GOES-R AWG Hydrology Team: ABI Rainfall Potential Algorithm

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Hydrology Algorithm Team

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

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- Requirements Specification Evolution
- Algorithm Description
- Validation Strategy
- Validation Results
- Summary

Executive Summary

- This ABI Rainfall Potential algorithm generates the Option 2 Rainfall Potential product.
- Version 3 is on track for late June delivery. ATBD (80%) is on track for August delivery.
- The K-means rainfall nowcasting algorithm developed at the National Severe Storms Laboratory (NSSL) has been adapted for producing extrapolation-based forecasts from ABI-retrieved rainfall rates.
- Ground validation is being performed against ground radar (Nimrod) over Western Europe.
- Validation studies indicate spec compliance.

Requirements Specification Evolution

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 Potential	GOES -R	FD	N/A	2.0 km	1.0 km	0 to 100 mm	5 mm for pixels designated as raining	FD: 15 min	FD: 5 min	266 sec	5 mm for pixels designated as raining

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 rainfall cases

Algorithm Description

Algorithm Description

- This ABI Rainfall Potential algorithm generates the Option 2 Rainfall Potential product.
- The algorithm is an extrapolation-based algorithm; i.e., rainfall is extrapolated based on a comparison of current and previous Rainfall Rate imagery
  - » ONLY motion is extrapolated (no growth / decay)
  - » No initiation in an extrapolation-based approach
- Three basic algorithm components:
  - » Identify features in rain rate imagery
  - » Determine motion vectors between features in consecutive images
  - » Apply motion vectors to create rainfall nowcasts

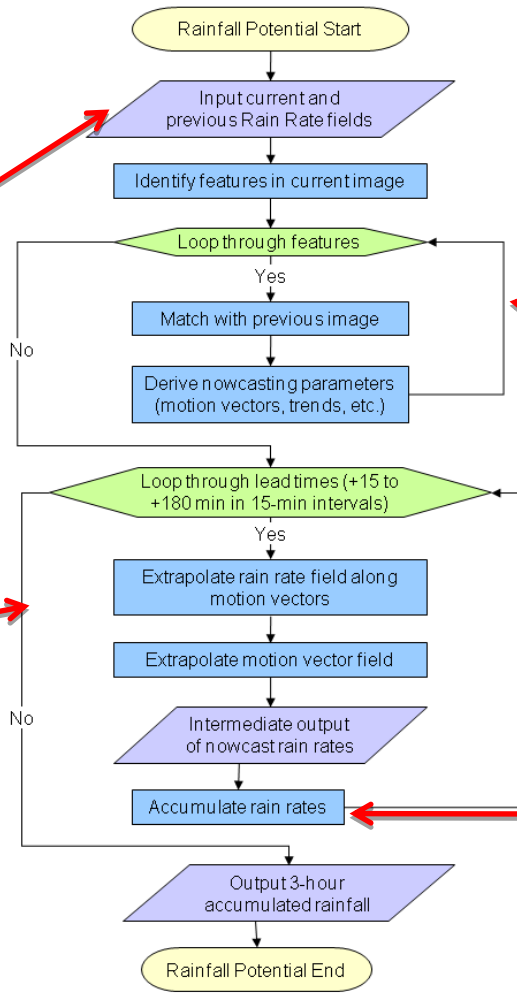
Algorithm Description

- Identify features (clusters) in rainfall imagery
  - » Filter rain rate image to reduce noise
  - » Use cost minimization to organize pixels into clusters
  - » Combine smaller clusters into larger ones
- Determine motion vectors between features in consecutive images
  - » For each cluster in current image, determine spatial offset that maximizes match with corresponding cluster in previous image
  - » Objectively analyze the resulting spatial offsets for all clusters to create a spatially distributed motion field
- Apply motion vectors to create rainfall nowcasts
  - » In 15-minute increments…
    - – Project each pixel forward in time based on motion vectors
    - – Project motion vectors forward in time
  - » Sum 15-min rain rate fields to get a 3-hour total

Algorithm Description

Input current and previous Rainfall Rate fields

Extrapolate rain rate field and motion field forward in time

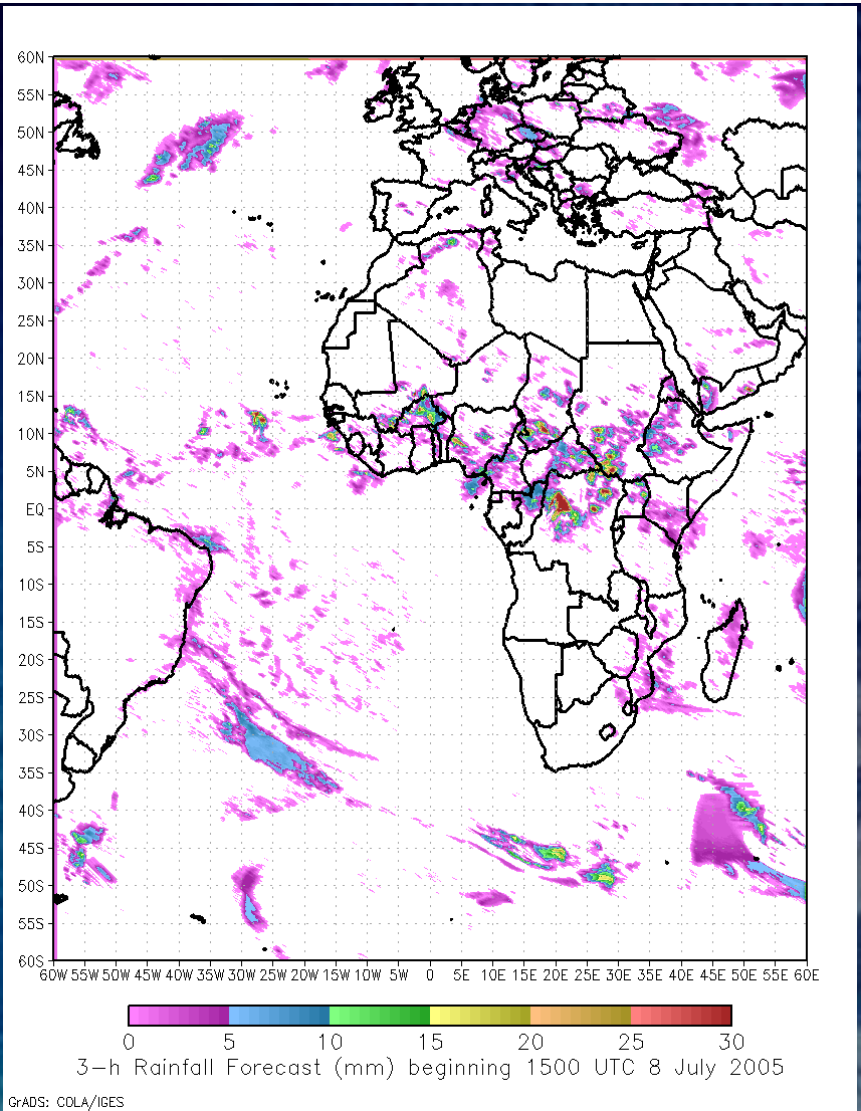


Organize rain features into clusters and derive motion parameters

Accumulate rainfall over 3 hours

Example Rainfall Potential Output

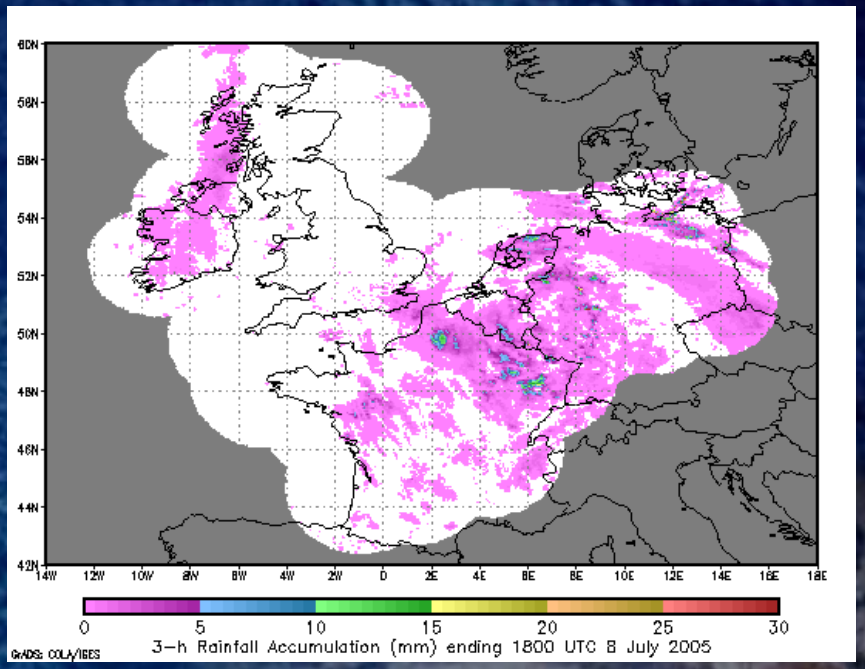
Rainfall Potential from 1500-1800 UTC 8 July 2005 derived from Rainfall Rate fields (retrieved from SEVIRI data) at 1445 and 1500 UTC.



Validation Strategy

Validation Strategy

- Since the requirement is for rainfall accumulations of 3 h, radar and short-term gauges are the only available source of data for validation against spec
- Ground-based radars:
  - » Nimrod radars in UK and Western Europe—5-km grid composite



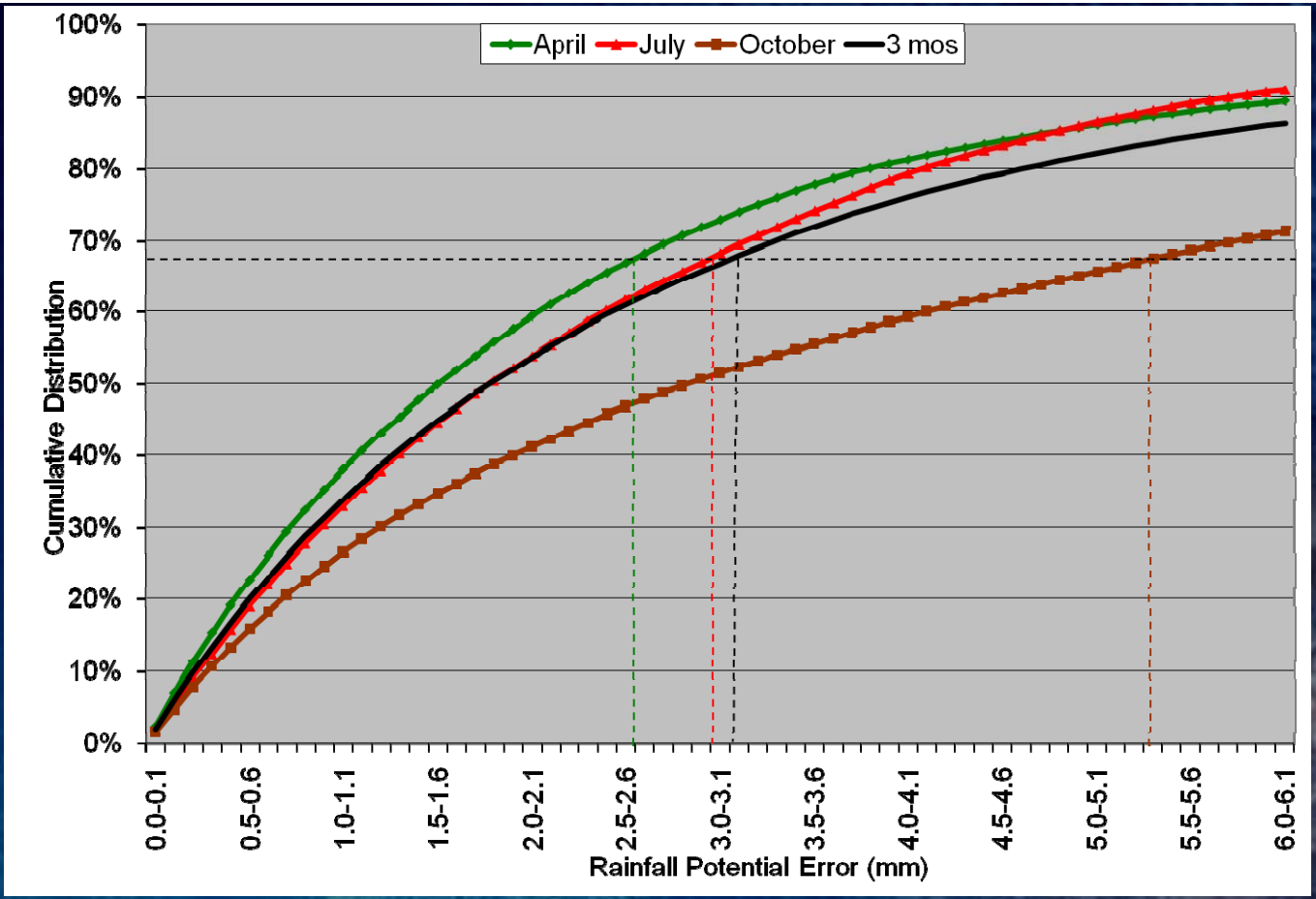
Sample Nimrod 3-h accumulation

Validation Strategy

- Derive rainfall potential from rainfall rates retrieved from GOES-R ABI proxy data
  - » Meteosat-8 SEVIRI inputs to rainfall rates: 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 potential with ground validation rainfall accumulations
  - » 3-hour observed rainfall accumulation derived from Nimrod radar
- Generate comparative statistics (satellite rainfall accumulation – ground truth rainfall accumulation)
  - » Accuracy
  - » Precision

Validation Results

Rainfall Potential Validation



CDF's of (absolute) errors of Rainfall Potential vs. Nimrod radar data (Western Europe only) for the 5th-9th of April, July, and October 2005.

Rainfall Potential Validation vs. Spec

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

	F&PS		Evaluation vs. Nimrod radar	
mm	Accuracy	Precision	Accuracy	Precision
Rainfall Potential	5.0	5.0	2.4	3.1

Next Steps to Reach 100%

- Algorithm already meets spec at 100% on validation data; additional validation on 3 months of data will follow to confirm
- Tuning of K-Means parameters planned to further enhance algorithm performance:
  - » Experiment with growth / decay option (currently turned off)
  - » Alter minimum rainfall threshold to reduce effects of light rain on motion estimates
  - » Tune scaling parameters

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