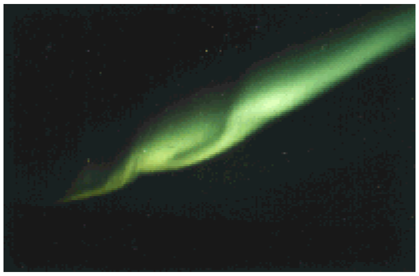
Auroral arcs

Introduction



Arcs are the most typical auroral forms in the premidnight sector auroral oval. They belong to the group of discrete aurora for which field-aligned acceleration plays an important role. Because of this, the spectrum of the precipitating electrons includes a monoenergetic component, and the resulting ionospheric ionisation profile has a sharper E layer peak than other auroral types. The average energy of the precipitating electrons is higher than in diffuse aurora, but lower than in pulsa ting aurora.

Auroral arcs are luminous bands elongated in east-west direction. Their thickness (in the ionosphere) is typically several (or even tens of) kilometers (see, e.g., Borovsky, 1993). However, embedded an arc one finds structures or elements of finer scale, down to tens of meters only (Maggs and Davis, 1968). Arcs drift often in north-south direction. During increased geomagnetic activity arcs tend to get deformed.

Electrodynamics

There are two types of electric fields related to auroral arcs (see, e.g., Johnson et al., 1998). The first one, polarization electric field, forms within the arc because of the increased ionospheric conductivity (de la Beaujardiere, 1977, 1981). It's direction is opposite to local convection electric field, and thus there is an anticorrelation between optical intensity and strength of this electric field.

The other type of field relates to the field-aligned currents. The electron precipitation within the arc creates an upward flowing current. It is matched with an downward directed current, carried by cold ionospheric electrons, on the equatorward (poleward) side of the arc in the evening (morning) sector. These field-aligned currents are connected by a Pedersen current flowing in the direction of ionospheric convection electric field. An arc-associated electric field ensures that this current continuity is maintained in the vicinity of the arc. Accordingly, horizontal electric fields are often observed near auroral arcs (e.g., Burch et al., 1976; Opgenoorth et al., 1990; Aikio et al., 1993; Lewis et al., 1994).

The location of these fields follows the current distribution, ie. they are mostly found on the equatorward side of the arc before local midnight and on the polaward side after local midnight, and are directed toward the arc, i.e., they are enhancing the local convection electric field. The fields are connected spatially to the optical aurora and move with them. Intensifications in the field have been shown to correlate with optical brightening of the arc, i.e., bursts of electron precipitation (Aikio et al., 1993; Lanchester et al., 1993).

Other features

It is known that strong ionospheric electric fields relate to frictional ion heating (e.g., McCrea et al., 1991). In addition, some arcs are related to strong ionospheric ion outflow events. The high currents related to arcs can lead instabilities and produce flickering aurora (see also the discussion of waves in ion outflows). An auroral plasma cavity exists above few thousand km altitude (Calvert, 1981), and relates to AKR producti on. Also whistler mode auroral hiss is closely related to auroral arcs.

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