# Magnetosphere-ionosphere coupling using Cluster and ground-based observations

H. Alleyne(1), **N. Balan**(1), S. Walker(1), H. Reme(2), A.Balogh(3), M. Andre(4), N. Cornilleau(5), S.-R. Zhang(6), and A. P. van Eyken(7)

(1)Automatic Control and Systems Engineering, University of Sheffield, Sheffield S13JD, UK. (2)CNRS, CESR, F-31028 Toulouse 04, France. (3)Blackett Laboratory, Imperial College, London, SW7 2BZ, UK. (4)Swedish Institute of Space Physics, S-75121, Uppsala, Sweden. (5)CETP/CNRS, F-78140, Velizy, France. (6)MIT Haystack Observatory, MA 01886, USA. (7)EISCAT Scientific Association, P. O. Box 164, SE-981 Kiruna, Sweden.

An extreme solar wind of speed $\approx$ 600 km $s^{-1}$, proton pressure 30-55 nPa, density 25-75 $cm^{-3}$, and temperature 0.2-0.5 MK (following a coronal mass ejection) flowed pass the Earth for about seven hours on 24 October 2003. The geoeffectiveness of the extreme solar wind are presented using Cluster (FGM, CIS, STAFF and EFW) and ground-based (EISCAT VHF radar and IMAGE magnetometer network) observations for the first 2.5 hours of the event when IMF $B_z$ remained negative up to -20 nT for first 40 min and positive up to 25 nT for rest of the period. The observations show that while the extreme solar wind interacts with magnetosheath and exterior cusp regions under both negative and positive IMF $B_z$ conditions, the ionospheric response is limited to the negative $B_z$ condition. The solar wind has almost instantaneously compressed and deformed the magnetosphere in such a way that Cluster, which was in the southern magnetospheric lobe at about 7.0 $R_e$ away from the Earth, suddenly found itself in the magnetosheath at 15:24:45.25 UT, and then crossed through the magnetosheath and exterior cusp regions for about 2.5 hours. During this period (15:24:45-18:02:00 UT) Cluster detected large and sudden changes in plasma, fields and waves, which are also modulated by the changes in IMF $B_z$, solar wind azimuthal flow, and $\mathbf{E}\times\mathbf{B}$ effects. Following the start of the effects in the magnetosheath, the EISCAT radar (field of view $\approx$ 71-77°N) and magnetometer network (8-stations at 68-79°N) detected strong effects until IMF $B_z$ remained negative. The ground-based observations suggest the possibilities of an afternoon cusp (or open-closed field line boundary) descending to low latitudes as shown by model calculations and an afternoon westward electrojet ascending to high latitudes under the high solar wind pressure and negative IMF $B_z$ conditions.