Network for Greening the Financial System

Workstream on Scenario Design and Analysis

NGFS long-term scenarios for central banks and supervisors

November 2024

NGFS

Central Banks and Supervisors
Network for Greening the Financial System

Key messages

What is new in the NGFS scenarios?

- **The NGFS scenarios have been brought up to date with new economic and climate data, policy commitments, and model versions:** the scenarios use the latest release – i.e. version 3.0 – of the Shared-Socioeconomic Pathways (SSPs). In addition, the NGFS scenarios account for the most recent country-level commitments announced by March 2024.

- **A new damage function has been applied to enhance physical risk modelling.** The new damage function incorporates the latest climate science findings, and it is calibrated using state-of-the-art climate datasets. Consequently, it captures climate change impacts in a comprehensive manner beyond increases in mean temperature and assesses their persistence effects on the economy. The new damage function helps better prepare the financial system for the economic impacts of global warming.

Main results of the NGFS scenarios

- **Limiting the temperature increase to 1.5 °C above pre-industrial levels in an orderly fashion is within reach but it requires substantially more intensive efforts than delineated in previous vintages.** While economic impacts differ significantly across countries, regions and economic sectors, almost all countries will benefit from keeping global warming levels close to the 1.5 °C threshold. Early and coordinated policy action will yield the highest long-run returns. The scale of the adjustment grows disproportionately, if action is delayed.

- **A substantial economic transformation affecting all sectors of the economy is required to achieve global net zero CO_2 emissions by 2050.** Slow progress in implementing climate policies so far necessitates more ambitious approach going forward. It also means higher emissions in the near term and a more disruptive transition than previously anticipated fostered by a higher (shadow) carbon price.

- **In all scenarios, the impact of physical risk rapidly outweighs the impact of transition efforts.** The expected economic impact of unabated climate change has significantly increased. Due to the implementation of the new damage function, the projected physical risk impact has quadrupled by 2050 in some scenarios. These strong negative impacts on GDP could be mitigated by timely transition efforts.

NGFS scenarios Overview

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What are the NGFS scenarios?

A shared understanding of how climate change affects the economy can be the basis for global action. The NGFS developed climate scenarios to inform analysis and guide policy worldwide.

The NGFS **long-term climate scenarios** map out how economies might evolve under different assumptions, answering the questions:

What can happen? E.g., if policy ambition diverges and climate change is not mitigated.

What should happen? E.g. to shed light on the benefits of a timely green transition from a macro-financial perspective.

- **The NGFS scenarios have been created to provide a common starting point for analysing the impact of climate risks on the economy and financial system.** They map out **different futures**, depending on how climate change (physical risk), transition policies, technological developments and changes in preferences (transition risk) evolve.

- **The NGFS scenarios explore a range of plausible outcomes.** To reflect the uncertainty inherent to the modelling of climate-related macroeconomic and financial risks (e.g. due to uncertainty of climate change and the transition), the NGFS scenarios use **different models**, and explore **a wide range of scenarios across regions and sectors**.

- **The NGFS scenarios are not forecasts.** They are intended to explore the **range of plausible futures** (neither the most probable nor the most desirable) for the assessment of financial risk and to prepare the financial system for the shocks that may arise.

- **The NGFS scenarios present unique features that make them particularly suitable for a wide range of applications.** They produce **internally consistent results** that combine **transition and physical risks and macro-financial developments**, are applicable at the **global level**, and are **freely accessible** through an online public platform.

- **While the NGFS scenarios are constantly improved, the uncertainty and limitations of climate and economic modelling remain high.** For instance, tipping points are not represented in the NGFS scenarios.

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Objectives and framework

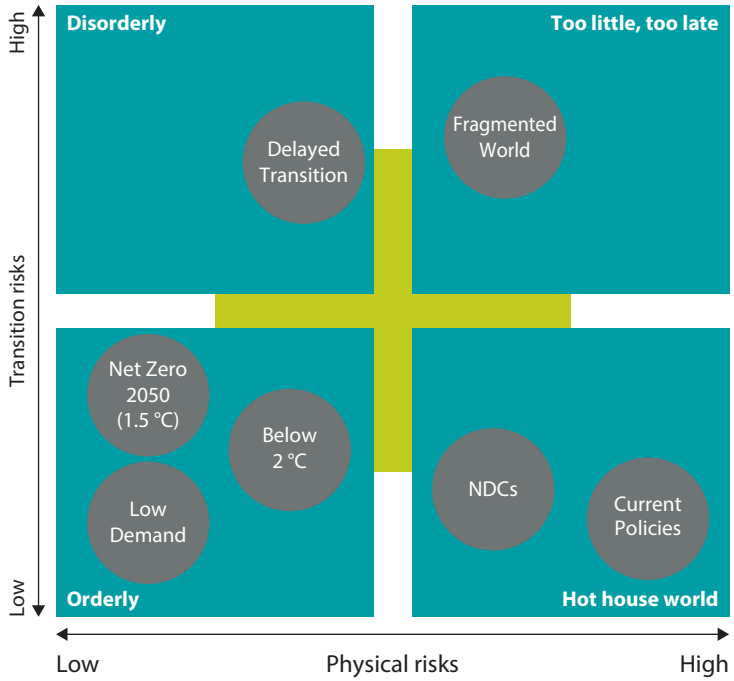
The NGFS scenarios explore the impacts of climate change and the transition with the aim of providing a common reference framework.

The NGFS scenarios explore a set of **seven scenarios** which are consistent with the NGFS framework published in the First NGFS Comprehensive Report covering the following dimensions:

- **Orderly** scenarios assume climate policies are introduced early and become gradually more stringent. Both physical and transition risks are relatively subdued.
- **Disorderly** scenarios explore higher transition risks due to policies being delayed or divergent across countries and sectors. For example, (shadow) carbon prices* are typically higher for a given temperature outcome.
- **Hot house world** scenarios assume that some climate policies are implemented in some jurisdictions, but globally efforts are insufficient to halt significant global warming. The scenarios result in severe physical risk including irreversible impacts.
- **Too-little-too-late** scenarios assume that a late and uncoordinated transition fails to limit physical risks.

(*) Shadow carbon prices are defined as the marginal abatement cost of an incremental ton of greenhouse gas emissions. Prices are influenced by the stringency of policy as well as how technology costs will evolve.

NGFS scenarios framework in Phase V



Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.

Main results of the NGFS scenarios

Transition risk

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Emissions and primary energy consumption

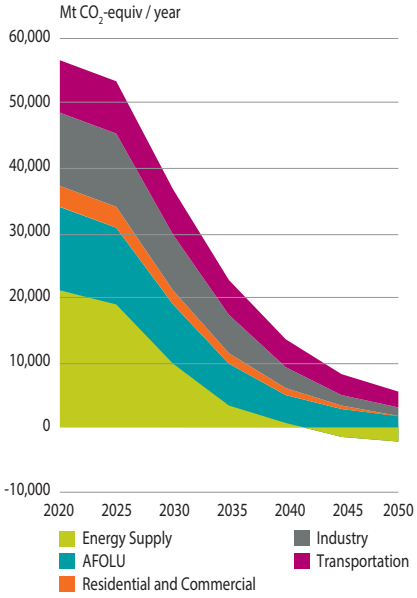
A substantial economic transformation is required to achieve Net Zero with heterogenous impact across sectors. Most of the global emissions reduction under the Net Zero 2050 scenario is driven by large decreases in the Energy Supply and the Industry sector. Substantial changes in the global supply of primary energy are key, both in terms of overall production levels as well as the composition of the energy source.

- **Imposition of steep (shadow) carbon prices raises costs of polluting energies at the source.** Most of the global emissions reduction under the Net Zero 2050 scenario is driven by large decreases in the Energy Supply and the Industry sector.
- **Sectors for which transition from fossil fuels is more challenging will remain amongst the higher emitters.** By 2050, the largest emitter of CO_2 is the Transportation sector where, based on current technologies, moving away from fossil fuels is most challenging.
- **To achieve emissions reduction, primary energy supply needs to shift from carbon intensive to renewable sources.** Compared with today (i.e. 2025 levels), global primary energy supply needs to decline by around 19% by 2050 in the Net Zero 2050 scenario. The decline in primary energy supply can result from lower energy demand and improvements such as increased energy efficiency.
- **By 2050, renewables and biomass would deliver almost 80% of global primary energy needs in the Net Zero 2050 scenario.** Reliance on fossil fuels declines by around 16 pp between 2025 and 2050 under the Current Policies scenario, reaching ca. 67% of total primary energy supply in 2050. In an ambitious Net Zero scenario, the share of energy production from fossil fuels would need to drop drastically to around 20% in 2050.
- **The structural transformation requires significant investment flows to be directed towards greener sources of energy production in the coming decades.** In the Net Zero 2050 scenario global energy investments need to be on average $3.8 trillion/year, with more than one-third going to renewables mostly for the generation and storage of renewable electricity.

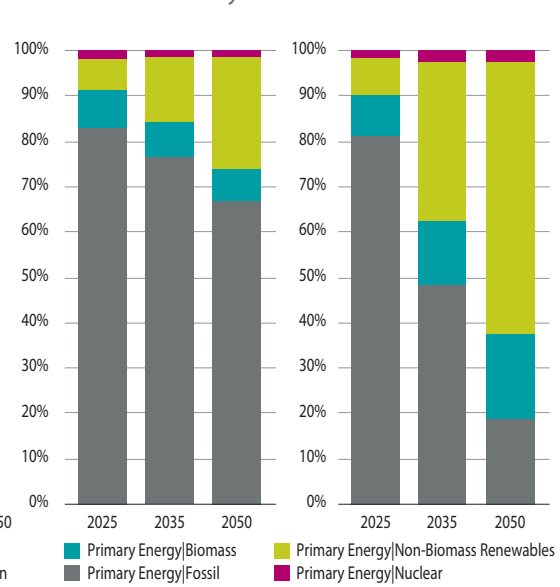
(*) Prices tend to be lower in emerging economies as policy stringency is lower and there tends to be a greater number of low-cost abatement options still available.
AFOLU stands for Agriculture, Forestry, and Other Land Uses

Global Sectoral Kyoto Gases Emissions

Net Zero 2050, REMIND-MAgPIE



Global Primary Energy Mix (based on REMIND-MAgPIE outputs)



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Main results of the NGFS Scenarios

Physical risk

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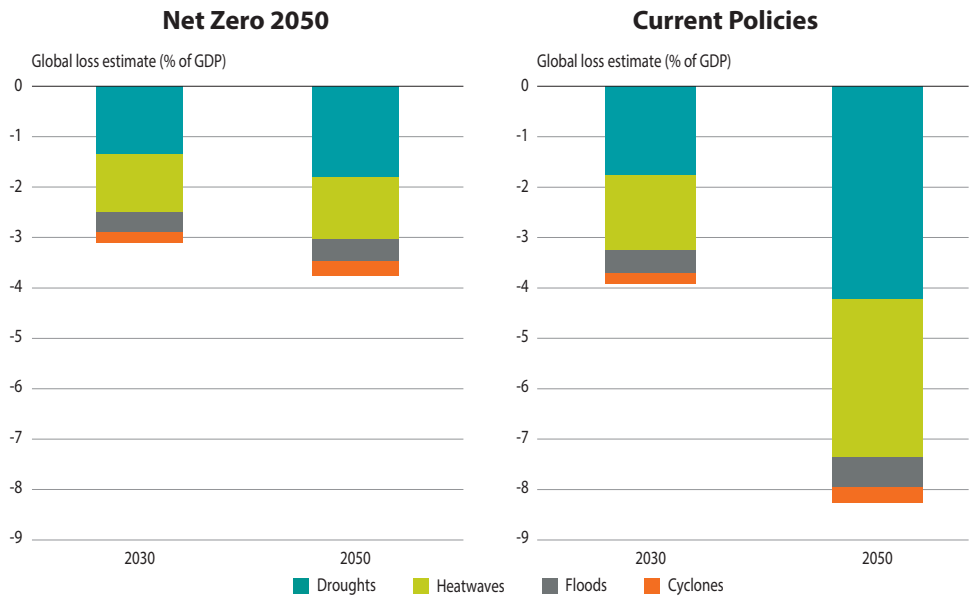
Acute physical risk: individual hazards modelling

There are no updates of individual hazards modelling in Phase V.

- **Acute physical risks are represented by four perils in the NGFS scenario framework: droughts, heatwaves, floods, and cyclones.** There have been no changes and updates in Phase V. Results from Phase IV continue to be reported.
- **Under the Current Policies scenario, losses due to these four perils exceed 8% of global GDP**, while in the Net Zero 2050 scenario, damages remain below 4% of global GDP.
- **Droughts and heatwaves account for the largest share of losses globally**, but large regional differences exist. Together they account for more than 75% of total losses from acute physical risks in the NGFS scenarios.



Note: Phase IV results for NiGEM using Climate Analytics input. Damages shown correspond to 90th damage percentile for droughts, heatwaves, and cyclones (floods are represented by a point estimate).

(Chronic) physical risk: higher impact

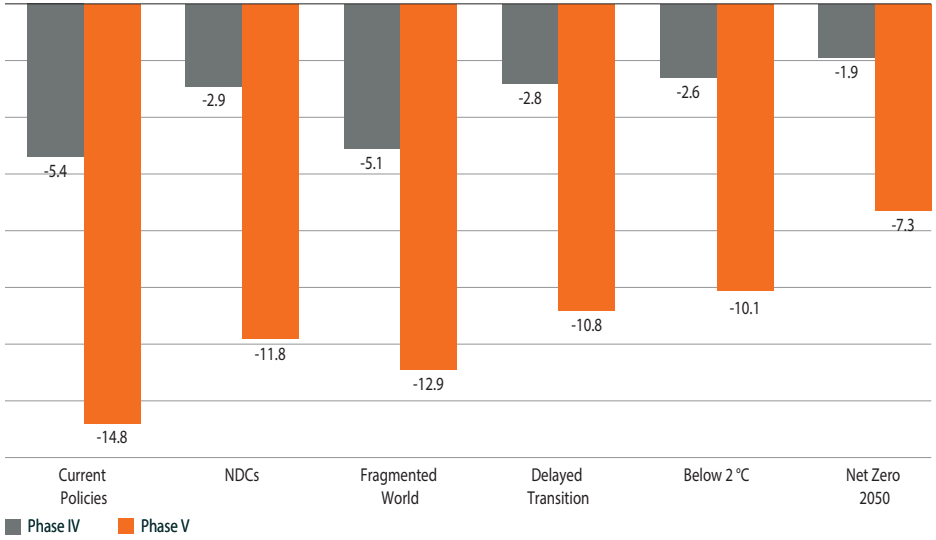
The projected (chronic) physical risk impact has significantly increased in Phase V. This increase mostly results from a change in estimation methodology, i.e., a new damage function.

- **Using the updated damage function, the NGFS Current Policies scenario foresees around 15% losses compared to a scenario without climate change by 2050.** To recall, in Phase IV, losses from chronic physical risk stood at ca. 5% in 2050.

- **The increase in damage is mostly attributable to the change of damage function.** Only 1.5 pp of the change in Current Policies damages in 2050 can be attributed to differences in projected temperature pathways*. The damages displayed also encompass changes in modelling assumptions.

Losses from (chronic) physical risk by 2050: Phase IV vs Phase V (% of global GDP)

NiGEM with REMIND-MAgPIE inputs



(*) See Annex 1 of the explanatory note on "Damage functions, NGFS scenarios, and the economic commitment of climate change" for a full breakdown.

Interpreting and using physical risk results

The introduction of the new damage function in NGFS scenarios calls for careful reconsideration of how loss projections are interpreted and used.

- **A simple aggregation of chronic and acute physical damages could lead to double-counting.** The methodologies used to estimate chronic and acute risks are not mutually exclusive. We no longer represent total physical climate risks as the simple sum of acute and chronic impacts. Both types of risk assessment can still be used as each other's complement, but users need to exercise caution when combining results.

- **While damage projections are much higher with the new damage function, a global economic recession caused by climate change is not foreseen.** A 30% loss under the Current Policies by 2100 scenario should be compared with a baseline that assumes no climate change. Under the baseline, the GDP is expected to grow substantially by the end of the century, so even with climate change damages standing at 30%, global GDP would still grow by more than 150% in the Current Policies scenario by 2100 compared to today (while it would grow by 215% without climate change).

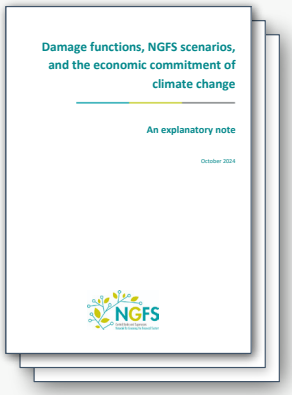
- **Adaptation is not explicitly covered by the damage function.** The study underlying the damage function may implicitly account for historic short-run adaptation. Persistence effects indicate that it may require at least ten years to fully recover from a climate shock. However, as long-term climate adaptation is not included in this damage function, it remains uncertain if long-term climate change losses will be higher or lower than those projected based on short-term shocks.

- **While the new damage function is a significant improvement, the NGFS scenarios still have some limitations in physical risk modelling.** The scenarios do not claim to capture the exhaustive impact of climate change (e.g. the impact of tipping points). Caution should always be exerted when using the NGFS scenarios and damage function results, especially in light of the high uncertainty surrounding these projections. Consequently, the scenarios should not be considered a suitable standalone instrument for a cost-benefit analysis on the opportunity of climate action.

More on (chronic) physical risk modelling

As part of the Phase V release, we drafted an explanatory note on the implementation of the new damage function. The key arguments of the note are also reflected in two VoxEU columns.

Explanatory note



Chapter 1: **Physical climate risks and damage functions**

Chapter 2: **New damage function explained**

Chapter 3: **Results of the new damage function under review**

Chapter 4: **Implications of new damage function for the NGFS scenarios**

VoxEU columns

Part 1: Measuring economic losses caused by climate change

The column explores the concept of damage functions, highlighting the persisting uncertainties and the importance of continued dialogue to refine our understanding of climate-induced economic losses.

Part 2: Economic losses from climate change are probably larger than you think: new NGFS scenarios

The column highlights advances in understanding and measuring the economic impact of climate change and discusses their implications for NGFS climate scenarios.

Main results of the NGFS Scenarios

Key macrofinancial results

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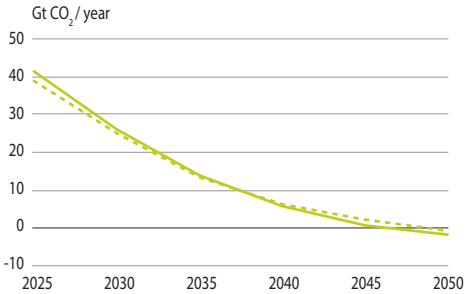
Phase V vs Phase IV: Net Zero 2050 scenario

Net Zero 2050 is an ambitious scenario that limits global warming to 1.5 °C through stringent climate policies and innovation, reaching net zero CO_2 emissions around 2050. This scenario assumes that ambitious climate policies and technological shift are introduced immediately and forcefully impact the economy.

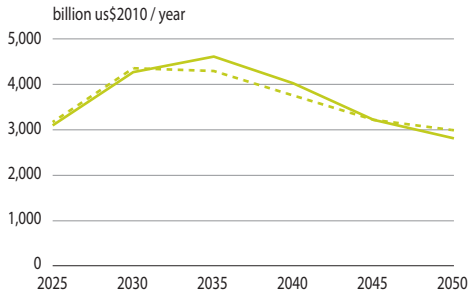
Global CO_2 Emissions

REMIND-MAgPIE, Phase IV in dotted



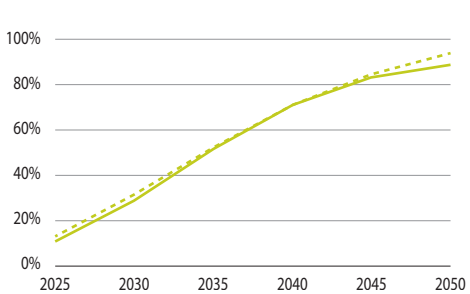
Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



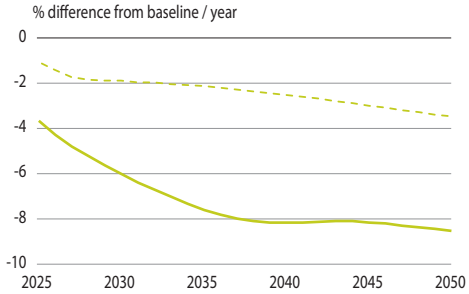
Share of Renewables in Global Primary Energy Mix

REMIND-MAgPIE, Phase IV in dotted



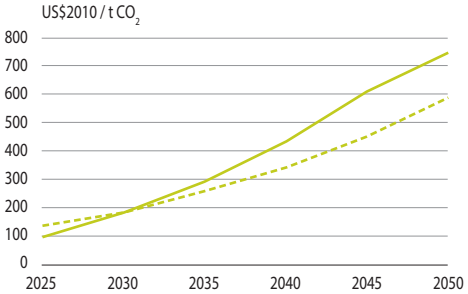
Global GDP Impacts*

NiGEM based on REMIND-MAgPIE, Phase IV in dotted



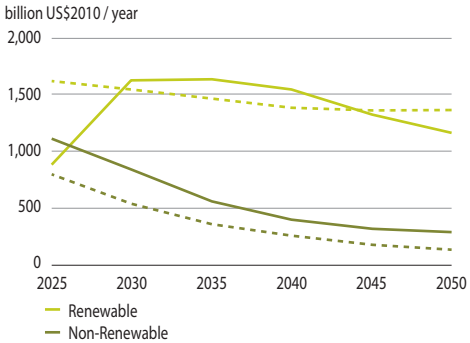
Global (Shadow) Carbon Price

REMIND-MAgPIE, Phase IV in dotted



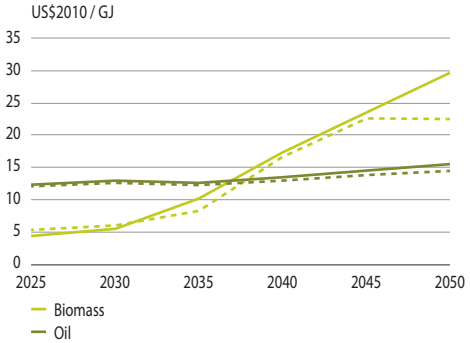
Renewable & Non-Renewable Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



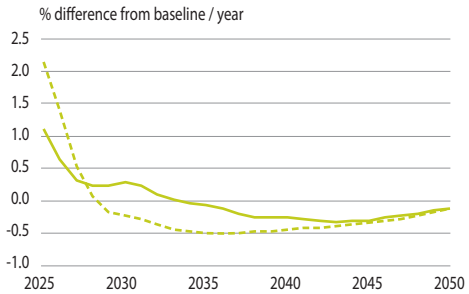
Global Oil & Biomass (Pre-tax) Prices

REMIND-MAgPIE, Phase IV in dotted



Global Inflation (%)

NiGEM based on REMIND-MAgPIE, Phase IV in dotted



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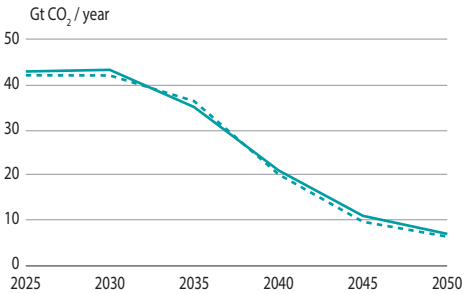
*GDP losses stemming from chronic physical and transition risk.

Phase V vs Phase IV: Delayed Transition scenario

Delayed Transition assumes global annual emissions do not decrease until 2030. Strong policies and investments are subsequently needed to limit warming to below 2 °C. The level of commitments of countries depend on currently implemented policies, leading to heterogeneity at the global level.

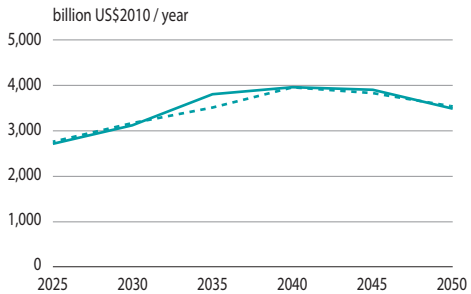
Global CO_2 Emissions

REMIND-MAgPIE, Phase IV in dotted



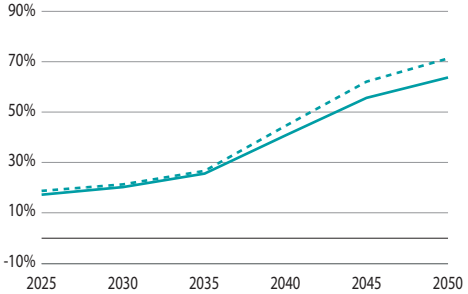
Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



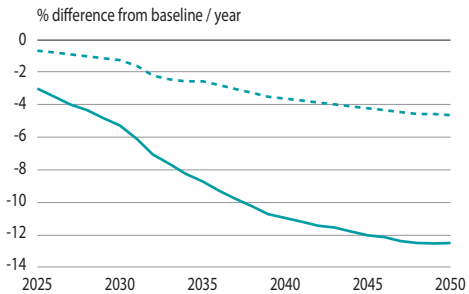
Share of Renewables in Global Primary Energy Mix

REMIND-MAgPIE, Phase IV in dotted



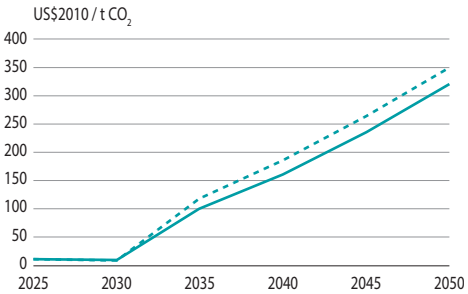
Global GDP Impacts*

NiGEM based on REMIND-MAgPIE, Phase IV in dotted



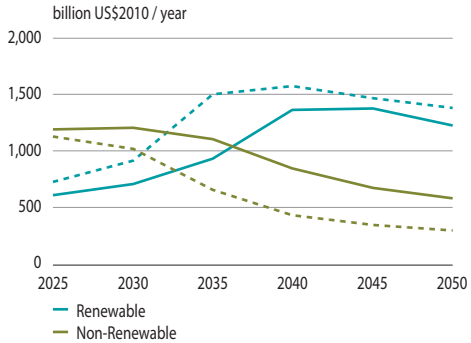
Global (Shadow) Carbon Price

REMIND-MAgPIE, Phase IV in dotted



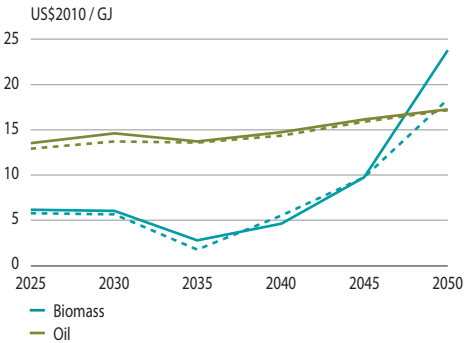
Renewable & Non-Renewable Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



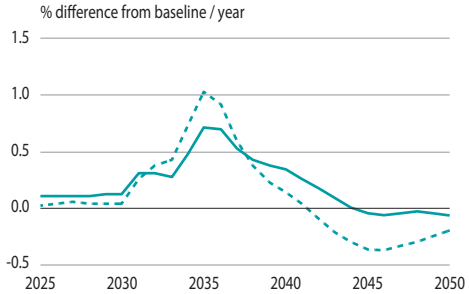
Global Oil & Biomass (Pre-tax) Prices

REMIND-MAgPIE, Phase IV in dotted



Global Inflation (%)

NiGEM based on REMIND-MAgPIE, Phase IV in dotted



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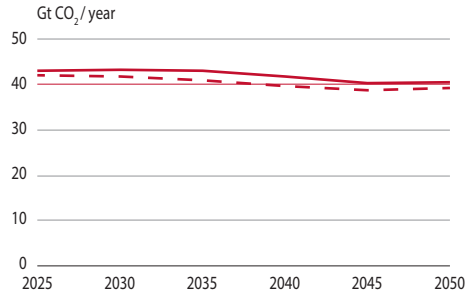
* GDP losses stemming from chronic physical and transition risk

Phase V vs Phase IV: Current Policies scenario

Current Policies assumes that only currently implemented policies are preserved, leading to high physical risks. Emissions grow leading to about 3 °C. Investments allocation and energy mix do not change.

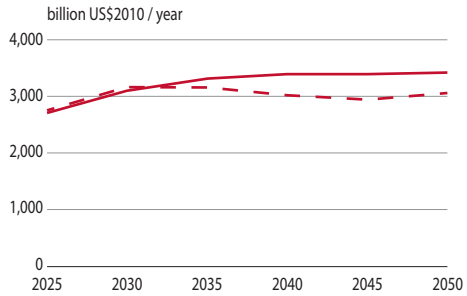
Global CO_2 Emissions

REMIND-MAgPIE, Phase IV in dotted



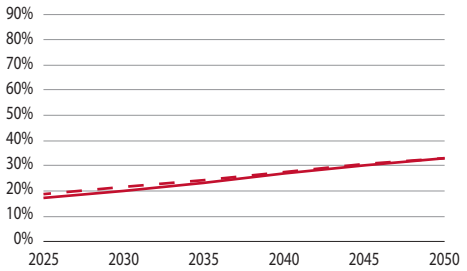
Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



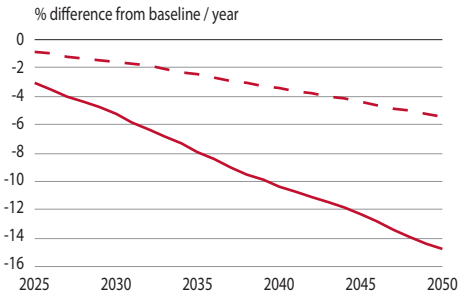
Share of Renewables in Global Primary Energy Mix

REMIND-MAgPIE, Phase IV in dotted



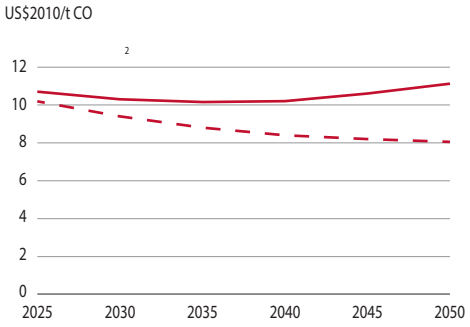
Global GDP Impacts*

NiGEM based on REMIND-MAgPIE, Phase IV in dotted



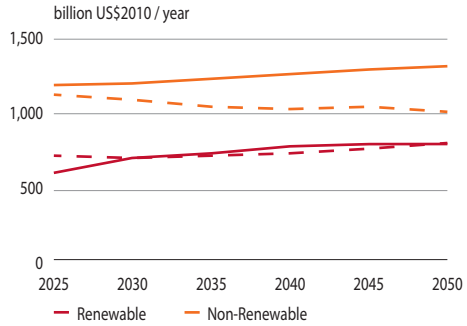
Global (Shadow) Carbon Price

REMIND-MAgPIE, Phase IV in dotted



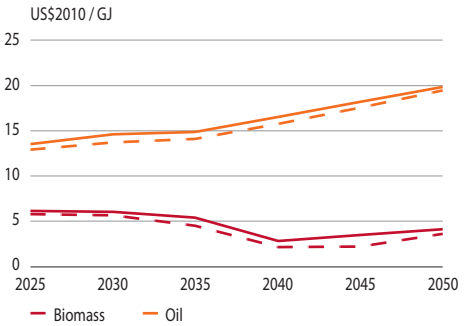
Renewable & Non-Renewable, Global Energy Investments

REMIND-MAgPIE, Phase IV in dotted



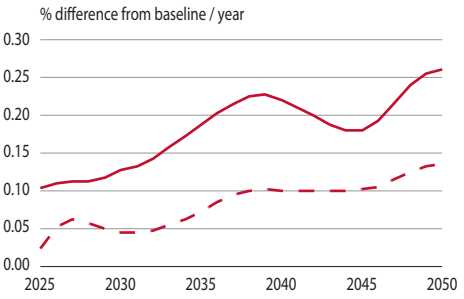
Global Oil & Biomass (Pre-tax) Prices

REMIND-MAgPIE, Phase IV in dotted



Global Inflation (%)

NiGEM based on REMIND-MAgPIE, Phase IV in dotted

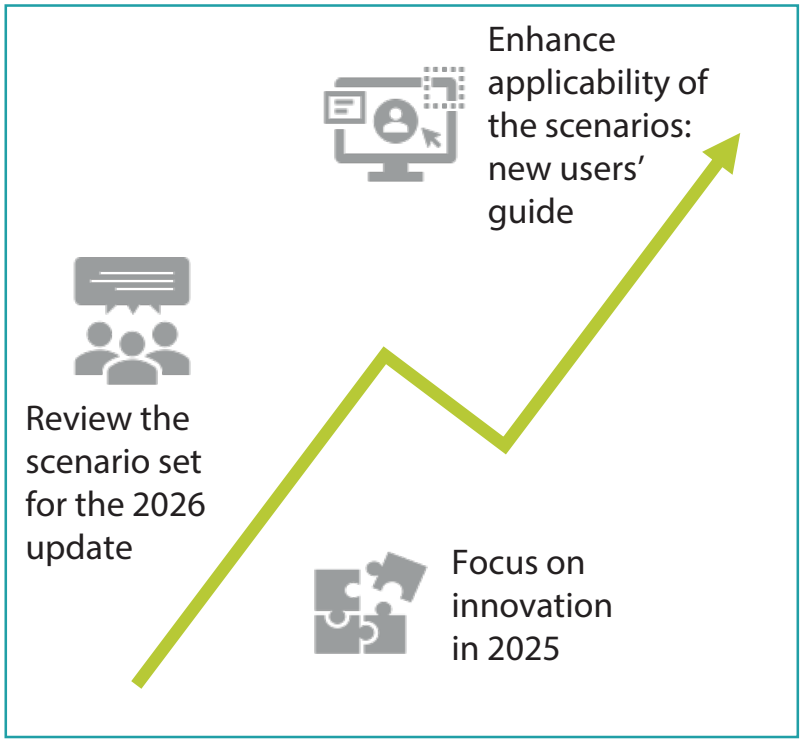


*GDP losses stemming from chronic physical risk.

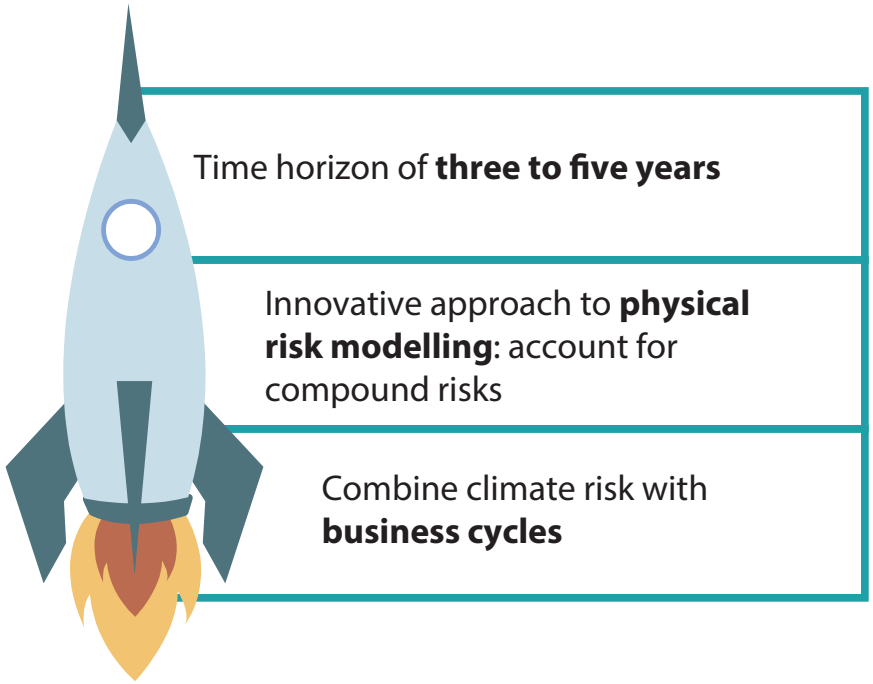
What is next?

NGFS scenarios: improvement & innovation

NGFS long-term scenarios to be further enhanced



First vintage of the NGFS short-term scenarios



Modelling Framework (IAMs)

IAMs | What's new?

GCAM	MESSAGEix-GLOBIOM	REMIND-MAgPIE
Update SSP drivers (population and GDP projection used for baseline calibration) Policy details and assumptions (Current Policies, NDC, Net Zero), cut-off date of March 2024.		
GCAM version 6.0 Updated abatement potentials for methane (CH4) Tighter constraints for CCS use Updated assumptions for 2025 emissions and energy based on historic trends SCHOOL OF PUBLIC POLICY CENTER FOR GLOBAL SUSTAINABILITY	MESSAGEix-GLOBIOM 2.0 Historic calibration to 2020/25 New energy demand trajectories based on sectoral models for buildings, transport, industry (lower, long-term) IIASA International Institute for Applied Systems Analysis	REMIND 3.3, MAgPIE 4.8: update datasets and calibrations Industry: feedstocks for chemicals and plastics, process-based steel model Improved short-term realism **New damage function based on Kotz et al. 2024** PIK

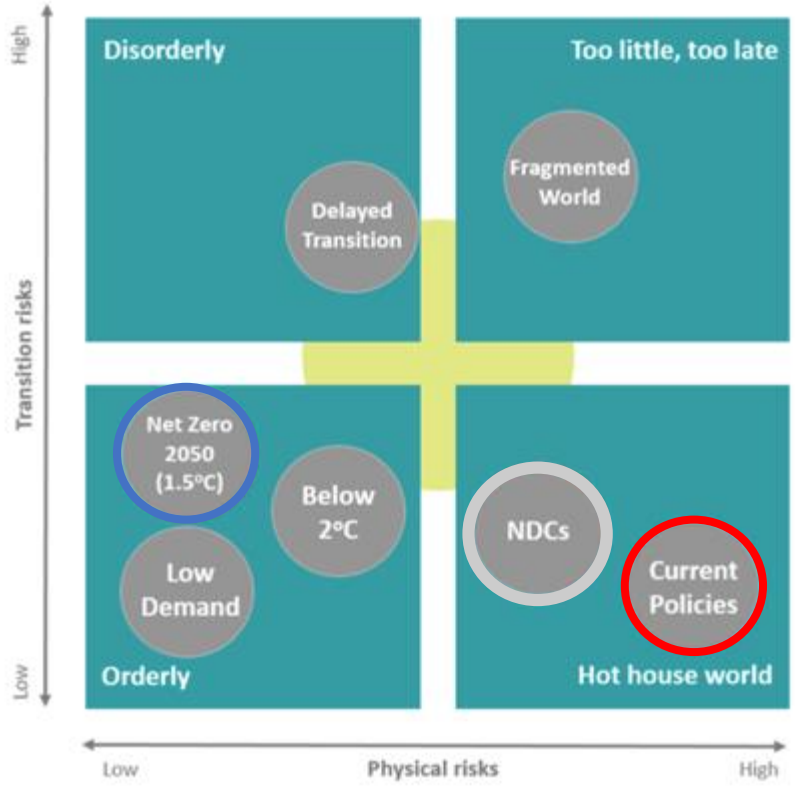
NGFS Central Banks and Supervisors Network for Greening the Financial System

IAMs | Core scenario assumptions

Net Zero 2050

- Limits global warming to 1.5°C, reaching global net zero CO_2 emissions around 2050.

- Regional net-zero targets (CO_2 or GHG) are implemented as defined by countries (e.g. 2050 for most OECD, 2060 for China and 2070 for India).



Nationally Determined Contributions (NDCs)

- All pledged 2030 NDC targets (even if not yet backed up by implemented effective policies.)

- No automatic achievement of net-zero targets, only assumes continuation of extrapolated ambition in line with 2030 NDCs.

Current Policies

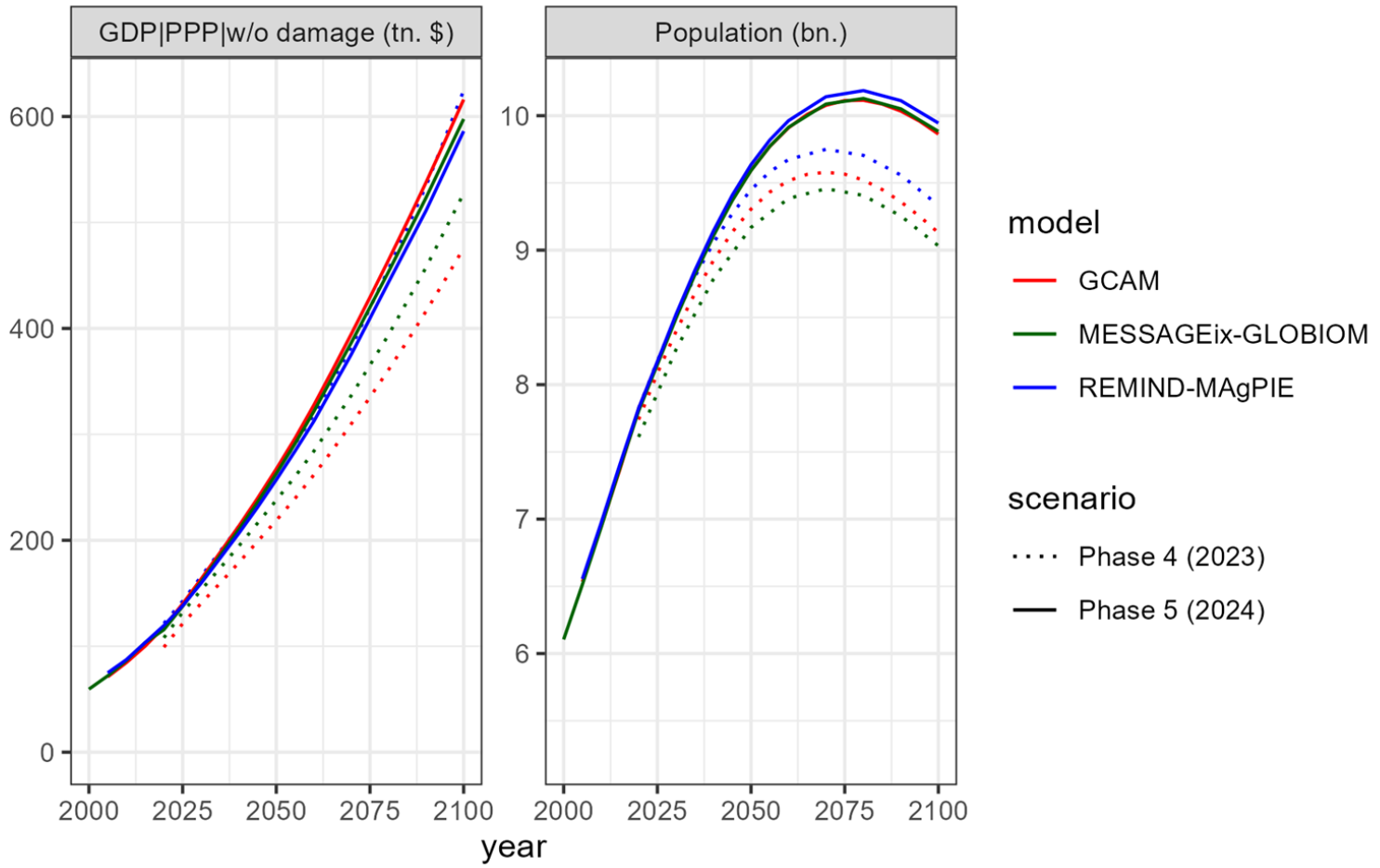
- Only currently implemented policies preserved, high physical risks.

- NDC targets in 2030 only reached if current policies are sufficient.

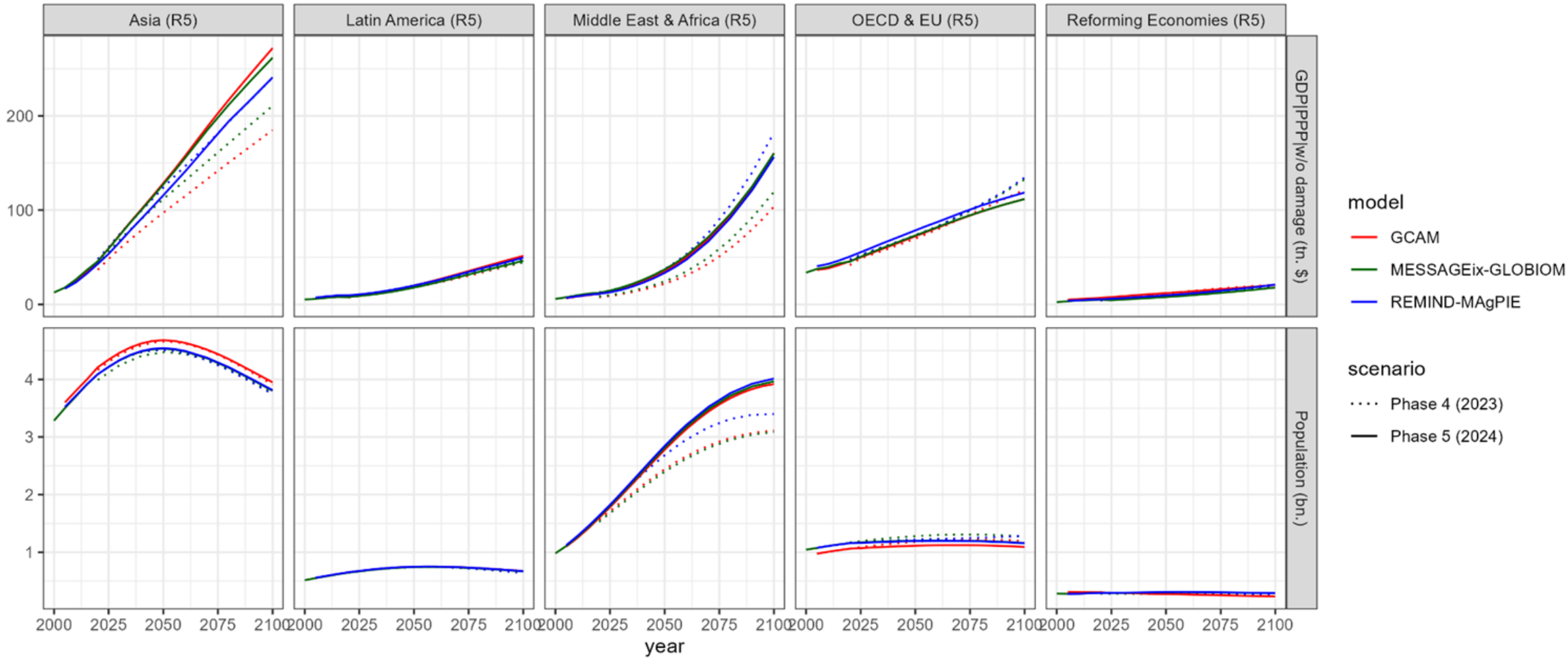
IAMs | Updated and more aligned GDP projections

Update middle-of-the-road socio-economic projections for population and GDP (SSP2):

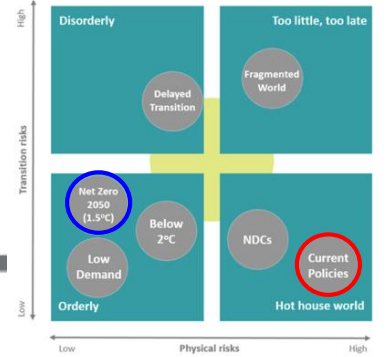
- Better alignment across models
- Later and higher global population peak



IAMs | Updated and more aligned GDP projections



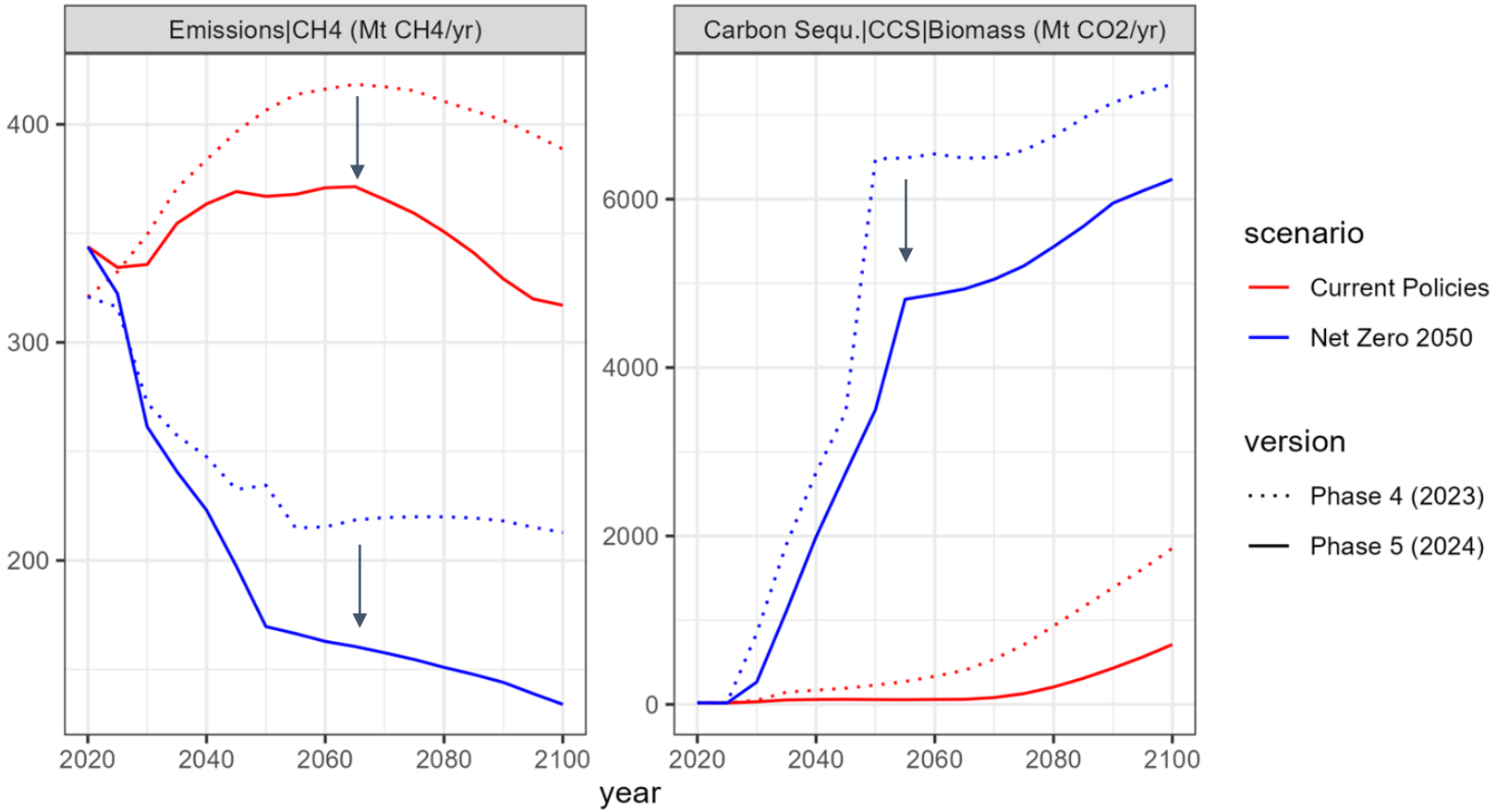
IAMs | GCAM modeling adjustments



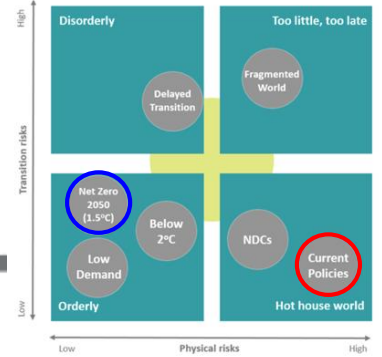
Adjusted assumptions on baseline **methane (CH_4)** emissions and abatement potentials:
lower emissions in all GCAM scenarios

Implies lower demand for carbon dioxide removal to achieve net-zero greenhouse gases (GHG)

Less bioenergy with carbon capture and storage required.

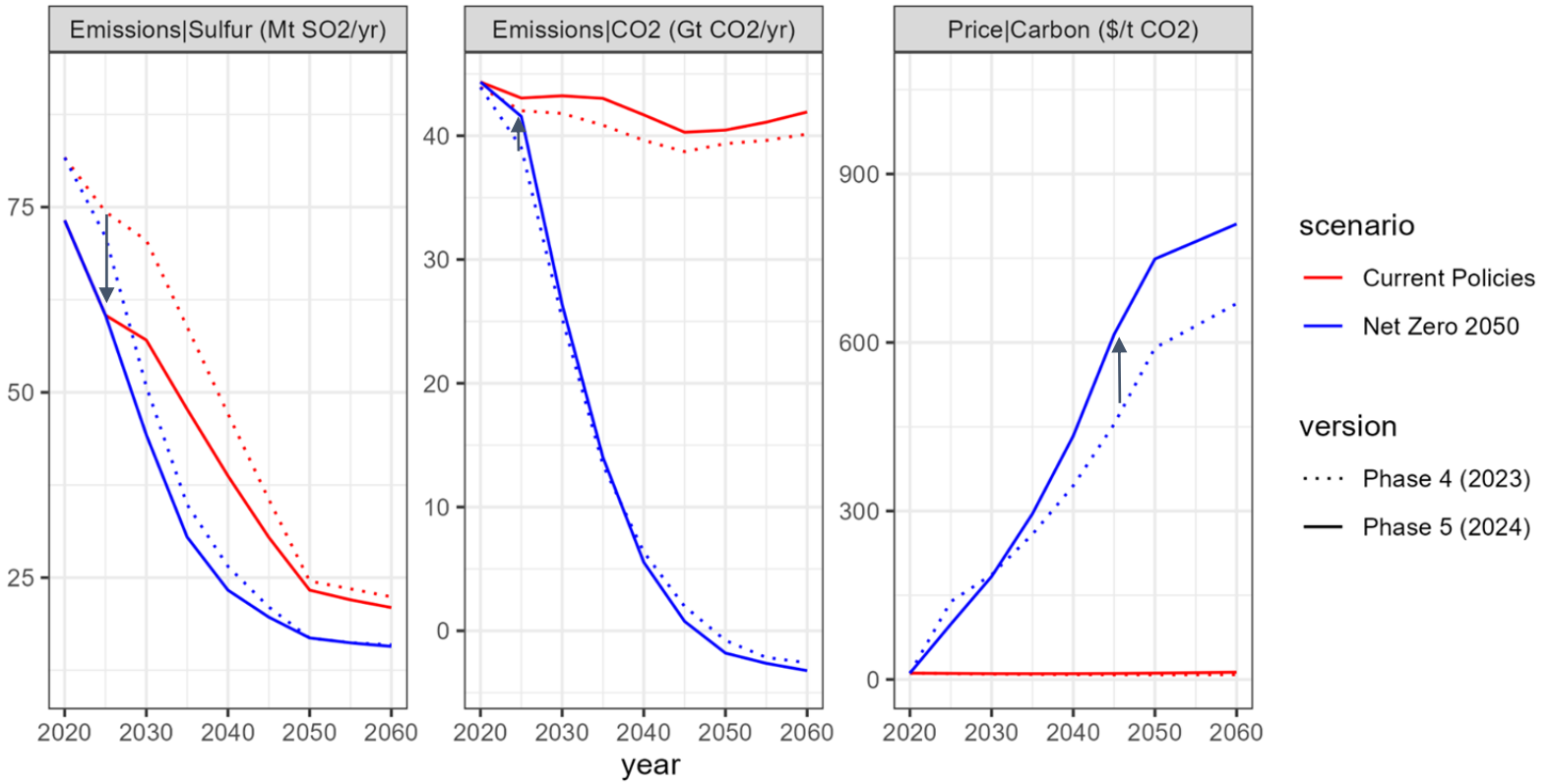


IAMs | REMIND-MAgPIE modeling adjustments

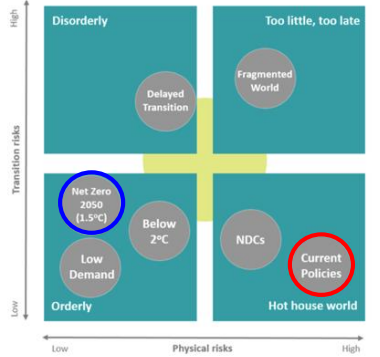


Recalibration of sulfur dioxide, accounting for faster than anticipated phase-in of emissions controls, leading to **lower local air pollution, but also higher global warming (+0.06°C in peak T).**

CO_2 Emissions: accounting for insufficient current action results in **higher 2025 emissions**, and, along other updates, in higher **carbon prices to reach net-zero.**

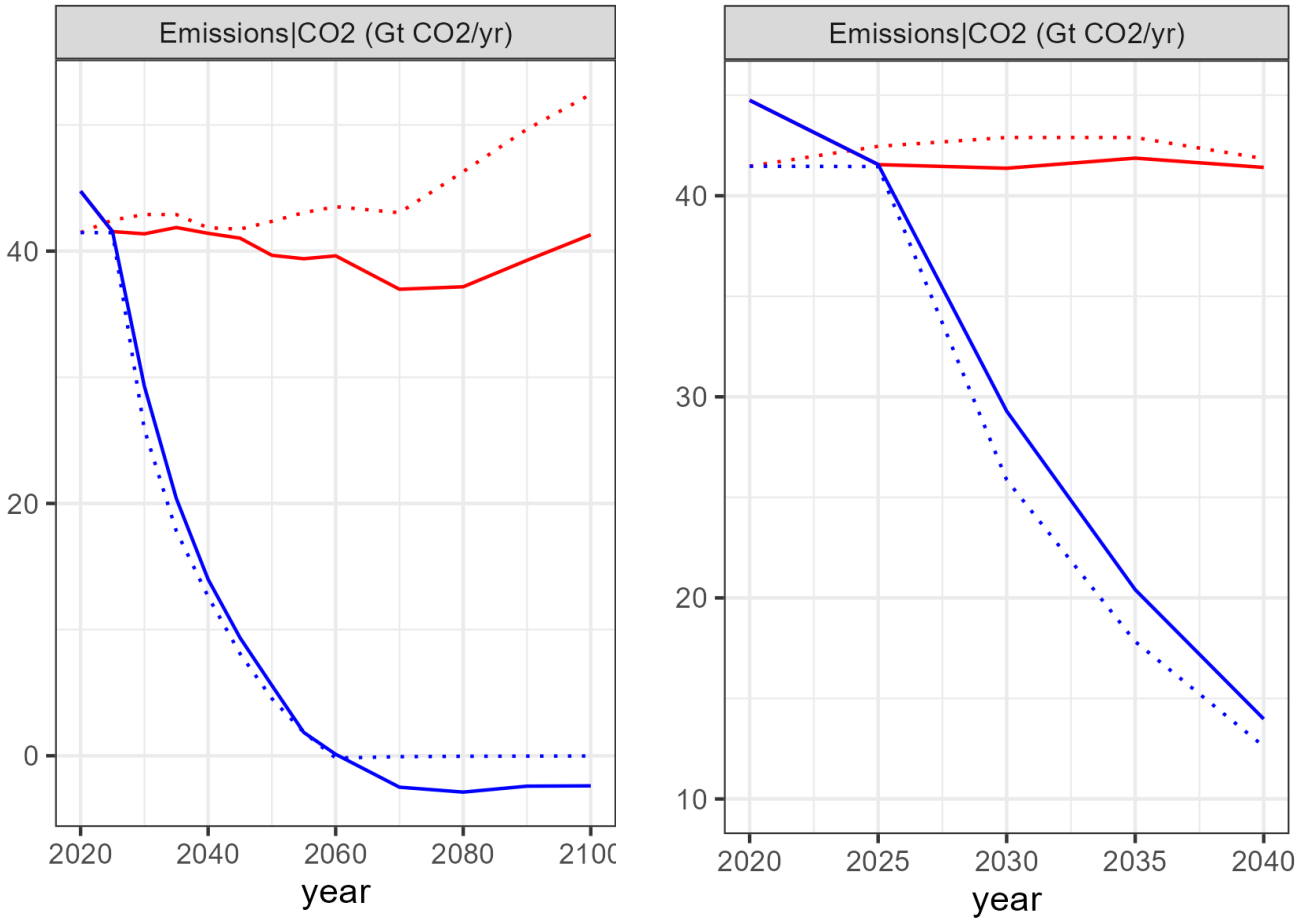


IAMs | MESSAGEix-GLOBIOM

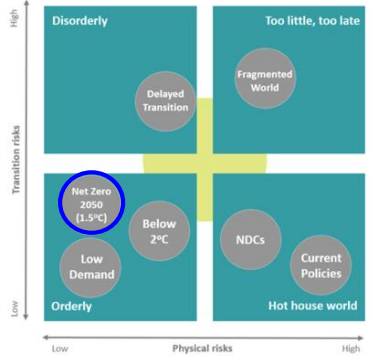


Updated 2020-2025 calibration increased recent emissions and limits near-term mitigation

New long-term demand trajectories decreased Current Policy emissions towards 2100.

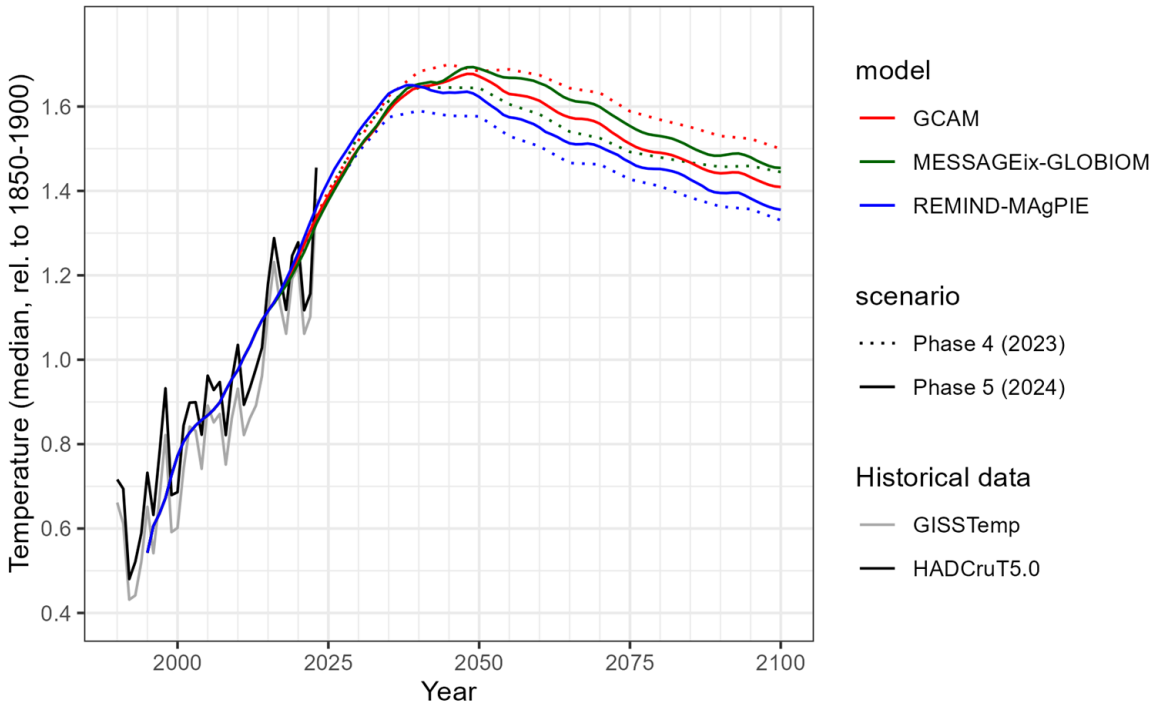


IAMs | Updated temperature evaluation

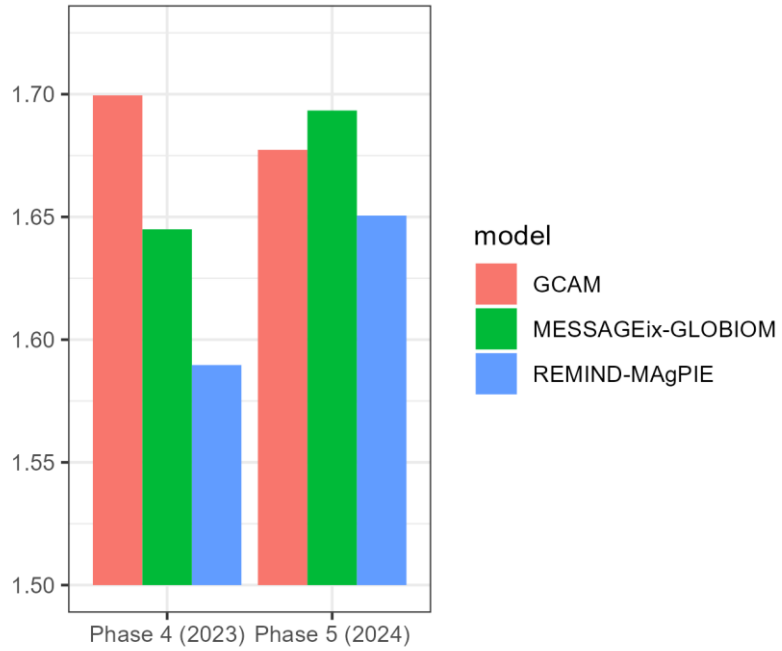


Higher alignment across scenarios due to model changes and change in emissions harmonization:

→ Higher peak temperature now even with most optimistic policy scenario



Median peak temperature in Net Zero 2050 (°C)

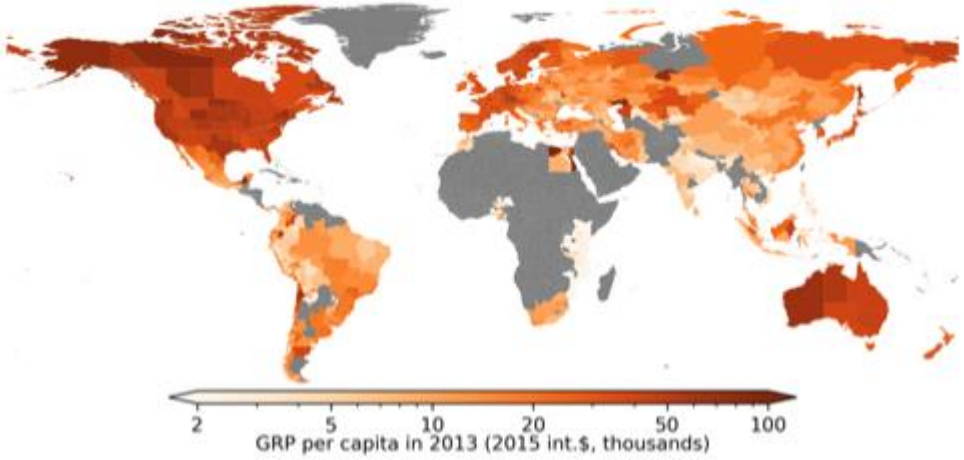


Modelling Framework (Chronic physical risk)

Chronic physical risk: new damage function Kotz et al. (2024)

Damage function recap:

- Quasi-global panel of sub-national production



Kalkuhl & Wenz (2020), Wenz (2023)

- Panel fixed-effects:

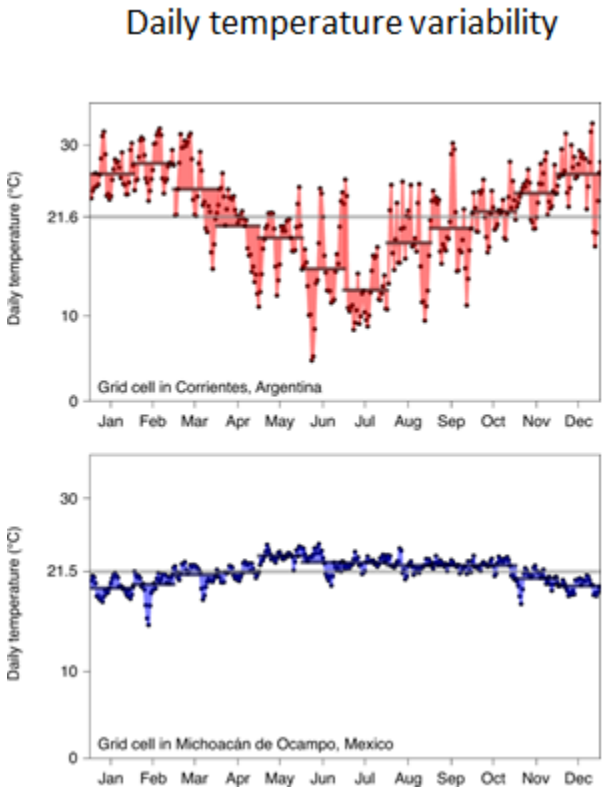
$$g_{r,y} \sim \alpha\, \Delta T_{r,y} + \beta T_r . \Delta T_{r,y} + \mu_r + \eta_y + \theta_r y + \varepsilon_{r,y}$$

- Random annual climate exposure > “quasi-experimental” exogenous treatment > causal effect
- Assumes future response to climate will follow historical one.

Kalkuhl & Wenz (2020)

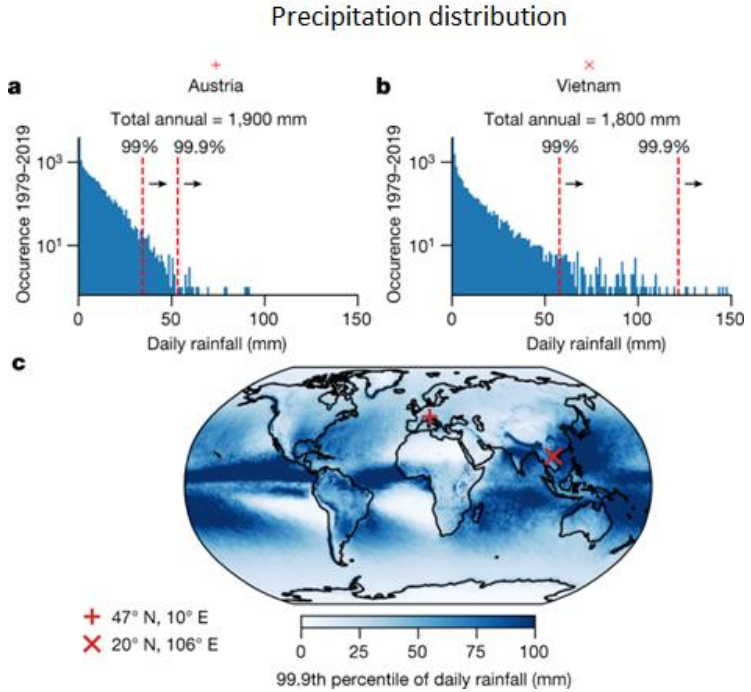
Chronic physical risk: new damage function Kotz et al. (2024)

What drives the higher damages? - expansion of climate drivers beyond annual mean temperature change



Kotz et al. (2021)

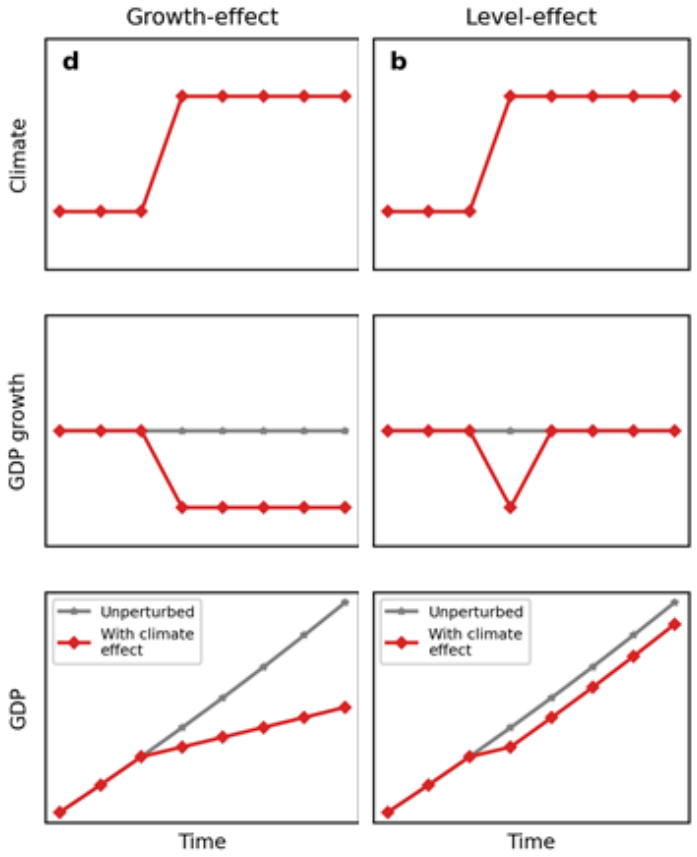
total annual rainfall, monthly rainfall deviation, number of wet days, extreme daily rainfall



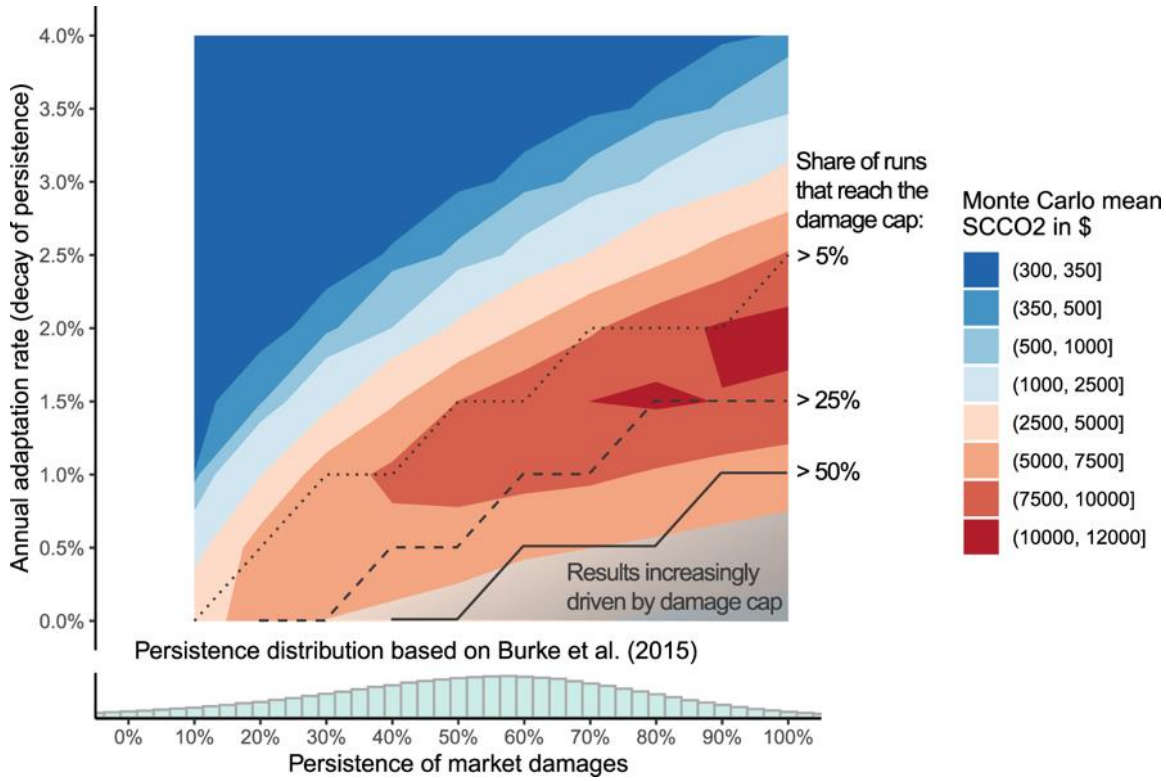
Kotz et al. (2022)

Chronic physical risk: new damage function Kotz et al. (2024)

What drives the higher damages? - persistence of growth effect

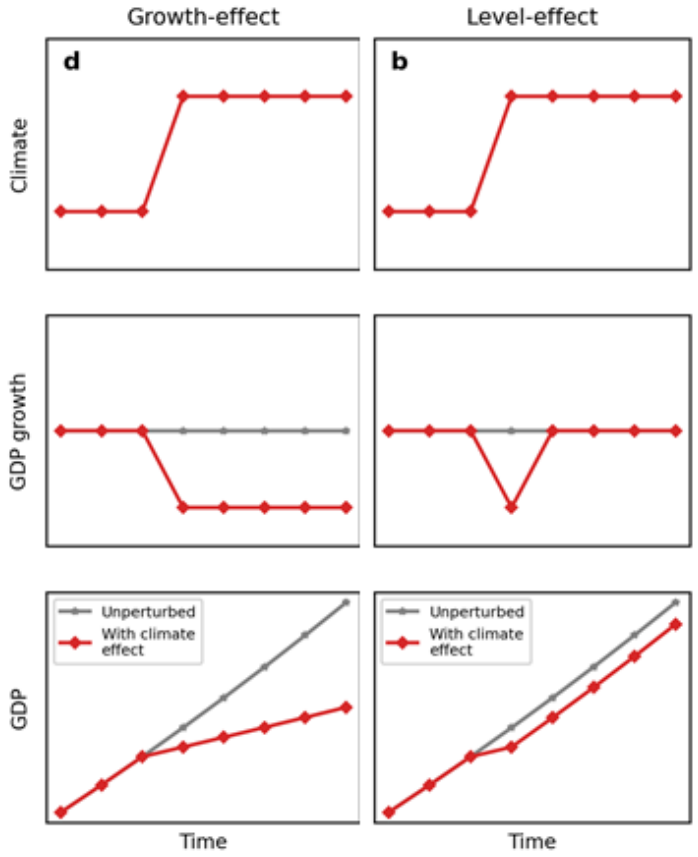


First-order problem!



Chronic physical risk: new damage function Kotz et al. (2024)

What drives the higher damages? - persistence of growth effect



First-difference framework of Kalkuhl & Wenz 2020:

$$g_{r,y} \sim \alpha\, \Delta T_{r,y} + \beta T_r . \Delta T_{r,y} + \mu_r + \eta_y + \theta_r y + \varepsilon_{r,y}$$

Assumes level-effect, but can be expanded to allow more persistence.

Chronic physical risk: new damage function Kotz et al. (2024)

What drives the higher damages? - persistence of growth effect

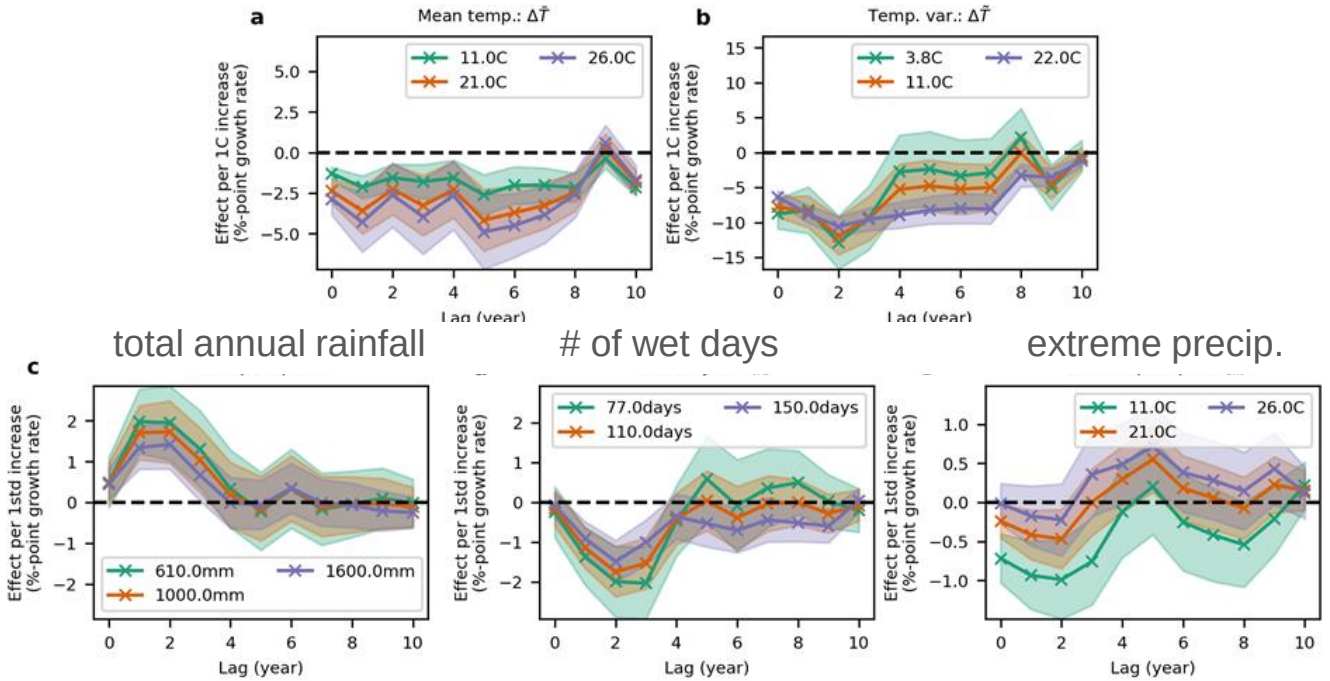
mean temperature

temperature variability

total annual rainfall

# of wet days

extreme precip.



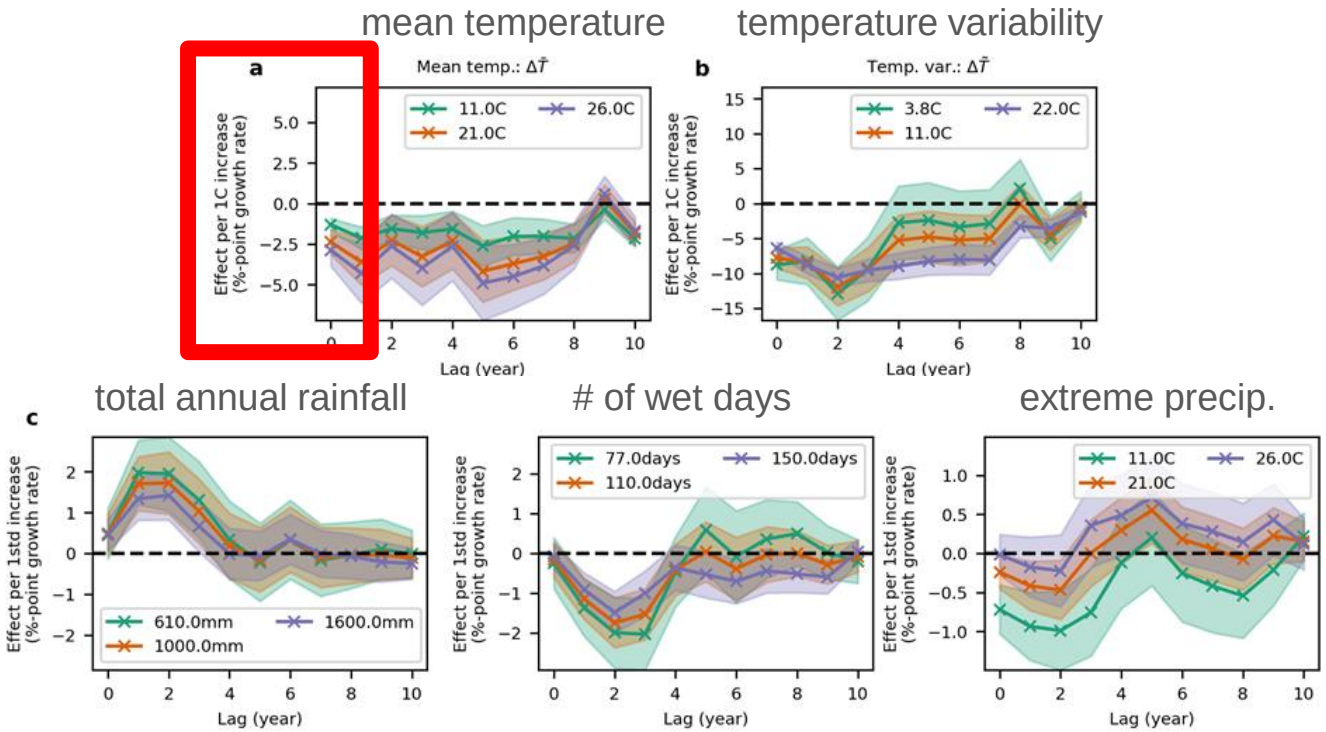
persistence varies by driver, up to 10 years

Kotz et al. (2024)

Chronic physical risk: new damage function Kotz et al. (2024)

What drives the higher damages? - persistence of growth effect

Kalkuhl & Wenz damage function



persistence varies by driver, up to 10 years

Kotz et al. (2024)

Extra tests:

- BIC / AIC
- Monte-Carlo

Chronic physical risk: new damage function Kotz et al. (2024)

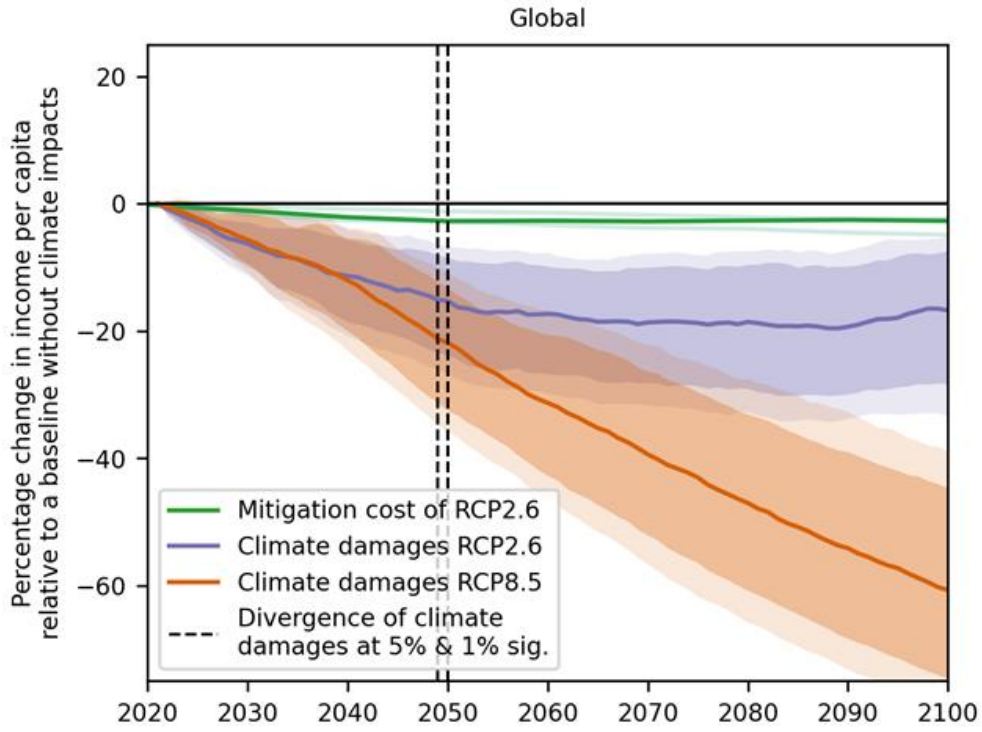
Damage specification

+

Climate projections from GCMs along different RCP scenarios

GDP projections along different SSP scenarios

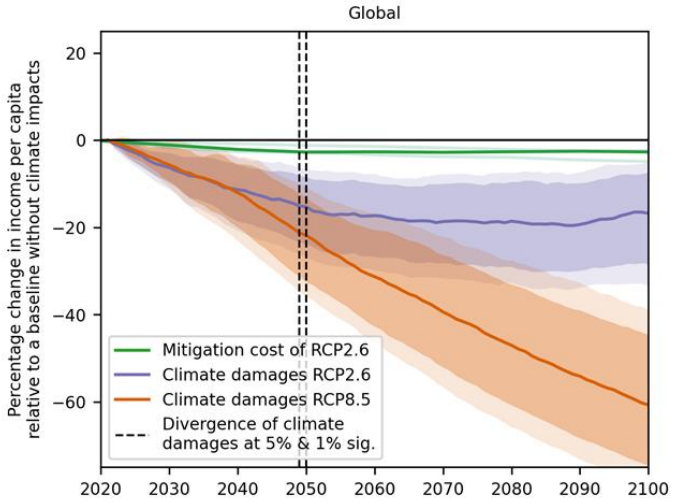
=

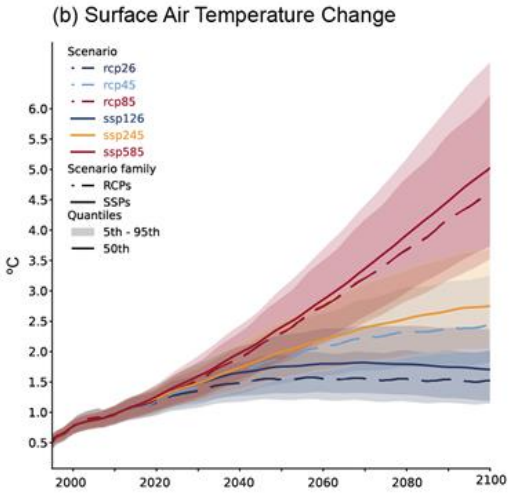


temperature + persistence main drivers

Kotz et al. (2024)

Chronic physical risk: new damage function Kotz et al. (2024)





i = country

r = realization across the uncertainty space

country level damage "emulator":

$$D(i,r,t) = \alpha(i,r)\, T(t) + \beta(i,r)\, T(t)^2$$

T = global mean temperature change compared to 2020 level!

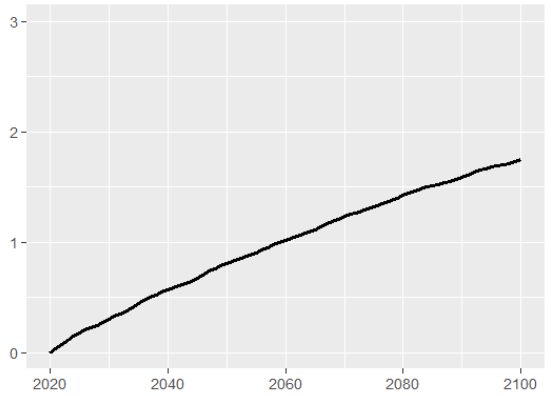
→ for emissions falling below this level (i.e. in low demand scenario) the damage function is not defined!

Chronic physical risks in NGFS Phase V scenarios: example

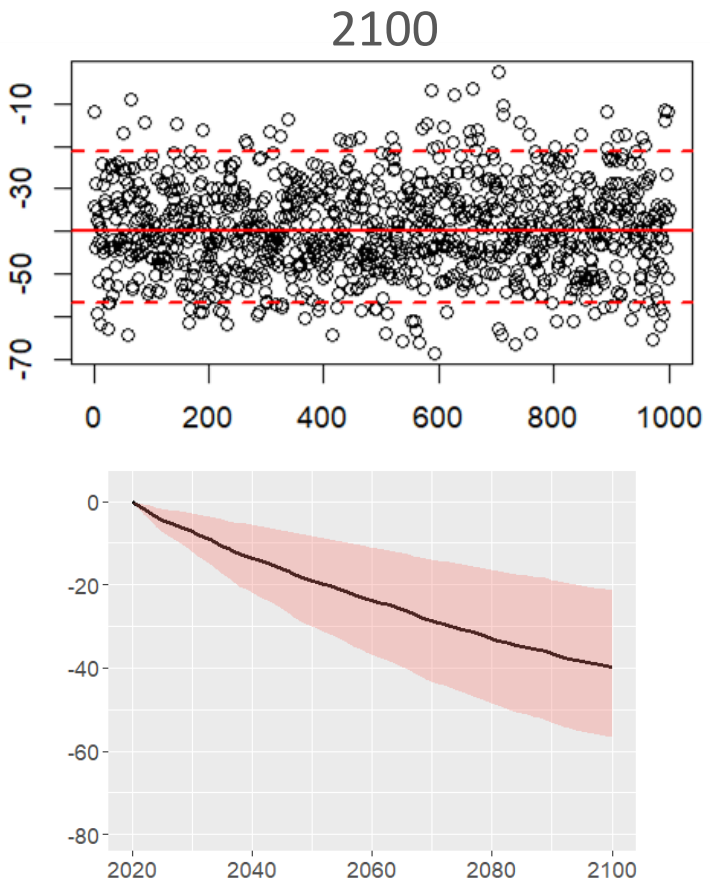
Country-level damages, 1000 realizations

$$D(India,r,t) = \alpha(India,r)\,T(t) + \beta(India,r)\,T(t)^2$$

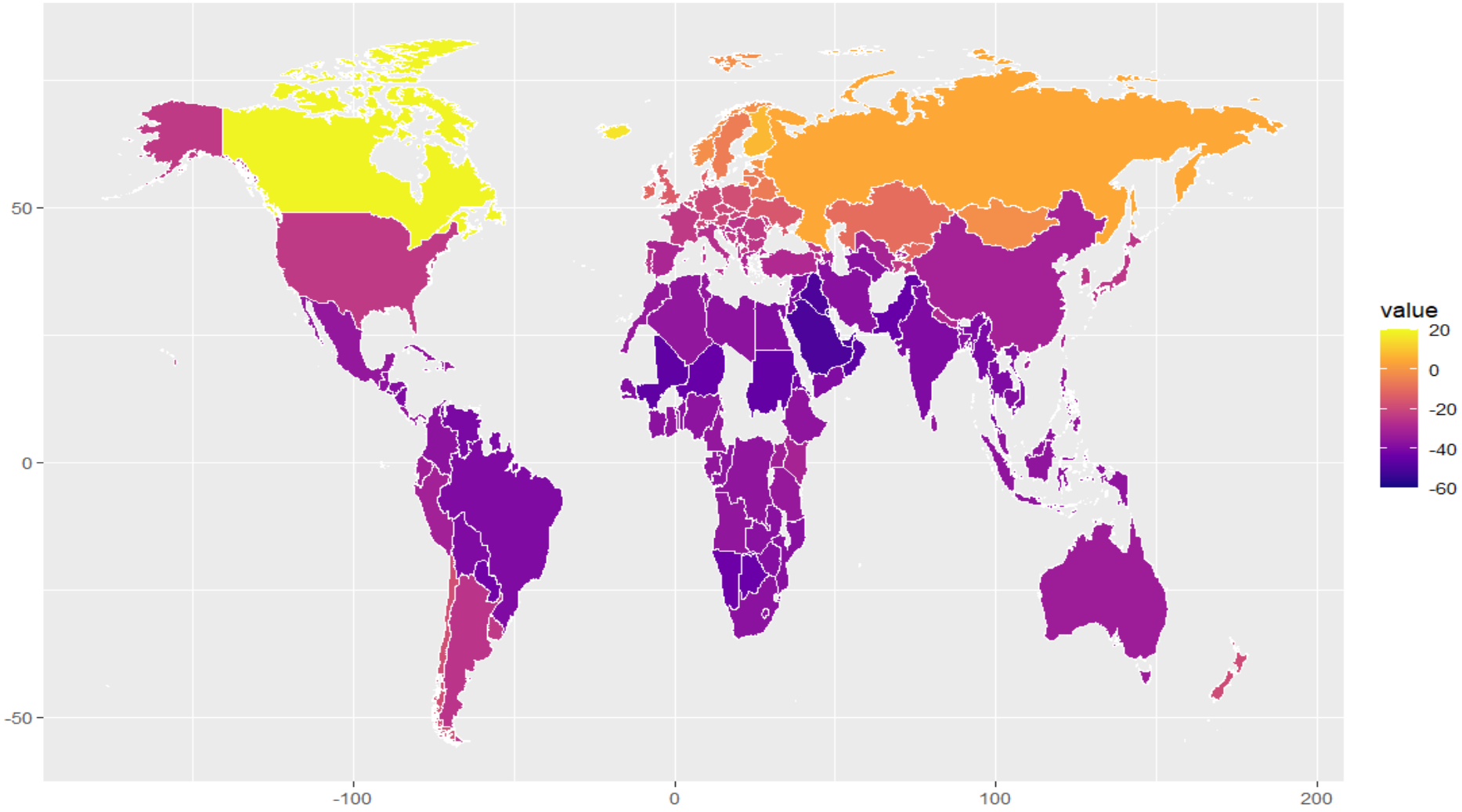
Global mean temperature for current policy scenario (T > T(2020))



GDP change for India under current policies and median temperature:

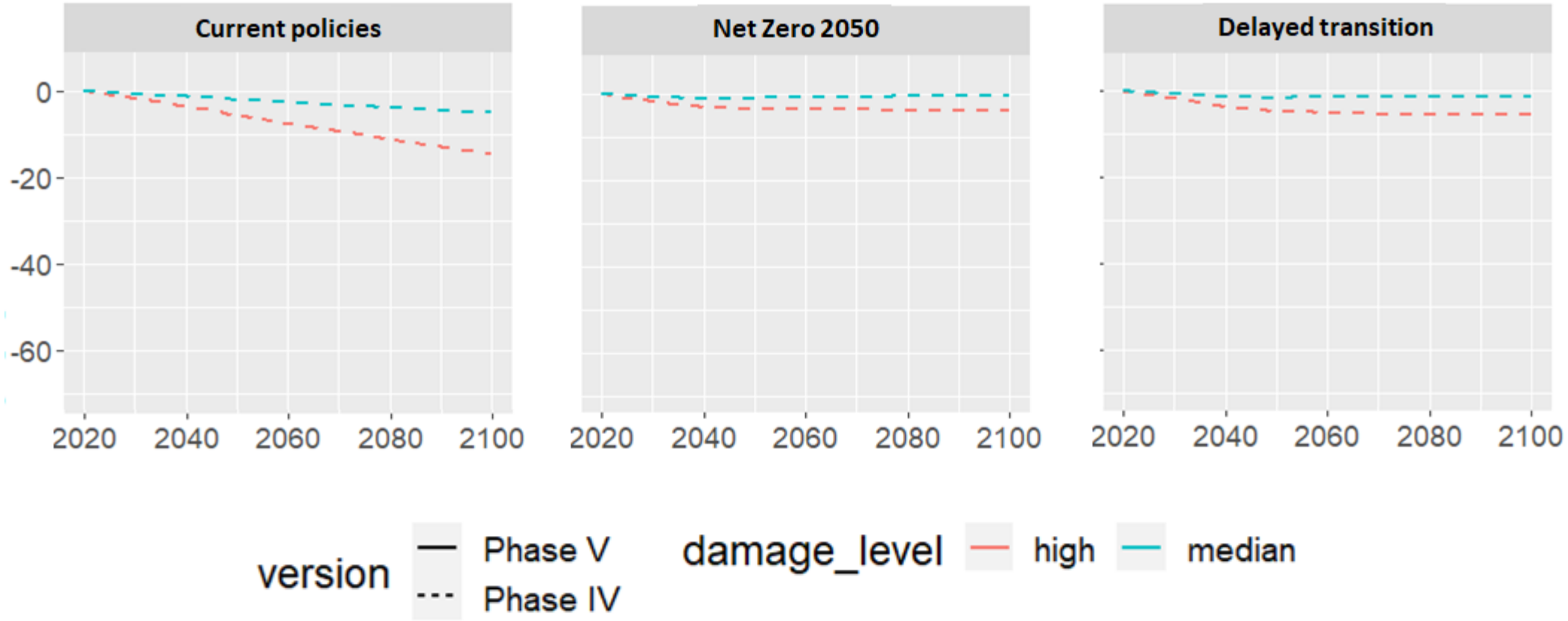


Chronic physical risks in NGFS Phase V scenarios: median GDP loss under current policies in 2100

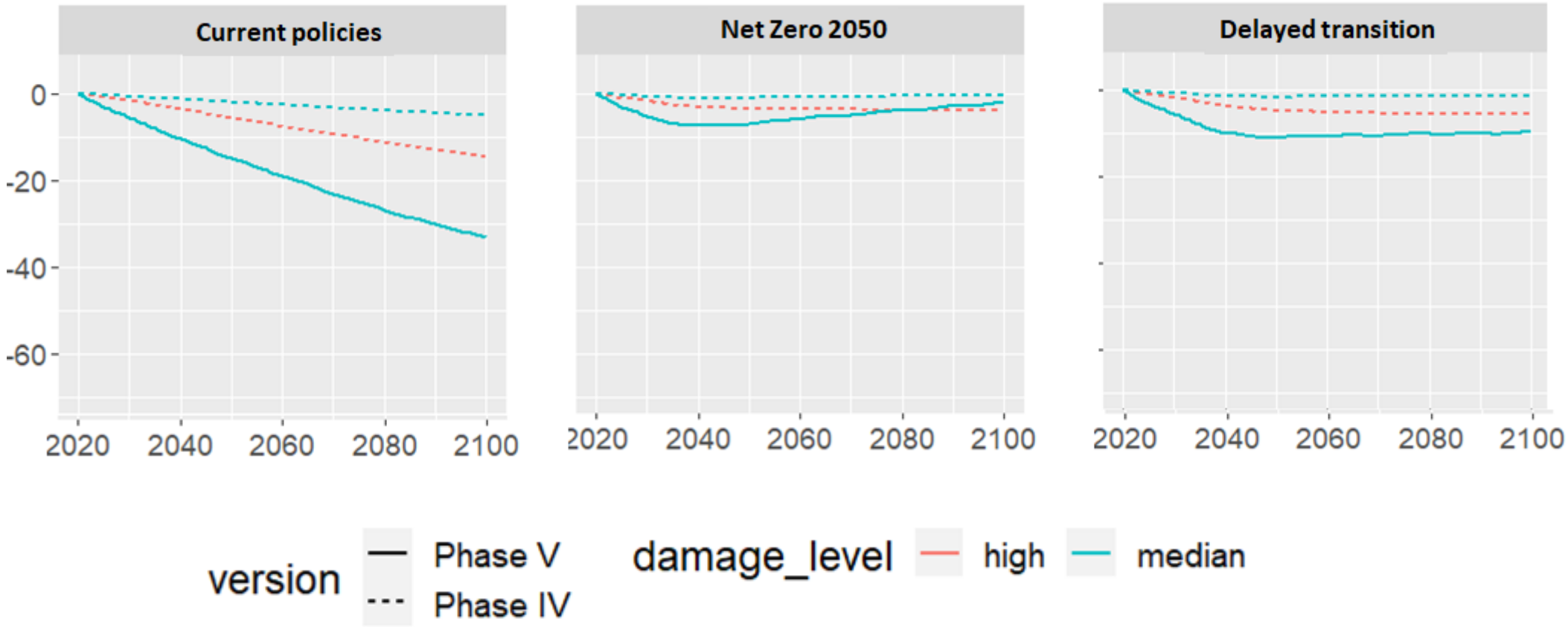


Chronic physical risks in Phase V scenarios: comparison to Phase IV (global GDP change, median temperature)

Phase IV: high = upper percentiles of damage & temperature

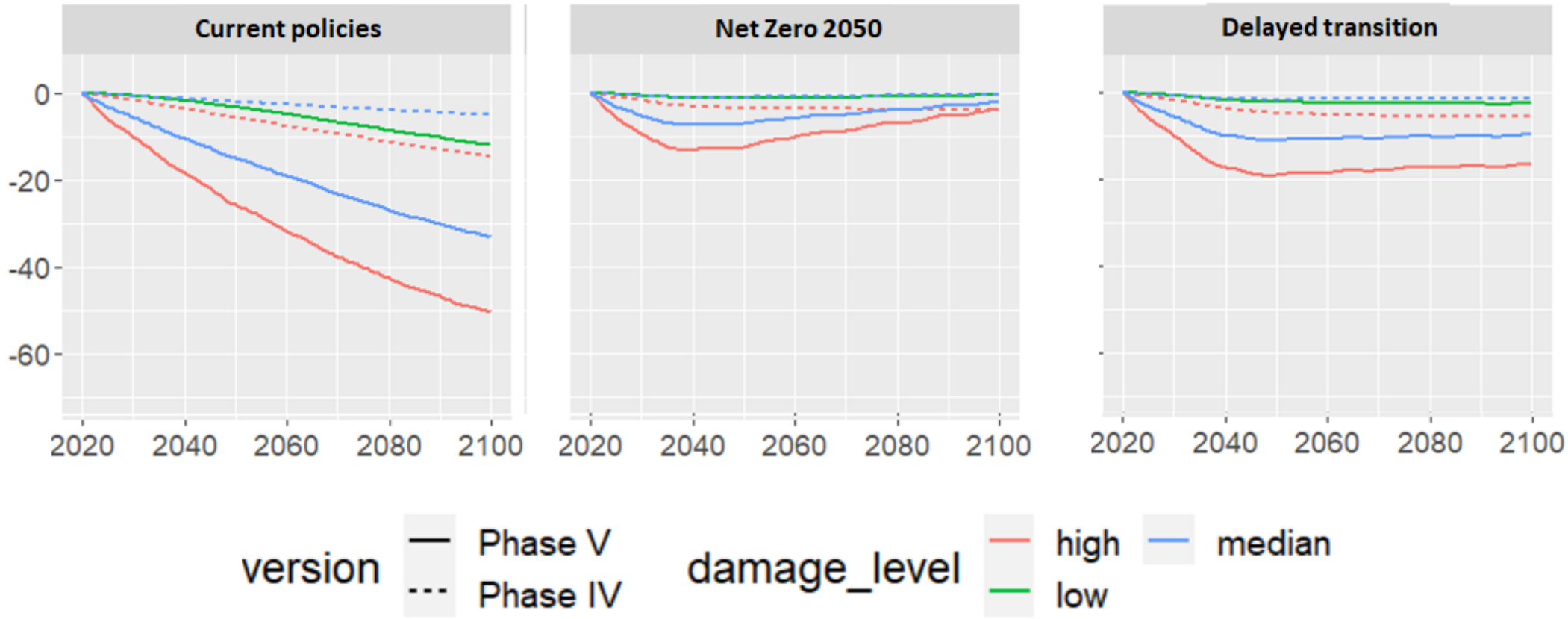


Chronic physical risks in Phase V scenarios: comparison to Phase IV (global GDP change, median temperature)



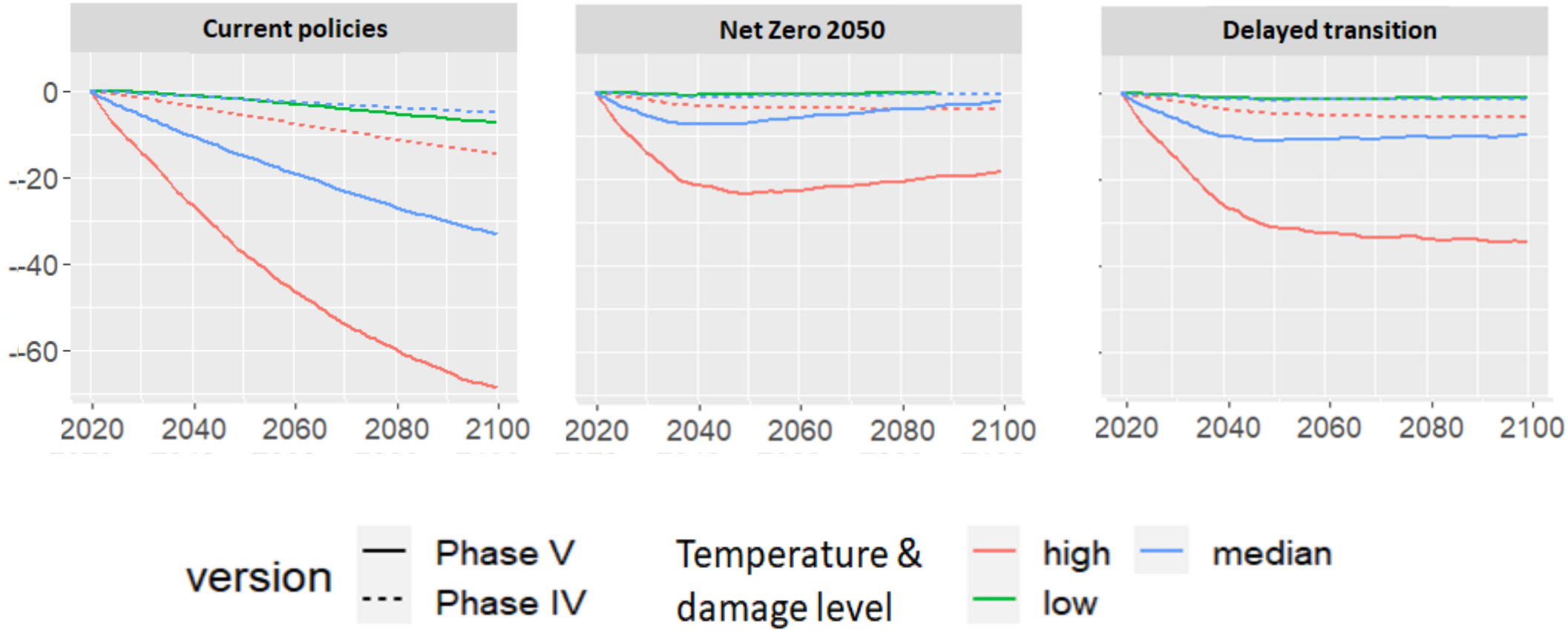
Chronic physical risks in Phase V scenarios: comparison to Phase IV (global GDP change, median temperature)

Phase V: high = upper percentiles of damage & median temperature



Chronic physical risks in Phase V scenarios: comparison to Phase IV (global GDP change, median temperature)

Phase V: combination of high/low damage & high/low temperature



Overlap of chronic and acute risks

Acute risk indicators:	Correlates with:	Bottom-up vs top-down approach:
• heat stress (impacts on labor productivity and consumption) • droughts (impacts on agricultural production) • floods (impacts on assets) • tropical cyclones (impacts on assets)	• annual mean temperature change • precipitation extremes	• empirical damage function captures dynamic effects in the whole economy to some degree already • acute risks only capture event directly ➢ complementary, not separate ➢ difficult to separate out of aggregate function, could separate drivers in the future

Modelling Framework (NiGEM)

NiGEM – What's new?

Phase 5 is based on NiGEM climate expansion v1.24

- Re-based countries: Australia:2020-2021; Canada:2012-2017; Egypt:2016-2021; Hong Kong:2019-2021; Ireland:2020-2021; Mexico:2013-2018; Norway:2020-2021; Russia:2016-2021; Sweden:2021-2022; USA:2012-2017. Equation intercepts corrected where necessary.
- Malaysia expanded to a full country model and re-estimated.
- Reduced country variable coverage standardised.

Chronic impacts updated

- Latest damage function from PIK used
- All scenarios use the same percentile damages

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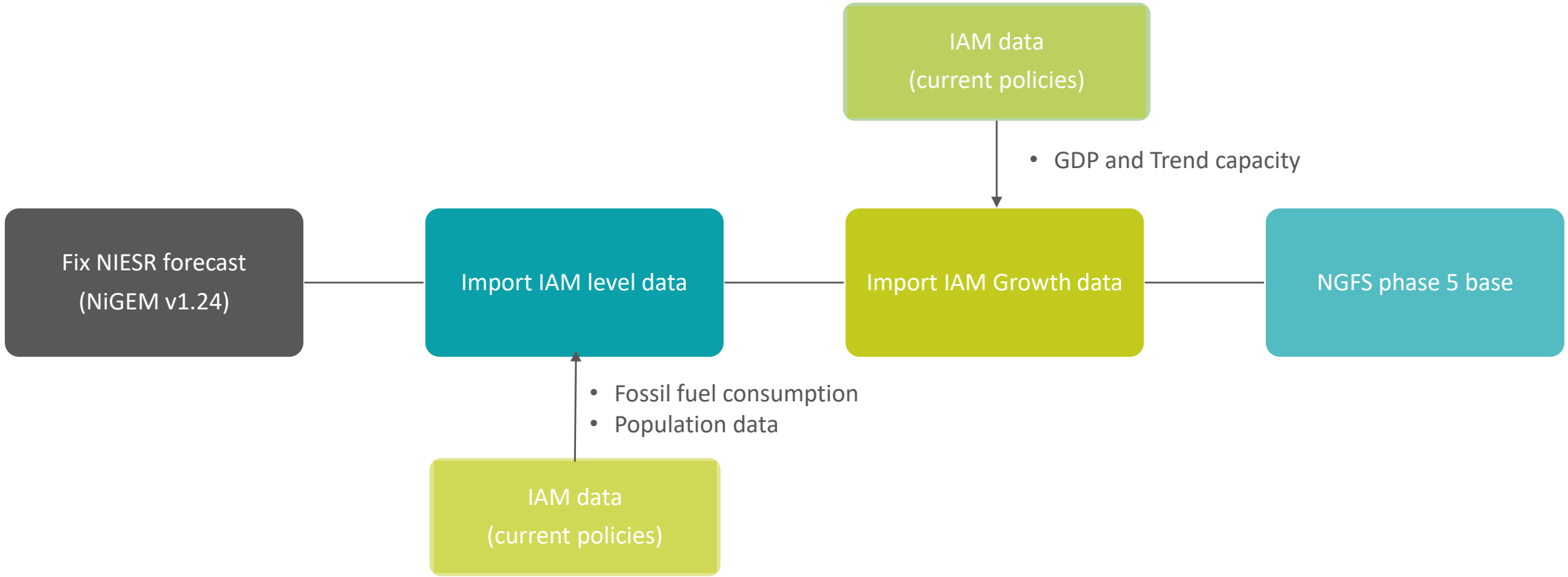
Central Banks and Supervisors Network for Greening the Financial System

Climate neutral scenario base



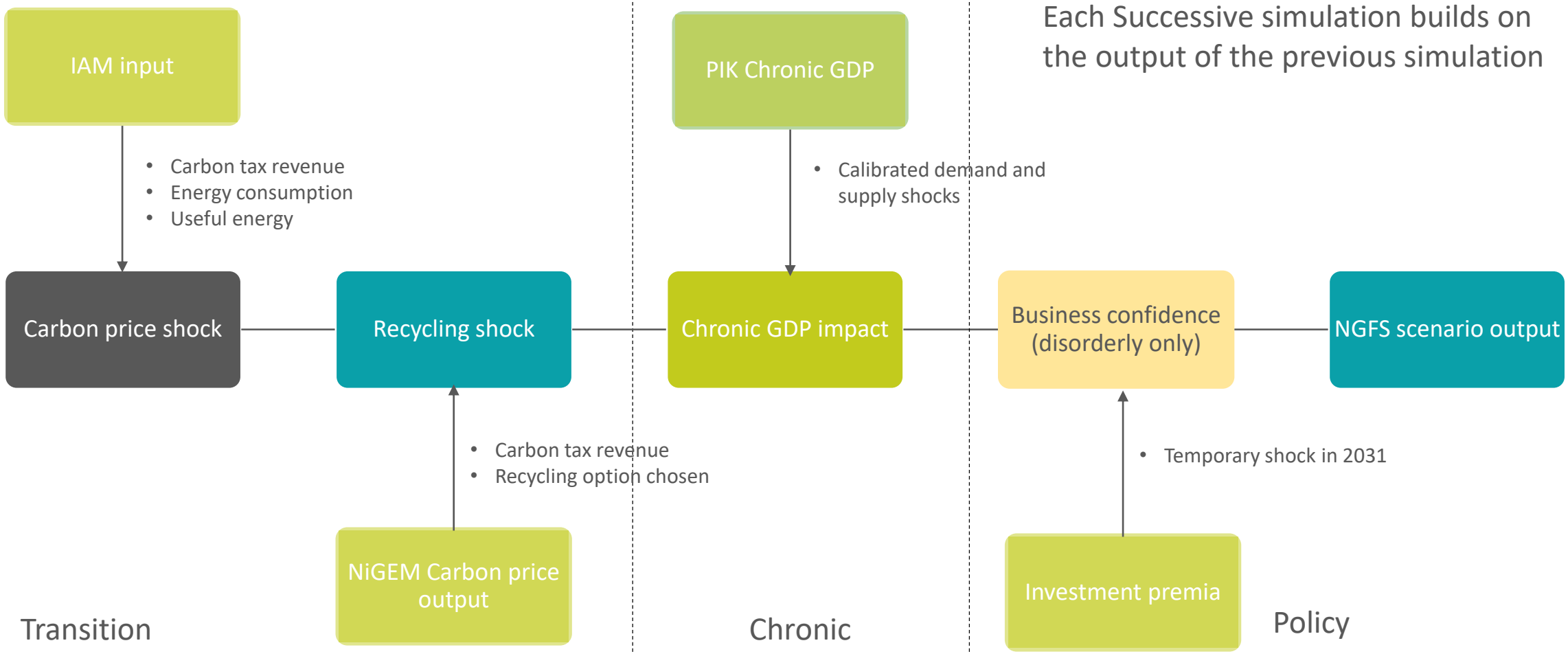
Climate neutral scenario base

NIESR forecast base harmonised with IAM current policies to provide a scenario base

- Energy consumption and population set to IAM current policy levels
- GDP and trend capacity set to IAM current policy growth rates – GDP identity maintained by modifying personal consumption or domestic demand
- No additional transition or chronic impacts introduced into the forecast

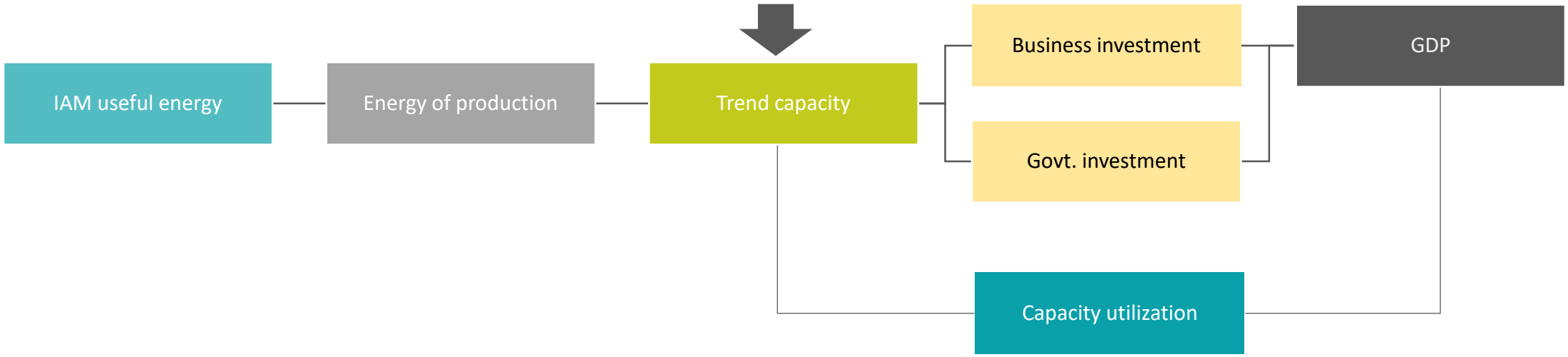
NGFS
Central Banks and Supervisors Network for Greening the Financial System

NGFS scenario run



NGFS scenario run - productivity

Energy into the economy falls - productivity impacted directly

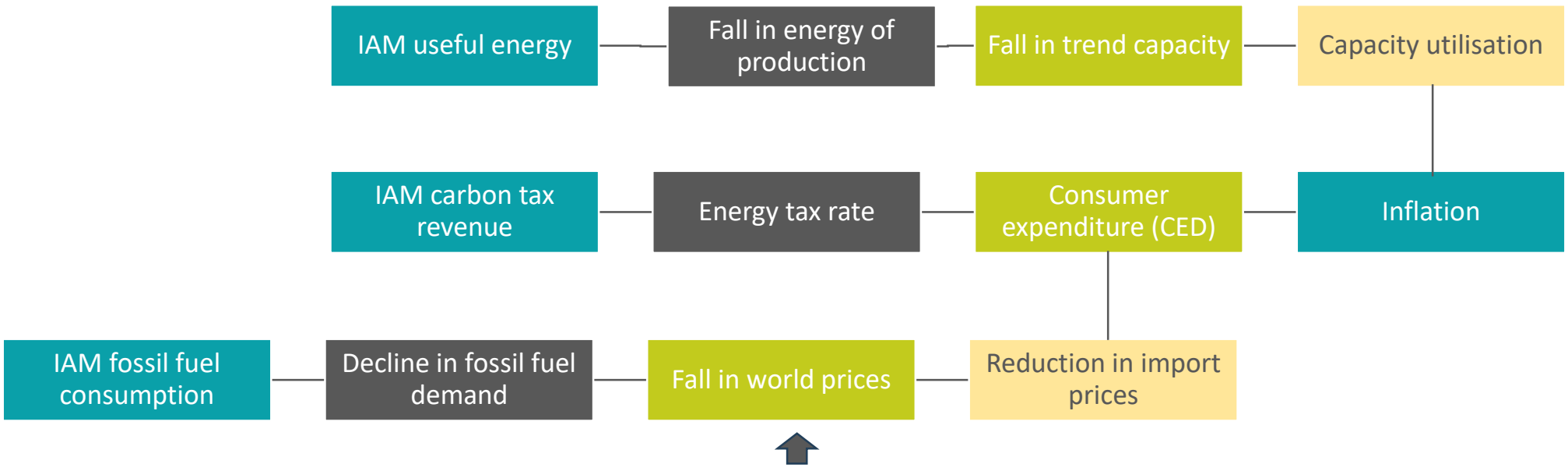


Deviations of actual output from potential output set in motion adjustment processes that bring the economy back to potential in the long run

NGFS scenario run - inflation

$$inflation = \left(\frac{ced_t}{ced_{t-4}} - 1\right)*100$$

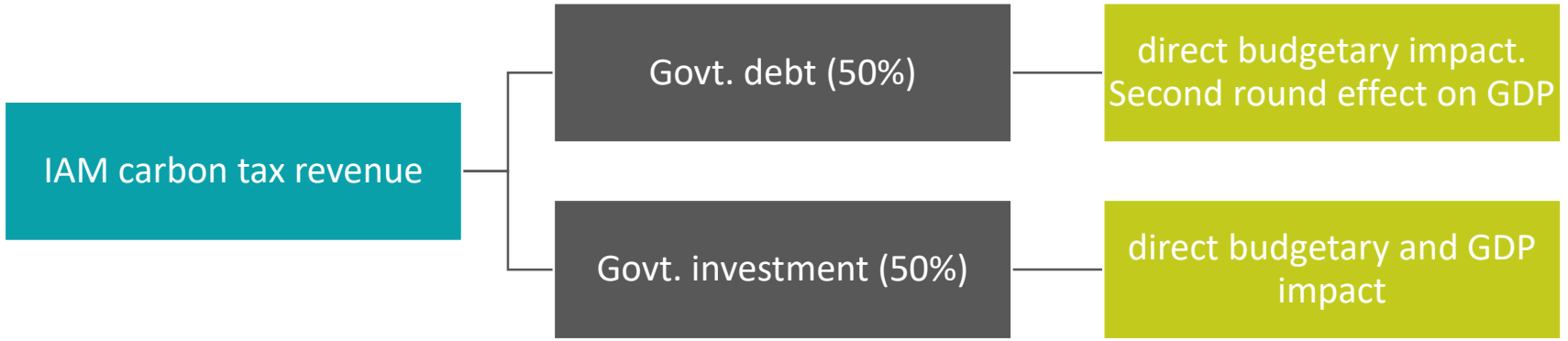
Capacity utilisation impact depends on shock size and if importer/exporter of fossil fuels



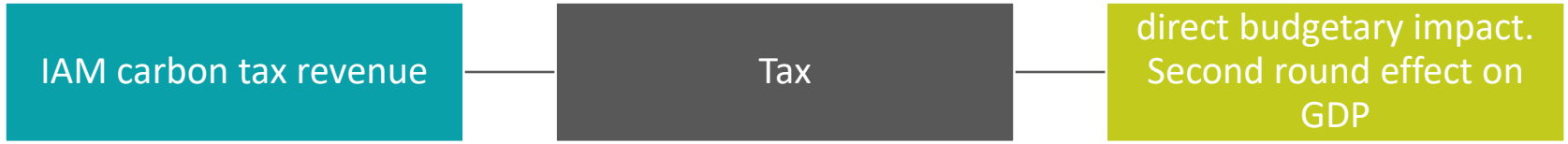
World fossil fuel prices in NiGEM driven by IAM consumption of fossil fuel input

NGFS scenario run - recycling

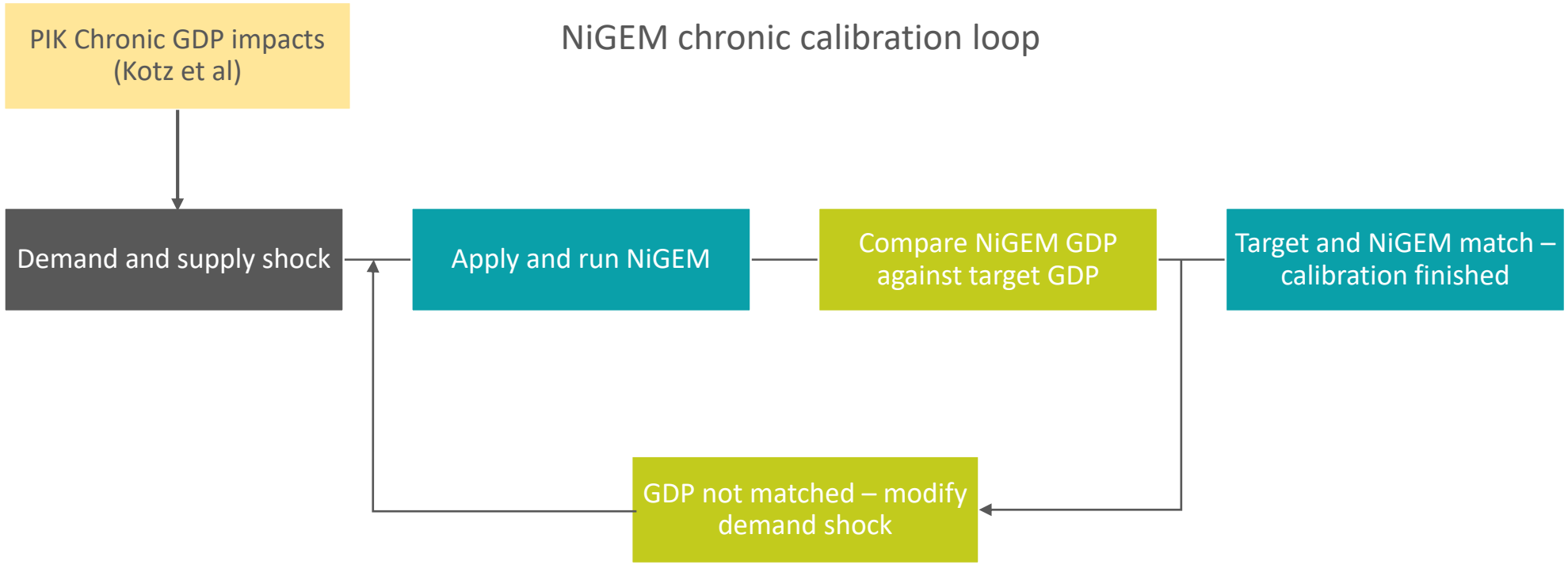
Orderly scenarios (Net Zero 2050, Below 2°C)



Other scenarios (Delayed Transition, Fragmented World, NDCs, Current Policies)



NGFS scenarios - chronic



Trade and monetary policy OFF

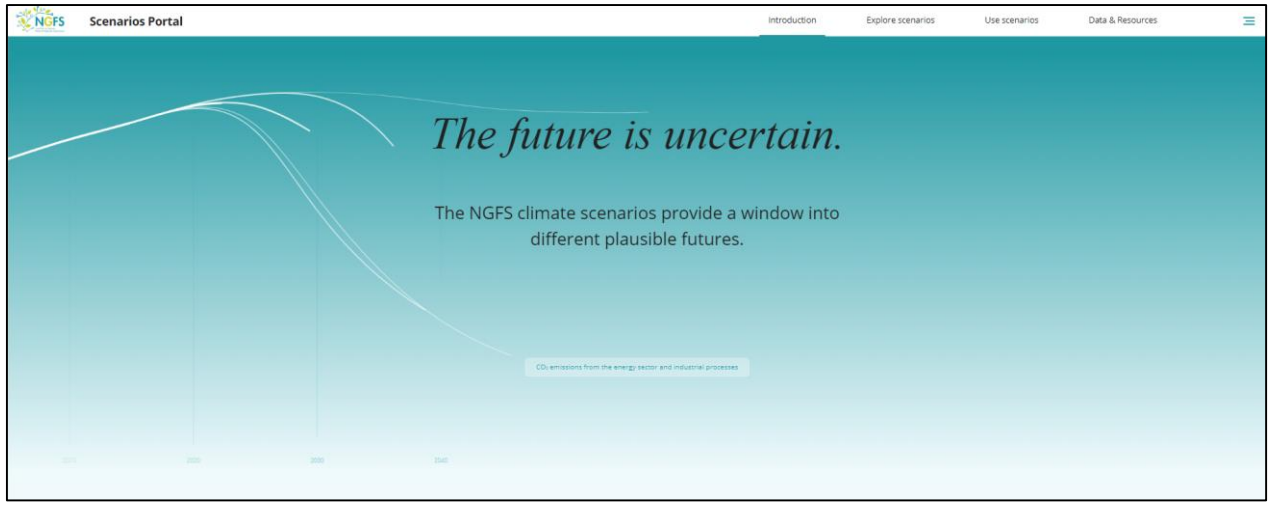
IAMS and NiGEM

- The role of the carbon tax (price) in productivity impact is circumvented using IAM useful energy to more accurately harmonise NiGEM with IAM investment and technology assumptions.
- Emissions in NiGEM are based on the total CO2 which would be created by burning the fossil fuels indicated by the IAM primary energy values. The CO2 does not correspond to the emissions indicated by the IAM models.
- Country-level fossil fuel prices are calculated in NiGEM based on the NiGEM world fuel price and the carbon price applied

Additional Existing Material

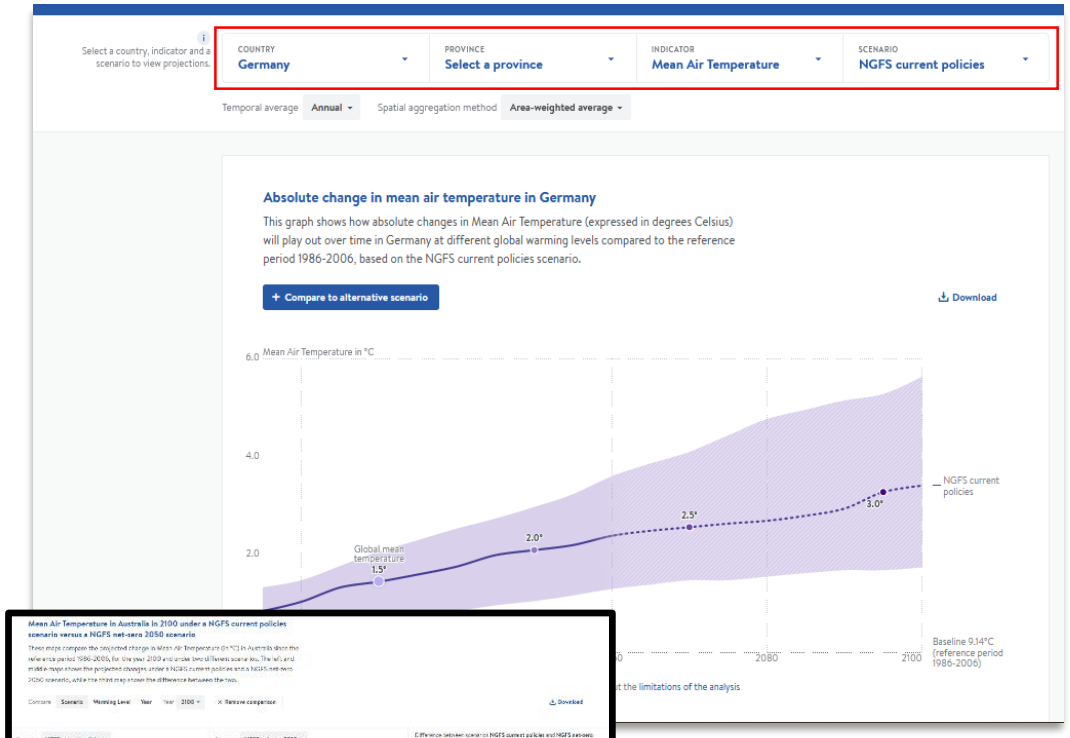
Central access point for NGFS Scenario material: The Scenarios Portal

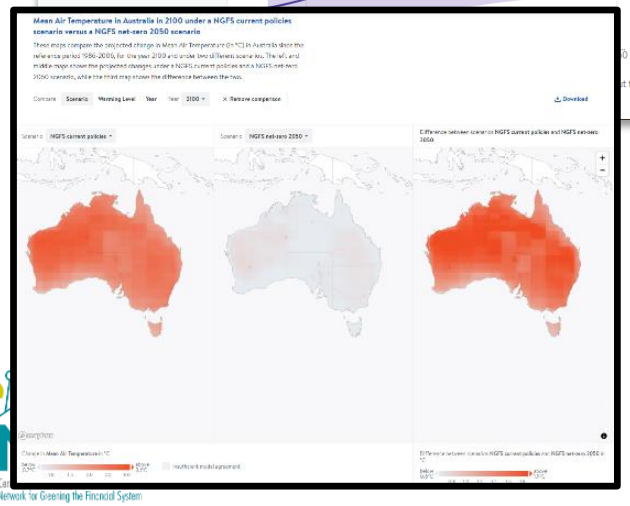
The NGFS Scenarios Portal (https://www.ngfs.net/ngfs-scenarios-portal/) contains all useful links for accessing NGFS Scenarios material. It is a useful starting point to get acquainted with NGFS Scenarios.



- **Frequently Asked Questions**
- **Links to additional NGFS data platform**
- **Technical resources**
- **Scenario analysis resources**

Accessing additional climate impact data: the Climate Impact Explorer





A comprehensive free online tool for Climate Risks

CIE provides a **comprehensive, globally consistent dataset** of physical risk projections for 12 climate scenarios

- Global + regional coverage
- 31 indicators (chronic and acute physical risks)
- Scenarios: 7 NGFS, 4 RCPs, Climate Action Tracker (CAT) and 1.5°C, 2°C, 2.5°C and, 3°C scenario comparison possible
- Temporal and spatial resolution
- Modelling and climate uncertainties reflected
- Data and maps can be downloaded

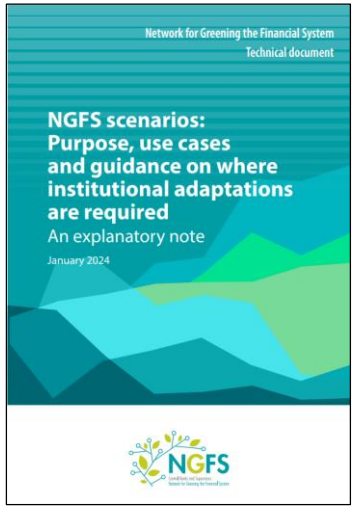
Main data sources: CMIP Coupled Model Intercomparison Project; ISIMIP Inter-Sectoral Impact Model Intercomparison Project; CLIMADA Economics of Climate Adaptation

https://climate-impact-explorer.climateanalytics.org/

Guidance note on NGFS scenarios (released in January 2024)

This document sets out the purposes and practical applications of the NGFS scenarios, as well as acknowledges the need for scenario users to clarify what they intend to achieve and to consider how the scenarios they use allow them to meet their objectives and/or specific requirements.

Explanatory note



Chapter 1: **How does scenario analysis help with assessing climate risk?**

Chapter 2: **How do the NGFS scenarios fit in the global climate scenarios framework?**

Chapter 3: **What are the main use cases of the NGFS scenarios and in which cases might tailoring be necessary?**

Main takeaways are still valid for Phase V NGFS scenarios

NGFS
Central Banks and Supervisors Network for Greening the Financial System

Q&A

Appendix

Climate neutral scenario base

IAM variables input into NiGEM	Variable Description	Units	NiGEM Suffix	Processing for use in NiGEM
Primary Energy|Coal	Energy consumption	EJ/yr	COLC	Level import Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Gas	Energy consumption	EJ/yr	GASC	Level import Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Oil	Energy consumption	EJ/yr	OILC	Level import Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Biomass **Primary Energy|Geothermal** **Primary Energy|Hydro** **Primary Energy|Solar** **Primary Energy|Wind** **Primary Energy|Nuclear**	Energy consumption	EJ/yr	RNWC	Level import Exajoules to Million tonnes of oil equivalent Non-carbon = summation Annual to quarterly
GDP|PPP/Trend capacity	GDP/YCAP	billion US$2010/yr	Y	Growth rate import Annual to quarterly To prevent additional inflationary impacts from supply/demand imbalances, growth rates set equal to IAM GDP
Population	Population	million	POPT	Level import Millions to 1000's

NGFS scenario run

IAM variables input into NiGEM	Variable Description	Units	NiGEM suffix	Processing for use in NiGEM
Primary Energy|Coal	Energy consumption	EJ/yr	COLC	Level import: Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Gas	Energy consumption	EJ/yr	GASC	Level import: Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Oil	Energy consumption	EJ/yr	OILC	Level import: Exajoules to Million tonnes of oil equivalent Annual to quarterly
Primary Energy|Biomass **Primary Energy|Geothermal** **Primary Energy|Hydro** **Primary Energy|Solar** **Primary Energy|Wind** **Primary Energy|Nuclear**	Energy consumption	EJ/yr	RNWC	Level import: Exajoules to Million tonnes of oil equivalent Annual to quarterly Non-carbon = summation
Price|Carbon	Carbon price	US$2010/t CO2	CBTAX	Level import Constant to current prices using NiGEM US GDP deflator (NIESR). Deprecated since phase iii as the carbon revenue is now provided directly from the IAMs to account for CDR & CSS
Useful Energy|Industry **Useful Energy|Residential and Commercial** **Useful Energy|Transportation** **Electricity; Gases; Heat; Hydrogen; Liquids; Solids**	Useful Energy	EJ/yr	OIVOL	Multiplicative residual import Delta calculated (w.r.t. current policies) Annual to quarterly
Revenue|Government|Tax|Carbon	Carbon Revenue	billion US$2010/yr	ETAX	Level import Constant to current prices using NiGEM US GDP deflator. PPP (2019) used to convert to local currency Annual to quarterly