# The Science of Climate Change

The IPCC Third Assessment
and recent developments in the US and the UK


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## Overview

- The Science of Climate Change : Update
  - the IPCC Third Assessment Report
  - the long term : 2100 and beyond...
  - in the context of natural variablity & past climate change
- Three special issues
  - the trans-atlantic dimension : do US scientists agree?
  - the size of the problem, in a global & long-term context
  - what is needed for a solution...
    - Conservation, renewables, economic incentives, carbon taxes, direct $CO_2$ sequestration, the role of nuclear power

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## Global Warming : the IPCC view

- The third assessment states that
  - "The global-average surface temperature has increased over the 20th century by about 0.6 °C."
  - "Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."
  - "Global mean temperatures are likely to rise by between 1.4 and 5.8 °C by 2100..."
  - ... and to continue rising for a long time after that
- to stay near the bottom end of this range...
  - **global** $CO_2$ emissions will need to be reduced to **less than 50%** of their current global level
- to achieve this is going to be a **massive** problem

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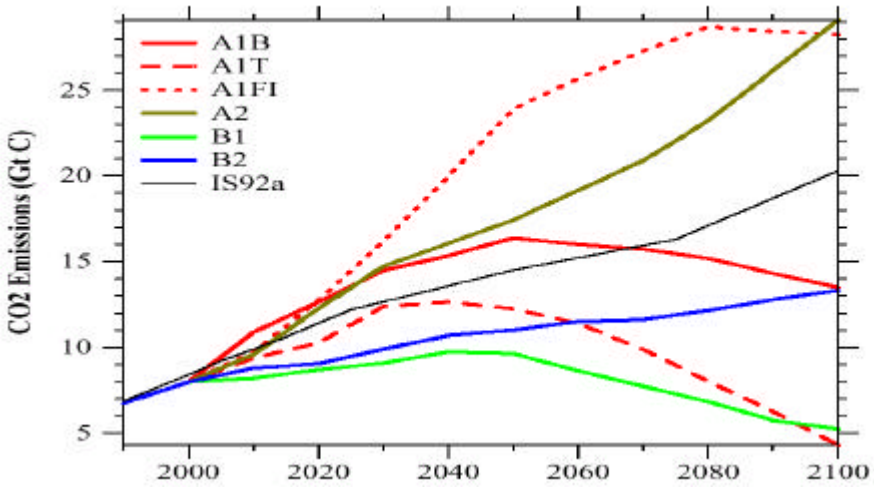
## $CO_2$ emissions under various scenarios

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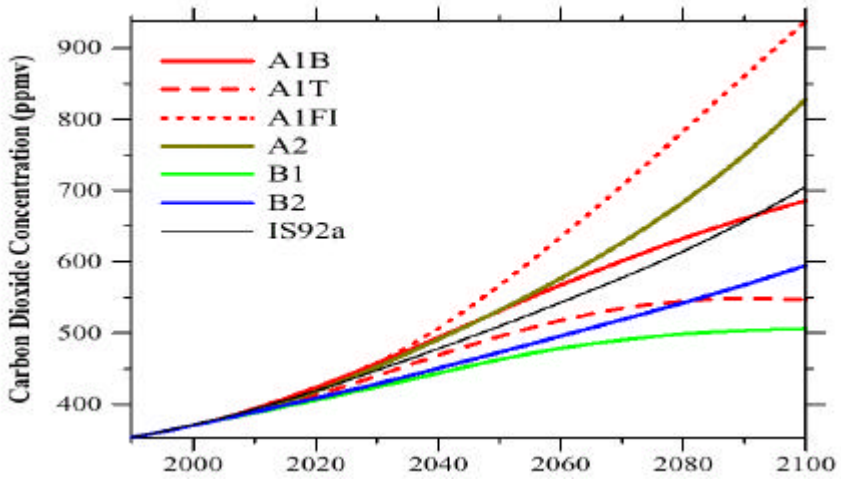
## $CO_2$ concentrations under various scenarios

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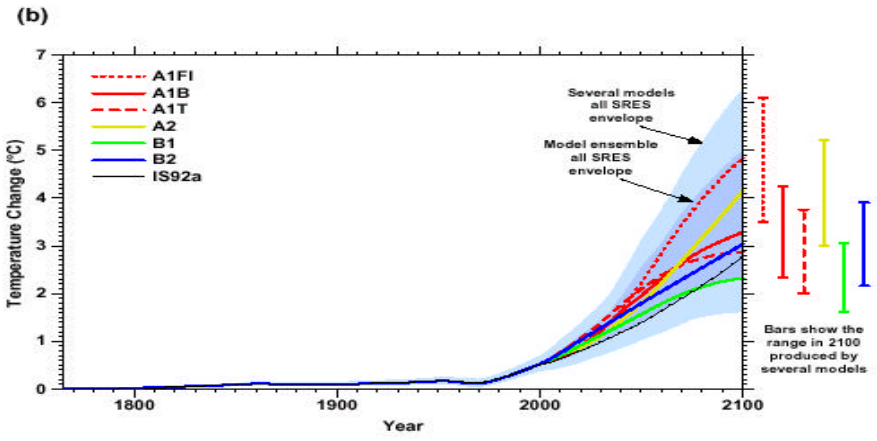
## Projected temperature change under various scenarios (1750 to 2100 AD)

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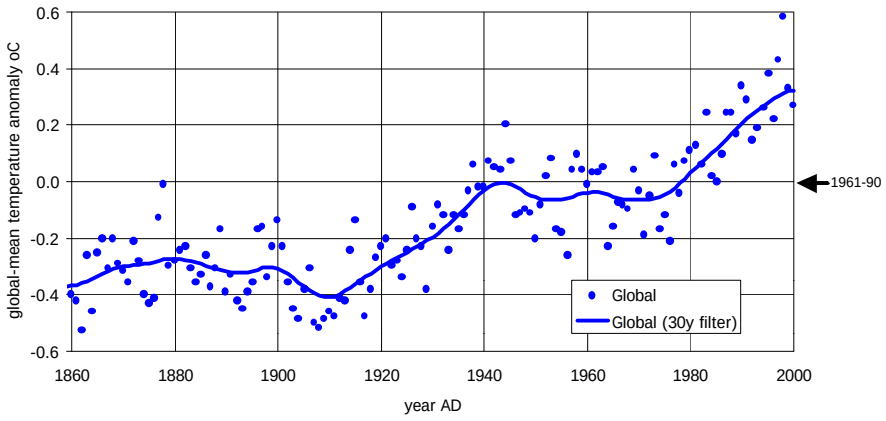
## Global Temperature Change, 1860-2000

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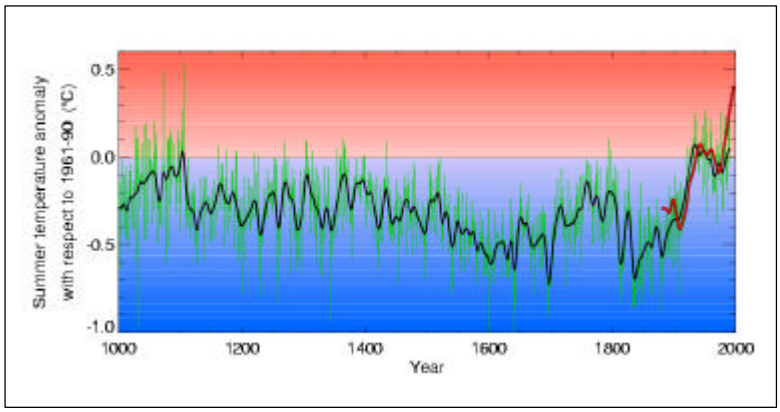
## Northern Hemisphere temperature since 1000 AD

**Source: Jones, Briffa and Osborn**

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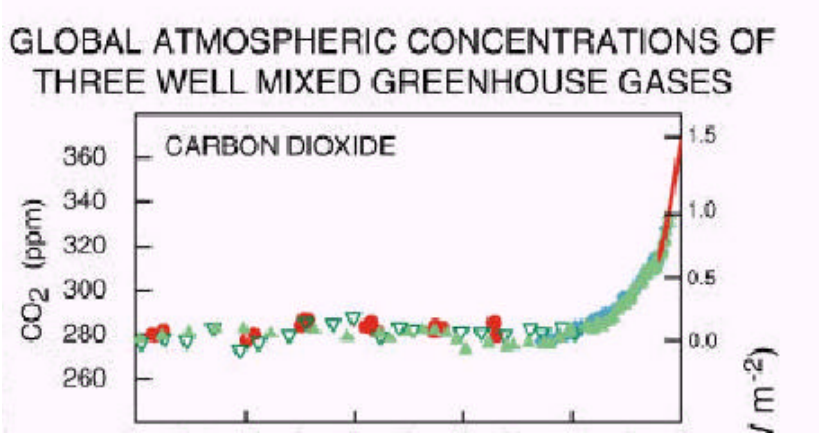
# $CO_2$ Concentration since 1000 AD

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# Climate Science

## US scientists versus the rest ?

- Report by US National Academy of Sciences (www.nas.edu), June 2001
- Commissioned by President Bush, as urgent task
- Panel composed of scientists **not** involved in the work of IPCC, including some influential sceptics
- Resounding endorsement of the IPCC conclusions
- Only one significant reservation : that not all qualifications were included in the summary for policymakers (q.v., see www.ipcc.ch)

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## The trouble with Kyoto

- After Bonn 2001, the Kyoto Protocol is now a **very** small step in the right direction
- It **is** flawed, because
  - it is short term (it includes targets for the first committment period only)
  - it lacks a declared long-term strategy (e.g. contraction & convergence)
  - there are too many loopholes (especially land carbon sinks, see Royal Society report at www.royalsoc.ac.uk)
  - the USA is not included !
- ...but the flaws may not be fatal

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## Global Warming : The Big Picture

- Reducing emissions by 50% : factor **2**
- with population growth (global) : factor **2**
- and increased energy use (per capita) in the developing world (to EU level only) : factor **5**
- Altogether we need **factor 20** (decarbonisation)
- Energy efficiency, renewables (etc) : maybe we can achieve **factor 4** (?)
  - (c.f. Weizsacker, Lovins & Lovins)
- Hydrogen is only a carrier...
- Nuclear power ?
- We shall need to deploy **$CO_2$ sequestration....**

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## Carbon Dioxide Sequestration

- Must be **physical/chemical**
  - biological sinks are too small (maybe ~ 100 Gt total)
  - and too uncertain (easily remobilised)
- Options include
  - **geological** (liquid $CO_2$, into deep aquifers)
    - e.g. Sleipner Project (1 Mt/yr)
  - **oceanic** (liquid $CO_2$, to water depths > 3000m)
    - residence time ~ 500 years, ~ 80% permanent
    - good enough (?), favoured by Japan
  - **chemical** ($CO_2$ + serpentine → magnesite)
    - solid, and most can replace rock mined
    - use some to neutralise acidified surface ocean water ?
- **Cost** is non-trivial, but maybe < $50/t (and falling)

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## A way forward ?

- We should develop $CO_2$ sequestration technology
  - as a precautionary measure ("no regrets")
  - on a large scale (plan for several/many Gt/yr)
  - building up over the next few decades
  - it will take a long time...
  - ... so we should start soon
- See DTI/IEA report (2000)
- We need to increase (global) R&D in this area substantially
  - expand existing UK & EU work
    - N.B. Tyndall Centre, small study, commencing 2001
  - the energy industry could and should take a lead

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# Low Carbon Transportation...

A possible solution by Emily Boon & Fenella Martin
Class 4DS, Forres Sandle Manor School


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