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TRMM achievements and GPM plan in Japan

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The Tropical Rainfall Measuring Mission (TRMM) which was launched in November 1997, and is still working. TRMM is equipped with a precipitation radar (PR), a microwave radiometer (TMI), a visible/infrared radiometer (VIRS), a lightning imaging sensor (LIS) and an Earth radiant energy sensor (CERES). TRMM was designed as a flying rain gauge for tropical rainfall observation and PR is the essential instrument. PR has a limited swath width and works as a reference for microwave radiometers which have much wider swath. Based on the very successful result of TRMM, the Global Precipitation Measurement (GPM) has been proposed. To overcome the severe sampling issue, GPM consists of a core satellite which is a kind of TRMM follow-on, and multi-satellites which have microwave radiometers. For observation of cold regions, better sensitivity is required for the radar and also more channels are needed to microwave radiometers. For the radar, to expand the dynamic range, another radar with higher frequency was developed. For the accuracy of the rain retrieval, precipitation echo profiles from two radars will be utilized.

Japan Aerospace Exploration Agency (JAXA) has developed DPR, and one of the main parts of science activities in Japan is focused on DPR. Algorithm for DPR is being developed under close collaboration between Japan and US, and the prototype of the algorithm is nearly completed. For the DPR algorithm development, JAXA developed a ground-based Ka-band (35 GHz) radar system. This system consists of identical two radars. The concept of the system is to observe the same precipitation system from opposite directions. The Ka-band radiowave suffers from severs rain attenuations. Due to the rain attenuation, rain echo from one radar reduces when the range is longer. The same thing occurs but opposite direction from the other radar. By summing up the two rain echoes, the rain attenuation can be eliminated, and the true equivalent radar reflectivity can be derived. Using the true equivalent radar reflectivity, the rain attenuation or specific rain attenuation can be estimated. The observational result on the scattering and attenuation is important, particularly for solid precipitation measurements.

The data from TRMM PR are accumulated over more than 15 years. The PR performance is very stable and data quality is well confirmed. This fact greatly helped for understanding precipitation climatology over tropical and subtropical regions. JAXA is developing a satellite based global precipitation map called GSMaP which mainly uses microwave radiometer derived rain rates tuned using PR data. Generally speaking, the results are reasonable. There, however, are several discrepancies with ground based rain gauge data. One of them seems to be due to warm rain or orogographic rain. The microwave radiometer rain retrieval over land uses scattering signatures of ice particles which exist in the upper layer of cloud or precipitation systems. However, there exists warm rain which does not have much ice particles but sometimes causes much rain.

Rain retrieval from space is a kind of ill-posed problem, since many parameters are included in the retrieval algorithm. So, the parameters must be validated in various climate regimes. Asia is largely influenced by the Asian monsoon activity, and also by various topographies. Comparisons of the rain estimate from space with ground measured rain data were performed under collaborations with Asian countries. Application including flood warning is also explored.

Keywords: precipitation, satellite, radar, algorithm