Climate change: a summary for policy-makers

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Climate change: a summary for policymakers

- How rising atmospheric CO_2 causes global warming
- How global temperatures and sea level respond
- Quantifying human influence on climate and weather
- The fate of CO_2 and other anthropogenic emissions
- Global impact functions and the social cost of carbon
- Mitigation costs and pathways
- Policy options from carbon pricing to geo-engineering
- Capstone activity: design a robust climate policy

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- How rising atmospheric CO_2 causes global warming
- How global temperatures and sea level respond
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- The fate of CO_2 and other anthropogenic emissions
- How Trump is gutting the Clean Power Plan.
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Are we worrying about climate change for the right reasons?

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What we (still) have to contend with...

Doomsday prediction for surging tides was WRONG: Study claims ice-cliffs of Antarctica will be responsible for just a 6-inch boost in sea levels - SEVEN times less than previously thought (but it will still cause 'climate chaos')

The latest study found that, by the end of this century, global sea levels will rise by a grand total of less than four feet (120 cm), noticeably less dramatic than the doomsday predictions of a 2016 paper from US-based scientists that estimated it would exceed 6.5 feet (2 metres)

- "This house believes that the dangers of Global Warming have been exaggerated, and that the policies to moderate it are fundamentally flawed."

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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

"Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C (*high confidence*)."

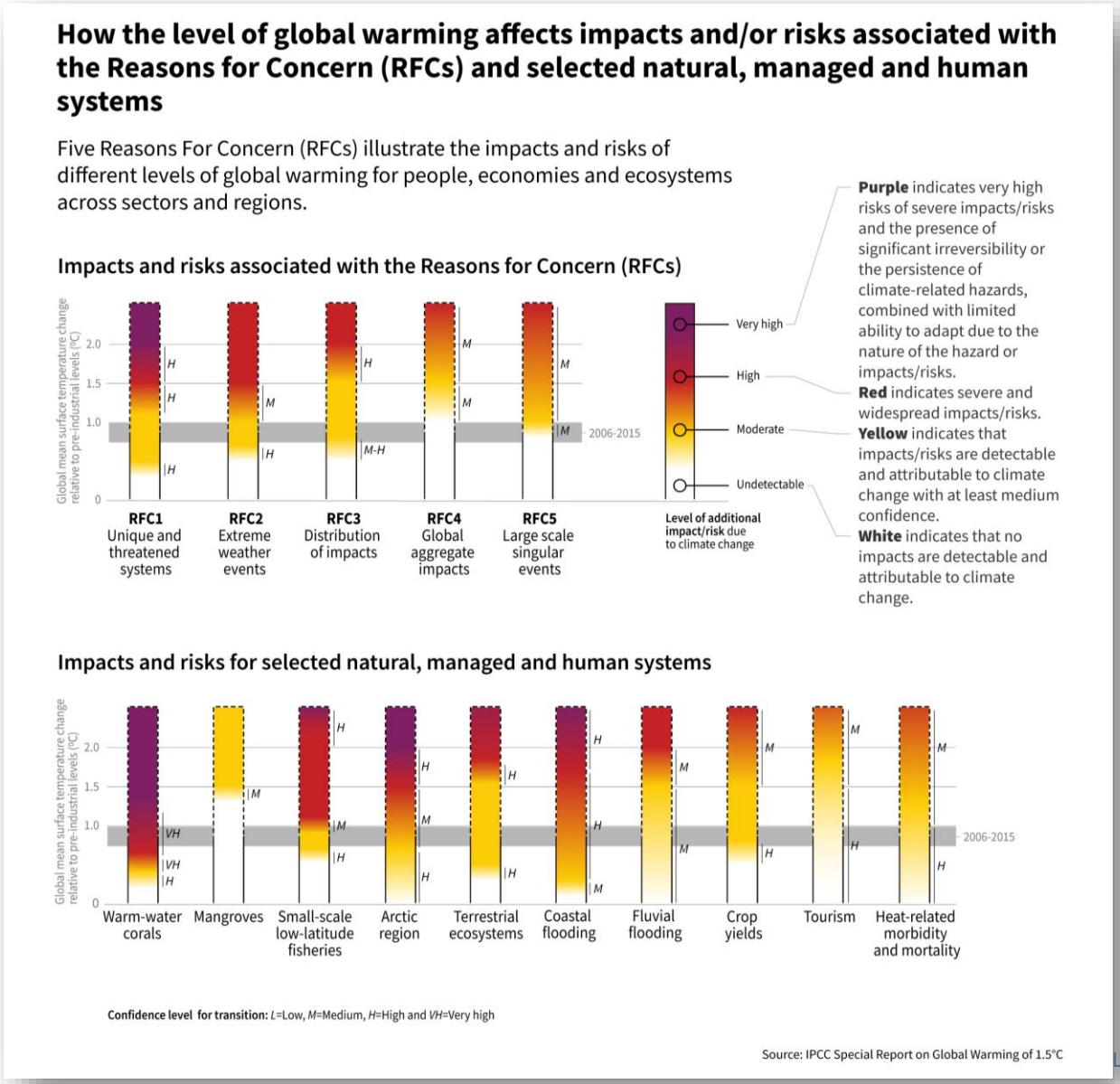

Figure SPM.2

ipcc climate change

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Background Definitions: the IPCC's Reasons For Concern

- **RFC1 : Unique and threatened systems** encompass ecological and human systems that (i) have restricted geographic ranges constrained by climate related conditions and (ii) have high endemism or other distinctive properties. They include coral reefs, the Arctic and its indigenous people, mountain glaciers, and biodiversity hotspots.

- **RFC2 : Risks associated with extreme weather events.** risk to human health, livelihoods, assets, and ecosystems from extremes such as heat waves, heavy rain, drought and associated wildfires, and coastal flooding

- **RFC3 : Risks associated with the uneven distribution of impacts.** This category of risk reflects climate change impacts that disproportionately affect particular groups due to uneven distribution of physical climate change hazards, exposure or vulnerability. Unevenness can be with respect to geographic location, income and wealth, gender, age, or other physical and socioeconomic characteristics.

Background Definitions: the IPCC's Reasons For Concern

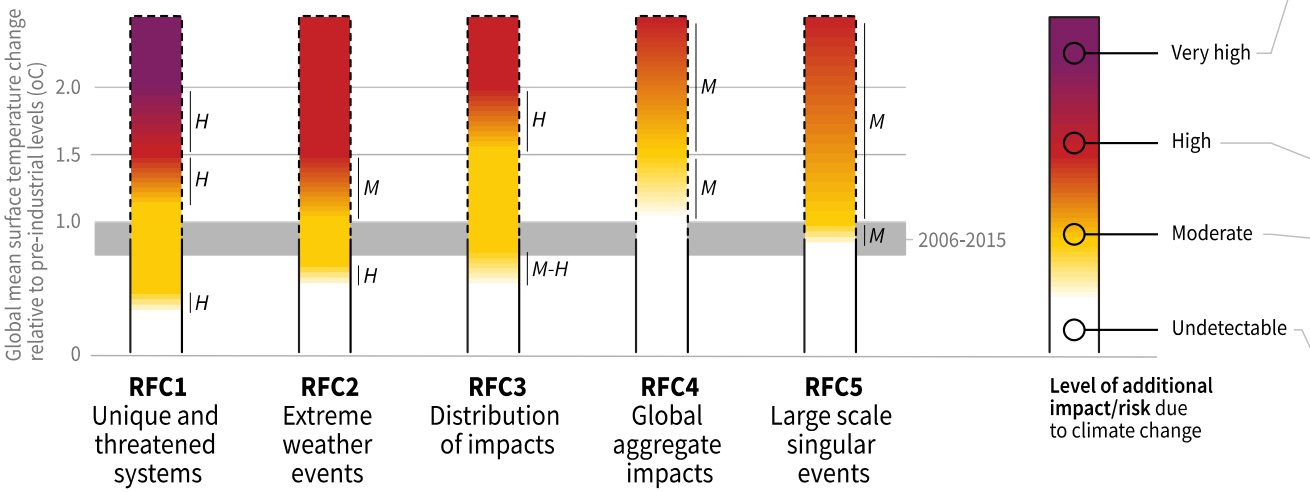
- **RFC4 : Risks associated with global aggregate impacts.** This category of risk reflects a combination of global aggregate economic damages and the impacts on ecosystems and their services which are not included in most economic damage assessments

- **RFC5 : Risks associated with large-scale singular events.** Large-scale singular events (sometimes called tipping points or critical thresholds) are relatively large, abrupt and sometimes irreversible changes in physical, ecological, or social systems in response to smooth variations in driving forces. Includes Greenland and Antarctic ice sheets, the thermohaline circulation: slowdown of the Atlantic Meridional Overturning Circulation (AMOC), the El Niño–Southern Oscillation (ENSO) as a global mode of climate variability, role of the Southern Ocean in the global carbon cycle.

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs)

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

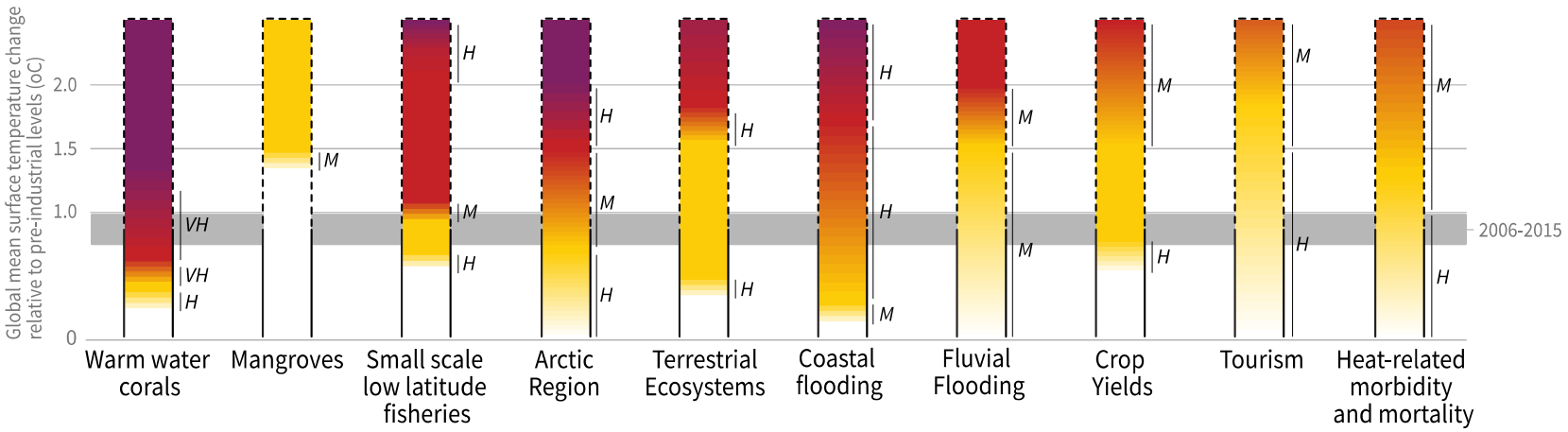
Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs)

Impacts and risks for selected natural, managed and human systems



Confidence level for transition: *L*=Low, *M*=Medium, *H*=High and *VH*=Very high

Source: IPCC Special Report on Global Warming of 1.5°C

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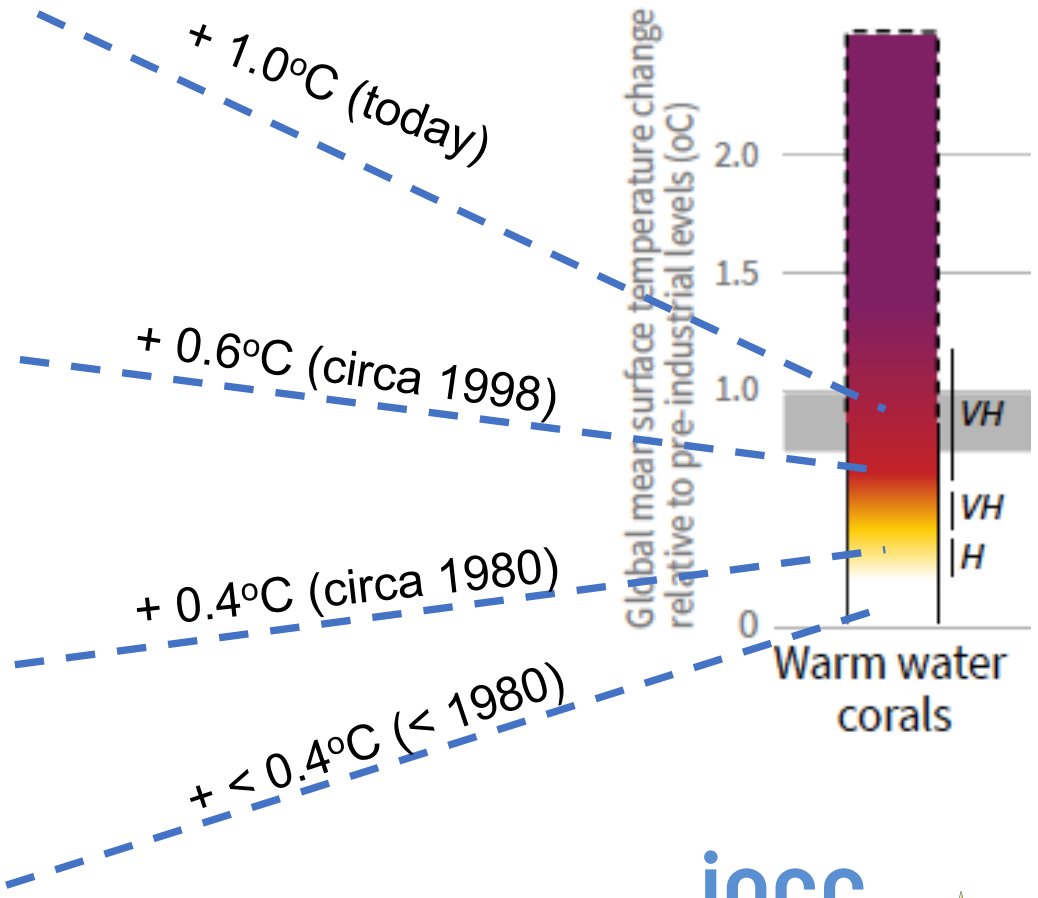
Unique and threatened systems: Coral reefs

First back-to-back global mass bleaching and mortality events (2016-2017; many authors including Hughes et al 2017a,b; risks Frieler et al, Donner et al *irreversibility*)

First global mass bleaching and mortality event (1998; many authors, HG 1999, Wilkerson et al 2000, Glynn et al 2000; *some recovery*)

Mass coral bleaching reported (isolated events, not global; Glynn 1983, others)

No reports of mass coral bleaching



Global aggregate impacts: Terrestrial ecosystems

By 2.5˚ C, biome shifts and species range losses escalate to very high levels – adaptation options are very limited (*irreversible*).

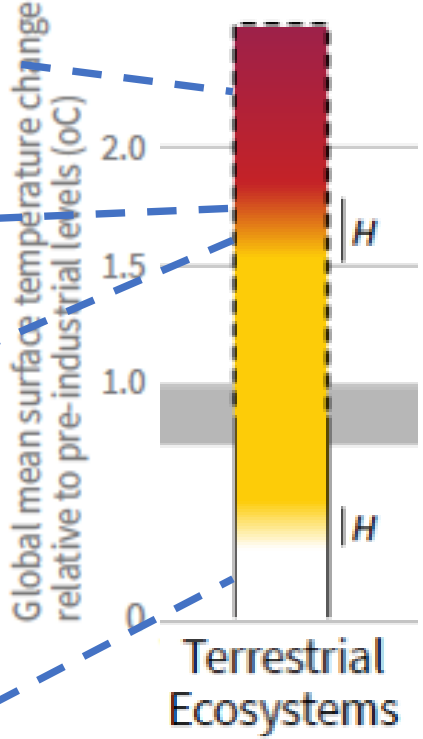
Key transition between 1.5°C to 2.0°C due to extensive shifts of biomes (major ecosystem types) and a doubling or tripling of the number of plants, animals or insects losing over half of their climatically determined geographic ranges

Differences become much larger between 1.5°C and 2.0°C

> 2.0°C (*risk*)

+ 1.5 to 2.0°C (risk)

+ < 0.3°C (< 1975)



No detection and attribution of impacts of global warming on terrestrial ecosystems

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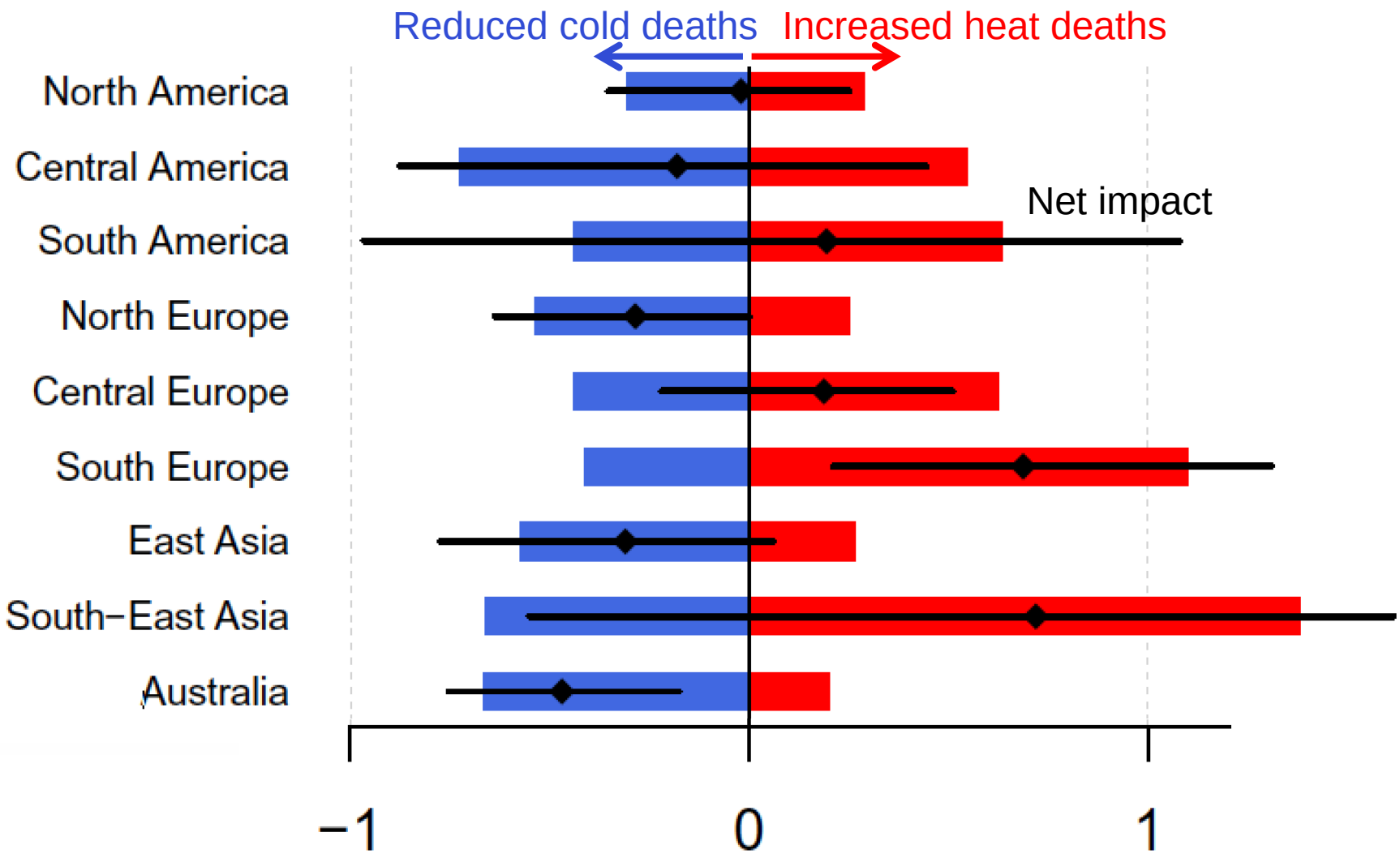
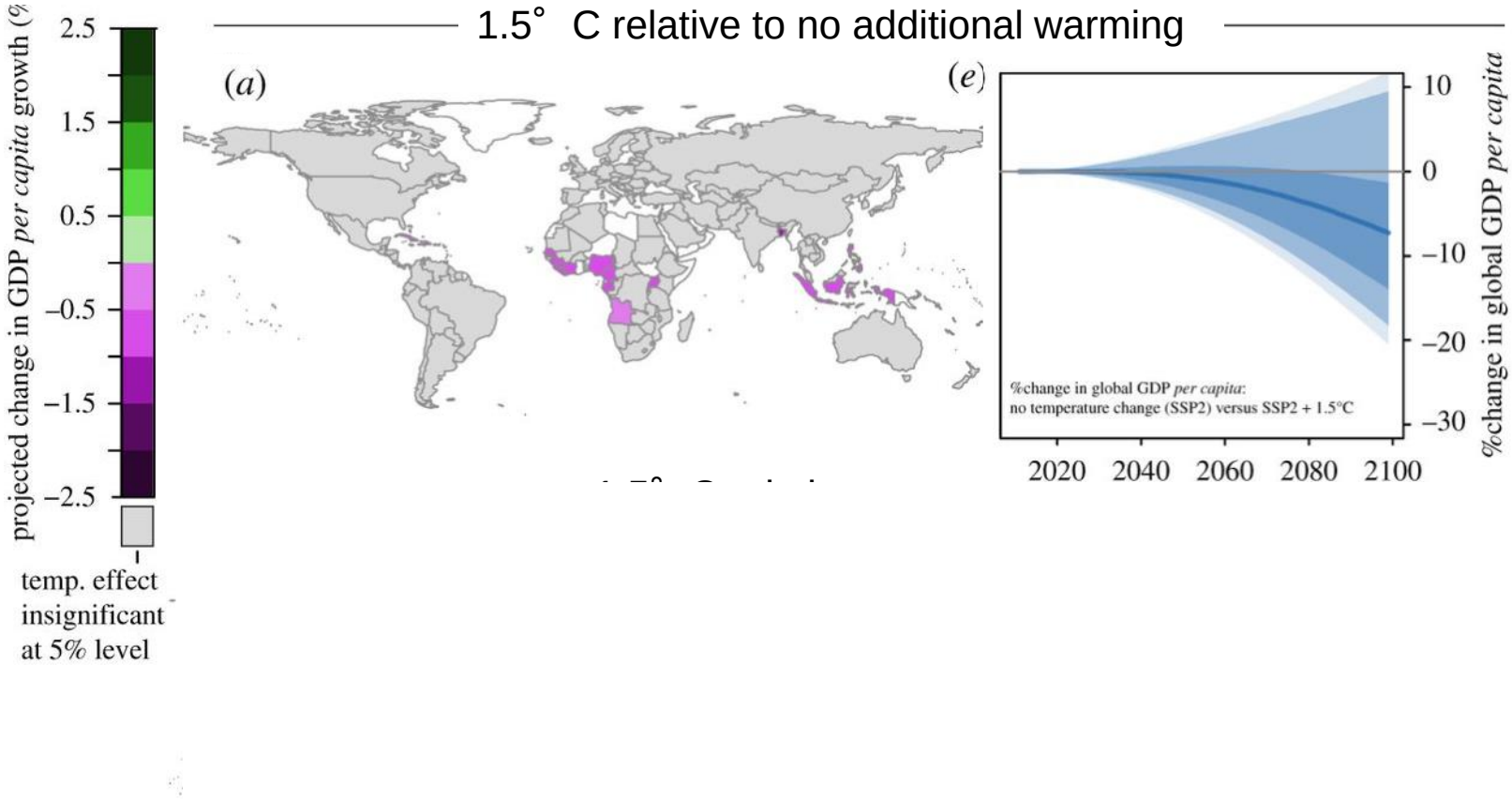
Distribution of impacts: Differential impacts on human health



SR1.5: “Any increase in global warming is projected to affect **human health**, with primarily negative consequences” – Figure shows difference in excess mortality (%) due to extreme temperatures @ 2˚ C versus 1.5˚ C – Vicedo-Cabrera et al (2018)

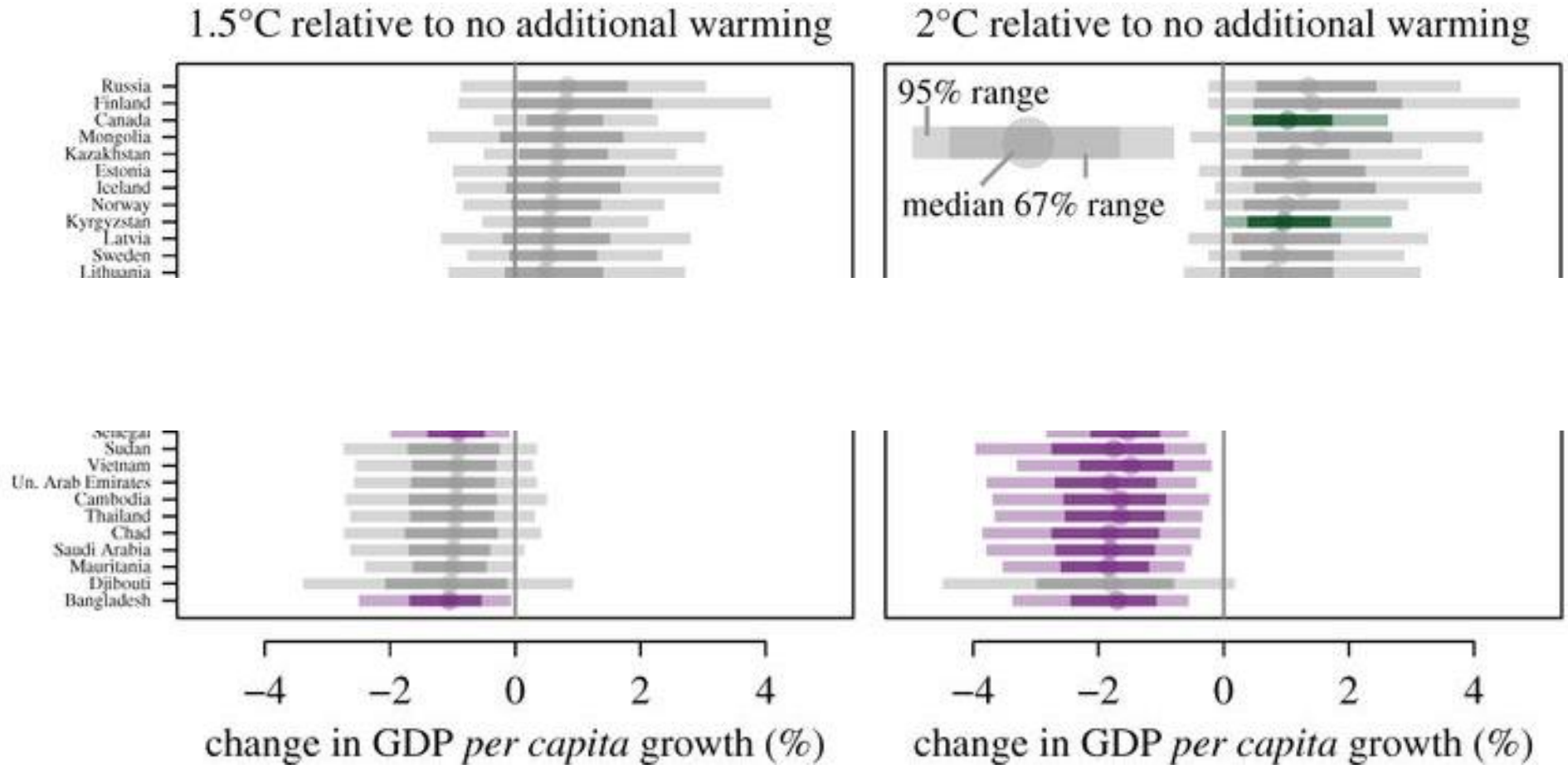
Economic impacts at 1.5°C versus 2°C



Felix Pretis et al. Phil. Trans. R. Soc. A 2018;376:20160460

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

“Countries in the tropics and Southern Hemisphere subtropics are projected to experience the largest impacts on **economic growth** due to climate change should global warming increase from 1.5°C to 2°C”



Felix Pretis et al. Phil. Trans. R. Soc. A 2018;376:20160460

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

Carefully worded sentences

Approved SPM – copyedit pending IPCC SR1.5

B6. Most adaptation needs will be lower for global warming of 1.5°C compared to 2°C (*high confidence*). There are a wide range of adaptation options that can reduce the risks of climate change (*high confidence*). There are limits to adaptation and adaptive capacity for some human and natural systems at global warming of 1.5°C, with associated losses (*medium confidence*). The number and availability of adaptation options vary by sector (*medium confidence*). {Table 3.5, 4.3, 4.5, Cross-Chapter Box 9 in Chapter 4, Cross-Chapter Box 12 in Chapter 5}

Why am I particularly concerned about RFC3: Uneven distribution of impacts?

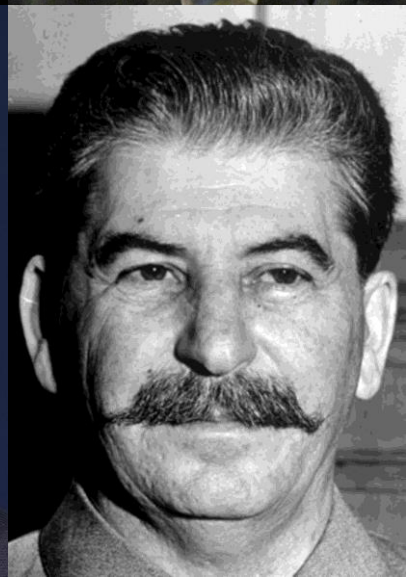
- Rawls' (1971) Theory of Justice: 'there, but for the grace of God, …'
  - We are particularly sensitive to risks that might fall disproportionately on us as individuals.
- Veenhoven's (1991) Theory of Happiness:
  - "life satisfaction depends only partly on comparison"
- By focusing on global aggregate collective risks, we encourage people to be more tolerant of climate change.

What do these four have in common?

Bjorn Lomborg

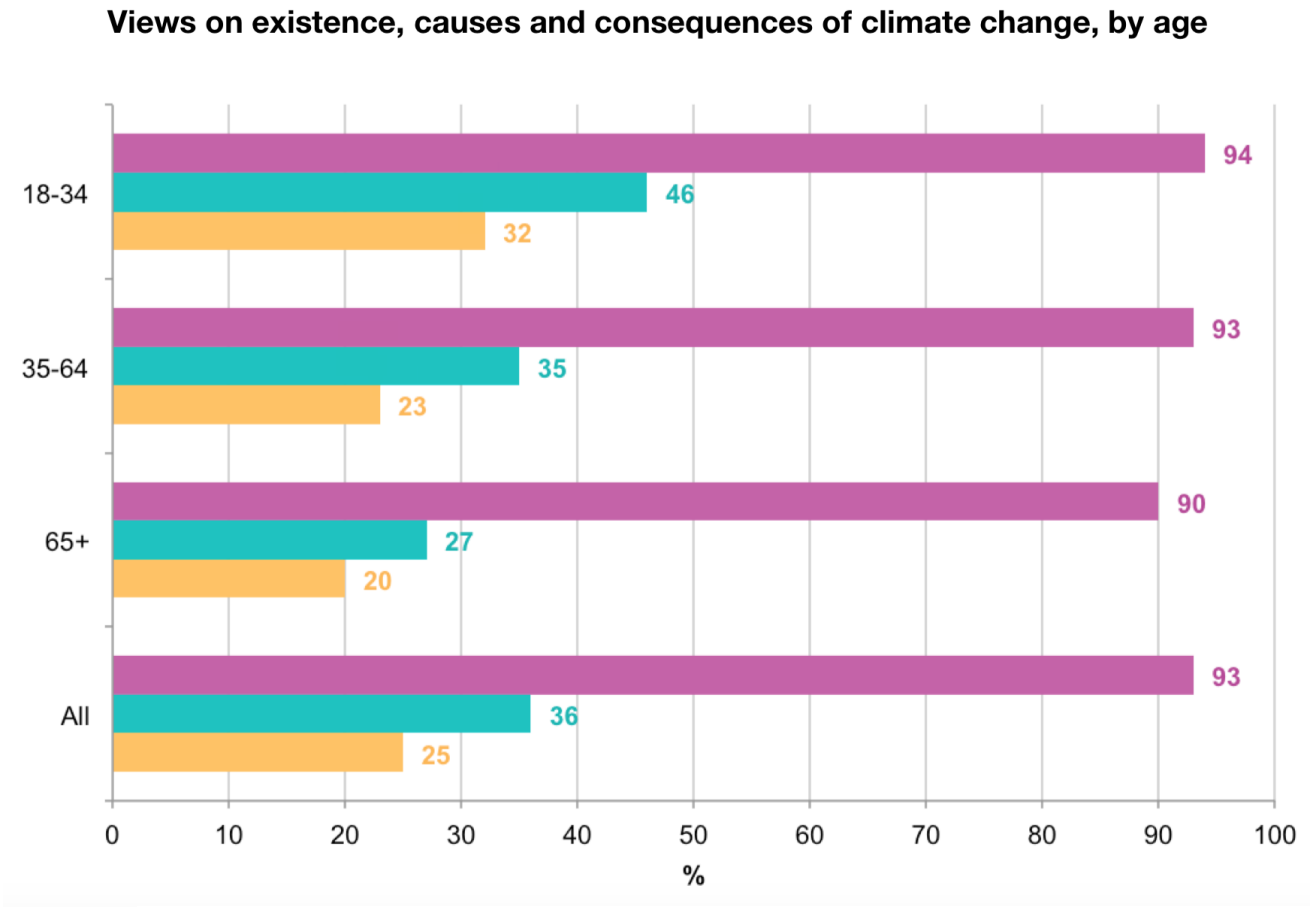
Richard Tol

Matt Ridley



Josef Stalin

Rawls' theory of justice and intergenerational attitudes to climate change



Philips et al, British Social Attitudes survey No. 35, 2018

Note: questions asked about "climate change", not "global warming" or even "global climate change"

Before we get quantitative again...

- Different, arguably (equally?) legitimate, views on justice, equity, optimism, individualism etc. appear to have as much impact on how "bad" people perceive climate change to be than the numbers I'm about to show you.
- Any presentation of numbers depends on some coded assumptions about these ethical issues.
- The remainder of this lecture will use the ethical framework of the Government of the United States of America.

Does anyone have a problem with that?

The Social Cost of Carbon Dioxide Emissions ($SC\text{-}CO_2$)

- "The social cost of carbon ($SC\text{-}CO_2$) for a given year is an estimate, in dollars, of the present discounted value of the damage caused by a 1-metric ton increase in carbon dioxide (CO_2) emissions into the atmosphere in that year or, equivalently, the benefits of reducing CO_2 emissions by the same amount in that year."
  - US National Academies Report, "Updating estimates of the Social Cost of Carbon", 2017
- N.B. "Increase" means "one-off temporary increase": no change in emissions in subsequent years.

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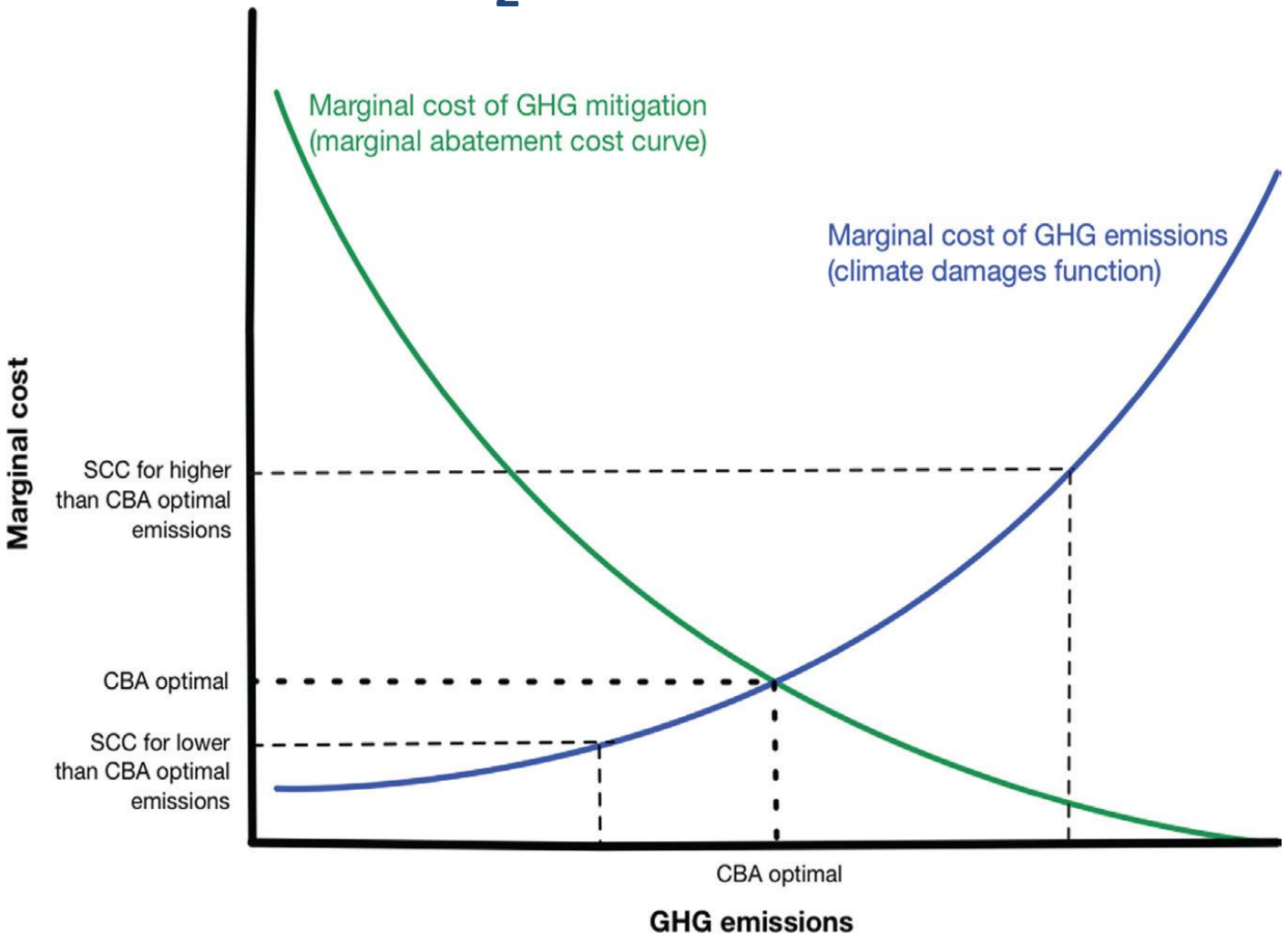
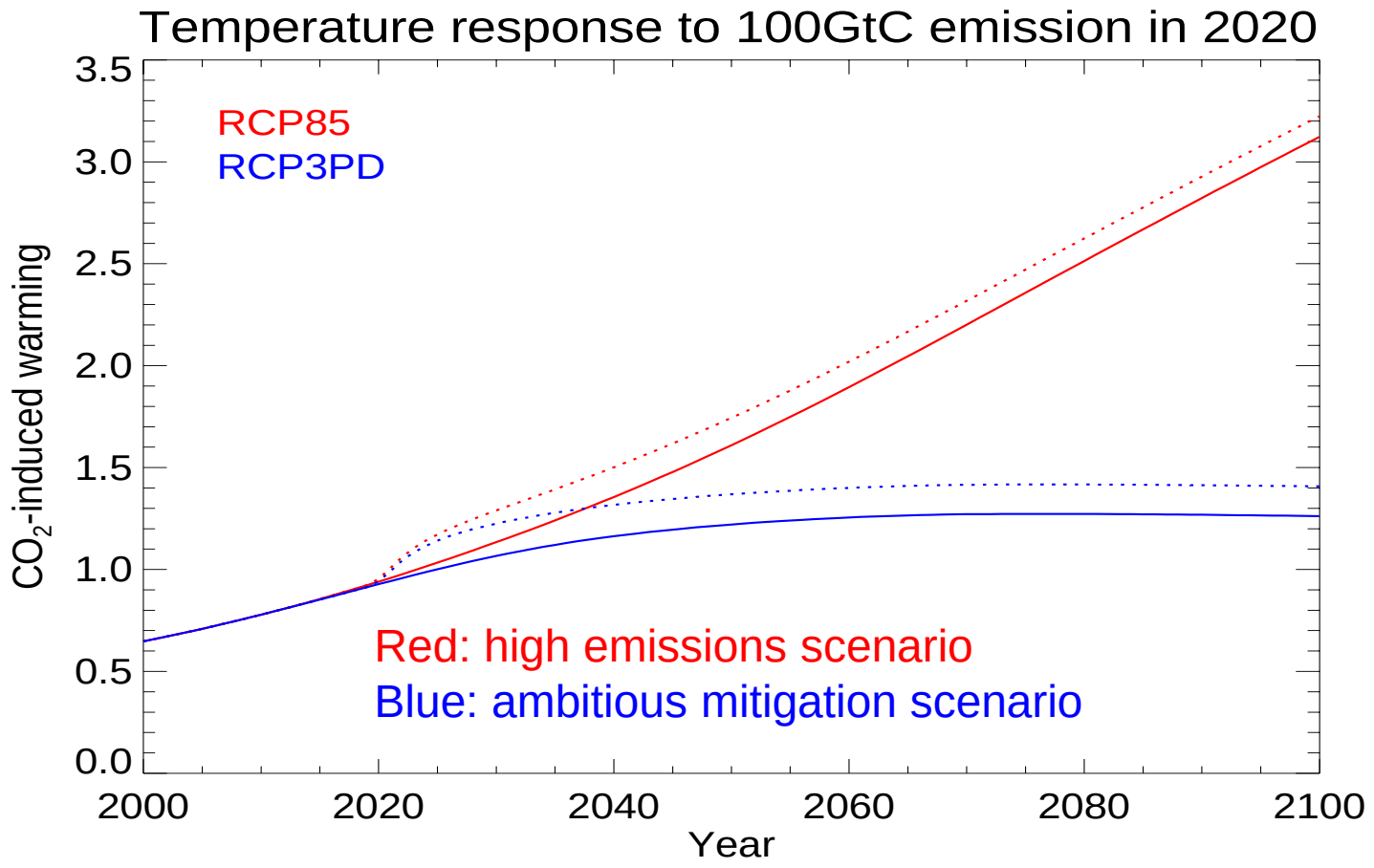
Use

- The SC-CO_2 is used in Benefit-Cost Analysis of environmental regulations (compulsory in the US) and (some) investment decisions to account for the impact of CO_2 emissions on climate.
- It provides one indication of the monetary value of emission reductions – whether this value is directly comparable, or should be compared, to the cost of these reductions is strongly contested.

Conventional Benefit-Cost-Maximising framework: "Marginal cost of GHG emissions" = SC-CO_2



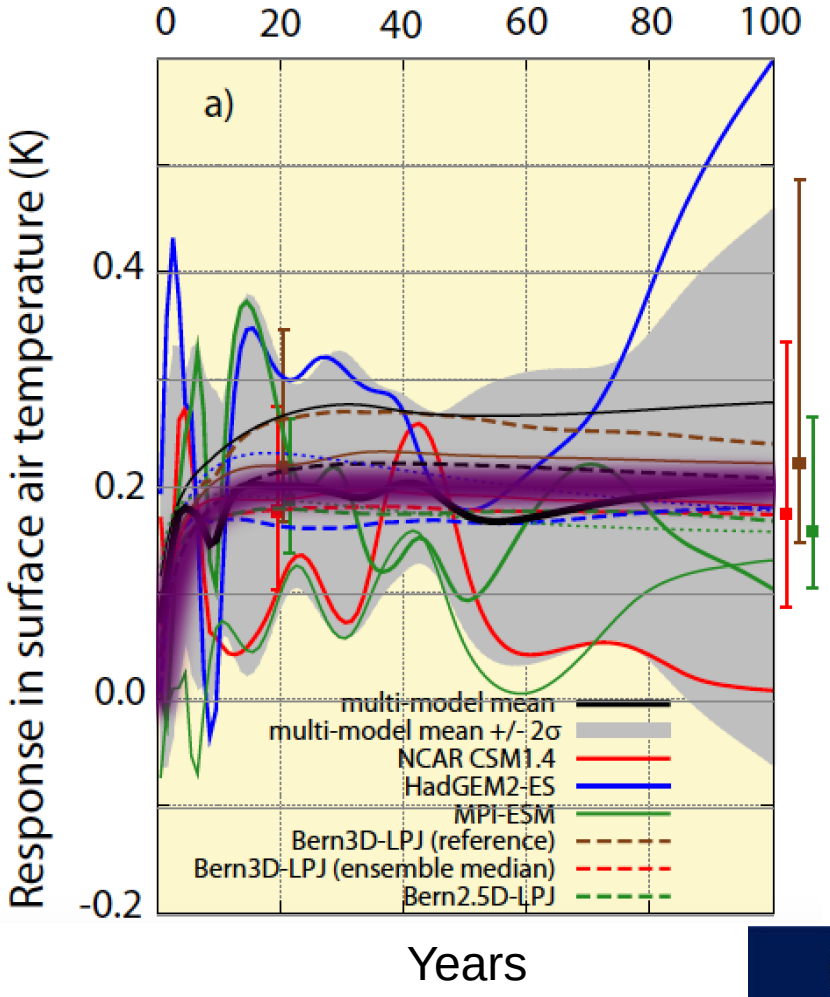
Two scenarios for future CO_2-induced warming & impact of a one-off 100GtC CO_2 injection in 2020



Temperature response to a pulse injection of CO_2

- Responses of various climate models to 100 billion tonnes of carbon injected in year zero (Joos et al, 2013).
- Idealized temperature response:

$$dT_{t+t¢} = T_{\mathrm{TCRE}} \left(1 - e^{-k_s t¢}\right)$$



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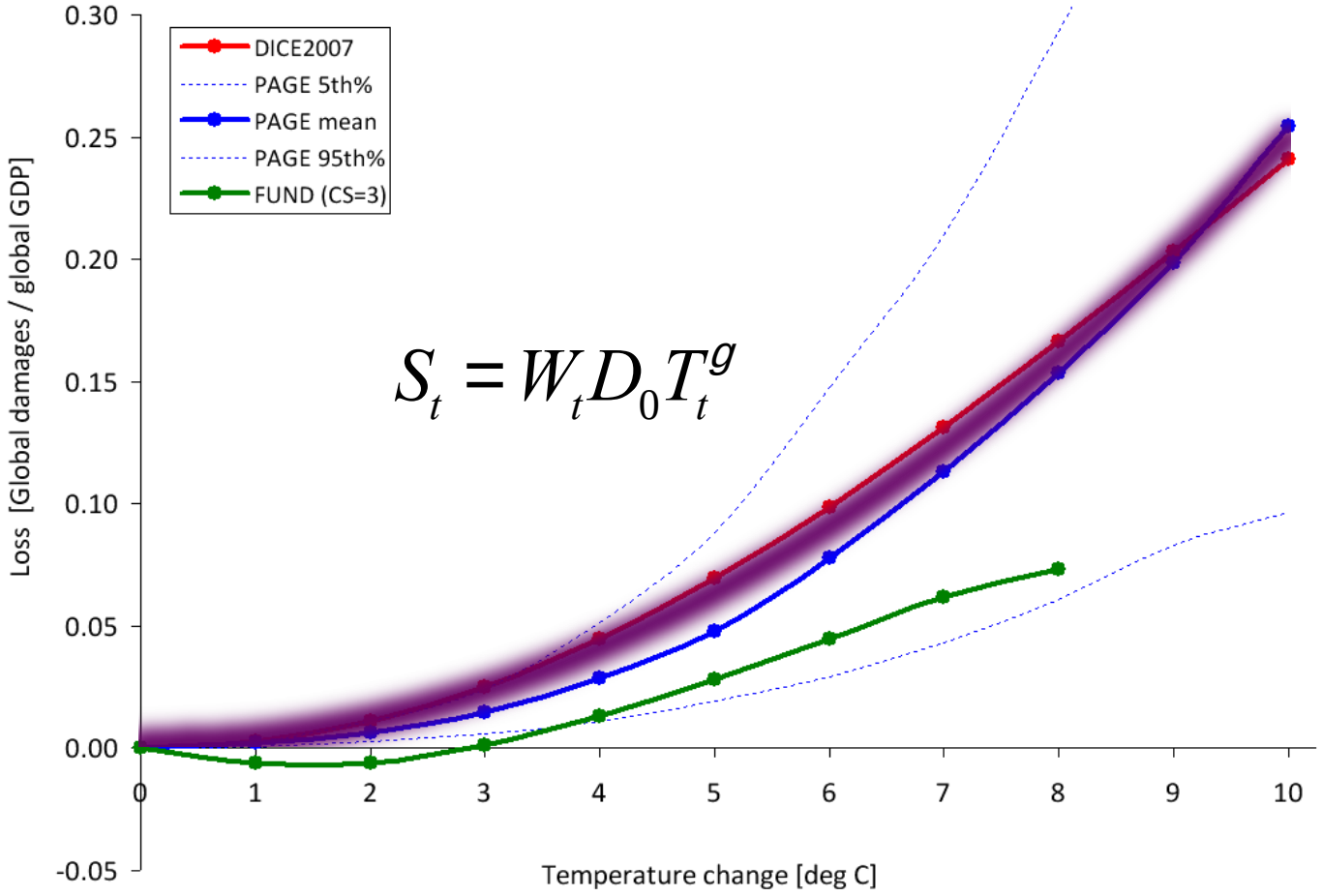
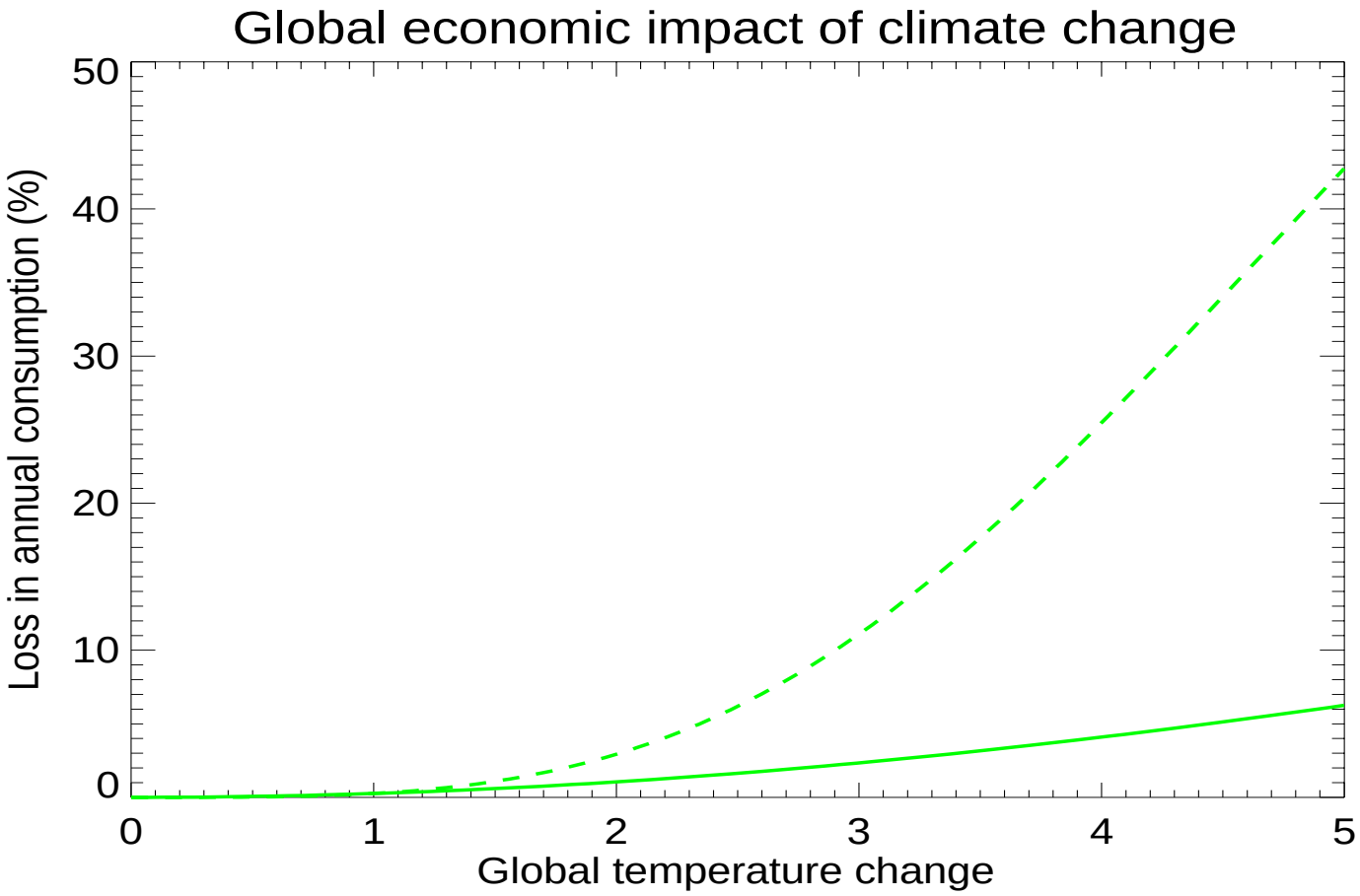
Climate damages as fraction of global GDP



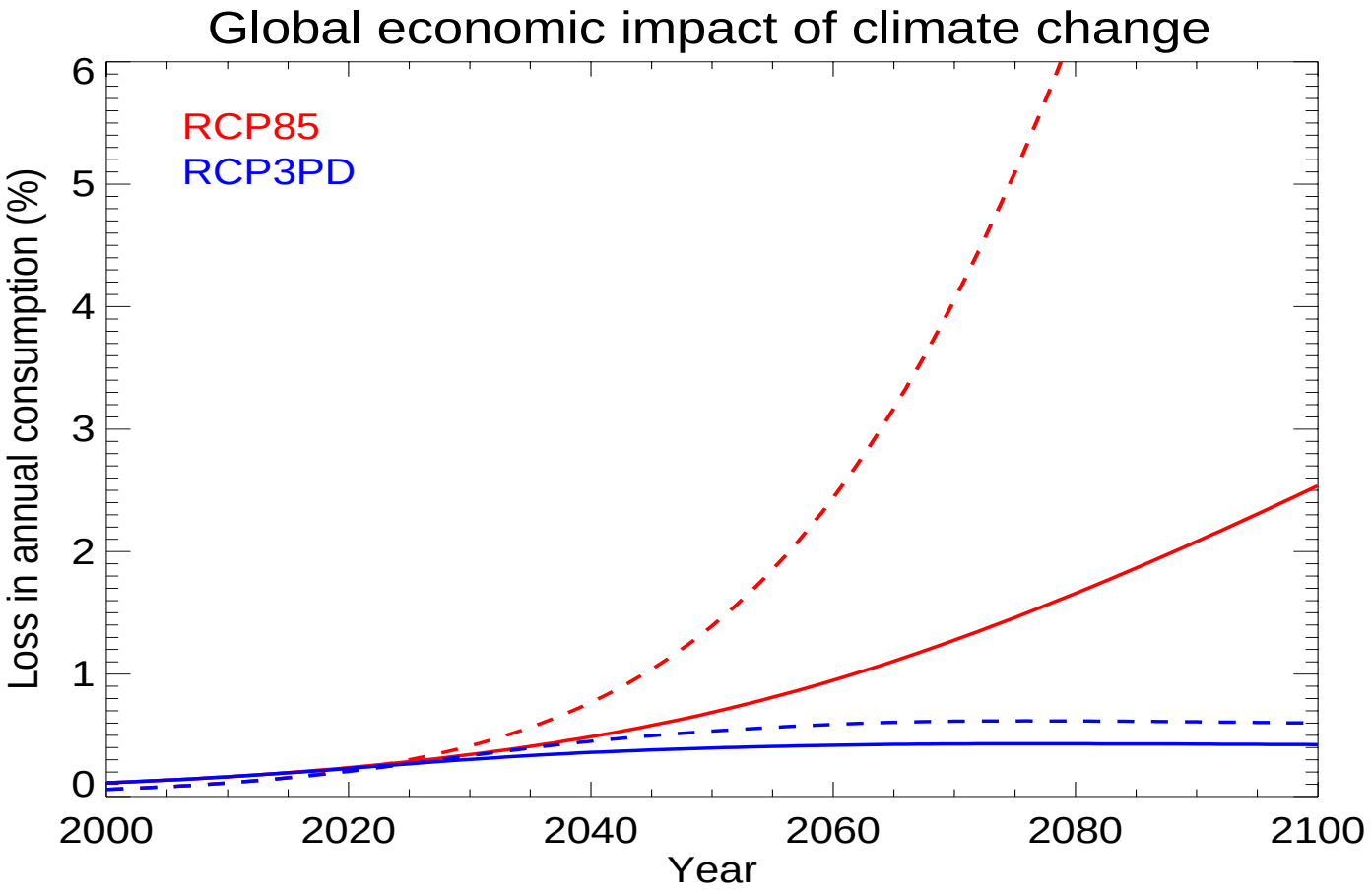
Note: 6°C of cooling would probably cost more than 10% of global consumption

So don't complain I didn't warn you

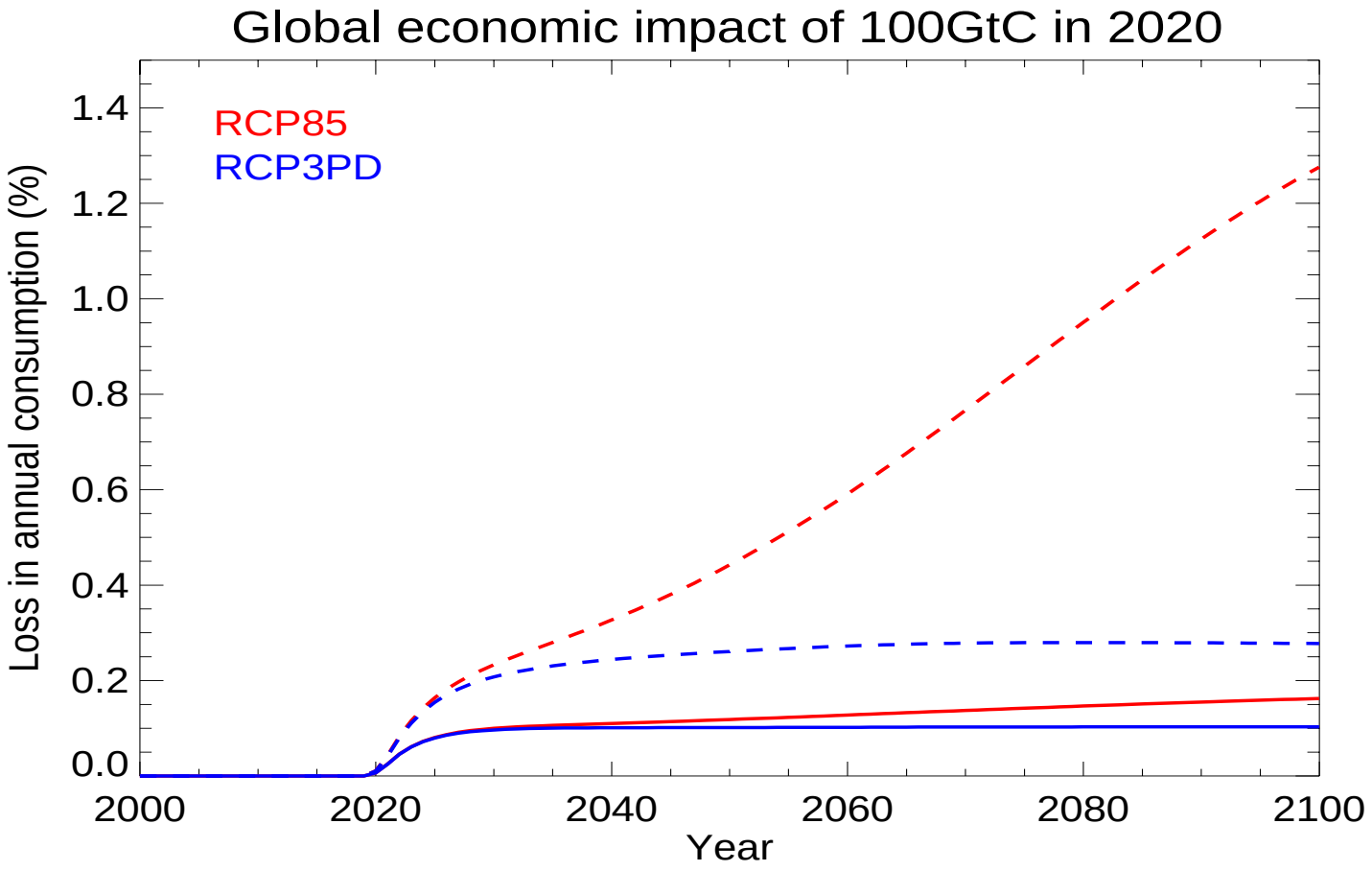
Two estimates of the impact of climate change on global consumption: the “damage function”



Loss in global consumption for two scenarios and two estimates of the global damage function



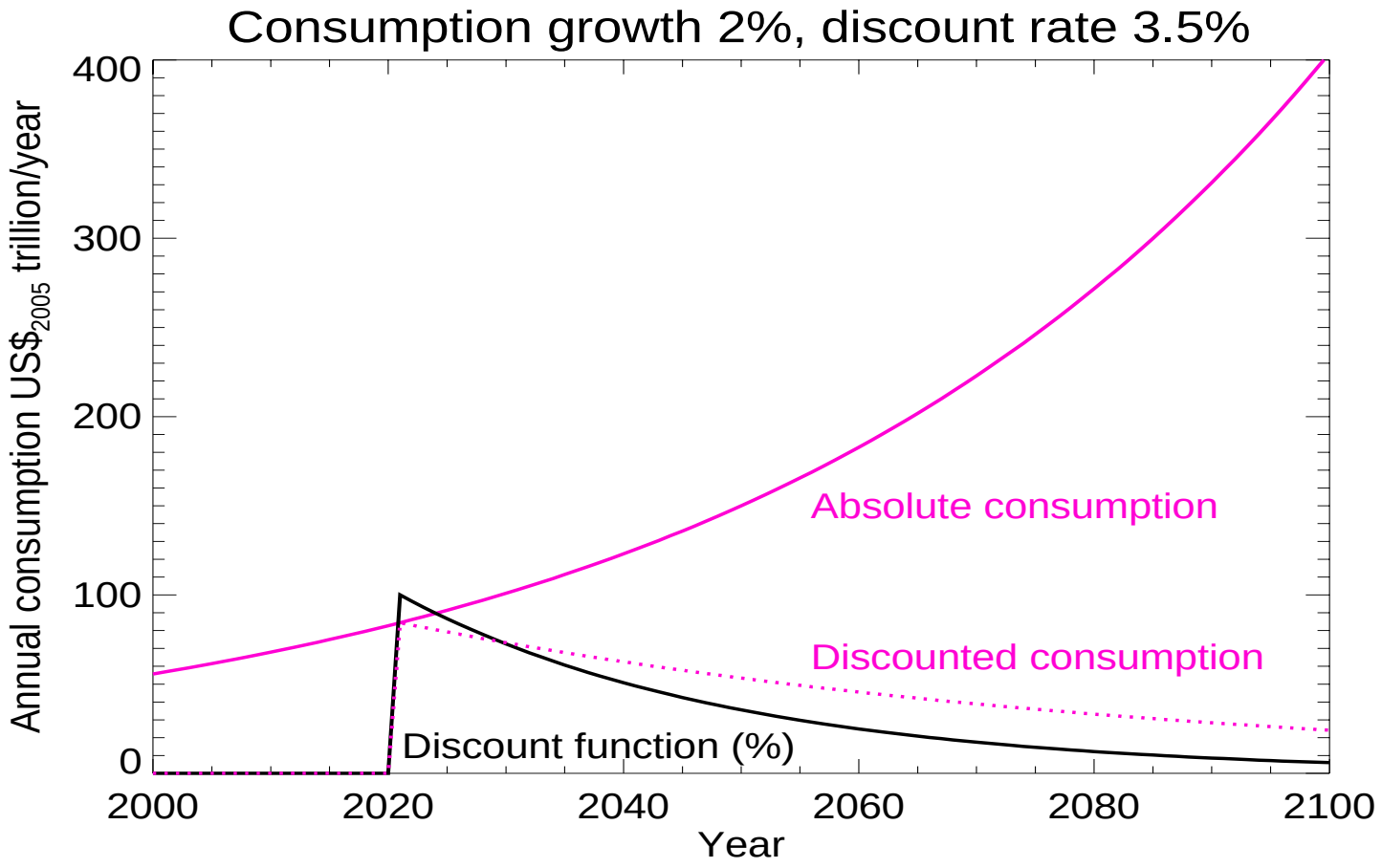
Percentage loss in global consumption due to 100 GtC emission in 2020



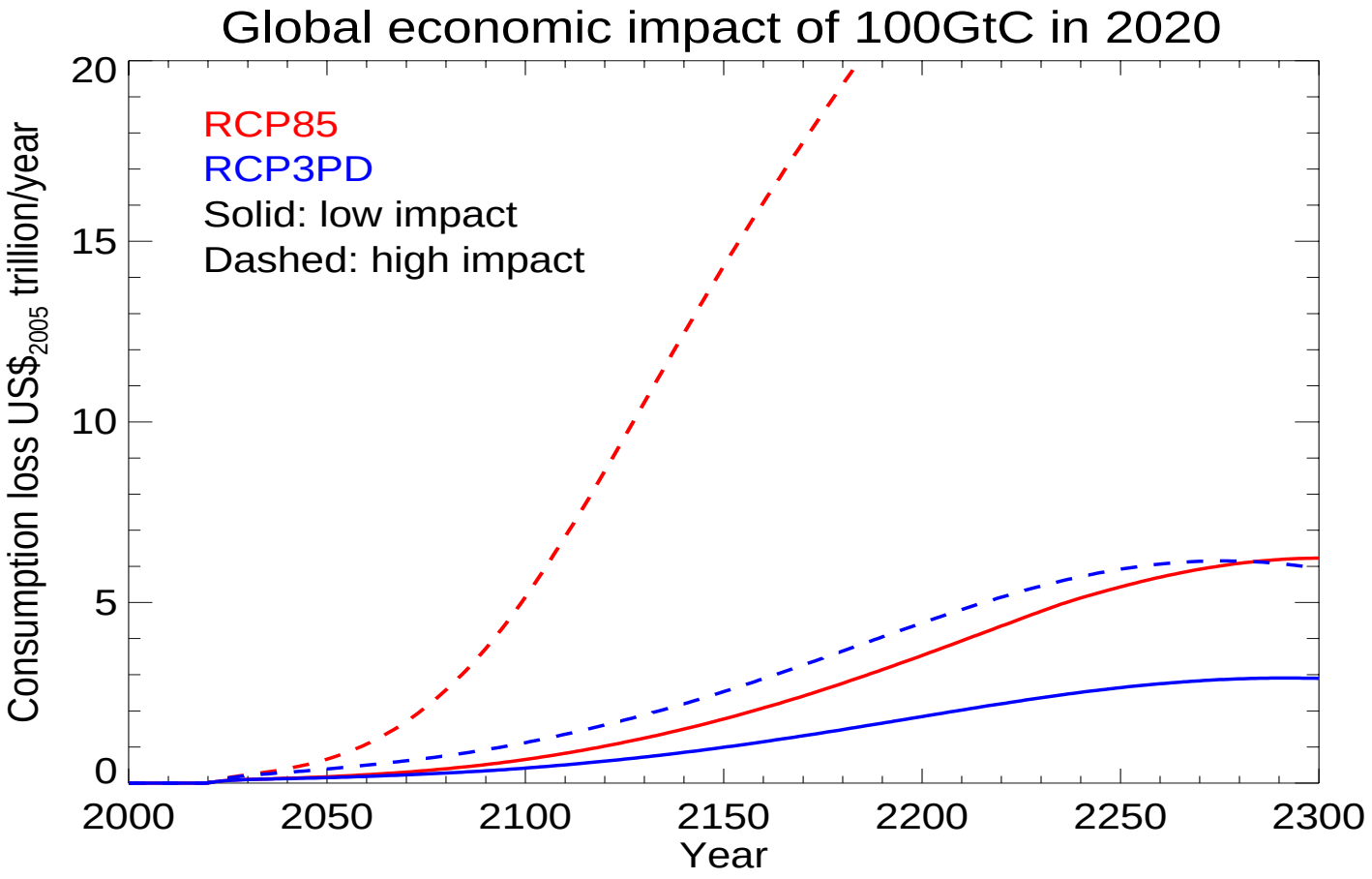
Different types of uncertainty

- How the climate system responds to 100GtC emissions: uncertain, but not a matter of opinion.
- Quantifying economic losses due to warming: uncertain, and depends on:
  - Weighting of impacts on rich versus poor
  - Inclusion of domestic versus global impacts
  - Non-monetary impacts (e.g. ecosystem losses)
  - Future mitigation decisions
- All dependent on ethical/political position, no correct "scientific" answer.

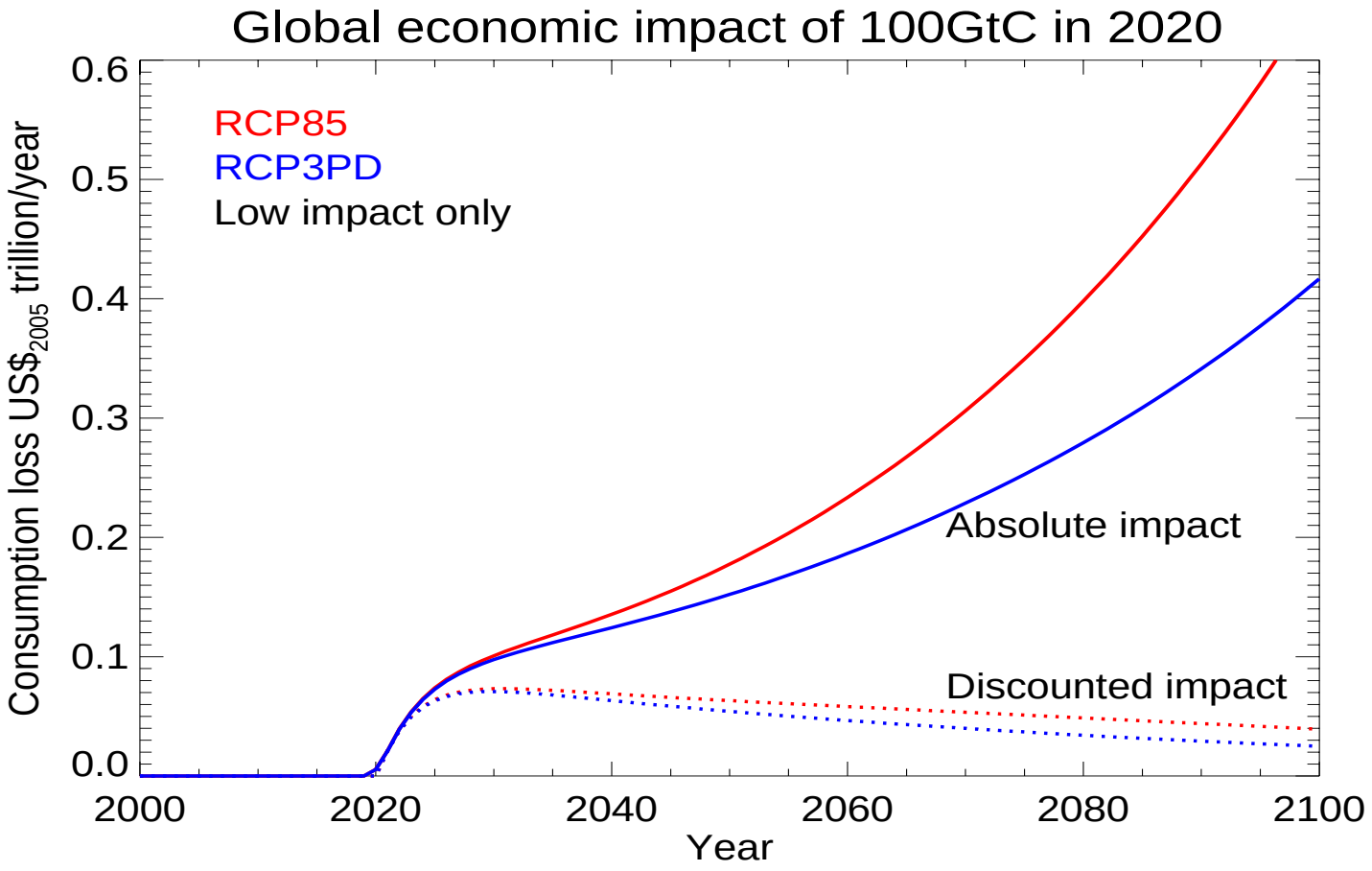
Assumptions about the future size of the world economy and the discount rate



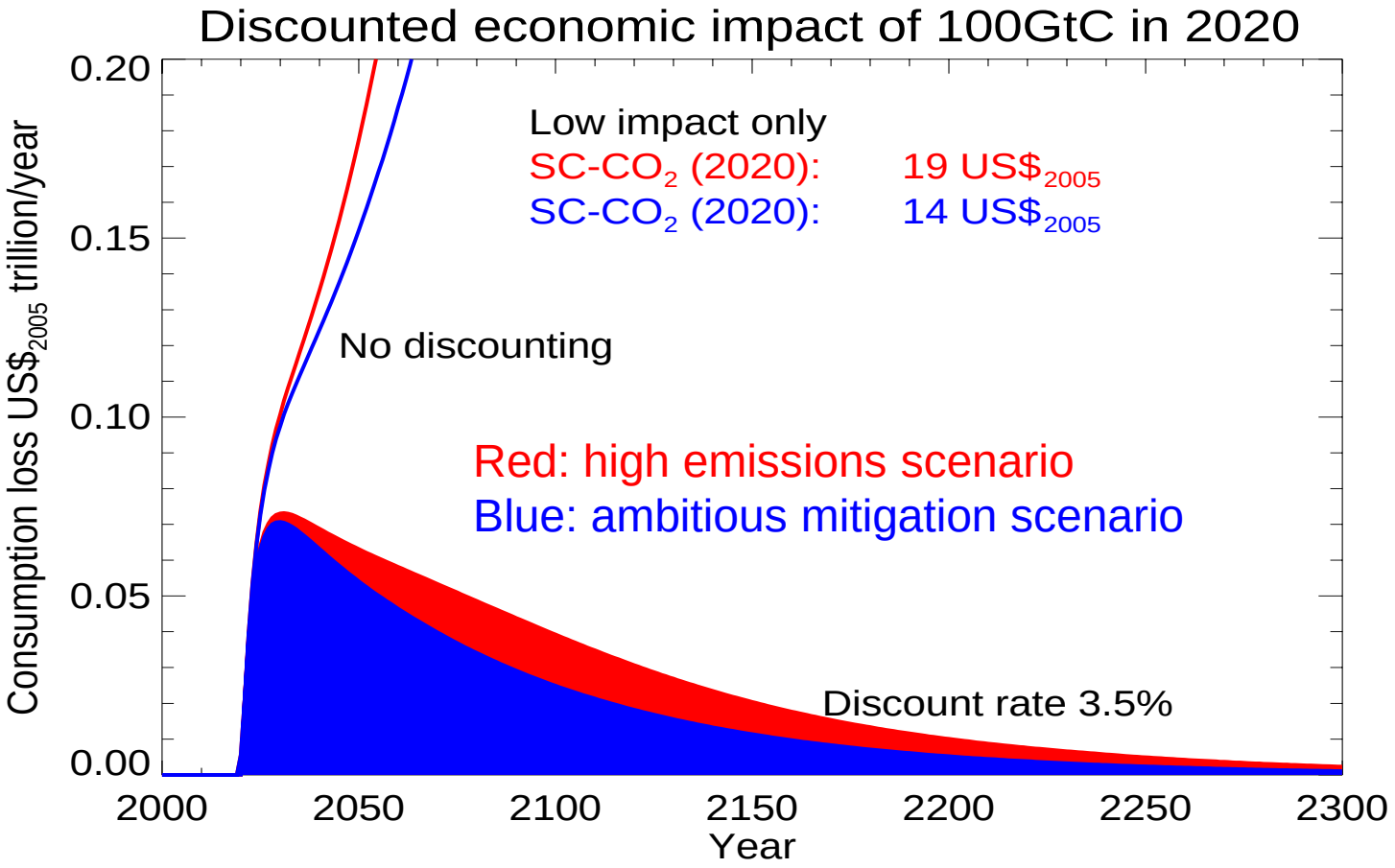
Absolute economic impact out to 2300 of 100 GtC emissions in 2020: low and high damage functions



Absolute and discounted economic impact of 100 GtC in 2020 under low damage function

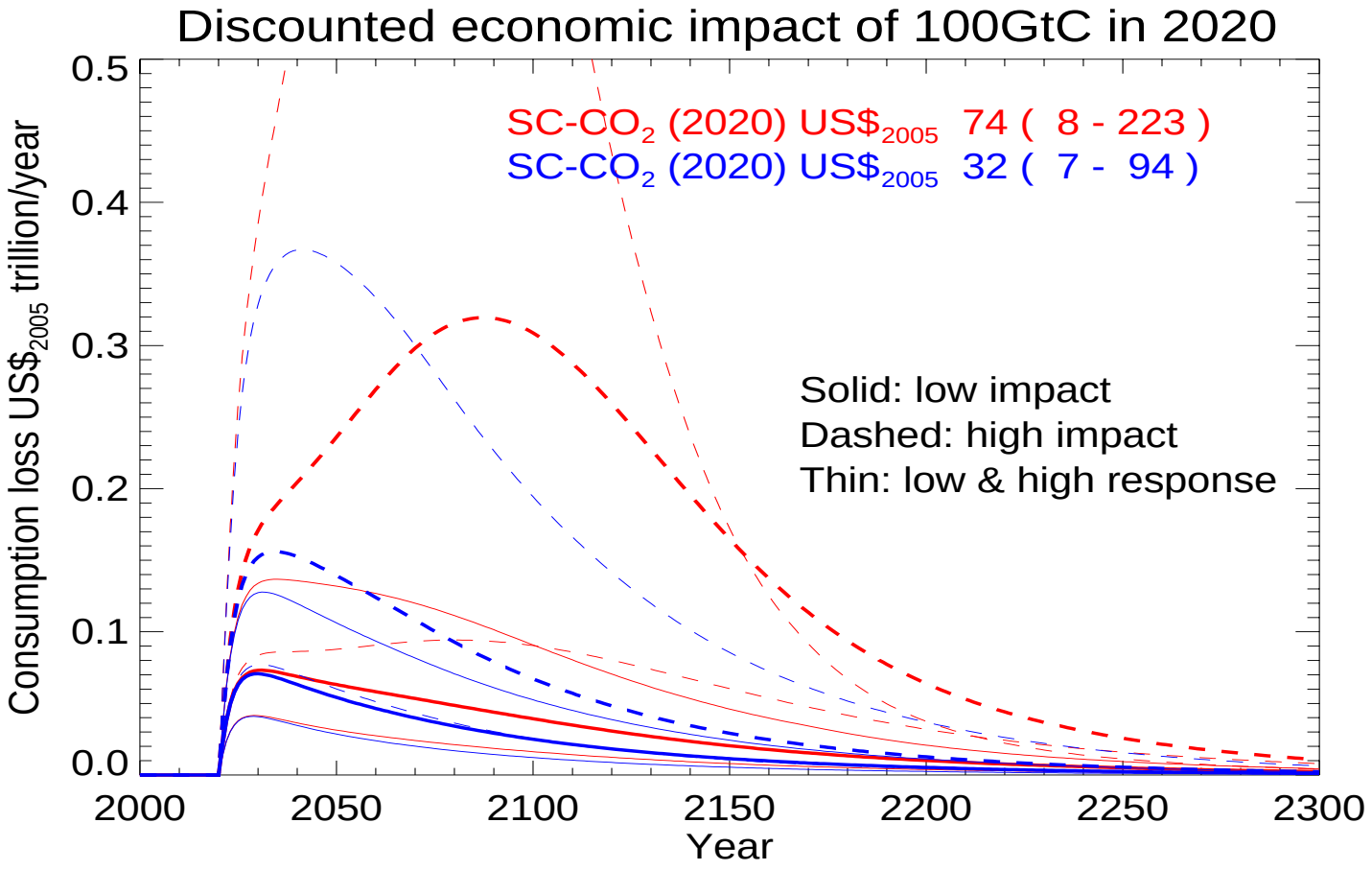


Discounted impact of 100 GtC in 2020: 2% growth, 3.5% discount rate, low damage function

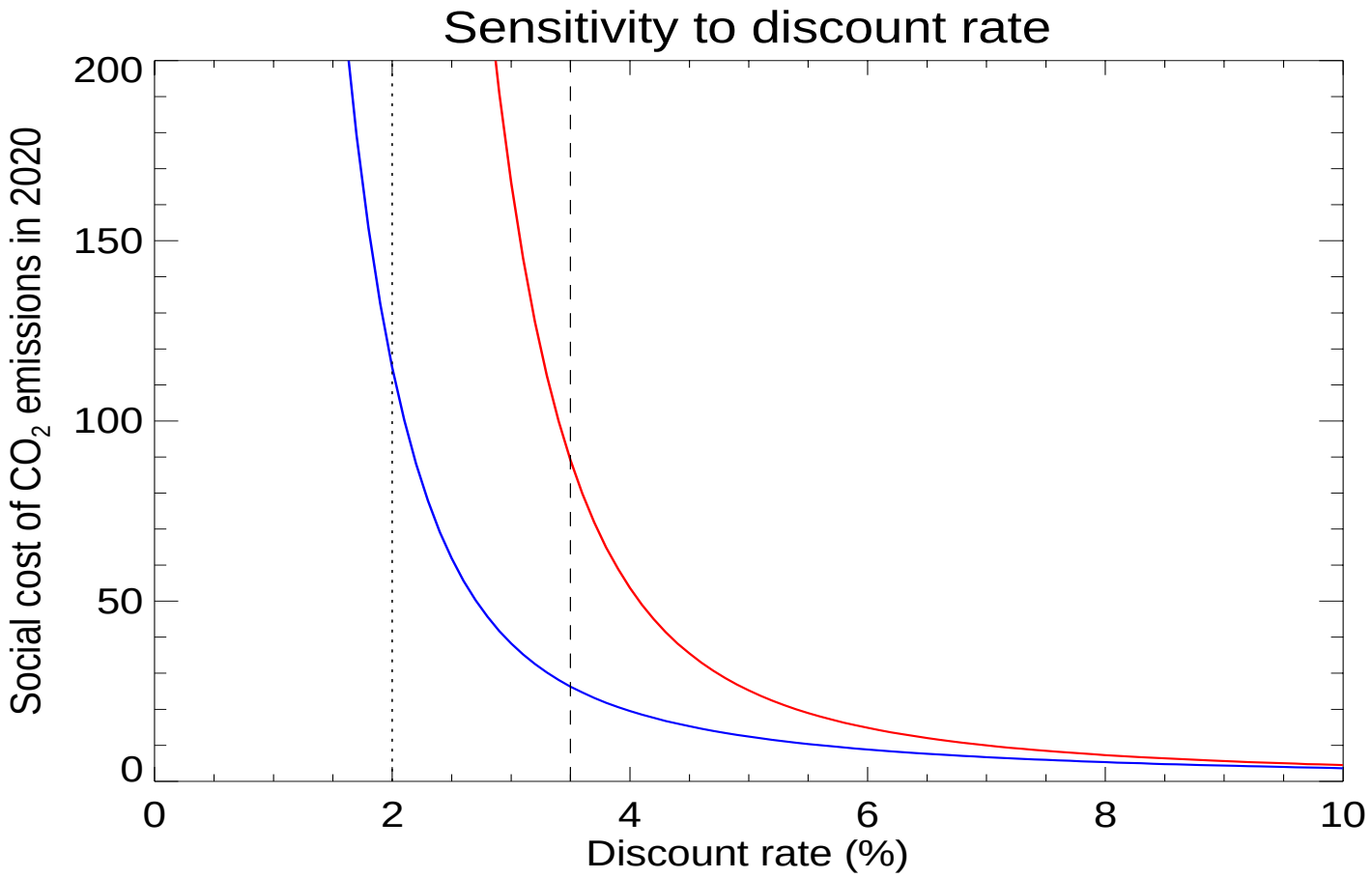


Two estimates of SC-CO_2 = shaded areas

Discounted impact of 100 GtC in 2020: 2% growth, 3.5% discount rate, varying damage function



Sensitivity of "average" SC-CO_2 to discount rate



2017 proposal to revise the SC-CO_2

- Use 3% “social” & 7% “market” discount rate
  - Global SC-CO_2 values of 44-53 \$/tCO_2 in 2020s @ r=3%
  - Global SC-CO_2 values of 5-7 \$/tCO_2 in 2020s @ r=7%
- Only consider US “domestic” climate damages
  - About 10% of global damage (Nordhaus, PNAS, 2017)
- Giving a revised SC-CO_2 as low as 50 cents/tCO_2
- Should Canada and Mexico also use “domestic” SC-CO_2 estimates (c. 9% and 12% of US value respectively)?
- https://www.epa.gov/sites/production/files/2017-10/documents/ria_proposed-cpp-repeal_2017-10.pdf

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Bean-counters can be your friends

- Many environmentalists (and IPCC authors) question the entire legitimacy of the SC-CO_2, pointing to deep (and opaque) dependence on contestable ethical framework.
- But even the Trump administration, using a 3% discount rate and optimistic impact function, estimates the global cost of today's CO_2 emissions to be $1.8-2.1 trillion dollars per year.
- That would justify spending a lot more than we are spending on mitigation.