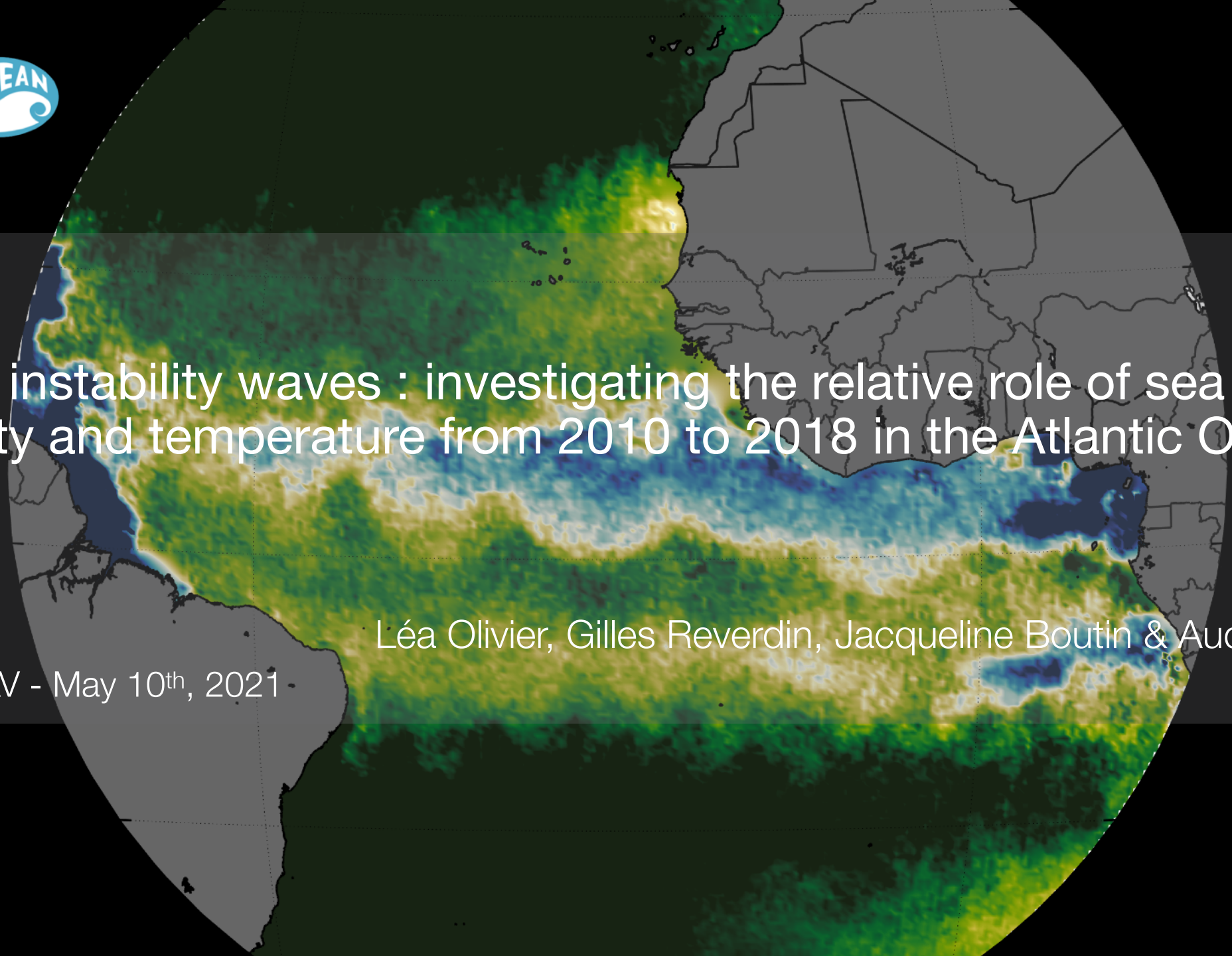


Tropical instability waves : investigating the relative role of sea surface salinity and temperature from 2010 to 2018 in the Atlantic Ocean

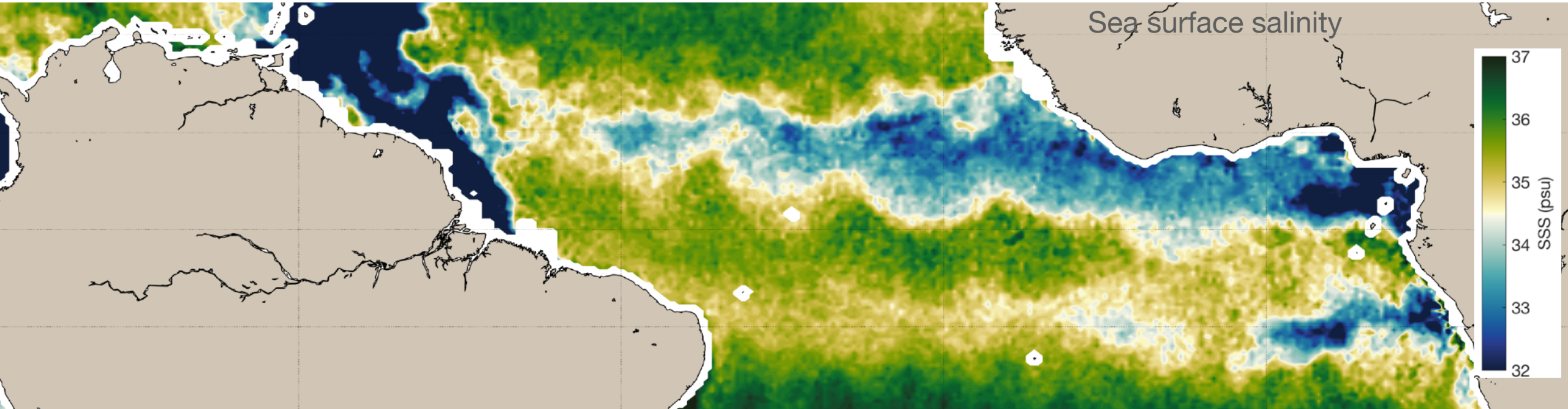
Léa Olivier, Gilles Reverdin, Jacqueline Boutin & Audrey Hasson

PIRATA-24/TAV - May 10th, 2021

Tropical Instability waves - formation and properties

Period of 20-30 days (eg. Legeckis and Reverdin, 1987)

~1000 km spatial scale

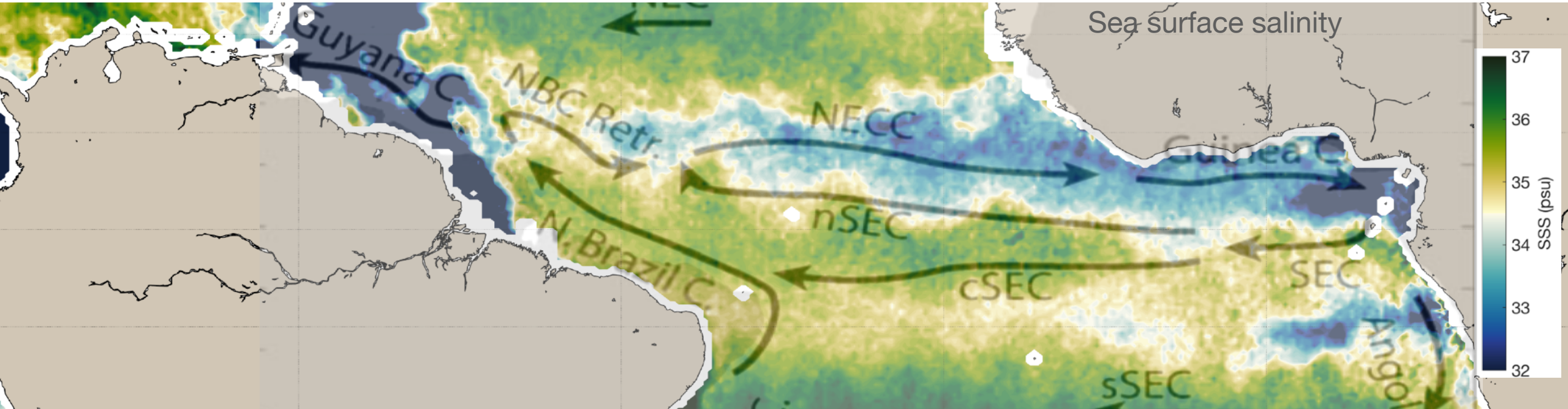


Tropical Instability waves - formation and properties

Period of 20-30 days (eg. Legeckis and Reverdin, 1987)

~1000 km spatial scale

Formed by barotropic and baroclinic instabilities in the region of the equatorial shear (Philander 1976,1978; Cox 1980, Jochum 2004, Von Suckmann 2008)

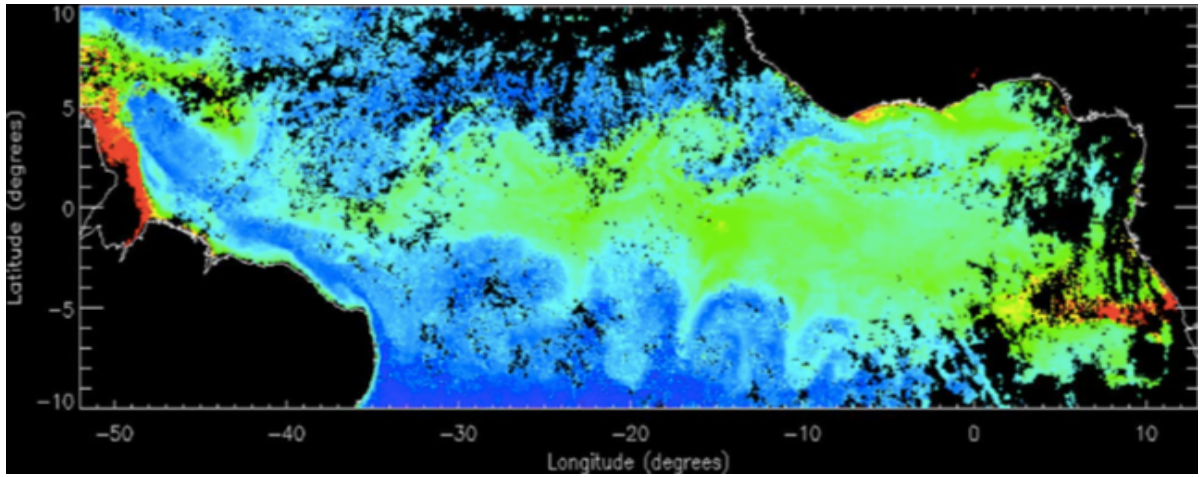


Tropical Instability waves - role

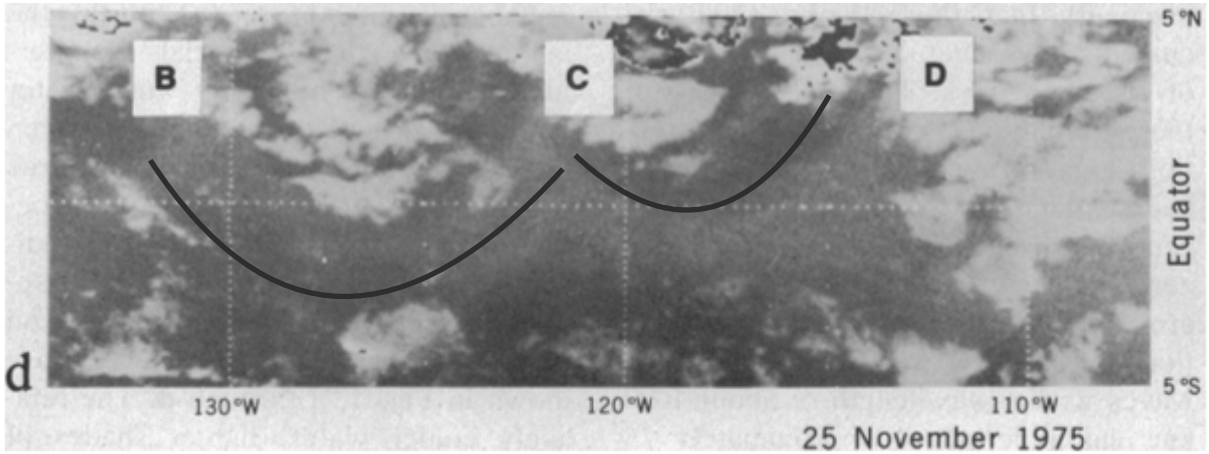
Important role on atmosphere-ocean exchanges (eg. Chelton et al., 2001, Jochum et al., 2004-2006)

Affect the nutrient distribution and ecosystems (Menkes et al., 2002)

Possibly enhanced in future climate (Seo & Xie, 2011)



Sea water colour (Jochum et al.,2004)



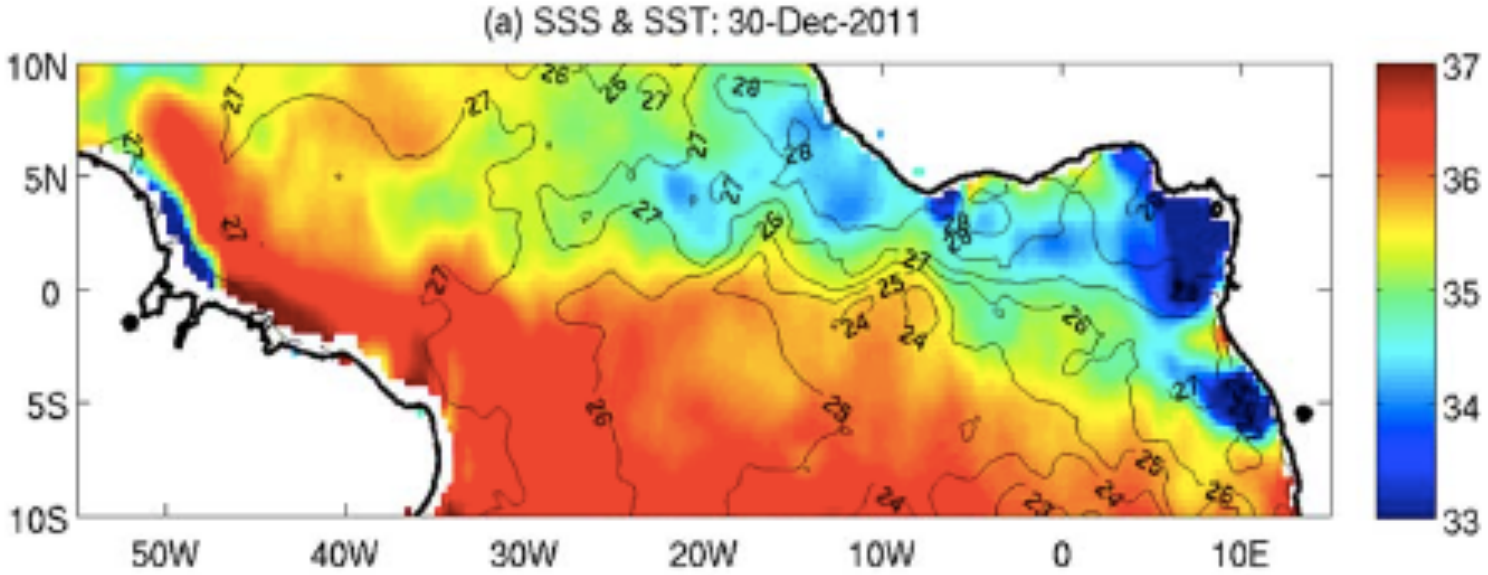
SST (Legeckis, 1977)

Tropical Instability waves – salinity

Less documented in salinity (than SST and currents)

Importance of salinity on TIWs (Grodsky et al., 2005, Lee et al., 2014)

Observed recently by satellite salinity (Lee et at al., 2012, Yin et al., 2014)



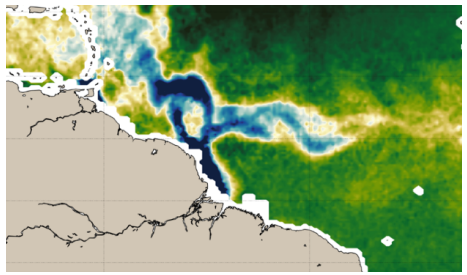
Lee et al., 2014

How does salinity influence tropical instability waves ?

How does the horizontal density gradient contribute to TIW’s energetics ?

Data

SSS

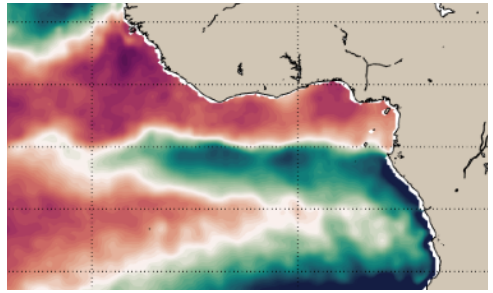


SSS CCI

~50 km

Combined SMOS, Aquarius, SMAP

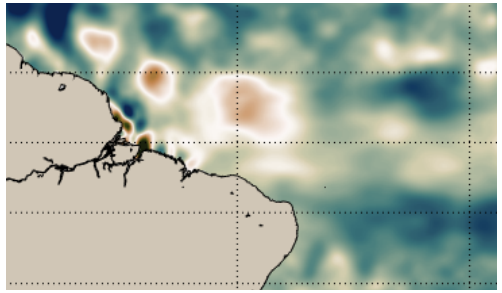
SST



SST OSTIA

~5 km

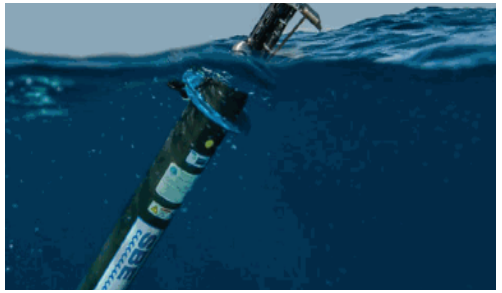
SLA



SLA AVISO

~25 km

ARGO floats



0-3°N

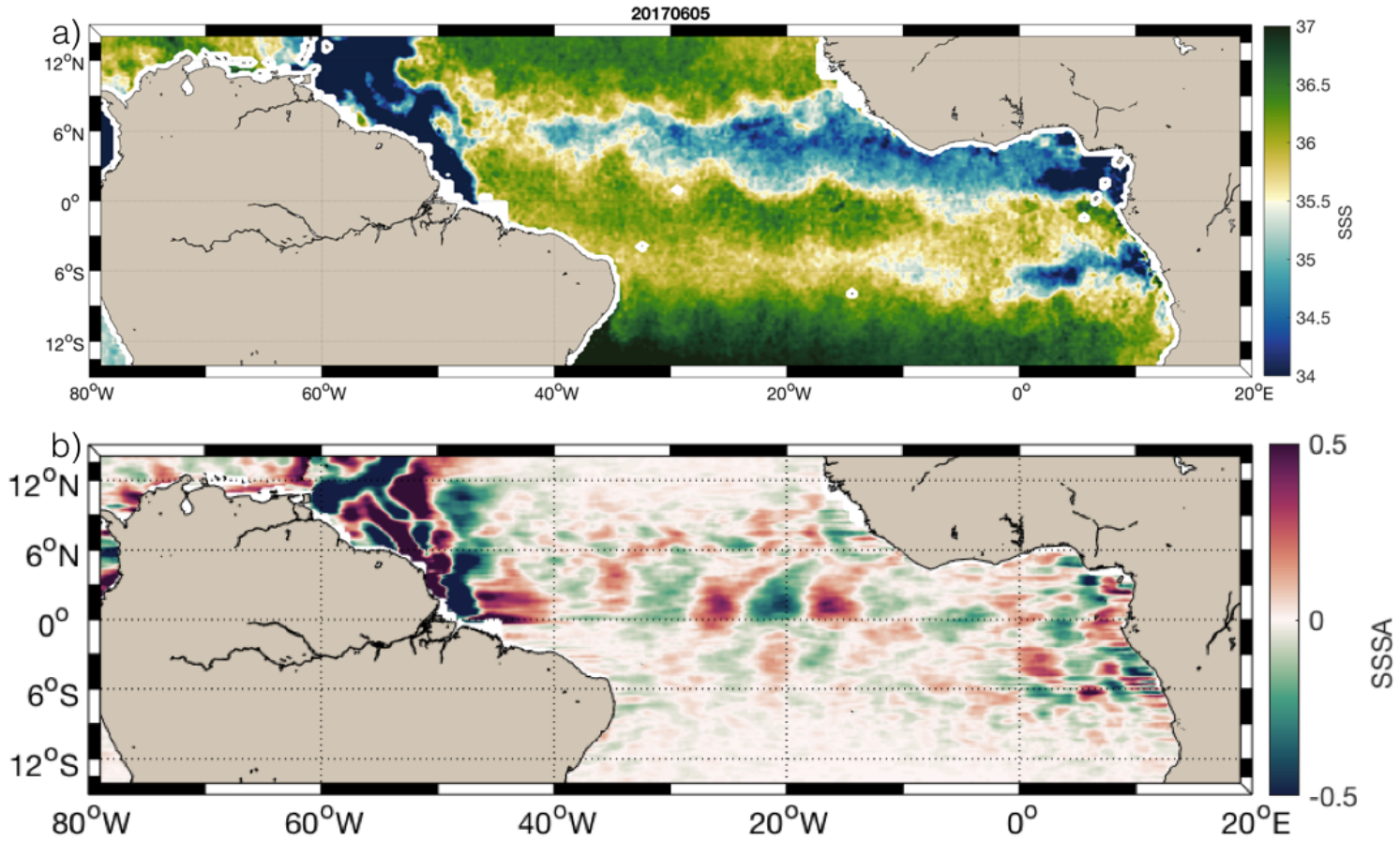
10°W-20°W

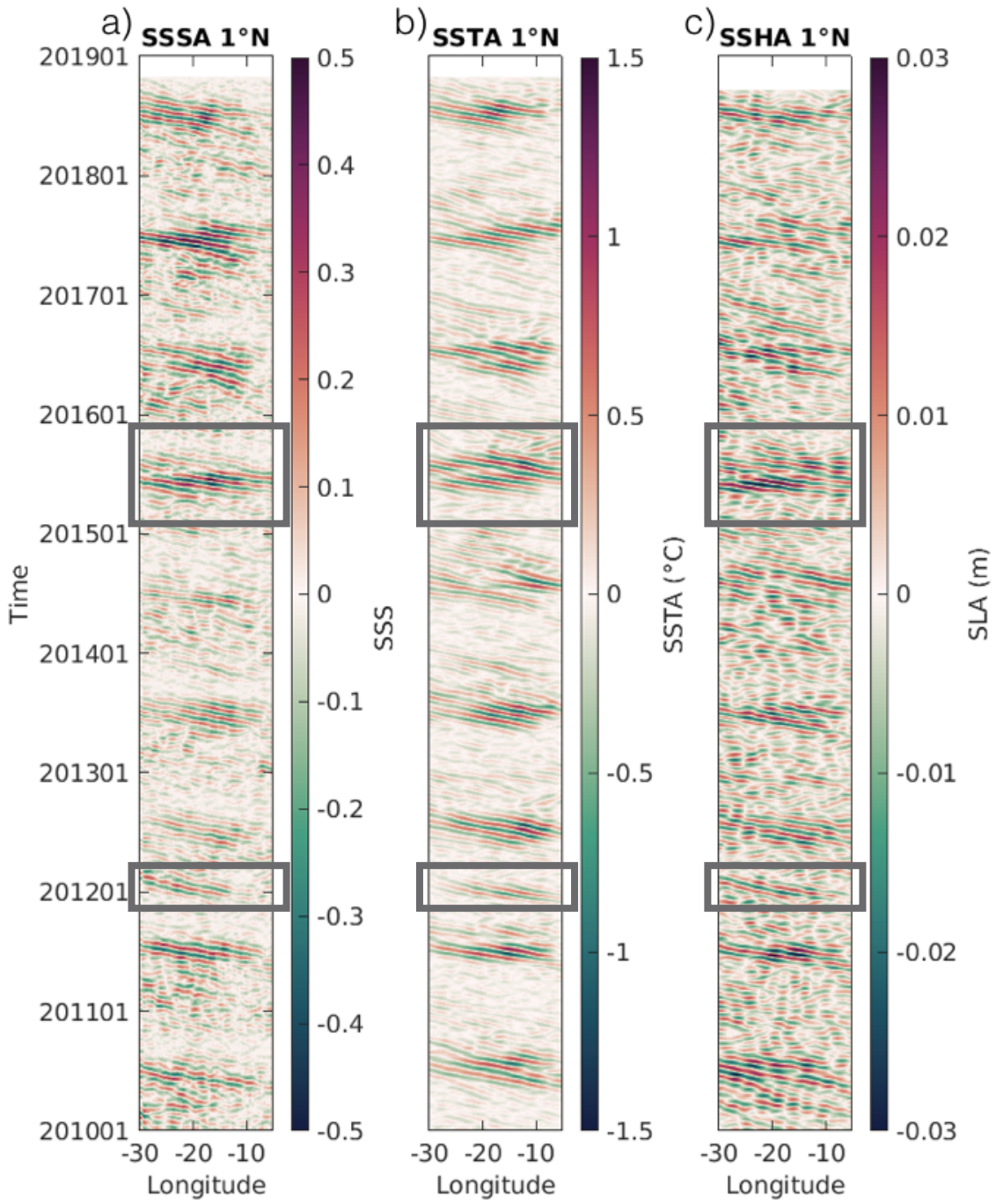
Methods - Filtering

Filtering :

20-50 band pass filter

20° high pass filter





From mid-spring to mid-autumn every year

Winter TIWs in early 2012

Mean westward phase speed of 0.4m/s

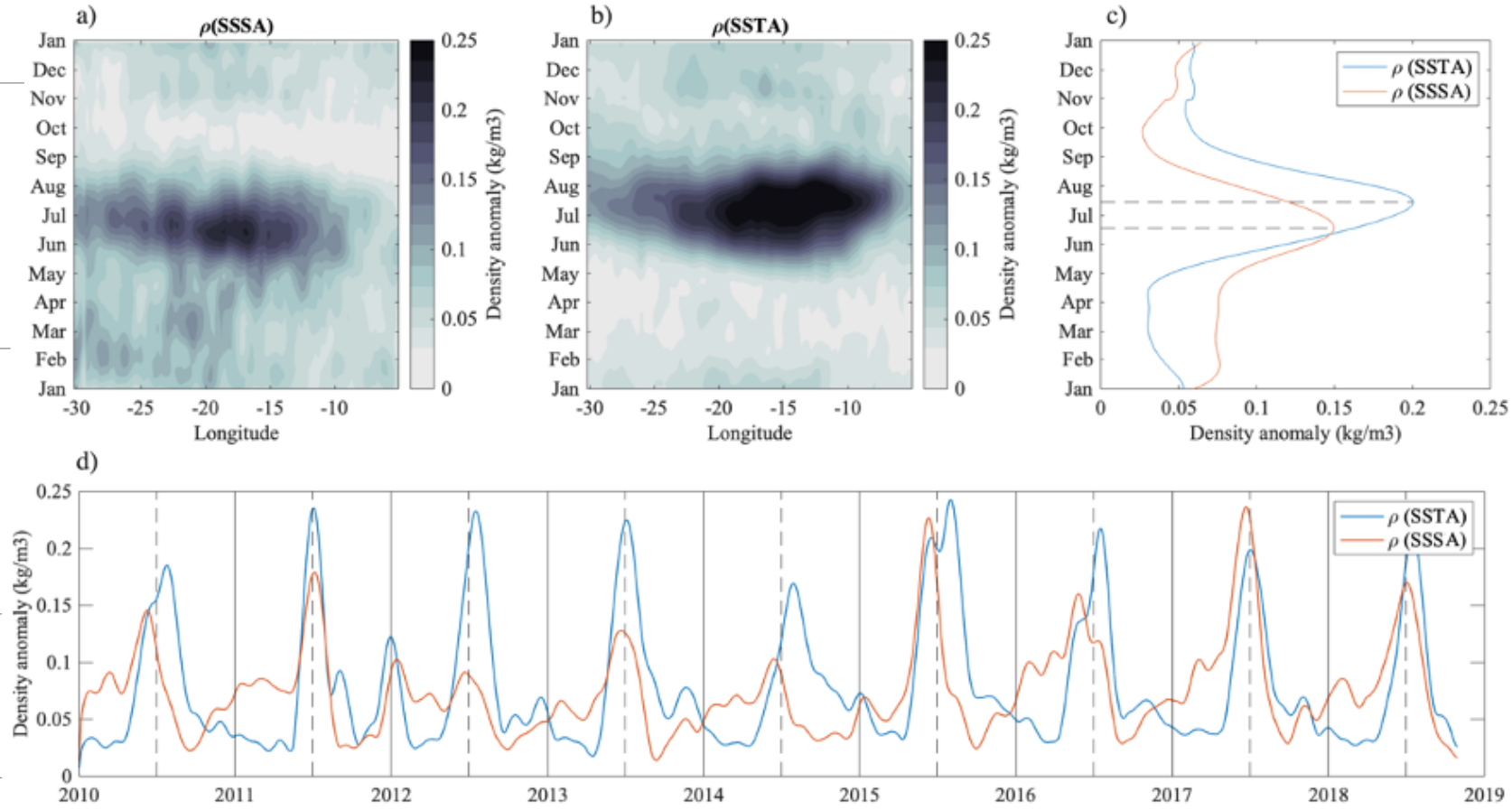
Seasonality - contribution to the density

Comparable order of magnitude

S dominates the density signal until June, 11th

T lags S by 26 days

Strong interannual variability



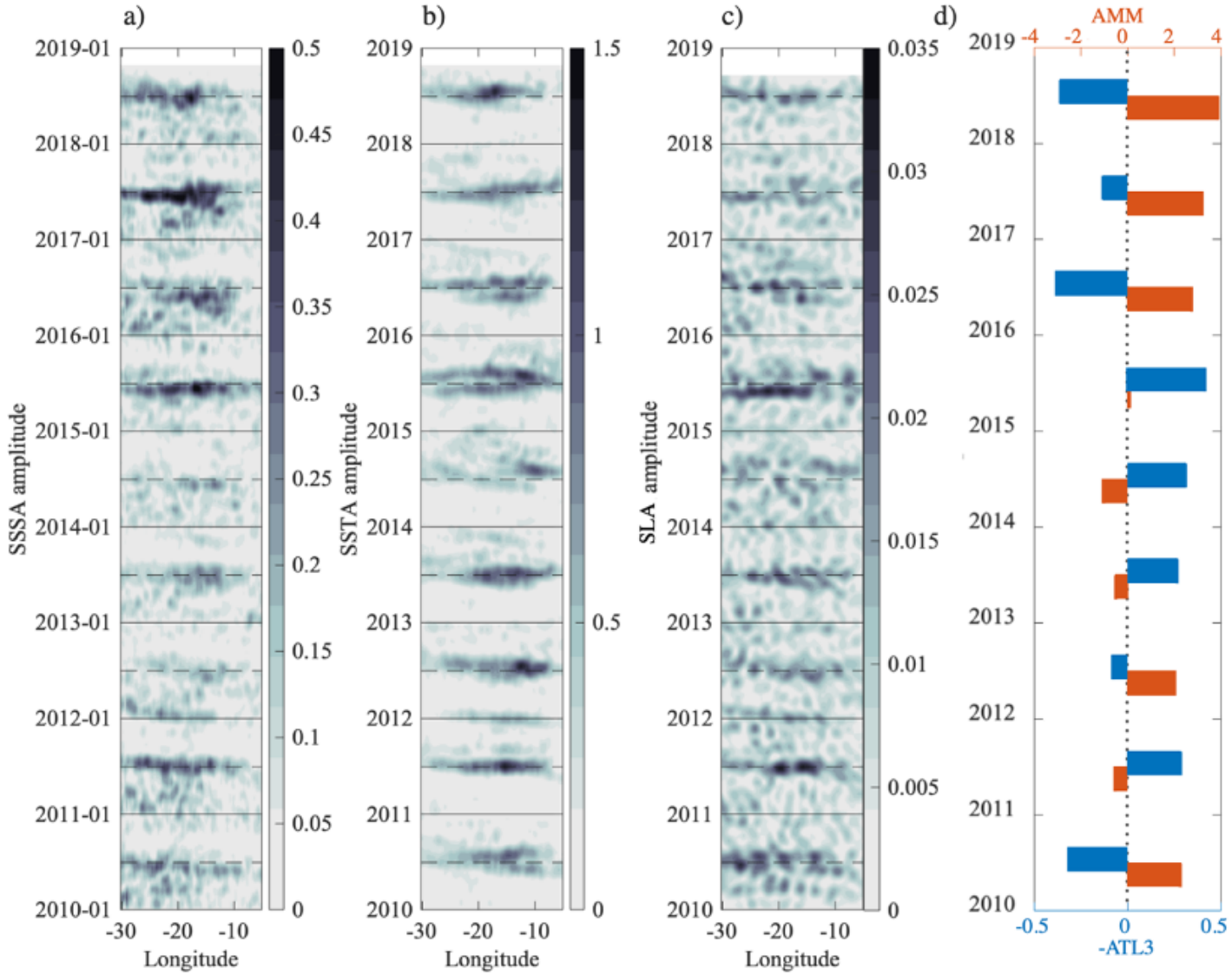
Interannual variability

Different variability in SSS and SST

SST better correlated with SLA than SSS

No evident link with AMM and ATL3 indexes

Link between AMM phases and SSS variability



TIW energetics - PPE

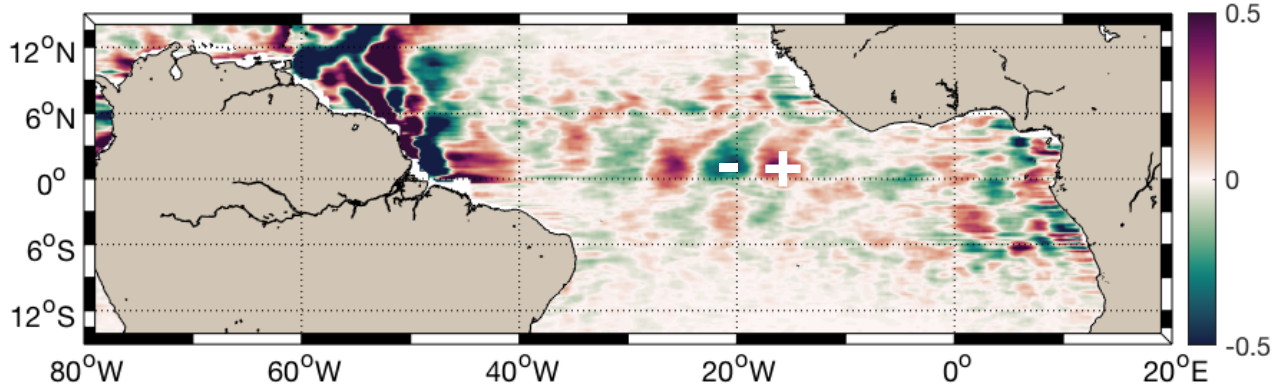
Perturbation Potential Energy - computed from argo profiles

$$PPE = \int_{-60}^{0} \rho' g z dz \qquad \rho' = \rho_+ - \rho_-$$

$$\rho' = \rho_0 \cdot \beta \cdot S' - \rho_0 \cdot \alpha \cdot T'$$

$$S' = S_+ - S_- \qquad T' = T_+ - T_-$$

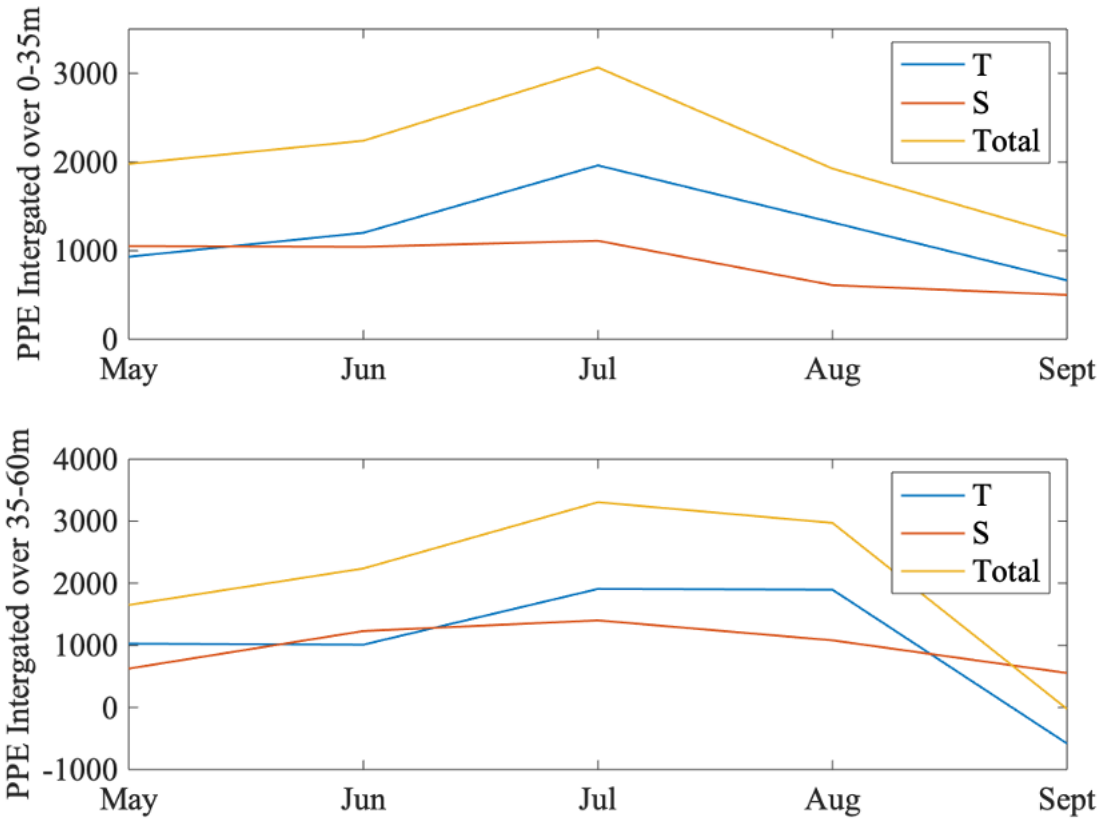
$$PPE_S = \int_{-60}^{0} \rho_0 \beta S' \qquad PPE_T = -\int_{-60}^{0} \rho_0 \alpha T'$$



May to September Argo profiles

Colocated with a + or - TIW-generated density anomaly

TIW energetics - PPE



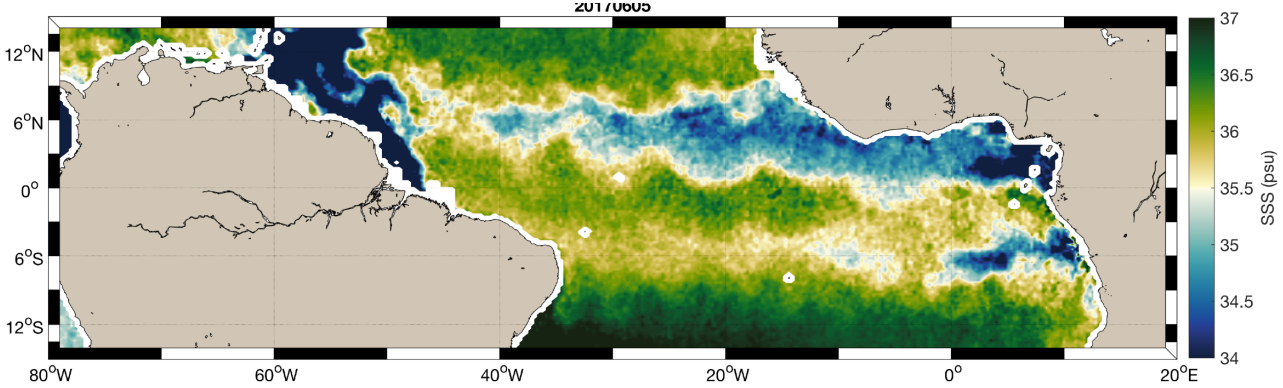
May- June equal contribution of S & T
In top and bottom layer

July - peak of PPE, due to strong contribution of T

July - September PPE dominated by T, but salinity still contributes contributes to 30-45% of PPE

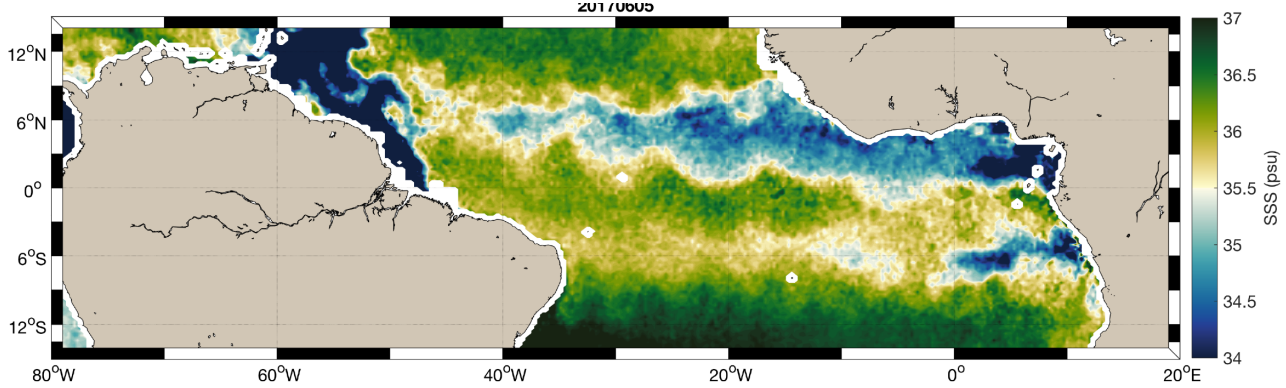
DISCUSSION -

Why is there a lag between the contributions of S and T ?

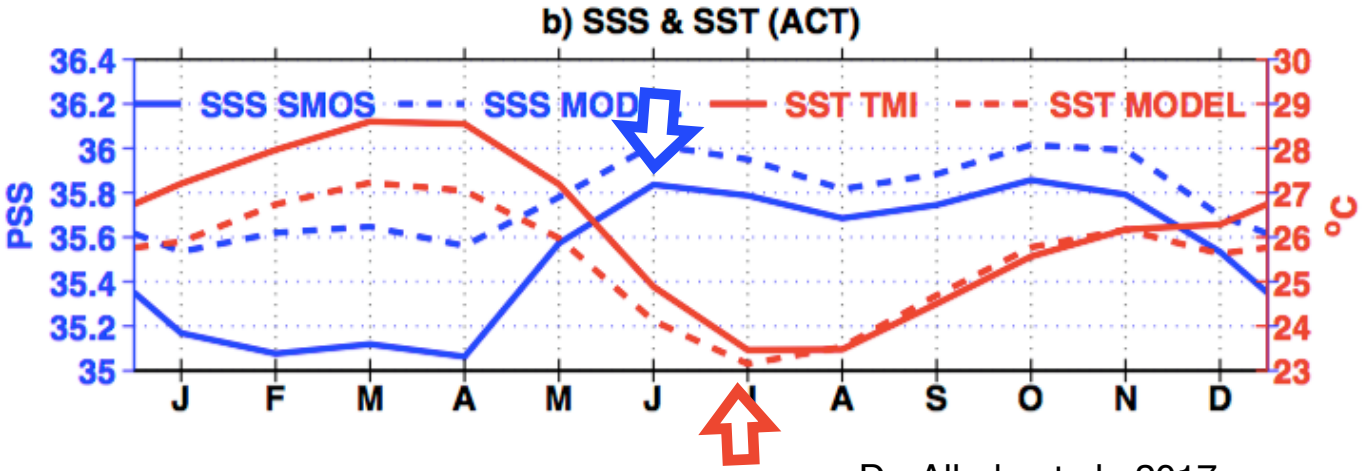


Strong SSS signal due to precipitation distribution in Spring weaken in summer (more wind and vertical mixing)

DISCUSSION -
Why is there a lag between the contributions of S and T ?



Strong SSS signal due to precipitation distribution in Spring weaken in summer (more wind and vertical mixing)



Shallowing of the EUC salinity core in June

Weakening/erosion of the EUC in June-July

Da-Allada et al., 2017

CONCLUSIONS

1 month lag between SSS and SST :

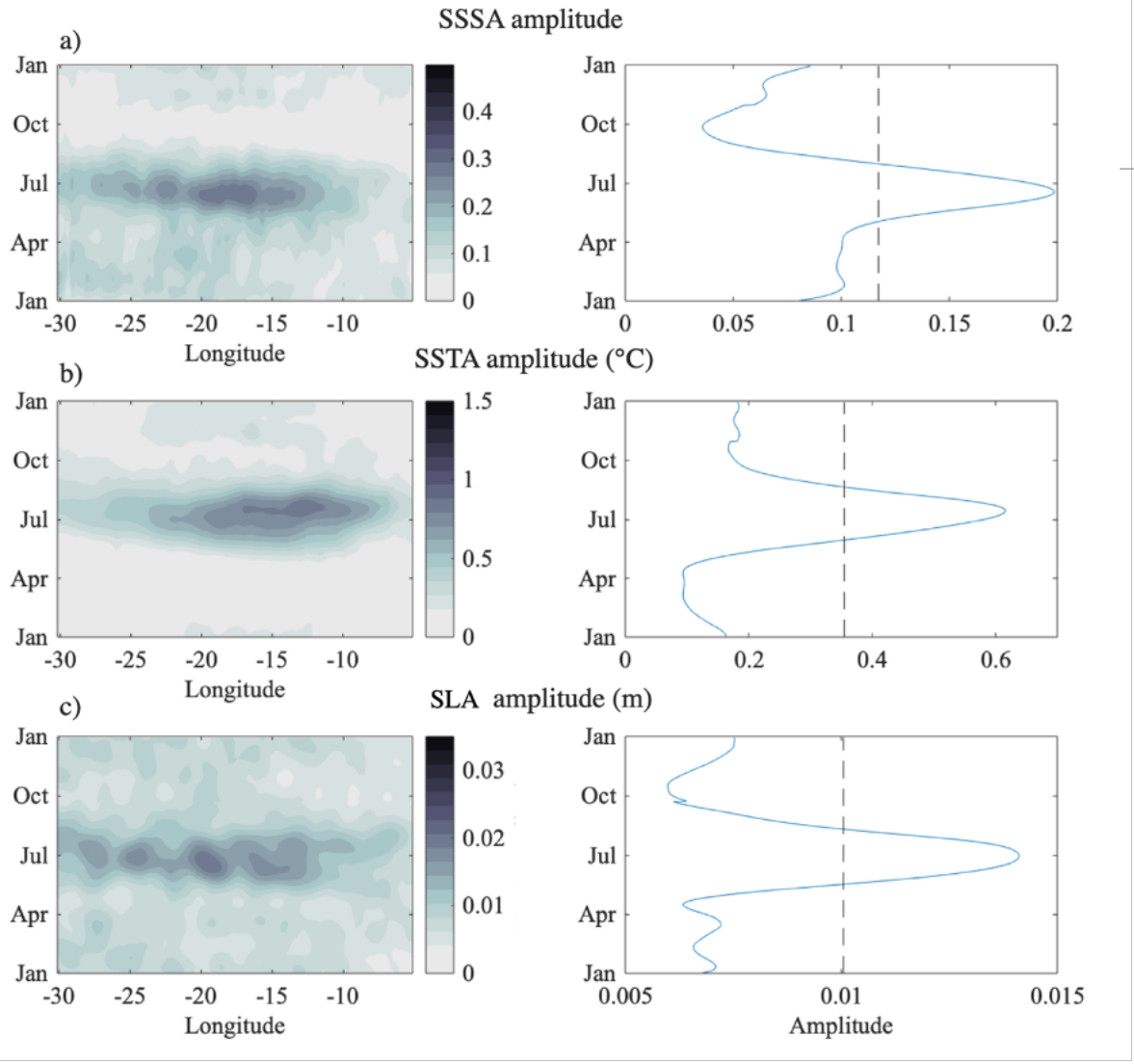
- due to the erosion of the EUC and precipitation signal
- impacts the seasonality of gradients and energetics of the TIWs

Energetics of TIWs :

- In the top 60m, salinity and temperature each contribute to ~50% of the TIW's PPE

Olivier, L., Reverdin, G., Hasson, A., & Boutin, J. (2020). Tropical Instability Waves in the Atlantic Ocean: investigating the relative role of sea surface salinity and temperature from 2010 to 2018. *Journal of Geophysical Research: Oceans*, *125*(12), **e2020JC016641**.

Seasonal variability



May 5th - August 1st

~27 days

June 1st - August 21st

May 19th - August 11th

TIW energetics - PPE

Perturbation Potential Energy - computed from argo profiles

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$$\rho' = \rho_0 \cdot \beta \cdot S' - \rho_0 \cdot \alpha \cdot T'$$

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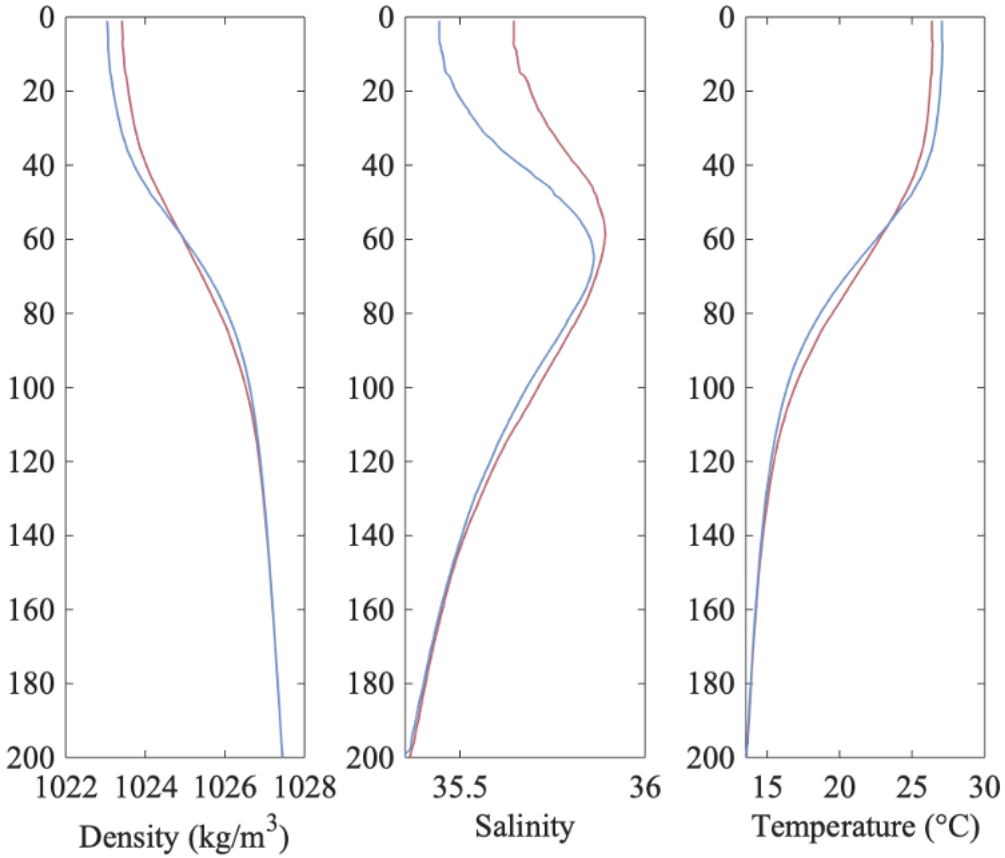
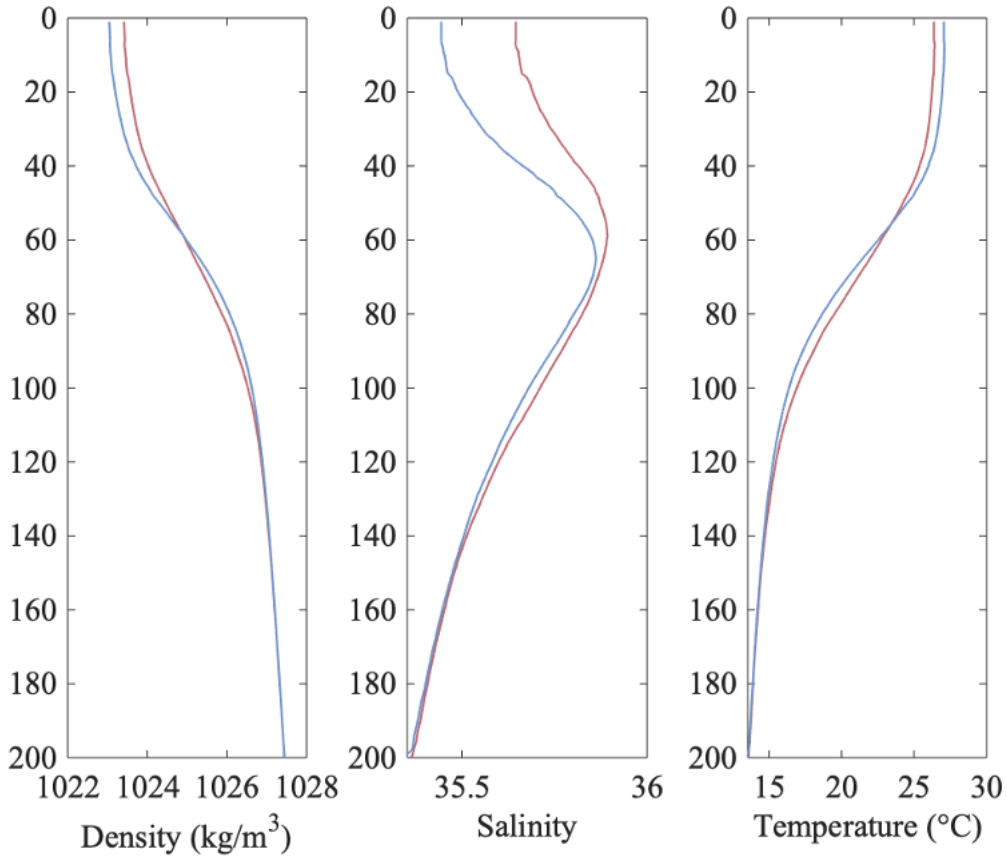


TIW energetics - PPE



Salinity signal mainly present in the top 35 m

Signal too uncertain to interpret below 60 m (EUC core depth)

PPE computed for 2 layers : 0-35m, 36-60m