Mathematical modelling of carbon capture

Tim Myers
Centre de Recerca Matematica
Barcelona

Global warming?

- **Definitions**

  Global warming: the increase in Earth's average surface temperature due to rising levels of greenhouse gases.

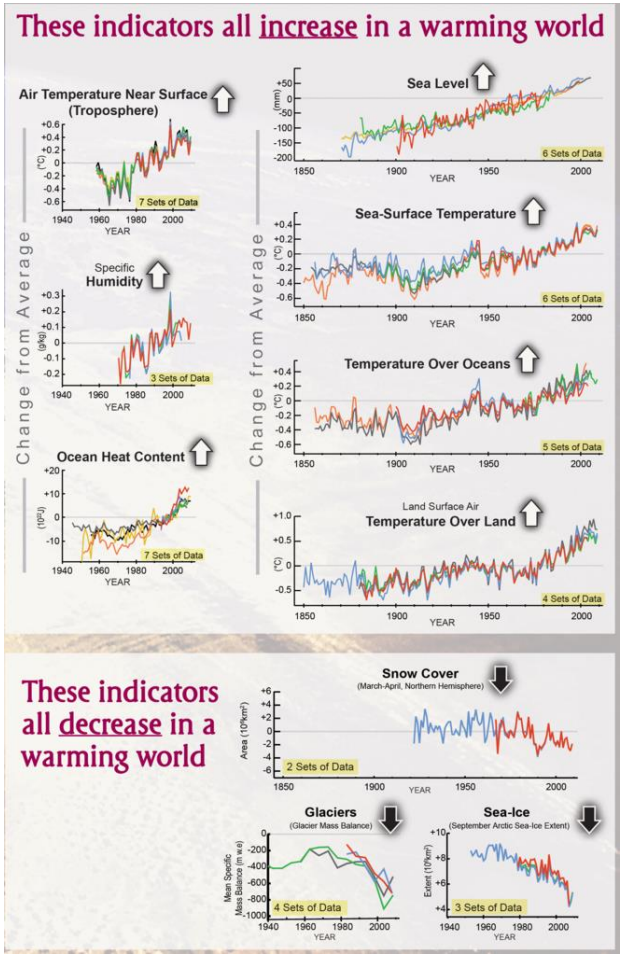
  Climate change: a long-term change in the Earth's climate, or of a region on Earth.

Before 1975 termed 'inadvertent climate modification': nobody knew what effect it would have.

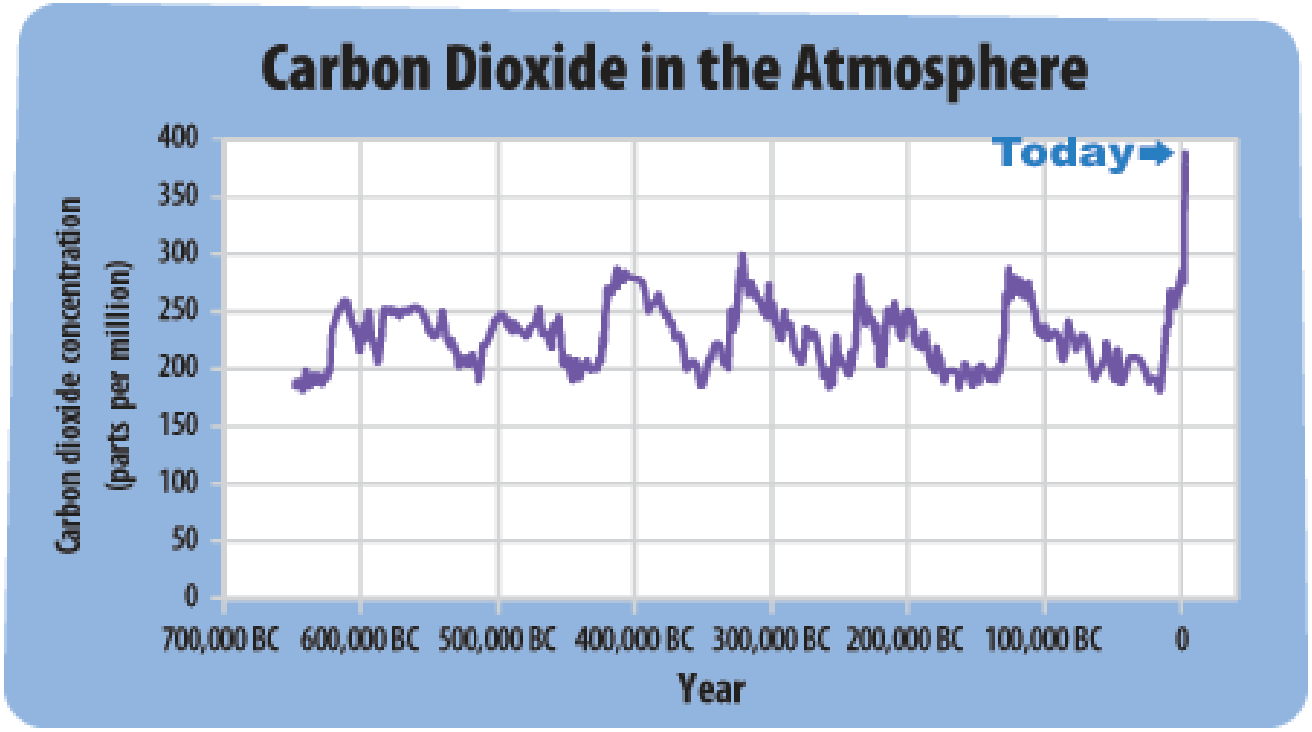
Really just adding energy to the system, which leads to more energetic events including global warming, but also increased likelihood of extreme events: more powerful storms; heat waves 1; flooding etc.

1. The mortality from extreme heat is larger than from hurricanes, lightning, tornadoes, floods and earthquakes together.

What does global warming do?



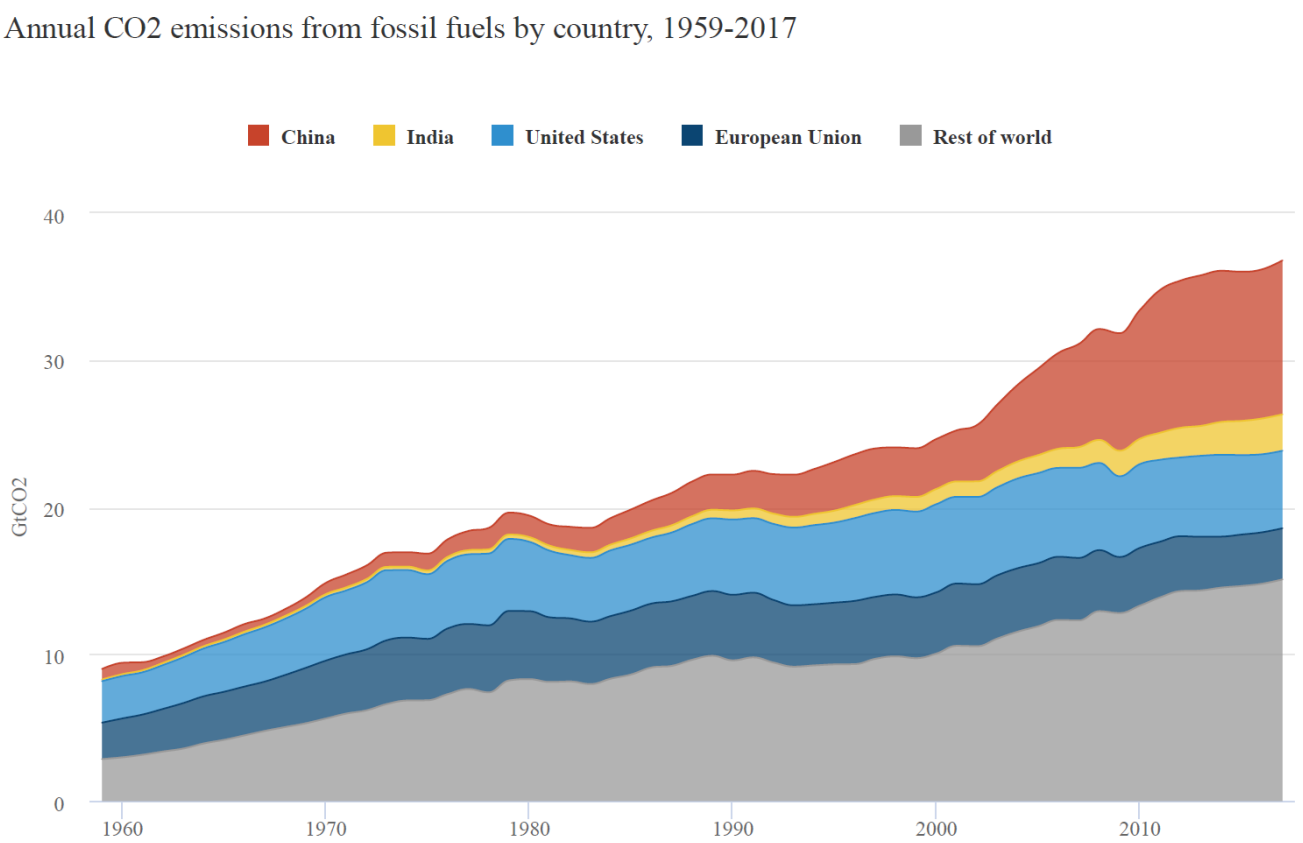
Why consider carbon capture?



Scientists can compare the amount of carbon dioxide in the atmosphere today with the amount of carbon dioxide trapped in ancient ice cores, which show that the atmosphere had less carbon dioxide in the past. *EPA's Climate Change Indicators (2016)*

The obvious solution is to cut emissions but, that's not happening

Recent reductions in emissions?



China represents the single most important reason for the resumption of global emissions growth in 2017. This is driven by a projected 3% increase in coal consumption, 12% increase in natural gas consumption and 5% increase in oil consumption.

How much needs to go?

- The IPCC, the international body that issues comprehensive reports on climate change, has estimated that the world will need to be removing an average of 10 gigatons of CO2 (10 billion tons) a year from the atmosphere by midcentury.

How do we do it?

Natural ways: trees, ocean, land. For example grow more trees? We're cutting down a lot more than growing new ones.

Need artificial means …

First commercial direct air capture near Zurich (2017)

Mathematical models

- Adsorption – most common approach and … seems open to mathematical modelling

Shafeeyan et al, Chem. Eng. Res & Design 2014 - *it was evident that the design and modeling of a fixed-bed adsorption system require the simultaneous solution of a set of coupled PDEs representing mass, energy, and momentum conservation together with transport rate and equilibrium equations. The simultaneous solution of such a rather complex system of PDEs requires complicated numerical solutions, and the computation time is often inconveniently long*

Sounds ideal for mathematicians.

Questions for the MISG …

- Can we improve current/develop new models?
- Models other than adsorption?
- What are the best methods? What is the state of the art?
- Where to place devices?
- Anything you can think of really?
- What about removal of other greenhouse gases?