Alaska Climate Research Center
The Alaska State Climate Center

ANNUAL REPORT 2023

Nome, September 8, 2023.
Photo source: Alaska Climate Research Center, Martin Stuefer

Geophysical Institute
University of Alaska Fairbanks

KEY OBSERVATIONS

Temperature

Alaska as a whole was moderately warmer than the 1991-2020 normal with a deviation of about 0.4°F. There were pronounced regional differences in annual air temperature: Western Alaska had a substantially cooler than average year, while the northern and eastern parts of the state were above normal. Utqiaġvik was once again the warmest of the selected First Order stations in relative terms with an annual deviation of almost 4°F.

Precipitation

Precipitation was regionally variable but mostly above average at the annual scale. The North and Interior continued an ongoing streak of unusually wet years. Only the southwestern parts of the state were slightly drier than the long-term average. Sustained drought conditions did not develop this year and only a limited region in the Interior was affected by abnormally dry conditions during summer.

Snowfall

The 2023/24 winter season in Anchorage has been the snowiest in over 50 years. For the 2023 calendar year, Anchorage recorded about 170% of normal snowfall. Fairbanks was also above average at almost 140% of normal, while Bettles and Juneau had slightly below or near normal snowfall amounts. The record snowfall in Anchorage was driven mainly by impactful storms in November and December.

Wildfire season

The 2023 fire season started and ended relatively late in the year. Practically all fire activity occurred after July 24, when a thunderstorm with a lot of lightning sparked numerous fires. About 295,000 acres, mostly in the Interior, had burned by mid-August when wet weather ended the fire season. While Alaska had a fairly moderate fire year, neighboring Canada experienced a historic and destructive season with a total of more than 45 million acres burned.

Sea ice extent

Arctic Sea Ice reached its minimum extent for 2023 on September 19 at 1.63 million square miles. This was the sixth lowest minimum extent in the satellite record.

General overview and significant weather events

Globally, 2023 was the warmest year on record by a substantial margin. In Alaska, the year was slightly warmer than the 1991-2020 climate normal but not extremely so. Mean annual air temperature (MAAT) in Alaska remained well below the below the record years 2016 and 2019 and was marginally cooler than in 2022.

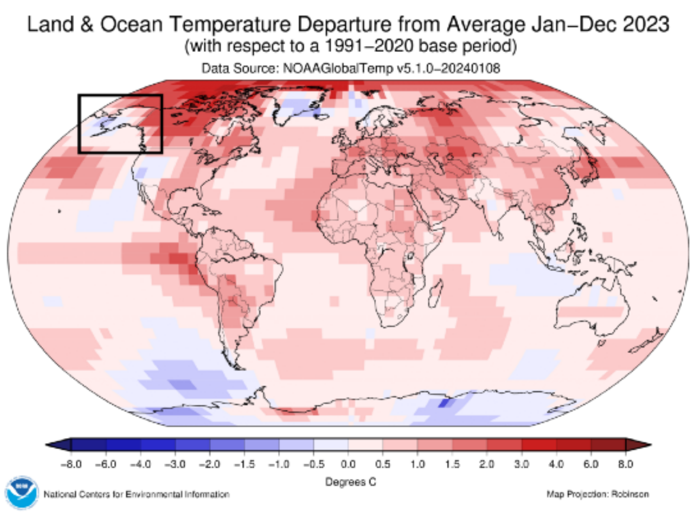

Figure 1. *NOAA GlobalTEMP annual temperature, deviation from the 1991-2020 base period. Black rectangle indicates Alaska.*

In a map of global temperatures for 2023 (Fig. 1; NOAAGlobalTemp data, Vose et al., (2021)), Alaska stands out as one of very few blue (cool) areas in a predominantly red map. Looking more closely at Alaska, the map further shows that the "blob" of cooler temperatures was centered over the Bering Sea and western AK, while the Arctic coast and eastern parts of the state were much warmer. This pattern is also apparent in the records from the First Order weather stations in Alaska (Fig. 2, Table 1) and spatially aggregated data products such as the NOAA Climate Division data set (Figs. 3, 4; Bieniek et al., 2012) and ERA5 reanalysis data (Hersbach et al., 2020). Of the First Order stations, Utqiaġvik had the highest positive annual deviation with +3.8°F above the 1991-2020 normal. Nome was coldest with -1.7°F below normal.

2023 was a wetter than average year in most of Alaska. Only the southwest (Cook Inlet and Bristol Bay region) deviates from this pattern with a moderately below normal year. Regionally, a number of major snowfall events contributed substantially to the annual statistics. Kotzebue saw an impactful storm in March, during which snow in combination with high winds produced wind drifts that temporarily blocked access to homes and important infrastructure. Anchorage and the surrounding areas as well as parts of the Panhandle had multiple episodes with record or near record snowfall in November and

December. After an unusually cold April, May brought destructive spring flooding to multiple communities mainly along the Yukon and Kuskokwim rivers.

In August, a glacial lake outburst flood (GLOF) originating in Suicide Basin, a side drainage of the Mendenhall glacier, destroyed multiple homes in Juneau. GLOFs occur when lakes contained by glacier ice or moraines suddenly drain. The Mendenhall GLOF has been a near-annual occurrence for over a decade but the destructiveness of the 2023 event was unprecedented. The processes driving the GLOFs at the Mendenhall and Suicide glacier system are strongly linked to glacial recession. As Suicide glacier retreated over the last decades and lost its former connection to Mendenhall, a lake formed in Suicide Basin. Water pressure increases during the melt season and drainage channels form under Mendenhall glacier, eventually resulting in the GLOF.

In November, a landslide near Wrangell tragically killed six people. The landslide was likely triggered by heavy rain during a storm immediately preceding the event, which came on top of a relatively wet fall season in the area. Southeast Alaska is a region prone to landslides due to the topographic and climatic setting, but predicting the exact timing and location of landslides is complicated due to the interplay of various possible causative factors.

2023 Temperature in Detail

Annual Temperature in Alaska

The First Order stations show a split pattern of mean annual temperatures (MAAT) with warmer than average conditions in the north and east of the state and near normal or moderately cooler than average temperatures in the west and southwest (Figure 2, Table 1). Utqiaġvik once again topped the list as the warmest of the selected stations in relative terms, with an annual deviation of +3.8°F from the 1991-2020 normal. The Panhandle stations are next warmest with around 1.7-1.9°F above normal. Nome was the coldest station in 2023, relatively speaking, with about -1.7°F below normal. In Utqiaġvik, 2023 was the fourth-warmest year of the time series. There has not been a year with a negative deviation from the 1991-2020 normal since 2012 at the Utqiaġvik station. Most of the other First Order stations have had at least one or two cooler years in the last decade.

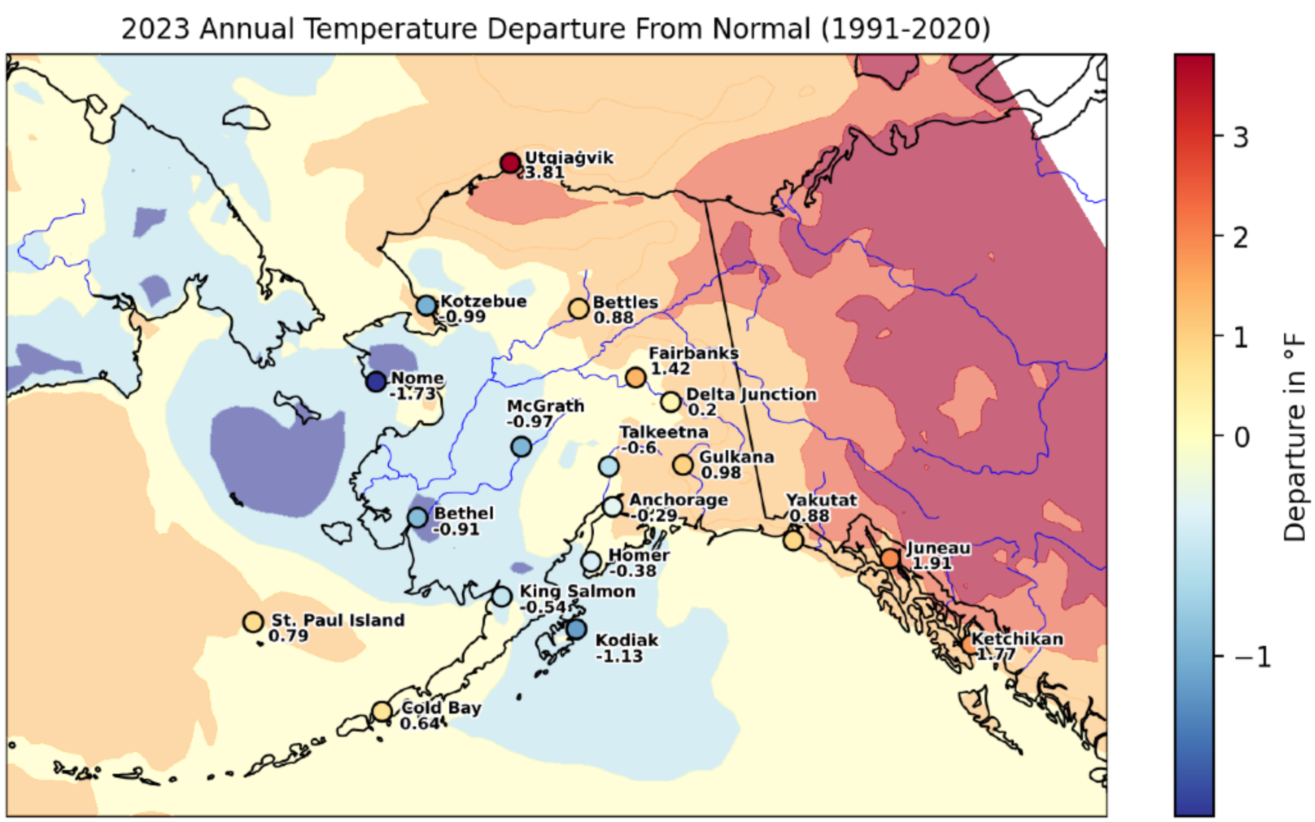

Figure 2. *Mean annual (2023) air temperature deviations (in Fahrenheit) from the normal (1991 - 2020) for selected stations. Overlay: ERA5 gridded temperature data, courtesy of Copernicus.eu.*

The mean deviation from normal across the 19 selected stations was 0.3°F. The statewide mean deviation per the NCEI nClimDiv data set (Vose et al., 2014) was 0.4°F, Figure 3). Individually, all of Alaska's NCEI climate regions except the West Coast were warmer than average. The North Slope region had the largest positive deviation from normal with +2.1°F, followed by the Panhandle with +1.1°F (Figure 4). The West Coast region was coldest, relatively speaking, with -0.5°F below normal.

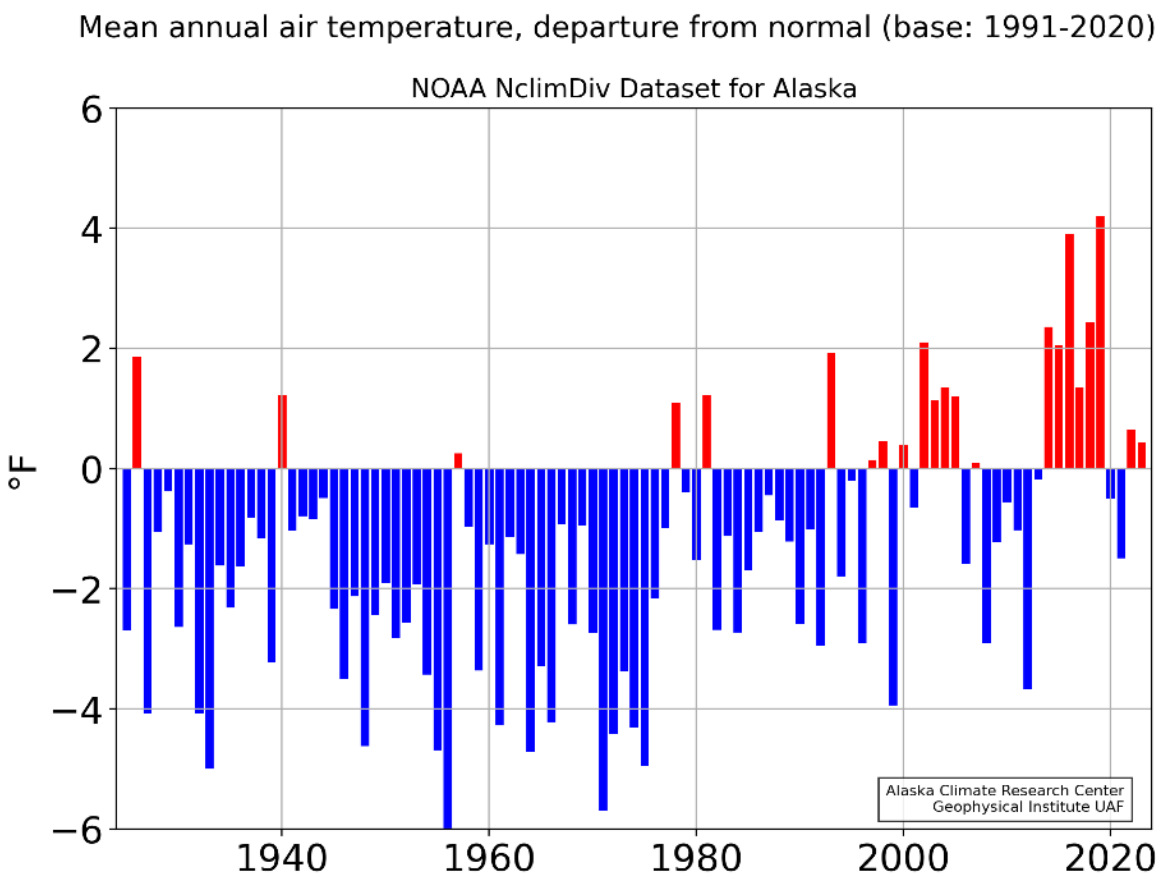

Figure 3. *Mean annual air temperature deviations (in Fahrenheit) from the normal (1991-2020).*

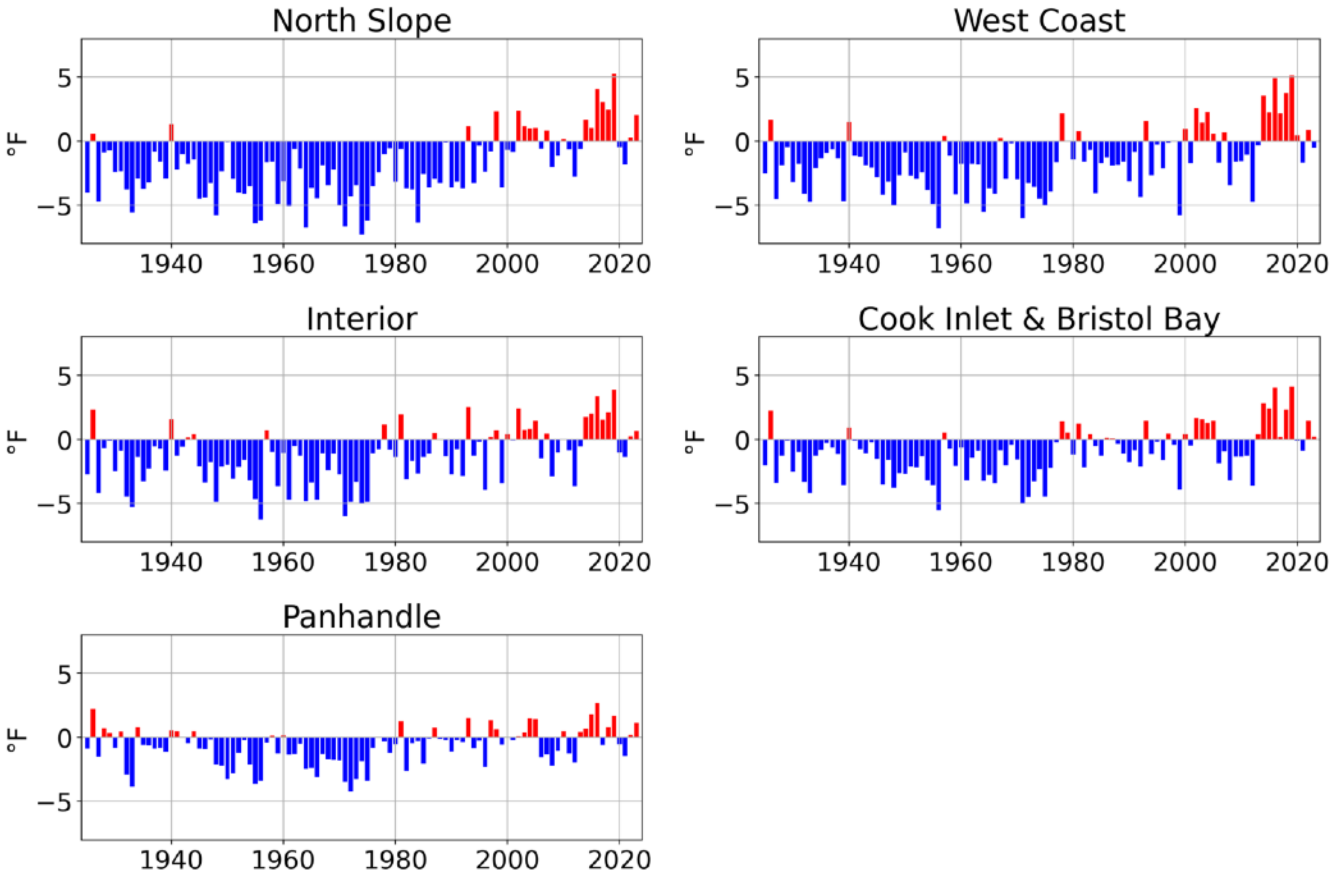

Figure 4. *Time series of annual mean temperature departure from the normal (1991-2020) for the Alaska climate divisions. Data source: NOAA nClimDiv.*

Monthly Mean Temperatures

Averaging over the First Order stations, July was the warmest month of 2023 followed by June and August in absolute terms. The largest positive deviations from normal were recorded in November (+6.2°F) and January (+5.4°F). March, July, August, and October were also warmer than average. April was exceptionally cold with a deviation of -7.2°F. February and December were next coldest in relative terms with -2°F and -1°F below normal, respectively.

There were considerable variations in monthly temperatures between individual stations and different regions of Alaska. Most of the selected stations recorded the highest positive deviations in January or November. The highest positive monthly deviations were reached in the Interior in November (10-13°F above normal in Bettles, Fairbanks, Delta Junction and Gulkana).

At 12 of the 19 stations, April was the coldest month in relative terms. The most negative deviations were recorded on the northern Bering and Chukchi coast and in the western Interior. The southern coastal areas deviate from the pattern: The Panhandle stations had their coldest month in March, while the western Gulf of Alaska coast had theirs in December. Figures 5 through 9 show climographs for, respectively, Anchorage, Utqiaġvik (Barrow), Fairbanks, Juneau, and St. Paul Island, as examples of 2023 temperature deviations in the five main climate regions of Alaska.

For a more detailed look at spatial variations across the state, Fig. 10 shows monthly anomaly maps based on ERA5 reanalysis data (Hersbach et al., 2020). January was substantially warmer than the 1991-2020 reference period in all of Alaska. Only the northern Bering Sea coast saw close to normal monthly temperatures. February brought much colder weather and negative temperature anomalies for the north and west of the state. The Aleutians and Gulf of Alaska coastal areas were mostly warmer than average. March saw a reversal of the February pattern with relatively cool temperatures on the

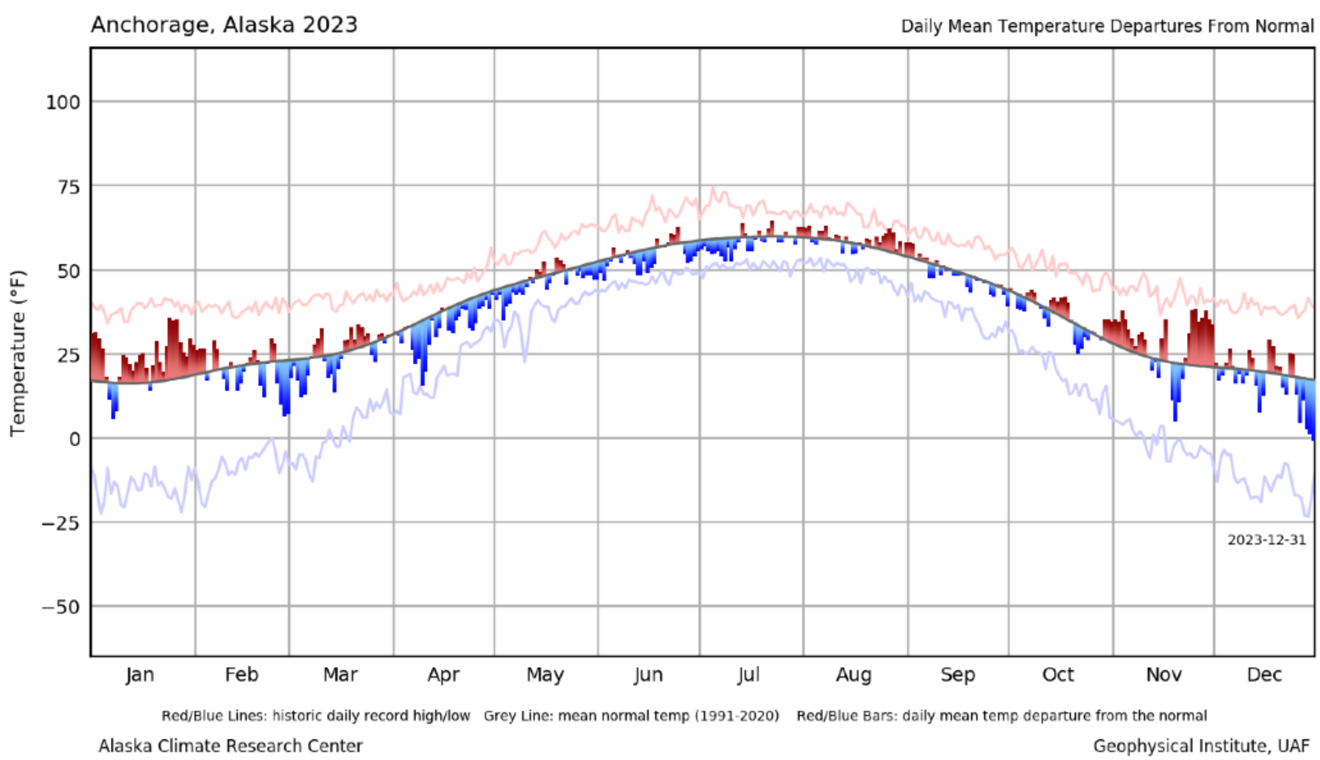

Figure 5. *Mean normal temperature, daily mean departure from normal, and historic daily record minimum and maximum for Anchorage, 2023.*

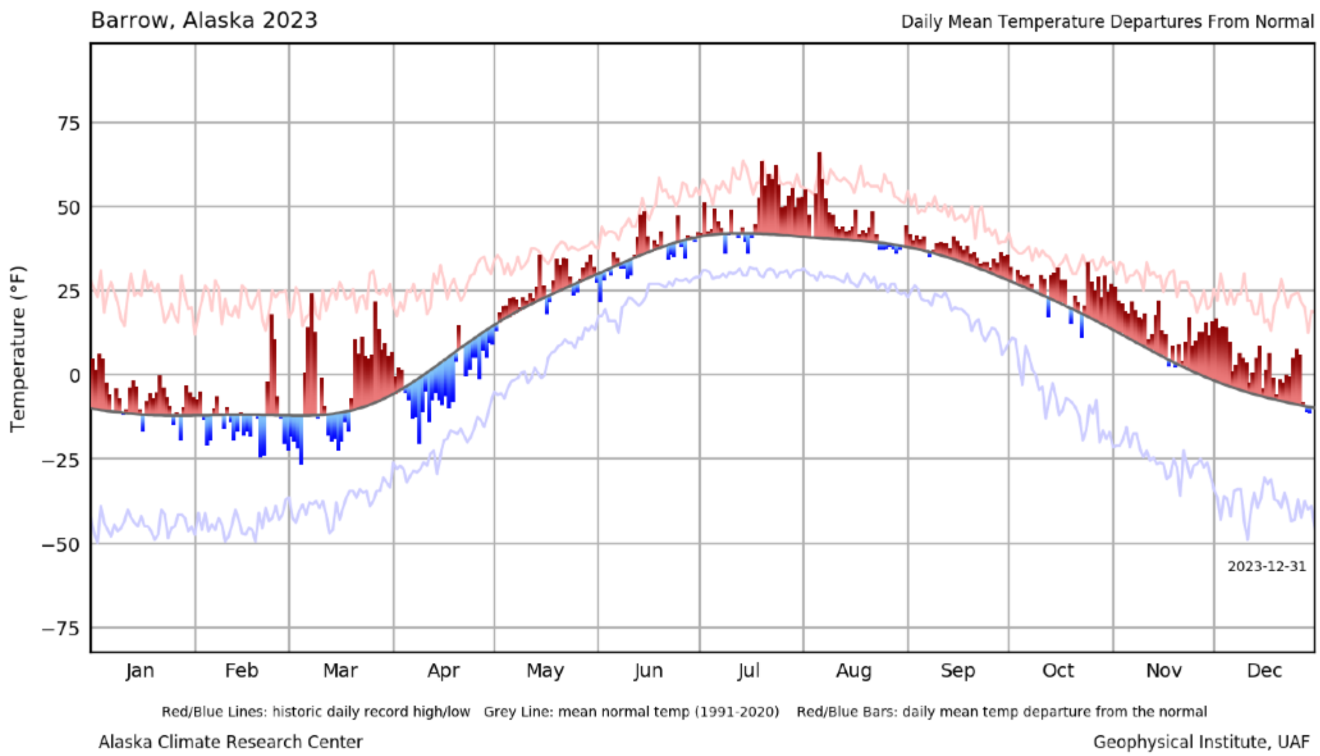

Figure 6. *Mean normal temperature, daily mean departure from normal, and historic daily record minimum and maximum for Utqiaġvik (Barrow), 2023.*

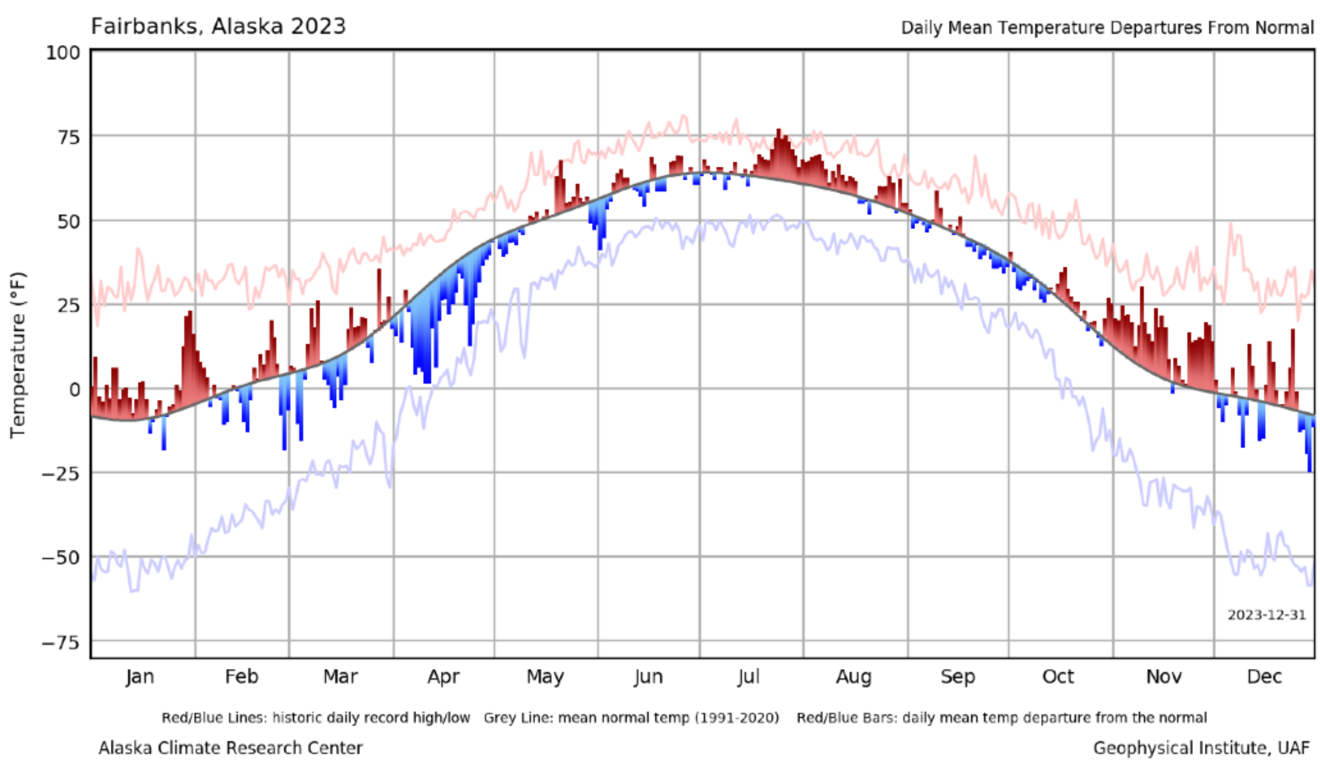

Figure 7. *Mean normal temperature, daily mean departure from normal, and historic daily record minimum and maximum for Fairbanks, 2023.*

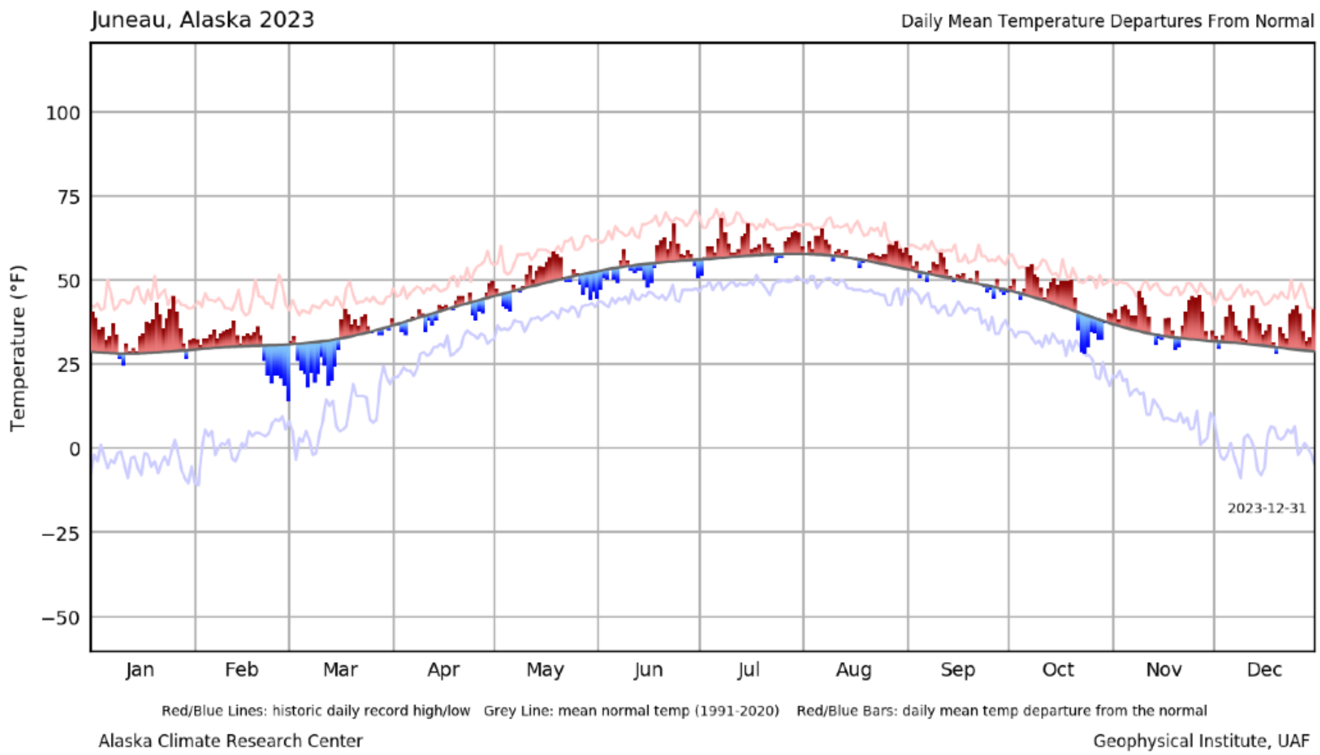

Figure 8. *Mean normal temperature, daily mean departure from normal, and historic daily record minimum and maximum for Juneau, 2023.*

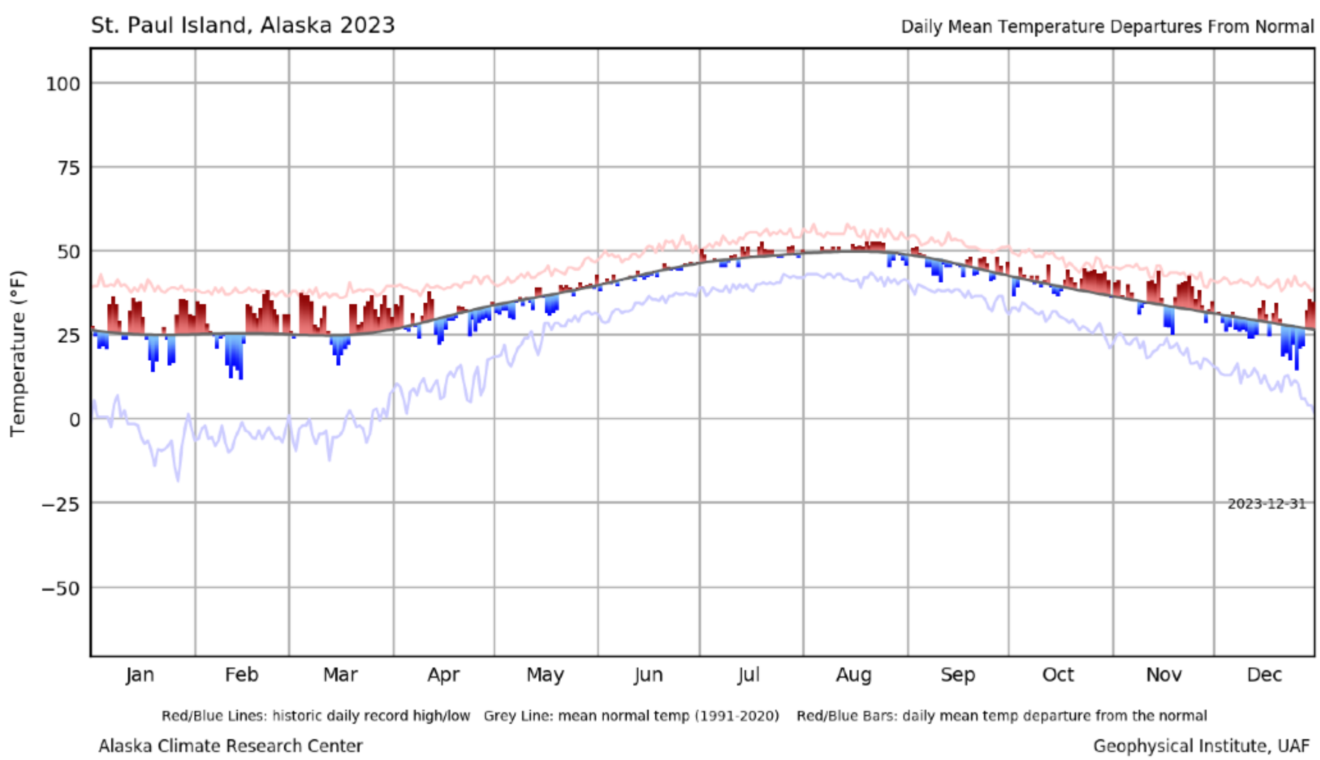

Figure 9. *Mean normal temperature, daily mean departure from normal, and historic daily record minimum and maximum for St. Paul Island, 2023.*

Panhandle and the South-central coast and positive anomalies in the north and west. April stands out as an exceptionally cold month with negative deviations from normal almost everywhere. The western Interior and west coast were coldest in relative terms. Monthly mean temperature anomalies in May were fairly moderate with near normal or slightly cooler than average conditions in the west and southwest and warmer than average conditions in the north and east. June was slightly warmer than average along the Bering and Gulf of Alaska coasts and on the North Slope, while the rest of the state saw relatively cool conditions. July shows a split pattern with very high positive deviations from normal on the North Slope (new records for July mean temperature were set in Utqiaġvik and Delta Junction) and in the eastern parts of the state and cool or close to normal monthly means in the southwest. August was warmer than average throughout the state. The largest positive deviations were again reached in the north and eastern Interior. September brought moderately cool conditions for most of the state but warmer than average weather persisted on the North Slope. October once again was much warmer than normal in the north. The southern half of the state saw more moderate temperatures with a mix of near normal monthly means in the west and Interior and higher deviations in the Aleutians and along the Gulf of Alaska coast. November was far above average in all of the state with highest deviations in the north and eastern Interior. December saw a return of the characteristic split pattern with some very low temperatures in the west and southwest and much warmer than average conditions in the north, east and southeast of the state.

Temperature connections with Large-Scale Circulations

The large-scale coupling between atmospheric circulation, El Niño-Southern Oscillation (ENSO) and the related Pacific Decadal Oscillation (PDO) also influences the climate of Alaska (Mantua et al. 1997, Hartmann and Wendler 2005). For example, a positive PDO usually leads to above normal temperatures in Alaska. In 2023, the PDO was negative throughout the year with values comparable to those of 2022. This continues an ongoing phase of negative PDO that began in fall 2019.

ENSO phases cycle from positive to negative on a much shorter time scale than the roughly decadal time scale of the PDO, with cold and warm phases typically lasting 6-8 months. El Niño winters are characteristically warm and wet over southern Alaska and western Canada, while La Niña winters are often cold and dry over the same areas. After a prolonged La Niña period, we transitioned into a relatively pronounced El Niño in early summer of 2023. El Niño conditions are still ongoing as of January 2024. In 2022, the combination of negative PDO and La Niña in 2022 likely dampened temperatures in Alaska to some extent. In 2023, the combined signal of a negative (cool) PDO and (warm) El Niño is harder to decipher. While El Niño likely influenced the historically high global mean temperatures this year, it could be speculated that the influence of the PDO is greater in the Alaska region and may have contributed to an only slightly warmer than average yearly statistic.

Station	Observed (ºF)	Normal (ºF)	Departure (ºF)
Anchorage	37.4	37.7	-0.3
Bethel	30.6	31.5	-0.9
Bettles	25.0	24.1	0.9
Cold Bay	40.1	39.3	0.6
Delta Junction	30.4	30.1	0.2
Fairbanks	29.8	28.4	1.4
Gulkana *	30.9	28.4	1.0
Homer *	40.3	40.1	-0.4
Juneau	44.1	42.2	1.9
Ketchikan	47.9	46.1	1.8
King Salmon	36.0	36.6	-0.5
Kodiak	41.1	42.2	-1.1
Kotzebue	23.2	24.2	-1.0
McGrath*	28.0	29.0	-1.0
Nome	26.3	28.1	-1.7
St. Paul Island	36.8	36.0	0.8
Talkeetna *	36.4	36.0	-0.6

Station	Observed (ºF)	Normal (ºF)	Departure (ºF)
Utqiaġvik	17.7	13.9	3.8
Yakutat	42.2	41.1	0.9

Table 1. *Mean temperature for 2023, normal temperature (1991-2020) and deviations from the mean for the 19 first-order meteorological stations in Alaska, color-coded to Figure 1. An asterisk (*) marks stations with more than five days of missing data. Missing data are ignored in the computation of the mean. Homer, Gulkana, and Talkeetna had prolonged data outages in November.*

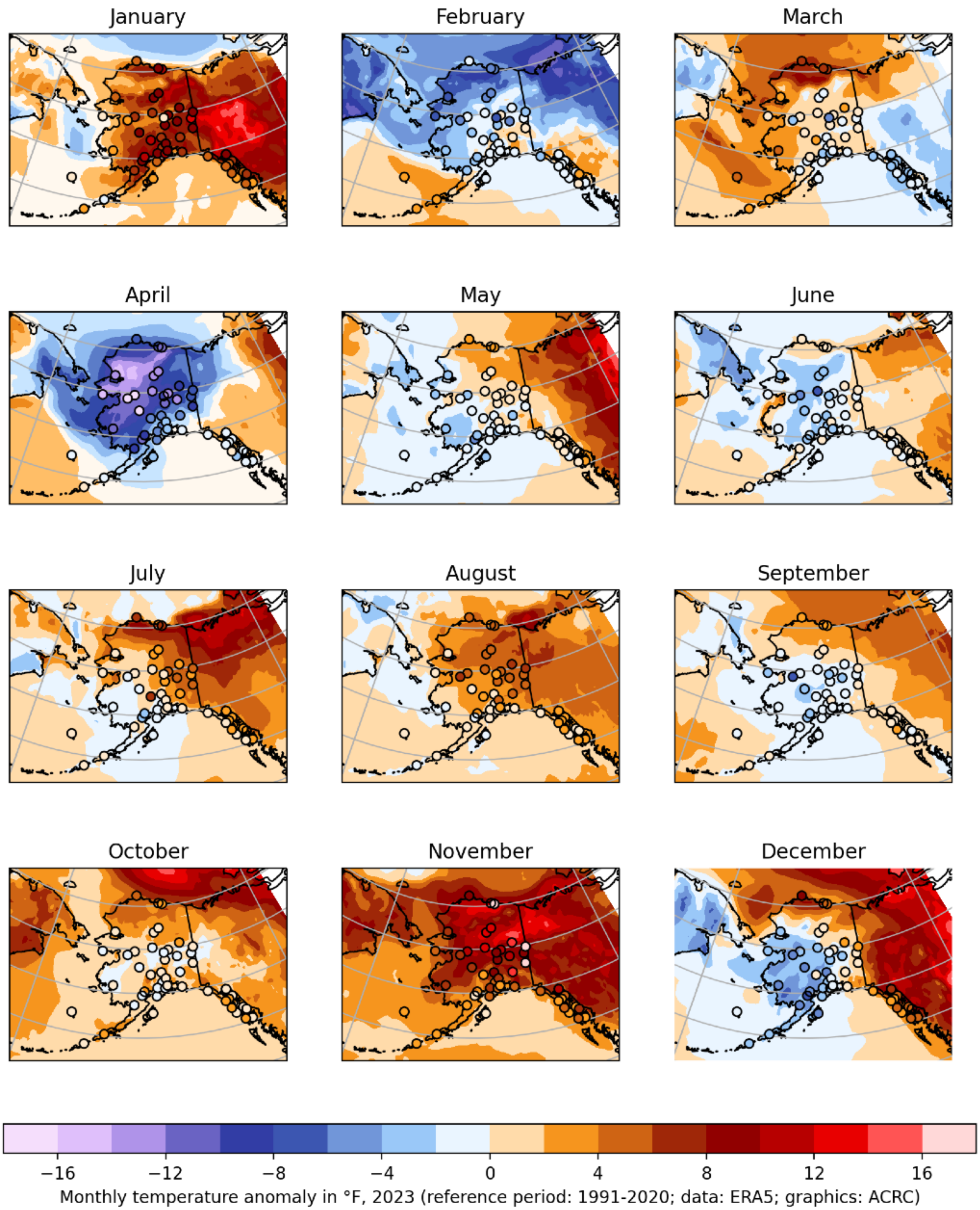

Figure 10. *January - December monthly anomaly maps over Alaska based on ERA5 reanalysis data and the 1991-2020 climatology. Circle markers show station data in the same color scale as the ERA5 background.*

2023 Precipitation in Detail

Annual Precipitation

2023 was a wetter than average year in all AK climate divisions except the Cook Inlet and Bristol Bay region, which had around 95% of normal annual precipitation. The North Slope was wettest with 129% followed by the West Coast with 123%. The Interior and Panhandle regions both come in at around 116-117% (Fig. 11). At the First Order Stations, Utqiaġvik, Kotzebue, Anchorage and Gulkana had the wettest year in relative terms with between 163% (Utqiaġvik) and 148% (Anchorage) of normal. The driest station was Delta Junction with 77% of normal (Fig. 12 & 13, Table 2).

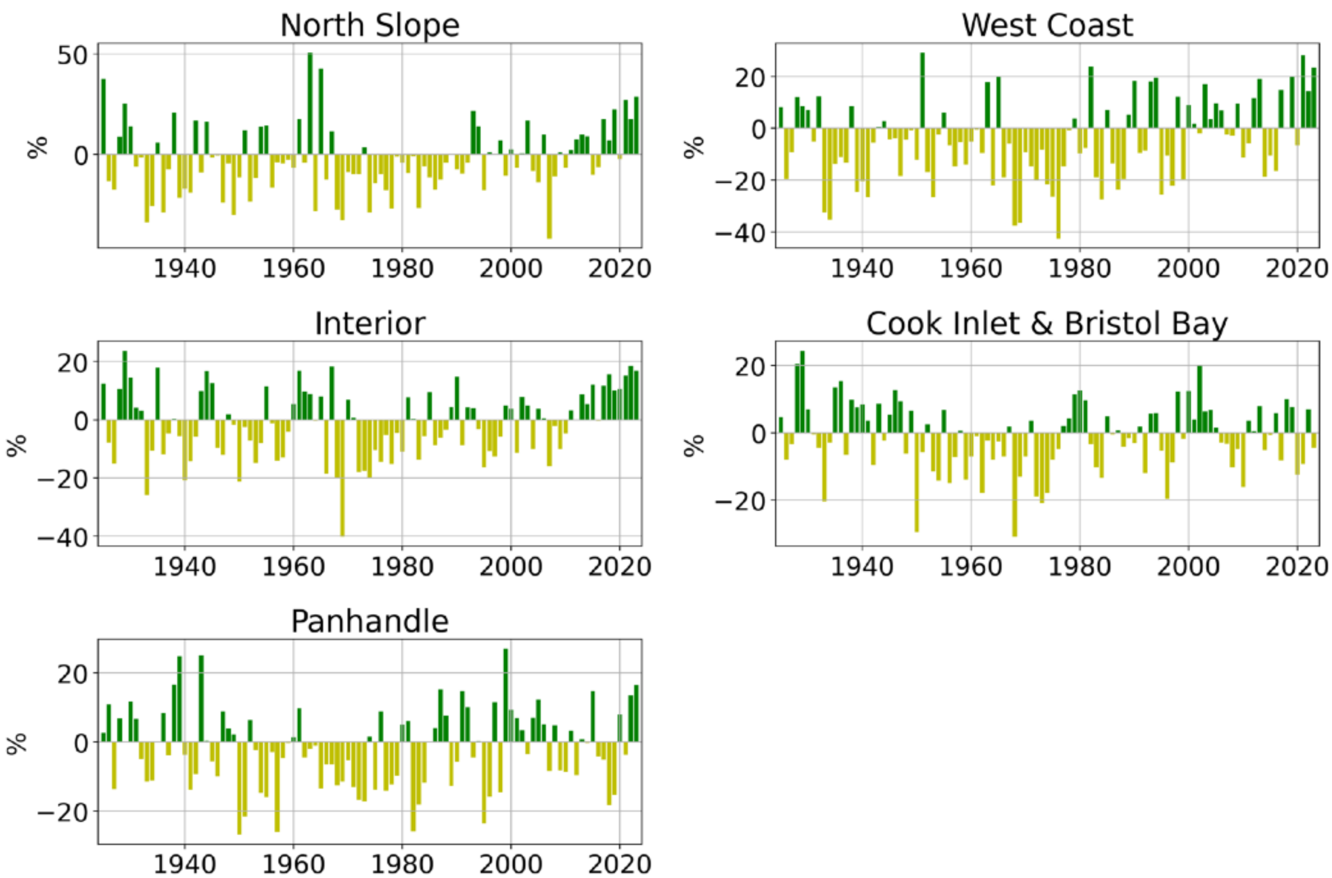

Figure 11. *Time series of annual precipitation sums as percentage departure from the normal (1991-2020) for the Alaska climate divisions. Data source: NOAA nClimDiv. Note: Y-axis scale differs for the regions to show more detail.*

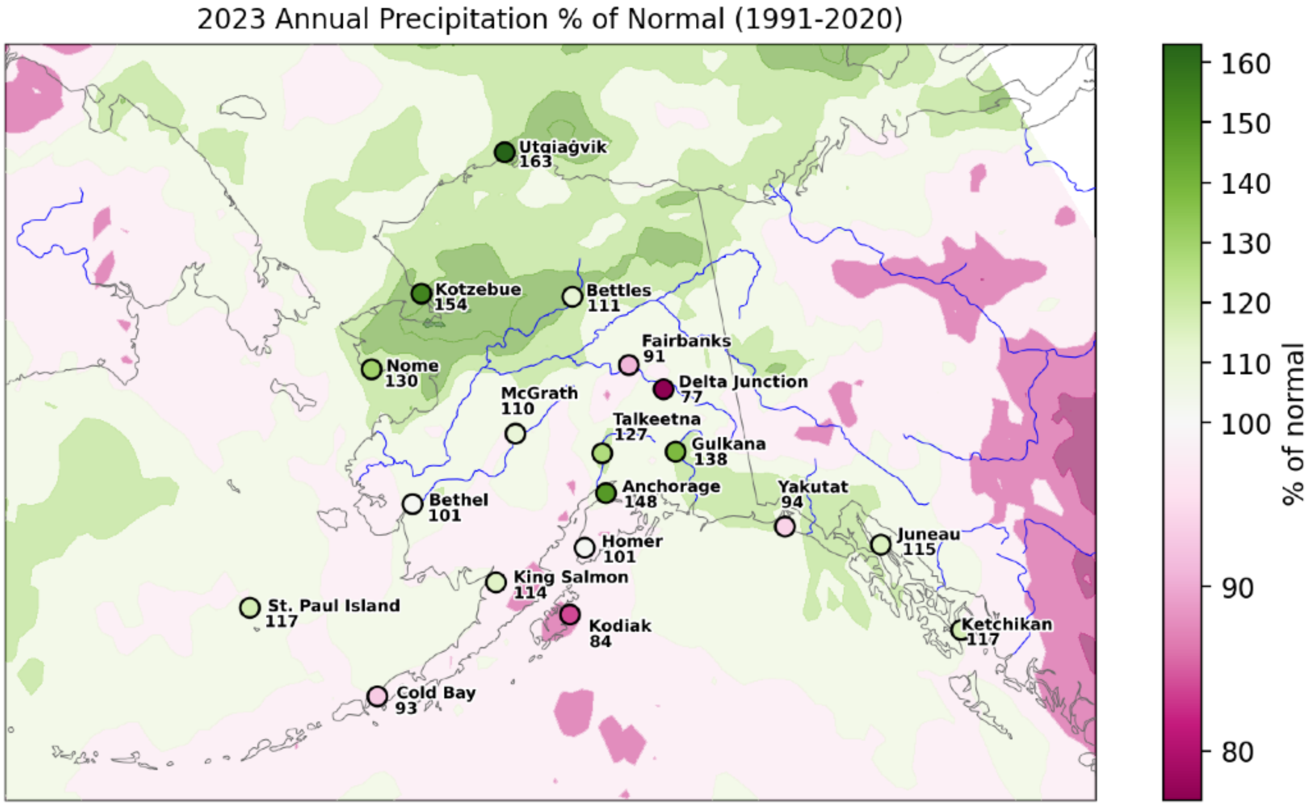

Figure 12. *2023 precipitation deviation (%) from the normal (1991-2020) for the selected stations. Overlay: ERA5 gridded precipitation data, courtesy of Copernicus.eu.*

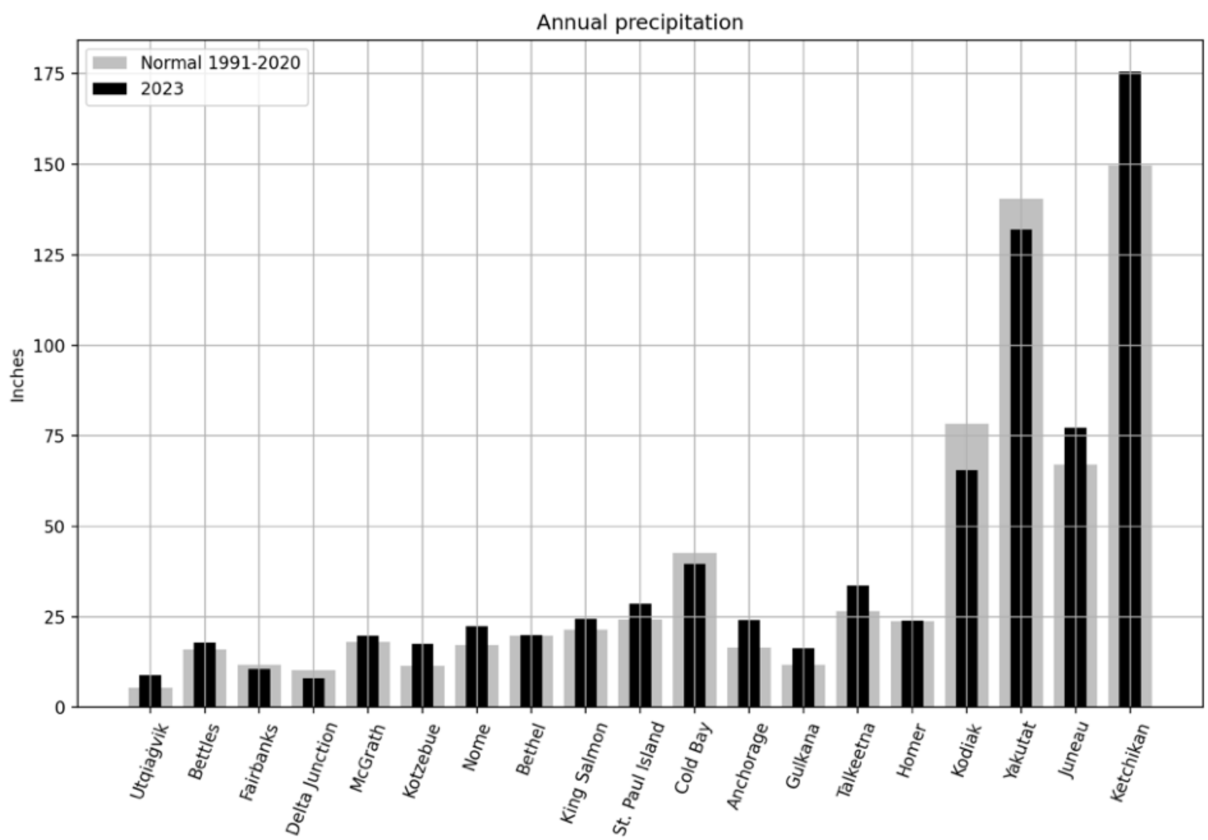

Figure 13. *Precipitation sums (in inches) for 2023 and corresponding normal values at the selected stations (1991-2020) for the selected stations.*

Monthly Precipitation

Precipitation is spatially and temporally very variable. The monthly anomaly maps (Fig. 14) paint a more detailed picture: January was regionally variable with a relatively wet north and northeast. In February, the North Slope and South-central Alaska were unusually dry. March was extraordinary wet in the northwest along the Chukchi coast - the Kotzebue and Nome stations had their third wettest March on record. In contrast, April was very dry in the western half of the state, while the east had wetter than average conditions. May was relatively wet in most parts of the state with the exception of the Arctic coast. June saw a a wet northwest and Gulf Coast. July presented another west-east split, with lots of precipitation in western Alaska and dry conditions in the east. Homer set a new record for July monthly precipitation. August and September had variable patterns, while October had another very clear regional split: The southwest up to almost the Bering Strait was very dry, the north and east had more precipitation than normal. In November, most of Alaska was moderately wetter than average with the exception of the Bering Coast and Aleutians. Anchorage set a new record for wettest and snowiest November in the history of the station, largely due to a very large snowfall event on November 8-10. December was relatively dry in the west and North and wet to very wet in the east and northeast. The Gulkana station had its wettest December on record.

Comparing the monthly precipitation patterns in Fig. 14 with the temperatures in Fig. 10, it is apparent that very cold conditions tend to coincide with dry weather, and unusually warm temperatures often (but not always!) go hand in hand with increased precipitation, e.g. in the western half in the state in April (cold and dry) and on the Chukchi and Arctic coast in March (warm and wet).

Alaska was mostly free of drought conditions in 2023. August was the month with the highest percentage of area affected by abnormally dry or moderate drought conditions as per the US Drought Monitor. The affected region was centred around the area of Fort Yukon and did not extend beyond the eastern Interior.

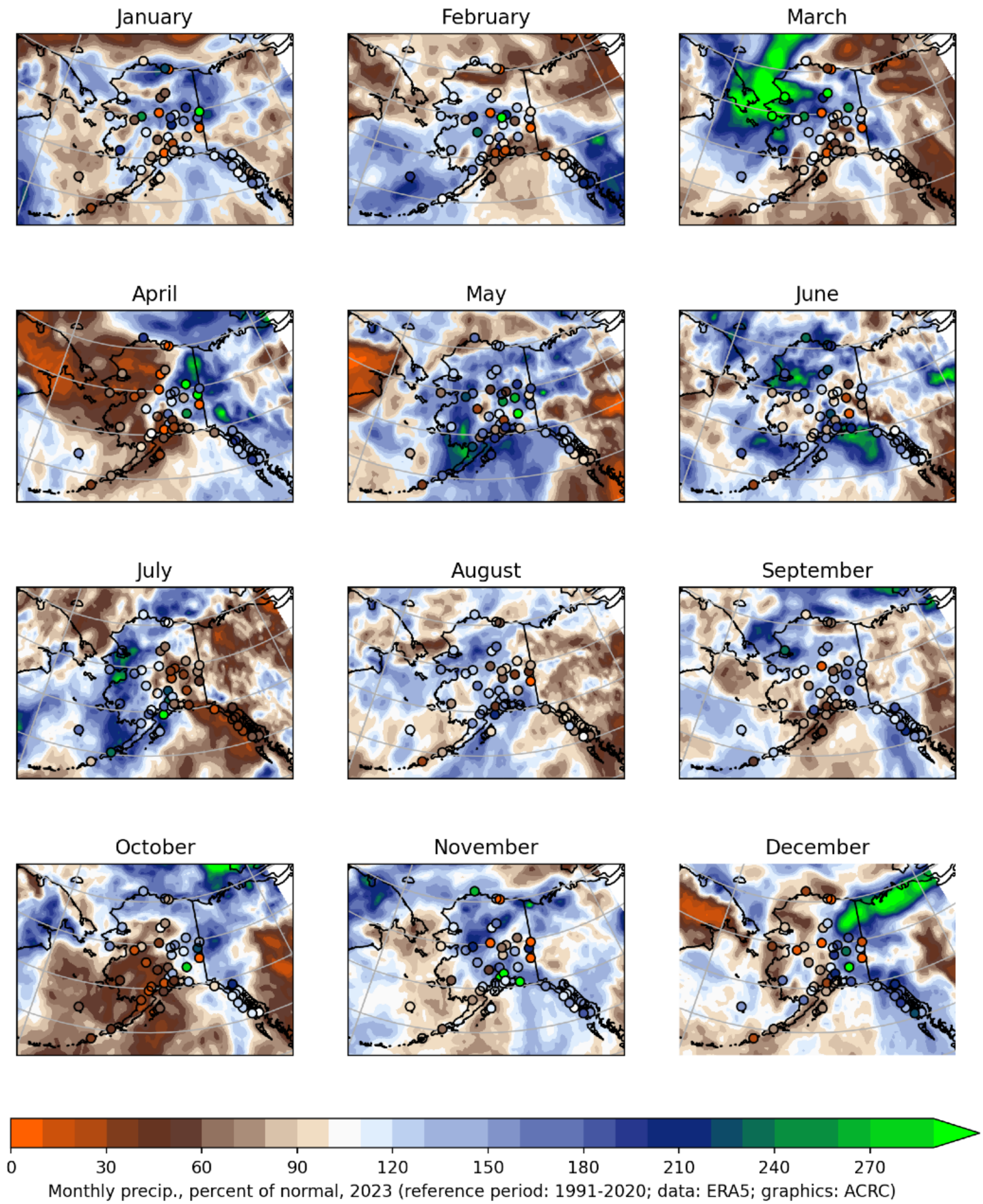

Figure 14. *January - December monthly precipitation anomaly maps over Alaska based on ERA5 reanalysis data and the 1991-2020 climatology. Circle markers show station data in the same color scale as the ERA5 background.*

Station	Observed (ºF)	Normal (ºF)	Departure (ºF)
Anchorage	24.2	16.4	147.5
Bethel	19.9	19.7	101.3
Bettles	17.8	16.0	111.4
Cold Bay	39.6	42.7	92.7
Delta Junction	7.9	10.3	77.1
Fairbanks	10.6	11.7	90.7
Gulkana *	16.2	11.8	138.2
Homer *	24.0	23.9	100.7
Juneau	77.1	67.0	115.1
Ketchikan	175.5	149.5	117.4
King Salmon	24.4	21.4	113.8
Kodiak	65.5	78.3	83.6
Kotzebue	17.5	11.4	153.9
McGrath *	19.8	18.0	109.6
Nome	22.5	17.2	130.4
St. Paul Island	28.5	24.3	117.1
Talkeetna *	33.6	26.5	126.9
Utqiaġvik *	8.8	5.4	162.9
Yakutat	132.0	140.4	94.0

Table 2. *Annual precipitation (inches) for 2023, normal precipitation (inches) (1991-2020), and deviations from normal (%) for the 19 first- order stations. Shades of purple and green correlate with Figure 12. An asterisk (*) marks stations with more than five days of missing data. Missing data are ignored in the computation of the mean. Homer, Talkeetna, and Gulkana had prolongued data outages in November.*

2023 Snowfall

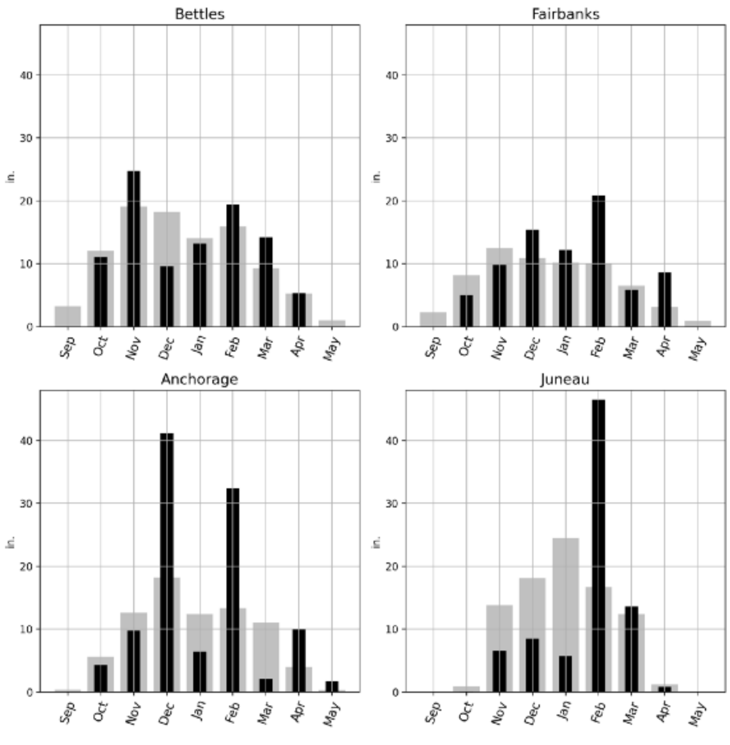

Figure 15. *Monthly snowfall in inches for selected stations in 2022/2023 (black bars), compared to the 1991-2020 normal (gray bars).*

Snowfall during the 2022/23 winter season was above average in two of the four First Order stations with long term snowfall records. Fairbanks and Anchorage had 120% and 138% of normal, respectively. Juneau and Bettles were close to the climatological mean (Figs. 15 & 16, Table 3). In Anchorage, much of this positive deviation was accumulated in November 2022 and February 2023, which were both exceptionally snowy. Anchorage is continuing on a snowy path in the 2023/2024 season and had its snowiest November on record with over 300% of normal monthly snowfall. By December, Anchorage had its snowiest season to date since at least 1953 (see our monthly reports for November and December 2023 for more details on the historic Anchorage snowfalls). In Fairbanks, both 2022/23 and 2023/24 to date mostly had somewhat higher snow depths than average. Anchorage was at or near the time series maximum for snow depth during 2022/23 and seems to be on a similar trajectory this current winter. Snow depth in Bettles was close to average in 2022/23, with an above average spring season. Juneau snow depth increased to average and above average values during spring 2023. In the 2023/24 season to date Juneau has not built up a lasting snow pack at the airport.

The 2023 spring season was relatively snowy and April was a very cold month throughout most of the state. Snowmelt and breakup were delayed in many areas. The Tanana River at Nenana recorded a late breakup on May 8, about a week later than the 1991-2020 average (see our blog post on the Nenana Ice Classic time series). Based on data from the NRCS snowtel network, snow water equivalent (SWE) values were above average in most of the state at the end of April, reaching values of around 200% of normal in the Interior.

In May, the warming temperatures and relatively high snowpack contributed to substantial spring flooding. Several communities along the Yukon and Kuskokwim rivers were affected by flooding from an ice jam. The village of Circle saw particularly severe flooding and damage. Buckland on the Buckland River also experienced significant ice jam related flooding, while Glenallen was affected by snow melt driven flooding.

2023 Snow (calendar year)			
	Snow (in)	**Normal (in)**	**Deviation (%)**
Anchorage	132.1	77.9	169.6
Bettles	80.8	97.9	82.5
Fairbanks	88.3	64.6	136.7
Juneau	86.3	87.6	98.5
2022/23 Snow (September 2022-May 2023)			
	Snow (in)	**Normal (in)**	**Deviation (%)**
Anchorage	107.9	77.9	138.5
Bettles	97.6	97.9	99.7
Fairbanks	77.7	64.6	120.3
Juneau	81.7	87.6	93.3

Table 3. *Snowfall sums for the 2023 calendar year and the 2022/2023 winter season, normal snowfall (1991-2020), and deviations from normal (%) for the selected stations that report snowfall.*

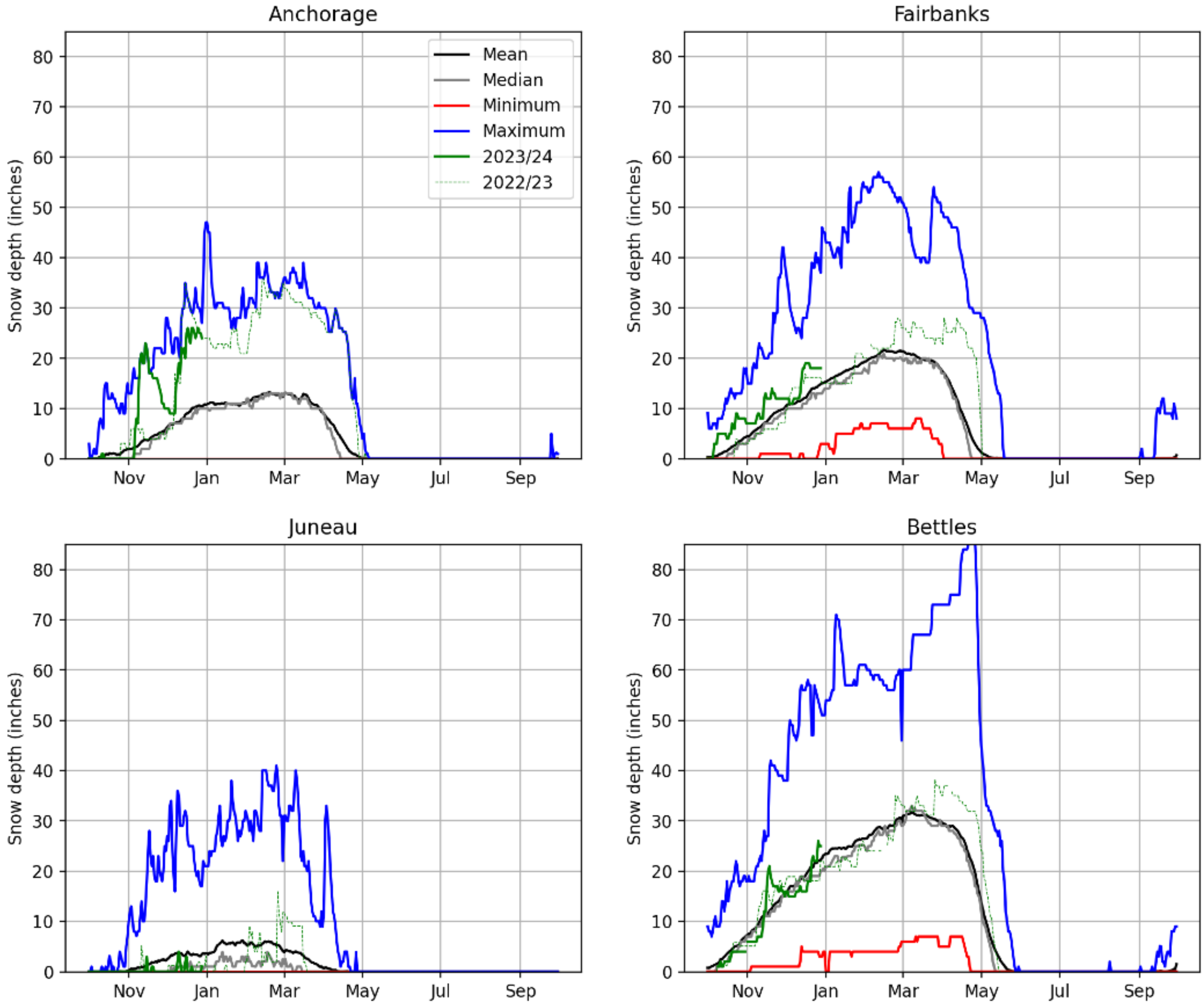

Figure 16. *Snow depth in Anchorage, Fairbanks, Juneau, and Bettles for the current season (2023/24, solid green line) and for 2022/23 (thin, dashed green line) compared to the time series minimum, maximum, and median.*

2023 Sea Ice

Arctic sea ice, particularly the development of sea ice in the Bering and Chukchi Sea, is a key driver for Alaska's climate. In 2023, Arctic sea ice extent was below the average of the satellite record for the entire year. Despite continuous below average conditions, no new negative records were set. The annual minimum, set on September 19th, 2023, was the sixth lowest in the satellite record with 1.63 million square miles. Sea ice growth in the fall months in the Bering and Chukchi Sea was impeded by a number of strong storms that brought southerly winds and high temperatures. Sea ice growth picked up substantially in the Bering and Chukchi Sea in December. A time series of daily Arctic sea ice extent can be seen in Figure 17.

For a wider perspective, a very notable feature of global sea ice conditions in 2023 was the unprecedented Antarctic winter season. Antarctic sea ice extent reached its annual

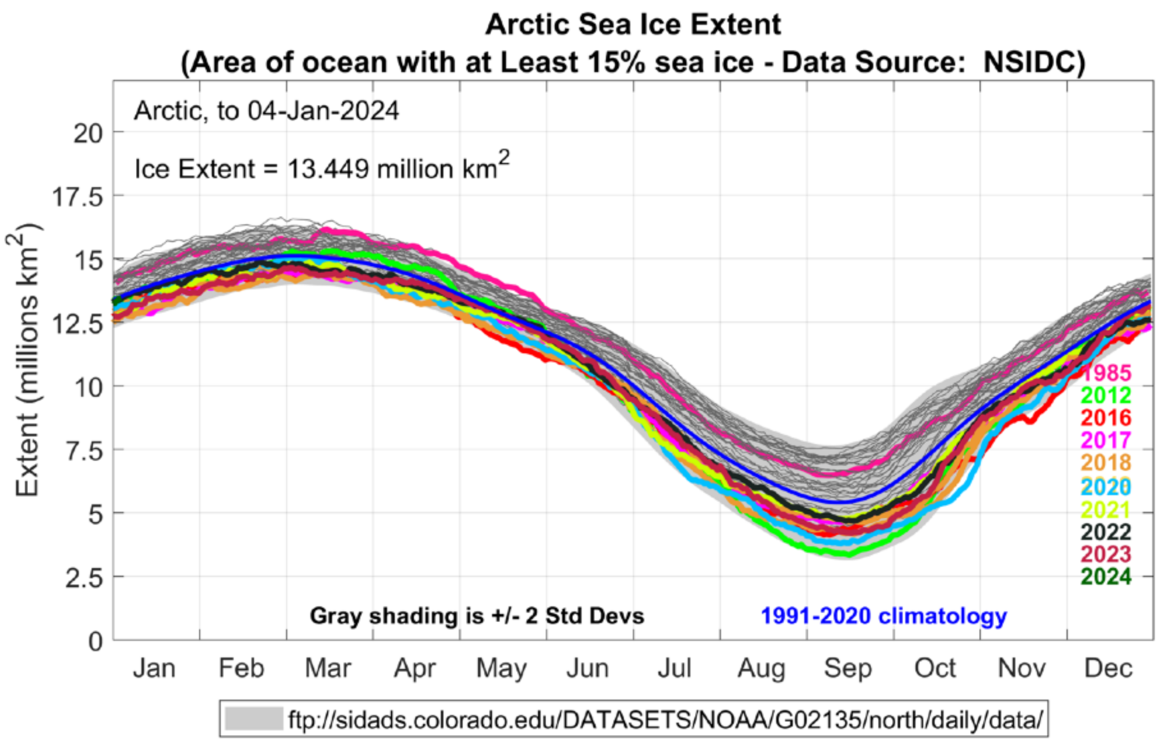

Figure 17. *Time series of daily Arctic sea ice extent. This year's data (2023), seen in dark red, are updated through January 5, 2024. The median sea ice extent for the 1981-2010 reference period is depicted in dark blue. Plot compiled by: Howard J. Diamond, PhD; Climate Science Program Manager at NOAA's Air Resources Laboratory Data Source: National Snow & Ice Data Center (nsidc.org/).*

maximum on September 10 at 6.55 million square miles. This was 398,000 square miles below the previous low record from 1986. Reasons for the extremely low Antarctic sea ice extent are the subject of ongoing research. A connection with high ocean temperatures in the region appears likely.

2023 Wildfire Season

After the intense but short 2022 wild fire season, 2023 was another unusual year though for different reasons. Fire activity was at a record low in Alaska until mid-July. The wet spring and late snow melt contributed to this along with a lack of thunderstorms and lightning. The season then rapidly picked up on July 24th with an intense lightning event that sparked numerous fires. For comparison, the 2022 season, which burned over 3 million acres, had mostly ended by late July (Figs. 18a, 18b). With several more thunderstorms in late July and early August, the total burned area in 2023 reached 295,126 acres. 99% of burned acreage was from 175 lightning sparked fires mostly located in the Interior. 171 human caused fires were recorded by the Alaska Interagency Coordination Center (AICC), bringing the total number of fires for the season to 346. With a shift to wetter weather in mid August, the 2023 fire season in Alaska quickly came to an end.

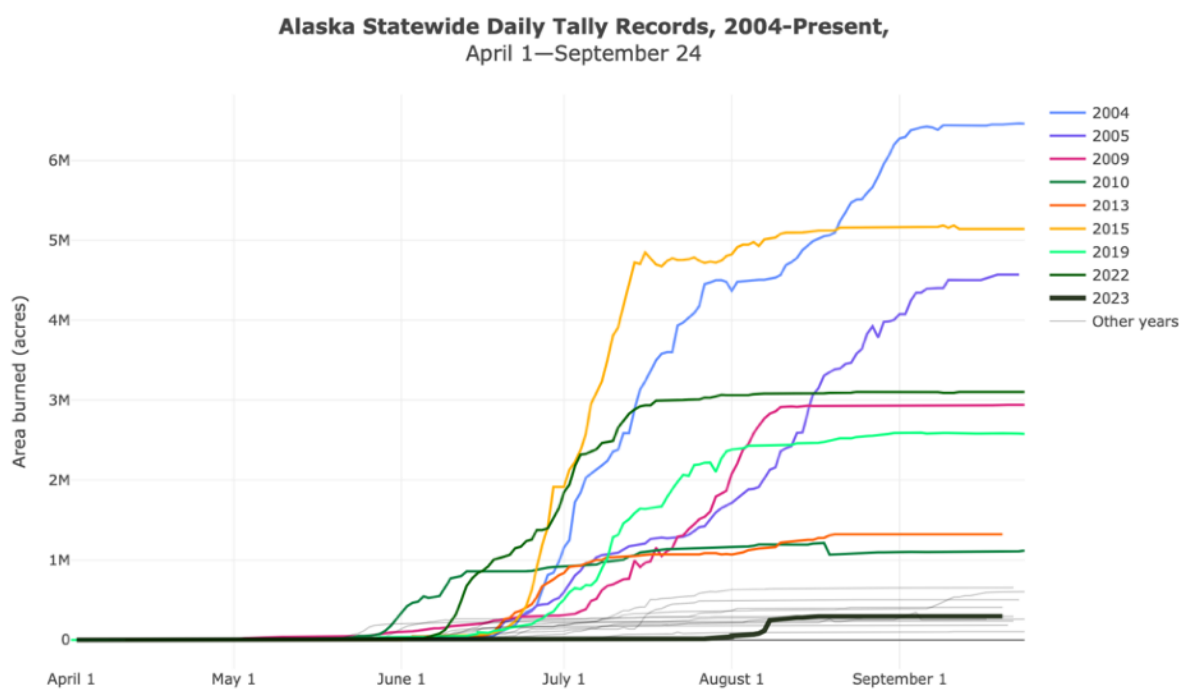

Figure 18a. *Daily acreage burned, cumulative sum through mid September. Plot produced by the Scenarios Network for Alaska and Arctic Planning (SNAP). Data: AICC*

In stark contrast to the late but relatively low intensity fire season in Alaska, neighboring Canada had an extreme season with major impacts for communities in the Northwest Territories (NWT) and the Canadian Yukon. Fire ravaged Canada in 2023 like no other year, by a stupendous margin. A record 45.7m acres (18.5m hectares) went up in flames, an area about the size of Washington State, shattering the previous annual record nearly three times over. This is huge: The 2004 Alaska record wildfire year burnt 6.5m acres, and impacted the entire northern hemisphere (e.g. Pfister et al., 2008; Mathur, 2008). We only can imagine the 2023 impact of wildfires with 7 times the acreage of the 2004 Alaska record year on the composition of the atmosphere (e.g. carbon, O3, small particulate matter) as well as on the radiative fluxes. Numerous communities faced evacuation orders as the fire season progressed, among them Yellowknife, the capital of the NWT, with a population of around 20 000. Alaska's Northslope and the Brooks Range were affected by smoke dispersed to the west from Canada for weeks during the summer of 2023.

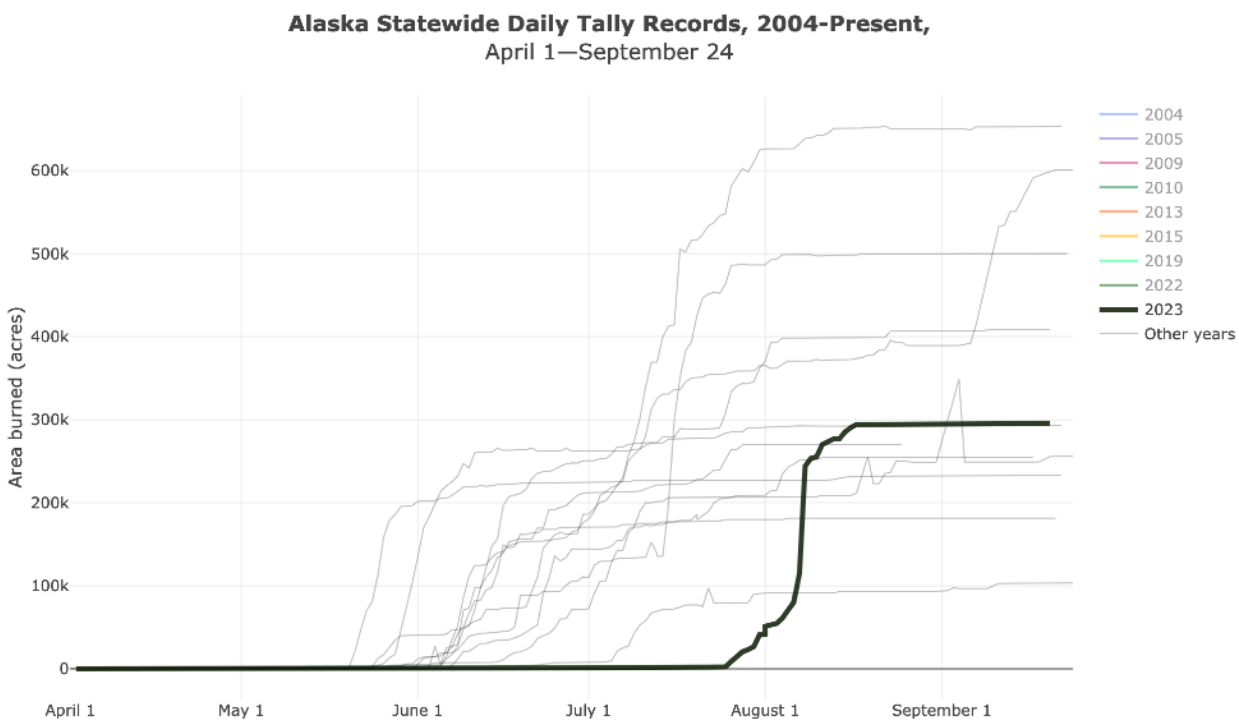

Figure 18b. *Daily acreage burned, cumulative sum through mid September, scale adjusted to show more detail for 2023. Plot produced by the Scenarios Network for Alaska and Arctic Planning (SNAP). Data: AICC*

Newsworthy Information

January

Sunrise on the North Slope

The sun rose above the horizon again in Utqiaġvik on January 23 for the first time in 65 days.

Earthquake research

A new study explains why earthquakes in the Nenana Basin last longer and feel much stronger than elsewhere. Due to the special geology of the region, seismic waves get amplified as they bounce back and forth off the sides and bottom of the sedimentary basin. More information.

February

Mount Edgecumbe volcano may be reawakening

The Alaska Volcano Observatory will install seismic instruments to monitor activity of the Volcano near Sitka. Preliminary data shows magma moving below Mount Edgecumbe. More information.

High avalanche danger in Juneau: The Juneau Urban Avalanche Advisory raised the avalanche danger level to 4 (high) during the storms at the end of the month. Travel in avalanche terrain is dangerous and not recommended during such conditions. Warnings were issued for certain urban trails that cross avalanche terrain.

March

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. 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.

April

Unusual spiral in the sky

April brought a number of opportunities for viewing the Aurora. On April 15, the night time sky over Alaska not only glowed green with northern lights, a bright spiral shape also appeared. The mysterious lights were caused by a SpaceX rocket launch, explained Don Hampton, geophysicist and chief scientist at the Poker Flat rocket Range. More information.

UAF researcher shows geological history of Alaska graphite

Graphite is needed for lithium-ion batteries and in high demand. New research details the metamorphic history of a graphite deposit on the Seward Peninsula. The findings are relevant for graphite potential mining projects and geological exploration in Alaska. More information.

Increased activity at Aniakchak volcano

The Alaska Volcano Observatory (AVO) put out a statement on recent volcanic activity at Aniakchak volcano in the Aleutians. Observations suggest that magma is intruding at a depth of 3-4km under the Aniakchak caldera. This increases the likelihood of an eruption over the coming months to years. AVO report.

Eruption of Sheveluch volcano (Russia) affected air traffic

Sheveluch volcano on the Kamchatka Peninsula erupted on April 11. The plume lead to partial, temporary closures of the Pacific airspace, affecting flights into and out of Alaska. More information.

May

Major flooding due to ice jams and snow melt

Flooding was the primary weather-related hazard in Alaska this month. Several communities were severely impacted by ice jams that caused near-historic flooding along the Yukon and Kuskokwim rivers from around mid-month onwards. Residents had to evacuate and there was extensive infrastructure damage in Circle. Eagle, Fort Yukon, and other communities in the region were also affected. The village of Buckland was severely impacted by ice jam flooding on the Buckland river (NWS report on twitter). In Glenallen, snow melt rather than an ice jam also caused significant flooding. Spring flooding received widespread coverage in Alaska media, e.g.: Alaska Public Media: "Breakup brings serious flooding to Yukon and Kuskokwim River communities"

Nenana Ice Classic and Fairbanks green up

The tripod on the Tanana River at Nenana fell over on May 8, adding another data point to the unique time series of river break up on the Tanana. Like many time series that show aspects of Alaska's climate and weather, the Nenana break-up dates reflect the overall warming trend (leading to earlier break up on average), as well as considerable year-to-year variability. Break-up in 2023 occurred late in the season compared to the 1991-2020 average. Cold April temperatures likely contributed to the late break-up. Compared to the previous 30-year climate normals, this year's break-up date would have been close to average. See our blog for more information.

Green Up - the sprouting of tree leaves in spring - often occurs quite suddenly over the course of one or two days. The date of Green Up on the Chena Ridge in Fairbanks has been recorded since 1974. The Fairbanks NWS office announced Green Up on May 16, a little over a week later than the time series average.

June

Firefighters receive training in weather station maintenance

Remote Automatic Weather Stations (RAWS) provide essential information for wildfire response and fire danger forecasting. The remote location of many AK stations makes them difficult to service and maintain. In a training session at the BLM Alaska Fire Service facilities at Fort Wainwright, Alaska firefighters and communication experts received instruction on how to assemble and repair portable weather stations. As per akfireinfo.com, "This essential training was part of a broader interagency venture to ensure that Alaska and other states in the country have the tools and resources needed to monitor key meteorological factors that lead to wildfires."

New instruments for monitoring air quality in Delta Junction

As past of a new national network for monitoring the chemical and physical properties of airborne particulate matter, instrumentation to measure, e.g., size distributions and optical properties of fine particles, was installed in Delta Junction. The data will allow scientists to assess aerosol composition in near real time. More information.

Solstice celebrations

Throughout Alaska, the longest day of the year was cause for celebrations. In Fairbanks, the traditional "Midnight Sun Baseball Game" marked the occasion, while Anchorage celebrated with music, food trucks, and other entertainment in the Downtown area.

July

National coverage of Alaska heatwave

The Washington Post reported on the unusually high July temperatures on the North Slope, pointing out that Alaska is one of the fastest warming regions in the world. The loss of sea ice has strong climatological and environmental impacts the region.

Members of Congress view impacts of climate change in Denali NP

Five members of Congress recently visited Denali National Park to observe the effects of a warming climate on Alaska's natural environment. The visitors focused on the Pretty Rocks landslide, which has been linked to rising ground temperatures and thawing permafrost. More information (ADN).

Large tube worm colony discovered on ocean floor

A NOAA Ocean Exploration mission to map and explore the see floor around the Aleutians has revealed an extensive colony of tube worms living in the Sanak cold seeps. Cold seeps are areas on the sea floor where gas bubbles are emitted from cracks and fissures. The tube worms discovered in the Sanak seeps are chemosynthetic, which means they live in symbiosis with bacteria that can turn the hydrogen sulphide emitted from the seeps into energy for themselves and the worms. More information (NOAA).

August

Destructive GLOF in Juneau

Flooding of Mendenhall River in Juneau destroyed multiple homes in early August following a glacial lake outburst flood (GLOF) from Suicide Basin at Mendenhall glacier. Mendenhall Lake crested at a record level of 14.97 feet late on August 5. Although Suicide Basin regularly drains suddenly, this event was unprecedented in terms of water level and downstream damage to infrastructure.

Glacier lake outburst floods occur when a dam containing a glacial lake fails. The dam may consist of a moraine or of glacier ice. The hydrology and drainage systems involved vary and the flood-producing water bodies may be sub-glacial or marginal lakes. Suicide Basin is a side valley of Mendenhall Glacier. The valley contains Suicide Glacier, a tributary glacier which is no longer connected to the main branch of Mendenhall Glacier. As the tributary glacier receded, a lake formed in a topographic depression in the newly ice-free basin bordering on the main branch of Mendenhall Glacier. This basin periodically drains, causing inundations downstream. See our blog post for more information. The event was covered by numerous Alaskan and national media outlets (e.g., AP, Washington Post, overview by NOAA).

Fires and smoke

Late season wildfires sparked by unusual lighting activity caused evacuations and widespread very poor air quality in parts of the Interior and northern Alaska in August. Chinook winds contributed to smoke development. The fires were covered by various Alaskan media outlets (e.g., newsminer.com).

Shishaldin Eruption

Shishaldin Volcano on the Aleutians produced a high reaching ash cloud on August 25. The Alaska Volcano Observatory notes that several pilots reported the plume. A "RED" aviation code was issued and the Volcano Alert Level for Shishaldin was raised to "warning". More information (USGS/AVO).

UAF scientists discover largest known dinosaur track site

The newly discovered dinosaur tracks at a remote location in Denali National Park are about 69 million years old and suggest that different kinds of dinosaurs visited the same location, perhaps to access water. Some tracks are very well preserved and show details like toes and skin texture. UAF researchers involved in the discovery and documentation of the tracks recently published their remarkable findings in the journal Historical Biology. See here for more information.

September

NWS realigns Alaska forecast zones

The NWS has rolled out changes to the forecast zones to provide more accurate local forecasting and warning services. The aim of the changes is to make forecast zones align more closely with borough, municipality and census boundaries and avoid over-alerting. More information and detailed visualisations of the new zoning can be found in an interactive story map produced by the NWS.

Study shows: less ice fog in Fairbanks due to rising temperatures and changes in air pollution

An analysis of climatological time series by UAF and ACRC researchers shows that ice fog in Fairbanks is occurring less often than it has in the past. There is large interannual variability but downward trends are very robust. In addition to rising temperatures due to climate change, changes in near ground moisture and/or pollution are also important for the frequency of ice fog occurrence. See our blog post for more information.

Algal bloom in the Bering Sea
Satellite imagery shows a phytoplankton bloom in the Bering Sea near St. Matthew Island. The color of the bloom suggests a kind of phytoplankton called coccolithophores. The image below was acquired by NASA's TERRA satellite on September 3. The bloom was still visible during the last week of September. Some algal blooms are harmful to humans because they produce toxins that accumulate in subsistence foods. Predicting and monitoring harmful algal blooms (HABs) in Arctic waters is subject of ongoing research (more information).

October
New research: Marine heatwave to blame for Bering Sea snow crab collapse
A new study recently published in Science Magazine investigates the disappearance of 10 billion snow crabs from the eastern Bering Sea. Snow crabs are an important species for Alaska fisheries and the population decline has previously been widely covered in the media. The new study finds that marine heatwaves were likely the cause of the mass death of snow crabs. Snow crabs are able to withstand the observed water temperatures but high temperatures challenge their system and they require more calorie intake in very warm conditions. The increased energy needs due to the heat wave led to widespread starvation in the Bering Sea snow crab population.

UAF researchers win grant to study rising sea levels
UAF glaciologist Andy Aschwanden and collaborators have received an NSF grant that will allow them to make improvements to an ice-sheet model (PISM) that is used to model future sea level rise from melting ice sheets. The grant will allow the team to develop a cloud computing-based version of the model, which will improve the accessibility of PISM for the international research community. More information.

Nasa SnowEx: Autumn field survey in northern Alaska
UAF Scientists travelled to the North Slope this month to support a Nasa SnowEx field campaign. SnowEx is a multi-year field experiment which aims to better quantify the amount of water stored in seasonal snow. The study combines extensive field surveys with different kinds of remote sensing applications for more accurate SWE estimates. Nasa SnowEx has previously carried out surveys in Alaska. The October campaign specifically targeted tundra snow cover.

November
Deadly landslide in Wrangell

A landslide hit the community of Wrangell in Southeast Alaska on the night of November 20, killing at least four people. The landslide was triggered by heavy rains following an extended period of wetter than average weather. According to Gabriel Wolken of the AK Division of Geological and Geophysical Surveys, Southeast Alaska is a region naturally prone to landslides due to the geology and topographic setting. Climate change leads to more frequent extreme precipitation events, further contributing to the landslide risk. More information.

December
Winter solstice
Day light hours are increasing once again in Alaska. The winter solstice occurred on December 21 this year and was celebrated with various musical events and other gatherings in communities all over the state (e.g., Anchorage, Denali National Park)

AGU conference
Researchers from Alaska and the world gathered at the American Geophysical Union annual meeting in December to present their work. More than 100 UAF scientists joined the meeting (UAF news item) and showcased studies from a large variety of topics touching on many aspects Alaska's environment and climate (e.g., sea ice forecasting, volcanic tremors).

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Appendix

	J	F	M	A	M	J	J	A	S	O	N	D
Anchorage	23.73	19.89	25.0	32.42	46.31	53.88	58.08	58.84	48.23	36.21	28.12	16.81
Bethel	10.05	10.48	18.56	17.61	40.71	52.4	54.85	53.69	44.53	32.35	25.27	4.85
Bettles	-2.55	-9.09	3.52	11.18	46.61	55.98	62.58	57.26	41.25	22.3	13.55	-5.31
Cold Bay	26.98	32.27	33.68	33.98	39.5	47.68	52.11	53.23	48.63	44.34	38.2	28.52
Delta Junction	7.18	2.68	12.27	21.17	48.85	58.27	65.37	60.13	42.15	25.55	18.45	-0.77
Fairbanks	-0.08	0.34	11.23	21.45	50.94	60.45	67.08	61.21	44.67	26.95	15.72	-3.94
Gulkana	4.55	7.12	14.76	26.77	43.48	54.52	60.98	58.0	41.85	25.92	22.0	0.77
Homer	31.35	26.32	28.81	34.45	44.63	52.32	56.02	56.84	48.35	39.97	36.23	24.58
Juneau	34.65	29.89	30.65	40.62	49.55	54.83	60.39	58.58	50.87	43.42	38.45	35.92
Ketchikan	39.45	35.02	36.65	42.52	53.23	56.45	61.84	61.4	54.42	47.95	43.35	41.02
King Salmon	23.56	20.09	22.35	26.87	44.45	53.5	57.89	56.9	47.12	36.29	27.92	14.08
Kodiak	34.19	30.75	32.55	36.42	43.31	49.83	54.77	55.48	48.68	42.56	36.25	27.61
Kotzebue	3.71	-4.66	3.89	2.98	29.5	44.53	57.34	53.5	41.28	27.6	17.05	-0.85
McGrath	4.06	2.12	12.19	10.7	46.82	56.22	60.61	57.71	43.18	26.56	15.03	-7.48
Nome	6.52	2.98	10.47	8.4	34.94	46.53	52.47	51.5	40.03	29.24	24.08	6.97
St. Paul Island	27.11	27.32	29.31	29.77	35.68	43.0	48.69	49.97	45.52	41.16	36.23	27.02
Talkeetna	21.37	14.84	23.26	31.02	46.11	54.48	60.24	57.76	46.18	34.52	30.09	10.95
Utqiaġvik	-6.21	-12.34	-2.9	-2.43	26.06	36.63	48.42	44.52	37.12	26.02	14.12	1.79
Yakutat	33.89	28.19	28.55	37.75	45.58	51.25	55.71	56.39	49.67	43.15	38.28	34.55

Table A1: Monthly mean temperature (in °F) at the 19 selected stations. The highest and lowest monthly means are colored in red and blue, respectively.

	J	F	M	A	M	J	J	A	S	O	N	D
Anchorage	6.88	-1.36	-0.8	-5.09	-1.84	-2.01	-1.47	1.38	-1.07	-0.14	4.53	-2.6
Bethel	3.1	-2.84	4.07	-11.58	-2.34	-0.9	-1.44	-0.21	-1.53	0.2	6.71	-5.15
Bettles	8.1	-5.69	-0.18	-13.37	1.65	-2.61	2.78	4.61	0.05	0.52	13.26	0.7
Cold Bay	-1.46	2.02	3.77	-1.04	-1.5	0.63	0.56	0.57	0.22	3.04	2.95	-2.23
Delta Junction	8.11	-4.68	-1.87	-12.68	0.41	-0.18	4.67	4.53	-2.7	-0.91	10.31	-3.17
Fairbanks	8.22	0.15	0.48	-12.21	0.59	-0.56	4.18	4.21	-1.09	0.69	11.62	0.42
Gulkana	7.9	1.52	0.07	-5.84	-2.31	-0.39	3.07	4.45	-1.79	-1.18	11.28	0.99
Homer	5.96	-1.99	-1.29	-4.24	-1.38	0.32	-0.13	1.54	-1.15	-0.24	3.34	-3.1
Juneau	6.2	-0.25	-2.25	-0.18	0.6	0.24	3.34	2.58	0.77	1.22	4.71	5.61
Ketchikan	3.85	-1.19	-1.35	-1.0	3.13	1.15	2.99	2.41	0.8	1.75	3.71	4.61
King Salmon	6.92	-2.01	-1.14	-9.19	-1.21	0.7	1.14	1.25	-1.53	-0.11	2.87	-4.47
Kodiak	3.04	-1.6	-0.64	-2.73	-2.5	-1.52	-1.38	-1.06	-1.98	0.42	0.55	-4.29
Kotzebue	5.66	-6.05	2.35	-13.32	-3.65	-2.97	2.04	1.35	-1.82	0.7	6.3	-3.25
McGrath	9.81	-2.43	0.28	-18.86	-1.81	-2.49	-0.19	1.81	-2.77	-1.89	7.04	-5.21
Nome	0.91	-6.06	0.87	-14.25	-2.32	-1.77	0.46	1.3	-3.06	-1.2	5.84	-2.13
St. Paul Island	1.82	2.02	4.15	-0.34	-0.94	-0.09	0.8	0.42	-0.49	1.71	2.34	-1.88
Talkeetna	7.77	-3.96	-0.25	-5.18	-1.59	-2.56	0.19	1.25	-1.32	0.36	6.83	-4.65
Utqiaġvik	5.29	-0.45	7.6	-6.48	3.36	0.63	6.77	4.72	3.42	4.81	8.42	8.1
Yakutat	5.28	-2.5	-3.36	-0.85	-0.08	-0.65	0.32	1.74	0.27	1.29	4.58	3.8

Table A2: Monthly temperature deviations (in °F) from normal at the 19 selected stations. The highest and lowest deviations are colored in red and blue, respectively.