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Multi-spacecraft observations of diffuse ions upstream of Earth's bow shock under different solar wind conditions

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We report on several simultaneous measurements of energetic ions upstream of Earth's quasi-parallel bow shock by Cluster during time periods of large (1-1.5 Re) inter-spacecraft separation distances. Using a bow shock model we determined for each 8 spin averaged data set the distance of the Cluster 1 and Cluster 3 spacecraft from the bow shock along the magnetic field. Using the differences of the partial energetic ion densities observed on the two spacecraft we determined the spatial gradient of partial densities at various distances from the bow shock under different solar wind conditions in 4 energy channels ranging from 10 to 32 keV. The gradients in all four energy channels decrease exponentially with distance in all cases. The e-folding distance of the gradients depends not only on energy but also on solar wind velocity. The diffusion coefficients (obtained under different solar wind conditions) match quite well on higher ion energies, but on lower ion energies they present different values. Our results show that this discrepancy might be a consequence of an interaction between energetic ions and upstream compressional waves.