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Methods for Processing Satellite Constellation Measurements of Earth-External Magnetic Field Sources

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The magnetic fields of space-borne current systems contribute significantly to magnetometer measurements made by low Earth orbit (LEO) satellites. The accurate characterisation of these spatially and temporally varying fields is important in order to make effective use of the abundance of high-precision satellite magnetic data collected over the last decade. With the launch of ESA's *Swarm* satellite constellation mission in 2012, the future of LEO satellite exploration of the geomagnetic field will be driven by constellation missions. We report on advances in processing techniques for Earth-external field measurements made with a constellation of satellites in LEO.

Stauning and Primdahl (2000) have proposed a method of applying Ampère's law integral along-track for a single satellite path to infer ionospheric current flow through a closed loop. Ritter and Lühr (2006) have since proposed a higher resolution application of the Ampère's law integral designed to resolve radial ionospheric currents with the *Swarm* constellation. We expand on these methods by posing the closed loop as the outline of the radial arc formed by the overflight of two satellites at different altitudes. The CHAMP and Ørsted LEO magnetic satellites are used for this purpose. Throughout the period 2000-2005, we solve for toroidal ionospheric current flow in the region between the two satellites at discrete intervals. Analysis focuses on the characterisation of the toroidal currents at different local times. Since the orbit of CHAMP decays faster than that of Ørsted, a limited characterisation of changes in the toroidal currents with altitude is possible.

The number of viable overlaps of the two satellites is relatively small. To avoid the possibility of rapidly temporally variant magnetospheric fields biasing the toroidal field solutions, we test the application of a further constellation-specific processing method. Using a limited number of orbits of the upper satellite, we solve for the dipole component of the magnetospheric field sources. Using a series of these solutions we can gauge the magnetospheric field activity at that local time. An index of this type is suitable for the processing of data from overlying satellite tracks. In future, a similar approach could be used to provide an 'instantaneous' external field correction in a satellite constellation.

References:

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