Internal tides off the Amazon shelf : importance for the structuring of ocean temperature (during two contrasted seasons)

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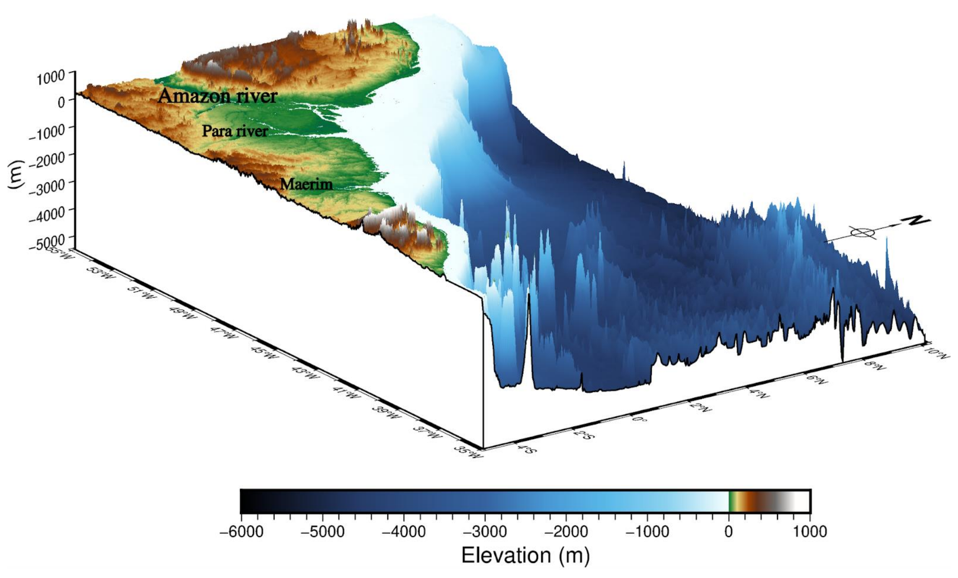
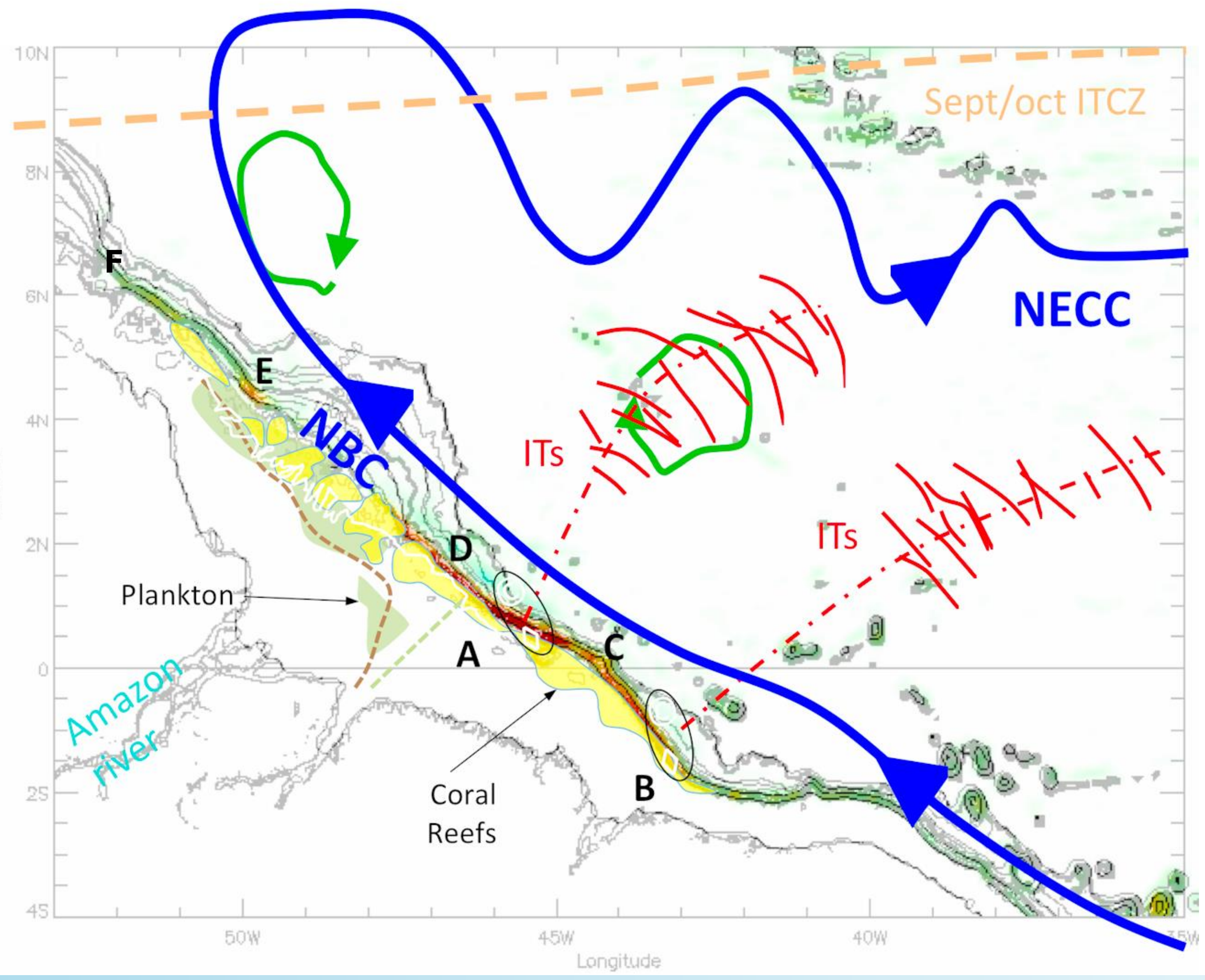
F. Assene [1*], A. Koch-Larrouy [2], I. Dadou [3], M. Tchilibou [4], G. Morvan [5], J. Chanut [6], A. C. da Silva [7], V. Vantrepotte [8], D. Allain [9], T-K Tran [10]

General context of Amazon Offshore Region (AOR)



Contrasting seasonal variation:
- ➔ First season : apr-mai-june (AMJ) ; Second season : aug-sep-oct (ASO)
- ➔ Strong current along the coast : NBC (North Brazilian Current) ; and eddy activity
- ➔ The vertical gradient of the stratification
- ➔ The highest freshwater river input 3x10^5 m^3.s^{-1}
- ➔ Six known Internal Tidal Waves (IT) generation sites (A to F), two are more intensive (A & B)



Scientific question

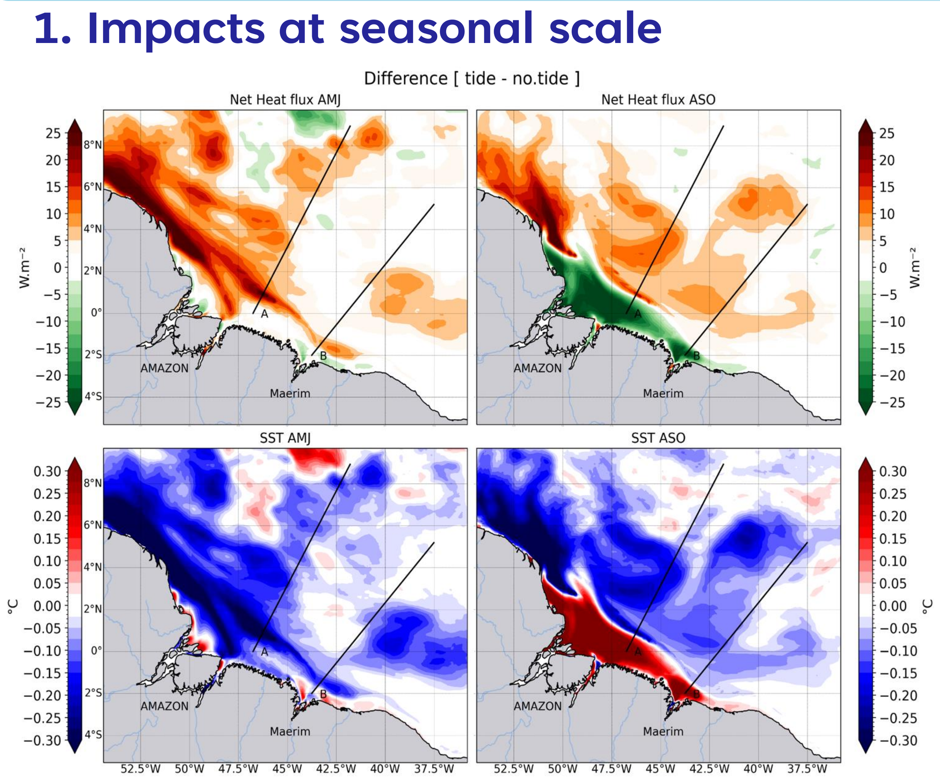
How can internal tidal waves (IT) impact the ocean's temperature from the surface to deeper layers ?
What are the processes and time scale involved ?

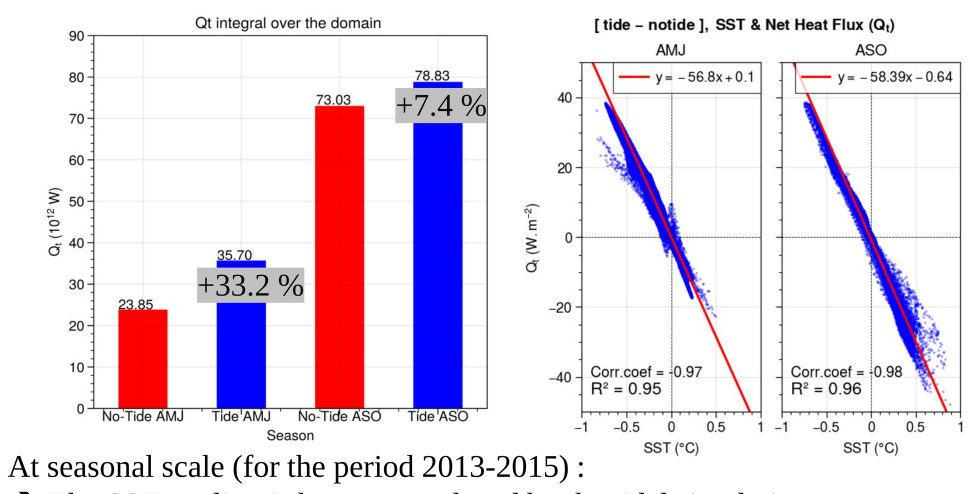
Datasets

- 10 years daily Sea Surface Temperature (SST) :
  - ➔ TMI SST : ¼° , MicroWaves (MW)
  - ➔ MUR SST : 1/100° , Merged InfraRed+MW
- 10 years daily and 1 year hourly model Temperature :
  - ➔ « AMAZON36 » configuration 1/36°
  - ➔ twin (tide & no-tide) simulations

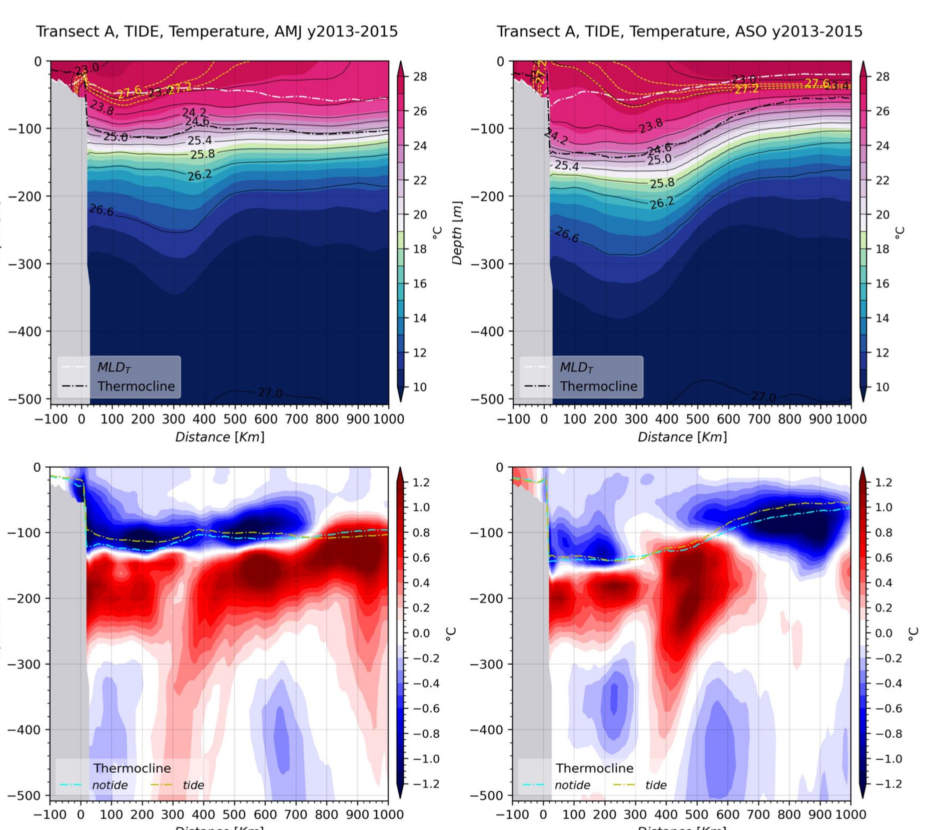
Result : impact on ocean's temperature

1. Impacts at seasonal scale



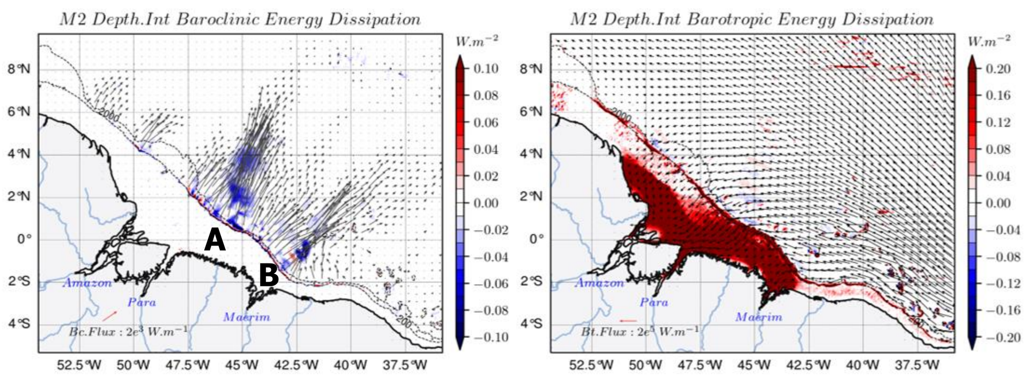


At seasonal scale (for the period 2013-2015) :
- ➔ The SST cooling is better reproduced by the tidal simulation
- ➔ IT and tides induce a SST cooling of about +0.3 ^{0}C highlighted by the SST difference between tide and no-tide simulation
- ➔ and an increase of the neat heat flux (Qt) at the same location of up to +33 %



Along the vertical :
- ➔ A cooling of about +1 ^{0}C above the thermocline and a warming of bout -1 ^{0}C below

2. Processes involved

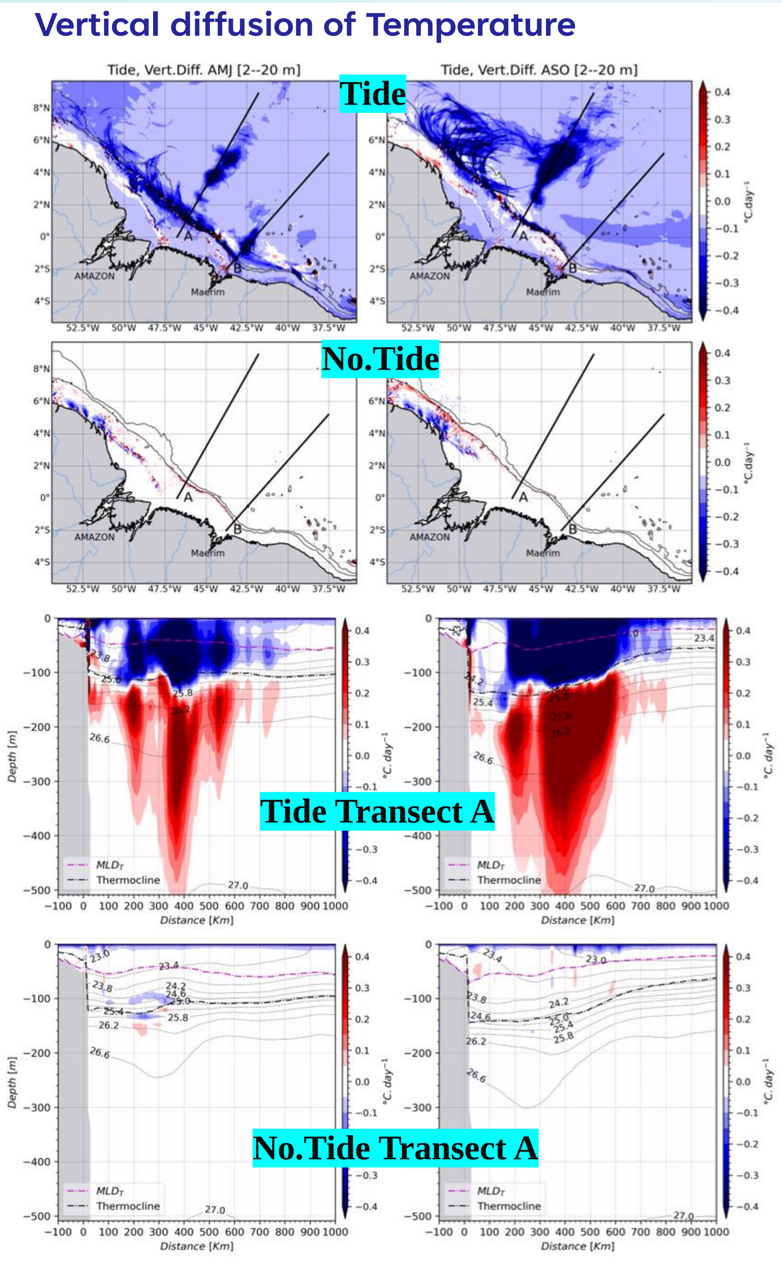


- ➔ IT (baroclinic) energy is dissipated by mixing on the slope and along A and B propagation pathways
- ➔ Whilst, barotropic energy dissipation occurs all over the shallow shelf

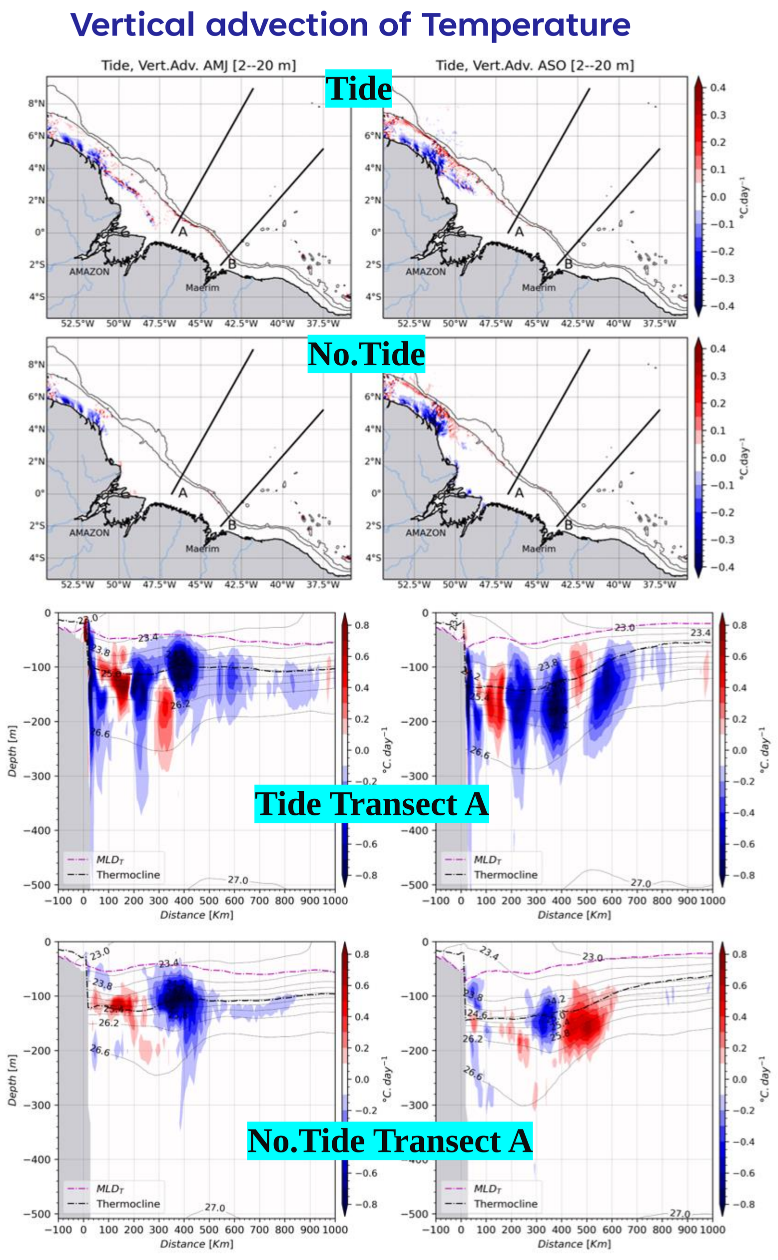
- ➔ Vertical diffusion (mixing) linked with IT induce a cooling of about +0.4 ^{0}C/day at the surface and stronger cooling (up to +0.6 ^{0}C/day) above the thermocline, and warming (up to -0.4 ^{0}C/day) uder the thermocline

- ➔ Vertical advection of temperature only acts deeper close to the thermocline depth, with a cooling of (up to +0.8 ^{0}C/day) with mode.1-like (100-120 km) structure

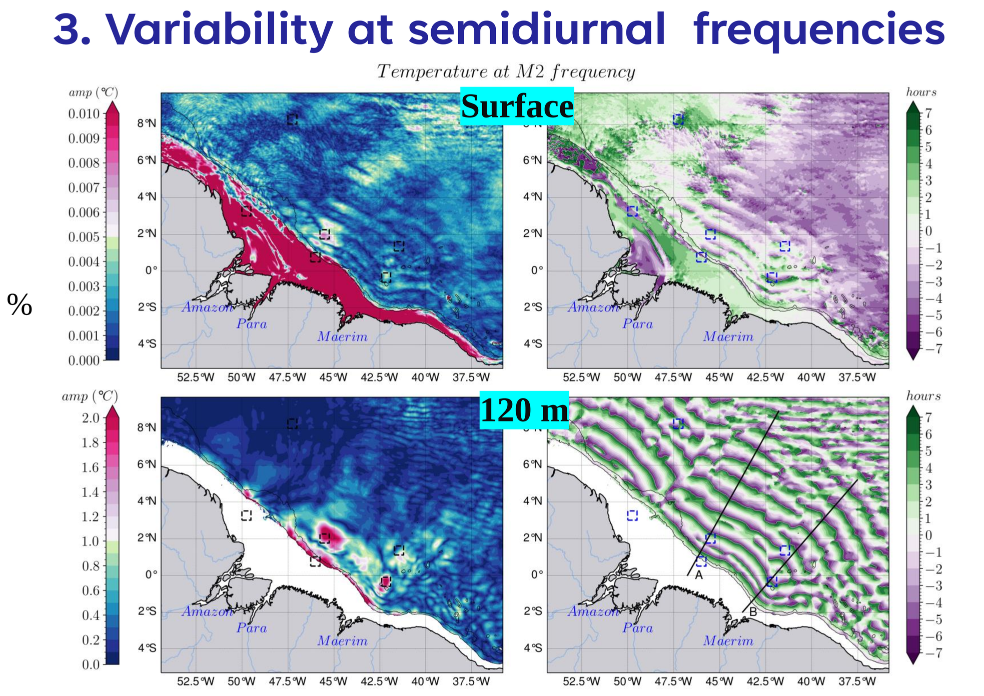
Vertical diffusion of Temperature



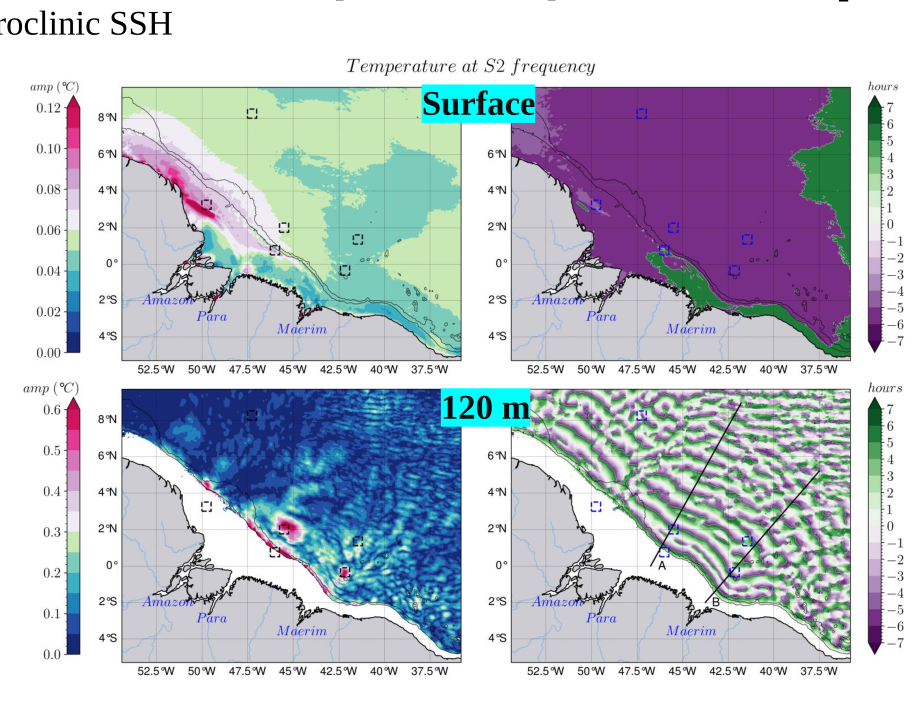
Vertical advection of Temperature



3. Variability at semidiurnal frequencies



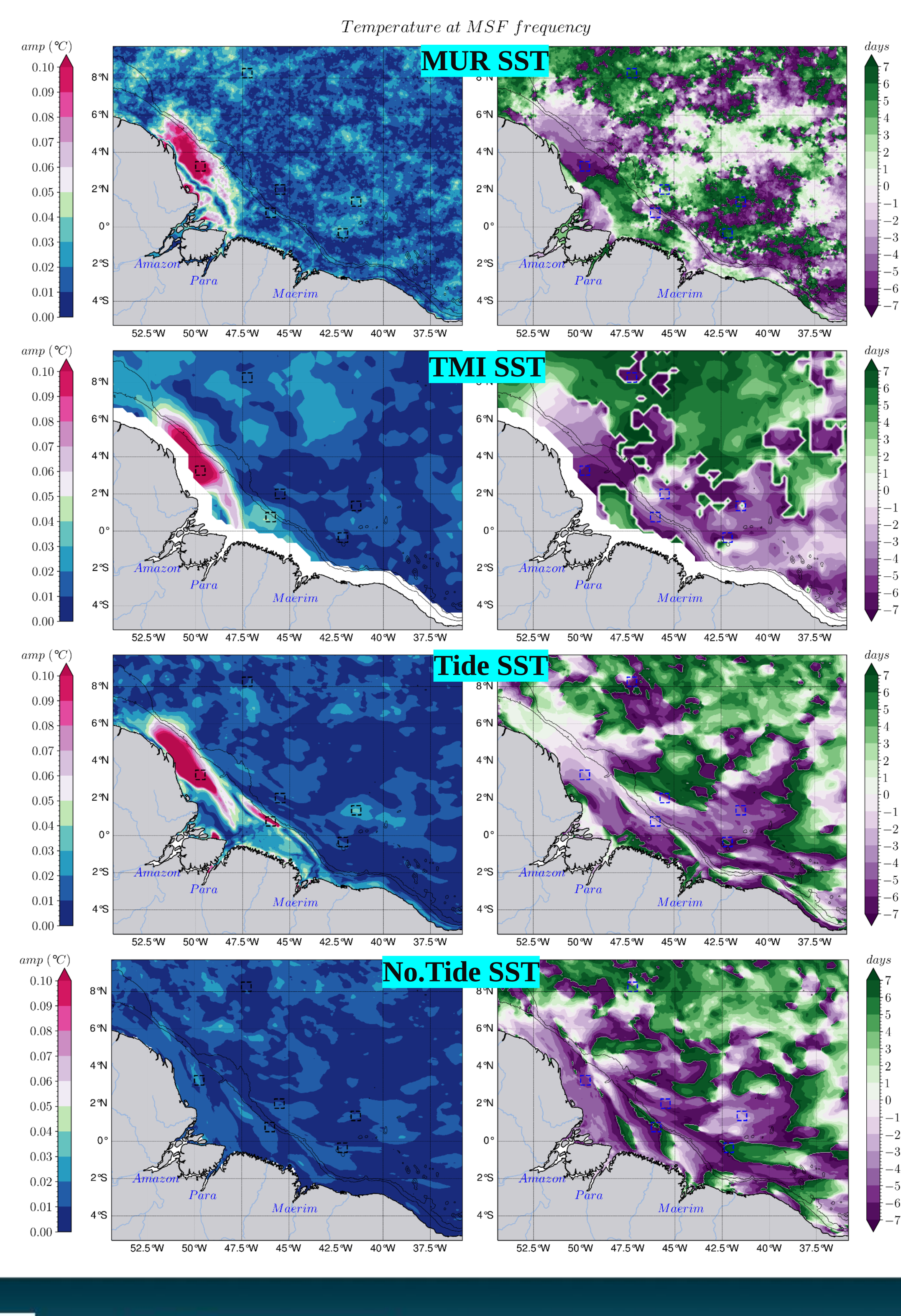
- ➔ Barotropic tides induce weak fluctuations (~ 10^{-2} ^{0}C) at the surface all over the shelf
- ➔ IT induce stronger fluctuations (> 2 ^{0}C) deeper, maximum close to the thermocline depth, with same pattern as surface M$_2$ baroclinic SSH



- ➔ Weak fluctuation (~ 0.12 ^{0}C) at the surface in the northern part of the shelf linked with solar variation
- ➔ IT induce stronger fluctuations (> 0.6 ^{0}C) deeper, maximum close to the thermocline depth, with same pattern as surface S$_2$ baroclinic SSH

4. Variability at Spring-Neap frequency

- ➔ At the surface, weak fluctation (~ 0.1 ^{0}C) in the northern part of the shelf for both observations (TMI and MUR) and tidal simulation, seems to be linked with S2 fluctuations.
- ➔ Null amplitude for non tidal fluctuation
- ➔ We also found that deeper, the amplitude is weak (<0.1 ^{0}C) , and there is no evident difference between tidal and non tidal simulations
- ➔ For deeper layers, other processes such as ITW, Coastal Kelvin Waves or Circulation may induce Spring-Neap fluctuation



Conclusion

- Tides induce cooling (warming) above (below) the thermocline
- The processes involved are vertical mixing and vertical advection
- Temperature implies seasonal and tidal scale

References

Moura et al., 2016 ; Magalhaes et al. 2016, Buijsman et al., 2016 ; Lentini et al., 2016 ; Assene et al., 2023 ;

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The preprint is accessible at : https://egusphere.copernicus.org/preprints/2023/egusphere-2023-418/