Section S1: Study site

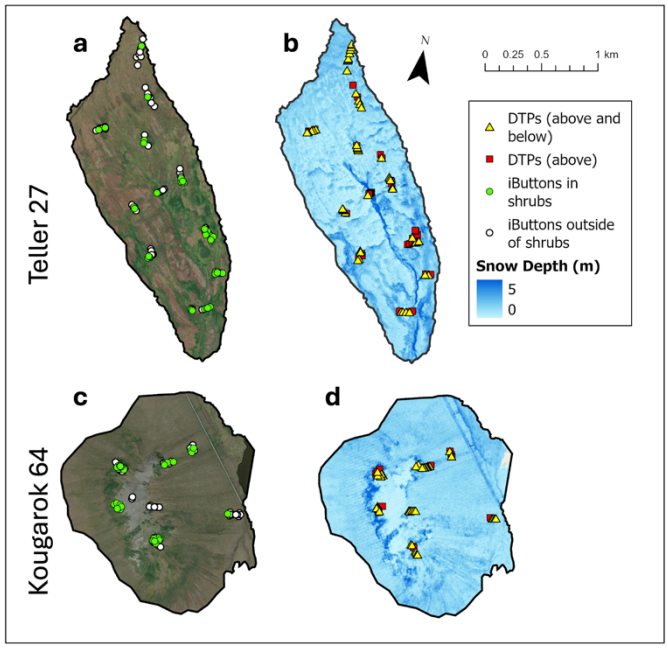

Figure S1. Locations of iButton Link Thermochron (DS1921G-F5#) temperature sensors deployed in (green circles) and outside (white circles) of shrubs over WY2023 at a) Teller27 and c) Kougarok64. Background imagery from Esri, Garmin, USGS, Maxar, 2024, ArcGIS RGB Basemap. Locations of DTP temperature sensors that recorded both *above* and *below* ground temperature (yellow triangles) or only *above* ground temperature (red circles) over WY2022 at b) Teller27 and d) Kougarok64. Blue background imagery shows snow depth in April 2022 estimated using Light Detection and Ranging (LiDAR) data (Singhania et al., 2023b, a).

Section S2: Model hyperparameters

Parameter	Value
Number of decision trees	70
Maximum depth of decision tree	10 layers
Minimum number of samples required to form a yes/no split	15
Maximum amount of samples used to build a decision tree	80%
Maximum number of features used in each decision tree	2

Table S2. Random forest parameters. To tune hyperparameters, we first visualized how different hyperparameter values affected model performance using the validation dataset. After selecting three candidate values for each hyperparameter, we used a 5-fold cross validation grid search algorithm to determine the best hyperparameter combination.

Section S3: Model evaluation sites

Site	Years	Sensor Details	Snowpack Bulk Density	Source
Bayelva Station, Svalbard, Norway	2003 - 2017	5 cm *above* the ground surface	0.35 g/cm^3	Boike et al., 2018
Senator Beck Basin, CO, USA (2 sites)	2003 - 2022	At snow-ground interface	0.45 g/cm^3 to 0.50 g/cm^3	Center for Snow and Avalanche Studies, 2012; Landry et al., 2014
Imnaviat Creek, North Slope, AK, USA	1990 - 1992	At snow-ground interface	0.25 g/cm^3	Stuefer et al., 2020; Sturm and Holmgren, 1994
Los Alamos, NM, USA (18 iButtons deployed in pairs)	2023 - 2024	9 at the snow-ground interface; 9 1-5 cm *below* the ground surface	0.4 g/cm^3 during the 2024 water year, according to the nearby Quemazon SNOTEL Station	Temperature sensors were deployed for this study. Snow depth data at site B is from https://weathermachine.lanl.gov/
SnowEx Grand Mesa Study Plot, CO, USA	2017 - 2022	5 cm *below* the ground surface	0.4 g/cm^3, according to the nearby Mesa Lakes SNOTEL Station	(Houser et al., 2022)
Samoylov Island, Siberia, Russia	2002 - 2020	1 cm *below* the ground surface in low centered polygon; 5.4 cm tall wet tundra vegetation	0.18 g/cm^3 to 0.23 g/cm^3	(Boike et al., 2019)
Council, Seward Peninsula, AK, USA (two sites)	2000 - 2004	0 to 1 cm *below* the soil surface; tussock and mossy tundra vegetation	Unknown	(Hinzman et al., 2016)
Ivotuk, North Slope, AK, USA	1998 - 2006	0 to 1 cm *below* the soil surface; tussock sedge and dwarf-shrub tundra	Unknown	(Hinzman et al., 2016)

Table S3. Description of model evaluation sites