



## Supplement of

## Interannual snow accumulation variability on glaciers derived from repeat, spatially extensive ground-penetrating radar surveys

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## **1** Supplementary Material

- 2 Table S1. Observed density and calculated radar velocity at Gulkana and Wolverine glaciers.
- 3 Density uncertainty is the standard deviation of all density observations collected that year,
- 4 density velocity error is uncertainty introduced by uncertainty in density observations. Probe
- 5 velocity uncertainty is the standard error of the least-squares regression line.
- 6

Gulkana	Density [kg m <sup>-3</sup> ]	<b>Density Velocity</b>	Probe velocity	Mean Velocity				
		[m ns <sup>-1</sup> ]	[m ns <sup>-1</sup> ]	[m ns <sup>-1</sup> ]				
2013	$365 \pm 37$	$0.229 \pm 0.005$	$0.216 \pm 0.003$	$0.223 \pm 0.003$				
2014	$380 \pm 29$	$0.227 \pm 0.004$	$0.215 \pm 0.003$	$0.221 \pm 0.003$				
2015	$328 \pm 13$	$0.235 \pm 0.002$	$0.228 \pm 0.009$	$0.231 \pm 0.005$				
2016	$370 \pm 27$	$0.229 \pm 0.004$	$0.194 \pm 0.005$	$0.211 \pm 0.003$				
2017	$366 \pm 8$	$0.229 \pm 0.001$	$0.227 \pm 0.002$	$0.228 \pm 0.001$				
Mean	$362 \pm 11$	$0.230 \pm 0.002$	$0.216 \pm 0.002$	$0.223 \pm 0.001$				
Wolverine								
2013	$446 \pm 23$	$0.218 \pm 0.003$	$0.193 \pm 0.003$	$0.207\pm0.002$				
2014	$445 \pm 43$	$0.218 \pm 0.006$	$0.210 \pm 0.002$	$0.214 \pm 0.003$				
2015	$414 \pm 14$	$0.222 \pm 0.002$	$0.235 \pm 0.002$	$0.229 \pm 0.001$				
2016	$456 \pm 6$	$0.216 \pm 0.001$	$0.229 \pm 0.003$	$0.223 \pm 0.002$				
2017	$438 \pm 12$	$0.219 \pm 0.002$	$0.217 \pm 0.002$	$0.218 \pm 0.001$				
Mean	$440 \pm 10$	$0.219 \pm 0.001$	$0.217 \pm 0.001$	$0.218 \pm 0.001$				

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Method	2013	2014	2015	2016	2017
Gulkana <i>B</i> <sub>w</sub> [m w.e.]					
MVR	1.38	1.44	0.96	1.31	0.65
<b>Regression</b> Tree	1.38	1.44	0.95	1.32	0.65
Z - CL only	1.40	1.38	0.81	1.27	0.65
Z - All	1.37	1.45	0.94	1.28	0.64
Site-Index	1.30	1.31	0.77	1.07	0.57
Profile	1.44	1.45	0.97	1.36	0.64
Mean	1.38	1.41	0.90	1.27	0.63
Wolverine <i>B<sub>w</sub></i> [m w.e.]					
MVR	2.83	2.17	2.70	3.56	2.14
<b>Regression</b> Tree	2.84	2.06	2.55	3.47	2.04
Z - CL only	2.31	1.87	2.36	3.37	1.77
Z - All	2.58	1.97	2.51	3.44	1.95
Site-Index	2.24	1.74	2.37	3.38	1.70
Profile	2.30	1.79	2.49	3.54	1.89
Mean	2.52	1.93	2.50	3.46	1.91

Table S2. Glacier-wide average  $B_w$  from different approaches across study interval.

49 Figure S1. GPR surveys (a,c,e,g,h) and MVR model residuals (b,d,f,h,j) for Gulkana Glacier for

50 2013-2017.



55 Figure S2. GPR surveys (a,c,e,g,h) and MVR model residuals (b,d,f,h,j) for Wolverine Glacier

56 for 2013-2017.



61 Figure S3. DEM-derived terrain parameters for Wolverine Glacier.



67 Figure S4. DEM-derived terrain parameters for Gulkana Glacier.



- 73 Figure S5. Example of training (black lines) and test (red lines) datasets for the 100 iteration loop
- 74 for Gulkana. This same procedure was applied to both glaciers and all years.

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89 Figure S6. Average wind rose from *in situ* weather station for (a) Wolverine and (b) Gulkana

90 over the five-year study period.

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- 119 Figure S7. Distributed normalized SWE fields for Gulkana glacier from MVR (a,c,e,g,i) and
- regression tree model (b,d,f,h,j) for 2013-2017.



- 125 Figure S8. Distributed normalized SWE fields for Wolverine glacier MVR (a,c,e,g,i) and
- regression tree model (b,d,f,h,j) for 2013-2017.



- 132 Figure S9. Median out-of-bag predictor importance estimates from the regression trees for (a)

133 Gulkana and (b) Wolverine glaciers.



- 145 Figure S10. Photograph of the off-glacier terrain near Wolverine Glacier showing significantly
- 146 greater spatial variability in SWE. Photograph was taken in April 2017.
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150 Figure S11. Photograph of Wolverine Glacier's lower icefall in May 2014 showing exposed ice.

