3D Earth
Towards a global Solid Earth reference model with satellites

Jörg Ebbing (Kiel)
&
3D Earth study team

EO Symposium „Neue Perspektiven der Erdbeobachtung“
Köln, 12.11.2019
Earlier Global Earth models: From Litho1.0 to LithoRef18

Global Solid Earth models
- Resolution of 1 to 2 degree
- Based mostly on a single geophysical technique
- Blocky structure due to parametrisation
Global gravity spectra obtained from Litho1.0

- **Lith+asthenosphere** complement the upper mantle to deg 70
- From deg 70 **crust (+w,ice,seds)** dominates upper mantle
- For wavelengths <286 km (deg 140) **upper mantle** hardly contributes
- 3 mGal model error from deg 140 components don’t compensate => input to thermal, composition and isostatic model improvements?

Seismological models do not fit to the gravity field and gravity models do not fit to seismology
Global models from seismic tomography
- a suite of alternatives -

Schaeffer & Lebedev 2013
Satellite gravity gradients from the GOCE satellite mission

Results indicate segmentation of the continent -> input to estimate sub-glacial heat-flux
3D Earth: An opportunity for integrated thermochemical imaging of the Earth...

Gravity (GOCE & GRACE)

Electromagnetics

Magnetic field (Swarm)

Seismology

www.3DEarth.uni-kiel.de
The 3D Earth simulator

www.3DEarth.uni-kiel.de
The 3D Earth simulator

3D Earth Summer school
@ESRIN, Frascati
July 6-10, 2020
3D Earth - The first global reference model of crust and upper mantle based on joint inversion of seismology and satellite gravity

Density model starts to resemble seismic tomography
3D Earth - The first global reference model of crust and upper mantle based on joint inversion of seismology and satellite gravity

Density model starts to resemble seismic tomography
Earth’s squishy interior gives rapid rise to Antarctica

http://www.esa.int/Our_Activities/Observing_the_Earth/GOCE/Earth_s_squishy_interior_gives_rapid_rise_to_Antarctica
Conclusions and outlook

3D-Earth model should serve as input for a variety of applications:

• Plate configuration: deciphering tectonic forces and the makeup of the tectonic plates

• Hot spots and mantle plumes: where is the heat source and how dynamic are they (link to volcanic eruptions)?

• Geothermal heat flux in Antarctica: How does basal melting effect the ice sheets?

• Link between erosion, sedimentation, uplift and subsidence with Solid Earth models
  • prediction of surface uplift and subsidence over time to estimate natural resources and geohazards

• Neotectonics: understanding tectonic and GIA induced earthquakes (with link to InSAR) - increased hazard assessment