THE GOES-R PROBABILITY OF RAINFALL ALGORITHM

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Background

Requirements

- The GOES-R Algorithm Working Group (AWG) Hydrology Algorithm Team (AT) has been tasked with providing a recommended, demonstrated, and validated algorithm for retrieving probability of at least 1 mm of rainfall during the 0-3 h time frame from GOES-R data meeting the following requirements:
  - Cover the region 60°S to 60°N within 70° LZA at the full resolution of the ABI (2 km at nadir);
  - Update every 5 min, day and night;
  - Possess an accuracy of 40% and precision of 25% for 3-h rainfall probabilities.
- Note that this is a Future Capabilities algorithm.

Algorithm Development

- No current real-time algorithms for retrieving probability of rainfall from geostationary satellite data; one was developed "from scratch".
- It was determined that the most straightforward and internally consistent approach would be a statistical algorithm based on information from the corresponding Rainfall Potential algorithm—specifically, the 3-h rainfall accumulations plus the intermediate instantaneous rainfall rates at 15-min intervals from lead times of 15 to 180 min that are produced during the Rainfall Potential algorithm processing.
- All of the rainfall-related algorithms were developed using EUMETSAT SEVIRI data as a proxy for the GOES-R ABI. Because of the lack of reliable ground data in this region, the algorithm was developed using the GOES-R Rainfall Rate algorithm as "ground truth".
- The information in these 13 fields were condensed into a variety of predictors and tested. The best predictors were determined experimentally and are described next.

DISCLAIMER: The contents of this poster are solely the opinions of the authors 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.

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Theoretical Basis

Inputs, Predictors, and Outputs

- Input: the 3-h total accumulation from the GOES-R Rainfall Potential algorithm, plus intermediate instantaneous rainfall rates at lead times of 15-180 min produced during the algorithm processing.
  - All fields are on the intermediate 4400x4400 field of the Rainfall Potential algorithm rather than the native satellite grid.
- Predictors: these inputs are converted into three predictors for use by the algorithm (Fig. 1):
  - 'RegMean' = Average 3-h Rainfall Potential accumulation within 37 km of the pixel.
  - 'RegRateTot' = Total number of instantaneous rainfall rate pixels with rates ≥1 mm/h at any lead time within 37 km of the pixel of interest.
  - 'DistMin' = Distance to the nearest pixel with nonzero 3-h Rainfall Potential.
- Outputs: a field of predicted probability of at least 1 mm of rainfall for the subsequent 3 h derived from lookup tables (LUTs; Fig. 2) plus a field of error flags on the native satellite grid. See Fig. 3 for the process flow diagram.

Assumptions and Limitations

- Assumes the Rainfall Potential fields are available and accurate.
- The Rainfall Potential algorithm uses a steady-state assumption for rainfall; i.e., does not account for the initiation, growth, or decay of rainfall.
- Assumes the development region (Europe and Africa) is sufficiently representative to be applicable to GOES-R in the Western Hemisphere.
- Data are processed on a 4400x4400 lat / lon grid for processing to avoid distortions from the satellite pixel spacing on the limb.

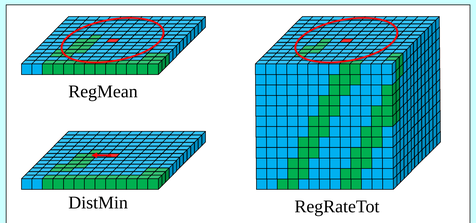

Figure 1. Illustrations of the neighborhoods used to create the predictors.

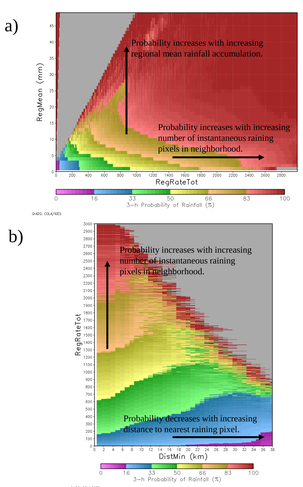

Figure 2. Probability of Rainfall algorithm lookup tables for (a) pixels with 'RegMean' ≥ 1 mm/h and (b) < 1 mm/h.

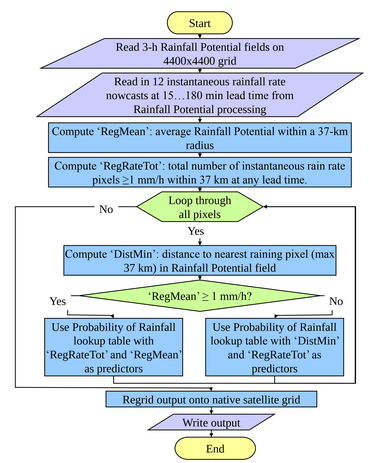

Figure 3. Probability of Rainfall algorithm flowchart.

Validation and Future Work

Validation against Nimrod

- Due to the scarcity of 3-h gauge data, the algorithm has so far been evaluated against the occurrence of at least 1 mm of rain in 3-h rainfall totals from the NIMROD radar network in Western Europe (Fig. 4).
- Table 1 shows evaluation statistics for the 6th-9th of April, July, and October 2005; the algorithm meets spec for accuracy but not for precision. However, the Nimrod data needs to be checked for artifacts that may be affecting the precision value.
- The reliability diagram in Fig. 5 shows that the algorithm generally overpredicts probability values; e.g., for a probability of 70%, at least 1 mm of rainfall is observed only about 27% of the time. However, the algorithm does clearly distinguish low-probability and high-probability situations and thus has skill.

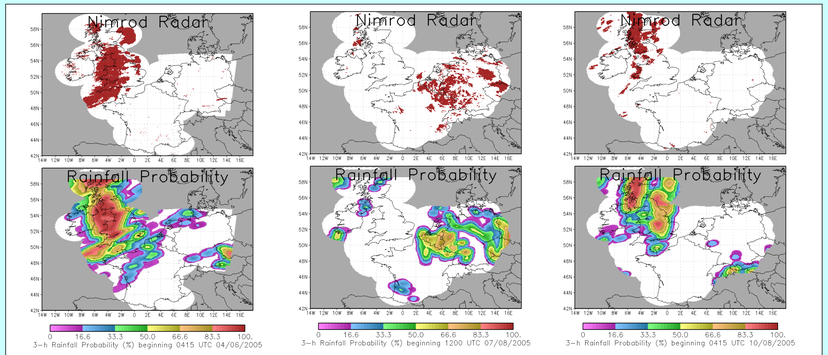

Figure 4. Comparison of 1-mm regions in Nimrod radar with corresponding Probability of Rainfall.

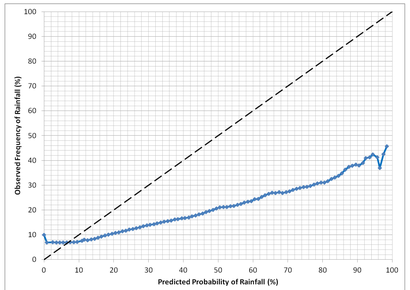

Figure 5. Reliability diagram for the Probability of Rainfall algorithm against Nimrod data for 5-9 April, July, and October 2005.

	Accuracy (%)	Precision (%)
vs. Nimrod	10	51
F&PS Spec	25	40

Table 1. Initial validation results for the GOES-R Rainfall Potential algorithm against ground validation data.

Future Work

- Update the LUTs using the most recent version of the Rainfall Potential algorithm.
- Carefully QC the Nimrod data for artifacts.
- Additional validation on 4 months of data.
- Turn in version 5 code and documentation in September.