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Evaluation and Improvement of the NPP CrIMSS Rain Flag

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Introduction

As part of the Suomi National Polar-orbiting Partnership (NPP), 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, an ATMS only rain flag is utilized to edit out potentially rain contaminated scenes that will lead to degraded temperature and moisture profiles.

Comparing to MIRS, the standard NOAA rainrate product via NESDIS, the current CriMSS rain flag has shown several deficiencies, e. g.,

1. Little rain detected in the ITCZ (rainiest region on the globe);
2. Little precipitation over land is detected;
3. Too much mid-latitude rain over ocean (Note that recent relaxation of Chi-Sq convergence term has improved this problem – not shown)
4. Little high-latitude rain.

Possible reasons for the inadequacy of the rain flag algorithm may be attributed to

1. Outdated nature of the AMSU-A algorithm,
2. The algorithm was not implemented properly

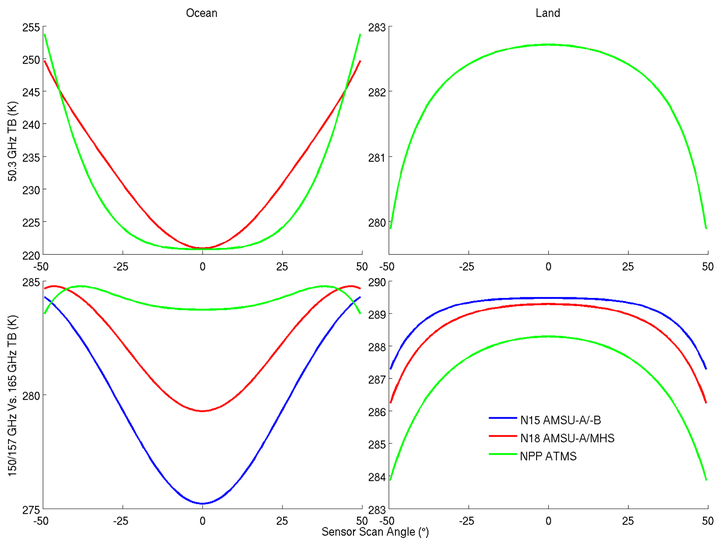
To improve the CriMSS rain flag algorithm, a more accurate scheme that utilizes both AMSU-A and AMSU-B/MHS channels through MSPPS heritage has been introduced, in particular, measurements at above 89 GHz which is more sensitive to precipitation than those which use more traditional channels at or below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

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

Angular Comparison Given the Same Profile



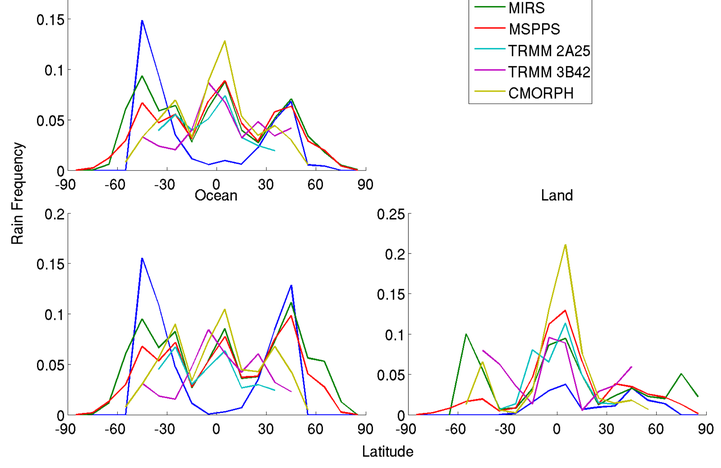
Simulating AMSU Channels Utilizing ATMS

To build the relationship between AMSU and ATMS channels, a bunch of atmospheric profiles (approximately 240,000) from ERA-Interim are selected, and 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:

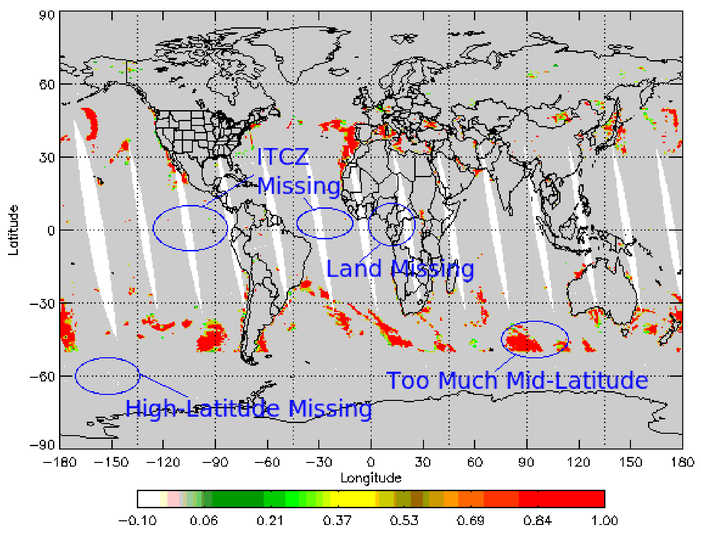
$$B3 = a_0 + a_1 S3 + a_2 S3^2$$

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

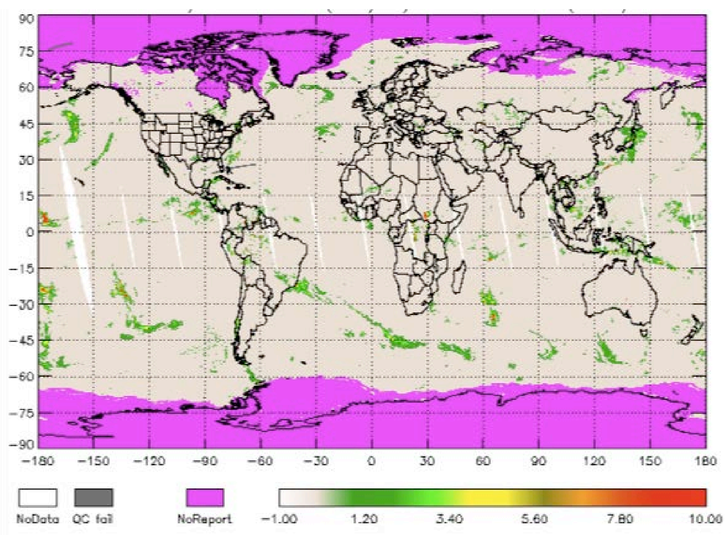
Evaluation Utilizing Other Rain Products



Current CrIMSS Rain Flag, May 15, 2012



MIRS Rain Rate for ATMS, May 15, 2012



MSPPS Rain Rate for ATMS, May 15, 2012