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GIMS: AN INSTRUMENT FOR TYPHOON MONITORING FROM GEOSTATIONARY EARTH ORBIT

Abstract

Typhoon is mature tropical cyclone generated in northwestern Pacific Ocean. Typhoon-related disasters caused lots of damages in the East and Southeast Asia every year, imposing significant negative effects on the social economic developments in this region. In China, there are almost 20 typhoons that can bring impacts and cause damages to the eastern coastal area per year, about 7-8 out of them landed on the continent.

The existing typhoon observations from space are largely depended on the optical/infrared sensors onboard GEO meteorological satellite and also the optical/infrared and microwave sensors onboard LEO meteorological satellites. Microwave observation from GEO is demanding due to its cloud-penetration capability, which can continuously provide the inner thermal/humidity structure of typhoon. However, this tool is still missing because of the technical challenges.

The largest obstacle of GEO microwave sounding is the required spatial resolution, since the GEO altitude increases 60 times as compared to LEO. GEM/GOMAS concept was proposed in 1990's, based on 2.5-3m real aperture reflector, covering frequencies from 53GHz-424GHz. Manufacturing, testing and scanning such a large antenna aperture at sub-millimeter wave band in space are difficult.

Interferometric aperture synthesis is another possible solution to this problem, by using a thinned antenna array to replace the single large aperture antenna. Especially for the relative low sounding frequency (50-56GHz), aperture synthesis has now been deemed as the most suitable and practical approach for space implementation at the timeframe in 2015-2020. Based on this technology, NASA/JPL and ESA proposed GEOSTAR and GAS concept, and developed ground-based demonstrators respectively.

The Geostationary Interferometric Microwave Sounder (GIMS) is millimeter wave imaging sounder concept proposed for China's next generation geostationary meteorological satellite (FY-4M). GIMS is supposed to utilize a rotating circular thinned array, instead of a stationary Y-shape array, to reduce the required number of the antenna elements. A full-scale ground-based 53GHz GIMS demonstrator with 28 elements has been successfully developed and tested.

In this paper, the current efforts on GEO microwave sounding instrument will be reviewed. The GIMS concept will be introduced. The system design and imaging performance of the ground-based demonstrator will also be presented. At last, two possible technical resolutions for future space-borne GIMS will be discussed, including a so-called dual-mode system concept (including both synthetic aperture mode for 53GHz, and real aperture mode for frequencies above 183GHz), and also a 53/183GHz synthetic aperture system which might be a good opportunity to introduce international contributions.