Alaska Climate Research Center

Alaska State Climate Center

ANNUAL REPORT 2020

IN THIS ISSUE

KEY OBSERVATIONS

Temperature

Alaska was **noticeably cooler in 2020 than in the previous seven years**, with a mean temperature of 0.4 ºF above the 1981 – 2010 average. A very stable pattern of the polar vortex and subsequent "lobe" of cold air brought very cold temperatures to Alaska in the early months of 2020. A healthy winter sea ice pack near the long-term normal also kept temperatures on the cooler side. Overall, thirteen first-order stations recorded positive departures from normal temperatures and six stations recorded negative departures for the year.

Precipitation

The North Slope, Interior, and Panhandle regions were wetter than normal, **ending drought conditions that had lasted for 18 months**. The West Coast, Cook Inlet and Bristol Bay regions were drier than normal, with moderate drought conditions developing over Kotzebue and Kodiak Island in August.

Snowfall

Above average snowfall was observed in Anchorage (with the mountains around Anchorage also receiving significant snow), Bettles, and Fairbanks. Juneau saw below average snowfall for the year.

Wildfire season

The 2020 Alaska wildfire season was **much less active** than the previous year, with only 340 fires recorded and just over 181,000 acres of land burnt, significantly less than the 719 fires recorded and 2 million acres burnt in 2019. Overall, the state experienced a below-normal fire season. In a typical fire season, Alaska burns about 650,000 acres.

Sea ice extent

Below normal temperatures in early 2020 enabled the Bering Sea ice to reach **near-normal extent for the winter,** but the ice was thin and brittle. The seasonal sea ice extent maximum was reached on March 5 at 15.05 million square kilometers, the 11th lowest in the satellite record and the highest since 2013. By September 15, the minimum sea ice extent was reached and ended up **the second lowest in the 42-year satellite record**, at 3.74 million square kilometers.

A New Climate Normal

A new period of climate reference normal values became available with the end of the year 2020. Climate normals have been defined according to the World Meteorological Organization (WMO, https://public.wmo.int/en) as the 30-year average of weather conditions across certain regions. The recent decade of 2011 - 2020 was characterized by unprecedented warming; non-uniform subtle climatological changes in precipitation were observed. Warming was most pronounced in the Arctic, emphasized by a decadal retreat of sea ice. The recent decade included extreme warm years with the year 2019 as an all-time record year, while 2020 was slightly cooler and more normal in terms of temperature. Normals reported here use the 1981 - 2010 timeframe.

2020 Temperature in Detail

Annual Temperature at the First Order Stations

In 2020, Alaska's 13 out of 19 first-order weather stations reported warmer than average annual temperatures with Utqiaġvik (+2.9 ºF), Nome (+2.0 ºF), and St. Paul Island (+3.8 ºF) showing the largest departures, followed by Kotzebue (+1.6 ºF), Cold Bay (+1.3 ºF) and Bethel (+1.0 ºF). Bettles and King Salmon were close to normal (0.04 ºF and 0.08 ºF, respectively). Colder than average temperatures were observed at six stations, ranging from -0.28 ºF at Anchorage to -1.12 ºF at Delta Junction (Figure 1, Table 1). The mean deviation from normal across the first order

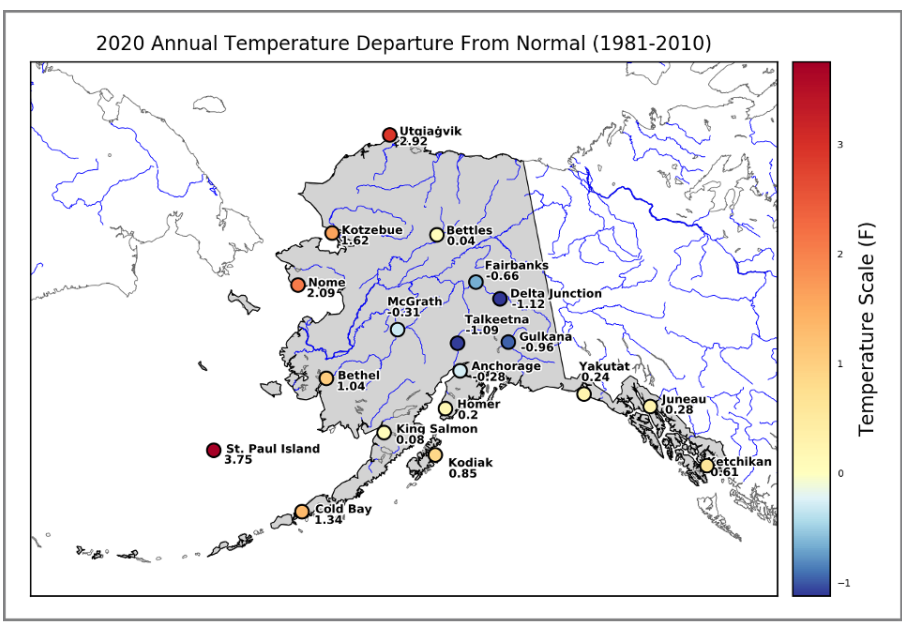

Figure 1. Mean annual (2020) air temperature deviations (in Fahrenheit) from the normal (1981 - 2010) for selected stations.

Station	Observed (ºF)	Normal (ºF)	Departure (ºF)
Anchorage	36.7	37	-0.3
Bethel	31.6	30.6	1.0
Bettles	23.4	23.4	0.0
Cold Bay	40.1	38.8	1.4
Delta Junction	27.8	28.9	-1.1
Fairbanks	26.9	27.6	-0.7
Gulkana	27.2	28.1	-0.9
Homer*	38.9	38.7	0.2
Juneau	42.4	42.1	0.3
Ketchikan	45.7	45.1	0.6
King Salmon	35.2	35.1	0.0
Kodiak	41.7	40.9	0.8
Kotzebue	24.3	22.7	1.6
McGrath*	26.9	27.3	-0.3
Nome	29.4	27.4	2.1
St. Paul Island*	39.1	35.3	3.9
Talkeetna	34.8	35.9	-1.1
Utqiaġvik	14.6	11.7	2.9
Yakutat	40.5	40.2	0.3

Table 1. Mean temperature for 2020, normal temperature (1981 - 2010) 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.

stations was 0.56 ºF. Figure 2 shows the mean annual air temperature deviations for the period of record, with the 2020 annual temperature close to that seen back in 2010. Regionally, the North Slope, West Coast, Cook Inlet and Bristol Bay were warmer than average, but they were still substantially cooler than previous years. The Interior and Panhandle were slightly cooler than average in 2020, especially in the Interior, which had not seen such cool temperatures since 2012 (Figure 3).

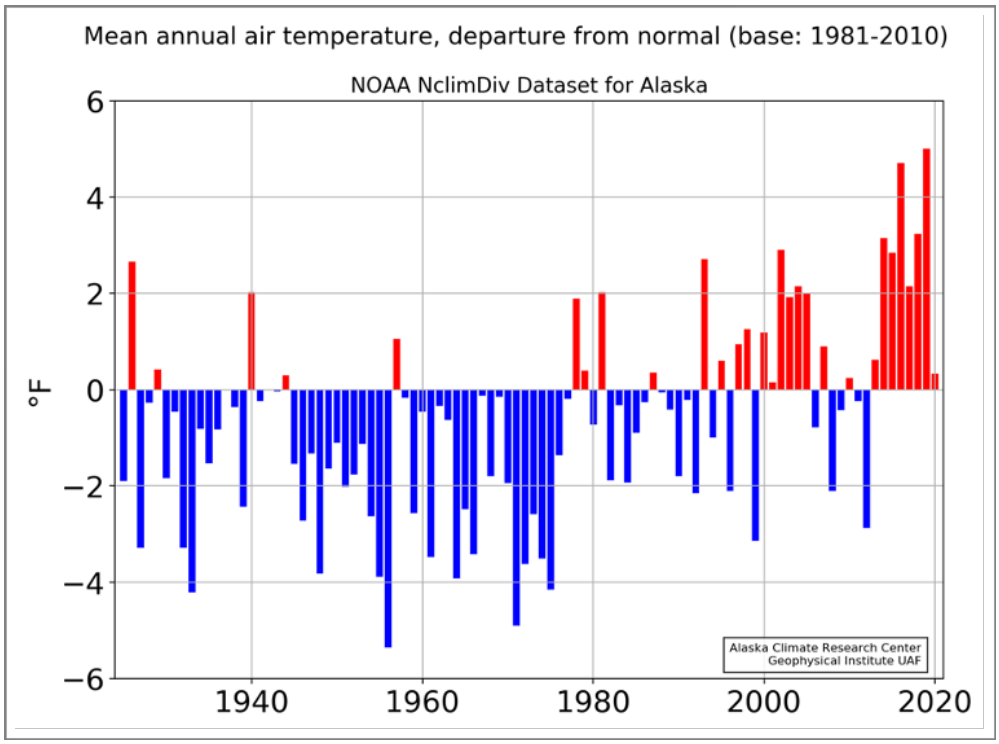

Figure 2. Mean annual (2020) air temperature deviations (in Fahrenheit) from the normal (1981 - 2010).

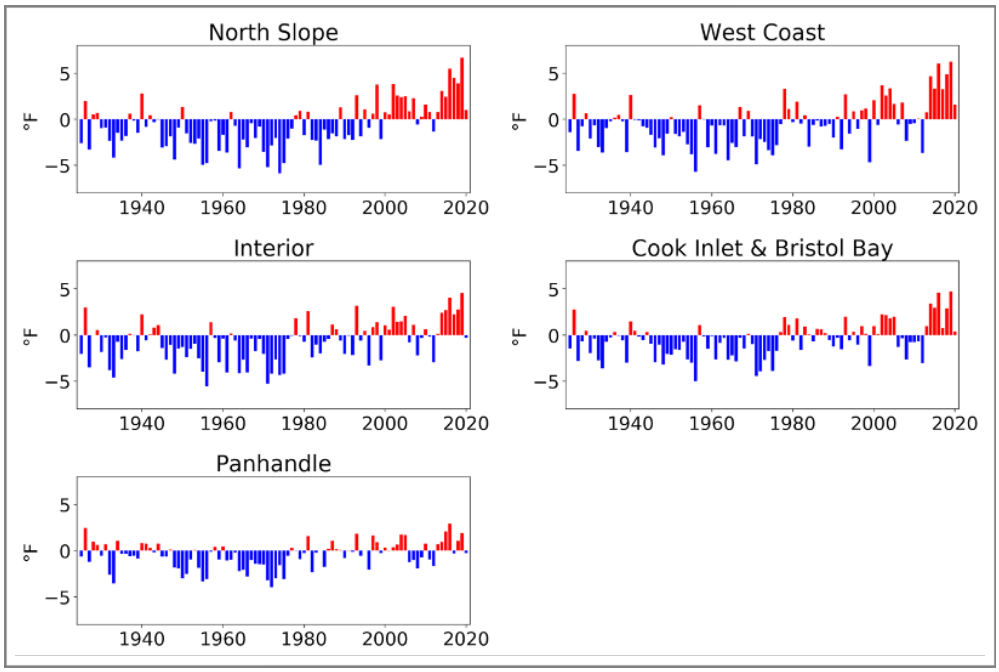

Figure 3. Time series of annual mean temperature departure from the normal (1981 - 2010) for the Alaska climate divisions. Data source: NOAA nClimDiv data.

Monthly Mean Temperatures at the First Order Stations

July was the warmest month in 2020, based on station average of 56.4 ºF, while August was the second warmest at 55.2 ºF. May and December were the warmest in terms of deviation from the average (4.0 ºF and 3.7 ºF, respectively). The coldest month in 2020 was January, with a station average of 2.2 ºF. February came in second at 11.1 ºF but was the coldest month in terms of deviation from the average. While the first three months of 2020 were colder than average, the rest of the months were observed to be warmer than average.

Monthly temperatures peaked in July at most stations (14/19 first-order stations with Bettles peaking in June, and four others peaking in August). The coldest month for most stations was January (while two were coldest in February). Highest deviations in December were for 9 stations (regionally, this includes the Interior, Panhandle, and part of the south coast); November for Utqiaġvik and Nome; and April/May for the West Coast. Lowest deviations were for January (with 16 stations) and February (Kotzebue, Nome, Utqiaġvik).

Monthly Mean Temperatures within the Climate Regions

Monthly temperature variations and deviations from normal for the five climate regions: North Slope, West Coast, Interior, Bristol Bay & Cook Inlet, and the Panhandle, are shown in Figure 4. At the North Slope, February was the coldest month and showed the greatest departure from normal. The West Coast, Interior, and Cook Inlet & Bristol Bay showed January as the coldest month, with both January and February showing the greatest deviations from normal. At the Panhandle, January was also the coldest month with varying deviations from normal throughout the year.

Figures 5 to 9 show climographs for, respectively, Anchorage, Utqiaġvik (Barrow), Fairbanks, Juneau, and St. Paul Island, as examples of 2020 temperature deviations in the five main climate regions of Alaska. Anchorage had colder than average temperatures for nearly all of January and half of February, but a warmer fall (Figure 5). Utqiaġvik (Barrow) had a cooler than average February but much warmer than average March and April, as well as a warmer than average fall (Figure 6). Fairbanks showed a cooler than average winter in 2020 (Figure 7). Juneau had a much warmer than average December (Figure 8), and St. Paul Island was warmer than average for most of the year (Figure 9).

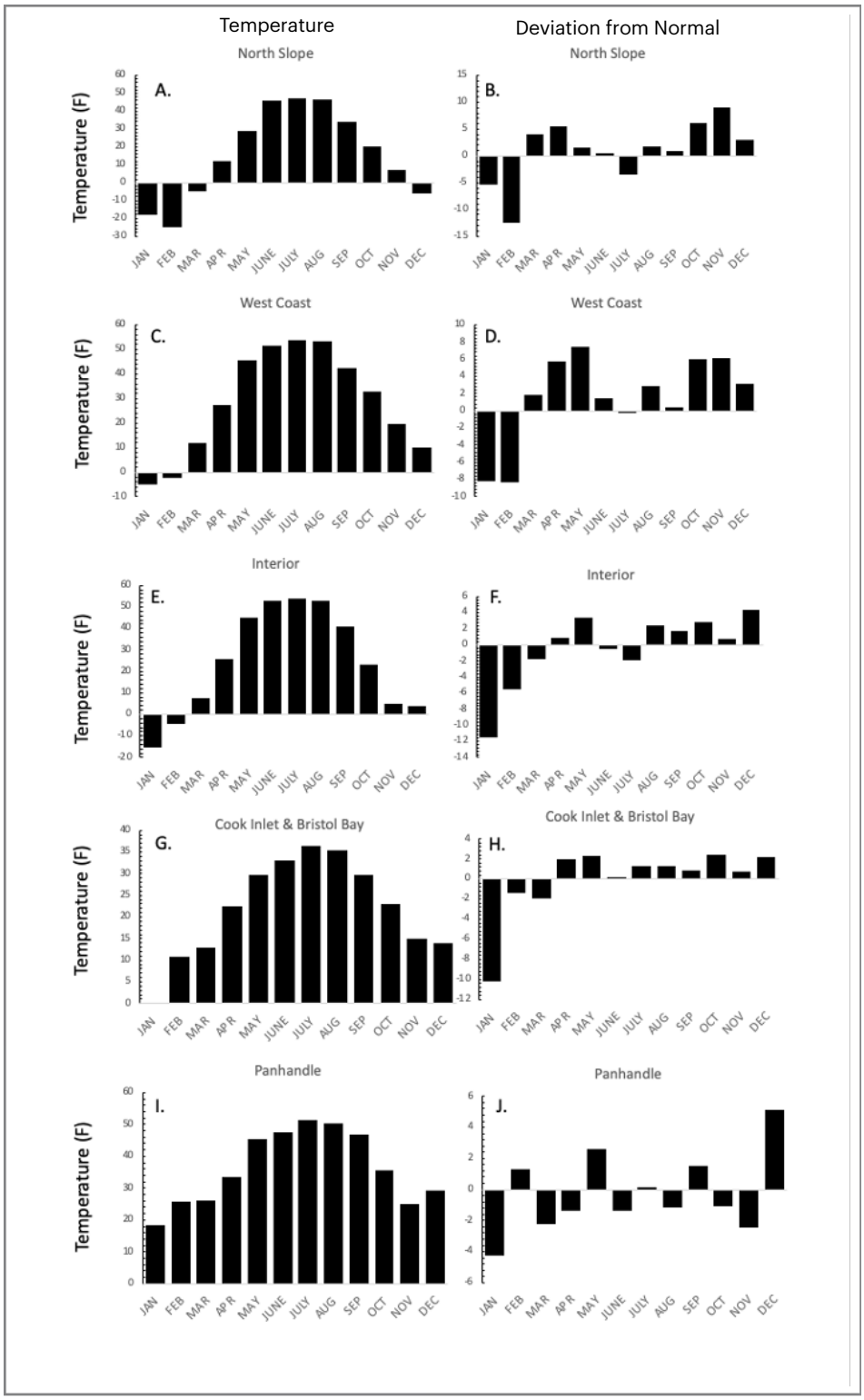

Figure 4. Monthly mean temperature and temperature deviation from normal (1981 - 2010) for the five climate regions: (North Slope (A,B); West Coast (C, D); Interior (E, F); Cook Inlet and Bristol Bay (G, H); and the Panhandle (I, J). Data source: NOAA nClimDiv data.

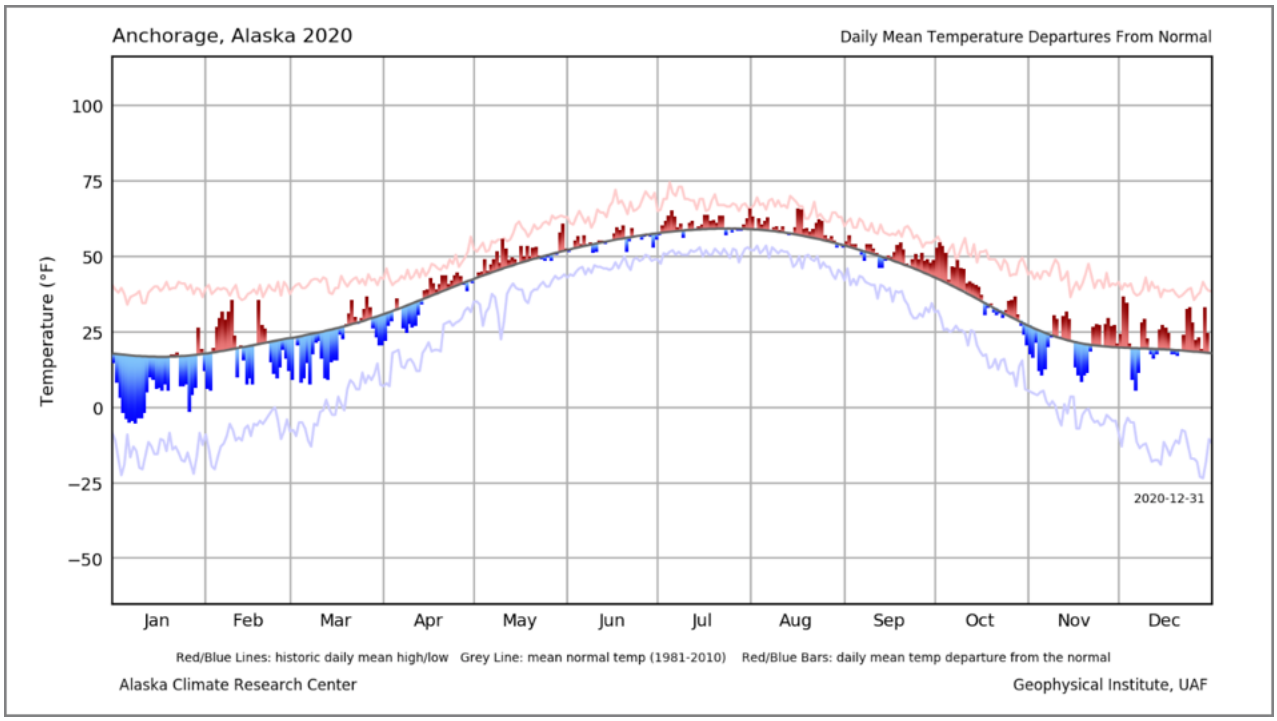

Figure 5. Mean normal temperature, daily mean departure from normal, and historic daily mean minimum and maximum for Anchorage, 2020.

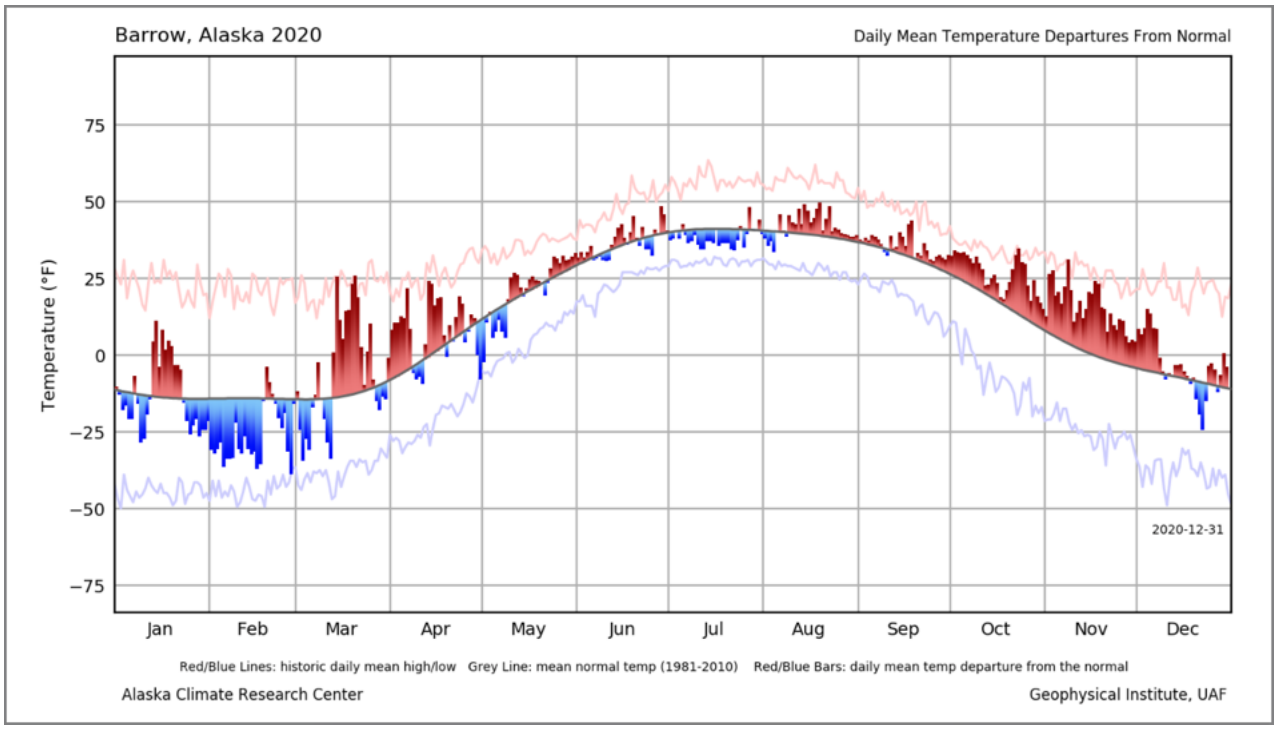

Figure 6. Mean normal temperature, daily mean departure from normal, and historic daily mean minimum and maximum for Utqiaġvik (Barrow), 2020.

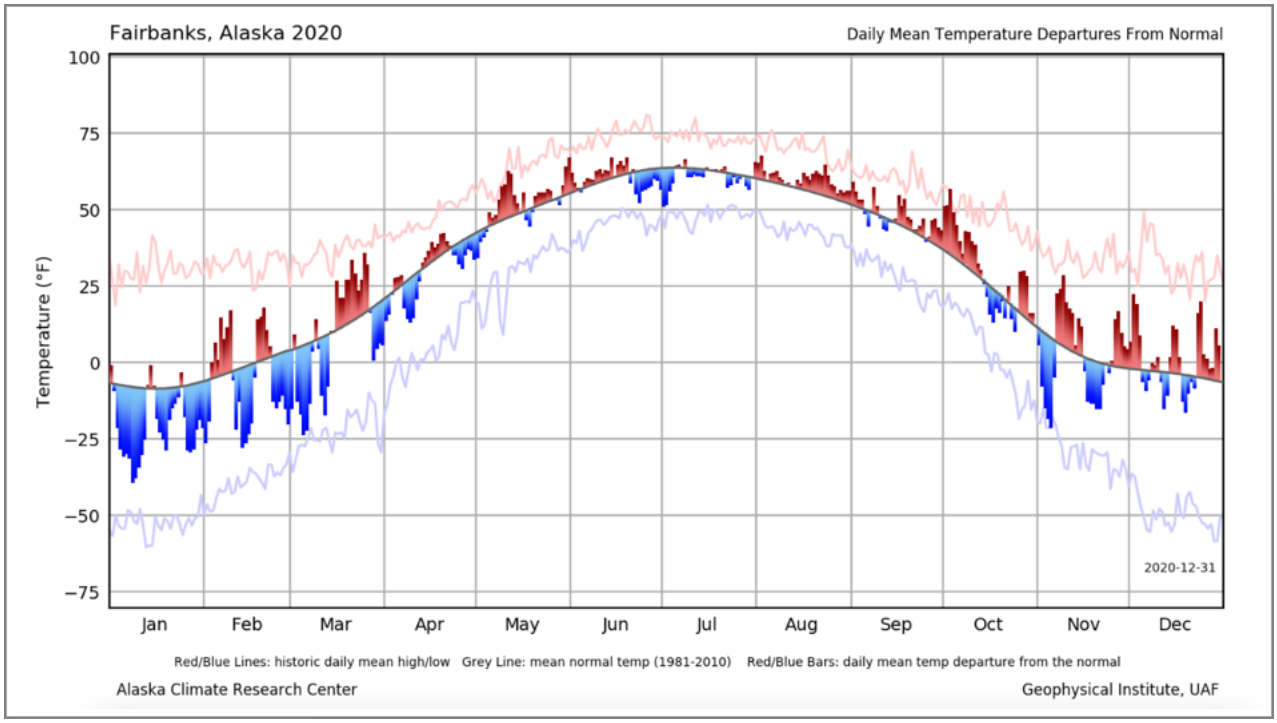

Figure 7. Mean normal temperature, daily mean departure from normal, and historic daily mean minimum and maximum for Fairbanks, 2020.

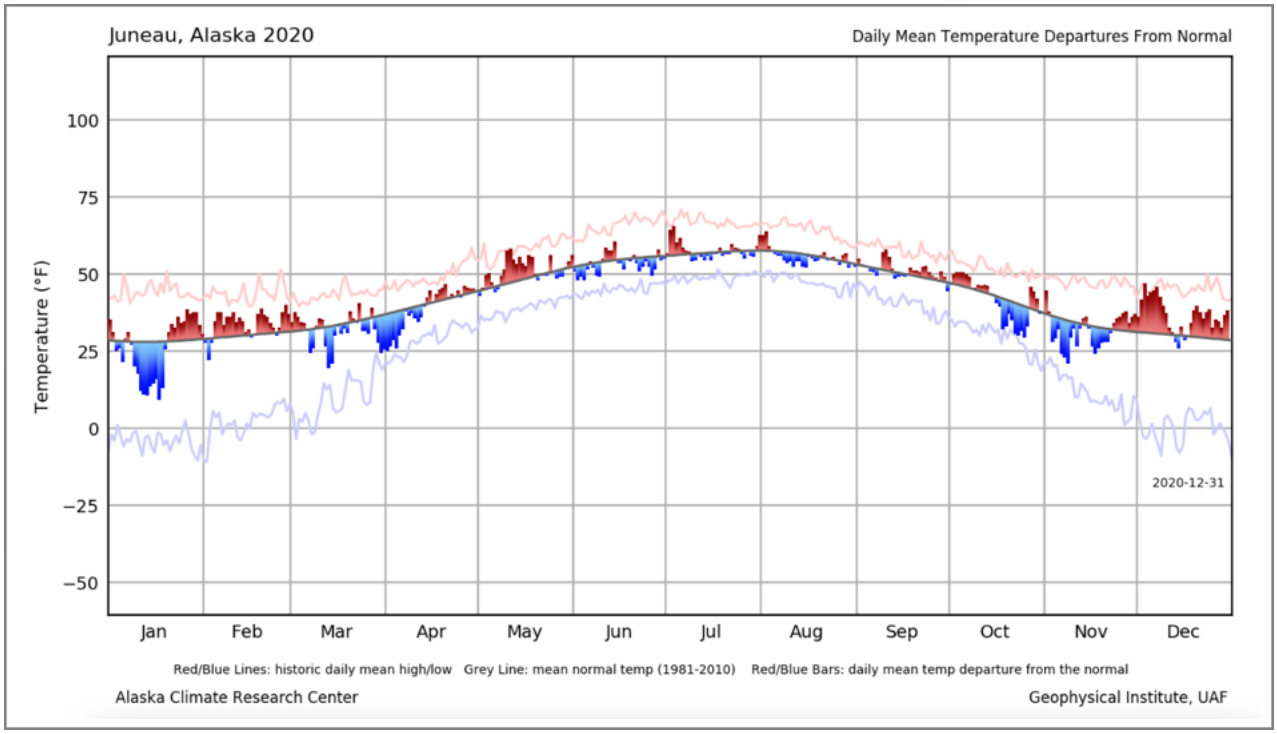

Figure 8. Mean normal temperature, daily mean departure from normal, and historic daily mean minimum and maximum for Juneau, 2020.

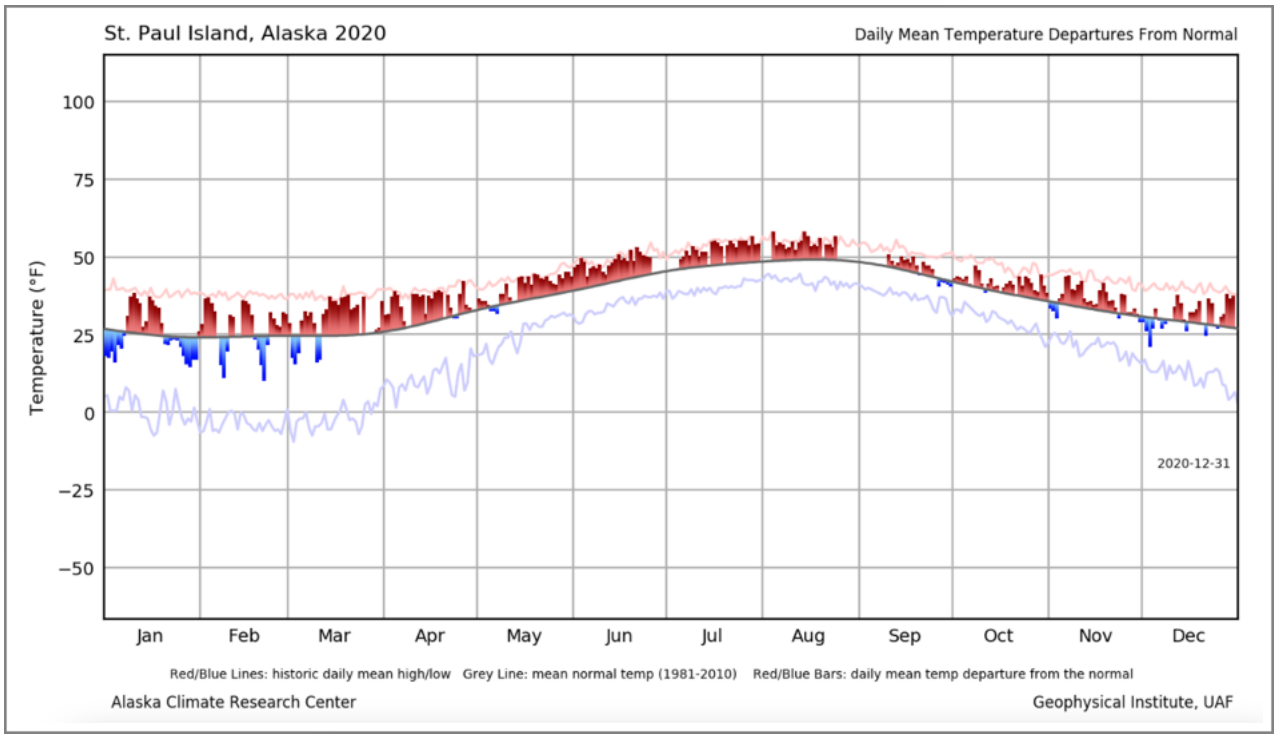

Figure 9. Mean normal temperature, daily mean departure from normal, and historic daily mean minimum and maximum for St. Paul Island, 2020.

Temperature connections with large scale circulations

Considering the large-scale coupling between atmospheric circulation, the 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. There was a negative PDO throughout the year, with the most negative in March and November, and less negative in May. 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 timescale than the PDO with cold/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 characteristically cold and dry over the same areas. 2020 saw El Niño conditions in Alaska (with a positive Oceanic Niño Index) in December - part of May. Then, later in May, June, July and in October, November, December, this shifted to La Niña conditions and a negative ONI. The interaction between PDO and ENSO is complex, but the combination of El Niño conditions in the first half of

the year, La Niña conditions in the second half of the year, and negative PDO led to overall cooler annual temperatures for Alaska, with a wet summer in certain regions and drier Interior during the winter.

2020 Precipitation in Detail

Annual Precipitation at the First Order Stations

In 2020, a total annual precipitation amount of 6.1 inches was observed in Utqiaġvik, representing 134.9% of the normal precipitation. Most precipitation was measured in Ketchikan (175.1 in), compared with the normal of 141.2 inches (124%). Other above average precipitation stations include Anchorage (103.9%), Delta Junction (114.1%), Fairbanks (141.5%), Gulkana (131.3%), Juneau (124.5%), King Salmon (117.4%) and Nome (107.8%). Close to average precipitation was observed at Bethel (99.5%), Bettles (99.9%), Gulkana (96.4%) and Talkeetna (91.5%). Stations that showed below normal precipitation include Yakutat (67.4% of normal) and Kotzebue (88.4%), which was under moderate drought conditions throughout the summer (Figures 10, 11; Table 2). Regionally, 2020 saw above average annual precipitation for the Interior and Panhandle; near normal precipitation for the North Slope; and below average for the West Coast, Cook Inlet and Bristol Bay (Figure 12).

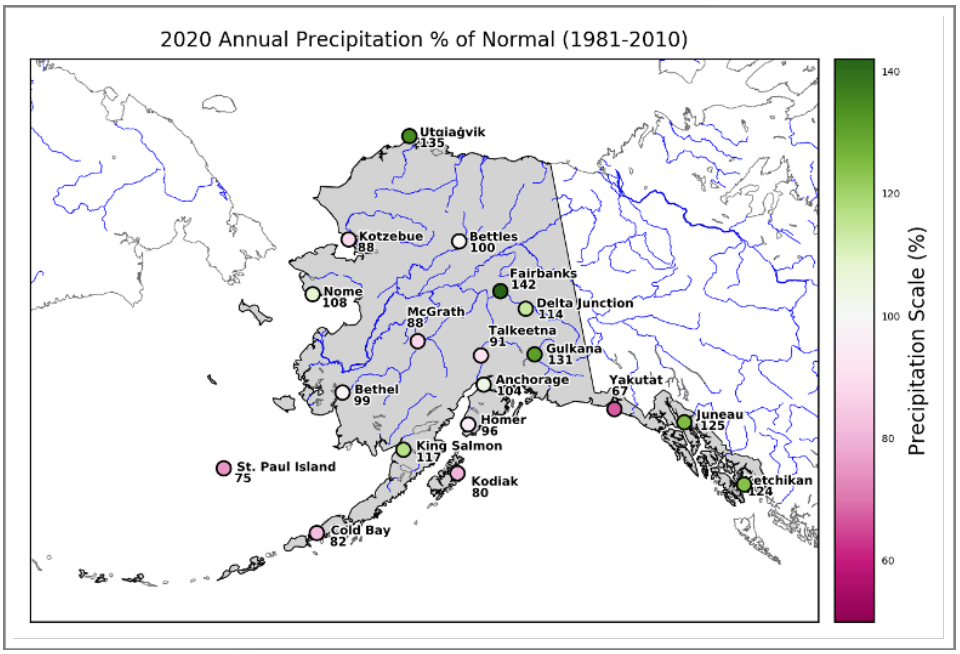

Figure 10. 2020 precipitation deviations (%) from the normal (1981 - 2010) for the selected stations.

Station	Precipitation (in)	Normal (in)	% of Normal
Anchorage	17.2	16.6	103.9
Bethel	18.4	18.5	99.5
Bettles	14.9	14.9	99.9
Cold Bay	34.1	41.7	81.8
Delta Junction	13.3	11.6	114.1
Fairbanks	15.3	10.8	141.5
Gulkana	14.8	11.3	131.3
Homer	23.5	24.3	96.4
Juneau	77.6	62.3	124.5
Ketchikan	175.1	141.2	124
King Salmon	22.9	19.5	117.4
Kodiak	62.6	78	80.2
Kotzebue	9.7	11	88.4
McGrath	15.8	18	87.6
Nome	18.1	16.8	107.8
St. Paul Island	17.6	23.7	74.5
Talkeetna	25.6	28	91.5
Utqiaġvik	6.1	4.5	134.9
Yakutat	104.6	155.1	67.4

Table 2. Annual precipitation (inches) for 2020, normal precipitation (inches) (1981 - 2010), and deviations from normal (%) for the 19 first-order stations. Shades of purple and green correlate with Figure 10.

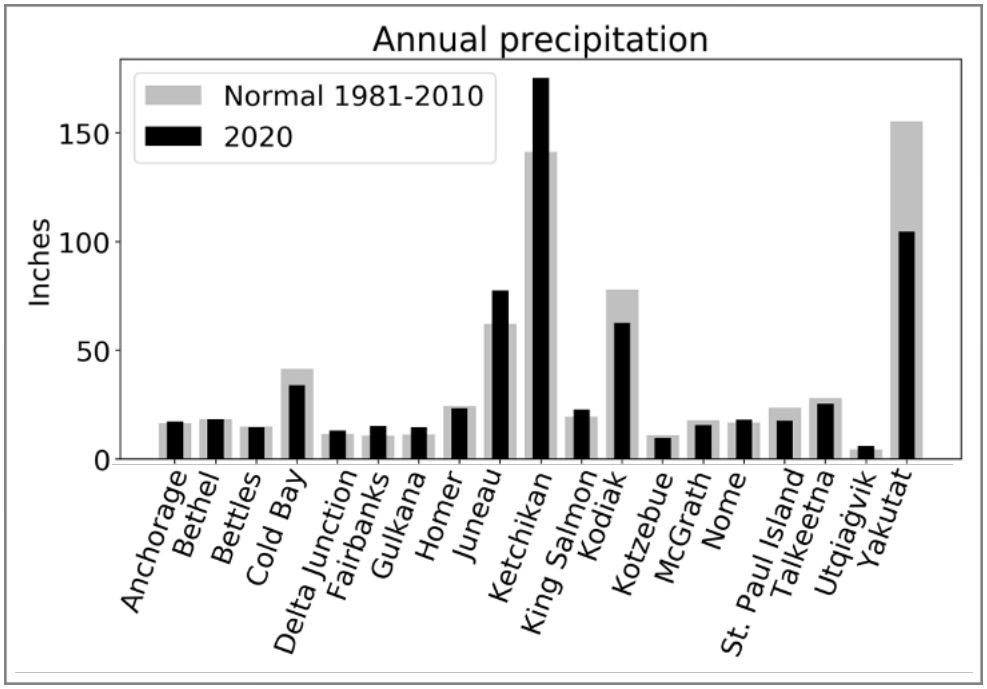

Figure 11. Precipitation sums (in inches) for 2020 and corresponding normal values at the selected stations (1981 - 2010) for 2020 for the selected stations.

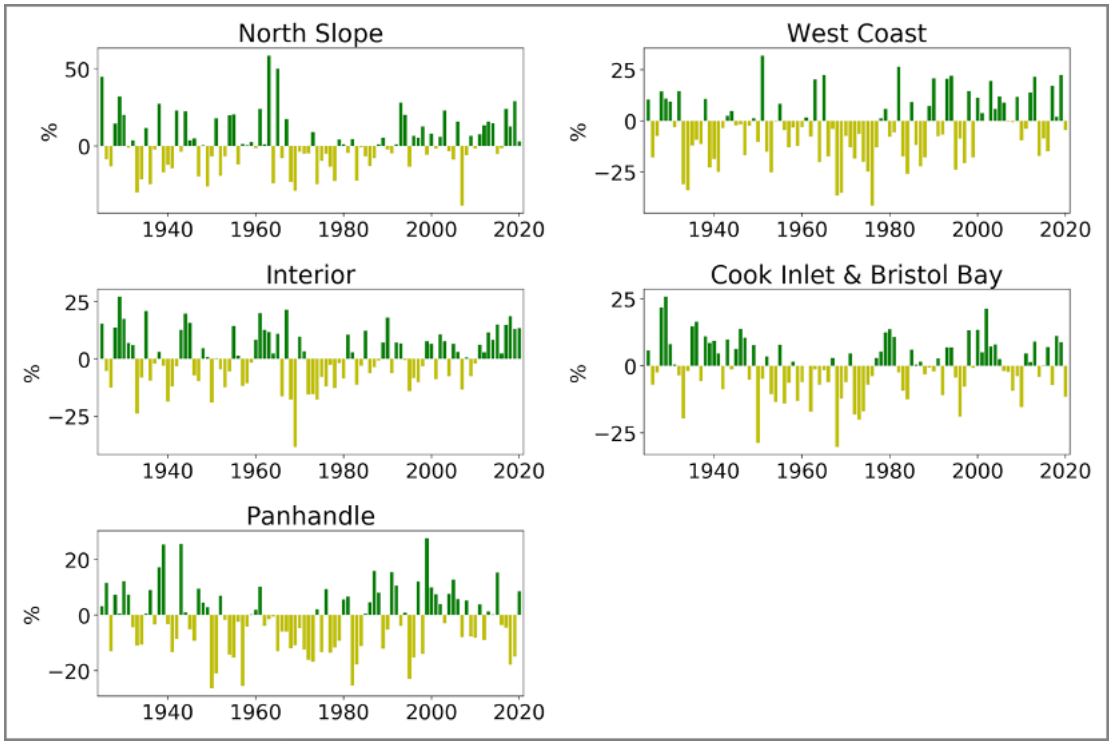

Figure 12. Time series of annual precipitation sums as percentage departure from the normal (1981 - 2010) for the Alaska climate divisions. Data source: NOAA nClimDiv data.

Monthly Precipitation at the First Order Stations

In February 2020, precipitation was above normal in much of the state with heavy precipitation on the eastern Kenai Peninsula. Precipitation was significantly above normal across most of the state in March, with the Southern Coast drier than normal and stations to the north receiving significantly above average precipitation. Utqiaġvik broke a monthly precipitation record in March. Regions along the Gulf of Alaska and Aleutian Islands were drier than normal in April while above average in other areas. Significant flood hazards presented in some areas due to river ice breakup. Most of the state was drier than normal in May with the exceptions of Bethel, Delta Junction and Gulkana. St. Paul Island received no precipitation in June, while Fairbanks and Ketchikan broke monthly precipitation records. It was the second wettest June ever in Juneau. In July, it was drier than average for much of the West Coast and portions of the Aleutians and Central Interior, with above average precipitation for most of the Panhandle. Record breaking rainfall was observed on July 21 in Fairbanks (1.13 in daily total, 1.88 in 3-day total, previous daily record of 0.58 in). While Juneau and Ketchikan had a very wet August, Kotzebue and Utqiaġvik were extremely dry and Kodiak was drier than normal for the month. Overall more stations were below average for the month.

Lower than normal precipitation was observed over the southern and eastern coasts in September, Interior locations, and along the Aleutian Islands, while Kodiak received higher precipitation than normal. Below normal precipitation was observed at most locations in October, with the largest departures along the southern and eastern coasts. In November, the North Slope, West Coast, Northwest Gulf, Bristol Bay and parts of Cook Inlet saw significantly above normal precipitation. Below normal precipitation was observed in isolated locations (Delta Junction, Yakutat, Kodiak). Finally, lower than normal precipitation was observed for the Interior and higher than normal for the Panhandle and North Slope in December 2020.

2020 Snowfall

At the four reporting locations for which the National Weather Service still collects snowfall data, the 2019/2020 winter season led to above average snowfall in Anchorage (119% of normal), Bettles (130% of normal) and Fairbanks (130% of normal), with below average snowfall in Juneau (83% of normal) (Figure 13, Table 3). On a month-by-month basis (Figure 14), January snowfall was above average in

Anchorage and Juneau and below average in Bettles and Fairbanks. A heavy snowfall event was reported in Kodiak on January 28. In February, snowfall was above normal in Anchorage, Bettles and Juneau, while Fairbanks was near-normal. Anchorage set a new daily snowfall record on Feb 18, the same day that tied the daily record for maximum high temperature.

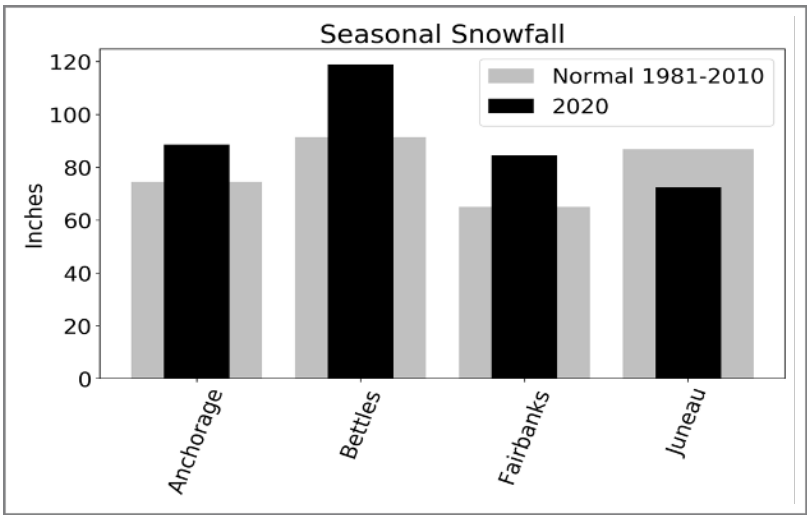

Figure 13. Annual snowfall averaged over four of the selected stations. 2020 values (black) compared to the normal for 1981 - 2010 (gray).

Station	Snow (in)	Normal (in)	Deviation (%)
Anchorage	88.6	74.5	119
Bettles	118.9	91.4	130
Fairbanks	84.6	65	130
Juneau	72.4	86.8	83

Table 3. Snowfall sums from the 2019/20 winter season, normal snowfall (1981 - 2010), and deviations from normal (%) for the selected stations that report snowfall.

March saw above average snowfall in Anchorage, resulted in the 7th snowiest March on record in Fairbanks, and the snowiest March on record in Utqiaġvik. Above normal snowpack was observed in the Interior, Western Alaska, Southeast, and Susitna Basin in April while Kenai Peninsula, portions of Southcentral Alaska, and the Northern Cook Inlet area had below normal snowpack. Late spring snowfall contributed to 400% of the normal precipitation amount from the North Slope to parts of the Interior.

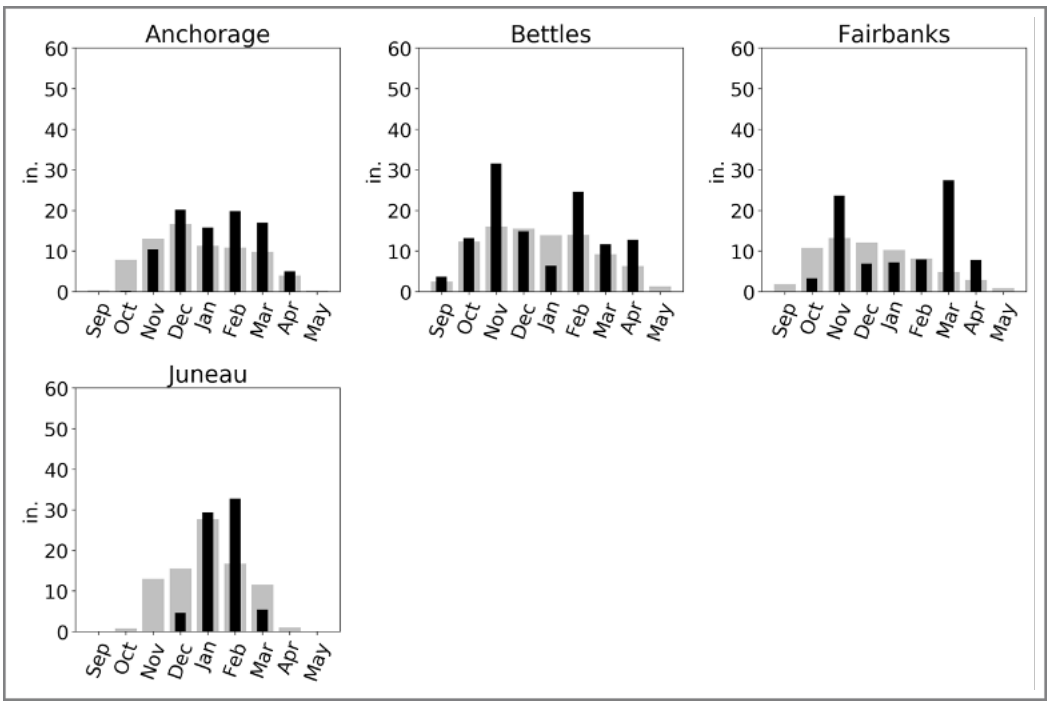

Figure 14. Monthly snowfall in inches for selected stations in 2019/20 (black bars), compared to the 1981 - 2010 normal (gray bars).

In the fall 2020, snow started sticking to the ground starting on October 6 in Utqiaġvik, and started falling and sticking in Fairbanks on October 26th, reaching 4 inches. This beat a record previously set in 1930 of 3.1 inches for that day. While Fairbanks and Juneau saw closer to normal snowfall in October, there was significantly lower snowfall in Anchorage and Bettles. A heavy snowfall event in Fairbanks on Nov 5 and 6 broke a daily record for snowfall previously set in 1950. Thus, November saw above average snowfall in Fairbanks, as well as Juneau, while Anchorage and Bettles saw near normal values. In December, above normal snowfall was observed in Anchorage, while it was below normal in Bettles, Fairbanks, and Juneau.

2020 Arctic Sea Ice

In 2020, early sea ice loss in the Beaufort and Chukchi seas (important drivers for Alaska's climate) was near the 30-year climatological mean. Sea ice often rotates for several years in the Beaufort Gyre, the dominant ocean current of the Beaufort Sea, growing into thick, resilient multi-year ice. However, climate change in the Arctic has led to more and more loss of this multi-year ice. The seasonal sea ice extent maximum was reached on March 5 at 15.05 million square kilometers, the 11th lowest in the 42-year satellite record and the highest since 2013. Then sea ice extent rapidly decreased in late summer. The annual minimum sea ice extent of 3.74 million square kilometers was reached on September 15, the second lowest in the 42-year satellite record and the second minimum extent below 4 million square kilometers (Perovich et al. 2020). During the remainder of the year, sea ice growth was slow: the departure in sea ice extent from normal in October was the largest in any month in the satellite record. The total sea ice extent was the second lowest on record for November, and third lowest for December. In summary, the sea ice loss was near the climatological mean in spring, there was accelerated loss in the late summer and a slow recovery in fall/early winter. A time series of daily Arctic sea ice extent can be seen in Figure 15, with the light blue line showing data for 2020.

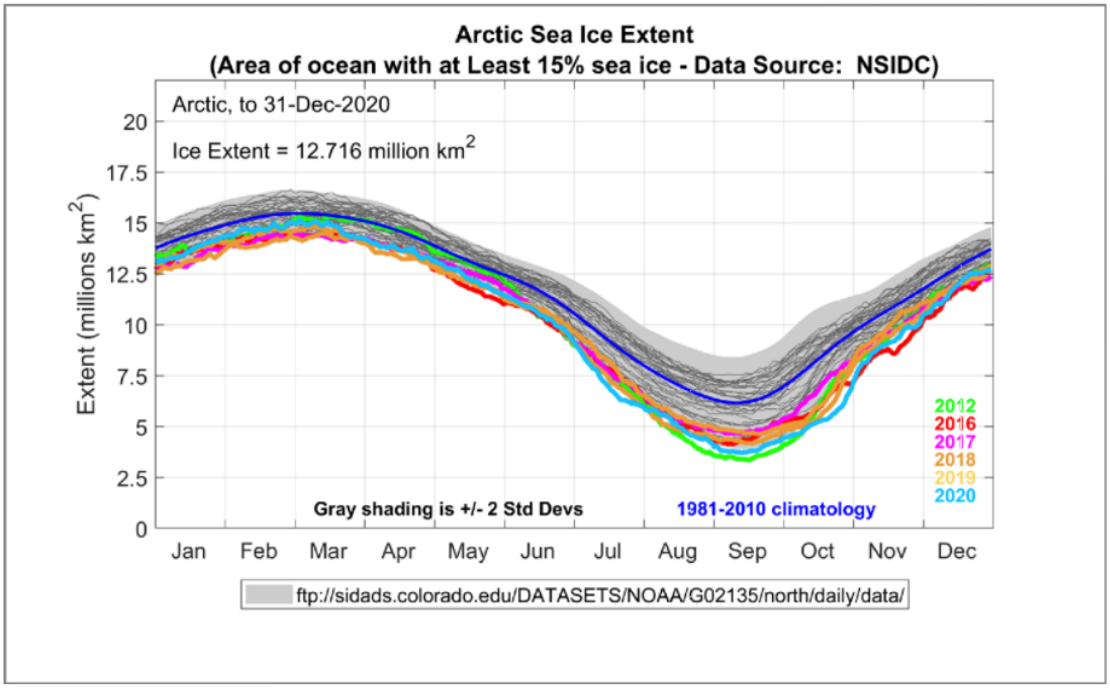

Figure 15. Time series of daily Arctic sea ice extent. This year's data (2020), seen in light blue, are updated through December 31, 2020. The median sea ice extent for the 1981-2010 reference period is depicted in dark blue.Plot Compiled by: Howard J. Diamond, PhD; Climate Science Program Manager at NOAA's Air Resources Laboratory Data Source: National Snow & Ice Data Center (https://nsidc.org/).

2020 Wildfire Season

The 2020 wildfire season was significantly less active than the previous year. There were 340 fires reported statewide, with a total area burnt of 181,253 acres (AICC 2020). While just over half (171) of the fires in 2020 were caused by humans compared to fires caused by lightning (169), the area burnt by human-caused fires (307 acres) was substantially smaller than lightning-caused fires (180,945 acres). Wetter conditions compared to the 2019 wildfire season, where over 2 million acres were burnt, were attributed to the below normal wildfire activity for the year. In a typical year, 650,000 acres burn in Alaska.

2020 Drought Conditions

In January 2020, the drought which began in Ketchikan in the summer of 2018 ended after 18 months. By March there was neither dryness nor drought in the state, with above normal precipitation and snowpack in many locations. There was a continued lack of dryness through June despite some areas receiving below normal precipitation. Abnormally dry conditions developed in the south-central part of the state in July, and in the northwestern part in August. Kotzebue and Kodiak were under moderate drought conditions starting in August 2020, with conditions improving in Kodiak in September while drought conditions continued in Kotzebue until November. At the close of the year, no significant drought conditions were present in the state, although abnormally dry conditions were still present in the northwestern parts of the state and Kodiak Island.

1991 – 2020 New Normals

On May 4, 2021, the National Oceanic and Atmospheric Administration (NOAA) revealed new climate normals spanning the 1991 – 2020 timeframe. These 30-year averages are calculated from measurements of weather variables like temperature and precipitation from thousands of weather stations across the globe. The data get corrected for erroneous or missing values and the process takes many months to ensure good data quality control. What do these new normals mean for the state of Alaska?

For Alaska, figures 16a,b and 18a,b show the 30-year temperature and precipitation normals for the periods 1981 - 2010 and 1991 - 2020, while figures 16c and 18c show the difference between the normals for temperature and precipitation. Climate warming occurred all across the state, with the most significant warming along the North Slope, the Arctic Coast and the adjacent Arctic Ocean from the Beaufort to

the Chukchi Sea. This is tied to the distinct changes in the extent of sea ice: there has been significantly less sea ice in recent years, with historic lows recorded in the Bering Sea. In Alaska, the normal temperature has risen nearly 1 degree Fahrenheit since the 1981 – 2010 period. As seen in Figure 17d, fall temperatures were notably warmer compared to 1981 – 2010. Fairbanks is no longer considered a sub-Arctic climate, instead termed a "warm summer continental" climate due to May now having an average temperature above 50 degrees Fahrenheit.

Many areas of the state are seeing increasing precipitation, although the location is much more varied (Figures 18, 19). In places where normal precipitation has not changed significantly, the seasonal normal is shifting with less snow in the fall and more during the winter – an overall shortening of the snow season. Anchorage, for example, is seeing more snow but it's being concentrated into a shorter period of time: while snowfall totals for the season have gone up 3.5 inches, October's snowfall totals have dropped by more than 2 inches.

More information on the calculation methodology for the new normals can be found here: https://www.ncei.noaa.gov/data/normals-annualseasonal/1991-2020/doc/Normals_Calculation_Methodology_2020.pdf

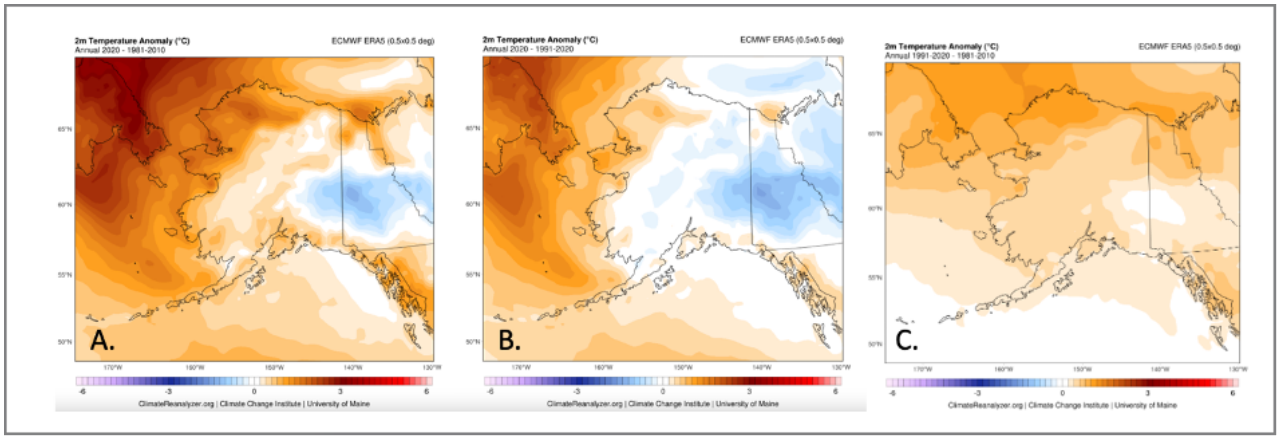

Figure 16. Temperature anomaly for the state of Alaska, showing the change in annual normal temperature using the 1981 - 2010 normal (A), 1991 - 2020 new normal (B), and the difference between the two (C), as derived from the ECMWF ERA5 4th generation reanalysis data (source: Climate Reanalyzer, Climate Change Institute, University of Maine).

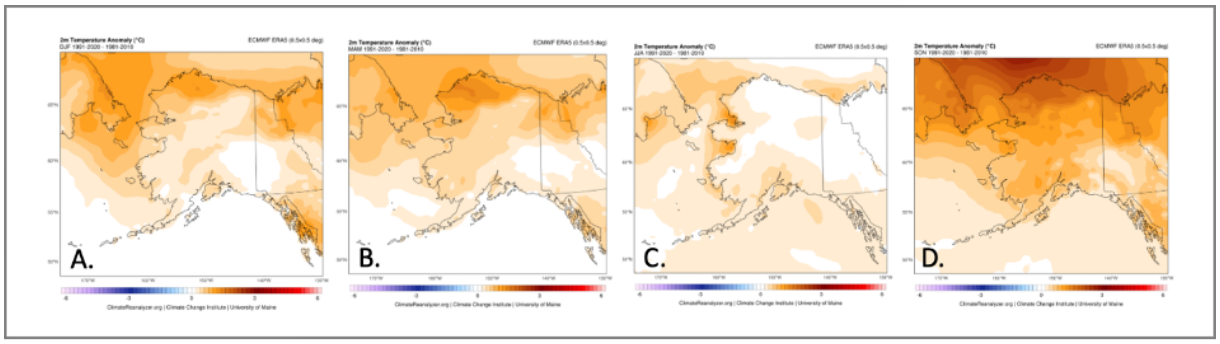

Figure 17. Temperature anomaly for the state of Alaska, showing the change in annual normal temperature (1991 - 2020 normal minus 1981 - 2010 normal) for the winter (A), spring (B), summer (C), and fall (D), as derived from the ECMWF ERA5 4th generation reanalysis data (source: Climate Reanalyzer, Climate Change Institute, University of Maine).

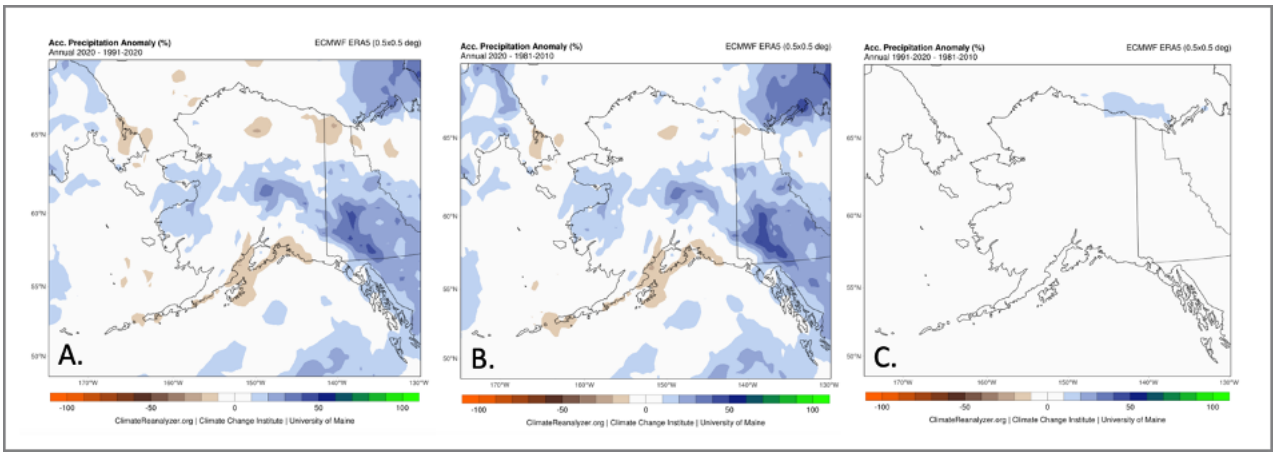

Figure 18. Precipitation anomaly for the state of Alaska, showing the change in annual normal temperature using the 1981 - 2010 normal (A), 1991 - 2020 new normal (B), and the difference between the two (C), as derived from the ECMWF ERA5 4th generation reanalysis data (source: Climate Reanalyzer, Climate Change Institute, University of Maine).

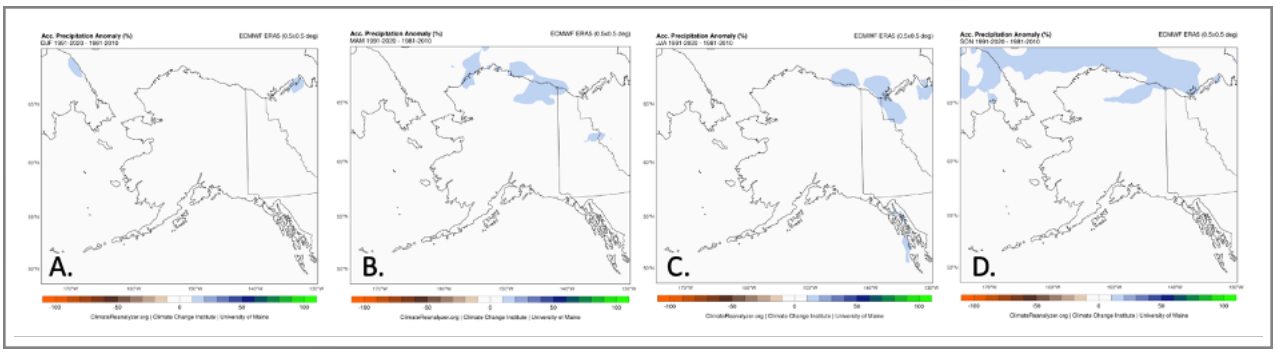

Figure 19. Precipitation anomaly for the state of Alaska, showing the change in annual normal precipitation (1991 - 2020 normal minus 1981 - 2010 normal) for the winter (A), spring (B), summer (C), and fall (D), as derived from the ECMWF ERA5 4th generation reanalysis data (source: Climate Reanalyzer, Climate Change Institute, University of Maine).

Climate Change in Alaska: Impacts to Wildlife, Economy and Tourism

Increases in warming in Alaska have been more than twice that observed in the lower 48. The impacts of warm record-breaking temperatures have resulted in thawing permafrost and thinning sea ice in the seas surrounding the state. This has led to increases in flooding and erosion and raised concerns about impacts to infrastructure including damage to buildings, roads and airports. As coastal erosion increases due to declining sea ice, residents become more vulnerable. Reduction in subsistence harvests has also raised concerns of food safety and security, as a warming climate poses a higher risk for diseases affecting the flora. While tourism might respond positively to warmer springs and autumns in the state, it may be impacted negatively to less favorable conditions for winter activities and increased summer smoke from wildfire.

While diminishing sea ice is opening new opportunities for shipping, oil and gas exploration, tourism and other economic activities, it is also creating a pathway for invasive species and habitat loss for a variety of ice-dependent species like walrus and polar bear. Changes in sea ice can also impact timing and location of plankton blooms in the ocean, in turn affecting the areas where commercial fisheries typically thrive. Monitoring the climate change in Alaska is critical to US economic strength given Alaska's commercial fishing industry is the most productive such industry in the US. It is estimated that the Alaskan seafood industry generates $12.8 billion in annual economic output for the US. Climate change and the resulting ocean acidification put all the state's fisheries at risk.

Alaska is home to 40% (229 of 556) federally recognized tribes in the US. Thawing permafrost, loss of coastal sea ice, sea level rise and more intense extreme weather events are increasing erosion and flooding along Alaska's northwestern coast. More than 30 Native villages are either in the process of or in need of relocating their entire village. However, due to high costs and land constraints, tribal communities in Alaska have been experiencing difficulty relocating to safer areas. In addition, most of these communities are not connected to the state's road system or electrical grid, so the cost of living is high and it is challenging to supply food, fuel, materials, healthcare, and other services. Climate impacts on these communities are magnified by additional social and economic stresses. However, Alaskan Native communities have for centuries dealt with scarcity and high environmental variability and thus have deep cultural reservoirs of flexibility and adaptability.

Noteworthy Events

January: Fairbanks had a longer than average cold spell of days below 5 °F. The temperature was below 5 °F for 34 days from December 30, 2019 until February 2, 2020. This was the 4th longest streak of days below 5 °F. The last time a similar event happened was in the winter of 1974-75, however that event had much colder temperatures. The longest stretch of days below 5 °F was 49 days in the winter of 1942-43.

Kodiak had a snowfall of 22 inches over the 24-hour period from the afternoon of Tuesday, January 28th to the afternoon of Wednesday, January 29th causing the Kodiak Island Borough School District to cancel classes for the first time in more than a decade. Many businesses also closed, including the borough offices, medical centers, the senior center, and the airport.

February: Snowfall, locally strong winds and blowing snow created regional extreme avalanche conditions. A snow machine rider was buried in an avalanche and died near Cooper Lake on the Kenai Peninsula on February 10th. Heavy winds and blowing snow likely contributed to the avalanche according to Wendy Wagner, director of the Chugach National Forest Avalanche Information Center.

Anchorage set a new daily snowfall record on February 18th, the same day it tied the daily record for maximum high temperature. Temperature went up briefly to 44 ºF degrees in Anchorage early on February 18 during the midnight hour, tying the daily record high for the date. However, a cold front then pushed through Anchorage, causing temperatures to drop. Snow fell throughout the day due to the cold front and another low that was approaching from the south. By the end of the day 8.9 inches of snow fell, setting a new daily snowfall record.

March: A 17-year-old man died after he was caught in an avalanche in Hatcher Pass on March 9, 2020. According to the Hatcher Pass Avalanche Center, more than 30 inches of snow accumulated at the pass over the weekend, creating dangerous avalanche conditions.

The Iditarod started on March 8, 2020 with deep snow along much of the trail, in contrast to recent years when little to no snow marked long sections of the trail. Three Iditarod mushers were rescued March 20 after they activated their

emergency beacons. According to the Alaska State Troopers' release, warm weather "has caused deep overflow on parts of the trail and the wind has been constant". The Army Guard added that "south blowing winds had persisted overnight and pushed seawater up onto the Iditarod Trail, and the mushers weren't aware that it was underwater." Race crews reworked the section of trail so that remaining teams could proceed to Nome.

April: Rapid snow melt and river breakups caused flooding in low-lying areas across the Interior. The Taylor Highway was closed after an overflowing river washed out a section of the road at Mile 54 on April 22nd. An ice jam in the Chena River resulted in a 2-foot rise in water levels in downtown Fairbanks and minor river overflows along the Chena Hot Springs Road, the Dalton Highway, the Elliott Highway, and the Taylor Highway on April 23rd. (http://www.newsminer.com/news/local_news/river-breakups-cause-minor-flooding-across- interior-alaska/article_a098253c-85cb-11ea-847a-53cf445ed743.html).

A record-breaking Arctic ozone hole closed. The Earth's ozone layer acts as protection between the sun's harmful UV radiation and the Earth's surface. The ozone hole opened up in March before becoming the largest stratospheric ozone hole observed over the Arctic. The hole was driven by an unusually strong and long-lived polar vortex. Earlier in April, scientists from the European Space Agency said that the hole covered an area about three times the size of Greenland. The hole disappeared as temperatures increased, breaking down the Arctic polar vortex and allowing ozone-depleted air to mix with ozone-rich air from lower latitudes. Copernicus Atmosphere Monitoring Service announced the closure on April 23rd. Paul Newman, chief scientist for Earth Sciences at NASA's Goddard Space Flight Center said that if people hadn't stopped putting chlorofluorocarbons into the atmosphere because of the Montreal Protocol, the ozone hole would have been much worse.

May: A large ice jam damaged buildings and property in Kotzebue on May 28th as lake ice in Kobuk Lake became stuck and pushed onto shore. The buildings had been there a long time and had never been damaged by an ice jam.

Lightning ignited at least 15 fires across Alaska during the last weekend in May. There were approximately 1,858 recorded lightning strikes throughout the state on Saturday, May 30th and more than 2,900 on Sunday, May 31st. Most of the new

lightning-caused fires over that weekend occurred in Southwest Alaska. The only human-caused fire on Saturday, May 30th occurred when a structure fire in Anchor Point spread to grass and was quickly extinguished by firefighters. (https://akfireinfo.com/2020/05/31/lightning-ignites-at-least-15-fires-across-alaska-this-weekend/)

June: June 2020 was the second wettest June ever in Juneau, with 7.3 inches of rain falling (normal = 3.2 inches). The record of 7.48 inches was set in June 2014: https://www.ktoo.org/2020/07/01/that-was-the-second-wettest-june-on-record-in-juneau/

Wreckage from a 1952 plane crash on a mountain near Anchorage is melting out of the Colony Glacier. High melt rates and opening crevasses mean the wreckage needs to be recovered sooner than later in order to finally give closure to the families.

July: Kodiak experienced an unusually dry year, receiving only 23.8 inches of rain since the start of 2020. This is about 20 inches less than normal: http://www.kodiakdailymirror.com/news/article_6587588a-dd0c-11ea-a269-a33c5ffeb6a9.html

Meanwhile, Juneau reached its summer rain average of 13 inches by July 26. This contrasts with last summer, when Juneau was extremely dry, seeing only 10 inches of rain: https://www.ktuu.com/2020/07/29/juneau-on-track-to-break-summer-rainfall-record/

Record rainfall was recorded in June for Fairbanks, breaking the previous record set in 1962.

A powerful 7.8 magnitude earthquake struck off the coast of the Alaskan Peninsula, about 17 miles deep, around 10:15 PM on July 21st. No tsunami was reported.

August: Unalaska recorded 120 mph winds when a rapidly developing storm moved from the North Pacific and across the Eastern Aleutians. This is the strongest storm to affect Alaska during the month of August on record. Ketchikan unofficially broke its summer rainfall record with 47 inches in the months of June,

July and August. Of the 90 or so days from June through August, Ketchikan saw 68 days with measurable rainfall. The city's previous record, 67 days, was set in 1933 and last tied in 1966.

The National Weather Service recorded 2020 as a record year for rainfall in Juneau. Juneau International Airport secured the 5th wettest meteorological summer, measuring 19.89 inches of precipitation from June – August.

September: A low pressure system in the Gulf approached the Alaskan coast on September 26th, bringing strong winds and big waves to the southeastern Alaskan coast. Kodiak experienced extreme weather due to two powerful weather systems at the end of September.

October: Record low Arctic sea ice in October seen as alarming, as regrowth has been slower than ever: https://www.vox.com/21536859/arctic-sea-ice-2020-climate-change-alaska-polar-bears-charts

A magnitude 7.6 earthquake struck near Sand Point, Alaska on October 19, 2020. The earthquake occurred as the result of strike-slip faulting near the subduction zone interface between the Pacific and North America plates and is considered to be an aftershock of a large M 7.8 quake in July 2020.

November: On Monday, November 2nd, temperatures dropped to -23°F in Fairbanks for the first time this season, which is the earliest the city has recorded a temperature that low since October 25, 1996. The coldest November 2 on record in Fairbanks is -33°F, and that temperature reading was recorded back in 1907. Several hundred miles to the east of Fairbanks, the remote town of Chicken, Alaska, (population of 13, according to the United States Census Bureau) reached -40°F early Monday, making it the earliest minus 40 or below reading in Alaska since 2008, according to the National Weather Service (NWS): https://www.wkyc.com/article/weather/accuweather/alaska-has-recorded-its-earliest-minus-40-or-below-reading-since-2008/507-70087284-8282-4280-8e63-6c7419eb191e

December: At the beginning of the month, on December 2, 2020, a severe storm with heavy rainfall led to destructive landslides, mudslides and flooding in communities throughout Southeast Alaska. Several homes were destroyed and two

residents were killed in Haines. The disaster is considered to be a 200-500 year storm event: http://www.newsminer.com/news/alaska_news/haines-disaster-considered-200-500-year-storm-event/article_1d078756-499a-11eb-afc7-0793b6e202dd.html

On December 3, 2020, a tandem of three surface cyclones was observed off the coast of Alaska, connected to each other with the frontal boundary in between. The westernmost system was the strongest and most organized, with a central pressure of 978 mbar.

At the end of the month, on December 31, 2020, a new Alaska land-based low pressure record was set when pressure dropped to 924.8 mb in Shemya, Alaska. The previous record was set back in 1977. This bomb cyclone in the far western Aleutian Islands did not cause major damage to communities.

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Appendix

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

	J	F	M	A	M	J	J	A	S	O	N	D
Anchorage	-10.92	-1.55	-5.06	-0.19	2.6	0.29	2.16	2.09	2.09	2.39	-0.83	3.62
Bethel	-12.11	-6	-0.91	5.94	6.57	1.4	0.46	2	-0.27	5.79	7	2.51
Bettles	-11.09	-10.68	-4.04	1.74	4.42	0.85	-1.81	4.62	2.56	3.32	2.28	7.91
Cold Bay	-5.47	3	2.06	4.68	3.95	2.94	3.11	0.91	-0.65	1.69	1.86	-1.81
Delta Junction	-14.14	-5.51	-4.37	-1.35	2.98	-1.35	-1.1	1.36	1.63	2.31	0.08	6.02
Fairbanks	-13.5	-4.85	-2.63	-2.02	3.89	-0.65	-1.54	3.58	2.75	3.19	-0.57	4.25
Gulkana	-13.2	-0.28	-5.24	-0.57	3.55	-1.82	0.91	0.99	1.24	-0.95	-3	7.18
Homer	-13.04	-0.84	-2.94	2.43	2.67	0.57	2.76	1.32	2.65	2.02	1.32	3.79
Juneau	-2.32	3.74	-2.63	-1.1	2.73	-1.17	0.86	-0.85	0.78	-0.96	-2.31	6.64
Ketchikan	-4.05	1.11	-0.34	0.5	3.35	0.2	0.22	-0.7	3.6	-0.95	-0.48	4.93
King Salmon	-17.75	-2.11	-3.6	6.5	3.3	0.23	2.14	1.24	-0.57	4.32	3.18	3.62
Kodiak	-8.5	-1.21	-0.15	3.19	3.1	1.43	5.34	2.41	1.15	2.22	0.51	0.34
Kotzebue	-3.67	-12.88	4.13	6.84	7.91	1.17	-1.36	2.19	0.49	6.02	5.98	1.85
McGrath	-17.92	-5.87	-2.01	1.05	4.75	0.41	-0.27	3.07	1.1	5.38	2.54	3.96
Nome	-5	-9.3	3.56	4.27	8.9	3.65	-0.82	1.17	0.46	6.26	8.36	3.13
St. Paul Island	0.15	2.95	5.36	6.7	4.36	6.59	5.61	5.57	1.46	2.58	2.95	2.39
Talkeetna	-15.33	-1.4	-5.76	-1.13	3.05	-0.82	1.51	2.03	1.85	1.64	-1.48	2.98
Utqiagvik	0.46	-11.9	7.2	6.28	1.32	1.24	-2.63	2.9	3.2	8.65	14.64	3.2
Yakutat	-5.81	1.77	-1.36	-0.08	3.09	-0.03	1.63	0.79	1.05	-0.45	-1.81	4.35

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

	J	F	M	A	M	J	J	A	S	O	N	D
Anchorage	6.18	18.72	21.48	36.62	50.4	55.53	60.97	58.84	50.63	37.19	21.37	22.63
Bethel	-5.52	5.12	14.29	32.83	48.5	53.85	56.56	55.5	45.33	36.05	24.4	12.87
Bettles	-21.15	-15.55	0.32	25.03	48.8	59.3	57.89	57.11	43.17	22.18	1.23	2.16
Cold Bay	22.77	32.02	32.16	38.68	44.2	49.23	53.97	53	47.45	42.15	36.4	29.29
Delta Junction	-15.19	-0.45	9.73	30.9	50.6	56.25	59.1	56.16	45.48	26.4	6.33	8.13
Fairbanks	-21.4	-6.02	8.82	30.53	53.3	59.8	60.97	59.73	47.6	27.39	2.03	0.21
Gulkana	-16.05	5.38	10.37	31.28	48.8	52.53	58.47	54.53	44.53	25.6	2.8	7.65
Homer	11.76	25.43	26.97	39.38	47.1	51.22	57.37	55.23	50.71	40.13	30.82	30.85
Juneau	25.94	33.88	31.18	39.75	51.3	53.38	57.81	55	50.9	41.44	31.15	36.48
Ketchikan	30.85	36.88	37.47	42.95	52	54.25	57.92	57.31	56.1	44.34	37.92	40.27
King Salmon	-1.57	16.83	20.55	40.22	47.5	51.68	57.69	55.84	47.03	37.82	26.08	22.23
Kodiak	21.93	29.62	32.65	40.78	47.4	51.08	59.84	57.56	50.55	42.68	34.47	31.53
Kotzebue	-6.47	-13.59	5.18	20.13	39.8	46.87	53.23	53.9	42.62	30.32	15.08	4.15
McGrath	-24.42	-4.26	9.6	30.75	51.5	57.82	59.73	57.66	45.55	30.48	8.1	0.76
Nome	0.15	-1.79	13.87	24.77	45.7	51.45	51.39	51.27	43.27	35.02	25.25	12.53
St. Paul Island	25.24	27.31	30.17	35.82	40.6	48.35	52.88	54.52	45.98	41.18	35.95	31.24
Talkeetna	-1.13	16.84	19.15	34.7	50.8	56.23	61.66	58.73	49.35	34.84	17.97	18.98
Utqiagvik	-12.95	-26.1	-5.44	8.07	22.5	36.88	38.21	41.9	35.36	25.85	15.33	-4.6
Yakutat	22.29	31.48	30.63	37.72	47.8	50.77	55.98	54.65	49.45	40.6	30.53	33.98

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 any errors to webmaster@akclimate.org.