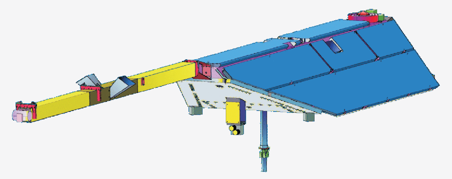

http://geomag.org

Where do we stand on identifying motional ocean induction signals in satellite magnetic data?

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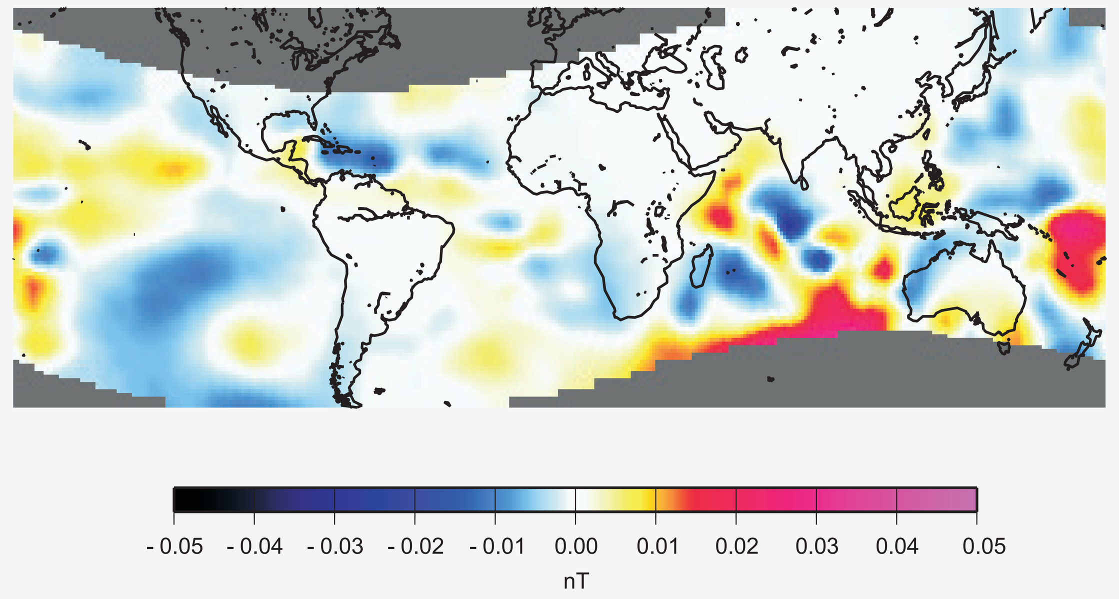
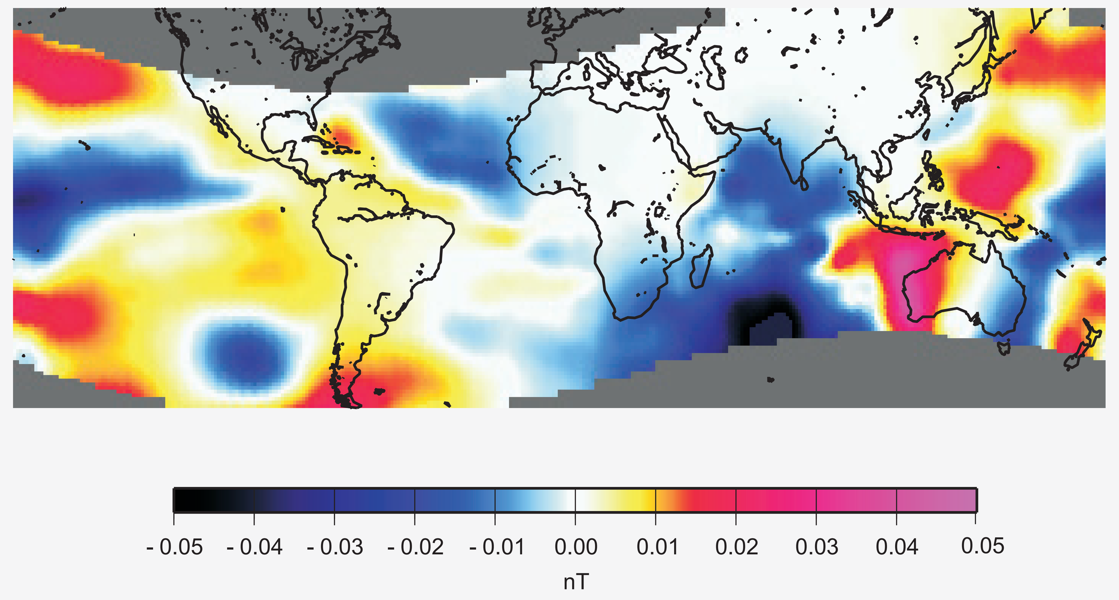
Prediction

The magnetic signal was predicted using the method of Manoj *et al.* (2005) from the ECCO ocean circulation model annual variation during the years 2000-2006.

Winter-summer difference

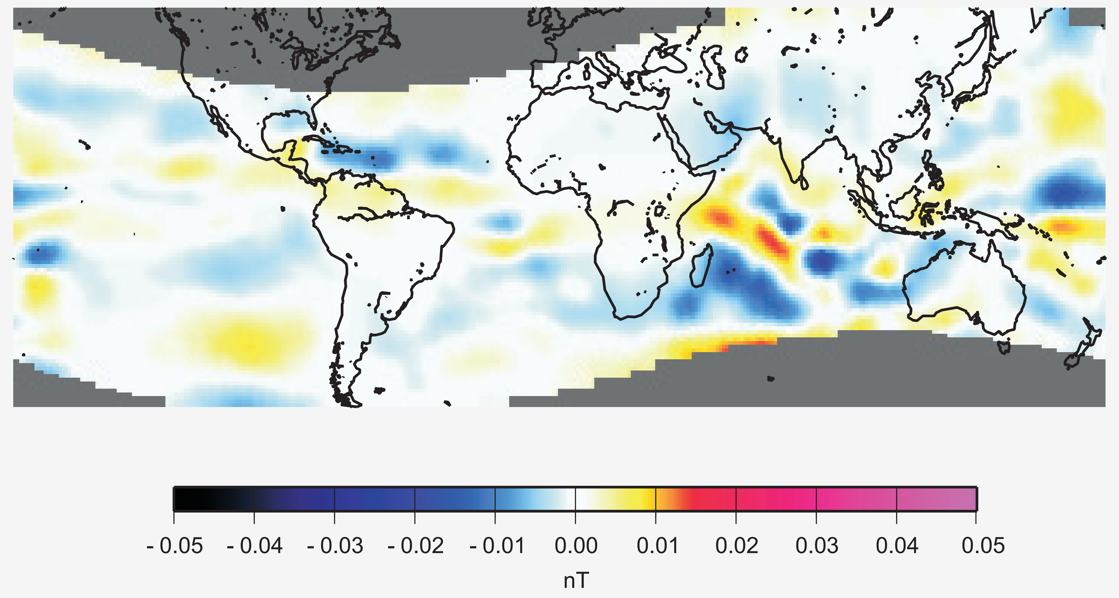


Fall-spring difference

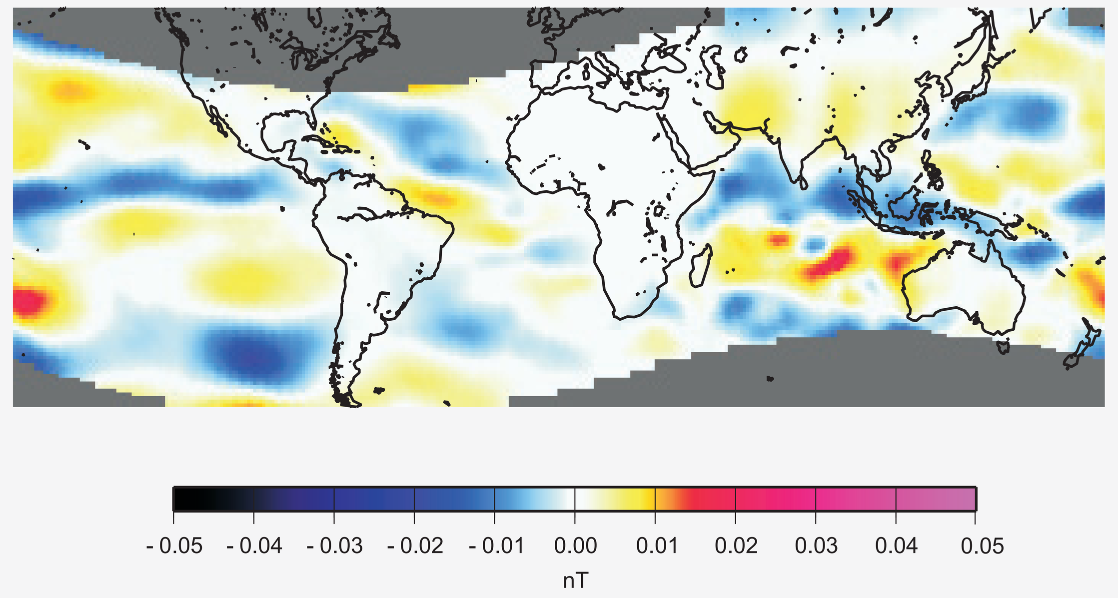


filtered

Winter-summer difference



Fall-spring difference



Introduction

After the successful identification and mapping of the M2 ocean tidal signal in CHAMP magnetic field measurements (Tyler *et al.*, 2003), no further significant progress has been reported in inferring motional ocean induction signals from satellite data. Apart from the necessity to resolve remaining disagreements between model predictions and observations of the M2 tidal signal, the next important step is to find evidence of non-tidal ocean flow signals. Unfortunately, the steady ocean circulation signal is practically indistinguishable from the crustal magnetic field. Efforts have therefore concentrated on identifying signals of annual variations in ocean currents. Model simulations indicate that these signals have amplitudes of the order of only 0 05 nT at satellite altitude. In an unpublished study in 2004, these signals were found to be masked in CHAMP residuals by noise levels of around 0.5 nT.

With advances in field modeling and the decreasing altitude of the CHAMP satellite under solar minimum conditions, we make another attempt here at identifying these small signals.

Results and conclusions

We track-by-track filtered magnetic field residuals from 7 years of data from the CHAMP scalar OVM magnetometer (for $Kp \leq 2$) and estimated the annual variation. For comparison, the predicted annual variation of the magnetic signal of steady ocean circulation was filtered in the same way.

As expected, we find that annual variations of ionospheric signatures strongly dominate over annual variations of oceanic signals, by a factor of ten.

Applying a correction for the ionospheric diamagnetic effect (Lühr *et al.*, 2003) and selecting passes at low plasma densities failed to reduce the ionospheric contamination.

A promising finding is that the contamination by ionsopheric currents is much reduced when comparing fall-spring differences. This is understandable, since ionospheric currents are similar during both equinoxes. In contrast, there is a significant difference in the steady ocean flow between spring and fall.

References

Lühr H., M. Rother, S. Maus, W. Mai, D. Cooke; The diamagnetic effect of the equatorial Appleton anomaly: Its characteristics and impact on geomagnetic field modeling, *Geophys. Res. Letts.*, 30 (17), 1906, doi:10.1029/2003GL017407, 2003

Manoj, C., Kuvshinov, A., Maus, S. and Lühr, H., Ocean circulation generated magnetic signals, Swarm special issue of Earth Planets and Space, Vol. 58 (No. 4), pp. 429-437, 2006

Tyler, R., Maus, S., Lühr, H., Satellite observations of magnetic fields due to ocean tidal flow, *Science*, vol. 299, 239-241, 2003

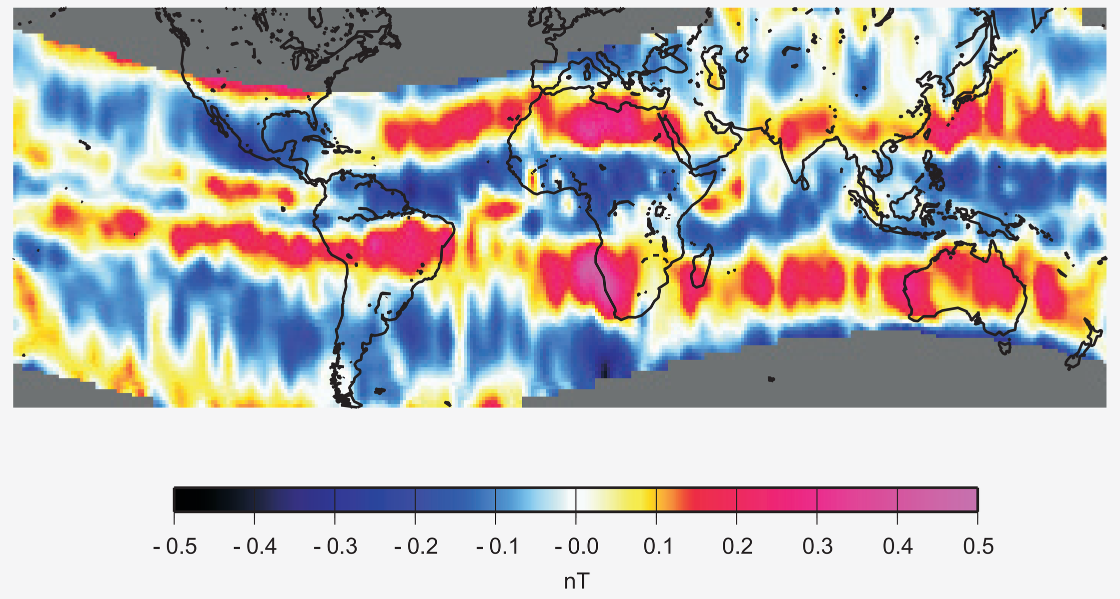
Observations (filtered)

CHAMP residuals from the scalar Overhauser magnetometer for 2000-2007.

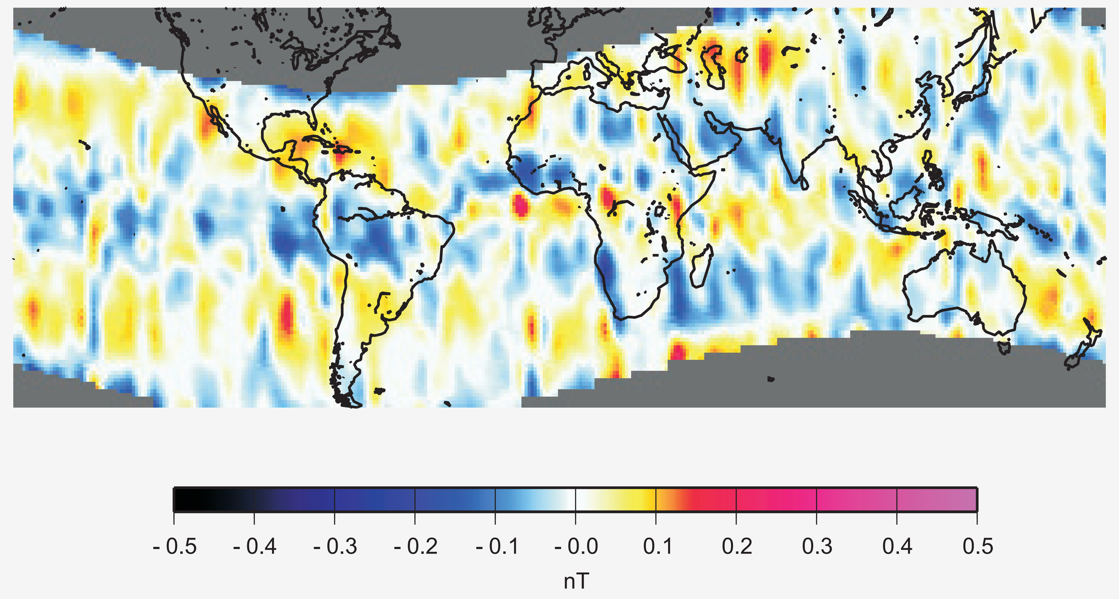
Criteria: Kp < 2, 20 < LT < 05, resulting in 12,000 passes.

While there appears to be some similarity between observation and prediction for fall-spring, note the different color scales!

Winter-summer difference



Fall-spring difference



... after plasma correction

To reduce ionospheric noise, we applied a diamagnetic correction, using the plasma density readings from the CHAMP Langmuir probe (Lühr et al., 2003).

Furthermore, all passes with diamagnetic corrections exceeding 0.2 nT were rejected, resulting in 3000 remaining passes.

The result is still dominated by ionospheric noise.