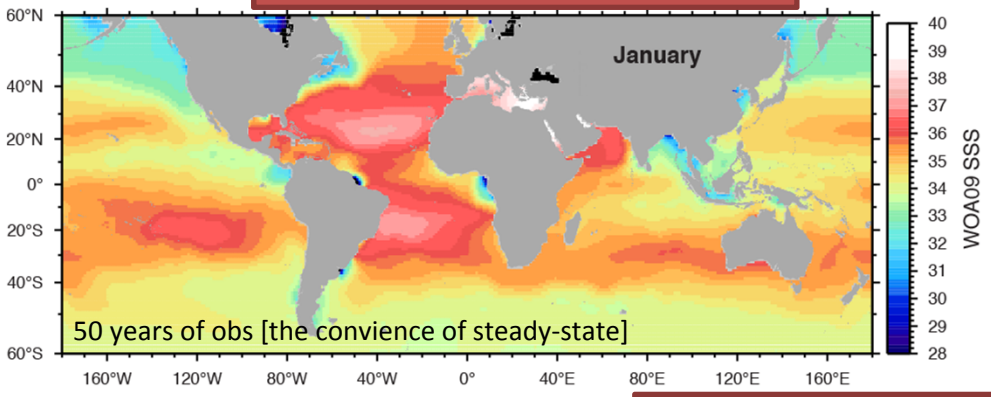
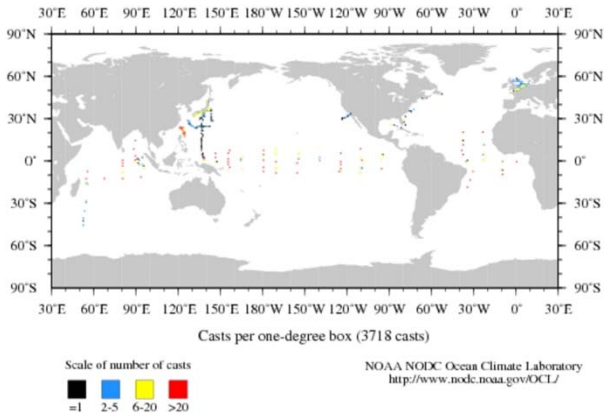
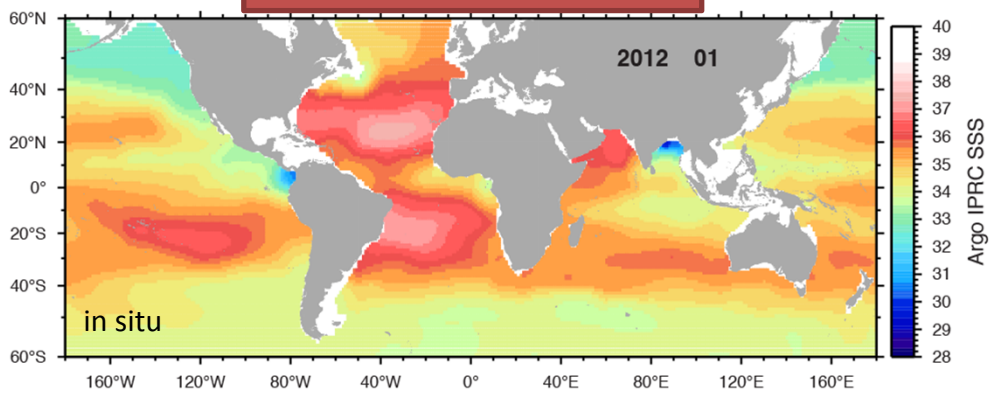
~50 year Climatic January SSS WOA09



January 2012 varied in situ 'hydro' [not Argo]

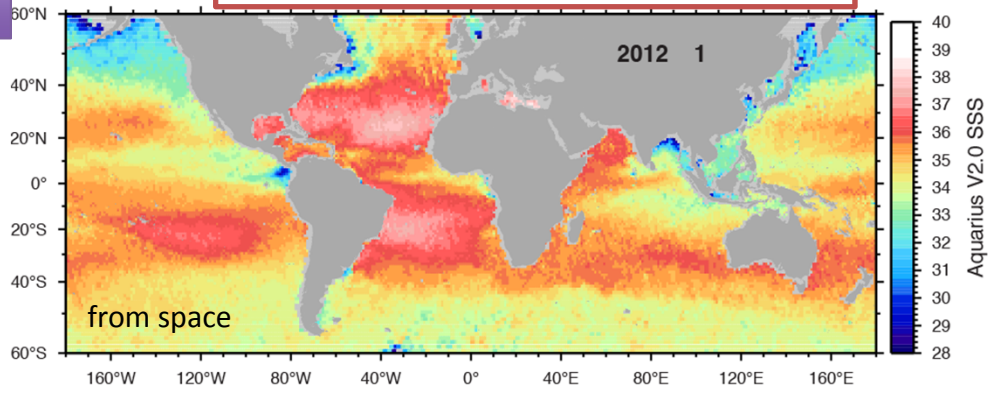


January 2012, SSS Argo gridded



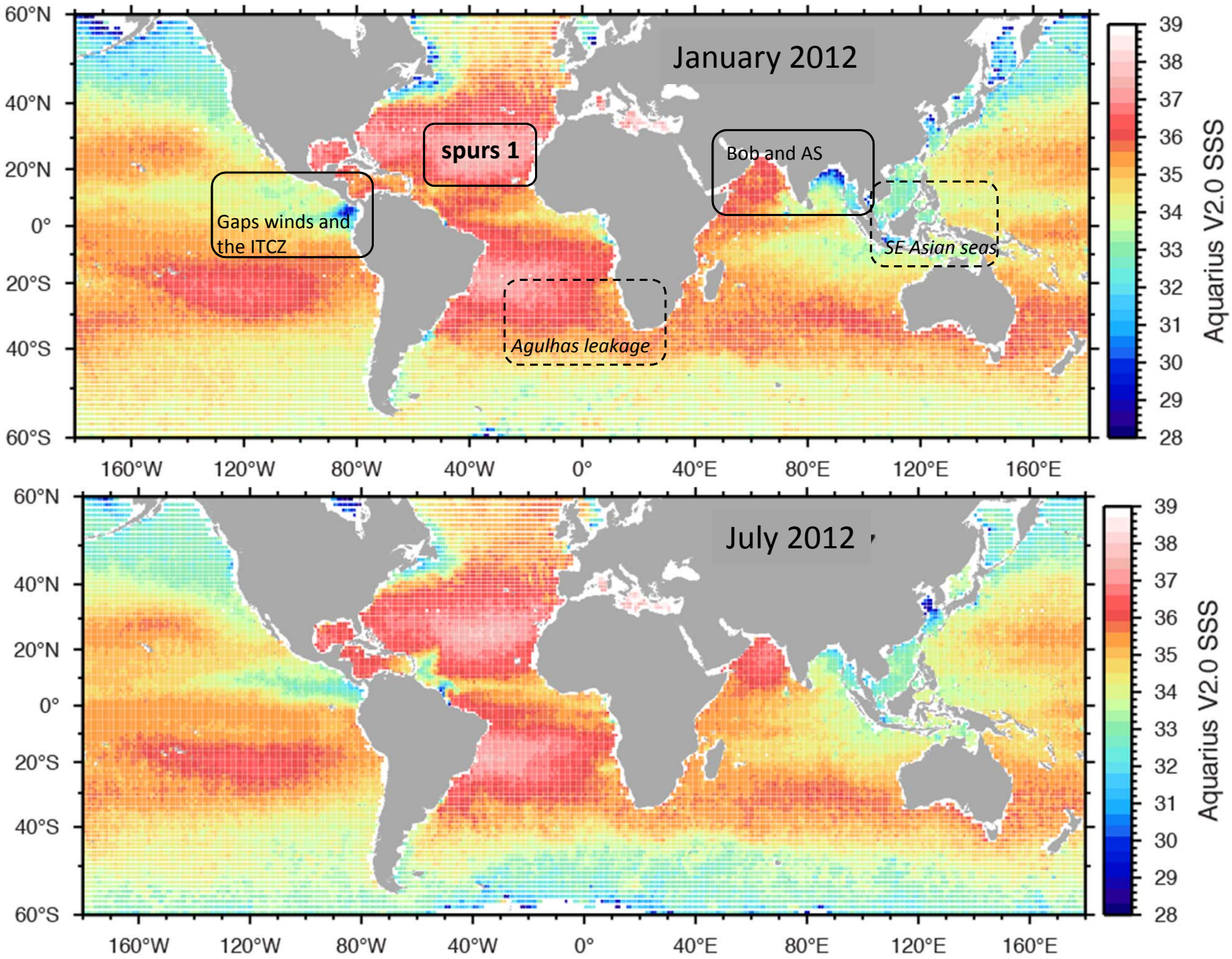
SMOS & AQUARIUS SCIENCE WORKSHOP
IFREMER, Brest, France, 15-17 April 2013

January 2012, SSS Aquarius V2.0 L3, monthly



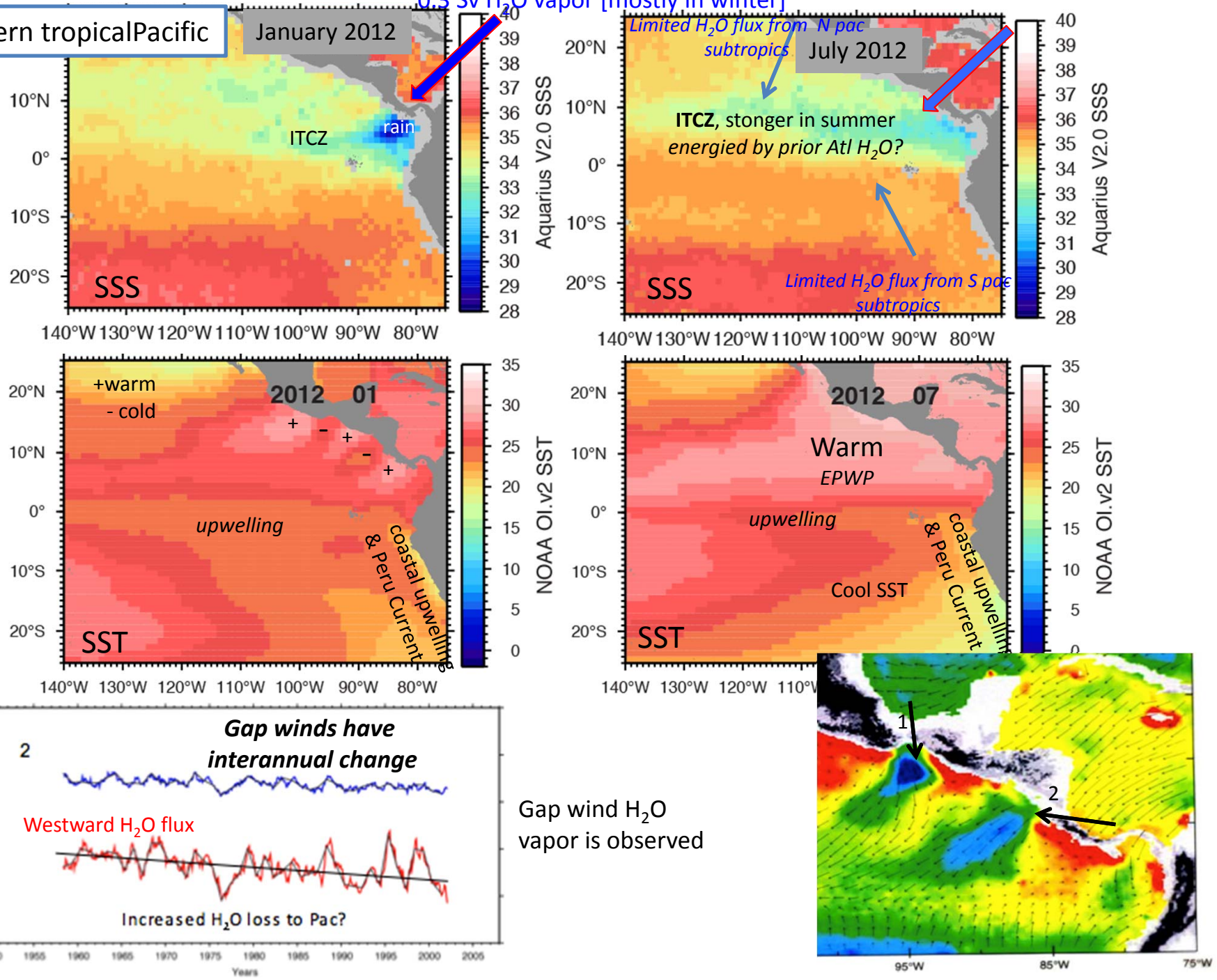
Ocean Eddy Freshwater Flux

Arnold L. Gordon & Claudia F. Giulivi
Lamont-Doherty Earth Observatory
Of Columbia University

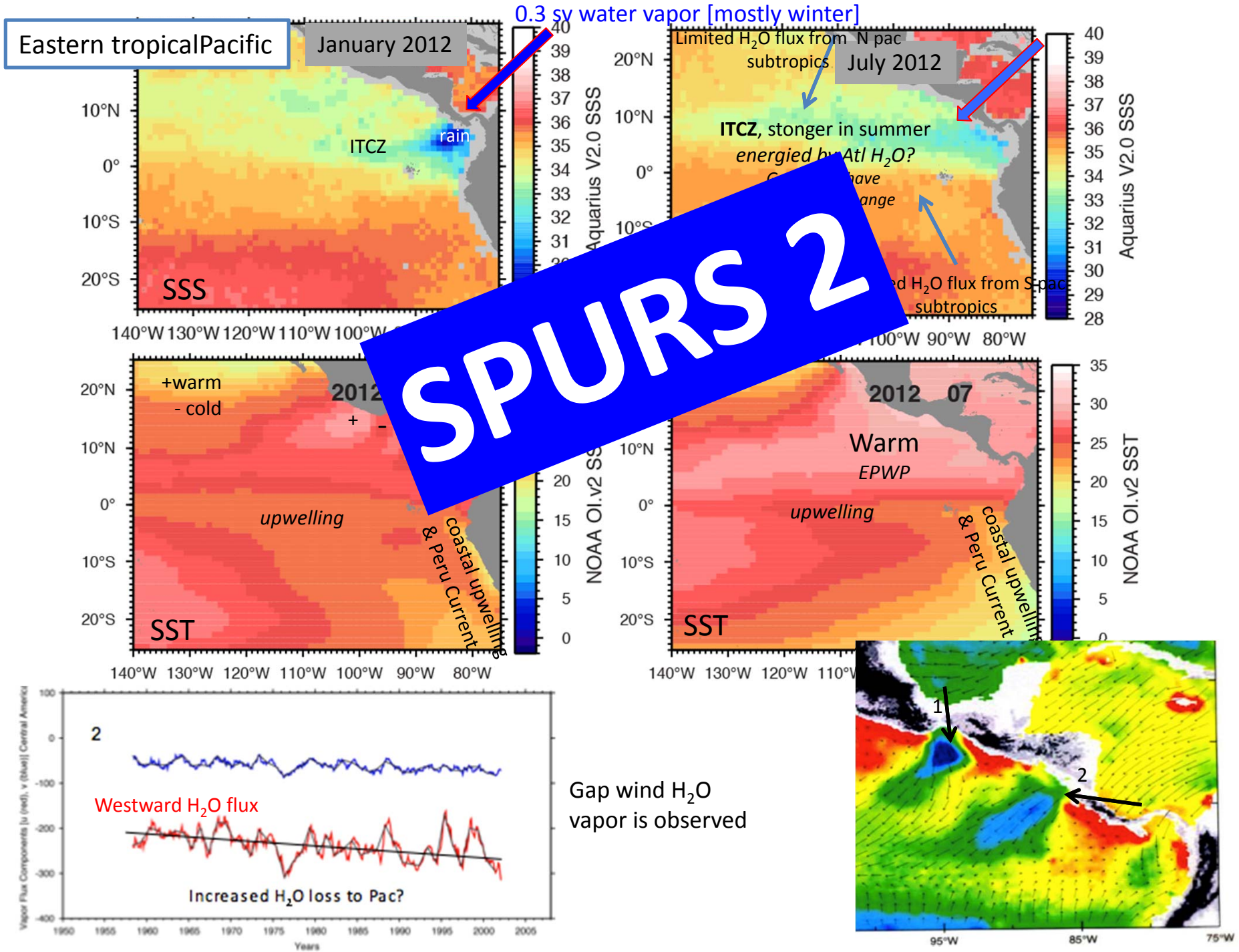

January 2012
spurs 1
Bob and AS
Gaps winds and the ITCZ
SE Asian seas
Agulhas leakage
July 2012
60°N
40°N
20°N
0°
20°S
40°S
60°S
160°W
120°W
80°W
40°W
0°
40°E
80°E
120°E
160°E
Aquarius V2.0 SSS
39
38
37
36
35
34
33
32
31
30
29
28

Eastern tropicalPacific

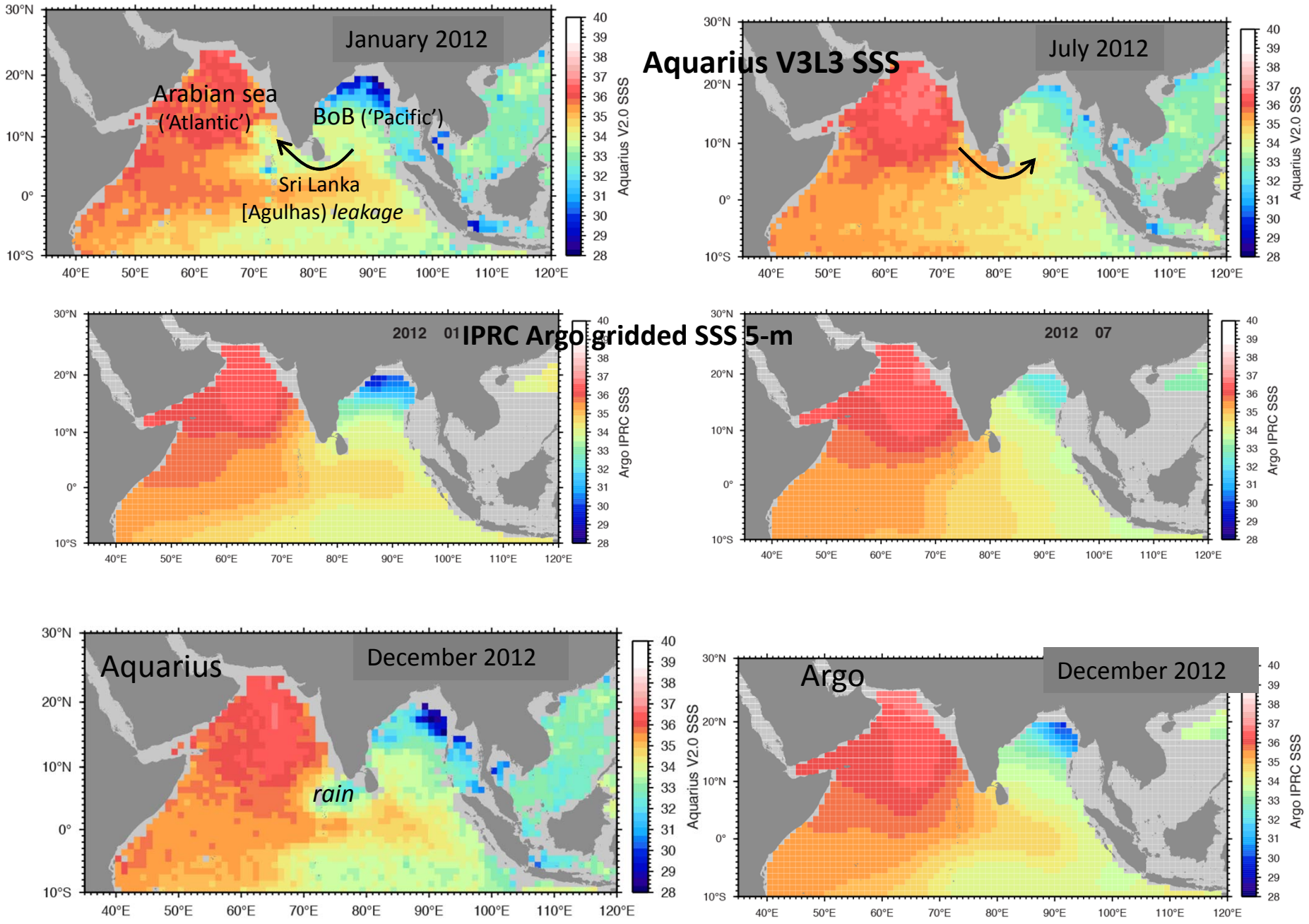
0.3 Sv H_2O vapor [mostly in winter]

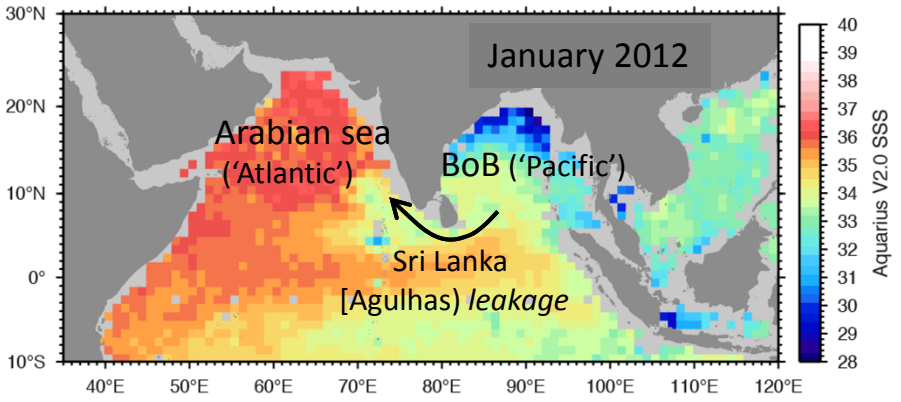


Gap wind H_2O vapor is observed

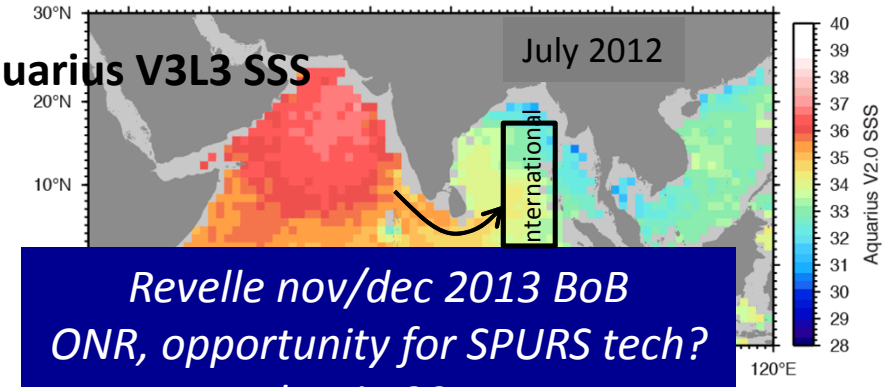


Gap wind H_2O vapor is observed


Aquarius V3L3 SSS
January 2012
Arabian sea
('Atlantic')
BoB ('Pacific')
Sri Lanka
[Agulhas) *leakage*
July 2012
Aquarius V2.0 SSS
IPRC Argo gridded SSS 5-m
2012 01
2012 07
Argo IPRC SSS
Aquarius
December 2012
rain
Argo
December 2012
Aquarius V2.0 SSS
Argo IPRC SSS

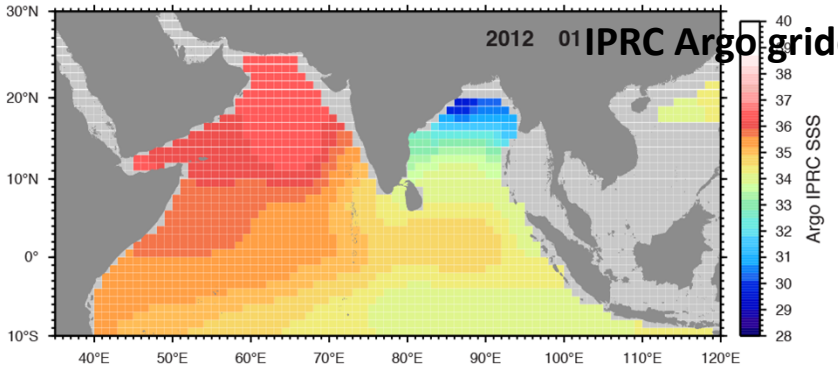


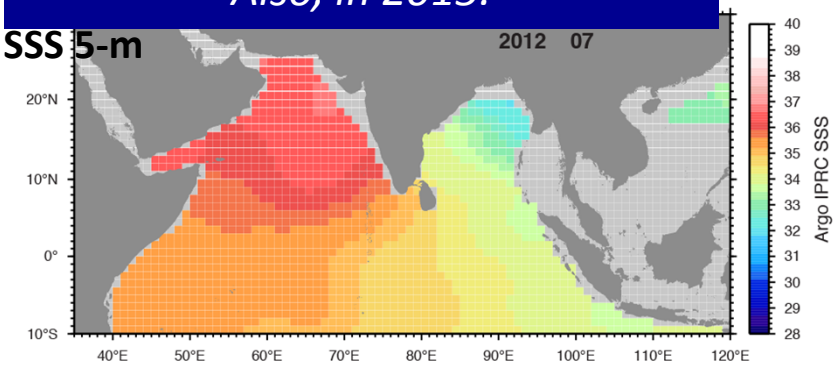
Aquarius V3L3 SSS

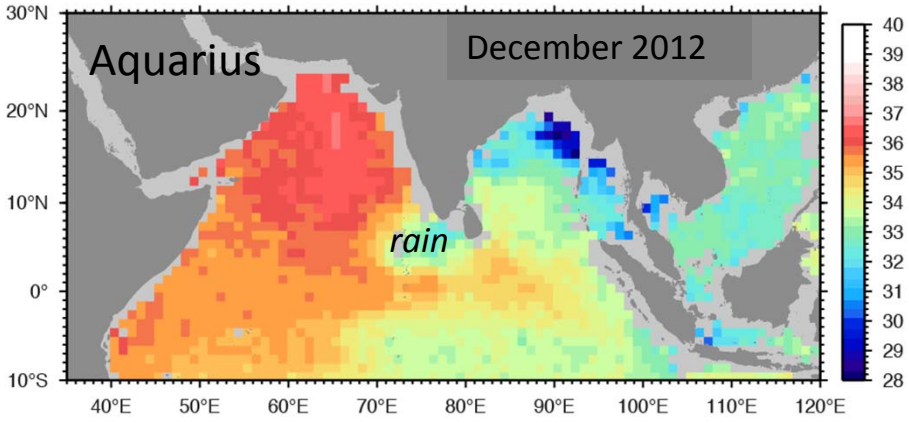


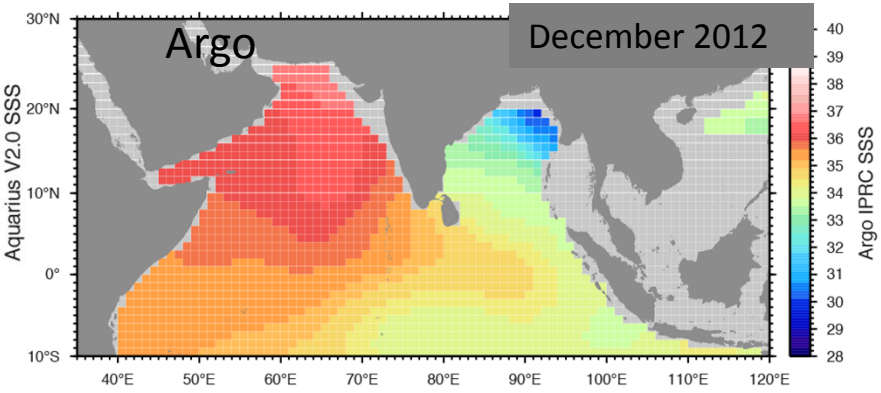
Revelle nov/dec 2013 BoB
ONR, opportunity for SPURS tech?
Also, in 2015.

IPRC Argo gridded SSS 5-m









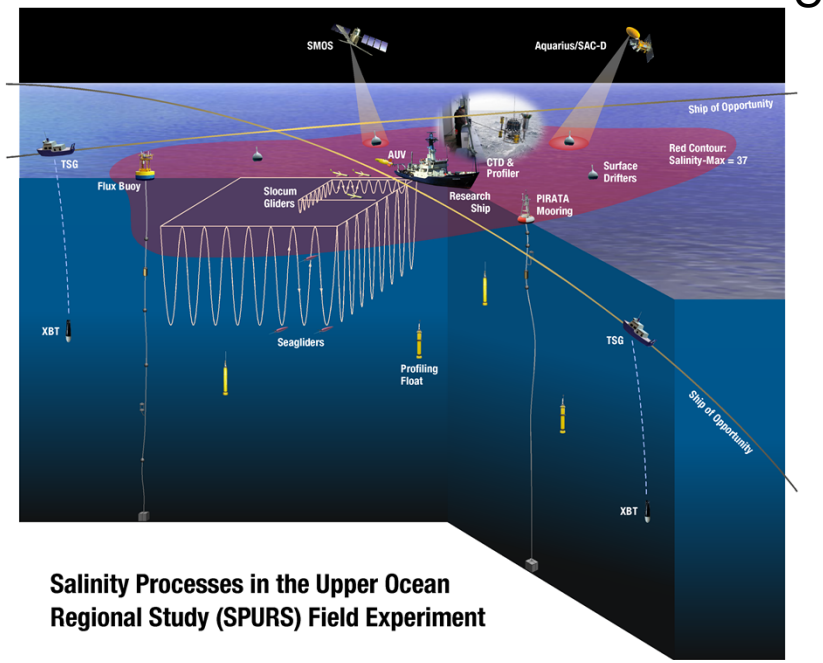
SPURS: Salinity Processes in the Upper-Ocean Regional Study

SPURS 1 subtropical SSS-max of North Atlantic *[the saltiest subtopical regime]*

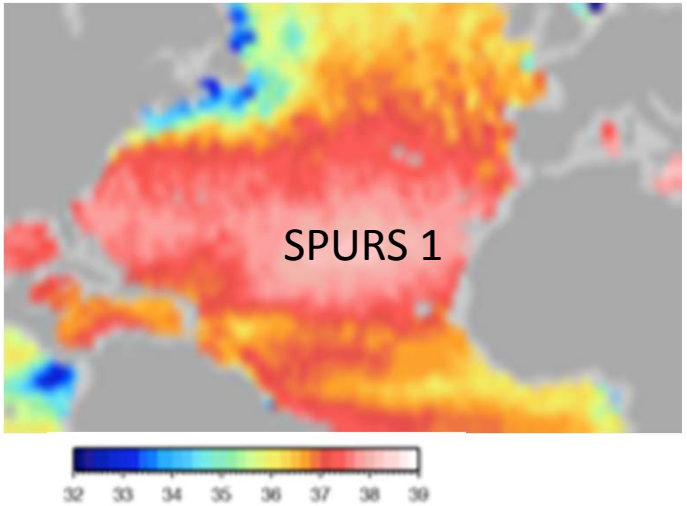
Science Question: What is controlling the upper ocean salinity?
or How do ocean processes compensate E – P? Its variability?

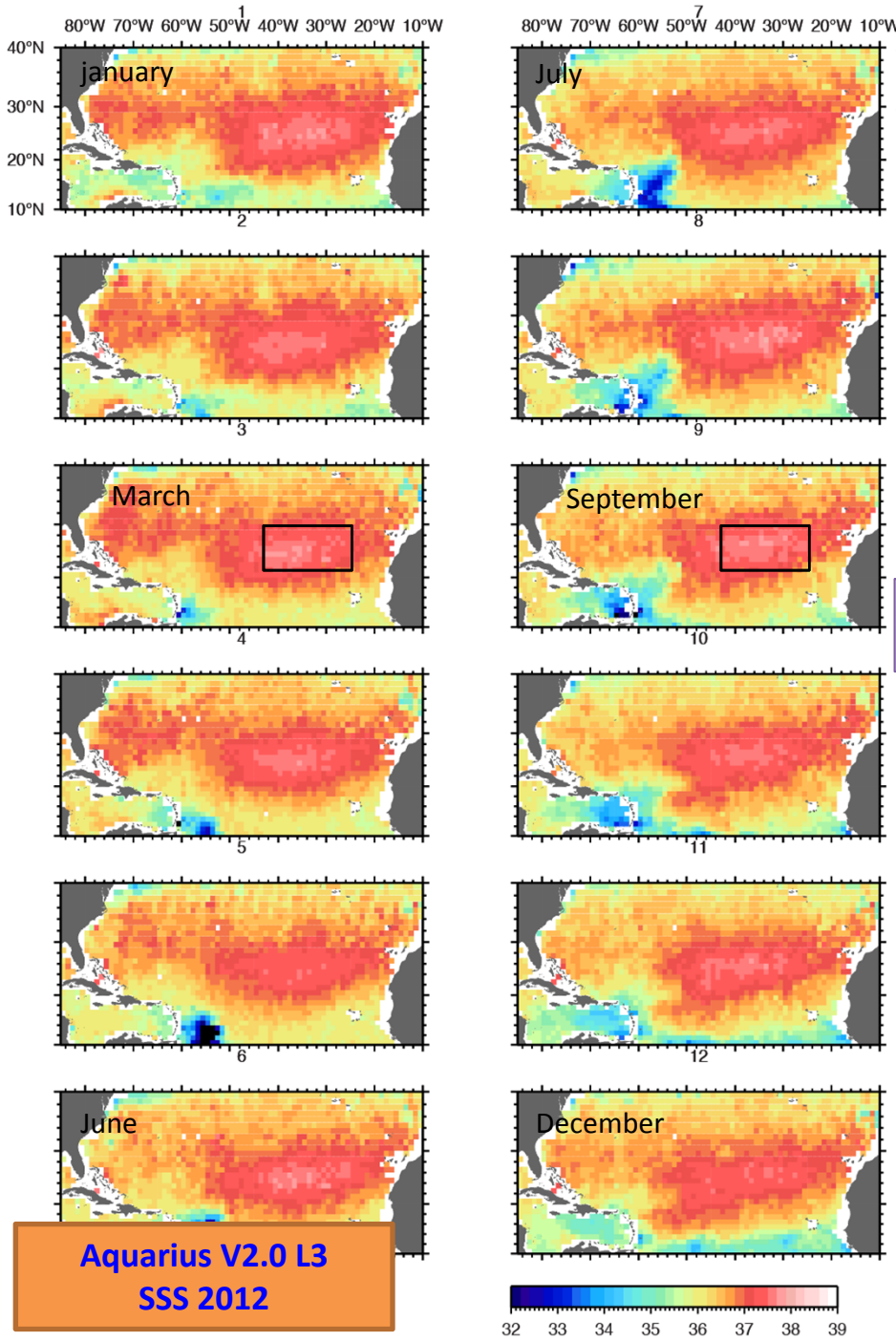
This question is addressed with measurements from satellites, ship based obs, drifting surface buoys & profilers, and array of mooring instrumentation, gliders, with theoretical & numerical model simulations.

SPURS, ship presence: August, 2012; September-October 2012; March-April 2013; September-October 2013



Salinity Processes in the Upper Ocean Regional Study (SPURS) Field Experiment



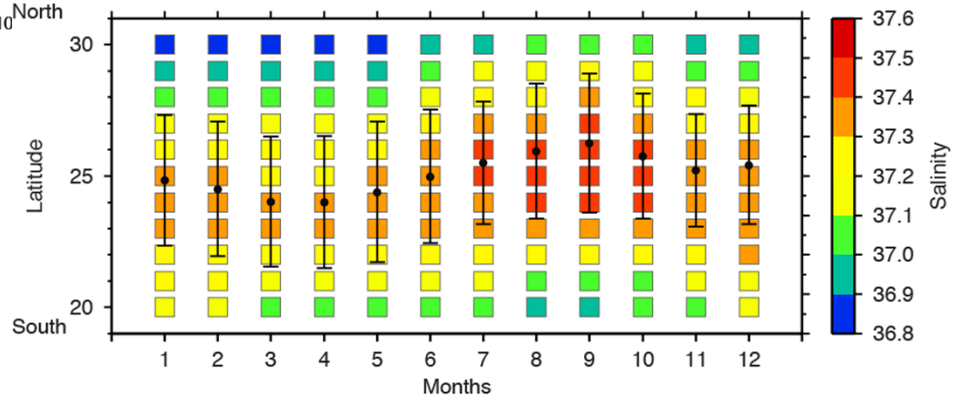


Aquarius V2.0 L3
SSS 2012

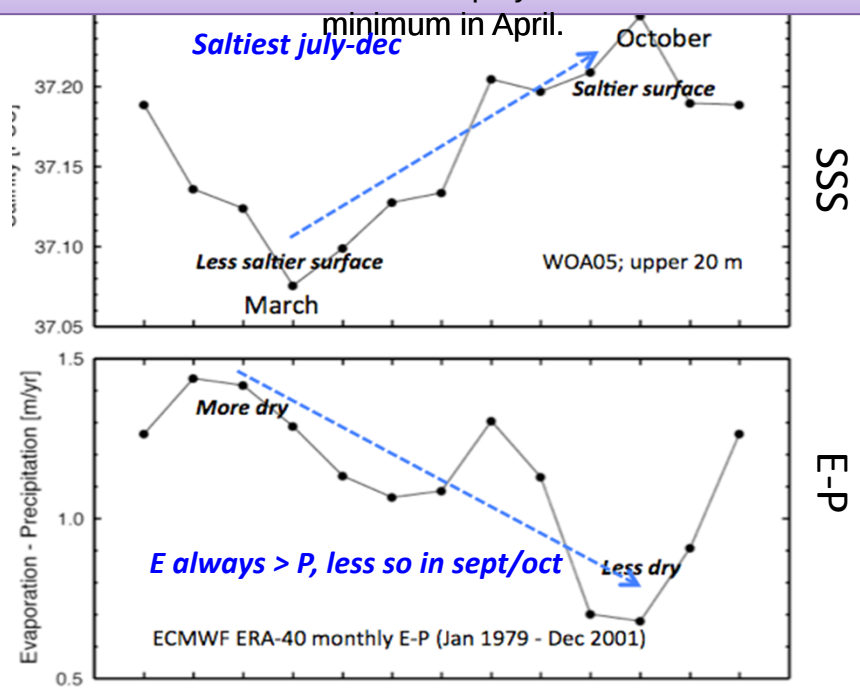
VOS Mean 1970-2009

SPURS

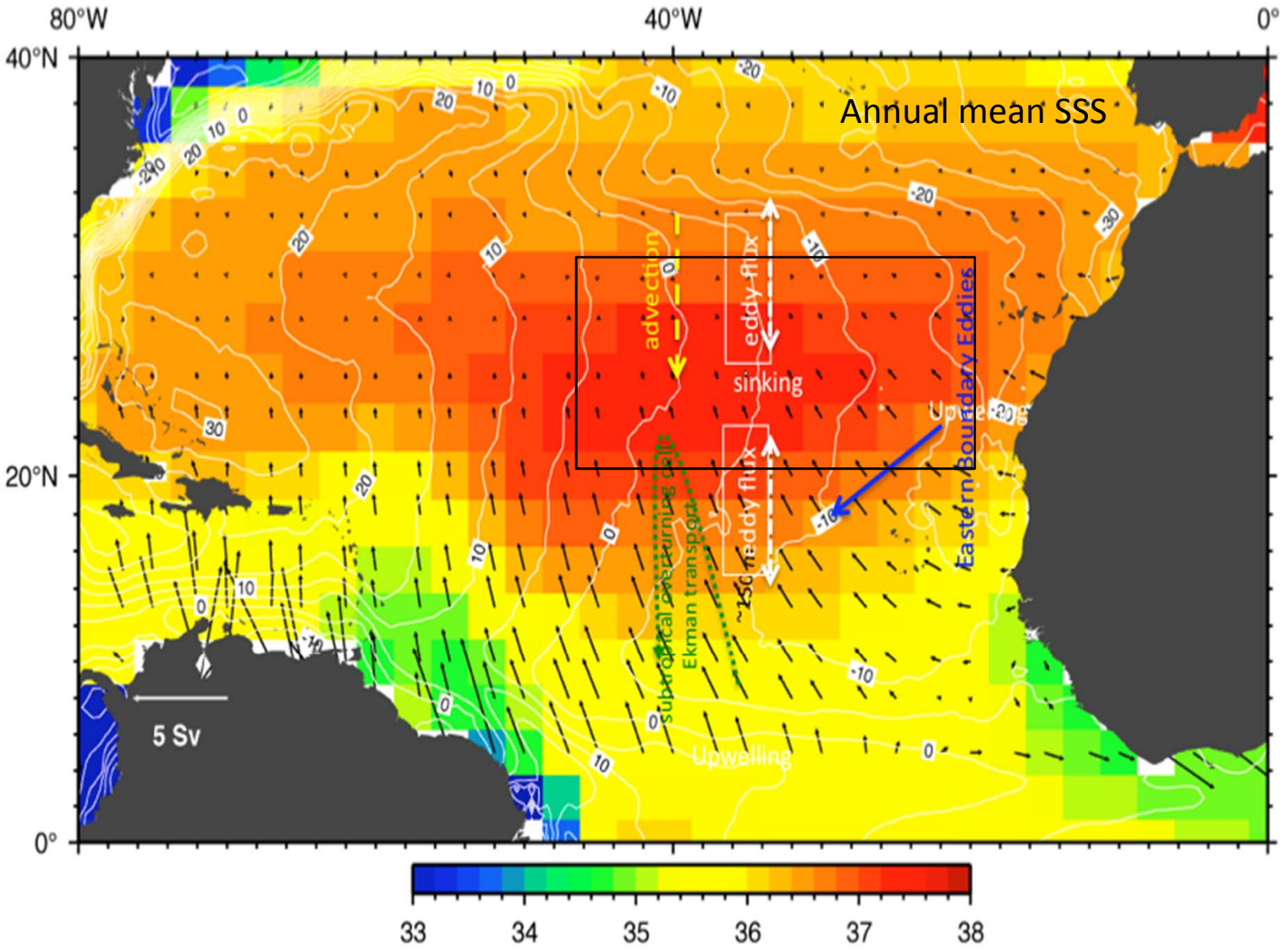
SSS-max more intense, northward in august-september



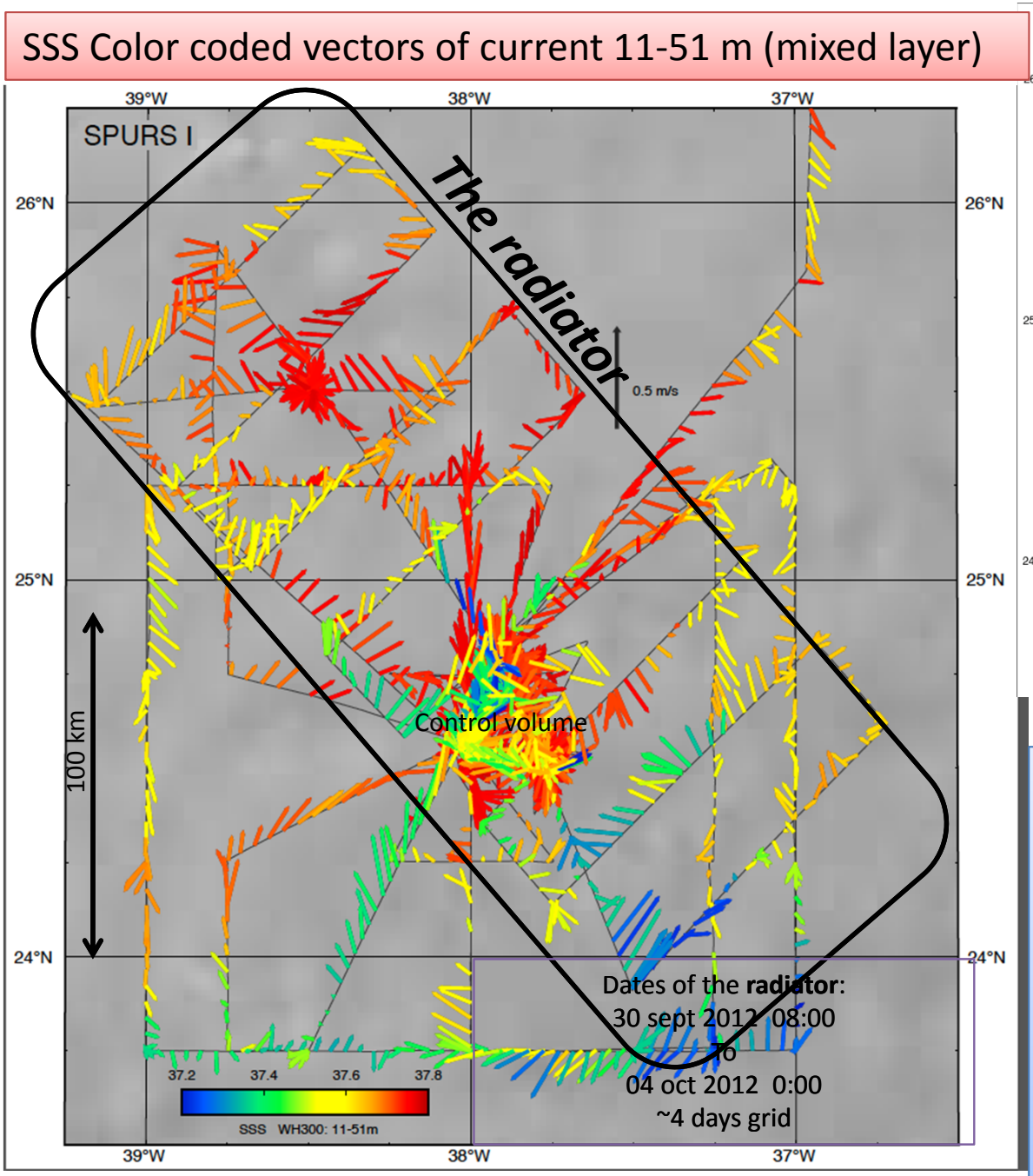
While E-P is always positive, maximum in January-July, minimum in October, the SSS displays a maximum in October, minimum in April.

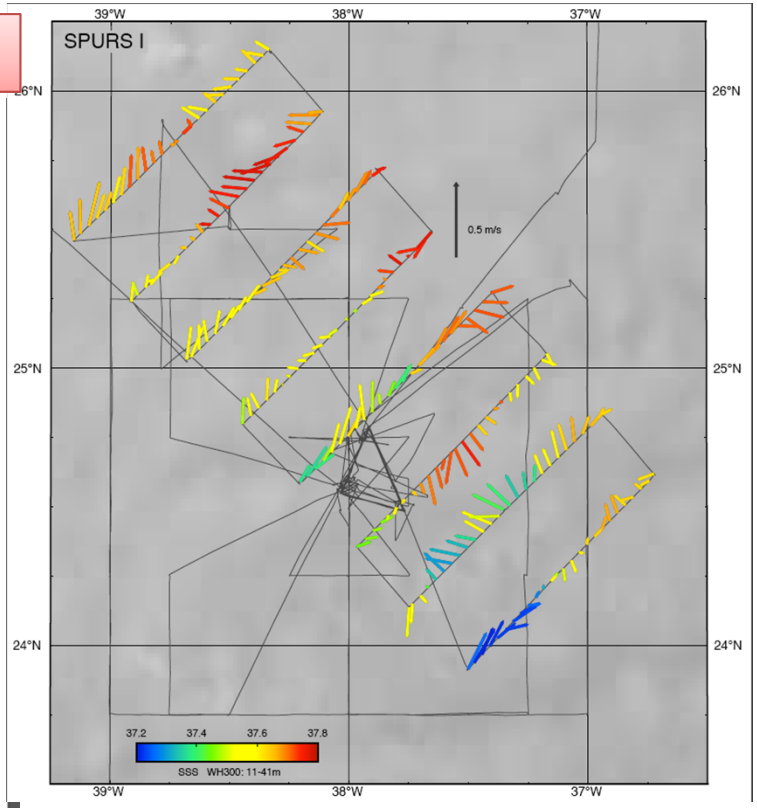


Ocean processes, e.g. Ekman (vectors on map), geostrophic (white contours), eddies, turbulence balance net sea-air E-P



SSS Color coded vectors of current 11-51 m (mixed layer)





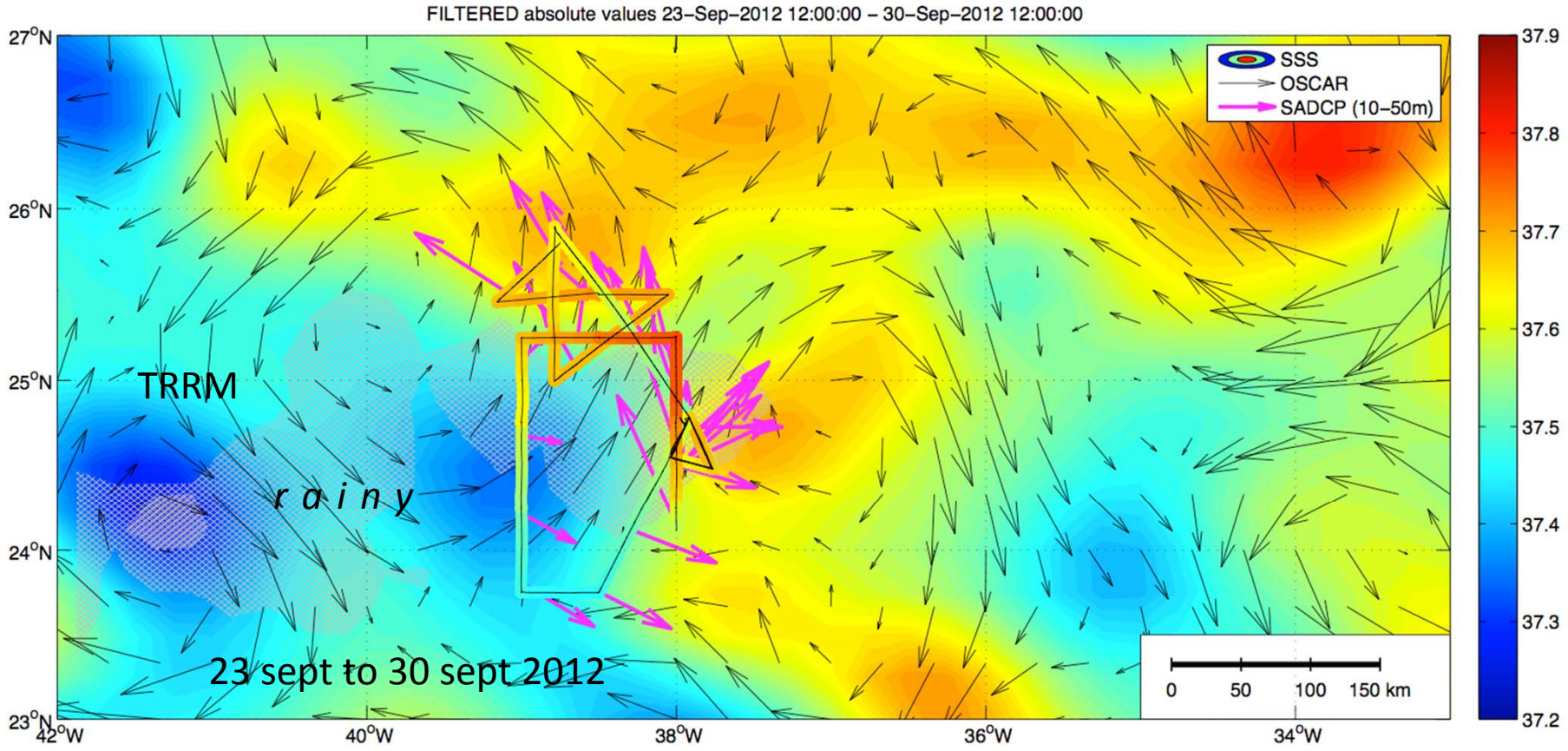
The real world SSS has a lot more texture [eddies/swirls] than the overly smoothed climate view of the subtropical SSS-max shown in atlas. The processes are a not more complicated than the Ekman induces shallow meridional overturning cell.

SPURS Sept/Oct '12 cruise:

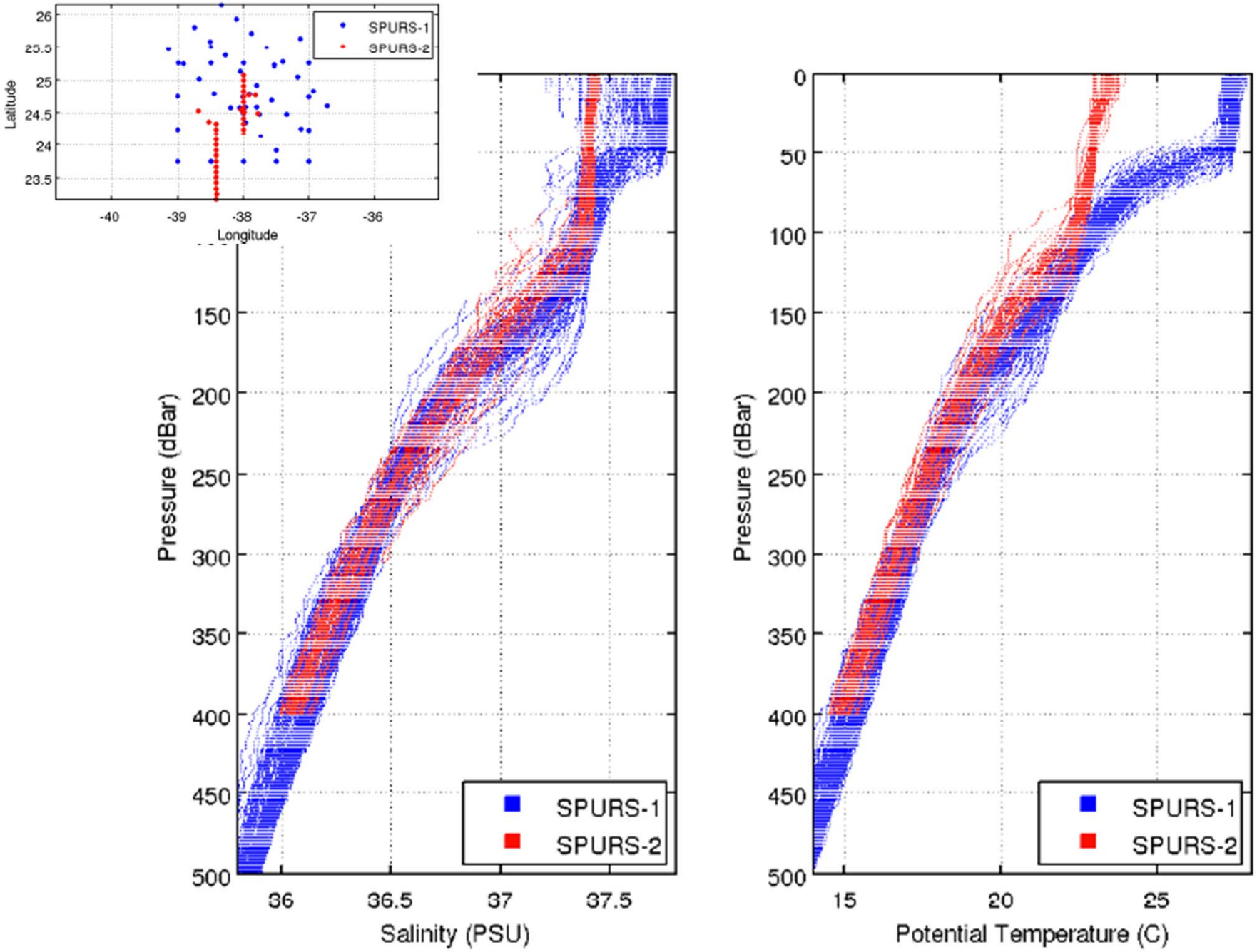
§ Swirls of salty and not so salty surface water *Good for both salty and fresh teams*

§ Start of the subsurface S-max

Are we seeing smearing of local rain induced low SSS patches or eddies from far away?
Are we seeing submesoscale dynamics between these contrasting clumps?

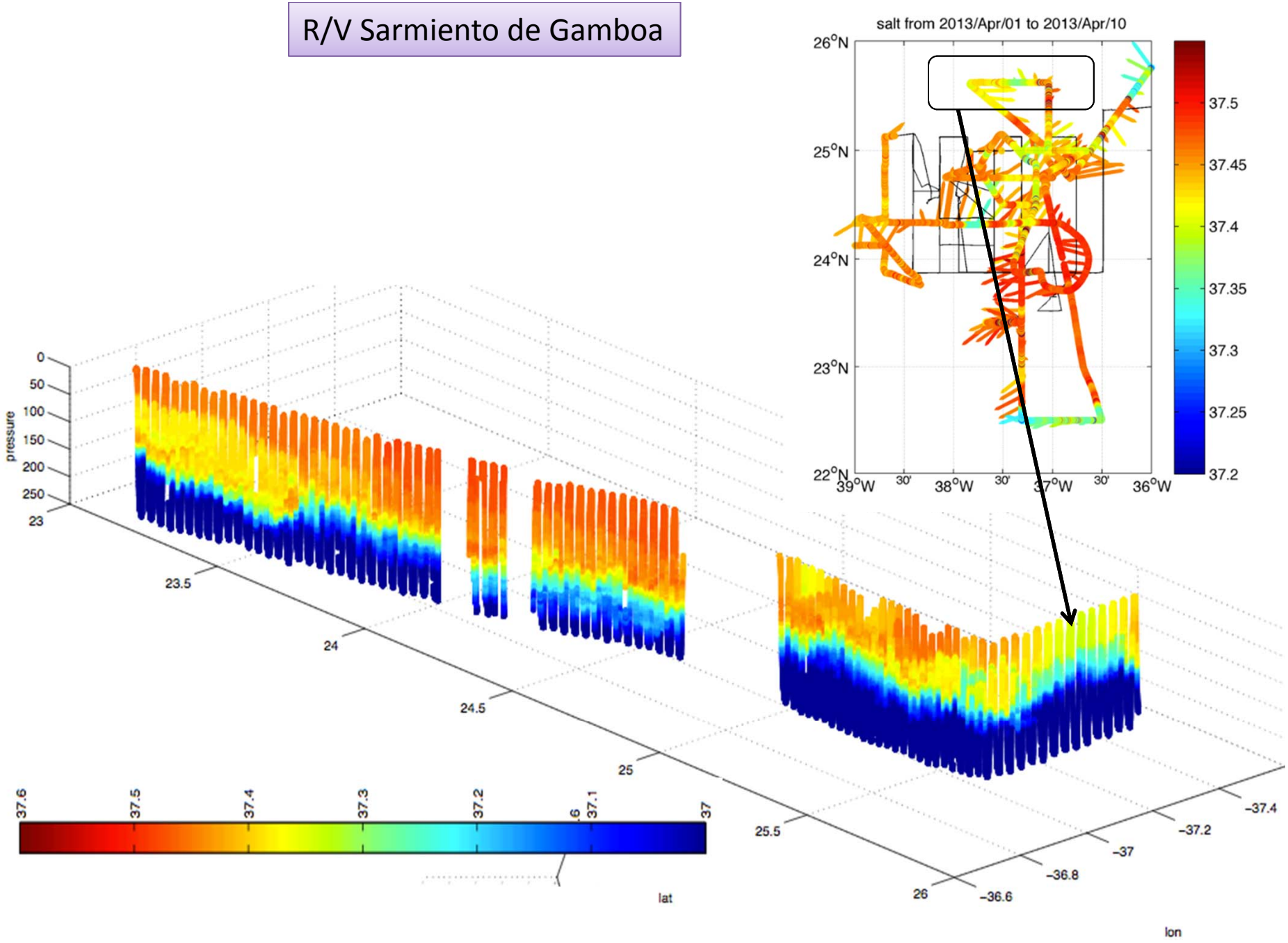


Aquarius: 7 day averages (Oleg Melnichenko)
Oscar: average of two 5-day patterns
Underway: 300 kHz, 1 day low-pass, 10-50 m, 50 km blocks; SSS ½ day low pass



Fm Ray Schmitt

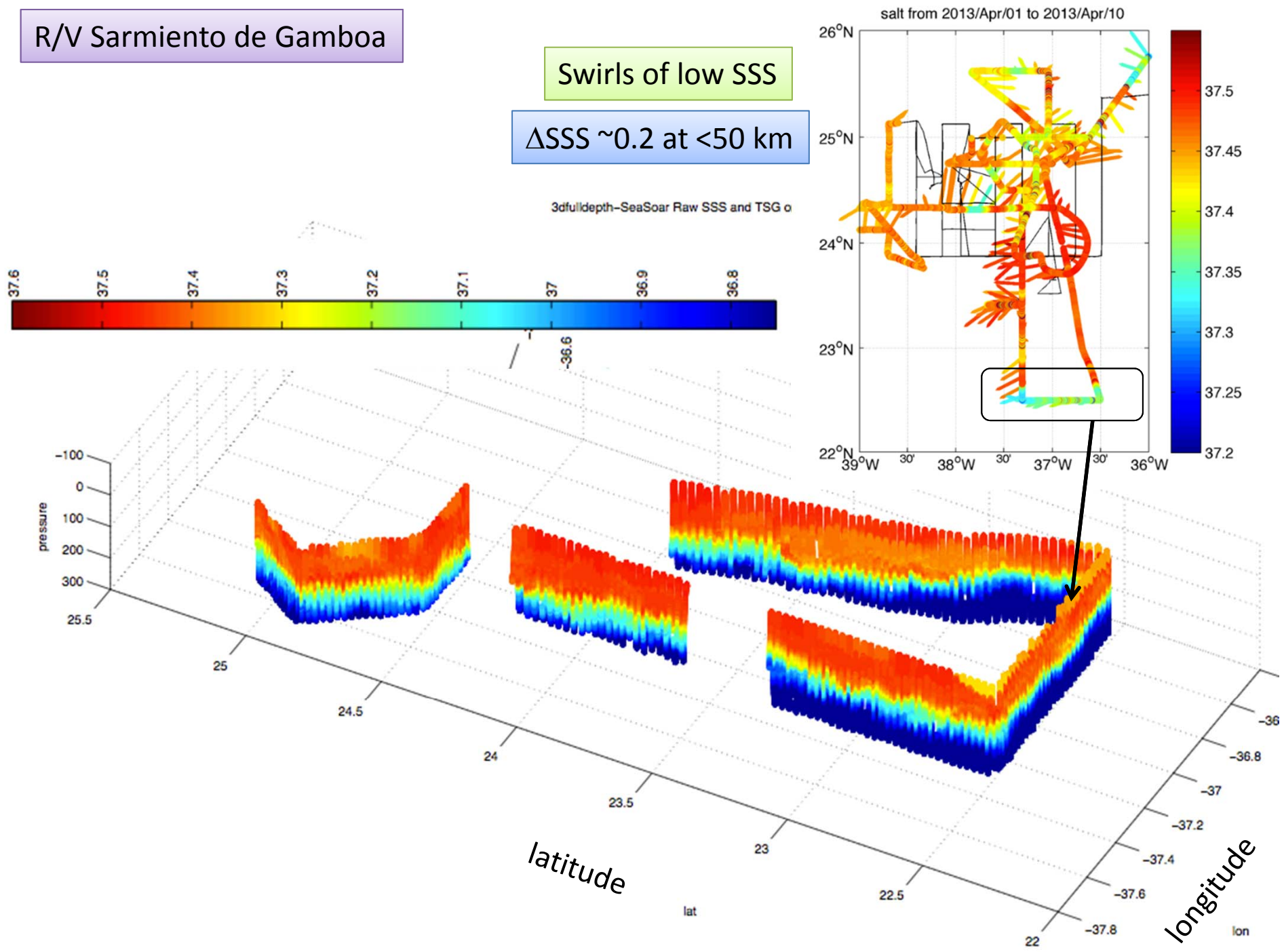
R/V Sarmiento de Gamboa



R/V Sarmiento de Gamboa

Swirls of low SSS

ΔSSS ~0.2 at <50 km



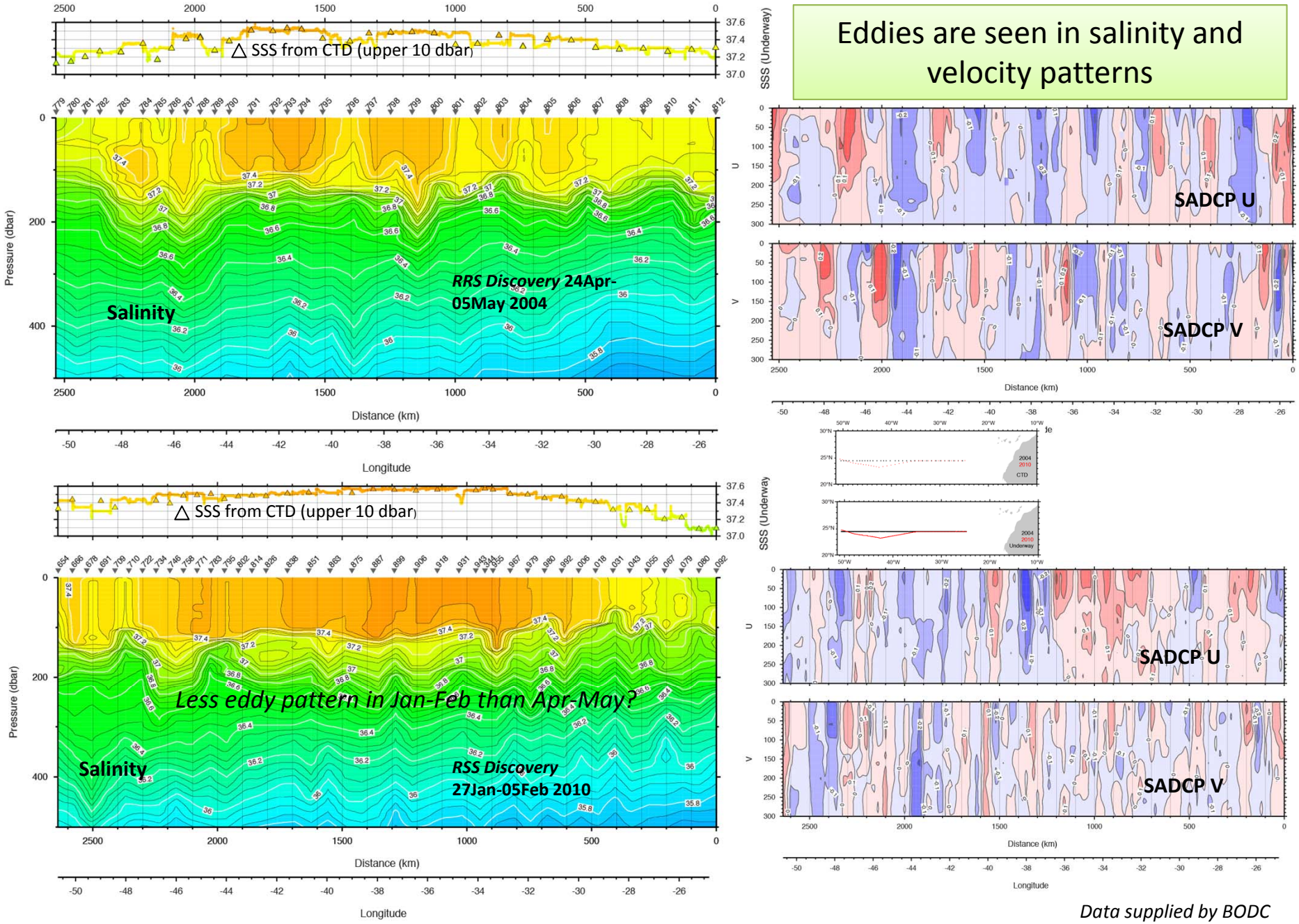
What role does the mesoscale play in compensating the air-sea flux of heat and freshwater?

Do the eddies induce a convergence of freshwater into the SPURS subtropical region to signficanially compensation to E – P?

We now estimate the meridional freshwater flux by eddies across the SPURS latitudes using Simple Ocean Data Assimilation (SODA) re-analysis data, in order to calculate the convergence of freshwater.

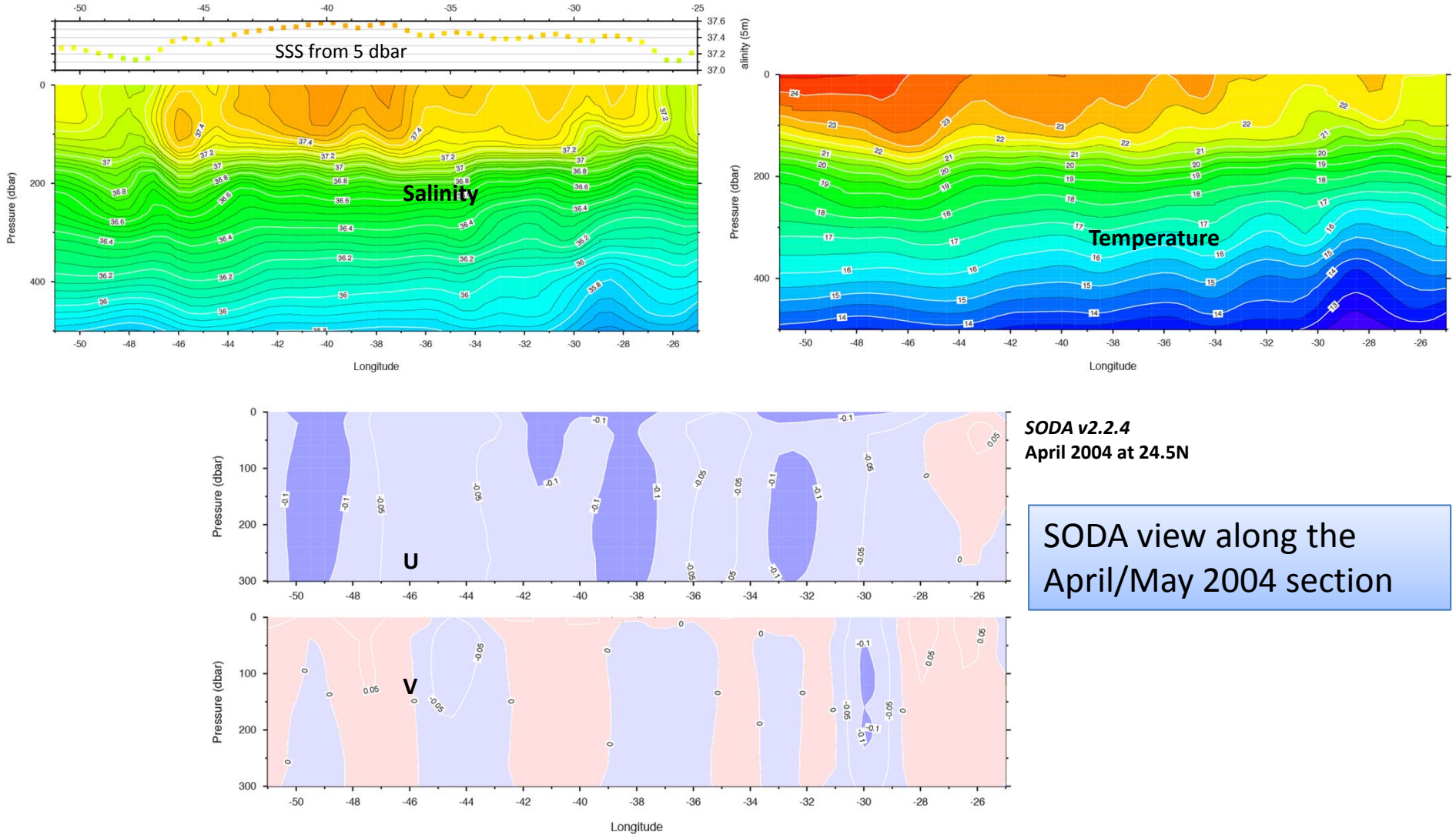
We need to see if Aquarius can contribute to the eddy flux story

RAPID program sections along 24.5°N provide SSS, stratification (CTD) and currents (hull ADCP)



Data supplied by BODC

To evalate the net convergence of freshwater by the eddy action within the subtropical box we need SSS and velocity data. We turn to the Simple Ocean Data Assimilation (SODA).



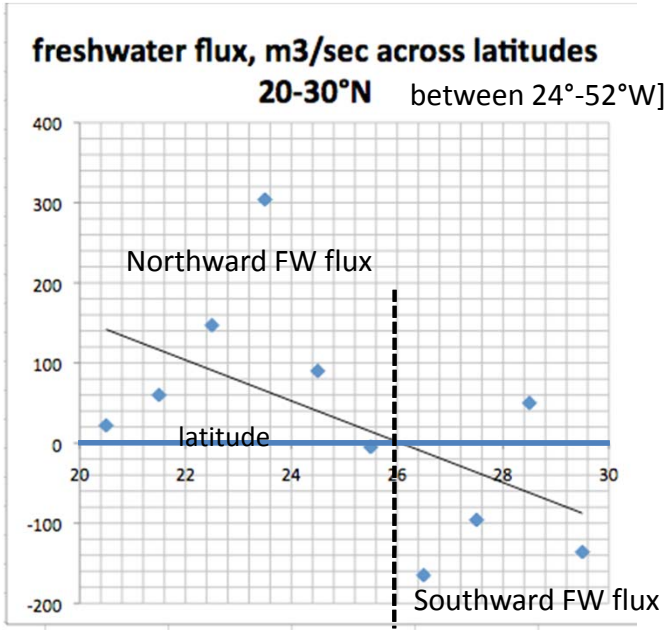
SODA v2.2.4
April 2004 at 24.5N

SODA view along the April/May 2004 section

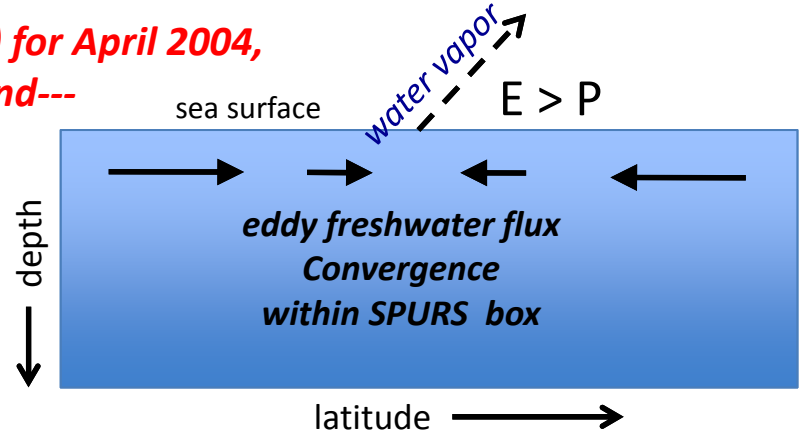
Carton, J. A. and B. S. Giese, 2008: A Reanalysis of Ocean Climate Using Simple Ocean Data Assimilation (SODA), *Mon. Weather Rev., 136, 2999-3017*

0.5°x0.5°

Using SODA salinity anomaly and meridional velocity (5 m) for April 2004, as a function of latitude from 24° to 52°W, we find---



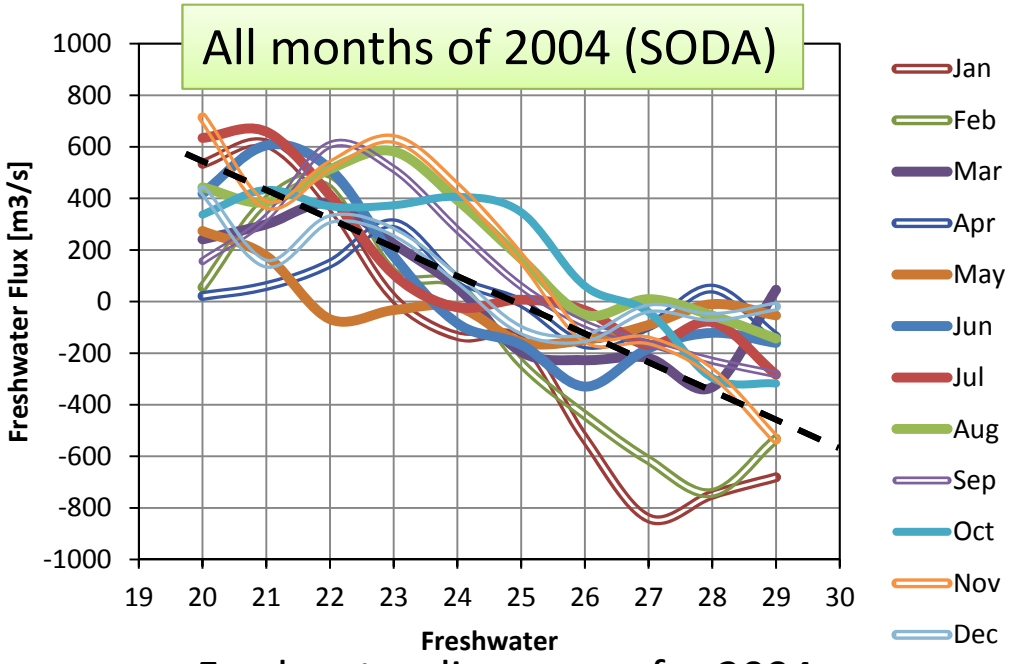
□ΔSSS * v*z

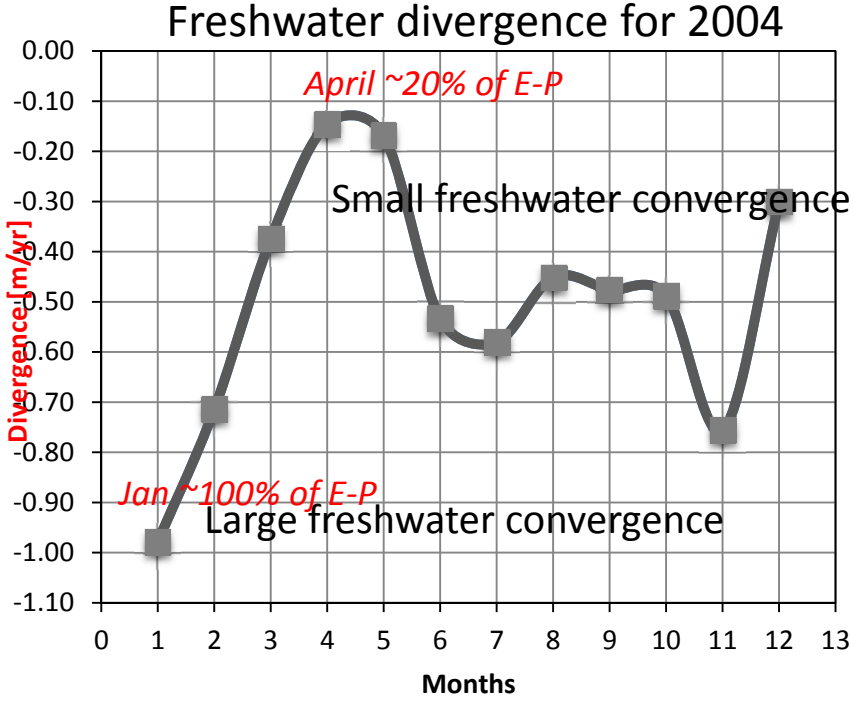


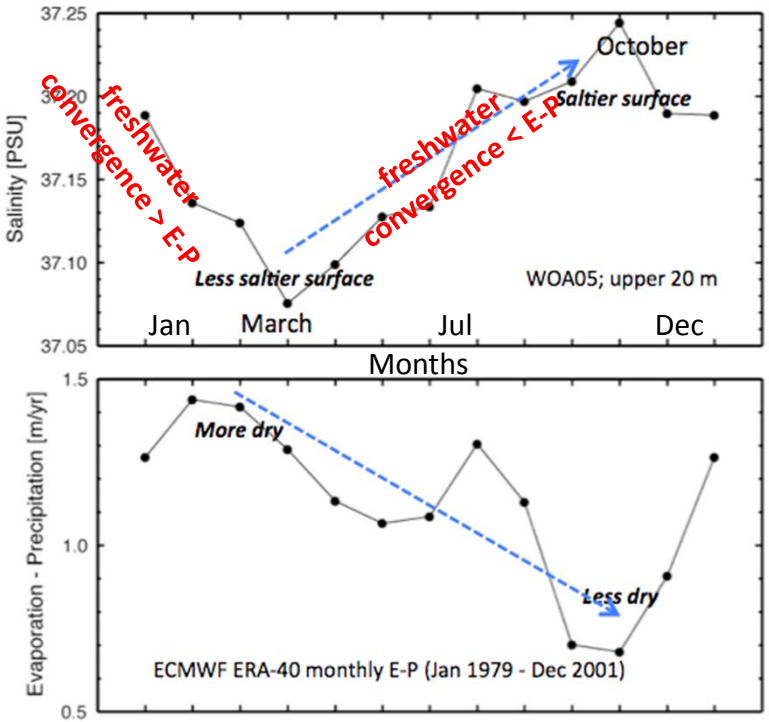
Linear fit slope for April 2004 SODA: ~0.2 m/year FW loss for surface slab of 50 m [50 m suggested by rapid and spurs data]

From the linear fit slope, assuming that the FW flux per meter depth slab is valid for the upper 50 m, we derive the freshwater convergence per m² water column of ~0.2 m/year using the April 2004 FW flux as representive of all months of the year, approximately 20% of the annual E-P.

We have not taking into account the zonal FW flux, that is freshwater may be lost along the east west dimension from the peak of the S-max near 35°W, but perhaps a more significant issue: the April 2004 mostly likely does not represent the annual mean or even the April mean.



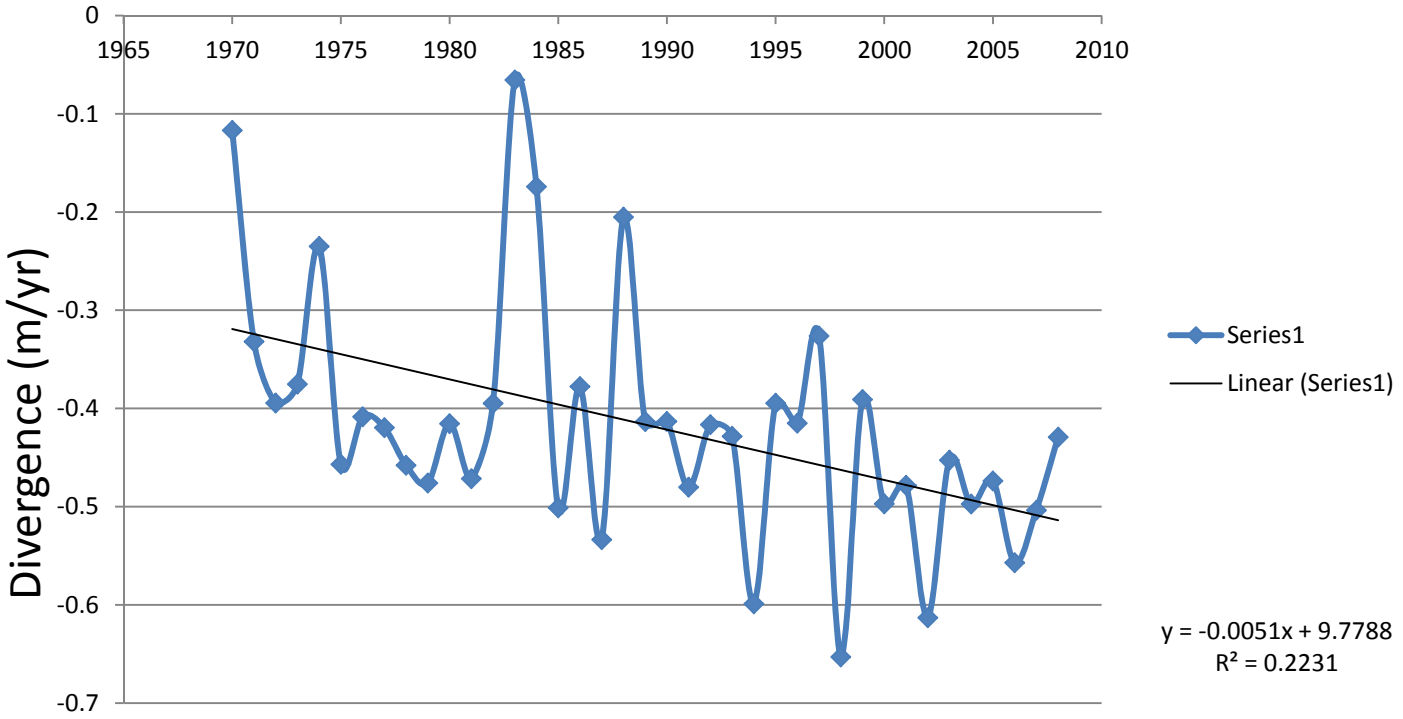


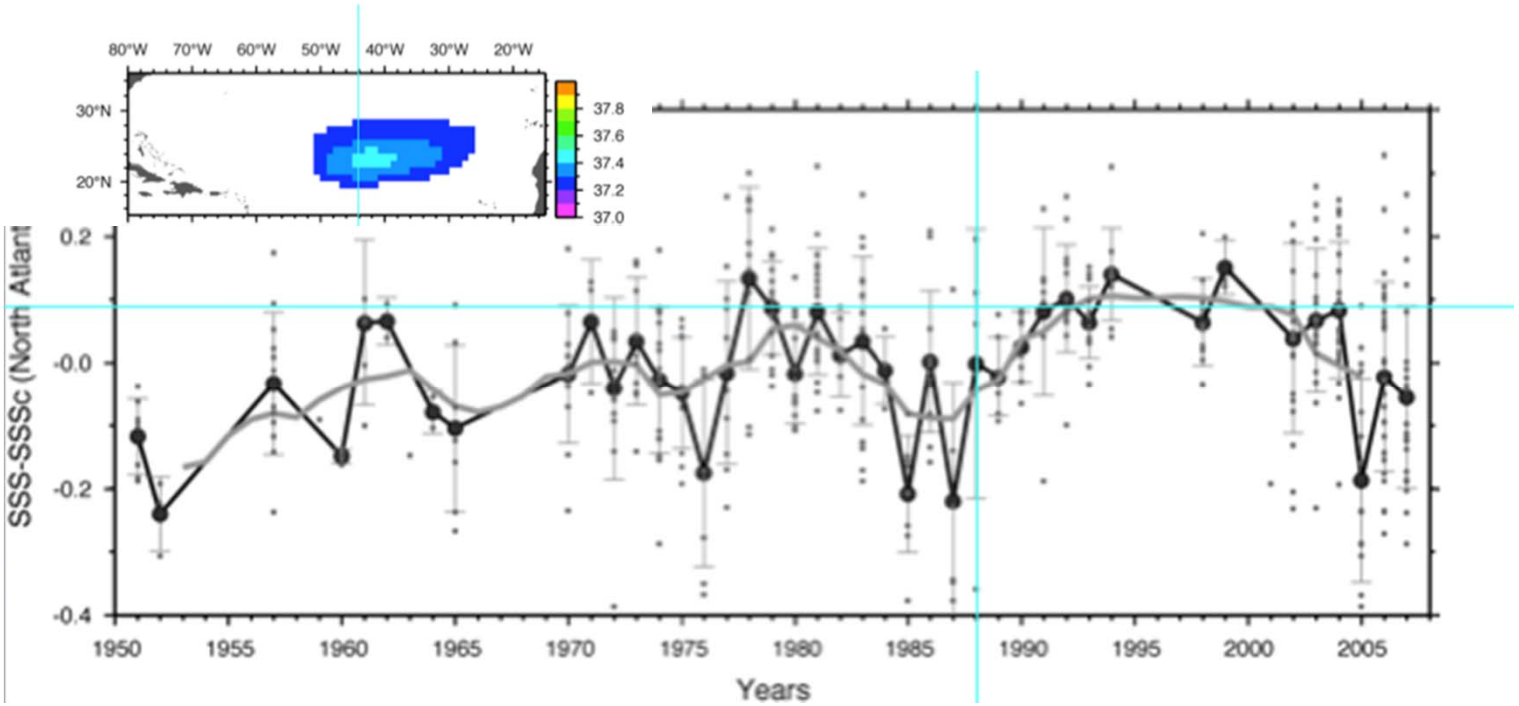


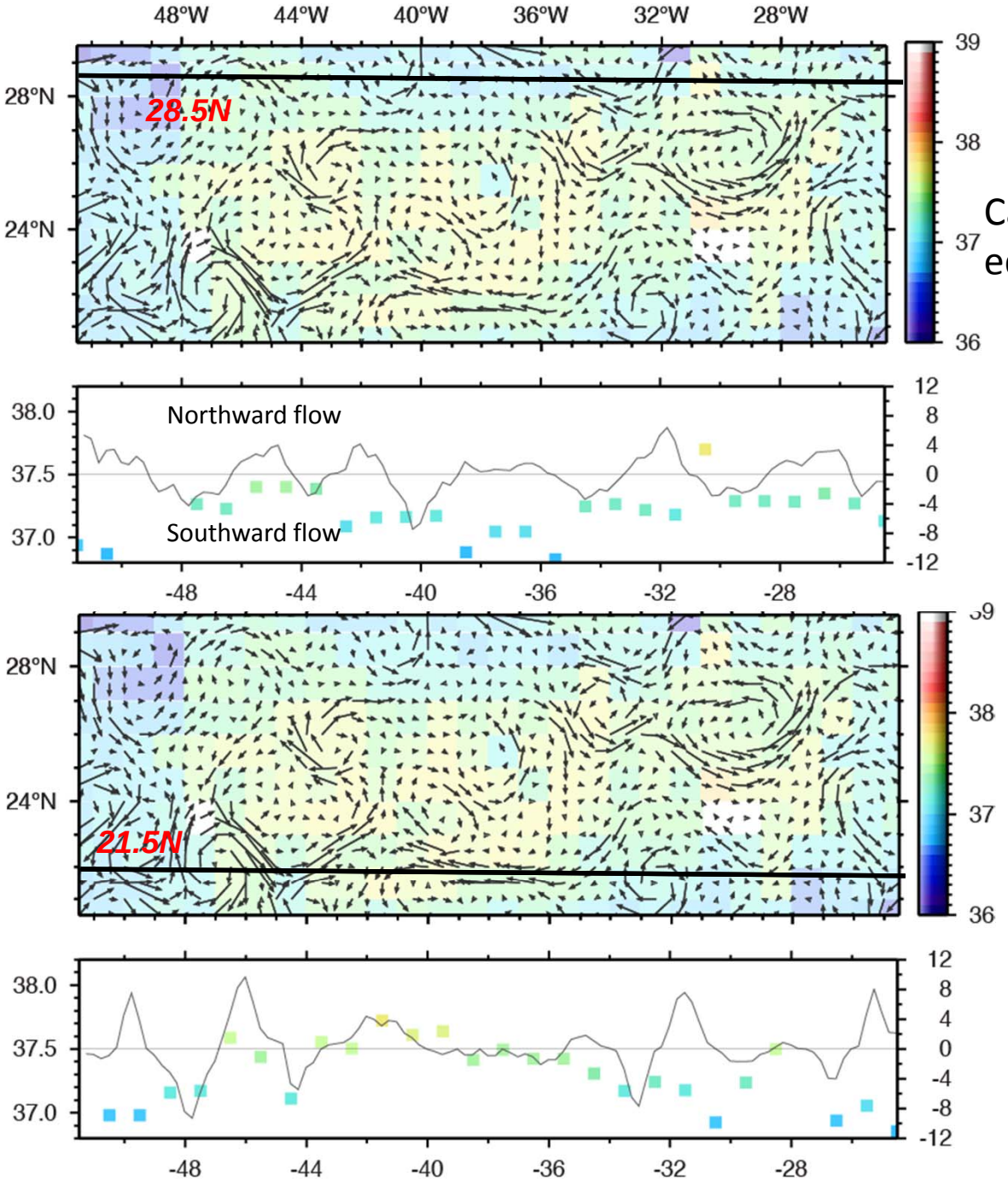
The eddies may do 50% of annual E-P

~0.50 m/year for 2004

Are eddies becoming more active? If so its not lowering N.Atl SSS-max



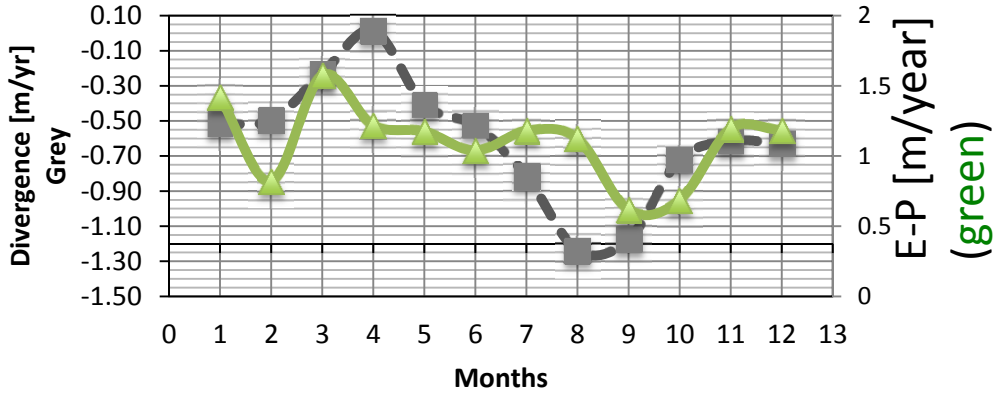


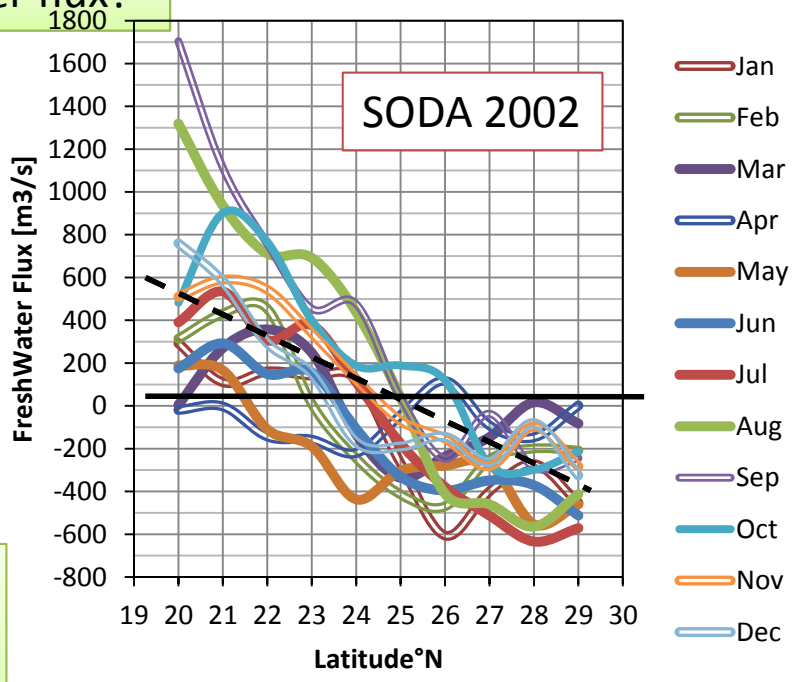


4Mar-10Mar 2012

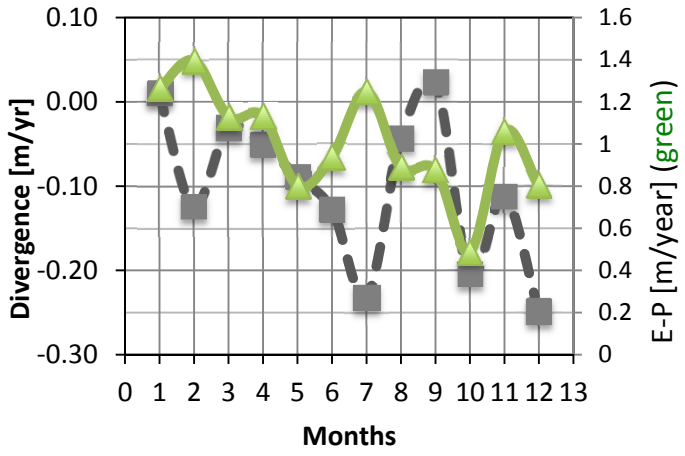
Can the Aquarius L3 get to the eddy flux [mesoscale >100 km]

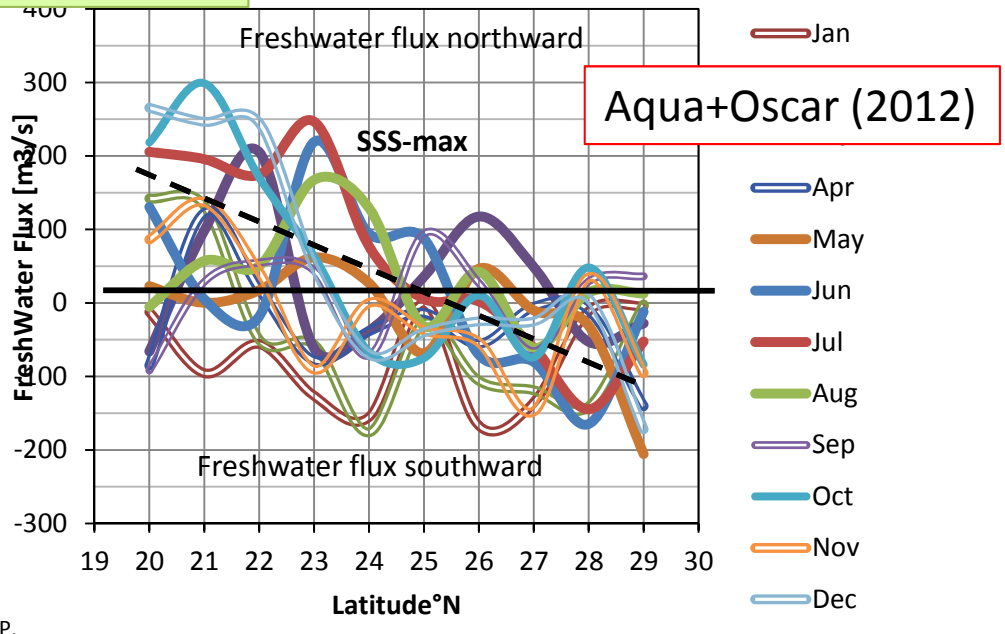
Can Aquarius L3 and Oscar get to the eddy freshwater flux?





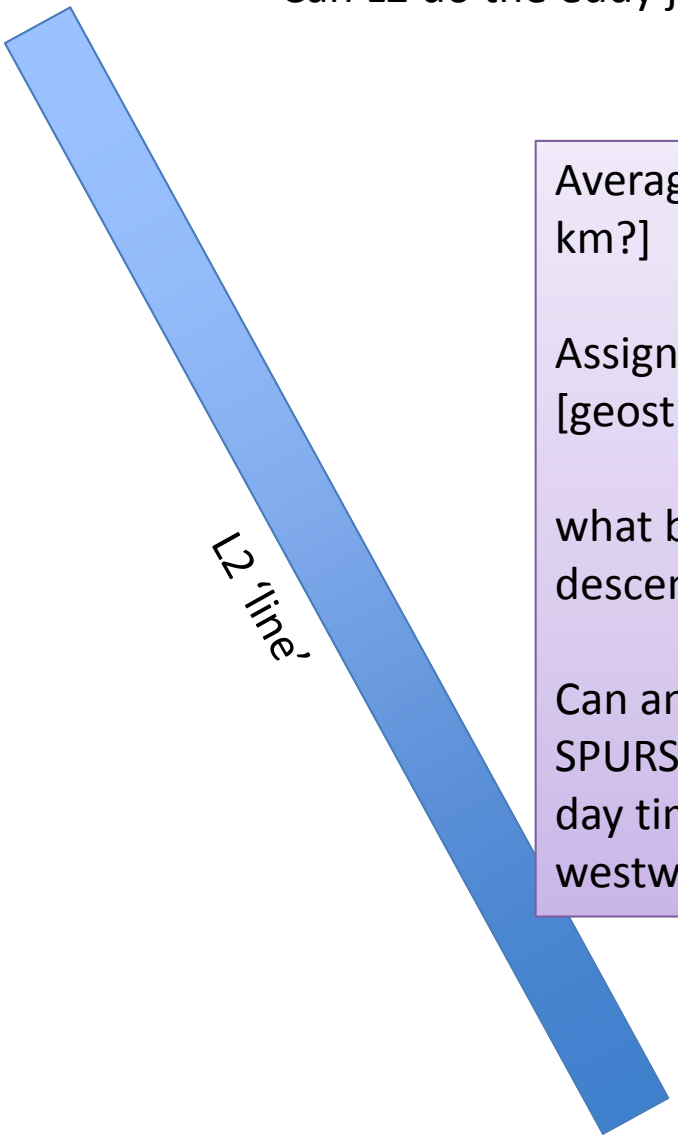
No; Aquarius based convergence annual ~0.15 m/yr
only 20% of SODA based convergence
E-P annual ~1.0 m/yr





The E-P is calculated using E from OAFlux (WHOI) and the precipitation from GPCP.

Can L2 do the eddy job?



Average SSS [anomaly] at x km [10 km?]

Assign a u and v from Aviso [geostrophic] along a L2 line.

what beams? Ascending? descending?

Can an array of dSSS*Vg within the SPURS box be constructed over a <7 day time scale? [eddies more westward ~4 km/day]

Freshwater convergence within the ocean by mesoscale eddies are essential part of the marine hydrological cycle, shaping the sea surface salinity *[surface temperature and density]* pattern.

Might satellite based observations of sea surface salinity (Aquarius L2) with sea surface topography be able to quantify this component of the ocean/climate system on the near global ocean scale?