Leveraging stable water isotopes and synthetic aperture radar to assess the complex hydrology of snowfed agricultural lands in Southwestern Montana

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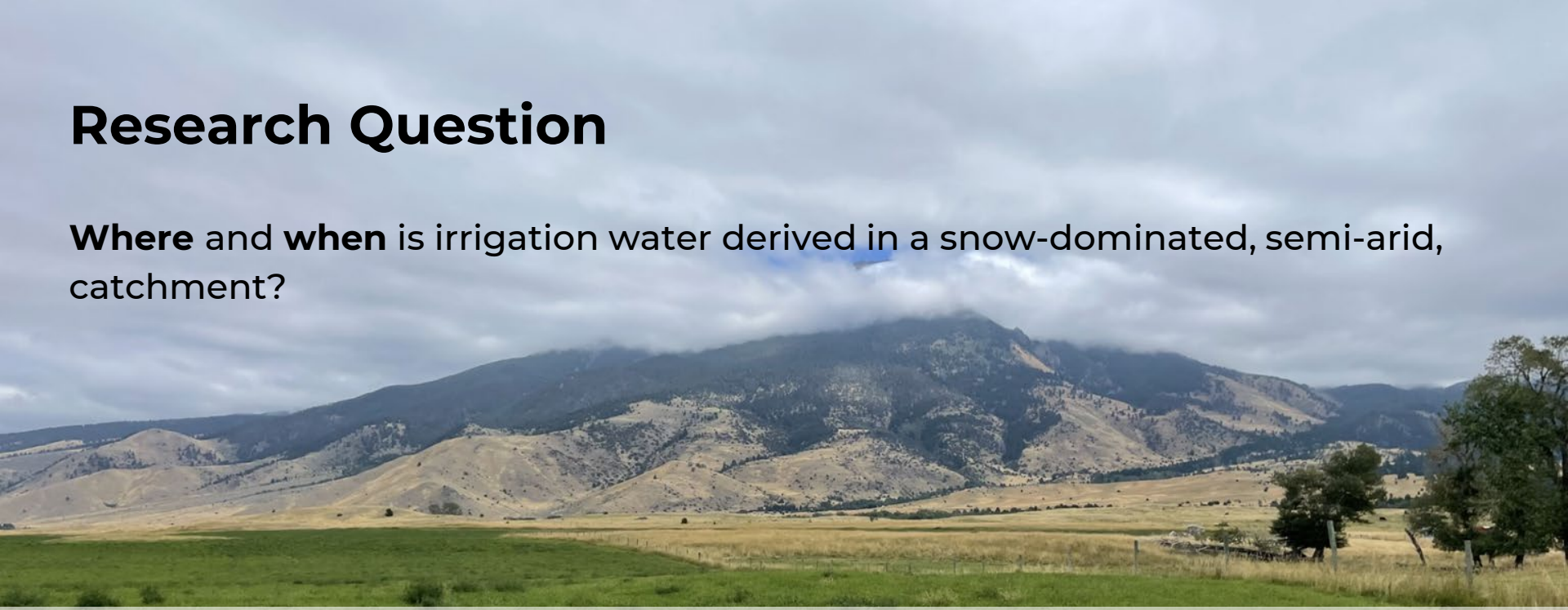
Research Question

Where and **when** is irrigation water derived in a snow-dominated, semi-arid, catchment?



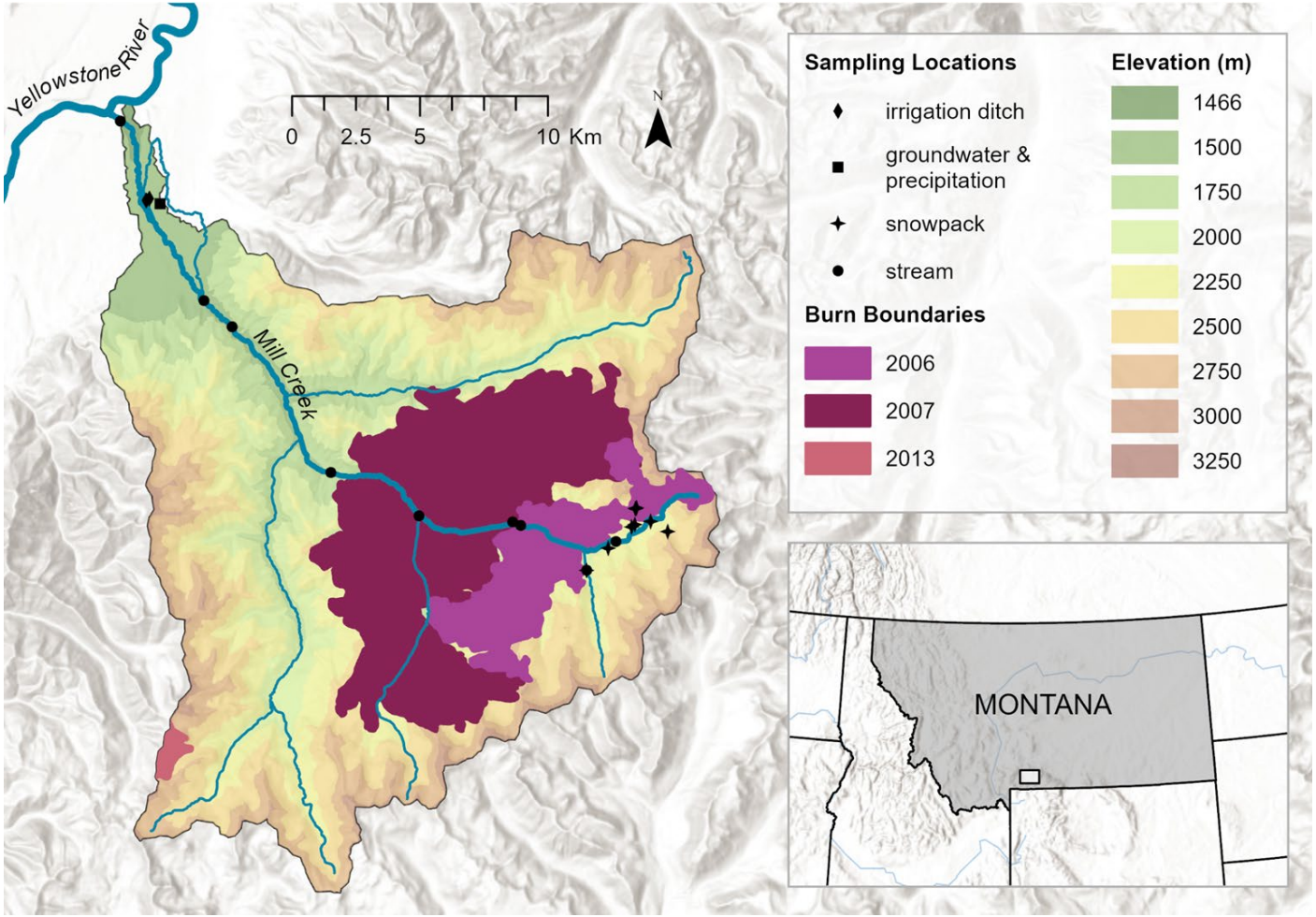
Where → Stable water isotopes

When → Synthetic Aperture Radar (SAR)

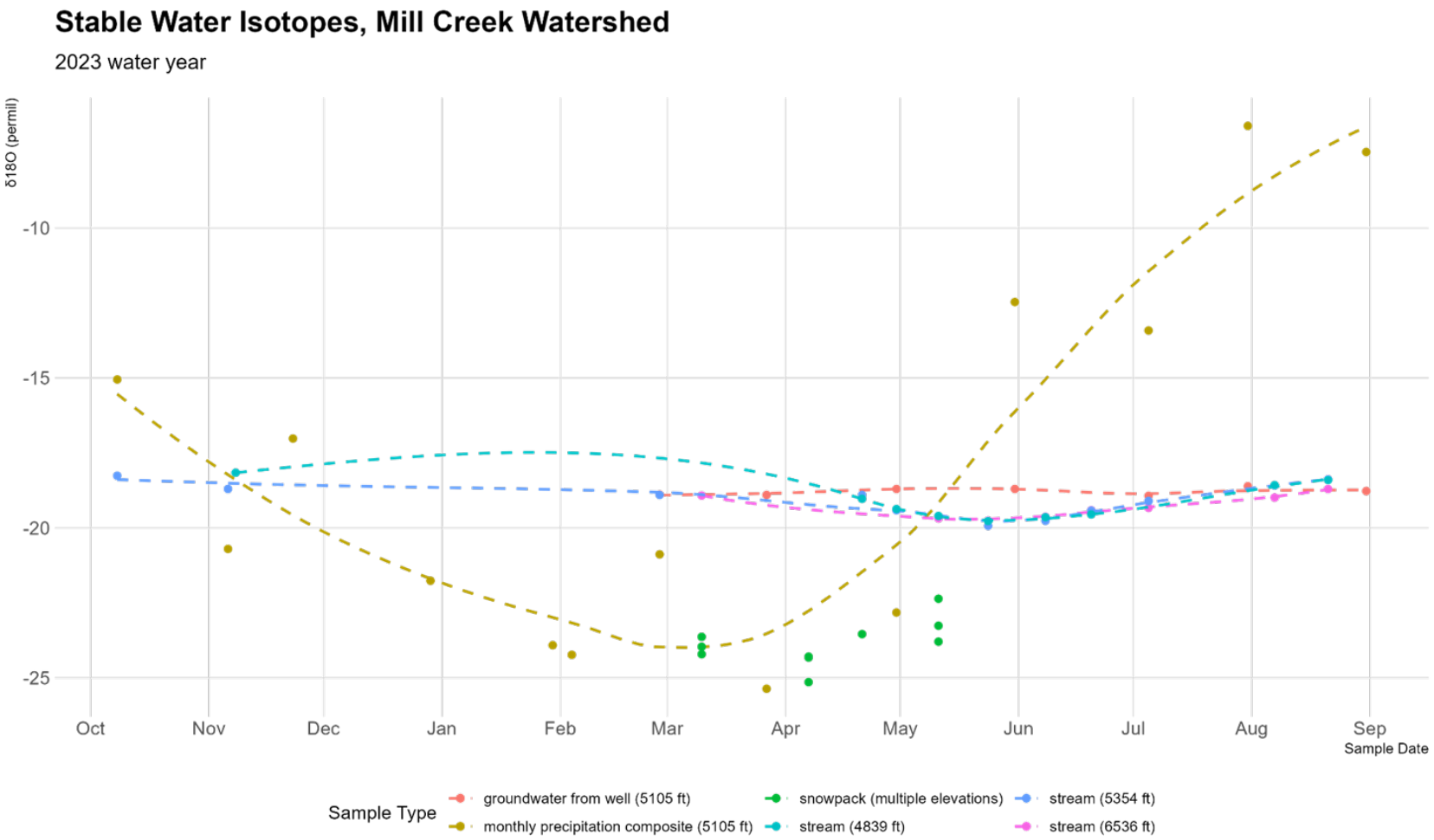
Research Site

Mill Creek,

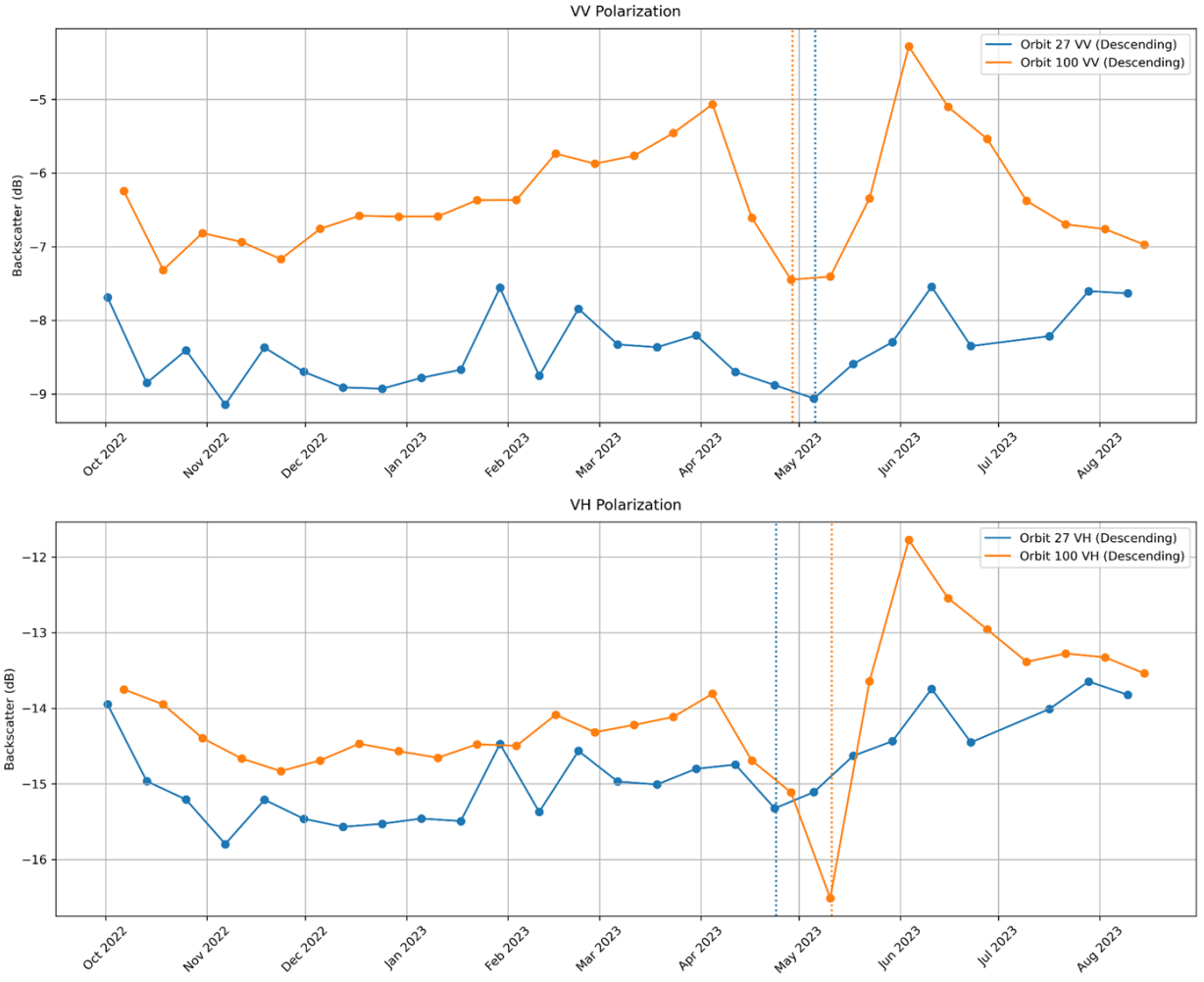
Paradise Valley, MT



Sampling Sites

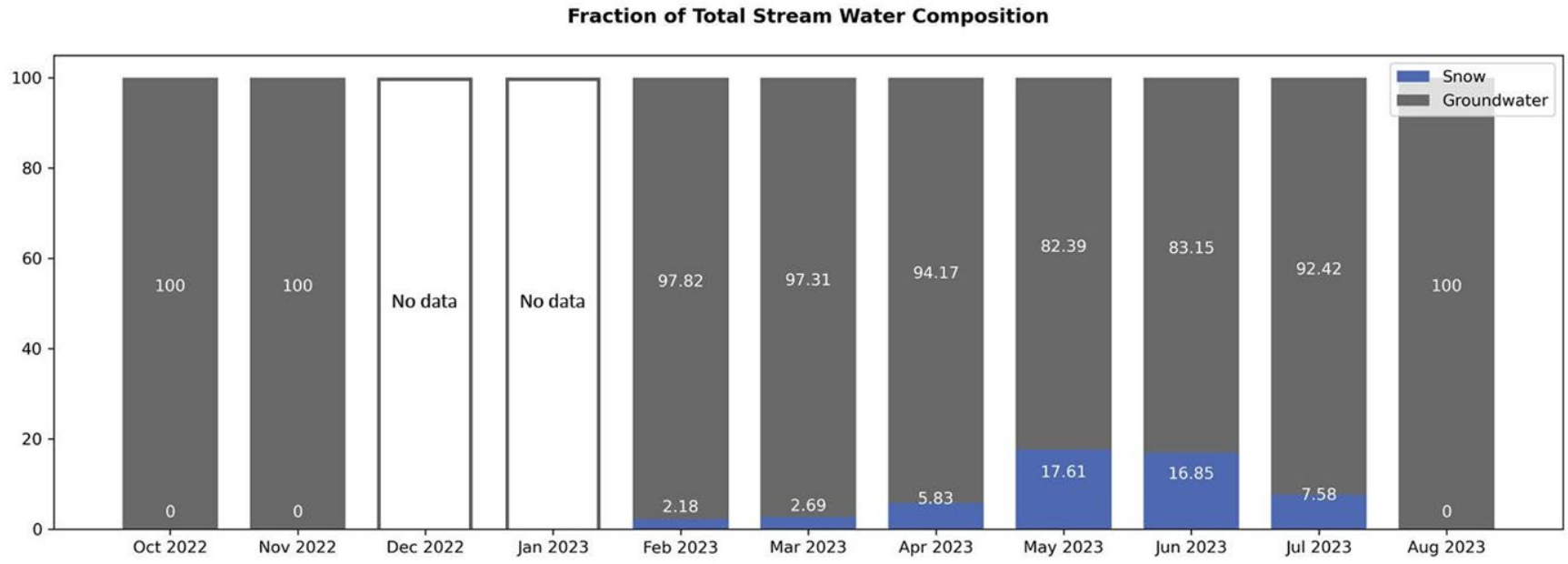

Stable Water Isotopes, Mill Creek Watershed
2023 water year
δ18O (permil)
-10
-15
-20
-25
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Sample Date
Sample Type
groundwater from well (5105 ft)
monthly precipitation composite (5105 ft)
snowpack (multiple elevations)
stream (4839 ft)
stream (5354 ft)
stream (6536 ft)

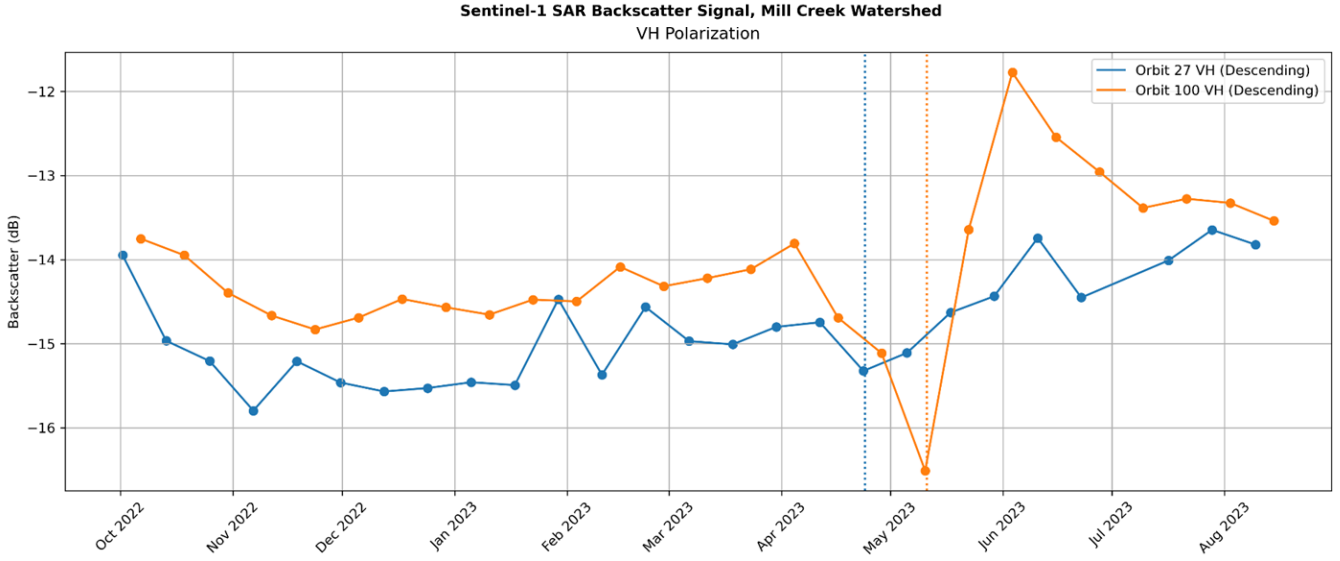
Sentinel-1 SAR Backscatter Signal, Mill Creek Watershed

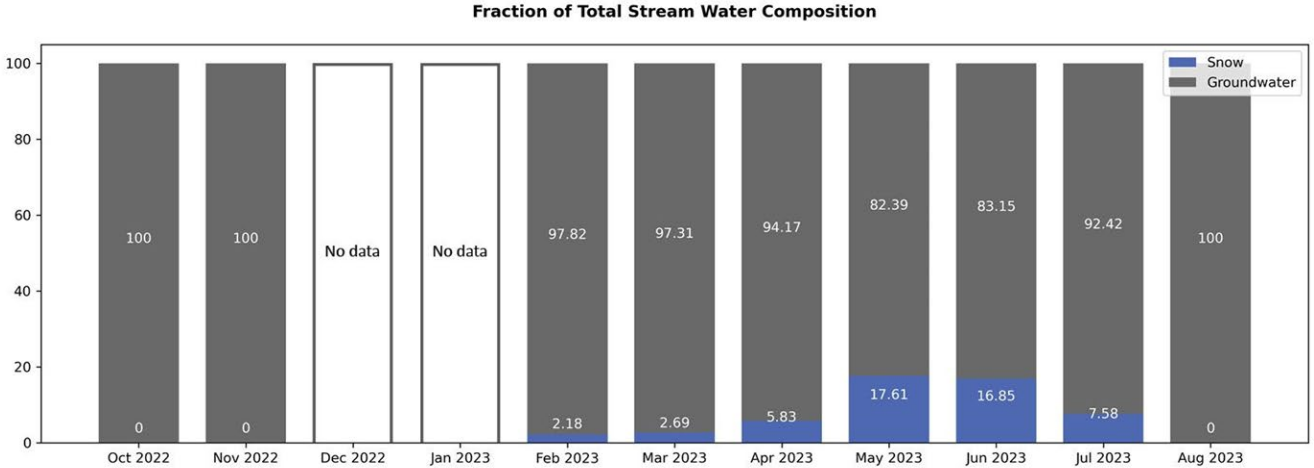


$$\textbf{fraction}_{\textbf{snow}} = \frac{\text{monthly average } \delta^{18}O_{\text{stream}} - \text{ annual average } \delta^{18}O_{\text{groundwater}}}{\text{annual average } \delta^{18}O_{\text{snow}} - \text{ annual average } \delta^{18}O_{\text{groundwater}}}$$

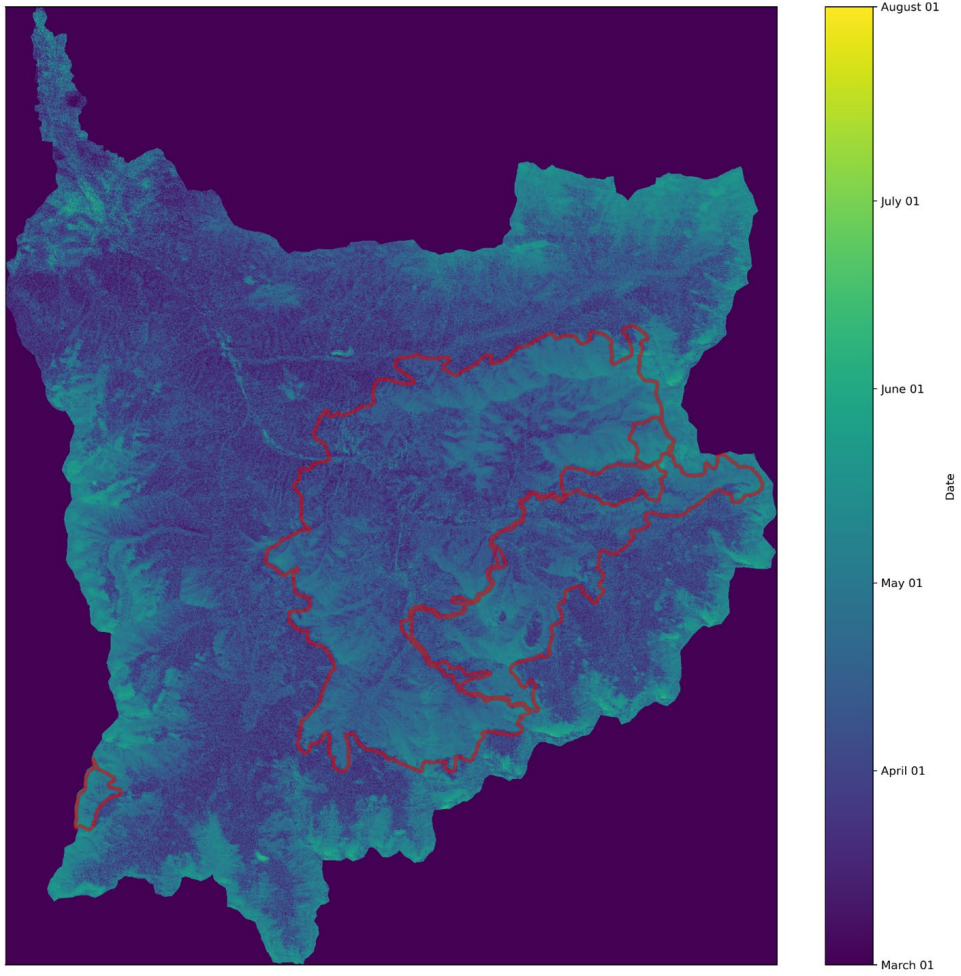
$$\textbf{fraction}_{\textbf{groundwater}} = \frac{\text{monthly average } \delta^{18}O_{\text{stream}} - \text{ annual average } \delta^{18}O_{\text{snow}}}{\text{annual average } \delta^{18}O_{\text{groundwater}} - \text{ annual average } \delta^{18}O_{\text{snow}}}$$



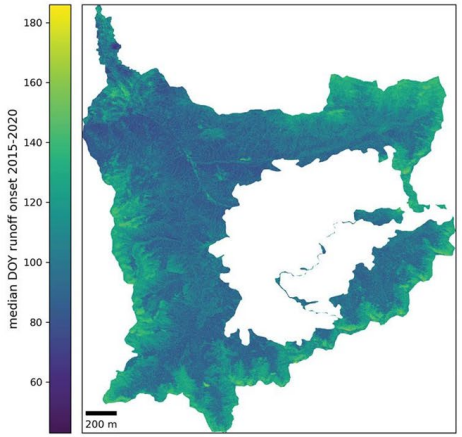

Sentinel-1 SAR Backscatter Signal, Mill Creek Watershed
VH Polarization
Orbit 27 VH (Descending)
Orbit 100 VH (Descending)
Backscatter (dB)
−12
−13
−14
−15
−16
Oct 2022
Nov 2022
Dec 2022
Jan 2023
Feb 2023
Mar 2023
Apr 2023
May 2023
Jun 2023
Jul 2023
Aug 2023

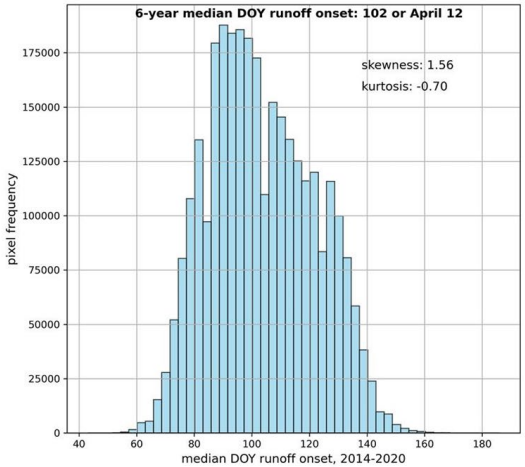

Fraction of Total Stream Water Composition
Snow
Groundwater
100
80
60
40
20
0
100
0
100
0
No data
No data
97.82
2.18
97.31
2.69
94.17
5.83
82.39
17.61
83.15
16.85
92.42
7.58
100
0
Oct 2022
Nov 2022
Dec 2022
Jan 2023
Feb 2023
Mar 2023
Apr 2023
May 2023
Jun 2023
Jul 2023
Aug 2023

Median DOY Runoff Onset, 2015-2022

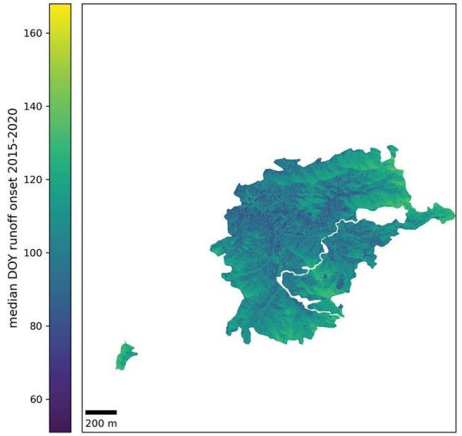


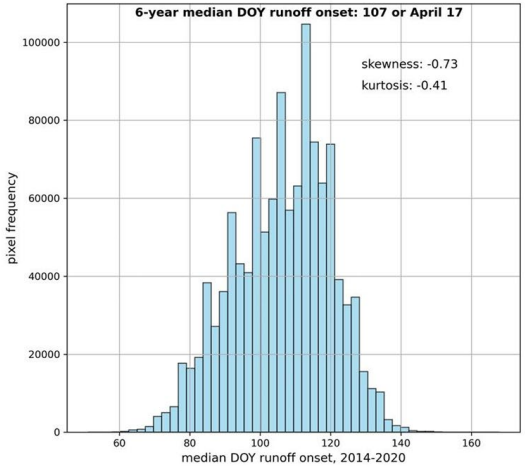
Unburned area, Mill Creek watershed





Burned area, Mill Creek watershed






Questions?