Probing the magnetospheric generator properties from ALIS observations of quasi-stable arcs

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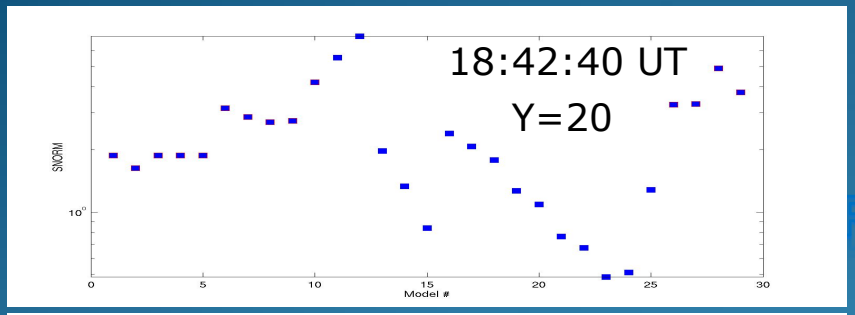
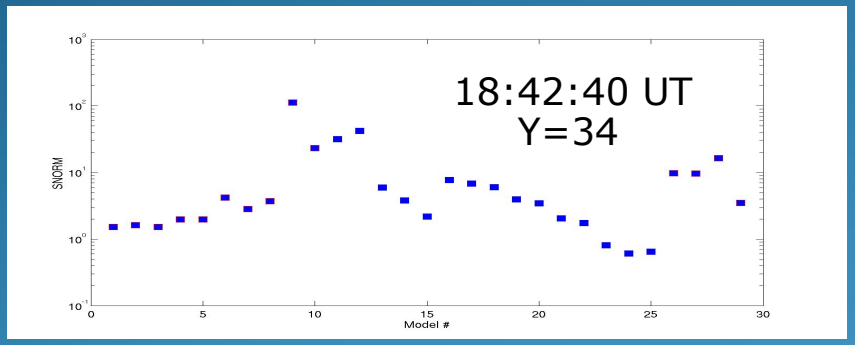
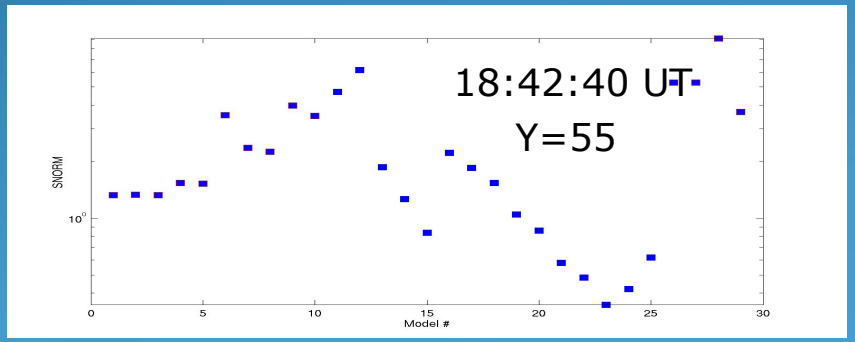
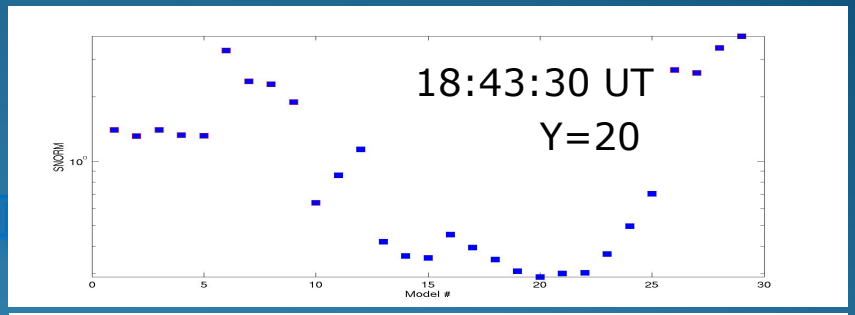
Estimation of generator properties from ALIS observations

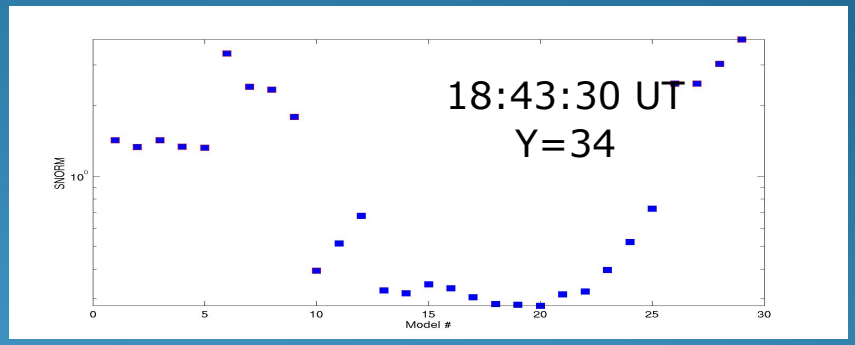


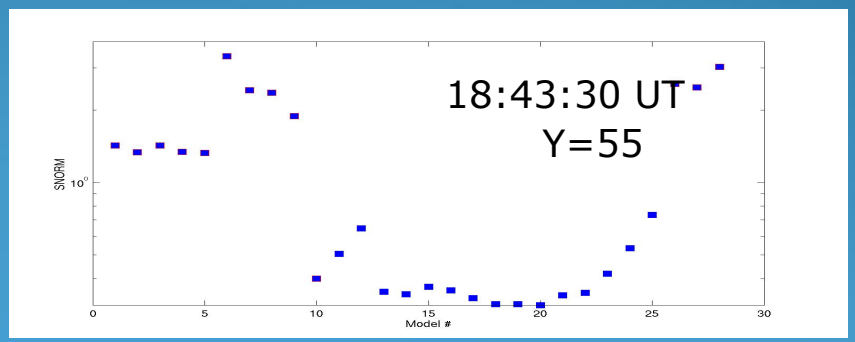




SNORM evaluated for three different sections through the arc observed by ALIS at 18:42:40 UT. Results indicate a slight variation in longitude of generator properties.

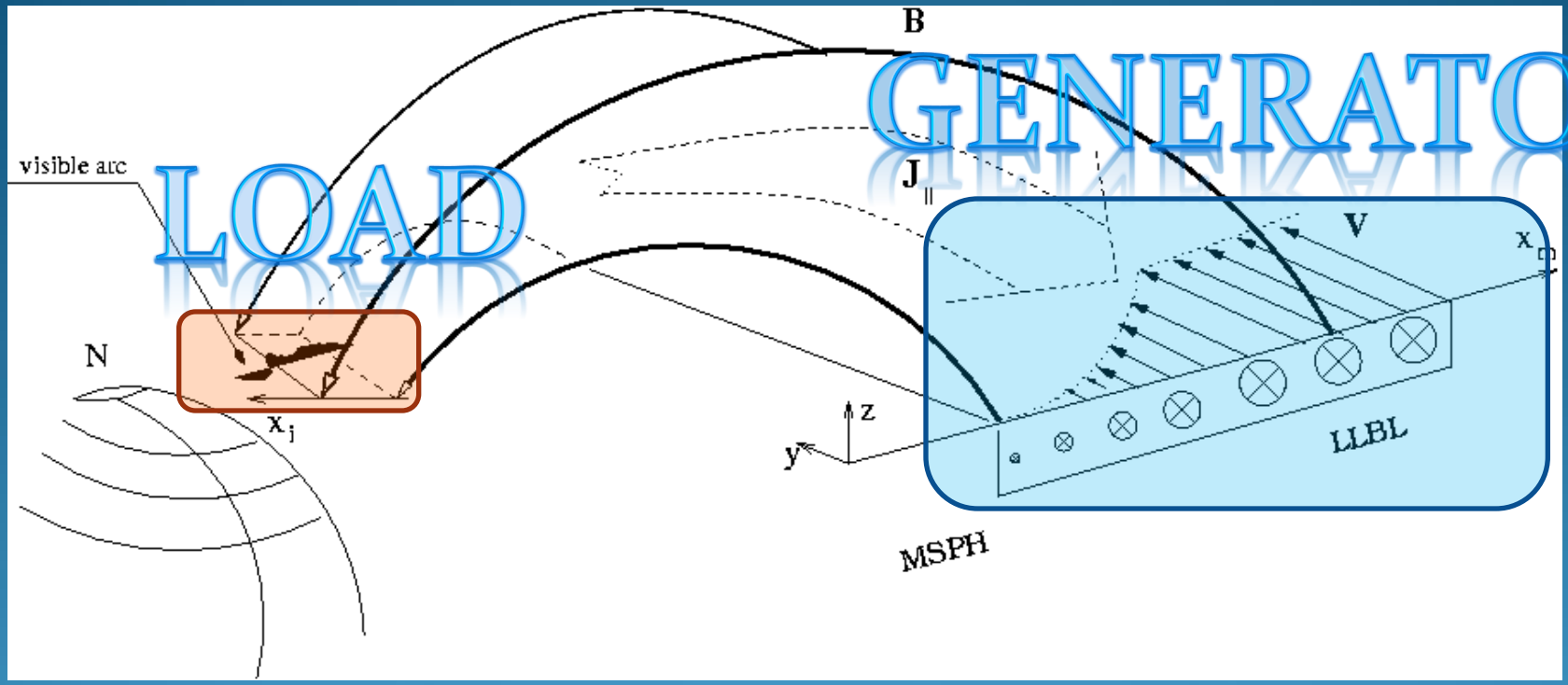






SNORM evaluated for three different sections through the arc observed by ALIS at 18:43:30 UT.

Modeling the global auroral circuit



- planar TD surface at the interface between plasmas with different macroscopic properties (*Sestero, 1966, Lemaire & Burlaga, 1976, Roth et al., 1996, Echim & Lemaire, 2005*)
  - latitudinal dependence of electrodynamic parameters: $j_{\parallel}, \varepsilon, E_{em}, \Sigma$
  - uniform ionospheric densities and temperatures: e^-, H^+, O^+, He^+
  - empirical model for Pedersen conductance
- magnetospheric generators with convergent E-field: *Chiu and Cornwall, 1978; Lyons 1980, 1981*
- Models of auroral generators based on sharp interfaces: *Galperin et al, 1992; Roth et al. 1993; Lennartsson , 2006, Johnsson et al., 2006, Echim, Roth, De Keyser, 2007,2008*
  - B parallel to z axis: $E = (E_x, 0, E_z)$; $J = (J_x, 0, J_z)$

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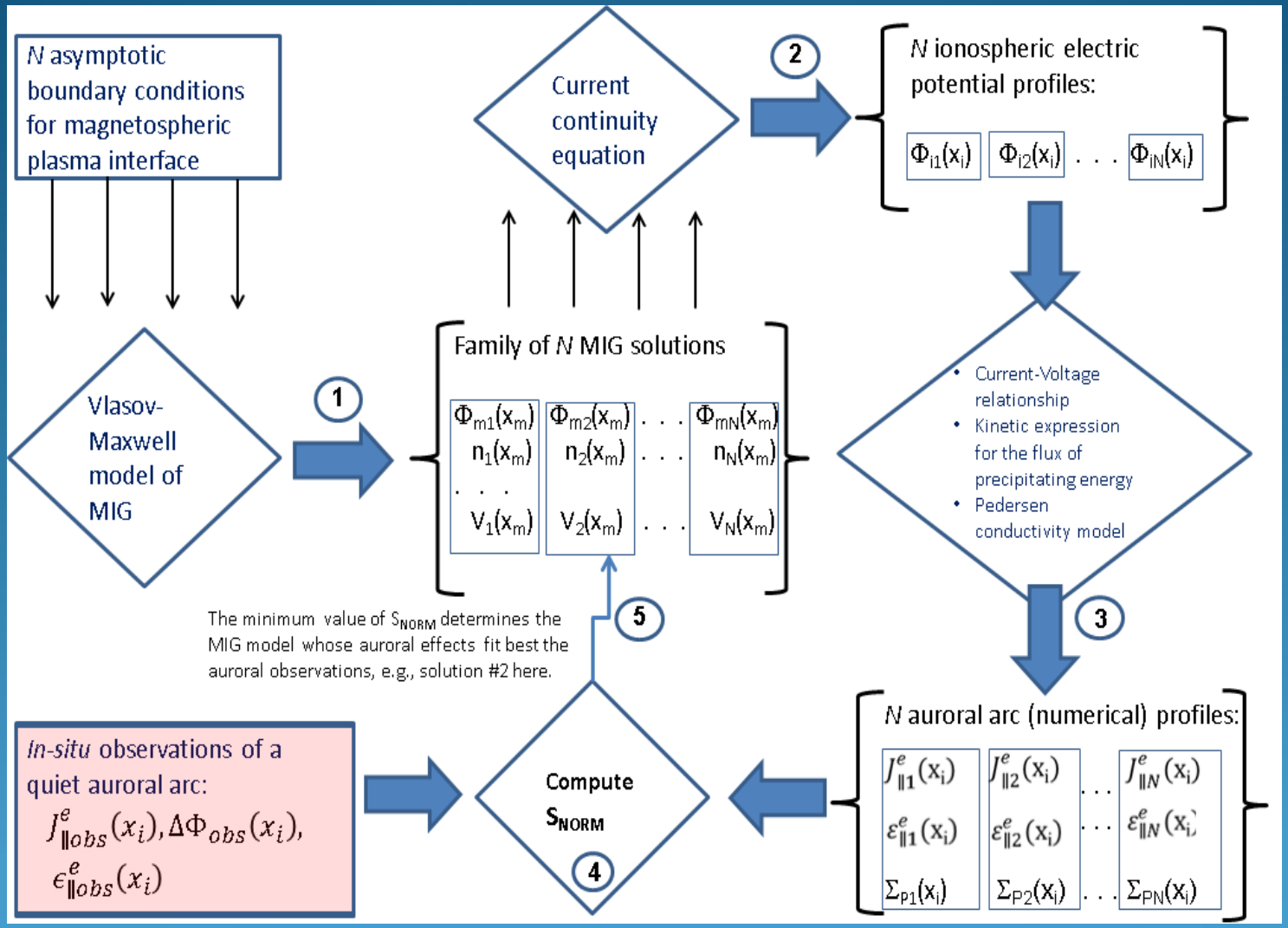
METHODOLOGY



Echim et al. (2019)

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Minimization procedure

Evaluate the accuracy of each arc solution, in the least squares/defect measure sense:

$$S_{NORM} = \sum_{(\Pi)} S_{NORM}^{(\Pi)}$$

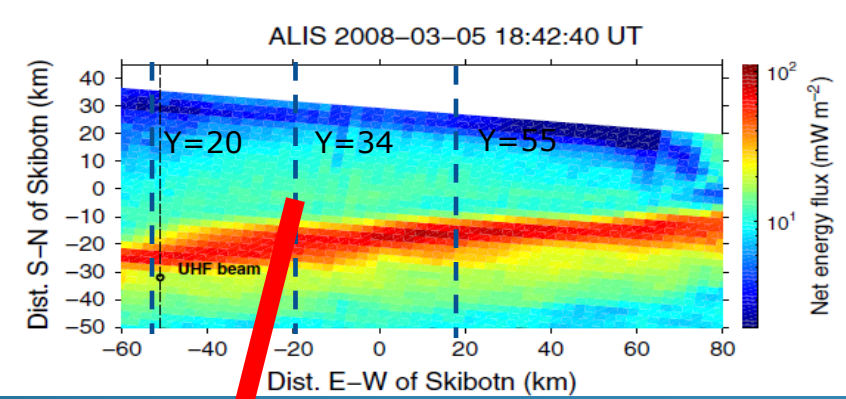
Summation is over defect measures estimated for different observable measures Π be it accelerating potential measured in situ or flux of precipitating energy estimated from ground. Each measure is defined as:

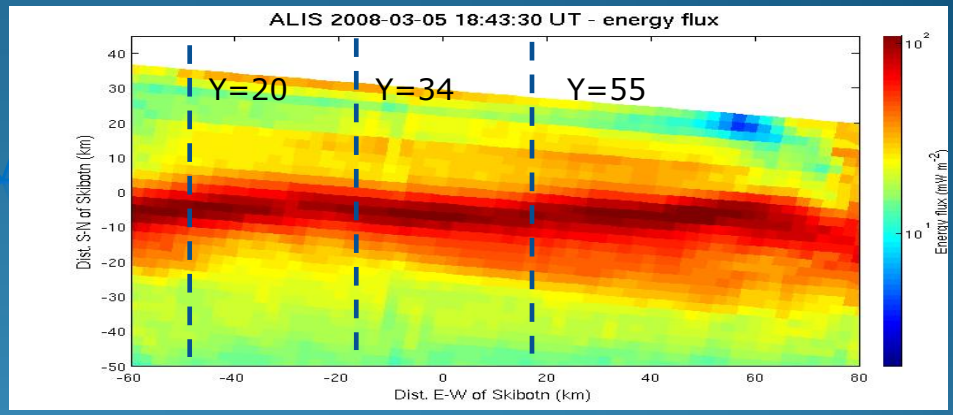
$$S_{NORM}^{(\Pi)} = \sum_{i=1}^{N} \frac{\sqrt{\left|\left(\Pi_i{}^{model}\right)^2 - \left(\Pi_i{}^{obs}\right)^2\right|}}{\left|\Pi_i{}^{obs}\right|}$$

From ALIS tomography we compute a defect measure from an estimation of the flux of precipitating energy:

$$S_{NORM}^{(\Delta\epsilon)} = \sum_{i=1}^{N} \frac{\sqrt{\left|\left(\Delta\epsilon_i{}^{model}\right)^2 - \left(\Delta\epsilon_i{}^{ALIS/mart}\right)^2\right|}}{|ALIS/mart|}$$

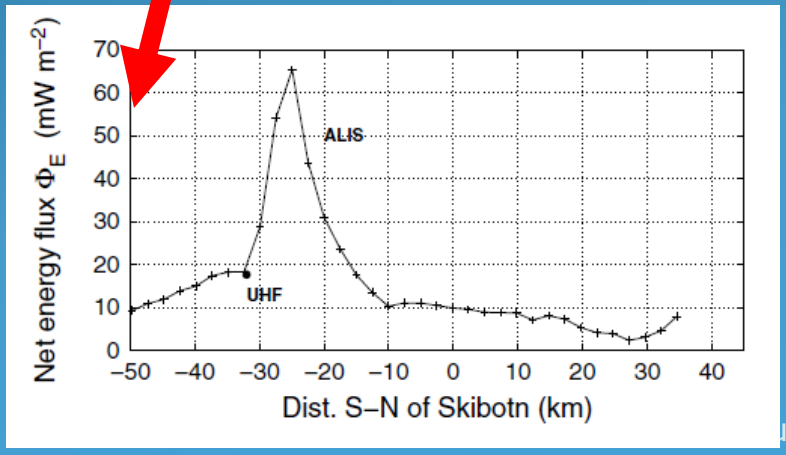
Estimation of generator properties from ALIS observations





2-D map of the integrated net energy flux (in mW/m^2) at 18:42:40 UT on 05/03/2008 derived from reconstructed fluxes of precipitating electrons at 260 km (Simon-Wedlund et al, 2013)

2-D map of the integrated net energy flux (in mW/m^2) at 18:43:30 UT on 05/03/2008 derived from reconstructed fluxes of precipitating electrons at 260 km



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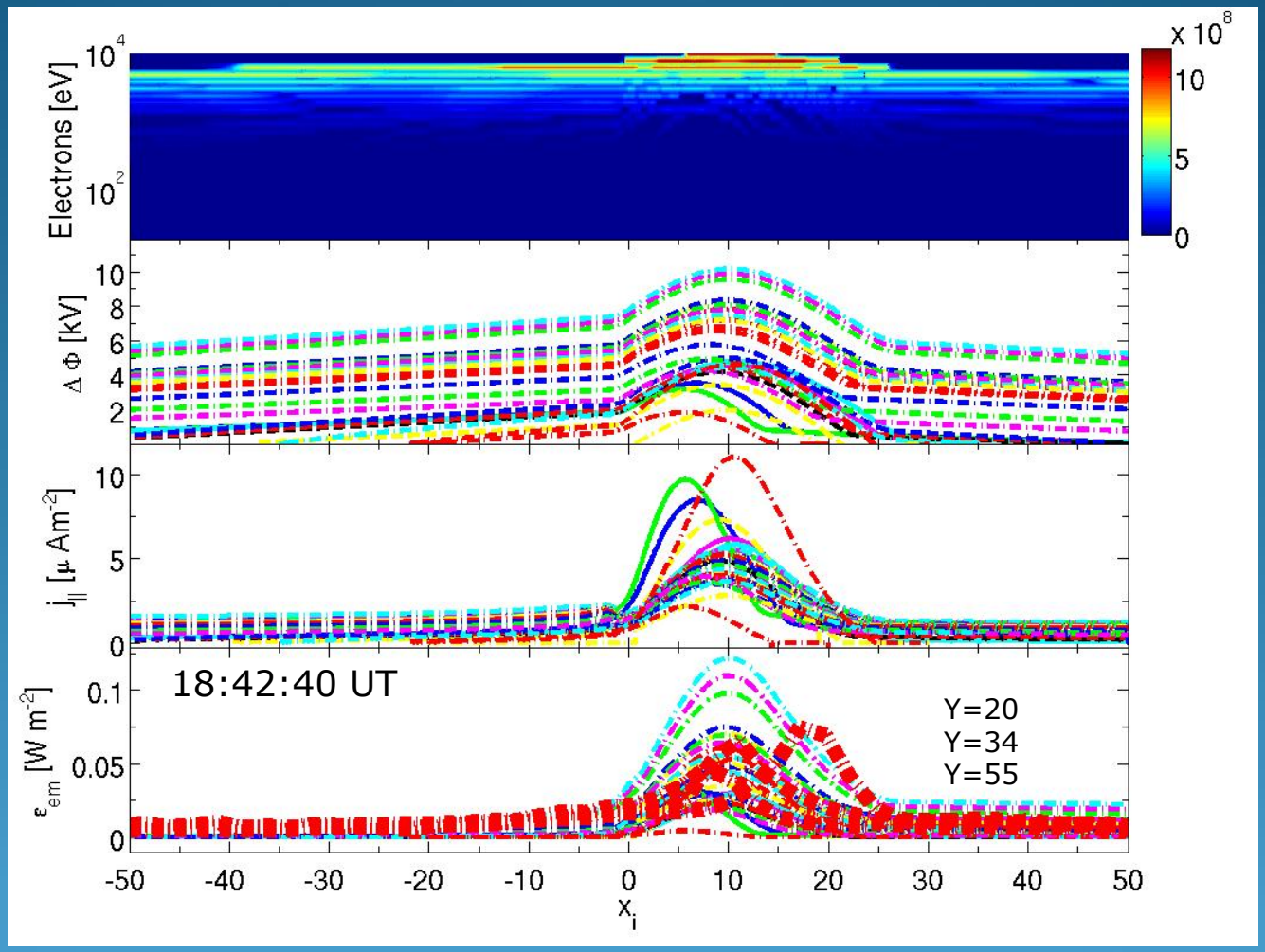
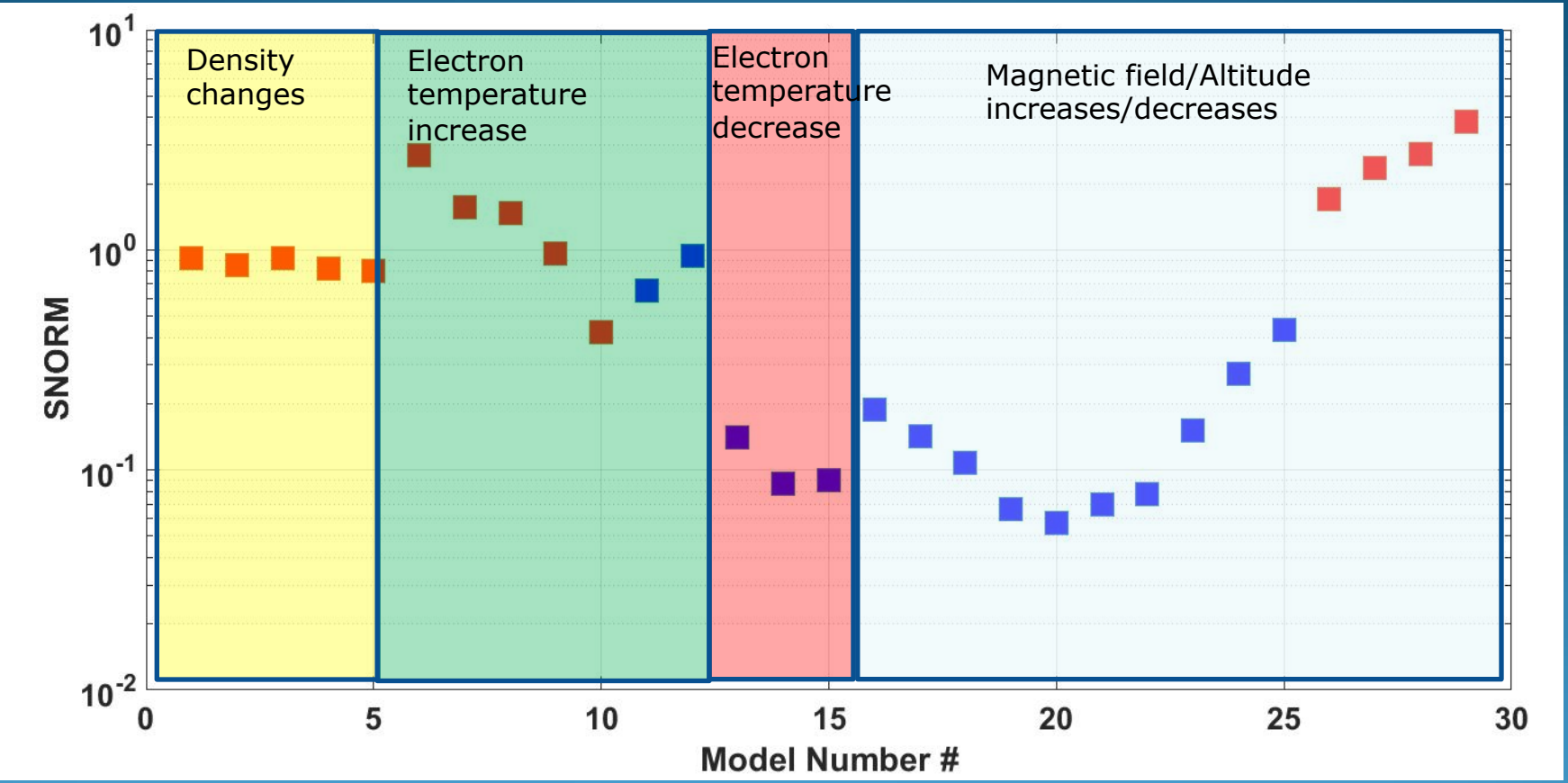


Set of 29 arc solutions. Panels show: energy spectrum of precipitating electrons injected at generator altitude, accelerating potential, field-aligned current density, flux of precipitating energy. Three profiles of ε_{em} from ALIS observations at 18:42:40 UT are superimposed in bold red.

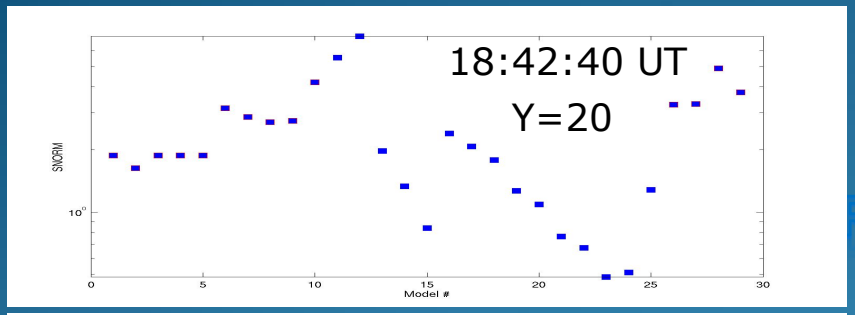
METHODOLOGY

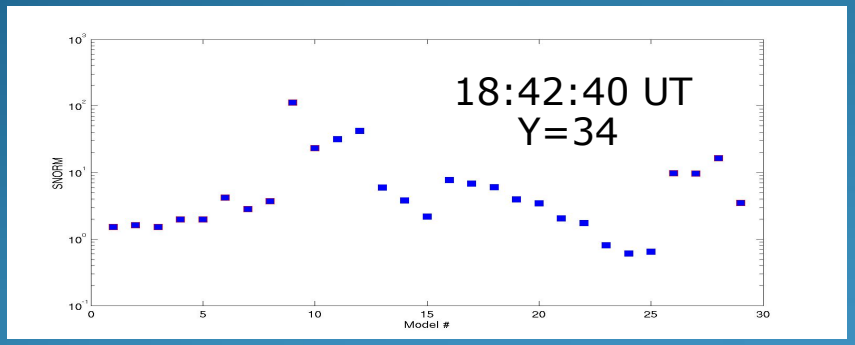
SNORM evaluated for one auroral observable (flux of precipitating energy from ALIS tomography)

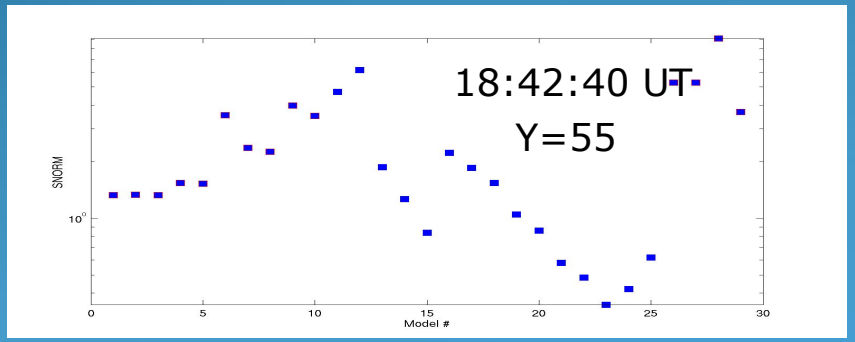


Solutions computed for S_{NORM} from the 29 generator models. The red symbols illustrate the results of a first scan of the parameter space; the blue symbols correspond to a refined estimation. Different colors emphasize different trends explored in the parameter space

Estimation of generator properties from ALIS observations







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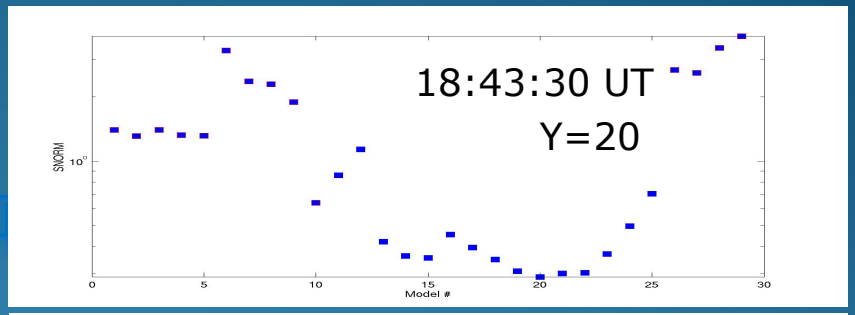

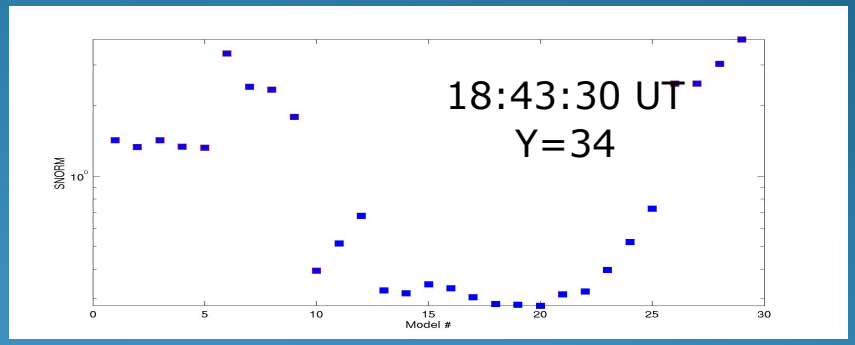

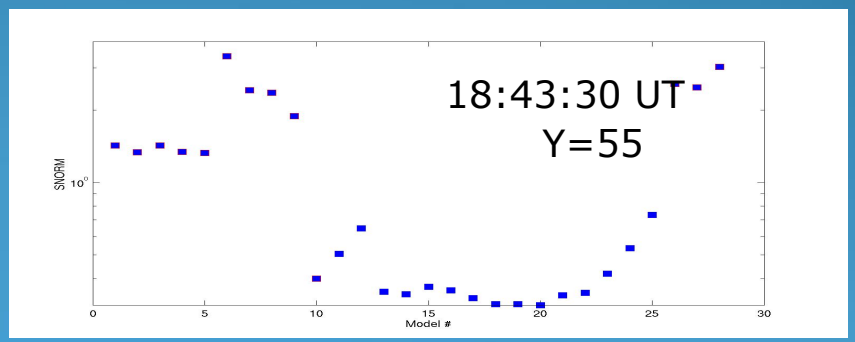

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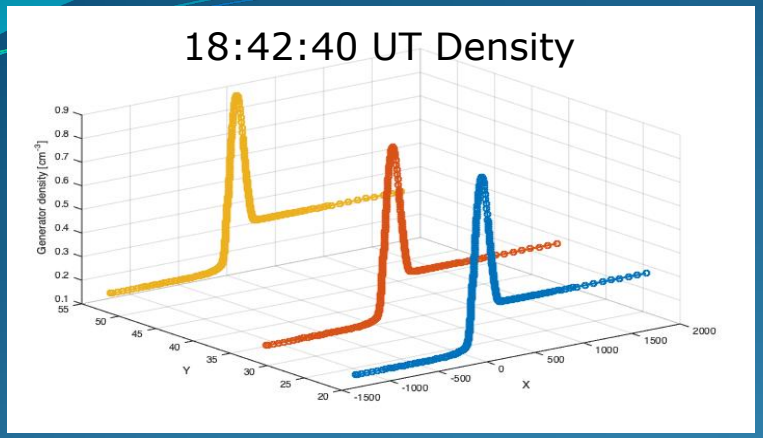
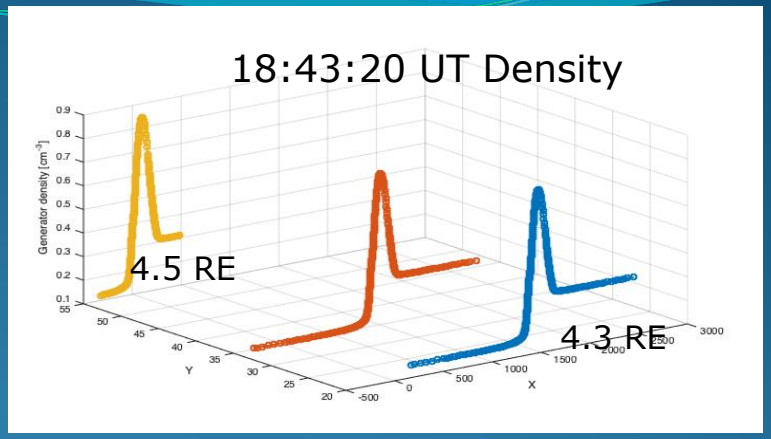
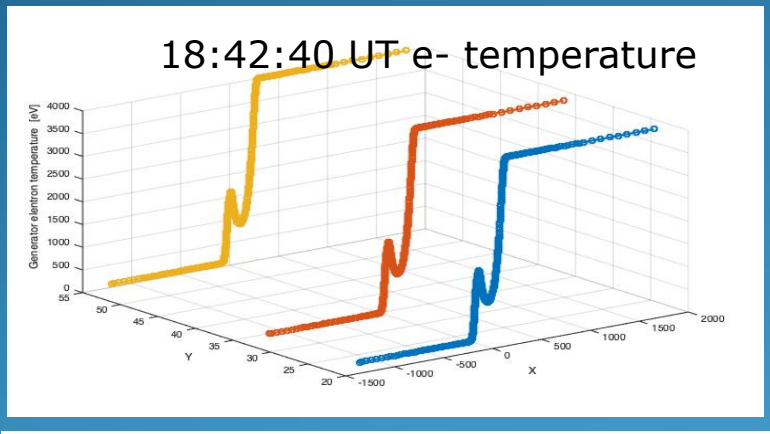
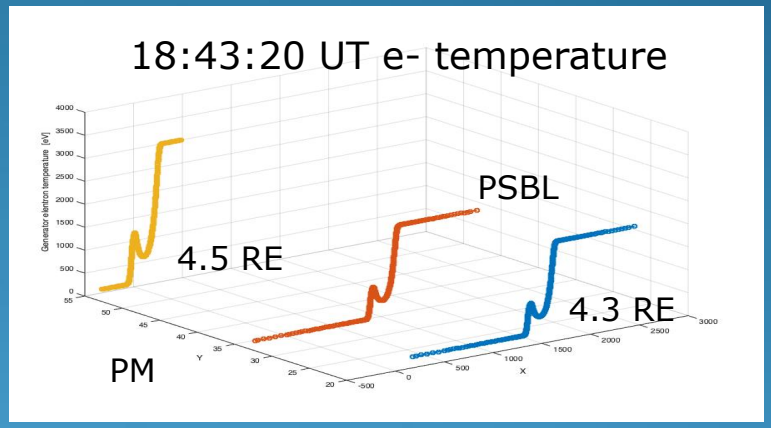
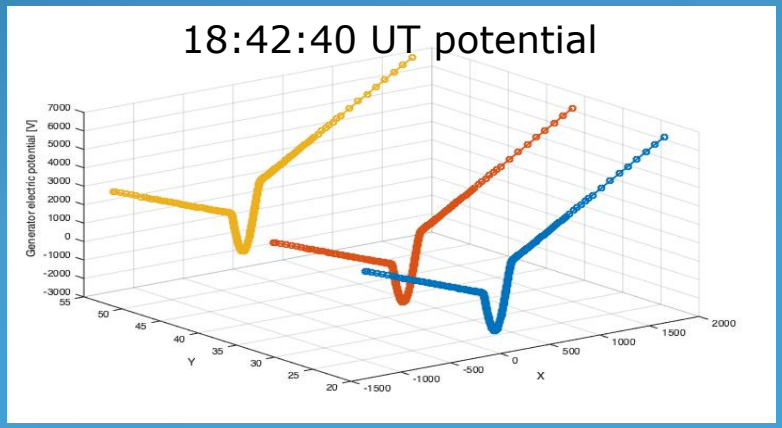
Estimation of generator properties from ALIS observations 05/03/2008

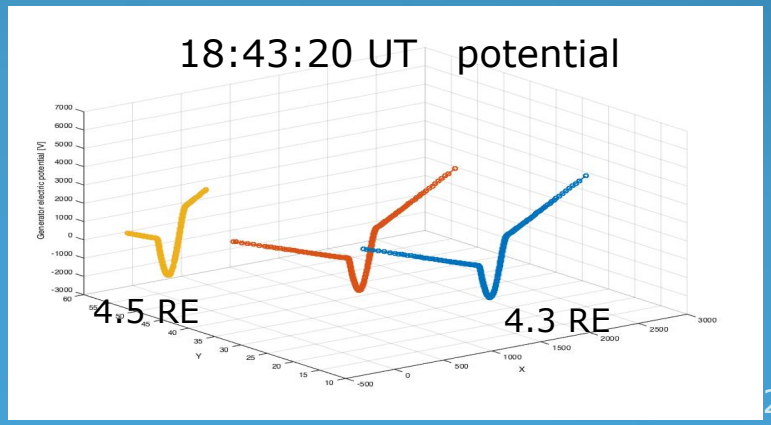












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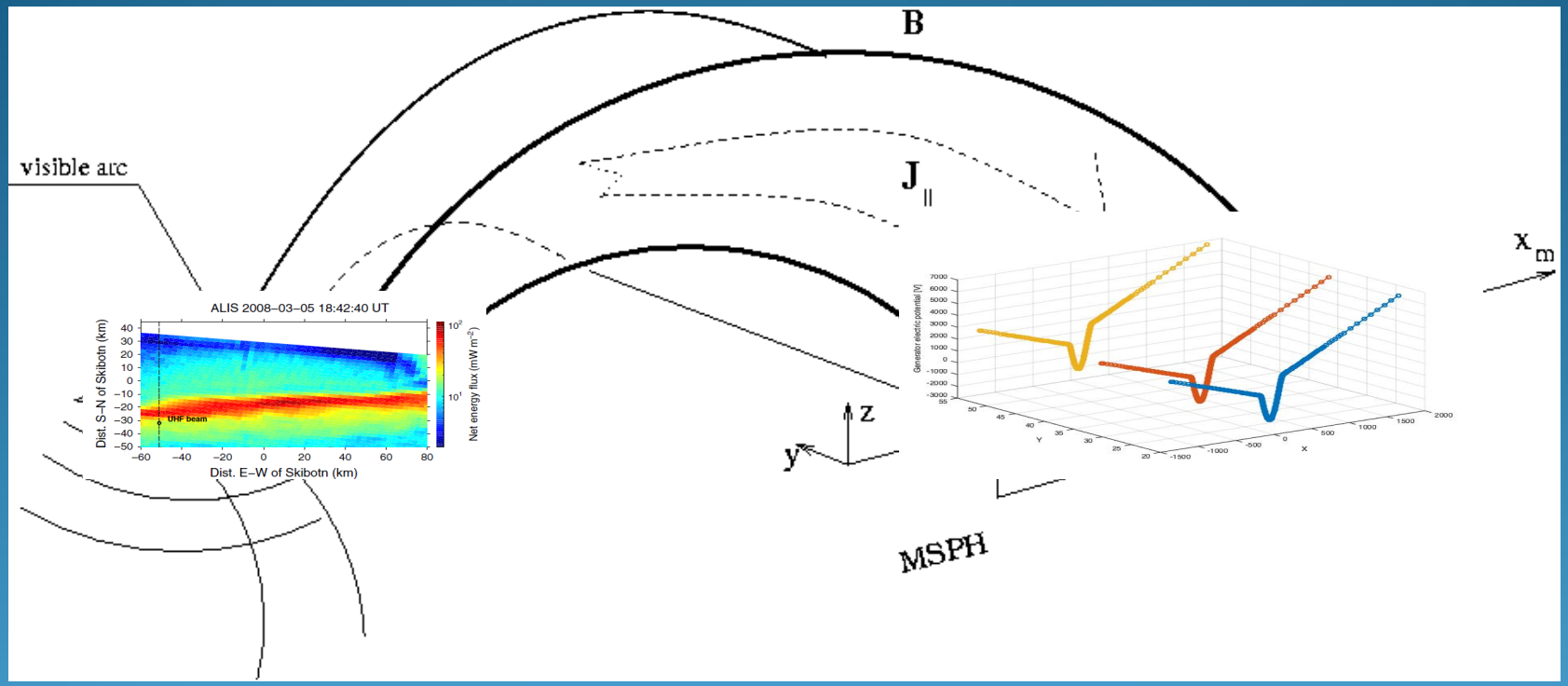

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Summary, Conclusions

• A minimization procedure allows for an estimation of the generator properties from observations of quasi-static auroral arcs.

•Results from ALIS tomography allows probing of a generator structure, similar to a tangential discontinuity as the ones formed at the PSBL-lobe interface.

•The 3D tomographic data allows for a pseudo-2D reconstruction of the genenrator and its quasiadiabatic time evolution.

•The generator is localized at approximately 4,3 RE altitude and has rather stable properties.

•The slight variations observed in ALIS flux of precipitating energy can be explained by a slight decrease of the generator altitude and a slight cooling of the electrons at the PSBL side.

•This study reveals the potential of the methodology to use ALIS as a too for remote probing the magnetosphere at quiet times.

•Other studies based on BISA auroral campaigns are under way for estimating the properties of generators of more variable arcs.