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Multi-instrument observations of pre-noon auroral arcs: Plasma flows and dynamics of the arcs

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Using multi-instrument ground-based (all-sky camera, EISCAT, SuperDARN) and satellite (WIND, IMP-8, Polar, DMSP) observations, we have investigated the high-latitude (around 75 deg. MLAT) morning (8-10 MLT) auroral arcs. These rayed arcs occurred in a central part of the morning auroral oval related to BPS/LLBL closed magnetospheric region. We categorise the auroras in terms of the physical mechanism for their origin. Two mechanisms, the eigenmode field line oscillations model and the interchange instability have been suggested. The arcs of first type are linked to the Alfvén eigenmode toroidal oscillations initiated by sharp IMF disturbances simultaneously at different L-shells having different eigenperiods. The arcs are associated with the flow shear that arises and propagates poleward due to de-synchronization of the L-shells. The arcs of second type, explained by the interchange instability, are multiple arcs expanding along the east-west direction and propagating north- or southward following the plasma convection. In the case reported here, arcs of this type were generated in the course of a gradual IMF Bz transition from negative to positive. Polar satellite data of electric and magnetic fields show that: the arcs were within a layer of large-scale downward field-aligned current, the large-scale FAC was split into azimuthal sheets at a spatial periodicity of the order of 100 km, the FAC sheets were associated with flow shears, and the most prominent flow shear (of the order of 3 km/s per 30 km in the ionosphere) was associated with downward FAC. The large-scale FAC and the current sheets agree with the interchange instability model. We suggest that the flow shear can lead to the Kelvin-Helmholtz instability, which produces plasma irregularities giving rise to the auroral rays forming a rayed auroral arc. Thus, rayed arcs may be associated with sheets of intensive downward FAC.