A preliminary evaluation of upper-ocean heat and salt budgets during the SPURS campaign

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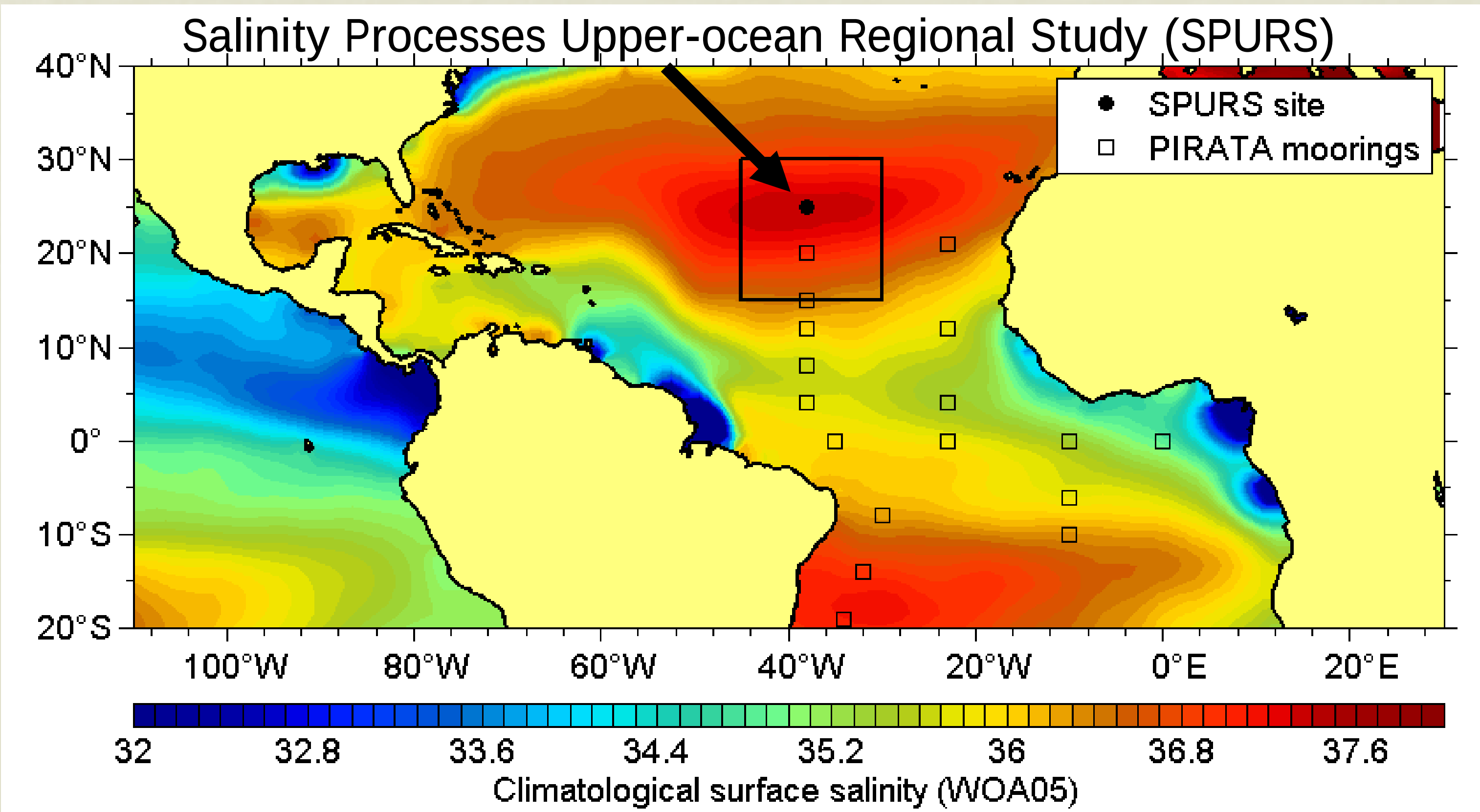
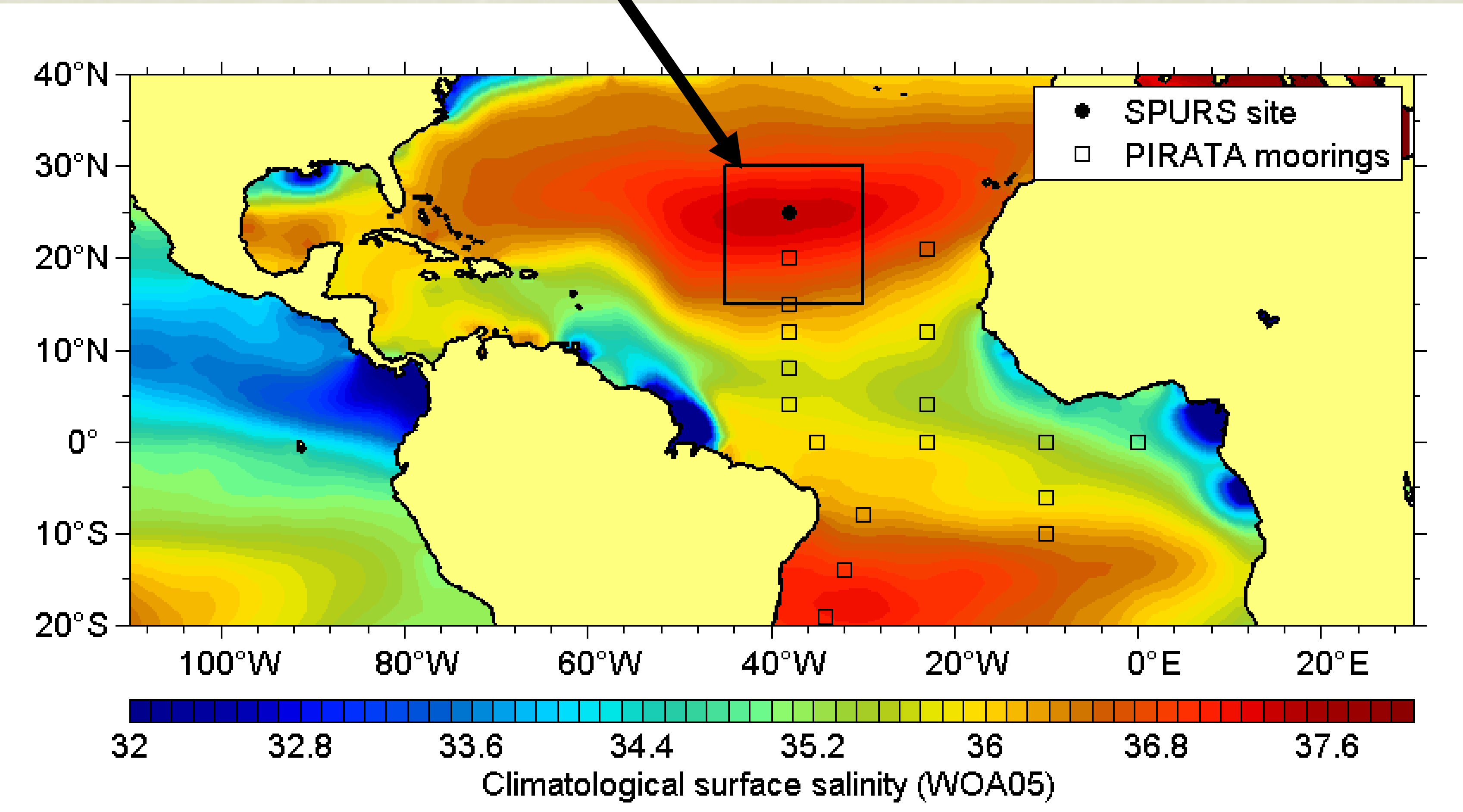


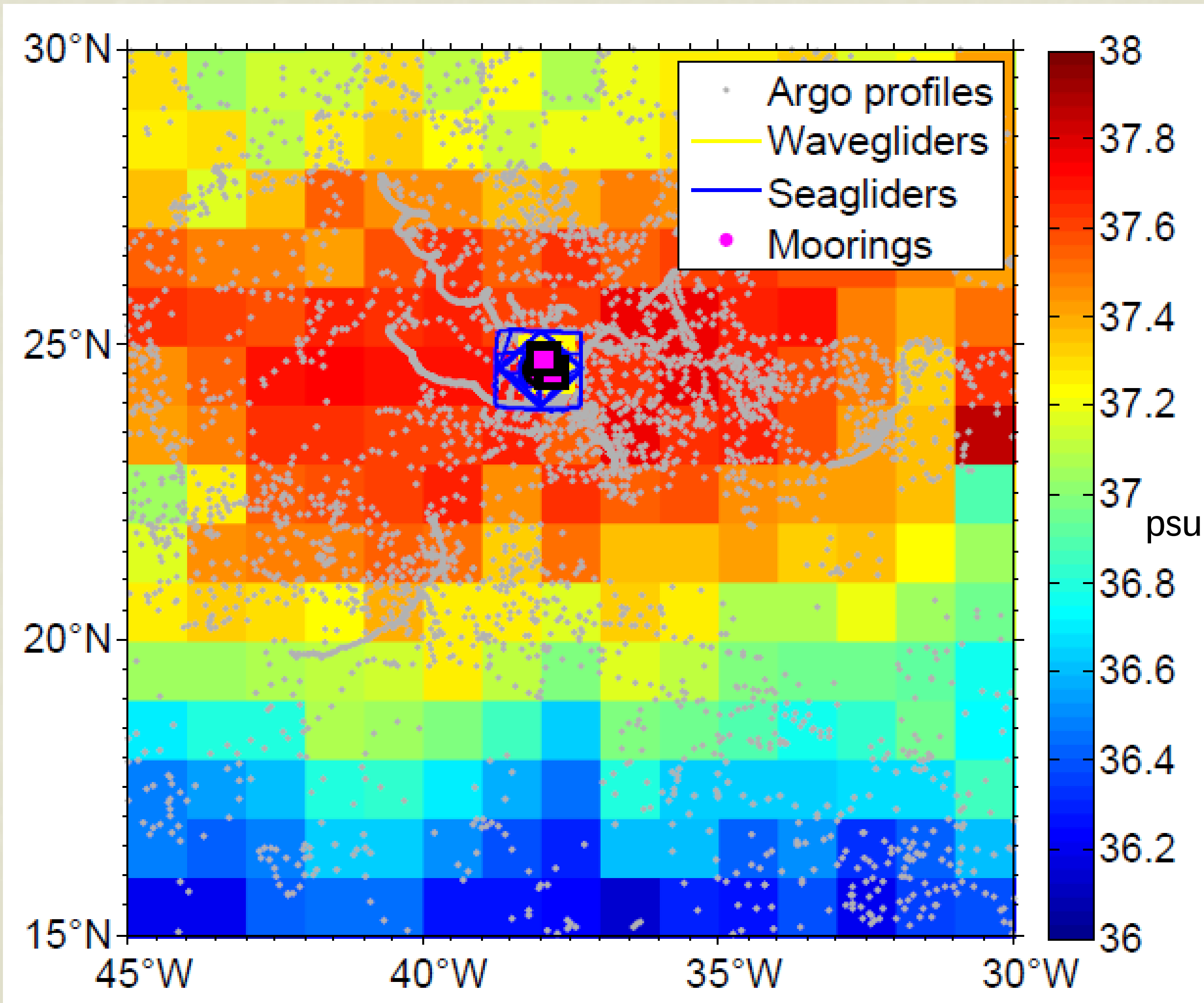
Salinity Processes Upper-ocean Regional Study (SPURS)

The SPURS “large box”



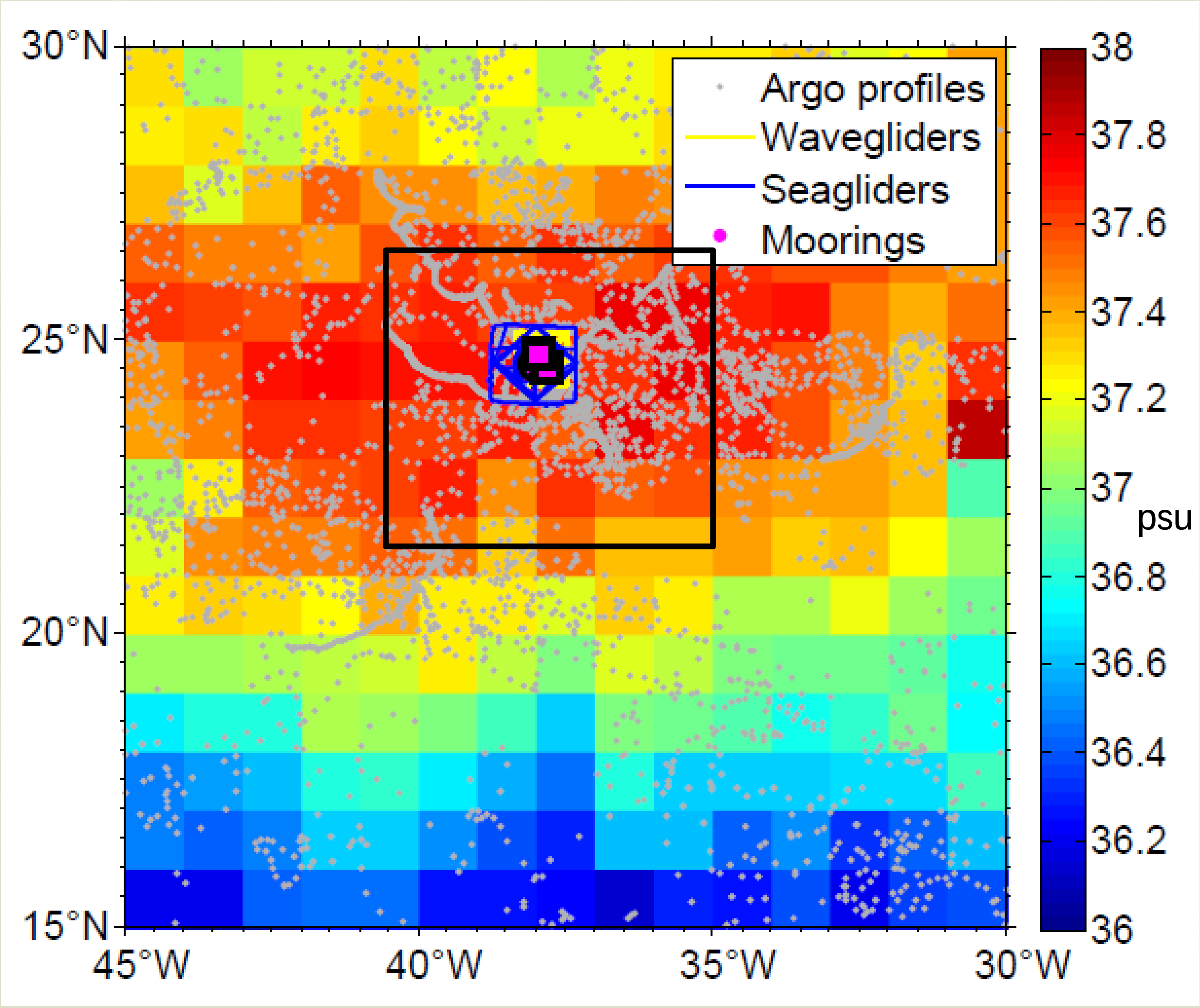
The SPURS "large box"

Aquarius salinity, March 2012



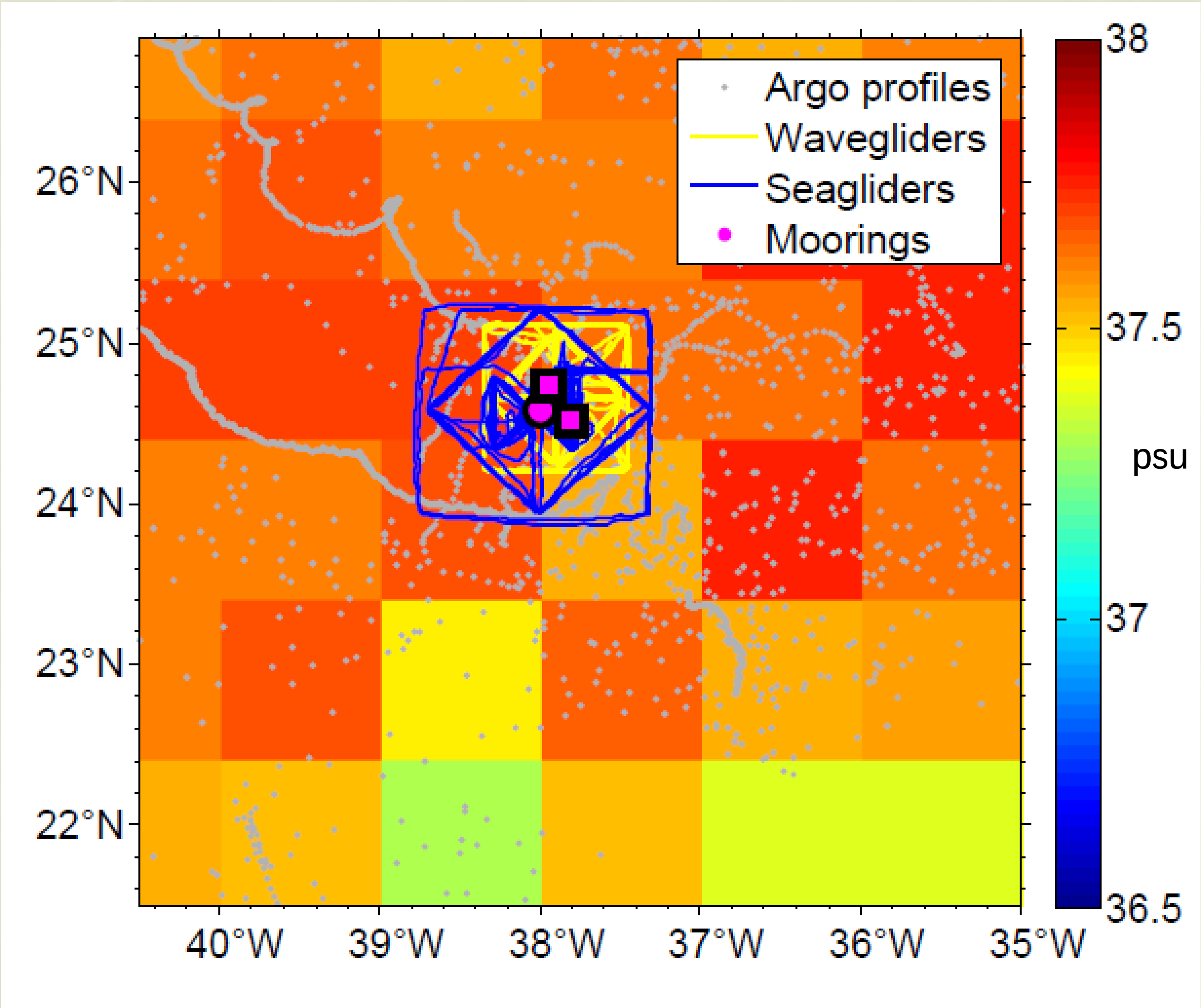
The SPURS “large box”

Aquarius salinity, March 2012



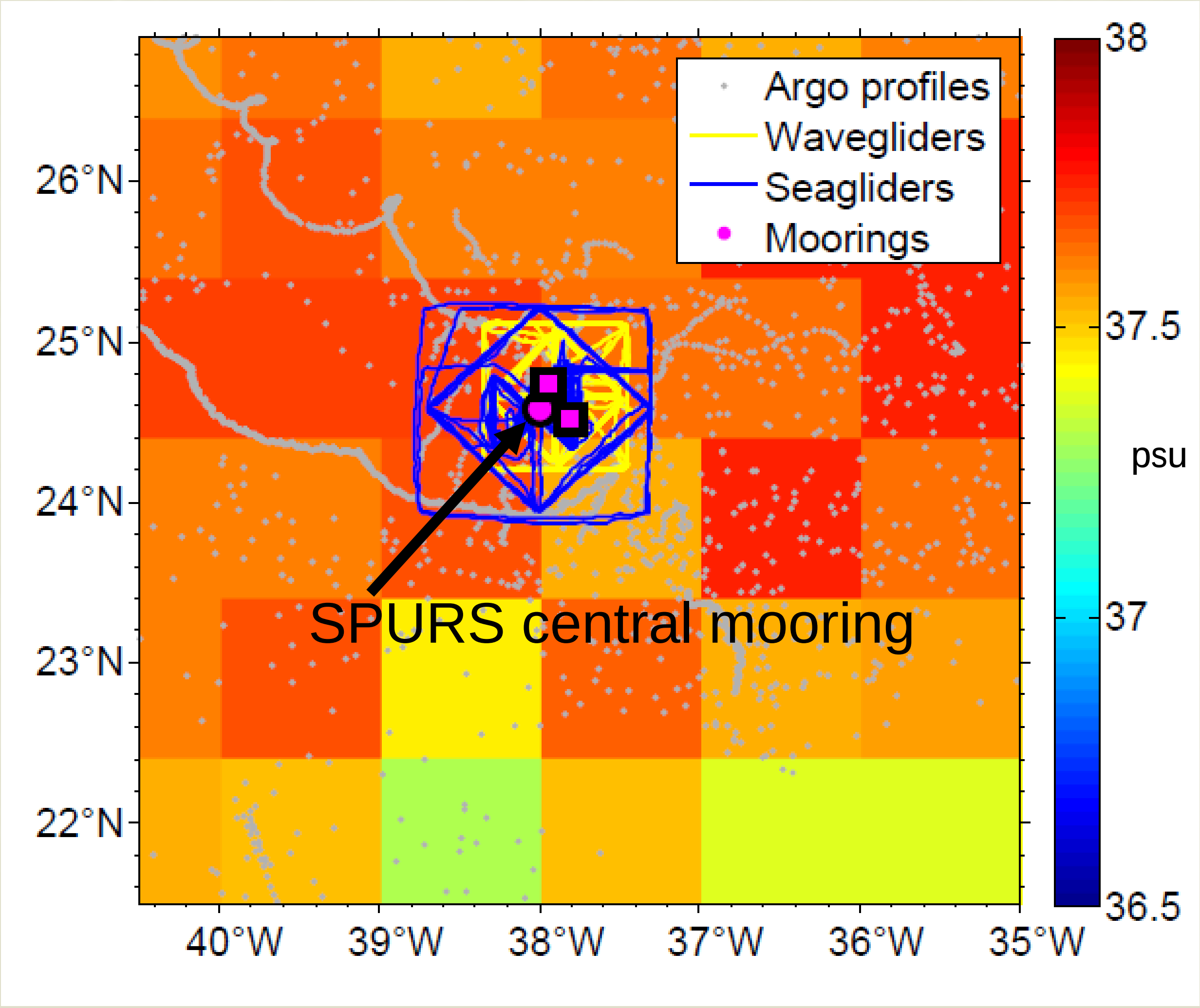
The SPURS “small box”

Aquarius salinity, March 2012



The SPURS “small box”

Aquarius salinity, March 2012



Buoy/mooring measurements:

(1) Measurements of surface meteorology and radiation for air-sea fluxes

(2) Direct turbulent flux measurements (wind stress, latent heat flux/evap, sensible heat flux)

(3) Measurements of T, S, and U with good vertical and temporal resolution (<5m in upper 90 m)

SPURS central mooring

Vertically averaged equations for conservation of heat and salt:

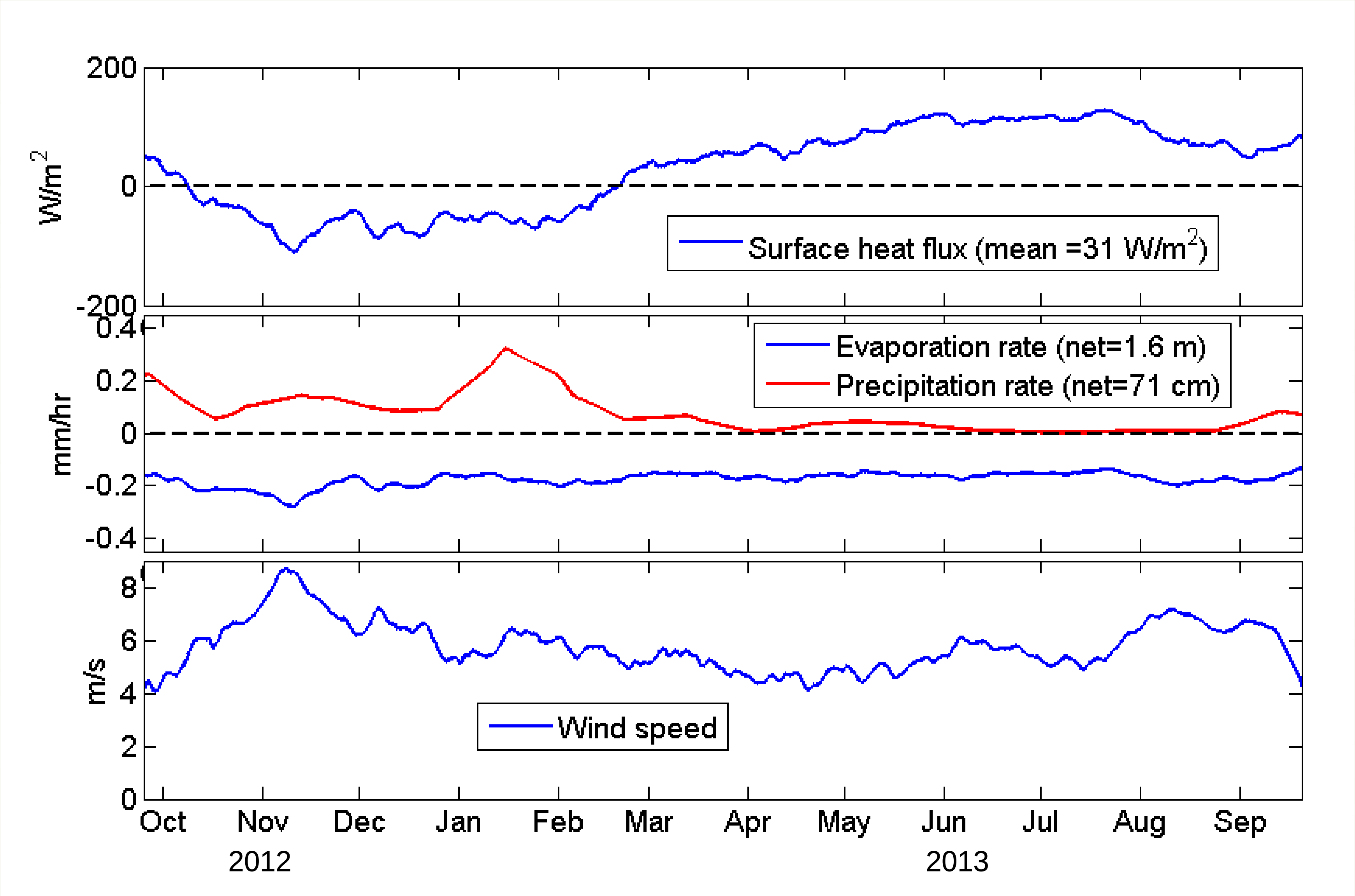
$\overline{S} \equiv$ vertical average of S over depth h(t)

$\hat{S}(z) \equiv$ deviation of S from its vertical average in the mixed layer (h)

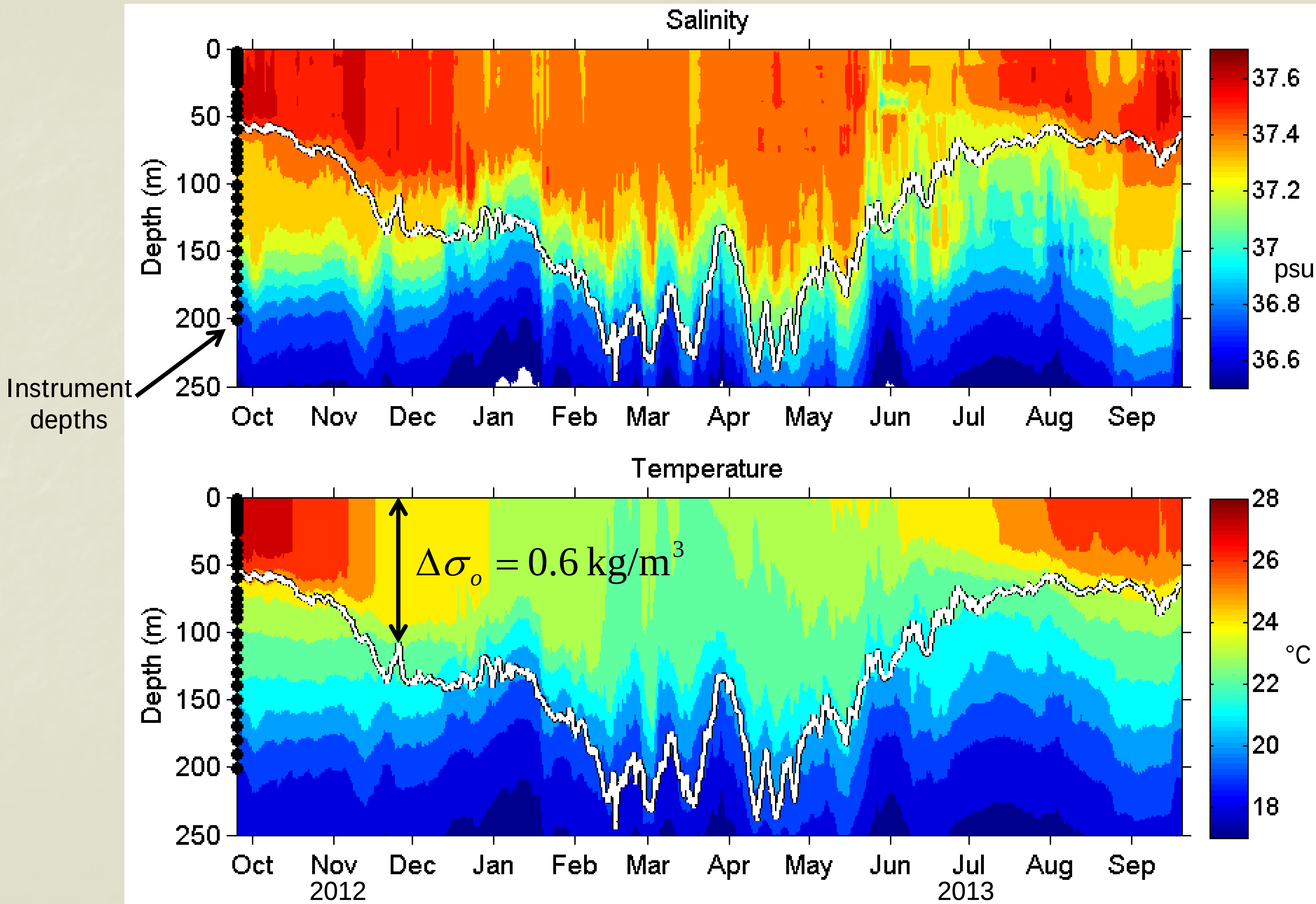
$$\frac{\partial \overline{S}}{\partial t} = -\overline{\mathbf{u}} \cdot \nabla \overline{S} + \hat{S}_{-h}\left(\frac{\partial h}{\partial t} + w_{-h} + \mathbf{u}_{-h} \cdot \nabla h\right) - \frac{Q_{-h}}{\rho h} + \frac{(E-P)S_o}{\rho h} - \frac{1}{h}\nabla \cdot \int_{-h}^{0} \hat{\mathbf{u}}\hat{S}dz$$

$$\frac{\partial \overline{T}}{\partial t} = -\overline{\mathbf{u}} \cdot \nabla \overline{T} + \hat{T}_{-h}\left(\frac{\partial h}{\partial t} + w_{-h} + \mathbf{u}_{-h} \cdot \nabla h\right) - \frac{Q_{-h}}{\rho c_p h} + \frac{Q_o}{\rho c_p h} - \frac{1}{h}\nabla \cdot \int_{-h}^{0} \hat{\mathbf{u}}\hat{T}dz$$

Surface forcing at the SPURS buoy: (3-week running averages)



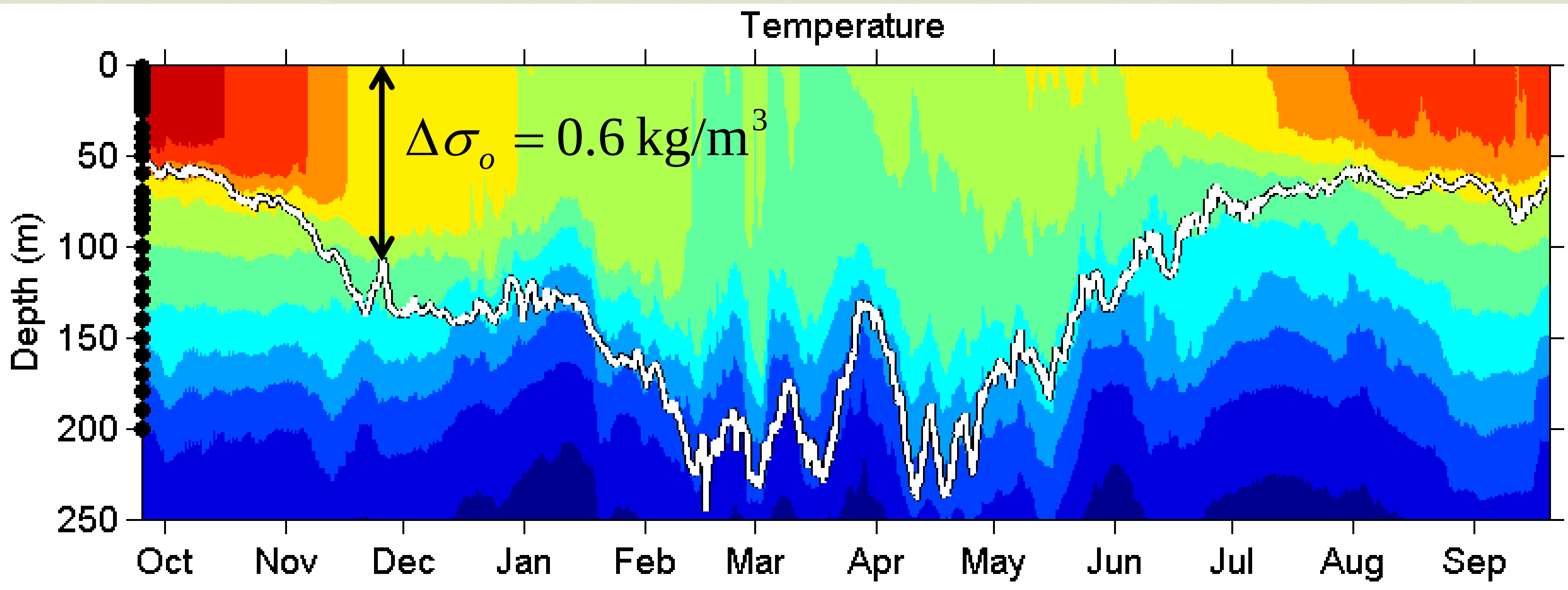
Temperature and salinity at the mooring:



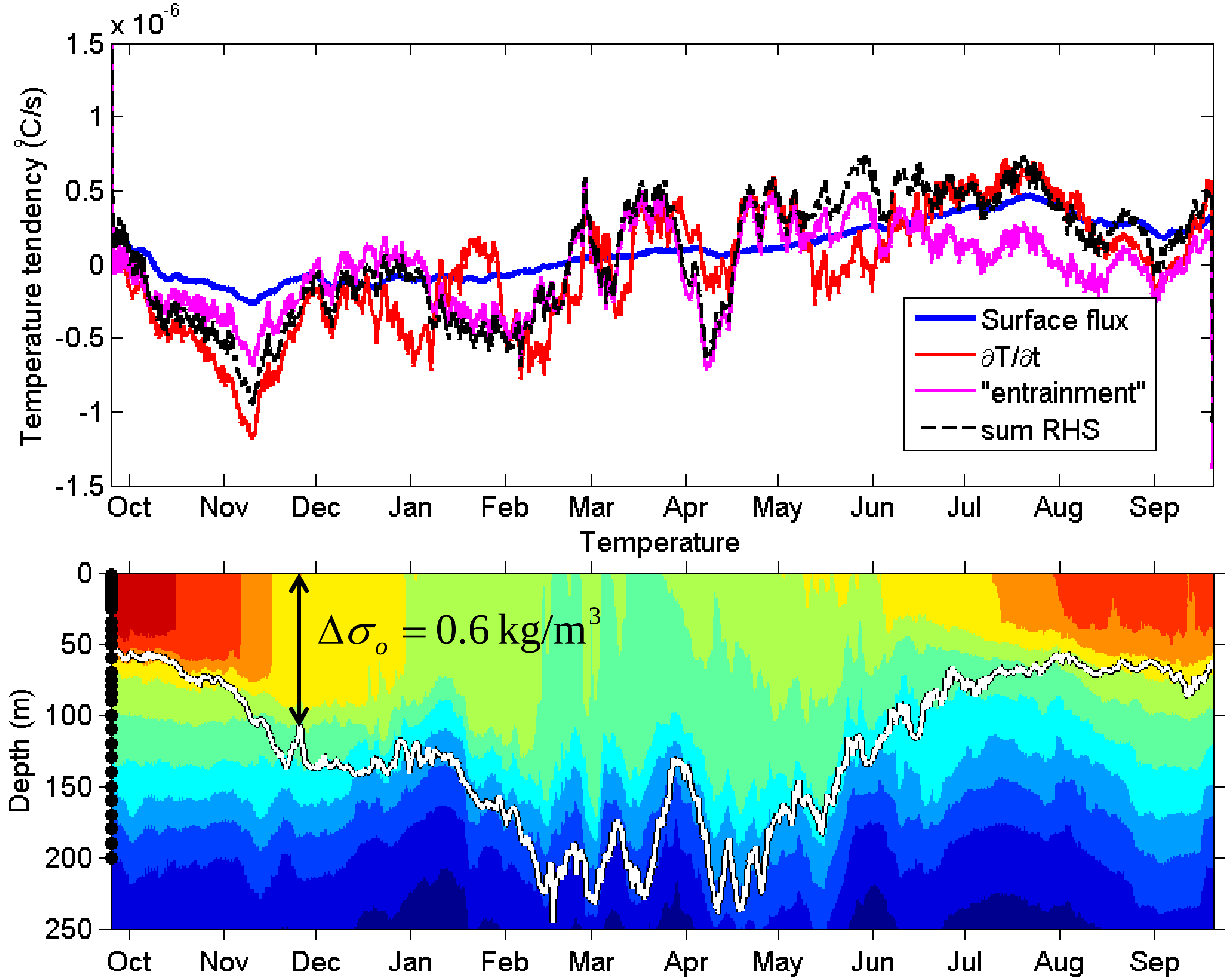
Preliminary mixed-layer temperature balance:

Evaluated for 3-week running average:

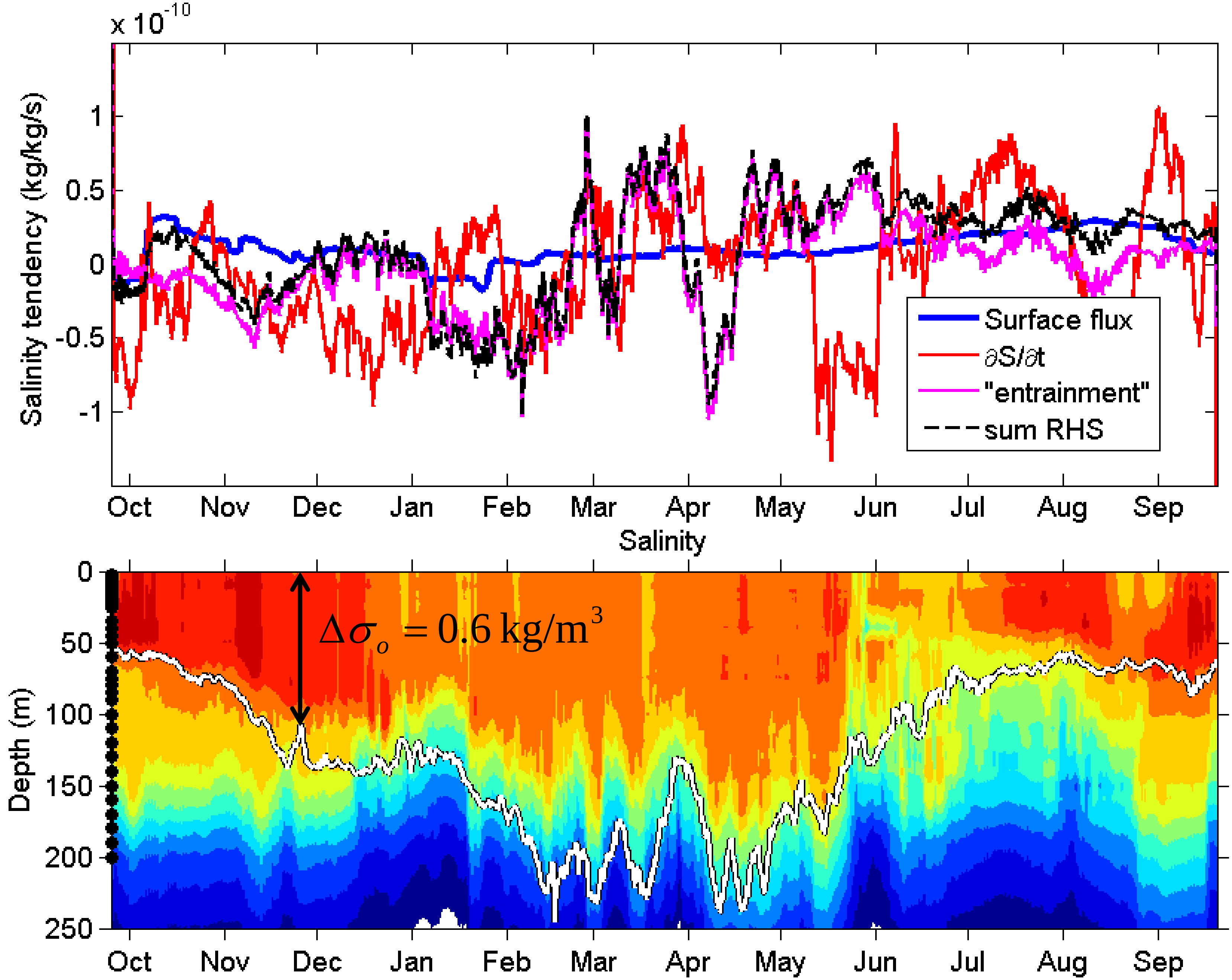
$$\frac{\partial \overline{T}}{\partial t} = -\overline{\mathbf{u}} \cdot \nabla \overline{T} + \hat{T}_{-h}\left(\frac{\partial h}{\partial t} + w_{-h} + \mathbf{u}_{-h} \cdot \nabla h\right) - \frac{Q_{-h}}{\rho c_p h} + \frac{Q_o}{\rho c_p h} - \frac{1}{h}\nabla \cdot \int_{-h}^{0} \hat{\vec{u}}\hat{T} dz$$



Preliminary mixed-layer temperature balance:



Preliminary mixed-layer salinity balance:



Conclusions and discussion of this preliminary budget:

(1) The mixed-layer temperature tendency appears to be roughly balanced by the sum of surface heat flux and mixed-layer “entrainment” terms

(2) The mixed-layer salinity balance appears to be far from 1D on the 3-week timescales examined here

(3) This difference is not too surprising because horizontal gradients of SSS are relatively strong. Surface heat fluxes will tend to damp SST anomalies, while surface freshwater fluxes are essentially independent of SSS.

(4) The relative importance of terms in the budget equations will be different at different spatial and temporal scales– a larger goal of SPURS is to improve understanding of the various physical phenomena setting the mean and variability of SSS in the region.