Climate change impacts on the energy system

David Gernaat,

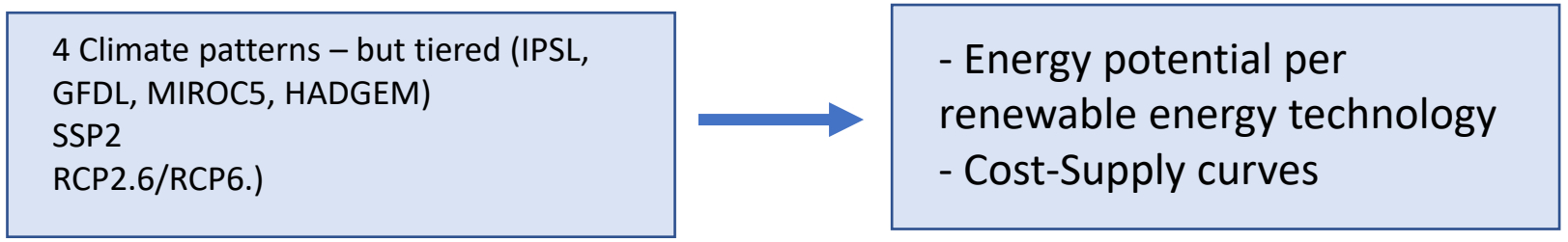
De Boer HS, Daioglou V, Yalew SG, Van Vuuren DP

Introduction

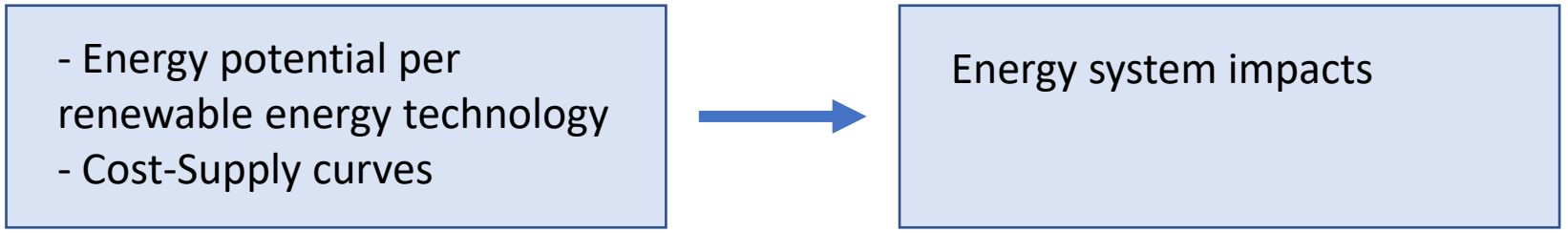
- The energy sector does not only contribute to climate change, but it is also impacted by climate change.
- Its vulnerability to climate change could increase in the future, given the expected increasing role of renewable energy production.
- The objective of this project is to evaluate the impacts of climate change on primary renewable energy generation under different climate scenarios.
- For implementation of ISIMIP climate data in different energy models, two complementary tracks were proposed.
  - Track A
  - Track B

Methods
2 tracks were proposed

- Track A: From climate data to energy model input data



- Track B: From energy model input data to energy system impacts

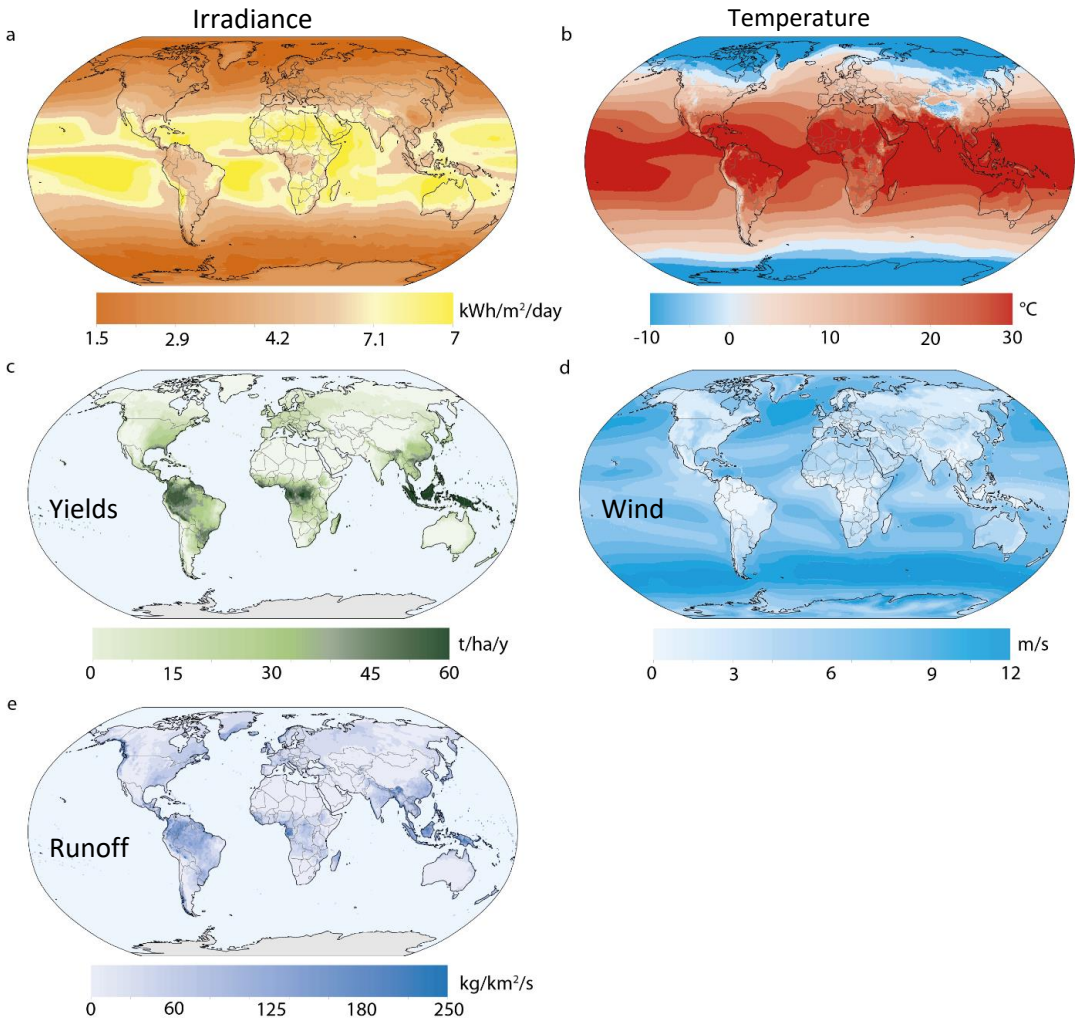


Methods – track A

ISIMIP2B data

- **Irradiance, wind speeds, temperature, yields, runoff**
- Historic, RCP2.6 and RCP6.0

Climate inputs



Climate change impacts on renewable energy supply

David E. H. J. Gernaat, Harmen Sytze de Boer, Vassilis Daioglou, Seleshi G. Yalew, Christoph Müller & Detlef P. van Vuuren

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Methods – track A

ISIMIP2B data

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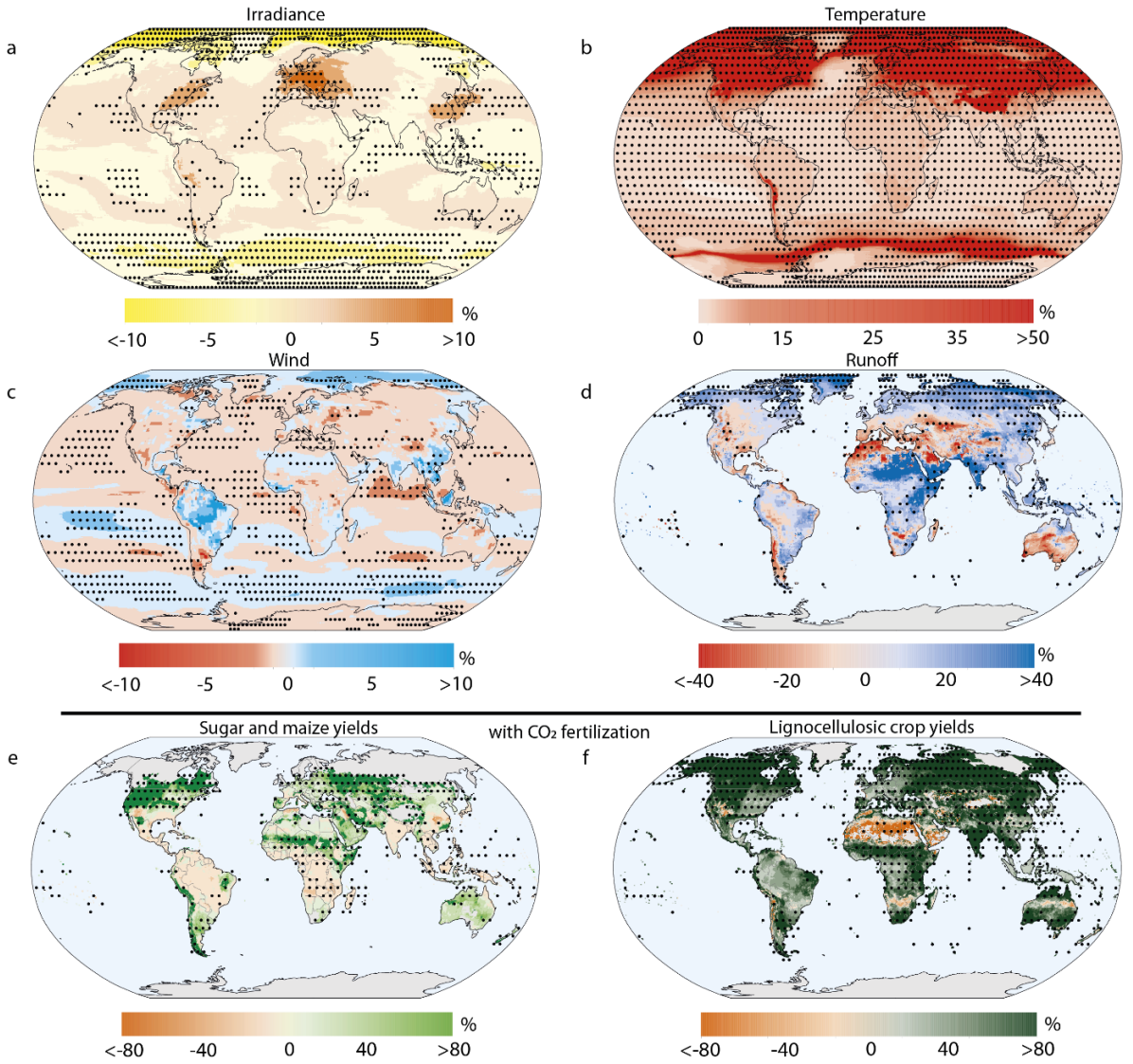
Planbureau voor de Leefomgeving

Climate inputs:

Historic Vs RCP60 (2070-2100)



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Results - Potentials

Planbureau voor de Leefomgeving

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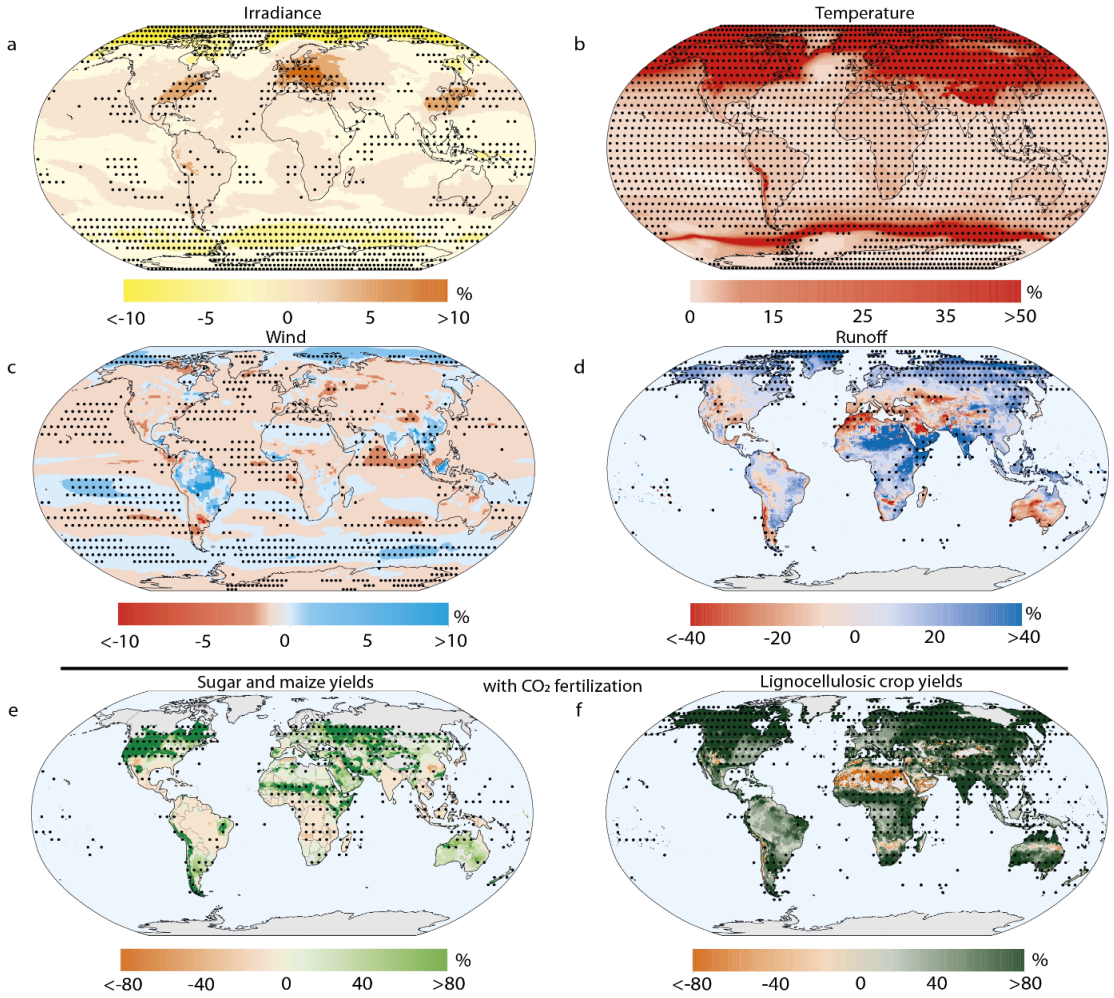
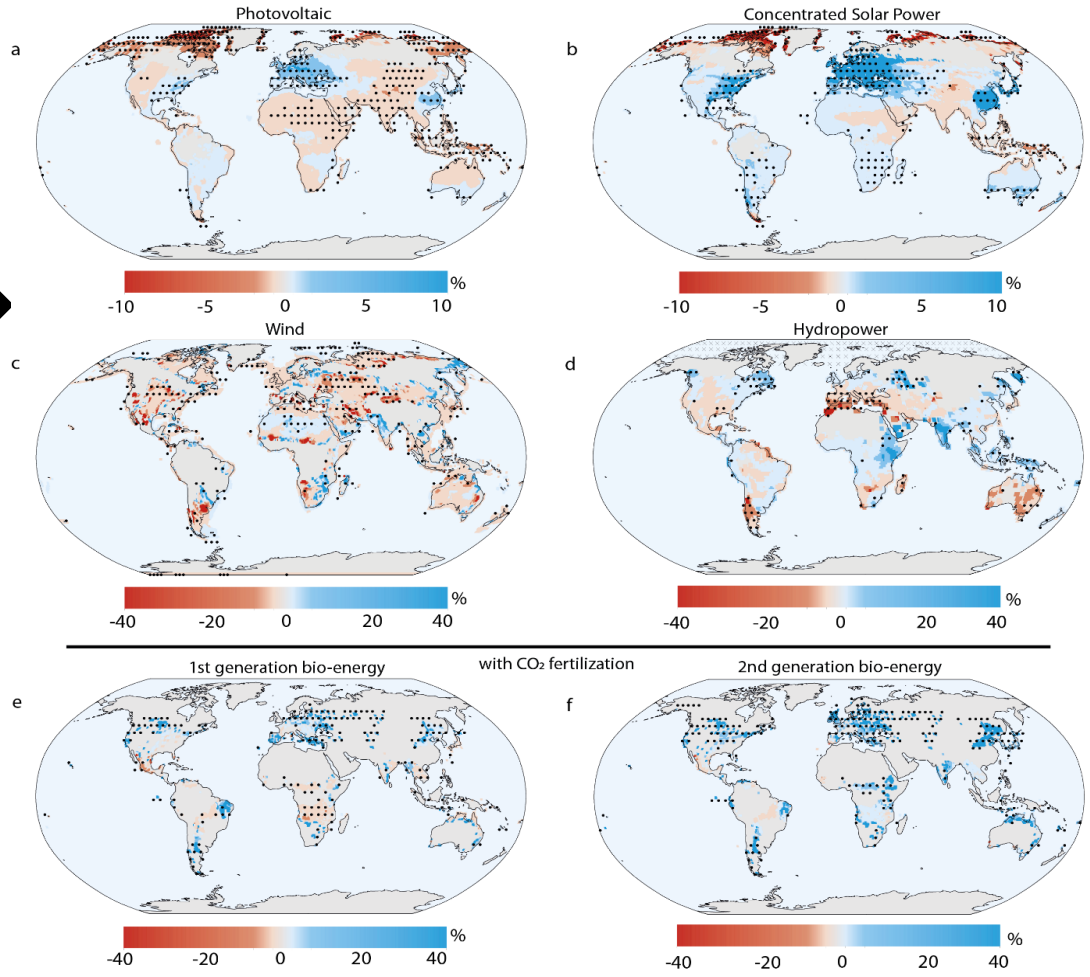
Climate inputs
Historic vs RCP60 (2070-2100)



Renewable energy potentials
Historic vs RCP60 (2070-2100)



Track B

Climate change impacts on primary energy production: A model comparison

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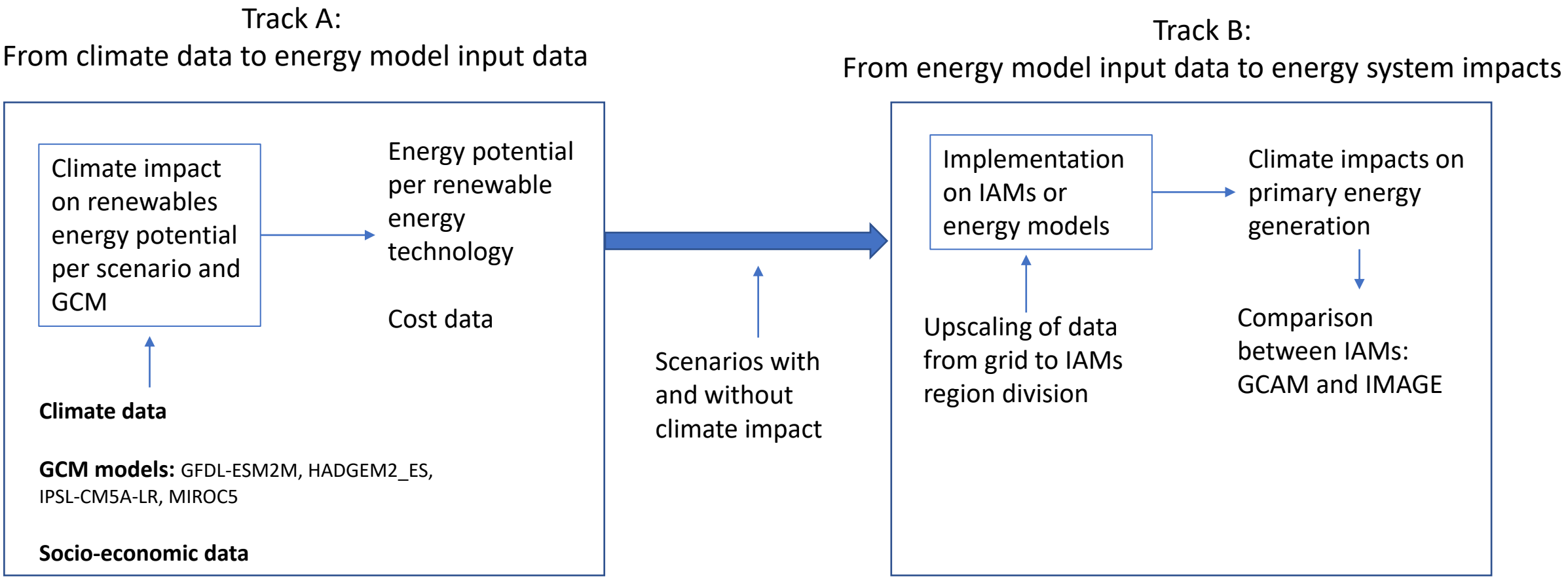
David Gernaat, Seleshi G. Yalew, Silvia R. Santos da Silva, Iyer Gokul, Mohamad Hejazi, Detlef P. van Vuuren

Context track B

- There is a need for analyzing climate impacts on the energy sector as a system and considering the uncertainty from variation between different models.
  - David Gernaat et al., already investigated climate system impacts but using a single modelling system

- This research intends to fill this gap by performing a model comparison of climate impacts results between IMAGE and GCAM across 4 GCMs.

Track B: General Methodology



* For track B, The bioenergy potential data used considers the effect of CO2 fertilization on yields.

Track B – 6 scenarios each with 4 set of climate data

Scenarios without climate impact

Only historical climate data is implemented

- **SSP2-RCP60-NoCI**:
  SSP2 baseline scenario.
- **SSP2-RCP26-NoCI**:
  SSP2 scenario that leads to 2.6 W m-2 additional radiative forcing in 2100 (consistent with 2°C) without climate impacts on renewables.

Climate impact on the system

Climate impact on all renewable sources

- **SSP2-RCP60-CI**
- **SSP2-RCP26-CI**

Sensitivity runs

Direct climate impact on

- **Biomass only: SSP2-RCP60-Bio-CI**
- **Wind only: SSP2-RCP60-Wind-CI**

General Circulation Models:

- GFDL-ESM2M
- HADGEM2-ES
- IPSL-CM5A-LR
- MIROC5

Results- Climate impacts on the energy system SSP2-RCP6.0 - Period 2071-2100

Impact results depend on:

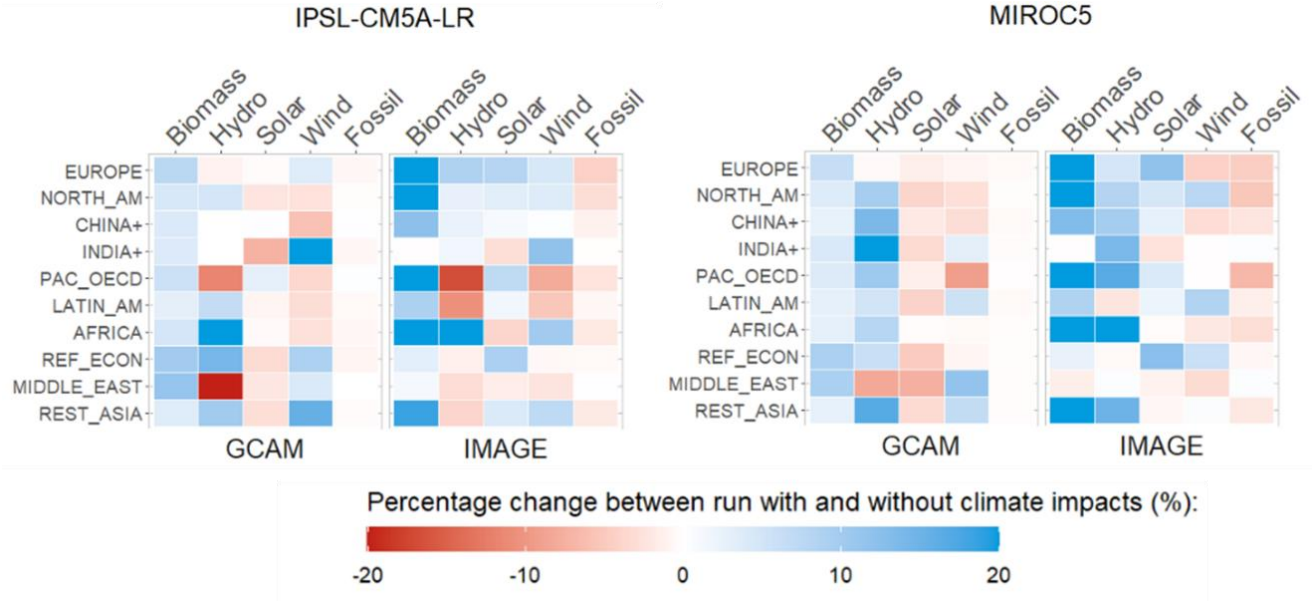
- Tradeoff between cost and energy supply (input data)
- System compensation between the different sources

Both models have similar impact ranges

Larger impacts for Biomass

- Considering CO2 fertilization

Small reduction on fossil energy use can be expected



Proposed future topics discussed during the ISIMIP-Energy session

- Enriched track B: Climate impacts on energy production (system impacts). Further comparison with other models and/or focus on specific countries/regions.
- Model comparison for climate impacts on energy demand: The focus is for impacts on cooling and heating demand.
- Model comparison for climate impacts on energy demand and supply.
- Analysis of climate impacts on thermal power plants. For example, climate impacts on cooling systems of fossil fueled power plants.
- Model validation experiments. For example, how the estimates on energy demand and/or supply compare with present empirical values.

References

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