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Joint inversion of teleseismic and gravity data beneath the Fennoscandian Shield

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Many geophysical studies have been performed to understand lithospheric structures and to unravel the evolution and stabilisation of the Fennoscandian Shield, the oldest part (2.5-3.4 Ga) of the East European Craton. However, getting a clear vision of the upper-mantle structure still remains difficult due to a loss of resolution and a poor consistency between different methods. Recently, a huge effort has been made to better constrain regional tomographic inversion using additional informations from gravity data. In this context, we present new 3D density and velocity models of the Fennoscandian upper-mantle. These models were obtained by performing a non linear joint inversion of both teleseismic and gravity data. To ensure a good agreement between recovered models, we assumed a depth dependent linear relationship linking density and velocity perturbations according to Birch's law, which was also inverted. We computed 3315 teleseismic P-delay times from 54 events recorded by the dense SVEKALAPKO experiment (140 seismometers) deployed around the transition zone between Proterozoic and Archean domains in Finland. Gravity data consist in Bouguer anomalies covering the whole Finland and were provided by the National Gravity net of the Finnish Geodetic Institute and processed by the Geological Survey of Finland. As the Fennoscandian crust is well known from previous studies, we also corrected both data set for crustal effects. Consistent inversion regularisation was found through cost functions analysis. Besides, to assess the accuracy of our results, we carried out different sensitivity tests. Resulting models show significant velocity (3%) and density (100 kg/m^3) perturbations with a quite good resolution down to 350 km. Globally, models are in good agreement except for shallower layers. This study supports the assumptions that (1) uppermost mantle is governed by mantle heterogeneities which matches crustal segment (until at least 150 km in depth) and should be related to mantle metasomatism and melt depletion (2) beneath 150 km a huge positive anomaly which was previously seen as the signature of a continental "keel" is recovered (3) even though no distinct LAB was found, isostatic compensation of the density model argues for a chemical boundary layer located between 225 and 275 km whereas (4) buoyancy estimation pleads for a thermal boundary layer around 200 km. As a whole, this study confirms the idea of a complex lithosphere structure in line with the tectosphere hypothesis.