Updates on Instrument Calibration in SMAP Salinity Processing

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Remote Sensing Systems

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Goal and Tasks

- The accuracy of the SMAP L1B TB calibration that is performed for the land applications is not sufficient for salinity retrievals.
  - 1 K accuracy requirement (land)
  - 0.1 K accuracy requirement (salinity)

- The SCPS salinity retrieval algorithm inputs RFI-filtered antenna temperatures (TA) from the L1B files.

- Performs its own calibration down-stream from there:
  - Ocean target calibration.
  - Antenna spillover correction.
  - APC.
  - Correction for reflector emissivity.

- The value of the reflector emissivity is expected to change over time.
  - Needs to be continuously monitored for drift.
Antenna Pattern Correction (APC)

\[ T_{B,TOI} = A \cdot T_{A,Earth} \]

<table>
<thead>
<tr>
<th></th>
<th>j=1</th>
<th>j=2</th>
<th>j=3</th>
<th>j=4</th>
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<tbody>
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<td>0.0014</td>
<td>+0.0117</td>
<td>1.1297</td>
</tr>
</tbody>
</table>

Pre-launch value
Post-launch adjusted
Early Mission Calibration Issue
SMAP Down Time June/July 2019
Emissive Antenna

requires additional calibration effort

- The Aquarius antenna was not emissive.
- The SMAP reflector mesh and component of the feedhorn are lossy (emissive).
- \( T_A = T_{A,\text{Earth}} + \varepsilon (T_{\text{refl}} - T_{A,\text{Earth}}) \)
- Emissivity about 1%. This is 4 times larger than pre-launch value (0.25%).
Determination of Reflector Emissivity

Linear regression
TA (meas – exp) versus $T_{\text{refl}} - TA$.

Slope is the reflector emissivity.

Data are weighted by number occurrence.

Outliers do not matter.
### Time Period | emiss refl v-pol | emiss refl h-pol
---|---|---
SEP 2015 – AUG 2016 | 0.01014 | 0.01021
SEP 2016 – AUG 2017 | 0.01015 | 0.01020
SEP 2017 – AUG 2018 | 0.01014 | 0.01020
SEP 2018 – AUG 2019 | 0.01011 | 0.01018

No significant drift of reflector emissivity in time.
A wrong value for the reflector emissivity and/or the reflector temperature results in ascending – descending biases.
TA (meas – exp) ascending – descending
V-pol

NASA/RSS SMAP V4
Salinity
\( \varepsilon_{\text{refl}} = 0.01 \)
empirical adjusted \( T_{\text{refl}} \)

Pre-launch
\( \varepsilon_{\text{refl}} = 0.0025 \)
JPL thermal model \( T_{\text{refl}} \)

\( \varepsilon_{\text{refl}} = 0.007 \)
proposed for upcoming
Version 5 L1B release
(or even lower!)
JPL thermal model \( T_{\text{refl}} \)
NASA/RSS SMAP V4 Salinity

$\varepsilon_{\text{refl}} = 0.01$

empirical adjusted $T_{\text{refl}}$

Pre-launch

$\varepsilon_{\text{refl}} = 0.0025$

thermal model $T_{\text{refl}}$

$\varepsilon_{\text{refl}} = 0.007$

thermal model $T_{\text{refl}}$

proposed for upcoming Version 5 L1B release


Observed in both salinity and wind speed.

Cause?
Summary and Outlook

• Decreasing the value for the reflector emissivity (currently 1%) is not warranted and will not be done for RSS SMAP Salinity Processing.
  – Supported by analyzing TA versus $T_{\text{refl}}$
  – Ascending – descending.
• Monitoring of reflector emissivity (2015 – 2019) shows no significant drift in the emissivity value.
  – Likely not caused by reflector emissivity.
• Future changes of back-end calibration system (reference load, noise diodes, losses) in SMAP L1B processing will necessitate new analysis and possible calibration changes in salinity processing.
• No calibration degradation after downtime June/July 2019.
• Early mission issue: Calibration?