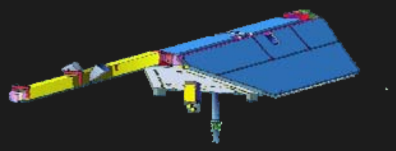
Field models from CHAMP data:
The main field model POMME-3 and the lithospheric field model MF4

- Main field
- Crustal field
- Magnetosphere + induced
- F-region ionospheric fields
- Ocean tidal fields
- Outlook and summary

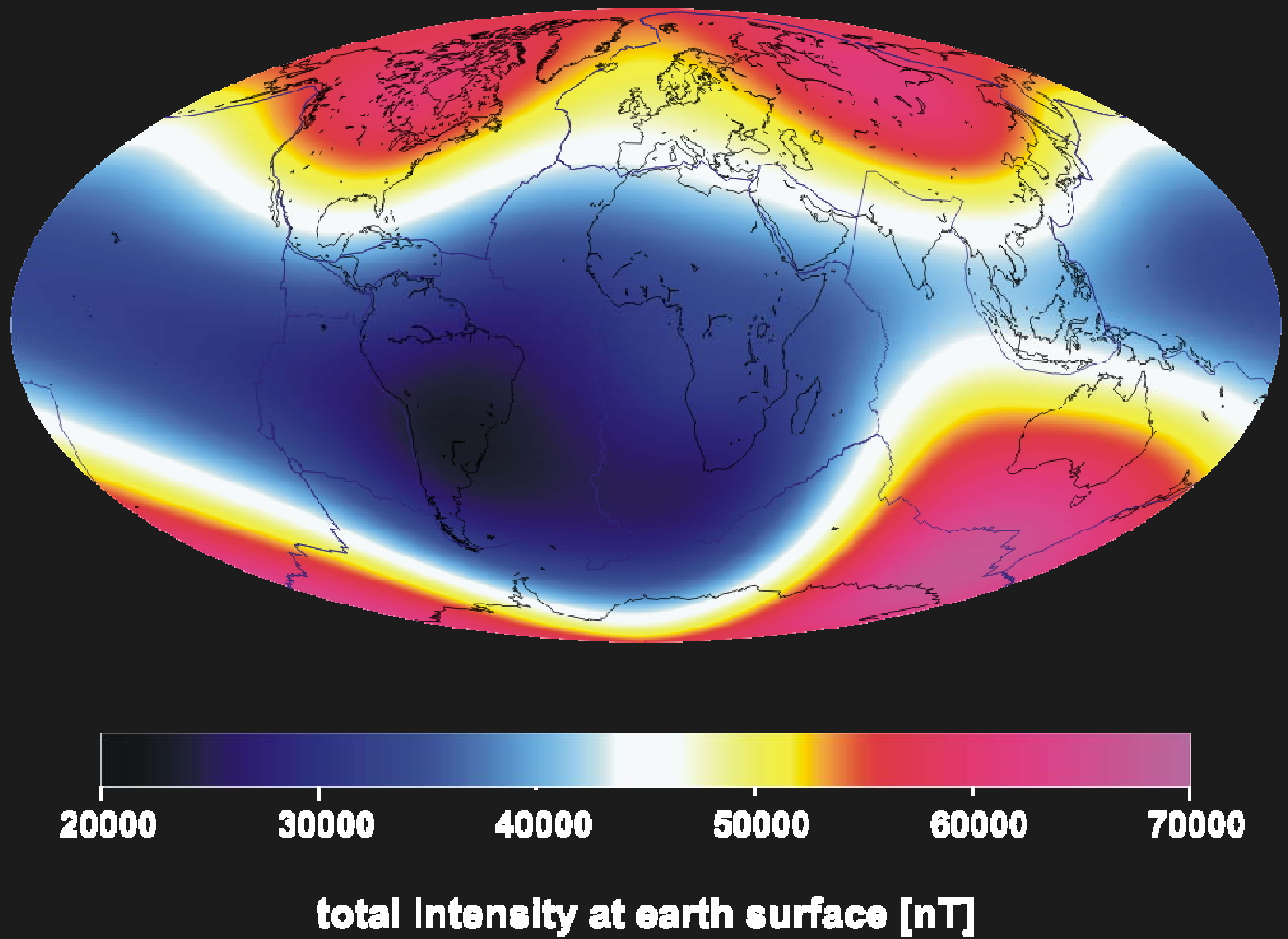
Stefan Maus (CIRES, NGDC), Martin Rother and Hermann Lühr (GFZ, Potsdam)



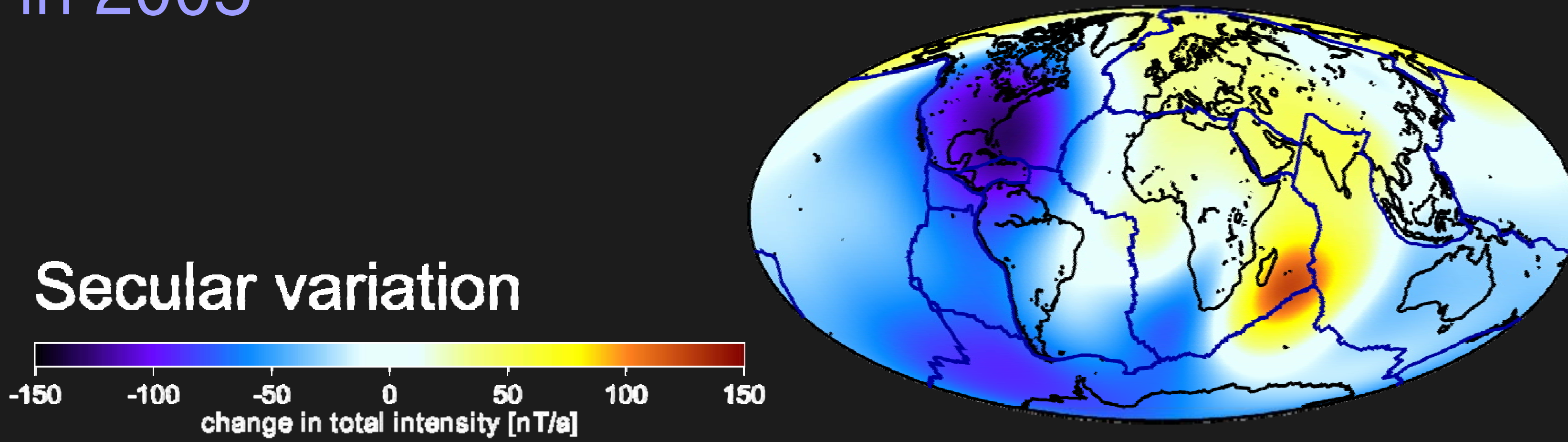
Use of magnetic field models

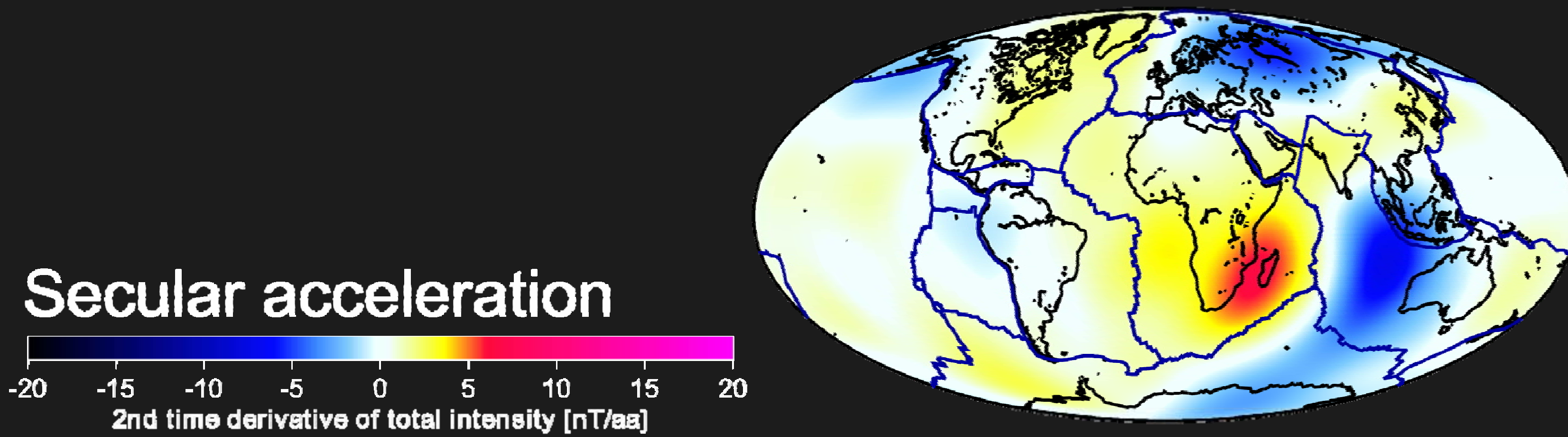
- Parent models for IGRF and WMM (navigation)
  - → Need accurate prediction of field for upcoming 5 year epoch
- Magnetic field Interpretation (Core flow, Crustal magnetization)
  - → Need accurate field at Earth surface or C/M boundary
- Subtract model from observation to obtain residuals (e.g. to study induction, ionospheric currents)
  - → Need accurate field estimate at observatory or satellite location

Main field originating in the Earth's core



Change of the main field in 2005



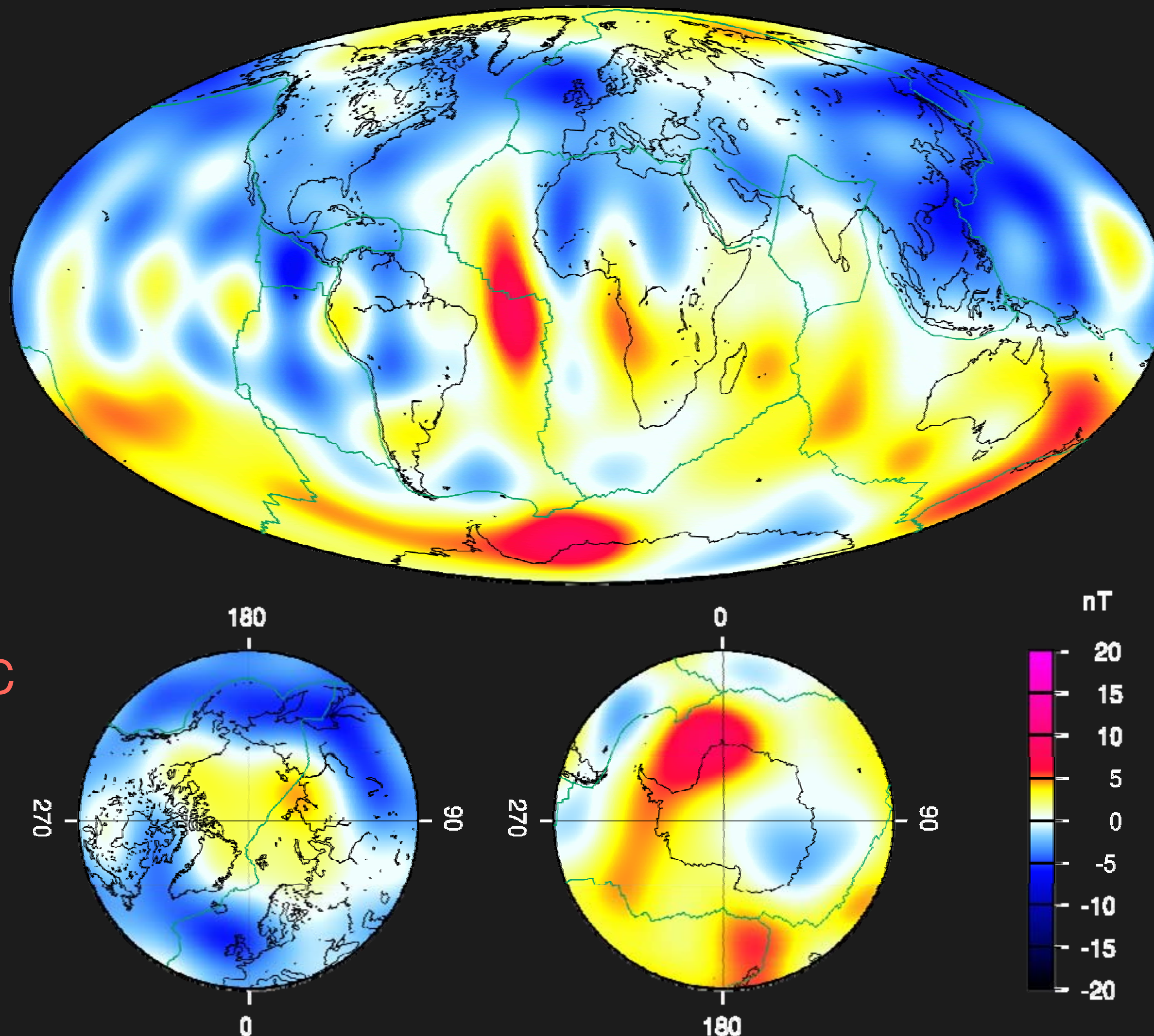


Difference between independent CHAMP and Oersted/SAC-C field models in 2002

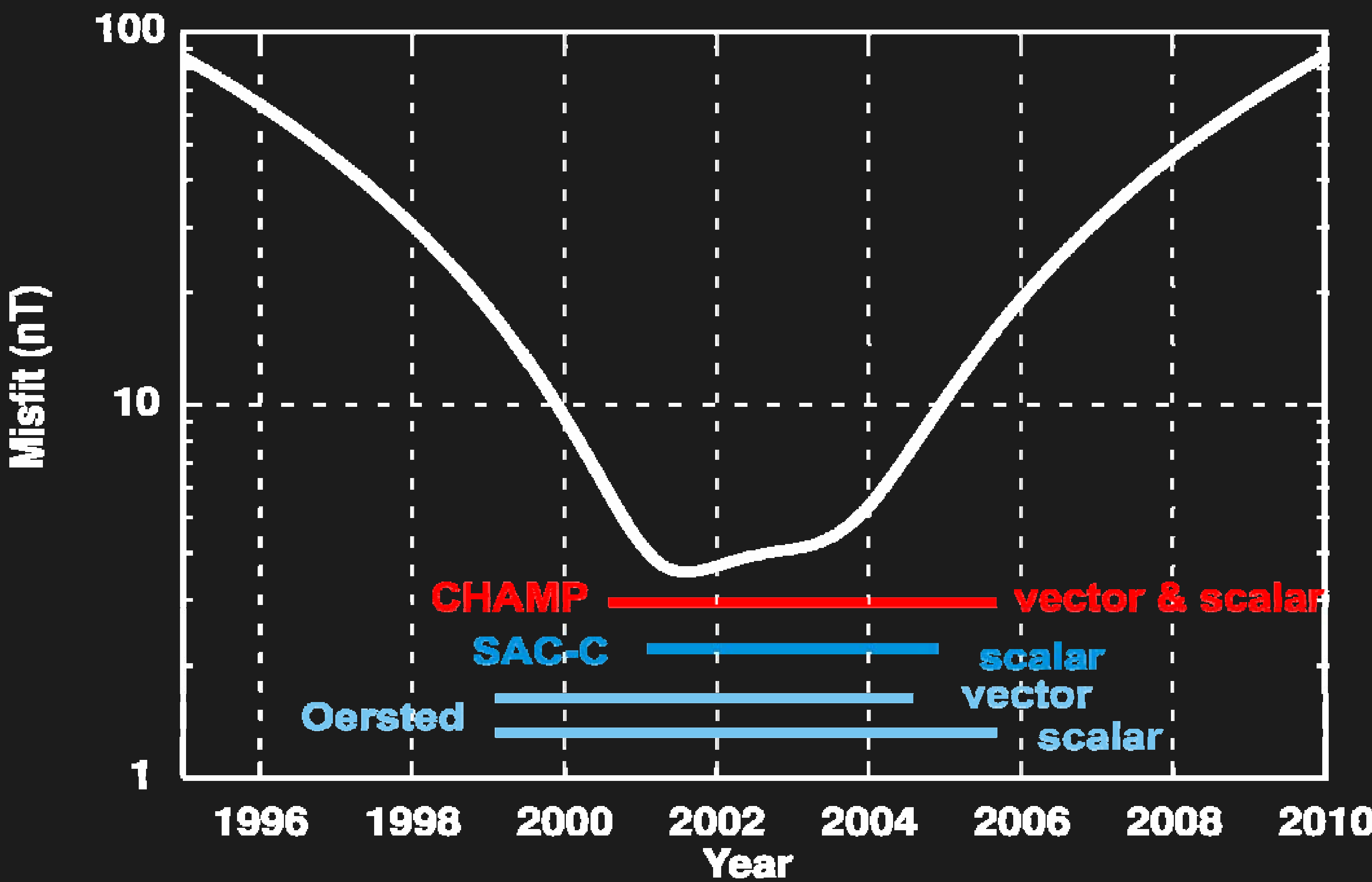
Difference in
vertical component
at Earth's surface

CHAMP – Oersted/SAC-C

RMS < 4 nT



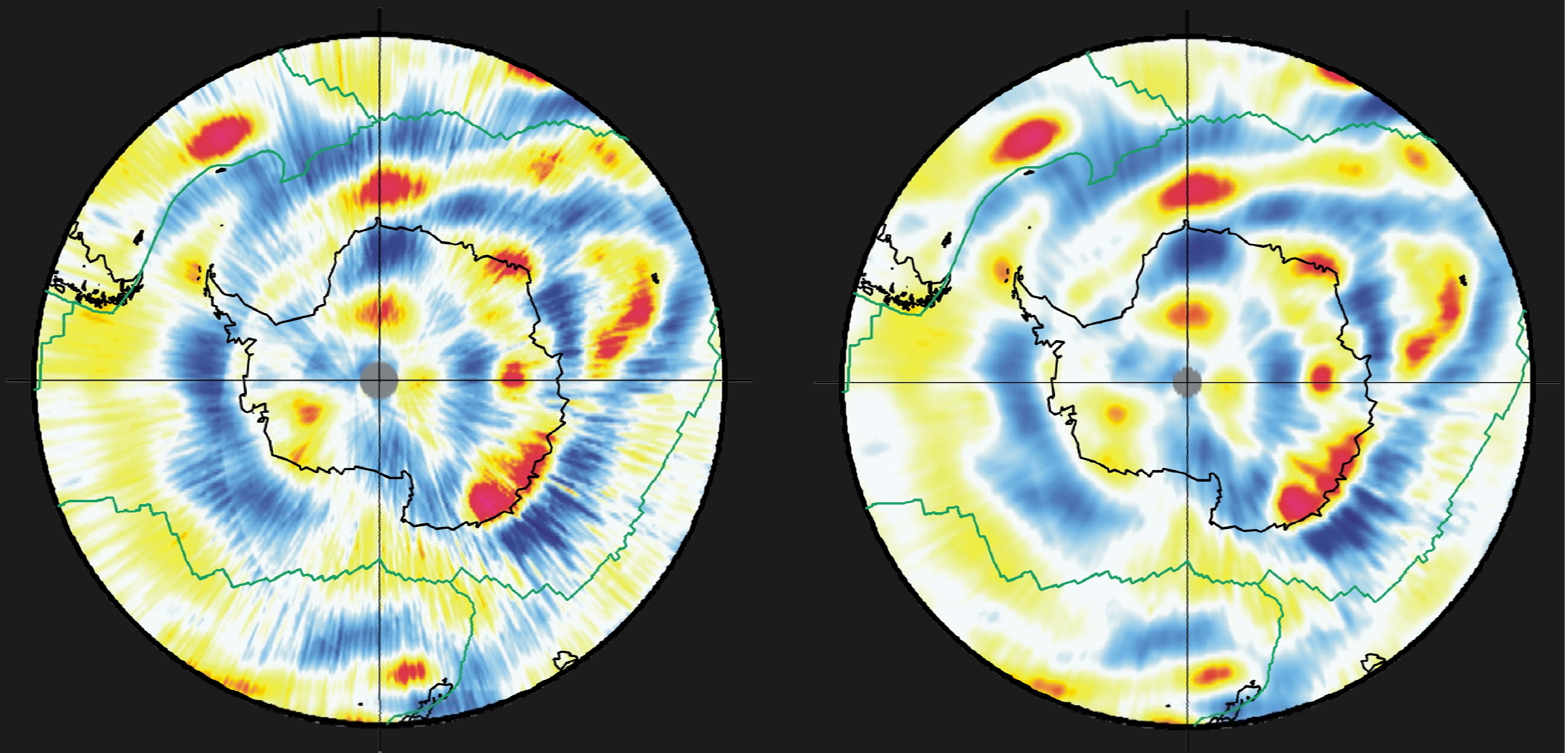
Difference between independent CHAMP and Oersted/SAC models



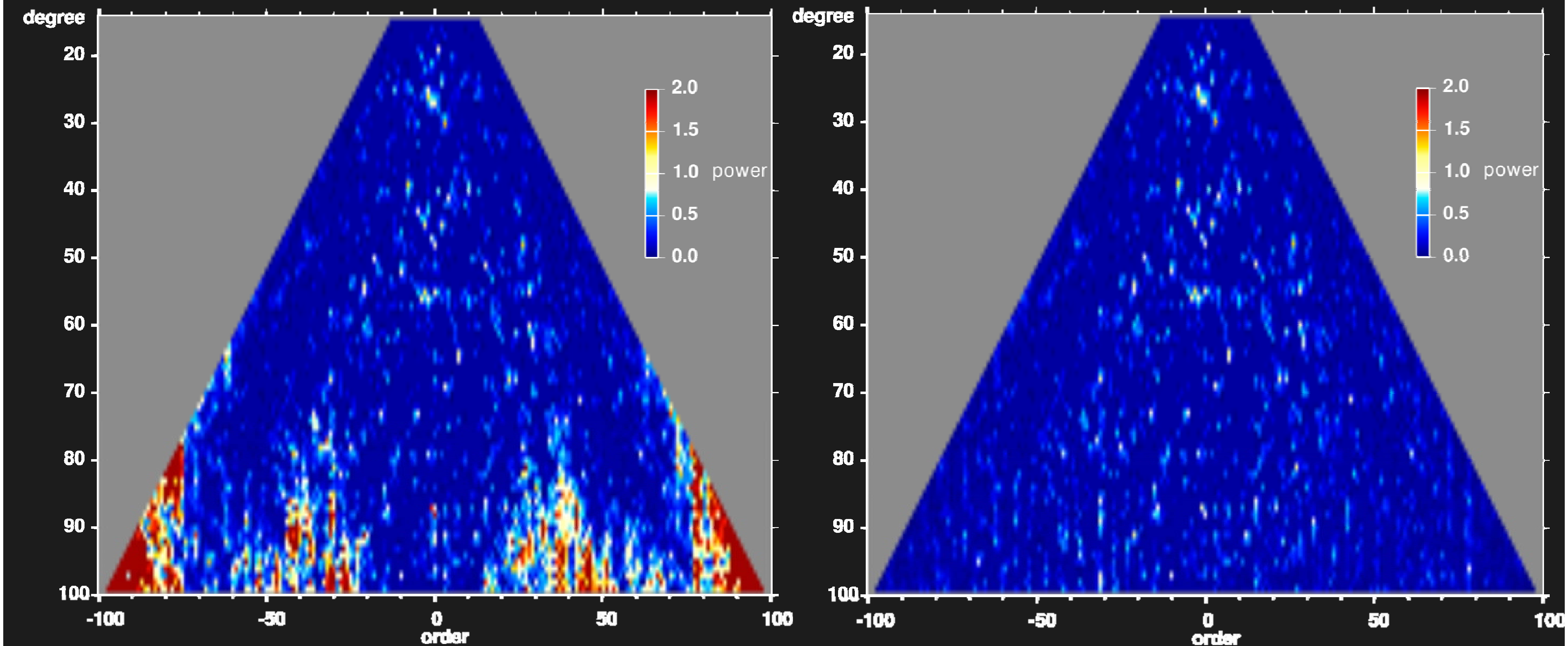
MF4 Crustal field model processing steps

- Select data using indices Kp, Dst, IMF
- Reject tacks with ionospheric bubbles (Stolle)
- Subtract POMME-2.4
- Subtract predicted ocean tidal fields (Kuvshinov)
- Subtract approximations for diamagnetic effect
- Subtract model for gravity driven currents
- Along track filter: sph. harm. degree 1
- Identify and discard remaining tracks with high rms
- Line leveling
- Least squares estimation of coefficients (with regularization)

Before and after line leveling



MF4 coefficient matrix

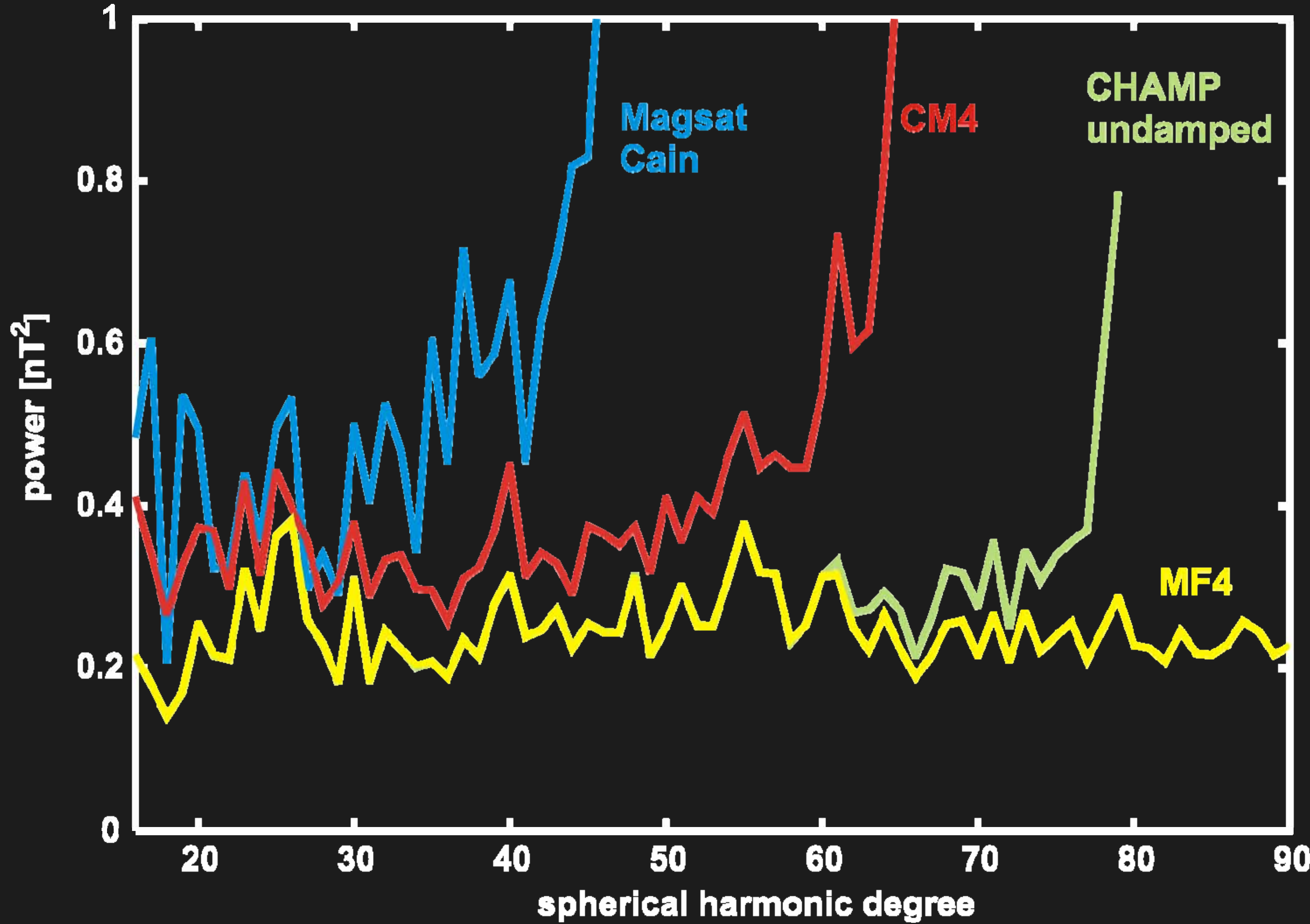


before

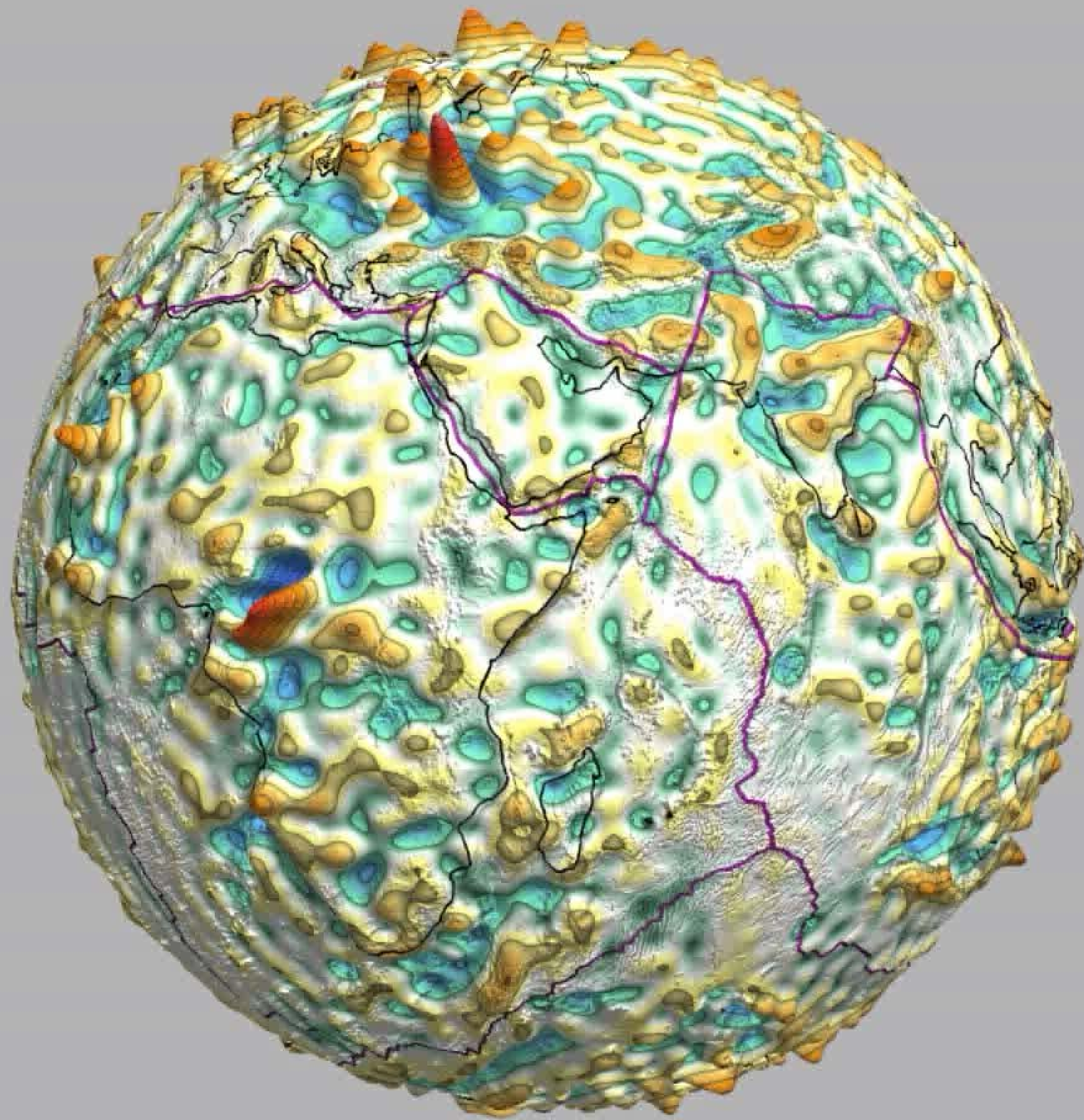
after

regularization

Mauersberger/Lowes spectra divided by (2n+1)



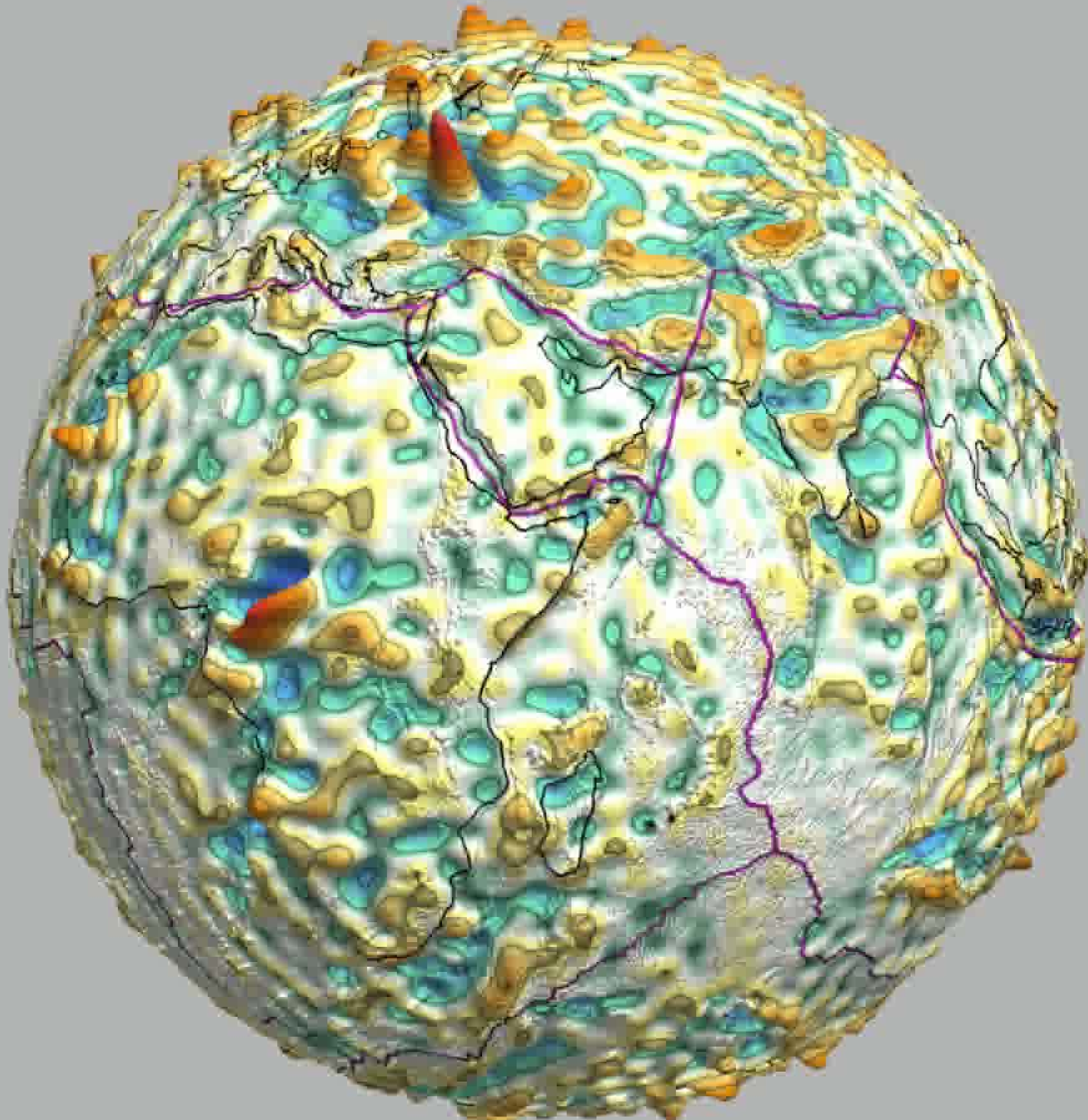
Visible crustal magetic field (MF4 model to SH deg 90)



Downward continued to 100 km altitude

Rother and Maus, 2005

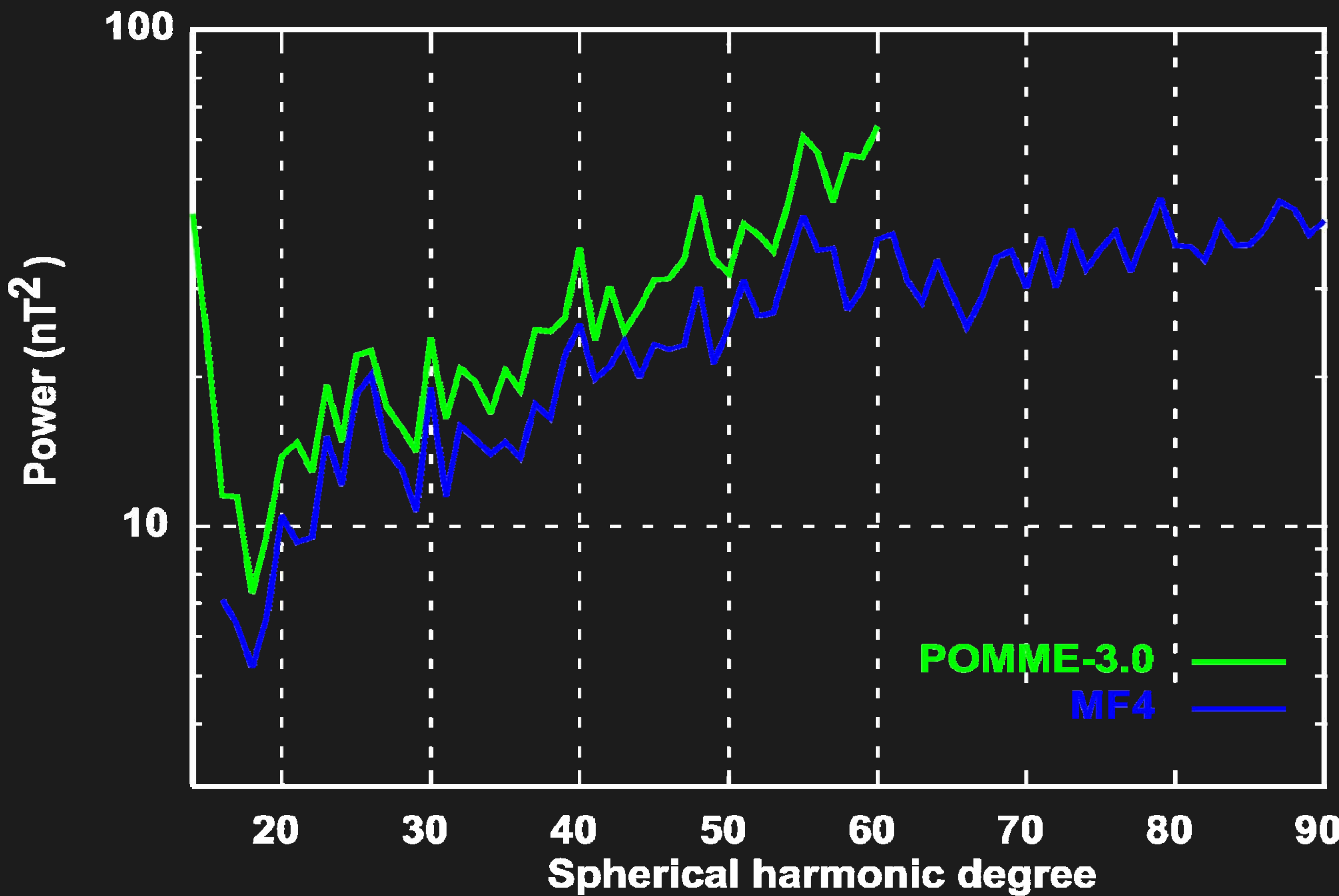
Visible crustal magetic field (MF4 model to SH deg 90)

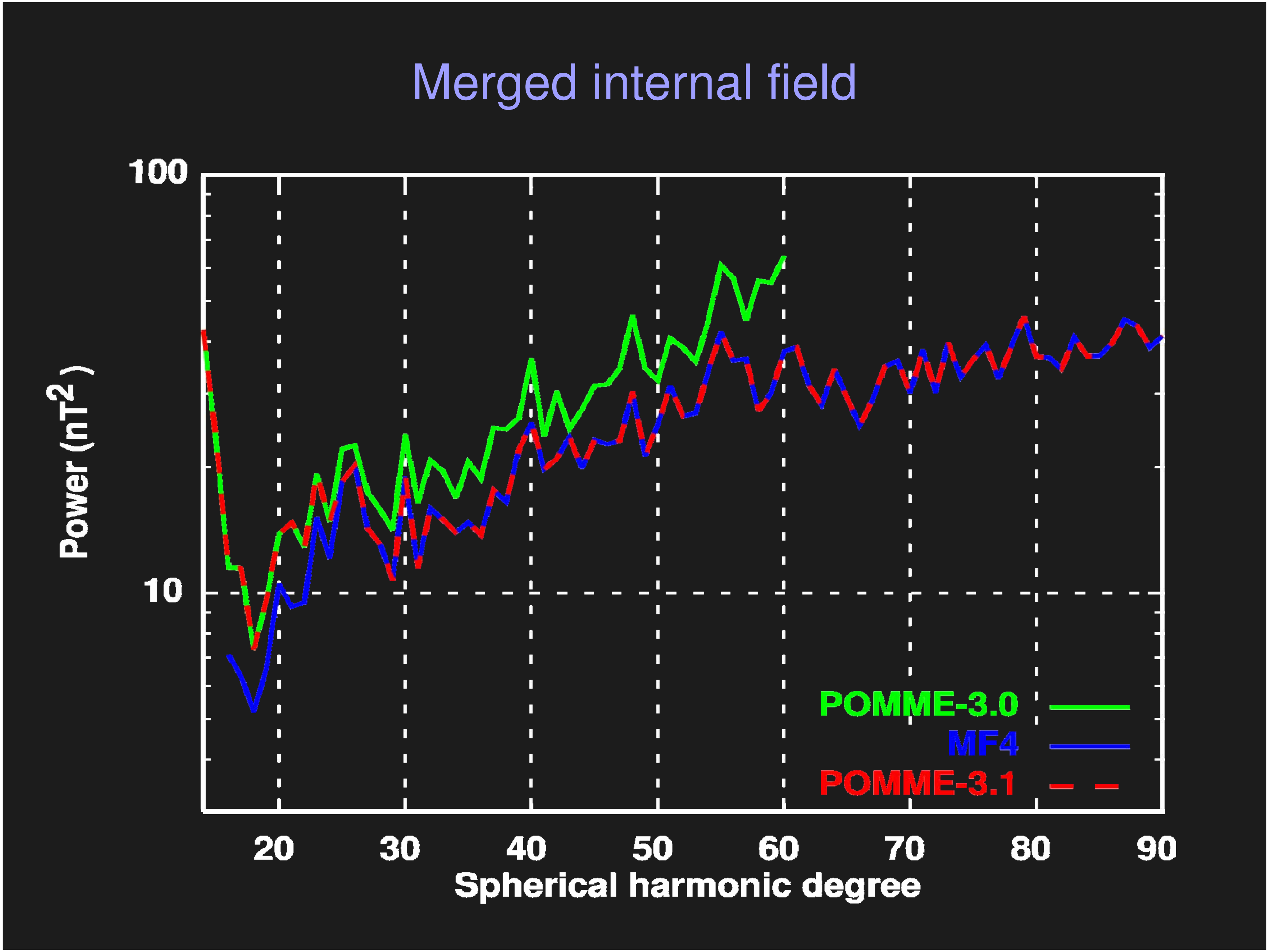


Downward continued to 100 km altitude

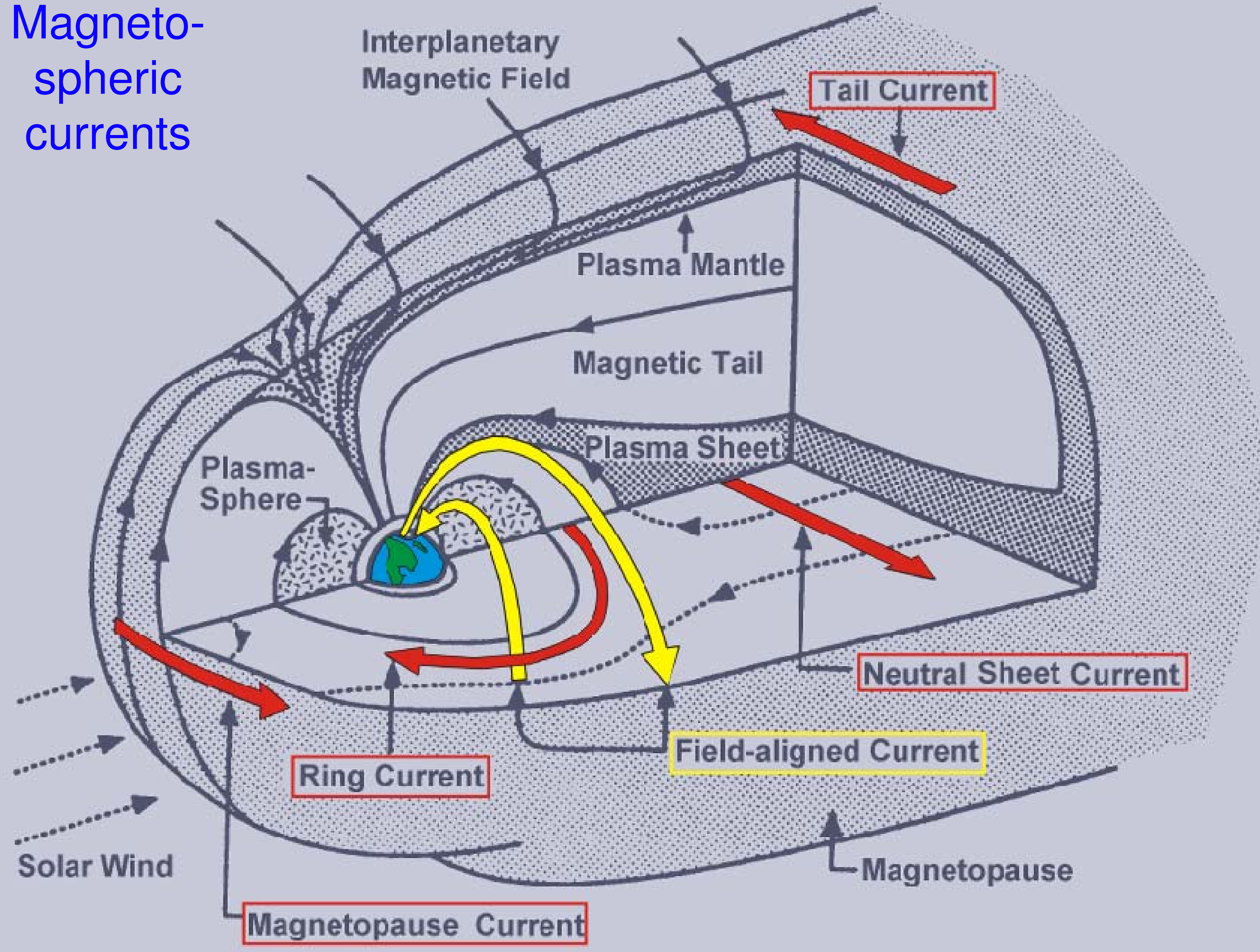
Rother and Maus, 2005

Internal Field Spectra (Lowes)

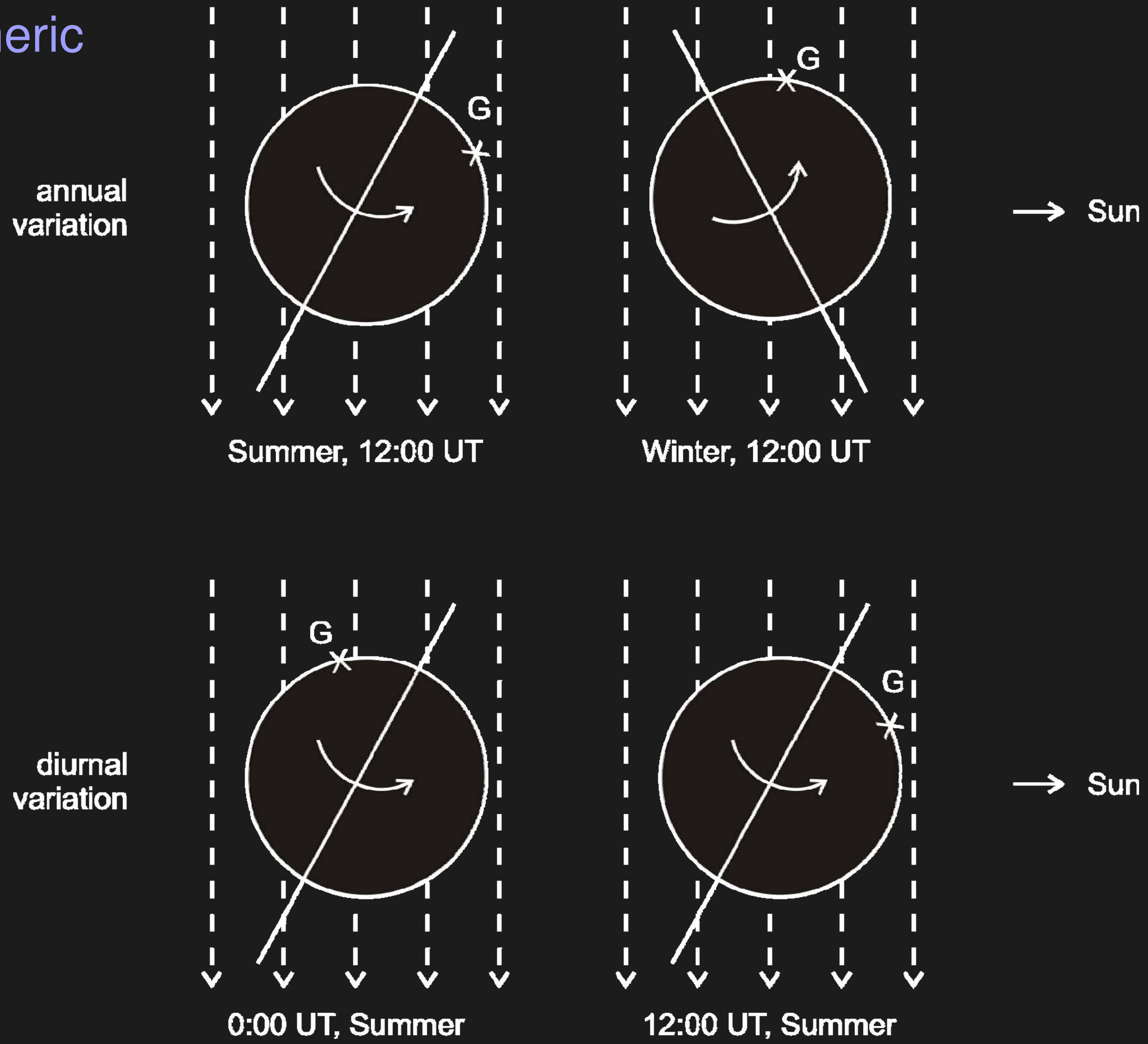



Merged internal field
100
10
Power (nT^2)
20
30
40
50
60
70
80
90
Spherical harmonic degree
POMME-3.0
MF4
POMME-3.1

Magneto-spheric currents

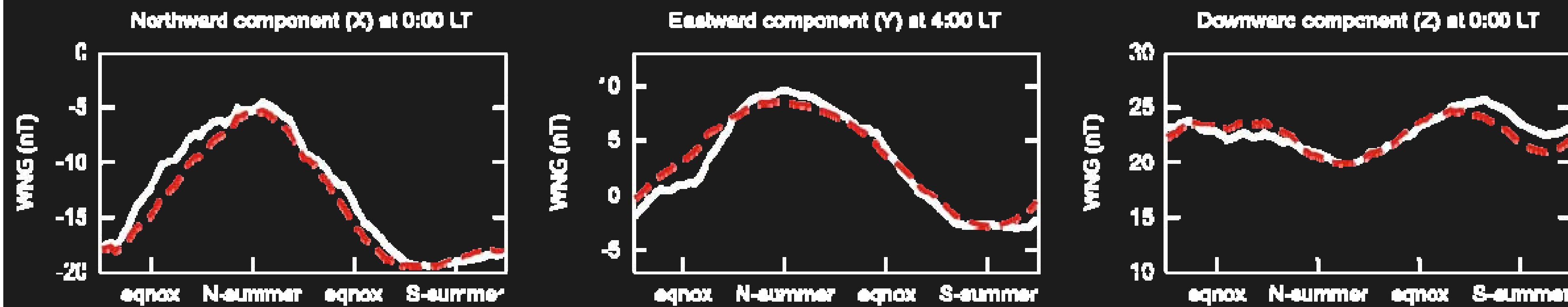


Magnetospheric fields

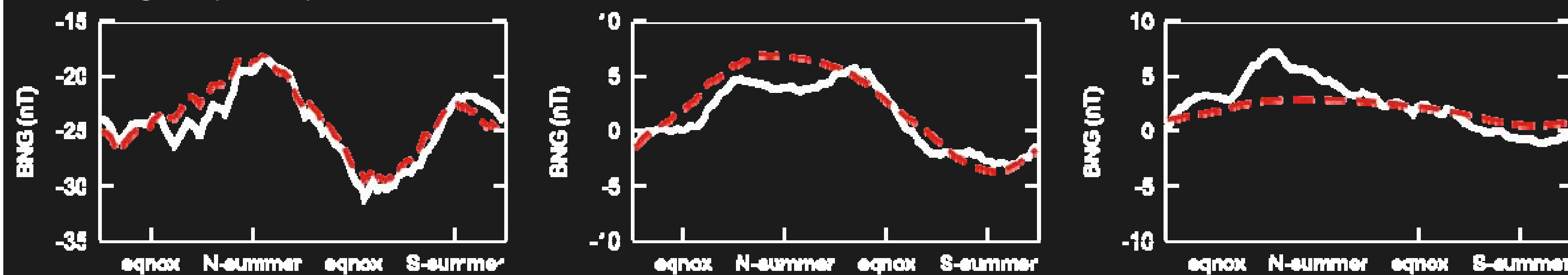


Annual variations in ground observatory data

Wingst (54º N):



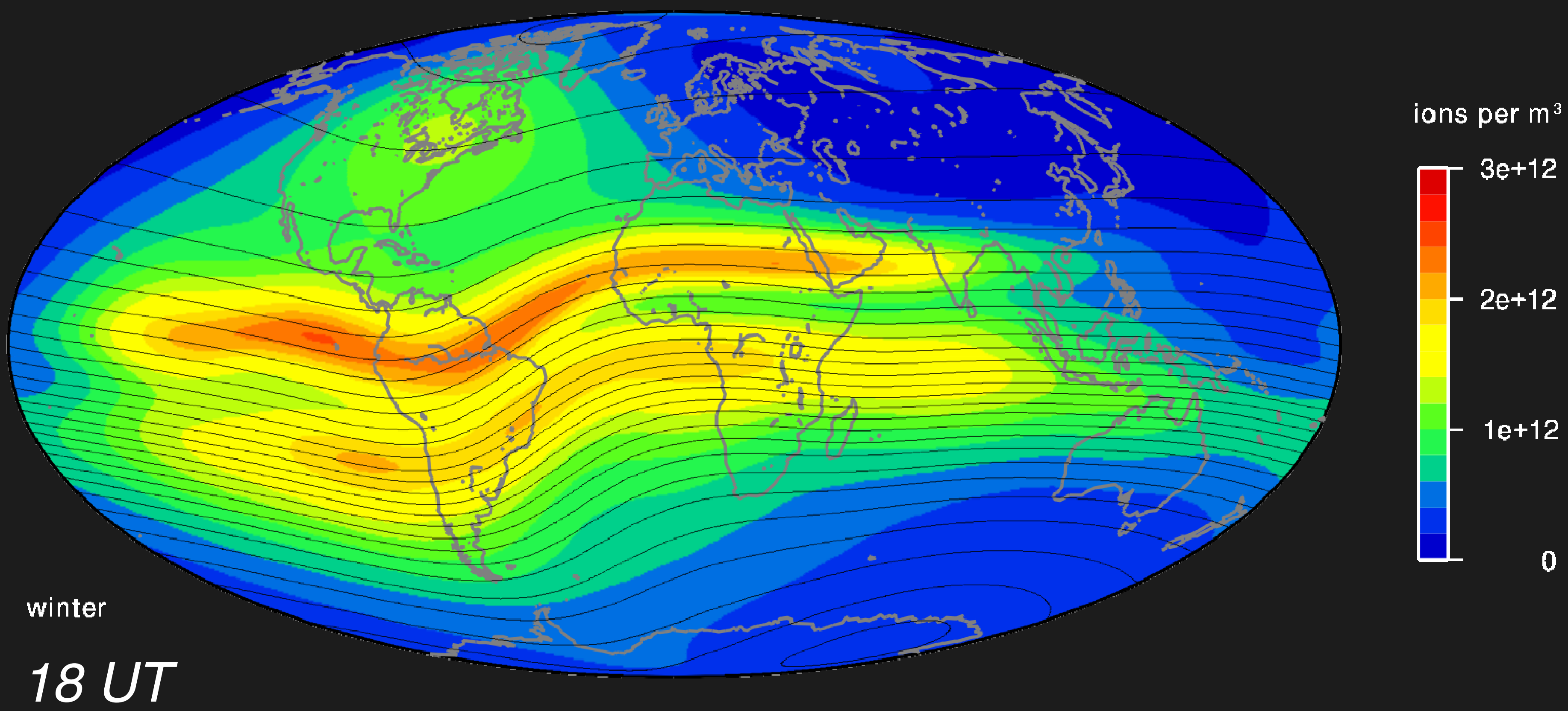
Bangui (4º N):



- - - - Magnetospheric field model estimated from CHAMP and Oersted data with 24h LT coverage

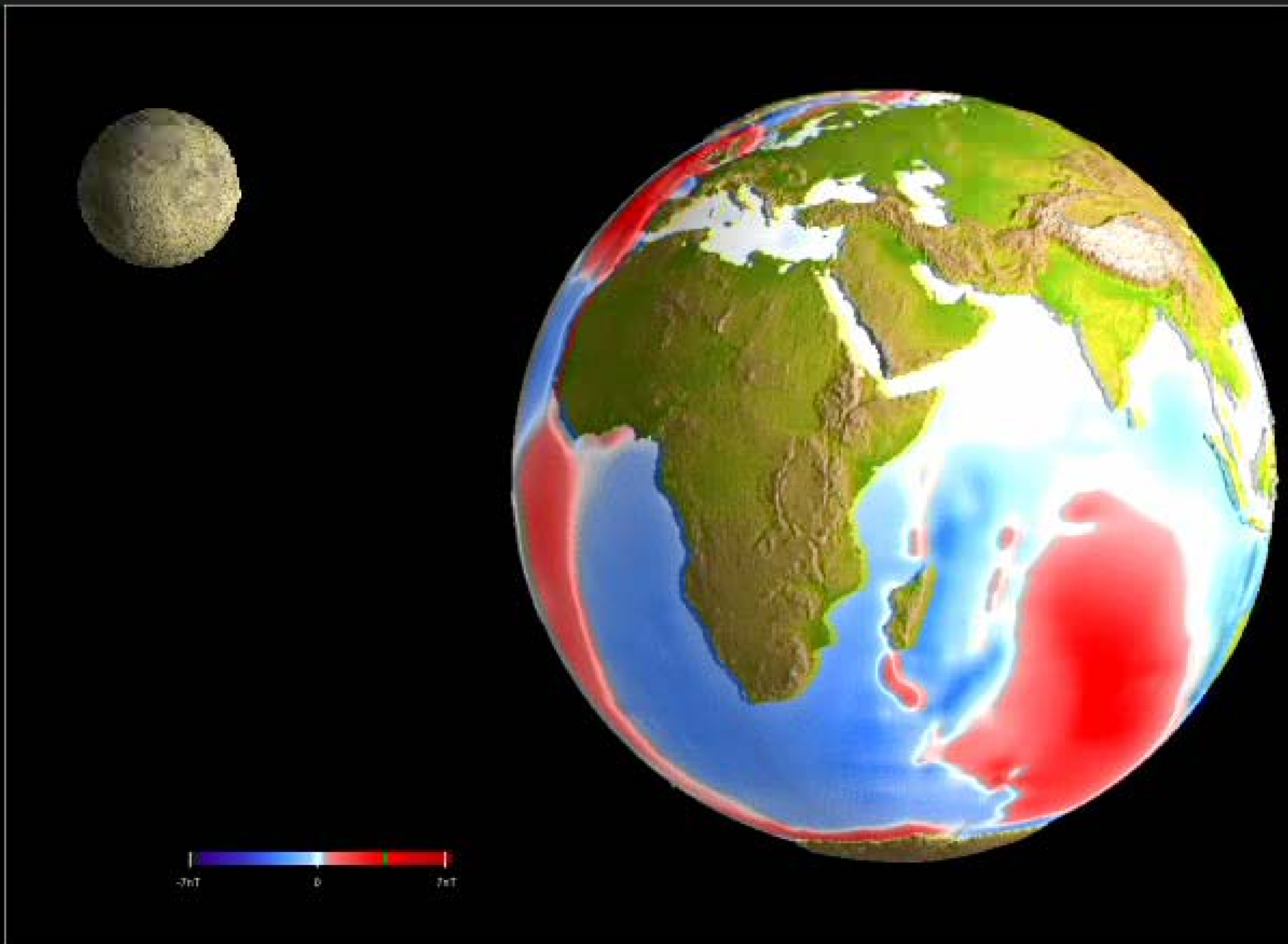
Maus and Lühr, GJI, 2005

Ionospheric fields
(shown here: plasma density at 400 km altitude)

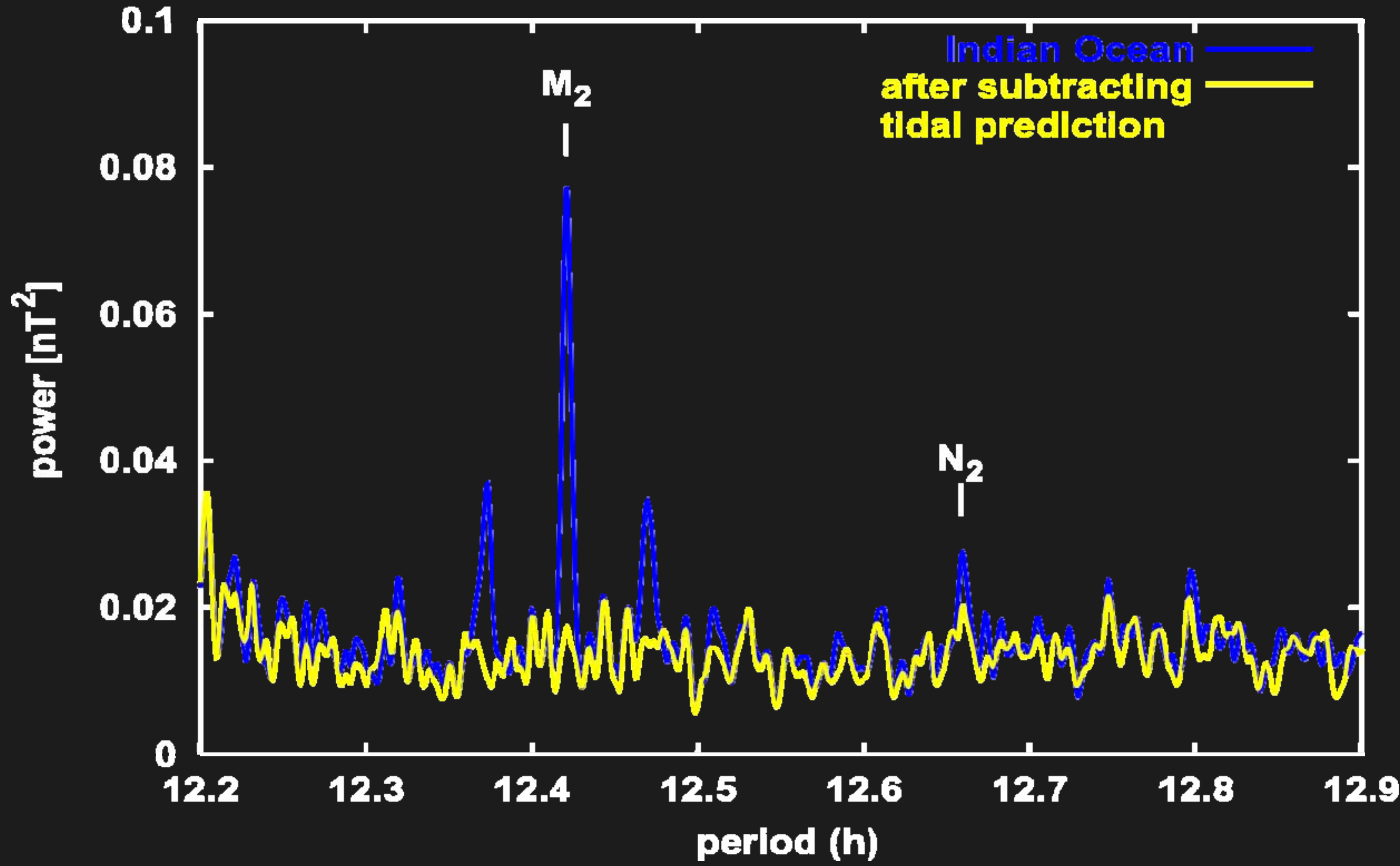


Ocean tidal magnetic fields

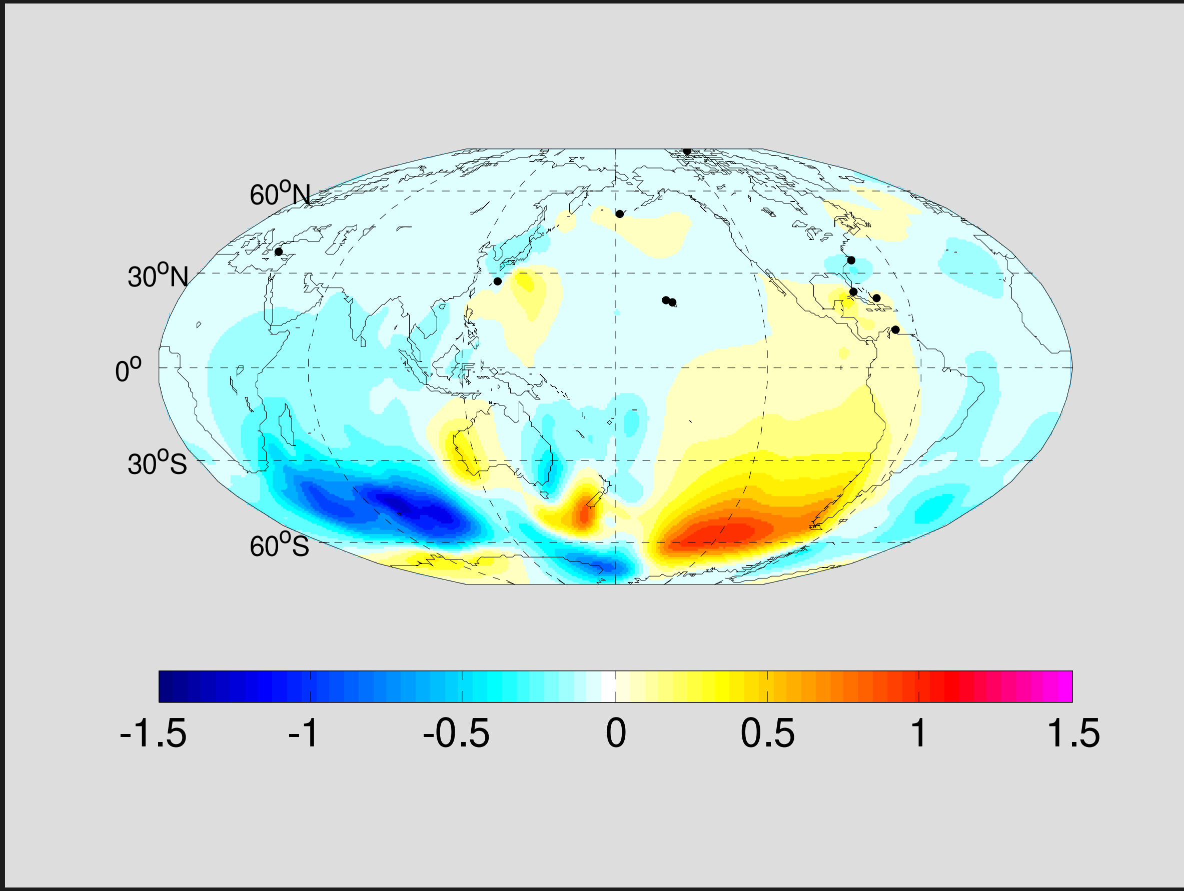
M2 tide at surface predicted by A. Kuvshinov



Ocean signal: Spectra before/after correction using predictions by Alexei Kuvshinov

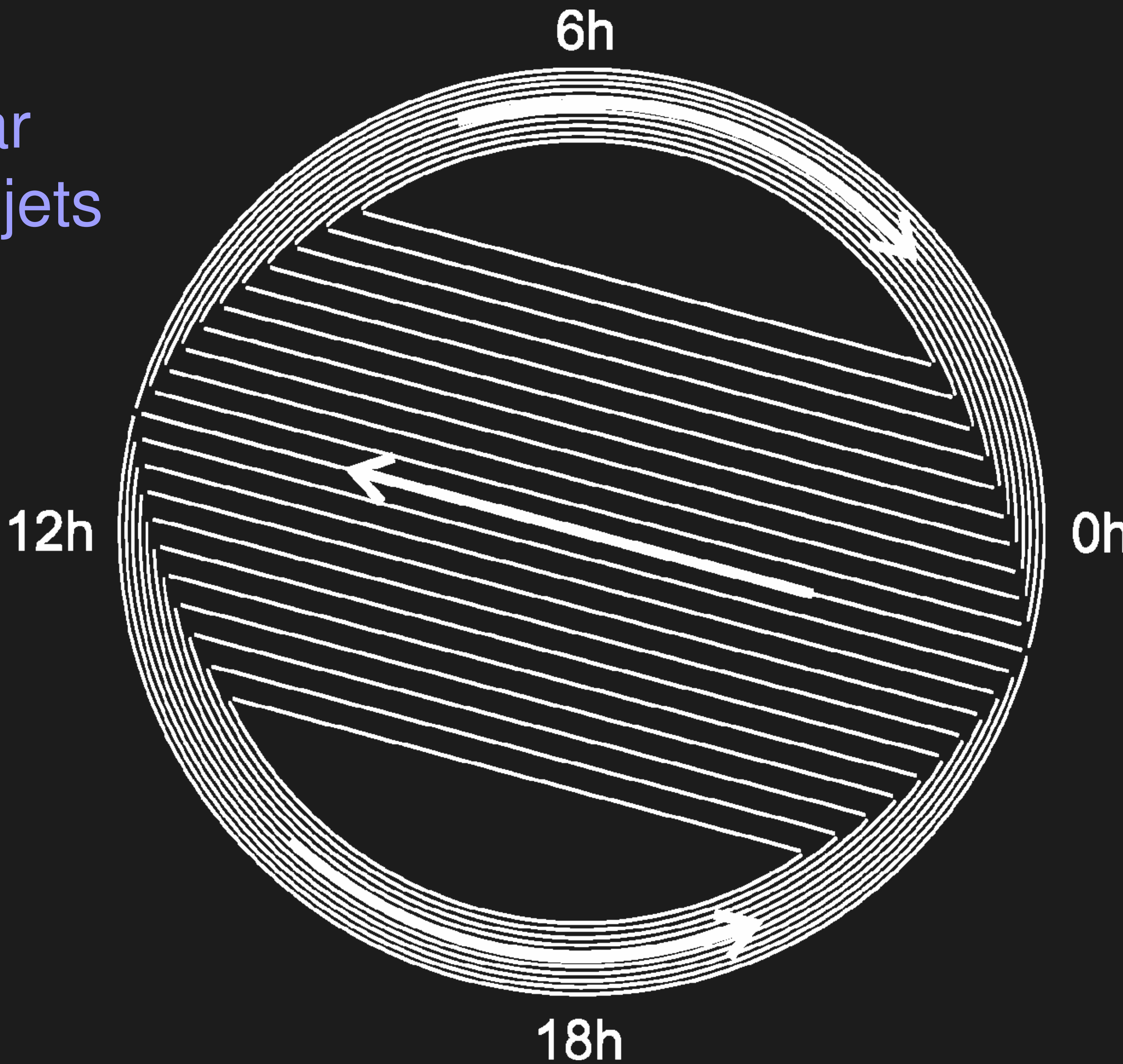


Steady ocean circulation (after Manoj et al.)



- Generates fields of up to 2 nT at satellite altitude
- Should be subtracted from MF4 model

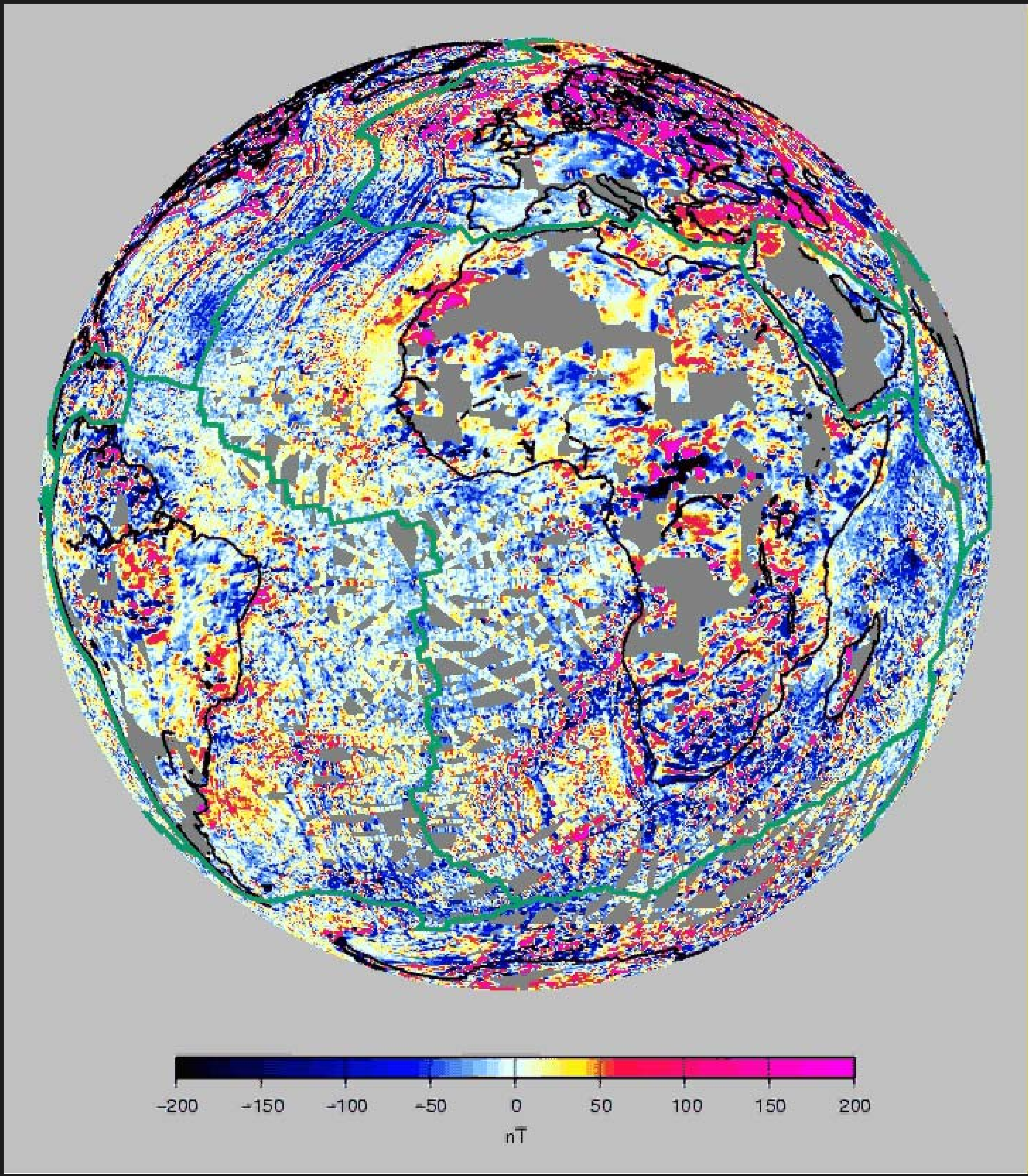
Polar electrojets



Near-surface data

Presently available:

- Continental scale aeromagnetic compilations
- Project Magnet aeromagnetic data
- NGDC marine data



Summary

Pomme-3.1 is a merger of Pomme-3.0 and MF4

- Main field (including SV and SA to degree 16)
- Crustal field to degree 90
- Magnetospheric/induced field (Est/Ist, IMF)

Model, software and input data available at:

http://geomag.colorado.edu/model.html

http://www.gfz-potsdam.de/pb2/pb23/Models/