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Study of the applicability of the curlometer technique with the four Cluster spacecraft in regions close to Earth

S. Grimald, I. Dandouras, P. Robert, and E. Lucek
IRAP, Toulouse, France (grimald@cesr.fr)

The knowledge of the inner magnetosphere current system (intensity, boundaries, evolution) is one of the key elements for the understanding of the whole magnetospheric current system. In particular, the calculation of the current density and the study of the changes in the ring current is an active field of research as it is a good proxy for the magnetic activity. The curlometer technique allows calculating the current density from the magnetic field measured at four different positions inside a given current sheet using the Maxwell-Ampere's law. In 2009 the CLUSTER perigee pass was located at about 2 RE allowing a study of the ring current deep inside the inner magnetosphere, where the pressure gradient is expected to invert direction. In this paper, we use the curlometer in such an orbit. As the method has never been used so deeper inside the inner magnetosphere, this study is a test of the curlometer in a part of the magnetosphere where the magnetic field is very high (about 4000 nT) and changes in small distances ([U+F044]B = 1 nT in 1000 km). To do so, the curlometer has been applied to calculate the current density from measured and modelled magnetic fields and for different sizes of the tetrahedron. The results shows that the current density cannot be calculated using the curlometer technique at low altitude perigee pass, but that the method may be accurate in an [3 RE;5 RE] and [6 RE;8.3 RE] L-shell range. It also demonstrates that the parameters used to estimate the accuracy of the method are necessary conditions but not sufficient ones.