

MWR in RSS L2 Algorithm

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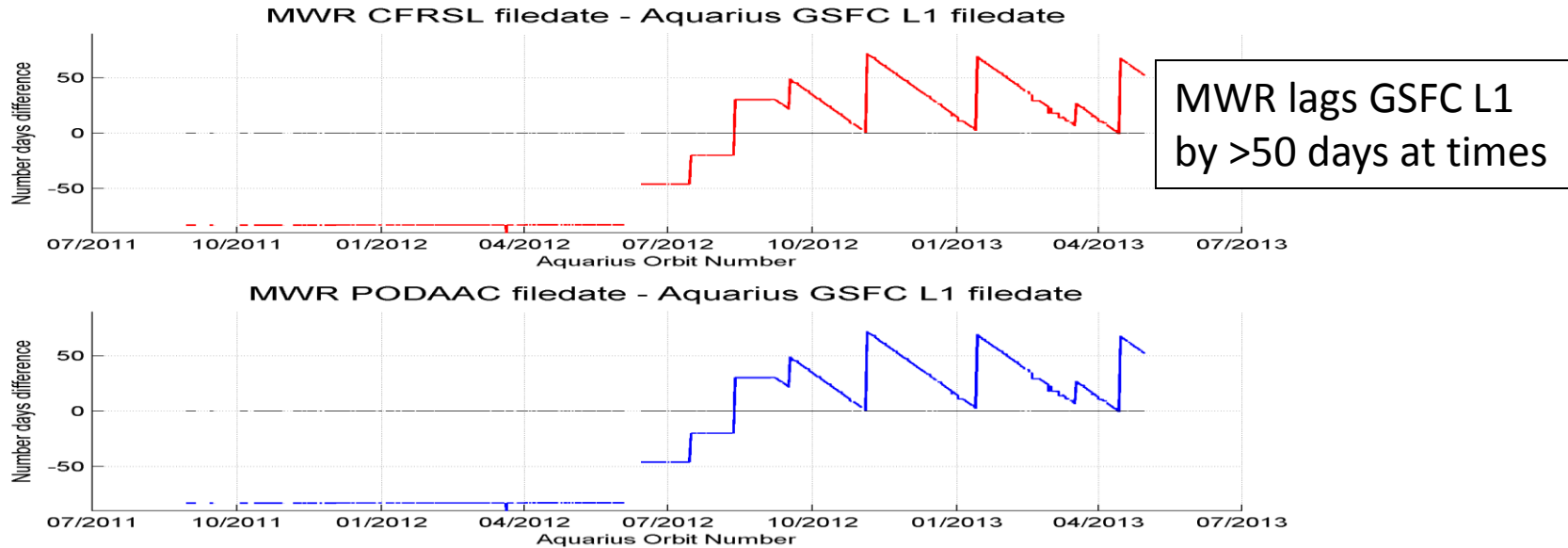


Summary: Use of MWR in Aquarius

- MWR provided instantaneous measurement of rain rate
 - Rain flagging.
 - Study of surface splashing.
 - Study of freshening in/after rain.
- Cloud water and liquid cloud water absorption.
 - Marginal improvement over using NCEP cloud water fields.
 - L-band liquid cloud water absorption is very small, even in rain.
- Wind speeds are NOT useful for Aquarius roughness correction.
 - No 18.7 GHz.
 - Even outperformed by NCEP.
 - No competition for scatterometer (HHH) winds.

AQ and MWR Data Availability

File latency



For MWR to be ingested as an ancillary dataset by AQ L2 processing,
data latency must be reduced!

SOLUTION: RSS MWR processing via direct, near-real-time CONAE feed (RSS V5C)



RSS MWR Data Flow

- L1A and L1B from CONAE User Segment Services (CUSS)
 - Near-real-time availability
 - Fetched by RSS ~14 times per day via SFTP
- RSS L2B
 - **RSS MWR geolocation from S/C ephemeris**
 - **RSS Aquarius geolocation from S/C ephemeris (GSFC L1 data, near-real-time)**
 - **Counts to T_A from CONAE L1**
 - **T_A to T_B using RSS V7 RTM**
 - CFRSL Algorithm uses double difference method
 - **Geophysical retrievals: water vapor, cloud liquid water, rain rate, wind using RSS Algorithms**
- **RSS L2C**
 - **MWR geophysical retrievals on AQ 3dB footprints**
 - **Cloud liquid water content, L-band liquid absorption, rain rate, vapor, wind speed.**
 - Using a weighted average of MWR obs within AQ fp using the convolution of MWR (circular Gaussian, odd/even horns) with Aquarius (elliptical Gaussian)
- Current data holdings at RSS:
 - Orbits: 9262 to >12900. Dates: 2013.60 to today.
 - CUSS only serves most recent 3 months of data. Back data in progress of being ordered/delivered.
 - Before that date we have CFRSL files.

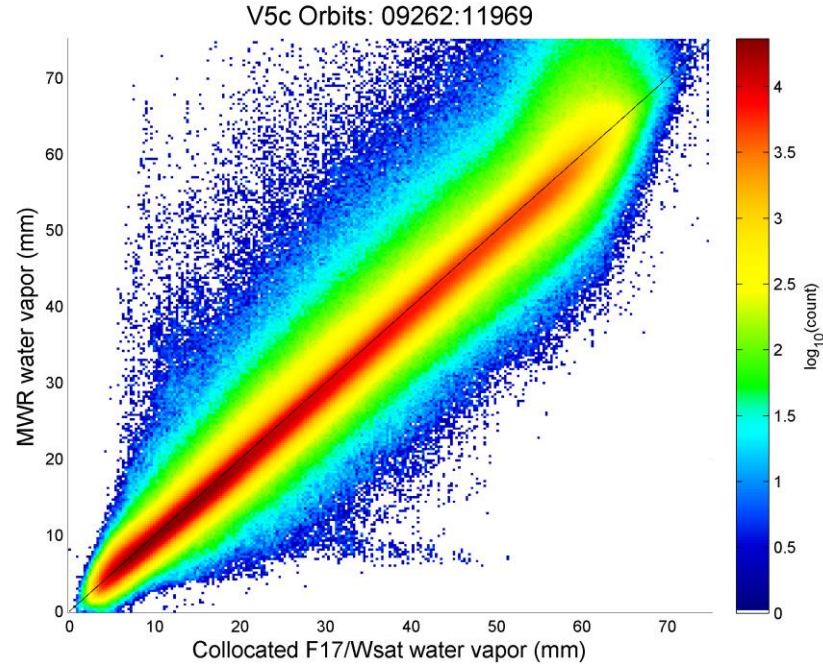
Validation of RSS MWR Product

Collocated with 1 hour RSS WindSat / SSMIS F17

No rain

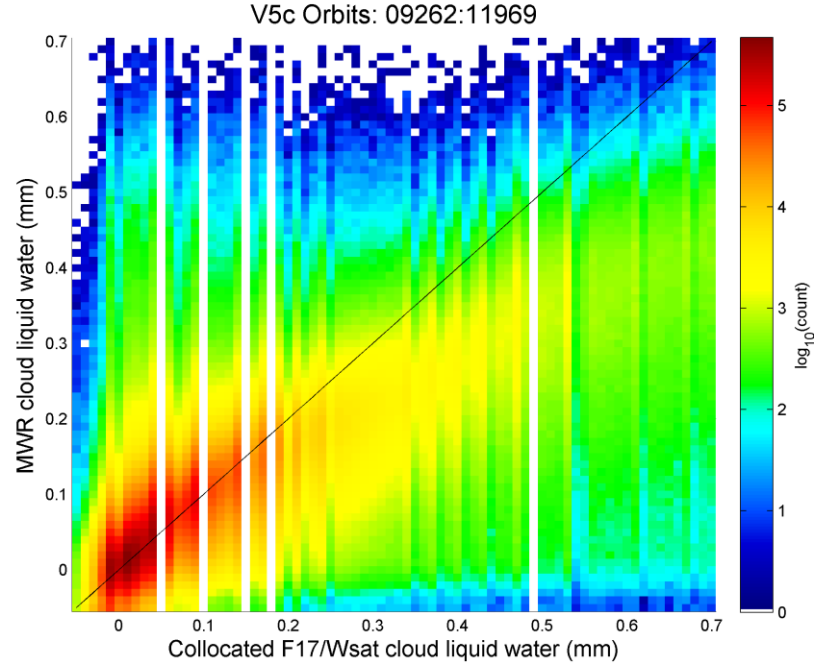
No exclusion of outliers

Vapor

No outlier
exclusion

Vapor	Mean Collocated	27.15060241
	Mean Retrieved	26.58750942
	Bias	-0.563092983
	RMS Error	2.65472766

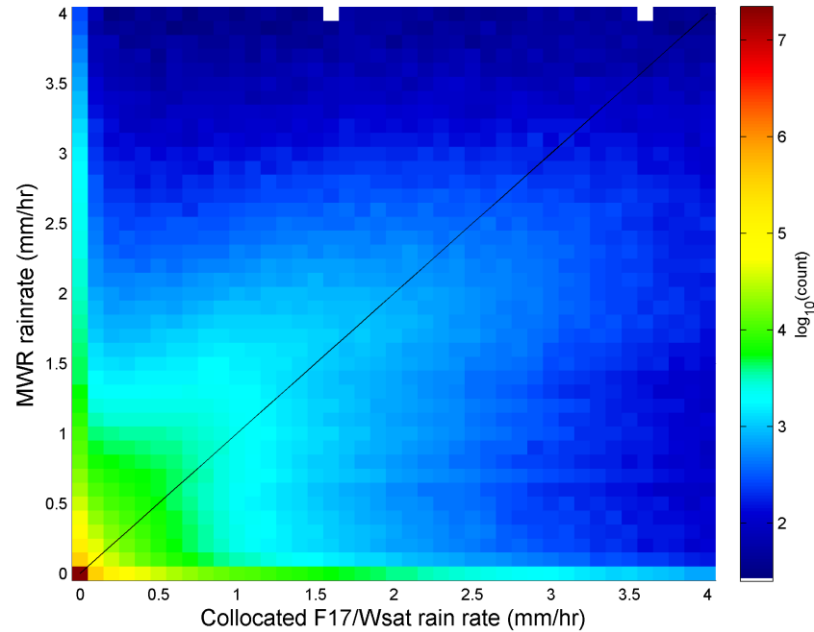
Cloud



Cloud	Mean Collocated	0.074900812
	Mean Retrieved	0.07172171
	Bias	-0.003179102
	RMS Error	0.072243996

Rain Rate

V5c Orbits: 09262:11969

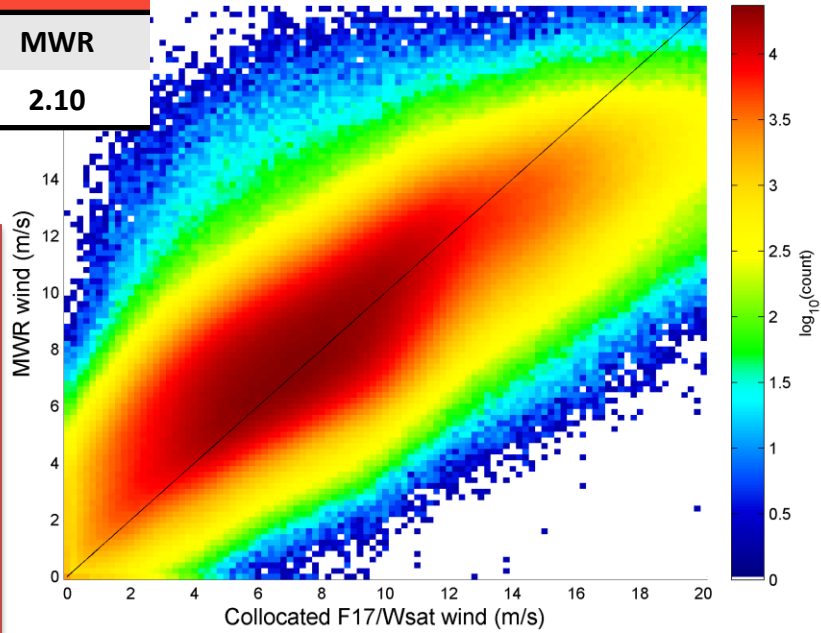


Rain rate	Mean Collocated	0.069220854
	Mean Retrieved	0.071120692
	Bias	0.001899838
	RMS Error	0.285387628

Wind

V5c Orbits: 09262:11969

RMS [m/s]			
Evaluated against WindSat, 1hour, rain-free			
AQ HHH	AQ HH	NCEP	MWR
0.77	0.86	1.24	2.10



- MWR has no 18 GHz channels, which are important for wind speed (SSM/I)
- Difficult to distinguish cloud from wind
- I am pessimistic about using MWR in Aquarius for roughness correction.

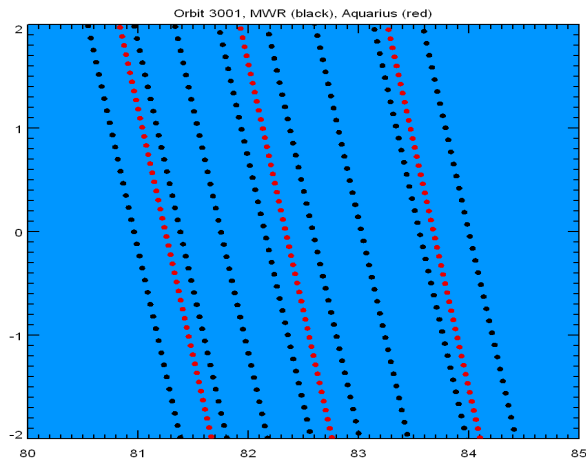
Wind	Mean Collocated	7.804519254
	Mean Retrieved	8.383896984
	Bias	0.57937773
	RMS Error	2.095243916



Path to MWR used for GSFC L2 Processing

- Obtain and process all back-data from CONAE
 - Time period: Launch of instrument to 2013.060
- Make RSS MWR L2C data available via FTP
- GSFC ingest L2C data as ancillary dataset
 - RSS provides read code and documentation
- The RSS L2C data are collocated to the L2 Aquarius array.
- The RSS L2C data contain the value of:
 - The liquid cloud water absorption A_L to be used in the Aquarius L2 processing for the atmospheric correction.
 - Rain rate and columnar liquid cloud water content: To be used for rain flagging and diagnostic purposes.

MWR RSS L2C Methodology



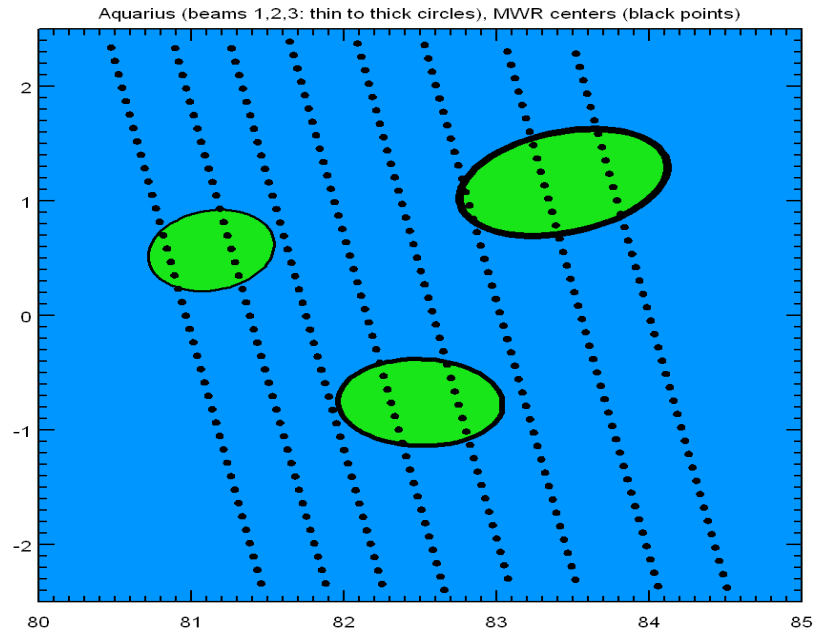
Dots represent center of IFOV

MWR

Horn	EIA (deg)	IFOV (km)
Odd	52	27 x 45
Even	58	31 x 63

Aquarius

Horn	EIA (deg)	IFOV (km)
1	28.7	76 x 94
2	37.8	84 x 120
3	45.6	96 x 156



- Locate MWR obs within Aq 3dB footprints
- Create a weighted average of them using the convolution of MWR (circular Gaussian, odd/even horns) with Aquarius (elliptical Gaussian)



Geophysical Retrievals: Vapor and Cloud Algorithm

- AMSR-E retrieval algorithm simplified for MWR processing
 - Only retrieving water vapor and cloud water
 - Uses isotropic model function (no wind direction)
 - Only does one stage (AMSR-E does three) where coefficients are localized to SST and wind speed regime using Reynolds and NCEP (rather than using first guess retrievals)
 - Uses T_b 37V and 37H, log of 23H, and squares of these
 - Retrieval coefficients are derived in same way as AMSR-E
 - *Wentz and Meissner* [2000] AMSR ATBD (available on www.remss.com)
 - Make simulated brightness temperatures for a wide variety of scenes
 - Uses radiosonde profiles of temperature and vapor, launched from small islands, quality-control applied
 - Cloud layers of varying density are superimposed on profiles
 - SST and wind speed are randomly varied
 - Brightness temperature is calculated using RSS Version-7 RTM
 - Noise is added to simulated T_b to represent measurement error
 - Multiple linear regression to find coefficients



Geophysical Retrievals: Rain Algorithm

- Used the RSS rain algorithm described by *Wentz and Spencer* [1998] with improvements by *Hilburn and Wentz* [2008]
 - Made as minimal changes as possible
- Removed the parts making use of 19 GHz
 - Beamfilling correction (uses 19/37 ratio)
 - 19 GHz used for high rain rates
- Used one year of AMSR data to develop table-based beamfilling correction
 - Calculated $B = A_{\text{corr}} / A_{\text{uncorr}} = (\exp(X)-1)/X$
 - X is a measure of sub-pixel spatial variability, and this expression derives from a gamma probability distribution [*Hilburn and Wentz, 2008*]
 - Made a table of X versus uncorrected attenuation and rain column height, which is a function of SST
 - X also depends linearly on footprint diameter
 - Add MWR footprint size contribution (36 km for odd horns and 47 km for even horns)
 - Version-7 rain algorithm uses D/96 km (instead of 120 km in V6) for better agreement among sensors (which have D ranging from 20-60 km)