

Permafrost and Gelisol Distribution-Soils and a Changing Climate



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Service

Whether natural, man caused, or both...Climate Facts (IPCC 2001)

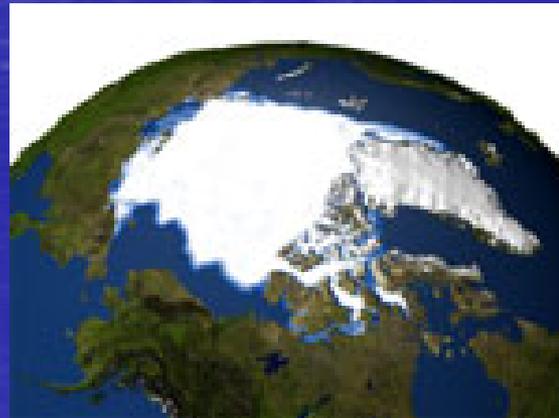
- Global average surface temperature has increased by 0.6 degrees C over the 20th century (average winter temperatures in Alaska and western Canada increased 3-4 degrees C during the past 50 years)
- Snow cover and ice extent have decreased by about 15% since 1950 (40% decline in Arctic sea-ice thickness)
- Global average sea level has risen 0.1-0.2 m during 20th century
- Greenhouse gas increase CO₂-31%, CH₄-151% since 1750

Why does the arctic warm faster than lower latitudes?

- As snow and ice melt, darker land and ocean surfaces absorb more energy
 - The snow-free period has been increasing over the past 50 years
- Atmosphere is thinner in the sub-arctic and arctic requiring less heat input to increase temperatures
- As sea ice retreats, solar heat absorbed by oceans in summer is more easily transferred to the atmosphere in winter
- Associated changes in global circulation patterns

Arctic Climate
Impact Assessment, 2004

<http://www.nasa.gov/centers/goddard/news/topstory/2003/1023esuice.html>



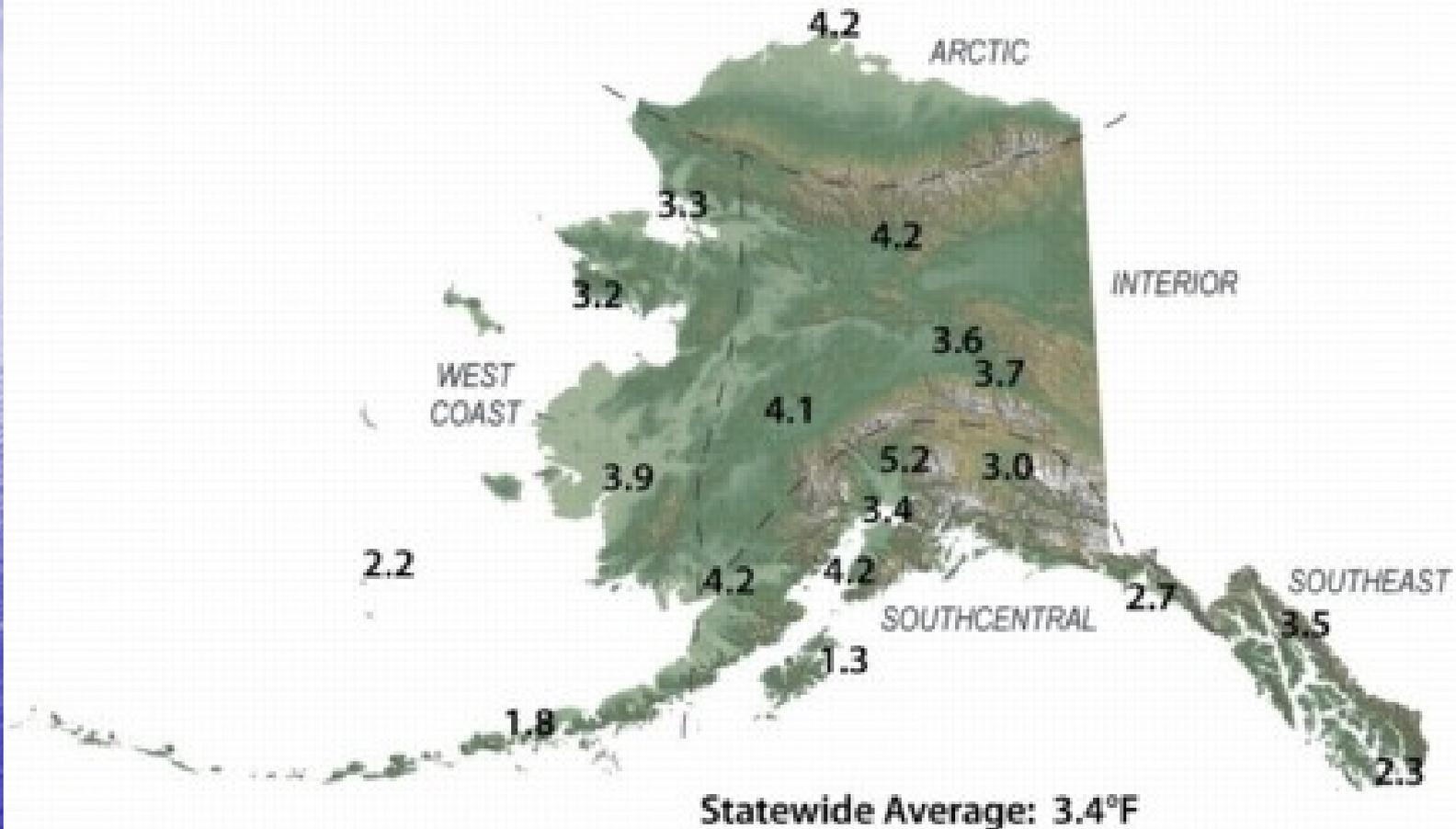
1979



2003

Alaska Temperature Facts

Total Change in Mean Annual Temperature (°F), 1949 - 2007



Source: Alaska Climate Research Center

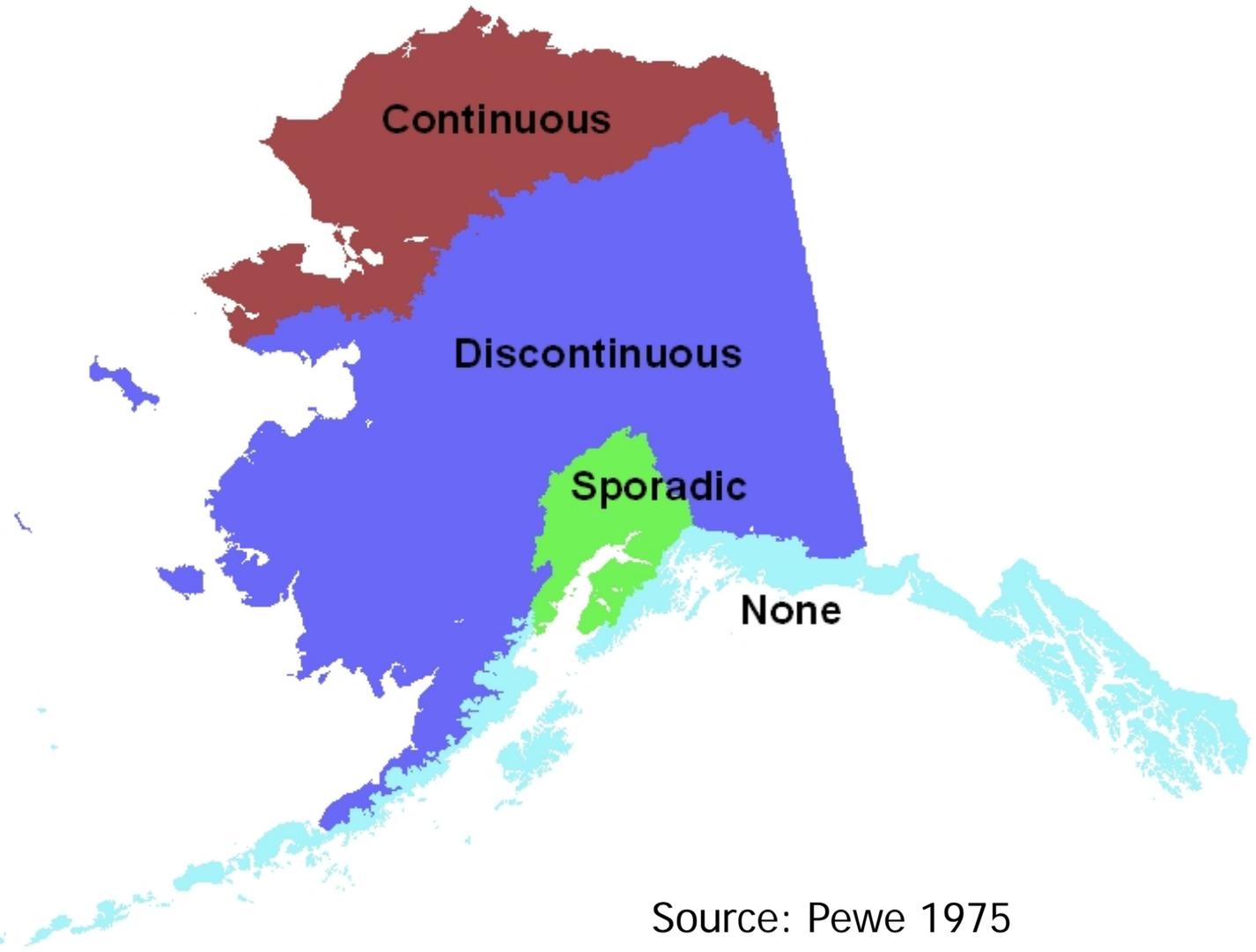
What impacts attributed to a warming climate have been observed in Alaska?

- Melting glaciers
- Global sea level rise
- Coastal erosion
- Increasing fires and insect outbreaks
- Threatening of ice-dependent animals like seals and polar bears
- Changes in vegetation
- Warming soils and thawing permafrost

Soil at or below the freezing point of water 0 °C for two or more years.

Permafrost Zones

50% of Alaska is underlain by permafrost



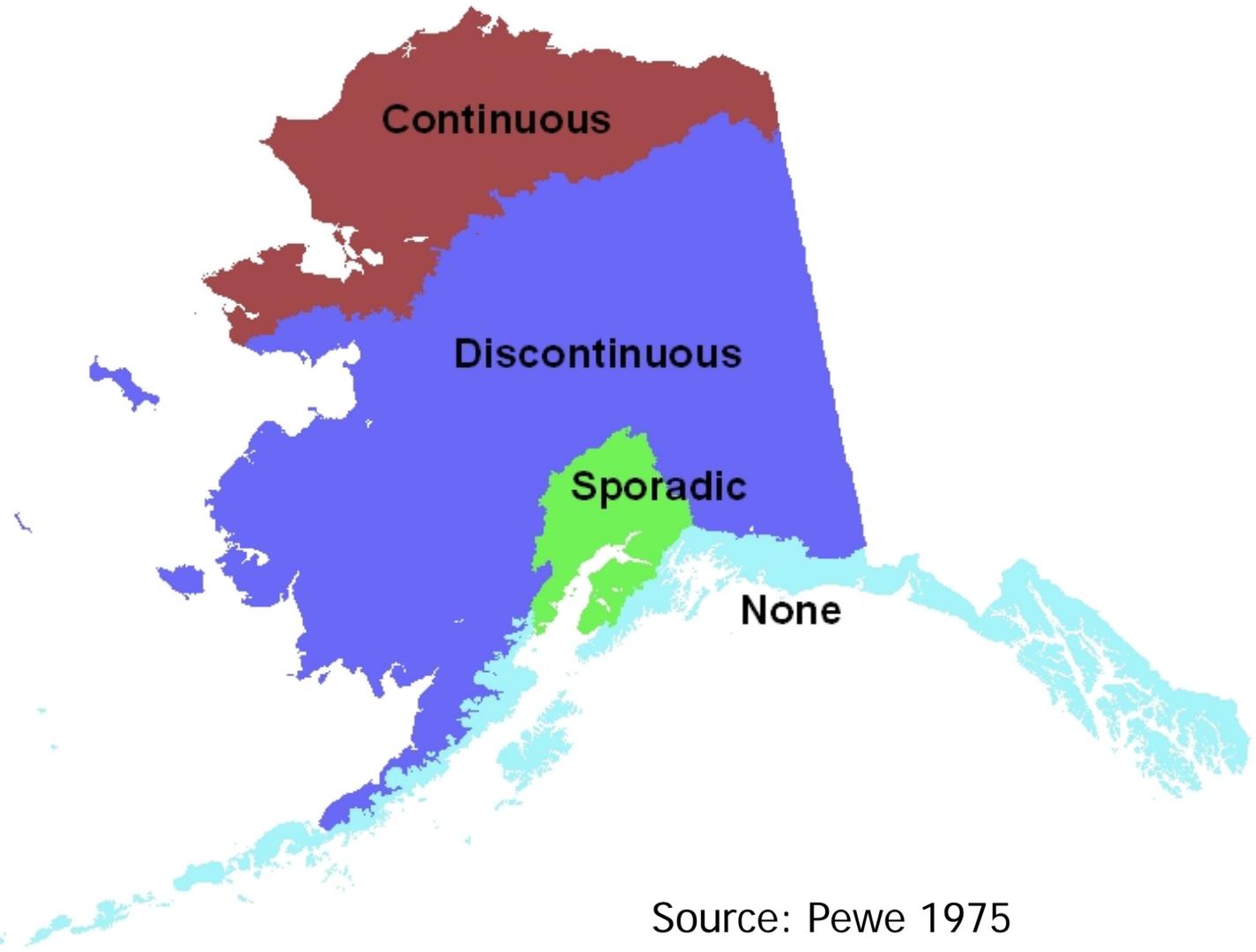


344° NNW mag
W: 141° 20' 21. 16"
N: 062° 27' 02. 64"

Source: Pewe 1975

Permafrost Zones

50% of Alaska is underlain by permafrost

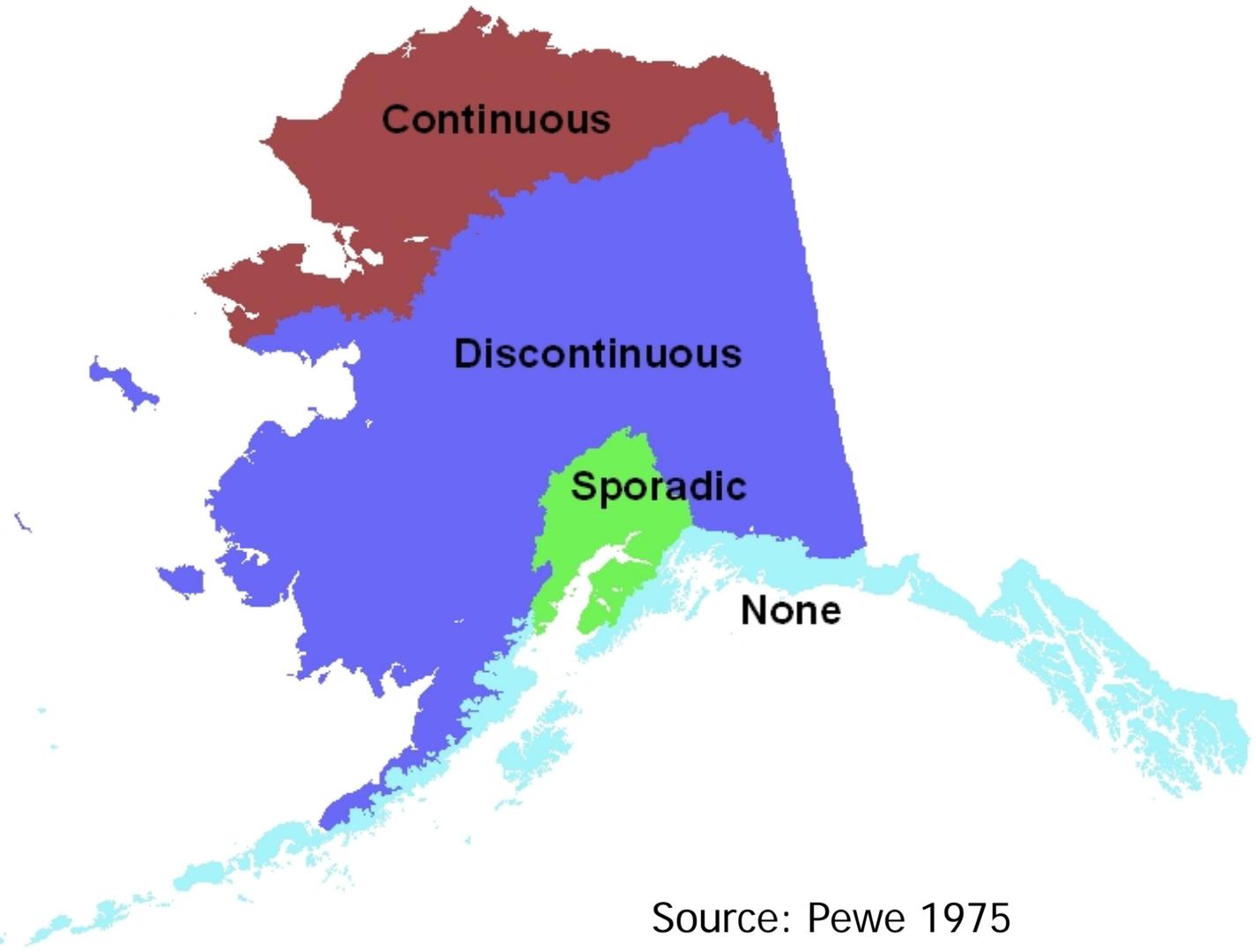




247° WSW mag
W: 149° 20' 54.55"
N: 068° 26' 42.51"

Permafrost Zones

50% of Alaska is underlain by permafrost



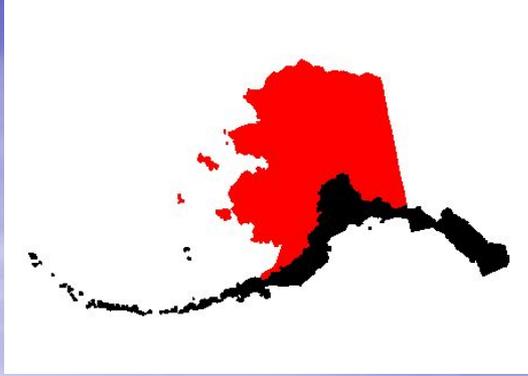


The background is a smooth blue gradient, transitioning from a lighter blue at the top to a darker blue at the bottom. A bright sun flare is visible on the left side, creating a white and yellow glow that fades into the blue. The overall effect is a serene, ocean-like atmosphere.

Why the Alaska concern?



Alaskan's for Global Warming!!!



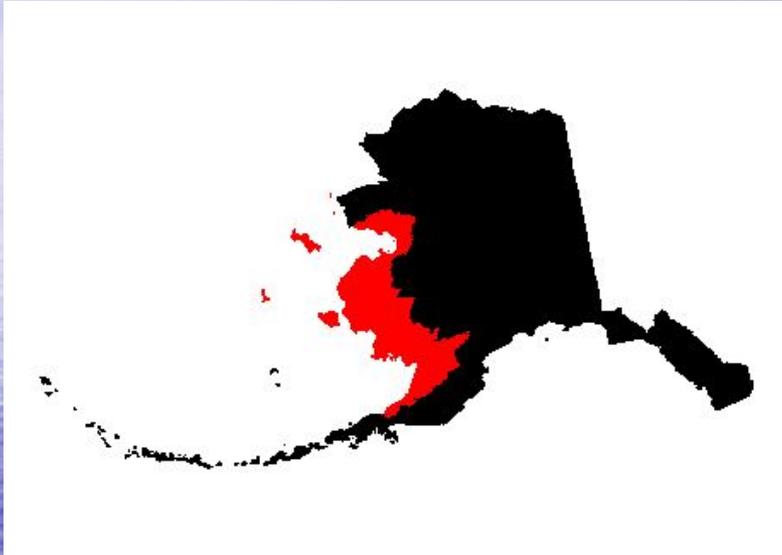
Arctic and Subarctic Soils

- Includes approximately 17 percent of the planets land mass
- Includes about 40% of the total pool of soil carbon [1]
- Concerns focused on permafrost (Gelisols)
 - Thermokarst erosion and collapse of infrastructure
 - Drying the upper soil layers and increasing decomposition rates
 - Carbon stored in the active layer and permafrost could be released to the atmosphere, thereby increasing CO₂ emissions and exacerbating CO₂-induced warming
 - Altered plant communities and fisheries

Sources: 1/ Intergovernmental Panel on Climate Change 2001
2/ Osterkamp and Romanovsky 1999



Where Have Changes Been Observed? Western Alaska



- Winter temperatures are influenced by pack ice formation in Bering Sea
- Later less extensive pack ice formation means the persistence of more moderate maritime climate later into winter with break-up earlier in the spring
- Permafrost within this region is near-zero and subject to slight changes in temperatures

Soil Survey Observations of Changing Soils- Western Alaska



GELISOL
Typic
Historthel

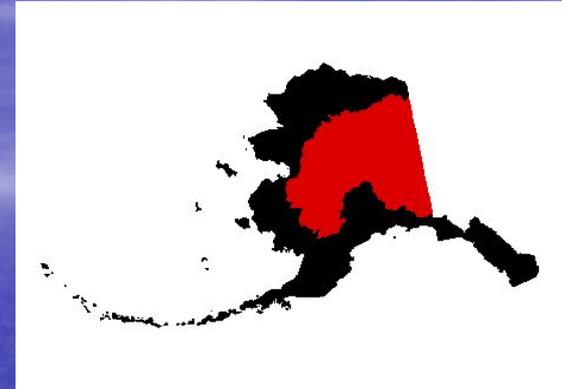


- Soils with thick organic mats
- Near surface permafrost
- Saturated conditions

- Soils with thick organic mats
- Permafrost absent
- Saturated conditions brief or nonexistent

Changing Soils-Interior Alaska

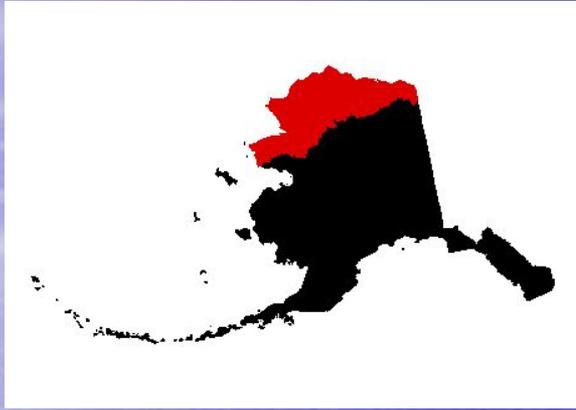
Typic and Glacic Hemistels



83% of land area of the Tanana Flats is underlain by permafrost
31% of area have partially and 4 percent totally degraded between since 1949

Source: Jorgenson et. al. 2001

Changing Soils-North Slope Alaska



Interconnected ice wedges form a pattern of polygonal ground on Alaska's North Slope (Glacic Histoturbels)



Permafrost degradation of ice wedges have formed water-filled pits covered 3.8% of the land area in 1995 compared to 0.6% in 1982.

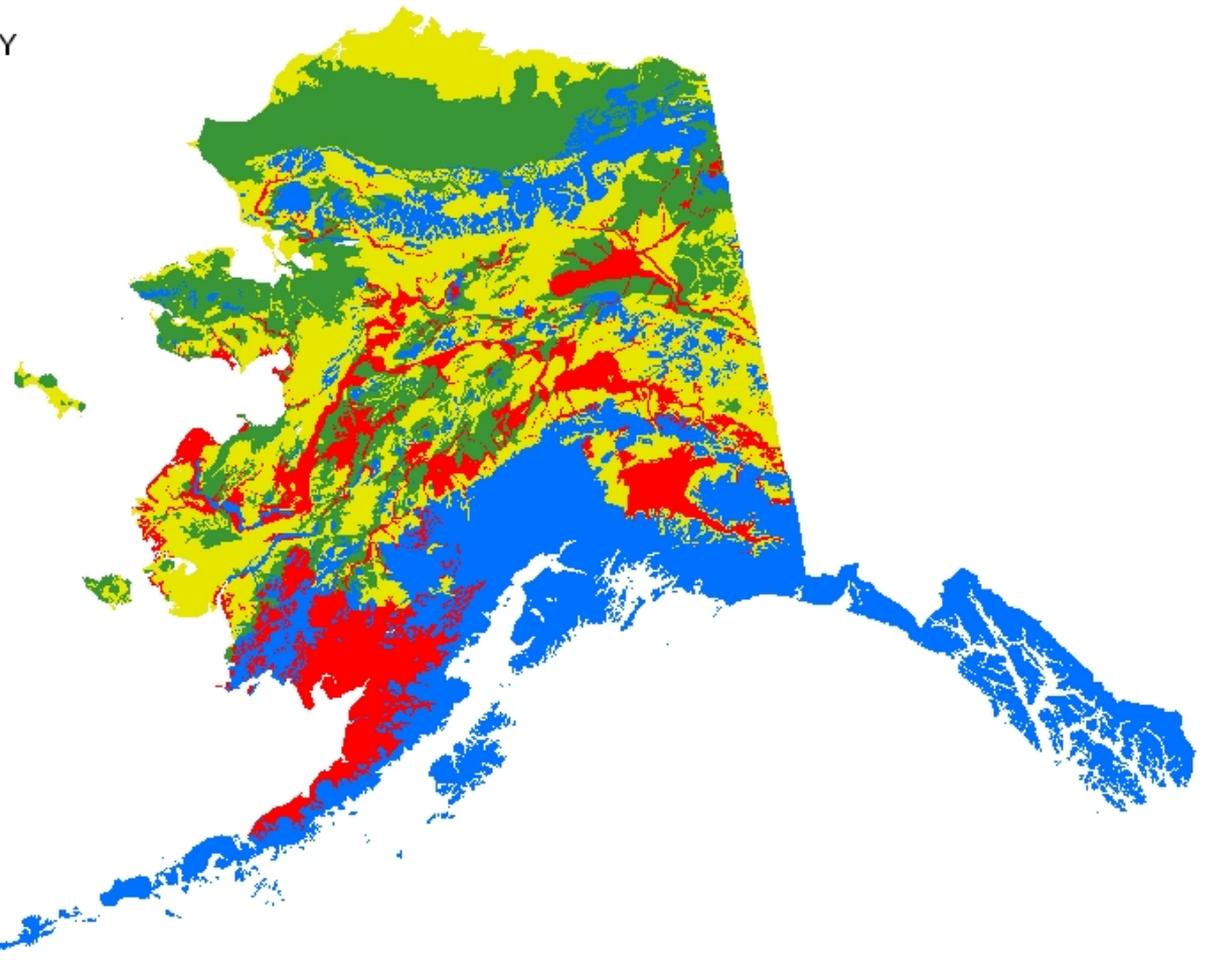
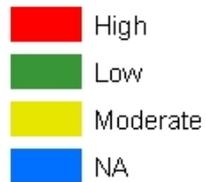


Red-High Sensitivity

Gelisols within the zone of discontinuous permafrost with high thermal conductivity properties or on landscapes consisting of 5% or more water bodies

Permafrost Sensitivity

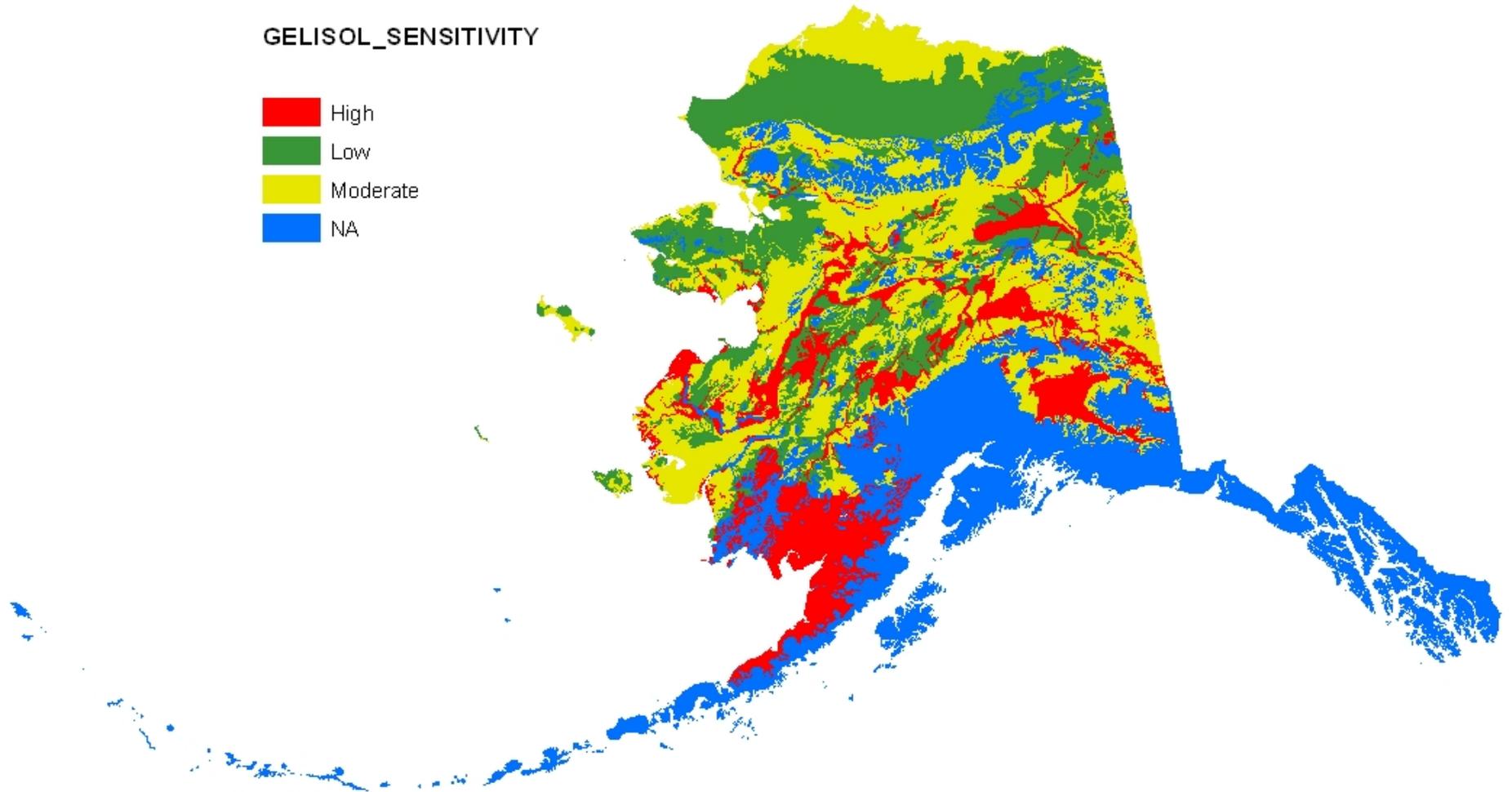
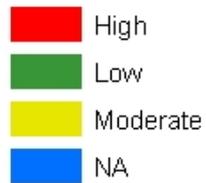
GELISOL_SENSITIVITY



Yellow- Moderate Sensitivity
Gelisols within the zone
of discontinuous permafrost formed in materials
with moderate thermal conductivity properties.

Permafrost Sensitivity

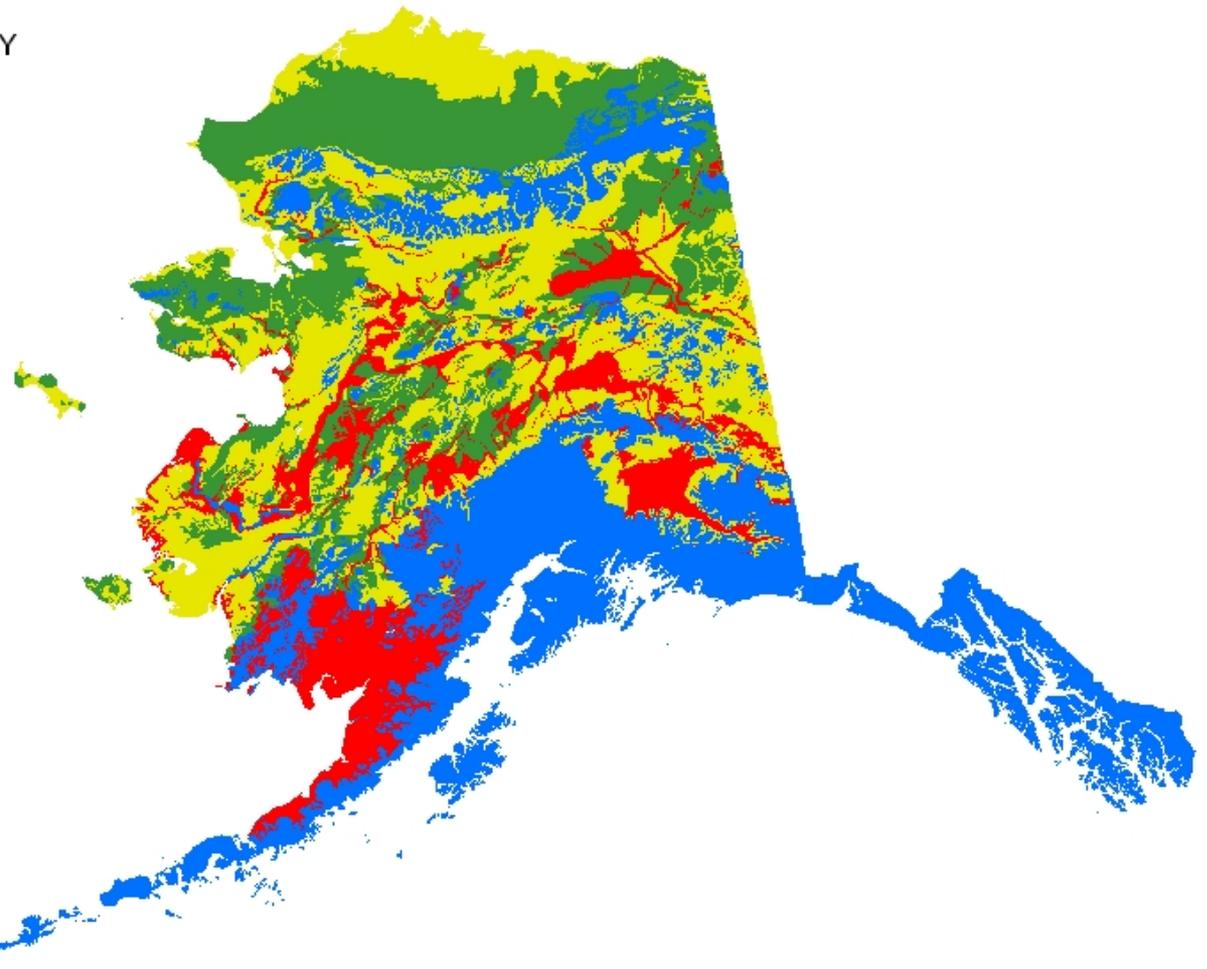
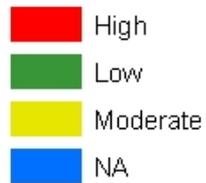
GELISOL_SENSITIVITY



Green-Low Sensitivity-Gelisols formed
in low thermal conductivity materials

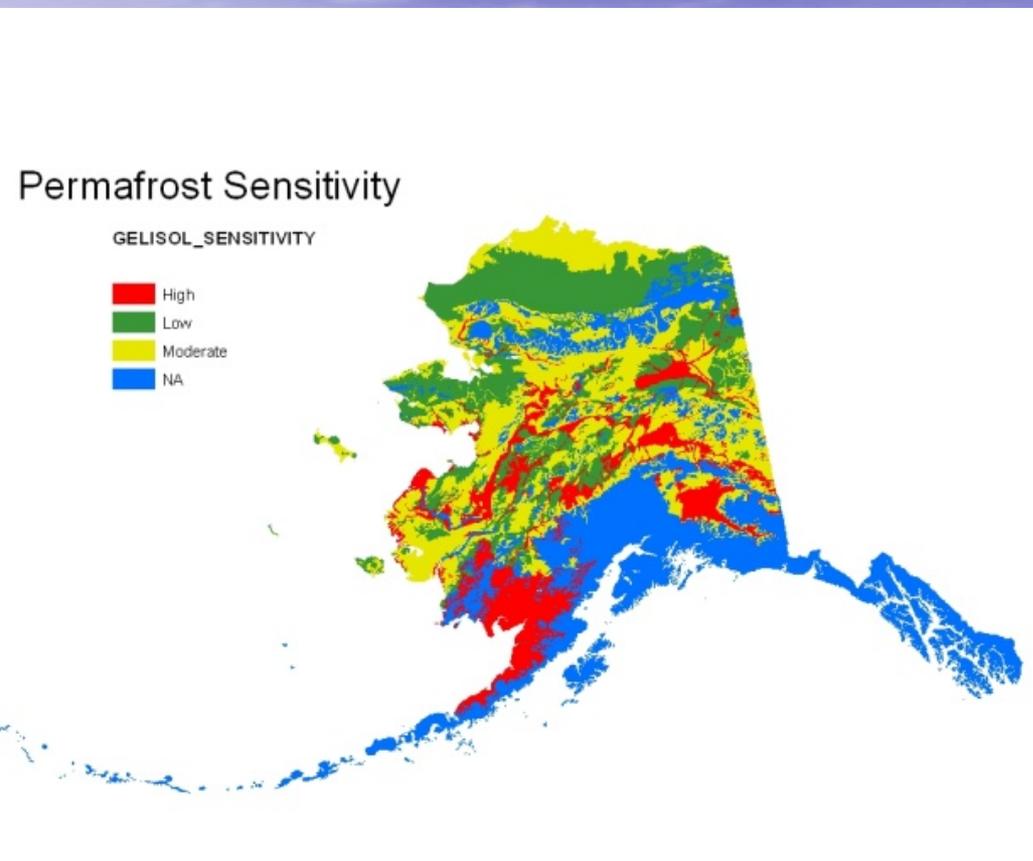
Permafrost Sensitivity

GELISOL_SENSITIVITY



Source: Alaska STATSGO, 2012

Scenario of Potential Change Based on Soil Thermal Properties



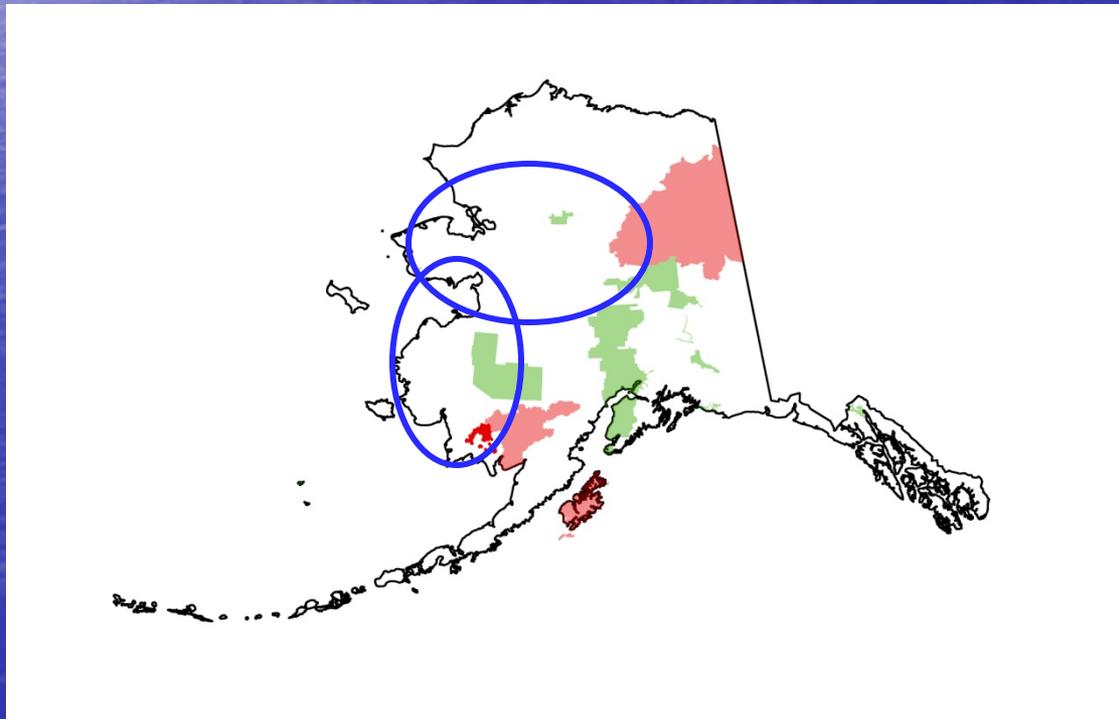
Warming of 0-2 degrees C
Loss of thermally sensitive soils
in Western Alaska and Interior
Lowlands
Currently

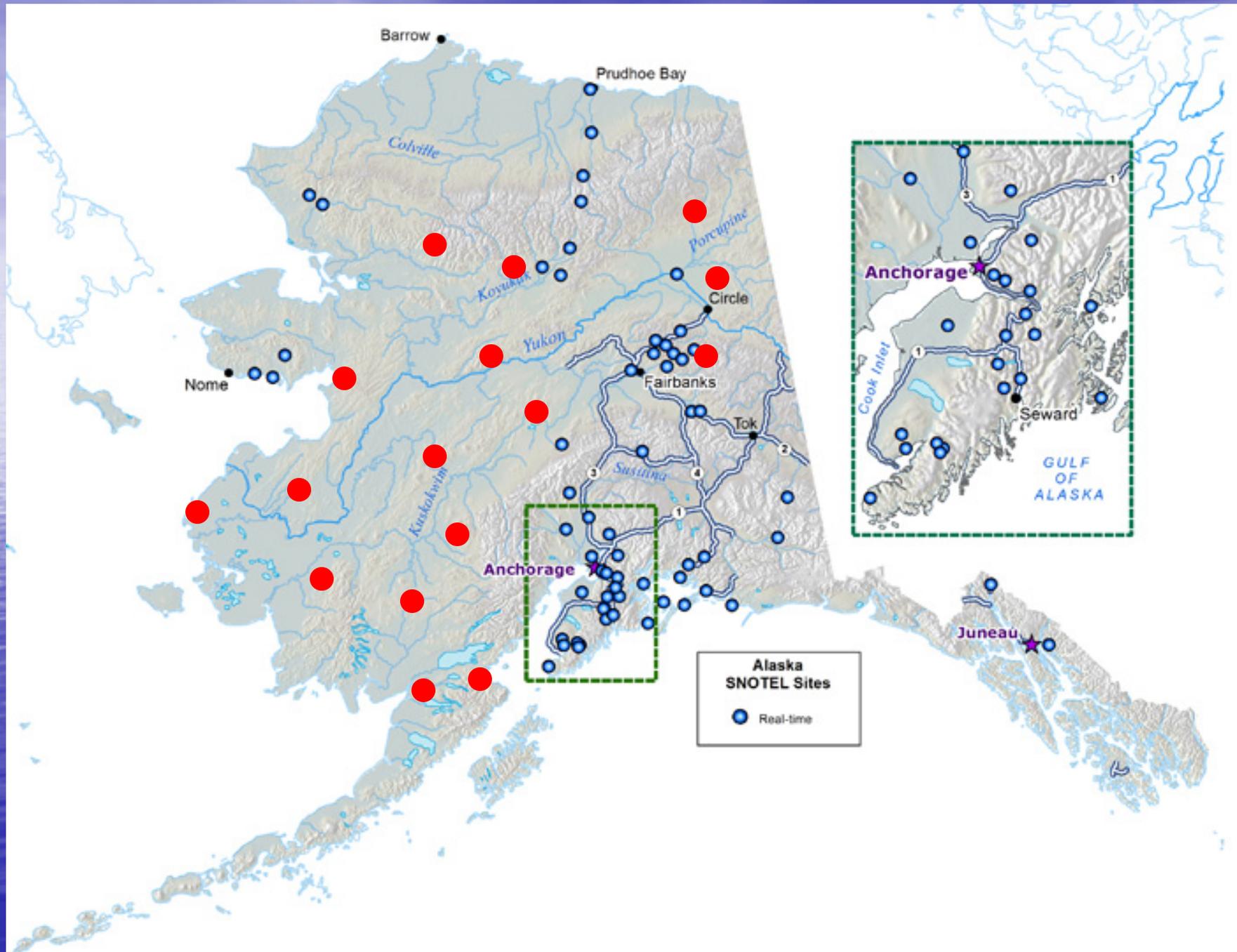
Warming of 2-5 degrees C
All soils in Interior and Western
Moderately sensitive on North Slope
Foothills
30 to 100 years

Warming of 5-8 degrees C
All permafrost soils except
Low sensitivity soils on North
Slope
???

To better prepared for future change

- Strategy: focus work with federal partners to complete soil/ecological site inventories on federal lands in Western and Interior Alaska to better understand distributions







N 67° 03.432' W 154° 49.738' 267° 2017 ft 09/07/2006 5:32:40 PM Sep07 0957



N 64° 39.278' W 163° 57.949' 255° 849 ft 09/06/2006 1:59:42 PM Sep06 0509

Questions?