**Supplemental Figure 1.** Reference map of LGM glaciated massifs from this study (light blue; <http://akatlas.geology.buffalo.edu/>; date of last access: 1/4/23; Kaufman et al., 2011).). Glaciated massifs used in this study outlined in dark blue boxes.

**Supplemental Figure 2.** Summary of terminal LGM moraine cosmogenic nuclide exposure ages across Alaska (Briner et al., 2005; Young et al., 2009; Dortch et al., 2010; Matmon et al., 2010; Pendleton et al., 2015; Tulenko et al., 2018; Valentino et al., 2021). A: Summed probability density functions, organized from northernmost to southernmost across Alaska, for each dated moraine based on the mean of the population of samples on the moraine and one standard deviation of the population of samples. Samples on moraines were excluded if they fell outside 1.5 standard deviations (SD) of the mean of the total population of samples. Moraine mean age and SD were then re-calculated without outliers and reported here. Moraine names and regions, mean age and one SD, sample count and reference are listed to the right of each pdf. B: All probability distribution functions from panel A (red lines) summed into one summary function (black line), with reported mean and 1 SD of the distribution of terminal LGM moraines across Alaska. C: Map of Alaska with geographic locations of each sample used in this exercise.

To summarize terminal moraine ages across Alaska, we used a python script to query the ICE-D database (<https://www.ice-d.org>; date of last access: 6/29/23), filter the results and plot them. For this exercise, we filtered samples in the database with the following criteria: (i) samples exclusively from moraine boulders (i.e., no sculpted bedrock or erratics), (ii) samples with calculated ages between 17 - 30 ka, and (iii) samples that, when grouped by their respective moraines, fall within 1.5 standard deviations of the mean of the population of samples on their respective moraine. Ages for each sample are calculated using the Arctic Production Rate of Young et al. (2013) and Lal/Stone Scaling (Lal, 1991; Stone, 2000), which was used in all the original studies that reported these data. Of the total amount of samples available in the study area (n = 525, spanning 0.13 - 169 ka in age), the relatively strict filtering process selected 65 samples on 18 distinct terminal LGM moraines. Python code to query ICE-D and then plot results is available upon request.

**Supplemental Figure 3.** Average AAR LIA ELAs for valley systems that hosted LIA glaciers.

**Supplemental Figure 4.** AAR LGM (blue) and LIA (yellow) ELAs plotted against latitude with lines of best fit.

**Supplemental Figure 5.** AAR LGM ∆ELAs plotted against longitude with lines of best fit.

**Supplemental Figure 6.** AAR LGM ∆ELAs plotted against latitude with lines of best fit.

**Supplemental Figure 7.** AAR LGM polynomial trend surfaces calculated with powers 1 - 4. Also reported are RMS and X2 results. Note that these decrease (i.e., less error) with increasing powers, but that the fourth order polynomial begins to show abnormally high ELAs in several parts of the state, including SW and NW Alaska. Thus, we chose the 3rd order polynomial surface to represent the LGM ELA trend surface, as the differences between RMS and X2 between the 3rd and 4th order polynomials are negligible.

**References**

Briner, J. P., Kaufman, D. S., Manley, W. F., Finkel, R. C., and Caffee, M. W.: Cosmogenic

exposure dating of late Pleistocene moraine stabilization in Alaska, Geological Society of America Bulletin, 117, 1108-1120, 10.1130/B25649.1, 2005.

Dortch, J. M., Owen, L. A., Caffee, M. W., Li, D., and Lowell, T. V.: Beryllium-10 surface

exposure dating of glacial successions in the Central Alaska Range, Journal of

Quaternary Science, 25, 1259-1269, https://doi.org/10.1002/jqs.1406, 2010.

Kaufman, D. S., Young, N. E., Briner, J. P., and Manley, W. F.: Alaska palaeo-glacier atlas

(version 2), in: Developments in Quaternary Sciences, Elsevier, 427-445, 10.1016/B978-0-444-53447-7.00033-7, 2011.

Lal, D.: Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion

models, Earth and Planetary Science Letters, 104, 424-439, 10.1016/0012-

821X(91)90220-C,1991.

Matmon, A., Briner, J. P., Carver, G., Bierman, P., and Finkel, R. C.: Moraine chronosequence

of the Donnelly Dome region, Alaska, Quaternary Research, 74, 63-72, 10.1016/j.yqres.2010.04.007, 2010.

Pendleton, S. L., Ceperley, E. G., Briner, J. P., Kaufman, D. S., and Zimmerman, S.: Rapid and

early deglaciation in the central Brooks Range, Arctic Alaska, Geology, 43, 419-422, 10.1130/G36430.1, 2015.

Stone, J. O.: Air pressure and cosmogenic isotope production, Journal of Geophysical Research:

Solid Earth, 105, 23753-23759, 10.1029/2000JB900181, 2000.

Tulenko, J. P., Briner, J. P., Young, N. E., and Schaefer, J. M.: Beryllium-10 chronology of early

and late Wisconsinan moraines in the Revelation Mountains, Alaska: Insights into the forcing of Wisconsinan glaciation in Beringia, Quaternary Science Reviews, 197, 129-141, 10.1016/j.quascirev.2018.08.009, 2018.

Valentino, J. D., Owen, L. A., Spotila, J. A., Cesta, J. M., and Caffee, M. W.: Timing and extent

of Late Pleistocene glaciation in the Chugach Mountains, Alaska, Quaternary Research, 101, 205-224, 10.1017/qua.2020.106, 2021.

Young, N. E., Briner, J. P., and Kaufman, D. S.: Late Pleistocene and Holocene glaciation of the

Fish Lake valley, northeastern Alaska Range, Alaska, Journal of Quaternary Science, 24, 677-689, https://doi.org/10.1002/jqs.1279, 2009.

Young, N. E., Schaefer, J. M., Briner, J. P., and Goehring, B. M.: A 10 Be production‐rate

calibration for the Arctic, Journal of Quaternary Science, 28, 515-526, \10.1002/jqs.2642, 2013.