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From optical ground-based observations of discrete auroral arcs to the magnetospheric generator: fine-tuning model and time evolution

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We discuss an analysis method developed to estimate some of the properties of auroral generators (electron density, n_e, temperature, T_e, and altitude of the generator), from ionospheric observations of the energy flux of precipitating electrons, ε, measured across an auroral arc. The method makes use of a quasi-static magnetosphere-ionosphere (M-I) coupling model. Assuming that the generator is a magnetospheric plasma interface, one obtains a parametric description of the generator electric field as a function of the kinetic and MHD properties of the interface. This description of the generator is introduced in a stationary M-I coupling model based on the current continuity in the topside ionosphere (Echim et al, 2007). The model is run iteratively for typical values of the parameters of the magnetospheric generatorsthat are adjusted until a global convergence criterion, based on matching the model results with observations, is satisfied.

First, the precipitating energy flux ε at ionospheric altitudes provided either by in-situ spacecraft measurements or remotely optical ground-based observations, is considered as observational reference for the matching criterion. This approach was validated with observations of ε by DMSP on April 28, 2001, above a discrete auroral arc. An additional parameter, like for instance the field-aligned potential drop, can be added as a supplementary constraint for the convergence criterion that can fine-tune the results.

The methodology is applied to the energy flux of precipitating electrons estimated from optical images of a discrete auroral arc obtained simultaneously with the CCD cameras of the ALIS (Auroral Large Imaging System) network located in Scandinavia on 5 March 2008 (Simon Wedlund et al, 2013). The auroral arc was stable between 18:41 and 18:44 UT with an average intensity and a global morphology that remained stable.

Tomography-like techniques are used to retrieve the three-dimensional volume emission rates at 4278 Å from which the energy spectra of precipitating magnetospheric electrons can be further derived. These spectra are obtained along and across the arc, with a spatial resolution of approximately 3 km and provide E_0, the characteristic energy andgε, the total flux energy of precipitating electrons. The characteristic energy will be used as an estimate of the field-aligned potential difference ϕ. The generator properties are then estimated using the iterative technique validated with data from the DMSP-Cluster conjunction. The time-resolution of ALIS observations was typically 20-30 seconds which allows us to present the time-evolution of the generator properties during this period of $\sim$ 3 minutes.