Jason-3 Wet Path Delay Correction

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Recent assessments of the global sea level budget have resulted in increased scrutiny of estimates of global sea level change based on Jason-3 (https://www.ncei.noaa.gov/archive/accession/Jason3-xGDR). After a careful assessment of the wet tropospheric correction derived from the Advanced Microwave Radiometer (AMR) instrument, it was determined that further improvements to the accuracy of the historical Jason-3 observations could be made. Since this assessment was only completed after Jason-3 data was reprocessed to GDR-F (Geophysical Data Record – Version F) standards, it was not included in the GDR-F product release. For this reason, a supplementary correction product has been created using the method of Brown et al. (2012) that will allow users to correct path delay and sea surface height observations, reducing errors in estimates of global sea level change by 2-3 mm over 8 years.

The correction is supplied on a pass-by-pass basis in a 4-column text file. Because the correction is slowly varying in time, linear interpolation can be used to fill any missing passes if desired. To do so, users can interpolate in time using the given time stamp associated with the middle of each pass. The columns provided contain:

1) Jason-3 cycle number
2) Jason-3 pass number
3) Midpoint time of each pass
4) Path delay correction in centimeters

The correction should be applied in an ADDITIVE sense to RANGE, or it can be SUBTRACTED from SEA SURFACE HEIGHT ANOMALY (variable "ssha") in order to apply the correction. When corrected properly, the result should be to REDUCE the amount of global sea level rise observed by the Jason-3 mission by about 2 mm between 2016 and 2023.

Documentation for the correction can be found here:
https://podaac.jpl.nasa.gov/dataset/JASON_3_PD_CORRECTION/

Reference:

Brown, S. (2012). Maintaining the long-term calibration of the Jason-2/OSTM advanced microwave radiometer through intersatellite calibration. IEEE transactions on geoscience and remote sensing, 51(3), 1531-1543.

The correction was computed based on comparison of the AMR-observed brightness temperatures with independent satellite observations from the Special Sensor Microwave Imager Sounder (SSMI), F16, F17 and F18, Fundamental Climate Data Records. SSMI data was obtained from the NOAA Climate Data Record (CDR) of SSMIS Microwave Brightness Temperatures, RSS Version 8 (Wentz et al., 2019, https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.ncdc:C01567/html). The method described in Brown et al. (2012) to map SSMI Brightness Temperatures to AMR equivalent brightness temperatures (TBs) was used. Although it was found that it made little difference to the result, a bias was removed between SSMI equivalent AMR TBs and AMR TBs with respect to latitude for all data prior to computing temporal trends. In addition, only rain free, mostly clear data (TB18.7 GHz < 160K) data were considered.

Comparison with SSMI

Differences between SSMI and AMR between 2016 and 2023 show a small trend in the 23.8 GHz channel and an extended drift in the 34 GHz channel as shown in Figure 1.

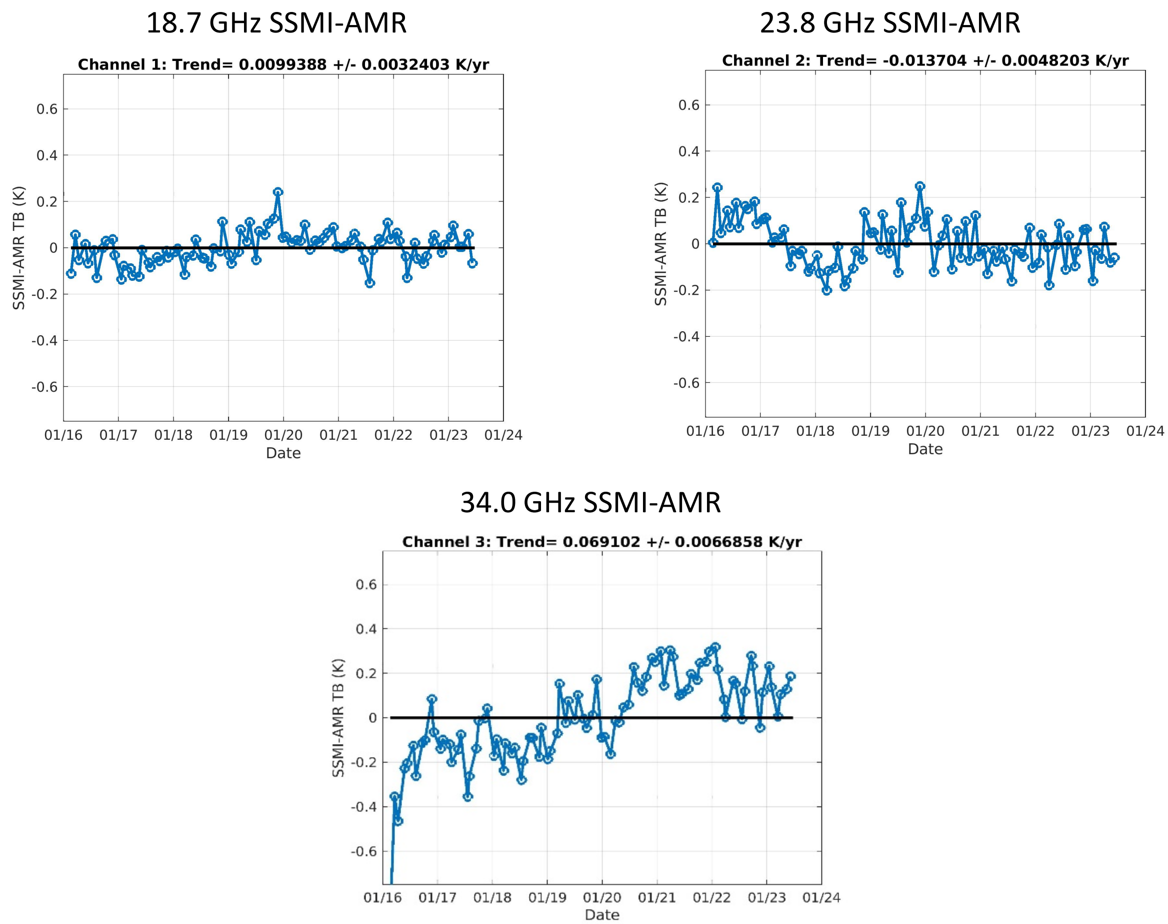

Figure 1. *Brightness temperatures from SSMI minus AMR for different channels over the Jason-3 mission.*

The AMR bias correction for each channel was derived from these comparisons.

Assessment of Correction

The impact of the bias correction was assessed relative to traditional calibration tools. The vicarious cold reference provides an independent assessment of the AMR wet path delay, both before and after correction as shown in Figure 2.

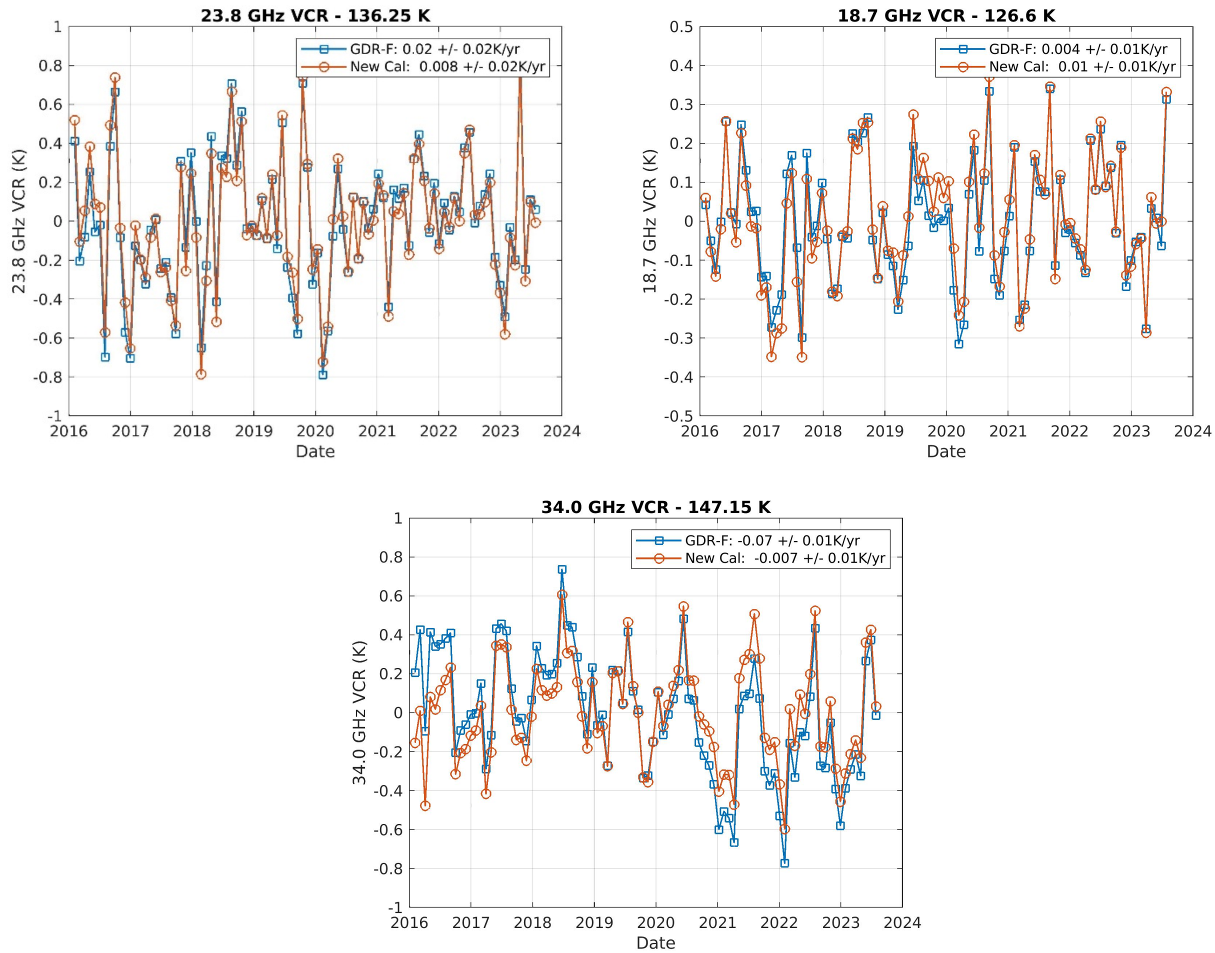

Figure 2. *Corrected and uncorrected brightness temperatures are shown in comparison to the vicarious cold reference.*

In all cases, drift with respect to vicarious cold reference metric statistically insignificant after SSMI correction

Cloud liquid water (CLW) was calculated using both corrected and uncorrected brightness temperatures. Because CLW depends most heavily on the 34 GHz channel, it was significantly affected by the correction, as shown in Figure 3.

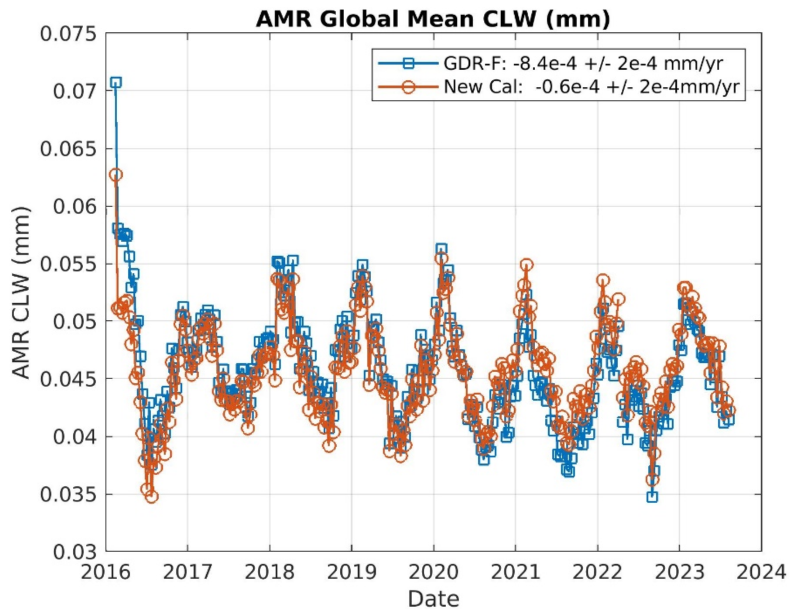

Figure 3. *Cloud liquid water estimated from corrected and uncorrected brightness temperatures.*

Note that After SSMI-based correction, globally averaged CLW between 2016 and 2017 was more consistent with long-term annual variations, and the trend in CLW was reduced to a statistically insignificant level.

Impact on Path Delay Correction, Range and SSH

The corrected brightness temperatures had a small, but significant impact on the globally averaged wet path delay correction observed by AMR as shown in Figure 4.

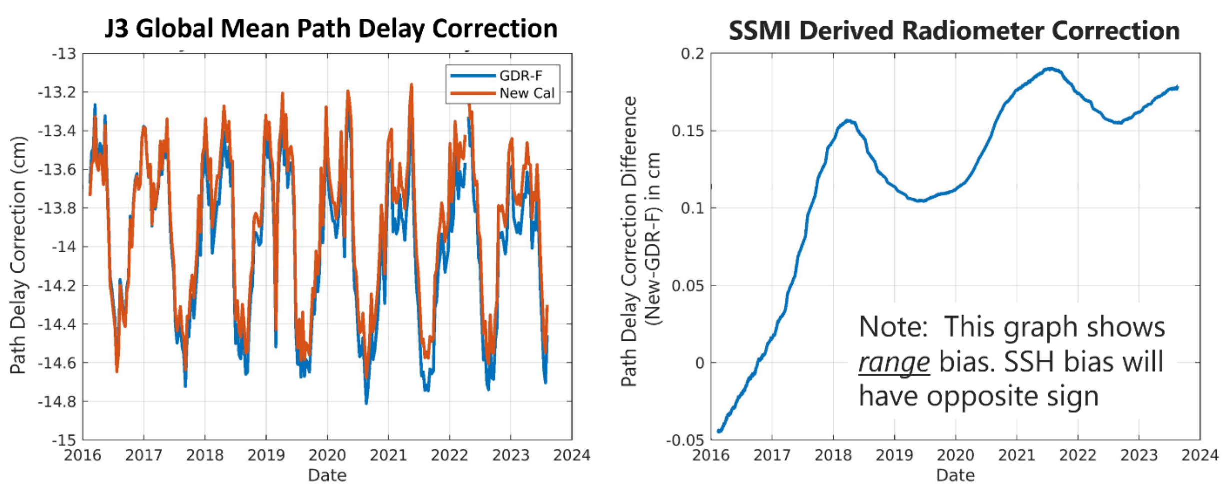

Figure 4. *Globally averaged path delay correction for Jason-3, with and without the new brightness temperature correction (left). The difference between corrected and uncorrected path delay correction. This is the quantity provided in the 4-column text file, and it represents an additive correction range.*

Since this bias affects all range measurements without geographic dependence, it directly applies to estimates of globally averaged sea level as well. Note that since the correction shown in Figure 4 applies to *range*, it will have the OPPOSITE sign if applied as an additive correction to SSH. When the correction is properly applied, SSH should rise about 2 mm LESS over 8 years than uncorrected SSH. This represents a REDUCTION in the global mean sea level trend of about 0.25 mm/year between 2016 and 2023.

References

Brown, S. (2012). Maintaining the long-term calibration of the Jason-2/OSTM advanced microwave radiometer through intersatellite calibration. IEEE transactions on geoscience and remote sensing, 51(3), 1531-1543.

Frank J. Wentz, Carl A. Mears, and NOAA CDR Program (2019): NOAA Climate Data Record (CDR) of SSMIS Microwave Brightness Temperatures, RSS Version 8. [indicate subset used]. NOAA National Centers for Environmental Information. doi:10.7289/V5Q23XK7