1981-2010 High-Resolution Temperature and Precipitation Maps for Alaska

Final Report

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Introduction

Climate is one of the primary drivers of ecological change in Alaska parks, and the current climate maps are out of date. Climate observations in Alaska are often available for major towns and airports, but are lacking in areas where they are needed most-- in mountainous regions and remote areas. The PRISM Climate Group produces and disseminates the most detailed, and the highest-quality spatial climate datasets currently available. These digital climate maps are created using PRISM, an analytical tool that uses point data, a digital elevation model, and other spatial data sets to generate gridded estimates of monthly, yearly, daily, and event-based climatic parameters, such as precipitation, temperature, and dew point. PRISM is uniquely designed and constantly updated to map climate in difficult situations, including high mountains, rain shadows, temperature inversions, coastal regions, and other complex climatic regimes found in Alaska.

Maps previously available for Alaska were based on an outdated 1971-2000 climatological period. This project was designed to rectify this situation, using the latest applicable climatological period (1981-2010) to produce spatially gridded average monthly and annual, 30-year normal precipitation and temperature (average, maximum, minimum) data sets. Distribution of the point measurements to a spatial grid was accomplished using the PRISM model and verified to PRISM standards, including a product peer-review in cooperation with Alaska state and regional climate specialists.

Tasks performed in this project were as follows.

Task 1 -- Collect and process data
Task 2 -- Conduct quality control checks
Task 3 – Perform initial mapping
Task 4 – Conduct peer review and create final products

These tasks are discussed below.

Tasks 1 and 2 – Data Collection and Quality Control

Climate Data

Collecting station climate data and metadata for Alaska was a major undertaking (as it was in the 1971-2000 mapping project). There is no central repository for climate data in Alaska; data reside at a large number of agencies around the state (and country), in various formats, and at various levels of quality and completeness. The metadata are often incomplete, inaccurate, and contradictory, requiring graphical analysis for resolution or official permission for use. "Fragmented" and "unpredictable" accurately describe the state of the data.

We obtained data for several research and government networks through a data delivery from the Arctic Landscape Conservation Cooperative's Imiq Hydroclimate Database including: the University of Alaska Fairbanks' Water and Environmental Research Center (WERC) and International Arctic Research Center (IARC); Arctic Observation Network (AON); Circumarctic Lakes Observation Network (CALON); Arctic Long Term Ecological Research (LTER); Bureau of Ocean Energy Management (BOEM); RWIS (Roadway Weather Information System); Department of Interior's Bureau of Land Management (BLM) and Geological Survey (USGS).

Climate data were also collected and processed for the National Weather Service's (NWS) Cooperative Observer Program (COOP), Weather Bureau Army/Navy (WBAN), and surface hourly stations from the National Centers for Environmental Information (NCEI); Soil Climate Analysis Network (SCAN), Snow Telemetry (SNOTEL), and Snow Course stations from the Department of Agriculture's Natural Resources Conservation Service (NRCS); Remote Automatic Weather Stations (RAWS) from the Western Regional Climate Center (WRCC) and MesoWest; Community Collaborative Rain Hail and Snow network (CoCoRaHS); National Data Buoy Center (NDBC); and the Hydrometeorological Design Studies Center (HDSC).

Additional surface hourly data and the NWS Daily Hydrometeorological Product were collected via the Unidata Internet Data Distribution project (IDD). Data from the Fairbanks and Juneau Weather Forecast Offices, Alaska Department of Transportation (AKDOT), and the Hydrometeorological Automated Data System (HADS) network were also obtained from MesoWest. Data for the Central Alaska Inventory & Monitoring Network (CAKN), Juneau Icefield Research Program (JIRP), McCall Glacier, and Chugach National Forest Avalanche Information Center (CNFAIC) were made available through, or with the assistance of, the National Park Service (NPS). Data for the Alaska-Canada border region were obtained from Environment Canada, the Pacific Climate Impacts Consortium (PCIC) and NCEI.

Station data were filtered to remove extreme values, logical errors, and other contaminants. Native hourly data were converted to daily time step, combined with native daily data, then converted to common units and inserted into a database, creating the longest, most complete record possible for each station. A minimum of 75 percent of hours with valid data were required to make a valid daily value. Daily data were converted to a monthly time step and combined with native monthly data to create yearly and 30-year PRISM files. A minimum of 85 percent of days with valid data were required to make a valid monthly value. Short-period stations (<23 years) within the 30-year files were adjusted to make them more representative of

the full period (see Daly et al. 2008 for details). Spatial quality control was performed on the monthly data at the yearly, and 30-year unadjusted and adjusted time scales. Metadata were collected for stations, many having their components assembled or cross-checked using a mixture of references. Identified errors were corrected.

An adjustment was made to temperature data from SNOTEL and NPS stations to compensate for an error made in programming the equation used to convert voltage from YSI Extended Range probes to temperature. YSI Extended Range installation dates at each SNOTEL site were obtained from the NRCS station history files, and reviewed by NRCS personnel. NPS personnel worked with technicians from NOAA to determine the correct temperatures from their YSI sensors. A relationship between the original and adjusted NPS sensor temperatures was developed by the PRISM Climate Group, and applied to the SNOTEL YSI Extended Range temperature data (Figure 1).

$$\text{Adjustment (°C)} = 1.352\text{x}10^{-15}T^9 - 7.914\text{x}10^{-14}T^8 - 1.005\text{x}10^{-11}T^7 + 5.075\text{x}10^{-10}T^6 + 4.123\text{x}10^{-8}T^5 - 1.781\text{x}10^{-6}T^4 - 8.983\text{x}10^{-5}T^3 + 2.984\text{x}10^{-3}T^2 + 6.582\text{x}10^{-2}T - 0.8661$$

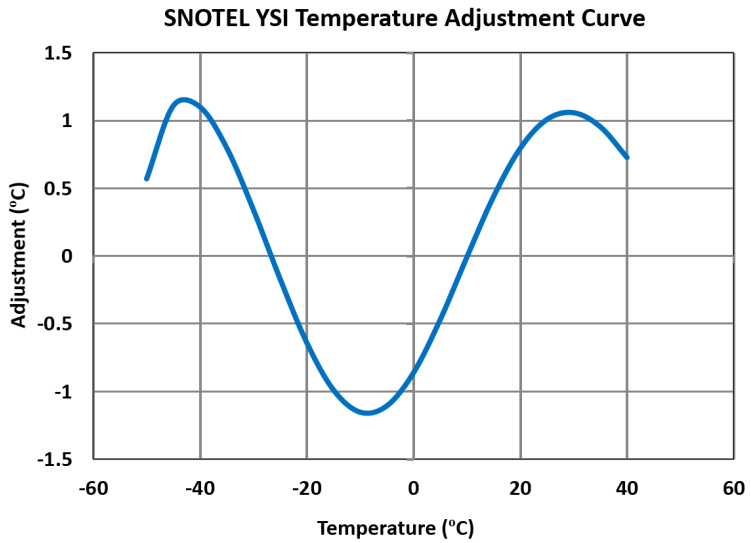


Figure 1. Temperature adjustment function applied to all SNOTEL temperature values recorded with the YSI Extended Range sensor.

The use of multiple sources of station data resulted in many "clusters" of stations when plotted on a map, each station from a different data source, and each with a different ID string and location. It became very difficult to determine which stations were unique, and which were duplicates. Many of these station clusters had to be thinned manually once the modeling began. Often, our best judgment was used to determine which to keep and which to omit, based on period of record and perceived quality of the data.

A major source of uncertainty in the station data was the measurement of winter precipitation. Surprisingly, very few gauges in Alaska are equipped to capture and store frozen precipitation. Many are small and unshielded, allowing wind-blown snow to blow over the gauge orifice and be lost, or to be buried during heavy snowfalls. Both conditions can lead to an undercatch of snowfall of 100 percent or more. The only gauges found to measure snowfall in a reasonably

accurate way were those used by SNOTEL installations.

Snow water equivalent (SWE) from NRCS snow courses also provided useful, but indirect, information on winter precipitation, often in remote locations were other data were unavailable. Using SNOTEL sites with data for both SWE and precipitation, we found that the relationship between winter precipitation and SWE was a function of temperature. (As the temperature increases, chances for melt and rainfall increase, hence less SWE per unit precipitation). We developed a function relating the ratio of winter precipitation to SWE with winter mean temperature. Estimates of temperature needed to predict this ratio at snow course sites were provided by the PRISM gridded temperatures developed in this project.

NARR (North American Regional Reanalysis) gridded free-air temperatures, averaged to the 1981-2010 period, were downloaded and sampled every 0.75 degrees lat/lon at the 1500m, 2000m, and 4000m levels. Since there were very few surface stations available above 1000m, these data helped map temperature inversions much more effectively and consistently. The main difficulty with using NARR data in this analysis was the discrepancy between conditions in the free atmosphere and those on the surface. These discrepancies varied by season and location, and few high-elevation stations were available for use in adjusting the free-air mean temperatures to reflect surface maximum and minimum temperatures. The free-air temperatures were modified to reflect surface conditions using best judgment.

DEM Elevation Data

The preparation of a 30-arc-second DEM (digital elevation model) for Alaska and adjoining areas of Canada was done as part of the 1971-2000 normals mapping project completed in 2009. Canadian elevation data were necessary for the use of stations outside Alaska in the interpolation process. There was no high-quality 30-sec DEM for Alaska that extended into Canada in a consistent manner. The GTOPO30 DEM had global coverage at 30 sec, but was of poor quality. SRTM (Space Shuttle Radar Topography Mission) data were discontinuous and limited to latitudes south of 60N. The only remaining option was to manually download 5000 2-arc-second DEM tiles from Alaskan and Canadian repositories, patch these together, and filter them to the desired 30-sec resolution. The sheer size of these data sets (each 1x1 deg box contained 3.24 million grid cells) hit the 2-GB PC operating system limit very quickly when attempts were made to patch multiple tiles together. We dedicated several computers to the patching task, but the process still required months to complete. Software developed in-house was used to downscale the merged and patched datasets, resulting in a high-quality 30-arc-second DEM spanning the entire state of Alaska and adjoining regions of Canada.

Task 3 – Perform initial mapping

Using the 30-sec DEM as a basis, PRISM input grids were developed. A modeling mask was created that included all land areas and many near-shore areas within Alaska and small parts of adjacent Canada. The 30-sec DEM filtered to 2.5-min effective wavelength was created for use in precipitation modeling. Other input grids include topographic facets, topographic index, effective terrain height, coastal proximity, and inversion height.

Due to the large size of the Alaskan region at 30-sec resolution, and differences in climatic regime across the state, the state was divided into four overlapping modeling regions: southeast, southwest, south, and north. PRISM was parameterized separately for each region. Temperature was modeled first, so that the gridded temperatures could be used to estimate winter precipitation at snow course sites.

Many iterations of modeling and data QC were made, and close data scrutiny during modeling revealed additional data quality issues. Initial PRISM parameterizations were made, and adjusted during the process. At least 30 modeling iterations, each using different PRISM parameterizations and station data sets, were made for each climate variable.

Task 4 – Review and creation of final products

Review of the draft maps was done via Internet Map Server (IMS). IMS eliminates the need for reviewers to have GIS capability, thus allowing all to contribute to the analyses. The IMS has capabilities to zoom, pan, query a map layer, and get information on station locations and observed values. Three draft climate maps were selected for review: 1981-2010 mean annual precipitation, mean January minimum temperature, and mean July maximum temperature. The goal of the review process was to ensure that the climate maps reflect, as much as is practical, the current state of knowledge regarding the long-term mean patterns and magnitudes of temperature and precipitation in Alaska. We asked for input on the following:

1. Are the estimates and patterns reasonable when compared to your local knowledge?
2. Are the stations plotted correctly on the map?
3. Are the local high and low values (extremes) in a given region of interest reasonable and located properly?
4. Do you have any supplemental data sets you wish to offer that would significantly improve this analysis?

Comments were submitted electronically using the IMS website. The map view the reviewer was examining at the time they submitted their comment was saved along with the comment.

Several experts participated in the review process. The comments were essential to the revision process, and resulted in significant improvements to the maps. A full presentation of the reviewer comments and our responses to each are presented in Appendix A. Many responses were made via email within a day or two after the comment was made; this was done to clear up issues quickly and allow the reviewer move forward with additional reviews.

Deliverables

- GIS raster data layers (grids in ARC ASCII GRID format) of 1981-2010 mean monthly and annual precipitation and temperature (average, maximum, and minimum). Grid resolution is

30-arc-second resolution, which is approximately 1 x 0.5 km at 60 degrees north latitude.

- GIS-compatible CSV files of station data used in compiling climate maps, including station parameters, period of record, and network affiliation for each station.

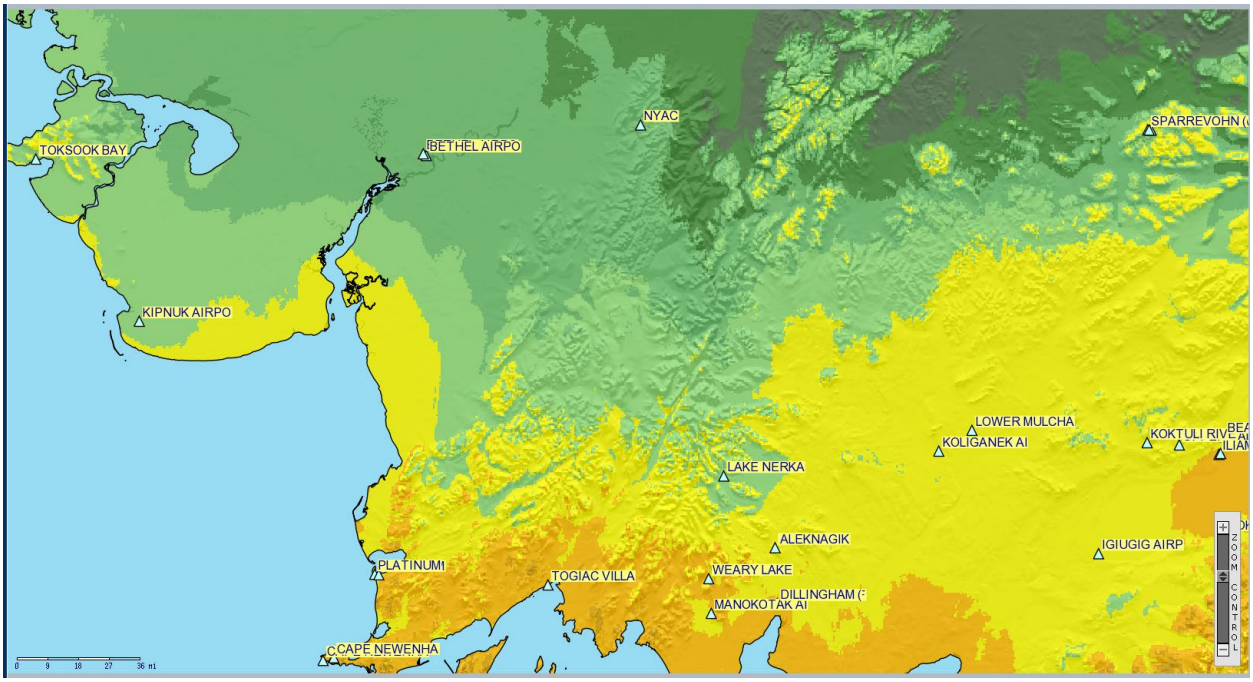
- Browse graphics for GIS raster layers.

- FGDC compliant metadata.

APPENDIX A

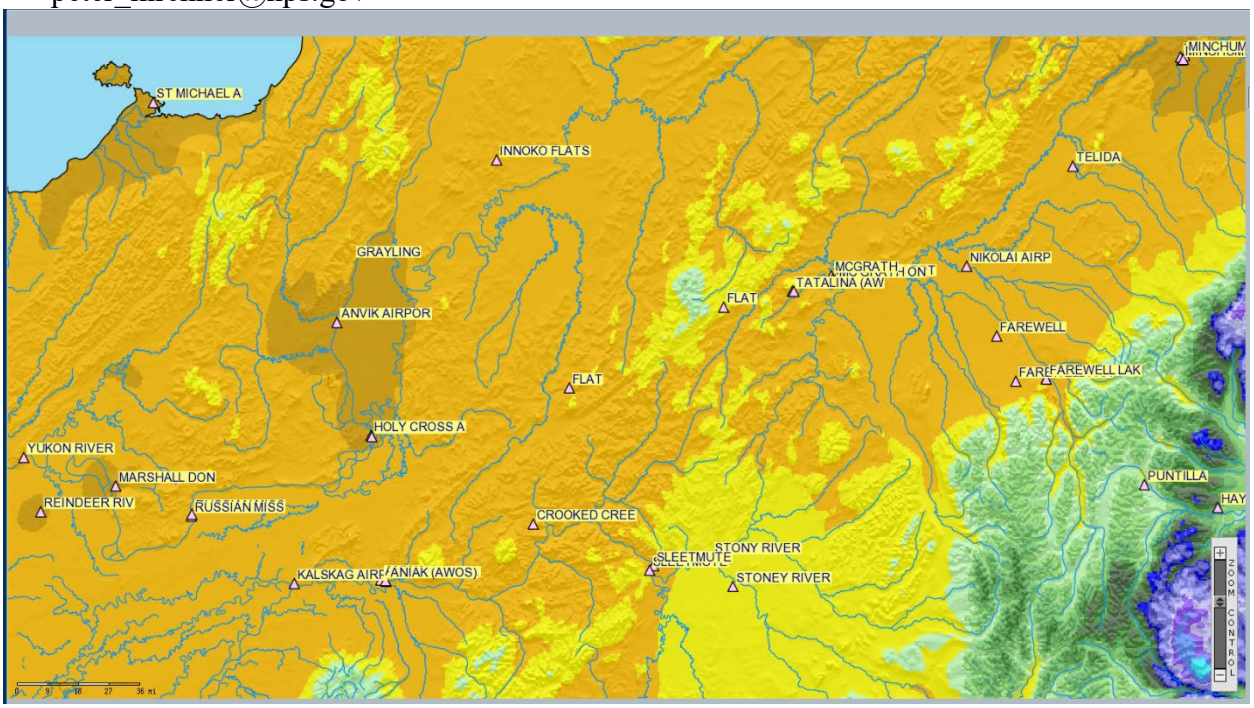
Alaska Climate Mapping Reviews and Responses

Email: richard.thoman@noaa.gov
Name: Richard L Thoman Jr
Office: NWS Alaska Region
Mapname: Alaska tmin
URL: Click Here to view
Comments
Hi, Some FAA AWSS sites not plotted on the stations used, e.g. Buckland, Shageluk, Noorvik. Also some NW Alaska RAWS, e.g. Howard Pass, Makpik Creek (called "Noatak" by AFS).



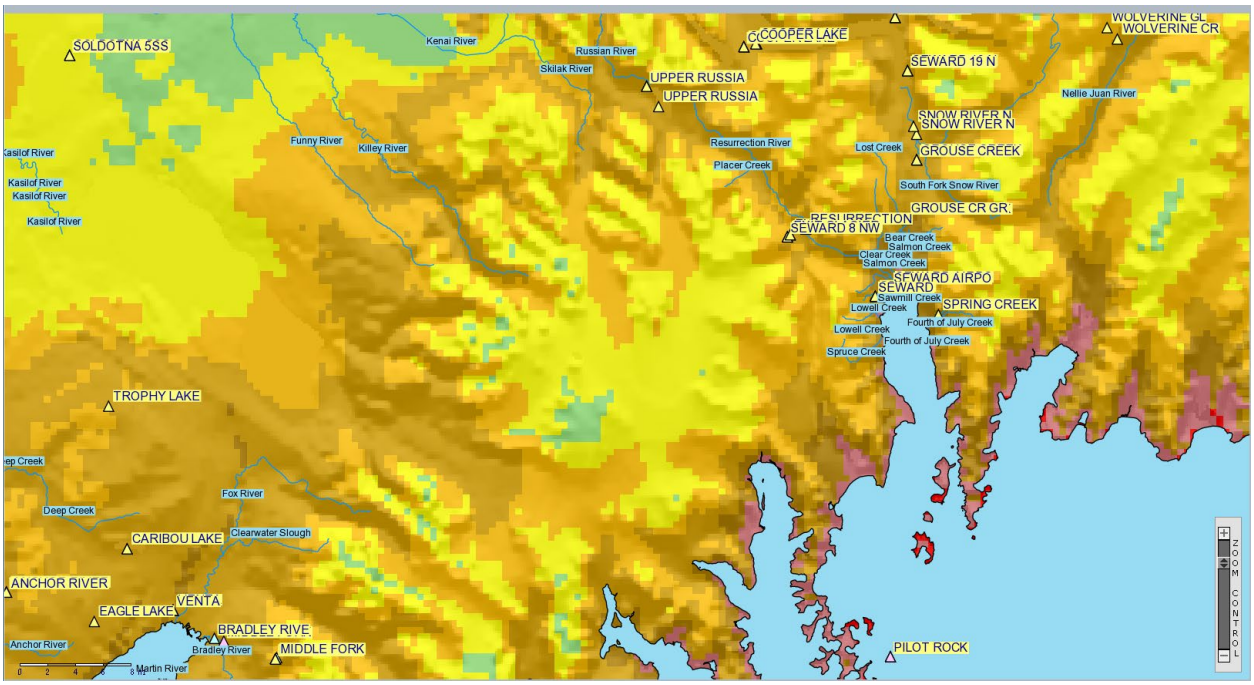
Via email:
Hi Rick,
We made the decision to not plot stations for Jan tmin and Jul tmax that did not contribute to the mapping for those specific months. I found it annoying to hover over a station on the Jan tmin map, for example, and see that the station had a missing value for that month. It seemed like we were mis-representing the station density that way. This is different than the case of mean annual ppt, where we show all stations that contributed at least one month to the annual value, since the annual grid is the sum of the monthly grids.
Many stations had months that did not meet our data completeness criteria, either because of missing data or data marked suspicious. For example, here is what tmin looks like for the stations you mention:
Buckland - all months OK EXCEPT January, infilled, now complete
Shageluk - Mar, May, Jun OK, too many other months incomplete
Noorvik - Not present in my station list
Howard Pass - Jun-Oct OK, data incomplete in other months
Noatak "ASOS" is OK in all months and being used
Chris

Peter Kirchner
It appears that some stations appear in two different locations when labeled. please see the associated screen, ie. Flat, Farwell Lake etc...
peter_kirchner@nps.gov



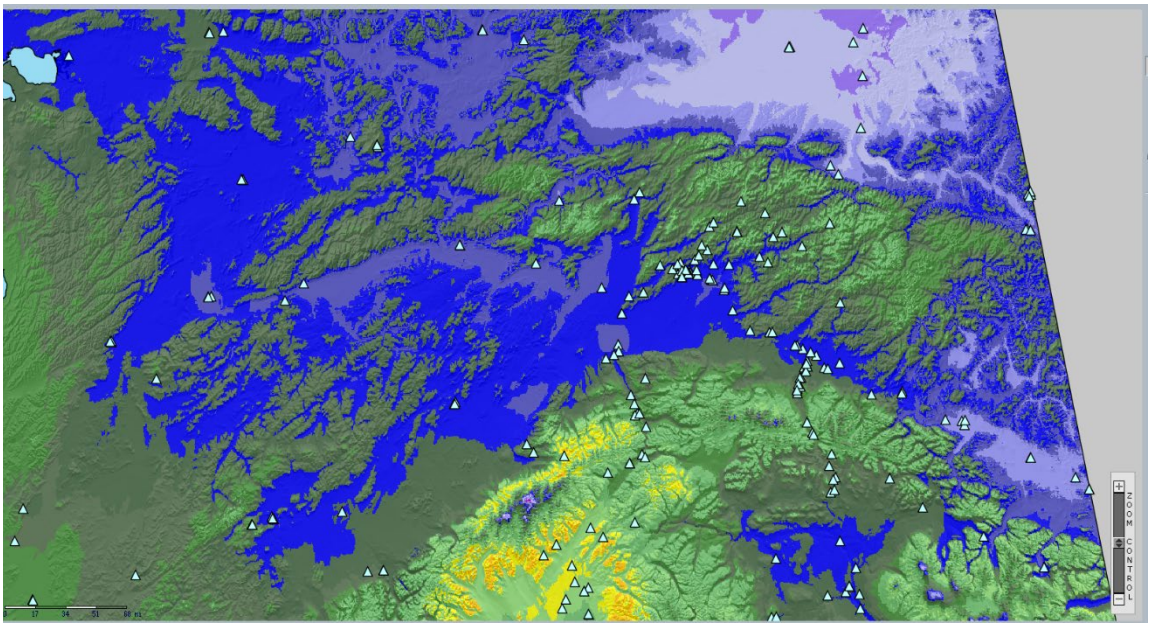
Via email:
Hi Peter,
Those stations with the same name but different locations represent COOP and RAWS pairs. So different networks but same names. Our database shows different locations for these guys, so either they just used the same name because they were in the vicinity, or the locations in one of the network's metadata are incorrect.
Chris

Peter Kirchner
Harding Icefield is missing from the stations, it first logged data in 2004, I can provide the most up to date QA/QCd data set if usefull, although pre 2010 data are available through WRCC. This station is one of the few high altitude stations in the region. I/'/m assuming that the labeled stations were used in the analysis, however some of the stations listed appear to be post 2010 (ie. Silver Salmon Lakes, which is mislabeled in XMACIS-2). Were more recent data assimilated for the analysis? If so that makes sense if not there is an error in the assimilation process.



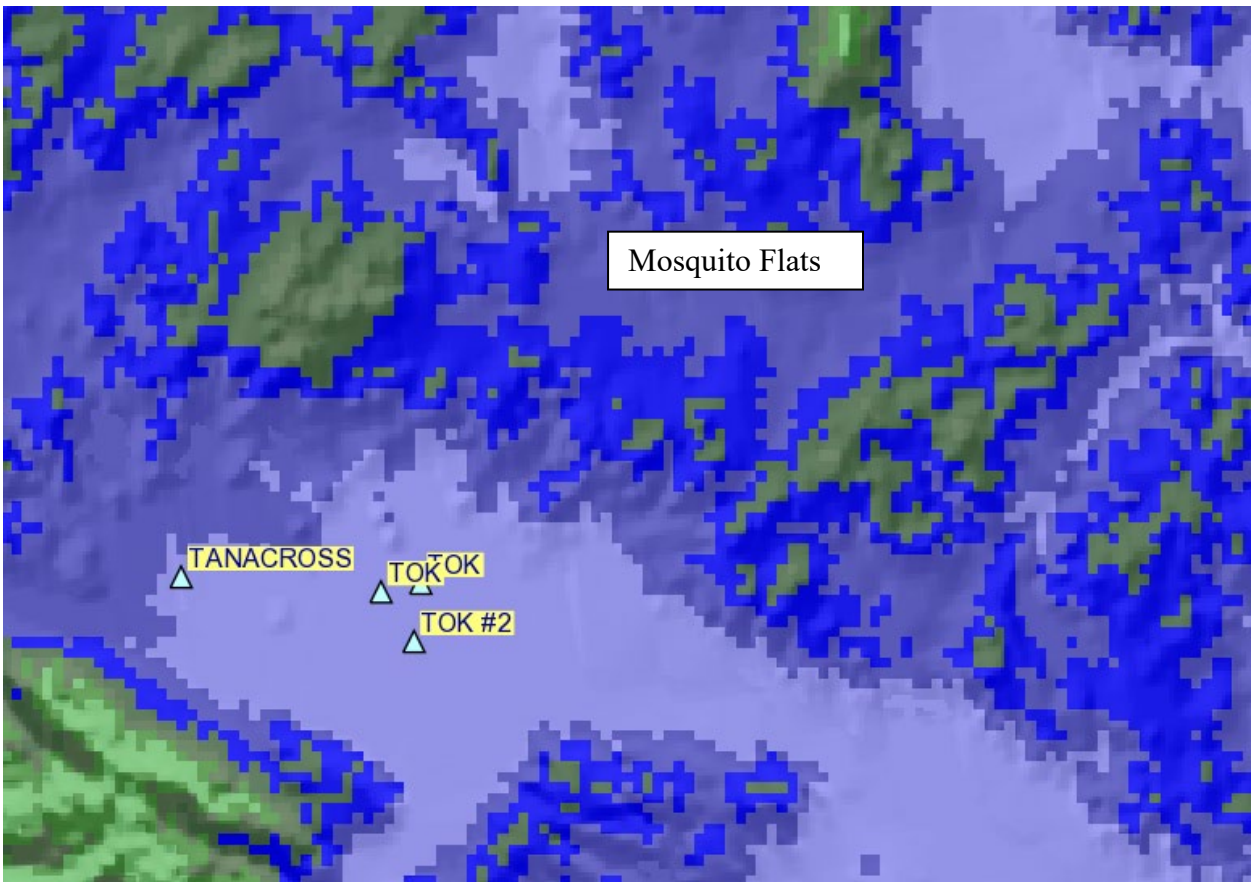
Via email:
Peter,
Yes, we have Harding Icefield data. However, it only met our data quality and completeness criteria for a few months. For tmin it was May-Aug and for tmax is was May, Jun, and Aug. Since we only plot stations which were used in the Jan tmin map or Jul tmax map, respectively, Harding doesn't show up in either. We can turn them all on, but then many will look they were used but actually have no contribution to that map. Kind of a judgement call, here.
On your question of using post-2010 data, yes we do use it. We adjust the resulting averages into the 1981-2010 period using nearby long-term stations. This has allowed us to use data from many recently-installed stations.
Chris

Email: richard.thoman@noaa.gov
Name: Richard L Thoman Jr
Office: NWS Alaska Region
Mapname: Alaska tmin
URL: Click Here to view
Comments
The Mosquito Flats north of Tok often appear on IR imagery to be considerably colder than Tok-land and likely as cold as the narrow valleys of the Fortymile County. Minto Flats (NW of Nenana) are notoriously windy in winter. Suggest "warming" the western portion of this area (eastern area is already depicted as "warmer"). Upper Kobuk valley (above Ambler) is often distinctly cold in the appropriate conditions, but does not show up well here. Kobuk village has a reputation of being exceptionally cold area. Western Seward Peninsula (west of Pilgrim Hot Springs, east of Teller) there appears to be a possible discontinuity in color band in a small area. Upper Porcupine River valley looks too cold. This area often gets some wind (as evidence in IR imagery). I/'/d be mildly surprised if Canyon Village had an average Jan min lower than Ft. Yukon. IR imagery has long suggested that the coldest area on the inland North Slope is southwest of Umiat (Umiat being on the NE edge of the cold pool). At the very fine scale, the Goldstream Creek coop near Fairbanks (503368) does have good data post 2008 and would define the valley bottom smartly.

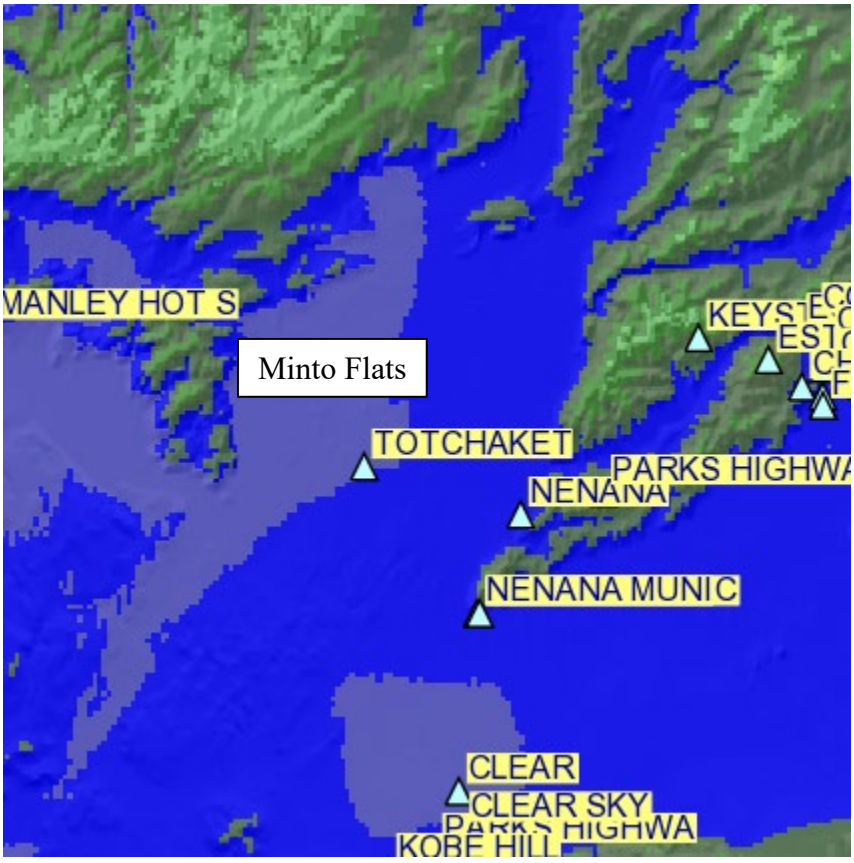


Chris notes (not to Rick):

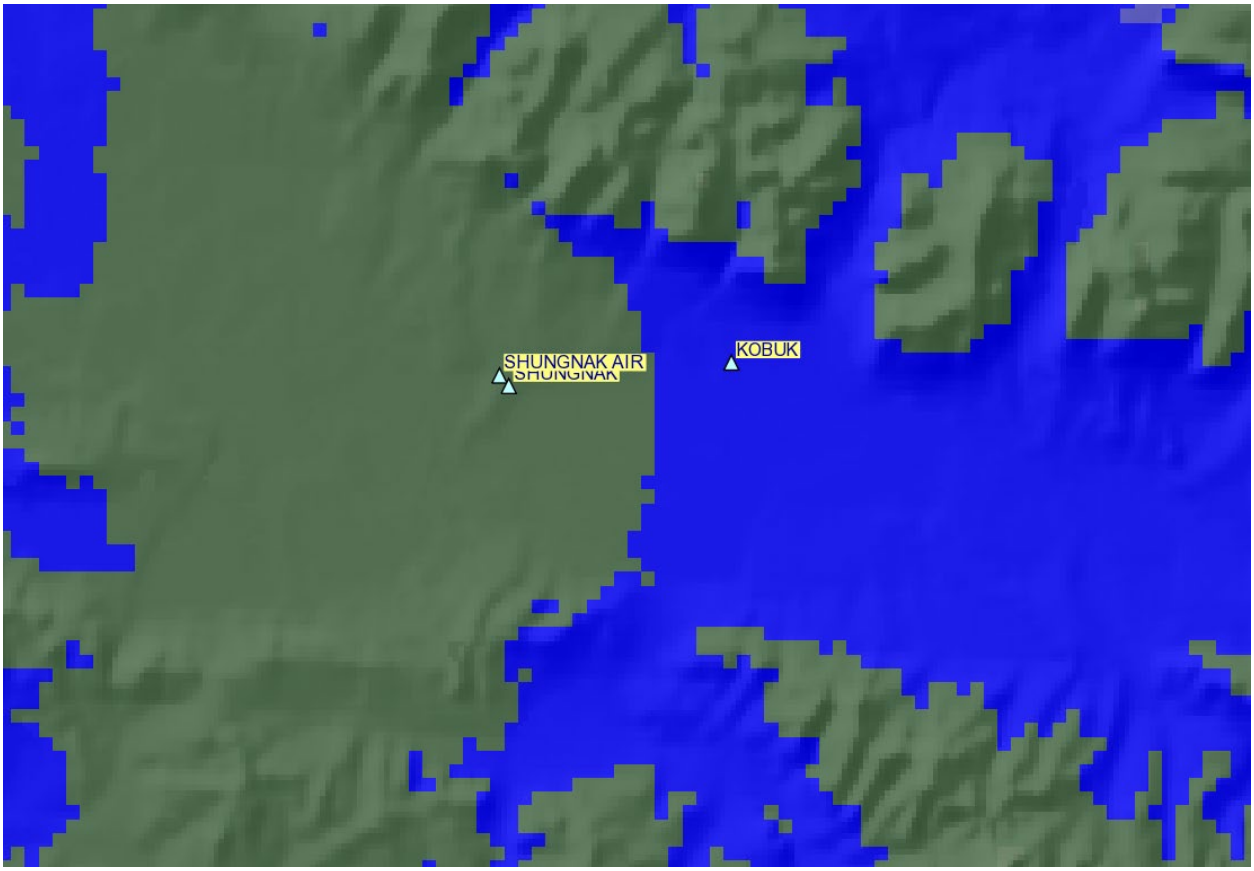
**Color discontinuity on western Seward Peninsula due to terrain/water body overlay.
**Goldstream data now complete.
**Added Chicken data and pseudo near O'Brien Creek.


Mosquito Flats
TANACROSS
TOK
TOK #2

Make Minto Flats a bit warmer.
**Added pseudo. Now same temp as eastern side of flats.

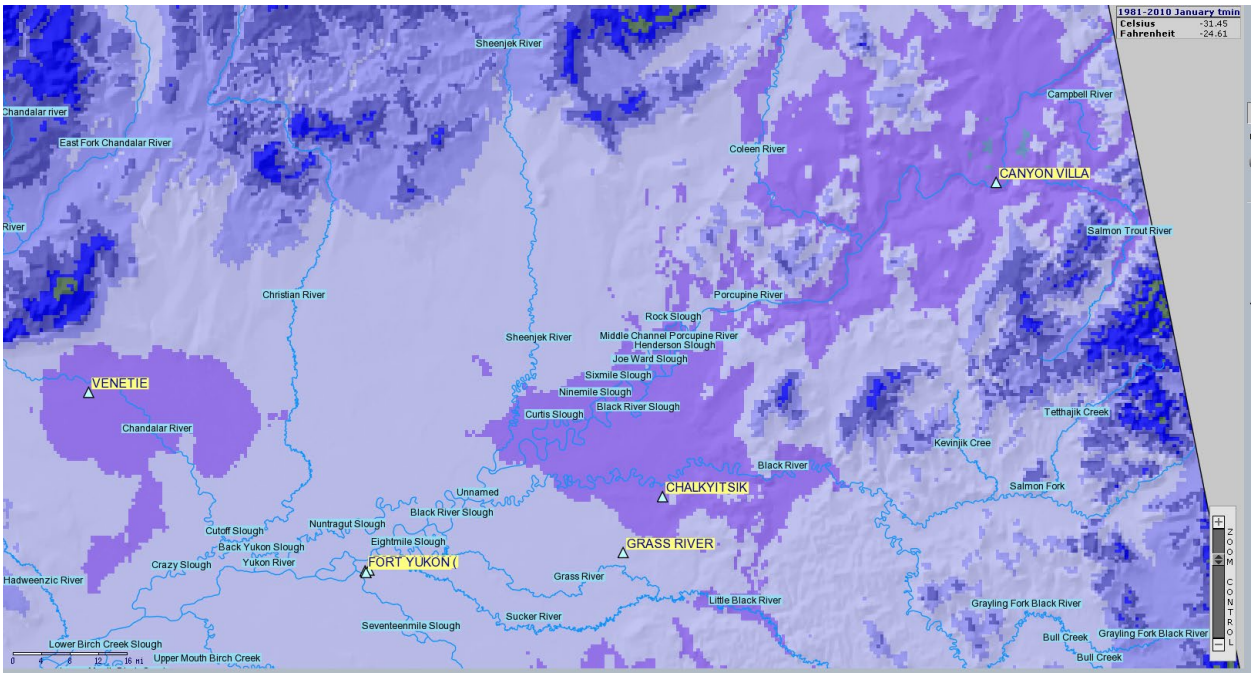


**Omitted one of the Shungnak stations that was warmer and with little data. Temps colder, now.



**Canyon Village had a short period of record back in the 1960s, so could be too cold. We do adjust the averages to place them in the 1981-2010 period, but given the sparse records in this area, the adjustments may not have been sufficient. Venetie is also a short POR station operated in the 1960s.

Omitted a few stations in area, all with very short PORs. Upper Porcupine Valley is now a bit warmer than Ft. Yukon.

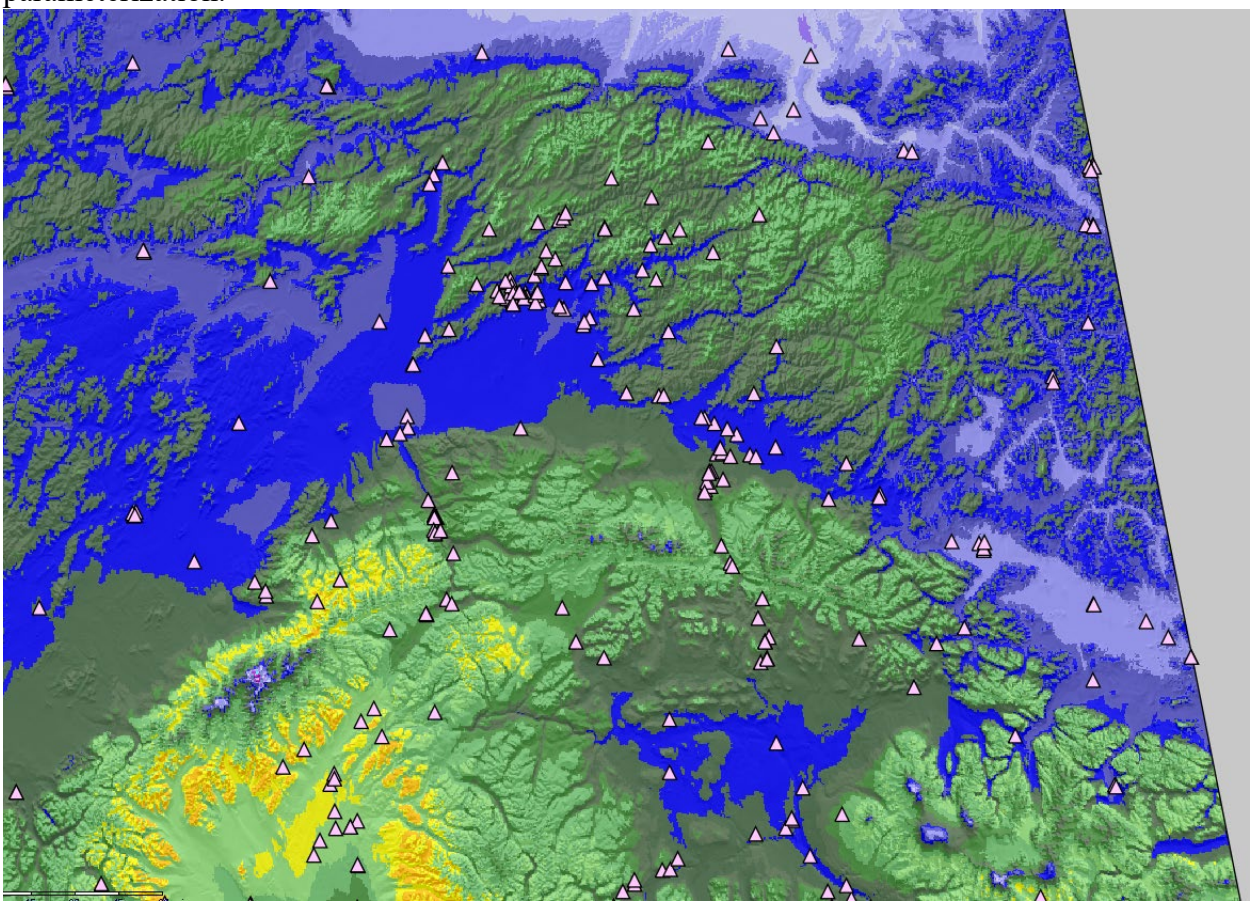


Upper Kobuk valley (above Ambler) is often distinctly cold in the appropriate conditions, but does not show up well here.
Kobuk village has a reputation of being exceptionally cold area.
**We are using data from the Kobuk ASOS. January tmin average is not that cold there, but Norutak Lake, much further upriver and to the east, is substantially colder. I have added a pseudo station between Kobuk and Norutak Lake to cool things off a bit in that narrow drainage.

IR imagery has long suggested that the coldest area on the inland North Slope is southwest of Umiat (Umiat being on the NE edge of the cold pool).

**Current map agrees with that. Umiat is a the NE edge of the cold pool along the Colville River. To reinforce cold pool, added pseudo 1 degree colder than Umiat up the Colville.

Email: pam_sousanes@nps.gov
Name: Pam S
Office: NPS
Mapname: Alaska tmin
:
URL: Click Here to view
Comments
The uplands in Yukon-Charley area looks great and compares very well to mean Jan MInT at the Upper Charley site (station not used). Coal Creek seems like it might be a bit colder than mapped, it is usually colder than Eagle in the winter. Maybe that cold band along the Yukon extends a bit farther upstream and into some of the valleys a tad more?
**I've tried to sharpen up the cold pooling a bit more, so valley bottoms heading south and SW from Eagle are colder. Valley bottoms in the 40-mile country are much colder now, with the addition of data from Chicken and a pseudo at O'Brien Creek, and changes in the PRISM parameterization.



Email: pam_sousanes@nps.gov
Name: Pam S
Office: NPS
Mapname: Alaska tmin
:
URL: Click Here to view
Comments
Eastern Noatak mid-elevations sites - Jan MinT sites at newer sites average a bit warmer than mapped. However the POR for these sites is short and 2014-2016 were warmest years on record for AK. Gates of the Arctic mid elevation sites were the same, except for Killik Pass which is generally colder. These sites were not mapped. I don't know if it is worth another year of data? The files are now all accessible on the web for the Central Alaska sites at https://irma.nps.gov/DataStore/Reference/Profile/2244661 and for the Arctic parks https://irma.nps.gov/DataStore/Reference/Profile/2247898 . The WC_G files are the QA/QCd data sets.

**We have added these mid-elevation sites back in by modifying our QC tests, and added the additional years of data in the files specified. Temperatures should be more in line with observations, now.

Email: pam_sousanes@nps.gov
Name: Pam S
Office: NPS
Mapname: Alaska tmin
:
URL: Click Here to view
Comments
Jan MinT PRISM averages a bit colder than the mid elevation RAWS data, especially the Wrangell/Chugach area. There are some decent records for Jan MinT (Gates Glacier, Tebay, Chtitu in particular).

**Agreed, 2-3C too cold. These stations had valid normal data for most all months, except for one or two winter months. Data have been filled in for all months, now, and I worked with the inversion height settings, as well. Temperatures have warmed up appropriately.

Email: pam_sousanes@nps.gov
Name: Pam S
Office: NPS
Mapname: Alaska tmin
:
URL: Click Here to view
Comments
In Denali on the bend of the Muldrow Glacier there is a warm spot centered right over the ice, same on the Kahiltna Glacier. Not sure if these would be warm spots in Jan over snow covered glacial ice?

**These warm spots are gone in the current runs.

Email: jewalsh@alaska.edu
Name: John Walsh
Office: UAF/IARC
Mapname: Alaska tmin
:
URL: Click Here to view
Comments
Temperatures around Fairbanks look quite reasonable, with higher temperatures over the hills than on the flats. Was any correction made for the urban heat island effect on temperatures? The consensus seems to be that the Fairbanks airport temperatures (and perhaps temperatures at nearby sites) are warmer by a degree or two (C) than if there were no urban effect (including ice fog).

**There was no specific station weighting function to account for urban land use categories.

Email: pam_sousnaes@nps.gov
Name: Pam S
Office:
Mapname: Alaska tmax
:
URL: Click Here to view
Comments
Noatak River -The Noatak RAWS station seems to be driving the warmer temps, I would expect the warmer temps to follow the lowland river corridor a bit more rather than being an isolated warm spot. There is also a warmer area in the upper Noatak headwaters that probably shouldn't be warmer than the lower river corridor. Same with that warm spot that shows up in the bend of the Killik River in Gates of the Arctic.

**The warmer temperatures now follow the river corridor better between Noatak and Kelley Station. I was able to improve the upper Noatak headwaters a bit, but there still is a warmer spot there, due to the influence of stations to the east, which are a bit warmer per unit elevation than those to the west. Same with Kilik River. With such a steep lapse rate for July tmax, it takes only a degree or so difference between two stations at the same elevation to cause this effect, and these short POR stations do not have stable long term averages, despite our trying to adjust them to the 1981-2010 period.

Email: paam_sousanes@nps.gov
Name: Pam S
Office:
Mapname: Alaska tmax
:
URL: Click Here to view
Comments
The detail on the maps are great - I think the addition of stations refined the elevation gradient quite a bit. Thank you for adding the x,y tool, it came in very handy! The map server in general worked great and I liked the ability to look at the imagery and terrain maps. Nice job!

**Thanks Pam!

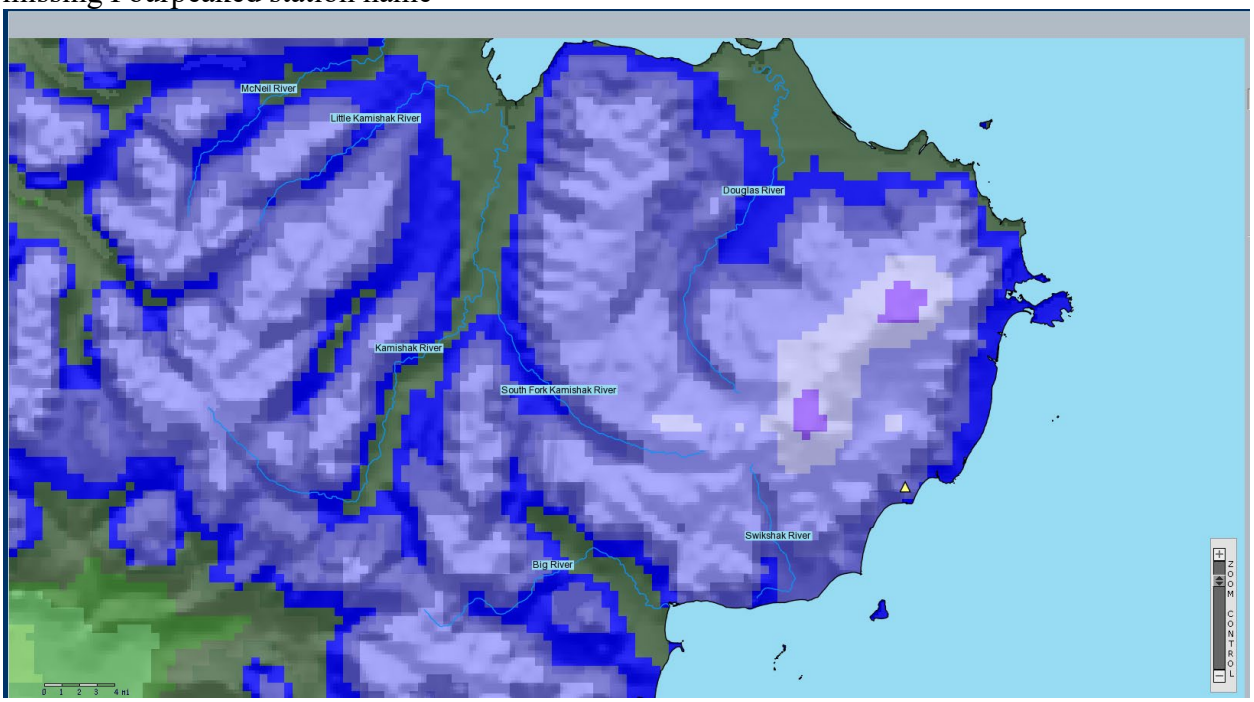
Email: jewalsh@alaska.edu
Name: John Walsh
Office: UAF/IARC
Mapname: Alaska tmax
:
URL: Click Here to view
Comments
Outstanding detail (spatial resolution). Temperatures and precip amounts all look reasonable; I found no smoking guns or suspicious features. Suggestion: Station symbols are a nice addition to the product. However, it would be nice to indicate each stations/'/s period of available data. Many of those stations did not operate the entire 30 years, and some only operated for a few years. I could not get the transparency option to work when I tried to overlay the terrain height map and a temperature map. Documantation should include some clear information about the interpolation procedure. For temperature, you must have assumed a certain lapse rate. What was the assumed lapse rate? What else was done in filling the gaps between the station temperatures? How was precipitation made a function of elevation?

**Station periods of record are available from the interface by selecting the “i” icon.
Local lapse rates were calculated dynamically by PRISM for each grid cell from surrounding station data, plus upper air data from the NARR reanalysis. Same procedure was used for precipitation. PRISM weights surrounding stations by their physiographic similarity to the grid cell. Factors include elevation, large scale aspect, terrain profile, topographic position, and coastal proximity.

Email: jlittell@usgs.gov
Name: Jeremy Littell
Office:
Mapname: Alaska tmax
:
URL: Click Here to view
Comments
Color swatch for -7 - -6 looks too close to color swatch for 23 (e.g., near WEIN lake or TOTCHAKET). With the transparency to show the topo, the colors are close. This gets at a larger problem - this is only a quasi-divergent color scale, and colorbrewer or Light and Bartlein (https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2004EO400002) have better approaches.

**Thanks for the input on color schemes. Interface was developed for reviewer use only, and will be taken down once the project is finished, so is not an official portal for future access to the new map.

Email: peter_kirchner@nps.gov
Name:
Office: NPS
Mapname: Alaska ppt
URL: Click Here to view
Comments
missing Fourpeaked station name



Via email:
Chris and Pam,

Peter's feedback said that the Fourpeaked station did not have a name - Peter had the station labels selected (on) for both the tmax and the tmin temperature stations, but Fourpeaked is not in those datasets. He had the ppt stations on but he did not have the ppt stations labels turned on and when ppt station labels are on the label is visible for Fourpeaked.

Mike
Thanks Mike!
So if I understand correctly, Fourpeaked station had ppt but no temps in the dataset, is that right?
Pam

Pam,
Fourpeaked shows up as contributing temperature data for Feb, Jun, Jul, and Dec. It contributed only July to ppt.
Chris

Email: eric.holloway@noaa.gov
Name: Eric Holloway
Office: NWS APRFC
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
It seems to me that there should be a little more detail in the shaded yellow region in the Bristol Bay area.

**It is not clear which kinds of additional detail is needed in this area. The areas has very little station data.

Email: jlittell@usgs.gov
Name: Jeremy Littell
Office:
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
When the Alaska imagery toggle is clicked, the "i" information button does not identify stations when they are clicked, but they work with the data mapped. Browswer = Google Chrome.

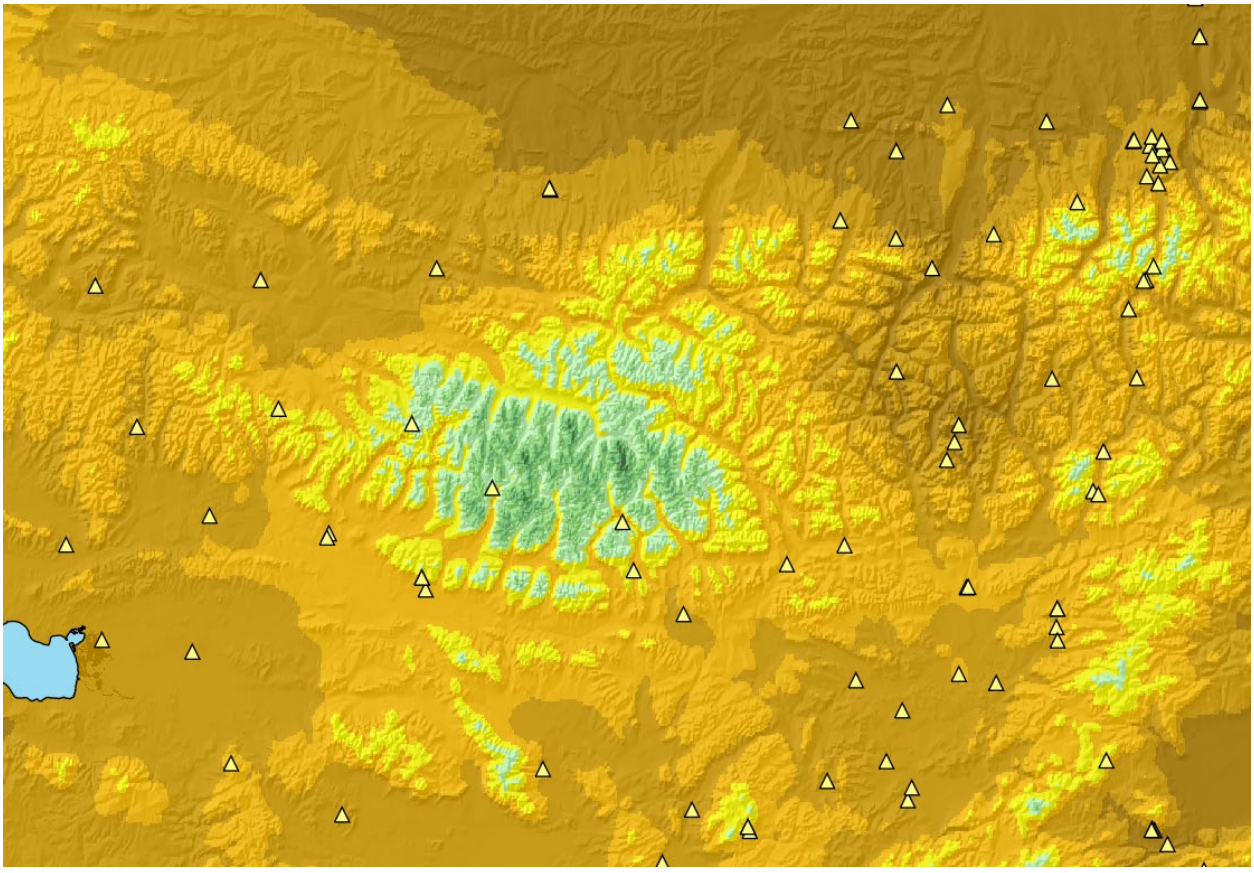
**Thanks for the heads up. We will try to fix this.

Email: eric.holloway@noaa.gov
Name: Eric Holloway
Office: NWS APRFC
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
I/'/m a little curious as to the missing data for the ASOS at Chignik PAJC. I see that there is data outside of May-Sept. Data source
http://mesonet.agron.iastate.edu/request/download.phtml?network=AK_ASOS

Via email:
Hi Eric,
We have had a lot of trouble using ASOS data, as a network, during the winter. Way too much garbage, and usually too low. So with a very few exceptions, we only use them during May-Sep.
Chris

Email: eric.holloway@noaa.gov
Name: Eric Holloway
Office: NWS APRFC
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
I find it curious that there is one section of the Brooks range is much higher than the rest.
Via email:
Hey Chris,

I notice there are a couple of stations in the heart of this higher Brooks Range precip...i haven't heard of this IMIQ network (DAM7 and DAM8). What is that???



Via email:
Eric,
This Brooks range precip max seems to be driven by a persistent wet Jul-Sep period. I and others have also seen this as worth further investigation.
Chris

These stations are part of the WERC Ambler Corridor Project, designed to acquire hydro-meteorological data needed to evaluate the concept of building a roadway from the Dalton Highway westward to near Kobuk. See URL below for more information.

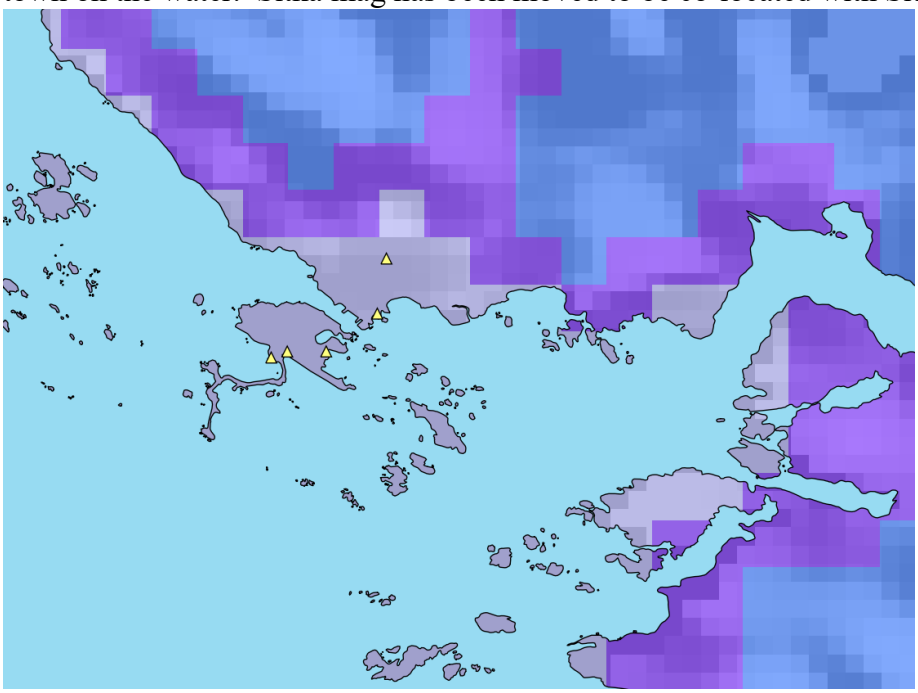
http://ine.uaf.edu/werc/projects/ambler/

The rain gauges used in our analysis were installed in summer 2012 with the aim of measuring summer precipitation. We have data through most of 2014. August and September of 2012 happened to be extremely wet, and skewed the averages severely for those two months. Our algorithm that adjusts the averages to reflect the 1981-2010 period could not compensate fully, because there nearest long-term stations were well outside the area affected by the 2012 wet period. In response, I manually reduced the averages to minimize the effects of 2012. This area still appears as somewhat wet, but there are reasons to suspect that that may be true; it is a local "front range" of the Brooks Range that would provide a reasonable orographic uplift of moisture coming in from the south.

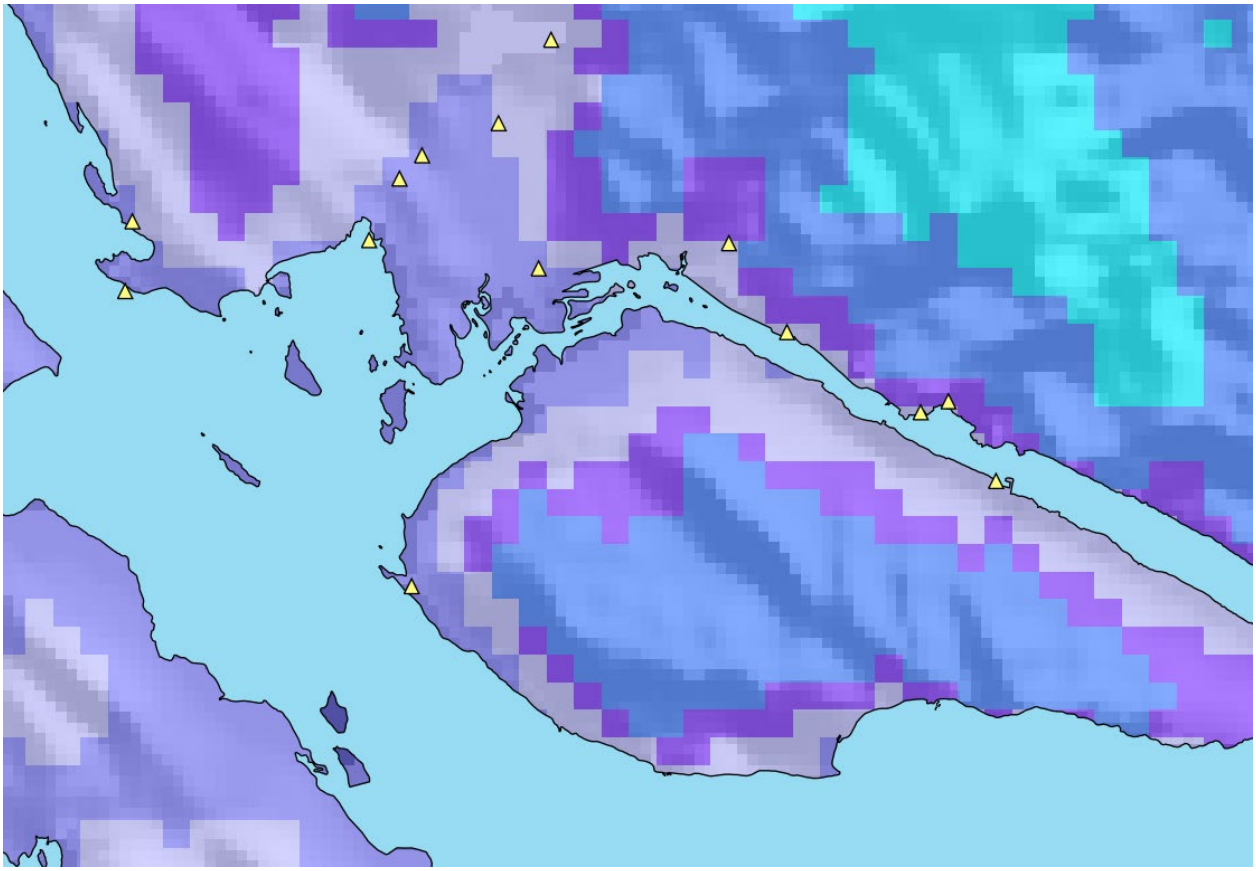
Email: pbieniek@alaska.edu
Name:
Office:
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
The spatial distributions look reasonable. It is difficult to make a direct comparison with other data sets without access to raster data files.

Email: aaron.jacobs@noaa.gov
Name: aaron jacobs
Office: NWS Juneau
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
I see that there are a few locations here near Sitka that are not correct. The sitka mag should be the same location as Sitka 1NE and the water treatment is more in town than near the airport. Not sure how many other places have been misplaced. Also why is Sitka airport missing data?

These are the locations provided by NCEI's GHCN-D database. Sometimes they are not very precise. This is a well-known issue. There are two water treatment plants in the area, one at the airport and one on the western edge of town. We moved the station to the one near the edge of town on the water. Sitka mag has been moved to be co-located with Sitka 1NE.

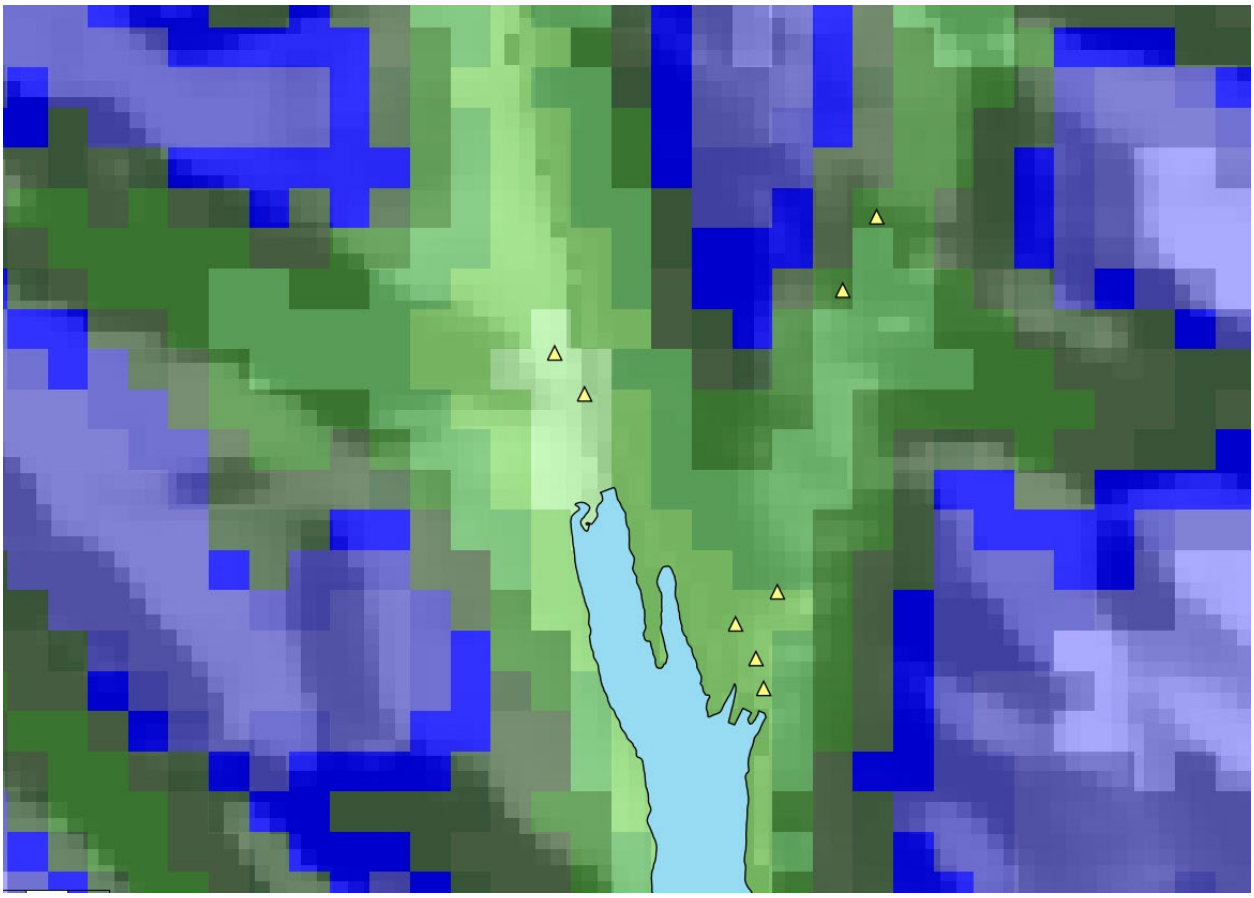


Email: aaron.jacobs@noaa.gov
Name: aaron jacobs
Office: NWS Juneau
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
Where is the Juneau airport information?



Juneau airport ASOS has now been added back into the dataset. It was initially removed because the PRISM system classifies ASOS as providing poor precipitation data, and uses it only if it is the only station in the area. In this case, the data looked reasonable, so an exception was made.

Email: aaron.jacobs@noaa.gov
Name: aaron jacobs
Office: NWS Juneau
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
Skagway 6 NE is in the wrong location it should be below Klondike hiway SNOTEL. Also where is all of the precip info for the Skagway airport?



Hi Aaron,
Thanks very much for providing feedback. Just a quick note on the lack of ASOS precip data – we have not been using ASOS precipitation data in the winter, because it is really poor over most of the state and do not make for stable climatologies (long term averages). If there are ASOS stations in SE that you think we can safely use in winter, we can add them in.
Also, if you don't see a station plotted on the Jan and Jul temp maps, it doesn't necessarily mean we didn't have it, it may mean that it did not have sufficient good quality data to create a stable average for that month.

Chris

**The location metadata for the Skagway 6 NE COOP comes from NOAA via GHCN-D. We checked this location with the HOMR database, and it agrees with the GHCN-D location. This station is at the US Customs Office on the Klondike Hwy. I located the office on Google Earth, and it gave a location of
59.527340, -135.229601
The GHCN-D location is
59.5272, -135.2319
which is within a few hundred yards of the Customs Office, so looks OK. However, the location of the Klondike Highway SNOTEL could not be verified; it operated only for a few years and appears to have been closed in 1992. So it may be that this station is mis-located. Its elevation is higher than that of the Customs Office, so is likely above it. Given its short POR, we have omitted it from the dataset.
Skagway airport ASOS has now been added back into the dataset. It was initially removed because the PRISM system classifies ASOS as providing poor precipitation data, and uses it only if it is the only station in the area. In this case, the data looked reasonable, so an exception was made.

Email: pam_sousanes@nps.gov
Name: Pam S
Office: NPS
Mapname: Alaska ppt
:
URL: Click Here to view
Comments
We could use more data for Brooks Range PPT for sure! I do think it is quite wet at Imelyak - the site is high and the few times we have been there it always seems to be in the clouds. From flying around out there, it seems like the southwest region of the Brooks Range (southern flanks) east of ~ 160° lat. is definitely wetter including the uplands of Kobuk Valley NP and extending east into Gates of the Arctic. We do see quite a bit of snow at the Salmon River RAWS in the winter. So I would think the wetter band would extend further west.

Via email
Pam,
Thanks for your comments on the Brooks Range precip - there is definitely something going on there, and you have a pretty good perspective. We will have to discuss further and see if we can come to some kind of consensus.
Chris

Email: richard.james@prescientweather.com
Name: Richard James
Office: Prescient Weather Ltd
Mapname: Alaska tmax
URL: Click Here to view

Comments

The July max temp values and spatial distribution look good to me - I have no immediate concerns. Well done!

Email: richard.james@prescientweather.com
Name: Richard James
Office: Prescient Weather Ltd
Mapname: Alaska tmin
URL: Click Here to view

Comments

The overall distribution of January min temps looks very reasonable, but I/'/m a bit surprised at the absence of some stations (based on the station plotting feature). For example, the Chicken co-op site has reported high-quality data for 20 years and provides valuable information on the valley-level climate of the Fortymile country (roughly between Northway and Eagle). Another example is the RAWS site on the Salcha River; while the record is not as long or complete as at Chicken, there is evidence that this site is colder than Fairbanks airport in winter. However, the map shows January tmin of -15F in Fairbanks and about -12F in the Salcha River valley. My sense is the Salcha River valley should be closer to -20F. Are any RAWS data used in the analysis? I feel that daily RAWS minimum temperatures are useful year-round. (But maximum temperatures are subject to serious warm bias issues and should not be used, especially in the warm season.)

Email: richard.james@prescientweather.com
Name: Richard James
Office: Prescient Weather Ltd
Mapname: Alaska ppt
URL: Click Here to view

Comments

I have some concerns about the east-west gradient of precipitation in the central-western Brooks Range. To the northeast of Kobuk, the values are 30-40" in the high terrain, but not far to the east (south of Anaktuvuk Pass) at nearly the same elevation the values are only around 15" or less. It appears there are only 3 years of valid data in the stations to the west (Imelyak, DAM8, DAM7), and most of the stations in the east (Pamichtuk etc) are similar, so I fear the observational support for the strong gradient is not robust. Perhaps the precipitation field is being constrained too strongly by these very few years of data?

Via email:

Hi Richard,
Just wanted to let you know that we received your three feedback submissions. They are VERY useful and well thought out. The Brooks Range precipitation issue is something that has been bothering me, as well. We do attempt to adjust the short term station data to better match long term averages, but the wetness in Jul-Sep seems to persist in above the Kobuk area, and then shows up in the annual totals. We will investigate further.
Chris

Feedback from NOAA National Weather Service Alaska Pacific River Forecast Center

Feedback came in the form of an email with a report attached.

Text excerpted from Anchorage RFC report on selected basin water balances by Lynker Technologies, Leesburg, VA:

Basin	Site Name	USGS Gage	LAT	LON	Local Area (sq. mi)	Total Area (sq. mi)	Calb Type	WFO
IRVA2	Indian River at Sitka	15087700	57.053	-135.314	12.1	12.1	H - 1hr	pajk
WULA2	Wulik River nr Kivalina	15747000	67.876	-163.674	705	705	H	pafg3
ABLA2	Kobuk River at Ambler	15744000	67.0869	-157.848	6420	6420	H	pafg3
KIAA2	Kobuk River at Kiana	15744500	66.9736	-160.131	3030	9480	L	pafg3
KNKA2	Knik River at Palmer	15281000	61.505	-149.031	1220	1220	H	pafc

Table 3-9. Calculated water balance components to be used for MAP generation

Basin	Est AET (in)	Calc MAP (inch)	Calc ROC (RO/MAP)
IRVA2	11.18	136.61	0.92
WULA2	4.68	23.78	0.79
ABLA2	5.03	23.95	0.78
KIAA2	5.79	27.47	0.78
KNKA2	4.20	75.42	0.94

From the APRFC email:

“Here are a few more numbers for water balance estimates of mean annual precipitation:

Power Creek near Cordova PWRA2 : 166"
Matanuska River MATA2 : 24.9"
Snow River SNOA2 : 120"

If you have any questions about where the basin outlet is you can check our main page for a map with gages. The shapefile should have the sub-basin identified in an attribute field that can be used to clip out MAP estimates from the newer prism data. Keep us posted on your results and let us know if you have any questions.”

**Based on this information, we (OSU) prepared a comparison of estimated and PRISM basin averaged precipitation for eight watersheds in Alaska, and found that several basins were too dry.

Basin	PRISM Avg	APRFC CALC	PRISM-APRFC	PRISM-APRFC%
ABLA2	21.41010536	23.95	-2.54	-10.60498808
IRVA2	134.8310133	136.61	-1.78	-1.302237517
KIAA2	21.20915911	27.47	-6.26	-22.79155768
KNKA2	76.65030231	75.42	1.23	1.63126798
MATA2	29.31143967	24.90	4.41	17.71662517
POWA2	139.2175609	166.00	-26.78	-16.13399948
SNOA2	118.7526461	120.00	-1.25	-1.039461592
WULA2	19.04552251	23.78	-4.73	-19.90949324

Results shown above reflect PRISM averages after pseudo stations were added to improve results. The water balances for ABLA2, KIAA2, and WULA2 confirmed that the southern slopes of the western Brooks Range are significantly wetter than previously thought. PRISM is still low in some basins, but given the issue of gauge undercatch in the observations and uncertainties in the water balance estimates, the level of agreement seems acceptable.

Regine Hock provided feedback on the earlier 1971-2000 PRISM data based on her work on the Juneau Icefield. She reported that PRISM appeared to be too wet in that area, because they were unable to model the mass balance of the glacier with degree-day factors that were within reasonable ranges.

We added several pseudo stations to the icefield to lower the precipitation in this area. However, there is still some doubt about the precipitation patterns here, because their modeling work appears to have used temperatures that were quite cold. Our 1971-2000 temperatures matched those observed on the icefield (obtained recently from JIRP and included in the 1981-2010 grids) well.