

## **Proposal for a Geomagnetic Centre for the NCEO**

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In 2010, as part of its Earth Explorer programme, ESA is due to launch the three-satellite mission, Swarm. This mission is designed to study all contributions to the magnetic field including: the dynamo field from Earth's core; the crustal field (induced and permanently magnetised rocks); the ionospheric and magnetospheric fields and electric current systems; electric currents in Earth's mantle, and the motional induction in the oceans. Historically, the UK has been a leader in all aspects of magnetic field studies, and boasts world-leading capability, particularly in dynamo theory, solar-terrestrial (magnetospheric and ionospheric) physics (STP), and observational geomagnetism. The NCEO has a remit to support the ESA Earth Observation programme, but currently has no centre into which Swarm-based research and other activity would fit comfortably. We propose that the NCEO consider establishing a facility through which Earth Observation geomagnetic research can be supported and coordinated.

Study of the geomagnetic field is a pure science, but is one that currently has a surprising number of applications which map to NERC's environmental science themes. These include: Natural Resources (magnetic exploration, magnetically oriented directional drilling), Hazards (Space Weather), Earth System science (particularly relating to core dynamics), and Climate system (the interaction of the charged and neutral atmosphere). Satellite observations have been crucial in driving forward our understanding in many of these areas, with the recent low-orbiting satellites Ørsted and CHAMP being particularly noteworthy. The success of these missions together with the experience gained from some other multiple spacecraft missions (notably the ESA Cluster mission), has motivated the design of Swarm, resulting in a unique configuration of 3 satellites; two flying at 450km altitude initially, and very close together (typically at 150km separation), and one in slightly higher orbit (550km initially). Each will measure the scalar and vector magnetic field; other in-situ measurements will include direct determination of the electric field. Swarm offers the unprecedented chance to untangle the various source fields which contribute to the measured geomagnetic field, and allow corresponding improvements in our understanding of their origin and prediction. Over the past five years, NERC has supported a consortium of scientists (Geospace – originally proposed as a Centre of Geomagnetic Earth Observation – based at the Universities of Liverpool, Edinburgh and Leeds, the British Geological Survey and Rutherford-Appleton Laboratories, plus strong international collaborations), who have initiated combined studies to use multiple data sources to look at all field components. This consortium was, however, strongly slanted towards traditional NERC disciplines; interactions with the STP community were limited, but extremely productive. To make full use of Swarm, it will be necessary to build on the established proven team of researchers, particularly in relation to ionospheric science, and handling of multiple spacecraft data, both UK strengths. Possible collaborative targets include source studies for geomagnetic induction in the solid Earth (magnetotellurics and geomagnetic depth sounding), and studies of polar geomagnetism (auroral processes, lithospheric magnetic anomalies for tectonic history, flows near the poles in Earth's core) with links to BAS; many more are likely to emerge with broader community discussions.

This proposal may be particularly timely, given discussions on possible added NERC responsibility for STP research. Such activity will only fulfil its potential if this science is integrated into other NERC activities; linked studies of Swarm data are ideally positioned to achieve this. Additionally, ESA intends to invite proposals to contribute as guest investigators on SWARM; areas of their interest include measurement calibration, ground truthing (including with ground radar, a particular strength of the UK community), multi-spacecraft methodology and surface field modelling (Earth's environment response to space weather input). ESA are keen to see much greater UK involvement in Swarm; the NCEO would provide an ideal focus to coordinate such research in the UK.

A Royal Astronomical Society discussion meeting on space-based geomagnetic field studies is planned to take place in October, 2009, convened by Geospace members (Dr. Richard Holme, Liverpool; Prof. Malcolm Dunlop, RAL; Prof. Kathy Whaler, Edinburgh). Contributions are solicited from the whole range of scientific disciplines which may make constructive use of Swarm data. With encouragement, this meeting would be extended to provide a timely forum for broader community discussions to generate a detailed proposal to the NCEO for support of geomagnetic earth observation research.