Interactive comment on "Internal tides in the Solomon Sea in contrasted ENSO conditions" by Michel Tchilibou et al.

Response to reviewer 2

Billy Kessler's referee 2

This is useful work that will be of interest to the community. The authors use simulations with and without tidal forcing, following and progressing from previous such work. They have advanced the understanding of the role of tides, and the modeling of tides, in the Solomon Sea. The results might have implications for ENSO effects, and also be of interest for other such partly-confined seas.
I recommend MINOR REVISION.

We are pleased that our work has been well received. We try to address the different comments as best we can, especially the main remark.
Thank to your remark on the possible role of the seasonal cycle in the interpretation of our results, we have redone some calculations that highlight two points:

- First there was some problems with the files used to do the last Figure (Fig. 14). It drastically changes our conclusion on the ENSO tidal effect at the surface
- Second, we will show below that the variations described between the two ENSO periods used are mainly due to interannual variability and not to the different phases of the seasonal cycle.

So to take account of these points, the section 5 has been rewritten and some conclusions have been revisited.

Major point:

- *The authors consider the periods JFM 1998 (El Nino) and AMJ 1999 (La Nina). They should emphasize that these are truly extreme periods, likely to exemplify the very maximum possible effects of ENSO variations.*

Yes, we are conscious that the period chosen corresponds to extreme periods. This is mentioned in the discussion/conclusion (l. 657-659), and we agree that it needs to be mention earlier. We report this point earlier in the text by explicitly citing the year and the phase of the seasonal cycle corresponding at each El Nino and La Nina events and the extreme character of such events. By example:
l. 140-141:

Old:"… , that have been performed during a 3 year period including an El Niño and a La Niña event."
→
New:" We will also consider case studies for two extreme periods: the summer 1998 El Niño and the fall 1999 La Niña that exhibits different stratification and mesoscale activity.

l. 258-260:
Old: "this section is motivated by a presentation of the Solomon Sea circulation, its variability, and its vertical stratification for two distinct ENSO periods: the 1998 El Niño and the 1999 La Niña. All of these dynamical elements may influence the internal tide fields from its generation to its propagation and dissipation."
→
New: "This section presents the Solomon Sea circulation, its variability, and its vertical stratification for the three year daily simulations, and for the two extreme ENSO periods: The January- March 1998 El Niño and the April-June 1999 La Niña."

- *In that light, the rectified anomalies due to tides are quite small: about 0.08psu in the surface layer, and 0.06psu in the upper thermocline (lines 568-583, and Fig.13). These small signals, given that* *extreme-opposite situations are compared, are not particularly convincing that ENSO-related tidal mixing is an important part of the observed erosion of thermocline properties that has been shown in several publications. In effect they are an upper limit of tidal effect variation, and the values given really aren't that impressive.*

Yes, we agree, and this is especially true once results have been revisited as mentioned above. The section 5 has been rewritten. The new version of this section is added at the end of the review.

- *In addition, there may be tidal-effect anomalies due to the study periods being in different phases of the seasonal cycle. These are not brought out, but they should be since we can't tell if the rectified tidal difference signals are due to ENSO or to seasonality.*

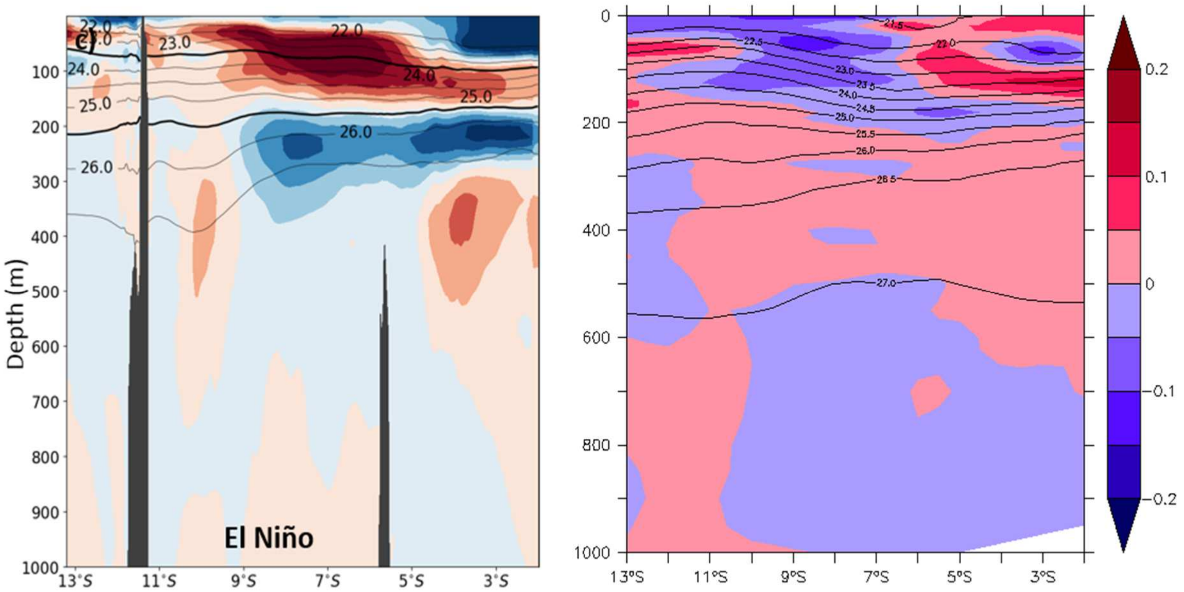
This comment refers to section 5.b and Figure 13 where we discuss results on tidal effect at the surface between El Nino and La Nina. As mentioned at the beginning of the review, this discussion was wrong because of the use of a wrong file, and section 5 has been rewritten (we add it at the end of the review).

But the reviewer is right that there may be tidal-effect anomalies due to the study periods being in different phases of the seasonal cycle. So, we illustrate below that the anomalies as described in Figure 4 of the paper are mainly due interannual variability rather than to the different phases of the seasonal cycle (Figure 1). The January-March 1998 and the April-June 1999 salinity anomalies (Fig. 4 of the paper) are compared to the corresponding seasonal anomalies from CARS. It illustrates how the effect of the vertical heaving due to the interannual conditions dominate the effect of the seasonal cycle. This point is now mentioned in the new version of the manuscript. By example:

Section 2.1:" For these two periods the interannual conditions dominate the effect of the mean seasonal cycle (not shown)."

Section 3: ' We verified that most of the circulation and stratification changes between these two periods are not due to the different phases of the mean seasonal cycle (not shown)."

a) b)



c) d)

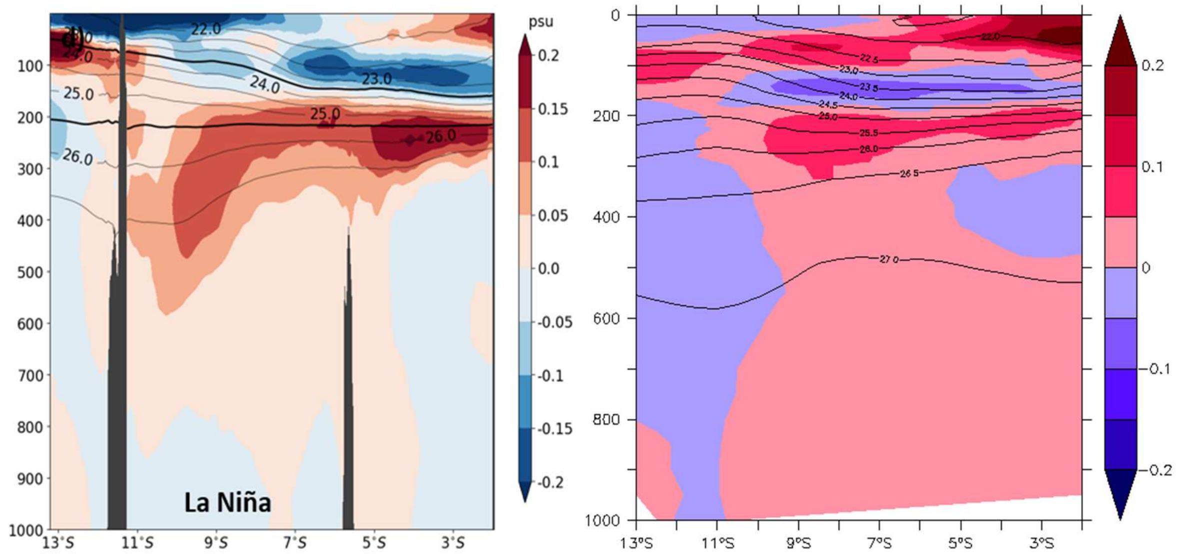


Figure 1: Section at 154°E of salinity anomalies relative to the long term mean (shading) and density (contours) for a) the January-March 1998 El Nino period, b) the January-March seasonal cycle, c) the April-June 1999 La Nina period and d) the April-June seasonal cycle.

Because one file was corrupt, the last figure of the paper has been redone. After corrections, the ENSO-tidal effect anomalies are relatively limited. I present below the TIDE-NOTIDE temperature anomalies for the SW waters (each temperature are relative to their long term mean) during the El Nino and La Nina period phase locked on the seasonal cycle (Figure 2). The temperature anomaly due to the ENSO-tidal effect is only of 0.15°c and is limited in areas characterized by a drastic change of the mean circulation that is along the LLWBCs during El Nino (increase of the LLWBCs), and along the Solomon archipelago during La Nina (increase of the SSI). The positive temperature anomalies damp the cooling of the surface layer induced by the tides as illustrated on figure 12 of the paper. So, more the circulation is intense, less the tidal effect is visible. In consequence, the section has been rewritten (see at the end of the reply).

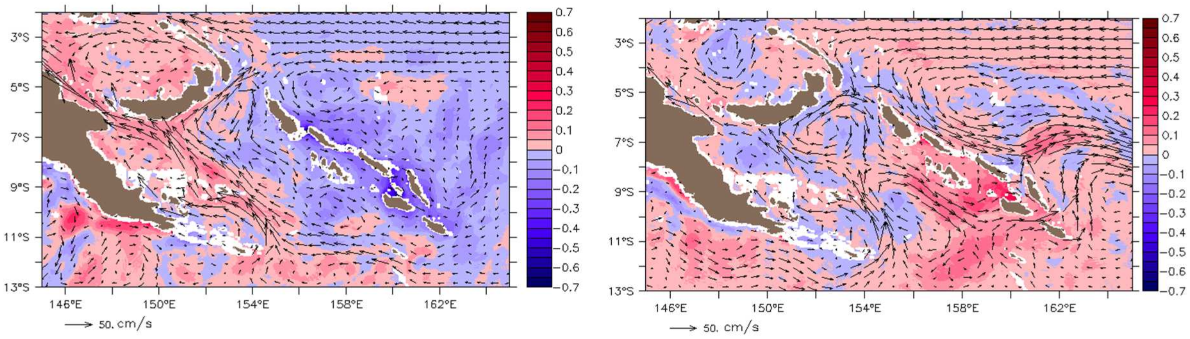


Figure 2: Temperature differences between the TIDE-NOTIDE simulations during El Nino (left) and La Nina (right) conditions. The TIDE (NOTIDE) temperature are anomalised relative to the 3 years mean TIDE (NOTIDE) temperature. The mean SW circulation over the El Nino and La Nina period is superimposed.

- *It would therefore help to expand the work to include a comparison of the phases of the seasonal cycle (say by compositing an annual cycle from the many years of the NEMO simulation). That* *might explain part of the differences found. (It might even be that the ENSO anomalies are _larger_ in the context of the seasonal cycle).*

This remark is in the continuity of the precedent remark. The reviewer suggests to expand the work to include a comparison of the phases of the seasonal cycle. It will allow to illustrate seasonal-tidal effect. To do that we need a robust annual cycle based on many years of the Nemo simulation, but our simulations is only 3 years long and include two strong ENSO events. We have looked at the relative importance of the seasonal variability against interannual variability by the use of the CARS climatology (see above). It seems that the impact of the seasonal cycle is relatively small compared to ENSO.

- *Given the above, some of the results are over-claimed. Examples would be the last, and 3rd-last, sentences of the abstract, and the paragraph in lines 640-645.*

Yes, we agree. This remark is also declined on points 5,6 below. According to the reviewer, we have rewritten the section 5 and some sentences in the manuscript. See the corresponding answers.

Other comments:

1) The boundaries of the nested region should be stated in the text, and ideally shown on a map (probably Fig.1). The crucial tidal forcing is specified as a boundary condition at these edges, so this is an important point that should be stated precisely (section 2.1).

Yes, you are right: We have forbidden to mention the domain of the nested region. We add this information in section 2.1 and in the legend of Fig. 1:

l.155:

Old: "It is a 1/36° horizontal resolution model originally developed by Djath et al. (2014)."

→

New:"It is a 1/36° horizontal resolution model originally developed by Djath et al. (2014) that encompasses the Solomon Sea from 143°E to 165.5°E in longitude and from 13°S to 2°S in latitude."

Figure 1:

Old: Bathymetry of the Solomon Sea (in color, unit in m)…

→

New: Bathymetry of the Solomon Sea over the domain of the regional simulation (in color, unit in m)…

2) The explanation/definition(s) of barotropic and baroclinic components is explained very nicely in section 2.2a. This was especially clear and helpful to this non-specialist. Bravo!

Thank you

- *However, one point remains to be explained, possibly reflecting my ignorance: I am familiar with a Sturm-Liouville mode decomposition, but only by assuming a complete separation of z from (x,y,t). In that case the vertical structure cannot vary in (x,y,t), but here it apparently is computed locally (according to the topography) and therefore does so vary. That means that the vertical mode structures differ by location; presumably the modes would then disperse in hard-to-understand ways, and their propagation becomes unclear.*

Yes, you are right. The modes are computed at every grid cell as classically done in other publications on tidal analysis (Merrifield and Holloway, 2002; Zaron and Egbert, 2014….). This is particularly crucial to analyze the propagation of the mode 1 energy flux within the thermocline.

Sloping topography is mostly an issue for w-modes (bottom boundary condition), but not really for u-modes and p-modes (which are the base modes for tidal energy budget). In addition, the w bottom boundary condition (w-BBC) fails only if significant internal tide currents meet a sloping topography, which occurs only on some locations. Finally, the w-BBC does not fundamentally alter the w-mode profiles. So, despite its limitation, the vertical mode approach remains the most efficient ones to separate barotropic and baroclinic dynamics.

- *On a related point, lines 504-506 assert a mode change due to the near-surface T/S ENSO variability. This could be verified by doing the S-L decomposition for these two periods. Do the modes in fact change?*

Yes, we have done the S-L decomposition for the two periods. Yes, the modes change, this is highlighted by the Fig. 5 of the paper that shows the difference of the N^2 profiles.

3) (nearly a "Major comment") Lines 336-341 describe large-scale water mass changes during the ENSO cycle. But I think this might be confusing "heaving" of the thermocline (vertical motion of the entire T/S structure) with water mass changes. This is apparently the cause of the anomalies in Fig.4c/d. It is easy to be misled as these might appear to be T/S variations if measured at a particular depth. But if what is really happening is heaving, then no water mass changes are implied. Please clarify this point, perhaps by plotting on isopycnals instead of depth. This is a crucial point because the paper argues that differences in tidal effects across the ENSO cycle have implications for mixing and downstream impacts.
The reviewer is right that most of the anomalies in Fig. 4c/d are due to heaving of the thermocline. The objective here is not to describe large-scale water mass changes during the ENSO cycle but to illustrate how the thermocline is pulled up and down during El Nino and La Nina and change the vertical stratification discussed on Fig. 5.
The misunderstanding here comes from the first sentence (l. 329) that introduces the paragraph:
"To illustrate the changes in the properties of water masses with the ENSO cycle…"
This sentence is wrong in this context and is rewritten:
"To illustrate the role of the ENSO cycle in the vertical heaving of this mean structure, the salinity anomalies for El Niño and La Niña periods from R36Td are calculated with reference to the complete period (Fig. 4c, d)."

4) Lines 479-495: This paragraph reads like an incoherent list of information. It jumps topic from sentence to sentence. I found it very difficult to read. Please improve it, perhaps by making an outline of the points to be made, and then probably separating into several paragraphs, each with a clear topic.
This remark was also done by the other reviewver. We try to rewritten the summary to be more readable:
Old:
"In summary, there are three areas where a large part of the barotropic flux energy is converted into baroclinic energy (63 to 79%), and a considerable fraction of the excited baroclinic energy is dissipated locally (46 to 80%). The two main generation sites radiating baroclinic tidal energy into the Solomon Sea are at Solomon strait and at the Southeast extremity of PNG. The generation box at Solomon strait radiates most of the baroclinic energy, especially during the La Ni.a state with a 27% increase of the energy flux compared to El Ni.o. There is a strong modification of the circulation at this site between the two periods, since the strong northward LLWBC current exiting the Solomon Sea during El Ni.o is replaced by the southward SSI current during the La Ni.a period that favors the advection of the tidal baroclinic energy inside the Solomon Sea. Most of this baroclinic energy is dissipated in the northern Solomon Sea as illustrated by Figure 9f, showing higher dissipation in the northern Solomon Sea during La Ni.a compared to El Ni.o. Indeed, the higher EKE level during La Ni.a than during El Ni.o (Fig. 2) favors stronger interactions between eddies and internal tides. This appears to render the internal tide more incoherent (e.g. Fig. 3gh) and to increase the tidal dissipation. The impact of ENSO is particularly visible at the southern Solomon Sea with a 70% increase of the baroclinic flux radiating away from this generation site during El Ni.o compared to the La Ni.a period. The EKE is strongest in this area duringLa Ni.a with higher dissipation and in consequence, there is a lower baroclinic energy flux radiating away."
→
New:
"In summary, there are three areas where a large part of the barotropic flux energy is converted into

baroclinic energy (63 to 79%). Most of the excited baroclinic energy is dissipated locally (46 to 80%), and only two generation sites at Solomon Strait and at the Southeast extremity of PNG radiate significant baroclinic tidal energy into the Solomon Sea.

Solomon Strait radiates most of the baroclinic energy into the Solomon Sea, especially during the La Niña state with a 27% increase of the energy flux compared to El Niño. Most of this baroclinic energy is dissipated in the northern Solomon Sea as illustrated by Figure 9f, with higher dissipation here during La Niña compared to El Niño. This is likely to be impacted by the contrasted circulation and mesoscale activity in this area between the El Niño and La Niña periods. The strong northward LLWBC current exiting the Solomon Sea during El Niño is replaced by the southward SSI current during the La Niña period (see Fig. 2) that favors the advection of the tidal baroclinic energy inside the Solomon Sea. Also, the higher EKE level during La Niña than during El Niño (Fig. 2) favors stronger interactions between eddies and internal tides. This appears to render the internal tide more incoherent (e.g. Fig. 3gh) and to increase the tidal dissipation (Fig. 9f).

At the Southeast extremity of PNG (Fig. 9f, blue) crossed by the strong NGCU the tidal baroclinic energy exhibits no contrasted situations between the two ENSO phases."

5) *The analysis of potential effects on SST - and thus on air-sea fluxes - is intriguing but not developed enough (lines 610-624). The idea seems plausible but with the short description here the conclusion is not well established. Since this is mentioned in the abstract and several other places (e.g. L642-645) the conclusion needs to be clearer and more confident. Otherwise it is could be mentioned in the discussion but not highlighted as much as done here.*

This remark and other main remarks concern the section 5.b. We have already respond on this point in the main remarks. This part is no more valid and the new results bring new conclusion. In consequence the section 5 has been rewritten (see this new section at the end of the report)

- *Worth noting here (line 621) is that anomalies don't mix, only total properties do. Please rephrase this sentence.*

The text has been suppressed (see above), so this remark is no more relevant.

6) Line 641: As noted in the major comment above "greatly" is much too strong for the small rectified changes described, given the extreme forcing differences.

This part has been suppressed, so this remark is no more relevant.

7) I have spent a great deal of time along coasts of the Solomon Sea in several locations on both sides of the sea, and consistently observe a very predominantly diurnal (24-hr) sea level tide. This phenomenon appears in Fig.6a. Why is this paper almost entirely focused on the M2 tide? Why doesn't the diurnal tide also produce a baroclinic component worth analyzing? If there is a straightforward answer it would be useful to say it.

The reviewer is right: the diurnal barotropic tides is dominant in the Solomon Sea but not the diurnal baroclinic tides (Fig. 3). But the main forcing of the baroclinic tides is the M2 barotropic component as highlighted by the SSH amplitude of the baroclinic components (Fig. 4). This is the raison why the paper focuses on the M2 tide.

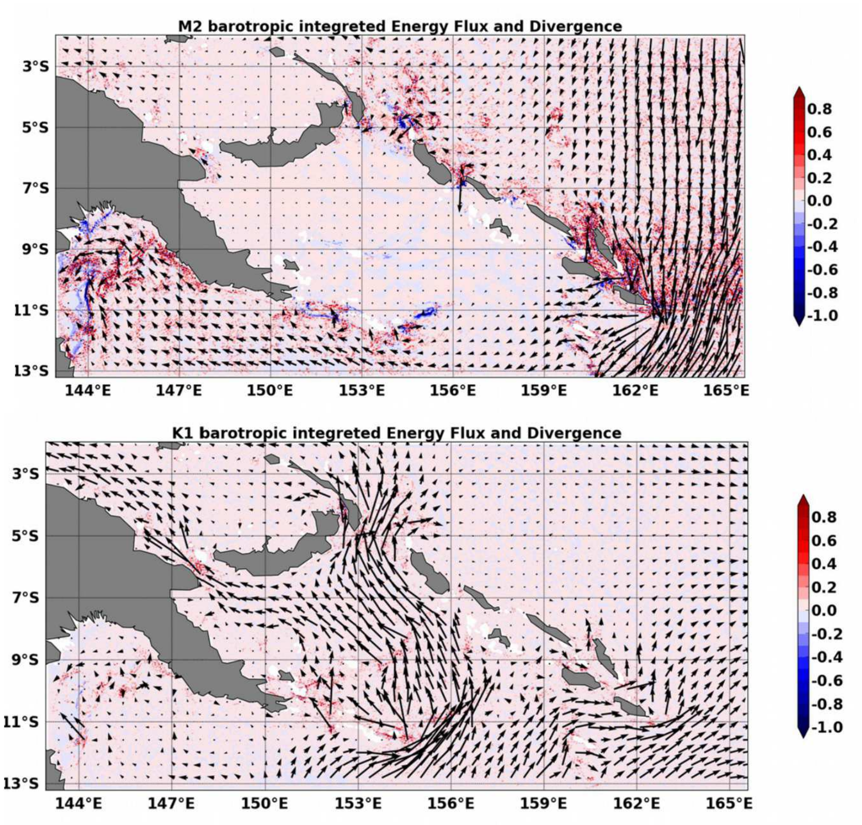


Figure 3: barotropic integrated energy flux (arrows) for the M2 (top) and K1 (bottom) components

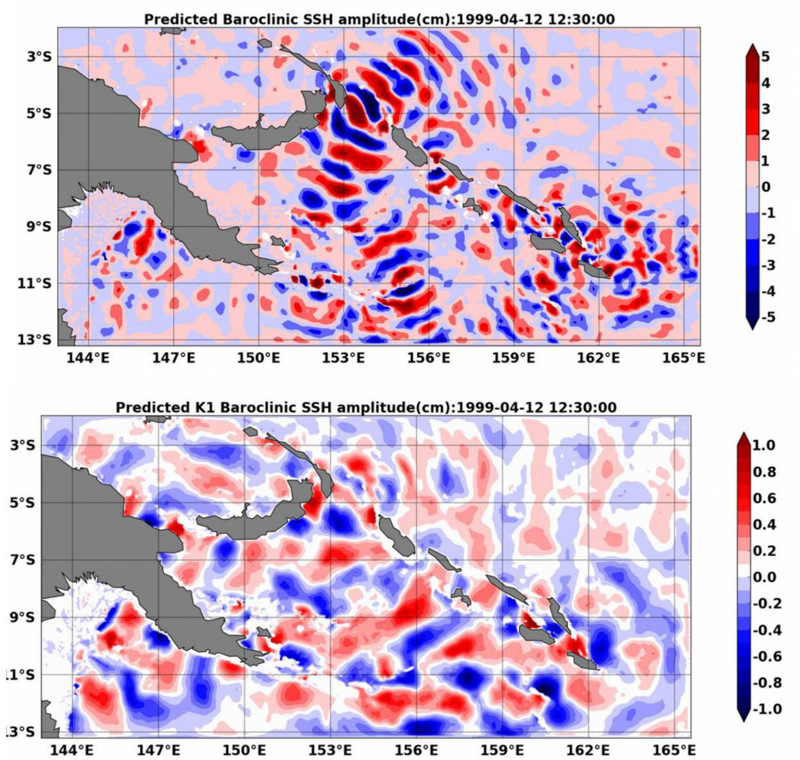


Figure 4: SSH signature of the baroclinic tides (shaded) for the M2 (top) and K1 (bottom) components (look at the different shading scales)

8) *Considering the small rectified changes noted in the major comment above, it might be worth noting that there is a different hypothesis for the mixing that apparently occurs in the Solomon Sea. Kessler et*

al (2019) show very large changes of velocity structure between their two glider lines, one just outside the sea, the other just inside (e.g their Figs.1 and 6 or 11). The two inflows (SEC and NGCU) merge (and presumably mix) just at the southern entrance to the sea. They speculated that the property differences between entrance and exits noted in several papers could be due to this non-tidal effect.
Yes, we agree. We add such hypothesis in the text for the discussion, see the new section 5 at the end of the reply. We also point this hypothesis in the abstract.

Abstract: “However, when averaged over the Solomon Sea, the tidal effect on water mass transformation is an order of magnitude less than that observed at the entrance and exits of the Solomon Sea. These localized sites appear crucial for diapycnal mixing, since most of the baroclinic tidal energy is generated and dissipated locally here, and the different currents entering/exiting the Solomon Sea merge and mix. Finally, the extreme ENSO condition case studies highlight the dominant role of local circulation changes that modify the internal tides more than the vertical stratification changes.”

9) *The figures need a good deal of improvement:*
a) Many (most) of the figures have information that is too small to see. These include:
- Teeny-tiny axis labels (Fig.4 is the worst, but 3, 6b, 10, 11, 13, 14 are also very hard to read).
- Some fine contours are impossible to read and are thus useless. E.g. phase lines in Fig.7 and EKE contours in Fig.14.
- I strained to see the "isobathymetric lines" referred to in many figures. I still don't know what this refers to; is it just the reef edge? (In any case I would call these "isobaths").
- Teeny vectors and color blotches in Figs.9 and 10. These figures thus do not convey the information desired. Perhaps use fewer, larger vectors and simplify the color shading?
b) It is hard to see the difference between the green and blue lines in Fig.5. Then these colors change meaning in Fig.6. These should be more distinct, and use consistent colors (for El Nino/La Nina) between these figures.
Yes, We hope that now the new figures are readable.

Minor comments:
1) *The English is quite good throughout, with the exception of the Introduction which is sprinkled with distracting small errors. Since one of the authors is a native English speaker (let's accept for the moment that Australian is a close-enough dialect of English ;-), it would be worth going over this section.*
The English has been revised.

2) *Line 323: I think this should be "154E" (not 154S).*
Yes!

3) *The citation for Kessler et al (2019) is wrong (author list as published is different).*
Ok, the citation has been suppressed.

The section 5 has been rewritten:

5. Tidal effect on water mass transformation

Here, we take advantage of our twin simulations, forced with tides (TIDE) and without tides (NOTIDE), to analyze the impact of internal tides on the Solomon Sea's water mass modification. Most of the transformation occurs in the SW (σ_θ <23.3), UTW (23.3< σ_θ <25.7), and IW (26.7< σ_θ <27.5) water masses. We recall that the salinity maximum of the SPTW waters in the UTW is the key variable that impacts on the T–S modifications on the EUC. Whereas the SWs, which feed into the west Pacific warm pool, can modulate the critical air-sea interactions there. At depth, the IW influence the water mass properties of the cross-equatorial intrusion, in turn impacting on the North and equatorial Pacific's overturning circulation (Qu and Lindstrom, 2004).

This section will firstly address the long-term impacts of internal tides on the SW, UTW and IW, based on the daily outputs from the 3-year simulations. Also, the transit time for the SW waters are short enough (e.g. Melet et al., 2013) to allow us to investigate any sensitivity of the internal tide on the SW properties during our contrasting ENSO conditions.

a) Long term changes between TIDE and NOTIDE simulations

Salinity is a key parameter defining the water mass extrema. The mean salinity distribution of UTW waters shows the intrusion of the high salinity SPTW water in the Solomon Sea on Figure 12 for the 3-year NOTIDE and TIDE simulations compared to the CARS climatology. This high salinity tongue is firstly advected westward by the NVJ at 11°S before joining the NGCU around 155°E. As it continues to be carried northward into the Solomon Seas, it is eroded along its route. Interactions between the NGCU and the bathymetry, as well as the merging of the different currents, and the effects of tides are components that can erode the salinity maximum. The models with and without tides and the CARS data all show a strong erosion at the entrance of the Solomon Sea with a 0.06 freshening between the southeastern extremity of PNG and the Woodlark archipelago at 9°S. The salinity erosion is enhanced in the TIDE simulation compared to the NOTIDE simulation, and erosion is also visible in the northern Solomon Sea along the NGCU pathway. We note that the mean N^2 profile along the axis of this high salinity tongue at 154°E (Fig.5) had already highlighted the close resemblance of the UTW in the CARS and TIDES simulations compared to the NOTIDES simulation.

Another discrepancy between the TIDE and NOTIDE simulations concerns the zonal salinity gradient between the salinity tongue carried by the LLWBCs and the lower UTW salinity along the Solomon Islands. This zonal salinity gradient is enhanced in the TIDE simulation, suggesting that tides induce diapycnal mixing that is particularly efficient in the eastern and northern parts of the Solomon Sea. These regions where mean currents and EKE are relatively low (eastern Solomon Sea) and where strong recirculation exists (northern Solomon Sea) could be favorable to tidal mixing because of longer transit time for particles here.

The strong zonal salinity gradient in the TIDE simulation is also visible in the CARS climatology, although a fresh bias of about 0.02 psu may be noted in the TIDE simulation compared to CARS. This comparison with the long-term CARS climatology has some limitations with regard to the particular conditions of our 3-year simulation including strong El Niño and La Niña events. We note that CARS shows a strong salinity maximum around 5°S outside and to the east of the Solomon Sea that does not match our 3-year period simulations, where this salinity maximum in the open ocean is shifted to the south around 11°S. We have verified that the UTW salinity averaged over the same period as our simulations based on a monthly gridded T-S data (CORA05; Cabanes et al., 2013), also exhibits such a southward shift (not shown). Unfortunately, CORA05 has few observations available inside the Solomon Sea, since it is based mainly on ARGO data. So we can perform interannual validations outside the Solomon Sea, but only long-term climatological comparisons inside.

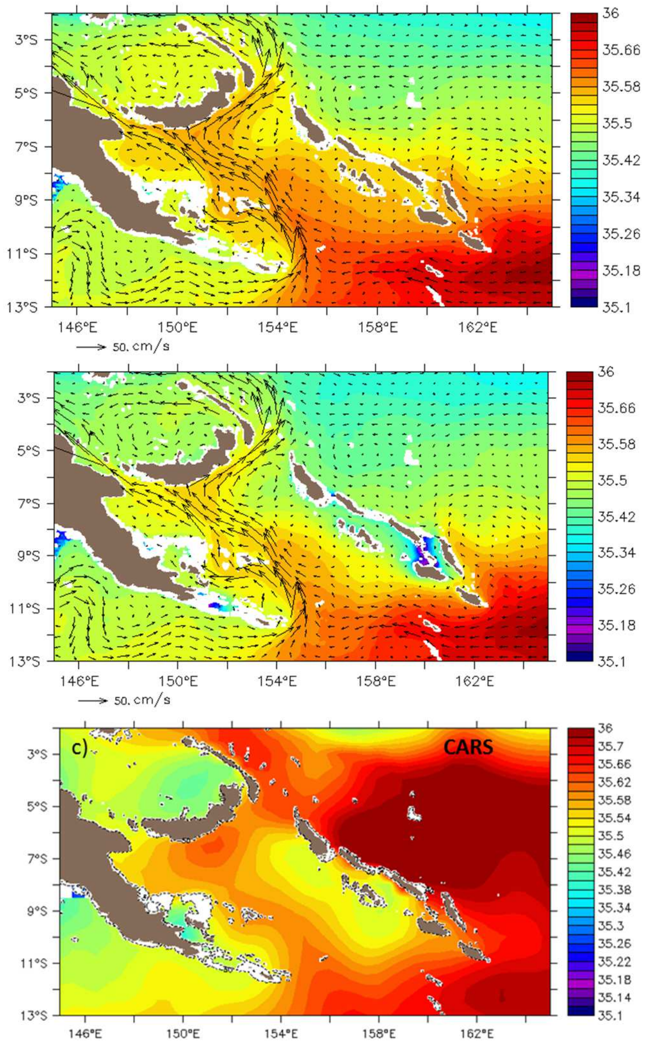


Figure 12. Mean salinity of the UTW waters for NOTIDE (top), TIDE (middles) simulations and the CARS climatology. The mean modelled circulation at the UTW level is plotted for the NOTIDE and TIDE simulation (arrows).

Temperature and salinity changes between the NOTIDE and TIDE simulations are presented on Figure 13 for the different water masses. The difference between these 3-year simulations shows that tidal mixing reduces the T/S extrema, and induces cooler and saltier SW, cooler and fresher UTW, and warmer and saltier IW. It means that the corresponding salt flux is transferred downward to IW, and upward to SW. In the same way, the diapycnal mixing from tides at the thermocline level induces a heat flux that cools the UTW and SW, and warms the IW. This results in a weaker stratification at the thermocline level in the TIDE simulation compared to the NOTIDE simulation (e.g. Fig. 5).

The largest impact of the tides is for the UTW, and the tide effect is strongest along the Solomon Islands with fresher salinity up to -0.08 psu and colder temperature up to -0.3°C for the TIDE simulation. But when averaged over the Solomon Sea, the rectified anomalies due to the tides are only of -0.04 for salinity and -0.1°C for temperature. The salt and heat fluxes in the TIDE simulation impact the SW and IW waters to a lesser effect, again with the highest differences along the Solomon Islands. Once again, when averaged over the Solomon Sea, the rectified anomalies due to the tides are only of -0.06°C (0.08°C) for temperature and of 0.01 for salinity for IW and SW, respectively, although locally the differences may reach 0.9°C and 0.15 psu (Fig. 13).

At the surface, the cooling of SW by the tides could affect the SST field that in return affects the latent heat flux and the corresponding net heat flux (Qnet). This corresponds to a positive Qnet anomaly between the simulation with and without tides (not shown) that acts to reduce the SST cooling induced by internal tides. Averaged over the Solomon Sea, the SST cooling due to the tides is of -0.06°C for SW, and only -0.04°C at the surface. This is an order of magnitude less that the SST cooling in the Indonesian Seas that drastically affects the overlying deep atmospheric convection when modeled in a coupled ocean-atmosphere model including a tidal parameterization (Koch-Larrouy et al. , 2010).

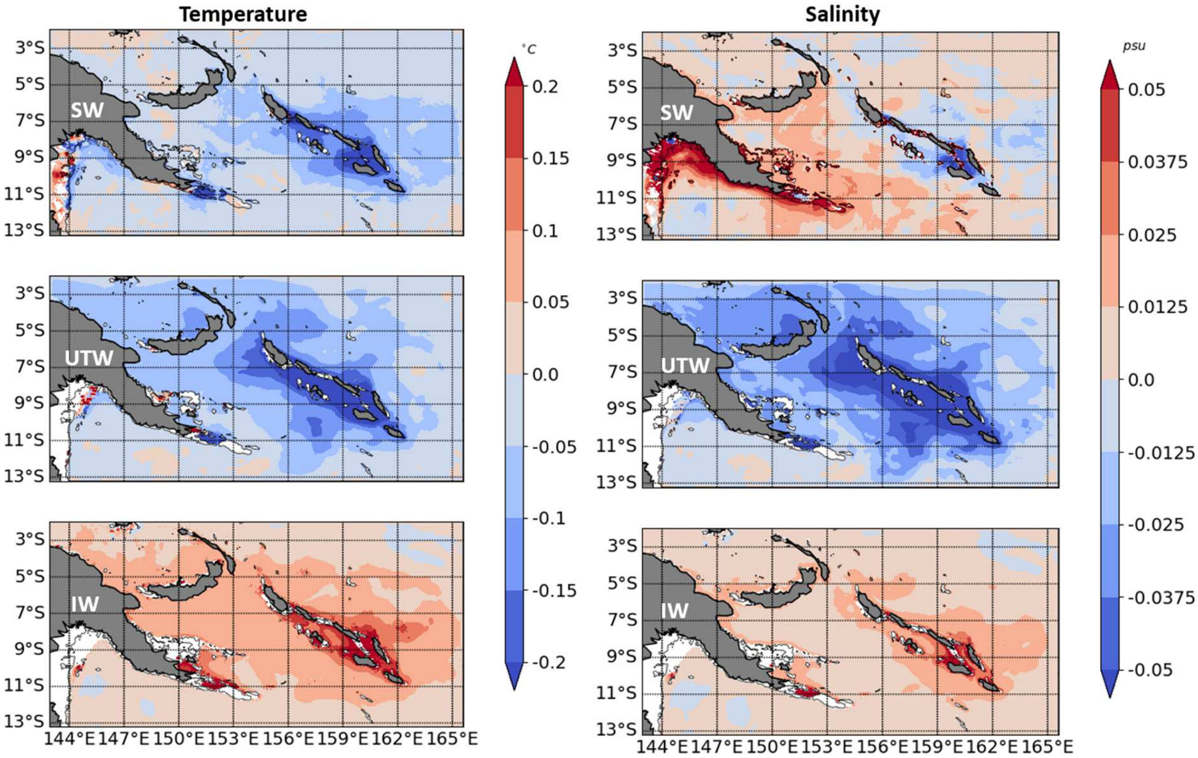


Figure 13: Mean temperature (left) and salinity (right) differences between the TIDE – NOTIDE simulations for the SW (top), UTW (middle), and IW (bottom) waters.

b) Sensitivity to extremes conditions

The mean tidal effect on water mass transformation is rather modest, but we can ask if extreme conditions like ENSO events impact on the role of tides on water mass transformation because internal tides are sensitive to contrasted ENSO periods (e.g. section 4). To illustrate this point, we focus on the 3-month periods of El Niño and La Niña, and we concentrate on SW waters since the transit time of SW waters is short enough to be influenced by these extreme conditions. Fig. 14 shows the temperature differences of SW between the TIDE-NOTIDE simulations for the two ENSO periods, calculated relative to their 3-year mean. The tidal impact on SWs during the ENSO period is quite small, with maximum differences within the Solomon Seas of +/- 0.15°C between the TIDE and NOTIDE simulations. But it is notable that the differences are strongly related to the circulation anomalies. During El Niño, the LLWBC strongly increases and we observe maximum positive temperature differences due to the tides along its pathway (Fig. 14a). In the same way, during La Niña maximum positive differences are present along the Solomon Islands where the SSI increases strongly southward (Fig. 14b). Since these positive temperature anomalies are relative to the 3-year mean cooling of SWs (Fig. 13) by the tides, they highlight that the intense circulation changes during the ENSO periods lead to a reduced effect of the tides on the SW waters. In other words, the tidal effect will be more efficient when the circulation has lower energy. When averaged over the Solomon Sea, the tidal differences compare to the 3-year mean are weaker in the La Niña condition with a temperature difference of 0.018°C compared to 0.05°C for El Niño, and these values are of same order as the mean tidal effect.

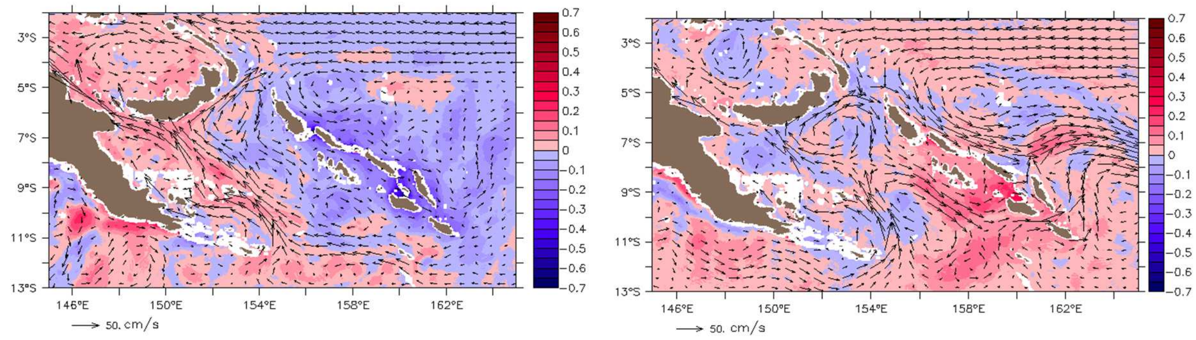


Figure 14: Temperature differences between the TIDE-NOTIDE simulations during El Nino (left) and La Nina (right) conditions. The TIDE (NOTIDE) temperature are anomalised relative to the 3 years mean TIDE (NOTIDE) temperature. The mean SW circulation over the El Nino and La Nina period is superimposed.