

# Canadian Rockies Hydrological Observatory: Observations and Diagnosis 2021-2022

John Pomeroy, Alex Cebulski, Terava Groff, Phillip Harder, Madison Harasyn, Logan Fang, Kieran Lehan, Chris DeBeer, Lindsey Langs, Hannah Koslowsky

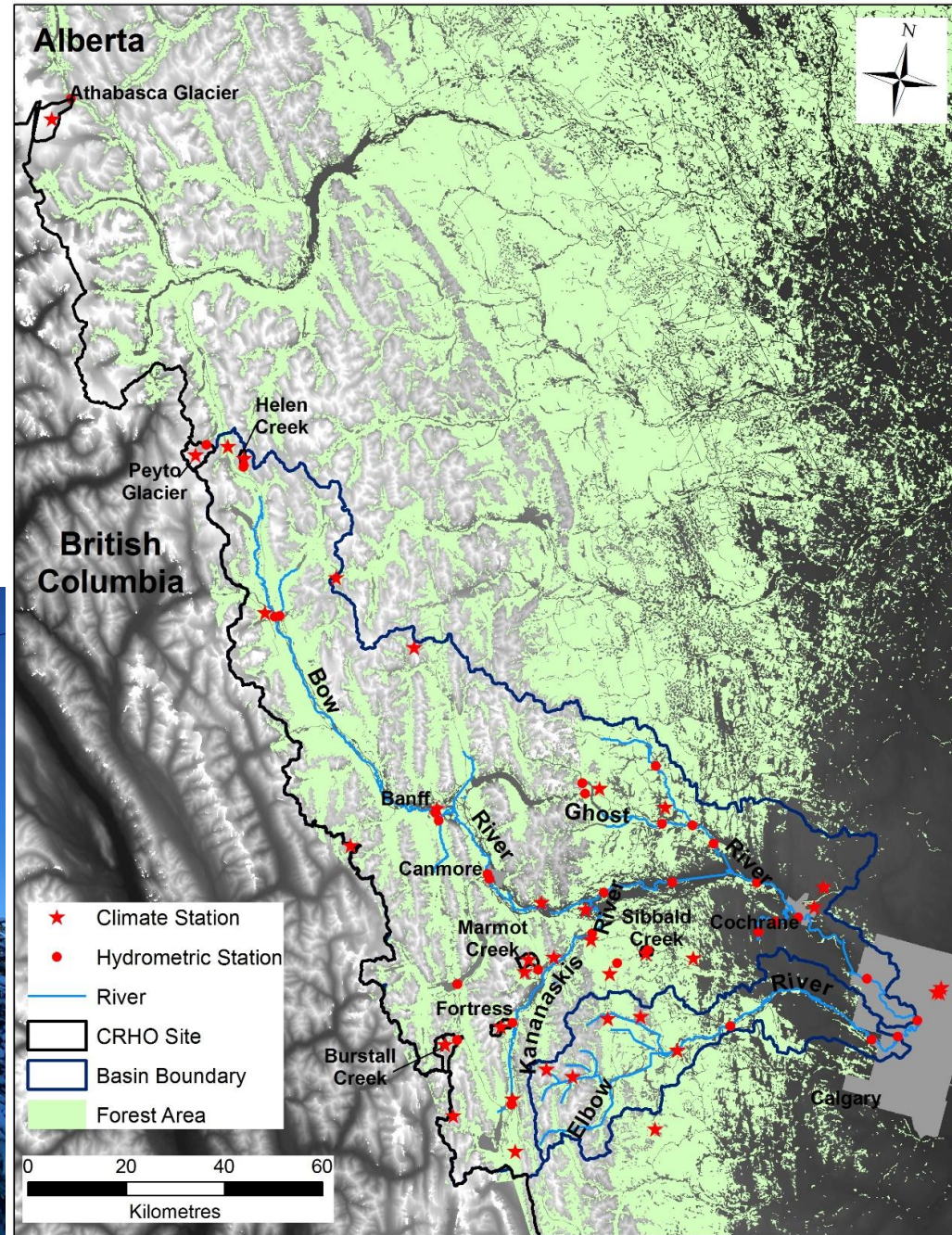
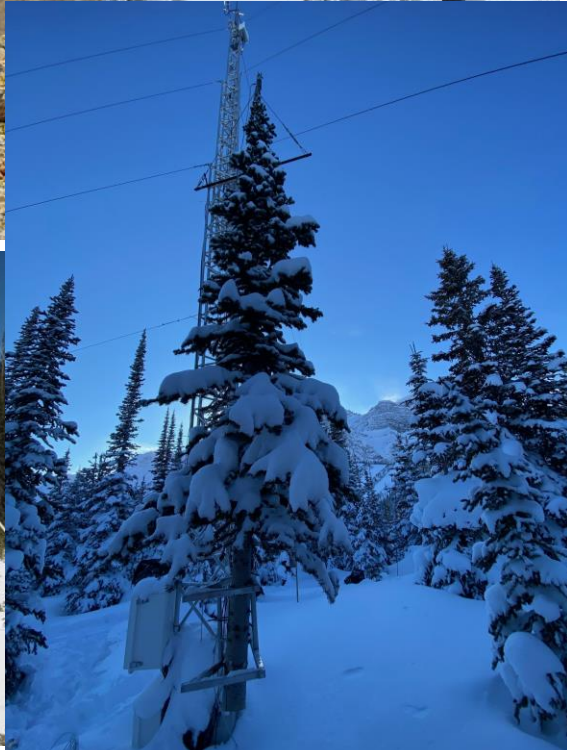
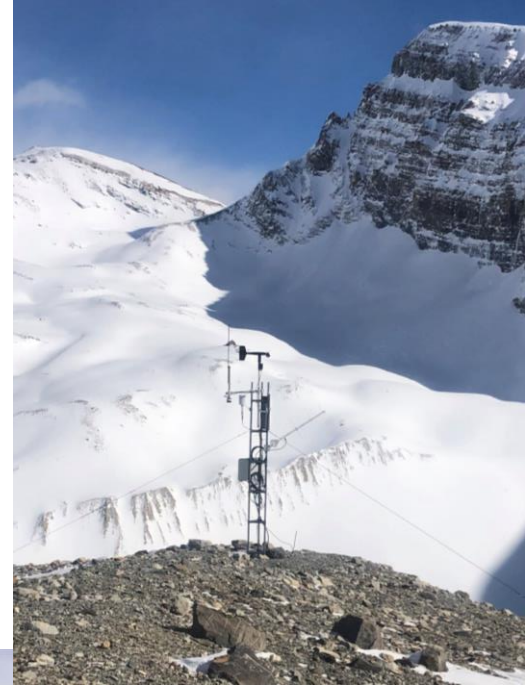
Centre for Hydrology,  
University of Saskatchewan,  
Canmore, Canada

Centre for Hydrology Coldwater Laboratory,  
Canmore, Canada



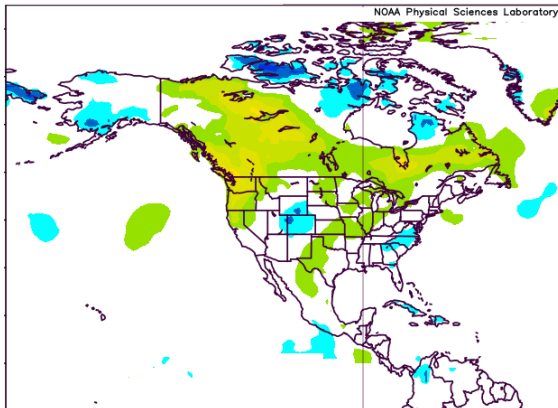


# CRHO Stations

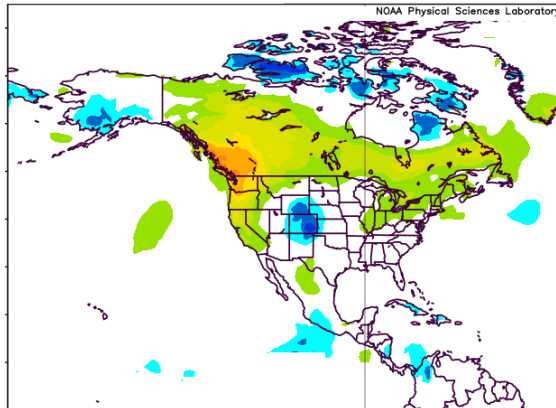




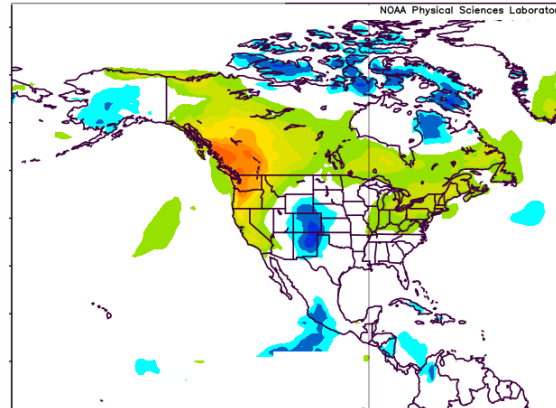
June 25, 2021



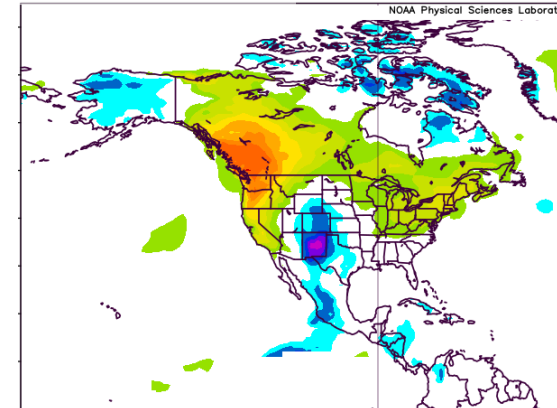
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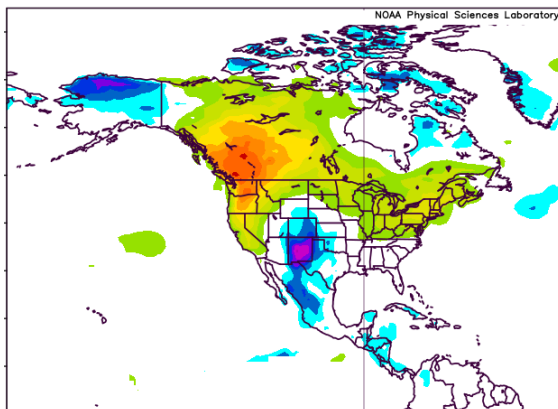
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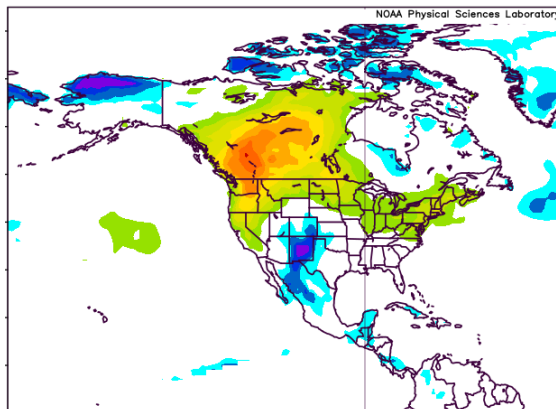
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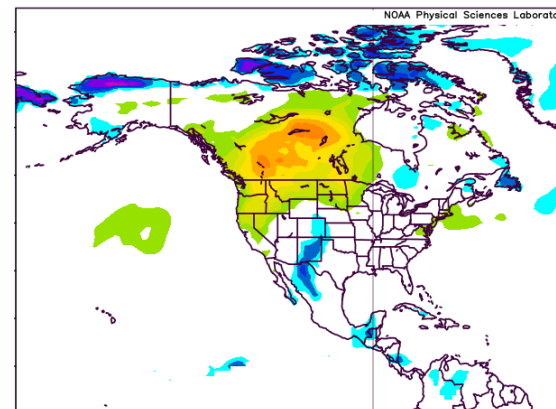
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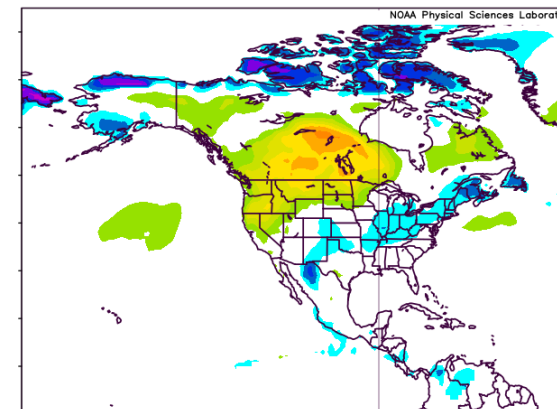
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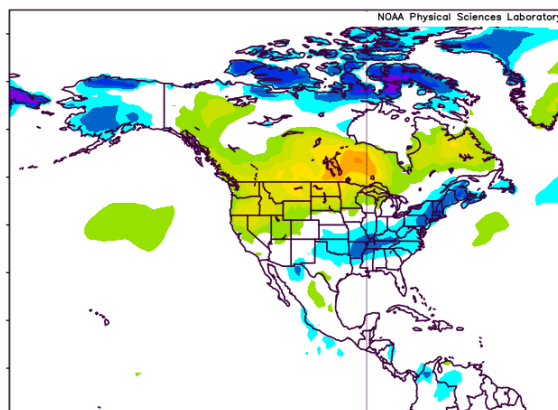
July 1



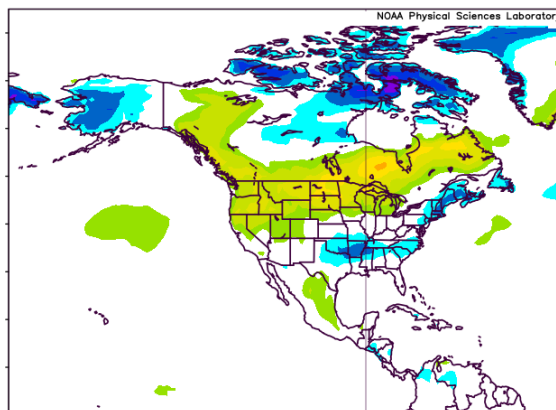
July 2



July 3



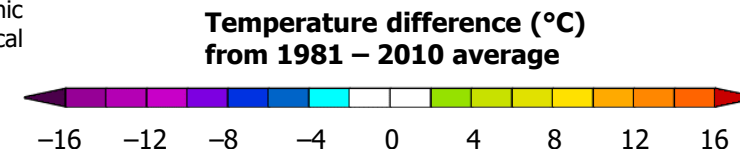
July 4



**Western Canada heat dome  
late-June – early-July, 2021**

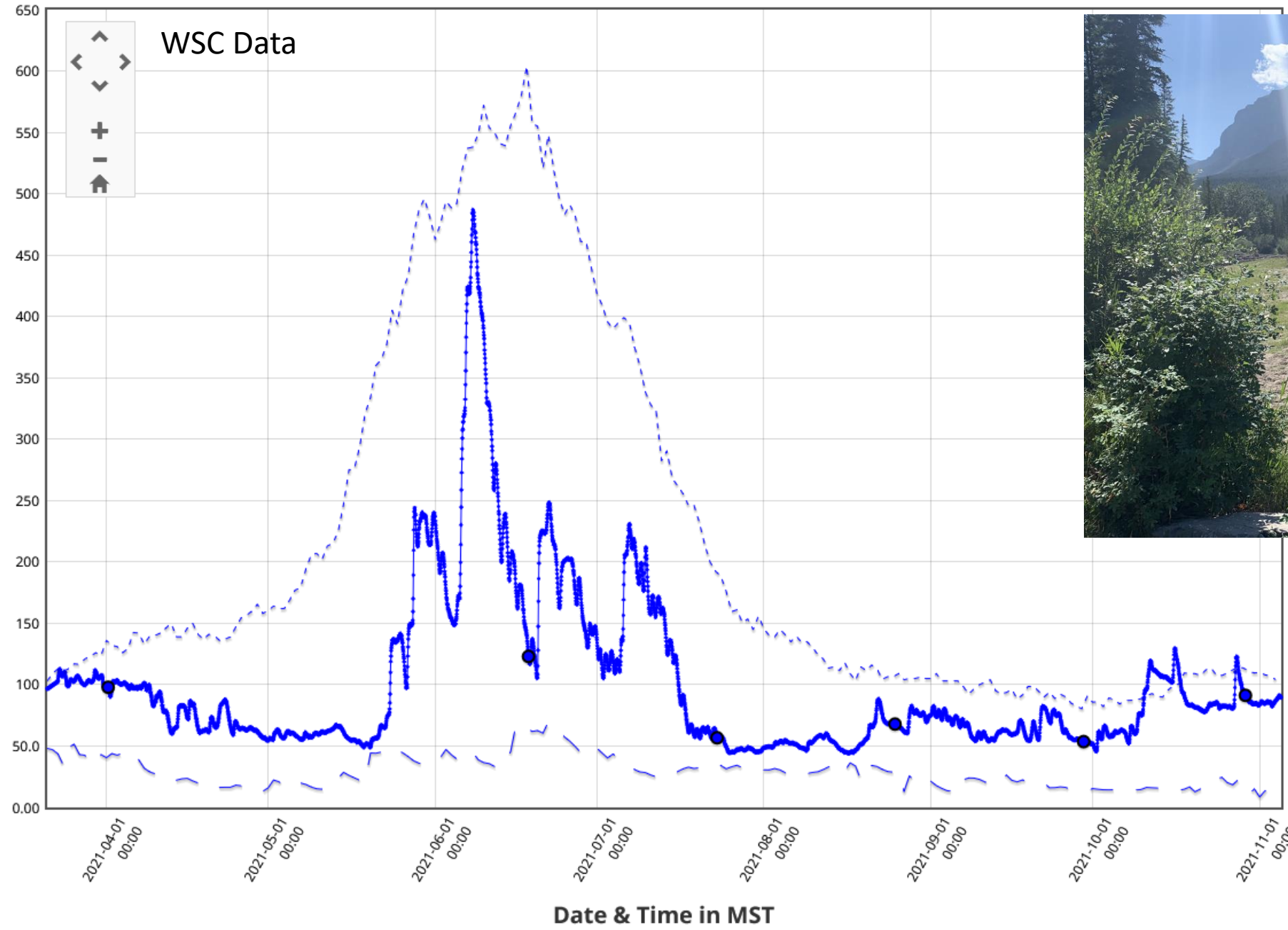
The intense heat dome that settled over western North America in late-June, and moved eastward in Canada in early July, not only broke all-time records, but smashed them at numerous locations by many degrees Celsius. This event was unusual for being so vast, spreading from coast-to-coast in Canada, and for its long duration. Above normal heat lasted well into the summer for much of Canada.

Map plots are from the National Oceanic and Atmospheric Administration Physical Sciences Laboratory, daily average NCEP NCAR composites, <https://psl.noaa.gov/>



Discharge (primary sensor derived) (m<sup>3</sup>/s)

# South Saskatchewan River at Medicine Hat

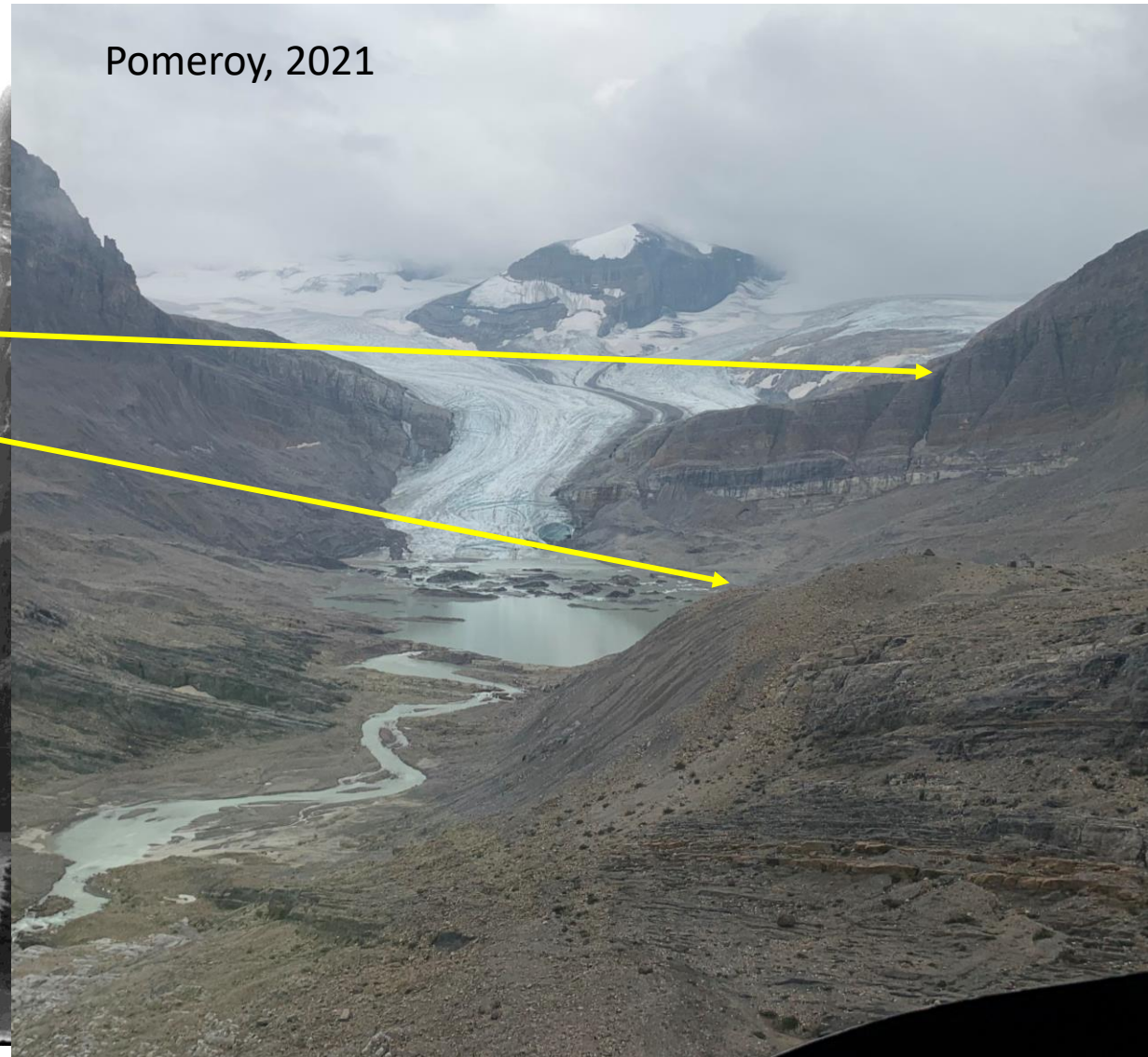
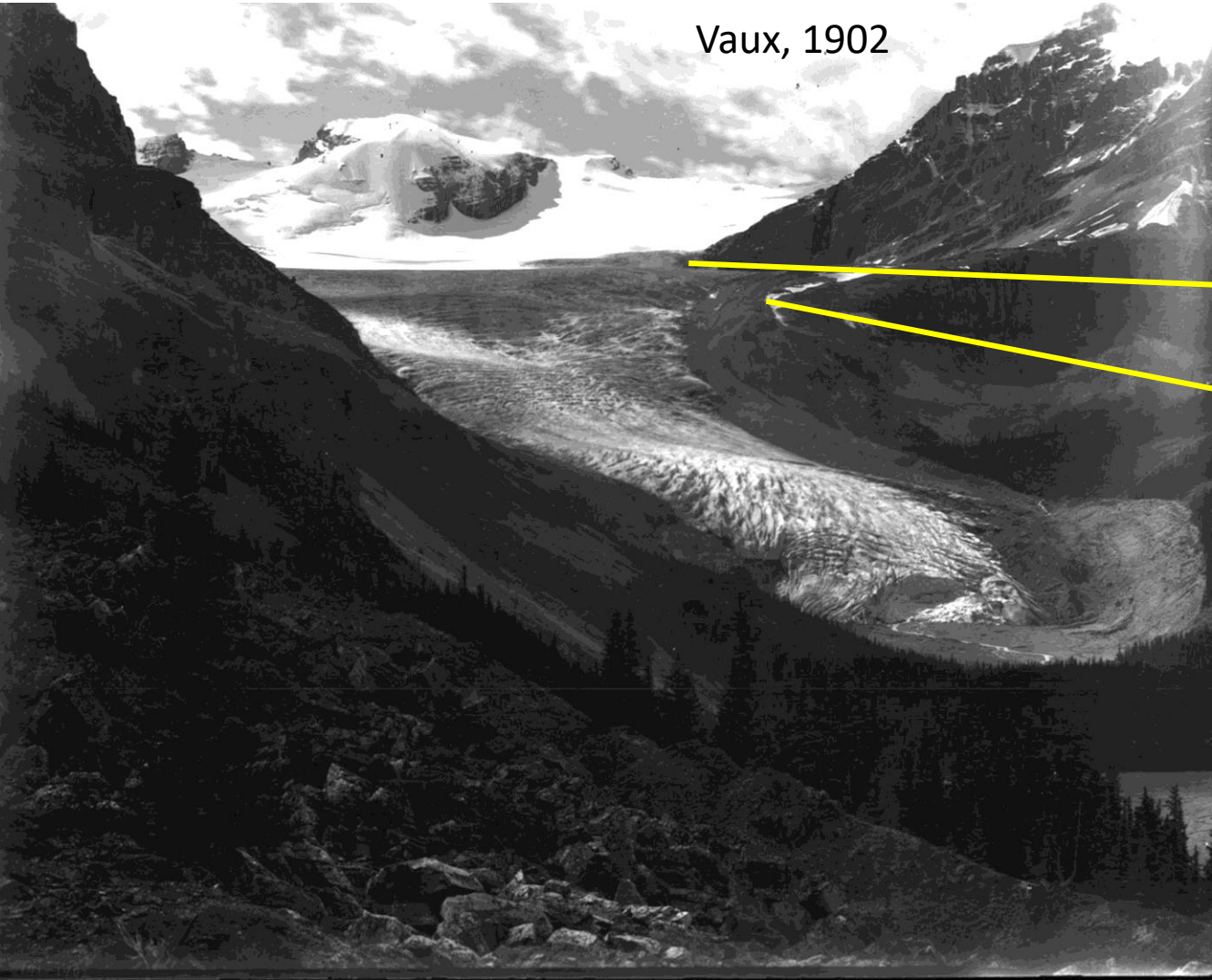








# Peyto Glacier Retreat to 2021



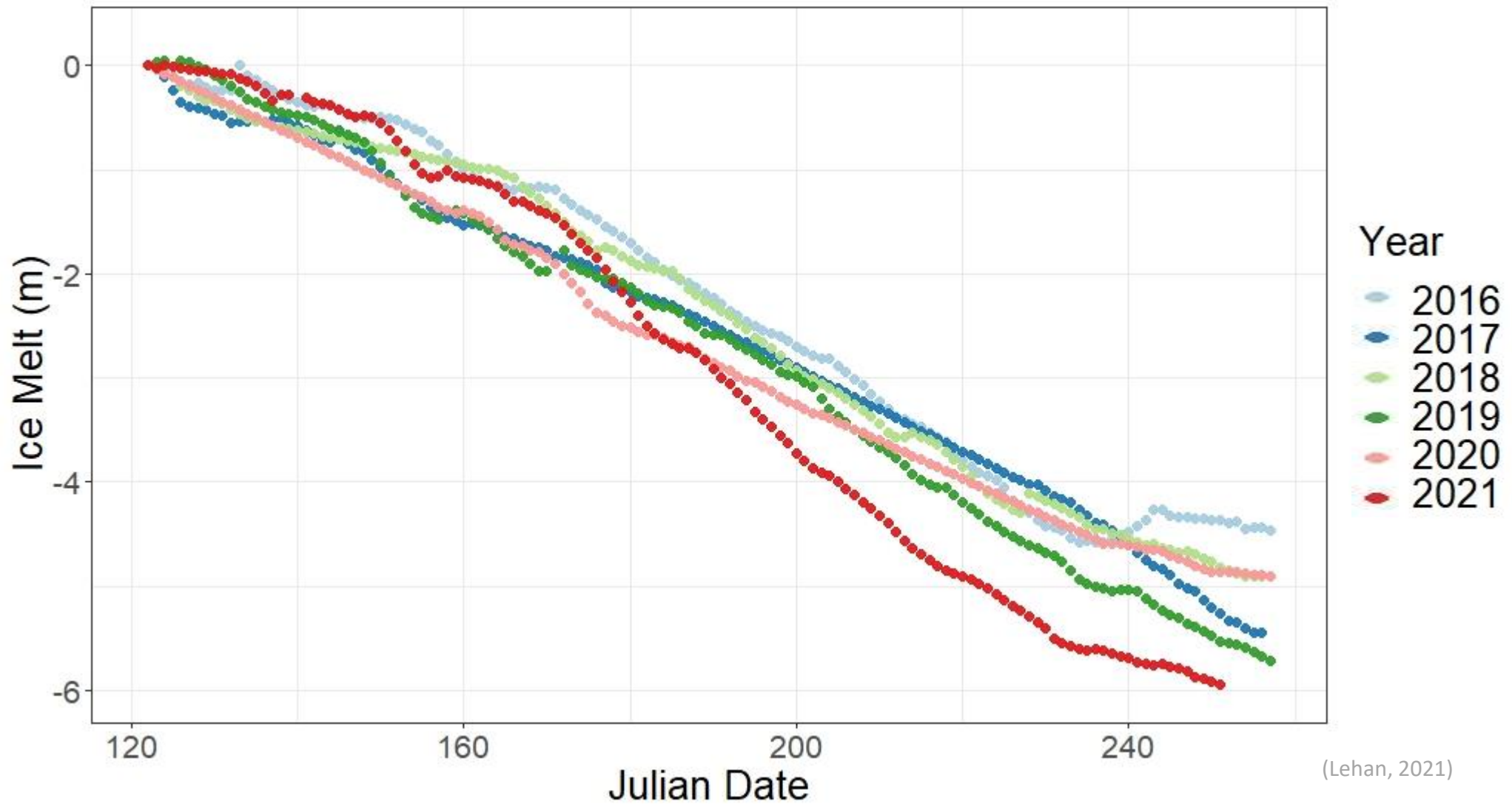






# Ice Surface Change (m) at Peyto Glacier

for May 1<sup>st</sup> – September 15<sup>th</sup> as recorded by ultrasonic depth transducer on Lower Ice (Snout). Gap filled by linear interpolation, and elevation verified by manual measurements



(Lehan, 2021)



Year	2016	2017	2018	2019	2020	<b>2021</b>
Daily change (m)	-0.04	-0.041	-0.041	-0.045	-0.038	<b>-0.052</b>

**Daily ice surface change (m) at Peyto Glacier**

Year	2016	2017	2018	2019	2020	<b>2021</b>
mean	5.2	6.1	6.9	5.7	5.5	<b>8.0</b>
median	5.4	6.1	6.6	5.8	5.7	<b>7.8</b>
Max	16.3	18.8	20.5	17.3	17.3	<b>23.6</b>

**Temperature (°C) 2-m above Peyto Glacier**

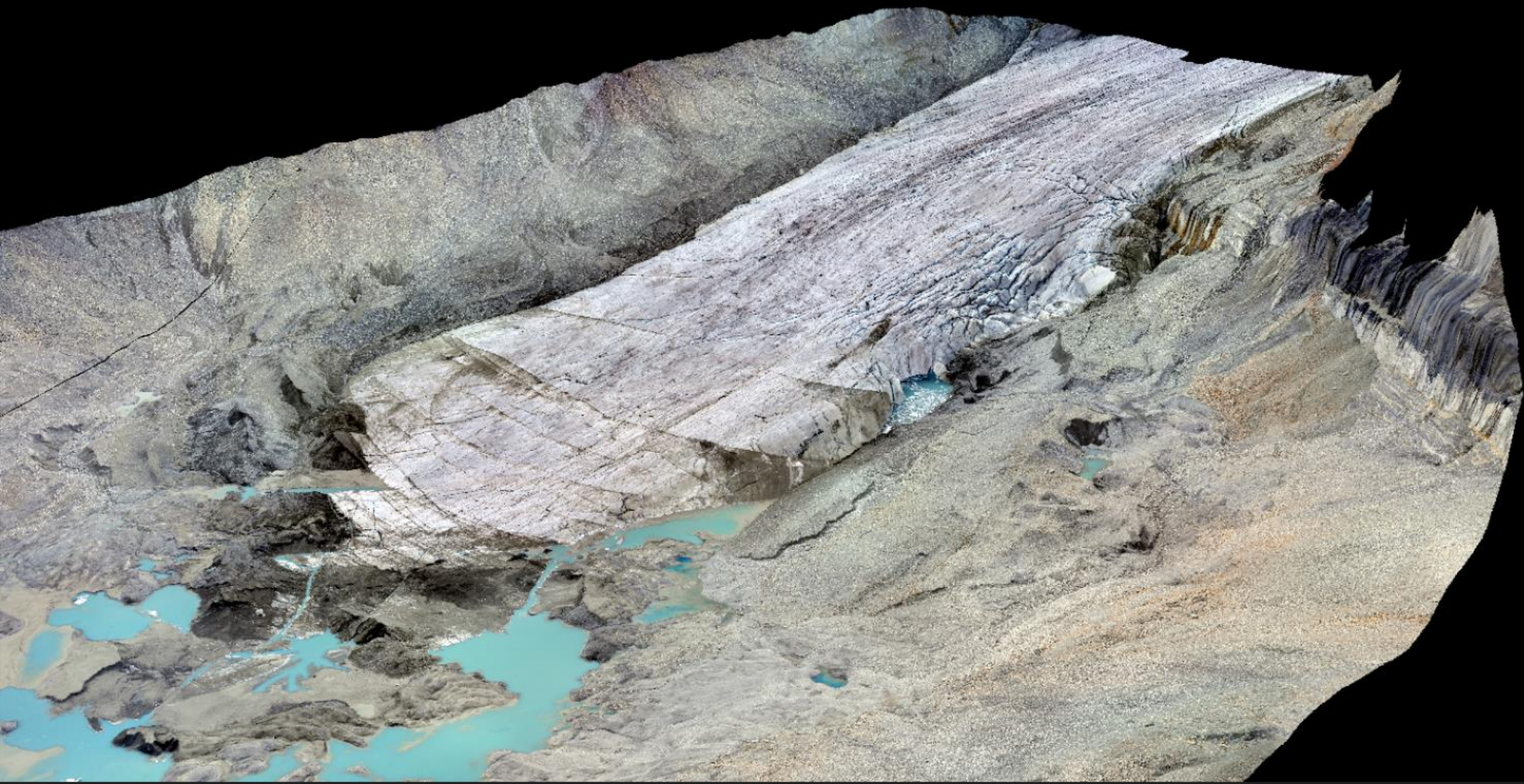
Year	2016	2017	2018	2019	2020	<b>2021</b>
mean	196	223	184	175	166	<b>197</b>
median	53	54	44	48	42	<b>58</b>
Max	1081	1148	1097	1030	1117	<b>1108</b>

**Shortwave irradiance (W/m<sup>2</sup>) to Peyto Glacier**

May 1<sup>st</sup> to September 15<sup>th</sup> Lower Ice Station (snout)

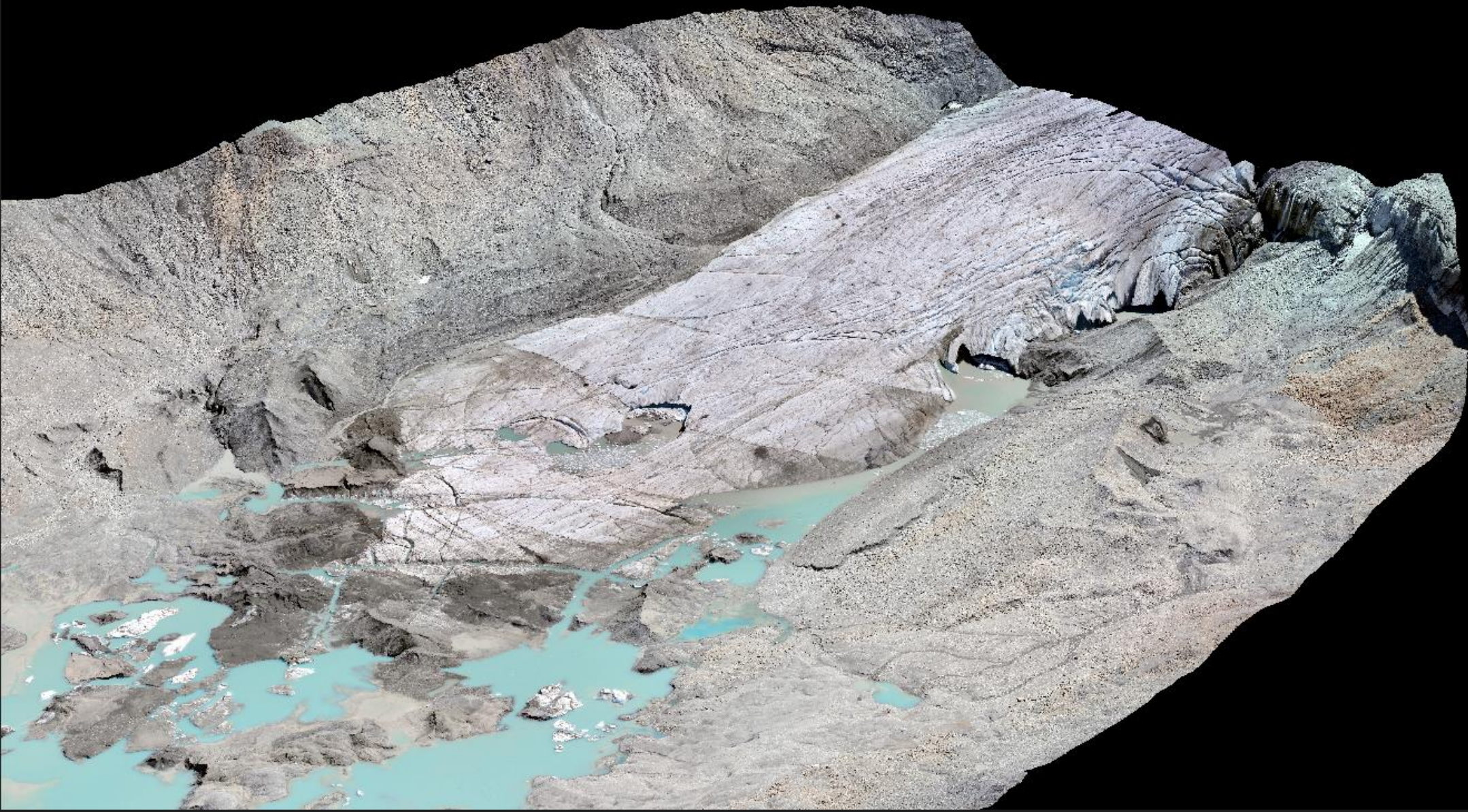


August 27, 2019



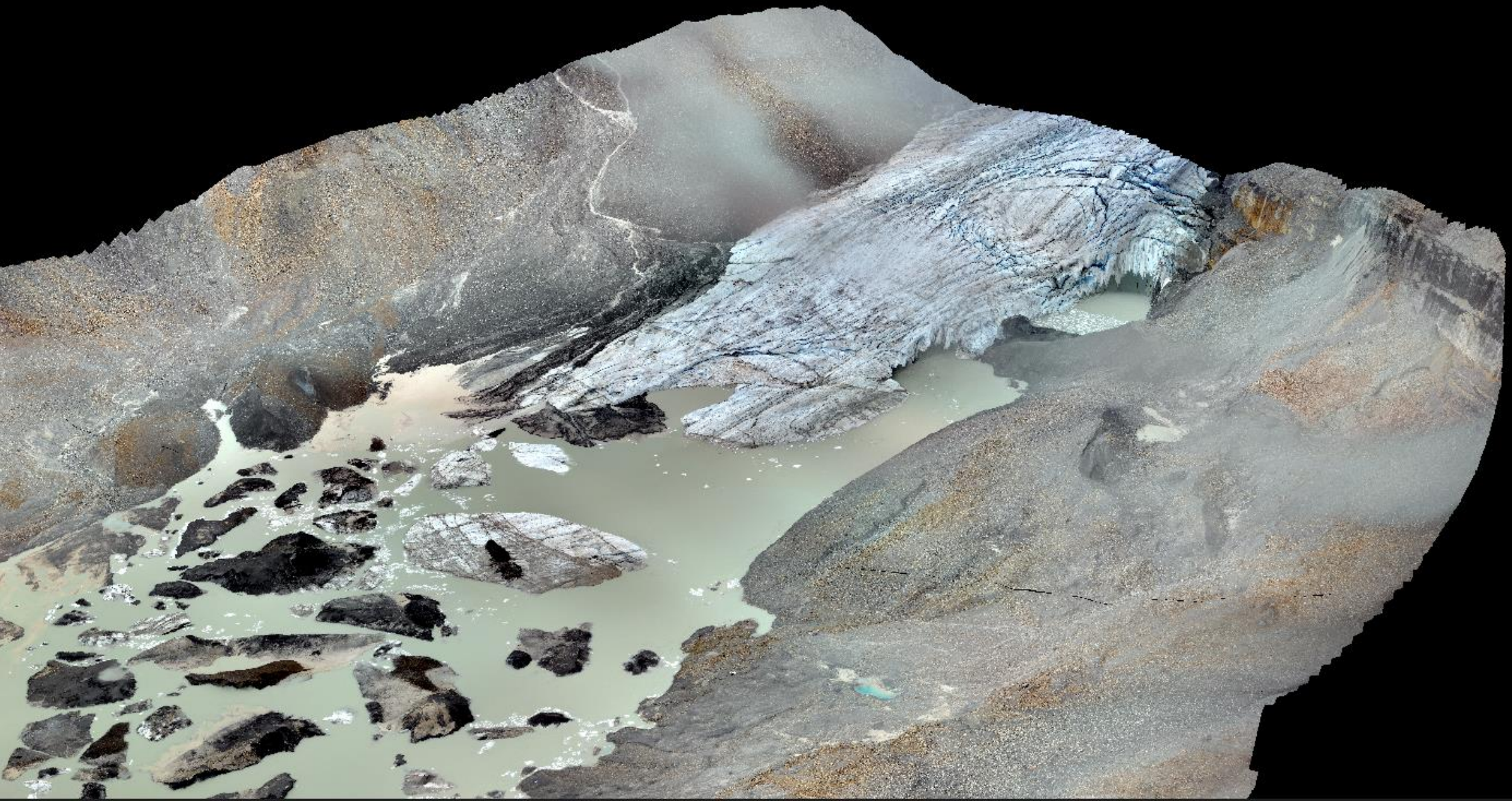


August 25, 2020



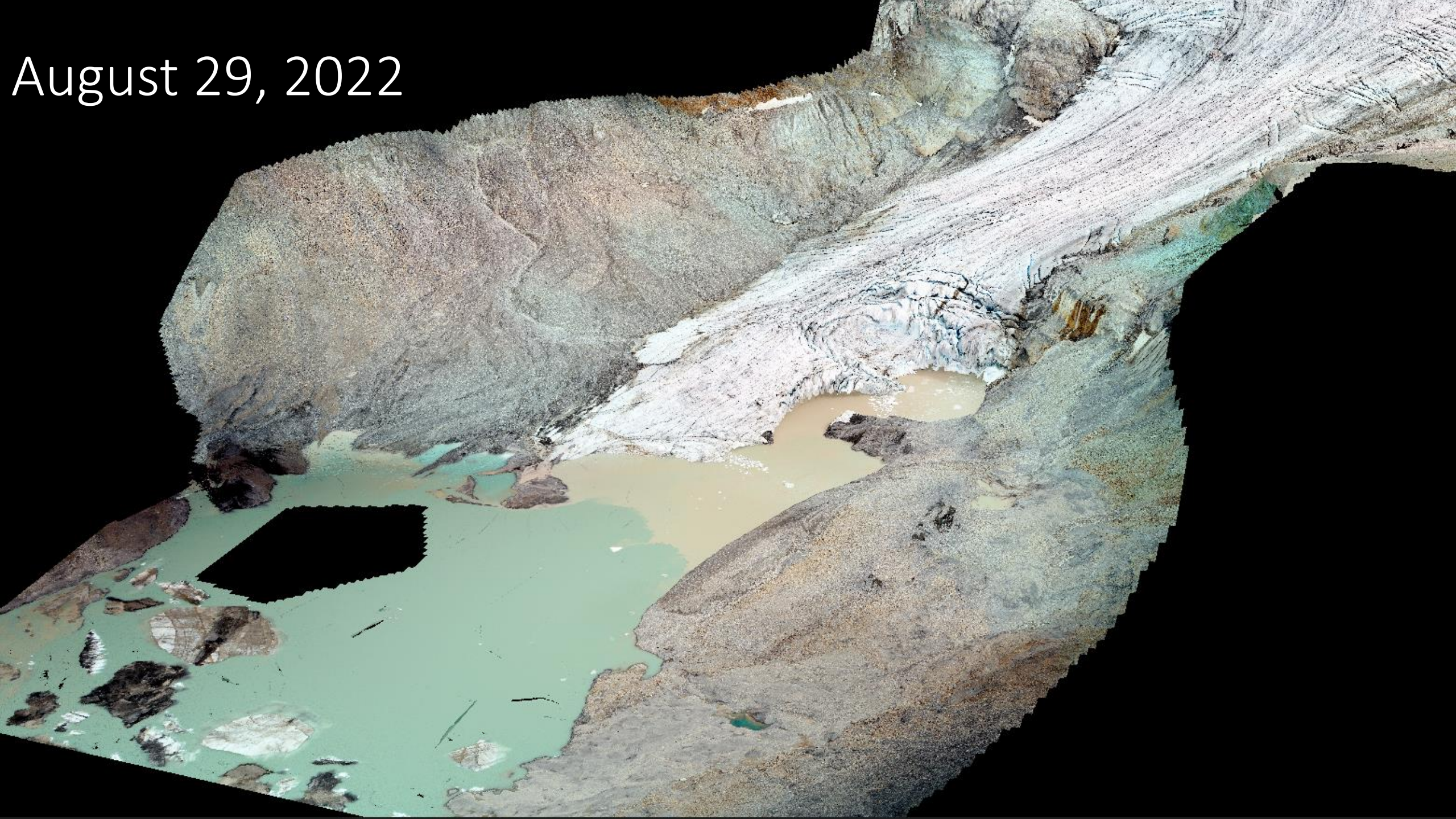


August 19, 2021

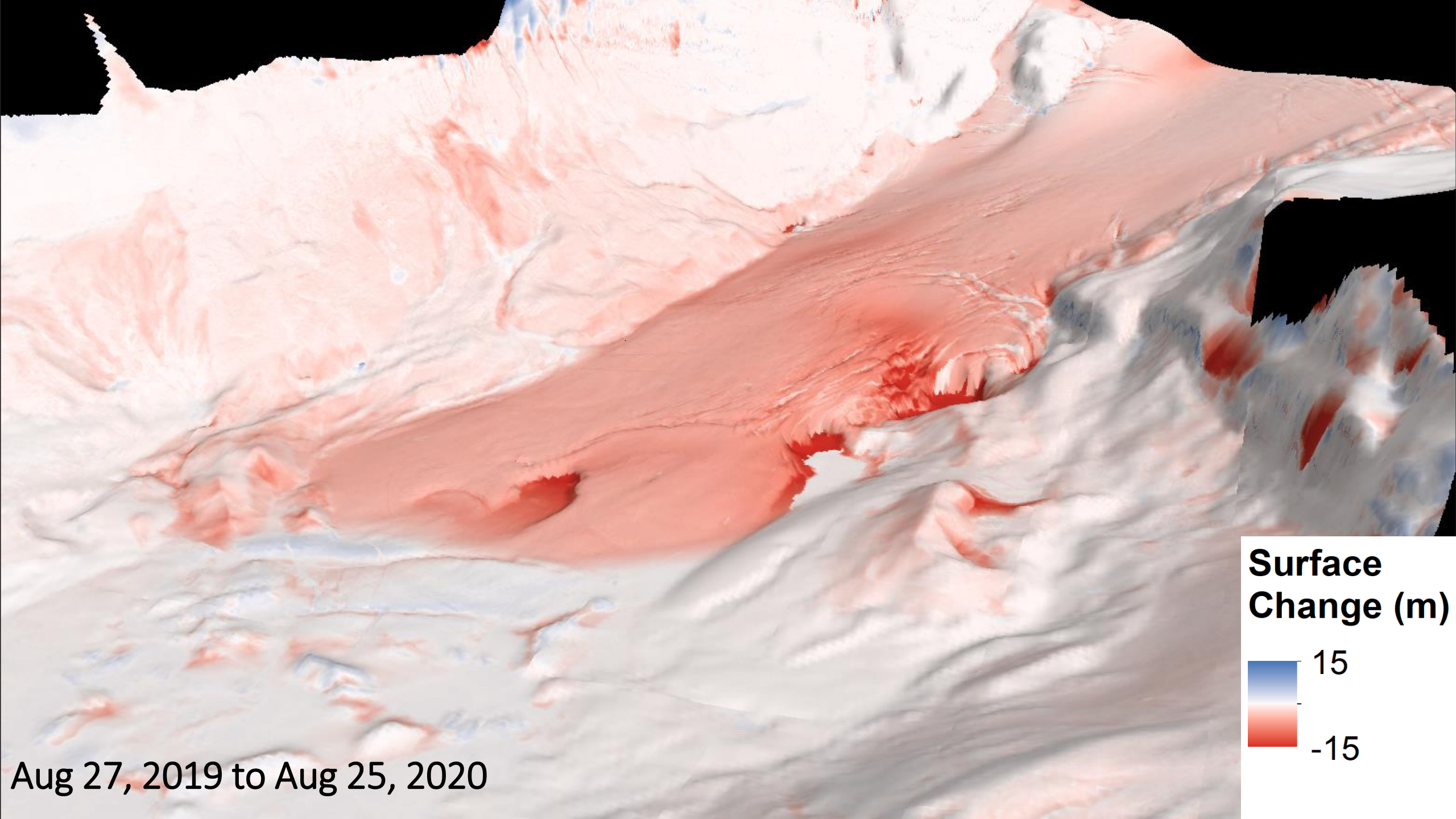




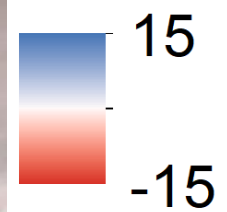
August 29, 2022





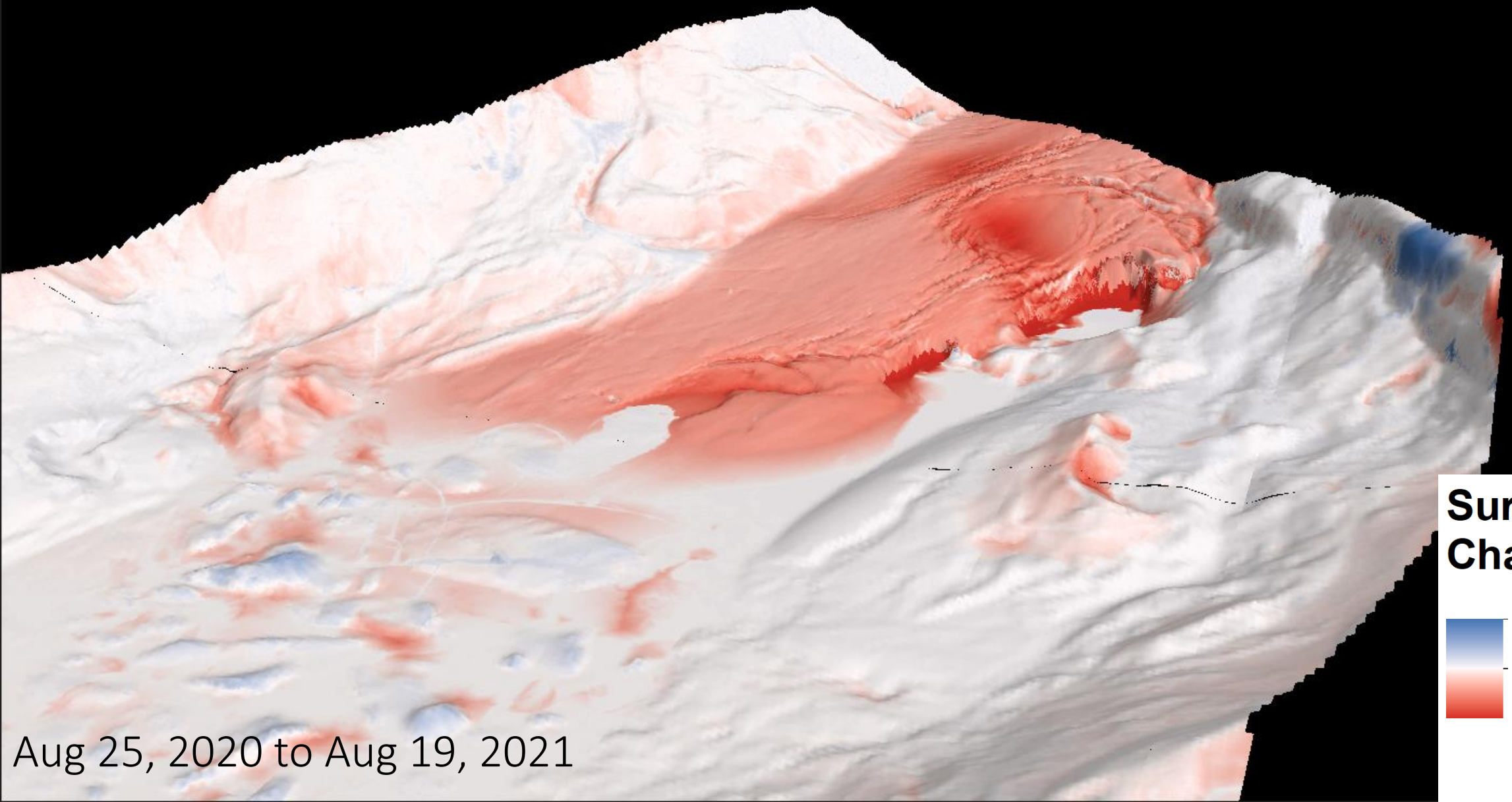


**Surface  
Change (m)**

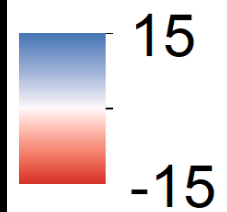


Aug 27, 2019 to Aug 25, 2020



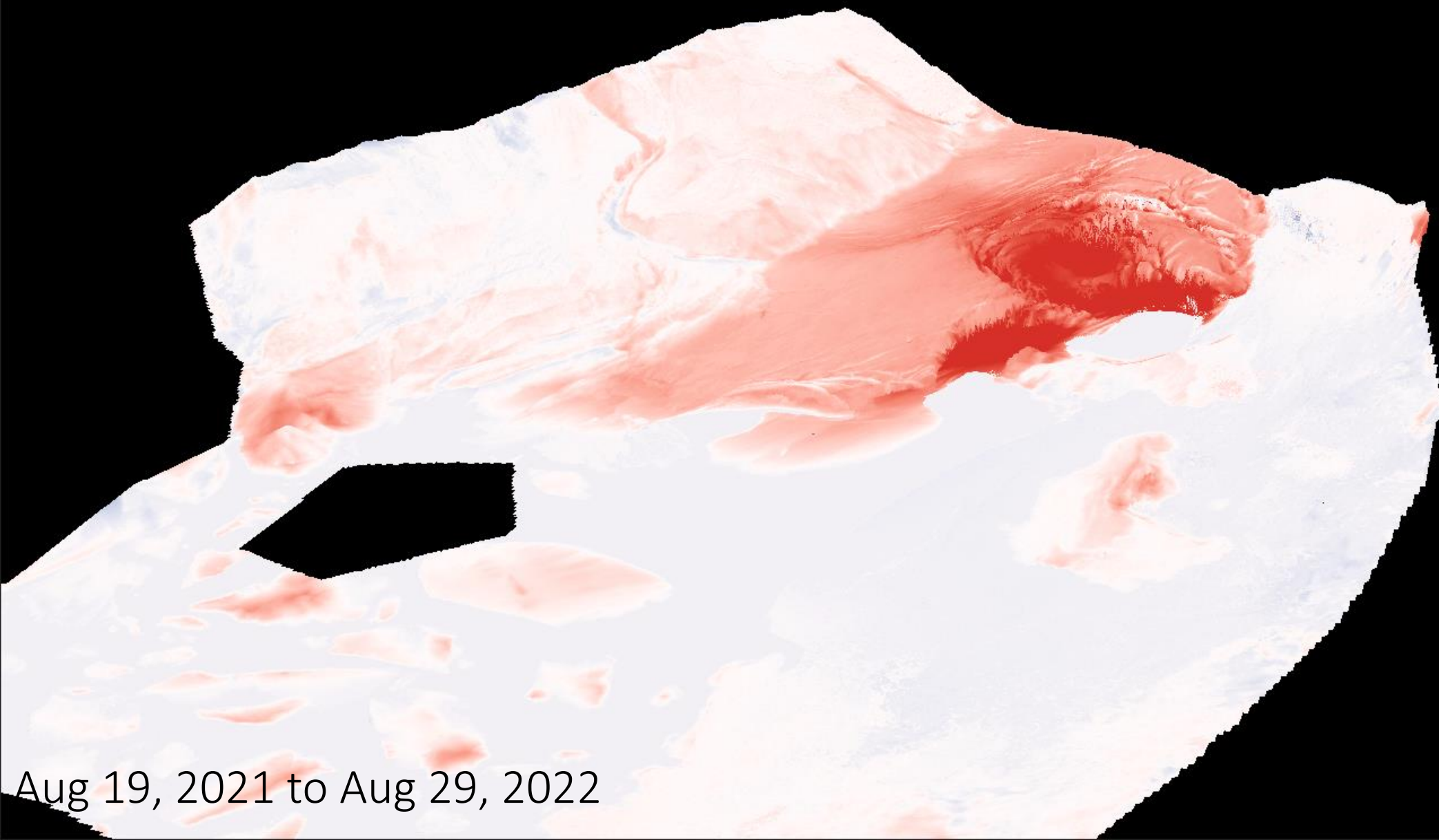


**Surface  
Change (m)**

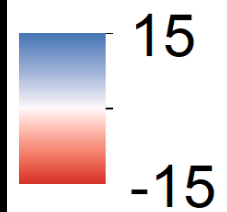


Aug 25, 2020 to Aug 19, 2021



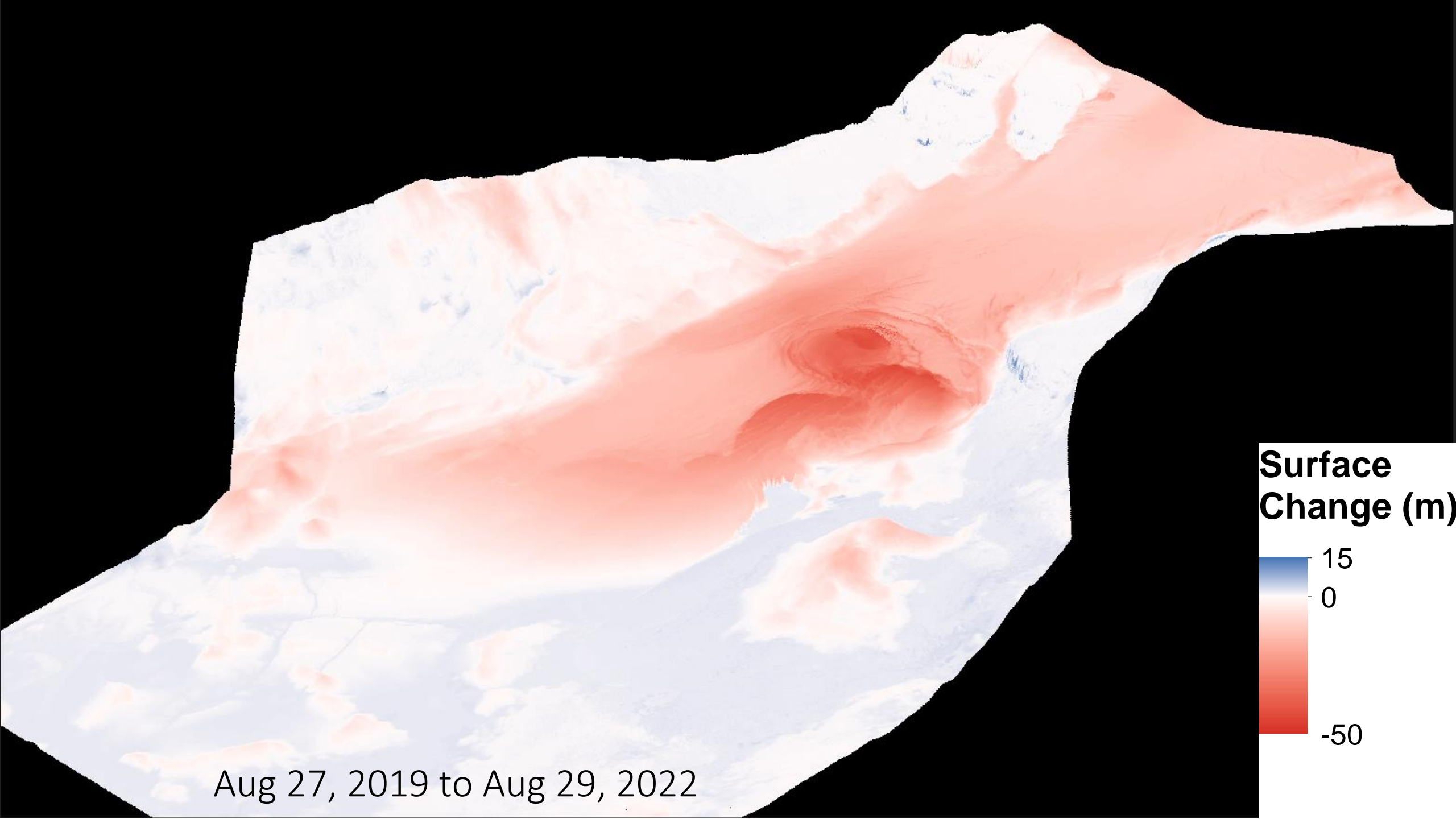


**Surface  
Change (m)**

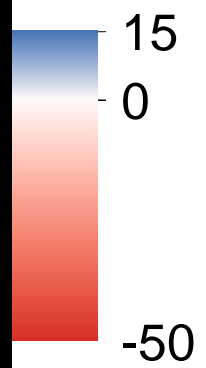


Aug 19, 2021 to Aug 29, 2022





**Surface  
Change (m)**



Aug 27, 2019 to Aug 29, 2022



# Peyto Glacier Retreat – 2019-2022



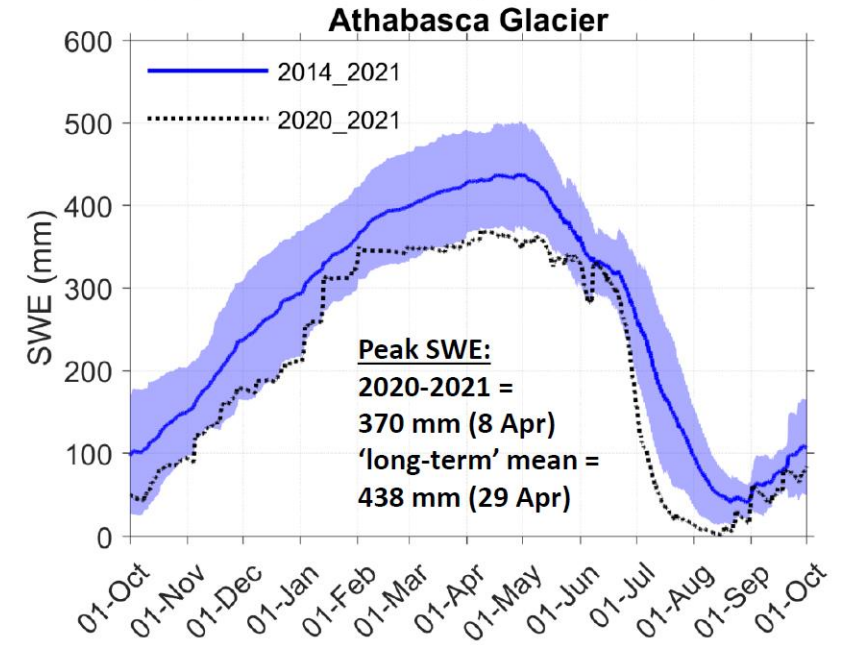
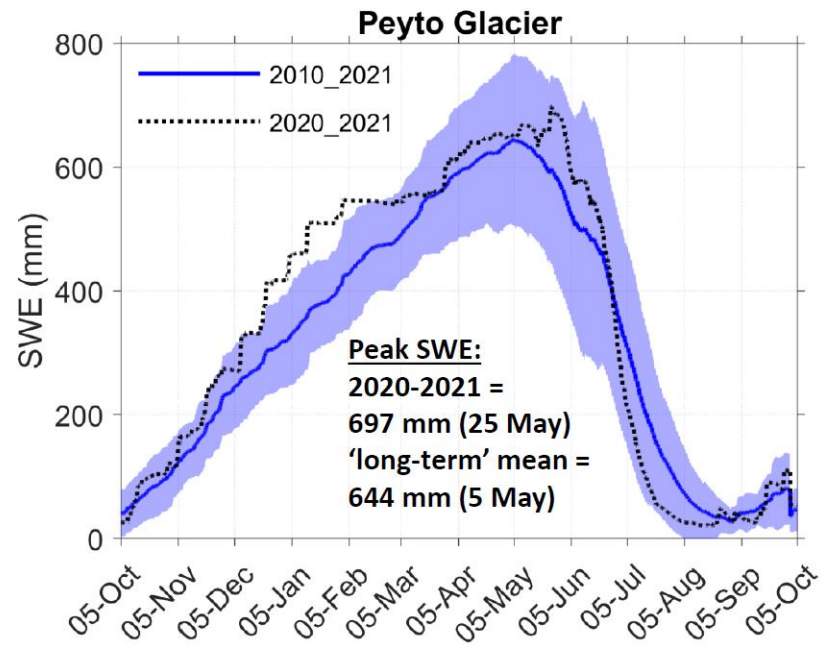
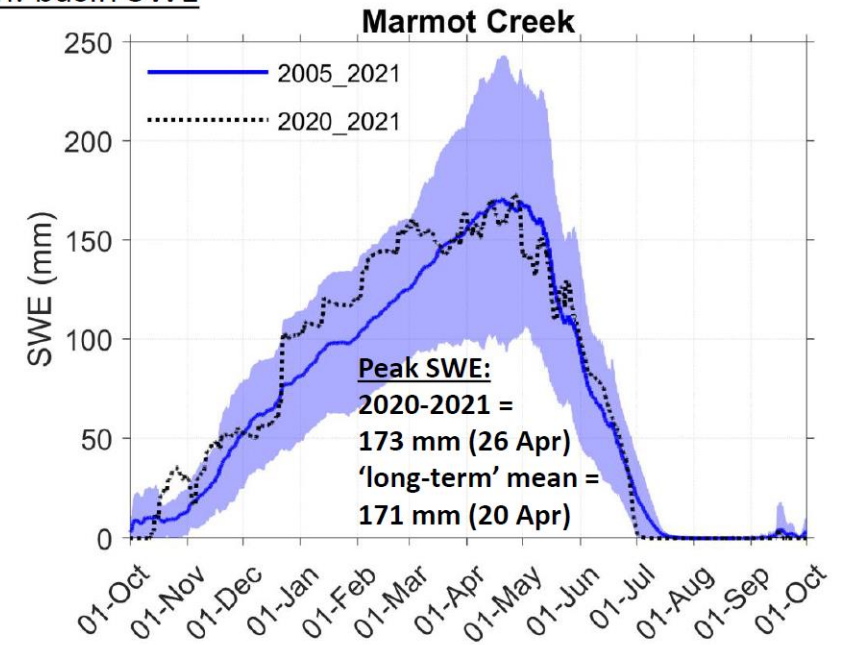
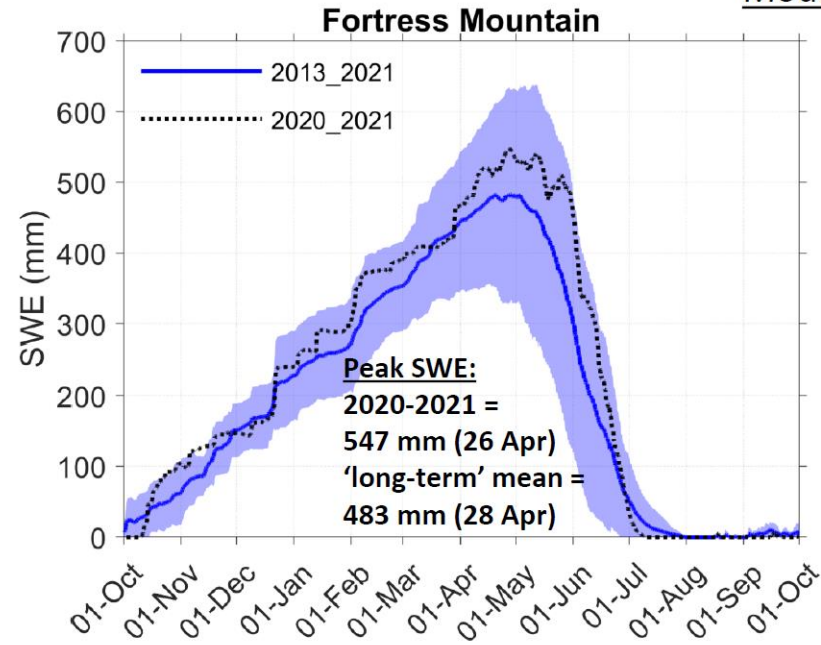
329 m retreat  
2019-2022

M. Harasyn, P Harder  
Centre for Hydrology



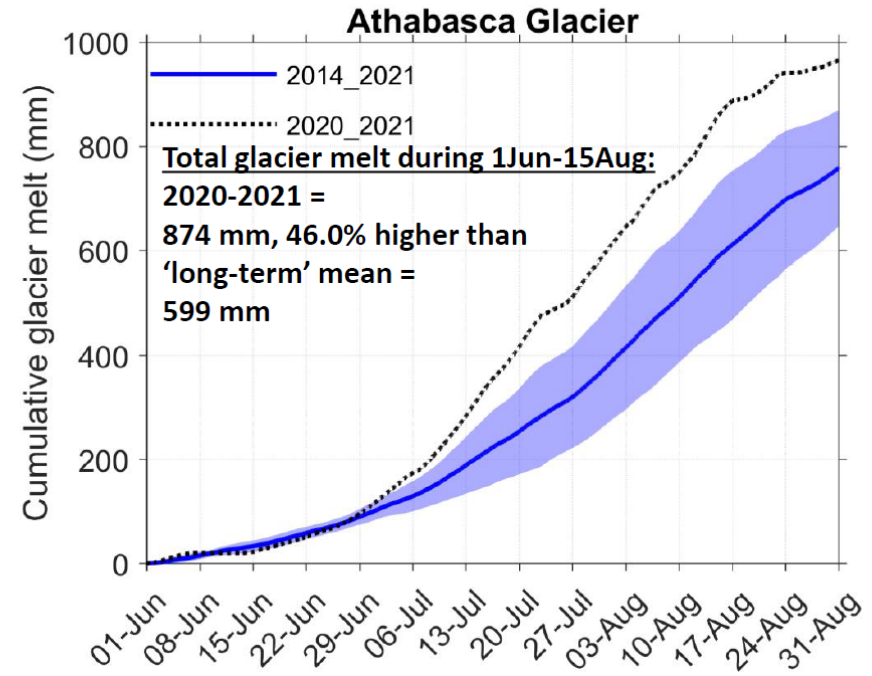
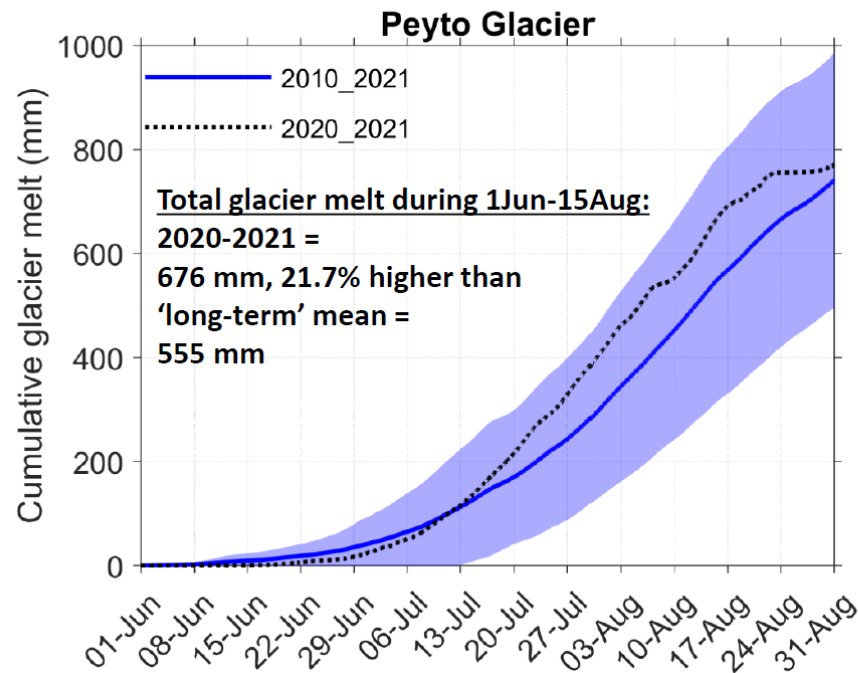
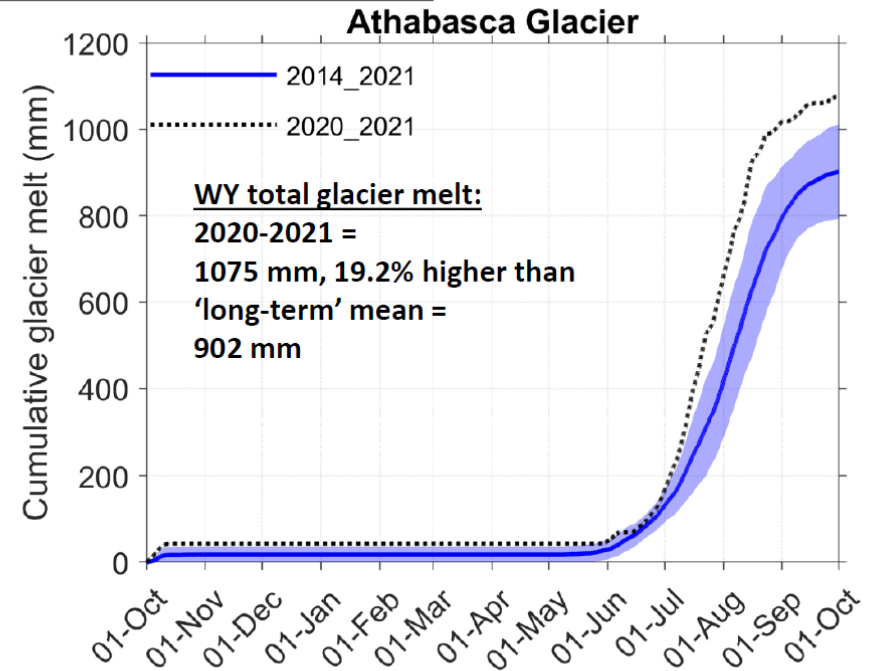
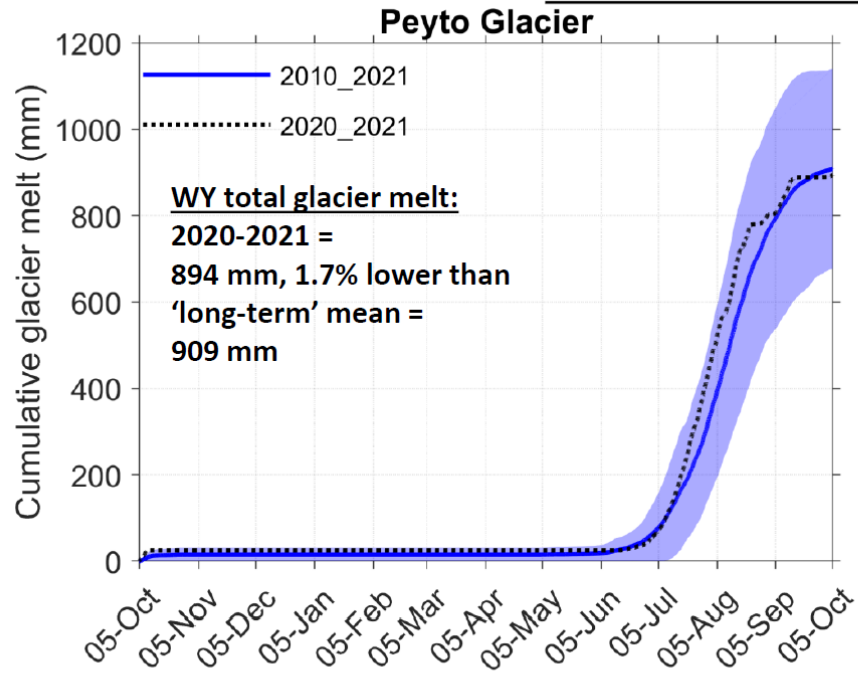
Cold Regions  
Hydrological Model  
(CRHM) Diagnosis of the  
2021 Heatwave Impact  
on CRHO Basin  
Hydrology

Model simulation: basin SWE



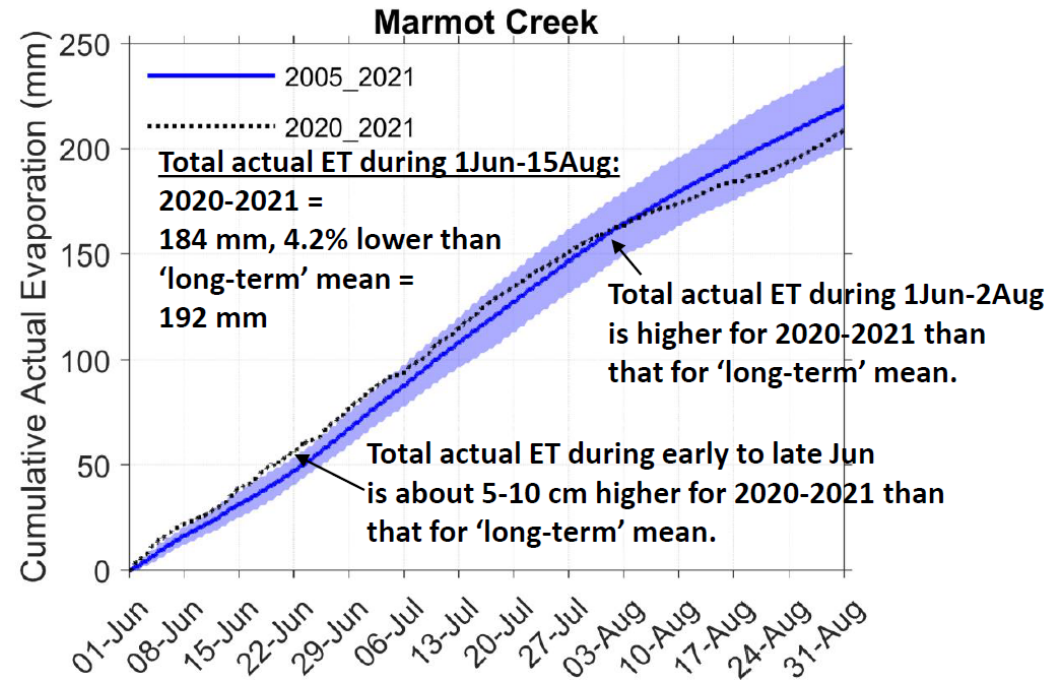
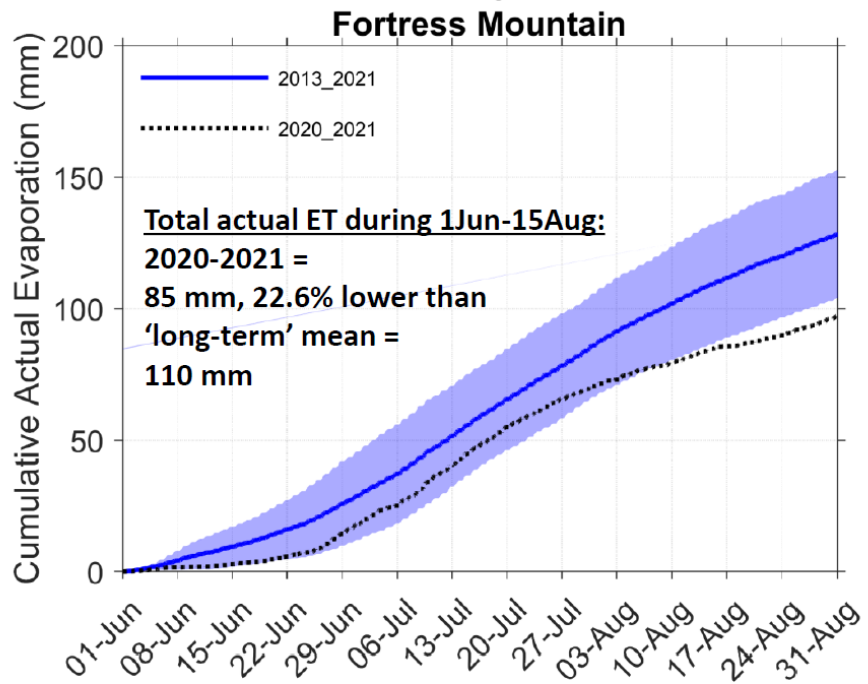
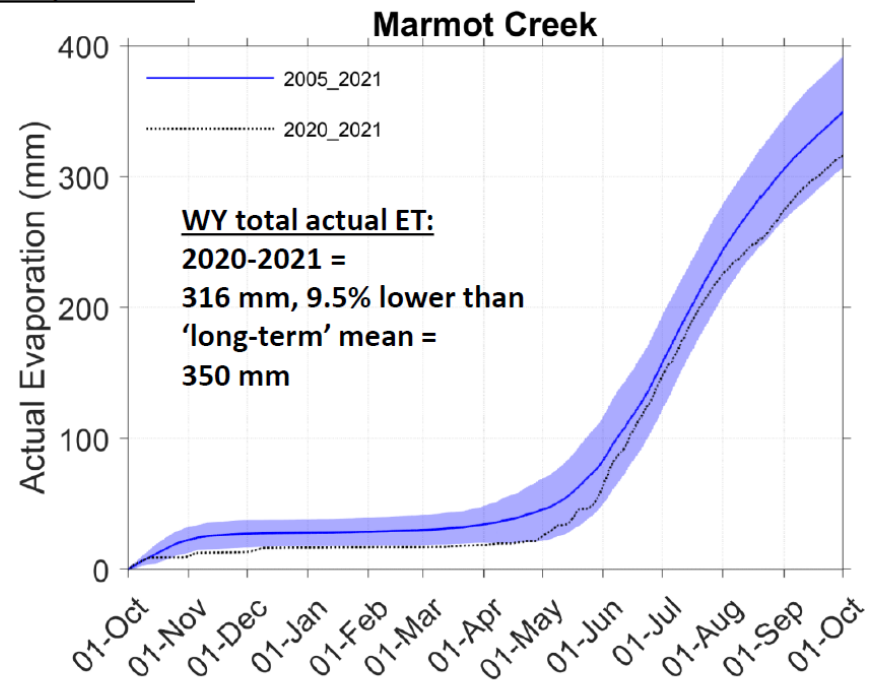
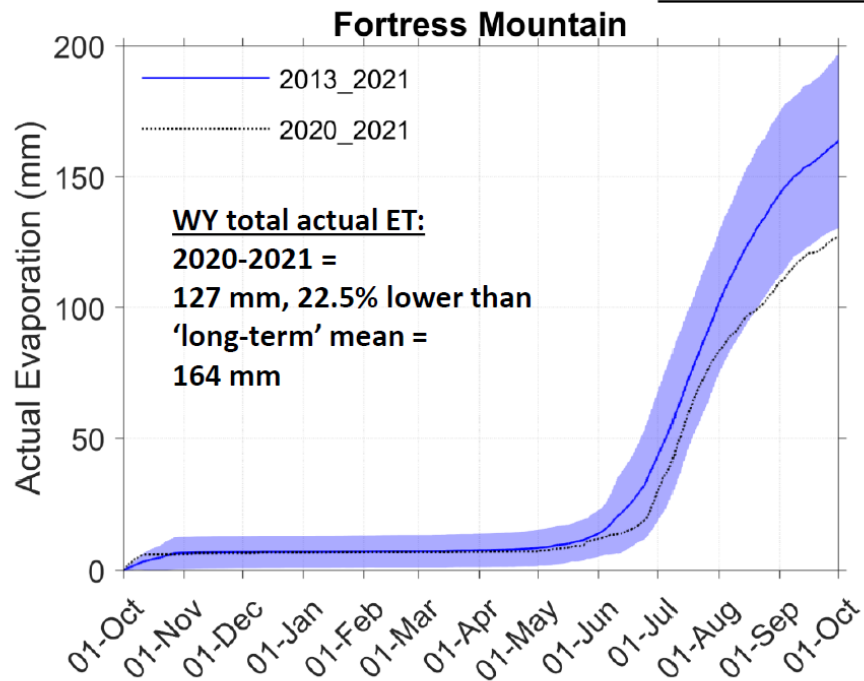


Model simulation: basin total glacier melt from firn and ice



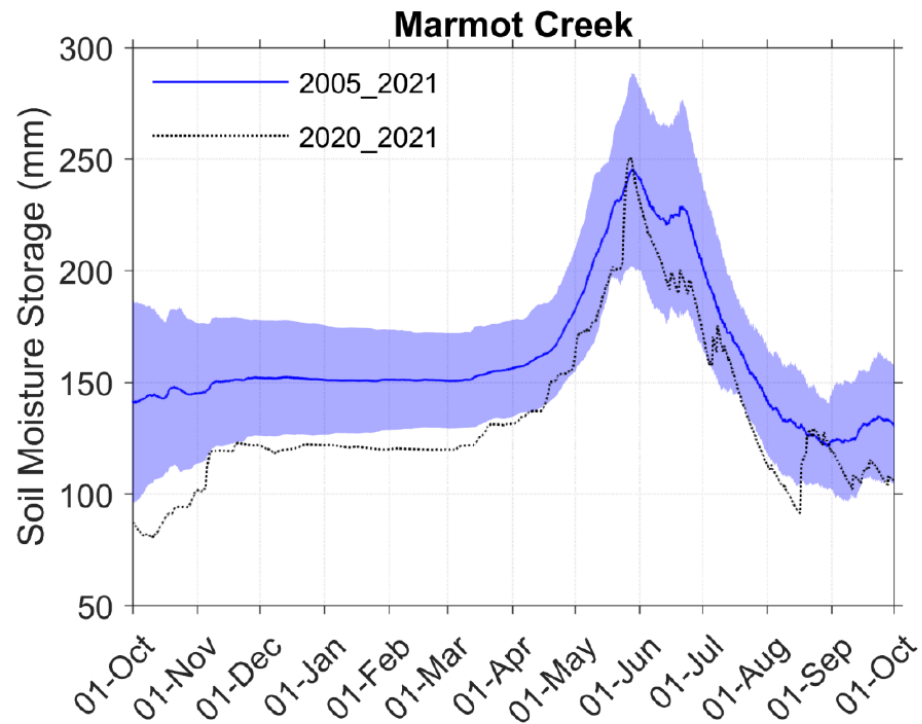
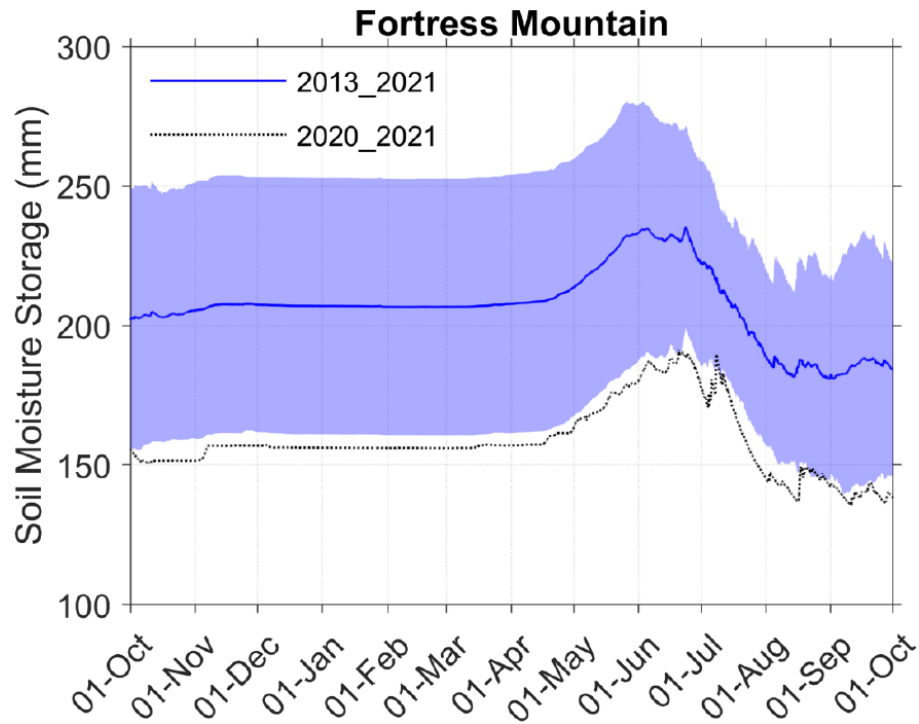


Model simulation: basin evaporation





## Model simulation: basin soil moisture storage



#### Fortress: WY soil moisture storage (mm)

WY	2020-21	long-term
mean	158	207
max	191	235
min	136	181

**The WY mean Fortress basin soil moisture storage is 23% lower in 2020-2021 than 'long-term' mean.**

#### Fortress: Soil moisture storage during 1Jun-15Aug (mm)

1Jun-15Aug	2020-21	long-term
mean	169	212
max	191	235
min	137	182

**The mean Fortress basin soil moisture storage during 1Jun-15Aug is 20% lower in 2020-2021 than 'long-term' mean.**

#### Marmot: WY soil moisture storage (mm)

WY	2020-21	long-term
mean	134	161
max	251	245
min	80	121

**The WY mean Marmot basin soil moisture storage is 18% lower in 2020-2021 than 'long-term' mean.**

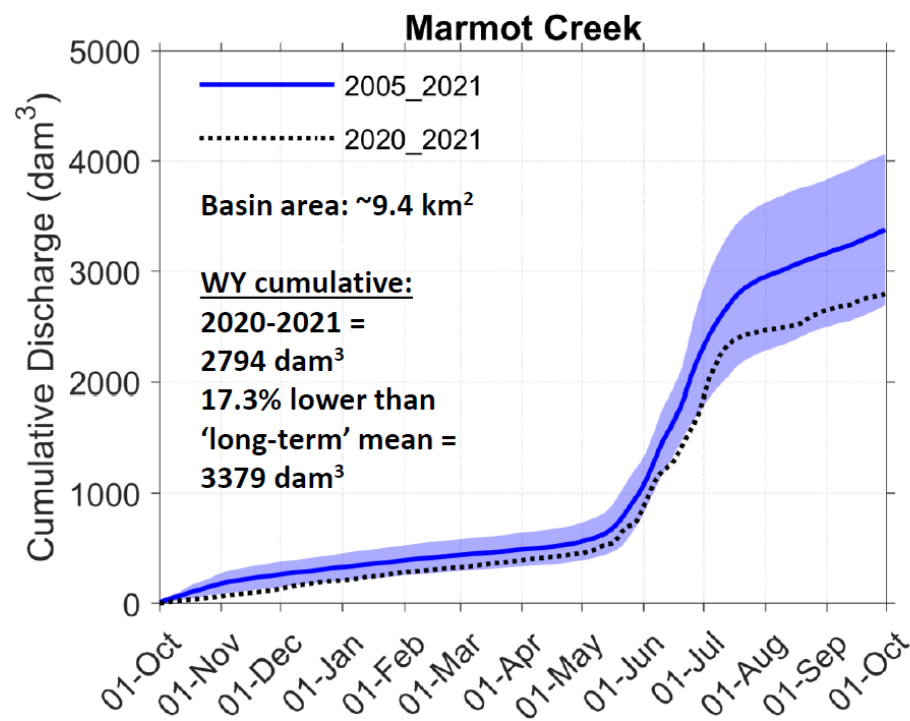
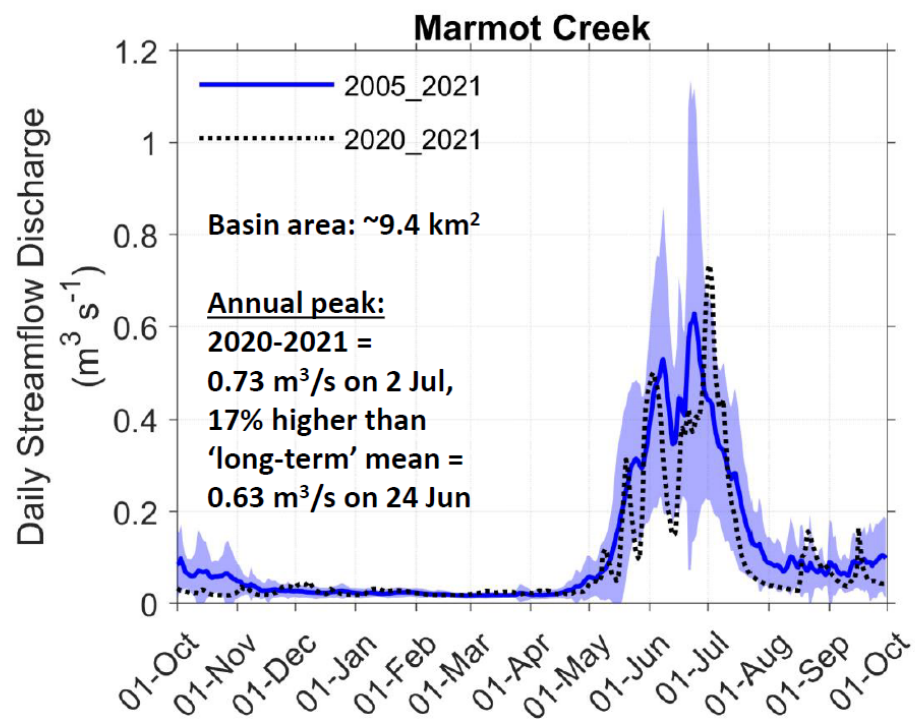
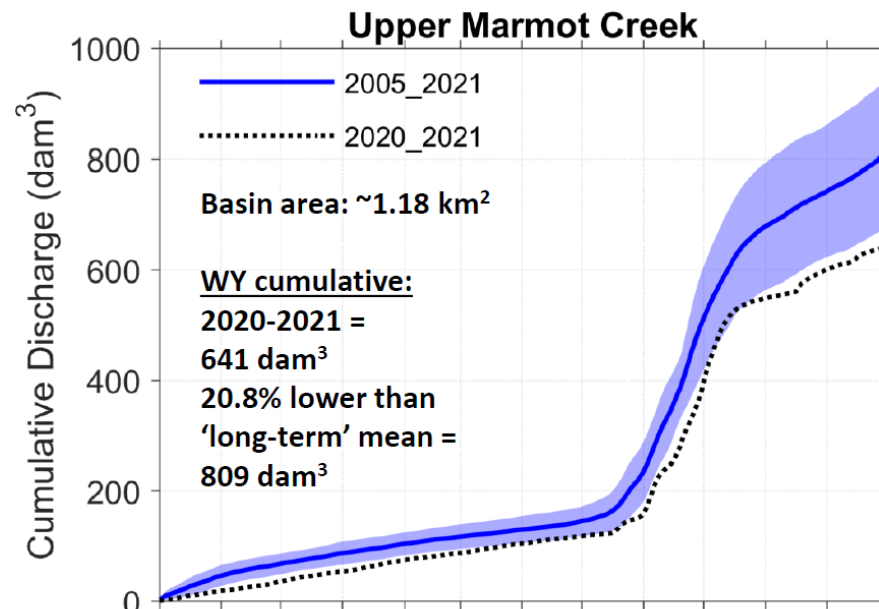
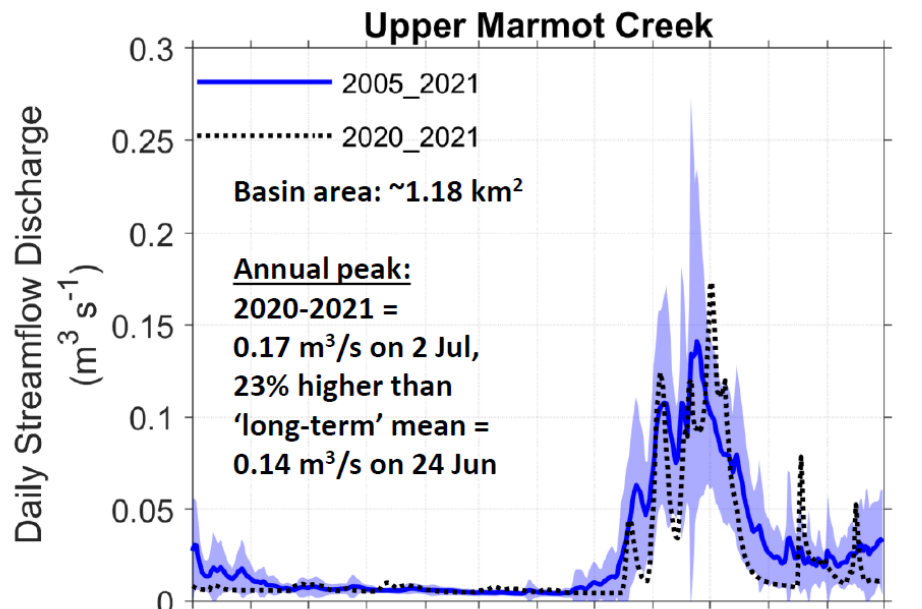
#### Marmot: Soil moisture storage during 1Jun-15Aug (mm)

1Jun-15Aug	2020-21	long-term
mean	160	184
max	230	241
min	92	129

**The mean Marmot basin soil moisture storage during 1Jun-15Aug is 14% lower in 2020-2021 than 'long-term' mean.**

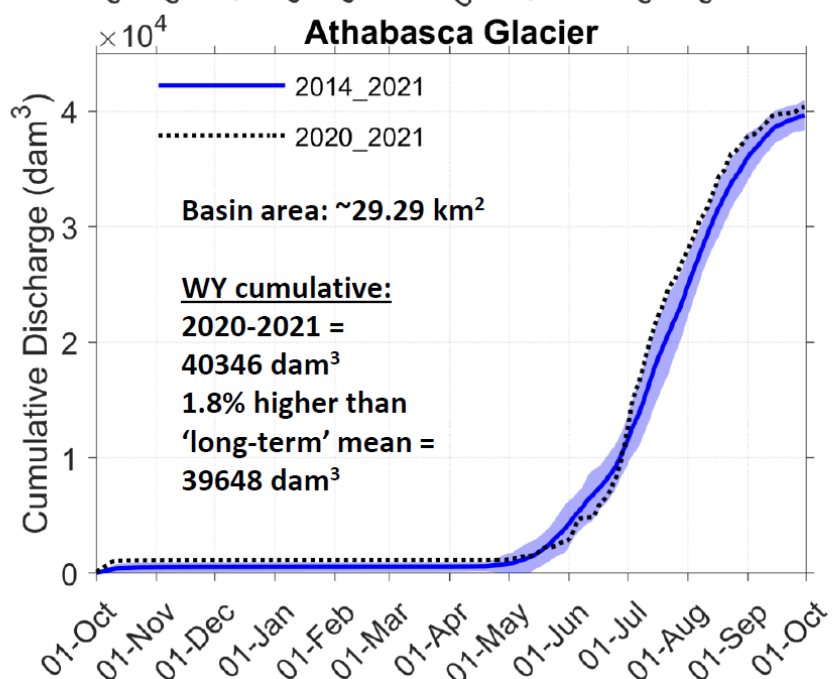
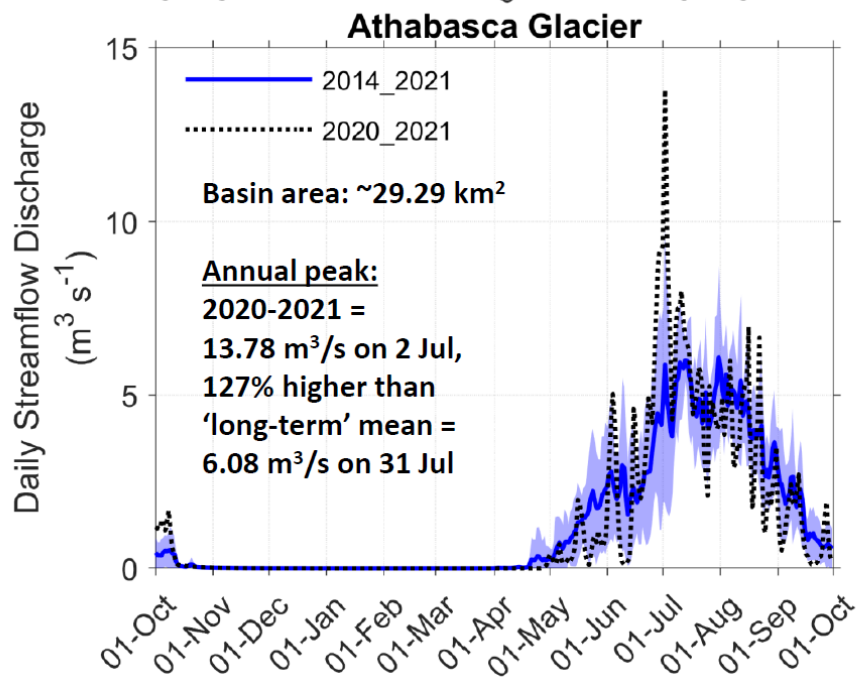
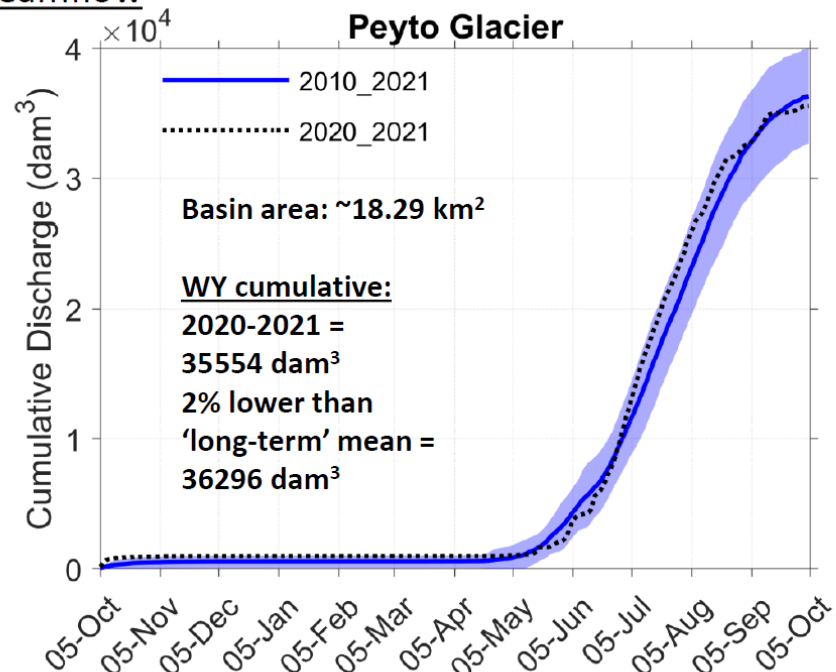
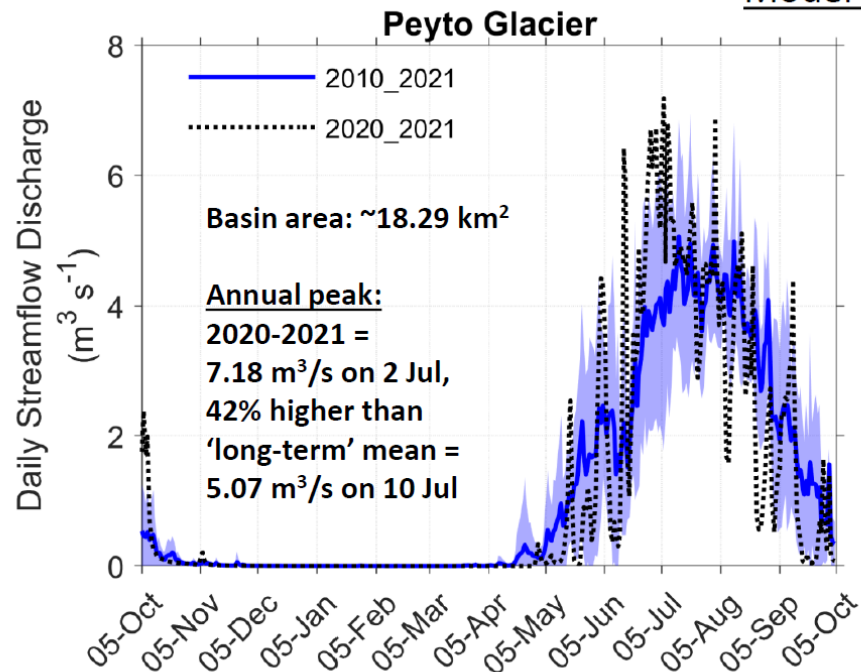


Model simulation: streamflow





Model simulation: streamflow

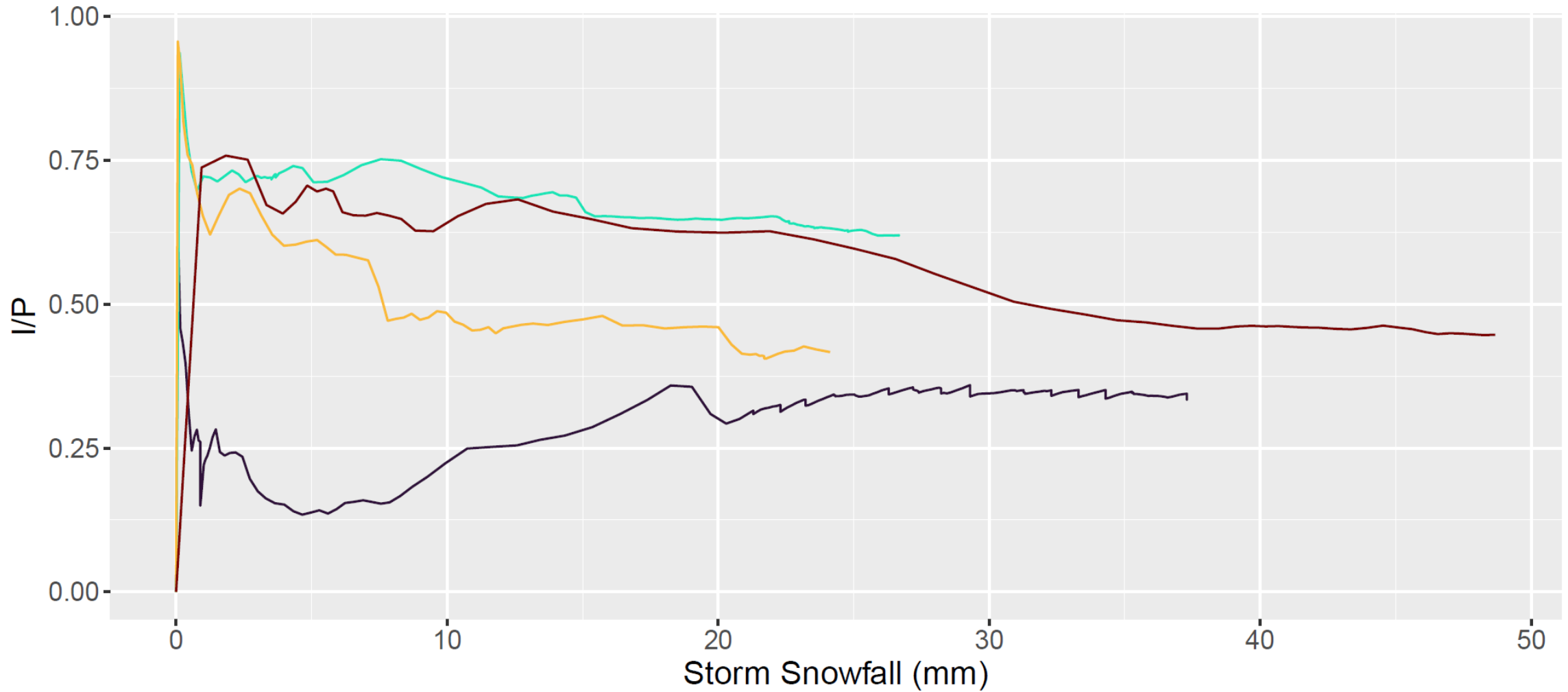








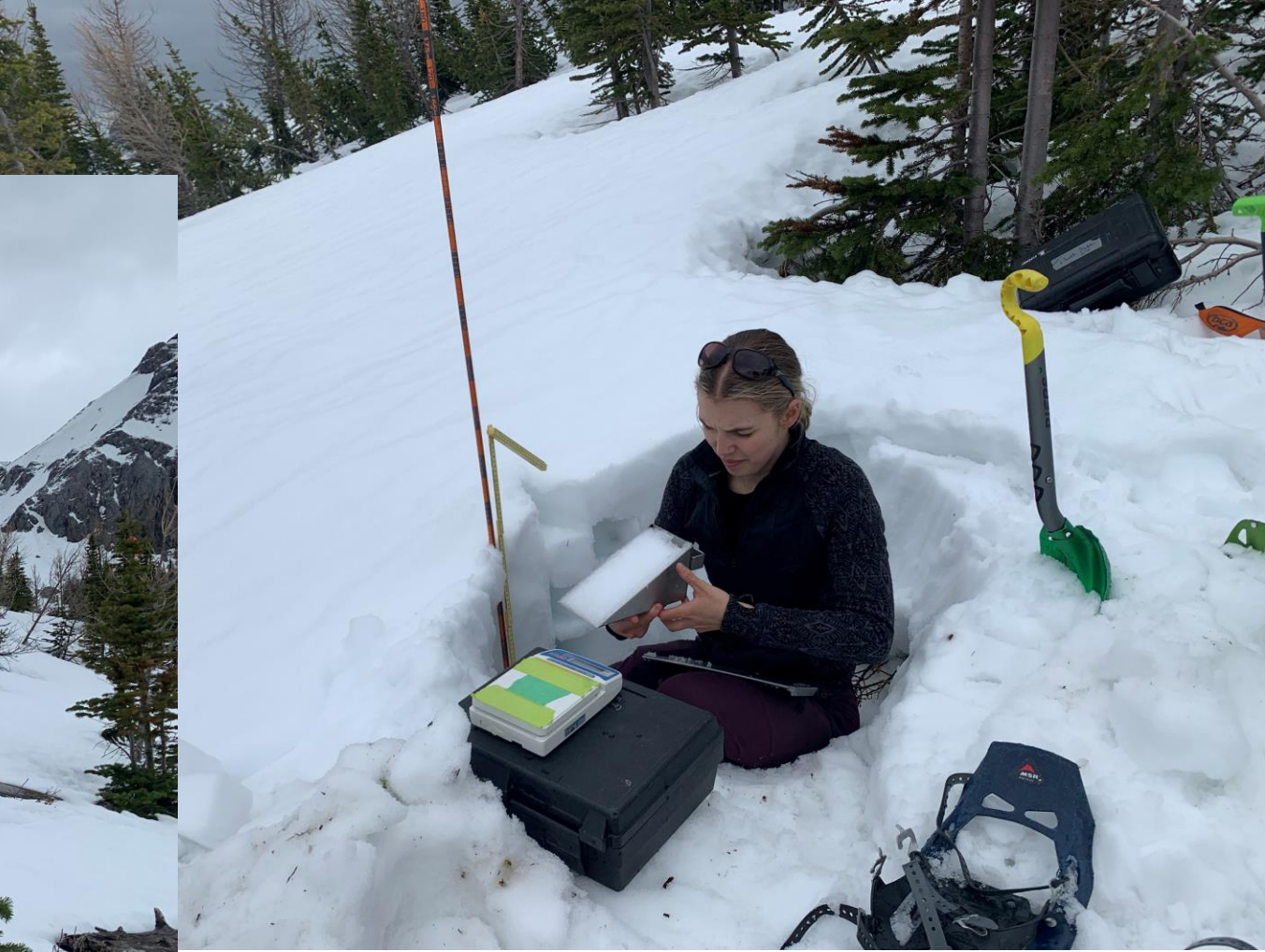
# Canopy Interception Efficiency Observations



— 2021-12-23 — 2022-04-18 — 2022-05-19 — 2022-06-13



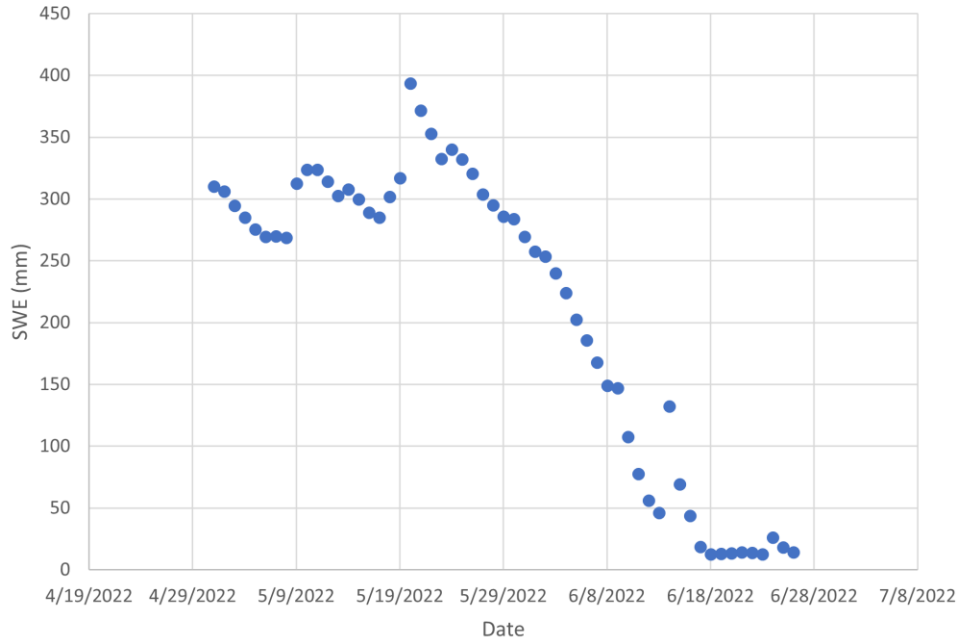
# Snowmelt Infiltration to Frozen Soils - Hillslopes



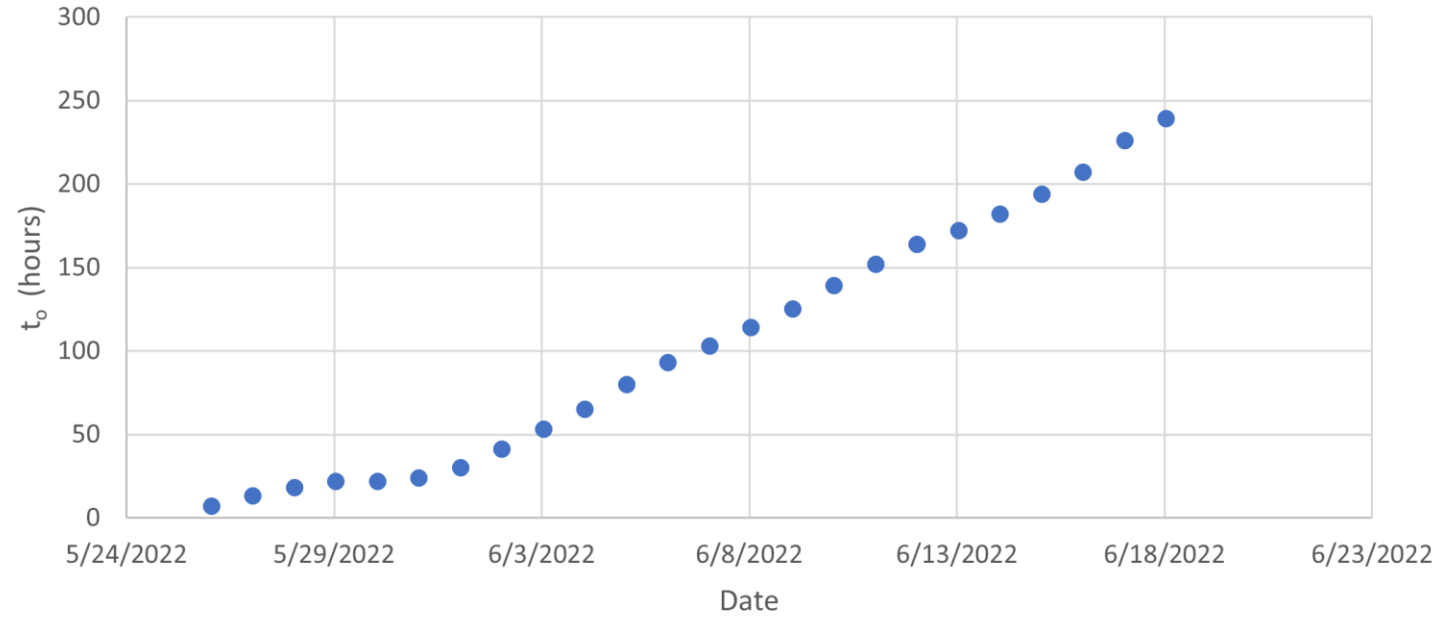


# From SWE to Infiltration Opportunity Time, $t_o$

Daily SWE at Fortress - CRN Station



CRN at Fortress Cummulative  $t_o$





# Data Publications

- Fang X., Pomeroy J.W., DeBeer C.M., Harder P. and Siemens E., (2019), Hydrometeorological data from Marmot Creek Research Basin, Canadian Rockies., Earth System Science Data, 11 , 455:471, doi: 10.5194/essd-11-455-2019
- Pradhananga D., Pomeroy J.W., Aubry-Wake C., Munro S., Shea J., Demuth M.N., Kirat N.H., Menounos B. and Mukherjee K., (2021), Hydrometeorological, glaciological and geospatial research data from the Peyto Glacier Research Basin in the Canadian Rockies., Earth System Science Data, 13 , 2875:2894, doi: 10.5194/essd-13-2875-202
- Rasouli K., Pomeroy J.W., Janowicz J.R., Williams, T.J. and Carey S.K. , (2019), A long-term hydrometeorological dataset (1993-2014) of a northern mountain basin: Wolf Creek Research Basin, Yukon Territory, Canada., Earth System Science Data, 11 , 89:100, doi: 10.5194/essd-11-89-2019

<https://research-groups.usask.ca/hydrology/data.php>