SPoRT Trial of Global Precipitation Measurement (GPM) Mission Level 2 Rain Rate and Level 3 IMERG Products

1. Introduction

Forecasters at National Weather Service (NWS) Forecast Offices (WFO) face challenges related to ground-based radar voids in coastal areas, mountain regions, and near international borders. One way to approach addressing this forecast challenge is through the use of satellite-based precipitation measurements, such as those from the Global Precipitation Measurement (GPM) mission, a joint mission with NASA and the Japanese Aerospace Exploration Agency (JAXA). GPM officially began with the launch of its Core Observatory platform in February 2014. The mission, however, includes data from an international constellation of 12 satellites with similar passive microwave instruments (and more to be launched in the coming years). The GPM Microwave Imager (GMI) and its Dual-frequency Precipitation Radar (DPR) aboard the Core Observatory are being used to intercalibrate GPM products, to generate opportunities for unprecedented temporal resolution from polar-orbiting precipitation sensors.

Through discussions with NWS partners in the geographical areas noted above, it was determined that swath-based rain rates from the Level 2A Goddard PROFiling (GPROF) algorithm may be valuable for situational awareness and filling radar voids, and gridded Level 3 products from the Integrated Multi-satellitE Retrievals for GPM (IMERG) may be useful for hydrologic applications. (Specifically, the *calibrated precipitation* variable was used in IMERG products.) The L2A rain rates are available 20-35 times per day at a spatial resolution of approximately 15-30 km. The L3 IMERG product is calculated on a 0.1˚ grid, available every 30 minutes. The Early Run product, which currently has a latency of ~6 hours, was used to mitigate operational challenges due to data latency that appeared in the Late and Final Run products. Cumulative precipitation amounts of 1, 3, 6, 12, and 24 hours were also made available to forecasters.

As a GPM Early Adopter, SPoRT was able to obtain early access to the data to begin the process of transitioning the derived products to forecasters by reformatting the data for display in the NWS Advanced Interactive Weather Processing System (AWIPS) starting in April 2015. Forecasters were asked to compare the GPM products to the NESDIS Quantitative Precipitation Estimate (QPE; previously evaluated in 2013) for both instantaneous rain rate and the same cumulative precipitation amounts mentioned above.

Three regions with widely differing precipitation regimes and forecast challenges were selected for participation in this trial. The evaluation period was from 15 July – 30 August 2015. The NWS Juneau (AJK) and Anchorage (AFC) WFOs participated to investigate the impact of better knowledge of off-shore precipitation. Much of the precipitation that falls in southern Alaska comes from over the Gulf of Alaska, so use of satellite-based precipitation observations helps forecasters to view where, when, and how much precipitation may occur. The NWS Albuquerque (ABQ) and Tucson (TWC) WFOs participated to investigate the impact of better knowledge of precipitation in radar-void regions, such as over northern Mexico and gaps in coverage in the U.S. During the summer months, moisture flow tends to come from monsoon conditions that set up and move moisture across northern Mexico, where there is no quality radar coverage. Use of satellite-derived precipitation from GPM may add value here. For the forecast challenge of analyzing the impacts of GPM precipitation in hydrologic models, the Southeast (Atlanta, GA), Colorado Basin (Salt Lake City, UT), and Alaska/Pacific (Anchorage, AK) NWS River Forecast Centers (RFC) were provided with IMERG observations to use as part of their hydrologic forecasting procedures. Feedback was

requested to help identify any specific limitations to operational use of the data products and to communicate the potential for more sustained operational utility in the future.

2. User Feedback

SPoRT requested that participating forecasters send questions and comments via phone or email. Forecasters were also provided with a brief web-based survey to rate the impact of each product. In total, there were 21 online surveys submitted; summary results are shown below. A more thorough overview of these results was presented at the 30th Conference on Hydrology (96th AMS, New Orleans, LA 2016 Jan 14)

GPM L2 Rain Rate: Forecasters at the Alaska WFOs were the primary users of these data. The products were deemed most useful for rainfall placement and timing. The shorter latency of the L2 products made these products useful for both WFO and RFC applications. Confidence of rainfall rates was not high due to mixed over- and under- estimation when compared to local gauge results.

GPM L3 IMERG: This proved to be the most popular product evaluated. It was definitely useful in areas where radar coverage was missing or lacking. It provided important timing and pattern information, though not always perfect estimation of rain rates. Due to the latencies (6+ hours), the product was really only valuable in a post-event mode. As with L2 products, there were instances of over-, under-, and accurate estimations of rain rates.

Product Impacts and Limitations

The overall results from the evaluation provided some examples for two of the regions.

GPM L2 Rain Rate: When compared to other precipitation data sources, the swath products had instances of missing some light and moderate rain events as well as good agreement with observed precipitation. The product was routinely used to determine location and direction of precipitation.

GPM L3 IMERG: As an operational decision-making product, the IMERG data was marginally impactful to operations, with 34% of participants deeming the product as having "some", "small", or "large" impact on operations (see chart below). This was not particularly surprising given the latency of the products and access to the L2 product. However, there were two specific instances where the IMERG product was used in a post-event report. The first instance was related to a local canyon flash flood fatality by NWS ABQ where the cumulative IMERG products were used to capture the precipitation amount in

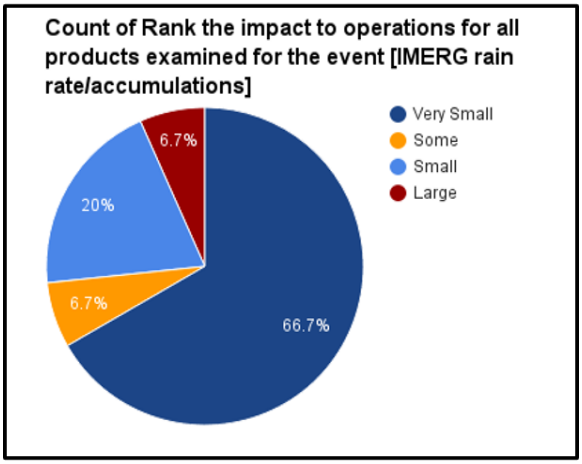

Fig. 1. Forecaster feedback on the operational impact of IMERG rain rate/accumulation products.

a radar-void area. The second example was from NWS AJK, where the product was used following a fatal landslide in the Sitka, Alaska area.

For the landslide case, NWS AJK forecaster Aaron Jacobs found that the IMERG product did an excellent job of capturing the localized nature of the extreme precipitation event that caused the landslide (see Fig. 2). One frequent limitation noted by the forecasters was light rainfall being missed by the product (particularly over southeastern Alaska). On the other end of the

spectrum, heavy precipitation (especially related to convection) was overestimated. Forecasters found that they could trust the locations of the heaviest rain, but were challenged to trust the quantitative measurements.

Conclusions and Recommendations

GPM L2 Rain Rate: The smaller latency of this product made it useful in WFO forecaster situations, in addition to RFC applications. The product was somewhat more trusted than IMERG for rain/no-rain and precipitation motion situations due to shorter latency and less complicated processing.

There are no specific recommendations on improvements needed for the product.

GPM L3 IMERG: The IMERG product proved useful for post-event weather and hydrologic applications. The most telling quote from the evaluation period came from, among others, Aaron Jacobs - a hydrologist/forecaster at AJK, who asked whether the GPM data would continue to be available to them after the conclusion of the trial period. Above any survey response or case study, the operational utility of the products can be inferred from a desire by the forecasters to have continued access. SPoRT continues to make these data available to the forecasters in their operational AWIPS system.

Specific recommendations:

- Reduce product latency to make the product more operationally viable. GPM's 4-hour latency goal for the Early Run would be useful to RFCs or perhaps even the NWS Weather Prediction Center. Current IMERG latency (~6 hours) makes the product only valuable in a post-event mode.
- Improve the detection efficiency of low and high rainfall rates.
- Extend the IMERG domain poleward of 60ºN. Forecasters in Alaska are very eager for this type of data.