

Internal tides in the Solomon Sea: Characteristics and impacts

Paper to be Submitted

Michel Tchilibou

L.Gourdeau, F.Lyard, R.Morrow, A. Koch Larrouy, D.Allain, B. Djath

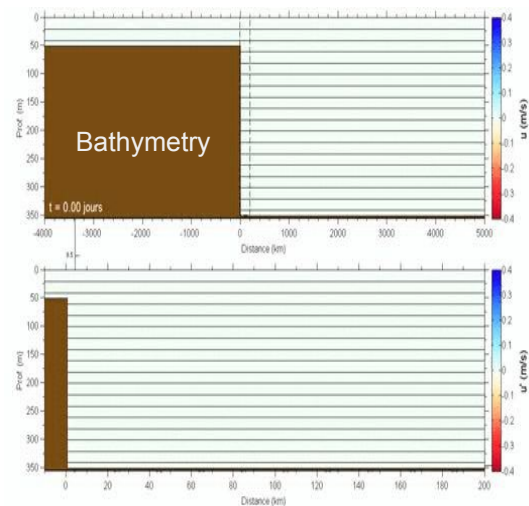


Projet TOSCA/CNES

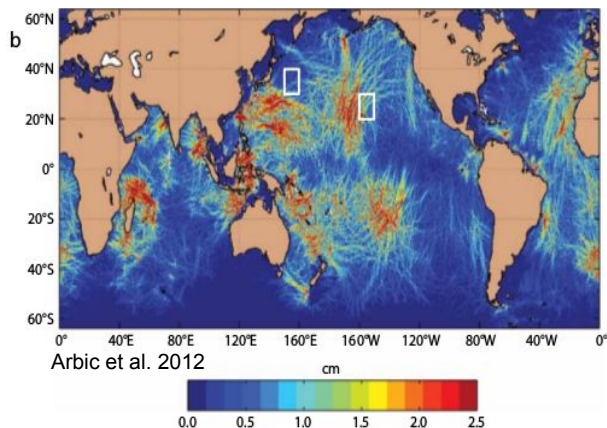
SWOT in the Tropics
(P.I. L. Gourdeau, F. Marin, A. Ganachaud)

Internals or baroclinic tides are coherent and incoherent

Internal or baroclinic tide:
**Vertical isopycnal displacement
at tidal frequency**

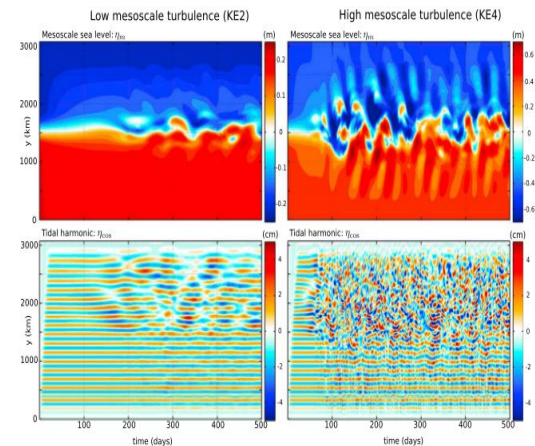


Coherent and **predictable**:
in phase with tidal forcing



a sea level signature of order of several Cm

incoherent and **unpredictable**:
no fixed phase with tidal forcing



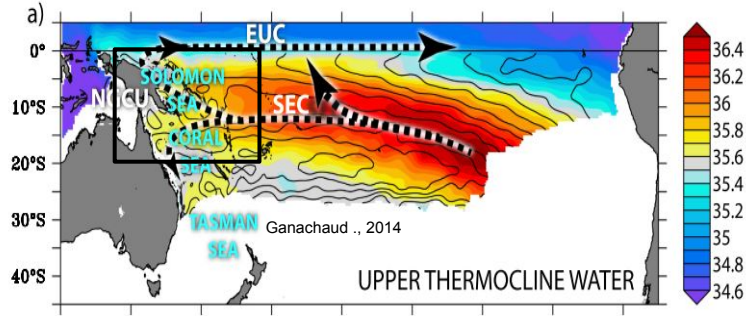
Ponte and Klein. 2015

Incoherence \Rightarrow eddy strength and stratification
modulations

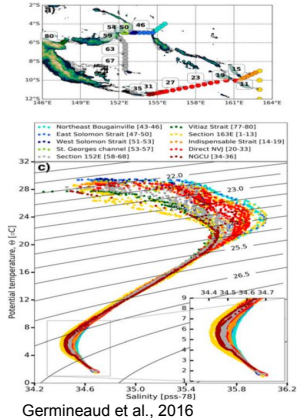
A better Knowledge of internal tide both coherent and incoherent is primordial for SWOT altimetry mission

Solomon sea : a good laboratory for tide and mesoscale

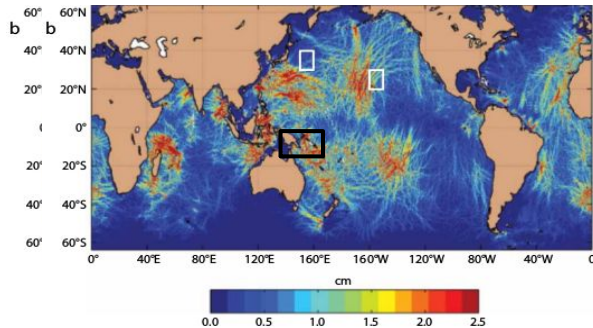
1. Water mass pathway from subtropical to tropical area



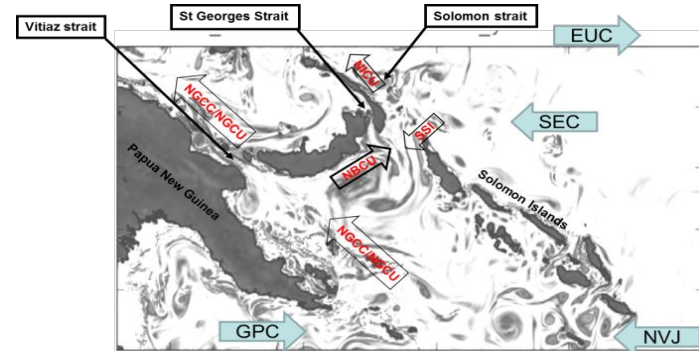
2. Water mass transformation



3. High M2 internal tide generation



4. High mesoscale activities

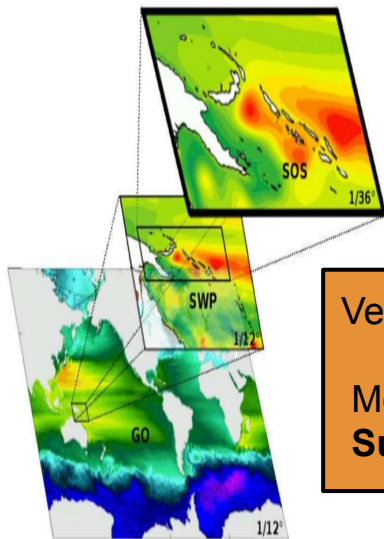


Mesoscale and stratification modulation by ENSO

A good candidate to study **diversity** of internal tide signature and their consequence on water mass

Data, method and questions

- Regional $1/36^\circ$ Nemo model
- 75 vertical level
- 9 tidal components forcing by FES2014
- **Hourly** and **daily**
- Tidal and no tidal configurations



El Nino period: 31/12/97 to 19/04/98

La Nina period: 31/03/99 to 08/07/99

Daily: 31/12/97 to 30/03/99

Vertical mode for tidal separation:

Mode 0 \Rightarrow barotropic tide

Sum of other mode \Rightarrow baroclinic tide

Questions:

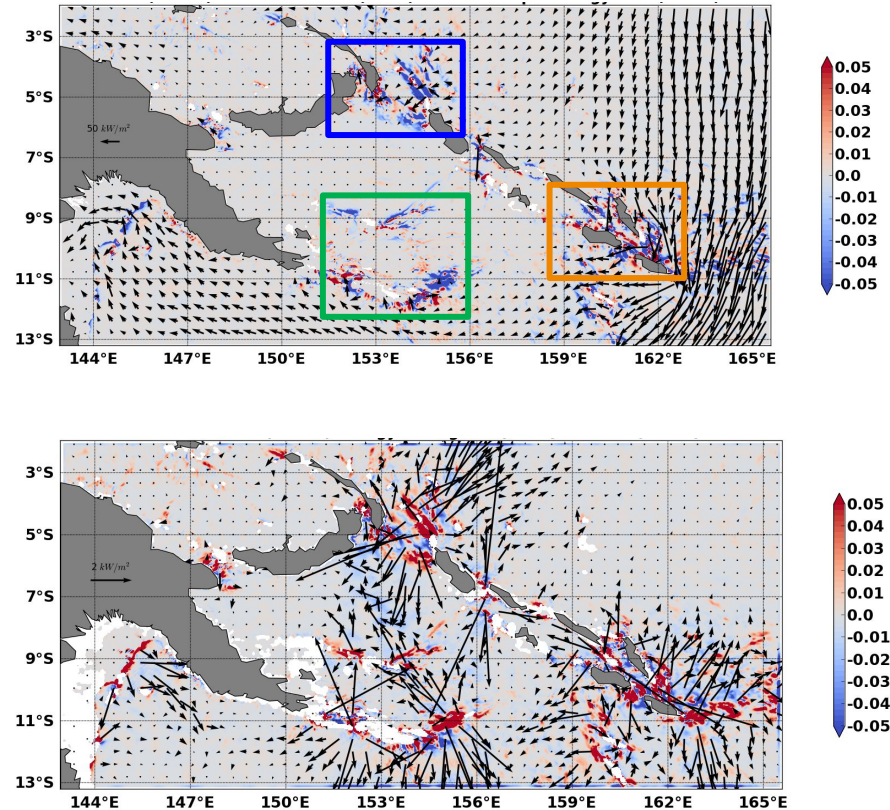
1- Where internal tide are generated in the Solomon sea ?

2- How does internal tide characteristics change depending on ENSO phase ?

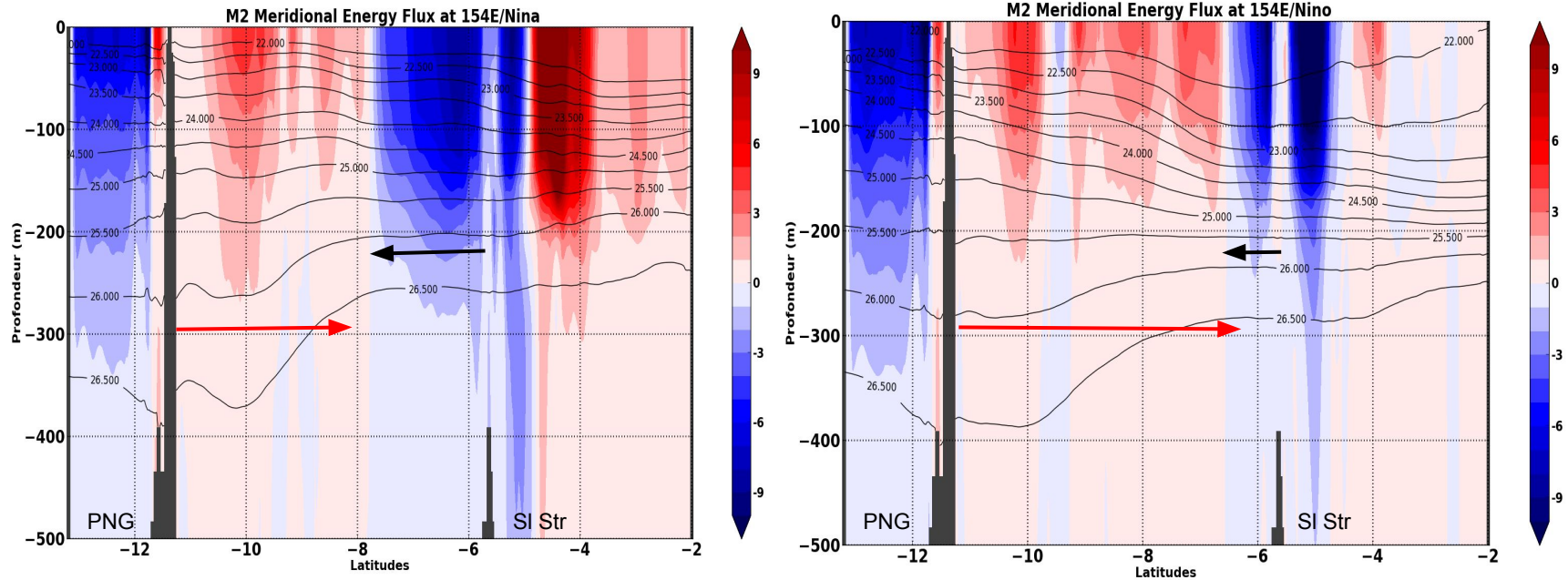
3- How internal tide impact water mass properties ?

Internal tide generation: Barotropic and baroclinic energy flux

- 1- M2 the more important component
- 2- Barotropic flux southward east of Solomon sea
- 3- Principal site of generation :
 - Solomon and St George strait**
 - South of Solomon Island**
 - East of Papouasie New Guinea**
- 4- Baroclinic flux converge between 153-156°E
- 5- Same flux characteristic for Nino and Nina at first order



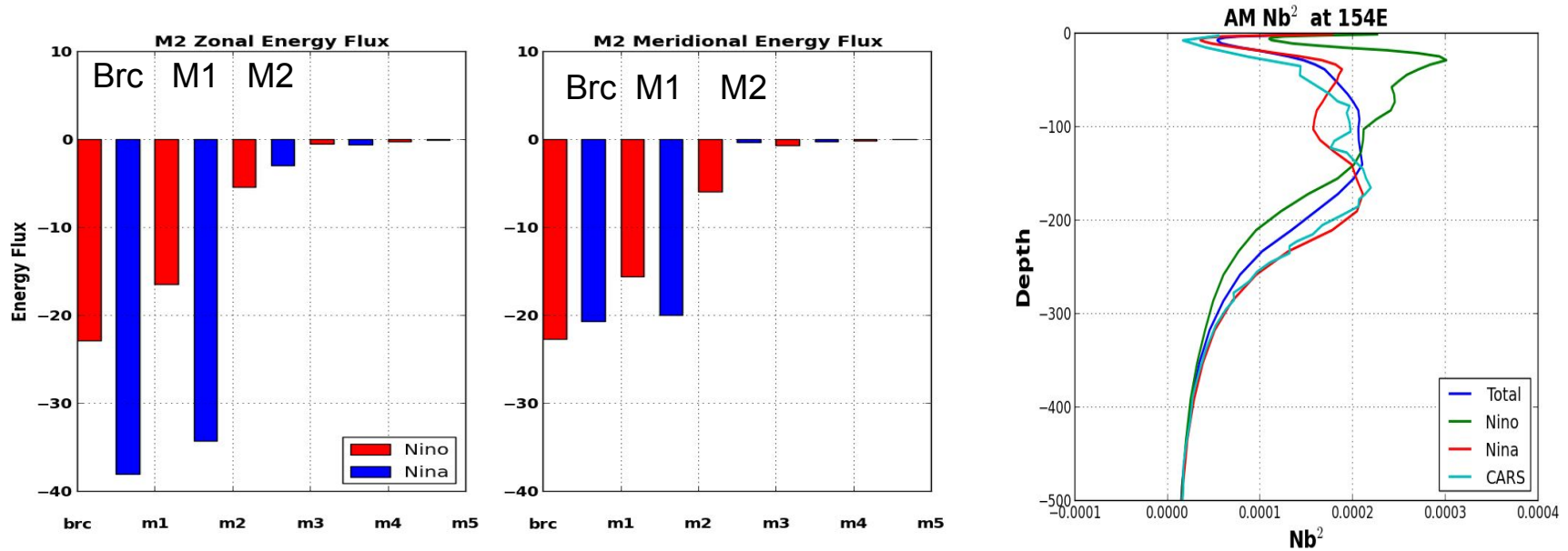
ENSO dependence: M2 flux propagation and background current



Meridional flux latitudinal extension depend on ENSO and current:

- PNG: Nino, NGCU strong, northward flux extend to 6.5°S
- SI Str: Nina, SSI strong, southward flux extend to 7°S

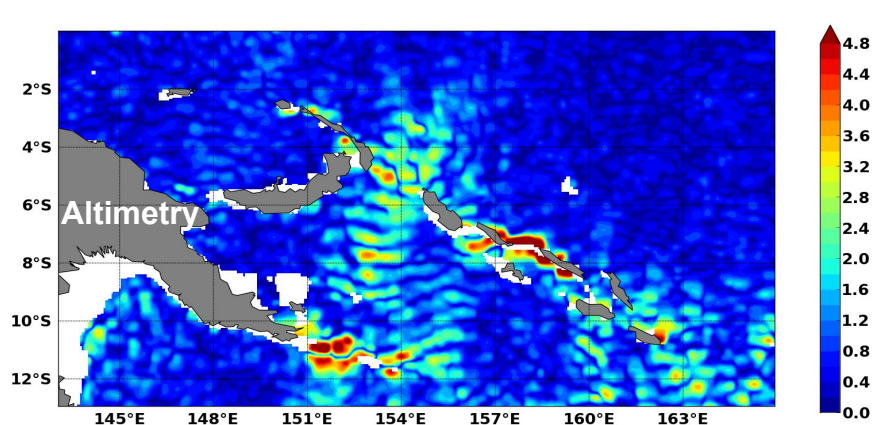
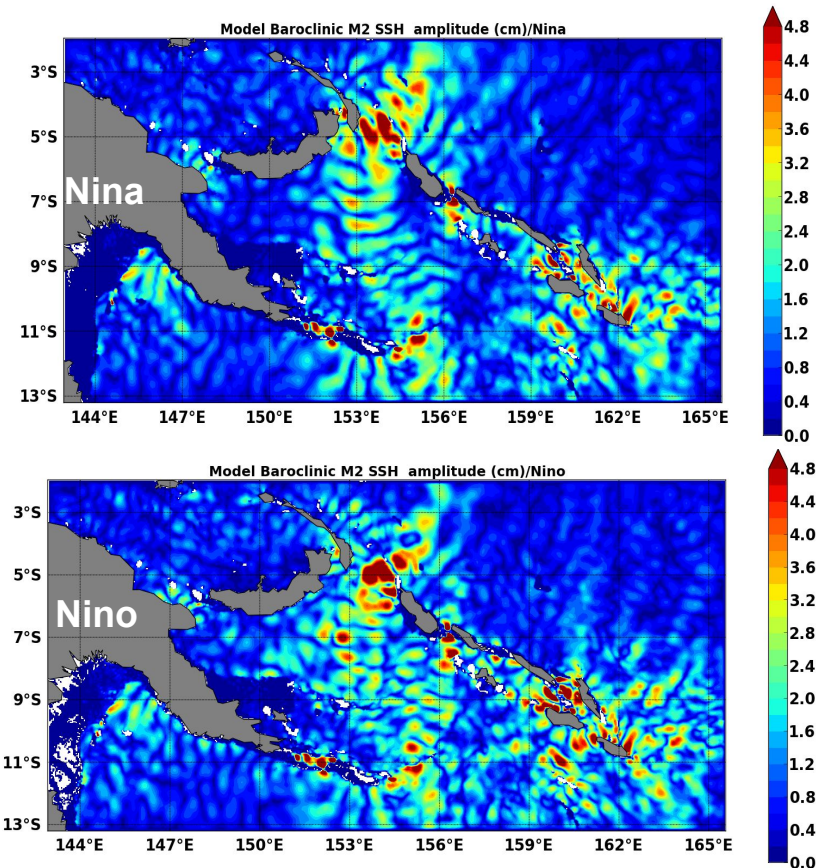
ENSO dependence: M2 modal repartition and stratification



Stratification modulation lead to modal flux modulation:

- ❖ **Nino**: strong surface and maximum stratification, **mode 1 and 2 flux**
- ❖ **Nina**: deeper stratification, **mode 1 flux**

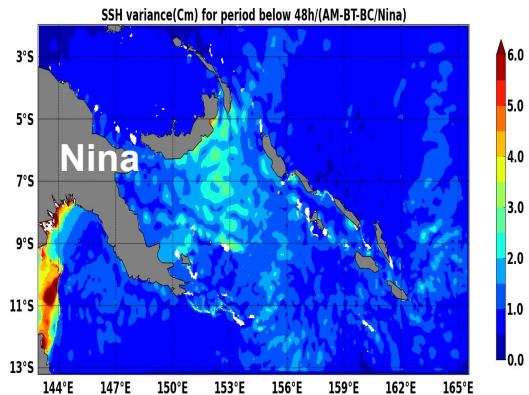
ENSO dependence: M2 coherent SSH



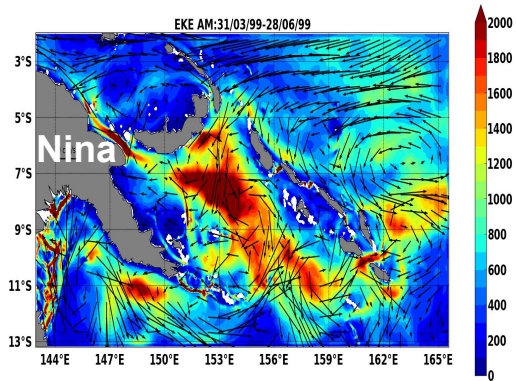
- SSH signature of order of 5 Cm
- Nina and altimetry signal agrees
- Nina: Continuous tide propagation
- Nino: Small scale structures associated to higher mode development.

ENSO dependence: incoherent SSH and EKE

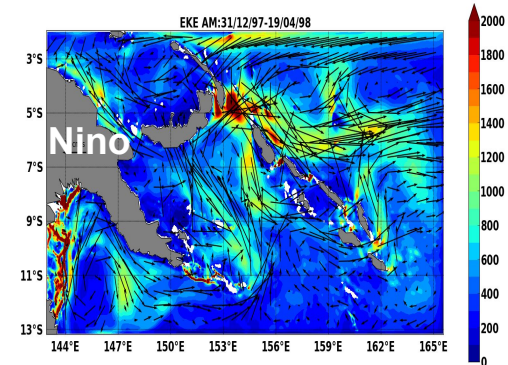
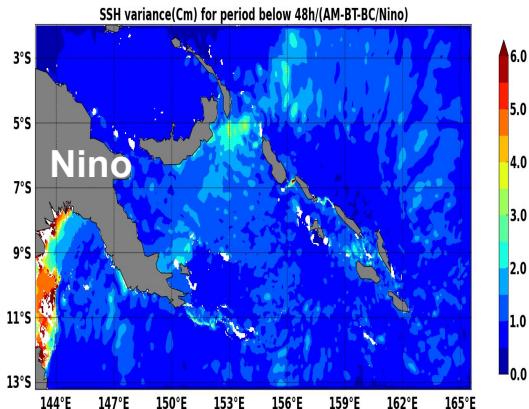
Incoherent SSH



EKE



High EKE \Rightarrow High incoherent SSH



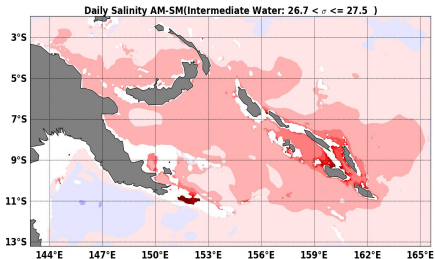
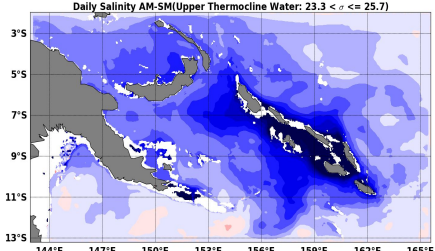
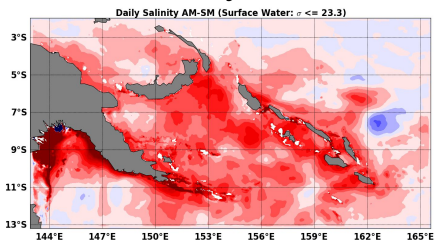
Low EKE \Rightarrow Low incoherent SSH

Variations of coherent and incoherent tide on SSH at interannual time scale

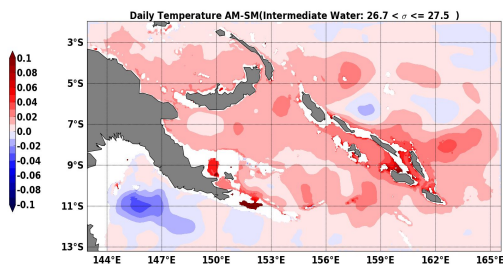
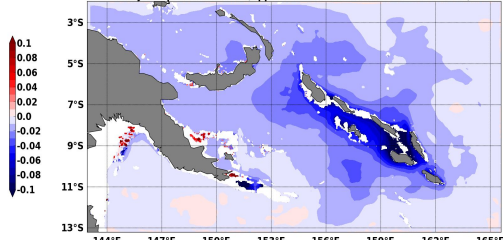
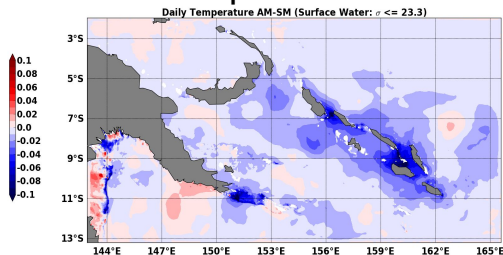
Impacts on water mass: salinity and temperature changes

Daily tide mean - daily no tide mean

Salinity



Temperature



Diapycnal mixing improve by tide

Surface water : Saltier and fresher.
Possible impact on air-sea interactions

Upper thermocline water: cooler and fresher. Possible impact on EUC

Intermediate water: Saltier and warmer.
Possible impact on overturning circulation

Conclusions

1- Where internal tides are generated in the Solomon sea ?

M2 is the most important tide component, it is generate at three principal site.

2- How does internal tide characteristics change depending on ENSO phase ?

During la Nina, the incoherent SSH is higher in the Solomon sea. The El Nino phase is characterised by an increase of the mode 2 which lead to small scale coherent SSH. The propagation of energy flux seems to depend on the background current intensity.

3- How internal tide impact water mass properties ?

Diapycnal mixing by tide change salinity and temperature properties with in the water column. Surface water are saltier and cooler, while upper thermocline water are fresher and cooler.

More details in paper to be submitted