# Internal tide energy decay in the equatorial Pacific

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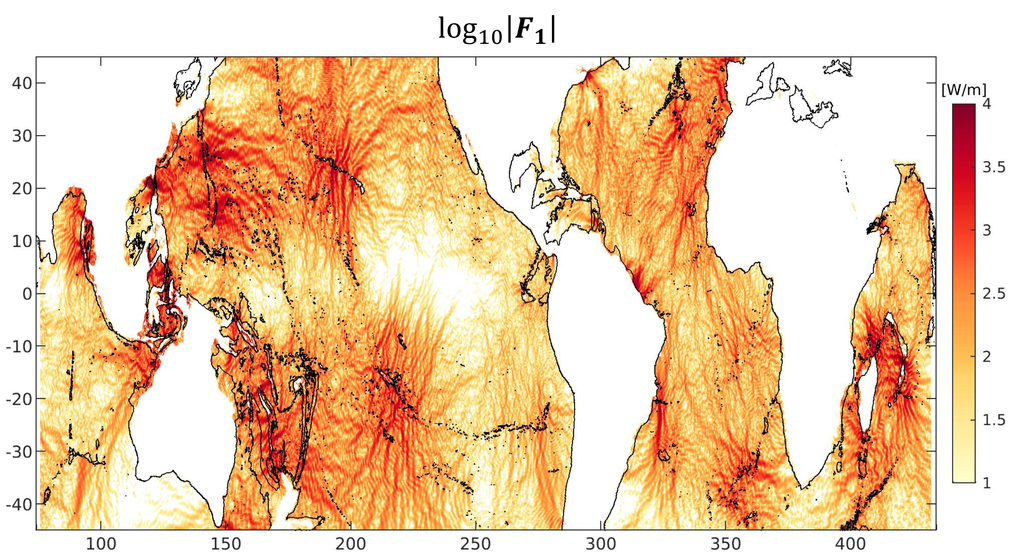
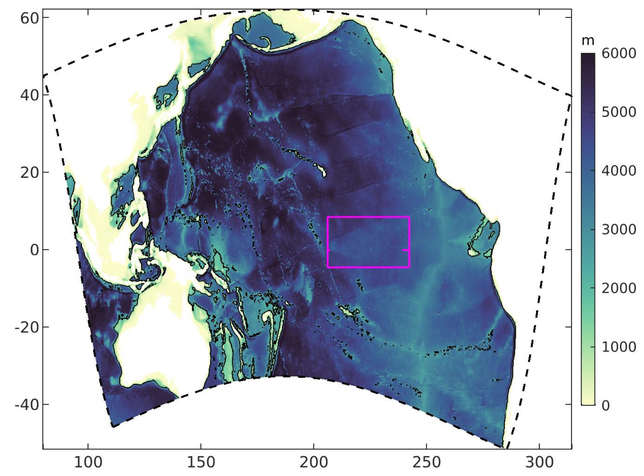
## 1.0 Background



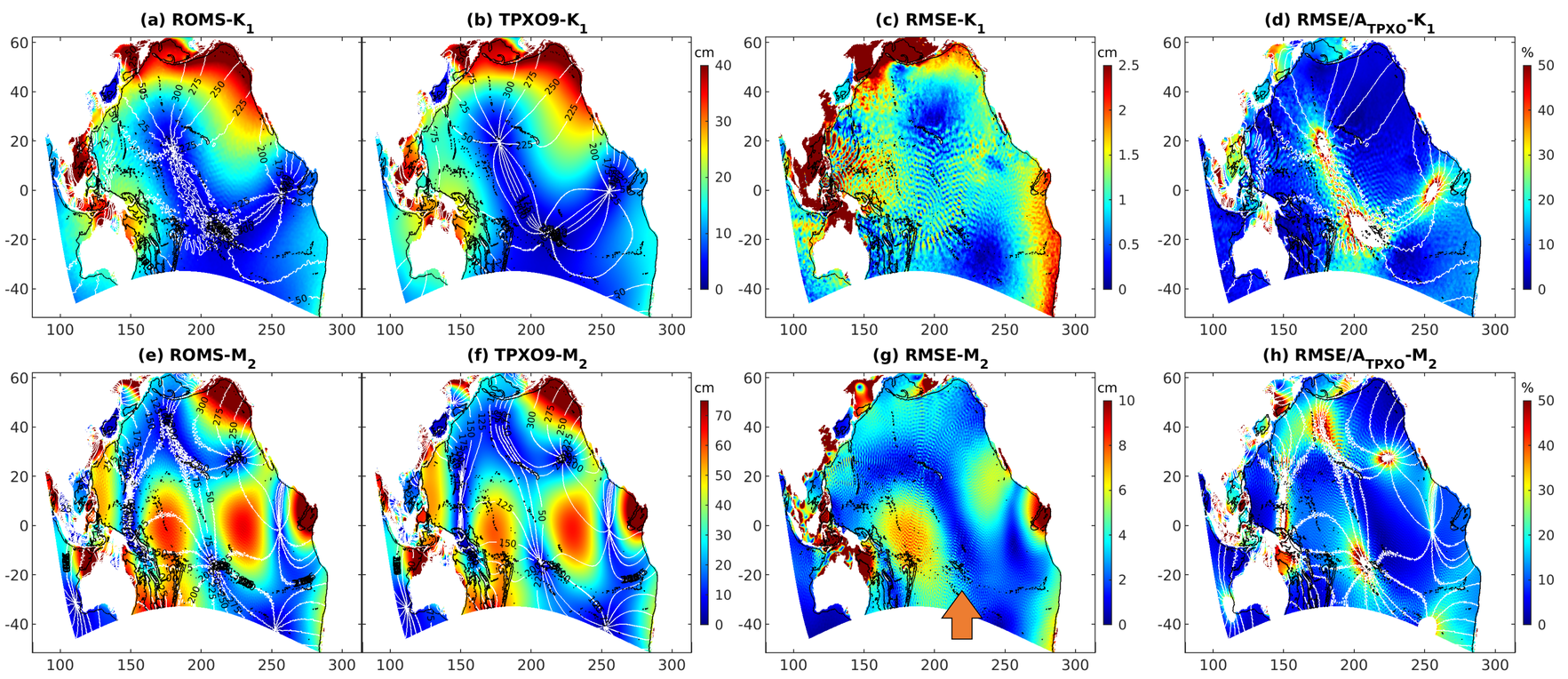

- SST predictions in the equatorial Pacific hinges critically on vertical distribution of mixing
- Internal tide energy decay is suggested to play a key role in mixing in the equatorial Pacific
- Remote internal tides from Hawaiian and French Polynesian Islands decay when they cross the equatorial Pacific
- **What are the mechanisms behind the internal tide (IT) energy decay in the equatorial Pacific? (see Buijsman poster)**

## 2.0 Model




We run a 6-km (100 $\sigma$-layers) basin scale regional ocean modeling system (ROMS) simulation of the equatorial Pacific with realistic stratification, wind and tidal forcing

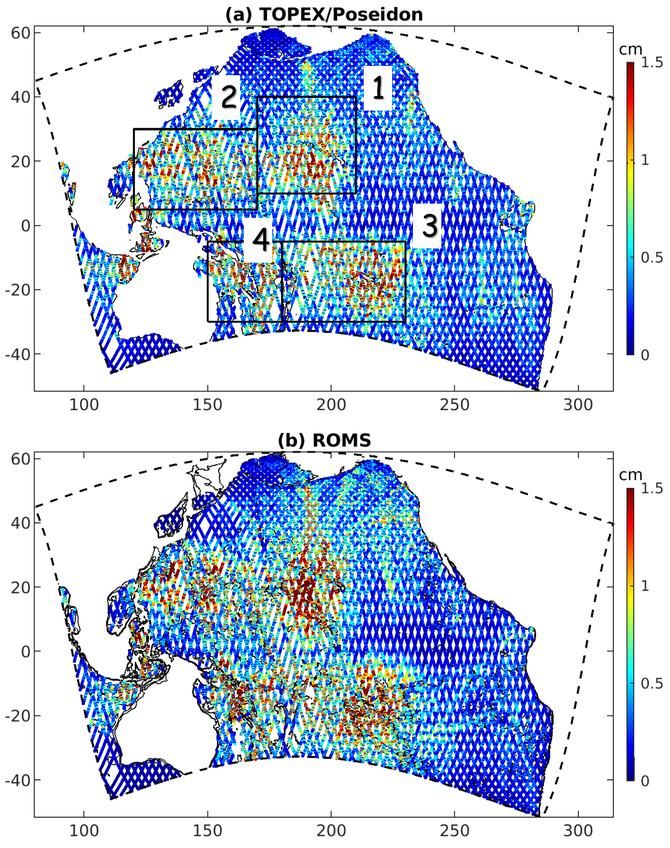
## 3.0 Surface Tides




- We validate the surface tide SSH with the TPXO9 barotropic tidal model
- Small scale perturbations in the phase contours for ROMS depict the presence of internal tides
- Overall, $M_2$ has the highest area-averaged tidal error of the five tidal constituents ($O_1$, $K_1$, $N_2$, $M_2$, $S_2$) considered
- Tidal errors are much greater in the shallow waters than in the open ocean
- The tidal errors are low near the French Polynesian Islands (orange arrow)
- The ratio between the RMSE and the tidal amplitudes is highest near the amphidromic points and in shallow seas where topography is not well resolved

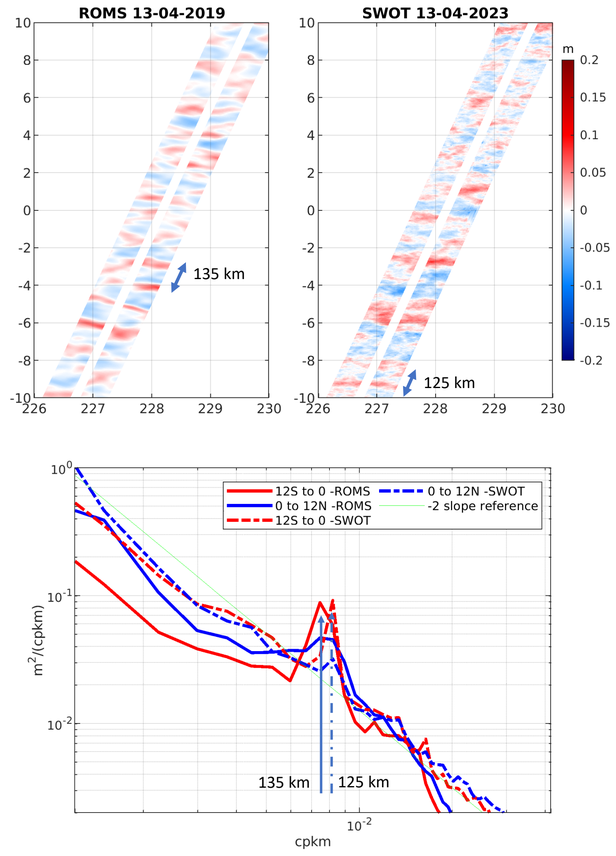
- The combination of errors in the amplitude *A* and phase Ø is determined by $RMSE = \sqrt{\frac{1}{2}\left((A_R \cos \emptyset_R - A_T \cos \emptyset_T)^2 + (A_R \sin \emptyset_R - A_T \sin \emptyset_T)^2\right)}$ where subscripts “R” and “T” denote ROMS and TPXO, respectively

## 4.0 Baroclinic $M_2$ Sea Surface Height (SSH) Amplitude




- We perform along-track spatial bandpassing (50-400 km) to isolate low-mode ITs from the total $M_2$ SSH complex harmonic constants for ROMS and TOPEX/Poseidon Altimetry datasets
- ROMS has a good spatial correlation with the altimeter dataset, showing IT generation hotspots such as Hawaii and the French Polynesian Islands (FPI)
- However, without wave drag, ROMS overestimates variance relative to TOPEX/Poseidon—by
  - 80% near Hawaii (box 1),
  - 18% in the NW Pacific (box 2),
  - 43% around the FPI (box 3), and
  - 31% in the SW Pacific (box 4)

## 5.0 Comparison with SWOT




- ROMS and 1-day repeat Cal/Val SWOT data show energy peaks at mode-1 IT with wavelength ~130 km
- SWOT data also reveals the decay of IT energy from the FPI crossing the equator
- At high wavenumbers, SWOT spectra follow closely with the $k^{-2}$ slope reference
- However, ROMS has a sharp drop in energy for the high wavenumbers
- The coarse 6-km ROMS simulation may not resolve wave-wave and wave-mean flow interactions that contribute to the internal tide decay and the high wave number energy

## 6.0 Conclusions

- ROMS shows good spatial agreement with both barotropic tidal model and, nadir and wide swath satellite altimetry datasets but it is more energetic
- In both model and observations, we observe the decay of the internal tide energy across the equatorial Pacific, but it is more pronounced in the observations

**References:**

Shriver, J.F., et al. (2012). An evaluation of the barotropic and internal tides in a high-resolution global ocean circulation model. Journal of Geophysical Research: Oceans, 117, C10024. https://doi.org/10.1029/2012JC008170

Buijsman, M.C., et al. (2020). On the interplay between horizontal resolution and wave drag and their effect on tidal baroclinic mode waves in realistic global ocean simulations. Ocean Modelling, 152, 10165. https://doi.org/10.1016/j.ocemod.2020.101656

## Future Work

- We will run a 2-km resolution child solution of the equatorial Pacific (magenta box in Panel 2.0) with increased vertical resolution (200 $\sigma$-layers) nested within the ROMS 6-km parent run
- We will validate the stratification, background flows and internal tides in the 2-km child solution against climatology and SWOT data
- We will quantify energy transfers in the equatorial Pacific due to wave-wave and wave-background flow interactions using the coarse-graining approach