

A framework for modeling uncertainty in regional climate change

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<http://globalchange.mit.edu/>

Objectives

Investigate the contributions of major sources of uncertainty to regional climate projections and provide guidance for climate impact studies.

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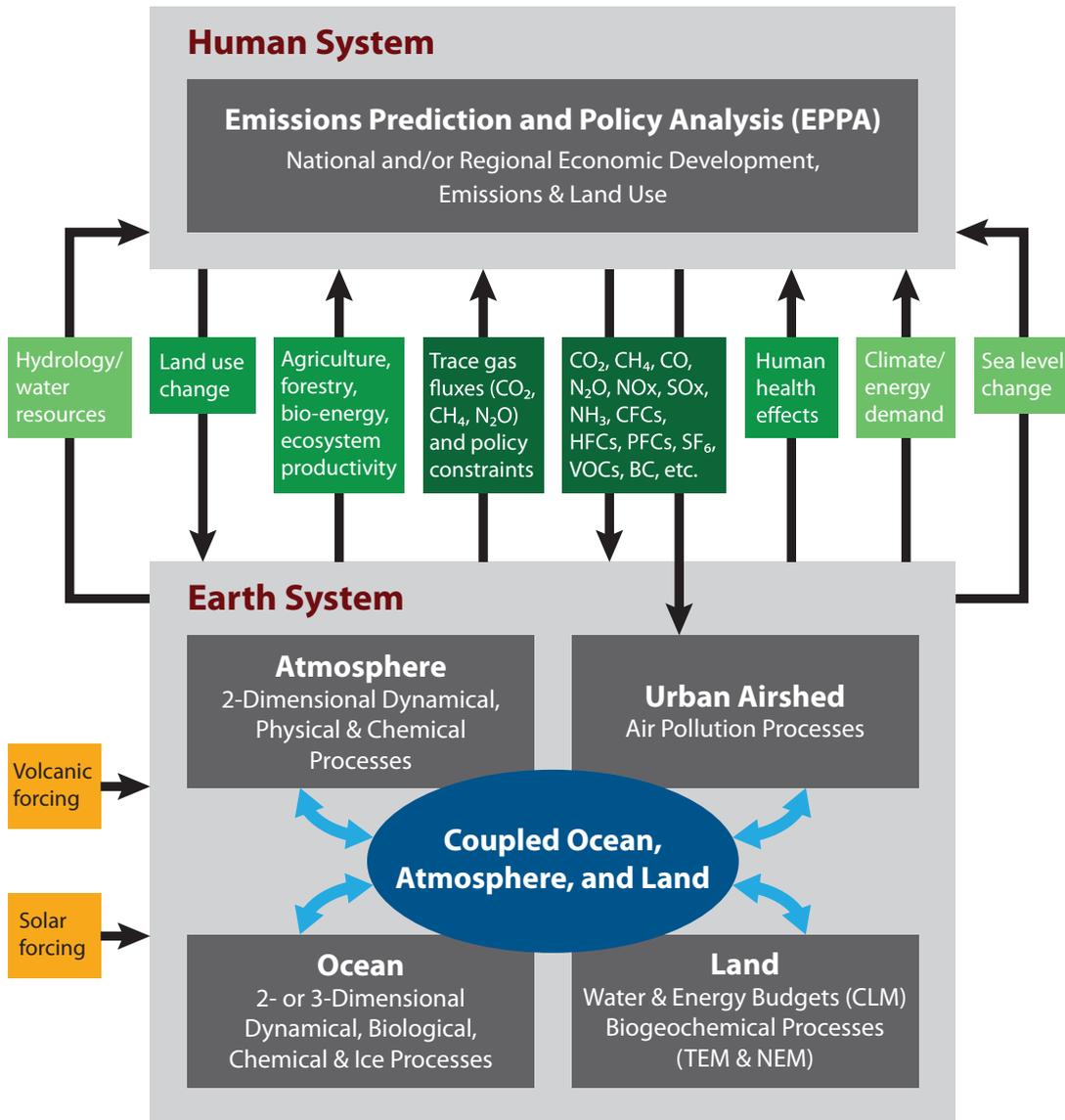
Investigate the contributions of major sources of uncertainty to regional climate projections and provide guidance for climate impact studies.

Examples of sources of uncertainty:

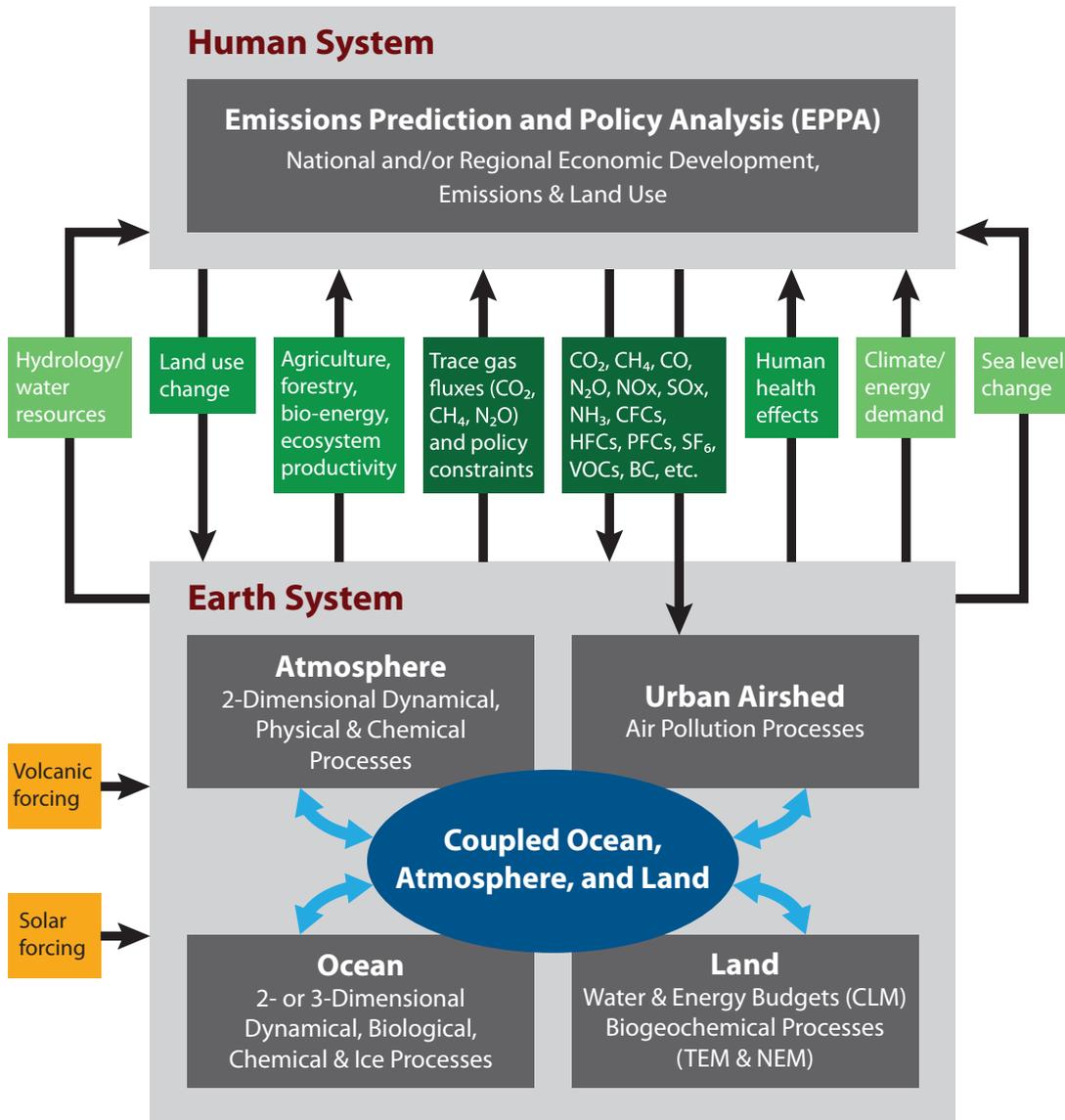
- Emissions forecasting
 - Assumptions on economic growth
 - Implementation of climate policies
- Climate system response
 - Climate sensitivity
 - Strength of aerosol forcing
 - Ocean heat uptake rate
- Natural variability
 - Chaotic nature of the climate system
- Model structural uncertainty
 - Differences in parameterizations, resolution...

The MIT Integrated Global System Model

Integrated assessment model: couples an earth system model of intermediate complexity to a human activity model.



The MIT Integrated Global System Model

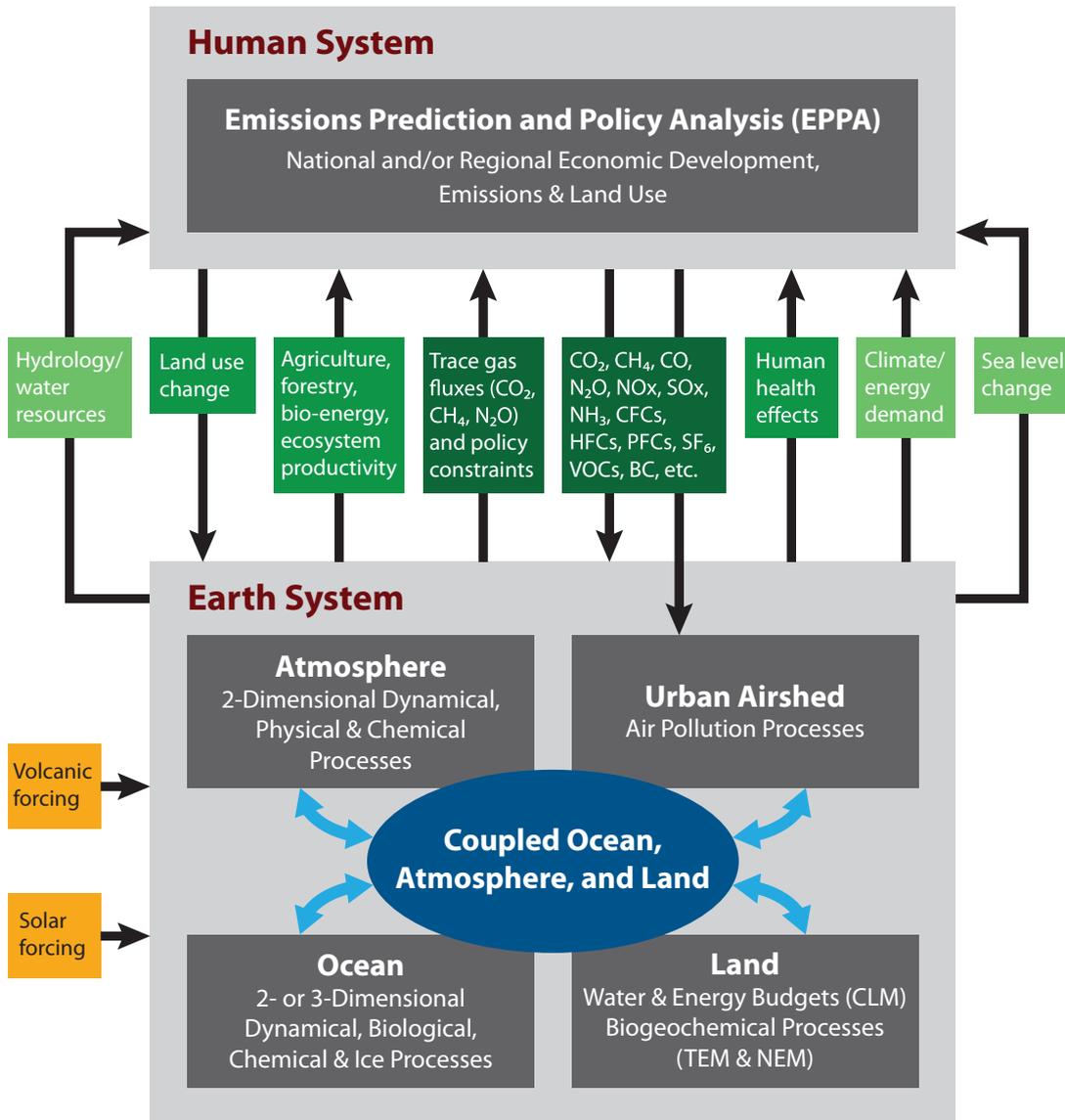


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Representation of uncertainty:

- Emissions
- Climate system response
- Greenhouse gas cycle

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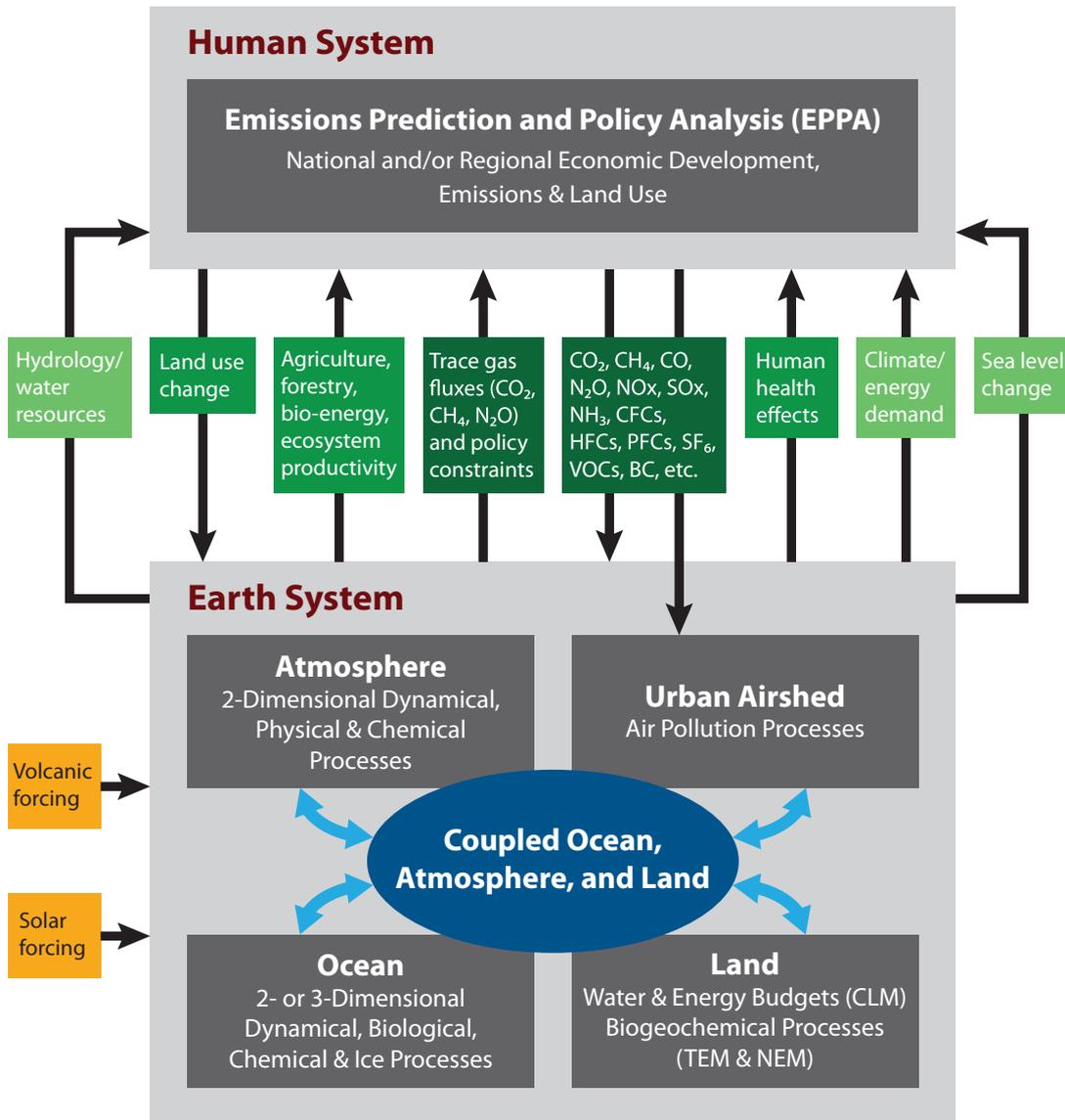
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Computationally efficient framework that allows ensemble simulations with number of members in the 100s/1000s

Regional Climate Modeling Framework

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- Dynamical downscaling:

The IGSM-CAM framework, which links the IGSM to the NCAR Community Atmosphere Model (CAM).

- low, median and high climate sensitivity based on its PDF
- net aerosol forcing that best reproduces historical climate change
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- Statistical downscaling:

A pattern scaling method that extends the IGSM 2D zonal-mean atmosphere using patterns from observations and climate models.

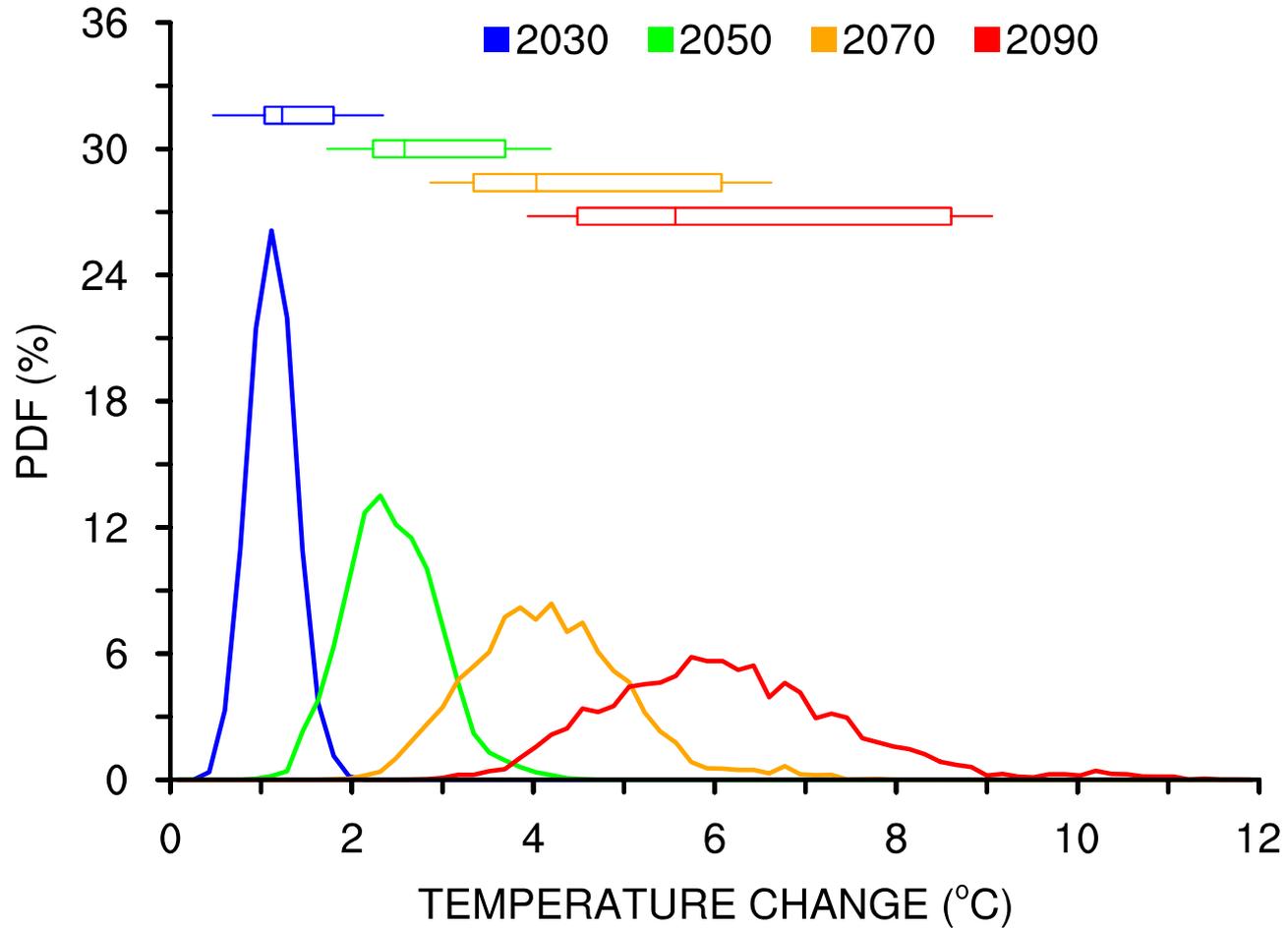
- 400-member ensemble of IGSM, with Latin Hypercube sampling of climate parameters (climate sensitivity, strength of aerosol forcing, ocean heat uptake rate) based on their PDFs
- Pattern scaling based on 17 CMIP3 models

NORTHERN EURASIA



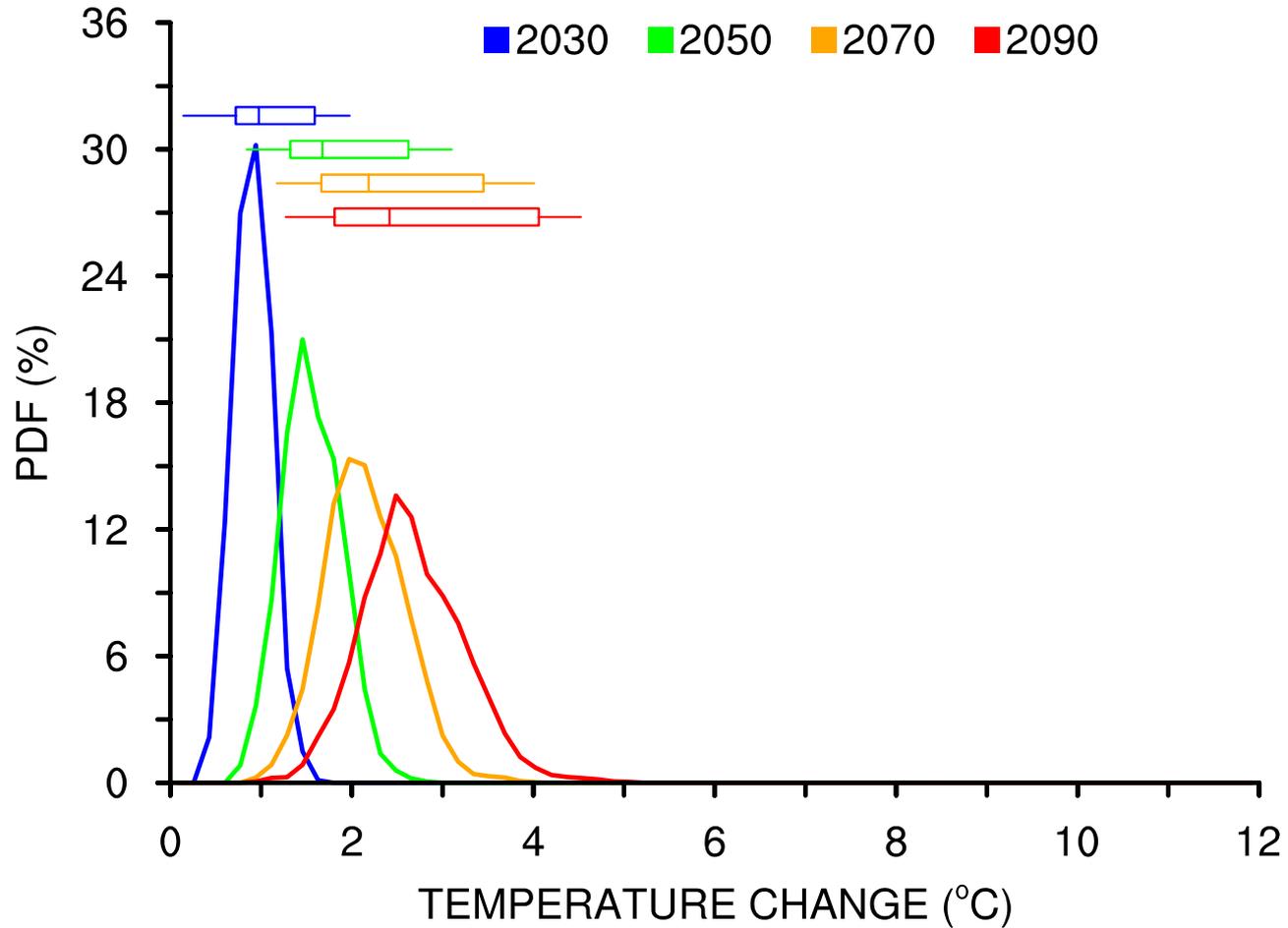
Northern Eurasia Projections

No Policy



Northern Eurasia Projections

Stabilization at 660 ppm CO₂-eq

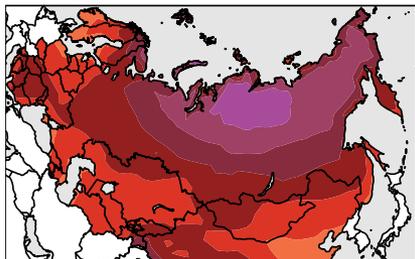


Northern Eurasia Projections

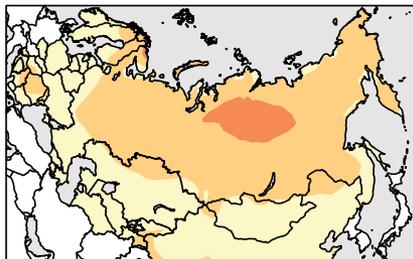
2081-2100 MEAN MINUS 1981-2000 MEAN

IMPACT OF POLICY AND CLIMATE RESPONSE

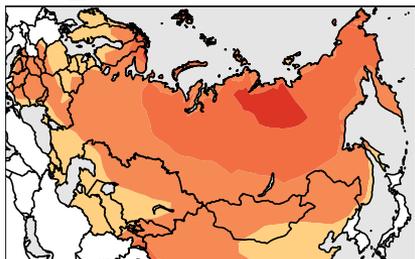
HIGH_UCE



HIGH_LS2



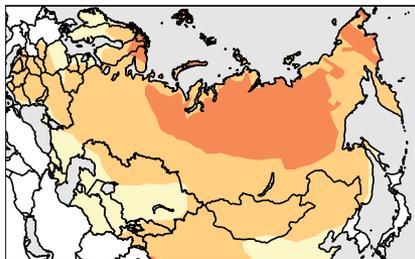
MED_UCE



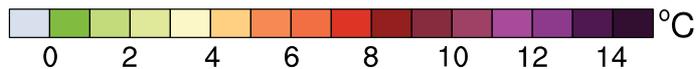
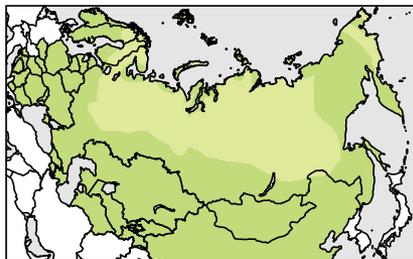
MED_LS2



LOW_UCE



LOW_LS2

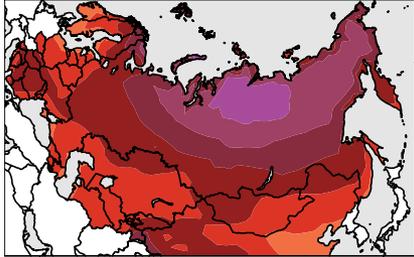


Northern Eurasia Projections

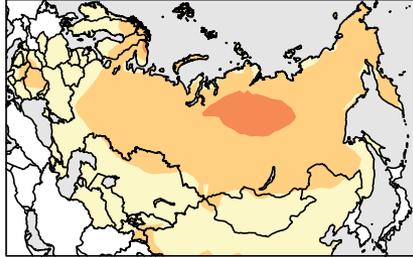
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IMPACT OF POLICY AND CLIMATE RESPONSE

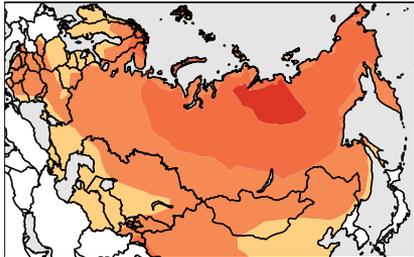
HIGH_UCE



HIGH_LS2



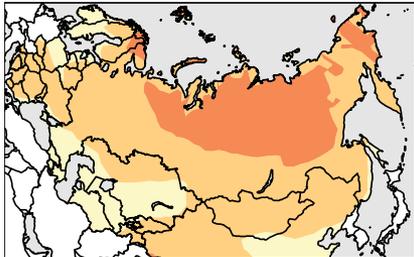
MED_UCE



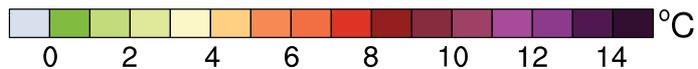
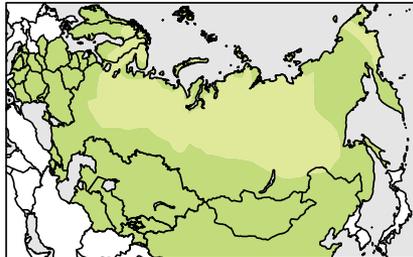
MED_LS2



LOW_UCE

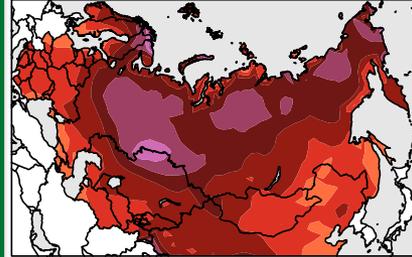


LOW_LS2



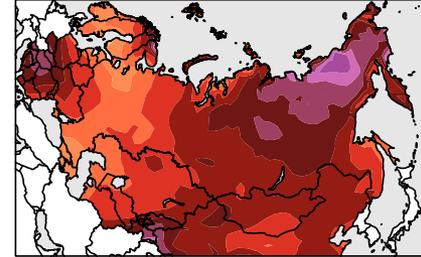
IMPACT OF NATURAL VARIABILITY

MED_LS2



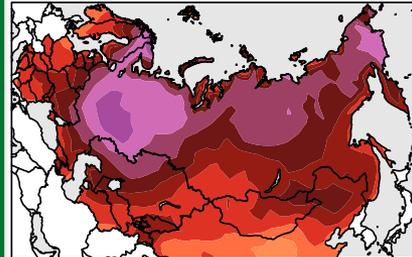
MEMBER #1

MED_LS2



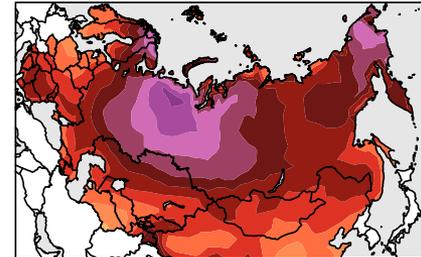
MEMBER #2

MED_LS2



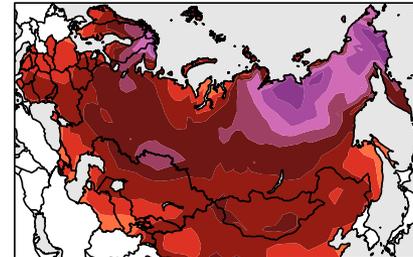
MEMBER #3

MED_LS2

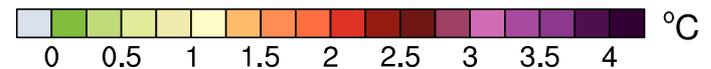


MEMBER #4

MED_LS2



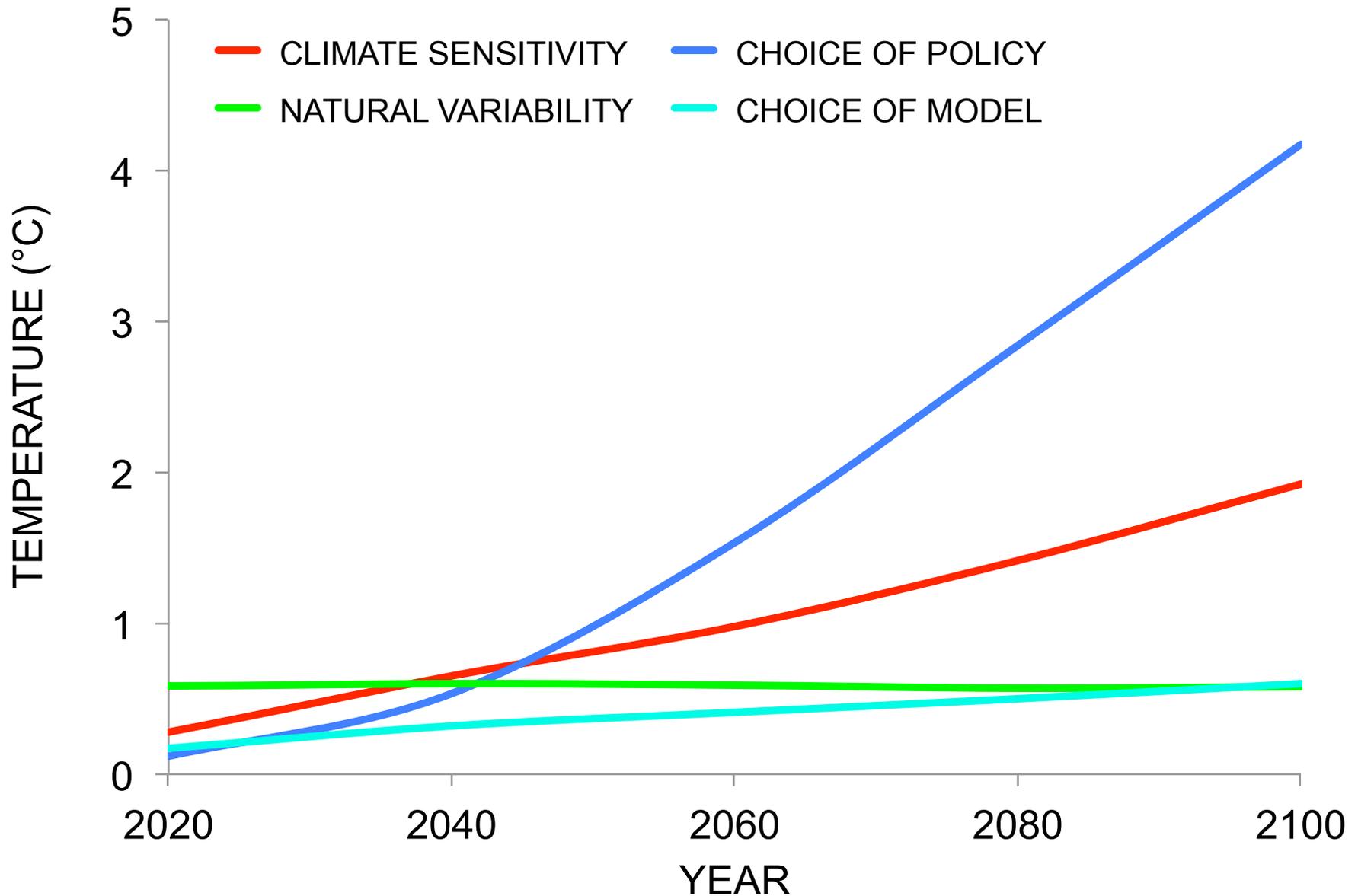
MEMBER #5



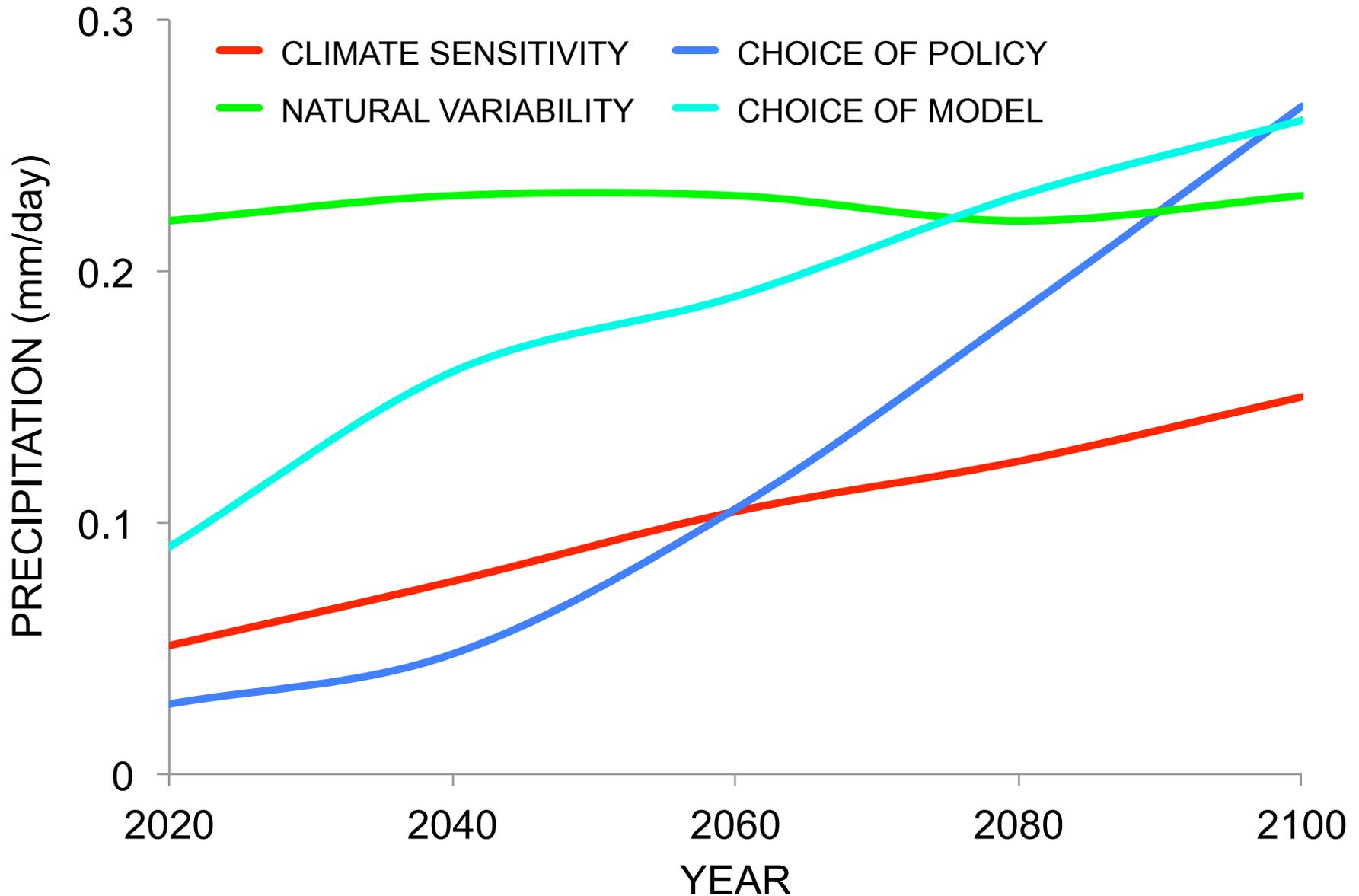
CONTIGUOUS UNITED STATES



Uncertainty in US Temperature Projections



Uncertainty in US Precipitation Projections



Conclusions

Wide range of temperature and precipitation changes over Northern Eurasia and the contiguous US, even using one single climate model.

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 - choice of policy and climate sensitivity
- For precipitation:
 - natural variability dominates until 2050
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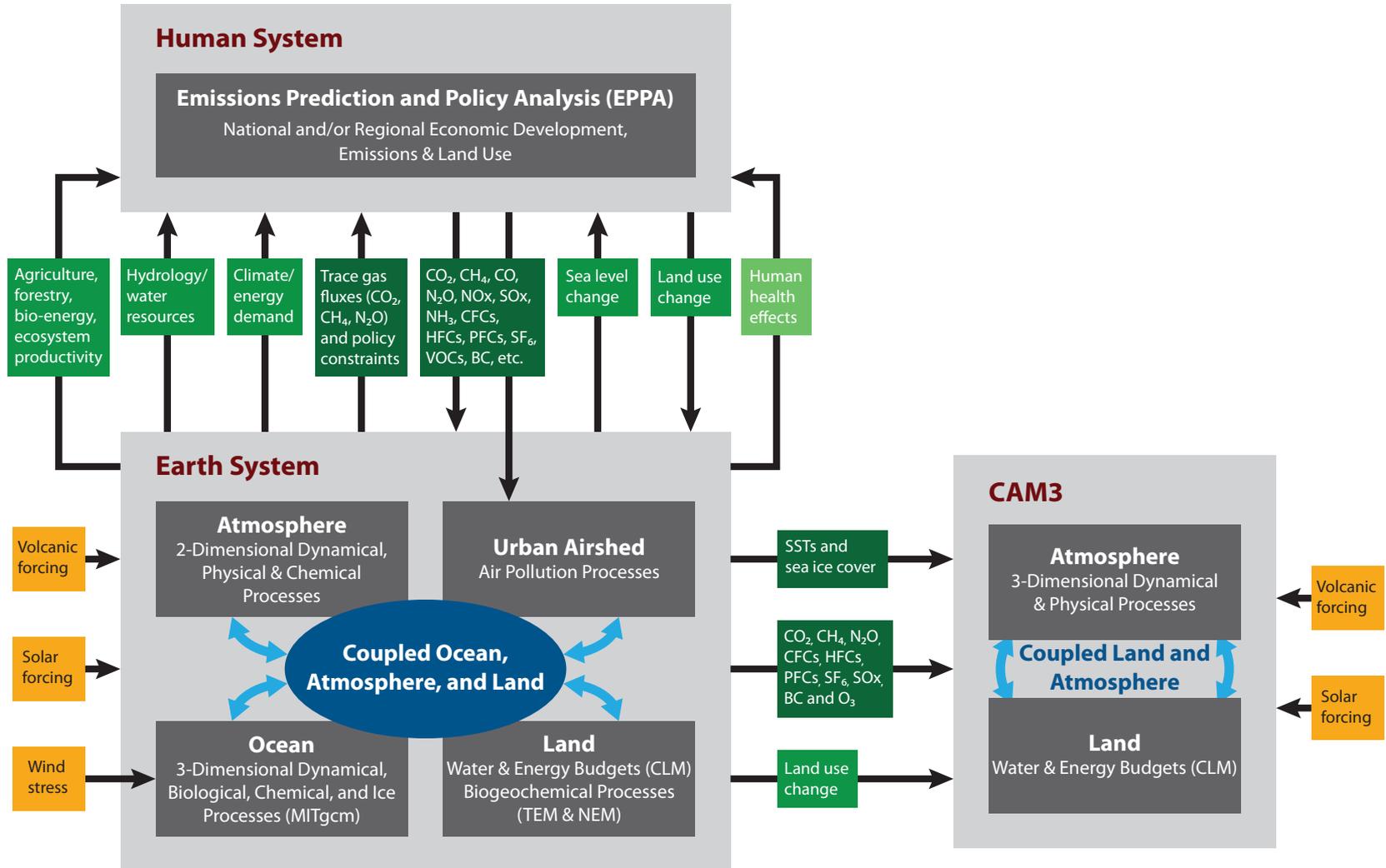
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What does this mean for climate impacts?

Relying on a small ensemble of climate simulations or not accounting for the major sources of uncertainty in climate projections would likely underestimate climate impacts.

IGSM-CAM



IGSM-pattern scaling

