Supplementary Data: Sediment supply on the West Greenland passive margin: redirection of a large pre-glacial drainage system.

Isostatic modelling

Hydrological analysis

Chi mapping

Isostatic flexural model

Isostastically balanced digital elevation models of Greenland are used to define a 'pre-glacial' landscape of Greenland. Producing these requires calculating the extent of lithospheric deformation caused by the Greenland Ice Sheet. Our approach utilises three principal parameters; definition of the flexural rigidity of the lithosphere, the extent of the ice load atop the lithosphere of Greenland and a 2D flexural isostatic response filter to calculate the effect of the load on the lithosphere. Values and references for given parameters can be found in the Table 1.

Flexural rigidity

$$D = \frac{ET_e^3}{12(1 - v^2)} \tag{1}$$

where E is Young's modulus, T_e is the elastic thickness of the lithosphere and v is Poisson's ratio.

Ice load

$$P_{ice} = \rho_{ice} \cdot g \cdot h_{ice} \tag{2}$$

where ρ_{ice} is the density of the ice load, g is gravity and h_{ice} is the ice thickness.

2D flexural isostastic response filter

$$\Phi(k_x, k_y) = \left[D\left(\pi k_x\right)^4 + 2D\left(\pi k_x\right)^2\left(\pi k_y\right)^2 + D\left(\pi k_y\right)^4 + \rho_a \cdot g\right]^{-1} \tag{3}$$

where ρ_a is the density of the underlying asthenosphere and $k_{x,y}$ are wave numbers in the x and y directions.

Topographic response

$$Y\left(k_x, k_y\right) = P_{ice} * \Phi\left(k_x, k_y\right) \tag{4}$$

Variable	Value
E	$1x10^{11}$ Nm^{-2}
T_e	45 km; 75 km (Tesauro et al., 2013; Strujik et al., 2017)
v	0.25
ρ_{ice}	950 kg m^{-3}
ρ_a	3250 kg m^{-3}
g	9.82 m s^{-2}
h_{ice}	Morlighem et al. (2017)

Table 1: Table of variables, values and sources

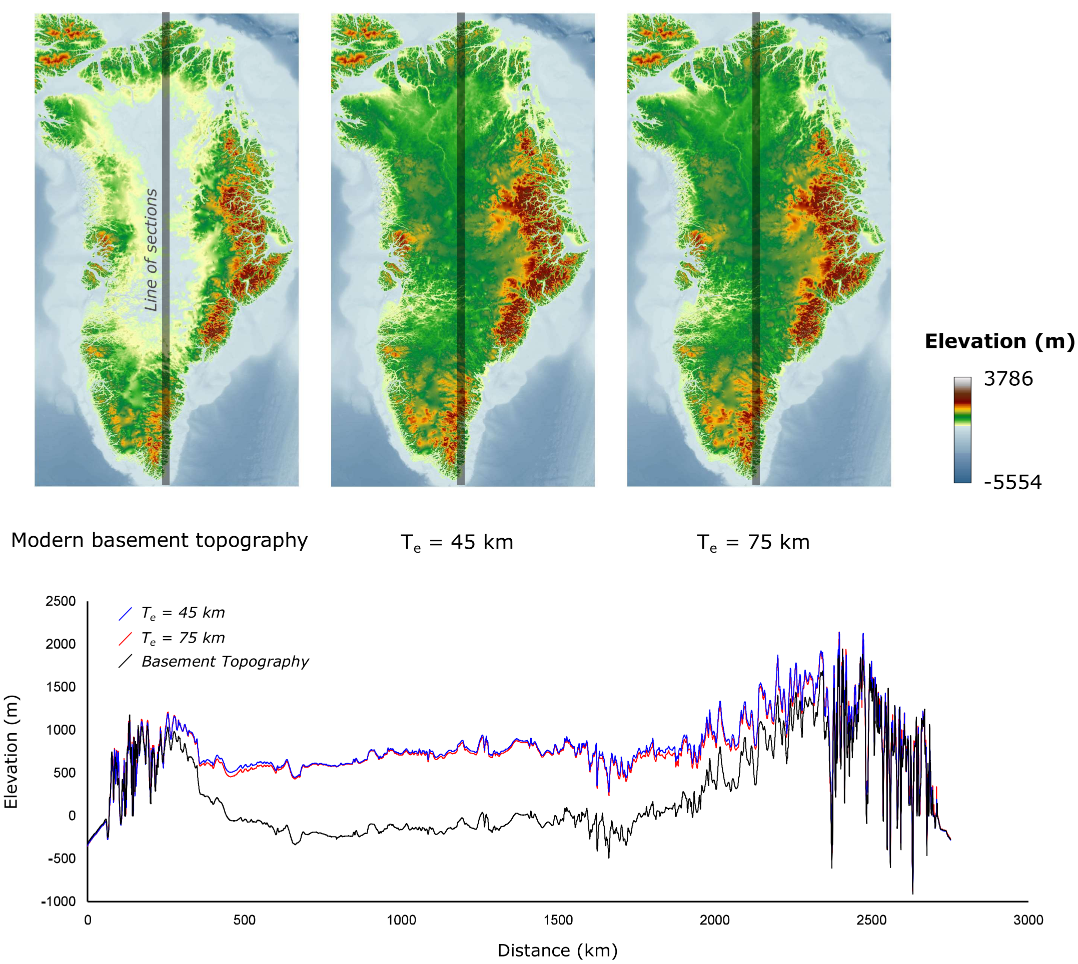

Figure 1: *Resultant digital elevation models from isostastically balancing the basement topography of Greenland, including the initial input landscape from Morlighem et al. (2017), the isostatically balanced landscape with a T_e of 45 km and another with a T_e of 75 km. Cross sections across these digital elevation models show that much of the topographic response is across the central portion of Greenland and that only limited differences are observed between the results of the two different T_e values.*

Hydrological analysis

The identification of drainage system in the isostatically balanced DEM was completed using the hydrology tool-set on ArcMap. This approach initially identifies the direction of flow across the landscape through the comparison of slopes between each cell, before calculating the accumulation of flow to each cell on the DEM. Finally, the stream order can be calculated using the Shreve method, which cumulatively adds the number of tributaries to each stream, helping to identify the axial river system.

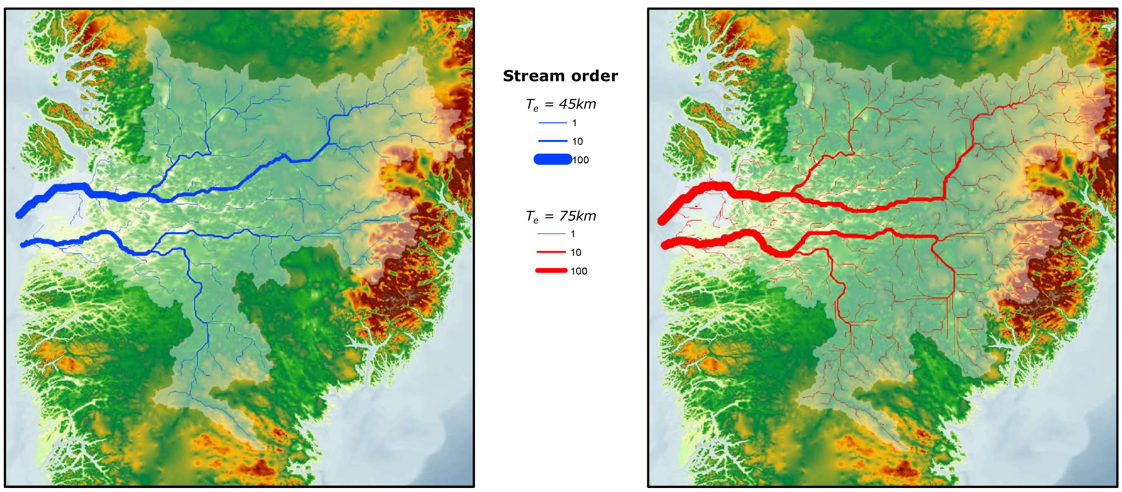

Figure 2: *Results of hydrological analysis on each isostatically balanced surface using ArcMap. The map to the left shows the results from the* $T_e = 45$ *km landscape, outlining two drainage systems both flowing east to west across Greenland and terminating offshore adjacent to the Sisimiut Basin. The map to the right shows the results from the* $T_e = 75$ *km landscape, exhibiting two drainage systems flowing east to west across Greenland and terminating adjacent to the Sisimiut Basin. The only notable difference between the results is the inclusion of a 40,000* km^2 *of drainage area in the SE, though no changes to the courses of the two systems obvious.*

Chi mapping

Chi mapping of the isostatically balanced DEMs was used to interpret the dynamics of the large drainage systems identified through hydrological analysis. TopoToolbox (Schwanghart & Scherler, 2014) was used to produce the maps using the approach outline in (Willet et al., 2014). Chi values themselves hold limited interpretative value, however the comparison of chi values over drainage divide helps to establish if the divide is in equilibrium (static) or in disequilibrium (in motion). When values are similar across divide it is interpreted to be in equilibrium, when they differ it is considered to be in disequilibrium, where the side with higher values is being pirated (Willet et al., 2014).

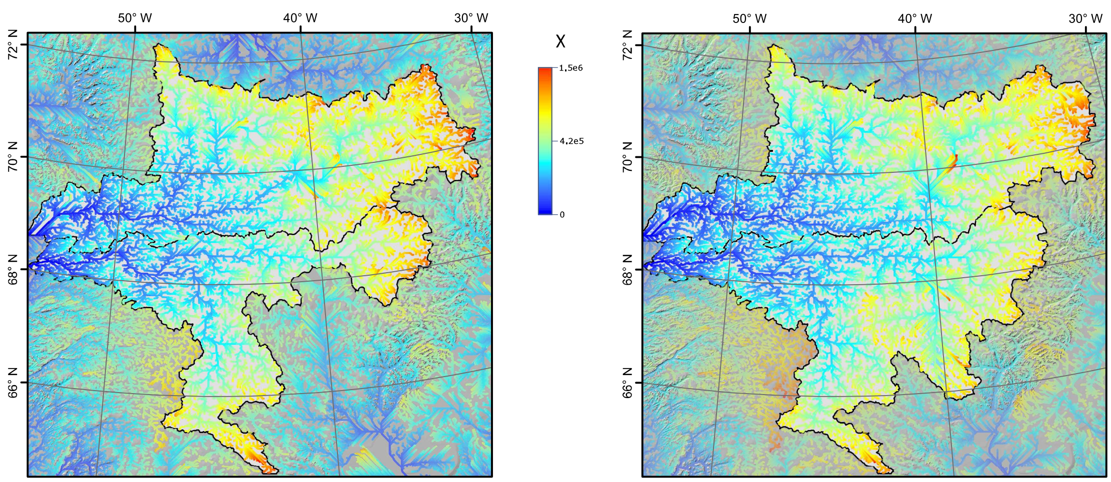

Figure 3: *Results from chi mapping of the two isostaically balanced DEMs (T_e = 45 km (left) and T_e = 75 km (right)). Comparing chi values across drainage divides from the T_e = 45 km DEM suggests the NDS is being pirated by a drainage system to the north, as higher χ values are present along the north edge of the NDS, while the SDS is expanding south-westward into the drainage systems of the SE coastline, as higher χ values are found outside the SE margin of the SDS. Similar results are observed from the T_e = 75 km DEM, the only major difference being the inclusion of 40,000 km^2 of drainage area in the SE.*