

CURRENT STRUCTURES IN THE TRANSMISSION REGION BETWEEN PLASMA SHEET AND IONOSPHERIC SUBSTORM CURRENT WEDGE AS SEEN BY CLUSTER

**Förster Matthias, M. Bouhram, P. Decreau, A. Fazakerley, S. Haaland,
B. Klecker, G. Paschmann, R.A. Treumann, A. Vaivads, J. Vogt**
Plasma physics group, Max-Planck-Institut für extraterrestrische Physik, P.O. Box 1312,
Garching, Bavaria, Germany 85741

ABSTRACT

The classical paradigm of the substorm current wedge as diversion of the neutral sheet current closing through the ionosphere from dawn to dusk is probed with the four-point Cluster measurements in a new-fashioned way. We examine the current structures within the high-altitude (at $\sim 4.3 R_E$) inner-magnetosphere intermediate region between the equatorial plasma sheet and the ionospheric Harang discontinuity or substorm current wedge (SCW) sector for one particular interval during a series of substorm pseudo-onsets.

For the case study of this paper, March 12th, 2001, we observe regularly spaced (every ~ 10 -15 minutes) pseudo-onsets during the interval of interest that precede the onset of a major substorm expansion phase initiated at approximately 08:00 UT according to CANOPUS magnetic records near the footpoints which are conjugate to the spacecraft positions along the magnetic field lines.

The traditional single-spacecraft methods for current estimations are applied to deduce both the field-aligned (FAC) and field-perpendicular currents. They are supplemented by various methods for the estimation of the current sheet normal and motion to determine the complex current structure in that region. These single-spacecraft methods are then contrasted with the new opportunities of the full vector current estimation with the Cluster tetrahedron by use of the reciprocal vector (RV) method (mathematically identical to the curlometer technique). The four-point methods allow the full vector spatial determination of the current structures with characteristic scale lengths of the satellite's volumetric tensor or larger and enable to differentiate between spatial and temporal variations in the same scales. The actual configuration of the tetrahedron as well as the preliminary knowledge of the current structures and the orientation of their characteristic axes relative to each other are also of some importance for the accuracy and correctness of the current estimations.

Single-spacecraft methods allow, on the other hand, a much better resolution of fine structures, although their interpretation is often equivocal. The combination of both proves to be a valuable tool for the unambiguous description of such phenomena.

The magnetometer-based current estimations are then compared with measurements of the particle and wave instruments of Cluster like the Ion Spectrometry (CIS) measurements, Electric Field and Wave (EFW) experiment, the PEACE (Plasma Electron and Current Experiment), and Whisper (Waves of High frequency and Sounder for Probing of Electron

density by Relaxation) data to obtain a more complete picture of the processes in that region and to come to conclusions about the intricate substorm-related plasma processes.