# VARIABILITY OF COASTAL CIRCULATION NORTH OF NEW GUINEA USING ALONG TRACK ALTIMETRY

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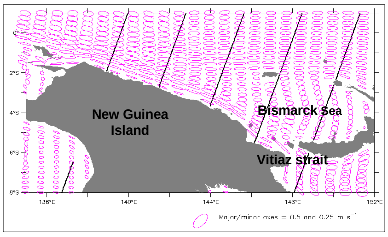
## ➢The circulation north of Papua New Guinea (PNG)

The coastal current system flowing along the northern coast of PNG is composed of the north-westward New Guinea Coastal Undercurrent in subsurface and of the more variable New Guinea Coastal Current (NGCC) at the surface. It is part of the Low Latitude Western Boundary Current system of the South Pacific connecting subtropical to equatorial water masses. Because five Topex/Poseidon and Jason ascending tracks are orthogonal to the coast, the core of this study relies on the analysis of high resolution along-track altimetric data.




At the annual time scale, the phase difference between coastal and open ocean SLA creates along-shore (cross-track) geostrophic currents.

**Figure 1** : Variance ellipses of the surface current derived from a regional simulation from the ROMS model at ⅛°

## ➢*Calculation of the cross-track geostrophic current*

1 Hz along-track Topex/Poseidon and Jason SLA (6.2 km, 10 days, March 1993 – April 2008) reprocessed at CTOH (Roblou et al., 2010) are used to compute the current.

The cross-track geostrophic current anomaly is calculated from the along-track SLA gradient filtered with a σ = 0.3° (or 1.2° near the equator) Gaussian filter . It is the weighted sum of Uf calculated in the f-plane, away from the equator, and Uβ calculated in the β-plane near the equator (Lagerloef et al., 1999) $U = W_f U_f + W_\beta U_\beta$

$$U_f = \frac{g}{f}\frac{\partial \eta}{\partial l} \qquad U_\beta = \frac{g}{\beta}\frac{\partial^2 \eta}{\partial l^2}$$

with $\beta = 2.3\ 10^{-11}\ m^{-1}.s^{-1}$

Weight functions are applied to ensure a smooth transition between the equator and higher latitudes : $W_\beta = \exp[-(\theta / \theta_s)^2]$
$W_f = 1 - W_\beta$
with $\theta_s = 2.2°$

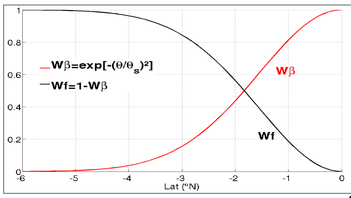
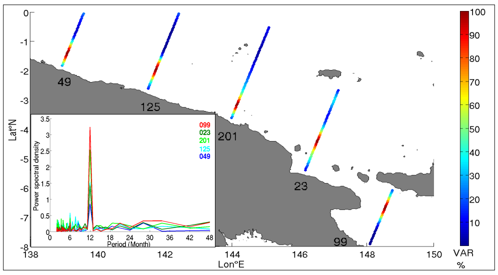



**Figure 2** : Weight functions as a function of latitude

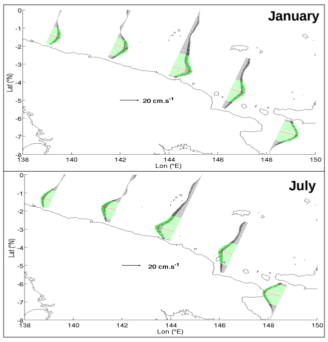
## ➢Seasonal variation of the NGCC : annual shift

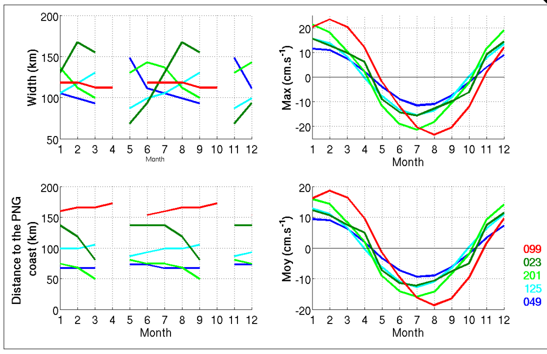



**🡸Figure 3** : Variance percentage of the cross-track geostrophic current Annual harmonic for the 5 altimetric tracks and their Fourier spectra

**Figure 4** : Characteristics of the annual cycle of the NGCC for the 5 altimetric tracks: width of the current vein, distance to the coast, speed of the maximum, and mean cross-track current 🡺

**Figure 5** : Two contrasted situations of the annual cycle of the coastal current. Black arrows represent the cross-track current, red arrows the maximum, and the green ones the current amplitude higher than Vmax/2.




▪ Along the coast, the annual signal clearly dominates the coastal current variability At this time-scale, the coastal current forms an 80-150 km wide coherent vein from Vitiaz Strait to the north-western coast.

▪The along-shore current flow is southeast in austral summer, during the north-west monsoon season, and northwest in austral winter when trade winds are blowing (Kuroda et al., 2000).

▪ The maximum north-westward current anomaly occurs in January and it reverses in July with 10 to 20 cm $s^{-1}$ amplitude. Reversals in Vitiaz Strait occur about one month later.

▪The coast line is very rectilinear between 138°E and 145°E and the core of the coastal current is found 70-80 km off shore for tracks 049, 125, and 201.

▪The direction, magnitude, distance from the coast, and width of the current change over the course of the year. April and October correspond to the current direction shifts.

▪ After reversals, the current core reappears north and displaces southward until the following direction shift.

▪ The current tends to widen as its magnitude increases.

## ➢ Relationship with the annual SST and surface chlorophyll patterns

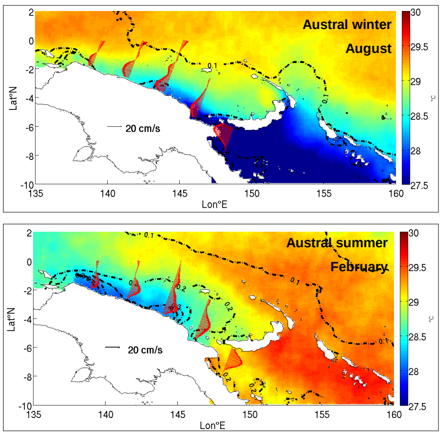



**Figure 6** : Cross-track geostrophic current (vectors), SST (colors) and Seawif chl (dashed lines): annual + semiannual harmonic.

**Table 1** : Correlation between annual NGCC and SST

| Tracks | 49 | 125 | 201 | 23 | 99 |
|---|---|---|---|---|---|
| R | -0,880 | -0,807 | -0,104 | 0,958 | 0,999 |

▪SST is a good signature of the surface current along the PNG north coast.

▪During austral winter, the NGCC flows northwest, driving cold water from the Salomon sea along the PNG coast. The coastal cold vein is wider, longer and colder when the NGCC is stronger (February).

▪During austral summer, the coastal upwelling drives a negative SLA slope which in turn forces a southeast NGCC. At that time, the upwelling can be detected by a cold water plume and a chlorophyll bloom. The upwelled chlorophyll-rich and cool surface water departs from the coast into the Bismarck Sea east of 146°E.

## ➢Conclusion

The variability of the NGCC is clearly dominated by the annual signal and correlated with SST and chlorophyll.

- **Monsoon period (Nov – Mar)**
  - Southeastward NGCC
  - Coastal upwelling with cold water and high chlorophyll
- **Trade wind period** **(May – Sep)**
  - Northwestward NGCC
  - No upwelling
  - Cold surface water from Salomon Sea

But the interannual modulation is also significant. Northwestward anomalies tend to occur during the peak period of the different El Niño (1997-98, 2002-03, 2004-05, 2006-07) in the south tracks. During La Niña years (1996 and 1999-2001), the anomaly is southeastward.

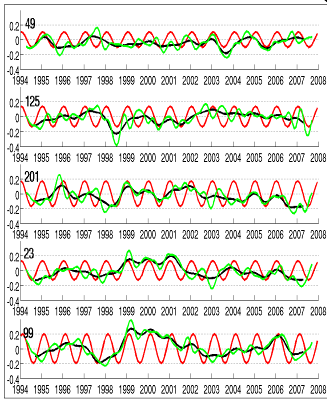



**Figure 7** : *Comparison of the annual cycle and interannual anomaly of the cross-track current (m.s⁻¹). 17-month Hanning filtered current (black), annual harmonic (red), and anomaly relative to the annual cycle (green)*

### ➢References

▪ Lagerloef GSE, Mitchum GT, Lukas RB, Niiler PP (1999) Tropical Pacific near-surface currents estimated from altimeter, wind and drifter data. J Geophys Res 104(C10):22313–22326

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