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Improved Understanding of Near-Surface Salinity Stratification
(with Aquarius, Argo, and Ocean Model)

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- **Song, Y. T**., T. Lee, J.-H. Moon, T. Qu, and S. Yueh (2015), Modeling skin-layer salinity with an extended surface-salinity layer, *J. Geophys. Res. Oceans,* 120.
- Moon, J.-H., and **Y. T. Song** (2014), Seasonal salinity stratifications in the near-surface layer from Aquarius, Argo, and an ocean model: Focusing on the tropical Atlantic/Indian Oceans, *J. Geophys. Res. Oceans*, 119.

Motivation: Seasonal Variability Maps from (a) Aquarius, (b) Argo, and (c) model

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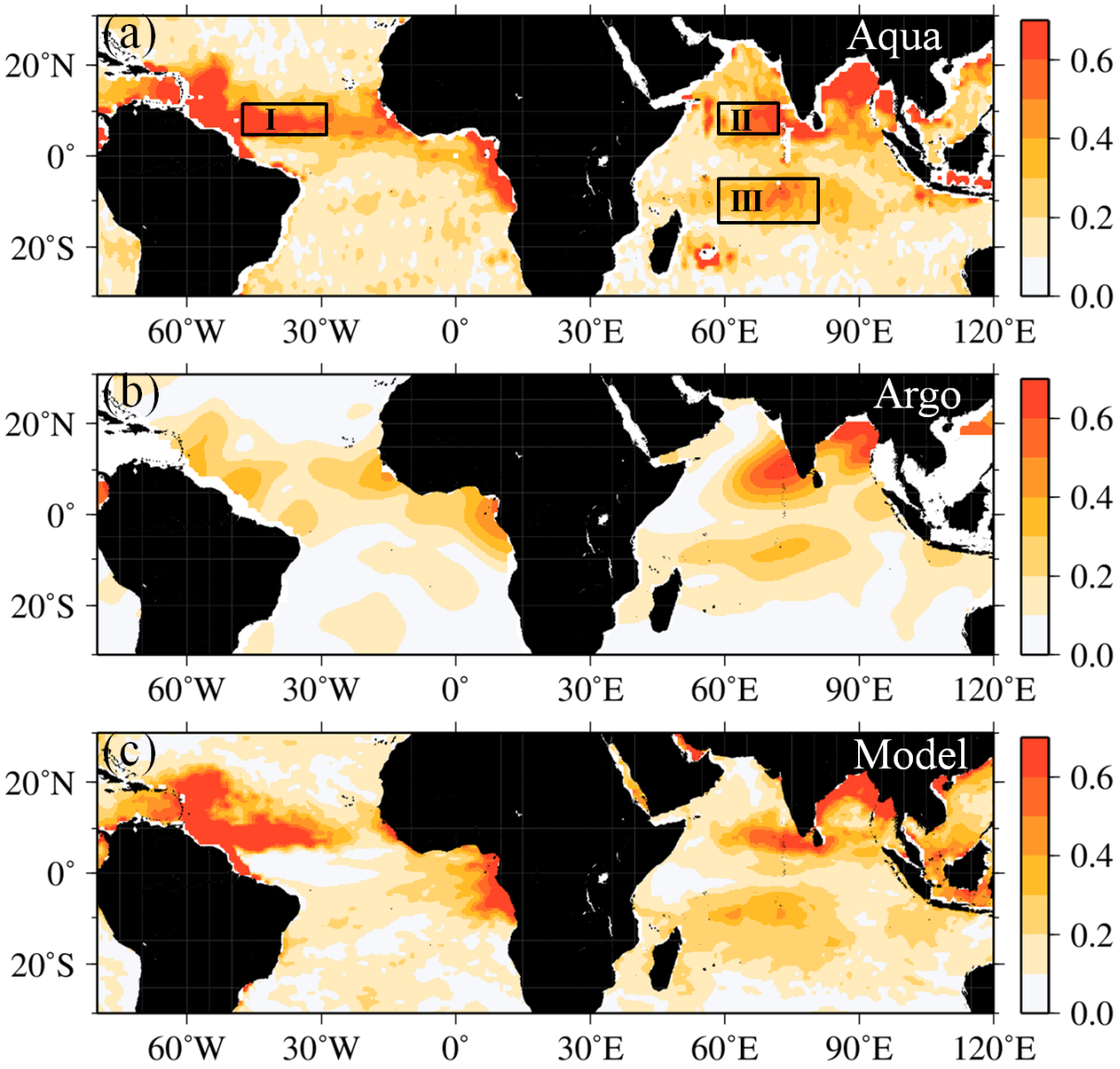

Strong

Weak

Between

Focusing on Regional Mechanism

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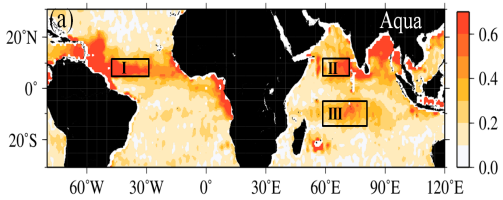

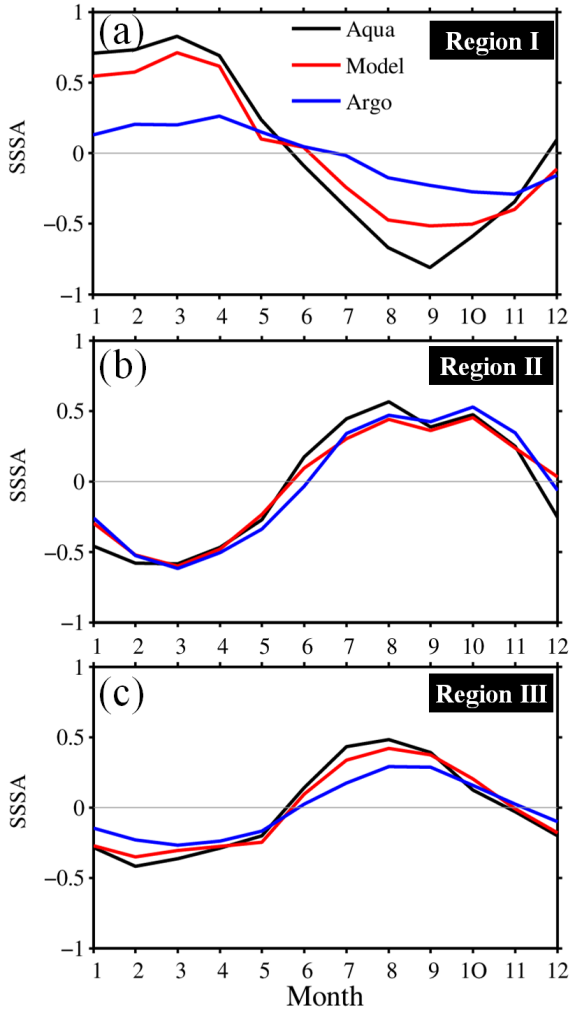

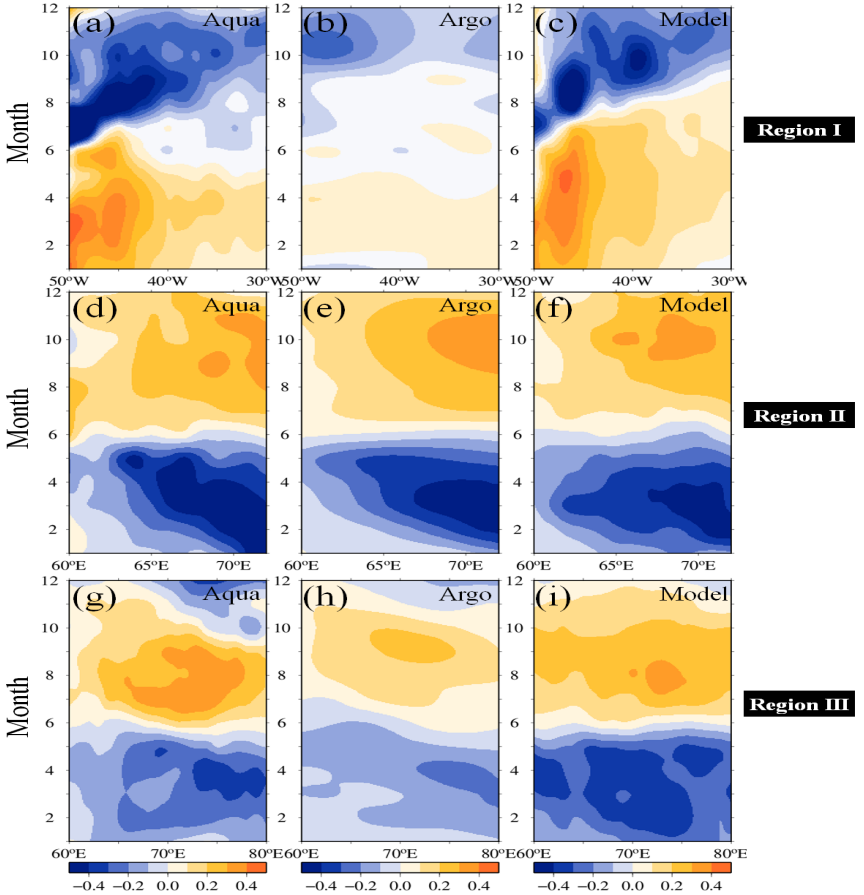

<u>Underline physics:</u>

I: river runoff and/or surface freshwater

II: monsoon-wind driven ocean currents mixing

III: surface freshwater (E-P) flux

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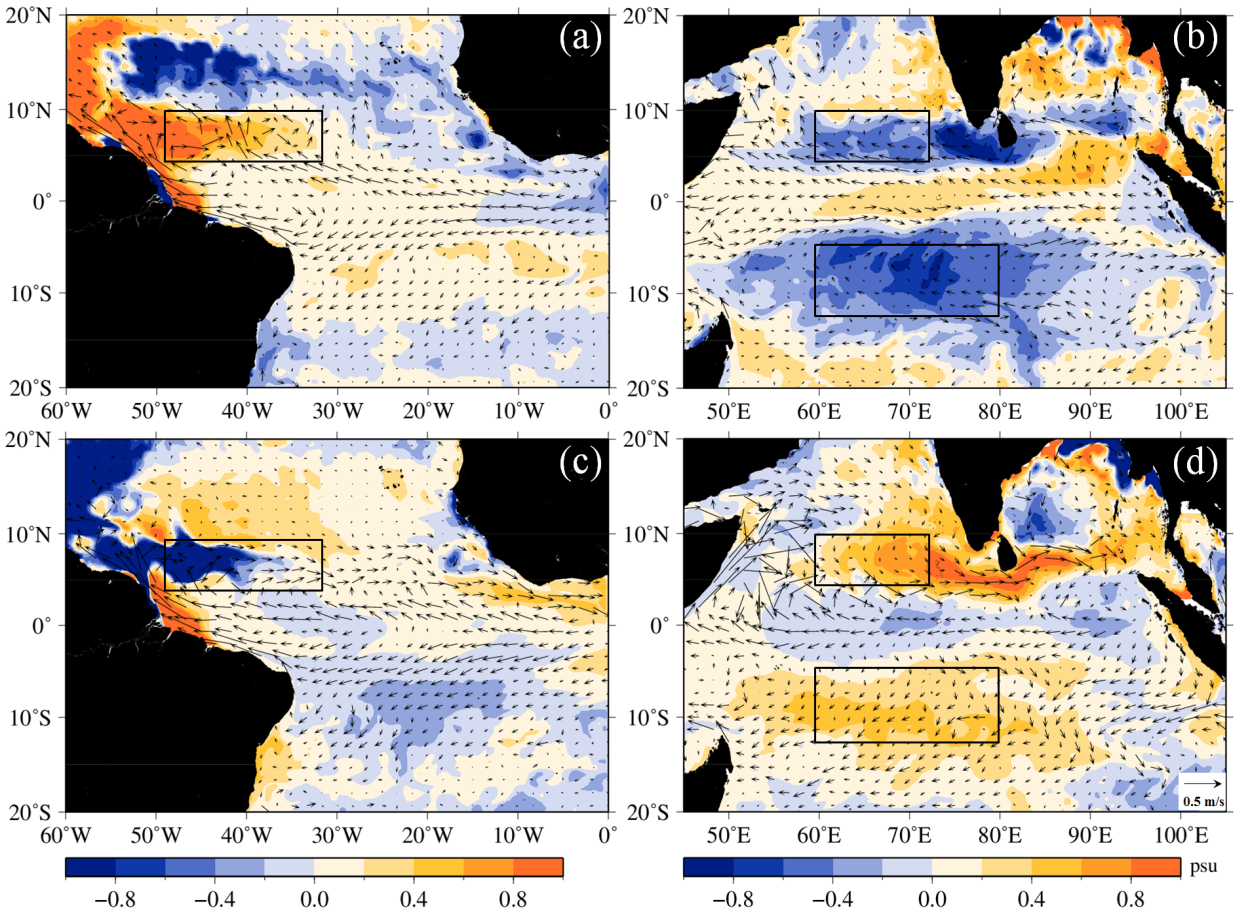
Model SSS & Currents

Winter

Summer



Study suggests:

- dynamical differences lead to different vertical salinity stratifications locally;
- explaining the differences between Aquarius (~cm), Argo (~5m), and model's representation of averaged salinity.

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Improve Model Representation of Aquarius and Argo

Main Issue: Near-surface salinity stratification

Related references: Alory et al. 2012; Boutin et al. 2013; Drucker & Riser 2014

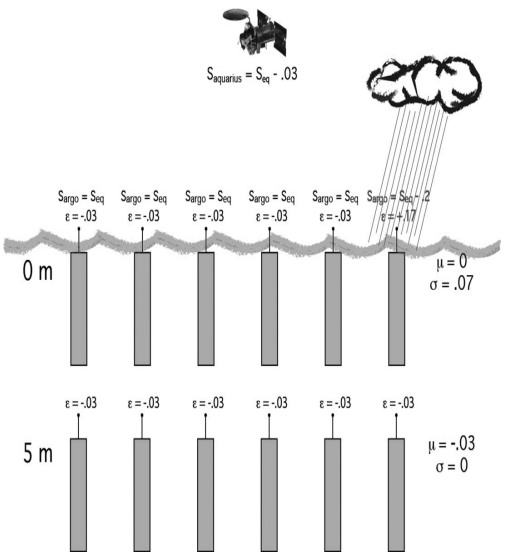
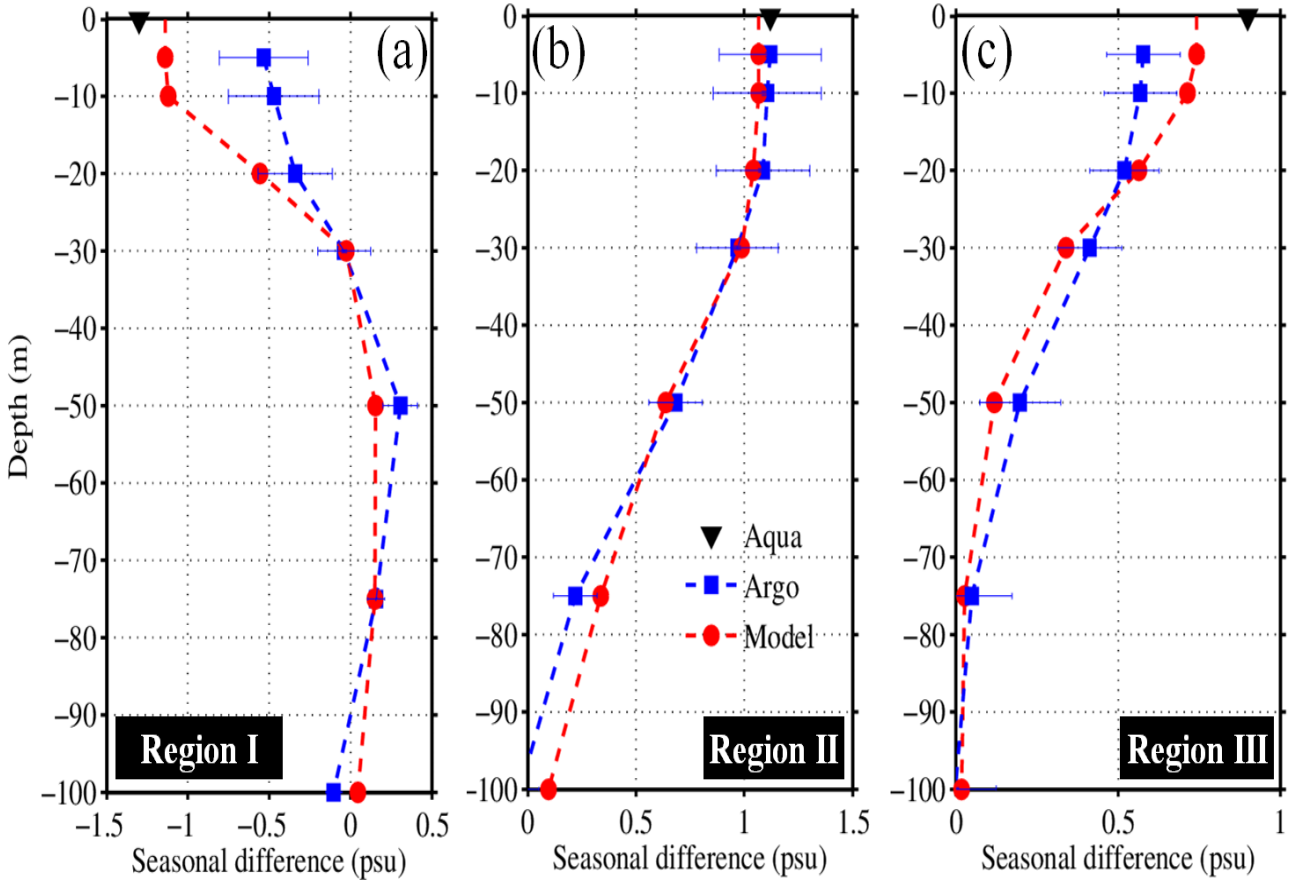


Figure B1. Error due to vertical salinity stratification for in situ references at the surface (top row) and at 5 m (bottom row). Stratification $\gamma = -0.2$ PSU occurring with probability $p = .16$.



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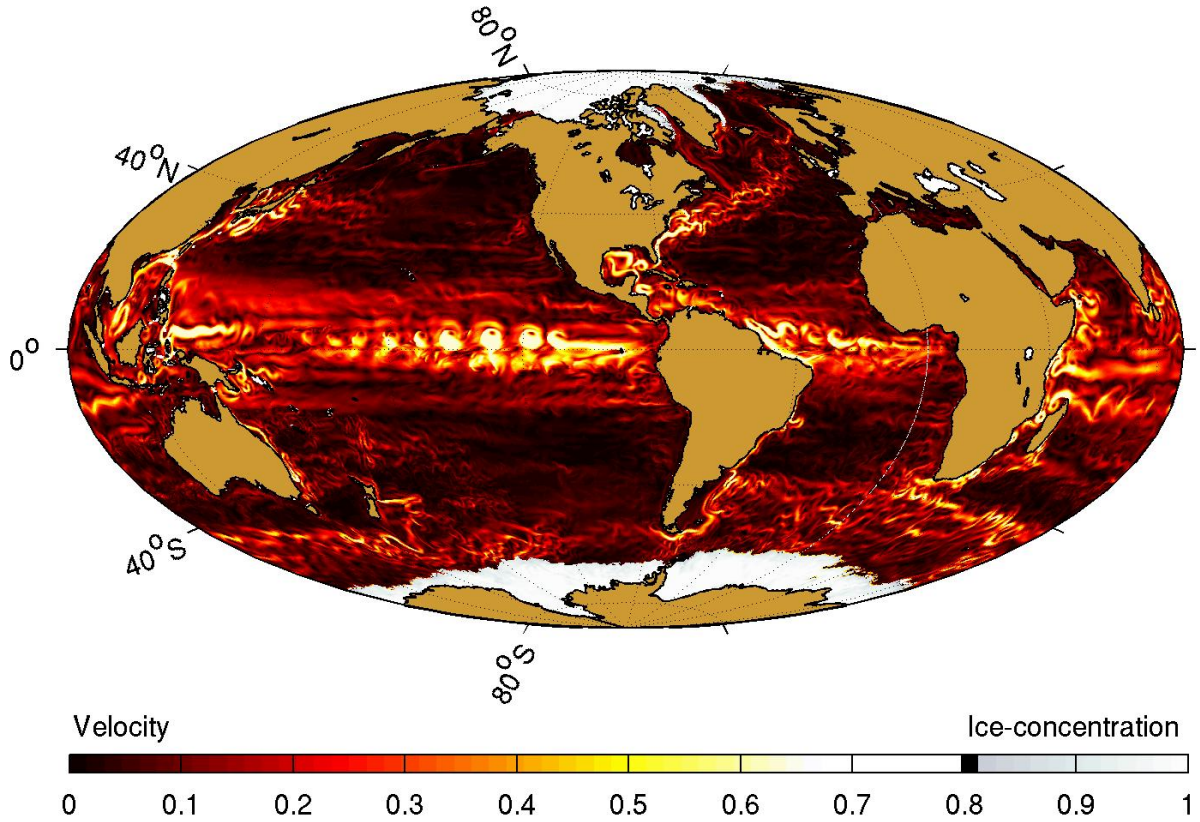
The Non-Boussinesq Global ROMS
(1/4-degree, sea-ice coupled)



Heat & momentum:

- NCEP SST & flux
- NCEP winds

Freshwater flux:

- -E+P+R==GRACE;
- Greenland melting
- River runoffs (256) since 2011

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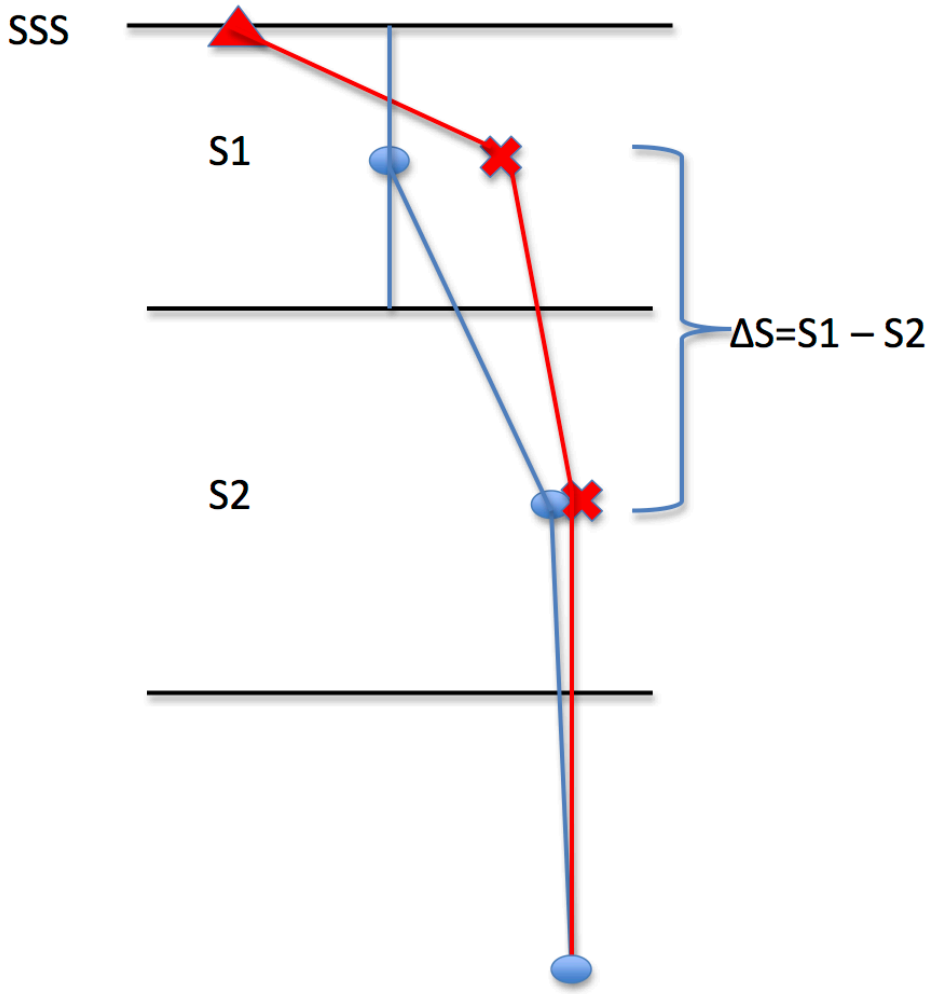
Extended Surface Salinity Layer (ESSL)



$$\frac{\partial S_1}{\partial t} = \frac{(E-P)}{h} S_1 + OD$$

E-P: NCEP and/or OAFlux (Yu et al. 2008)
River: Dai et al. 2009

$$ESS = S1 + \Delta S \times CF \times c0$$
$$ES1 = S1 - \Delta S \times CF \times c1$$
$$ES2 = S2 - \Delta S \times CF \times c2$$

- **CF = Correlation Function:** between S1 and E-P
- c0, c1, and c2: empirically and mathematically determined constants

Correlation Function (CF)

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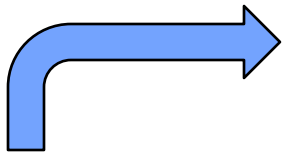
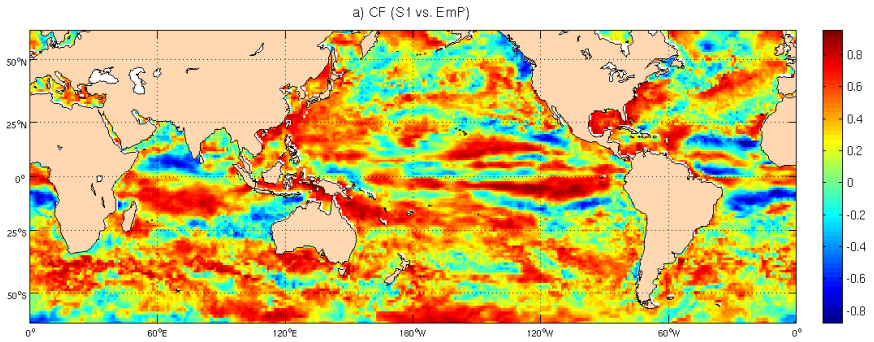
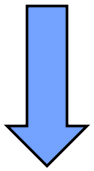
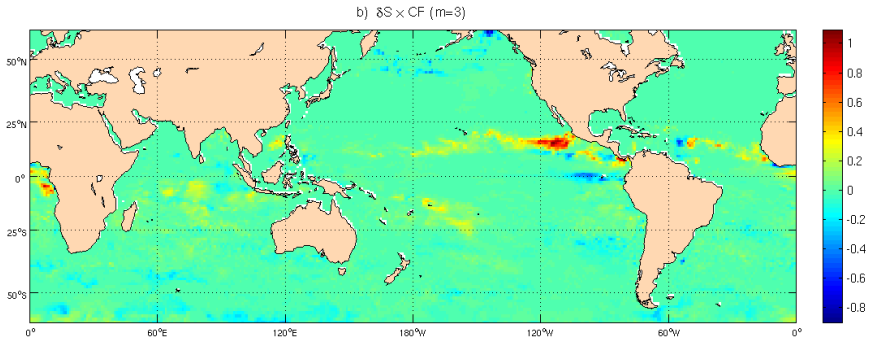
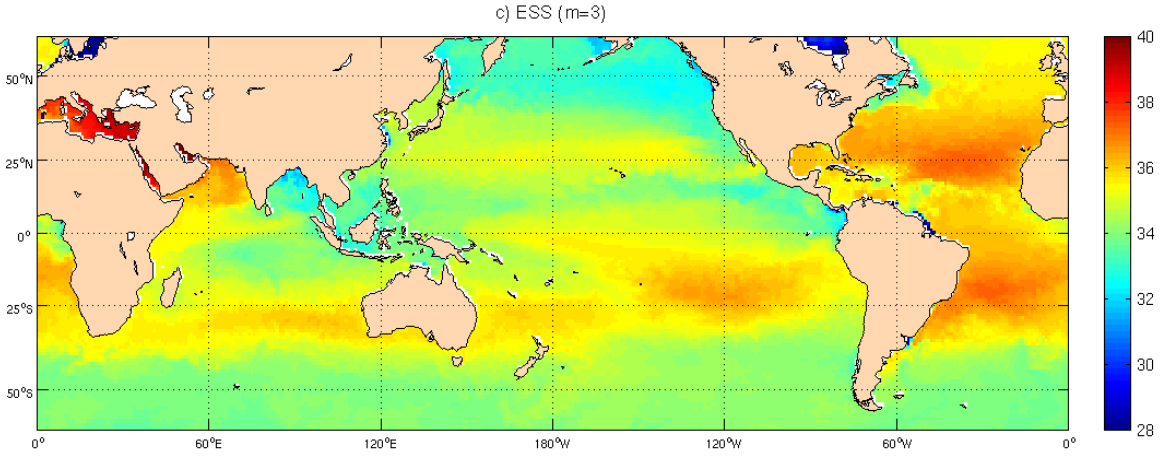
$$ESS(t) = S1(t) + \Delta S(t) \times CF(x,y) \times c0$$











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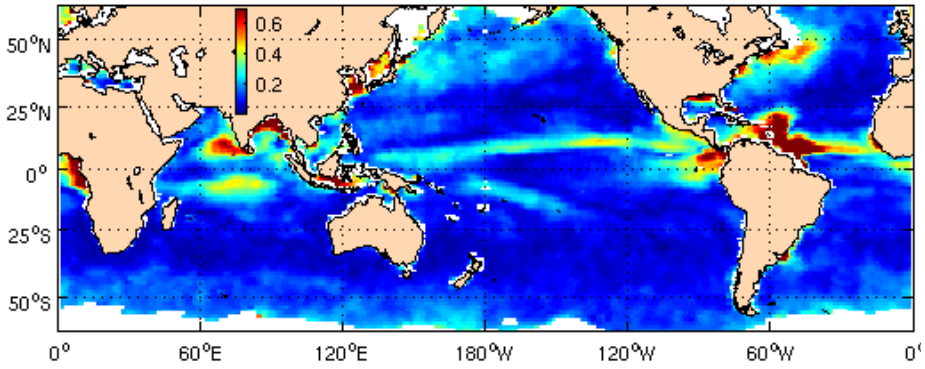
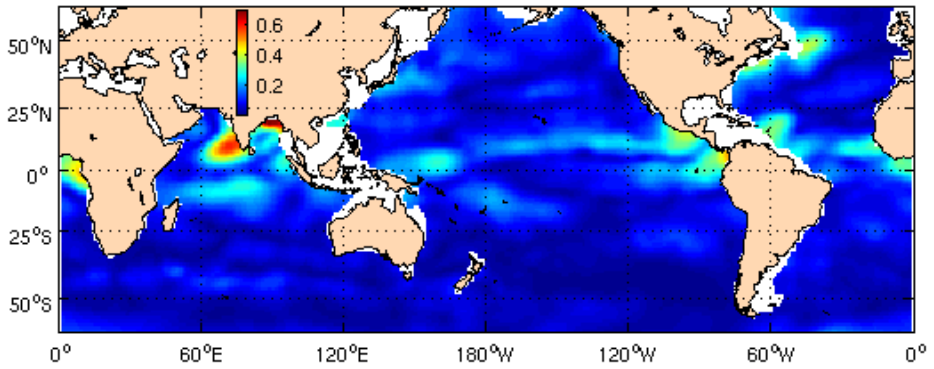
Annual Amplitude

$$V(t)=A * \sin(B * t + C)$$

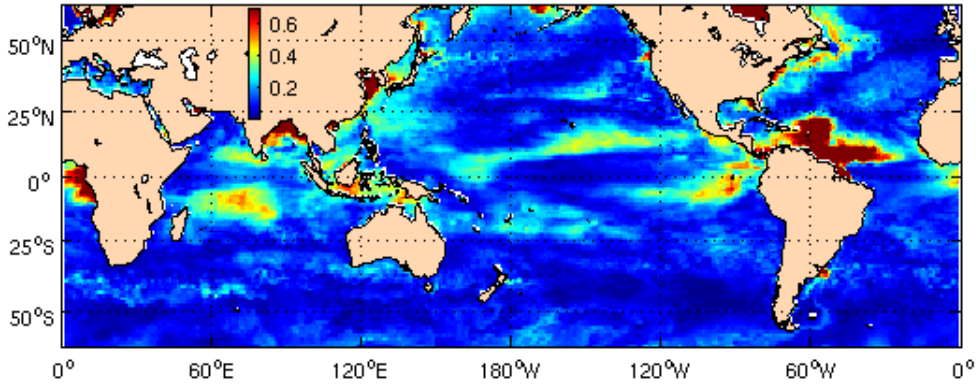
a) Aquarius SSS (amplitude)



e) Argo SSS (amplitude)



e) NB-ROMS ESS (amplitude)



Model-Data improved

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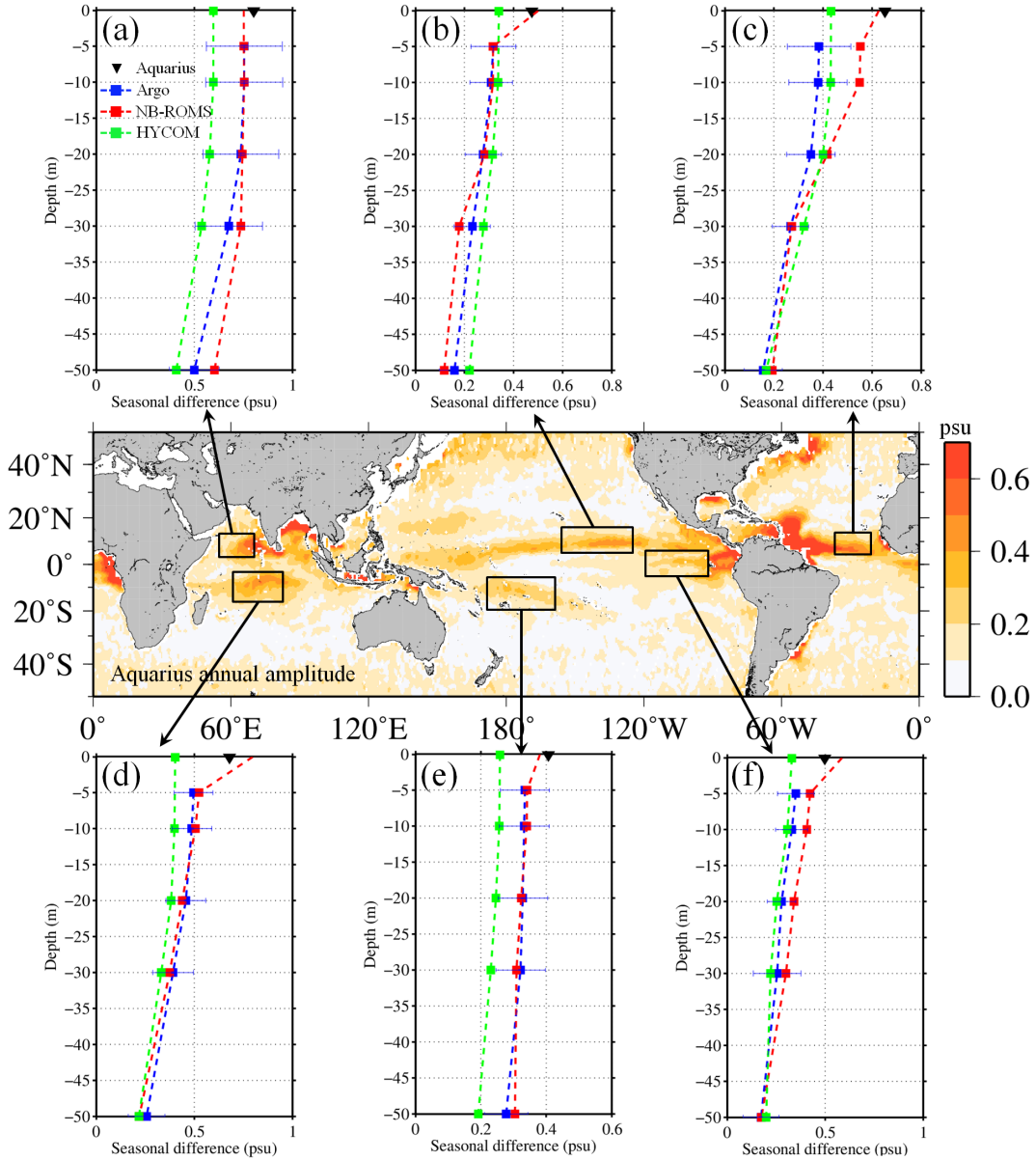
Comparisons in depths

Regional improvement



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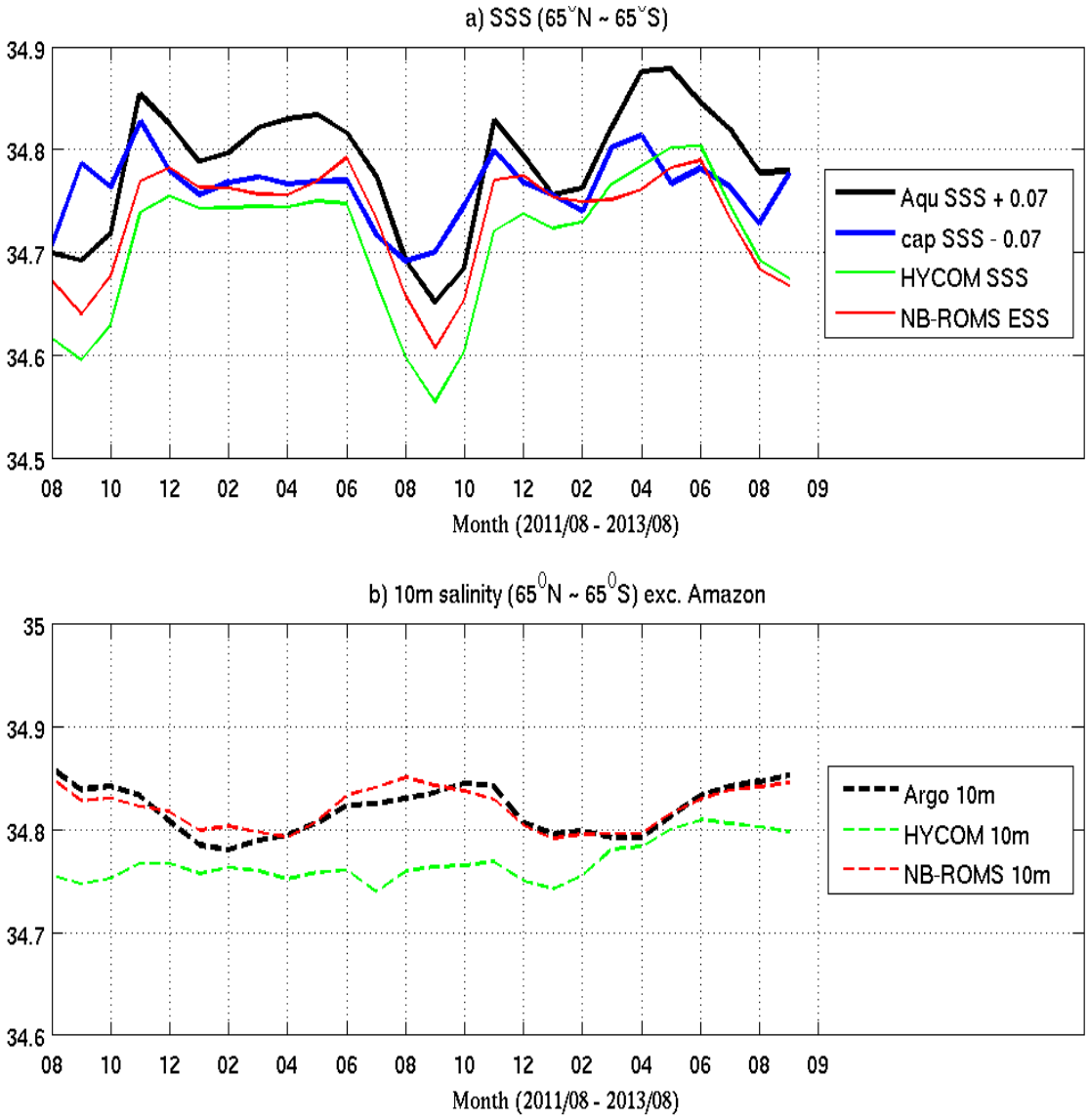
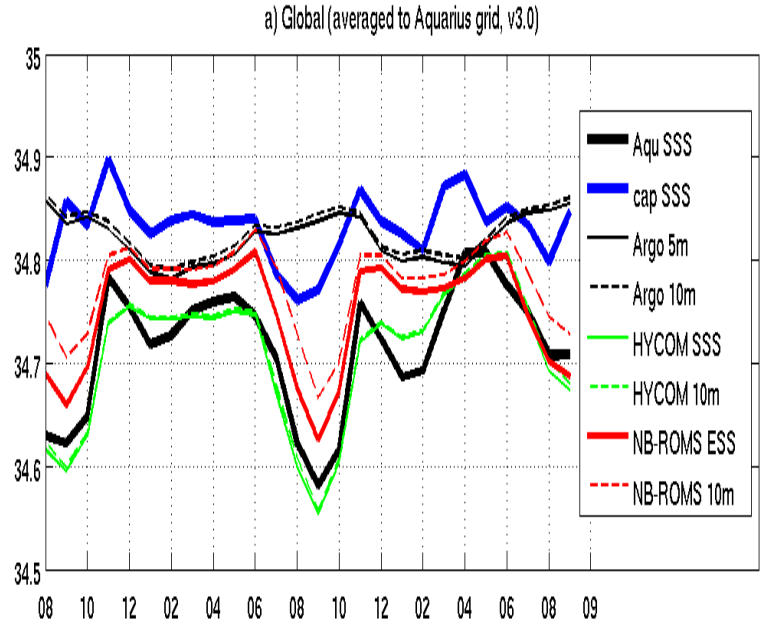
Finally: Global mean SSS

After



Before



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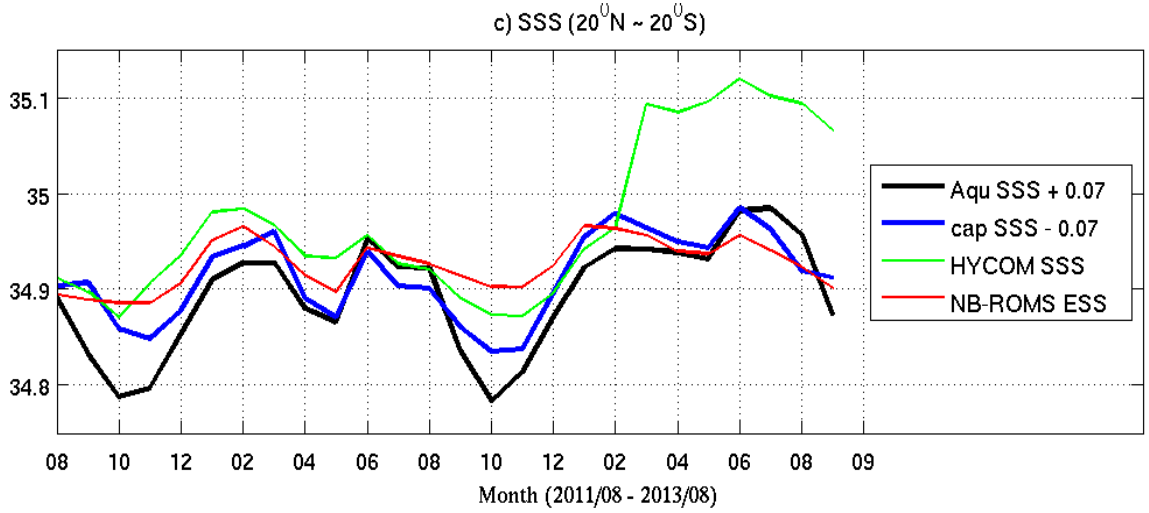
Tropical SSS

After



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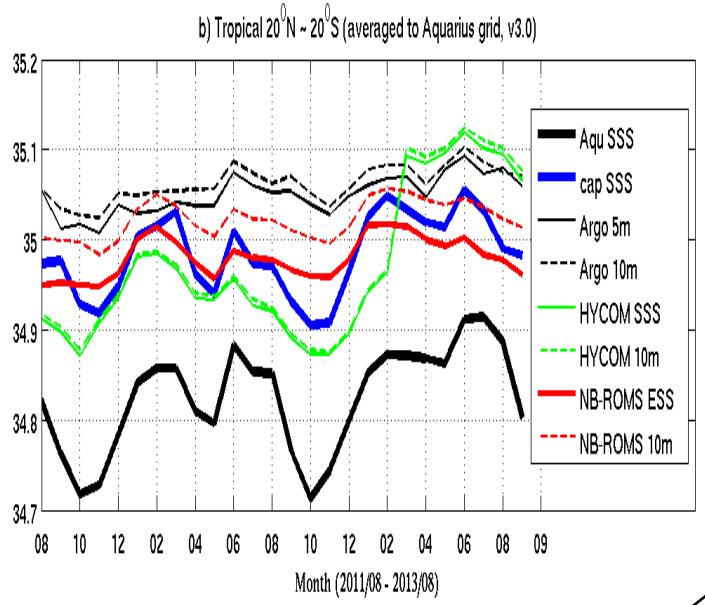

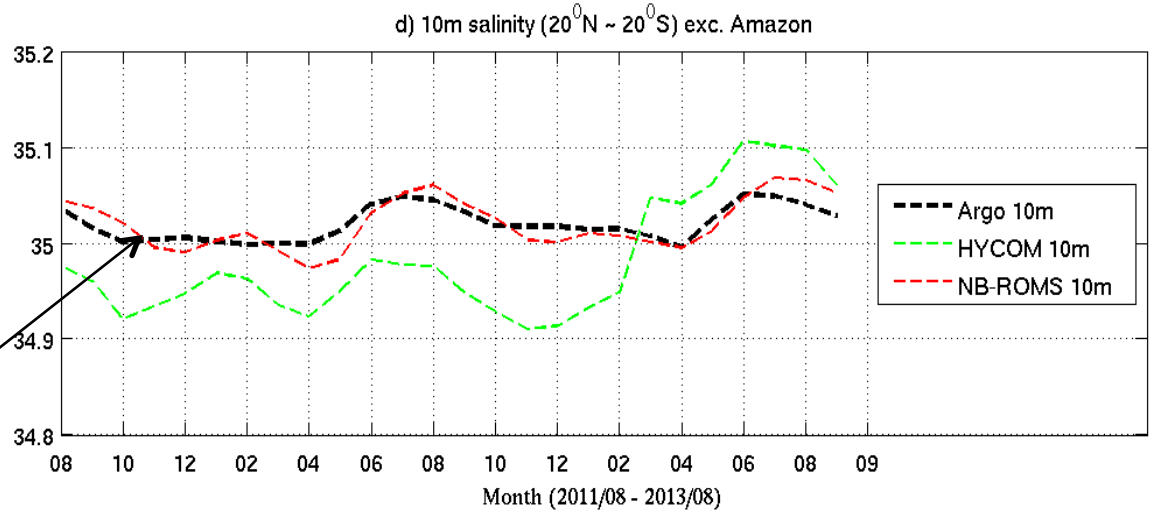

Aqu-Argo error = 0.03 PSU

Summary: The ESSL scheme allows extrapolating sub-surface ARGO salinity to the skin-layer for a "global mean salinity" reference.