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esa SWARM L2

Swarm satellites in EM induction studies

Alexander Grayver, Alexey Kuvshinov — *Institute of Geophysics, ETH Zurich, Switzerland*
Nils Olsen, Lars Tøffner-Clausen — *DTU Space, Denmark*
Terence Sabaka — *Geodesy and Geophysics Laboratory, NASA, USA*

Motivation

- There exists no single EM induction source that is sensitive to the whole mantle.
- We need to integrate several natural sources in order to bridge across the scales.
- On the global scale, the most promising methodology is to combine magnetospheric and ocean tidal signals to image mantle under both continents and oceans.

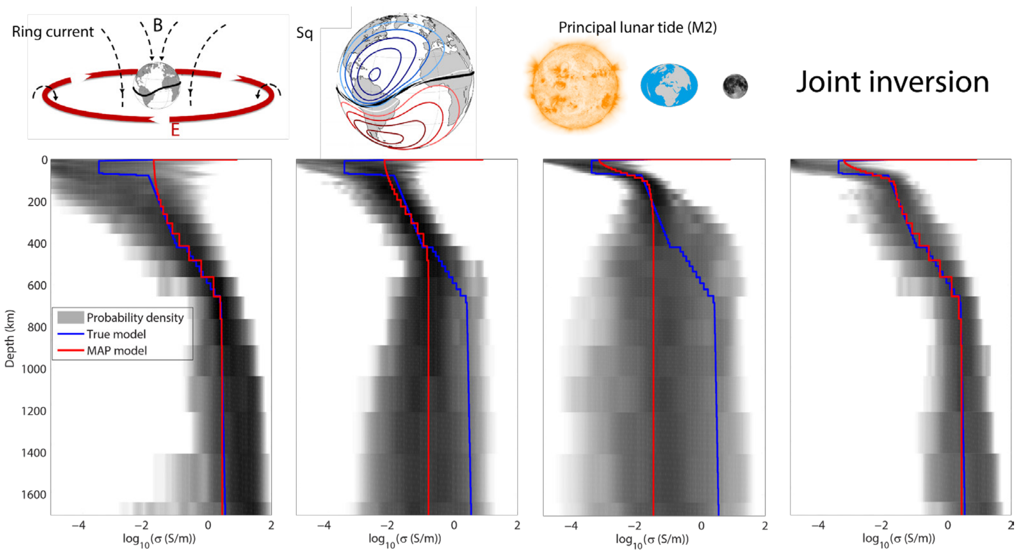

Figure: Individual and joint inversions for a synthetic conductivity profile.

SWARM Data

Magnetospheric source:
- Four years of SWARM data enable us to reliably estimate C1-response up to the period of six months.
- The responses become biased if too simplistic source assumption is assumed. Therefore, we include spherical harmonic terms up to degree n = 2 when estimating magnetospheric source.

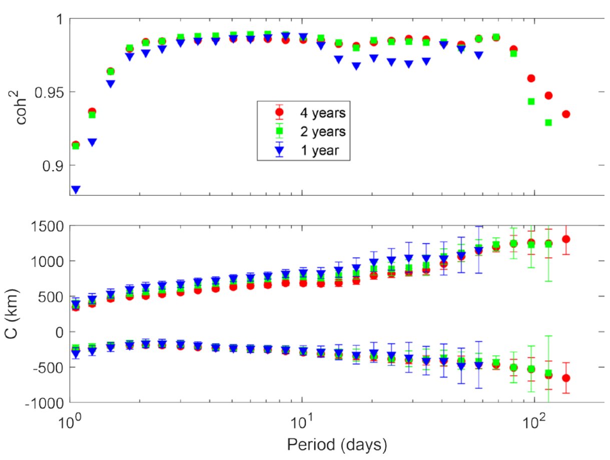

Figure: C1-responses estimated using different lengths of Swarm time series.

Principal semi-diurnal lunar M2 tide:
- M2 magnetic field is co-estimated from the four years of SWARM data.
- The noise level is significantly lower compared to CHAMP data (Sabaka et al. 2015).
- The spectrum for the SWARM signal has systematically higher level than spectra based on synthetic and CM5 data for n < 15.

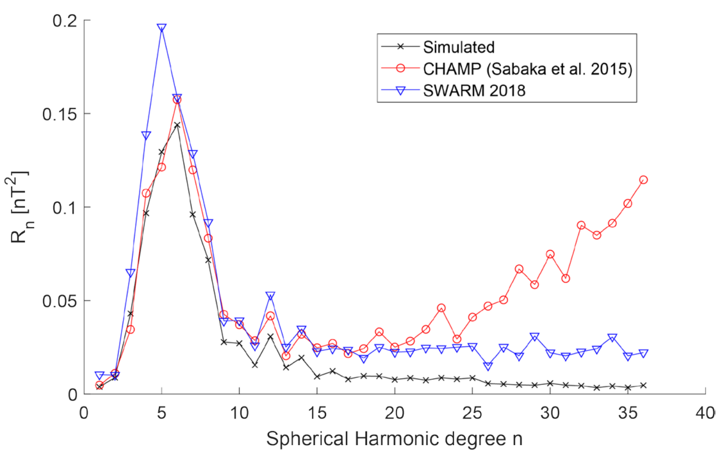

Figure: Spherical harmonic spectra for tidal magnetic signals at the ground level.

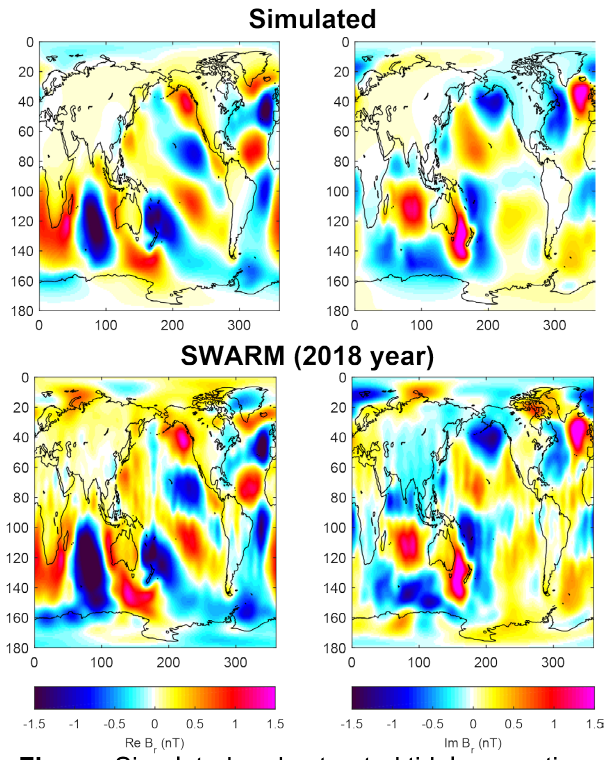

Figure: Simulated and extracted tidal magnetic signals at 430 km altitude.

Inversion results

- We inverted magnetospheric responses and tidal magnetic signals detected by SWARM and CHAMP (Grayver et al. 2017).
- Full 3D forward operator was used to account for the ocean-induced effect.
- The global conductivity model has been derived in the whole mantle depth range, thereby improving resolution of individual inversions.
- Retrieved conductivity profiles are compatible with a pyrolytic composition and a moderate mantle water content.

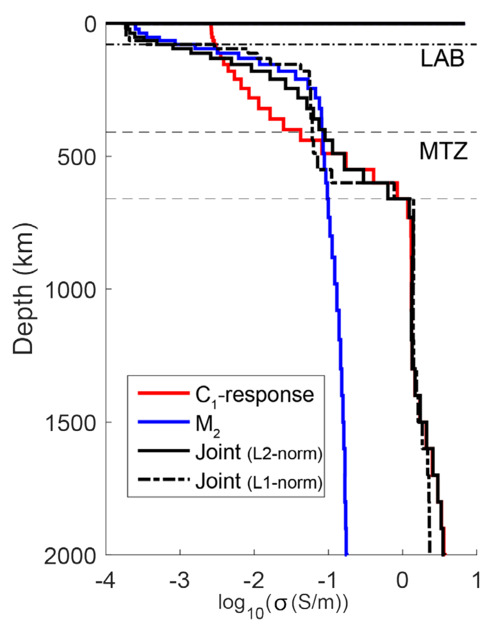

Figure: Conductivity profiles retrieved from individual and joint inversion of satellite data

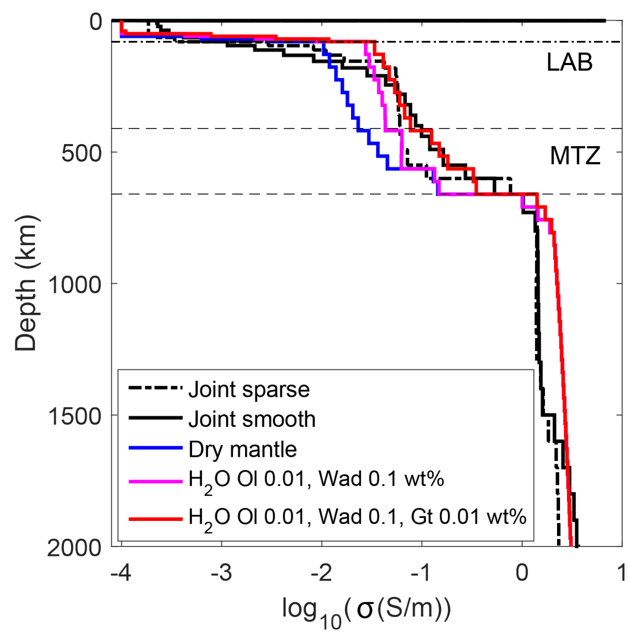

Figure: Comparison of the recovered models with the lab-based conductivity profiles.

References:

Grayver, AV, Munch, FD, Kuvshinov, AV, Khan, A, Sabaka, TJ, Tøffner-Clausen, L. 2017, Geophysical research letters, 44(12).
Sabaka, TJ, Olsen, N, Tyler, RH, & Kuvshinov, A. 2015, Geophysical Journal International, 200(3).

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