Arase observation of the source region of auroral arcs and diffuse auroras in the inner magnetosphere

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Auroral arcs and diffuse auroras are common phenomena at high latitudes, though characteristics of their source plasma and fields have not been well understood. We report the first observation of electric and magnetic fields and electron and ion spectral features, including their pitch-angle distributions, in the source region of auroral arcs and diffuse auroras, using data from the Arase satellite at L˜6.0-6.5. The auroral arcs appeared and expanded both poleward and equatorward at local midnight from ˜0308 UT on 11 September 2018 at Nain (magnetic latitude: 66o), Canada, during the expansion phase of a substorm, while diffuse auroras covered the whole sky after 0348 UT. The auroral arcs were characterized by purple and green emissions at the top and bottom parts, respectively. Bi-directional field-aligned electrons with structured energy-time spectra were observed in the source region of auroral arcs, while source electrons became isotropic and less structured in the diffuse auroral region afterwards. We suggest that structured electrons were caused by upward field-aligned potential differences reaching high altitudes (˜30,000 km) near Arase. The bi-directional electrons were probably caused by Fermi-type acceleration associated with the observed field dipolarization. Strong electric-field fluctuations and earthward Poynting flux were observed at the beginning of the arc crossing, and are probably also caused by the field dipolarization. The ions showed time-pitch-angle dispersion caused by reflection by mirror force. These results indicate a clear contrast between auroral arcs and diffuse auroras in terms of source plasma and fields and possible generation mechanism of auroral arcs in the inner magnetosphere.