Future precipitation measuring mission from space

*Nobuhiro Takahashi[1], Kinji Furukawa[2], Misako Kachi[2], Yusuke Muraki[2], Riko Oki[2]

1.Institute for Space-Earth Environmental Research, Nagoya University, 2.JAXA

Since the launch of Global Precipitation Measurement (GPM)/Core satellite in February 2014, the dual frequency precipitation radar (DPR) that is the key instrument of GPM has been working nominally with better performance than expected. The success of the GPM/DPR demonstrates the feasibility of the precipitation radar technology is now well established with high reliability. It also leads the expectation of use of the radar for more general purpose of precipitation like passive microwave radiometers and for more next step of the precipitation study. In this paper, current direction of the future precipitation-measuring mission is reported as well as the possible mission plans. In addition, since the nominal lifetime of the GPM/Core satellite is 5 years, we need to prepare the future precipitation-measuring mission now.
Two types of the directions are considered as the follow-on mission of the GPM/core: 1) development of the smaller and cheap radar satellite by using the GPM/DPR technology and the current advanced radar technologies such as power device (e.g. GaN) and the pulse compression technique to gain the sensitivity significantly, and 2) development of the DPR type radar with better sensitivity and the wider swath observation. The former has advantages on the cost that leads the multiple radar satellite observation and also leads the great improvement of the hourly global precipitation map (such as GSMaP) because of the utilization of the radar data directly into the precipitation map. The low cost satellite can be purchased by other countries. Considering that the satellite altitude is 800 km with inclination angle of less than 30 degrees and the radar aperture is quarter of the KuPR (Ku-band radar with 2.2 x 2.2 m aperture) on GPM/Core, the sensitivity is about 20 dBZ for each resolution of about 20 km and the swath width is about 800 km that corresponds to the 3 to 6 hourly observation between 30 degree south and the 30 degree north. The latter is more scientific purpose such as cloud-precipitation processes relating to the assessment of the impact to the precipitation by the climate change such as global warming. The response of the precipitation systems to the climate change is one of the most unknown and the most concerned parameter of the global warming issue. Both the numerical simulation studies and observational study are essential to reveal this issue and the satellite observation is the only the tool to cover the global precipitation with equal quality. Since current issues of the precipitation radar are the sensitivity and the swath width (also sampling frequency), improvement of the DPR is essential. The sensitivity can be improved by introduce the current power device and pulse compression system and the swath width can be extended even current DPR design based on the special experiment during the end of mission of the TRMM satellite. The goal of the sensitivities of both KuPR and KaPR are -10 dBZ with twice wider swath width of GPM/KuPR (490 km). Sensitivity budget with current technology indicates that the achievable sensitivity is about 0 dBZ; even this number is great improvement from GPM/DPR.
The future goal of the radar technology is observation from the geostationary orbit; the merits are the continuous observation with Doppler velocity measurement and the demerits are the sensitivity (> 20 dBZ) and horizontal resolution (20 km) assuming the 30 m diameter antenna. Continuous observation makes it possible to monitor the precipitation system such as typhoons and to directly utilize the numerical weather prediction. Current technology indicates that the radar observation from the geostationary orbit is possible with current radar technology if you can develop the 30 m diameter antenna.

Keywords: Precipitation Measurement, Satellite

