The vertical structure of eddy freshwater transport inferred from satellite observations

and Argo profile data

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2017 Salinity Workshop, May 22-26, 2017, WHOI

Introduction

Eddy FW fluxes into the evaporative subtropics - Where do they matter?

Gordon and Giulivi (2014), North Atlantic, "…eddies can accomplish 50% to 75% of the required FW convergence into the subtropical regime" to compensate for E-P.

Amores et al. (2017), North Atlantic, "…mesoscale eddies are able to provide between 4 and 21% of the salt flux out of the area required to compensate for local E-P".

Johnson et al. (2016), "Eddy advection plays a primary role in the climatological balance of E-P fluxes, from a high of balancing 77% of climatological annual mean E-P for NI S_{max} to a low of 41% for SP S_{max}".

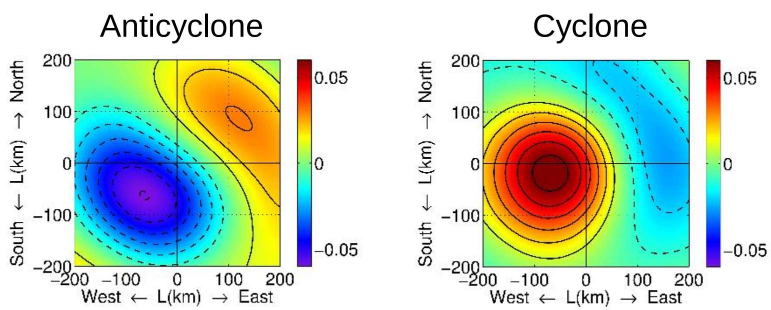
Busecke et al. (2017), "The ratio of destruction by eddy mixing in the surface layer versus the surface forcing (E-P) exhibits regional differences in the mean – from 10% in the South Pacific to up to 25% in the south Indian.

To be continued

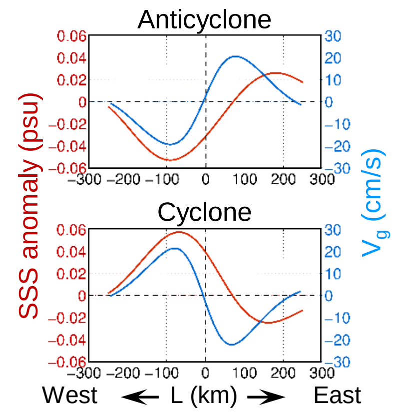
Journal of Geophysical Research: Oceans, 122(2), doi:10.1002/2016JC012420 (2017)

Signature of mesoscale eddies in satellite sea surface salinity data

Oleg Melnichenko, Angel Amores, Nikolai Maximenko, Peter Hacker, and James Potemra



Composite averages of eddy-induced SSS anomalies



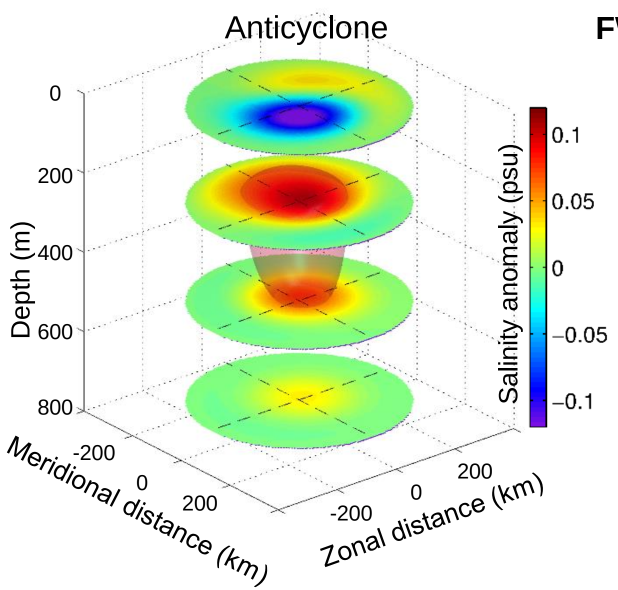
FW flux by an eddy

$$F_y = -\frac{h}{S_o}\int_{-L}^{L}\langle v'\rangle\langle S'\rangle dx$$

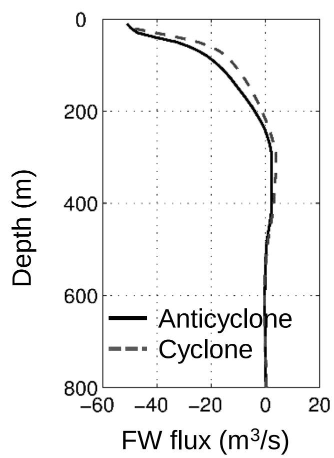
Journal of Geophysical Research: Oceans, 122(1), doi:10.1002/2016JC012420 (2017)

Coherent mesoscale eddies in the North Atlantic subtropical gyre: 3D structure and transport with application to the salinity maximum

Angel Amores, Oleg Melnichenko, and Nikolai Maximenko

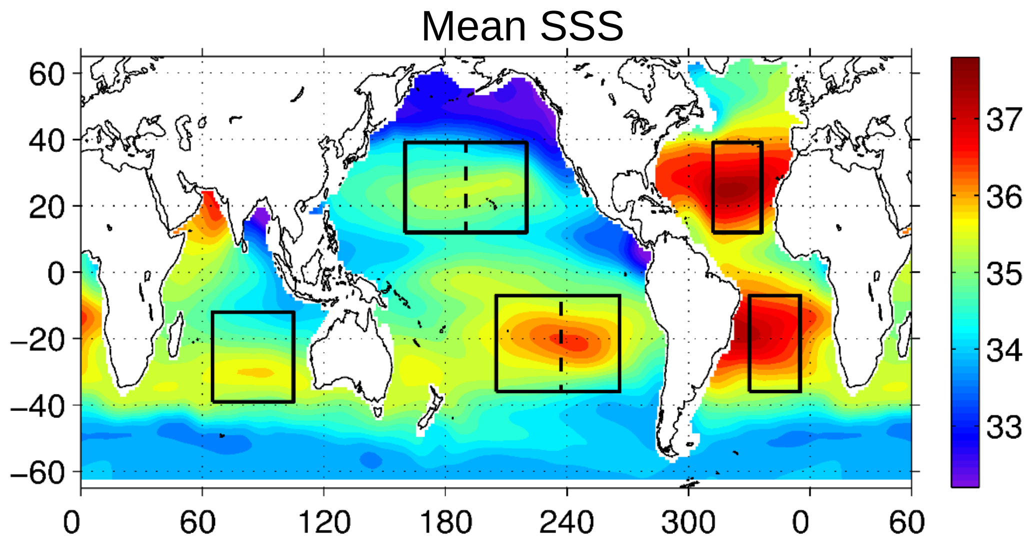


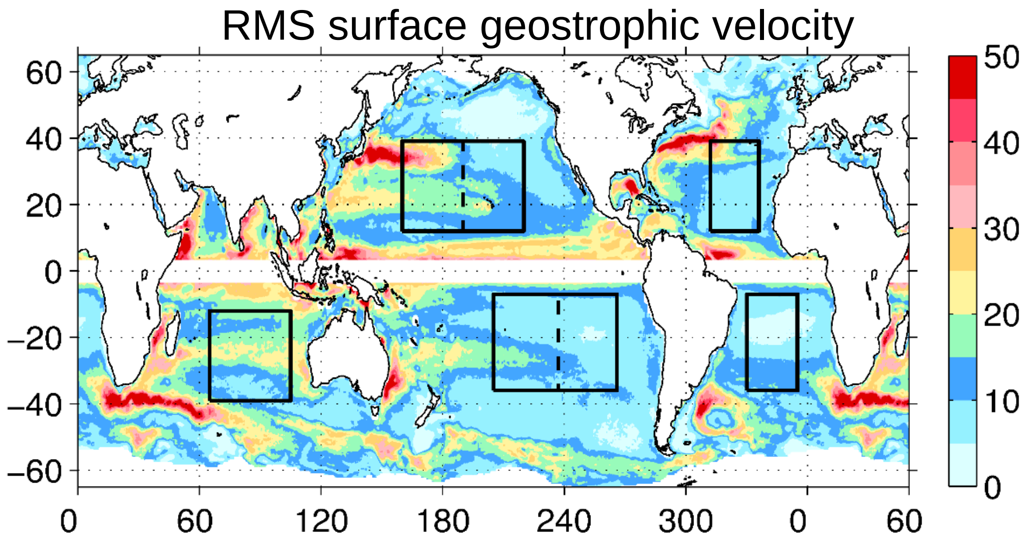
FW flux per eddy in 1 m depth bins



Example: Composite eddies in the south Indian Ocean [65°E-105°E, 29°S-16°S]

Focus areas



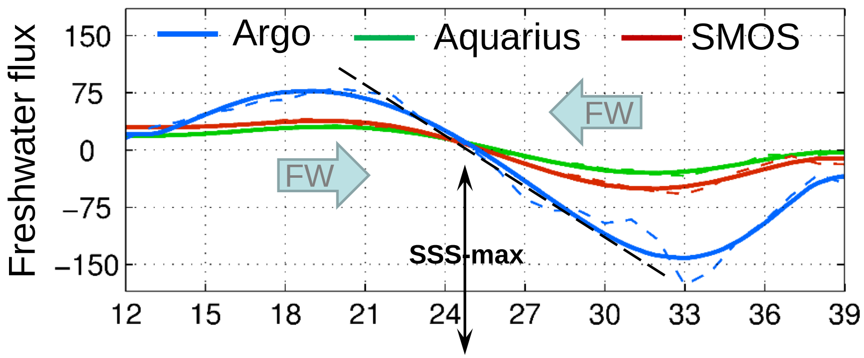


Data: Aquarius OI SSS, SMOS BEC SSS, SLA by Aviso, Argo profile data, Eddy dataset by Chelton et al. (2011).

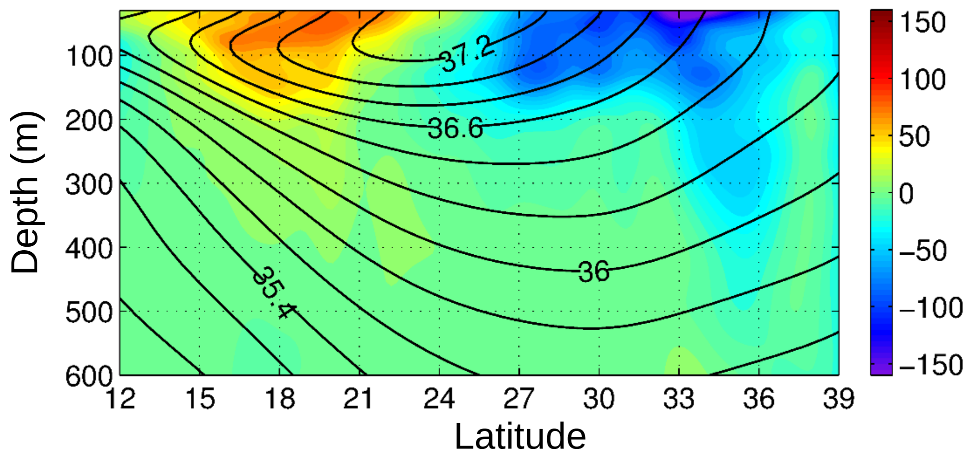
Eddy freshwater transport in the subtropical NA

Meridional eddy FW transport in 1 m depth layers

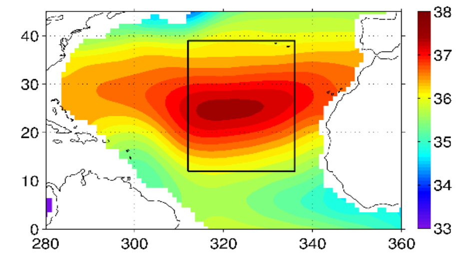
In the surface mixed layer



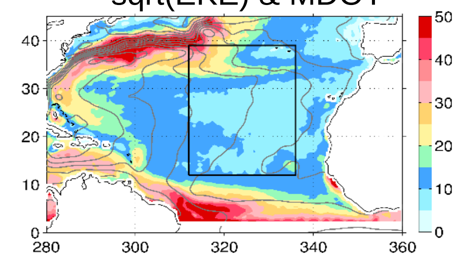
as a function of depth



Mean SSS



sqrt(EKE) & MDOT

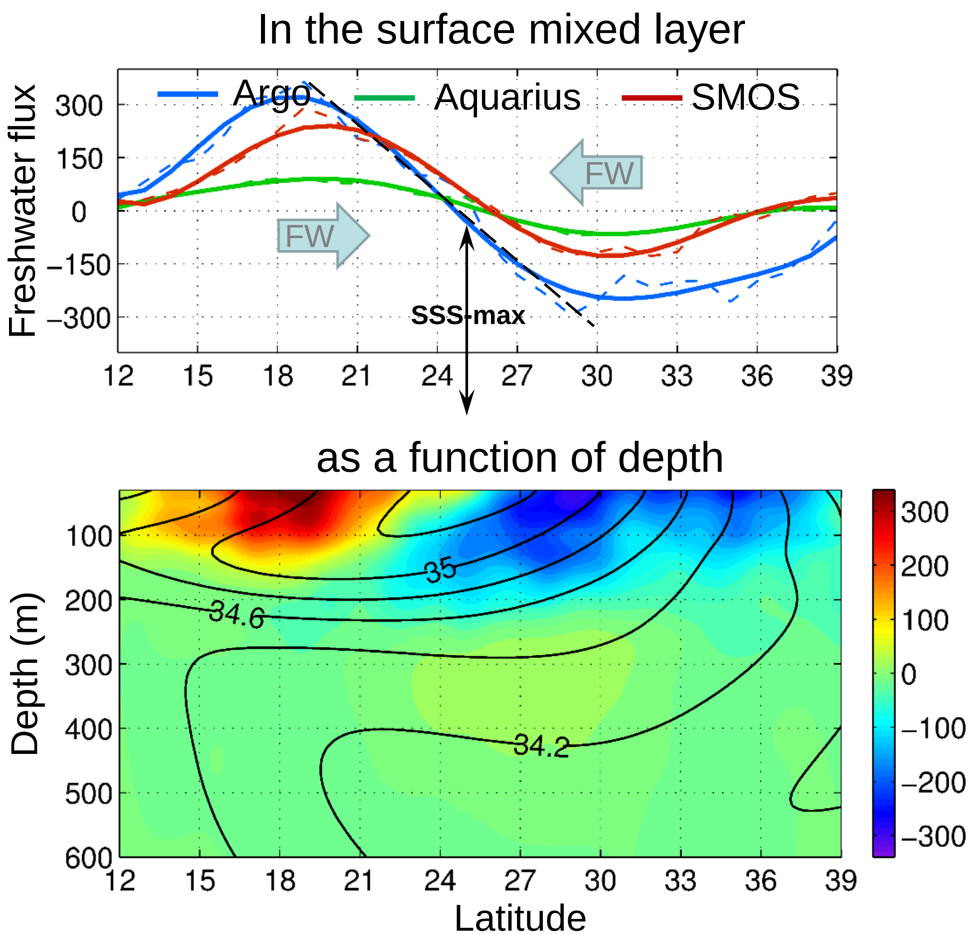


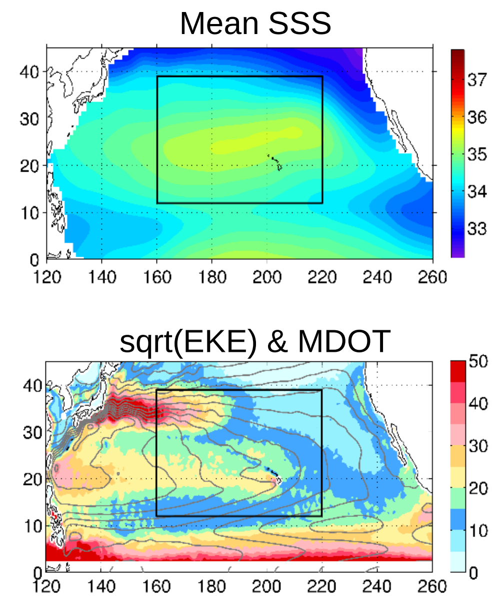
Eddy FW div in 50 m ML as % of E-P

Argo	– 12%
SMOS	– 6%
Aquarius	– 3.5%

Eddy freshwater transport in the subtropical NP

Meridional eddy FW transport in 1 m depth layers





Eddy FW div in 50 m ML as % of E-P

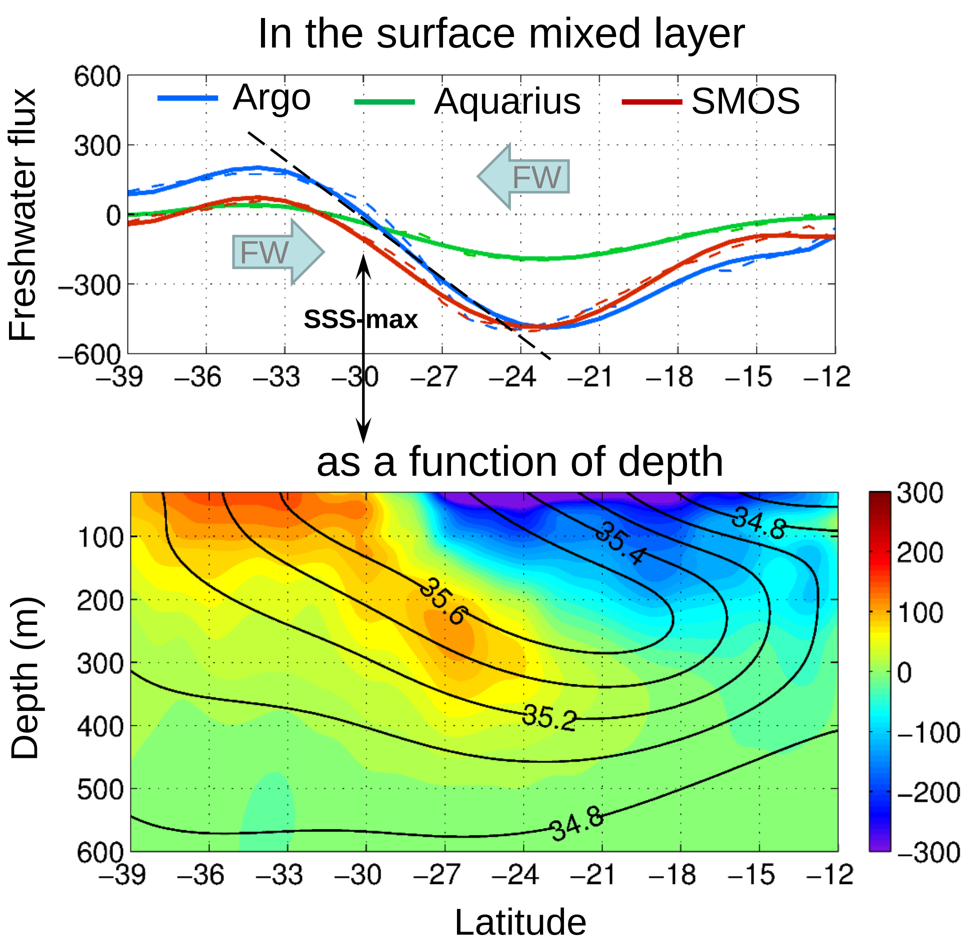
Argo – 17%

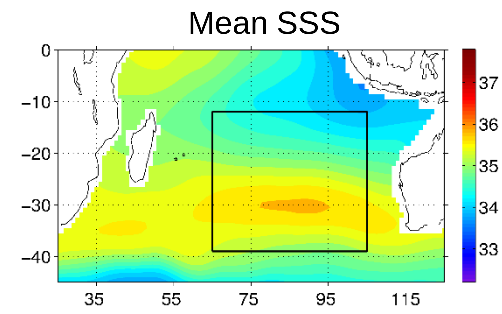
SMOS – 8.5%

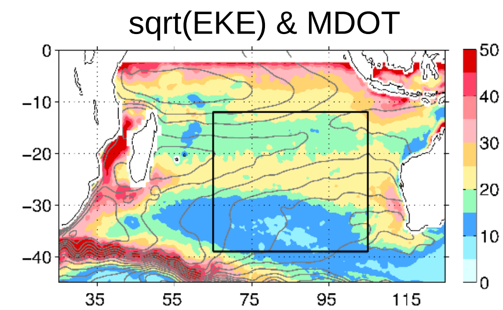
Aquarius – 4%

Eddy freshwater transport in the south Indian Ocean

Meridional eddy FW transport in 1 m depth layers







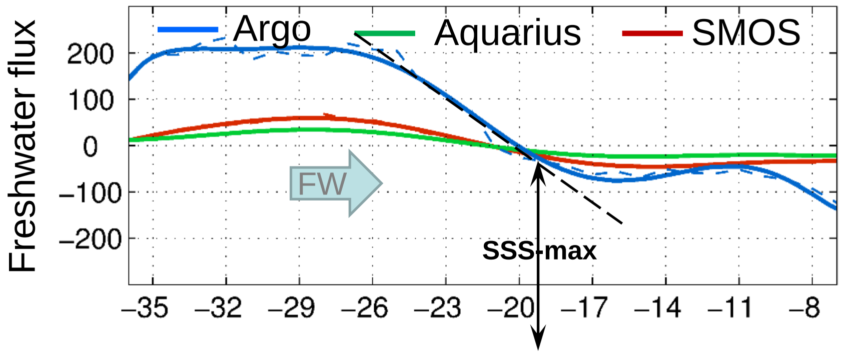
Eddy FW div in 50 m ML as % of E-P

Argo	– 27%
SMOS	– 23%
Aquarius	– 11%

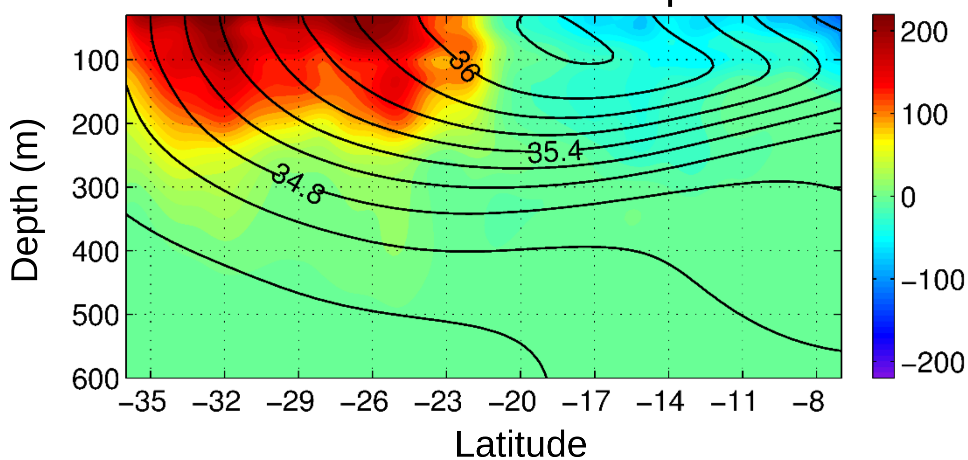
Eddy freshwater transport in the subtropical SP

Meridional eddy FW transport in 1 m depth layers

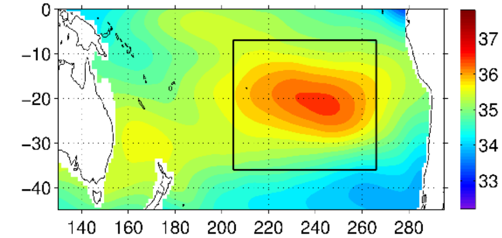
In the surface mixed layer



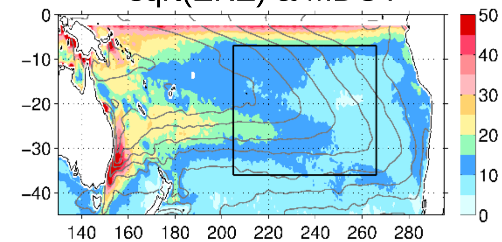
as a function of depth



Mean SSS



sqrt(EKE) & MDOT

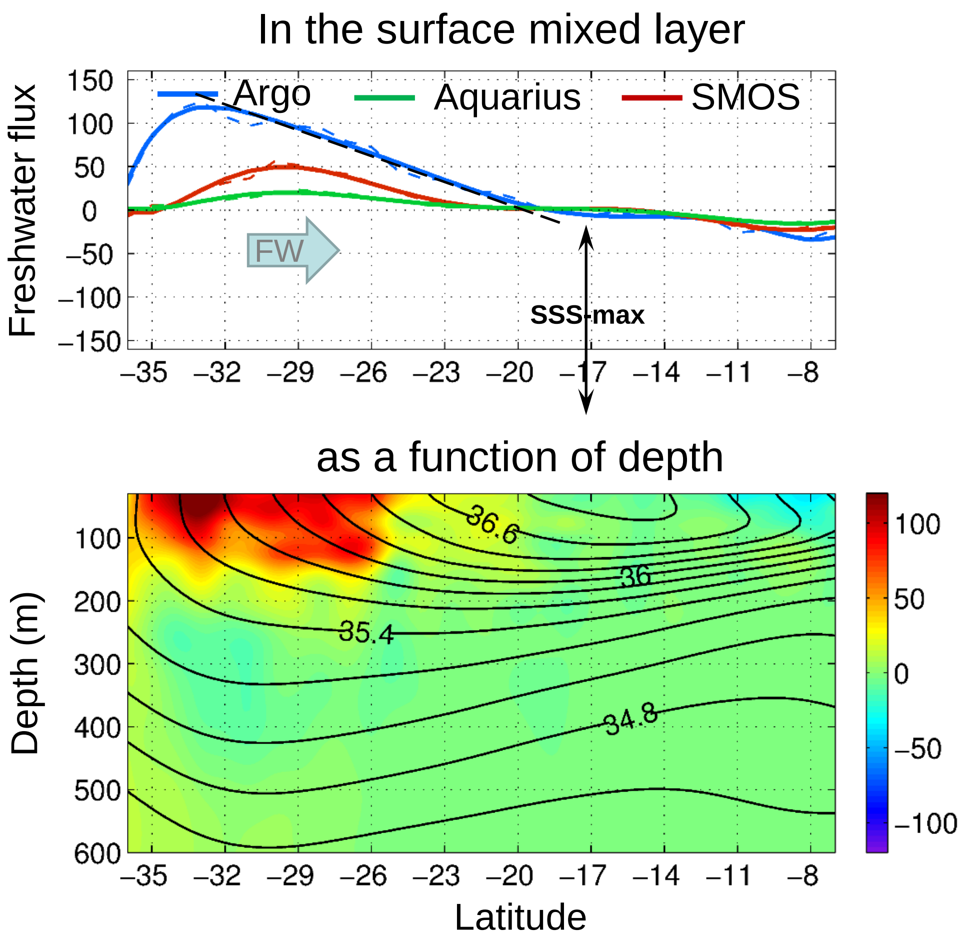


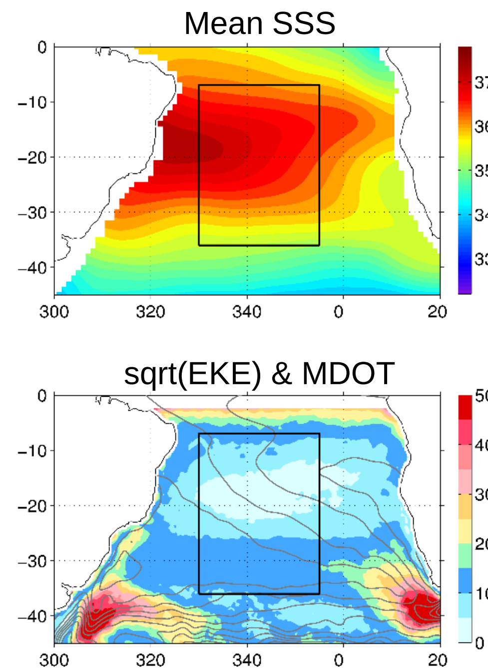
Eddy FW div in 50 m ML as % of E-P

Argo	– 11%
SMOS	– 5%
Aquarius	– 2.5%

Eddy freshwater transport in the subtropical SA

Meridional eddy FW transport in 1 m depth layers



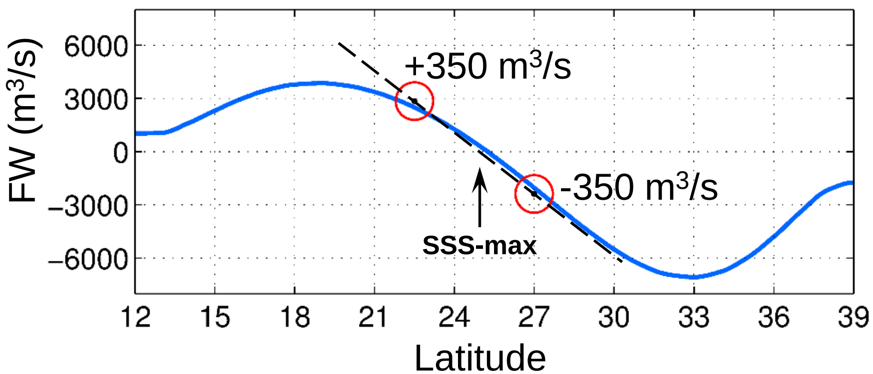


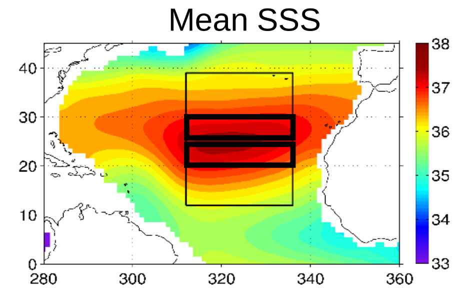
Eddy FW div in 50 m ML as % of E-P

Argo	– 7.5%
SMOS	– 4%
Aquarius	– 2%

Where do eddy FW fluxes matter?

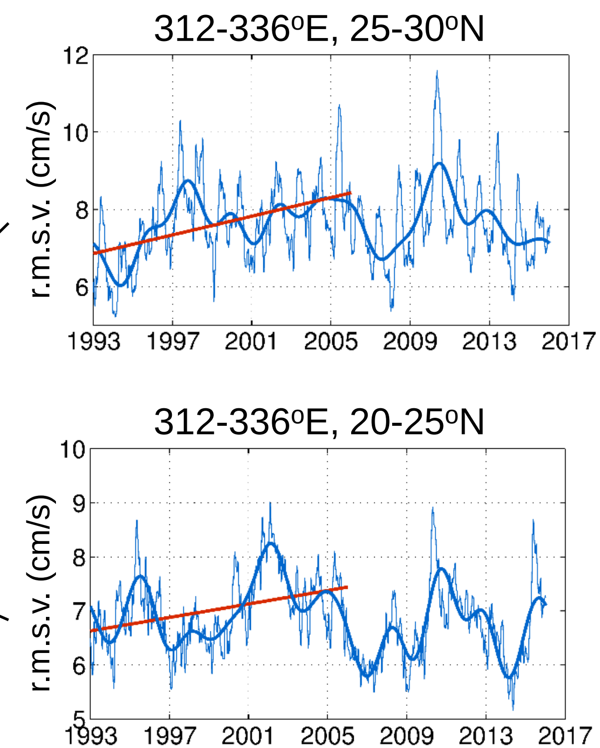
Meridional eddy FW transport in ML of 50 m between 312-336°E

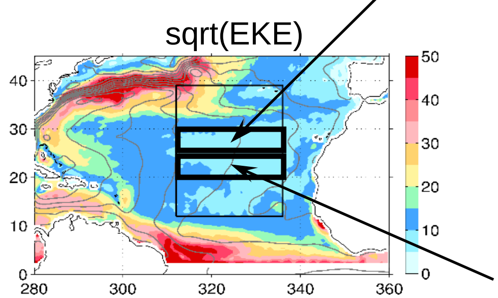




Horizontal eddy advection balances ~10% of climatological annual mean E-P. However, temporal variations are extremely important. E.g., changing the eddy FW convergence by 10%, acting alone, would lead to SSS decrease in the SSS-max by 0.1 psu accumulated over a 10-yr period.

RMS eddy velocity





Conclusions

1) % of E-P balanced by horizontal eddy advection estimated from satellite SSS and Argo profile data

	NA	**NP**	**SI**	**SP**	**SA**
In-situ	12%	17%	27%	11%	7%
SMOS	6%	8%	23%	5%	4%
Aquarius	3%	4%	11%	3%	2%

2) Satellite and in-situ estimates of the eddy FW flux in the surface mixed layer are consistent qualitatively. They agree quantitatively if “attenuation” coefficients are taken into account.

3) In the vertical, the eddy FW transport is largely confined to the upper 200 m (southern Indian is an exception) with a clear signature of the subsurface “river of salt”. Thus eddies and the eddy transport are an essential component of the shallow meridional overturning circulation, connecting tropics and subtropics.

4) Temporal variability in the eddy FW transport is extremely important and can be an essential component of climate variability.


Thank you