Aurora and airglow observations with the imaging system onboard Antarctic research vessel "Shirase"

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Optical observations of the ionosphere have been widely conducted by ground-based imagers [Shiokawa et al., 1999] and satellites [Immel et al., 2004]. There are, however, some observational gaps due to limited observation areas. As for ground-based observations, there are large observational gaps especially in the southern hemisphere, which has a large proportion of the ocean. To fill these gaps, we developed vessel-borne imaging system and conducted observations of the ionosphere and mesosphere from the ocean. The system was installed on the Antarctic research vessel "Shirase" and multi-wavelength observations were conducted during three voyages: The 61th Japanese Antarctic Research Expedition (JARE61) (from November 2019 to March 2020), JARE62 (from November 2020 to February 2021), and JARE63 (from November 2021 to March 2022). Figure 1 shows Shirase's routes of the three voyages. It makes a round trip between Japan and Syowa Station once a year, and so it is possible to conduct observations widely from the high latitude zone to the equatorial anomaly zone on its routes. 630.0 nm emission was observed in JARE61, 630.0 nm and 670.0 nm emissions were observed in JARE62, and 630.0 nm and 760.0 nm emissions in JARE63. Both 670.0 nm and 760.0 nm emissions correspond to N_2 molecular aurora and OH airglow in the E-region of the ionosphere and the mesosphere. The vessel-borne imaging system is affected by the movement and vibration of the vessel, and so it is necessary to compensate them, unlike ground-based imagers. The imagers were mounted on a 3-axis attitude-stabilized gimbal and designed to cancel out the vessel's vibration during the exposure time. The yaw-angle direction drift over a long time, however, changes the imagers' line-of-sight directions. Therefore, a method to solve this problem specific to vessel-borne imagers and to correct the orientation of the images was established. The aurora was successfully observed during JARE61 and 63, the atomic oxygen airglow in 630.0 nm associated with equatorial ionization anomaly in JARE61 and 62, and the OH airglow during JARE63. The accuracy of the imaging system and image correction method was evaluate using the these observed phenomena. It was found that the accuracy of them was equivalent to that of the ground-based imagers. The vessel-borne imaging system for the ionosphere and mesosphere has been completed, and it is anticipated that the observation area will be further expanded by vessel-borne imaging systems in the future.

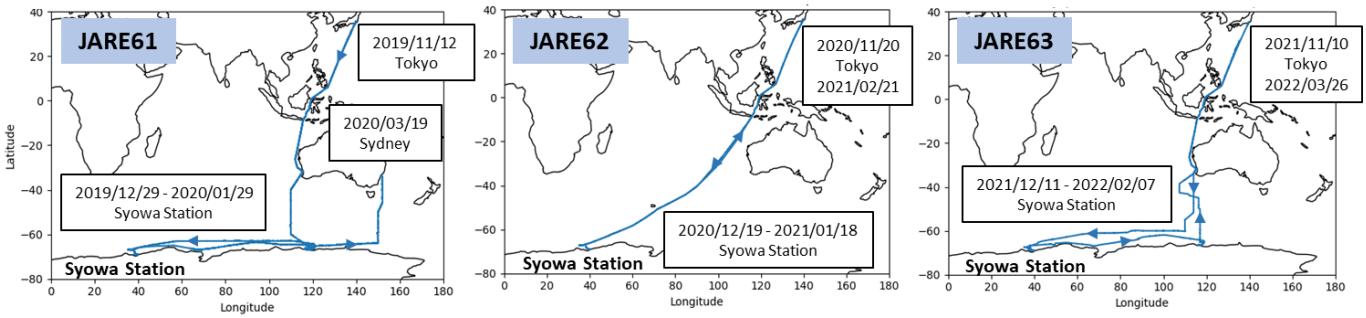

Figure 1. The routes of Shirase in JARE61-63.

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References

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