VALIDATION OF THE GOES-R RAINFALL RATE ALGORITHM: INITIAL FINDINGS

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Background

Brief Algorithm Description

- The GOES-R Rainfall Rate algorithm produces estimates of instantaneous rain rate every 15 min on the ABI full disk at the IR pixel resolution.
- The rain rates are derived from the ABI IR bands, calibrated against rain rates from MW instruments.
- This allows the rapid refresh and high spatial resolution of IR data from GEO while trying to capture the accuracy of MW rain rates from LEO.
- A rolling-value matched MW-IR dataset with a fixed number of pixels with rates of at least 1 mm/h is maintained (Fig. 1); the calibration is updated whenever new MW rain rates become available and then applied to independent ABI data (Fig. 2):
  - Discriminant analysis is used to select the best two rain / no rain predictors and coefficients based on matches with the MW rain rates;
  - Linear regression is used to select the best two rain rate predictors and coefficients (including nonlinear transformations of the predictors) based on matches with the MW rain rates.
  - To correct regression-induced distortions in the distribution, the derived rainfall rates are matched against the training MW rain rates to create a lookup table (LUT) for adjusting the resulting rain rates.
- To account for differences among precipitation regimes, separate calibrations are performed for each 30-degree latitude band and for three cloud types based on brightness temperature differences (BTDs; Fig. 2).

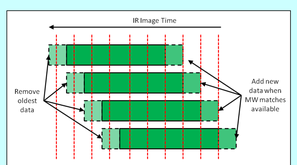

Figure 1. Illustration of the rolling-value matched MW-IR data file.

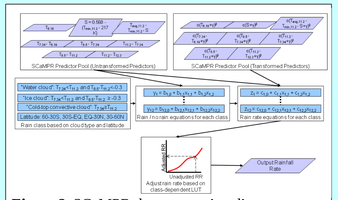

Figure 2. SCaMPR data processing diagram.

DISCLAIMER: The contents of this poster are solely the opinions of the author and do not constitute a statement of policy, decision, or position on behalf of the GOES-R Program Office, NOAA, or the U.S. Government.

Ackonowledgment: This work was supported by the GOES-R Program Office.

Datasets, Findings, and Modifications

Datasets

- The algorithm was developed using SEVIRI data as a proxy for ABI; consequently, development and validation are being performed over Europe and Africa, where quality high-resolution data is difficult to find.
- Two primary sources for validation data (Fig. 3):
  - Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR)
  - British Atmospheric Data Centre (BADC) Nimrod radar composites.
- Dates: 5-9 January, April, July, and October 2005.

Precipitation Structure Study

- **Problem:** non-physical fine-scale structures in the Rainfall Rate fields.
- **Cause:** the rain type classification became noisy where the BTD value was close to the threshold (Figs. 4a, b).
- **Solution:** aggregate the BTD fields before determining rain type; 9x9 aggregation gave the best results (Fig. 4c).
- **Result:** much smoother, more reasonable-looking rainfall fields (Figs. 4d, e).

Precipitation Stability Study

- **Problem:** occasional non-physical variations in total rainfall area and volume (Fig. 4a-c).
- **Cause:** significant changes in the algorithm calibration from one time period to the next.
- **Solutions:**
  - Significantly increase the amount of training data required from 5,000 raining pixels for cloud types 1 and 2 and 1,000 training pixels for type 3 to 15,000 training pixels with rain rates 2.5 mm/h.
  - For the rainfall rate calibration, require a correlation coefficient of at least 0.15 to accept new calibration coefficients.
- **Result:** the most significant variations have been removed, though some smaller ones remain. (Figs. 4d-f). Subsequent efforts to address these have been unsuccessful thus far.

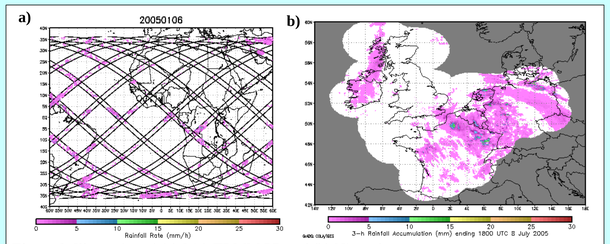

Figure 3. Illustration of (a) 24-h TRMM PR and (b) Nimrod coverage.

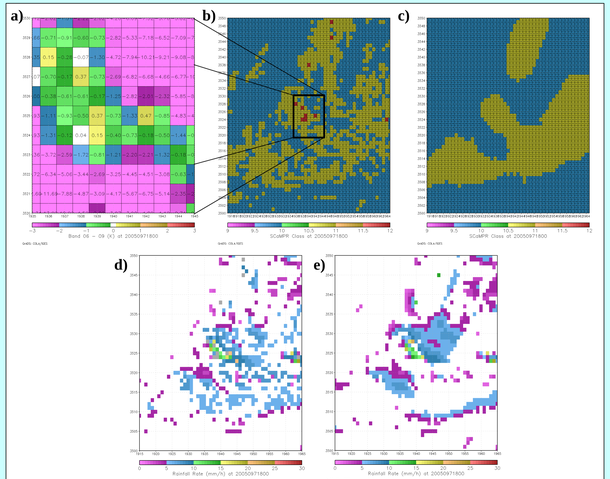

Figure 4. BTD between SEVIRI bands 6 (7.3 µm) and 9 (10.8 µm) at 1800 0UTC 7 April 2005 (a); corresponding rain type classes (b) without smoothing; and (c) with 9x9 smoothing; corresponding rainfall rates (d) without BTD smoothing; and (e) with BTD smoothing.

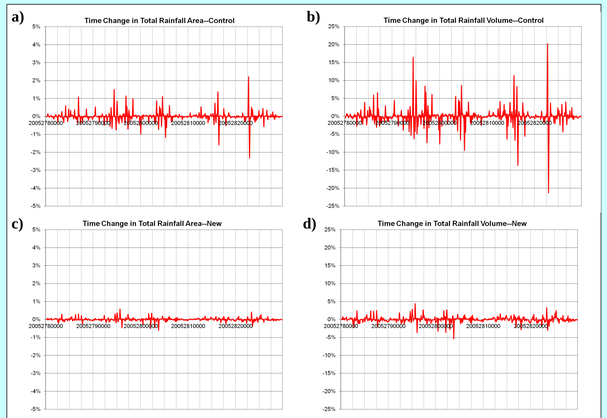

Figure 5. Time series of image-to-image change in total rainfall area and volume of the Rainfall Rate algorithm before (a, b) and after (c, d) the increase in the amount of required training data to 15,000 pixels of at least 2.5 mm/h.

Other Issues and Next Steps

Conditional Wet Bias

- Although the LUT should produce an unbiased result, in practice it induces a conditional wet bias (Fig. 6).
- This wet bias has gotten worse since version 5.
- A number of possible causes have been investigated but nothing conclusive has been found yet.

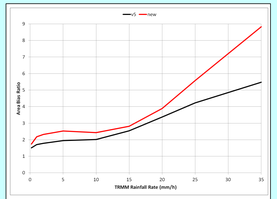

Figure 6. Area bias ratio of Rainfall Rate vs. TRMM PR as a function of TRMM PR rainfall rate for 20 days in 2005.

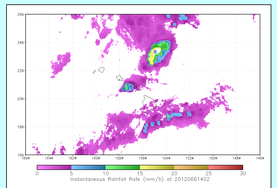

Figure 7 Area bias ratio of Rainfall Rate vs. TRMM PR as a function of TRMM PR rainfall rate for 20 days in 2005.

Cloud Class Calibration Inconsistency

- In the current-GOES version (which has only two cloud classes due to the absence of the 8.5 µm band), the deep-convective cloud class will occasionally have lower rain rates and a higher rain / no rain threshold than the nearby non-deep convective cloud (Fig. 7).
- Implications for the GOES-R version are still being investigated (it has not been observed there).
- Potential fixes are still being investigated.

Future Work

- Address the above issues.
- Apply calibration coefficients derived by Zhanqing Li (UMCP) et al. in previous GOES-R Risk Reduction work to real-time GOES cloud property information and evaluate impact on warm-cloud light rainfall which typically IR and MW have difficulty detecting.
- Experiment with a model PW / RH adjustment to rain rates to account for moisture availability and subcloud evaporation of hydrometeors.
- Continue experiments with orographic rainfall modulation.
- Incorporate findings from GOES-R Risk Reduction work by Adler et al., Rabin, Dong and Li, etc.