Updates on AIM global modeling and relevant international activities

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AIMWS

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International activities

- IAMC
  - ✓ SWG on national scenarios will be practically activated this year
- IAM MIPs:
  - ✓ ELEVATE (International policy, European Horizon)
  - ✓ NAVIGATE (Inequality, European Horizon)
  - ✓ JMIP (Japanese policy, MOEJ)
- AgMIP
  - ✓ New exercise starts as EAT-Lancet framework
  - ✓ AIM proposes a new study on Ozone impact on food security
- ScenarioMIP (CMIP)
  - ✓ Designing new climate community scenarios
- GEO (Global Environmental Outlook) 7
  - ✓ Contribution to providing illustrative scenarios for solution pathways
  - ✓ CLA contribution

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Energy system

- Frontier of the global energy system modeling
  - ✓ Advanced technologies: e-fuel, hydrogen, ammonia, battery, …
  - ✓ High temporal resolution: representative days' 24 hours, seasonal storage

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Carbon dependent net-zero pathway Scenario framework

- Three representative scenarios were quantified
- Emission pathways are consistent with 1.5°C goal (500Gt-CO_2 by 2100)

Name	Characteristics	Model specification
1.5C-CDR	• Offsetting residual emissions by CDR (BECCS, DACCS)	• Model default settings
1.5C-DEC	• Attaining DECarbonzation by renewables and electrification	• CCS 4Gt-CO_2/yr, bioenergy supply:100EJ/yr (similar to the AR6 IMP-Ren)
1.5C-CCU	• Low dependencies on CDR and energy demand transformation • Synthetic fuels (including e-fuels) production mainly renewable hydrogen and DAC	• In addition to the 1.5C-DEC, • CDR (BECCS+DACCS):1Gt-CO_2/yr • Electrified or hydrogen-based technology diffusion rate: ~50% of new sales (based on SSP2 assumptions by MESSAGE)

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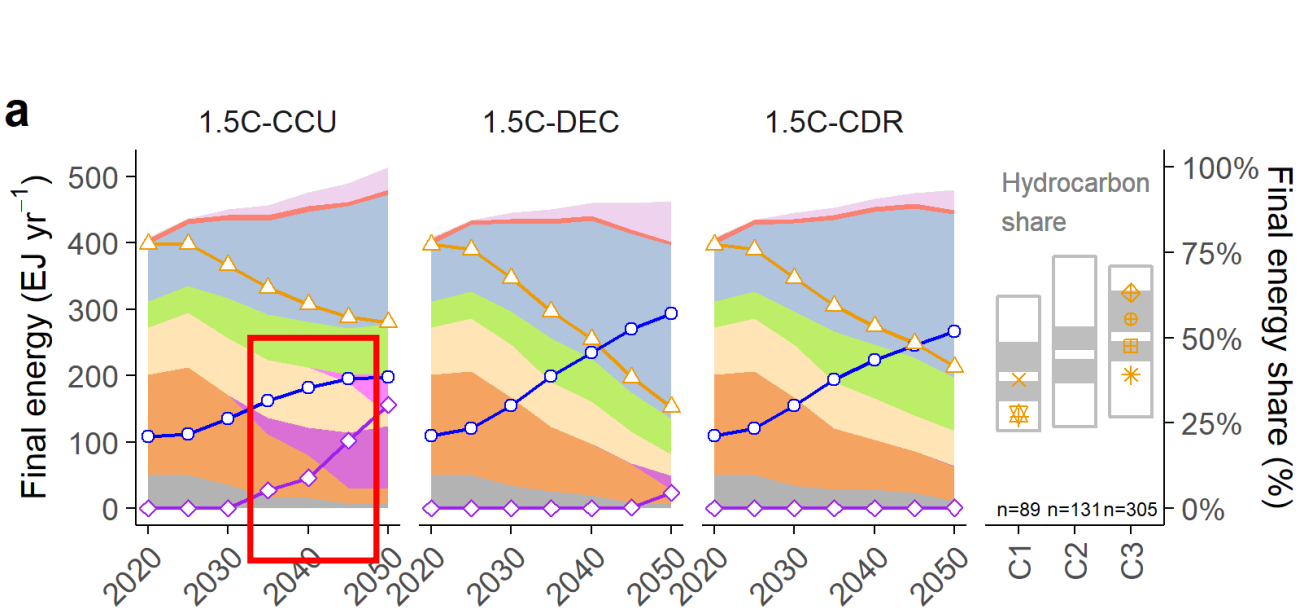
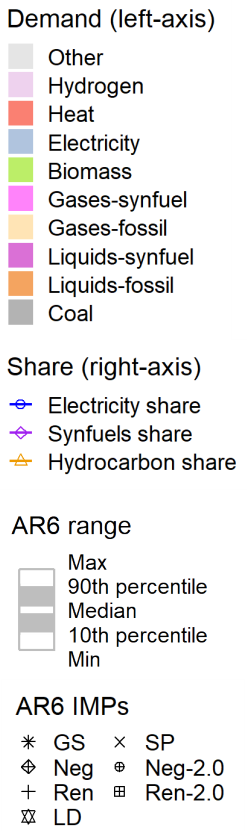
Energy demand side changes

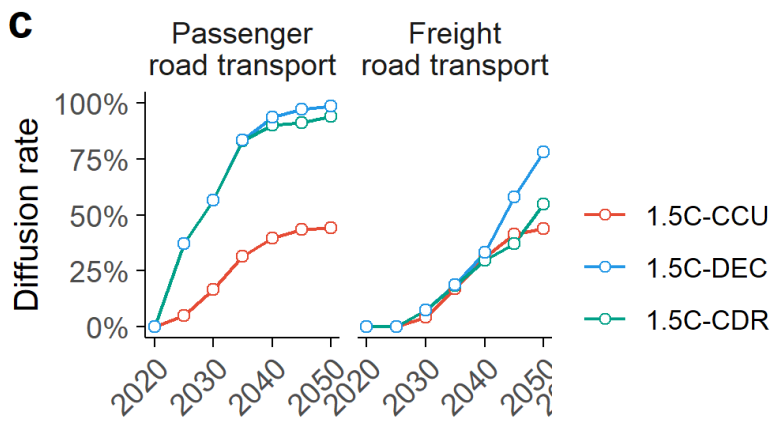
- Synthetic fuels (incl. methane) accounts for about 30% in the 1.5C-CCU.
- Hydrocarbon energies (fossil, biomass and synthetic fuels) in the 1.5C-CCU: 50%
  - Moderate technological changes in the energy demand.
- Transport is the largest consumer of synthetic fuels.



Final energy demand



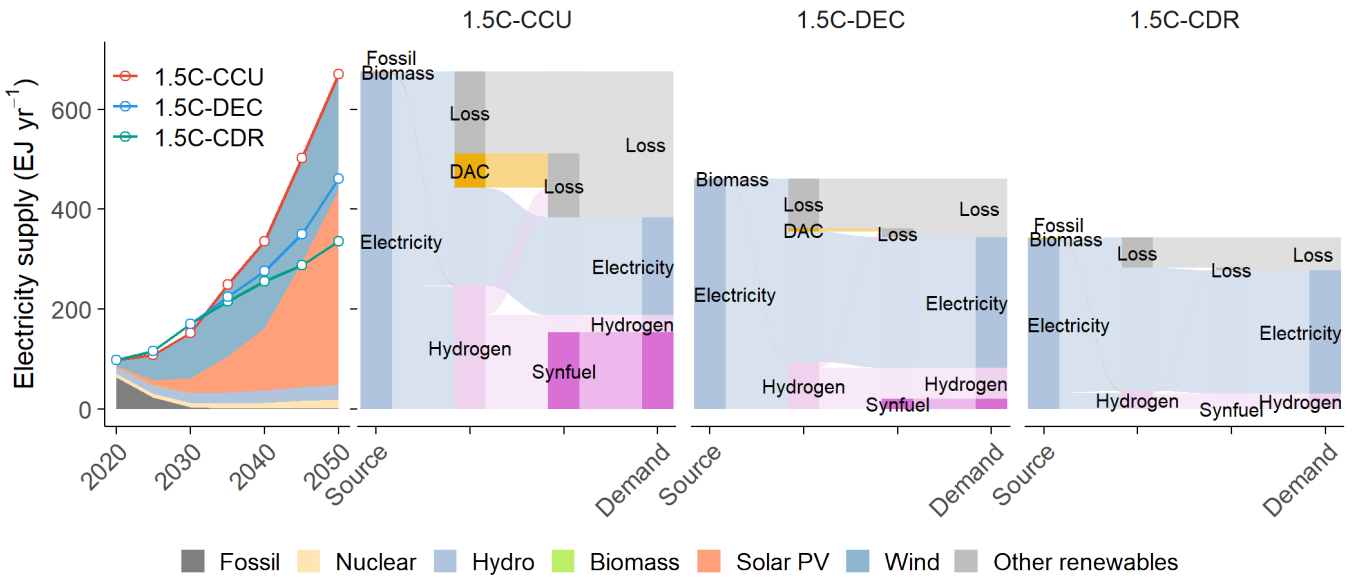
Electrification rate
(stock base, incl. hydrogen)

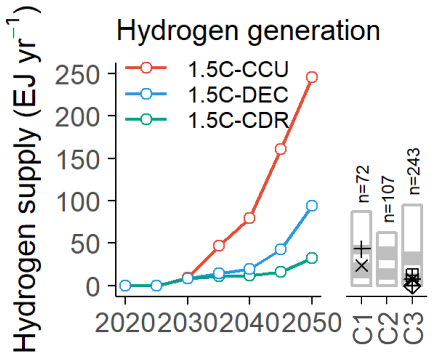


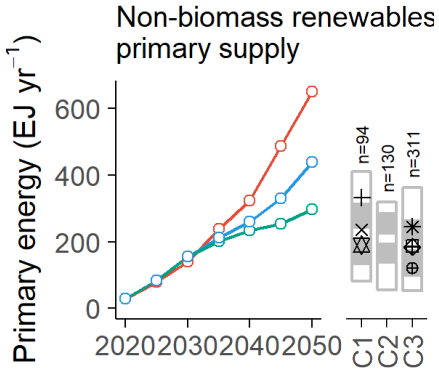
Energy supply transformation

- 1.5C-CCU requires drastic changes in the energy supply side.
- Renewable electricity generation exceeds 600EJ in 2050.
- Hydrogen production reaches 250EJ by 2050 (including those for synthetic fuel production)
- Around a half of generated electricity is lost by conversion losses and energy consumption for DAC.

Secondary energy flow associated with hydrogen and CCU







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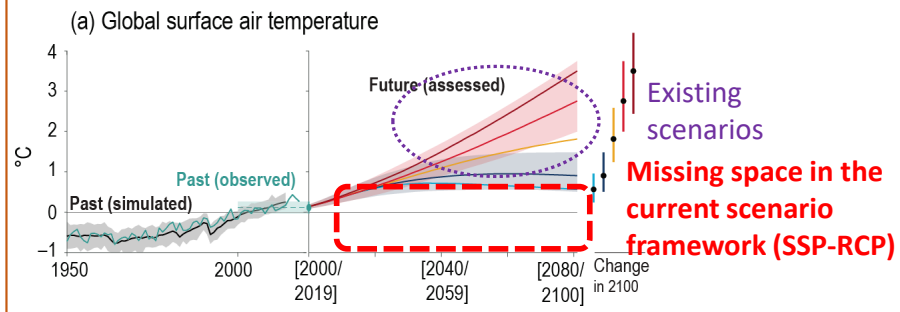
Questioning current climate scenario framework

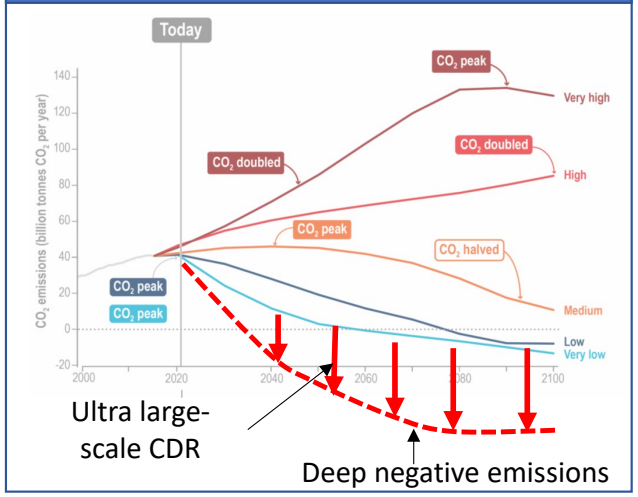
- Does the RCP-SSP framework sufficiently covers the range of climate? In particularly, lower boundary??

Reasons to consider low temperature stabilization



- Already visible impacts
  - Heat wave
  - Intensified rainfall
  - Frequent wildfires etc.
- Risk of irreversible changes such as continuous sea level rise (at least several hundred years)
- Would CDR condition be unchanged?
- Would 1.5 °C be immobilized ultimate climate goal?

Consideration for climate return



Potential new research agenda for new climate return scenarios

WG1	• Long-term sea level changes • Irreversible risk assessment • Carbon cycle responses • Risk of cooling the earth
WG2	• Risk reduction from 1.5 °C • Assessment on best climate change levels and adaptation strategy • Ecosystem responses
WG3	• Feasibility assessment on ultra large-scale CDRs • Socioeconomic impacts induced by ultra large-scale CDRs

Fujimori et al.(Under review)

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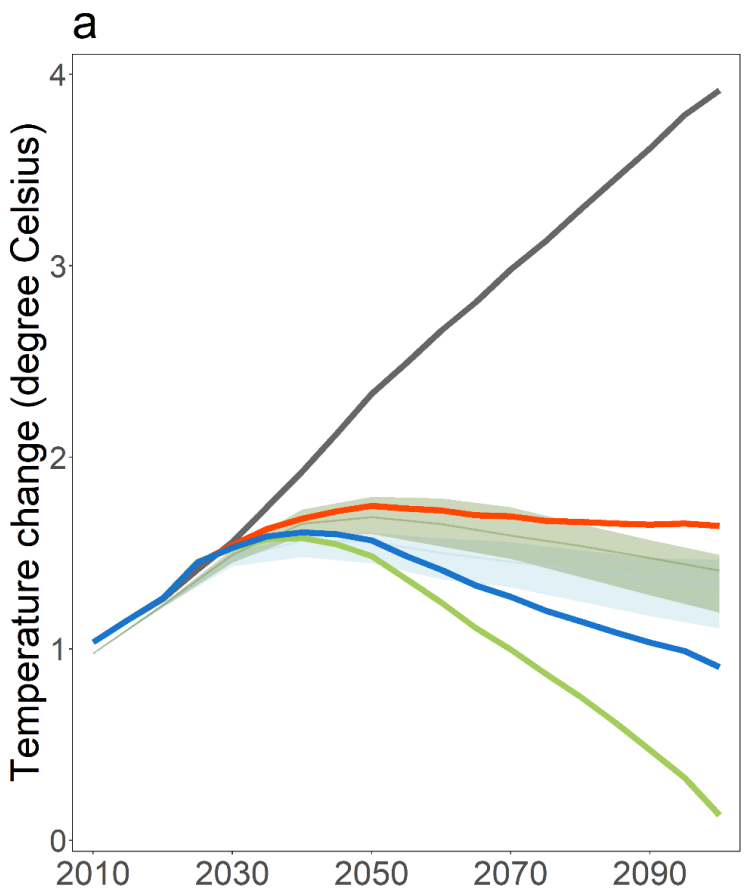
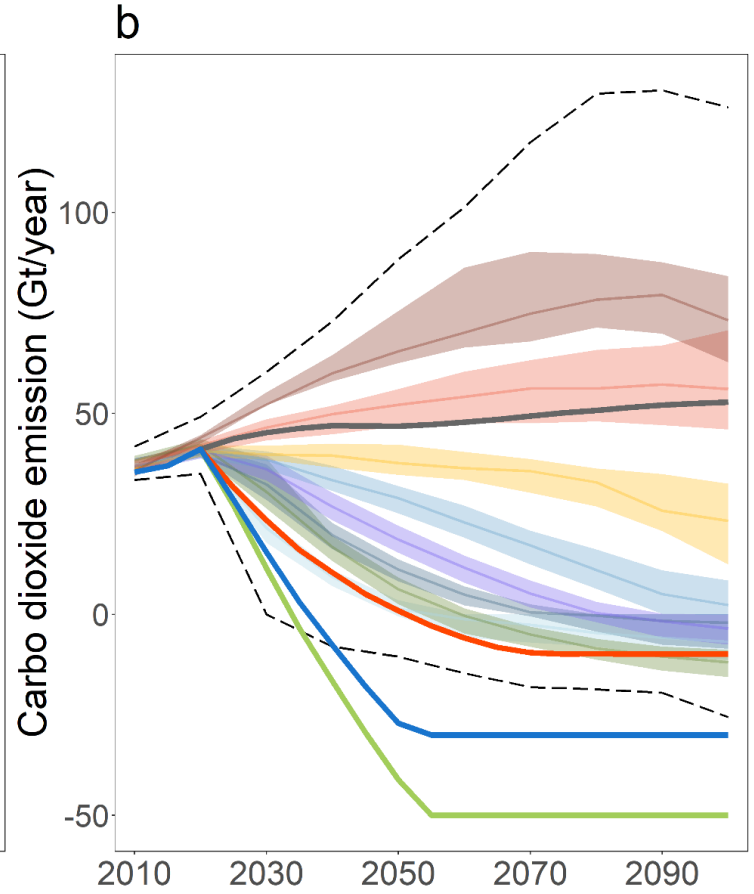
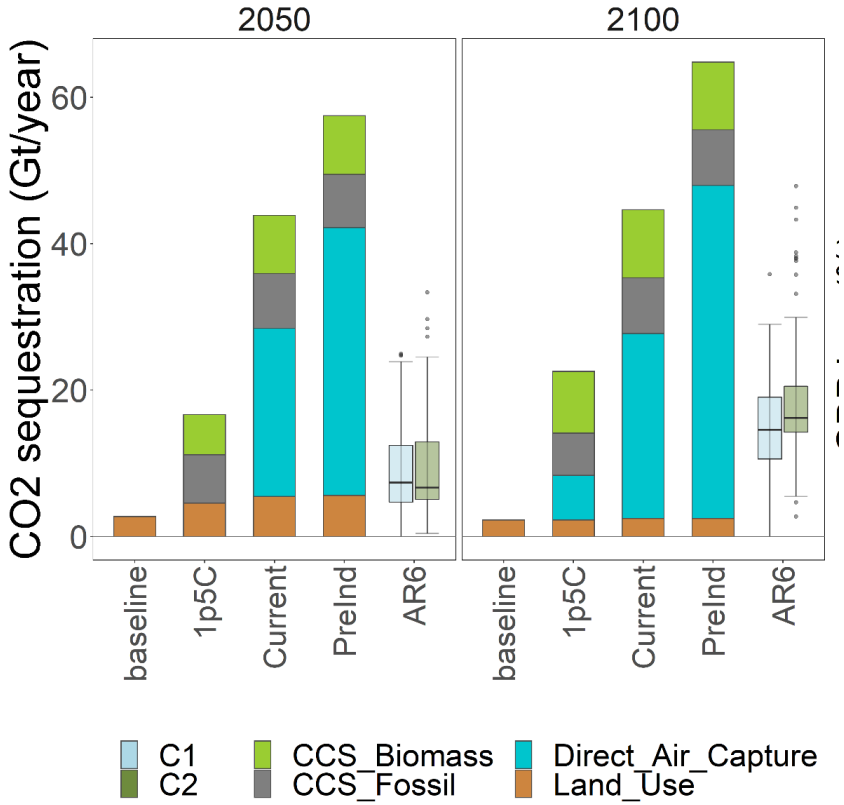
CGE model update: DAC representation



Global mean temperature



Emissions



CDR portofolio

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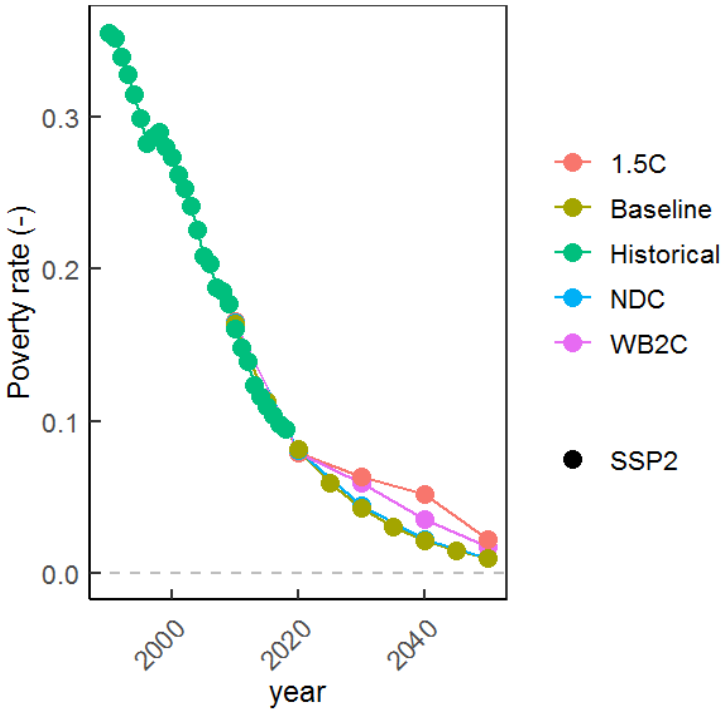
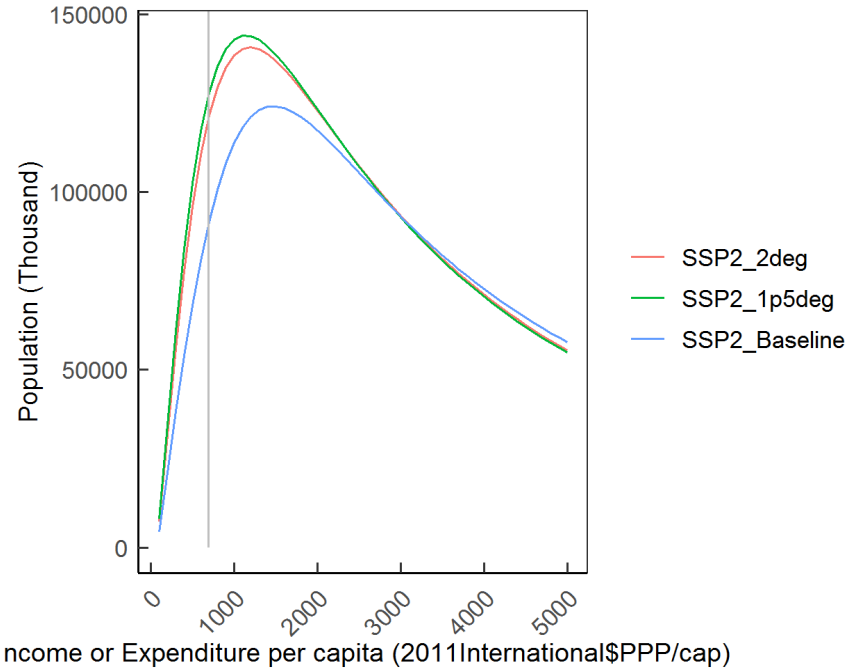
Poverty headcount could increase due to climate change mitigation



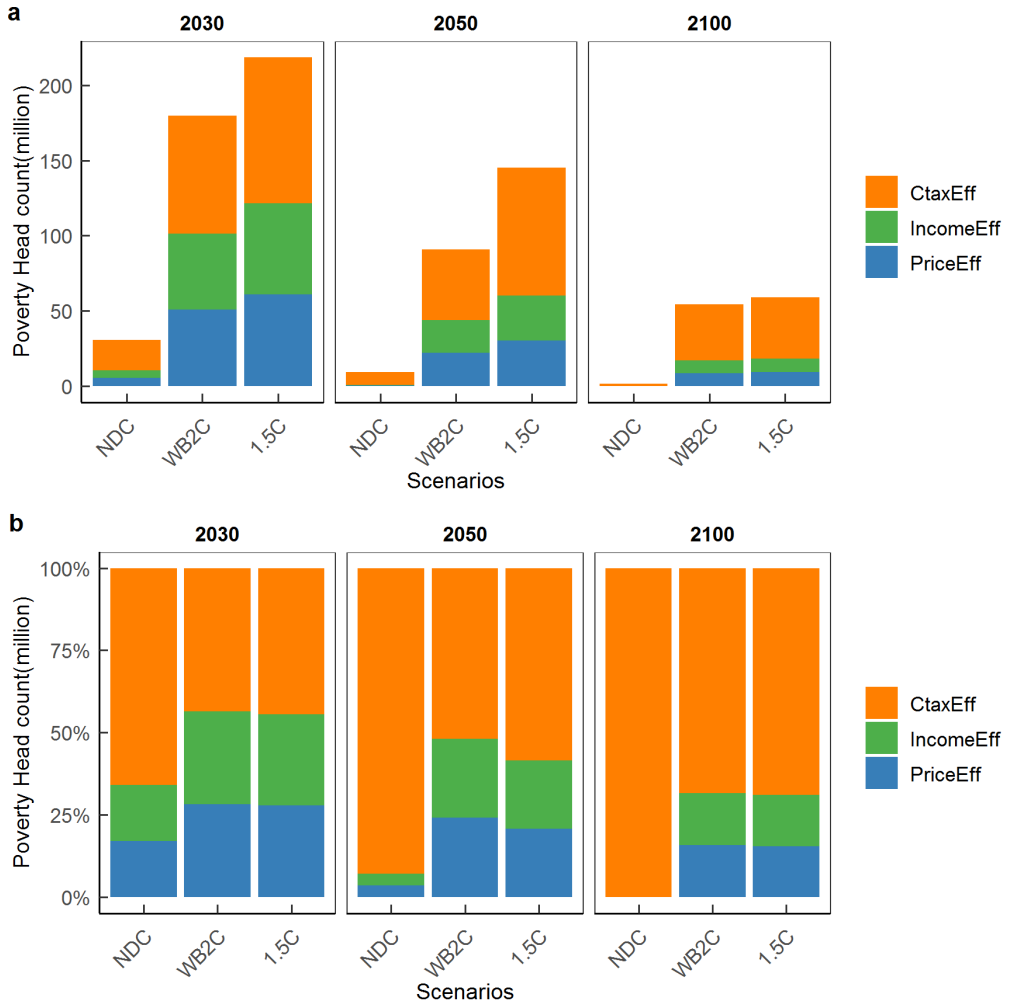


- Historically declined.
- Baseline is projected continuously due to the income growth in low-income countries.
- Climate change mitigation increases poverty headcount
  - Price and income effects

Fujimori et al.(2023)

Decomposition of price, income and carbon tax effects

- Three effects decomposition
  - Price(mitigation cost distributional effects), income and direct carbon tax on household
- Overall, carbon tax effects are large
- In the near-term, relatively income is large



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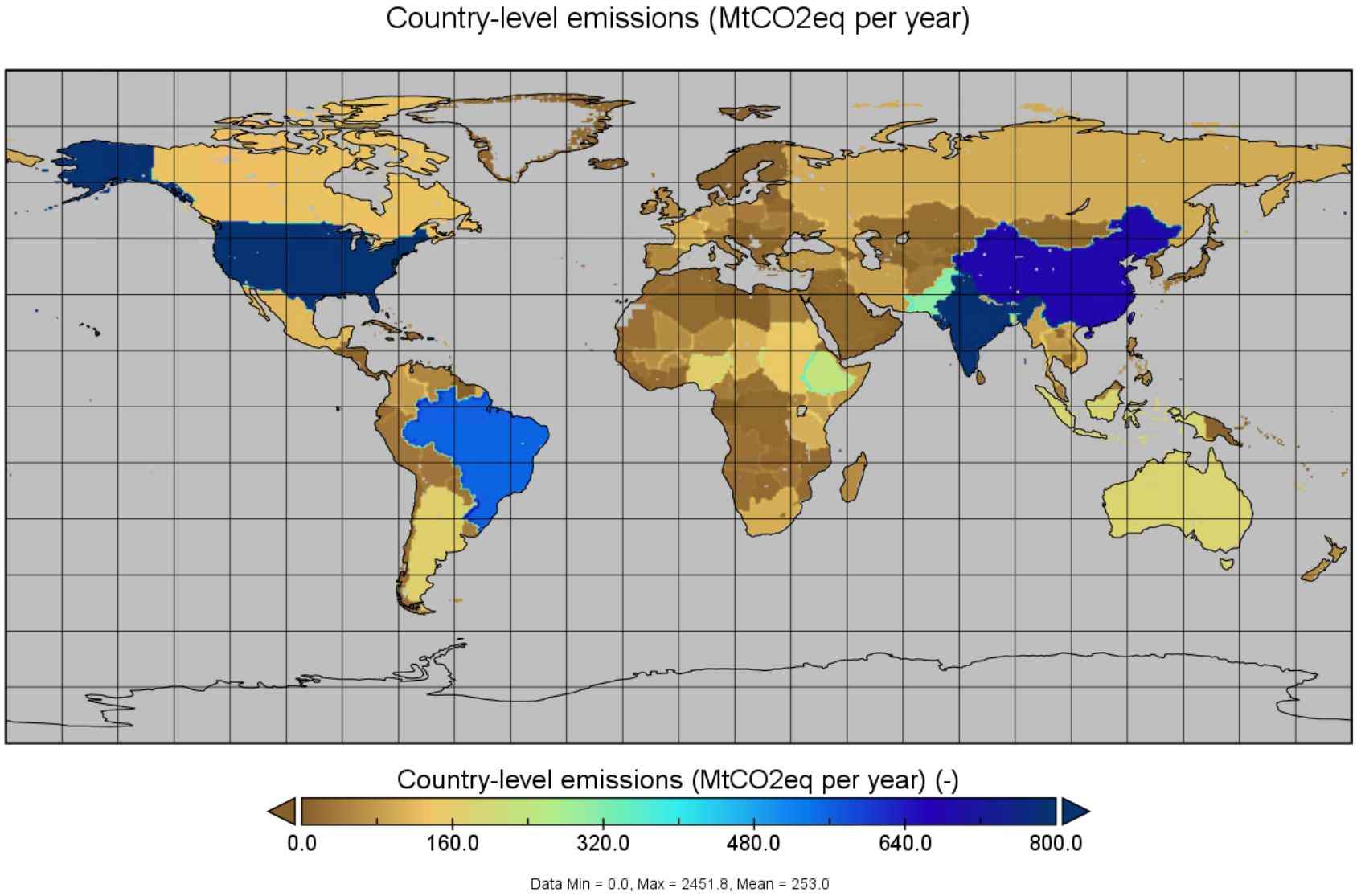
Land and agriculture: national representation
National AFOLU emissions in 2050



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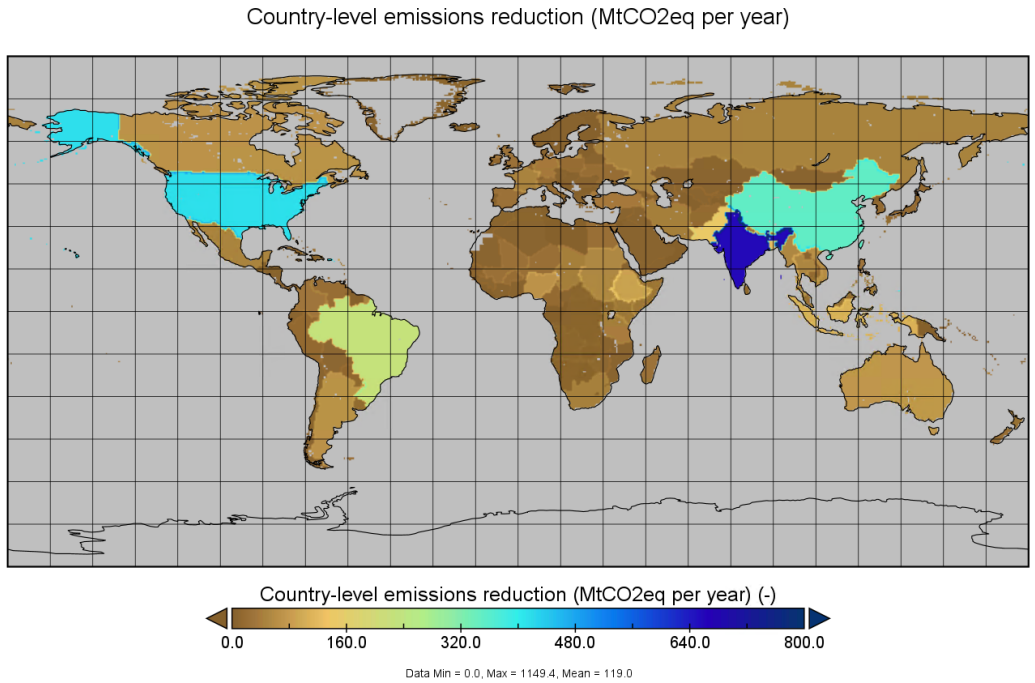
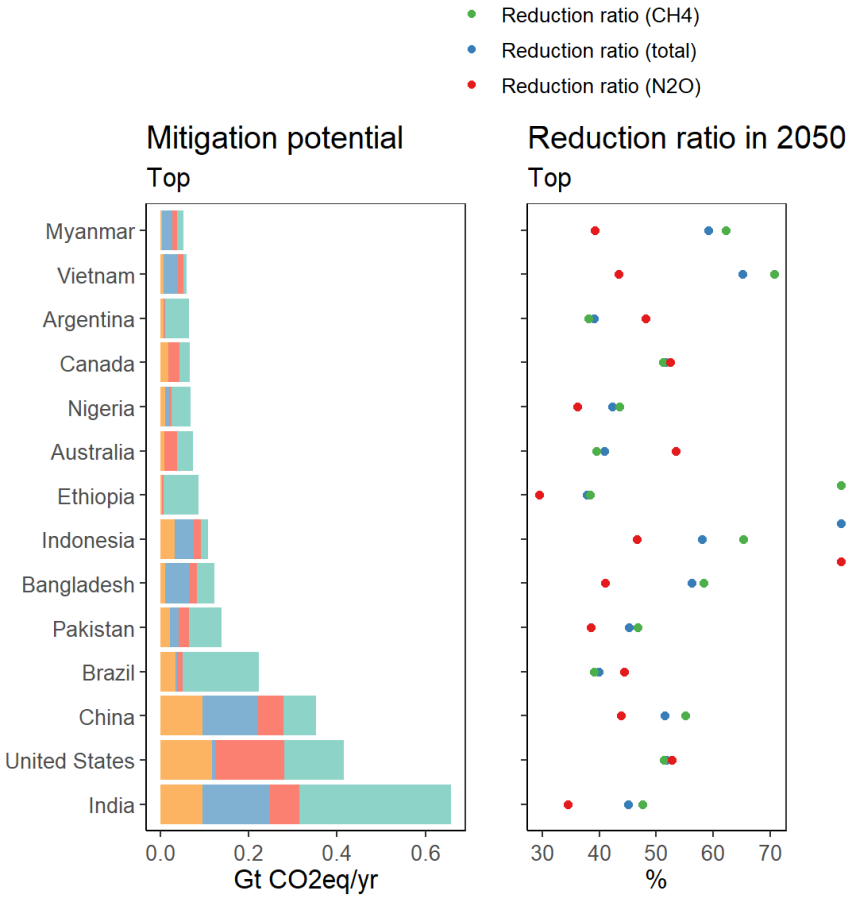
Top countries for potential reduction in AFOLU

- Top 12 countries dominate 60% of abatement
- Asia is the major contributing continent.





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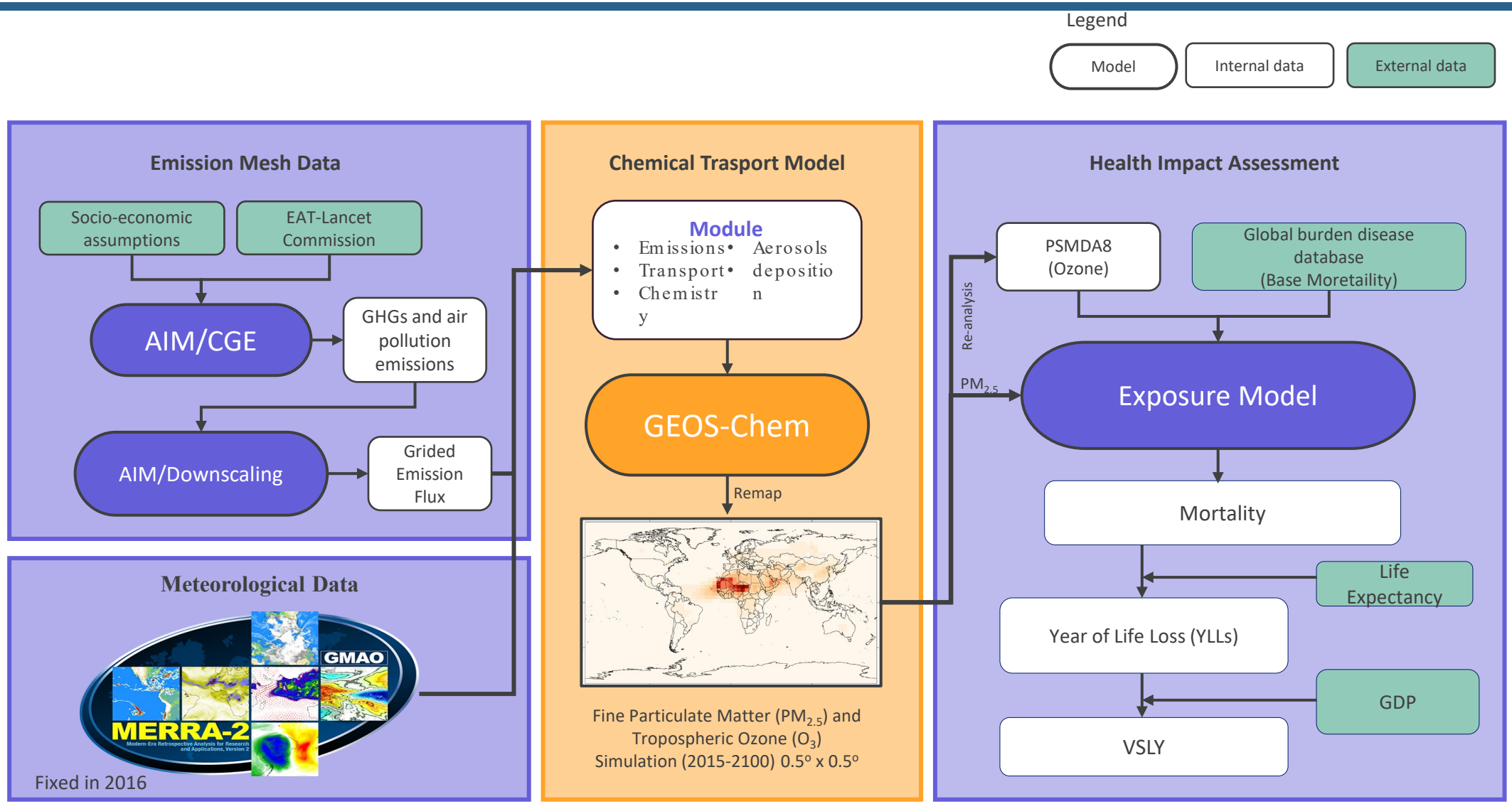
Atmospheric modeling



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SCENARIO

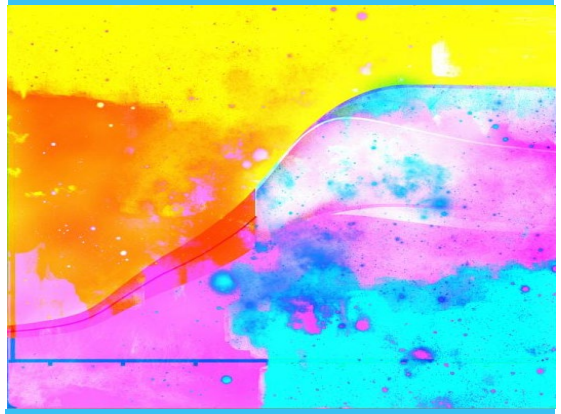
SCENARIO 0: Baseline

The Shared Socioeconomic Pathways 2 (SSPs) scenario, also known as the "middle of the road" scenario was used to be a baseline scenario to represent current situation and future trend that energy use is dominated by fossil fuels, with renewable energy sources playing a minor role and climate change mitigation policy will be not applied in this scenario.

SCENARIO 1: Dietary change and food loss reduction

In the future eating behavior of the people will change to be healthier by consume plant base protein from beans, lentils, pulses instead of red meat and dairy product according to the **EAT-Lancet** commission, red meat consumption would be cut by 50% by 2050. In term of food loss reduction, SDG target 12.3 would be applied by halve global per capita food waste in 2030

SCENARIO 2: Climate change mitigation policy



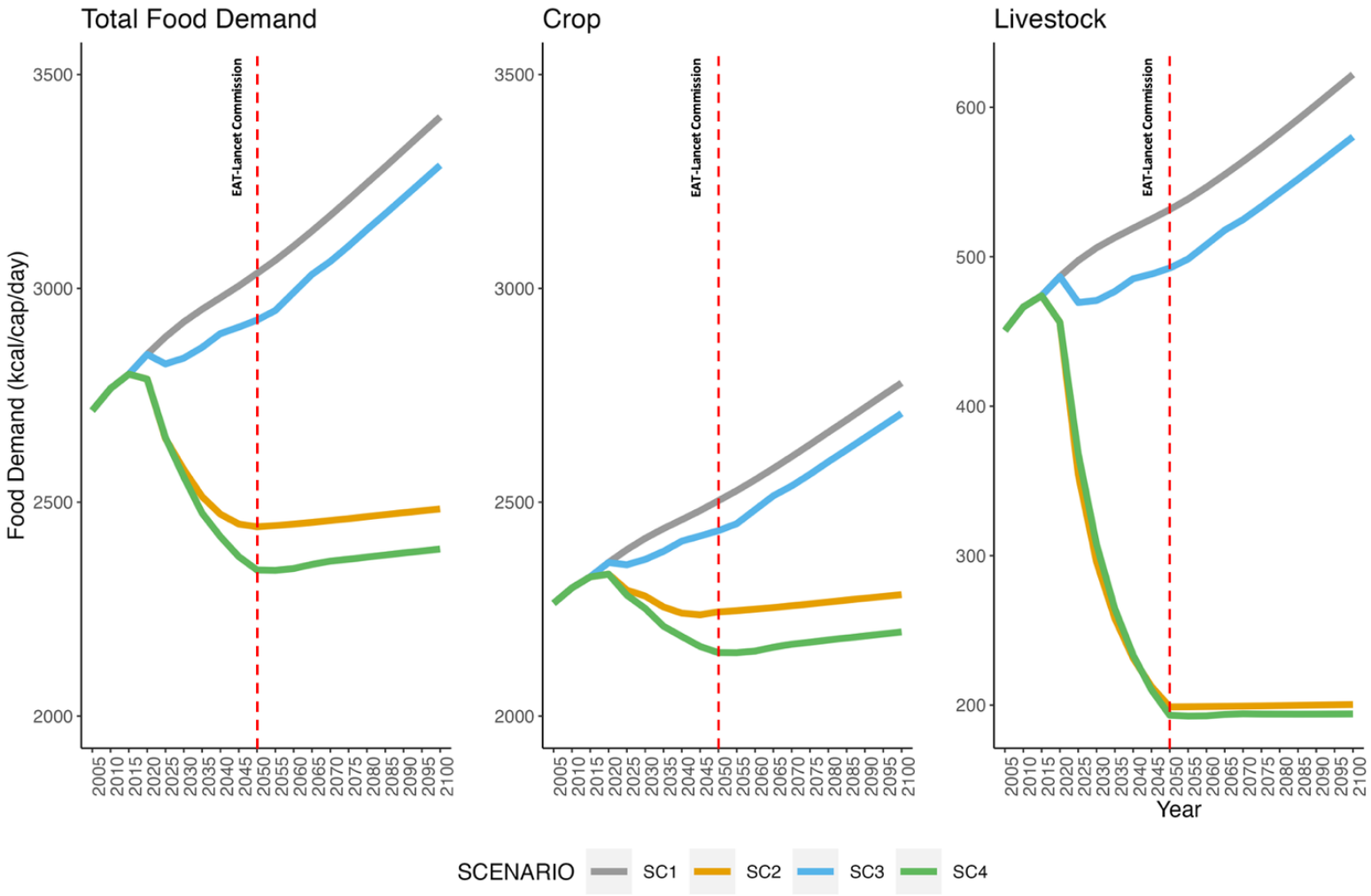
we refer to the Paris Agreement's objective of reducing global warming to 1.5 degrees Celsius over pre-industrial levels

SCENARIO 3:

coupling mitigation of climate change policy with dietary change and food loss reduction

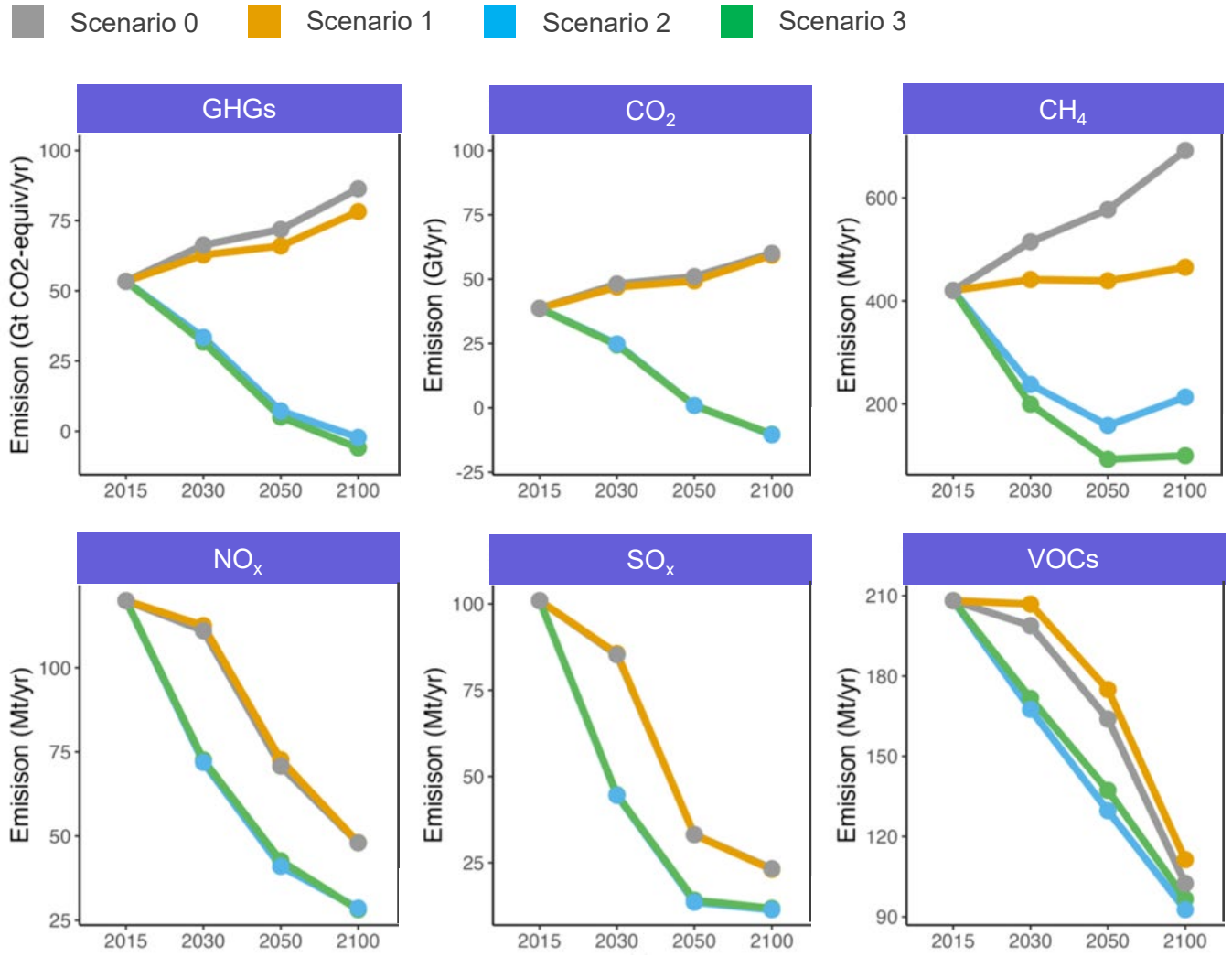
The simultaneous implementation of policies and strategies that address both the environmental impacts of the food system and dietary habits of individuals.

Dietary change impacts on air quality



EMISSION IMPACT

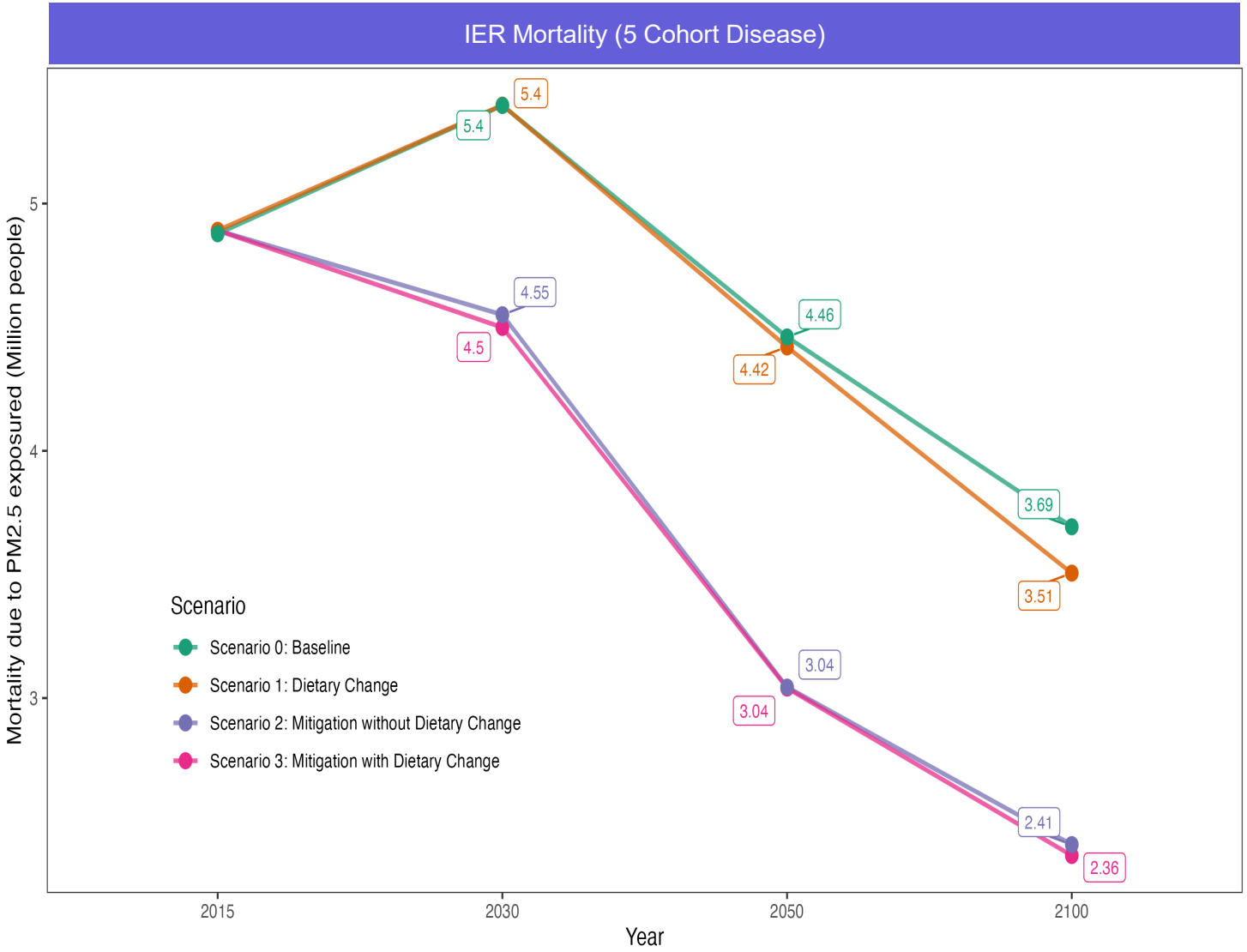
The impact of dietary transformation and climate change policies on future emissions

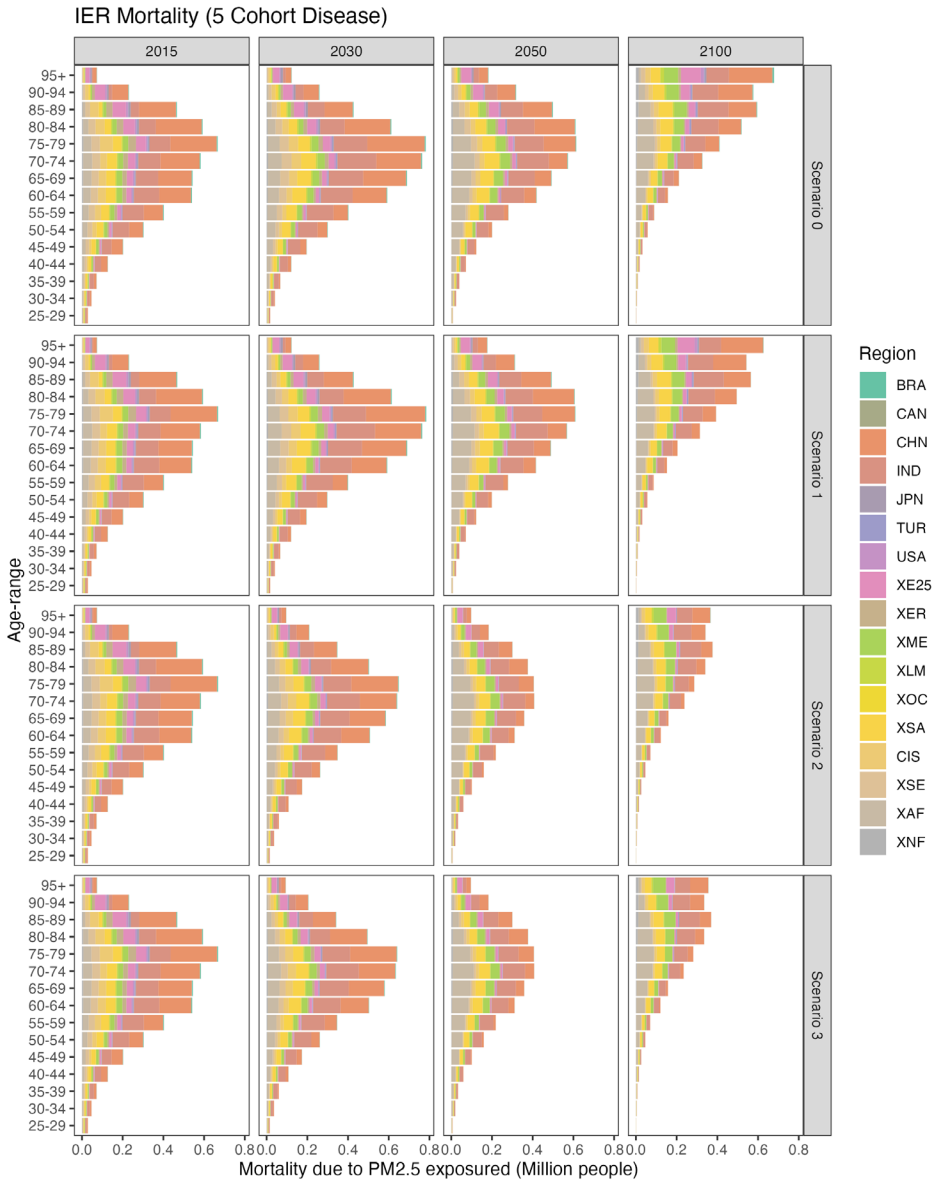


"Dietary change and food loss prevention policy have little impact on greenhouse gas (GHG) emissions"

- if climate change mitigation measures are implemented, total GHG emissions will continue to be dramatically reduced and reach zero by 2100.
- Furthermore, when these measures are combined with dietary changes and reductions in food loss, it is possible to achieve GHG negative emissions by 2100.

HEALTH BENEFITS





Final remarks

- International activities
  - ✓ Actively participating in the international community
- Model development
  - ✓ Energy system model has remarkable advancement
  - ✓ Recent new models (AIM/PHI and GEOSChem) have been well integrated within AIM.