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

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

(a) Aquarius

(b) Argo

(c) Model

Strong

Weak

Between
Focusing on Regional Mechanism

**Underline physics:**
I: river runoff and/or surface freshwater
II: monsoon-wind driven ocean currents mixing
III: surface freshwater (E-P) flux
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.
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 \( \varepsilon = -0.2 \) PSU occurring with probability \( \mu = 0.03 \).
The Non-Boussinesq Global ROMS
(1/4-degree, sea-ice coupled)

Heat & momentum:
- NCEP SST & flux
- NCEP winds

Freshwater flux:
- \(-E+P+R=\text{GRACE}\);
- Greenland melting
- River runoffs (256) since 2011
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

\[
\text{ESS} = S_1 + \Delta S \times CF \times c_0
\]
\[
\text{ES1} = S_1 - \Delta S \times CF \times c_1
\]
\[
\text{ES2} = S_2 - \Delta S \times CF \times c_2
\]

- \text{CF = Correlation Function:} between S1 and E-P
- \text{c0, c1, and c2: empirically and mathematically determined constants}
Correlation Function (CF)

$\text{ESS (t)} = S_1 (t) + \Delta S (t) \times \text{CF (x,y)} \times c_0$
Annual Amplitude

\[ V(t) = A \sin(B \cdot t + C) \]

a) Aquarius SSS (amplitude)

e) Argo SSS (amplitude)

e) NB-ROMS ESS (amplitude)

Model-Data improved
Comparisons in depths

Regional improvement
Finally: Global mean SSS

Before

After

a) Global (averaged to Aquarius grid, y/0.0)

b) 10m salinity (65°N - 65°S) exc. Amazon
Summary: The ESSL scheme allows extrapolating sub-surface ARGO salinity to the skin-layer for a “global mean salinity” reference.