COMPARISONS OF RAIN RATE AND REFLECTIVITY BETWEEN TRMM PRECIPITATION RADAR AND GOSAN S-BAND RADAR

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1. INTRODUCTION

Precipitation measurements using both passive and active microwave sensors provide vital environmental information for both scientific and societal applications. It has given emphasizing to use space-borne microwave remote sensors to improve the monitoring severe weather and precipitation forecast. Followed by success of the Tropical Rainfall Measurement Mission (TRMM), core satellite of the Global Precipitation Measurement (GPM) is scheduled to launch July 2013 with follow-on constellation satellite afterward to improve predictions of weather and climate through accurate, precise, and frequent measurement of precipitation over the globe.

On the other hand, first Korean meteorological geostationary satellite, COMS (Communication, Ocean, and Meteorological Satellite), is scheduled to launch March 2010 and expecting to use blending the precipitation data with polar orbit satellites. Korea Meteorological Administration (KMA) retains dense surface observation network including automated weather systems (AWS), ground-based radar (GR), and intensive observation sites. It will give an excellent validation network for GPM GV.

During the GPM pre-launch stage, Ground Validation (GV) prototypes will be used to develop and test GPM precipitation retrieval algorithms by using TRMM data. These prototypes will also be used to test requirements and operations concepts for the GPM Ground Validation System (GVS) that will later be employed in the GPM era. KMA collaborates with GPM Precipitation Measuring Missions (PMM) office on research of prototype GV using TRMM and ground-based radar in Korea. It starts with direct reflectivity comparisons between TRMM Precipitation Radar (PR) data and Gosan radar site (RGSN) as a beginning among the six radar sites (including one WSR-88D). This study is constructed based on the previous comparisons with TRMM PR and 21 WSR-88D sites in the southeast of the US national network, Australia's Darwin S-band radar, and University of Alabama, Huntsville ARMOR C-band radar [1-2].

2. GPM GV IN KOREA

2.1. Korea National Network

KMA established dense rain gauge network and conventional network replaced with AWS starting 1988. It's been located on spatial resolution of around 13 km over all around Korea. These AWS have capability of automated data QC algorithm and transmit/receive/data logger system. Currently, there are national network of operational weather and hydrologic measurements with 660 AWS stations, 83 conventional surface measurement sites, 9 upper-air sites, 13 wind profiler, 21 lightening observation sites, 229 snow depth measurements (including 71 automated stations), 19 radar sites (including 2 WRS-88D, 5 Rep. of Korea Air Force stations, 1 research mobile polarimetric X-band station), 3 lidar stations, and 7 moored buoys. KMA also has two intensive observation sites at HaeNam and DaeGwalLyeong. Each intensive observation site has Wind Profiler, Auto-sonde System, Micro Rain Radar, Optical Rain Gauge, Synoptic Weather Observation, Microwave Radiometer, and Optical Disdrometer. Using these facilities, GPM satellite data can be compared to similar measurements to find a significant discrepancy between satellite observations and ground-based networks.

2.2. Direct Network Validation

To get started GV in Korea, one of the radar sites, RGSN S-band, 1-degree beamwidth radar site at Gosan, Jeju Island, South Korea has been selected. The viewing geometry appears to wide area of open sea water and RSSP (Sungsan) is located within about 100 km. Also both radars well overlap with RPSN (Gudeoksan) and RJNI (Jindo) within the TRMM PR swath. RGSN is located at 33.3N/126.2E and site runs since June 13, 2006. TRMM PR 2A25 and RGSN data has been resampled to 4 km horizontal grid on 3-dimensional uniform Cartesian grid for 300 x 300 km area centered on radar site and 1.5 km vertical grid from 1.5 to 19.5 km altitude. Collocated rain event cases selected on criteria of at least 25 % overlap of the PR swath, and 25 % or more of the points in the overlap area indicating rain certain in the PR data. During August 2006 to May 2008, there are 60 events available to match-up with these criteria. Both reflectivity data of 18 dBZ or greater were used since 18 dBZ is sensitivity cutoff of TRMM PR.

3. PRELIMINARY RESULTS

TRMM product 2A-25 attenuation corrected PR radar reflectivity comparison statistics are generated for each match-up dataset. Fig. 1 (a) shows the distribution of reflectivity values at the 6 km height level for RGSN for an individual TRMM PR overpass during the test period. The plot shows roughly 1.37 dBZ low bias over 163,586 points which means attenuation corrected TRMM PR reflectivity greater than the GR. Fig. 1 (b) shows the layer-

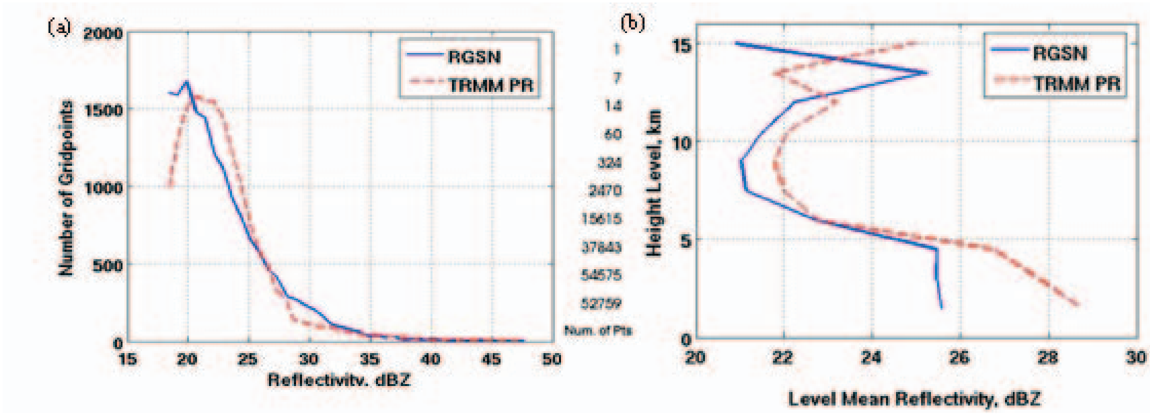

Fig. 1. Total distribution for the RGSN (blue solid) and TRMM PR (red dashed) for the TRMM overpass during the two-year period. (a) reflectivity values at 6 km height, (b) layer-averaged reflectivity.

averaged reflectivity. More investigation is required to verify the trend and identify the vertical distribution reflectivity bias.

All 60 events mean reflectivity difference with only points where the PR rain type is indicated as stratiform and the base of the 1.5-km-deep vertical layer represented by the grid point at least 250 m above the bright band height, as indicated in the TRMM 2A25 PR product. It looks like there is no seasonal variation except normal systematic noise. Also it is showing a good comparison between ground and satellite radar reflectivity at 1.5 km with around 3 dBZ low bias. Furthermore, instantaneous rain rate has been converted from the given reflectivity for the ground radar and compared with 2A25 estimated rain rate for all cases. It looks like TRMM overestimated instantaneous rain rate.

Fig. 2 is the plots of the reflectivity comparisons between RGSN and TRMM PR for the rain types and surface types. Rain types are separated into stratiform and convective rain using PR 2A25 rain type flag, and surface types are used to separate into ocean, land, and water and land mixed area. In all surface type, the comparisons of mean and correlation are approximately the same. However, for RGSN case, there are not many points for land or mixed surface area since surrounded by ocean. It might be needed further investigating with other sites. For rain type, most of rain cases are classified on straifrom type rain and it follows the total comparisons, however a glance at the scatter plots for stratiform and convective rain shows that the data are more highly correlated for stratiform than for convective rain and that the mean dBZ in stratiform rain is significantly lower than that for convective rain. Overall, Fig. 2 is showing in good agreement for all categories.

These S-band ground-base results are similar with previous ground validation network prototype the U.S. national network of operational weather radars WSR-88D [3-5].

4. CONCLUSION

One of the goals of the GPM GV prototype is to help improve the attenuation correction algorithm for the

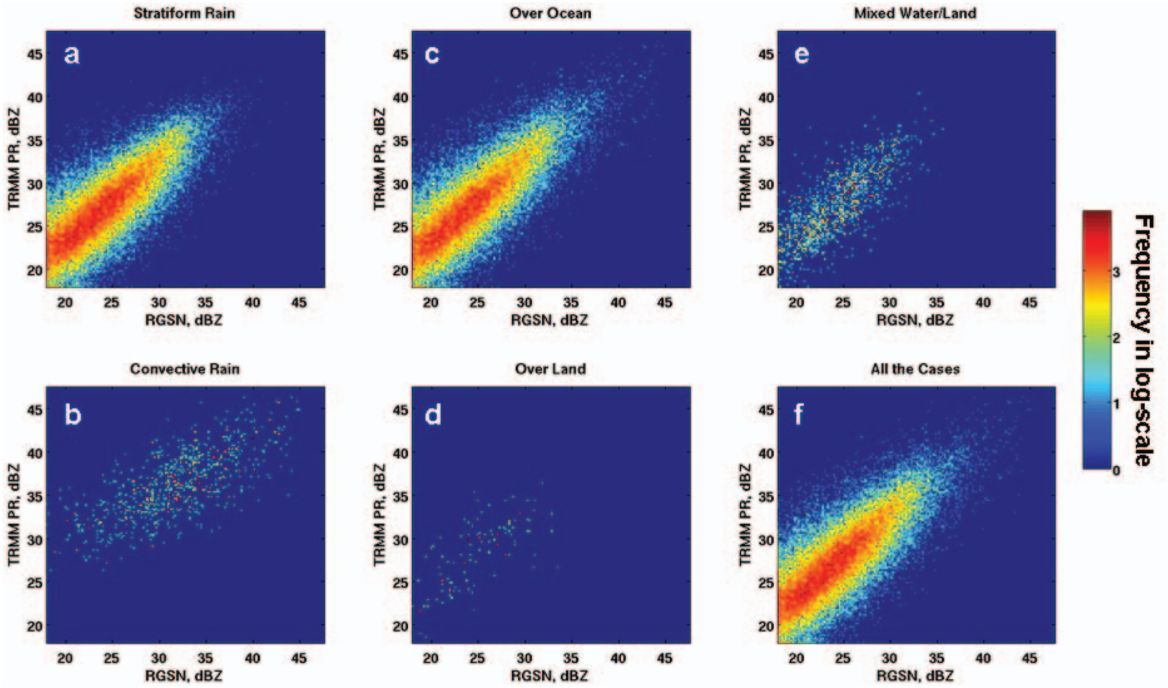

Fig. 2. Reflectivity comparisons between the RGSN and TRMM PR for the TRMM overpass during the two-year period by rain type and surface type. (a) stratiform rain type, (b) convective rain type, (c) over ocean, (d) over land, (e) over mixed water and land, and (f) for all cases. (colors are frequency in log scale)

TRMM PR, so that this knowledge can be applied to the future GPM DPR, GPM Microwave Imager (GMI), and both combined rain rate retrieval algorithm. The preliminary results came out good quality and recently asked the TRMM Precipitation Processing System (PPS) to add the RGSN to the daily TRMM site overpass coincidence table (CT) product. Final goal after participating in the GPM GV with statistical validation of rainfall, physical validation on precipitation process, and integrated hydro meteorology application is to involve in their algorithm improvement, data assimilation, and GPM data application on weather forecast and global climate changes. This opportunity is giving a good chance to understand and improve the short-term regional precipitation model.

11. REFERENCES

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