2019 Alaska Climate Review:

Key observations

- *New temperature records were set: 2019 was the warmest year on record in Alaska, with a mean temperature of 37.4 °F, breaking the previous record set in 2016 by 0.2 degrees. All first order stations recorded positive departures from normal annual temperatures.*

- *The Panhandle and Northeast Gulf were drier than normal, contributing to the most significant drought conditions observed over Southeast Alaska in the 20-year history of the drought monitor.*

- *The southern coast experienced below average snowfall totals every month during the 2018/2019 winter season. Cold Bay, Juneau, and King Salmon received less than 60% of their normal snowfall. Juneau experienced below average snowfall totals every month during the 2018/2019 winter season. Nearly all stations in the Interior and Panhandle recorded less snowfall than normal in October because precipitation fell as rainfall due to unusually high temperatures that month. Conversely, Bettles, Nome, Kotzebue, and Utqiaġvik received above average snowfall for the season.*

- *The 2019 Alaska wildfire season caused many residents across the state to be evacuated. There were 719 fires recorded throughout the warm season; 2.5 mio acres of land burnt. Poor air quality and low visibility was observed across the state. Alaska's statutory wildfire season was extended from Aug. 31 to Sept 30 because of high fire danger due to continued warm, dry conditions into September.*

- *A new "blob", or large area of warm water observed in the Gulf of Alaska, named the Northeast Pacific Marine Heatwave of 2019, formed in May 2019 and reached its maximum size in August. It has since decreased in size and intensity, but is still one of the most significant events seen in the past 40 years. The 2014-1016 blob was linked to multiple fishery disasters.*

- *The September minimum sea ice extent tied with 2007 and 2016 for the second lowest sea ice extent in the 41-year satellite record at 4.15 million square kilometers.*

Temperature

Annual Temperature at 19 selected stations

Based on the 19 First Order stations, 2019 was the warmest year in Alaska on record with a mean temperature of 37.4 °F, breaking the previous record of 37.2 °F set in 2016 by 0.2 degrees. Five of the past 6 years have been amongst the five years with record high temperatures for Alaska, the exception being 2017 (Figure 2). Looking at individual climate regions, five of the past 6 years have been amongst the five years with record high temperatures in all of Alaska except for the Panhandle. The Panhandle has had some years warmer than the past 6 years; the years 2004 and 2005 were for example above normal along the Panhandle. In general, the Arctic, Interior, and West Coast show a higher warming trend over the time series than the Panhandle (Figure 3). All selected stations recorded positive departures from normal, with magnitudes ranging from +1.8 °F in Ketchikan to up to +9.1 °F in Kotzebue and Utqiaġvik (Barrow) (Figure 1). The mean deviation from normal over all 19 selected stations was 4.9 °F. The positive departure from normal was especially high along the Arctic coast. The Panhandle recorded moderate positive temperature deviations.

Table B lists the mean annual air temperature at the 19 stations, as well as the normal for 1981-2010 and the departure from normal at each station. Figure 1 shows the departure from normal at the 19 stations.

Table A: Five highest mean annual temperatures in Alaska since 1949

Year	Mean Annual Temperature (°F)
2019	37.4
2016	37.2
2014	35.7
2018	35.7
2015	35.3

Monthly Mean Temperatures

Averaged over all 19 stations, July was the warmest month of 2019 with a mean temperature of 60.2 °F (Table C, Figure 4). January was coldest at 14.6 °F, followed by December at 16°F. December and August had the least deviations from normal in relative terms with positive deviations from normal of 1.7°F and 2.6°F respectively. March and November were by far the warmest months of 2019 with temperatures of 11.4°F and 8.7°F above normal respectively

Monthly temperatures peaked in July at most of the selected stations. Kodiak, Cold Bay and St. Paul Island recorded the highest monthly temperatures of the year in August. The coldest months of the year were January, February, or December, depending on the station (see Table E). In Juneau, the least positive deviations from the normal monthly temperatures were observed in December. The majority of stations on the western and Arctic coast, as well as Delta Junction and Fairbanks, recorded the highest deviations from normal in February and March.

*Table B: Mean temperature for 2019, normal temperature (1981-2010) and deviations from the mean for the 19 First Order meteorological stations in Alaska. * marks stations with more than five days of missing data. Missing data are ignored in the computation of the mean.*

Station	Observed T (°F)	Normal (°F)	Delta (°F)
Anchorage	42.5	37	5.5
Bethel	36.8	30.6	6.2
Bettles	27.1	23.4	3.8
Cold Bay	43.5	38.8	4.7
Delta Junction*	33.6	28.9	4.8
Fairbanks	32.5	27.6	4.9
Gulkana*	32.8	28.1	4.7
Homer*	42.9	38.7	4.2
Juneau	44.2	42.1	2.1
Ketchikan	46.9	45.1	1.8
King Salmon*	41.7	35.1	6.6
Kodiak	45.4	40.9	4.5
Kotzebue	31.9	22.7	9.1
McGrath	32.1	27.2	4.9
Nome	31.8	27.4	4.5
St. Paul Island*	40	35.3	4.7
Talkeetna*	39.7	35.9	3.8
Utqiaġvik (Barrow)	20.8	11.7	9.1
Yakutat*	43.8	40.2	3.6
Mean	**37.4**	**32.5**	**4.9**

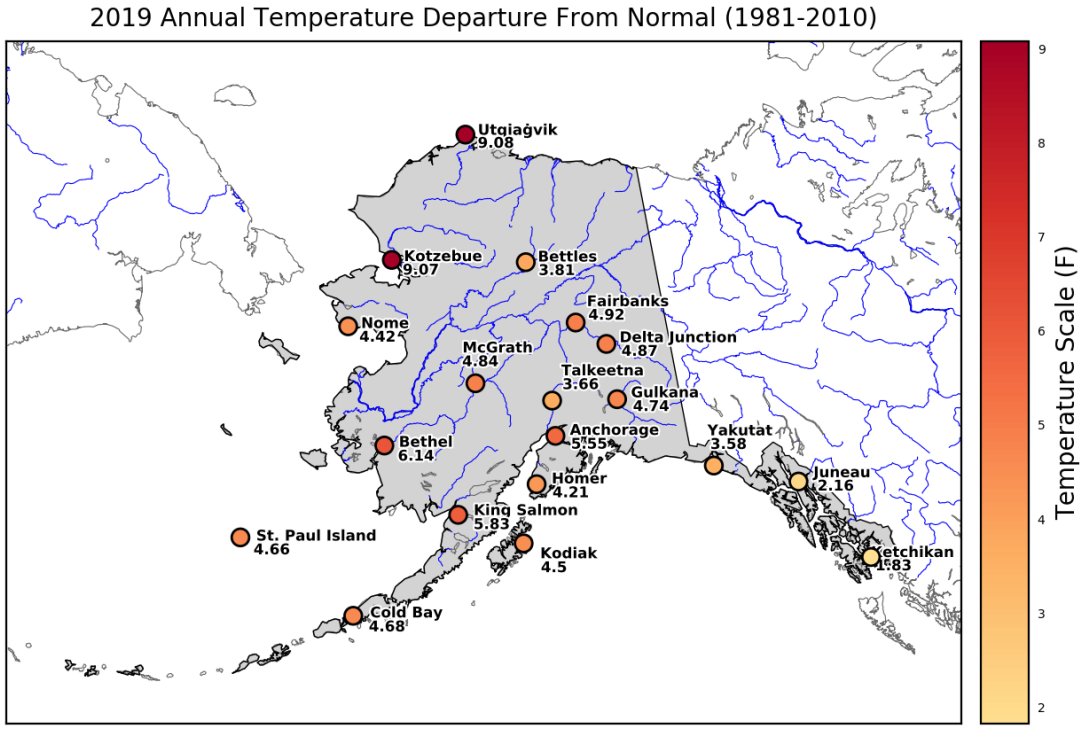

Figure 1: Mean annual air temperature deviations (°F) from the normal (1981-2010) for 2019 for the selected stations.

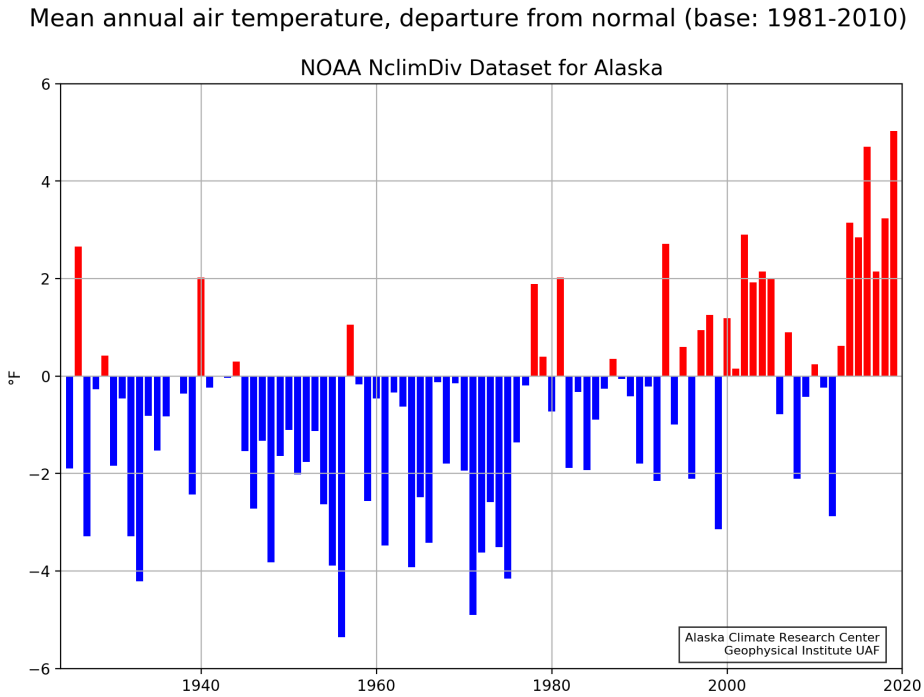

Figure 2: Mean annual air temperature deviations (°F) from the normal (1981-2010).

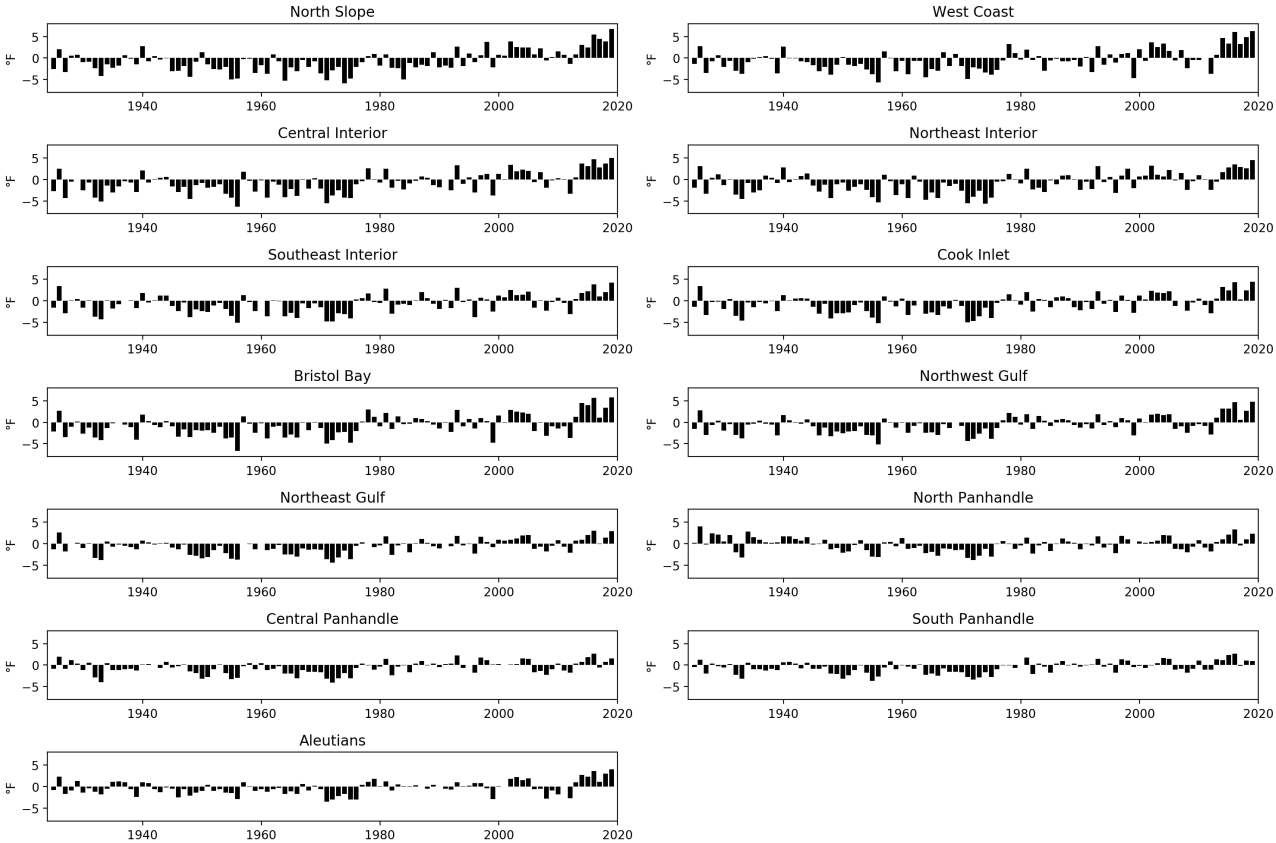

Figure 3: Time series of annual mean temperature departure from the normal (1981-2010) for the Alaska climate divisions. Data source: NOAA nClimDiv data.

The record warmth in March was due to a high-pressure ridge over Alaska and northwest Alaska that lasted two weeks. Low pressure over the Bering Sea produced southwest winds along Alaska's west coast, pushing warm air from southern latitudes into the Arctic. High water temperatures in the northern Pacific and Bering Sea starting in the summer contributed to the warm fall season and raised concerns about a return of the "blob", a large area of warm water that was observed in the Gulf of Alaska from 2014 to 2016. A new "blob", named the Northeast Pacific Marine Heatwave of 2019, formed in May 2019 and reached its maximum size in August. It has since decreased in size and intensity, but is still among the most significant events seen in the past 40 years. The 2014-2016 blob was linked to multiple declared fishery disasters, thousands of young California sea lions stranding on beaches and the largest harmful algal bloom recorded on the West Coast, as well as the lower than expected 2018 sockeye run to the Copper River. Water close to the shore is typically colder when the Gulf is warm, so that the 2018 Copper River Salmon would have entered cold water when they swam out to sea from their estuaries in the years prior. This is likely to have impeded their growth. Further off shore, sand lance and plankton were killed off by the high-water temperatures, leading to food scarcity for the sockeye and further diminishing their numbers.

Considering the large-scale coupling between atmospheric circulation, El Niño–Southern Oscillation (*ENSO*) and the related Pacific Decadal Oscillation (*PDO*) also influence the climate of Alaska (Mantua et al. 1997, Hartmann and Wendler 2005). A positive PDO usually leads to above normal temperatures in Alaska. The PDO was above zero in April, May, and July 2019 and hovered around zero during September and December. PDO cycles tend to persist for several years to several decades. Intermittent months of negative values, as recorded in 2019, do not indicate a long-term shift to a negative PDO mode. Mantua et al. (1997) state that per unit standard deviation positive PDO, positive precipitation anomalies of 20 to 30 mm are typical in the central Gulf of Alaska.

ENSO phases cycle from positive to negative on a much shorter time scale than the PDO with cold/warm phases typically lasting from 6 to 8 months. El Niño winters are characteristically warm and wet over southern Alaska and western Canada. The Oceanic Niño Index (ONI) continuously decreased from January through September, before increasing again through November 2019. January through June classified as weak El Niño conditions. The interaction between PDO and ENSO is complex, but the combination of warm (El Niño) ENSO conditions – associated with warm, wet winters and positive PDO – associated with wet conditions made for a warmer year than would have occurred without these factors.

Figures 5 to 9 show climographs for, respectively, Anchorage, Utqiaġvik (Barrow), Fairbanks, Juneau, and St Paul Island, as examples of 2019 temperature deviations in the five main climate regions of Alaska. Each station set new records for daily high mean temperature for a specific day. The Arctic saw the highest monthly deviations from normal with temperatures 18.7 °F and 18.5 °F above normal in February and March, respectively, and 16.0 °F above normal in November. The Interior was 15.5°F above normal in March. The Panhandle reported the coldest deviation from normal, 6.1 °F below normal in February (Table C).

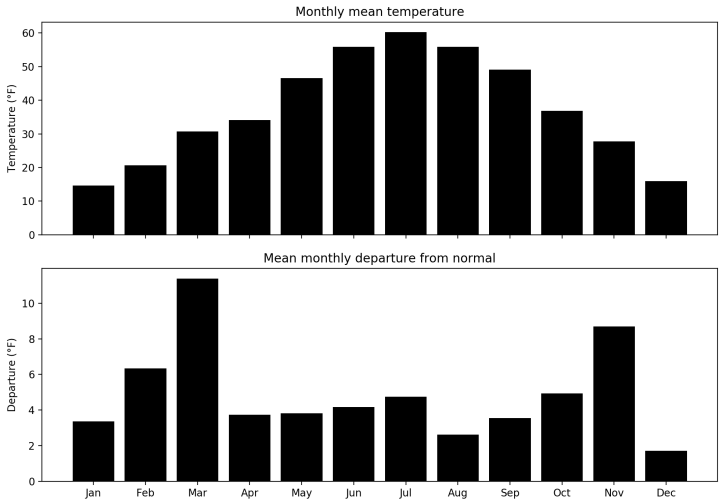

Figure 4: Monthly mean temperature (top) and temperature deviation from normal (1981-2010) (bottom), averaged over the 19 selected stations by month for 2019.

Table C: Monthly mean temperatures and deviations from normal in Fahrenheit for 2019, averaged over selected meteorological stations.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
State	T mean (°F)	14.6	20.7	30.7	34.1	46.6	55.9	60.2	55.9	49.1	36.9	27.8	16
	T dev (°F)	3.4	6.3	11.4	3.7	3.8	4.2	4.8	2.6	3.6	4.9	8.7	1.7
Arctic	T mean (°F)	-8.8	4.5	5.9	7.3	27.7	37.0	48.3	42.7	40.8	28.8	16.8	-0.8
	T dev (°F)	4.6	18.7	18.5	5.5	6.5	1.3	7.5	3.7	8.7	11.6	16.1	7.0
West Coast	T mean (°F)	17.5	28.0	28.8	30.7	42.7	52.7	57.1	54.8	48.6	37.7	26.5	16.3
	T dev (°F)	5.1	13.8	12.5	6.0	5.3	5.8	4.9	3.5	3.8	5.3	4.4	-0.1
Interior	T mean (°F)	-4.4	6.5	26.9	33.7	50.0	61.5	63.9	54.4	46.8	29.6	14.1	-3.3
	T dev (°F)	1.3	5.4	15.5	3.8	3.4	3.8	3.9	0.1	3.4	5.9	10.3	-1.2
Bristol Bay & Cook Inlet	T mean (°F)	23.2	24.5	36.0	38.2	48.3	58.0	62.6	59.1	50.9	40.5	36.0	22.9
	T dev (°F)	5.2	3.5	9.6	2.4	2.2	4.4	5.3	3.6	3.0	5.6	12.4	2.8
South Central	T mean (°F)	30.9	32.1	38.7	39.8	47.5	54.2	60.0	59.4	52.4	43.3	41.1	35.8
	T dev (°F)	1.6	1.9	6.3	2.1	3.0	3.9	5.6	4.9	3.5	2.5	8.0	5.4
Pan-handle	T mean (°F)	33.4	26.9	39.1	43.3	52.6	56.5	60.4	58.8	53.3	43.2	41.1	37.7
	T dev (°F)	1.8	-6.1	3.3	1.6	4.0	2.2	3.0	1.9	2.1	-0.7	5.1	5.1

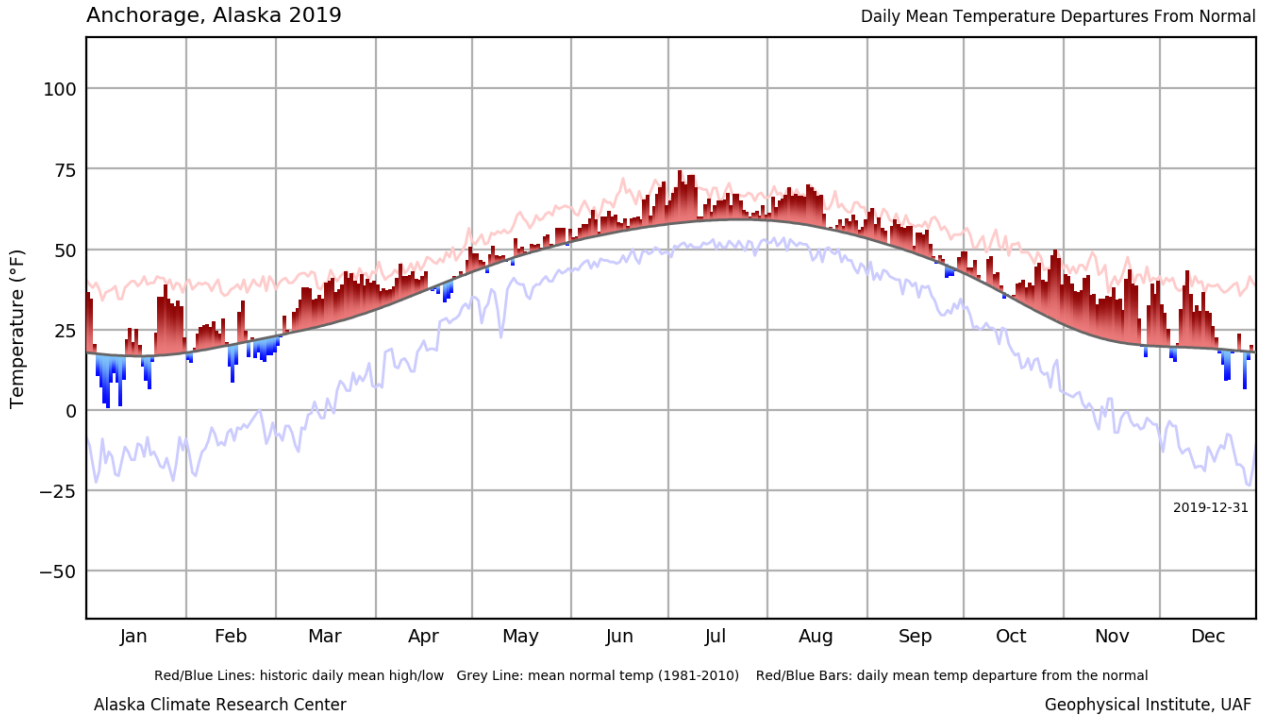

Figure 5: Mean normal temperature, daily mean departure from normal and historic daily mean minimum and maximum for Anchorage, 2019.

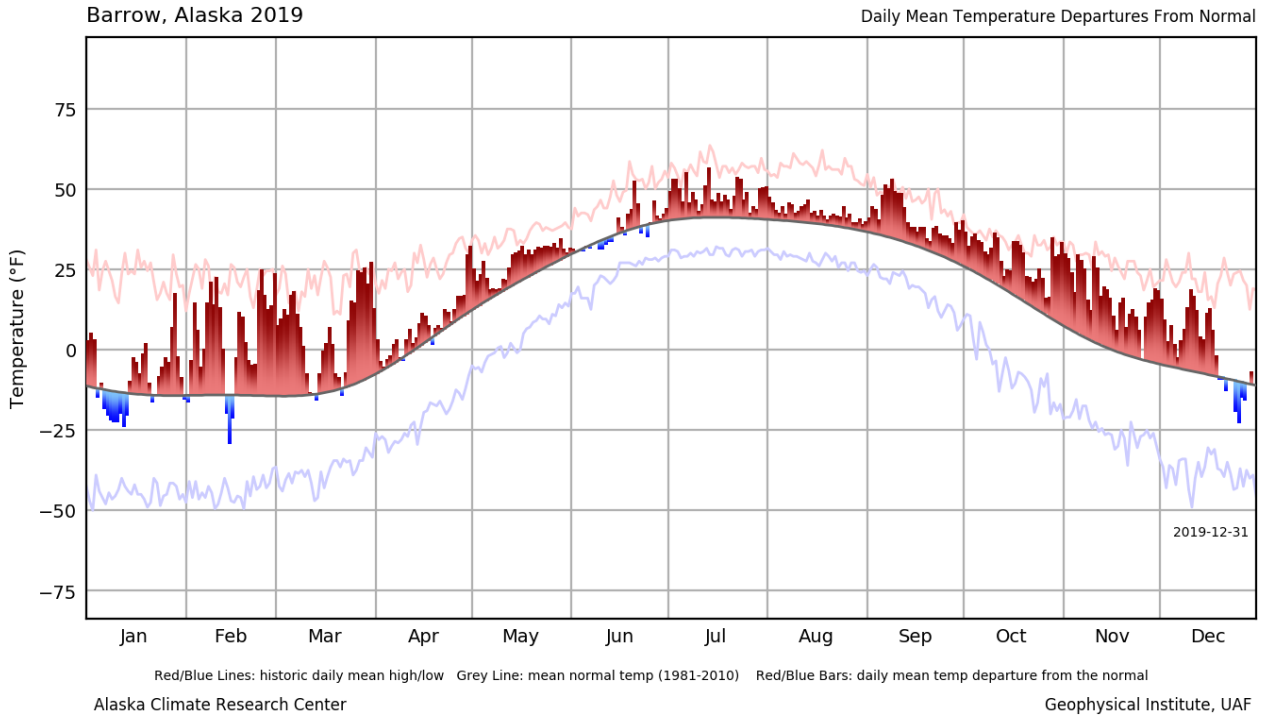

Figure 6: Mean normal temperature, daily mean departure from normal and historic daily mean minimum and maximum for Utqiaġvik (Barrow), 2019.

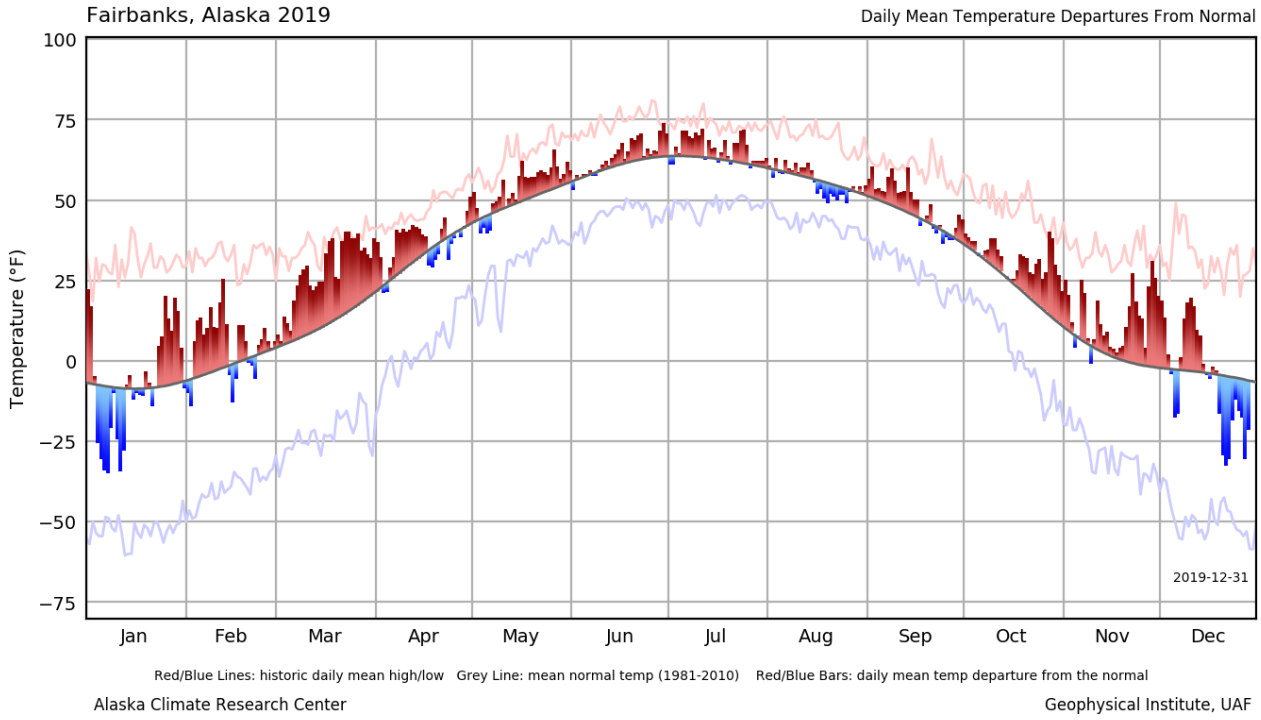

Figure 7: Mean normal temperature, daily mean departure from normal and historic daily mean minimum and maximum for Fairbanks, 2019.

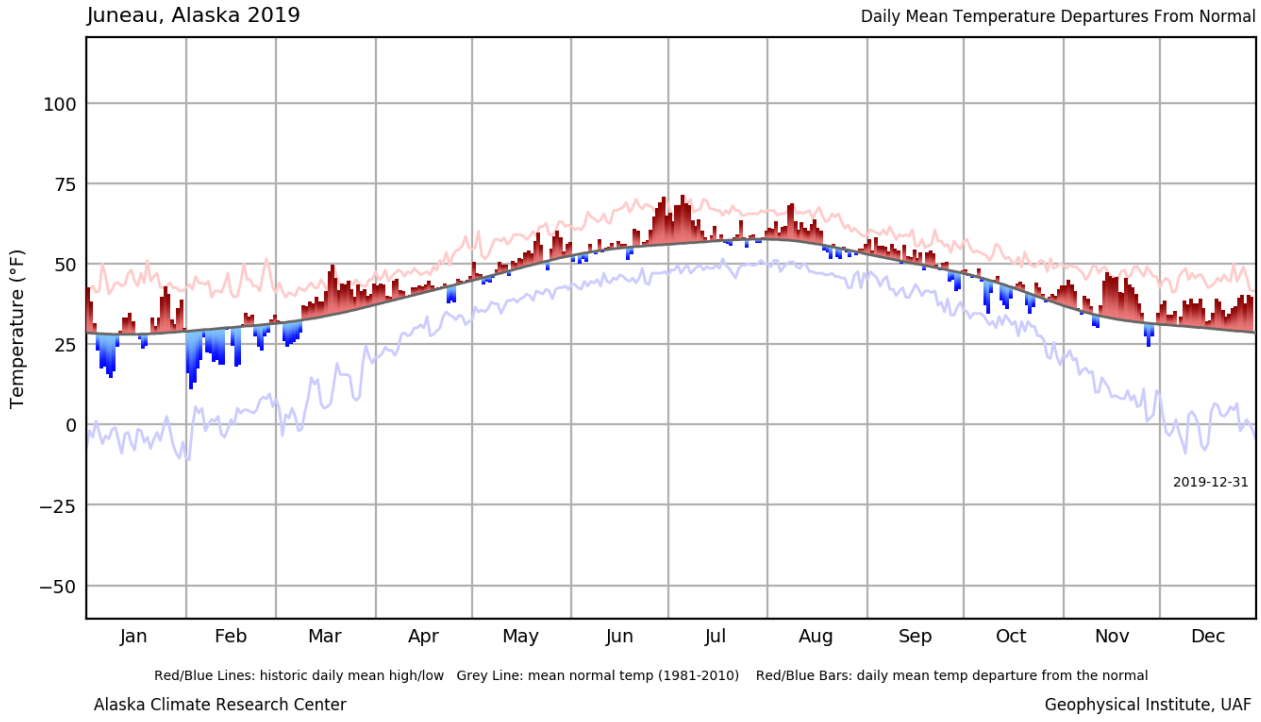

Figure 8: Mean normal temperature, daily mean departure from normal and historic daily mean minimum and maximum for Juneau, 2019.

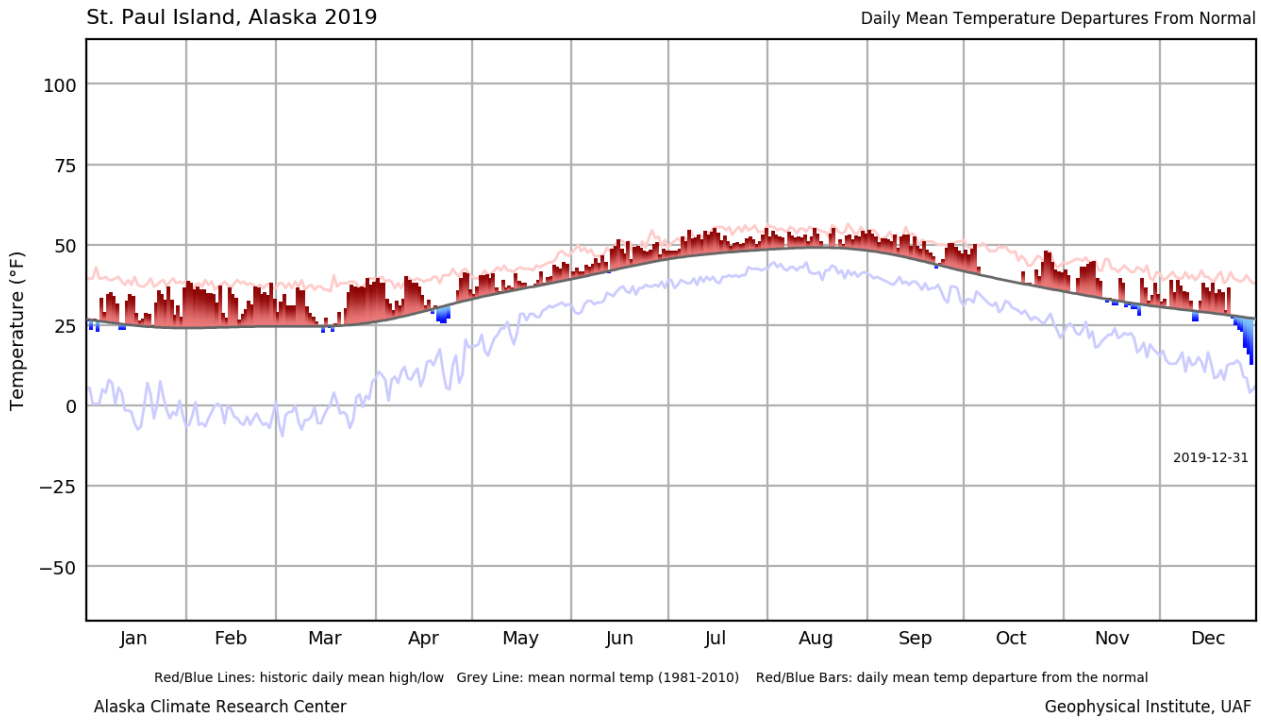

Figure 9: Mean normal temperature, daily mean departure from normal and historic daily mean minimum and maximum for St. Paul Island, 2019.

Precipitation

Annual Precipitation at the First Order Stations

The mean annual precipitation in the Arctic was 10.1", about 223% of the long-term mean. The West Coast saw an average of 24.2", 130% of normal. Above average precipitation was recorded in the interior, receiving 136% of the long term mean which is 14.9". The Bristol Bay and Cook Inlet region was drier than normal for the year, receiving an average of 14.6" of precipitation, almost 88% of the long term normal of 16.6". The South Coast was close to normal, receiving 97% of the long term mean of 62.3" (Table D). Precipitation totals vary strongly when traversing from the southeast to Arctic Alaska (Fig. 10, 11, Shulski and Wendler 2007). Utqiaġvik is the driest station with a normal annual precipitation of 4.5". In 2019, Utqiaġvik received 10.1" or 223.2% of normal, which was the highest precipitation deviation observed across the state. Nome and Fairbanks, received 158.8% and 151.7% of normal annual precipitation. Yukatat was drier than normal receiving 70% of its normal precipitation, which is 108.6". Anchorage and Talkeetna were also dryer than normal, receiving less than 90% of their normal precipitation values for the year.

Precipitation values across Alaska are presented in figure 10 and the annual departure from normal for the Alaska climate divisions are shown in figure 11. The North Slope, Interior, West Coast and Bristol Bay were wet. Conversely, the Panhandle and Northeast Gulf were drier than the 1981-2010 normal. This is similar to previous years as the North Slope, Interior and Bristol Bay have seen an increase in precipitation amounts over the past decade, while the Panhandle has experienced a decrease in precipitation over the same time period. The Panhandle has experienced similar dry periods in the historical record, most recently in the 1990's (Figure 11).

Monthly Precipitation at the First Order Stations

The months of October, November, and December were normal or wet over all the regions. On the other hand, the month of August showed a fairly clear separation between the southern and the central-northern part of Alaska. During August, the south recorded extremely low precipitation, the western and southeastern regions recorded closer to normal precipitation, and the Interior and Arctic were significantly wetter than normal (Figure 13). Figure 14 shows the monthly precipitation sums and corresponding normal values for all of the First Order stations and illustrates the large variation of precipitation in the different climatic zones. The plot for Yakutat in Figure 13 shows the exceptionally dry conditions the southeast experienced throughout most of the year. Usually one of the wettest regions of the state, the Panhandle as a whole has been in drought and the southern half of the panhandle remained in moderate drought conditions throughout the year. Figure 14 shows monthly precipitation sums averaged over the five main climatic regions.

Table D: Annual precipitation for 2019, normal precipitation (1981-2010) and deviations from normal in percent of the normal for the 19 selected meteorological stations.

Station	*Precipitation 2019 (in)*	*Normal (in)*	*Delta (% of normal)*
Anchorage	14.6	16.6	87.8
Bethel	24.2	18.5	130.3
Bettles*	20.3	14.9	136.2
Cold Bay	50.6	41.7	121.4
Delta Junction*	11.2	11.6	96.7
Fairbanks	16.4	10.8	151.7
Gulkana*	12.2	11.3	108.1
Homer*	26.2	24.3	107.7
Juneau	60.5	62.3	97.2
Ketchikan	147.2	141.2	104.2
King Salmon	25.5	19.5	131
Kodiak	73.5	78	94.2
Kotzebue	13.7	11	124.7
McGrath	22.8	18	126.8
Nome	26.7	16.8	158.8
St. Paul Island*	28.2	23.7	119.1
Talkeetna*	25	28	89.4
Utqiaġvik (Barrow)	10.1	4.5	223.2
Yakutat	108.6	155.1	70

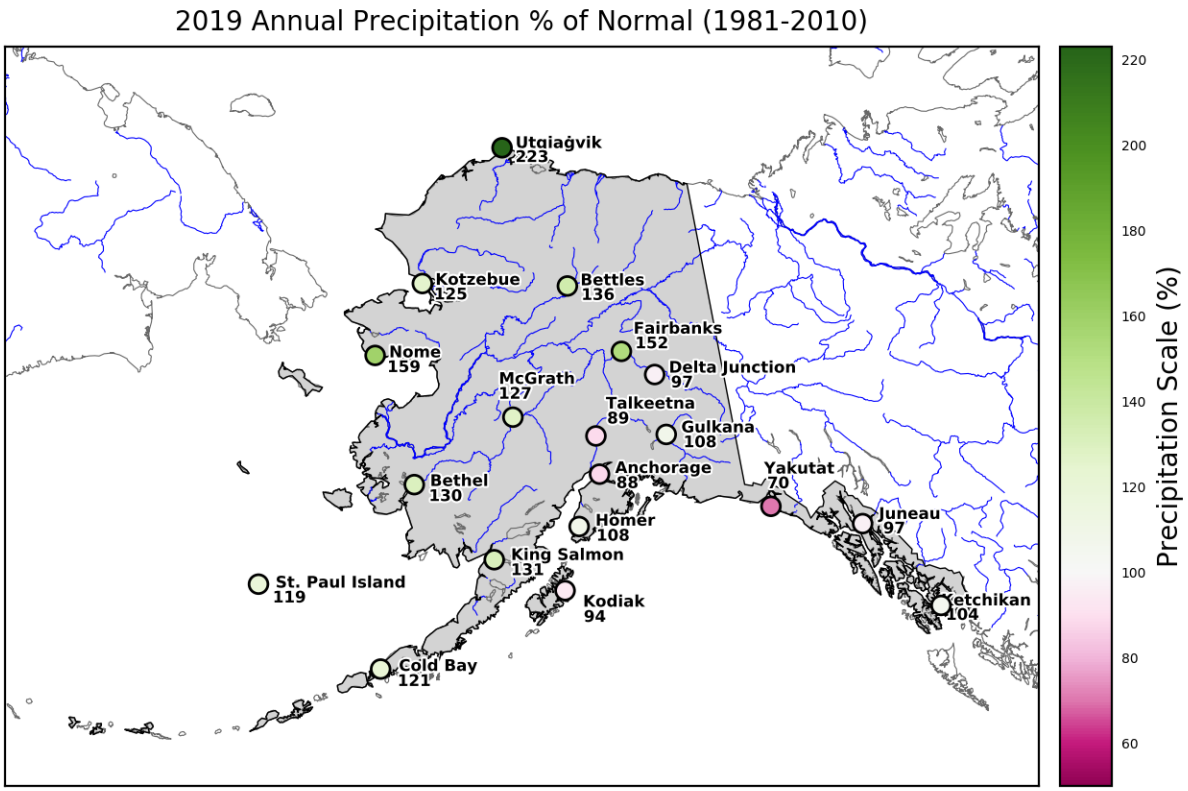

Figure 10: Precipitation deviations (%) from the normal (1981-2010) for 2019 for the selected stations.

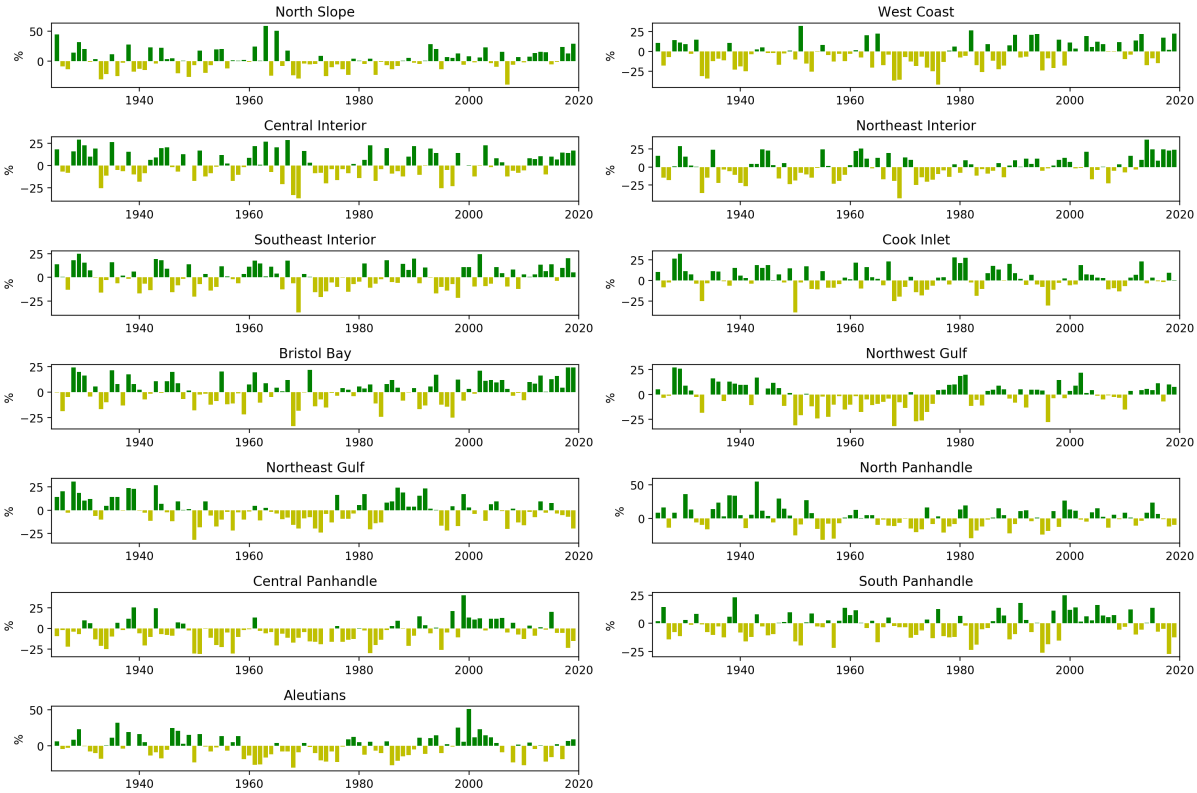

Figure 11: Time series of annual precipitation sums as percentage departure from the normal (1981-2010) for
the Alaska climate divisions. Data source: NOAA nClimDiv data.

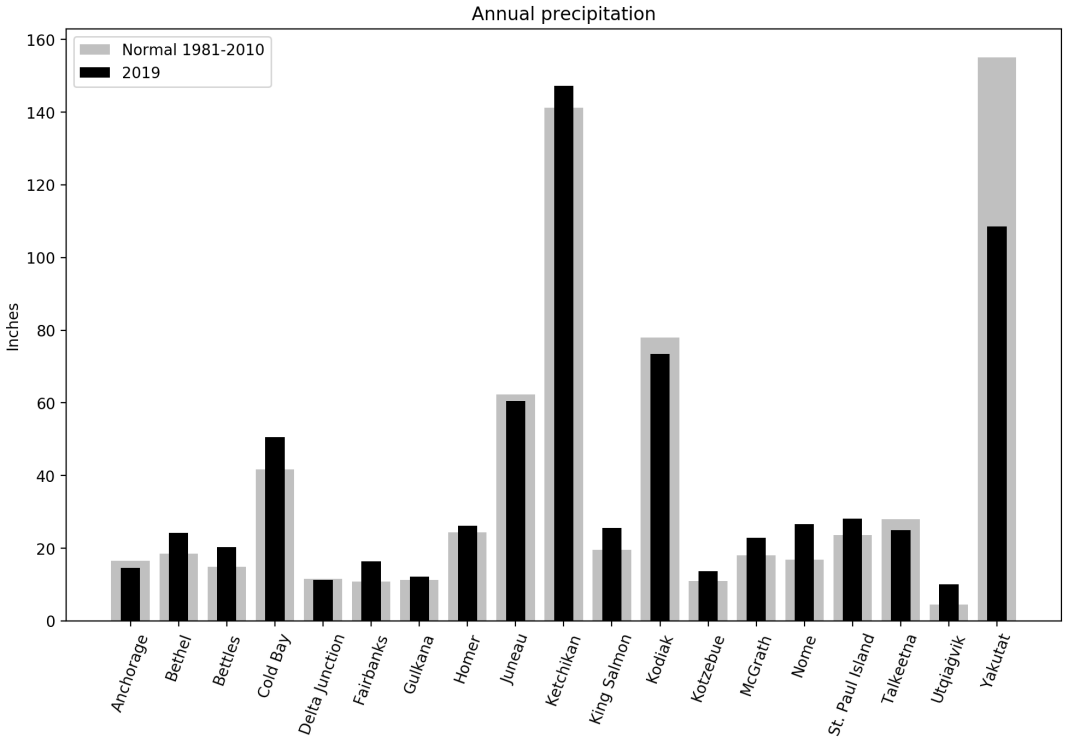

Figure 12: Precipitation sums for 2019 and corresponding normal values at the selected stations. (1981-2010) for 2019 for the selected stations, in inches.

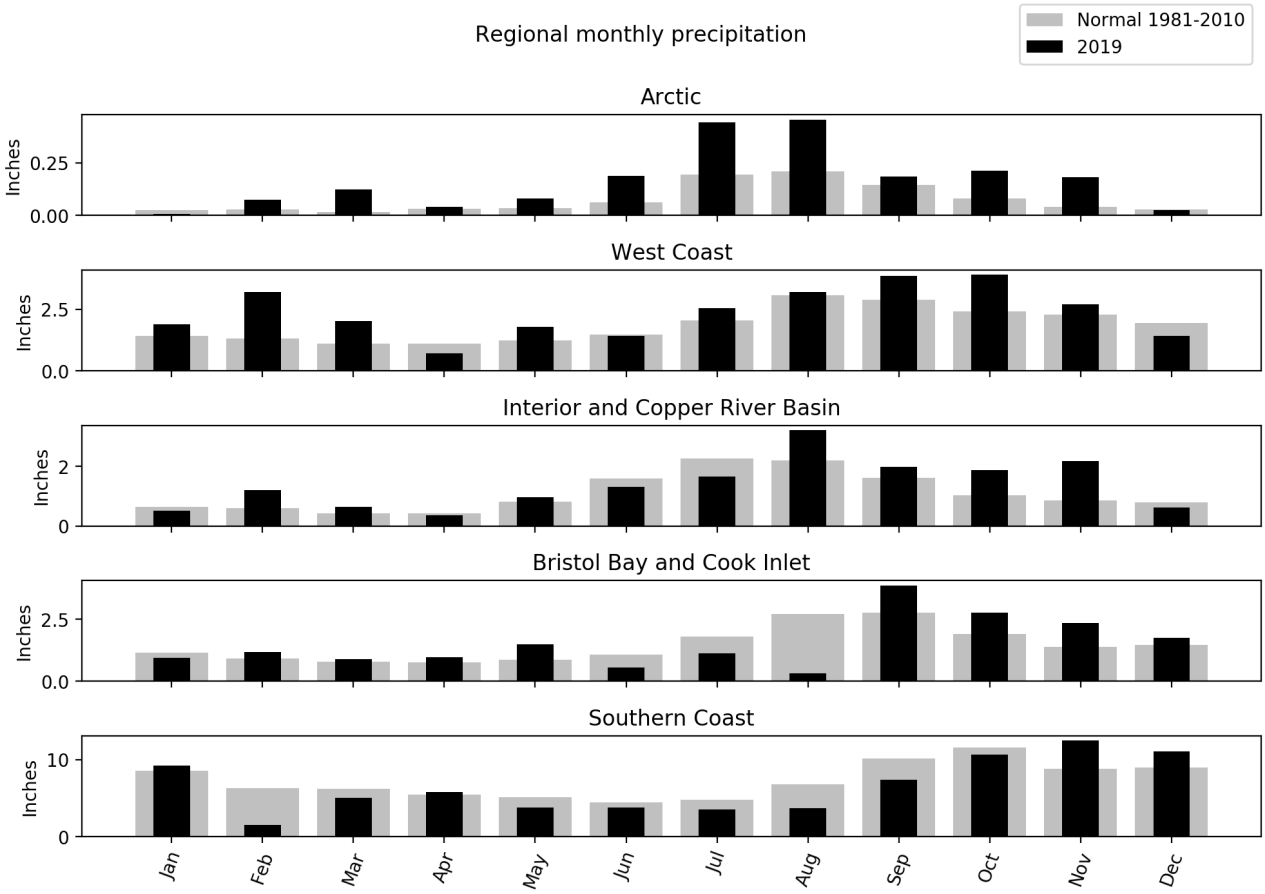

Figure 13: Monthly precipitation sums for 2019 and corresponding normal values at the selected stations, grouped by Alaska's main climatic regions. Stations correspond to regions as follows: Arctic - Utqiaġvik (Barrow); West Coast - Bethel, Cold Bay, Kotzebue, Nome, St. Paul Island; Interior and Copper River Basin - Bettles, Delta Junction, Fairbanks, Gulkana, McGrath; Bristol Bay and Cook Inlet - Anchorage, Homer, King Salmon, Talkeetna, South Coast - Juneau, Ketchikan, Kodiak, Yakutat.

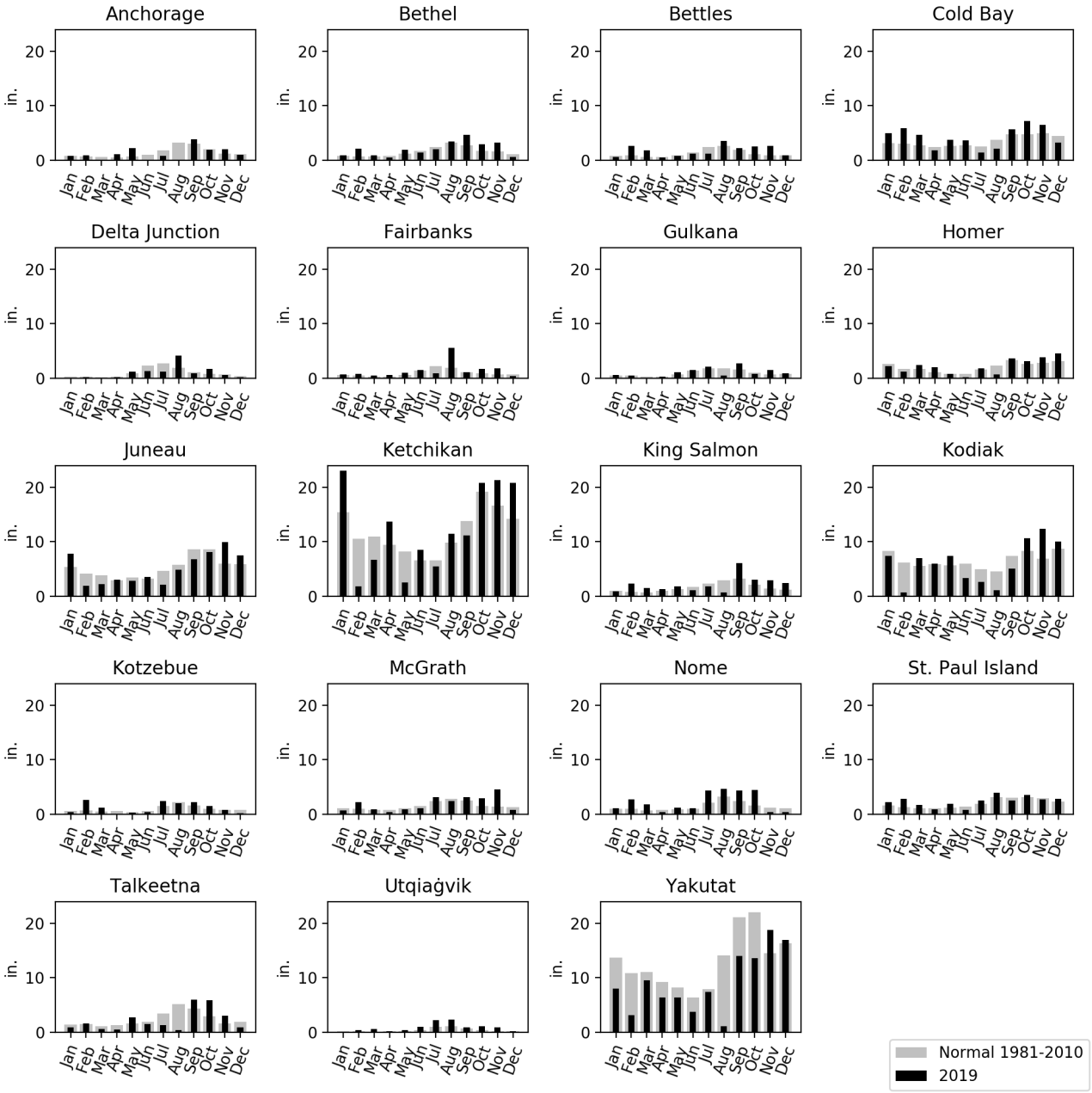

Figure 14: Monthly precipitation sums for 2019 and corresponding normal values at the selected stations.

Snowfall

The normal snowfall over the stations with snowfall measurements range from 35.9 inches in Utqiaġvik to 97.3 inches in McGrath. The mean annual sum of snowfall for the 2018/19 winter season (September-May), averaged over the 10 stations that measure snowfall, is about 97% percent of the normal (Table E). Snowfall has been declining in the Arctic since 2011, when the amount of snowfall peaked after increasing from the mid-1970's when there was less snow (Figure 15). There does not appear to be a trend in snowfall over the Interior, which has seen similar snowfall amounts since 2000, alternating with years of lower snowfall. Juneau has experienced a decrease in snowfall since 2009, however this year's total is higher than 2016 which was one of the three lowest snowfall seasons in the region. Bristol Bay and Cook Inlet experienced a sharp drop in snowfall, similar, but smaller than, the decline in snowfall in 2014. Seven stations received less snow than normal (Table E, Figure 16).

King Salmon received the least amount of snow in relative terms with 44% of the normal. Juneau also experienced a poor snow season with 58% of normal. Bettles and Nome were snowiest with 178% and 141% of normal, respectively. Bettles set a new record for monthly snowfall in December 2018 with 56.7", well over 300% of normal and received well above normal snowfall in February and March (Figure 17). Kotzebue, McGrath, and Nome similarly received well above normal snowfall in February.

The southern coast experienced below average snow fall sums every month during the 2018/2019 winter season (Figure 18). There was less snowfall than normal in October at nearly all stations because precipitation fell as rainfall due to unusually high temperatures. December was a snowy month in all regions, with well above average snowfall in Anchorage, Bettles, Cold Bay, and Utqiaġvik (Figure 17). January and November experienced less snow than normal in all regions except the Arctic.

Please note that only 10 of the 19 selected weather stations measure snowfall. Bethel, Delta Junction, Gulkana, Homer, Ketchikan, Kodiak, St. Paul Island, Talkeetna, and Yakutat do not report snowfall amounts.

Table E: Snowfall sums from the 2018/19 winter season (Sept. 2018 – May 2019), normal snowfall (1981-2010) and deviations from normal in percent of the normal for the selected stations that measure snowfall.

Station	Snowfall 2017/18 (in)	Normal (in)	2017/18 % of normal
Anchorage	65	74.5	87
Bettles	162.3	91.4	178
Cold Bay	43.1	73.1	59
Fairbanks	57.5	65	88
Juneau	50.6	86.8	58
King Salmon	20.5	46.6	44
Kotzebue	60.8	59.8	102
McGrath	95.5	97.3	98
Nome	106.4	75.4	141
Utqiaġvik	41.4	35.9	115
Mean	70.31	70.58	97

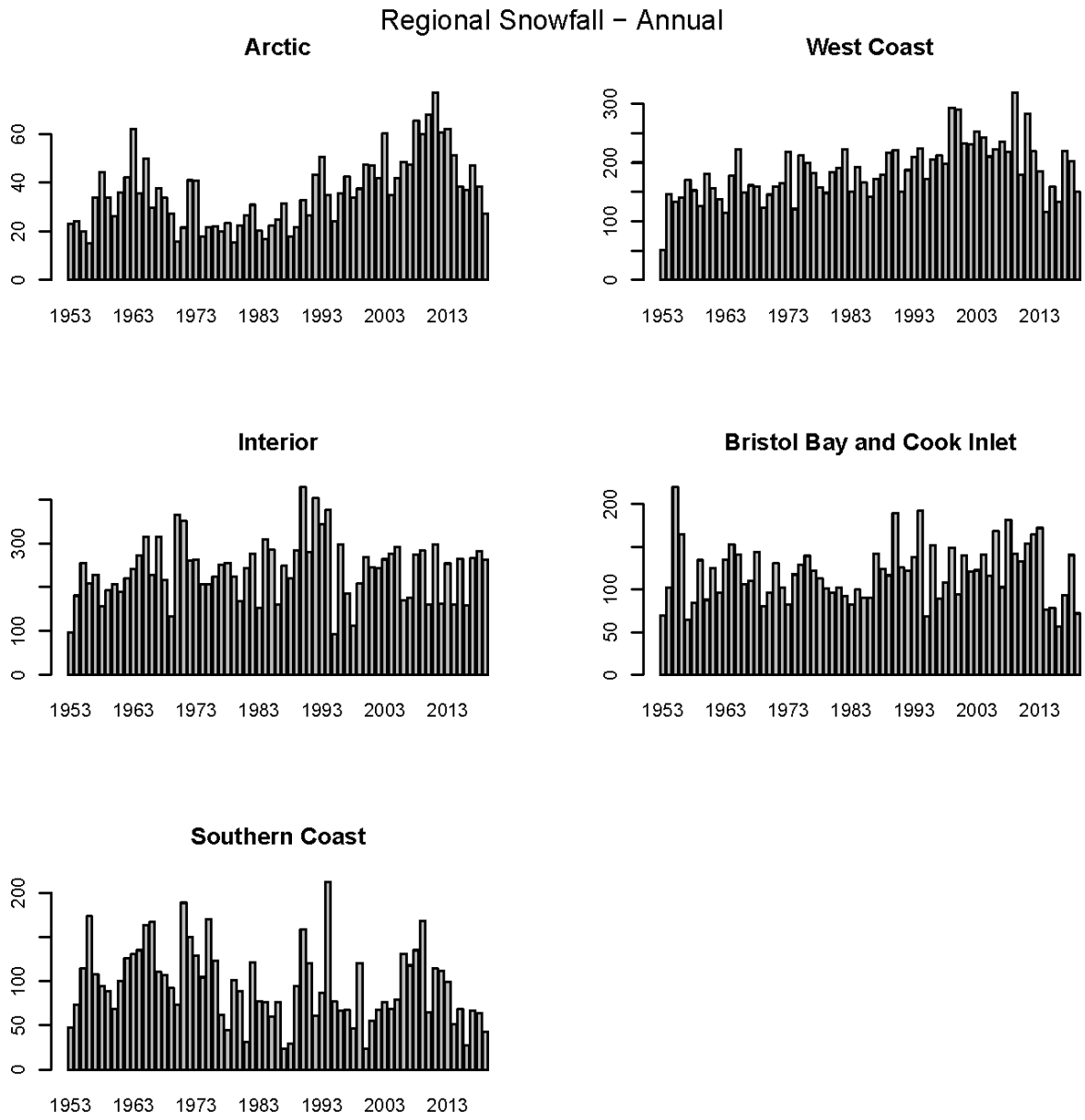

Figure 15: Monthly snowfall sums for 2019 at the selected stations, grouped by Alaska's main climatic regions. Stations correspond to regions as follows: Arctic - Utqiaġvik (Barrow); West Coast - Cold Bay, Kotzebue, Nome; Interior and Copper River Basin - Bettles, Fairbanks, McGrath; Bristol Bay and Cook Inlet - Anchorage, King Salmon, South Coast - Juneau.

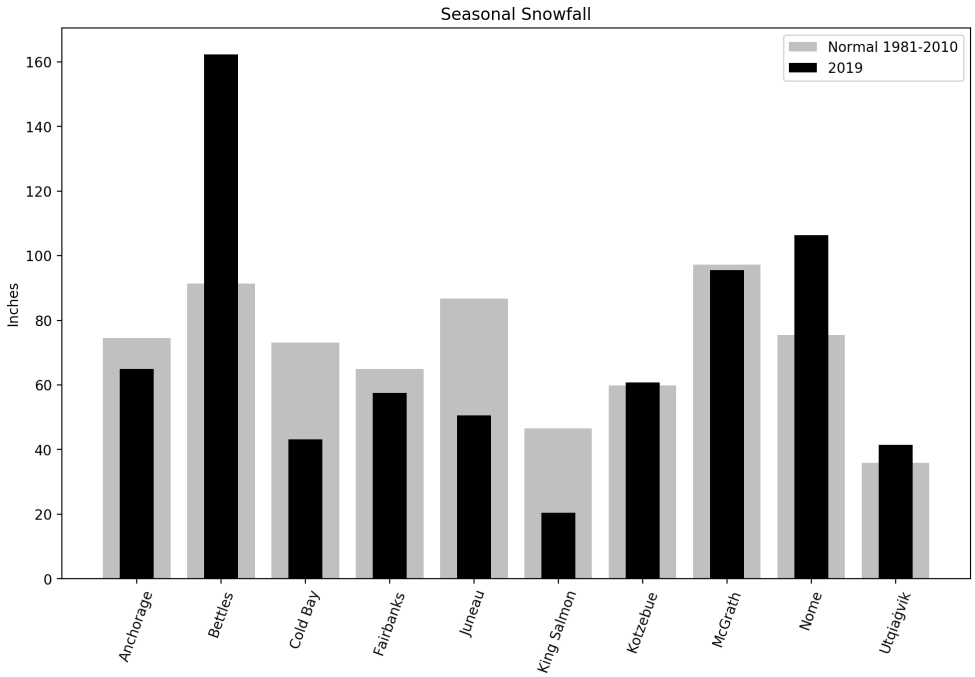

Figure 16: Annual snowfall averaged over fourteen of the selected stations. 2019 values (black) compared to the normal for 1981-2010 (grey).

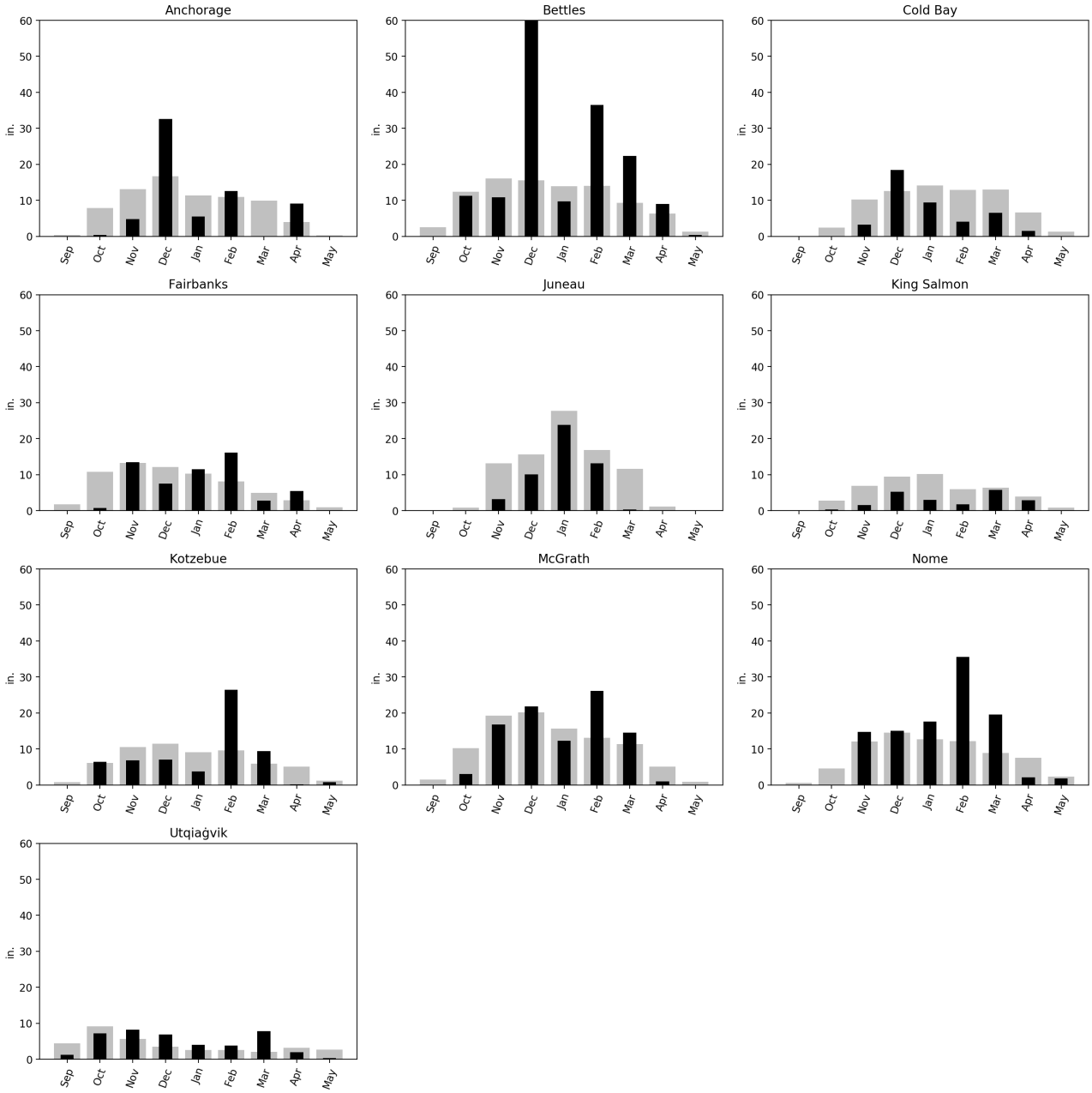

Figure 17: Monthly snowfall in inches for (black bars) the selected stations for 2018/19, compared to the normal (grey bars) (1981-2010).

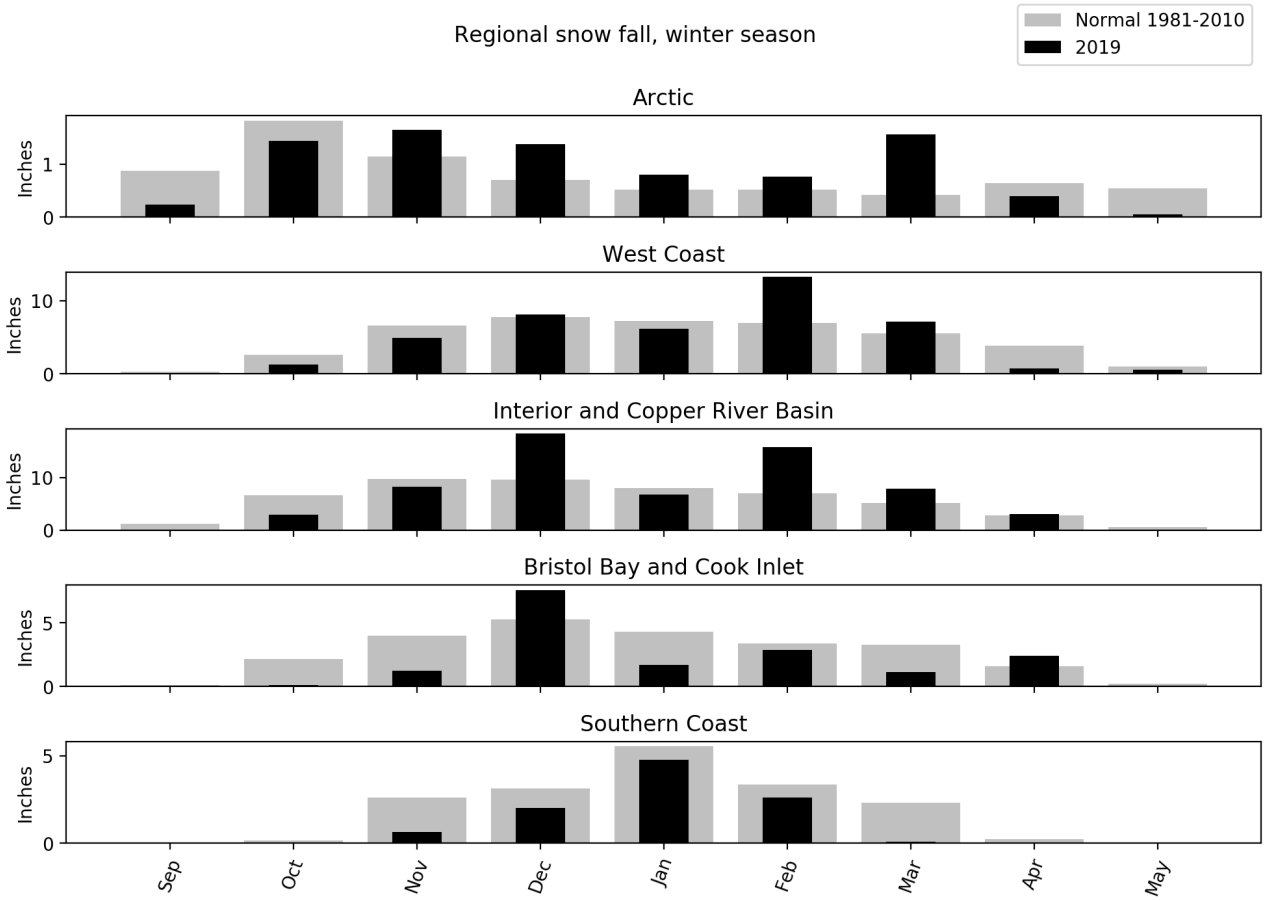

Figure 18: Monthly snowfall sums for the 2018/19 winter season and corresponding normal values at the selected stations, grouped by Alaska's main climatic regions. Stations correspond to regions as follows: Arctic - Utqiaġvik (Barrow); West Coast - Cold Bay, Kotzebue, Nome; Interior and Copper River Basin - Bettles, Fairbanks, McGrath; Bristol Bay and Cook Inlet - Anchorage, King Salmon, South Coast - Juneau.

2019 Arctic Sea Ice

Arctic sea ice, and specifically the seasonal development of sea ice in the Bering and Chukchi Sea, is a key driver for Alaska's climate. The year 2019 saw an early melt onset and high sea surface temperatures during summer in the Beaufort and Chukchi Seas. The seasonal Arctic sea ice extent maximum, reached on March 13, was seventh lowest in the satellite record (Figure 18). Extent dropped to record low levels in mid-July through early August, but the loss then slowed considerably compared to average. The September minimum extent ended up tied with 2007 and 2016 for second lowest in the 41-year satellite record at 4.15 million square kilometers. The thickness of the sea ice has also decreased, resulting in ice cover that its more vulnerable to warming air and ocean temperatures (Richter-Menge, J., et al., 2019). Autumn freeze up was initially slow, particularly in the Chukchi Sea. In December, the Chukchi Sea finally completely refroze and sea ice extended south into the Bering Sea. The year 2019 still ended with low extent in the Bering Sea.

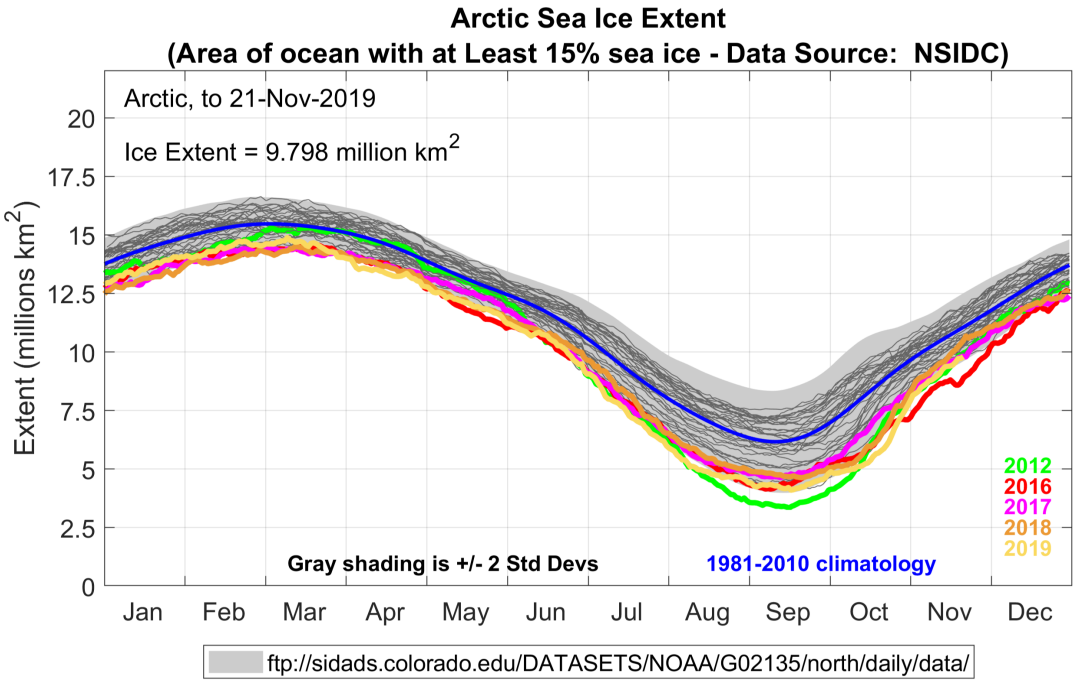

Figure 18: Arctic sea ice extent, 2018 shown as orange line. Plot complied by Howard J. Diamond. Data Source: National Snow & Ice Data Center (NSIDC, nsidc.org)

2019 Wild Fire Season

In 2019, 719 fires were reported statewide, with a total area bunt of 2,589,893 acres. The majority of 2019 fires (372) were caused by lightning burning 2,544,968 acres (AICC Report, 2019). This is large compared to the area burnt in the 372 human caused fires (burnt area: 44,925). Human caused fires tend to occur nearer to areas, such as homes and infrastructure, where containment is more crucial than lightning caused fired in remote locations. Although summer 2019 did not surpass the record season of 2004, when approximately 6.6 million acres burned, it marks the fifteenth time in 80 years of records that Alaska has seen more than 2 million acres burn in a single season. Alaska's statutory wildfire season was extended from Aug. 31 to Sept. 30 (State of Alaska Department of Natural Resources Press Release, 2019) because of several wildfires burning in Southcentral Alaska and high fire danger due to continued warm, dry conditions into September. This is the first time the fire season has been extended since 2006, when legislation shifted the five-month season to start and finish one month earlier.

During June, many residents across the state suffered from dense smoke, low visibility, and poor air quality caused by fires. In late June, people were evacuated from Fairbanks as the Shovel Creek wildfire burned nearby. In July, air quality was harmfully low in many areas with concentrations of particulate matter surging to dangerous levels around Fairbanks and surrounding communities. The spread of wildfires led to evacuations of the population in many areas across the state. In August, as many as 50 homes, 3 businesses and 80 outbuildings between Willow and Talkeetna were destroyed by fire. The Swan Lake fire, which was discovered at the beginning of June and almost contained by the end of July , flared up again in August causing schools to close and residents to evacuate in Sterling and Cooper Landing. Anchorage experienced the worst air quality conditions ever recorded, ranking as the city with poorest

air quality in the United States this summer. In August, the Anchorage School District cancelled after school activities and Anchorage citizens were strongly advised to avoid strenuous outdoor activities.

2019 Drought Conditions

The 2019 drought conditions in Southeast Alaska were the most significant observed in the nearly 20-year history of the drought monitor, reaching Extreme Drought (D3) conditions in May. However, the National Weather Service in Juneau confirmed that during the late 80s into the early 90s there have been significantly drier years where droughts lasted longer. The drought conditions near Juneau improved to Moderate Drought (D1) by the end of the year. In July, moderate to severe drought was observed in parts of the northeast Interior, fueling wildfires. There were extreme drought conditions in the region of Anchorage and in the Kenai Peninsula in August.

Noteworthy Events throughout the year

January: Fairbanks was just one of a number of communities that recorded the coldest temperatures in 2 years during the cold snap at the beginning of the month. While temperatures of -40°F and below are common in many parts of Alaska during winter, prolonged periods of deep cold have become rarer in recent years. As temperatures rose to exceptionally high values later in the month, organizers were forced to cancel 2 sled dog races due to rain. A portion of the 1000km Yukon Quest race was also cut due to lack of snow.

After 2-5 feet of new snow fell in the area, a special avalanche advisory was issued for Turnagain Pass for the weekend of January 25th-27th and the advisories for Hatcher Pass also warned backcountry travelers about the dangers associated with significant amounts of new snow and wind.

February: Persistent high pressure characterized the weather for much of February in the Interior and Eastern parts of the state. The ridging pattern associated with this was part of a large-scale omega-type block between centers of low pressure over eastern Siberia and eastern Canada. Influx of cold air from Siberia favored cyclogenesis in the northern Pacific and multiple storms embedded in the polar front moved South to North, roughly tracking the Alaskan coast from the Aleutians to Utqiaġvik. This led to advection of warm air from the south and very stormy conditions on the Arctic and Subarctic coast. This in turn led to a dramatic reduction in sea ice in the Bering Sea. The warm, south to southeasterly storms erode existing ice and prevent new ice from forming. Open water is visible in locations such as Unalakleet and Shishmaref, which is very unusual for this time of year and cause for concern due to the possibility of severe coastal flooding. The 2019 Iditarod sled dog race will not follow the normal race course across Norton Sound due to unstable ice conditions and instead take an overland route.

March: A number of sporting events were affected by the unusually warm temperatures and lack of snow and ice: Mushers of the 2019 Iditarod Trail Sled Dog Race had to deal with stretches of wet and soggy trail and adjusted their rest schedules to deal with the warm weather. The course of the race was moved overland between Elim and Golovin because of a lack of sea ice.

Due to the thin ice associated with the recent high temperatures, the Sonot Kkaazoot Nordic Ski Race, held in Fairbanks on Saturday March 23rd, was moved from its usual course on the Chena River to Birch Hill. The 40 and 50 km events were combined and shortened to 30 km and the 20 km event was shortened to 9.5 km.

Unexpectedly high temperatures, together with heavy rainfall events and strong wind, raised avalanche risk in mountainous areas. The Alyeska Resort in Girdwood (Chugach State Park) shut down mountain operations for few days due to high avalanche risk. On March 9th an avalanche on Madson Mountain close to Moose Pass (Kenai Fjords National Park) killed a 33-year-old Anchorage resident. A second fatality was reported in the same week: a 34-year-old was buried by an avalanche on Takshanuk Mountain near Haines. Both incidents were related to weak layers in the snow pack associated with the unusual weather.

April: In 2019, the Tanana River broke up on April 14 at 12:21 am, allowing the large tripod to move downstream. The 2019 break-up date, the earliest in 103 years of record, was 6 days earlier than the prior record for earliest breakup which was April 20 in both 1940 and 1998. The Kuskokwim River at Bethel set a record as well. The ice breakup occurred on April 12, 8 days before the previous record of April 20 in 2016.

Thin river ice and early breakup is strongly affecting Alaska, sled-dog races have been cancelled, hunters cannot ride safely to spring camps, connections to rural villages are not safely accessible. Travelling on frozen rivers has become dangerous or impossible very early this spring, leading to casualties and huge expenses for remote communities. On April 15, three family members were killed after breaking through ice with their snowmobiles on their way to the small village of Noatak, northeast Alaska.

May: Drought conditions in Southeast Alaska were the most significant observed in the nearly 20-year history of the drought monitor. However, the National Weather Service in Juneau confirmed that during the late 80s into the early 90s there have been significantly drier years where droughts lasted longer. Abnormally dry to extreme drought conditions impacted local communities, especially due to their reliance on hydroelectric power. Due to low reservoirs level, some communities had to use supplement generators fueled by expensive diesel and implement water restrictions. Because of the drought, damages to trees from insects, especially Salal and Hemlock, were widespread.

Very low sea ice extent, associated with the unprecedented warm temperatures experienced in Alaska during last months, affected the arctic ecosystem and local communities. A mass die-off of thousands of seabirds in the Bering Sea was linked to lack of nutritional sources, most likely due to declining sea ice and warmer sea surface and atmospheric temperature

June: Extremely low arctic sea ice extent is heavily impacting the arctic ecosystem and consequently local communities. Hunters report that seals and walrus usually found close to the coast at this time of the year, moved further north chased by melting sea ice.

Local communities report large numbers of dead seals along the western and northern coasts of Alaska. At least 60 dead seals have been reported in early June on the coast of the Bering

and Chukchi seas from NOAA Fisheries. This could be partially related to substantially above normal sea surface temperatures, reaching 60 °F, observed in the Arctic, especially in Kotzebue and Nome sounds. Likewise, warmer than normal sea surface temperatures, recorded off Alaska's southern coasts, could be associated to the unusually high number of dead grey whales.

July: Due to very low sea ice extent, several thousand Pacific walruses moved to a barrier island off the coast of Point Lay in the Chukchi Sea, about 1100 km northwest of Anchorage. Usually walruses move on shore when there is not enough sea ice for the youngest to rest. This is the earliest such a large number of walruses gathered ashore since 2007.

August: Due to the prolonged and intense drought, the rainforest in southeast Alaska was weakened and under the threat of spruce bark beetles and hemlock saw flies. In some areas of the Panhandle, cuts in hydropower production were forced, pushing local communities to switch to more expensive diesel power generation.

Anchorage experienced the worst air quality conditions ever recorded, ranking as the city with poorest air quality in the United States this summer. The Anchorage School District cancelled after school activities and Anchorage citizens were strongly advised to avoid strenuous outdoor activities.

September: A massive seabird die-off was observed in Alaska this summer, for the fifth straight year. According to the U.S. Fish and Wildlife Service, the death of more than 9000 seabirds along the west coast is associated to starvation. At the basis of the seabird starvation, researchers indicate changes in zooplankton and fish populations, which might be linked to high sea surface temperatures and decline in sea ice extent.

October: Heavy rainfall of 4-6 inches over a 24- to 36- hour period near Juneau during the first weekend of October caused flooding, mudslides an, and a road to collapse in one Douglas Island neighborhood. The heavy rainfall was caused by a strong weather system that entered Southeast Alaska from the west and southwest.

November: The decline in Arctic sea ice has been linked to the emergence of a deadly virus threatening mammals in the North Pacific. According to a study from the University of California, low sea ice extent observed in the Arctic in the last years might have opened pathways for contact between Arctic and sub-Arctic seals, allowing the introduction of the virus. The virus debilitates the immune system of seals which become more susceptible to pneumonia.

On November 16, Anchorage set both a daily snowfall and an hourly high temperature record with 8.4 inches of snowfall, 0.1 more than the previous record of 1958 and 45°F recorded at 2.33 am.

December: Ice jammed at the Deneki bridge in Matanuska-Susitna Borough on the evening of December 21st, restricting normal water flow and causing Willow Creek to flood. Six homes were immediately flooded and at least 13 households were evacuated in Willow. While the area has seen flooding in the past, the director of the borough's emergency services said that flooding this late in the year is not normal.

The annual Christmas in Ice sculpture park in North Pole was canceled for the first time in its 14-year history because of a lack of ice on ponds to harvest for ice carving. The lack of ice on lakes and ponds followed a warm October. It was further exacerbated by snowfall, which hampers the formation of ice.

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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, contact the center at 474-6477 or visit the center web site at http://akclimate.org. Please report any comments or errors to webmaster@akclimate.org.

Appendix:

Table A1: Monthly temperature deviations from normal at the 19 selected stations. The highest and lowest deviations are colored in red and blue, respectively.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anchorage	3.2	0.6	9.2	3.2	2.4	5.2	6.5	5.9	4.1	7.0	13.5	5.5
Bethel	7.2	18.3	15.3	5.4	5.0	5.4	4.6	3.0	3.0	5.5	4.4	-2.6
Bettles	0.9	9.9	13.8	3.5	2.3	3.1	4.0	-0.4	2.6	5.7	7.0	-7.1
Cold Bay	4.8	8.8	5.5	4.5	3.2	3.7	4.3	5.3	3.9	4.3	6.8	1.7
D. Junction	1.4	3.2	18.9	4.5	4.2	3.6	3.4	-1.8	4.0	5.6	10.2	-0.1
Fairbanks	1.0	6.8	16.2	4.4	4.4	3.1	3.5	-0.5	3.6	7.5	10.6	-1.3
Gulkana	-0.1	-2.7	12.7	4.1	2.5	4.4	4.9	1.6	3.8	4.0	15.7	6.2
Homer	2.8	4.8	9.0	1.9	3.0	3.4	4.0	2.9	2.1	3.7	10.3	2.0
Juneau	1.4	-6.0	4.1	1.6	2.9	2.4	3.8	2.5	1.6	-1.0	5.0	7.0
Ketchikan	2.2	-6.2	2.6	1.6	5.0	2.0	2.3	1.2	2.5	-0.3	5.3	3.1
King Salmon	14.8	12.3	11.7	2.7	2.7	4.5	5.7	3.6	3.1	7.1	12.2	-1.5
Kodiak	3.0	4.6	6.1	1.4	2.4	4.2	5.9	6.6	3.9	3.8	8.7	3.6
Kotzebue	5.7	18.5	21.9	12.4	11.4	11.1	9.2	5.6	4.9	6.6	3.4	-0.8
McGrath	3.3	9.8	15.6	2.4	3.3	5.0	4.0	1.5	2.9	6.6	7.7	-3.7
Nome	2.4	13.7	13.5	2.9	3.8	4.8	2.3	0.0	2.7	4.3	3.5	0.0
St. Paul Island	5.1	9.7	6.6	4.6	3.1	4.1	4.4	3.7	4.5	5.8	3.8	1.3
Talkeetna	-0.1	-3.6	8.7	1.8	0.9	4.5	5.1	2.2	2.6	4.8	13.6	5.0
Utqiagvik (Barrow)	4.6	18.7	18.5	5.5	6.5	1.3	7.5	3.7	8.7	11.6	16.1	7.0
Yakutat	0.2	-0.9	6.5	2.8	3.6	3.7	5.2	3.1	3.1	1.2	7.3	7.1

Table A2: Monthly mean temperatures at the 19 selected stations. The highest and lowest temperatures are colored in red and blue, respectively.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anchorage	20.3	20.8	35.7	40.1	50.2	60.5	65.3	62.7	52.7	41.8	35.7	24.6
Bethel	13.8	29.4	30.5	32.3	46.9	57.8	60.7	56.5	48.6	35.7	21.8	7.8
Bettles	-9.2	4.8	18.2	26.8	46.7	61.5	63.7	52.2	43.2	24.6	6.0	-12.7
Cold Bay	33.0	37.8	35.6	38.5	43.5	50.0	55.1	57.4	52.0	44.7	41.4	32.8
D. Junction	0.3	8.1	33.0	36.8	51.8	61.2	63.6	53.1	47.8	29.7	16.5	2.0
Fairbanks	-6.9	5.5	27.6	37.0	53.8	63.5	66.0	55.6	48.4	31.7	13.2	-5.4
Gulkana	-3.0	2.8	28.3	35.9	47.7	58.7	62.4	55.1	47.1	30.5	21.5	6.6
Homer	27.6	31.1	38.9	38.9	47.5	54.1	58.6	56.8	50.2	41.8	39.8	29.1
Juneau	29.7	24.1	37.9	42.4	51.5	57.0	60.7	58.3	51.7	41.4	38.5	36.9
Ketchikan	37.1	29.6	40.4	44.1	53.7	56.1	60.0	59.2	55.0	45.0	43.7	38.5
King Salmon	30.8	31.4	35.8	36.4	46.8	56.0	61.2	58.2	50.7	40.6	35.1	17.2
Kodiak	33.4	35.5	38.9	39.0	46.7	53.8	60.4	61.7	53.3	44.2	42.6	34.8
Kotzebue	2.9	17.7	23.0	25.7	43.3	56.8	63.8	57.3	47.2	30.9	12.5	1.5
McGrath	-3.2	11.2	27.2	32.1	50.0	62.4	64.0	56.1	47.5	31.7	13.3	-6.9
Nome	7.6	21.1	23.8	23.4	40.6	52.6	54.5	50.1	45.5	33.1	20.4	9.5
St. Paul Island	30.2	34.0	31.4	33.9	39.2	46.5	51.6	52.6	49.9	43.9	36.6	30.1
Talkeetna	14.1	14.6	33.6	37.6	48.6	61.5	65.2	58.9	50.1	38.0	33.5	20.9
Utqiagvik (Barrow)	-8.8	4.5	5.9	7.3	27.7	37.0	48.3	42.7	40.8	28.8	16.8	-0.8
Yakutat	28.3	28.7	38.5	40.6	48.4	54.5	59.6	57.0	51.5	42.3	39.7	36.8