Le prix Nobel de physique 2021

Comment les découvertes des lauréats ont servi de base aux conclusions récentes du GIEC

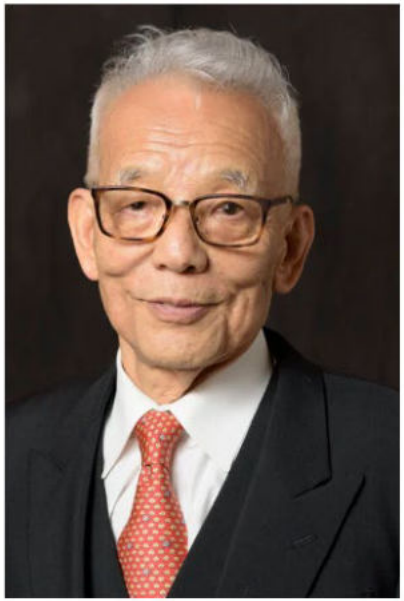
Dr Andrew Ferrone

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Agriculture, de la Viticulture
et du Développement rural

Administration des services techniques
de l'agriculture

AgriMeteo

The Nobel Prize in Physics 2021



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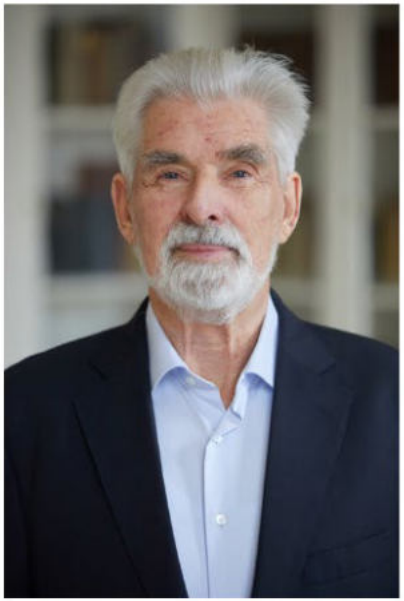
Syukuro Manabe

Prize share: 1/4



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Klaus Hasselmann

Prize share: 1/4

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Giorgio Parisi

Prize share: 1/2

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics 2021

“for groundbreaking contributions to our understanding of complex physical systems”

with one half jointly to
Syukuro Manabe
Princeton University, USA
Klaus Hasselmann
Max Planck Institute for Meteorology, Hamburg, Germany
“for the physical modelling of Earth’s climate, quantifying variability and reliably predicting global warming”

and the other half to
Giorgio Parisi
Sapienza University of Rome, Italy
“for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales”

Syukuro Manabe
The Nobel Prize in Physics 2021

Born: 21 September 1931, Shingu, Ehime, Japan

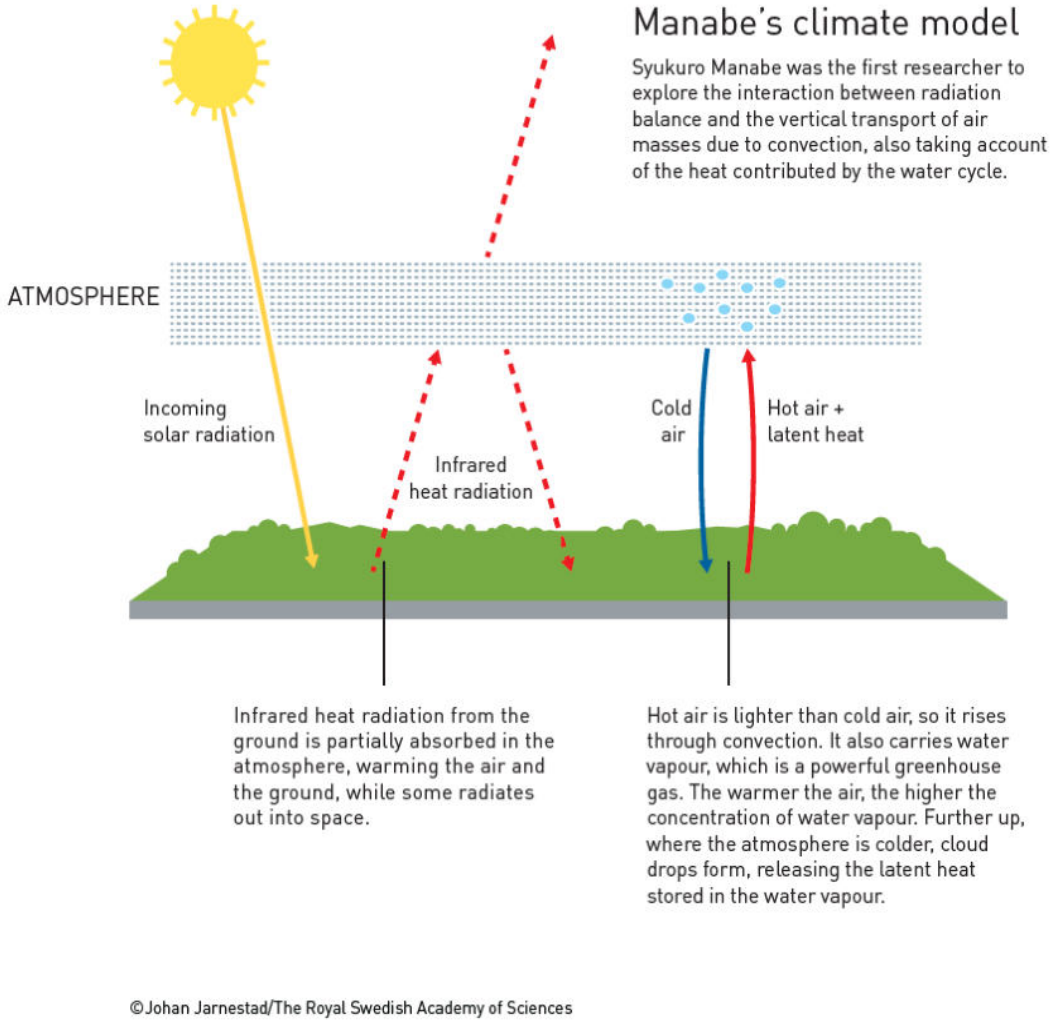
Affiliation at the time of the award: Princeton University, Princeton, NJ, USA

Prize motivation: “for the physical modelling of Earth’s climate, quantifying variability and reliably predicting global warming”

Prize share: 1/4

Work

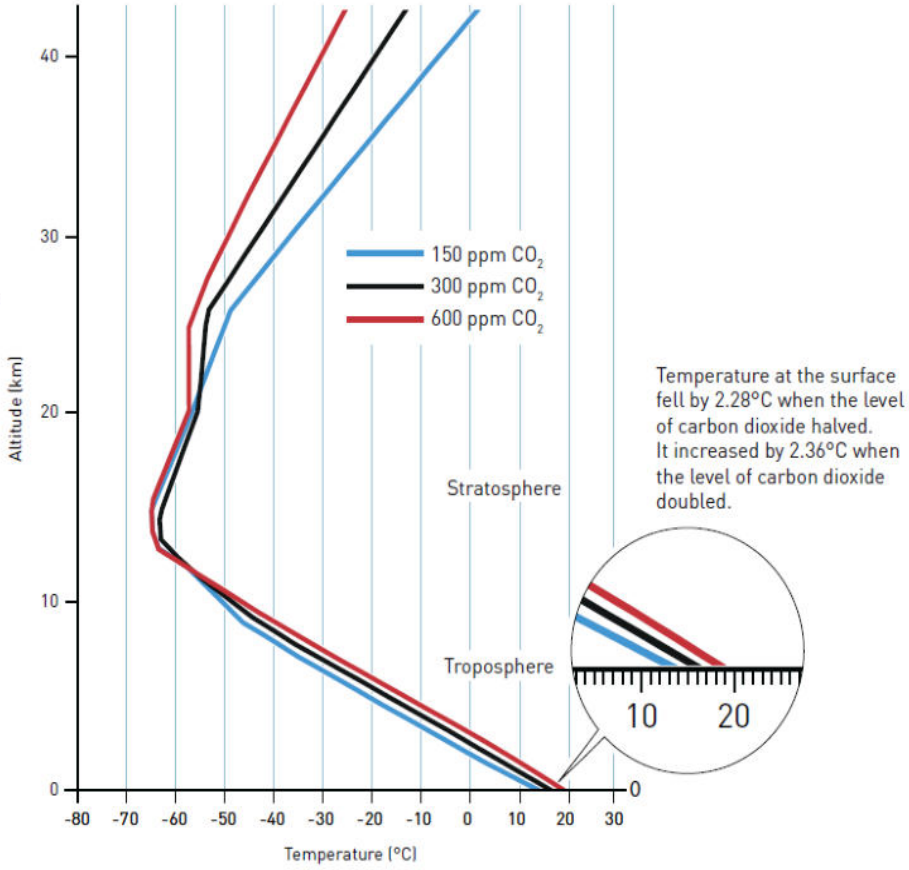
Our world is full of complex systems characterised by randomness and disorder. One complex system of vital importance to humankind is Earth’s climate. Syukuro Manabe demonstrated how increased levels of carbon dioxide in the atmosphere lead to increased temperatures at the surface of the Earth. In the 1960s, he led the development of physical models of the Earth’s climate and was the first person to explore the interaction between radiation balance and the vertical transport of air masses. His work laid the foundation for the development of current climate models.



Manabe, S., & Wetherald, R. T. (1967). Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity. Journal of the Atmospheric Sciences, 24, 241-259.

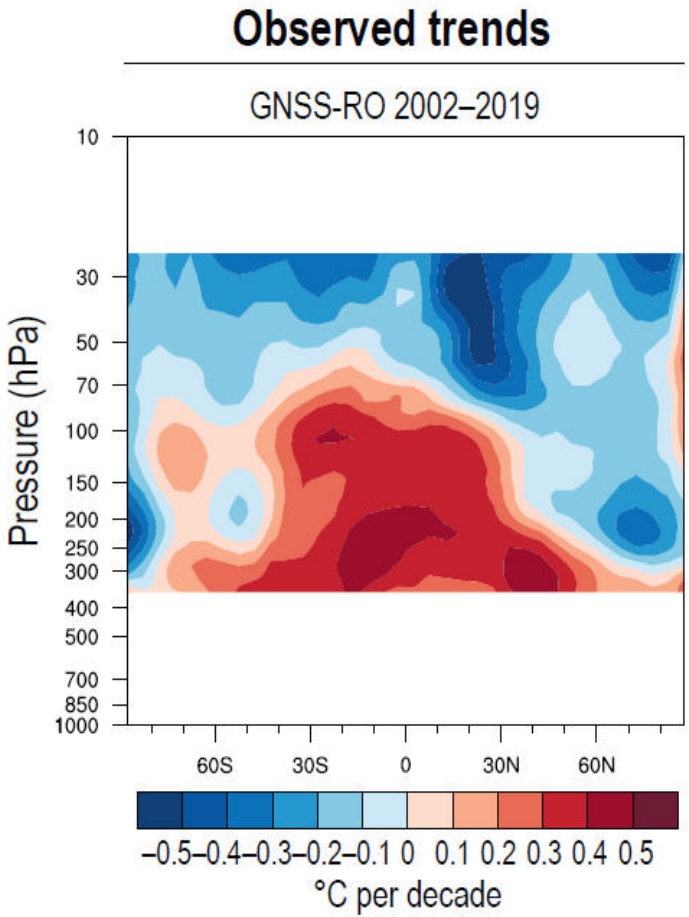
Carbon dioxide heats the atmosphere

Increased levels of carbon dioxide lead to higher temperatures in the lower atmosphere, while the upper atmosphere gets colder. Manabe thus confirmed that the variation in temperature is due to increased levels of carbon dioxide; if it was caused by increased solar radiation, the entire atmosphere should have warmed up.

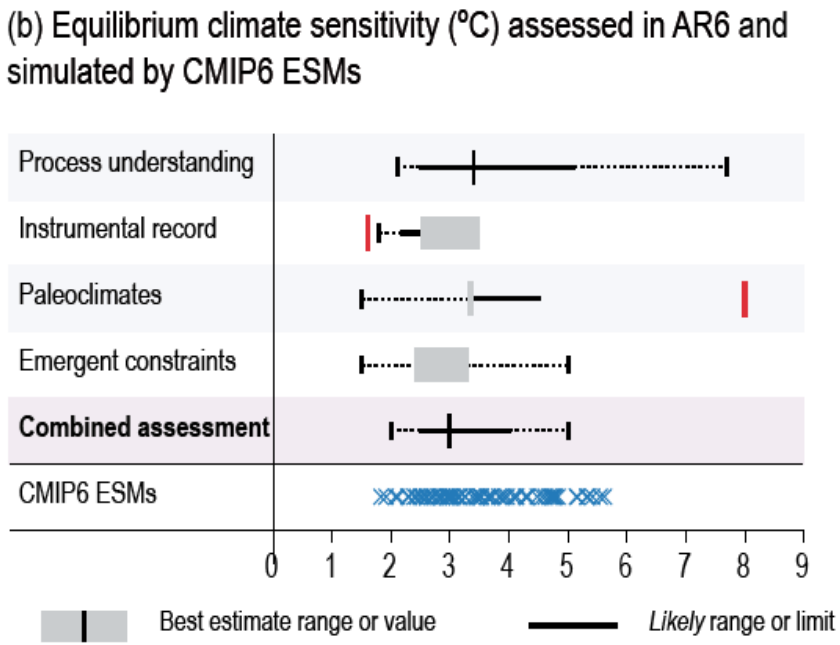


Source: Manabe and Wetherald (1967) Thermal equilibrium of the atmosphere with a given distribution of relative humidity, *Journal of the atmospheric sciences*, Vol. 24, Nr 3, May.

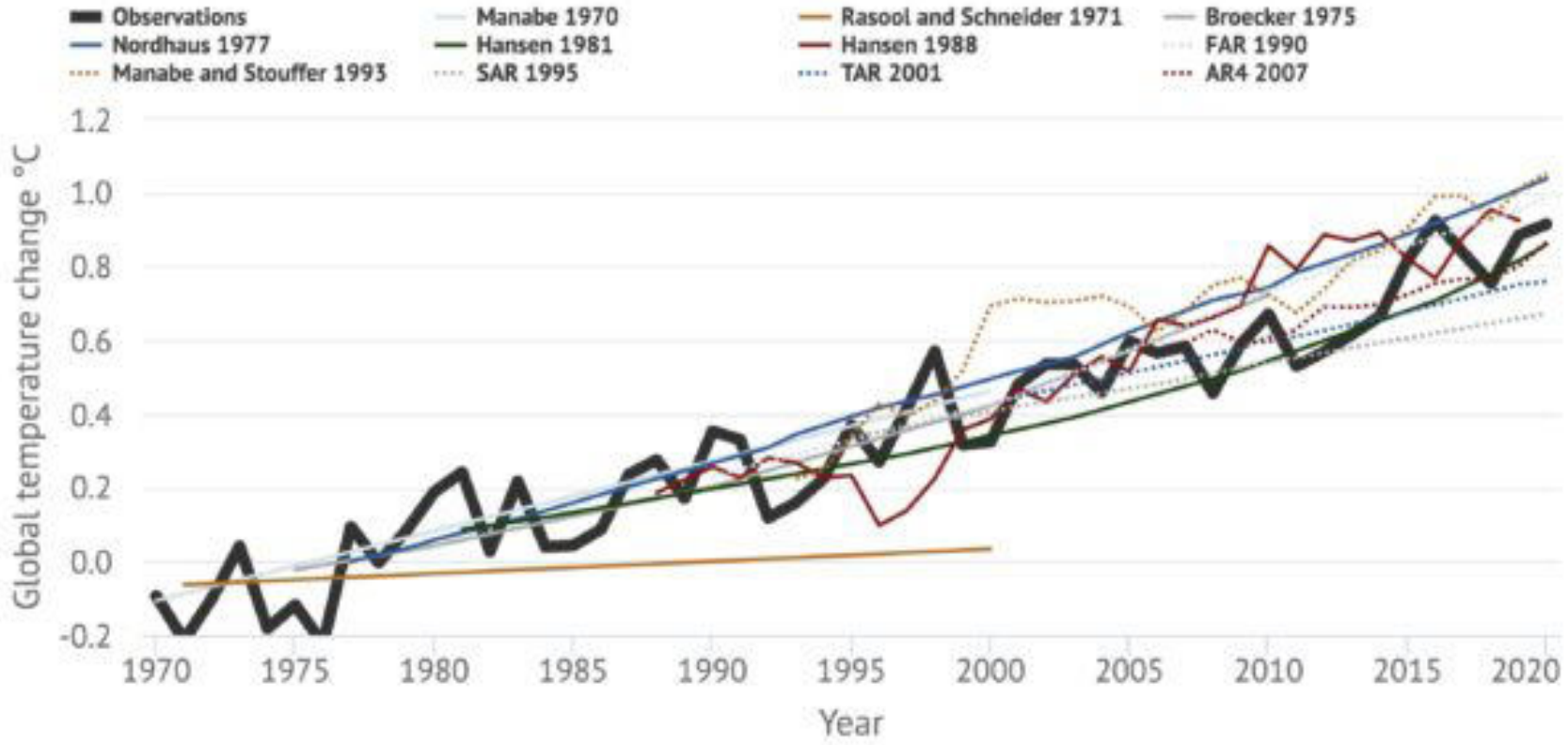
Manabe, S., & Wetherald, R. T. (1967). Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity. Journal of the Atmospheric Sciences, 24, 241-259.



IPCC AR6, WGI, Figure TS.10



IPCC AR6, WGI, Figure TS.16



Hausfather et al., 2020

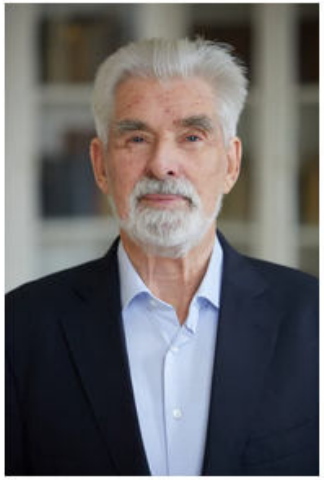


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Photo: Bernhard Ludewig

Klaus Hasselmann
The Nobel Prize in Physics 2021

Born: 25 October 1931, Hamburg, Germany

Affiliation at the time of the award: Max Planck Institute for Meteorology, Hamburg, Germany

Prize motivation: “for the physical modelling of Earth’s climate, quantifying variability and reliably predicting global warming”

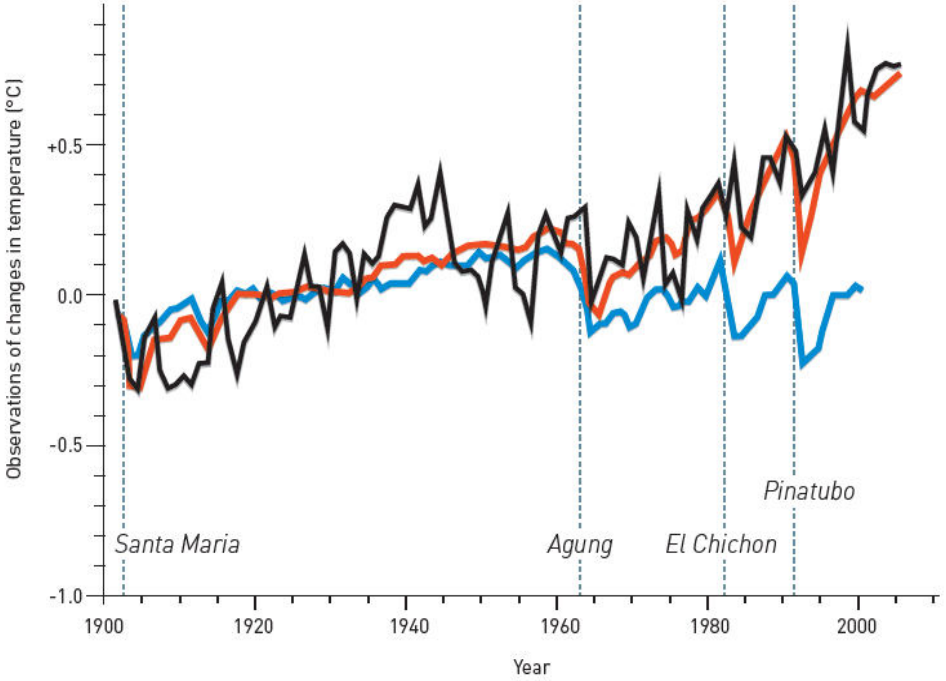
Prize share: 1/4

Work

Our world is full of complex systems characterised by randomness and disorder. One complex system of vital importance to humankind is Earth’s climate. In the 1970s, Klaus Hasselmann created a model that links together weather and climate, thus answering the question of why climate models can be reliable despite weather being changeable and chaotic. He also developed methods for identifying specific signals that both natural phenomena and human activities imprint in the climate. An important result is that the increased temperature in the atmosphere is due to human emissions of carbon dioxide.

Identifying fingerprints in the climate

Klaus Hasselmann developed methods for distinguishing between natural and human causes (fingerprints) of atmospheric heating. Comparison between changes in the mean temperature in relation to the average for 1901–1950 (°C).



Source: Hegerl and Zweirs (2011) Use of models in detection & attribution of climate change, *WIREs Climate Change*.

Observations

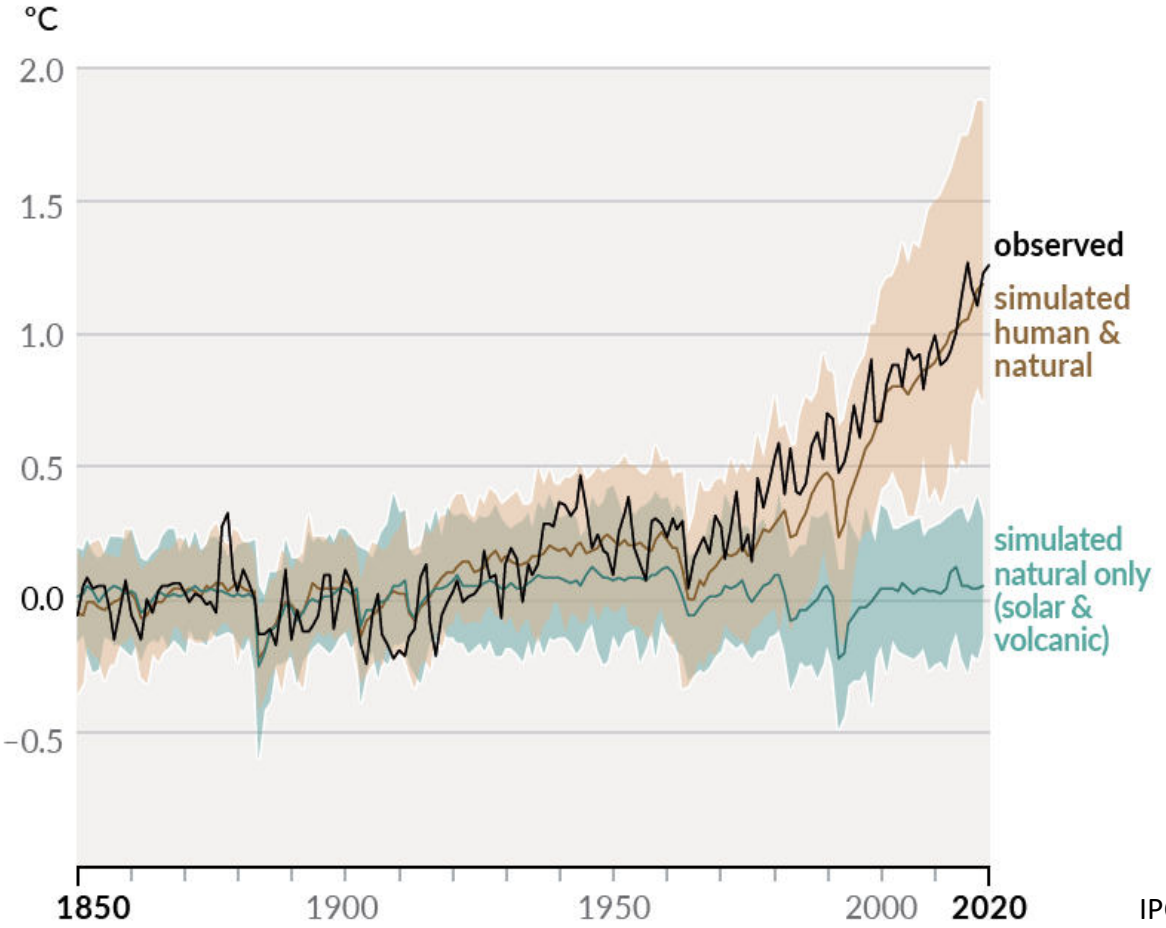
Calculations that show the effect of only natural sources, such as volcanic eruptions.

Calculations of the effect of both natural and human sources.

Volcanic eruptions

Hasselmann, K. (1979). On the signal-to-noise problem in atmospheric response studies. In D. B. Shaw (Ed.), *Meteorology over the tropical oceans* (pp. 251-259). Bracknell: Royal Meteorological Society.

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



IPCC AR6, WGI, Figure SPM.1

Sixth Assessment Report

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Climate Change 2022

Main findings of the latest reports by the IPCC

Dr. Andrew Ferrone

Administration of Technical Agricultural Services

Based on slides by the co-chairs of the IPCC

[Matt Bridgestock, Director and Architect at John Gilbert Architects]

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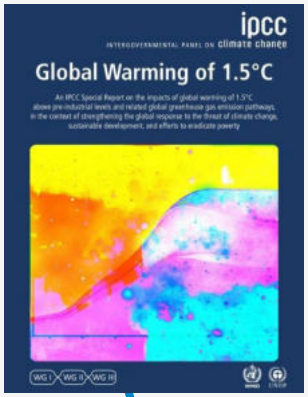
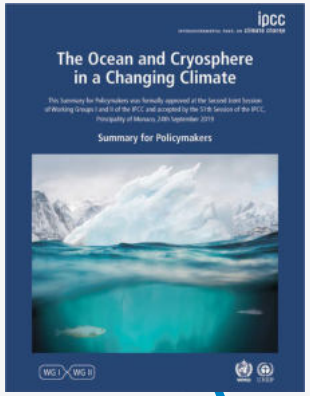
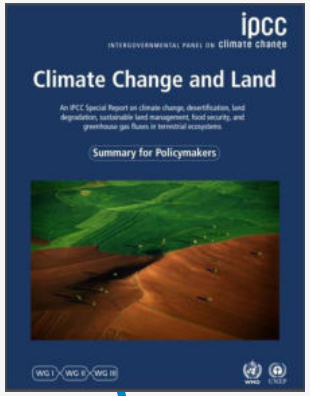
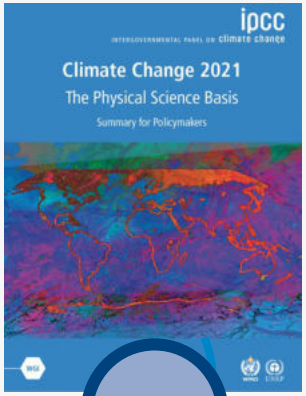
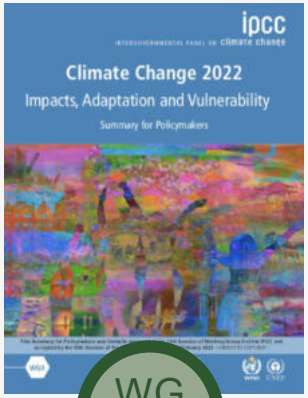




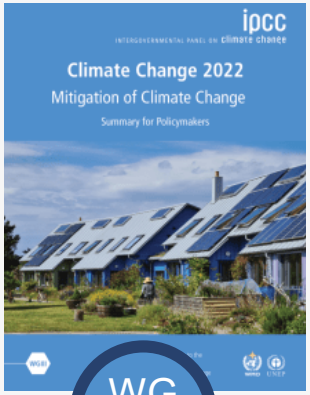




WG I



WG II



WG III

Synthesis Report

Report by numbers

	Authors	Contributing authors	Women / Men	Scientific papers	Review comments
WG I	243	517	28% / 72%	14 000 +	78 000 +
WG II	270	675	41% / 59%	34 000 +	62 000 +
WG III	278	354	29% / 71%	18 000 +	59 000 +

WG I

[Credit: NASA]

“Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.

WG I

[Credit: Yoda Adaman | Unsplash]

> It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

WG I

[Credit: Hong Nguyen | Unsplash]

“Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

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WG II

Global warming has caused dangerous and widespread disruption in nature…

[Pacific Southwest Forest Service, USDA CC BY 2.0]

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…and climate change is affecting the lives of billions of people, despite efforts to adapt.

[NLRC via IFRC CC BY-NC 2.0]

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WG II

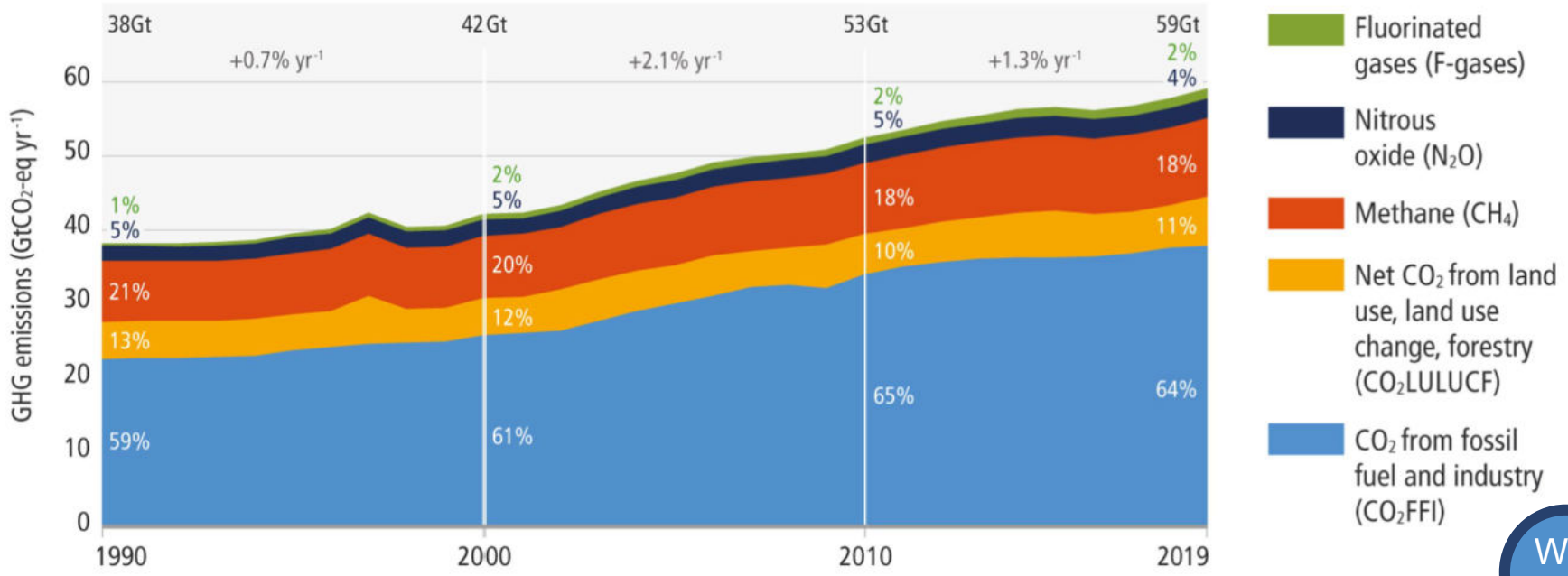
3.3 – 3.6 billion people live in hotspots of high vulnerability to climate change.

[Denis Onyodi / KRCS CC BY-NC 2.0]

“Climate resilient development is already challenging at current global warming levels.

The prospects will become further limited if warming exceeds 1.5°C and may not be possible if warming exceeds 2°C.

We are not on track to limit warming to 1.5 °C.



WG III

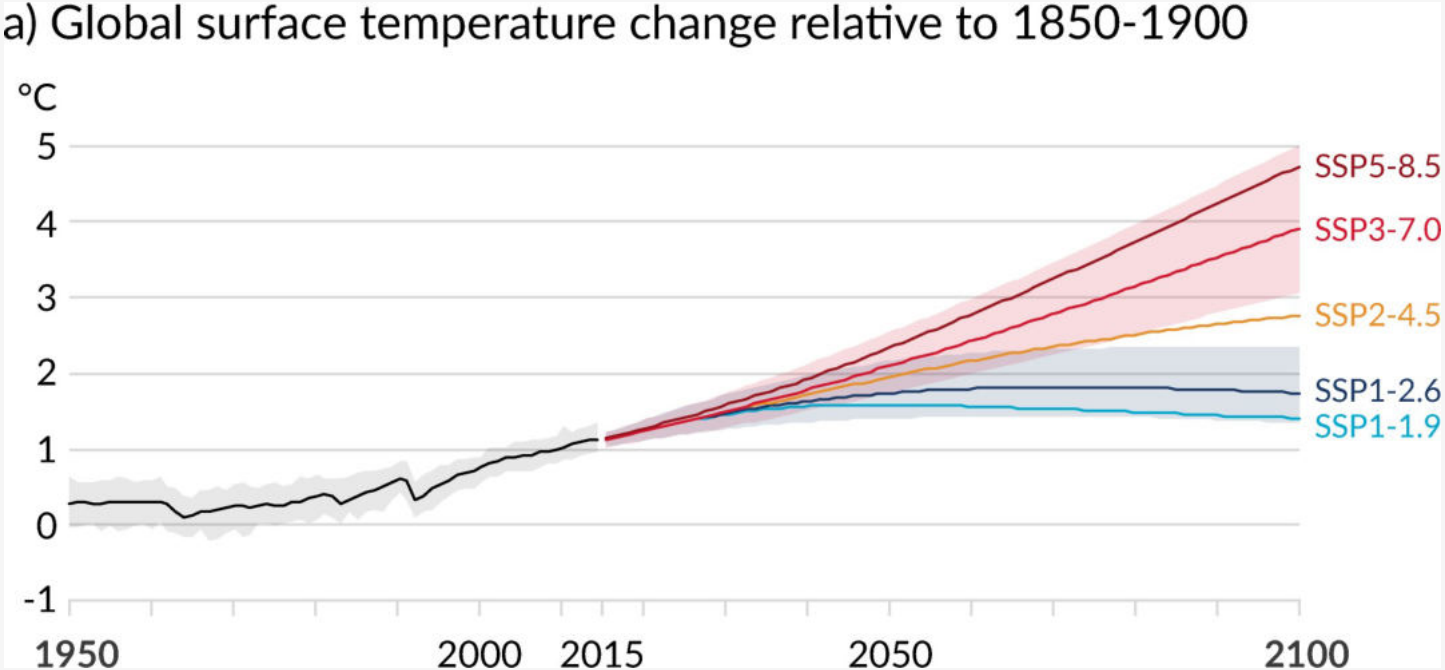
…but there is increased evidence of climate action

[Charlie Chesvick/IStock.com]

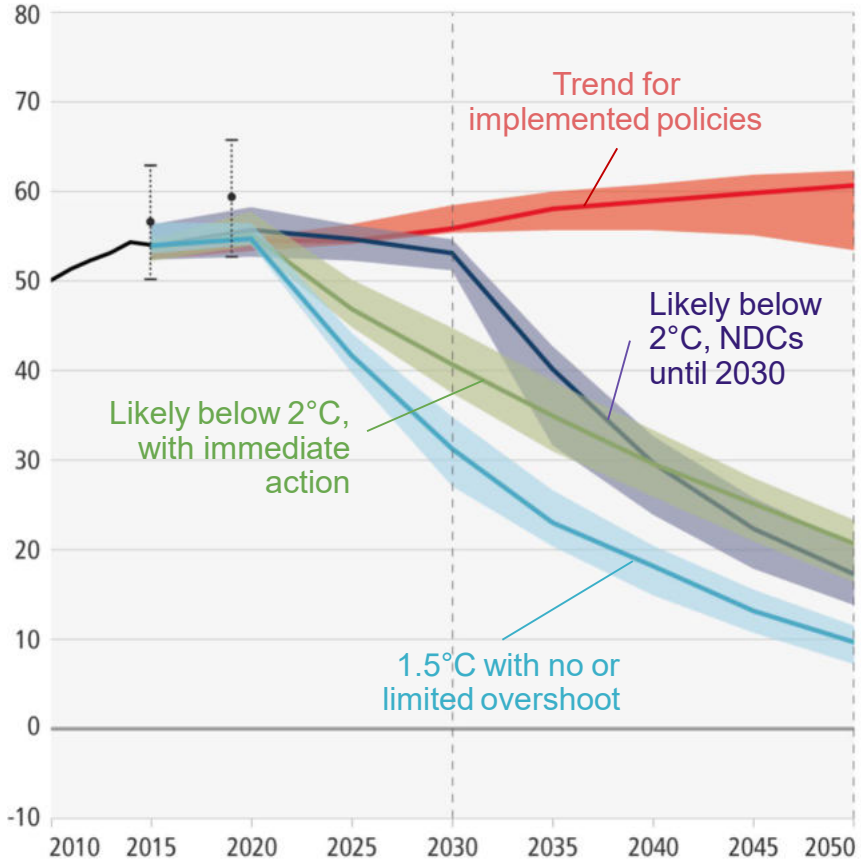
WG III

Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



WG I



Limiting warming to 1.5 °C

- Global GHG emissions peak before 2025, reduced by 43% by 2030.
- Methane reduced by 34% by 2030

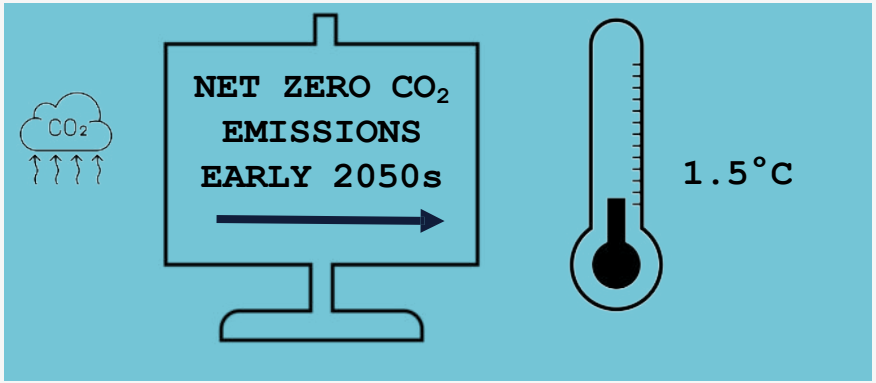
Limiting warming to around 2°C

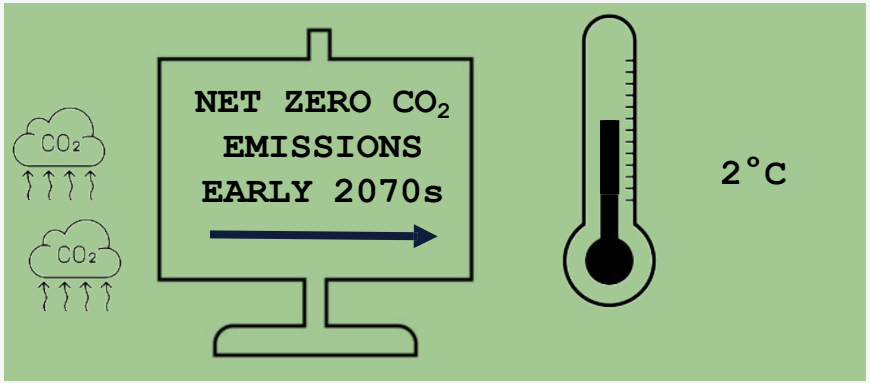
- Global GHG emissions peak before 2025, reduced by 27% by 2030.

(based on IPCC-assessed scenarios)

WG III

The temperature will stabilise when we reach net zero carbon dioxide emissions





(based on IPCC-assessed scenarios)

WG I WG III

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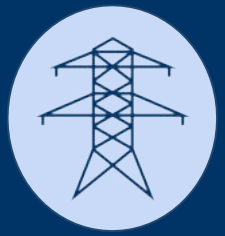
WG III

There are options available **now** in every sector that can at least **halve** emissions by 2030

Demand and services



Energy

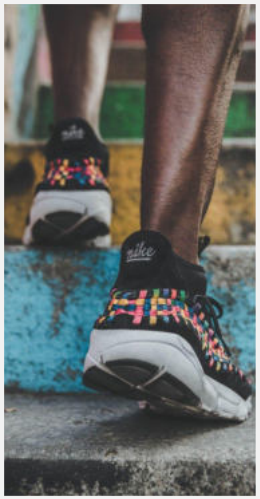
Land use

Industry

Urban

Buildings

Transport



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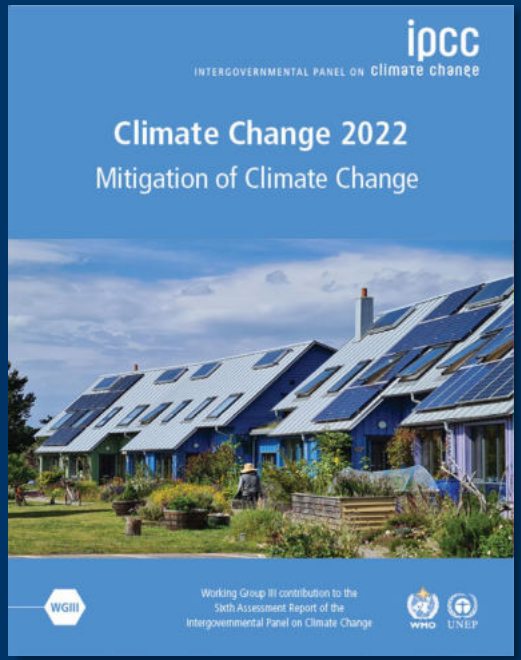
Demand and services

WG III

- potential to **bring down** global **emissions** by **40-70%** by 2050
- walking and cycling, electrified transport, reducing air travel, and adapting houses make large contributions
- **lifestyle changes** require **systemic changes** across all of society
- **some** people require additional **housing**, **energy** and **resources** for human wellbeing

[Bosch, Unsplash/Yoav Aziz, Adam Bartoszewicz, Victor Hernandez]



“ The evidence is clear: The window to secure a livable future is closing and the time for action is now.

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