Roughness Correction for Aquarius (AQ) Sea Surface Salinity (SSS) Algorithm using MicroWave Radiometer (MWR)

W. Linwood Jones, Yazan Hejazin
Central FL Remote Sensing Lab (CFRSL)
Aquarius Science Team Meeting
Seattle, WA, USA
Nov. 13th, 2014
AQ Smooth Surface Tb Measurement

- Smooth ocean surface Tb is used to retrieve SSS
  - There are 12 major sources of Tb, which must be corrected before retrieving SSS
  - Of these, ocean surface roughness (wind speed) correction has the greatest residual error
Aquarius Ocean Roughness Correction

• Baseline SSS retrieval algorithm uses the AQ Scat to provide the roughness correction ($\Delta T_b$)
  – $\Delta T_b$ is correlated with measured radar backscatter

• The CONAE MWR provides an alternative approach for obtaining an AQ roughness correction
  – MWR measured $T_b$ at Ka-band is used to calculate excess ocean emissivity due to wind speed (and wind direction)
  – Using ocean Radiative Transfer Model (RTM) it is possible to translate Ka-band excess emissivity to L-band $\Delta T_b$
MWR Roughness Correction: L-Band RTM

• The MWR roughness correction algorithm has made a significant advances over the past year – Tuning of the L-band RTM for ocean emissivity using the AQ L-2 V3.0 ocean surface Tb and NCEP wind vector
Tuning L-band RTM for Wind Speed

V-pol
280 < SST < 285
34 < SSS < 35

H-pol
280 < SST < 285
34 < SSS < 35
Tuning L-band RTM for Wind Direction

V-pol

\[
280 < \text{SST} < 285 \\
34 < \text{SSS} < 35
\]

\[\text{AQ Measured } \text{T}_b \quad \text{CFRSL Modeled } \text{T}_b\]

\[\text{Relative Wind Direction}
\]

\[\text{ws} = 12 \text{ m/s}\]

\[\text{ws} = 6 \text{ m/s}\]

H-pol

\[
280 < \text{SST} < 285 \\
34 < \text{SSS} < 35
\]

\[\text{AQ Measured } \text{T}_b \quad \text{CFRSL Modeled } \text{T}_b\]

\[\text{Relative Wind Direction}
\]
MWR Roughness Correction: MWR Tb’s

• The MWR roughness correction algorithm has made a significant advances over the past year
  – Improved MWR counts-to-Tb algorithm V6.0
    • Incorporates non-linearity correction
    • Validated using WindSat Tb XCAL
      – Revealed systematic radiometric calibration drift
V6.0 23H, DD biases (MWR-WS)
July 2012 – Nov 2013
MWR Roughness Correction: MWR Tb’s

• The MWR roughness correction algorithm has made a significant advances over the past year
  – Improved MWR counts-to-Tb algorithm V6.0
    • Incorporates non-linearity correction
    • Validated using WindSat Tb XCAL
      – Revealed systematic radiometric calibration drift
      – Removed XCAL Tb biases using WindSat V7.0
V7.0 DD Adjusted to WindSat 23H
July 2012- Nov 2013

B1

B2

B3

B4

B5

B6

B7

B8

July 2012 - Nov 2013
Tuning Ka-band RTM using V7.0

• Tuning coefficients of Ka-band ocean emissivity RTM for wind speed to minimizes the difference between model and observed Tb’s
  – Averaged over all relative wind directions

• Added effect of wind direction
  – Ocean anisotropy is function of:
    • Relative wind direction (χ),
    • Earth incidence angle
    • Wind speed
Tuning Ka-band RTM for Isotropic Wind Speed

V-pol

H-pol

\[ \text{MWR Measured } Tb \quad \text{and} \quad \text{CFRSL Modeled } Tb \]
Tuning Ka-band RTM for Relative Wind Direction

V-pol

H-pol

@ \( ws = 12 \text{ m/s} \)

@ \( ws = 6 \text{ m/s} \)
Empirical MWR Roughness Correction

- Cross-correlation between L-band and Ka-band RTM establishes the AQ $\Delta T_b$ roughness correction
  - First wind direction effects are removed using NCEP wind directions and corresponding AQ/MWR antenna azimuth geometries
  - AQ $\Delta T_b$ calculated using measured MWR $\Delta T_b$ and Empirical X-correlation relationship by AQ beam with corresponding MWR collocated beams
Empirical Roughness Correction Relationship
(for Isotropic Wind)

V-pol

H-pol

\[ Y = -0.03X^2 + 0.90X - 0.15 \]

\[ Y = 0.00X^2 + 0.07X + 0.74 \]
AQ $\Delta T_b$ Comparison with NCEP Wind Speed

V-pol

H-pol

AQ Scat Roughness
MWR Derived Roughness

NCEP Wind Speed (m/s)
Salinity Retrieval Comparison for Various Roughness Corrections (3 months global avg)

Mean (AQ SSS – HYCOM)

SDT (AQ SSS – HYCOM)
Summary

- A legacy data set of 30 mos of MWR data exist for roughness correction
- Preliminary roughness correction algorithm completed for AQ Beam-1
- Release of MWR derived AQ roughness correction (3 beams) in Summer 2015
- Validation of SSS will be performed using MWR derived roughness correction using AQ SSS comparisons with HYCOM
  - Also inter-comparison with scatterometer derived roughness correction