Correction of satellite precipitation data (IMERG) based on ground measurements over Korean Peninsula

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Introduction

Satellite-derived precipitation products have an advantage of continuous and large observation coverage. Their accuracy however may depend on precipitation types, geolocation and seasons. This study presents a method to correct the difference between satellite precipitation estimates and ground-based rainfall measurements. The method first find an optimal number of gauges based on the spatial variability of rainfall and then correct the difference with the selected gauges. As a test, this method is applied to the Integrated Multi-satellite Retrievals for Global Precipitation Measurement (GPM) (IMERG) data with a rainfall event that caused severe floods in South Korea during the period, 26-28 August, 2018.

Data and method

- Rain gauge: 1 hour accumulated precipitation at 505 stations in South Korea (33 – 39 N, 124 – 132 E)

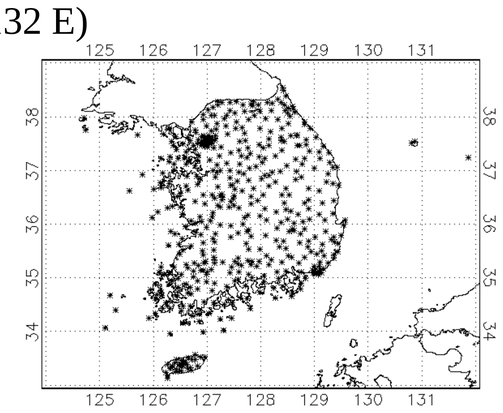

Fig. 1. Locations of rain gauge stations in South Korea.

- Satellite rainfall data: IMERG
  - ➢ IMERG combines satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, precipitation gauge analyses over the global area.
  - ➢ IMERG includes CPC Morphing-Kalman Filter (CMORPH-KF) Lagrangian time interpolation scheme, the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks – Cloud Classification System (PERSIANN-CCS) re-calibration scheme, and TRMM Multi-satellite Precipitation Analysis (TMPA) gauge adjustment scheme (Huffman et al., 2018).
  - ➢ Products
    - Early: multi-satellite product ~4 hr after observation time
    - Late: multi-satellite product ~12 hr after observation time
    - Final: satellite-gauge product ~2.5 months after the observation month.

      Version 05 Early run product is used in this study
  - ➢ Spatial resolution: 0.1˚, time resolution: 30 min

- Period of the data: 26 – 28, Aug 2018
- Collocation
  - ➢ Time: Instantaneous satellite precipitation data (every 30 min) are accumulated for 1 hours to match rain gauge data.
  - ➢ Space: The rain gauge data are averaged according to the resolution of satellite data.

- **Correction Method**
  - ➢ **Selection of the optimal number of gauges**: The number of gauge measurements used for the correction of satellite precipitation data is determined by **the spatial information of rainfall**.
    - ✓ The spatial information is identified by the coefficient of variation ($CV=\frac{\sigma}{\mu}$) of rainfall around the satellite data.
    - ✓ The variable boundary of the gauges to be used is determined by the e-folding scale of CV.
    - ✓ If there are no gauge within the selected distance, all gauge data in the study area is utilized for correction.

  - ➢ **Transforming distributions of satellite data with the rain gauge data** (Immerzeel (2010)).

$$SRE_c = (SRE_o - \mu_{SRE}) \cdot \tau_f + \mu_{SRE} \cdot \mu_f$$

SRC_C: corrected satellite data, SRE_O: original satellite data
μ_{SRE} : average satellite data for collocated pixel
τ_f : ratio of standard deviations from rain gauge and satellite data
μ_f : ratio of average from rain gauge and satellite data

Results

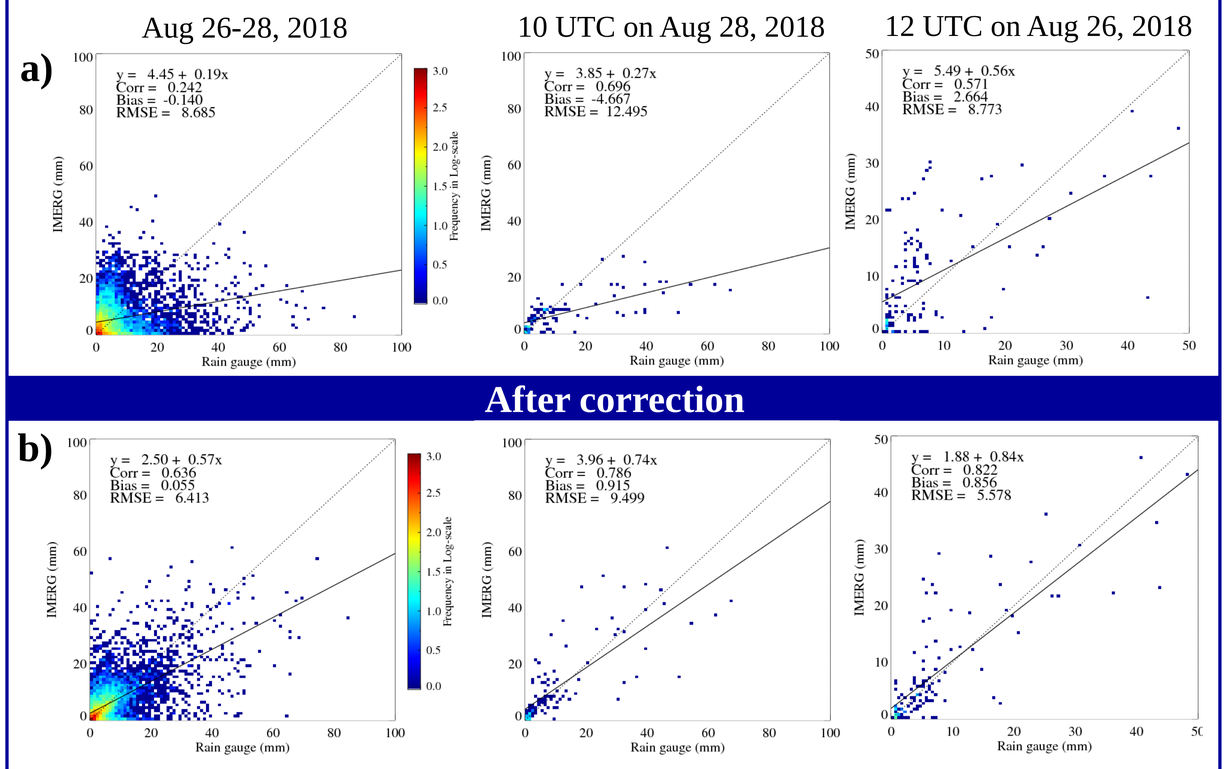

Fig. 2. Scatter density diagrams for three days (left column) and rainfall cases (middle and right columns) of 1 hour accumulated rainfall from a rain gauge at South Korea and IMERG data when a) before correction and b) after correction.

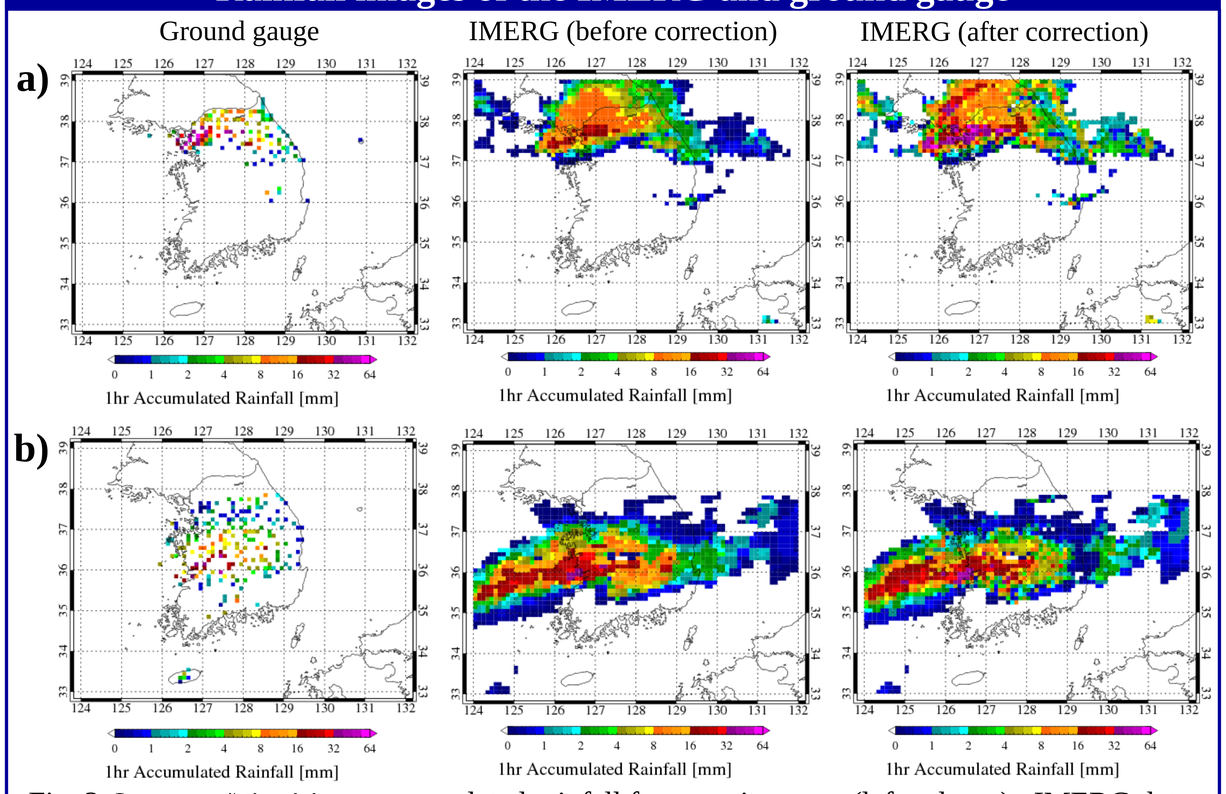

Fig. 3. Images of the 1 hour accumulated rainfall from a rain gauge (left column), IMERG data before correction (middle column), and IMERG data after correction (right column) at a) 1000 UTC on August 28, 2018 and b) 1200 UTC on August 26, 2018.

Summary

- The satellite rainfall data correction method proposed in this study is based on the selection of different number of gauges depending of the spatial inhomogeneity of rainfall.
- The method has been applied to the IMERG data over the South Korea.
- Results show that the correction method improves comparison statistics such as bias, correlation coefficients, and RMSE.

Reference

- Immerzeel, W. W. 2010. Bias correction for satellite precipitation estimation used by the MRC Mekong flood. Mission Report. FutureWater Report 94: 1-32.
- Huffman, G. J. and Coauthors, 2018: Algorithm Theoretical Basis Document (ATBD) Version 5.2. NASA Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG).

Acknowledgement

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