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A lithospheric magnetic field model to spherical harmonic degree 1300

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SUMMARY

Detailed mapping of the Earth's magnetic field brings key constraints on the composition, dynamics, and history of the crust. Satellite and near-surface measurements detect different length scales and are complementary. Here, we build a model, selecting and processing magnetic field measurements from the German CHAMP and ESA Swarm satellites, which we merge with near-surface scalar anomaly data. We follow a regional approach for modeling the magnetic field measurements and next transform the series of regional models into a unique set of spherical harmonic (SH) Gauss coefficients. This produces the first global model to SH degree 1300 derived by inversion of all available measurements. The new model agrees with previous satellite-based models at large wavelengths and fits the CHAMP and Swarm satellite data down to expected noise levels. Further assessment in the geographical and spectral domains are in progress but preliminary results show that the model is stable when downward continued to the Earth's surface.

ALGORITHM

We apply a procedure developed during the Swarm preparation phase (Thébault et al., 2013). We consider the Swarm A and C (A/C) measurements from March 2014 to August 2022 (baseline 0602) and the last 2 years of the CHAMP data (2008-2010). We select night time (23LT-5LT) vector/scalar measurements corresponding to Dst value lower than ± 5 nT, Kp index smaller than 2 σ and $|\text{IMFBy}| < 2$ nT and $\text{IMFBz} > 0$. The measurements are corrected for the main and external magnetic fields. Along-track scalar and vector gradients for Swarm and CHAMP and across track Swarm A/C gradients are built. We extend the satellite dataset with the World Digital Magnetic Anomaly grid data (WDMAM 2.0: Lesur et al., 2015) at 5 km altitude above the Earth's surface. The full dataset ($> 110 \cdot 10^6$ data) is processed by a series of 700 equally distributed regional models derived to 30 km resolution, which are then transformed into Spherical Harmonics to SH degree 1300 (Thébault et al., 2021).

THE LITHOSPHERIC MAGNETIC FIELD MODEL

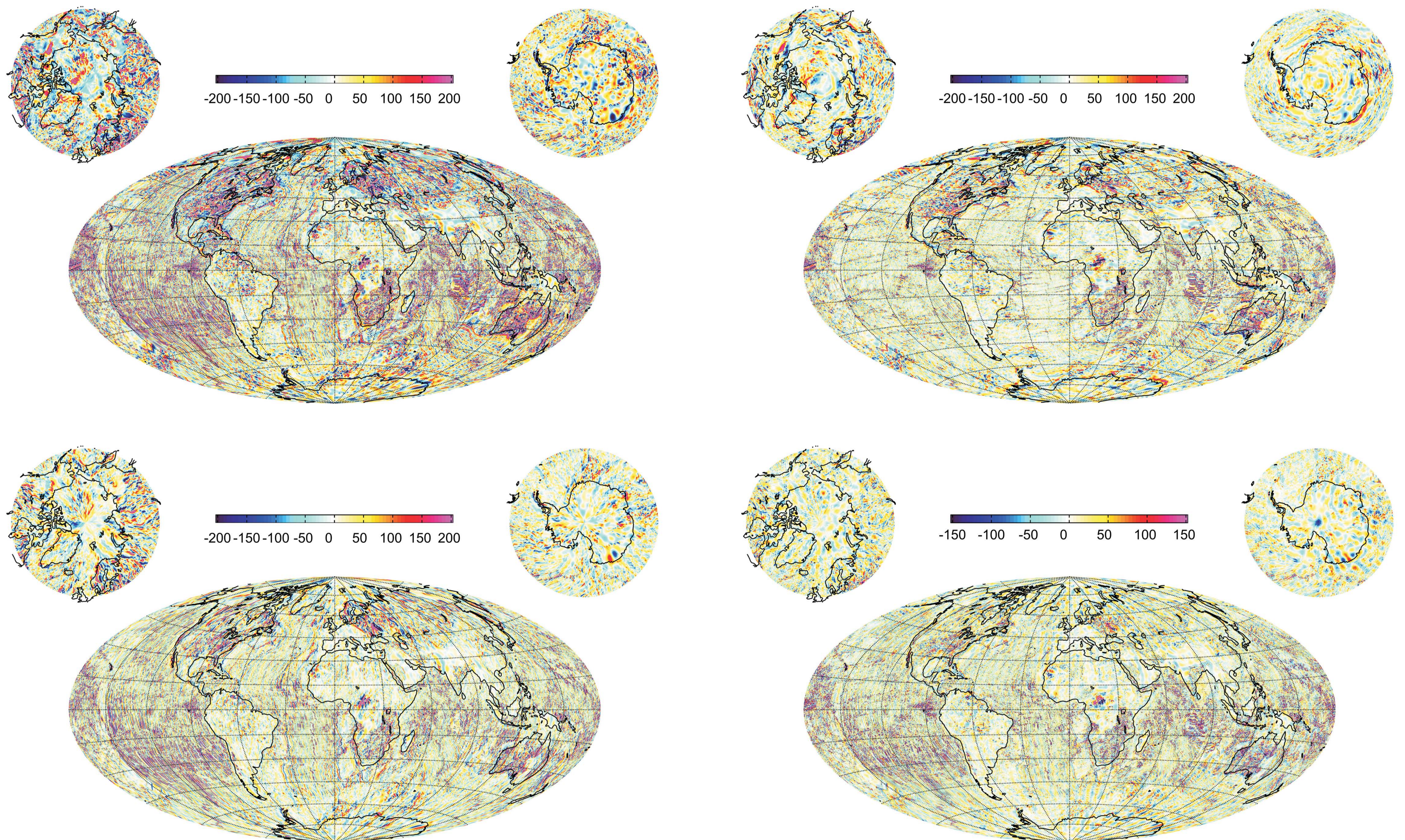


Figure : (top left): Down vertical component; (top right) North component ; (bottom left) East component ;(bottom right) residuals between the anomaly field predicted by the SH model and the WDMAM scalar anomaly gridded data. Projections are Mollweid. The field components in the unit of nT are sketched at the Earth's mean radius to SH degree 1300.

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