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Optimal Field Gradients Derived from Multi-Spacecraft Observations

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The MMS mission offers the unique opportunity to check the quality of magnetic gradient estimates made by multi-spacecraft analysis methods. Particle detectors onboard MMS have enough energy and time resolution to provide ion and electron currents hence the electric particle current Jp. Magnetic records from the four spacecraft are used to estimate the tensor gradient of the vector magnetic field from which the magnetometer current Jm and divB are derived. Since the early 90's when preparing the CLUSTER mission several methods have been designed for estimating gradients of vector fields which differ by their approaches and abilities meanwhile they all give the same weight to the four spacecraft. The theory based on reciprocal vectors allows a detailed analysis of errors affecting the estimated components of the tensor gradient of a vector field which demonstrates that less regular is the tetrahedron larger are the uncertainties. An alternative to this Standard Reciprocal Vectors (SRV's) approach is the Generalized Reciprocal Vectors (GRV's) approach which improves the estimate of the gradient when the tetrahedron is not regular. GRV's will be introduced first, and then shown to improve the estimated divergence of B and the agreement between Jp and Jm on two MMS event cases. GRV's applied to CLUSTER data lead to an improved estimation of divB, i.e. closer to zero, meanwhile leading to new current estimates. It is expected that improving divB with CLUSTER data is an indication of improvement of the estimated current as for MMS data. It should nevertheless be mentioned that deformations of the tetrahedron are much smaller for MMS than for CLUSTER.