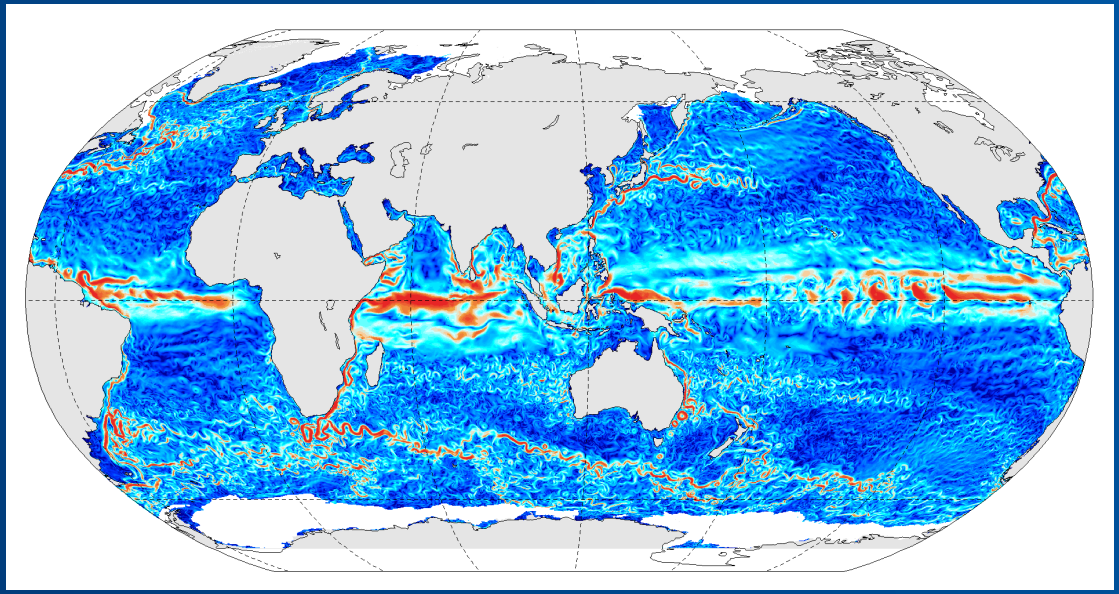
Ocean eddies drive the export of salt out of the subtropical gyres: insights from the DRAKKAR 1/12° global model



Instantaneous surface velocity in the 1/12) ORCA12 numerical model

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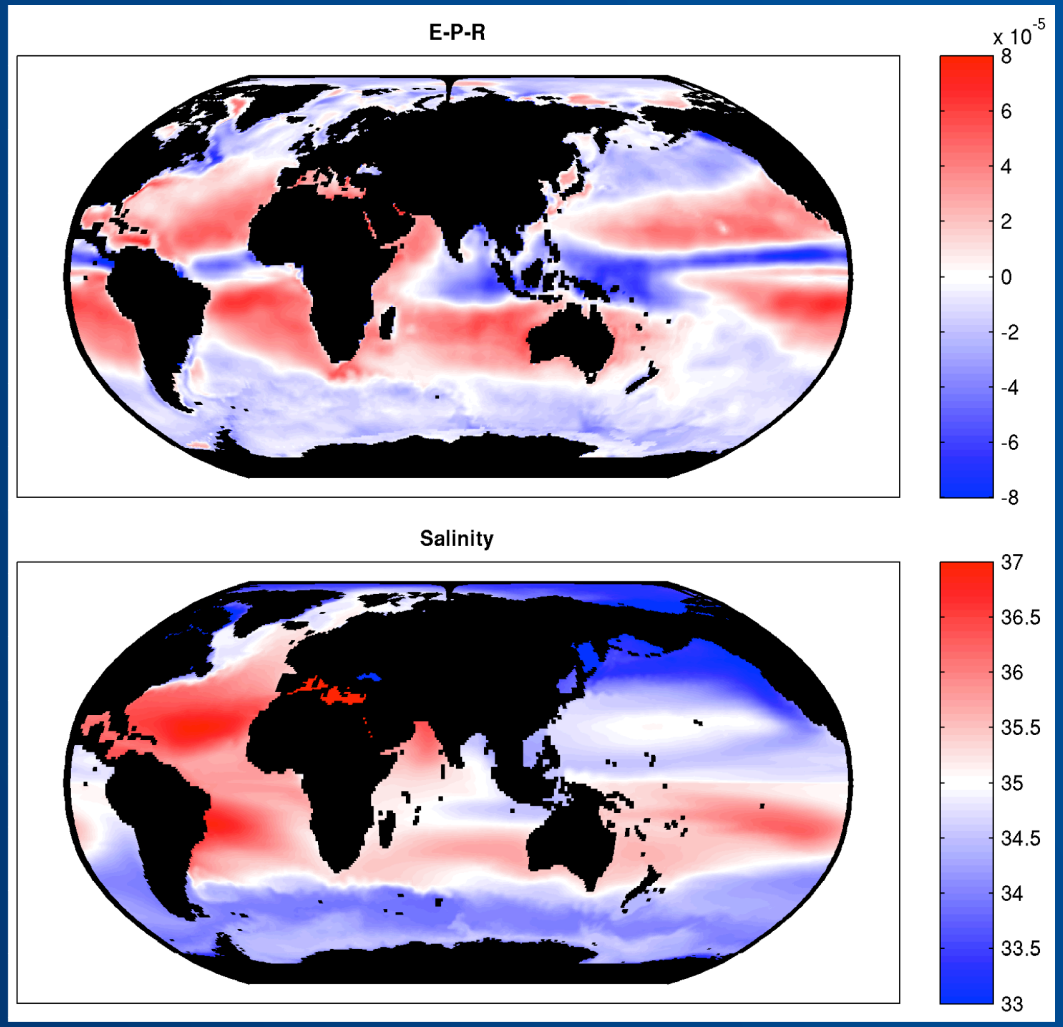
What controls the distribution of salt in the ocean?



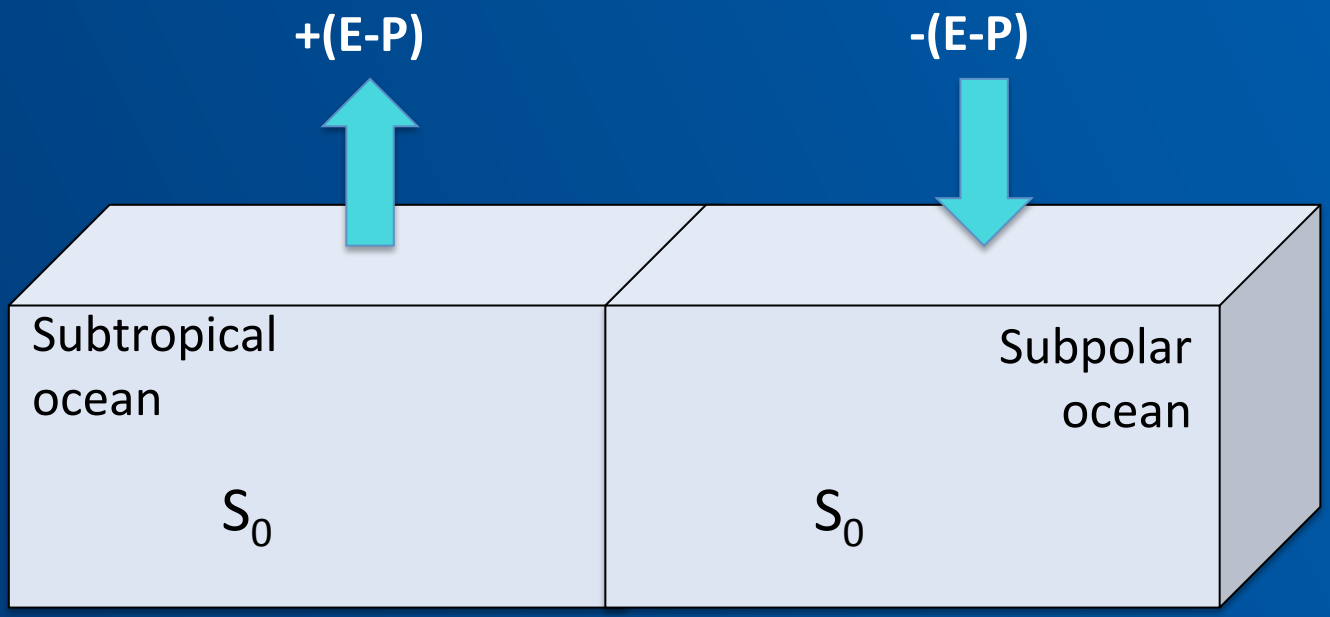
Balance between E-P-R …

And transport by the ocean circulation

E-P-R: $Kg.m^{-2}s^{-1}$

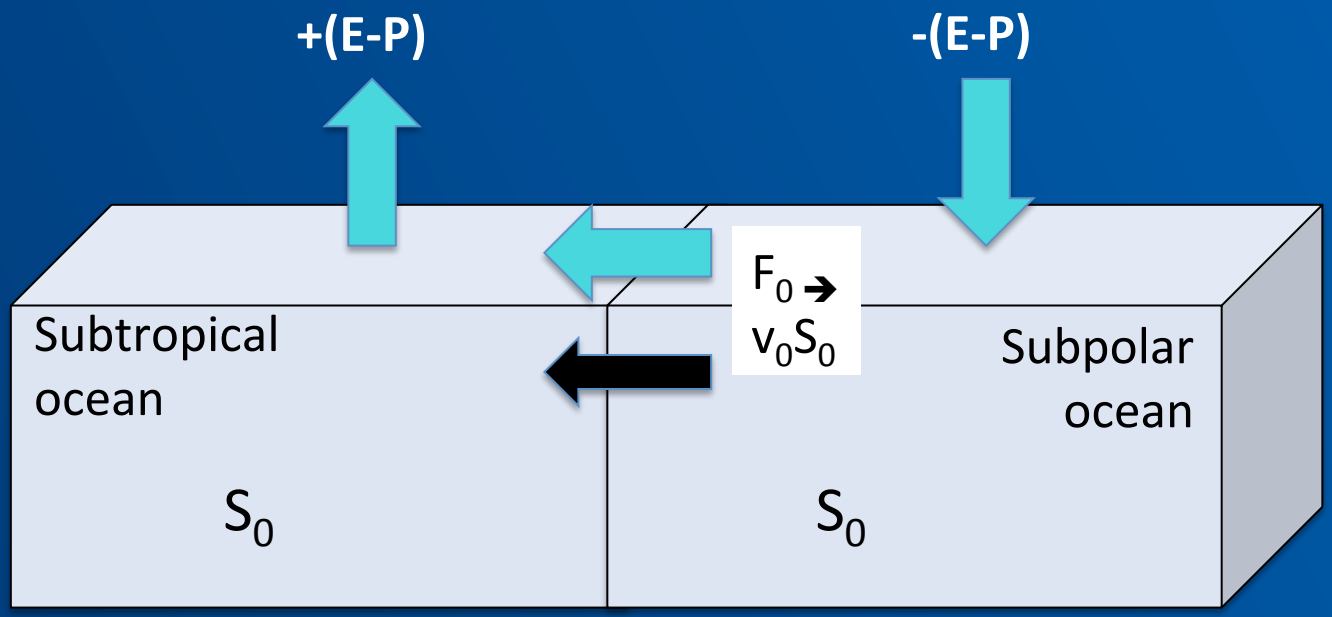
Salinity (PSU) averaged over the top 200m

E-P-R and ocean circulation



A simple two-box model: ocean at rest, uniform salinity

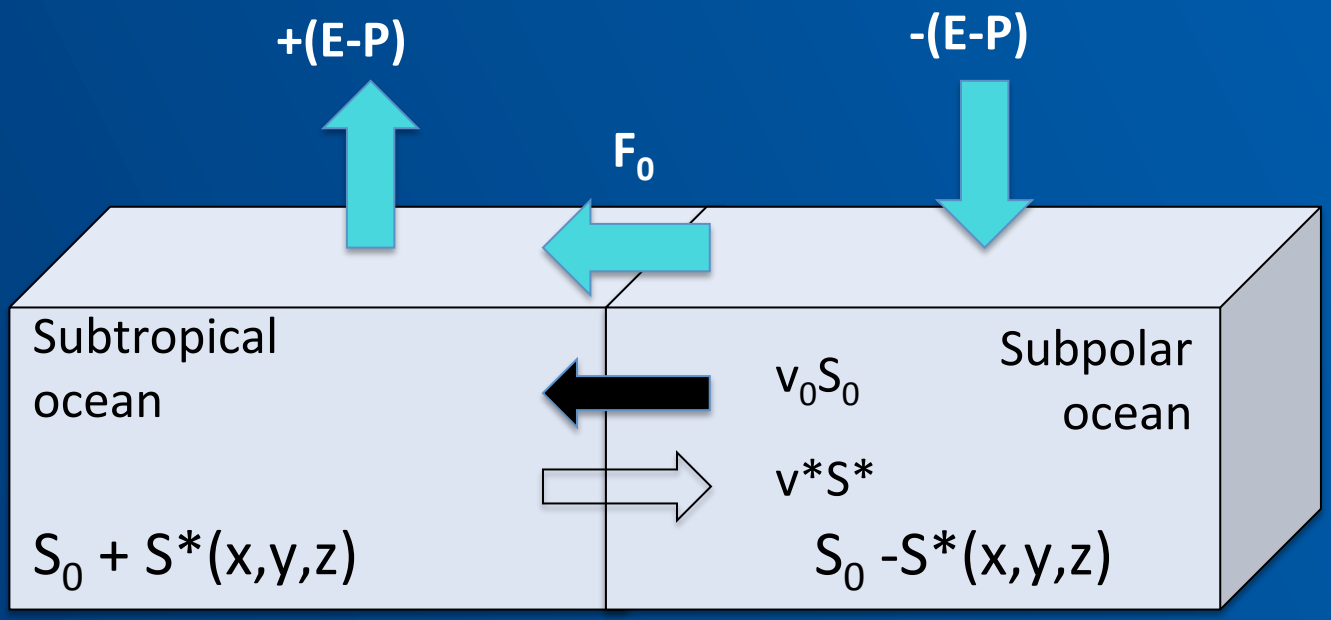
Spin up of a two-box ocean



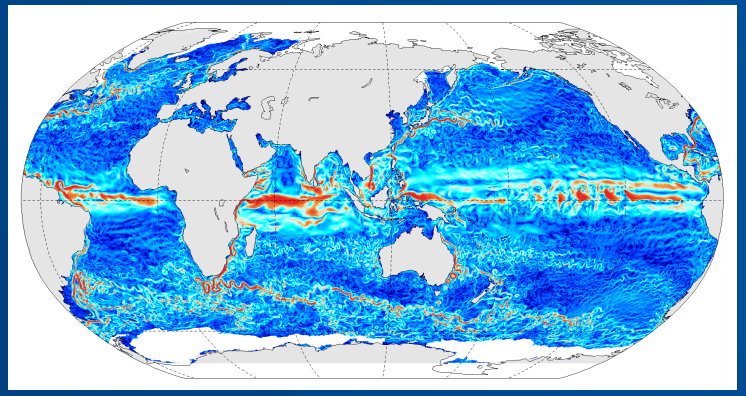
Mass flux F_0 implies a salt flux :

the subtropical ocean gets saltier, the subpolar ocean fresher.

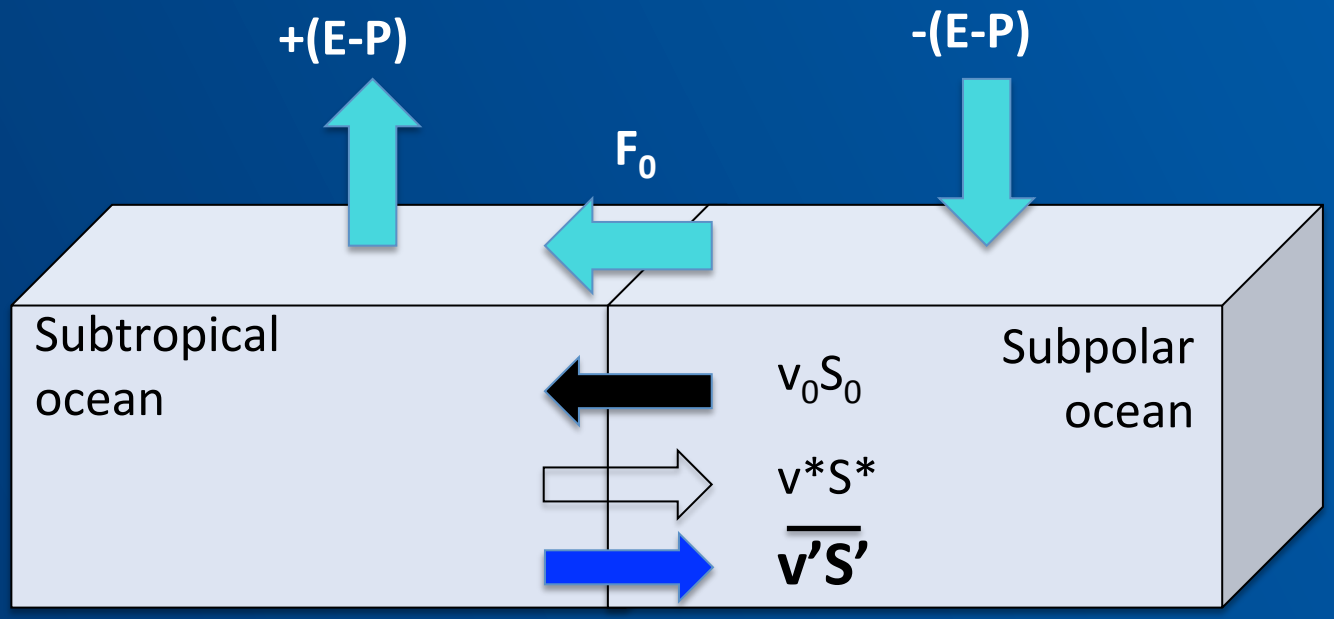
At equilibrium, salt transport is zero



A mass-compensated recirculation, v*S*, compensates the salt carried by the net mass flux.



In the eddying ocean…



Objective: quantify the salt flux due to transient eddy correlations

Global 1/12° DRAKKAR simulation

Ocean-ice model, www.drakkar-ocean.eu

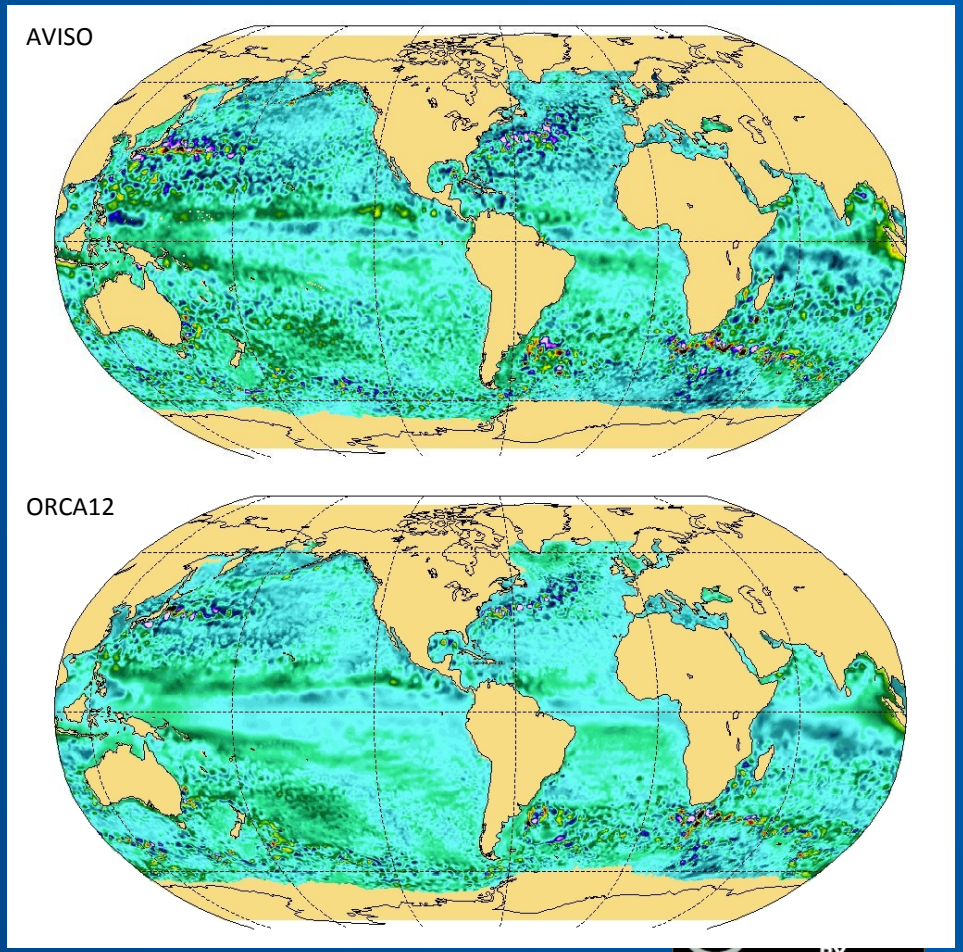
Global 1/12° tripolar ORCA grid, NEMO platform (www.nemo-ocean.eu)

Climatological atmospheric forcing (DFS, Brodeau et al 2013)

We use the last 10 years of a 85-years long simulation

At 1/12°:

Good representation of sea level anomaly and Western boundary currents



A decomposition of the meridional salt transport in the model

$$F_0(y,t) = \iint_s v$$

$$S_0(y,t) = \frac{1}{A}\iint_s S$$

F_0 : volume flux across the section *s*
S_0 : salinity averaged over the section area *A*

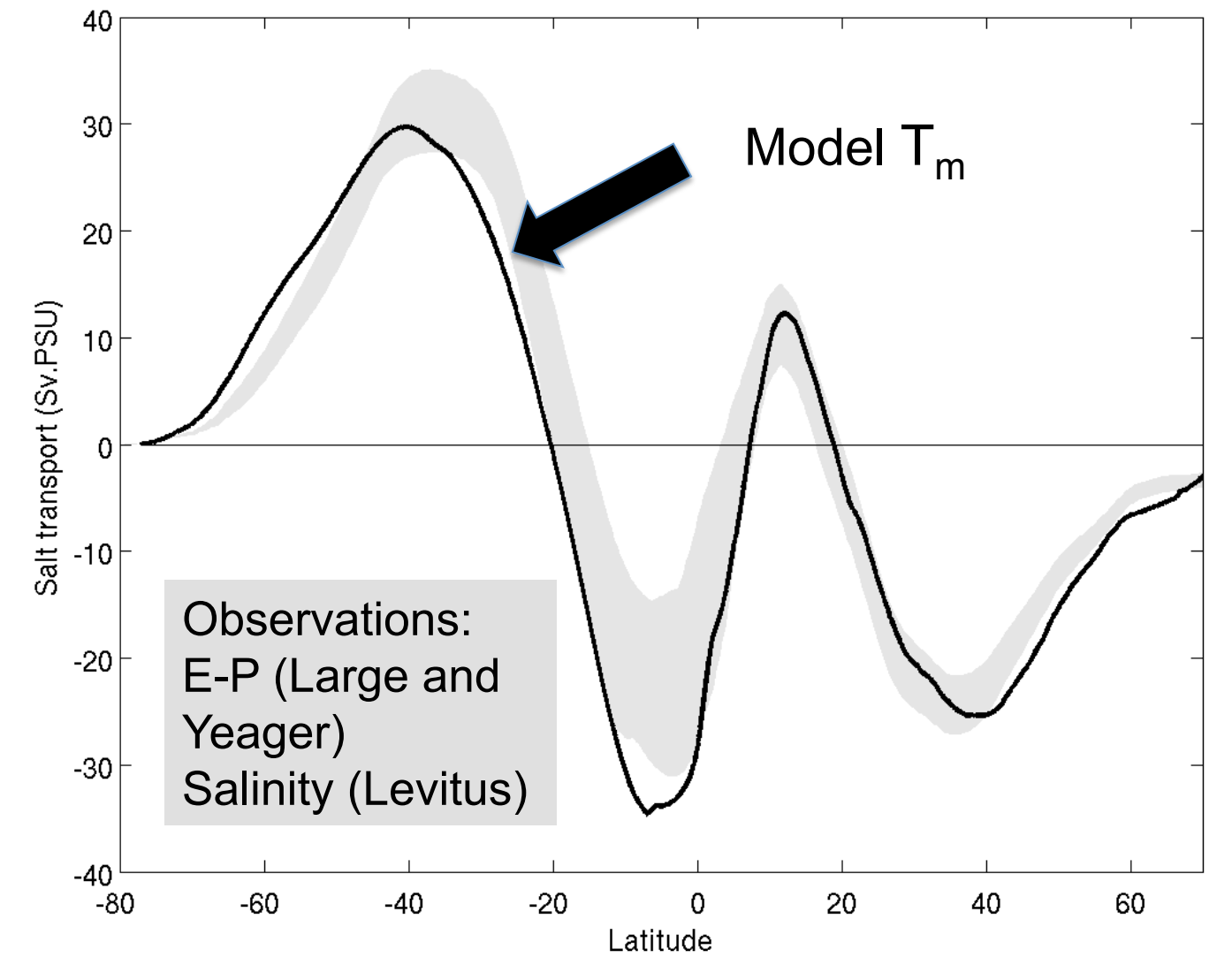
$$\iint_s vS = F_0 S_0 + \iint_s \overline{(vS)^*} + \iint_s \overline{v'S'}$$

T_m
Transport by net mass flux (related to E-P-R)

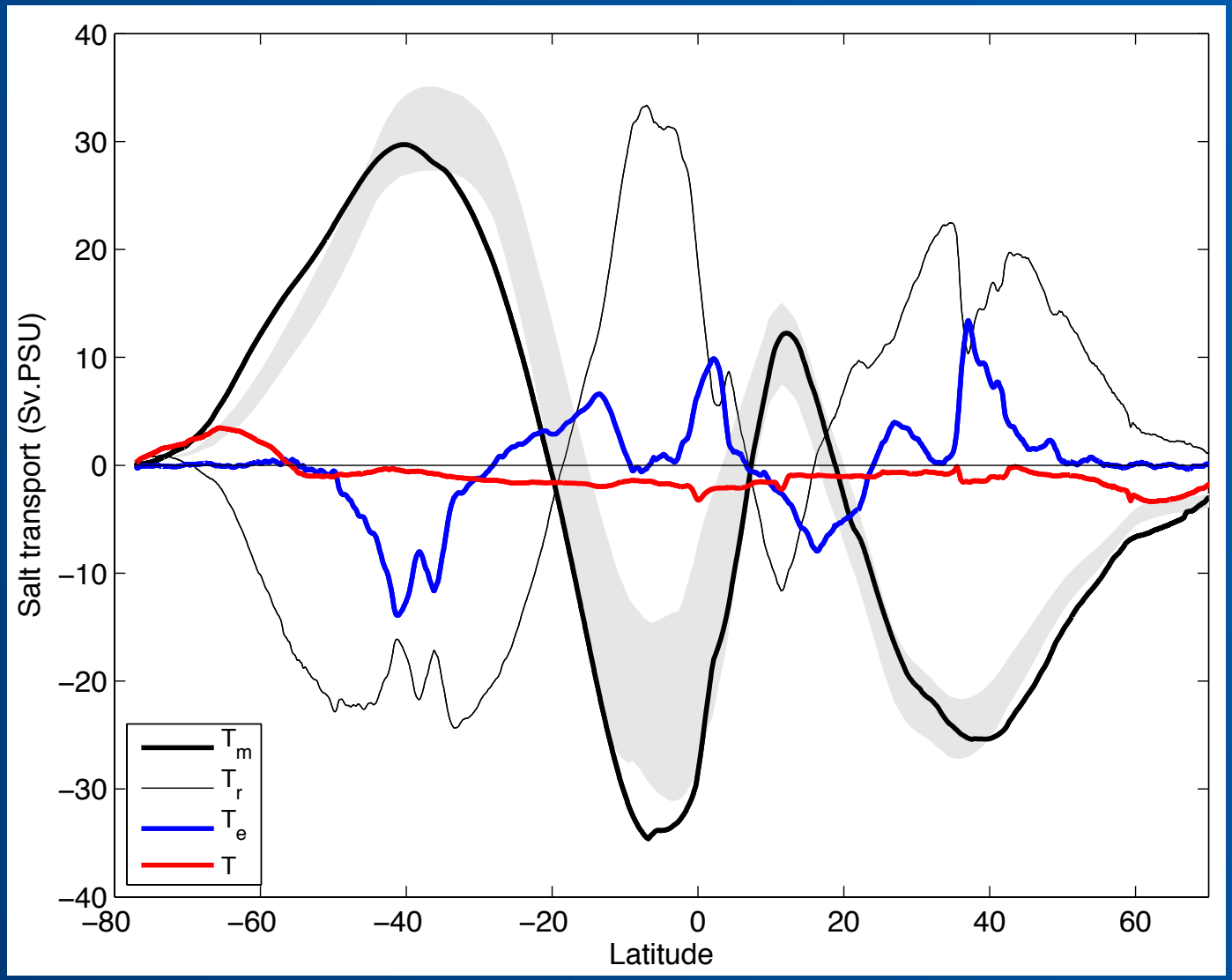
T_r
Transport by time-mean recirculation

T_e
Transport by eddy fluctuations.

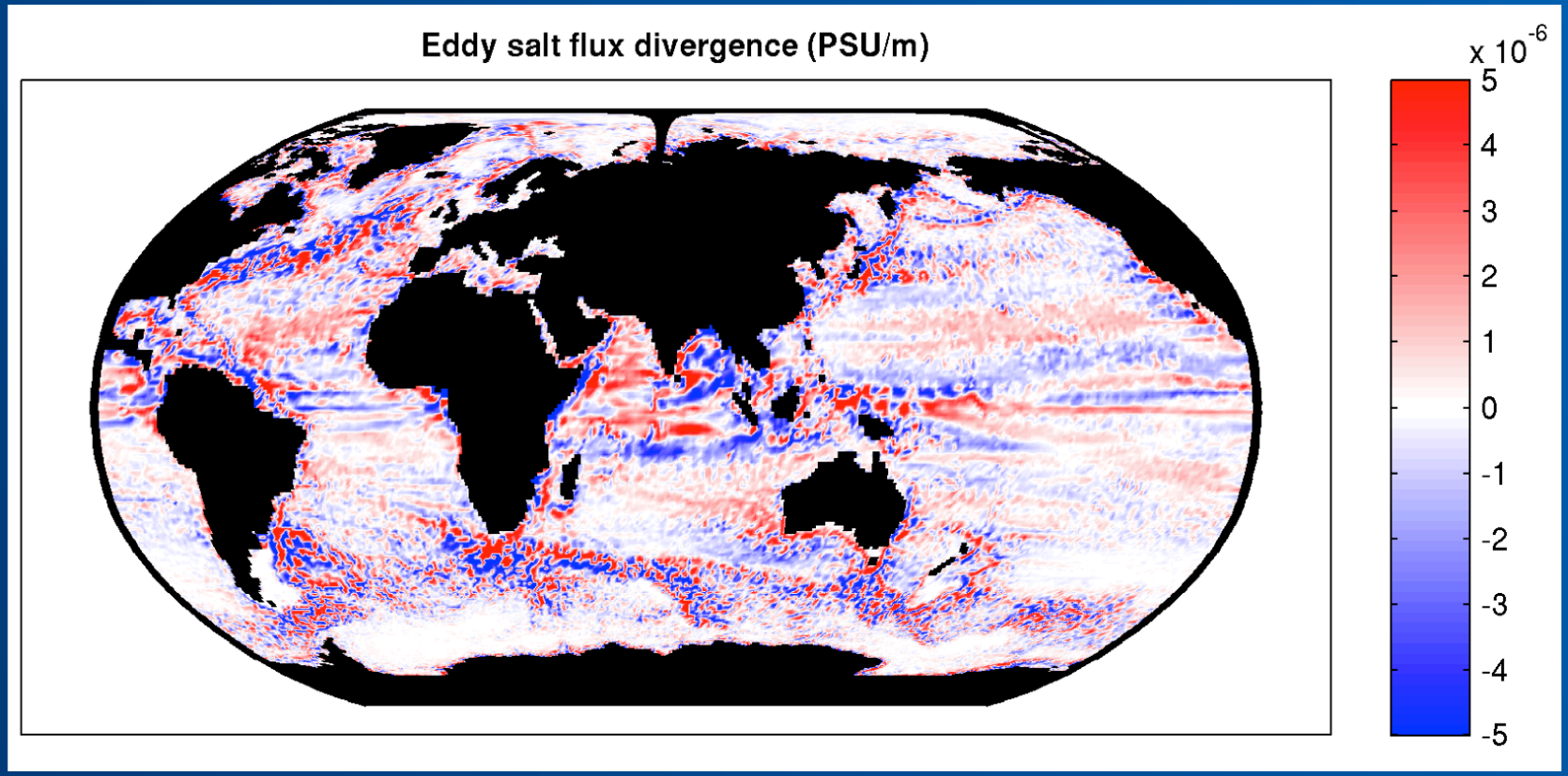
Salt transport by the net mass flux



All contributions to the salt transport



Map of eddy salt flux divergence

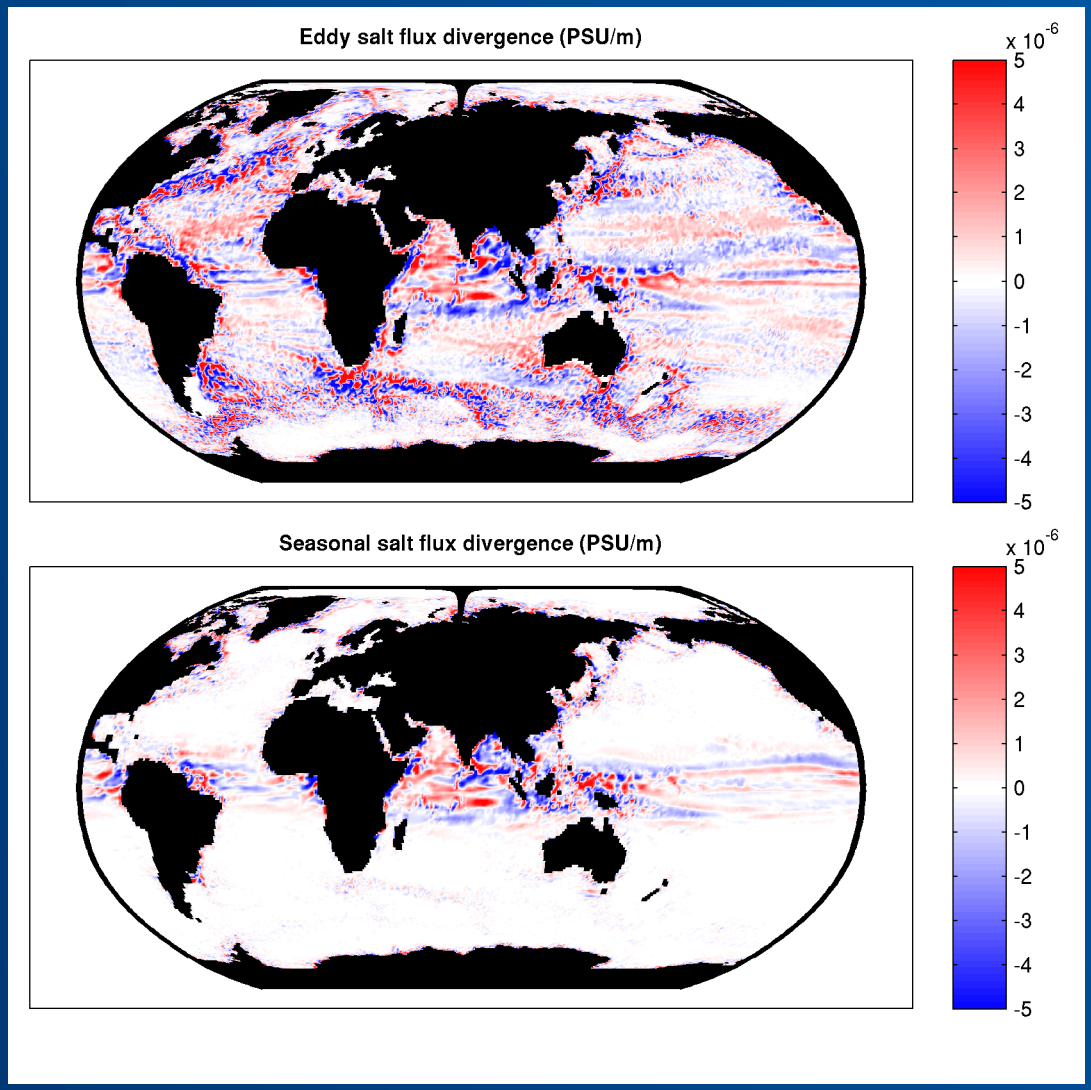


Equatorial region: waves, seasonal variability

Tropics (15°-20°): basin-wide eddy propagation and waves

Mid latitudes (40°): western boundary currents

Salt transport by seasonal variability



Total transient

Seasonal variability only

Conclusions

1) About ocean eddies

Eddies play a key role in the salt budget of the global ocean: **at 40°N and 40°S, half the export of salt out of the subtropical gyres is due to transient eddy fluxes.**

2) A method to study the salt budget

The salinity distribution of the ocean and the salt budget can be understood without invoking a so called « freshwater anomaly » or worrying about arbitrary reference salinities.

More online in the journal « Ocean Science »: Treguier et al, 2014