COMMUNICATING ALASKA CLIMATE INFORMATION via SOCIAL MEDIA

A NON-AGENCY EXPERIENCE

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Where do people receive their weather and climate information? Television, newspapers, and radio are our traditional media sources, but beginning in the late 1990s, the Internet became a go-to source of weather and climate information. As the Internet became more accessible to the average person, weather and climate information became more accessible to the general public. The days of waiting until the evening newscast are long gone. Traditional media, which provide value-added weather and climate information by applying local knowledge and context to publically financed weather and climate products (e.g., NOAA), saw their influence wane with the rise of the Internet. This article will describe my experience with and observations about communicating Alaska climate information to the general public using social media, in a way that is not systematic but all about sharing my fascination with these science topics.

A BRIEF HISTORY

In the last five years, social media has emerged as a new medium for obtaining weather and climate information. Most people are familiar with Facebook as a way to connect with friends and family, and many also understand that they can follow celebrities, media, athletes, musicians, government agencies, and anyone else who has a public Facebook Page set up. The sky really is the limit.

When an interesting weather or climate phenomenon occurs, the Alaska NWS (or some other agency) will post an infographic on the event. This post will be seen by the 50,000+ followers of the Alaska NWS Facebook Page. Any of those 50,000+ followers can comment, share, or Like the post – which makes it appear on the feed of anyone connected to those people that interacted with the post even if they do not follow the Alaska NWS Page.
DIFFERENT MISSIONS

The National Weather Service has a very specific mission: to “Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.” NWS social media posts are heavily weighted toward providing information that enables various institutions and the general public to make decisions regarding safety, such as warnings about flood safety, marine safety, etc. This directly supports the NWS core mission. Beyond the safety-related social media posts, they also issue statements on record temperatures, climate outlooks, interesting phenomena, and so on. If you are not connected to NWS and other NOAA Facebook/Twitter pages, I highly encourage you to do so.

For the last four years, I have maintained a Facebook page called Alaska Climate Info (https://www.facebook.com/AlaskaClimateFacts/). The idea behind the Page was to provide random information about weather and climate topics in Alaska that I find interesting. Since I do not have any affiliation with an official weather or climate agency, there are no mission statements that guide my posts’ content; therefore, anything goes.

FACEBOOK VS. TWITTER VS. INSTAGRAM

Currently Facebook is the most frequently used social media platform, but other sites abound, such as Twitter and Instagram. Twitter is a micro-blogging site where users post short pieces of information (including graphics) in 140 characters or less. Twitter’s immediacy is favored by news outlets for quick dissemination of information. Instagram is primarily a photo-sharing medium. While Instagram is frequently used by younger social media users, it is not widely used for transmitting weather and climate information.

The rest of this article is a first person account of my experience posting about Alaska climate and related topics.

THE AUDIENCE

As a climatologist, I have a tendency to think that everyone finds climate minutiae fascinating, but I’ve learned that is not always the case. Since public Facebook Pages are visible to any of the 1.7 billion+ users worldwide, any one of them may decide to Like (follow) my Page. As of this writing, the Alaska Climate Info Facebook Page has nearly 9,000 followers. The Page is followed by most major Alaska newspapers (Alaska Dispatch News, Fairbanks Newsminer, Juneau Empire, and others) and television stations (KTUU, KTVA, and others), but the typical follower is a weather and climate enthusiast from the general public. Approximately 90% of the followers are from within the United States and nearly that same percentage are English speakers based on summary statistics provided by Facebook. City and state information are less complete, but nearly 90% of the followers that list a city in their profile are from Alaska. Assuming the statistics are correct, approximately 1.5% of Alaskan adults follow my Facebook Page.

In contrast, my approximately 2,000 Twitter followers are mostly media individuals or organizations from outside of Alaska. Around 25% of my followers are everyday weather and climate enthusiasts. Because of the media heavy presence among my Twitter followers, a Twitter post is far more likely to “go viral” or generate interest outside of Alaska. This disparity between Facebook and Twitter is not unique to my pages; Facebook tends to be more of a casual and personal information platform, whereas Twitter is more of a breaking news platform. As such, Facebook posts have a longer shelf life (hours to days) while Twitter posts are generally relevant for no more than a few hours and usually less than 60 minutes. Because of the news focus of Twitter, my posts are often a reflection of very short-term conditions and fall more into the weather category versus the climate category. Therefore, the rest of this article will focus on the Facebook interactions.

WHAT DO PEOPLE LIKE TO READ ABOUT?

Since the inception of my Page, I’ve uploaded over 2,000 posts. Based on the number of Likes, shares, comments, and post views (also known as Reach), I’ve developed a profile of user interest. It is worth noting in this discussion that I consider the Page to be a science portal and not an entertainment venue, and therefore that it is not my goal to gain the maximum number of followers. There is no advertising revenue, no content sharing agreements, and no incentive for me to generate clicks. These are the categories I’ve identified as garnering the most interest among my followers:

- Different Missions
- The Audience
- What do people like to read about?

Alaska Climate Info: http://www.facebook.com/AlaskaClimateFacts
Sometimes it helps to not take yourself too seriously. Posting a simple graphic or map with non-controversial, entertaining material has proven to be a successful recipe for a hit post. Several people have asked me over the years if the upcoming spring/summer was going to be bad for mosquitoes. That is a difficult question to answer empirically, but since everywhere in Alaska has a lot of mosquitoes, it seemed like a good opportunity to have some fun with it. Figure 3 shows a make believe seasonal mosquito forecast. While the content is entirely made up, it does introduce the concept of seasonal forecasting to people who may not know that such products exist.

In Anchorage, whenever there is a big windstorm in the fall, the newspapers and television stations invariably show pictures or video of backyard trampolines that have blown away and become mangled around a light post or utility pole. When the Anchorage NWS Office decided to upgrade a High Wind Watch to a High Wind Warning on September 20th, I thought it would be engaging to have the Watch upgraded instead to a Trampoline Warning, using a stock photo of a trampoline stuck in some power lines (see Figure 4). A browse of the comments indicated that many people actually heeded my warning to tie down or disassemble their trampolines.
One of the most dangerous winter weather conditions is rain or melting snow that freezes to roadways. Last winter, wet snow fell on a frozen road surface in Anchorage and was immediately followed by a Chinook event, which melted the snow. Since the road surface was below freezing, the melted snow froze to the road. I decided to strap on my ice skates and skate around the neighborhood. The video I posted was viewed 675,000 times and the post Reach was over 1.5 million. Media outlets all over the country shared the video. Hopefully the video played a small role in discouraging a few people from trying to drive on the ice.

These types of humorous and irreverent posts are not very science-worthy, yet they provide an opportunity for people who otherwise might not be interested in the climate of Alaska to tune into the Page and learn a few things they might never be exposed to otherwise.

2. PICTURES

Digital cameras are ubiquitous in today’s society. If something photogenic or noteworthy occurs, there is likely to be a camera nearby. As an early adopter of digital technology, and as an outdoor enthusiast, I am always taking pictures of snow, flowers, mountains, sunsets, aurora, and anything else that seems interesting. Alaska-themed photos uniformly receive enthusiastic responses. Figures 6, 7, and 8 are examples of well-received photo posts that highlight some aspect of the climate of Alaska.
Like many of you, I live for the science. While the humorous posts and Alaska photographs may bring in new Page followers, I particularly enjoy relaying everyday scientific information to the public, whether it is El Niño effects in Alaska, the movement of sea ice, or an especially favorite topic of mine, daylight.

Alaskans are particularly in tune with the amount of daylight at various times of years. It is something that people in the Lower 48 cannot easily relate to. Whenever I post about daylight hours, the post engagement is very high. Figure 9 is an example of a GIS model of daylight on the winter solstice in Fairbanks and Anchorage. Another example is the hours of daylight on the summer solstice (Figure 10).

One of the reasons that there are so many armchair meteorologists and climatologists is that everyone can look outside and make their own weather and climate observations. In springtime, anyone looking out their window can easily observe the rapid green up of birch trees across the southern mainland and interior portions of the state. People want context for their own observations. Figure 11 is a good example of an annual event (green up) for which people are keenly interested in the background climatology, and I think interest in this type of data is growing due to Alaskans’ experiences with climate change and its impacts to their local environment. The record early green up of 2016 is consistent with that experience.

4. FIRSTS, STREAKS, RECORDS, AND EXTREMES

Everyone can relate to record conditions. The bonds between people are strengthened when they share similar experiences, particularly extreme events that make for easy conversation. In the
climate & social media

world of weather and climate, that can be a record temperature or precipitation event, an extended spell of climate futility, or some unusual situation that will be long remembered.

This next example combines two popular themes. Figure 12 shows extreme conditions (extensive Red Flag warnings due to high fire danger) and adds a dose of Alaskan’s pride in being the largest state by overlaying Texas on the Great Land.

Many stories were written about the unending warmth of 2016. Through the first 100 days of the year, several places in Alaska were above normal every day. The table shown in Figure 13 provided a difference perspective on the warmth. Instead of a raw number of degrees above normal, the table showed the number of
days above normal. This perspective added a layer of depth to the more familiar warmth statistics that people strongly related to.

All-time records make for all-time favorite posts. A station, region, or an entire state does not set an all-time record very often, so when they occur, people are intensely interested. The post in Figure 14 noted the record high temperature observed at the Deadhorse airport in July 2016. The high temperature that day at Deadhorse and Kuparuk set a record for any Alaska station within 50 miles of the Arctic Ocean north of the Brooks Range. The post was shared by over 1,000 people on Facebook and retweeted over 700 times on Twitter.

Since global warming is a subject with broad public interest inside and outside of Alaska, many national media outlets shared my Twitter post. Within an hour, the Twitter post accumulated over 150,000 views. Within a day, the total number of views stood at 170,000. The Facebook post received a similar number of views, but they were spread out over a several day long period. This highlights the breaking news aspect of Twitter versus the gentler flow of information through Facebook.

5. MAPS

Given the choice, people are far more likely to respond to a map instead of a table or chart. While map posts do not often generate a lot of Likes, shares, and comments, they are the posts that I feel are the most informative. The saying “a picture is worth a thousand words” can be restated as “a map is worth a thousand words.”

Over the last few years I have posted hundreds of maps showing normal, observed, record, and historical temperatures and precipitation. In many cases, the feedback is minimal, yet the people who do engage with the posts often provide detailed descriptions of their recollection of these events and how it affected them. In Figure 15, the global stations that have ever observed a temperature of -70°F are shown. In Figure 16, the climatological probability of a white Christmas is depicted. In both cases, traditional station data is graphically depicted to answer a question that I was always curious about or to highlight Alaska in a way that has not been shown before.

CONCLUSION

The Facebook Page that I run has provided valuable insight into the type of weather and climate musings that the general public in Alaska find interesting and useful. Since I do not have a mandate to provide timely information for public safety purposes (thank you NWS for serving this function!), there is unlimited freedom to post anything that pops into my head.

The aforementioned examples describe topics that the public finds engaging. At the other end of the spectrum, the public is decidedly less interested in some themes and methods of presentation.
Here are a few of my observations of posts that are less engaging to the public:

- Posts that are overly technical or overly academic generally fall flat – very flat.
- Charts/graphs don’t do well unless they are carefully produced in Photoshop.
- Long, wordy posts are often skipped over.
- Posts about off-the-road-network places do not do well.

The temptation to gear the posts toward the best performing categories is tempting; however, I try to stay true to my own interests. It’s okay to have a low engagement post about a small town in Southeast Alaska if a pretty interesting climate event is happening there. Similarly, if posts become all humorous and irreverent, then it becomes an entertainment Page and not a science Page. Hopefully the Page is useful as a template for others who wish to communicate Alaska-based science information, or climate and weather information in other regions.

During the last several years, many people have told me that information that they saw on the Page helped them to better understand the state of, and the issues involved, in Alaska climatology. I receive e-mails and direct messages all the time from people asking if they can use the materials in lesson plans, reports, manuscripts, newspapers, blogs, websites, and even on television. As a scientist, I want to better understand the world. As an educator, I want all people to have a better understanding of the world. Hopefully the Page makes a small contribution to that goal.”

It is important to note that various people within NOAA, the State of Alaska, the University of Alaska, and members of the general public, send me bits of information that are seeds for many of the posts. I am always appreciative of the assistance and relish the opportunities for collaboration. Alaska is a big place, but it is also a small community of people. No one person can effectively summarize the day-to-day climate activities in Alaska.
SUMMER AND FALL 2016: WEATHER CONDITIONS IN ALASKA

by Rick Thoman, National Weather Service

JUNE
June was the ninth month in a row to be warmer than average across Alaska, with the National Centers for Environmental Information (NCEI) ranking this as the ninth warmest June since 1925. The warmth was most pronounced in southern Alaska, with St. Paul Island having the second warmest June, with an average temperature for the month of 47.0°F. For the first time of record, St. Paul had back-to-back June days with highs in the 60s on June 26 and 27. Both King Salmon and Anchorage had their third warmest Junes. At Anchorage, the only warmer June months were in 2013 and 2015.

As is usual for early summer, rainfall was highly variable. Fairbanks recorded more than double the normal rainfall for the month, enough for 2016 to rank as the fourth wettest June in the past 110 years. In contrast, parts of the eastern Interior saw well below average rainfall. Anchorage had 170% of normal rainfall with some urban flooding on June 6, while Kodiak received just 59% of normal. Low elevation snowfall was confined to the North Slope coast. At Barrow, total June snowfall of 2.7” made this the snowiest June since 1981, while Colville Village, north of Nuiqsut reported 3.3” for the month.

JULY
Unusual warmth prevailed over Alaska in July, with the NCEI ranking this as the fourth warmest July statewide in the past 92 years. The warmth was most extreme over southern Alaska: Anchorage and Kenai both recorded not only the warmest July of record but also the warmest calendar month. Anchorage, with a monthly average temperature of 62.7°F just edged out July 1977 (62.5°F) as warmest month. Kenai Airport reported a monthly average temperature of 59.0°F exceeding July 2004’s 58.8°F average.
as warmest month. Both Homer (57.9°F) and Sitka (59.6°F) also reported the warmest July of record, and most other long-term climate stations in Southcentral and Southwest Alaska had a top five warmest July. The only notable spell of hot weather occurred at mid-month, with widespread high temperatures mid to upper 80s over Interior Alaska. Most notable was the warmth in the Prudhoe Bay region on the North Slope. July 13 and 14, 2016 were hottest days on record in this area. High temperatures over these days included 86°F at Kuparuk and 85°F at Deadhorse Airport, both locations within ten miles of the Beaufort Sea coast (see Figure 14).

In parts of the central Interior, the big story for July was rain. Fairbanks Airport received 240% of normal rainfall, fourth greatest July total of record. Though amounts were considerably higher north and east of the city. Eielson Air Force Base received a remarkable 7.60” of rain, the wettest month in nearly 70 years of records, even exceeding the historically wettest month of August 1967. Much higher amounts of rain fell in the uplands, but because the rain was spread over many days, there was only minor flooding. Repeated activation of the Moose Creek flood control project near North Pole meant high water for much of the month on the Chena River. In Denali National Park, the western end of the park was incredibly wet, with the Wonder Lake Ranger Station measuring 10.11” of rain. Eielson Visitor Center, at 3700’ elevation, received an astonishing 16.24” of rain. After a wet June as well, there were several mudslides that temporarily closed the Park road (see Figure 18). The most significant occurred just west of Eielson Visitor Center on July 30. More than 100 people west of the slide were stranded for more than two days, and it took two weeks to completely clear the debris and reopen the road to normal traffic.

AUGUST

August was exceptionally warm over a large portion of Alaska. Following on the heels of the fourth warmest July, NCEI ranked this as the third warmest August in the past 92 years. Several coastal communities experienced not only the warmest August but also the warmest calendar month of record, including Annette (63.6°F), Homer (58.3°F), Cold Bay (56.5°F) and St. Paul (52.9°F). Other locations reporting the warmest August of record included Kodiak (58.9°F) and King Salmon (59.5°F). Anchorage had the second warmest August, Fairbanks the third warmest and Juneau fourth warmest for each of their respective records. Perhaps the most outstanding event of the month was very warm weather over much of southern and western Alaska during the last week of the month. Strong high pressure aloft allowed for maximum sunshine in most areas, and as a result many long-term climate observation locations recorded the highest temperatures of record so late in the summer. These included Barrow (64°F), Cordova (80°F), Homer (75°F) and Yakutat (78°F) on August 27, Anchorage (77°F) and Kenai (76°F) on August 28, Kodiak (78°F) on August 29, and King Salmon (77°F) and Nome (72°F) on August 31.

Much of Southcentral Alaska was unusually wet in August. Anchorage Airport received 5.45” of rainfall, which was 168% of normal rainfall (3.25”), and therefore the fourth highest August total. The Cordova area was especially soggy; the Cordova Airport received 21.21” of rain during the month, the second highest August total of record there. Cordova City has a wetter climate than the airport due to different terrain, as reflected in the 39.55” of rain at the Waste Water Treatment Plant. The August rain, combined with the rain in the Alaska Range in July, produced minor flooding on low-lying areas along the Yenta River several days during the month (see Figure 17). The Taiya River near Skagway also briefly reached minor flood stage during August.

SEPTEMBER

September was not as extreme climate-wise in Alaska as the earlier months of 2016, though there were several notable
storms that affected parts of the state. For the state as a whole, the average temperature was 1.6 degrees above the 20th century average, ranking as the 27th warmest September in the past 92 years. The North Slope and parts of the Interior saw temperatures close to normal, while the Aleutians and western Gulf of Alaska coasts remained at near record warm levels due in large part to continued far above normal sea surface temperatures in the Bering Sea and northeast Pacific. Record monthly warmth occurred again in the Bering Sea region. Cold Bay recorded an average temperature in September of 51.2°F, and at St. Paul the monthly average was 49.9°F. For both of these locations the previous warmest September occurred in 2014.

Bettles, in the north central Interior, received 5.34” of rain (and a little melted snow), easily the greatest September precipitation of record in the Bettles area. In sharp contrast to September 2015, there was little low elevation snow in September, with only Bettles and Barrow reporting more than an inch for the month. Two significant storms affected Southcentral Alaska during the month. Heavy rain on September 11 and 12 over the southern Kenai Peninsula brought the Resurrection River in Seward nearly to flood stage. Seward Airport recorded 4.15” of rain on September 12. The same storm caused high winds and widespread power outages over in the Anchorage and Palmer areas. Ten days later, a strong, fast-moving storm brought heavy rains. September 21 and 22 brought high winds to the Anchorage area, with gusts up to 90 mph on the upper hillside, with some damage reported, and widespread—though—short-lived power outages. Several cargo flights were diverted from Anchorage to Fairbanks due to low-level wind shear. This second storm also produced brought heavy rains to areas around Prince William Sound and the eastern Kenai Peninsula. The Seward airport measured 4.65” of rain in 24 hours, with flooding on Bear Creek and water over the runway at the Seward airport. At the Portage Glacier Visitor Center near Whittier, a stunning 9.06” of rain fell on September 21.

OCTOBER
Temperatures relative to average varied sharply across the state. Western and northern Alaska were exceptionally warm, while parts of the Panhandle and the southeast mainland were cooler than normal. Overall, NCEI ranked 2016 as the 18th warmest October since 1925. Barrow had a monthly average temperature of 30.1°F, almost 13° warmer than normal and by far the warmest October of record. Kotzebue (35.3°F), Nome (37.7°F)
and St. Paul (44.8°F) were all the warmest of record. In addition to the warmest October average temperature, Barrow also observed the highest daily temperature of record for the month, when the temperature reached 44°F on October 10. In contrast, the Southeast mainland and much of Panhandle were colder than normal, thanks in large part to unusually clear skies that allowed for much lower nighttime temperatures than is typical. At Gulkana, this was the fifth coldest October of record, while at Juneau this was the second coolest October in the past 20 years.

The highlight of October over Alaska was the exceptionally dry conditions that occurred over a large portion of the state. Every long term climate site along the eastern Gulf of Alaska coast and the Panhandle had either the driest or second driest October of record. Among locations that had the driest Octobers included Yakutat (14% of normal), Cordova (16%), Juneau (30%), Sitka (37%) and Ketchikan (38%). The dryness extended into mainland Alaska, with some places in the Interior recording almost no precipitation at all. Northway had a monthly total of just 0.01” and Fairbanks 0.02”. At Northway this was the driest October of record, at Fairbanks, the driest in more than a century. For Alaska as a whole, the NCEI ranked this as the driest October of record (since 1925).

Snowfall of course was very low in areas that received almost no precipitation. At Fairbanks, just 0.8” of snow fell in October, the lowest amount in 90 years. This was the first Halloween without measurable snow on the ground in more than 50 years. Ironically, while Southeast was exceptionally dry on October 16–17th, parts of the central and northern Panhandle had one of the largest early autumn snowfalls of record. At the Juneau Airport, 5.1” of snow fell on the 16th, which was the greatest calendar day of snow so early in the season. In Haines, there was 11” of snow, and 19” at the Customs Station on the Haines Highway. There was also a little snow at low elevations in Southcentral around mid-month. Seward reported 3” of snow on October 17 and Cordova 2” on October 16. Anchorage Airport received 2.6” on the 20-21st, with up to 7” accumulation on the east side of Anchorage. The month wrapped up with a strong Bering Sea storm. On the 29th in the Aleutians, winds gusted to 98 mph at Unalaska and 91 mph at Adak. In the northern Bering Sea, the same storm produced roof damage at Nome and Gambell.
Arctic sea ice reached its minimum extent for 2016 on September 10, when the extent dropped to 4.14 million square kilometers. This minimum was second only to 2012, when the September minimum fell to slightly below 3.5 million square kilometers (Figure 21). The 2016 minimum was essentially the same as 2007’s 4.15 million square kilometers. The 2016 minimum on September 10 was followed by cold temperatures and freeze-up over the next two weeks, so the average ice extent for the month of September was 4.72 million square kilometers, the fifth-lowest September average since the beginning of the satellite records in 1979. In each of the past 10 years (2007-2016), the September average ice extent has been lower than in any year prior to 2007. In other words, every single year of the past ten would have been a new record minimum if it had occurred immediately after 2006.

The previous issue of the Alaska Climate Dispatch presented the Sea Ice Prediction Network’s September outlook, based on information available at the end of May (https://www.arcus.org/sipn/sea-ice-outlook/2016/june). The outlook was a compilation of 30 different predictions, which ranged from 3.4 to 5.2 million square kilometers, with a median value of 4.28 million square kilometers. Based on the actual September coverage of 4.72 million square kilometers, the median prediction was too low by about 0.44 million square kilometers (-8.8%). However, the median forecast was quite close to the 2016 minimum of 4.15 million square kilometers.

After about two weeks of rapid growth in late September, the rate of expansion of the Arctic sea ice cover was unusually slow during October (Figure 21). This slow expansion resulted in a record-low average ice extent for the month of October (Figure 22). Expressed as a percentage departure from the mean for 1981-2010, the October ice extent was about 30% (or 2.67 million square kilometers) below the old normal. The October 2016 anomaly easily surpassed the previous record, which was set in 2007.

The geographical distribution of the October ice extent and the departures from normal October ice concentrations are shown in Figure 23. The largest departures from normal ice extent and concentration were in the Beaufort, Chukchi and East Siberian Seas. North of Alaska, for example, the ice edge was several hundred miles north of its normal (1981-2010) position. Most of

Figure 21. Seasonal evolution of pan-Arctic sea ice extent during the years of 2016 (blue line) and the previous four summers. Black line is the 1981-2010 average, and gray shading is the two-standard deviation range for that period. Source: National Snow and Ice Data Center.

Figure 22. October ice extent as a departure (%) from the mean for 1980-2010. Dashed line is a linear regression showing a decrease of -7.4% per decade. Source: National Snow and Ice Data Center.

Figure 23 (left). October 2016 ice coverage in the Arctic. Left panel shows October 2016 ice extent (white), with the 1980-2010 average extent for October shown by the purple lines. Right panel shows departures from mean (1981-2010) ice concentrations, with blue shades denoting below-normal concentrations. Source: National Snow and Ice Data Center.
the Beaufort and Chukchi Seas had ice concentration anomalies of -100% (Figure 23, right panel), consistent with the northward position of the ice edge. Other large areas of ice concentration anomalies of -90% to -100% can be seen north of the Barents Sea, in the Kara-Barents Seas, and in the Greenland Sea.

In the blue areas of Figure 23 (right panel), the atmosphere was underlain by open ocean rather than the usual sea ice cover. The open ocean, with its water temperatures above freezing, is a source of heat that would not be available to the atmosphere if sea ice were present. This heat source results in warmer-than-normal air temperatures, which are strikingly apparent in the surface air temperatures for October 2016. Figure S4 shows these temperatures, plotted as departures (°C) from the corresponding averages for the month of October. In the orange and red areas, the air was warmer than normal by more than 6°C (about 11°F). Several hundred miles offshore of the northern Alaskan coast, the departures from normal exceeded an amazing 12°C (21.6°F). The largest departures from normal temperature in (orange/red areas in Figure 24) coincide almost exactly with the areas of “missing” sea ice, indicated by the blue areas in Figure 23 (right panel): the Beaufort/Chukchi/East Siberian Seas, the region north of the Barents/Kara Seas, and the Greenland Sea. The combination of Figures 23 and 24 represent the albedo-temperature feedback in action, because the heat stored in the anomalously ice-free ocean areas during summer is released to the atmosphere in autumn, warming the air and delaying the freeze-up of the ocean as autumn evolves into winter. The warmth driven by the absence of ice also extends to adjacent land areas, including Barrow, Alaska, where the past decade has seen an unprecedented string of warm Octobers – all in the warmest third of Barrow’s historical distribution of October temperatures. This decade of warm Octobers coincides with the reduction of ice cover highlighted in Figures 22 and 23.

As a result of the delayed freeze-up of the offshore waters, much of the northern Alaskan coast developed near-shore ice cover locally while there was still considerable open water farther offshore. Figure 25 shows the ice coverage on November 7, 2016. Nearshore ice had formed by this date along the coastline from the Canadian border to nearly Cape Lisburne, and also along northern portions of Kotzebue Sound and Norton Sound. This pattern of simultaneous ice expansion outward from the coast and southward from the main ice pack has characterized the autumn/early-winter freeze-up seasons in Alaskan waters during recent years. In decades prior to the 1990s, the much smaller summer ice retreat offshore of the northern coast of Alaska allowed for a rapid return of the main pack to the coast without the window of growth for coastal sea ice.
NEW ANALYSIS SUGGESTS CLIMATE CHANGE INCREASED LIKELIHOOD OF EXTREME FIRE SEASON OF 2015

by Alison York, Program Coordinator, Alaska Fire Science Consortium, UAF

The two largest fire seasons in Alaska on record, 2004 (6.2 million acres burned) and 2015 (5.1 million acres), were very different. 2004 burned significant acreage in July and again in August during extended warm and dry late summer weather, while 2015 saw the bulk of fire activity (4.79 million acres) concentrated from mid-June to mid-July, when exceptionally warm and dry weather created very burnable fuel conditions and a remarkably compressed season (Figure 26).

The NOAA Regional Climate Services Director for the Alaska Region, James Partain, along with the Alaska Center for Climate Assessment and Policy (ACCAP) RISA team and the Alaska Fire Science Consortium, assembled a collaborative team of university, NOAA/NWS, and Predictive Services personnel to investigate whether the extreme 2015 Alaska fire season could be scientifically attributed to climate change—that is, has climate change increased the likelihood of conditions as extreme as those seen in 2015? As the assessment metric, the team used the Build Up Index (BUI), a management-relevant fire danger index based on daily temperature, relative humidity, and precipitation. BUI reflects fuel availability and flammability. The analysis concluded that fuel conditions reached a level in 2015 that is 34-60% more likely to occur in today’s changed climate than in the past. This is consistent with recent studies in California, the western U.S., Canada, and Alaska that used different approaches to reach similar conclusions.

The resulting peer-reviewed paper was published in the Bulletin of the American Meteorological Society (BAMS) special report on Explaining Extreme Events of 2015 from a Climate Perspective and released at a press conference at the American Geophysical Union Fall Meeting.

Partain et al. 2016. An assessment of the role of anthropogenic climate change in the Alaska fire season of 2015. DOI:10.1175/BAMS-D-16-0149.1


Figure 26. Averaged daily cumulative acres burned for specific high-fire years compared to the climatological 25th and 75th percentile (1994–2015) levels. The other above-75th percentile years of 1997 and 2002 are not shown for clarity because they lie close to the 75th percentile. Source: Figure 3.1.b in BAMS article by Partain et al.
“Collectively, Alaska’s glaciers are shrinking rapidly today. Long-term records from Wolverine and Gulkana glaciers show that summer warming has resulted in sustained mass loss. These changes are evident in both field and in airborne and space-borne data. Alaska's glaciers are important contributors to sea level rise, and also influence coastal ecosystems through the water that they store and release,” said Dr. Shad O’Neel, head of the Glacier Research Program at the USGS Alaska Science Center.

Since the 1990s, the retreat of glaciers in Alaska has made a disproportionally large contribution to global sea level rise. In total, Alaska glaciers are losing 75 billion tons of ice annually, the equivalent of releasing 150,000 Yankee Stadiums full of water each year. Although the development of regional estimates is relatively new, the detailed and long-term records at the benchmark glaciers reveal an increasing rate of change through the past 50 years.

“These records are a testament to the hard work of many individuals and an early vision by USGS on the importance of glaciers in the landscape,” said Daniel McGrath, a research geophysicist with the program. “The benchmark glaciers provide an important long-term perspective to the changes we’re observing throughout this region.”

The glaciers and ice fields of Alaska are responsible for nearly 50% of the water flowing into the Gulf of Alaska. This water has a unique “glacial fingerprint” that is evident in its timing, volume, and temperature, and the nutrients carried by it. Glacial runoff drives the Alaska Coastal Current and supplies the marine ecosystem with highly bioavailable nutrients. These in turn sustain commercial and subsistence fisheries, and millions of coastal marine birds and mammals.

USGS scientists travel to Wolverine and Gulkana glaciers twice a year to make observations of snow accumulation and snow/ice melt. These measurements allow them to calculate the health of the glaciers, track changes in glacier size through time, and document the sustained and continuous mass losses seen since about 1990. In addition to this work, the team is currently focused on measuring regional change with geophysical and remote sensing methods, and modeling how glaciers will respond to future climate scenarios.
Predicted summer warming of 3.6 - 7.2°F (2-4° C) and a marked decrease in snow accumulation will drive the loss of many thousands of glaciers in Alaska and northwest Canada by the end of this century. By coordinating with landscape ecologists, biologists, and oceanographers, the team is assessing how socioeconomically important species like salmon are likely to fare in the warmer Alaska of the future.

In addition to the work in Alaska, the USGS Benchmark Glacier program also includes South Cascade Glacier in Washington State and Sperry Glacier in Montana. Each of these glaciers are influenced by different climates, allowing scientists to compare how glaciers respond in different regions.

The Benchmark Glacier data are available at: https://www.sciencebase.gov/catalog/item/57ad09ea4b0d18356756141

Additional information about the USGS Benchmark Glacier program can be found at: https://www2.usgs.gov/climate_landuse/clu_rd/glacierstudies/default.asp.

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**Figure 28. Repeat oblique photographs of Wolverine glacier in Alaska. 1966 image by unknown USGS photographer; 2015 image by L. Sass, USGS.**