WORKSHOP ON MAGNETIC FIELD LEVEL 1b CAL/VAL

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INTRODUCTION

A dedicated workshop on the Calibration and Validation (CAL/VAL) of Swarm Level 1b (L1b) Magnetic Field products was held on the afternoon of June 25 as part of session 6 of the *Second Swarm International Science meeting*.

Several activities proposed by the workshop participants for in-orbit verification are currently already under preparation by ESA but not yet publically described. As a consequence, the discussion during the workshop largely concentrated on activities that

- require a "scientist in the loop",
- take advantage of the Satellite constellation (as opposed to single-satellite approaches).

An important issue raised during the workshop was whether all necessary data to carry out the proposed validation procedures would be available as Level-1b products or whether additional information contained only in the lower level products would be required. To partly address this question, L. Tøffner-Clausen (DTU Space) presented an overview of the contents of the (magnetic) L1b products.

It was also discussed whether there could be wake effects in the magnetic (and/or electric) field data. Since the CHAMP satellite will be rotated into a Swarm-like attitude during re-entry (expected mid-2010) with the boom facing backwards, analyzing CHAMP data gained during this re-entry is expected to help to solve this issue.

Ideas for possible CAL/VAL activities of the Level 1b data were presented by the following groups:

- GSFC (presented by M. Purucker)
- GFZ (presented by V. Lesur)
- IPGP (presented by A. Chulliat)
- DTU (presented by L. Tøffner-Clausen)
- NGDC (presented by S. Maus)

EXAMPLES OF POSSIBLE CAL/VAL ACTIVITIES

Pre-requisite for most CAL/VAL activities is an accurate magnetic field model, to be subtracted from the observations. The above listed groups are experts in deriving such field models and will make these models available for CAL/VAL activities.

The following list summarizes possible approaches for validation of L1b data that have been suggested during the workshop:

- Approaches in connection with magnetic field modeling
  - Tools: looking at residual statistics (mean, variance)

  - Residual statistics in dependence of time shift of the various parameters (position, vector data, attitude data, ...)
  - Inter-comparison of the residuals of the different satellites
  - Estimation of a $n = 0$ term (magnetic monopole) in a spherical harmonic expansion of the magnetic potential allows for verifying the condition $\mathrm{div}\mathbf{B}_{\mathrm{obs}} = 0$
  - Assessment of the in-flight calibration of the VFM
- Track-by-track detection of spikes, jumps (single- and multi-satellites)
  - Tools: Second time derivative, Fourier transform
  - Challenge: How to distinguish sensor effects from geophysical effects (e.g. plasma bubbles)? A proper decision can only be made by an experienced scientist after careful multi-sensor analysis.
- Looking for timing errors, thermal/shadow and radiation control, linearity and cross-talk between the magnetometers
  - Tools: Auto- and cross-spectra between ASM (VFM) of Swarm A and B (and C, when nearby)
  - Coherencies to identify wavelength resolution of crustal field
- Computation of field gradients between satellites
  - Comparison with gradients expected from crustal field model
- Euler angle determination, verification, and stability check
  - Estimation using a-priori field model vs. co-estimation with field model
  - Single-satellite vs. multi-satellites approach

Further issues raised during the workshop were how to verify and merge the (possibly conflicting) attitude information from the three star imager (STR) heads, and how to verify the relative timing between the different instruments.