Alaska Climate Research Center
Geophysical Institute, University of Alaska

Annual Report for 2016 prepared for
The American Association of State Climatologist

The Alaska Climate Research Center (ACRC) is part of the Geophysical Institute, University of Alaska, Fairbanks. It was established by the State of Alaska via Title 14, Chapter 40, Section 085. Specific information can be found about this statute at http://www.legis.state.ak.us/basis/statutes.asp - 14.40.085. Funding support for the ACRC comes from the Geophysical Institute and from the State of Alaska.

Key Personnel:

Martin Stuefer, Director, ACRC, Associate Professor
Gerd Wendler, previous Director, ACRC, Professor Emeritus
Blake Moore, Programmer
Telayna Gordon, Research Technician
Chris Waigl, PhD Student

Purpose:

The purpose of the center is threefold:

- Dissemination of climatological data (free of charge)
- Research on climate variability and climate change in Alaska and Polar Regions, and
- Education

Dissemination:

For nearly three decades we have made climatological data available to the public, research organizations and interested industries. Today this is mostly accomplished via our website (http://akclimate.org/) which received in 2016 over 170,000 unique visitors. On a daily basis we receive on average close to 5000 visits. Analyzing by domain, “net” is the most frequent source of visitors, followed by "com" and “edu”. From the international realm Europe "eu" was most interested in our data, and by country, - Germany "de" and Russia "ru". Over the course of a year, winter is the busiest season, probably due to the fact that very cold temperatures (down to -40°F and colder) can occur paired with ice fog, which makes driving difficult, if not dangerous. There also exists a high pollution potential locally due to strong surface inversions. Furthermore, our webcam, which displays also the climate data in real time, is very popular (see photo).

The ACRC website contains many summaries, products, meteorological and climatological information. Furthermore, from our home page, users can select a number of links: Fairbanks weather and climate, our popular webcam and on-campus weather station, climatological data, up-to-date summaries, Alaska weather, information for tourists, seasonal and other weather and climate links, and a 'spotlight on climate' section giving a list of the latest features posted.

Specific request of data, normally received online, by telephone, and sometimes by walk-ins, are filled free of charge. It should be noted that we do not make predictions on future climate change, nor assess the socio-economic and biophysical impacts of such predicted climate projections. Our focus is on observations.

We publish monthly and annual reviews both for selected cities (Barrow, Fairbanks, Anchorage, Nome, King Salmon, Juneau, Ketchikan) as well as for Alaska as the State, the latter one based on the 19 first order stations of Alaska. Further, in conjunction with ACCAP (https://accap.uaf.edu/), we supply seasonal climate reviews.

Research:
A substantial number of journal and other publications on the climate of Alaska and Polar Regions have been produced over the years including a book on the Climate of Alaska, which was recently translated into Chinese. More recently we wrote a paper on the climate change of Sitka, the old capital of Alaska under Russia, for which station the records go back to 1827 (G. Wendler, K. Galloway, M. Stuefer 2015: On the Climate and Climate Change of Sitka, Southeast Alaska , ***Theor. Appl. Clim***.p.1-8), an open access journal. Springer, the publisher, congratulated us recently for 500 downloads of the article within a year.

Education:
We have been giving talks and seminars on the climate and observed climate change in Alaska and Polar Regions. We also provided educators and community groups with charts and data for use in educating their classes and communities, as well as answering a variety of queries from the community regarding issues such as the lake effect, Alaska's warming, and abnormal weather events in Alaska, etc.

2016 in Review:

Temperature

The temperature of Alaska for 2016 was a year for the record books. Based on the 19 First Order stations, and the time period since 1949, the five highest temperatures were observed in the following years:

Table A: Five highest mean annual temperatures for the First Order stations in Alaska since 1949.

Station	Mean Annual Temperature (°F)
2016	37.2°F
2014	35.7°F
2015	35.3°F
1993	35.0°F
1981	34.8°F

The temperature of 2016 was the warmest by a large margin, 1.5°F warmer than the previous record holder (2014). While 1.5°F is not a large deviation for a single station on a monthly basis, it is a very large value for an area as large as Alaska and for a whole year. This can be also deduced from the previous four maxima, which lie all within 1°F of each other. Furthermore, the three last consecutive years have been the warmest, most likely caused by the strong El Nino and global warming. In Figure 1 the temperature deviations from the normal are presented.

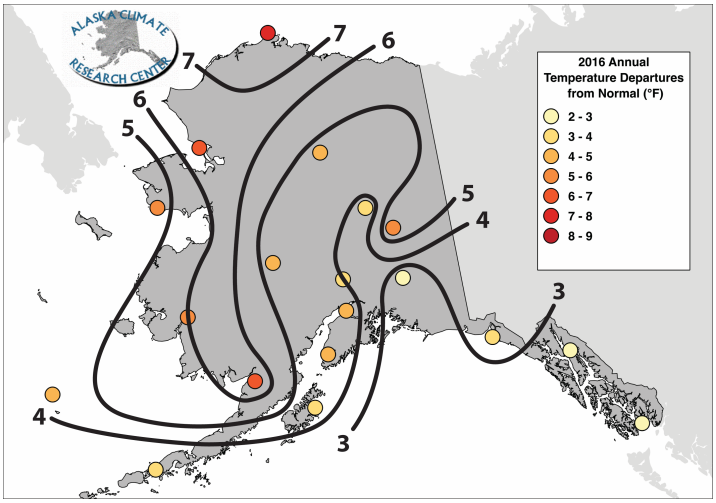

Figure 1: Isoplete presentation of the temperatures deviations from the normal (1981-2010) for 2016 based on the 19 First Order Alaskan meteorological stations.

Northern Alaska reported the highest deviation from normal with Barrow leading the way with an amazing annual deviation of 7.1°F. In general the figure shows that northwestern Alaska showed the highest deviation, while the deviation decreased substantially in the southeastern part. For the First Order stations, the temperature deviation from the annual normal was 4.6°F. All actual values are presented in Table B.

Table B: Mean temperature for 2016, normal temperature (1981-2010) and deviations from the mean for the 19 First Order meteorological stations in Alaska.

Station	Temperature		
	Observed (°F)	Normal (°F)	Delta (°F)
Anchorage	**41.4**	**37.1**	**4.3**
Annette	**49.3**	**46.6**	**2.7**
Barrow	**18.9**	**11.8**	**7.1**
Bethel	**36.7**	**30.7**	**6.0**
Bettles	**27.7**	**23.5**	**4.2**
Cold Bay	**42.5**	**38.8**	**3.7**
Delta Junction	**34.2**	**29.0**	**5.2**
Fairbanks	**31.6**	**27.7**	**3.9**
Gulkana	**30.9**	**28.2**	**2.7**
Homer	**43.4**	**38.7**	**4.7**
Juneau	**44.8**	**42.1**	**2.7**
King Salmon	**41.7**	**35.2**	**6.5**
Kodiak	**44.9**	**40.9**	**4.0**
Kotzebue	**29.7**	**22.9**	**6.8**
McGrath	**32.0**	**27.4**	**4.6**
Nome	**32.5**	**27.4**	**5.1**
St. Paul Island	**40.3**	**35.4**	**4.9**
Talkeetna	**40.0**	**36.0**	**4.0**
Yakutat	**44.0**	**40.3**	**3.7**
Mean	**37.2**	**32.6**	**4.6**

Looking at the annual course of the deviation by month (Figure 2), a strong decrease over the year can be observed. This might be explained by the weakening of the El Nino through 2017, which caused also the Pacific Decadal Oscillation (PDO) to become less positive. The PDO is related to the surface temperature of the Pacific Ocean between 20° and 60° North, and has a strong influence on the climate of Alaska (Mantua et al. 1997, Hartmann and Wendler 2005). While the mean temperature deviation in January exceeded the normal by 10°F, by December hardly any deviation could be observed. Hence, it is not expected that 2017 will be as warm as 2016.

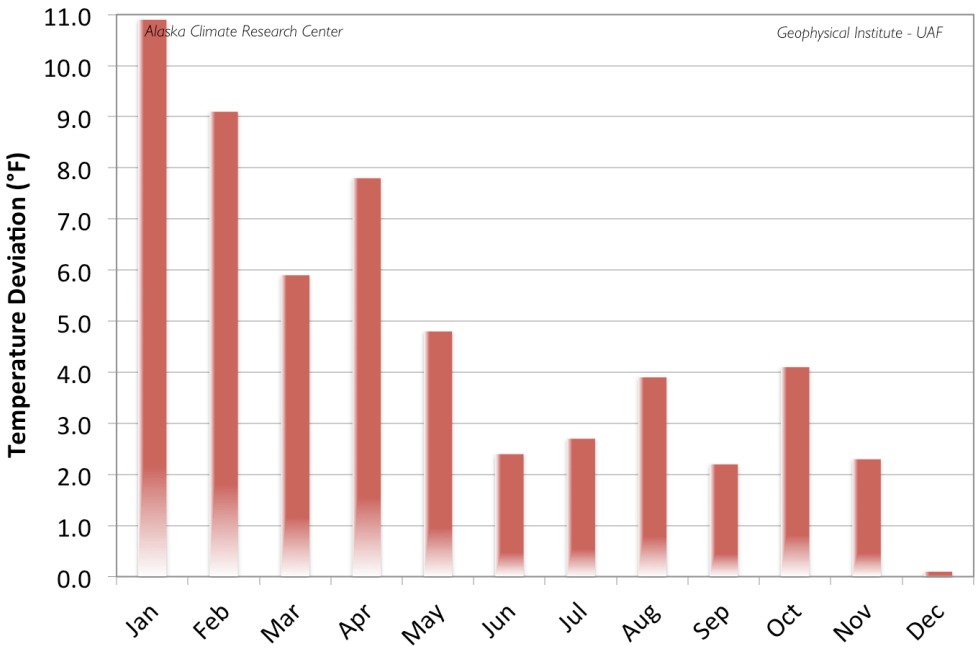

Figure 2: Mean monthly temperature deviation for the 19 First Order stations in Alaska by month for 2016.

Figure 3 shows stations, which reported new annual record high temperatures for the time period since 1949. Here we selected all stations, which reported for this time period.

The Washington Post published an article entitled *"Arctic Ocean getting warm, seals vanish and icebergs melt"*. This paper was not published in recent times, but on 2 November 1922. Looking at the long time temperature series for Barrow, the most northerly station in Alaska, for which good data are available the early 20th century, the last year was not the warmest but 1918 holds the record. In general,

the first decades of the 20th century were a warm period in Alaska (Wendler et al 2016).

A similar observation can be found for Fairbanks, which in the first half of the 20th century was the largest town in Alaska and has a temperature record exceeding a century (Wendler and Shulski 2008). While Fairbanks also observes a general warming trend, with large deviations from a linear trend, 1926 is still the warmest year ever observed.

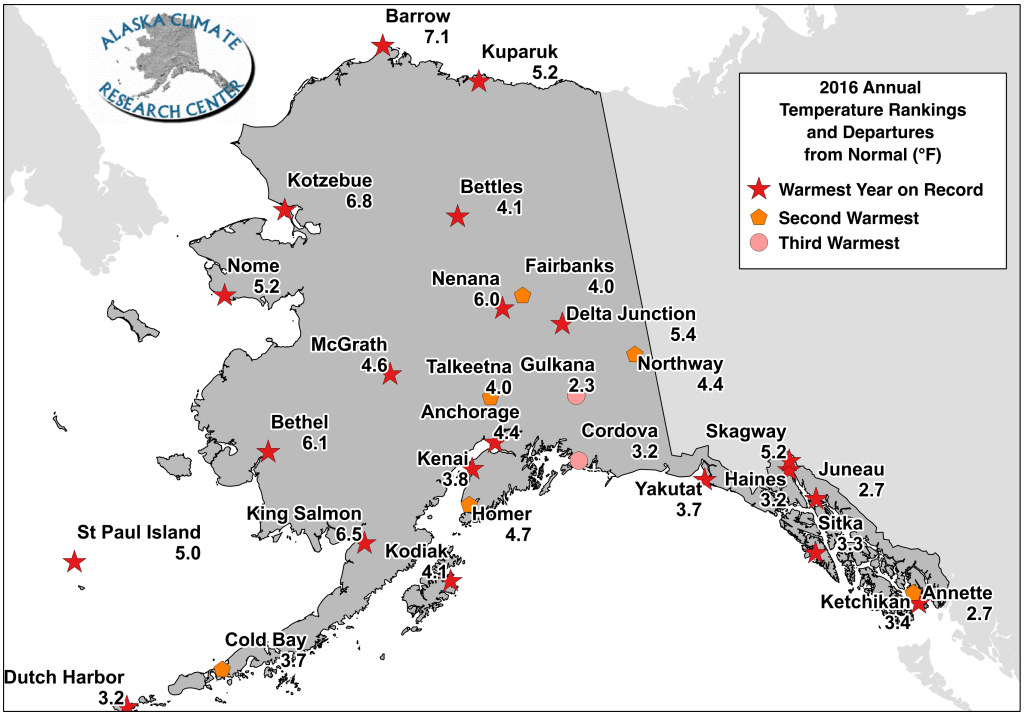

Figure 3: Map of the mean temperature rankings for selected stations in Alaska for 2016.

Precipitation

The mean annual precipitation of the 19 stations was 33.83", which is 4% below the long-term mean. As reported previously (Shulski and Wendler 2007), there is a very large variation in the precipitation totals, when traversing from the southeast to Arctic Alaska. For example, Yakutat reported for 2016 a total of 120.69", while Barrow in Northern Alaska, recorded a value of just 5.42" for the same time period. It is even more remarkable as Barrow for 2016 reported 20% above normal precipitation, while the value for Yakutat was 22% less than normal. This large gradient in precipitation explains the fact that the most glaciers are found in southern Alaska, with many calving in the ocean, while in the Brooks Range, in Northern Alaska, with much colder temperatures, glaciers are less common and

smaller in size. In Figure 4 the precipitation values are presented across Alaska, however, isolines are not provided, as large variations can occur over short distances especially in mountainous terrain and in the summer due to localized shower activities. The figure shows that most of Alaska is fairly close to normal in precipitation. Expressed in percentages, Fairbanks with 149% of normal recorded relatively the highest amount of precipitation, while Yakutat reported relatively the lowest amount with 78% of normal.

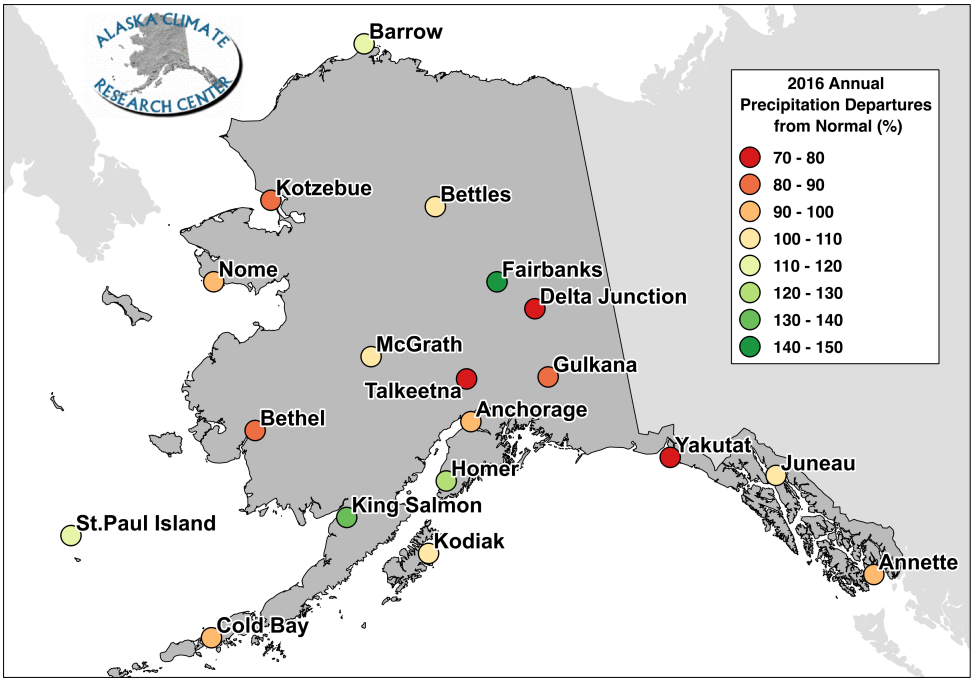

Figure 4: Precipitation deviations (%) from the normal (1981-2010) for 2016 based on all twenty First Order stations in Alaska.

In Figure 5 the monthly deviations are presented. Three months reported below normal precipitation with October leading with -45%, followed by November (-29%) and January (-22%). Three months (April, May and August) were close to normal with deviations of less than 4% in either direction. September was much too wet with a value of 27% above normal, followed by March, June, July, December and February in declining order.

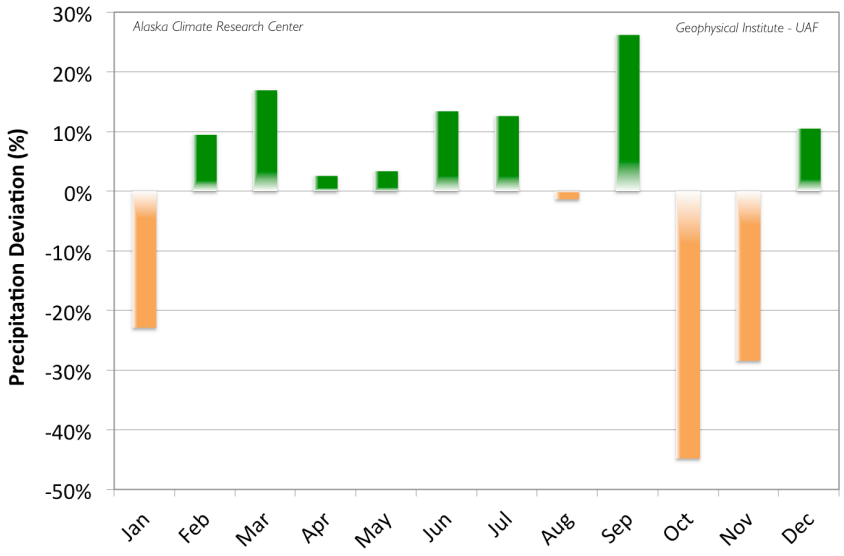

Figure 5: Precipitation deviation for the mean of the 19 First Order stations in Alaska by month for 2016.

Snowfall

It should be pointed out, that only 15 of the 19 First Order Stations measure snowfall, while Delta Junction, Gulkana, Homer and Talkeetna, do not report snowfall amounts. Over all, snowfall was about half of the expected amount. The deviations from normal are presented Figure 6.

As 2016 was the warmest year on record, a larger percentage of the precipitation falls as rain and not as snow. Nevertheless, the deviations from normal are astounding, especially in Southern Alaska, where the temperature even in winter can be above or close to the freezing point. Kodiak (15%) Annette (17%) and Yakutat (21%) of normal are the stations with the relatively lowest snowfall amount.

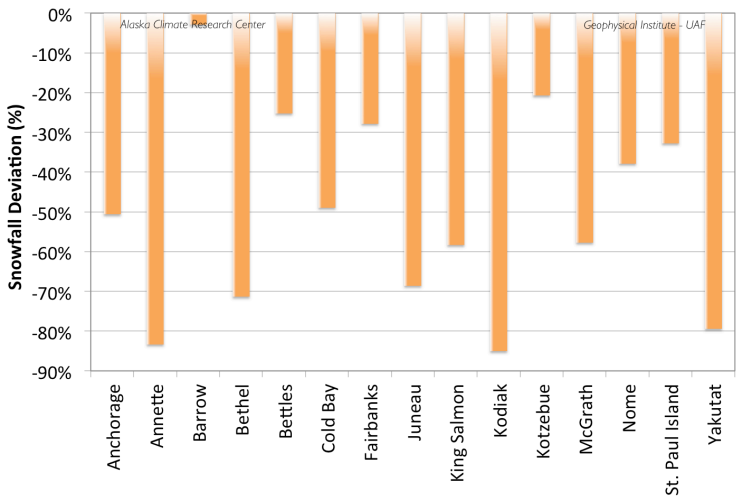

Figure 6: Mean annual snowfall deviations for fifteen of the First Order stations in Alaska for 2016.

Forest Fires

There were 558 wildfires observed, which burned 500,095 acres in Alaska in summer 2016. The 2016 fire activity was relatively small due tot he predominantly

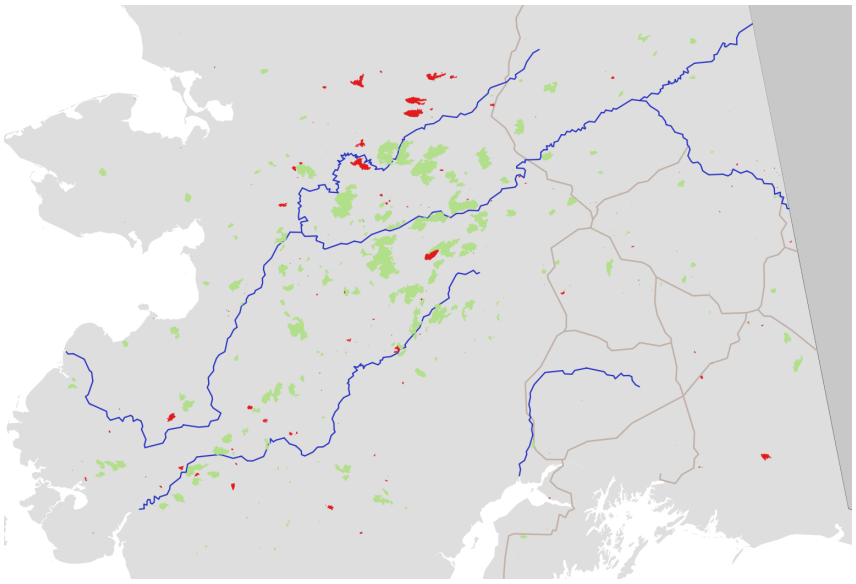

Figure 7: Area burned by wildfires in Alaska for 2016 (red) and 2015 (green). Note that most of the area burned occurred in the interior, specifically in then middle Yukon Flats, and comprising mostly of boreal forest. Data courtesy of the Alaska Interagency Coordination Center.

wet conditions during the summer. The average Alaska fire season accounts for about 500 fires and approximately 1 million acres burned. Figure 7 shows fire perimeter, and relates the fire activity tot he previous year 2015 for reference.

For more exhaustive monthly statewide summaries as well as some select station summaries, including more detail on record events, please visit the ACRC website at: http://akclimate.org. For seasonal values visit ACCAP's website for the Alaska's Climate Dispatch at: http://ine.uaf.edu/accap/. In addition, the papers referenced below can be accessed from the ACRC's website at: http://akclimate.org.

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This information consists of preliminary 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 474-7885 or visit the center web site at http://akclimate.org. Please report any errors to webmaster@akclimate.org.