

# How fast can the climate change?

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You have already looked at some global temperature data that are a window into climate change (below).

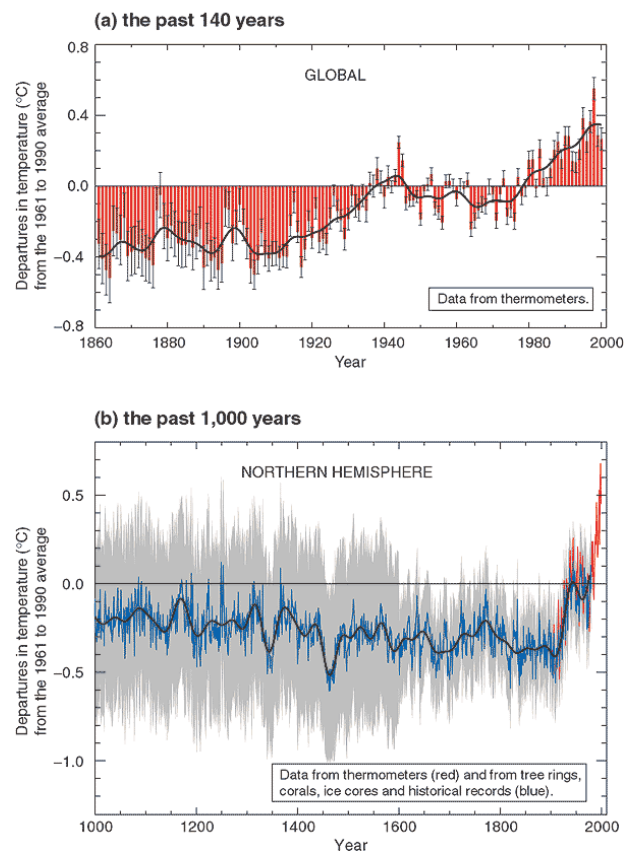
From IPCC Climate Change 2001: The Scientific Basis. Summary for Policy Makers.

[http://www.grida.no/climate/ipcc\\_tar/wg1/figspm-1.htm](http://www.grida.no/climate/ipcc_tar/wg1/figspm-1.htm). Figures captions modified from this source.

(a) For the 140 years before the year 2000, the Earth's **global surface temperature** is shown **year by year (red bars)** and approximately **decade by decade (bold black line)**, a smoothed annual curve suppressing fluctuations that occur on timescales of less than a decade). *Uncertainties* due to a variety of sources are shown in the annual data by *thin black whisker bars* that represent the 95% confidence range.

(b) Same data as in (a) on far right of plot. Additionally, the **year by year (blue curve)** and **50 year average (bold black curve)** variations of the **average surface temperature of the Northern Hemisphere for the past 1000 years** have been reconstructed from "proxy" data calibrated against thermometer data (see list of the main proxy data in the diagram). The 95% confidence range of *uncertainty* in the annual data is represented by the *grey region*.

## Variations of the Earth's surface temperature for:



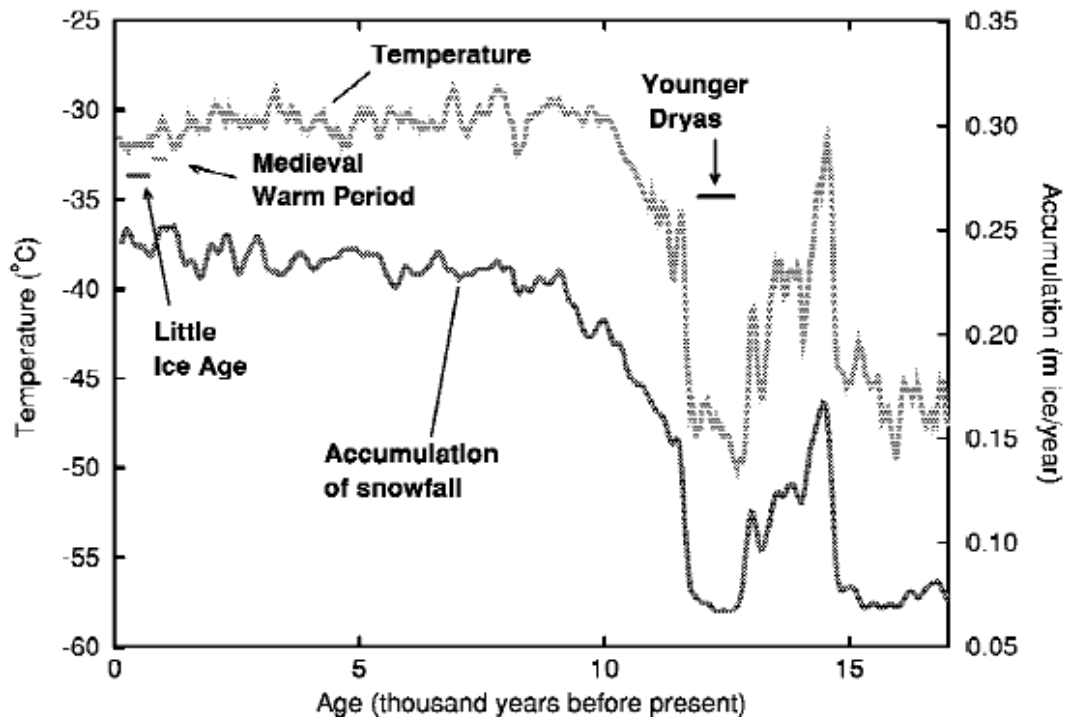
Now we will look at climate change from a different perspective. This side of the issue is recently developed and still fairly unknown in the political community, yet it has the potential for reframing the political debate on global warming. Much of what you will learn has been discovered only in the last 5-10 years.

Over the 5-billion years of Earth's history, the planet has continued to warm up and cool down, leaving behind evidence of climates very unlike the climate of today. Until about 10,000 years ago, much of the United States had been covered by glaciers for many thousands of years. Even during these years, however, the climate would fluctuate drastically between glacial and interglacial periods. How fast did these changes occur? This is the question that paleoclimatologists (scientists who study the earth's past climates) have been trying to answer.

Below, you will look at a variety of data plots to find evidence of rapid change in climate. You will explore these questions and others: How much did the climate change during the abrupt climate changes of the past? Was the phenomenon regional or global? How fast can an abrupt climate change occur?

## Working with Climate Data

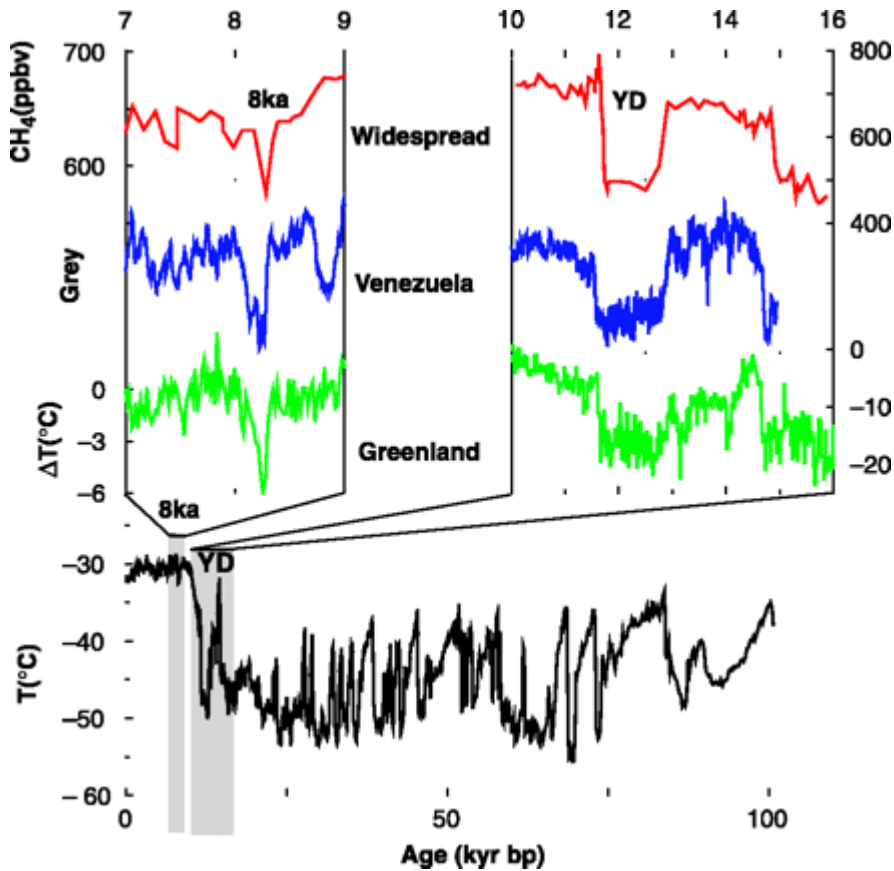
Work with and analyze the data in the following plot from the National Research Council Report, *Abrupt Climate Change: Inevitable Surprises*<sup>1</sup>:



**FIGURE 1.** Temperature and snow accumulation records from central Greenland. The plotted data show 100-year averages over the last 17,000 years.

1. Using what you learned in the tippy games, identify abrupt climate changes and regime shifts on this plot (mark up your plot). When were they in years BP (before present)?
2. Characterize the stable regimes in terms of temperature and length of time.
3. Quantify the changes in temperature during these abrupt climate changes.
4. The Vikings left Greenland suddenly around 1500 A.D., better known as “The Little Ice Age.” Most likely, the temperature drop caused the conditions in Greenland to become unsuitable for habitation. How does this change in climate compare to others before it?

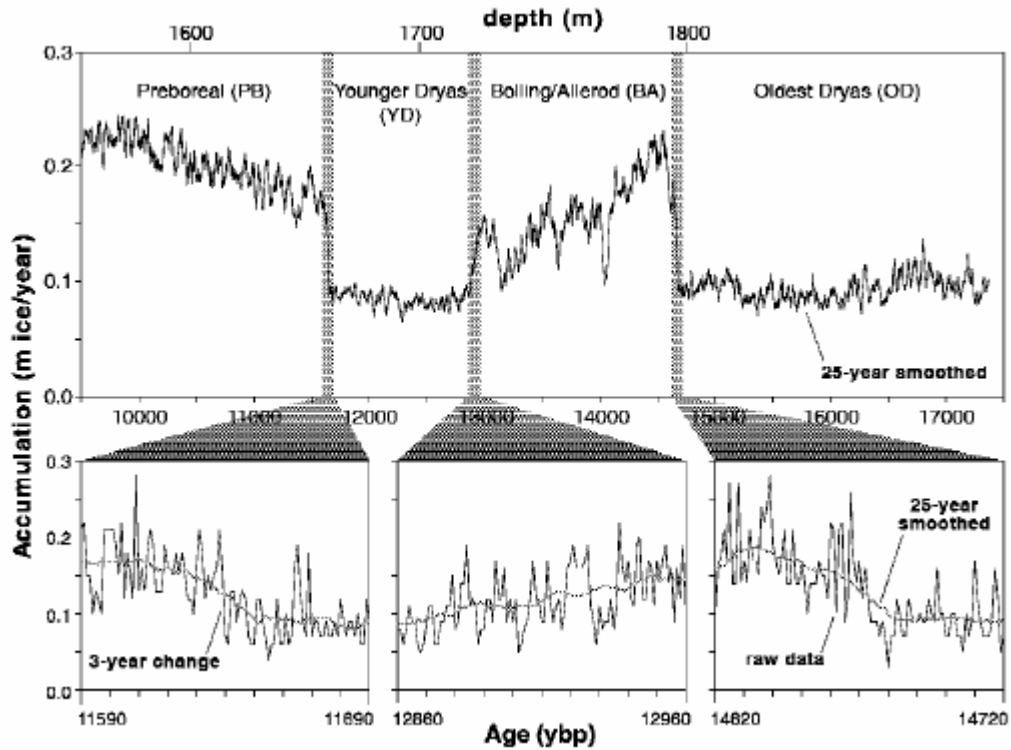
Next, to put things in a longer time perspective, examine the following figure from the article “Abrupt Climate Change”:<sup>2</sup>



**FIGURE 2.** The last 110,000 years of temperature changes in central Greenland. The grey-scale and methane plots correspond to other environmental factors; for now, just focus on the temperature plots.

5. Does the Younger Dryas (YD) period look unique on this figure?
6. Characterize the stability of the present day climate (since about 10BP).
7. What questions are raised by these data?

To determine the precise timeframe of change for these events, examine the figure below from *Abrupt Climate Change: Inevitable Surprises*.<sup>3</sup>

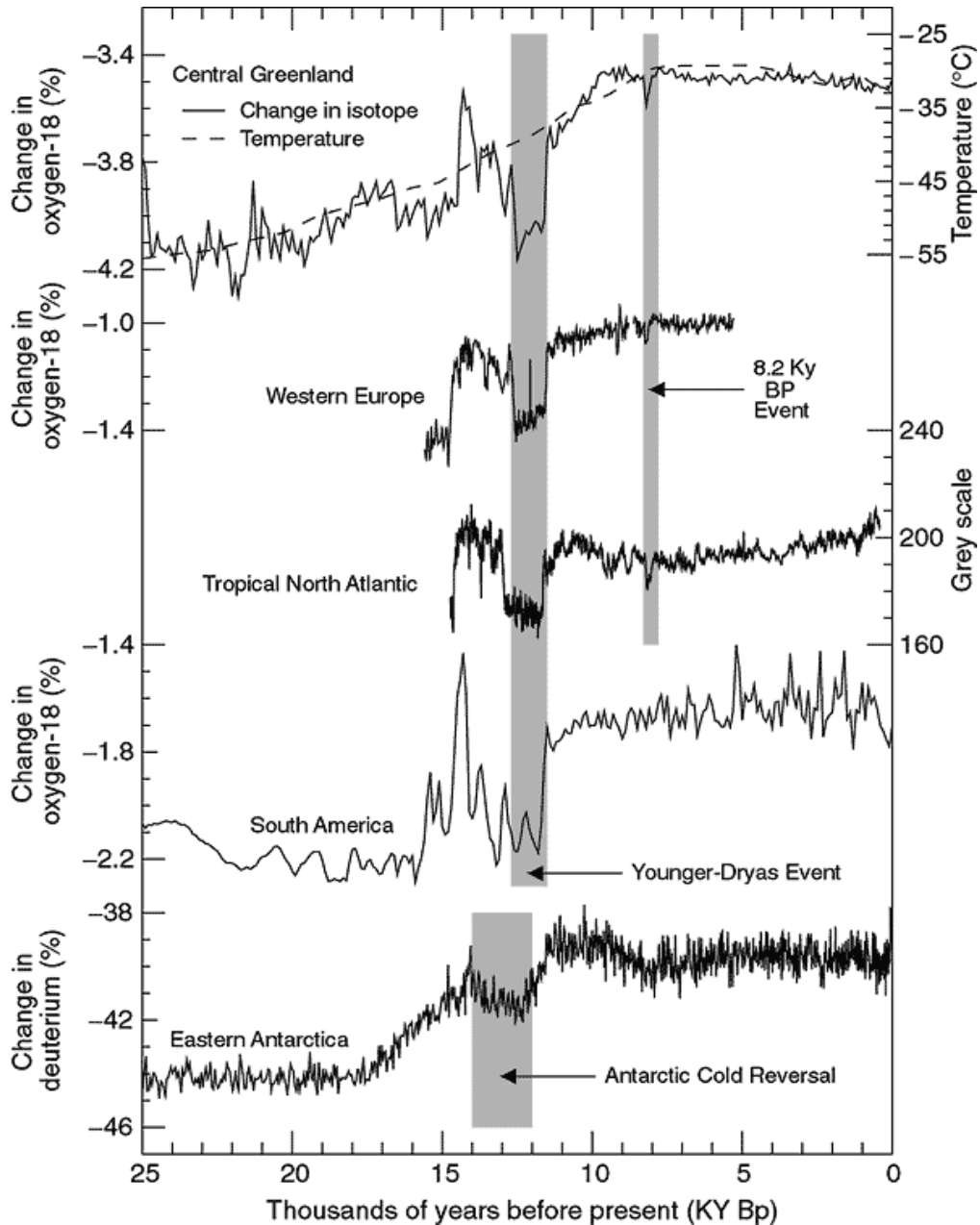


**FIGURE 3.** The ice accumulation in Greenland. Low amounts of ice generally correlate to a colder period.

8. What time frame does this plot cover? How is the top axis (labeled “depth”) related to the time before present?
  
9. How fast did each of the 3 highlighted abrupt changes occur?

Finally, look at the following figure from IPCC<sup>5</sup>:

[http://www.grida.no/climate/ipcc\\_tar/wg1/fig2-24.htm](http://www.grida.no/climate/ipcc_tar/wg1/fig2-24.htm)



**FIGURE 4:** Records of climate variability during the last 25,000 years. The shaded areas show the 8.2 ky BP event and the Younger Dryas event. The grey scale used in the Tropical North Atlantic record is a measure of sea surface temperature, deduced from the color of plankton-rich layers within an ocean sediment core. The other y axes (oxygen and deuterium isotope ratios) are "proxies" for temperature; more on proxies soon.

10. How widespread were the Younger Dryas and the 8,000BP event?

11. **Research question:** Experts believe that modern climate change will most likely have the greatest effect on the Northern Hemisphere (for example, in the Arctic, where lots is already changing). Why might the Northern Hemisphere be more affected by abrupt climate changes?

## References

<sup>1</sup> National Academy of Sciences, Committee on Abrupt Climate Change, *Abrupt Climate Change: Inevitable Surprises*, National Academy Press, Washington, DC (2002), pp.15.

<sup>2</sup>Alley *et al.*, “Abrupt Climate Change” *Science*, Vol. 299, Iss. 28. Mar. 2003, pp. 2005-2010.

<sup>3</sup>Ref. 1, pp. 28.

<sup>4</sup>IPCC (Intergovernmental Panel on Climate Change), *Climate Change 2001: The Scientific Basis*. Figure 2.24.