Observation of auroral polarization using a polarization imaging spectrometer in Alaska

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We aim to reveal the elevation distribution of auroral polarization along the magnetic meridian by using a wide field auroral polarization imaging spectrometer by observing auroral red line at OI 630 nm. We developed this instrument which consists of a fisheye lens, a wire grid type linear polarizer mounted on a rotating stage, a VPH transmission type diffraction grating and an EMCCD. It has a wide field-of-view of 130 degree covering the magnetic zenith and magnetic perpendicular, and its wavelength range is from 450 nm to 710 nm with a resolution of 2.0 nm. The polarization state of the incident light can be measured from the intensity change detected by the EMCCD when the polarizer is rotated by 45 degrees. In addition to auroral polarization, measurement data involve polarization effects due to atmospheric scattering, acrylic domes and optical system in the instrument (hereinafter referred to as instrumental polarization). Therefore, it is a key to carry out to obtain precise calibration data to correct the instrumental polarization. Although we have performed auroral polarization measurements since 2013, we got a problem in the calibration instrument and then did not obtain sufficient calibration data. In this study, we develop a new calibration instrument with a LED lamp monitoring the rotation angle of linear polarizer and succeeded to obtain the precise calibration data to correct the instrumental polarization. We also developed the data analysis method to apply the calibration data to measurement data to estimate the auroral polarization accurately.
We installed this instrument at Pokar Flat Research Range, Alaska in November of 2015 and took many calibration data for various field-of-view during our stay for about two weeks. As a result, calibration data with a quantitative accuracy better than 0.2 percent was obtained. Auroral polarization measurement continued till March of 2016. For a case of auroral polarization on November 19, 2015, the linear polarization degree of 630 nm aurora was 1.6 +/- 0.9 percent. For most cases, polarization degree showed a tendency that maximized at the low elevation angle toward the magnetic north, and decreases as the elevation angle increases. In addition, it showed that polarization degree increases again around the magnetic zenith toward the low elevation angle side in the magnetic south. We also obtained that the auroral linear polarization increases during auroral active period.

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