Report on the Workshop "Global models and data assimilation strategies", 5 May 2006 at the 1st Swarm International Science Meeting, Nantes

S. Maus[(1)], G. Hulot[(2)], G. Egbert[(3)], and T. Sabaka[(4)]

[1]CIRES, University of Colorado, and NOAA's National Geophysical Data Center, 325 Broadway, Boulder, CO 80305, USA, Email: stefan.maus@noaa.gov
[2]IPGP - Boite 89 - 4 place Jussieu - 75252 Paris cedex 05, Email: gh@ipgp.jussieu.fr
[3]Oregon State University, 104 Ocean Admin Building, Corvallis, OR 97331-5503, USA, Email: egbert@coas.oregonstate.edu
[4]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, Email: sabaka@geomag.gsfc.nasa.gov

ABSTRACT

The Swarm mission will provide a wealth of highly accurate measurements of the magnetic field, the electric field, and related properties of the ambient ionosphere. Building new models from this data and assimilating data into existing models presents a veritable challenge to the geomagnetic field modeling community. This workshop was held to assess the present state of models related to the geomagnetic field, discuss the utility of data assimilation strategies and formulate recommendations to ESA for supporting research, production and dissemination of Swarm-related models.

WORKSHOP OVERVIEW

A workshop on *Global models and data assimilation strategies* was held by G. Egbert, S. Maus and T. Sabaka. The 3-hour workshop started with an overview by *Stefan Maus* of the University of Colorado on already existing global models relevant to geomagnetism. Depending on the data sources used, geomagnetic field models extend over thousands of years (archeomagnetic measurements), hundreds of years (magnetic observatories and shipborne declination), or encompass only the most recent period with high resolution satellite data coverage. With increasingly accurate measurements, smaller and smaller effects have to be taken into account, necessitating the use of models for related parameters of the ionosphere, thermosphere and magnetosphere.

These models can be classified into

- Climatological models which represent the relevant quantities as an empirical average of conditions characterized by the local time, season, and indices for solar and magnetic activity
- Physics-based models which compute the relevant quantities as a consequence of given starting values and boundary conditions
- Assimilative models which provide a full temporal characterization of the system, carrying the system forward using all available observations.

In practice, different types of models are often used in combination. In particular, assimilative models require an underlying physics-based model. Numerous models already exist, some are open source, or are readily available from their authors, and it was recommended here that new modeling efforts should build on existing resources.

Gary Egbert of Ohio State University provided an overview of data assimilation strategies which could be used in geomagnetic field modeling. He argued that it was time that dynamic information was incorporated into modeling the geomagnetic field. In particular, he pointed out the need for more complex source characterizations of the external electric currents, in order to enable 3D conductivity mapping of the Earth's mantle. The relevant data assimilation techniques were introduced and illustrated by using the example of Ohio State University's Inverse Ocean Modelling (IOM) system.

Following these two presentations, a final discussion touched a number of issues relevant to the modeling activities surrounding Swarm:

It was pointed out that the extensive assimilative modeling efforts in the space weather community require near-real-time availability of measurements. With the foreseen latency of several days, Swarm data will be of limited interest to that community.

In view of the success of the Community Coordinated Modelling Center, it is suggested that a similar level-2 modeling facility should be initiated and supported by ESA. This facility should be the point of contact for users requiring higher-level Swarm products.

It was further recommended that models be produced in a modular way, in order to enable users to individually select and combine parts from different models, representing, for example, the core, crustal and ionospheric fields.

Indices can provide a simple and efficient way of characterizing the space environment. They also provide an important input to climatological models. It was therefore suggested that the production of new indices from Swarm data should be explored and supported.

Magnetic observatories provide a temporal characterization of the magnetic field at a fixed location, supplementing the spatio-temporal information from satellites. Furthermore, their location beneath the ionosphere offers important complementary information. The importance of the worldwide network of magnetic observatories and variometers was pointed out, and the particular role of

the Intermagnet organization was emphasized.

Analysis of Swarm data may benefit from the availability of datasets from earlier satellite missions. The importance of having access to Magsat, Oersted, Champ and SAC-C data was emphasized and it was suggested that ESA could possibly act as a long-term archive for those mission that do not have one.

One of the science objectives of the Swarm mission is to narrow the spectral gap between satellite crustal magnetic field models and continental scale magnetic compilations of marine and aeromagnetic data. This objective is closely linked to the scope of the International Association of Geomagnetism and Aeronomy's working group for the World Digital Magnetic Anomaly Map. It was proposed that ESA should lend its support to the activities of this working group.

CONCLUSIONS AND RECOMMENDATIONS

This workshop illustrated that modeling efforts from Swarm data can build on substantial experience and resources of the wider geoscience community. On the other hand, it also became clear that the efficient production of models from Swarm data would benefit from an active engagement and support by ESA. In particular, it was recommended that ESA set up a level-2 product facility and that ESA should offer support for model-related research activities.