Exploring Internal Wave signature on remote sensing infrared SST observations.

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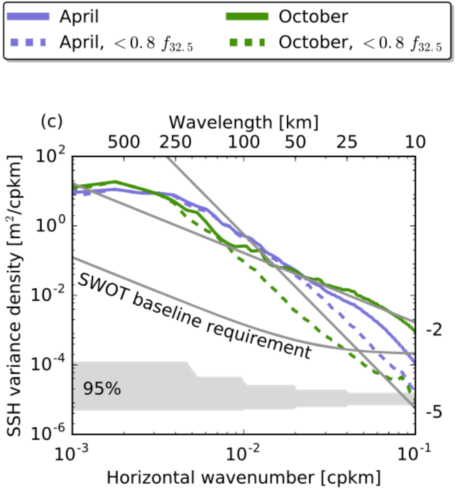
Outline

Context

- Internal waves (IW) significantly contribute to sea level variability at scales lower than 100 km

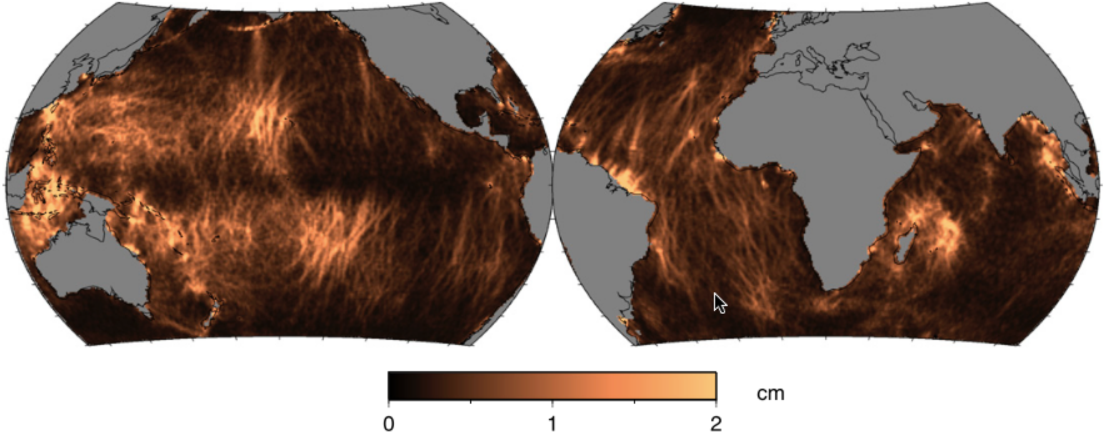
- Fast motions (including IW) will complicate our ability to retrieve ocean currents from altimetry (geostrophy fails)



Rocha et al 2016

Context

- Some IW are of tidal origin and stationary
- They can be predicted and removed from altimetric data



Ray and Zaron 2016

Context

- However, a significant fraction of IW are

  1. From tidal origin but they have lost their phase relationship with respect to astronomical forcing, because of their interactions with slower oceanic turbulence (non stationary internal tides) [Ponte and Klein 2015, Zaron 2016]

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- Thus, difficult to predict nowadays

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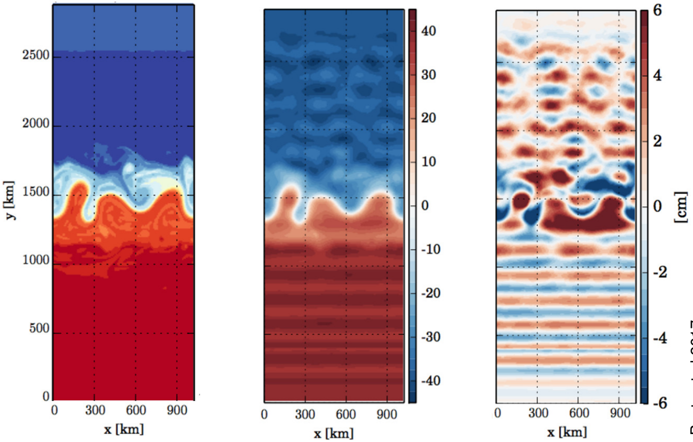
- Ponte et al. 2017 proposed in an idealized context a tentative method that relies on the synergy between SST-SSH

2 critical ingredients

- IW filtering capability of the QG framework
- Weakness IW signature on surface tracers(SST)



Ponte et al 2017

Objective

- Quantify the IW signature on SST images
- Validate or not the assumption of weak signature IW
- If possible, identify regions with some internal tides signature, strong SST gradients, cloud free regions.

Theoretical Background

- Quantify the IW signature on SST images
  - IW currents (u_w,v_w) are expected to periodically advect SST (T_s) fronts and result in SST fluctuations (T_w):

$$\partial_t T_w = -u_w \partial_x T_s - v_w \partial_y T_s$$

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  - Assuming that $u_w = \Re(u_c e^{-iwt})$ where $u_c = u_r + iu_i$ and w is the IW frequency

$$\Re(-iwT_w e^{-iwt}) = -\Re(e^{-iwt}[u_c \partial_x T_s + v_c \partial_y T_s])$$

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Tidal atlas

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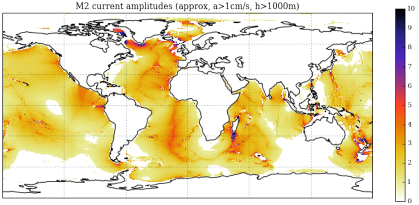
- Tidal atlas
- SST remote sensing

Data Sources

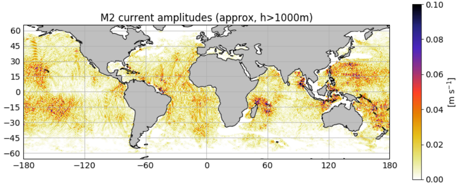
- Atlases of **baroclinic** and **barotropic** sea level (currents):

Baroclinic



HRET
(High Resolution Empirical Tide) [Zaron]
Spatial resolution = 1/20°

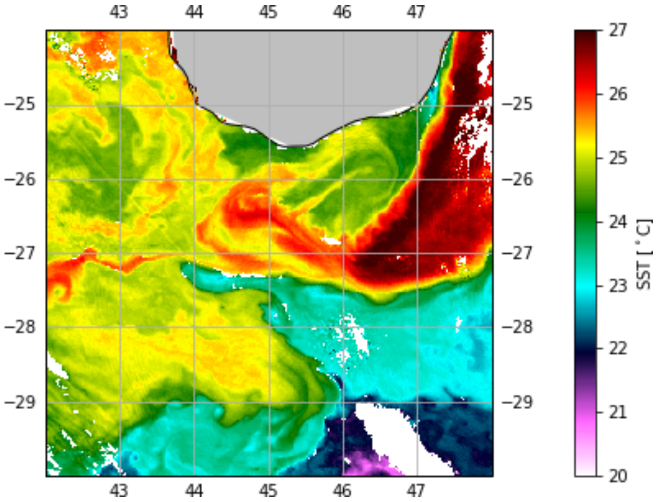
Barotropic



FES
(Finite Element Solution)
Spatial resolution = 1/16 °

Data Sources

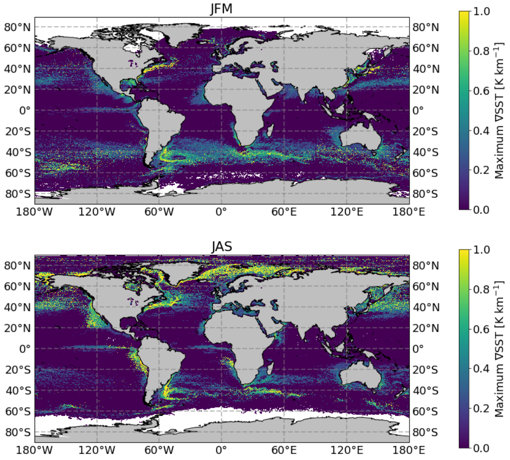
- L2 SST granules from: METOP, VIIRS, MODIS (2014-2016)



L2 SST METOP
06/06/2014
Spatial resolution = 0.02°
(remapped)

Data Sources

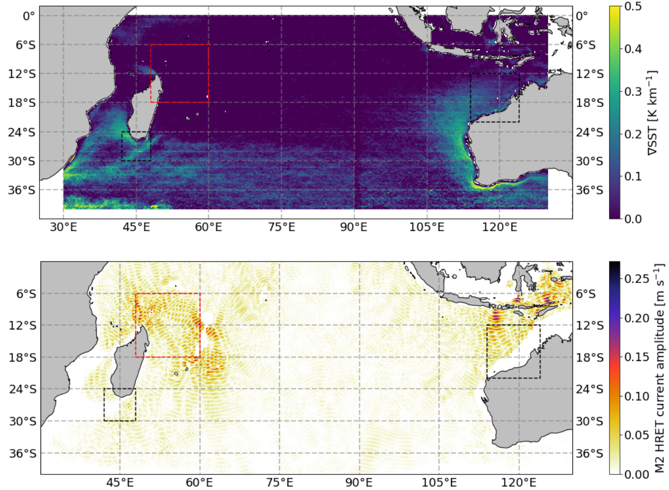
- Climatology of Maximum SST gradient. Courtesy of Peter Cornillon , Graduate School of Oceanography, University of Rhode Island (URI).



- Obtained from the entire (1985-1996) Pathfinder 9 km resolution SST dataset
- Based on the automated procedure by Cayula 1991
- Spatial resolution 9 km

Regions of study

- Strong thermal SST gradients
- Significant signature of IW



Preliminary Results

- Signature of IW on SST:

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M2 Baroclinic (w = 1.932cpd)

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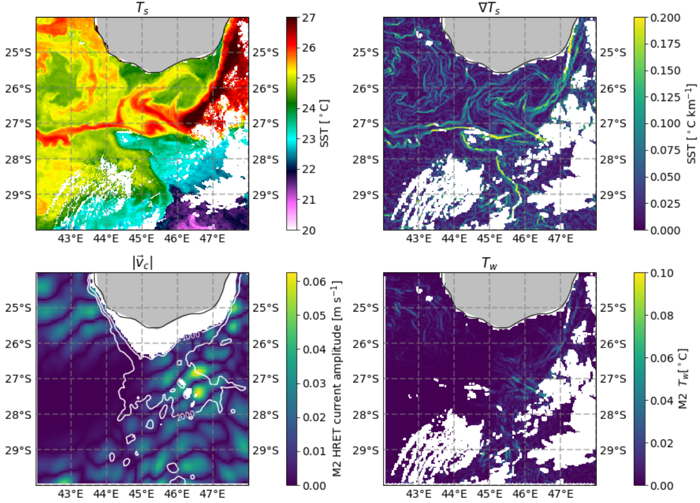

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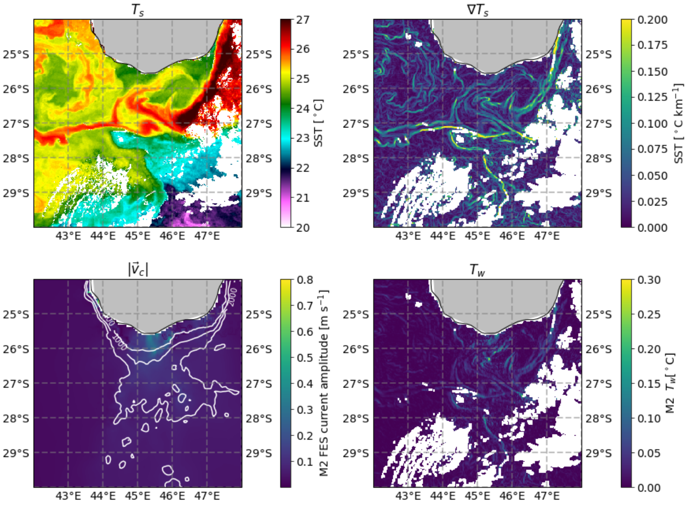
Preliminary Results

- Signature of IW on SST:

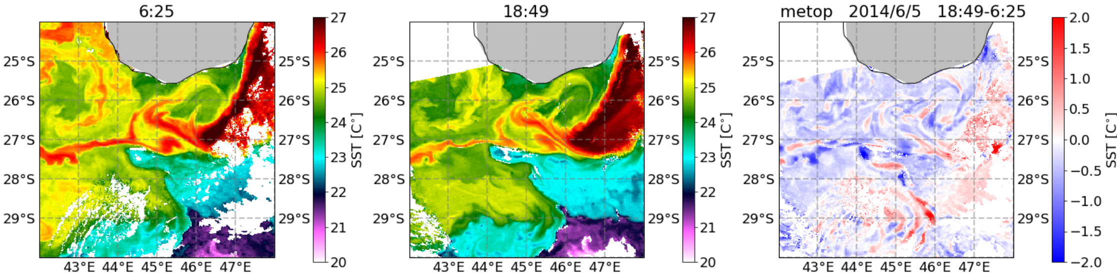
M2 Barotropic (w = 1.932cpd)



$$T_w = \frac{u_c \, \partial_x T_s + v_c \, \partial_y T_s}{iw}$$

Preliminary Results

- Temporal gradient between consecutive passes



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- This **signature** is related to the **advection** of **fine scale SST fronts** (fine-scale and confined to the front location). It is proportional to the product of the SST frontal gradient and tidal currents.

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- We present here a first attempt to **quantify** the signature of **IW** on **SST observations** provided by **orbiting satellites**.
- This **signature** is related to the **advection** of **fine scale SST fronts** (fine-scale and confined to the front location). It is proportional to the product of the SST frontal gradient and tidal currents.
- **SST fluctuations** due to **barotropic** tidal motions are lower than **0.3 °C**.
- **SST fluctuations** due to **internal** tides motions are lower than **0.1 °C**.

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- Such **signatures** appear to be **weak** compared to **SST variations over short** (tidal) **temporal windows** associated to: mesoscale/submesoscale; diurnal cycles.

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- Such **signatures** appear to be **weak** compared to **SST variations over short** (tidal) **temporal windows** associated to: mesoscale/submesoscale; diurnal cycles.
- These **amplitudes** may be **compared** to the **absolute accuracy** of **SST products** ($\simeq$0.3 K) for the M2 barotropic and lower for M2 internal tides [Ocarroll et al. 2012, Wu et al. 2017] and to the **instrument pix noise** (presumably weaker than the former).

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