EVALUATION OF SEA SURFACE SALINITY VARIABILITY IN THE EAST CHINA SEA OBSERVED BY THE AQUARIUS INSTRUMENT

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Results available in JGR 2014 special issue.
Motivation

- Challenging retrieval
  - Land contamination
  - Radio frequency interference
- Routine monitoring of SSS
  - Lacking (East China Sea)
  - Discontinued
- 5th largest river runoff

[Lagerloef, ESR]

[RFI probability, SMOS, CESBIO, Sept 2012]
Outline

- Motivation

- Evaluation
  - Using in situ data
  - Using regional ROMS model with simultaneous river input
  - Effects of land contamination and RFI

- Science
  - Upper ocean salinity balance
  - Impact from the regional drought

- Used v2.5.1 standard product
In situ observation

- By Korea Ocean Research Dev. Inst and/or Japanese collaborators
- CTD salinity record at 0.5m depth (2011); 2-5m (2012; three are 7-10m)
- Early October 2011 (O); late September 2012 (X); weak solar insolation/stratification
Aquarius vs CTD

- Better match with in situ along ascending tracks
Effect of radio-frequency interference (RFI)

- $T_A$ and $T_F$ are brightness temperatures before and after RFI filtering → indicates the RFI presence.
- Descending tracks are contaminated heavily → choose ascending observations.
Effect of land contamination

- 0.5% land contamination
  - About 0.75 K (or 1.5 psu) perturbation to Aquarius SSS
  - Mitigated through land correction

- Away from the coast by 1 pixel, the correction amount is fairly insensitive to radiometric aspect of land emission modeling.
## In situ validation

<table>
<thead>
<tr>
<th>in psu</th>
<th>Aquarius</th>
<th>In situ</th>
<th>AQ - in situ</th>
<th>Dist2coast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 2011 (mean)</td>
<td>33.71</td>
<td>34.07</td>
<td>-0.36</td>
<td>300km</td>
</tr>
<tr>
<td>(stdev)</td>
<td>0.52</td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept 2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area-north (mean)</td>
<td>31.450</td>
<td>31.455</td>
<td>-0.005</td>
<td>100km</td>
</tr>
<tr>
<td>Area-north (stdev)</td>
<td>0.79</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area-south(mean)</td>
<td>32.89</td>
<td>33.66</td>
<td>-0.77</td>
<td>300km</td>
</tr>
<tr>
<td>Area-south(stdev)</td>
<td>0.67</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Ascending tracks only
- Despite gaps in spatial/temporal matchup, the difference is smaller than 1 psu. There were no major rain or typhoon events.
Aquarius and numerical model

- Model: Regional model (ROMS) by Jeju Univ. Korea. 6 depth (1, 10, 20, 30, 50, 75). 1/12th deg.

- Aquarius (original) is lower than model by 0.98 PSU – the bias may be due to unfiltered RFI.

- Once the bias is removed, the two matches with an RMSE of 0.55 PSU (0.48 to 0.62 PSU over all 3 tracks) → 0.24 to 0.31 PSU over a month – close to the open ocean L1 requirement.

- The spatial SSS variability matches well between model and data (lower panel): within 0.5 PSU mostly.
Is unfiltered RFI a quasi-bias?

beam 2, ascending orbits only

beam 3, ascending orbits only
Comparison with river discharge

- **Full-signal**
  - Correlation is 0.65 with no time lag between Aquarius and discharge
  - Aquarius SSS tracks the regional drought
River discharge vs Aquarius

- Seasonal signal
  - Correlation is 0.7
  - discharge leading SSS by 20 to 60 days

\[ \frac{dS}{dt} \times \frac{1}{S} = \frac{(E-P-R)}{H} + (u,v) \cdot \nabla S + \text{subsurface} + \text{mixing} \]
Summary

- East China Sea
  - Coastal sea with 5th largest river runoff (regional hydrology balance)
  - Land contamination
  - RFI
  - Argo non-present
  - Analysis of L2 allows SSS monitoring on challenging areas

- Aquarius vs CTD (and model)
  - Aquarius and in situ data agree within 0.3 to 0.8 psu
  - Matches with a model with 0.24 to 0.31 psu over a month – close to the open ocean L1 requirement.
  - SSS variability has strong correlation with river discharge (correlation is 0.65).

- RFI
  - Undetected RFI
    - Appears stable in time → does not affect the variability

- Science
  - River signal dominates seasonal SSS
  - Seasonal SSS lags river discharge by 30 to 50 days (0.71 correlation)
  - SSS responds to the regional drought
  - JGR special issue paper
Seasonal SSS map

2012 07

2013 07

2012 10