Hourly Comparison of GPM-IMERG-Final-Run and IMERG-Real-Time (V-03) over a Dense Surface Network in Northeastern Austria

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Introduction

- Accurate quantitative daily precipitation estimation is key to meteorological and hydrological applications, particularly over mountainous basins, in hazards forecast and management. In-situ observations over mountainous areas are mostly limited, however, currently available satellite precipitation products can potentially provide the precipitation estimation needed for meteorological and hydrological applications. Over the years, blended methods that use multi-satellites and multi-sensors have been developed for estimating of global precipitation. One of the latest satellite precipitation products is GPM-IMERG (Global Precipitation Measurement with 30-minute temporal and 0.1-degree spatial resolutions) which consists of three products: Final-Run (aimed for research), Real-Time early run, and Real-Time late run. The Integrated Multisatellite Retrievals for GPM (IMERG) products built upon the success of TRMM's Multisatellite Precipitation Analysis (TMPA) products continue to make improvements in spatial and temporal resolutions and snowfall estimates.
- Recently, evaluated IMERG-Final-Run V-03 and other precipitation products indicated better performance for IMERG-Final-Run against other similar products.
- As a result, In this study two GPM-IMERG products, namely final run and real time-late run, were evaluated against a dense synoptic stations network (62 stations) over Northeastern Austria for mid-March 2015 to end of January 2016 period at hourly time-scale.

Study Area

- To examine the accuracy of satellite observatory precipitation data in Center of Europe, we selected Northeast part of Austria which there is rather high density of gauge network; moreover in this area more or less precipitation is homogenous.
- Austria is located in a temperate climatic zone with a Central European climate influenced by the Atlantic climate. Due to the topographical diversity and the relatively large west-east expanse, there are three quite different climatic regions: Eastern-Northwestern: Pannonian climate with a continental influence, low precipitation, hot summers but only moderately cold winters,. Alpine region with Alpine climate, west of the country with transient climate influenced by the Atlantic and a continental influence in the South-east.
- Altitude determines the precipitation pattern; high-level areas in the Alps may have a high average rainfall in excess of 2000 mm per year, while our interest region in east and northeast in the flatlands of Austria have only 600 mm annually

Methods

- In this study, we used 62 in-situ meteorological synoptic stations with 10 minutes time interval observation.
- Before evaluating this data we quality control based on Laplacian Filter is done.

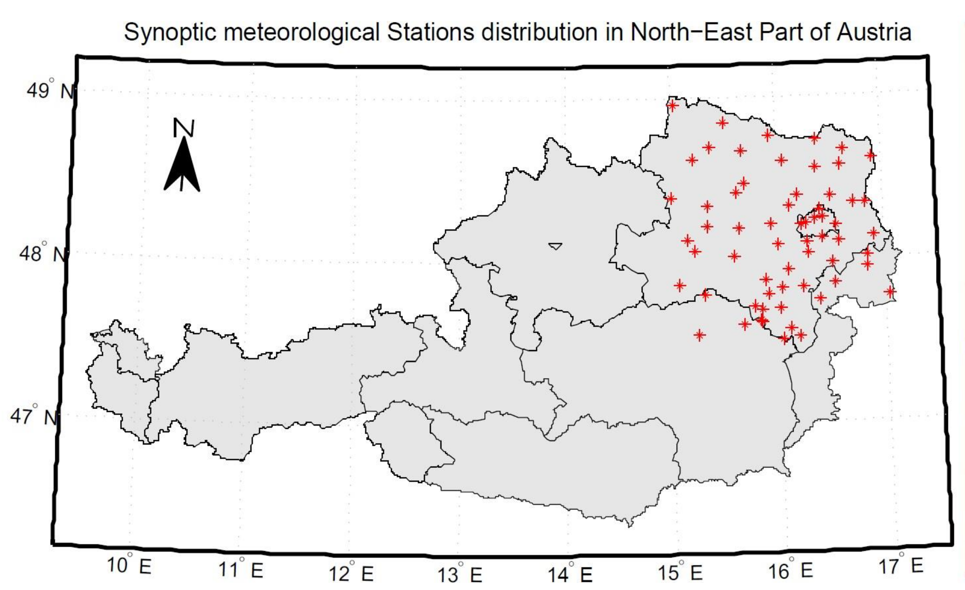

Fig. 1. Map of meteorological synoptic stations distribution in northeast of Austria.

Fig. 2. Elevation map of Austria.

- Since the same rainfall amount in the form of long-lasting light rain or a short-duration storm will yield quite different impacts in natural hazards, in this study, probability distribution function (**PDF**) and cumulative distribution function (**CDF**) is used to provide detailed information about the frequency of rainfall with different intensities.

Table 1. Characteristics of Satellite/Model Precipitation Products

Products	Temporal resolution	Spatial resolution	Regions	Availability Period
IMERG-FR	half-hourly	0.1 degree	90ºN - 90ºS	mid-March 2014 – January 2016
IMERG-RT	half-hourly	0.1 degree	90ºN - 90ºS	mid-March 2015- present

$$Bias = \frac{\sum_{i=1}^{N}(P_{S_i} - P_{O_i})}{N} \quad (mm) \qquad (1)$$

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_{S_i} - P_{O_i})^2} \quad (mm) \qquad (2)$$

$$CC = \frac{\sum_{i=1}^{N}(P_{S_i} - \bar{P}_S)(P_{O_i} - \bar{P}_O)}{\sqrt{\sum_{i=1}^{N}(P_{S_i} - \bar{P}_S)^2}\sqrt{\sum_{i=1}^{N}(P_{O_i} - \bar{P}_O)^2}} \qquad (3)$$

Where P_{S_i} is the value of satellite precipitation estimates for the *i*th event, P_{O_i} is the value of rain-gauge observation for the *i*th event, N is the number of observed events, P_S is the average value of satellite precipitation estimates and P_O is the average value of rain-gauge observation for N observed events over each pixel.

Results

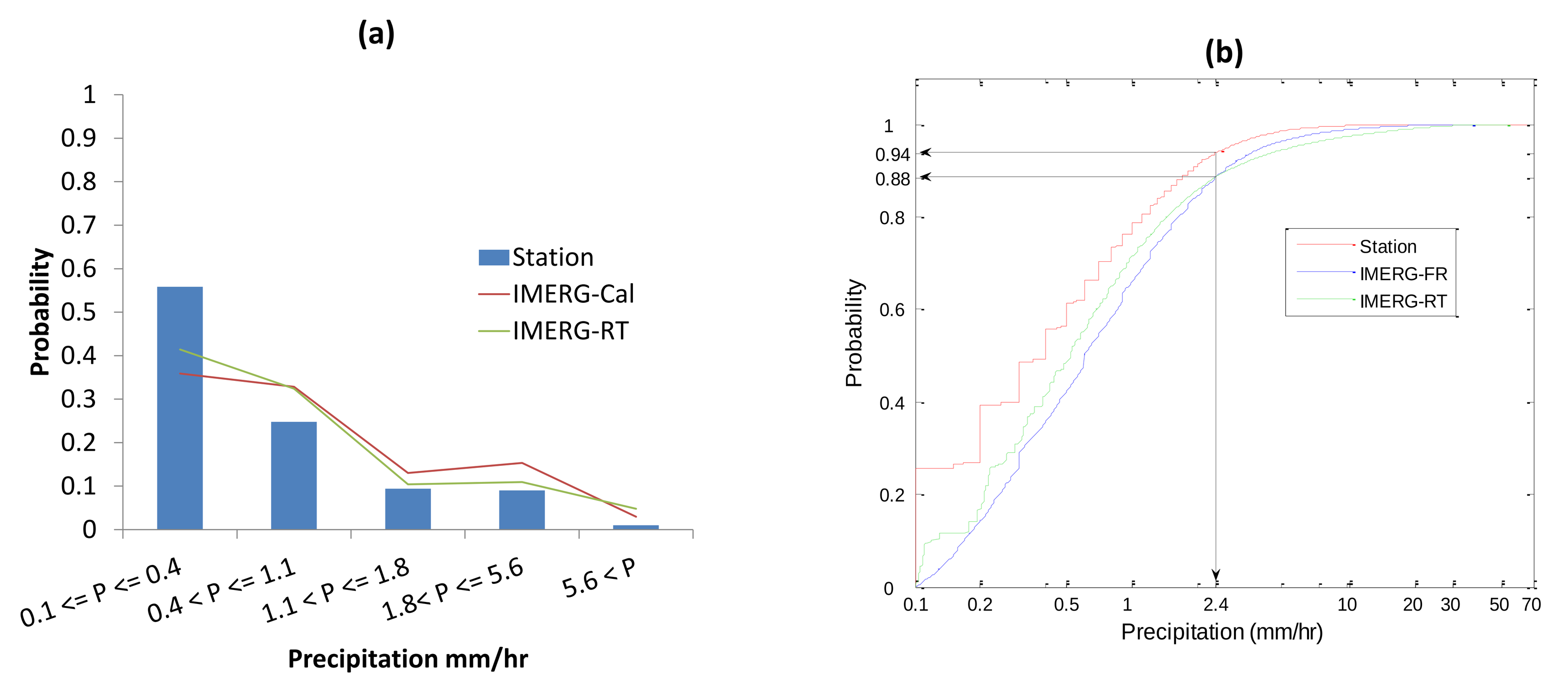

Fig 3: a) Probability Density Functions (PDF) and b) Cumulative Distribution Functions (CDF) of hourly precipitation events

Table 2. Summary of evaluation metrics for IMERG-FR and IMERG-RT products at hourly time scale over Northeastern Austria. The metrics were calculated based on all hours of all stations.

	0.1<=P<=0.4		0.4<P<=1.1		1.1<P<=1.8		1.8<P<=5.6		5.6<P		0.1<=P	
	IMERG-FR	**IMERG-RT**	**IMERG-FR**	**IMERG-RT**	**IMERG-FR**	**IMERG-RT**	**IMERG-FR**	**IMERG-RT**	**IMERG-FR**	**IMERG-RT**	**IMERG-FR**	**IMERG-RT**
RMSE	1.02	1.31	1.38	2.11	1.77	3.08	3.20	6.14	8.33	9.07	1.72	2.67
Bias	**0.07**	0.12	-0.14	**-0.05**	-0.44	**-0.23**	-0.99	**-0.11**	-5.97	**-3.56**	-0.18	**-0.01**
CC	0.09	0.07	0.09	0.07	0.05	0.06	0.15	0.14	0.00	0.05	0.30	0.29

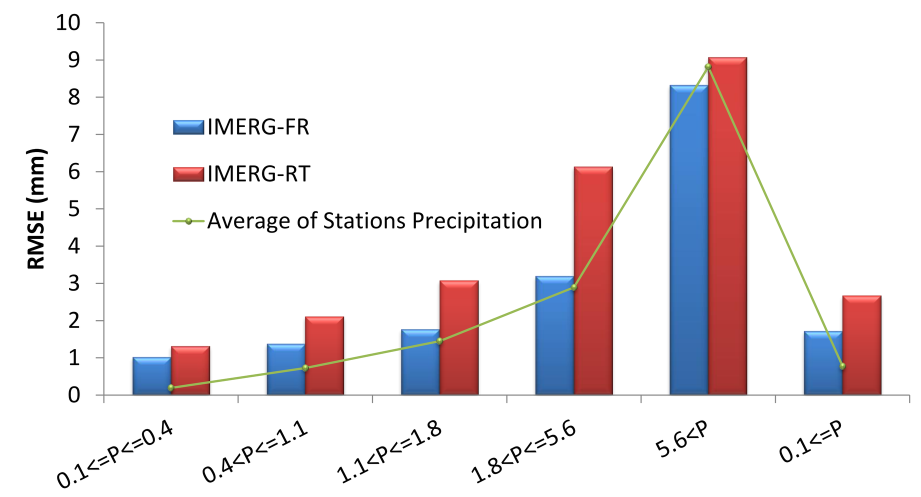

Fig 4: RMSE of hourly precipitation events

Conclusion

The PDF of hourly precipitation with different intensities are shown (Fig. 3-a) both IMERG-FR and IMERG-RT, capture less precipitating events than the reference dataset for mainly between 0.1 to 0.4 mm/hr. For precipitation above 0.4 mm/hr the trend is reversed that there are more precipitating detected by both satellite products.

As shown in Figure 3.b, the result showed that both IMERG products' CDFs were well above that of the stations' precipitation. However, at 94% frequency level, ground data was less than 2.4 mm/hr which corresponded to 88% frequency level in IMERG-FR and IMERG-RT. Bellow 2.4 mm/hr, IMERG-RT was slightly lower than the IMERG-FR whereas IMERG-RT was above IMERG-FR at higher precipitation levels.

From the result (Table 2) precipitation has shown weak correlation for both products at hourly time scale for all precipitation intensities. RMSE values in Figures 4 and table 2 confirm that the larger the amounts of precipitation, the larger the deviations. Table 2 indicates that both products in all intensities except light-rain understimate precipitation slightly.

References

- Sharifi, E.; Steinacker, R.; Saghafian, B. Assessment of GPM-IMERG and Other Precipitation Products against Gauge Data under Different Topographic and Climatic Conditions in Iran: Preliminary Results. Remote Sens. 2016, 8, 135.
- NASA. "GPM_3IMERGHH 03D". Available online: http://disc.sci.gsfc.nasa.gov/SSW/ (accessed on 26 May 2016).
- http://www.vidiani.com/large-detailed-physical-map-of-austria-with-all-cities-roads-and-airports/ ((accessed on 3 April 2017).

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