Karlsruhe Institute of Technology

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DeepDyn - DFG Priority Program 2404

Understanding the influence of seismic mantle structures at the CMB on intense magnetic flux regions

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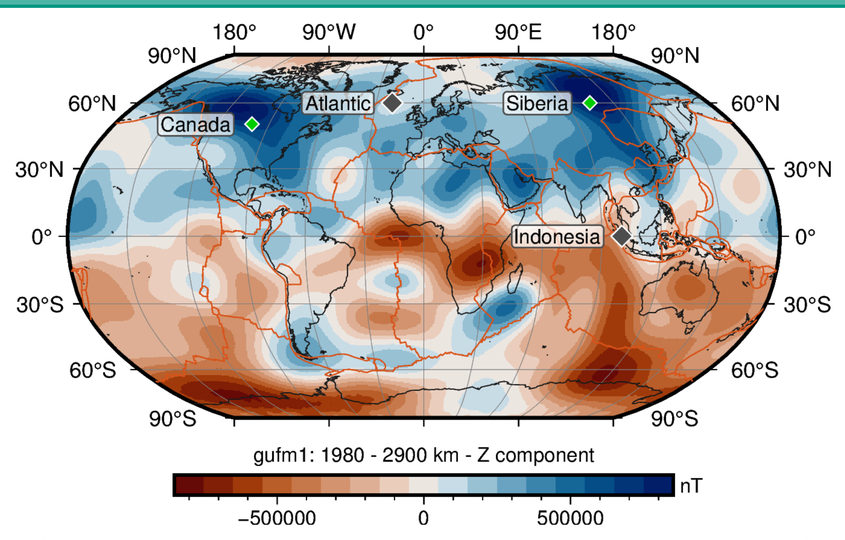
We study the lowermost mantle (LMM) with seismological methods as contribution to the DFG Priority Program 2404 "*Reconstructing the Deep Dynamics of Planet Earth over Geologic Time – DeepDyn*". For this we explore anisotropy and reflectors at the core-mantle boundary (CMB). Specific study areas are the geomagnetic high-latitude flux loops (HLFL) where dense bundles of magnetic field lines are proposed. In the first funding period we concentrate on the northern hemisphere at spots in the LMM below Canada, the North Atlantic and Siberia as well as Indonesia.

Target regions: LMM below

- **Siberia**
  - very stable magnetic field
- **Canada**
  - more mobile magnetic field
- **North Atlantic**
  - unclear, expected due to symmetry
- **Indonesia**
  - mobile, westward movement



Aims: Understanding of

- Seismic structure and anisotropy
- Deformation
- Mineralogy from seismic observations and deformation
- Thermal conductivity from petro-physical modeling

Seismology: Combination of two approaches

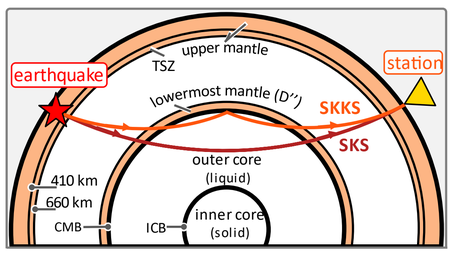
Seismic Anisotropy

- Search for **shear wave splitting**
  - **SKS**, **SKKS** (*X*KS) phases
  - S, ScS phases

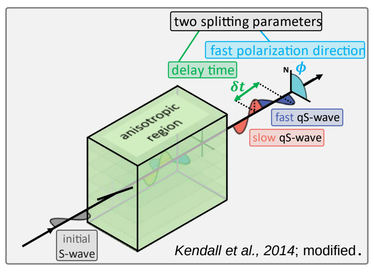
→ splitting parameters, splitting intensity

- Search for **phase pair discrepancies**

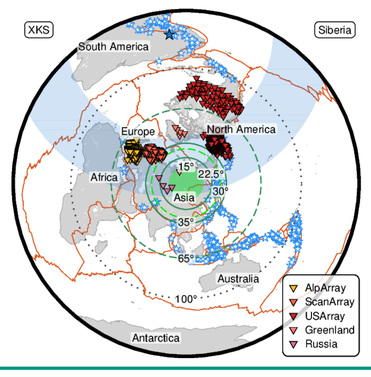
→ LMM mantle contribution

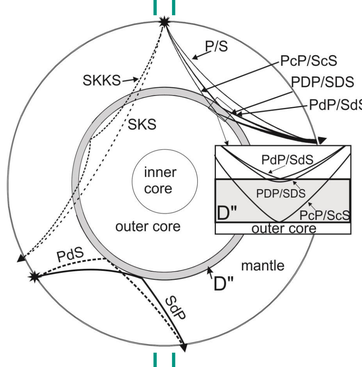


Ray paths after *iasp91* Earth model (*Kennet 1999*).
Calculation with *tauP* (*Crotwell et al., 1999*).



Kendall et al., 2014; modified.





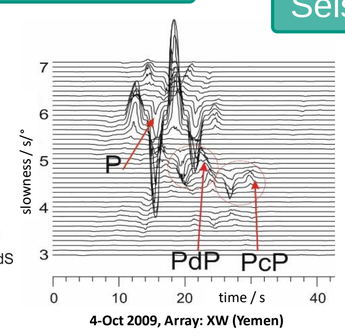
Seismic Reflections

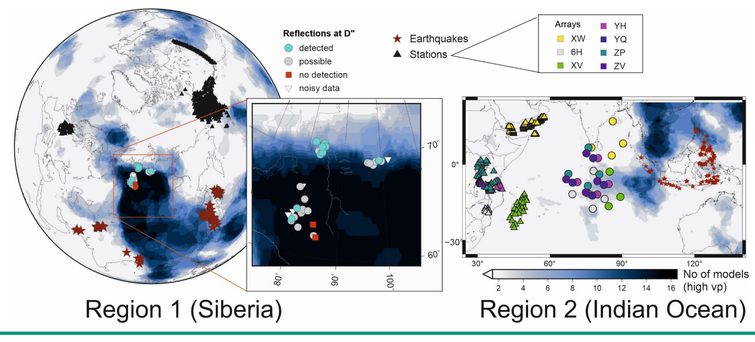
- Search for **D" reflections**
  - **PdP**, **SdS** phases
  - PdS, SdP phases

→ travel time, amplitude, polarity

- Calculation of **reflection coefficients**

→ velocity contrast across the D" reflector





Region 1 (Siberia) Region 2 (Indian Ocean)

Inclusion of Existing Models and Databases

Seismic Models

- **Cluster analysis** (*Lekic et al., 2012*)
  - 5 models
  - low S wave velocities
- **Votemap analysis** (*Shephard et al., 2017*)
  - 7 models
  - high S wave velocities

Shear wave splitting database (*Wüstefeld et al., 2009*)

Library of elastic tensors for LMM seismic anisotropy (*Creasy et al., 2020*)

MATLAB Seismic Anisotropy Toolbox (MSAT) (*Walker and Wookey, 2010*)

Deep mantle anisotropy database (*Wolf et al., 2023*)

- **SKS-SKKS**
- **LLSVP**
- **S-ScS**

Modeling

- Consideration of different scenarios in the LMM
  - minerals
  - structures

AxiSEM2D AxiSEM3D

- Wave propagation
  - backazimuth-dependent
  - shear wave splitting for *X*KS
  - reflection coefficients for P, S

References & Acknowledgements

- YF is supported by DFG grant RI1133/14-1 (SPP 2404 DeepDyn).
- HT is supported by DFG grand TH1530/25-1 (SPP 2404 DeepDyn).
- Geographic maps were generated with *PyGMT* and *GMT.*
- The *gufm1* model was generated with *pymagglobal.*
- *Amit et al., 2011.*
- *Jackson et al., 2000.*

DFG Deutsche Forschungsgemeinschaft