A new strategy for aeromagnetic survey merging and application to Greenland

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Introduction

We present a new approach to process large aeromagnetic surveys with a block-wise equivalent layer approach. The new technique is applied to Greenland, where a large number of aeromagnetic surveys exist. Processing the entire data base (ca. 1.6 Million data points) at once is numerically expensive, and challenging to account for the highly variable data coverage and resolution.

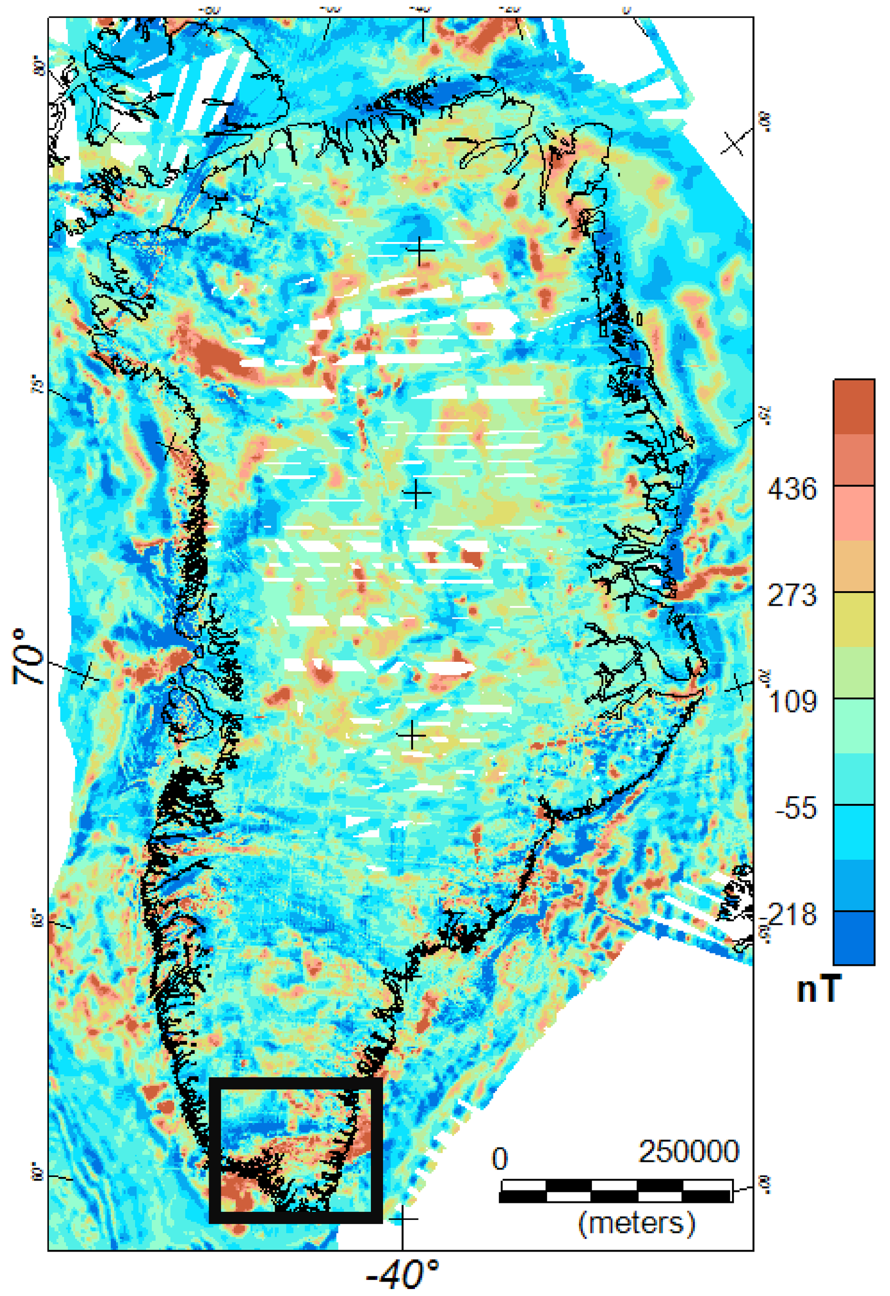

Fig. 1: aeromagnetic data of Greenland with good data coverage on coastlines and bad data coverage in the central. The black box shows the example area in southern Greenland.

Block-wise Inversion

The basis of our approach is an iterative linear inversion of equivalent sources with Tikhonov regularization. We replace a regular grid of dipoles at a constant depth and invert for the dipole strength, that best explains the measured data. Purely induced magnetization is assumed. The processing is carried out in blocks and the block size as well as spacing and depth is decreased iteratively.

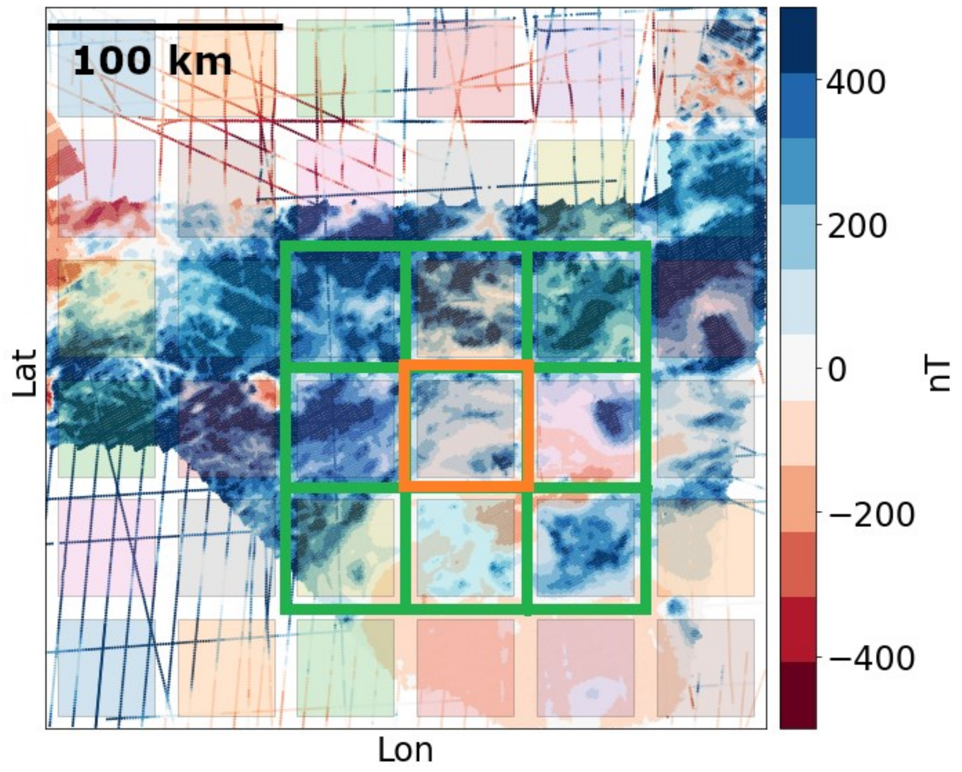

Fig. 2: We define blocks of specific size with a central block as near field (orange) and the directly surrounding as far field (green). Points beyond these blocks are assumed to be neglectable.

Multi-layer approach

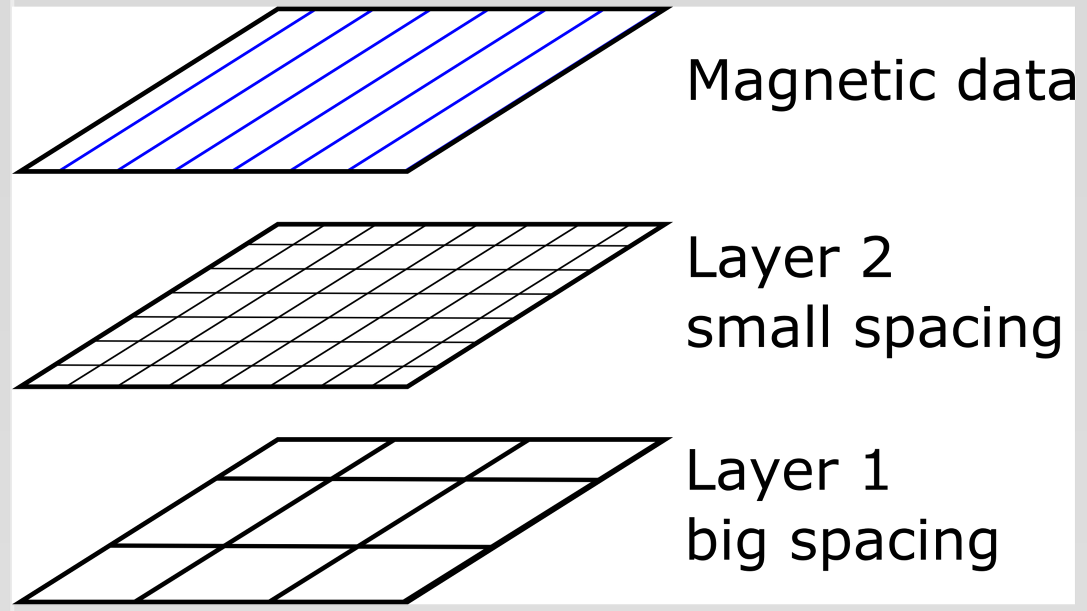

Fig. 3: Concept of the multi-layer approach to represent different wavelengths of the magnetic data. We start with a layer with big spacing and applying a layer with small spacing to the residuals of the previous step.

The first step of the multi-layer approach only accounts for large-scale structures, leading to high residuals. As the spacing is reduced, the residual amplitude decreases and becomes more spatially confined.

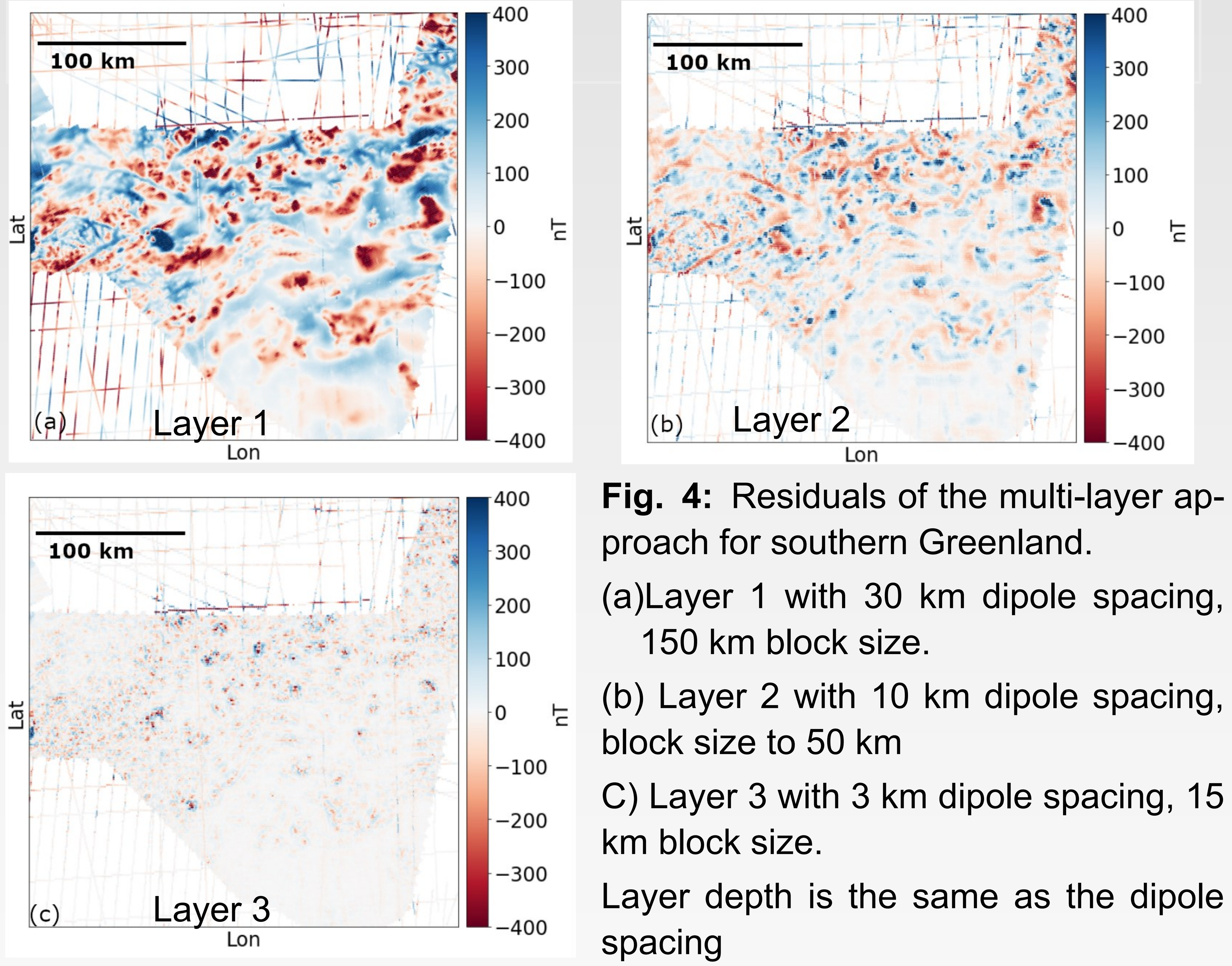

Fig. 4: Residuals of the multi-layer approach for southern Greenland.

(a)Layer 1 with 30 km dipole spacing, 150 km block size.

(b) Layer 2 with 10 km dipole spacing, block size to 50 km

C) Layer 3 with 3 km dipole spacing, 15 km block size.

Layer depth is the same as the dipole spacing

Calculation example southern Greenland with 91 599 data points:

Our approach: RMS 74.9 nT time: 91 s

Full inversion: RMS 80.5 nT time: 117 s

Advantages

The new approach ensures both a good representation of the large and small-scale structures as well as reasonable computational costs. Great dipole spacing and depth cannot resolve small anomalies, small dipole spacing and depth has difficulties to fit large scale anomalies. The unblocked Inversion cannot calculate large study areas and struggles with small dipole spacings and depths due to limited memory.

Summary

The iterative, blocked inversion by splitting allows to effectively merge the different surveys for Greenland. The multi-layer strategy separates regional and local sources, leading to an implicit multi-resolution grid, fit for multiple applications, e.g. to enhance the sub-ice geology in Greenland.

Further improvements can be made by replacing the long wavelength part of the compilation with corresponding satellite data.

Outlook

Presently, all blocks are handled with same size and constant dipole spacing and depth in each layer though data coverages varies. This could lead to unwanted effects. A possible solution is to adaptively adjust the dipole spacing according to data coverage.

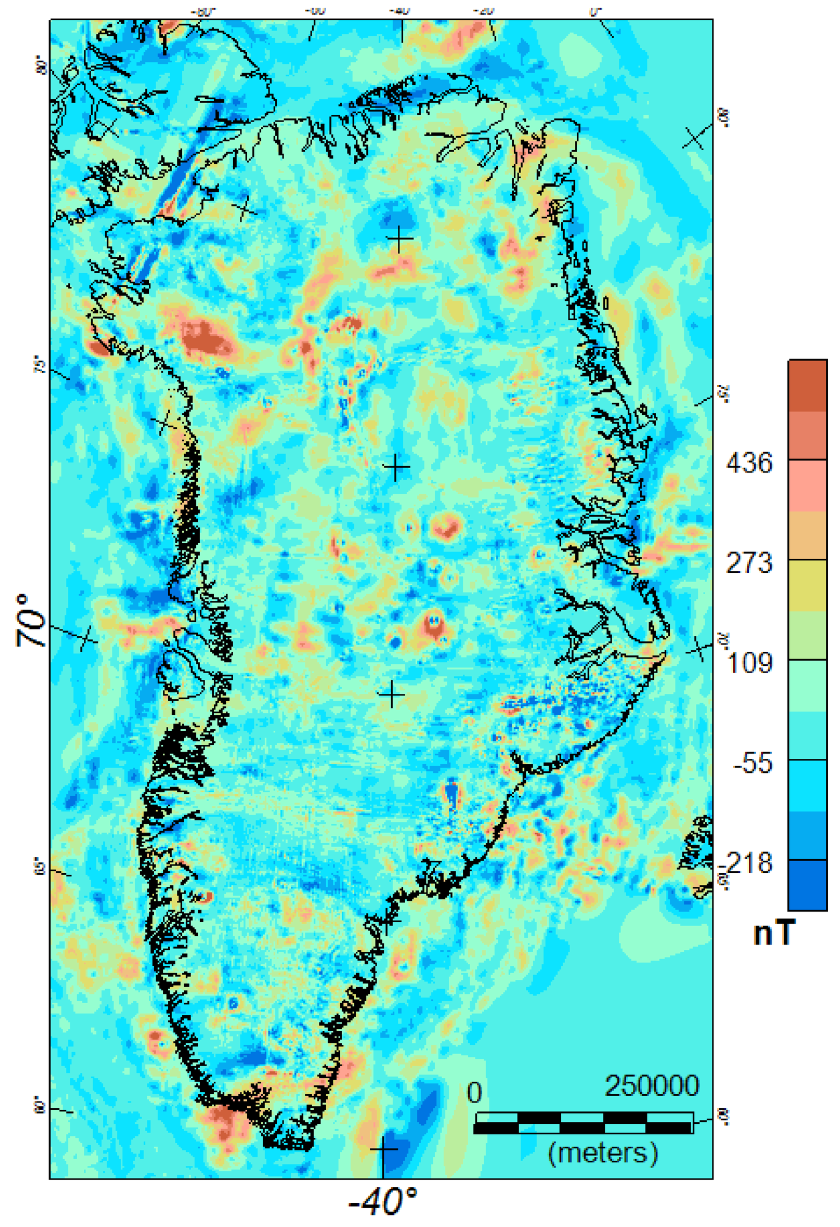

Fig. 5: Final compilation with 30 km, 10 km and 3 km dipole spacing and depth and replacing long wavelength with satellite data

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