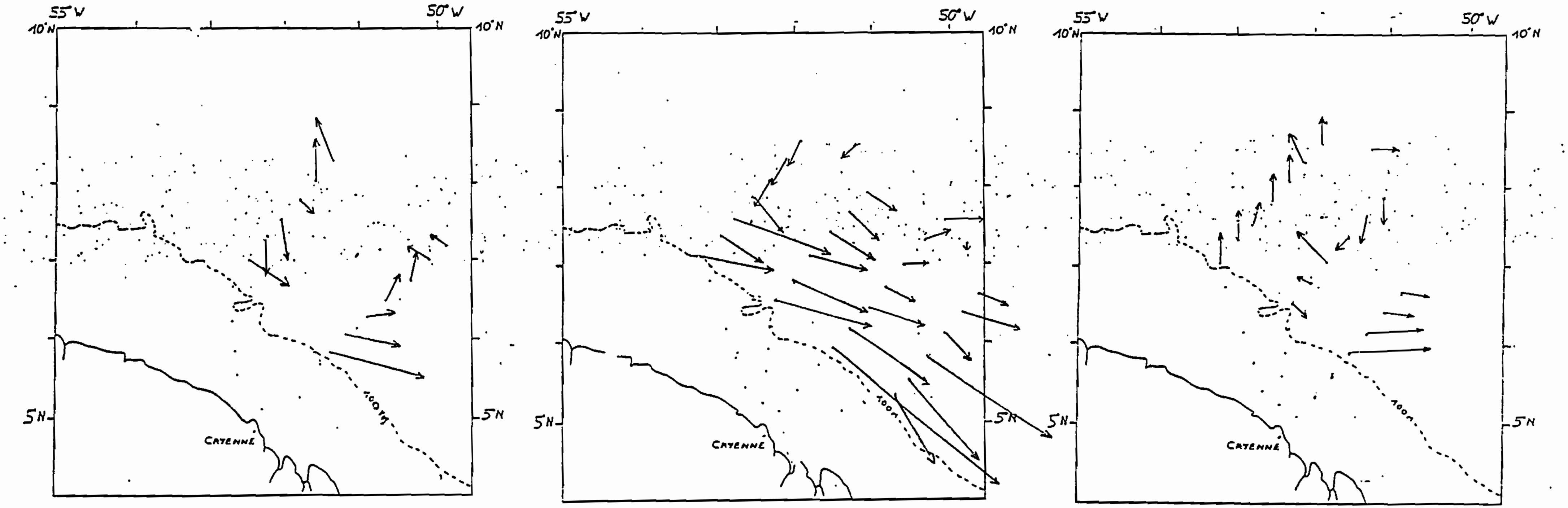
NOE-2 2-12 Juin 1989

NOE-3 4-12 Juillet 1989

40 cm/s

figure 2

COURANT COUCHE 200 - 300 M



NOE-1 12-22 Mai 1989

NOE-2 2-12 Juin 1989

NOE-3 4-12 Juillet 1989

20 cm/s

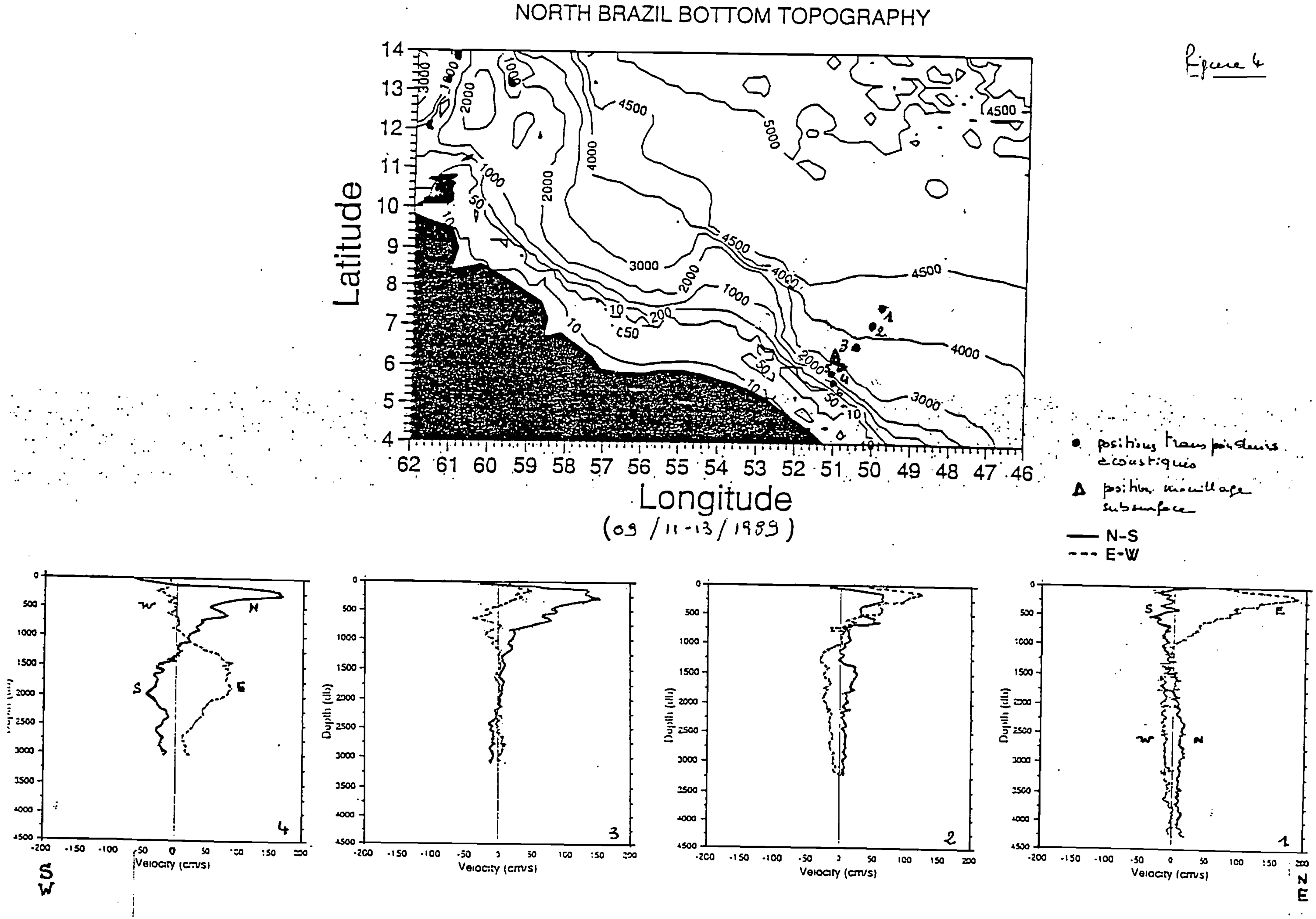

NORTH BRAZIL BOTTOM TOPOGRAPHY
Latitude
Longitude
(09 / 11-13 / 1989)
positions transpondeurs acoustiques
position mouillage subsurface
N-S
E-W
Velocity (cm/s)
Depth (db)
S
W
N
E

Figure 4

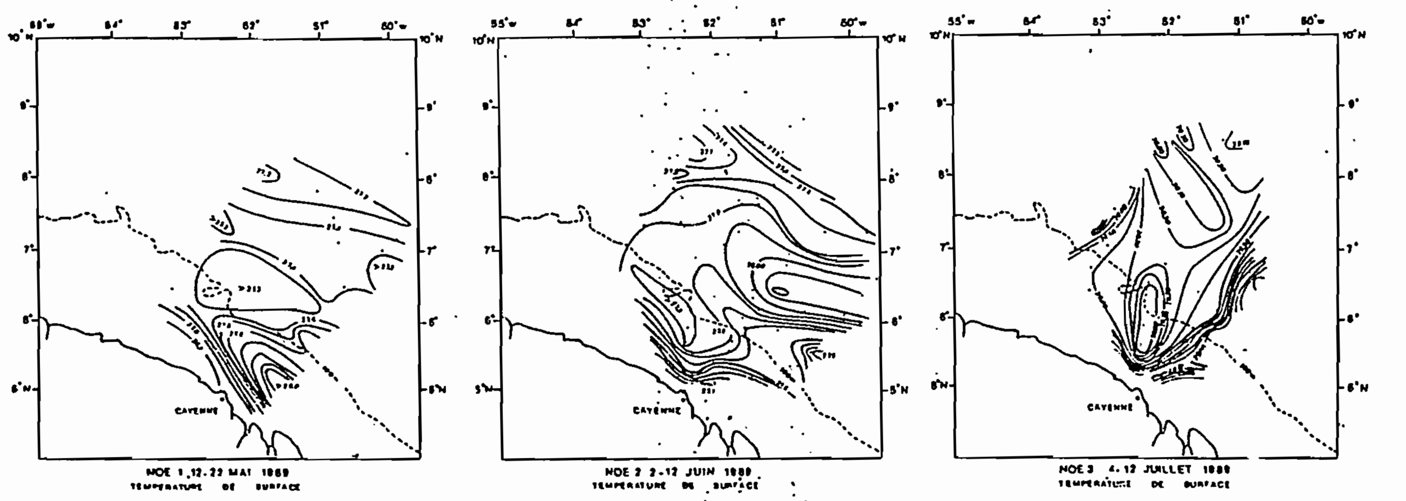
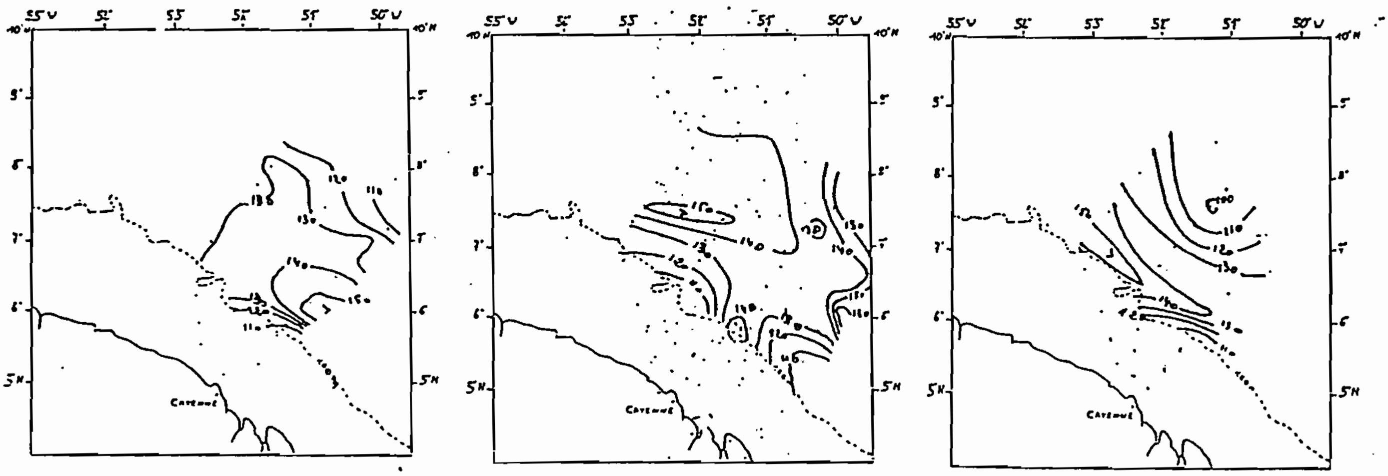


figure 5



PROFONDEUR DE L'ISOTHERME 20°C (m)

NOE-1 12-22 Mai 1989

NOE-2 2-12 Juin 1989

NOE-3 4-12 Juillet 1989

figure 6

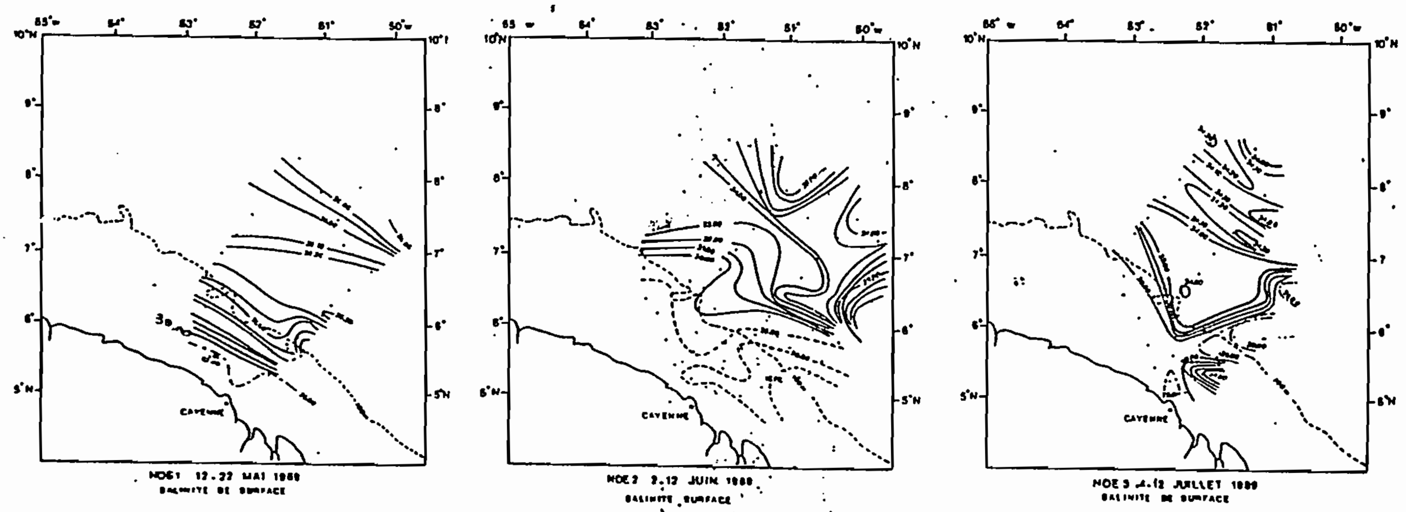


figure 7

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