Energy, the Environment, and What Mathematicians Can Do

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http://math.ucr.edu/home/baez/what/

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Universiti Putra Malaysia

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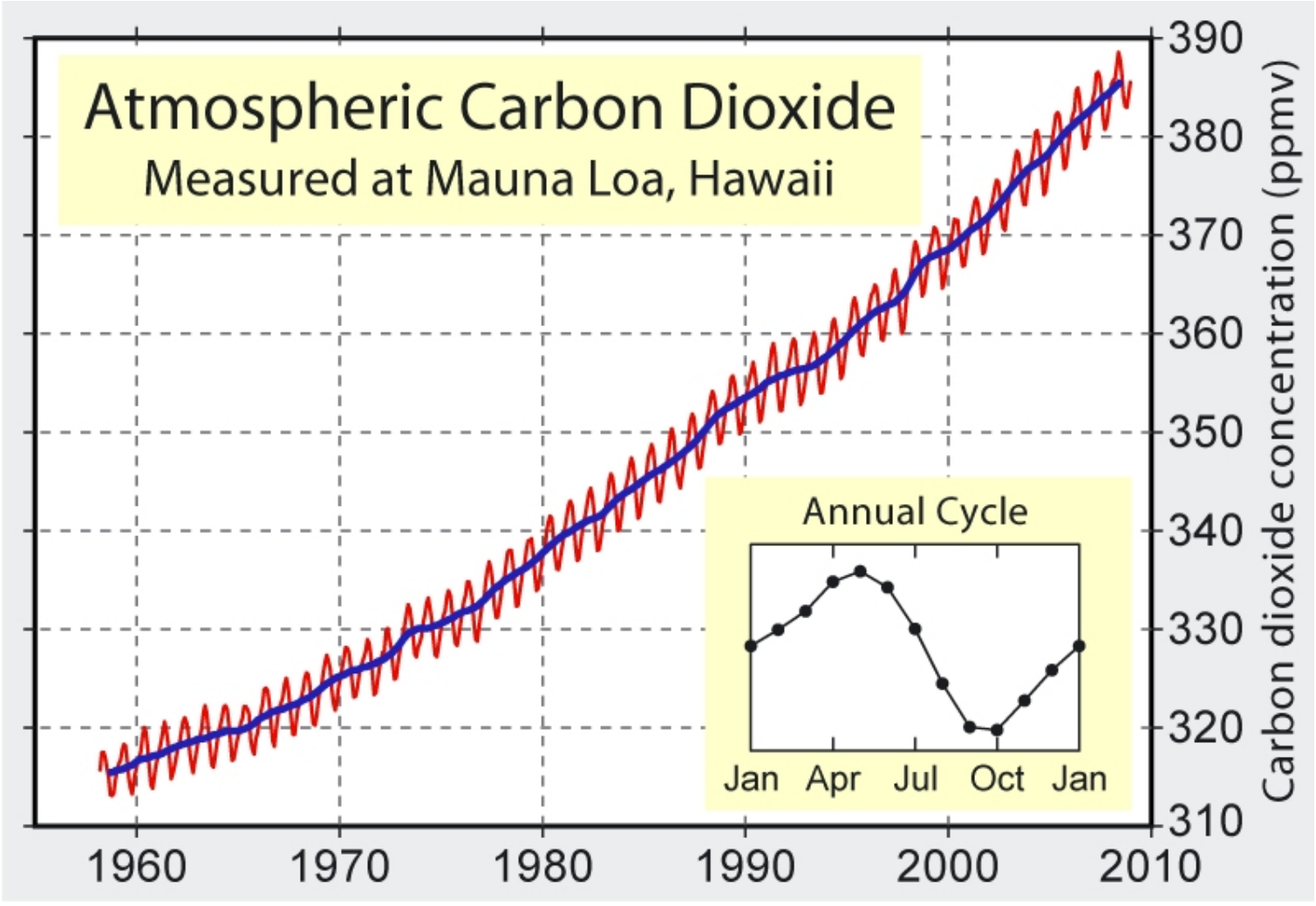
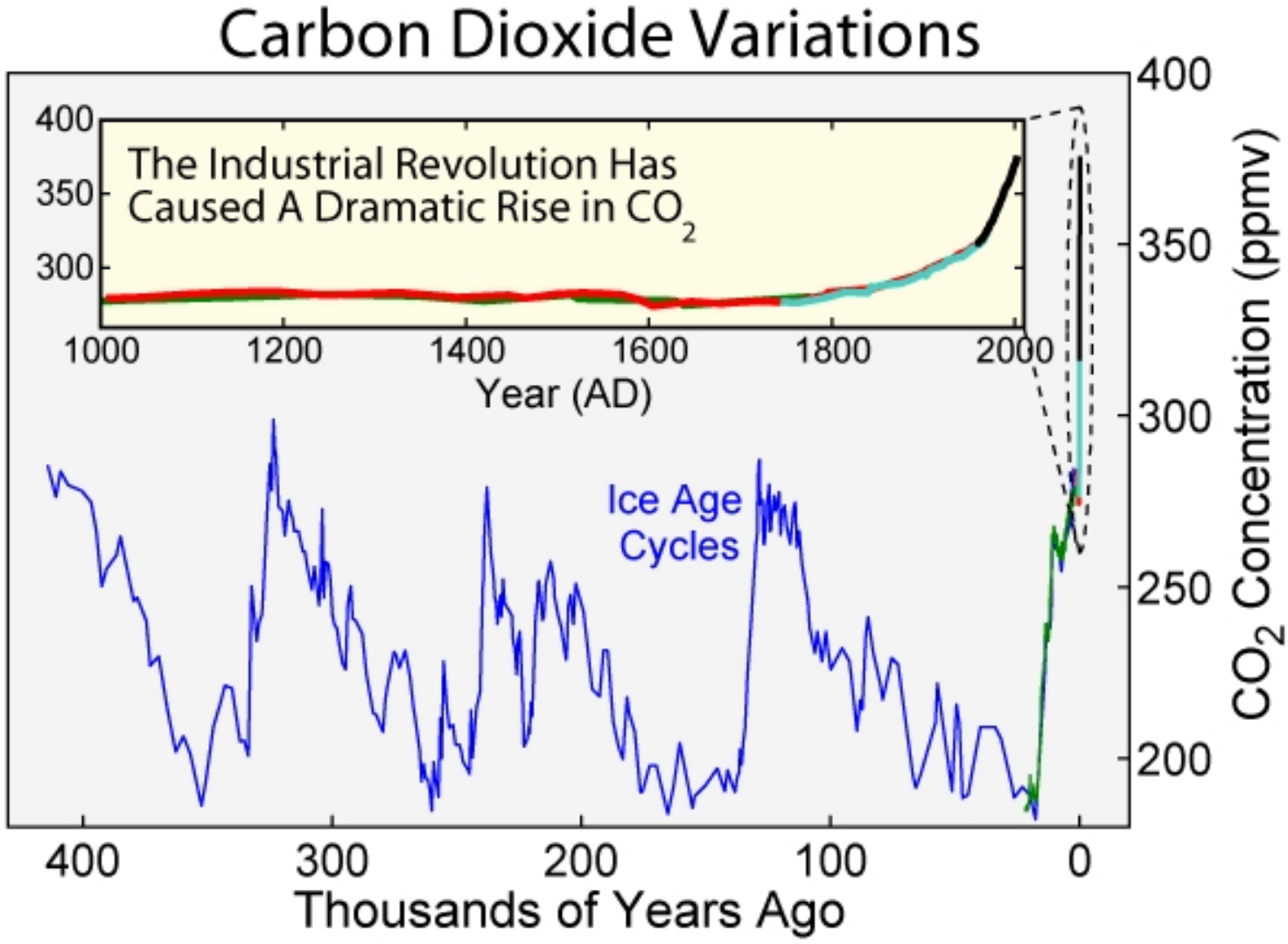
Worldwide, we burnt 8.15 gigatonnes of carbon in 2008.

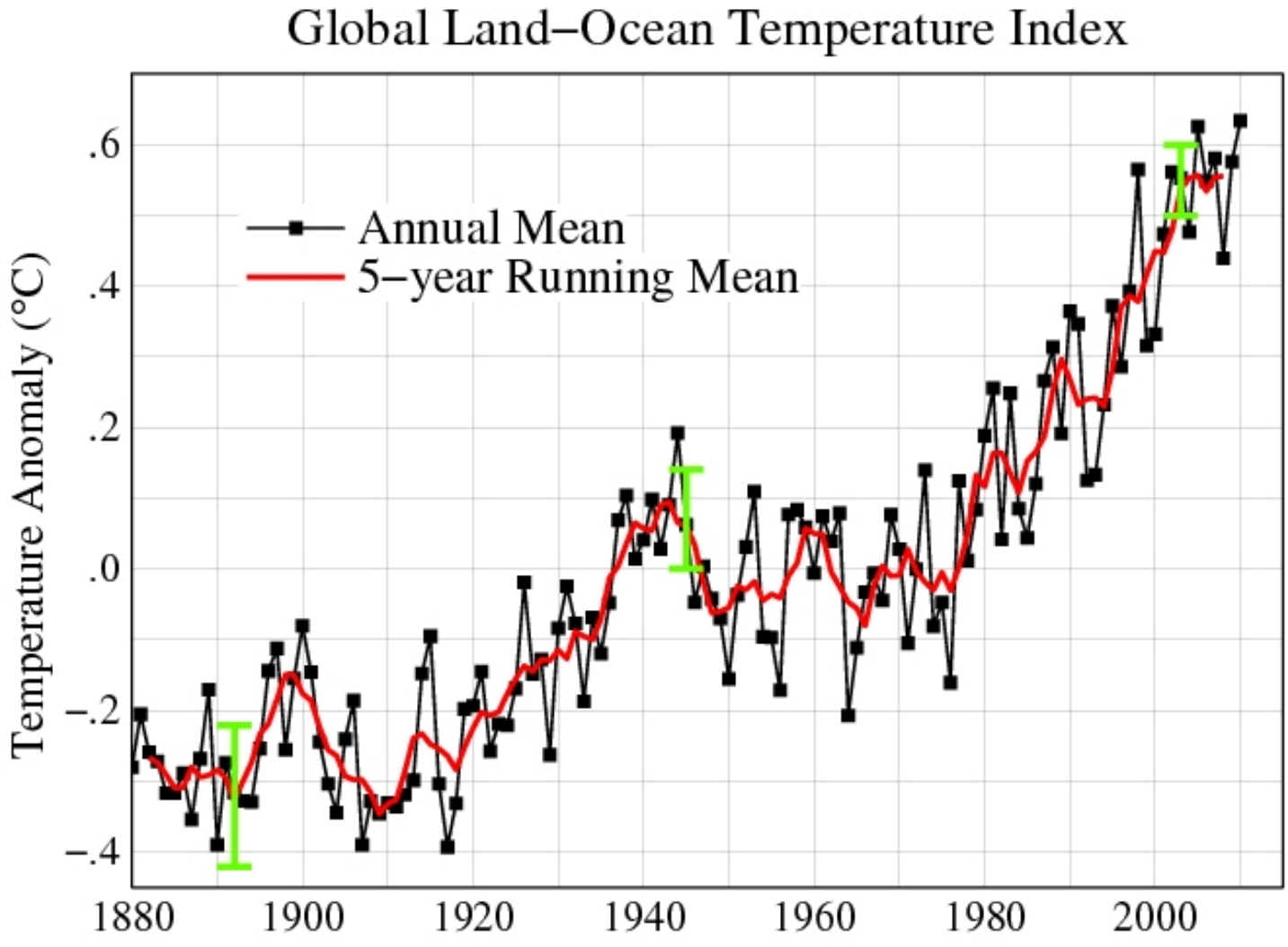
So, the amount of carbon dioxide in the air is soaring:



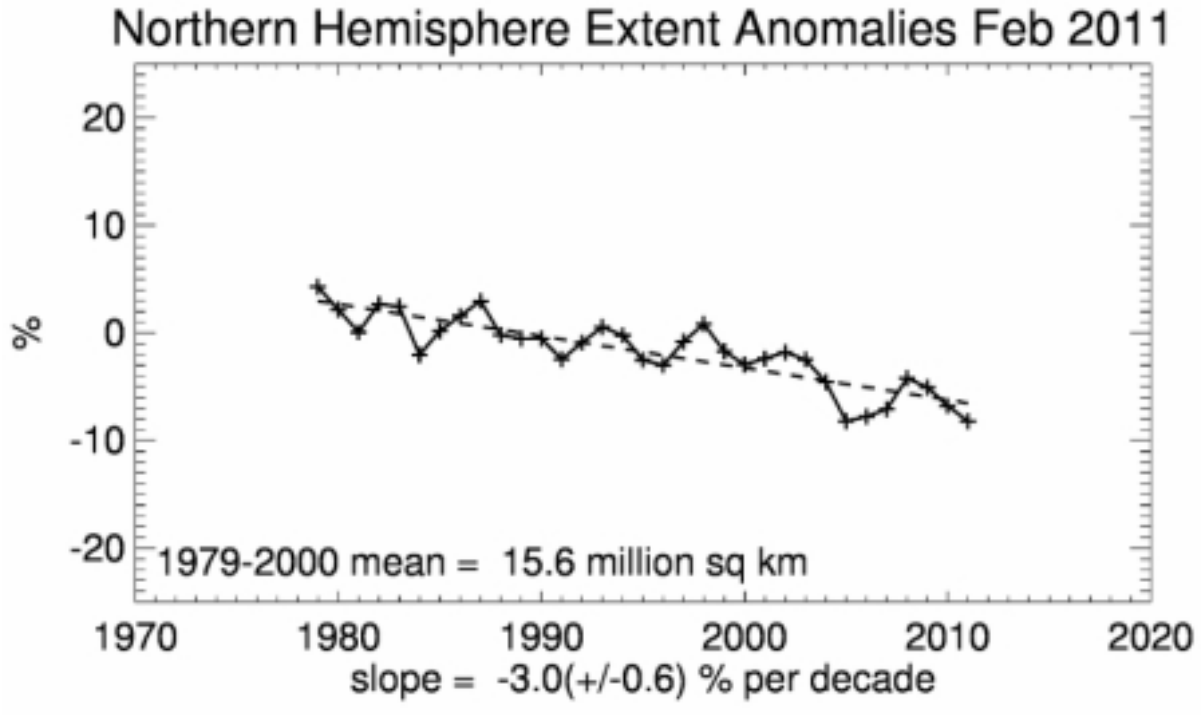
To understand just how much, we need to take the long view:



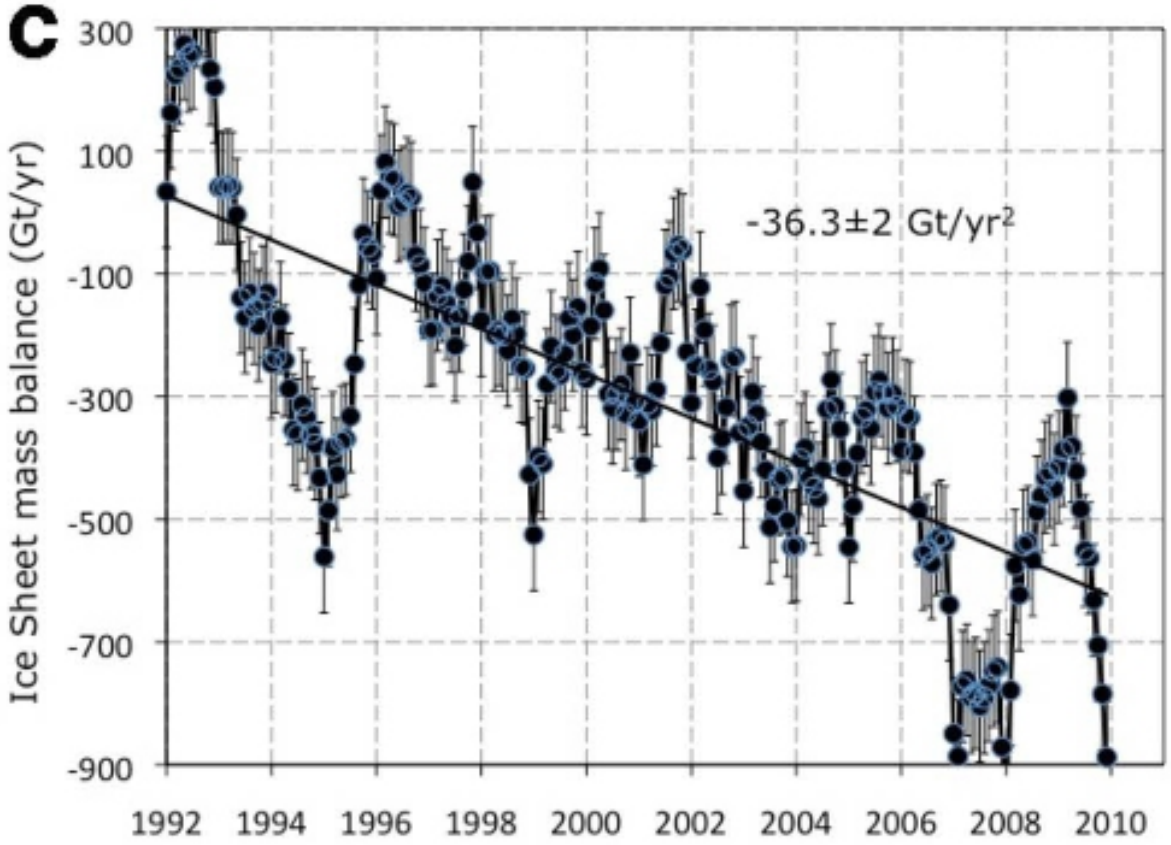
As you'd expect, the temperatures have gone up — about 0.8°C since 1880:



Arctic sea ice is shrinking in extent:



According to Rignot *et al*, the melting of Antarctica and Greenland is accelerating:



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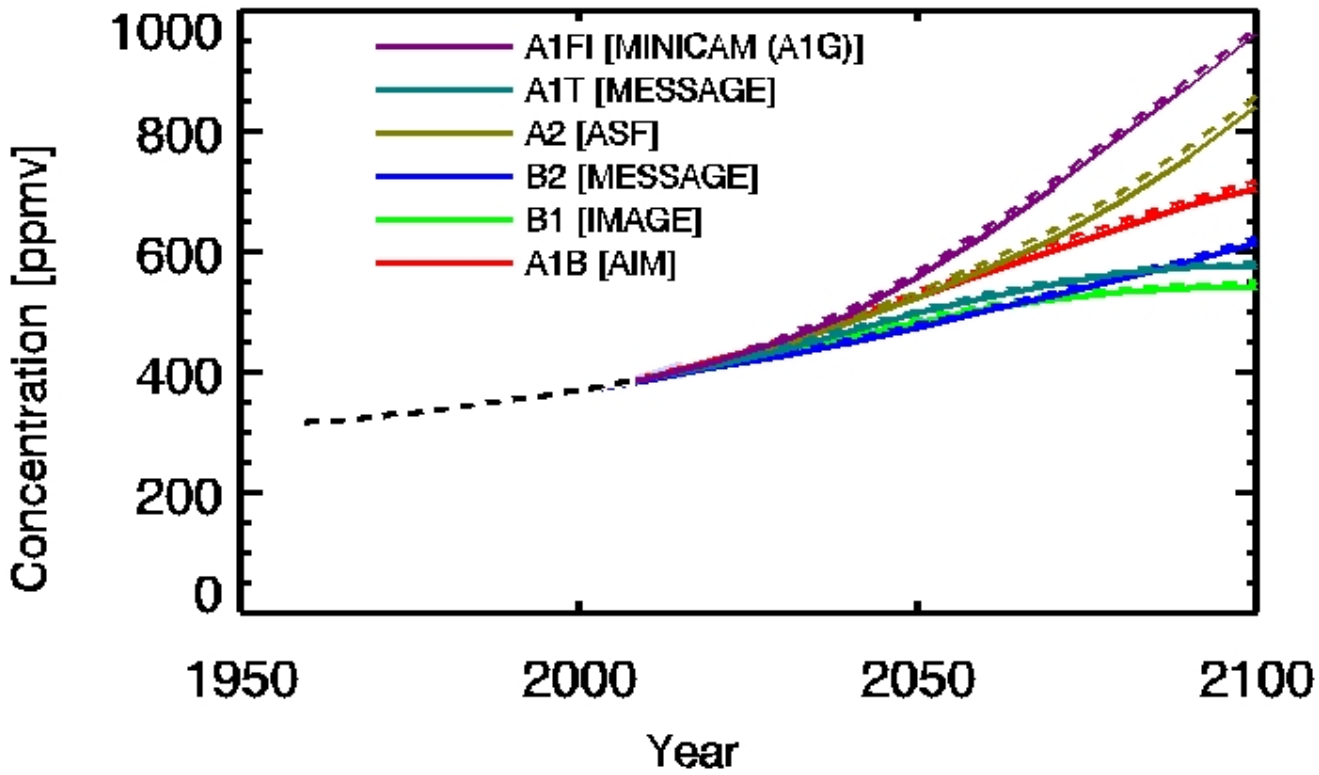
Before the industrial revolution, the CO_2 concentration was 290 parts per million. Now it's 390. What next?



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This could cause temperatures roughly $2.4 - 6.4°C$ higher than today.

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- Rainfall in some dry regions will drop by 15-30%

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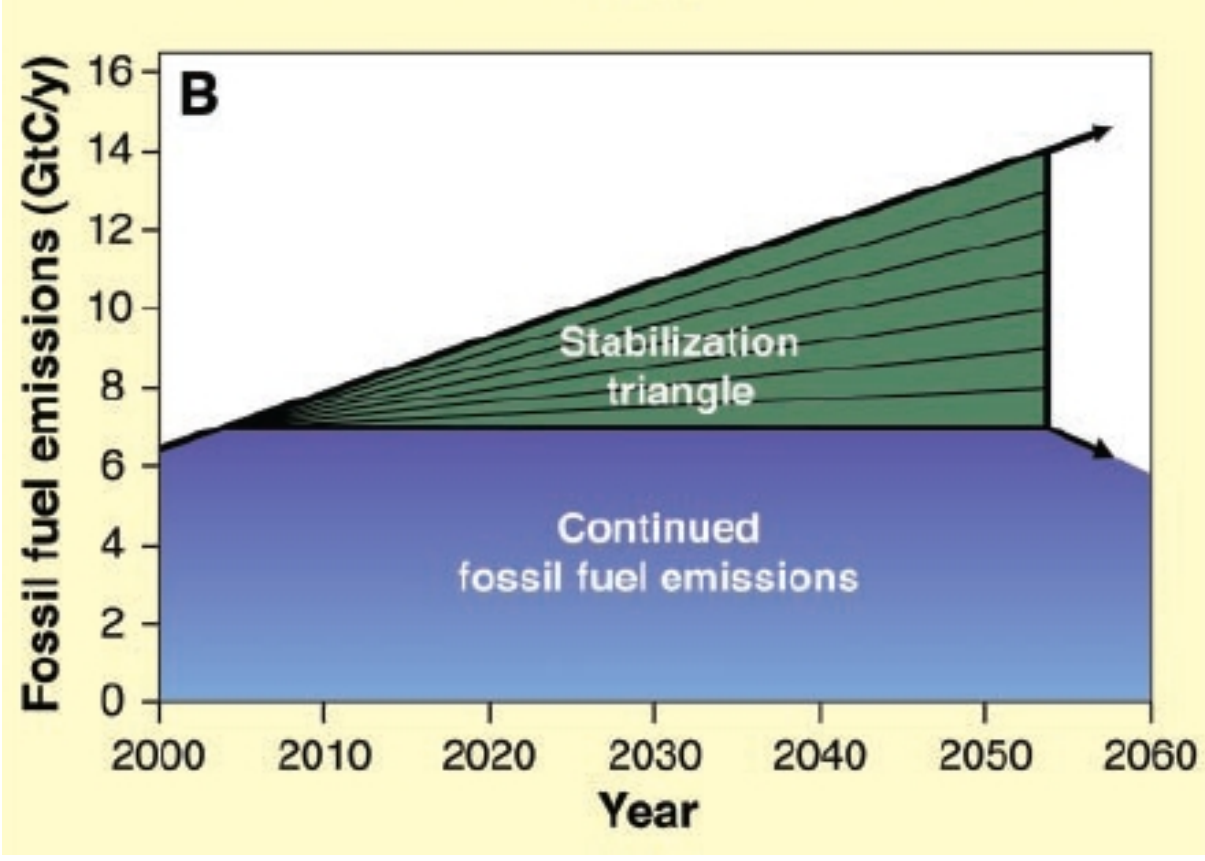
And it's not just people in trouble: species are already moving 6 kilometers closer to the poles each decade. The rate of extinction will increase.

What can we do? Slowing the rate of carbon burning is not enough: most CO_2 stays in the air a *very long time*, though individual molecules come and go. We need to:

- leave fossil fuels unburnt,
- live with a hotter climate,
- sequester carbon, and/or
- actively cool the Earth.

In 2004, Pacala and Socolow looked for ways to hold carbon emissions constant until 2054 — *not a solution, just a start!*



They said it would require 7 ‘wedges’. Each wedge is a way to reduce carbon emissions by 1 gigatonne/year by 2054.

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Conservation/efficiency: Cut carbon emissions by 25% in buildings and appliances.

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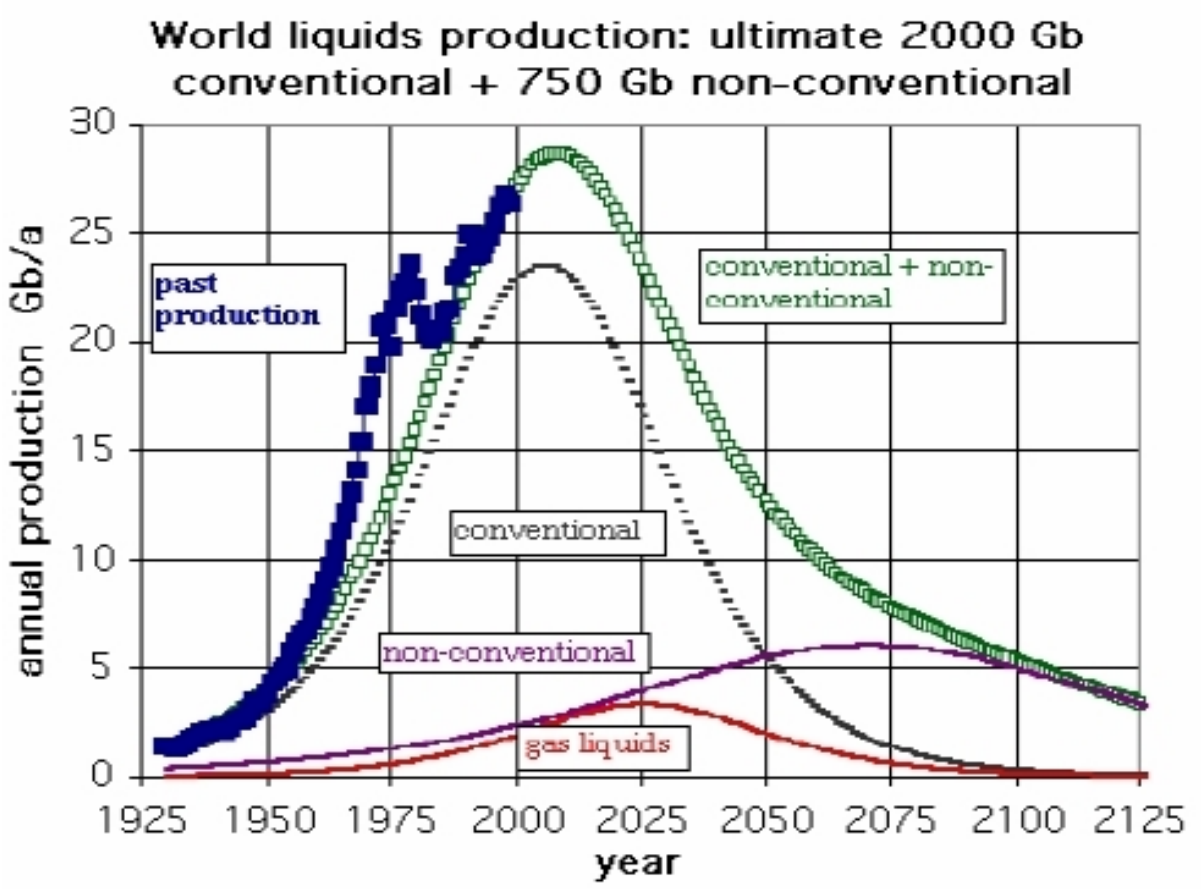
The floods in Pakistan covered 800,000 square kilometers, affecting 20 million people. Suppose events like this become more common. How many will it take before we:
1) decide global warming is to blame and
2) decide to do something very difficult to stop it?

If we wait 20 years, weather disasters and crop failures will combine with *declining oil supplies* to make us change our ways:



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But what can someone like me do? I'm not a politician, an inventor, or a climate scientist.

I'm just a mathematician!

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But I've cut back immensely... and I'm happier.

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It seems unthinkable... just like every other new thing we ever did.

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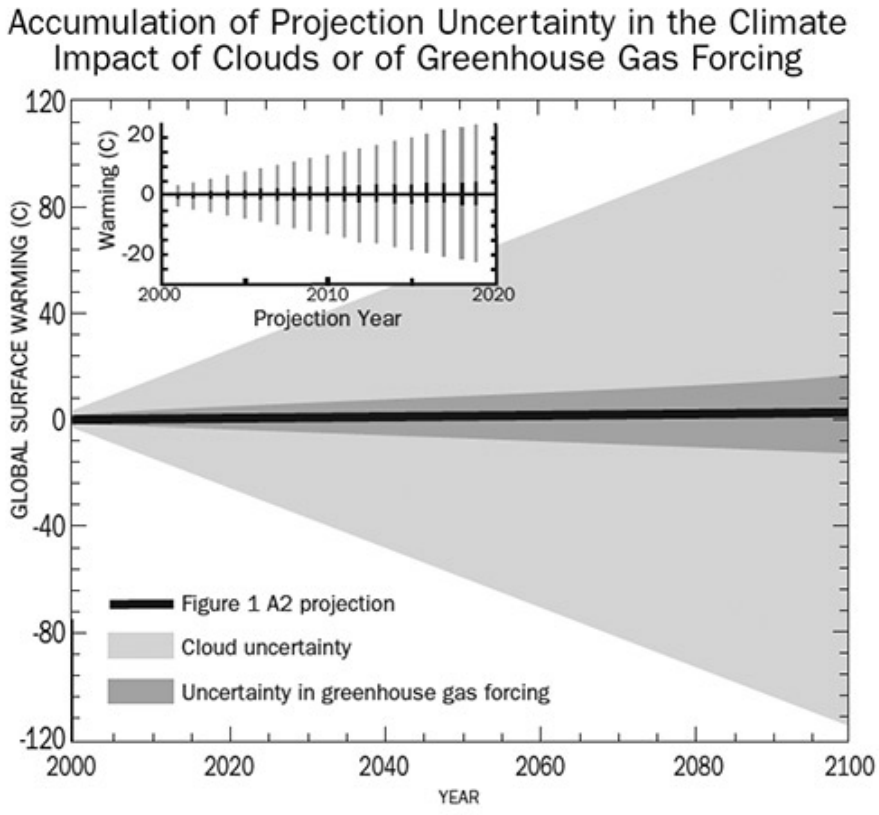
Innumeracy and illogic can be found on both sides of almost every argument about climate change and energy policy. I will unfairly single out one example!

Patrick Frank, in *Skeptic Magazine*, said: uncertainty in estimates of cloud cover causes a 1.1°C uncertainty *per year* in temperature predictions. So:

> *"By 50 years, the uncertainty in projected temperature is* $\pm 55°$*. At 100 years, the accumulated physical cloud uncertainty in temperature is* ± 111 *degrees."*




HUH??

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Climate cycles: what causes the ice ages? How important are changes in the Earth's' orbit, perhaps made stronger by stochastic resonance?

On the **Azimuth Wiki**, we are explaining the main environmental and energy problems the world faces today:

- Global warming - human caused climate change.
- Extinction - mass die-offs caused by global warming and habitat changes.
- Deforestation - loss of primary and secondary forests.
- Ocean acidification - rise in ocean acidity due to rising CO_2.
- Dead zones - large areas of the ocean that can't support life.
- Water crisis - the decline of aquifers and freshwater supplies.
- Peak oil - the decline in the availability of oil as an energy source.

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