Consistency of Aquarius and Argo SSS in depicting temporal variations on various space and time scales

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Motivation and Objectives

• The mission target accuracy of Aquarius SSS of 0.2 psu on monthly time scale and 150-km spatial scale includes time mean and temporal variations.

• It does not isolate Aquarius’ ability to characterize temporal changes on various space and time scales, which is more fundamental to science requirements (in depicting scale-dependent physical phenomena).

• This presentation focuses on evaluating the consistencies of Aquarius V4 monthly gridded SSS using two Argo monthly gridded (OI) products on different space and time scales, and

• Contrasting these consistencies with those between the two Argo products.

• Important question: what portion of std. dev. of Aquarius-Argo SSS can be explained by the std. dev. between the two Argo products?
Data

- Aquarius V4 monthly gridded SSS.

- Argo monthly 1° gridded salinity products at 2.5 m from Scripps Institution of Oceanography (SIO) and from Asian Pacific Data Research Center of University of Hawaii (UH), denoted by Argo-SIO and Argo-UH.

- Argo-SIO uses all data during 2004-2014 to form a gridded seasonal climatology, then add gridded monthly anomalies on top to get total salinity; small smoothing scale, noisy monthly fields, but sharp time-mean gradients.

- Argo-UH uses a larger smoothing scale, giving less noisy monthly fields, but very weak gradients.

- The difference in gridding scheme between Argo-SIO and Argo-UH reflects different approaches to alleviate Argo’s limited space-time sampling.
Comparison of time mean SSS (Sept. 2011-May 2015) for Aquarius vs. Argo-SIO and Argo-SIO vs. Argo-UH
Differences among Argo monthly OI SSS products that are used to evaluate satellite SSS: examples for Scripps & UH/IPRC products (2005-2014)

(a) Time-mean difference between SIO & APDRC monthly OI SSS products

(b) RMS difference between SIO & APDRC monthly OI SSS products

Spatially averaged rmsd = 0.11 psu
Zonally averages of time-mean SSS for Aquarius and Argo-SIO and their differences

(a) Zonally averaged time-mean SSS

(b) Zonally averaged time-mean SSS difference: Aquarius - Argo-SIO
STD of SSS differences for Aquarius vs. Argo-SIO & Argo-SIO vs. Argo-UH for different spatial scales

(a) Std. dev. of $S_{Aqu} - S_{Argo-SIO}$ for $1^\circ \times 1^\circ$ scale

(b) Std. dev. of $S_{Argo-SIO} - S_{Argo-UH}$ for $1^\circ \times 1^\circ$ scale

(c) Std. dev. of $S_{Aqu} - S_{Argo-SIO}$ for $3^\circ \times 3^\circ$ scale

(d) Std. dev. of $S_{Argo-SIO} - S_{Argo-UH}$ for $3^\circ \times 3^\circ$ scale

(e) Std. dev. of $S_{Aqu} - S_{Argo-SIO}$ for $10^\circ \times 10^\circ$ scale

(d) Std. dev. of $S_{Argo-SIO} - S_{Argo-UH}$ for $10^\circ \times 10^\circ$ scale
STD of SSS differences for Aquarius vs. Argo-SIO & Argo-SIO vs. Argo-UH for different spatial scales: seasonal time scales
STD of SSS differences for Aquarius vs. Argo-SIO & Argo-SIO vs. Argo-UH for different spatial scales: non-seasonal time scales

(a) Std. dev. of non-seasonal $S_{Aq} - S_{Argo-SIO}$ ($1^0 \times 1^0$)

(b) Std. dev. of non-seasonal $S_{Argo-SIO} - S_{Argo-UH}$ ($1^0 \times 1^0$)

(c) Std. dev. of non-seasonal $S_{Aq} - S_{Argo-SIO}$ ($3^0 \times 3^0$)

(d) Std. dev. of non-seasonal $S_{Argo-SIO} - S_{Argo-UH}$ ($3^0 \times 3^0$)

(e) Std. dev. of non-seasonal $S_{Aq} - S_{Argo-SIO}$ ($10^0 \times 10^0$)

(d) Std. dev. of non-seasonal $S_{Argo-SIO} - S_{Argo-UH}$ ($10^0 \times 10^0$)

0.10 psu

0.07 psu

0.09 psu

0.06 psu

0.05 psu

0.03 psu
Zonally averaged STD of SSS differences for Aquarius vs. Argo-SIO & Argo-SIO vs. Argo-UH for different spatial scales (seasonal: left, non-seasonal: right)
“Global” (65N-65S) area-weighted averages STD of SSS differences for Aquarius vs. Argo-SIO & Argo-SIO vs. Argo-UH for different spatial scales: seasonal time scales

Table 1. Globally averaged standard deviation values (in PSU) between Aquarius and Argo-SIO and between Argo-SIO and Argo-UH.

<table>
<thead>
<tr>
<th></th>
<th>1°x1°</th>
<th>3°x3°</th>
<th>10°x10°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquarius vs. Argo-SIO (total)</td>
<td>0.16</td>
<td>0.14</td>
<td>0.09</td>
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<tr>
<td>Argo-SIO vs. Argo-UH (total)</td>
<td>0.10</td>
<td>0.09</td>
<td>0.04</td>
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<tr>
<td>Aquarius vs. Argo-SIO (seasonal)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.07</td>
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<tr>
<td>Argo-SIO vs. Argo-UH (seasonal)</td>
<td>0.06</td>
<td>0.05</td>
<td>0.02</td>
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<tr>
<td>Aquarius vs. Argo-SIO (non-seasonal)</td>
<td>0.10</td>
<td>0.09</td>
<td>0.05</td>
</tr>
<tr>
<td>Argo-SIO vs. Argo-UH (non-seasonal)</td>
<td>0.07</td>
<td>0.06</td>
<td>0.03</td>
</tr>
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</table>
Summary

• The discrepancies between the two Argo OI products in depicting temporal variations of SSS on various space and time scales amount to a significant portion of the Aquarius-Argo consistency.

• The consistencies of Aquarius-Argo SSS is similar to those between the two Argo products for seasonal time scales in the tropics, and for non-seasonal time scales for the tropics and subtropics (averaged ratio of STDs of 1.2).

• Consistencies of among Argo OI products need to be considered in evaluating Aquarius SSS.

• Discrepancies between Aquarius and Argo at high-latitudes are substantial: 0.2-0.3 psu both for time mean and for temporal variations.

• Innovative technologies are necessary to improve high-latitude satellite SSS measurements, esp. in light of the ongoing changes in sea ice and the potential impacts on ocean circulation, climate variability, and water cycle.