Initial result on aurora and airglow observations with the all sky 630nm imager on Shirase

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To cover the auroral and airglow observation gap in the Southern Ocean, we developed an all-sky imager (Shirase ASI) with a 3-axis attitude stabilized gimbal installed on the icebreaker Shirase. The route of Shirase from February to March is preferable to observe aurora in the aurora region at the south of Australia. This region is also important to understand the height and zonal variations of mesospheric dynamics. All-sky image data taken in the observation gap provide us unique opportunity to examine the auroral and airglow phenomena, and contribute to network observation in collaboration with ground-based imagers. The advantage of Shirase ASI is to observe faint auroral and airglow emissions with a long exposure time more than 10s under the conditions where the ship is swaying. In addition to auroral observation, Shirase ASi can observe airglow variations caused by plasma bubbles and MSTID when Shirase is located at the mid- and low-latitudes.
On the development of Shirase ASI, we selected the low-noise cooled CMOS (ZWO ASI183MM Pro) as a detector. We developed compact and small optical system which consists of a bandpass filter (Andover interference filter, center wavelength 630 nm, FWHM 4.4 nm), and objective fisheye lens (Fujinon FE185C086HA, focal length 2.7 mm, F value 1.8). Optical system was mounted on a 3-axis attitude stabilized gimbal (DJI Ronin-S). The optical system with the gimbal was installed in the water-proof observation box on the 06 deck of Shirase. During observation time, the data is temporarily recorded in the mini-PC (LIVA Q2) in the observation box, and data is transferred to NAS via the laptop PC in the observation room of Shirase during the next day. The laptop PC obtains the current location from GPS signal, and calculates the appropriate start and end timings of observation every day. The exposure time and interval are 19 s and 20 s, respectively, and the data is integrated in later analysis for up to 120 s depending on the intensity of target. All of observation data will be collected in April when Shirase returns to Japan, but in order to confirm the status of instruments and observation data, about 10 thumbnail images and housekeeping data, such as the temperatures and humidity in the observation box, are sent to Japan via e-mail. The observation box on the deck is temperature controlled using an automatic oil heater, and circulation of cooled air from the air cooler in the observation room connecting with insulated hoses.
We got sensitivity calibration data of Shirase ASI using the integrated sphere in NIPR on June 26 and 27, 2019. We confirmed that ASI has the dynamic range of intensity from 34 R to 3000 R with a resolution of 0.73 R/bit when the camera operates with a gain of 400 and an exposure time of 120 s. We obtained 630 nm airglow images with ASI at the Zao observatory of Tohoku University (geographic latitude and longitude: 38.1 deg. N, 140.5 deg. E) on June 13, 2019. From the test observation data integrated for 120 s, we obtained the variation of 630.0 nm airglow with an amplitude of 43 R caused by MSTID travelling from north-east to south-west. On September 3, 2019, the whole system of Shirase ASI was installed on the Shirase 06 deck and in the observation room 1. From the data obtained during the test cruise on October 11, 2019, we examined the performance of gimbal that attenuate the sway of ship. We estimated that typical sway range of Shirase to be 8 deg, and that of field-of-view of ASI to be 0.5 deg. 0.5 deg of the sway corresponds to 2km of horizontal distance in the 630nm emission layer at a 250 km altitude, which

satisfies the scientific requirement of spatial resolution of airglow variations in the F-region.
We confirmed that Shirase ASI has been operated correctly from the departure of Japan on November 12, 2019. We will perform detailed data analysis after returning of Shirase to Japan in April 2020. In this talk, I will report the initial results of data analysis.

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