

Climate Station Maintenance in the Central Alaska Inventory and Monitoring Network

2023 Summary



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Photo

Chicken Creek weather station, Wrangell - St. Elias National Park and Preserve.
NPS/Pam Sousanes

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Abstract

The mission of the Central Alaska Network Inventory and Monitoring Program (CAKN) is to collect, compile and synthesize scientific information about the central network of parks to manage park resources "unimpaired for the enjoyment of future generations". The Inventory and Monitoring (I&M) Program is a major component of the National Park Service's (NPS) strategy to improve park management through greater reliance on scientific information.

The objective of the climate monitoring program is to monitor and record weather conditions at representative locations to identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts beyond park boundaries. Thirteen remote automated I&M weather stations (RAWS) have been installed in CAKN parks since 2003. There are additional weather and climate stations in the parks run by state and federal agencies with specific objectives and missions. It is in the best interest of the CAKN program to cooperate with these other entities on maintenance site visits. During the 2023 field season maintenance site visits were conducted at twenty-five sites, including twelve CAKN RAWS, three SNOTEL (snow telemetry) stations, eight fire RAWS stations, and one NOAA climate reference network site. We did not visit one of the CAKN RAWS and one of the Snotel sites due to schedule conflicts.

This report summarizes all work for the 2023 field season and includes current sensor metadata. These annual operations reports are compiled each year along with other deliverables so that it is clear how the data were collected. For more information, including data access, weather summaries, and annual reports please visit the CAKN climate website at <https://www.nps.gov/im/cakn/climate.htm>.

List of Acronyms

Ah:	Amp hour
AT:	Air Temperature
AT-RH:	Air Temperature-Relative Humidity
CAKN:	Central Alaska Network
DENA:	Denali National Park and Preserve
DLP:	Data Logger Program
FTS:	Forest Technology Systems
GOES:	Geostationary Operational Environmental Satellite
GPS:	Global Positioning System
I&M:	Inventory and Monitoring
NESDIS ID:	National Environmental Satellite, Data, and Information Service Identifier
NPS:	National Park Service
NRCS:	Natural Resource Conservation Service
RAWS:	Remote Automated Weather Station
RG-TB:	Rain Gauge - Tipping Bucket
SD:	Snow Depth
SNOTEL:	Snow Telemetry
SR:	Solar Radiation
ST:	Soil Temperature
W:	Watt
WFMI:	Wildland Fire Management Information
WRST:	Wrangell-St. Elias National Park and Preserve
WS-WD:	Wind Speed - Wind Direction
YUCH:	Yukon-Charley Rivers National Preserve

Introduction

For the 2023 field season, the Central Alaska Network (CAKN) continued its climate monitoring program by visiting stations in Denali National Park and Preserve (DENA), Yukon-Charley Rivers National Preserve (YUCH), and Wrangell – St. Elias National Park and Preserve (WRST) (Figure 1). Twelve of the thirteen CAKN climate stations were maintained (Table 1) along with NPS support at four NRCS snow and soil sites, eight fire RAWS stations, and one NOAA Climate Reference Network station. Annual maintenance includes downloading data, updating software and programming, replacing sensors, and troubleshooting problems. Maintenance is critical to provide continuous, high-quality meteorological data.

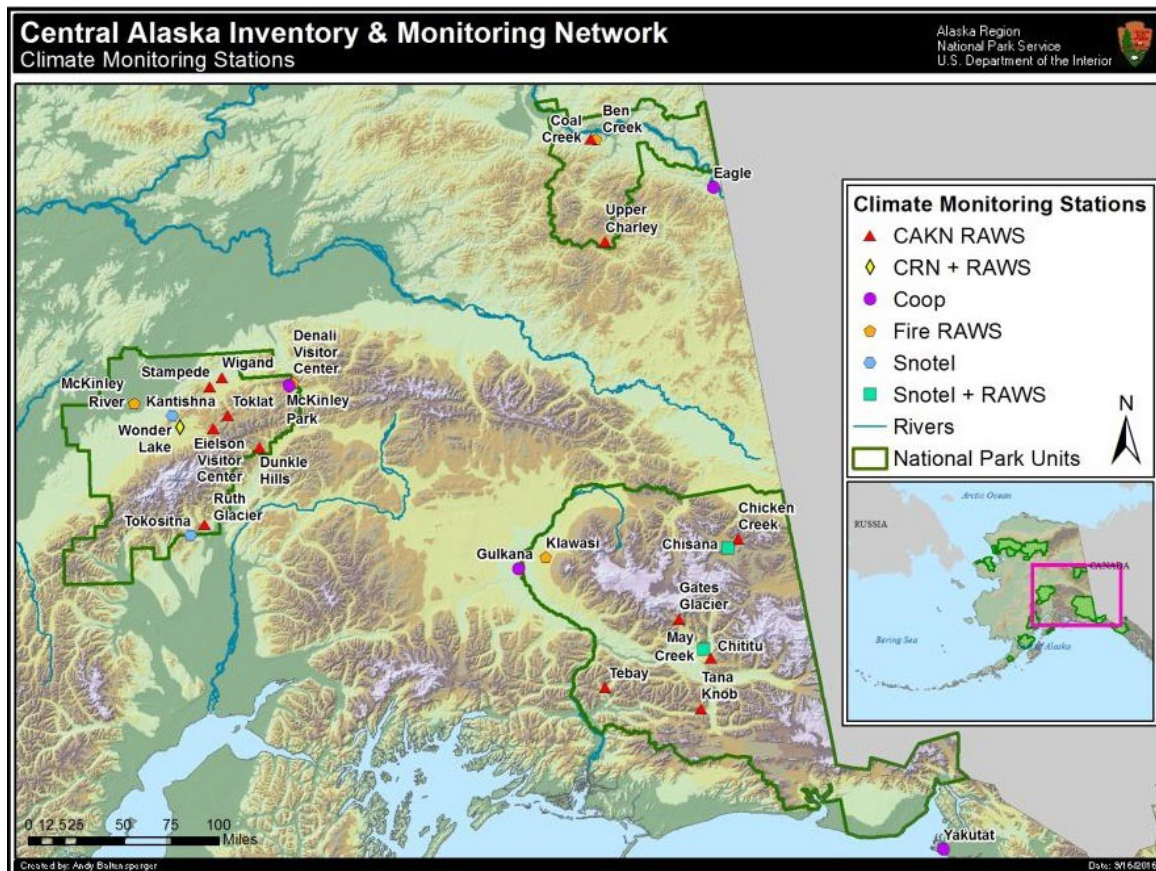


Figure 1. Locations of CAKN climate stations.

Table 1. Locations of CAKN climate stations maintained in 2023 field season.

Station Name	Latitude	Longitude	Elevation (m)	Park
Chititu	61.274	-142.621	1385	WRST
Chicken Creek	62.124	-141.847	1597	WRST
Tana Knob*	60.908	-142.901	1140	WRST
Gates Glacier	61.603	-143.013	1237	WRST
Tebay	61.181	-144.342	573	WRST
Chisana SNOTEL/RAWS*	62.072	-142.065	1012	WRST
May Creek SNOTEL/RAWS	61.348	-142.694	503	WRST
Klawasi RAWS	62.217	-144.995	2513	WRST
Strelna/Chitina RAWS	61.521	-144.198	1232	WRST
Upper Charley	64.517	-143.202	1114	YUCH
Coal Creek	65.314	-143.132	292	YUCH
Toklat	63.524	-150.043	890	DENA
Eielson Visitor Center	63.431	-150.309	1202	DENA
Wigand	63.814	-150.109	1716	DENA
Ruth Glacier	62.710	-150.540	1006	DENA
Stampede	63.747	-150.328	549	DENA
Dunkle Hills	63.268	-149.539	808	DENA
Wonder Lake CRN	63.452	-150.875	2163	DENA
Kantishna SNOTEL	63.540	-150.990	472	DENA
Tokositna SNOTEL	62.629	-150.775	259	DENA

*No site visits in 2023

Climate Station Maintenance Summaries

This section describes the maintenance details of twenty-five climate stations in CAKN organized by park unit. This work is being implemented based on Central Alaska Network (CAKN) climate vital sign protocols (Sousanes 2018) and standard operating procedures (Sousanes et al. 2017).

See Appendix A for detailed logistics for each of the base locations. Appendices B and C provide sensor specifications and metadata.

Denali National Park and Preserve

This section includes descriptions of all station maintenance in DENA in 2023. The sites include: Eielson Visitor Center, Stampede, Toklat, Wigand, Dunkle Hills, Ruth Glacier, Wonder Lake CRN, Tokositna SNOTEL, Kantishna SNOTEL, Denali Visitor Center Fire RAWS, McKinley River Fire RAWS, Wonder Lake Fire RAWS, and Lake Minchumina Fire RAWS.

Eielson Visitor Center

Date/Time: 6/20/2023 13:15

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N149AE – Josh Han

Weather: mid 50s

Damage:

1. Temp sensor 109_2 was out of radiation shield.
2. Crossarm with snow and AT/RH was rotated $\sim 20^\circ$ - may have impacted snow depth measurement depending on when it happened. Sensor was close to tripod leg.

Sensors replaced:

Removed AT/RH EE181 #21351AC, SR Licor #PY46238, RM Young 05103 #53406

Installed AT/RH EE181 #202016000042CD, SR Licor 60144, RM Young #WM87997

Other hardware replaced: none.

Additional Comments: Entered new SR50a height of 86.1 inches because crossarm had moved.

Potential Data Issues:

1. 109_2 unshielded
2. Snow depth – crossarm moved, height to sensor changed

To Do:

Bring small radiation shield for 109_2 temp sensor.

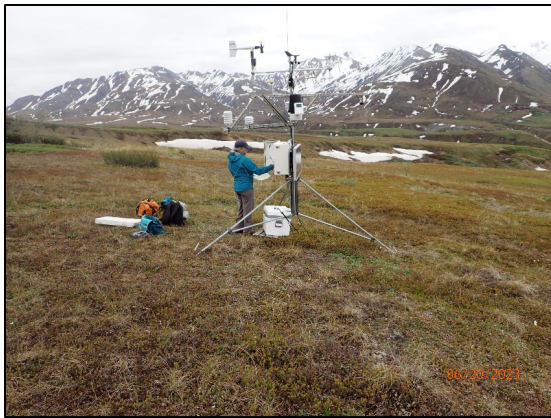


Figure 2. Eielson Visitor Center climate station, June 20, 2023.

Stampede

Date/Time: 6/22/2023 11:00

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N149AE – Josh Han

Weather: low 60s, calm, buggy.

Damage: AT/RH sensor bad, WS out of level, leaning to the east. Failsafe tripped on transmitter.

Sensors replaced:

Removed AT/RH 181 #10237, SR Licor LI200X #63670

Installed AT/RH EE181#139750, SR Licor LI200X #93093

Other hardware replaced: Charging regulator (CH200)

Additional Comments: Transmitter was reset, but then was tripped again when testing batteries.

Again, many low 12V counts, but battery seemed OK at the site visit. Data gaps were associated with voltage drops in February and March 2023 (see QA/QC notes). Site stopped transmitting seven hours after site visit.

Potential Data Issues:

1. AT/RH

To Do:

1. Swap batteries, battery box, power cable, and solar panel.



Figure 3. Stampede climate station, June 22, 2023. The wind sensor was out of level on arrival (left). End of site visit photo (right).

Toklat

Date/Time: 6/20/2023 11:30

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N149AE – Josh Han

Weather: mid 50's

Damage: none

Sensors replaced:

Removed AT/RH EE181 #04190, RM Young 05103 #58427

Installed AT/RH EE181 #74351, RM Young 05103 #58429

Other hardware replaced: Swapped charging regulator for CH200.

Additional Comments: Once again the failsafe was tripped on the transmitter, everything else was fine. Reset by holding fault button for 10 seconds. Plan to upgrade datalogger and transmitter on next visit.

Potential Data Issues: Some drift in soil temperature sensors (see QA/QC notes).

To Do:

1. Replace datalogger and transmitter. Done 9/1/2023.

Second Visit: 9/1/2023. Returned for second visit with helicopter N149AE. Installed CR1000X datalogger and TX325 satellite transmitter. Uploaded new CR1000X program. Visit was rushed due to deteriorating weather conditions. Downloaded data from CR1000 in office upon return.

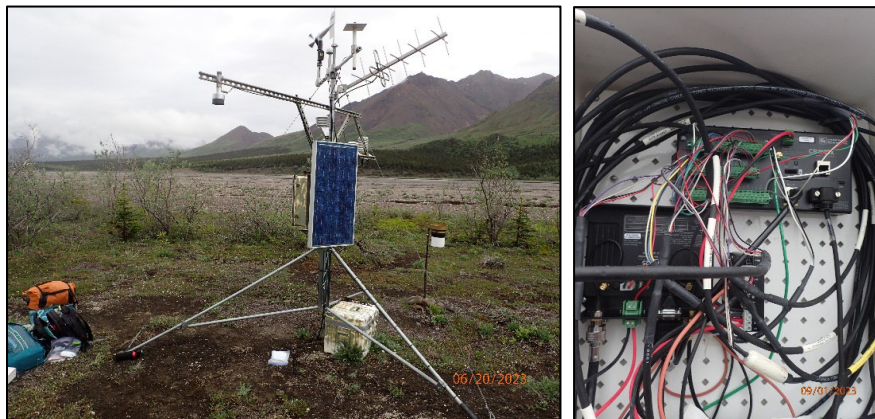


Figure 4. Toklat climate station, June 20, 2023 (left). Installation of new datalogger and transmitter, September 1, 2023 (left).

Wigand

Date/Time: 6/21/2023 11:00

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N149AE – Josh Han

Weather: low 60s, calm, buggy

Damage: Mast is leaning $<5^\circ$, so most sensors out of level. STF3 heaved out ~10 cm, could be OK because tripod leg is sinking but sensors are OK.

Sensors replaced:

Removed AT/RH EE181 #0992A, RM Yong 05103 #159861

Installed AT/RH EE181 #086CD, RM Yong 05103 #87976

Reinstalled STF1, 2, and 3 (107)

Other hardware replaced: Station was overhauled because it was sinking into thawing permafrost. 30' mast replaced with 10' mast, replaced large solar panel with 10 w panel, and added Geoblock under tripod feet to float station to prevent from sinking. Tripod legs secured to Geoblock with wire and wood stakes were used to anchor Geoblock to ground.

Additional Comments: The 60 cm soil sensor was reading high, did not reinstall. Reinstalled soils sensors at 10, 20, and 50 cm. Electric fence repaired. Downloaded data from CR1000.

Potential Data Issues:

1. Mast was out of level; could skew rain and solar radiation data for 2022-2023.
2. AT-RH sensor (EE181 SN:1711160000992A) reading much different than 109_1 and 109_2 sensors.

To Do:

1. Consider bringing smaller piece of Geoblock to go under battery box.
2. Take notes on soil sensors – are they heaving, loose, good?



Figure 5. Wigand climate station June 21, 2023 before overhaul (left), and after station overhaul at end of visit (right).

Dunkle Hills

Date/Time: 6/20/2023 15:30

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N149AE – Josh Han

Weather: low 50s

Damage: Not transmitting, failsafe tripped. ThermX temperature sensor's cable was severed. Minor damage to outer shield on snow depth cable.

Sensors replaced:

Removed AT/RH EE181 #183116000198BD, SR LiCor Li200X #68925, RM Young 05103 #132710

Installed AT/RH EE181 #212916001391E1, SR LiCor Li200X #90559, RM Young #87973

Other hardware replaced: Swapped ThermX for 109 as secondary air temperature sensor.

Additional Comments: Loaded new program for 109 sensor addition and verified snow sensor height. Failsafe was tripped. Reset by holding fault button for 10 seconds. There were many fly larvae in the radiation shields, in tipping bucket, and inside enclosure. Cleaned them all out and replaced putty in enclosure opening. Tipping bucket funnel screen is missing.

Potential Data Issues:

1. ThermX – secondary air temperature sensor data missing since cable was severed.
2. Possible under catch for rain total due to missing screen and funnel spout blocked by larvae.

To Do:

1. Bring replacement screen for tipping bucket
2. Swap batteries



Figure 6. Dunkle Hills climate station June 20, 2023. Bug larvae on side of battery box (left) and station at end of site visit.

Ruth Glacier

Date/Time: 6/30/2023 15:30

Personnel: Ken Hill

Logistics: A-star helicopter – Temsco – N570AE – Jon Combs

Weather: high 40s

Damage: Not transmitting, failsafe tripped. Snow depth sensor reading NAN.

Sensors replaced:

Removed AT/RH EE181 #19271600022892, Li200x #36882, 05103 WS-WD #13720, SR50a
Snow depth #2544

Installed new EE181 #192516000342BC, Li200x #102542, 05103 WD-WD 126353, SR50a
Snow Depth #10201

Other hardware replaced: Swapped ThermX for 109 as secondary air temperature sensor. Swapped CH200 charging regulator. Drilled new holes for power cable and conduit.

Additional Comments: Snow depth sensor reading NAN. Tipping bucket had strange data. Last reset June 23, 2023. There was one watchdog error and 275 low 12 V counts. Failsafe had tripped and was reset. One element on Yagi replaced. Cleaned coax terminals. Loaded new program for 109 sensor addition and verified snow sensor height.

Potential Data Issues:

1. Snow – reading NAN.
2. Rain – reset a week prior to site visit.

To Do:

1. Swap datalogger and transmitter
2. Swap batteries
3. Swap snow depth



Figure 7. Ruth Glacier climate station June 30, 2023. Power cable before it was replaced (left) and station at end of site visit (right).

Denali Fire RAWS

DENA staff completed annual maintenance at all fire RAWS in summer 2023. More information is available through [WXx-Weather](#).

Denali Visitor Center: Annual maintenance performed 6/20/2023 by Sarah Hayes and Taylor Bracher. Installed RH/AT 48796, replaced Solar Radiation with 40174, TB replaced with 59261. Station is not level on n/s axis and some nearby trees need to be removed.

Lake Minchumina: Annual maintenance performed 6/06/2023 by Shannon Coykendall and Charlie Rudacille. Replaced RH/AT (40533), replaced wind (43063). All sensors scanned. Mapped SDI sensors. Reset tipping bucket. Light bear chew marks on top of GPS sensor.

McKinley River: Annual maintenance completed 6/6/2023 by Shannon Coykendall. Replaced RH/AT (39162), rain (47791) rain gauge zeroed. Sensors scanned, Reset tipping bucket. Need to bring more fence insulators and post driver to restring electric fence.

Wonder Lake: Annual maintenance completed 6/2/2023 by Shannon Coykendall, repair visit by Sarah Hayes 6/13/2023. On 6/2: Replaced RH/AT Sensor (23571), wind (48327), and solar radiation (121040). Tipping bucket reset. Did not map sensors after swapping out, ran out of time. Station in good condition. 6/13: Solar radiation installed on 6/2 was reading 'no data'. Attempted to troubleshoot, still did not work. Replaced with solar radiation (58848) mapped sensor and scanned OK.

Denali SNOTEL

Tokositna SNOTEL 6/30/2023: Tony DeMarco and Austin Hart from the Natural Resources Conservation Service completed the annual maintenance. The snow pillow had to be replaced and that involved slinging equipment and fluid from mile 131 gravel pit on the Parks Highway to the site. The Talkeetna Ranger staff helped with the slinging/helicopter managing for this trip. The precipitation gage was flushed, and 10 gallons of fresh antifreeze were added for the winter. Sensors were replaced as needed according to the SNOTEL network protocols (National Engineering Handbook 2015).

Kantishna SNOTEL 9/12/2023: Keegan Krantz completed the annual maintenance. Access was by fixed-wing aircraft (N709M) with Denali fleet pilot Justin Wiseman. The site was down and needed to be repaired. The precipitation gage was flushed, and 10 gallons of fresh antifreeze were added for the winter. Sensors were replaced as needed according to the SNOTEL network protocols (National Engineering Handbook 2015).

Wonder Lake Climate Reference Network Station (AK Denali 27N)

9/5/2023. Pam Sousanes, Blake Randolph and Zack Henderson (NOAA) maintained the station according to CRN standards. The site was accessed by A-Star helicopter N149AE. Staff traveled from Fairbanks to Denali, flew to the site for the day, and returned to Fairbanks.

Wrangell-St. Elias

Stations maintained in WRST include Chicken Creek, Chititu, Gates Glacier, and Tebay. We did not get to Tana knob this year due to aircraft schedule conflicts. The May Creek, Chisana, and Strelna/Chitina fire RAWS were also maintained. May Creek Snotel was maintained, but the Chisana Snotel was not.

Chicken Creek

Date/Time: 7/25/2023 11:00

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N142AE – Eric Steinbauer

Weather: upper 50s.

Damage: none

Sensors replaced:

Removed: AT/RH EE181 #2128160011910A, WS/WD 05103 #174241

Installed: AT/RH EE181 #183116000047DE, WS/WD 05103 #95219

Other hardware replaced: none

Additional Comments: Changed snow depth height to 84.5 inches. Station looked great. Batteries looked good.

Potential Data Issues: None. Shouldn't impact time stamp, but GPS month/day are off. The year and time are correct.

To Do:

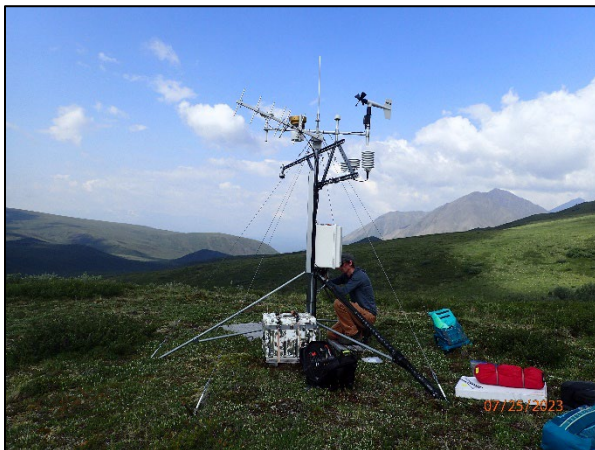


Figure 8. Chicken Creek climate station, July 27, 2023.

Chititu

Date/Time: 725/2023 13:45

Personnel: Pam Sousanes, Ken Hill

Logistics: A-star helicopter – Temsco – N142AE – Eric Steinbauer

Weather: low 60s. Pleasant.

Damage: none

Sensors replaced:

Removed: AT/RH EE181 #2129160013562F

Installed: AT/RH EE181 #1929160001188D

Other hardware replaced: Swapped CH100 #5850 charging regulator to CH200 #15558. Swapped CR1000 datalogger #26933 to CR1000X #43329 and TX321 satellite transmitter #2157 to TX325 #300001470.

Additional Comments: Loaded new program for CR1000X/TX325 combo. Reconnected guy wire that had come loose.

Potential Data Issues: none

To Do:



Figure 9. Chititu climate station, July 25, 2023.

Gates Glacier

Date/Time: 8/19/2023 10:15

Personnel: Ken Hill, Louis Sass (USGS)

Logistics: Alpine Air helicopter - Loso/Scott WRST task order

Weather: upper 40's.

Damage: none

Sensors replaced:

Removed AT/RH EE181 2129160013713D.

Installed new AT/RH EE181 20181600056321.

Replaced SR50a snow depth sensor.

Other hardware replaced: Battery for camera. SD memory card on CC5MPX phenology camera.

Moved camera solar panel higher to have more available sunlight in winter.

Additional Comments:

Potential Data Issues:

AT-RH: RH readings bad

Snow: Reading 99.5

To Do:

1. Continue to monitor solar panel mount.
2. Swap batteries



Figure 10. Gates Glacier climate station on June 10, 2023 (left photo by M. Loso) and station at end of site visit August 19, 2023 (right).

Tebay

Date/Time: 8/19/2023 ~13:00

Personnel: Ken Hill and Louis Sass

Logistics: Alpine Air helicopter - Loso/Scott WRST task order

Weather: low 60s

Damage: Station damaged. Bear and/or snow damage. Almost all sensors/cables damaged, including:

AT-RH (EE181) cable disconnected from sensor.

WS-WD – Cable pulled out

SDI (SR50a) - Cable pulled out

RNIN tipping bucket out of level.

YAGI antenna horizontal with poor azimuth

GPS & Coax – cable cut

Battery cable and solar panels – wires disconnected

Sensors replaced:

AT/RH swapped EE181 sensor (In: 655A3, Out: 70904)

SR: Removed Li200x and replaced with CS320.

WS/WD: 05103 swapped

Snow Depth: Cable replaced; sensor left in place.

ST1 (10cm), ST2 (20cm), ST3 (50 cm): All sensors reinstalled.

RNIN: Sensor cable spliced.

Air Temp: Primary and Secondary 109 sensors replaced.

Other hardware replaced: Replaced CR1000 datalogger with CR1000x. Replaced TX321 with TX325. GPS cable and YAGI Coax cable replaced.

Additional Comments: All sensors and cables damaged. Had to rebuild entire site. Kept fence posts and rehabbed fence. Left extra posts (3) at site. One desiccant pack was missing, one had split open and spilled. Cleaned some corrosion on battery terminals

Potential Data Issues: All parameters. Missing logger data: 6/24/2021 – 6/13/2022. Attempted to retrieve from logger to no avail.

To Do: Consider removing the site.



Figure 11. Tebay climate station, August 19, 2023. Site had been damaged (left and center). Station after site maintenance was completed (right).

Tana Knob

Date/Time: No site visit in 2023 (due to helicopter availability)

Wrangell-St. Elias Fire RAWS

Chad Leshuk completed RAWS maintenance at May Creek (5/13/2023). Station down on arrival, replaced GPS and GPS antenna, still not working. Ordered new F6 returned to site 6/3/2023, station back online. They also did the maintenance on the Chitina/Strelna site on 6/28/2023. Chad also did maintenance at Chisana (5/16/2023), swapped RH/AT (124494), WS/WD (54533) and at Klawasi (5/14/2023). Swapped RH/AT (51539), WS/WD (42214), and SR (104259). All sensors scanned. Updated application software. Additional details are available in [WXx-Weather](#).

Wrangell-St. Elias SNOTEL

The SNOTEL site at May Creek was maintained by NRCS on September 26, 2023. Keegan Krantz accessed the site via NPS fleet aircraft with NPS pilot Justine Wiseman (Denali fleet pilot) from Gulkana. Sensors were replaced as needed according to the SNOTEL network protocols (National Engineering Handbook 2015). The precipitation gages were flushed, and 10 gallons of fresh antifreeze liquid added for the winter. The electric fence were repaired. Chisana was not visited in 2023.

Yukon-Charley Rivers National Preserve

CAKN stations maintained in YUCH include Coal Creek and Upper Charley.

Coal Creek

Date/Time: 9/7/2023 18:10

Personnel: Pam Sousanes, Ken Hill

Logistics: Fixed-wing fleet aircraft N473YC – Brian Manning

Weather: mid 50s

Damage: NEMA enclosure hinge seal is failing

Sensors replaced:

Removed AT/RH EE181#139662, SR LiCor Li200X #43130

Installed AT/RH EE181 #149866, SR LiCor Li200X #60145

Other hardware replaced:

Additional Comments: Wires were crimped under 109_2 shield, moved them. Station looked good.

Potential Data Issues: none

To Do:

1. Replace NEMA enclosure.
2. Check on replicate soil sensors to see if there is any evidence of heaving.
3. Swap batteries



Figure 12. Coal Creek climate station, September 7, 2023. Broken door hinge on enclosure (left). After station visit (right).

Upper Charley

Date/Time: 5/25/2023 12:15

Personnel: Ken Hill

Logistics: A-star helicopter – Temsco – N142AE – Erik Steinbauer

Weather: upper 50s

Damage: none

Sensors replaced:

Removed AT/RH EE181 #73117, WS/WD 05103 20117

Installed AT/RH EE181 #5345F, WS/WD 05103 95225

Other hardware replaced: Swapped SD memory card in CC5MPX camera. Swapped AT/RH shield.

Additional Comments: The GPS light was on, RC status =2, changed to zero. GPS year 2027. Site looked great. Fence was perfect. Cleared brush around site and near LZ.

Potential Data Issues: none

To Do:

1. Swap batteries

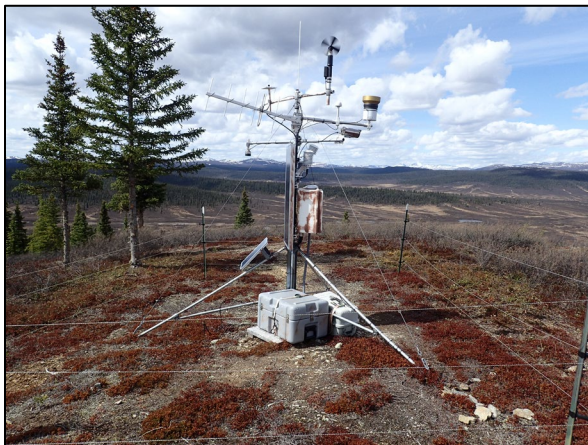


Figure 13. Upper Charley station May 25, 2023.

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Appendix A. Logistics Summary 2023

DENA Logistics

June 20-22, 2023: Toklat, Wigand, Eielson, Stampede, and Dunkle were completed by Pam Sousanes and Ken Hill. Site accessed via DENA fire A-star helicopter N149AE with pilot Josh Han. Stayed in the Admin Camp at Denali.

June 30, 2023: Ruth Glacier and Tokositna SNOTEL. Ken Hill worked with the Talkeetna Ranger staff and NRCS staff from mile 131 Parks Hwy. NRCS needed to sling gear into the site. Used the DENA rescue A-star helicopter N570AE.

September 1, 2023: Second trip to Toklat to replace datalogger and transmitter. Attempted to get to Stampede, but weather did not cooperate. Also retrieved a sound station and dropped off backcountry rangers at Toklat.

Sep 5, 2023: Wonder Lake CRN. Pam Sousanes, Blake Randolph (NOAA), and Zack Henderson (NOAA) accessed station by helicopter from Denali Park headquarters with the Temsco A-star western area fire helicopter N149AE with pilot Josh Han.

September 12, 2023: Kantishna SNOTEL accessed by park plane (N709M) with NPS pilot Justin Wiseman from the park airstrip. Keegan Krantz (NRCS) did the maintenance.

WRST Logistics

July 25-26, 2023

Personnel: Pam Sousanes, Ken Hill, Chad Leshuk (helicopter manager), and Erik Steinbauer (Temsco pilot).

Aircraft: For 2023 we used the Temsco A-star on exclusive use contract with NPS eastern area fire program. Helicopter staged at John Adam's airstrip. *In the future all work in WRST needs to be completed no later than July 24.* The 2022 helicopter policy restricts helicopter use from July 25 through September for sheep hunting, unless we apply for a waiver.

Fuel: McCarthy Airport. Account and PIN arranged prior to project. Contact Lori Rowland in McCarthy.

Housing: McCarthy B&B. Note: We were charged for all the nights we booked this summer even though we only stayed one night. Not sure if we will be able to stay here in the future.

Vehicles: Government vehicle from Fairbanks

Stations maintained: Chicken Creek and Chititu.

Equipment: All equipment transported via government vehicle.

Narrative: Pam, Ken, Trey, and Julie (SIP) traveled to McCarthy via GOV. Chad Leshuk flew with Erik Steinbauer and met the crew in McCarthy on June 25. The helicopter was called away to fires on July 26 and we could not finish the work. We spent one night at the McCarthy B&B. Fuel was purchased at the McCarthy Airport this year since there were some issues with space and aircraft at the Fireweed airstrip earlier in the season. Note: On June 22 we were made aware of the helicopter policy restricting use five days prior to the sheep hunting season that starts on August 1. Our dates overlapped with the start of the restricted period. We prioritized the sites that were in sensitive sheep

hunting areas for the first (and only) day of work. (Chicken Creek and Chititu). We did not get to Tebay, Tana, and Gates Glacier on this trip as planned.

August 19, 2023:

Ken traveled back to McCarthy and was able to use the Alpine Air helicopter under a WRST/CAKN task order established by Mike Loso and Joshua Scott. Ken drove to McCarthy on August 18 and camped. He met the Alpine Air pilot and Louis Sass (USGS glaciologist working with Mike Loso) the next morning. Ken traveled to the Gates Glacier and Tebay site with Louis. They did not have enough time to get to Tana Knob.

September 26, 2023. The SNOTEL site at May Creek was accessed from Gulkana with NPS fleet pilot Justin Wiseman from Denali. Keegan Krantz (NRCS) completed the maintenance. Weather conditions deteriorated and they could not get to the Chisana Snotel site.

YUCH Logistics

5/19/2023

Personnel: Ken Hill, Tim Nolan (helicopter manager), and Erik Steinbauer (pilot).

Aircraft: N142AE. Temsco A-star on exclusive use contract with NPS eastern area fire program.

Fuel: Jet A tanks Fort Wainwright. There was no fuel available at Coal Creek this summer due to the damaged airstrip. The airstrip was repaired in September 2023.

Vehicles: Government vehicle to Fort Wainwright/AFS heli base

Stations maintained: Upper Charley

Equipment: All equipment transported via government vehicle and aircraft.

Narrative: Crew flew from Fort Wainwright to Upper Charley and returned to Fairbanks the same day.

9/7-8/2023

Personnel: Ken Hill, Pam Sousanes

Aircraft: N473YC NPS Cessna 206. Pilot-Brian Manning

Fuel: 100 LL from Fairbanks fuel truck.

Vehicles: Personal vehicle to NPS hangar.

Stations maintained: Coal Creek

Equipment: All equipment transported via aircraft.

Narrative: Pam and Ken met NPS pilot Brian Manning at the NPS Hangar at FAI east ramp. Brian dropped crew off at Coal Creek on the afternoon of July 7. Two Coal Creek camp staff met the plane with an Argo for the crew to get to camp and the site. Spent one night at Coal Creek Camp. Brian picked up crew the next day in the afternoon. This work was done in conjunction with the CAKN Coal Creek permafrost survey.

Appendix B. CAKN I&M Station Specifications

Tables B1 through B6 provide details on the climate station specifications.

Table B1. Sensor specifications.

Measurements	Model/Manufacturer/Item#	Purchased from:
Air Temperature 1/Relative Humidity	EE181 Temperature and Relative Humidity Probe	Campbell Scientific
Air Temperature 2	109 Temperature Probe (primary beginning summer 2016)	Campbell Scientific
Air Temperature 3	109 Temperature Probe (secondary beginning in 2022 – replaced Therm-X)	Campbell Scientific
Wind Speed and direction	RM Young 05103/05103-45 (alpine version); or 05108 HD Alpine version	Campbell Scientific
Precipitation (summer rainfall)	Texas Electronics TE525WS Rain Gage	Campbell Scientific
Solar Radiation (incoming)	LI-COR LI200X, LI200RX, CS320	Campbell Scientific
Snow Depth	SR50A sonic ranging sensor	Campbell Scientific
Soil Temperature	107 or 109 Temperature Probe (3)	Campbell Scientific

Table B2. Datalogger specifications.

Datalogger	Purchased from:
CR1000-XT/CR1000X- XT Measurement and Control System	Campbell Scientific

Table B3. Satellite communication specifications.

Satellite Communication	Model/Item #	Purchased From:
GOES Satellite transmitter	TX321/TX325 GOES Transmitter	Campbell Scientific
GPS Antenna	GPS Antenna 3.3 V 17992	Campbell Scientific
GPS Cable	Antenna Cable 18017	Campbell Scientific
GOES Antenna	GOES 11 dBi YAGI RHCP Antenna 25316	Campbell Scientific
Coaxial Cable	Antenna Cable RG8 COAXNTN	Campbell Scientific

Table B4. Power specifications.

Power	Model	Purchased From:
Batteries	Concorde Sun Extender PV 1040 T 12 Volt 100 Amp hour (2)	ABS Alaskan/RES Fairbanks
Solar Panel	60-75 watt	Varies
Battery Box	Pelican Hardigg Single Lid Case	AllCases
Charging Regulator	CH100/200 12V Charging Regulator	Campbell Scientific

Table B5. Hardware specifications.

Station Hardware - Item	Type/Model	Purchased from:
Tripod	CM110 10 ft. stainless-steel tripod w/grounding kit	Campbell Scientific
Guyline Kit	Guy Kit for Tripod 19239	Campbell Scientific
Crossarm – 4 ft.	CM204 Sensor crossarm with mounting hardware – 4ft	Campbell Scientific
Crossarm – 6 ft.	CM206 Sensor crossarm with mounting hardware – 6ft	Campbell Scientific
Enclosure with (2) 1.5" diameter holes and mounting hardware for tripod	Weather Resistant 16" x 18" enclosure ENC 16/18 – DC -MM	Campbell Scientific

Table B6. Electric fence specifications.

Electric Fence Parts	Type/Model	Purchased from:
Metal fence posts	6 ft. T-Posts	Various local vendors
T-Post Insulators	5-inch extender insulators	Various local vendors
Poly wire	200 ft. Poly-wire	Various local vendors
Solar fence charger	10 mile low impedance fence charger – various models	Various local vendors

Appendix C. CAKN RAWS Components by Climate Station

Tables C1 through C 13 provide metadata on each climate station.

Table C1. Metadata for Chicken Creek climate station.

Station Name	Item	Model	Start Date
Chicken Creek	Antenna	25316 YAGI	8/21/2004
Chicken Creek	AT	109	7/6/2016
Chicken Creek	AT (2)	109 (2)	7/29/2022
Chicken Creek	AT-RH	EE181	7/25/2023
Chicken Creek	Battery	100 AH (x2)	8/21/2004
Chicken Creek	Cross arm	CM204	8/21/2004
Chicken Creek	Datalogger	CR1000	6/19/2013
Chicken Creek	DLP	Chicken2022	7/29/2022
Chicken Creek	GPS	17992 GPS	7/3/2014
Chicken Creek	RG-TB	TE525	7/12/2017
Chicken Creek	SD	SR50a	6/19/2013
Chicken Creek	Solar Panel	75 W	8/21/2004
Chicken Creek	SR	Li200x	7/29/2022
Chicken Creek	ST -10 cm	107	7/7/2020
Chicken Creek	ST -20 cm	107	7/7/2020
Chicken Creek	ST -50 cm	107	7/7/2020
Chicken Creek	ST -100 cm	107	7/7/2020
Chicken Creek	Tripod	CM106	8/21/2004
Chicken Creek	TX321	NESDIS ID 39603396	7/12/2018
Chicken Creek	WS/WD	5103	7/25/2023

Table C2. Metadata for Chititu climate station.

Station Name	Item	Model	Start Date
Chititu	Antenna	25316 YAGI	8/20/2004
Chititu	AT	109	6/30/2016
Chititu	AT (2)	109 (2)	7/29/2022
Chititu	AT-RH	EE181	7/25/2023
Chititu	Battery	100 AH (x1)	7/8/2020
Chititu	Cross arm	CM204	8/20/2004
Chititu	Cross arm	CM206	8/20/2004
Chititu	Datalogger	CR1000X	7/25/2023
Chititu	DLP	Chititu_2023_CR1000XwithTransmitter	7/29/2022
Chititu	Enclosure	ENC 16/18	8/20/2004
Chititu	GPS	17992 GPS	6/21/2013
Chititu	RG-TB	TE525	8/20/2004
Chititu	SD	SR50a	Out 2021
Chititu	Solar Panel	75 W	8/20/2004
Chititu	SR	Li200x	7/29/2022
Chititu	ST -10 cm	107	6/23/2021
Chititu	ST -20 cm	107	6/23/2021
Chititu	ST -50 cm	107	6/23/2021
Chititu	ST -100 cm	107	6/23/2021
Chititu	Tripod	CM106	8/20/2004
Chititu	TX325	NESDIS ID 396020E0	7/25/2023
Chititu	WS/WD	5103	6/23/201

Table C3. Metadata for Coal Creek climate station.

Station Name	Item	Model	Start Date
Coal Creek	Antenna	25316 YAGI	9/16/2004
Coal Creek	AT	109	7/6/2016
Coal Creek	AT (2)	109 (2)	8/8/2022
Coal Creek	AT-RH	EE181	9/7/2023
Coal Creek	Battery	100 AH (x2)	9/16/2004
Coal Creek	Crossarm	3/4"	9/16/2004
Coal Creek	Crossarm	3/4"	9/16/2004
Coal Creek	Datalogger	CR1000	7/24/2013
Coal Creek	DLP	CoalCreek2022	8/8/2022
Coal Creek	Enclosure	ENC 16/18	9/16/2004
Coal Creek	GPS	17992 GPS	9/8/2012
Coal Creek	RG-TB	TE525	9/16/2004
Coal Creek	SD	SR50a	7/24/2013
Coal Creek	Solar Panel	75 W	9/16/2004
Coal Creek	SR	Li200x	9/7/2023
Coal Creek	ST1	107	9/16/2004
Coal Creek	ST2	107	9/16/2004
Coal Creek	ST3	107	9/16/2004
Coal Creek	STF1_2	107	8/8/2022
Coal Creek	STF2_2	107	8//2022
Coal Creek	STF3_2	107	8/8/2022
Coal Creek	Tripod	CM106	9/16/2004
Coal Creek	TX321	NESDIS ID 39605670	6/14/2018
Coal Creek	WS/WD	5103	7/10/2020

Table C4. Metadata for Dunkle Hills climate station.

Station Name	Item	Model	Start Date
Dunkle Hills	Antenna	25316 YAGI	8/1/2002
Dunkle Hills	AT	109	8/11/2016
Dunkle Hills	AT (2)	Therm-X	8/1/2002
Dunkle Hills	AT-RH	EE181	6/20/2023
Dunkle Hills	Battery	100 AH (x2)	8/1/2002
Dunkle Hills	3/4"	CM204	8/1/2002
Dunkle Hills	3/4"	CM206	8/1/2002
Dunkle Hills	Datalogger	CR1000	5/26/2015
Dunkle Hills	DLP	Dunkle2020	7/29/2020
Dunkle Hills	Enclosure	ENC 16/18	9/19/2011
Dunkle Hills	GPS	17992 GPS	8/1/2002
Dunkle Hills	RG-TB	TE525	8/1/2002
Dunkle Hills	SD	SR50a	8/22/2014
Dunkle Hills	Solar Panel	75 W	8/1/2002
Dunkle Hills	SR	Li200x	6/20/2023
Dunkle Hills	ST1	107	8/8/2017
Dunkle Hills	ST2	107	8/14/2013
Dunkle Hills	ST3	107	8/14/2013
Dunkle Hills	ST4 – 90 cm	107	6/14/2021
Dunkle Hills	Tripod	CM106	8/1/2002
Dunkle Hills	TX321	NESDIS ID 3960B582	7/29/2020
Dunkle Hills	WS/WD	5103	6/20/2023

Table C5. Metadata for Eielson Visitor Center climate station.

Station Name	Item	Model	Start Date
Eielson	Antenna	25316 YAGI	6/4/2005
Eielson	AT	109	9/8/2016
Eielson	AT (2)	109 (2)	8/16/2022
Eielson	AT-RH	EE181	6/20/2023
Eielson	Battery	100 AH (x2)	6/4/2005
Eielson	Crossarm	3/4"	6/4/2005
Eielson	Datalogger	CR1000	5/28/2014
Eielson	DLP	Eielson2022	8/16/2022
Eielson	Enclosure	ENC 16/18	6/4/2005
Eielson	GPS	17992 GPS	6/4/2005
Eielson	RG-TB	TE525	6/5/2019
Eielson	SD	SR50a	5/28/2014
Eielson	Solar Panel	75 W	6/4/2005
Eielson	SR	Li200x	6/20/2023
Eielson	Tripod	CM106	6/4/2005
Eielson	TX321	NESDIS ID 39604506	8/21/2018
Eielson	WS/WD	5103	6/20/2023

Table C6. Metadata for Gates Glacier climate station.

Station Name	Item	Model	Start Date
Gates Glacier	Antenna	25316 YAGI	7/6/2005
Gates Glacier	AT	109	6/29/2016
Gates Glacier	AT (2)	109 (2)	7/29/2022
Gates Glacier	AT-RH	EE181	8/19/2023
Gates Glacier	Battery	100 AH (x2)	7/6/2005
Gates Glacier	Camera	CC5MPX	6/21/2013
Gates Glacier	Camera Battery/Solar Panel	12 Volt – 100 AH / 10 W panel	8/19/2023
Gates Glacier	Crossarm	3/4"	7/6/2005
Gates Glacier	Crossarm	CM206	7/6/2005
Gates Glacier	Datalogger	CR1000	6/21/2013
Gates Glacier	DLP	GatesGI2022	7/29/2022
Gates Glacier	Enclosure	ENC 16/18	7/6/2005
Gates Glacier	GPS	17992 GPS	7/6/2005
Gates Glacier	RG-TB	TE525	7/6/2005
Gates Glacier	SD	SR50	8/19/2023
Gates Glacier	Solar Panel	75 W	7/7/2020
Gates Glacier	SR	Li200x	7/7/2020
Gates Glacier	ST1	107	6/27/2019
Gates Glacier	ST2	107	6/27/2019
Gates Glacier	ST3	107	6/27/2019
Gates Glacier	Tripod	CM106	6/21/2013
Gates Glacier	TX321	NESDIS ID 39608018	7/11/2018
Gates Glacier	WS/WD	5103	6/24/2021

Table C7. Metadata for Ruth Glacier climate station.

Station Name	Item	Model	Start Date
Ruth Glacier	Antenna	25316 YAGI	9/6/2008
Ruth Glacier	AT	109	6/21/2017
Ruth Glacier	AT (2)	Therm-X	9/6/2008
Ruth Glacier	AT-RH	EE181	6/30/2023
Ruth Glacier	Battery	100 AH (x2)	9/6/2008
Ruth Glacier	Battery Cable	Power Cable	6/13/2012
Ruth Glacier	Charging Regulator	CH-200	6/30/2023
Ruth Glacier	Datalogger	CR1000	8/3/2021
Ruth Glacier	DLP	Ruth2019	6/26/2019
Ruth Glacier	Enclosure	ENC 16/18	6/26/2019
Ruth Glacier	GPS	17992 GPS	9/6/2008
Ruth Glacier	RG-TB	TE525	9/6/2008
Ruth Glacier	SD	SR50a	6/20/2023
Ruth Glacier	Solar Panel	75 W	9/6/2008
Ruth Glacier	SR	Li200x	8/11/2020
Ruth Glacier	ST1	107	9/6/2008
Ruth Glacier	ST2	107	9/6/2008
Ruth Glacier	ST3	107	6/24/2014
Ruth Glacier	ST4 – 90 cm	107	6/26/2019
Ruth Glacier	Tripod	FTS RAWS Lunar Lander	9/6/2008
Ruth Glacier	TX321	NESDIS ID 396063EA	6/26/2019
Ruth Glacier	TX321 Cable	Coaxial Cable	8/11/2020
Ruth Glacier	WS/WD	5103 (30')	6/20/2023

Table C8. Metadata for Stampede climate station.

Station Name	Item	Model	Start Date
Stampede	Antenna	YAGI	6/14/2021
Stampede	AT	109	8/11/2016
Stampede	AT (2)	109 (2)	6/23/2022
Stampede	AT-RH	EE181	6/22/2023
Stampede	Battery	100 AH (x2)	2003
Stampede	Crossarm	3/4"	8/1/2002
Stampede	Datalogger	CR1000	9/16/2014
Stampede	DLP	Stampede2022	6/23/2022
Stampede	Enclosure	ENC 16/18	5/18/2011
Stampede	GPS	17992 GPS	8/1/2002
Stampede	RG-TB	TE525	6/23/2022
Stampede	SD	SR50a	9/16/2014
Stampede	Solar Panel	75 W	8/1/2002
Stampede	SR	Li200x	6/22/2023
Stampede	ST1	109	8/8/2019
Stampede	ST2	109	8/8/2019
Stampede	ST3	109	8/8/2019
Stampede	ST4 – 90 cm	109	8/8/2019
Stampede	Tripod	CM106	6/14/2021
Stampede	TX321	NESDIS ID 3960A6F4	8/8/2019
Stampede	WS/WD	5103	6/14/2021

Table C9. Metadata for Tana Knob climate station.

Station Name	Item	Model	Start Date
Tana Knob	Antenna	25316 YAGI	7/5/2005
Tana Knob	AT	109	6/28/2016
Tana Knob	AT (2)	109 (2)	7/29/2022
Tana Knob	AT-RH	EE181	7/29/2022
Tana Knob	Battery	100 AH (x2)	7/5/2005
Tana Knob	Crossarm	CM204	7/5/2005
Tana Knob	Crossarm	CM206	7/5/2005
Tana Knob	Datalogger	CR1000	7/2/2014
Tana Knob	DLP	Tana2022	7/29/2022
Tana Knob	Enclosure	ENC 16/18	7/5/2005
Tana Knob	GPS	17992 GPS	7/5/2005
Tana Knob	RG-TB	TE525	6/28/2016
Tana Knob	SD	SR50	7/29/2022
Tana Knob	Solar Panel	75 W	7/5/2005
Tana Knob	SR	Li200x	7/29/2022
Tana Knob	ST1	107	6/24/2021
Tana Knob	ST2	107	7/10/2018
Tana Knob	ST3	107	7/5/2005
Tana Knob	Tripod	CM106	6/27/2012
Tana Knob	TX321	NESDIS ID 3960709C	7/10/2018
Tana Knob	WS/WD	5103	7/29/2022

Table C10. Metadata for Tebay climate station.

Station Name	Item	Model	Start Date
Tebay	Antenna	25316 YAGI	7/6/2020
Tebay	AT	109	8/19/2023
Tebay	AT (2)	109 (2)	8/19/2023
Tebay	AT-RH	EE181	8/19/2023
Tebay	Battery	100 AH (x1)	7/6/2020
Tebay	Crossarm	CM204	7/8/2005
Tebay	Crossarm	CM206	7/8/2005
Tebay	Datalogger	CR1000X	8/19/2023
Tebay	DLP	Tebay_2023_CR100X	8/19/2023
Tebay	Enclosure	ENC 16/18	7/8/2005
Tebay	GPS	17992 GPS	7/8/2005
Tebay	RG-TB	TE525	7/8/2005
Tebay	SD	SR50a	7/6/2020
Tebay	Solar Panel	75 W	7/8/2005
Tebay	SR	CS320	8/19/2023
Tebay	ST1	107	8/19/2023
Tebay	ST2	107	8/19/2023
Tebay	ST3	107	8/19/2023
Tebay	Tripod	CM106	7/3/2014
Tebay	TX325	NESDIS ID 3960936E	8/19/2023
Tebay	WS/WD	5103	8/19/2023

Table C11. Metadata for Toklat climate station.

Station Name	Item	Model	Start Date
Toklat	Antenna	25316 YAGI	6/16/2005
Toklat	AT	109	9/9/2016
Toklat	AT (2)	109 (2)	6/23/2022
Toklat	AT-RH	EE181	6/20/2023
Toklat	Battery	100 AH (x2)	6/5/2019
Toklat	Crossarm	3/4"	6/16/2005
Toklat	Datalogger	CR1000X	9/1/2023
Toklat	DLP	Toklat_2023_CR100X_TX325	9/1/2023
Toklat	Enclosure	ENC 16/18	6/16/2005
Toklat	GPS	17992 GPS	5/28/2014
Toklat	RG-TB	TE525	9/9/2016
Toklat	SD	SR50a	8/24/2021
Toklat	Solar Panel	75 W	6/16/2005
Toklat	SR	Li200x	6/23/2022
Toklat	ST1	107	6/16/2005
Toklat	ST2	107	6/16/2005
Toklat	ST3	107	6/16/2005
Toklat	Tripod	CM106	6/16/2005
Toklat	TX325	NESDIS ID 396063EA	9/1/2023
Toklat	WS/WD	5103	6/20/2023

Table C12. Metadata for Upper Charley climate station.

Station Name	Item	Model	Start Date
Upper Charley	Antenna	25316 YAGI	8/3/2005
Upper Charley	AT	109	8/8/2022
Upper Charley	AT (2)	109 (2)	8/8/2022
Upper Charley	AT-RH	EE181	5/25/2023
Upper Charley	Battery	100 AH (x2)	8/3/2005
Upper Charley	Camera	CC5MPX	7/23/2013
Upper Charley	Camera Battery/Solar Panel	12 Volt – 100 AH / 10 W panel	8/6/2015
Upper Charley	Crossarm	3/4"	8/3/2005
Upper Charley	Crossarm	CM206	8/3/2005
Upper Charley	Datalogger	CR1000	9/7/2012
Upper Charley	DLP	UCharley2022	8/8/2022
Upper Charley	Enclosure	ENC 16/18	8/3/2005
Upper Charley	GPS	17992 GPS	9/8/2012
Upper Charley	RG-TB	TE525	8/3/2005
Upper Charley	SD	SR50a	6/13/2017
Upper Charley	Solar Panel	75 W	8/3/2005
Upper Charley	SR	Li200x	8/8/2022
Upper Charley	ST1	107	7/23/2013
Upper Charley	ST2	107	7/23/2013
Upper Charley	ST3	107	7/23/2013
Upper Charley	ST4 – 75 cm	107	5/14/2019
Upper Charley	Tripod	CM206	8/3/2005
Upper Charley	TX321	NESDIS ID 3960D064	6/13/2018
Upper Charley	WS/WD	5103	5/25/2023

Table C13. Metadata for Wigand climate station.

Station Name	Item	Model	Start Date
Wigand	Antenna	25316 YAGI	8/3/2005
Wigand	AT	109	8/11/2016
Wigand	AT (2)	109 (2)	6/23/2022
Wigand	AT-RH	EE181	6/21/2023
Wigand	Battery	100 AH (x2)	8/13/2013
Wigand	Crossarm	3/4"	8/13/2013
Wigand	Crossarm	CM206	8/13/2013
Wigand	Datalogger	CR1000	8/13/2013
Wigand	DLP	Wigand2022	6/23/2022
Wigand	Enclosure	ENC 16/18	8/13/2013
Wigand	GPS	17992 GPS	8/13/2013
Wigand	RG-TB	TE525	8/13/2013
Wigand	SD	SR50a	8/13/2013
Wigand	Solar Panel	10W	6/21/2023
Wigand	SR	Li200x	6/23/2022
Wigand	ST1	107	8/19/2023
Wigand	ST2	107	8/19/2023
Wigand	ST3	107	8/19/2023
Wigand	ST4	107	removed
Wigand	ST5	107	removed
Wigand	Tripod	CM206	8/13/2013
Wigand	TX321	NESDIS ID 39600060C	8/8/2019
Wigand	WS/WD	5103	6/21/2023

