A Global Perspective of the Current and Future CrIMSS EDR Algorithm

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Background:

The Suomi National Polar-orbiting Partnership (NPP) satellite, launched on October 28, 2011, carries the Advanced Technology Microwave Sounder (ATMS) and the Cross-track Infrared Sounder (CrIS), which together form the Cross-Track Infrared and Microwave Sounding Suite (CrIMSS). The CrIMSS Environmental Data Record (EDR) algorithm, developed by AER Inc. and implemented by Raytheon and Northrup Grumman, retrieves atmospheric vertical temperature profiles (AVTPs) and moisture profiles (AVMPs). In collaboration with the NASA Langley Research Center (LaRC), STAR has developed the infrastructure to emulate current IDPS versions of the products as well as future IDPS products based on research upgrades (e.g. updates to look-up tables, changes to the cloud clearing decision tree, etc.)

Subsetting Technique:

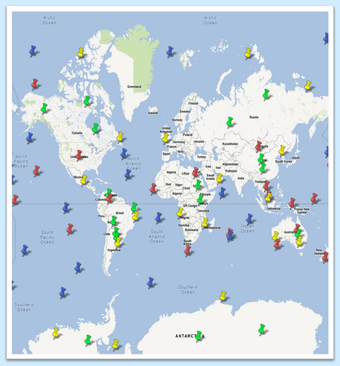
Over 2000 granules are collected per day from both the ATMS and CRIS instruments. This technique chooses approximately 100 granules that are equally divided between polar, mid-latitude, and coastal regions. Within these regions, granules are selected for land, coastal, and oceanic locations. In addition to these points, specific locations are chosen for field campaigns, ground truth locations, and areas of special interest.

The maps below mark chosen granules from May 15th, 2012. Blue points are ocean granules, yellow are coast, green are land, and red are special points of interest (not used in this study).

Ascending

Courtesy of Google Maps

Descending



Courtesy of Google Maps

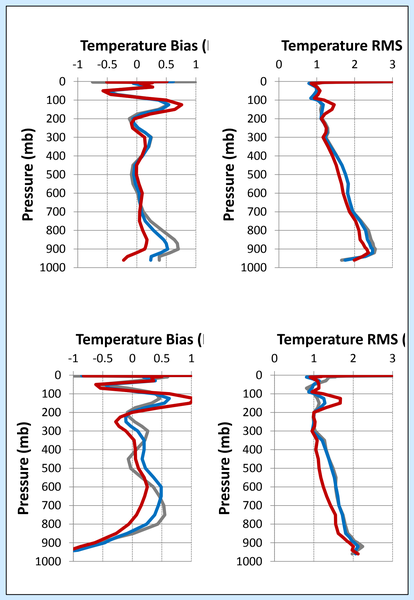
Emulations:

STAR has the capability to generate past, present, and future expected states of the operational EDR algorithm. These states are as follows:
MX5.3: Operational Product Prior to October, 2012.
MX6.3: Current Operational Product
MX7: Expected Future Operational Product in Early 2013.

We can also emulate any portion of the expected changes to the algorithm, and can test these changes rapidly using the subsetting technique. In the chart below, we have used the subsetting technique on data from October 20, 2012 to determine the impact of various discrepancy reports that make up the changes to MX6.3 and MX7. Each discrepancy report is justified by either fixing a bug, improving yield, or improving the overall quality of the product.

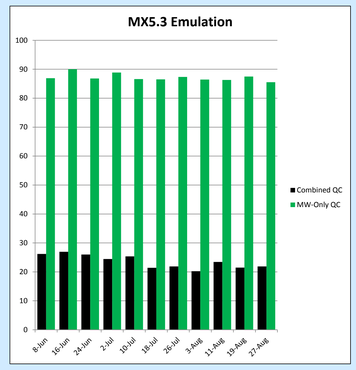
	Discrepancy Report #	Description of Discrepancy Report	Reason for Discrepancy Report	Approximate Overall Impact			
				Tempera-ture Bias	Tempera-ture RMS	Water Bias	Water RMS
For MX6.3	DR4922	Fixes indexing issue for non-LTE cases and ozone, where microwave channels were not accounted for in array.	Improves combined-run yield for daytime yields by approximately 20-25%.	Colder (good)	Better	Little Impact	Little Impact
For MX7	DR4926	Fixes error in how RTM error and total radiance error was combined.	Known bug. Has little impact on results.	Little Impact	Little Impact	Little Impact	Little Impact
	DR4942	Fixes glitch in discerning clear and cloud-contaminated profiles.	Known bug. Has little impact on results.	Little Impact	Little Impact	Little Impact	Little Impact
	DR4945	Allows for larger differences between air and surface temperature for daytime land.	Increases yields slightly over land. Generally favorable results for temps.	Colder (good)	Better	Drier (bad)	Slightly Better
	DR4946	Changes criteria to choose warm ocean vs. cold ocean climatology.	Increases yield over ocean, improves warm-ocean scenes.	Slightly Warmer (bad)	Slightly worse near surface	More moist in mid-troposphere	Mixed.
	DR4943	Replaces IR-NOISE-LUT and IR-ATM-NOISE-LUT with more realistic values. (Used proxy data before.)	Need to replace proxy LUTs with actual data. Improves temperature bias/rms.	Colder (good)	Better aloft of 700 mb	Drier (bad)	Slightly Worse
	DR4958	Adjusts QC passing value for microwave chisq in combined-retrieval.	Makes much more use of combined (IR+MW) retrieval by loosening threshold. Improves yield by nearly 20%.	Good near sfc, bad aloft.	Better	Slightly more moist	Slightly Better

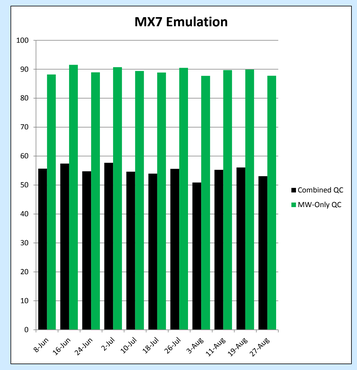
In the four rightmost columns of the table above, these results were determined using charts such as those to the right. These charts are based on the same data from October 20, 2012 against ECMWF data as a truth dataset, using the MX5.3 emulation (gray), the MX6.3 emulation (blue), and the MX7 emulation (black). The upper two charts shows the overall product, while the bottom row shows only the highest quality profiles (using both ATMS and CRIS data). We are seeking improvements both in quality flags (shown on top) and in product quality (shown on bottom).



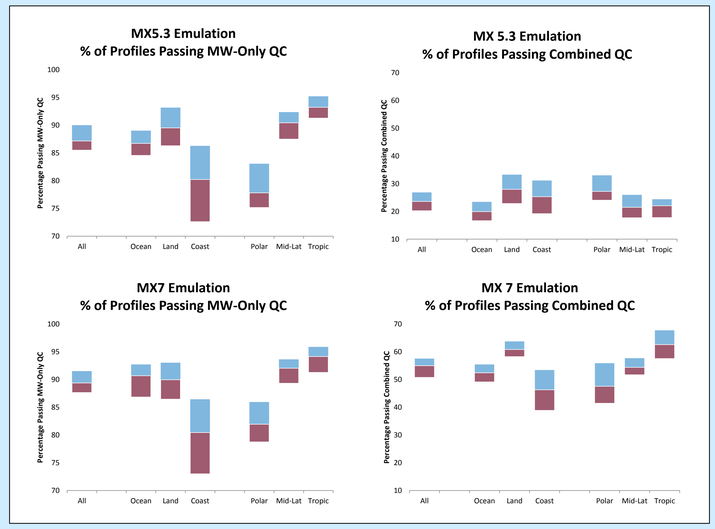
Seasonality:

Lookup tables for the EDR might be time-dependent. The experiment below is a yield demonstration for the ATMS instrument alone, and the ATMS/CRIS combined retrieval. ATMS and CRIS have a repeat cycle of 16 days. If the specific orbit plays a significant role, the chart will stagger every other day. If time from May 15th plays a role, the charts with decrease/increase with time. Neither of these occurs, showing the lookup tables are appropriate throughout the study.





The charts below divide the data into locations and land types. Coastal regions show the most variability by day, while tropical regions have consistently high yields.



Conclusions:

This study shows that the latest updates to the CrIMSS EDR algorithm all improve either the yield or overall accuracy of the product. In addition, the improvements to the product appear to apply to an entire season's worth of data. This study was feasible through the use of the subsetting technique.