Creating an Integrated Assessment Model to optimize paths for lowering greenhouse gas emissions for SSP1-5 scenarios

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Introduction

- Climate change researchers and policymakers can use the Optimal-type Integrated Assessment Model (O-IAM) to assess the best cost-benefit mitigation strategies.
- The current models, however, usually focus on a medium emission scenario like Shared Socioeconomic Pathway 2 (SSP2), which might not adequately capture the significant uncertainties that surround socioeconomic development.
- O-IAMs mainly consider emissions reductions for CO_2 while other greenhouse gases (GHG) and aerosols and pollutants are assumed to have constant time series, and the dynamics of mitigation for various emissions are thus not properly evaluated.
- In this study, we develop an O-IAM that combines a socioeconomic module and a Simple Climate Model (SCM) to determine the optimal GHG emissions pathways for SSP1-5.

Methodologies

- **SCM4OPT v3.3**
  - Socioeconomic module:
    - Based on DICE2016R;
    - MACs using AIM/Hub V2.2;
    - Renewed damage function;
    - Extended by 2300.
  - Simple Climate Model
    - Calibrated based on CMIP6;
    - Using GHG emissions and aerosols and pollutants as inputs.

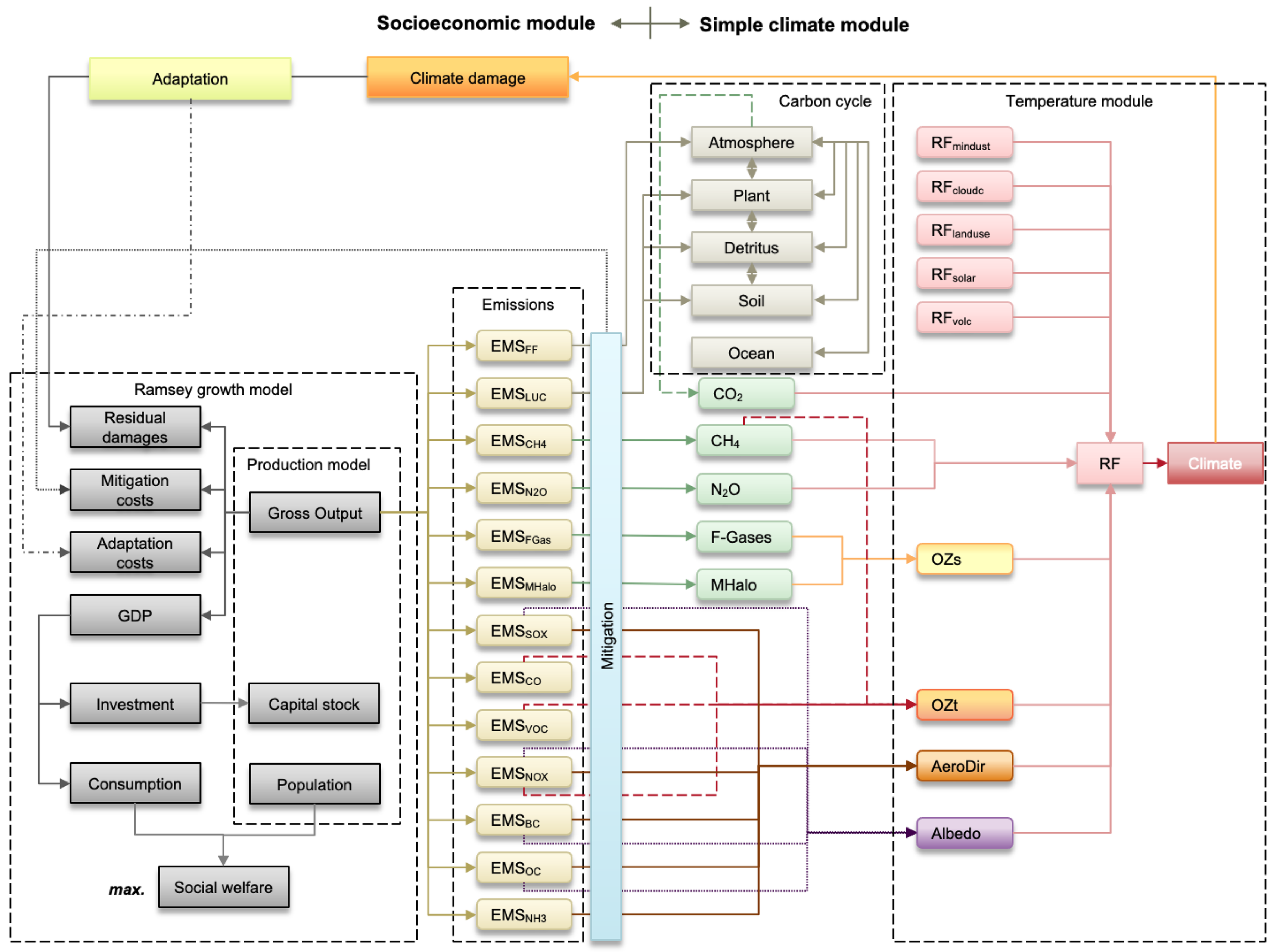

Figure 1: The framework of SCM4OPT v3.3

- **A new set of marginal abatement cost (MAC) curves based on AIM/Hub V2.2**

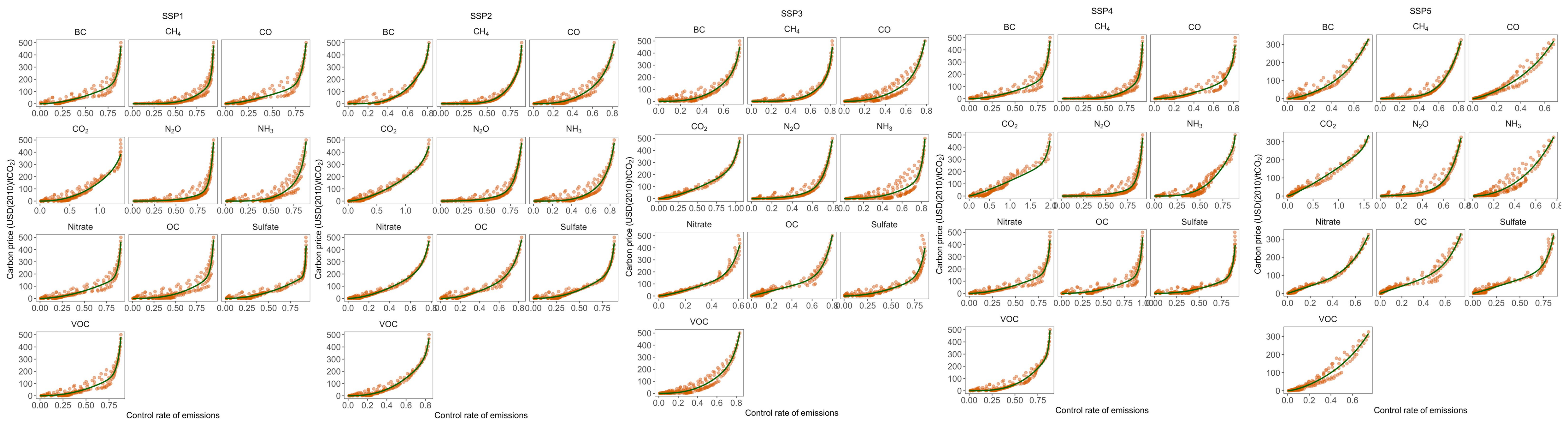

Figure 2: Marginal abatement cost (MAC) curve for the SSPs. The orange points represent sensitivity data relating the rate of control of emissions to the carbon price. The green line represents the MAC curve considered in this study.

Results

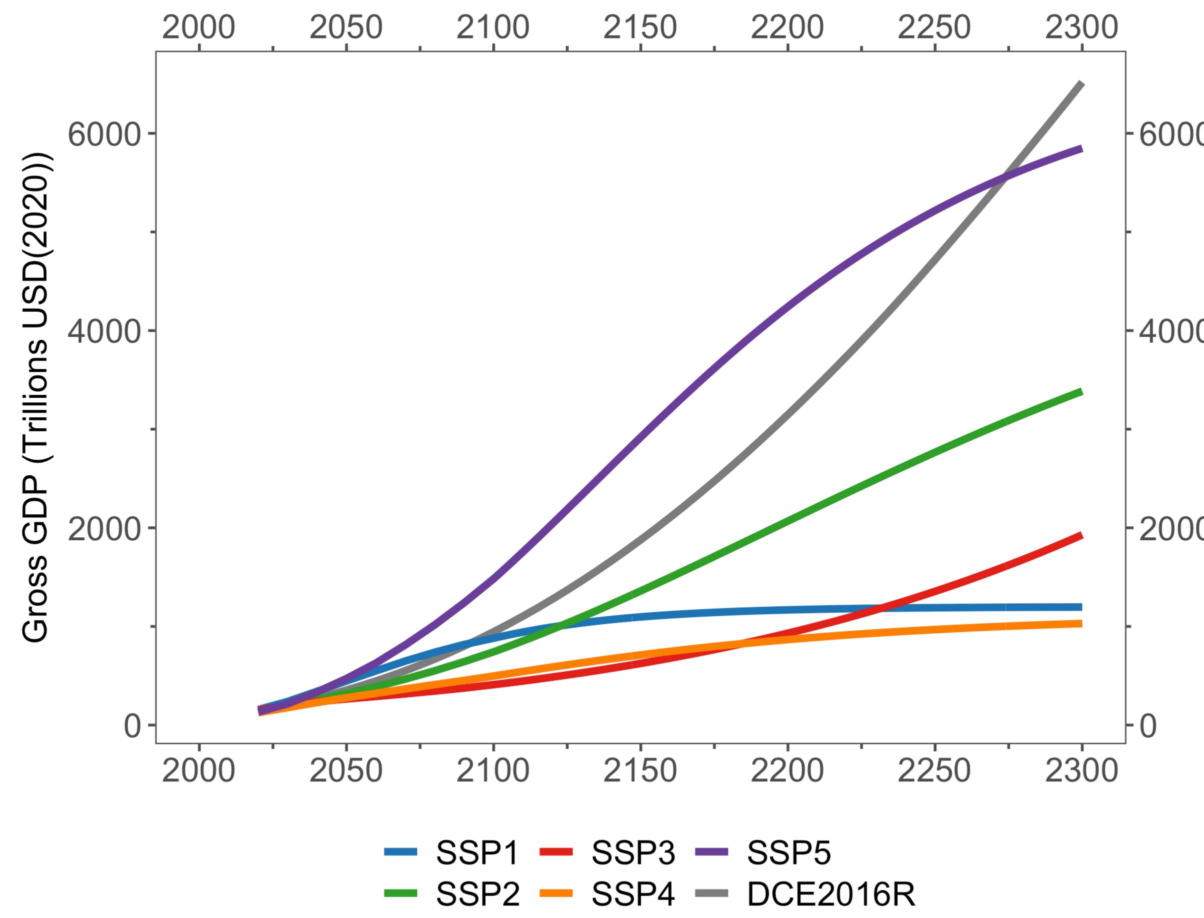

Figure 3: Gross GDP for reference scenario.

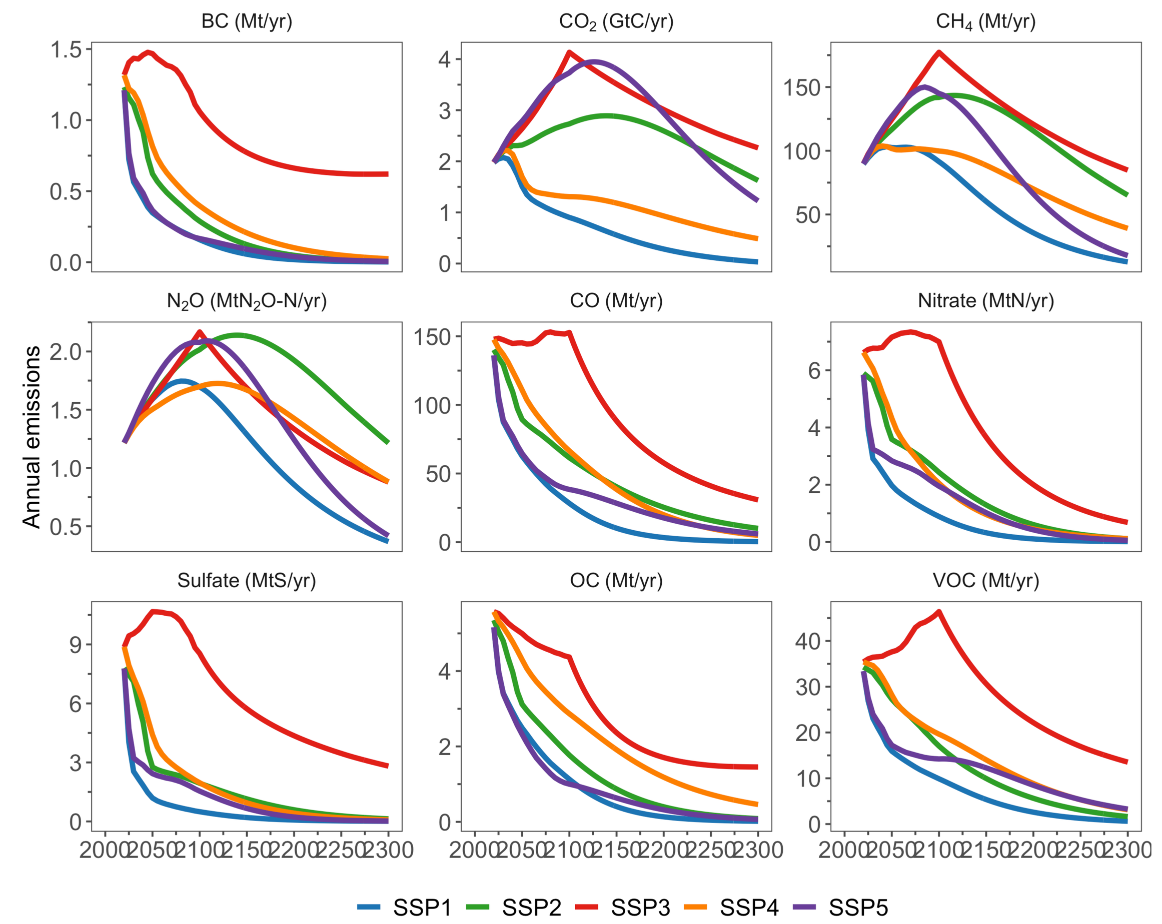

Figure 4: Emission assumptions after 2100.

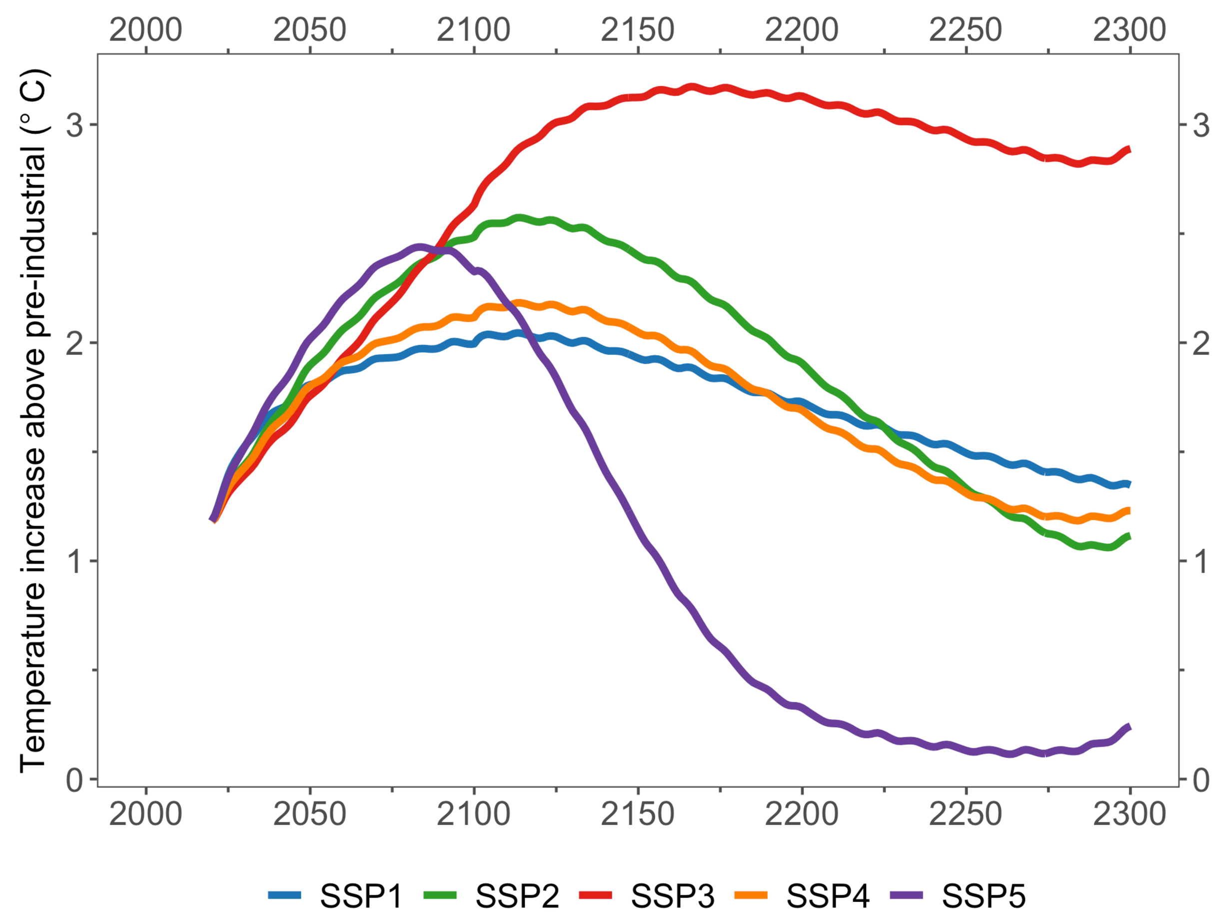

Figure 5: Temperature increases for optimal scenarios.

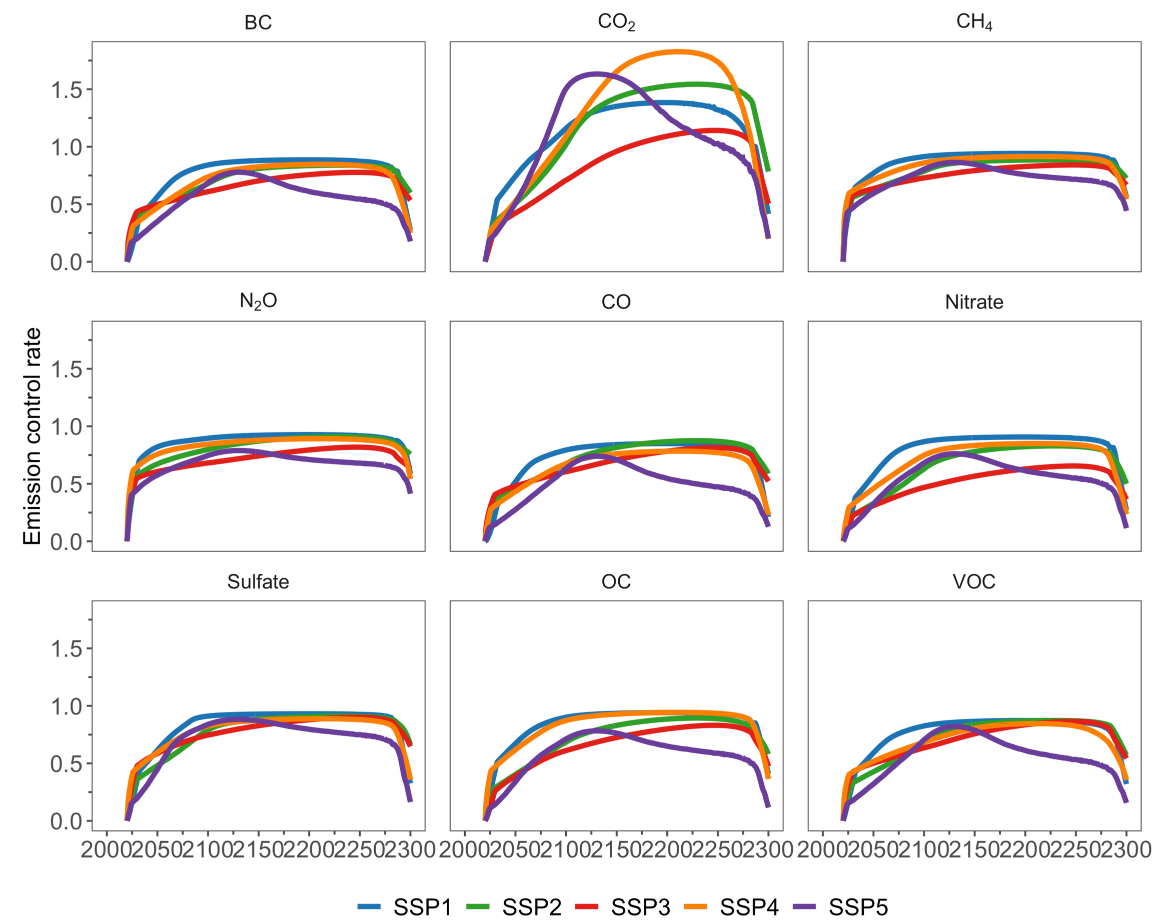

Figure 6: Emissions control rates of optimal scenario.

Summary

- Using the most recent AIM/Hub V2.2 model, we estimated a new set of MAC curves.
- We developed a SCM called the Simple Climate Model for Optimization v3.3 (SCM4OPT v3.3) to estimate changes in radiative forcing and global mean temperature using GHG emissions and aerosols and pollutants as inputs.
- The O-IAM was built by integrating the socioeconomic and SCM modules.
- Our results highlight the need to consider different socioeconomic backgrounds and mitigation strategies for various emissions, to determine the optimal climate policies.