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Internal tides in the Solomon Sea

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1. Introduction

The western Pacific is a place of energetic internal tides generated over its complex bottom topographic features. The Solomon archipelago is one of the most efficient place for the generation of M2 internal tides (**Fig. 1**).

The Solomon Sea is on the pathway of Western Boundary Currents (WBCs) connecting the subtropics to the equator (**Fig.2**). Modifications of water masses are thought to occur because of the significant mixing induced by internal tides, eddies, and the WBCs (Melet et al., 2011).

This poster presents the first analysis of the **M2 internal tides** in the Solomon Sea

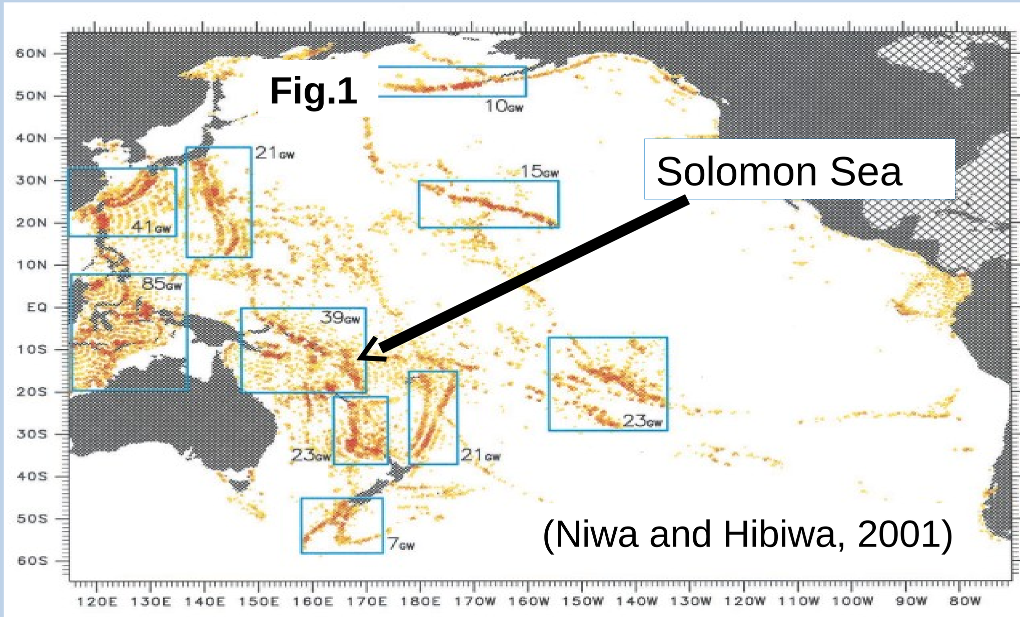


Figure 1: *Distribution of the depth-integrated M2 mode conversion*

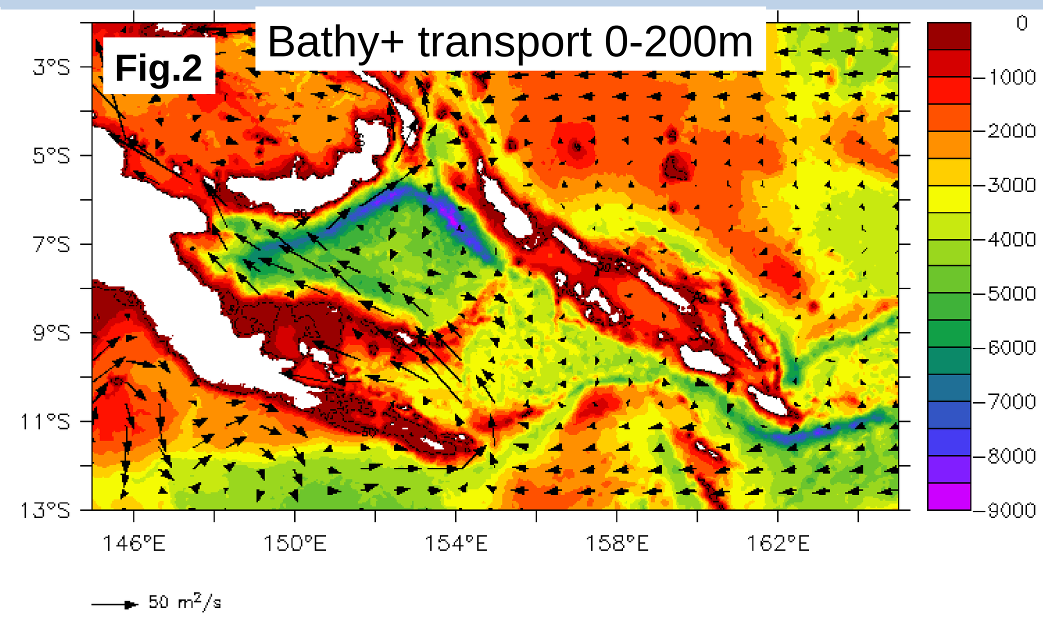


Figure 2: *Mean 0-200m transport and bathymetry (m) of the Solomon Sea*

M2 barotropic tide

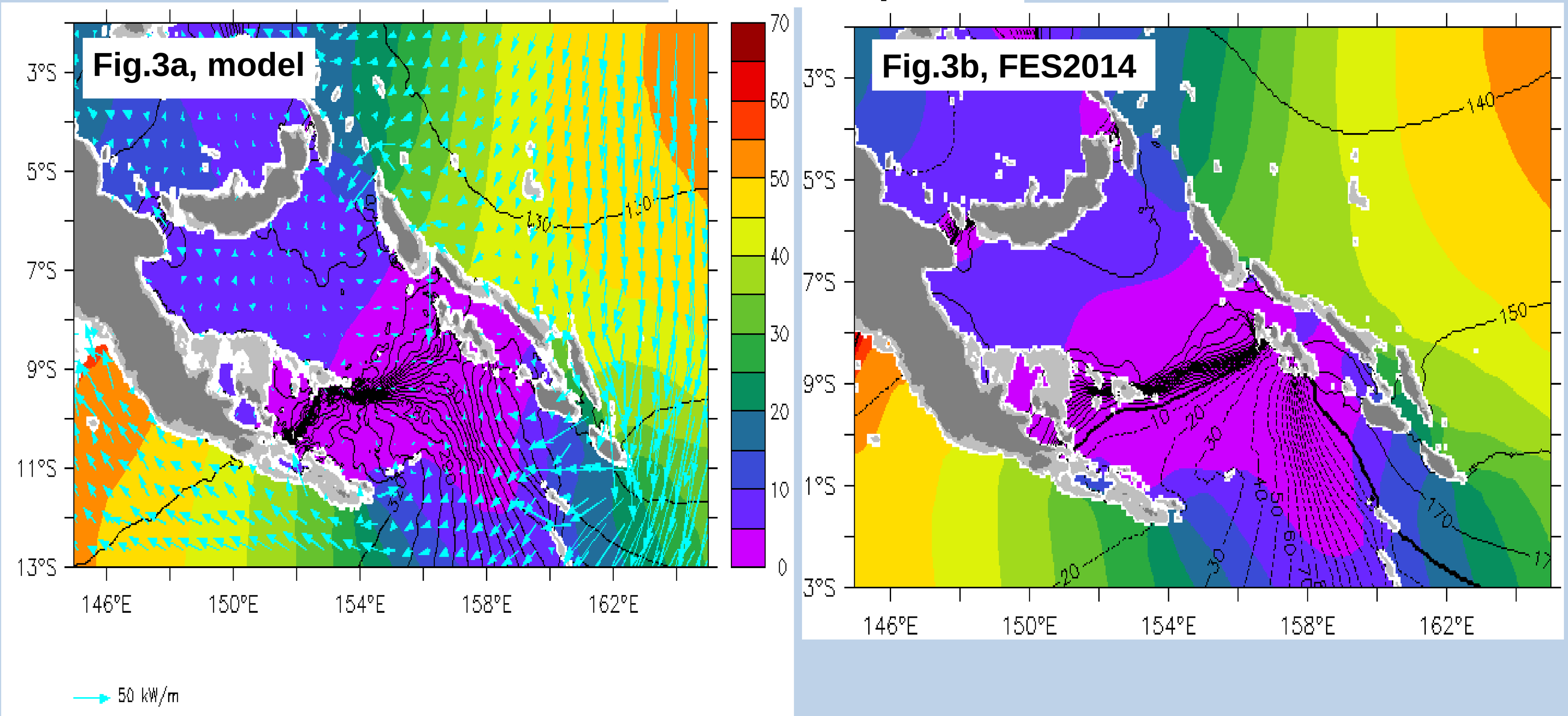


Figure 3: *Amplitude (cm, shading) and phase (contours) of the M2 barotropic tide from a) the model and b) FES2014. The M2 bartropic energy flux is superimposed (vectors)*

2. Numerical Model: NEMOv3.6

1/36° horizontal grid, 75 vertical levels ; partial step; partial slip boundary condition, time splitting

Bathymetry: GEBCO08; Interannual forcing: DFS5.2 (1992-2000)
Tidal forcing at the open boundary: nine major constituents from FES2014
Open boundary condition: DRAKKAR 1/12° model
Initialization: The 1/36° regional model without tide (Djath et al., 2014)
Two simulations: with and without tidal forcing

1h snapshots are analyzed from January to March 1998 to obtain **barotropic and baroclinic harmonic amplitudes and phases** after projection onto the **10 first vertical modes**.

M2 barotropic tide is evaluated against FES2014 (**Fig.3**). Its amplitude is very **low**: The barotropic energy flux is southward east of the Solomon Sea and turns westward, and no flux enters the Solomon Sea

→ **Tidal forcing well simulated by the model**

3. M2 internal tides: Depth integrated view

The **generation of M2 internal tides** is defined by the conversion rate from the barotropic to baroclinic tides (Fig. 4). **Three zones emerge**: two at the north and south extremity of the Solomon archipelago and one at the southeastern extremity of the PNG peninsula. The M2 baroclinic energy flux radiates from these zones inside and outside the Solomon Sea. A total of 13 GW is lost from the barotropic tide within the domain.

M2 baroclinic tide energy extends along the central Solomon Sea from the production zones (**Fig. 5a**). Energy decreases quickly meaning that **energy dissipates locally**. It is notable that most of the energy is contained in the first baroclinic mode (**Fig. 5b**).

✔ **generation and propagation on internal tides in the Solomon Sea**

✔ **Dominance of the first baroclinic mode**

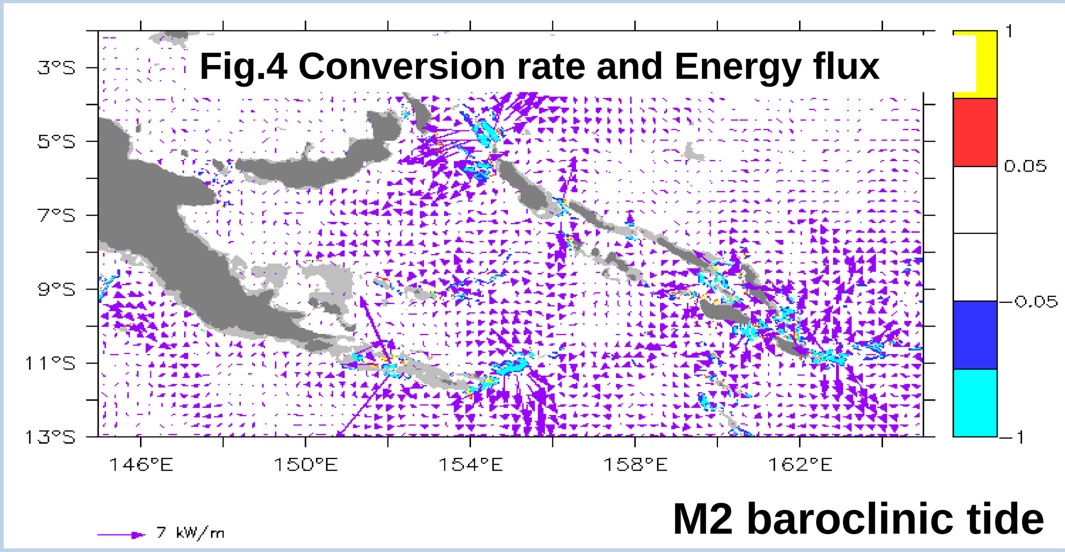
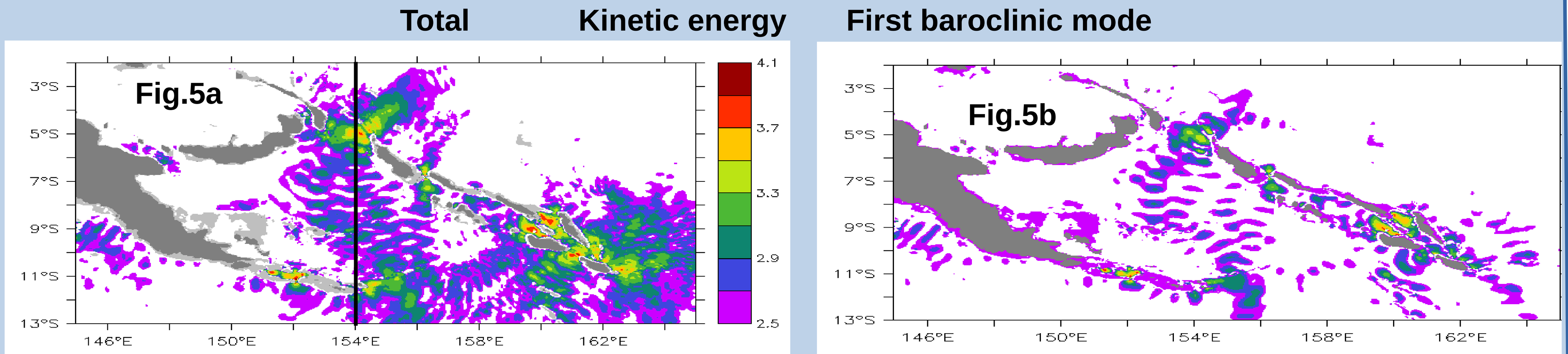


Figure 4: *Depth integrated conversion rate from the M2 barotropic to baroclinic tide (shadind, W m^-2^). Superimposed is the depth integrated M2 baroclinic energy flux (vector, kW m^-1^).*

Figure 5: *Depth integrated kinetic energy of the M2 baroclinic tide a) summed over the 9 first baroclinic modes, b) for the first baroclinic mode only (unit in J m-2, scaling key in Log) .*



4. M2 internal tides: Vertical view

With a well marked stratification typical of the tropical oceans, **M2 internal tides** don't propagate from the surface to the bottom as usual but they are located **in the surface layers** (**Fig. 6a**).
Snapshots of the velocity field related to the M2 internal tides at different depths illustrate that, except in the generation zones, no signature of internal tides exist below 300 m depth (**Fig. 6c,d**).
At the surface, **amplitude** of M2 internal tides is about **4-5 cm** reaching 8 cm in the generation zones. The associated wavelength is about 100 km (**Fig. 6b**).

➢ **Internal tides located in the surface layers with a 4-5 cm amplitude at the surface**

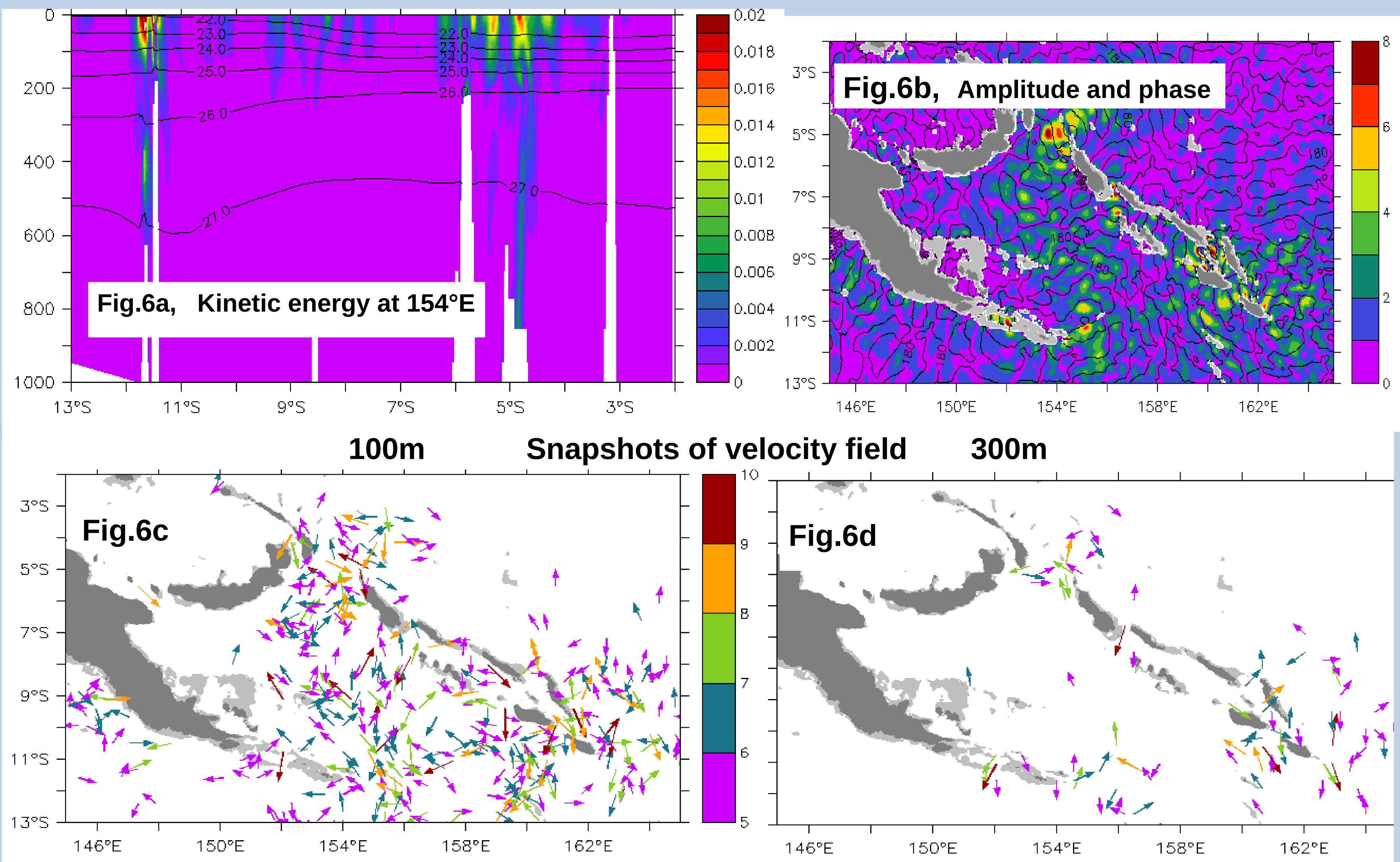


Figure 6: *a) Depth/latitude section at 154°E of M2 baroclinic kinetic energy (J m^-3^). b) Snaphots of the horizontal velocity field a) 100 m depth and b) 300 m depth for the M2 baroclinic tides (cm s^-1^). c) Amplitude (shading, cm) and d) phase (contour of the 180° phase) of the M2 baroclinic tide at the surface*

5. Water mass transformation

The impact of internal tides on mixing is illustrated by looking salinity anomalies between the simulation with and without tidal forcing for the Surface Waters (SW, 21-23.3 sigma) and the Upper Thermocline Waters (UTW, 23.3-25.7 sigma) (**Fig. 7**). Positive SW and negative UTW anomalies argue for diapycnal mixing by tides.

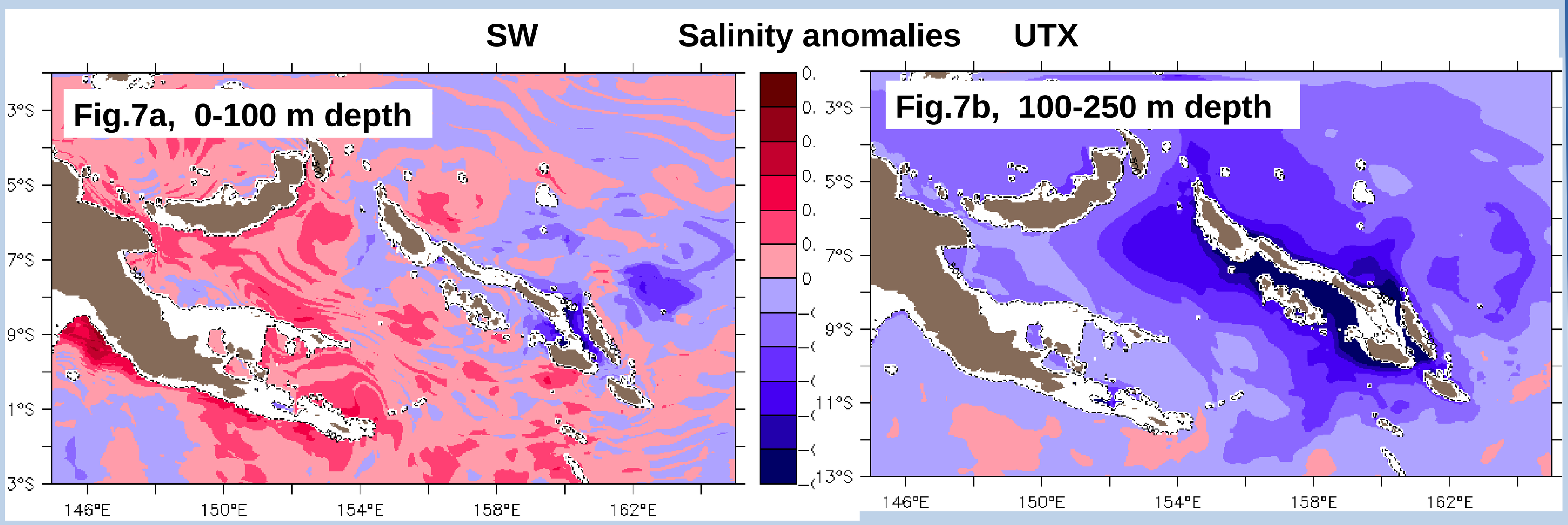


Figure 7: *Salinity anomalies between the model with and without tidal forcing for a) the Surface Waters* (SW, 21-23.3 sigma) *and b) the Upper Thermocline Waters* (UTW, 23.3-25.7 sigma).

6. Conclusion

This poster shows the first results about internal tides in the Solomon Sea based on a regional simulation. Only the M2 baroclinic tides are discussed here.
The model simulate well the tidal forçing.
Internal tides are generated at the extremities of the Solomon archipelago and of the PNG peninsula.
They propagate in the Solomon Sea with a 4-5 cm amplitude.

The next step is to quantify the impact of such tides on water mass transformation

References

Melet, A., J. Verron, L. Gourdeau, and A. Koch-Larrouy, 2011: Equatorward Pathways of Solomon Sea Water Masses and Their Modifications. *J. Phys. Oceanogr.*, **41**, 810–826, doi:10.1175/2010JPO4559.1; Niwa, Y., and T. Hibiya (2001), Numerical study of the spatial distribution of the M 2 internal tide in the Pacific Ocean, J. Geophys. Res., 106, 22,441–22,449; Djath, B., J. Verron, A. Melet, L. Gourdeau, B. Barnier, and J.-M. Molines, 2014: Multiscale dynamical analysis of a high-resolution numerical model simulation of the Solomon Sea circulation. *J. Geophys. Res. Oceans*, doi:10.1002/2013JC009695.