Eddy-internal tide interactions in the New Caledonia 'Adopt-A-Crossover' region

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Abbreviated abstract:

New Caledonia is characterized by strong meso- & submesoscale as well as hot spots of internal tide generation serving as a study site for SWOT observability of eddy-internal tide interactions. Here, we use the numerical output of a high-resolution regional model that was set up in two configurations - with and without barotropic tide forcing – in order to understand the impact of (internal) tides on the background flow dynamics. Preliminary results suggest tidal incoherence gaining in importance away from the internal tide generation sites, possibly related to the interaction with the meso-/submesoscale eddy field. Energy transfer between the simulation with and without is being investigated. It is shown that tidal forcing may enhance both the forward and inverse energy cascade, i.e. in summer time.

Related publications:

Bendinger et al. (in preparation)

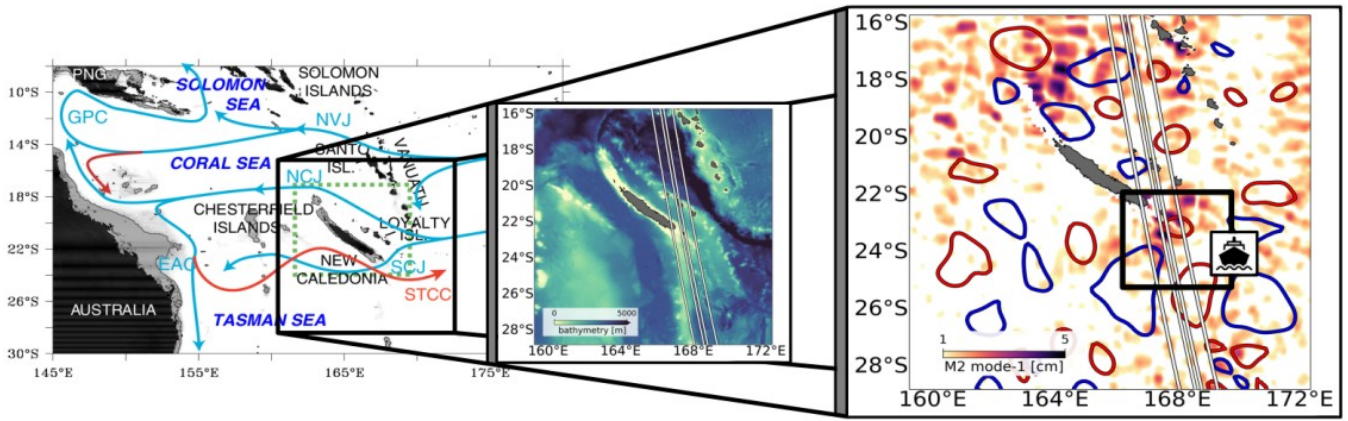
Data and methods

New Caledonia as a study site for eddy-internal interactions

① Strong meso-/ submesoscale activity

② Hot spot of internal tide generation

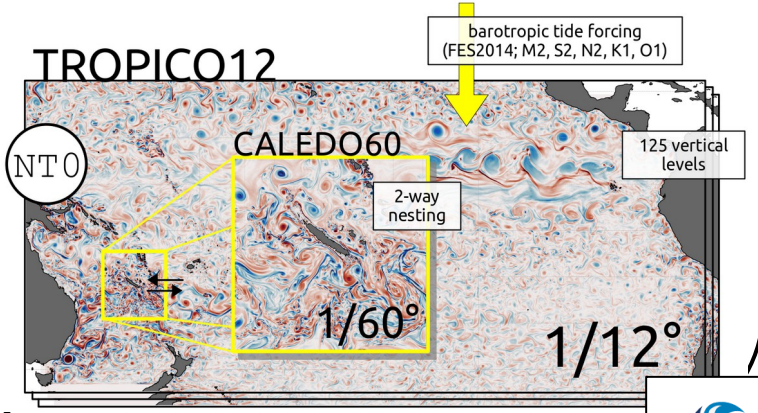
③ Region of eddy-internal interactions beneath SWOT fast sampling phase track



Left: Regional circulation in the Southwestern Tropical Pacific (red: surface, blue: thermocline, Gravatte et al., 2015). **Middle: Bathymetry** with SWOT fast-sampling phase track (thick white line). **Right: Coherent M2 mode-1 SSH** signature (shading, Ray and Zaron, 2016), superimposed by an eddy tracking snapshot (blue and red contours, Le Vu et al., 2018) with indicated field campaign

CALEDO60 high resolution (1/60°, 125 vertical levels) regional numerical solution embedded in mother domain **TROPICO12**

+ set up of two simulations: with and without barotropic tide forcing
+ barotropic tide forcing at the lateral boundaries of TROPICO12 allowing for free wave propagation in regional domain
+ 2-way nesting framework



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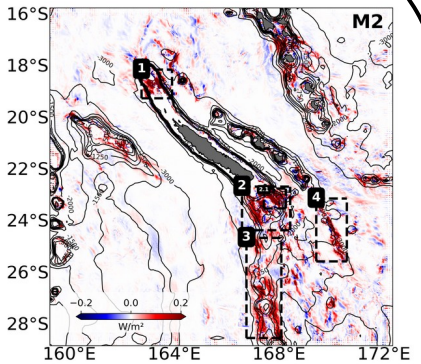
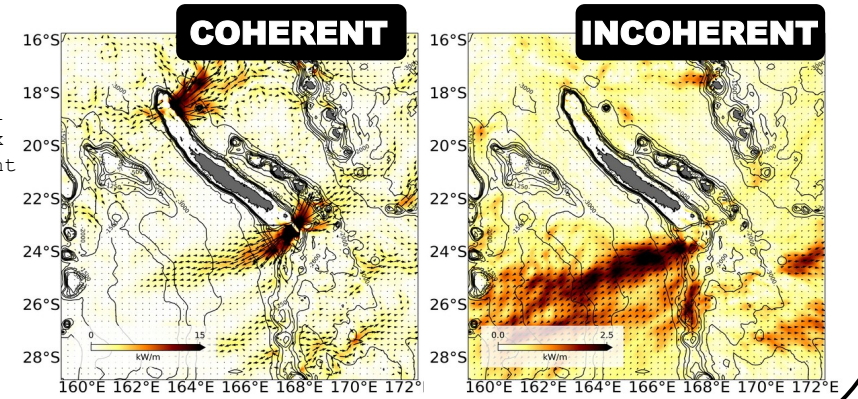
Results

Internal tide field & tidal incoherence

Hot spot of internal tide generation with locally >70% of the barotropic energy being converted into baroclinic internal tides (right).
Predominant internal tide field with a strong coherent signature and an incoherent signal gaining in importance away from the generation site (below)



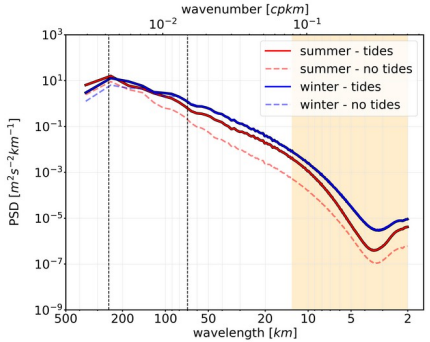
M2 Barotropic/baroclinic conversion term [W/m²]



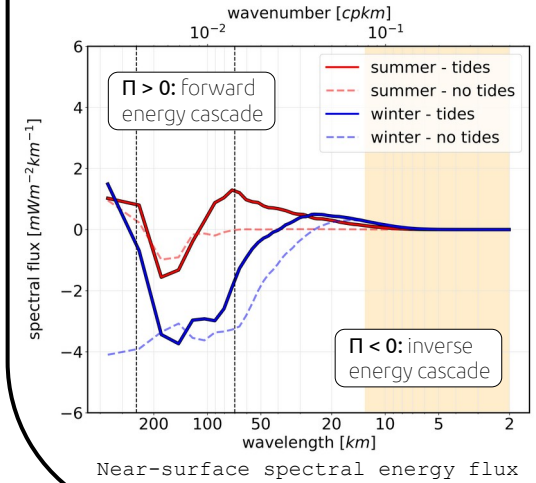
Semidiurnal energy flux for coherent (left) and incoherent (right) component. Note the different colorbar scales.

Tidal forcing impact on Meso-/Submesoscale

Simulation with tides features **elevated energy levels** across all spatial scales in **summer time** (right) compared to simulation without tides



Near-surface power spectral density of kinetic energy



Near-surface spectral energy flux

Tidal forcing introduces **intense forward cascade** in **summer time** which is otherwise nearly absent in the simulation without tides. Evidence is given for an **enhancement of the inverse energy cascade** (left).

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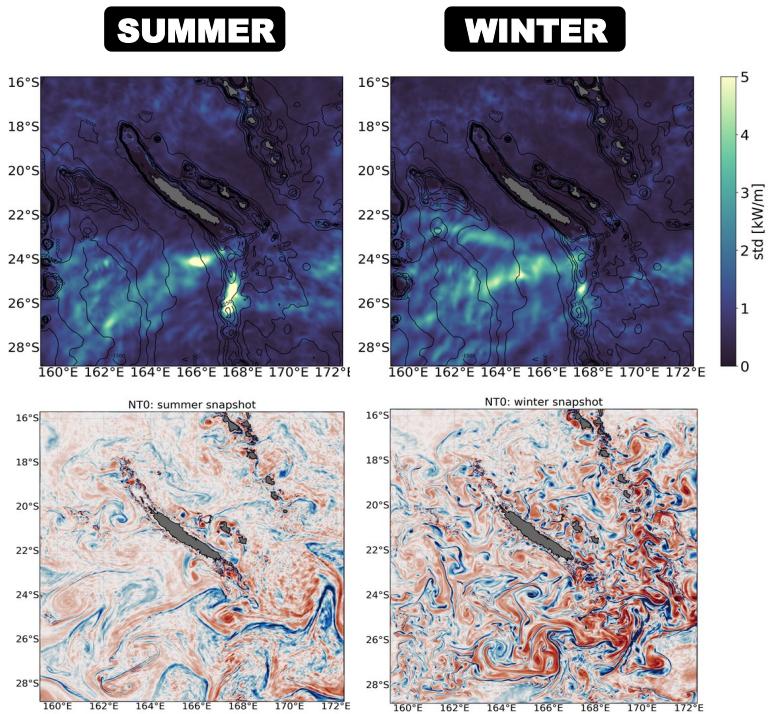
Discussion and conclusions

Open questions and work in progress:

1) What processes cause or influence tidal incoherence? Is it seasonally dependent through interaction with the meso-/submesoscale eddy field?

2) Can we separate submesoscale variability near tidal frequencies from tidal motion?

3) Further analysis on energy transfer between Meso- & Submesoscale: Are the findings of the enhancement of the forward and inverse energy cascade robust? Use longer timeseries and apply coarse-graining approach!



Incoherent energy flux variability (upper panels) and snapshots of surface relative vorticity (lower panels) for summer (left) and winter (right)