ZOOMING OUT
IN TIME

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All around we see hastening change:

Robert Fogel - *The Escape from Hunger and Premature Death, 1700-2100*
So far it relies on *burning carbon*:
So, the greenhouse effect is kicking in:
To understand what’s happening, we must *zoom out*:

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:

It lasted for about 1000 years, then suddenly ended!
Why? Some say the Gulf Stream warms Europe:

Union of Concerned Scientists
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:

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!
Barry Saltzman - Dynamical Paleoclimatology
Only by zooming out further do we see the full story:

Global Warming Art
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:
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?
The problem is: *it’s happening too fast!*

![Graph showing Carbon Dioxide Variations](#)

*The Industrial Revolution Has Caused A Dramatic Rise in CO₂*

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

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

Michael Benton - *When Life Nearly Died*
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:
for a total of roughly

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

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

Can we ‘zoom out’ in time?