Calibration Drift in AMSR-2 Brightness Temperatures: The Effect on Wind Speed and SST

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The Version 8.0 AMSR-2 retrieval of SST was drifting upward and the Wind Speed retrieval was drifting downward. This conclusion was based on:

1. Comparisons with WindSat and GMI retrievals, shown in Figure 1
2. Comparisons with the Reynolds SST and the CMC SST
3. Comparisons with buoy SSTs
4. Comparisons with ASCAT-B satellite scatterometer

The WindSat and GMI comparisons also reveal small drifts in the AMSR-2 Vapor and Cloud retrievals. The combined analysis gave the following drifts:

SST:	**+ 0.28 C per decade**
Wind:	**- 0.14 m/s per decade**
Vapor:	**+ 0.024 mm per decade**
Cloud:	**+ 0.0029 mm per decade**

AMSR-2 Compared to GMI and WindSat

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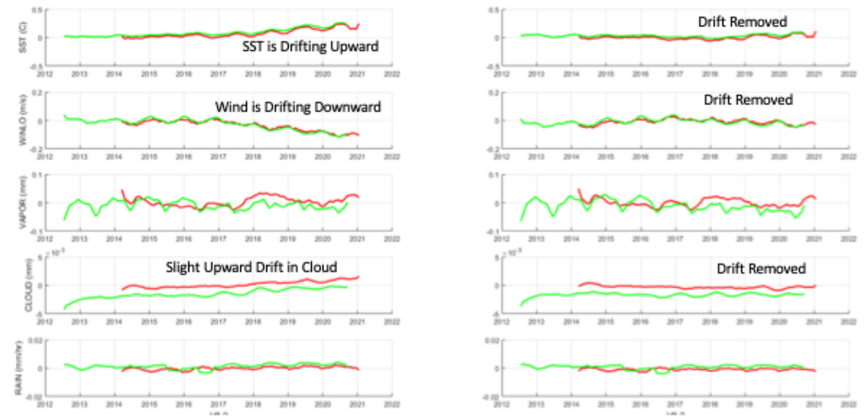

Fig. 1. Timeseries showing the difference of the AMSR-2 retrievals minus similar retrievals from WindSat (green curve) and GMI (red curve). The left column shows the obvious drift in the V8.0 product and the right column shows the new V8.2 product with the drifts removed. Seasonal variations in AMSR2 minus WindSat curves are probably due to the large difference in the local ascending node time between these two sensors.

Relating Drifts in AMSR-2 Retrievals to Drifts in Antenna Temperatures

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We used our Ocean Radiative Transfer Model (ORTM) to convert the drifts in SST, wind, vapor, and cloud to drifts in the AMSR-2 Antenna Temperatures (TA). In doing this, we assume the drifts are a linear function of time.

Figures 2 and 3 show the timeseries of the difference of the AMSR-2 TA measurement minus the ORTM TA for V-pol and H-pol, respectively. In computing the ORTM TA we use the AMSR-2 wind, vapor, and cloud retrievals after removing the spurious trends given above. For SST, we use the Reynolds product.

Drift in AMSR-2 V-Pol Antenna Temperature

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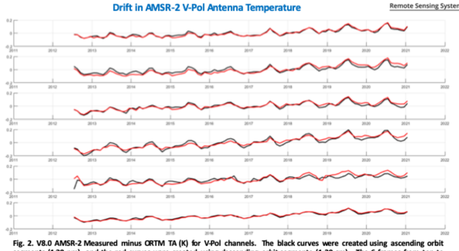

Fig. 2. V8.0 AMSR-2 Measured minus ORTM TA (K) for V-Pol channels. The black curves were created using ascending orbit segments (1:30 pm), and the red curves were created using descending orbit segments (1:30 am). The 6 frames from top to bottom are 6.9, 7.3, 10.7, 18.7 , 23.8, and 36.5 GHz. The 89 GHz channels are not shown. An upward drift is apparent.

Drift in AMSR-2 H-Pol Antenna Temperature

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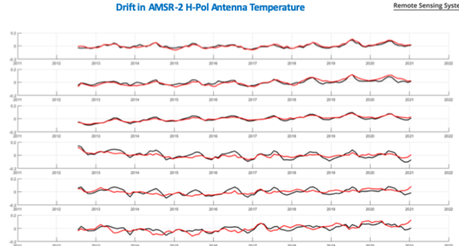

Fig. 3. Same as Figure 2 except the H-Pol channels are shown.

AMSR-2 V-Pol Antenna Temperature After Removing Drift

(compare this to Figure 2)

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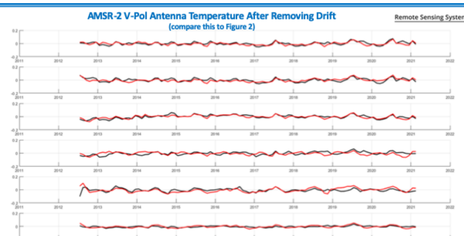

Fig. 4. V8.2 AMSR-2 Measured minus ORTM TA (K) for V-Pol channels. Black curves correspond to ascending orbit segments (1:30 pm) and red curves correspond to descending orbit segments (1:30 am). The 6 frames from top to bottom are 6.9, 7.3, 10.7, 18.7, 23.8, and 36.5 GHz. The upward drift is gone.

AMSR-2 H-Pol Antenna Temperature After Removing Drift

(compare this to Figure 3)

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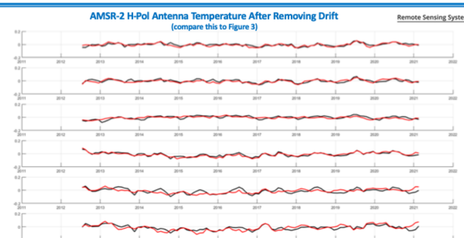

Fig. 5. V8.2 AMSR-2 Measured minus ORTM TA (K) for H-Pol channels. Black curves correspond to ascending orbit segments (1:30 pm) and red curves correspond to descending orbit segments (1:30 am). The 6 frames from top to bottom are 6.9, 7.3, 10.7, 18.7, 23.8, and 36.5 GHz. Drifts are gone and seasonal oscillations are diminished.

Possible Explanations for the TA Drifts

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Error in Specifying Earth Incidence Angle (EIA):
The EIA error would need to be about -0.07 deg/decade.
This would be large enough to detect in images of coastlines and islands, but such images look fine.
Also, at the lower frequencies the H-pol TA would show a decreasing trend. It does not.
We concluded the drift is not due to EIA.

Error in Specifying Hot Load Temperature:
The error in the Hot Load would need to be about 0.30 K/decade to explain the V-Pol drift.
Examining the TA trends of the 12 channels in detail, one sees a lot of variation that is not consistent with a simple hot load error.
Also, analysis of TA measurements of the Amazon Rainforest did not support the Hot Load hypothesis.
We concluded the drift is not due to the Hot Load.

Variation in the Non-Linearity Coefficients of the AMSR-2 Receivers:
Seemingly this is the one remaining explanation, and so it is the basis of our hypothesis.

Adjusting the Non-Linearity Coefficients of the AMSR-2 Receivers

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The internal temperatures of the AMSR-2 Signal Processor Control Unit (SPC) have been changing significantly over time. We hypothesize that the non-linear characteristics of the AMSR-2 receivers have slightly changed due to the changes in the SPC temperatures. We found two thermistors that correlated well with the TA drifts shown in Figures 2 and 3: SPC Thermistor #3 and #17. The dTA timeseries in Figures 2 and 3 are regressed versus the T_3 and T_{17} timeseries as follows:

$$dTA = a + b*T_3 + c*T_{17}$$

The a, b, and c coefficients are found for each of the 16 AMSR-2 channels. The non-linearity correction is then applied as:

$$TA_{corrected} = TA - (TA-T_{cold})(T_{hot}-TA)*dTA/A$$

where T_{cold} is the temperature observed by the cold-space mirror and T_{hot} is the temperature of the hot load. The term A is the average value of $(TA-T_{cold})(T_{hot}-TA)$ over the oceans for a given channel.

Figures 4 and 5 show the TA trends after applying the hot load and non-linearity correction. One sees that in addition to removing the long-term drifts in the TAs, the corrections also remove the seasonal variations in the TA measured minus TA ORTM differences. Comparisons with the GPM Microwave Imager (GMI) (not shown here) also show that these seasonal variations in V8.0 were spurious.

Conclusions

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The spurious drifts in the V8.0 AMSR-2 retrievals have been removed by making the non-linearity coefficients a function of the SPC temperatures. The new version is called V8.2.

In the future, we will carefully monitor the AMSR-2 performance relative to the GPM Microwave Imager (GMI) to verify the V8.2 methodology remains stable over time.

A mission-long (July 2012 to present) V8.2 dataset is now available at www.remss.com. Version 8.2 is a major update, and we encourage all users, particularly those doing climate studies, to transition to the V8.2 dataset. Both V8.0 and V8.2 datasets will be available for a short overlap period.