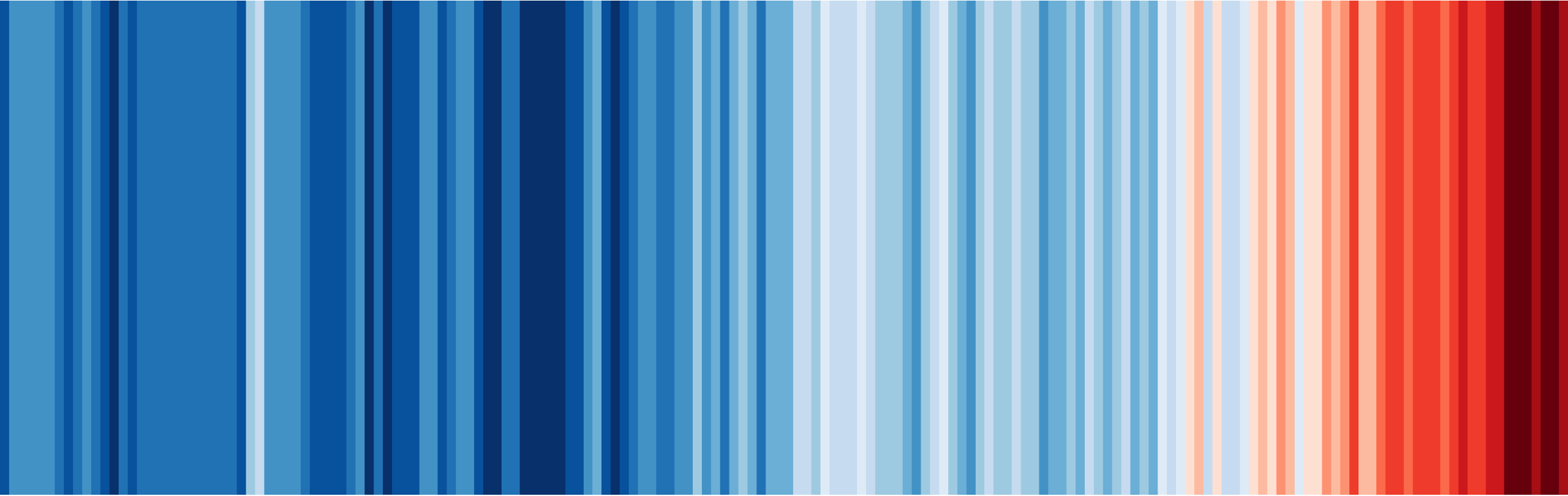


History and evolution of climate projections



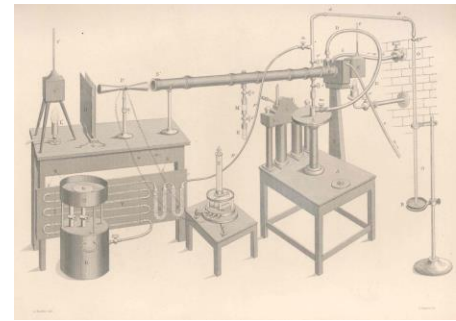
National Environmental Science Program

Michael Grose



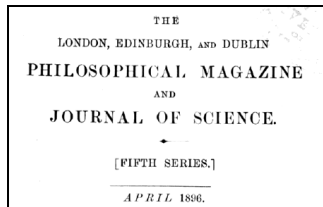
Eunice Foote 1856

- “Circumstances affecting the heat of the sun's rays”



Svante Arrhenius 1896

“On the influence of carbonic acid in the air upon the temperature of the ground” Doubling CO₂ = +5 to 6 °C (high end today)



XXXI. On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground. By Prof. SVANTE ARRHENIUS.

I. Introduction: Observations of Langley on Atmospheric

A GREAT deal has been said of late years in regard to the absorption of the solar radiation in particular has importance of this question. To the annual variations of the temperature of the ground in this circumstance. Another side of the question has attracted the attention of physicists, namely the influence of the presence of heat-absorbing gases in the atmosphere upon the temperature of the ground in particular that the atmosphere retains the dark rays from the earth under direct sunshine. This question has been elaborated by Pouillet & others, and the researches led to the view, that if the atmosphere were present as now, would the earth be warmer than it is at present, and that atmosphere did not possess

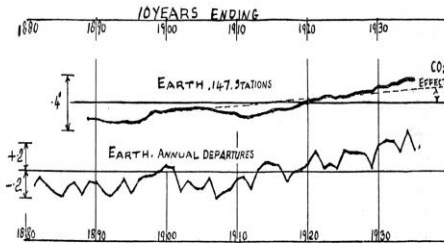
COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

1912

Guy Callender 1938

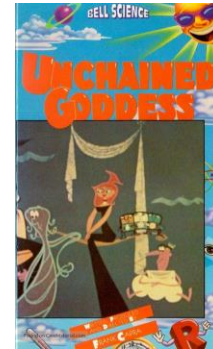
Trend in 147 stations and “CO₂ effect”



Thought this would only be beneficial—delay the “return of deadly glaciers”

Frank Capra school film 1958

‘Unchained Goddess’ Notes greenhouse gases effect on temperature and sea level rise



Me of s slide

Michael Grose - climate @ClimateGrose · Oct 19

I'm interested in opinions here - when do you think we had a sufficient evidence base to confidently justify reducing (or avoiding) greenhouse gas emissions?

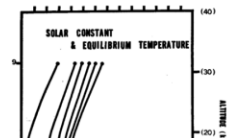
1890s-1970s (please note)	12.9%
the 1980s	54.8%
IPCC FAR 1990	22.6%
After 1990	9.7%

31 votes · Final results

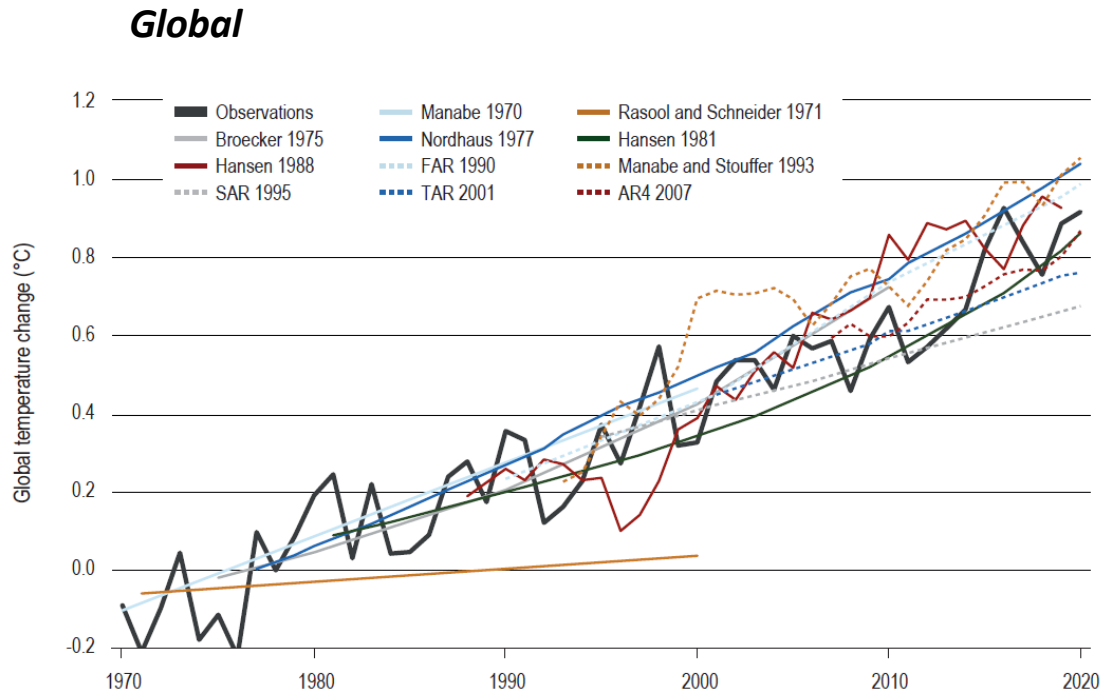
Manabe Hasselmann et al. 1960s – 1980s

Modelling, attributing, predicting climate changes

2021 Nobel Prize

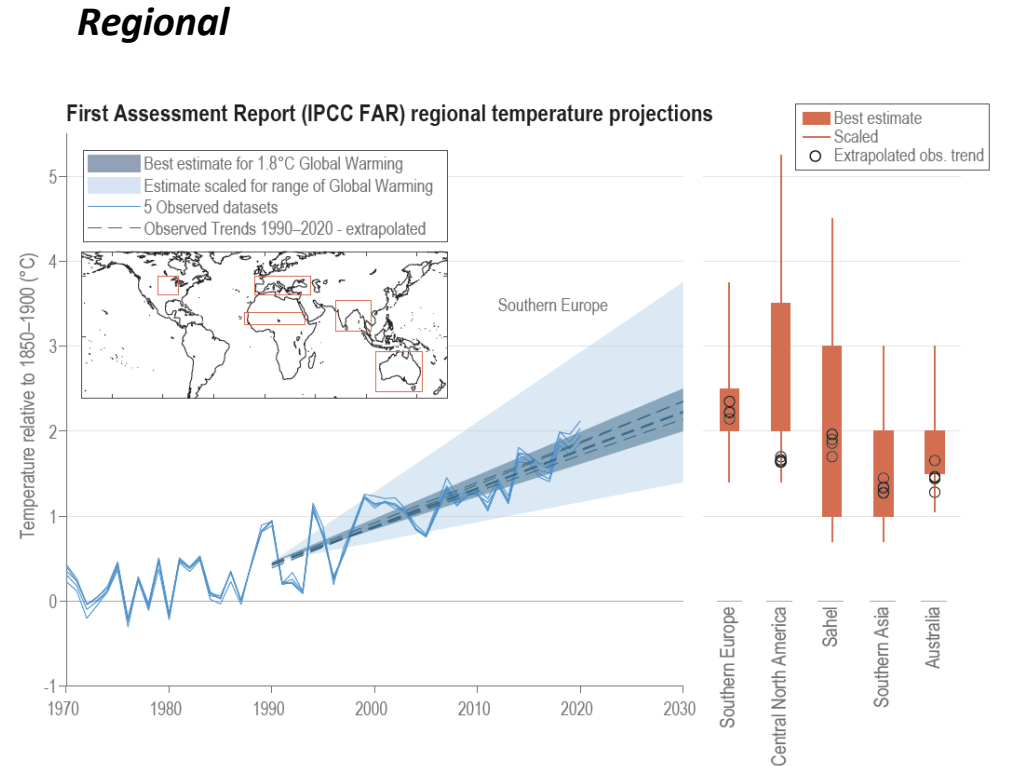


Early projections... and what happened



Manabe 1970 through to IPCC 2007,

Close agreement – especially if you account for different emissions assumptions (not the results themselves)



IPCC First Assessment (1990)

Europe, Sahel, Southern Asia – very close
 Australia, North America – in the lower range
 (transient ‘warming holes’ affected observed trends)

Australia: Greenhouse 1987, special volume 1988

Australian bushfire danger under changing climatic regimes

T. Beer, A.M.Gill and P.H.R.Moore

Climatic change: impact on international reinsurance

G. Berz

The energy policy implications of climate change

I. Lowe

Greenhouse - its impact on Australian hydrology: possible changes to flooding regimes

D.K. Robinson

Areas of Australia's coast prone to sea-level inundation

A.D. Short

The greenhouse effect and electricity generation in New South Wales

C.G. Coulter

Insurance and the greenhouse effect

B.D. Peele

The water resource implications of a drying climate in south-west Western Australia

B.S. Sadler, G.W. Mauger and R.A. Stokes

The potential impact of climate changes on Australian ski fields

R.W. Galloway

- 44 papers on many aspects
- Virtually all hits, very few misses
- Careful conclusions – lots of 'potential', 'possible'

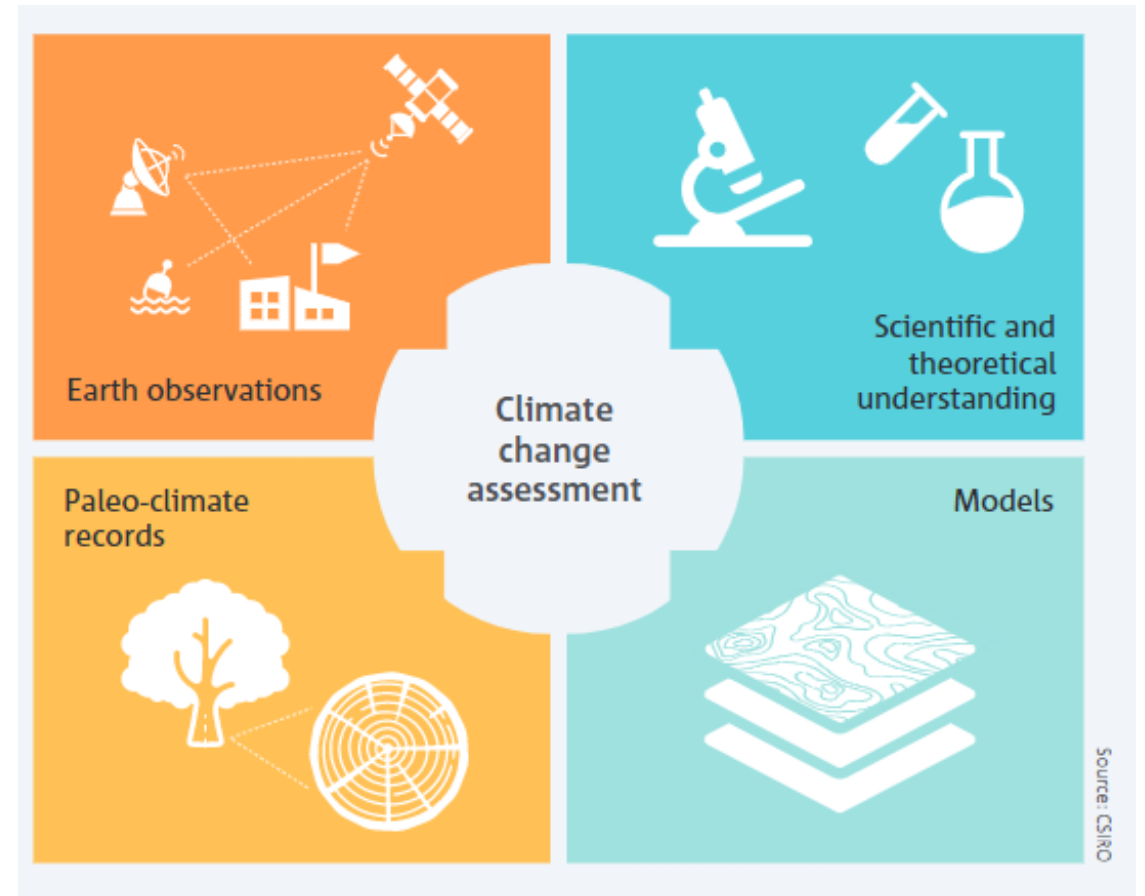
Why do projections change?

1. New evidence and assessment

Multiple lines of evidence used to assess climate change
New developments in all of these

New focus areas and areas of interest, e.g.:

- Tipping points
- 'Low likelihood, high impact' outcomes



Why do projections change?

2. Global emissions scenarios

Projections are a 'what if' exercise: if we follow X pathway, we get Y

All are sets of distinct pathways covering the plausible range – but updated:

- More years of observed data, better inventories
- Changing view of plausible futures

1988 – Hansen Scenario A, B, C

1992 – the IS92 scenarios (IPCC)

2000 – Special Report (SRES)

2010 – Representative Concentration Pathways (RCPs)

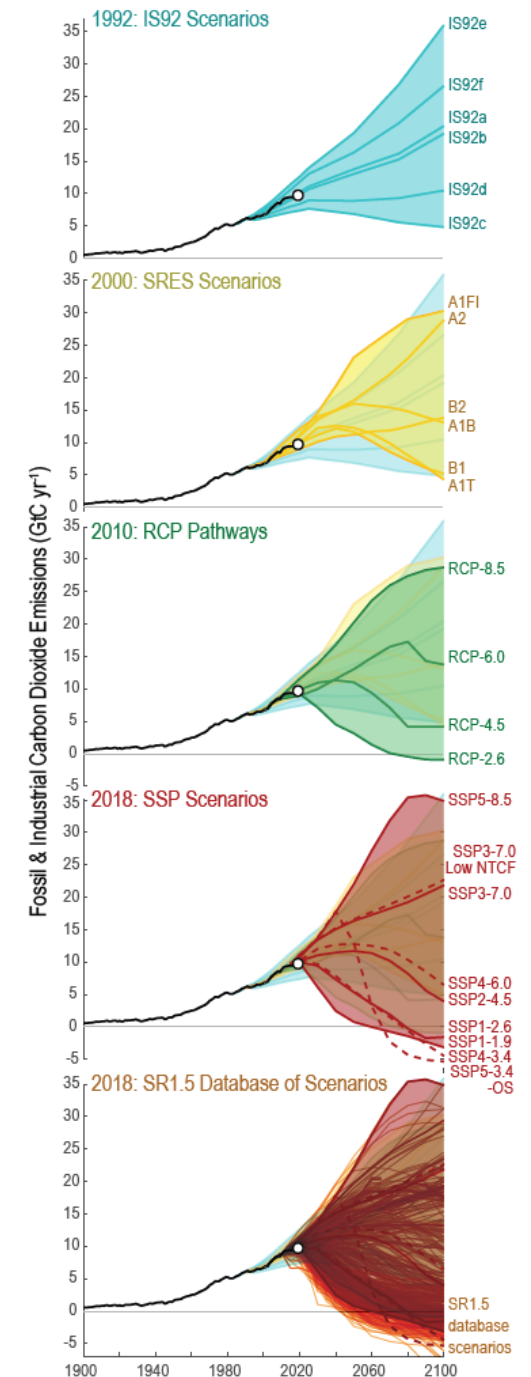
2018 – Shared Socio-economic Pathways (SSPs)

2018 – database of scenarios on 1.5 °C

2021 – NGFS special scenario sets

2022 – Category 1-8, IPCC WG3

Global Warming Levels (GWLs) largely standardise between scenario sets



Why do projections change?

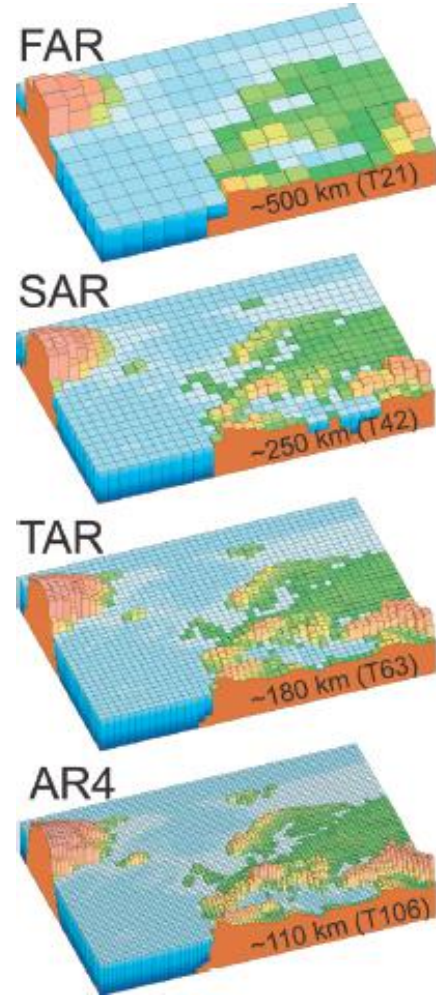
3. Updated modelling

Global model programs - CMIP

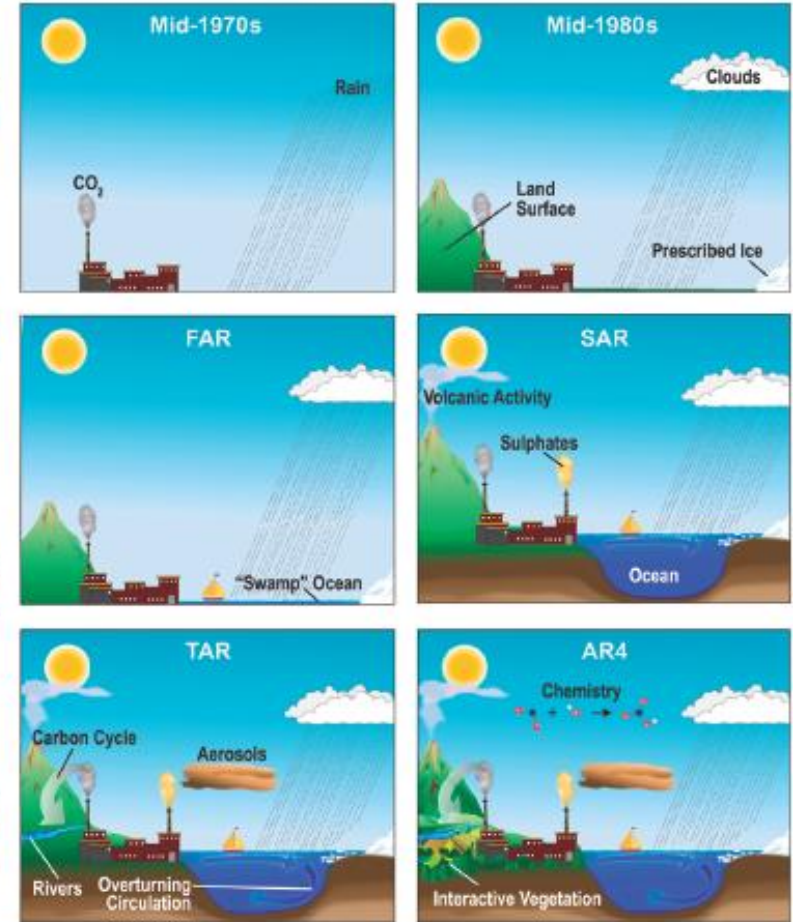
- More components
- Finer resolution More models! CMIP3 has ~23, CMIP6 has ~50 for projections

Other models used as well

- Regional models – statistical and dynamical models to go to local scale



The World in Global Climate Models

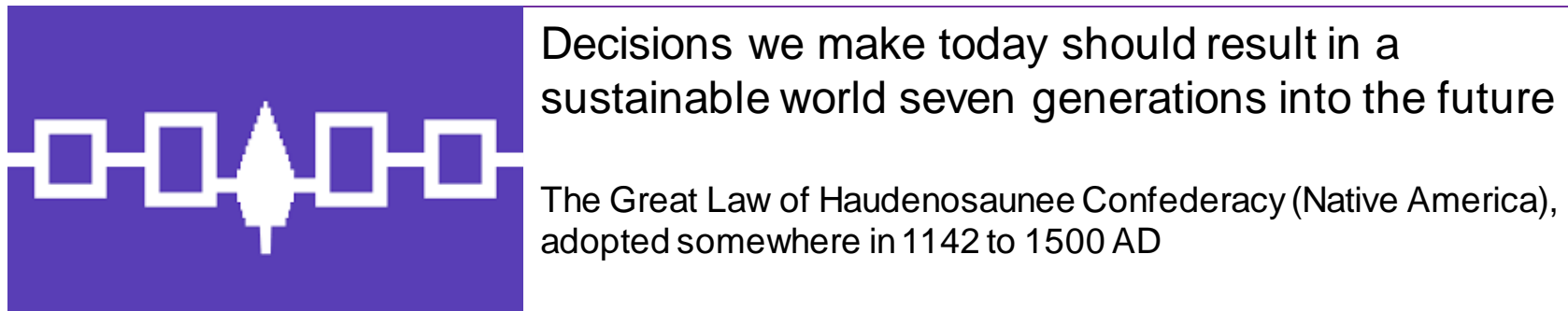


What we are adapting to?

- Much has been clear since the 1980s – warmer world, higher sea levels, more of some extremes
- But the picture evolves with time

How should we approach adaptation?

- Are we wiser now than the past?



Decisions we make today should result in a sustainable world seven generations into the future

The Great Law of Haudenosaunee Confederacy (Native America), adopted somewhere in 1142 to 1500 AD