

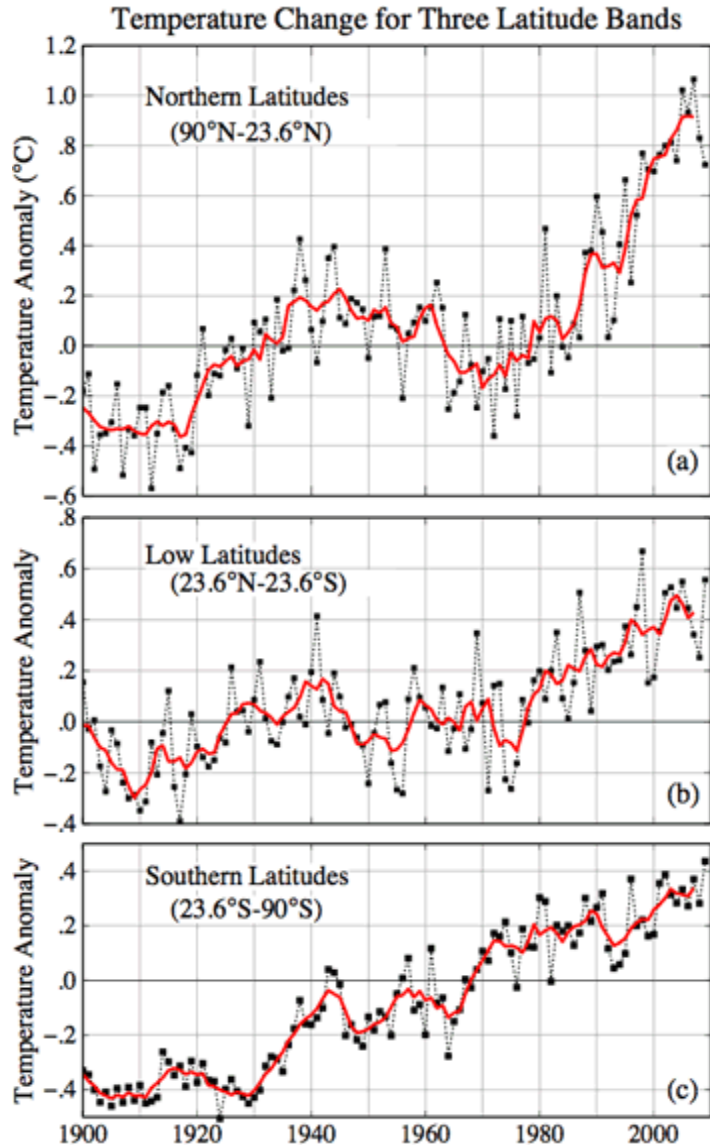


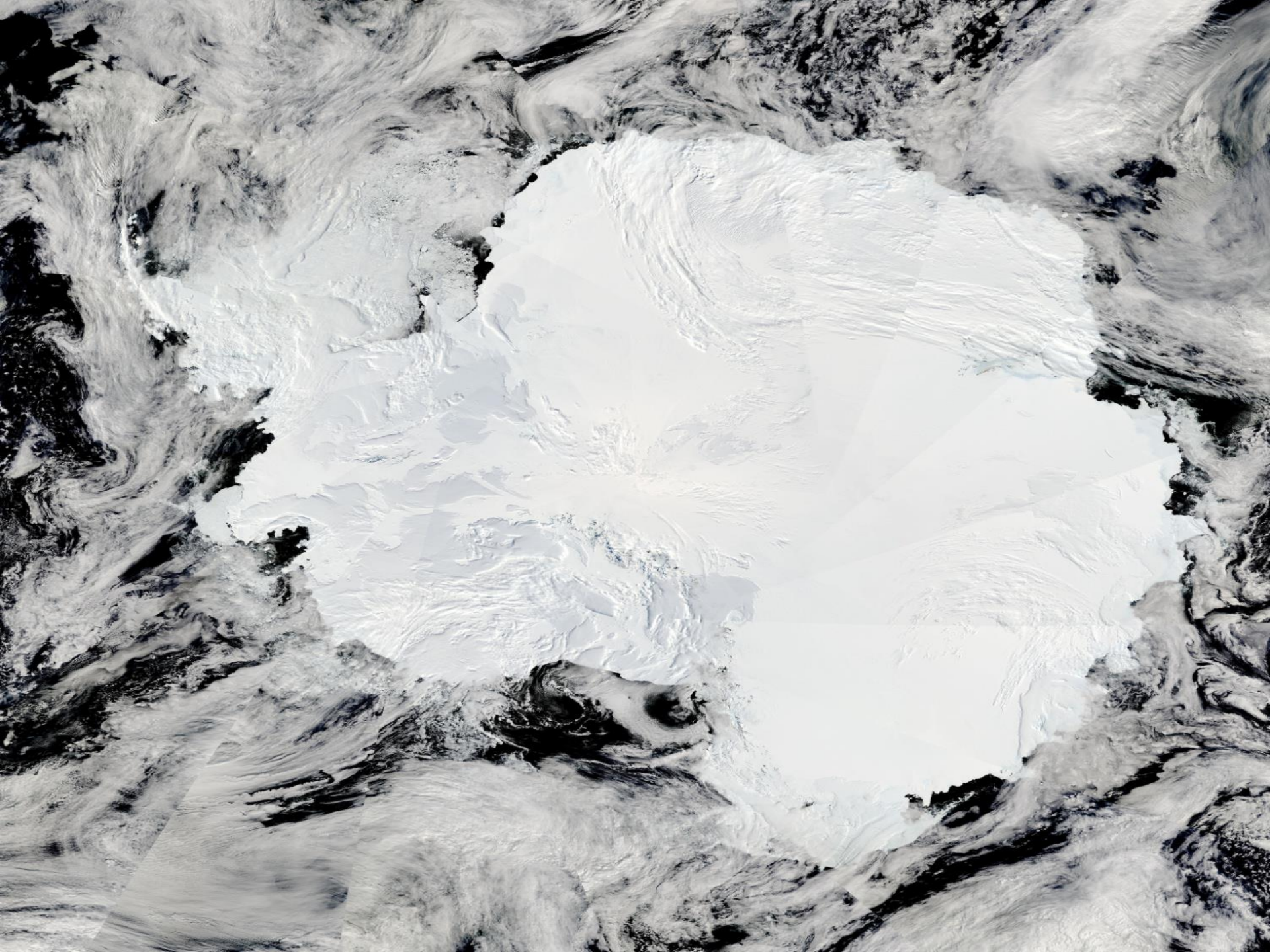
The Cryosphere & Climate Change

Fall 2013

Textbook pp.82-115

Is the Cryosphere Sending Signals About Climate Change?





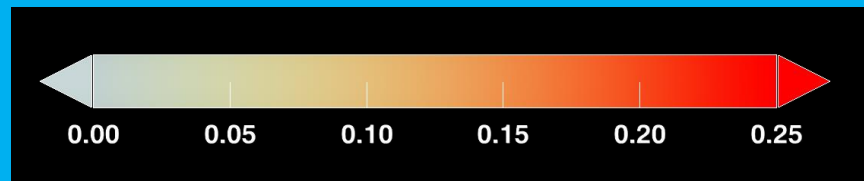
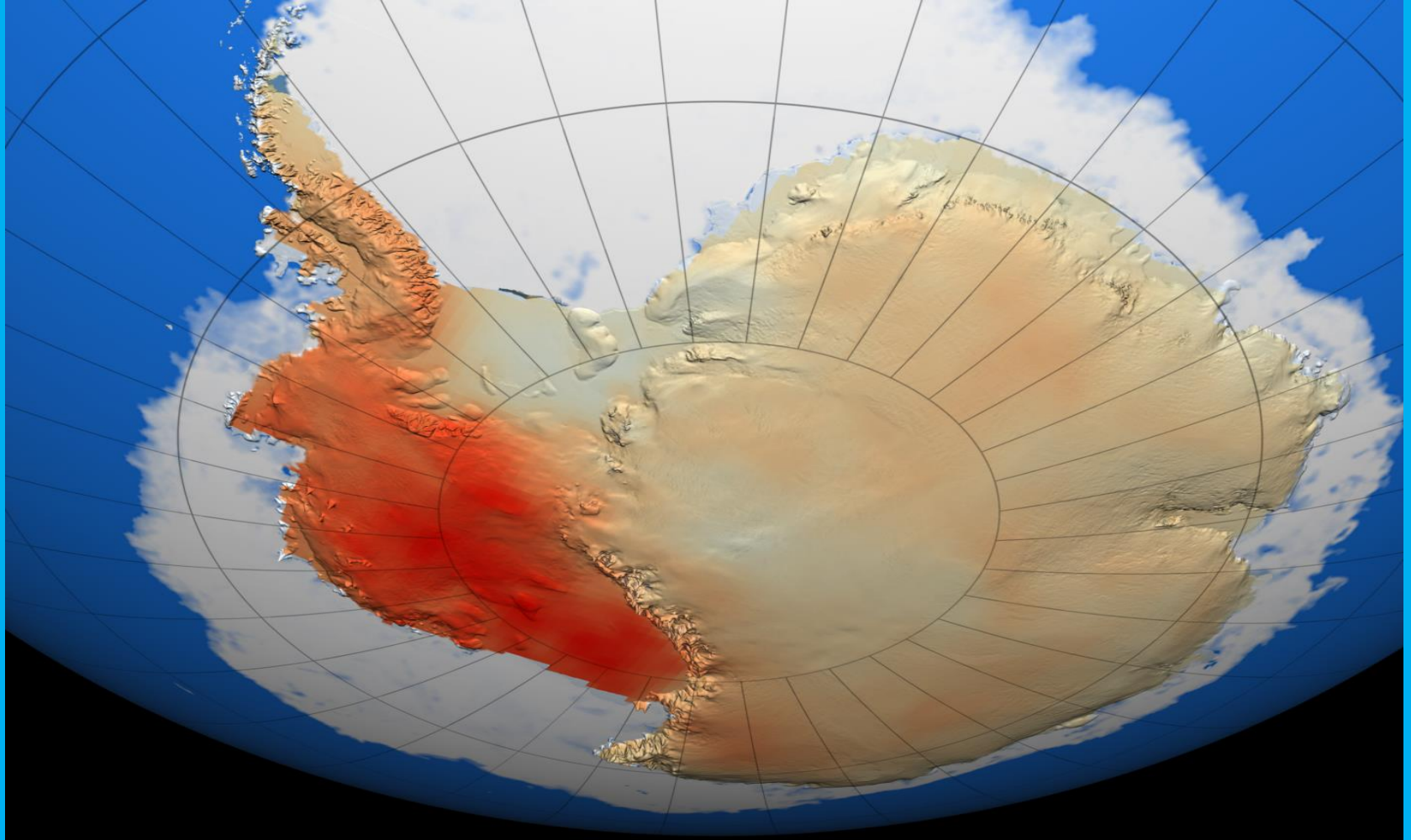


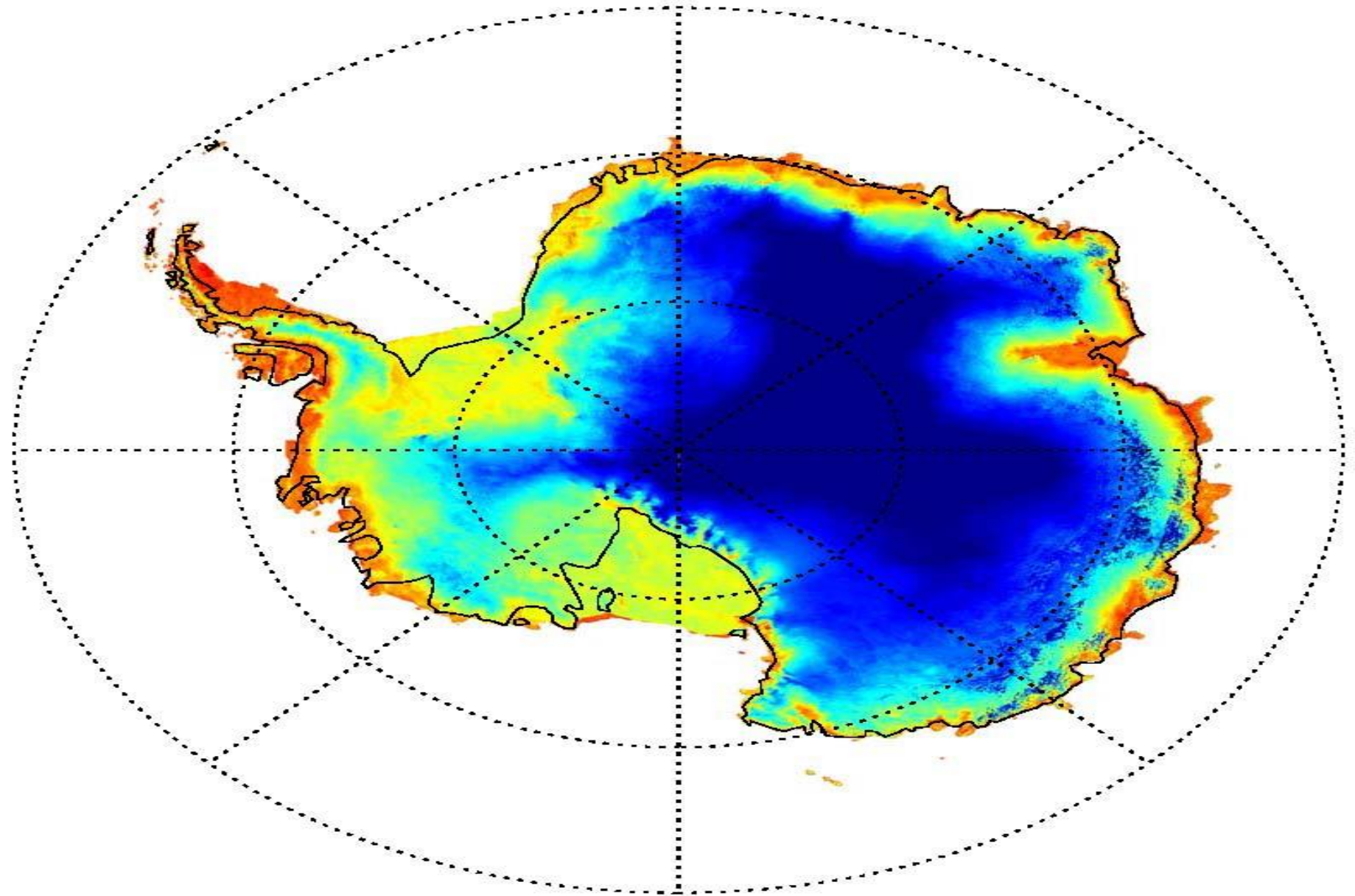
Figure 14: Observed Antarctic Warming Trend ($^{\circ}$ C/decade) from 1957-2006



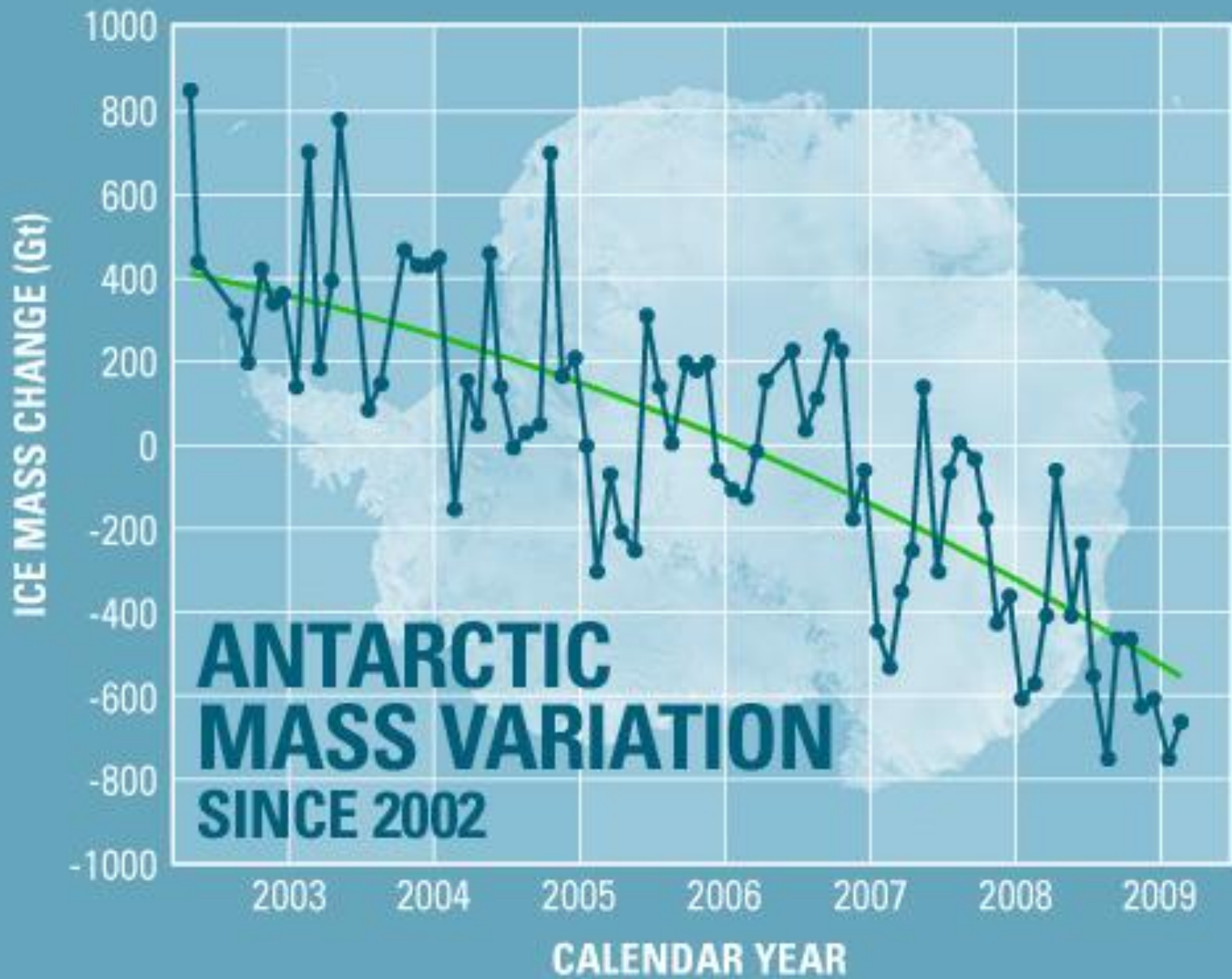




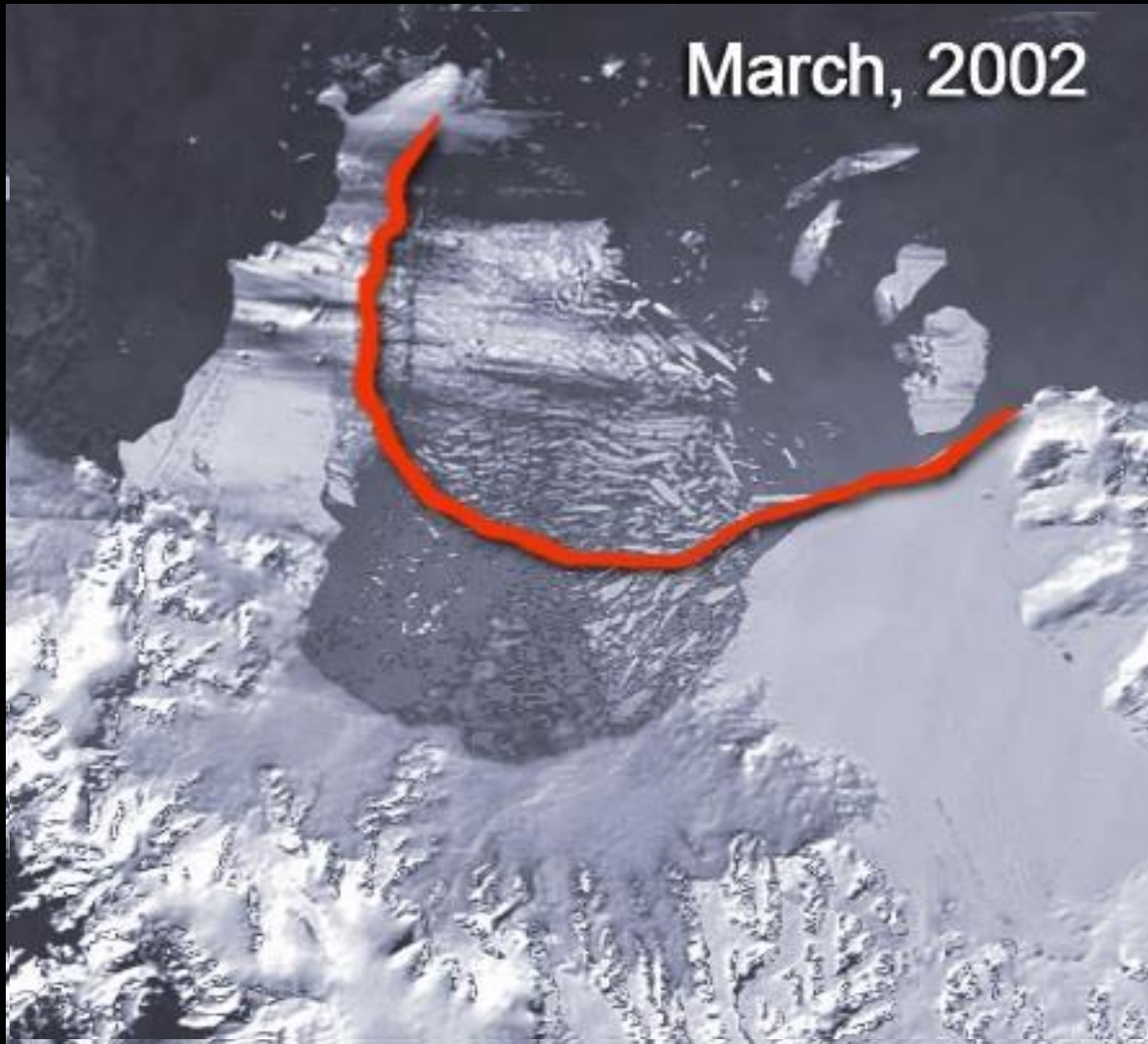




<math>< -25 </math> -20 -15 -10 -5 0 >5
Maximum Land Surface Temperature for 2006 (Celsius)

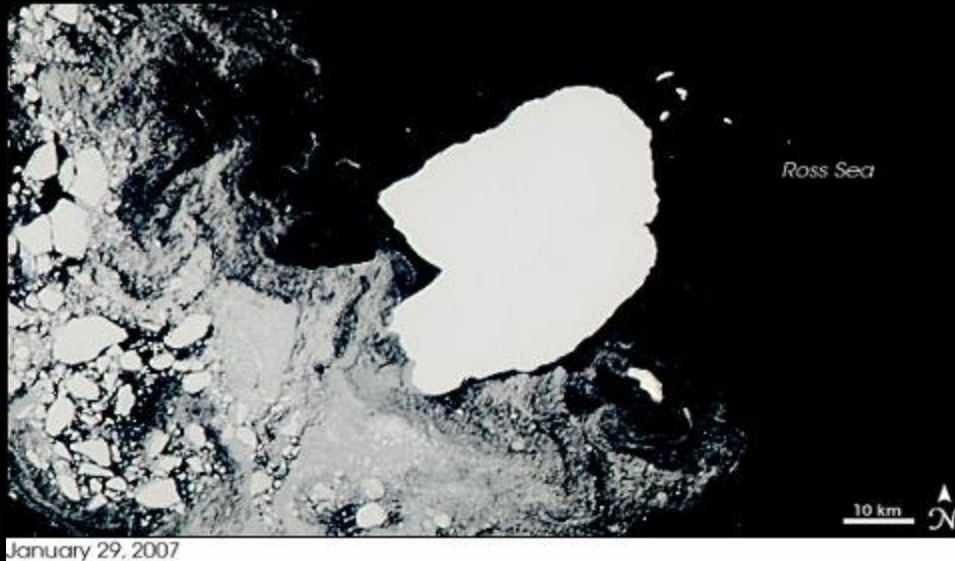


Breakup of Larsen ice shelf (Antarctic Peninsula)

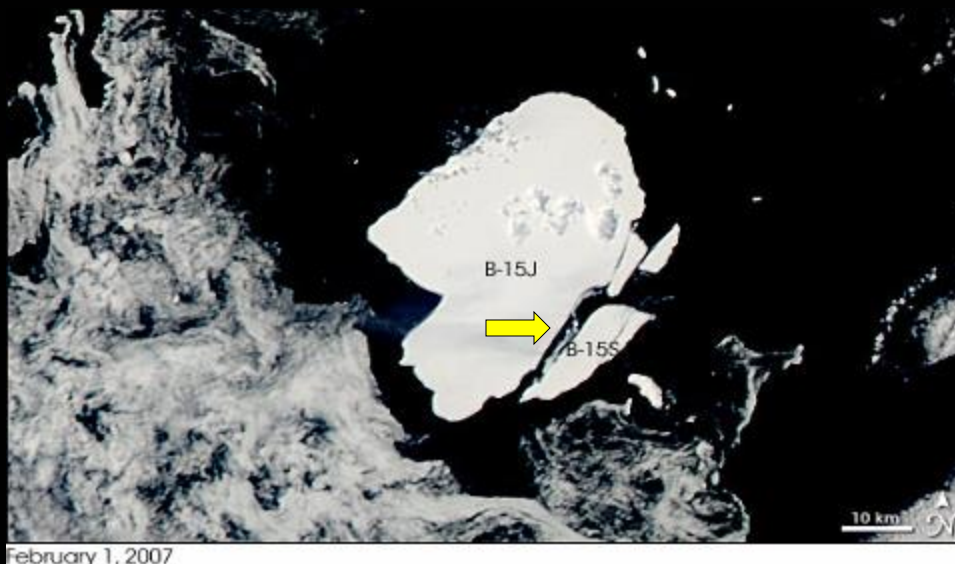


**220 metres thick
Larsen B shelf
existed for at
least 400 years
prior to breakup**

Breakup of Antarctica's Ross Ice Shelf



- An iceberg (B-15J) of size of a small United States state cracked off the Antarctica's Ross Ice Shelf in March 2000



- On February 1, 2007, three new icebergs were formed due to the break up of the original iceberg

NASA Earth Observatory



Average Sea-ice
minimum
1979-2006

Sea-ice minimum
2007

Figure 12: Minimum arctic sea-ice extent from 1979 to 2007

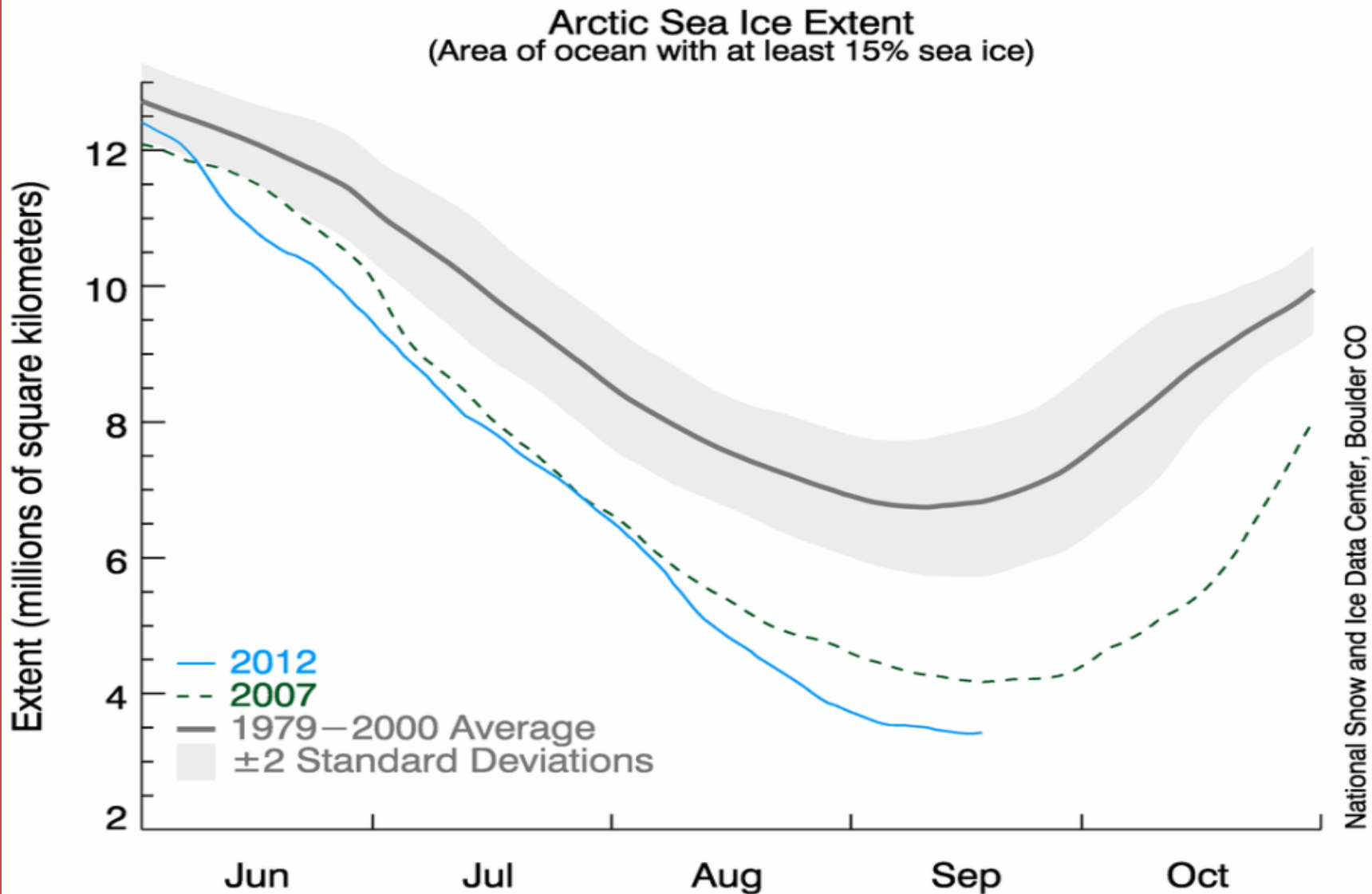
The Copenhagen Diagnosis

Updating the World on the Latest Climate Science



<http://www.copenhagendiagnosis.com/>

NEW RECORD IN 2012!!

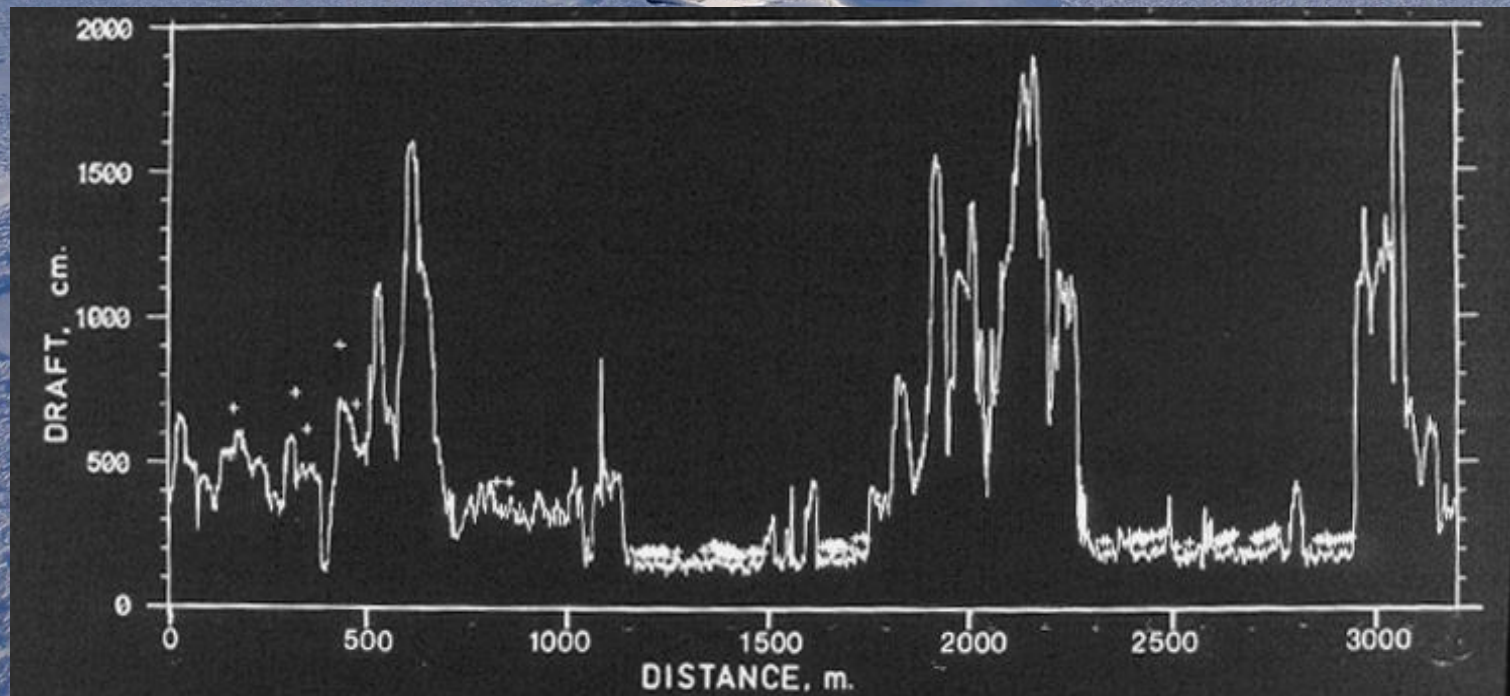


Superb May 1987 - North Pole

(plus USS Sea Devil)



Upward sonar profile

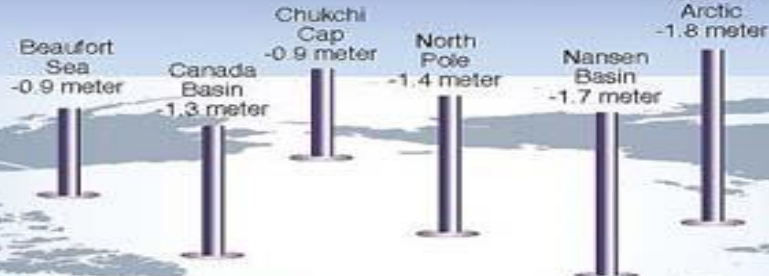


Thinning of the Arctic sea-ice

The height of the bars represent the reduction of ice thickness (draft) from the period 1958-1976 to 1993-1997

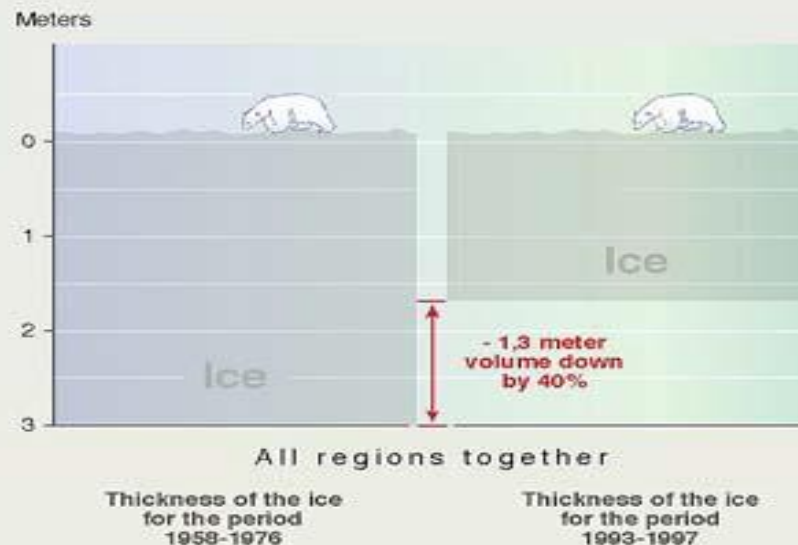
Location of the sampling points

Ice draft in the 90s is over a meter thinner than three decades earlier



GRAPHIC DESIGN: PHILIPPE BEPADEWICZ

Thinning of the Arctic sea ice cover



Greenland

<< The Runners-Up

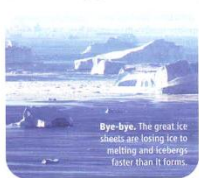
Neandertal genome sequence and, as more fossils become available to sequencers, the development of bacterial libraries containing DNA from several Neandertals.

This breakthrough owes a large debt to earlier sequencing feats that demonstrated the potential of a new approach called metagenomics for deciphering ancient DNA, both human and nonhuman, and of faster sequencing technologies. For metagenomics, a technique developed for assessing microbial diversity, all the DNA in a sample is sequenced, and then sophisticated computer programs pull out only the target DNA based on its similarity to the sequence of a closely related extant organism.

In January 2006, researchers combined metagenomics with a new rapid sequencing technique called pyrosequencing, which uses pulses of light to read the sequence of thousands of bases at once, to get a whopping 13 million bases from a 27,000-year-old mammoth. The same sample also yielded another 15 million bases from bacteria, fungi, viruses, soil microbes, and plants—DNA that will provide clues about this giant mammal's environment. With those two advances, ancient DNA sequencing is off and running.

and Antarctica—are indeed losing ice to the oceans, and losing it at an accelerating pace. Researchers don't understand why the massive ice sheets are proving so sensitive to an as-yet-modest warming of air and ocean water. The future of the ice sheets is still rife with uncertainty, but if the unexpectedly rapid shrinkage continues, low-lying coasts around the world—including New Orleans, South Florida, and much of Bangladesh—could face inundation within a couple of centuries rather than millennia.

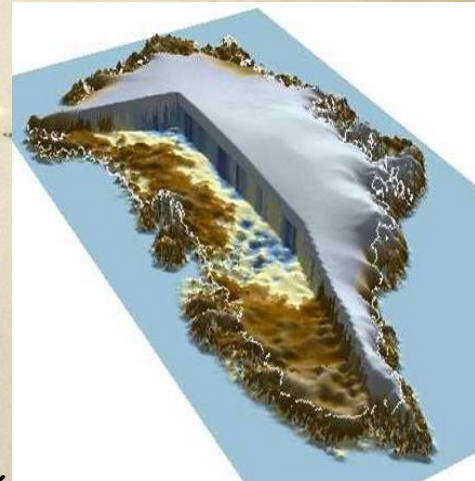
This disturbing breakthrough rests on decades of measurements by airborne laser altimeters and orbiting radars, and, more recently, by a pair of satellites that measure ice mass directly by its gravitational pull. Different techniques and even different analyses of the same data disagree about just how much ice volume is changing. All of them, however,



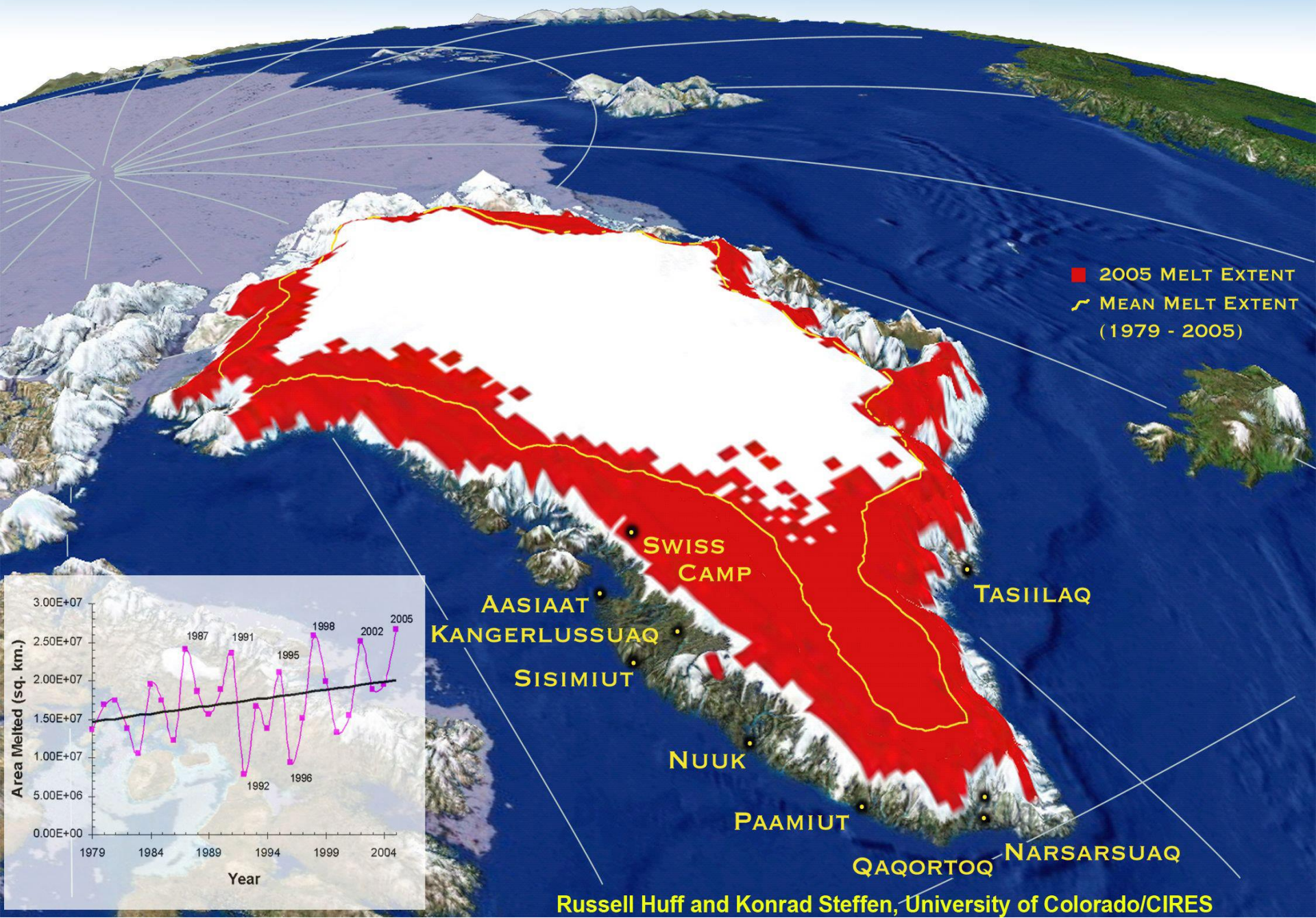
Bye-bye. The great ice sheets are losing ice to melting and icebergs faster than it forms.



Science Breakthrough of the Year 2006



GREENLAND 2005 MELT EXTENT



Russell Huff and Konrad Steffen, University of Colorado/CIRES

Glacier National Park, Montana, United States



Grinnell Glacier from Mt. Gould 1938 - 2006



1938

*Hileman photo
GNP Archives*



1981

*Key photo
USGS*



1998

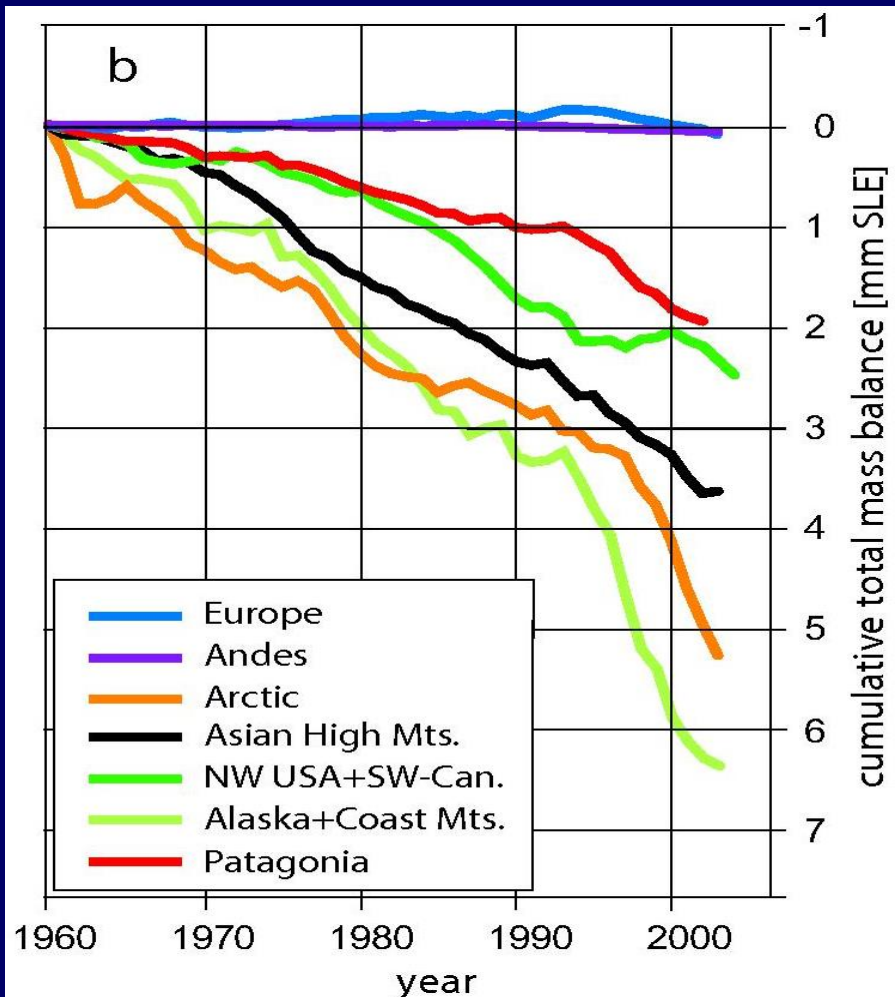
*Fagre photo
USGS*



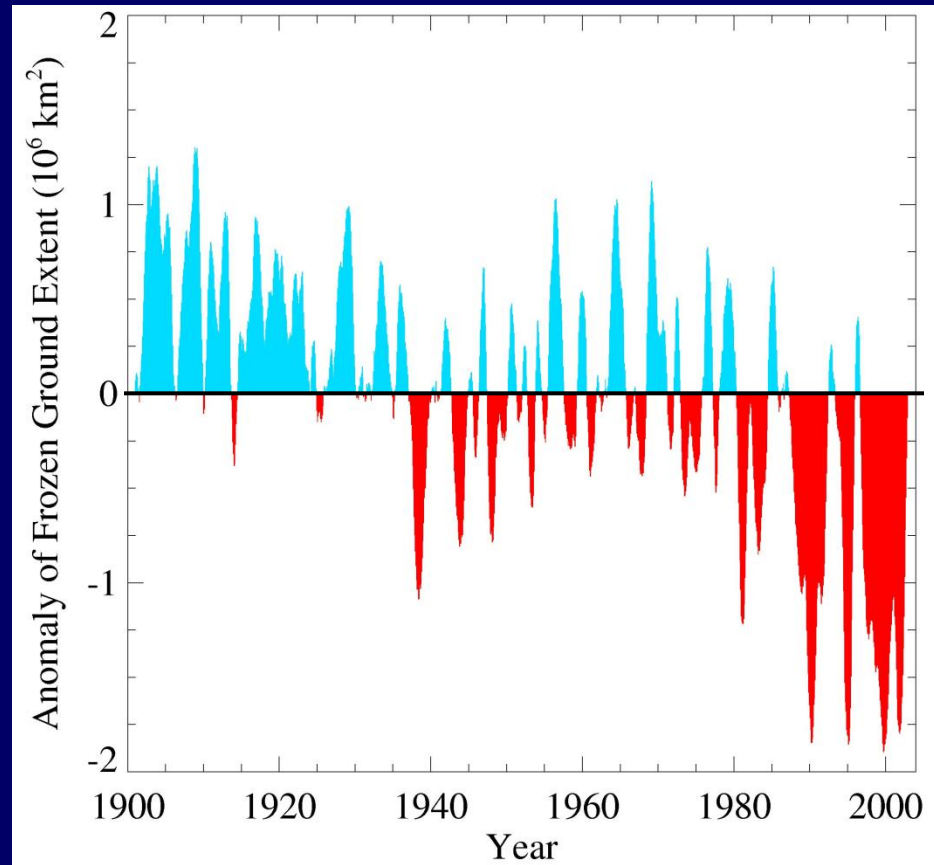
2006

*Holzer photo
USGS*

Glaciers and frozen ground are receding



Increased Glacier retreat since the early 1990s



Area of seasonally frozen ground in NH has decreased by 7% from 1901 to 2002

ALASKAN GLACIER MASS BALANCES 1950 - 2001

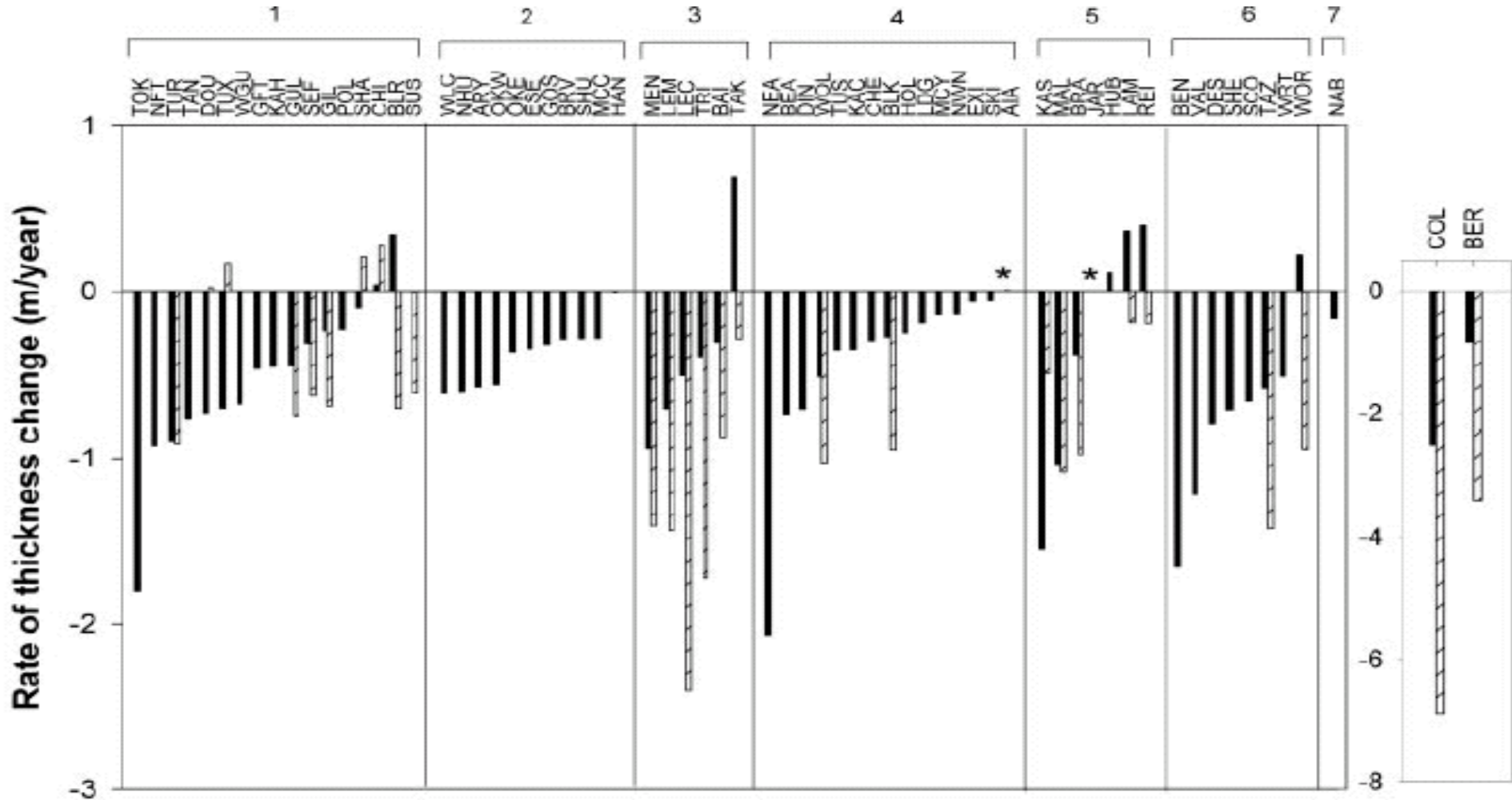


Fig. 3. Rate of glacier-wide average thickness change of 67 glaciers in Alaska during the early period (~1950 to 1995; solid black bars) and 28 glaciers during the recent period (~1995 to 2001; hatched bars). Glaciers (see table S1 for full names) are arranged according to their regions as given in Fig. 1; two large glaciers are plotted separately because of their exceptionally high rates of thinning. Asterisks denote thickness changes not resolved by the scale of the plot.

Arendt et al 2002. Science.

Permafrost Anomaly

