Supplementary Information

Sea-Level Model

We utilized sea-level predictions from a numerical algorithm[11] which takes accurate account of changes in shoreline geometry and feedback from perturbations in Earth rotation. The viscoelastic Earth model we used is characterized by the elastic structure of the seismic model PREM, an elastic lithospheric plate of thickness 100 km, an upper mantle viscosity of $5 * 10^{20}$ Pa s, and a factor of 40 jump in viscosity across the interface (at 670 km depth) between the upper and lower mantle. These choices are consistent with recent inferences of radial viscoelastic Earth structure derived from a suite of independent data sets related to the glacial isostatic adjustment process. The global ice history is constructed to provide a close fit to sea-level records in the far-field of the ice sheets that span the period subsequent to the last glacial maximum. Prior to LGM, we adopt the ice volume time series inferred in Ref. 8 and assume that ice geometries during the glaciation phase were identical to those within the most recent deglaciation period whenever the ice-volumes were equivalent. The algorithm yields a time series of global sea-level (relative to present) and a corresponding ocean/land-ice mask. These outputs can be combined with present-day topographic maps to reconstruct palaeobathymetries at any stage in the glacial cycle. Due to gravitational and loading effects, the relative sea-level predicted for locations near the high-latitude ice sheets can deviate markedly from the globally averaged value.

Tide Model

We simulate palaeotides in the one-layer forward model of Ref. 10, run on a 1/2° latitude-longitude grid from 86°S to 82°N. Our model captures 92 percent[10] of the sea-surface height variance in present-day pelagic tide-gauge records of the eight largest tidal constituents. Most experiments in the current paper were for simplicity run with M_2 (the largest constituent) only, and we use the optimally tuned topographic drag strength from our experiments of the present day[10]. The model elevation accuracy depends on the drag strength because the modeled tidal energy is sensitive to the amount of drag[10]. In the present paper, we always take results from the third iteration of the self-attraction and loading term (two iterations past the scalar approximation[10]). Both Ref. 10 and Ref. 13 discuss methods to improve globally integrated measures of convergence in such iterations. To assess the quality of convergence at our specific location of interest in the ice-age Labrador Sea, we performed more than three such iterations in the 17 ka, 20 ka and 45 ka experiments. The LS amplitude in succeeding iterations can vary from that in the third iteration by up to 0.6 m. This value, which is likely due to the near-resonance of the LS tides, may be considered a rough error estimate for the predicted amplitudes. The amplitude variations from iteration to iteration are also present in 17 ka and 45 ka simulations we performed at 1/4 degree resolution.

Our tide model uses a drag parameterization that depends on abyssal stratification, which is not well known for the ice age. We performed 45 ka simulations in which the strength of the optimally tuned present-day topographic drag was adjusted by constant factors, ranging from 1/4 to 4, over the entire model domain. In the 1/4 and 1/2 present-day drag 45 ka experiments, LS M_2 amplitudes are nearly equal to those in the 45 ka experiment with present-day topographic drag. In the twice and four times present-day drag experiments (the

latter being, in our opinion, a severe assumption), the amplitude decreases by about 20 and 45 percent, respectively, from the amplitude computed under the assumption of present-day drag.

To further test model sensitivities, we ran the 17 ka, 20 ka and 45 ka experiments with the northern model boundary at 86°N rather than 82°N, and found little difference in the LS M_2 amplitudes. We performed 45 ka experiments in which the water column depth over the area thought to be covered by the fringing LS ice shelf[5] was reduced by 300 m, an assumed ice shelf thickness. The LS M_2 tidal amplitude was altered by only 0.3 m.

We performed two 45 ka multi-constituent experiments, one with present-day drag and one with four times present-day drag. The amplitudes of other semidiurnal tides (S_2, N_2, and K_2; not shown) are also anomalously large in the LS, while the diurnal tides (K_1, O_1, P_1, and Q_1), as in the present-day, are rather small in the LS. For both values of drag, the maximum LS spring tide is about 1.8 times larger than the LS M_2 tide. Thus, during the spring-neap cycle, the maximum tidal range (which is twice the amplitude) is 3.6 times larger than the M_2 amplitude.

Ref. 10 is in press in *Deep-Sea Research II*; until published, it is most easily obtained at http://www.aos.princeton.edu/WWWPUBLIC/arbic/dsr2tidesarbicetal.pdf