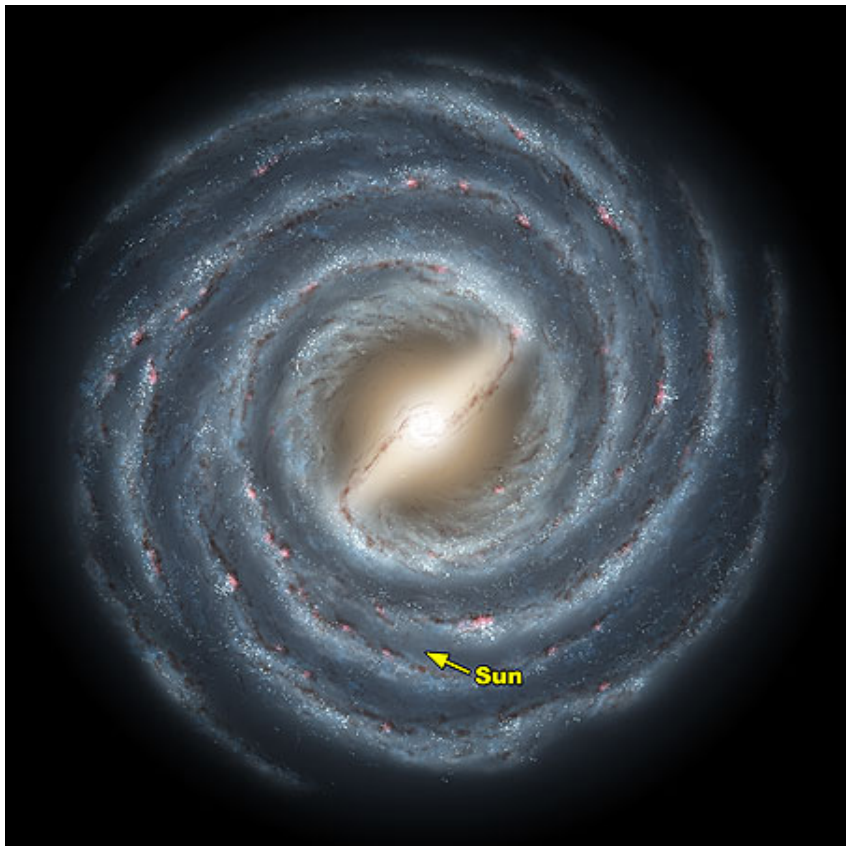
ZOOMING OUT IN TIME



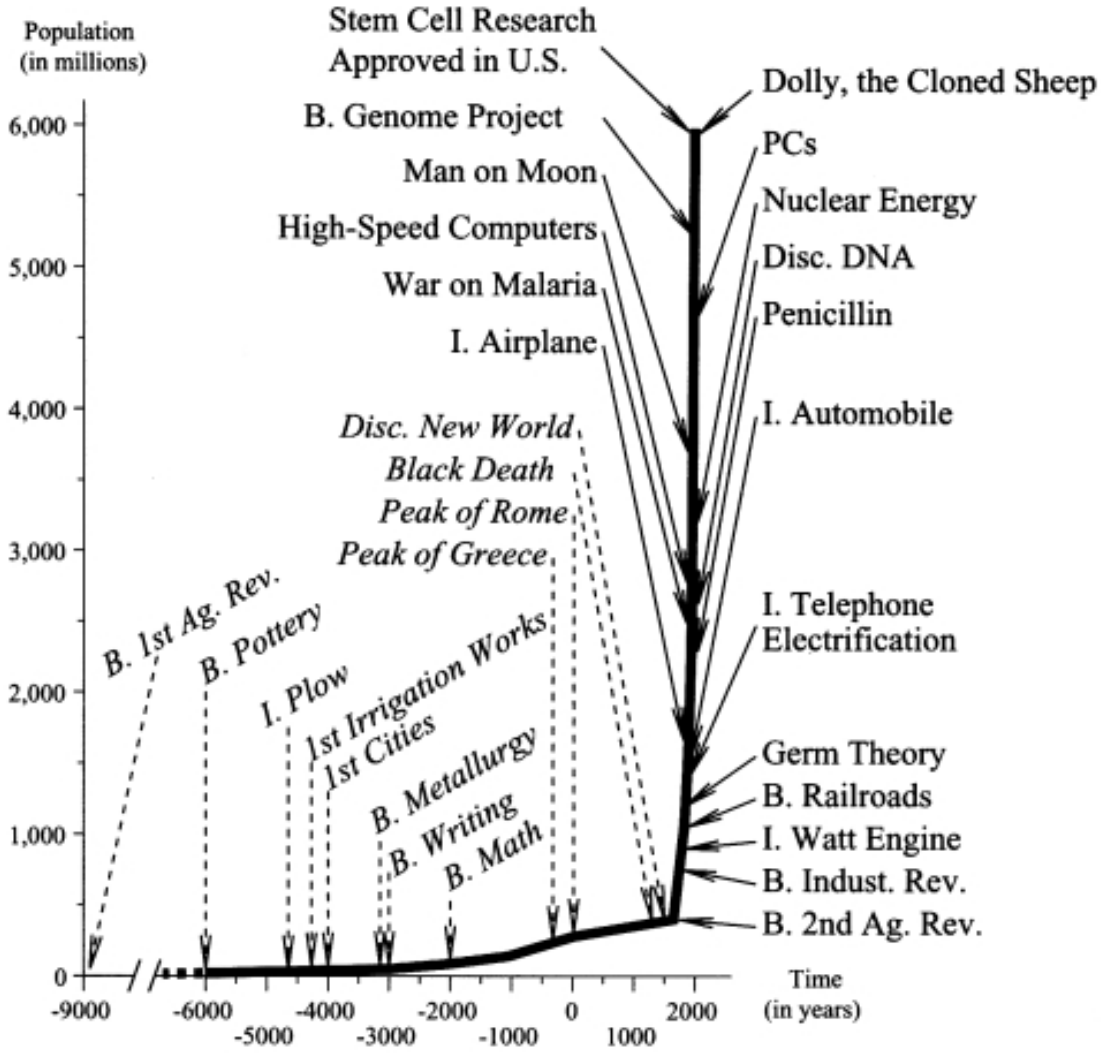
NASA

John Baez

Seminars About Long-Term Thinking

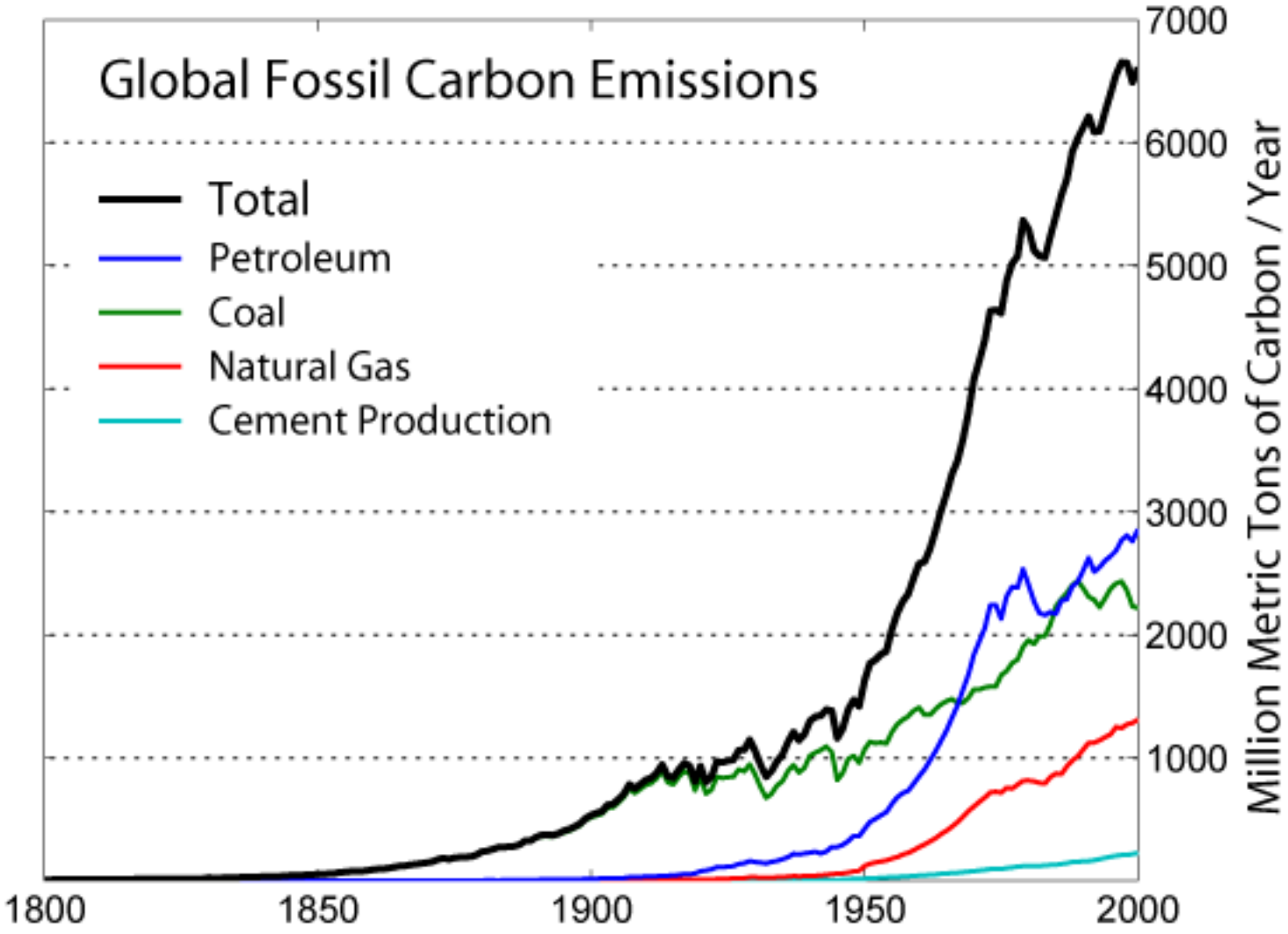
October 13, 02006

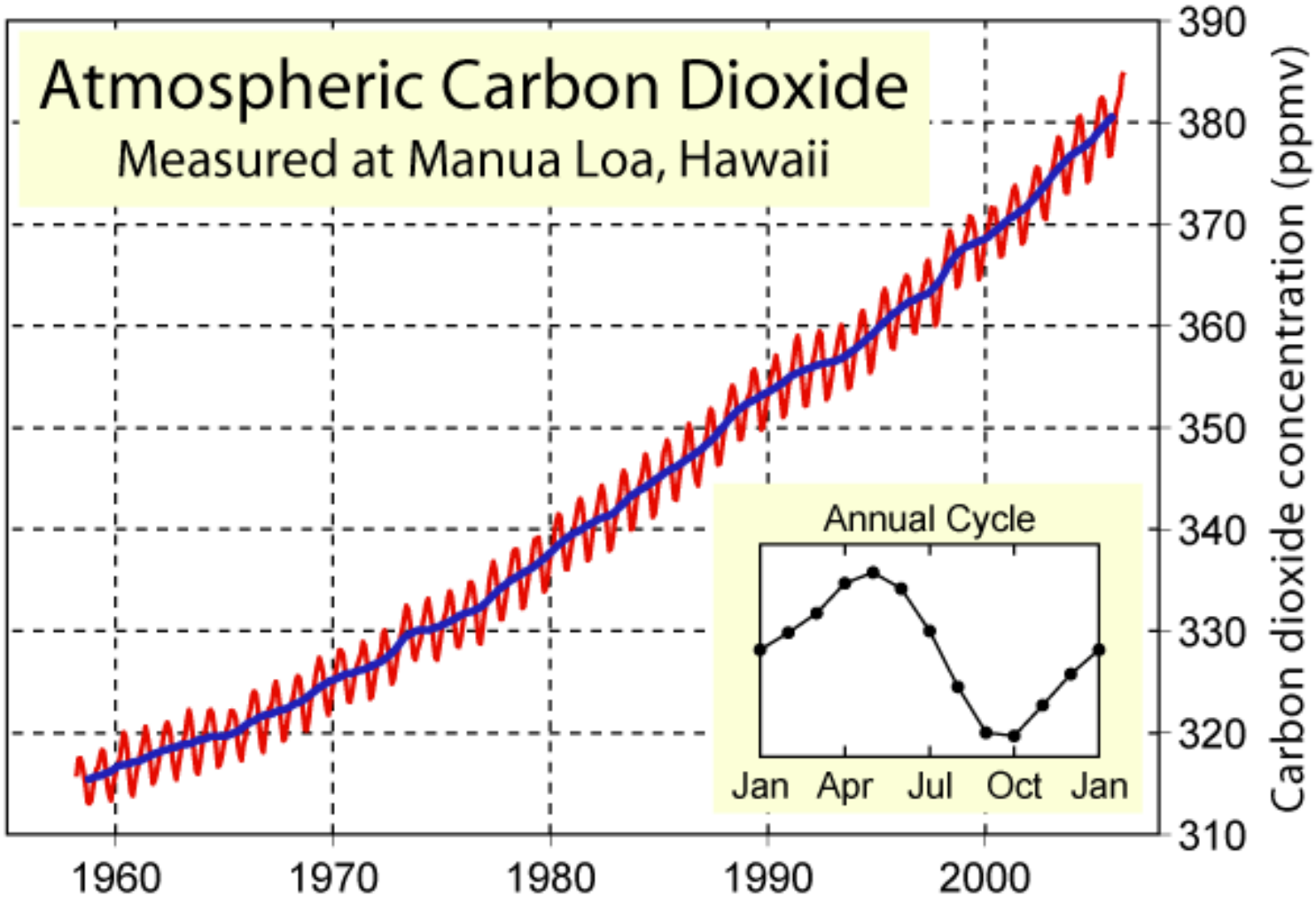
All around we see hastening change:



Robert Fogel - *The Escape from Hunger and Premature Death, 1700-2100*

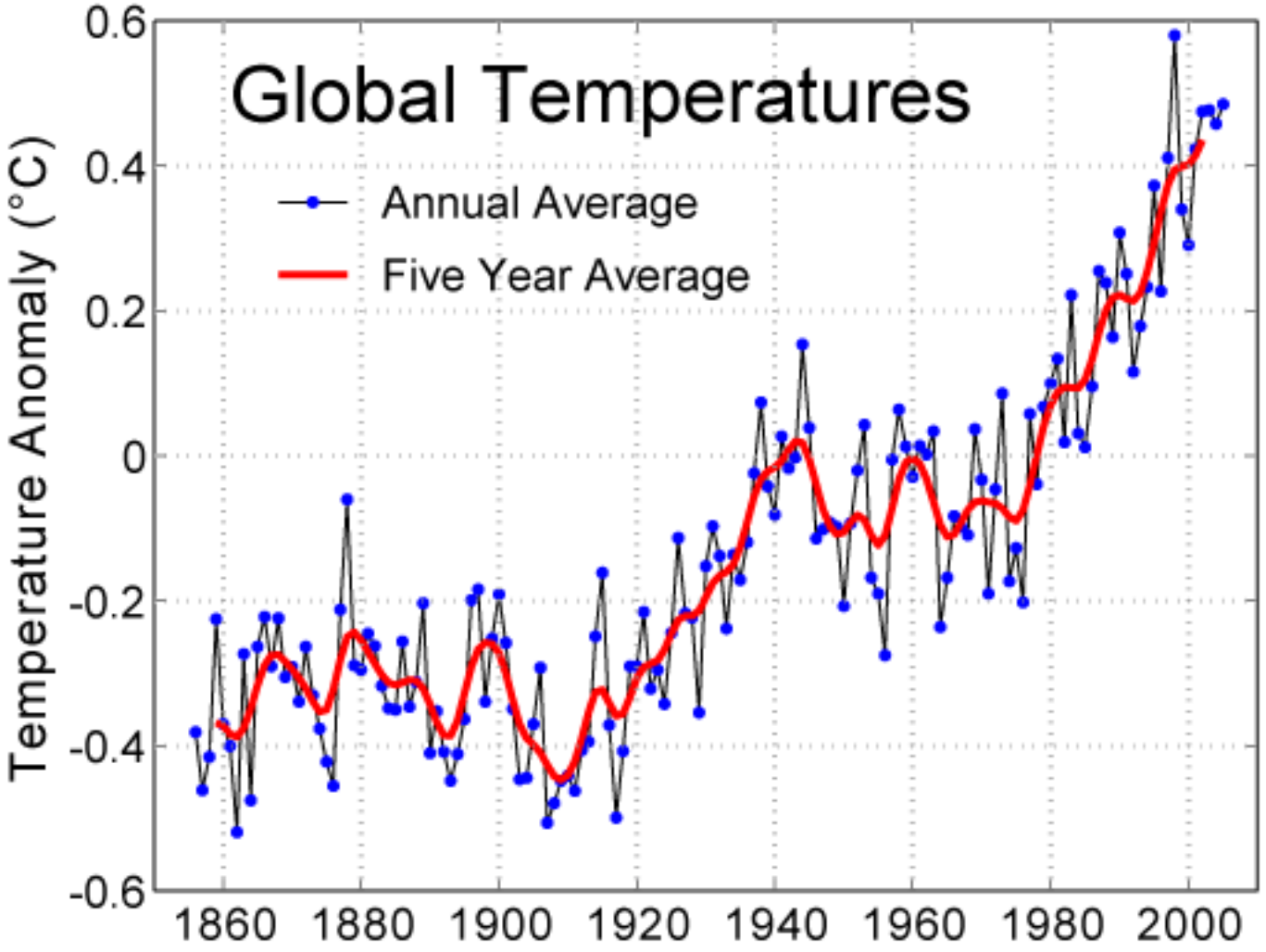
So far it relies on *burning carbon:*



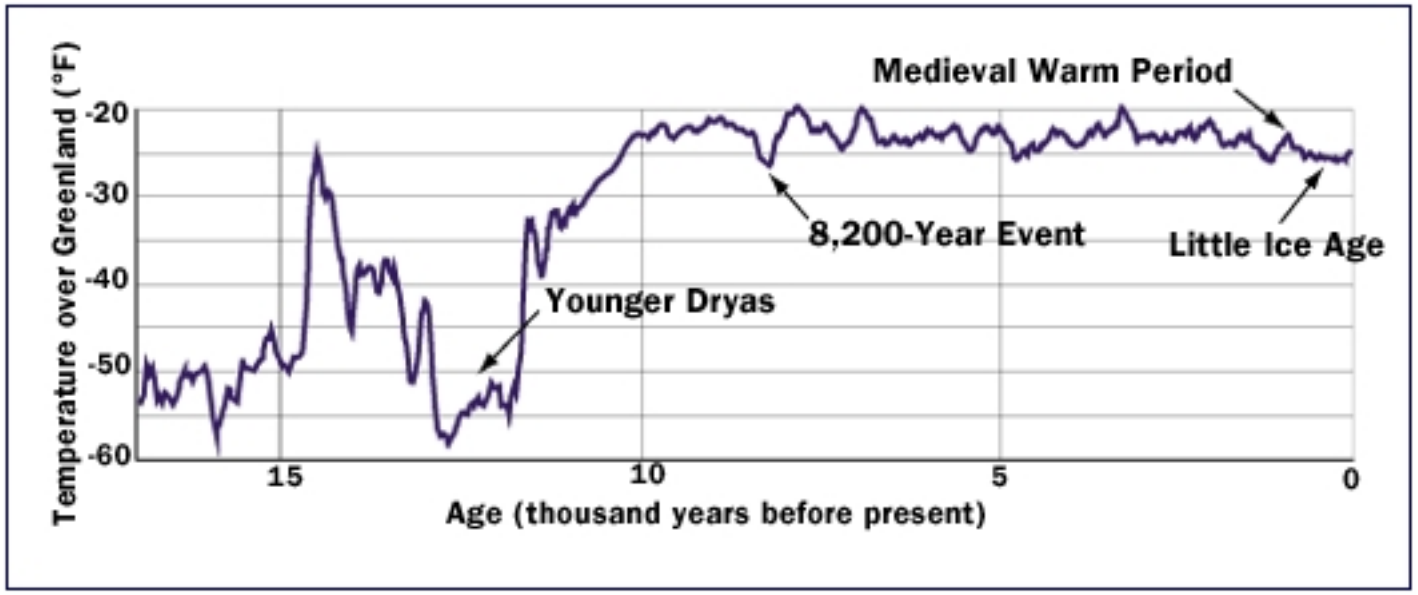


Global Warming Art

So, the greenhouse effect is kicking in:



To understand what's happening, we must *zoom out*:



Richard Alley - *The Two-Mile Time Machine*

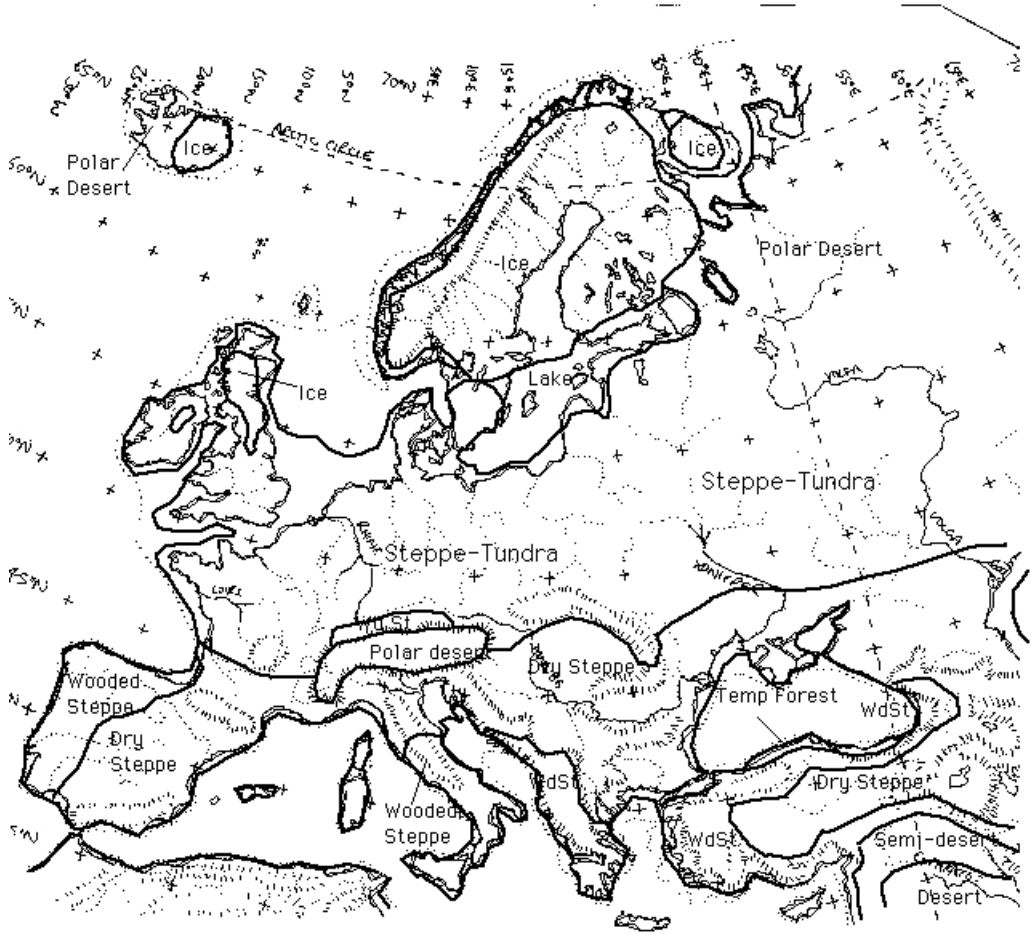
Let's look at two incidents:

- the 'Little Ice Age'
- the 'Younger Dryas'

During the ‘Little Ice Age’, roughly 1550–1850 AD, the temperature in Europe dropped about 1°C:

A Scene on the Ice, Hendryk Averkamp, Netherlands, 1608.

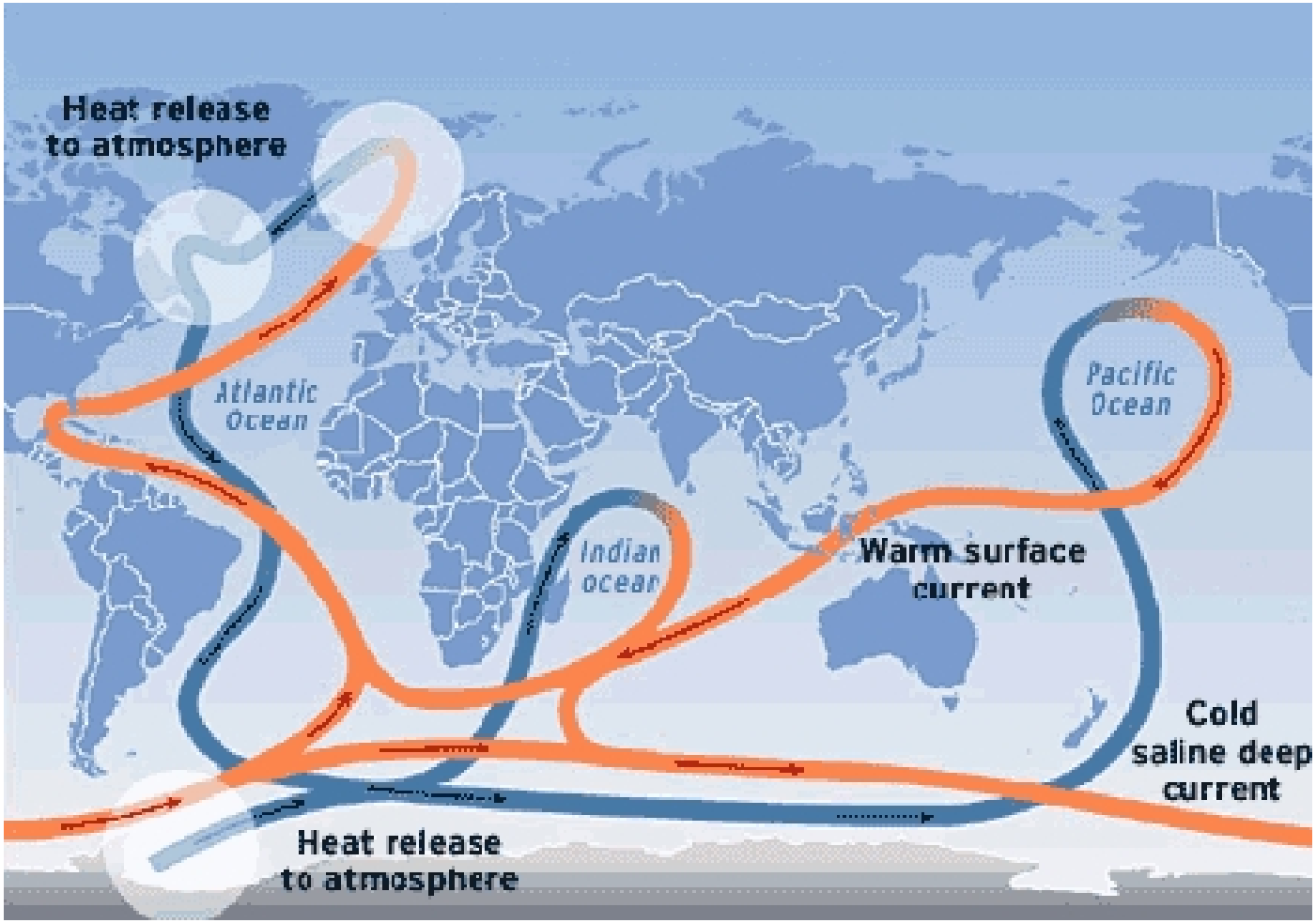
The ‘Younger Dryas’ began 12,900 years ago. In 20 years, the temperature in Europe dropped 7°C:



Jonathan Adams

It lasted for about 1000 years, then suddenly ended!

Why? Some say the Gulf Stream warms Europe:

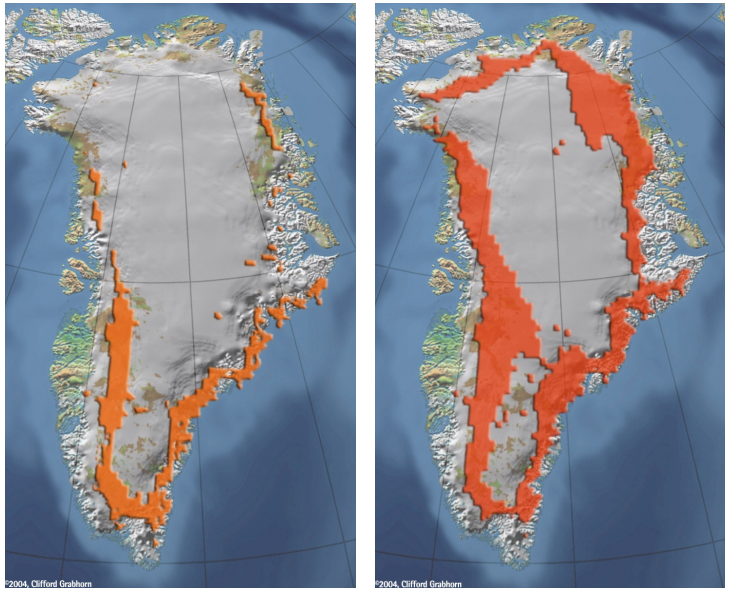


Union of Concerned Scientists

Dwight Brown

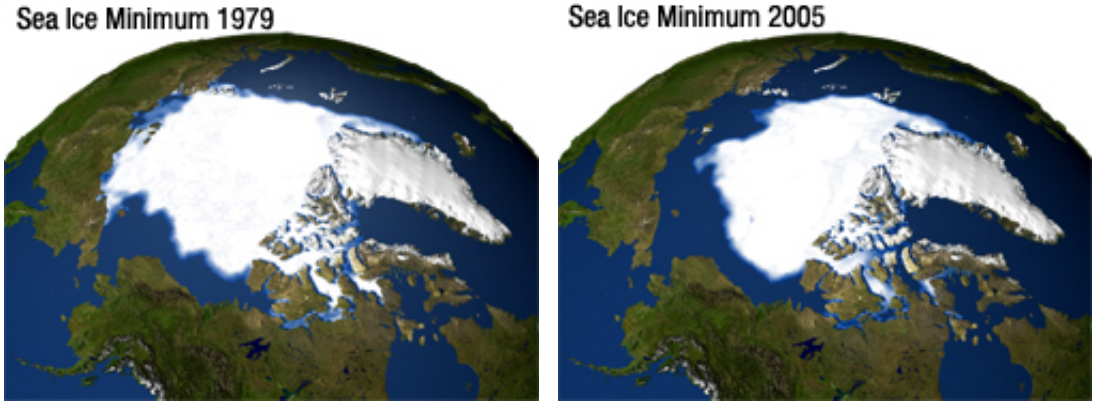
When the Ice Age ended, runoff from Lake Agassiz may have blocked the Gulf Stream and plunged Europe into a deep freeze.

Now Greenland and the Arctic are melting:



ACIA

1992 2002



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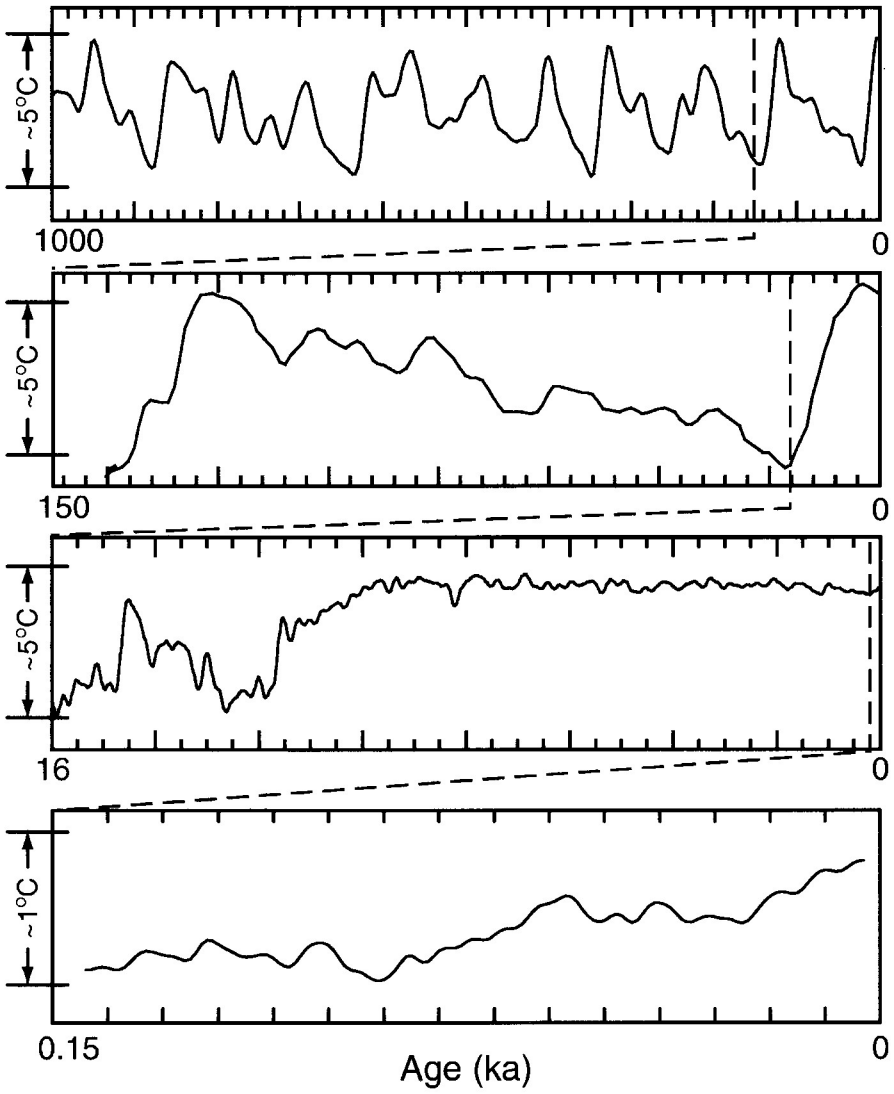
Could this trigger another 'Younger Dryas' event?

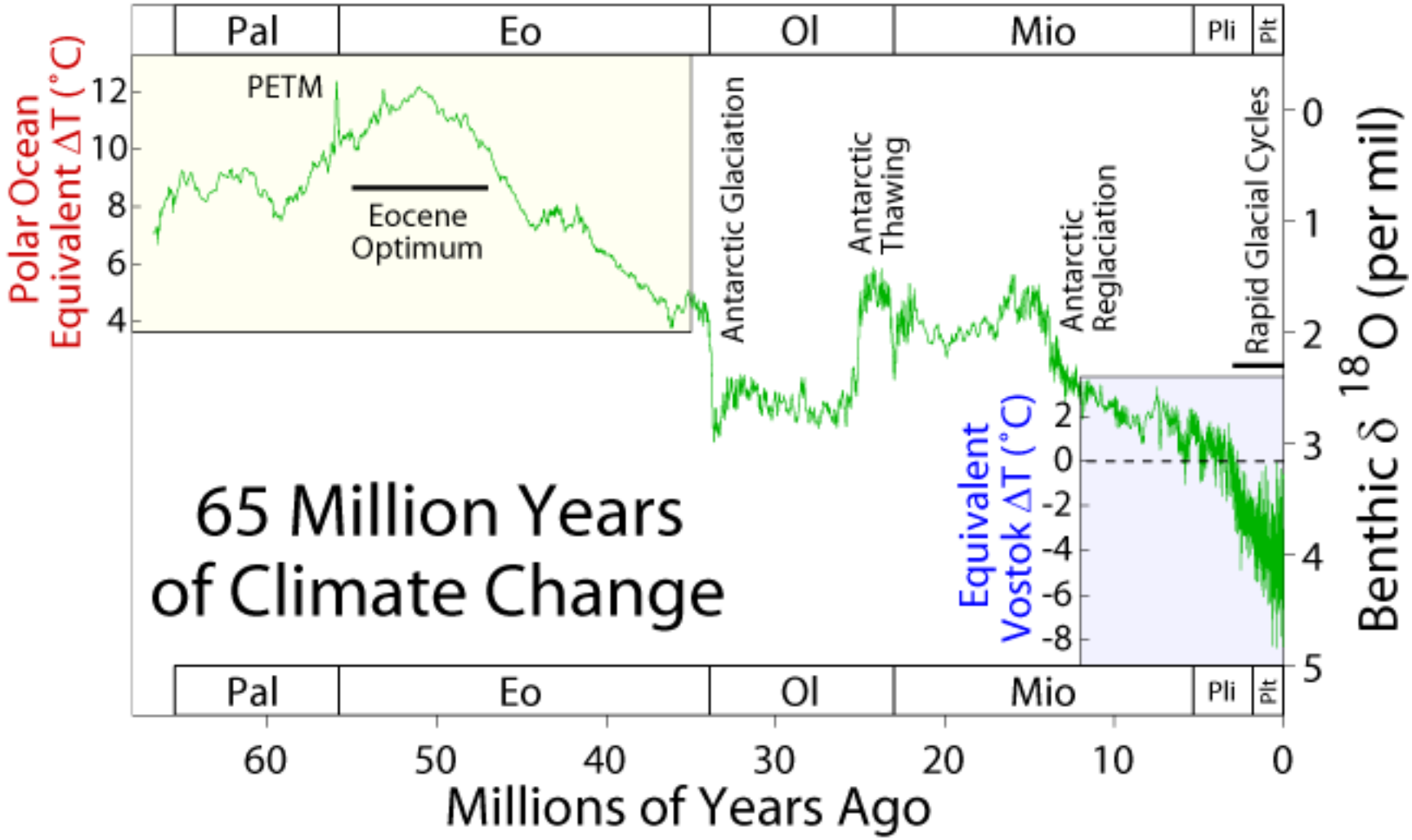
We don't know. To get a better perspective we must zoom out more:

- **150 years ago:** Industrial Revolution, human-caused warming.
- **1,500 years ago:** widespread empires.
- **15,000 years ago:** tail end of the last Ice Age, first agriculture.
- **150,000 years ago:** tail end of the *previous* Ice Age.
- **1,500,000 years ago:** beginning of serious Ice Ages, first firemaking by humans.
- **15,000,000 years ago:** cooling of climate well underway; apes have split off from other monkeys.

... and look at climate change!


~5°C
1000
0
~5°C
150
0
~5°C
16
0
~1°C
0.15
0
Age (ka)

Only by zooming out further do we see the full story:



65 million years ago, an asteroid 10 km (6 miles) across slammed into the Yucatan:

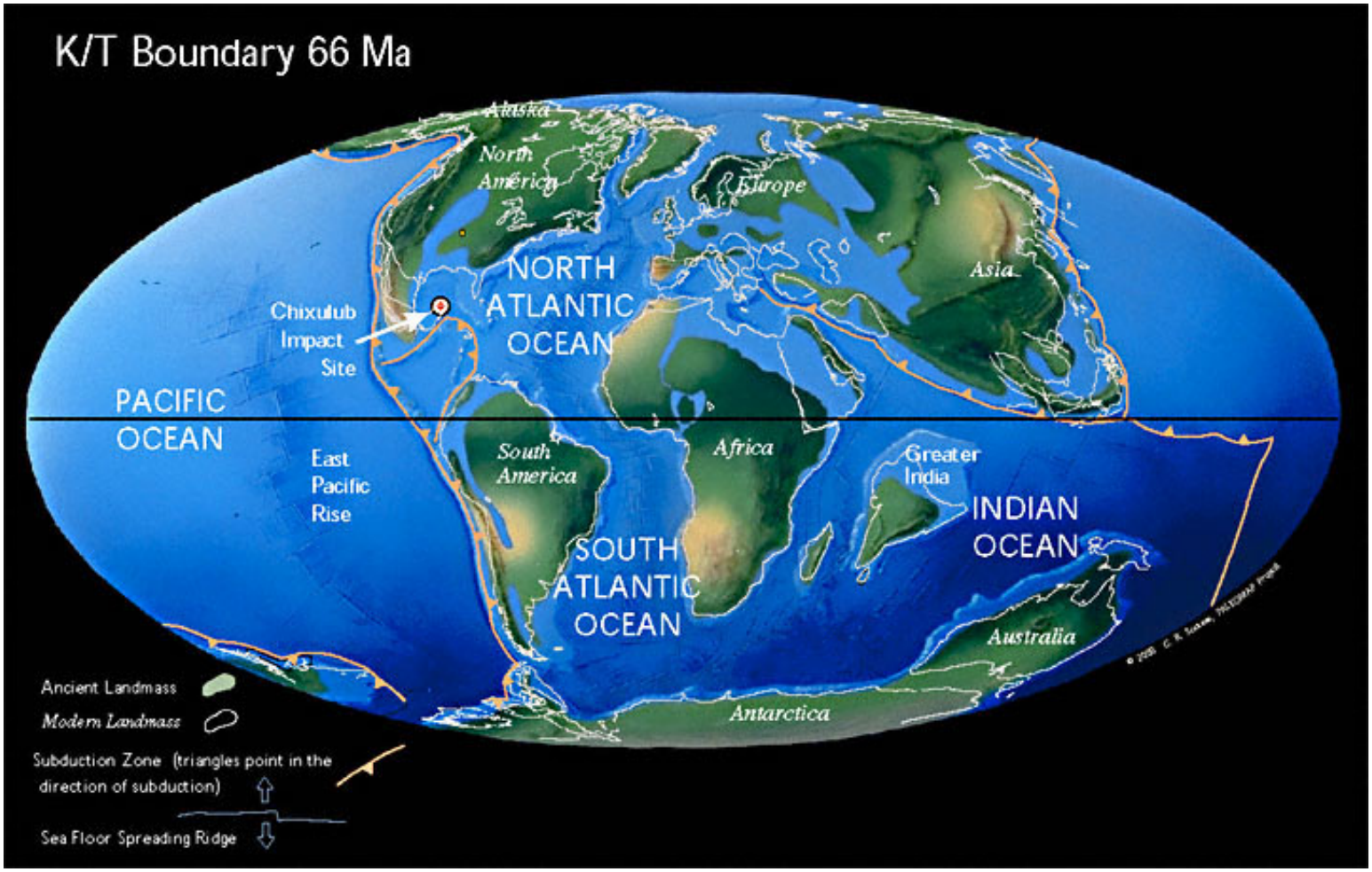
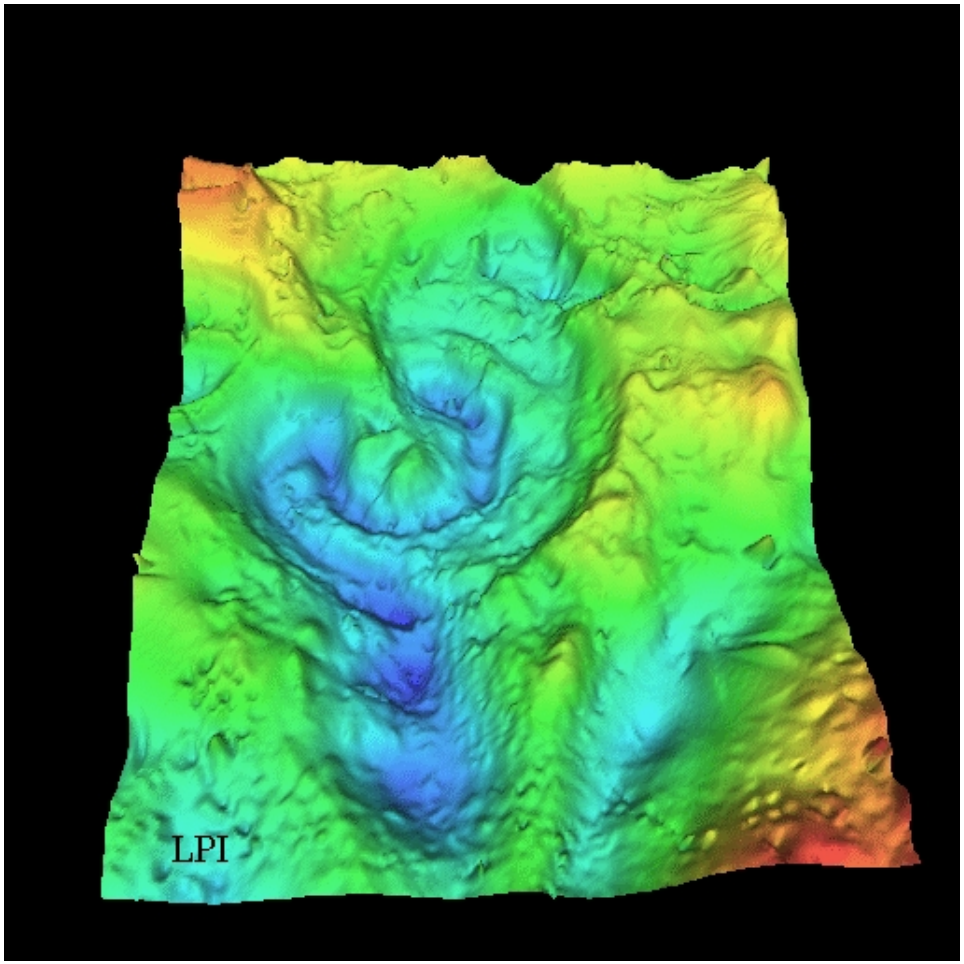


Plate tectonic maps by C. R. Scotese, PALEOMAP Project, www.scotese.com

Millions of tons of rock were thrown into the atmosphere, with molten quartz setting wildfires around the globe:

Donald E. Davis, NASA

It became too dark for plants to grow, and the dinosaurs died.

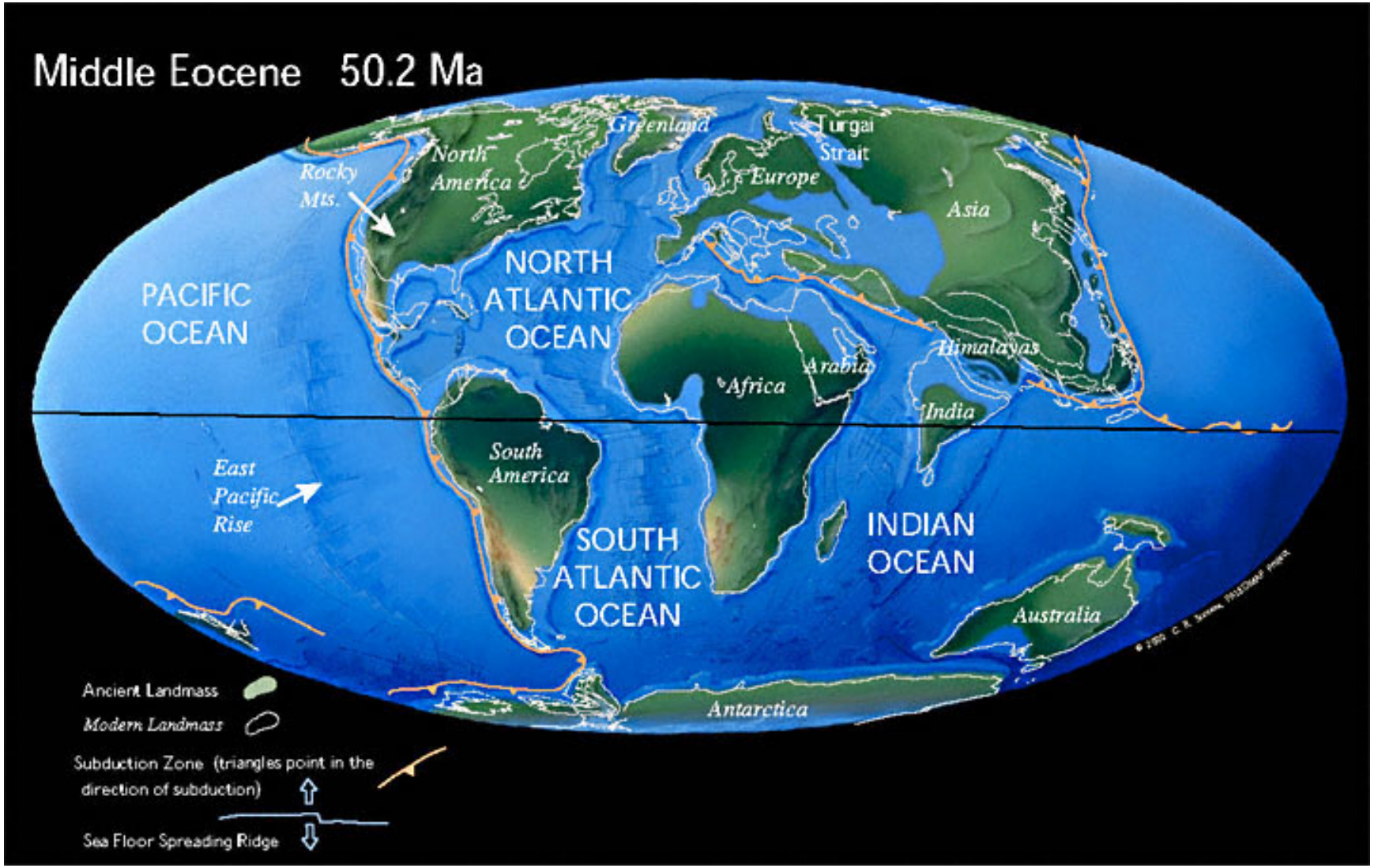


Chicxulub crater - V. L. Sharpton, LPI

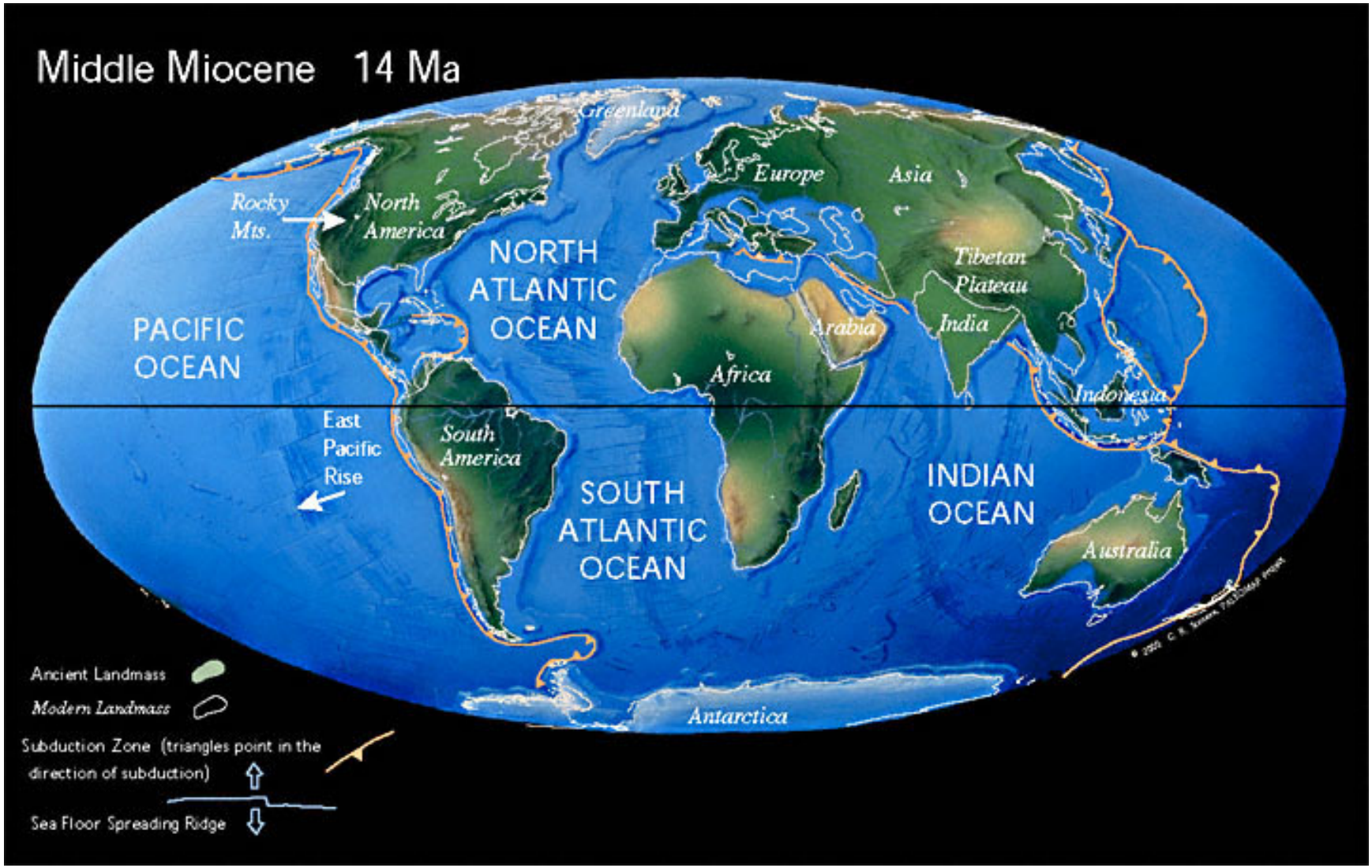
Afterwards, the biggest predators were 8-foot-tall ‘terror cranes’:

John Sibbick

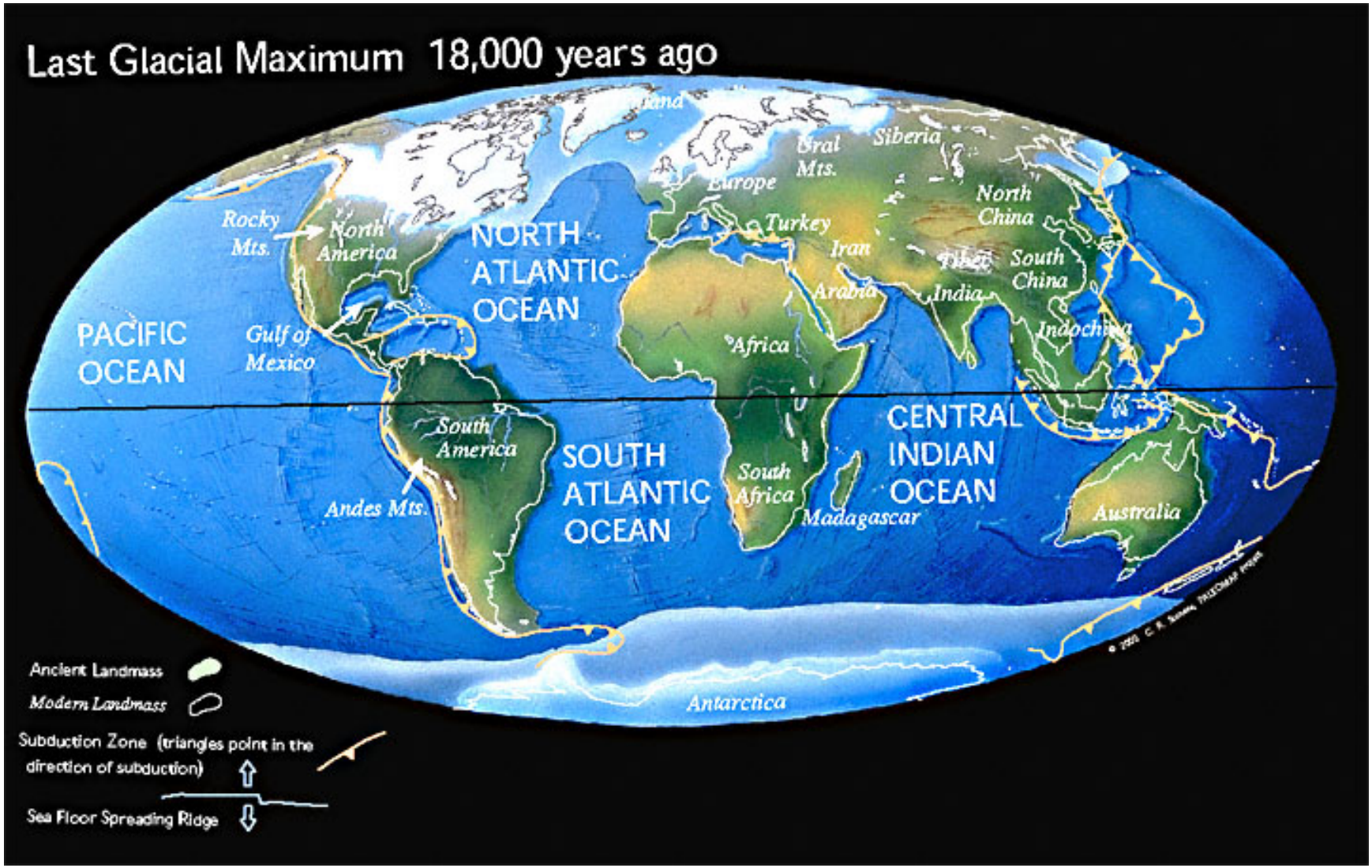
After 15 million years of warming, Antarctica separated from other land, and the Earth cooled:



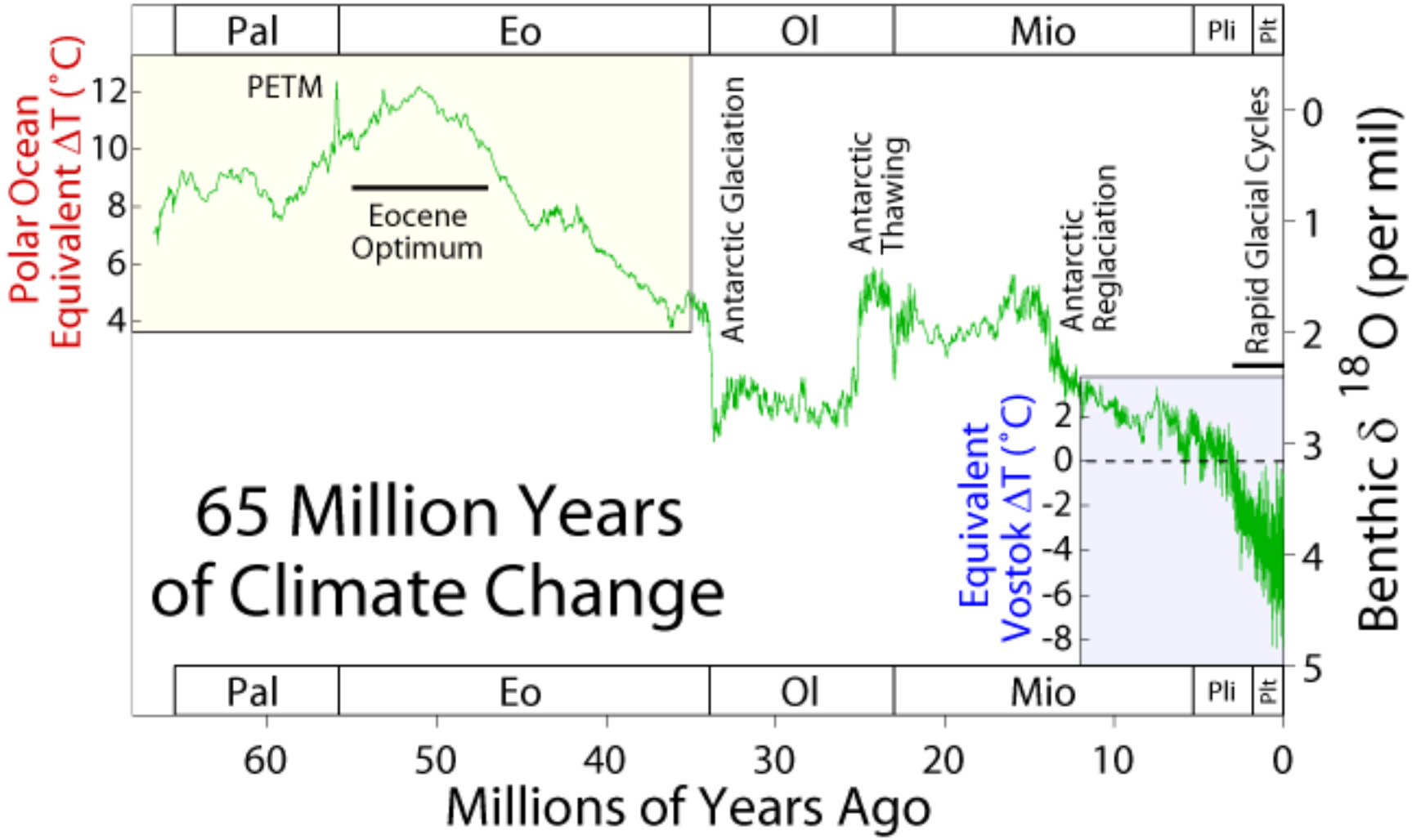
Eventually Antarctica froze over:



and serious Ice Ages began:

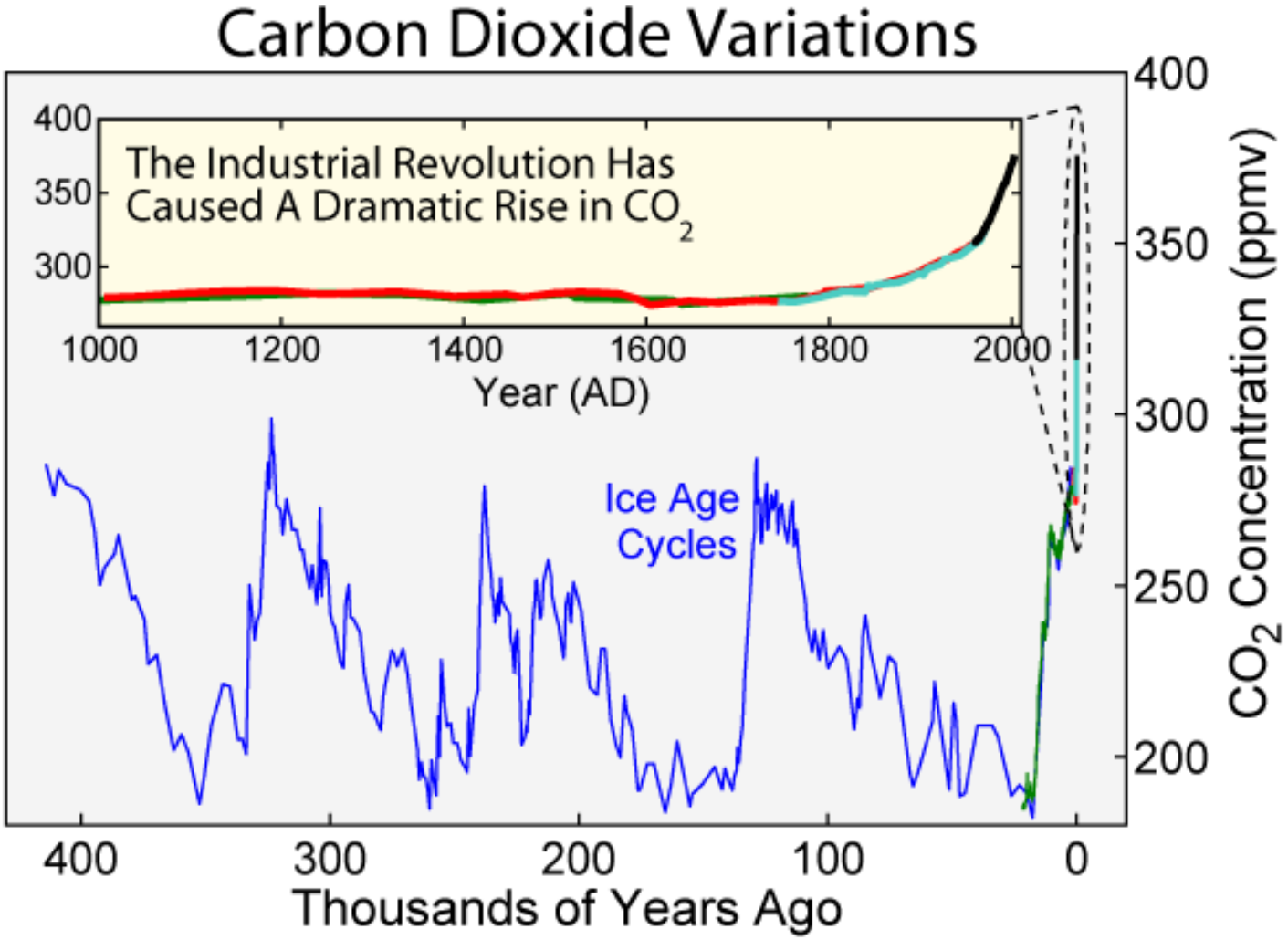


Now it's cold. What's wrong with a little warming?



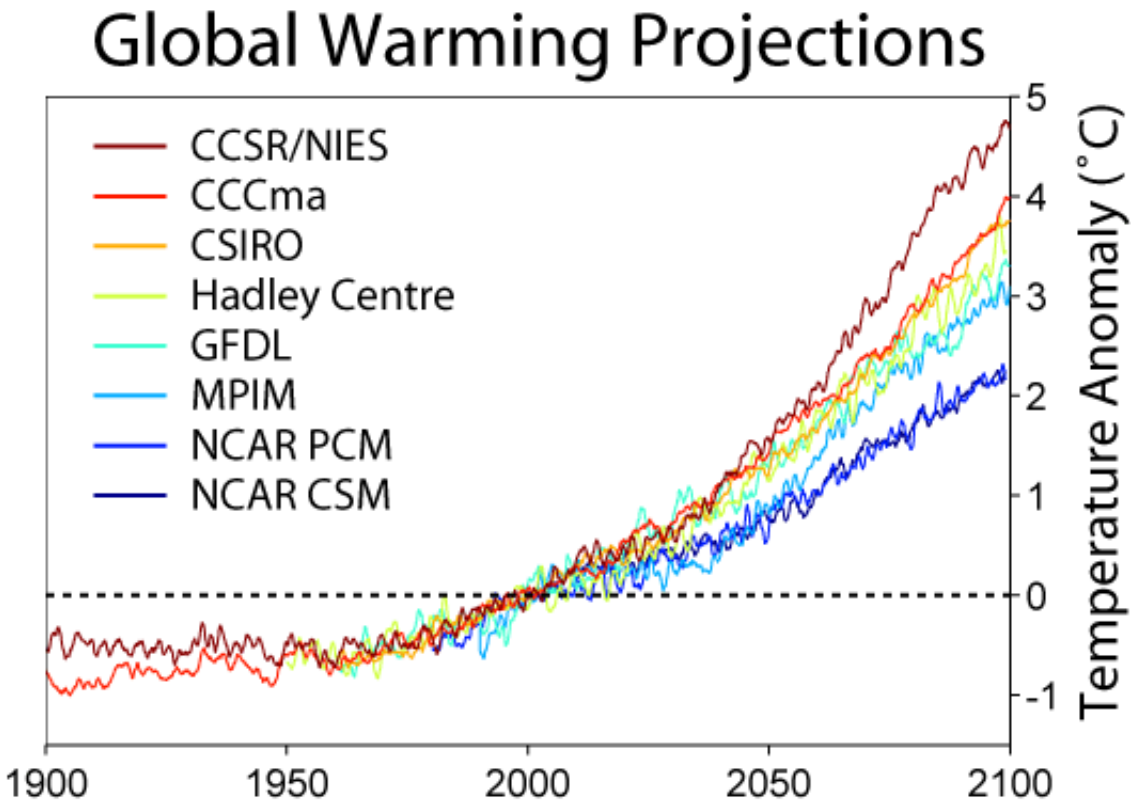
Global Warming Art

The problem is: *it's happening too fast!*



Global Warming Art

Species have been migrating north at 6 kilometers per decade since 1950. *They can't keep up:* since 1975, climate zones have been moving north at 4 kilometers per *year!*



Global Warming Art

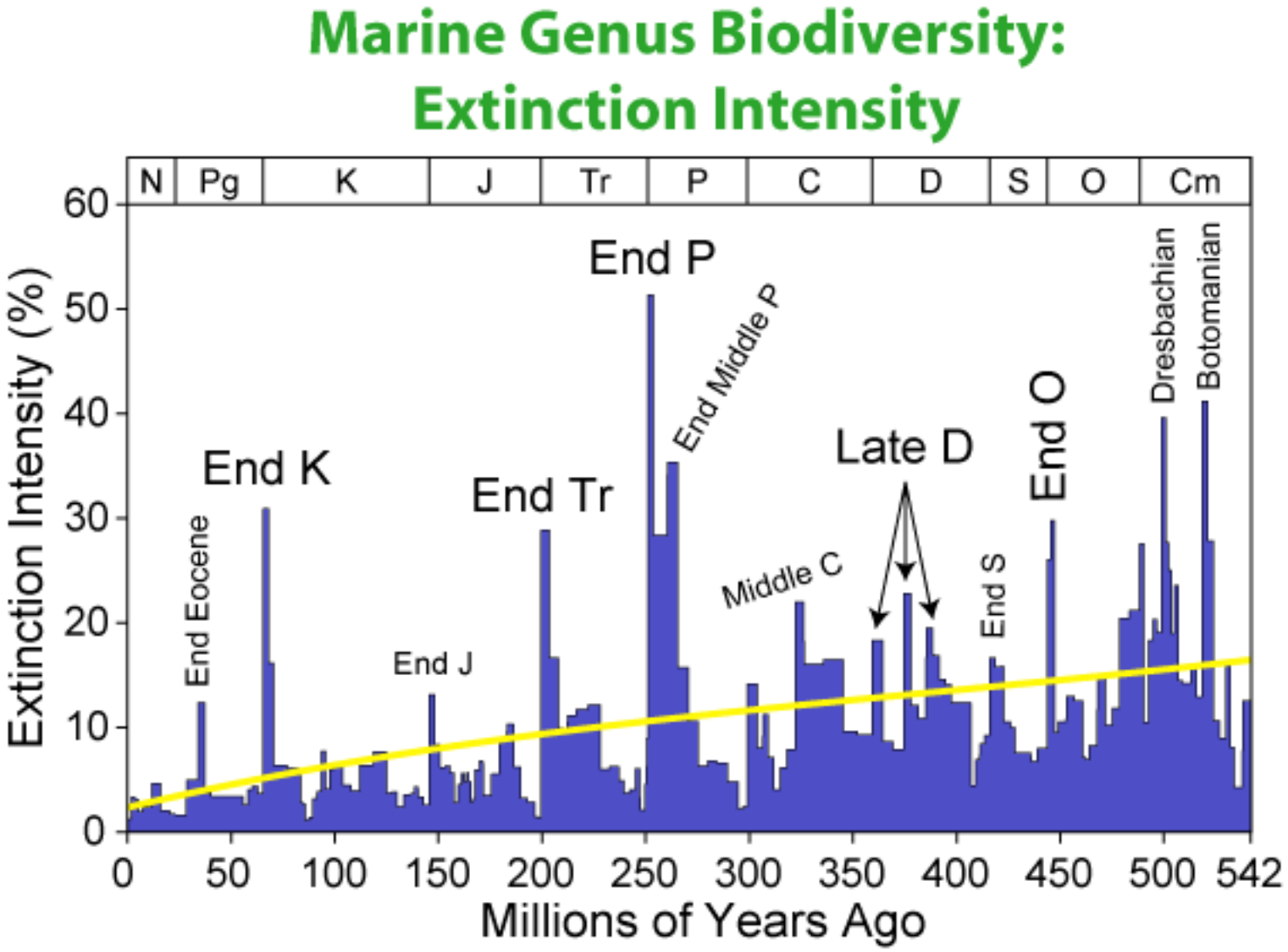
We may be entering a new geological era: the *Anthropocene*.

We just passed the temperature record set 120,000 years ago, before the last Ice Age.

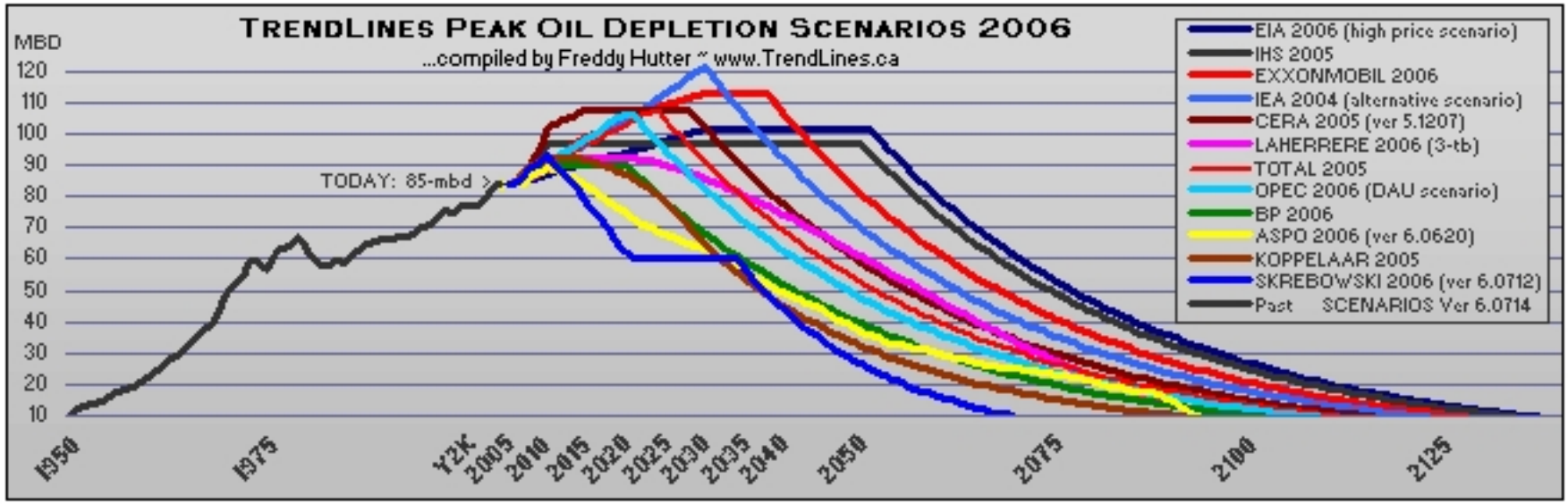
Just 1°C more, and the Earth will be hottest it's been in 1.35 million years – when the Ice Ages began. We can expect this by 2050. By then, we may see the death of 15-37% of all species.

For comparable situations, we must zoom out more...

... to the Mass Extinction Events.



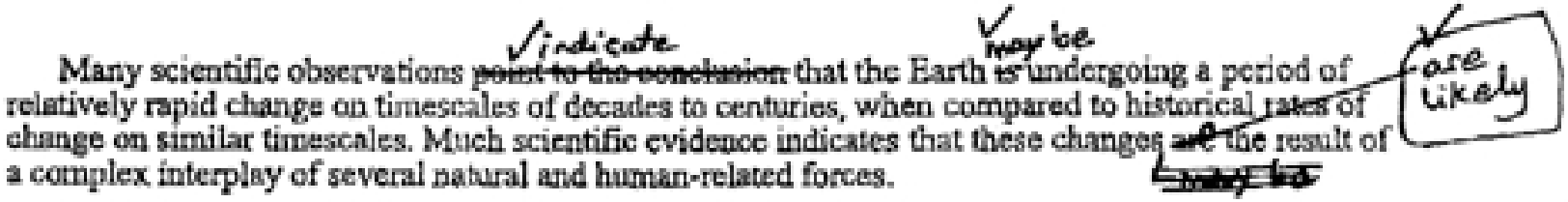
‘Luckily’, we’ll run out of oil in about a century:



But, there's much more left to burn:

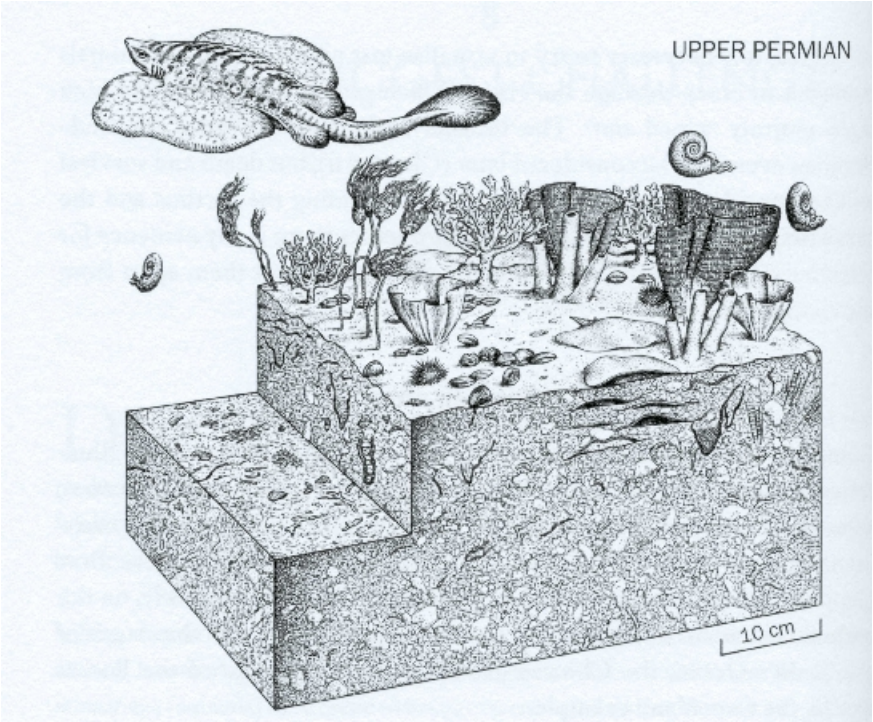
- Oil: 3 trillion barrels
- Natural gas: 1.1 trillion barrels
- Coal: 4.5 trillion barrels
- Tar sands: 4.3 trillion barrels
- Methane hydrates: 72,000 trillion barrels

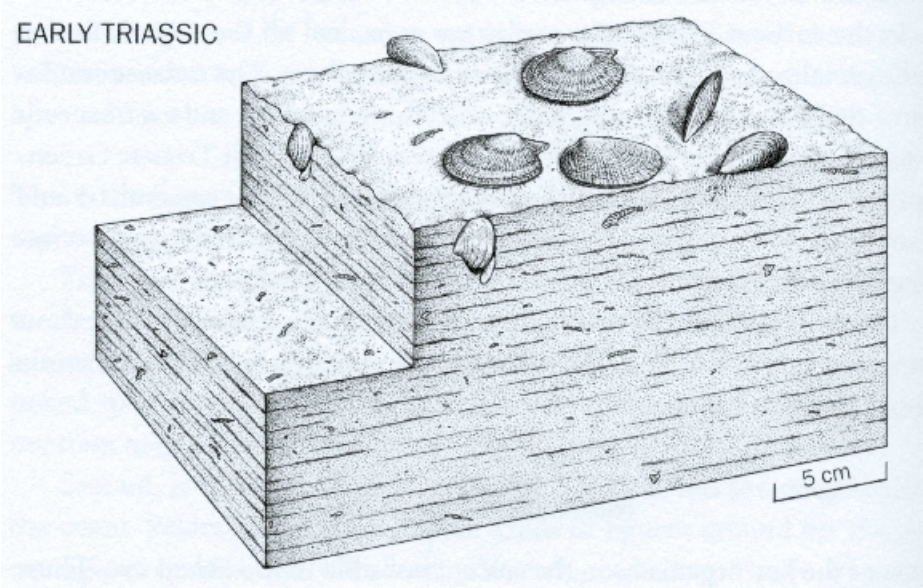
Can we resist burning it all?


Many scientific observations ~~point to the conclusion~~ indicate that the Earth is may be undergoing a period of relatively rapid change on timescales of decades to centuries, when compared to historical ~~rates~~ of change on similar timescales. Much scientific evidence indicates that these changes ~~are~~ may be the result of a complex interplay of several natural and human-related forces.
are likely

Notes by Philip Cooney, then chief of staff of the White House Council on Environmental Quality – now working for Exxon

In the long run, everything is okay.
A Mass Extinction Event is a sad thing...

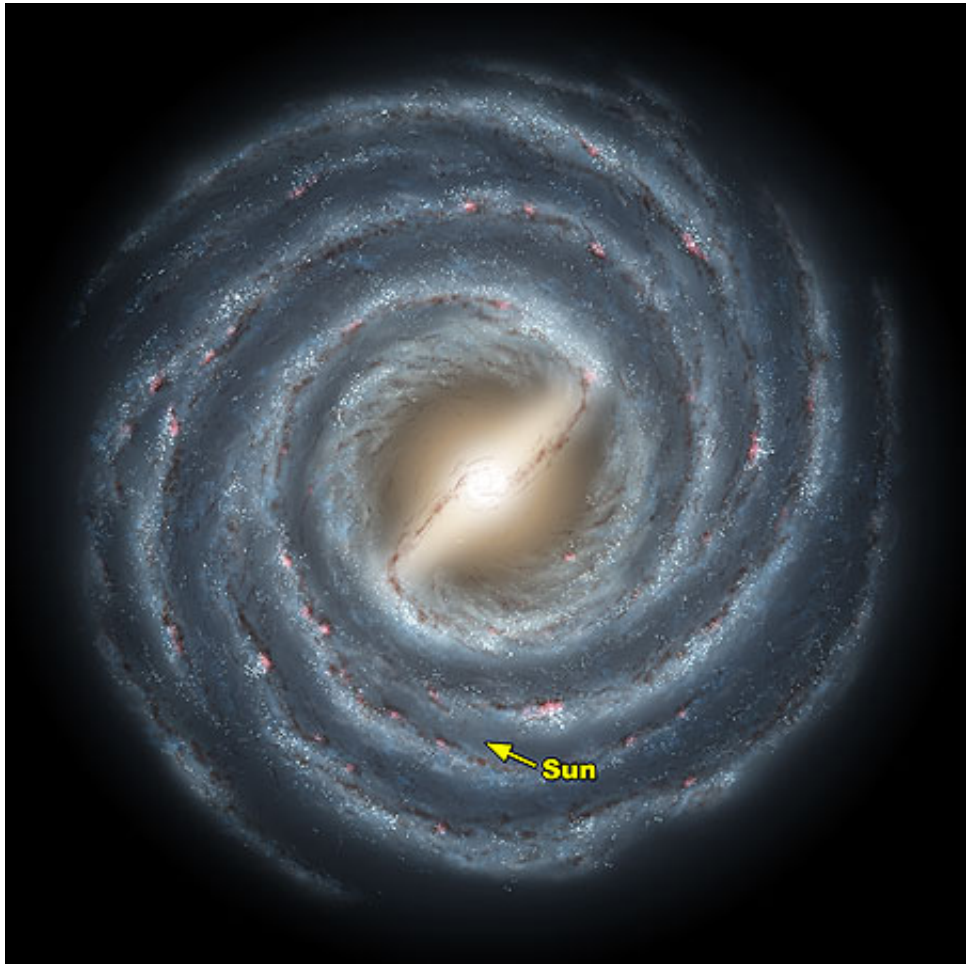




Michael Benton - *When Life Nearly Died*

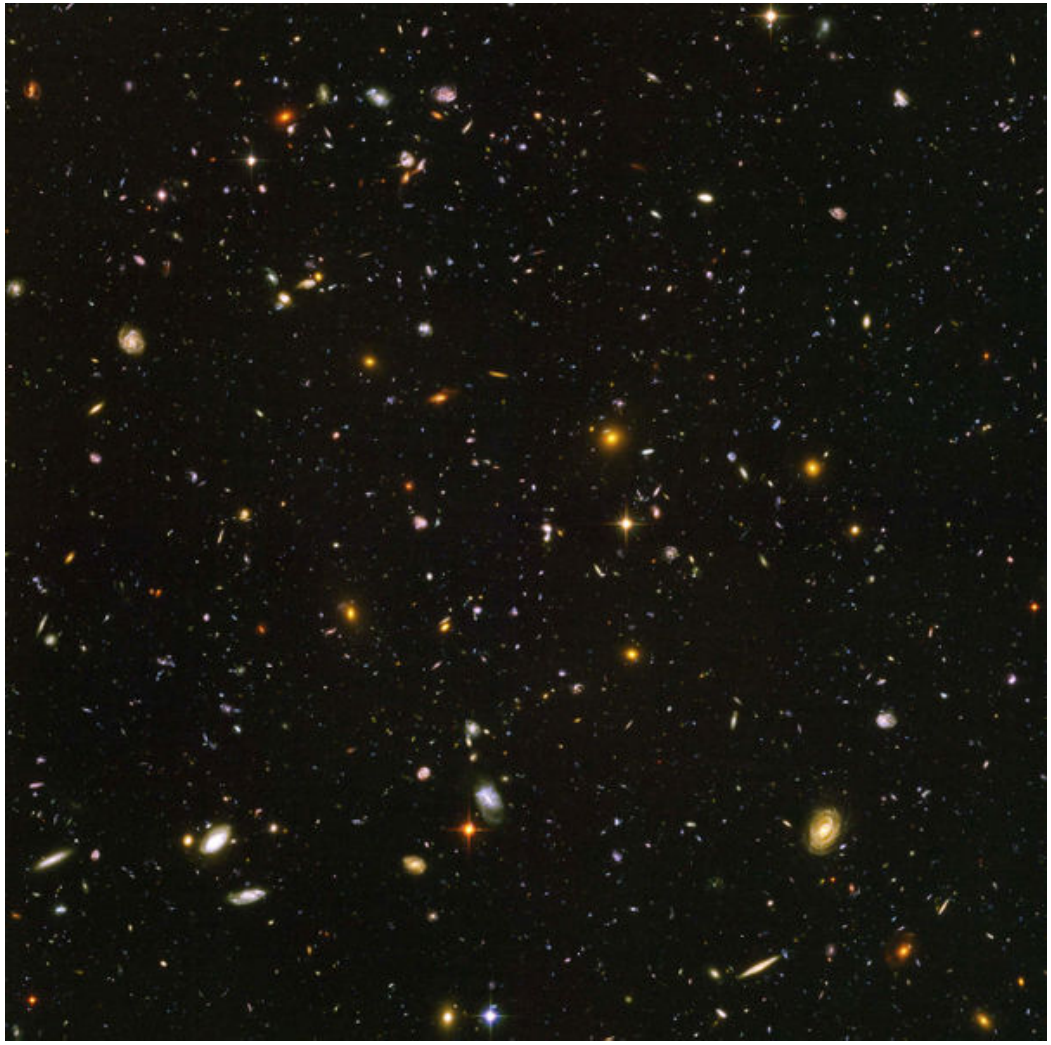
...but life has a way of bouncing back, new and strange.

We're unlikely to kill off life on Earth.
Even if we do, there are 100 billion stars in our Galaxy:



NASA

and 10 billion galaxies in the observable Universe:



NASA

for a total of roughly

$$10^{21} = 1,000,000,000,000,000,000,000 \text{ stars.}$$

So, if we screw up, it's no big deal... except for us!

Christoph Hoffman

Can we 'zoom out' in time?