Geophysical Research Abstracts
Vol. 17, EGU2015-5908, 2015
EGU General Assembly 2015

Multipoint observations and simulation of the effects of Earth's bow shock on magnetic clouds' structure and geoeffectiveness

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Magnetic clouds represent a sub-class of coronal mass ejection (CME) capable to trigger very strong storms in the terrestrial environment. Their magnetic structure can be described as a flux rope and statistical studies show a dependence of their geoeffectiveness on the orientation of this flux rope relative to the terrestrial magnetic field. However, this primary dependence does not fully explain by itself the storm triggering and strength. Other effects as the cloud's sheath or events on its leading or trailing edges have been discussed. We investigate here the role of the bow shock that magnetic clouds cross before interacting with the magnetosphere. From observations in the solar wind upstream of the bow shock (ACE) and downstream (CLUSTER), we show that the bow show may strongly modify the cloud's magnetic structure and even cause the reversal of the IMF Bz component: this is crucial for the development of geomagnetic activity inside the magnetosphere. We show that this modification is related to the shock configuration (quasi-parallel, quasi-perpendicular) and we derive the upstream conditions leading to strong downstream distortions. In addition, we run hybrid simulations to analyze the different plasma behaviours in both configurations. In particular we discuss the results concerning the distribution of dynamical, thermal and magnetic pressures and the associated forces.