Supplement of:
Tectonic controls of Holocene erosion in a glaciated orogen

Byron A. Adams[1,2], Todd A. Ehlers[1]

[1]Department of Geosciences, Univsität Tübingen, D-72074, Germany
[2]Now at the School of Earth Sciences, University of Bristol, Bristol, BS8 1RJ, UK

Correspondence to: Byron A. Adams (byron.adams@bristol.ac.uk)

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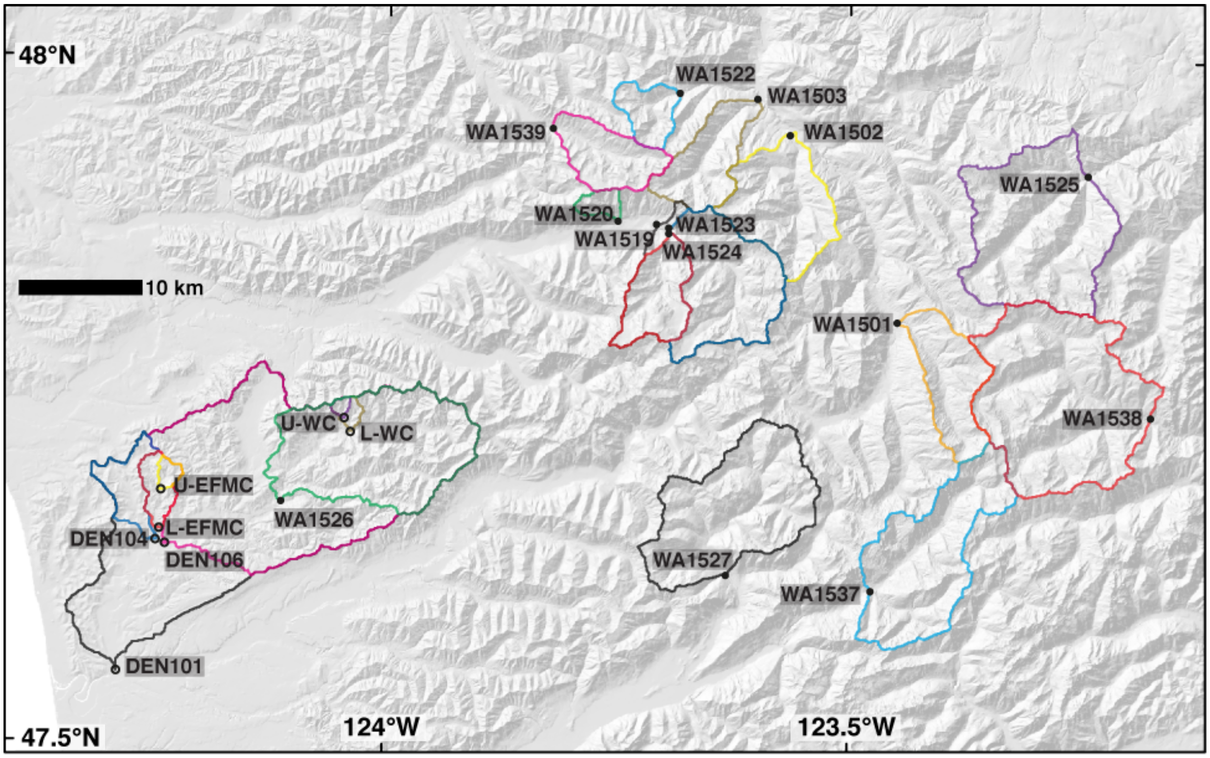

Figure S1. Basin sample location map. Samples marked with open circles are from Belmont et al. (2007).

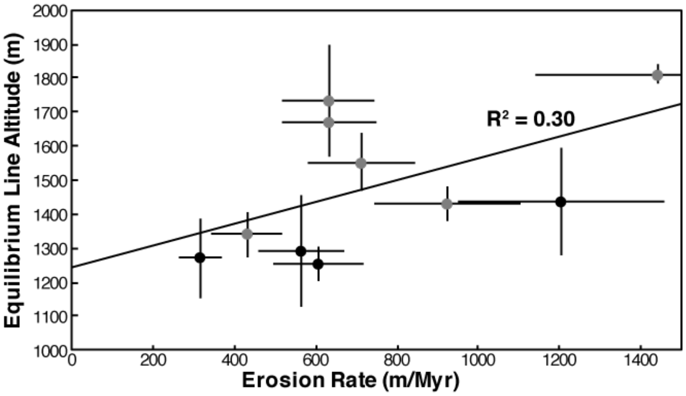

Figure S2. Comparison of basin-averaged erosion rates and equilibrium line altitudes (ELA). Black and grey data are from the west and east sides of the range, respectively.

Calculation of snow depth estimations

For this study, we utilized the MODIS/Terra Snow Cover Monthly L3 Global 0.05°, Version 6 dataset (Hall and Riggs, 2015), to estimate the distribution of snow for a given month. For any given pixel in the scene the value can vary between 0 and 100. While we consider these values to be spatially accurate they are only qualitative in that they do not have a magnitude equal to a physical dimension. To scale these data to represent snow depth values, we consider the snow cover values to be analogous to a percentage of the maximum snow depth in the Olympic Mountain range.

Our best estimate of maximum snow depth in the range comes from the Buckinghorse SNOTEL meteorological station (https://www.ncdc.noaa.gov/cdo-web/datasets/; Network ID: GHCND:USS0023B18S), located at 1484 m in the southern reaches of the Elwha Valley in the core of the range (Fig. S4 and S5). This station records the highest monthly snow depth measurements within the range. In the final step, we smoothed mean monthly snow cover data (2001-2015) using a bilinear algorithm and multiplied these percentages by the mean monthly snow depth station data (2009-2015). We do not assert that the resulting maps (Fig. S4) are completely accurate. However, we have calculated them to constrain the possible effect snow shielding may have on the calculation of erosion rates across the range. We assume a snow density of 0.25 g/cm^3 for shielding calculations.

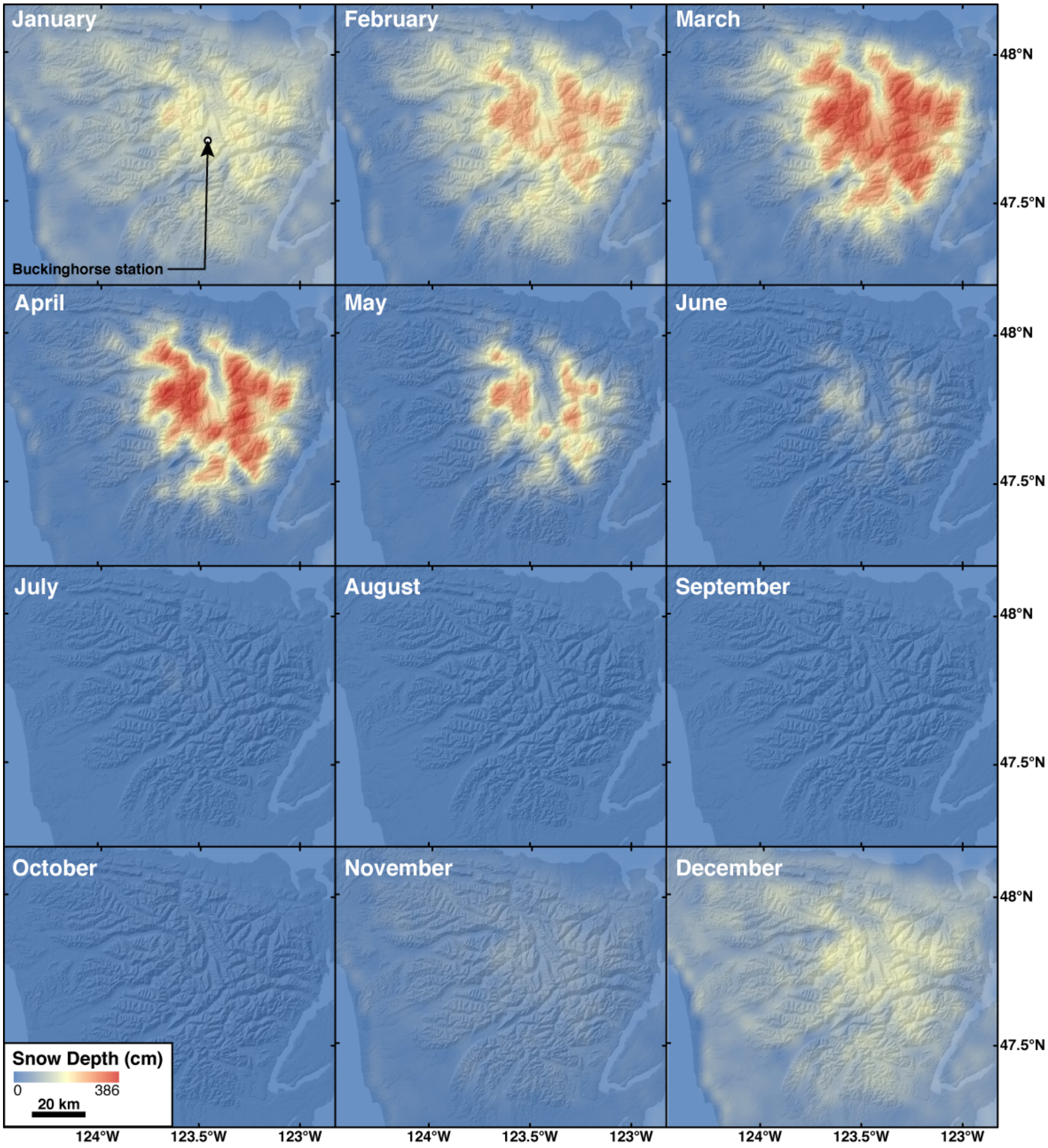

Figure S3. Monthly estimated snow depth map. The dot marks the position of the Buckinghorse SNOTEL meteorological station.

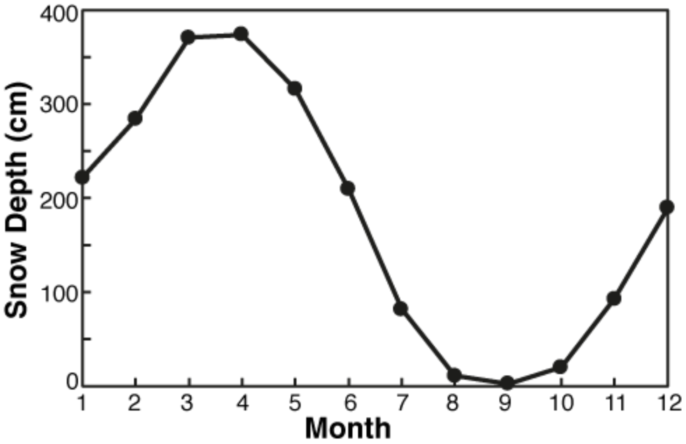

Figure S4. Mean monthly snow depth measurements from the Buckinghorse SNOTEL meteorological station. These means are calculated for the years 2009-2015.

Table S1. Laboratory and isotopic data for new Olympic Mountain samples.

Sample Name	Effective Latitude (°N)	Centroid Longitude (°E)	Effective Elevation (m)	Quartz (g)	Be from spike (g)	Total Al from ICP (g)	Laboratory Be Number	^{10}Be/^{9}Be from AMS	^{10}Be/^{9}Be 1σ	Be Blank Used	Laboratory Al Number	^{26}Al/^{27}Al from AMS	^{26}Al/^{27}Al 1σ	Al Blank Used
WA1501	47.761893	-123.38950	1397	90.382	3.29E-04	9.2640E-03	s09728	5.0260E-14	2.5300E-15	BA10	s09935	3.257E-14	2.850E-15	BA11
WA1502	47.856058	-123.57330	1266	88.882	3.29E-04	1.8151E-02	s09729	3.9650E-14	2.0600E-15	BA10	s09939	1.065E-14	1.500E-15	BA11
WA1503	47.96357	-123.65440	1195	88.350	3.28E-04	1.6448E-02	s09730	2.9910E-14	1.7300E-15	BA10	s09943	9.386E-15	1.400E-15	BA11
WA1519	47.86627	-123.65900	1421	90.386	3.28E-04	1.6600E-02	s09731	1.4260E-14	1.1200E-15	BA10	s09947	2.660E-15	7.420E-16	BA11
WA1520	47.902426	-123.77010	1184	81.778	3.27E-04	2.0658E-02	s09732	4.2830E-14	2.1100E-15	BA10	s09951	1.303E-14	1.670E-15	BA11
WA1522	47.977417	-123.71920	1252	51.239	3.26E-04	6.1441E-03	s09046	3.8700E-14	2.5800E-15	BA1	s10020	5.012E-14	3.490E-15	BA3
WA1523	47.89053	-123.63360	1404	73.762	3.28E-04	9.1110E-03	s09733	1.4880E-14	1.0900E-15	BA10	s09955	3.876E-15	8.750E-16	BA11
WA1524	47.832887	-123.70770	1505	99.716	3.47E-04	1.8004E-02	s09739	1.3250E-14	1.0000E-15	BA19	s09980	5.430E-15	1.010E-15	BA20
WA1525	47.862877	-123.29530	1547	84.053	3.27E-04	1.0421E-02	s09735	2.3580E-14	1.4600E-15	BA10	s09967	9.652E-15	1.450E-15	BA11
WA1526	47.674477	-124.01220	550	99.299	3.28E-04	2.1568E-02	s09734	9.1580E-14	3.7000E-15	BA10	s09959	2.296E-14	2.280E-15	BA11
WA1527	47.616827	-123.62340	1100	92.130	3.27E-04	1.9201E-02	s09735	4.8860E-14	2.4200E-15	BA19	s09976	1.731E-14	1.810E-15	BA20
WA1537	47.70025	-123.41140	1147	94.016	3.48E-04	8.3440E-03	s09740	2.2430E-14	1.4400E-15	BA19	s09984	1.722E-14	1.920E-15	BA20
WA1538	47.72078	-123.27090	1439	95.680	3.48E-04	1.0705E-02	s09741	5.0490E-14	2.3900E-15	BA19	s09988	2.849E-14	2.450E-15	BA20
WA1539	47.917853	-123.76290	1238	92.504	3.48E-04	1.4970E-02	s09742	8.6810E-14	3.5100E-15	BA19	s09992	4.037E-14	3.120E-15	BA20

Table S2. Blank data for new Olympic Mountain samples.

Blank Name	Laboratory Be Number	Be from spike (g)	^{10}Be/^{9}Be from AMS	^{10}Be/^{9}Be 1σ	Be Standard	Laboratory Al Number	Al from spike (g)	^{26}Al/^{27}Al from AMS	^{26}Al/^{27}Al 1σ	Al Standard
BA1	s09045	3.2750E-04	1.8410E-15	4.9500E-16	07KNSTD	--	--	--	--	--
BA10	s09737	3.2739E-04	1.9620E-15	3.6900E-16	07KNSTD	--	--	--	--	--
BA19	s09746	3.4758E-04	2.1870E-15	4.2600E-16	07KNSTD	--	--	--	--	--
BA3	--	--	--	--	--	s10024	2.5761E-03	1.647E-15	1.028E-15	KNSTD
BA11	--	--	--	--	--	s09967	2.5512E-03	1.905E-16	6.079E-16	KNSTD
BA20	--	--	--	--	--	s10008	2.5582E-03	2.077E-16	6.176E-16	KNSTD

Table S3. Shielding and erosion rate comparisons.

Sample Name	Topographic Shielding	Snow/Ice Shielding	Total Shielding	Topo+Snow Erosion Rate (m/Myr)	Erosion Rate 2σ (m/Myr)	Topo Only Erosion Rate (m/Myr)	Erosion Rate 2σ (m/Myr)	Percent Difference (%)
WA1501	0.95	0.87	0.82	638	118	726	136	12
WA1502	0.96	0.85	0.80	718	134	842	160	15
WA1503	0.95	0.86	0.81	930	183	1068	212	13
WA1519	0.95	0.85	0.80	2511	618	2922	725	14
WA1520	0.94	0.90	0.85	610	112	666	123	8
WA1522	0.95	0.87	0.82	432	90	492	103	12
WA1523	0.95	0.83	0.78	1881	442	2238	265	16
WA1524	0.94	0.87	0.81	3117	782	3558	898	12
WA1525	0.95	0.85	0.80	1451	301	1691	355	14
WA1526	0.97	0.96	0.92	224	37	235	39	4
WA1527	0.95	0.87	0.82	564	104	622	115	9
WA1537	0.93	0.86	0.79	1213	256	1396	297	13
WA1538	0.95	0.84	0.79	635	116	748	138	15
WA1539	0.96	0.87	0.83	318	55	361	63	12
U-EFMC	0.98	0.97	0.95	171	34	176	35	2
L-EFMC	0.98	0.97	0.96	129	20	131	20	2
U-WC	0.97	0.96	0.93	158	25	164	26	4
L-WC	0.98	0.96	0.93	199	31	207	32	4
DEN104	0.99	0.97	0.96	114	43	117	44	2
DEN106	0.97	0.96	0.93	237	110	246	114	3
DEN101	0.98	0.96	0.94	223	176	231	182	3

References

Belmont, P., Pazzaglia, F., and Gosse, J. C.: Cosmogenic 10 Be as a tracer for hillslope and channel sediment dynamics in the Clearwater River, western Washington State, Earth and Planetary Science Letters, 264, 123-135, 2007.

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