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Planetary lightning flash and thundercloud observation with spacecraft and telescope

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Abstract

It has been revealed that lightning is an good proxy of atmospheric circulation in the Earth. In planetary exploration, such as Venus and Jupiter, where very limited in-situ measurements can be made, the lightning measurement would be a powerful tool. Recently it is reported that the magnetometer on board Venus Express detected whistler mode waves whose source could be lightning discharge occurring well below the spacecraft. In order to identify the discharge phenomena in the atmosphere of Venus without ambiguity, we sent a high-speed optical sensor to Venus, the lightning and airglow camera, LAC onboard Akatsuki.
In Jupiter, the latest observational and theoretical studies suggest that strong moist convective clouds, that is thunderclouds, in Jupiter's atmosphere are very important. It is not only because of an essential ingredient of meteorology of Jupiter, which determines the large scale structures such as belt/zone and big ovals, but also as a potentially very useful tool for probing the water abundance of the deep atmosphere, which is crucial to constrain the behavior of volatiles in early solar system. We would suggest a very simple high-speed imaging unit onboard Jovian orbiter, Optical Lightning Detector, OLD, optimized for detecting optical emissions from lightning discharge in Jupiter. OLD consists of radiation-tolerant CMOS sensors and two H Balmer Alpha line (656.3nm) filters. In normal sampling mode the frame intervals is 29ms with a full frame format of 512x512 pixels and in high-speed sampling mode the interval could be reduced down to 0.1ms by concentrating a limited area of 30x30 pixels. Weight, size and power consumption are about 1kg, 16x7x5.5 cm (sensor) and 16x12x4 cm (circuit), and 4W, respectively, though they can be reduced according to the spacecraft resources in EJSM orbiters.

Also we plan to investigate the optical flashes using a ground-based middle-sized telescope, which will be built by Hokkaido University, with narrow-band high speed imaging unit. Observational strategy with such optical lightning detectors and spectral imagers, which enable us to estimate the horizontal motion and altitude of clouds, are to be discussed.