Alaska Climate Research Center
The Alaska State Climate Center

STATEWIDE CLIMATE SUMMARY MARCH 2023

A snapshot of ground-based snow measurements in foothills of the northern Brooks Range during NASA SnowEx Alaska 2023 campaign. Photo by Sveta Stuefer, March 11, 2023.

IN THIS ISSUE

Geophysical Institute
University of Alaska Fairbanks

Alaska's Statewide Climate Summary for March 2023 provides an overview of weather for the month based on data from selected weather stations throughout the state. "Departure from normal" refers to the climatological average over the 1991-2020 normal period. Here, we report on temperature, precipitation and drought conditions in the state, as well as the condition of the Arctic sea ice.

HIGHLIGHTS

Impactful storm series on the West Coast: Blizzard conditions, snow drifts, rain and snow, very mild temperatures

Third wettest March on record in Kotzebue and Nome

Unusually mild in the West and North of the state, cooler than average in the South East

Significant Weather Events and Synoptics

The first week of March brought multiple very strong storms to Alaska's West Coast. On March 3 and 4, a Bering Sea storm reached the coast and moved further north into the Chukchi Sea, causing wide-spread blizzard conditions in coastal communities. The very unsettled weather persisted until about March 8 as a series of shortwave systems moved up the coast with heavy precipitation and strong winds. Kotzebue was particularly impacted by large snow drifts and blizzard conditions. Nome also saw high winds and blowing snow but reported rain later on. Temperatures along the coast increased substantially due to warm and very wet air masses being advected to high latitudes from the south as the storm systems moved through. The upper level pattern during this time was characterised by troughing over the Bering Sea and a very pronounced ridge over Alaska. The West Coast storms moved almost due north along the pressure gradient associated with this pattern. Unusually warm temperatures were recorded in the West and North of the state due to the strong southerly flow. South-East Alaska saw the flip side of the early March patterns and experienced colder than normal weather downstream of the upper level trough (Fig. 1, upper panel).

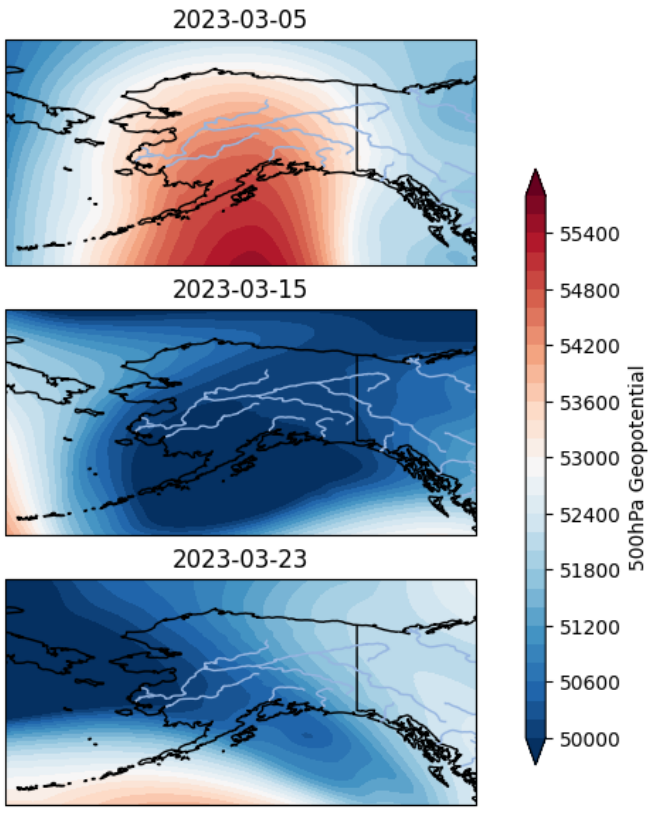

Figure 1. *Geopotentiial at the 500hPa level on March 3, 15 and 23, data courtesy of Copernicus ERA5 reanalysis.*

Following this period of warm, wet storms in the West, ridging spread over the Bering Sea and much of the state, while upper level troughing developed over Canada and the eastern Interior. Temperatures in the North dropped back to around normal values by the weekend of March 11, bringing an end to the period of extremely mild weather. It got even colder the following week. Cold Arctic air masses moved into Alaska in the wake of a long wave trough in the east that gradually spread further into the northern parts of the state.

By mid-month, widespread upper level troughing was centred over Alaska. The weather was mostly calm and cold during this period, with some blowing snow and at times significant wind chill. A pronounced long wave trough extended from the Arctic Ocean well into the Gulf of Alaska, allowing cold air to move relatively far south. Milder conditions returned to the Panhandle by about March 15 due to its location on the downstream side of the trough axis and associated southerly flow (Fig. 1, middle panel).

A cutoff low eventually developed in the Gulf of Alaska on the southern edge of the long wave trough, while a low pressure system over the Russian coast gradually moved east into the Bering Sea. This lead to rising temperatures and renewed storminess along the West Coast. A strong but relatively short-lived storm moved from the Bering Sea through the Bering strait and into the Chukchi Sea on March 20 and 21. Conditions remained unsettled in the southern coastal areas due to separate storm systems in the Gulf of Alaska. A long wave trough extending from the Russian coast to the US Pacific North West brought several weather fronts and colder air masses in the following days (Fig. 1, bottom panel). The last week of the month was once again characterised by a strong storm system in the Bering Sea. The associated low deepened very rapidly on March 24 (“bomb cyclogensis”) and brought blizzard conditions to the coastal communities. As the low moved north and east and eventually dissipated, ridging briefly spread across western and central Alaska before the next Bering Sea storm systems moved in during the last days of March.

Temperature

Monthly mean temperatures in March were quite variable throughout the state. The North Slope and the Southwest were the warmest regions. Utqiaġvik topped the list at 7.6°F above the 1991-2020 climatological mean followed by St. Paul Island, Bethel, and Cold Bay which all recorded about 4°F above normal. Interior stations were mostly close to normal. Southcentral Alaska and the Panhandle were cooler than normal this month. The greatest negative anomalies were recorded in Yakutat and Juneau with -3.4°F and -2.3°F below normal, respectively (Fig. 2, Table 1).

The daily anomalies show that there were multiple larger scale temperature swings in March, which is in line with the changeable upper level weather patterns. The month started out cool at almost all the selected First Order Stations. The storm series on the

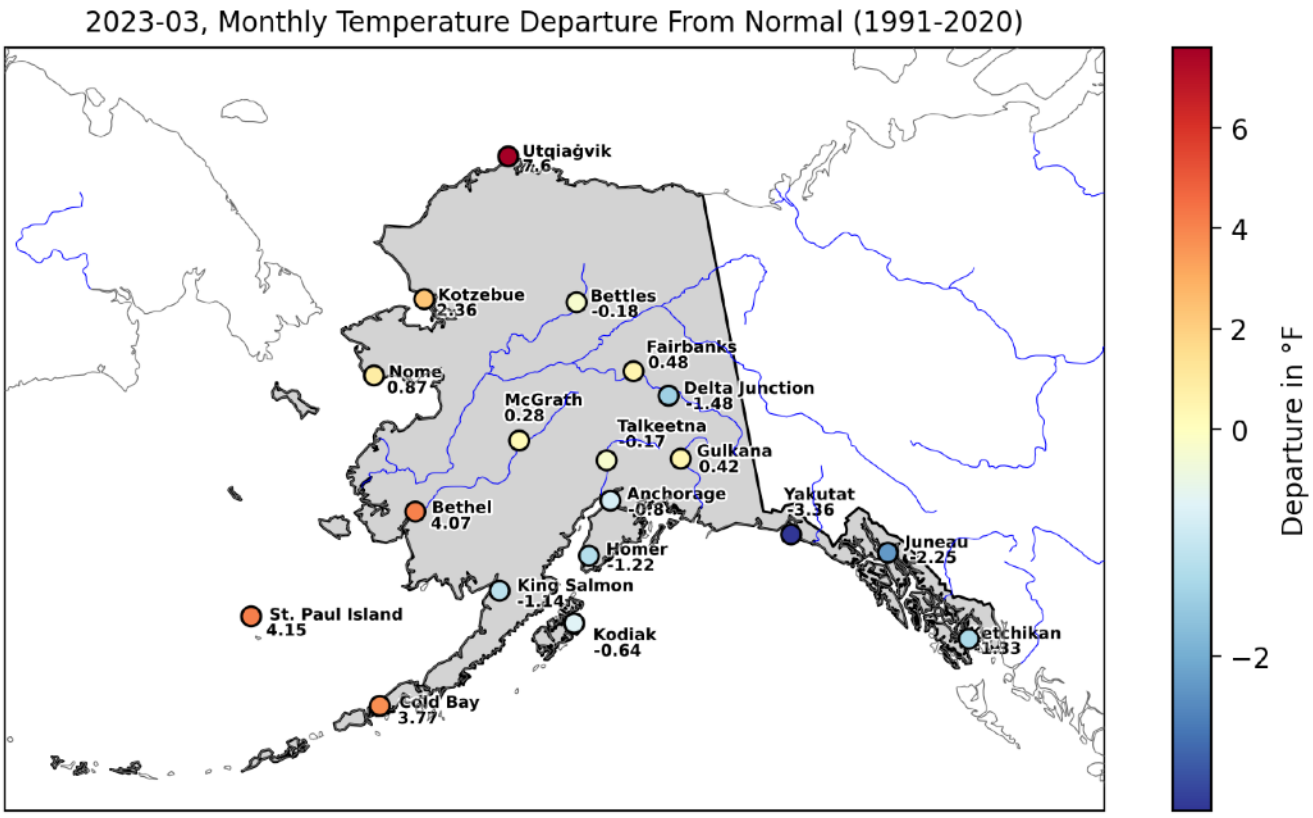

Figure 2. *Monthly mean temperature departure from normal (ºF), March 2023, at the selected First Order stations in Alaska.*

West Coast then brought some days of positive anomalies to all regions except the Southeast. As warm air flowed north during the first week of March, daily anomalies reached values of 25°F or more above normal in Utqiaġvik, Kotzebue, and Nome. Positive anomalies were less extreme in the eastern and southern parts of the state. A period of colder weather followed as the upper level pattern flipped and cold Arctic air masses spread into Alaska. Milder weather returned for about the last third of the month with a renewal of storm activity in the Bering Sea and the Gulf of Alaska.

Daily temperature records for March reflect the very mild nature of the stormy period early in the month. During this time, 5 new high records for daily mean temperature were set, in addition to 6 for minimum and maximum temperatures, respectively. The stations recording the records were almost exclusively in the western coastal areas most strongly impacted by the storms. One new record for a high minimum temperature was set later in the month (March 25 in St. Paul Island). See the tables in the appendix for a list of daily records. Now new low records were set this month. This indicates that the cold snap mid-month was not climatologically unusual, while the warmth early in month was quite extreme.

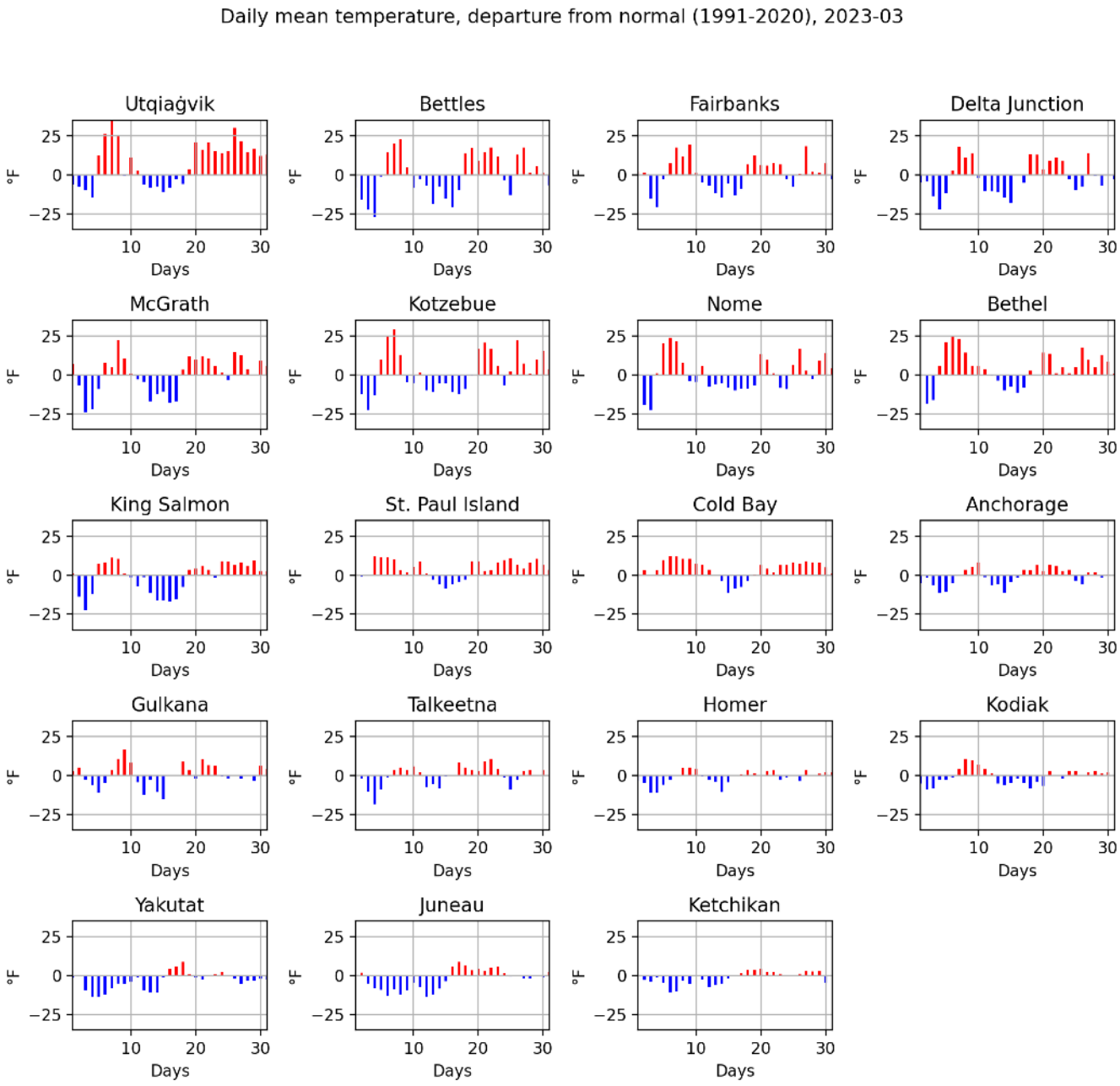

Figure 3. *Daily mean temperature departures for each day in March 2023 at the selected stations.*

Station	Observed (ºF)	Normal (ºF)	Departure (ºF)
Anchorage	25.0	25.8	-0.8
Bethel	18.6	14.5	4.1
Bettles	3.5	3.7	-0.2
Cold Bay	33.7	29.9	3.8
Delta Junction	12.7	14.1	-1.5
Fairbanks	11.2	10.7	0.5
Gulkana	14.8	14.7	0.4
Homer	28.9	30.1	-1.2
Juneau	30.6	32.9	-2.2
Ketchikan	36.6	38.0	-1.3
King Salmon	22.4	23.5	-1.1
Kodiak	32.5	33.2	-0.6
Kotzebue	3.9	1.5	2.4
McGrath	12.2	11.9	0.3
Nome	10.5	9.6	0.9
St. Paul Island	29.3	25.2	4.2
Talkeetna	23.4	23.5	-0.2
Utqiaġvik	-2.9	-10.5	7.6
Yakutat	28.5	31.9	-3.4

Table 1. *Mean monthly air temperature, normal (1991-2020) and departure for selected stations throughout the state, March 2023. Color-coded to match Figure 2 (yellow-orange-red = warmer than usual; shades of blue = cooler than usual).*

Precipitation and snow

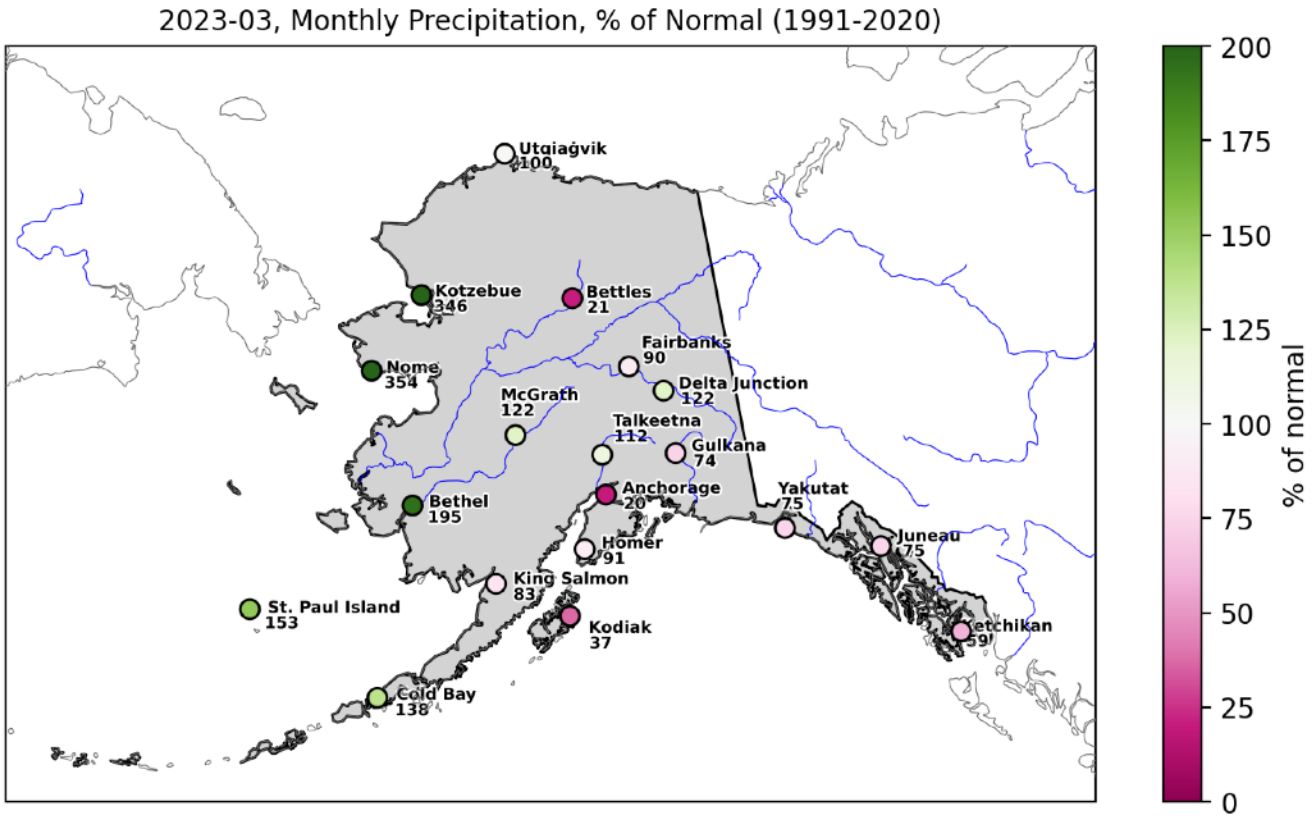

Figure 4. *Monthly mean precipitation departure from normal (in percent), March 2023, for selected stations around the state of Alaska.*

The western coastal regions most affected by the March storms had a very wet month. Kotzebue and Nome recorded the largest precipitation anomalies with over three times the 1991-2020 normal (346% and 354% of normal, respectively). March 2023 was the third wettest March ever recorded in Kotzebue and Nome. Bethel, St. Paul Island, and Cold Bay were in the path of the same storms early in the month and also had a wetter March than normal, though with less extreme deviations than Nome and Kotzebue. Utqiaġvik and most of the Interior stations were near normal. Bettles is an exception in this case and recorded only 21% of normal March precipitation. Southcentral Alaska and the Panhandle had a relatively dry month. Anchorage was the driest station in relative terms with 20% of normal (Fig. 4 and 5, Table 2).

Of the four selected stations with long term, continuous snow measurements, Fairbanks, Juneau, and Bettles recorded near normal values with 89%, 110% and 115% of normal,

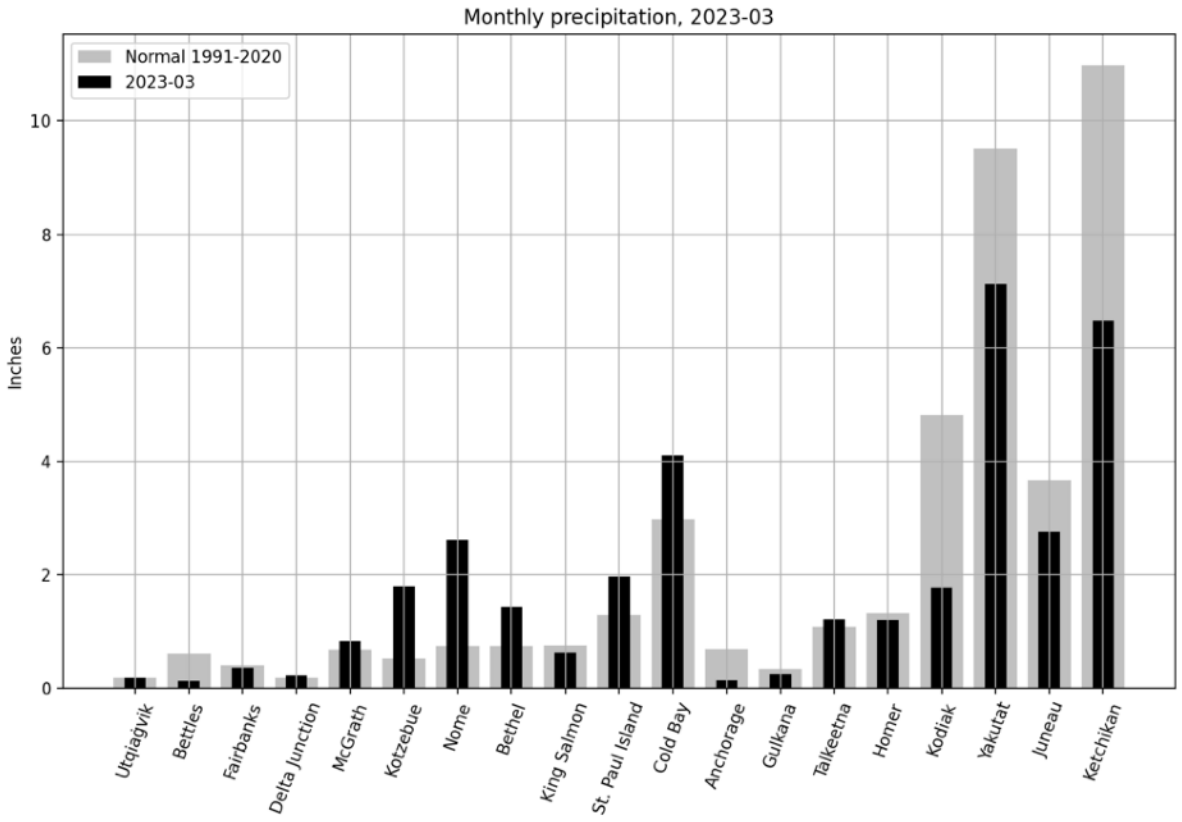

Figure 5. *Monthly precipitation sums for March 2023 at the selected First Order stations compared to the normal (1991-2020), in inches.*

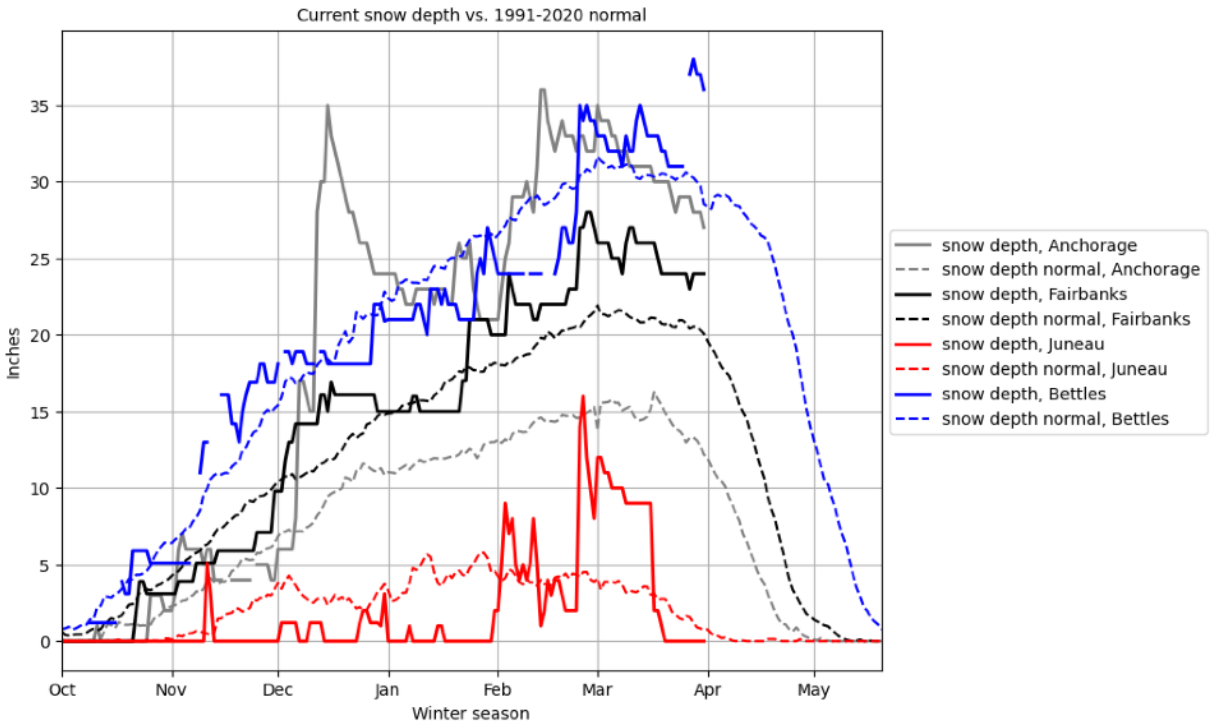

Figure 6. *Snow depth in Anchorage (grey), Fairbanks (black), Juneau (red), Bettles (blue) through March 31. Solid lines show current snow depth at the respective stations. Dashed lines show the 1990/91-2019/20 mean value throughout the winter season.*

respectively. Anchorage had the largest negative deviation from normal precipitation of the selected station this month and reported only 19% of normal snowfall in March. Snow depth in Anchorage remains substantially above normal although the seasonal decrease appears to have begun aided by the very dry month. Snow depth in Fairbanks and Bettles is hovering slightly above normal. Bettles suffered a data outage in March and there is a suspicious jump in the snow depth time series that may be corrected in future versions of the GHCN-Daily data plotted in Fig. 6. Juneau recorded above average snow depth during the first half of the month but has since dropped to near zero. SWE values from the SNOTEL network suggest that many regions have a near normal or above normal snowpack for the time of year (Fig. 7).

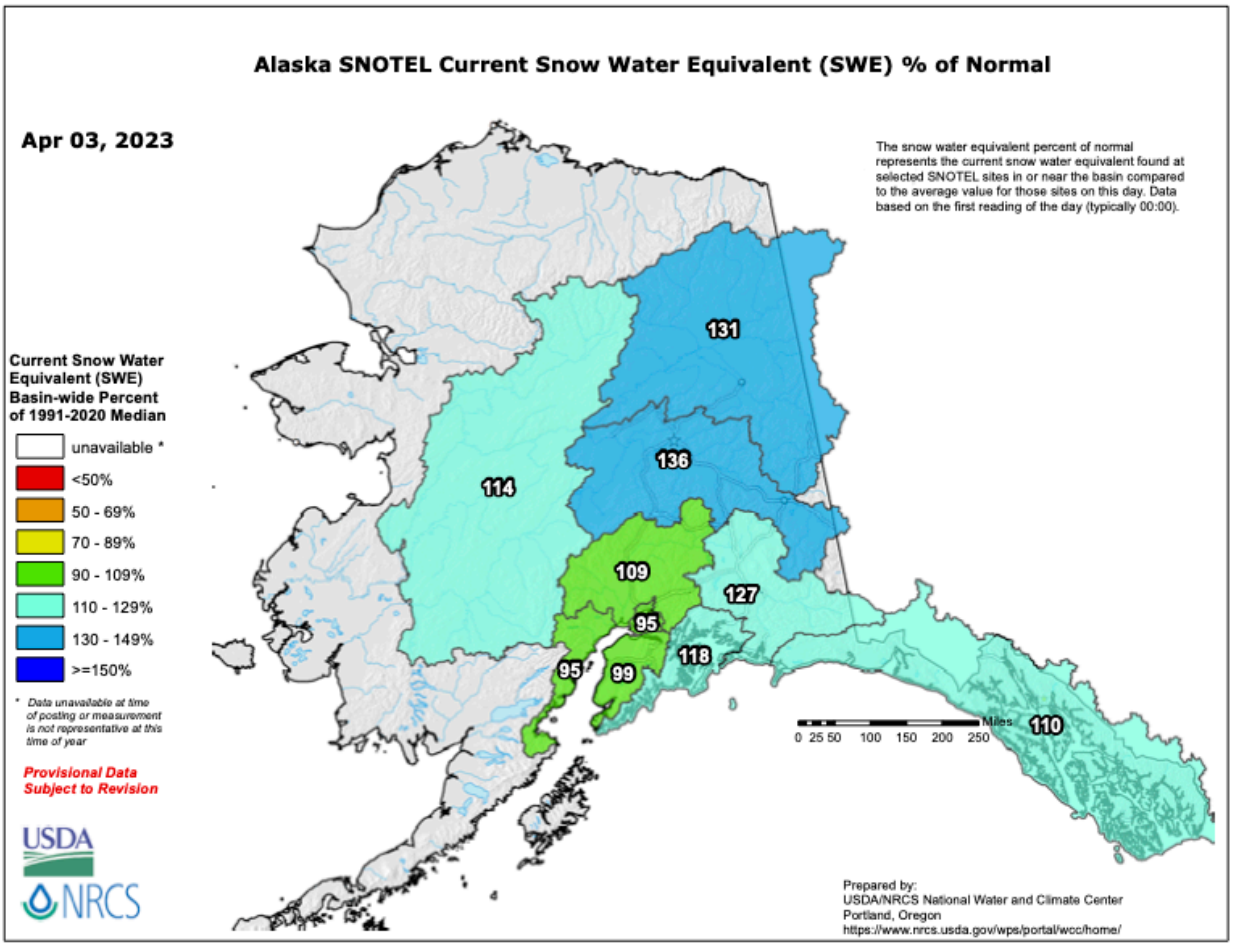

Figure 7. *SWE as % of basin-wide normal, AK SNOTEL Network. Data and graphic: NRCS, USDA*

Station	Precipitation (in)	Normal (in)	% of Normal
Anchorage	0.1	0.7	20.3
Bethel	1.4	0.7	194.6
Bettles	0.1	0.6	21.3
Cold Bay	4.1	3.0	137.6
Delta Junction	0.2	0.2	122.2
Fairbanks	0.4	0.4	90.0
Gulkana	0.2	0.3	73.5
Homer	1.2	1.3	90.9
Juneau	2.7	3.7	74.9
Ketchikan	6.5	11.0	58.9
King Salmon	0.6	0.8	82.9
Kodiak	1.8	4.8	36.9
Kotzebue	1.8	0.5	346.2
McGrath	0.8	0.7	122.1
Nome	2.6	0.7	354.1
St. Paul Island	2.0	1.3	152.7
Talkeetna	1.2	1.1	112.0
Utqiaġvik	0.2	0.2	100.0
Yakutat	7.1	9.5	74.8

Table 2. *Monthly precipitation sum, normal (1991-2020) and departure expressed as a percentage of the normal (1991-2020) for selected stations throughout the state, March 2023. Colors match the color scale in Figure 4.*

Arctic Sea Ice

Arctic sea ice has likely begun its seasonal decline. March saw some ups and downs with small increases and decreases. Sea ice extent was declining throughout the last week of the month. This kind of variability is not unusual for the time of year and characteristic of the shift from growth season to sea ice decline. As of March 30, Arctic sea ice extent was 14.284 M km2, down from 14.628 M km2 on March 2. Figure 9 shows a time series of sea ice extent while Figures 10 A and B show the sea ice extent and concentrations as of March 30 2023 compared to the average from 1981-2010.

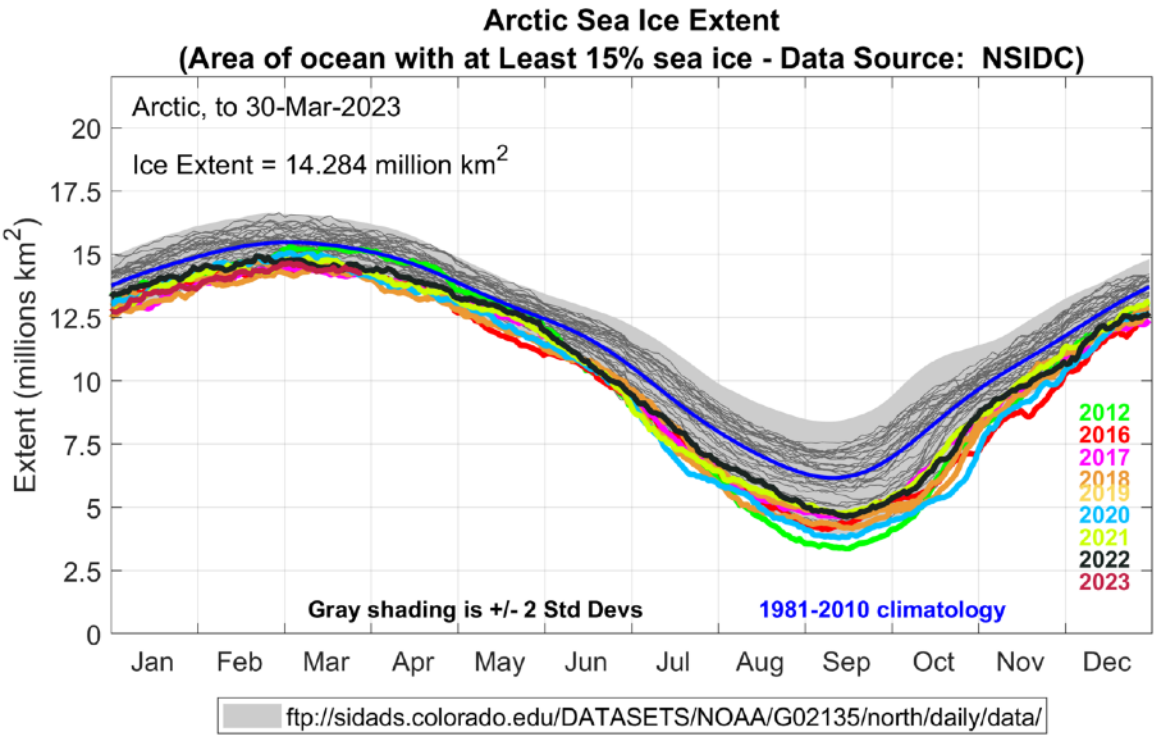

Figure 9. *Time series of daily Arctic sea ice extent. This year's data (black) are updated until March 30, 2023. The median sea ice extent for the 1981-2010 reference period is depicted in blue. Specific years are highlighted in colors. Plot Compiled by: Howard J. Diamond, PhD; Climate Science Program Manager at NOAA's Air Resources Laboratory Data Source: National Snow & Ice Data Center (nsidc.org/)*

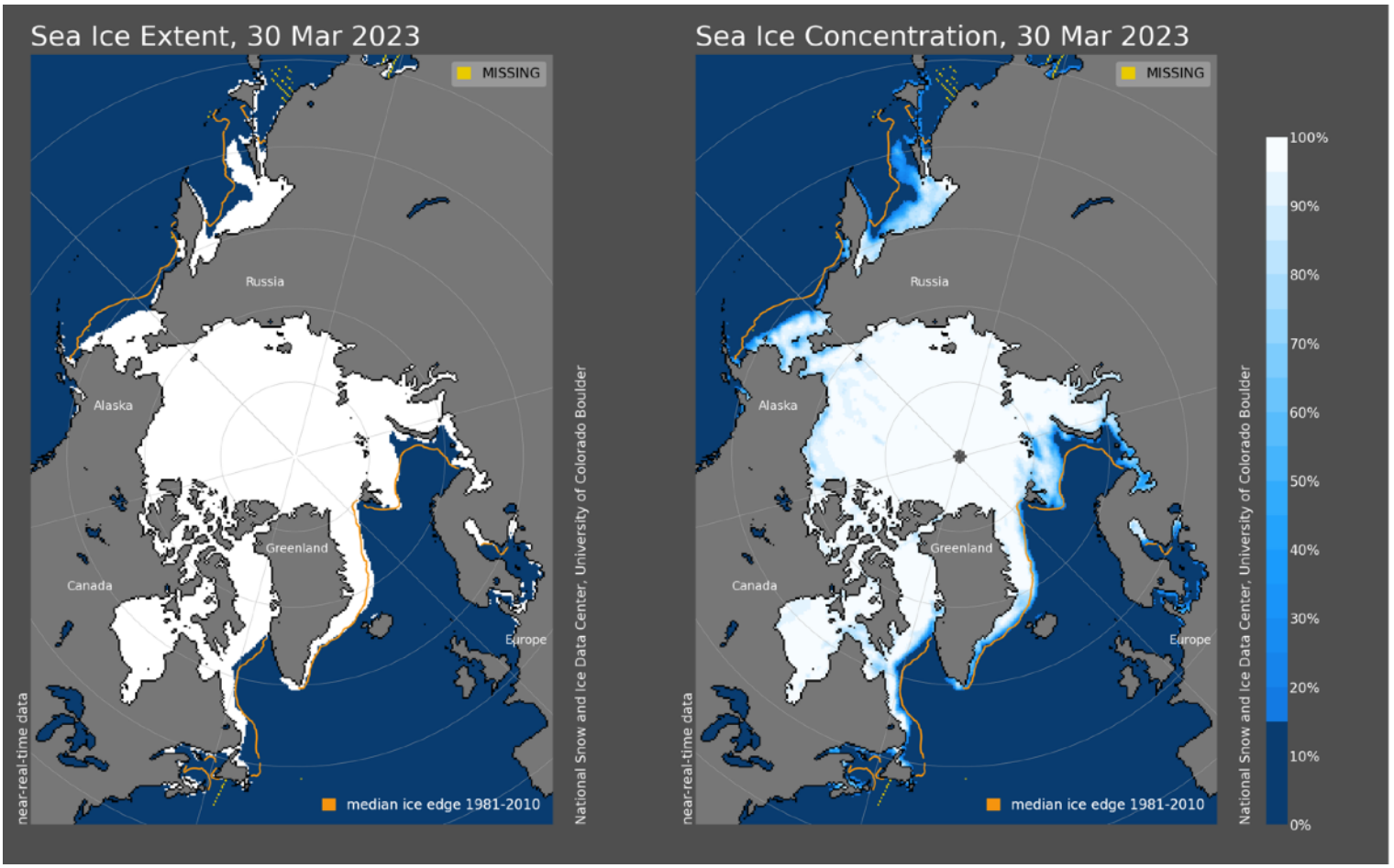

Figure 10. *A (left) Arctic sea ice extent and B (right concentrations as of March 30, 2023 compared to the average from 1981-2010 (Data and images: NSIDC)*

Newsworthy Information

Unusual warmth challenging for Iditarod mushers: The warm weather with freezing rain early in the month impacted Iditarod Sled Dog Teams. Mushers adapted their race strategies to avoid having the dogs run for extended periods of time in the mild temperatures. ADN report.

UAF researchers develop new method to improve shorefast ice change detection: A new study lead by UAF researchers shows that a portable interferometric radar system can be used to improve early warning systems for instabilities in shorefast ice. These can be dangerous to people working on the ice and pose challenges to navigation near the coast. More information.

NASA campaign to improve snow measurements: As part of NASA's SnowEx campaign, detailed snow measurements were carried out around Fairbanks and on the North Slope during March (see title photo and image below). The ground-based measurements serve as a robust validation data set to compare with time-synchronous airborne and overlapping satellite observations. The combined data sets of the SnowEx campaigns will improve estimates of how much water is contained the snow pack. More information.

Scientists conduct ground-based snow measurements in the foothills of the northern Brooks Range during NASA SnowEx Alaska 2023 campaign. Photo by Sveta Stuefer, March 11, 2023.

Appendix

Highest Mean Daily Temperature on Record				
Station	**Date**	**New Record (°F)**	**Year of Old Record**	**Old Record (°F)**
Bethel	2023-03-06	38.0	1950	36.5
Cold Bay	2023-03-06	42.0	1963	40.0
Cold Bay	2023-03-09	40.0	2019	39.5
Kotzebue	2023-03-07	30.0	1949	29.0
Utqiaġvik	2023-03-07	24.0	1949	12.0

Table A1: March 2023 daily records of mean daily temperature, i.e. highest/lowest values of mean daily temperature ever recorded on specific days. Records are computed since the beginning of the respective time series. Five new highest mean daily temperature records were set and none were set for lowest mean daily temperature.

Highest Maximum Daily Temperature Record				
Station	**Date**	**New Record (°F)**	**Year of Old Record**	**Old Record (°F)**
Bethel	2023-03-06	41.0	1938	40.0
Cold Bay	2023-03-09	50.0	1963	47.0
Cold Bay	2023-03-11	48.0	2003	44.0
Kodiak	2023-03-08	54.0	1955	50.0
Kotzebue	2023-03-07	34.0	2003	32.0

Utqiaġvik	2023-03-07	31.0	1949	23.0

Table A2: March 2023 daily records of maximum daily temperature, i.e. highest/lowest values of maximum daily temperature ever recorded on specific days. Records are computed since the beginning of the respective time series. Six new highest maximum daily temperature records were set and no new lowest records were set.

Highest Minimum Daily Temperature Record				
Station	**Date**	**New Record (°F)**	**Year of Old Record**	**Old Record (°F)**
Bethel	2023-03-05	31.0	2000	29.0
Bethel	2023-03-06	35.0	1950	33.0
Cold Bay	2023-03-06	40.0	1998	37.0
Nome	2023-03-06	32.0	1984	31.0
St. Paul Island	2023-03-05	35.0	1982	34.0
St. Paul Island	2023-03-25	35.0	1937	34.0
Utqiaġvik	2023-03-07	17.0	1995	5.0

Table A3: March 2023 daily records of minimum daily temperature, i.e. highest/lowest values of minimum daily temperature ever recorded on specific days. Records are computed since the beginning of the respective time series. Seven new records for highest minimum daily temperature were set. None were set for lowest minimum daily temperature.

This information consists of climatological data compiled by the Alaska Climate Research Center, Geophysical Institute, University of Alaska Fairbanks. For more information on weather and climatology, visit the center website at http://akclimate.org. Please report any comments, ideas or errors to uaf-climate@alaska.edu.