MWR Geophysical Retrievals

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MWR Geophysical Retrieval Status

- Prelaunch retrieval algorithms for columnar water vapor, oceanic wind speed and rain rate were developed using WindSat channels
  - MWR $Tb$’s (@ 52° & 58°) converted to WindSat 53° using statistical regression relationships
  - Geophys retrievals performed at 53° EIA
  - L-2C version-0 ATBD available
  - Preliminary MWR geophysical retrievals are compared with collocated WindSat environmental data records (EDR)
MWR/WindSat Geophys Comparisons (Water Vapor & Wind Speed)

- Period: Aug. 31 – Oct. 4 (155 orbits)
- Number of clear sky comparisons ~ 90,000
  - Data is earth gridded at 0.25°x 0.25°
  - Rainy pixels deleted based on WindSat EDR rain rates > 0.1 mm/hr
Water Vapor Comparisons

RMS = 1.9 mm
Wind Speed Comparisons

RMS = 1.2 m/s

Linear regression

MWIR retrieved wind speed vs. EDR wind speed

Linear regression

MWIR retrieved wind speed vs. EDR wind speed
MWR Rain Rate Measurements

• Rain rate retrieval algorithm must be tuned to account for MWR \( Tb \) EIA’s differences (\( @ 52^\circ & 58^\circ \)) compared to WindSat \( @ 53^\circ \)
  – Pre-launch algorithms do not perform well
    • Limited MWR/WindSat collocations available to tune algorithm
  – However, data are sufficient to develop an effective MWR rain flag that will be averaged over the AQ beam IFOV’s MWR L-3 product
  – Preliminary MWR rain flag results are compared to WindSat EDR rain rates
MWR Rain Flag Algorithm Basis

- MWR rain flag is based upon an empirically derived threshold of the MWR excess $T_b$
  - Threshold optimizes the correlation between binary WindSat rain flag and the MWR rain flag
  - The \textit{excess} $T_b$ is defined as

\[
\text{excess } T_b = \text{observed } T_b - \text{theoretical } T_b(freq, EIA, SST, WV, WS, O2)
\]

Where MWR \textit{theoretical} $T_b$ is calculated using a radiative transfer model with GDAS atmospheric and oceanic environmental input parameters

- RTM accounts for all environmental parameters except columnar cloud liquid and rain rate
- Therefore, we assume that the excess $Tb$ is proportional to liquid water absorption due the clouds and rain
MWR Rain Flag Algorithm

• Excess Tb is calculated for 3 MWR channels
  – Tb threshold ($T_{b\_th}$) is a compromise between the prob of rain detection ($P_{det}$) and the prob of false alarm (incorrect rain declaration) ($P_{fa}$)
  • Tb threshold selected to increase the agreement with WindSat rain flag > $EDR_{threshold}$, while minimizing the false alarm rate
• $P_{det} = “true”$ when EDR flag = rain and MWR flag = rain
• $P_{miss} = “true”$ when EDR flag = rain and MWR flag = no rain
• $P_{fa} = “true”$ when EDR flag = no rain and MWR flag = rain
• Note $P_{det} + P_{miss} = 1$
MWR Rain Flag Probabilities

• Binary comparison of MWR rain flag with WindSat flag ($EDR_{th}$)
  – Collocation data set: 4 days (53 orbits)
  – Parametrically vary $T_{b\_th}$ and $EDR_{th}$ and calculate $P_{det}$ & $P_{fa}$

• Validate selected thresholds by anecdotal rain event imaging

• Cal/Val team opinions solicited to understand user requirements for $P_{det}$ versus $P_{fa}$
Probabilities Comparison for 37H

$EDR_{th} = 0.2 \text{ mm/hr} \& = 0.8 \text{ mm/hr}$

$P_{detection}$

$P_{false\ alarm}$

$P_d$  

$P_{fa}$

Excess Tb Threshold, $K$
Probabilities Comparison for 37V

$E^{DR}_{th} = 0.2 \text{ mm/hr} & = 0.8 \text{ mm/hr}$

$P_{detection}$

$P_{false\ alarm}$

$P_{d}$

$P_{fa}$

Excess Tb Threshold, K
Probabilities Comparison for 23H

$EDR_{th} = 0.2 \text{ mm/hr } \& = 0.8 \text{ mm/hr}$

$P_{\text{detection}}$

$P_{\text{false alarm}}$

$EDR_{th} = 0.8 \text{ mm/hr}$

$EDR_{th} = 0.2 \text{ mm/hr}$

Excess Tb Threshold, K

Excess Tb Threshold, K
Rain Event Evaluation Procedure

• Prepare 4-color binary comparison of MWR binary rain flag with EDR binary rain flag
  – WindSat EDR rain rate earth gridded in pixels (0.125°x 0.125°)
    • Converted to equivalent binary flag > $ERD_{th}$
  – MWR 8 beams excess $Tb$ resampled to WindSat pixels

• Examine the spatial pattern of resampled MWR rain flag to WindSat binary rain
  – Two EDR thresholds used: $ERD_{th} = 0.2$ mm/hr & $= 0.8$ mm/hr
WindSat Rain Event
Aug. 31, 2011  AQ rev-427

MWR swath
Excess $Tb$ 37V

WindSat ERD Rain Rate

MWR 37V Excess $Tb$

Resampled to WindSat pixels

Longitude, deg

Latitude, deg

Longitudes, deg

Rain Rate, mm/hr

Excess $Tb$, Kelvin
Excess $T_b$ 37H

WindSat ERD Rain Rate

MWR 37H Excess $T_b$

Resampled to WindSat pixels

Longitude, deg
Latitude, deg
Rain Rate, mm/hr
Excess $T_b$, Kelvin

Longitude, deg
Excess $Tb$ 24H

WindSat ERD Rain Rate

MWR 24H Excess $Tb$

Resampled to WindSat pixels
4-color 37V Rain Flag Evaluation

WindSat EDR > 0.2 mm/hr & MWR $T_{b_{th}} = 11$ K

- Rain Threshold = 0.2
- Excess Tb Threshold = 11

Rain agree
$P_d = 51.8\%$

False alarm
MWR
$P_{fa} = 12.6\%$

No rain agree

Missed rain
MWR
$P_{miss} = 48.2\%$
37V Rain Flag Evaluation

Rain Threshold = 0.2  Excess Tb Threshold = 11

$P_d = 51.8\% \& P_{fa} = 12.7\%$

Rain Threshold = 0.8  Excess Tb Threshold = 11

$P_d = 69.8\% \& P_{fa} = 15.9\%$
37H Rain Flag Evaluation

Rain Threshold = 0.2  Excess Tb Threshold = 11

$P_d = 54.4\%$ & $P_{fa} = 10.6\%$

Rain Threshold = 0.8  Excess Tb Threshold = 11

$P_d = 73.8\%$ & $P_{fa} = 14.4\%$
23H Rain Flag Evaluation

$P_d = 48.2\% & P_{fa} = 17.2\%$

$P_d = 61.1\% & P_{fa} = 20.1\%$
Summary

• MWR retrievals of geophysical parameters are now routinely processed in the L-2C product posted on PODAAC
  – Columnar water vapor & ocean wind speed
  – Rain rate algorithm is not providing satisfactory results; however a MWR rain flag is available

• Feedback from AQ Cal/Val team is requested for rain rate threshold for MWR rain flag
  – Are flags > 0.2 mm/hr and > 0.8 mm/hr useful?
  – Other rain rate thresholds?

• How should MWR rain flags be averaged over AQ beam IFOV’s?