

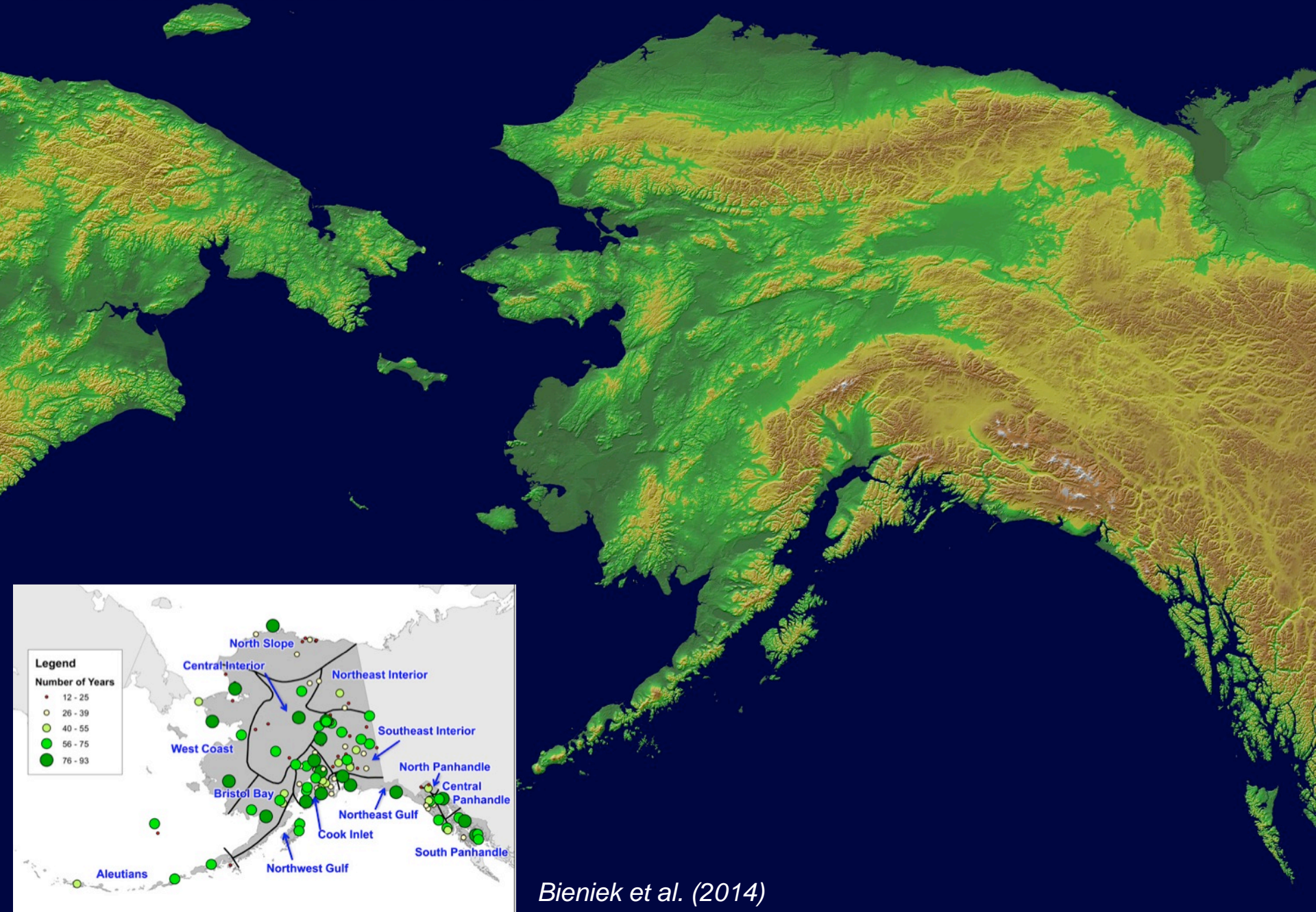
Continued Permafrost Warming on the Arctic Slope of Alaska, 2014 Update



Gary Clow
USGS/INSTAAR

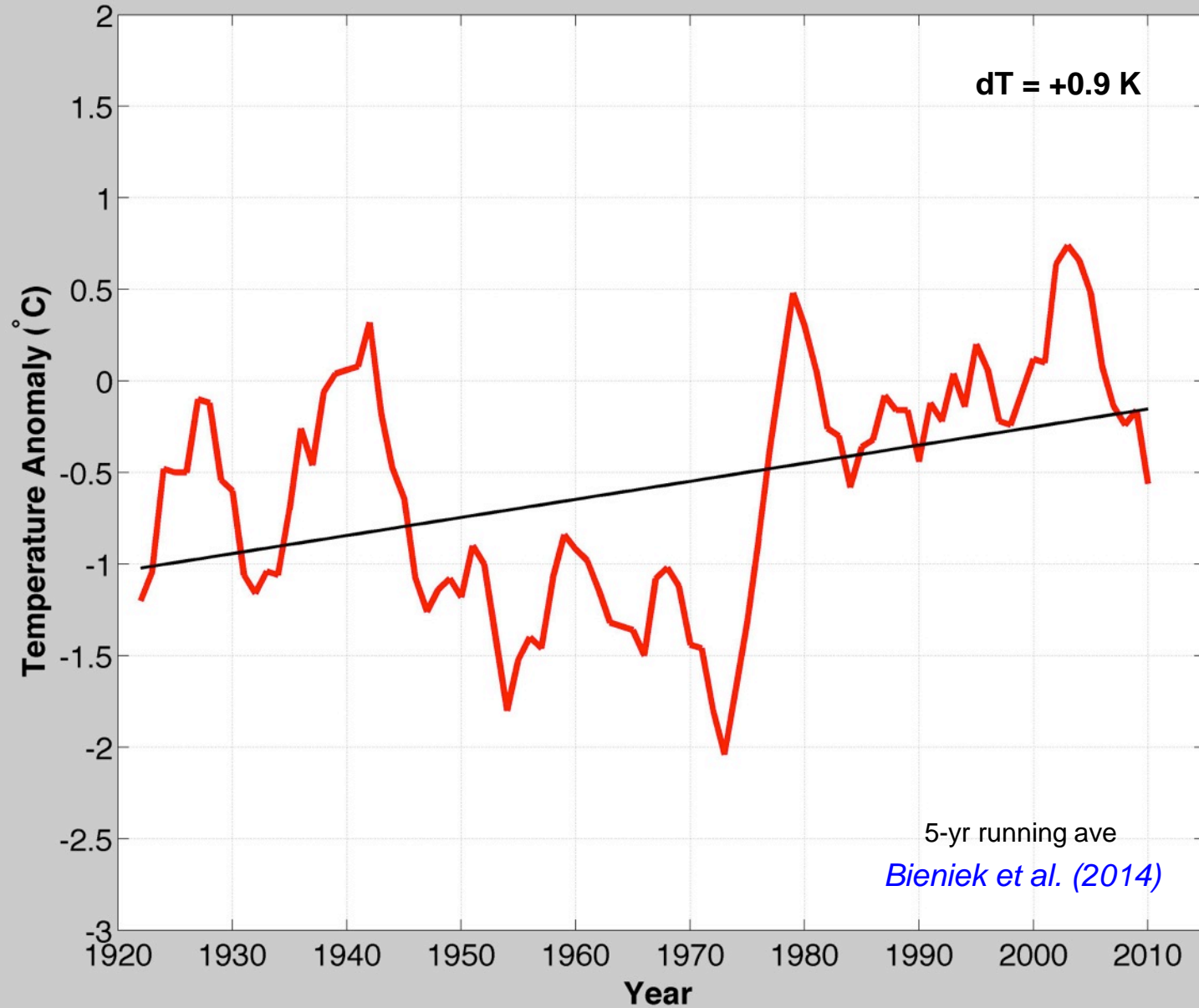


Alaska Climate Divisions

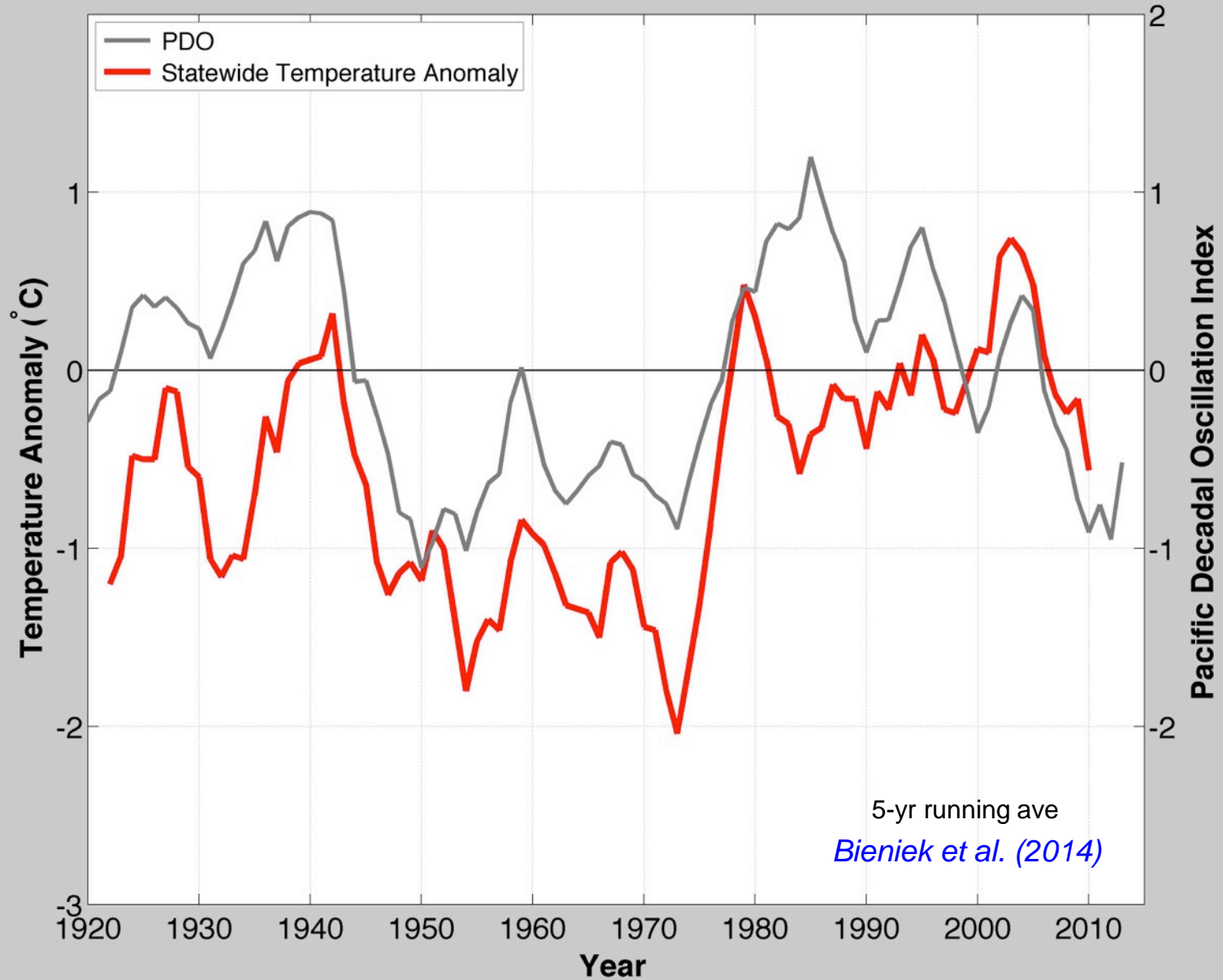


Bieniek et al. (2014)

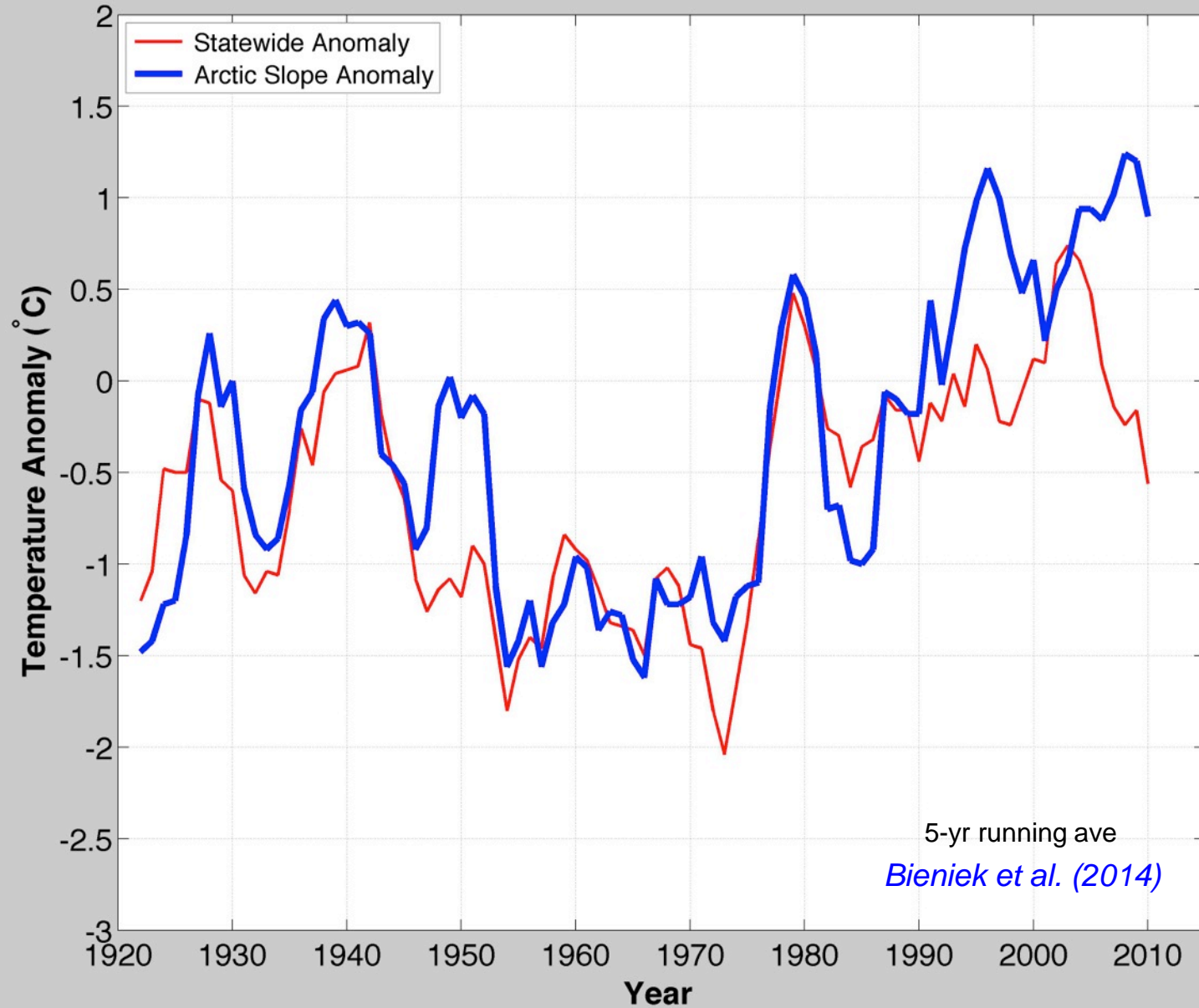
Statewide Air-Temperature Anomaly



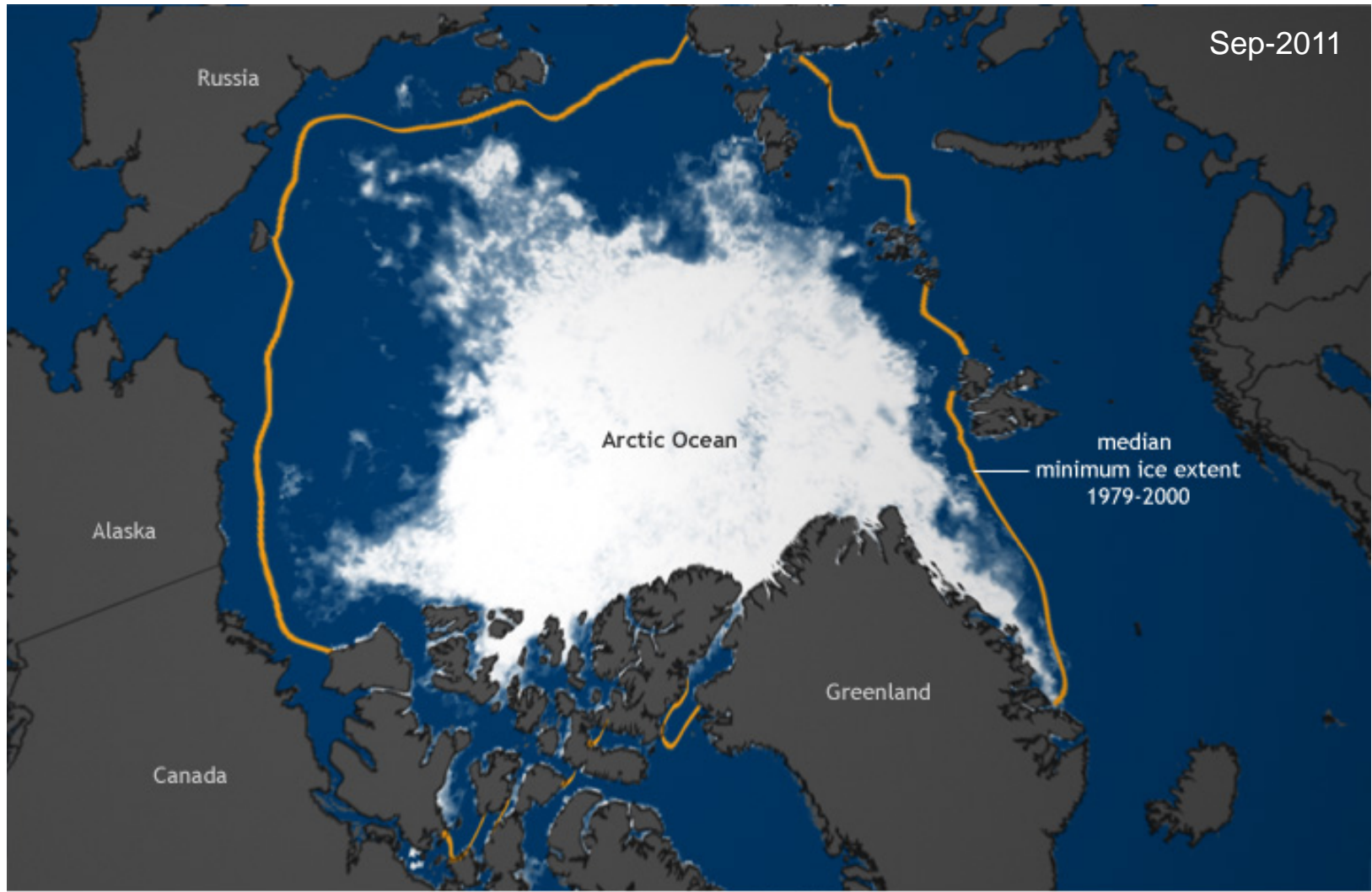
Statewide Air-Temperature Anomaly



Arctic Slope Air-Temperature Anomaly

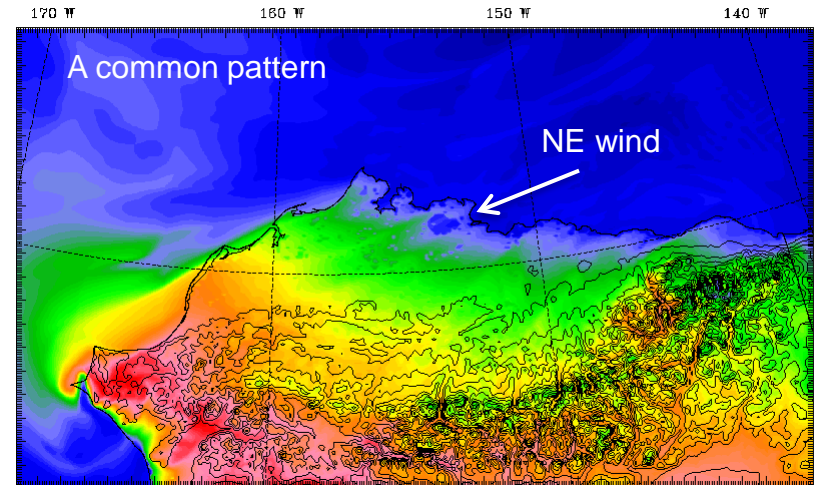


Sea Ice Extent

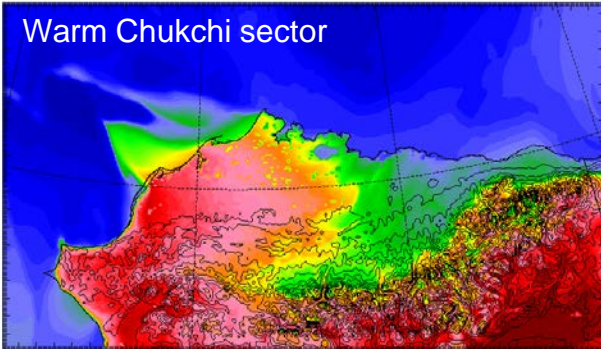


Air-Temperature Patterns, Arctic Alaska

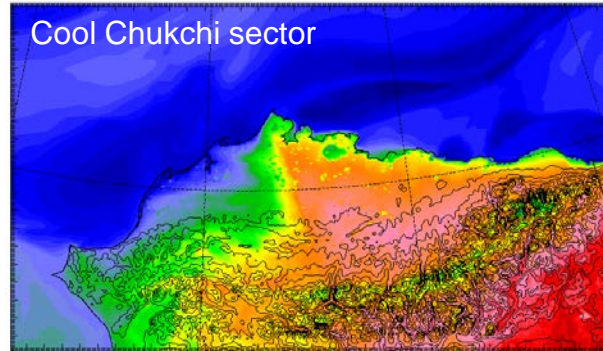
- With the juxtaposition of the Chukchi Sea, Beaufort Sea, and Brooks Range, weather and climate patterns are somewhat complicated on the Arctic Slope.



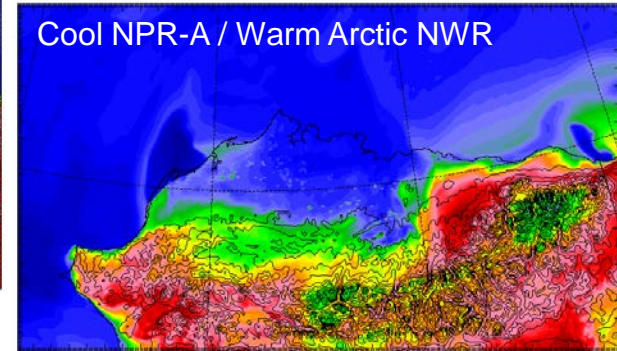
Warm Chukchi sector



Cool Chukchi sector



Cool NPR-A / Warm Arctic NWR



Air temperature reanalyses produced using the WRF model, 3.3-km resolution.

WRF 3.3-km resolution (Arctic Alaska)

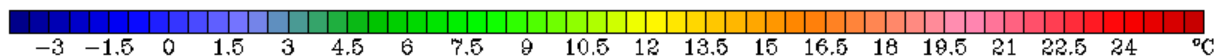
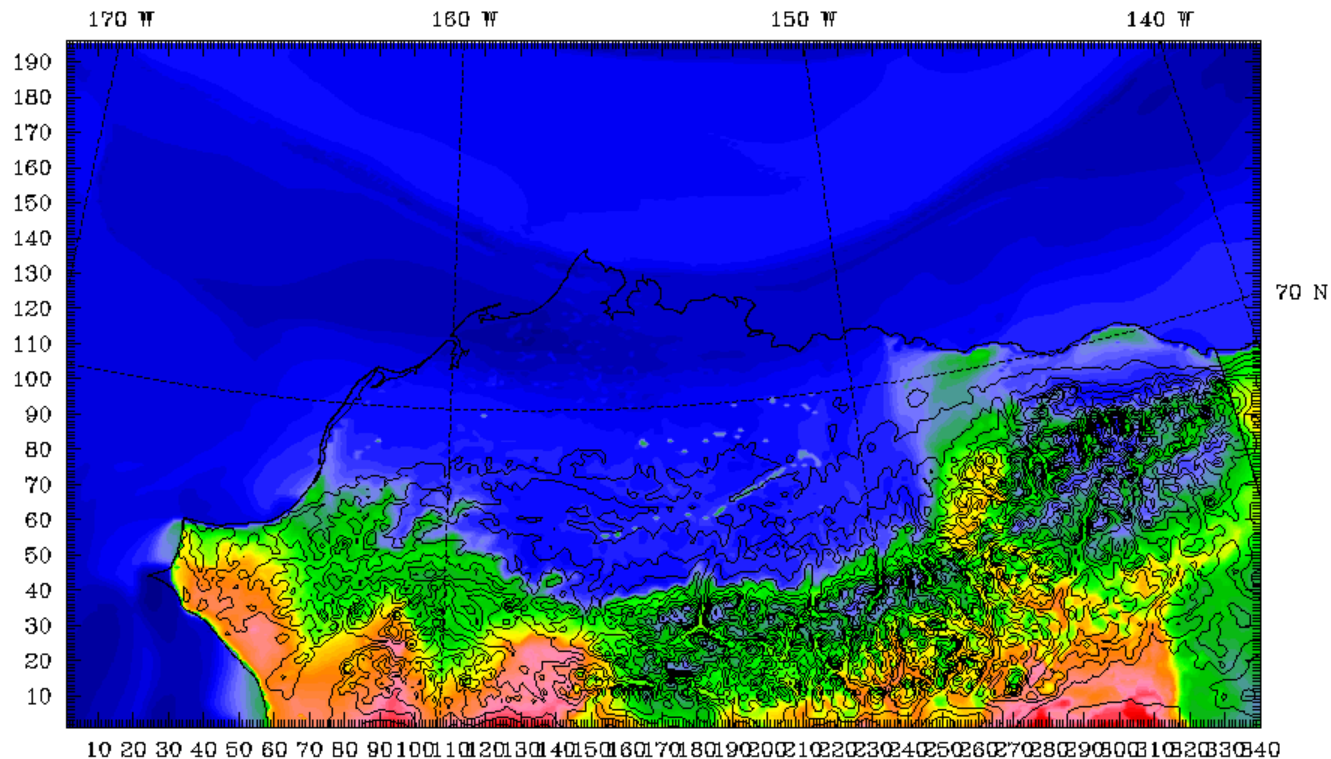
Init: 0000 UTC Thu 31 May 07

Fcst: 24.00 h

Valid: 0000 UTC Fri 01 Jun 07 (1600 LDT Thu 31 May 07)

Surface air temperature

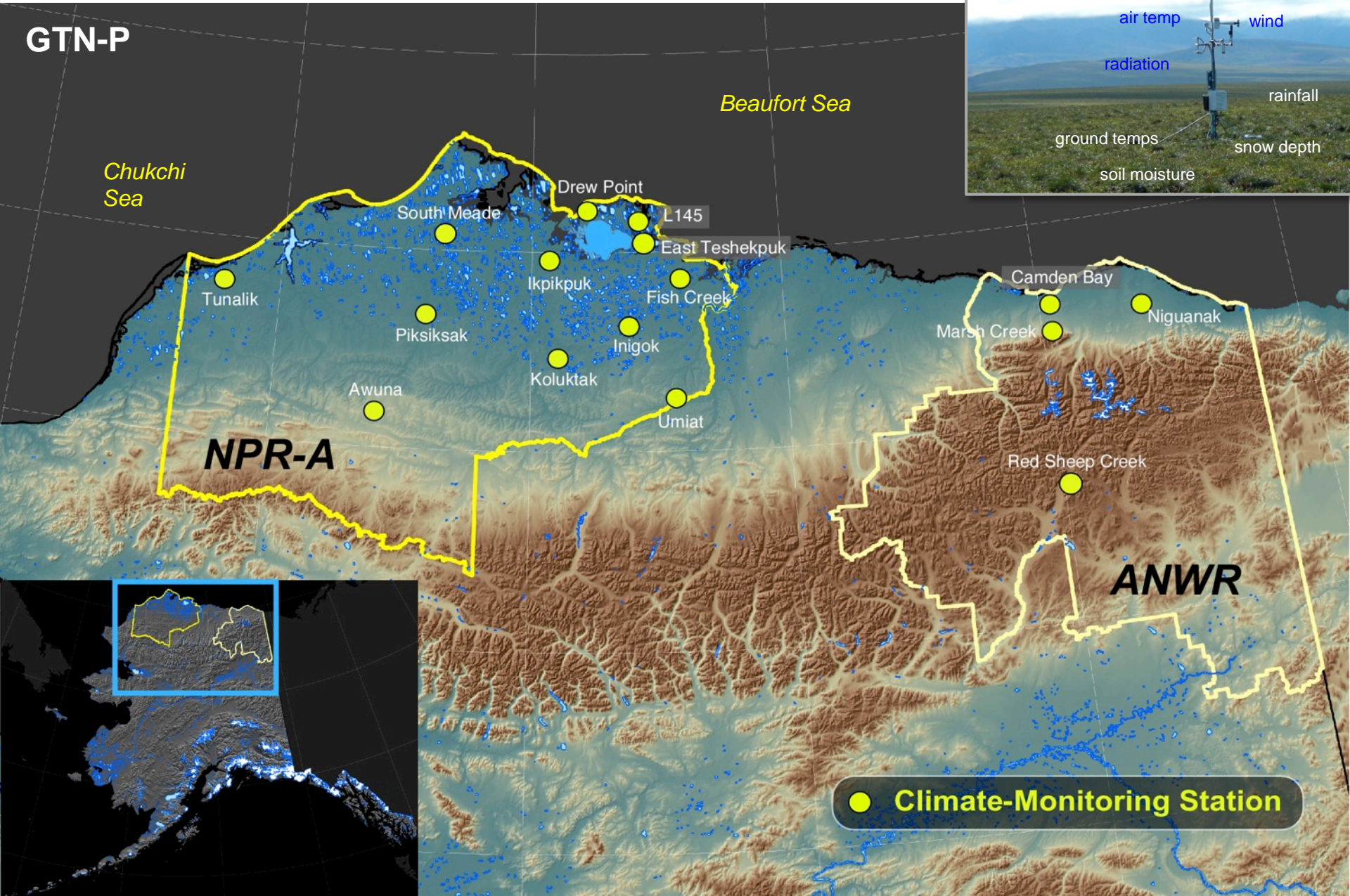
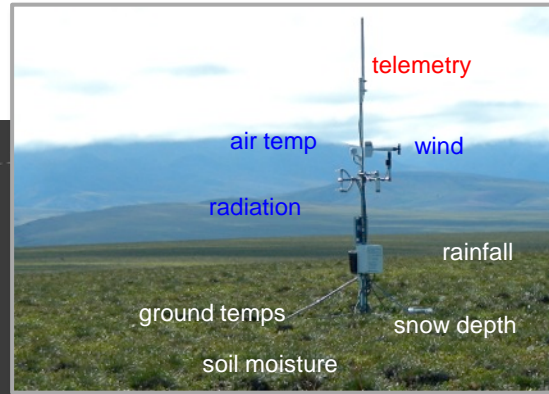
Terrain height AMSL



Model Info: V3.4 No Cu YSU PBL WSM 6class Noah LSM 3.3 km, 34 levels, 17 sec
LW: CAM SW: CAM DIFF: simple KM: 2D Smagor

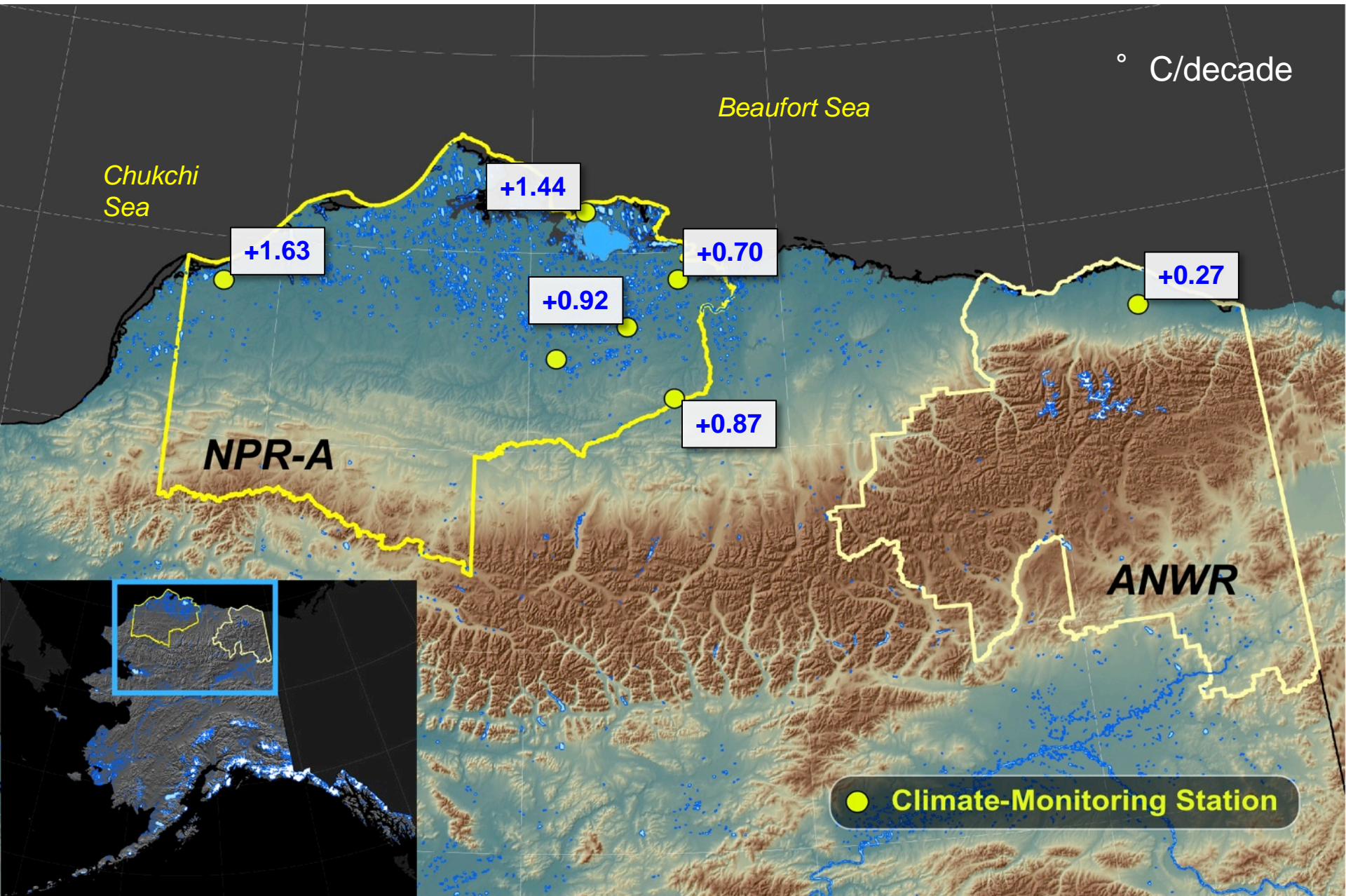
USGS Climate-Station Network, Arctic Alaska

GTN-P



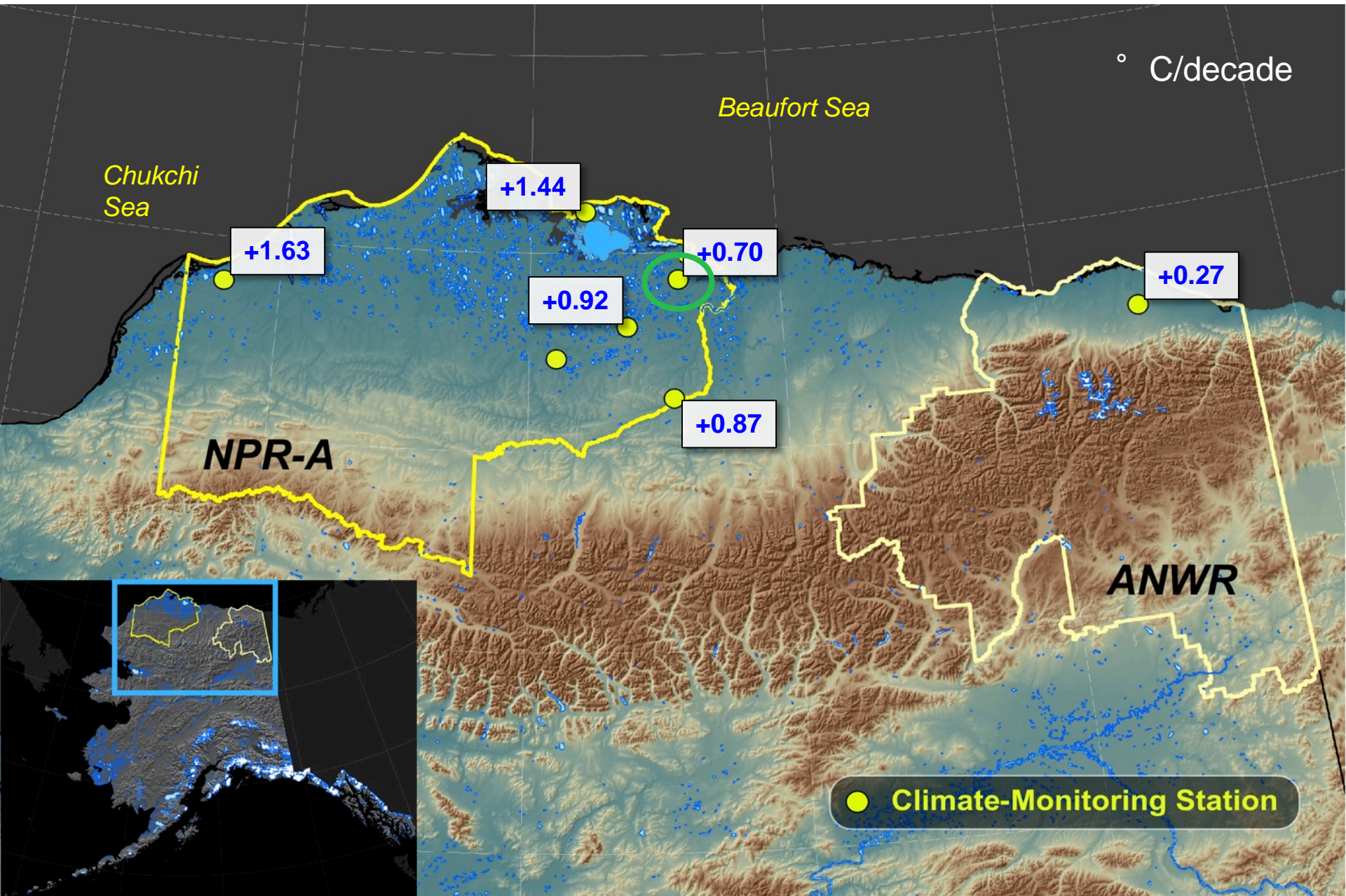
Mean-Annual Air-Temperature Trends

Stations with at least 10 years of data



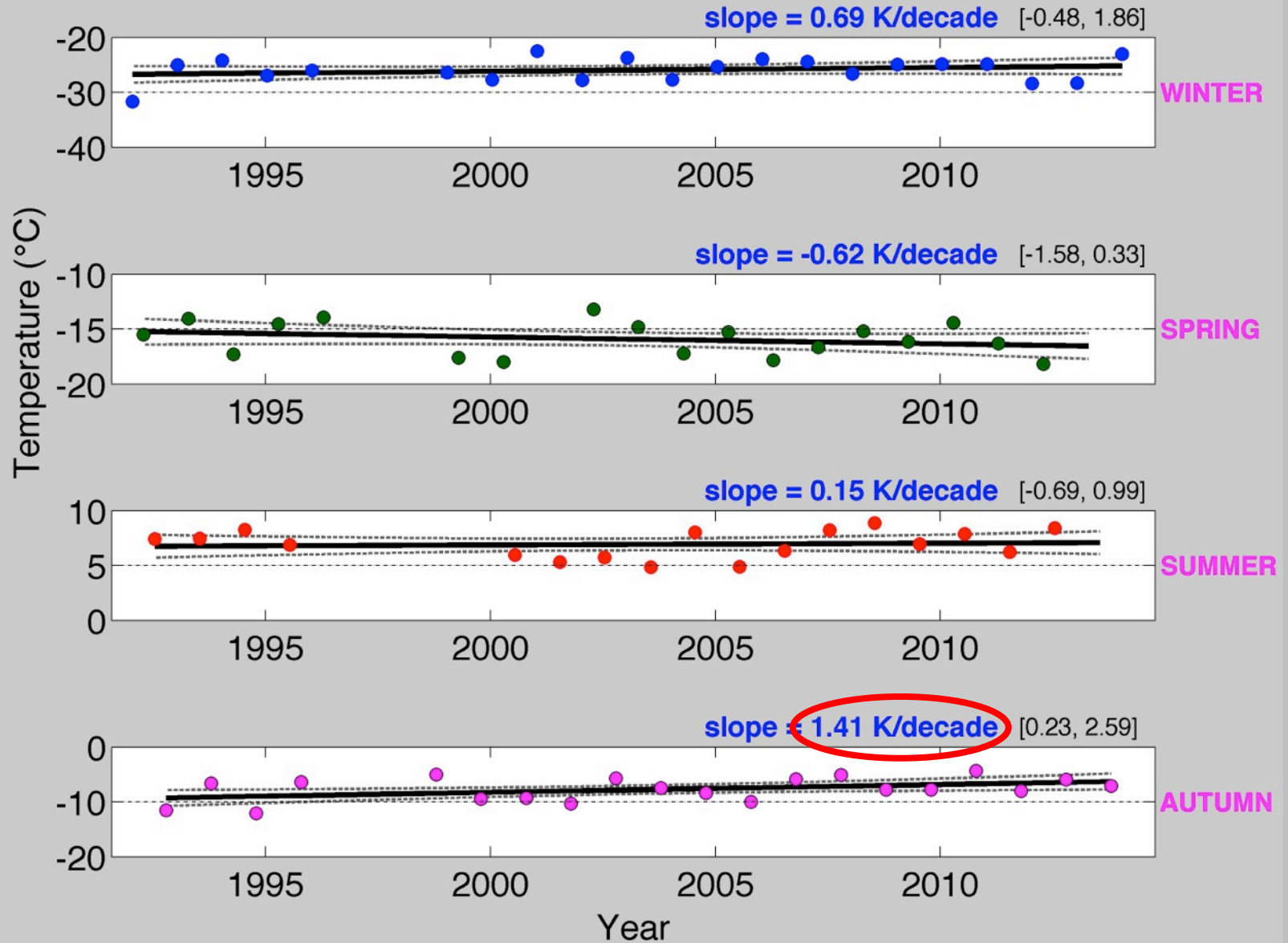
Mean-Annual Air-Temperature Trends

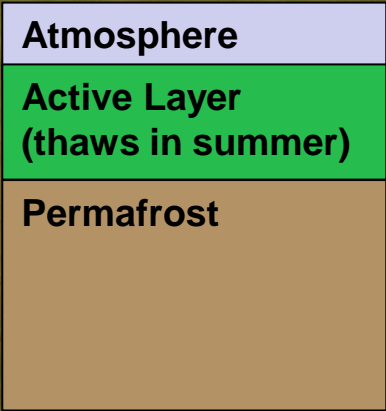
Stations with at least 10 years of data



Seasonal Air-Temperature Trends

Fish Creek
1992-2013

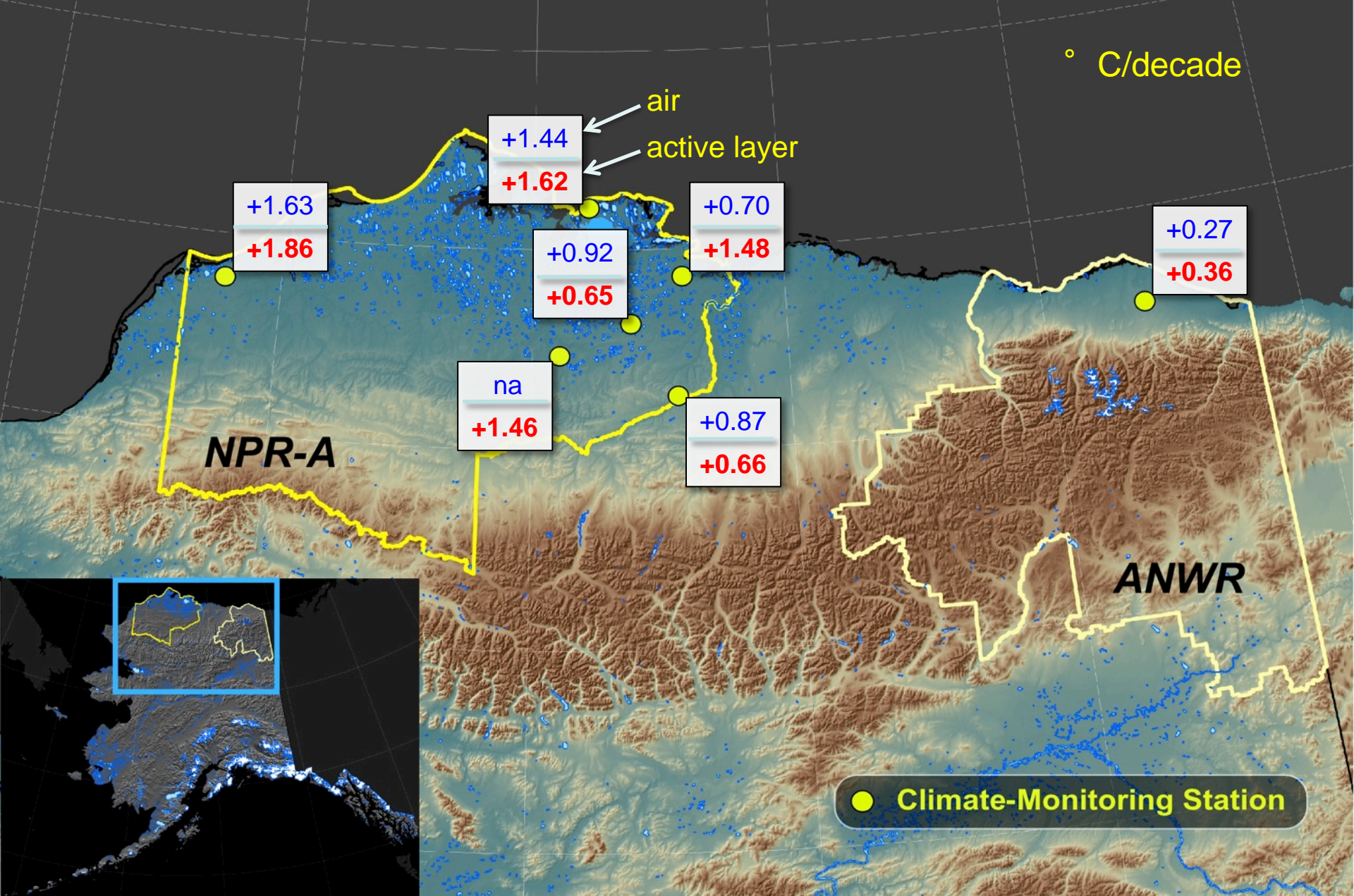




30 cm

Mean-Annual Active-Layer Temperature Trends

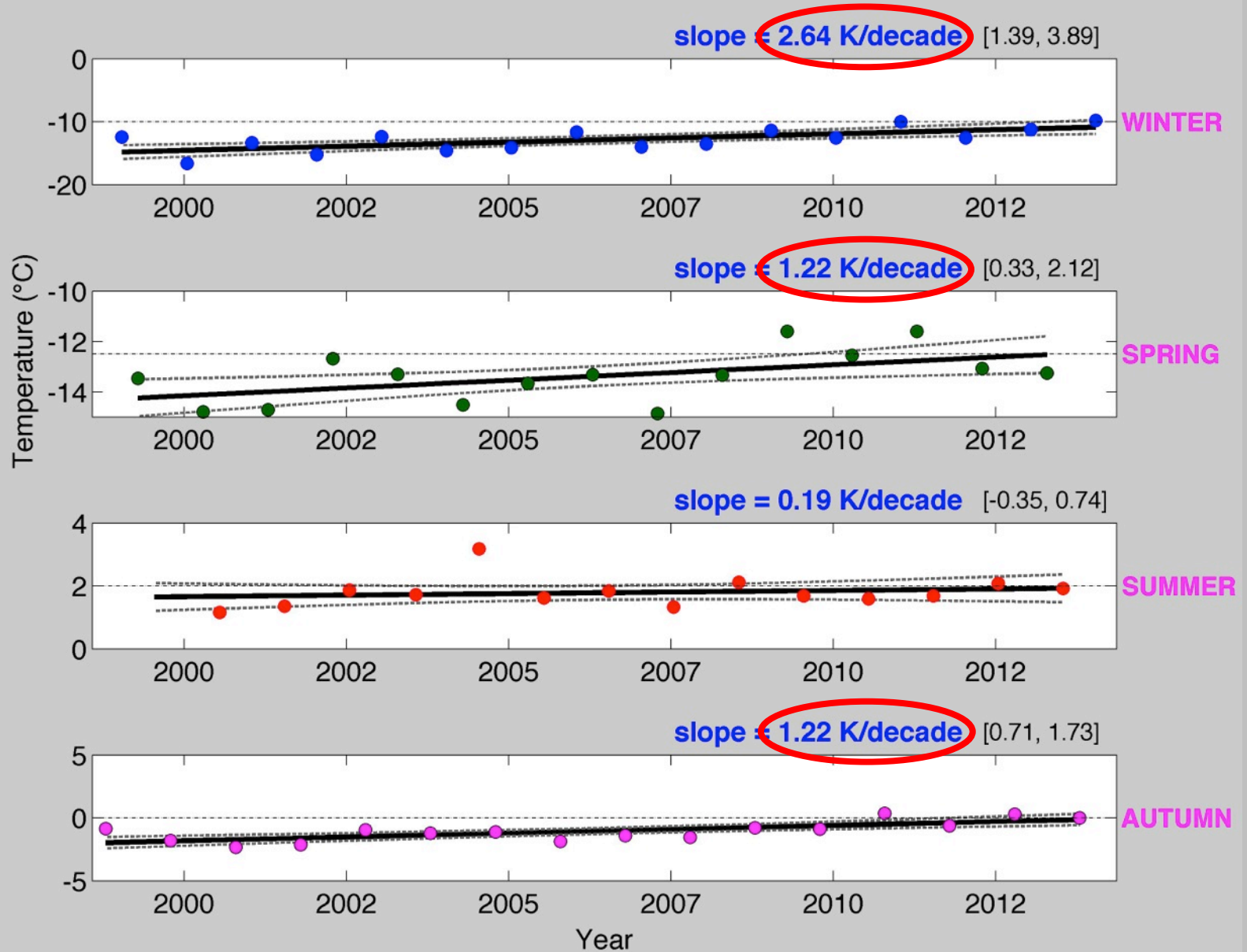
Stations with at least 10 years of data



Seasonal Ground-Temperature Trends

Fish Creek
1998-2013

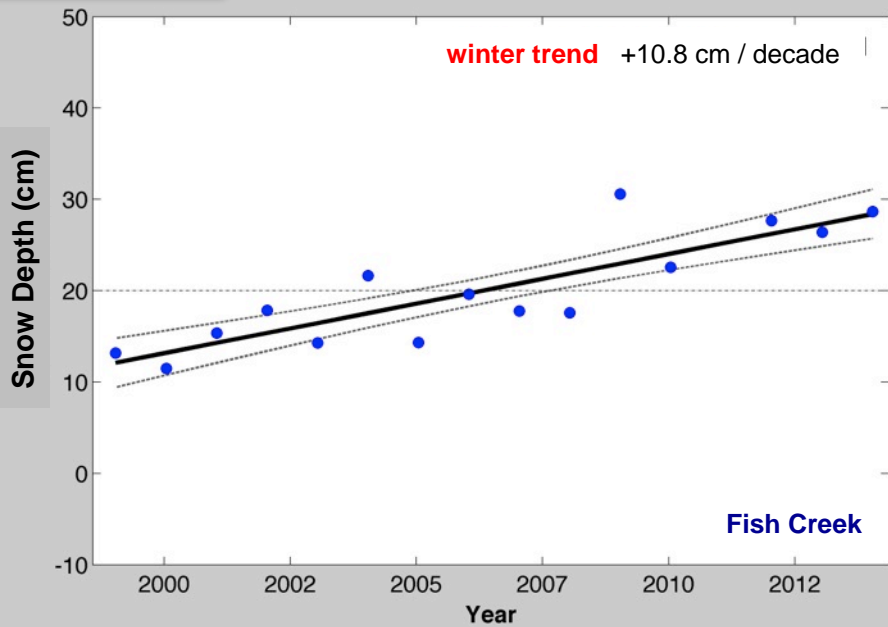
Active Layer (10 cm)



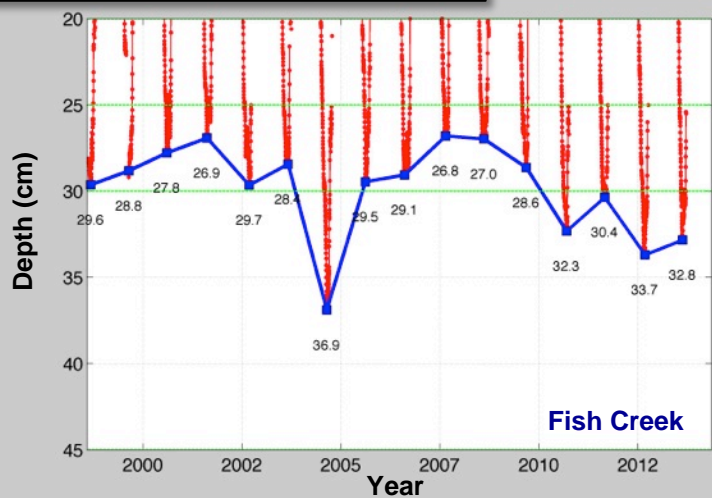
Snow and Active-Layer



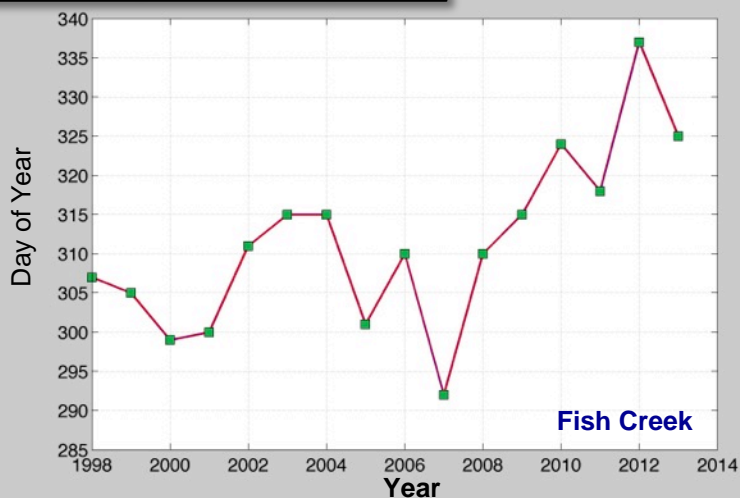
Snow Depth



Maximum Active-layer Depth

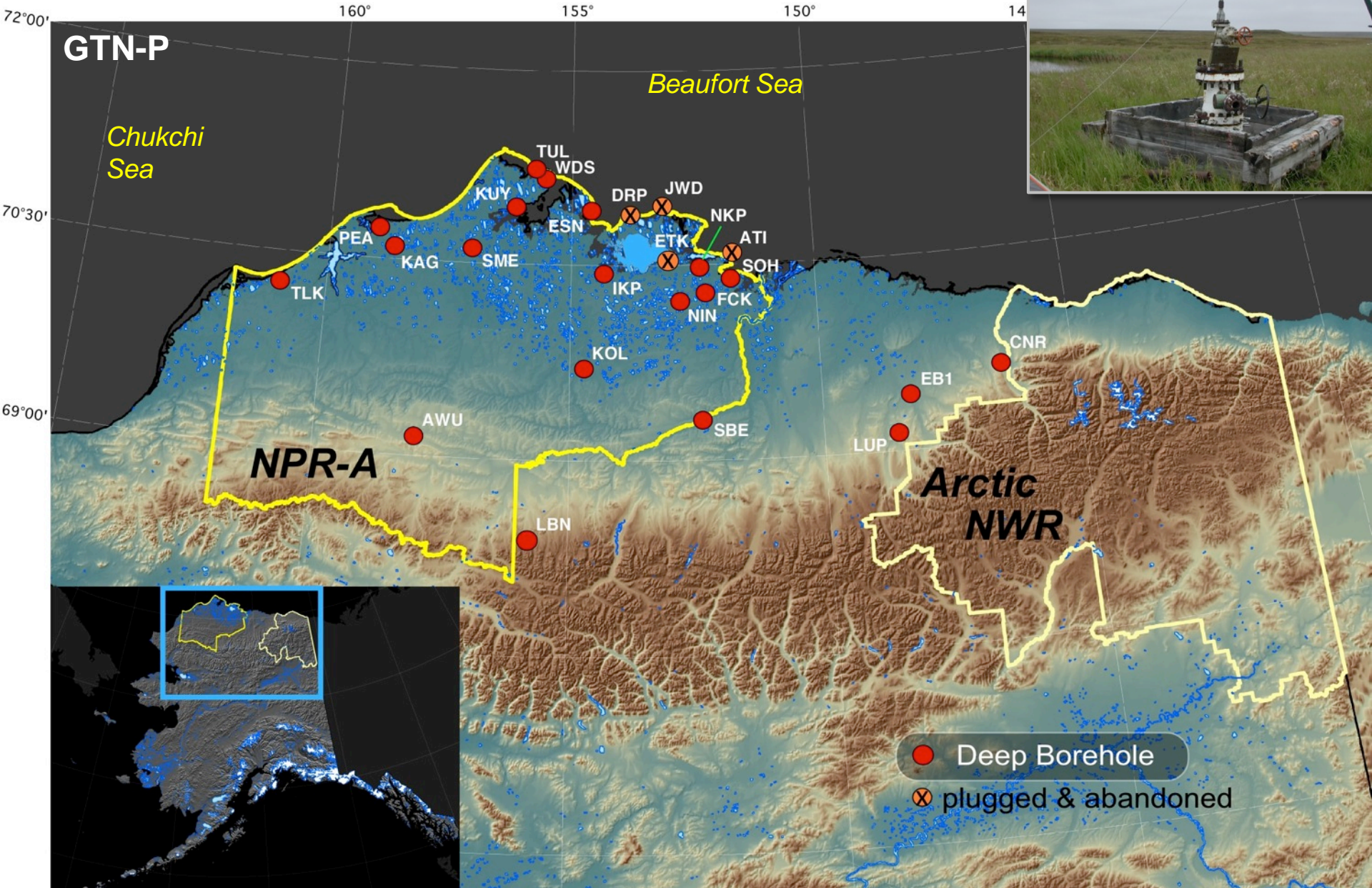


Active-layer Freeze-up Date



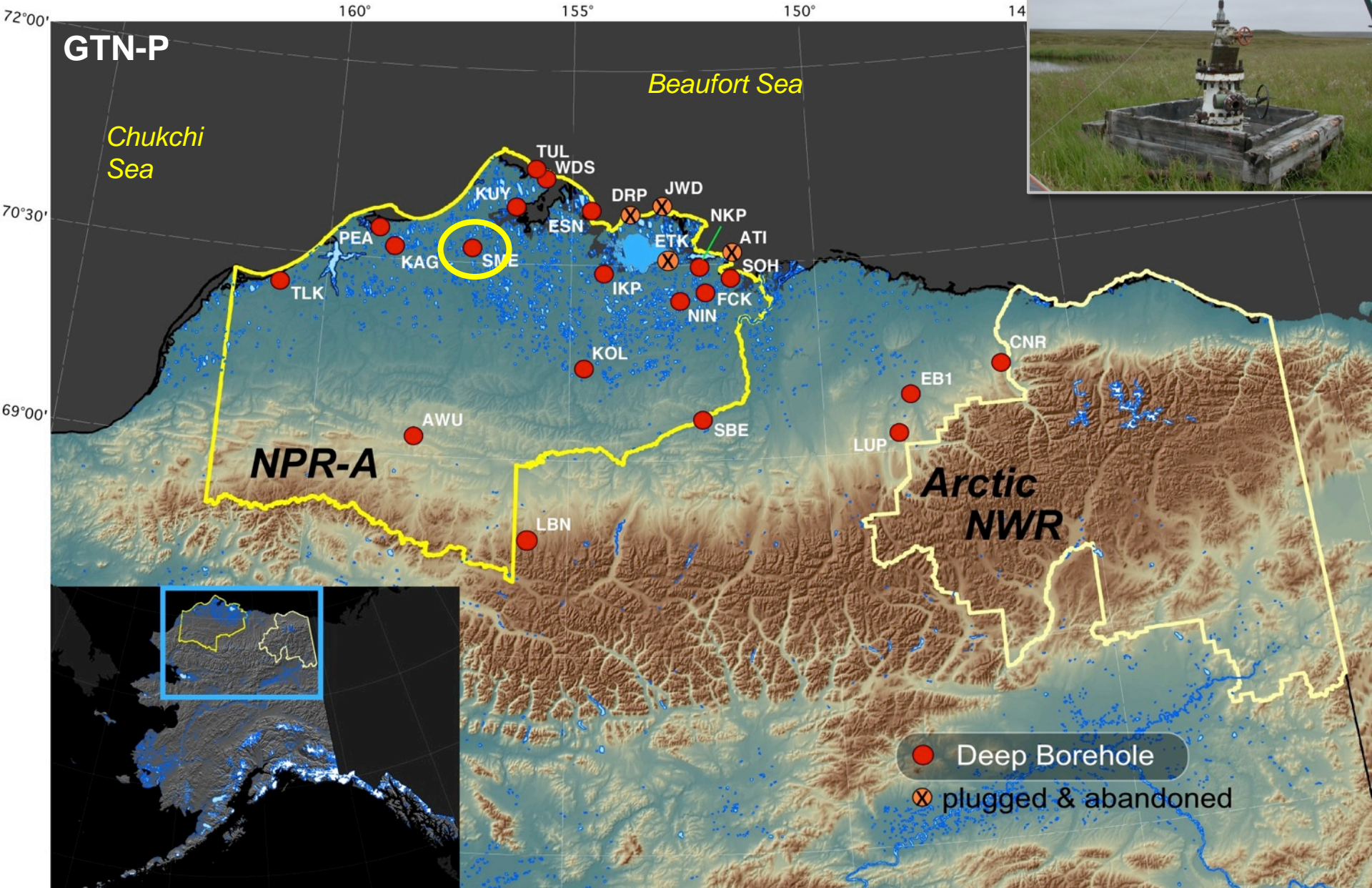
USGS Deep-Borehole Array

Thermal State of Permafrost

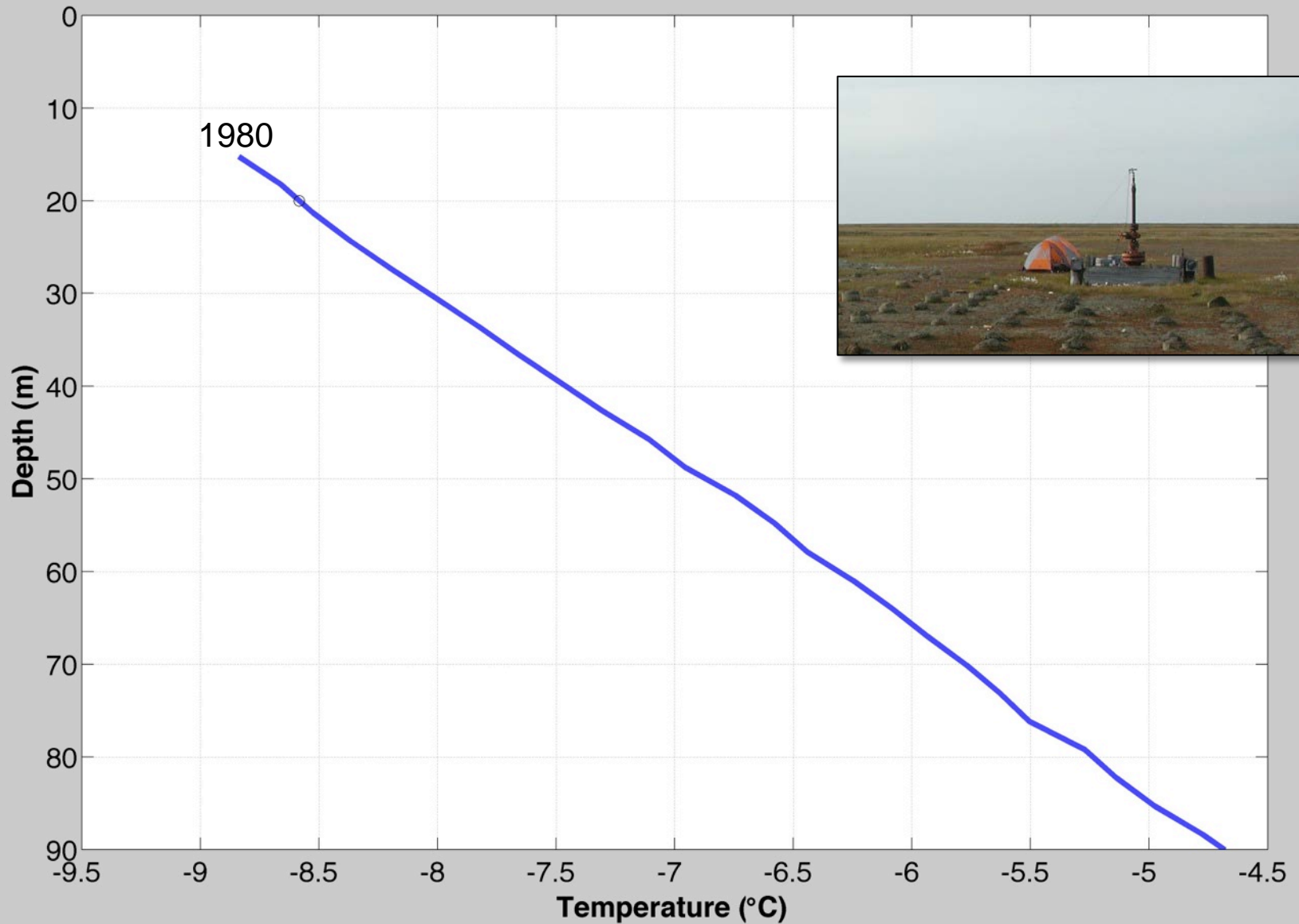


USGS Deep-Borehole Array

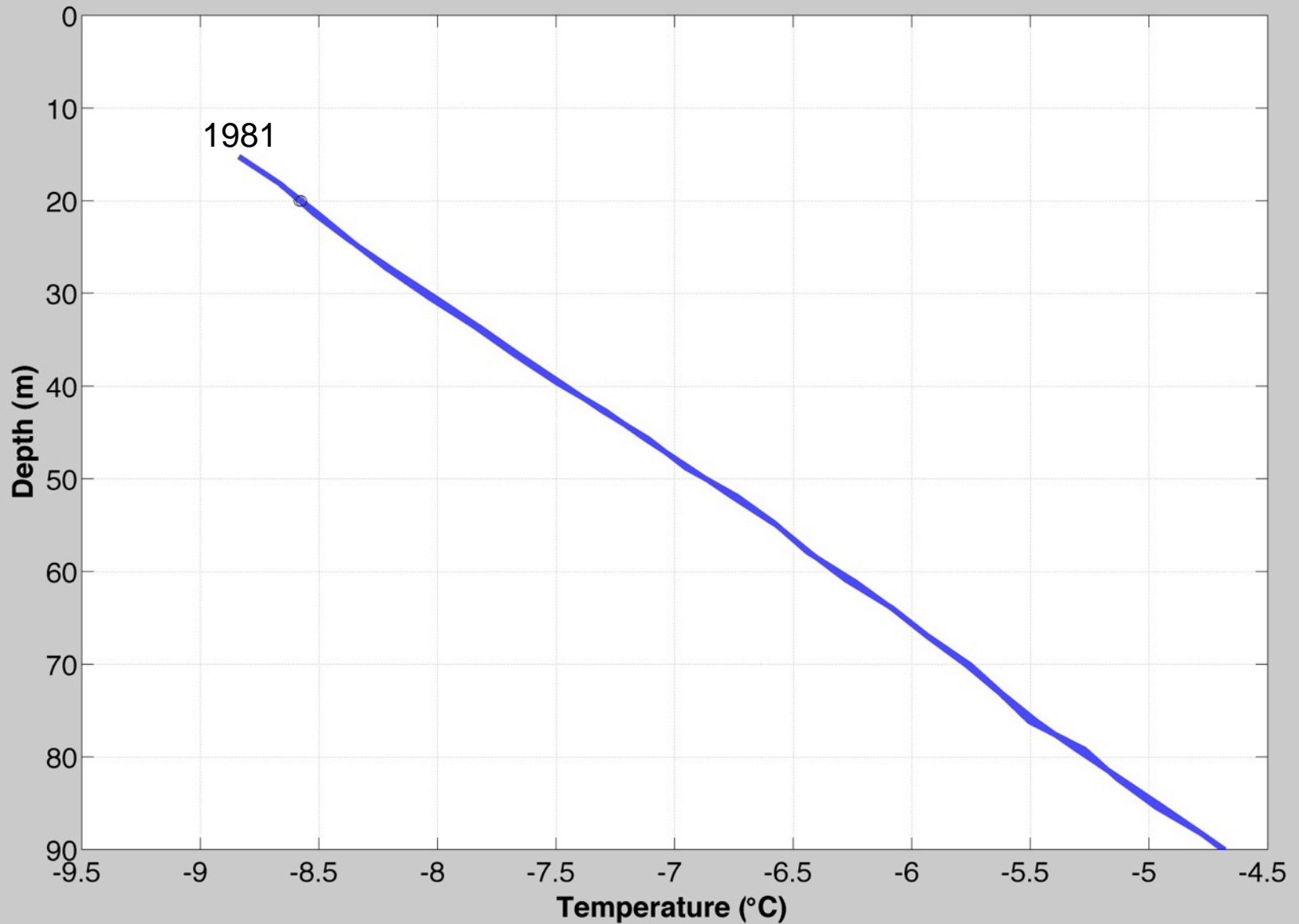
Thermal State of Permafrost



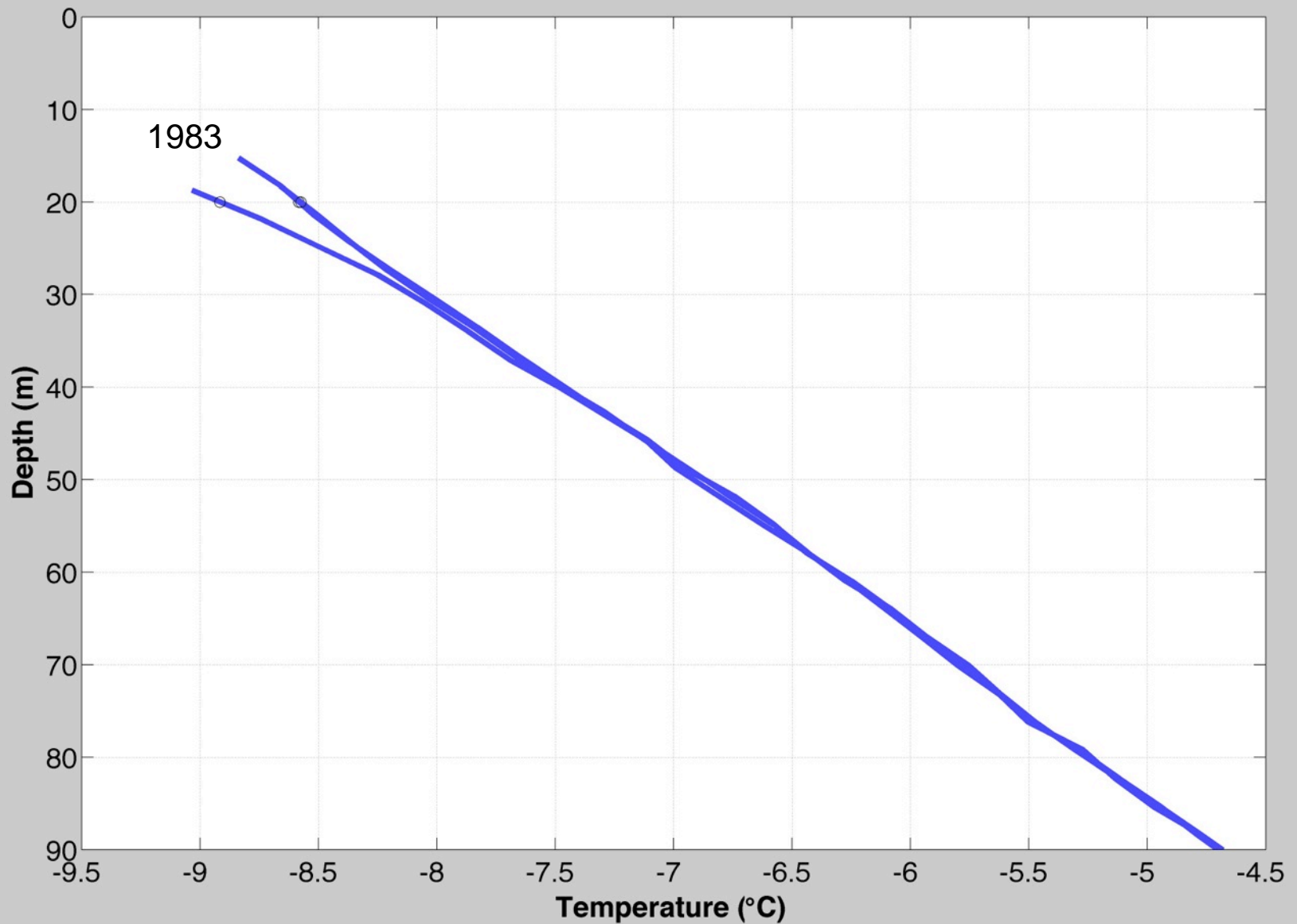
Permafrost Temperatures: South Meade Well



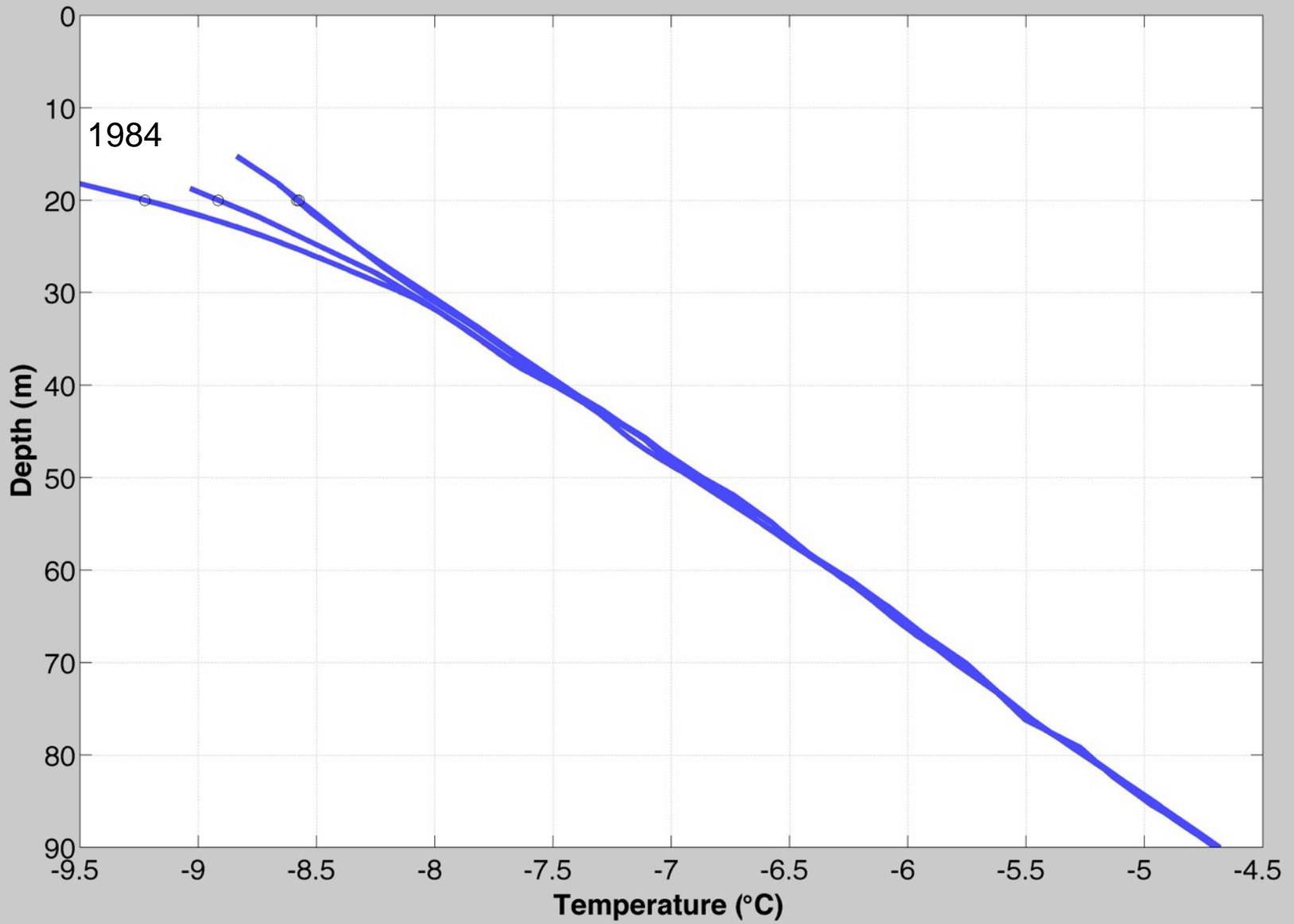
Permafrost Temperatures: South Meade Well



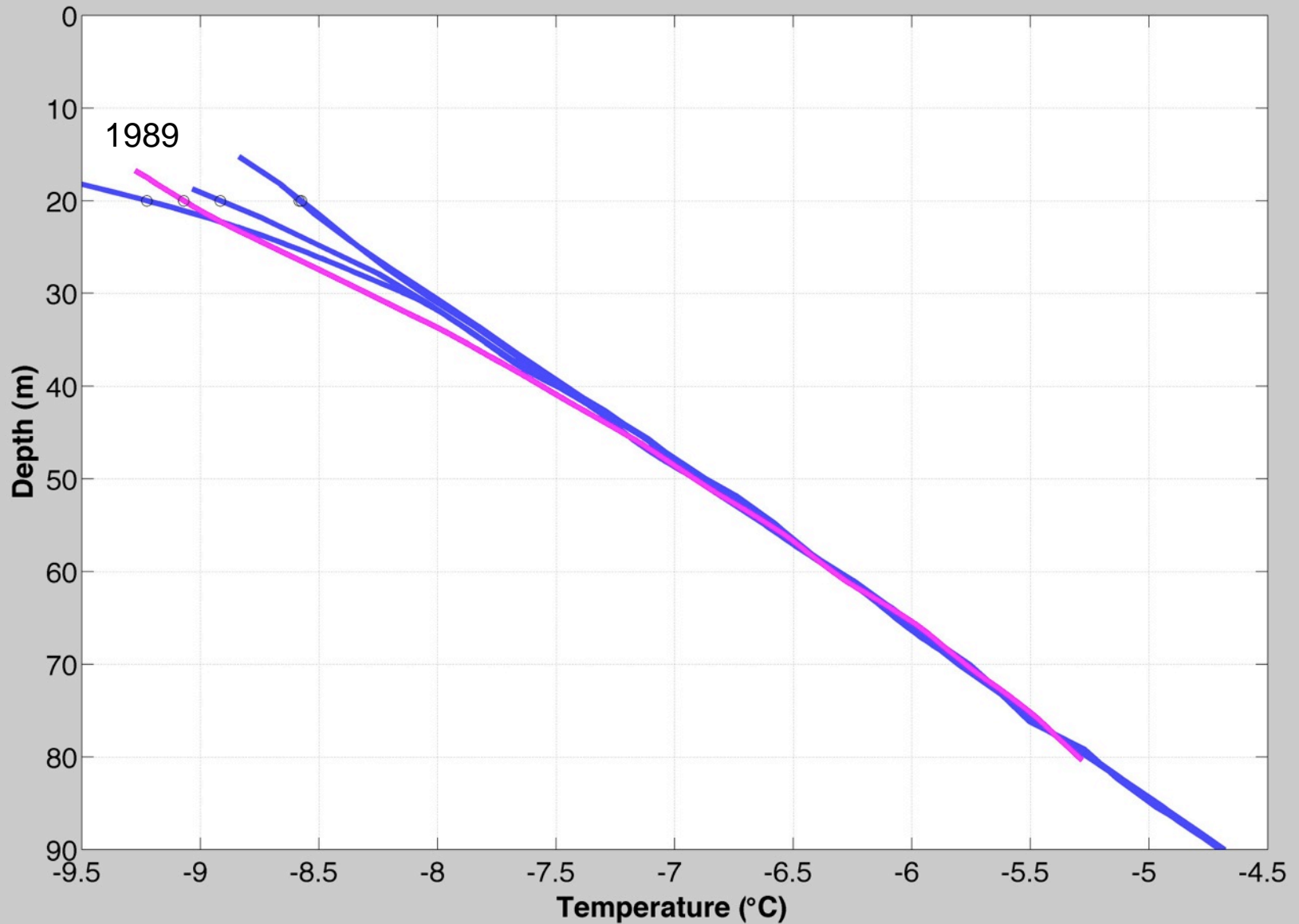
Permafrost Temperatures: South Meade Well



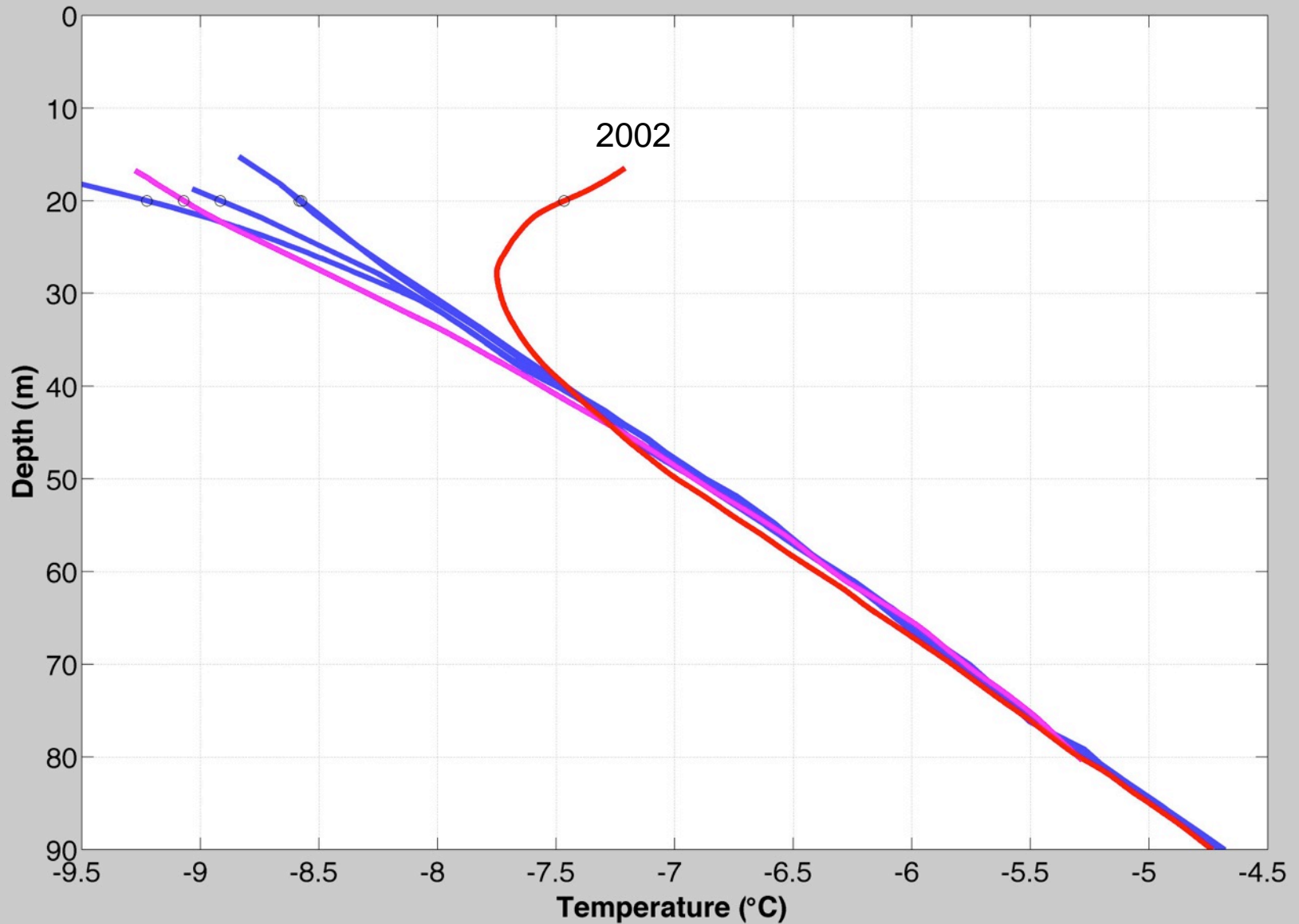
Permafrost Temperatures: South Meade Well



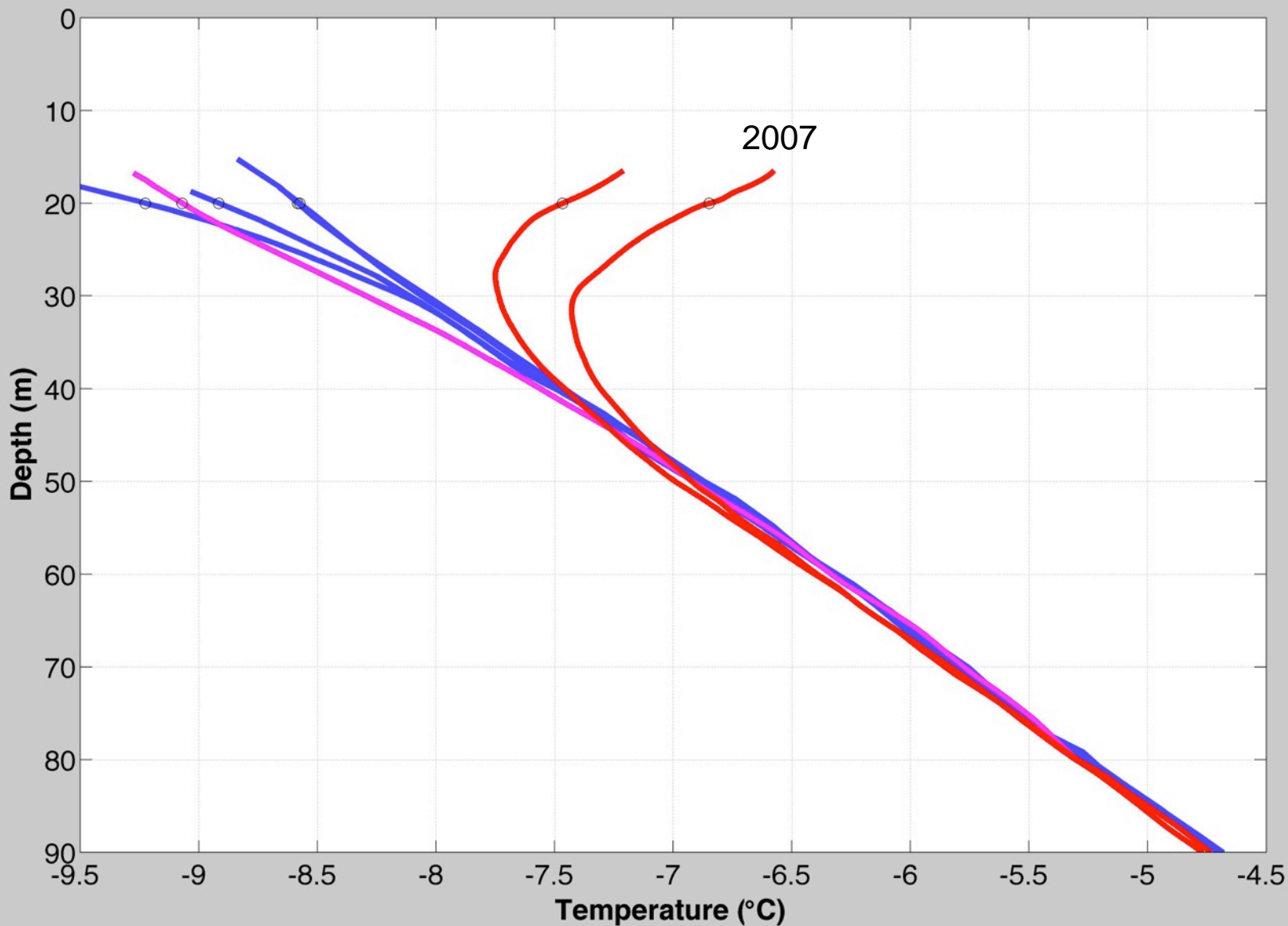
Permafrost Temperatures: South Meade Well



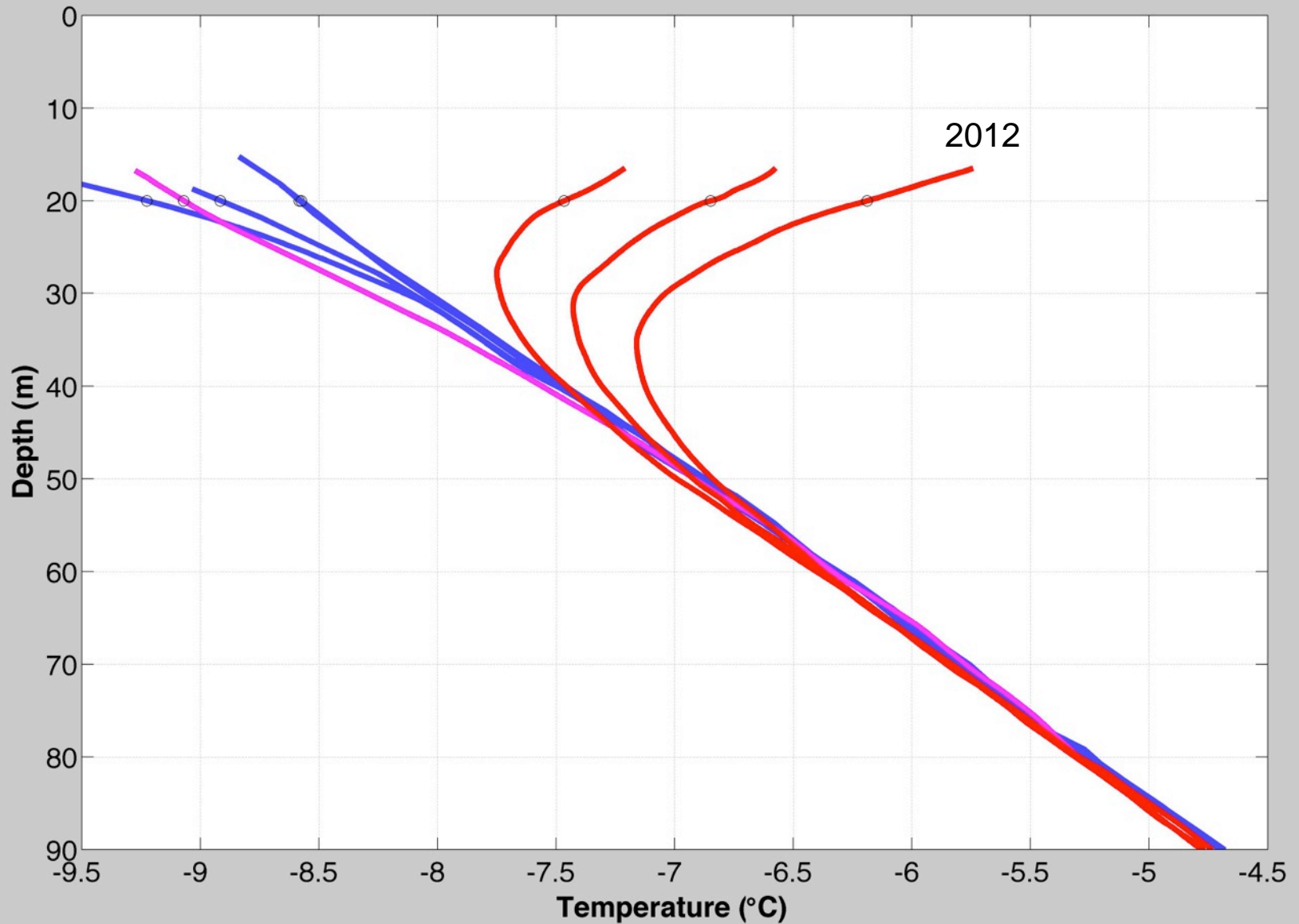
Permafrost Temperatures: South Meade Well



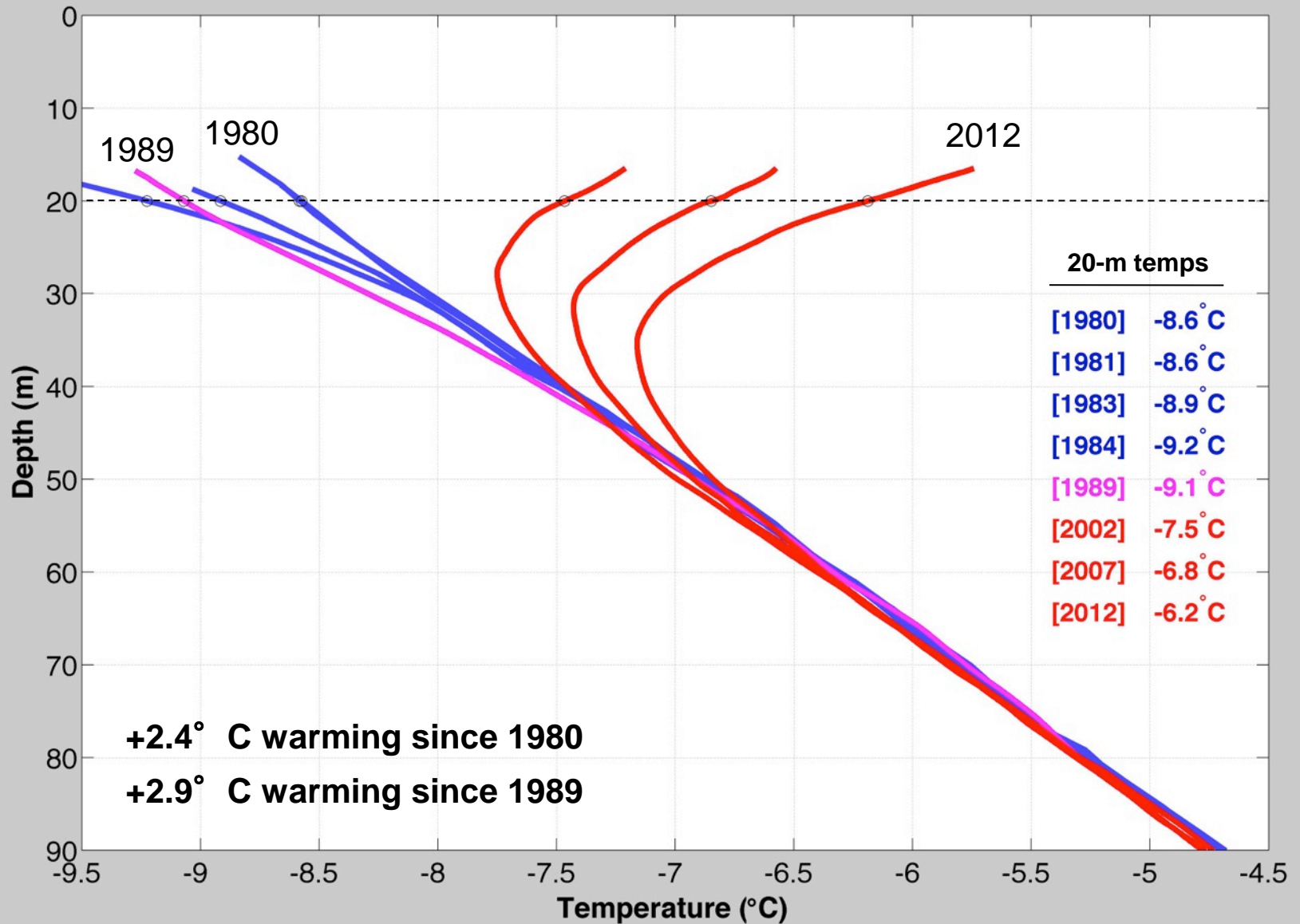
Permafrost Temperatures: South Meade Well



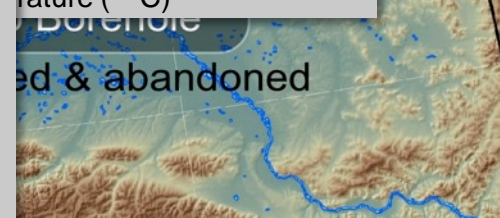
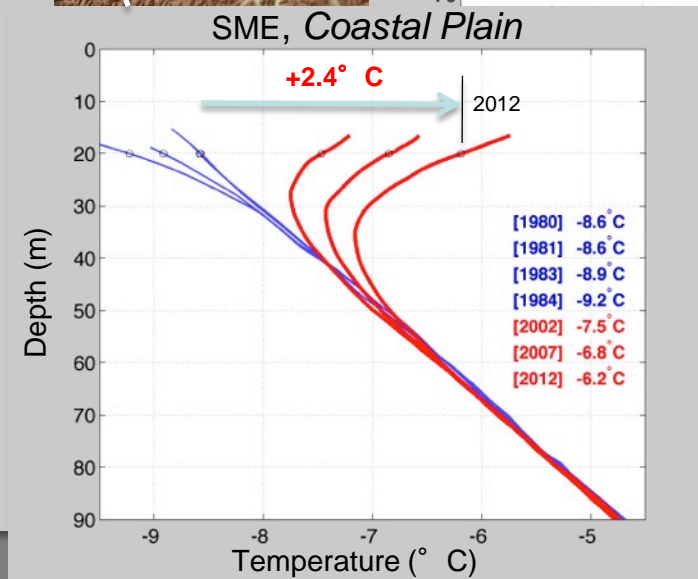
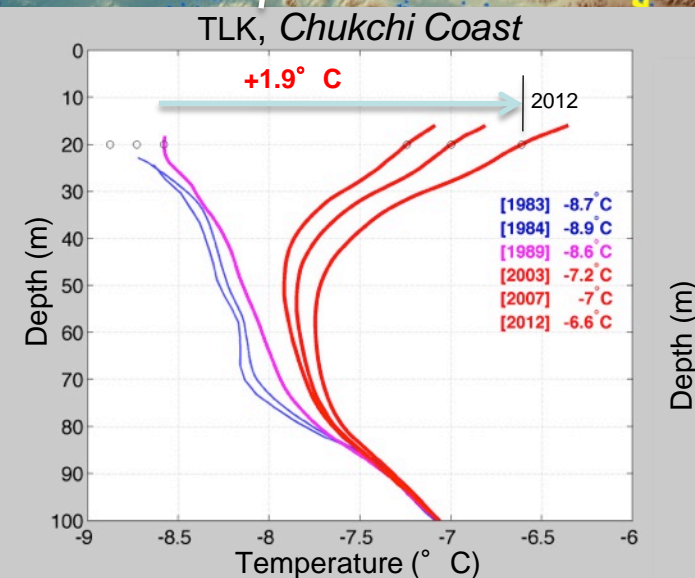
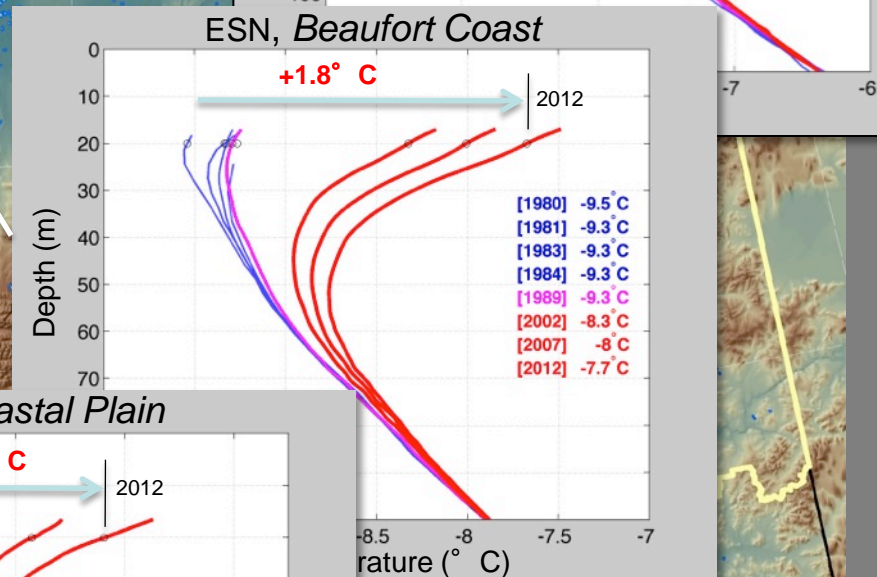
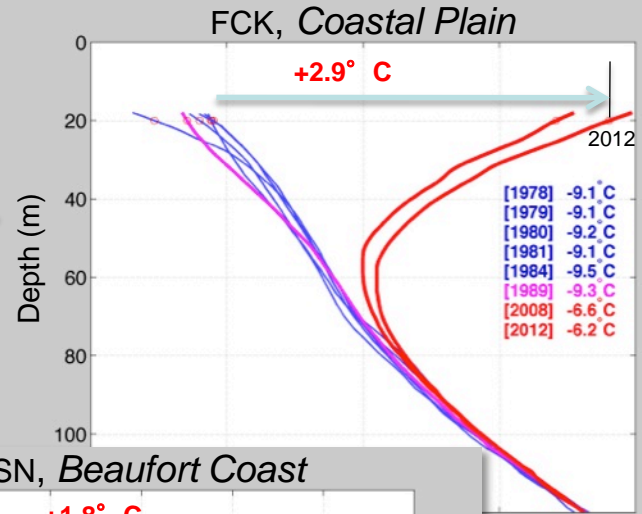
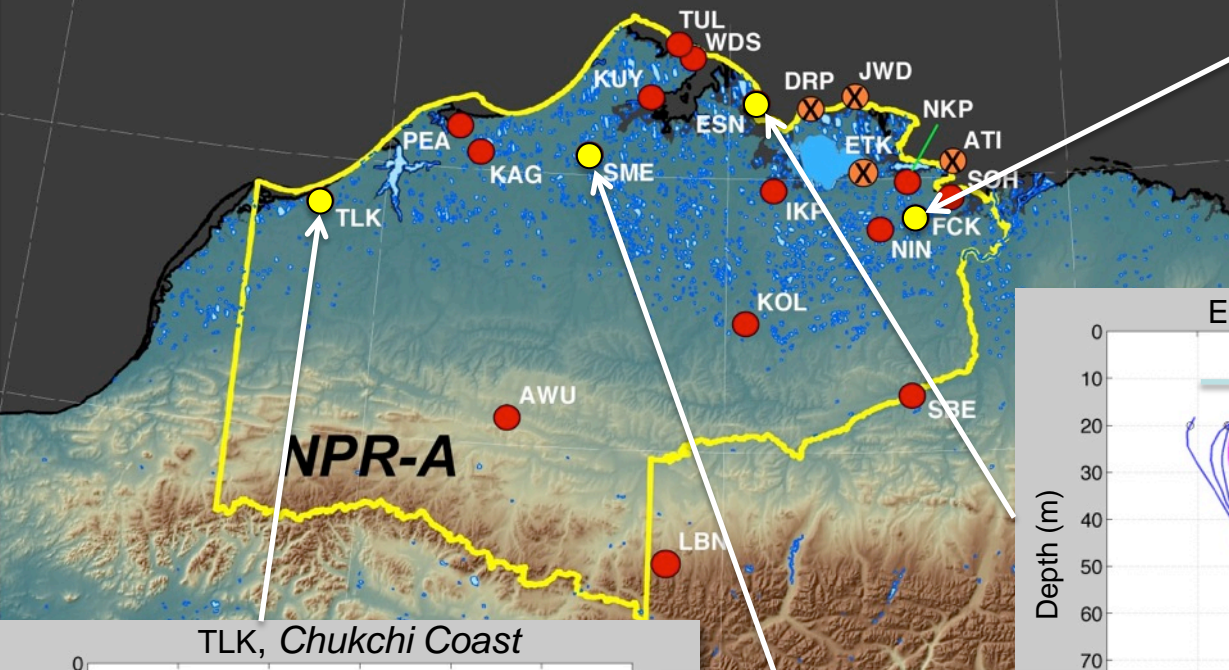
Permafrost Temperatures: South Meade Well



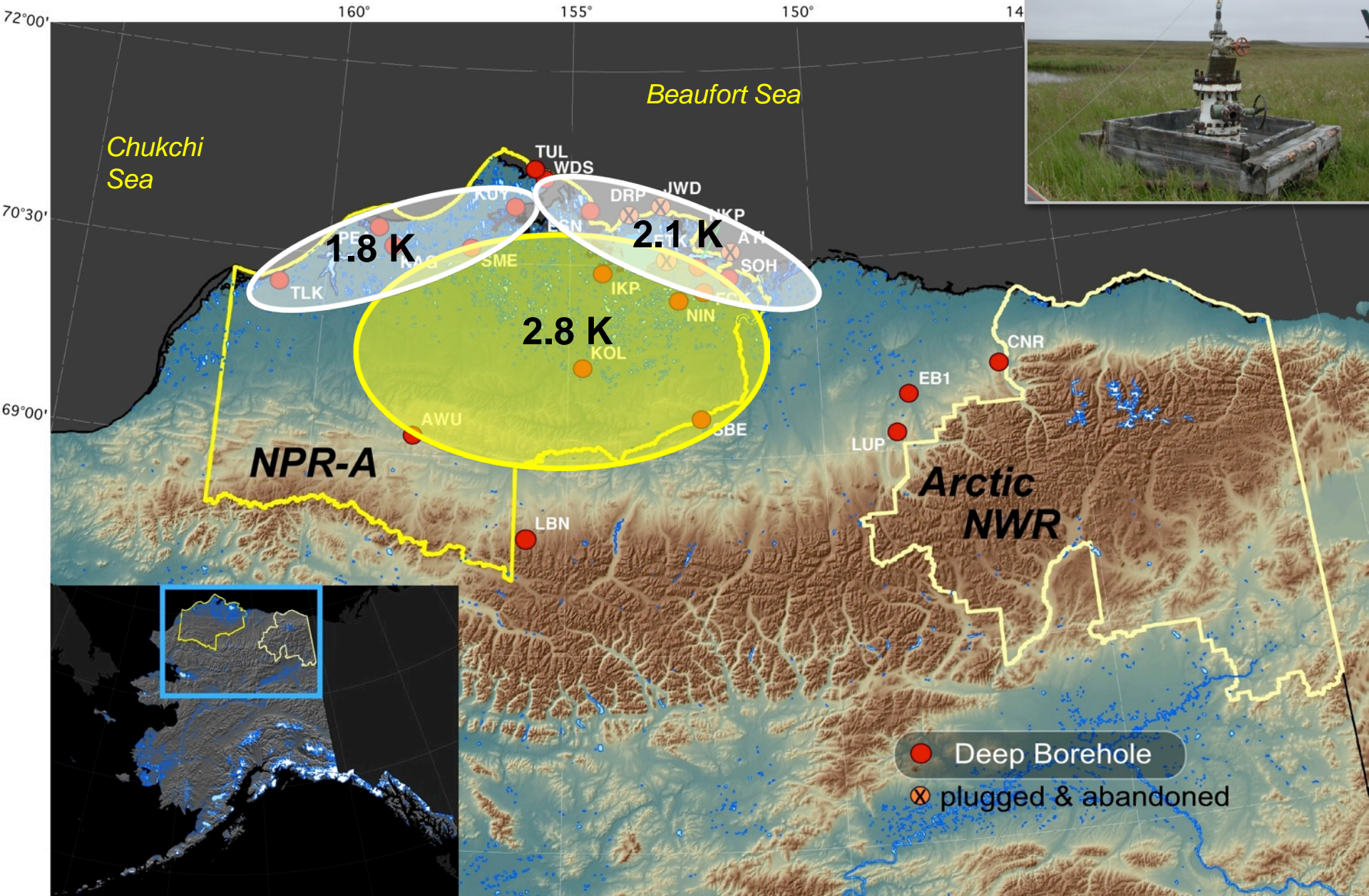
Permafrost Temperatures: South Meade Well



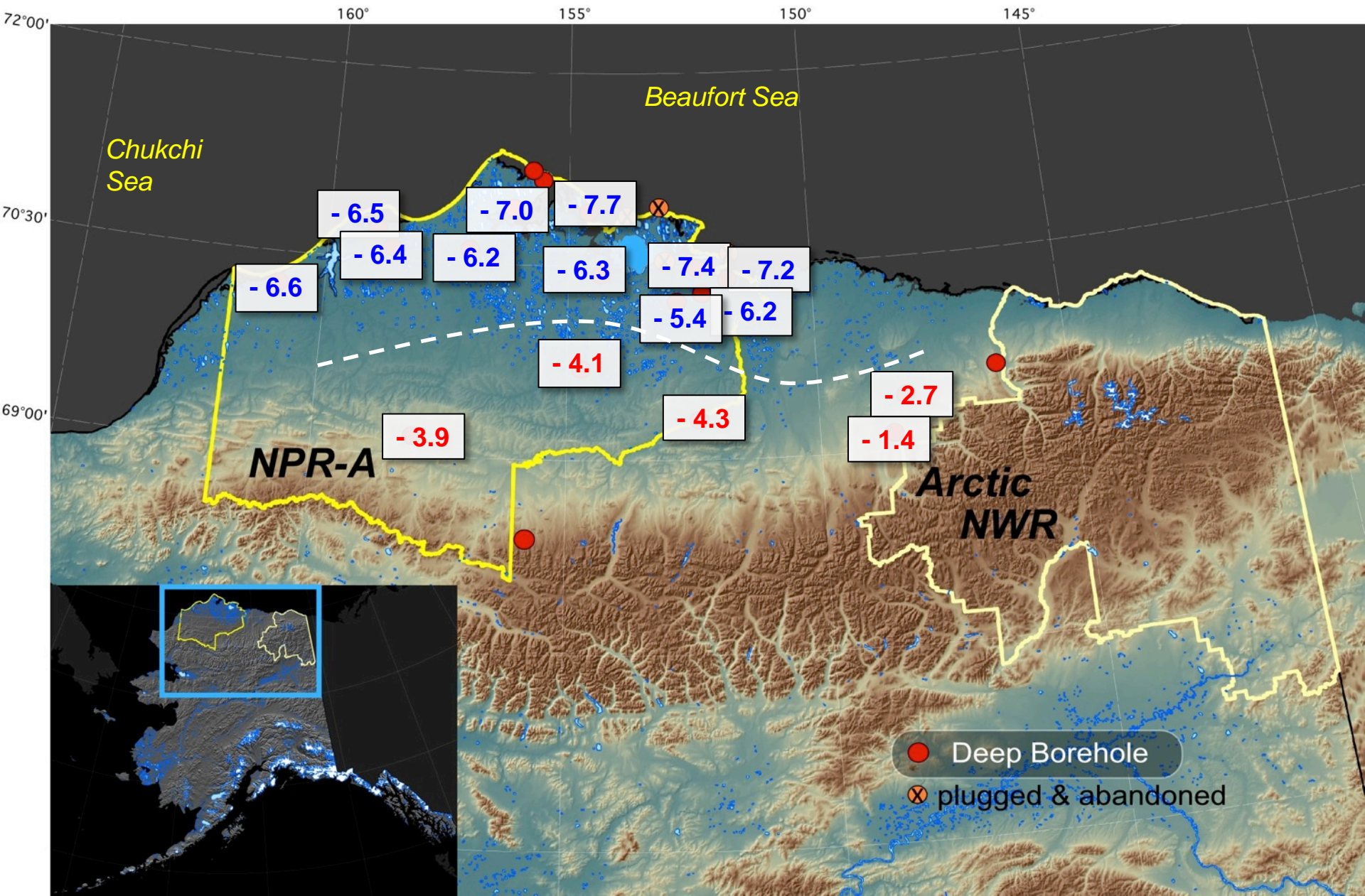
Permafrost Temperatures Deep Borehole Array



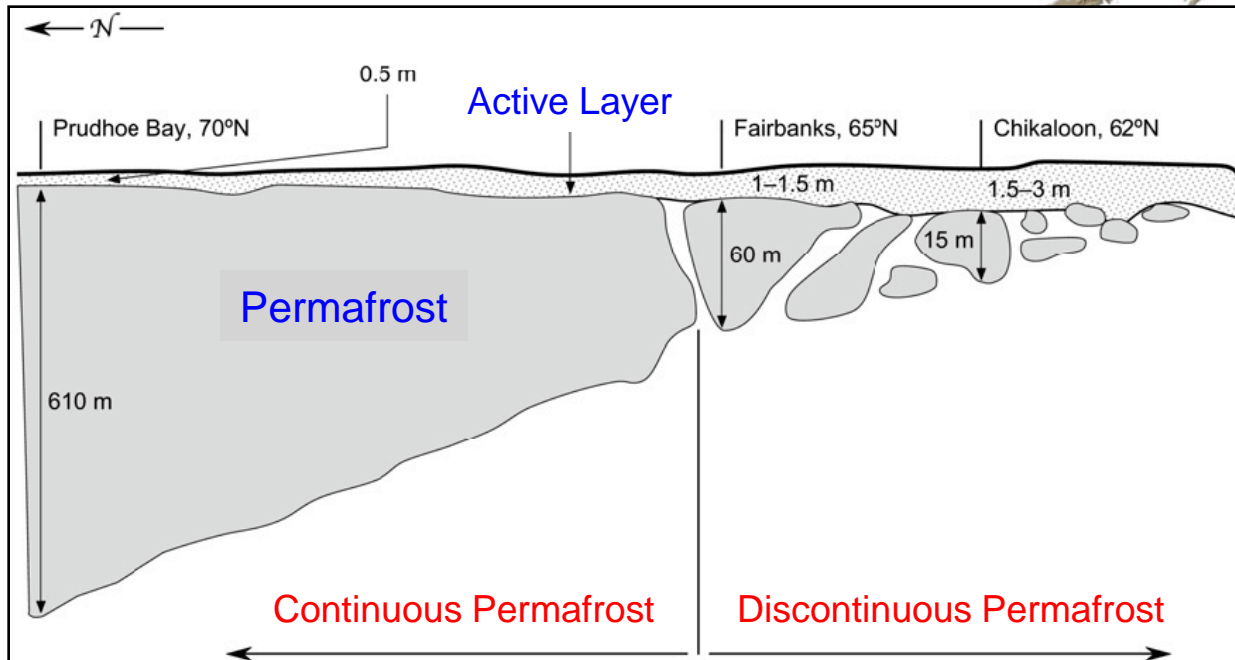
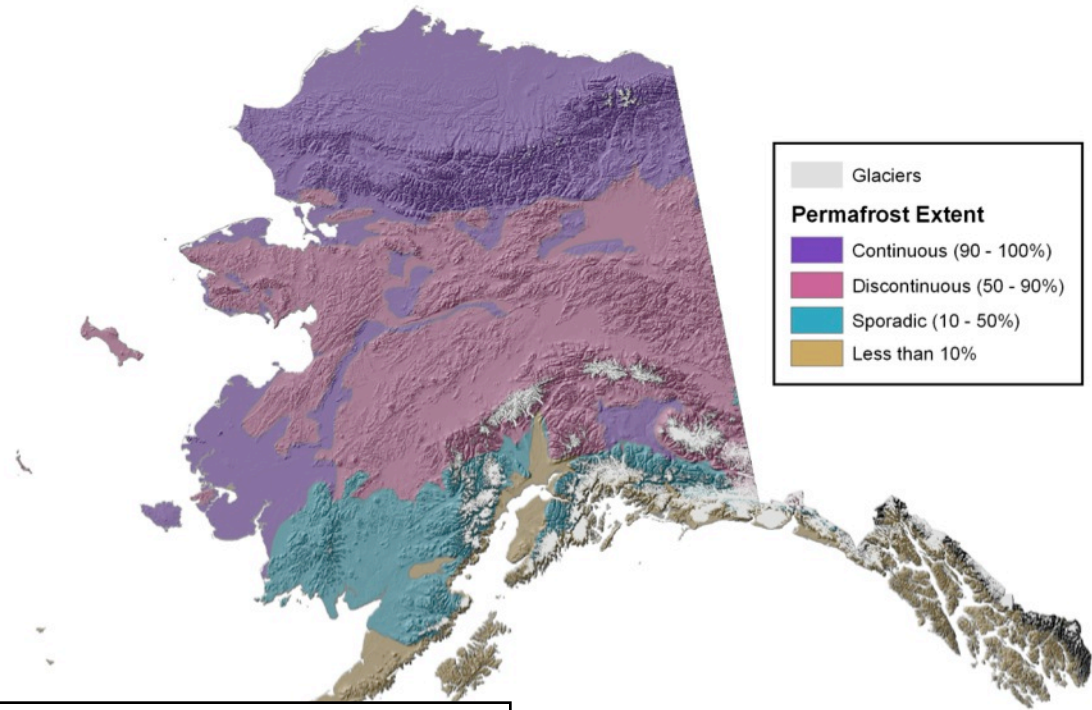
Permafrost Warming since 1990 (20-m depth)



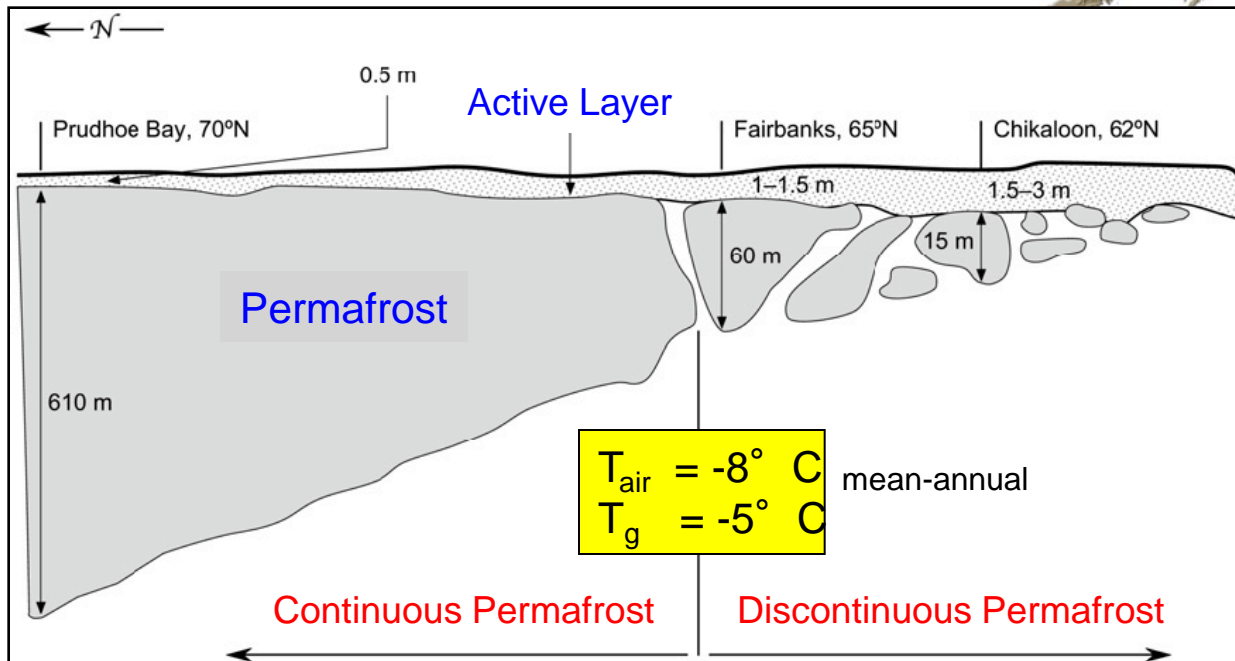
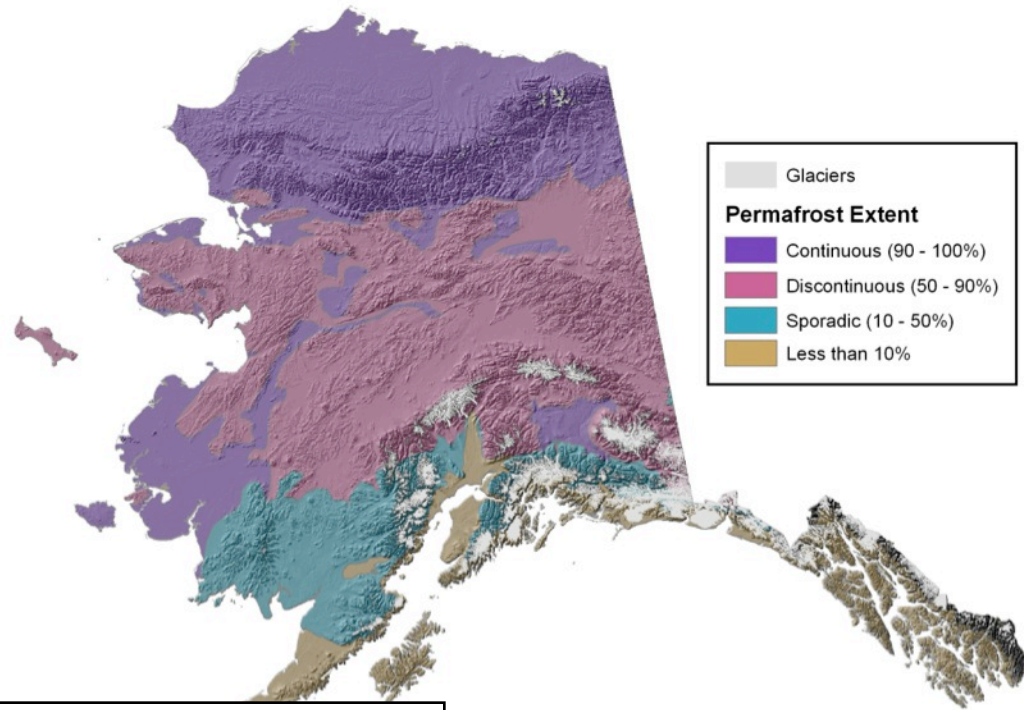
Current Permafrost Temperatures at 20-m Depth



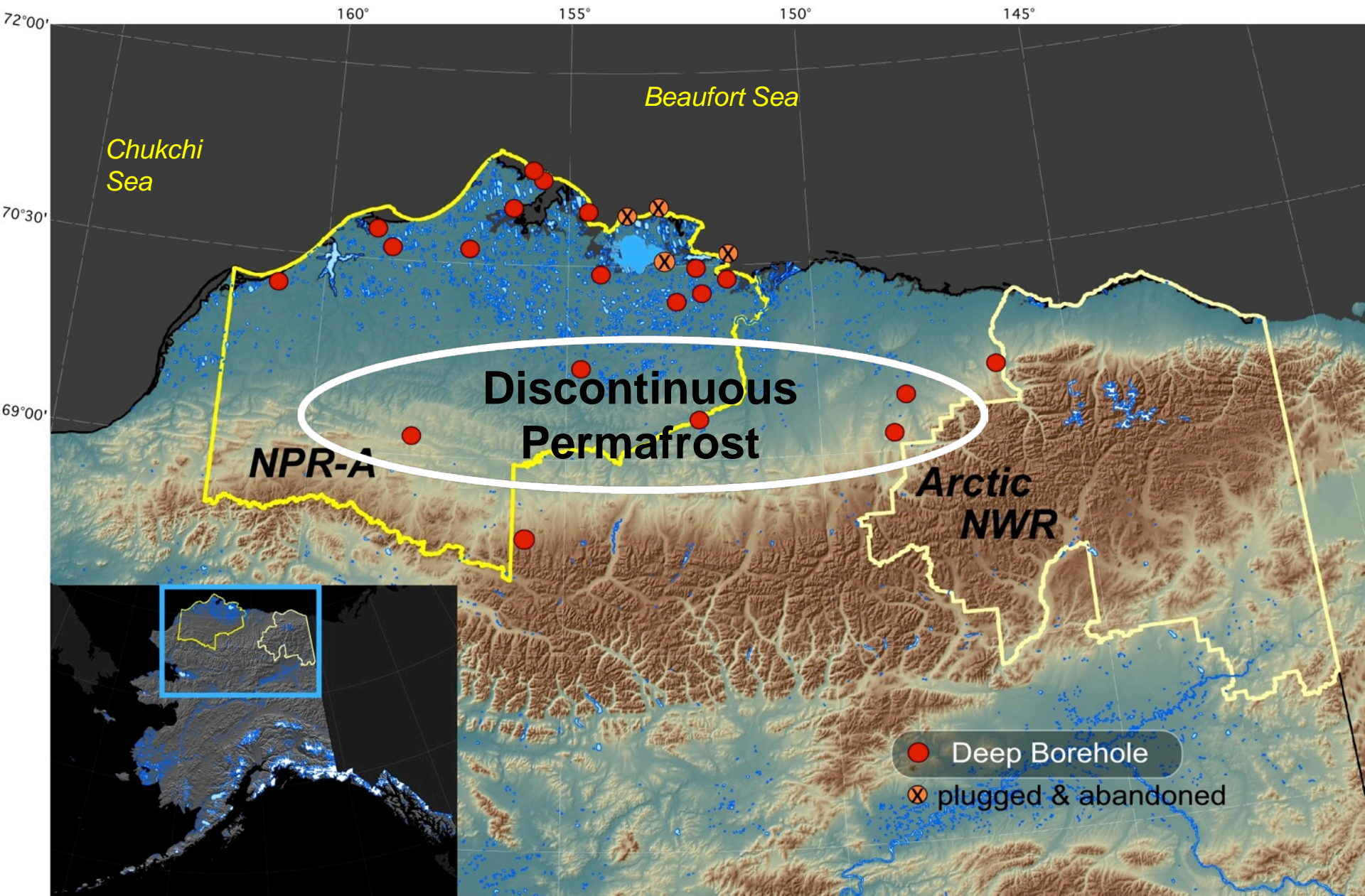
Permafrost Zones Alaska



Permafrost Zones Alaska



Current Permafrost Temperatures at 20-m Depth



Summary:

- **Air temperatures** across the Arctic Slope are continuing to warm during the autumn.
- **Active-layer temperatures** are increasing during all seasons except summer.
 - *increased autumn air temperatures*
 - *thicker cold-season snowpacks*
- **Permafrost temperatures** have warmed 2-3 K since 1990 and are continuing to do so. (*1 K / decade*)
- The **discontinuous permafrost boundary** is primed to jump north of the Brooks Range.

