MULTIPOINT OBSERVATIONS OF SMALL SCALE DENSITY IRREGULARITIES IN THE PLASMASPHERE USING THE WHISPER INSTRUMENT ONBOARD CLUSTER

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Every 57 hours the four CLUSTER spacecraft traverse the plasmasphere near perigee (around 4 R_E) from the Southern to the Northern hemisphere. These crossings occur with different separation distances between the spacecraft (600 km, 2000 km and 100 km). Frequency-time electric spectrograms obtained by the WHISPER instrument are shown (Figure 1). From the emissions at the electron plasma frequency F_{pe}, one can deduce the electron density N_e using the relationship: $F_{pe}\{kHz\} \sim 9\ [\ N_e\{cm^{-3}\}]^{1/2}$. High resolution electron density profiles (1.7 seconds sampling rate) are shown as a function of the equatorial distance R_{equat} (in units of Earth radii), which is the geocentric distance of the magnetic field line on which the spacecraft is located. It is identified by the geocentric distance along the field line where the magnetic field strength reaches a minimum.

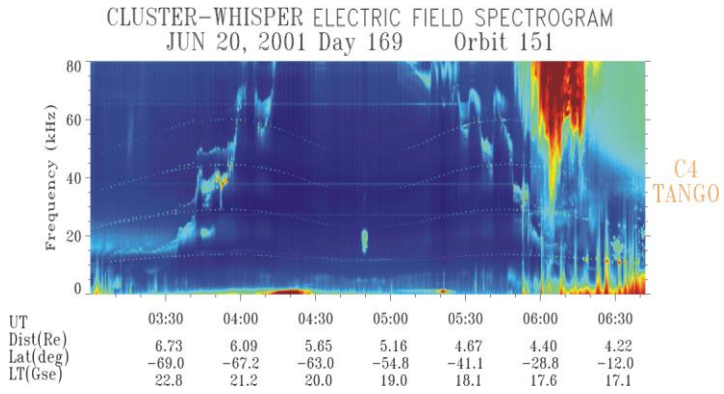

Figure 1:
Frequency-time electric spectrogram obtained by WHISPER onboard C4 during a plasmasphere crossing on 20 June 2001.

Density irregularities are often, though not always, observed in the electron density profiles in the plasmasphere and at the plasmapause. Over 260 CLUSTER plasmasphere crossings have been examined in this analysis. The density irregularities have a transverse equatorial size that is distributed exponentially. This distribution has an average value of 365 km and a maximum ranging up to 5000 km. They have a characteristic density ratio of 20%. There are more density irregularities when the level of geomagnetic activity is higher. There appears to be an asymmetry in their MLT distribution (Figure 2).

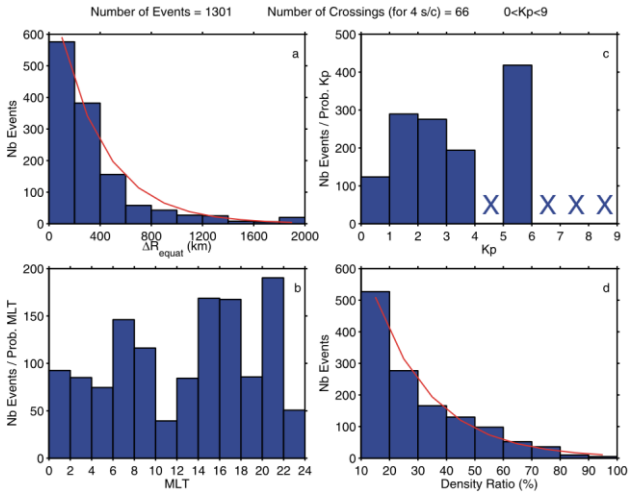

Figure 2:
Statistical results on the density irregularities observed during all 264 CLUSTER plasmasphere crossings.

All these results show that the plasmasphere and Plasmasphere Boundary Layer are a much more complex and dynamic region than considered so far from earlier experimental observations as well as from some early theoretical models and MHD simulations.

Multipoint techniques are also used to compare all four electron density profiles. We compute the spatial gradient of any scalar quantity along the trajectory of the centre of mass of the CLUSTER tetrahedron, from simultaneous measurements of that scalar quantity, with the hypothesis that all four spacecraft are embedded at any given time in the same structure (Figure 3).

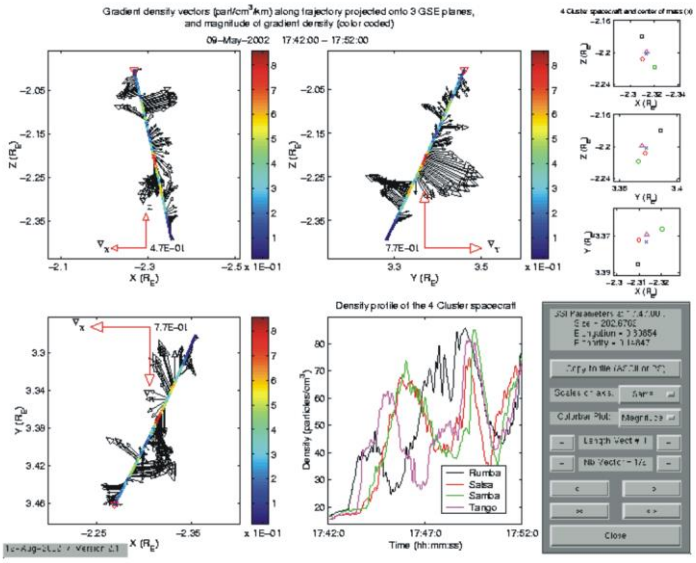

Figure 3:
Density gradient vector projections onto XY, YZ, and XZ GSE planes for the density irregularities observed in the plasmasphere on 9 May 2002.

We compute also the normal boundary velocity with a time delay method, i.e. from individual spacecraft positions and times of the boundary crossings, assuming the boundary to be a planar structure travelling at a constant velocity along its normal.