GOES-R AWG Hydrology Team: ABI Rainfall Rate Algorithm
June 16, 2010

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NOAA/NESDIS/STAR

Hydrology Algorithm Team

- **Chair:** Bob Kuligowski
- **Team Members**
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Outline

- Executive Summary
- Algorithm Description
- Requirements Specification
- ADEB and IV&V Response Summary
- Validation Strategy
- Validation Results
- Summary

Executive Summary

- This ABI Rainfall Rate algorithm generates the baseline Rainfall Rate product.
- Version 4 delivered in April. Version 5 and ATBD (100%) on track for July delivery.
- An approach was selected that uses more accurate microwave-derived rain rates to dynamically calibrate a GOES-based rain rate algorithm.
- Tools for validation against ground (Nimrod) and space (TRMM) based radar have been developed and applied to 10 weeks of SEVIRI data.
- Version 3 product did not meet spec, but version 5 product is expected to meet spec—full validation will be completed this summer.

Requirements Specification

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Product Refresh Rate / Coverage Time (Mode 3)	Refreshment Rate / Coverage Time (Mode 4)	Vendor Allocated Ground Latency	Product Measurement Precision
Rainfall Rate / QPE	GOES -R	FD	N/A	2.0 km	1.0 km	0 to 100 mm/hr	6 mm/hr at a rate of 10 mm/hr with higher values at higher rates	15 min	15 min	266 sec	9 mm/hr at a rate of 10 mm/hr with higher values at higher rates

Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Day and night	Quantitative out to at least 70 degrees LZA or 60 degrees latitude, whichever is less, and qualitative beyond	N/A	Over rain cases and mesoscale-sized surrounding regions. Quantitative for convective rainfall and qualitative for stratiform rainfall.

Algorithm Description

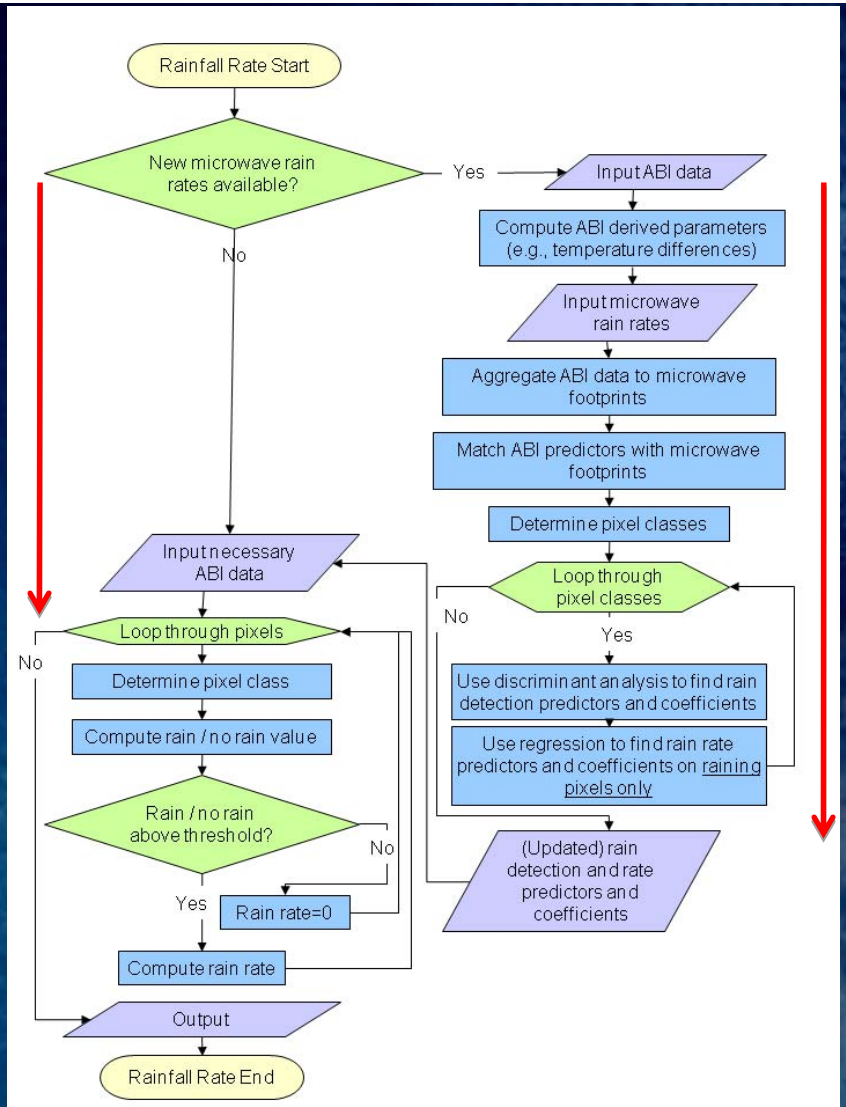
Algorithm Description

- This ABI Rainfall Rate algorithm generates the baseline Rainfall Rate product.
- The algorithm uses microwave-derived rain rates (which are more accurate than IR but not available continuously) to calibrate an algorithm based on IR data (which are available continuously), resulting in an optimal calibration for a particular geographic area, cloud type, and season.
- The algorithm uses discriminant analysis to calibrate the rain / no rain separation and regression to calibrate the rainfall rate retrieval.
- The chosen channel set includes 5 ABI bands (6.19, 7.34, 8.5, 11.2, 12.3 µm) plus selected BTD's.

Algorithm Description

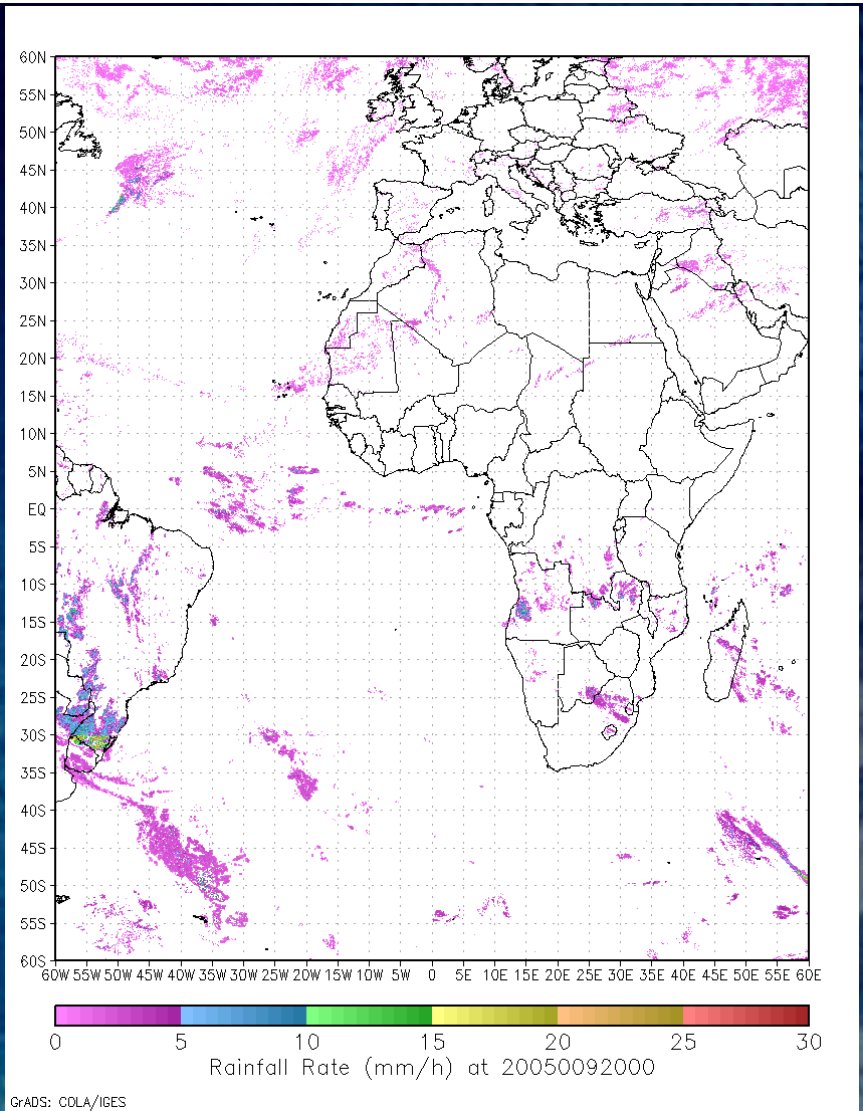
Apply most recent calibration in between new MW overpasses

Retrieve rain rates from ABI data



Update calibration when new MW rain rates available

Example Rainfall Rate Output



Algorithm Changes from 80% to 100%

- Corrected numerous minor bugs in the code.
- Removed ABI bands 1 (0.64 µm), 3 (0.865 µm), 5 (1.61 µm), 12 (9.61 µm) and 16 (13.3 µm) from the input data set:
  - » Could not completely adjust visible bands for solar zenith angle effects (seeing cloud sides at high angles)
  - » Occasional false rain signatures from 9.61 and 13.3 µm bands.
- Initial results indicate a 10% improvement in precision.

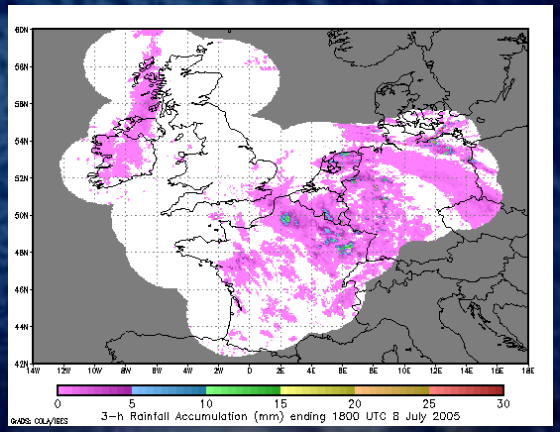
ADEB and IV&V Response Summary

- All ATBD errors and clarification requests have been addressed.
- No feedback required substantive modifications to the approach; responses were clarification only.

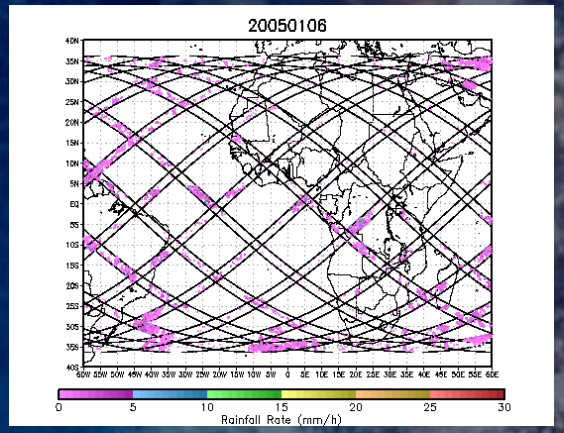
Validation Strategy

Validation Strategy

- Since the requirement is for instantaneous rain rates, radar is the only available source of data for validation against spec
- Ground-based radars:
  - » Nimrod radars in UK and Western Europe—5-km grid composite
- Space-borne radar:
  - » Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar
    - – Low-Earth orbit covers 35° S-35° N
    - – Swath width of ~250 km
    - – Surface footprint of ~3.1 km



Sample Nimrod 3-h accumulation



Sample TRMM rain rates for a 24-h period

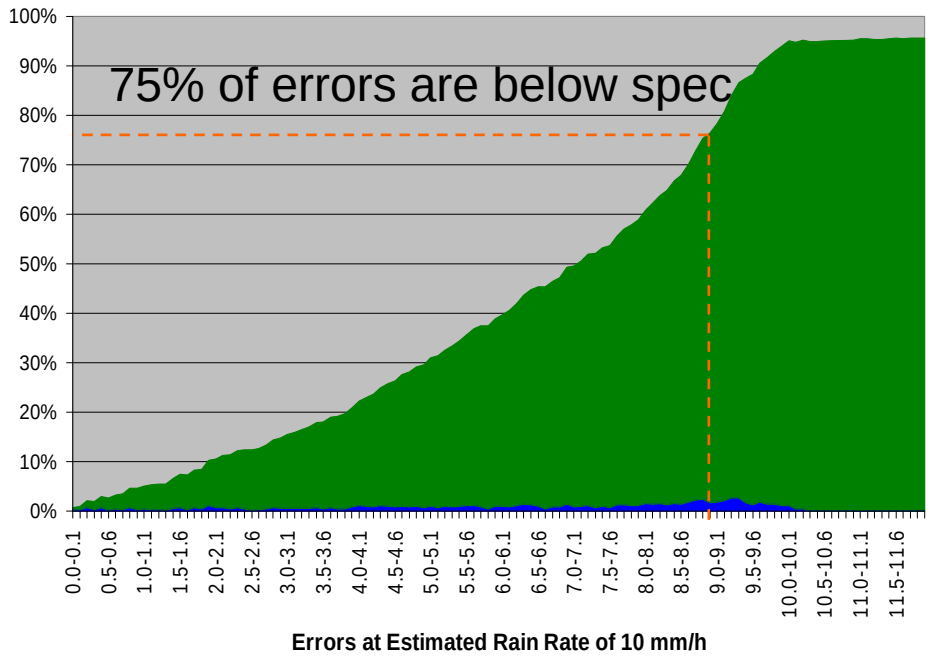
Validation Strategy

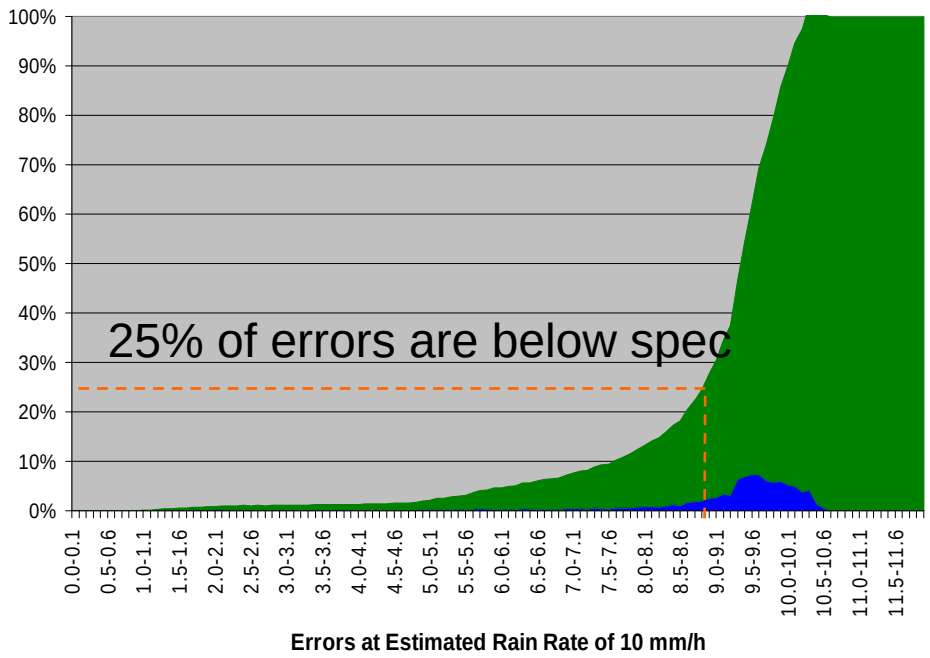
- Retrieve rainfall rates from GOES-R ABI proxy data
  - » Meteosat-8 SEVIRI: Bands 5 (6.2 µm), 6 (7.3 µm), 7 (8.7 µm), 9 (10.8 µm), and 10 (12.0 µm).
- Collocate (in space and time) derived rainfall rates with ground truth rainfall rates
  - » Retrieved rainfall rate and TRMM PR
  - » Retrieved rainfall rate and Nimrod radar
- Generate comparative statistics (satellite rainfall rate vs. ground truth rainfall rate)
  - » Accuracy
  - » Precision

Validation Results

(version 3)

Validation Results for Version 3





CDF (green) and PDF (blue) of (absolute) errors of version 3 Rainfall Rate pixels with rates of 9.5-10.5 mm/h vs. TRMM Precipitation Radar (±35° lat only) for 20 days: 6th-9th of January, April, July, and October 2005.

CDF (green) and PDF (blue) of (absolute) errors of version 3 Rainfall Rate pixels with rates of 9.5-10.5 mm/h vs. Nimrod radar data (Western Europe only) for 15 days: 6-9th of April, July, and October 2005.

Validation Results for Version 3 versus Spec

Validation of version 3 algorithm vs. collocated TRMM Precipitation Radar (covering ±35° lat only) for 20 days of data: 6th-9th of January, April, July, and October 2005:

	F&PS (at 10 mm/h)		Evaluation vs. TRMM radar	
mm/h	Accuracy	Precision	Accuracy	Precision
Rain Rate	6.0	9.0	6.2	9.8

Validation of version 3 algorithm vs. Nimrod radar data (covering Western Europe only) for 15 days of data: 6-9th of April, July, and October 2005:

	F&PS (at 10 mm/h)		Evaluation vs. Nimrod radar	
mm/h	Accuracy	Precision	Accuracy	Precision
Rain Rate	6.0	9.0	9.9	9.6

Validation results reflecting version 4/5 upgrades are not yet complete, but spec is expected to be met for version 5.

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