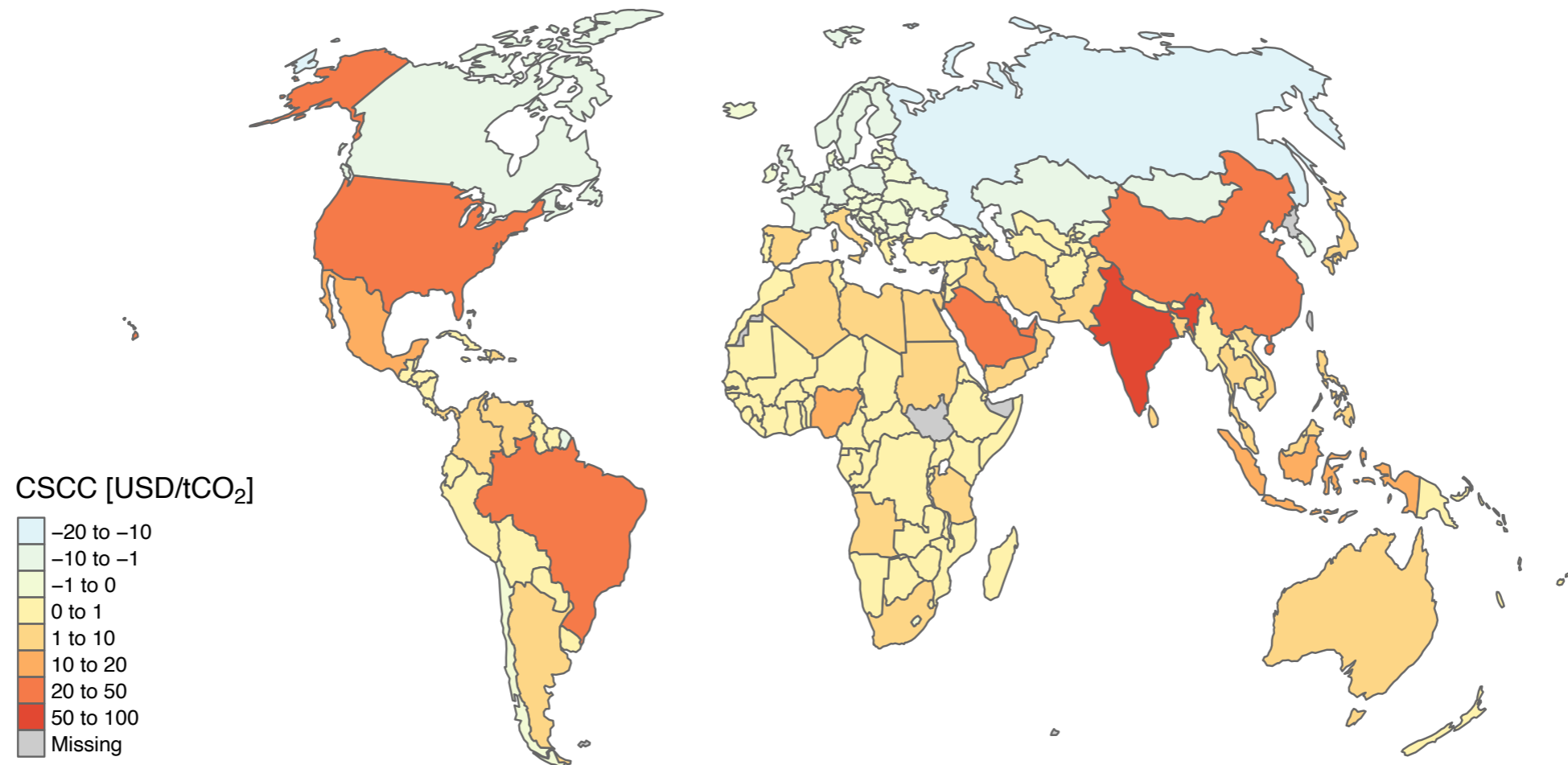


Country-level social cost of carbon

Kate Ricke, Assistant Professor
School of Global Policy & Strategy
Scripps Institution of Oceanography
UC San Diego

March 9, 2021

Country-level social cost of carbon



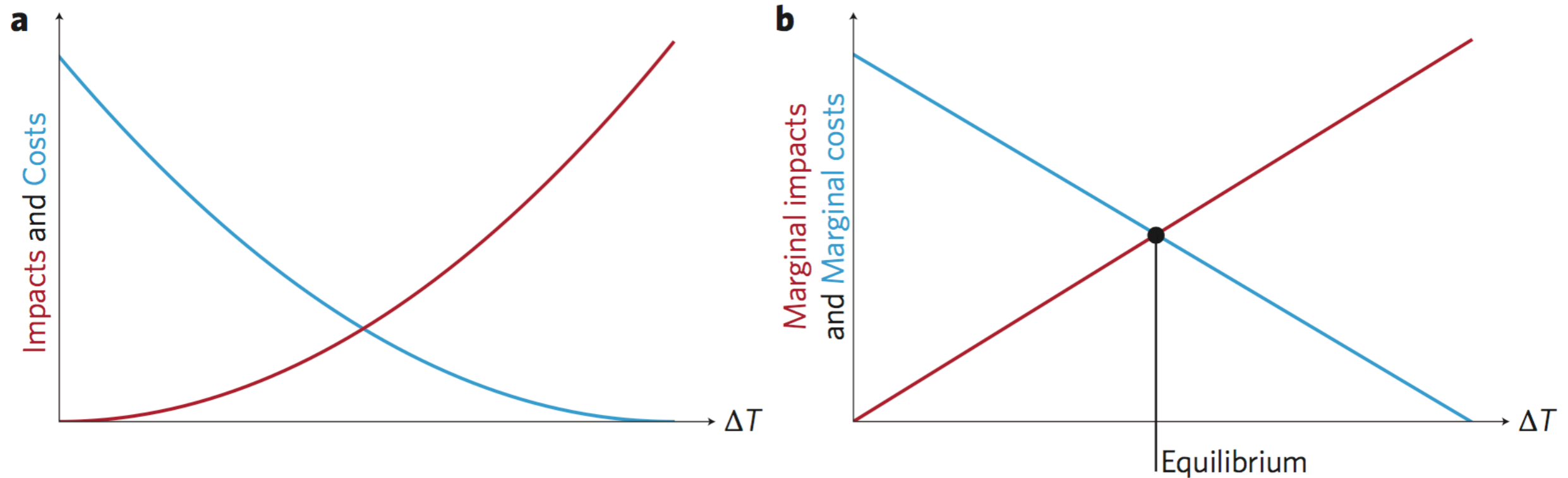
What is the "social cost of carbon"?

The social cost of carbon is the economic cost of a small increase in carbon dioxide emissions today.

It's the net present value of the additional damages associated with an incremental pulse release of CO₂ on top of a baseline (business-as-usual) climate change pathway.

It represents the marginal impacts of climate change.

The social planner



Optimal climate policy would aim to achieve the equilibrium level of warming where global marginal impacts equal global marginal costs.

Standard estimates: IAWG

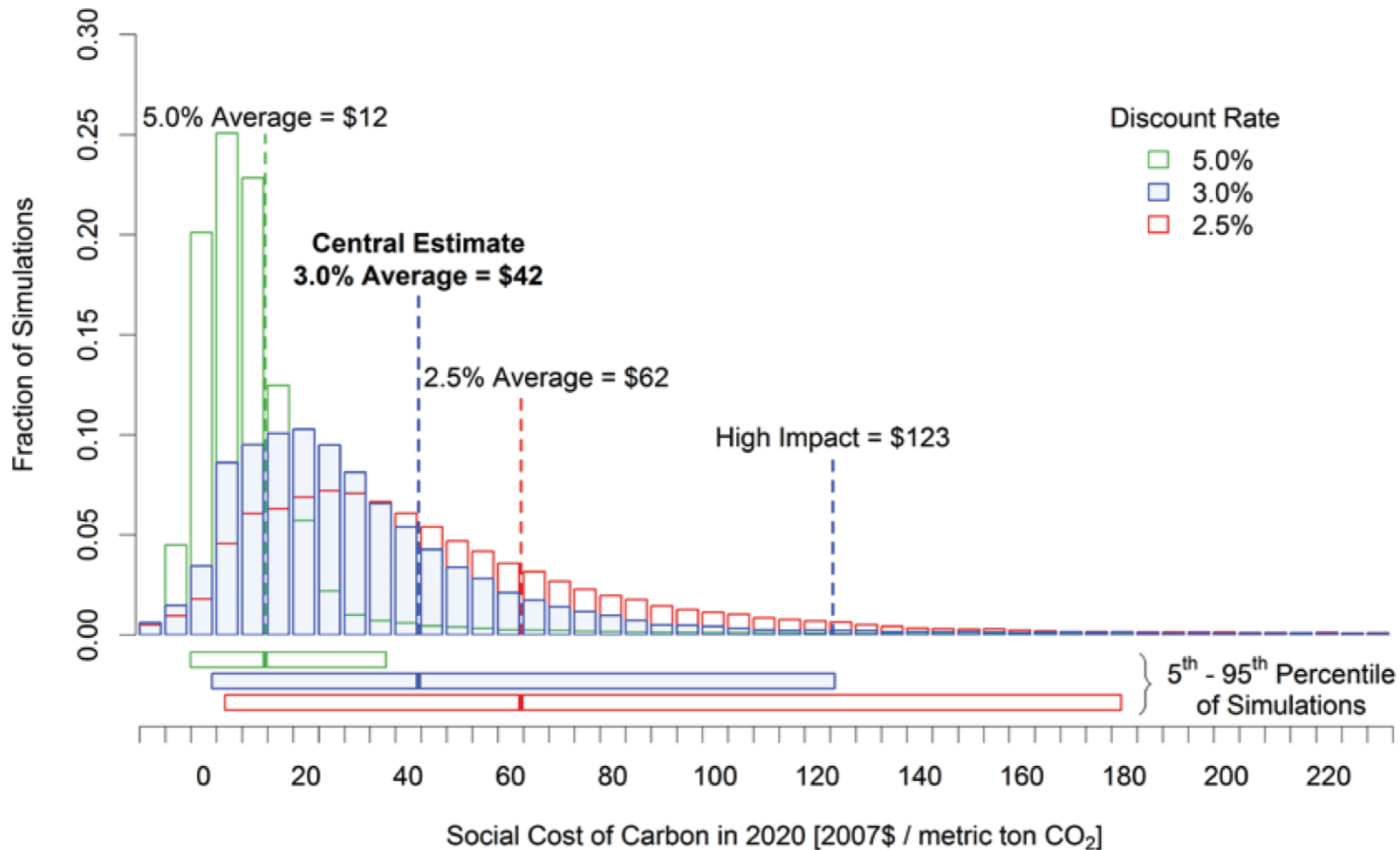
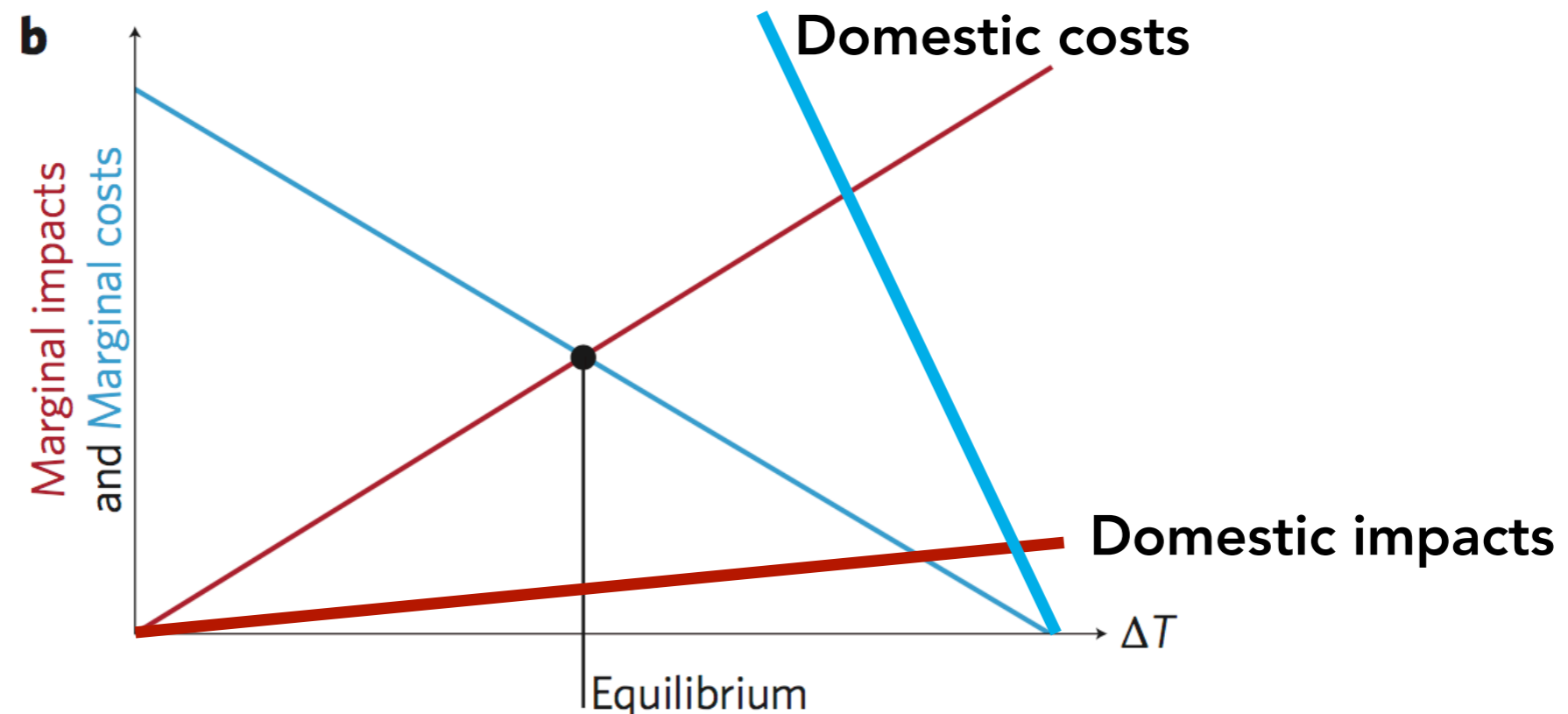


FIGURE 1-1 Frequency distributions of SC-CO₂ estimates for 2020 (in 2007 dollars per metric ton of CO₂).

The strategic incentives



The global optimum might not represent a stable outcome: rather, a Nash equilibrium which internalizes only domestic damages is a more likely occurrence

Why calculate SCC at the country level?

The strategic game: thanks to the contribution of non-cooperative game theory as brought to the climate field by economists...

- we know the global optimum might not represent a stable outcome, and that rather a Nash equilibrium which internalizes only domestic damages is a more likely occurrence.
- Complementing the standard normative assessment of the SCC based on global values with disaggregated estimates can in our view inform the all important strategic dimension of the climate game.
- given the current nationalistic tone in world politics, it is important to examine costs at the level most salient to decision makers

Why calculate SCC at the country level?

- **The social planner:** higher spatial resolution of climate damage and benefit estimates impacts estimates of net global climate damage, i.e., disaggregating and re-aggregating can produce more accurate results
- **The climate policy optimist:** what constraints must we apply for the Nash equilibrium to approach the global optimum?

Calculating SCC: Four modules

Socioeconomic

How would the economy change with no climate change?

(e.g., population, technology, governance)

Earth system

How does the Earth system respond to emissions of carbon dioxide?

(e.g., carbon cycle, temperature, precipitation)

Damages

How does the economy respond to changes in the Earth system?

(e.g., economic losses caused by warming)

Discounting

How should we value losses today vs. in 100 years?

(social discounting and net present value)

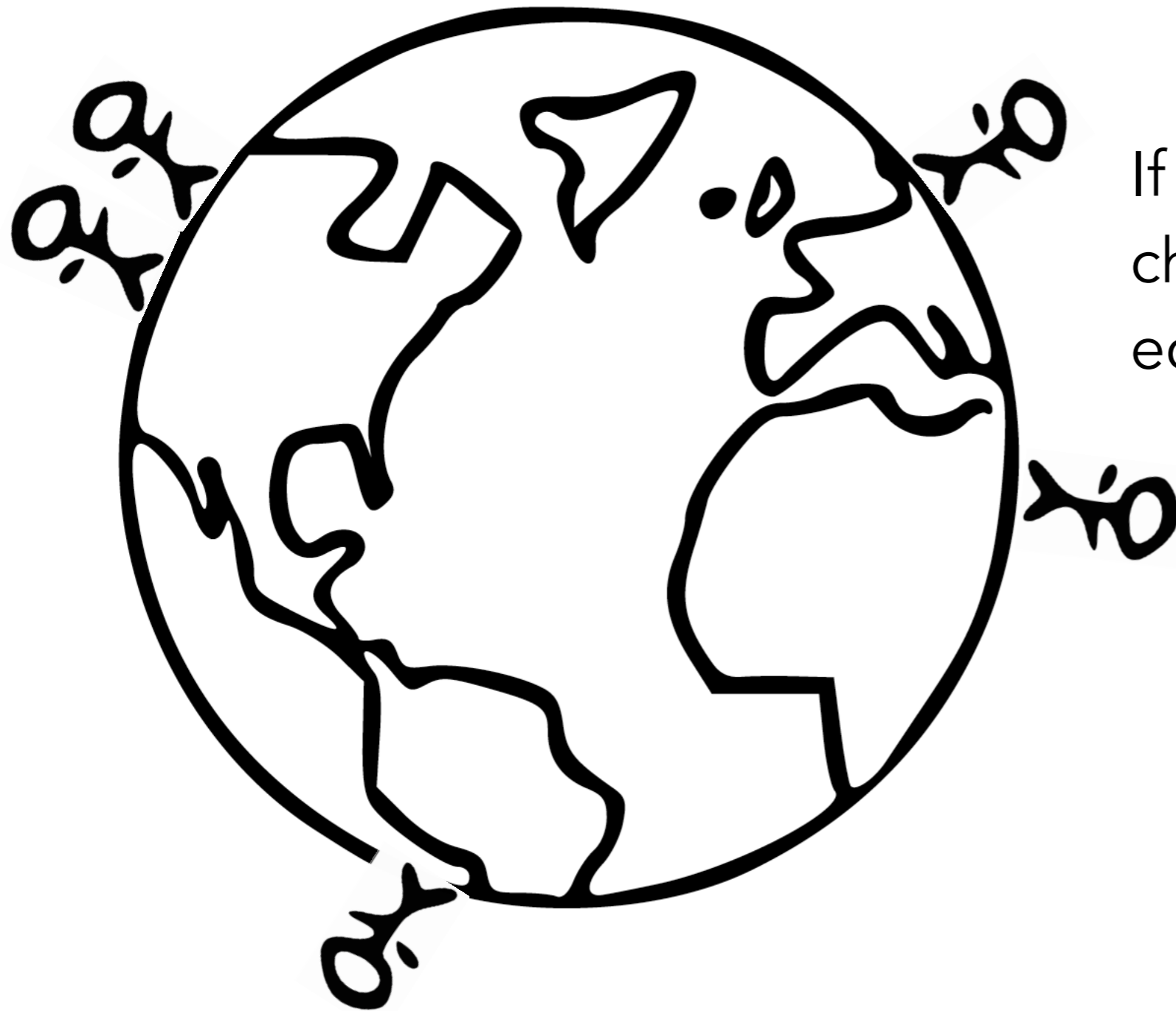


Socio-economic module



If there was no climate change, how would the economy change?

Socio-economic module



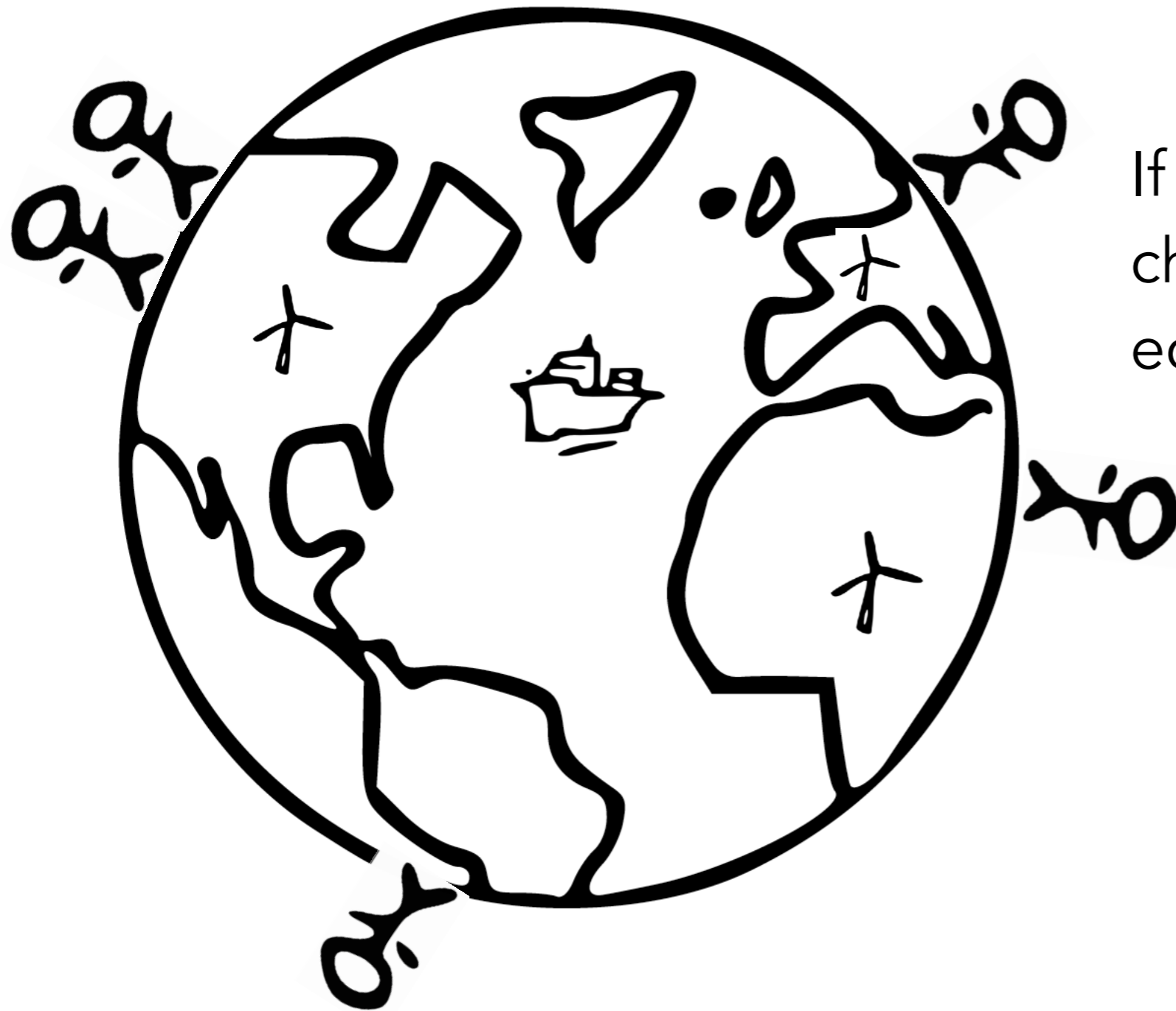
If there was no climate change, how would the economy change?

Socio-economic module



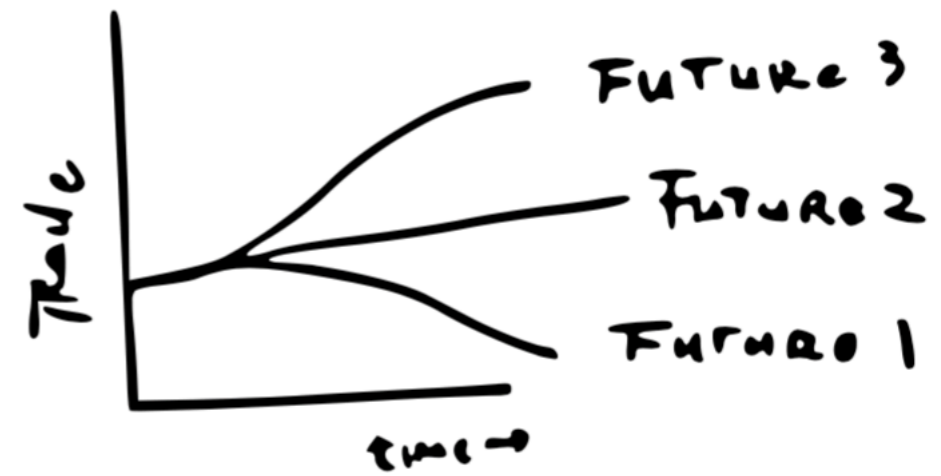
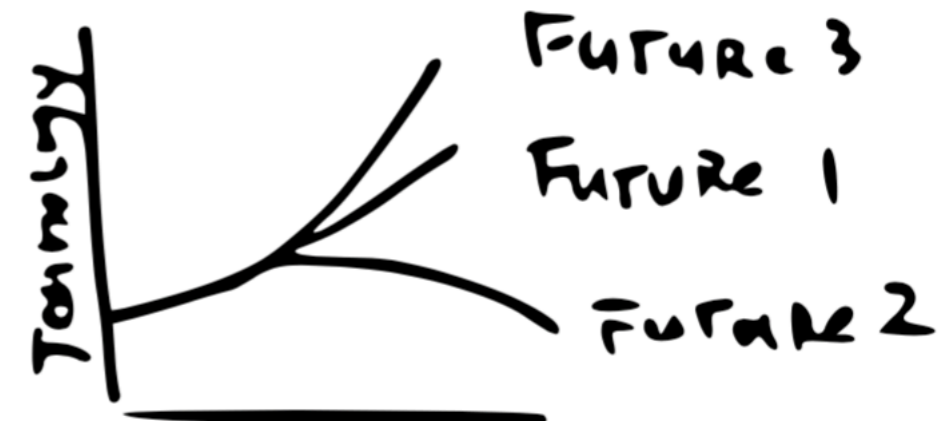
If there was no climate change, how would the economy change?

Socio-economic module

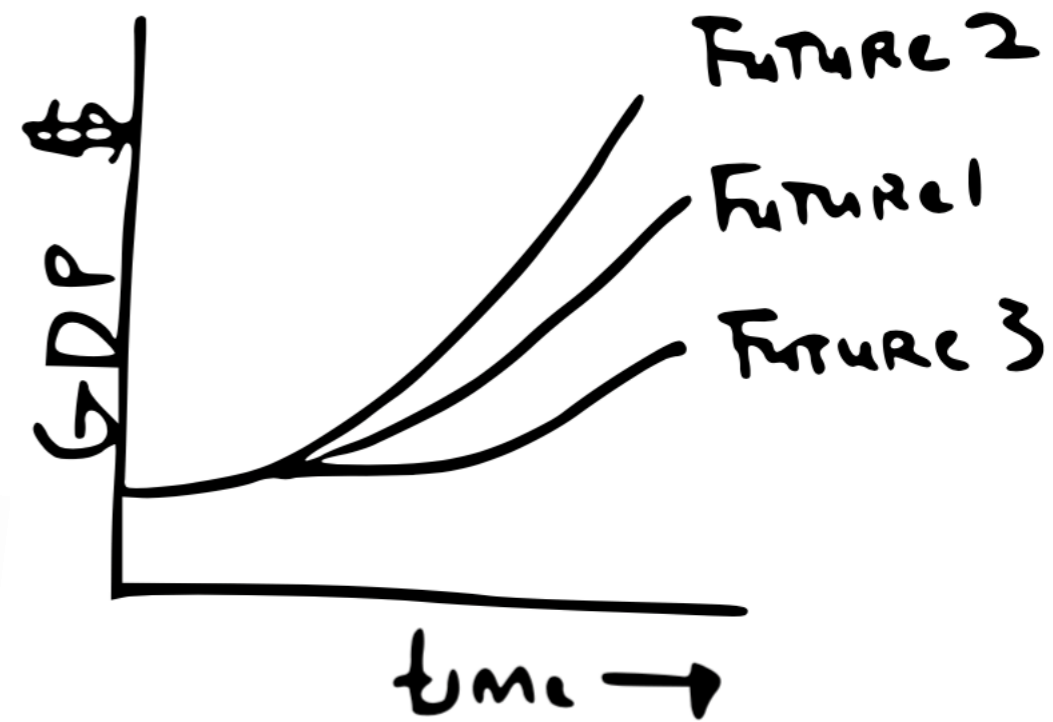


If there was no climate change, how would the economy change?

Socio-economic module

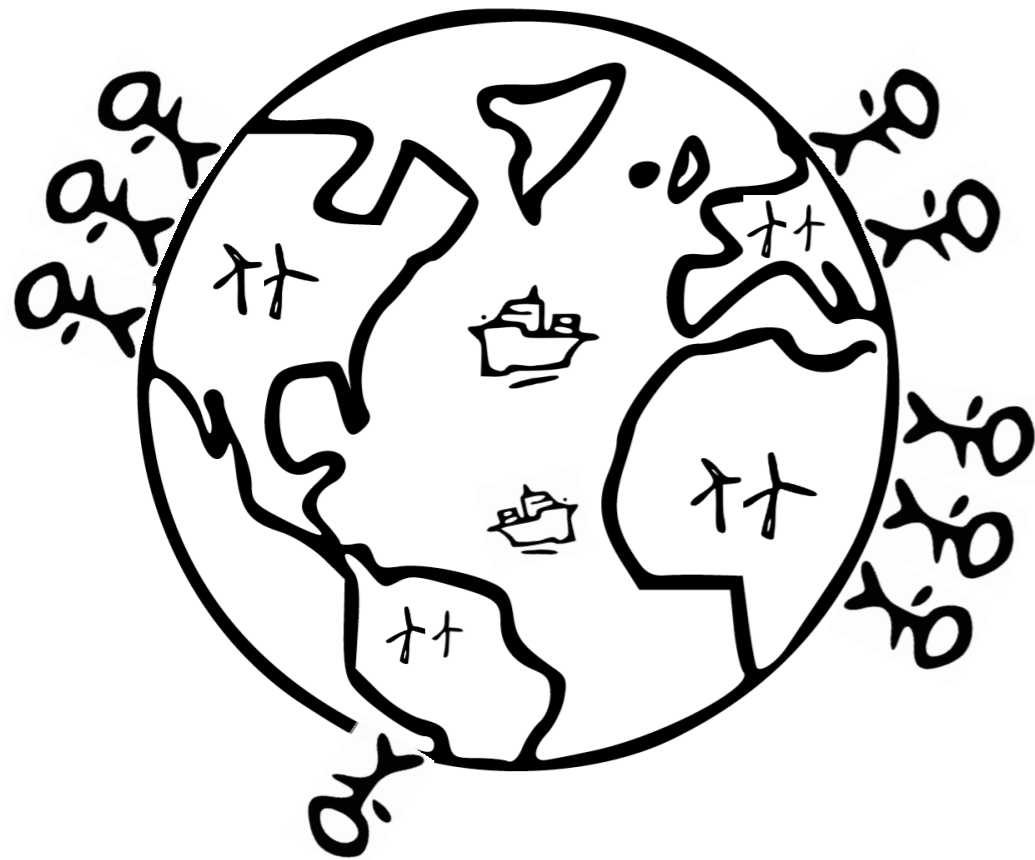


Socio-economic module

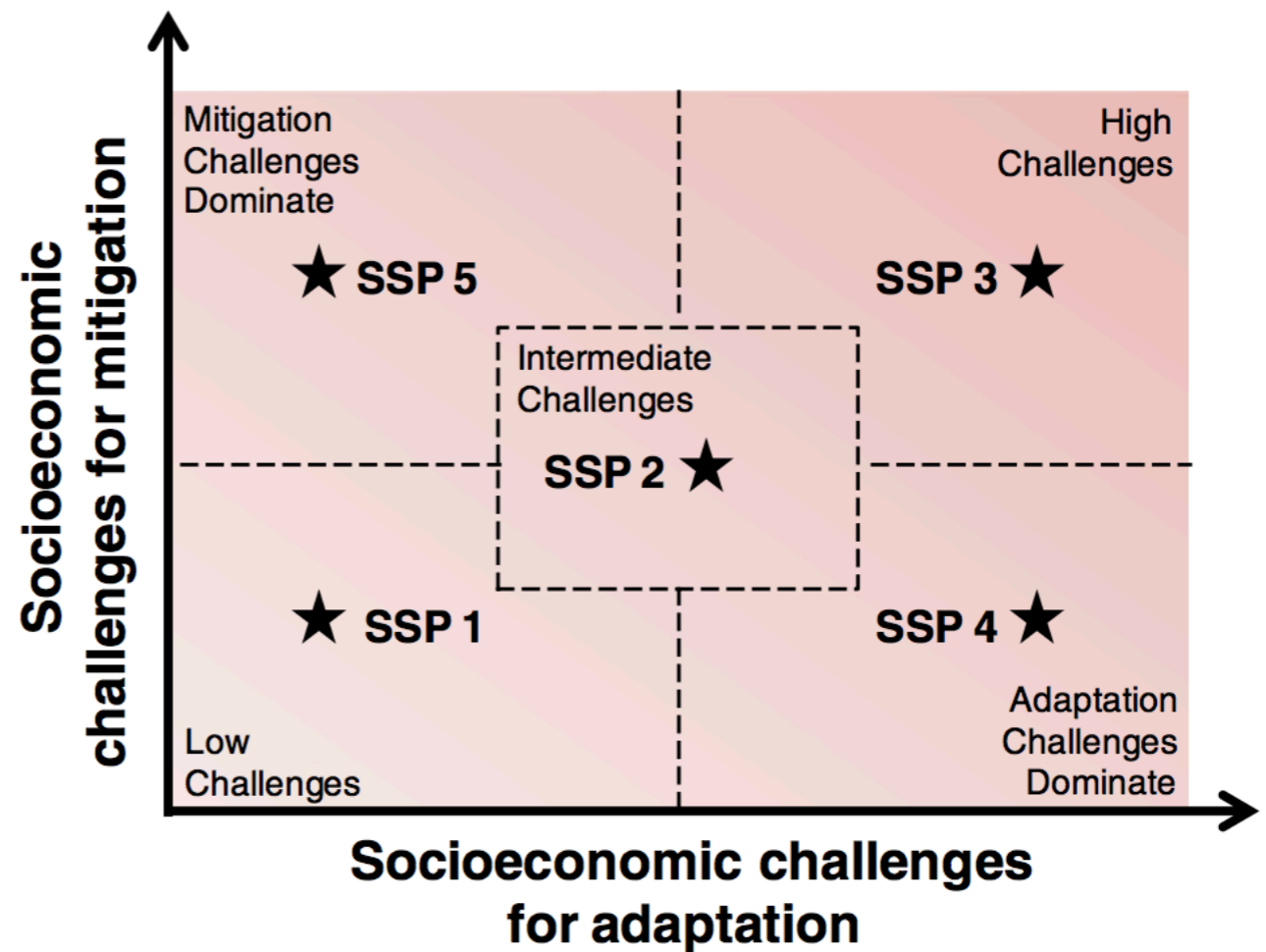


Business-as-usual

Socio-economic module

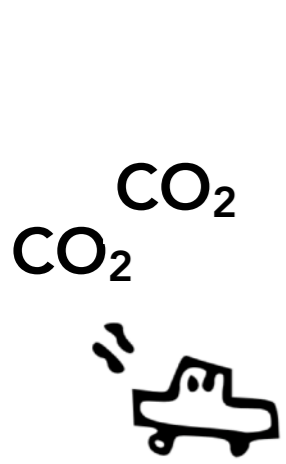


Shared Socioeconomic Pathways (SSPs)

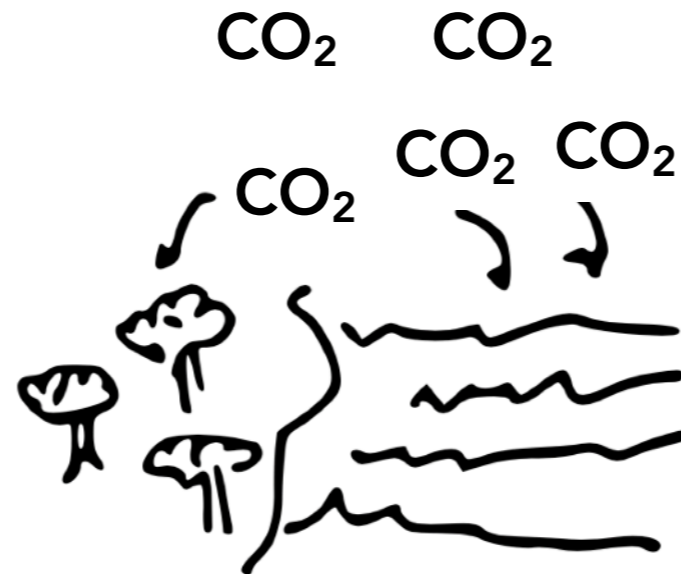
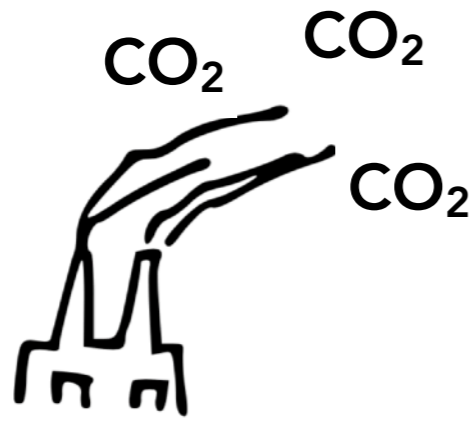


O'Neill et al (2014)

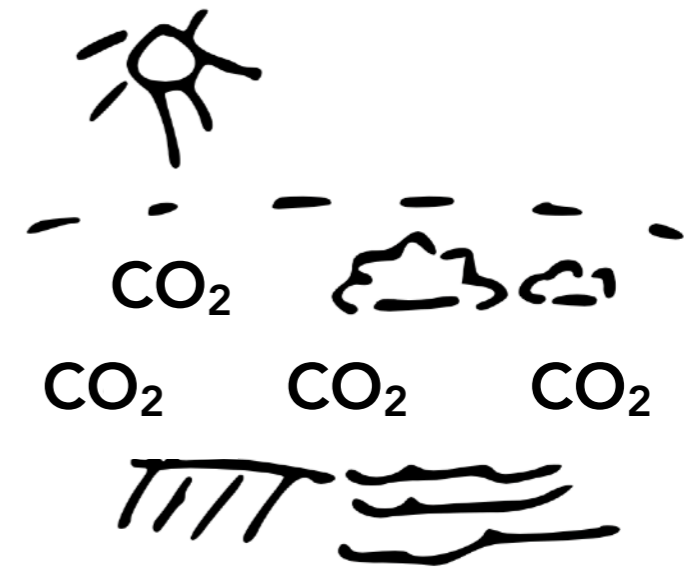
Earth system module



emissions



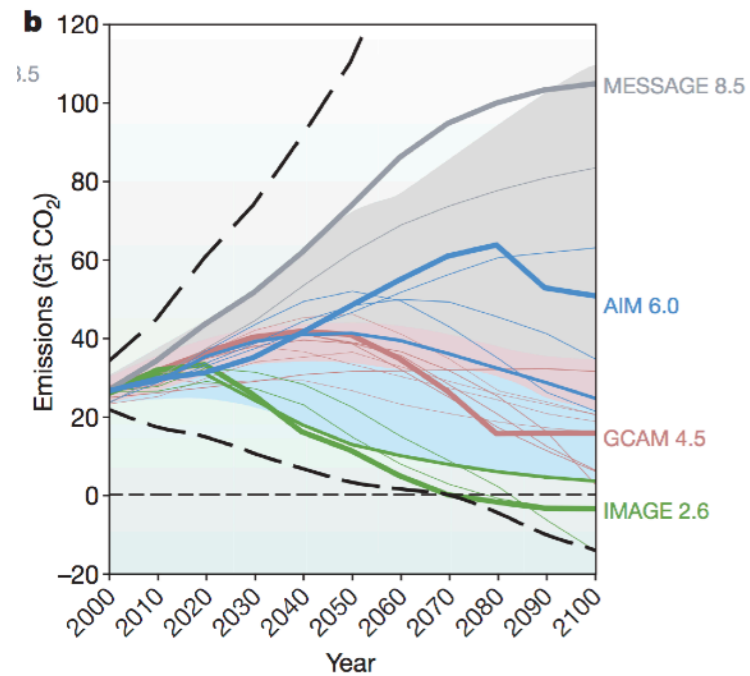
carbon cycle



climate

Earth system module

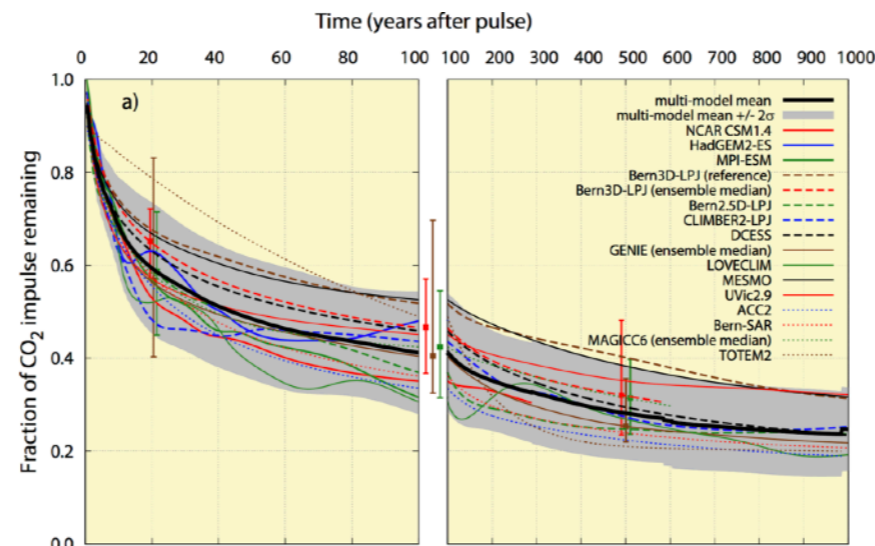
Representative Concentration Pathways (RCPs)



Moss et al (2010)

emissions

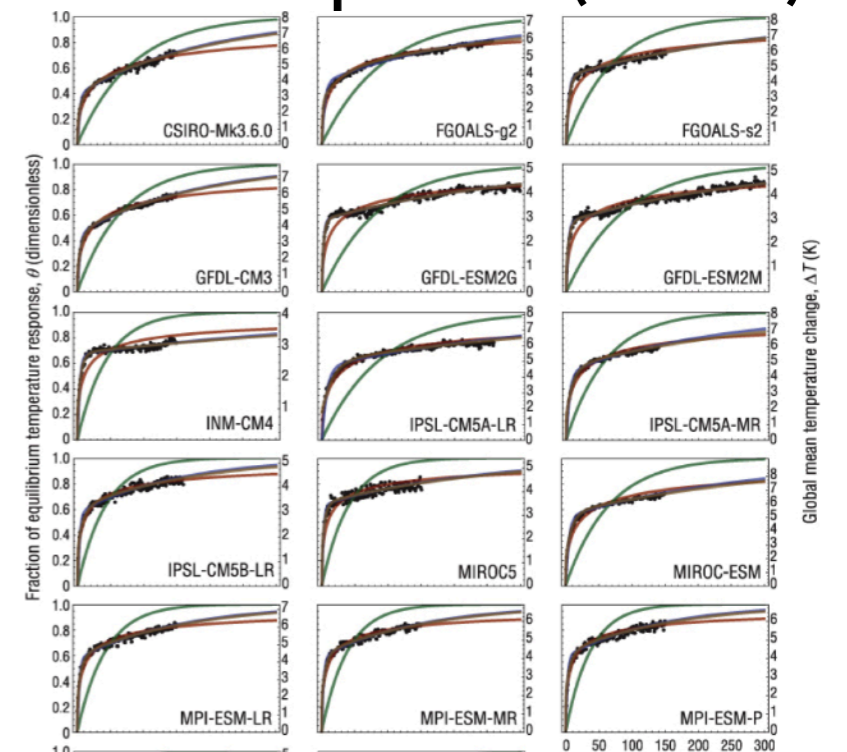
Carbon cycle model intercomparison



Joos et al (2013)

carbon cycle

Climate model intercomparison (CMIP5)



e.g., Cadeira & Myrsvold (2013)

climate

Damages module



Empirical,
macroeconomic
damage functions

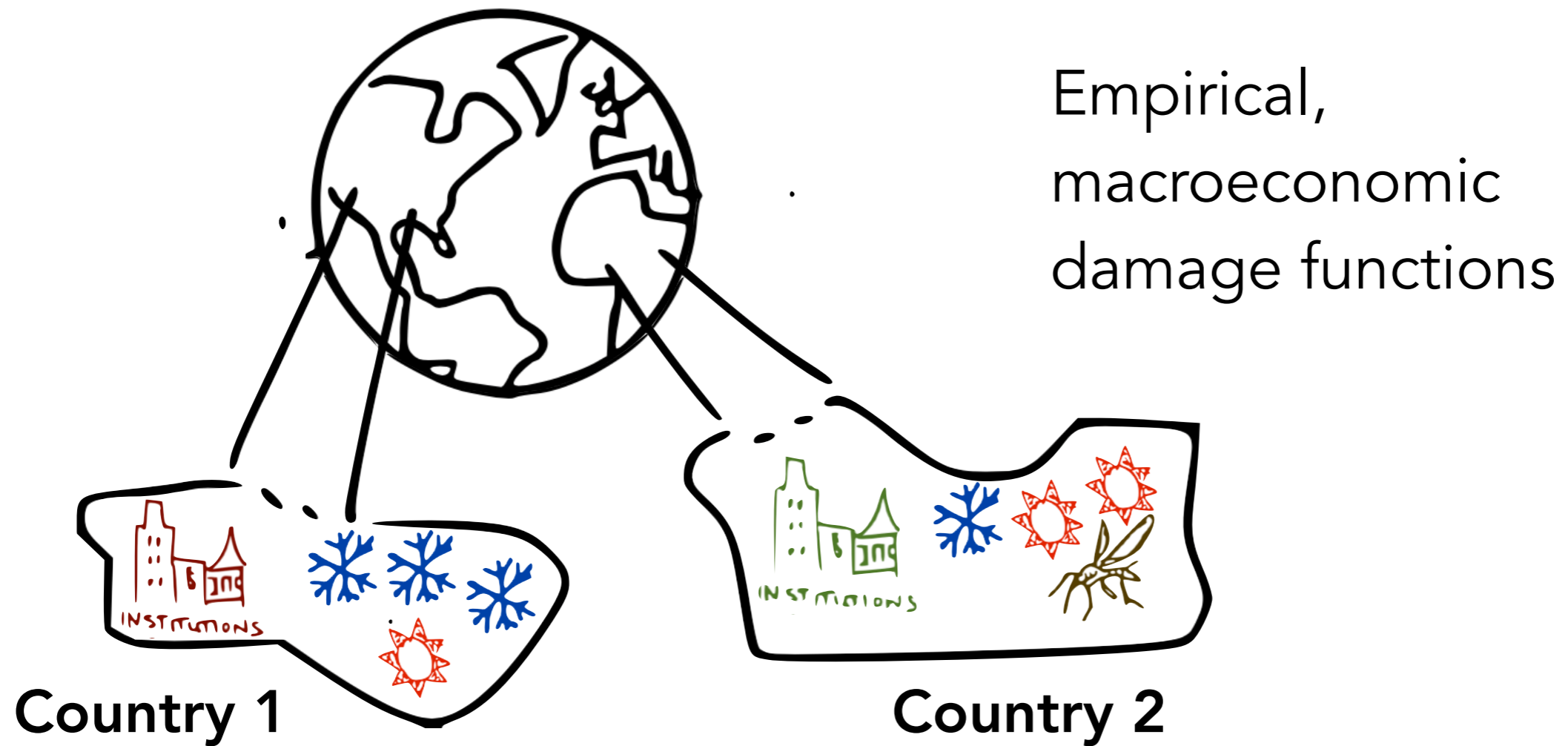
Damages module



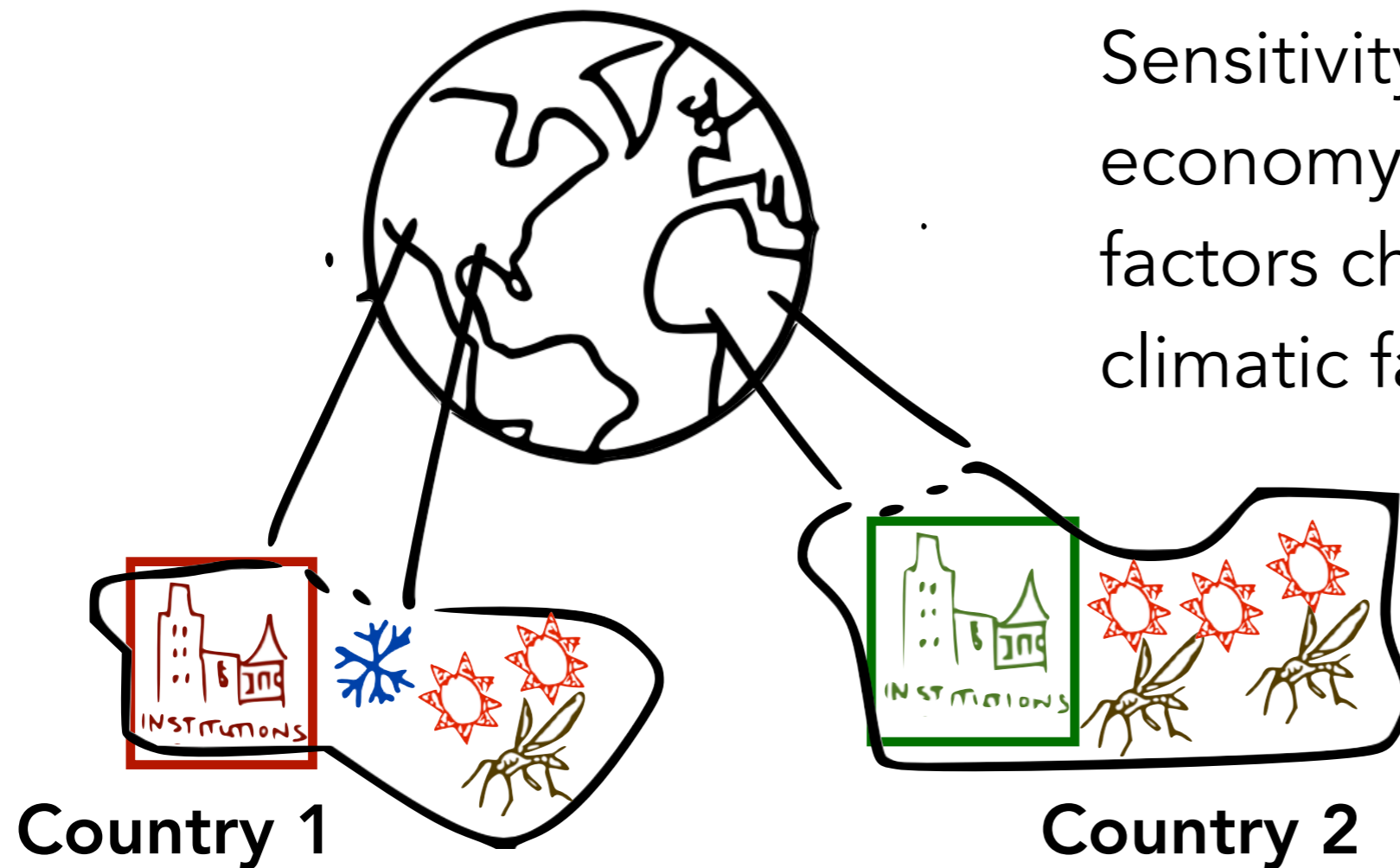
Empirical: based on 50 years of observations of how economies have responded to interannual variability

Macroeconomic: examining the response of the whole economy to climate

Damages module



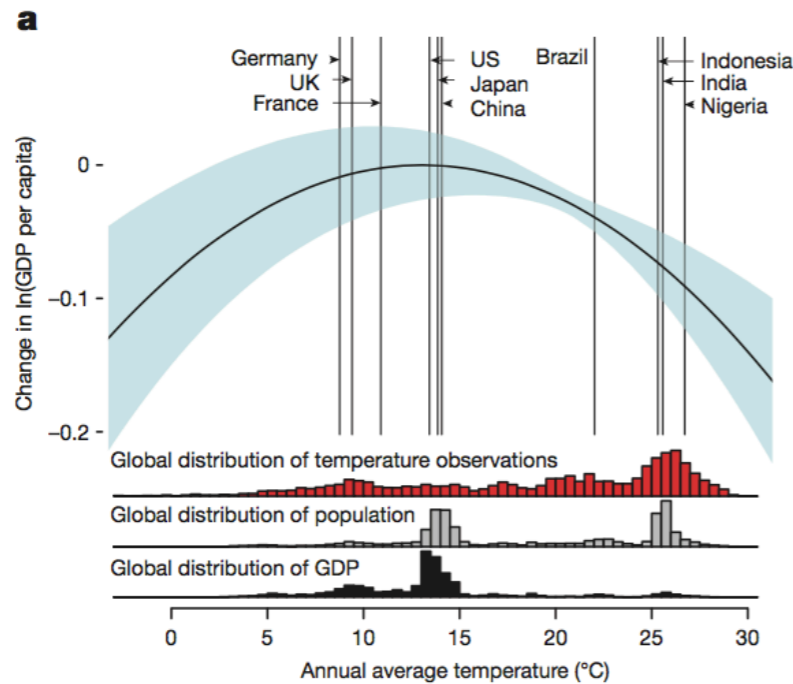
Damages module



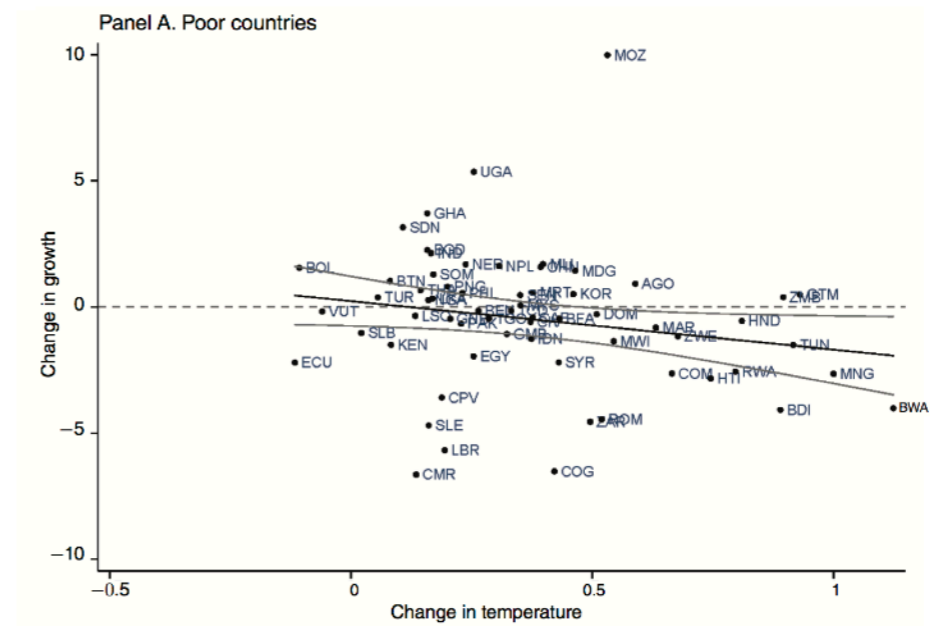
Sensitivity of a country's economy to climatological factors changes, while non-climatic factors are fixed

Damages module

Empirical, macroeconomic damage functions



Burke et al (2015)



Dell et al (2012)

Footnote: Unresolved questions about projected impacts of climate change

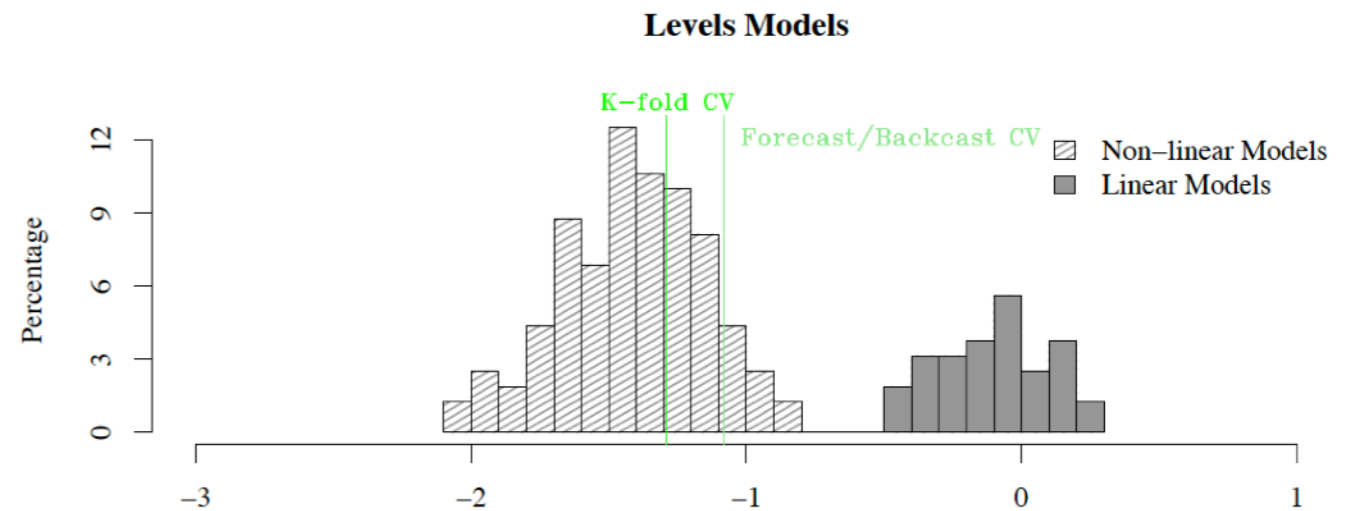
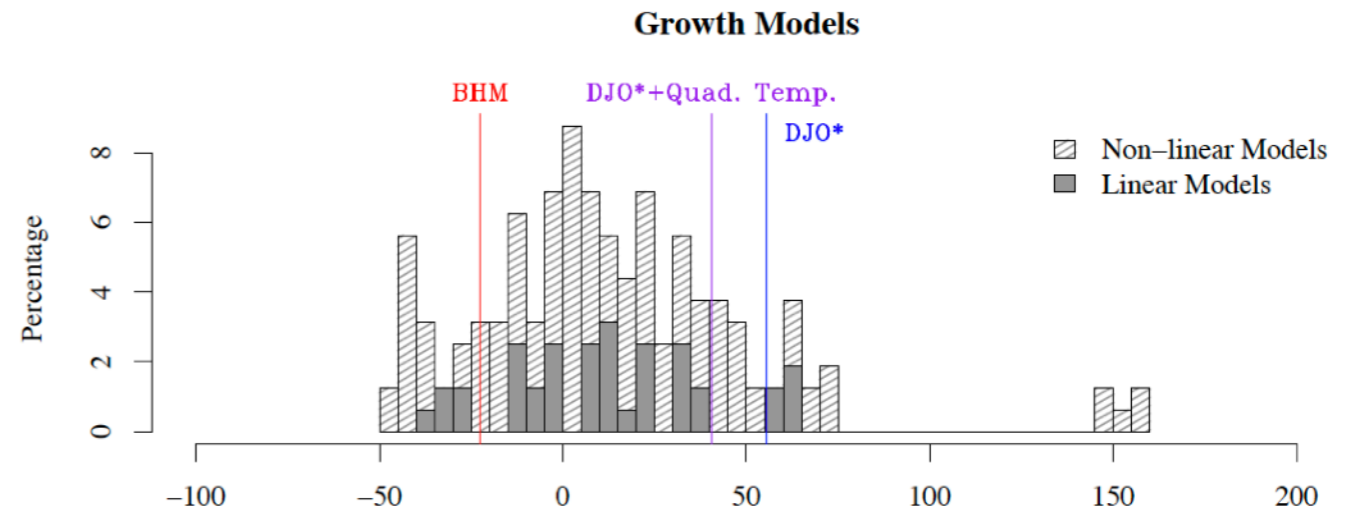
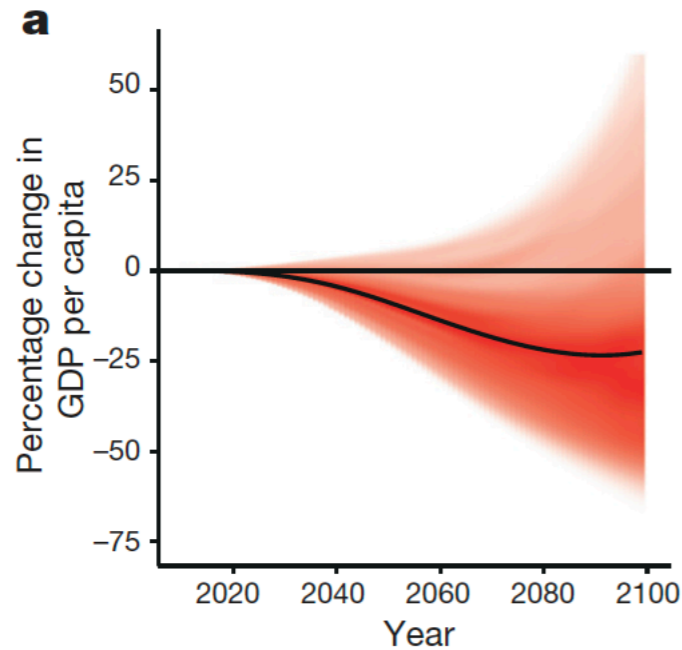
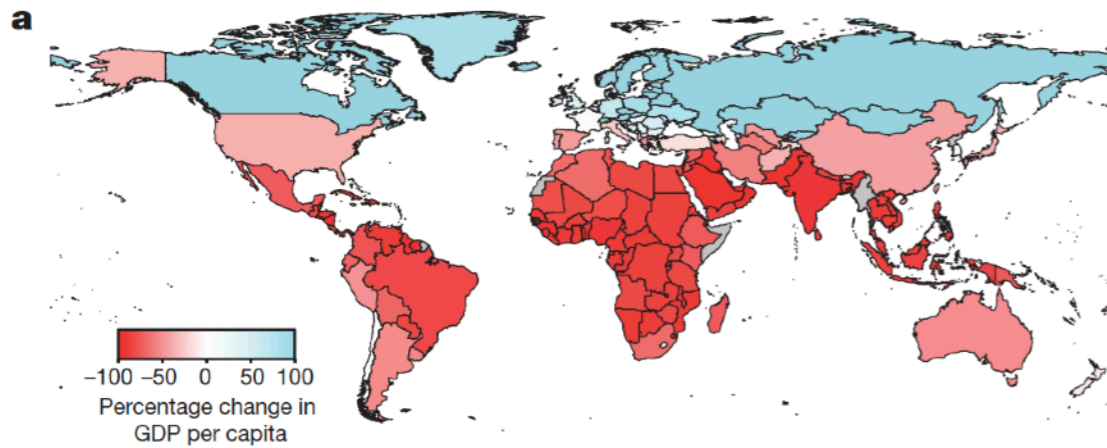


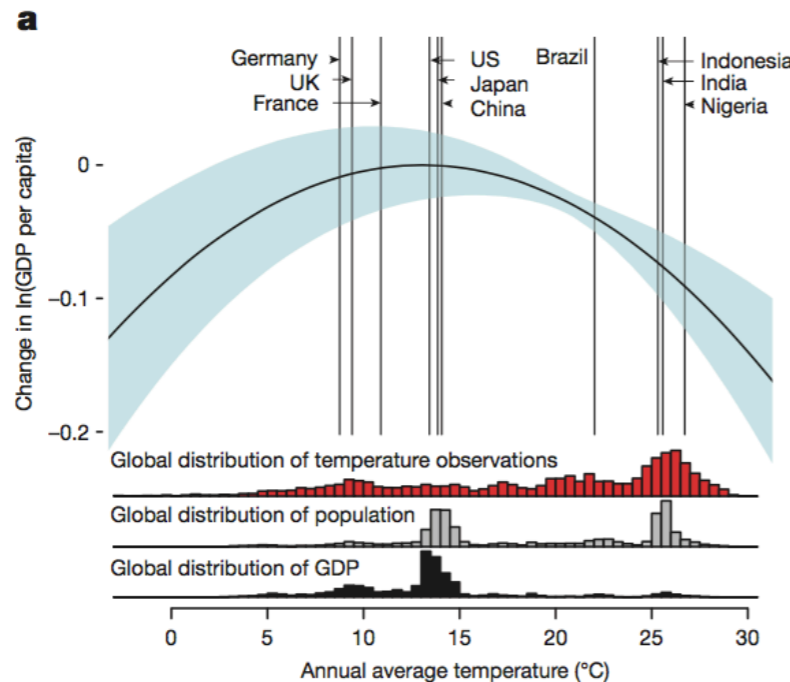
Figure 2: 2100 GDP Damage Estimates in Unmitigated Warming Scenario for GDP Growth Models (Top Panel) and GDP Levels Models (Bottom Panel)

Burke, Hsiang & Miguel (2015)

Newell, Prest & Sexton (2018)

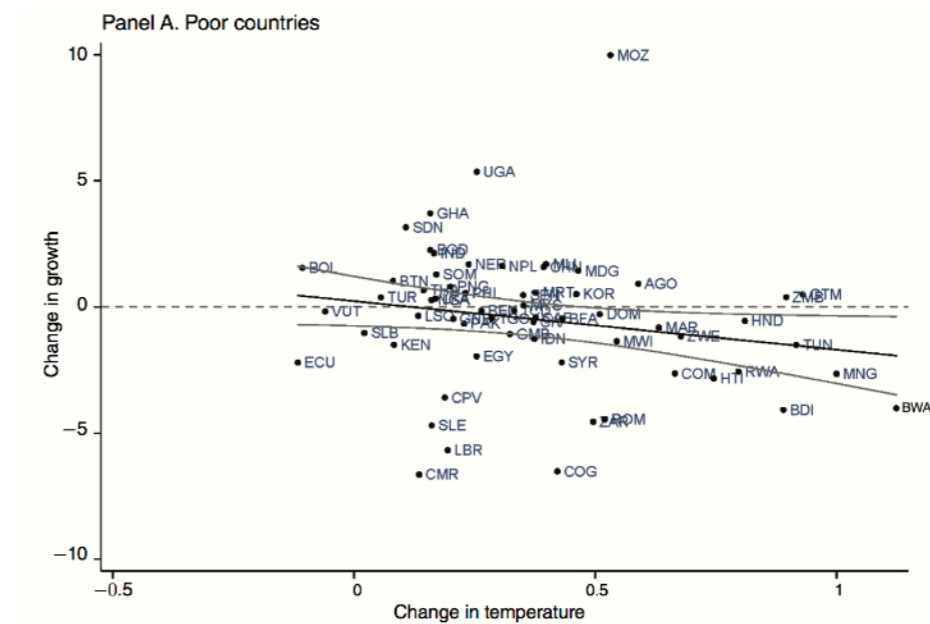
Damages module

Empirical, macroeconomic damage functions



Burke et al (2015)

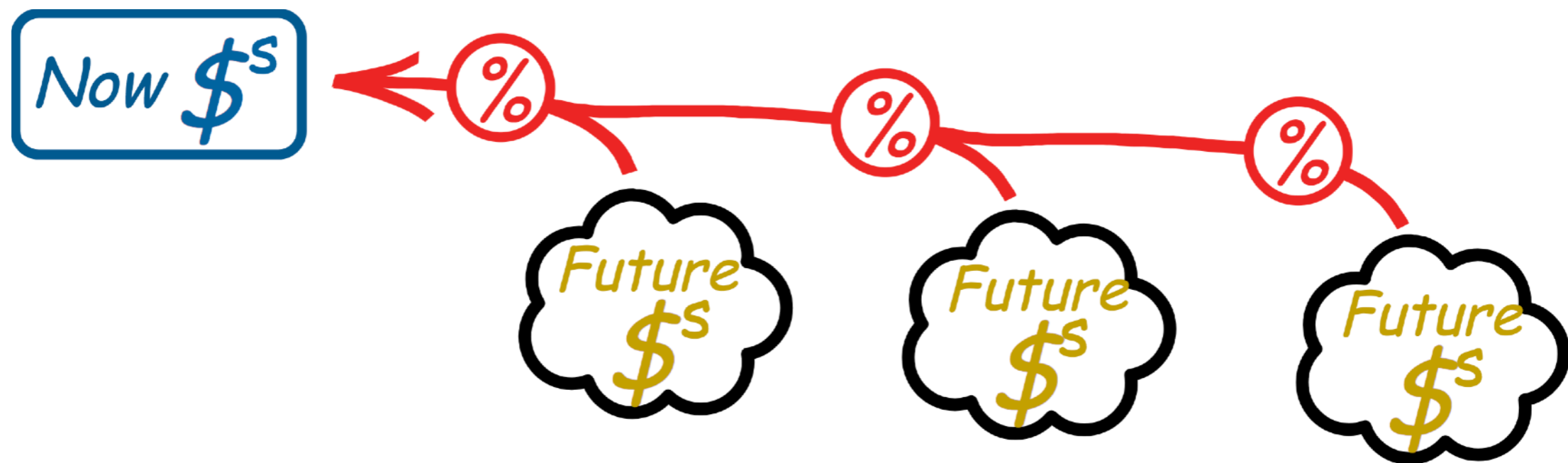
(Four model specifications:
short-run & long-run
pooled & rich-poor)



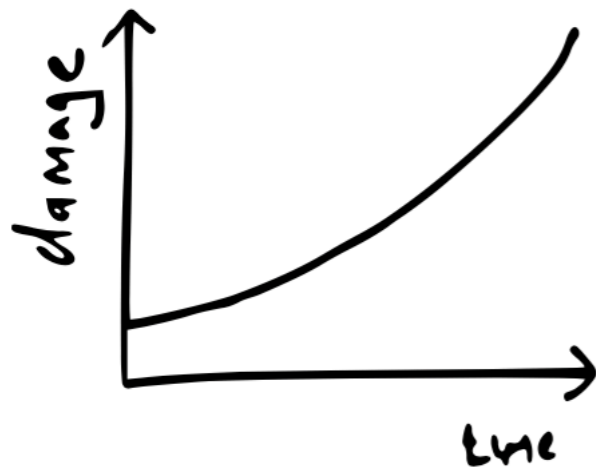
Dell et al (2012)

Discounting module

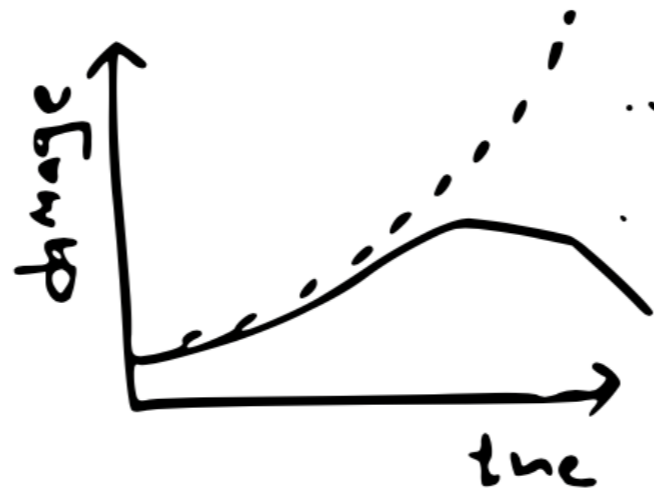
Net present value: The value today of a decision's consequences now and into the future



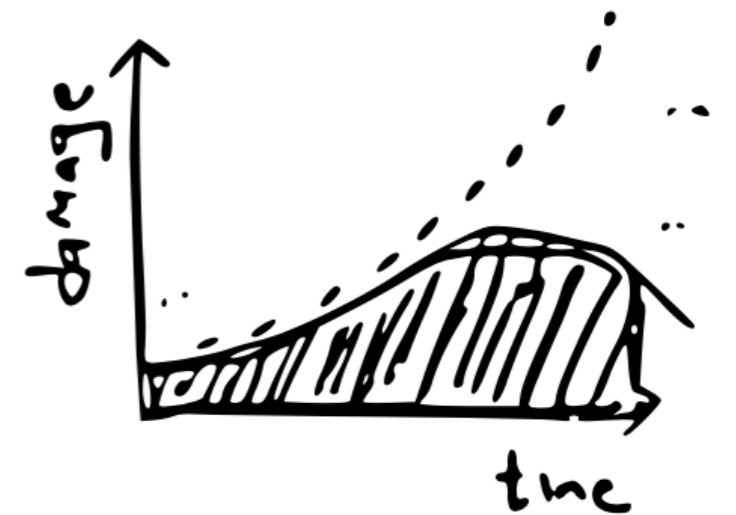
Discounting module



damages

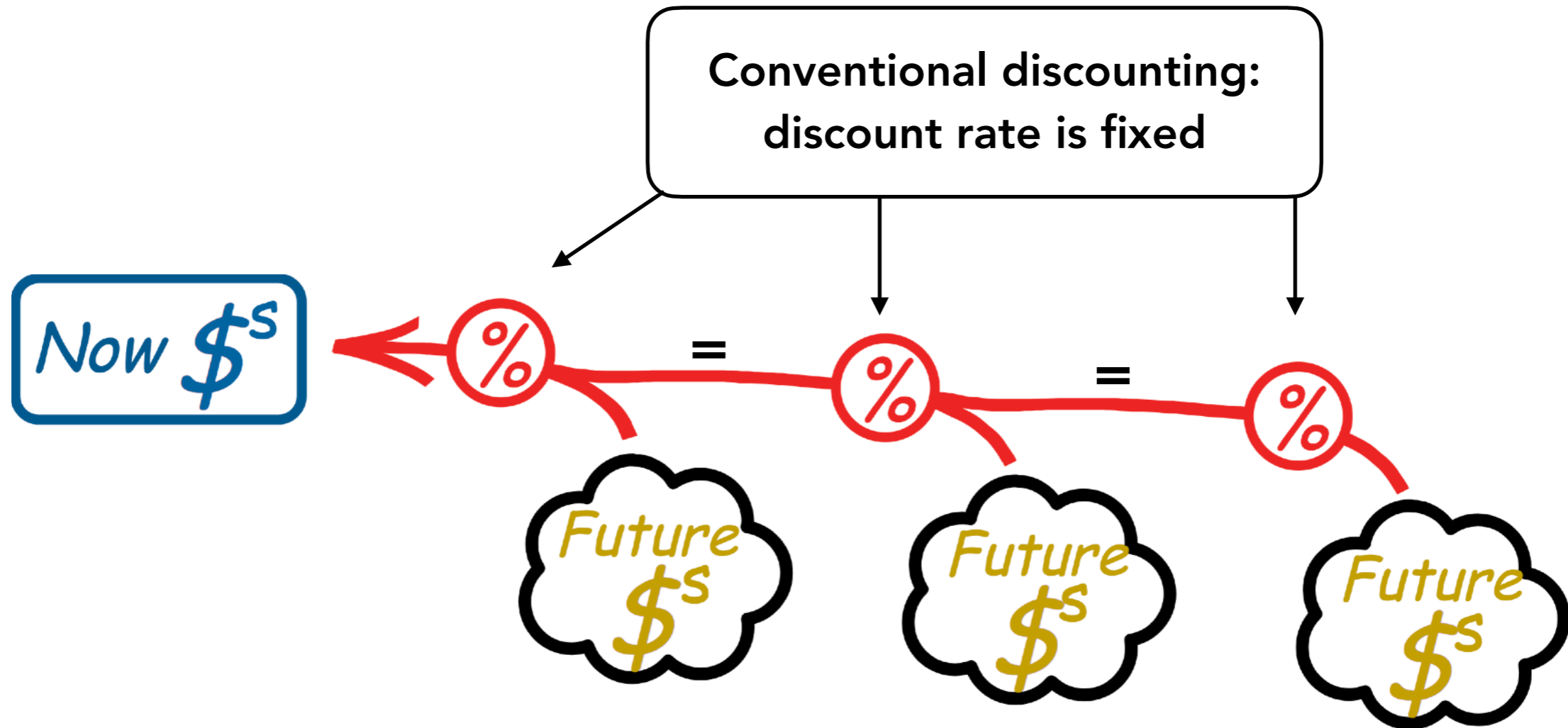


discounted
damages

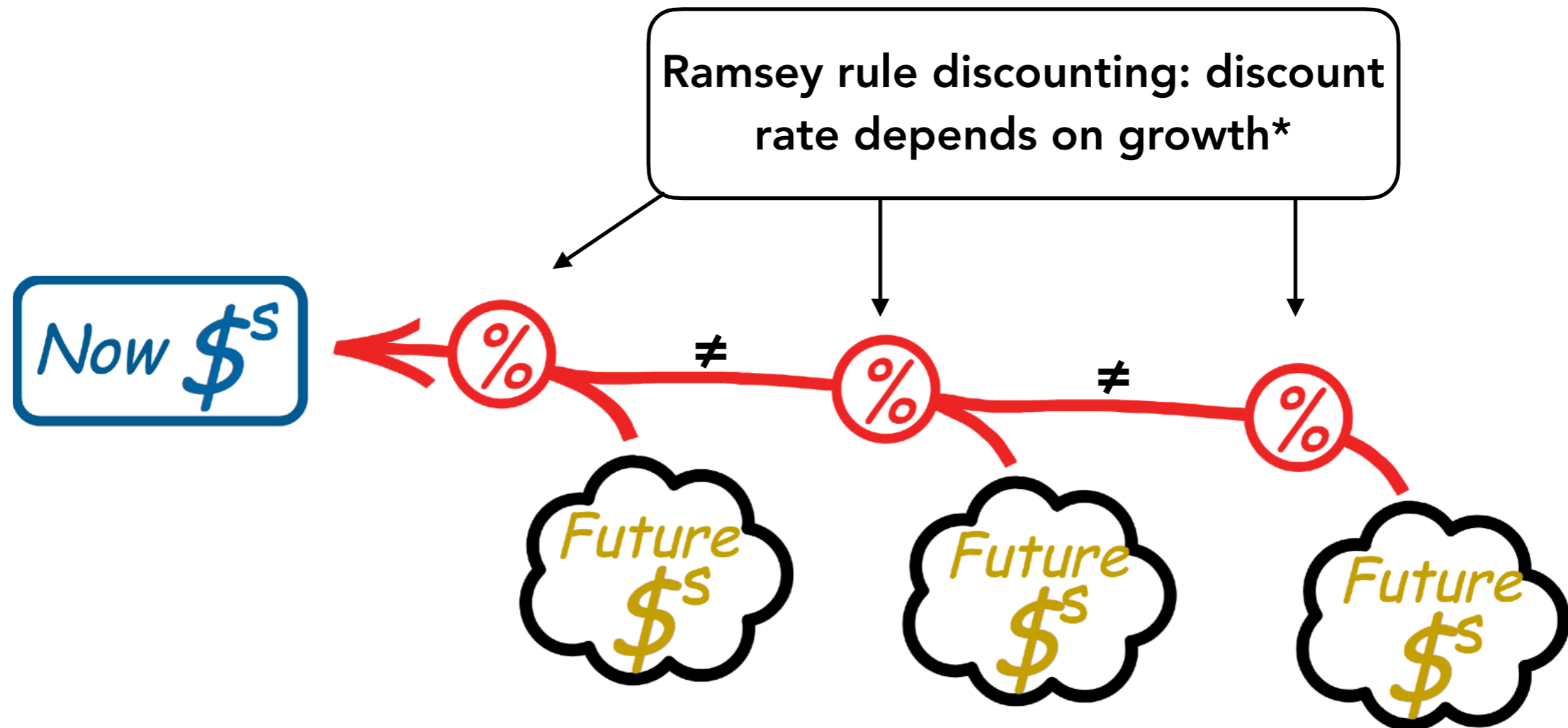


aggregate
discounted damages

Discounting module



Discounting module



* will vary by country, by baseline and over time

Calculating SCC: Four modules

Socioeconomic

Define how the economy will change in the future under business-as-usual scenarios

Earth system

Calculate how countries will warm under business-as-usual and with a small additional emission of carbon dioxide today

Damages

Calculate the economic losses (or gains) associated with those scenarios and the pulse of CO₂

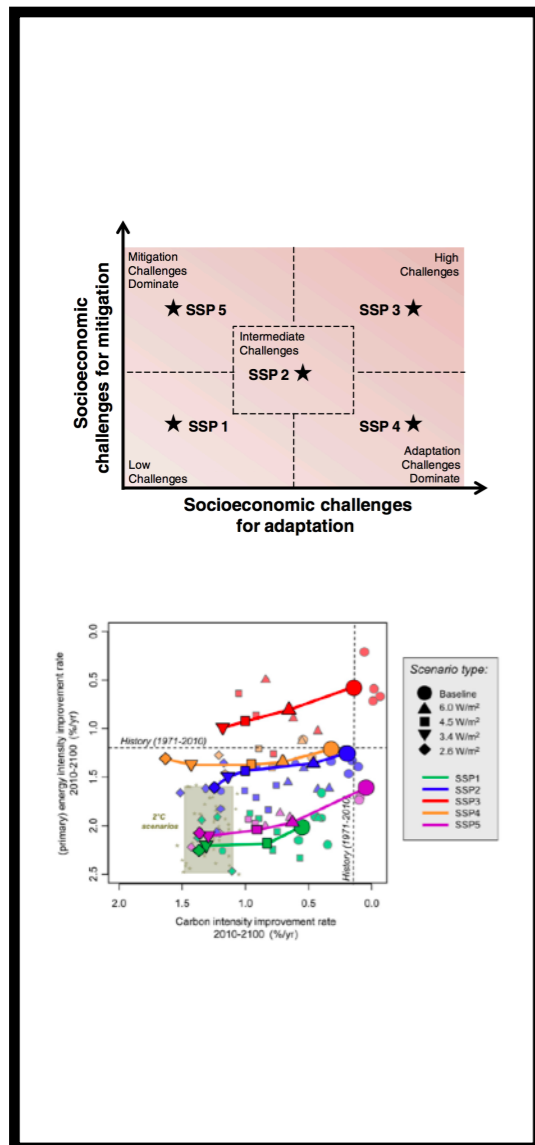
Discounting

Compress those losses and gains into a net present value using discounting

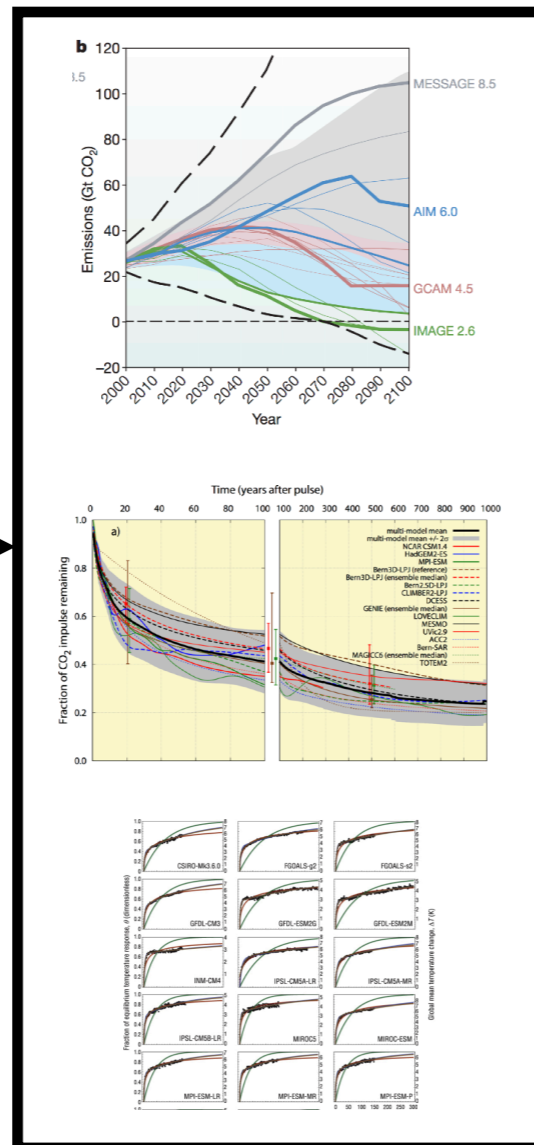


Calculating SCC: Four modules

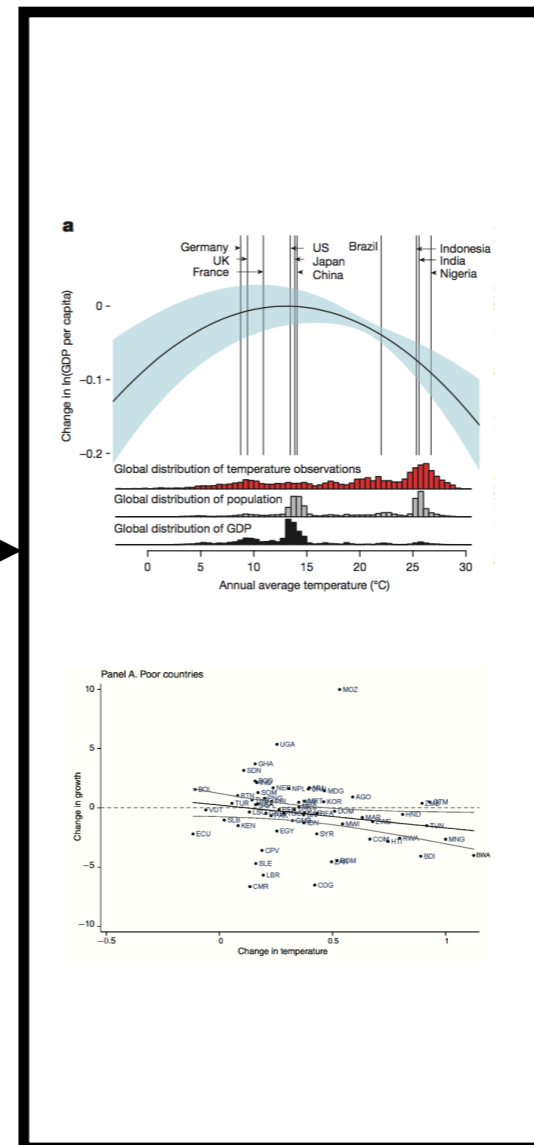
Socioeconomic



Earth system



Damages

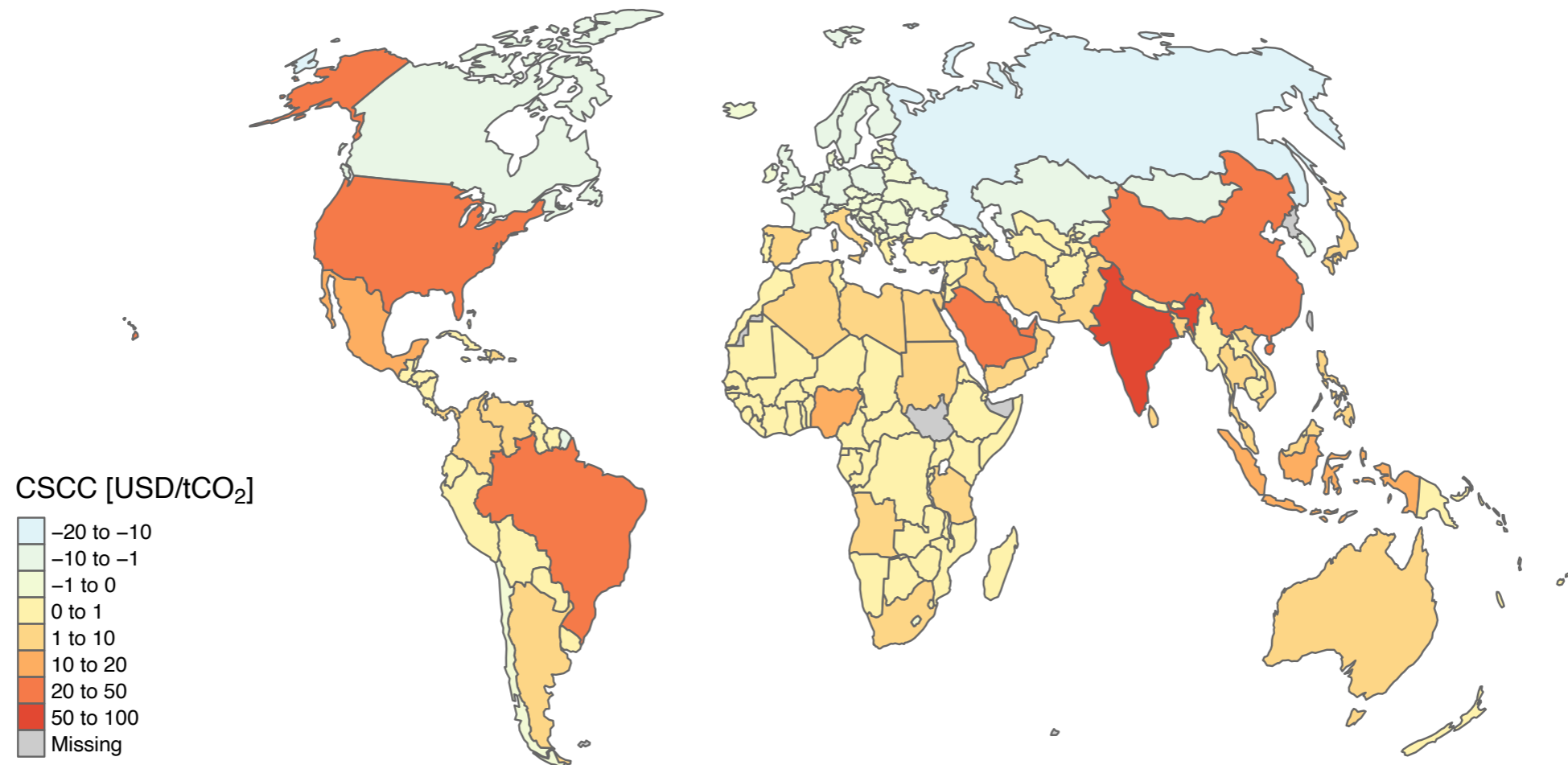


Discounting

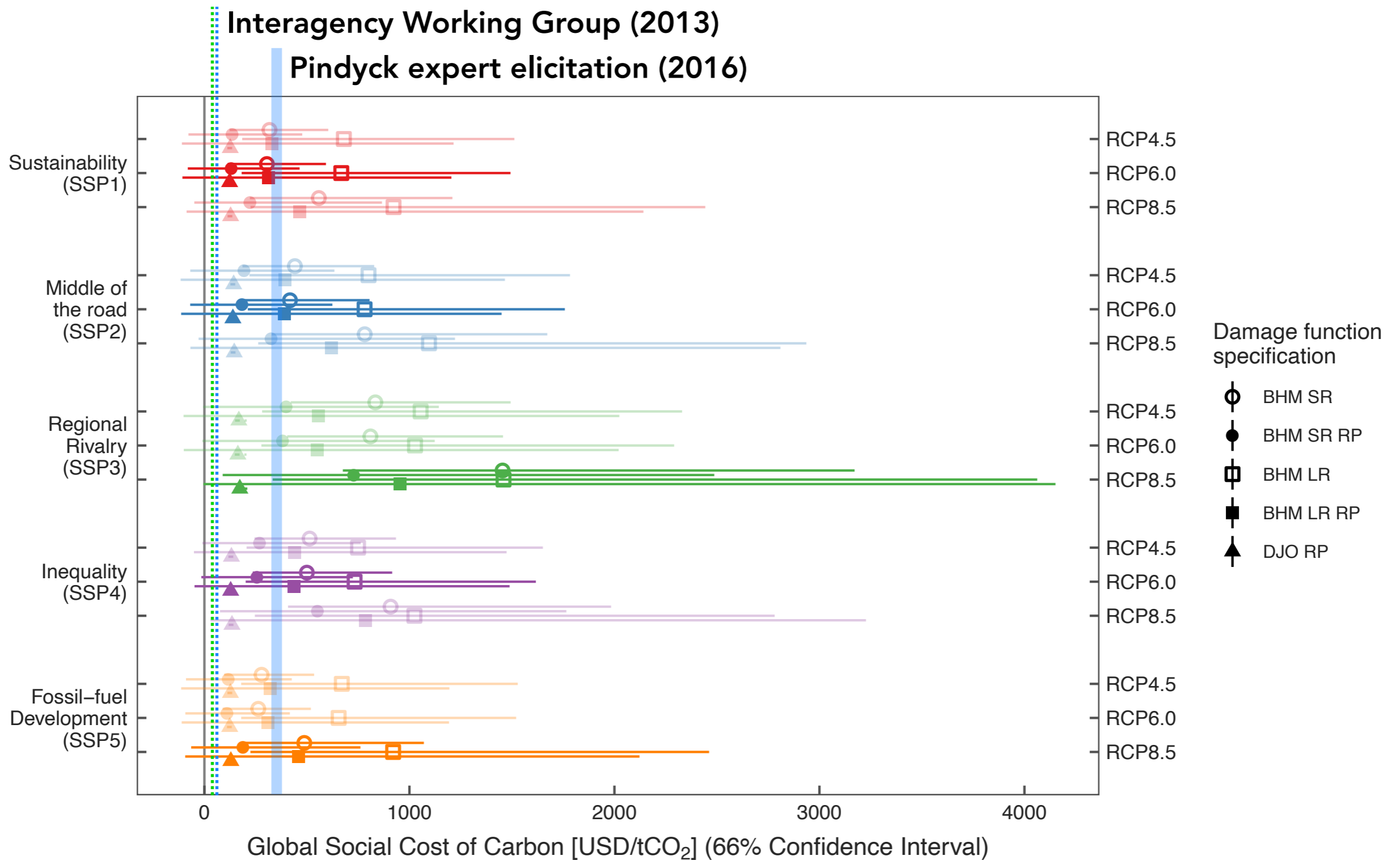


$$r = \delta + \eta g$$

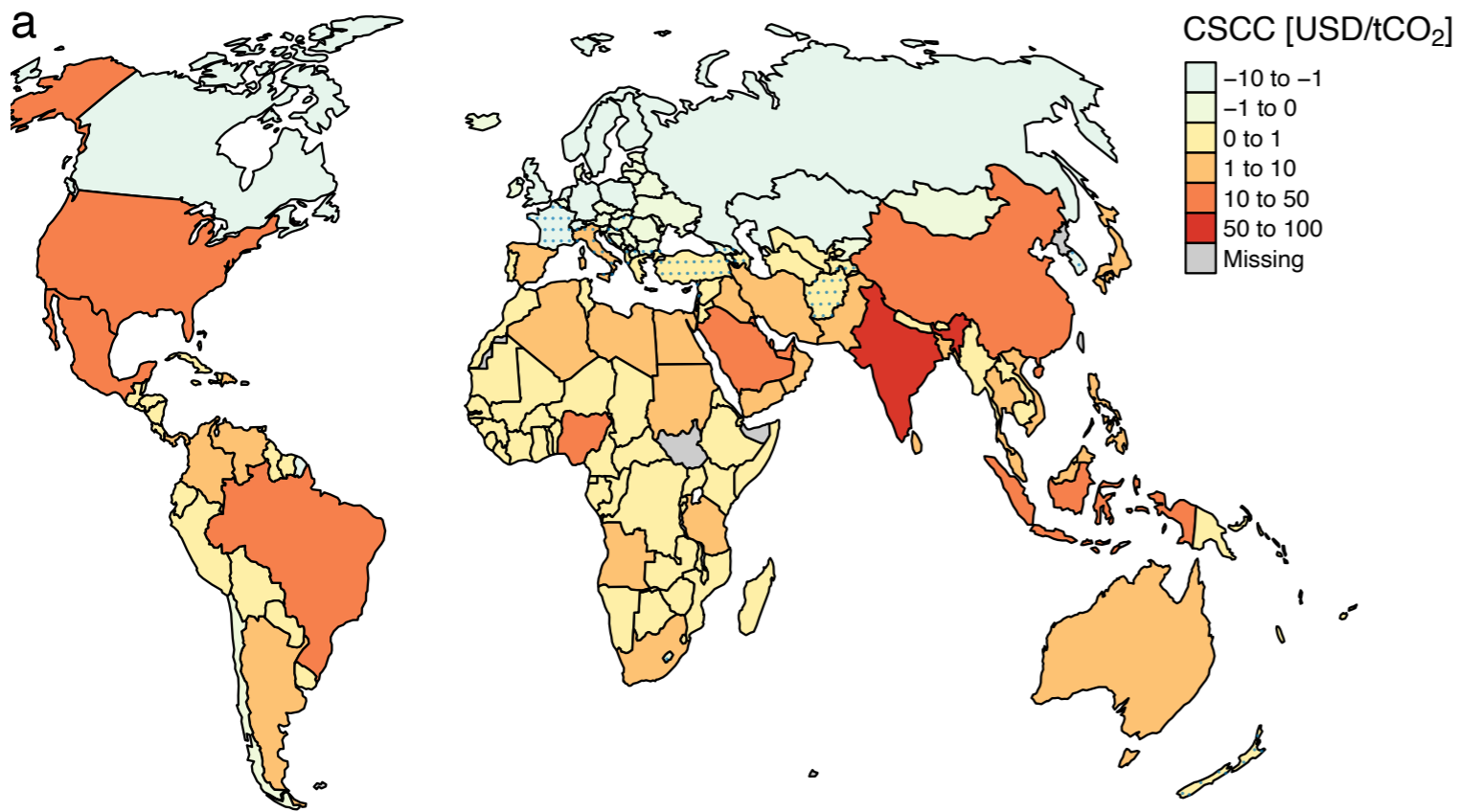
Country-level social cost of carbon (CSCC)



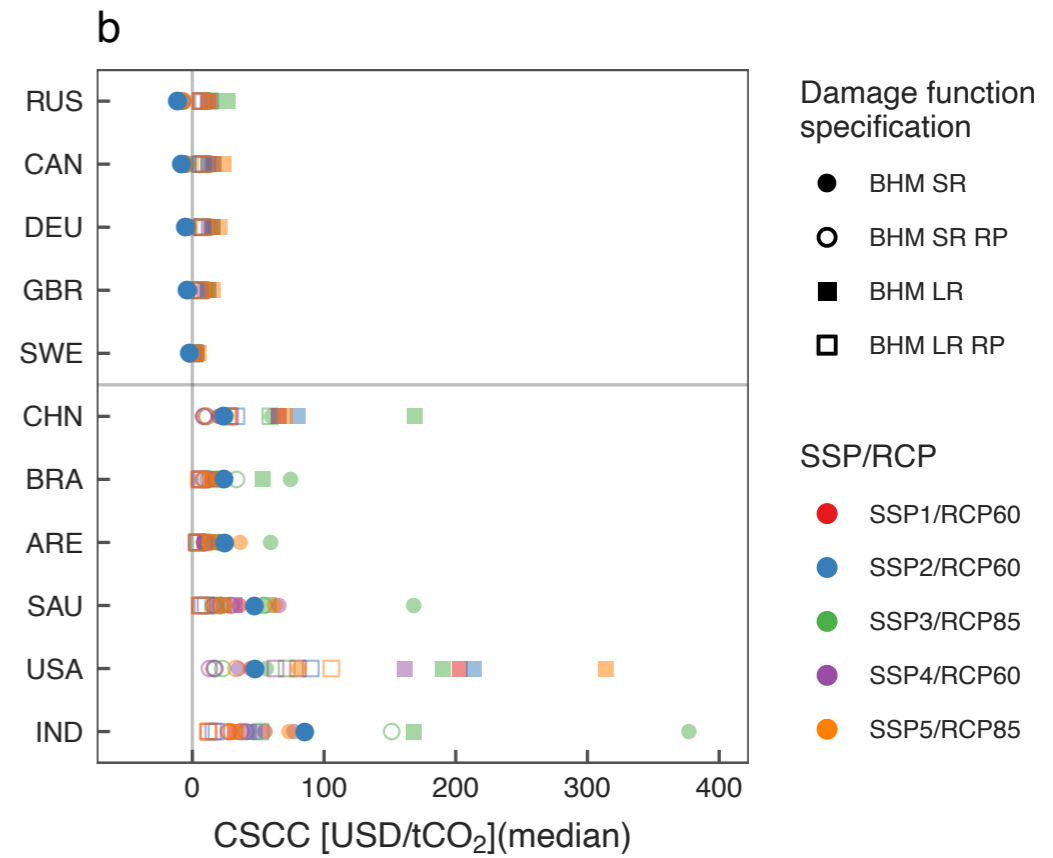
Global social cost of carbon



Country-level social cost of carbon (CSCC)

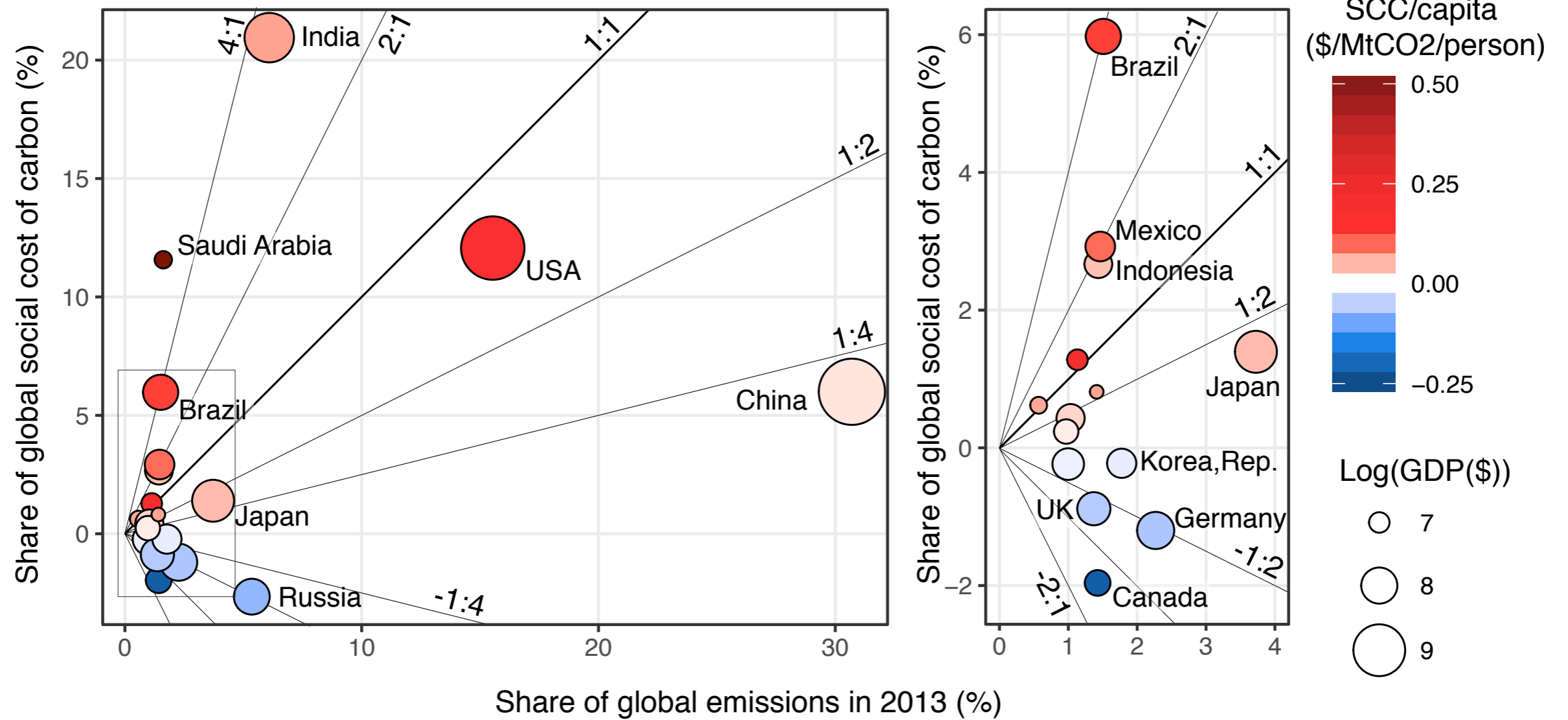


Reference case (SSP2/RCP6/BHM-SR/ $\rho=1, \eta=1.5$)



Uncertainty analysis

Strategic view



Reference case (SSP2/RCP6/BHM-SR/ $\rho=1, \eta=1.5$)

Trump Put a Low Cost on Carbon Emissions. Here's Why It Matters.



Coal at a power plant in Catlettsburg, Ky. Luke Sharrett/Getty Images

Trump administration revised SCC down to \$1 to \$7 per ton of CO₂



By Brad Plumer

Aug. 23, 2018



Want climate news in your inbox? Sign up here for [Climate Fwd](#), our email newsletter.

WASHINGTON — How much economic damage will global warming cause? That's one of the key questions embedded in the Trump administration's recent proposals to weaken Obama-era regulations on greenhouse gas emissions from both [vehicles](#) and [power plants](#).

When federal agencies calculate the costs and benefits of climate regulations, they use a figure called the "social cost of carbon," an estimate of the harm caused by releasing more carbon dioxide into the

The Biden Administration Social Cost of Carbon

A new White House policy tries to put a dollar value on greenhouse gas emissions.



PHOTOGRAPH: GETTY IMAGES

COMMENT · 19 FEBRUARY 2021

Eight priorities for calculating the social cost of carbon

Advice to the Biden administration as it seeks to account for mounting losses from storms, wildfires and other climate impacts.

Gernot Wagner, David Anthoff, Maureen Cropper, Simon Dietz, Kenneth T. Gillingham, Ben Groom, J. Paul Kelleher, Frauke Kemfert, James H. Stock



A coal-fired power plant in Montana. Credit: Jim West/Science Photo Library

One of the first executive orders US President Joe Biden signed in January 2021 was to direct the EPA to revise the social cost of carbon (SCC). This metric is used in

PDF version

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Can Joe Biden make good on his revolutionary climate agenda?

Emissions: world has four times the work or one-third the time

Base the social cost of carbon

Implications for policy

- Global and country-level SCC are hugely uncertain, but with a median GSCC of \$417/ton CO₂, \$40/ton is likely much too low
- Robust heterogeneity reinforces why collective action has been so difficult: countries like India benefit less from the status quo (CSCC:emissions > 4) than China (CSCC:emissions < 1/4)
- The three biggest emitters – China, US and India—also consistently have among the highest country-level SCC: **those that have the most power to do something to reduce climate damages also have the most incentive to do so**

Thanks

Ricke, K.L., L. Drouet, K. Caldeira and M. Tavoni. "Broad heterogeneity in country-level social cost of carbon." *Nature Climate Change*. October 2018. <https://doi.org/10.1038/s41558-018-0282-y>

website: <https://country-level-scc.github.io/>

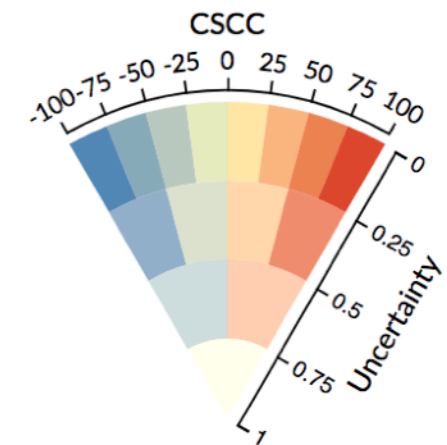
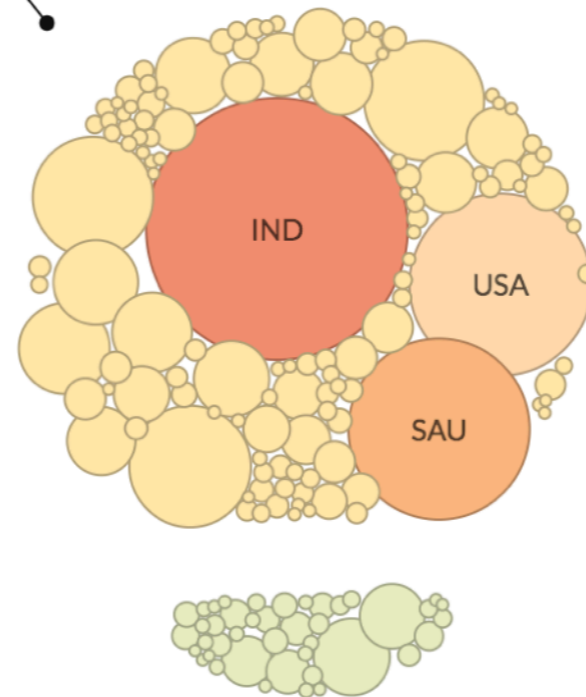
Country-level Social Cost of Carbon / Database Explorer

View: **Global** Lorenz curve Map

Future projection: SSP1/RCP60 **SSP2/RCP60** SSP3/RCP85 SSP4/RCP60 SSP5/RCP85 ⌵

Damage: BHM SR ⌵ Discounting: Growth-adjusted ⌵

Countries with a positive social cost of carbon (more damages).



Countries with a negative social cost of carbon (more benefits).

The Global Social Cost of Carbon is the sum of all country-level social costs of carbon.

Global Social Cost of Carbon: 418 USD/tCO₂ [177;806]



<https://country-level-scc.github.io/explorer/>