

Ion data aboard three Cluster satellites are used for the first time to assess the coherence in space and time of dayside ion outflows. The most remarkable finding is that, although dayside outflows are a permanent feature, steady-state conditions are surprisingly never achieved. A significant variability is particularly found for local outflow intensities on small time scales.

It is well known from earlier satellite missions that the Earth's ionosphere competes with the solar wind to supply plasma into the magnetosphere [Yau and Andre, 1997]. The outflow composition is mainly O⁺ and H⁺ ions, with the largest fluxes originating from the dayside cusp. Data from the Cluster multi-satellite system allow for the first time to access the spatial and temporal coherence of dayside outflows.

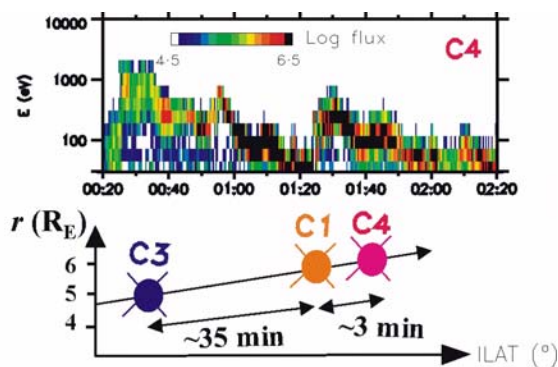


Fig. 1: From top to bottom; time-energy spectra of O⁺ ions measured onboard Cluster satellite C4; drawing of the satellite configuration along its polar orbit.

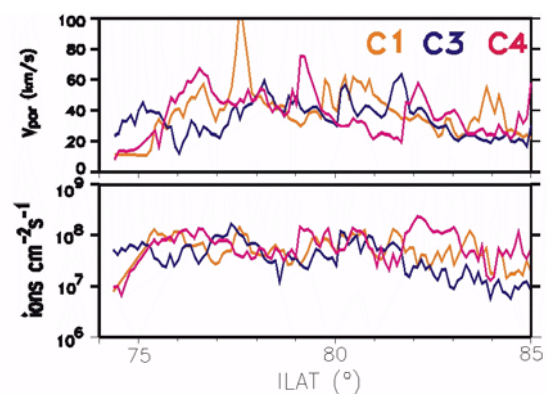


Fig. 2: From top to bottom; invariant latitudinal series of O⁺ upward mean velocity and integral flux from satellites C4 (pink), C1 (orange) and C3 (blue).

Figure 1 shows an example of an O⁺ outflow event observed on 3 of the Cluster satellites, when moving poleward in the high-altitude polar cap. The O⁺ outflow detected in the time-energy spectra (left) is the result of multi stage processes. First, ionospheric processes raise the scale height of O⁺ ions so that wave/particle interactions higher up in thin latitudinal regions lead to ion escape from gravity. Then, ions move up via the mirror force and drift in latitude due to the magnetospheric convection. This latter stage leads ions from a narrow source to spread out at Cluster altitudes.

To investigate whether O⁺ features are spatial or temporal, one can compare them on the same field line. In Figure 2, plots of O⁺ upward velocity and flux as a function of invariant latitude (ILAT) show significant variations at the same ILAT between satellites. This is the first direct evidence of O⁺ variations being temporal, demonstrating the importance of non-steady processes in the development of the outflow.

A statistical study with 18 similar events [Bouhram et al., 2004] confirmed the presence of significant variability. Such results associated with small scale processes may have some implications in the large scale transport of mass and energy through the magnetospheric system.

Yau, A., and M. André, Space Sci. Rev., 80, 1-25, 1997.

Bouhram, M., B. Klecker, G. Paschmann, et al., Ann. Geophys., 22 (7), 2507-2514, 2004.