COMPARISON OF EXTREME PRECIPITATION ESTIMATION FROM GPM DUAL-FREQUENCY RADAR AND GROUND-BASED RADAR NETWORK IN SOUTHERN CHINA

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ABSTRACT

This paper focuses on the inter-comparison of dual-frequency Precipitation radar (DPR) on board GPM core satellite and ground-based radar observations during the extreme precipitation estimation in southern China. Time and location matching technology is used to match DPR data and radar data. A Gauss function is applied to compute sample weights to obtain a more accurate result. By distinguishing convective rainfall and stratiform rainfall, different Z-R relationships are adopted to estimate precipitation. The results are as follows: 1) DPR\textsubscript{HS}, DPR\textsubscript{MS} and DPR\textsubscript{NS} show low correlation coefficient so that they are poorly correlated with radar for instantaneous precipitation rates; 2) DPR\textsubscript{HS}, DPR\textsubscript{MS} and DPR\textsubscript{NS} show much more occurrences of light rainfall rates than radar; 3) DPR\textsubscript{MS} occurrences of rainfall rates are similar with DPR\textsubscript{NS}.

Index Terms— DPR, ground-based radar, extreme precipitation estimation,

1. INTRODUCTION

Extreme climate events occur more and more frequently in recent decades due to global climate change. In recent years, extreme rainfall events cause tremendous loss of property and life. For example, the heavy rainfall storm on July 21 of 2012 leads to loss of 79 lives and direct economic losses of US $2 billion, and destroyed at least 8,200 homes in the city [1-2]. Extreme precipitation in a certain region, often triggers subsequent flash floods, city waterlogging and other catastrophic damage, which leads to huge economic losses and casualties. It is of profound significance to improve the accuracy of extreme precipitation estimation.

Radar is an important tool for rainfall estimation because of its advantage to provide high spatial and temporal sampling and ability to cover large area over flat region. Thus, a lot of countries deploy radar network over coastal region to monitor disastrous weather events like typhoon and hurricane. However, ground radar still has limitations over land. For example, radar is usually deployed over land and radar beams are usually blocked by mountains in complex terrains.

As another important mean to overcome ground radar’s disadvantage like limited coverage, satellite provides observation of precipitation at global scale. In recent decades, a great progresses of satellite technology have been achieved in recent decades, and the accuracy and resolution of satellite observation of precipitation has commanded more and more attentions throughout the world. On February 27 of 2014, the Global Precipitation Measurement (GPM) satellite jointly ventured by the Unites States National Aeronautics and Space Administration (NASA) and Japan Aerospace Exploration Agency (JAXA) was launched in Kagoshima, Japan. The satellite was equipped with the dual-frequency precipitation radar (DPR) and a GPM microwave imager (GMI) (Figure 1).

Fig. 1 GPM Instruments. More information can be found at http://spaceflight101.com/spacecraft/gpm-core-mission-spacecraft-overview/
rainfall brings so much water because of its location and circulation background.

The red circle in figure 2 indicate the radar coverage. Three extreme rainfall cases were selected in this study, i.e. 22:26 April 17th 2016(UTC, the same below), 00:48 April 10th 2016, and 00:42 April 10th 2016, respectively. As for the DPR of GPM level 2 data, the time are 22:02 April 17th 2016 and 00:14 April 10th 2016. The radar has scanned twice during the 00:14 April 10th 2016 DPR passed Guangdong, so two radar data are corresponded to it.

![Fig. 2 Guangdong Province and its radar coverage (red circle)](image-url)

### 3. METHODOLOGY

The two datasets need to be temporally and spatially matched with each other before analysis. The time and location matching technology is referred to Chen (2015)[3] as there in figure 3.

![Formula 1](image-url)

\[ Z = 300R^{1.4} \]  

Formula (1) is used for convective rainfall and formula (2) is used for stratiform rainfall.

![Formula 2](image-url)

\[ Z = 200R^{1.6} \]  

After differentiating convective rainfall and stratiform rainfall, different Z-R relationships are adopted to compute precipitation rate. A number of studies have shown that multiple Z-R relationships are more suitable for complex environment and can reflect the true situation of sophisticated rainfall condition[4].

![Fig. 3 (a) DPR and radar spatial overlapping; (b) Radar and DPR location matching.](image-url)

4. RESULTS

These metrics include the relative bias(RB) between DPR and the ground-based radar observation, root-mean-squared error (RMSE) and correlation coefficient (CC) are computed. The distribution of DPR estimation error as a function of rainfall rate will also be investigated.

![Diagram](image-url)

\[ \text{RB} = \frac{D}{R} \]  

\[ \text{CC} = \frac{\sum(D_i - \overline{D})(R_i - \overline{R})}{\sqrt{\sum(D_i - \overline{D})^2 \sum(R_i - \overline{R})^2}} \]  

where D means the precipitation rate of DPR, R means the precipitation rate of radar, \( \overline{D} \) and \( \overline{R} \) mean the average of DPR precipitation rate and average of radar precipitation, respectively.
Fig. 4 Scatter plots of (a) DPR_HS, (b) DPR_MS and (c) DPR_NS vs. radar precipitation rate on 00:42 April 10th 2016

Fig. 5 Scatter plots of (a) DPR_HS, (b) DPR_MS and (c) DPR_NS vs. radar precipitation rate on 00:48 April 10th 2016
5. CONCLUSION

This study works on the inter-comparison of precipitation measurement derived from DPR and and ground S-band Doppler weather radar in Guangdong province in southern China. The main findings are as follows:
1) DPR_HS, DPR_MS and DPR_NS show low correlation coefficient so that they are poorly correlated with radar for instantaneous precipitation rates.
2) DPR_HS, DPR_MS and DPR_NS show much more occurrences of light rainfall rates than radar.
3) DPR_MS occurrences of rainfall rates are similar with DPR_NS.

Since a lot of uncertainties existing both in the ground radar measurement and satellite measurement as well as the limited samples used in this study, readers need to keep in mind that more work is still needed to improve the accuracy of ground radar-based precipitation estimation for better ground validation of satellite-based precipitation measurement in future.

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7. REFERENCES


