IEEE Sustech Alaska Workshop 2024

Monitoring for Climate Change Impacts

Robert Seitz, PE
Anchorage, Alaska

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Advancing technology for the benefit of humanity

WORKSHOP OBJECTIVE

Alaska and a Changing Climate; from the USDA Northwest Climate Hub

- Alaska is at the forefront of climate change. Because of its northern latitude and seasonal changes in sea ice, the state is warming at two to three times the rate of the global average. Rising temperatures can be tied to most of the effects of climate change in Alaska. Reduced ice coverage, including shrinking glaciers, retreating sea ice, and thawing permafrost, are all serious impacts of rapid warming.

We will :

- Investigate air temperature at selected locations.
- Investigate sub surface soil temperature to determine status of permafrost and active layers.
- Investigate dates of landfast ice and spring breakup.
- Look at river and lake ice thickness.

Specific Impacts to be Discussed

- Sea ice is rapidly receding
  - Results in coastal erosion from storm waves.
  - Increased warming from solar radiation
- Glaciers are shrinking.
  - Reduced cooling of rivers and ocean waters
- Thawing permafrost
  - Causes surface erosion
  - Impacts wildlife habitat.
  - Results in unstable structure foundations

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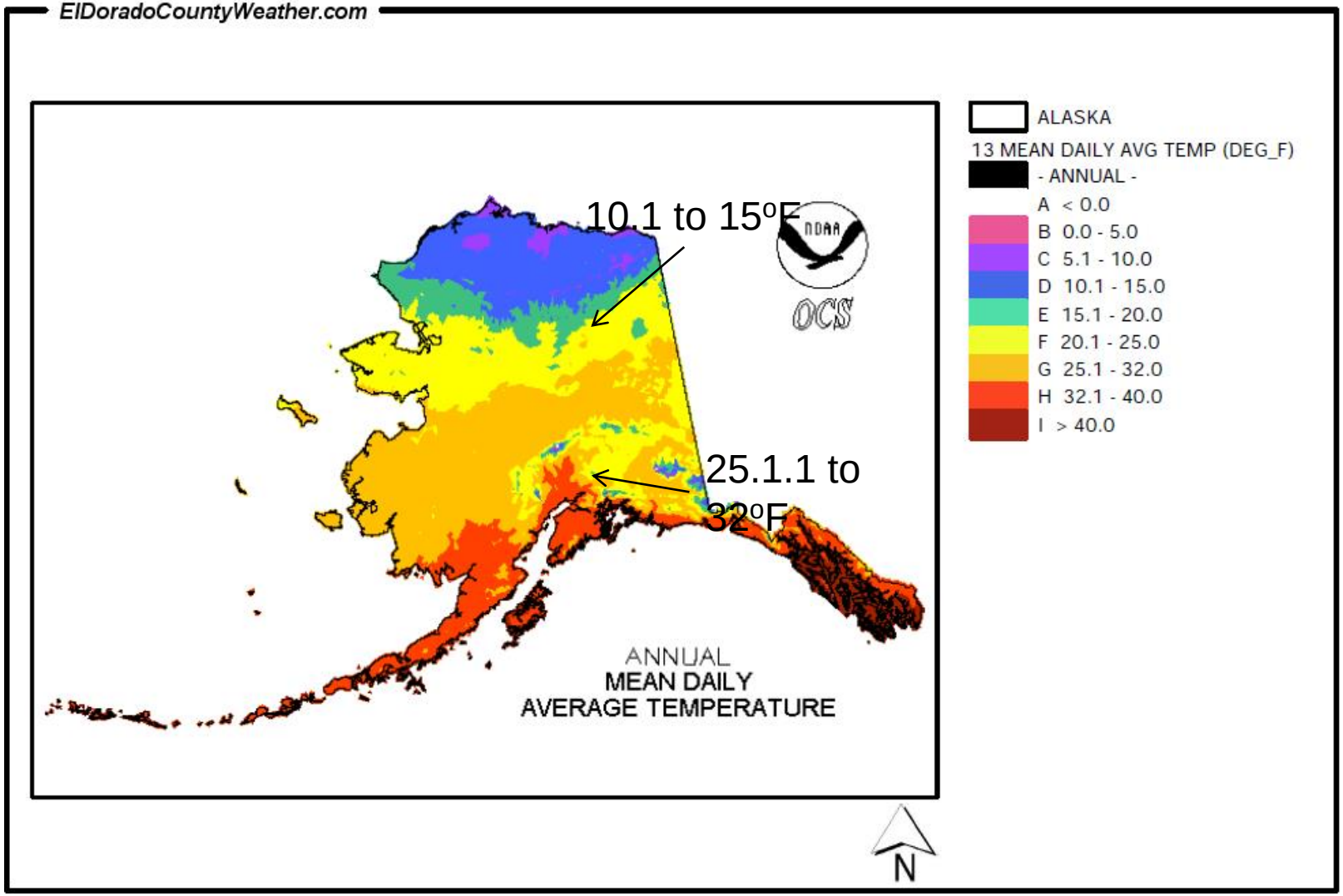
Specific Impacts Identified (cont'd)

- River bank erosion
- Increased rain
- Increased Wildfires
- Warming river and stream waters.
  - Impact on salmon and other fish

Let's look at Air Temperature



Air temperatures

- Representation of air temperatures as annual average anomolies are misleading.
- Need to see the actual temperatures.
- The average Alaskan air temperature are below freezing (now and historically).
  - The large change in the temperature is due to the absence of extreme low temperatures and not due to large changes in the high temperatures.

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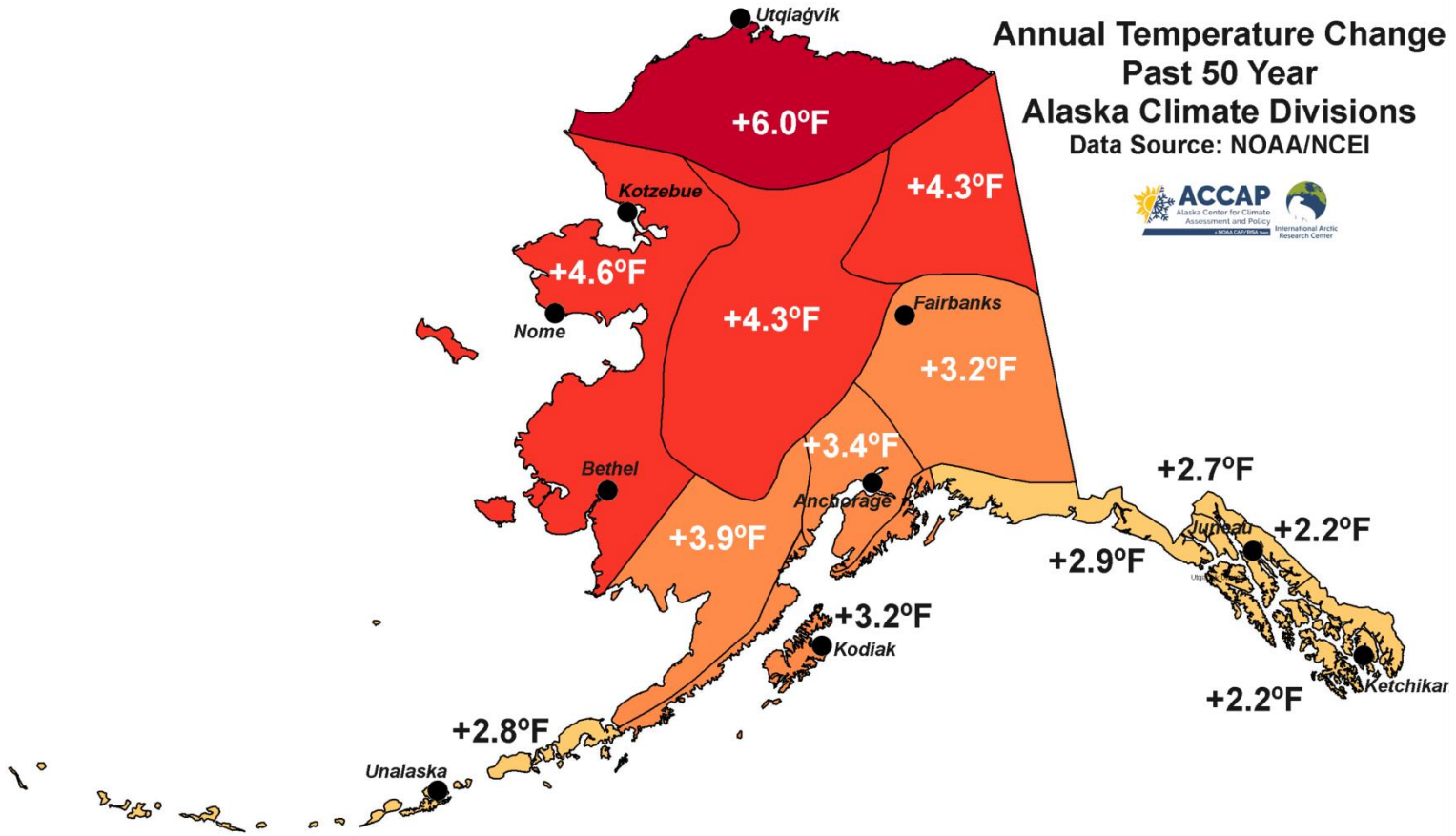
Let’s look at Average Air Temperature Anomaly



Alaska and a Changing Climate

Climate Hubs US Dept. of Agri.

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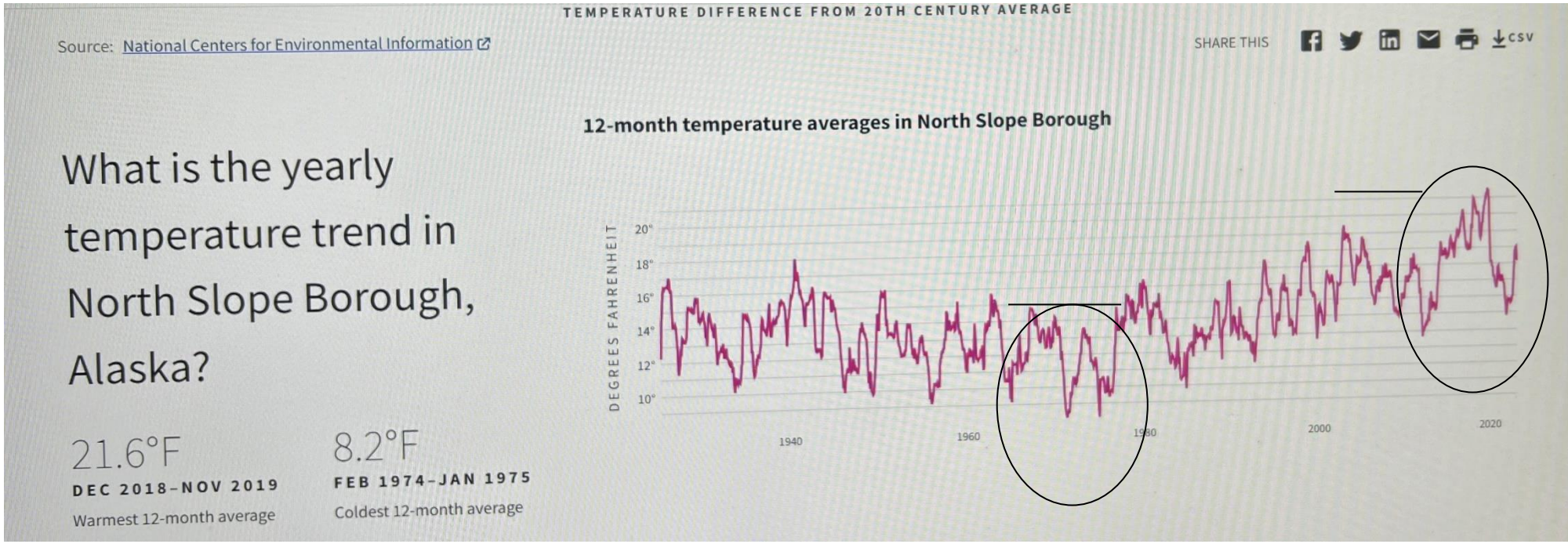
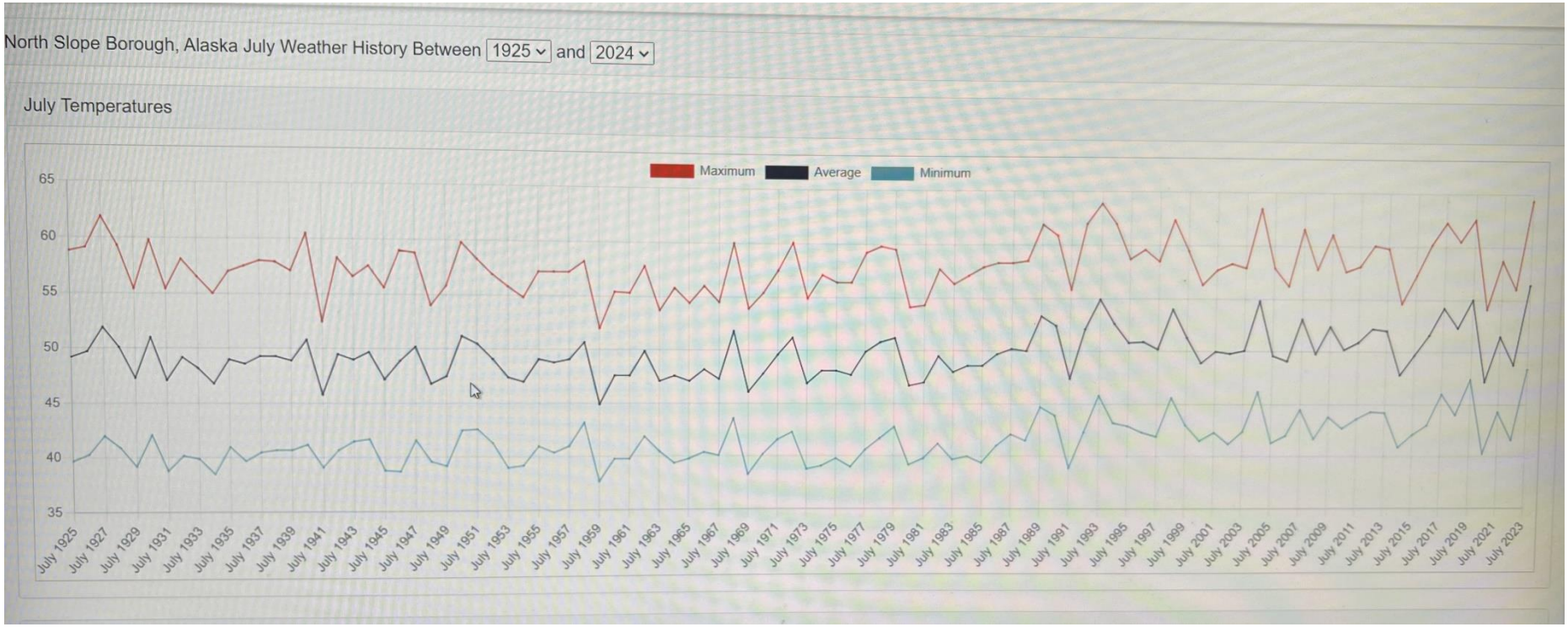
12 Month Temperature Averages in North Slope Borough



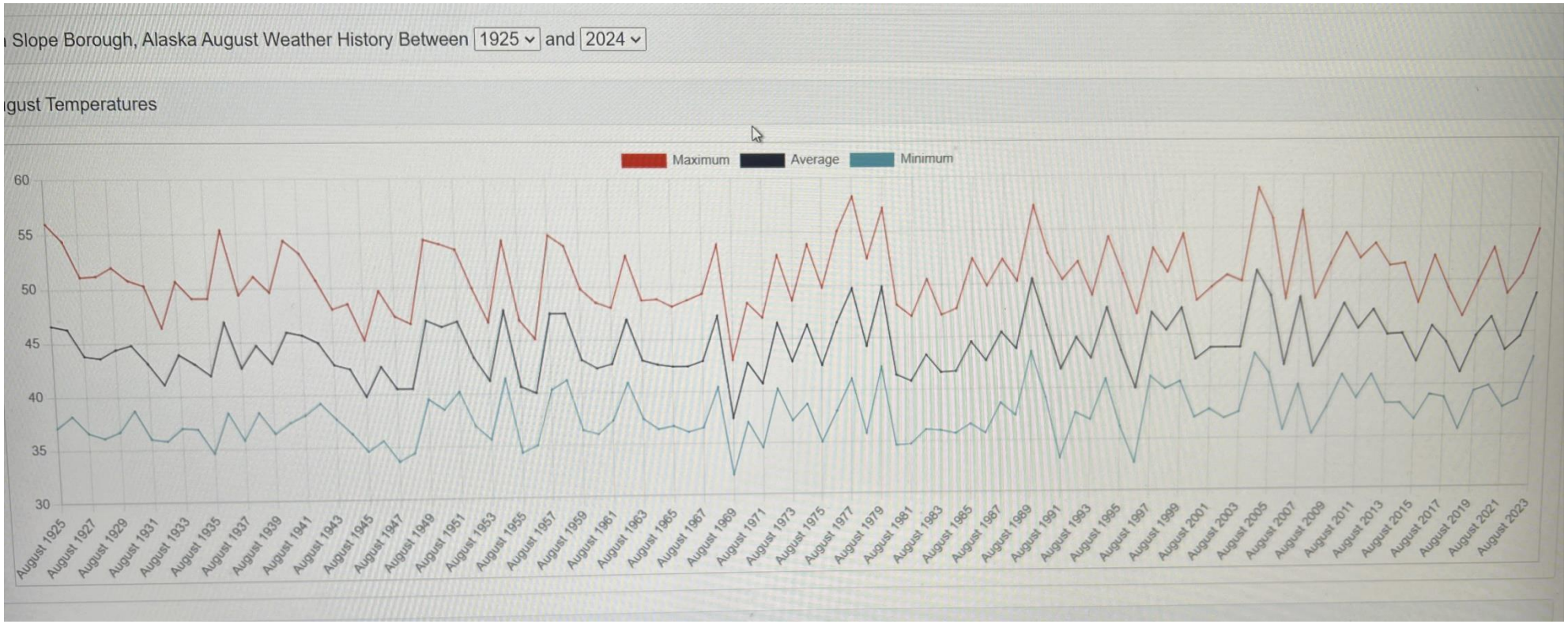
Next we'll look at temperatures, not just averages

North Slope Borough, Alaska Weather Data indystar.com



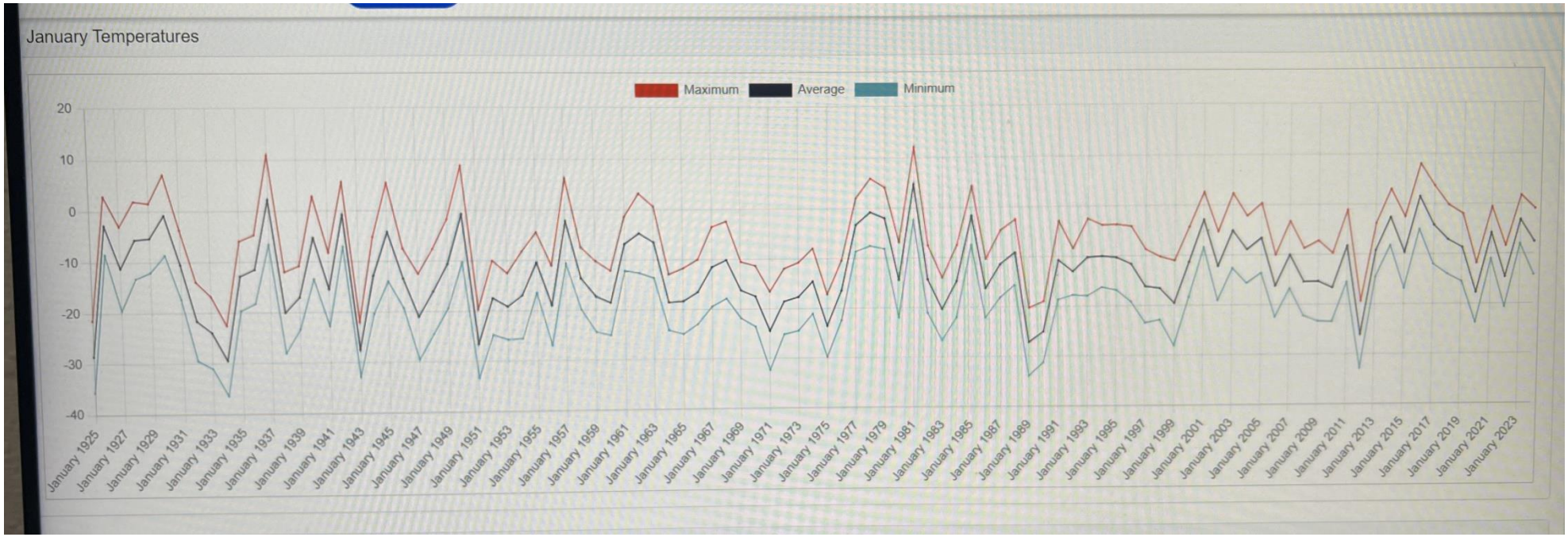
July

North Slope Borough, Alaska Weather Data indystar.com



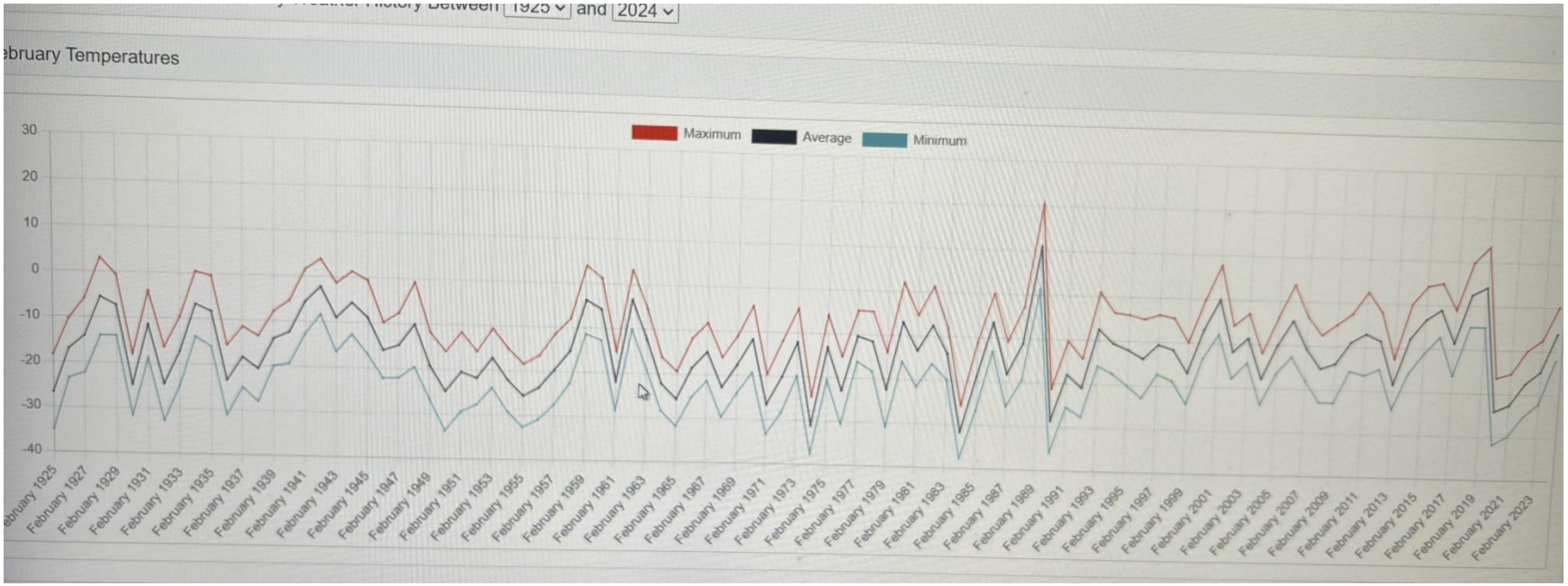
August

North Slope Borough, Alaska Weather Data indystar.com



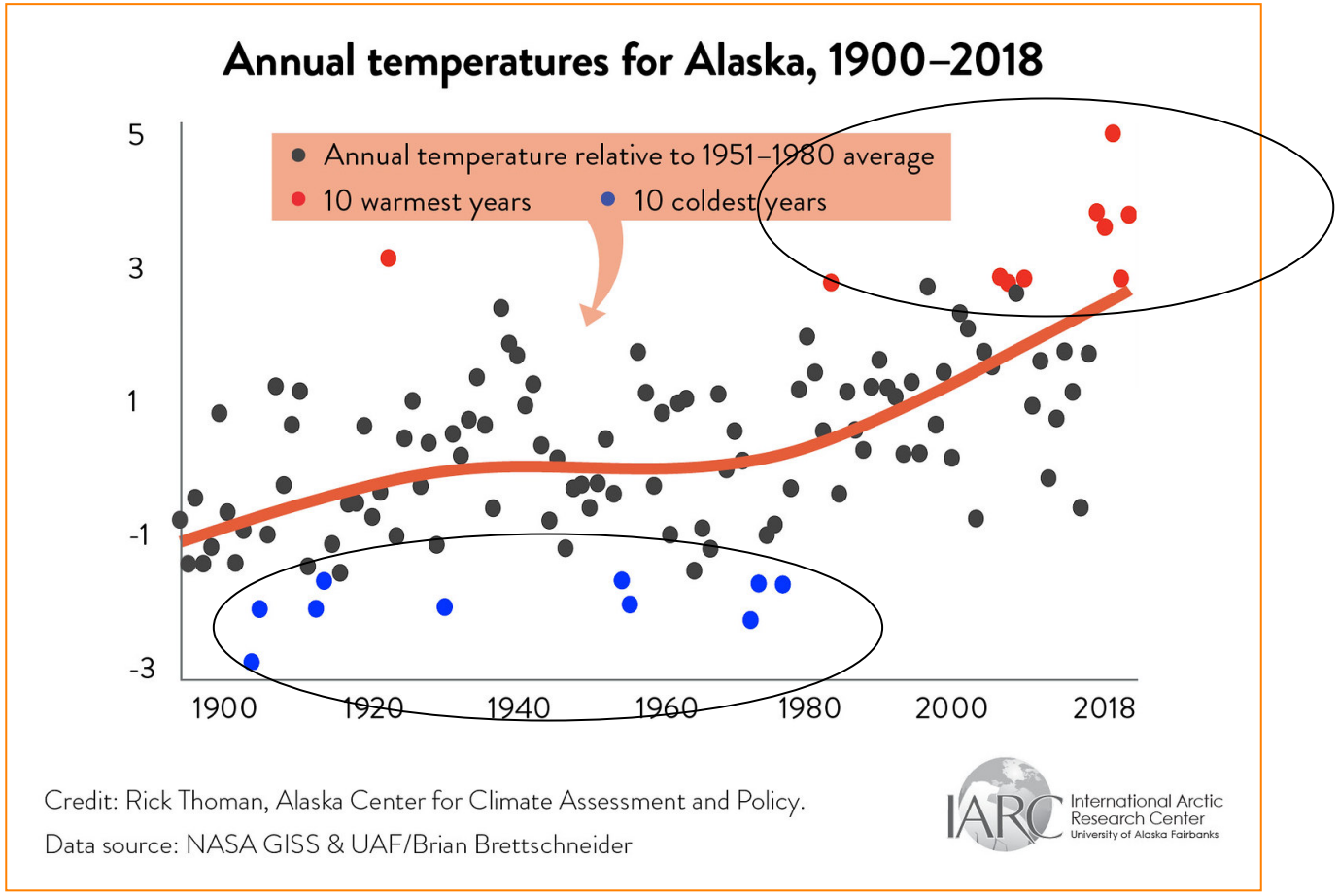
January

North Slope Borough, Alaska Weather Data indystar.com



February

The “warm” years really are just less “cold years”



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Alaska is not really warming, it is just less cold

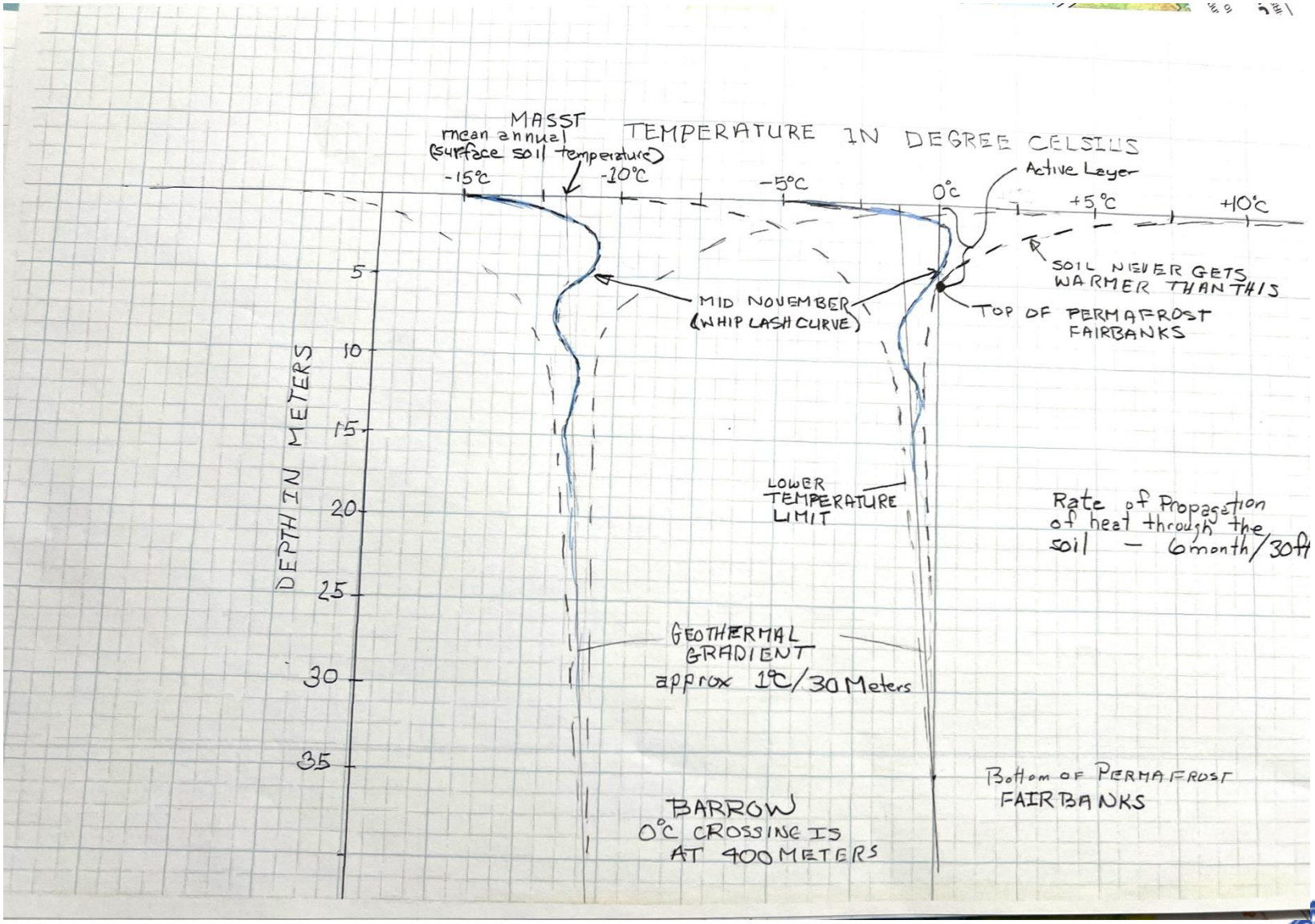
- The average annual air temperatures over much of Alaska are still below freezing.
- The average temperatures have become less cold so have more time above freezing which will allow soils to thaw a little deeper.
- Much less reason to panic than media indicates

- Note the lower temperatures for February for 2021, 2022, 2023 and even 2024.
- Don’t want to trend the data too soon. Reversals can always occur that will alter conclusions.

Soil Temperatures; Permafrost and Active layer

- The following slide was hand drawn from information in my notes from my CE 603 Arctic Engineering Course I took in 1974 from Dr. Eb Rice
- I shows representatives of the soil temperature curves for Fairbanks and for Barrow.

SOIL TEMPERATURE TRUMPET CURVES



Active Layer Data

- The active layer in Barrow is less than 1 meter
- The active layer in Fairbanks is about 5 meters
- Rate of propagation of heat through soil is approx. 6 month to travel 30ft (9.144meter). (or 5 ft/month)

Permafrost Data--Comments

- Permafrost data at Barrow shows depth of permafrost is about 400 meters deep.
- Permafrost data a Fairbanks shows depth of permafrost at about 35 meters.

- Where the MASST is just below 0^{o}C at thawed zone will propagate down through the summer that would be available to store items to be kept above freezing.
- Items likewize can be kept cool during the summer by burying as some depth in the soil.
- Increasing active layer depth would indicate that the permafrost layer is decreasing.

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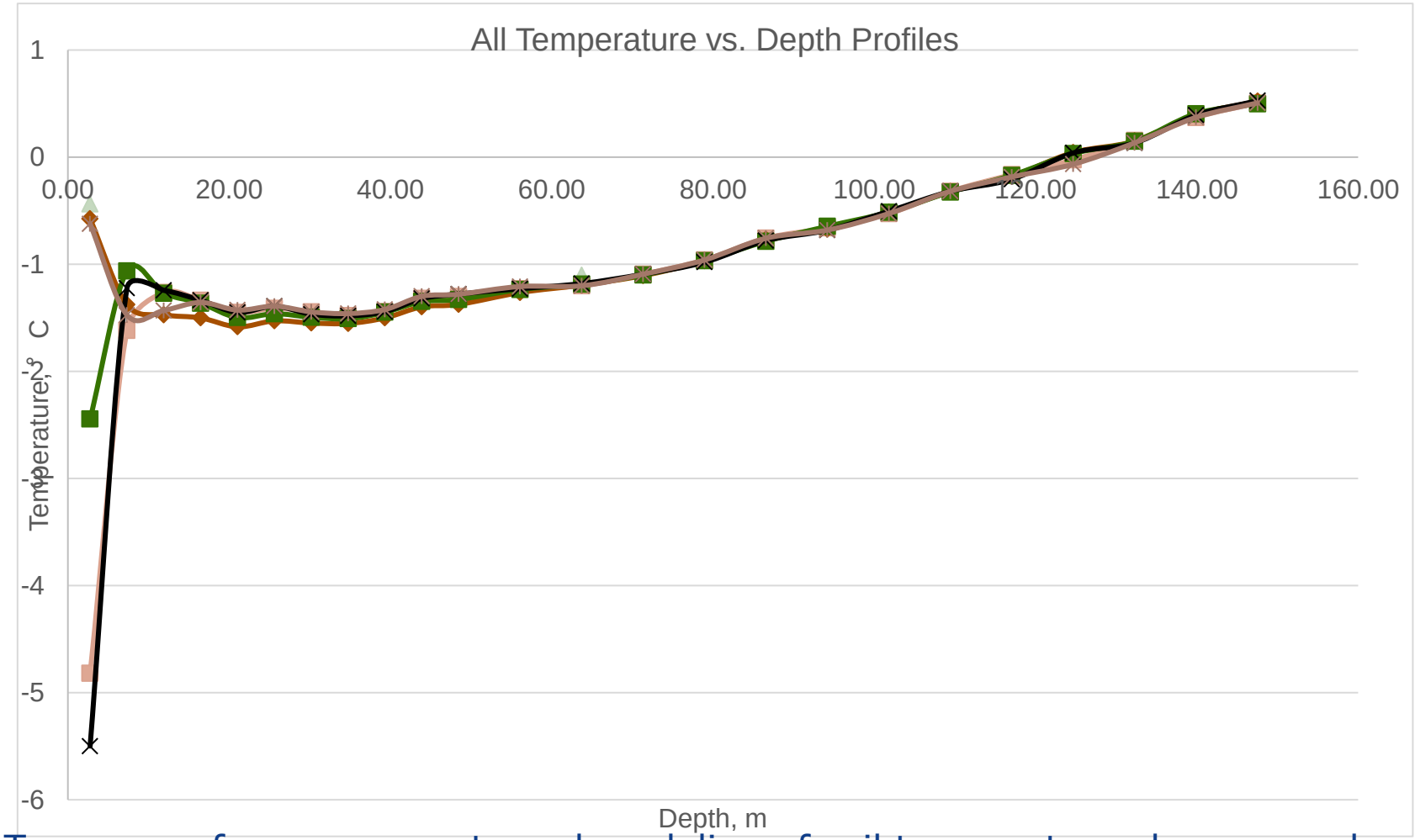
Red Dog Mine permafrost



Ten years of measurements and modeling of soil temperature changes and their effects on permafrost in Northwestern Alaska **Joseph F. Batir**, **Matthew J. Hornbach**, **David D. Blackwell** **Global and Planetary Change** Volume 148, January 2017,

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Data for Red Dog Mine

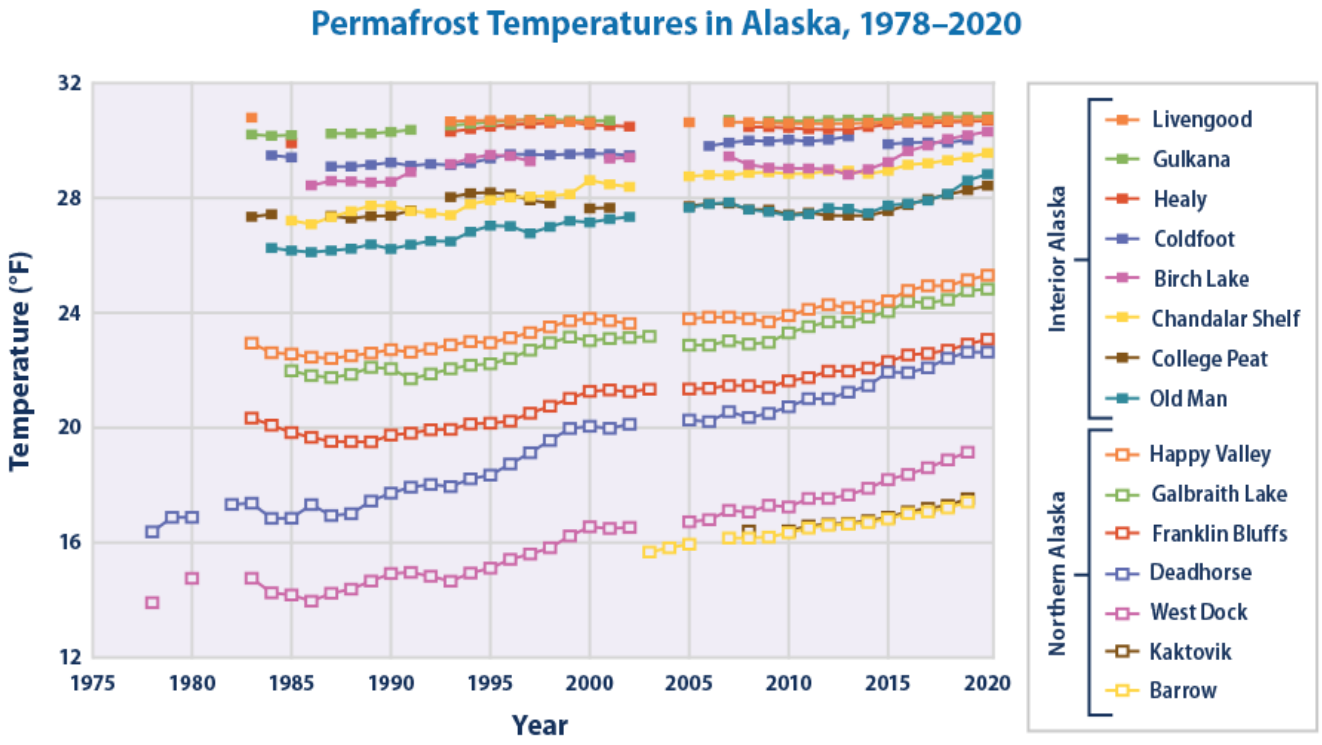
Depth (m)									
		15-Dec-96		15-Apr-98		10-Apr-99		10-Dec-99	
2.74		-0.574685		-2.44441		-5.49925		-0.6219	
7.32		-1.375304		-1.06086		-1.2226		-1.473757	
11.89		-1.470833		-1.27129		-1.24316		-1.430396	
16.46		-1.499561		-1.36323		-1.33539		-1.355558	
21.03		-1.583124		-1.4977		-1.44843		-1.427563	
25.60		-1.527337		-1.46064		-1.39065		-1.39065	
30.18		-1.547114		-1.49372		-1.46557		-1.44386	
34.75		-1.551185		-1.50772		-1.4806		-1.459308	
39.32		-1.499725		-1.44761		-1.44132		-1.421559	
43.89		-1.395638		-1.34721		-1.31959		-1.298464	
48.46		-1.373869		-1.32804		-1.27718		-1.278858	
56.08		-1.262614		-1.23487		-1.22689		-1.206758	
63.70		-1.193424		-1.18621		-1.17969		-1.200155	
71.32		-1.104678		-1.10007		-1.09231		-1.092309	
78.94		-0.966843		-0.96605		-0.98003		-0.959194	
86.56		-0.766854		-0.78555		-0.77751		-0.756687	
94.18		-0.670115		-0.64541		-0.68066		-0.680371	
101.80		-0.511768		-0.51316		-0.50376		-0.526038	
109.42		-0.320573		-0.32557		-0.31807		-0.31843	
117.04		-0.177012		-0.16954		-0.20551		-0.184088	
124.66		0.044526		0.033565		0.040732		-0.065741	
132.28		0.150681		0.148142		0.133979		0.133846	Above freezing values below 125m
139.90		0.39803		0.406234		0.393472		0.371594	
147.52		0.522576		0.498489		0.527822		0.506359	

Permafrost Data--Comments

- Top of curve is at 8 meters depth. Need to see if the depth of the active layer is increasing, and if so at what rate.
- Need the data for the active layer from the surface down to where the soil temperature does not change seasonally

- Foundation pile set to depth well below the active layer depth would support surface structures.

Permafrost Temperatures



Data source: University of Alaska Fairbanks. 2021. Sites map. Accessed February 2021. https://permafrost.gi.alaska.edu/sites_map.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Measurements at these sites were taken at depths between 49 and 85 feet.

- Foundation pile set to depth well below the active layer depth would support surface structures.
  - Need the data for the active layer from the surface down to where the soil temperature does not change seasonally

Lake and River Ice Thickness

Latitude	Longitude
71.199	-156.665

RegionName	Observation Year	Observation Day_doy	NumberofLakesSurveyed_n	MeasurementType	Ave ObservedIce Thickness_cm	Maximum Ice Thickness_cm	Thickness Inch
Barrow	1962	2-Apr	1	multiple	182	200	7.87
Barrow	1966	18-Apr	1	multiple	154	163	6.42
Barrow	1967	29-Apr	1	multiple	156	159	6.26
Barrow	1970	28-Mar	1	multiple	191	211	8.31
Barrow	1971	22-Mar	1	multiple	185	206	8.11
Barrow	1972	15-Apr	1	multiple	184	194	7.64
Barrow	1973	28-Apr	1	multiple	193	199	7.83
Barrow	1992	25-Apr	3	multiple	196	202	7.95
Barrow	1997	15-Apr	2	multiple	153	164	6.46
Barrow	2003	27-Mar	1	multiple	171	188	7.40
Barrow	2004	30-Mar	1	multiple	155	169	6.65
Barrow	2005	12-May	1	multiple	192	194	7.64
Barrow	2006	29-Mar	1	multiple	131	145	5.71
Barrow	2007	4-May	2	single	170	175	6.89
Barrow	2008	30-Mar	2	single	142	153	6.02
Barrow	2009	8-Mar	1	single	127	151	5.94
Barrow	2010	17-Mar	1	multiple	142	161	6.34
Barrow	2011	30-Apr	1	multiple	170	174	6.85
Barrow	2012	7-Apr	6	single	167	177	6.97
Barrow	2013	7-Apr	5	single	166	177	6.97
Barrow	2014	14-Apr	6	single	121	126	4.96
Barrow	2015	7-Apr	6	multiple	139	145	5.71
Barrrow	2016	4-May	2	multiple	181	183	7.20
Barrow	2017	28-Mar	10	multiple	108	120	4.72
Barrow	2018	12-Apr	3	multiple	106	115	4.53

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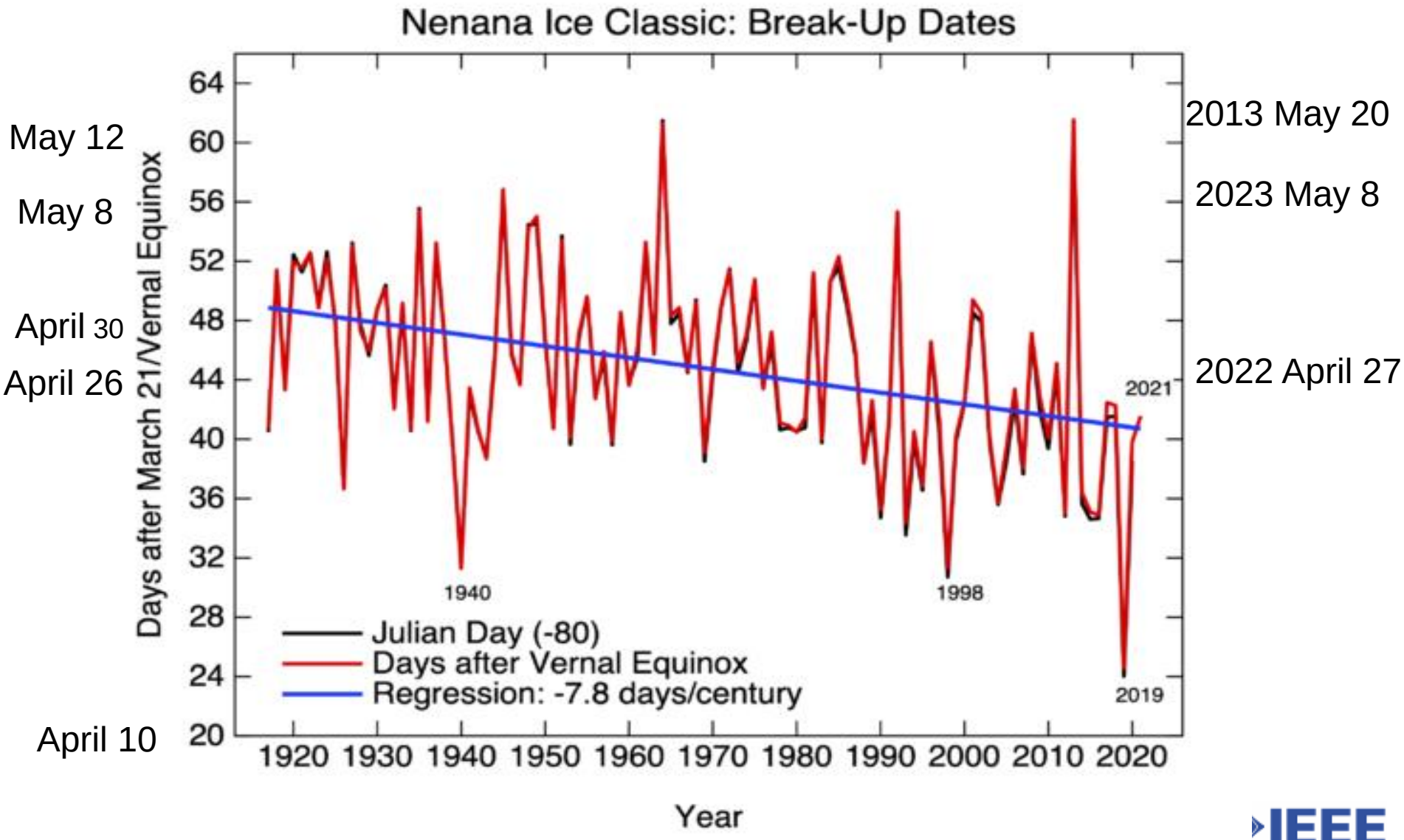
Lake and River Ice Thickness; comments

- Ice is thicker in colder winters.
- Snow cover will reduce ice thickness at any temperature.

Lake and River Ice Thickness



As of May 4th the Ice has not gone out

- **2024 Ice Measurements:**
-
- January 29 - 37.5 Inches
- February 17 - 42 Inches
- February 24 - 44 inches
- March 3 - 49 Inches
- March 10 - 50 Inches
- March 17 - 48 Inches
- March 23 - 50 Inches
- March 31 - 44 Inches
- April 4 - 50.5 inches
- April 8 - 50 inches
- April 12 - 43 Inches

Nenana Ice Classic Tanana River

- **2023 Ice Measurements:**
- Jan 3 - 22 Inches
- Feb 2 - 25.8 Inches
- Feb 15 - 26.2 INCHES
- March 1 - 27.6 INCHES
- March 14 - 31.3 Inches
- March 21 - 32.3 Inches
- March 24 - 30 inches
- March 27 - 26.3 Inches
- March 31 - 30.6 Inches
- April 3 - 30.8 inches
- April 7 - 28.8 Inches
- April 10 - 30.5 Inches
- April 14 - 29.5 Inches
- April 17 - 29.5 Inches
- April 21 - 29.8 Inches

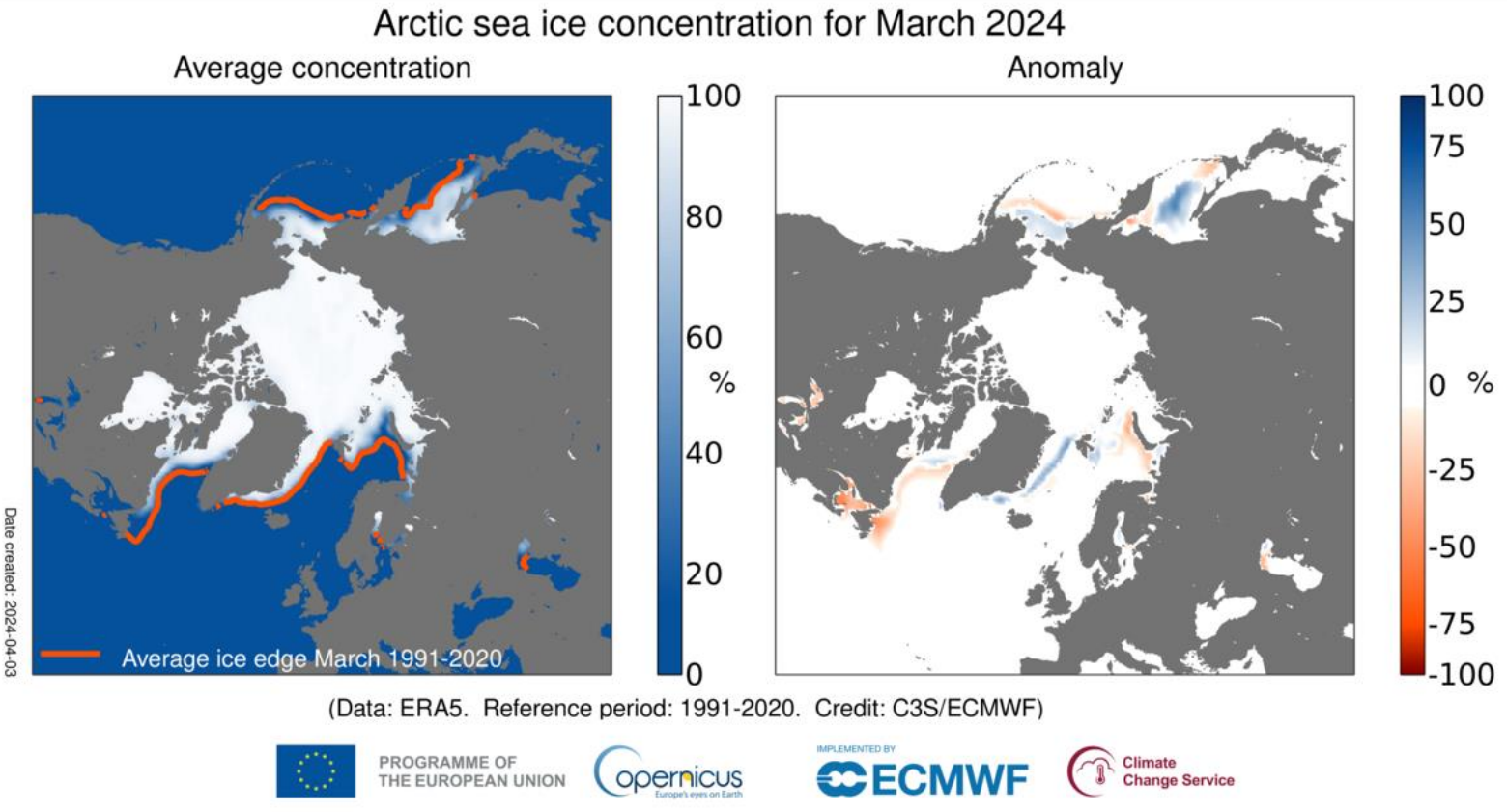
Nenana Ice Classic Tanana River

2013 Ice Measurements:

- Jan 14 - 41 Inches
- FEB 6 - 42 INCHES
- FEB 20 - 51 INCHES
- MARCH 4 - 48 INCHES
- MARCH 7 - 48.7 INCHES
- MARCH 10 - 52.8 INCHES
- MARCH 14 - 50 INCHES
- MARCH 18 - 50.3 INCHES
- MARCH 21 - 50 INCHES
- MARCH 25 - 51 INCHES
- MARCH 28 - 47.2 INCHES
- APRIL 1 - 49.3 INCHES
- APRIL 4 - 44.3 INCHES
- APRIL 8 - 50 INCHES
- APRIL 11 - 50 INCHES
- APRIL 15 - 50.3 INCHES
- APRIL 18 - 49.6 INCHES
- APRIL 22 - 49.2 INCHES
- APRIL 25 - 51 INCHES
- APRIL 29 - 47 INCHES
- MAY 2 - 36.7 INCHES
- MAY 6 - 40 INCHES

Lake and River Ice Thickness

- The last few records for Barrow lake ice were relatively thin. 2024 should result in much thicker ice as this was a cold and hard winter.
- Trends seem to be sought too soon as a cold winter occurs often enough to stall the warming.


Arctic sea ice concentration for March 2024
Average concentration
Anomaly
Average ice edge March 1991-2020
100
80
60
%
40
20
0
100
75
50
25
0 %
-25
-50
-75
-100
Date created: 2024-04-03
(Data: ERA5. Reference period: 1991-2020. Credit: C3S/ECMWF)
PROGRAMME OF THE EUROPEAN UNION
Copernicus
Europe's eyes on Earth
IMPLEMENTED BY
ECMWF
Climate Change Service

Arctic Sea Ice

- **The Arctic Sea Ice Extent is not decreasing every year. This needs to be continually monitored.**
- **Time of land fast ice each fall depends on how far offshore the end of summer ice has receded, and how warm the fall air temperatures are.**
- **There seems to be a increase in multiyear ice each year although I did not show anything in this presentation it is something I track. Could be our Arctic sea ice is making a come back.**

Arctic Sea Ice—mitigation for coastal erosion

- General solution has been to reinforce the coastal banks.
- Alternate solution would be to install artificial barriers offshore to expend the ocean wave energy before it reaches shore.

Conclusion

- Alaska is not really warming 2 to 4 times faster than the rest of the world. The analysis used to represent this effect appears to be purposefully used to develop fear.
- There is some warming of the permafrost and some increase in depth of the actively layer, but it only takes 2 or 3 cold winters to reverse that trend

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Recommendation for Monitor of Alaska Conditions

- The monitoring of permafrost should include monitoring of the active layer and the near surface permafrost.
- The soil temperatures should be presented for their own value and separate from whatever other research objective was intended (*ie CO2 release*)

Recommendation for Monitor of Alaska Conditions

- While comparison of annual relative temperature averages provides very sensitive detection of changes it is important that actual temperature values are also used in the valuations as lack of extreme cold conditions some years does provide a sense of warming where no warming actually exists.

Recommendation for Monitor of Alaska Conditions

- The importance of monitoring of conditions in the Arctic and sub-arctic is for safety of the citizens of Alaska and for the assurance of continued productivity.
- Creating a crisis out of

THANK YOU