**GOESR3 Periodic Reporting**

**Reporting Period: January 2018 – June 2018 (2nd half of FY17 funding cycle)**

**Team Lead: Pierre Kirstetter**

**Team Members: Pierre Kirstetter, Jonathan Gourley, Jian Zhang, Robert Kuligowski**

**Project Title**: **Probabilistic precipitation rate estimates from GOES-R for hydrologic applications**
**Project Number: 424**

## *Executive Summary*

The high-resolution and low-latency of GOES-R observations is essential for the monitoring and prediction of floods and flash floods, specifically in the Western United States where the vantage point of space can complement the degraded weather radar coverage of the NEXRAD network. The GOES-R rainfall rate algorithm will yield deterministic quantitative precipitation estimates (QPE). Accounting for inherent uncertainties will further advance the GOES-R QPEs that will be improved through the new bands, higher resolution, and basic algorithmic improvements. With quantifiable error bars, the rainfall estimates can be more readily fused with ground radar products and incorporated into ensemble hydrologic forecast applications. On the ground, the high-resolution NEXRAD-based precipitation products from the Multi-Radar/Multi-Sensor (MRMS) system, which is now operational in the National Weather Service (NWS), provides QPEs suited for flash flood monitoring and forecasting. However, NWS operations are challenged across the intermountain West due to a lack of suitable coverage of operational weather radars over complex terrain. An opportunity exists to combine the observations from GOES-R and MRMS to provide seamless, high-resolution and low-latency precipitation estimates across the CONUS. The goal of this research project is to derive consistent, accurate and fine-resolution precipitation rates with uncertainties over the CONUS. An already created MRMS-based precipitation database will provide an independent and consistent reference to document, analyze and design GOES-R QPE over a broad sample of precipitation situations. GOES-R precipitation estimates will be matched to the MRMS-based rainfall database in order to derive and analyze distributions of QPE uncertainties associated with the GOES-R deterministic retrievals. The probabilistic model mitigates biases compared to the deterministic GOES-R QPE and quantifies the associated uncertainty. It provides the basis for the generation of GOES-R precipitation ensembles suitable to 1) merge with MRMS-based probabilistic QPEs from ground radar-based algorithms already developed to advance multisensor QPE integration (Kirstetter et al. 2015a) and 2) serve as input to a framework being developed in an already funded project for probabilistic flash flood prediction across the U.S. (Gourley et al., 2013, 2016). The product will be further tested in an operational environment in order to improve its use for weather and water forecasting.

## *Progress toward FY17 Milestones*

The second half-year of the project has been devoted to refining the database of matched GOES-16 and MRMS data in preparation of the GOES-16 probabilistic precipitation estimates. The completed milestones are on-track with the project schedule.

Ground-based MRMS products (instantaneous rain rate, radar quality index, surface precipitation type) are processed to derive a ground reference at the retrieval scale of GOES-16 precipitation over areas with good radar coverage identified through the radar quality index. Correction and filtering procedures relevant for space-borne precipitation retrievals are applied and completed with newly developed probabilistic approaches (http://wallops-prf.gsfc.nasa.gov/NMQ/Docs/DailyProducts.pdf). It provides an independent and consistent ground-based reference matching the retrieval scale of GOES-16

precipitation estimates. Data have been collected through Spring 2018. The matching procedure between MRMS and GOES-16 precipitation estimates is currently being refined.

## *Plans for Next Reporting Period*

During the next period, the MRMS-based reference precipitation database will be used to benchmark the GOES-16 precipitation retrieval algorithm SCaMPR over the CONUS following the data collection over the 2018 warm season. A refined analysis of performances conditioned on precipitation types is underway to improve the GOES-16 precipitation retrievals. Analysis of SCaMPR using the reference precipitation will be pursued, with systematic attention to rainfall detection, classification, and quantification. Using data collected during the 2018 warm season, specific challenges will be addressed such as high rain rate retrievals, impact of low-level atmospheric humidity (specifically in dry regions such as the intermountain West), and detection of rain from warm clouds and orographic rainfall. Intermediate validation products will be communicated and close coordination with NOAA GOES-16 scientists and collaborators will proceed so that additional metrics and error sources can be investigated if deemed necessary.

## *Additional Information*

1. Interaction with operational partners –

- Exchanges with collaborator R. Kuligowski (NOAA/NESDIS/STAR)
- Telecons with the Hydrology Initiative working group (Ralph Ferraro)
- Discussion with the MRMS team for possible transition to operation.

2. Conference/workshop participation –

3. Outside project publicity –

- Hydrology Initiative working group (Ralph Ferraro)
- Conferences: AMS 2018 annual meeting, EGU2018, ERAD2018.
- Seminars:

  - *National Weather Center, University of Oklahoma*, Norman, OK, US*;*

  - *Laboratoire de Meteorologie Physique*, Clermont-Ferrand, France;

  - *Laboratoire Atmospheres, Milieux, Observations Spatiales*, Paris, France;

  - *Laboratoire des Sciences du Climat et de l'Environnement*, Paris, France;

  - *Invitation to NCAR to discuss the broader perspectives of the project on research in hydrometeology.*

4. Journal articles –

- Kirstetter, P.E., N. Karbalaee, K. Hsu, Y. Hong, 2018: Probabilistic Precipitation Rate Estimates with Space-based Infrared Sensors. *Quarterly Journal of the Royal Meteorological Society*, 1–15. doi: 10.1002/qj.3243

This paper demonstrates the concept of probabilistic precipitation rate estimates with space-based geostationary infrared sensors similar to GOES-16.

## Key Graphics

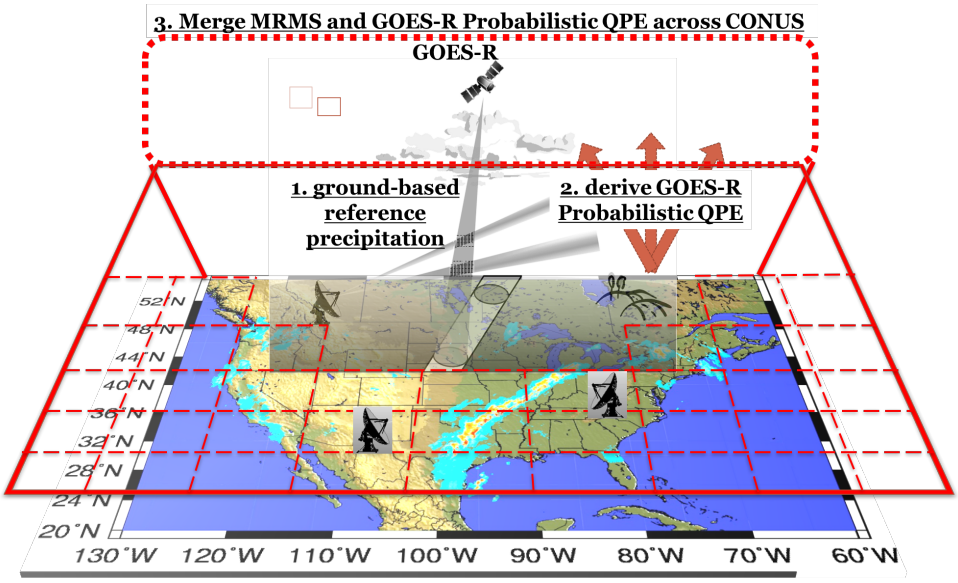


*Figure 1: Research framework and overview flowchart of the project.*