MWR Algorithms (Wentz): Provide and validate wind, rain and sea ice [TBD] retrieval algorithms for MWR data

Between now and launch (April 2011)

1. In-orbit Checkout (IOC) from launch until 6 weeks after launch (note that this phase may not apply to all WGs.
    1. develop and test wind and rain algorithms using ssmi data
    2. obtain pointing parameters for MWR
    3. simulate MWR push broom
    4. obtain L1 and L2 format descripions for MWR
    5. collocation procedures

2. Aquarius is activated over several days beginning after 3 weeks on orbit, and the other sensors follow, so there is very limited data (1-2 weeks) to evaluate during the IOC.)
    1. reasonablity of TB
    2. reasonablity of wind and rain

3. 6 months after the IOC, at which time we expect to apply the accumulated experience to update the algorithms are re-process the first 6 months of science data, and provide data quality analyses.

# Using the CONAE SAC-D Microwave Radiometer to Improve Aquarius Salinity Retrievals

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**ABSTRACT:**

The overall objective of this investigation is to use the 24/37 GHz microwave radiometer (MWR) that is being provided by the Space Agency of Argentina (CONAE) to reduce the errors in the Aquarius salinity retrievals. The MWR will fly on the SAC-D spacecraft along with Aquarius. The MWR observations will be used for rain detection and correction, for wind speed estimation, and for sea ice detection. Our primary concern is the effect of moderate to heavy rain on the Aquarius 1.4 GHz observations. Simulations have shown that 11% of the Aquarius salinity retrievals will have error greater than 0.1 psu if no rain flagging or correction procedure is implemented. An error of 0.1 psu represents half of the total error allocation (mission requirement is 0.2 psu). Extreme rain events (10 mm/hr) will produce a 0.8 psu error in the salinity retrieval. The ability to simply flag rain contamination will, in itself, be extremely valuable. This work will entail the on-orbit calibration of the MWR, the adaptation of existing retrieval algorithms for liquid water, wind speed, and sea ice, and research into the problem of estimating the total atmospheric liquid water within an Aquarius footprint given the MWR 24/37 GHz observations.

# MWR: Detecting Rain and Sea-Ice for Aquarius

**Rain has a small, but still significant, effect on the Aquarius 1.4 GHz Observation**

Three proposed solutions

1. Global Precipitation Mission (GPM) daily maps of global precipitation from multiple satellites.

2. The F17 SSMI/S (node time = 5:30) for +- 50 minute collocation

3. MWR (preferred solution).

**Aquarius observations near sea-ice must be flagged**

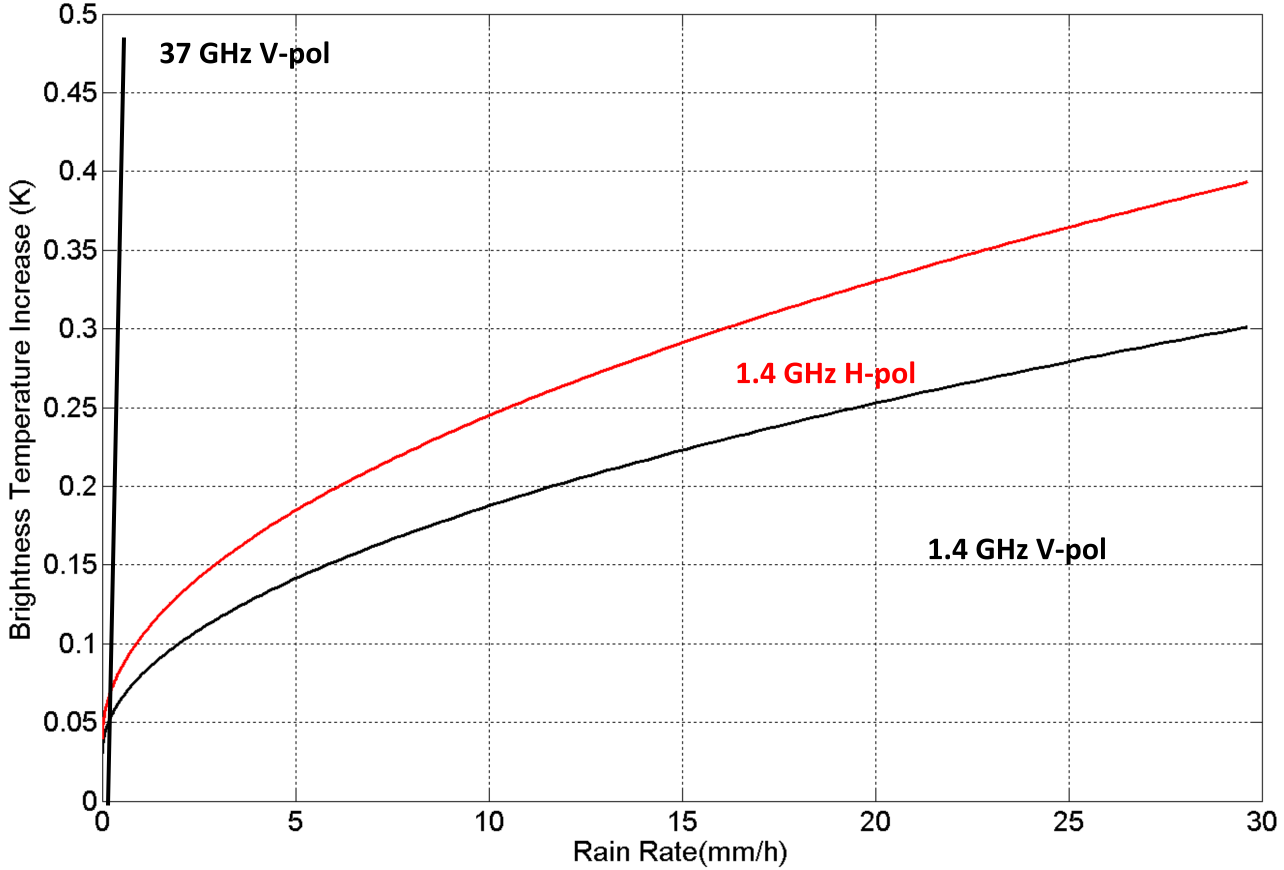
Three proposed solutions

1. Ancillary sea ice maps generated by SSM/I and other sensors (multiple sources)

2. Sea Ice detection done by scatterometer

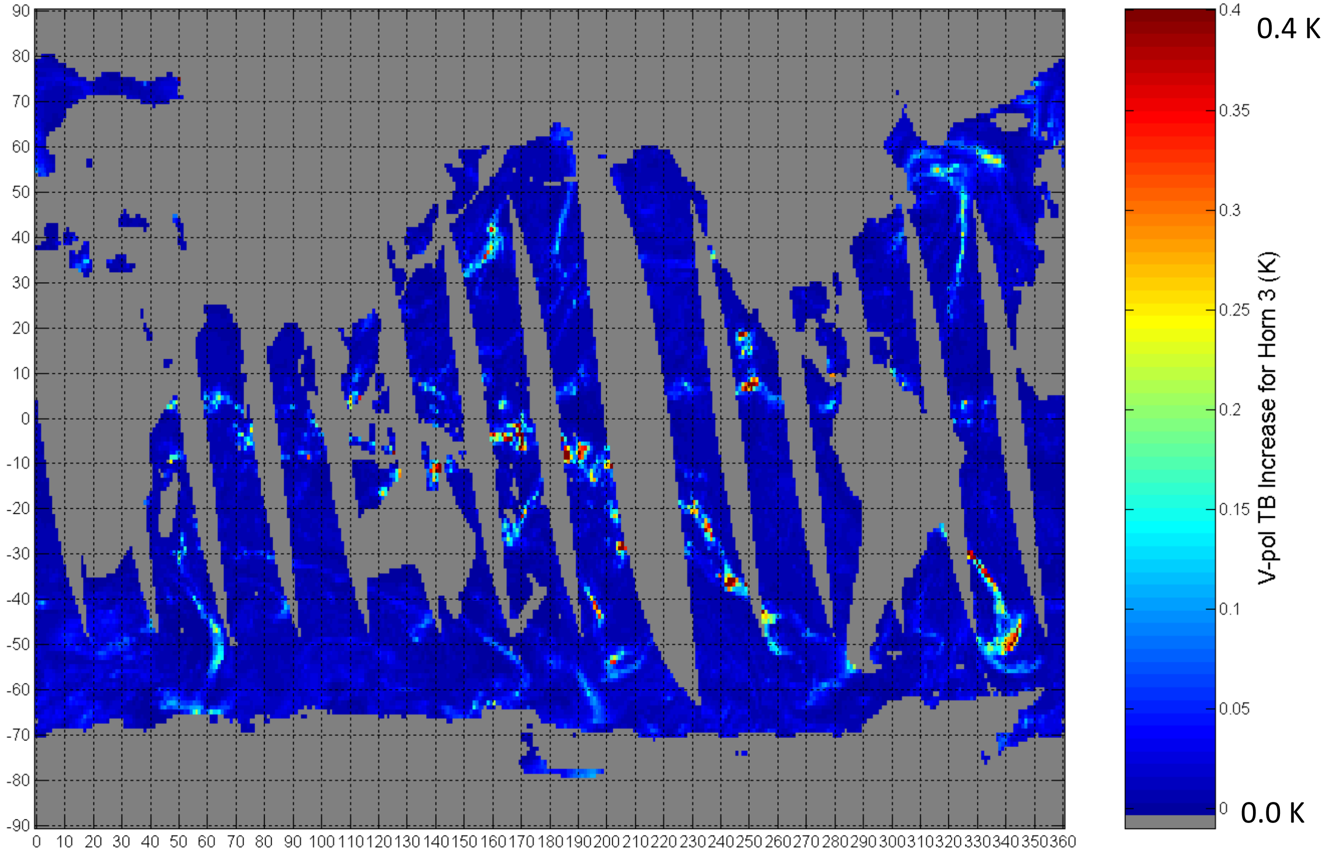
3. Sea Ice detection done by MWR.

# Increase in Brightness Temperature Versus Rain Rate



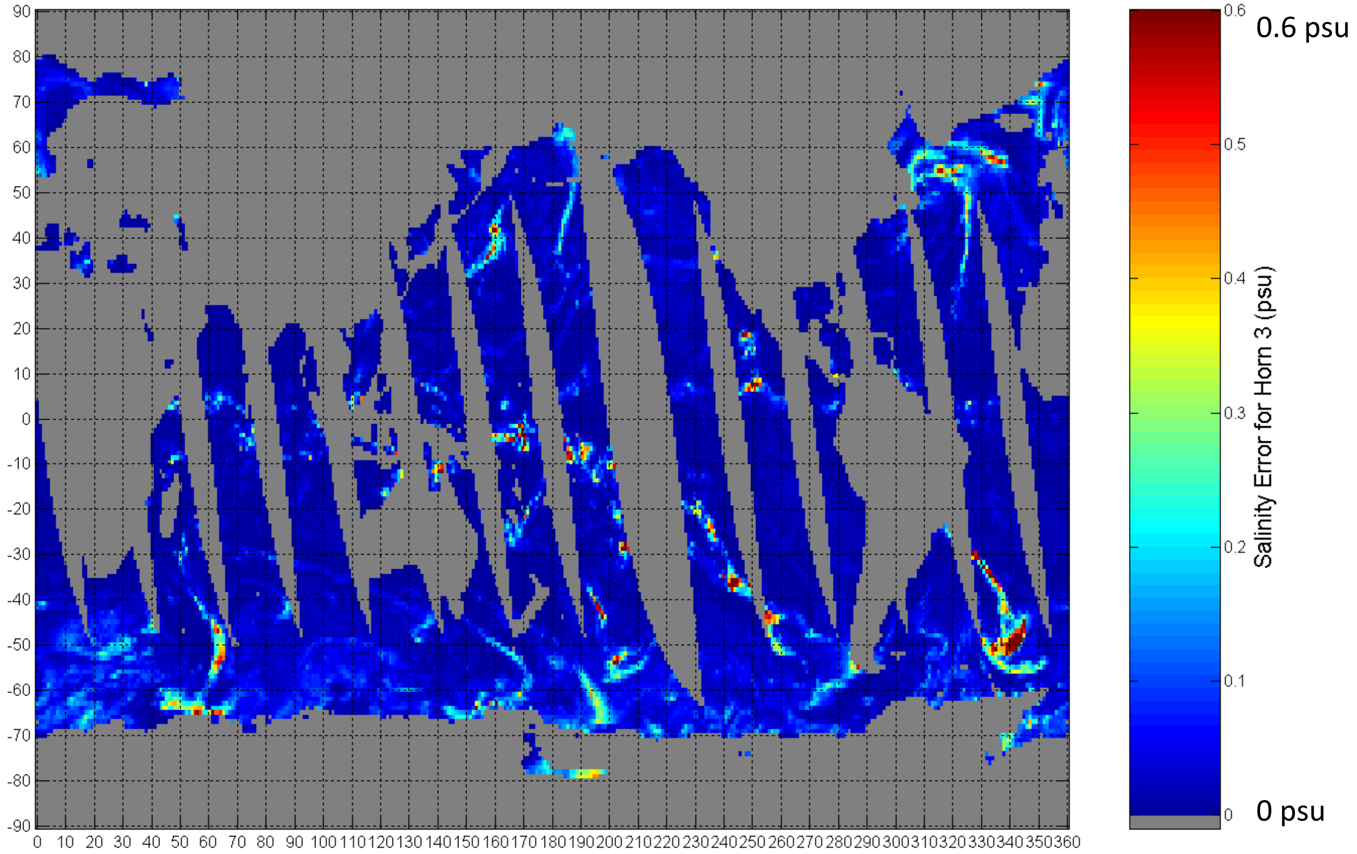
# Effect of Rain on Aquarius V-pol Brightness Temperature

**Simulated increase in the 1.4 GHz v-pol brightness temperatures due to rain derived from the AMSR-E observations for January 1, 2004.**



# Effect of Rain on Aquarius Salinity Retrievals

**Simulated error in the salinity retrieval**
**due to rain derived from the AMSR-E observations for January 1, 2004.**



# Estimation of 1.4 GHz Absorption from MWR

**MWR Required Calibration Accuracy for Rain Detection is 2 to 5 K.**

**Current RSS Ocean Model for TA accurate to within 0.5 K (no rain).**

**Self-Calibration Algorithm (see next slide):**

1. 10 minute orbit segment (moving window method)
2. Compute TA histogram
3. Find areas of no rain
4. Calibrate MWR TA to agree with Ocean Model
   (Automatically balances horns)

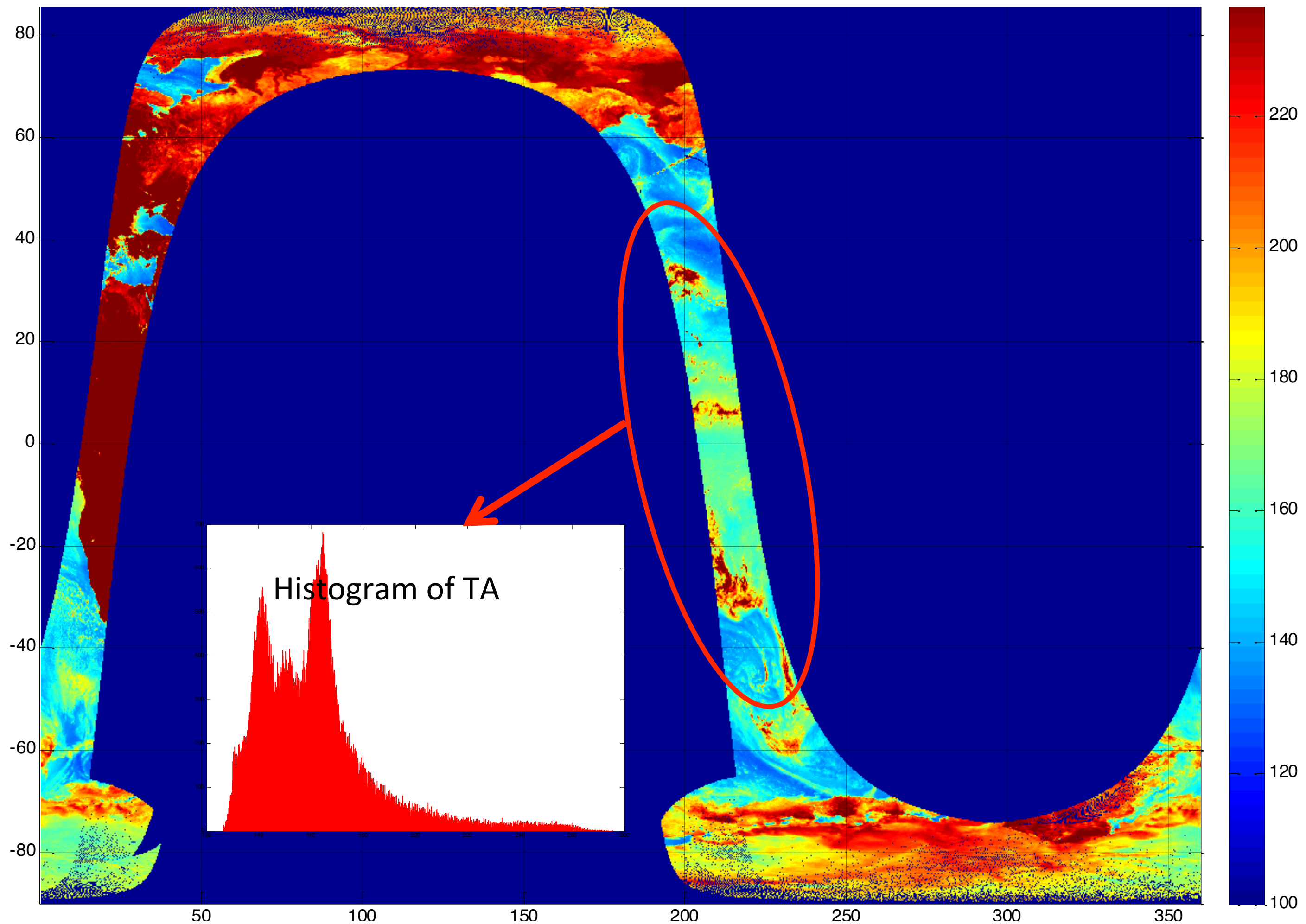
**TA Fore – Aft Resampling**

1. Use Optiumum Interpolation directly to an Earth-Fixed Grid

**Compute Liquid Water Absorption at 1.4 GHz.**

1. At 37 GHz, TA depends on detail nature of rain
2. At 1.4 GHz, TA just depends on total water
3. A model is being developed using AMSR 6.9 and 37 GHz obs.

# Example of Self-Calibration Algorithm




1. Histogram of Antenna Temperature (TA) for a swath segment is used to determine rain-free areas (i.e. low TA values)
2. Predicted rain-free TA values are computed from a radiative transfer model (RTM) using ancillary information
3. If needed , the MWR measured TA are adjusted to match the RTM TA.
4. This procedure is done in a on-going, operational manner.

# Schedule and Work Plan

**Year 1:** In the first year, we will develop and test the total liquid water *L* retrieval algorithm using the WindSat 22/37 GHz channels to estimate *L* and then using the 6.8 GHz channel to tune and validate the algorithm. The software for processing the MWR L1A data will be developed. This software will be an adaptation of the operational software that RSS uses for the SSM/I and SSM/IS.

**Year 2:** In the second year Aquarius will be in operation. Our plan is to start providing MWR rain detection/correction about 6-months after launch. These first 6 months will be spent updating the pre-launch software and algorithm to deal with real data coming from the MWR. The second half of the year will be spent analyzing and validating the application of the rain detection/correction to the Aquarius salinity retrievals.

**Year 3:** In the third year, we will work on improving the calibration of the MWR using other satellites, particularly the F17 SSM/IS, and implementing the MWR wind speed retrievals for the Aquarius sea-surface roughness correction. The daily processing of the MWR will continue along with the delivery of MWR retrievals to the ADPF at Goddard. The quality and characteristics of the MWR brightness temperatures and retrievals will be continuously monitored.

**Year 4:** Improvements in sensor calibration and retrievals will be implemented as needed. The daily processing of the MWR will continue along with the delivery of MWR retrievals to the ADPF. The quality and characteristics of the MWR brightness temperatures and retrievals will be continuously monitored. A final report along with appropriate publications will be delivered.

# MWR for Other Areas of Earth Research

**For these Additional Applications, MWR Required Calibration is 1 K or better**

**Potential Applications Include**:
1. Cloud water and rain retrievals
2. Atmospheric water vapor
3. Sea-surface wind speed (maybe direction)
4. Sea ice

**Analysis of MWR TA**
1. Use collocated SSMI/S observations
2. Need MWR antenna parameters
   (spillover and cross-pol)
3. Need to balance different horns

**Retrieval Algorithm to be use**: Heritage SSMI minus 19 GHz channels

**Leverage on existing programs at RSS**
1. Aquarius
2. DISCOVER
3. GPM