Initial Results in Global Flood Monitoring System (GFMS) Using GPM Data

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1. Introduction

A real-time Global Flood Monitoring System (GFMS) has been developed by coupling a widely used Land Surface Model, i.e. the Variable Infiltration Capacity (VIC) model (U. of Washington/Princeton U.) with a physically based Dominant River Tracing-based runoff-Routing (DRTR) model (Wu et al., 2011, 2012, 2014). The coupled model is named as the Dominant river tracing-Routing Integrated with VIC Environment (DRIVE) model. The GFMS driven by Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) rainfall products is operating routinely and producing flood detection and intensity results at (http://flood.umd.edu/) (Fig. 1).

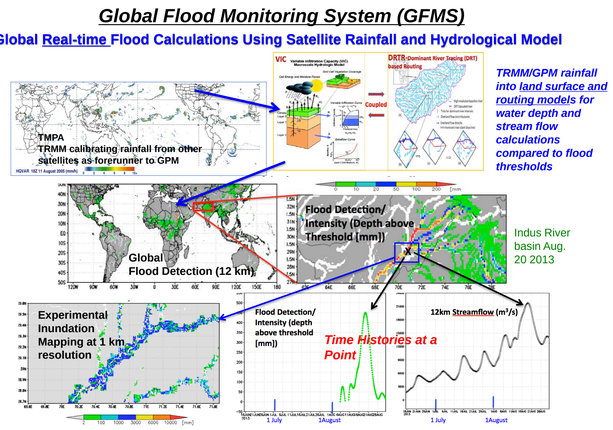

Fig. 1 Example of global to regional flood calculation by the GFMS with the DRIVE model.

We use the new GPM precipitation products in the GFMS to continue and improve the global flood monitoring and flood inundation mapping, which is considered as an very important application of the global precipitation measurement mission. In this study, we demonstrate the value of the GFMS in monitoring on-going flood events, and perform a first-cut evaluation of the IMERG based flood modeling system while dealing with the issues related to the short record of the IMERG data.

2. GFMS on Hurricane Matthew

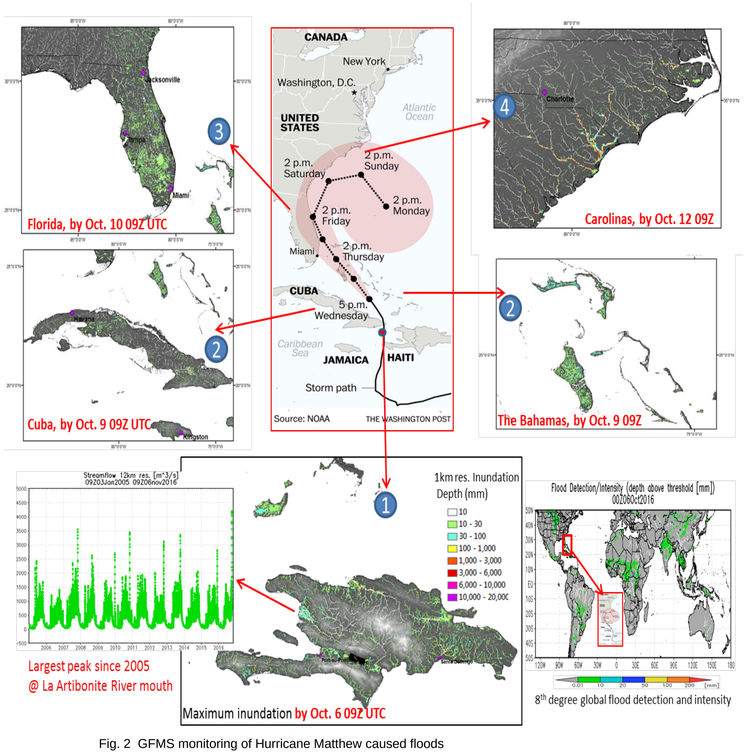

Fig. 2 GFMS monitoring of Hurricane Matthew caused floods

As one of the most recent examples, GFMS well detected the Hurricane Matthew landfall caused flooding events and provided 1km resolution flood inundation mapping along the hurricane path every three hours, which are used by flood relief agencies, such as FEMA.

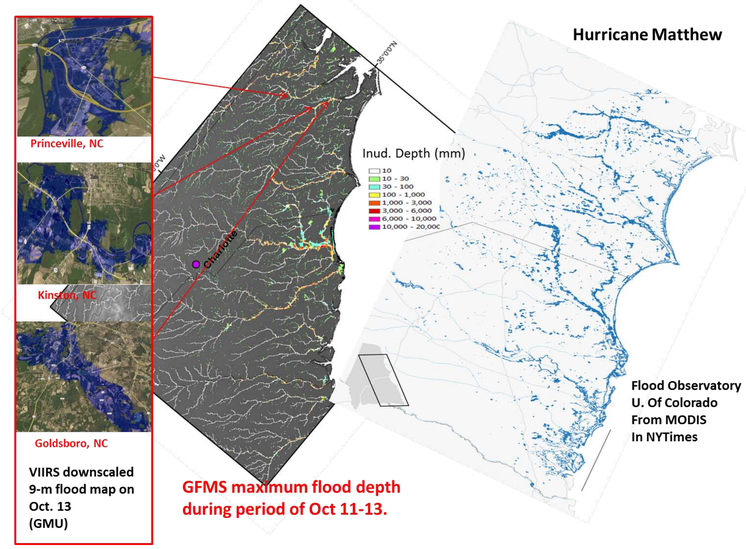

Fig. 3 Comparison of GFMS flood inundation map with MODIS and VIIRS inundation map

GFMS flood inundation map showed good agreement with available VIIRS and MODIS optical bands based inundation maps with capturing many common flood features.

3. GFMS from TRMM to GPM era

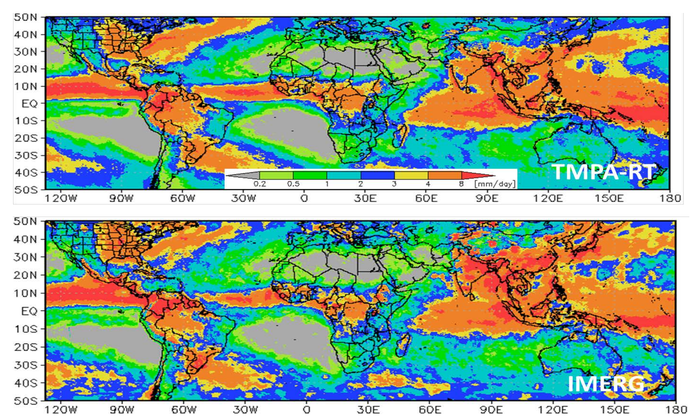

Fig. 4 Accumulated precipitation during May 1, 2015 – Oct. 15, 2016

IMERG early product showed more precipitation than TMPART in most of land areas, with which GFMS tends to derive much more flooding compared to the existing TMPART based system.

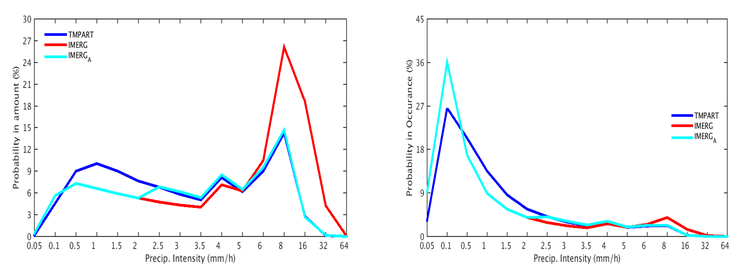

Fig. 5. Probability distribution of precipitation amount and occurrence in terms of intensity

A PDF matching process was performed on IMERG to make IMERG closer to TMPART in order to use the global flood threshold map which was derived from 15-year retrospective simulations using TMPART.

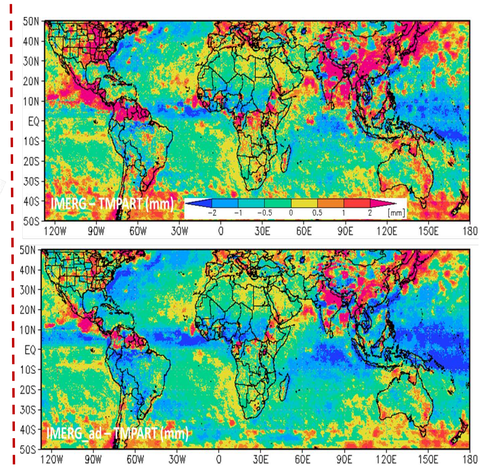

Fig. 6 Difference between IMERG, IMERG_ad (PDF matched) and TMPART

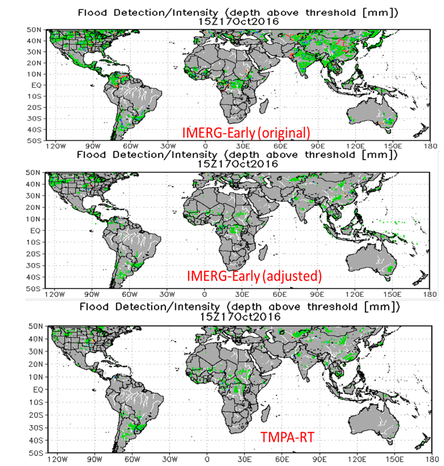

Fig. 7 Global flood detection with TMPART, IMERG, IMERG (PDF matched) respectively.

The PDF matching process can significantly reduce the high precipitation rates by IMERG, resulting in similar global flood detection map to TMPART (Fig.7) when the GFMS uses the same global flood threshold map as used by the current TMPART based system.

Recent Flood Case 1: South Carolina (Oct. 2015)

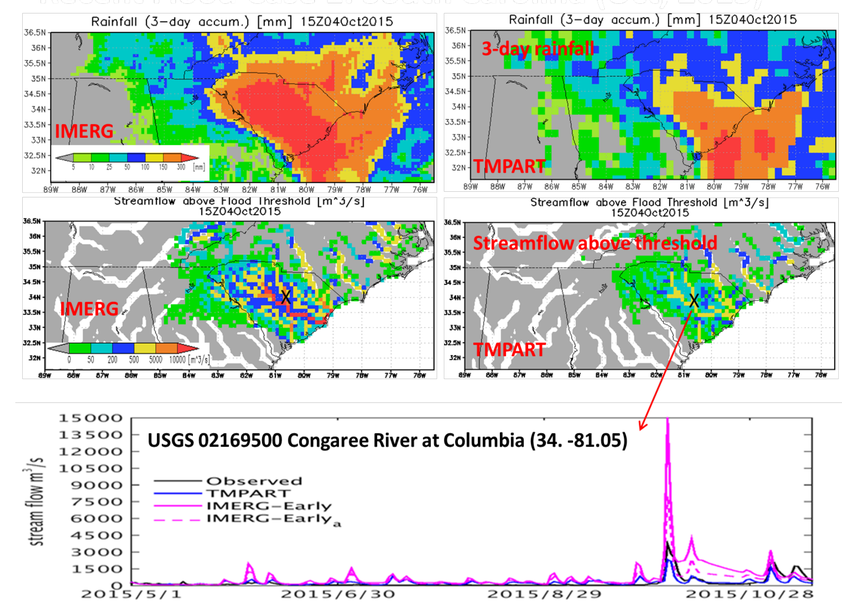

Fig. 12 An example of the improved flood peak flow using the PDF adjusted IMERG precipitation input.

6. Conclusion

(1) New GPM IMERG products have been initially driving the Global Flood Monitoring System (GFMS); GFMS now runs paralleled versions with TMPART, IMERG-Early and IMERG-late for first-cut evaluation, while the GFMS routinely functions well in monitoring on-going flood events, with the Hurricane Matthew caused inland flooding as one of the most recent examples.

(2) IMERG showed higher estimation than TMPART in most of land areas, while with remarkable lower estimation in some other areas , e.g., some deep tropical areas, which indicated different flood threshold map is needed for GFMS-IMERG.

(3) A simple PDF matching of IMERG to TMPART showed significantly improved flood detection and intensity mapping when using the existing global flood threshold map derived using TRMM era data, and flood peak estimation.

Future work

- A study on improved PDF matching of IMERG and TMPA will be performed to further improve the usage of IMERG before it accumulates up a long enough record.
- We'll further improve GFMS/DRIVE system by taking full advantage of GMP IMERG in higher time and space resolution, precipitation phase, high latitude coverage etc.
- Global to local scale evaluation and comparison between GFMS-IMERG and GFMS-TMPA