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Magnetic clouds' structure in the Earth's magnetosheath as observed by Cluster and Geotail

Lucile Turc (1), Dominique Fontaine (2), Philippe Savoini (2), Emilia Kilpua (3), and Philippe Escoubet (1)

(1) Scientific Support Office, Directorate of Science and Robotic Exploration, European Space Research and Technology Centre (ESA/ESTEC), Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands (lucile.turc@esa.int), (2) Ecole Polytechnique, CNRS, Sorbonne Universités, UPMC Univ Paris 06, Univ Paris-Sud, UMR7648, Laboratoire de Physique des Plasmas, F-91128, Palaiseau, France , (3) Department of Physics, University of Helsinki, P.O. Box 64, 00014 Helsinki, Finland

Magnetic clouds (MCs) are a subset of coronal mass ejections which are known to drive intense geomagnetic activity. When studying the geoeffectivity of MCs, it is generally assumed that their magnetic structure remains unchanged from the solar wind upstream of the Earth's environment, measured for example at the first Lagrangian point L1, to the magnetopause. However, before impinging on the magnetosphere, MCs first cross the Earth's bow shock which can alter the orientation of their magnetic field. In this study, we examine the effects of the bow shock crossing on the magnetic structure of MCs. To address this issue, we compare simultaneous spacecraft observations in the solar wind (ACE) and in the magnetosheath (Cluster, Geotail) and find that the variation of the magnetic field direction across the bow shock varies from one event to another, from one spacecraft to another, and even during the same MC event. We relate these differences to the shock configuration. We find that when the shock is in a quasi-perpendicular configuration, the MC's magnetic structure is similar in the solar wind and in the magnetosheath, whereas it is strongly modified if the shock is in a quasi-parallel geometry. In this case, the magnetic field reaching the magnetopause cannot be approximated by that measured in L1. We discuss the consequences for the MC's geoeffectivity.