Geophysical Research Abstracts, Vol. 9, 02721, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02721


# Estimating time and space derivatives using GALS

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GALS (Gradient Analysis by Least Squares) is a general method for estimating time and space derivatives from multi-spacecraft measurements of physical fields. GALS identifies structures in the field data and estimates their velocities. To obtain the best possible resolution, the derivatives are estimated in the frame of reference where a field structure is essentially stationary. Weights are calculated from the velocities and used by a weighted least square method to obtain the derivatives. The estimates are refined iteratively. Error estimates are obtained with Monte Carlo error propagation.

We investigate the ability to separate time and space variations in the observed data and we analyze the effect of the multi-spacecraft configuration on the accuracy of the result. The inclusion of the error estimates is a major improvement of the method and it allows us to extract regions where the results can be trusted. The method has been tested on both synthetic and real data obtained from the Cluster spacecraft. Our results show that GALS is superior to the Curlometer method for estimating the current density, on e.g. thin current sheets.