

SEA LEVEL RESPONSE TO QUATERNARY EROSION AND DEPOSITION IN SCANDINAVIA

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Introduction

The global-scale glaciations are the main driver of sea-level change. Since the last glacial eustatic sea level has changed upwards of 134 m (Lambeck et al 2014) and furthermore glacial-isostatic adjustment can affect local relative sea level significantly as isostatic rebound and great mass movement alters the solid earth surface and the geoid.

This study focusses on how glacial erosion and deposition in western Scandinavia has influenced relative sea level. This work includes finding the plausible onshore source to the offshore glacial sediments including the NAUST formation and adjacent areas in the North Sea. The temporal resolution of the offshore data limits the minimum time-scale to the last two glaciations corresponding to the T unit in NAUST.

The purpose of this study is to quantify the relative sea level change caused by glacial erosion and deposition in western Scandinavia both during the Quaternary and the last two glacial periods.

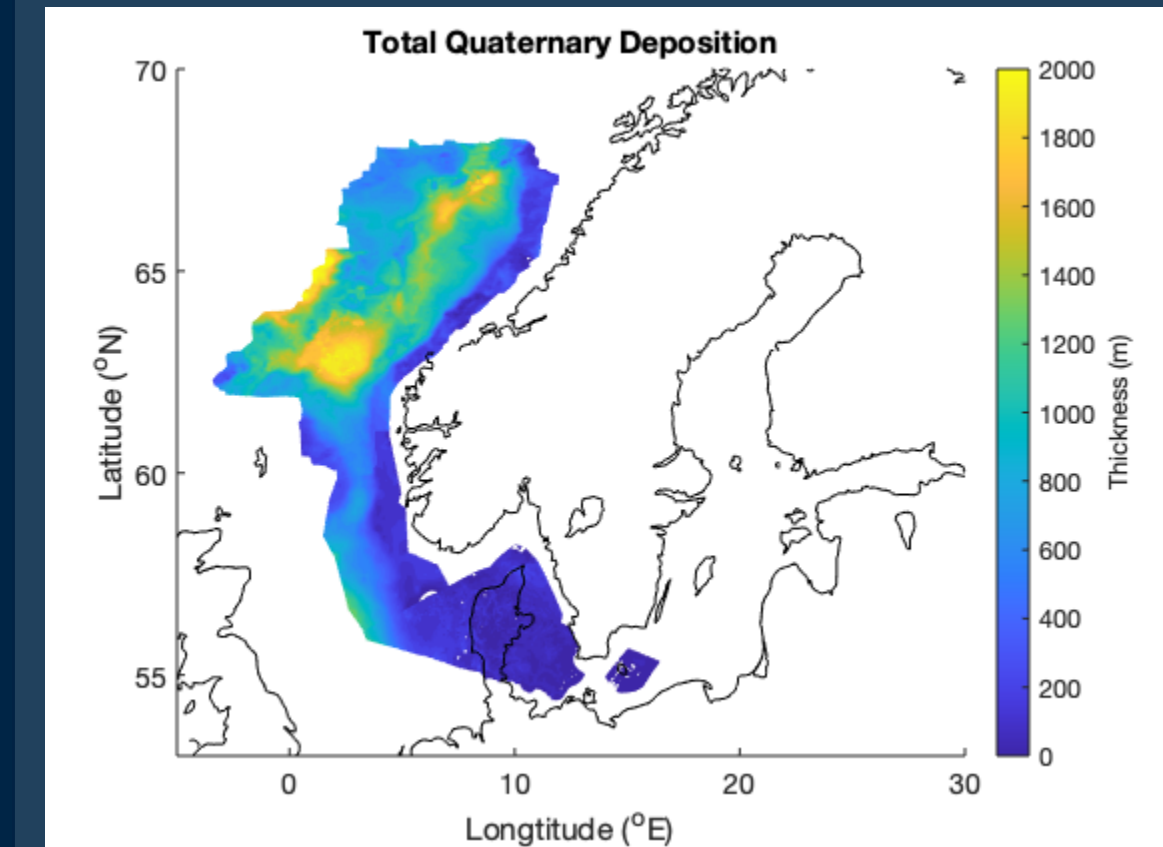


Fig 1) Offshore sediment deposit thicknesses used in this study

Methods

We adopt the gravitationally self consistent sea level theory from Dalca et al. (2013) including sediment redistribution using viscoelastic Love number theory for spherically symmetric earth models. Sea level change as difference in elevation between the sea surface and the solid earth through time is computed using the sea level equation from Farrel & Clark (1976),

$$\Delta SL = \Delta G - (\Delta R + \Delta H + \Delta I),$$

where **SL** is sea level, **G** is the geoid, **R** is the solid earth surface, **H** is sediment thickness and **I** is ice thickness. **H** and **I** are known a priori, and are thus the main drivers of sea level change, where **G** and **R** adjust in response to changes in **H** and **I**.

The offshore sediments are compiled from different data sets including the late Pliocene-Quaternary NAUST formation and other Quaternary sediment packages in the North Sea and the Danish region. (Rise et al., 2005, Binzer et al., 1994; Nielsen et al., 2008) The onshore fjord and valley erosion, inner shelf erosion and onshore erosion outside fjords and valleys are estimated and compared with offshore volumes.

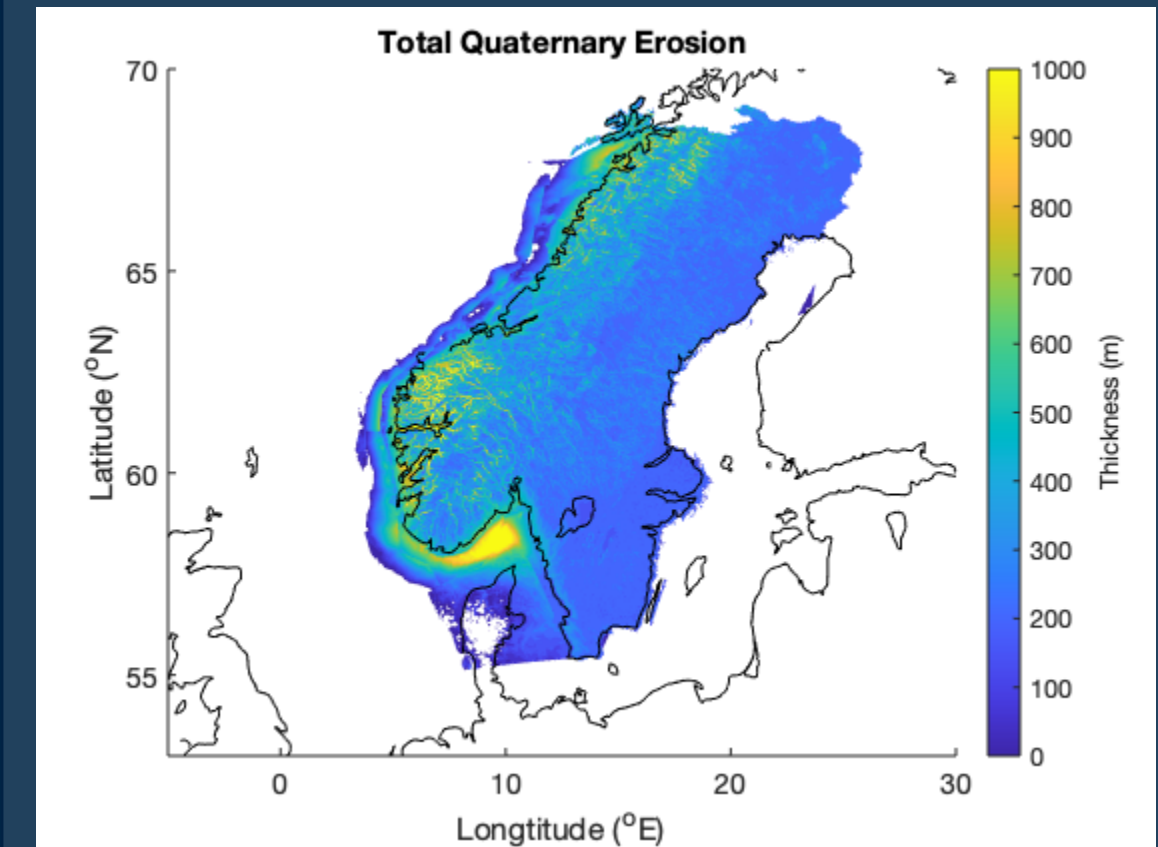


Fig 2) Modelled onshore erosion thicknesses used in this study, Pedersen et. al. 2021

Results

Here we show the total sea level change from sediment redistribution calculated by subtracting sea level change from ice mass changes only from a model with both ice mass changes and sediment redistribution.

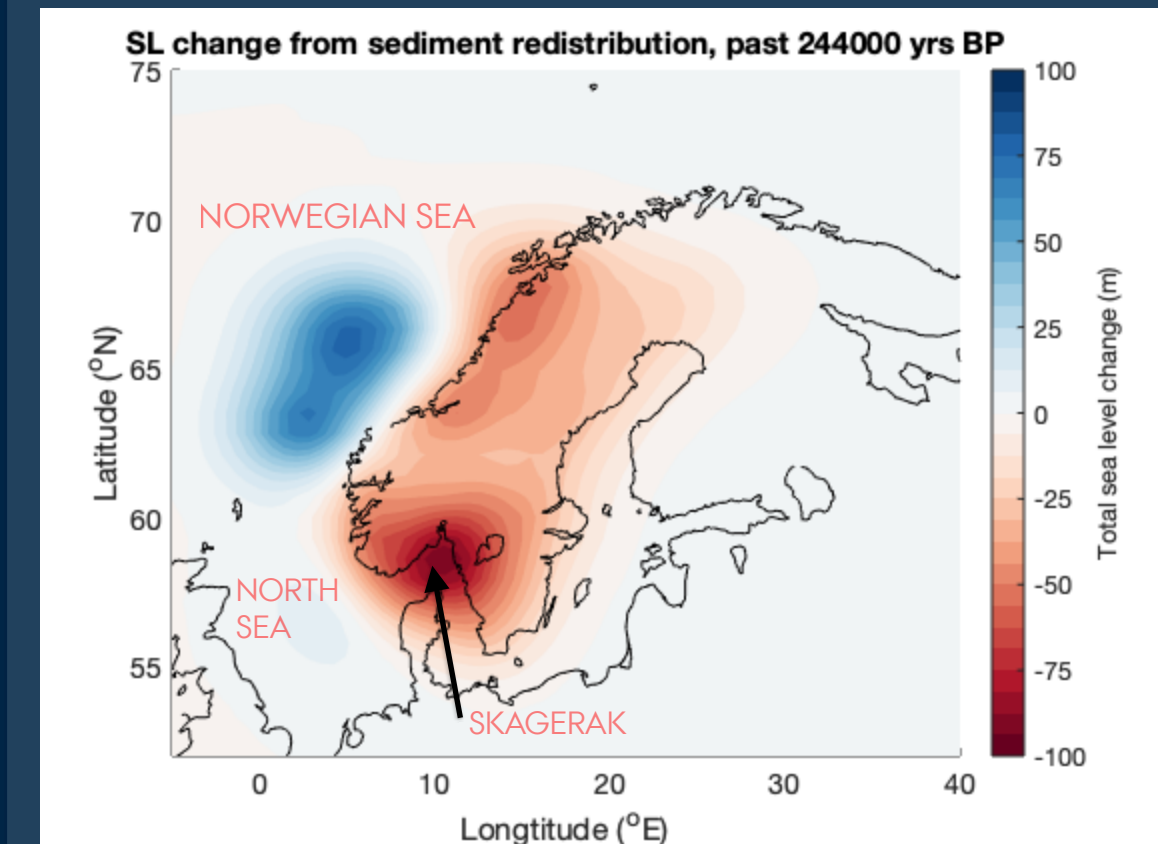


Fig 3) Sea level change from sediment redistribution during the last two glacial cycle

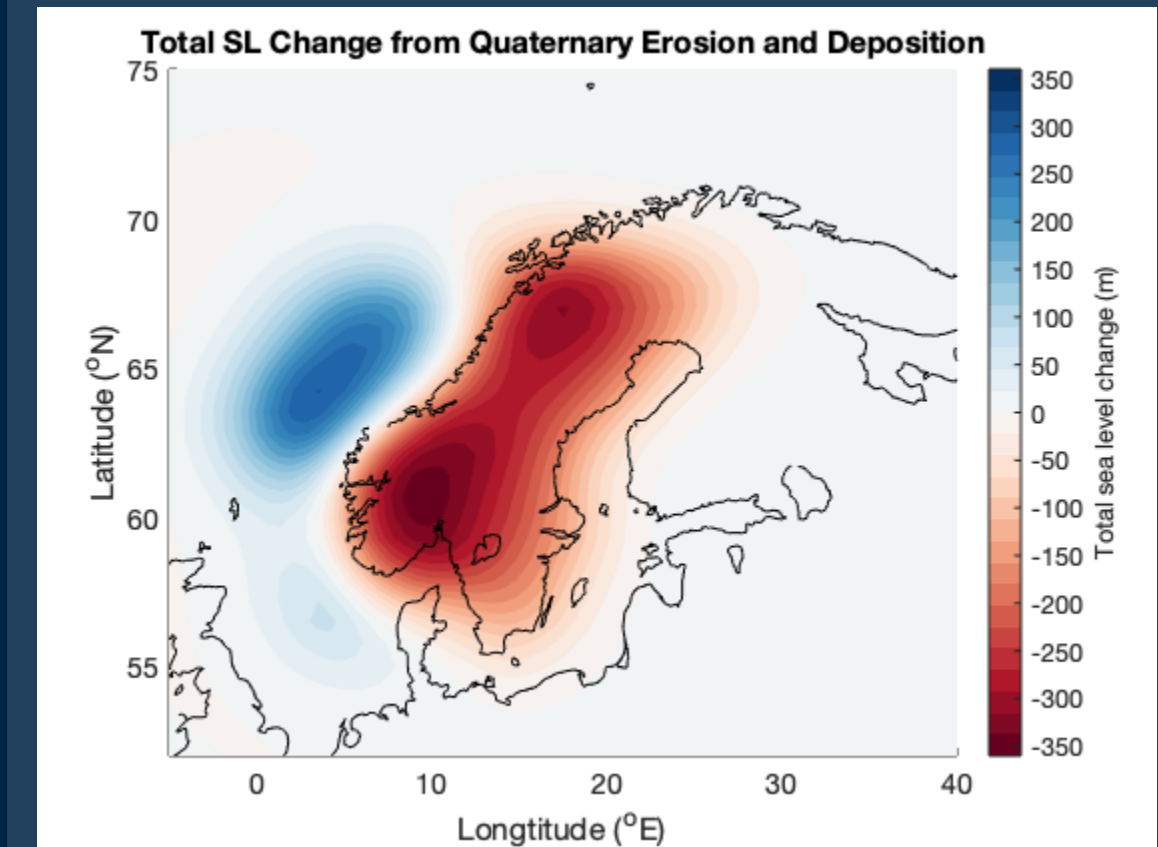


Fig 4) Sea level change from sediment redistribution during Quaternary

Discussion

Figures 3) and 4) shows how glacial erosion and deposition has driven a net sea level fall along the coast of western Scandinavia and a net sea level rise in the Norwegian Sea and North Sea.

The modelled sea level fall since the late Pliocene-Quaternary (Fig 4)) upwards of 330 meters in southern Norway is driven by both valley erosion and erosion in between valleys, and even though some areas in western Norway experience more erosion in the same time period, the offshore deposition and consequent subsidence compensates for the onshore uplift in western Norway.

The modelled sea level fall in Skagerak, south of Oslofjord, reaches 100 meters during the past two glacial cycles. This signal is dominated by erosion in the Norwegian Channel.

Conclusion

In this study we have shown that glacial erosion and deposition likely contributes to substantial relative sea level fall (>200 m in Northern Skagerak) along the coast of south-western Scandinavia during the Quaternary. The signal is dominated by glacial erosion in southern Norway.

We also show how the erosion of the Norwegian Channel leads to local sea level fall in Skagerak during the past two glacial cycles. These results suggest that glacial uplift patterns in Scandinavia, and thus constraints on ice thickness and volume, are influenced by erosional processes, underlining the importance of accounting for sediment redistribution in glacial isostatic adjustment-modelling when interpreting ice sheet history and regional glacial rebound.

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