## SUPPLEMENTARY MATERIAL

Southern Laurentide ice-sheet retreat synchronous with rising boreal summer insolation David J. Ullman\*, Anders E. Carlson, Allegra N. LeGrande, Angus K. Moore, Faron S. Anslow, Marc Caffee, Kent M. Syverson, Joseph M. Licciardi \*Corresponding author: <u>dullman@coas.oregonstate.edu</u>

#### Field methods and site descriptions

- We limit the impact of landscape change (Schulte et al., 2007) and post-glacial disturbance on exposure surfaces through the sampling the surfaces of large quartz-bearing glacial erratics in regions of WI with minimal human disturbance. Large, far-travelled glacial erratics have been shown to exhibit less cosmogenic inheritance than bedrock surfaces, particularly in regions where cold-based ice may have limited subglacial scouring (Corbett et al., 2013). We focus our site selection on stable topographic highs away from collapsed ice features with minimal till cover. Due to such geomorphic setting, topographic shielding correction was unnecessary for all of the samples. We preferentially selected boulders that were large in size (>1 m in diameter and height) and showed minimal signs of surface erosion (no pitting or spalling). For individual sample information on location, elevation, and thickness see Table DR1.
- The Baraboo Hills are a Proterozoic quartzite syncline in south-central WI. The eastern half of this range was covered by the sLIS during the LGM, depositing erratic boulders on top of the quartzite bedrock as part of the Johnstown LGM moraine (Clayton and Attig, 1990). We sampled far-traveled granite boulders in addition to local quartzite and sandstone boulders deposited in a prominent boulder-train moraine resting directly on bedrock (site sGBL) (Fig. DR1).
- About 10 km to the northeast, the i-sGBL site lies atop another quartzite hill, which was covered by ice during the LGM and exposed following ice-retreat from the terminal moraine (Fig. DR1) (Clayton and Attig, 1990). The lack of moraines in between i-sGBL and sGBL indicates a continuous retreat pattern between the two sampling locations.
- The Blue Hills are an outcrop of erosion-resistant quartzite in north-central WI of similar age to the Baraboo Hills (Mudrey et al., 1982). LGM ice covered most of the bedrock topographic highs in the Blue Hills. Site CL is along this maximum extent of the LGM phase of the Chippewa Lobe (Attig et al., 1985; Johnson, 1986), whereas the i-CL site is located ~12 km to the northeast of the terminal moraine (Fig. DR2). No moraines exist between CL and i-CL suggesting no stable ice margin positions between these two sites.
- The Gogebic Mountains (site GM) in northern Wisconsin are a high-relief set of parallel ridgelines of metasedimentary and meta-volcanic bedrock (Cannon et al., 2007). We sampled glacial erratics at GM resting directly on bedrock of these flat-topped topographic highs (Fig. DR3, DR4).
- The northern Green Bay Lobe (nGBL) samples come from a high-relief section of the prominent LGM Hancock Moraine that is correlative to the Johnstown Moraine (Fig. DR5) (Attig et al., 1985). The samples are from 2 stable sections of the Hancock Moraine crest, away from ice-collapse features (Fig. DR6, DR7).
- The inner nGBL site (i-nGBL) lies ~15 km east of the LGM extent of the LIS in the interlobate region of the Langlade and Green Bay Lobes, where the recessional Summit Lake Moraine of the Langlade Lobe and Bowler Moraine of the Green Bay Lobe connect (Attig et al., 1985; Fig. DR4, DR8). The Summit Lake Moraine is correlative with Tiger Cat and Flambeau moraines to the west. The Bowler Moraine continues south where it is called the Green Lake Moraine in southeast WI. We sampled boulders from a

constructional deposit that accumulated in an ice cavity (Mickelson, 1986). The exposure ages from these boulders are associated with the retreat of ice from this location.

# Laboratory methods

- Sample preparation and isolation of BeO was conducted in the Cosmogenic Isotope Laboratory at the University of Wisconsin-Madison (UW).
- Each sample was crushed and sieved to separate the 425-841 µm grain-size fraction. The quartz fraction was separated using a Frantz Magnetic Separator to remove mafic grains, followed by etchings with HCI and dilute HF/HNO<sub>3</sub>.
- The purity of this quartz fraction was verified through elemental analysis by Inductive-Coupled Plasma Atomic Emission Spectrometry at University of Colorado-Boulder.
- After addition of Be carrier, the BeO was isolated through a series of dissolution, oxidation, anion/cation removal, pH adjustments, and final sample drydown.
- <sup>10</sup>Be/<sup>9</sup>Be ratios were measured by accelerator mass spectrometry (AMS) at Purdue Rare Isotope Measurement (PRIME) Laboratory at Purdue University.
- Throughout this project, the UW Cosmogenic Lab made improvements in the <sup>9</sup>Be purity of its standard. Initial use of a commercially available Be standard resulted in blank AMS-measured <sup>10</sup>Be/<sup>9</sup>Be ratios that averaged to be 12.2x10<sup>-15</sup> ± 0.9x10<sup>-15</sup> (Claritas, Table DR1, ratio expressed as long-term laboratory mean with standard error as uncertainty). An intermediate standard of higher purity resulted in <sup>10</sup>Be/<sup>9</sup>Be ratios that averaged to be 3.4x10<sup>-15</sup> ± 0.4x10<sup>-15</sup> (Merck, Table DR1). Use of a new ultra-pure standard developed at Oregon State University (Murray et al., 2012) used in later analysis resulted in average procedural blank <sup>10</sup>Be/<sup>9</sup>Be ratios of 2.0x10<sup>-15</sup> ± 0.3x10<sup>-15</sup> (OSU Blue, Table DR1).
- Sample <sup>10</sup>Be concentrations are shown in Table DR1.

# Exposure age calculation

- We used the online CRONUS-Earth calculator (<u>http://hess.ess.washington.edu/</u>) to determine exposure ages (Balco et al., 2008) using the northeast North American production rate (NENA, Balco et al., 2009).
- All relevant sample data entered into the online CRONUS-Earth surface exposure calculator is presented in Table DR1.
- Our analysis throughout the text uses the Lal-Stone time-dependent scaling scheme (Lal, 1991; Stone, 2000) for calculating both the new chronology of this study as well as in recalculating the existing <sup>10</sup>Be dates (Colgan et al., 2002; Balco et al., 2009).
- Use of any of the other scaling schemes (Stone, 2000; Desilets et al., 2006; Dunai, 2001; Lifton et al., 2005) does not change the interpretation (within the uncertainty of measurement).

# Removal of outliers

- For the timing of initial retreat from the terminal moraines in Wisconsin (sites sGBL, nGBL, and CL), we exclude all ages that are older than 30 ka and younger than 17.5 ka for the Green Bay Lobe dates, because <sup>14</sup>C dates indicate that the sLIS was not present in Wisconsin until after 30 ka (Black, 1976; Attig et al., 1985; Dyke et al., 2002; Clark et al., 2009) and must have retreated from the Green Bay Lobe terminal moraines before 17.5 ka, based on the oldest calibrated minimum-limiting <sup>14</sup>C age from Valders Quarry of 17.7±0.2 ka (Maher et al., 1998) (Fig. DR9).
- After this *a-priori* removal of outliers and because our data sets are normally distributed

based on the Shapiro-Wilks test, we use Chauvenet's statistical test to exclude ages that have a large deviation from the sample set mean compared with the standard deviation and accounting for the number of samples (Clark et al., 2009; Rinterknecht et al., 2006).

- We have identified 13 outliers that were removed before calculating site averages and standard errors. Eleven outliers were excluded by *a-priori* removal; two outliers were excluded based on Chauvenet's criterion.
- Outliers that are removed are shown in Fig. DR9.
- Because the scatter in ages for a given sample site is larger than the analytical uncertainty of each individual measurement, we calculate the straight mean and standard error of the mean as the best estimate of the true age of deglaciation and its geological uncertainty for sites CL, nGBL, sGBL, i-nGBL, and GM (Bevington and Robinson, 2002).
- For sites i-CL and i-sGBL, where we only have two samples per site, the difference between ages is equal to or smaller than the analytical uncertainty of each measurement. Therefore we present the error-weighted mean and uncertainty for these sites, as the standard error between the consistent ages does not provide an adequate representation of overall uncertainty (Bevington and Robinson, 2002).

# Construction of time-distance diagrams

- In Fig. 2 of the text, we construct time-distance diagrams for the Green Bay, Lake Michigan, and Miami-Scioto Lobes using the bracketing <sup>14</sup>C ages on ice-margin advances and retreats. These diagrams have been previously published (see below).
- All radiocarbon ages discussed are calibrated using Calib 7.0 and IntCal13 (Stuiver and Reimer, 1993; Reimer et al., 2013).
- All information necessary to construct these diagrams is provided in Table DR2 and the respective publications.
- The Miami-Scioto Lobe time-distance curve (Fig. 2f) is an updated version of Eckberg et al. (1993), based on ages from Lowell et al. (1990), Dyke (2004) and Glover et al. (2011).
- The Lake Michigan Lobe time-distance curve (Fig. 2g) is an updated version of the Hansel and Johnson (1992) record from Curry and Petras (2011).
- The Green Bay Lobe time-distance curve (Fig. 2h) is from a combination of dates, and was recently summarized in Hooyer et al. (2007) (see Table DR2 for list of ages).
- In Fig. 2i, we draw a similar record of retreat for the northern Green Bay Lobe, constrained by the correlation of the ice margin positions (following Hooyer et al., 2007).
- Since chronological information for the Chippewa Lobe is limited prior to this study, we draw the time-distance diagram of Fig. 2j solely using our new <sup>10</sup>Be chronology.

## Surface mass balance modeling

- To simulate the surface mass balance (SMB) of the southern LIS, we conducted paired simulations of a fully-coupled atmosphere-ocean general circulation model (GCM) (NASA GISS ModelE2-R; Schmidt et al., 2014) and a surface energy balance model (SEBM) (Anslow et al., 2008; Carlson et al., 2009).
- The paired GCM-SMB approach used here forces the SMB calculations with an equilibrium climate from the GCM, given a particular set of ice sheet and solar/greenhouse gas forcings.
- The current version of ModelE2-R has an atmosphere resolution of 2 degrees latitude by 2.5 degrees longitude with 40 vertical layers up to 0.1 mb and an ocean resolution of 1 degree latitude by 1.25 degrees longitude with 32 depth layers.
- We conducted three separate simulations at 24 ka, 21 ka, and 19 ka using the appropriate

insolation of each time period due to changes in orbital parameters (Berger and Loutre, 1991) (see Ullman et al., 2014). We also ran a simulation at 16.5 ka that included appropriate insolation forcing and atmospheric greenhouse gas concentrations.

- We employed the LGM global ice-sheet topography of ICE-5G (Peltier, 2004) but substituted an alternative reconstruction of the LIS over North America (Licciardi et al., 1998). At the LGM, the Laurentide Ice Sheet abutted the Cordilleran Ice Sheet to the west, and the interface between the Licciardi et al. (1998) reconstruction of the LIS and the ICE-5G reconstruction of the Cordilleran Ice Sheet leads to a discontinuity in ice elevation, as the Licciardi et al. (1998) reconstruction does not include ice-buttressing effects of the adjacent Cordilleran Ice Sheet. However, we focus our calculations of surface mass balance to the southern margin alone, away from this interface between ice sheet masses.
- The Licciardi et al. (1998) reconstruction is based on a flow-line model that simulates icesheet dynamics over deformable and rigid beds. The advantage of this reconstruction for this study is its ability to resolve the low elevation margins of the sLIS that agrees with observations of inferred topographic gradients along the southern margin (Clark, 1992). Due to these geologic constraints, the Licciardi et al. reconstruction may capture of the topographic gradient and resolution of the equilibrium line altitude close to the ice margin better than other reconstructions (e.g., Fig. DR10) (Peltier, 2004; Clark et al., 1996; Licciardi et al., 1998; Tarasov and Peltier, 2004; Argus and Peltier, 2010; Lambeck et al., 2010; Tarasov et al., 2012).
- The Licciardi et al. (1998) model does not include the divergence of ice along flowlines with transverse spread. This limitation may result in greater ice elevations relative to regions with radial spreading centers, but such spreading centers are well above the equilibrium line altitude of the model and the inferred elevation bias may have little effect on surface mass balance for the sLIS.
- Each time slice SMB simulation was forced by temporally interpolated, daily climatologies of relevant parameters (surface air temperature, precipitation, wind speed, relative humidity, and surface radiation fluxes), which were calculated using the final 100 years of equilibrium GCM output.
- For the downscaling of relatively coarse-resolution GCM output (2 x 2.5 degree) to the higher-resolution (50 km) ice sheet topography of Licciardi et al. (1998), we use a temperature lapse rate of 5 °C km<sup>-1</sup> and a precipitation lapse scaling of 0.1 km<sup>-1</sup>, following Carlson et al. (2009; 2012), and suggested by previous climate reconstructions above ice sheets (Pollard et al., 2000; Marshall et al., 2002; Abe-Ouchi et al., 2007). Since we fix these lapse rates across each of the time slice simulations, varying them within the range of other lapse estimates does not significantly impact our resulting mass balance anomalies from the 24 ka results.
- We performed sensitivity tests and found that since the elevation distance is typically small between the GCM and SMB model grids; varying the parameters has a minimal effect on absolute surface mass balance that is well within the range of balances that arise from the changes in surface roughness and albedo decay. Testing at differing resolutions at and below 50 km x 50 km did not impact the model surface mass balance anomalies (Carlson et al., 2009).
- We use snow/ice roughness and albedo decay rate parameters that match average modern observations from the Greenland and Antarctic Ice Sheets (Carlson et al., 2009; Grainger and Lister, 1966; Duynkerke and van den Broeke, 1994; Greuell and Konzelmann, 1994; Smeets and van den Broeke, 2008).
- Because we are interested in the effects that changes in radiative forcing from Earth's orbit and greenhouse gases have on the southern LIS SMB, we only look at the change in SMB relative to the 24 ka simulation (Fig. DR10).

- The 16.5 ka simulation are the results of a hybrid SMB simulation, which uses a 16.5 ka GCM climate forcing downscaled and applied to the LGM (21 ka) ice-sheet topography. In the GCM resolution, the differences between 21 and 16.5 ka ice sheets are small (both in extent and ice sheet elevation), so the downscaling to the higher resolution ice sheet topography is similar to the straight LGM (24-19 ka) downscaling.
- Total surface mass balance across the southern LIS is negative and decreasing with increasing insolation forcing: -330 Gt yr-1 (24 ka), -540 Gt yr<sup>-1</sup> (21 ka), -690 Gt yr<sup>-1</sup> (19 ka). The 16.5 ka forcing with increases in both insolation and greenhouse gas forcing results in a southern LIS surface mass balance of -1320 Gt yr<sup>-1</sup> (Fig. DR12). We focus the results as anomalies in the main text so as to minimize uncertainty that may be inherent to our model design.

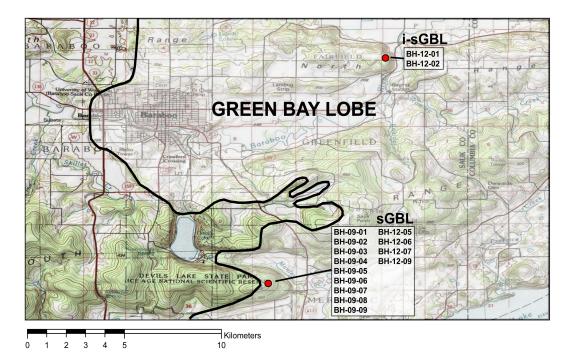


Fig. DR1. Topographic map of the sGBL and i-sGBL sampling locations and the samples collected at each site (shown as red circles). Extent of LGM ice is shaded in white, with a rough outline of the terminal moraine drawn with the heavy black line. Underlying topographic map provided by the USGS and the National Geographic Society (© 2011).

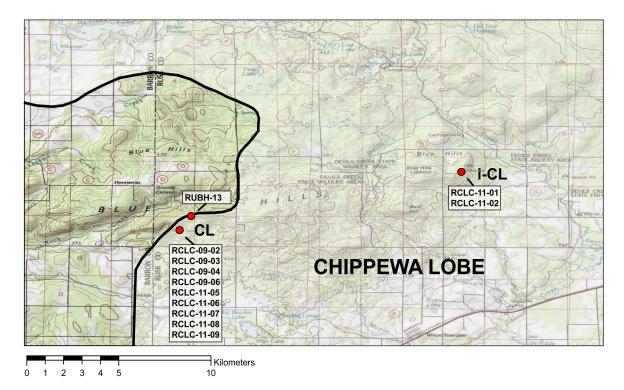


Fig. DR2. Topographic map of the CL and i-CL sampling locations and the samples collected at each site (shown as red circles). Extent of LGM extent of the Chippewa Lobe is shaded in white, with a rough outline of the terminal moraine drawn with the heavy black line. Underlying topographic map provided by the USGS and the National Geographic Society (© 2011).

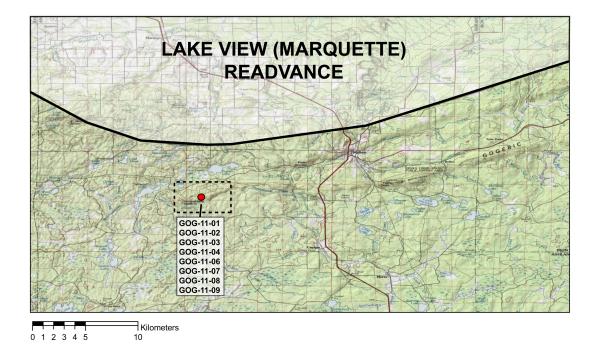


Fig. DR3. Regional topographic map of the GM sampling location and the samples collected at the site (shown as red circle). The parallel ridgelines of the Gogebic Range can be seen in eastern portion of the map. The sampling location is on one of the westernmost bedrock arms of this range. The rough extent of the Lake View Phase ice margin is shaded in white. This readvance occurred during Younger Dryas cold interval and is correlative with the Marquette Phase to the east (Lowell et al., 1999a). There is no evidence to suggest that this readvance overtopped the Gogebic Range. Region displayed in Fig. DR4 denoted by the black dashed box. Underlying topographic map provided by the USGS and the National Geographic Society (© 2011).

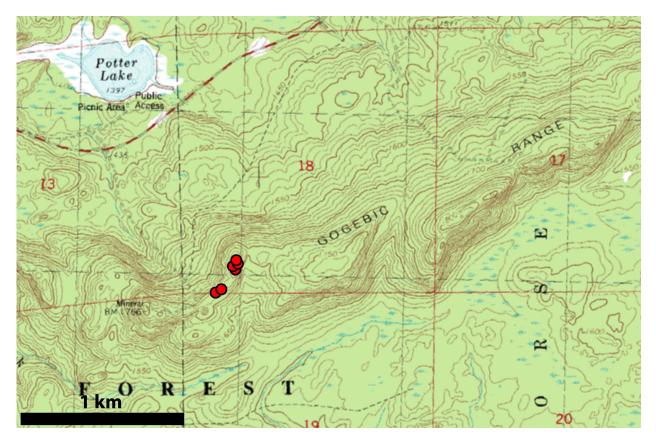


Fig. DR4. Map of topography immediately surrounding GM sampling sites (red circles). Underlying topographic map (1:24,000 scale, 10 foot contour interval) provided by the USGS and the National Geographic Society (© 2011).

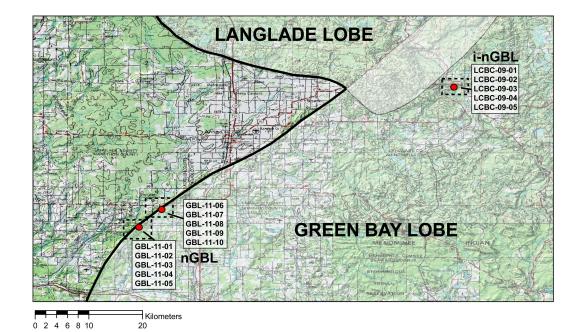


Fig. DR5. Regional topographic map of the nGBL and i-nGBL (LCBC) sampling locations and the samples collected at each site (shown as red circles). This map shows the confluence of the Langlade and Green Bay Lobes shaded in white, with their outer LGM extents drawn with the heavy black line. Regions displayed in Fig. DR6-DR8 denoted by the black dashed boxes. Underlying topographic map provided by the USGS and the National Geographic Society (© 2011).

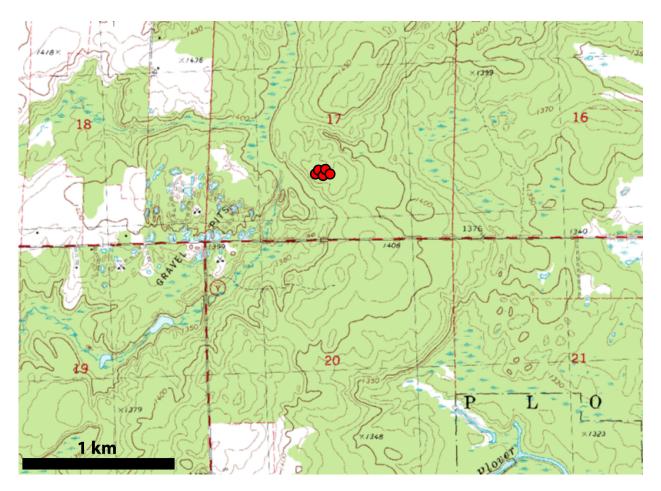


Fig. DR6. Map of topography immediately surrounding sampling sites GBL-11-01 through GBL-11-05 (red circles). Ice-collapse features are evidence along this moraine, but the sampling sites come from a stable and flat topographic high away from hummocky terrain. Underlying topographic map (1:24,000 scale, 10 foot contour interval) provided by the USGS and the National Geographic Society (© 2011).

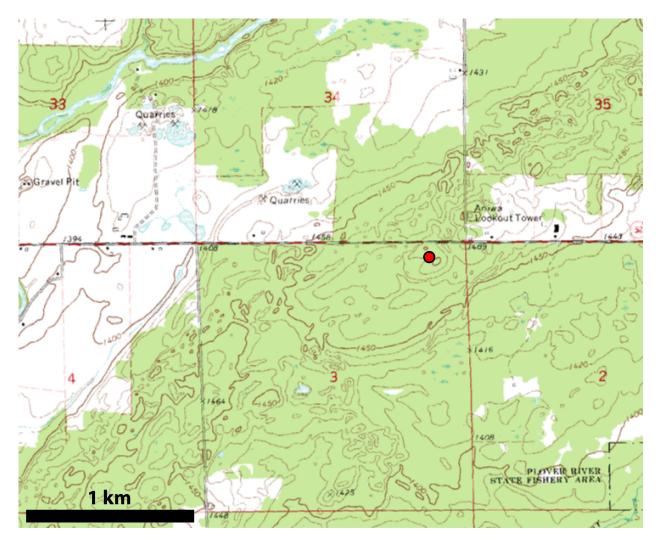


Fig. DR7. Map of topography immediately surrounding sampling sites GBL-11-06 through GBL-11-10 (red circle). The prominent terminal moraine of this site can be seen running from the southwest to northeast corners of this map, with the flatter outwash plain evident in the northwest corner. The sampling sites come from a stable and flat topographic high away from some of the collapsed features on this moraine. Underlying topographic map (1:24,000 scale, 10 foot contour interval) provided by the USGS and the National Geographic Society (© 2011).

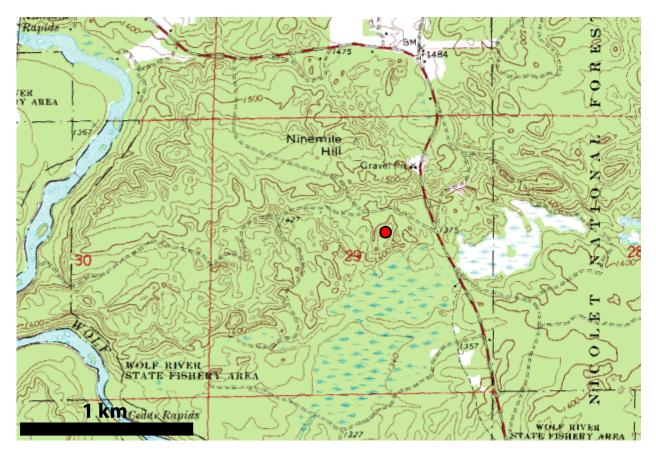


Fig. DR8. Map of topography immediately surrounding i-nGBL sampling sites (red circle). Underlying topographic map (1:24,000 scale, 10 foot contour interval) provided by the USGS and the National Geographic Society (© 2011).

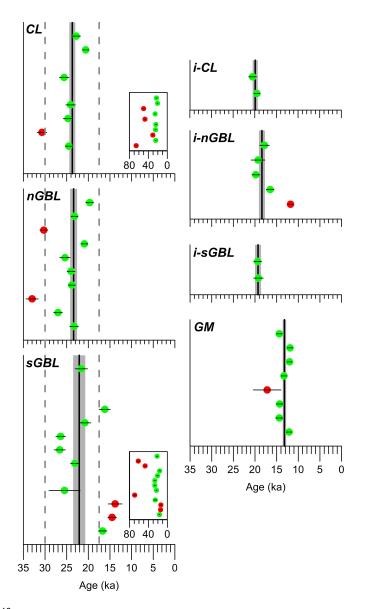


Fig. DR9. Individual <sup>10</sup>Be exposure ages for each of the sampling sites (denoted in upper left corner of each plot). Green symbols indicate ages used in site age calculation, and red symbols indicate outliers not included in the site age. Error bars for each age are  $1\sigma$  analytical uncertainty. Vertical black lines show mean age for each site with shaded gray bars indicating the  $1\sigma$  uncertainty range (standard error of the mean or error-weighted sigma for sites i-CL and i-sGBL). For CL and sGBL, inset plot with expanded age axis shows older outliers. Dashed grey lines indicate *a priori* <sup>14</sup>C constraints on initial ice retreat.

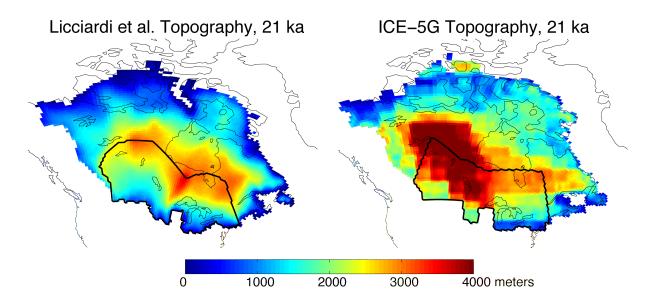


Fig. DR10. Comparison of the LIS topographies in the reconstruction used in our surface mass balance simulations (left; Licciardi et al., 1998) and the ICE-5G reconstruction (right; Peltier, 2004). Units are meters above 21 ka sea level. The region outlined in black indicates the area used to calculate the region-specific surface mass balance for the sLIS. This region is separated from the rest of the LIS using topographic ice drainage divides from the reconstruction. Because we focus only on the sLIS, we restrict our surface mass balance analysis to the two southernmost regions from the James Lobe to New England. Note: ICE-5G was not used in the analysis for this paper because it does not adequately resolve the low-elevation margins along the sLIS.

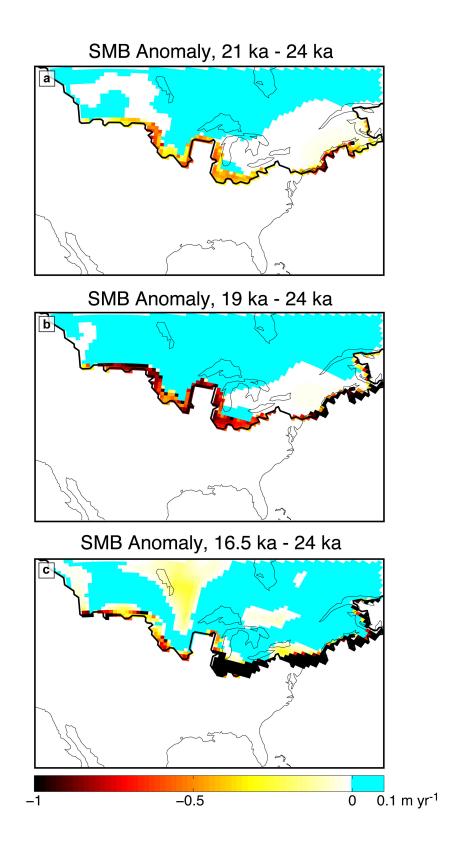


Fig. DR11. Modeled surface mass balance (SMB; units of meters water equivalent per year) anomalies relative to 24 ka at (a) 21 ka, (b) 19 ka, and (c) 16.5 ka.

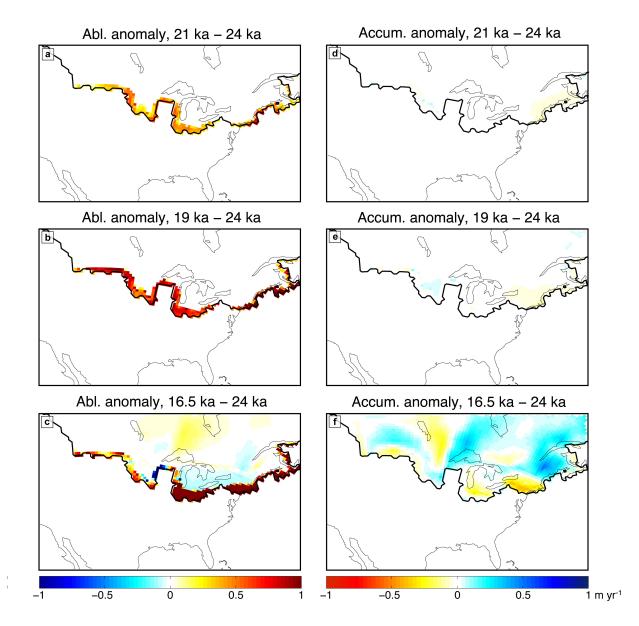


Fig. DR12. Ablation and accumulation anomalies for each of the SEBM simulations relative to 24 ka (units of meters water equivalent per year). (**a**) 21 ka ablation anomaly, (**b**) 19 ka ablation anomaly (**c**) 16.5 ka ablation anomaly, (**d**) 21 ka accumulation anomaly, (**e**) 19 ka accumulation anomaly (**f**) 16.5 ka accumulation anomaly.

		-										
Sample	Latitude (DD)	Longitude (DD)	Modern Elevation (m asl)	Sample Lithology <sup>a</sup>	Thickness (cm)	Quartz (g)	Be Standard Used	AMS <sup>10</sup> Be/ <sup>9</sup> Be ratio (10 <sup>-15</sup> ) <sup>b</sup>	AMS Uncertainty (10 <sup>-15</sup> )°	<sup>10</sup> Be (atoms g⁻¹) <sup>d</sup>	Uncertainty (atoms g <sup>-1</sup> )	<sup>10</sup> Be age (ka) <sup>e</sup>
CL RCLC-09-02	45.469	-91.535	449	granite	3.0	41.626	Claritas	178.7	6.8	134339	5706	- 1+
RCLC-09-03	45.469 45.470	-91.534 -91.534	449 440	granite quartzite	2.0 2.0	51.729 45.557	Claritas	200.1 412.8	6.0 10.7	120686 296900	4087 8522	20.6 ± 0.7 50.2 ± 1.5
RCLC-09-06	45.472	-91.531	461	granite	з Э.О	49.429	Claritas	236.3	9.2	152771	6527	F 1+
RCLC-09-13	45.480	-91.525	202	quartzite	3 N N	48.448	Claritas	435.U	44 O.O	292/06	8107	⊦ ⊩
RCLC-11-00	45.471 45.471	-91.531	444 410	granite	2.5	29.922	OSU Blue	255.0	11.0	141035	6297	H H
RCLC-11-07	45.471	-91.532	432	granite	2.5	30.111	OSU Blue	326.0	11.0	179304	6352	H 1
RCLC-11-08	45.472	-91.531	428	granite	3.0	22.242	<b>OSU Blue</b>	191.0	6.0	141880	4733	+
RCLC-11-09	45.472	-91.530	439	granite	2.0	21.188	OSU Blue	491.0	11.0	385319	9495	- 1+
FCI C-11-01	45 504	-01 388	514	oranite	30	29 421	OSU Blue	0 000	10.0	197894	5780	л + О
RCLC-11-02	45.503	-91.388	482	granite	2.5	29.909	OSU Blue	214.0	7.0	118463	4094	19.5 ± 0.7
GOG-11-01	46.286	-90.794	507	granite	2.0	21.692		119.0	5.0	90064	3964	+ 0
GOG-11-02	46.286	-90.794	л 538	granite	ч р л л	22.106	OSU Blue	103.0	4 <u>5</u> .0	76293	3864 3078	+ +
GOG-11-03	46.286	-90.794	531	granite	2.5	24.900	OSU Blue	128.0	6.0	84574	4124	
GOG-11-06	46.286	-90.794	518	granite	2.0	21.764		144.0	26.0	108943	19976	н ω
GOG-11-07	46.285	-90.795	522	granite	2,5	22.392		123.0	6.0	90230	4574	· + 0
GOG-11-08	46.285 46.285	-90.795	524 527	granite granite	2.0 1.0	24. <i>3</i> 94 24.785	OSU Blue	135.0 117.0	6.0	91213 77550	4894 4128	14.4 ± 0.8 12.1 ± 0.6
nGBL 11 01	A A 0000	00 316	447		ת ۲	20 074		356 0	2	106907	00000	⊦ →
GBL-11-01	44.990	-89.316	445	granite	4-0	30 102	OSU Blue	245 N	8 C C	1343007	4631	+ H > -
GBL-11-02	44.990	-89.317	436	granite	2.0	21.007		226.0	6.0	178036	5103	$20.2 \pm 0.0$ $30.3 \pm 0.9$
GBL-11-04	44.990	-89.316	438	granite	2.0	21.916		162.0	6.0	121899	4741	+ 0
GBL-11-05	44.990	-89.316	438	granite	о <u>-</u> 1 о Ст	29.958	OSU Blue	271.0	12.0	149339	6832	· +
GBL-11-05	45.029	-89.209	405 105	granite	ა. л С	30.077	OSU Blue	260.0	8.0 9.0	143081	961.98	
GBL-11-08	45.029	-89.269	465	granite	1.5	29.916		215.0	9.0	118532	5152	
GBL-11-09	45.029	-89.269	465	granite	3.0	21.894	OSU Blue	213.0	7.0	160754	5580	+
GBL-11-10	45.029	-89.269	465	granite	2.5	23.549	OSU Blue	198.0	8.0	138833	5842	+
$^{\rm a}$ All age calculations assume a density of 2.65 g cm $^{\rm 3}$ for granite and sandstone, 2.75 g cm $^{\rm 3}$ for quartzite	tions assum	e a density of	2.65 g cm <sup>-3</sup> t	for granite ar	nd sandstone	, 2.75 g cm	<sup>₋3</sup> for quartzit	ē				
<sup>b</sup> All AMS measu	measurements are	standardizer	standardized to 07KNSTD	D								
°1-sigma AMS uncertanty	uncertanty											
<sup>d 10</sup> Be atom concentrations are blank-corrected (see text)	centrations a	are blank-corr	rected (see te	ext).								
°All age calculations use standard atmosphere, modern elevation, and zero erosion. No shielding correction necessary.	tions use sta	Indard atmos	phere, mode	n elevation,	and zero ero	sion. No sh	ielding corre	ction necessa	ſŅ			
<sup>10</sup> Be age	s are presen	<sup>10</sup> Be ages are presented with 1-sigma analytical uncertainty.	ma analytica	l uncertainty.								
	-											

Table DR1a. Cosmogenic sample information.

Ages were calculated using the CRONUS Earth online calculator(v 2.2) with the NENA production rate and the Lal/Stone time-dependent scaling scheme (see text).

							J		ANAS			
Sample	Latitude (DD)	Longitude (DD)	Modem Elevation (m asl)	Sample Lithology <sup>a</sup>	Thickness (cm)	Quartz (g)	Be Standard Used	<sup>10</sup> Be/ <sup>9</sup> Be ratio (10 <sup>-15</sup> ) <sup>b</sup>	AIVIS Uncertainty (10 <sup>-15</sup> ) <sup>c</sup>	<sup>¹0</sup> Be (atoms g⁻¹) <sup>d</sup>	Uncertainty (atoms g <sup>-1</sup> )	<sup>10</sup> Be age (ka) <sup>e</sup>
i-nGBL												
LCBC-11-01	45.227	-88.768	412	granite	2.0	35.844	Merck	124.9	7.0	102066	6019	17.9 ± 1.1
LCBC-11-02	45.227	-88.768	408	granite	2.0	38.394	Merck	128.5	10.4	109884	9181	19.3 ± 1.6
LCBC-11-03	45.227	-88.768	417	granite	1.5	38.471	Merck	134.0	5.6	114498	5020	$19.9 \pm 0.9$
LCBC-11-04	45.227	-88.769	430	granite	2.0	38.069	Merck	110.2	5.4	95591	4981	$16.5 \pm 0.9$
LCBC-11-05	45.227	-88.769	375	granite	2.0	39.342	Merck	78.4	3.7	65205	3306	11.8 ± 0.6
sGBL												
BH-09-01	43.398	-89.692	397	granite	2.0	40.278	Claritas	154.1	9.1	119507	7840	21.6 ± 1.4
BH-09-02	43.397	-89.692	419	quartzite	4.0	38.344	Merck	396.5	14.4	342928	13020	$61.5 \pm 2.4$
BH-09-03	43.397	-89.692	411	sandstone	4.0	39.051	Merck	310.0	10.1	262284	9045	46.9 ± 1.7
BH-09-04	43.398	-89.693	427	granite	2.0	39.195	Merck	111.2	8.7	91498	7502	16.2 ± 1.3
BH-09-05	43.398	-89.693	431	granite	3.0	40.838	Claritas	153.9	9.3	117868	7871	20.9 ± 1.4
BH-09-06	43.398	-89.694	425	quartzite	3.0	40.023	Claritas	187.8	7.0	149105	6170	26.4 ± 1.1
BH-09-07	43.398	-89.695	425	sandstone	2.0	40.008	Claritas	190.5	8.2	151706	7226	26.7 ± 1.3
BH-09-08	43.399	-89.694	424	sandstone	4.0	44.319	Claritas	181.3	6.9	129017	5504	23.1 ± 1.0
BH-09-09	43.400	-89.692	404	quartzite	5.0	39.104	Merck	446.5	15.7	376692	13868	69.0 ± 2.7
BH-12-05	43.398	-89.686	363	granite	2.0	25.280	OSU Blue	113.0	13.0	73741	8670	13.8 ± 1.6
BH-12-06	43.397	-89.686	371	granite	2.3	24.862	OSU Blue	118.0	8.0	77596	5414	$14.4 \pm 1.0$
BH-12-07	43.397	-89.686	364	granite	2.3	24.693	OSU Blue	133.0	8.0	89353	5535	16.7 ± 1.0
BH-12-09	43.397	-89.690	405	granite	2.0	25.269	OSU Blue	220.0	30.0	142500	19665	25.5 ± 3.6
<b>i-sGBL</b> BH-12-01	43.498	-89.637	366	granite	2.0	24.698	OSU Blue	158.0	7.0	104533	4814	19.4 ± 0.9
BH-12-02	43.501	-89.640	336	granite	1.3	24.337	OSU Blue	151.0	8.0	101423	5547	19.3 ± 1.1

Table DR1b. Cosmogenic sample information (continued).

<sup>a</sup>All age calculations assume a density of 2.65 g cm<sup>-3</sup> for granite and sandstone, 2.75 g cm<sup>-3</sup> for quartzite.

<sup>b</sup>All AMS measurements are standardized to 07KNSTD.

°1-sigma AMS uncertanty

 $^{\rm d\,10}\text{Be}$  atom concentrations are blank-corrected (see text).

<sup>e</sup>All age calculations use standard atmosphere, modern elevation, and zero erosion. No shielding correction necessary.

<sup>10</sup>Be ages are presented with 1-sigma analytical uncertainty.

Ages were calculated using the CRONUS Earth online calculator(v 2.2) with the NENA production rate and the Lal/Stone time-dependent scaling scheme (see text).

	Sample ID	Radiocarbon Age ( <sup>14</sup> C years BP)	1 sigma error ( <sup>14</sup> C years)	(cal. years BP)	(cal. years BP)	Median Calendar Age (cal. years BP)	1 sigma error (cal. years)	Reference
ireen Bay Lobe	WIS-2022	26060	800	29443	30943	30193	750	Black, 1976
,	CAM-252810	14500	70	17560	17789	17675	115	Maher et al., 1998
	CAM-291200	14210	90	17163	17446	17305	142	Maher et al., 1998
	CAM-291210	13980	190	16646	17248	16947	301	Maher et al., 1998
	CAM-291190	13150	120	15601	15994	15798	197	Maher et al., 1998
	WIS-2293	12965	200	15210	15802	15506	296	Maher and Mickelson, 1996
	Beta-119360	13370	90	15954	16224	16089	135	Mickelson et al., 2007
	WIS-431	13120	130	15530	15966	15748	218	Black, 1976
	W-1004	12880	130	15192	15598	15395	203	Maher and Mickelson, 1996
	W-1004 W-1075	12520	160	14408	15081	14745	337	Maher and Mickelson, 1996
	W-1073	12260	100	13989	14496	14743	254	Maher and Mickelson, 1996
			200			13698		Maher and Mickelson, 1996
	2creeks_avg	11850		13465	13930		233	
	socha_2creeks	11690	70	13446	13572	13509	63	Socha, 2007
	socha_2creeks	12110	70	13847	14066	13957	110	Socha, 2007
	socha_2creeks	11210	100	12976	13198	13087	111	Socha, 2007
	socha_2creeks	11820	100	13552	13751	13652	100	Socha, 2007
	B4003	11620	50	13395	13538	13467	72	Kaiser, 1994
	b4005	11640	30	13430	13537	13484	54	Kaiser, 1994
	b4742	11560	40	13351	13445	13398	47	Kaiser, 1994
	eth8270	11865	65	13601	13744	13673	72	Kaiser, 1994
	eth8271	11760	90	13482	13708	13595	113	Kaiser, 1994
	eth8272	11915	100	13576	13842	13709	133	Kaiser, 1994
	eth8273	12035	60	13784	13959	13872	88	Kaiser, 1994
	eth8274	11885	100	13566	13795	13681	115	Kaiser, 1994
	eth8608	11965	95	13715	13980	13848	133	Kaiser, 1994
	eth8609	11890	95	13570	13792	13681	111	Kaiser, 1994
	eth8610	11805	95	13549	13742	13646	97	Kaiser, 1994
	eth8611	11980	95	13731	13980	13856	125	Kaiser, 1994
	eth8612	12015	90	13760	13981	13871	111	Kaiser, 1994 Kaiser, 1994
	wis1653	11690	130	13401	13708	13555	154	,
	DAL-340	9545	225	10584	11179	10882	298	Hughes and Merry, 1978
	W-3904	9780	250	10753	11607	11180	427	Hughes and Merry, 1978
	W-3866	9850	300	10784	11807	11296	512	Hughes and Merry, 1978
	DAL-338	10220	215	11419	12384	11902	483	Hughes and Merry, 1978
	W-3896	10330	300	11629	12565	12097	468	Hughes and Merry, 1978
	A-7878	9895	55	11232	11349	11291	59	Lowell et al., 1999b
	A-7876	9910	55	11240	11390	11315	75	Lowell et al., 1999b
	A-7877	9965	55	11267	11599	11433	166	Lowell et al., 1999b
	A-7879	10040	55	11399	11701	11550	151	Lowell et al., 1999b
	A-7881	10040	65	11396	11707	11552	156	Lowell et al., 1999b
	A-7883	10050	55	11404	11706	11555	151	Lowell et al., 1999b
	A-7880	10075	95	11397	11814	11606	209	Lowell et al., 1999b
	A-7882	10155	65	11650	11982	11816	166	Lowell et al., 1999b
	A-7875	10200	55	11774	12013	11894	120	Lowell et al., 1999b
	WIS-442	15560	150	18659	18957	18808	149	Bender et al., 1971
	WIS-1519	15940	150	19033	19426	19230	197	Steventon and Kutzbach, 198
			130					Steventon and Kutzbach, 198
	WIS-1515	16580		19833	20171	20002	169	,
	MAR-1-P	17020	70	20427	20638	20533	106	Carson et al., 2012
	L-1064	13300	300	15514	16413	15964	450	Farrand et al., 1969
orthorn Croon	CANA 252810	14500	70	17500	17700	17075	115	Maharatal 1009
orthern Green	CAM-252810	14500	70	17560	17789	17675	115	Maher et al., 1998
Bay Lobe	CAM-291200	14210	90	17163	17446	17305	142	Maher et al., 1998
	CAM-291210	13980	190	16646	17248	16947	301	Maher et al., 1998
	CAM-291190	13150	120	15601	15994	15798	197	Maher et al., 1998
	WIS-2293	12965	200	15210	15802	15506	296	Maher and Mickelson, 1996
	L-1064	13300	300	15514	16413	15964	450	Farrand et al., 1969
ike Michigan	ISGS-3021	23230	550	26885	27926	27406	521	Hansel and Johnson, 1996
obe	ISGS-1486	21460	470	25212	26201	25707	495	Garry et al., 1990
	ISGS-2484	21370	240	25470	25910	25690	220	Hansel and Johnson, 1996
	W-349	20340	500	23932	25148	24540	608	Hansel and Johnson, 1996
	ISGS-2047	20020	230	23809	24356	24083	274	Hansel and Johnson, 1996
	ISGS-3100	19830	190	23631	24088	23860	229	Hansel and Johnson, 1996
	ISGS-532	19680	460	23107	24207	23657	550	Hansel and Johnson, 1996
	UCIAMS-23773	15150	45	18342	18491	18417	75	Curry, 2008
	UCIAMS-23772	15150	150	18829	19171	19000	171	Curry, 2008
	UCIAMS-23765	17290	140	20651	21037	20844	193	Curry, 2008
	UCIAMS-23768	15125	45	18314	18466	18390	76	Curry, 2008
	UCIAMS-23770	17090	190	20371	20866	20619	248	Curry, 2008
			C0	20600	20000	20795	105	Curry, 2008
	UCIAMS-23769 OxA-W917-11	17250 16700	60 90	20690 20018	20900 20280	20793		Curry, 2008

Table DR2. Radiocarbon and calibrated ages used in construction of time-distance diagrams in Fig. 2 (main text).

0.4. W91.79     17.610     270     2022     21654     21281     240     Curry, 2018       UCAMS-52650     17.760     60     23.85     21.623     21.507     122     Curry and Petras, 2011       UCAMS-52651     18610     100     22.957     22.183     12007     122     Curry and Petras, 2011       UCAMS-52651     1460     120     127.97     20113     13997     181     Patterson et al., 2003       UCAMS-52651     1460     110     17.788     1122     18080     142     Patterson et al., 2003       UCAMS-52651     1460     110     17.788     1122     1188     Patterson et al., 2003       UCAMS-52651     1460     110     17.788     1120     1380     142     Patterson et al., 2003       UCAMS-52651     1460     0     1074     17110     1748     120     1380     140     120     1370     14110     1400     1400     1400     1523     1211     1380     1300     12011     1380     1300     12011									
ULAMA-52660     17960     60     2185     21629     21507     112     Curry and Petrs, 2011       OxA-W814-13     17540     130     20941     21381     21181     2010     Curry et al., 1999       ISSA A 10(4     1640     120     12777     115     1997     108     Petroson et al., 2003       ISSA A 10(4     1640     110     11764     12934     11766     113     Intern et al., 2011       ISSA 550     14430     200     17765     17785     1800     132     Hene and Ishons, 1992       UCAMA-56631     14400     400     177745     18142     18058     44     Curry and Petrs, 2011       ISSA 1570     14400     400     17774     18142     18058     44     Curry, 208       UCAMA-56631     14100     17975     1706     1257     270     Hene and Ishons, 1992       UCAMA-56635     1440     40     17963     1707     126     17770     126     17770     127     Hene and Ishons, 1996     1100     12652 <t< td=""><td></td><td>OxA-W917-9</td><td>17610</td><td>270</td><td>20927</td><td>21654</td><td>21291</td><td>364</td><td>Curry, 2008</td></t<>		OxA-W917-9	17610	270	20927	21654	21291	364	Curry, 2008
UCAMS-26267:     18210     60     2945     2138     22167     212     Curry ad. 1957       ISGS AD164     1660     120     1977     20115     1947     108     Patteron et al. 2023       ISGS AD164     1660     1220     1977     20115     1947     108     Patteron et al. 2023       ISGS AD164     14400     110     17383     1221     18080     100     17433     123     123     1433     123		ISGS-767	17690	270	21041	21764	21403	362	Hansel and Johnson, 1992
Ox-W841-13     1750     130     2091     2130     2191     2191     200     Curry etal., 1299       ISGS 405     15240     120     18867     18642     18808     424     18808     120     18867     18642     18808     424     18783     120     121     12		UCIAMS-26260	17760	60	21385	21629	21507	122	Curry and Petras, 2011
BGS A 0164     16540     120     1977     2015     1947     108     Patternon et al., 2003       BGS A-0155     14880     110     17388     18221     18808     114     Patternon et al., 2003       BGS A-0143     14610     110     17388     18221     18808     127     160     127     1786     138     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     181     127     127     128     127     128     128     127     128     128     127     128     128     127     128		UCIAMS-26261	18210	60	21945	22188	22067	122	Curry and Petras, 2011
ISGS 405     15,240     120     1867     19642     18808     143     Hansel and Ohmon, 1992       ISGS 40,115     1450     110     17648     17243     17783     27     Hansel and Ohmon, 1992       UC/MMS-2825     14330     200     17769     17243     27     Hansel and Ohmon, 1992       UC/MMS-2825     1480     40     17974     18036     43     Curry and Petras, 2011       UC/MMS-2825     1480     40     17974     18036     43     Curry and Petras, 2011       UC/MMS-28263     14110     35     17630     17976     20     Curry, 2008       UC/AMS-28264     14321     40     17973     1750     80     Curry, 2008       UC/AMS-28264     14321     40     17530     17649     120     Curry and Petras, 2011       UC/AMS-28264     14301     1300     1563     16647     1642     120     Curry and Petras, 2011       UC/AMS-28264     14301     1701     1532     17649     120     Curry and Petras, 2011		OxA-W814-13	17540	130	20991	21391	21191	200	Curry et al., 1999
ISGS A.0165     14800     110     1798     13221     12808     142     Patternon et al., 2003       ISGS A.0153     14330     200     17765     1733     273     Hansel and Johnson, 1992       UCIAMS 46831     14780     50     17765     17363     18060     17978     83     Curry, 2008       UCIAMS 26255     14800     40     17947     1842     18058     40     17970     84     Hansel and Johnson, 1992       UCIAMS 26254     14810     40     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     17937     1663     1793     1705     17150     179     171     17150     179     171     17150     170     1718     170     1705     171     1744     1730     170     171     171     171     1716     171     16424		ISGS-A-0164	16540	120	19779	20115	19947	168	Patterson et al., 2003
SGS-A0143     14610     110     17/648     17294     17786     138     Curry and Petra; 2011       UCMMS-64831     14780     50     17785     16060     17978     88     Curry, 2008       UCMMS-6425     14860     40     17534     17151     1707     84     Curry, 2008       UCMMS-6425     14800     640     16234     17917     17108     84     Curry, 2008       UCMMS-62625     14101     30     17063     17257     17131     94     Curry, 2008       UCMMS-62626     14110     30     17063     17257     17131     97     Curry, 2008       UCMMS-64257     13650     40     16325     1547     16666     16577     100     Curry, and Petras, 2011       UCAMS-643075     13695     45     16587     16666     16577     100     Curry, and Petras, 2011       UCAMS-643075     13695     45     16587     1666     16707     120     Curry, and Petras, 2011       UCAMS-643075     13695     141     <		ISGS-465	15240	120	18367	18642	18505	138	Hansel and Johnson, 1992
ISGS-1550     14330     200     17160     17755     17433     273     Interiel and Johnson, 1992       UCMMS-26255     14600     40     17974     1842     1608     84     Curry, and Petras, 2011       ISSS-1570     14100     640     15234     17031     1687     204     Hansel and Johnson, 1996       UCMMS-26263     14110     35     17063     12726     17100     97     Curry, 2008       UCMMS-26263     14110     35     17063     12726     17100     167     Curry, 2008       UCMMS-26263     14110     35     17064     16757     20     Marel and Johnson, 1996       UCMMS-26263     13507     1663     17064     16757     200     Curry, 2008     2011       UCMMS-46207     13300     300     15514     16413     15694     1507     1664     1672     160     Marel and Johnson, 1996       UCMMS-4627     14104     1470     14734     14746     1474     1474     1474     1474     1474     1474		ISGS-A-0165	14860	110	17938	18221	18080	142	Patterson et al., 2003
UCLAMS-64831     14780     50     17985     18000     17978     83     Curry 2008       USAMS-5625     14600     640     15234     17917     1705     824     Hansel and Johnson, 1996       USAMS-5622     14070     40     17093     17197     17103     9     Curry, 2008       UCLAMS-52623     14101     35     17061     1757     17103     9     Curry, 2008       UCLAMS-52624     14420     40     17490     17649     17575     20     Hansel and Johnson, 1996       UCLAMS-64223     13650     40     16335     15647     16442     160     Curry, 2008       UCLAMS-64275     13995     45     16387     16626     16577     1624     1607     120     Curry and Petras, 2011       UCLAMS-64275     13910     35     16677     16844     1637     1644     1632     1704     180     170     1301     1304     120     1401     1607     120     1701     1301     1302     1301     120		ISGS-A-0143	14610	110	17648	17924	17786	138	Curry and Petras, 2011
UCAMS 26265     14860     40     17974     18142     1805     84     Curry and Petras, 2011       ISSS 1570     1400     660     16234     17917     17076     844     Amasel and Johnson, 1966       UCAMS 26263     14110     35     17063     17256     17100     97     Curry, 2008       UCAMS 26264     14420     40     17769     17577     80     Curry, 2008       UCAMS 26264     14420     40     17669     17577     80     Curry, 2008       UCAMS 26264     14320     40     17663     17664     17577     80     Curry, 2008       UCAMS 63075     13905     45     16837     16656     15077     140     Curry, 2008       UCAMS 63075     13901     30     1514     16413     1557     140     Durry and Petras, 2011       UCAMS 63076     13300     300     1514     14743     14844     204     Hansel and Johnson, 1996       UCAMS 63076     13300     1307     13302     13706     13555 <t< td=""><td></td><td>ISGS-1550</td><td>14330</td><td>200</td><td>17160</td><td>17705</td><td>17433</td><td>273</td><td>Hansel and Johnson, 1992</td></t<>		ISGS-1550	14330	200	17160	17705	17433	273	Hansel and Johnson, 1992
ISG-1570     14100     640     16/214     17917     17076     842     Hansel and Johnson, 1996       UCAMS-26262     14070     40     17009     17197     17103     94     Curry, 2008       UCAMS-26263     14110     35     17663     17256     17160     7570     80     Curry, 2008       UCAMS-26275     13620     40     16335     16547     16442     106     Curry, 2008       UCAMS-6829     13650     40     16335     16547     16442     106     Curry, 2008       UCAMS-68275     13900     30     15514     16413     15964     45     1393     16079     1202     1204     1409     1632     13930     1300     13514     16413     15964     450     14704     14484     450     14704     14484     140     14304     14304     14304     14304     14304     14304     14304     14304     1430     15865     120     1331     13704     13305     1321     1400     1411		UCIAMS-46831	14780	50	17895	18060	17978	83	Curry, 2008
ISGS.1649     13890     120     16623     17031     16627     204     Hansel and Johnson, 1996       UCAMMS-36263     14110     35     17063     17256     17160     97     Curry, 2008       UCAMMS-36263     14420     40     17490     17570     80     Curry, 2008       UCAMS-36263     14320     40     1633     1567     1642     100     Curry, 2008       UCAMS-36267     13805     45     16387     16626     16577     120     Curry and Petras, 2011       UCAMS-63075     1390     35     16767     15984     16576     130     Monghan and Hansel, 1990       L1064     13300     300     15514     16413     15964     4507     1314     1413     15964     450     13704     1303     13704     1303     202     Garry et al, 1990       ISGS-161     11700     110     13423     13706     13565     141, 1980     130     13704     1303     202     Garry et al, 1917       ISGS-123     1640		UCIAMS-26265	14860	40	17974	18142	18058	84	Curry and Petras, 2011
UCAMS-26862     14070     40     17099     17197     17103     94     Curry, 2008       UCAMS-26863     14420     40     17490     1769     17570     80     Curry, 2008       UCAMS-26864     14420     40     16336     16547     1642     106     Curry, 2008       UCAMS-68629     13650     40     16336     16547     1642     106     Curry, 2008       UCAMS-68076     13910     35     16767     16984     16876     109     Curry and Petras, 2011       UCAMS-68076     13910     300     15514     16413     15964     450     Farand et al, 1999       L1064     13300     300     15514     14413     15964     450     Farand et al, 1999       L505-1601     11700     110     13423     13706     13565     122     Barat and binson, 1966       L654     1070     17781     18223     1080     20     Gaver et al, 2011       L055     10734     14823     14040     127     127 <t< td=""><td></td><td>ISGS-1570</td><td>14100</td><td>640</td><td>16234</td><td>17917</td><td>17076</td><td>842</td><td>Hansel and Johnson, 1996</td></t<>		ISGS-1570	14100	640	16234	17917	17076	842	Hansel and Johnson, 1996
UCIAMS-26263     14110     35     17063     17256     17160     97     Currr, 2008       UCIAMS-26264     1420     40     16525     17064     16795     270     Hansel and Johnson, 1996       UCIAMS-56275     13605     45     16387     16626     16507     120     Curry and Petras, 2011       UCIAMS-56375     13605     45     16387     16626     1507     120     Monaghan and Hansel, 1990       1565     1378     13470     130     16019     16404     1230     406     1444     240     Hansel and Johnson, 1996       1556     1578     12410     120     14204     14764     14844     280     Hansel and Johnson, 1996       1565     1551     1510     160     90     22255     22354     103     Glover et al, 2011       Lobes     1565     1510     160     16041     1514     1422     1360     120     1215     1243     120     1215     1243     1201     1201     1201     1201		ISGS-1649	13890	120	16623	17031	16827	204	Hansel and Johnson, 1996
UCLMMS 52624     14420     40     17490     17649     17570     80     Curry, 2008       UCAMS-68279     13650     40     16336     16647     11642     106     Curry, and Petras, 2011       UCAMS-63076     13910     35     16767     16984     16876     109     Curry and Petras, 2011       UCAMS-63076     13910     35     16767     16984     16876     109     Curry and Petras, 2011       UCAMS-63076     13900     300     15514     16413     19964     687     Farand etal, 1990       L1064     13300     300     15514     16413     19964     687     Farand etal, 1990       ISGS-1061     11700     110     13423     13706     1355     142     Luetal, 1996       ISGS-1051     14890     130     17955     1827     18116     166     Giover et al, 2011       Lobes     DIC-510     14810     170     17331     18253     18042     211     Giover et al, 2011       Lobes     DIC-510     13816		UCIAMS-26262	14070	40	17009	17197	17103	94	Curry, 2008
ISGS-15/9     13870     170     16525     17064     16795     270     Hamel and Johnson, 1996       UCLAMS-63075     13905     45     16387     16626     15507     120     Curry and Petras, 2011       UCLAMS-63075     13910     35     16767     16944     16876     169     Curry and Petras, 2011       ISGS-1378     13470     130     16019     16404     16212     193     Monaghan and Hansel, 1990       ISGS-1378     13470     130     16019     16404     16212     193     Monaghan and Hansel, 1990       ISGS-1051     1700     110     13232     13706     1356     142     Lue at, 1986       Ibbes     DIC-31     1480     170     1731     1253     1204     213     Glower et al., 2011       Lobes     DIC-31     1480     170     1731     1253     1204     213     Glower et al., 2011       Lobes     DIC-31     1480     170     1731     1253     1204     213     Glower et al., 2011       Lobes		UCIAMS-26263	14110	35	17063	17256	17160	97	Curry, 2008
UICAMS-6829     1350     40     16336     16547     16442     106     Curry 2008       UICAMS-63075     13910     35     16767     16984     16376     109     Curry and Petras, 2011       UICAMS-63076     13300     300     15514     16413     1564     450     Farand et al., 1959       L-1064     13300     200     15514     16413     1565     142     Liu et al., 1956       IS65-1661     11700     110     1323     13706     13565     142     Liu et al., 1956       IS65-1661     11700     170     13301     13704     13503     202     Garry et al., 2011       Lobes     DIC-243     14410     170     1781     18253     18042     211     Glower et al., 2011       Lobes     DIC-243     14410     170     1781     18253     18042     211     Glower et al., 2011       Lobes     DIC-243     1460     1603     16351     16278     237     Glower et al., 2011       Lobes     DIC-343 <t< td=""><td></td><td>UCIAMS-26264</td><td>14420</td><td>40</td><td>17490</td><td>17649</td><td>17570</td><td>80</td><td>Curry, 2008</td></t<>		UCIAMS-26264	14420	40	17490	17649	17570	80	Curry, 2008
UCAMS-63075     13695     45     16387     16626     16507     120     Curry and Petras, 2011       USAMS-63075     1330     130     15019     16044     15212     139     Monaghan and Hansel, 1990       ISGS-1378     13470     130     15019     16044     16212     139     Monaghan and Hansel, 1990       ISGS-1061     11700     110     13424     13706     13565     142     Lut et al., 1990       Miam/Scienc     22     Beta 72287)     18400     90     22251     22456     22354     103     Glower et al., 2011       Uobes     DIC-243     14400     1300     13706     13855     14304     211     Glower et al., 2011       Uobes     DIC-243     14400     1300     13916     14392     14104     228     Glower et al., 2011       ISS-1677     12210     150     13916     14392     14104     228     Glower et al., 2011       ISS-1677     12310     160     16941     16512     16727     278     Glower et al., 2011<		ISGS-1549	13870	170	16525	17064	16795	270	Hansel and Johnson, 1996
UCLMM-Se3076     13910     35     16767     16984     16876     109     Curry and Petras, 2011       L505     1378     13400     300     15514     1643     15964     450     Farand et al., 1969       L5064     13300     300     15514     1643     15964     450     Farand et al., 1969       ISGS-1061     11700     110     13423     13706     13565     142     Liu et al., 1986       ISGS-1061     11700     170     13301     13704     13503     202     Garry et al., 2011       Lobes     DiC-243     14410     170     17831     18253     13042     211     Glower et al., 2011       Lobes     DiC-243     14410     170     17831     18253     13499     91     Glower et al., 2011       Lobes     DiC-343     14410     170     17831     18273     1816     1602     Glower et al., 2011       Lobes     DiC-343     13510     160     16041     16514     16278     237     Glower et al., 2011 </td <td></td> <td>UICAMS-46829</td> <td>13650</td> <td>40</td> <td>16336</td> <td>16547</td> <td>16442</td> <td>106</td> <td>Curry, 2008</td>		UICAMS-46829	13650	40	16336	16547	16442	106	Curry, 2008
ISG5:1378     13470     130     16019     16403     15924     16131     15964     450     Farmad et al., 1969       IGS-482     12410     120     14204     14764     14484     200     Hansel and Johnson, 1996       IGS-1051     11700     110     13223     13706     13565     122     Liu et al., 1969       Miam//Scioto     22 (Beta 72287)     18460     90     22251     22456     22354     103     Glover et al., 2011       Lobes     DIC-543     18810     170     17831     18275     1816     160     Glover et al., 2011       ISG5-1677     12210     150     13816     14392     14104     288     Glover et al., 2011       ISG5-1677     12210     150     13816     14392     14104     14678     1275     1816     160     Glover et al., 2011       ISG5-1677     12210     150     13816     14392     14104     12875     1810     140     18874     1876     160 Glover et al., 2011       ISG5-1677 <td< td=""><td></td><td>UCIAMS-63075</td><td>13695</td><td>45</td><td>16387</td><td>16626</td><td>16507</td><td>120</td><td>Curry and Petras, 2011</td></td<>		UCIAMS-63075	13695	45	16387	16626	16507	120	Curry and Petras, 2011
ISG5:1378     14470     130     16019     16403     15964     450     Farrand etal., 1969       IGS-482     12410     120     14204     14764     14484     20     Hansel and Johnson, 1996       ISGS-1051     11700     113231     13706     13565     122     Liu et al., 1969       Miam//Scioto     22 (Beta 72287)     18460     90     22251     22455     2334     Liu et al., 2011       Lobes     DIC-543     14810     170     17831     18275     1816     Glover et al., 2011       ISGS-1677     12210     150     13408     13589     13499     Glover et al., 2011       ISGS-1677     12210     150     13816     14392     14104     288     Glover et al., 2011       ISGS-1675     13510     160     16041     16514     16278     237     Glover et al., 2011       ISGS-1677     12210     150     13842     19052     18947     105     Glover et al., 2011       ISGS-1671     1220     15514     1600     16011 <td></td> <td>UCIAMS-63076</td> <td>13910</td> <td>35</td> <td></td> <td></td> <td>16876</td> <td>109</td> <td>Curry and Petras, 2011</td>		UCIAMS-63076	13910	35			16876	109	Curry and Petras, 2011
L-1064 13300 300 15514 16413 15964 450 Faran et al. 1969 155-422 12410 120 14204 14764 1484 220 Hansel and lonkson. 1996 1555-1051 1170 110 13423 13706 13565 142 Line et al. 1990 1555-1051 1150 170 1301 13704 13503 202 Garry et al. 1990 DIC-243 14810 170 17831 18253 18042 211 Glover et al. 2011 Lobes DIC-243 14810 170 17831 18253 18042 211 Glover et al. 2011 IS55-1577 12210 150 13816 14392 14104 288 Glover et al. 2011 IS55-1577 12210 150 13816 14392 14104 288 Glover et al. 2011 IS55-1677 12210 150 13816 14392 14104 288 Glover et al. 2011 IS55-1677 1550 13510 160 16041 16514 16528 227 Glover et al. 2011 IS55-1679 1550 13510 140 18897 19236 19067 170 Glover et al. 2011 ETH-30202 15710 90 18842 19052 18947 105 Glover et al. 2011 A 45069 15810 140 18897 19236 19067 170 Glover et al. 2011 A 45069 15810 140 18897 19236 19067 170 Glover et al. 2011 A 45073 15503 91 18674 18856 18628 109 Glover et al. 2011 A 45074 14986 98 18076 18344 18210 134 Glover et al. 2011 A A45074 14986 98 18076 18344 18210 134 Glover et al. 2011 A A45074 14986 99 18076 18344 18210 134 Glover et al. 2011 A A45073 15503 91 18674 18856 18628 109 Glover et al. 2011 A A45074 14986 98 18076 18344 18210 134 Glover et al. 2011 A A45073 15503 91 18874 18856 18676 99 Glover et al. 2011 A A45078 14600 91 17675 17900 17779 122 Glover et al. 2011 A A45078 14600 91 17657 17900 17779 122 Glover et al. 2011 A A45078 1600 170 1988 19946 1971 206 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 158 12596 12692 1264 48 Glover et al. 2011 A A53429 16076 159 1370 1898 18979 1930 Glover et al. 2011 A A53429 16076 159 1370 1898 18979 1930 Glover et al. 2011 A A53429 16070 170 12989 13873 12800 13814 90 Glover et al. 2011 A A53429 16070 12089 13926 19986 1390 19970		ISGS-1378		130	16019		16212	193	Monaghan and Hansel, 1990
IGS-82     12410     120     14204     14764     14484     280     Hansel and Johnson, 1996       ISGS-1051     11700     11301     13706     13565     124     Liu et al., 1990       Miam//Scioto     22 (Beta-72287)     18460     90     22251     22456     22354     103     Glover et al., 2011       Lobes     DIC-543     14810     170     17831     18253     18042     211     Glover et al., 2011       GSS-1677     12210     150     13816     14392     14140     288     Glover et al., 2011       ISGS-1677     12210     150     13816     14392     14104     288     Glover et al., 2011       ISGS-1677     12210     150     13816     14392     14104     16278     237     Glover et al., 2011       ISGS-1677     12210     150     13842     19052     18947     105     Glover et al., 2011       A4-5069     15310     140     18897     19236     19067     170     Glover et al., 2011       A4-45073								450	-
ISGS-1061     11700     110     13423     13704     13505     142     Liu et al., 1886       Miami/Sciote     22 (Beta-72287)     18460     90     22251     22456     22354     103     Glover et al., 2011       Lobes     DIC-243     14810     170     17831     18253     18042     Clover et al., 2011       Lobes     DIC-243     14810     1705     18257     18116     160     Glover et al., 2011       LSSS-1677     12210     150     13816     14392     14104     288     Glover et al., 2011       LSSS-1677     12210     150     13816     14392     1404     288     Glover et al., 2011       LSSS-1677     12210     150     13816     14392     1404     288     Glover et al., 2011       LSSS-1677     12210     150     13812     16051     13736     16051     1675     Glover et al., 2011       AA-45069     15810     100     18879     19236     19667     170     Glover et al., 2011       AA-45073		IGS-482							Hansel and Johnson, 1996
Miami/Scioto     22 (Beta-72287)     18460     90     22251     22456     22354     103     Glover et al., 2011       Lobes     DIC-243     14810     170     17831     18253     18042     211     Glover et al., 2011       DIC-510     14890     130     17956     18275     18116     160     Glover et al., 2011       ICAMS-2409     11580     13816     14392     14104     288     Glover et al., 2011       ISGS-1675     13210     150     13816     14392     14104     288     Glover et al., 2011       ISGS-1675     13510     160     16041     16514     16727     2375     Glover et al., 2011       Ad-45069     15810     140     18897     19326     19067     170     Glover et al., 2011       AA-45069     15810     140     18897     18246     1906     170     Glover et al., 2011       AA-45073     15503     91     1666     18765     13170     14864     18210     134     Glover et al., 2011		ISGS-1061	11700	110	13423	13706	13565	142	Liu et al., 1986
Miami/Scioto     22 (Beta-72287)     18460     90     22251     22456     22354     103     Giover et al., 2011       Lobes     DIC-243     14810     170     17831     18253     18042     211     Giover et al., 2011       CAMS-2409     11680     90     13408     13589     13499     91     Giover et al., 2011       ISGS-1677     12210     150     13816     14392     14104     288     Giover et al., 2011       ISGS-1675     13510     160     16041     16514     16278     237     Giover et al., 2011       KASOE06     15810     140     18897     195     Giover et al., 2011       AA-45069     15810     140     18897     1925     19067     170     Giover et al., 2011       AA-45073     15503     91     18736     18628     199     Giover et al., 2011       AA-45074     14986     98     18076     18344     18210     134     Giover et al., 2011       AA-45077     14360     91     17657     1		ISGS-1234	11650	170	13301	13704	13503	202	Garry et al., 1990
Lobes     DC-243     14810     170     17831     18233     18042     211     Giover et al., 2011       CAMS-2409     11660     90     13468     13589     13499     91     Giover et al., 2011       ISGS-1677     12210     150     13816     14392     14104     228     Giover et al., 2011       ISGS-1055     13510     160     16041     16514     16278     237     Giover et al., 2011       EH1-30202     1570     90     18842     19052     18947     108     Giover et al., 2011       AA-45069     15810     140     18897     19236     19067     170     Giover et al., 2011       AA-45073     15503     91     18674     18836     18765     91     Giover et al., 2011       AA-45074     14966     98     1873     18902     18818     85     Giover et al., 2011       AA-45078     14600     97     17657     1790     1779     122     Giover et al., 2011       AA-45078     16400     97     <									
DC-51014800130179561827518116160Glover et al., 2011CAMS-2409116809013408135891349991Glover et al., 2011ISGS-167712210150138161439214104288Glover et al., 2011ISGS-16751351016016041151218977105Glover et al., 2011EtH-30201571090188421005213976136Glover et al., 2011AA-4506915810140188971923619067170Glover et al., 2011AA-45073155039118674188561876591Glover et al., 2011AA-450731550391186741885617493176Glover et al., 2011AA-450731556488187751790017779122Glover et al., 2011AA-45078146009117571790017779122Glover et al., 2011AA-450791617097193661946919508142Glover et al., 2011AA-54342160101701958519961971206Glover et al., 2011AA53425164009718780188791930Glover et al., 2011AA534261601010019184194751930146Glover et al., 2011AA534271601010019781196019370130Glover et al., 2011AA53428161629019376	Miami/Scioto	22 (Beta-72287)	18460	90	22251	22456	22354	103	Glover et al., 2011
CAMS-2409116809013408135891349991Glower et al., 2011ISGS-16771221015013816149214104288Glower et al., 2011ISGS-105513510160160411651416278237Glower et al., 2011ETH-302021571090188421905218947105Glower et al., 2011AA-4506915810140188971923619067170Glower et al., 2011AA-4506915500100185191873618628199Glower et al., 2011AA-45073155039118674188561876591Glower et al., 2011AA-450741498698180761834418210134Glower et al., 2011AA-45073155648818733189021881885Glower et al., 2011AA-45078146009117671790017779122Glower et al., 2011AA-450791617097193661964919508142Glower et al., 2011AA-450791617097193651994919508142Glower et al., 2011AA-534191586991198671924819118131Glower et al., 2011AA5342316400170191841947519330146Glower et al., 2011AA53423164009718780189781887999Glower et al., 2011AA534231640590 </td <td>Lobes</td> <td>DIC-243</td> <td>14810</td> <td>170</td> <td>17831</td> <td>18253</td> <td>18042</td> <td>211</td> <td>Glover et al., 2011</td>	Lobes	DIC-243	14810	170	17831	18253	18042	211	Glover et al., 2011
ISGS-16771210150138161439214104288Glover et al., 2011ISGS-10551351016016041195218947105Glover et al., 2011Bte1-15829111860270134201405113736316Glover et al., 2011AA-450691581014018871923619067170Glover et al., 2011AA-45073155039118674188561876591Glover et al., 2011AA-450741498698180761834418210134Glover et al., 2011AA-4507714360120173171766817493176Glover et al., 2011AA-45078160091176571790017779122Glover et al., 2011AA-45079157097193661964919508142Glover et al., 2011AA-45079157097193651999617719122Glover et al., 2011AA-35342516400911765719300142Glover et al., 2011AA53429160765812596126921264448Glover et al., 2011AA534291607658125961958019370130Glover et al., 2011AA53423161289019320188196Glover et al., 2011AA534231605090192401958019370130Glover et al., 2011AA5342316050901924019580<		DIC-510	14890	130	17956	18275	18116	160	Glover et al., 2011
ISGS-105S1510160160411651416278237Glover et al., 2011ETH-302021571090188421905218947105Glover et al., 2011AA-4506915810140188971923619067170Glover et al., 2011AA-4506915810140188971923619067170Glover et al., 2011AA-45073155039118674188561876591Glover et al., 2011AA-450741498698180761834418210134Glover et al., 2011AA-45077143601201737176817493176Glover et al., 2011AA-45078155648818733189021881885Glover et al., 2011AA-450781610091176571770017779122Glover et al., 2011AA-50791617097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA5342216010100191841947519330146Glover et al., 2011AA53423161289019326125921264448Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890 <td< td=""><td></td><td>CAMS-2409</td><td>11680</td><td>90</td><td>13408</td><td>13589</td><td>13499</td><td>91</td><td>Glover et al., 2011</td></td<>		CAMS-2409	11680	90	13408	13589	13499	91	Glover et al., 2011
FTH-302021571090188421905218947105Glover et al., 2011Beta-15829111860270134201405113736316Glover et al., 2011AA-4506915810100185191873619067170Glover et al., 2011AA-45073155010018519187361876791Glover et al., 2011AA-450741498698180761834418210134Glover et al., 2011AA-4507714360120173171766817493176Glover et al., 2011AA-450781460091176571790017779122Glover et al., 2011AA-450781640091176571790017779122Glover et al., 2011AA534191586991198671924819118131Glover et al., 2011AA534216010170195851999619791206Glover et al., 2011AA534216010170195851999619791206Glover et al., 2011AA534216010107195851999619791206Glover et al., 2011AA534216010107195851997619330146Glover et al., 2011AA5342160209019246195019370130Glover et al., 2011AA5342160509019240195019370130Glover et al., 2011AA53423162515630<		ISGS-1677	12210	150	13816	14392	14104	288	Glover et al., 2011
Beta-158291     11860     270     13420     14051     13736     316     Glover et al., 2011       AA-45069b     15350     100     18519     18736     18628     190     Glover et al., 2011       AA-45069b     15503     91     18674     18856     18765     91     Glover et al., 2011       AA-45074     14986     98     18074     18856     17439     176     Glover et al., 2011       AA-45077     14360     120     17317     17668     17493     176     Glover et al., 2011       AA-45078     14500     91     17657     17900     1777     122     Glover et al., 2011       AA-45078     14600     91     19875     1996     1971     226     Glover et al., 2011       AA-53419     1569     91     19887     1996     1971     226     Glover et al., 2011       AA53425     16400     100     19184     19475     19330     146     Glover et al., 2011       AA53423     16026     90     19246		ISGS-1055	13510	160	16041	16514	16278	237	Glover et al., 2011
AA-4506915810140188971923619067170Glover et al., 2011AA-45069b15350100185191873618628100Glover et al., 2011AA-4507315509118674188861867691Glover et al., 2011AA-450741498698180761834418210134Glover et al., 2011AA-4507714360120173171766817493176Glover et al., 2011AA-5335155648818733189021881885Glover et al., 2011AA-450781460091176571790017779122Glover et al., 2011AA-534191586991198871924819118131Glover et al., 2011AA5342116400170195851996619791206Glover et al., 2011AA5342316610100191841947519330146Glover et al., 2011AA534291067658125961562126448Glover et al., 2011AA534231661097187801897819370130Glover et al., 2011AA534231564097187801897819370130Glover et al., 2011AA534231563015018722190371881496Glover et al., 2011AA534231563015018722190371884158Glover et al., 2011AA53423156301501		ETH-30202	15710	90	18842	19052	18947	105	Glover et al., 2011
AA-45069b15350100185191873618628109Glover et al., 2011AA-4507315503911867618834187651876591Glover et al., 2011AA-4507414960120173171766817493176Glover et al., 2011AA-450771436091176571790017779122Glover et al., 2011AA-450781617097193661964919508143Glover et al., 2011AA-450791617097193661964919508143Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA5342216010100191841947519330146Glover et al., 2011AA53423166009718786189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958019370130Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958019370130Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011PHT-050619310		Beta-158291	11860	270	13420	14051	13736	316	Glover et al., 2011
AA 45073155039118674188561876591Glover et al., 2011AA 450741498698180761834418210134Glover et al., 2011AA 4507714360120173171766817493176Glover et al., 2011AA53435155648818733189021881885Glover et al., 2011AA 450781460091176571790017779122Glover et al., 2011AA 53079167097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA534201640017019585199619791206Glover et al., 2011AA534211601010019184194751330146Glover et al., 2011AA53423162609718786189781887999Glover et al., 2011AA534231605090192401950019370130Glover et al., 2011AA534231605090192401950019370130Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011FH-3217714780100		AA-45069	15810	140	18897	19236	19067	170	Glover et al., 2011
AA-450741498698180761834418210134Glover et al., 2011AA-450771436012017371766817493176Glover et al., 2011AA-5435315668818733189021881885Glover et al., 2011AA-450781460091176571790017779122Glover et al., 2011AA-450791617097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA5342516400170195851999619791206Glover et al., 2011AA5342416010100191841947519330146Glover et al., 2011AA53425164009718780189781887999Glover et al., 2011AA534231656090193261958619456130Glover et al., 2011AA534231612890193261958019370130Glover et al., 2011AA53423165090192401950019370130Glover et al., 2011AA534231653015018722190371881496Glover et al., 2011CAMS-2712915630150187761662116499123Glover et al., 2011CAMS-2712915630150163761662116499123Glover et al., 2011Eta-1908641388070 <td></td> <td>AA-45069b</td> <td>15350</td> <td>100</td> <td>18519</td> <td>18736</td> <td>18628</td> <td>109</td> <td>Glover et al., 2011</td>		AA-45069b	15350	100	18519	18736	18628	109	Glover et al., 2011
AA-4507714360120173171766817493176Glover et al, 2011AA53435155648818733189021881885Glover et al, 2011AA-450781460091176571790017779122Glover et al, 2011AA-450791617097193661964919508142Glover et al, 2011AA534191586991189871924819118131Glover et al, 2011AA534216400170195851999619791206Glover et al, 2011AA534216010100191841947519330146Glover et al, 2011AA53423166765812596126921264448Glover et al, 2011AA534231612890192401950019370130Glover et al, 2011AA53423165600018718189091881496Glover et al, 2011Eta-1908631605090192401950019370130Glover et al, 2011CAMS-2712915630150187221903718880158Glover et al, 2011CAMS-2712915630150187221903718880158Glover et al, 2011Eth-3217714780100178541811817986132Glover et al, 2011Eth-3217714780100178541811817986132Glover et al, 2011Eth-3217719360163761		AA-45073	15503	91	18674	18856	18765	91	Glover et al., 2011
AA53435155648818733189021881885Glover et al., 2011AA-450781460091176571790017779122Glover et al., 2011AA-450791617097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA5342516400170195851999619791206Glover et al., 2011AA5342916010100191841947519330146Glover et al., 2011AA53429166765812596126921264448Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011CAM5-2712915630150187121903718810158Glover et al., 2011CAM5-2712915630150187221903718880158Glover et al., 2011CAM5-2712915630150167561662116499123Glover et al., 2011Beta-1908641380070166751665516820145Glover et al., 2011PITT-050720200		AA-45074	14986	98	18076	18344	18210	134	Glover et al., 2011
AA-450781460091176571790017779122Glover et al., 2011AA-450791617097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA53425164001701958519996197120Glover et al., 2011AA5344216010100191841947519330146Glover et al., 2011AA53429106765812596126921264448Glover et al., 2011AA53433161289019326195861945130Glover et al., 2011AA534231605090192401950019370130Glover et al., 2011ETH-285231556010018718188091881496Glover et al., 2011CAM5-2712915630150187221903718880158Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1908641389050163761662116499132Glover et al., 2011PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819310170230312347823255224Lowell et al., 1990PITT-050819200		AA-45077	14360	120	17317	17668	17493	176	Glover et al., 2011
AA-450791617097193661964919508142Glover et al., 2011AA534191586991189871924819118131Glover et al., 2011AA5342516400170195851999619791206Glover et al., 2011AA5342416010100191841947519330146Glover et al., 2011AA53429106765812596126921264448Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011AA534231612890192401950019370130Glover et al., 2011Eta-190863160509019240195001881496Glover et al., 2011CAM5-271291550010018718189091881496Glover et al., 2011CAM5-27130157708018721903718880158Glover et al., 2011ETH-3217714780100178541811817986133Glover et al., 2011ETH-3217714780100178541811817986133Glover et al., 2011ETH-321771970136050163761662116499123Glover et al., 2011ETH-3217719701370238092422924019213Glover et al., 2011PITT-050719960170230312347823255224Lowell et al., 1990PITT-0508<		AA53435	15564	88	18733	18902	18818	85	Glover et al., 2011
AA534191586991189871924819118131Glover et al., 2011AA5342516400170195851999619791206Glover et al., 2011AA5344216010100191841947519330146Glover et al., 2011AA53429106765812596126921264448Glover et al., 2011AA53418156409718780189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950013370130Glover et al., 2011CAMS-271301556010018718189091881496Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1908641389050163761662116499133Glover et al., 2011PITT-022719960170230312347823255224Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-0508192001402338214592089561Dyke, 2004		AA-45078	14600	91	17657	17900	17779	122	Glover et al., 2011
AA5342516400170195851999619791206Glover et al., 2011AA5344216010100191841947519330146Glover et al., 2011AA53429106765812596126921264448Glover et al., 2011AA53418156409718780189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950019370130Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011Eta-194054136905016376166211649123Glover et al., 2011Beta-1940541368070166751695516820145Glover et al., 2011PITT-022719960170230312347823255224Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140229412334423143202Lowell et al., 1990PITT-0508 <t< td=""><td></td><td>AA-45079</td><td>16170</td><td>97</td><td>19366</td><td>19649</td><td>19508</td><td>142</td><td></td></t<>		AA-45079	16170	97	19366	19649	19508	142	
AA5344216010100191841947519330146Glover et al., 2011AA53429106765812596126921264448Glover et al., 2011AA53418156409718780189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1908641388070166751662116499123Glover et al., 2011PITT-050619310170230312347823255224Lowell et al., 1990PITT-050819200140229412344024267174Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53419	15869	91	18987	19248	19118	131	Glover et al., 2011
AA53429106765812596126921264448Glover et al., 2011AA53418156409718780189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231550010018718189091881496Glover et al., 2011CAMS-2712915503150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1908641369050163761662116499123Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050819200140240932444024267174Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53425	16400	170	19585	19996	19791	206	Glover et al., 2011
AA53418156409718780189781887999Glover et al., 2011AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-27130157080189101911619013133Glover et al., 2011ETH-321771478010017854181817986132Glover et al., 2011Beta-1908641369050163761662116499123Glover et al., 2011Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53442	16010	100	19184	19475	19330	146	Glover et al., 2011
AA534231612890193261958619456130Glover et al., 2011Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-27130157080189101911619013133Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1908641369050163761662116499123Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53429	10676	58	12596	12692	12644	48	Glover et al., 2011
Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641380070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140229412334423143202Lowell et al., 1990PITT-05081969015023531239122372219Lowell et al., 1990PITT-05091969015023531239122372219Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53418	15640	97	18780	18978	18879	99	Glover et al., 2011
Beta-1908631605090192401950019370130Glover et al., 2011ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986123Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641380070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		AA53423	16128	90	19326	19586	19456	130	Glover et al., 2011
ETH-285231556010018718189091881496Glover et al., 2011CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170230312347823255224Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-05091969015023531239122372219Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004		Beta-190863	16050	90	19240		19370	130	
CAMS-2712915630150187221903718880158Glover et al., 2011CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1940841388070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240332444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004								96	
CAMS-271301577080189101911619013103Glover et al., 2011ETH-3217714780100178541811817986132Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200150235312391223722191Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
ETH-3217714780100178541811817986132Glover et al., 2011Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170230302422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004							19013		
Beta-1940541369050163761662116499123Glover et al., 2011Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
Beta-1908641388070166751696516820145Glover et al., 2011PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
PITT-022719960170238092422924019210Lowell et al., 1990PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
PITT-050619310170230312347823255224Lowell et al., 1990PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
PITT-050720200140240932444024267174Lowell et al., 1990PITT-050819200140229412334423143202Lowell et al., 1990PITT-050919690150235312391223722191Lowell et al., 1990OWU-7617290436203382145920899561Dyke, 2004									
PITT-0508     19200     140     22941     23344     23143     202     Lowell et al., 1990       PITT-0509     19690     150     23531     23912     23722     191     Lowell et al., 1990       OWU-76     17290     436     20338     21459     20899     561     Dyke, 2004									
PITT-0509     19690     150     23531     23912     23722     191     Lowell et al., 1990       OWU-76     17290     436     20338     21459     20899     561     Dyke, 2004									
OWU-76 17290 436 20338 21459 20899 561 Dyke, 2004									
									, ,

\*Calibrated using Calib 7.0 and IntCal13 (Stuiver and Reimer, 1993; Reimer et al., 2013)

#### **Supplementary References**

- Abe-Ouchi, A., Segawa, T., and Saito, F., 2007, Climatic conditions for modeling the Northern Hemisphere ice sheets throughout the ice age cycle: Climate of the Past, v. 3, p. 423-438.
- Anslow, F.S., Hostetler, S., Bidlake, W.R., and Clark, P.U., 2008, Distributed energy balance modeling of South Cascade Glacier, Washington and assessment of model uncertainty: Journal of Geophysical Research, v. 113, F02019.
- Argus, D.F. and Peltier, W.R., 2010, Constraining models of postglacial rebound using space geodesy: a detailed assessment of model ICE-5G (VM2) and its relatives: Geophysical Journal International, v. 181, p. 697-723.
- Attig, J.W., Clayton, L., and Mickelson, D.M., 1985, Correlation of late Wisconsin glacial phases in the western Great Lakes area: Geological Society of America Bulletin, v. 96, p. 1585-1593.
- Balco, G., Stone, J.O., Lifton, N.A., and Dunai, T.J., 2008, A complete and easily accessible means of calculating surface exposure ages or erosion rates from <sup>10</sup>Be and <sup>26</sup>Al measurements: Quaternary Geochronology, v. 3, p. 174-195.
- Balco, G., Briner, J., Finkel, R.C., Rayburn, J.A., Ridge, J.C., and Schaefer, J.M., 2009, Regional beryllium-10 production rate calibration for late-glacial northeastern North America: Quaternary Geochronology, v. 4, p. 93-107.
- Bender, M.M., Bryson, R.A., and Baerreis, D.A., 1971, University of Wisconsin radiocarbon dates IX: Radiocarbon, v. 13, p. 475-486.
- Berger, A. and Loutre, M.F., 1991, Insolation values for the climate of the last 10 million years: Quaternary Science Reviews, v. 10, p. 297-317.
- Bevington, P. and Robinson, D.K., 2002, Data reduction and error analysis for the physical sciences, 3<sup>rd</sup> Ed.: McGraw-Hill, Boston, 336 p.
- Black, R.F., 1976, Quaternary geology of Wisconsin and upper Michigan, *in* Mahaney, W.C., ed., Quaternary Stratigraphy of North America: Stroudsber, PA, Dowden, Hutchinson, and Ross, p. 93-117.
- Cannon, W.F., LaBerge, G.L., Klasner, J.S., Schulz, K.J., 2007, The Gogebic Iron Range--A sample of the northern margin of the Penokean fold and thrust belt: USGS Professional Paper 1730, 44 p.
- Carlson, A.E., Anslow, F.S., Obbink, E.A., LeGrande, A.N., Ullman, D.J., and Licciardi, J.M., 2009, Surface-melt driven Laurentide Ice sheet retreat during the early Holocene: Geophysical Research Letters, v. 36, L24502.
- Carlson, A.E., Ullman, D.J., Anslow, F.S., He, F., Clark, P.U., Liu, Z., and Otto-Bliesner, B.L., 2012, Modeling the surface mass-balance response of the Laurentide Ice Sheet to Bølling warming and its contribution to Meltwater Pulse 1A: Earth and Planetary Science Letters, v. 315-316, p. 24-29.
- Carson, E.C., Hanson, P.R., Attig, J.W., and Young, A.R., 2012, Numeric control on the lateglacial chronology of the southern Laurentide Sheet derived from ice-proximal lacustrine deposits: Quaternary Research, v. 78, p. 583-589.
- Clark, P.U., 1992, Surface form of the southern Laurentide Ice Sheet and implications to icesheet dynamics: Geological Society of America Bulletin, v. 104, p. 595-605.

- Clark, P.U., Licciardi, J.M., MacAyeal, D.R., and Jenson, J.W., 1996, Numerical reconstruction of a soft-bedded Laurentide Ice Sheet during the last glacial maximum: Geology, v. 24, p. 679-682.
- Clark, P.U., Dyke, A.S., Shakun, J.D., Carlson, A.E., Clark, J., Wohlfarth, B., Mitrovica, J.X., Hostetler, S.W., and McCabe, A.M., 2009, The Last Glacial Maximum: Science, v. 325, p. 710–714.
- Clayton, L. and Attig, J.W., 1990, Geology of Sauk County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular, v. 67, 68 p.
- Colgan, P.M., Bierman, P.R., Mickelson, D.M., and Caffee, M., 2002, Variation in glacial erosion near the southern margin of the Laurentide Ice Sheet, south-central Wisconsin, USA: Implications for cosmogenic dating of glacial terrains: Geological Society America Bulletin, v. 114, p. 1581-1591.
- Corbett, L.B., Bierman, P.R., Graly, J.A., Neumann, T.A., and Rood, D.H., 2013, Constraining landscape history and glacial erosivity using paired cosmogenic nuclides in Upernavik, northwest Greenland: Geological Society of America Bulletin, doi:10.1130/B30813.1.
- Curry, B.B., Grimley, D.A., and Stravers, J.A., 1999, Quaternary geology, geomorphology, and climatic history of Kane County, Illinois: Illinois State Geological Survey Guidebook, v. 28, 40 p.
- Curry, B.B., 2008, Deglacial History and Paleoenvironments of North-eastern Illinois, 54<sup>th</sup> Midwest Friends of the Pleistocene Field Conference, May 16-18, 2008: Illinois State Geological Survey Open File Series 2008-1, 175 p.
- Curry, B. and Petras, J., 2011, Chronological framework for the deglaciation of the Lake Michigan lobe of the Laurentide Ice Sheet from ice-walled lake deposits: Journal of Quaternary Science, v. 26, p. 402-410.
- Desilets, D., Zreda, M. and Prabu, T., 2006, Extended scaling factors for in situ cosmogenic nuclides: new measurements at low latitude: Earth and Planetary Science Letters, v. 246, p. 265-276.
- Dunai, T., 2001, Influence of secular variation of the magnetic field on production rates of in situ produced cosmogenic nuclides: Earth and Planetary Science Letters, v. 193, p. 197-212.
- Duynkerke, P.D. and van den Broeke, M.R., 1994, Surface energy balance and katabatic flow over glacier and tundra during GIMEX-91: Global and Planetary Change, v. 9, p. 17-28.
- Dyke, A.S., 2004, An outline of North American deglaciation with emphasis on central and northern Canada, *in* Ehlers, J. and Gibbard, P.L., eds., Quaternary Glaciations-Extent and Chronology, Part II: Amsterdam, Elsevier Science and Technology Books, p. 373-424.
- Dyke, A.S., Andrews, J.T., Clark, P.U., England, J.H., Miller, G.H., Shaw, J., and Veillette, J.J., 2002, The Laurentide and Innuitian ice sheets during the Last Glacial Maximum: Quaternary Science Reviews, v. 21, p. 9-31.
- Eckberg, M.P., Lowell, T.V., and Stuckenrath, R., 1993, Late Wisconsin glacial advance and retreat patterns in southwestern Ohio, USA: Boreas v. 22, p. 189-204.
- Farrand, W.R., Benninghoff, W.S., Zhner, R., 1969, Cary-Port Huron Interstade: evidence from a buried bryophyte bed, Cheboygan County, Michigan: Geological Society of America Special Paper, v. 123, p. 249-262.

- Garry, C.E., Baker, R.W., Schwert, D.P., and Schneider, A.F., 1990, Environmental analysis of a Twocreekan-aged beetle (Coleoptera) assemblage from Kewaunee, Wisconsin: Geological Society of America Special Paper, v. 251, p. 57-66.
- Glover, K.C., Lowell, T.V., Wiles, G.C., Pair, D., Applegate, P., and Hajdas, I., 2011, Deglaciation, basin formation and post-glacial climate change from a regional network of sediment core sites in Ohio and eastern Indiana: Quaternary Research, v. 76, p. 401-410.
- Grainger, M.E. and Lister, H., 1966, Wind speed, stability and eddy viscosity over melting ice surfaces: Journal of Glaciology, v. 6, p. 101-127.
- Greuell, W. and Konzelmann, T., 1994, Numerical modelling of the energy balance and the englacial temperature of the Greenland Ice Sheet. Calculations for the ETH-Camp location (West Greenland, 1155 m a.s.l.): Global and Planetary Change, v. 9, p. 91-114.
- Hansel, A.K. and Johnson, W.H., 1992, Fluctuations of the Lake Michigan lobe during the late Wisconsin subepisode: Sveriges Geologiska Undersökning, v. 81, p. 133-144.
- Hansel, A.K. and Johnson, W.H., 1996, Wedron and Mason Groups: Lithostratigraphic reclassification of deposits of the Wisconsin Episode, Lake Michigan Lobe area: Illinois State Geological Survey Bulletin, v. 104, 116 p.
- Hooyer, T.S., 2007, Evolution of glacial Lake Oshkosh and the Fox River Lowland, *in* Hooyer, T.S., ed., Late-glacial history of east-central Wisconsin, Guide Book for the 53rd Midwest Friends of the Pleistocene Field Conference, May 18-20, 2007, Oshkosh, WI: Wisconsin Geological and Natural History Survey Open-File Report 2007-01, p. 1-16.
- Hughes, L. and Merry, W.J., 1978, Marquette buried forest 9,850 years old: American Association for the Advancement of Science, Abstract for Annual Meeting, no. 12-14.
- Johnson, M.D., 1986, Pleistocene geology of Barron County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular, v. 55, 42 p.
- Kaiser, K.F., 1994, Two Creeks Interstade dated through dendrochronology and AMS: Quaternary Research, v. 42, p. 288-298.
- Lal, D., 1991, Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion models: Earth and Planetary Science Letters, v. 104, p. 424-439.
- Lambeck, K., Purcell, A., Zhao, J., and Svensson, N.O., 2010, The Scandinavian Ice Sheet: from MIS 4 to the end of the Last Glacial Maximum: Boreas, v. 39, p. 410-435.
- Licciardi, J.M., Clark, P.U., Jenson, J.W., and Macayeal, D.R., 1998, Deglaciation of a softbedded Laurentide Ice Sheet: Quaternary Science Reviews, v. 17, p. 427-448.
- Lifton, N.A., Bieber, J.W., Clem, J.M., Duldig, M.L., Evenson, P., Humble, J.E., and Pyle, R., 2005, Addressing solar modulation and long-term uncertainties in scaling secondary cosmic rays for in situ cosmogenic nuclide applications: Earth and Planetary Science Letters, v. 239, p. 140-161.
- Lowell, T.V., Savage, K.M., Brockman, C.S., and Stuckenrath, R., 1990, Radiocarbon analyses from Cincinnati, Ohio, and their implications for glacial stratigraphic interpretations: Quaternary Research, v. 34, p. 1-11.
- Lowell, T.V., Larson, G.J., Hughes, J.D., and Denton, G.H., 1999a, Age verification of the Lake Gribben forest bed and the Younger Dryas advance of the Laurentide Ice Sheet: Canadian Journal of Earth Sciences, v. 36, p. 383-393.

- Lowell, T.V., Hayward, R.K. and Denton, G.H., 1999b, Role of climate oscillations in determining ice-margin position: hypothesis, examples, and implications: Geological Society of America Special Paper, v. 337, p. 193- 203.
- Maher, L.J., Jr. and Mickelson, D.M., 1996, Palynological and radiocarbon evidence for deglaciation events in the Green Bay Lobe, Wisconsin: Quaternary Research, v. 46, p. 251-259.
- Maher, L.J., Jr., Miller, N.G., Baker, R.G., Curry, B.B., and Mickelson, D.M., 1998, Paleobiology of the sand beneath the Valders diamicton at Valders, Wisconsin: Quaternary Research, v. 49, p. 208-221.
- Mickelson, D.M., 1986, Glacial and related deposits of Langlade County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular, v. 52, 30 p.
- Mickelson, D.M., Hooyer, T.S., Socha, B.J. and Winguth, C., 2007, Late glacial ice advances and vegetation changes in east-central Wisconsin, *in* Hooyer, T.S., ed., Late-glacial history of east-central Wisconsin, Guide Book for the 53rd Midwest Friends of the Pleistocene Field Conference, May 18-20, 2007, Oshkosh, WI: Wisconsin Geological and Natural History Survey Open-File Report 2007-01, p. 73-87.
- Monaghan, G.W. and Hansel, A.K., 1990, Evidence for the intra-Glenwood (Mackinaw) lowwater phase of glacial Lake Chicago: Canadian Journal of Earth Science, v. 27, p. 1236-1241.
- Mudrey, M.G., Brown, B.A., and Greenberg, J.K., 1982, Bedrock geologic map of Wisconsin: University of Wisconsin-Extension, Geological and Natural History Survey.
- Murray, D.S., Carlson, A.E., Singer, B.S., Anslow, F.S., He, F., Caffee, M., Marcott, S.A., Liu Z. and Otto-Bliesner, B.L., 2012, Northern Hemisphere forcing of the last deglaciation in southern Patagonia: Geology, v. 40, p. 631-634.
- Patterson, C.J., Hansel, A.K., Mickelson, D.M., Quade, D.J., Bettis III, E.A., Colgan, P.M., McKay, E.D., Stumpf, A.J., 2003, Contrasting glacial landscapes created by ice lobes of the southern Laurentide Ice Sheet, *in* Eastbrook, D.J., ed., Quaternary Geology of the United States, INQUA 2003 Field Guide Volume: Reno, Desert Research Institute, p. 135-154.
- Peltier, W.R., 2004, Global glacial isostasy and the surface of the ice-age earth: the ICE-5G (VM2) model and GRACE: Annual Reviews of Earth and Planetary Science, v. 32, p. 111-149.
- Reimer, P.J. and 29 others, 2013, IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP: Radiocarbon, v. 55, p. 1869-1887.
- Rinterknecht, V.R., Clark, P.U., Raisbeck, G.M., Yiou, F., Bitinas, A., Brook, E.J., Marks, L., Zelcs, V., Lunkka, J.-P., Pavlovskaya, I.E., Piotrowski, J.A., and Raukas, A., 2006, The last deglaciation of the southeastern sector of the Scandinavian Ice Sheet: Science, v. 311, p. 1449-1452.
- Schmidt, G.A., and 43 others, 2014, Configuration and assessment of the GISS ModelE2 contributions to the CMIP5 archive: Journal of Advances in Modeling Earth Systems, in press.
- Schulte, L.A., Mladenoff, D.J., Crow, T.R., Merrick, L.C., and Cleland, D.T., 2007, Homogenization of northern U.S. Great Lakes forests due to land use: Landscape Ecology, v. 22, p. 1089-1103.

- Smeets, C.J.P.P. and van den Broeke, M.R., 2008, Temporal and spatial variations off the aerodynamic roughness length in the ablation zone of the Greenland ice sheet: Boundary-Layer Meteorology, v. 128, p. 315-338.
- Socha, B.J., 2007, Evidence of tundra plants overridden by ice approximately 16,000 cal yr BP, Sherwood, Wisconsin, Calumet County, *in* Hooyer, T.S., ed., Late-glacial history of eastcentral Wisconsin, Guide Book for the 53rd Midwest Friends of the Pleistocene Field Conference, May 18-20, 2007, Oshkosh, WI: Wisconsin Geological and Natural History Survey Open-File Report 2007-01, p. 73-87.
- Steventon, R.L. and Kutzbach, J.E., 1985, University of Wisconsin radiocarbon dates XXII: Radiocarbon, v. 27, p. 455-469.
- Stone, J.O., 2000, Air pressure and cosmogenic isotope production: Journal of Geophysical Research, v. 105, p. 23753-23759.
- Stuiver, M. and Reimer, P.J., 1993, Extended <sup>14</sup>C data base and revised CALIB 3.0 <sup>14</sup>C age calibration program: Radiocarbon, v. 35, p. 215-230.
- Tarasov, L. and Peltier, W.R., 2004, A geophysically constrained large ensemble analysis of the deglacial history of the North American ice-sheet complex: Quaternary Science Reviews, v. 23, p. 359-388.
- Tarasov, L., Dyke, A.S., Neal, R.M., Peltier, W.R., 2012, A data-calibrated distribution of deglacial chronologies for the North American ice complex from glaciological modeling: Earth and Planetary Science Letters, v. 315-316, p. 30-40.
- Ullman, D.J., LeGrande, A.N., Carlson, A.E., Anslow, F.S., and Licciardi, J.M., 2014, Assessing the impact of Laurentide Ice-Sheet topography on glacial climate: Climate of the Past, v. 10, p. 487-507.
- van de Berg, W.J., van den Broeke, M., Ettema, J., van Meijgaard, E., Kaspar, F., 2011, Significant contribution of insolation to Eemian melting of the Greenland ice sheet: Nature Geoscience, v. 4, p. 679-683.
- van de Wal, R.S.W., 1996, Mass-balance modelling of the Greenland ice sheet: a comparison of an energy-balance and a degree-day model, Annals of Glaciology, v. 23, p. 36-45.