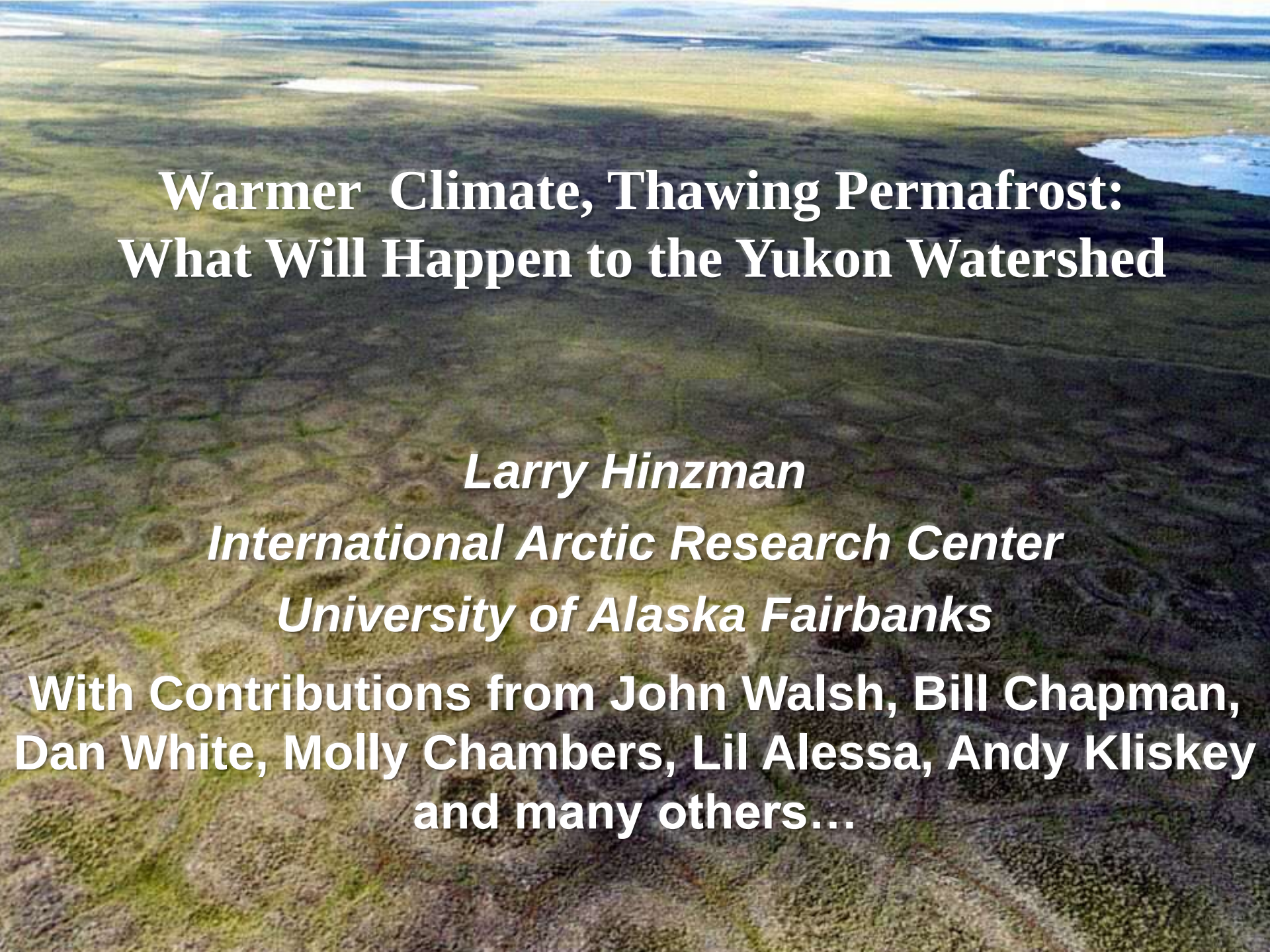


Warmer Climate, Thawing Permafrost: What Will Happen to the Yukon Watershed

Larry Hinzman

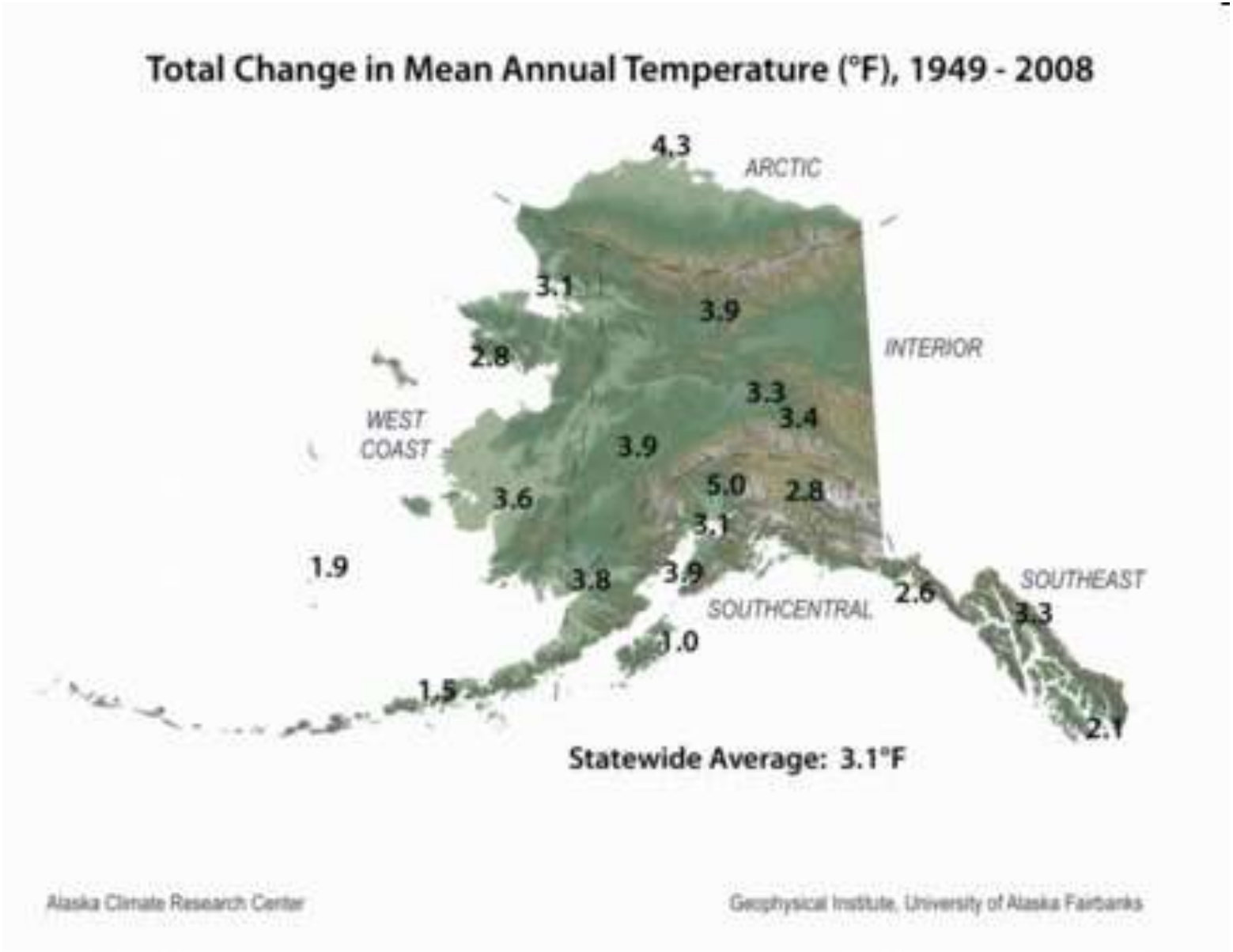
International Arctic Research Center

University of Alaska Fairbanks

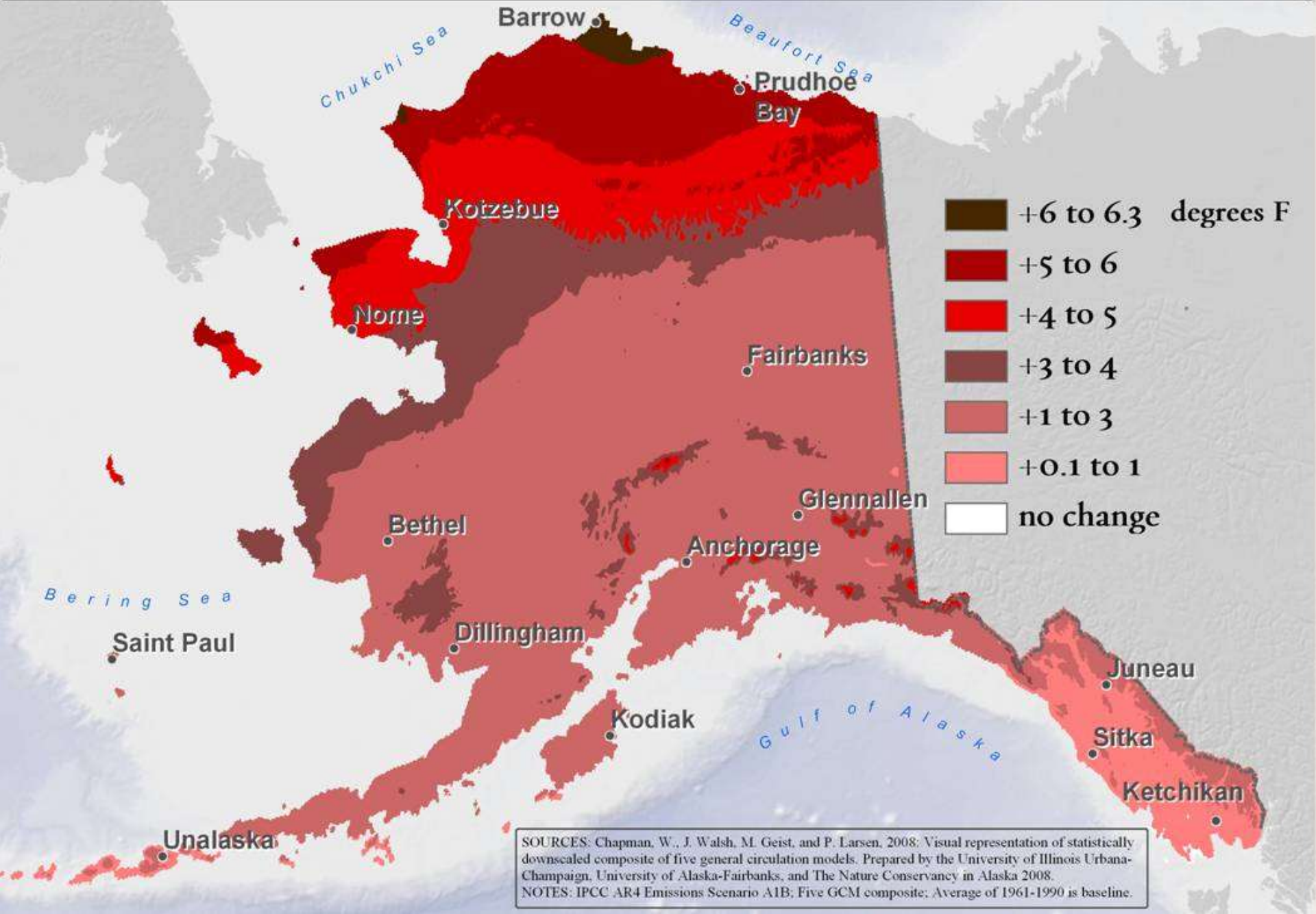
With Contributions from John Walsh, Bill Chapman, Dan White, Molly Chambers, Lil Alessa, Andy Kliskey and many others…

Temperature change in Alaska, 1949-2008

[from Alaska Climate Research Center]



Projected Annual Temperature Change 1961-90 to 2051-60



SOURCES: Chapman, W., J. Walsh, M. Geist, and P. Larsen, 2008: Visual representation of statistically downscaled composite of five general circulation models. Prepared by the University of Illinois Urbana-Champaign, University of Alaska-Fairbanks, and The Nature Conservancy in Alaska 2008.
NOTES: IPCC AR4 Emissions Scenario A1B; Five GCM composite; Average of 1961-1990 is baseline.

Changes of Alaskan station temperatures (°F), 1949-2008

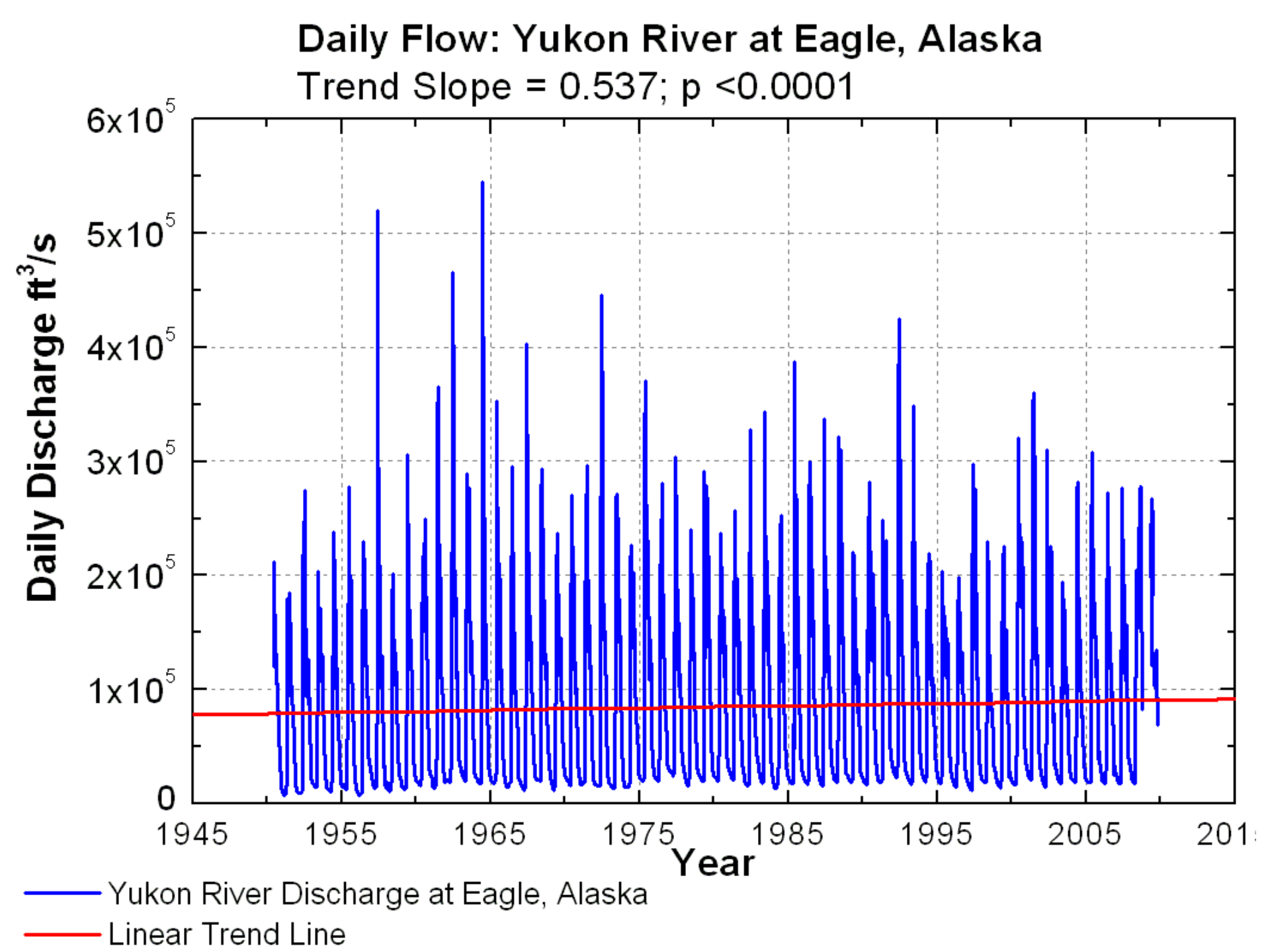
[from Alaska Climate Research Center]

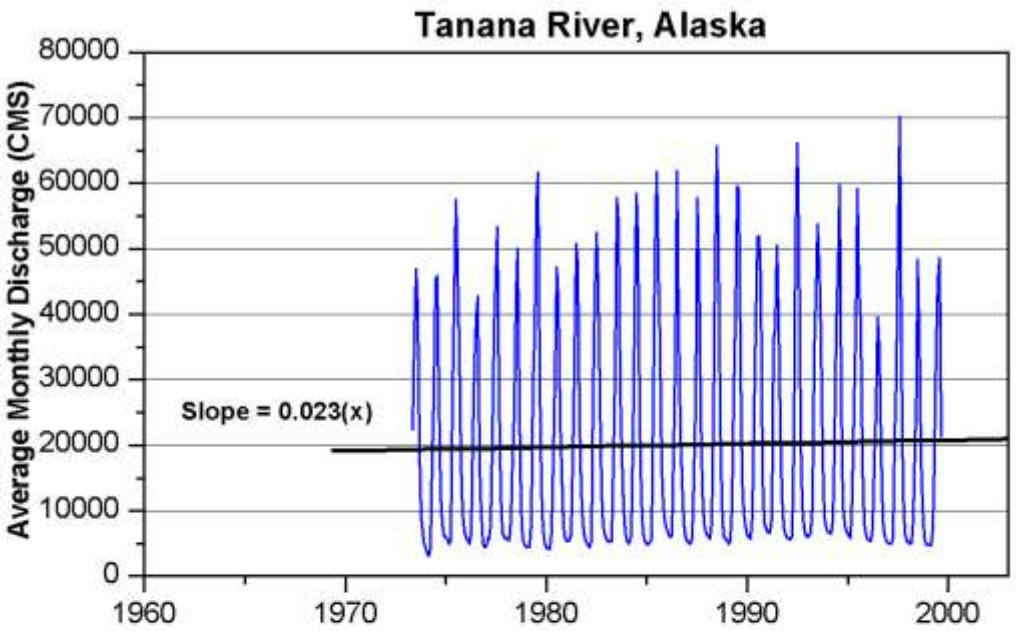
Total Change in Mean Seasonal and Annual Temperature (°F), 1949 - 2008

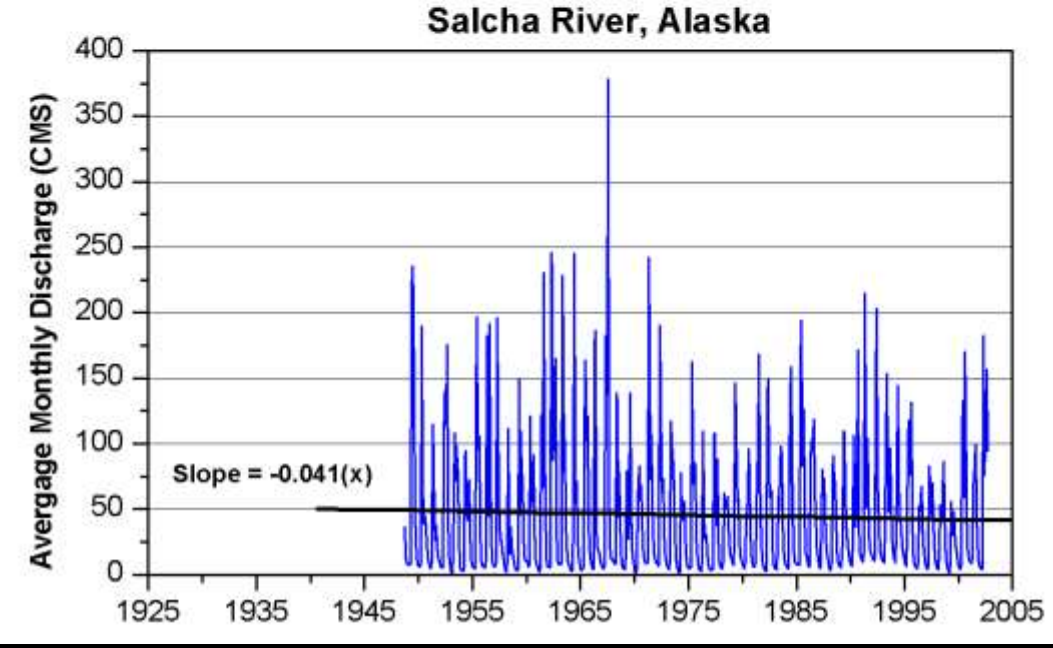
Region	Location	Winter	Spring	Summer	Autumn	Annual
Arctic	Barrow	6.5	4.4	2.8	3.4	4.3
Interior	Bettles	8.5	4.6	1.8	1.1	3.9
	Big Delta	9.2	3.5	1.2	-0.2	3.4
	Fairbanks	7.7	3.8	2.3	-0.4	3.3
	McGrath	7.4	4.8	2.7	0.6	3.9
West Coast	Kotzebue	6.6	1.8	2.5	1.6	3.1
	Nome	4.4	3.6	2.5	0.6	2.8
	Bethel	6.6	5.0	2.3	0.1	3.6
	King Salmon	8.1	4.7	1.8	0.6	3.8
	Cold Bay	1.5	1.8	1.8	0.9	1.5
	St Paul	1.0	2.4	2.8	1.3	1.9
Southcentral	Anchorage	6.8	3.6	1.6	1.4	3.1
	Talkeetna	8.9	5.4	3.1	2.4	5.0
	Gulkana	8.1	2.4	0.9	0	2.8
	Homer	6.3	4.0	3.4	1.7	3.9
	Kodiak	0.9	2.3	1.2	-0.4	1.0
Southeast	Yakutat	4.9	3.1	1.8	0.3	2.6
	Juneau	6.6	3.1	2.1	1.4	3.3
	Annette	3.9	2.5	1.7	0.2	2.1
	Average	6.0	3.5	2.1	0.9	3.1

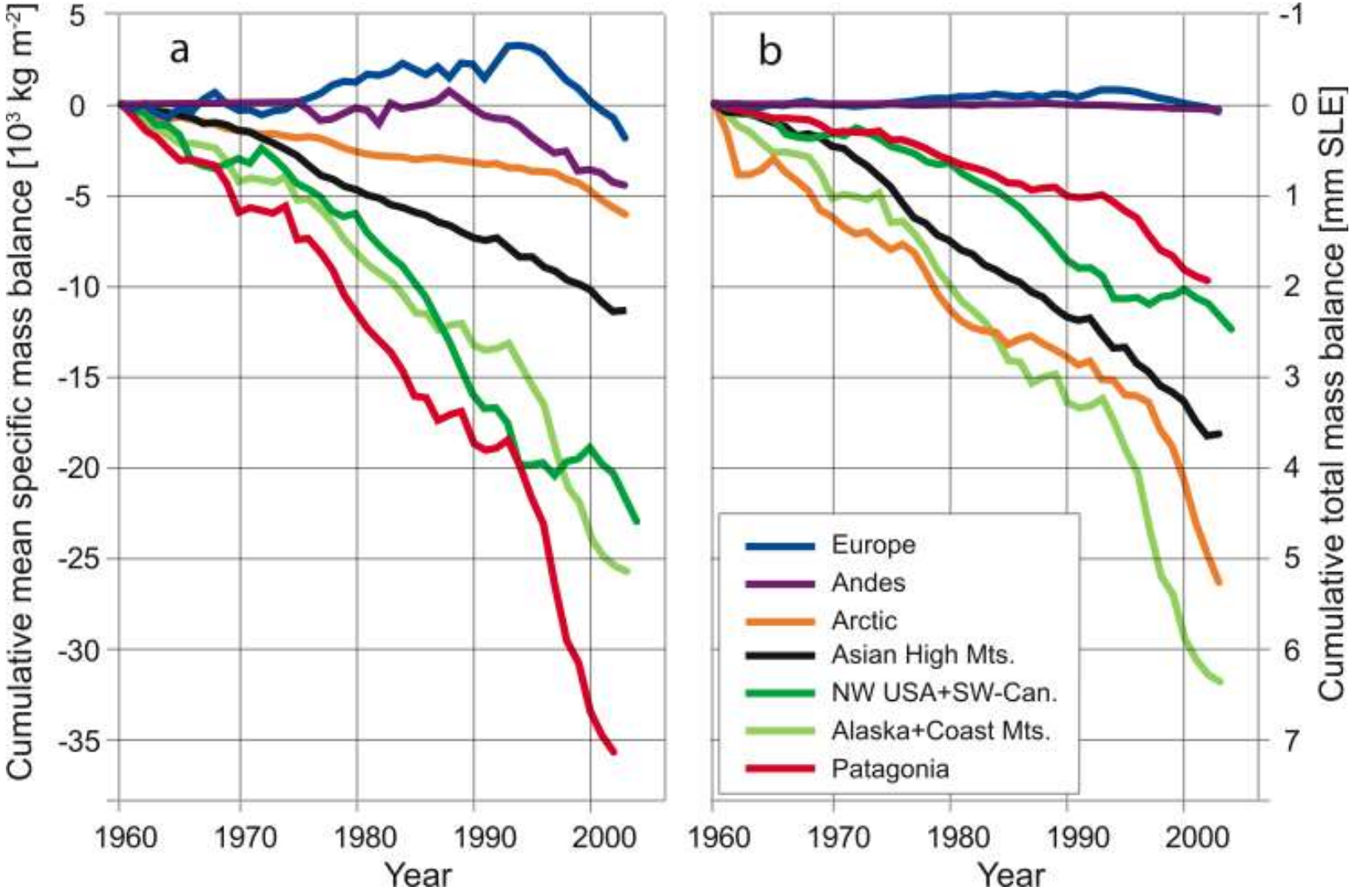
Alaska Climate Research Center

Geophysical Institute, University of Alaska Fairbanks

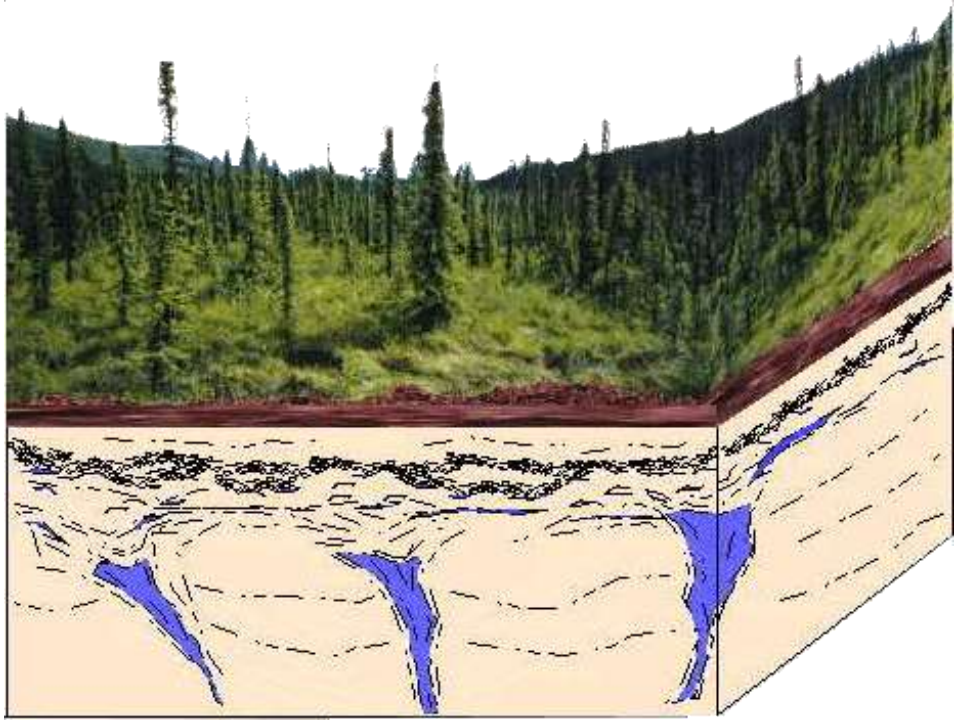

Daily Flow: Yukon River at Eagle, Alaska
Trend Slope = 0.537; p <0.0001
Daily Discharge ft3/s
6x10^5
5x10^5
4x10^5
3x10^5
2x10^5
1x10^5
0
1945
1955
1965
1975
1985
1995
2005
Year
Yukon River Discharge at Eagle, Alaska
Linear Trend Line

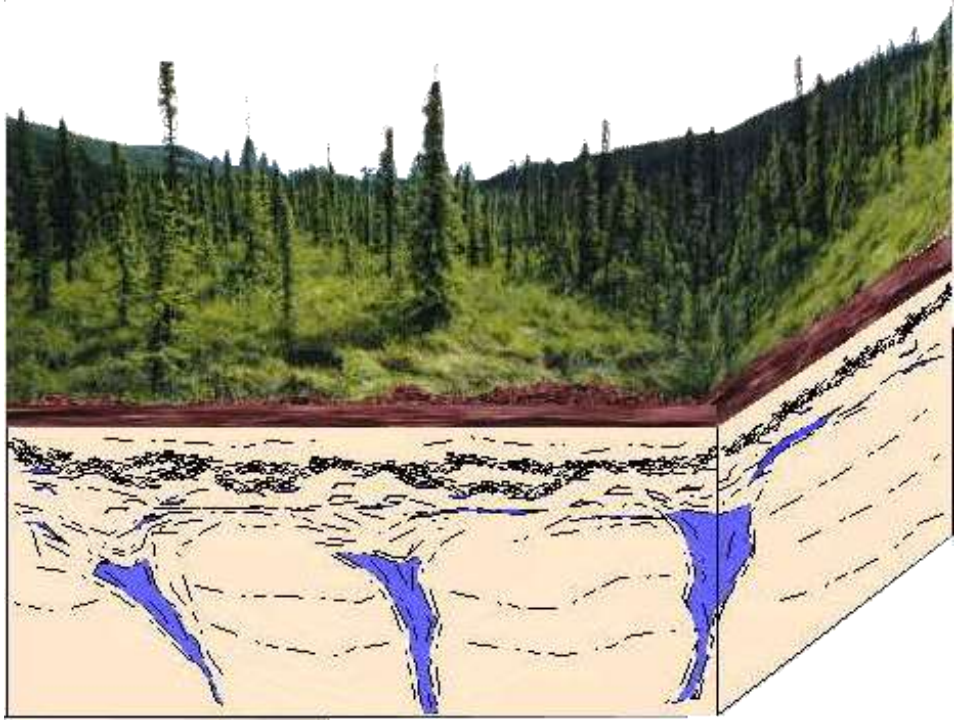

Tanana River, Alaska
Average Monthly Discharge (CMS)
80000
70000
60000
50000
40000
30000
20000
10000
0
Slope = 0.023(x)
1960
1970
1980
1990
2000

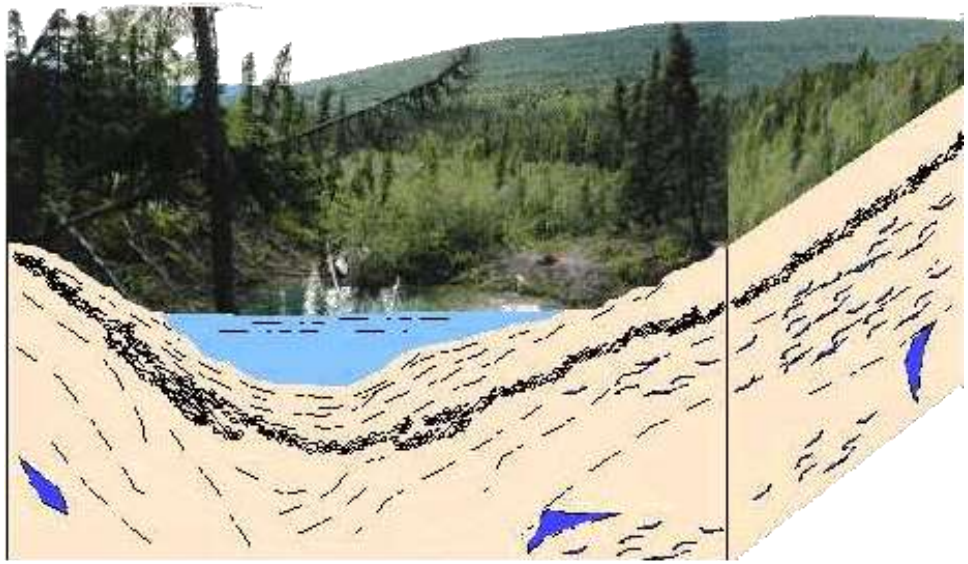

Salcha River, Alaska
Avergage Monthly Discharge (CMS)
400
350
300
250
200
150
100
50
0
Slope = -0.041(x)
1925
1935
1945
1955
1965
1975
1985
1995
2005



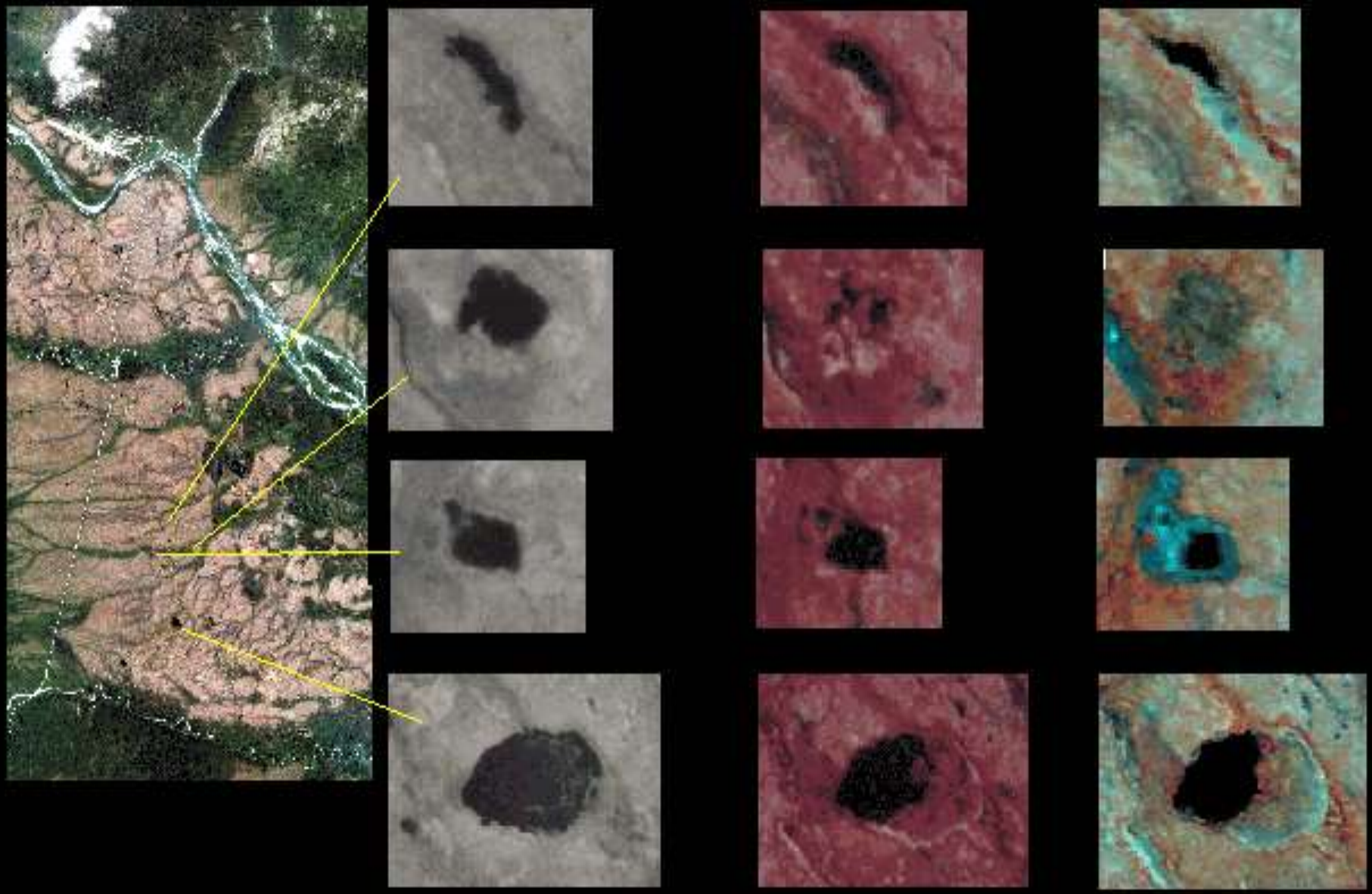
Dyurgerov and Meier, 2005

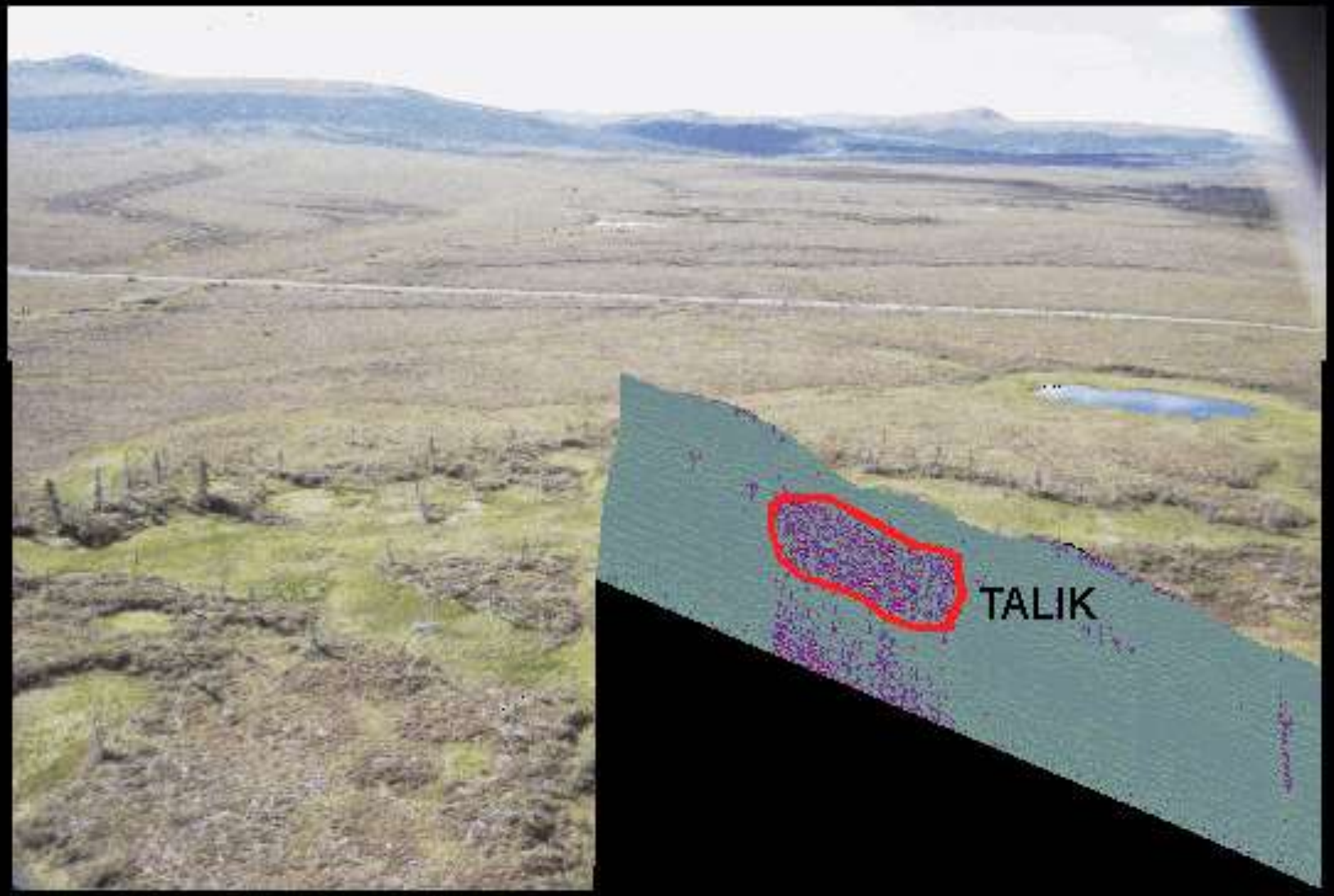


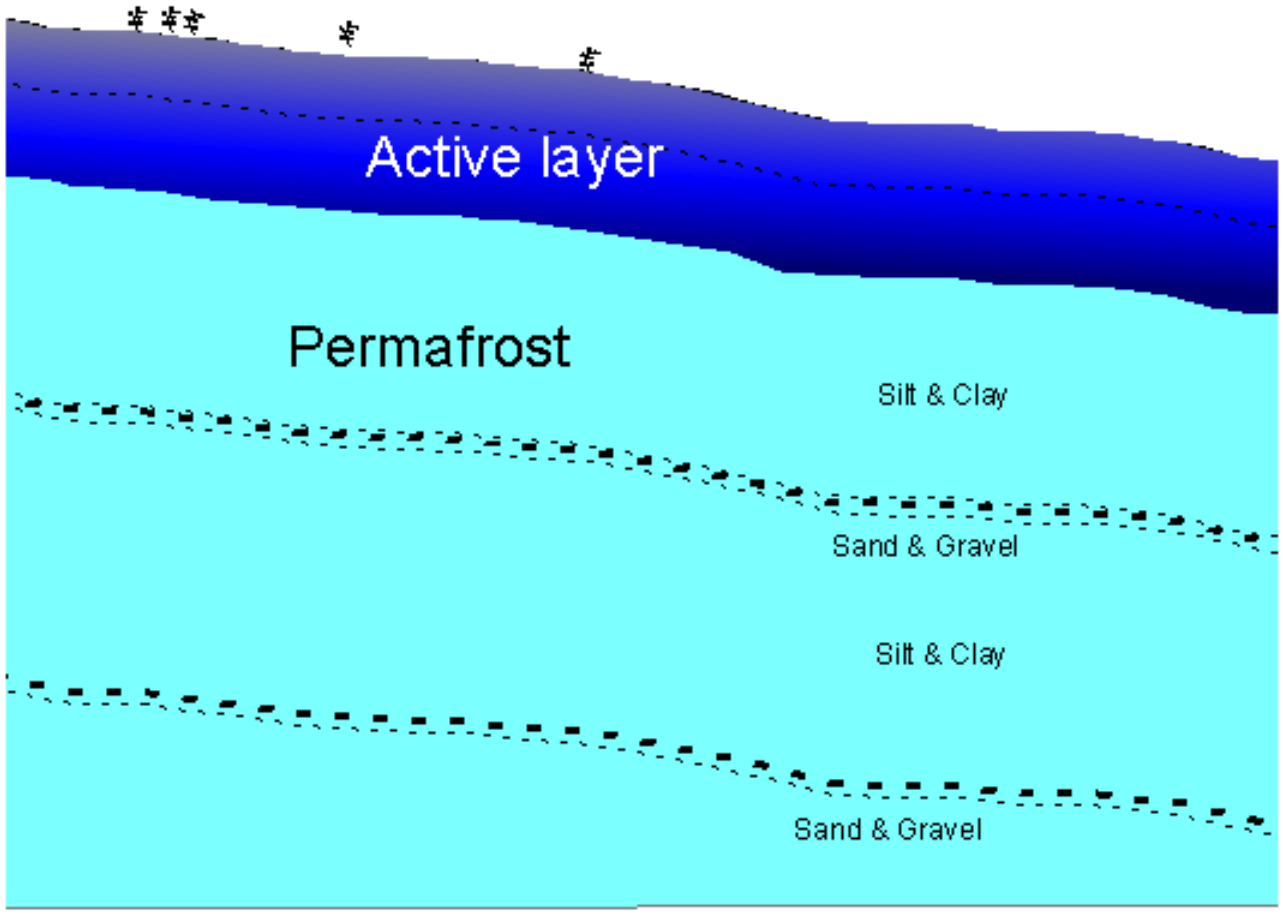


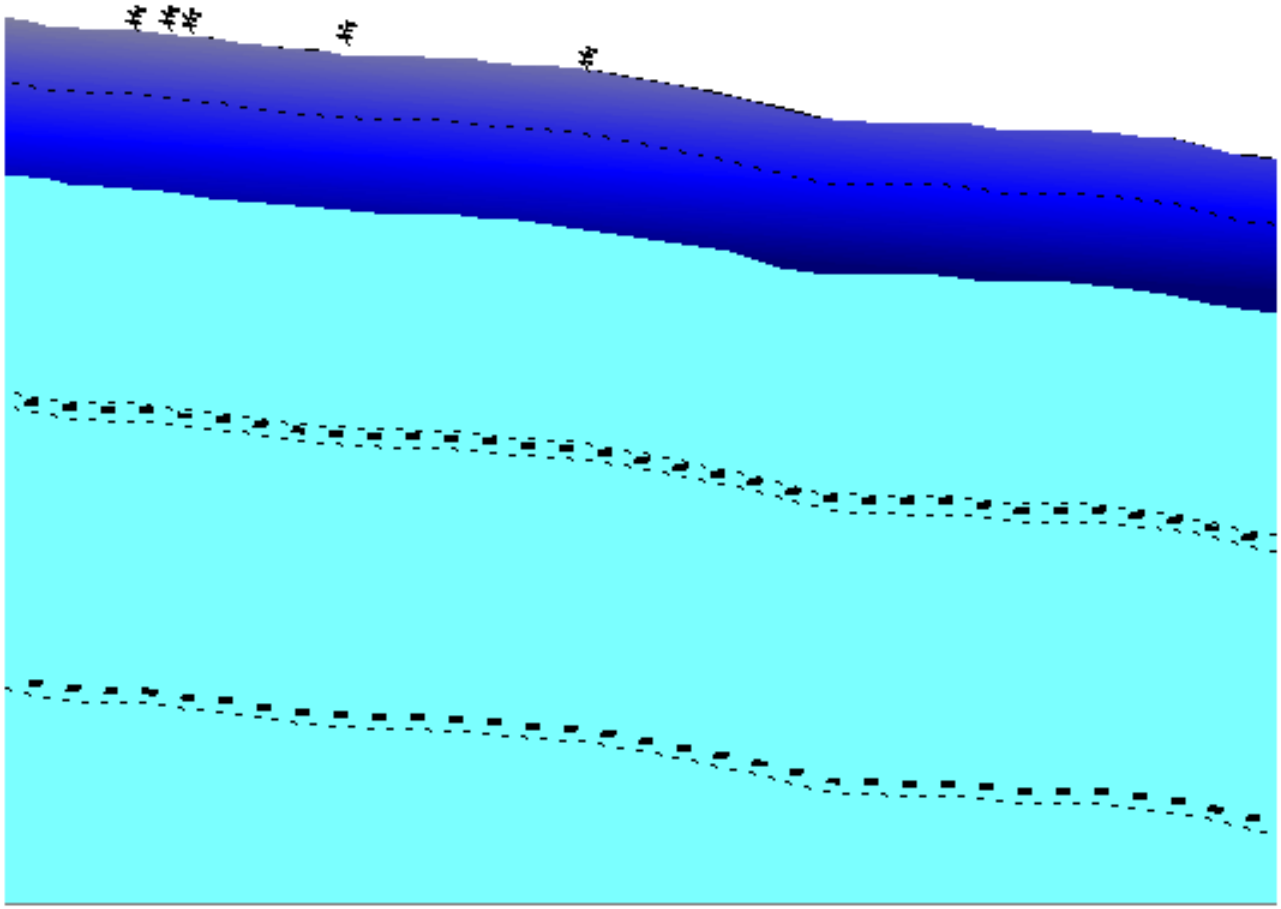


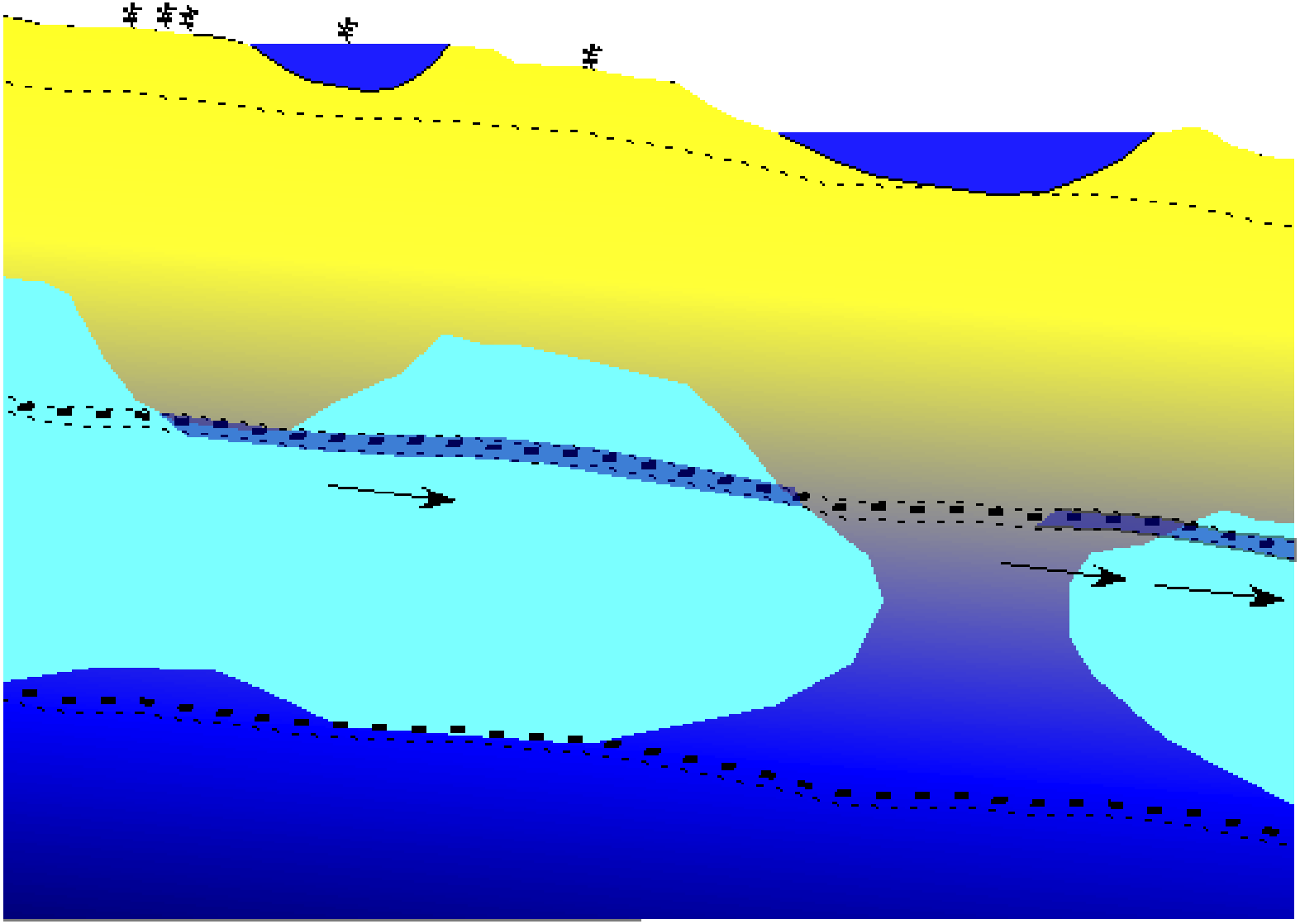
Impact of permafrost degradation on surface topography and infrastructure

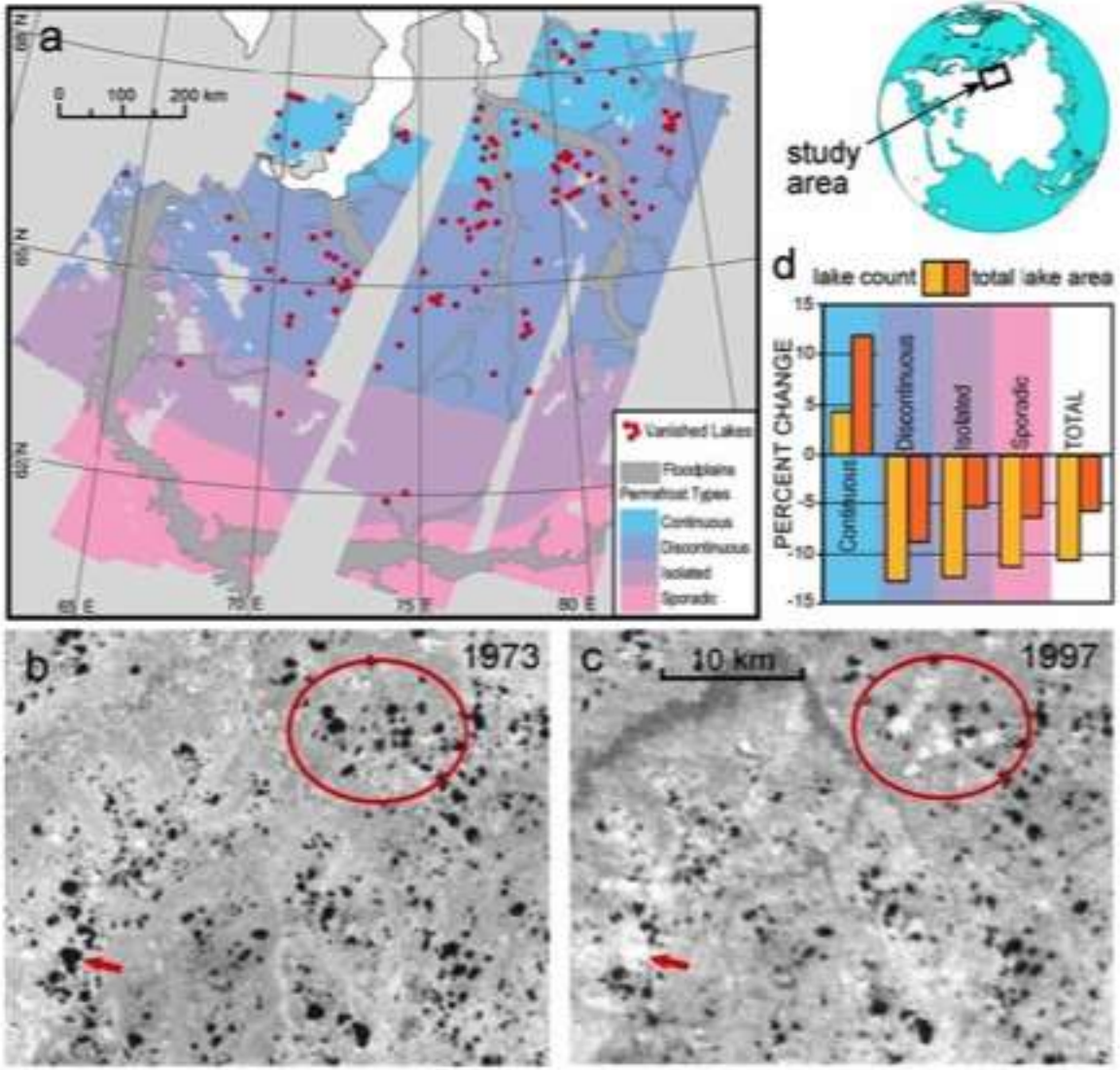

1950
1981
2000


TALIK


Active layer
Permafrost
Silt & Clay
Sand & Gravel
Silt & Clay
Sand & Gravel







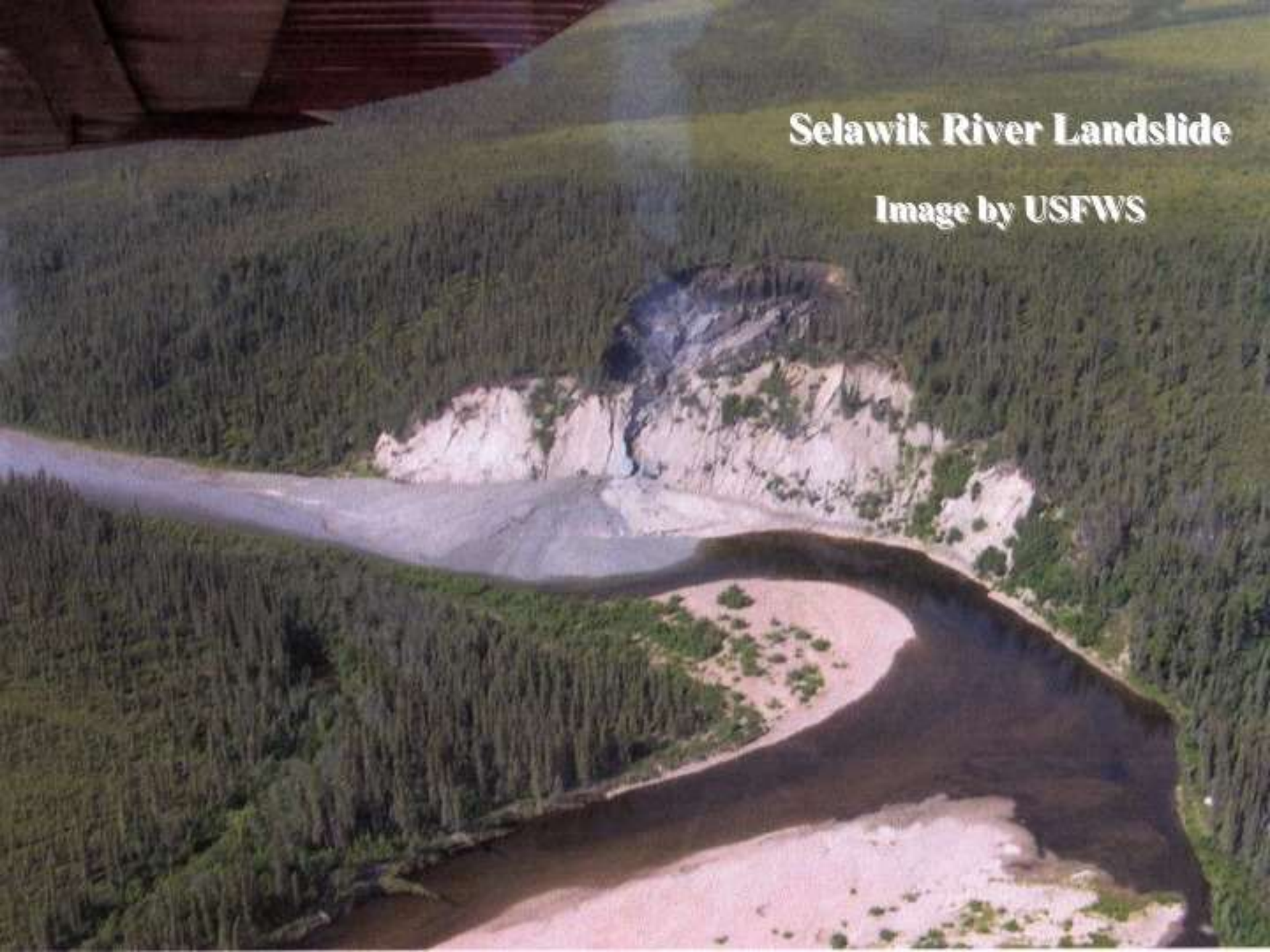
(a) Locations of Siberian lake inventories, permafrost distribution, and vanished lakes. Total lake abundance and inundation area have declined since 1973 (b), including permanent drainage and re-vegetation of former lakebeds (c). Interestingly, net *increases* in lake abundance and area have occurred in continuous permafrost (d), suggesting an initial but transitory increase in surface ponding (Larry Smith et al., 2005).

Impact of permafrost degradation on surface hydrology and vegetation

Photograph by T. Jorgenson

Permafrost exerts a dominant influence upon hydrologic and ecosystem dynamics through controls on vegetation and drainage. The climax vegetative species and soil forming processes are dominantly controlled by the closely coupled permafrost and hydrologic conditions.

As permafrost degrades, the soil moisture holding capacity increases, soil drainage improves and moisture is no longer held near the surface but percolates to deeper reservoirs. As permafrost becomes thinner or absent, connections between groundwater and surface water become more important.

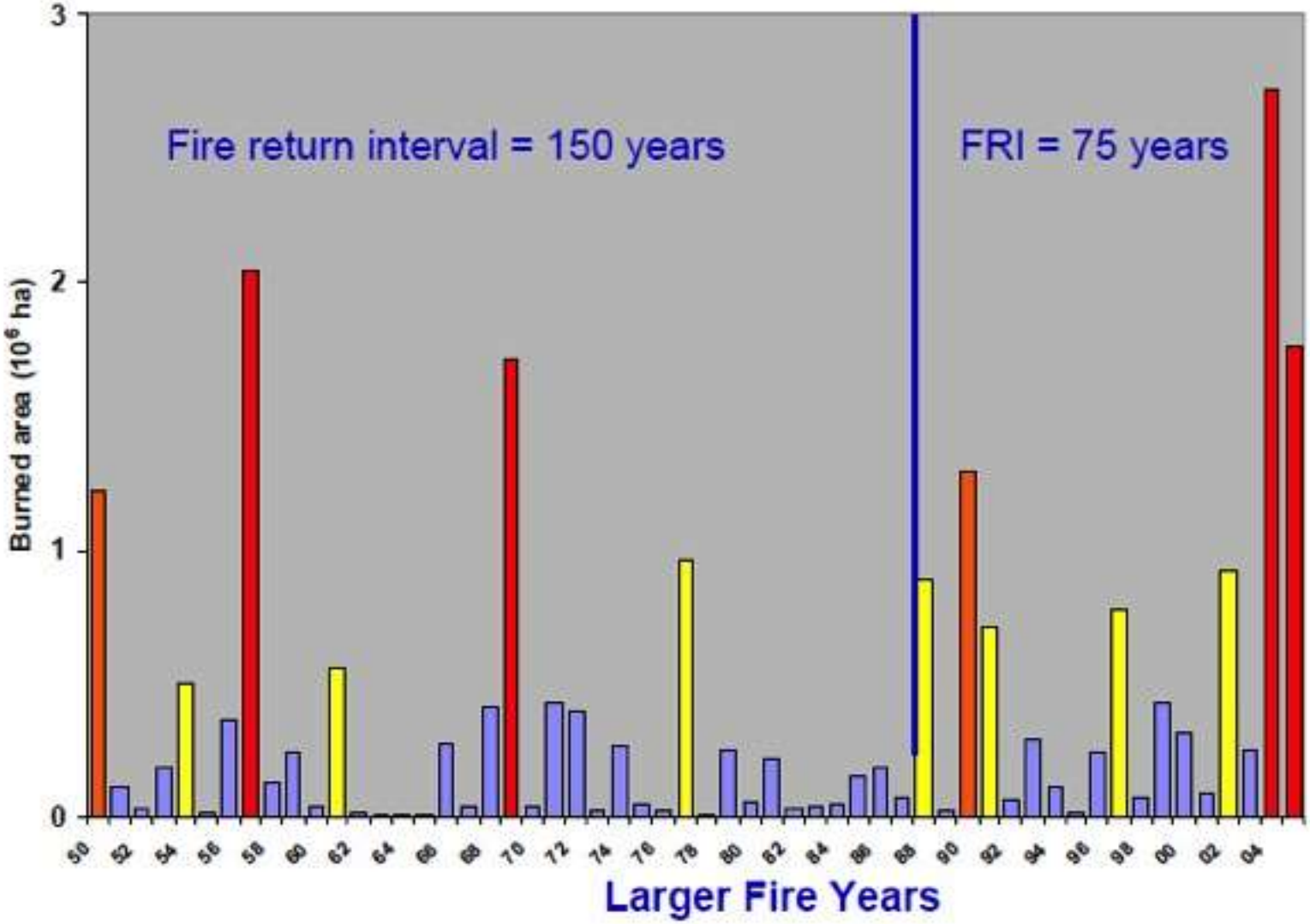

Selawik River Landslide
Image by USFWS

Selawik Retrogressive Thaw Slump

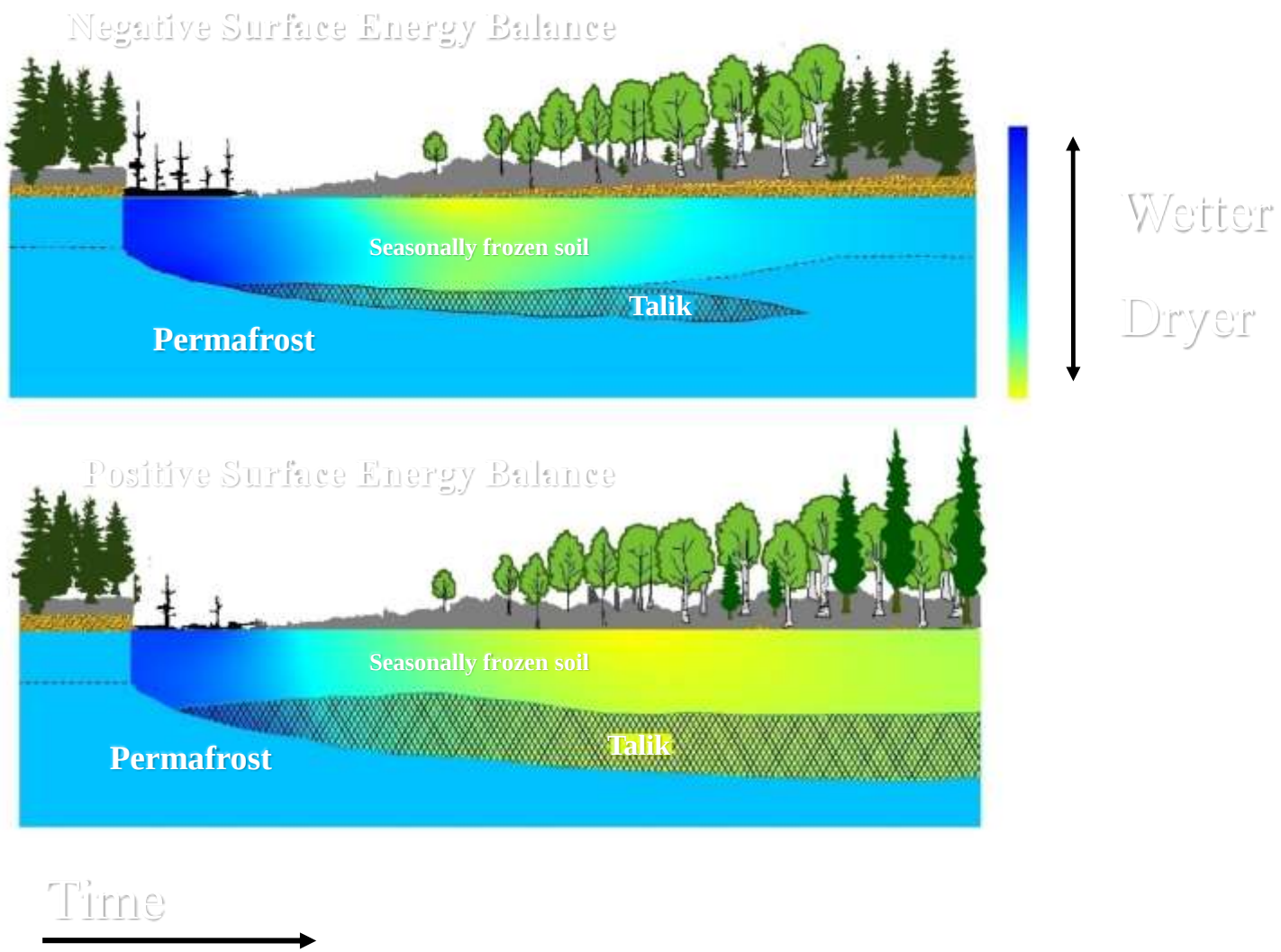
Image by USFWS

Forest fires in the North

Photo: John McColgan, Courtesy of Alaskan Type 1 Incident Management Team, Bureau of Land Management, Alaska Fire Service.



Ultra Fire Year > 3% of region burned
Very Large Fire Year > 2% of region burned
Large Fire Year > 1% of region burned


Negative Surface Energy Balance
Seasonally frozen soil
Talik
Permafrost
Wetter
Dryer
Positive Surface Energy Balance
Seasonally frozen soil
Talik
Permafrost
Time