# Gravitational signal and spectra of the crustal and the mantle layers


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## Abstract

Global Earth's density distribution models based on data from seismic tomography and crustal compilations still improve in the accuracy, and both in the lateral and vertical resolutions. We first evaluate the gravitational signal generated by such a model, LITHO1.0 (Pasyanos, 2014), and focus on its gravitational spectral properties. Because LITHO1.0 provides only about 10% of the total Earth's gravitational acceleration, we try to add a signal coming from the remaining part of the mantle (down to the CMB) with the help from the LLNL-G3D-JPS model (Simmons, 2016). Using the later we experiment with converting P and S velocities into the density information required in volume integrations. Then we examine how these models fit together and how their summed gravitational signal approaches the observed anomaly fields. The triangular parameterization used in both models is introduced in order to set up a global triangular surface-to-CMB density distribution model. This seems to be a useful starting point for testing various thermochemical scenarios in particular depths while constraining the outcome with modern satellite



## References

[1] International Centre for Global Earth Models (ICGEM): http://icgem.gfz-potsdam.de/ICGEM/ICGEM.html

[2] Pasyanos, M. E., Masters, T. G., Laske, G., & Ma, Z. (2014). LITHO1. 0: An updated crust and lithospheric model of the Earth. Journal of Geophysical Research: Solid Earth, 119(3), 2153-2173.

[3]Sebera, J., Haagmans, R., Floberghagen, R., & Ebbing, J. (2018). Gravity Spectra from the Density Distribution of Earth's Uppermost 435 km. Surveys in Geophysics, 39(2), 227-244.

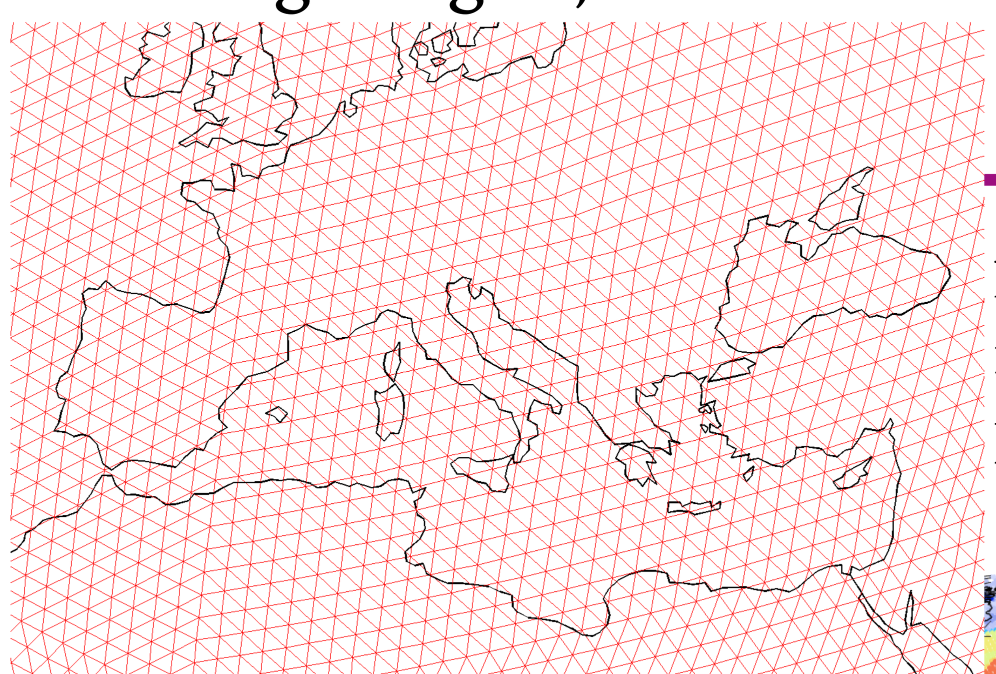
[4] Simmons, N. A., Myers, S., Johannesson, G., Matzel, E., & Grand, S. (2014, December). LLNL-G3D-JPS: Global-scale Joint Tomography of P and S Wave Speeds in the Crust and Mantle. In AGU Fall Meeting Abstracts.


## Intro & Motivation

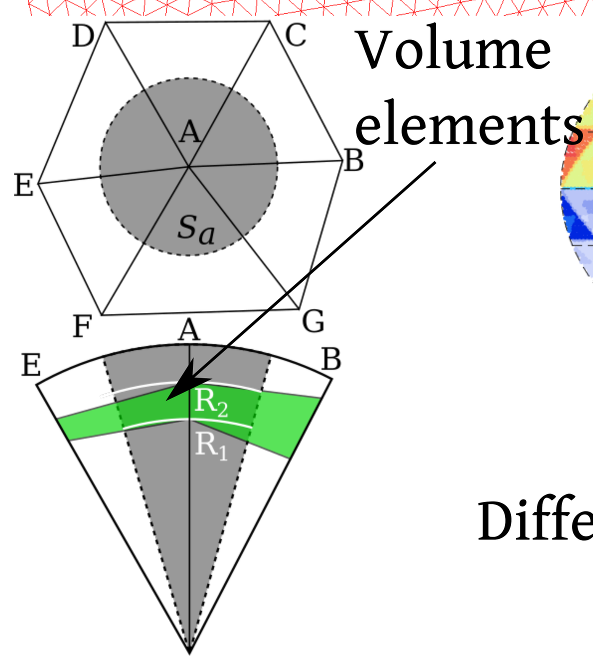
* **Global** seismic velocity and density density models reach comparable spatial resolution as Earth's gravimetry models (based on **GOCE** satellite, ESA)
* Forward modelling with velocity-based densities vs. the observed gravity (intensity, gradients) can contrain other effects on a global scale (e.g., mantle convection)
* **The deeper areas** are considered => **calculated gravity anomalies decrease** to reach observed gravity anomalies, and, the "**maneuvering**" space for other effects is thus more limited.

## Data

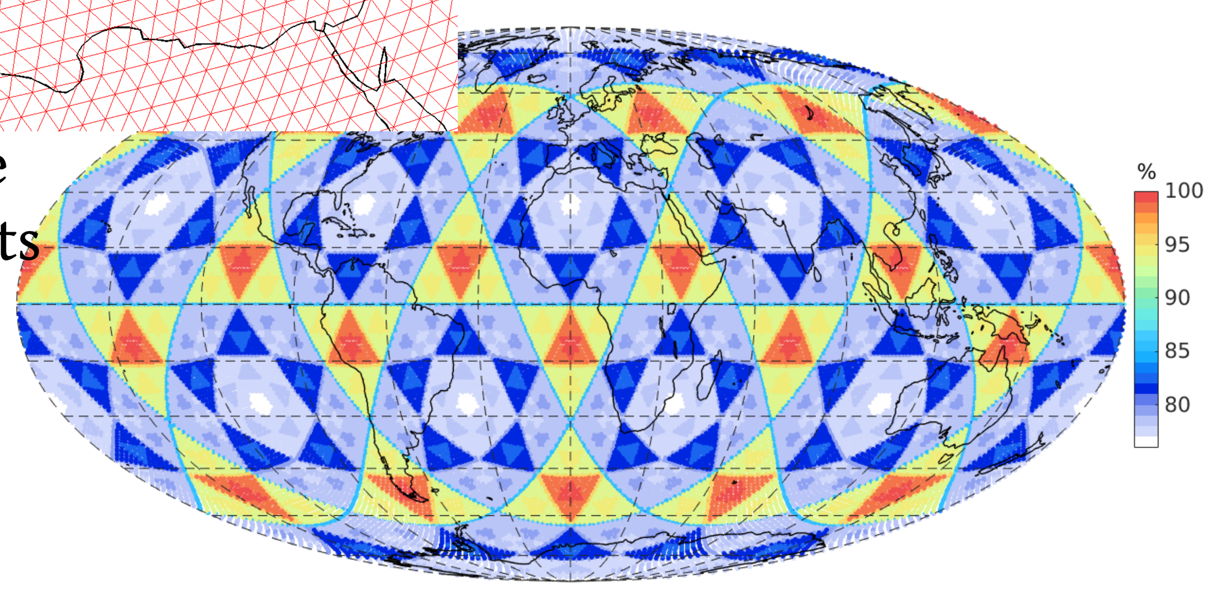
1. LITHO1.0 (0-435 km depth) - velocities and density, 28 inhomogenous layers
2. LLNL-G3D-JPS (0 - CMB depth) - Vp, Vs and more
   Triangular grid, Level 7



Both models have the same icosahedron parametrization!

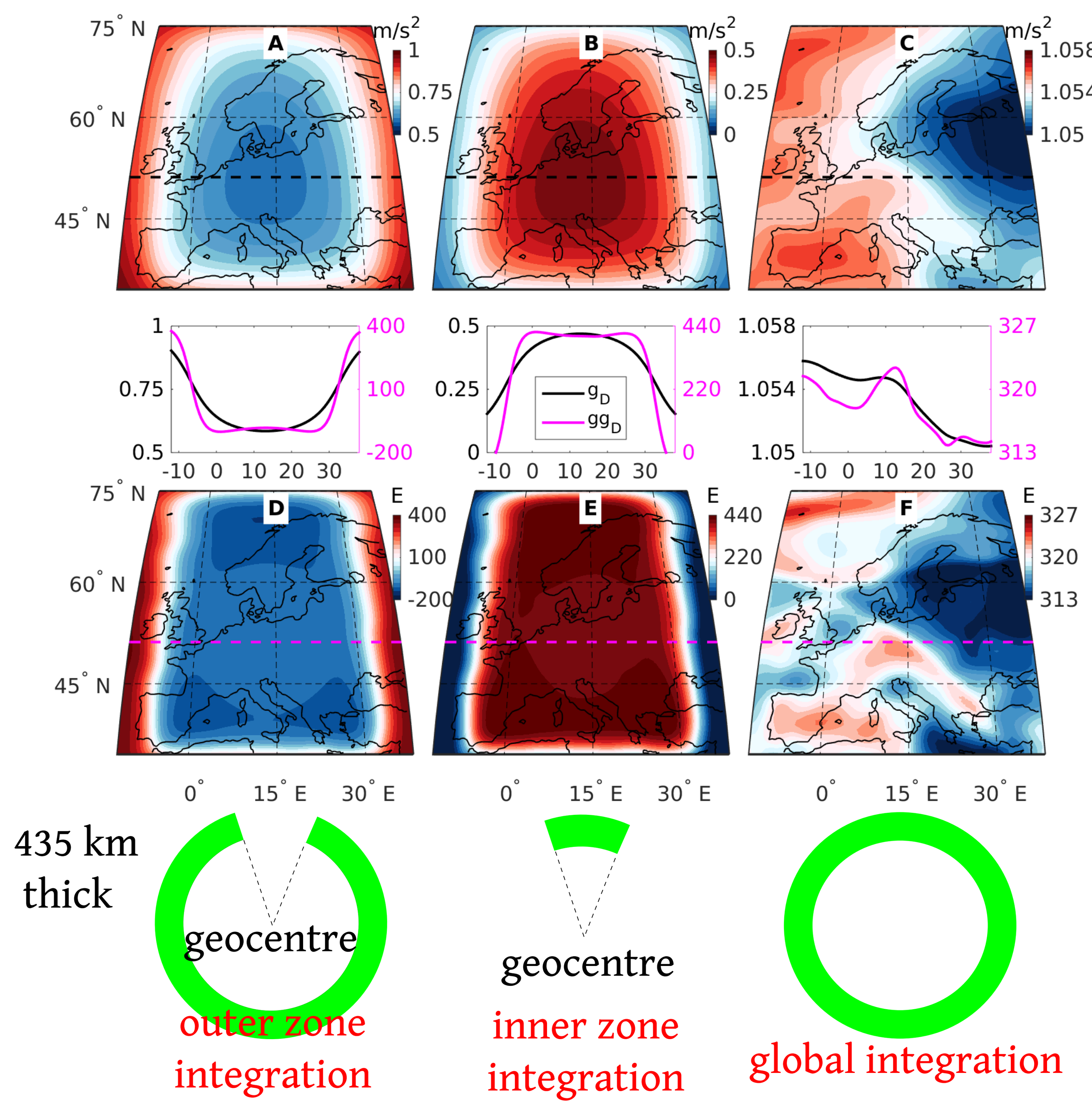



Volume elements




Differences between triangles in terms of the area

## Forward calculation - inner/outer/global (LITHO1.0)

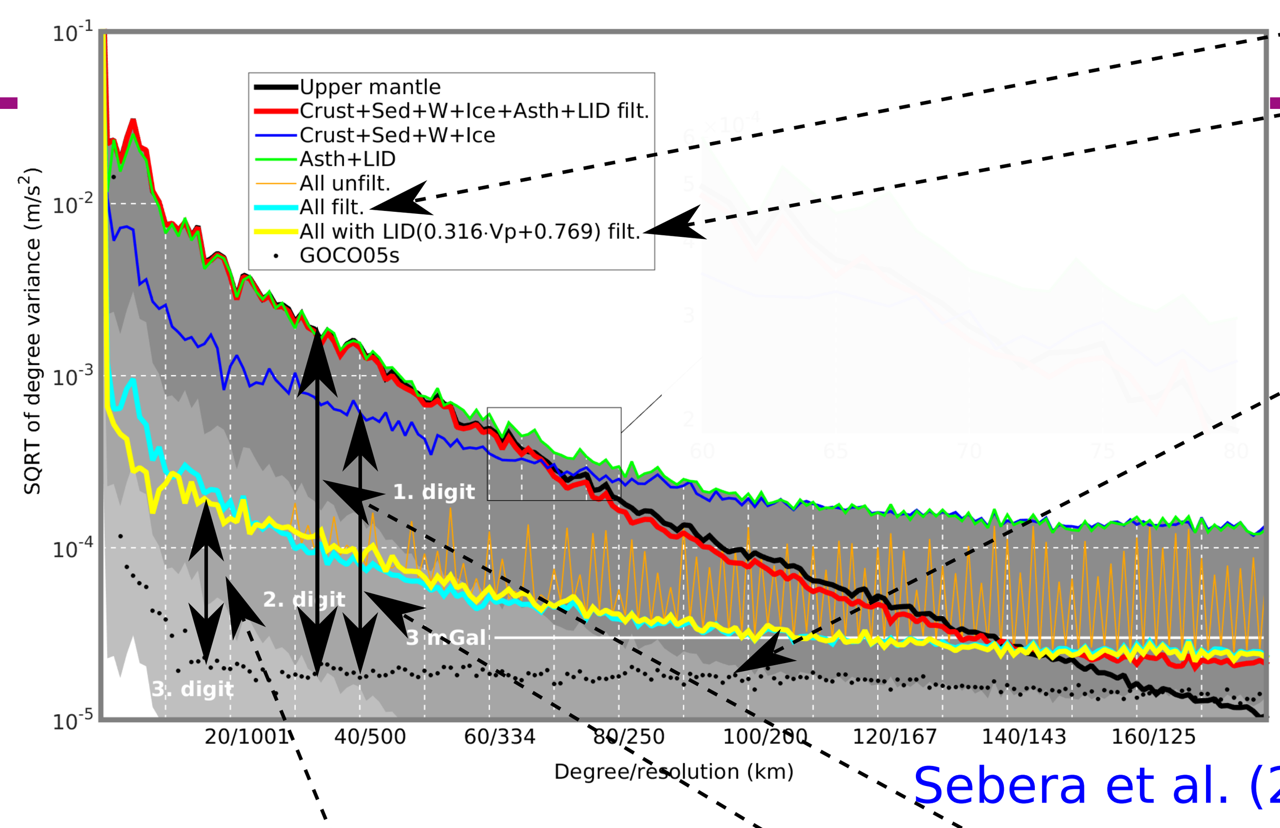



gravity gD

gravity gradient ggDD downward component

=> **gradient(s) less affected by outer zones**

## Global gravitational spectra (LITHO1.0)




LITHO1.0 only

LITHO1.0 modified in the mantle lid

real gravity (GOCO05s)

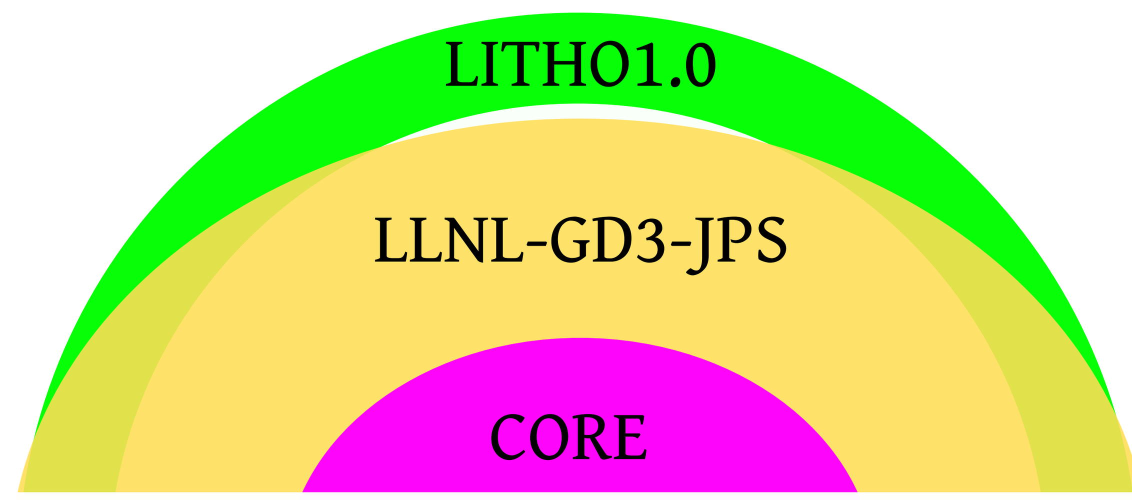
Sebera et al. (2017)

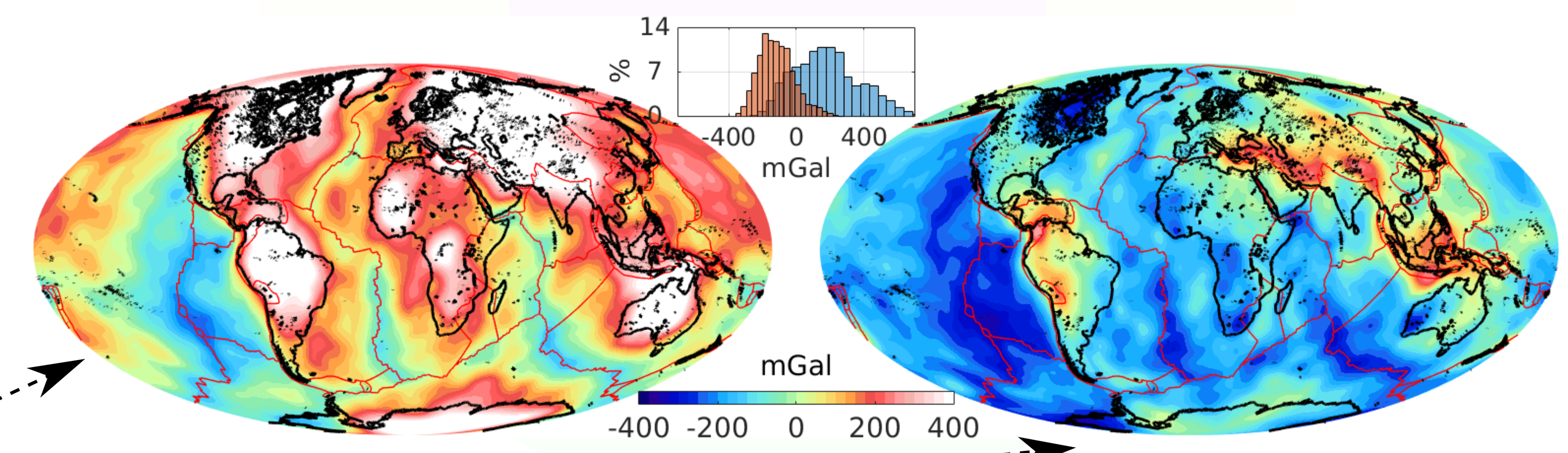
departure of the crust,Ast+LID from the real field

departure of LITHO1.0 from the real field

## Joining LITHO1.0 and LLNL-GD3-JPS

* LLNL-GD3-JPS has **spheroidal** geometry, while LITH01.0 **spherical** => linking both not trivial
* Vp, Vs of LLNL-GD3-JPS need yet to be converted to mass densities => error and trial




Sebera et al. (2017)

## Summary

* Although 435 km deep only, LITHO1.0 approaches real field and provides spectral relations between major players (Asthenosphere, Lid, Crust)
* LITHO1.0 cannot give long wavelengths of the gravity field since they depend on much deeper areas too
* LLNL-GD3-JPS has the same lat-lon parameterization as LITHO1.0 but a different geometry => can be adjusted
* The open problem is to reliably convert Vp and Vs in the whole mantle into the density => will be done in an iterative way considering thermochemical constraints


**Acknowledgements**

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