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Interactive comment on "A lithosphere-scale structural model of the Barents Sea and Kara Sea region" *by* P. Klitzke et al.

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We would like to thank you for constructive and helpful remarks, which supported us strongly in enhancing our text. Furthermore, we provide detailed comments on implemented changes in the manuscript according to the referee's concerns. We hope, the answers obtain your approval. In any case we are looking forward to answer further questions, should they arise.

Your sincerely,

Peter Klitzke and Co-Authors

General Comments

(1) Comment of reviewer: The authors present an integrated 3D lithospheric model of the Barents and Kara seas that can be used to enhance the knowledge of a complex area that has potential for hydrocarbon resources. Unlike previous studies –mainly integrating data either on the sedimentary successionor the crustal structure- the authors integrate for the first time all publicly available geological and geophysical data into a 3D lithosphere scale regional model that resolves the first-order characteristics of the sedimentary fill, the crystalline crust and the lithospheric mantle and discuss it in the context of regional geodynamics. The final 3D model extends over 2400 km in W-E and 1280 km in N-S direction. Undoubtedly the work is very interesting not only for the complexity and extension of the study area but also for the value of compiling a vast amount of data at lithospheric scale and making them available to the community. Having said that, I have some doubts that should be clarified either by the authors or by the editor. Since I have no experience as a reviewer for Solid Earth (my first time) I do not know whether data collection falls into the scope of the journal. If the answer is yes then I do feel that the paper should be published. On the other hand, it is a pity that the authors have not modeled the 3D gravity or even gravity and geoid response of the proposed lithospheric structure. 3D modelling could provide further veracity to the proposed crustal and lithospheric mantle structure. With the advantage of the availability of 3D academic or commercial software I do strongly recommend that the authors explore how the proposed 3D structure fits gravity and geoid data. I recommend the paper to be accepted for publication with minor/moderate revision providing that its contents meet the scope of the journal.

Answer to reviewer: We refrained from showing first gravity results, since the complex lithospheric setting of the Barents Sea/Kara Sea region would require detailed 3D-gravity modelling. The 3D structural model extends over a young oceanic and continental domains which amalgamated during different orogenies. There are a number of studies addressing the heterogeneity of the crystalline crust beneath the Barents Sea and Kara Sea region (e.g. Drachev, 2011; Gudlaugsson et al., 1998; Ivanova et al., 2011; Marello et al., 2013; Ritzmann and Faleide, 2007; Ritzmann et al., 2007).

Additionally, the BARMOD velocity model (Levshin et al., 2007) reveals also major heterogeneities for the upper mantle. Consequently, a first gravity model would only show the need for further detailed gravity modelling rather than showing new robust insights into the study area. However, we are now working on a follow-up paper including the density and thermal structure of the Barents Sea and Kara Sea region. In this second paper we report on results from 3D gravity modelling using IGMAS+. Since we link the 3D-gravitational and 3D-thermal modelling part, we think that it is more plausible to present the results in the next paper.

Changes in the manuscript: We added an outlook at the end of the conclusion chapter: 'In the next steps, the 3D structural model will be tested against independent observables such as gravity and temperature. Constraining the present-day lithosphere-scale 3D thermal field provides implications about the regional strength of the lithosphere and thus, will be essential to further unravel the evolution of the Barents Sea and Kara Sea region and the mechanisms behind subsidence and uplift.'

Other/Minor comments

(2) Comment of reviewer: Pag. 1859. I have some doubts on the following statement "We interpreted the depth where the incremental velocity reduction is greatest for an XY -position (Vs =minimum) as the depth at which the geotherm cuts the solidus of mantle rock to induce first significant partial melting". Velocity reduction could also be related to thermal gradient variations, which means that there could be inversion of velocities without partial melting.

Answer to reviewer: We do not fully understand the last comment of the reviewer. Thermal gradient induced velocity reductions would imply differences in mantle composition (different thermal properties) or adiabatic conditions (as in the deeper mantle asthenosphere). On both we have no control. In the conclusion however we stress the need for thermal and gravity modelling as a next step (Please see also answer to comment 1).

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Minor comments - Proposed wording

(3) Comment of reviewer: Pag. 1589: Therefore, the shear wave velocity of a grid node located at shallower depth, z1, is subtracted from the velocity at a grid node at larger depth, z2, respectively

Answer to reviewer: done

(4) Comment of reviewer: Pag. 1589: Thus, this reduction corresponds to an inversion of the usual, pressurecontrolled trend (Vs > 0) as evident above and below this zone of decreasing velocities.

Answer to reviewer: done

(5) Comment of reviewer: Pag 1589: In the central parts of this zone the vertical velocity gradient is of up to Vs = −0.02 kms−1 per kilometer.

Answer to reviewer: done

(6) Comment of reviewer: Pag 1604: 1) . . ...sediments indicating that its major subsidence phase. . ..

Answer to reviewer: done

(7) Comment of reviewer: Pag. 1604: and northern Kara Sea and may suggest an affiliation with the Siberian plate.

Answer to reviewer: done

Others

(8) Comment of reviewer: Page 1605: Lithospheric buckling with associated phase transitions (Gac et al., 2012, 2013; Semprich et al., 2010) could explain the intense subsidence in Permian to Triassic times, but also the elevated velocities in the lithospheric mantle. It should be better justified

Answer to reviewer: We rephrased that paragraph. The observed high-velocity

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anomaly may have the potential to have contributed to the rapid Permian-Triassic subsidence but we don't claim to know the origin of the anomaly.

Changes in the manuscript: As indicated above we rephrased the conclusion slightly. Furthermore, we added a subparagraph to the discussion (page 1600, line 30) on the possible origin of the high-velocity anomaly in the lithospheric mantle. Since the eastern Barents Sea experienced no major geodynamic events after the Uralian Orogeny in late Paleozoic times and the high-velocity anomaly follows the basin outline in depths of 80 to 100 km, the high velocity anomaly might be older than the main subsidence phase of the East Barents Sea Basin and, in turn, may have contributed to basin formation.

Please check typos and misspelling

(9) Comment of reviewer: Fig B1. . . ..of western Barents Sea and use as vertical interpolation barriers for the respective megasequence boundaries.

Answer to reviewer: done âĂČ Reference list

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Interactive comment on Solid Earth Discuss., 6, 1579, 2014.