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Determining the spatial scales of the cold inner magnetospheric plasma distribution by means of multi-point gradient calculation with constraints

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Determining the spatial distribution of the cold inner magnetospheric plasma has been a difficult task until the advent of multi-spacecraft missions, which allow to overcome the space-time ambiguity problems inherent in single-spacecraft in situ measurements. In this contribution, we focus on determining the spatial scales in the cold inner magnetospheric plasma distribution by means of multi-point gradient computation. In particular, we consider the magnetic field obtained by the FGM magnetometers and the cold plasma density derived from the plasma frequency measured by the WHISPER wave instruments on the four Cluster spacecraft. Given the difficulties inherent in computing derivatives, we examine how gradients of scalar and vector fields can be determined more reliably by making use of constraints. We discuss two types of constraints: geometric constraints (reducing the number of degrees of freedom in the orientation of the gradient) and physically-motivated constraints (e.g., the divergence-free condition). We describe how such constraints can be imposed in the context of least-squares gradient computation techniques, and what the benefit is in terms of reduced margins. We present some examples and draw conclusions about the spatial distribution of the plasmaspheric plasma.