POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

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# Accounting for Climate Change Impacts in Integrated Assessment Modelling

# How could the ISI-MIP data be used?

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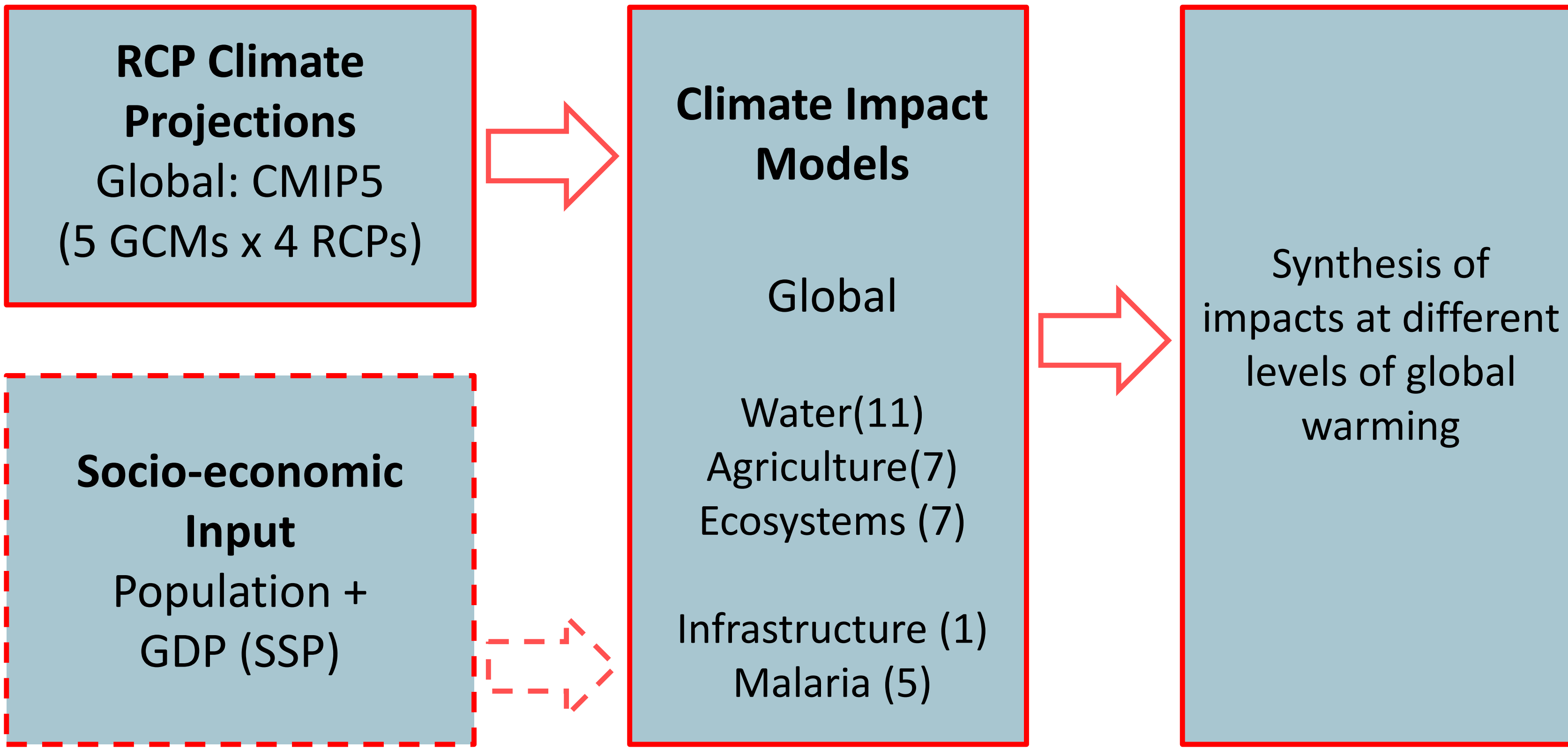
Leibniz Gemeinschaft

# What does ISI-MIP provide? –
# The raw material

# The Inter-Sectoral Impact Model Intercomparison Project

## Access to Multi-Impacts Model Projections across different sectors

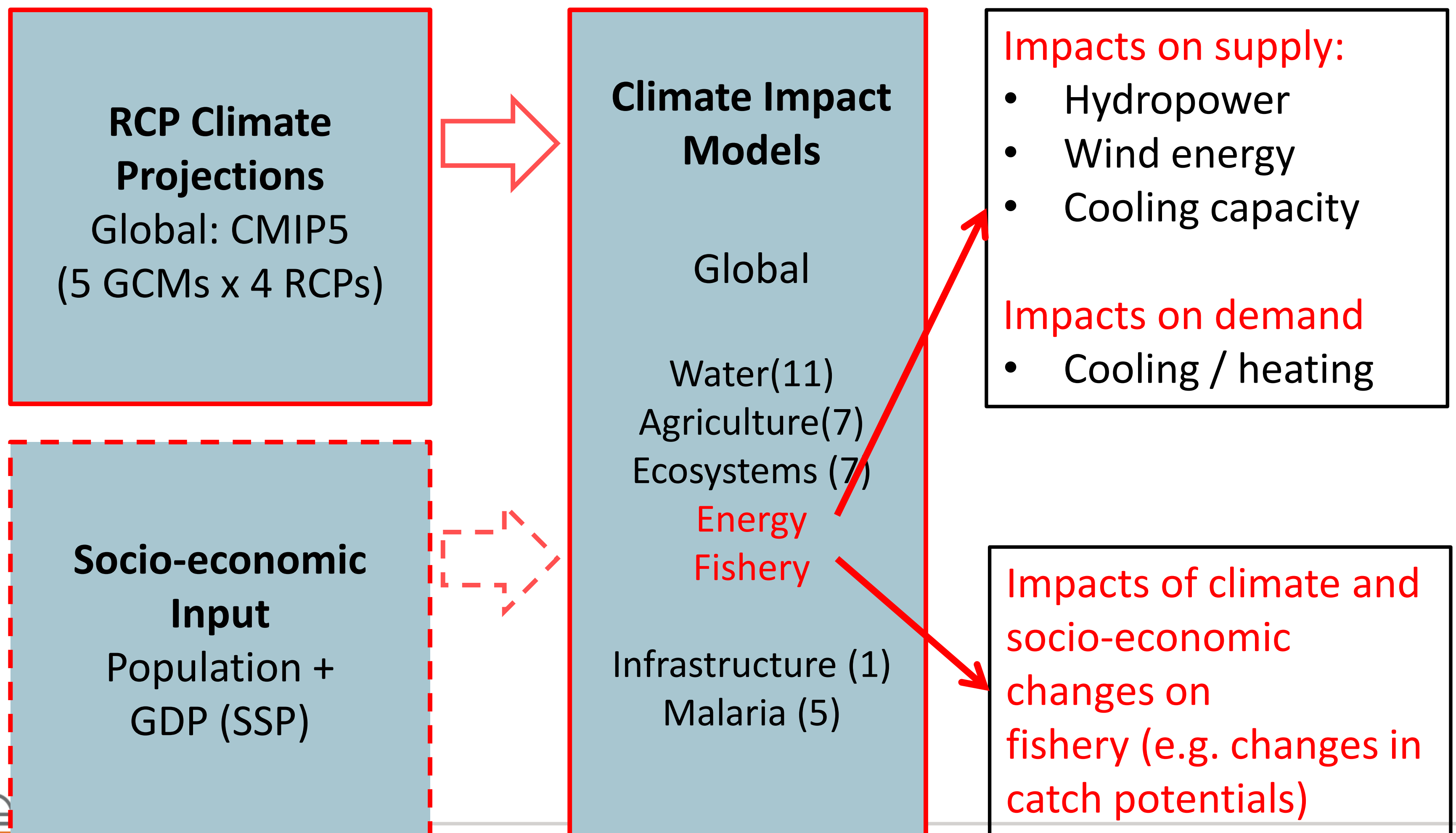



Simulations are available via the open ISI-MIP repository

**www.isi-mip.org**

# ISI-MIP2

## Inclusion of regional impact models and new sectors



# Available biophysical impact projections on a common 0.5 x 0.5 degree grid

- Water: Runoff and discharge (daily data)
- Agriculture: Crop yields (pure crop runs for wheat, maize, soy and rice; fullirr, rainfed; annual data)
- Biomes: Changes in C and water fluxes and pools (pure natural vegetation runs; annual data)

# How can we make the data usable in Integrated Assessment Studies?

# General Problems:

1. Translation of impact to other emission scenarios

2. Estimation of associated costs

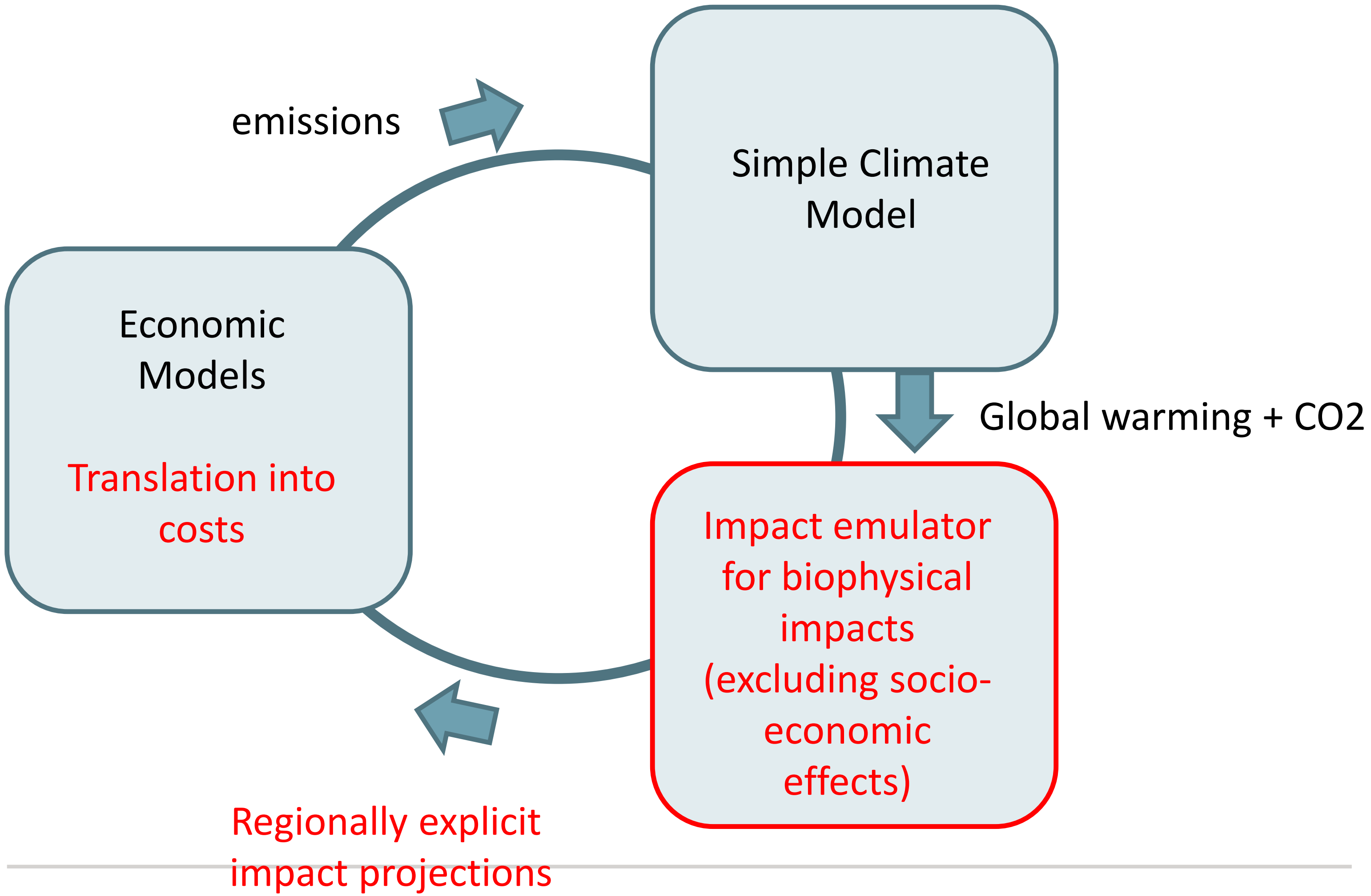
# Option 1: Scaling of the biophysical impacts of climate change with global mean temperature and later translation into costs

Costs of

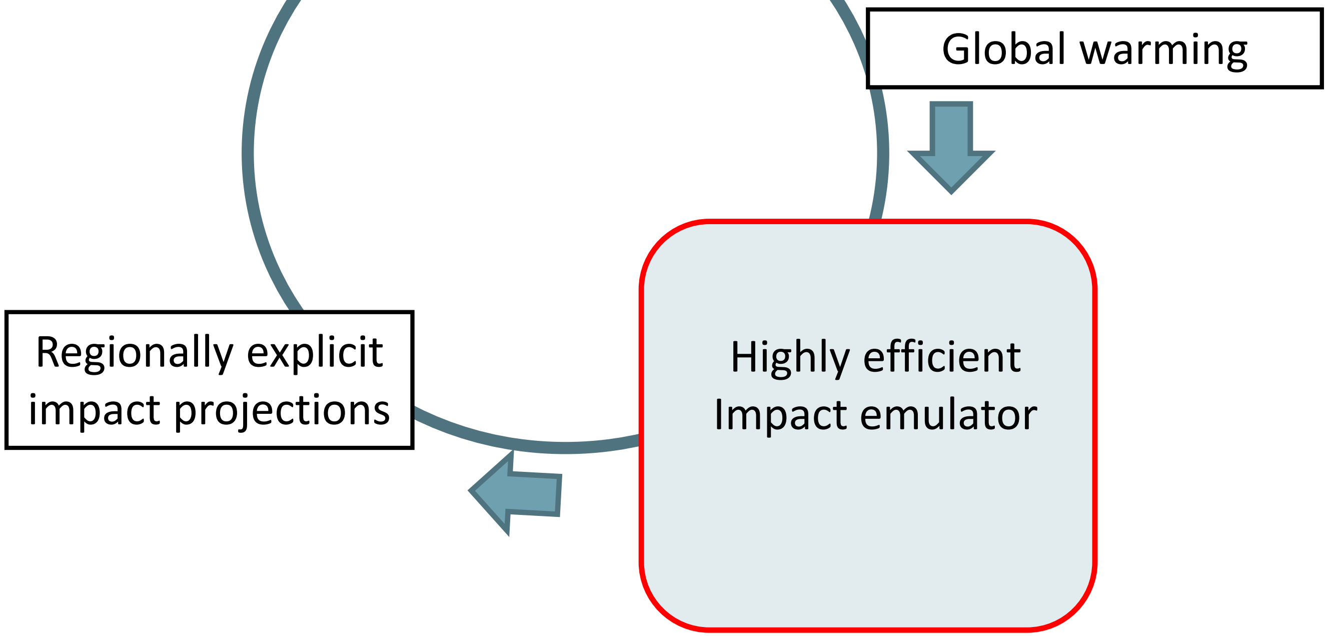
Mitigation

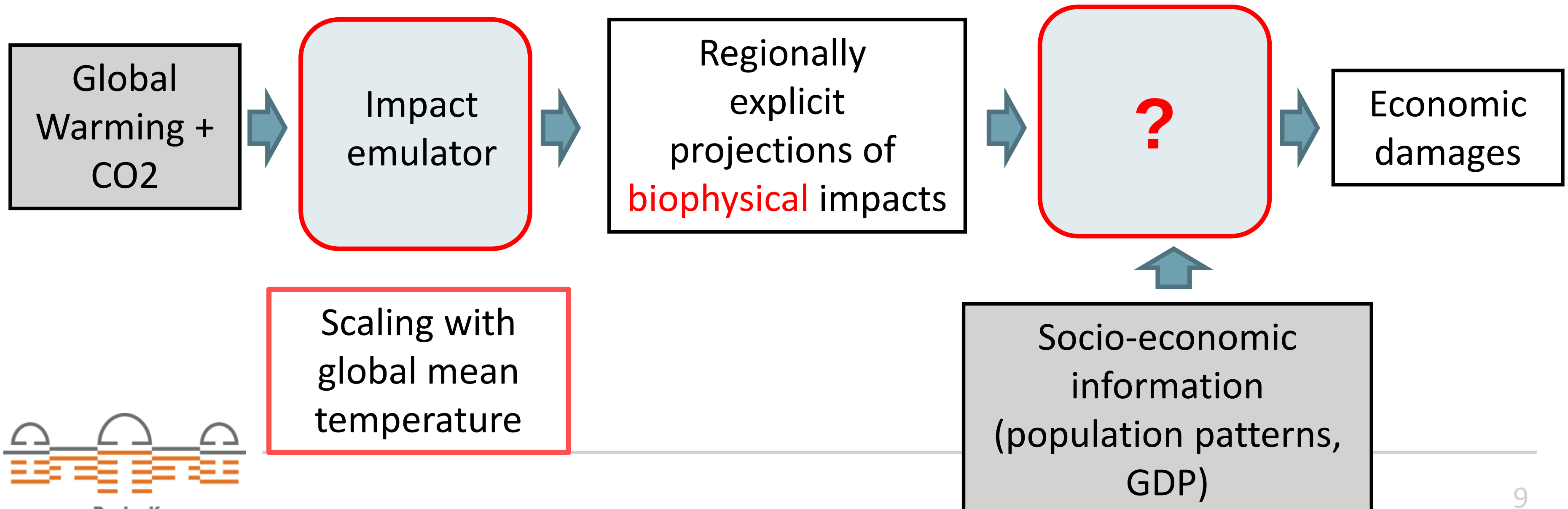
Adaptation

Damages



# Option 1: Scaling is restricted to the biophysical component of the impacts



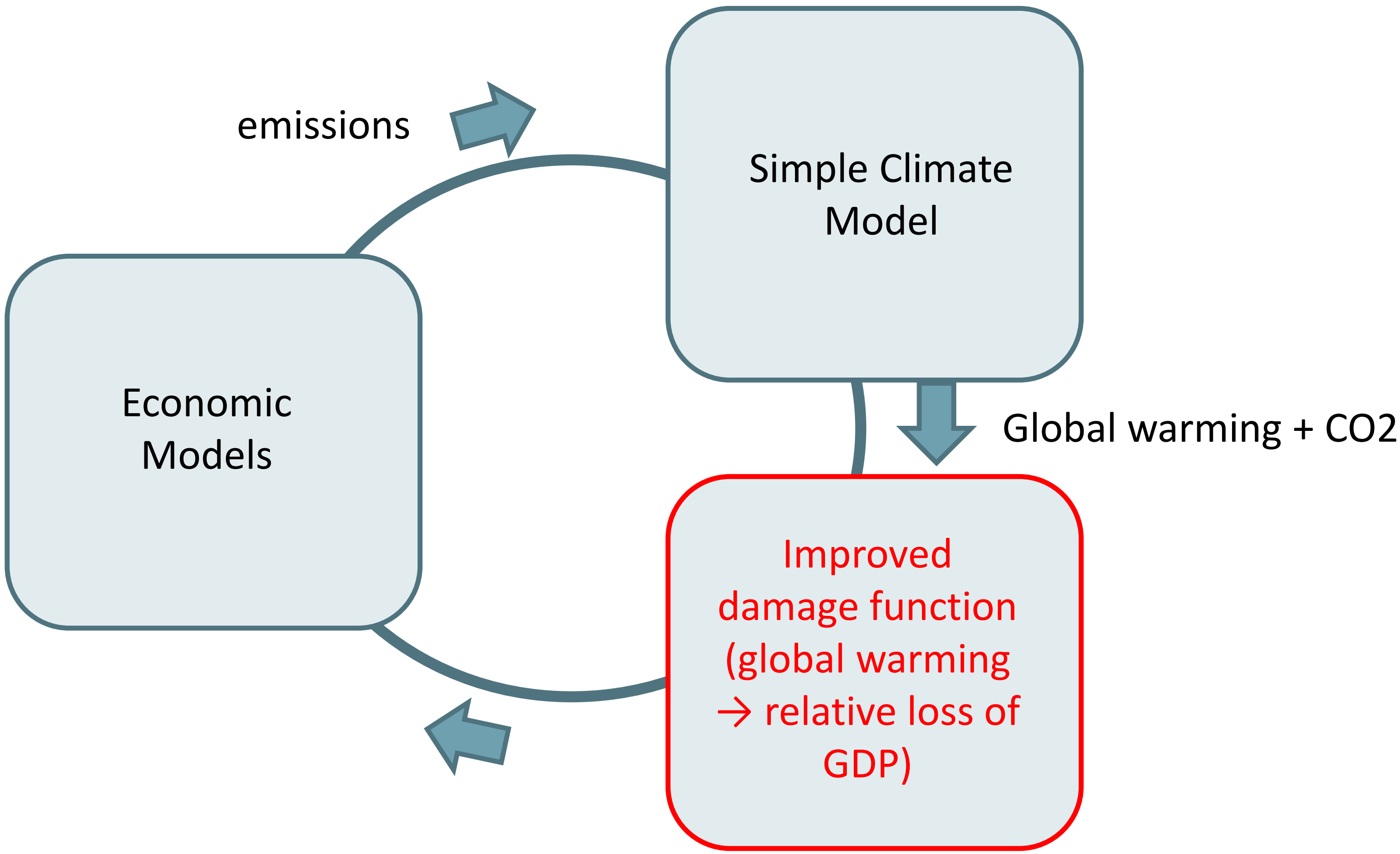
# Option 1: Scaling of the costs of climate change impacts (damage functions)

Costs of

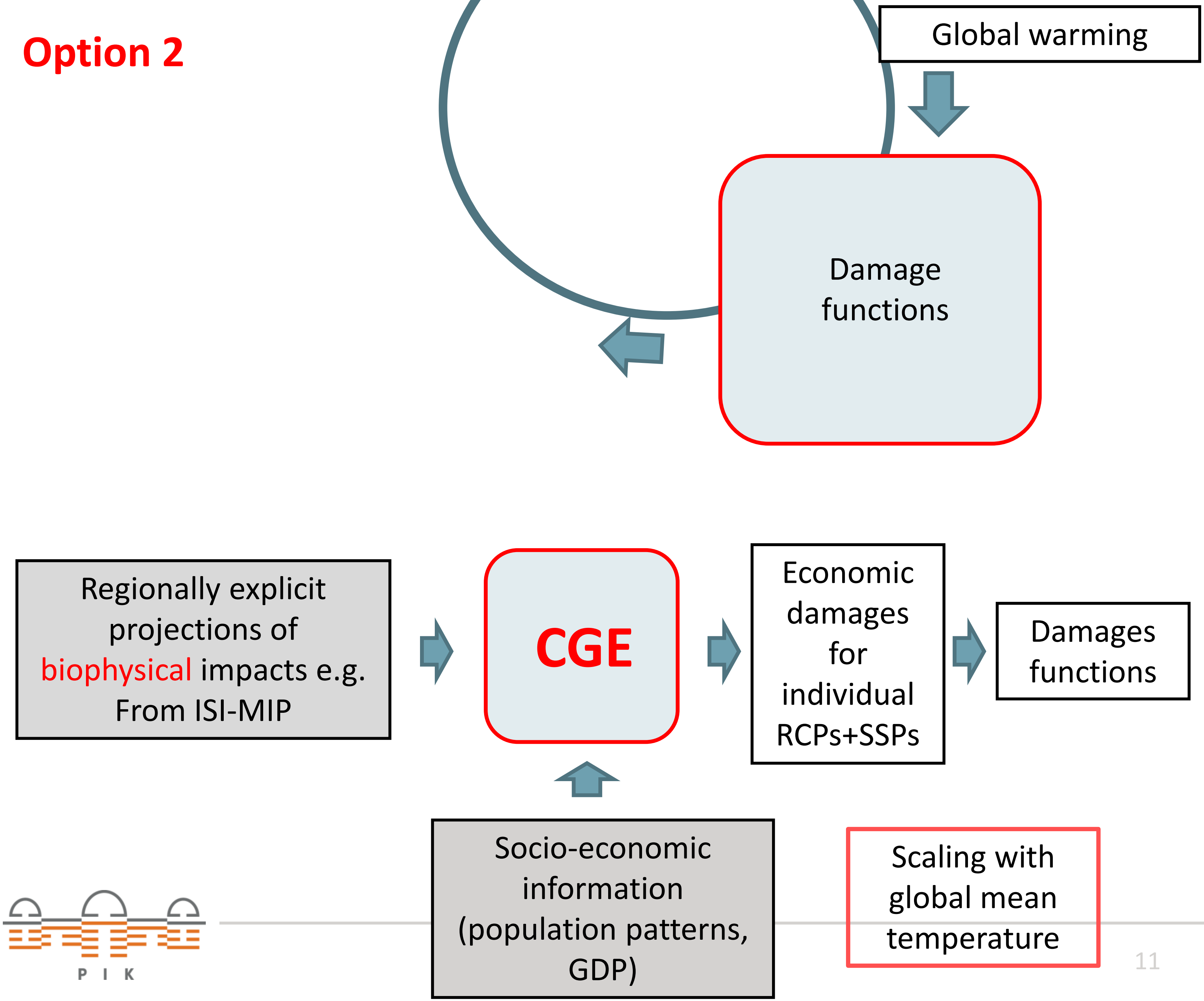
Mitigation

Adaptation

Damages

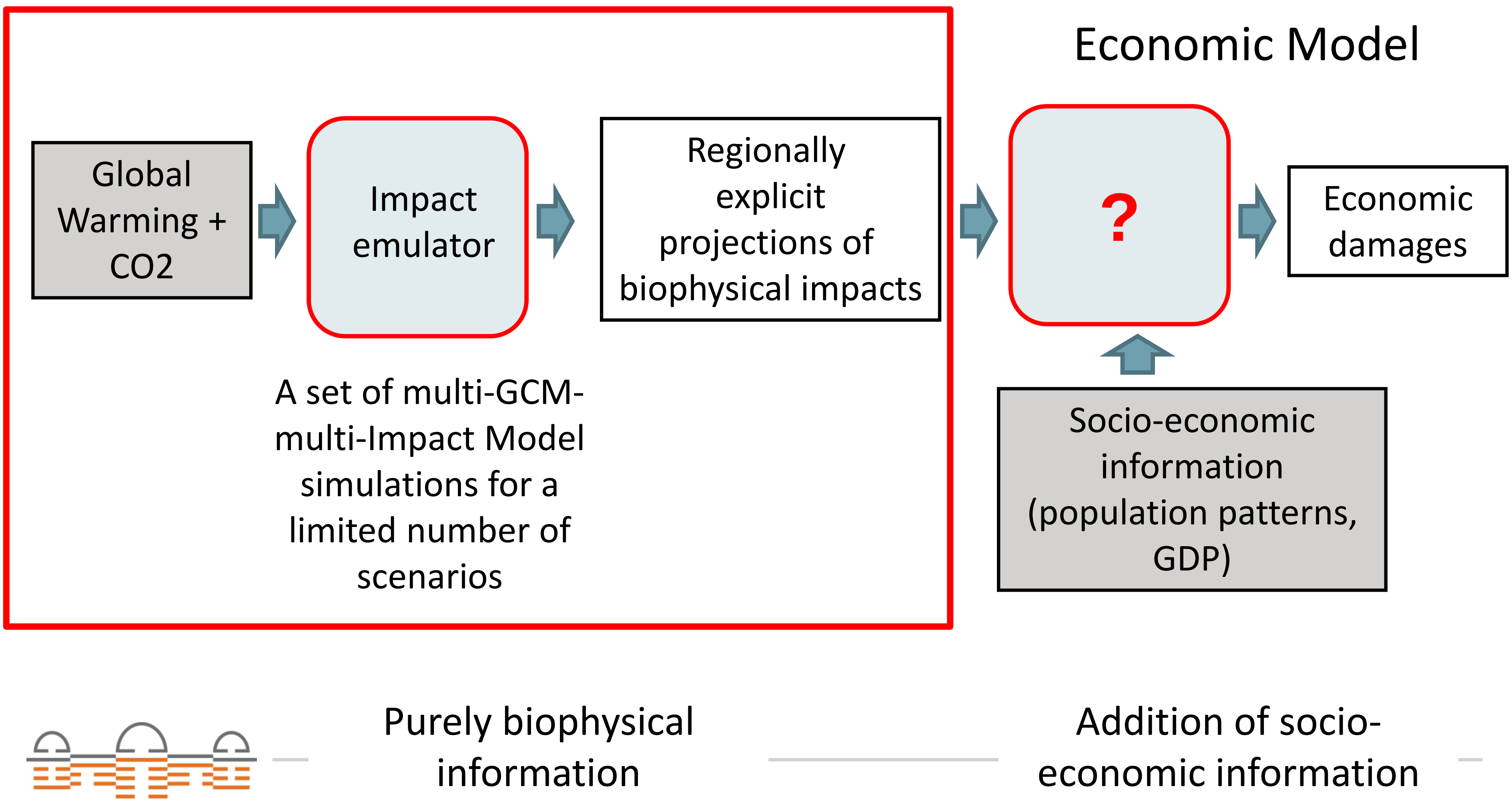


# Option 2


Global warming
Damage functions
Regionally explicit projections of biophysical impacts e.g. From ISI-MIP
CGE
Economic damages for individual RCPs+SSPs
Damages functions
Socio-economic information (population patterns, GDP)
Scaling with global mean temperature

**Option 1**

# There is some hope that the first step can be done…

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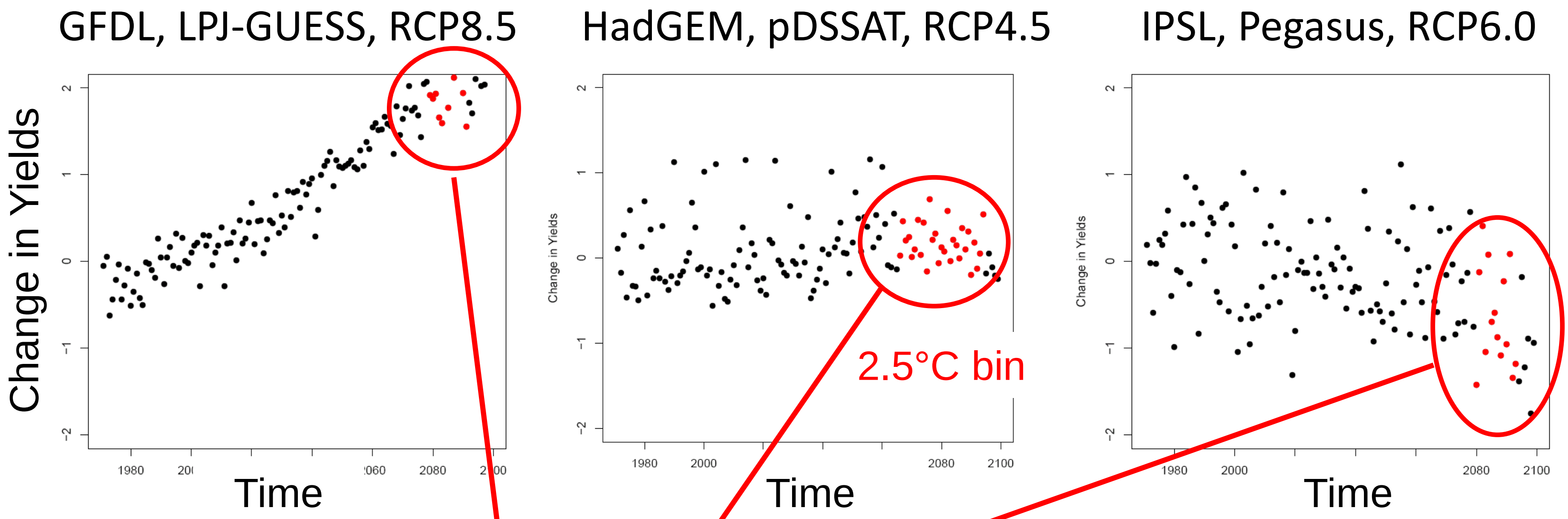
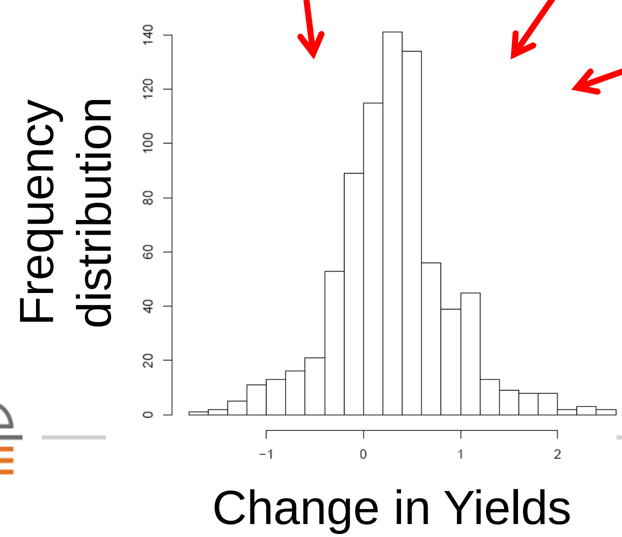
# Yield changes in terms of global mean temperature change

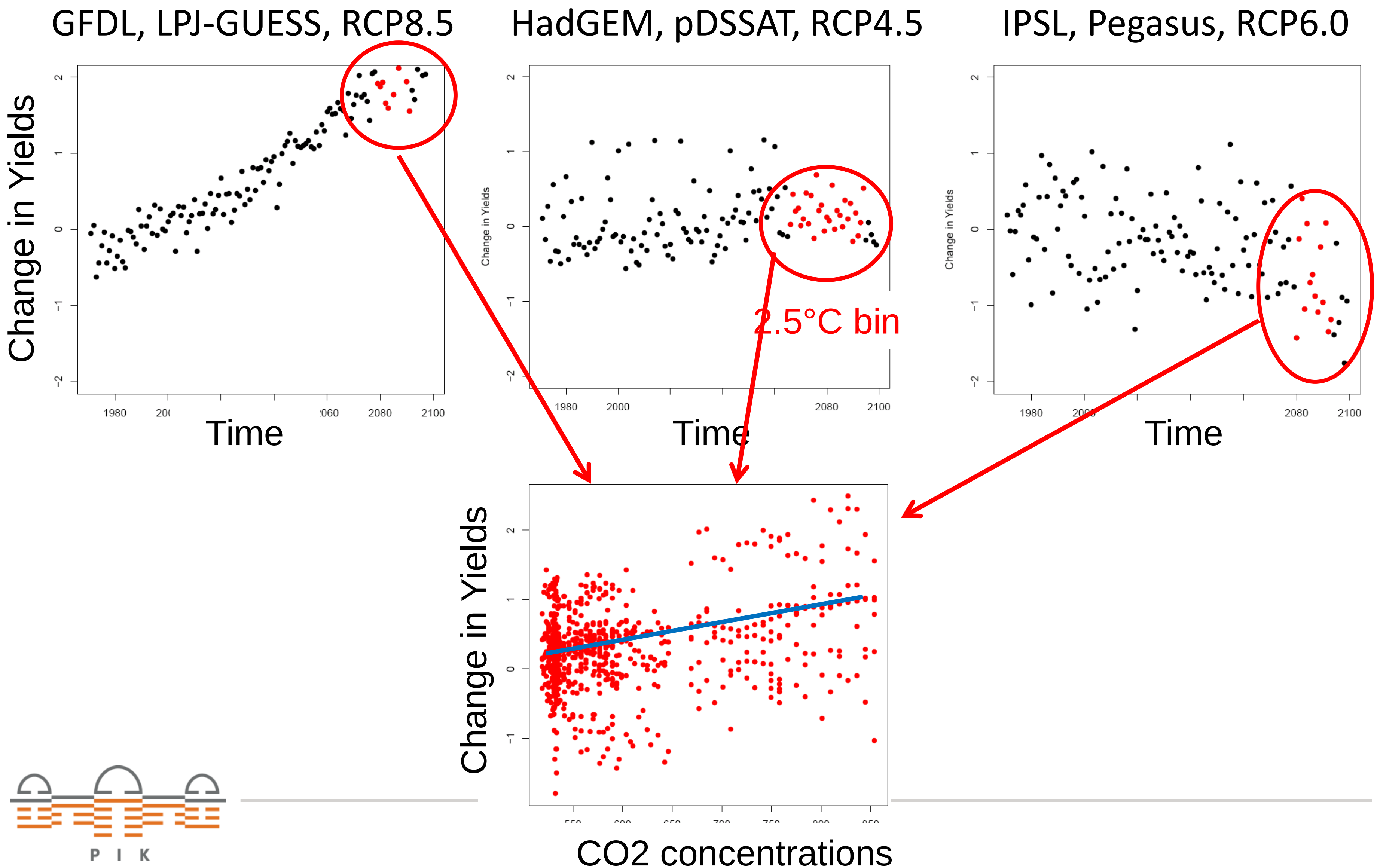


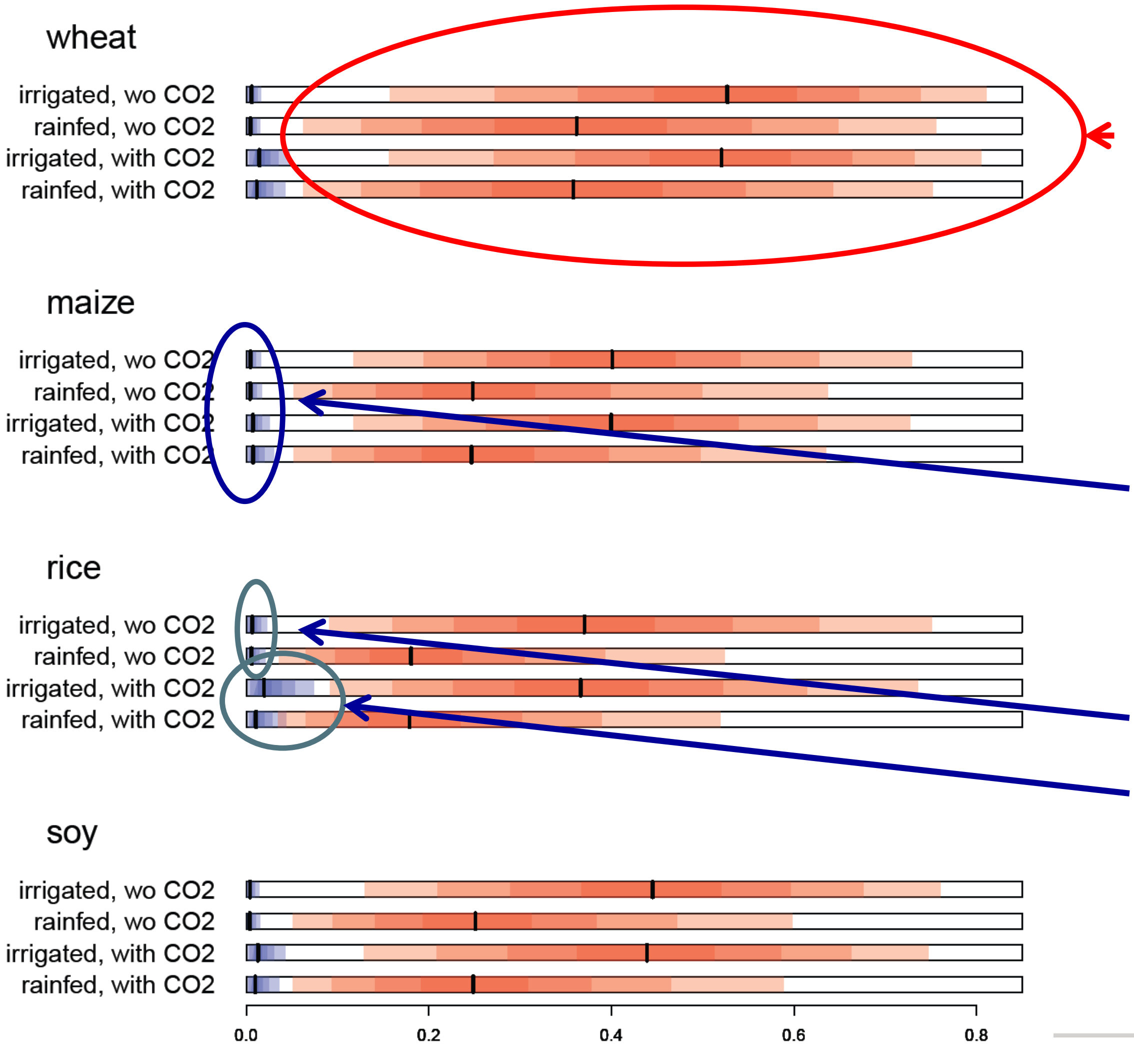

Which fraction of the variability can be explained by

1) inter-climate-model spread
2) inter-impact-models spread and
3) scenario-dependence

# Inclusion of CO2 levels as an additional predictor



# Impact model dependence in comparison to scenario dependence




Fraction of the variance that can be explained by different impact models

Fraction of the variance that is explained by different scenarios

Scenario dependence is further reduced if $CO_2$ is used as an additional predictor

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# Summary

Yield changes  at given levels of global warming seem to be quasi independent of the emission scenarios.

That may justify the use of averaged (but impact model and GCM specific) yield patterns representative for a given warming level

# Translation into costs given socio-economic effects has to be handled within the economic component:

If we had a global yield pattern at X°C of global warming it could be masked by any land use pattern to calculate production...

If we had a distribution of inundation areas at X°C of global warming it could be multiplied by any map of assets at risk to calculate damages...

If we had pattern of runoff at X°C of global warming it could be used to estimate irrigation potentials...

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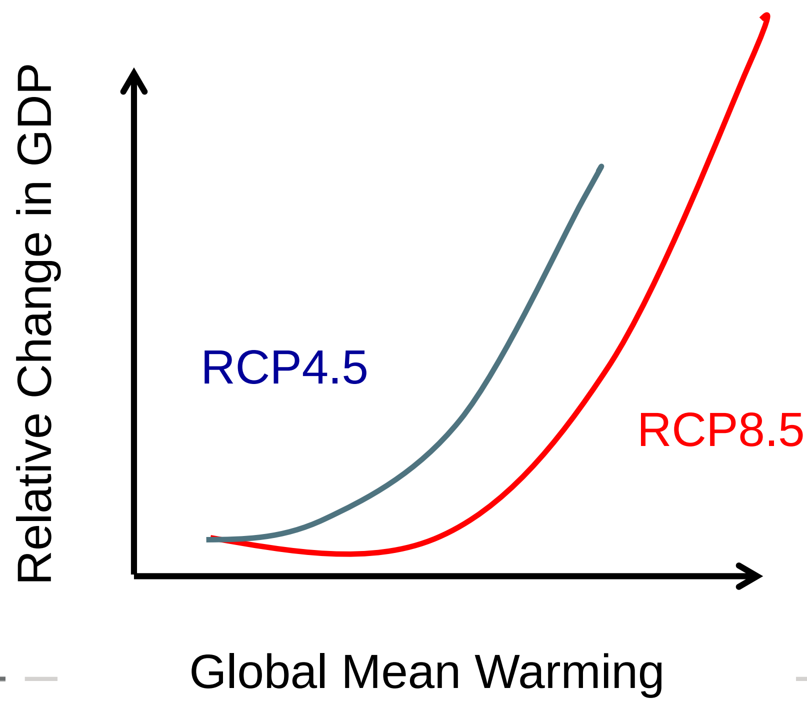
**If this cannot be handled within the economic model…**

**Option 2**

# Option 2: Improved Damage Functions

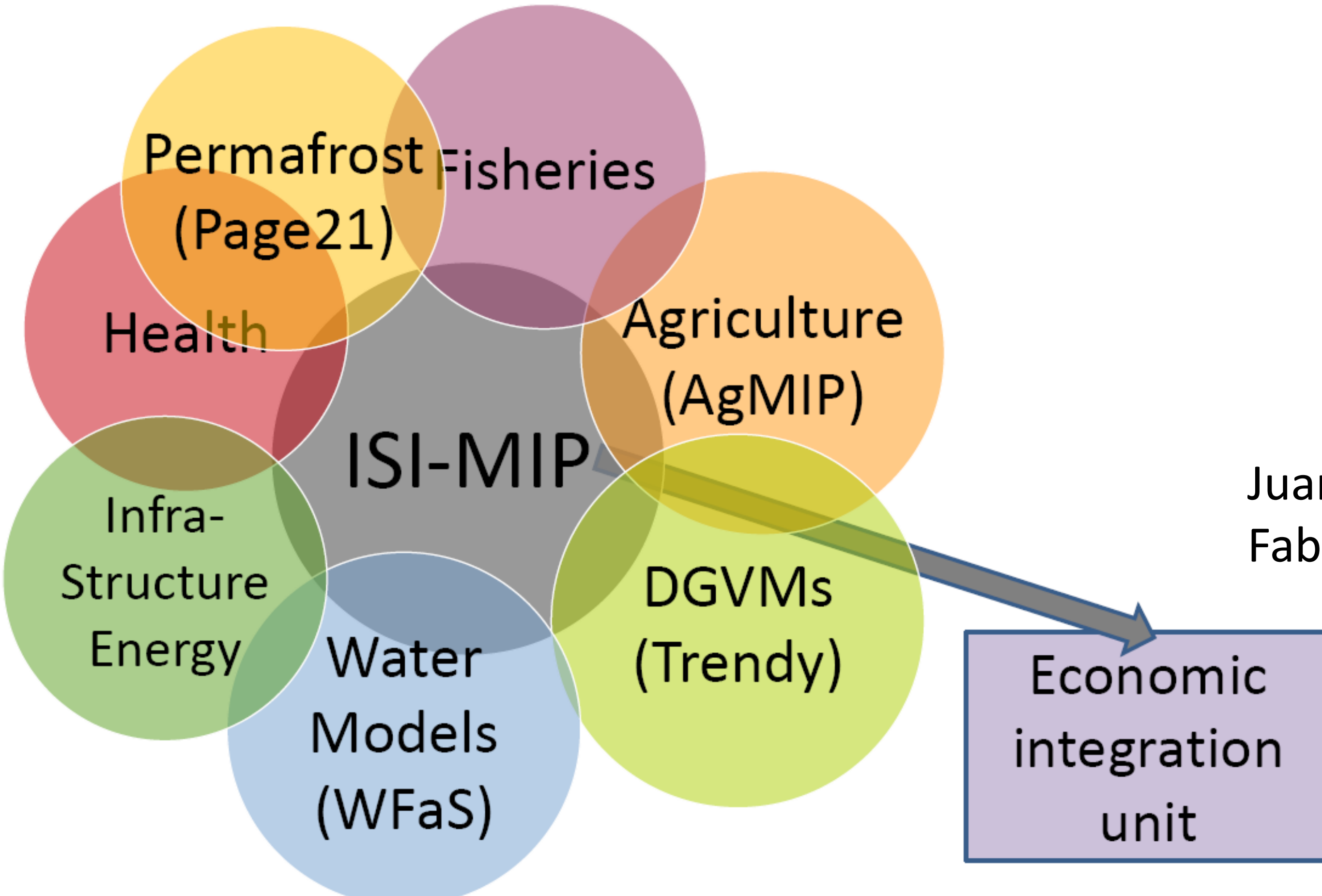
RCP projections of biophysical impacts as available from the Fast Track → CGE model → Damage function




Potential problem: Damage function may be scenario dependent as e.g. the timing of the warming differs and therefore it hits a richer, poorer, smaller or larger populations

Do we have to include other socio-economic predictors

# Option 2: Steps planned within ISI-MIP



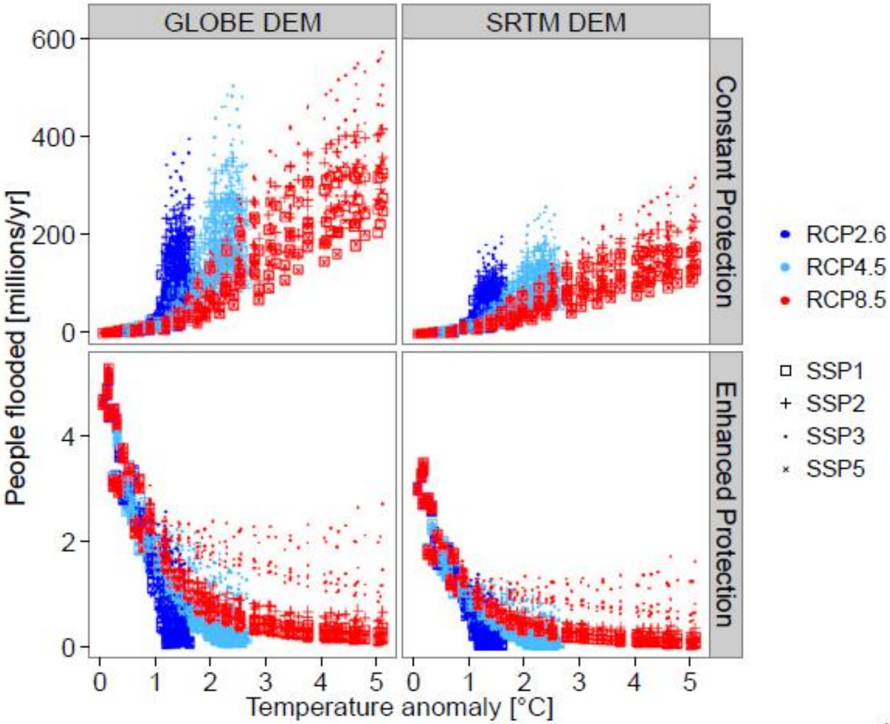

Juan Carlos Ciscar, JRC
Fabio Eboli, FEEM....

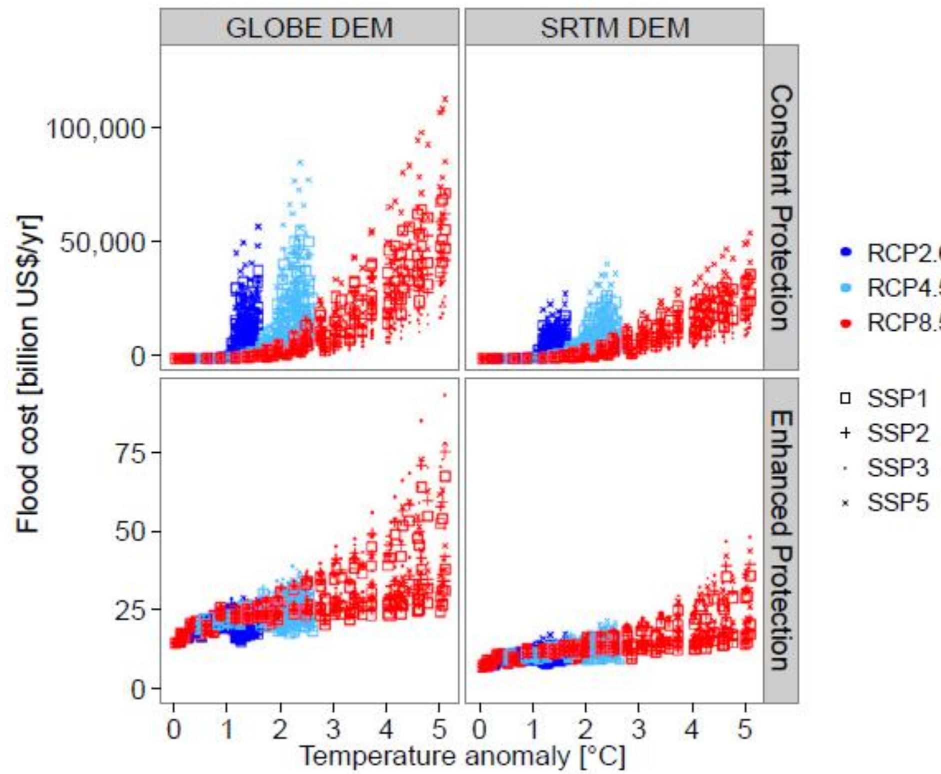
# Summary

What is the appropriate way? Is there a third one?

What are the steps, that have to be done anyways?

- Translation of runoff in inundation areas (flood risk)


GLOBE DEM
SRTM DEM
Constant Protection
Enhanced Protection
People flooded [millions/yr]
Temperature anomaly [°C]
RCP2.6
RCP4.5
RCP8.5
SSP1
SSP2
SSP3
SSP5


GLOBE DEM
SRTM DEM
Constant Protection
Enhanced Protection
Flood cost [billion US$/yr]
Temperature anomaly [°C]
RCP2.6
RCP4.5
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- Coastal infrastructure: Number of people flooded, annual losses of GDP, protection costs
- Malaria: Length of transmission period, population at risk

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# Data requirements

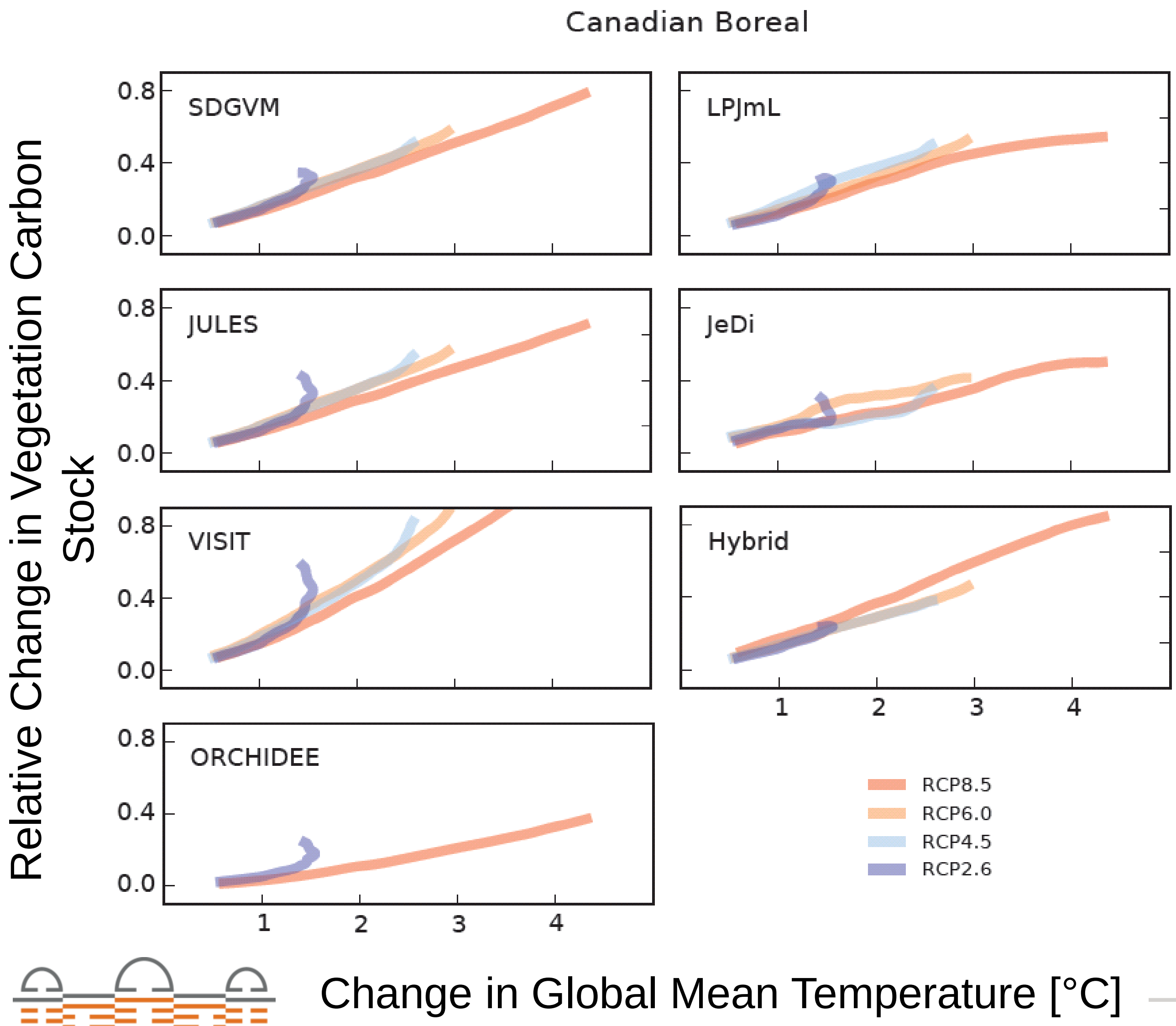
| Input data provided within ISI-MIP | | |
|---|---|---|
| Surface air temperatures Tavg, Tmin, Tmax | tas, tasmin, tasmax | daily |
| Precipitation (snow and rainfall separately) | pr (prsn) | daily |
| Surface radiation (short- and longwave downwelling) | rsds rlds | daily |
| Near-surface wind speed (east- and north-ward) | uas vas | daily |
| Surface air pressure | ps | daily |
| Near-surface relative humidity | rhs | daily |

Daily variability has to be added to the changes in long term mean.

Challenges:

- Accounting for changes in variability under global warming
- Physical consistency across the different variables

# Multi-Model Simulations of Vegetation Carbon Change




Relationship between global mean temperature change **not** necessarily linear but scenario dependent

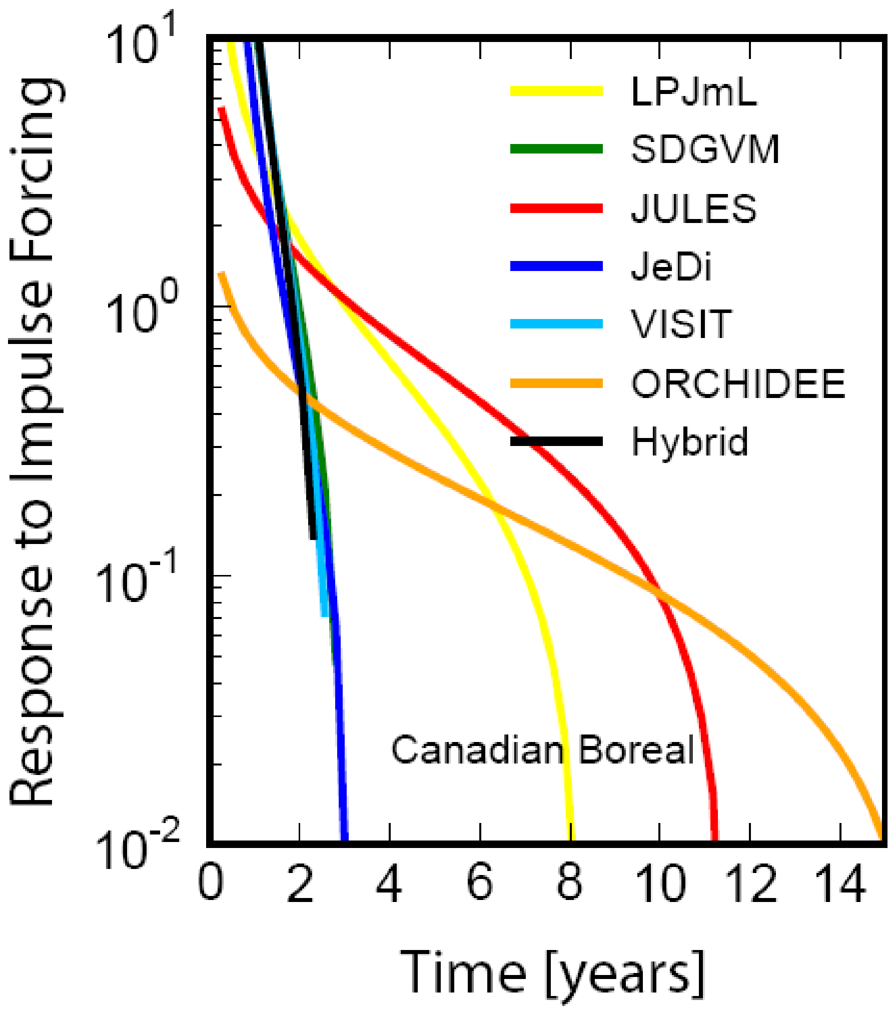
Warszawski et al., to be submitted

# Emulation Approach: Response Functions

$$\frac{d\Delta\tilde{C}_{\mathrm{veg}}}{dt}(t)$$

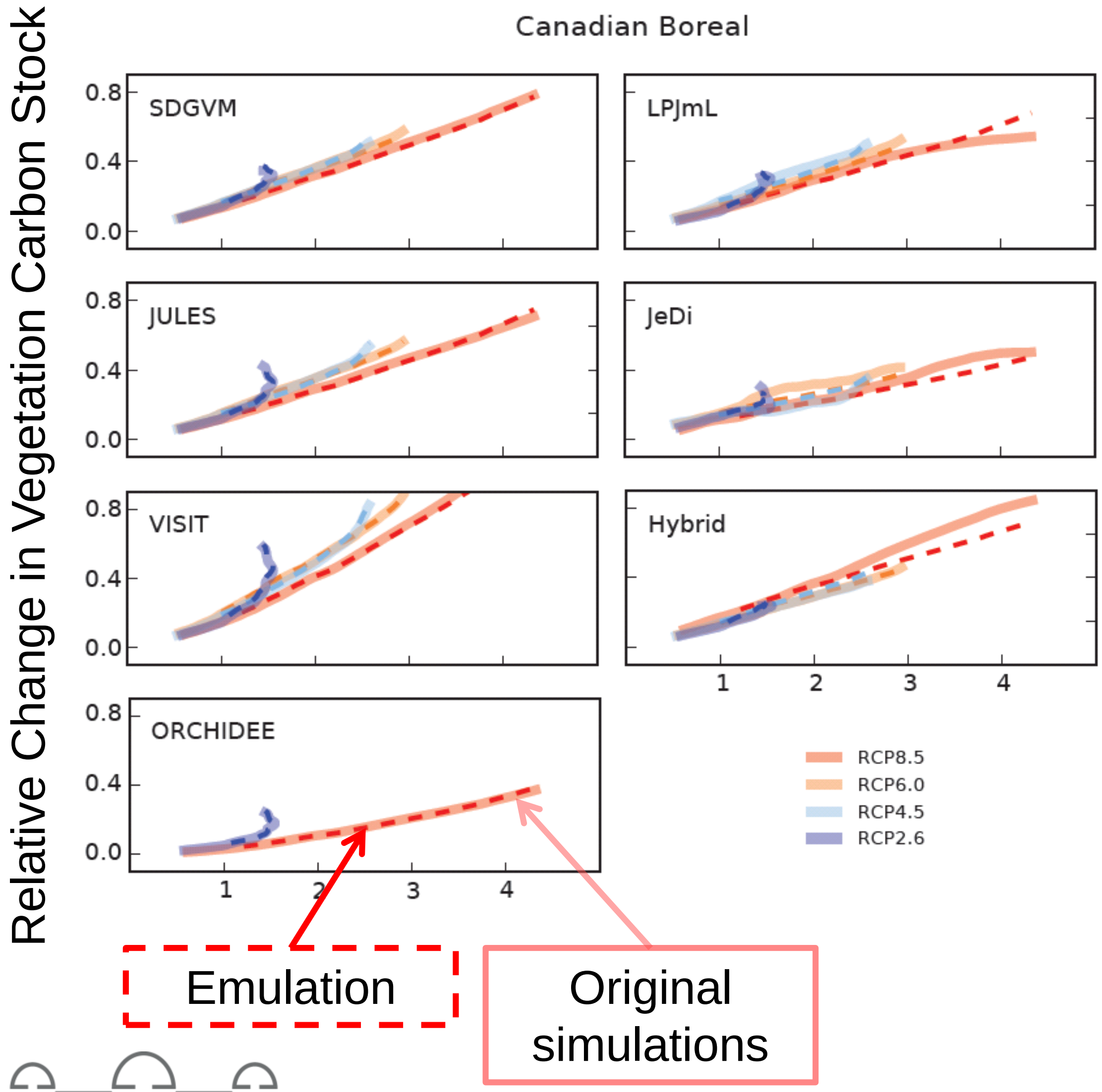
$$= \int_0^{\tau_{\max}} R(\tau)\Delta \mathrm{T}_{\mathrm{global}}(\mathrm{t}-\tau)\mathrm{d}\tau$$

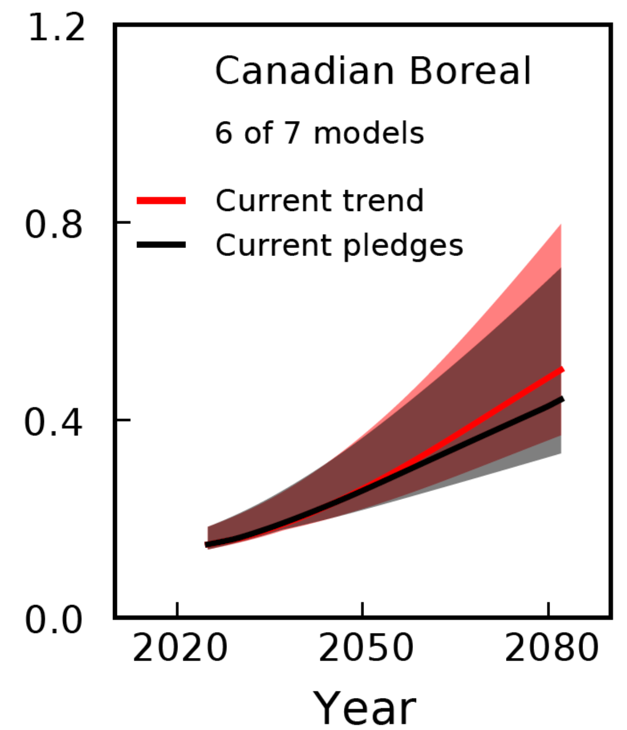
$$R(t) = At^{-g} - B$$




Warszawski et al., to be submitted

# Reproduction of Simulated Response and Projections

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