



## Community-collected Snow Pit Measurements

Snow pits are primary field experiment components of the NASA SnowEx field campaigns. Representative in situ measurements coincident with airborne acquisitions provide the necessary high-quality calibration/validation data products. A single snow pit contains several types of snow parameter measurements.

Snow Pit Parameters	Instrument Detail
Height of Snow (H.S)	Folding ruler
Density profiles	1000 cc wedge cutter
Temperature profiles	Digital thermometer
LWC profiles	A2 WiSe LWC sensor
Stratigraphy	2 mm grain card & 30x microscope
Soil Characteristics	SIPRE tube soil samples
Specific Surface Area (SSA)	IceCube, IRIS, or InfraSnow
Snow MicroPen (SMP)	SLF Snow Micro Penetrometer
Snow Casting Samples	Collected snow samples for microCT

Table 1: Snow pit and associated pit measurements.

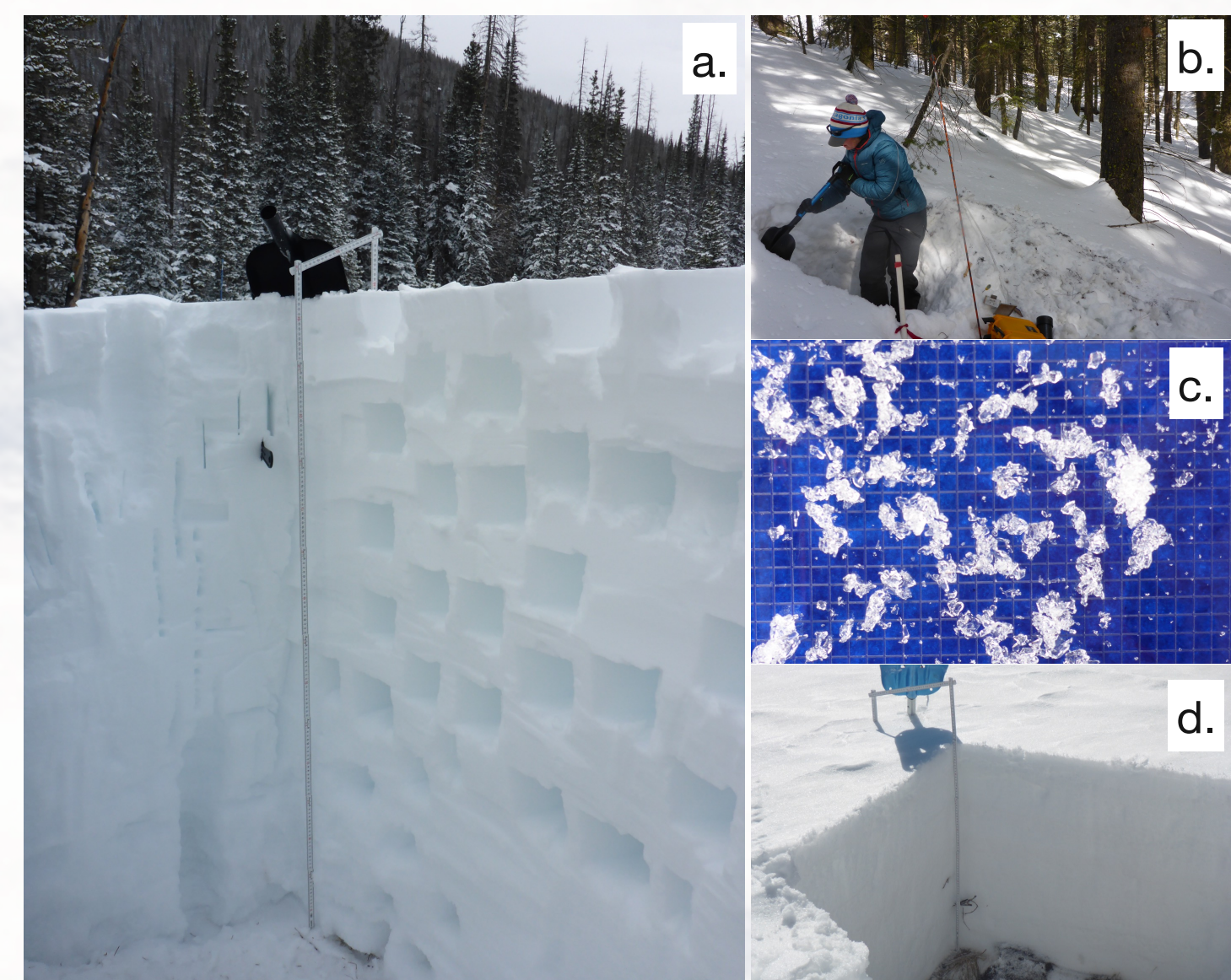


Figure 1: (a) Snow pit sampling in progress at the Senator Beck, Colorado, USA Swamp Angel site. (b) Snow pit excavation at a forested site near Bogus Basin ski area, Idaho. (c) Snow crystals on the snow grain card. (d) Open meadow site ready for snow pit sampling.



## NASA SnowEx Locations (2017-2023)

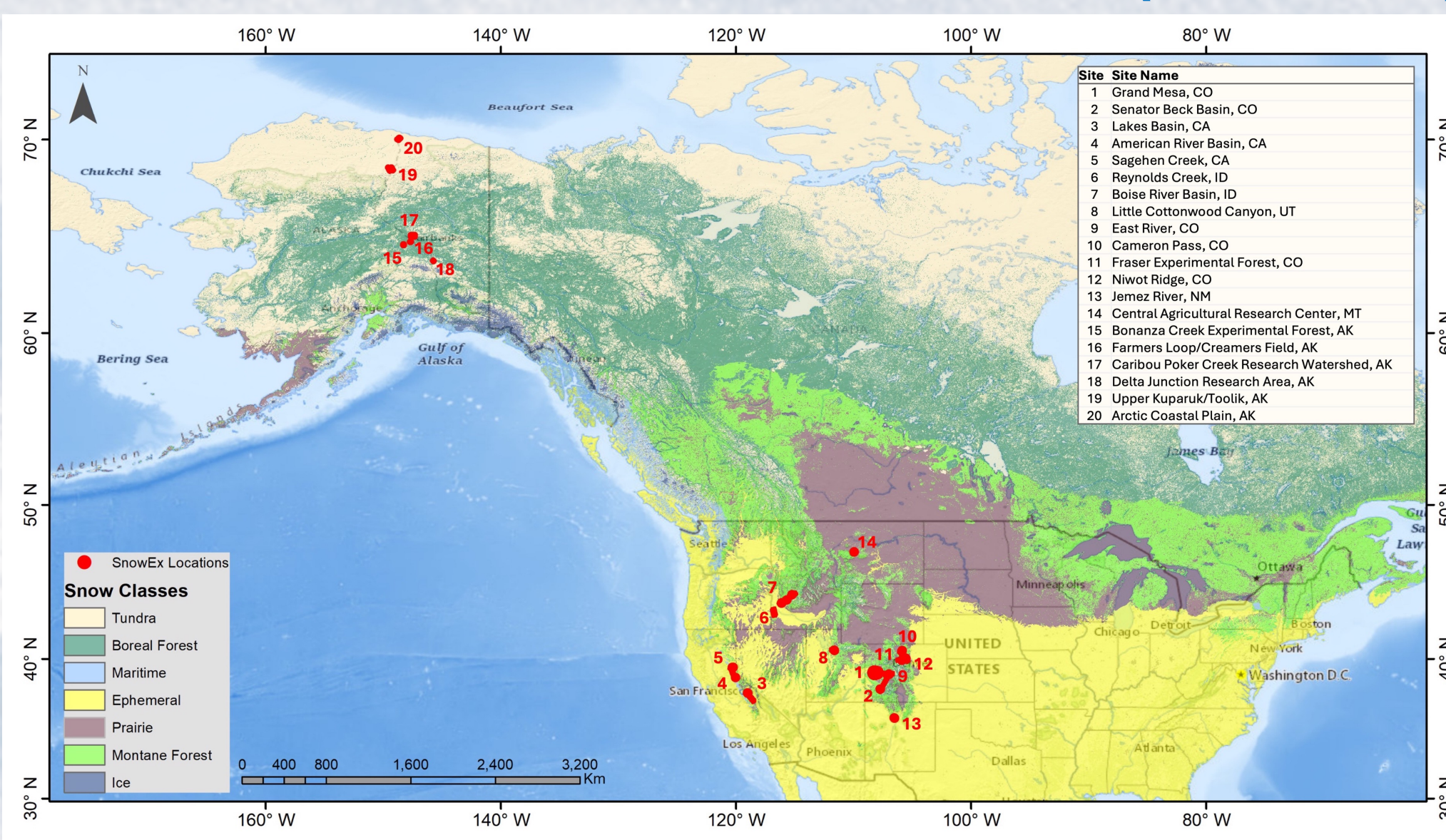


Figure 2: Map showing the locations of SnowEx field campaign areas (red dot). Base map shows snow classes defined in Sturm & Liston (2021).

SnowEx	Field Campaign Location	Temporal Coverage	Snow Pits
S17	Grand Mesa & Senator Beck Basin, Colorado	February 6-25, 2017	265
S20	Grand Mesa, Colorado Western U.S (13 sites)	January 27-February 12, 2020 October 24-May 20, 2020*	154 454
S21	Western U.S (7 sites)	November 16-May 27, 2021	247
S23	Tundra & Boreal Forest Alaska	March 7-17, 2022	18
	Tundra & Boreal Forest Alaska	October 22-27, 2022	186
	Tundra & Boreal Forest Alaska	March 7-16, 2023	170
	Tundra & Boreal Forest Alaska	April 5-May 6, 2023	13
	Tundra & Boreal Forest Alaska	October 17-28, 2023	127

Table 2: Number of snow pits associated with each SnowEx field campaign and measurement period. \*The majority of sites in 2020 have a temporal coverage of January-March due to the Covid-19 pandemic.



Figure 3: SnowEx Location corresponds to the site number in figure 2: Tundra (19), Boreal Forest (16), Maritime (3), Prairie (14), Montane Forest (12).

## I: 2017/2020 – Grand Mesa & Senator Beck, Colorado

- Objective: test several airborne and remote sensing techniques over a range of vegetation and topographical conditions

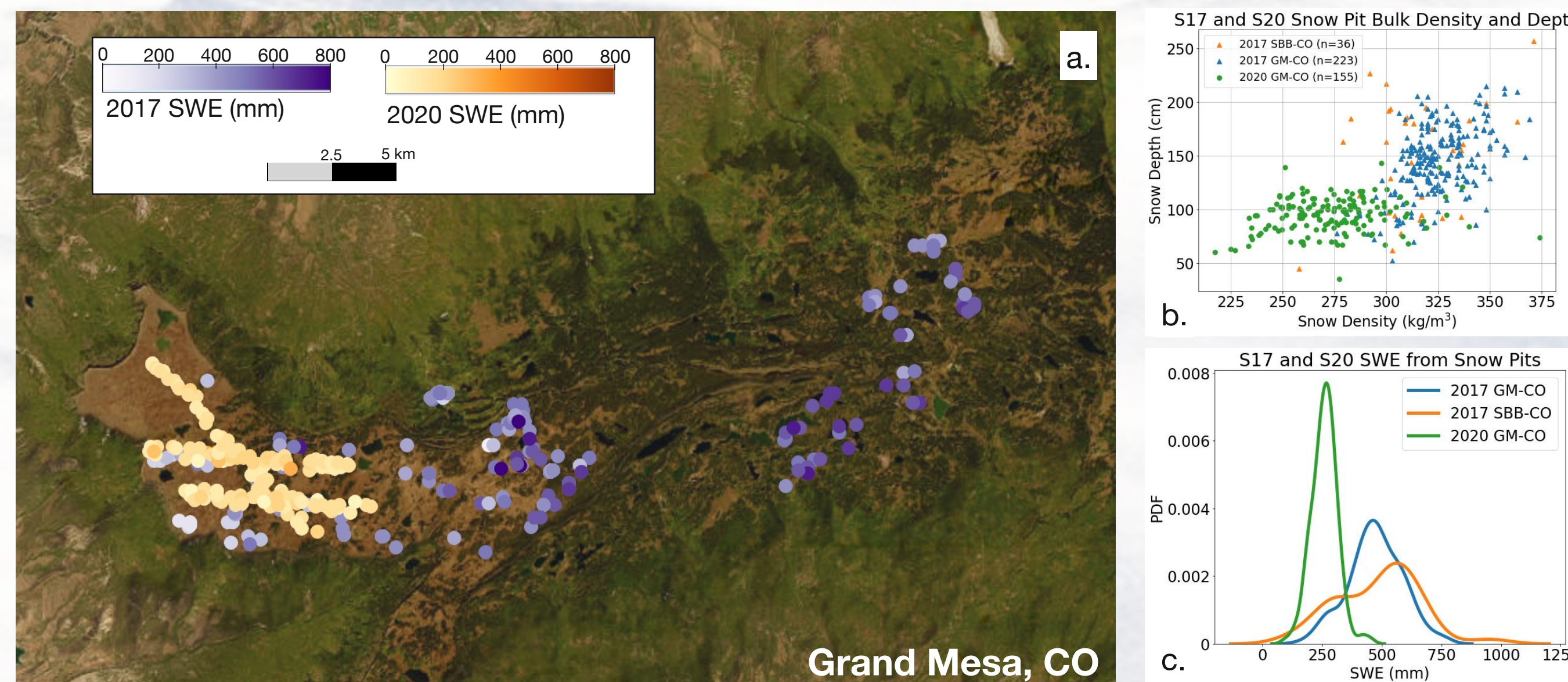


Figure 4: (a) Snow Water Equivalent (SWE) from snow pit measurements during the SnowEx 2017 (S17; February 6-25th, 2017; purple) and 2020 (S20; January 27- February 12th, 2020; orange) Intensive Observation Period (IOP) campaigns on Grand Mesa, Colorado, USA. (b) Distribution of snow density and snow depth during the Grand Mesa 2017 (blue circle) and 2020 (green circle) IOPs and 2017 IOP at Senator Beck Basin, Colorado (orange triangle). (c) Probability Density Function showing SWE distribution amongst the three IOP periods.

## III: 2023 – Arctic Tundra and Boreal Forest, Alaska

- Objective: address SWE/snow depth and albedo knowledge gaps in the Interior and Arctic regions of Alaska

### Snow Class Comparison

- On average, in situ SWE in the boreal forest are greater than the tundra sites as a result of the overall deeper snowpack.
- Preliminary snow pit results for all three parameters match those of the SWE tube data (available at NSIDC).

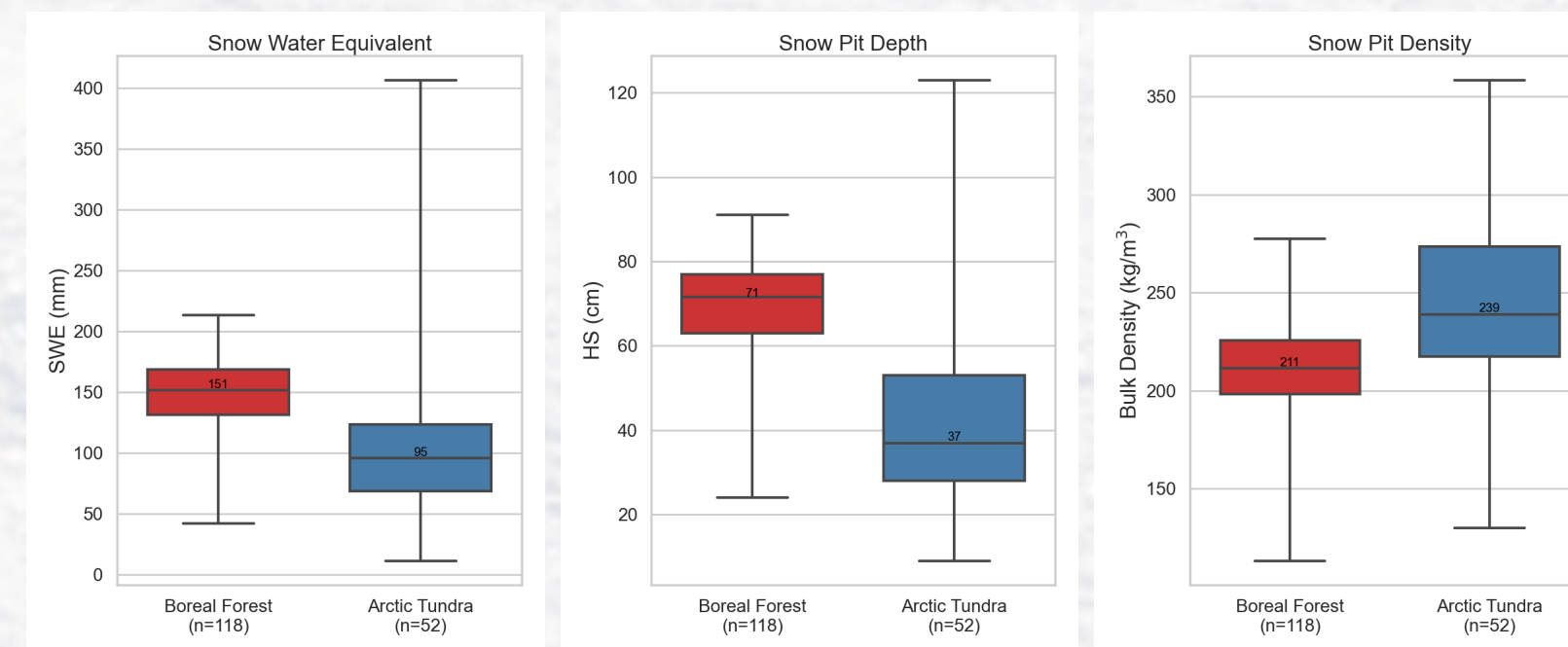


Figure 7: Boxplots show the median and interquartile range for SWE (a), snow depth (b) and density (c), for two dominate snow classes in Alaska.

Land Cover Classes in the Interior of Alaska - Sites in the boreal forest study regions were classified by five land cover types defined in the National Land Cover Dataset (NLCD).

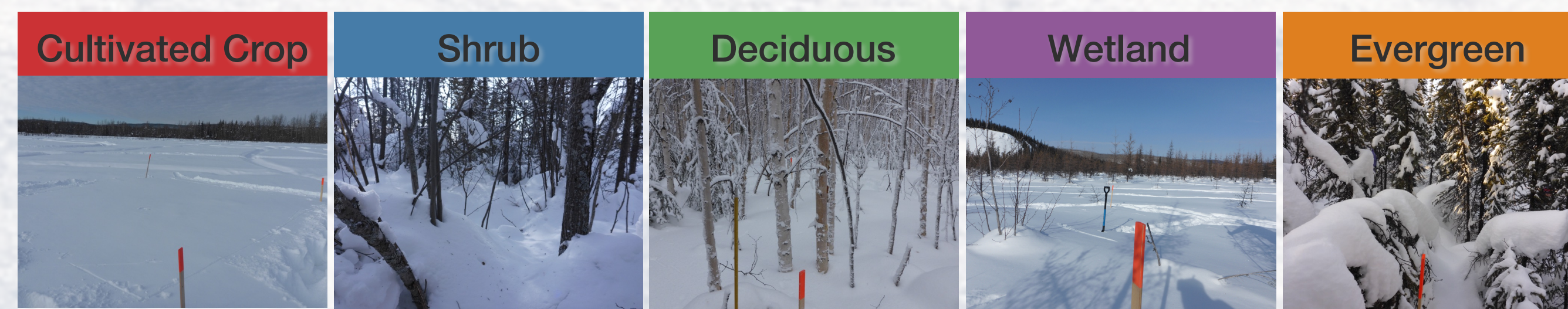
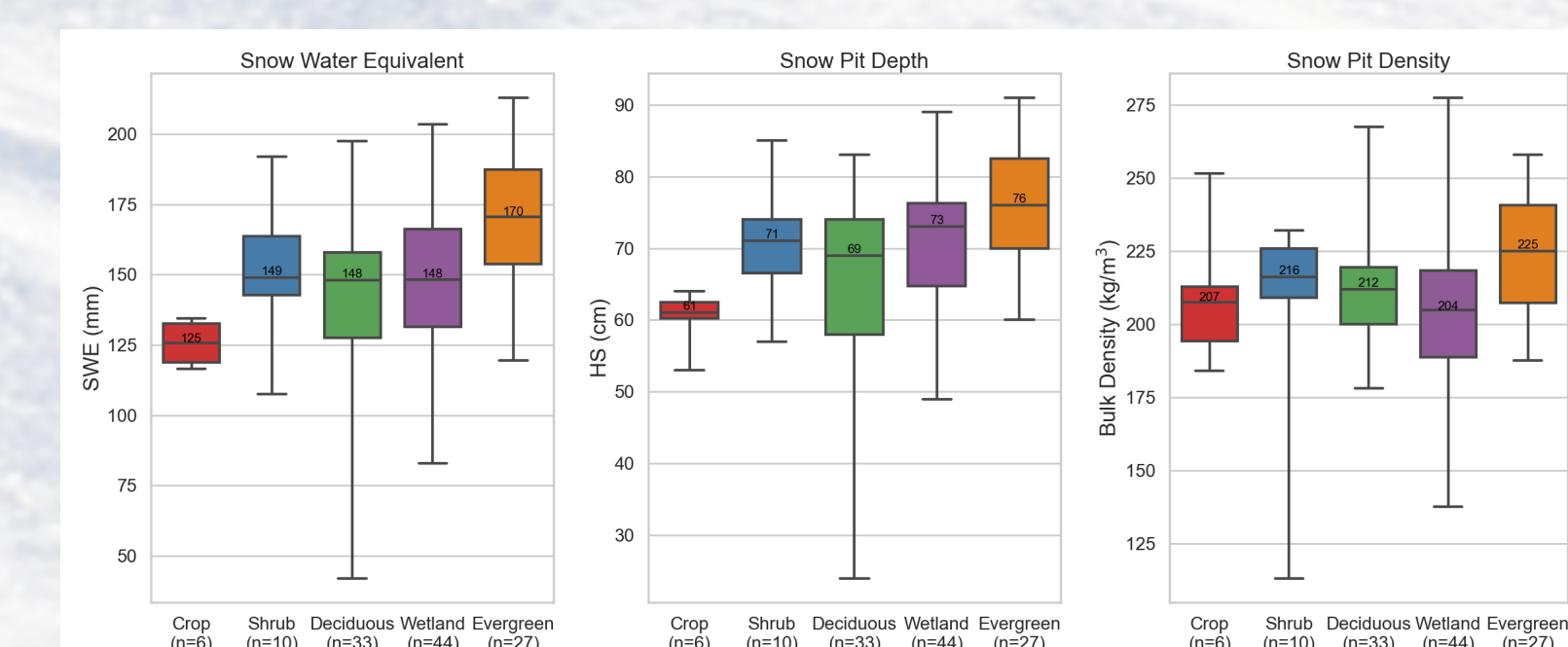


Figure 8: (above) Oblique view of each land cover type. The orange-capped stake marks the southeast plot corner. The snow pit is central in the 5x5m plot.

(right) Boxplots show the median and interquartile range for SWE (a), snow depth (b) and density (c), for the five land cover classes from the NLCD for the boreal forest plots located in interior Alaska.



## II: 2020 & 2021 - Western U.S Time Series

- Objective: conduct a time series experiment with L-band InSAR acquisitions to capture seasonal snow accumulation and melt periods

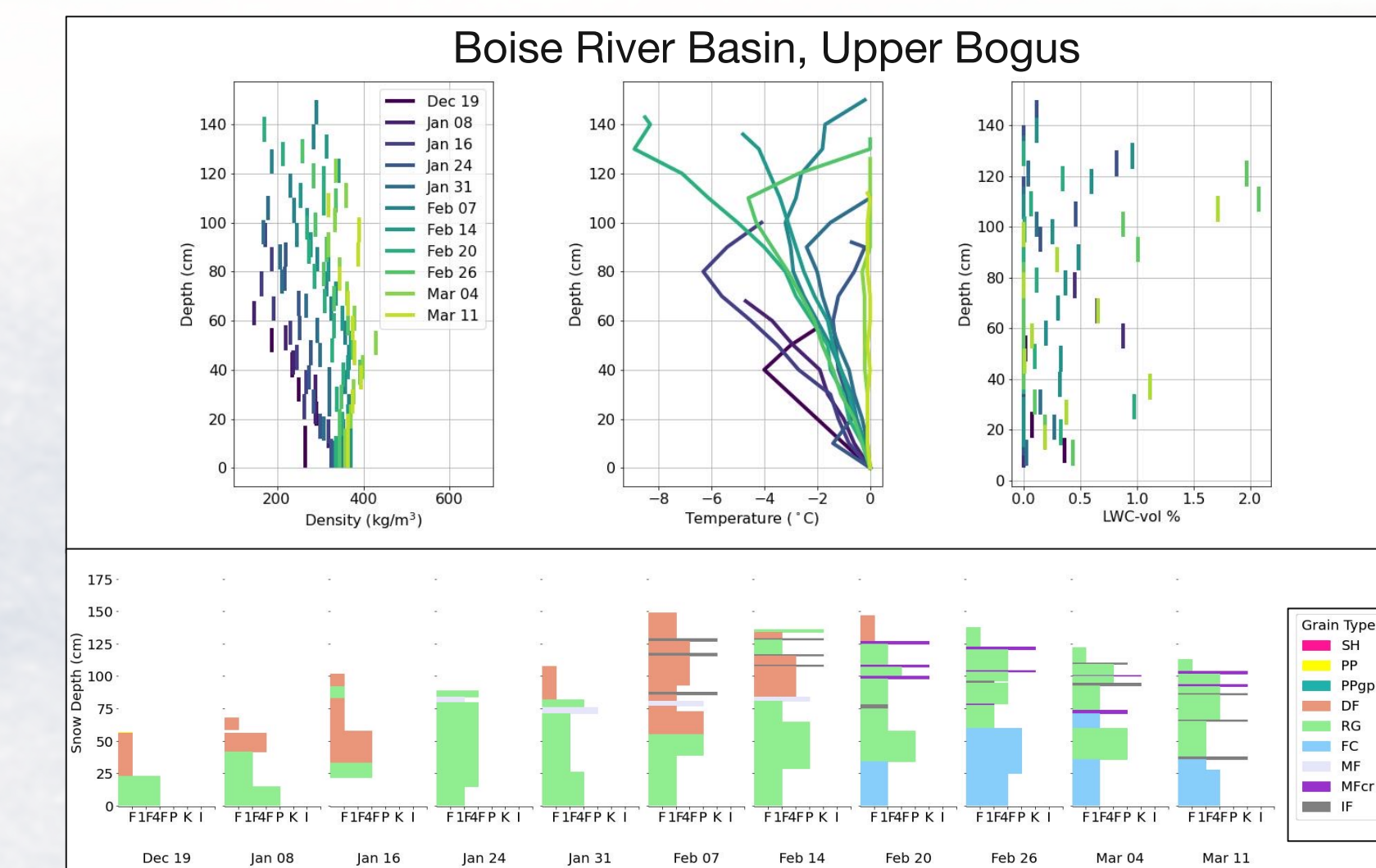


Figure 5: The snow pit time series data presented for Upper Bogus Basin, a site in the Boise River Basin in Boise, Idaho. Top Left: snow density progression throughout the season shown in 10 cm (vertical bar) sampling intervals. Top Center: Snow temperature profiles with respect to depth. Top Right: Liquid Water Content (LWC) by % volume from the A2 WiSe liquid water sensor. Bottom: the stratigraphy shown over time with respect to snow hardiness. Colors indicate the snow grain type for each recorded layer.

Scan the QR code for more examples from other snow pits.



Observation crews conducted weekly site visits following the SnowEx pit sampling protocol

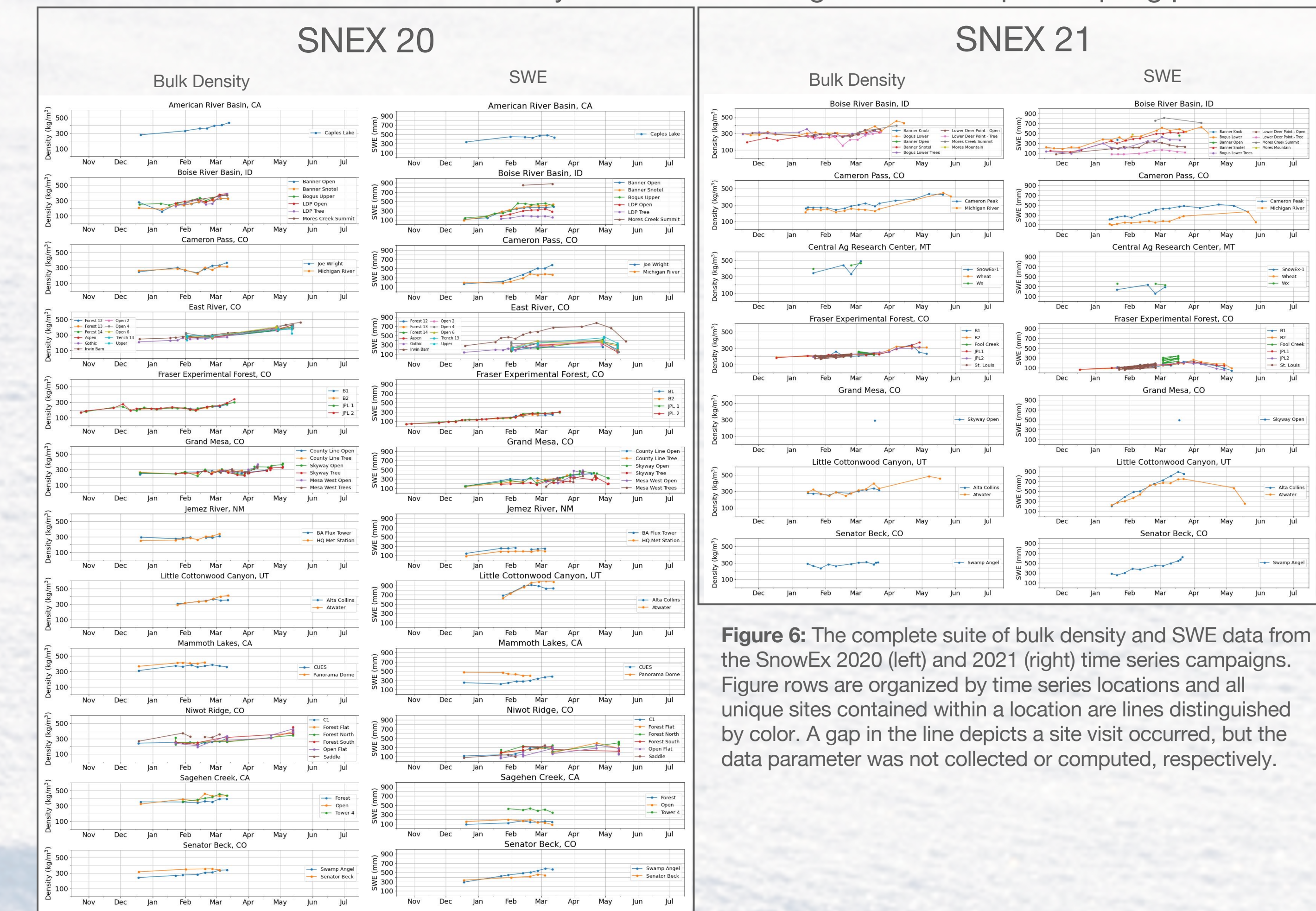


Figure 6: The complete suite of bulk density and SWE data from the SnowEx 2020 (left) and 2021 (right) time series campaigns. Figure rows are organized by time series locations and all unique sites contained within a location are lines distinguished by color. A gap in the line depicts a site visit occurred, but the data parameter was not collected or computed, respectively.

## Snow Pit Data Products

Scan to view the complete record of published data products



Field Campaign and Snow Pit Data Product	Status
S17 • SnowEx17 Community Snow Pit Measurements, Version 1	avail. at NSIDC
S20 • SnowEx20 Grand Mesa Autumn 2019 Snow Pits, Version 1	avail. at NSIDC
• SnowEx20 Grand Mesa Intensive Observation Period Snow Pit Measurements, Version 1	avail. at NSIDC
• SnowEx20 Time Series Snow Pit Measurements, Version 2	avail. at NSIDC
S21 • SnowEx21 Time Series Snow Pit Measurements, Version 1	avail. at NSIDC
S23 • SnowEx23 Snow Pit Measurements in Alaska during initial assessment period, March 2022	in prep.
• SnowEx23 Low-snow Pit Measurements and Ground Conditions at Freeze Up in Alaska, October 2022	in prep.
• SnowEx23 Snow Pit Measurements in Alaska, March 2023	prelim. data avail.
• SnowEx23 Snow Pit Measurements in Alaska from Albedo campaign, April 2023	in prep.
• SnowEx23 Low-snow Pit Measurements and Ground Conditions at Freeze Up in Alaska, October 2023	in prep.



Learn more about NASA Snow at [snow.nasa.gov](http://snow.nasa.gov)

## Acknowledgements

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Contact

Megan Mason  
megan.a.mason@nasa.gov