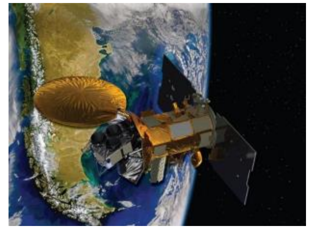

Salinity's role in tropical Atlantic instability waves – a unique vantage point from Aquarius/SAC-D

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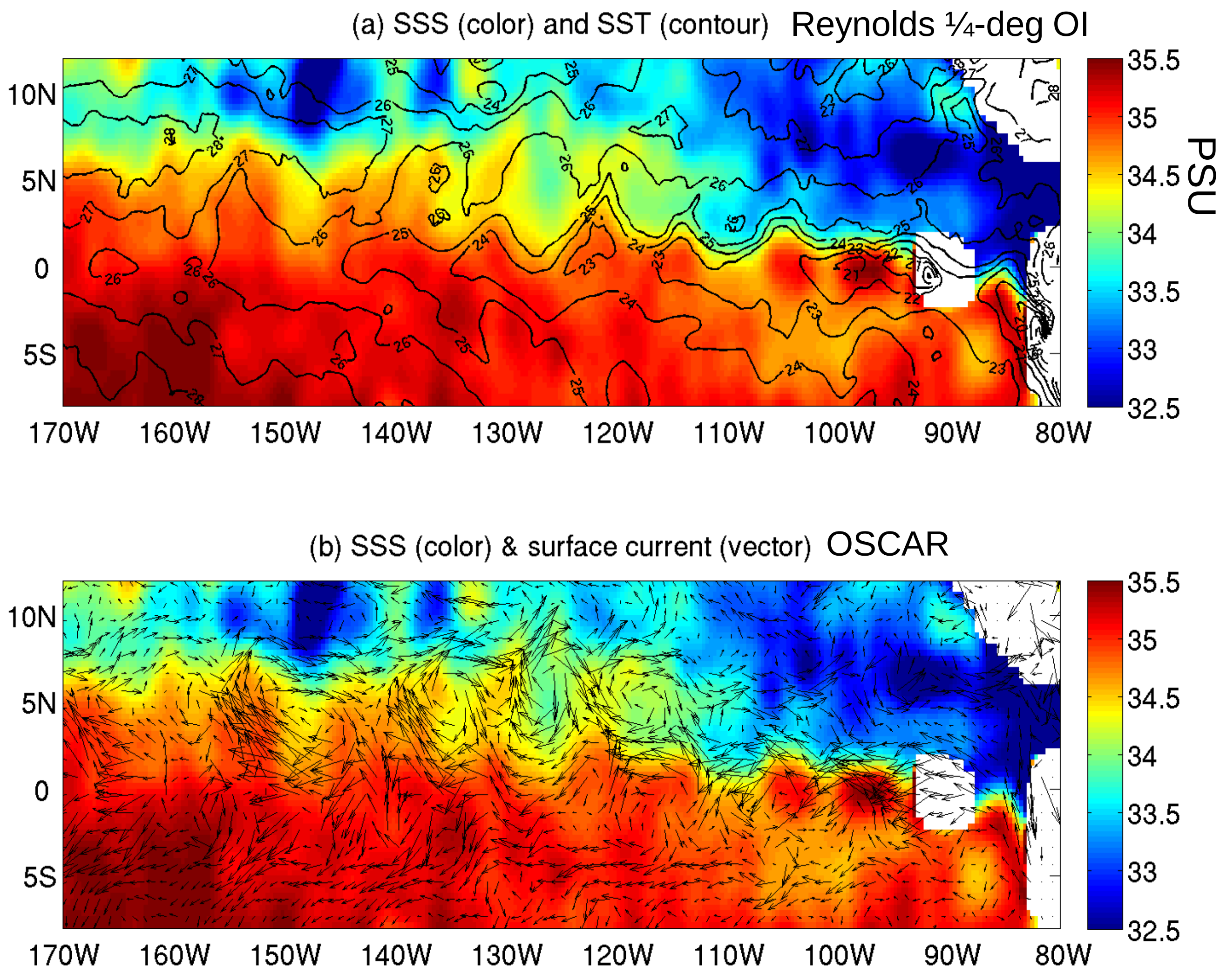
Aquarius brings new understanding to Pacific TIWs

AQUARIUS/SAC-D

SSS from Aquarius (color shading), SST (contours in a), surface currents (arrows in b) on Dec. 11, 2011 (7-day maps)

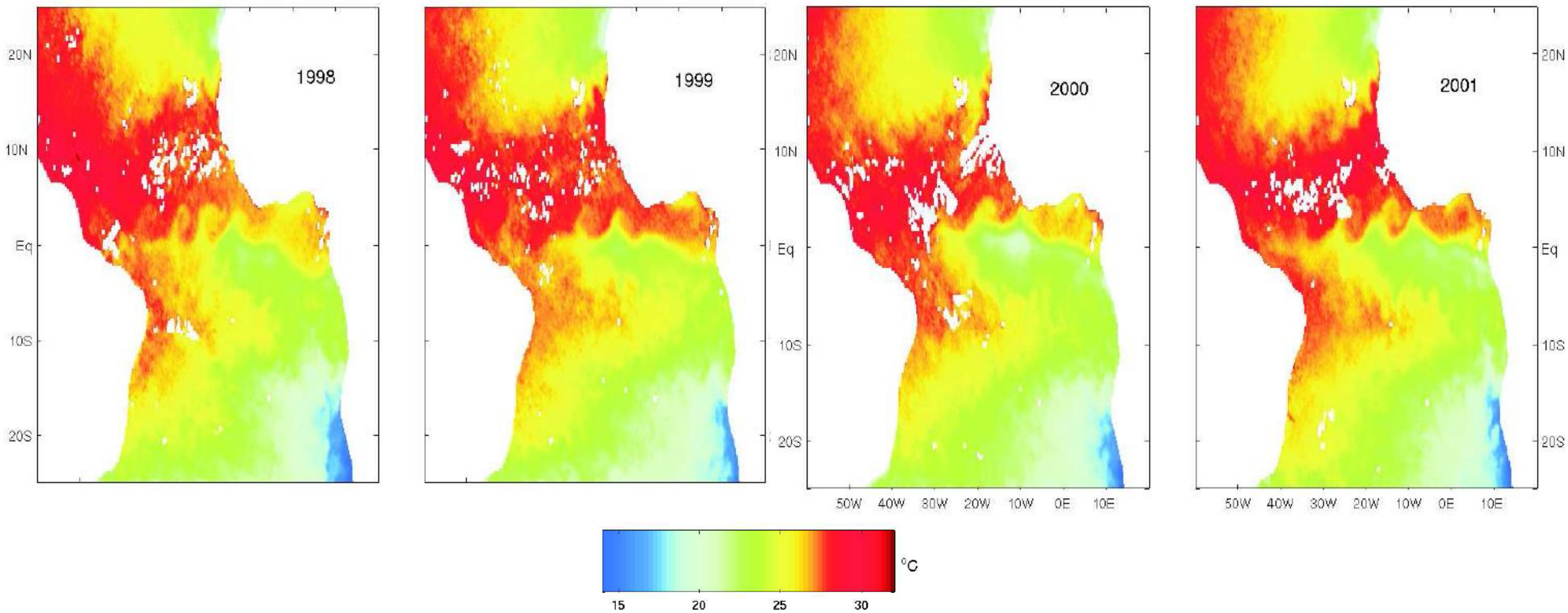
- TIWs affect ocean, climate, biogeochemistry
- Aquarius reveals TIWs salinity structure for the 1st time from space).
- New finding: c=1 m/s near equator (0.5 m/s off equator).
- 17-day (33-day) TIWs dominate near (away) from equator.
- Implications to energy transfer & mixing

Lee, Lagerloef, Gierach, Yueh, Dohan (2012)



Tropical Atlantic TIWs: what was known based on SST

Observations of Tropical Atlantic TIWs using TMI SST (Caltabiano et al. 2005): TIWs **strongest in the eastern-central part (10-20W), very weak in the west**.



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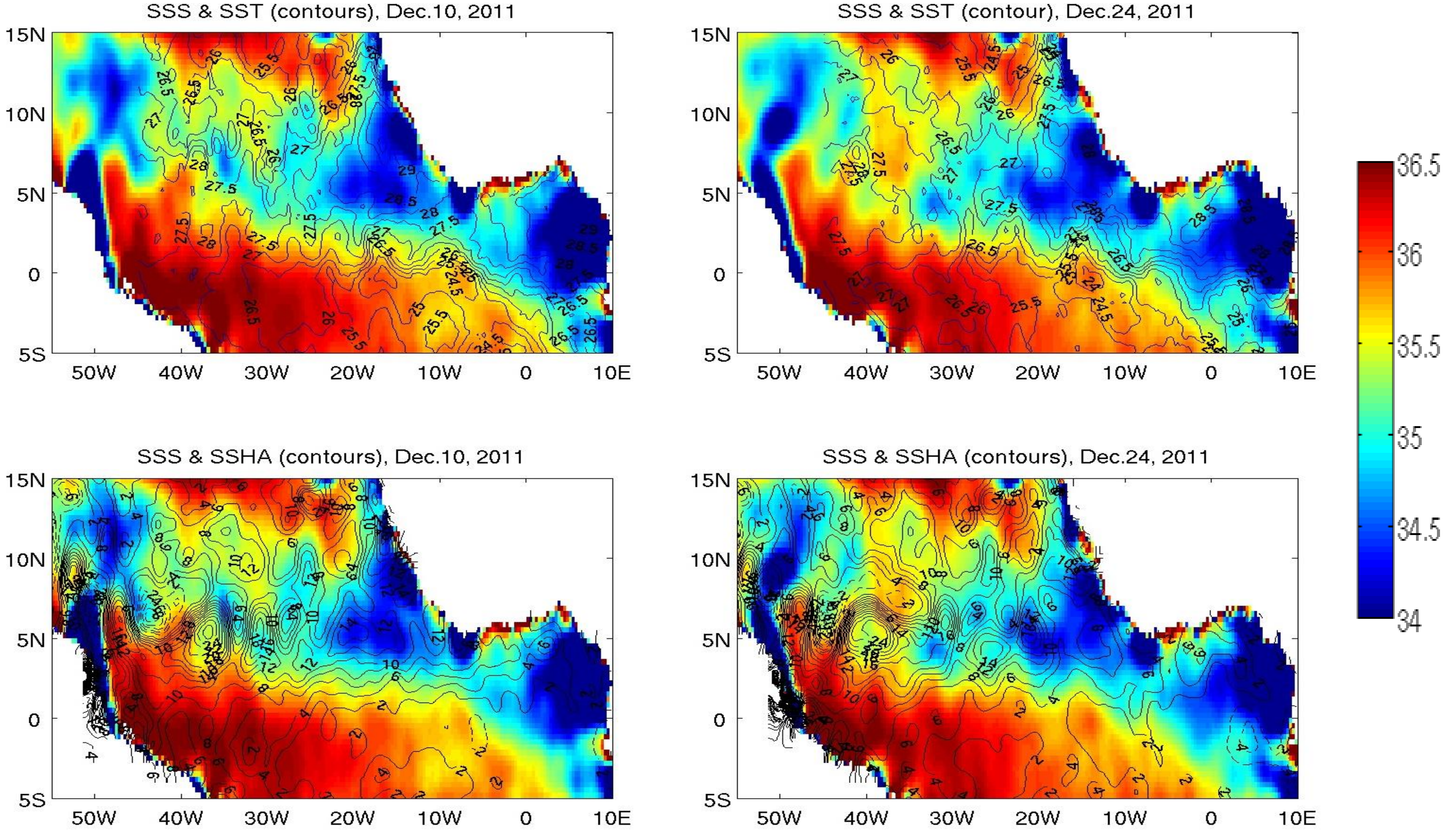
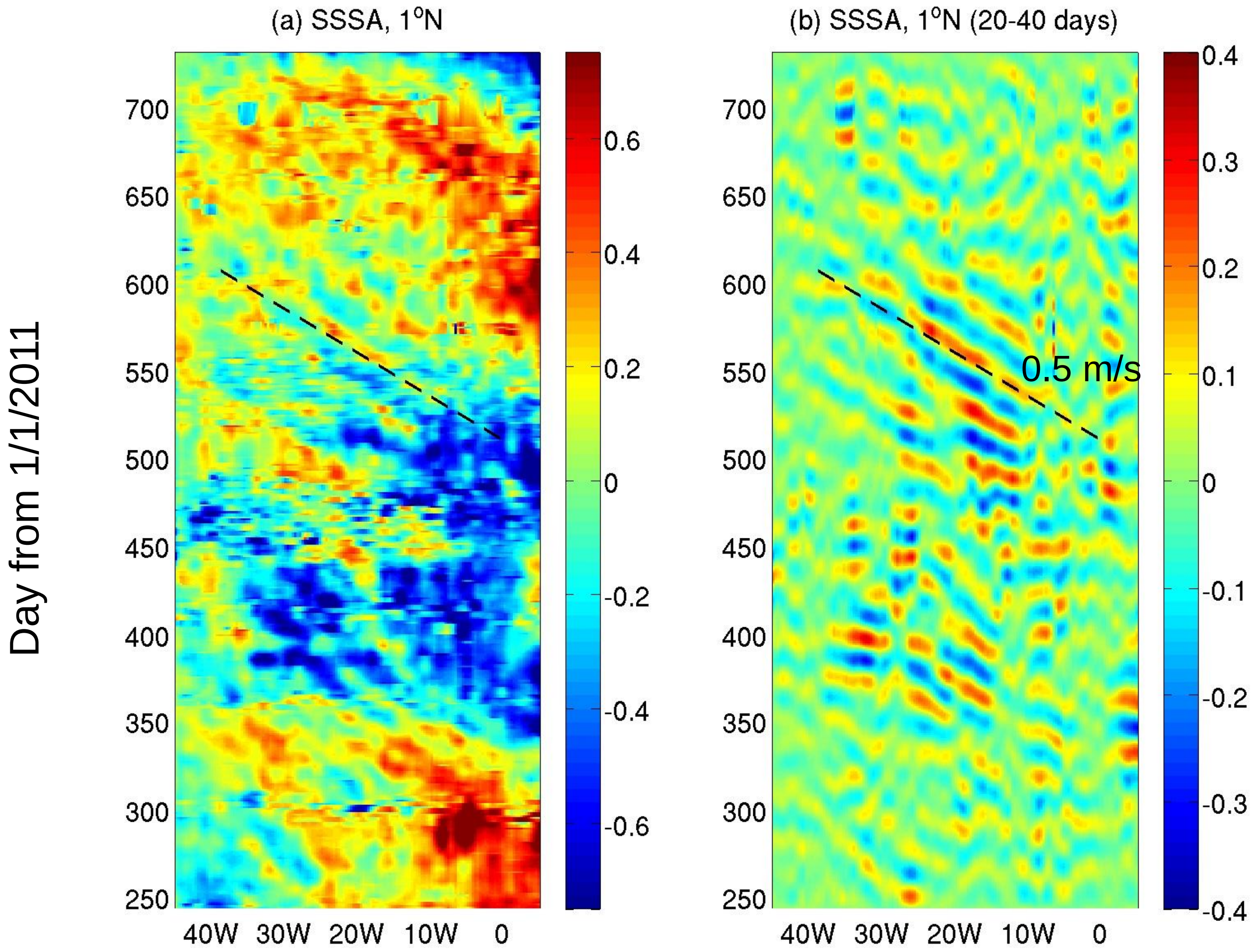
Tropical Atlantic TIWs: new features seen from SSS

- SSS show strong TIWs in the northwest tropical Atlantic (in contrast to SST).
- S may play a larger role than T in eddy-mean flow interaction in the NW.
- Active interactions with Amazon River plume, North Brazil Current retroflection, & ITCZ.



Tropical Atlantic TIWs: propagation in SSS



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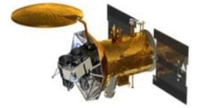
Perturbation Potential Energy (PPE)



PPE indicates baroclinic energy transfer (between mean the mean state and TIWs):

$PPE = g\rho'^2/\rho_{0z}$ (ρ' - surface density perturbation, ρ_{0z} – mean ρ gradient across mixed layer).

Based on linear equation of state for sea water (surface – zero pressure):

$\rho' = (-\alpha T' + \beta S')*\rho_0$ (α – thermal expansion coefficient, β – saline contraction coefficient)

$\rho'^2 = [(-\alpha T')^2 + (\beta S')^2 - 2\alpha\beta T'S']*\rho_0^2$

So has T' contribution, S contribution', and contribution by T'S' covariability (either positive or negative; but mostly positive for TIW because meridional T gradient is +, that for S is – at the northern edge of cold tongue).

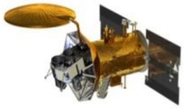
A previous study (Grodsky et al. 2005) based on mooring at 23W & auxilliary data, found that S effect enhances baroclinic energy conversion rate by 5 times. A challenging calculation due to incomplete obs (t,s,u,v) and various assumptions.

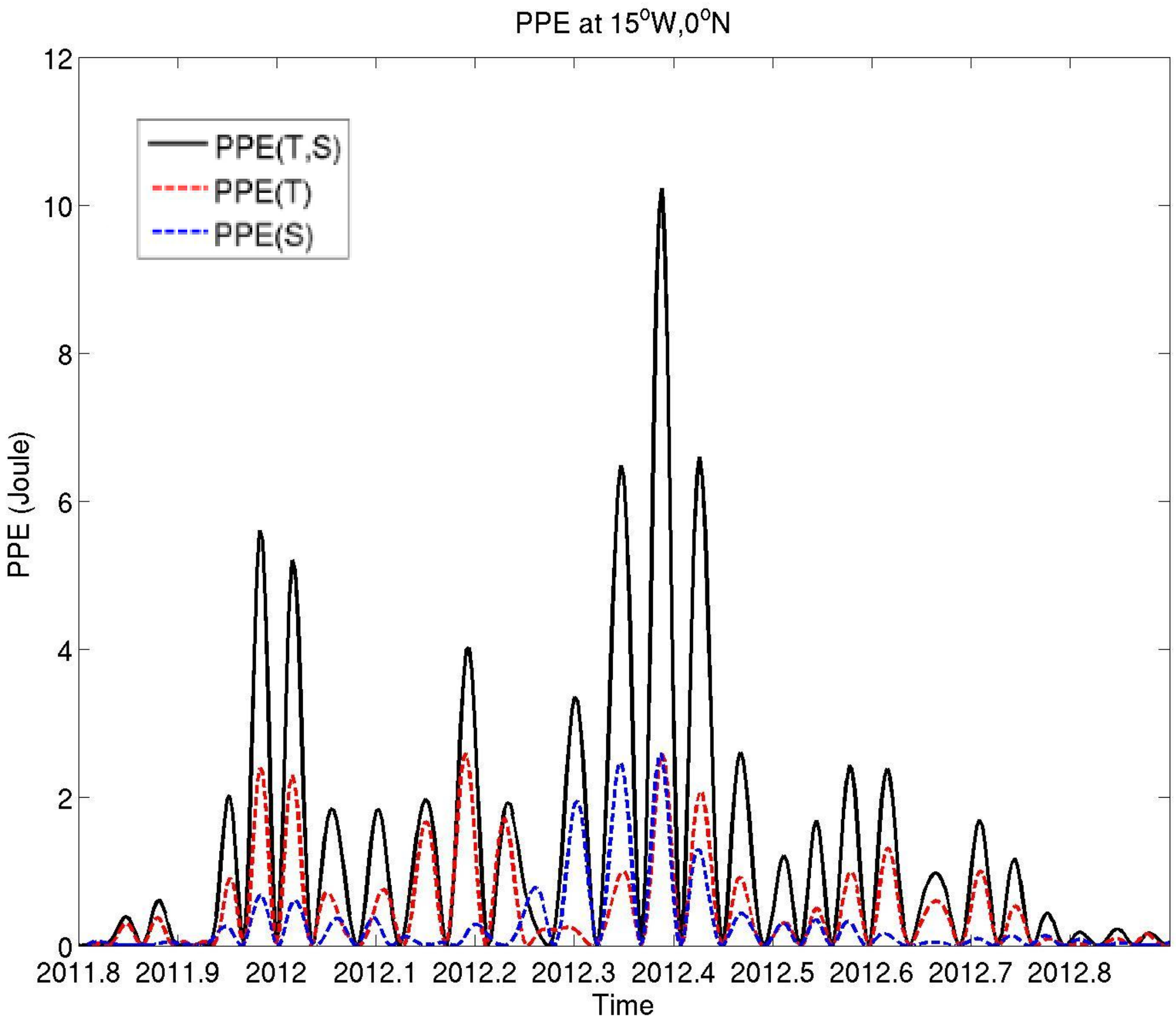
This study:

•A unique vantage point from Aquarius/SAC-D: basin-wide view of S.

•Direct estimate of PPE without having to calculate energy conversion rate.

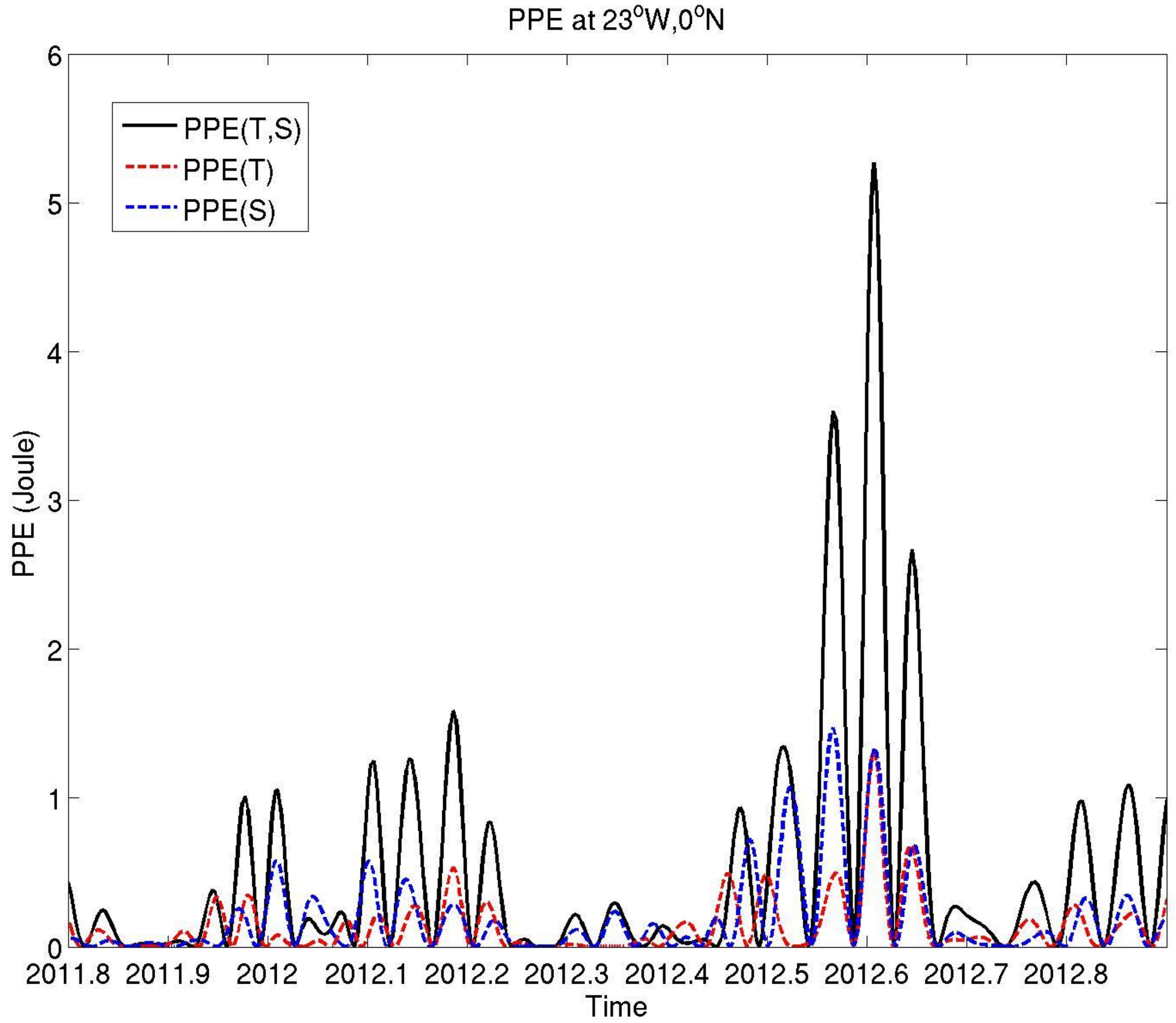
Salinity contribution to energetics
(Perturbation Potential Energy – PPE)





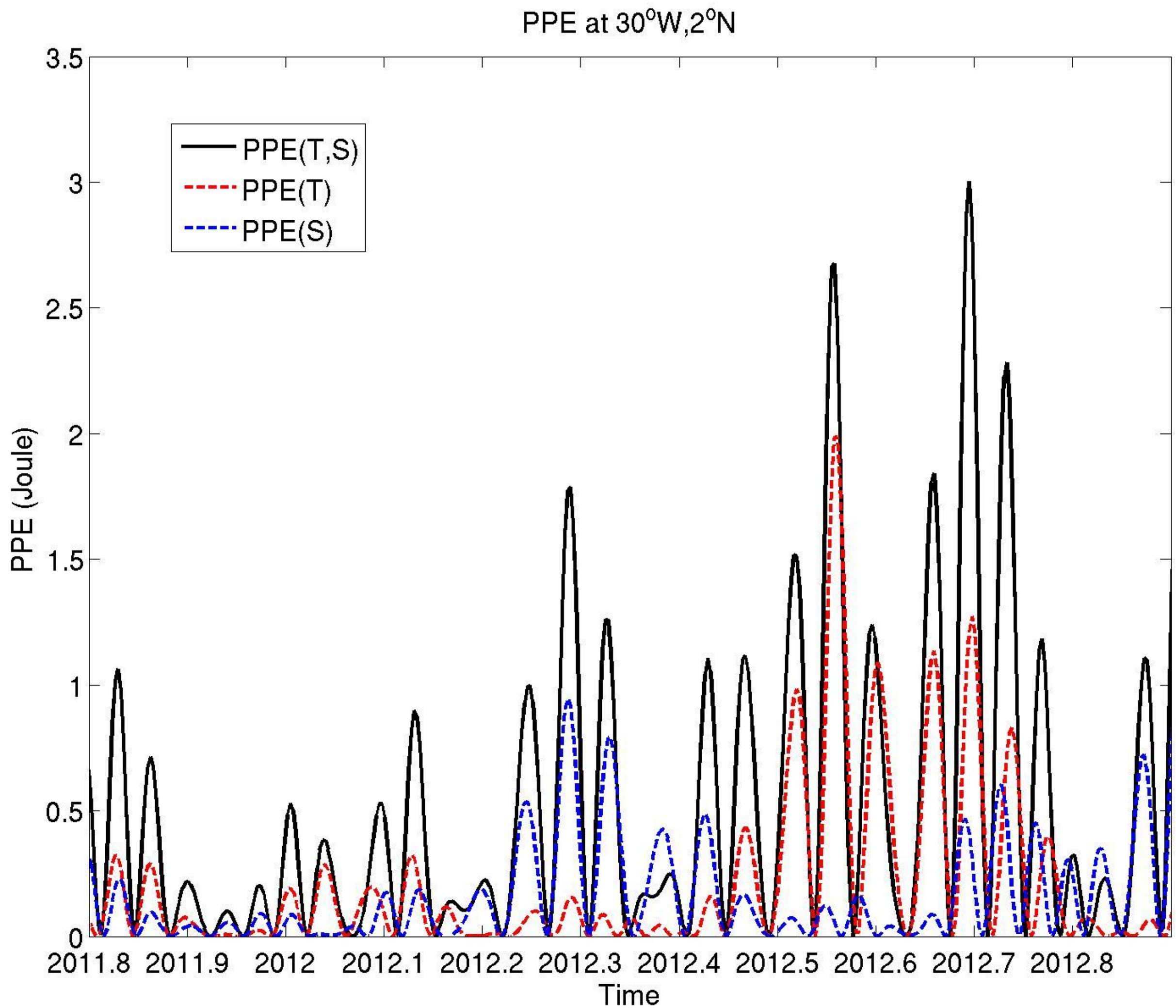
T' effect somewhat larger than S' effect in the east

Salinity contribution to energetics
(Perturbation Potential Energy – PPE)



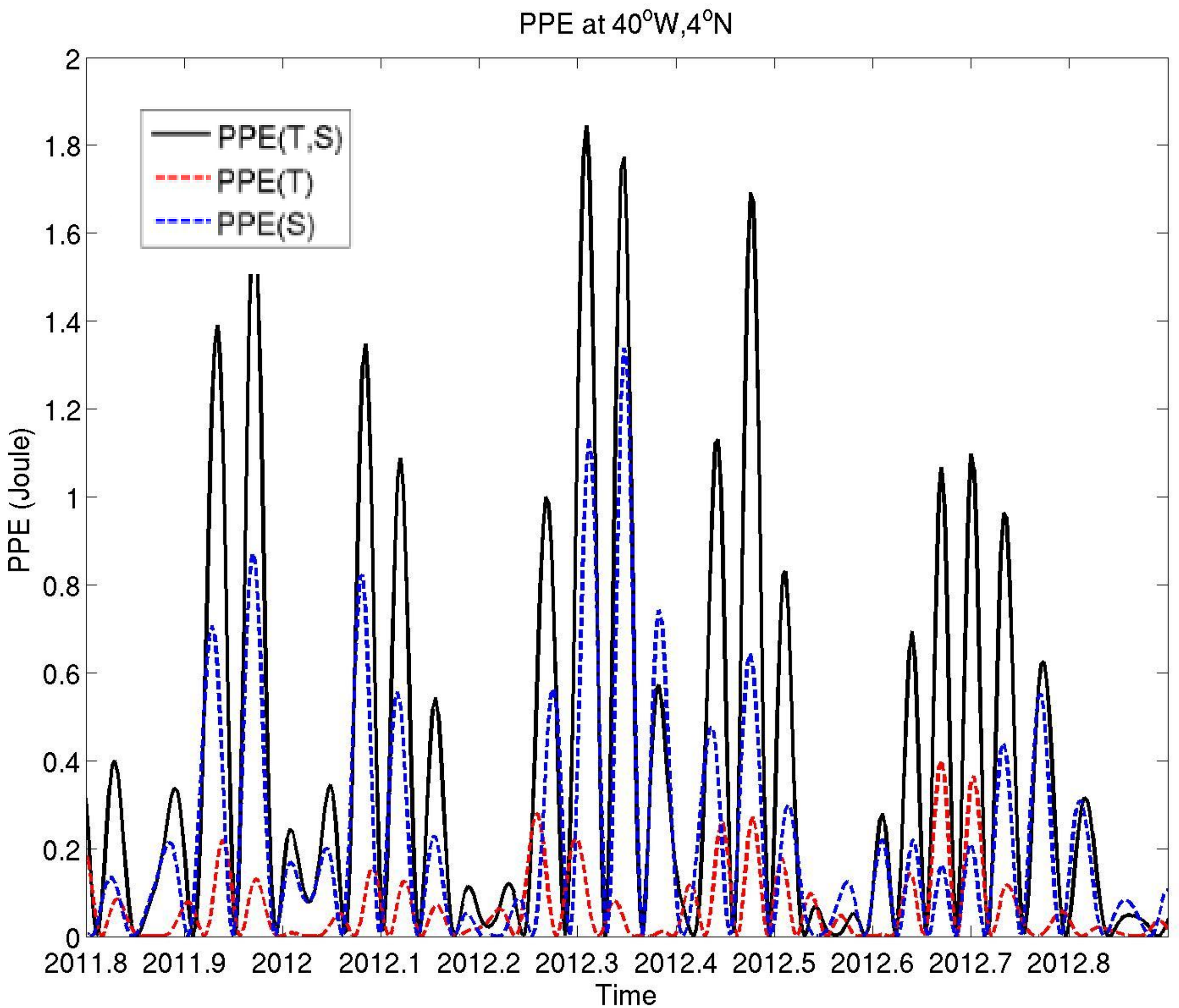
S' effect begins to increase in the central-eastern part

Salinity contribution to energetics
(Perturbation Potential Energy – PPE)



S’ & T’ effects are comparable in the central-western part

Salinity contribution to energetics
(Perturbation Potential Energy – PPE)



S' is the primary controlling factor for PPE & baroclinic energy transfer in the west

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Contributions of T’, S’ & T’S’ to PPE

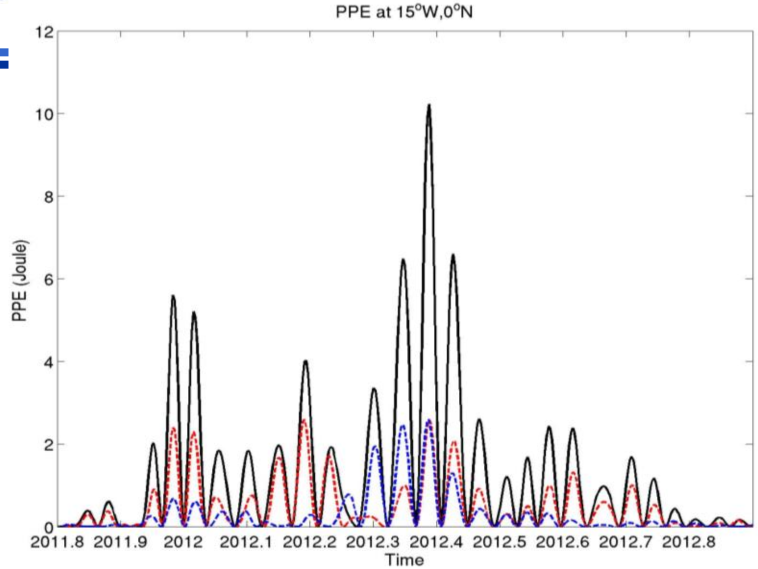
(time mean)

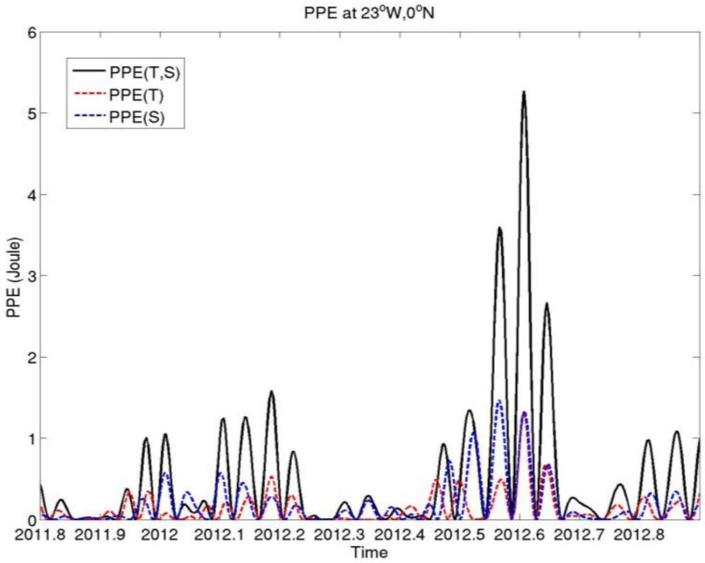
	PPE(T,S)	PPE(T)	PPE(S)
15W, 0N	1.52	0.70	0.25
23W, 0N	0.44	0.12	0.16
30W, 2N	0.50	0.19	0.16
40W, 4N	0.43	0.06	0.26

← Consistent with Grodsky et al. (2005) at 23W

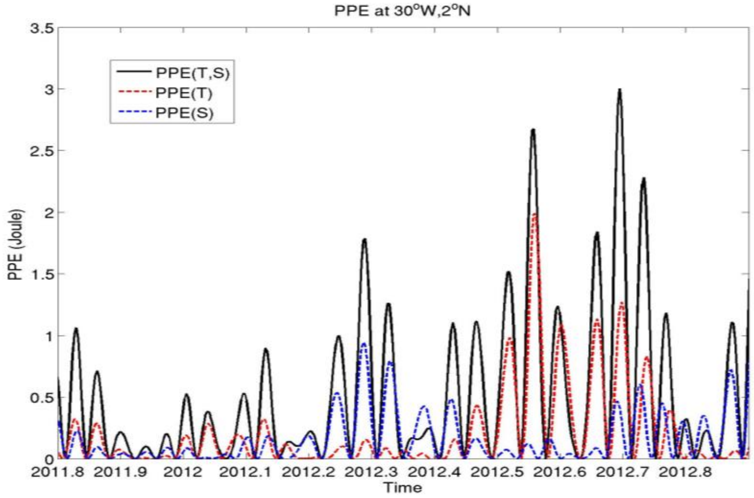
- Direct effect of S’ increases towards the west, becoming dominant in the west.
- PPE(T,S)-PPE(T)-PPE(S) indicates the effect of T’S’, which is very significant.
- Note how small the effect of T’ alone is.

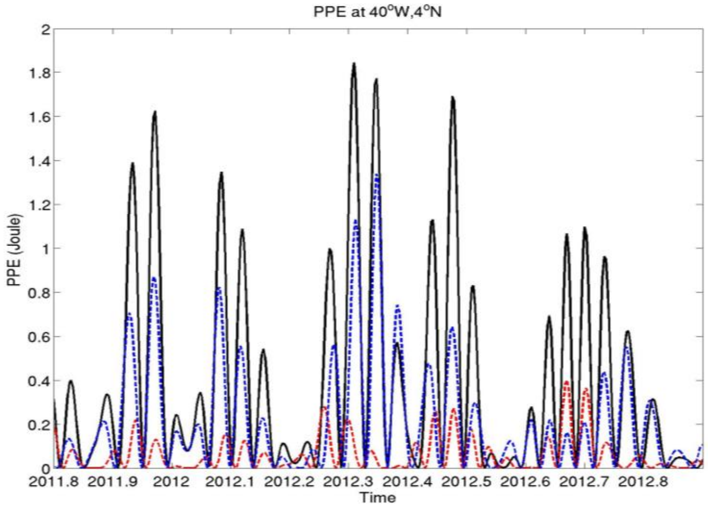
Temporal & spatial variations of PPE

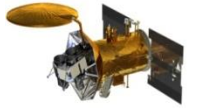




In the west, TIWs are not necessarily strongest in late spring/early summer as previously reported in the east – seasonality of meridonal velocity shear different?







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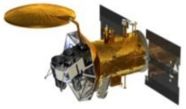
Summary



- Tropical Atlantic TIWs remain strong in the west although SST signature is weak.
- S effect on PPE is somewhat weaker than T effect in the east, but increases dramatically towards the west where it becomes much more dominant – effect of Amazon plume & retroflection into NBC that set up a large dS/dy.
- S effect on PPE has a direct effect (to density) & an indirect effect (due to T'S'), which is very significant.
- Seasonality of the growth/decay of TIWs are somewhat different between east & west, probably due to the differences in processes that set up the meridional velocity shear.