IMPROVING THE ABILITY OF ALASKANS TO RESPOND TO A CHANGING CLIMATE

IF YOU DON’T LIKE THE CLIMATE NOW, JUST WAIT A FEW MINUTES

By Brian Brettschneider, Borealis Scientific, LLC, Anchorage

This article is based primarily on data from the National Centers for Environmental Information (NCEI; http://www.ncei.noaa.gov), which now encompasses NOAA’s former three data centers—the National Climatic Data Center, the National Geophysical Data Center, and the National Oceanographic Data Center. Analyses of a broad range of data relating to Alaska climate and weather are available on the Alaska Climate Info Facebook page: https://www.facebook.com/AlaskaClimateFacts

IF YOU DON’T LIKE THE WEATHER IN NEW ENGLAND NOW, JUST WAIT A FEW MINUTES

— MARK TWAIN

This popular saying has been adopted by residents of cities across the U.S.—perhaps across the world. While specifically referring to weather, a similar argument can be made for climate. The climate variability of some portions of the U.S. is extraordinary; for other places, not so much. In this article, I introduce a simple climate variability model so that meaningful comparisons of the climate between two or more places can be made.

What defines climate variability? This question is not easily answered. The first part of the answer involves time. While a time frame of decades (or longer) is extremely important in the context of the global climate system, it does not easily translate into the human experience. When we think of climate variability from this perspective, we are typically thinking of climate on a monthly or seasonal time scale.

Most readers of the Alaska Climate Dispatch would agree with the statement that the climate of Fairbanks is more variable than the climate of Juneau. The index presented in this article evaluates climate variability on an intra-annual time scale; i.e., how much does the climate vary during a 12-month period? Comparing Fairbanks and Juneau, Fairbanks has a higher mean summer temperature (photo, above right), a lower mean winter temperature (photo, lower right), and the precipitation is less uniformly distributed over the course of the year. A climate variability score for Fairbanks would therefore be higher than a score for Juneau. In Alaska, maritime areas generally tend to have lower climate variability than their continental counterparts; however, this relationship is less pronounced in the Lower 48.

MARCH 2015

ALASKA CLIMATE DISPATCH

A STATE-WIDE SEASONAL SUMMARY AND OUTLOOK

IMPROVING THE ABILITY OF ALASKANS TO RESPOND TO A CHANGING CLIMATE
The key part of the climate variability question involves measurement criteria. The two variables used as the input parameters for the climate variability index are temperature and precipitation. Wind, wind chill, humidity, solar energy, cloud cover, etc., are also important components of the variability of a place but are not included in this index.

DATA

The data utilized in the development of this climate variability index were obtained from the National Centers for Environmental Information (NCEI). The NCEI publishes 30-year climate normals for nearly 9,000 stations across the U.S., 203 of which are located in Alaska. The data represents statistical normals for the 1981–2010 time period and is the most recent iteration of the normals data set. Only NCEI normal data were used in the development of this climate variability index.

TEMPERATURE

The NCEI publishes daily normal temperature standard deviations as well as daily normal high and low temperatures. A standard deviation is a statistical measure of dispersion about a mean value. By definition, 68% of observations fall within one standard deviation of a mean value of a normal distribution. Approximately 95% of observations fall within two standard deviations of a mean value, and so on; the larger the standard deviation, the greater the variability. For example, the average of all 365 daily standard deviations in Fairbanks is 10.0°F; for Anchorage, the value is 6.9°F. Therefore, Fairbanks has a statistically larger day-to-day temperature variability. Figure 1 shows the average daily temperature standard deviation for six stations in Alaska.

PRECIPITATION

Unlike temperature, precipitation data is strongly skewed. If a station records measurable precipitation on 100 days per year but has a calculated normal precipitation for all 365 days of the year (as is the case for most stations), the 265 days without precipitation all show up as below normal precipitation days. Therefore, daily precipitation is not a useful metric for precipitation variability. Total precipitation suffers from a different problem. Knowing the absolute amount of precipitation says nothing about the variability of the precipitation. To accurately portray intra-annual precipitation variability in this study, all 12 monthly precipitation values for a station were compared against a uniform precipitation distribution for that station. If a station’s monthly precipitation normals were evenly distributed throughout the year, that station received a score of 0 for precipitation variability. On the other hand, stations with most of their precipitation bunched into only a few months received a high variability score. The analysis of an actual distribution against a hypothetical distribution is called a goodness-of-fit test. The best known goodness-of-fit measure is the Chi-square test. In this analysis, monthly precipitation is transformed into the percentage of annual precipitation, and the Chi-square test is evaluated against a uniform monthly distribution (total precipitation ÷ 12). This allows for an equivalent station to station comparison. Figure 2 shows the monthly precipitation as a percentage of annual precipitation for six stations in Alaska.
METHODOLOGY

I assessed all station values across the entire U.S. for temperature variability (average daily standard deviation) and precipitation variability (Chi-square value). I ranked the values in each data set from lowest to highest and assigned a decimal percentile ranking from 0 to 100. Then the two data sets were combined into a single data set with the two percentiles added together and rescaled from 0 to 100 to give a combined variability index. Figure 3 (page 2) shows the temperature, precipitation, and combined variability index percentiles for five cities in Alaska based on these national indices.

Using the example of Anchorage, 27.7% of the U.S. had a lower temperature variability (average daily standard deviation). For precipitation, 85.1% had a lower precipitation variability (Chi-square value). This is due to the strong seasonality of precipitation in Southcentral Alaska, with its pronounced late summer/early fall peak. When those two numbers were combined and rescaled from 0 to 100, 65.0% of the entire U.S. had a lower combined climate variability than Anchorage.

MAPS AND ANALYSIS

TEMPERATURE

Interior Alaska is the undisputed champion of temperature variability in the U.S. (Figure 4). Every place in the U.S. with an average daily standard deviation greater than 11°F is north of the 62nd parallel. For the state as a whole, the average value of 9.3°F is substantially higher than the national average of 7.7°F. The average percentile value for Alaska is 77. At the 100th percentile, Umiat is the statewide—and U.S.—champion.

PRECIPITATION

For precipitation, interior Alaska exhibits strong seasonality with a summer maximum and a spring minimum. Looking back at Figure 2, Big Delta (Junction) receives 60% of annual precipitation during their three wettest months and only 9% during their four driest months. This precipitation distribution is more variable than 97.2% of the U.S. Only the areas around Tok and Prudhoe Bay exhibit greater precipitation variability in Alaska (99th percentile nationally). Figure 5 shows the monthly precipitation variability for Alaska and the U.S. With the exception of Kodiak Island and the Aleutian Islands, most of Alaska has precipitation variability well above the national average. At the statewide level, the average percentile value for Alaska is 71.
CLIMATE VARIABILITY

OVERALL VARIABILITY

No place in the entire country has greater overall temperature-precipitation variability scores than interior and northern Alaska (Figure 6). Nearly all of the areas with a score in the 99th percentile are in two arcs—one from Tanana to Eagle and another from Umiat to Nuiqsut.

In Alaska, temperature variability strongly controls climate variability. In fact, the R² value between the overall variability score and the temperature variability is 0.90. This is not so surprising given the fact that areas with large temperature variability are the coldest parts of the state during the winter. Those stations generally record very low winter precipitation totals due to the limited ability of a cold airmass to hold moisture, and therefore have high precipitation variability. In the Lower 48, the R² value between the overall variability score and the temperature variability is 0.55. In the Great Plains, high temperature variability is strongly associated with high overall climate variability. However, that relationship breaks down in New England and in California (inset, Figure 6).

The location with the highest combined variability score in the U.S. is Kuparuk/Prudhoe Bay. The location with the second highest score is Big Delta (Junction)—although you have to go out to the fourth decimal place to distinguish the two places. Therefore, I consider them co-national champions!

At the other end of the variability spectrum, the areas around Kodiak have the lowest values in Alaska and are in the bottom 0.4 percentile nationally, with a temperature variability index at the 4.4th percentile and precipitation variability at the 18.9th percentile.

CONCLUSION

The people in Delta Junction and on the North Slope can rightfully claim to live where climate variability is the greatest, both in Alaska and in the entire U.S. No other places in the country exhibit such extreme combined differences in seasonality of temperature and precipitation. Ironically, Mark Twain’s famous saying about the weather in New England was quite mistaken. The intra-annual climate variability in New England is rather low (inset, Figure 6). Were he alive today, Mr. Twain might well insert an Alaska locale into his quotation.
WEATHER IMPACTS ACROSS ALASKA

December 2014 started with freezing rain on the Kenai Peninsula on December 1 and in the Anchorage area on the 2nd. Snowfall totaled up to 9" at Two Rivers, creating hazardous driving conditions. The snowfall total for Twelvemile Summit was 12.4". Dense fog advisories were issued for the Fairbanks area for the 3rd and 4th. The snow and cold allowed Birch Hill downhill ski area and Chena Lakes ice fishing huts to open in Fairbanks. The Eaglecrest Ski area in Juneau opened on the 6th. An avalanche in the eastern Alaska Range killed a backcountry skier and a dog on December 6; a companion was able to dig himself out. Cold air pouring south from the North Slope brought locally very strong winds over the Brooks Range, northern Interior, and northwest coast starting on December 8. The automated weather station near Howard Pass, in the remote western Brooks Range, reported winds to 89 mph before transmission stopped, as the wind sensor presumably was blown apart. At Point Hope winds topped out at 78 mph.

**WEATHER IMPACTS ACROSS ALASKA**

By Kevin Galloway, Blake Moore, Rick Thoman, and Gerd Wendler. 1) Alaska Climate Research Center, Geophysical Institute, UAF; 2) National Weather Service

This article is based on information from the Alaska Climate Research Center and National Weather Service. The National Integrated Drought Information System hosts quarterly information on regional climate impacts and outlooks, available at: http://www.drought.gov/drought/content/resources/reports

The winter of 2014-15 was memorably mild over much of Alaska, with exceptionally light snowfall in many parts of the state (see pages 9–12 for details). The lack of snow and cold weather had impacts in many communities, and freezing rain was a repeated problem across much of mainland Alaska. Significant wind-storms were less common this winter than is often the case. The Department of Environmental Conservation issued repeated air quality advisories over the season in the Fairbanks and North Pole areas when cold air inversions trapped particulates near the surface. The following article is a chronological summary of the season’s notable weather impacts on Alaskans.

**WINTER 2014–15:**

**WEATHER IMPACTS ACROSS ALASKA**

*By Kevin Galloway, Blake Moore, Rick Thoman, and Gerd Wendler. 1) Alaska Climate Research Center, Geophysical Institute, UAF; 2) National Weather Service*

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**DECEMBER**

December 2014 started with freezing rain in Southcentral Alaska and winter storm warnings for the Interior. Small amounts of freezing rain fell on the Kenai Peninsula on December 1 and in the Anchorage area on the 2nd. Snowfall totaled up to 9" at Two Rivers, creating hazardous driving conditions. The snowfall total for Twelvemile Summit was 12.4". Dense fog advisories were issued for the Fairbanks area for the 3rd and 4th. The snow and cold allowed Birch Hill downhill ski area and Chena Lakes ice fishing huts to open in Fairbanks. The Eaglecrest Ski area in Juneau opened on the 6th. An avalanche in the eastern Alaska Range killed a backcountry skier and a dog on December 6; a companion was able to dig himself out. Cold air pouring south from the North Slope brought locally very strong winds over the Brooks Range, northern Interior, and northwest coast starting on December 8. The automated weather station near Howard Pass, in the remote western Brooks Range, reported winds to 89 mph before transmission stopped, as the wind sensor presumably was blown apart. At Point Hope winds topped out at 78 mph.

**Figure 7. Alaska weather and climate highlights for December 2014–February 2015. More highlights and details are available on the Alaska Climate and Weather Highlights page (https://accent.uaf.edu/?q=tools/climate_highlights), developed in collaboration with the National Weather Service.**
On December 10 freezing rain left enough glaze on roads to force officials to close most schools in the Matanuska-Susitna Borough School District. On December 12 winds gusting past 60 mph caused downed trees and power outages at Thorne Bay in Southeast Alaska. Winter storm warnings were in effect for Bering Strait and Chukchi areas on the 14th for high winds and blowing snow. The Turnagain Pass area remained closed to snowmachiners at mid-month due to low snowpack. On the 15th light freezing rain was again observed in the Talkeetna area, and on the 17th Kenai Borough Schools delayed opening due to freezing rain.

Thin ice on Interior rivers allowed two vehicles to sink into the Chena River in Fairbanks on December 15 and 16, trapping a dog, and a bulldozer fell into the Nenana River near Nenana on the 23rd. The upper mountain at Alyeska in Girdwood re-opened on the 19th after a four-day closure. A light snowfall in Anchorage on the 21st resulted in a number of vehicle accidents. The delayed freeze-up and related ice jams on the Kuskokwim River continued to impact travel in the region (photo, below).

High wind advisories were issued on Christmas Day for the eastern Alaska Range, with a simultaneous snow advisory for western areas of northern Alaska, then for the Fairbanks area the following day. Snow totaled about half a foot in affected areas over the two days; Bettles received 9.7”. The 27th saw temperatures drop to -20°F in Fairbanks for the first time of the winter, the third latest date to reach that temperature in more than 100 years. A large number of winter storm warnings and high wind warnings were issued across the state on the 29th. Anchorage residents endured a brief barrage of snow grains and ice pellets on the 30th. New Year’s Eve brought freezing rain into the Interior, with the Parks Highway between Nenana and Ester closed for several hours, while glazing was widespread south and east of Fairbanks, including the North Pole area.

**JANUARY**

January started with high Taku winds gusting up to 78 mph in Douglas Harbor, creating minor property damage and power outages in the Juneau area on the 4th. North Pole reported its worst air quality since 2012 on the 5th when a strong inversion trapped cold polluted air close to the ground. The Kenai Airport closed for several hours on January 8 due to a solid glaze of ice from freezing rain on the runway. In Valdez roads were especially icy on the 7th and 8th from rain. Freezing rain also caused slick conditions in Bethel, closing schools on the 8th and 9th. High wind warnings were issued for areas of the Interior and northern Alaska on the 8th. Freezing rain hit Alaska Range roads on the 13th. In the Healy area, stranded semi trucks blocked the Parks Highway, and the Denali Borough School District canceled bus service.

By mid-January the continuing warm winter forced organizers to postpone the Tustumena 200 sled dog race by two weeks to the end of February. Villages on the Kuskokwim River worked together to clear a trail for the Kuskokwim 300 sled dog race scheduled to start January 16. Crews used a bulldozer, a log skidder, and other equipment to clear 4 miles of river ice jams created late last year during winter thaws (photo, left). Anchorage residents were warned of slick road conditions on January 15. The Eaglecrest ski area in Juneau closed due to warm weather and rain on the 15th and 16th, then again on the 19th until more snow was on the ground. Treacherous road conditions developed in the Fairbanks area on the 19th.

The National Weather Service issued winter storm warnings across Southeast Alaska on January 19 and widespread landslide warnings on the 20th.
WEATHER IMPACTS

due to heavy rain. Heavy snow fell in the region’s passes; White Pass totaled more than 14”. On the
21st minor flood advisories were issued for small streams in the area. Ketchikan received more than
10” of rain in just 40 hours during the storm, and the Ketchikan Dam was monitored for signs of
failure as water topped the dam. The record-setting rain turned Ketchikan Creek into a raging torrent
(photo, upper right), and minor flooding prompted residents of more than a dozen homes to evacuate
the area. Juneau Harbor advised boat owners to check their vessels for safety, and a small mudslide
dumped onto the Glacier Highway. The Klondike Highway closed on the 22nd due to rockslides.

The Southcentral region got its heaviest snowfall of the winter on January 22 and 23. Talkeetna had
over a foot of new snow from the event, which continued into that weekend. Winter storm
warnings were issued for the Interior as the storm pushed north. After that storm, the Interior got
its first true cold snap of the winter over the last week of the month, with temperatures dropping
to -48°F at the Fort Wainwright Airport, while Granite Creek near Delta Junction bottomed out at
-55°F. The cold snap extended into the Southcentral region. Anchorage officially dropped to -1°F on
the 25th, ending a streak of 394 days continuously above 0°F. This was the second longest streak in
Anchorage’s history, far short of the 683 days from January 18, 2000, to November 20, 2001. Record
warm temperatures in Southeast Alaska balanced this cold spell over much of the state. Temperatures
again turned cool in Southeast during the final days of the month, and heavy snowfall forced Juneau
buses to switch to winter routes.

Nenana Ice Classic officials noted that the Tanana River at Nenana had not completely frozen
over until mid-January, very late compared to normal, and was at its second lowest thickness on record for the beginning of February.

FEBRUARY

February started with a short-lived intrusion of colder air bringing Taku winds to Southeast Alaska on February 5. Hurricane force wind warnings were issued for the region, perhaps for the first time ever for the Upper Lynn Canal, and gusts up to 140 mph were measured at Sheep Mountain. The next day, winds topped out at 114 mph at Eldred Rock near Juneau. Gusts as high as 77 mph buffeted Douglas Island and the city of Juneau, causing power outages due to trees on power lines, and the ferry Aurora canceled some trips. Similar winds buffeted the Gulf of Alaska coast and Southcentral Alaska from the 5th to 7th. Multiple power outages were reported to Matanuska Electric Association, and some property damage was reported in Valdez (photo, lower right). Winds peaked at 96 mph at Thompson Pass outside of Valdez, the Valdez airport reported a peak wind of 92 mph, and the Palmer Airport reported gusts up to 75 mph. In the Anchorage area widespread winds of 50 to 60 mph caused some damage to roofing. The high winds were followed by snow. Petersburg received

Above: Heavy rain combined with a 19-foot high tide on January 21, 2015, raised Ketchikan Creek higher than long-time residents had ever seen. Photo from Extreme Weather on YouTube.

Below: High winds peeled the roof off South Central Hardware in Valdez on February 6, 2015. Emergency responders blocked off portions of the adjacent street due to dangerous conditions caused by the flying debris. Valdez Star photo.
a total of 14.5” of snow on the 6th, while Hyder reported 21”. Juneau received 7.6” over the 7th and 8th. By the 8th the Klondike Highway was closed due to high winds and blowing snow. All the new snow allowed Juneau’s Eaglecrest ski area to reopen on February 14.

In a new winter program, the Park Service opened the first 12 miles of the Denali Park Road to private vehicles on February 14. The Tustumena 200 sled dog race, postponed until February 21, was finally canceled due to lack of snow. By the 19th, the Eaglecrest Ski Area had only been open a total of 30 days for the season. The mid-month wind and rain increased avalanche danger around the Turnagain Pass area considerably.

Perhaps the most widespread of the freezing rain storms occurred February 21–23. Rain fell over much of Southcentral Alaska on the 21st. In many areas, surfaces were cold enough for a thick glaze to develop, creating slick roads and walkways. The Fairbanks area was drenched with 8–10 hours of steady rain from the evening of February 21 into the morning of February 22. The Fairbanks airport measured 0.23” of rain, the greatest February rainstorm in Fairbanks since 1923. Extremely icy roads led to closed businesses and canceled activities over the following two days, including the start of the World Ice Art Championships. The Richardson Highway was closed the morning of the 22nd, and on the Parks Highway a school bus carrying Lathrop High basketball players was stranded for five hours between Nenana and Fairbanks until the road could be graveled. The Fairbanks Airport was briefly closed and two flights from Seattle diverted to Anchorage, while more flights from Anchorage were canceled on the morning of the 22nd. The impact of the icy roads was lessened by the 22nd being a Sunday, but the ice was thick enough for public schools and the University of Alaska to cancel classes on the 23rd. More freezing rain fell on the 23rd, mostly to the east of Fairbanks. This makes four of the past five winters that Fairbanks has had a significant winter rainfall (photo, below), previously an uncommon event.

On February 24, Nome reported two lightning strikes that accompanied a snow shower. This ‘thundersnow’ is relatively rare, but has been recorded in Nome 11 times since 1973. For more information on thundersnow, see http://ak-wx.blogspot.com/2015/02/thunder-snow-in-nome.html

February ended with a fast-moving storm tracking across the North Slope and the associated cold front trailing south across the Interior. Winds gusted to 76 mph at Point Thompson east of Prudhoe Bay, while 56 mph was reported at Kuparuk and 43 mph at Barrow. Kaktovik, on Barter Island just off the North Slope, was hard hit, but the wind instrument failed during the storm. Residents reported it was dangerous to go outside during the storm. Power was knocked out, and many residents sheltered in the village school. Snowdrifts abounded in the town after the storm. Some residents had to dig their way out of their houses. Across the Interior, strong winds and blowing snow from this storm closed the Steese Highway; peak winds included 50 mph at Fairbanks Airport and 49 mph at Eagle Summit. Travel advisories were issued on the 28th for the Dalton Highway with blizzard conditions and gusts up to 60 mph.

Lack of snow and mild temperatures forced many winter events to be canceled or changed. For the fifth time since 1996, the Anchorage Fur Rondy canceled the Open World Championship Sled Dog Races scheduled for the last weekend in February (photo, above left). In February, officials of the Open North American Championship sled dog race in Fairbanks announced that the March race would start from Musher’s Hall rather than downtown due to concerns about ice thickness on the Chena River. The restart of the Iditarod Trail Sled Dog Race, also in March, moved from Willow to Fairbanks for the second time in the race’s history, due to lack of snow in Southcentral Alaska.

Not all of the impacts from the lack of snow and cold were negative. Some communities reported significantly reduced winter road maintenance costs and warmer temperatures meant potentially reduced energy costs. The municipality of Anchorage estimated it had saved roughly $1 million on snow removal for the winter by the end of February.

Volunteer Griff Tucker prepares sun-shades to protect the snow blocks trucked in for the Anchorage Fur Rondy Festival snow sculpture competition in late February 2015. The festival’s sled dog race was canceled due to lack of snow. Photo by Mark Meyer for the Boston Globe.

Since winter rain has become more frequent in Interior Alaska, the Department of Transportation has begun loading trucks with 2,000-gallon brine tanks to improve road conditions following freezing rain. Photo by Erin Corneliussen, Fairbanks Daily-News Miner.
WINTER 2014–15 WEATHER CONDITIONS IN ALASKA

By Gerd Wendler, Blake Moore, and Kevin Galloway
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This article presents a climate summary of winter 2014–15 (December, January, February), concentrating on temperature and precipitation from the 19 first-order meteorological stations operated by National Weather Service (NWS) meteorologists in Alaska. The deviations from the long-term average are based on the new normal of 1981–2010. All figures and tables are provided by the Alaska Climate Research Center, "http://akclimate.org", except as noted.

TEMPERATURE

Statewide, all three winter months generally had temperatures substantially above the 30-year mean (Figure 8). Figure 9 presents each day’s deviation from its long-term mean temperature and shows that, besides a 4-day cold spell at the beginning of January and a longer one from the late January into early February, this Alaska winter was indeed very warm. The mean deviation for the whole winter and all of Alaska was +5.4°F, which would not be a great value for a single station and a specific month, but is a very substantial value when considering the size of Alaska and an entire season. Note that the observed global warming is less than 2°F over the past century.

Looking at each month independently, December temperatures were decidedly above normal across the state, with all stations reporting positive deviations. The monthly mean temperature of Alaska’s 19 first-order stations was 21.8°F, a significant 7.5°F above the normal of 14.3°F. McGrath showed the greatest positive deviation at a very substantial 13.9°F above its long-term December mean of -3.2°F. King Salmon (13.0°F), Fairbanks (12.1°F), Delta Junction (10.7°F), and Talkeetna (10.2°F) also reported positive deviations exceeding 10°F for the month.

The state’s mean daily temperature was above the 30-year normal every day in December 2014, with the peak deviation of 20.1°F on the 30th. The warmest daily temperature in December was 55°F at Annette on the 7th. Annette also reported the highest mean temperature for the month at 41.7°F. The coldest daily temperature was -29°F at Bettles on the 27th. Barrow reported the lowest December mean temperature at -6.8°F.

December’s warm trend continued into January 2015 with temperatures above normal across the state and 18 of the 19 stations reporting positive deviations. The monthly mean temperature was 15.0°F, 3.6°F above the normal of 11.4°F. Juneau showed the greatest positive deviation at a significant 6.8°F above its January mean of 28.3°F. Kotzebue (6.7°F), Homer (5.9°F), Kodiak (5.8°F), Annette (5.1°F), and St. Paul (5.0°F) also showed positive deviations of at least 5°F. With a negative deviation of -2.5°F, Bettles was the only station reporting a below-normal January mean temperature. The mean daily temperatures were

Figure 8. Winter 2014-15 isotherm map of the deviation in temperature (°F) from the 30-year normal (1981–2010) based on all first-order meteorological stations in Alaska.

Figure 9. Time series of the mean Alaska temperature deviations (°F) for winter 2014-15.
above the 30-year normal on 18 days in January (Figure 9). The peak positive deviation, an extreme 18.4°F, occurred on January 15, while the peak negative deviation was -13.6°F on the 26th. The warmest temperature in January was 52°F, reported at Annette on the 18th. Annette also reported the highest mean temperature for January at 42.7°F. The coldest temperature was -56°F at Bettles on the 26th and 27th. Bettles also reported the lowest January mean temperature at -12.5°F.

The warmth continued into February with temperatures above normal at 18 of the 19 stations. February’s mean temperature was 19.5°F, 5.1°F above the normal of 14.4°F. Kotzebue reported the greatest positive deviation at a significant 11.0°F above its February mean of 0.8°F. Nome (8.3°F), King Salmon (8.0°F), Barrow (7.6°F), McGrath (7.0°F), Homer (6.4°F), and Bethel (6.0°F) also showed positive deviations of at least 6°F. Gulkana was the only station with a negative deviation, a mere -0.2°F. February’s warmest temperature was 53°F at Annette on the 17th and at both Homer and King Salmon on the 21st. Annette also reported the highest mean February temperature at 41.2°F. The lowest daily temperature was -47°F at Bettles on the 7th. Barrow reported the lowest February mean temperature at -6.6°F. The mean daily temperatures were above the 30-year normal on 19 days in February 2015 (Figure 9). The only span of colder than normal temperatures occurred from February 2–10 and included the month’s greatest negative deviation of -12.4°F on the 7th. The highest positive deviation, an extreme 19.9°F, occurred on February 22.

Table 1 summarizes each station’s mean temperatures and deviations for each winter month and for the season. Remarkably, of the 19 stations and for all three months, there were only two monthly mean temperatures below the long-term normal.

**PRECIPITATION**

As has been pointed out in previous issues, locations throughout Alaska have a broad range of precipitation. For example, the average precipitation in Little Port Arthur is more than 50 times greater than in Barrow. This sizeable variability implies that actual deviations from the long-term average are not very meaningful because of the wide regional differences. Therefore, Figure 10 presents these deviations as percentages above (+) or below (-) normal, where normal is the 30-year average.

Figure 10 shows clearly that precipitation over the winter of 2014-15 was close to normal in southern Alaska, lower than normal in the Interior, and above normal in northern Alaska. Twelve of the 19 stations reported a seasonal deficit, while 7 stations reported above normal values. An overall mean deviation of 5% was calculated for the season. Barrow showed the season’s highest positive deviation (+88%), but because quite small amounts of precipitation are generally observed in northern Alaska (a seasonal total of 0.41” water-equivalent for Barrow), large variations are to be expected. Conversely, Delta Junction (-55%) reported the relatively driest winter. For more details, see Table 2 (page 11).

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**Table 1.** The winter 2014-15 means and deviations in temperature (°F) from the 30-year normal (1981–2010) for all first-order stations for each winter month and for the season.
The highest one-day snowfall occurred at Bettles with 5.2", also a new daily record. The high positive deviations are normally connected with strong storms, such as the late February storm shown in Figure 12 (page 12). These storms advect moisture into Alaska; in winter local evaporation or sublimation of snow and ice is generally of minor importance as far as precipitation is concerned.

Looking at each month independently, December 2014 was just a bit drier than normal with overall precipitation calculated as 2% below normal; this calculation is based on the mean of the deviations in percentage of the first-order stations. Ten of the 19 stations reported below normal values for the month. This is in contrast to the wet December of 2013, which had 46% more precipitation than normal. The greatest daily deviation of 214% occurred on December 2, when a storm passed over much of Alaska. King Salmon had the greatest positive deviation from normal for the month, with a total of 1.96", or 59% above the expected amount of 1.23". Kodiak (158%), Fairbanks (145%), Barrow (143%), and Bethel (142%) also had December precipitation greater than 140% of normal. Leading the stations with lower than normal precipitation totals was Delta Junction with just 18% of normal. Other stations with less than 60% of their normal precipitation were Kotzebue (46%), Nome (50%), and Juneau (56%). The maximum December precipitation total was reported at Kodiak (13.79"), which also reported the highest daily total of 3.03" on December 28, a new daily record.

Snowfall in December was relatively light, with 13 of the 15 first-order stations that measure snowfall reporting below normal amounts. Based on the mean of the deviations from all 15 stations, the overall deviation from the normals was just 52% of the expected amount. Kodiak reported the lowest amount at 0.3", just 2% of its normal. Bettles had the highest deviation at 157% of its expected amount with a total of 24.5". Mean snow depth was about 30% under the normal. The near normal amount of precipitation, but deficiency in snowfall and resulting snow cover is, of course, due to the warmer weather, resulting in a higher percentage of the precipitation falling as rain instead of snow. The highest one-day snowfall occurred at Bettles on December 18 with 5.2", also a new daily record. Bettles also reported the highest monthly snowfall of 24.5", and the highest snow depth at 18".

January was a little drier than normal, with overall precipitation calculated as 8% below normal. Again, this contrasts to the wet January of 2014, which had 66% more precipitation than normal. Gulkana recorded the greatest positive deviation with a total of 1.12", or 243% of the expected amount of 0.46". Juneau (224%), Barrow (200%), Annette (137%), and Kodiak (122%) all also reported precipitation greater than 100% of normal. Leading the stations with lower-than-normal precipitation totals was McGrath with just 25% of normal. Other stations with less than half their normal precipitation were Fairbanks (26%), Bettles (40%), and Cold Bay (45%). The highest January precipitation total was 14.71" at Annette, which also reported the highest daily total of 2.25" on the 20th.

January saw two monthly precipitation records set in Southeast Alaska. Juneau totaled 11.98", breaking the 10.17" record from 1939. Petersburg totaled 14.02", topping the 1985 record of 12.05".

Snowfall remained comparatively light in January, with 13 of 15 stations reporting below normal amounts. The overall deviation from the normals of 0.46%.

### Table 2. Deviation in precipitation (%) from the 30-year normal (1981–2010) is presented for the first-order stations for each winter month and for the winter 2014-15 season.

<table>
<thead>
<tr>
<th>Station</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>Seasonal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Dev</td>
<td>Total</td>
<td>Dev</td>
</tr>
<tr>
<td>Anchorage</td>
<td>0.72</td>
<td>-35%</td>
<td>0.37</td>
<td>-49%</td>
</tr>
<tr>
<td>Annette</td>
<td>12.96</td>
<td>21%</td>
<td>14.71</td>
<td>37%</td>
</tr>
<tr>
<td>Barrow</td>
<td>0.20</td>
<td>43%</td>
<td>0.26</td>
<td>100%</td>
</tr>
<tr>
<td>Bethel</td>
<td>1.59</td>
<td>42%</td>
<td>0.37</td>
<td>-35%</td>
</tr>
<tr>
<td>Bettles</td>
<td>1.12</td>
<td>22%</td>
<td>0.32</td>
<td>-60%</td>
</tr>
<tr>
<td>Cold Bay</td>
<td>2.92</td>
<td>-35%</td>
<td>1.41</td>
<td>-55%</td>
</tr>
<tr>
<td>Delta Junction</td>
<td>0.07</td>
<td>-82%</td>
<td>0.18</td>
<td>-42%</td>
</tr>
<tr>
<td>Fairbanks</td>
<td>0.93</td>
<td>45%</td>
<td>0.15</td>
<td>-74%</td>
</tr>
<tr>
<td>Gulkana</td>
<td>0.74</td>
<td>5%</td>
<td>1.12</td>
<td>143%</td>
</tr>
<tr>
<td>Homer</td>
<td>2.77</td>
<td>-10%</td>
<td>1.85</td>
<td>-30%</td>
</tr>
<tr>
<td>Juneau</td>
<td>3.29</td>
<td>-44%</td>
<td>11.98</td>
<td>124%</td>
</tr>
<tr>
<td>King Salmon</td>
<td>1.96</td>
<td>59%</td>
<td>0.52</td>
<td>-49%</td>
</tr>
<tr>
<td>Kodiak</td>
<td>13.79</td>
<td>58%</td>
<td>10.13</td>
<td>22%</td>
</tr>
<tr>
<td>Kotzebue</td>
<td>0.35</td>
<td>-54%</td>
<td>0.36</td>
<td>-42%</td>
</tr>
<tr>
<td>McGrath</td>
<td>1.40</td>
<td>9%</td>
<td>0.27</td>
<td>-75%</td>
</tr>
<tr>
<td>Nome</td>
<td>0.54</td>
<td>-50%</td>
<td>0.71</td>
<td>-24%</td>
</tr>
<tr>
<td>St. Paul Island</td>
<td>2.96</td>
<td>32%</td>
<td>1.20</td>
<td>-24%</td>
</tr>
<tr>
<td>Talkeetna</td>
<td>1.50</td>
<td>-22%</td>
<td>1.10</td>
<td>-19%</td>
</tr>
<tr>
<td>Yakutat</td>
<td>12.05</td>
<td>-26%</td>
<td>14.02</td>
<td>3%</td>
</tr>
</tbody>
</table>

Figure 11. Time series of the mean Alaska precipitation deviations (%) for winter 2014-15.
was just 50% of the expected amount. King Salmon reported the lowest amount at 0.7”, just 7% of its normal. Barrow had the highest deviation at 177% of its expected amount with a total of 2.6”. Mean snow depth was about 60% below normal. Again, this is due to the warmer weather resulting in a higher proportion of precipitation falling as rain instead of snow. The highest one-day snowfall occurred at Juneau on the 28th with 6.0”. Juneau also reported the highest monthly snowfall of 15.1”. Bettles reported the highest snow depth at 19” on the 22nd.

Like January, February was a little drier than normal, with the overall precipitation calculated as 8% below normal. Fourteen of the 19 stations reported below-normal values, and Nome hit its normal for the month. The month was, however, relatively wetter than February 2014, which was 38% below normal. As in January 2015, Gulkana recorded the greatest positive deviation in precipitation for February 2015, with a total of 1.30”, 255% of the expected amount of 0.51”. Other stations with precipitation greater than normal were Barrow (221%), Kodiak (143%), and Fairbanks (114%). Again as in January, McGrath, with just 18% of normal, led the stations with lower-than-normal precipitation totals, which also included King Salmon (36%), Cold Bay (37%), Bettles (38%), and Homer (48%). Yakutat reported the maximum February precipitation total with 10.35”, while Kodiak reported the highest daily total of 2.32” on the 20th, a new daily record.

The trend for relatively light snowfall due to comparatively warm temperatures continued in February, with 13 of 15 stations reporting below normal amounts. The overall deviation from the normals was 54% of the expected amount. Mean snow depth was about 30% below normal. Anchorage reported the lowest amount at 1.1”, just 10% of its normal. Barrow again had the highest monthly deviation at 165% of its expected amount with a total of 4.3”. The highest one-day snowfall occurred at Kodiak on the 8th with 4.5”. St. Paul reported the highest monthly snowfall of 10.5”. Bettles reported the highest snow depth of 20” at the end of February.

Table 3 shows the total seasonal snowfall and deviations from the normal for the 15 first-order stations that measure snowfall. The overall seasonal deviation was -48%. All the stations, with the exception of Barrow, reported below normal values. There are two reasons for this:

- Below-normal precipitation was reported for most stations in Alaska over the winter.
- The warmer-than-normal temperatures caused a higher percentage of the precipitation to fall as rain instead of snow.

<table>
<thead>
<tr>
<th>Station</th>
<th>Seasonal Snowfall (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Anchorage</td>
<td>14.5</td>
</tr>
<tr>
<td>Annette</td>
<td>6.0</td>
</tr>
<tr>
<td>Barrow</td>
<td>11.9</td>
</tr>
<tr>
<td>Bethel</td>
<td>13.4</td>
</tr>
<tr>
<td>Bettles</td>
<td>37.9</td>
</tr>
<tr>
<td>Cold Bay</td>
<td>4.8</td>
</tr>
<tr>
<td>Fairbanks</td>
<td>23.8</td>
</tr>
<tr>
<td>Juneau</td>
<td>28.9</td>
</tr>
<tr>
<td>King Salmon</td>
<td>10.2</td>
</tr>
<tr>
<td>Kodiak</td>
<td>14.7</td>
</tr>
<tr>
<td>Kotzebue</td>
<td>9.7</td>
</tr>
<tr>
<td>McGrath</td>
<td>23.4</td>
</tr>
<tr>
<td>Nome</td>
<td>25.7</td>
</tr>
<tr>
<td>St. Paul Island</td>
<td>29.0</td>
</tr>
<tr>
<td>Yakutat</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Table 3. The total snowfall (in) and deviation in snowfall (%) from the 30-year normal (1981–2010) is presented for the winter 2014-15 season.
SEA ICE AND OCEAN TEMPERATURES: MARCH 2015

By John Walsh, Chief Scientist, International Arctic Research Center, UAF

The coverage of sea ice in the Bering Sea in early 2015 was well below average. The pattern of delayed freeze-up reported in the previous issue of the Alaska Climate Dispatch continued into the winter. The ice edge remained north of St. Matthew Island for only the second time in the past six years; 2014 was the other year with the ice edge north of St. Matthew Island (Figure 13). By contrast, sea ice in early February 2012 extended south of St. George and St. Paul Islands. Even in early March, when the maximum ice coverage is usually reached, this year’s ice cover was limited to loose ice (concentrations of 50–80%) in the northern Bering Sea (Figure 14).

The Bering Sea ice coverage is presently on track to be among the lowest, if not the lowest, in the entire period since regular satellite passive microwave coverage began in 1979 (Figure 15). The extremely low ice coverage is consistent with anomalously warm sea surface temperatures in the region. As shown in Figure 16 (page 14), the Bering Sea was on the northern fringe of a broad area of unusually warm water in the eastern Pacific Ocean. In addition, warm water in the equatorial Pacific was associated with an El Niño that arrived in March (see previous issue of the Climate Dispatch).

Figure 13, top. Extent of sea ice at the beginning of February 2015 (dark blue), 2014 (light blue), 2013 (pink), 2012 (orange), 2011 (green), and 2010 (pale green). Figure provided by Rebecca Heim, Alaska Ice Desk, Anchorage Forecast Office, National Weather Service.

Figure 14, above. Sea ice coverage, shown by concentrations (see color bar) on March 8, 2015. From Cryosphere Today (http://arctic.atmos.uiuc.edu/cryosphere/), University of Illinois.

Figure 15, left. Ice covered area (black line) and departure from average (red line) for the Bering Sea from January 1, 1979 through March 10, 2015. Source: Cryosphere Today (http://arctic.atmos.uiuc.edu/cryosphere/), University of Illinois.
Like the Bering Sea, the Sea of Okhotsk had a relatively sparse ice cover in March 2015 (Figure 14, page 13), considerably below its long-term average. The 2015 ice cover for the Arctic as a whole is also well below its long-term average. However, sea ice coverage was actually greater than its long-term average in the eastern Canadian waters (Baffin Bay, Labrador Sea, Gulf of St. Lawrence), consistent with the cold winter in eastern North America. Ice cover was well below average in the Barents Sea and slightly below average in the Greenland Sea.

Overall, the total ice coverage in early March was about 1 million km$^2$ (386,000 square miles) less than the mean for 1978–2000, or 10–15% less than the late 20$^{th}$-century average for this time of year. The only years since 1979 with comparable pan-Arctic sea ice coverage in early March were 2011, 2007, 2006, and 2005.