Conjugate observations of auroral signatures

The computer session on auroral signatures makes use of data from the Fast Auroral SnapshoT (FAST) Explorer satellite. Comprehensive information on the satellite, data, and processing software is available at the FAST web site. The orbit 1827 selected below has been used by Stenbaek-Nielsen et al. (1998) for a study of auroral arcs in conjunction with optical data.

Tasks in italics are somewhat more challenging.

1. Bring up the data from FAST orbit 1827 (1997/02/06) from about 09:10 UT to 09:50:

1. In order to start the data visualization program Science Data Tool (sdt) go to the startup directory by 'cd sdt' and the start the program by 'sdt'.
2. Click on 'Configuration', then on '1827.stiinte', then 'Select', and finally 'Okay';
3. Minimize, than maximize the data window (to fix the colors)

The plots, from top to bottom show:

a) electron differential energy flux, in eV/cm^2-s-sr-eV, as a function of energy and time;

b) electron differential energy flux as a function of pitch angle (0 º indicates downward) and time;

c) ion differential energy flux as a function of energy and time, all ions;

d) ion differential energy flux as a function of pitch angle and time, all ions;

e) ion differential energy flux as a function of energy, H^+;

f) ion differential energy flux as a function of energy, O^+;

g) ΔB_z (perpendicular to the satellite track, roughly East–West);

h) Electric field component in the (rotating) satellite system;

i) Power spectral density for the electric field fluctuations, (mV/m)^2/Hz, in the range 0 – 16 kHz (the upper value on the y axis is wrong, 512 in not kHz but the number of frequency channels);

j) Power spectral density for the magnetic field fluctuations, nT^2/Hz, in the range 0 – 16 kHz (same note as above);

k) Power spectral density for the electric field fluctuations in the range 0–1 MHz;

l) Power spectral density for the magnetic field fluctuations in the range 0-1 MHz.

2. Identify the times of the satellite crossings of the polar cap boundary, both on the evening and morning side.

3. Zoom in on the evening side auroral oval. What boundaries can you identify in the electron and ion data (both regarding energies and pitch angles), and the electric and magnetic field data? Give the times and try to identify the nature of the boundaries. Can you for example identify the boundary between the Region 1 and Region 2 currents?

4. Identify three inverted-V events (start and stop times). Can you see any related change in the B-field? Give your interpretation. How wide is the loss-cone typically? For one of the inverted-V's estimate its width, *and how wide the corresponding auroral arc would be at 100 km altitude. (Hint: the spacecraft velocity is roughly 6 km/s and the geomagnetic field at the satellite level is about one fourth of the ground magnetic field).*

5. Of your three inverted V's, which one do you think would create the most intense aurora? Check if your guess agrees with the results in the paper by Stenbaek-Nielsen et al. (1998).

6. List the times when the FAST satellite crosses the border of the auroral acceleration region. How did you identify these crossings? What happens with the electric field at and close to these crossings? *Draw a sketch of what you think the geometry of the lower boundary of the acceleration region looks like. (In order to do this it is helpful to consider the energies of the ion beams and the electrons.)*

7. Identify two ion conics, one associated with an upward current, and one with a downward current. Do you see any difference in their properties? *If so, can you explain them?*

8. There is a strong wave emission at around 400 kHz during the evening auroral crossing. Can you guess what kind of waves these are? *From the lower cutoff, estimate the magnetic field strength and altitude of the source region of the waves. (Hint: the geomagnetic field at the Earth surface is approximately 50 000 nT in the auroral region.)*

9. *Relate the properties of the low-frequency wave emissions to the field-aligned current, and speculate on the nature of these waves.*

10. Let us now if you have any questions or comments.