Arctic Science for Improving Prediction

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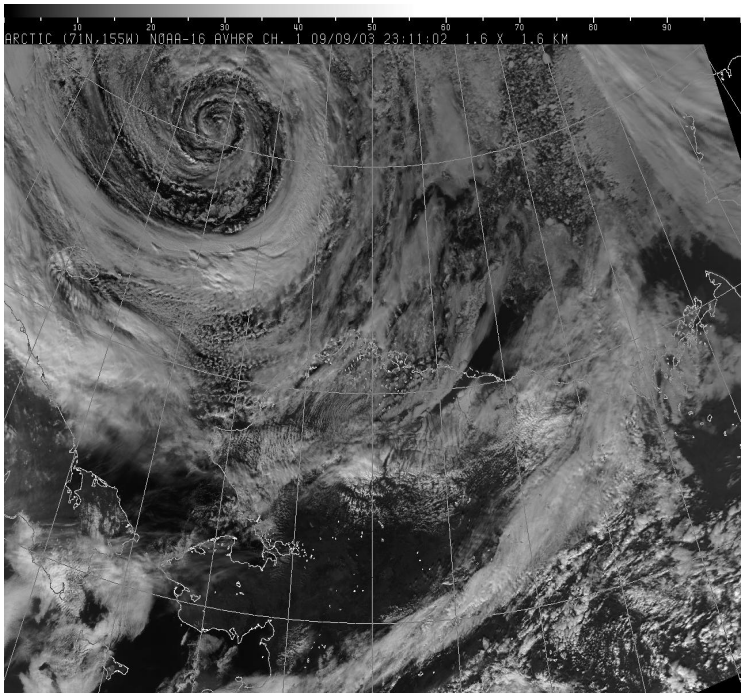

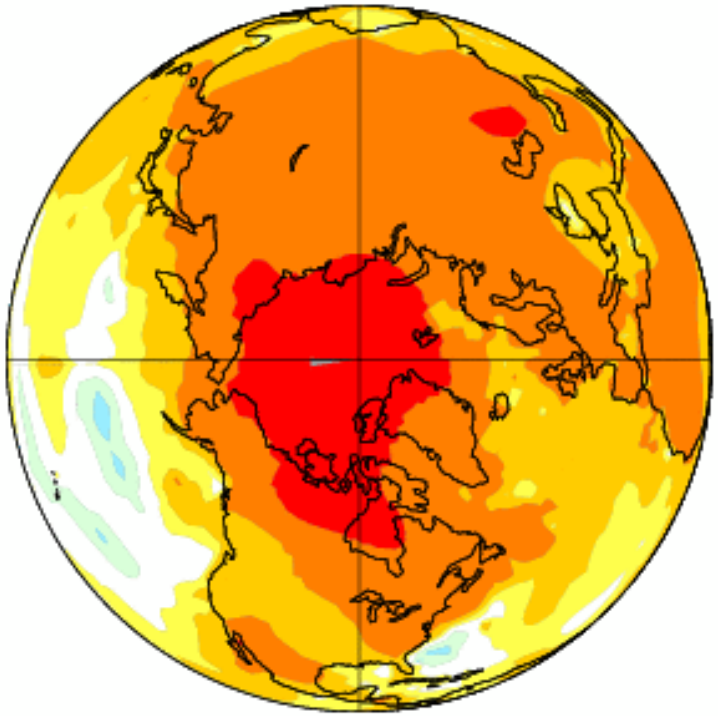

NOAA Science Challenge Workshop, May 2014

Timescales of interest:

- **Weather**
- **Interannual**
- **Decadal to multidecadal**

Timescales of interest:

- **Weather: clouds, storms**
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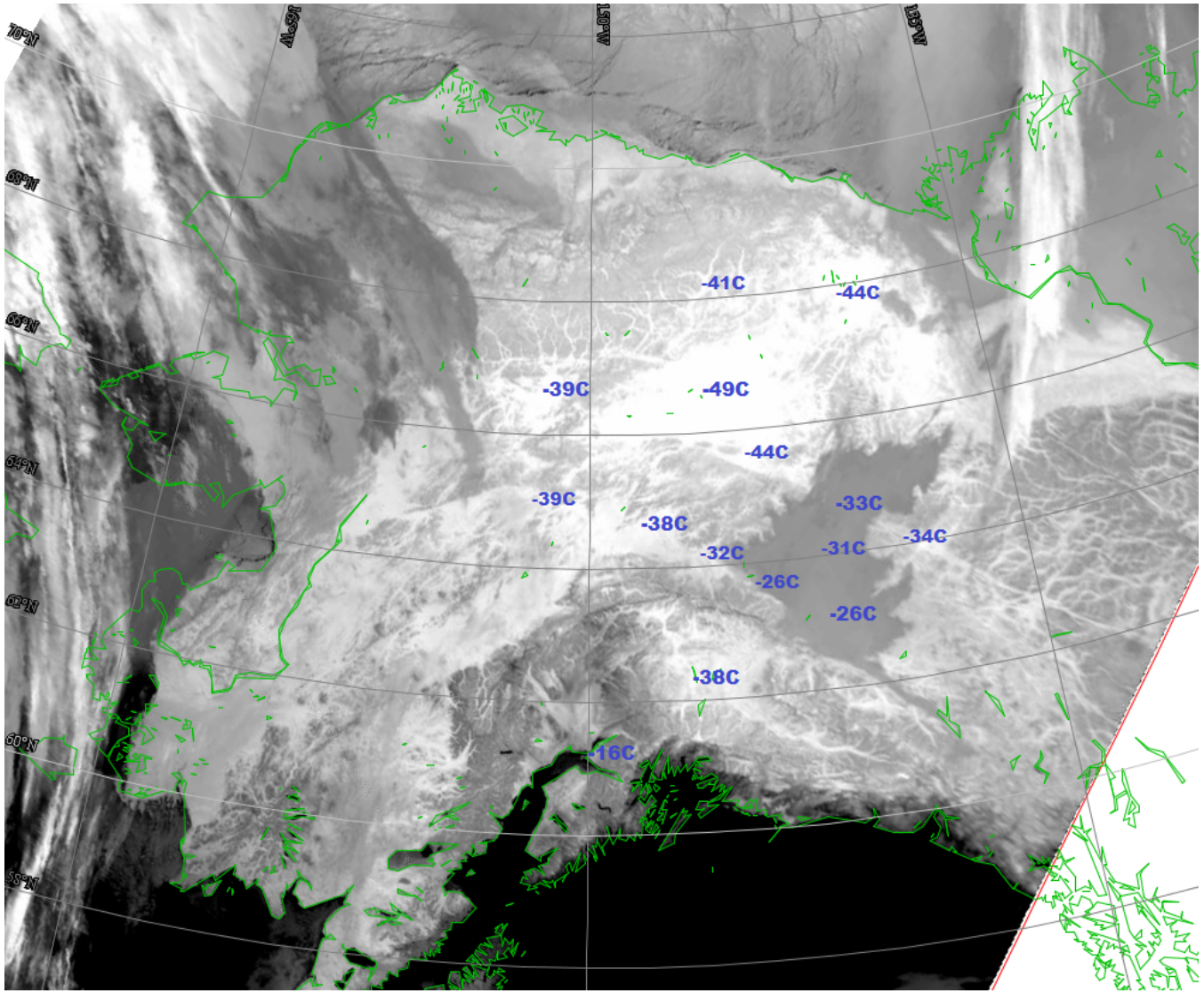
The cloud problem in Arctic weather prediction

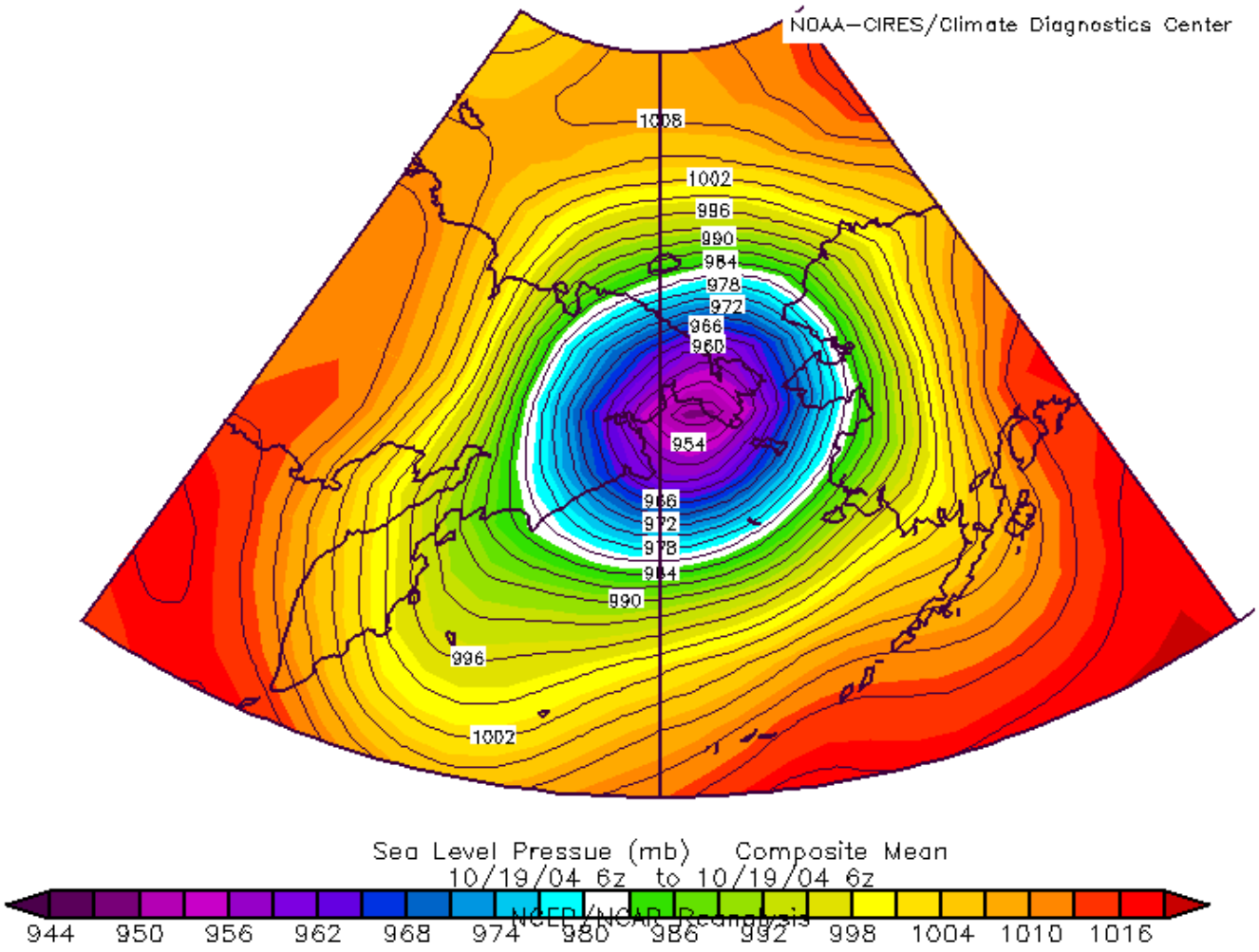
IR image: Dec. 17, 2010

[from R. Thoman, Fairbanks WSFO]

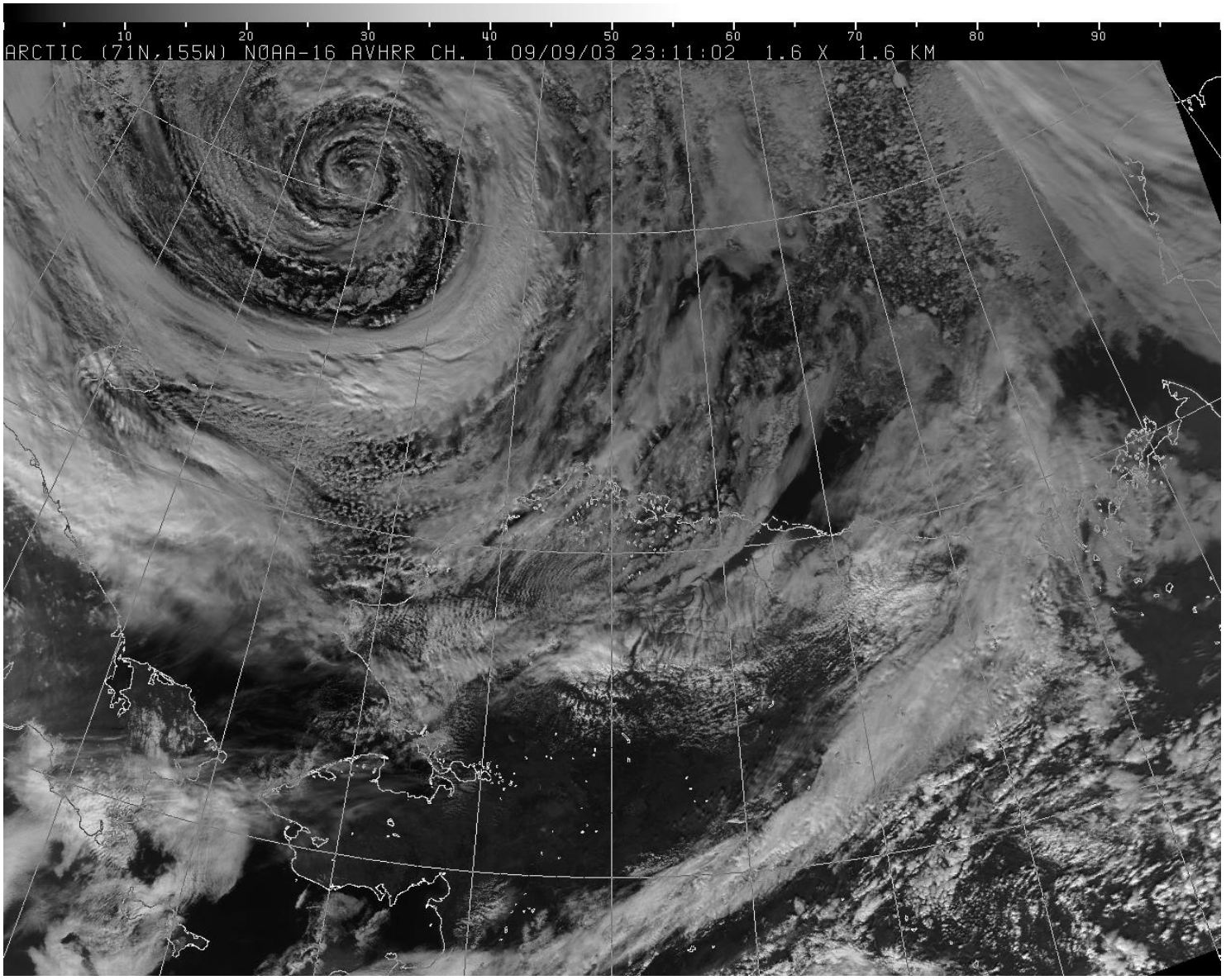


941 mb cyclone in the northern Bering Sea, Oct. 2004

[flooding of Alaskan coastal communities]



Intense *summer* Arctic cyclone affecting northern Alaskan coast



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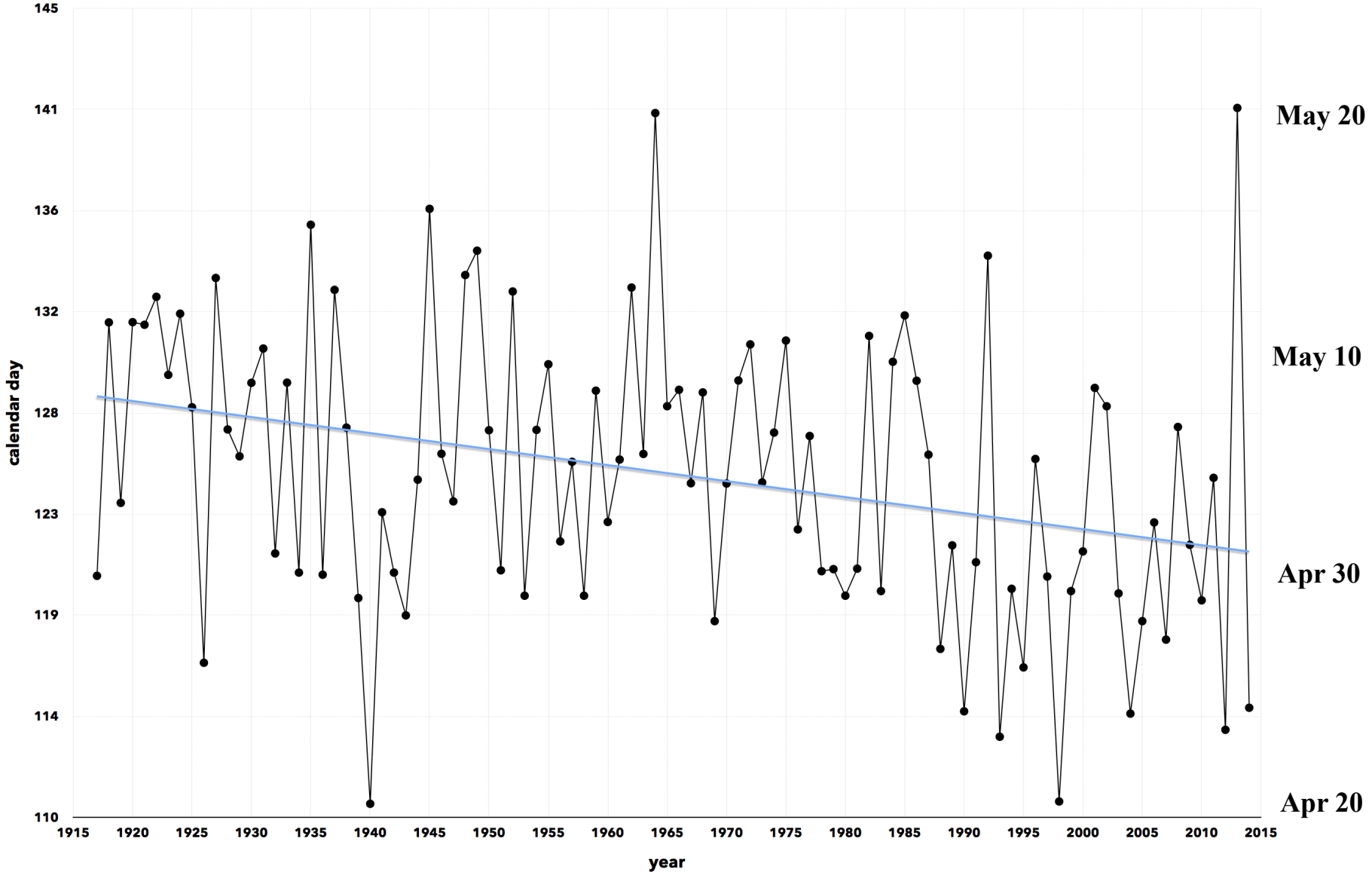
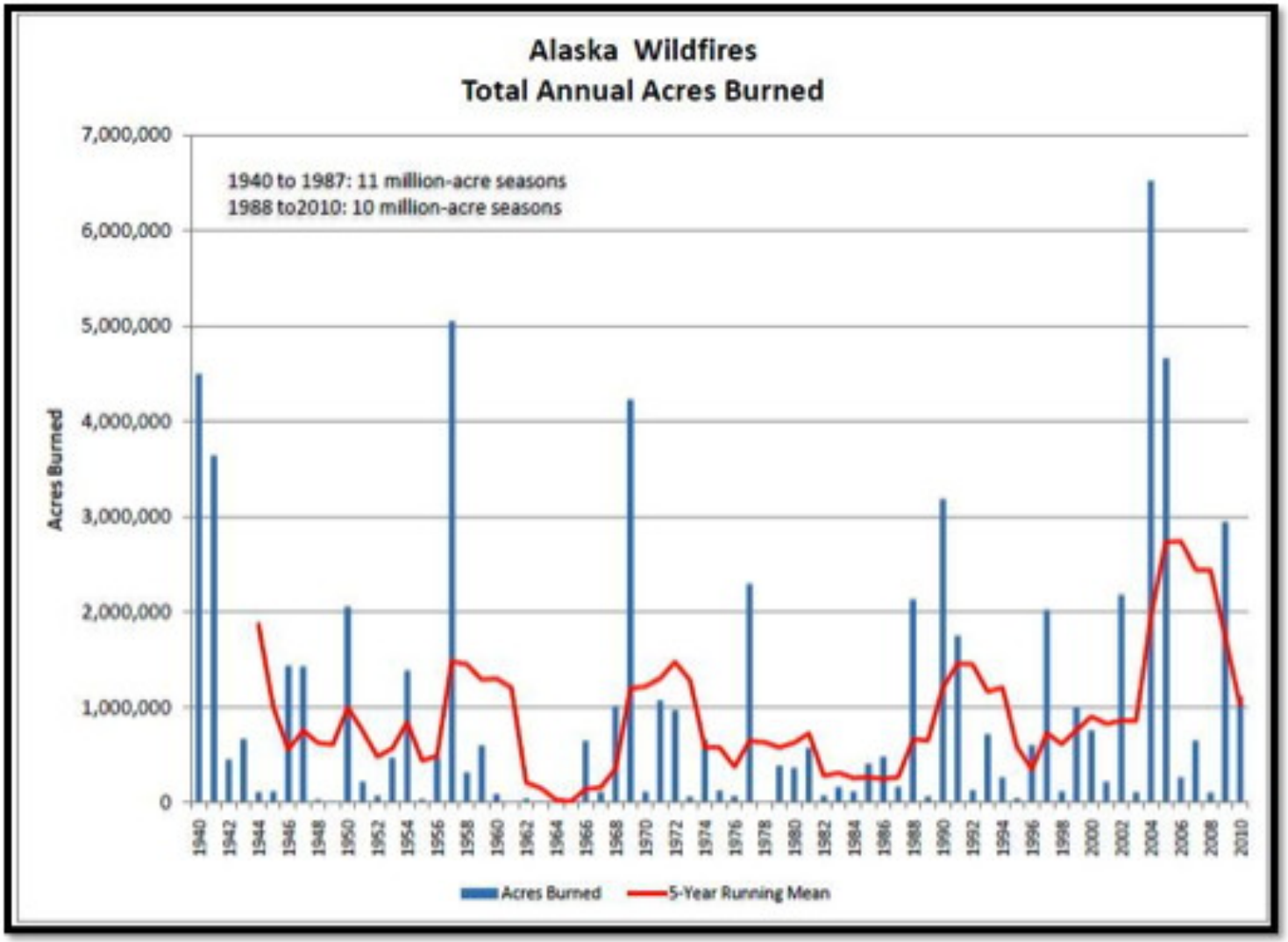
Tanana River (AK) ice break-up date, 1918-2014

Trend ~ -7 days/100 years, but large interannual variability

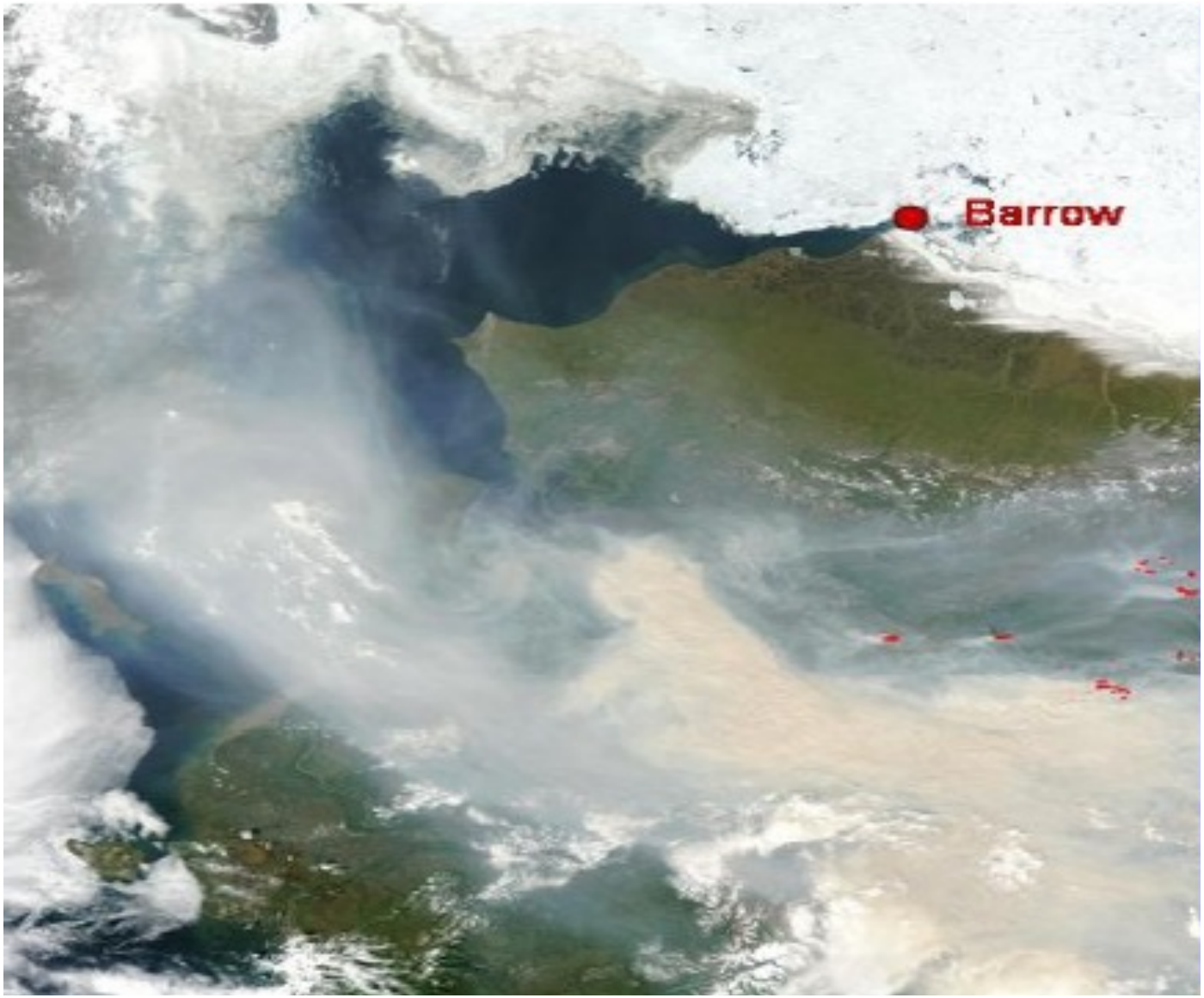


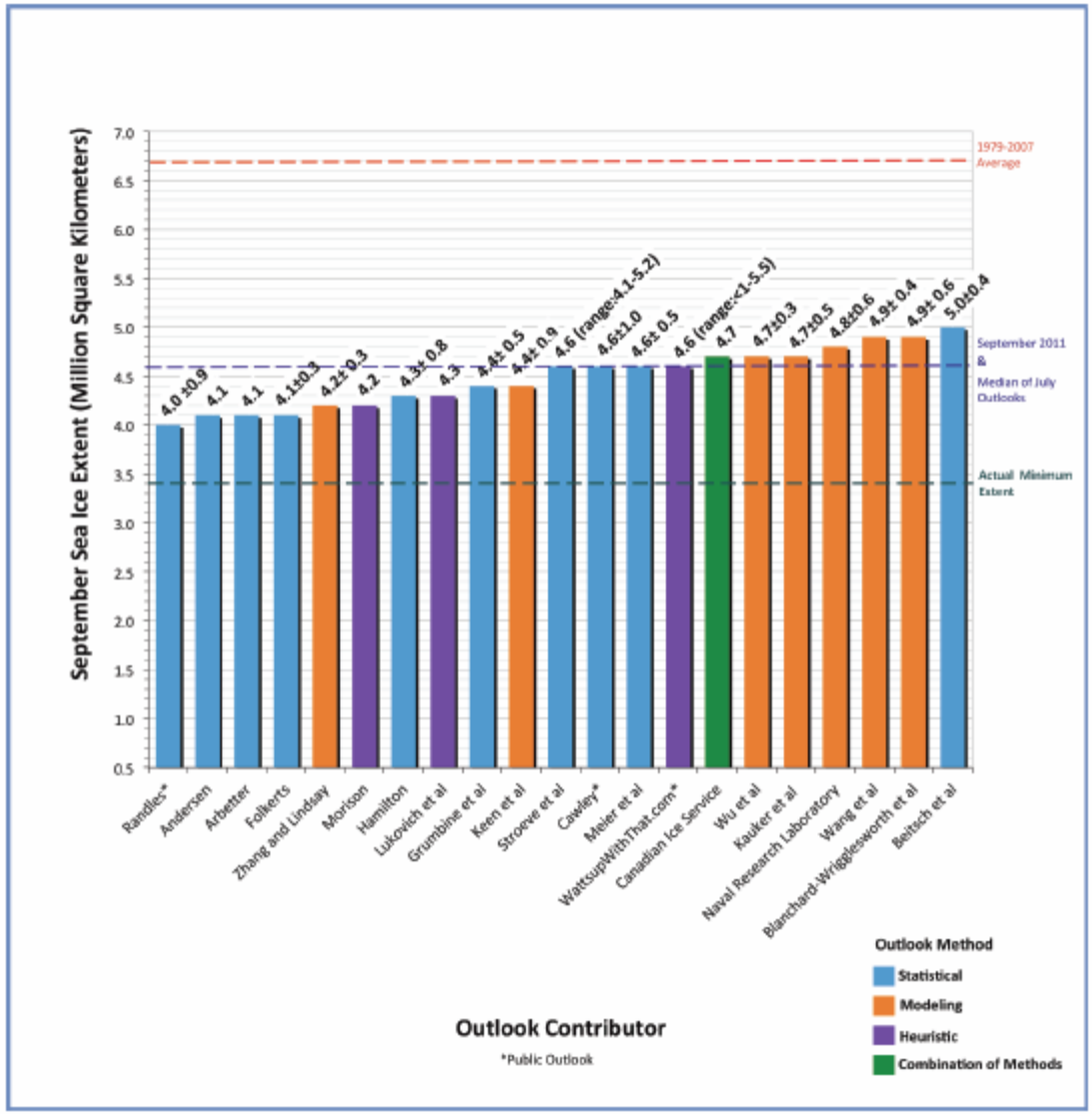
Yearly number of acres burned in Alaskan wildfires

-- huge interannual variability, major impacts



Forest fires in Alaska: 2004, 2005





Interannual sea ice variations -- *a challenge in seasonal prediction*

2012 September minimum extent --

Median forecast from May:

4.6×10^6 km^2

Observed:

3.4×10^6 km^2

[SEARCH Sea Ice Outlook]

Arctic impacts on the mid-latitude atmospheric circulation

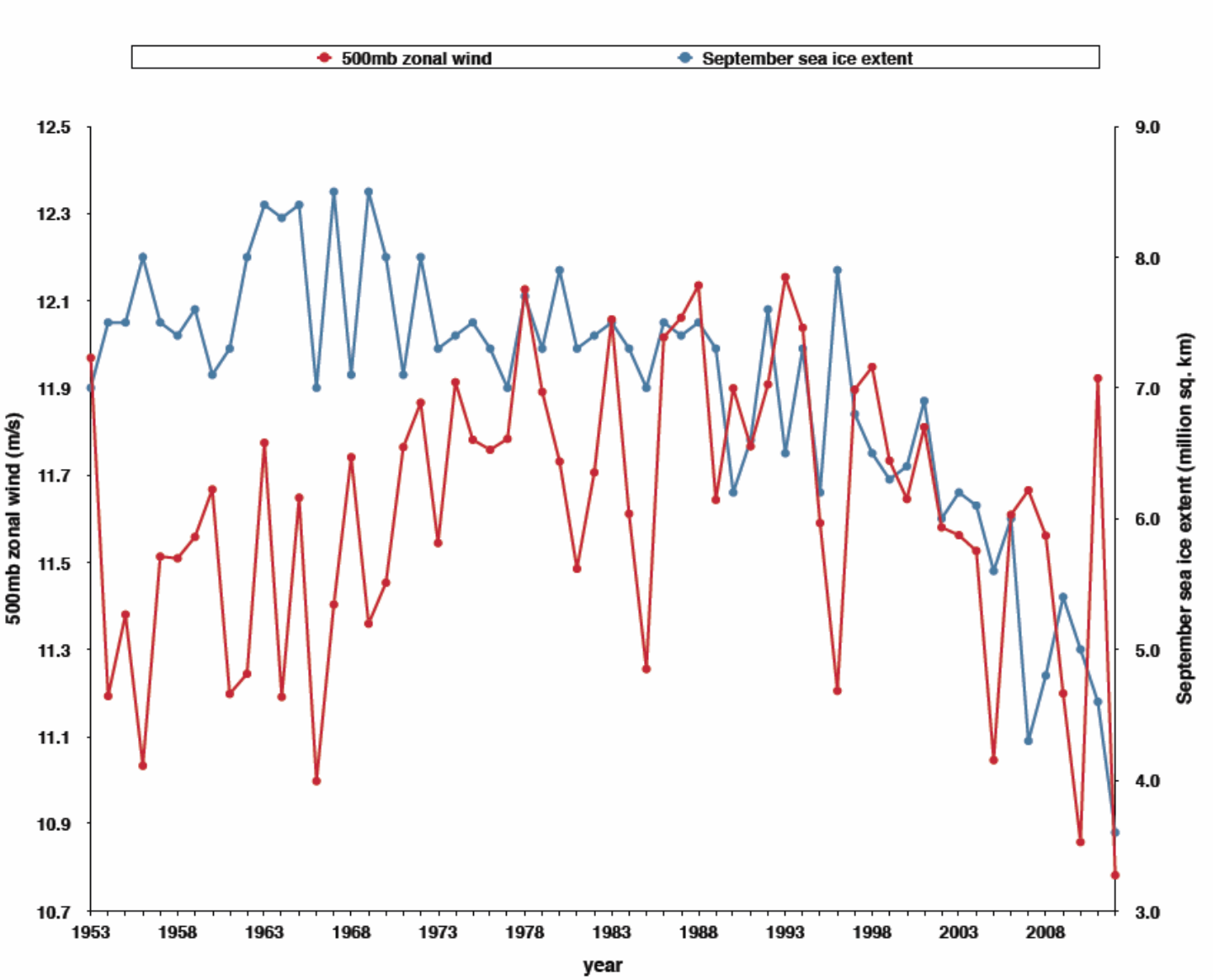
- **Suggested by some studies (sea ice loss and polar amplification favor stronger north-south meanders in jet stream)**

- **Other studies find no increase in blocking over past 50-60 years**

  ⇒ **How important is the metric of the atmospheric circulation?**

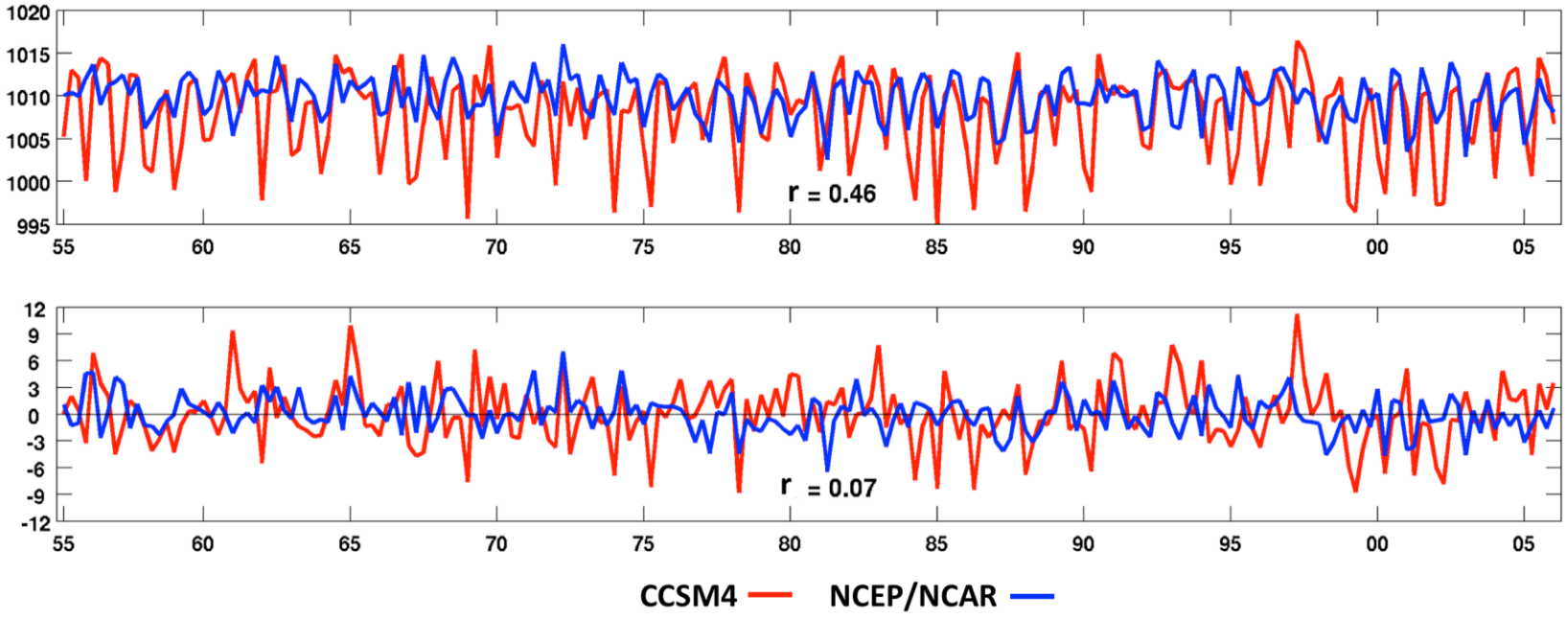
  ⇒ **Are the relationships robust in the face of interannual and decadal variability?**

Red: Oct-Dec mean zonal wind speed (30-70°N)
vs.
Blue: September pan-Arctic sea ice extent, 1948-2012



Monthly sea level pressures over the Bering Sea, 1955-2006

CCSM4 has twice the variance of NCEP/NCAR reanalysis in winter



SLP

dep. from monthly mean

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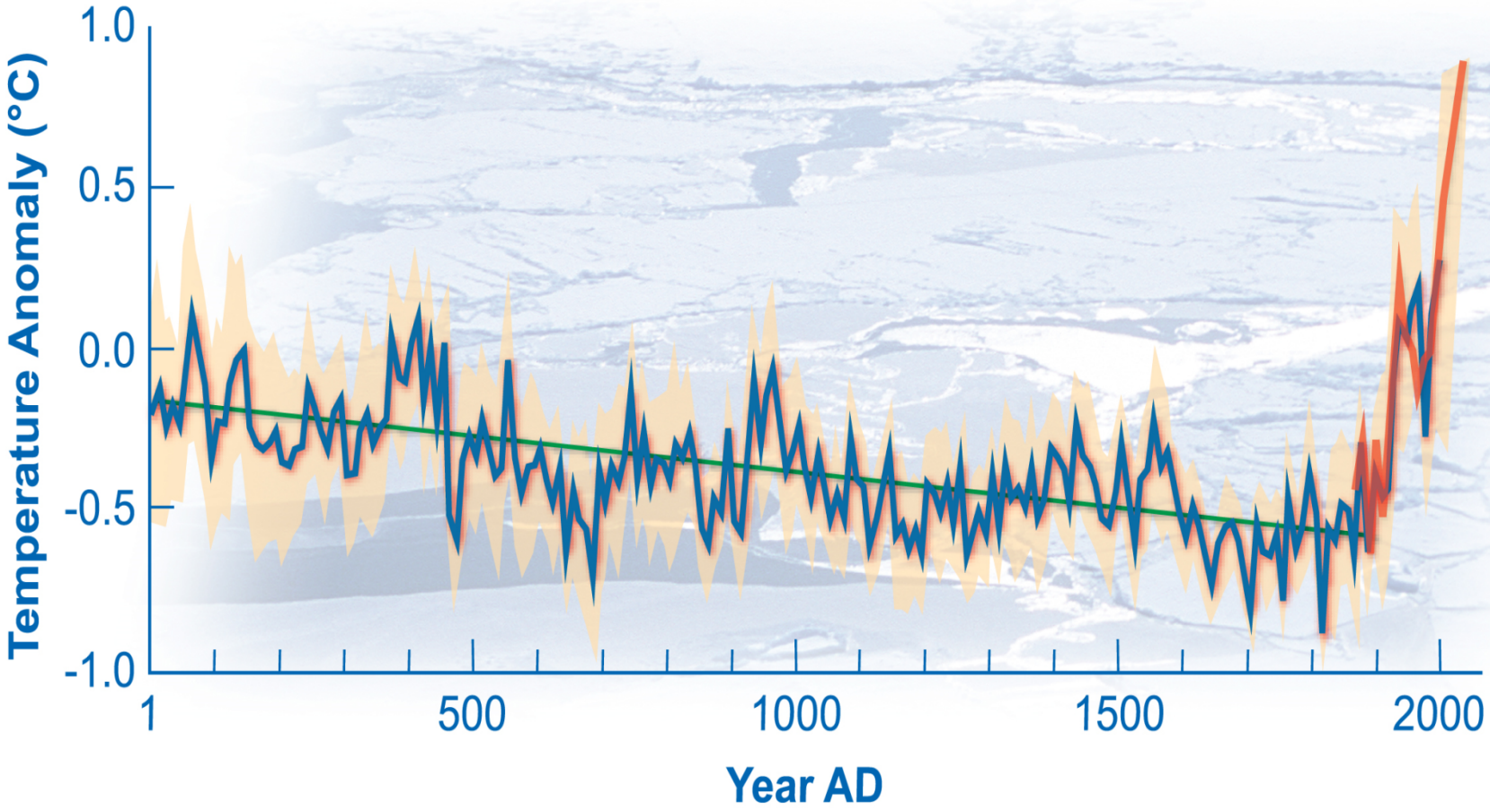
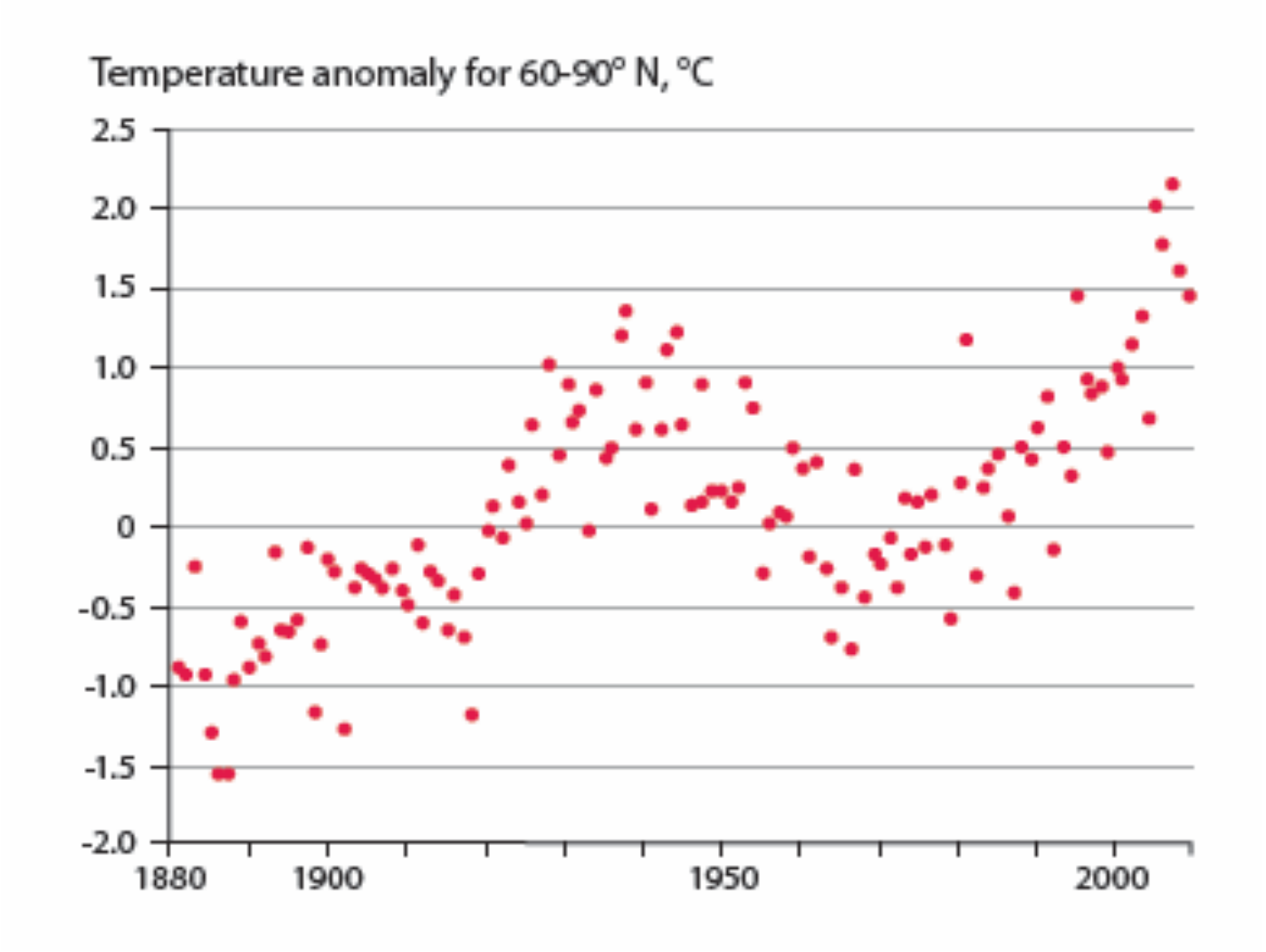
Reconstruction of summer Arctic temperatures

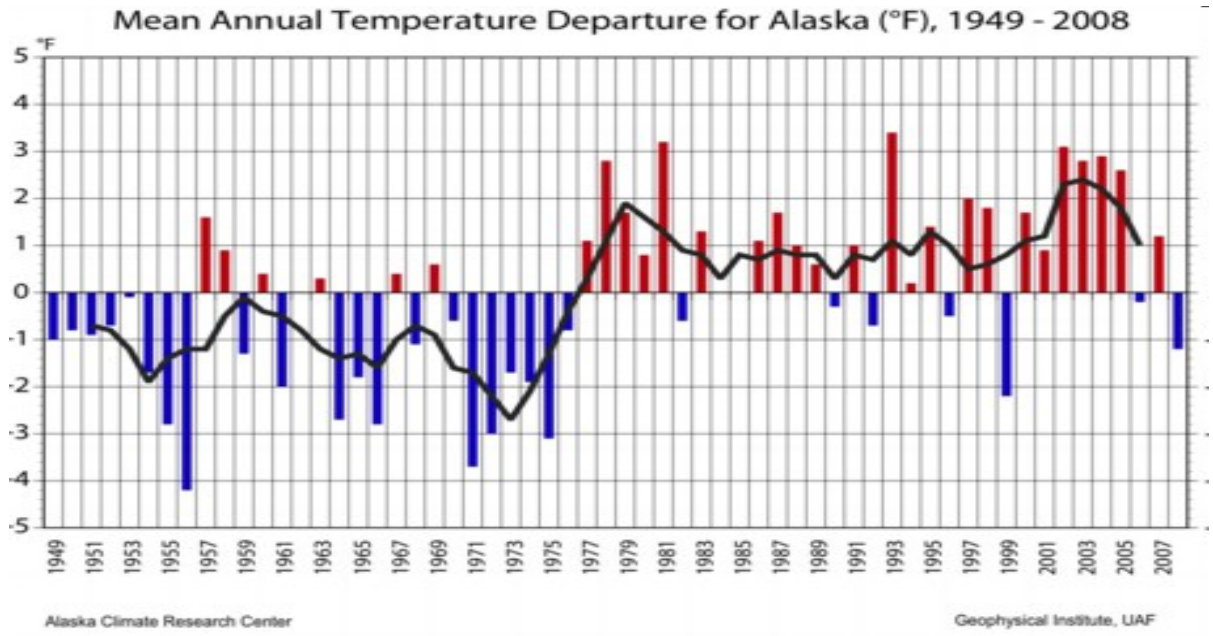
[Kaufman et al., 2009, Science]



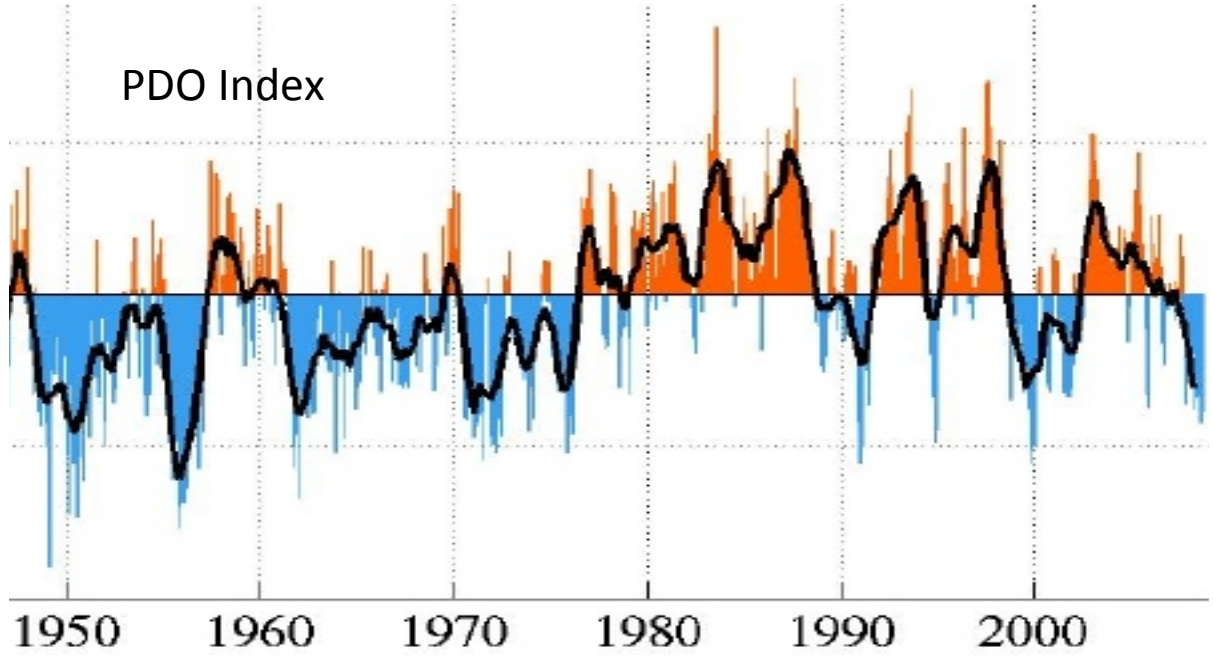
Yearly Arctic temperature anomalies (60-90°N), 1880-2011

[from P. Groisman, NCDC]





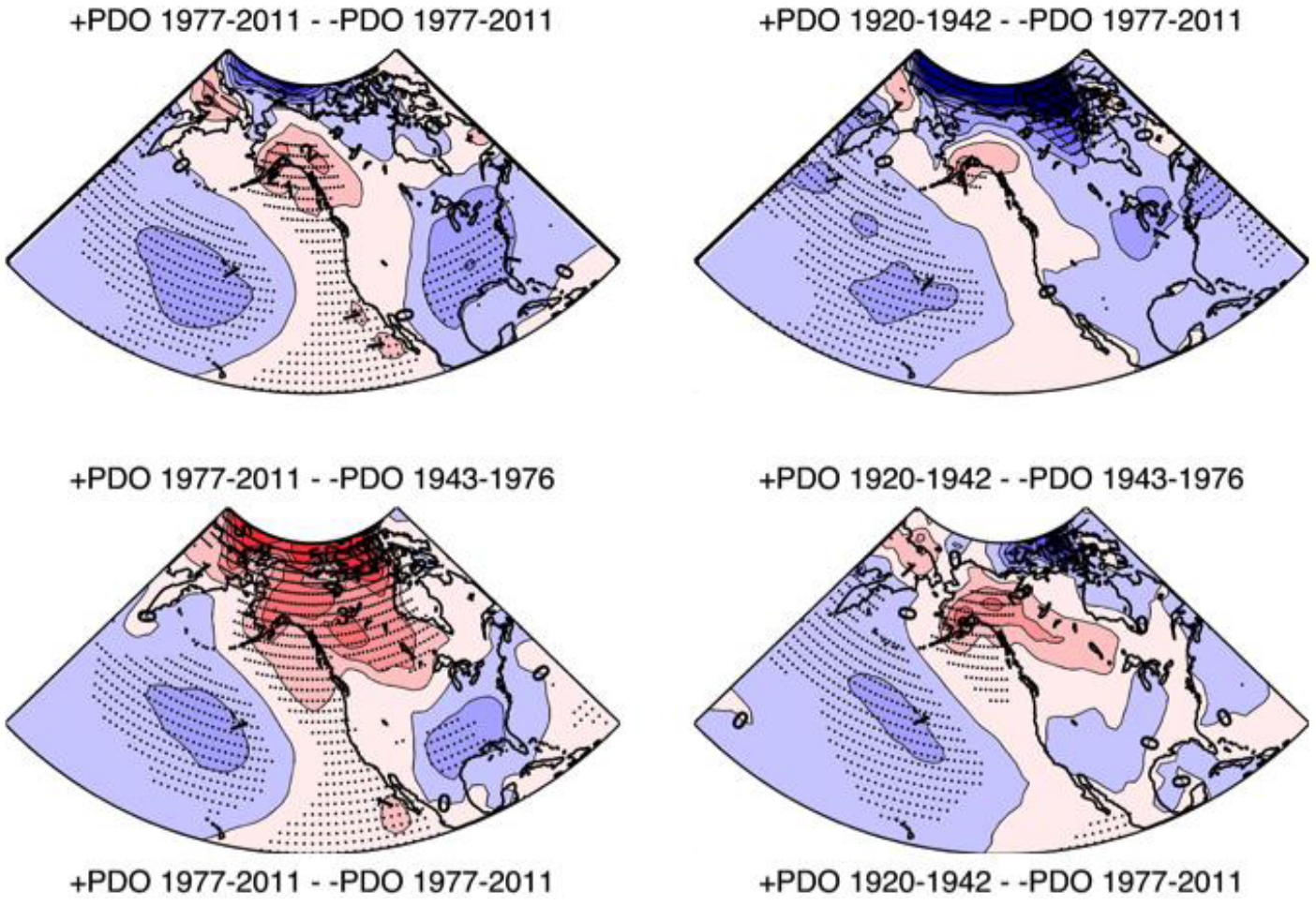
Alaska annual temperature anomalies



Pacific Decadal Oscillation Index

The changing signature of the Pacific Decadal Oscillation

[from S. McAfee, 2014]

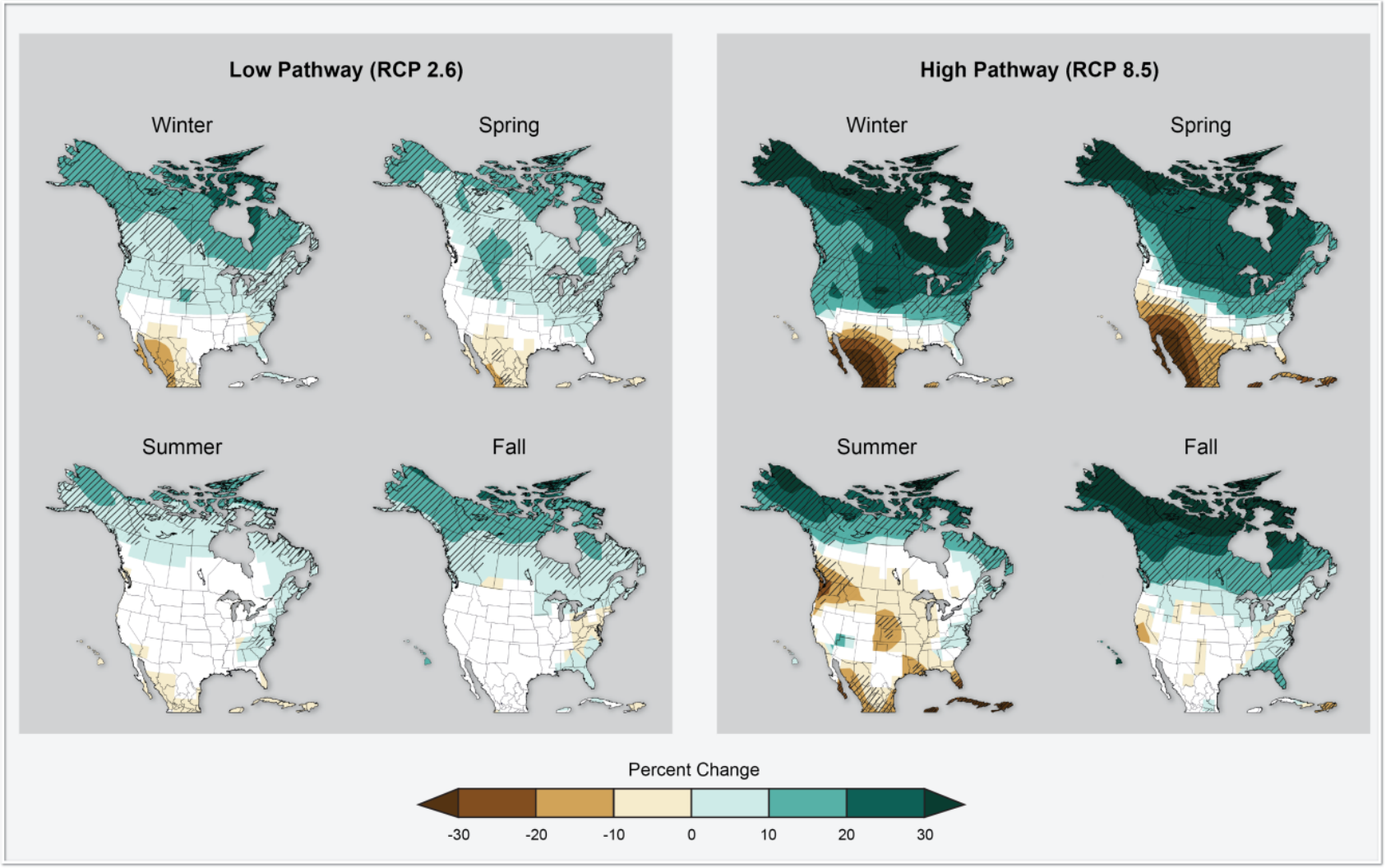


How will Arctic land areas change hydrologically?

[from L. Hinzman]

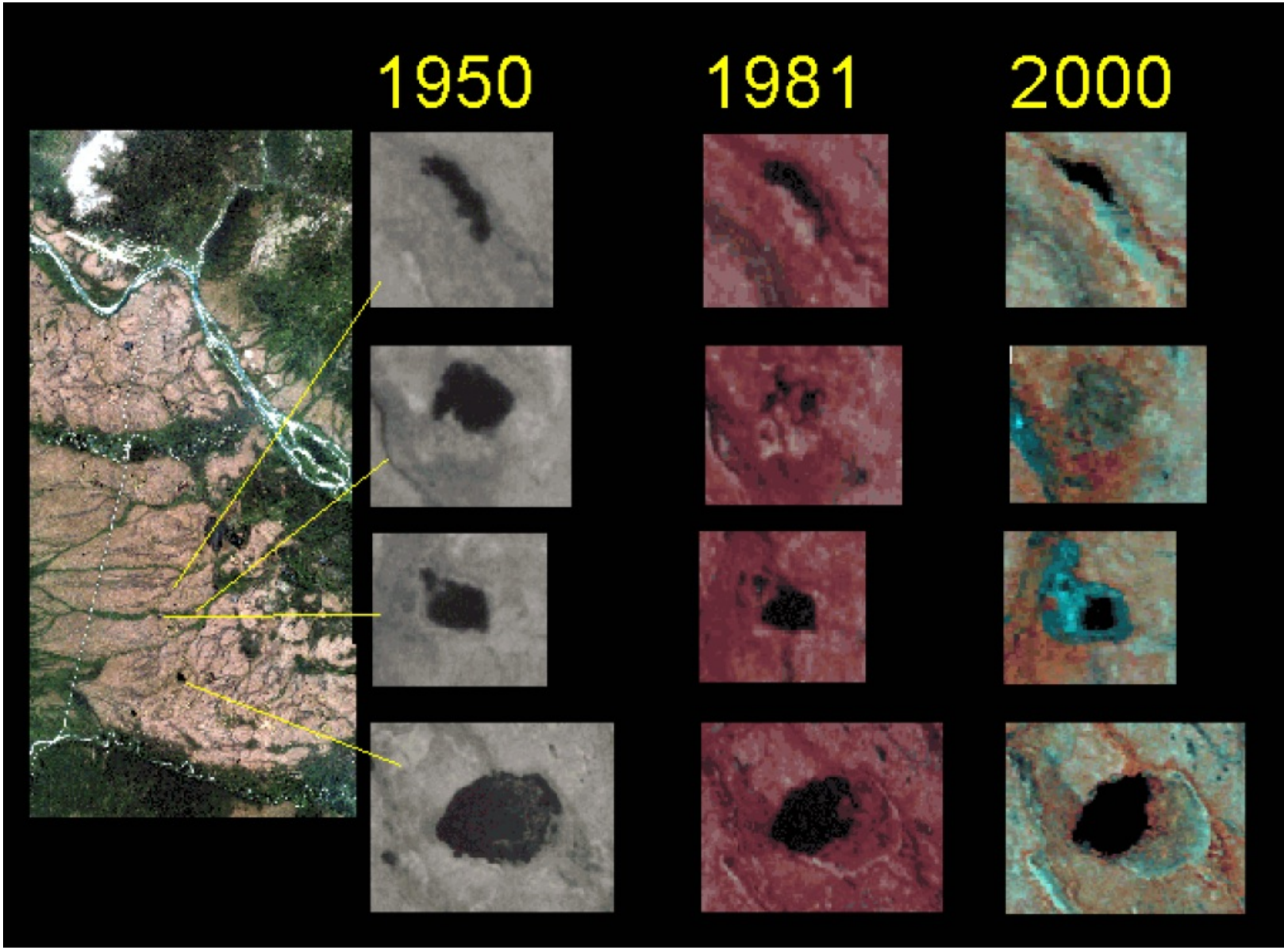
Projected precipitation changes by season, 2071-2100 minus 1971-2000

[U.S. National Climate Assessment, 2014]



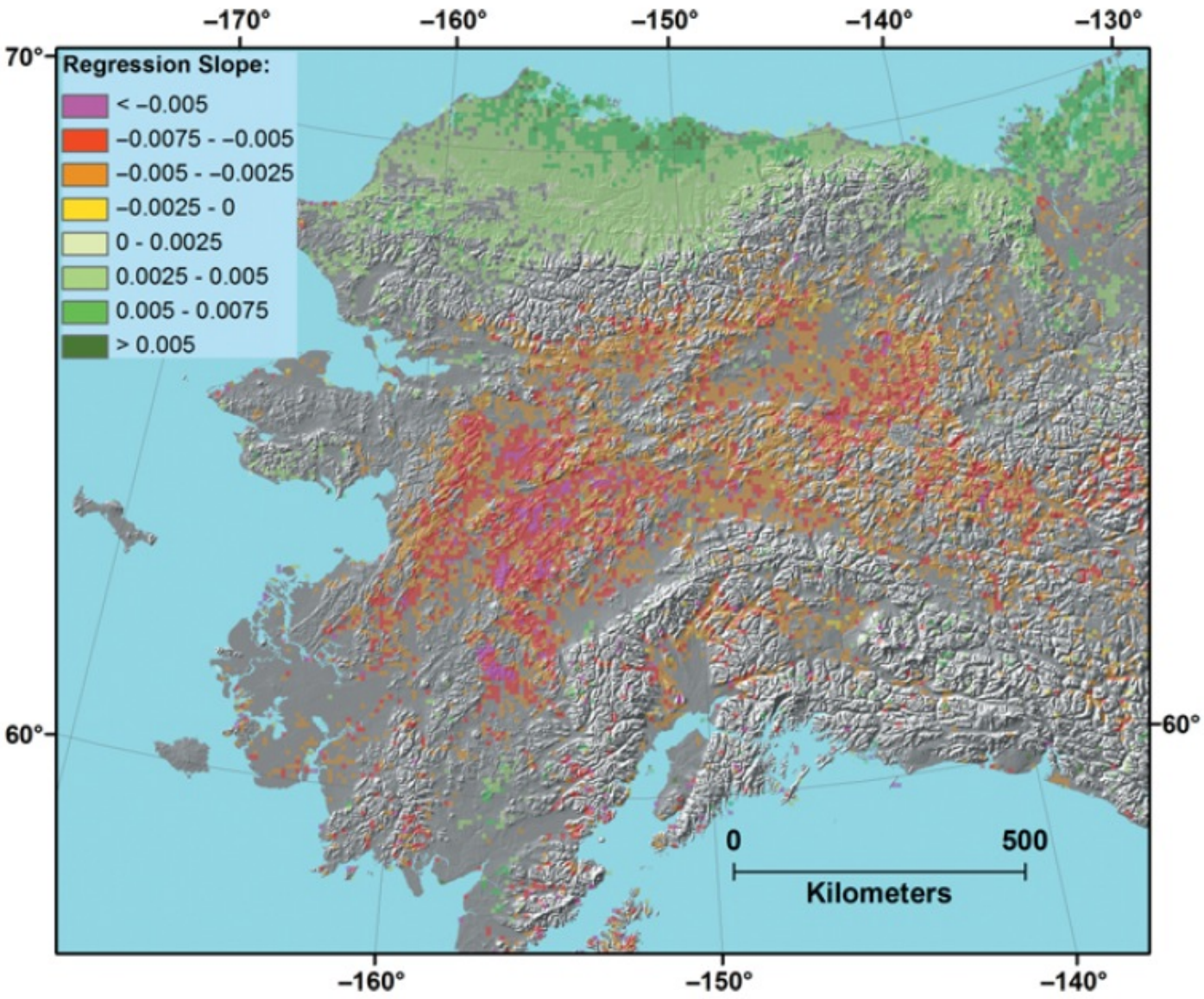
Drying of Arctic lakes

[from L. Hinzman et al.]



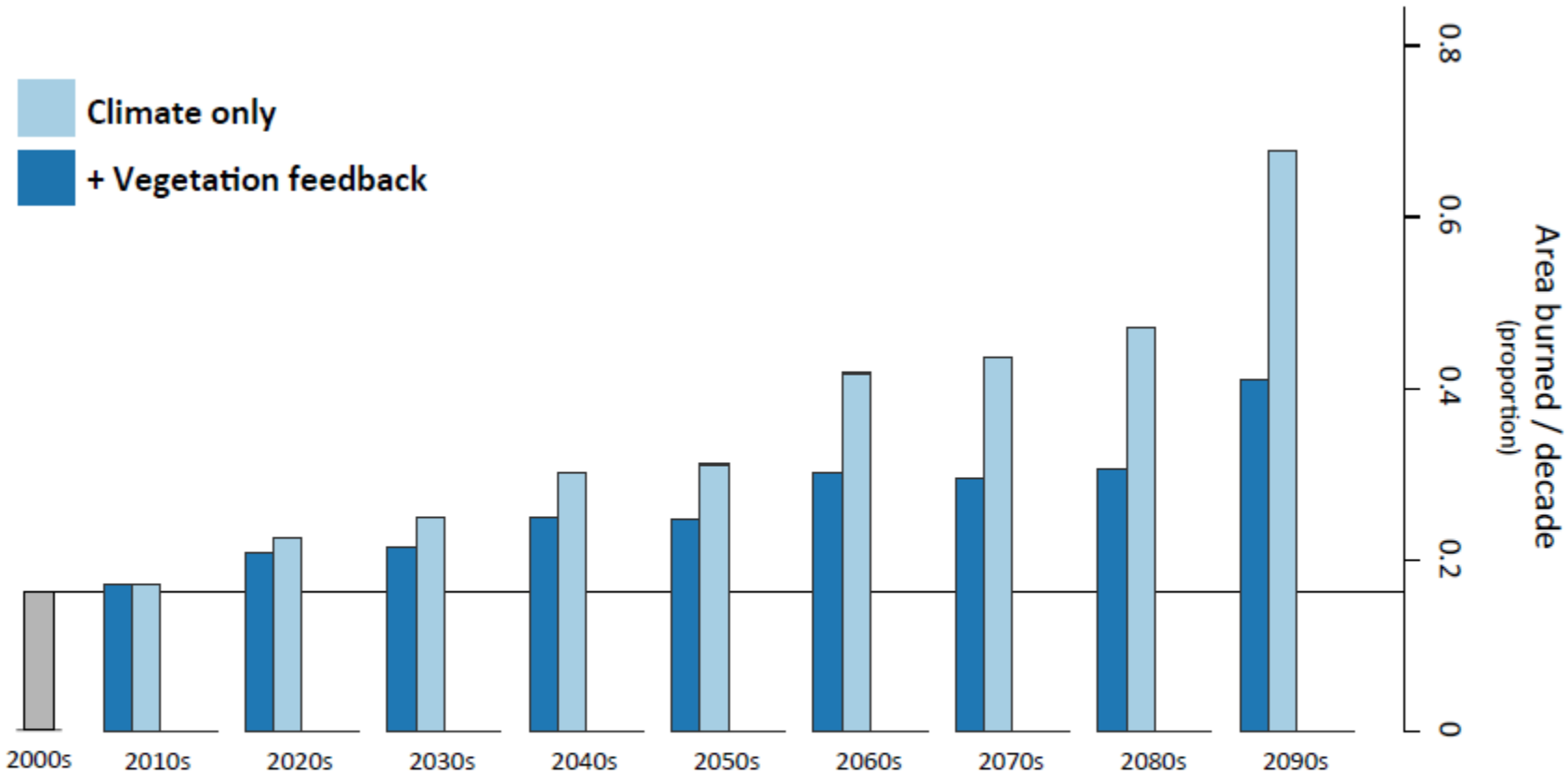
Trend of NDVI in Alaska, 1982-2003

[from D. Verbyla, 2008, Global Ecol. Biogeogr.]



Area burned by wildfires in Alaska is projected to increase

[from R. Kelly, 2014]



- Climate change → increased area burned in every decade
- Vegetation feedback slows this change but does not prevent it

Summary: Some key challenges

- **Clouds in the Arctic (weather and climate)**
- **Storm outlooks -- extended range and beyond**
- **Seasonal prediction of impact-variables (sea ice, fire, river breakup)**
- **Decadal variations (sea ice, leading ocean-atmosphere modes)**
- **Stability (over time) of**
  - **-- Arctic-midlatitude linkages**
  - **-- teleconnections of ocean-atmosphere modes affecting the Arctic**
- **Future hydrologic trends: wetter or drier land surfaces?**