Supplementary Information

The role of ocean and atmospheric dynamics in the marine-based collapse of the last Eurasian Ice Sheet

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Supplementary Notes

Supplementary Note 1

Radiocarbon dates from the North Sea (Supplementary Data 1), Mid Norwegian margin (Supplementary Data 2) and the Kara-Barents-Svalbard regions (Supplementary Data 3) are presented. Only dates which are considered to have some relevance for the dating of the 20-14 ka time slices have been included in the tables. Information of location (also marked in Fig. 1a, main text), context and material dated are from original references listed below for each region. The marine carbonate dates have been calibrated using the OxCal 4.4 program, Marine20 curve [1] with Delta R set to zero. Two dates on plant material from the Kara-Barents-Svalbard region (marked in italic) have been calibrated using the IntCal 20 curve and the same program. Uncertainty is given as one sigma.

References North Sea region, Supplementary Data 1: [2-23]

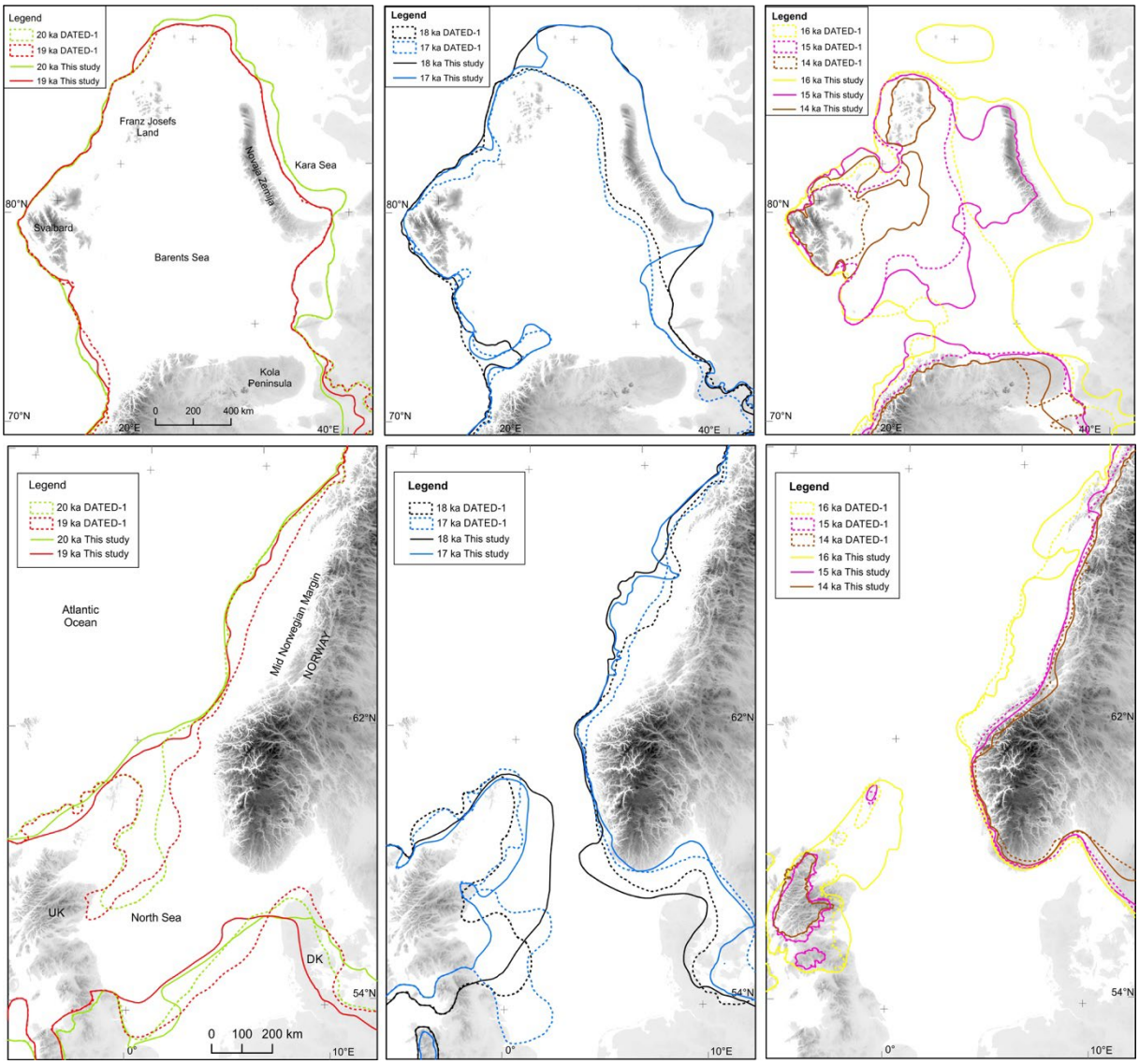
References Mid Norwegian margin region, Supplementary Data 2: [22,24-42]

References Kara-Barents Sea-Svalbard Sea region, Supplementary Data 3: [27,43-80]

Supplementary Figures

Supplementary Figure 1. Deviation from Hughes et al. (2016)

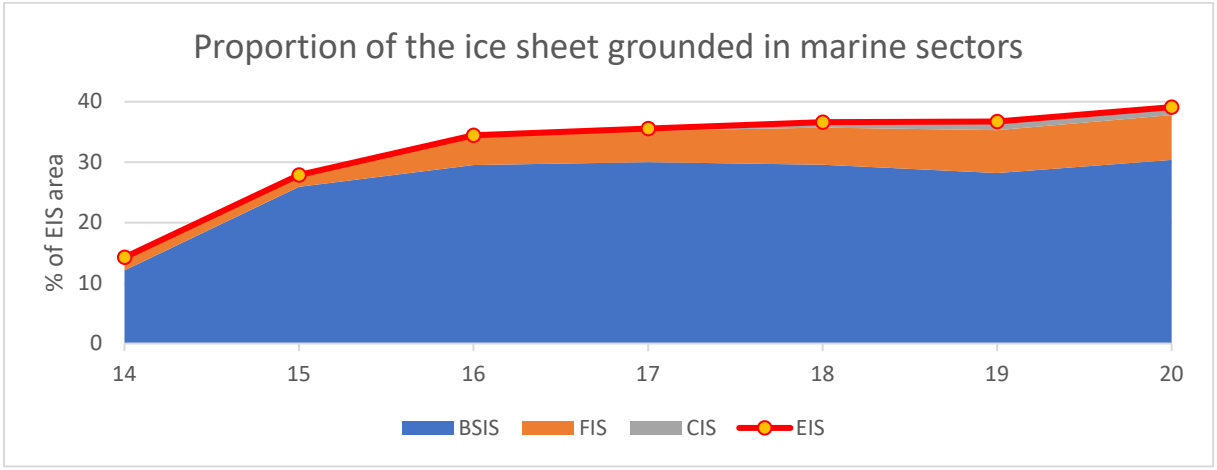
For the reconstructed time slices 20-14 ka presented in this study (whole colored lines) the panels below show the deviation from the preferred reconstruction of Hughes, et al. [81] (DATED-1, dashed lines).



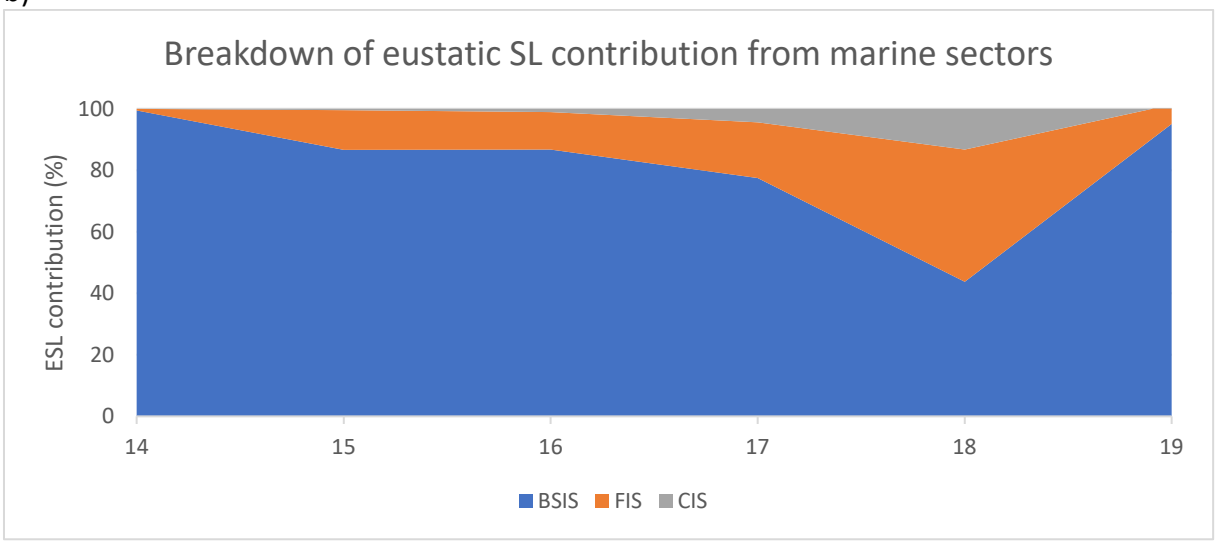
Supplementary Figure 2. Modelling - Marine sectors

For each time slice marine sectors are defined according to the isostatically adjusted topography (see Methods in main text), sea level position[82] and directly linked to ocean waters. Isolated basins below sea level, such as the Gulf of Bothnia, are not considered marine until a direct connection with ocean waters is realised. **a)** Proportion of ice sheet grounded in marine sectors. **b)** Breakdown of sea level contribution from marine sectors.

a)



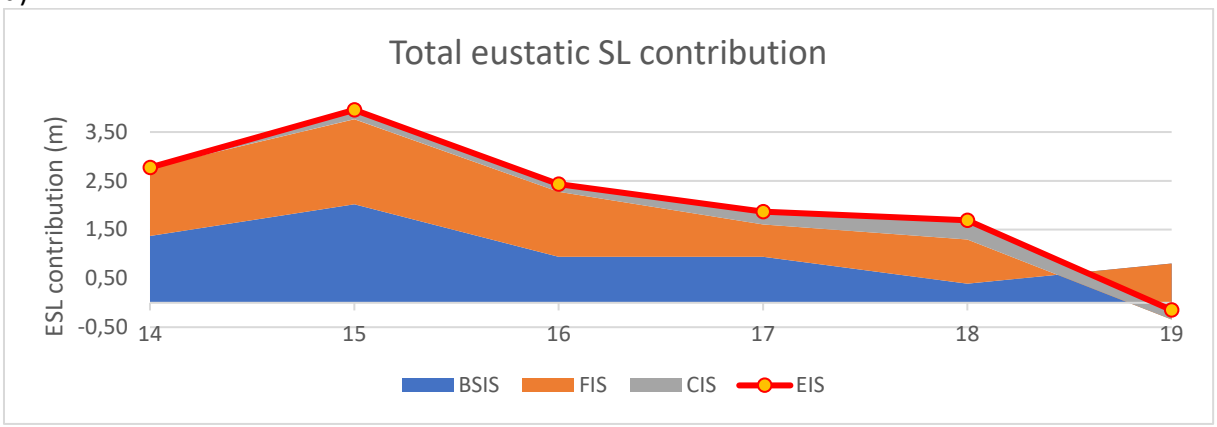
b)



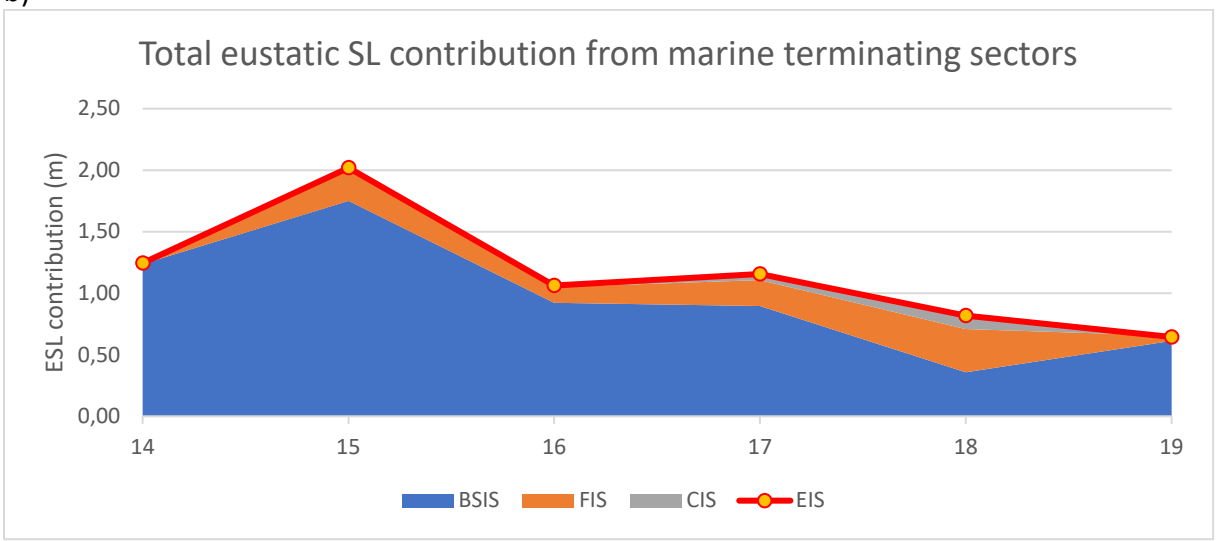
Supplementary Figure 3. Modelling - Sea level contributions

Eustatic sea level (SL) contributions (**a**) are calculated assuming a density of 916.7 kg/m^3 for glacial ice, a density of 1030 kg/m^3 for seawater, and a global ocean spanning of 3.618 x 10^8 km^2. For marine-based ice (**b**), the ice volume contributing to eustatic SL rise is calculated as the volume above hydrostatic equilibrium (freeboard).

a)

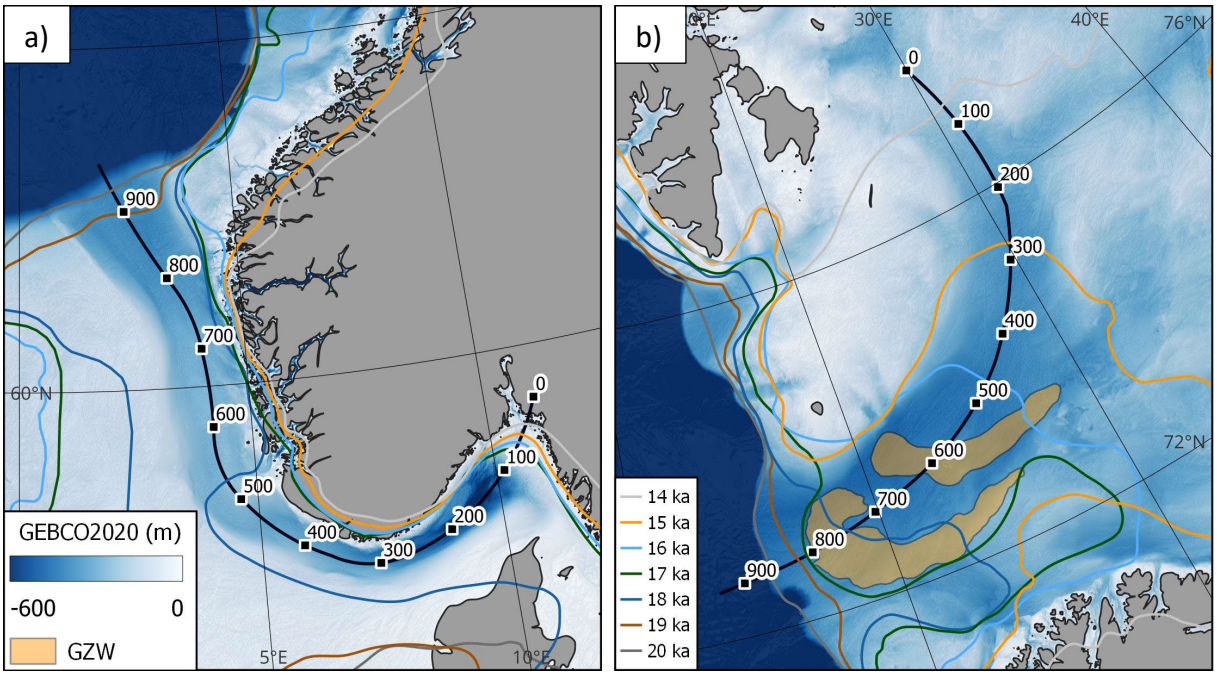


b)

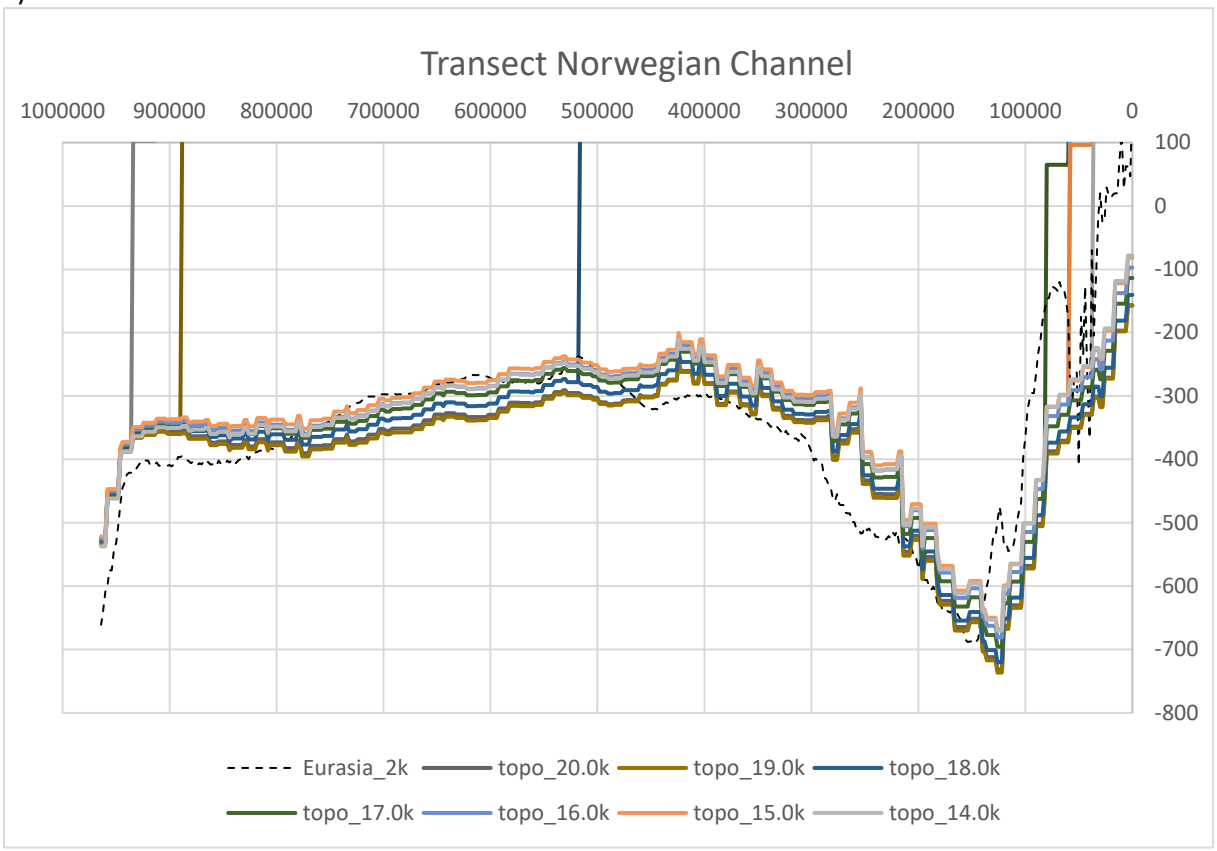


Supplementary Figure 4. Modelling - Depth of major glacial troughs during deglaciation

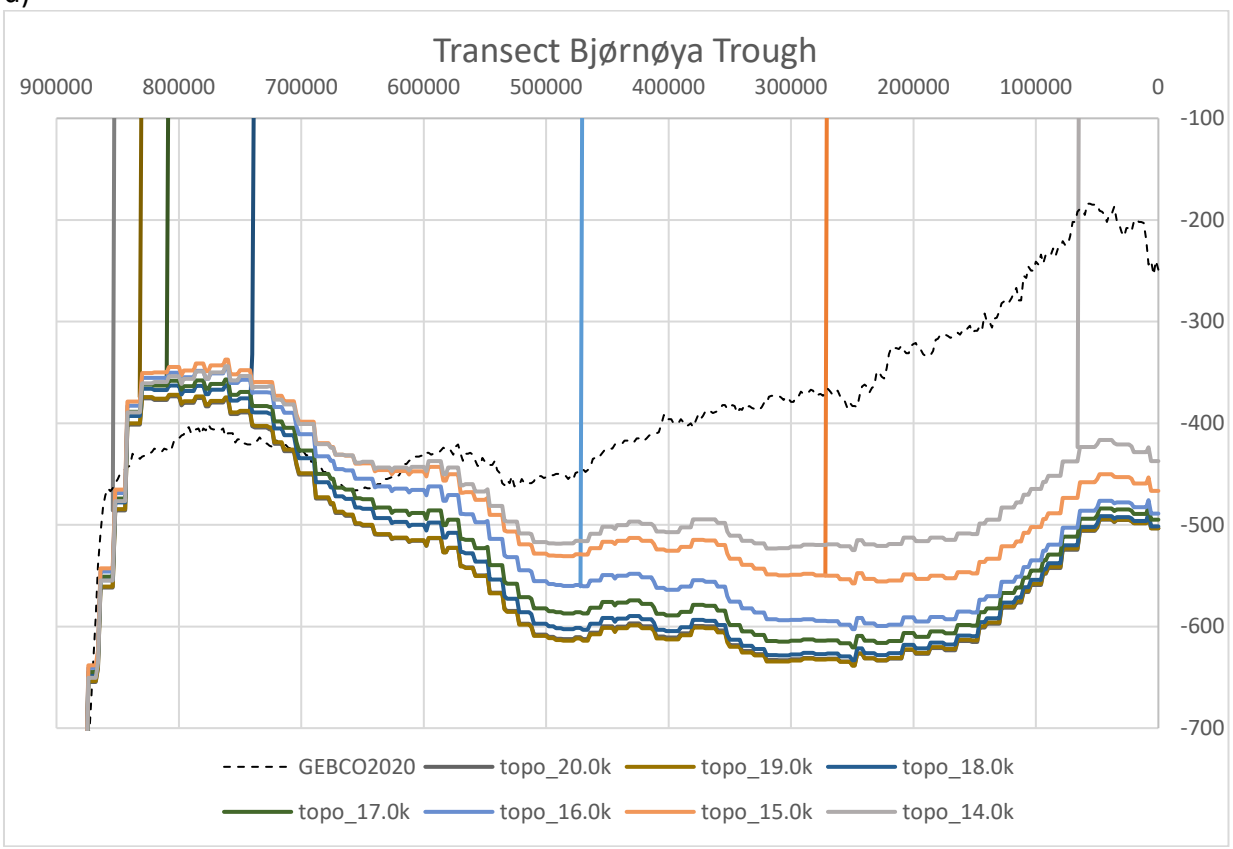
Transects along and Norwegian Channel (**a** and **c**) and the Bjørnøya Trough (**b** and **d**) highlight the rate of retreat of the major Bjørnøya Trough and Norwegian Channel ice streams during the last deglaciation and the contemporaneous water depth (accounting for isostasy and eustatic sea level changes). The present bathymetry (GEBCO2020) is included for comparison. Extreme loading of the central Barents Sea causes the inner Bjørnøya Trough to experience a relative deepening to >400 m through the deglaciation, despite a global reduction in sea level. Short-lived ice cover at the shelf edge in the southwest Barents Sea produced only minor isostatic adjustments, and thus a relative shallowing of the water column. Thin ice cover over the North Sea and the Norwegian Channel produced only minor isostatic adjustments, deepening the water column in the trough by up to c. 50 m.



c)

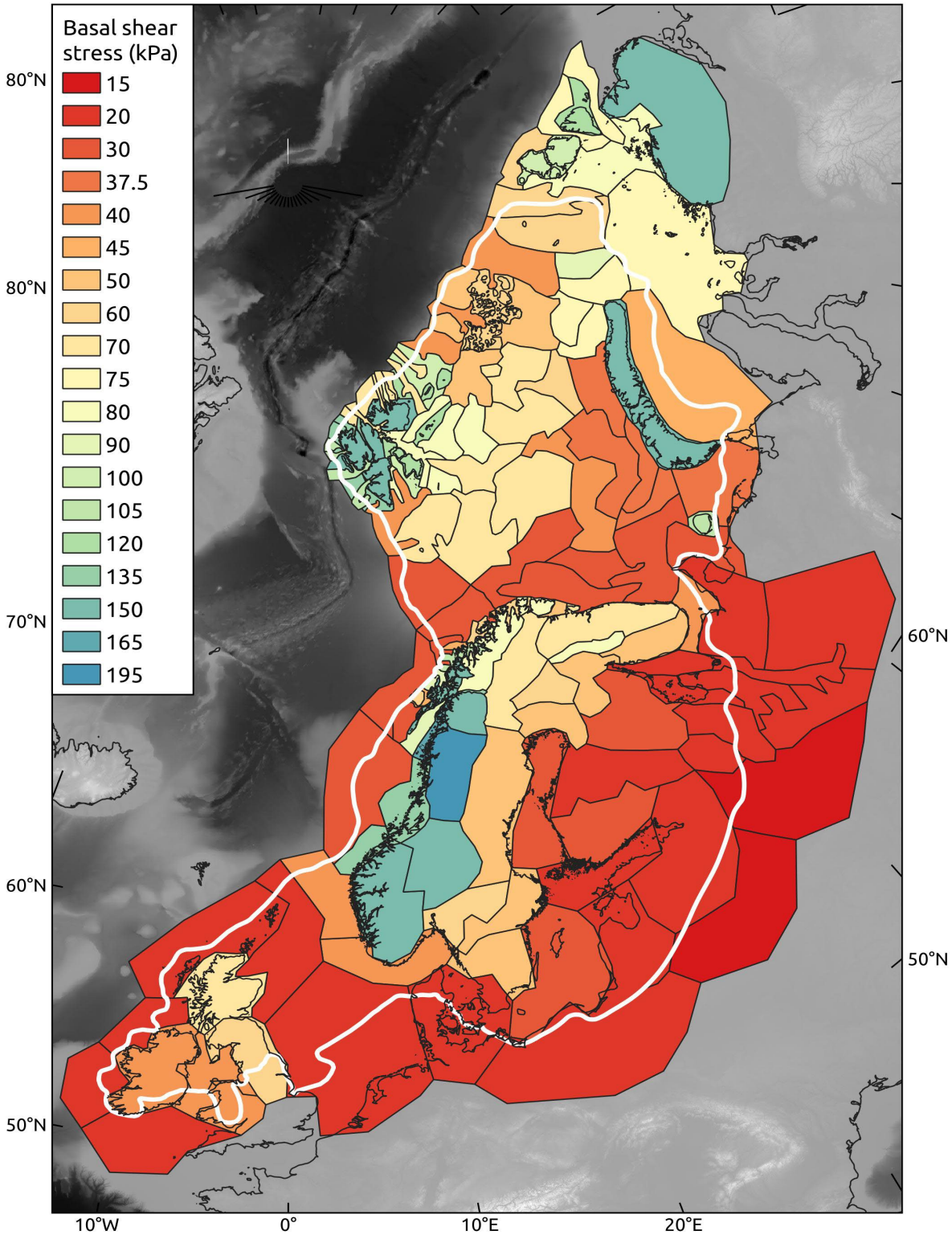

Transect Norwegian Channel
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
100
0
-100
-200
-300
-400
-500
-600
-700
-800
Eurasia_2k
topo_20.0k
topo_19.0k
topo_18.0k
topo_17.0k
topo_16.0k
topo_15.0k
topo_14.0k

d)


Transect Bjørnøya Trough
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
-100
-200
-300
-400
-500
-600
-700
GEBCO2020
topo_20.0k
topo_19.0k
topo_18.0k
topo_17.0k
topo_16.0k
topo_15.0k
topo_14.0k

Supplementary Figure 5. Basal shear stress values used in modelling

Basal shear stress values are parameterized on the basis of topography and sediment cover, with maximum values applied from the PaleoMIST 1.0 dataset [83]. Additional experiments perturbing these values by ±20% (Supplementary Data 4-6) were run to envelope the potential range in ice volume evolution through deglaciation.



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