Quasi real-time observation of typhoon and thunderstorms by the system of micro-satellites and ground-based lightning sensors

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We are conducting a SATREPS project “ULAT” and e-ASIA project for the development of extreme weather, including typhoon and individual thunderstorm, monitoring and alert system in the Philippines in 2017-2021 under international cooperation among Japan, Philippines, Indonesia and other SE-Asian countries supported by JST, JICA, PHL-Microsat and other funds. It is well known that intensification of lightning activity is precursor of typhoon growth as well as an indicator of individual thunderstorm activity. In these projects, we apply two new technologies, that is, the lightning activity estimated by the ground-based lightning networks with 12 sites for VLF radio wave measurement in nation-wide of Philippines and with 50 sites for electrostatic field measurement in Metro Manila together with infrasound sensor and automated weather station, and the 3 dimensional capturing of thunderstorms by the on-demand operation of 50-kg micro-satellites, including the Philippine-developed DIWATA-1 and 2, RISESAT, etc. Also few more lightning stations installed in Indonesia and Japan are used. We plan to establish a new methodology to obtain very detail semi-real time information of typhoon and thunderstorm activities that cannot be achieved only with conventional observational equipment. Based on these new observations together with advanced radar measurements and drop/radio sondes campaigns, we will try to construct the cutting-edge observation system to monitor the development of typhoons and thunderstorms, which may greatly contribute to the prediction of disasters and the public alerting system.

By the end of March 2017 we started the test observation for lightning at Quezon city, Philippines, Palau and Guam, forming the network for typhoons. We also succeeded in making 3-D cloud structure with telescope and wide angle spectral camera onboard DIWATA-1, achieving high resolution of ten to several meters. Now we are establishing the real-time target pointing operation with micro-satellites based on the last-minute lightning data measured by ground networks. Adding to DIWATA-1, three more our satellites, namely, RISESAT, MicroDragon and DIWATA-2 with advanced cameras will be used in 2018-2019. In September 2018, drop sonde campaign using aircraft in the eastside of Philippines was carried out under collaboration with Nagoya University team. Here we introduce the latest results of 3-D cloud modeling using images taken by satellite and on the ground together with preliminary lightning analysis, adding to the outline of the project.

Keywords: lightning, micro-satellite, typhoon, thunderstorm

