Verification of Precipitation Estimates for the Goddard Profiling Algorithm 2014

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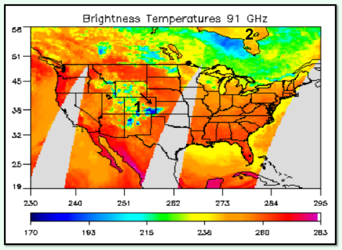
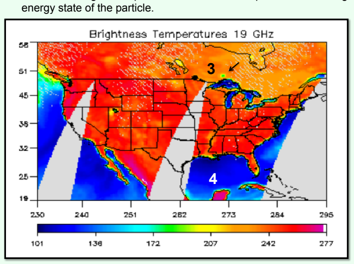
Introduction

The Goddard Profiling Algorithm (GPROF) is a Bayesian algorithm that came from NASA's Tropical Rainfall Measuring Mission (TRMM) program to retrieve surface rainfall rate and precipitation vertical structure (Kummerow et al, 2001). While the algorithm provides very robust results over oceans, the land portion is highly empirical, requiring a series of tests to separate cold brightness temperatures over land from actual precipitation. As GPROF 2014 is being readied for the upcoming GPM mission, one of the key objectives of the algorithm was to forego the empirical rain tests in favor of a more physical scheme to determine rainfall. This project analyzed the first set of systematic retrievals, focusing on nine days in 2011 from NMQ (National Mosaic and Multi–Sensor Quantitative Precipitation Estimation) to assess the ability of the algorithm to detect rain areas and assign rainfall rates with the new scheme. The results from the retrieval are being run on SSMIS (Special Sensor Microwave Imager/Sounder) on DMSP (Defense Meteorological Satellite Program) F16.

Features Misinterpreted as Rainfall

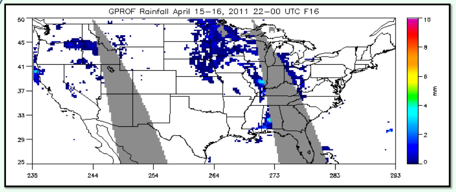


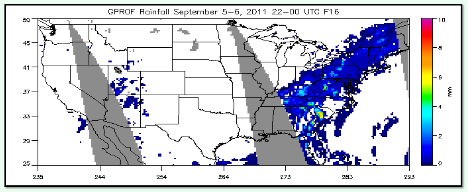
1: Lower brightness temperatures indicate ice aloft, not actual precipitation.
2: Land has higher temperatures because absorption leads to a higher energy state of the particle.

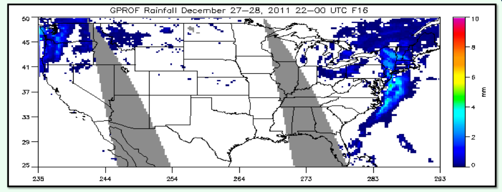


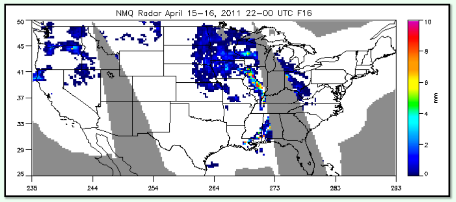
3: Shows ice on the surface. Lake Nipigon is frozen
4. Water surfaces only emit half the microwave energy specified by Plank's Law, and are only about half the temperature of the surface.

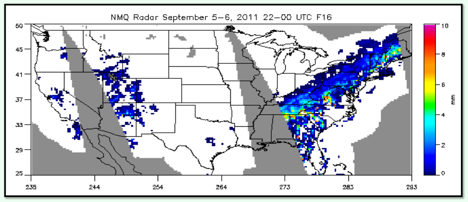
Verification

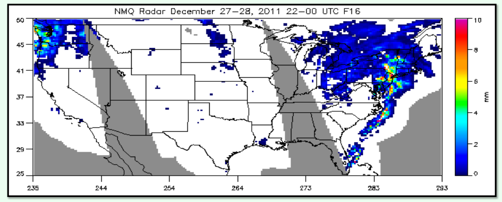


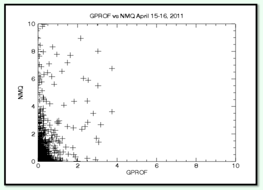


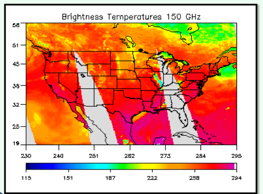




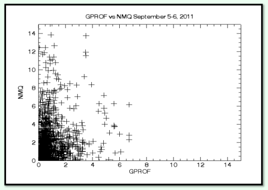


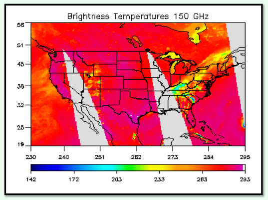




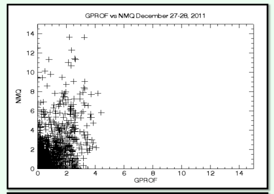


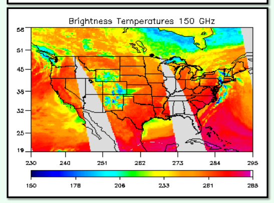
GPROF does an adequate job with the domain of precipitation in April, as well as other spring months, but the precipitation intensity is slightly lower than it should be. NMQ shows more precipitation in the Northwest corner, as well as in Montana, where GPROF misses a lot of the larger areas of precipitation. The 150GHz Tbs show where there is ice aloft for the heaviest rainfall.





During fall months, GPROF is able to see precipitation in the correct locations, yet still does not have the intensity it should. The typical squall line that appears in NMQ should produce more precipitation in GPROF than shown. The central United States is clear of precipitation which is correlated well between both NMQ and GPROF as well as the brightness temperatures.





Although GPROF shows the same general pattern of precipitation that NMQ does, a lot of the missing precipitation around the great lakes as well as North and South Dakota, is either ice or snow instead of rain. The 150GHz Tbs shows a lot of ice aloft in the Rocky Mountain range, and GPROF excels at not detecting that as rainfall.

Conclusions

	Correlation GPROF vs. NMQ	% Rain in NMQ	% Rain in GPROF	% No Rain in NMQ	% No Rain in GPROF	% Missing Data NMQ	% Missing Data GPROF
April 15, 2011	.4616	10.08 %	7.82 %	61.27 %	75.74 %	28.65%	16.44%
September 5, 2011	.5316	11.86 %	13.98 %	58.81 %	68.26 %	29.34%	17.75%
December 27, 2011	.6058	16.69 %	15.25 %	56.44 %	68.53 %	26.88%	16.23%

Strengths:
- Location of liquid precipitation between GPROF and NMQ match
- Non-precipitating ice clouds and surface ice are not retrieved as rain.

Weaknesses:
- Weighting on rain rates
- Recognizing frozen precipitation

Future Work

- The weights of the rainfall intensity have already been adjusted, but there are still more modifications that can be done.
- GPROF has a difficult time sensing frozen precipitation during winter months, and that is in the process of being improved in the algorithm as well.
- The launch of the GPM (Global Precipitation Measurement) satellite is scheduled for February 2014.

Acknowledgements

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