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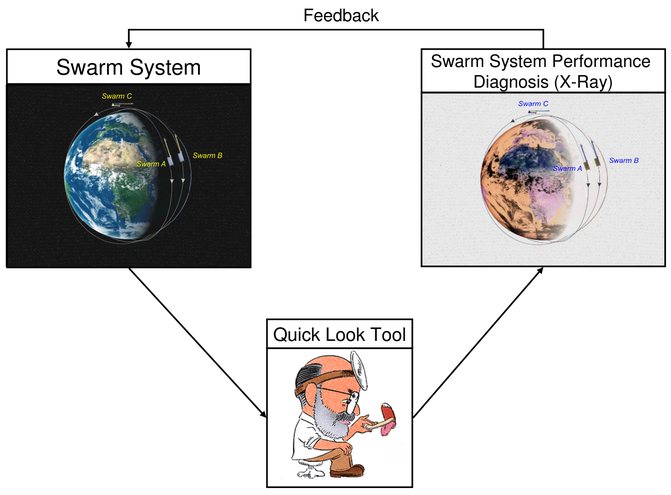
The Swarm satellite mission

The objective of the Swarm mission is to provide the best ever survey of the geomagnetic field and its temporal evolution, and gain new insights into improving our knowledge of the Earth's interior and climate. The Swarm concept consists of a constellation of three satellites in three different polar orbits between 490 and 530 km altitude. High-precision and high-resolution measurements of the strength and direction of the magnetic field will be provided by each satellite. In combination, they will provide the necessary observations that are required to model various sources of the geomagnetic field. The planned operational lifetime is 48 months, after a 3-month commissioning phase. Analysis of the Swarm data will greatly improve existing and provide new models of the near-Earth magnetic field of high resolution and authenticity compared to a single-satellite mission. This will provide the prospect of investigating hitherto undetected features of the Earth's interior.

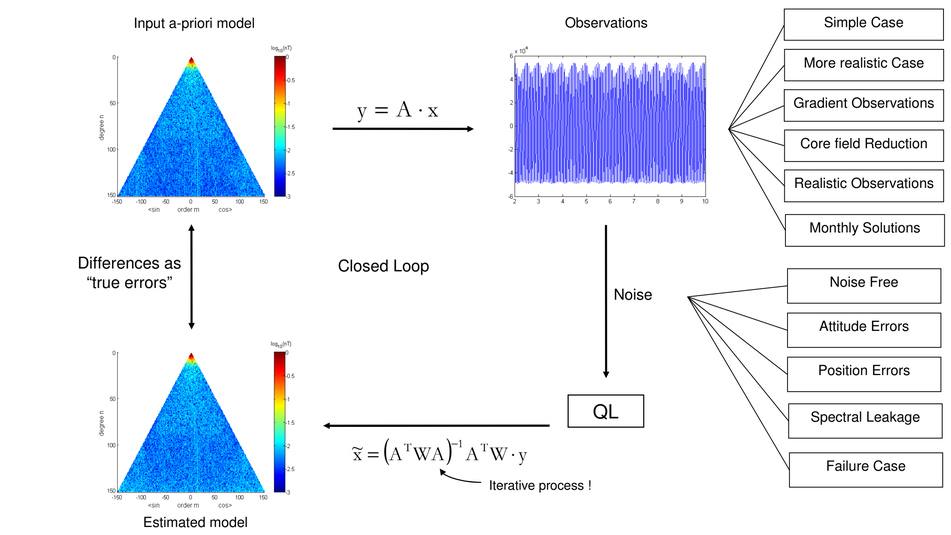
Quick-look tool

- Fast diagnosis for the Swarm system performance
- Fast feedback of the quality of produced data
- Static field only
- Single or Multi satellite approach
- Least squares adjustment
- Approximative solution strategy



1

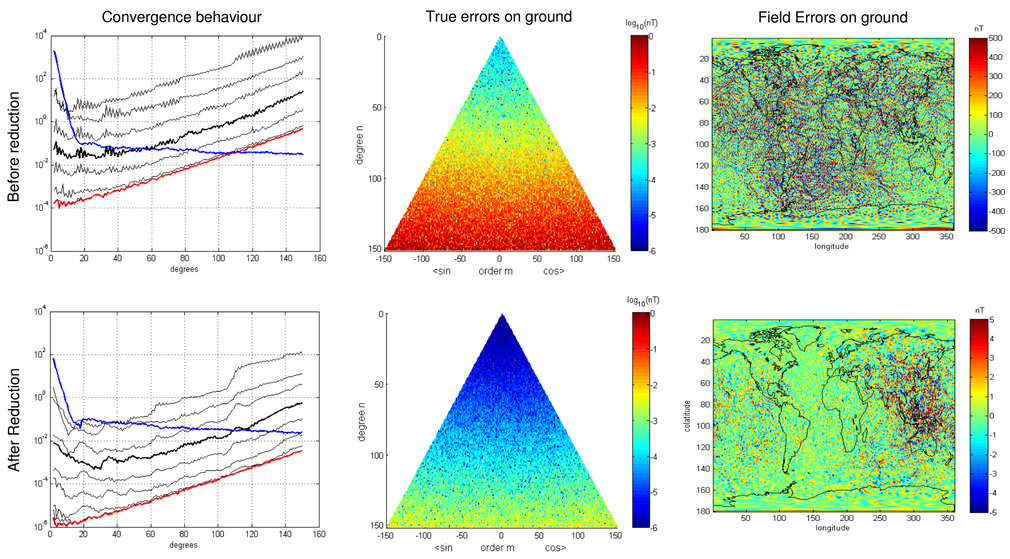
Closed loop simulation



- Investigation of the effects on the reconstruction of the static core and lithospheric magnetic field resulting from various error sources
- QL uses iterative approach, i.e. Conjugate Gradient
- Two major cases investigated:
  - Lithospheric field retrieval
  - Core and Lithospheric field retrieval
- Different scenarios investigated for each case
- Different noise levels applied for each scenario (white noise)

2

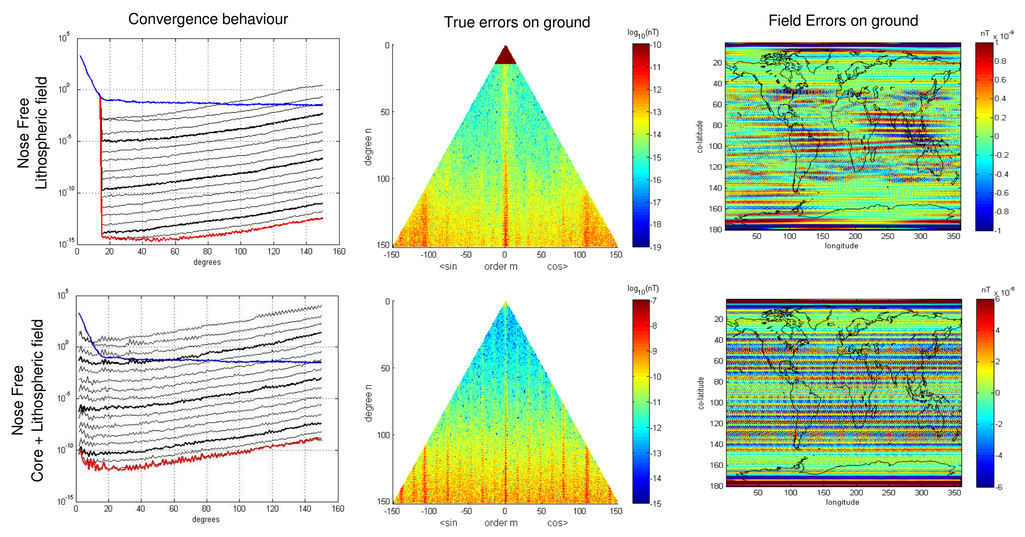
Core Field Reduction



- ⇨ Core field reduction by an independent IGRF model[3] leads to improved retrievals
- ⇨ Deviations between the reference model & observations influence the ground field errors
- ⇨ Attitude error of 1 arcsec applied
- ⇨ Uniformly distributed true errors and increasing for increasing degree

3

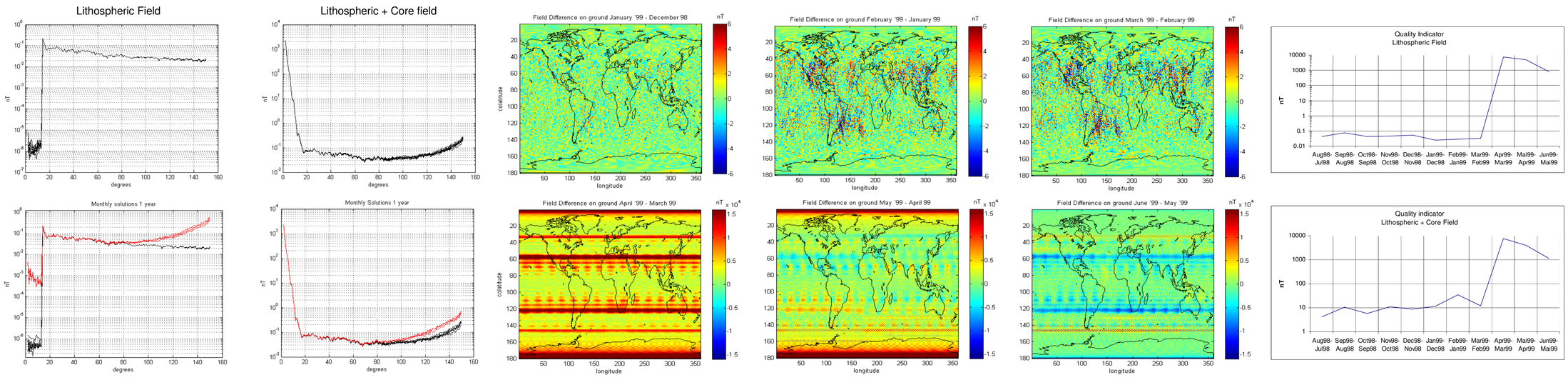
Noise free case



- ⇨ Enhanced error structures above order 100 in the simple case (poor spatial resolution)
- ⇨ Enhanced error structures in the zonal coefficients (polar gap)
- ⇨ Bigger true errors when the core field is included (Core – lithospheric field coupling)
- ⇨ Enhanced error structures at certain orders (Swarm orbit daily revolution frequency)

4

Monthly Solutions



- ⇨ Error/failure of Swarm system represented as 5nT bias
- ⇨ System error/failure applied for 3 months starting after a few months
- ⇨ Clear separation of the biased monthly solutions for the LF Case
- ⇨ Detectable separation of the biased monthly solutions for the LF+CF Case
- ⇨ Time series of monthly solutions
- ⇨ Quality indicator
- ⇨ Clear separation of the biased monthly solutions in terms of field errors on ground
- ⇨ System error/failure starting in April

5

Conclusions & Outlook

The Quick Look tool software package could provide a fast diagnosis of the Swarm system performance during all mission phases of the spacecraft. At first only the Earth's lithospheric field is considered and at second the core field is also included. For each case closed loop simulations are performed covering three different scenarios. The noise free scenario generally demonstrates that the Quick Look software package works. The model is reconstructed fast and with good accuracy in both cases. The core – lithospheric field coupling imposes a worse retrieval accuracy in case the core field is included. Therefore, reducing the core field by an independent reference model improves the lithospheric field retrieval significantly. Finally, monthly magnetic field retrievals are performed for one of the lower orbiting Swarm satellites and they are compared against each other in terms of degree RMS values and field differences on ground. Deviations of monthly solutions indicate a change in performance and therefore a possible error/failure in the Swarm system.

The next step to be performed in the near future is the extension of the monthly solutions to include other sources (e.g. magnetospheric field). As a conclusion, this study provides a reference on how the errors interfere and propagate into the models whereas the results indicate that through model retrievals there is a potential for further elaboration and development of the Quick Look tool as a quality monitoring support.

1 ESA, Mission Science Division
2 DTU - Space
3 http://www.ngdc.noaa.gov/IAGA/vmod/