Greenland's lithospheric structure from integrated modelling of potential field data

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Agnes Wansing[1], Jörg Ebbing[1], Max Moorkamp[2], Björn Heincke[3]
(1) Kiel University, (2) LMU Munich, (3) GEUS Copenhagen
agnes.wansing@ifg.uni-kiel.de

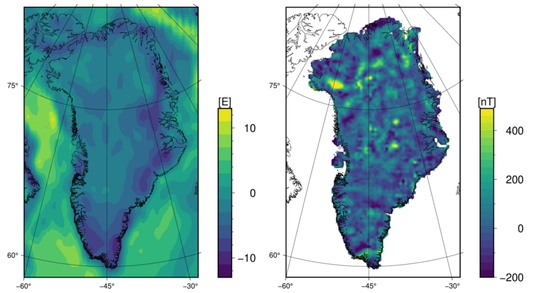
1. Introduction

Greenland's tectonic history is complex, and the resulting lithospheric structure is, although extensively studied, not well constrained. Most models agree regarding the location of the North Atlantic Craton in South Greenland, and the most recent surface heat flow model also predicts a cold lithosphere for that area. However, the velocity anomaly from the regional tomography NAT2021 shows two additional cratonic blocks in North Greenland that are not included in geological maps and previous lithospheric models.

2. Data

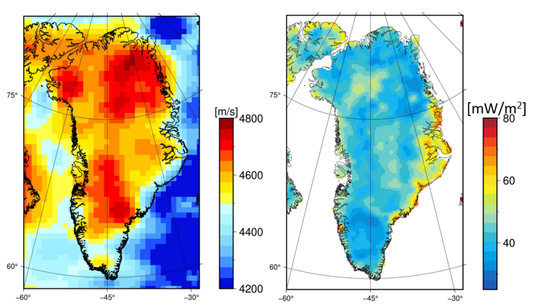
Vertical gravity gradient G_{uu} at 50 km from XGM2019 (Zingerle et al. 2019)

Magnetic total field anomaly (TF) (Heincke et al. in prep.)



Shear wave velocity Vs from NAT2021 at 130 km depth (Celli et al. 2021)

Geothermal heat flow GHF (Colgan et al. 2022)



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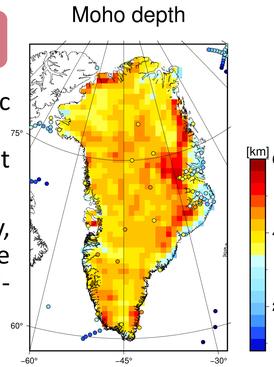
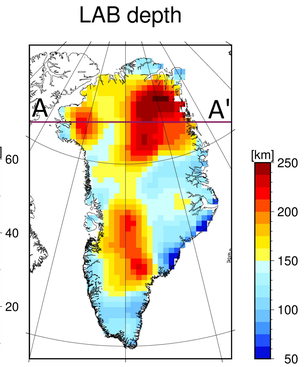
3. Method & Results

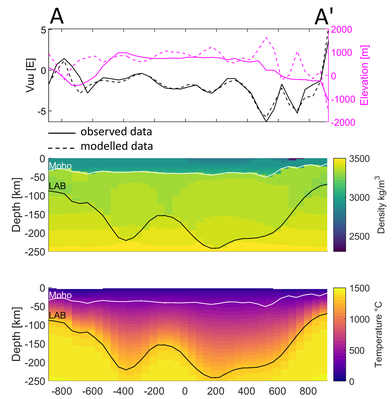
A. Lithospheric background model

- fitted to Vs, G_{UU} & the isostatic topography
- constructed with LitMod3D (Fullea et al. 2009)

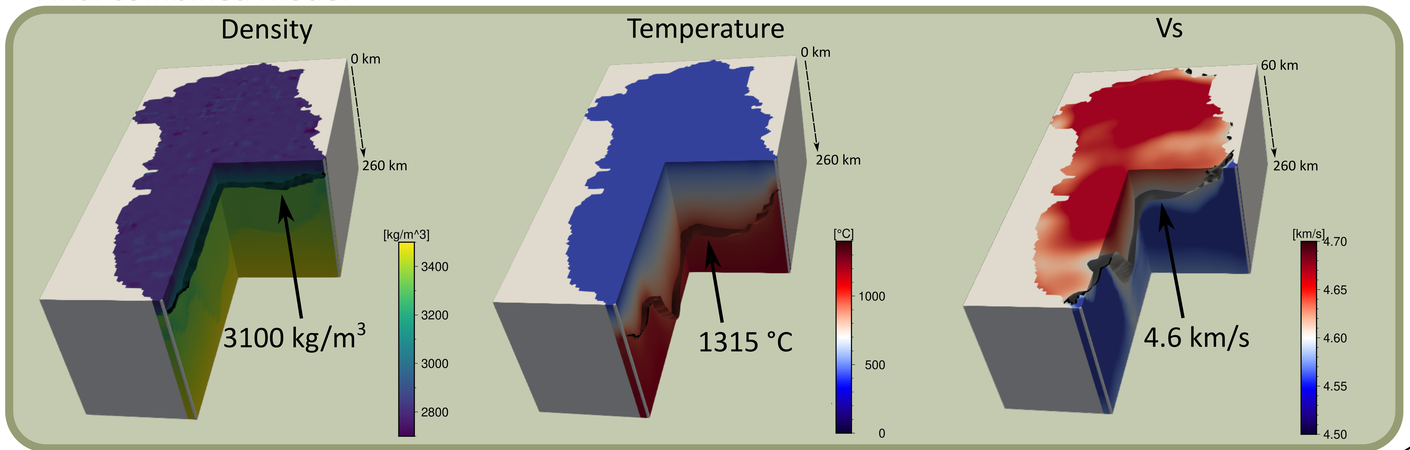
- forward calculates the 3D density, pressure, temperature and Vs structure in a self-consistent geophysical-petrological framework





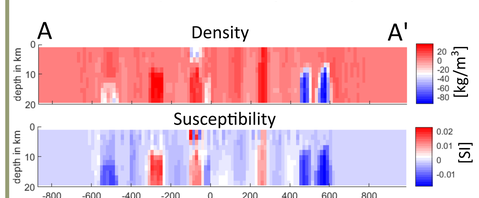


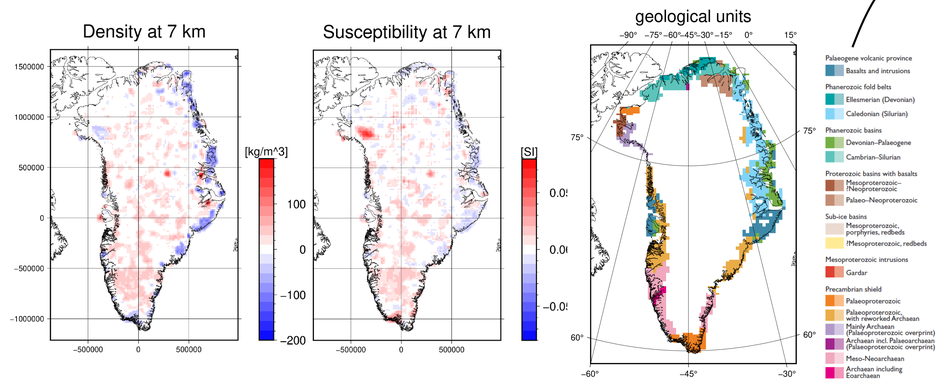
Final combined model



C. Joint inversion

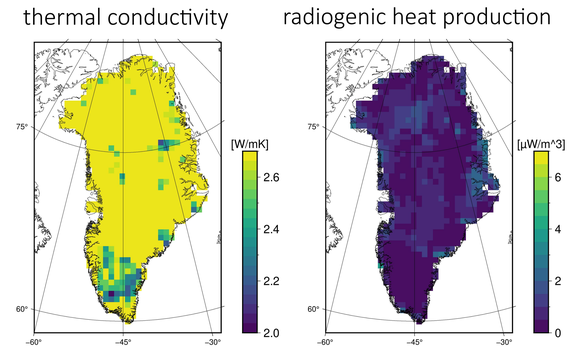
- joint inversion of residual gravity from the lithospheric background model & magnetic TF anomaly with jif3D (Moorkamp et al. 2011)
- coupling with a variation of information (Moorkamp 2021)

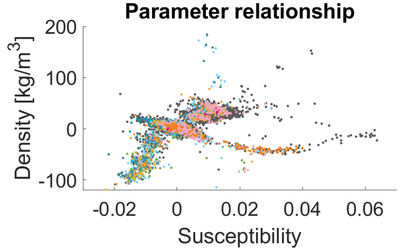




B. Grid search

- grid search to find upper crustal thermal parameters to reproduce GHF from Colgan et al. 2022 with the lithospheric background model
- thermal conductivity is set to 2.7 W/mK if possible, otherwise the maximum possible value





4. Conclusion

We present an integrated model of the lithospheric structure of Greenland that agrees to a large degree with the majority of observed data. The model also reproduces the most recent GHF model.
The modelled LAB includes three deep lithospheric roots down to 250 km depth, indicated by elevated mid-lithospheric velocities in the tomography model.
Comparing the inverted crustal density and susceptibility structure with the surface geology from the ice-free coast helps to identify different units in the parameter relationship.