Using satellite data to decipher geodynamics in northeast Atlantic

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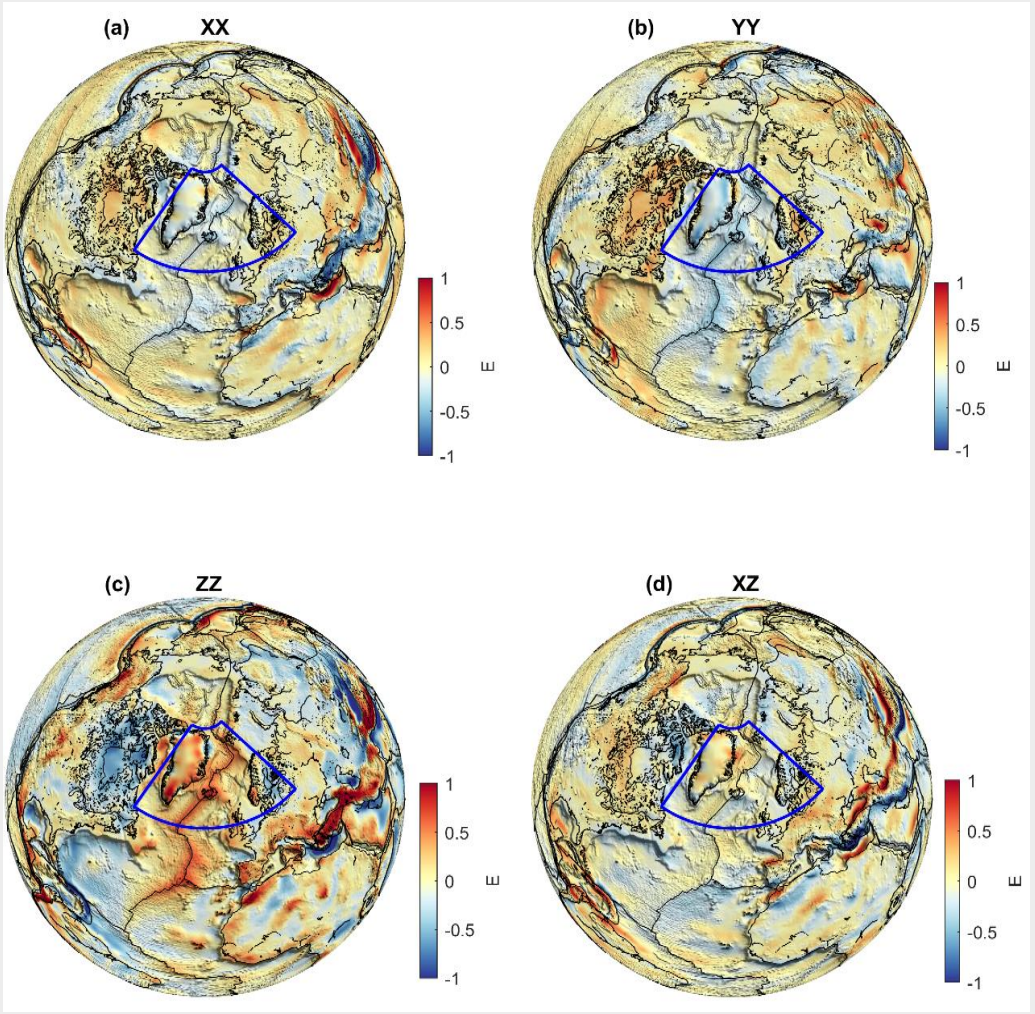
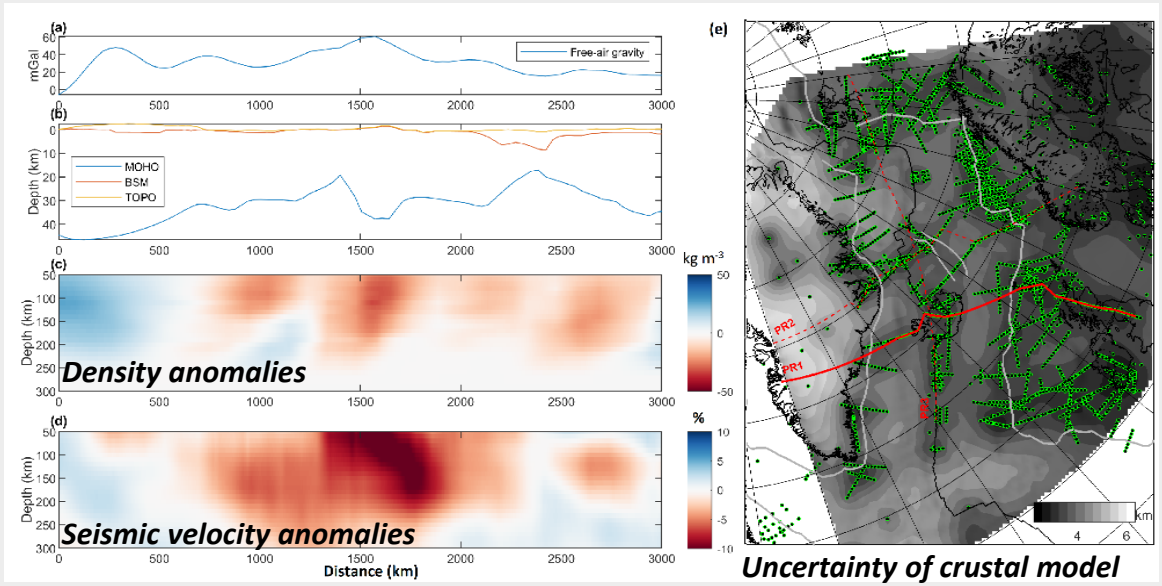
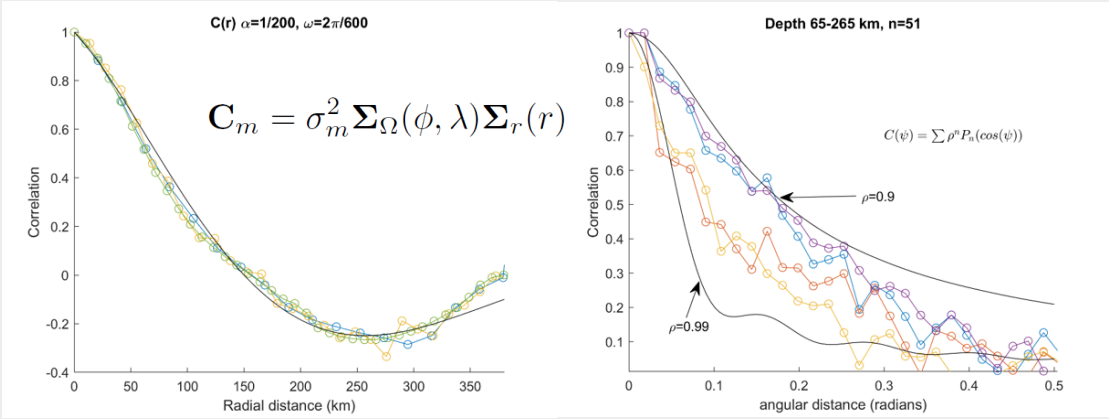


GOCE gravity gradients (a) XX-, (b) YY-, (c) ZZ-, and (d) XZ-components.



Uncertainty of crustal model

Mantle density anomalies based on constrained linear inversion of gravity gradients in 3D. The model is extracted along 2D profile following the Iceland-Greenland-Faroe Ridge and across the conjugate passive margins. For comparison, the regional S-wave tomography model by Fichtner et al. (2018) is shown.



Empirical radial (a) and angular (b) correlation functions estimated using regional seismic tomography model

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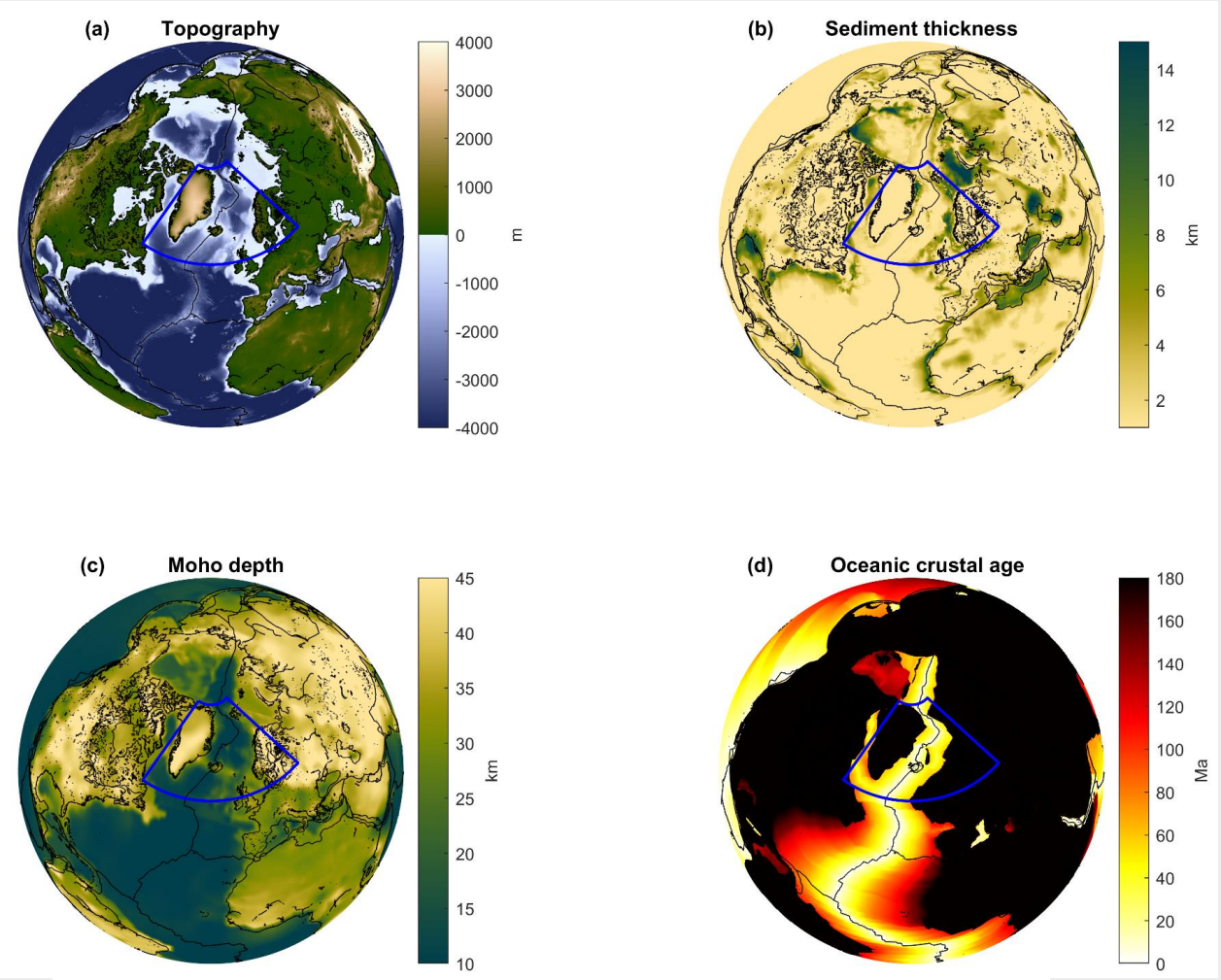
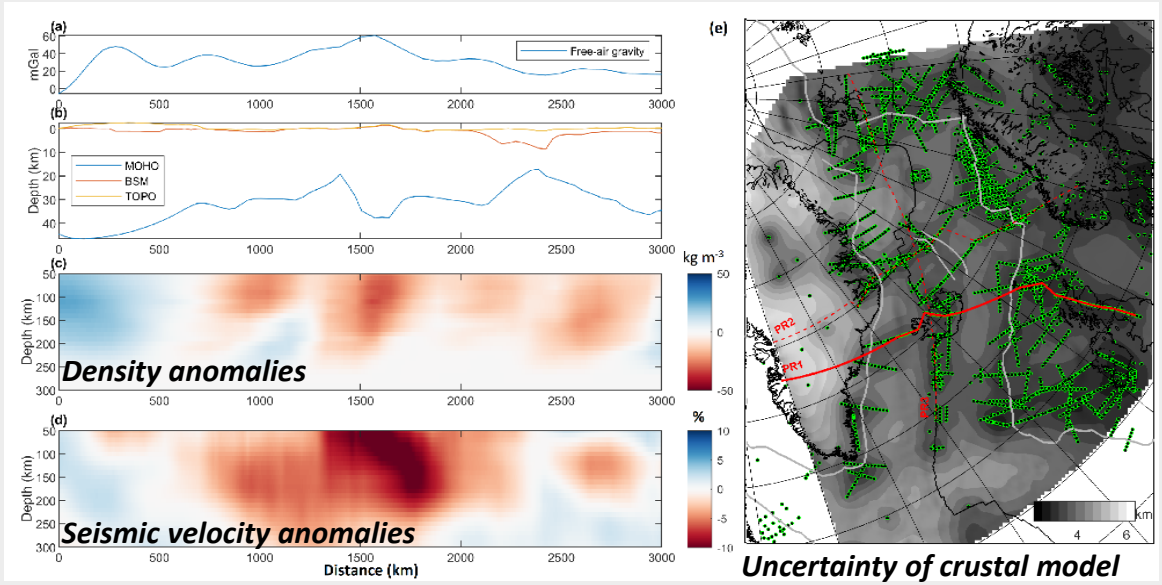


Crustal layers and lithospheric age model to compute gravity corrections



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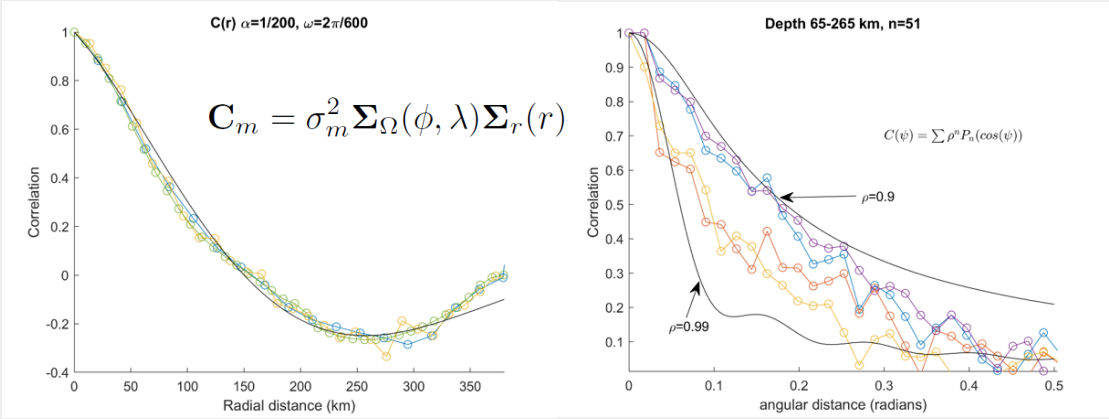

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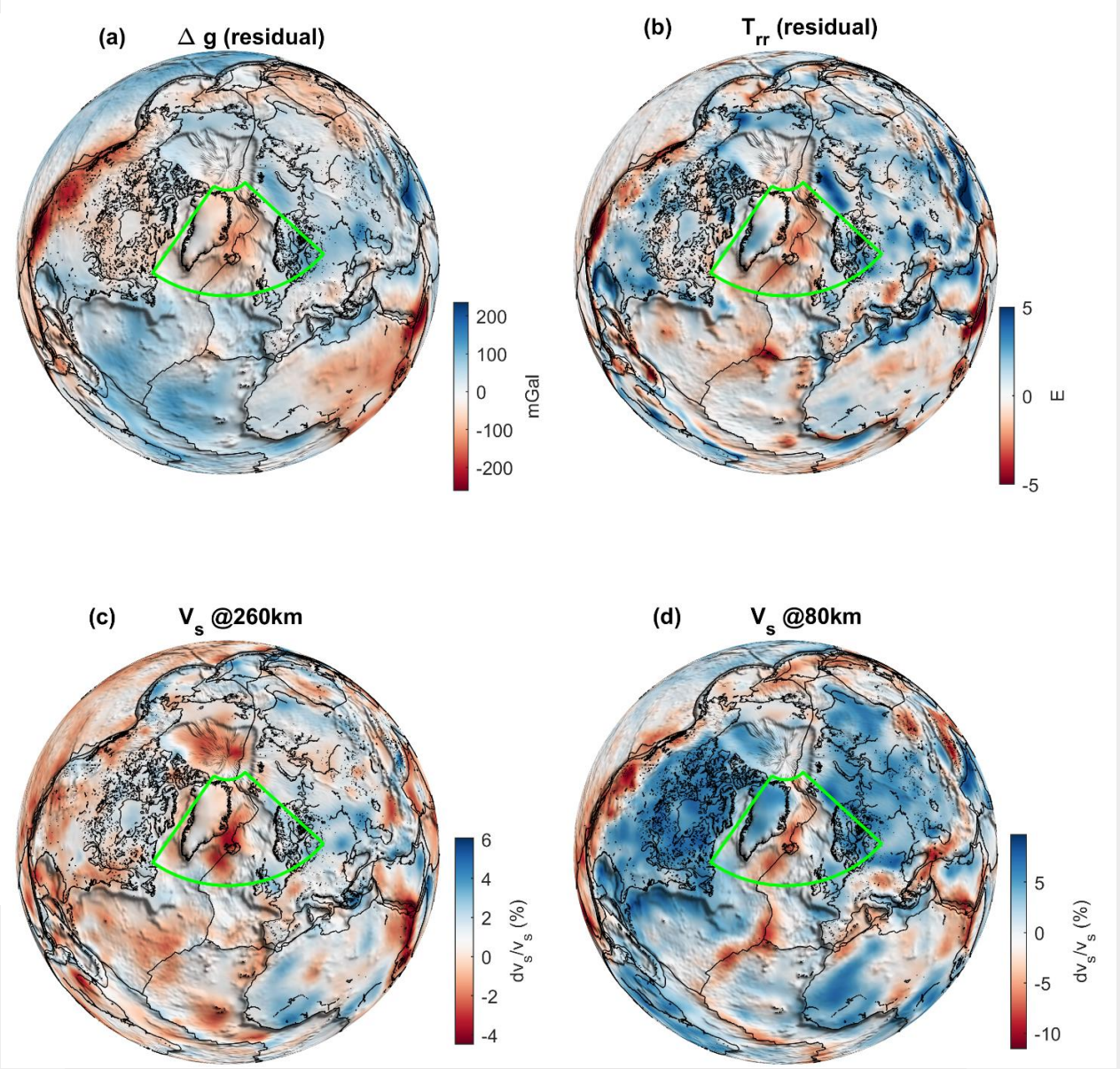
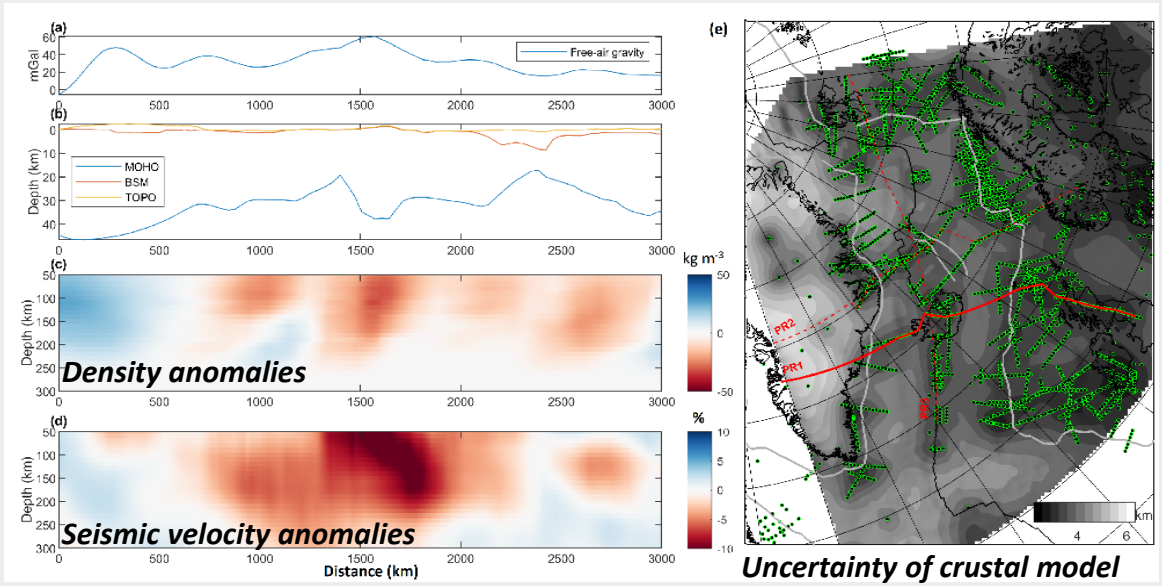


Residual gravity signal and seismic tomography images



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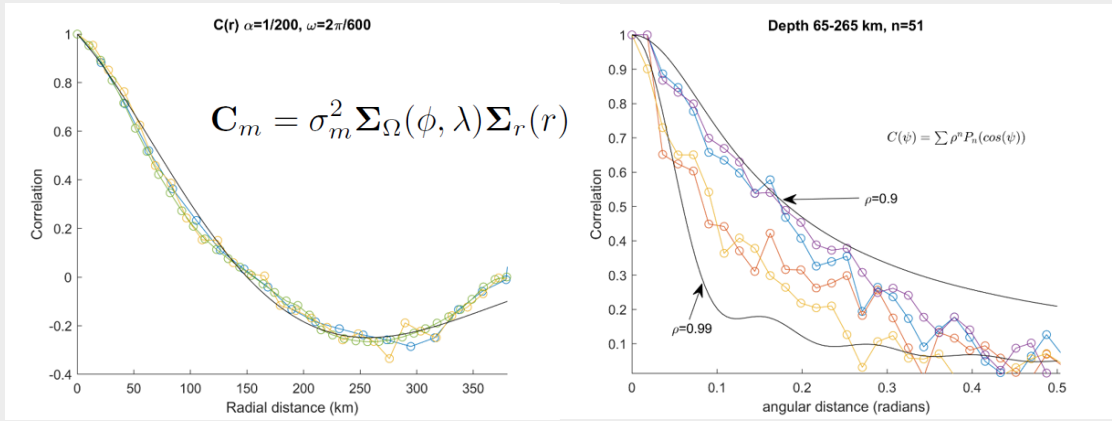

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Solution of the inverse linear Gaussian problem

Posterior probability distribution

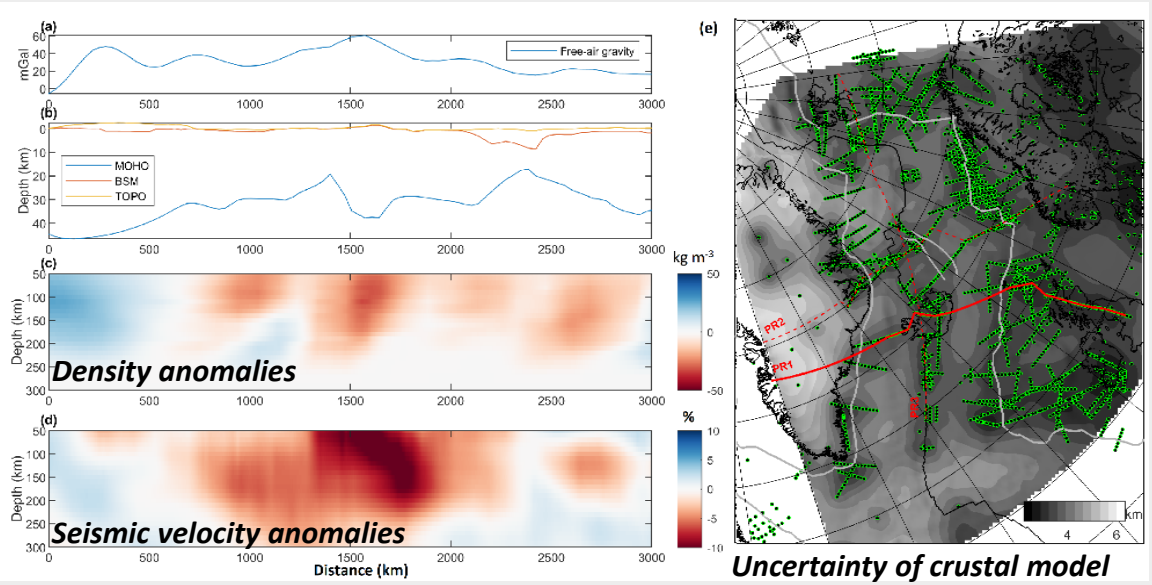
$$p(\mathbf{m}|\mathbf{d}) \propto \exp\Big(-\Phi(\mathbf{m})\Big)$$

$$2\Phi(\mathbf{m}) = \sigma_d^{-2}\big(\mathbf{Gm}-\mathbf{d}\big)^T\boldsymbol{\Sigma}_d^{-2}\big(\mathbf{Gm}-\mathbf{d}\big) + \\ + \alpha\sigma_m^{-2}\big(\mathbf{m}-\mathbf{m}_0\big)^T\mathbf{W}^T\boldsymbol{\Sigma}_m^{-1}\mathbf{W}\big(\mathbf{m}-\mathbf{m}_0\big)$$

Mean $\quad \Delta\mathbf{m}_w = \mathbf{G}_w^\dagger\left[\mathbf{G}_w\mathbf{G}_w^\dagger + \alpha\mathbf{I}_d\right]^{-1}\delta\mathbf{d},$

Covariance $\quad \tilde{\boldsymbol{\Sigma}}_m = \boldsymbol{\Sigma}_m - \mathbf{G}_w^\dagger\left[\mathbf{G}_w\mathbf{G}_w^\dagger + \alpha\mathbf{I}_d\right]^{-1}\mathbf{G}_w\boldsymbol{\Sigma}_m$

Adjoint kernel $\quad \mathbf{G}^\dagger = \dfrac{\sigma_m^2}{\sigma_d^2}\boldsymbol{\Sigma}_m\mathbf{G}_w^T\boldsymbol{\Sigma}_d^{-1}.$



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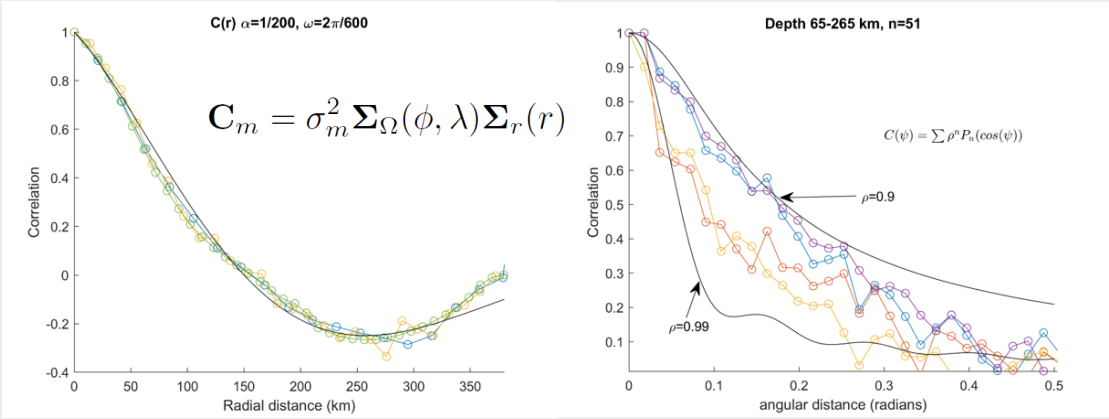

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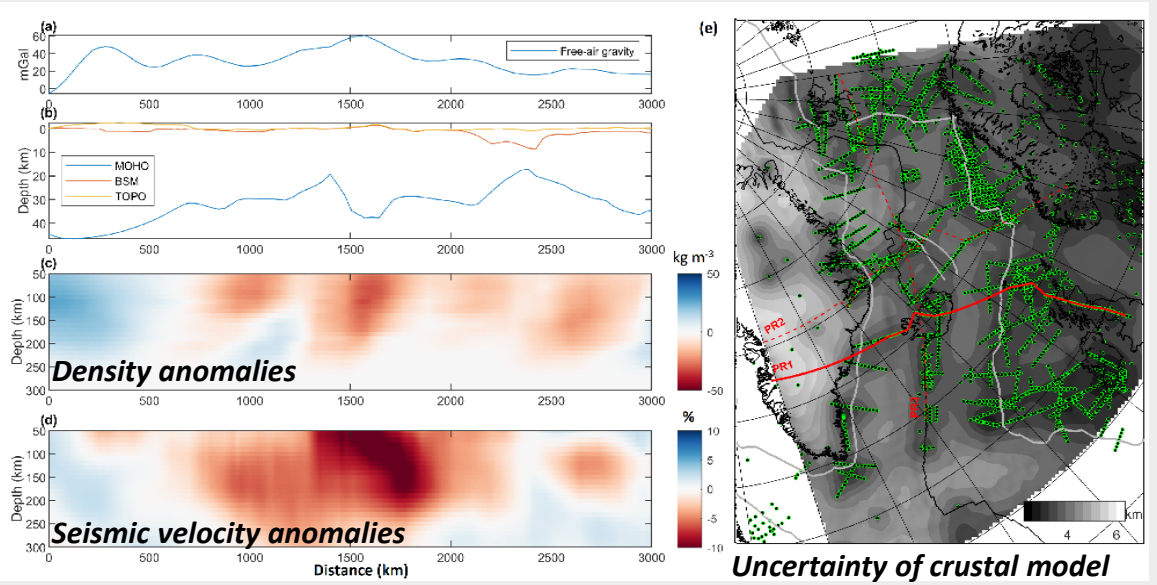
CONCLUSIONS

- We present a probabilistic linear inversion method to image the density heterogeneity within the lithosphere and sub-lithospheric upper mantle using satellite gravity gradient data.
- The prior information is incorporated through the spatial weighting of the model and the data and the model covariance functions, estimated using spherical geostatistical analysis of independent models based on seismological data.
- The predicted density variation in the upper mantle is generally consistent with seismic velocity anomalies implying a mostly thermal origin of density heterogeneities.



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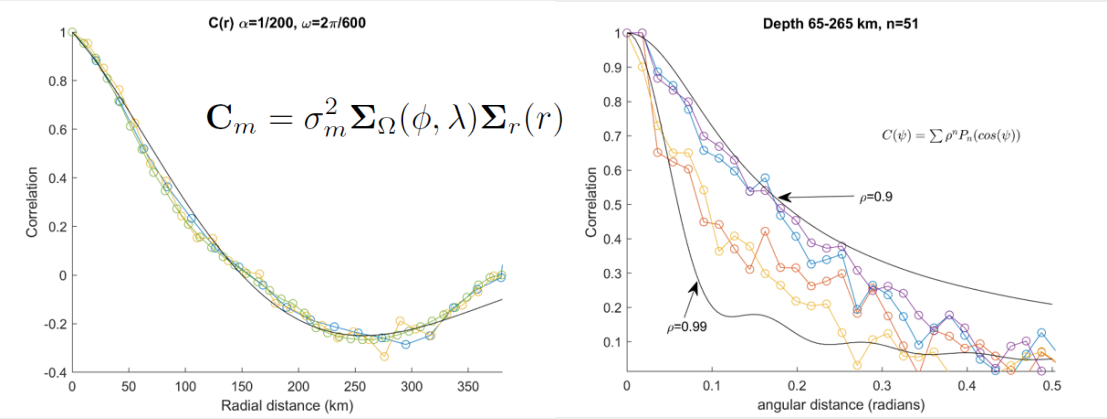

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