Meso-scale activity in the Solomon Sea

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Solomon Sea

Transit zone for tropical/subtropical water feeding the western Pacific warm pool and the EUC via the Low Latitude Western Boundary Currents (LLWBCs) **(Fig.1)**

Strong Currents + bathymetric constraint → What's meso-scale activity?
→ Importance for water mass transformation

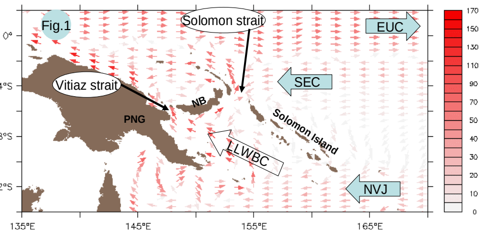


Fig. 1: Mean 0-300 m transport (m²/s) in the western tropical Pacific simulated in the Drakkar ORCA12 simulation. The Solomon Sea is bounded by Papua New Guinea (PNG), New Britain (NB) and Solomon Island

Analysis based on:

AVISO gridded data from AVISO + MSSHRIO-09

-Eddy Kinetic Energy (EKE) at the surface from the high-pass filtered Dynamic Topography (DT)
-Eddy detection and tracking based on Chaigneau et al. (2009)

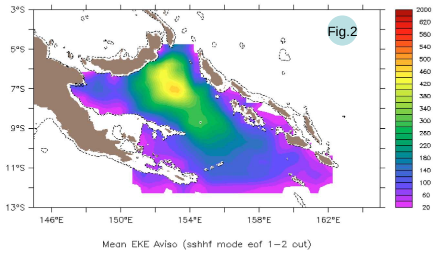
Results supported by a model analysis (DRAKKAR 1/12°)

Spatial distribution of mean EKE (Fig. 2)

EKE extends along the central Solomon Sea

High level of energy (up to 500 cm²/s²) in the northern basin

Fig. 2: Mean EKE (cm²/s²) at the surface calculated from the high pass filtered DT from AVISO gridded data,



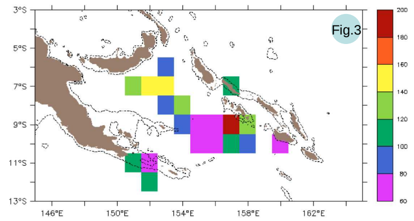


Fig. 3: Spatial occurrence of eddies (number/month)

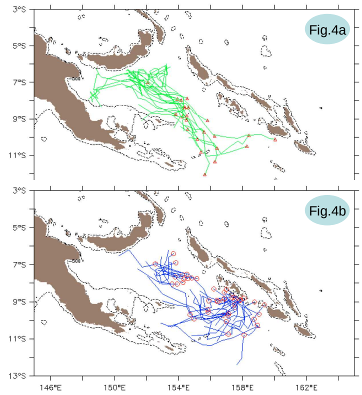
Spatial distribution of eddies

In accordance with EKE distribution: More eddies in the northern basin **(Fig. 3)**

Cyclonic eddies (CEs) are generated in the southern part and propagate to the north probably advected by the LLWBC **(Fig.4a)**

Anticyclonic eddies (AEs) are generated mainly in the southeastern basin close to the Solomon Island coast, and propagate westward **(Fig.4b).**

Fig. 4 : Trajectories of eddies from altimetry: a) CES (green), and c) AEs. Red symbols indicate the location where eddies where first detected.

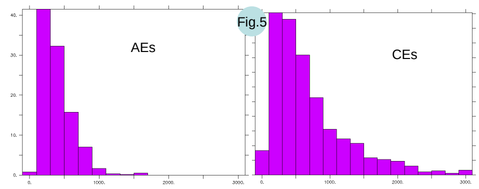


Eddy characteristics

Most of detected eddies have a radius in a range of 80-120 km and more than 60% of eddies have an an amplitude higher than 6 cm.

The level of EKE for CEs is spread over a higher range of energy than for AEs **(Fig. 5)**

50% of eddies havig a lifespan higher than 6 weeks.
CEs travelled over longer distance with 25% of CEs propagating over more than 300 km against 7% only for AEs.



Fig;5: Frequency distribution (in %) of energy for CEs and AEs

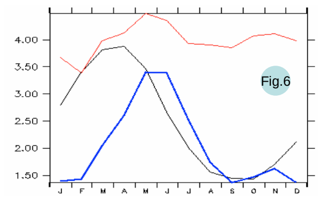


Fig. 6:Seasonal cycle of the number per month of AEs (black), CEs (red), and EKE (blue)

Seasonal cycle of eddies and EKE

The signal is well phased over the Solomon Sea

EKE is maximum in May-June and minimum in September in relation to both Ces and Aes **(Fig.6)**

EKE and eddies grow with the intensity of the SEC inflow at Solomon strait **(Fig.7)**

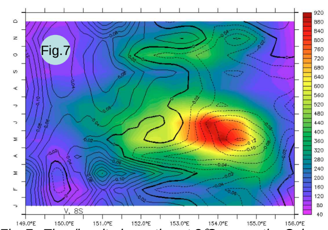
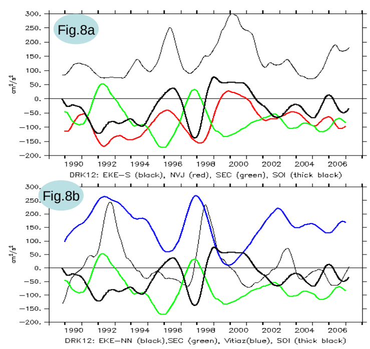


Fig. 7: Time/longitude section at 8°S across the Solomon Sea of the surface EKE (shading, cm2/s2), and the latitudinal current (m/s). The southward current (dashed line) is representative of the SEC inflow at Solomon strait.

Interannual modulation of eddies and EKE



In the southern basin, modulation of EKE in phase with ENSO : higher level of EKE during La Nina than during El Nino.
In the northern basin, modulation out of phase with ENSO. EKE lags a strong outflow at Vitiaz strait pointing the effect of a bathymetric control at Vitiaz strait. **(Fig. 8)**

AEs and CEs behave differently.

AEs are closely linked to ENSO. More Aes durig La Nina than El Nino due to the increase of the SEC inflow at Solomon strait

CEs are poorly correlated with ENSO.An increase of CEs seems to appear 5-6 months after an El Niño

Fig. 8: a) Low frequency modulation of the modelled surface EKE averaged over the southern basin (black thin line), and of the transports from the NVJ (red), and the SEC inflow at Solomon strait (green). b) Low frequency modulation of the modelled surface EKE averaged over the far north basin (black thin line), and of the transports from the SEC inflow at Solomon strait (green), and the Vitiaz outflow. The SOI is in black thick line.

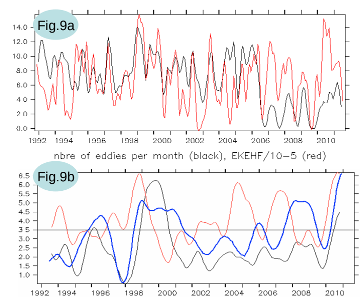


Fig. 9:a) Time evolution of the number of eddies per month (black) versus EKE (red). b) low frequency evolution of the number per month of AEs (black) and CEs versus the SOI (blue).

Conclusion:

The meso-scale in the Solomon Sea is investigated for the first time despite. High levels of EKE, mainly located in the northern basin; suggest a high meso-scale activity. Coherent cyclonic and anticyclonic vortices are associated with the EKE signal, and explain both the seasonal and low frequency modulation of the EKE level. The meso-scale activity is more linked to the intensity of the SEC inflow at Solomon strait than to the strong LLWBCs. The effect of the mesoscale activity to the water mass tranformation reaching the equatorial band needs to be investigated. A high resolution model (1/36°) has been implemented for this purpose.

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Useful references:

Chaigneau, A., G. Eldin, and B. Dewitte (2009), Eddy activity in the four major upwelling systems from satellite altimetry (1992–2007), Prog. Oceanogr., 83, 117–123, doi:10.1016/j.pocean.2009.07.012.
Ganachaud et al., 2008. Southwest Pacific Ocean Circulation and Climate Experiment (SPICE). Part II. Implementation Plan, NOAA OAR Special Report, International CLIVAR Project Office, CLIVAR Publication Series No. 133.
Hristova H, Kessler W (2012) Surface circulation in the Solomon Sea derived from Lagrangian drifter observations. J Phys Oceanogr 42:448–458
Melet, A., Gourdeau, L., Kessler, W.S., Verron, J., Molines, J.M., 2010a. Thermocline circulation in the Solomon Sea: a modeling study. Journal of Physical Oceanography 40, 1302–1319.
Melet, A., Gourdeau, L., Verron, J., 2010b. Variability in Solomon Sea circulation derived from altimeter sea level data. Ocean Dynamics 60, 883–900.
Melet A., L. Gourdeau, J. Verron and N. Djath : Solomon Sea circulation and water mass modifications: response at ENSO time-scales, *Ocean Dynamics*, doi 10.1007/s10236-012-0582-0, 2013