Climate policy

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Sustainable Policy instruments: synergies and trade-off in global environmental policy

Who am I?

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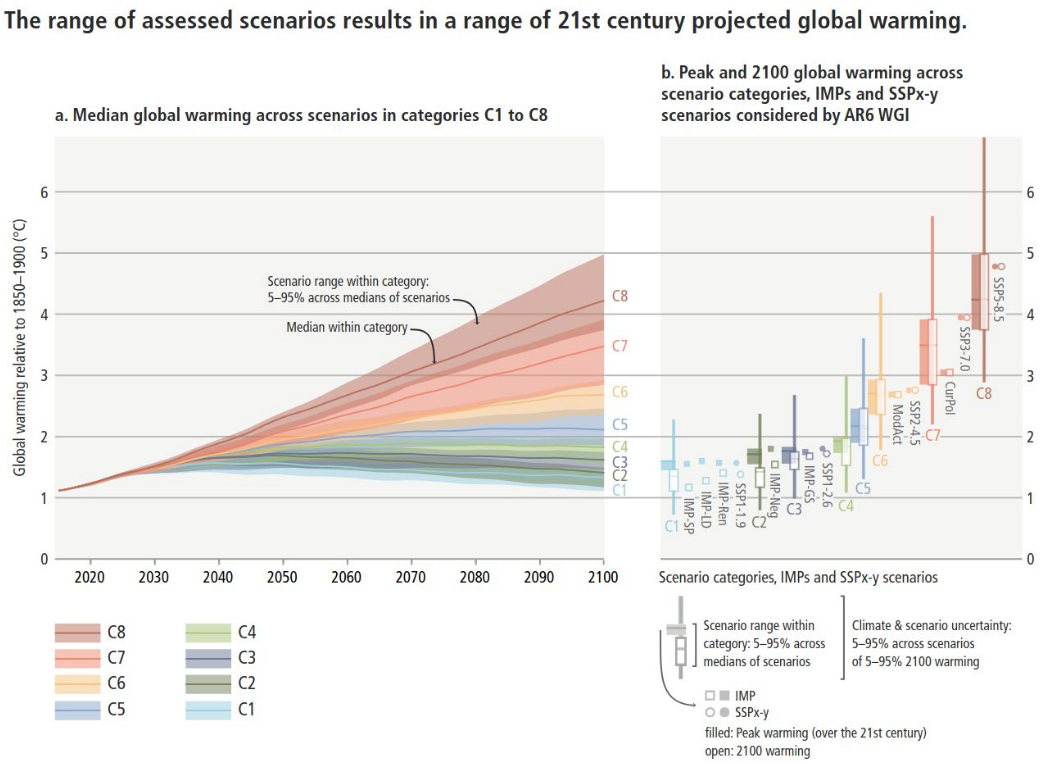
What do I do?

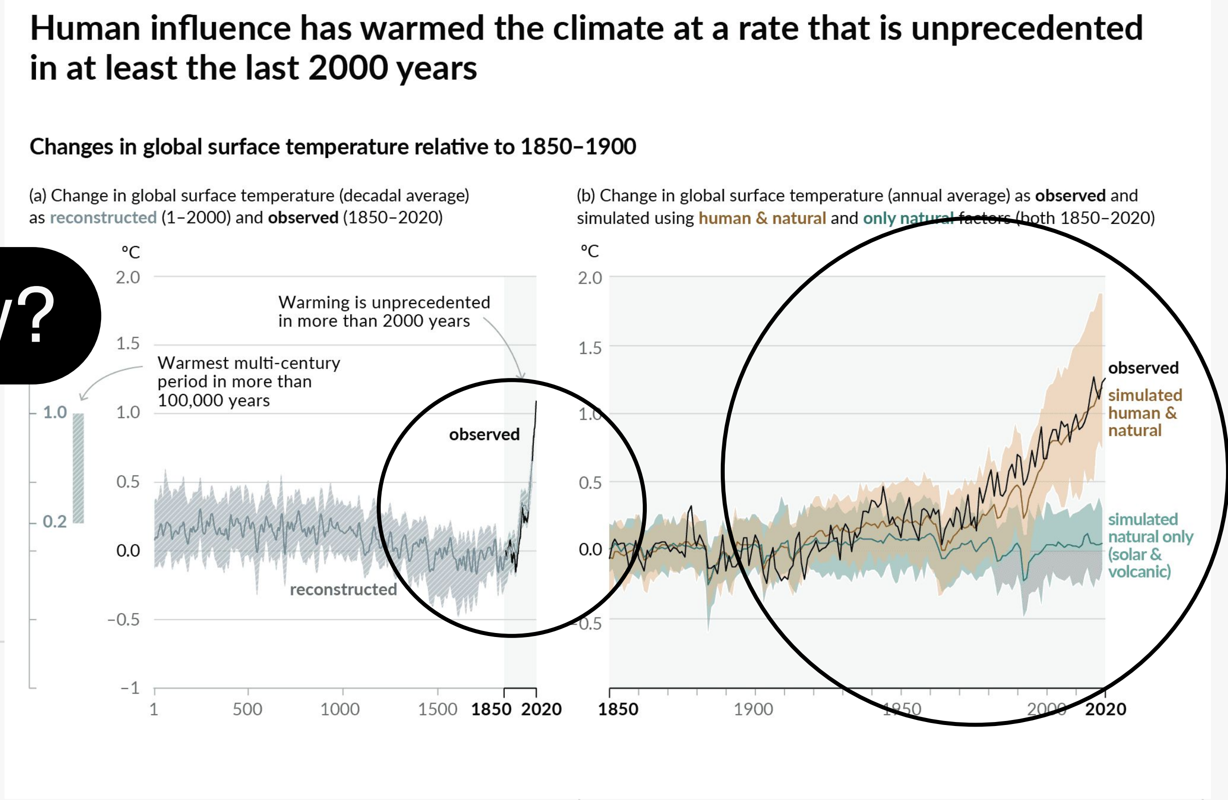


Source: IPCC AR6 WGIII

The Climate problem

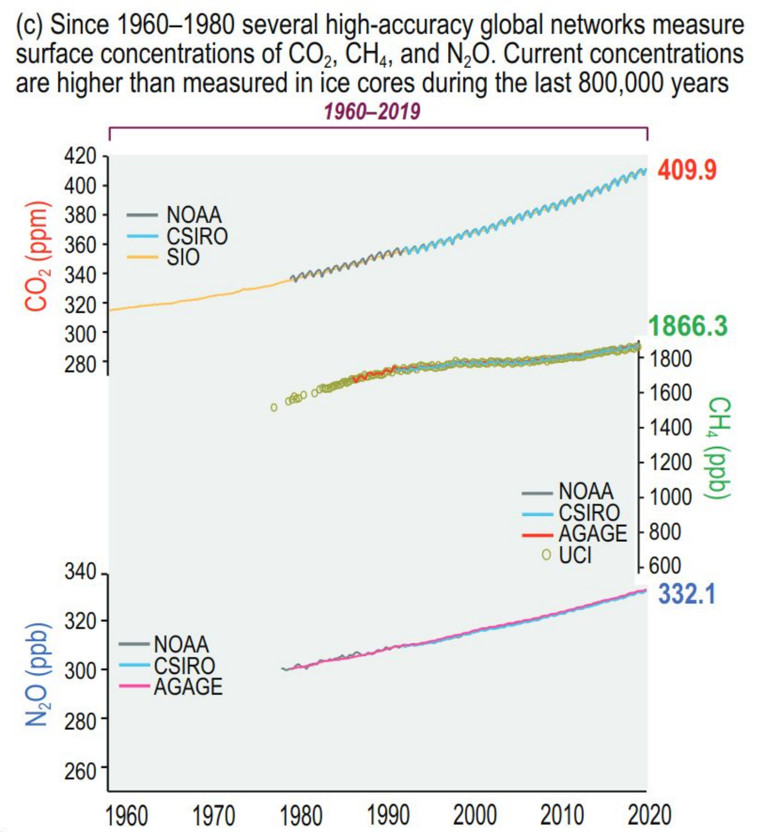
What do we know?

'It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred' (IPCC AR6, 2022)



What do we know?

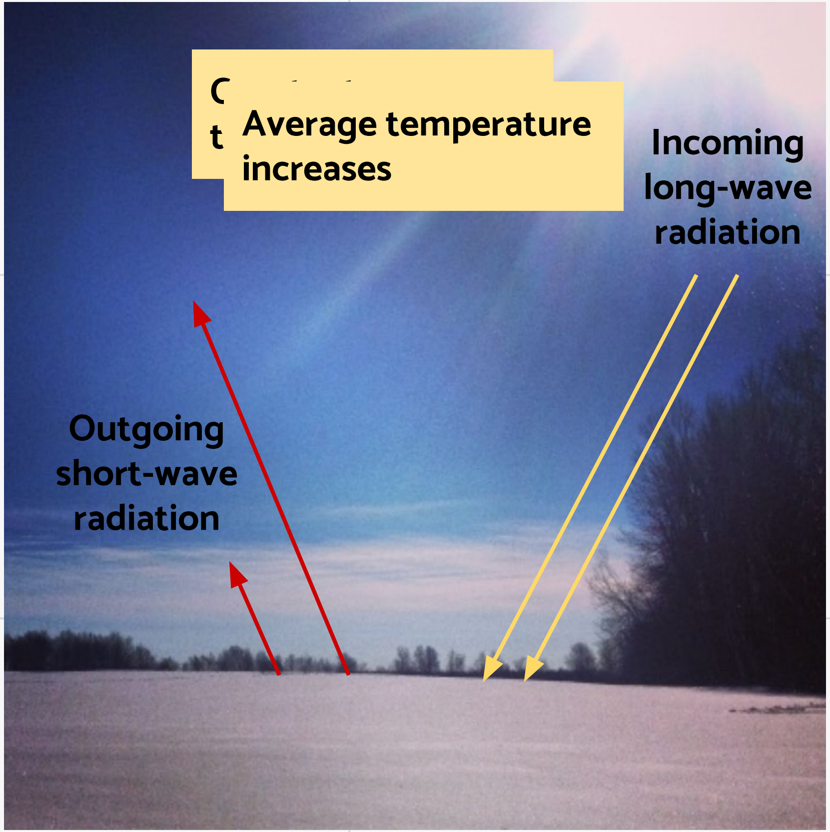
‘**Observed increases in well-mixed greenhouse gas (GHG) concentrations since around 1750 are unequivocally caused by human activities.** Since 2011 (measurements reported in AR5), concentrations have continued to increase in the atmosphere, reaching annual averages of 410 parts per million (ppm) for carbon dioxide (CO_2), 1866 parts per billion (ppb) for methane (CH_4), and 332 ppb for nitrous oxide (N_2O) in 2019.[6] Land and ocean have taken up a near-constant proportion (globally about 56% per year) of CO_2 emissions from human activities over the past six decades, with regional differences (high confidence)’ (IPCC AR6, 2022)



Source: IPCC AR6, 2022

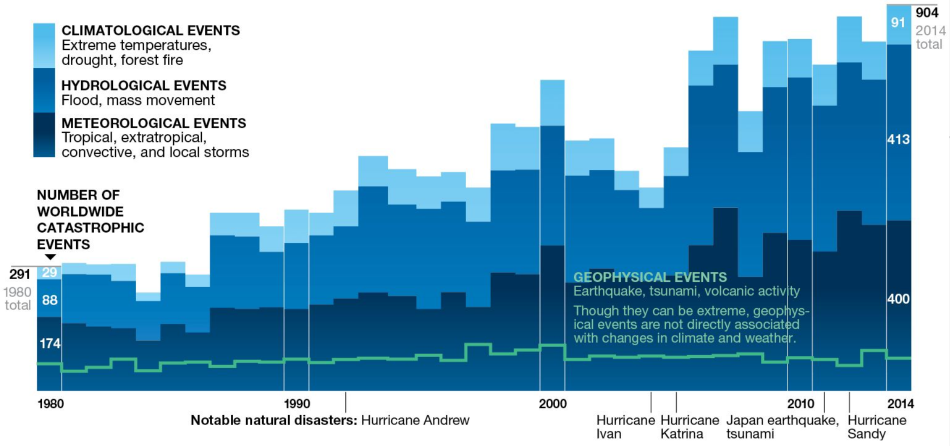
What do we know?

The balance between incoming and outgoing radiation determines the temperature



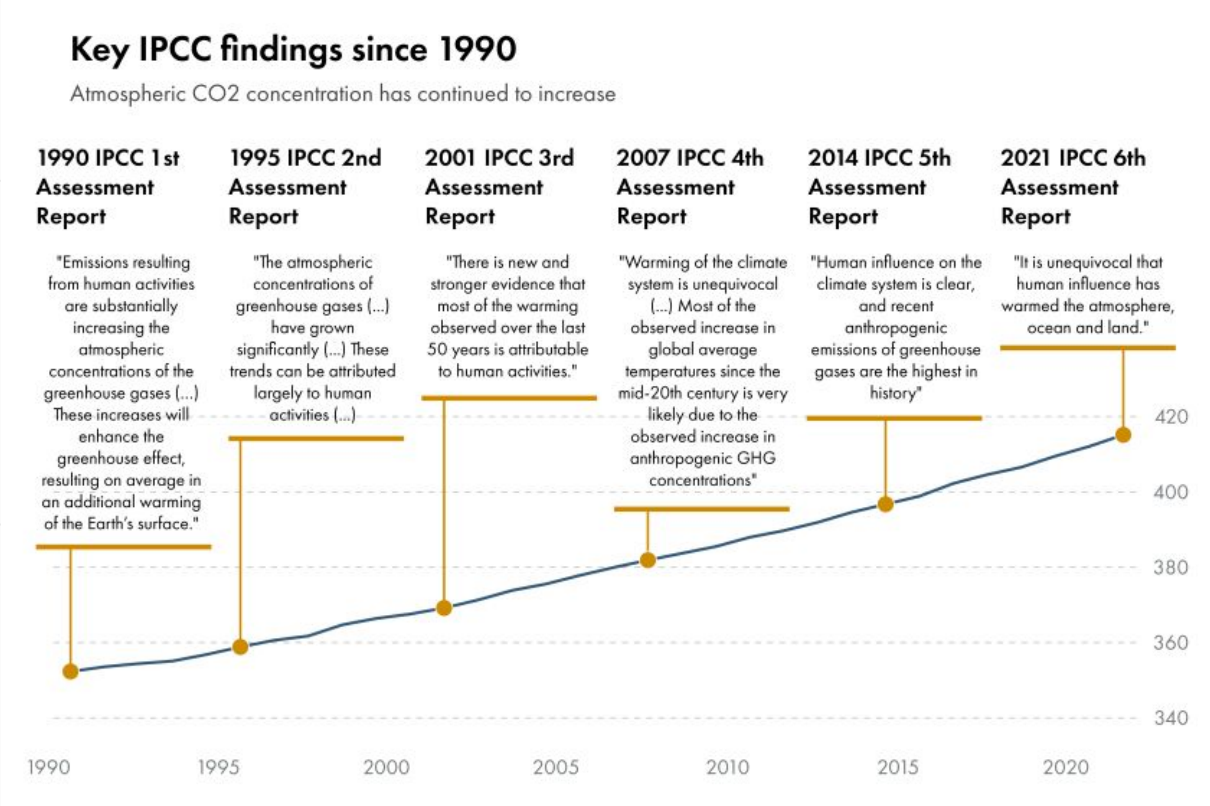
Consequences of a warmer world

- Sea Level rise
- Sea Ice and snow melting
- Ocean acidification
- Disrupts ocean circulations
- Increases floods
- Increasing wildfires
- Increasing droughts -> reduce the availability of freshwater
- Increase in climate refugees -> conflict
- Biodiversity loss
- Human health
- Economic loss

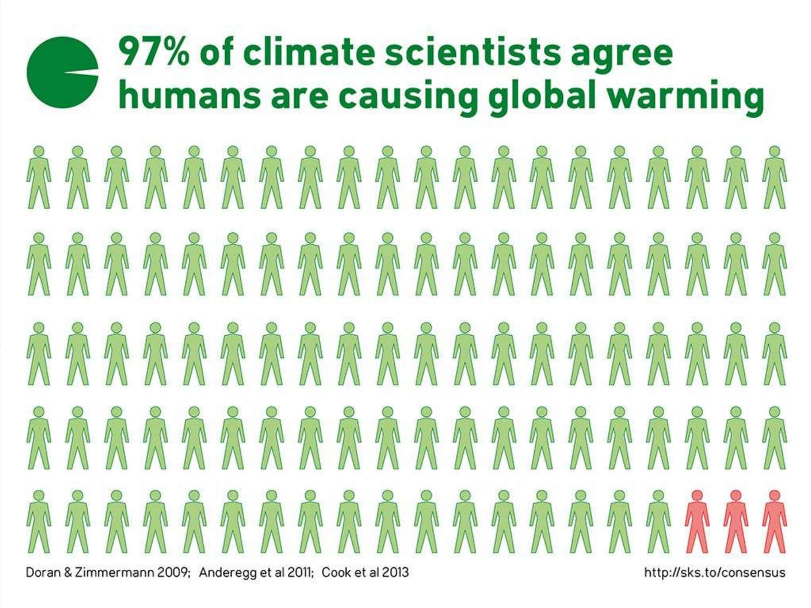


Source: National Geographic

How did we get here?



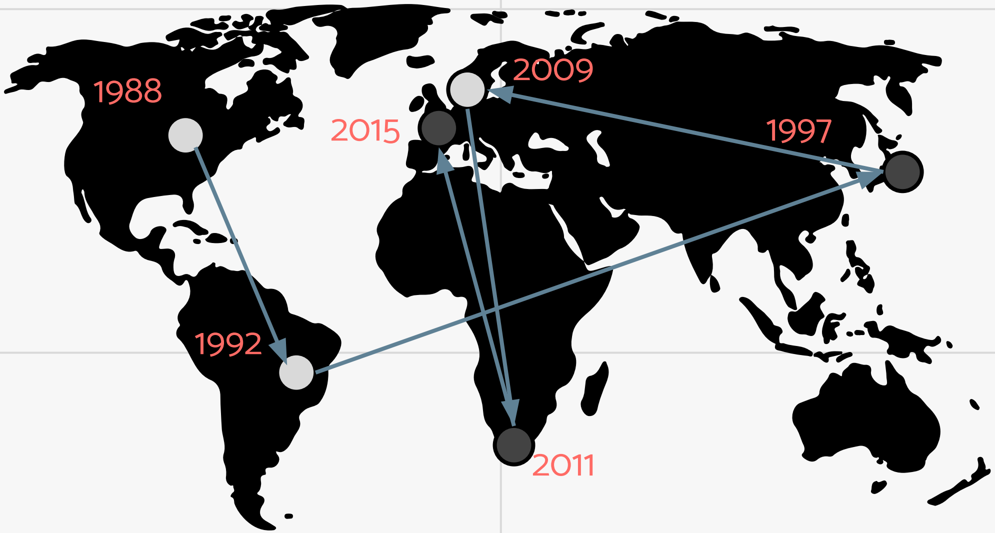
How does science works and do we all agree?



- Only 3% disagree
- Examining 11 944 climate abstracts from 1991–2011

source: John Cook *et al* 2013 *Environ. Res. Lett.* **8** 024024

History of climate treaties and negotiations

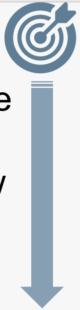


1988 WMO and UNEP established the **IPCC**
1992 **Earth summit** in Rio

1997 Kyoto Protocol
2009 Copenhagen accord
2011 Durban platform
2015 Paris agreement

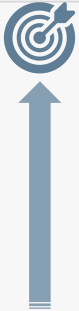
Kyoto vs Paris
Top-down vs Bottom-up

KYOTO



- From 2008 to 2012, the developed countries were required to reduce their emissions by 5.2% below the 1990 level
- Legally binding

PARIS

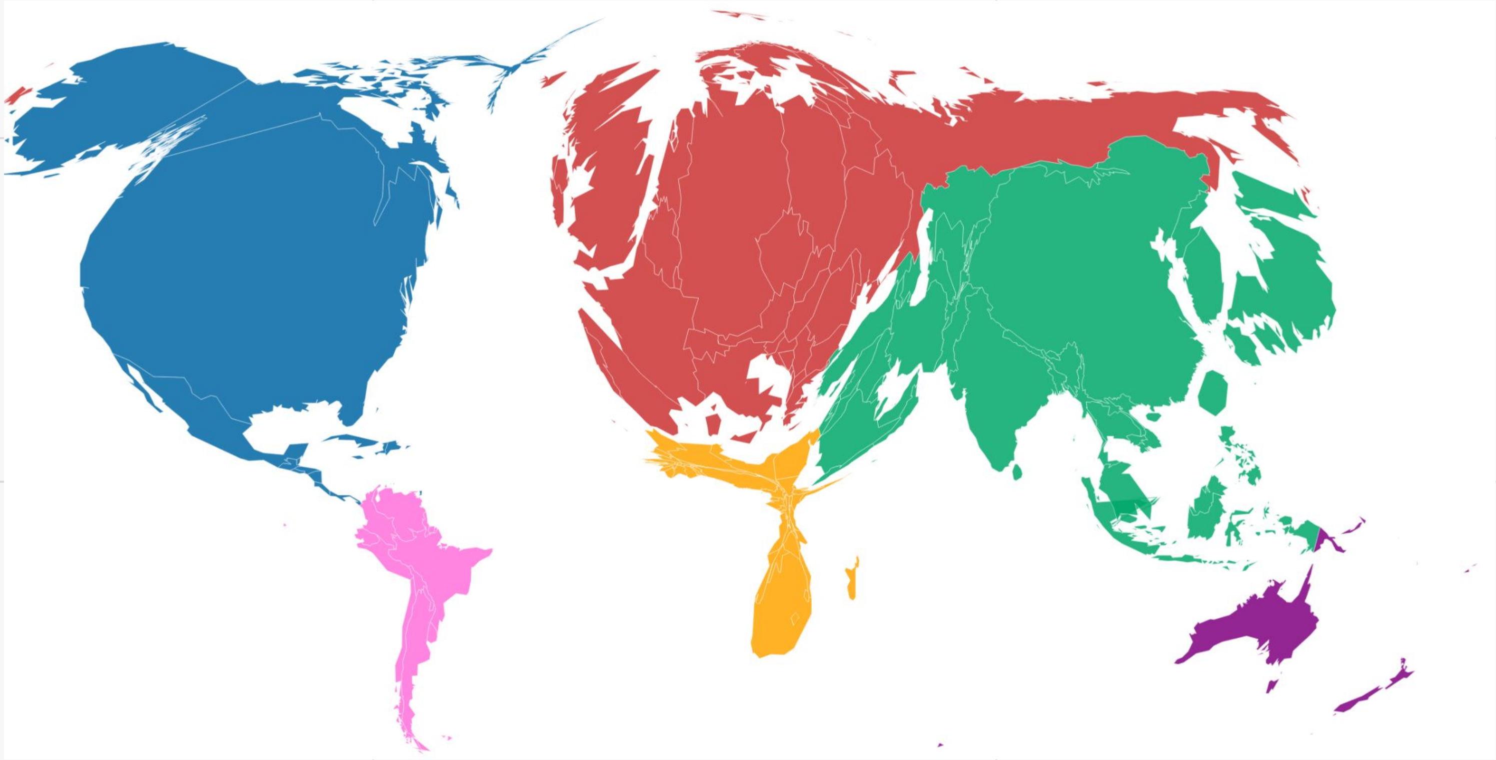


- All parties were invited to submit their contributions
- Not Legally binding
- Keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius

02

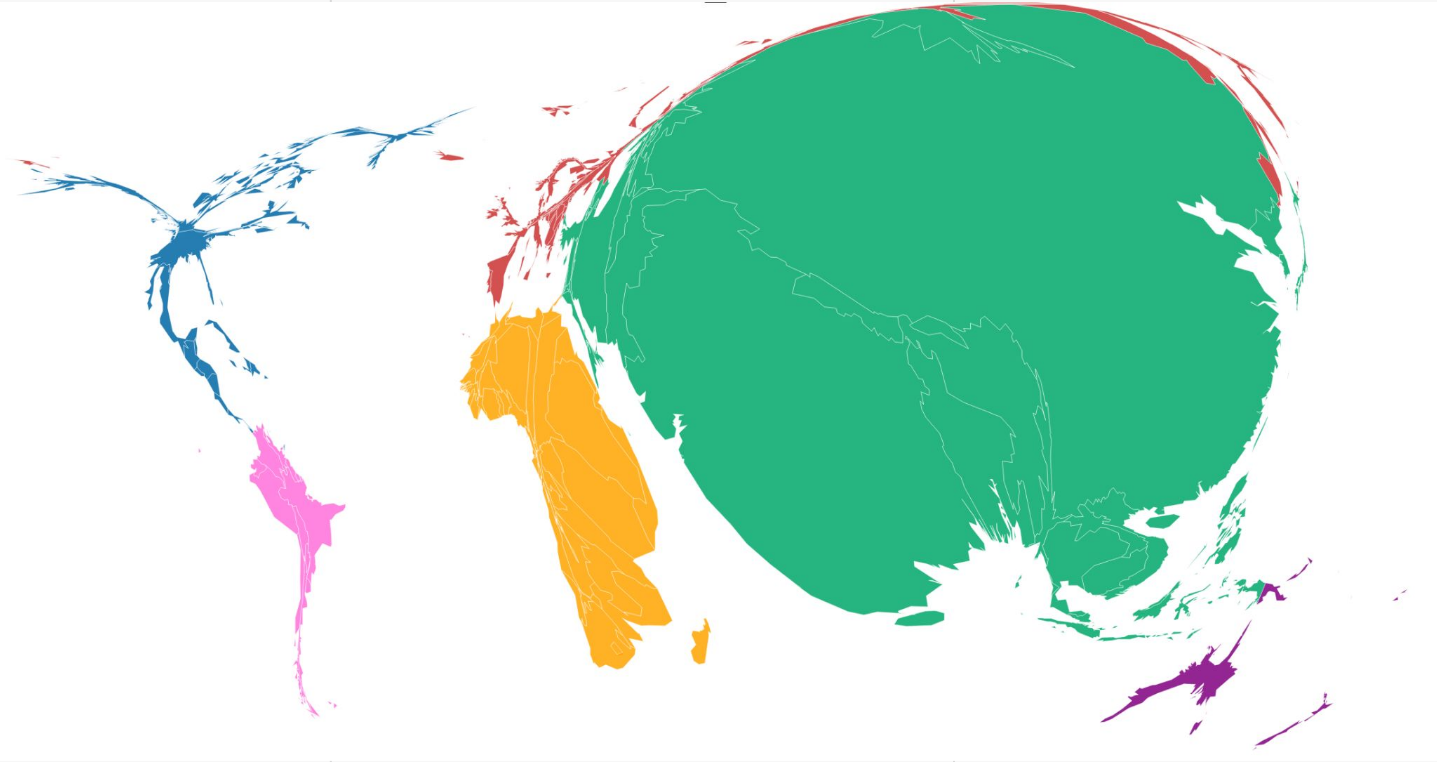
Climate, a complex problem…

Historical CO_2 emissions



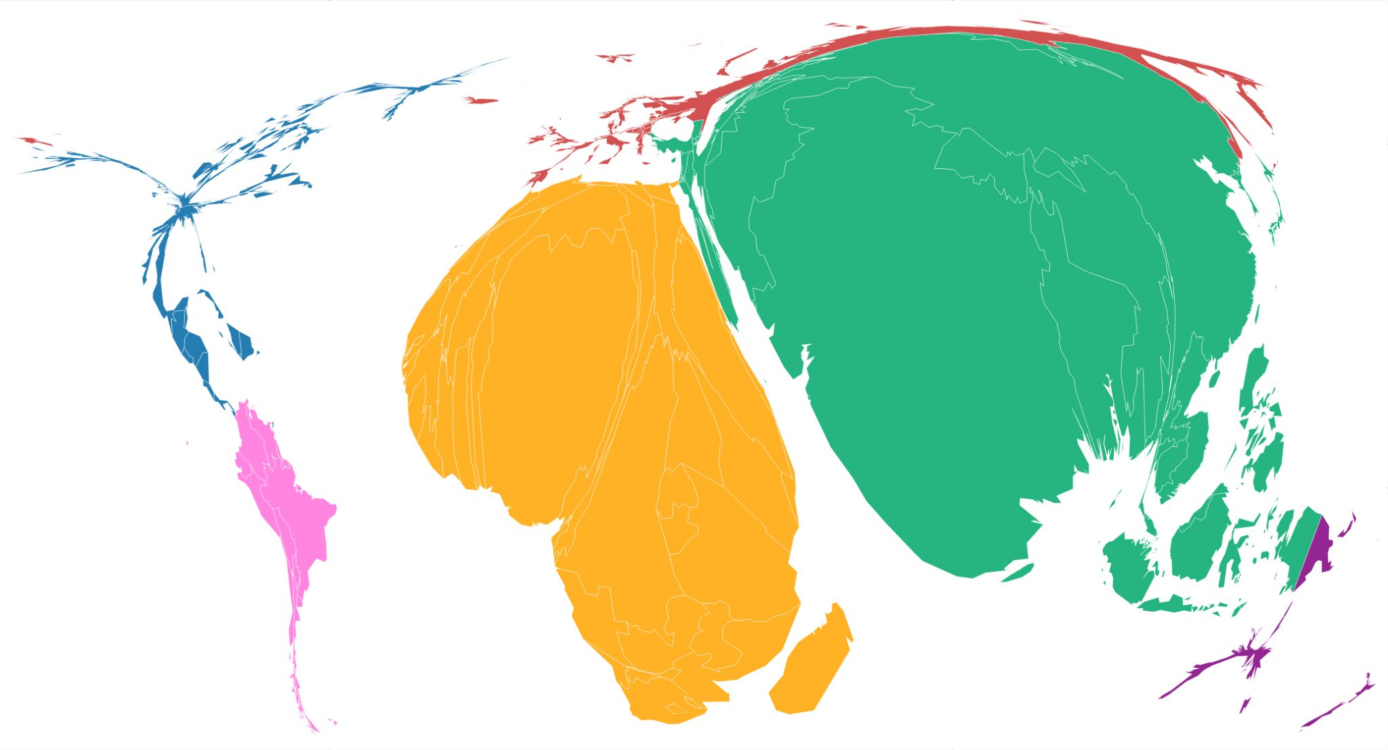
source: World Bank and Global Carbon Project

People at risk



source: World Bank and Global Carbon Project

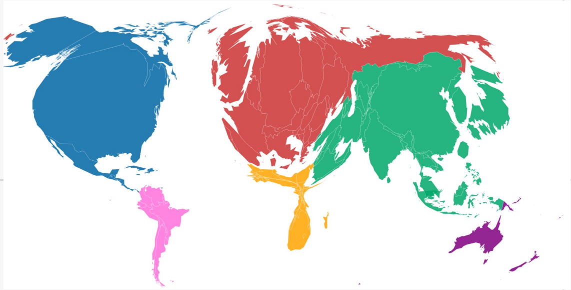
Poverty



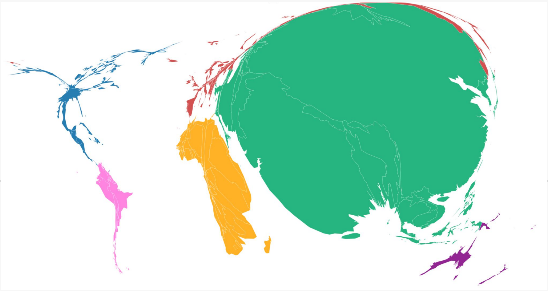
source: World Bank and Global Carbon Project

Do you see the problem?

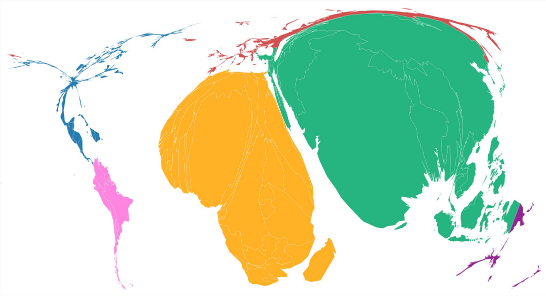
Historical CO2 emissions



People at risk



Poverty



source: World Bank and Global Carbon Project

The Intertemporal Problem

We will have to decide now but the future generations will be the ones living the consequences of our decisions.

How should we discount the future?

(mitigation, risky options (e.g. geo-engineering))

1M$ today * e ^ (-r*t) (r= discount rate)

in 2100:

1% -> 458406,0 $

3% -> 96327,6 $

4% -> 4253,6 $

Why is Climate change such a complex problem?

Long time horizons: CO_2 stays in the atmosphere for ~100 years

North-South equity concerns: mismatch between responsibility and vulnerability

How to deal with GDP growth? And energy poverty

Many-nation "commons": A country alone cannot avoid impacts even if it cuts its emissions completely

Uncertainty: adaptation and mitigation measures and tipping-points

Emissions reductions will not be felt immediately, but need to be reduced now!

So…How do we solve it?

The principles of Climate policy (UNFCCC)

Fairness	Justice	Equity
Agree on fairness	Impacts are unevenly felt (adaptation) Loss and damage	”common but differentiated responsibilities”

Policy instruments

Three types of policy tools

Command & control

- Emissions standards
- Performance
- Labels
- Renewable mandates
- Extraction bans

Market-based

- Carbon tax (or social cost of carbon)
- cap-and-trade

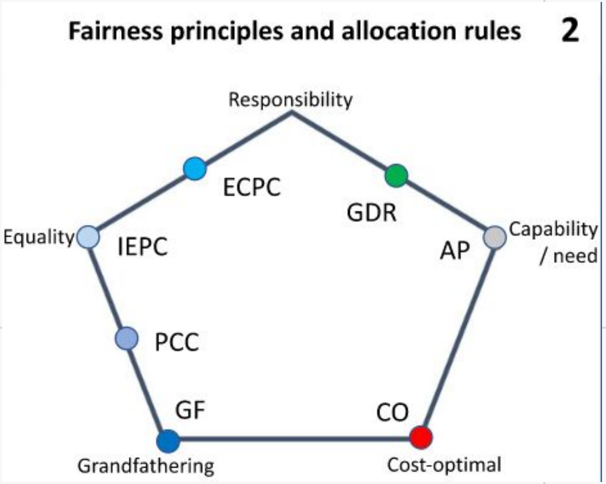
R&D based

Subsidies
R&D spending

Cap-and-trade

Effort sharing

There are several ways of allocating everyone's pollution permits



- GF: Grandfathering
- IEPC: Immediate per capita convergence
- PCC: Per capita convergence
- ECPC: Equal Cumulative per capita emissions
- AP: Ability to pay
- GDR: GH development rights
- CO: Cost-Optimal

source: van den Berg, N.J., van Soest, H.L., Hof, A.F. *et al.* Implications of various effort-sharing approaches for national carbon budgets and emission pathways. *Climatic Change* **162,** 1805–1822 (2020). https://doi.org/10.1007/s10584-019-02368-y

Climate policy tools (the article 6)

CDM and JI

Clean development mechanism and Joint implementation

Loss and damage fund

Adaptation fund

Green Climate fund

REDD+

Reducing emissions from deforestation and forest degradation

IAMs, a way to sneak a peek at possible futures

Integrated assessment models (IAMs): combine different strands of knowledge to explore how human development and societal choices interact with and affect the natural world.

IAMs offer valuable insights how the world's energy and land-use systems would need to change to respond to the climate challenge

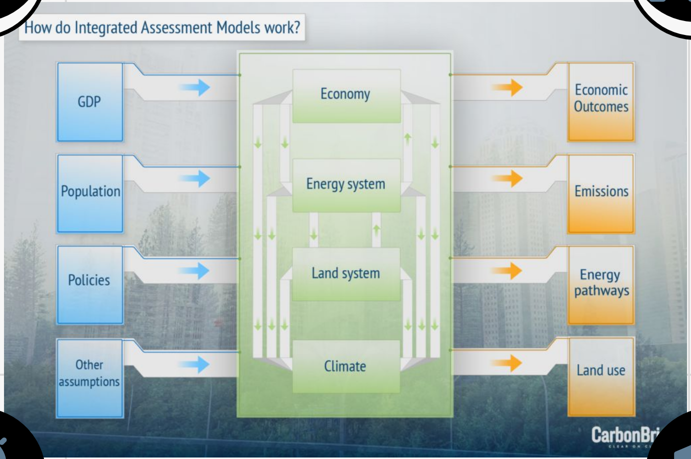
How IAMs work?

Socioeconomic assumptions

Assumptions about population and GDP

Technology innovation

Technology costs and breakthroughs



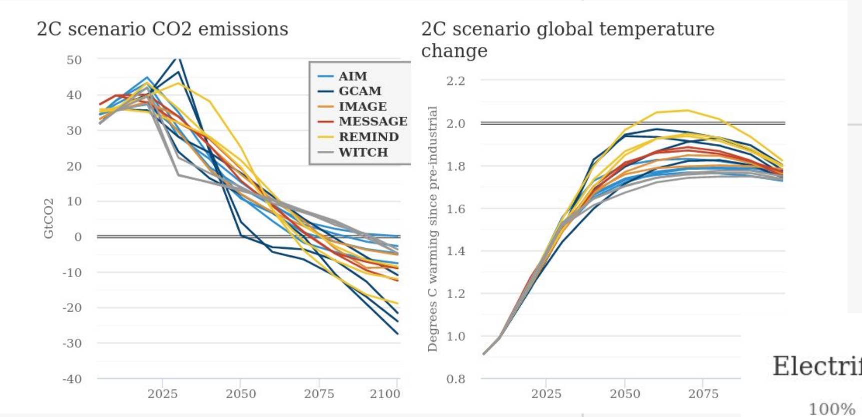
Climate response

Climate sensitivity
Climate damages

POLICY

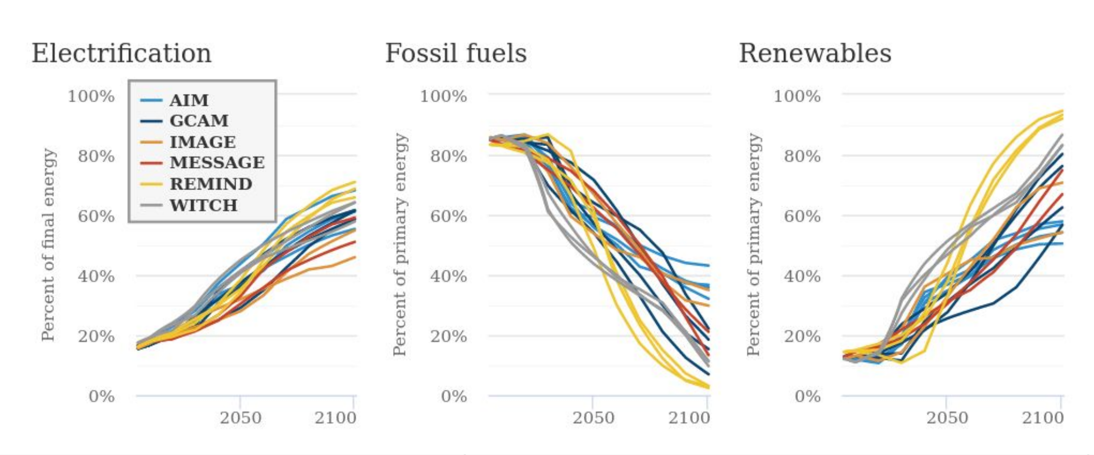
Is the one driver that can impact the future temperature

Why do we use IAMs? (uncertainty)



Models may disagree on:

- How fast should technology be deployed
- Reliance on negative emission technologies
- ...



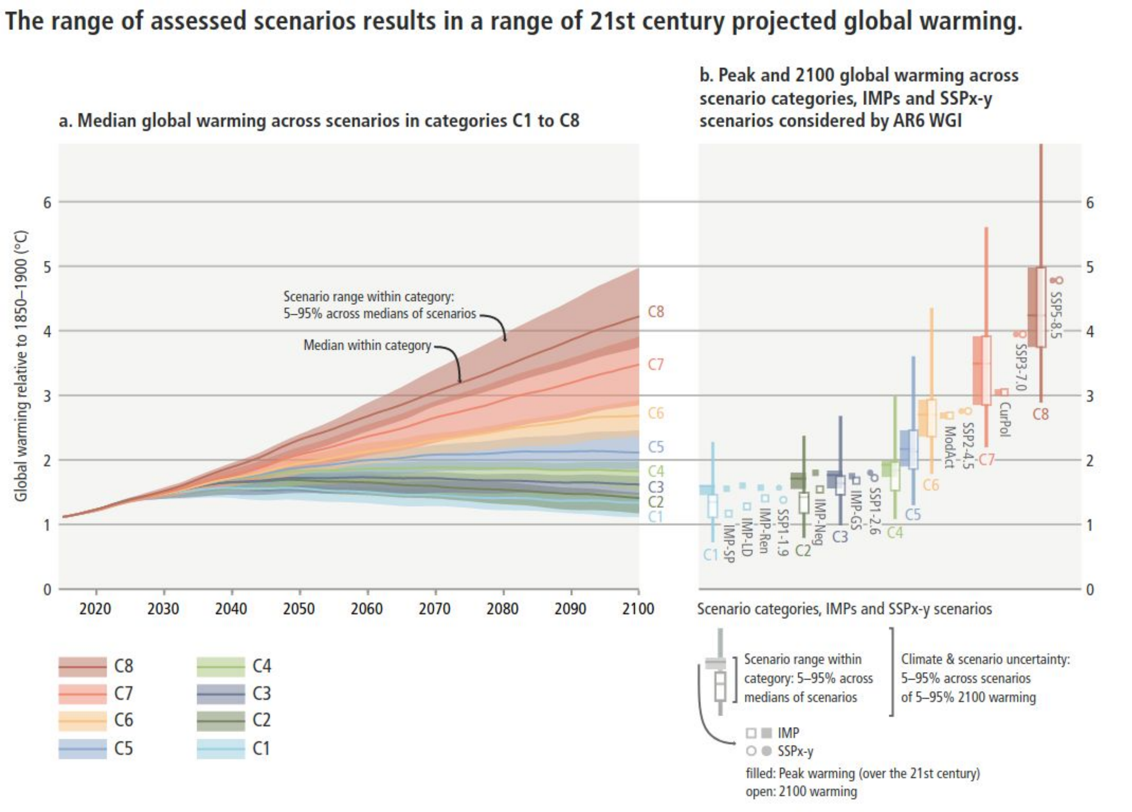
Models agree on:

- Peak years
- Net-zero timing
- Phase-out fossils
- Scale-up renewables
- ...

Source: Carbon Brief

IAMs in IPCC AR6?

The way in which the future will unfold, depends on GHG emissions which in turn depend on Policy

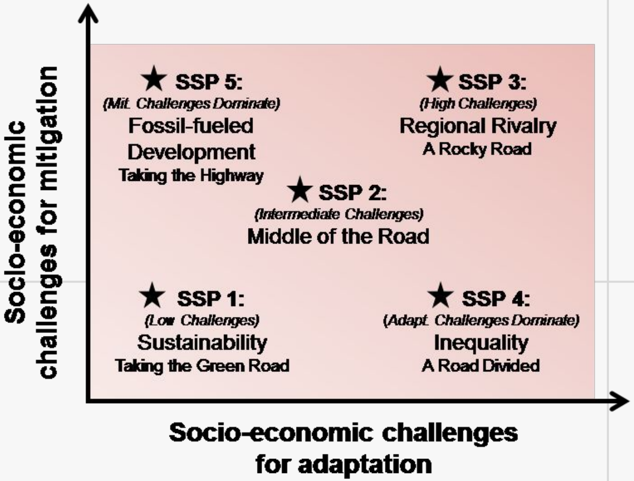


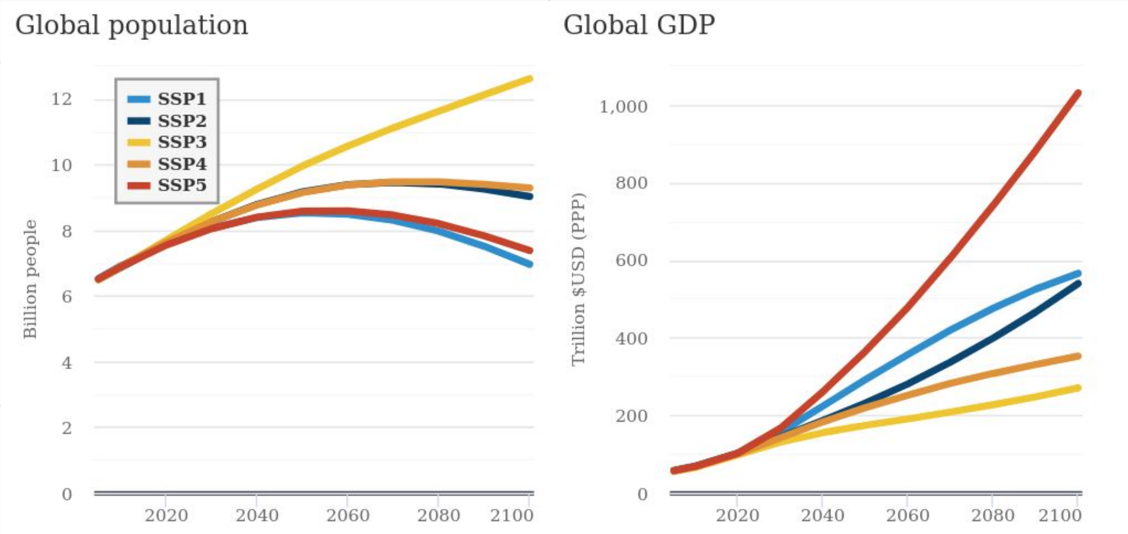
Source: Carbon Brief

What type of scenarios are we considering?

The Shared Socioeconomic Pathways (SSPs)

Socioeconomic narratives (baselines) that do not assume any climate policy

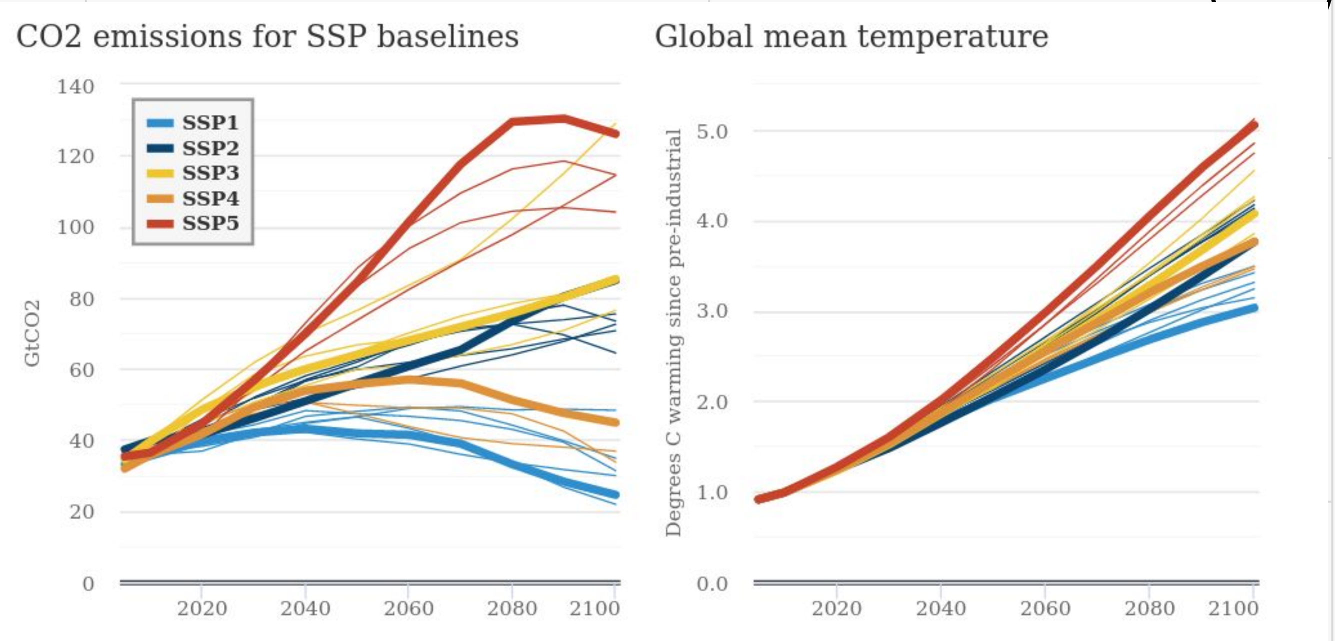




Source: Carbon Brief

The Shared Socioeconomic Pathways (SSPs)

Socioeconomic narratives imply different futures if no climate policy is implemented



Source: Carbon Brief

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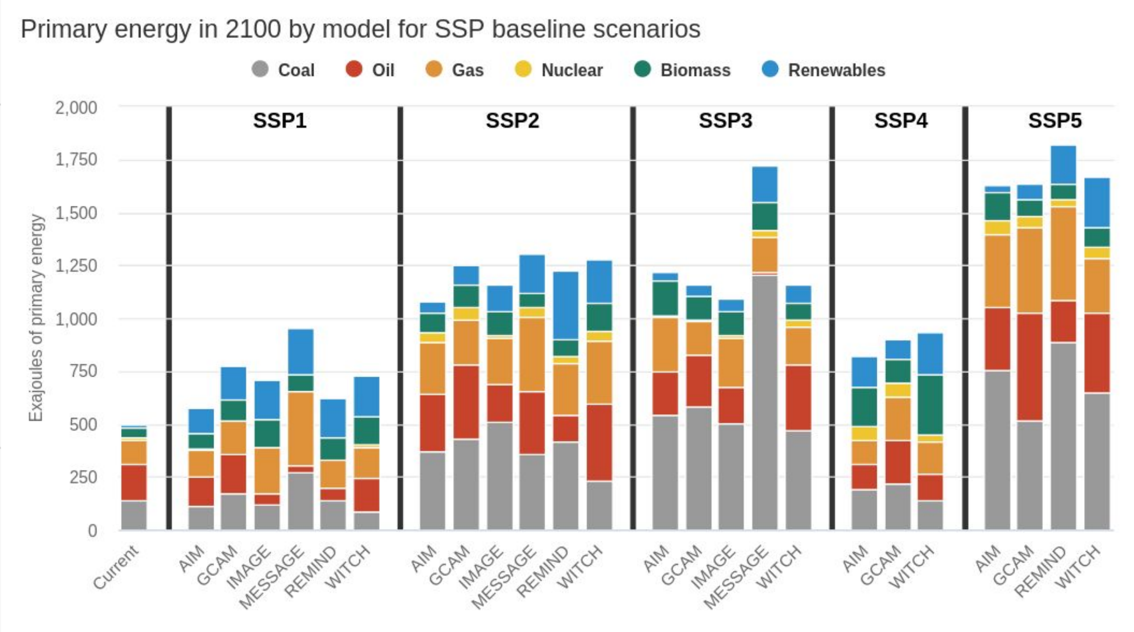
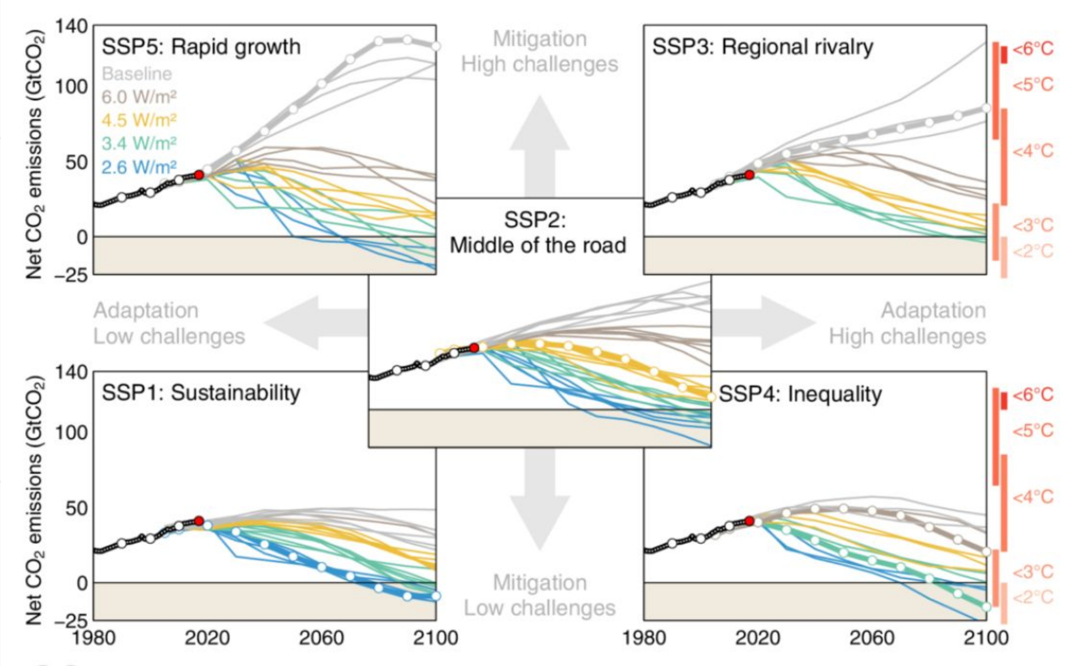


Source: Carbon Brief

Combining narratives with Climate policy

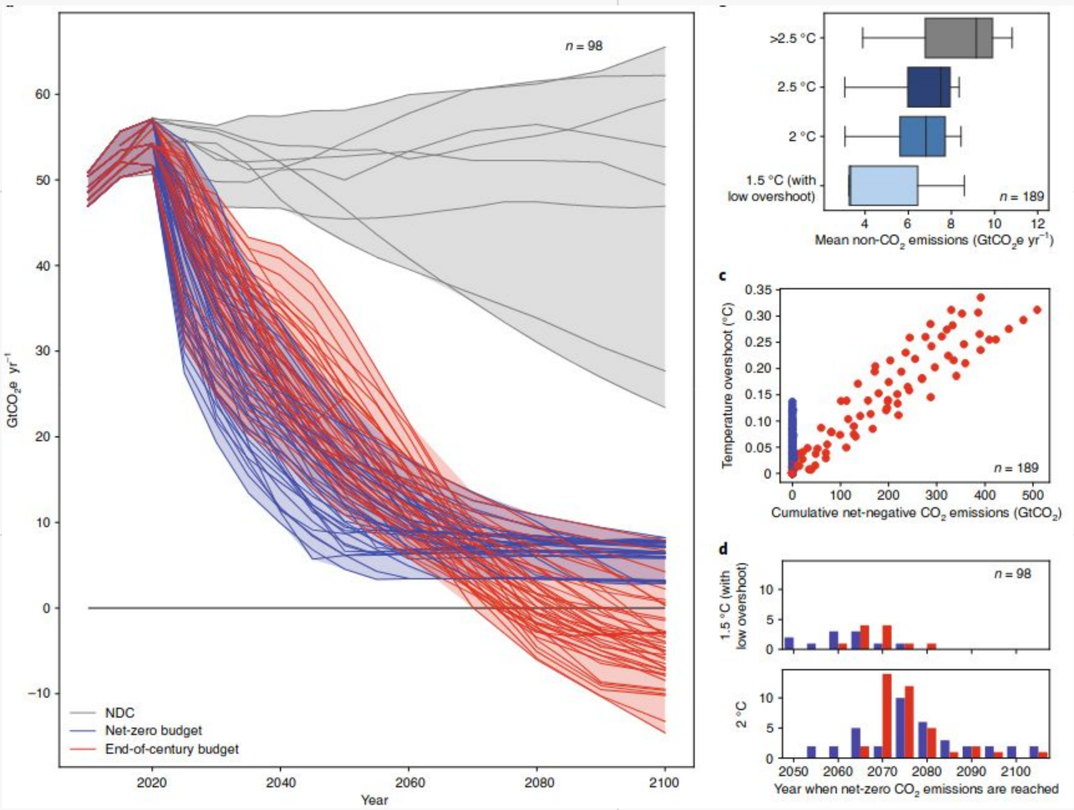
Socioeconomic narratives combines with the Representative Concentration Pathways (Climate stringency)



Source: Carbon Brief

New generation of Scenarios (IPCC AR6)

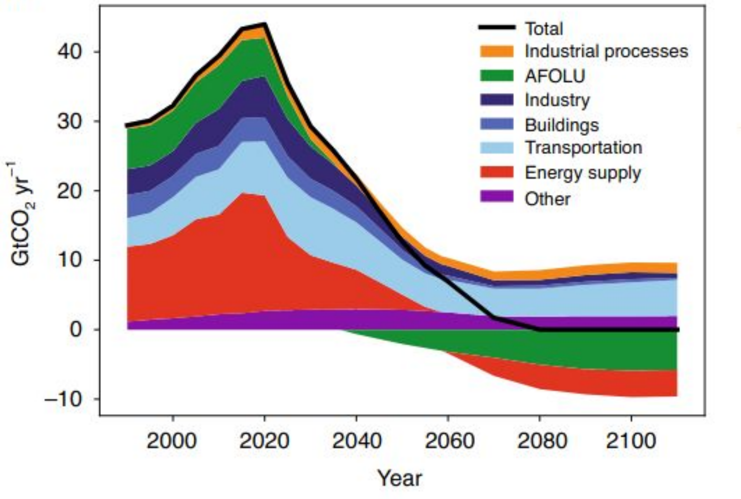
Net-zero budgets: Avoiding irreversible damages

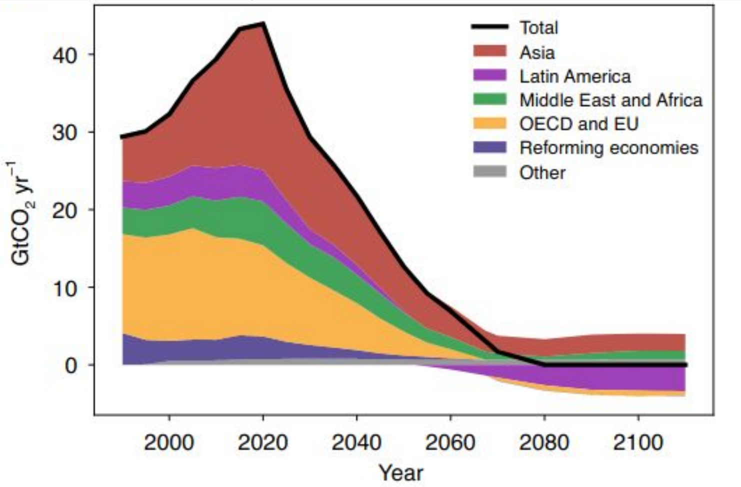


Source: Riahi, K., Bertram, C., Huppmann, D. *et al.* Cost and attainability of meeting stringent climate targets without overshoot. *Nat. Clim. Chang.* **11,** 1063–1069 (2021). https://doi.org/10.1038/s41558-021-01215-2

New generation of Scenarios (IPCC AR6)

Net-zero budgets: Avoiding irreversible damages





Decision under uncertainty

Parametric uncertainty

Uncertainty about a assumptions o values and quantities

Structural uncertainty

Uncertainty in the form of functions or models

Indeterminacy

We do not know what we do not know

Decision Criteria

Maximax

Chose the alternative with the best possible outcome

Maximin

Choose the best of the worse possibilities

Minimax Regret

Choose the least regret possibilities, minimize loss in case of a bad decision

Coefficient of optimism criteria

Choose your level of risk aversion and do a weighted average of the best and worst possible outcomes

Likelihood criteria

Choose the alternative with the best average value

Expected value

When probability of each outcome is known

Let's look at a practical example

Internalizing air pollution health-economic impacts into climate policy — A global modelling study

The Lancet Planetary Health (2022)

L. Aleluia Reis, L. Drouet, M. Tavoni

RFF CMCC European Institute on Economics and the Environment

Air Pollution and Climate Change

- **Air pollution** is responsible for millions of deaths worldwide and crop loss every year.
- **Air pollution** Globally, in 2019, from all the reported causes of death, 1 out of 9 people died prematurely due to air pollution exposure (IHME, 2021)
- **Climate change** will be responsible for a wide range of impacts, including mortality.
- **Both** share a common origin — fossil fuel burning — and possibly a common solution — a clean energy transition.

Air Pollution and Climate Change — Synergies and trade-offs

No straightforward synergies and co-benefits

- Some air pollutants are reflecting aerosols ⟶ Removing pollution may cause warming
- 2 channels of air pollution reduction:
  - control: end-of-pipe (EOP) technology ⟶only reduces air pollution
  - structural: by changing the energy system (sources) ⟶ reduces both GHG and air pollutants
- Different temporal (long lived vs short lived) and spatial scales (controlled by local policies and regional meteorological and topographical effects.)

Cost-Benefit Analysis of Air Pollution (CBAP)

- **CBAP** quantifies economically the costs and benefits of a given policy.
- **Optimal CBAP** balances pollution abatement costs and the avoided impacts from reduced mortality and crop losses.
- **In this study**, we compute global optimal CBAP policies in the context of the Paris Agreement.

Previous studies

- Bollen et al. (2009): Global optimal CBA of AP and CC
- Vandyck et al. (2018): Non-optimal CBAP of the Paris Agreement
- Scovronick et al. (2019): Global optimal CBA of AP and CC

Global Optimal CBAP of the Paris Agreement

All features of our study:

- **Detailed energy system** with a rich set of mitigation technology options (WITCH)
- **Marginal abatement costs** rather than total abatement costs (Optimization)
- AP impacts from O_3 and $PM_{2.5}$: premature deaths and 4 crop losses (FASST**R**)
- Impacts on **aerosol forcing** using a climate model (MAGICC)
- **Endogenous** end-of-pipe control measures via abatement cost curves (GAINS)

Integrated Modelling Framework

WITCH RFF CMCC

Integrated Modelling Framework

WITCH RFF CMCC

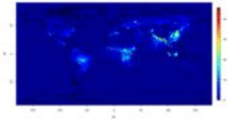
AP EMISSIONS

$$E = E_f \left(1 - ABAT_{ap}\right) \times A_{ct}$$

Integrated Modelling Framework

AP IMPACT

FASST**R**



$C = f\,(E, M, Chem)$

Premature Deaths

$M = f\left(m_0, P, C_{PM_{2.5}, O_3}\right)$

Crop Loss

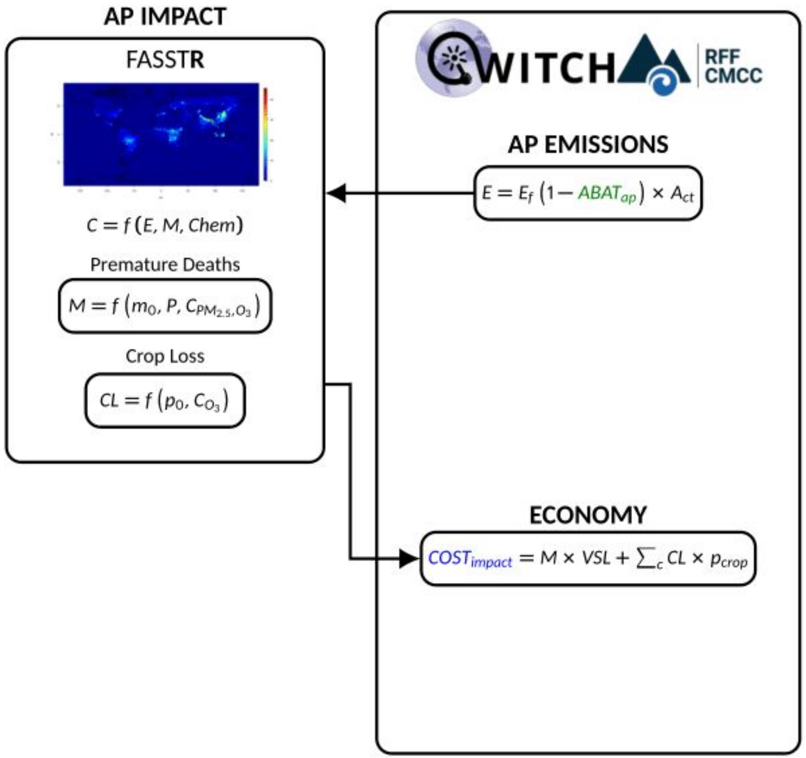
$CL = f\left(p_0, C_{O_3}\right)$

WITCH RFF CMCC

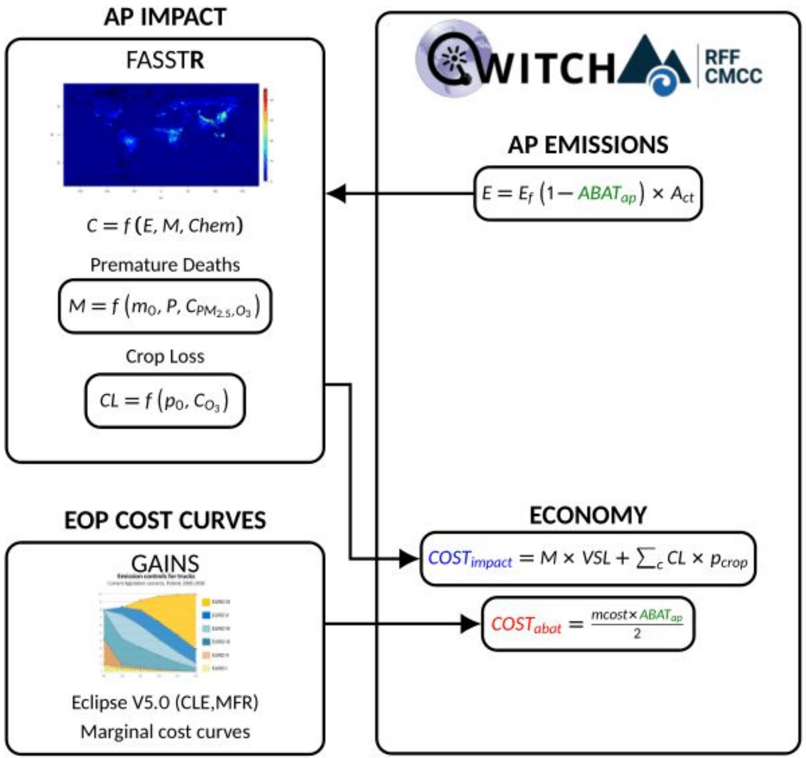
AP EMISSIONS

$E = E_f\left(1 - ABAT_{ap}\right) \times A_{ct}$

Integrated Modelling Framework



Integrated Modelling Framework



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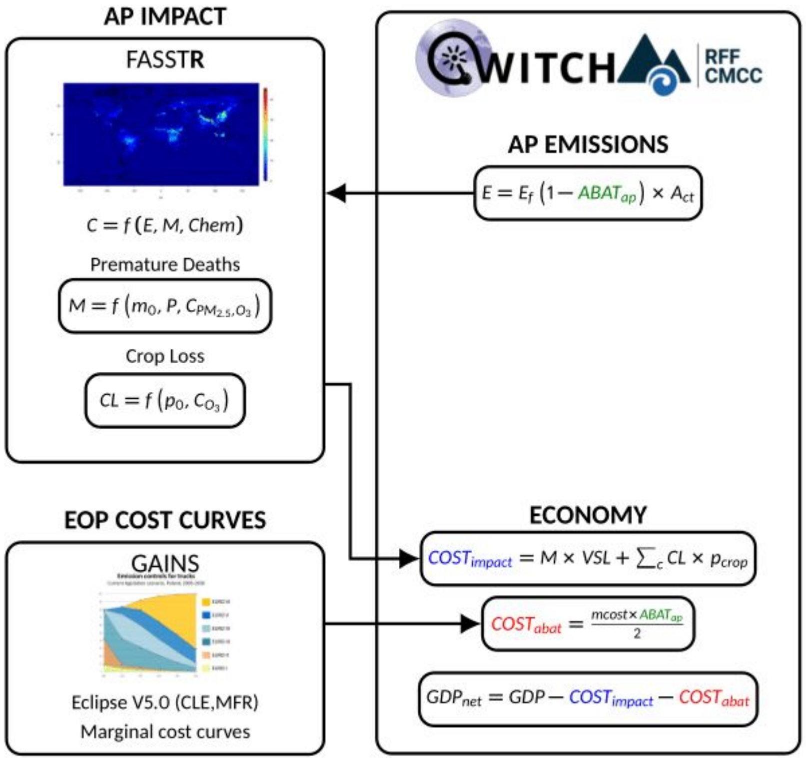

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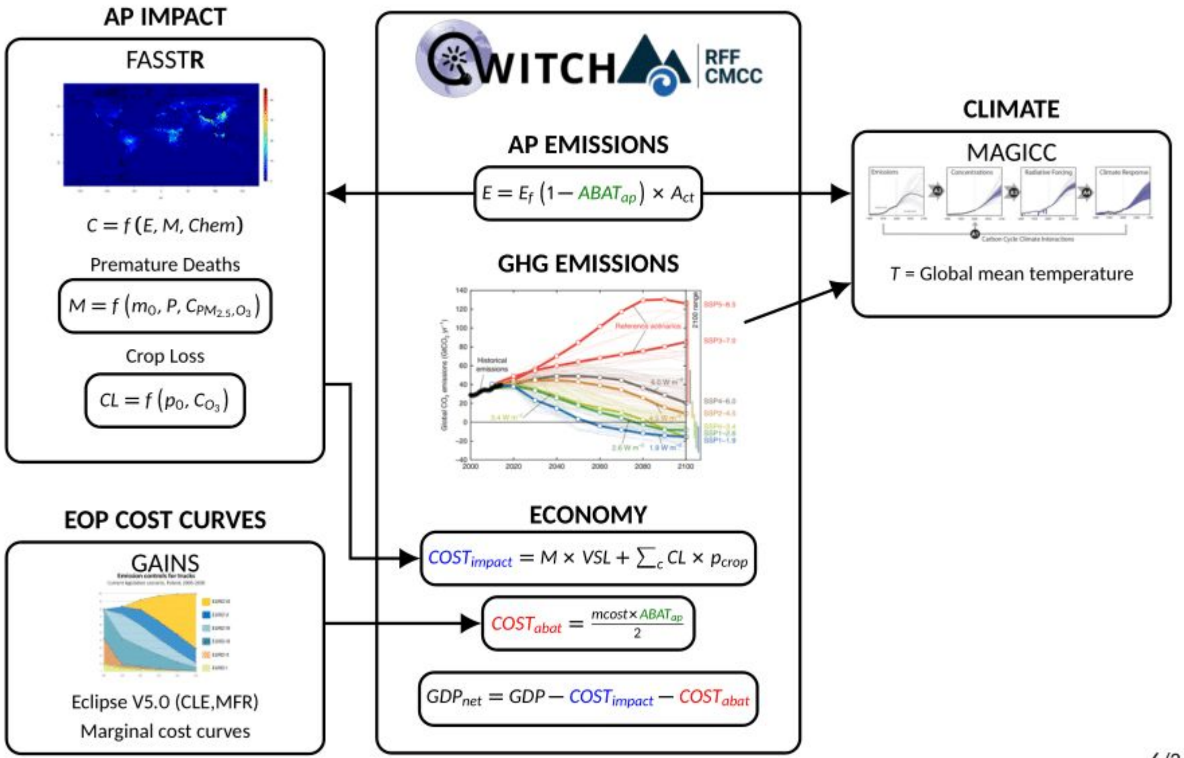

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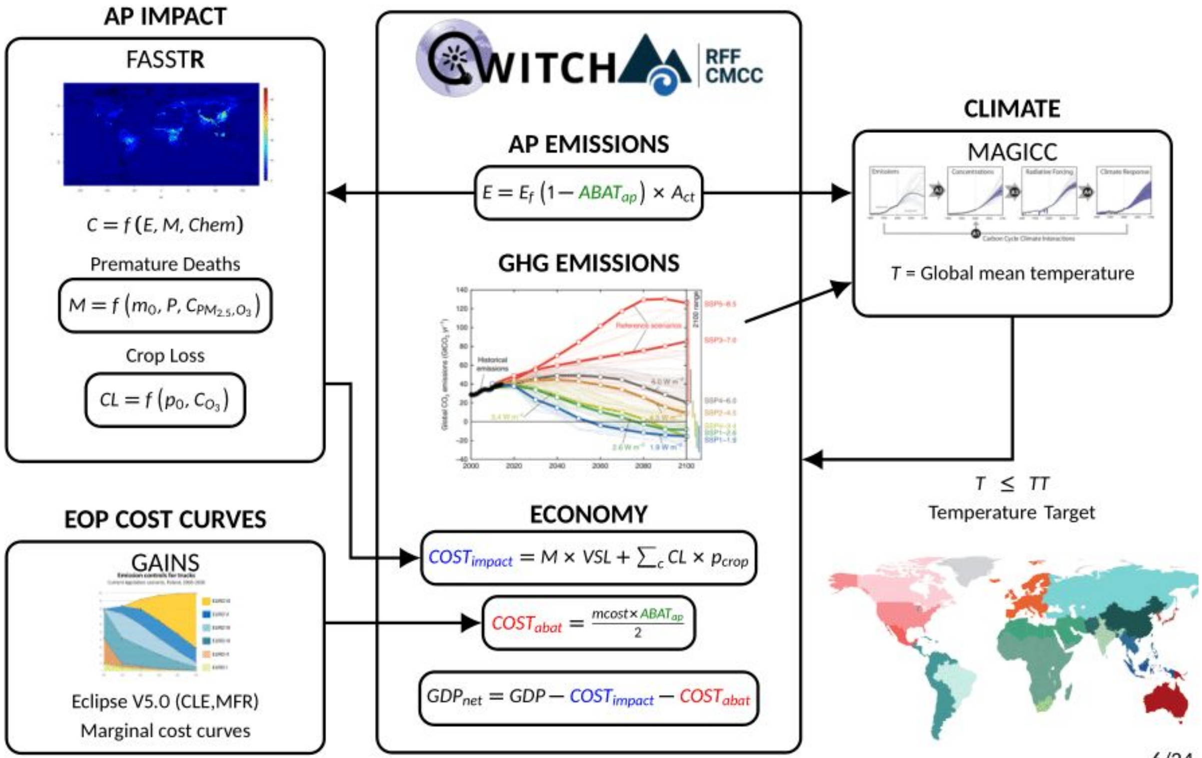


Scenarios Matrix

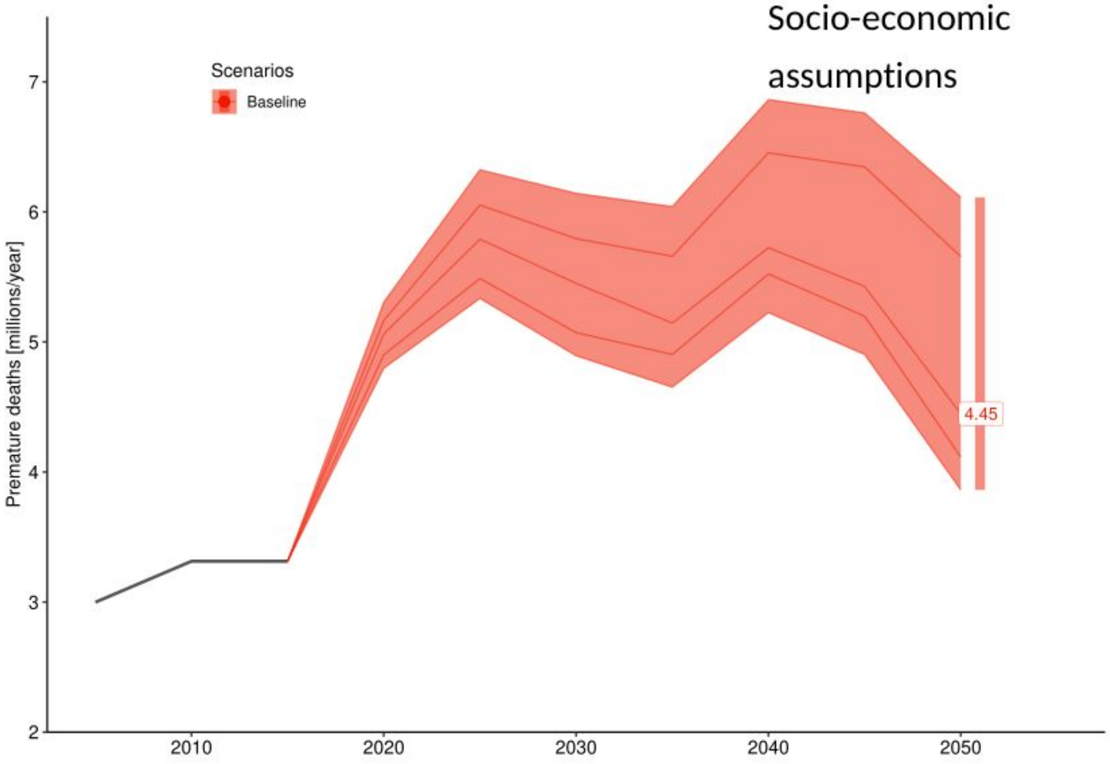
	Socio-economic baseline (SSP)	Temperature targets	International climate agreement	CBAP	Value per statistical life
Baselines	SSP1, SSP2, SSP3, SSP4, and SSP5	Baseline (no temperature target)	..	Yes and no*	High, medium, or low
Climate policy	SSP1, SSP2, SSP3, SSP4, and SSP5	2°C and 1·5°C	Carbon tax starts in 2020	Yes and no*	Low
Delayed policy	SSP2	2°C and 1·5°C	Carbon tax starts in 2025 or 2030	Yes and no*	Low

CBAP=cost–benefit assessment of air pollution. SSP=shared socioeconomic pathway. *All SSPs and temperature targets within the row are run with and without the CBAP.

Table: **Scenario matrix description**

SSPs includes Air Pollution narratives.

Premature deaths — Impact of CBAP



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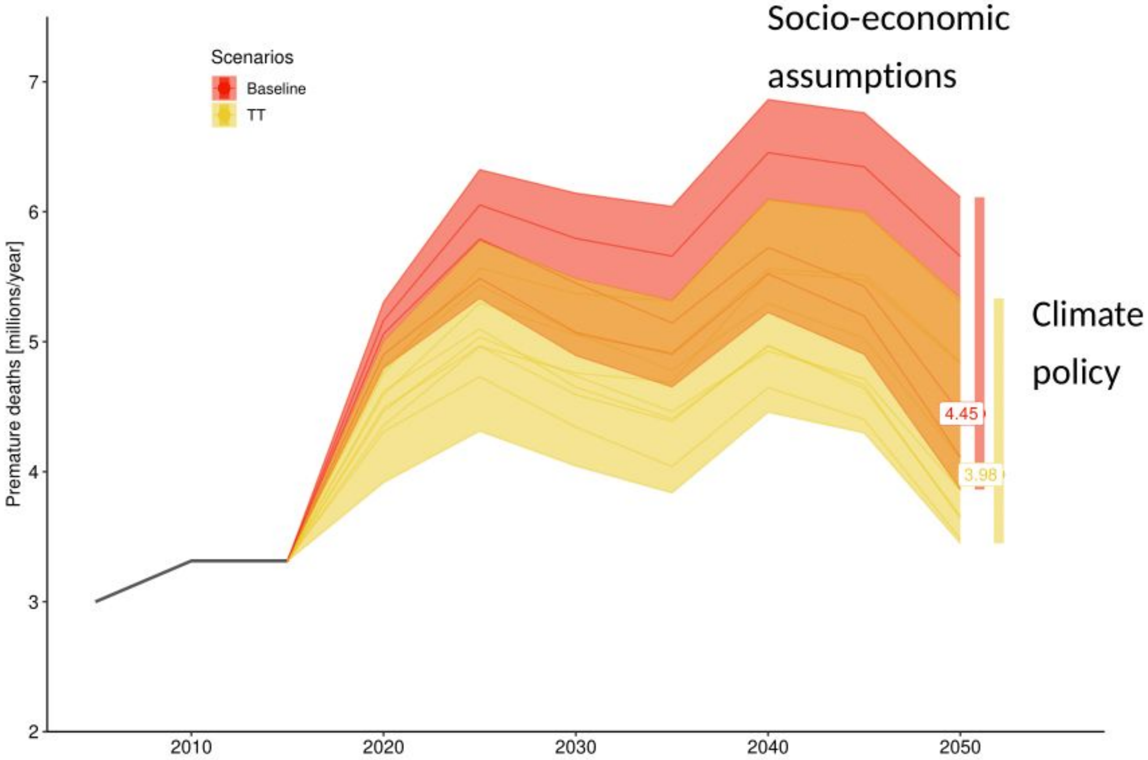

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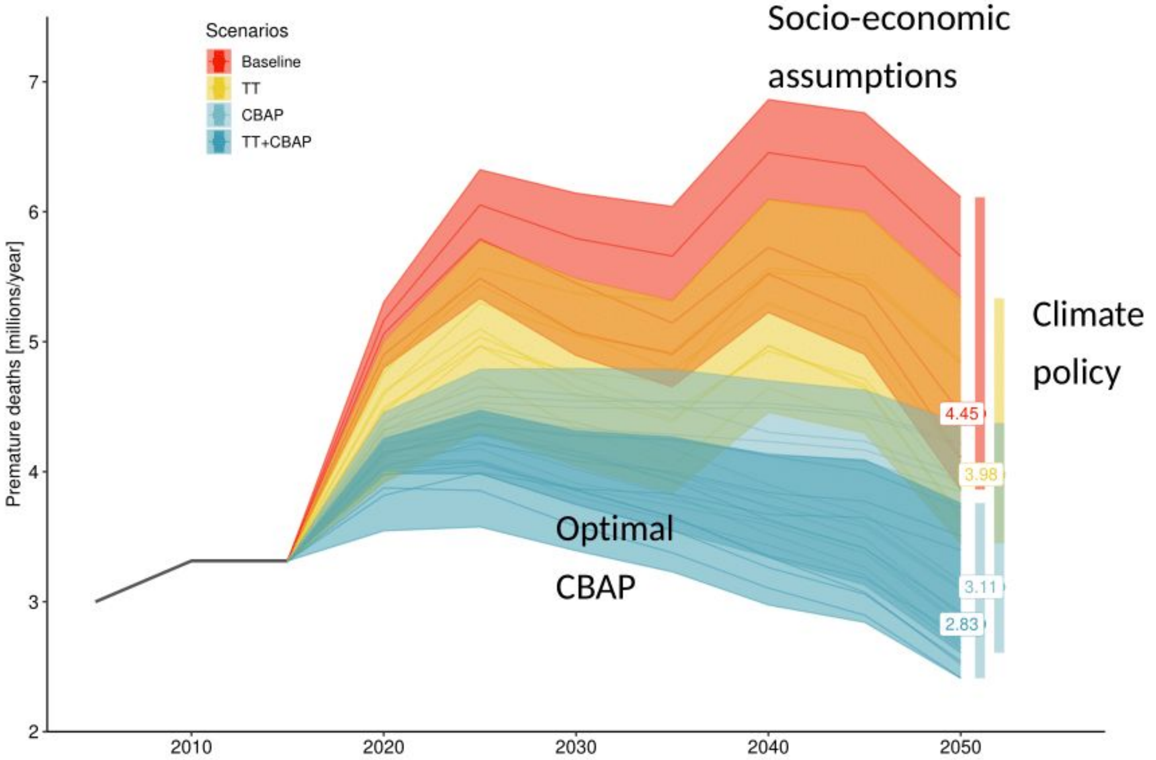
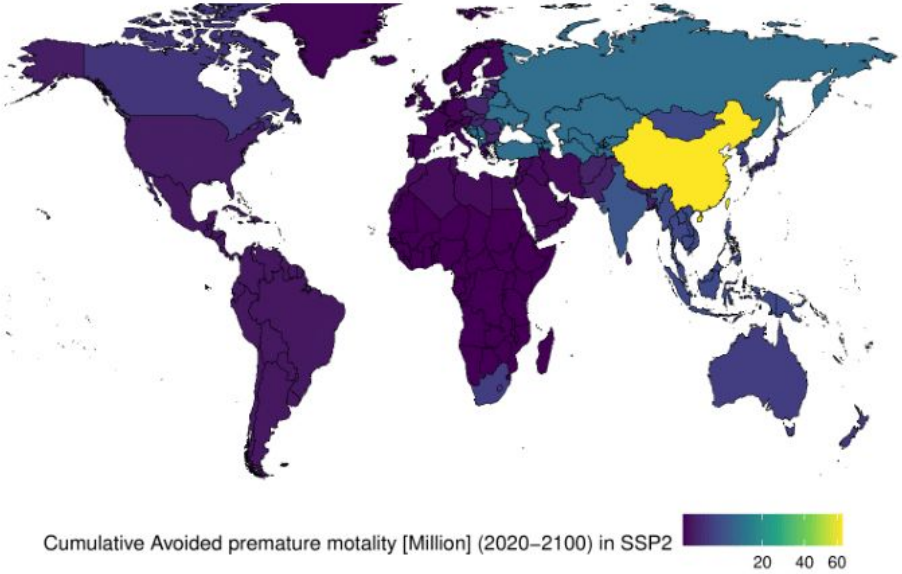
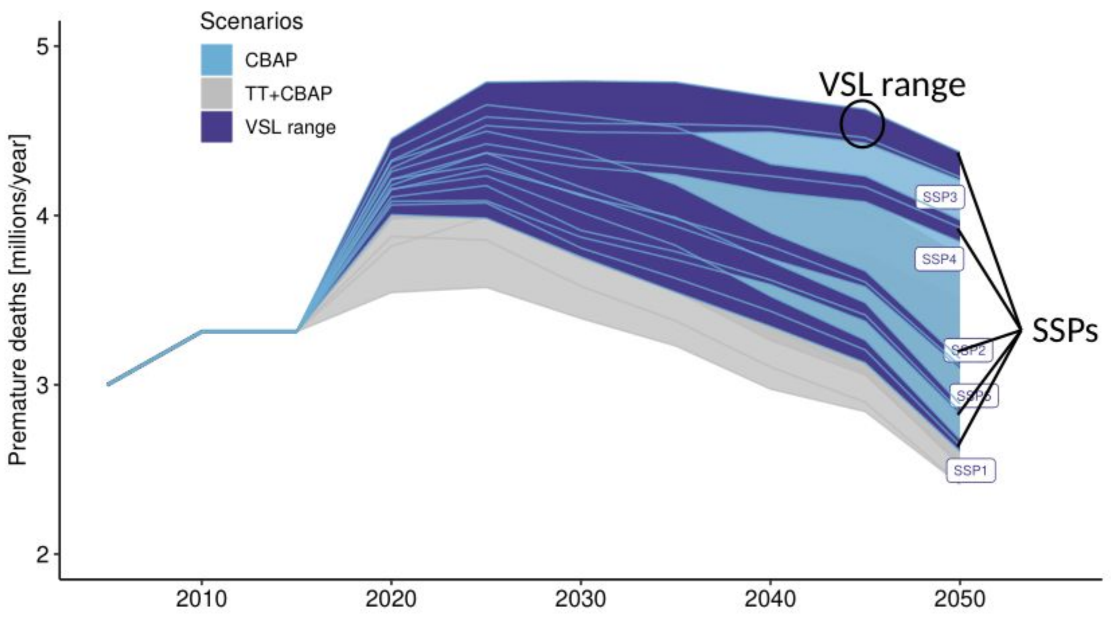


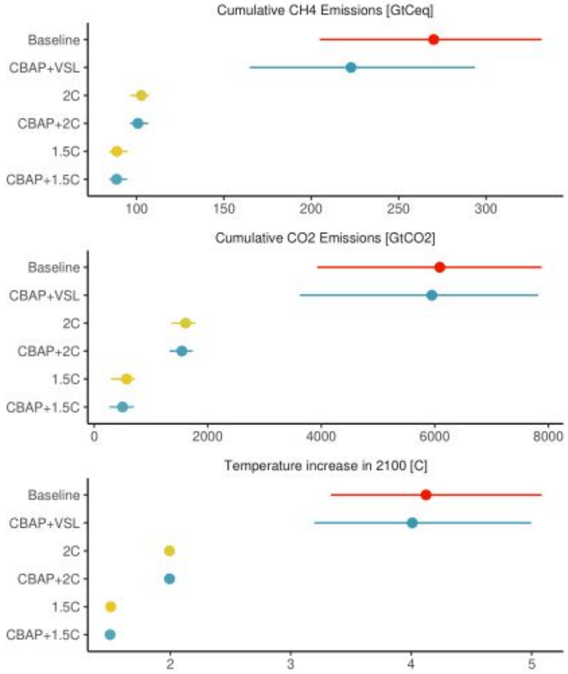
Regional distribution of the avoided damages



Premature deaths — Impacts of VSL

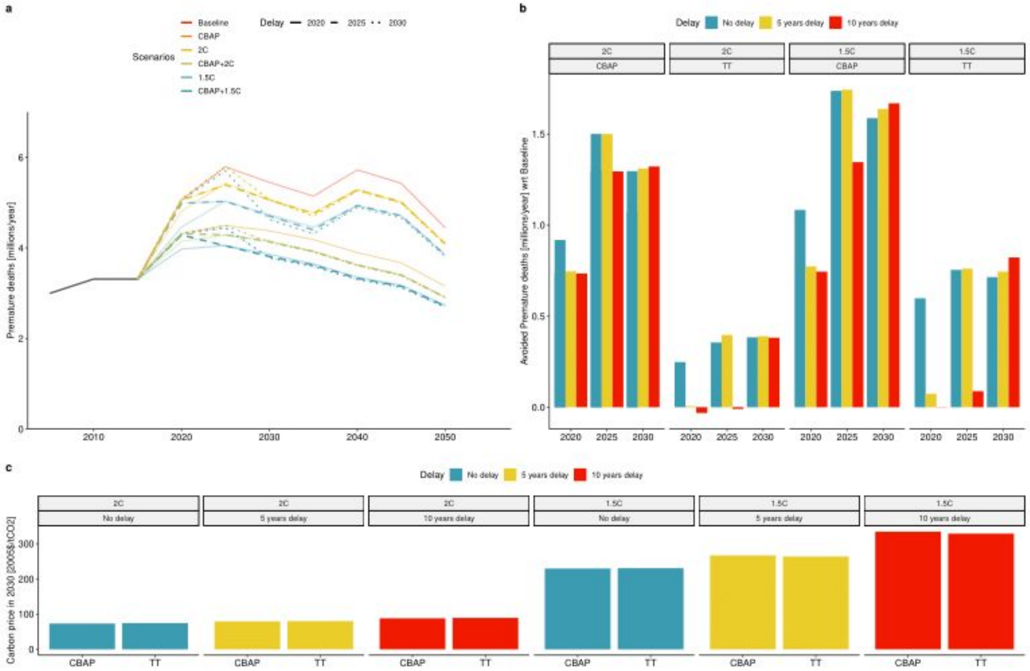


CBAP and decarbonization

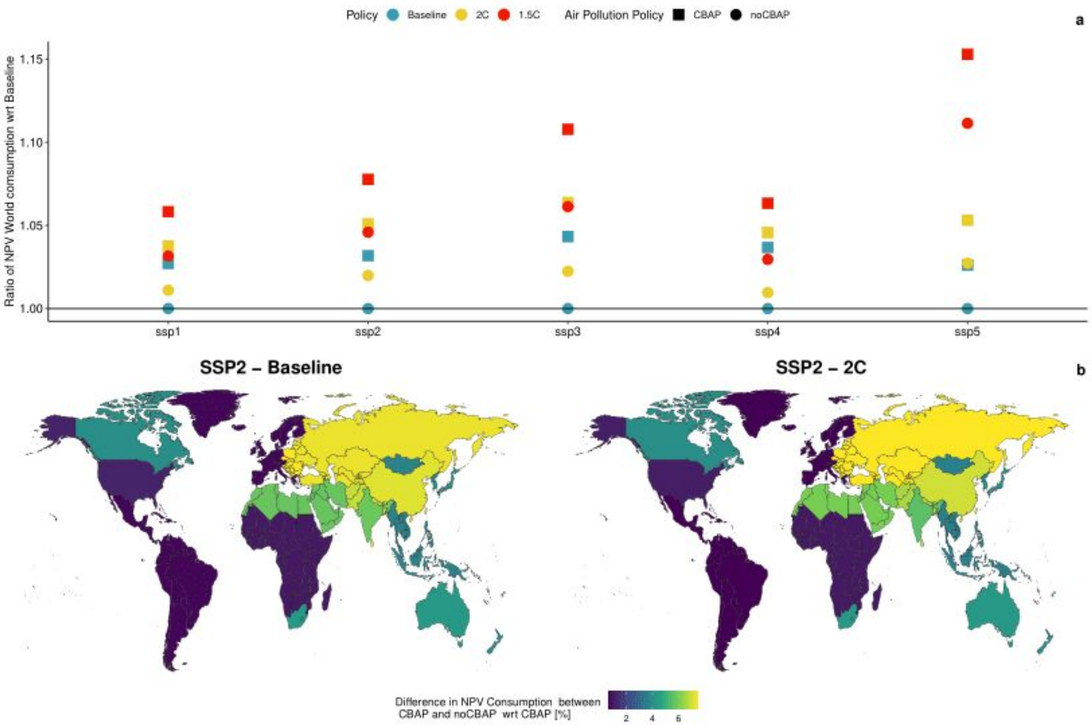


- Very little impact of CBAP on decarbonization

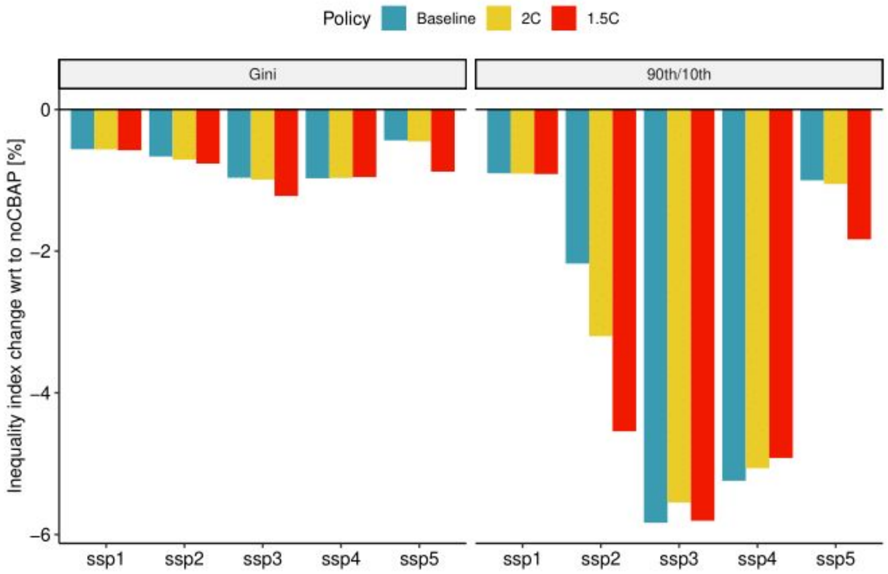
Delaying climate policy



Regional Impact on Welfare of CBAP



Impact on Inequality of CBAP



Global and regional welfare increases when air pollution impacts are internalised, with no negative repercussions on global inequality

Conclusions

- Welfare-maximising policies accounting for air pollution benefits reduces premature mortality by 1.62 million deaths annually.
- This is three times greater than the co-benefits of climate policies.
- Results robust to the choice of VSL
- SSPs have a large influence on premature deaths and on carbon prices
- CBAP, alone, has a very little impact on decarbonization
- Global and regional welfare increases when air pollution impacts are internalised, with no negative repercussions on global inequality.

THANKS!

Do you have any questions?

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