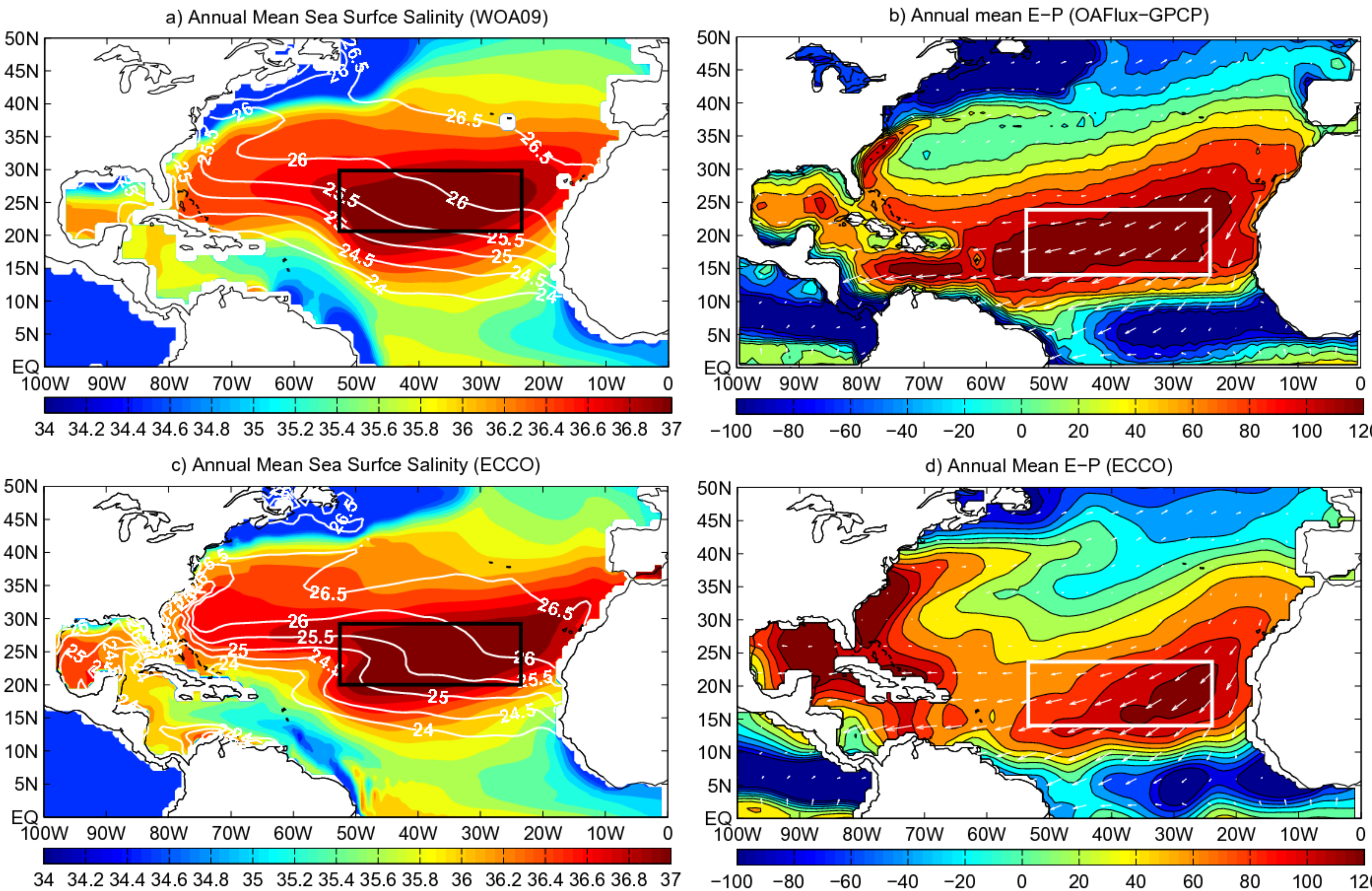


a) Annual Mean Sea Surfce Salinity (WOA09)
50N 45N 40N 35N 30N 25N 20N 15N 10N 5N EQ
100W 90W 80W 70W 60W 50W 40W 30W 20W 10W 0
34 34.2 34.4 34.6 34.8 35 35.2 35.4 35.6 35.8 36 36.2 36.4 36.6 36.8 37
b) Annual mean E−P (OAFlux−GPCP)
50N 45N 40N 35N 30N 25N 20N 15N 10N 5N EQ
100W 90W 80W 70W 60W 50W 40W 30W 20W 10W 0
−100 −80 −60 −40 −20 0 20 40 60 80 100 120
c) Annual Mean Sea Surfce Salinity (ECCO)
50N 45N 40N 35N 30N 25N 20N 15N 10N 5N EQ
100W 90W 80W 70W 60W 50W 40W 30W 20W 10W 0
34 34.2 34.4 34.6 34.8 35 35.2 35.4 35.6 35.8 36 36.2 36.4 36.6 36.8 37
d) Annual Mean E−P (ECCO)
50N 45N 40N 35N 30N 25N 20N 15N 10N 5N EQ
100W 90W 80W 70W 60W 50W 40W 30W 20W 10W 0
−100 −80 −60 −40 −20 0 20 40 60 80 100 120

Mixed layer Salinity Budget Equations

$$\frac{\partial [S]}{\partial t} = \frac{(E-P)}{h}[S] - [\nabla_H \cdot (uS, vS)]_{ml} + [ML\ mixing] + subsurface$$

$$subsurface = -\frac{1}{h}\Delta S \frac{\partial h}{\partial t} - [\nabla_H \cdot (uS, vS)]_{induct} - [\nabla_z (wS)] - \frac{1}{h}(\kappa_z \nabla_z S)_{z=-h}$$

Results from a smoothed wind-driven assimilation (dr080) for the period 1993-2006 are analyzed. Compared with ECCO's Kalman Filter run results, the dr080 results are physically consistent, i.e. the temporal evolution of ocean states satisfies model equations, and thus can be used for budget analyses.

All salinity budget terms were computed at the model's integration time step and archived as 30-day averages. Thus, the mixed layer salinity budget is closed exactly. Although the effect of meso-scale eddies and mixing was merely parameterized, the model results provide the first quantitative evidence for the ocean's role in governing the SSS maximum in the North Atlantic.

Annual Mean Budget

Table 1 Mean salinity budgets in the SSS and E-P maximum regions. Here SEF represents surface external forcing due to E-P and relaxation, and ver Ent+Diff represents the sum of vertical entrainment and diffusion. Unit is 1×10^{-9} g s^{-1}.

	SEF	Advection	Ver Ent+Diff	GM Mixing	KPP Mixing	Others
SSS Maximum	17.8	-9.8	-5.2	-1.8	-0.7	-0.3
E-P Maximum	22.1	-25.2	11.4	-6.5	-0.3	1.5

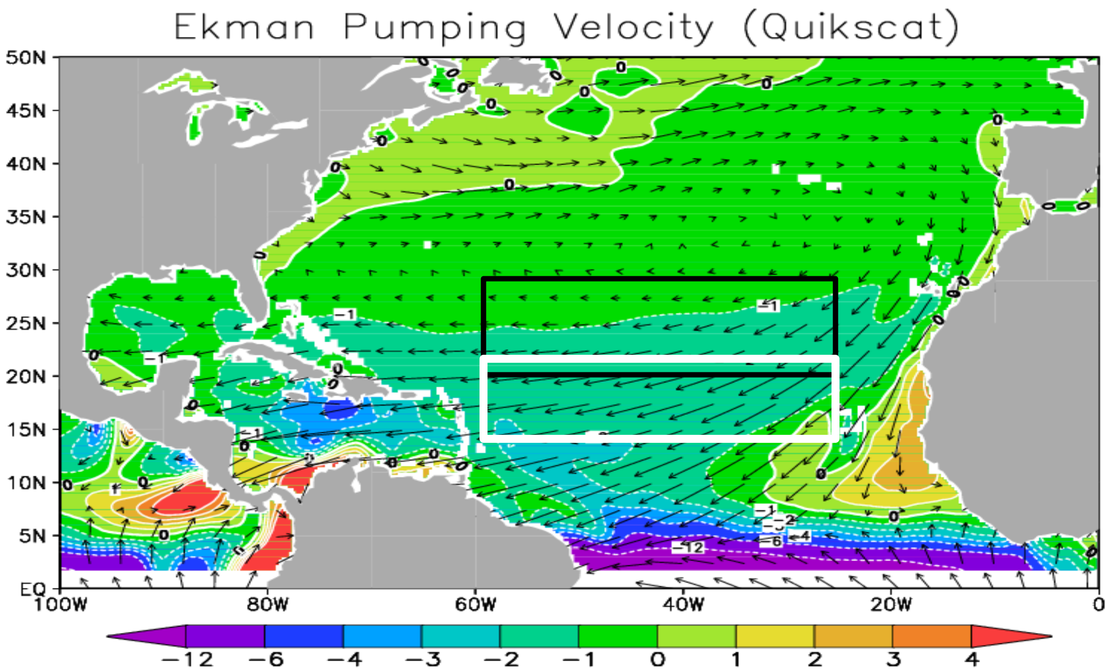
Advection is enhanced by 2.5 times

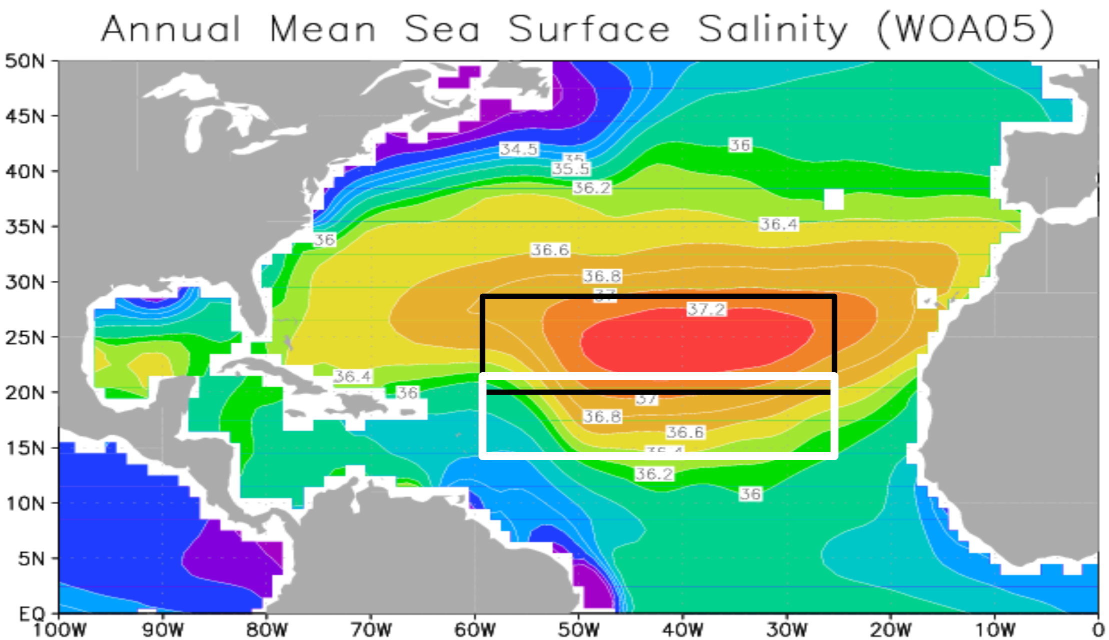
Mixing associated with meso-scale eddies enhanced by 3.5 times.

Vertical entrainment and diffission becomes positive.

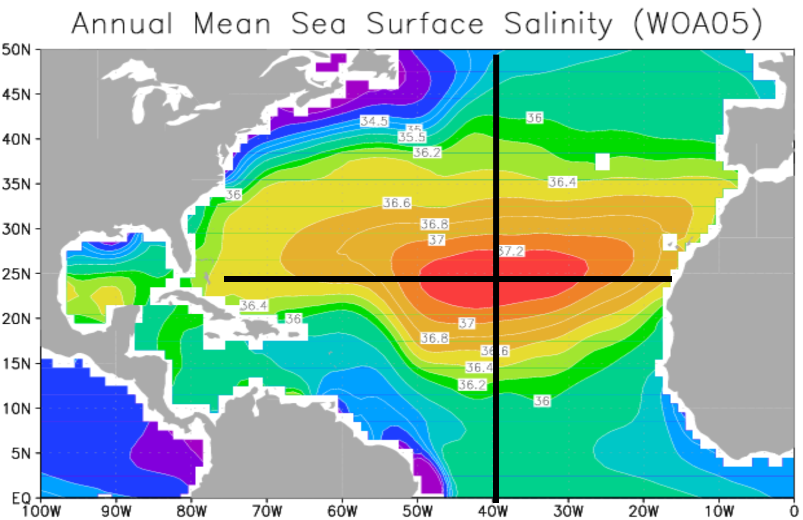
Advection

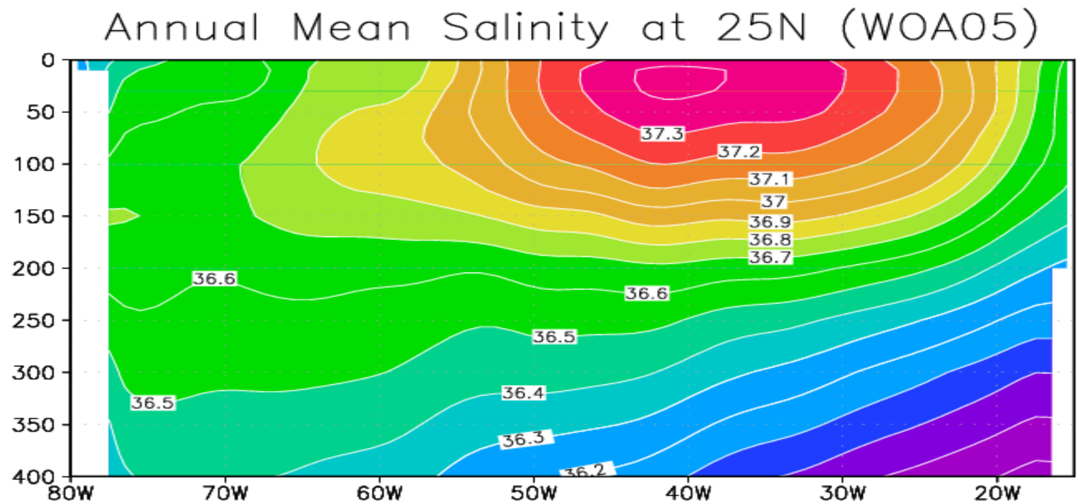
Both surface Ekman current and SSS gradient are smaller in the salinity maximum region (black box) nthan in the E-P maximum region (white box).

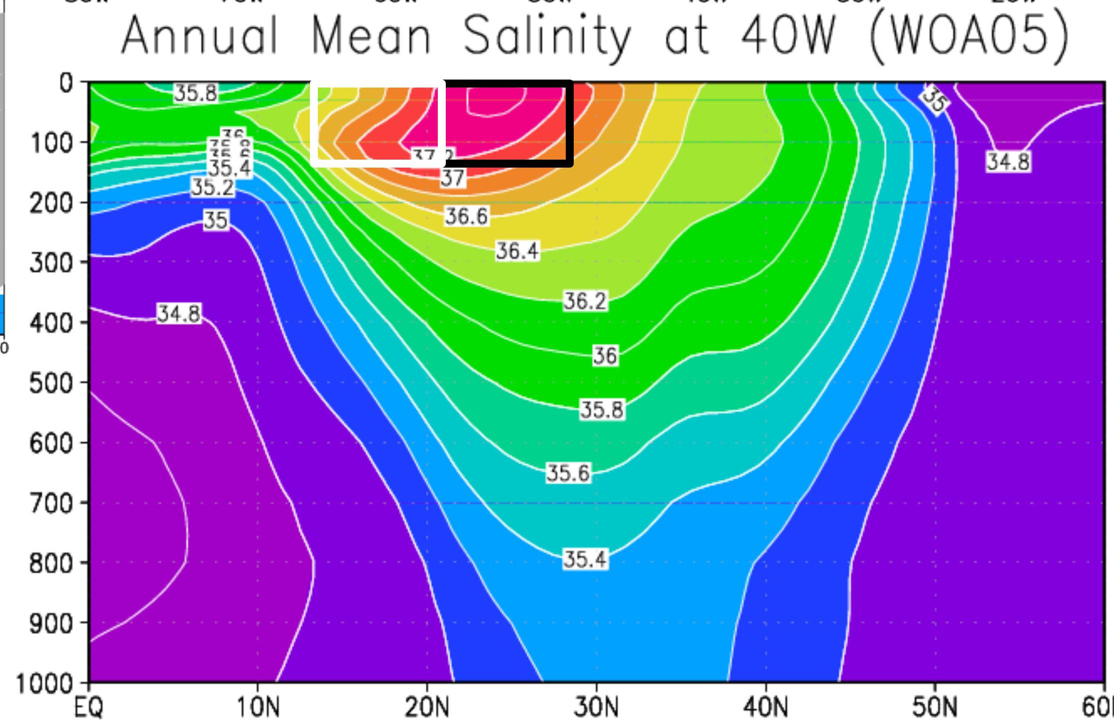




In the vertical, there is a positive salinity gradient across the base of mixed layer in the E-P maximum region (white box), while this gradient is always negative in the SSS maximum region (black box).

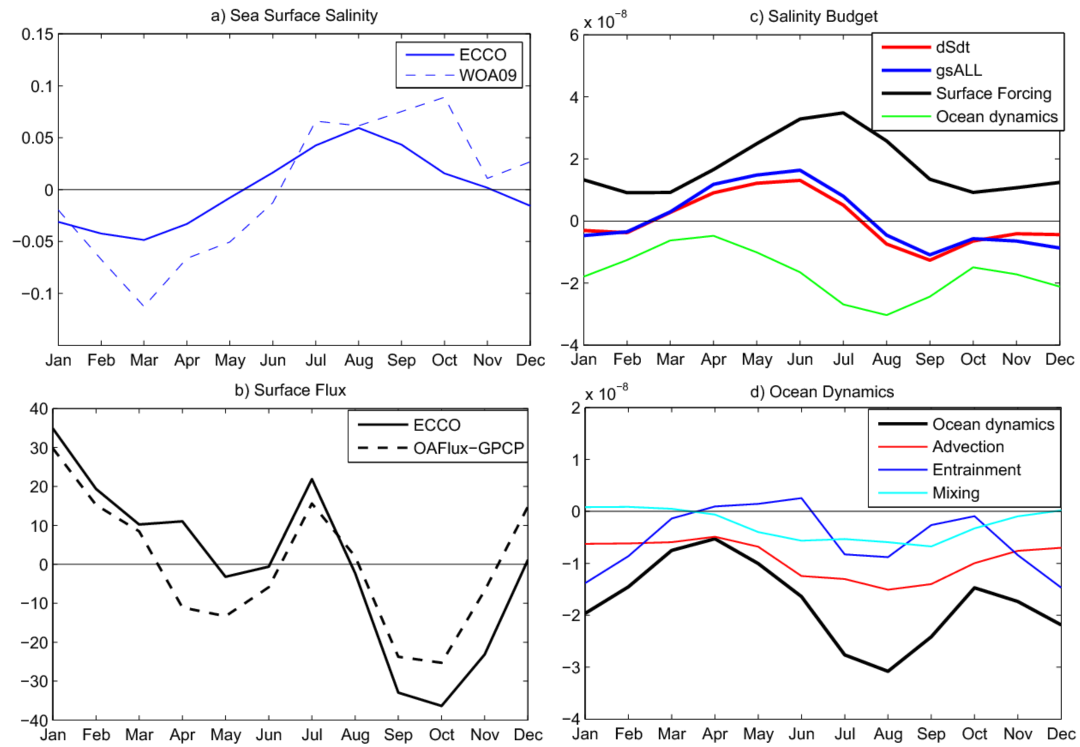


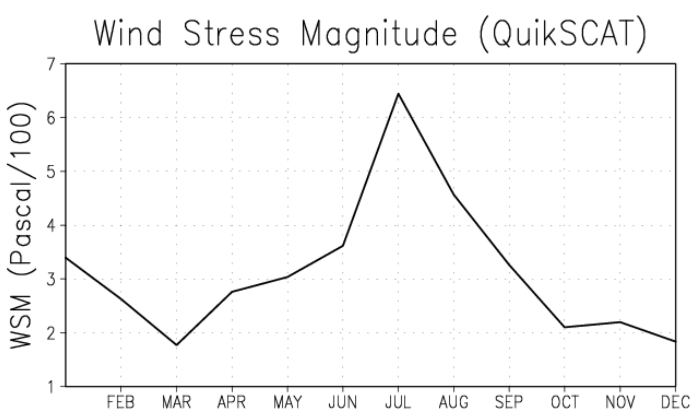


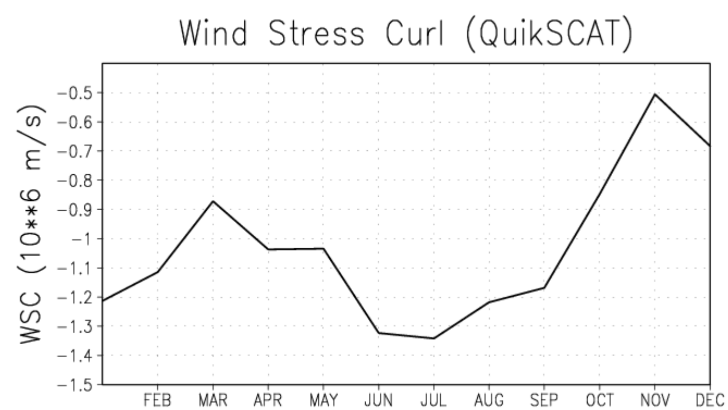


Seasonal Budget (salinity maximum region)

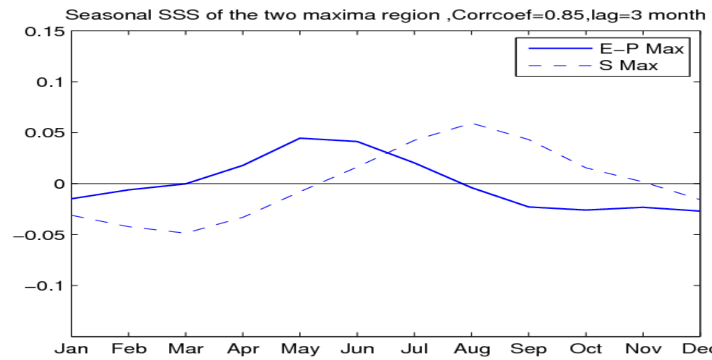
1. Surface flux increases SSS and ocean dynamics decreases SSS all year round.
2. Surface flux and ocean dynamics are of equal importance.
3. There is a semi-annual signal, in response to surface wind stirring and downward Ekman pumping.



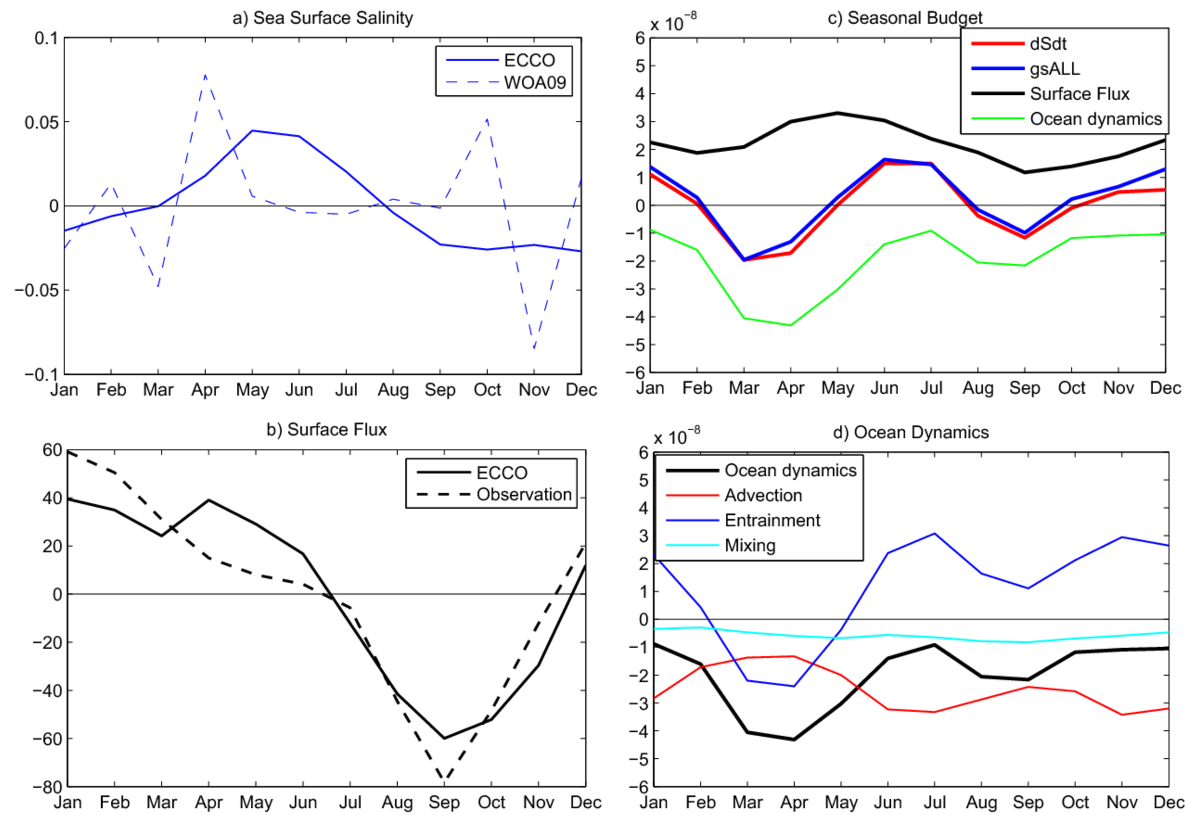




Seasonal Budget (E-P maximum region)

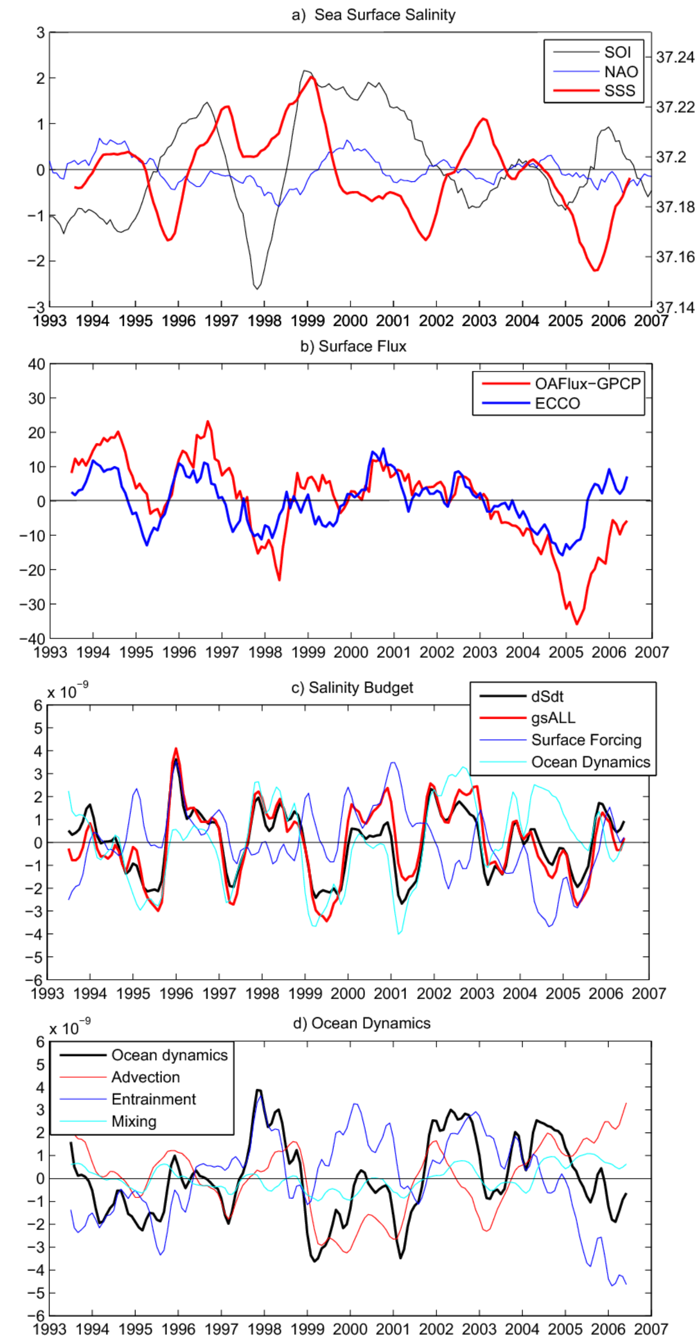


1. There is a temporal coherent relationship in SSS between the two regions, with a phase difference of 3 months.
2. Surface forcing and contribution due to ocean dynamics are maximum in May and Mar-Apr, respectively.

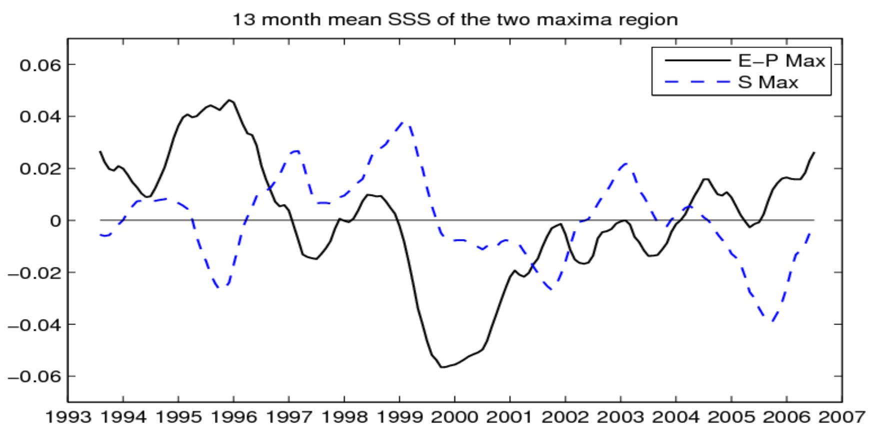


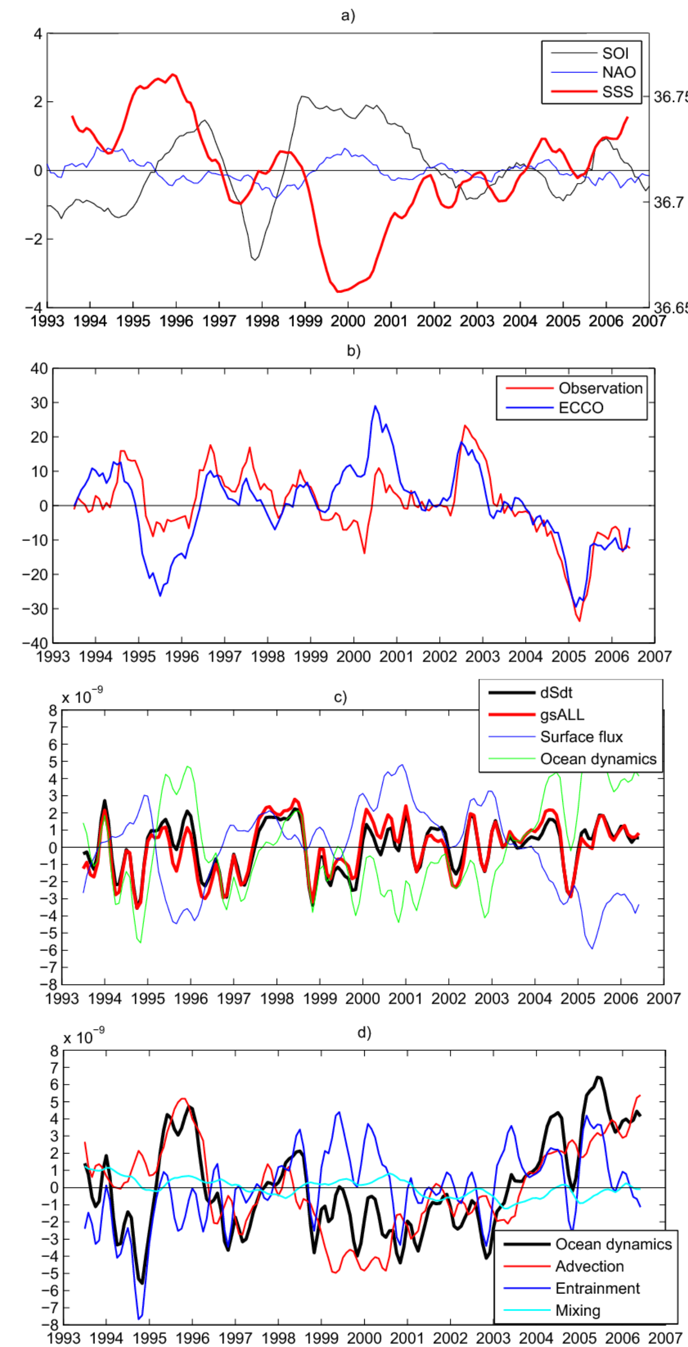
Interannual Budget (salinity maximum regio

1. SSS variability shows ENSO and NAO signature, with their correlation reaching -0.25 and -0.51, respectively.
2. Ocean dynamics explains about half of the variance, being of equal importance as surface flux.
3. Advection and entrainment are primary ocean processes modulating the SSS variability.



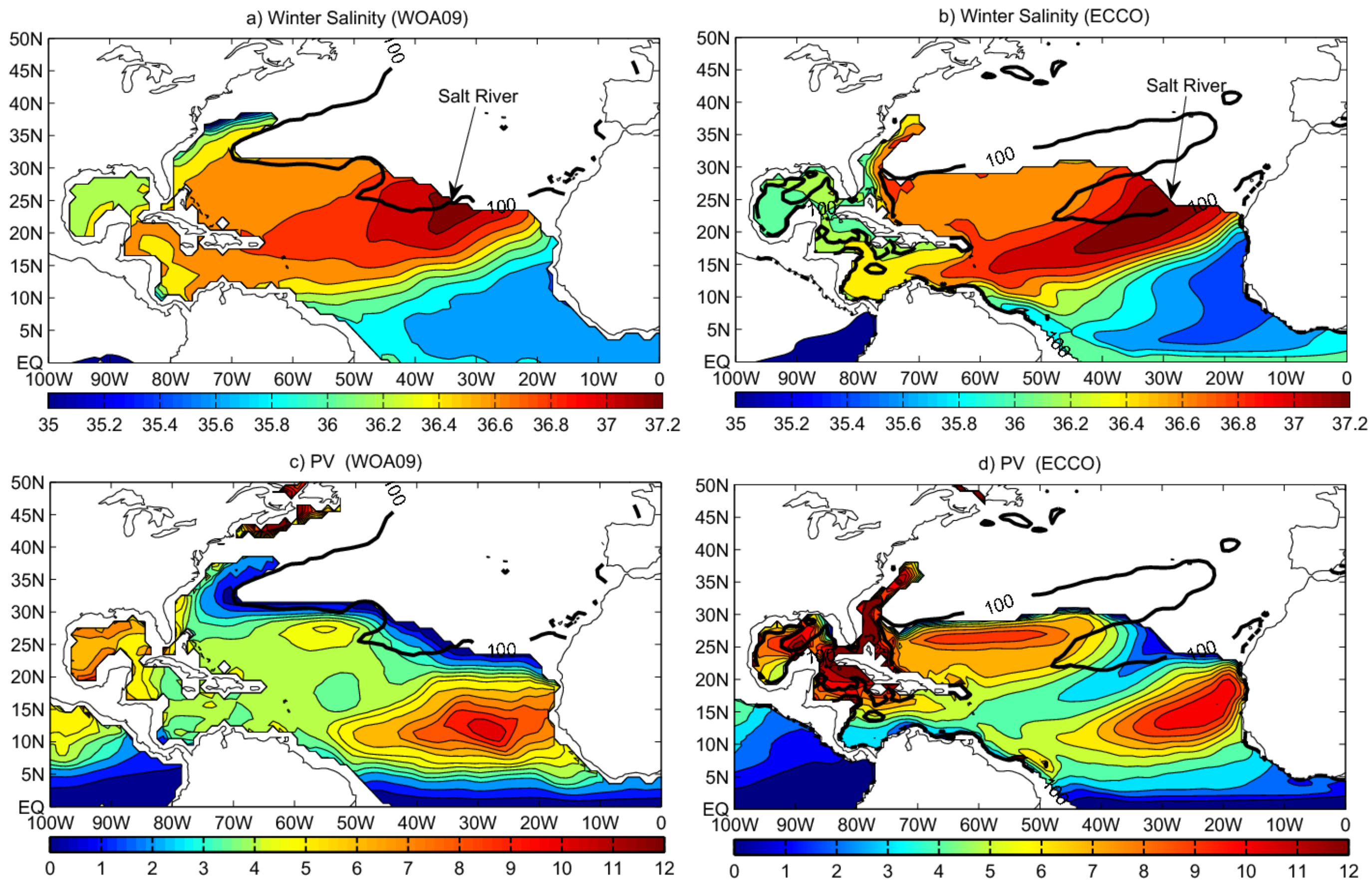
Interannual Budget (E-P maximum region)





1. No apparent coherence in SSS between the two regions is obvious.
2. The correlation of SSS with ENSO increases to -0.68.
3. Again, advection and entrainment are primary ocean processes which together explains about half of the variance.

Salt River



A large portion of the excess salt is subducted into the thermoccline. From there, the high salinity water spreads as part of the subtropical gyre. This high salinity pathway acts as a “salt river”, through which variability in the salinity maximum can be conveyed into the equatorial and subpolar regions, thereby playing a role in regulating the global thermohaline circulation. The details will be investigated further by research.