Internal tides in the Solomon Sea: Characteristics and impacts

Paper to be Submitted

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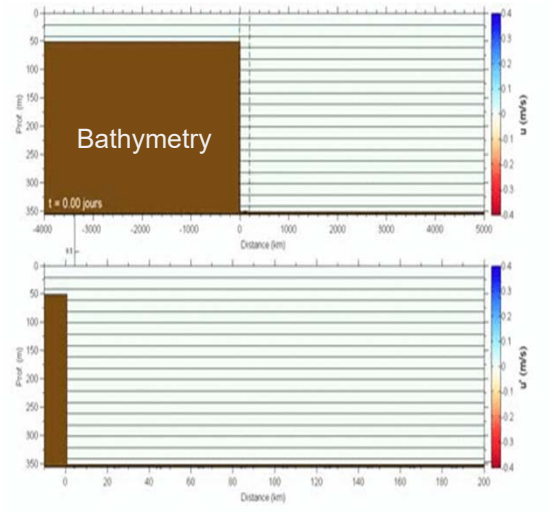
Projet TOSCA/CNES

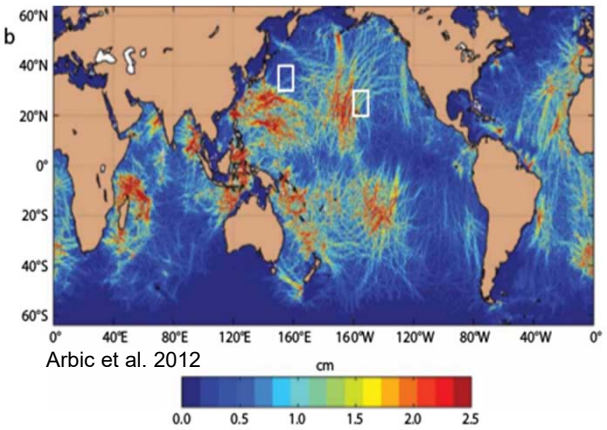
SWOT in the Tropics
(P.I. L. Gourdeau, F. Marin, A. Ganachaud)

Internals or baroclinic tides are coherent and incoherent

Internal or baroclinic tide:
Vertical isopycnal displacement at tidal frequency



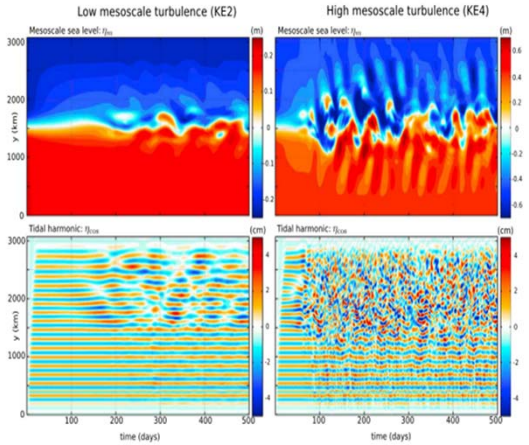
Coherent and **predictable**:
in phase with tidal forcing



Arbic et al. 2012

a sea level signature of order of several Cm

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



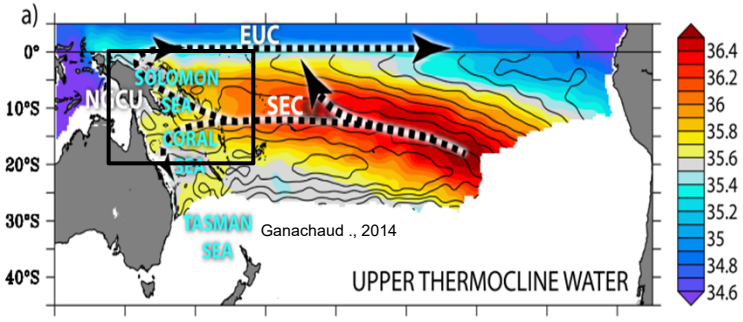
Ponte and Klein. 2015

Incoherence ⇒ eddy strength and stratification modulations

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

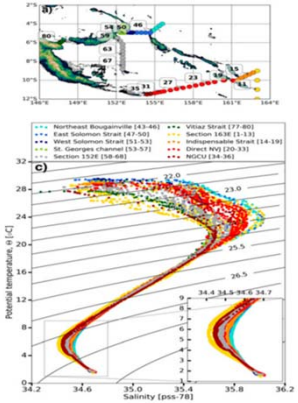
Solomon sea : a good laboratory for tide and mesoscale

1. Water mass pathway from subtropical to tropical area

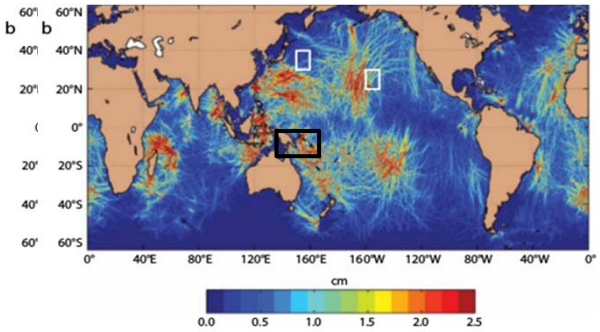


Ganachaud ., 2014

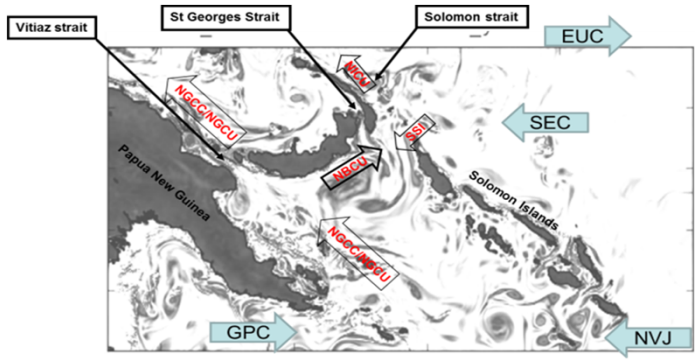
2. Water mass transformation


Germineaud et al., 2016

3. High M2 internal tide generation



4. High mesoscale activities

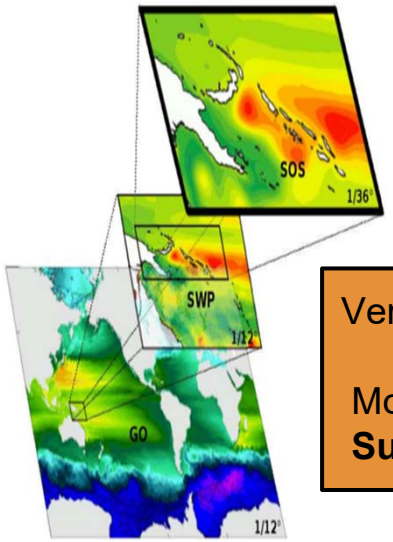


Mesoscale and stratification modulation by ENSO

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

Data, method and questions

- Regional 1/36° 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 ⇒ barotropic tide
Sum of other mode ⇒ 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 largest component

2- Barotropic flux southward east of Solomon sea

3- Principal site of generation :

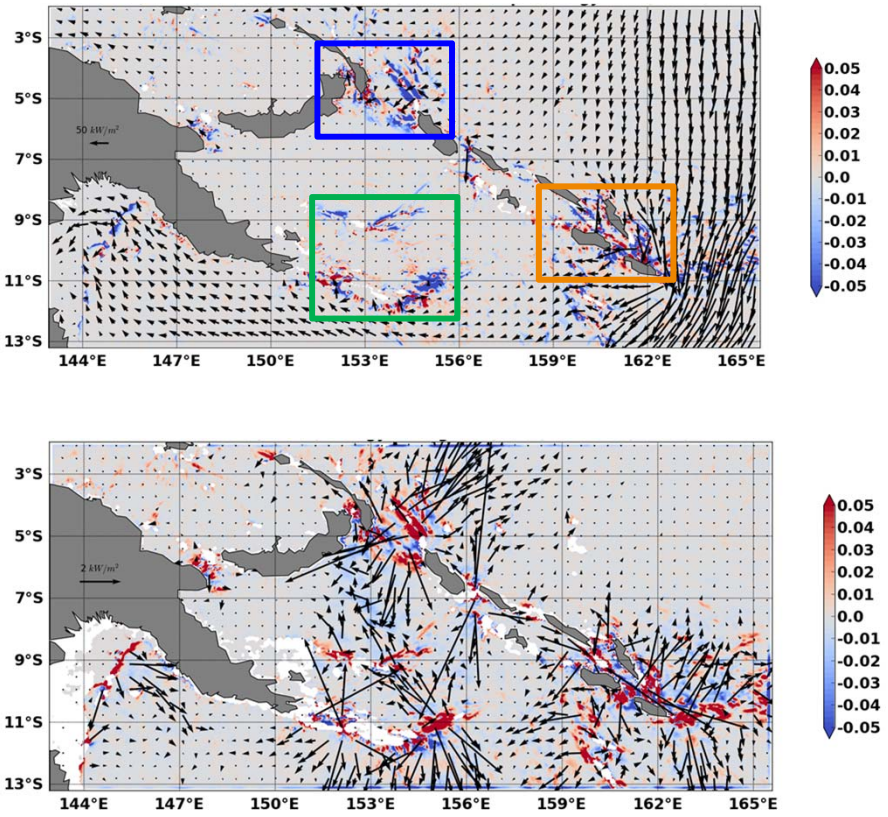
Solomon and St George strait

South of Solomon Island

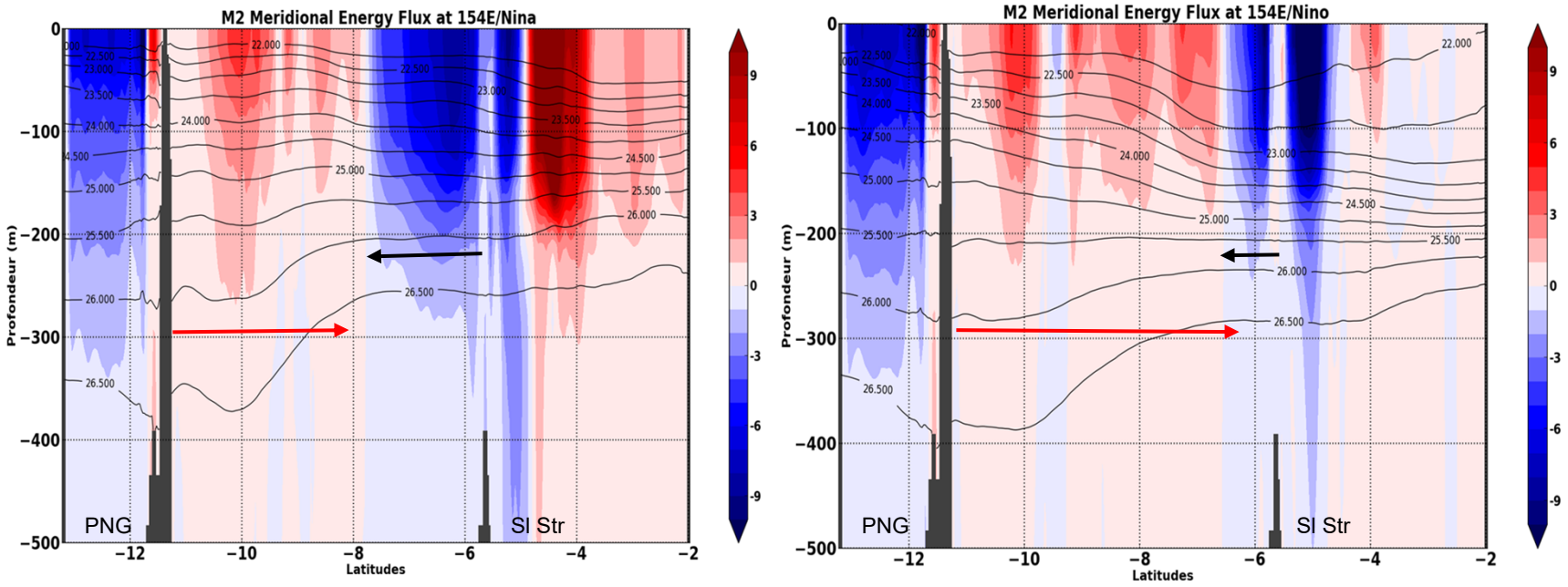
East of Papouasie New Guinea

4- Baroclinic flux converge between 153-156°E

5- Same flux characteristic for Nino and Nina at first order



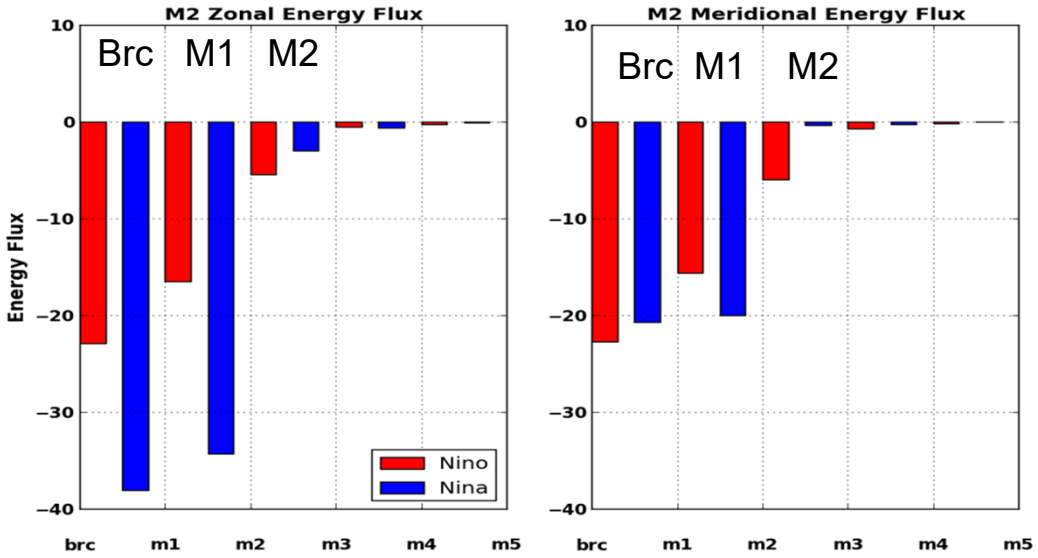
ENSO dependence: M2 flux propagation and background current

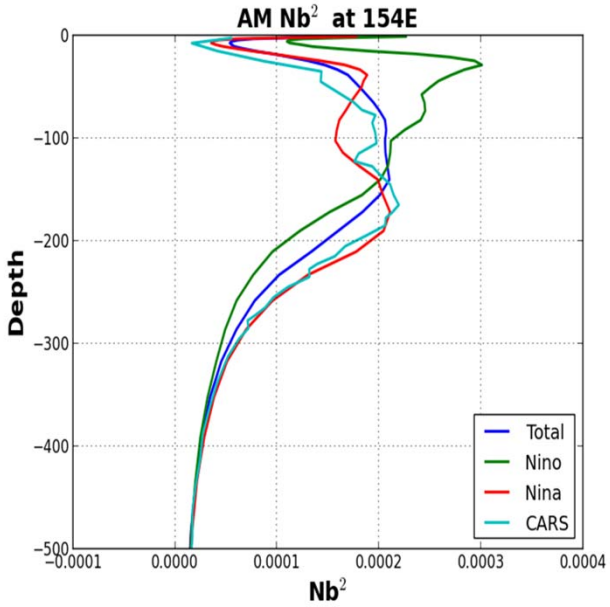


Meridional flux latitudinal extension depend on ENSO and current:

- ➔ 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

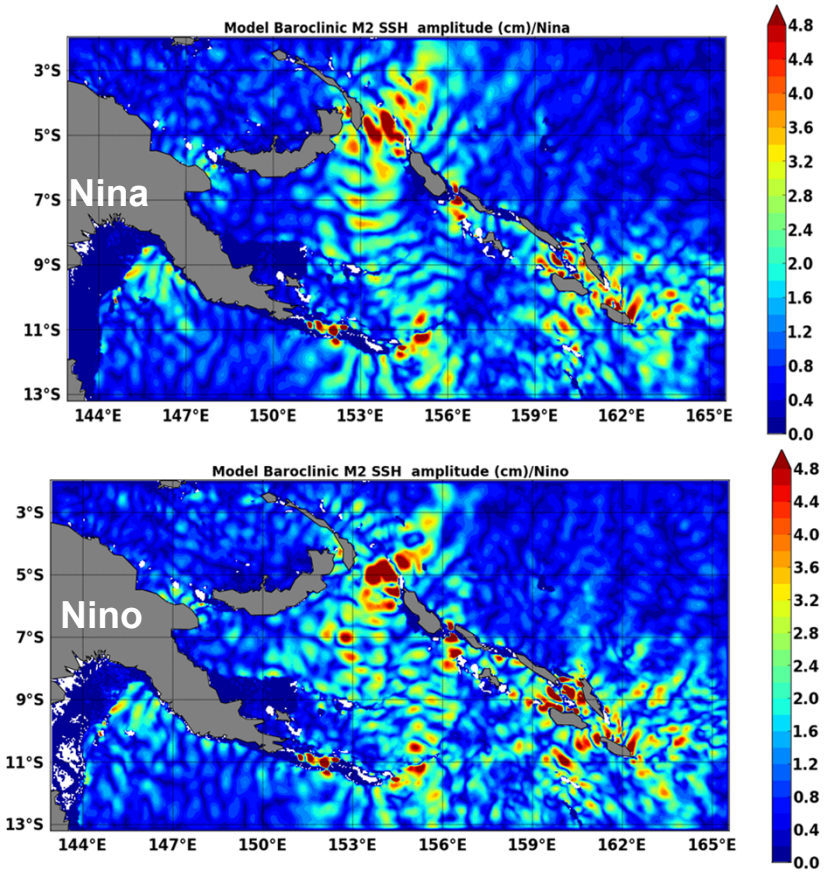


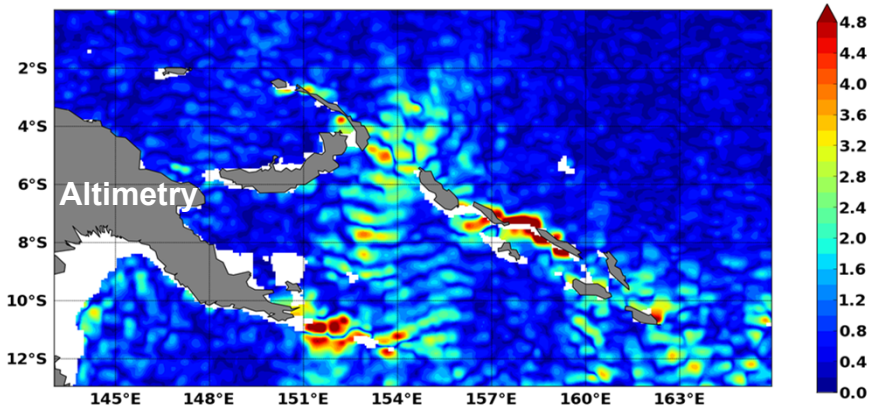


Stratification modulation lead to modal flux modulation:

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

ENSO dependence: M2 coherent SSH

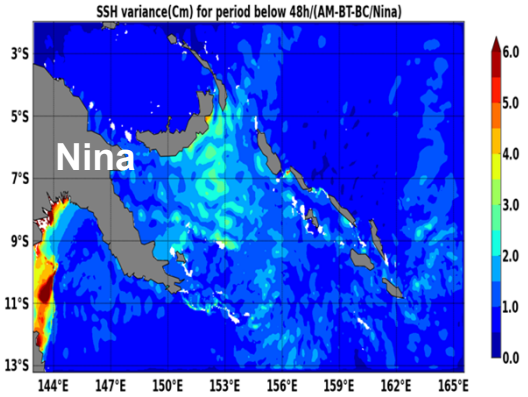


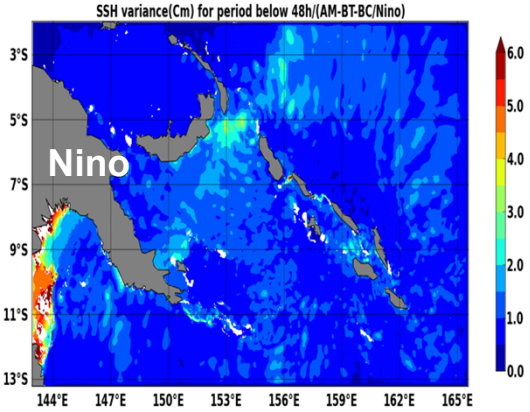


- ❏ SSH signature of order of 5 Cm
- ❏ Nina and altimetry signal agrees
- ❏ Nina: Continuous tide propagation
- ❏ Nino: Small scale structures associated to higher mode development.

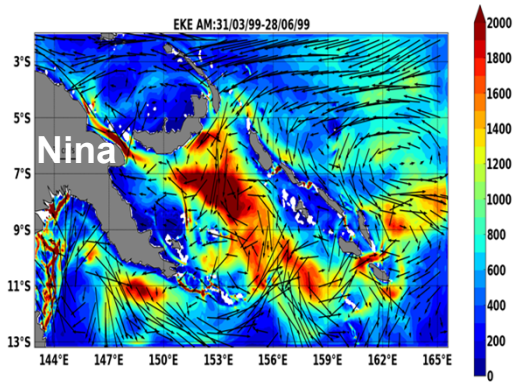
ENSO dependence: incoherent SSH and EKE

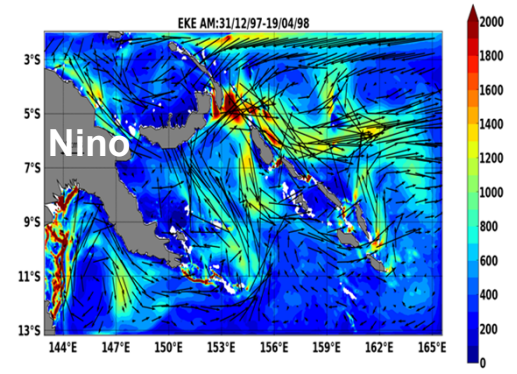
Incoherent SSH





EKE





High EKE ⇒ High incoherent SSH

Low EKE ⇒ Low incoherent SSH

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

Conclusions

1- Where internals 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