Evaluation and Improvement of the S-NPP CrIMSS Rain Flag

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Introduction

As part of the Suomi National Polar-orbiting Partnership (S-NPP), a new rain flag, based on the Microwave Surface and Precipitation Products (MSPPS) rain detection algorithm, has been implemented into Crosstrack Infrared and Micrwoave Sounding Suite (CrIMSS), a joint system that utilizes the Crosstrack Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) in synergy, to edit out potentially rain contaminated scenes that will lead to degraded temperature and moisture profiles.

Comparing to the Microwave Integrated Retrieval System (MIRS), the standard NOAA rainrate product from NESDIS, the original CrIMSS rain flag has shown several deficiencies as left figure below. Possible reasons for the inadequacy of the rain flag algorithm may be attributed to (1) the outdated nature of the MSPPS AMSU-A algorithm; and (2) the algorithm was not implemented properly.

To improve the CrIMSS rain flag algorithm, a more accurate scheme that utilizes both AMSU-A and AMSU-B/MHS channels through MSPPS heritage has been introduced, in particular, measurements at above 89 GHz which are more sensitive to precipitation than those which use more traditional channels at or below 89 GHz. To apply the scheme correctly, the ATMS channels are retrofitted to AMSU counterparts.

Also, by substituting real-time wind with fixed wind as input, the algorithm has been successfully merged into the offline CrIMSS retrieval package, with minimum complexity added. Climatological wind will be adopted in the next version.

Frequency Differences

AMSU			ATMS		
Ch	GHz	Pol	Ch	GHz	Pol
1	22.3	QV	1	22.3	QV
2	31.4	QV	2	31.4	QV
3	50.3	QV	3	50.3	QH
16	89.0	QV	16	88.2	QV
17	150	QV	17	165.5	QH
18	183.31±1	QH	22	183.31±1	QH
			21	183.31±1.8	QH
19	183.31±3	QH	20	183.31±3	QH
			19	183.31±4.5	QH
20	183.31±7	QH	18	183.31±7	QH

Exact match to AMSU/MHS
Only Polarization different
Unique Passband
Unique Passband, and Pol. different from closest AMSU/MHS channels

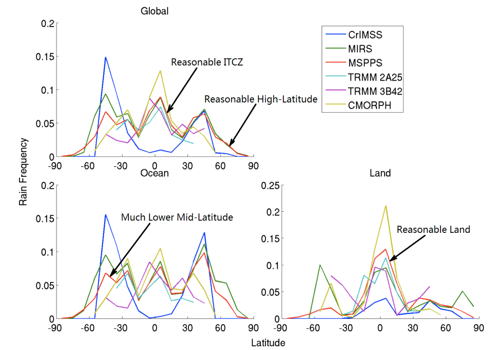
Simulating AMSU Channels Utilizing ATMS

To build the relationship between AMSU and ATMS channels, over 200,000 atmospheric profiles from ERA-Interim are selected, and the Community Radiative Transfer Model (CRTM) is used to simulate brightness temperature at ATMS and AMSU-A/B frequencies, for ocean and land, under clear-sky. The simulated brightness temperatures are compared with respect to frequencies and sensor scan angles, and following channels and approaches are selected for final regression, note *B* stands for AMSU channels and *S* for ATMS:

$$B3 = a_0 + a_1 S3 + a_2 S3^2$$

$$B17 = a_0 + a_1 S16 + a_2 S17 + a_3 S16^2 + a_4 S17^2 + a_5 S16 \cdot S17$$

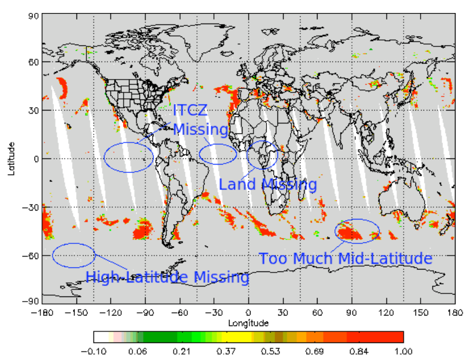
Evaluation Utilizing Other Rain Products



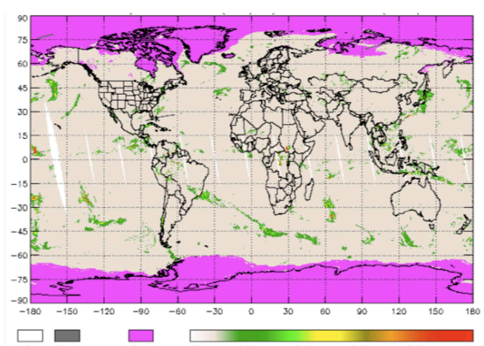
Climatological Wind as Input

To merge the stand-alone rain flag code into the off-line CrIMSS retrieval package, tests were performed to streamline the algorithm's input by eliminating the need for NWP model inputs of ocean surface wind speed and land surface temperature. By comparing three wind parameterization schemes, including fixed wind speed, interpolate wind speed as a function of latitude, and climatological wind, with regards to probability of detection (POD) and false alarm ratio (FAR), it was found that the use of a climatological varying wind speed (based on scatterometer measurements) serves as a reasonable proxy for the more real-time wind observations.

Original CrIMSS Rain Flag, May 15, 2012



MIRS Rain Rate for ATMS, May 15, 2012



MSPPS Rain Rate for ATMS, May 15, 2012