Aquarius Warm End Calibration

Rajat Bindlish, Thomas Jackson, Tianjie Zhao, Gary Lagerloef, David Le Vine

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Overview

• Introduction
• Objectives
• Methodology
• Comparison results for areas with concurrent observations
• Vicarious targets
Introduction

• Verifying the calibration of the Aquarius data over the entire dynamic range is necessary.
• Land brightness temperatures over land fall in a completely different range of response and it is prudent to verify that the primary calibration extends to these levels.
• It is a challenge to validate TB over land using models because there are more factors that contribute to TB and the footprints are more heterogeneous than the oceans.
Approach

• Use SMOS as a tool in assessing the calibration of the Aquarius radiometer over land
• On orbit inter-comparison of two L-band radiometers
• Need for consistent observations:
  – Aquarius and SMOS provide an opportunity to check each others calibration
  – Critical to develop a long-term climatic data record of L-band brightness temperature observations
  – A physical algorithm for development of a long term environmental data record that spans multiple L-band missions requires consistent input observations
SMOS

- Passive microwave L-band 2D-synthetic aperture
  - Multiple incidence angles at every location along the swath
- Sun Synchronous orbit with an ascending orbit of 6:00 AM
- Spatial resolution 40 km
- Swath – 1400 km
- 3 day global coverage
Methodology

• Approach: Use SMOS as a tool in assessing the calibration of the Aquarius radiometer over land (under the assumption that SMOS is a well calibrated L-band radiometer)

• Concurrent observations in both time (within 30 min → eliminates effect of change in physical temperature) and space (same location)

• Aquarius and SMOS inter-comparison notes
  – Aquarius evaluation Version 1.3.7
  – Land and ocean
  – Concurrent SMOS and Aquarius observations within 30 min
  – Same incidence angle (after re-processing SMOS data)
  – Only alias free portions of SMOS observations
  – Multiple SMOS DGG locations within a single Aquarius footprint
  – Min number of SMOS observations per Aquarius footprint required– 20 (to minimize partial Aquarius footprint coverage)
  – Std. Dev. of SMOS data averaged < 5 K (land) and 1 K (ocean) (to minimize footprint variability; also results in screening RFI)
  – Differences in azimuth angle and orientation of the footprints ignored
Comparison between Aquarius and SMOS
## Comparison between Aquarius and SMOS over Land

### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>RMSD (K)</th>
<th>R</th>
<th>Bias [Aq-SMOS] (K)</th>
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<tr>
<td><strong>H pol</strong></td>
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<td>Inner (29.36°)</td>
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## Comparison between Aquarius and SMOS over Ocean
### Summary Statistics

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<th>RMSD (K)</th>
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<th>Bias [Aq-SMOS] (K)</th>
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</thead>
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<td><strong>V pol</strong></td>
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<td>Outer (46.29°)</td>
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Comparison between Aquarius and SMOS

• Intercomparison results:
  – SMOS and Aquarius compare well over oceans
  – Very high correlation between SMOS and Aquarius observations
  – Systematic difference in gain and offset for all channels
  – H-pol bias greater than V-pol bias for all beams
  – Expecting improvements in future versions

• Scatter possibly due to:
  – RFI (possible RFI in SMOS/Aquarius)
  – Heterogeneous footprint
  – Different azimuth angles
  – Noise in SMOS data
Vicarious Calibration Targets

- **Amazon**
  - Hot target

- **Dome-C**
  - Stable cold target in Antarctica
    - ESA has done extensive studies over this location.
    - Multi-year field experiment with a ground based radiometer (RADOMEX)
- Surface temperature effects eliminated by the use of land surface emissivity (NCEP surface temperature)
- Very little difference in Asc and Dsc observations over Amazon
- H and V pol observations are similar
- TB and emissivity does not change with incidence angle for both h- and v-pol
- Variability – Aquarius has higher stability (lower St. Dev.)
- Consistent difference between Aquarius and SMOS observations

Amazon
Vicarious Targets

• Amazon
  – Hot target

• Dome-C
  – Stable cold target in Antarctica
    • ESA has done extensive studies over this location.
    • Multi-year field experiment with a ground based radiometer (RADOMEX)
- Very little difference in Asc and Dsc observations over Dome-C
- Variability – Aquarius has higher stability (lower St. Dev.)
- V pol observations higher than h pol for both satellites
- TB increases with incidence angle for v-pol and vice versa for h-pol
- Bias between Aquarius and SMOS observations
Multi-platform Dome-C observations

Comparison between Aquarius and SMOS over Dome C (Asc)

Comparison between Aquarius and SMOS over Dome C (Dsc)

Aquarius (h-pol)  Aquarius (v-pol)  SMOS (h-pol)  SMOS (v-pol)
Summary

• Aquarius observations compare well with SMOS observations over oceans

• Scatter due to:
  – RFI (possible RFI in SMOS/Aquarius)
  – Heterogeneous footprint
  – Different azimuth angles
  – Noise in SMOS observations

• Aquarius observations very stable over Dome-C

• Very little variability in Aquarius observations over Dome-C

• SMOS observations lower than Aquarius observations for all channels over land