

Lecture 3

Science, Uncertainty and Evidence

8th Jan 2025

Recap

- What is climate change and the basic difference between climate change, climate variability and weather
- Svante Arrhenius (1859-1927) - a Swedish scientist, was first to talk about change in climate due to CO₂ emission
- 1930 Guy Stuart Callendar – British Scientist
- From 1930 till date science has improved and climate change is no longer a radical claim
- But denial to accept the science – delayed action
- We are already late as we wasted a lot of time to accept the fact that Climate is changing faster, and we need to act.
- Questions were raised on the accuracy of science of climate change

What is science ?

- A latin word 'scientia'
 - Organized knowledge
 - Highly integrated form of knowledge
 - Proven knowledge
- But, scientific methods on which science relies is about 'probability' rather than certainty
- There is always an element of uncertainty
- Science rather than proving something, finds the most likely theory to fit the observations
- It is all about probability and nothing is absolutely certain!
- "we say less than 5% chance of it being wrong" – even for something that is true and established

Uncertain nature of reality

- This uncertainty has given birth to denial
- Asking for definite statement
- Scientists are conservative – will not put themselves forward in a strong and definite way – evident in IPCC reports
 - “90% chance that recent climate trends are caused by humanity” (IPCC 2007)
 - Note this has now changed and in recent reports of IPCC we see more confidence
 - Scientists in IPCC stated what is most probable – when there is a high degree of probability – law – law of thermodynamics, law of gravity (supported by massive evidence)
- Public is often looking for 100% certainty – delayed climate action for decades

Climate Change and uncertainty

- Climate science over centuries have come to be well understood
- For example
 - Climate scientists are certain about basics of climate change but less certain about some impacts
 - The poorly understood aspect of CC do not invalidate the very well understood parts
- Uncertainty is a part of science – helps science to progress
- Proof vs Precautionary principle – should we wait for absolute proof?
- Climate risk – risk is a probability – e.g. health insurance

History of climate

- Medieval warming - warm climate in the Europe and North Atlantic region that lasted from 950 to 1250 AD
- Ice age : An ice age is a long period of reduction in the temperature of Earth's surface and atmosphere (expansion of continental ice sheets, glaciers, and permanent ice cover over large portions of the planet)

Can we handle a radically different world if changes occur/ climate shifts?

- Climate science is progressing and now we are confident that change is happening, and impacts are visible
- Concerns for climate change has been growing in the last two decades

The beginning of IPCC – 1988

(Intergovernmental Panel for Climate Change)

- In 1988, the World Meteorological Organization (WMO) and the UN Environment Programme (UNEP) jointly established the Intergovernmental Panel on Climate Change (IPCC), with a mandate to assess the available scientific information on climate change, including its potential impacts, and options for adaptation and mitigation.
- By 1990, the IPCC had produced its First Assessment Report on the state of climate change science, warning that, although there were many uncertainties, human activity was leading to increased atmospheric concentrations of greenhouse gases (GHGs) and rising temperatures.

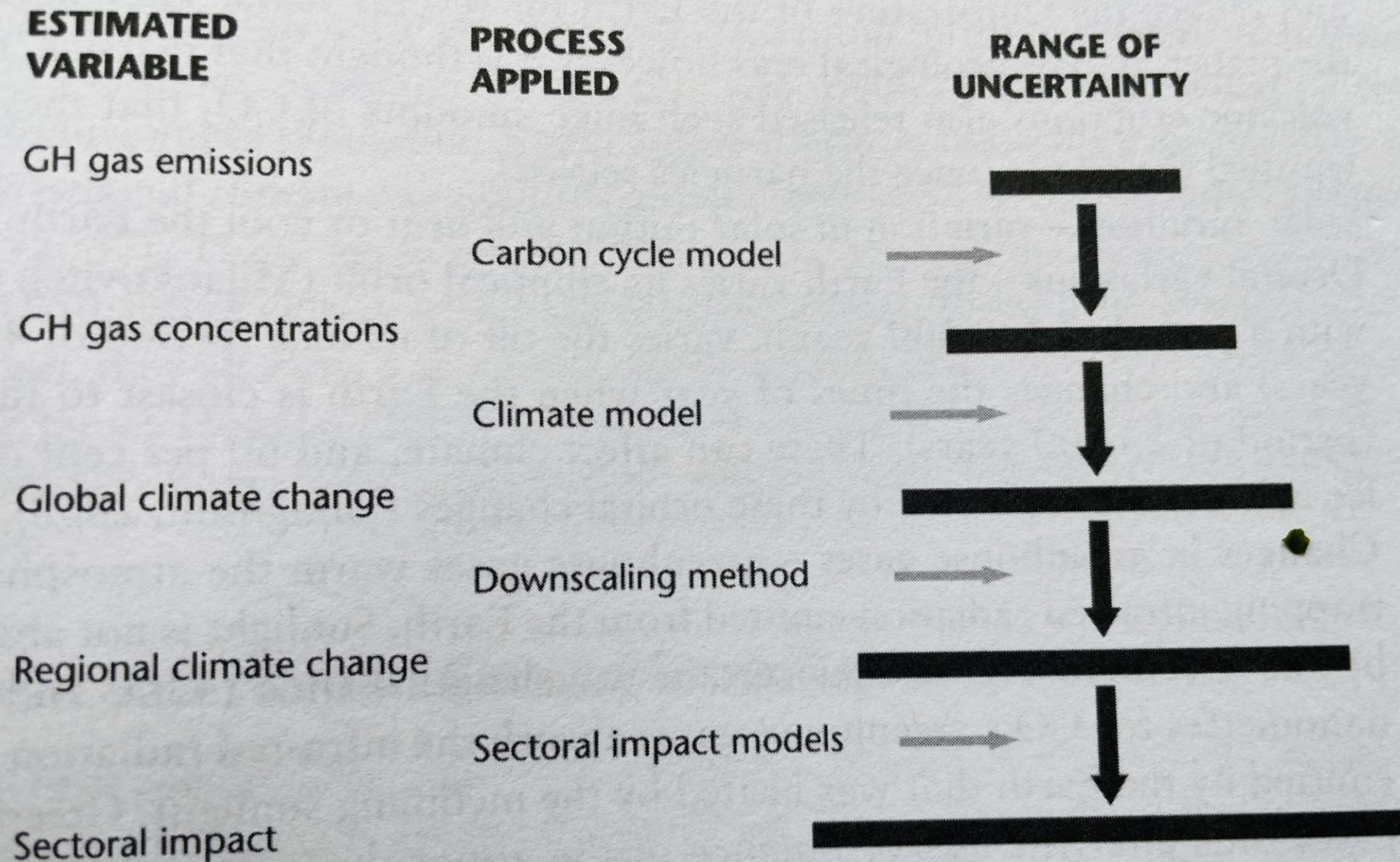


Figure 1 *The cascade of uncertainties around climate change*

Natural and Human Greenhouse Effect

- Human influence and sharp rise in temperature since 1900
- The Hokey stick
- Green House Gases are blanket around the earth
- Anthropogenic – human caused GHG effect

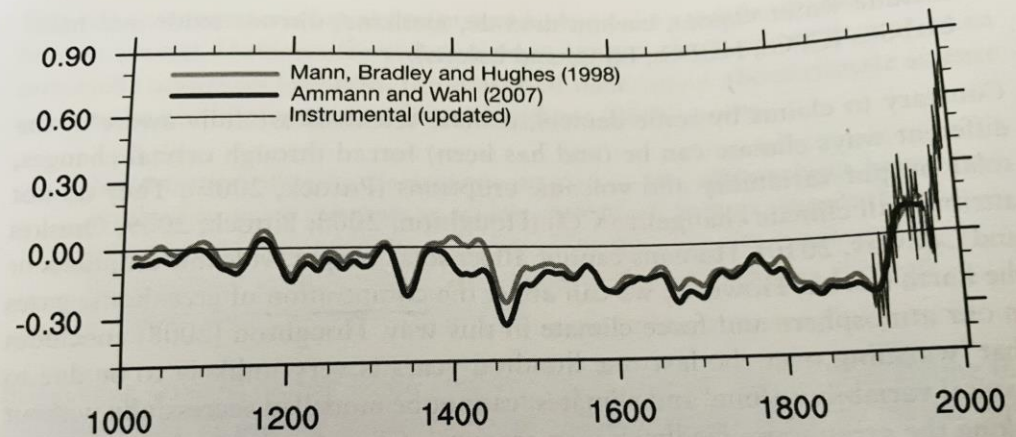


Figure 2 *The 'hockey stick'*

Vertical axis shows global temperature change in degrees Celsius; horizontal shows time since 1000 AD. Original hockey stick graph (Mann et al, 1998) compared to Ammann and Wahl (2007) reconstruction, plus the instrumental record (after 1900). Note strong agreement despite some variation. Note also the steeply rising instrumental temperature after 1900.

Source: Ammann and Wahl (2007, Figure 2); to view related data from Wahl and Ammann (2007) in colour see www.ucar.edu/news/releases/2005/ammann.shtml

IPCC 1990

IPCC 1995

IPCC 2001

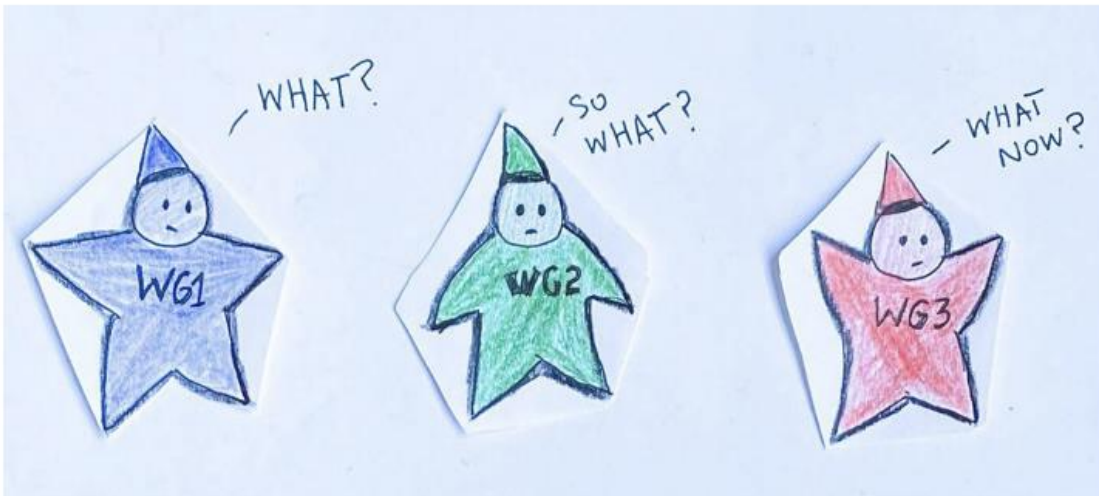
IPCC 2007

IPCC 2014

IPCC 2021/22



IPCC Report structure



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Whether global warming / Climate Change is happening?

- IPCC 2007 –
 - Very high confidence that the global average net effect of human activities since 1750 has been one of warming
 - Very high confidence – $< 90\%$
 - Warming of the climate system is unequivocal – we can see the impacts! Such as
 - Global temperature rise
 - Warmest years recorded
 - Summer period extending
 - Arctic sea ice declining
 - Snow cover decreased

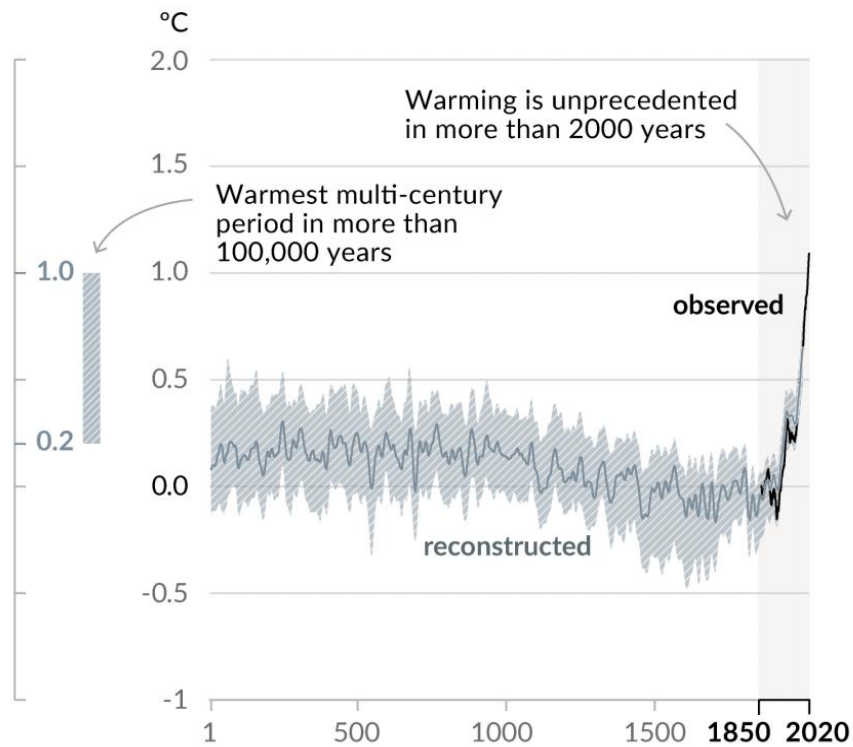
Humans are responsible for these changes

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

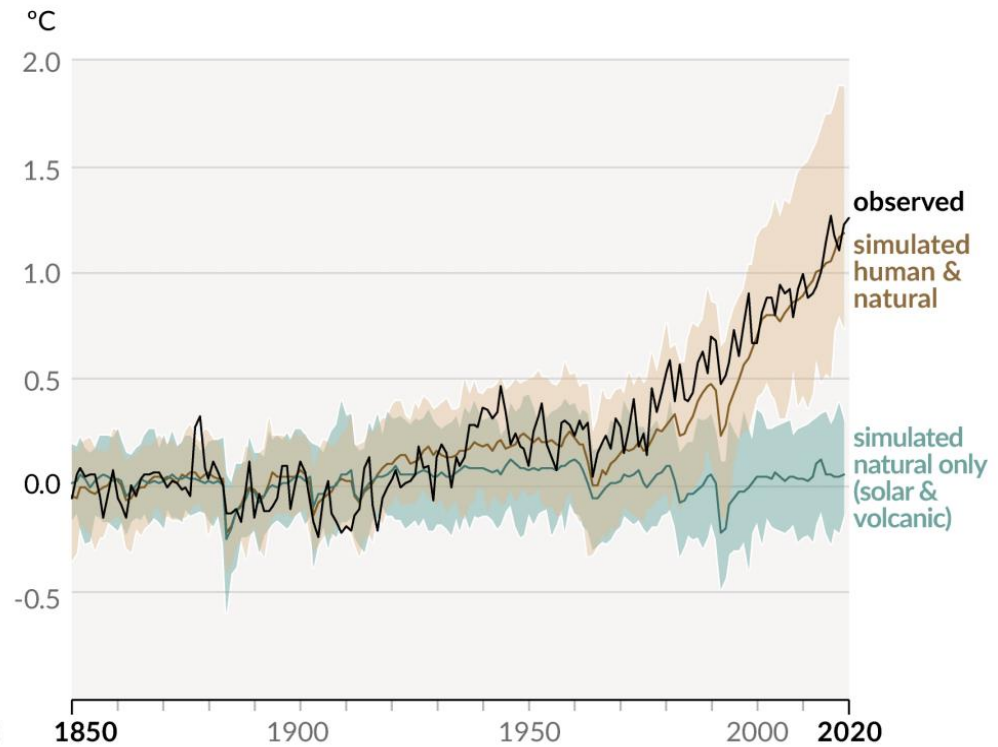
Figure SPM.1

Changes in global surface temperature relative to 1850-1900

a) Change in global surface temperature (decadal average) as **reconstructed** (1-2000) and **observed** (1850-2020)



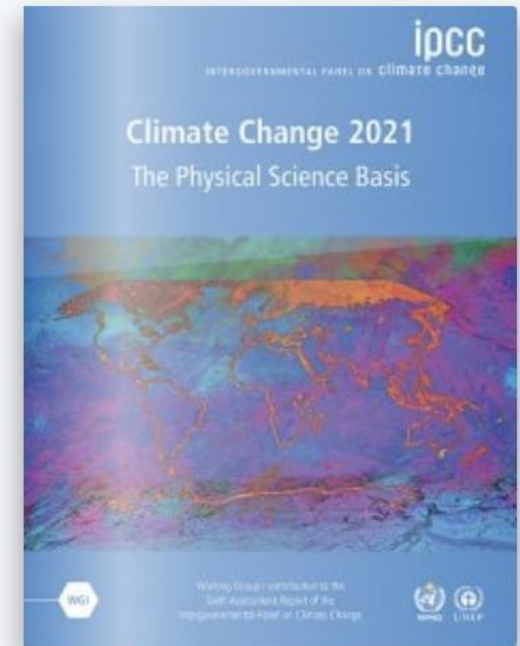
b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)



The IPCC report 2021/22

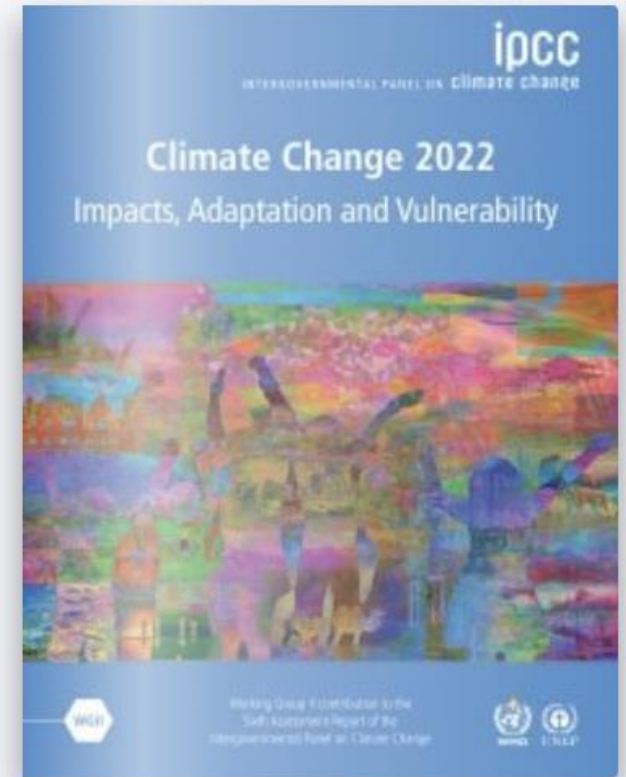
Working Group I

- “unequivocal” and “indisputable” that humans have warmed the planet, causing “widespread and rapid” changes to Earth’s oceans, ice, and land surface
- new estimates of the chances of crossing the global warming level of 1.5°C in the next decades,
- Requires immediate, rapid and large-scale reductions in greenhouse gas emissions
- We are already experiencing climate change, including more frequent and more extreme weather events,” and that “the consequences will continue to get worse for every bit of warming, and for many of these consequences, there’s no going back”.



Working Group II

- Increases in the frequency and intensity of climate and weather extremes, including hot extremes on land and in the ocean, heavy precipitation events, drought and fire weather (high confidence)
- The vulnerability of ecosystems and people to climate change varies – across regions, **socio-economic development, unsustainable ocean and land use, inequity, marginalization, historical and ongoing patterns of inequity such as colonialism, and governance.**
- Climate change including increases in frequency and intensity of extremes have reduced food and water security, hindering efforts to meet Sustainable Development Goals
- Leading to humanitarian crises where climate hazards interact with high vulnerability
- Regions and people with considerable development constraints have high vulnerability to climatic hazards



Working Group III

- The decisions we make now can secure a liveable future.
- There are policies, regulations and market instruments that are proving effective, need to be scaled up
- Need right policies, infrastructure and technology in place to enable changes to our lifestyles and behaviour.
- **The next few years are critical** - limiting warming to around 1.5°C (2.7°F) requires global greenhouse gas emissions to peak before 2025 at the latest, and be reduced by 43% by 2030
- For 1.5°C (2.7°F), this means achieving net zero carbon dioxide emissions globally in the early 2050s; for 2°C (3.6°F), it is in the early 2070s.
- Accelerated and equitable climate action in mitigating and adapting to climate change impacts is critical to sustainable development

