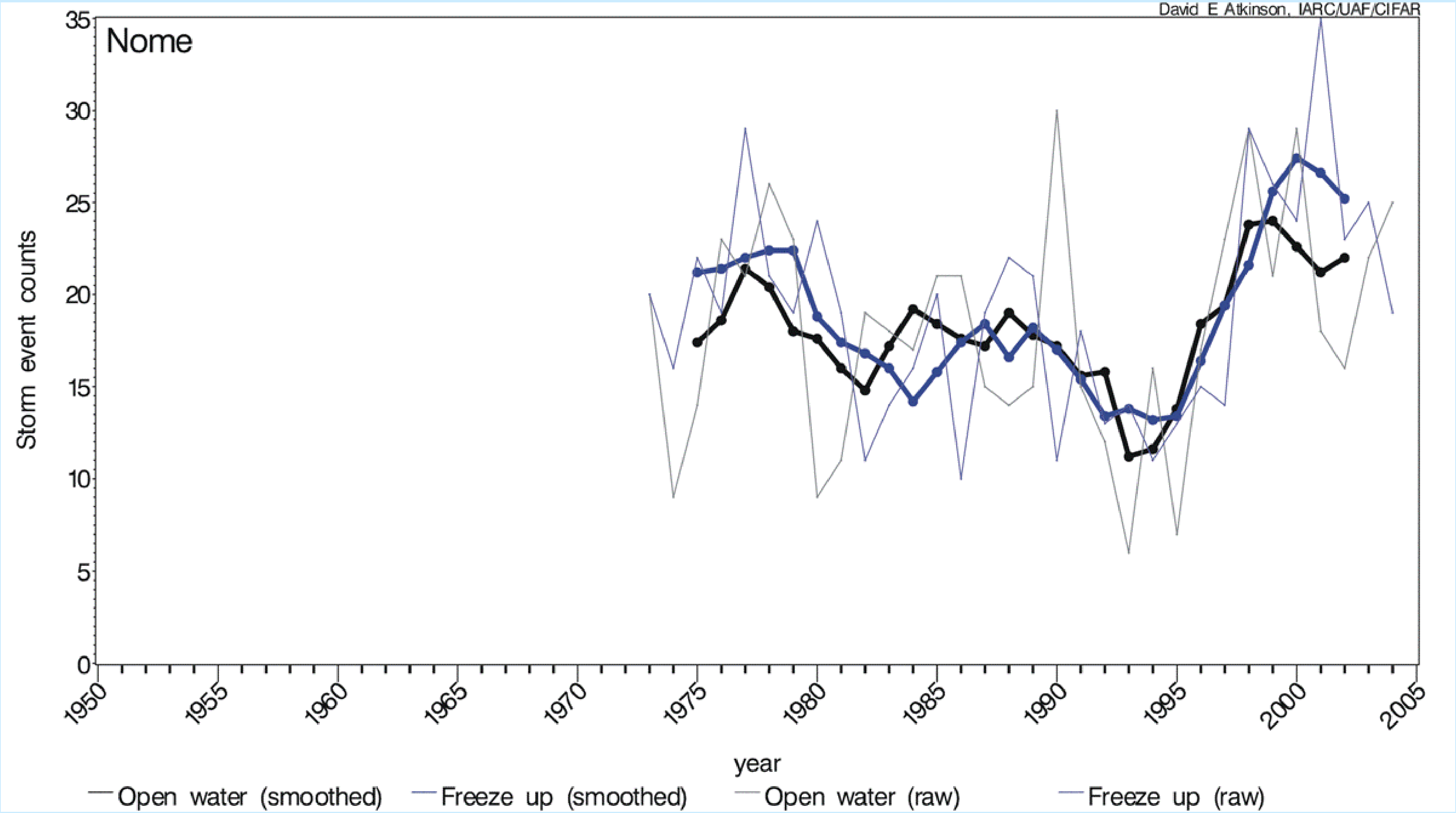
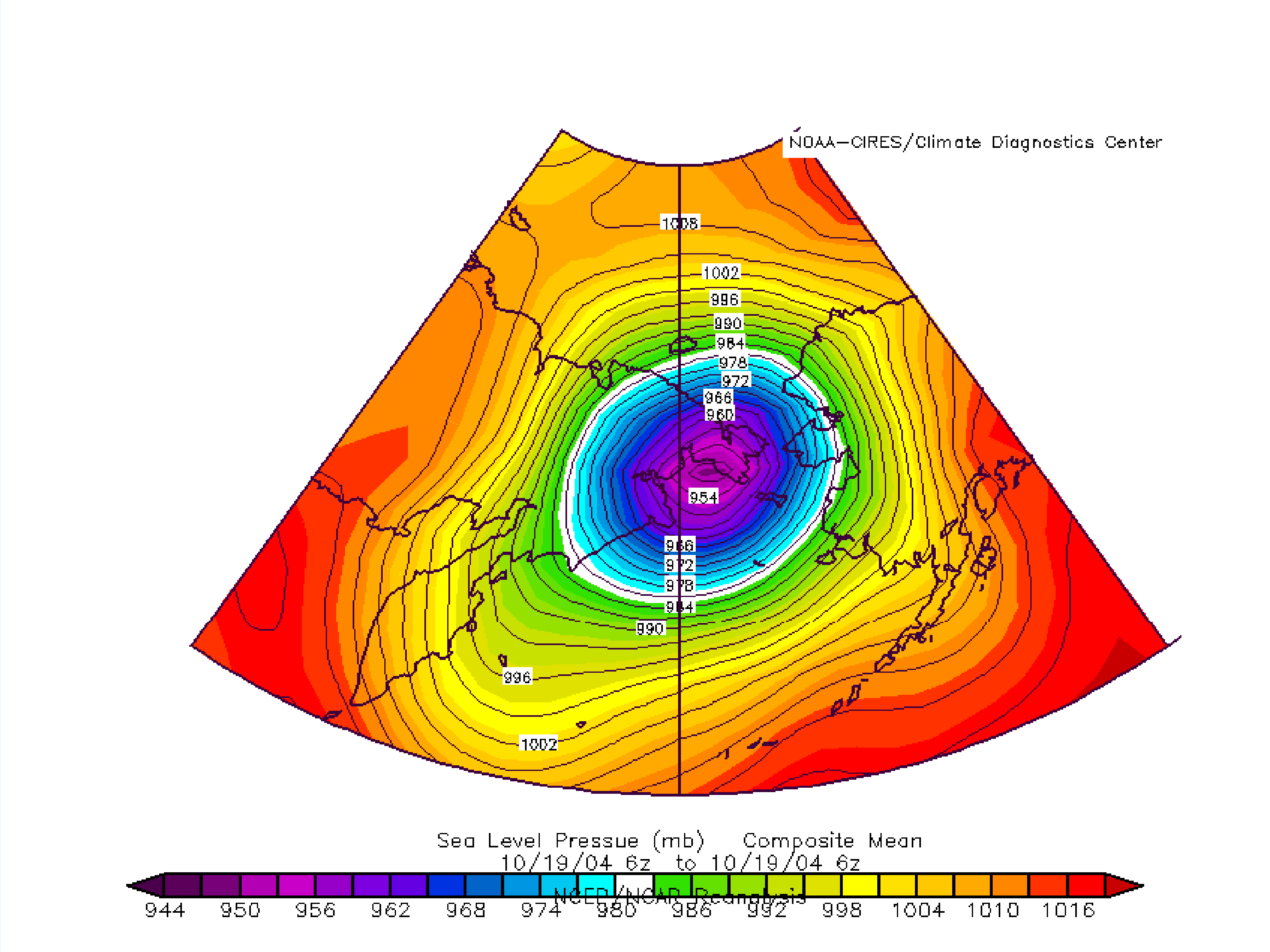
Yearly storm counts at Nome, Alaska



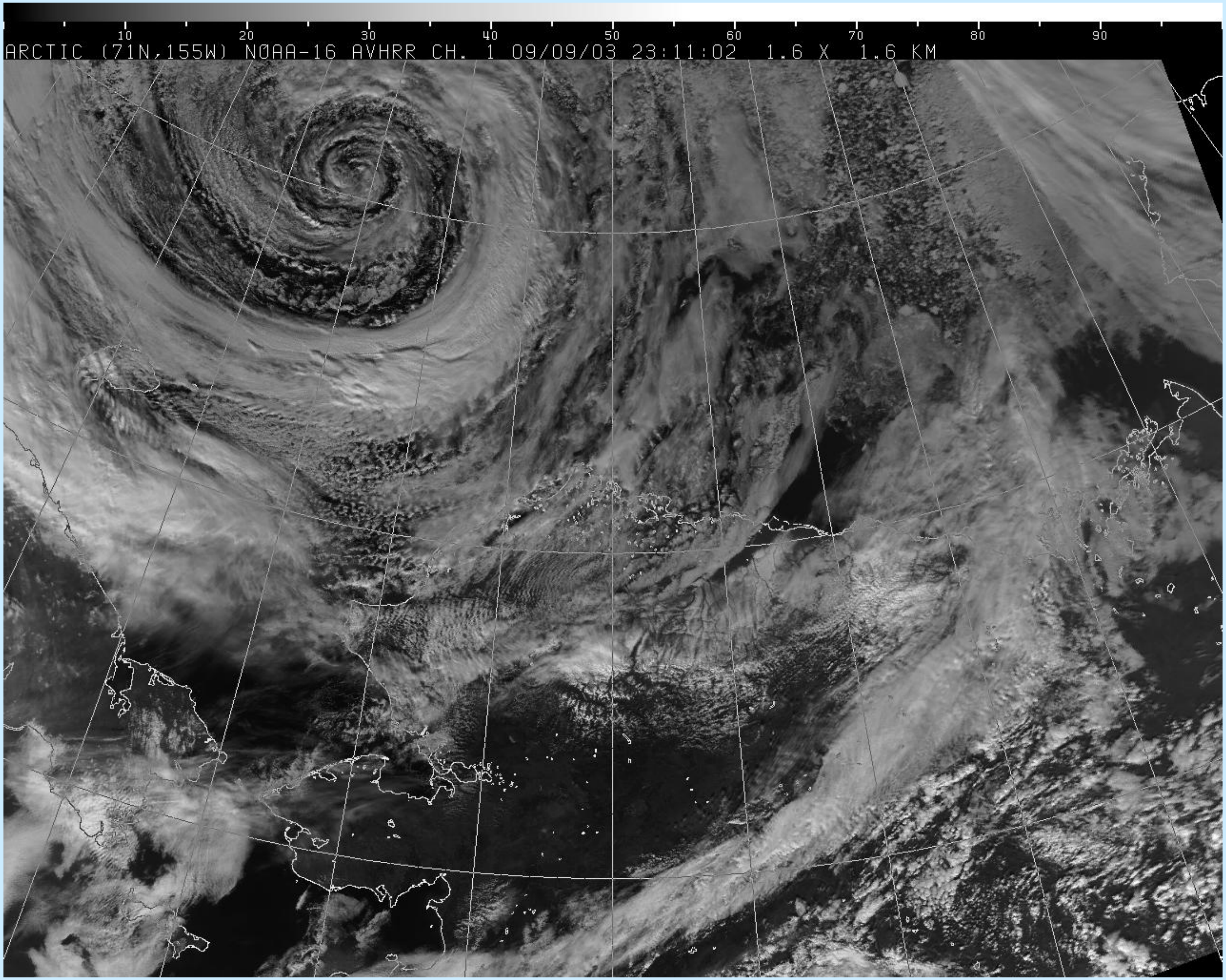
Extreme event: 941 mb cyclone, flooding of Nome, AK on 19 Oct 2004



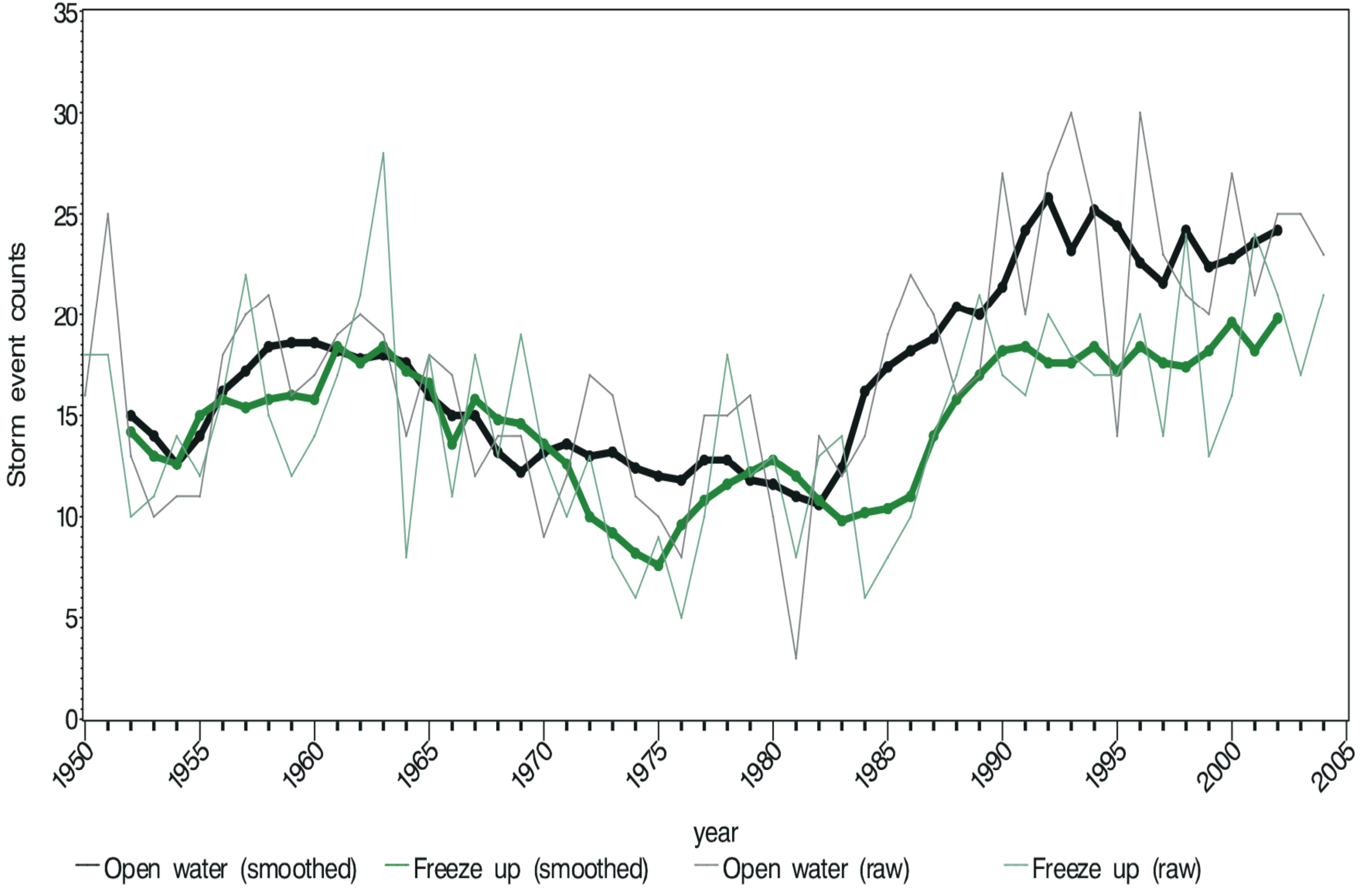
Front Street, Nome, AK   October 19, 2004

(photo by J. Steiger, WSO Nome)

Intense Arctic cyclone affecting northern Alaskan coast

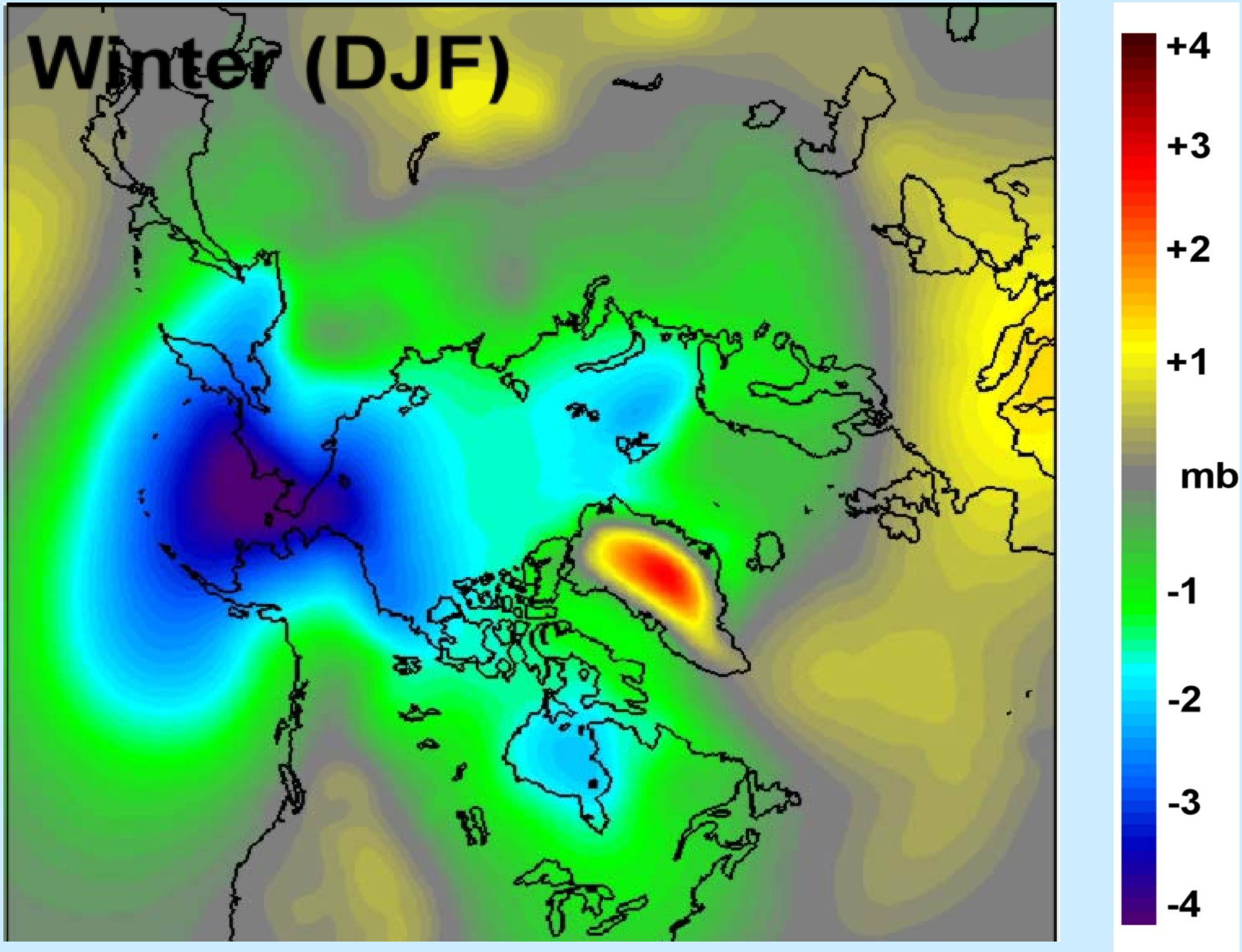


Yearly storm counts at Barrow, Alaska

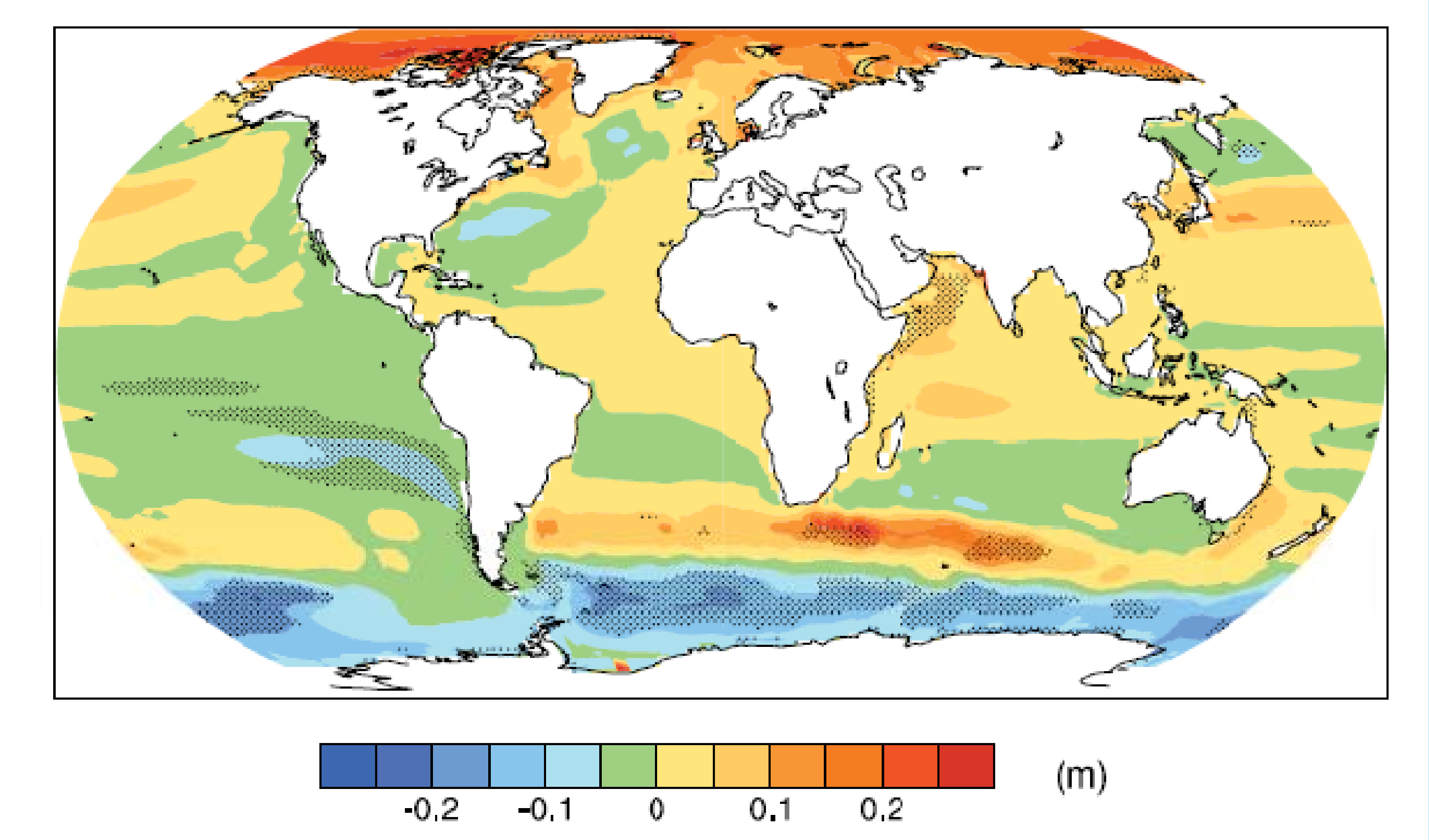


Barrow

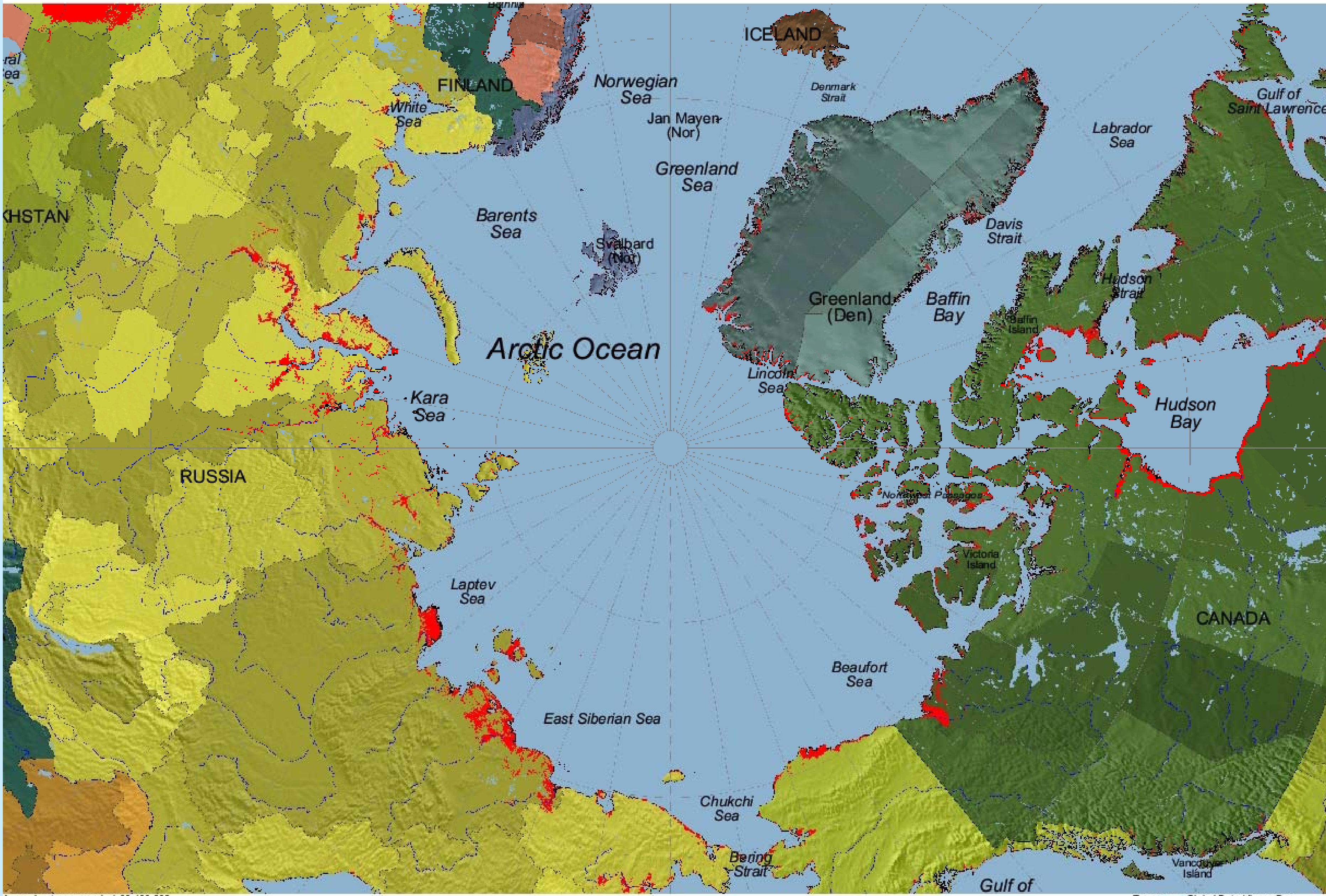
Projected change in winter sea level pressure: 2070-2090
lower pressure ⇒ more storms? Plausible



Projected change of sea level (16 models), 2080-2099, due to ocean density and circulation changes



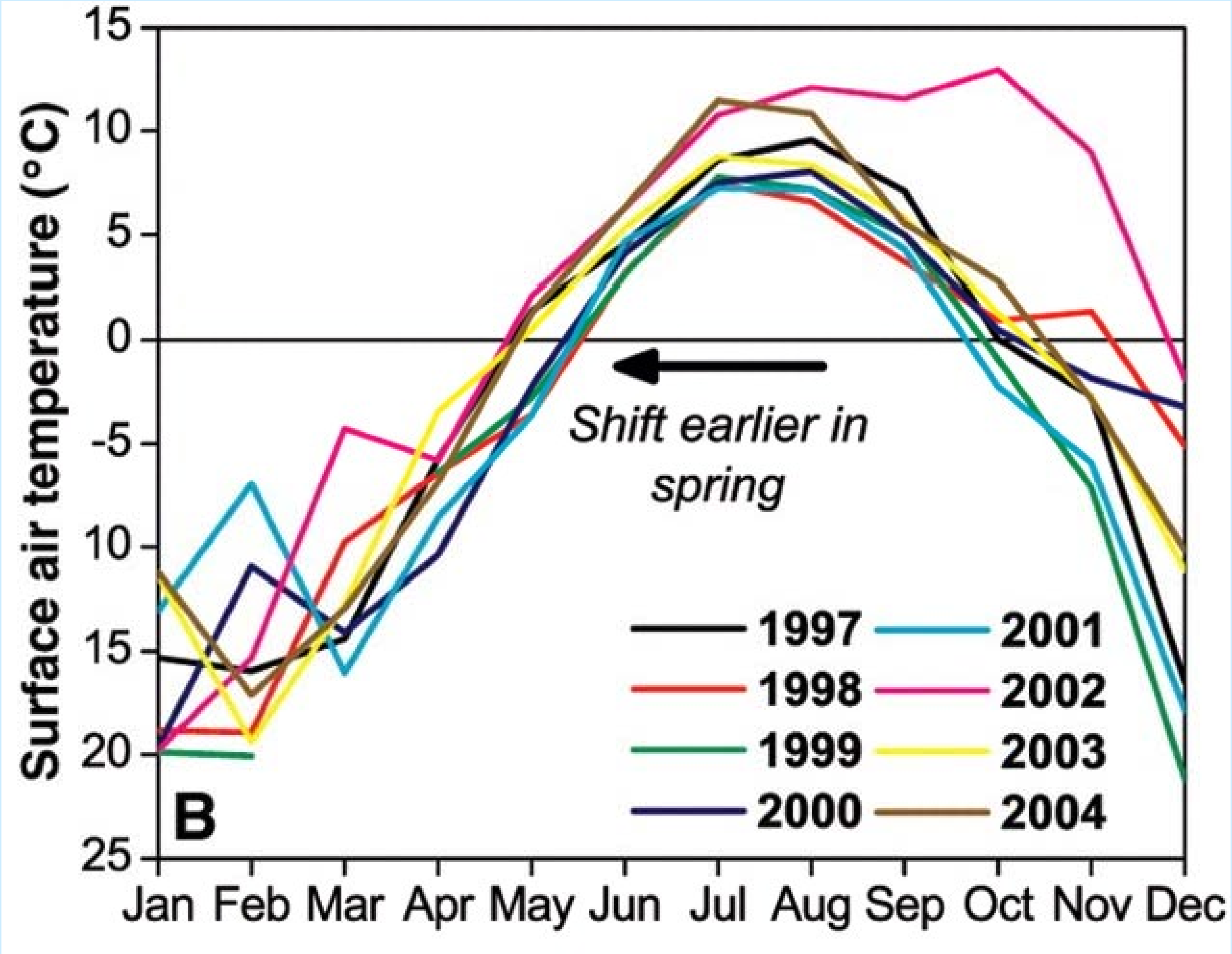
Political Boundaries (sub-national)



Approximate map scale 1:30,400,000

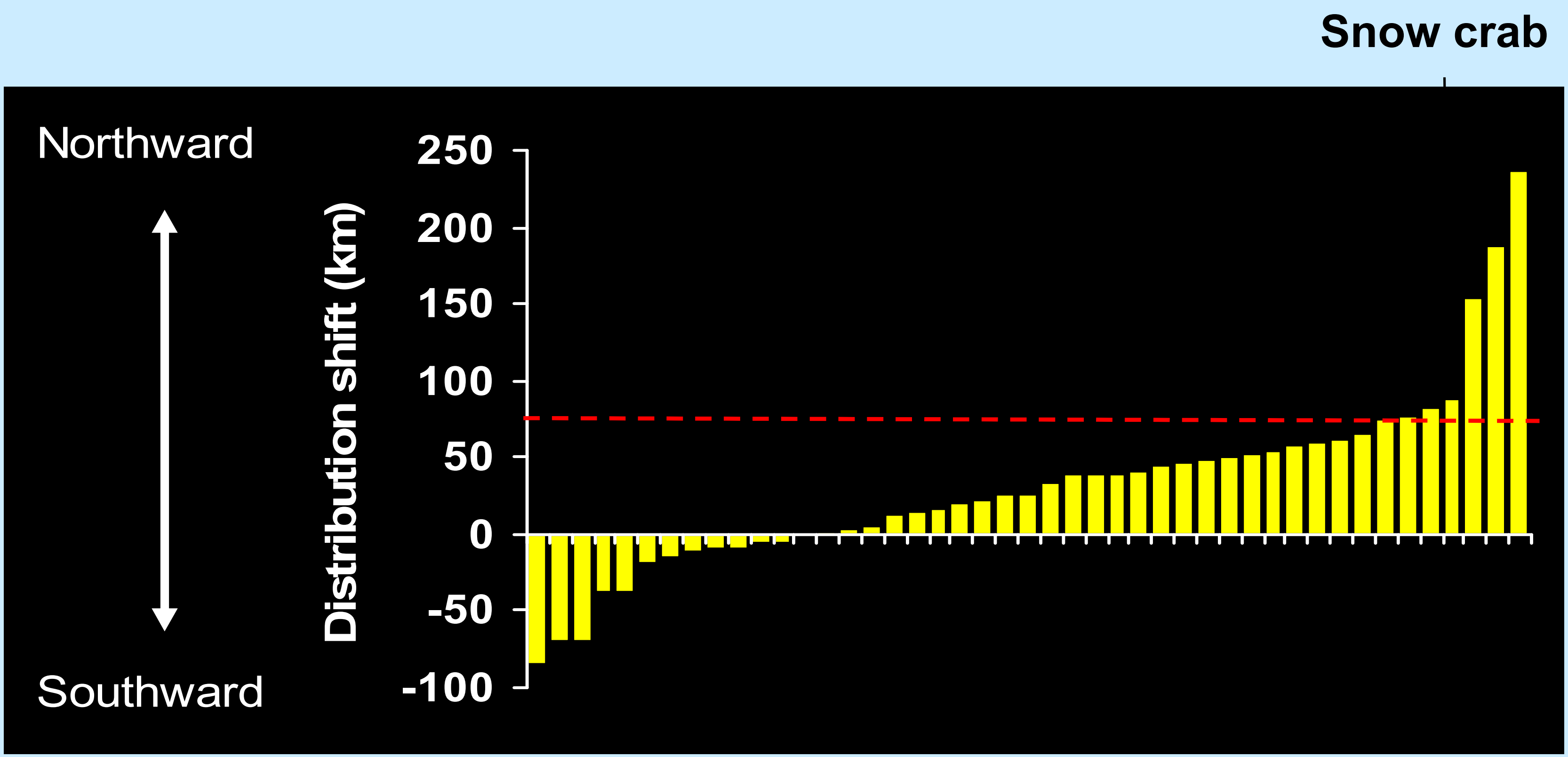
Spring ice edge has moved northward onto the Bering Sea shelf

Monthly averaged SST measured at Savoonga on St. Lawrence Island



J. M. Grebmeier et al., (2006) Science 311, 1461 -1464.

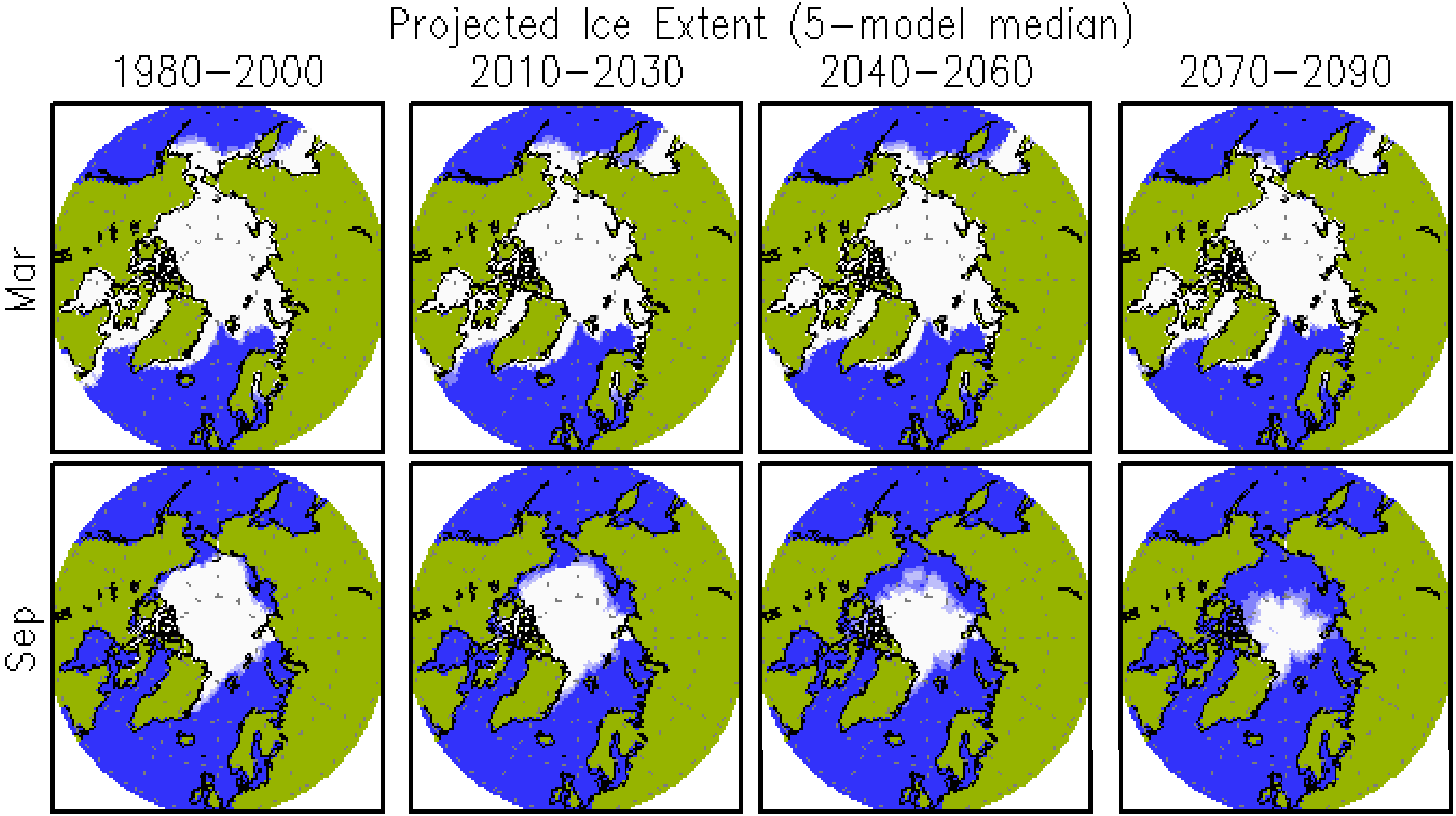
Shifts in center of distribution for 45 taxa in SE Bering Sea, 1982-2006

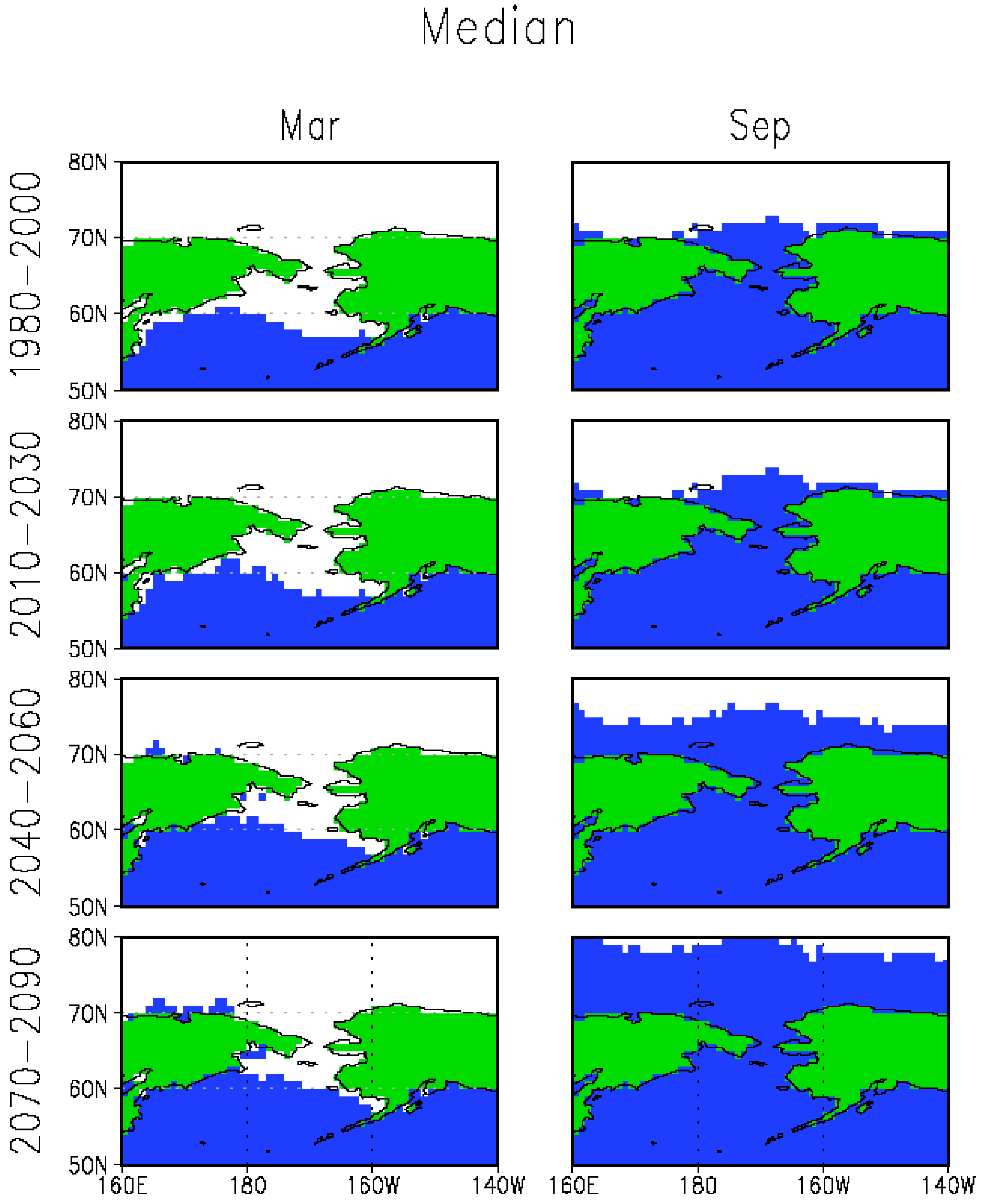


Rate similar to North Sea (Perry et al. 2005)

2-3 times faster than terrestrial mean (Parmesan and Yohe 2003)

Projected changes of Arctic sea ice (ACIA, 2005)



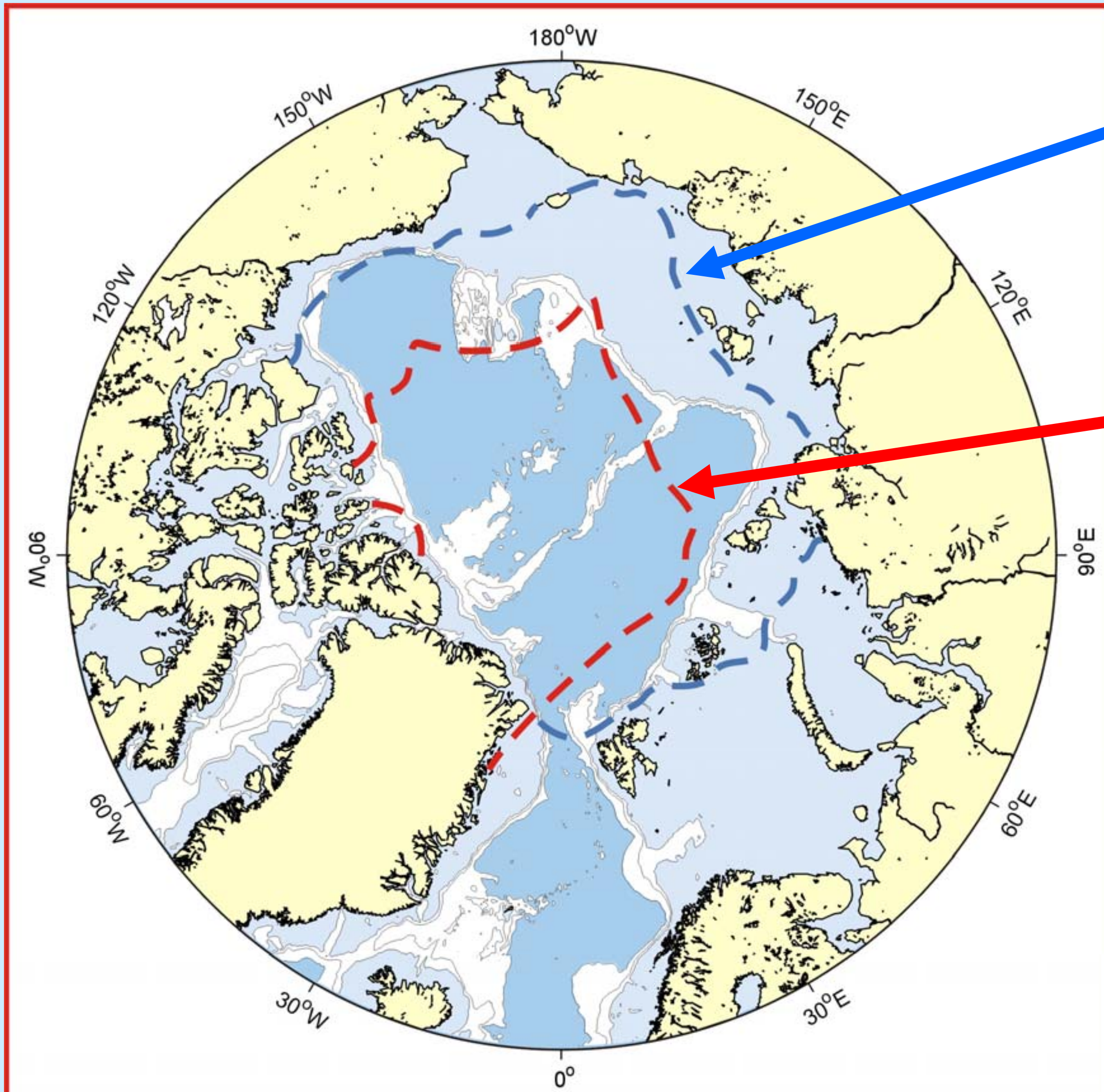


IPCC (2007) model projections:

sea ice in Alaska/Bering sector

Ice edge vs. shelf edge: 1979-1989 vs. 2050

- - - - 1979-89 - - - - 2050

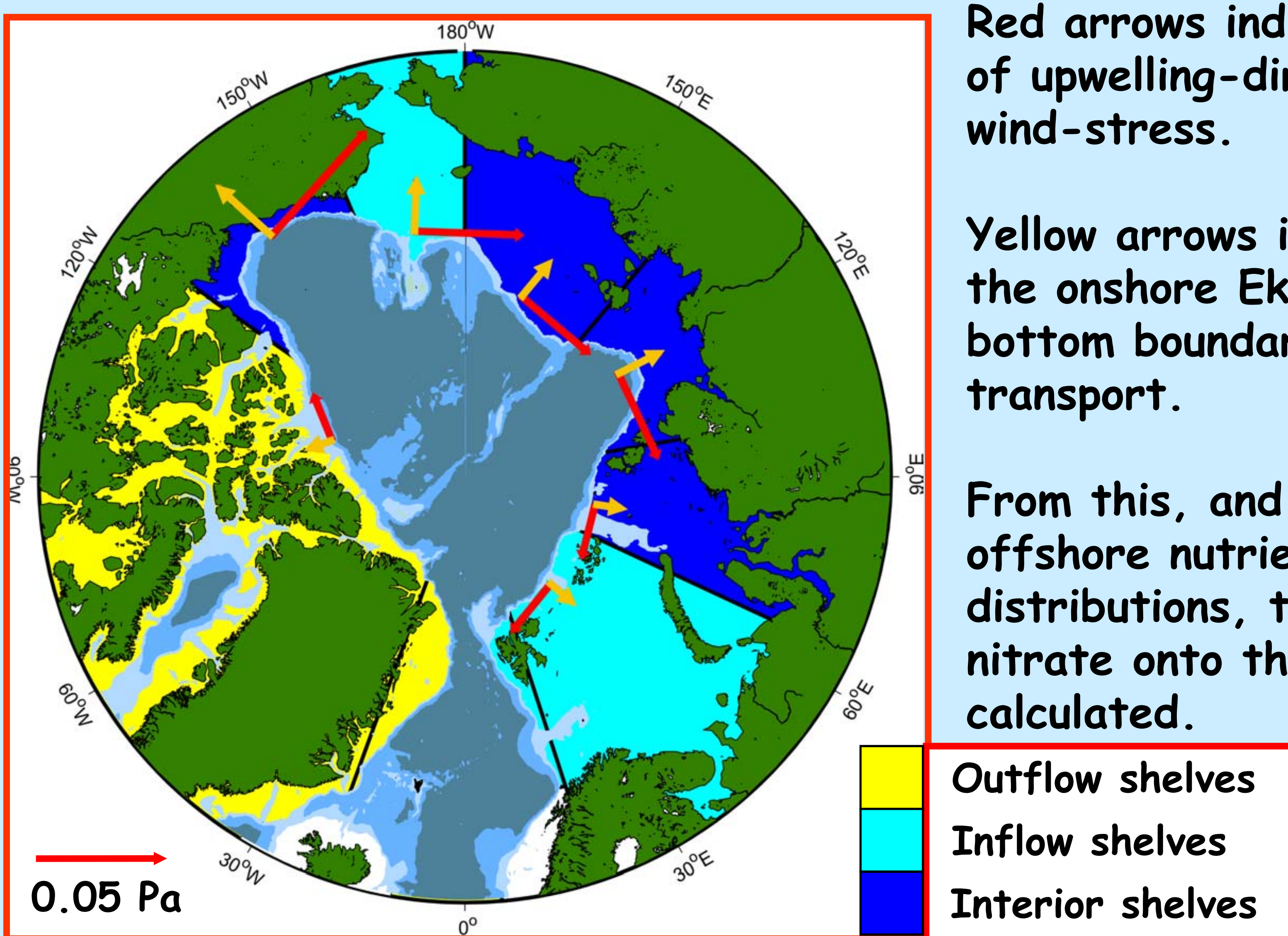


Currently the shelf break is largely ice covered in summer

But by 2050 the ice edge retreats well beyond the shelf break.

What would be the impact on shelf-basin exchange and new production - for example, on shelf-break upwelling?

Mean of upwelling-directed NCEP wind-stress in 1998:

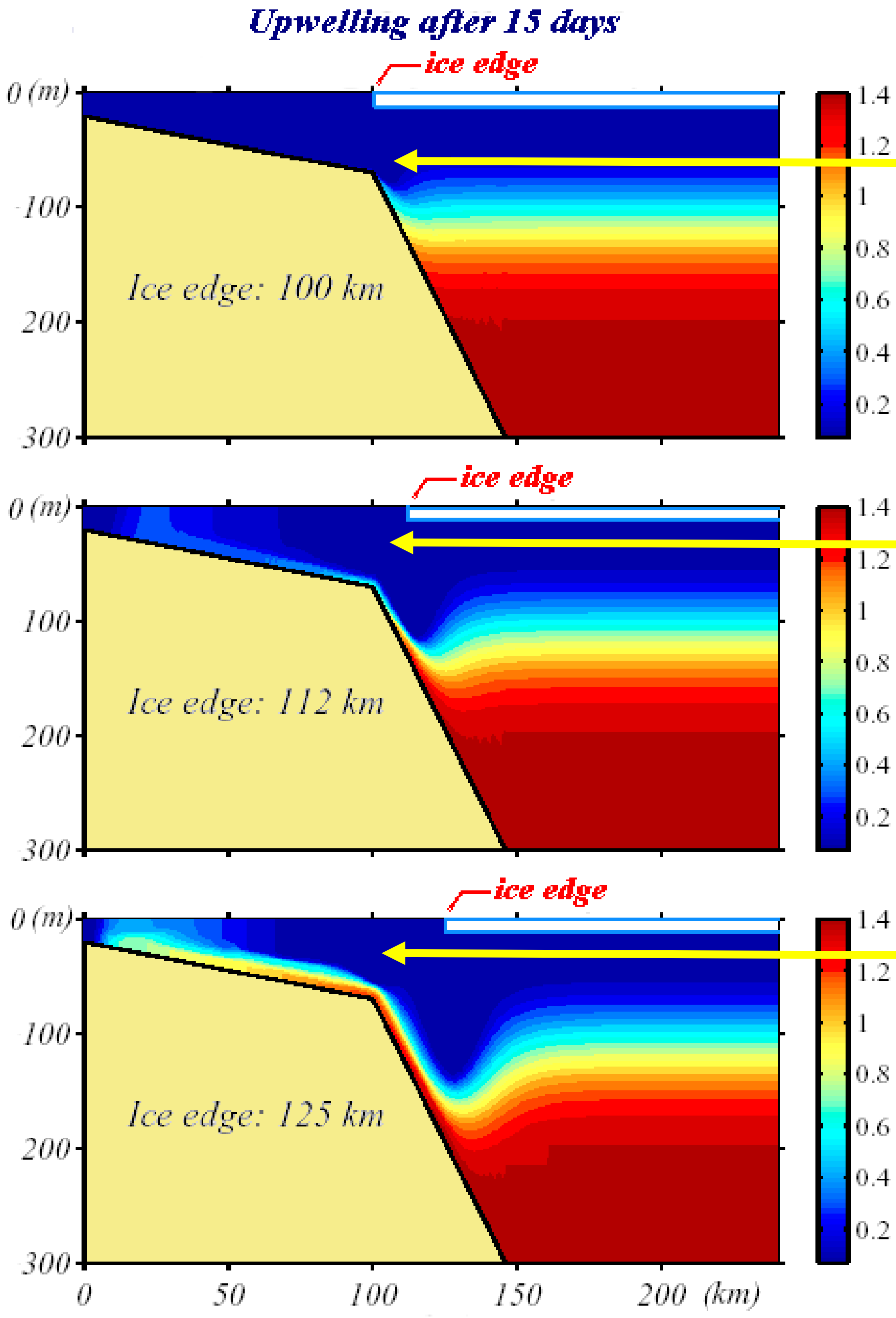


Red arrows indicate mean of upwelling-directed wind-stress.

Yellow arrows indicate the onshore Ekman (i.e. bottom boundary layer) transport.

From this, and from offshore nutrient distributions, the flux of nitrate onto the shelf is calculated.

Model Results:



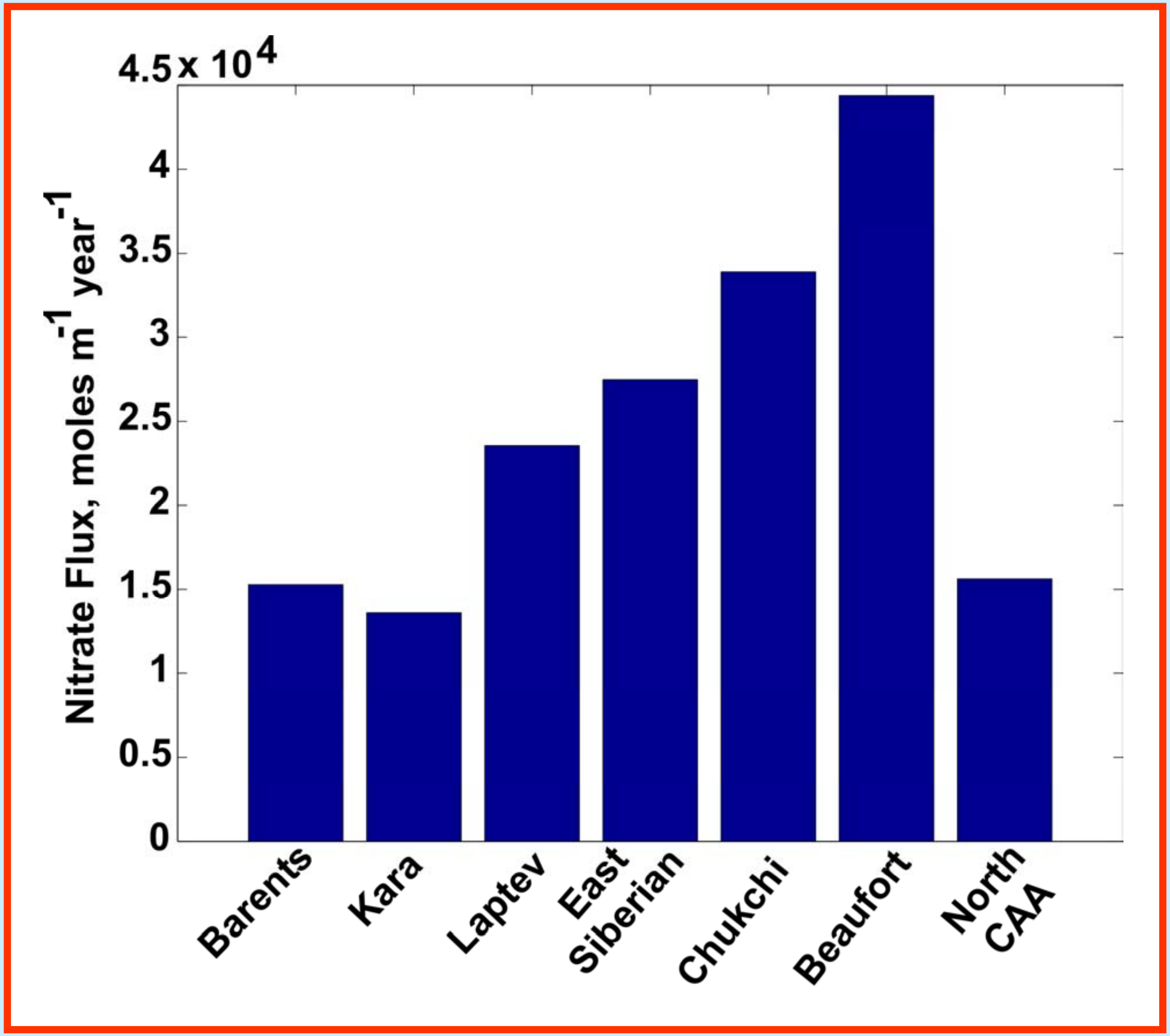
A circulation 'cell' forms with upwelling at the coast and downwelling at the ice edge. Only shelf water circulates if the shelf-break is ice-covered.

Continued retreat of summer ice cover exposes more and more of the shelf-break for longer periods of time to upwelling favorable winds.

Upwelling depth increases as slope waters become ice-free. Salty, nutrient-rich water can now cross the whole shelf in a thin bottom boundary layer.

From: Carmack & Chapman, GRL, 2003

Projected increase in total nitrate flux onto shelves due to upwelling:

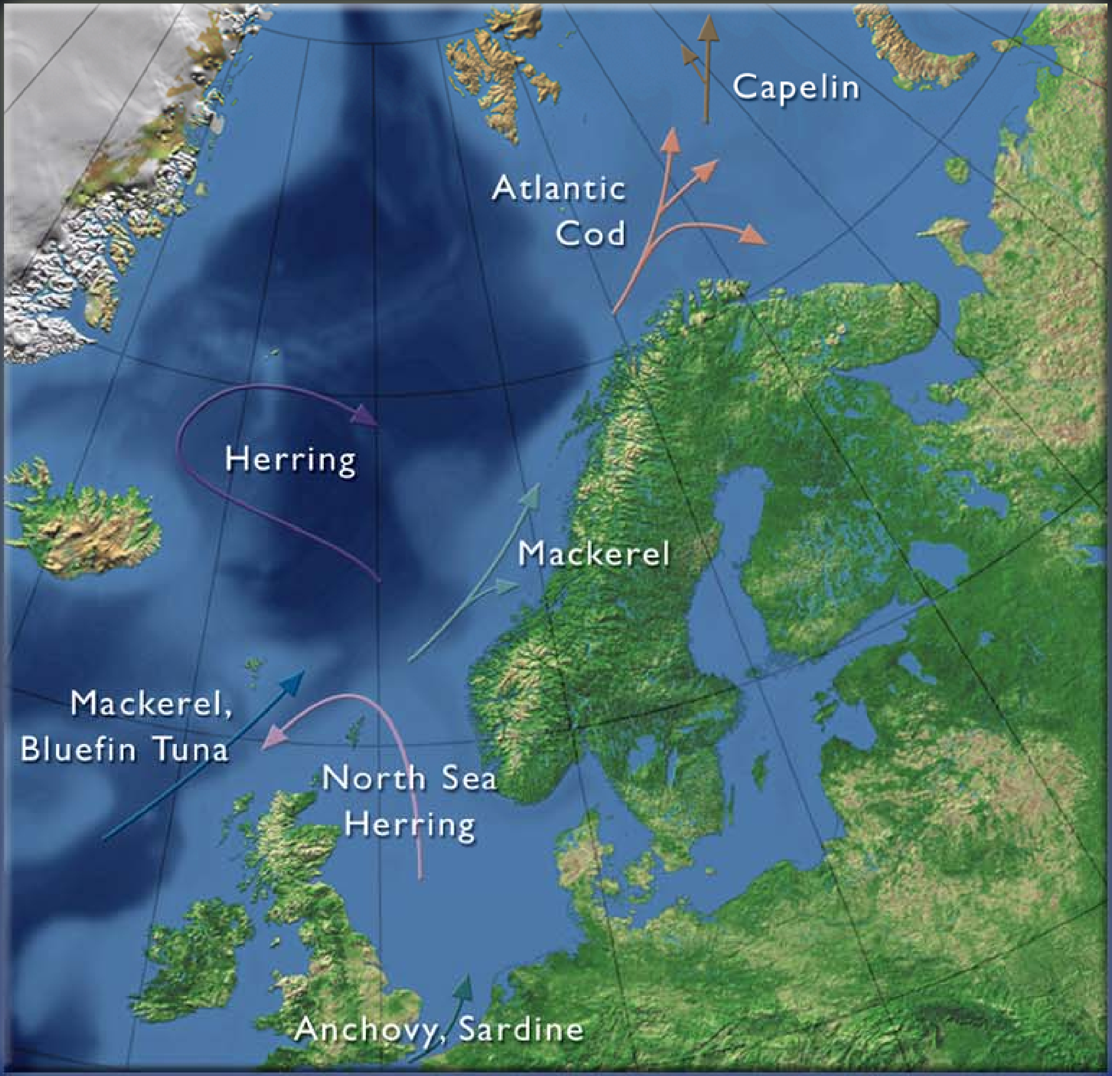


The bars show increase in nitrate flux across each shelf break. Values are the onshore Ekman transport multiplied by the maximum nitrate in the water column.

The increase is not uniform. Some shelves experience greater upwelling than others, particularly the Beaufort.

IMPACTS OF A WARMING ARCTIC

Possible Changes in Fish Distribution



Conclusions

- **Despite strong winter warming, *winter* sea ice north of Alaska shows less evidence of change than *summer* ice**
- **Storminess shows signs of increase in N and W Alaskan coastal seas; vulnerability ↑ as open water season length ↑**
- **Ecosystem shifts have been detected in seas west of Alaska; shifts projected for waters north of Alaska**
- **Projected changes: thinner winter sea ice**
  $\Rightarrow$ more dynamically active sea ice during winter?