The Implications of Deep Mitigation Pathways

23RD AIM INTERNATIONAL WORKSHOP

November 2017

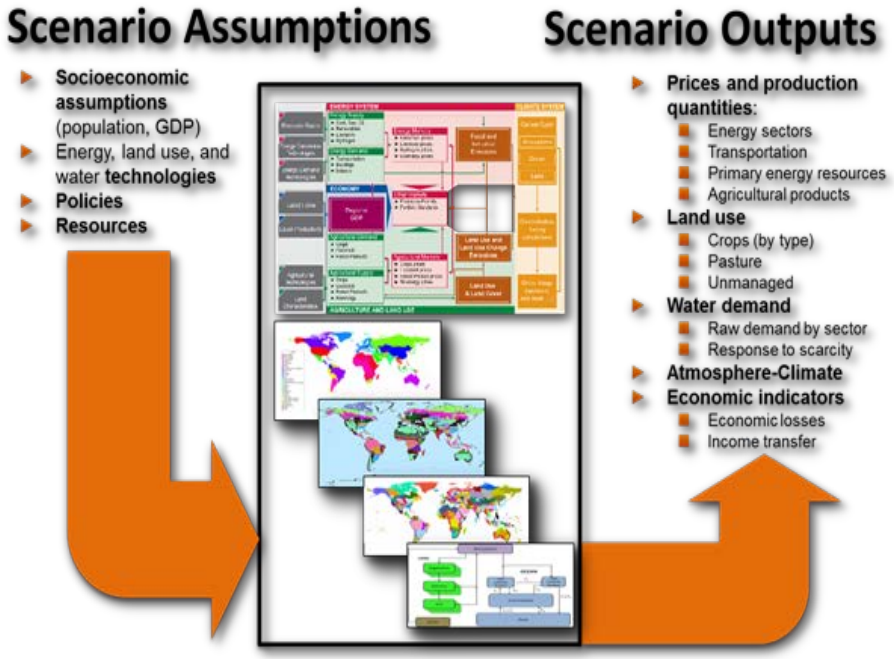
Tsukuba, JAPAN

Science Questions

- What are the implications of mitigating to 1.5°C on the economy, energy, agriculture, and land use sectors?
- How sensitive are our results to changes in underlying assumptions?

Approach

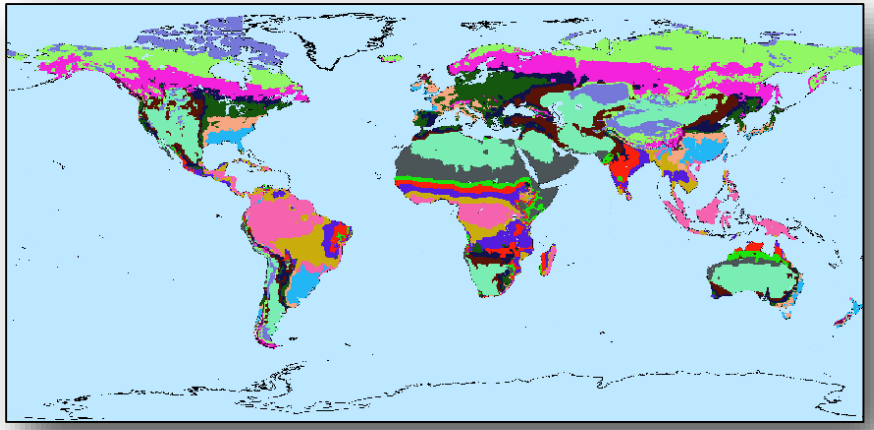
- Model:
  - Global Change Assessment Model (version 4.3), with the Hector climate emulator
- Target:
  - Limiting 2100 temperature to 1.5°C
  - Overshoot is allowed.



The Global Change Assessment Model (GCAM)

32 Region Energy/Economy Model

283 Agriculture and Land Use Model



- GCAM is a **global complex, multi-scale, human-Earth system model**
- GCAM links **Economic**, **Energy**, **Land-use**, and **Climate** systems
- Typically used to examine the effect of technology and policy on the economy, energy system, agriculture and land-use, and climate
- Technology-rich model
- Emissions of 24 greenhouse gases and short-lived species: CO_2, CH_4, N_2O, halocarbons, carbonaceous aerosols, reactive gases, sulfur dioxide.
- Runs through **2100** in 5-year time-steps**.**
- Open source: **https://github.com/jgcri/gcam-core**
- Documentation available at: **http://jgcri.github.io/gcam-doc/**

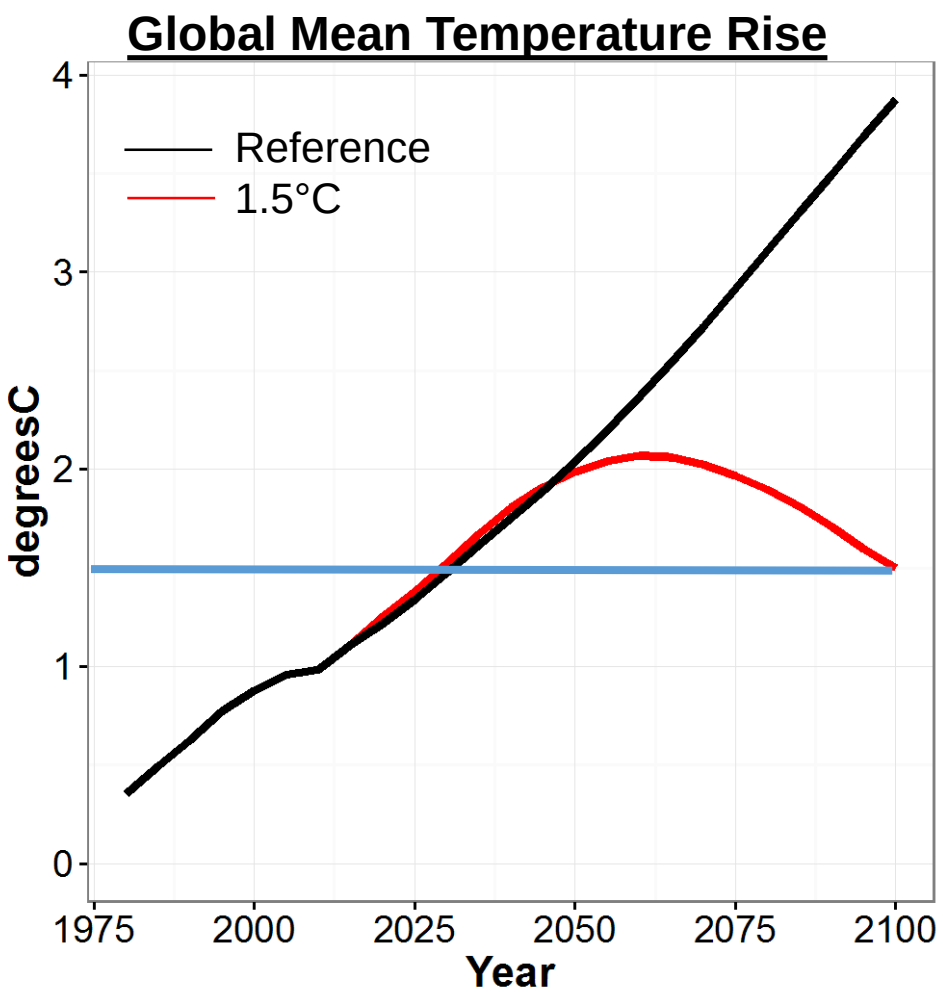
Note: this research uses the GCAM v4.3 release

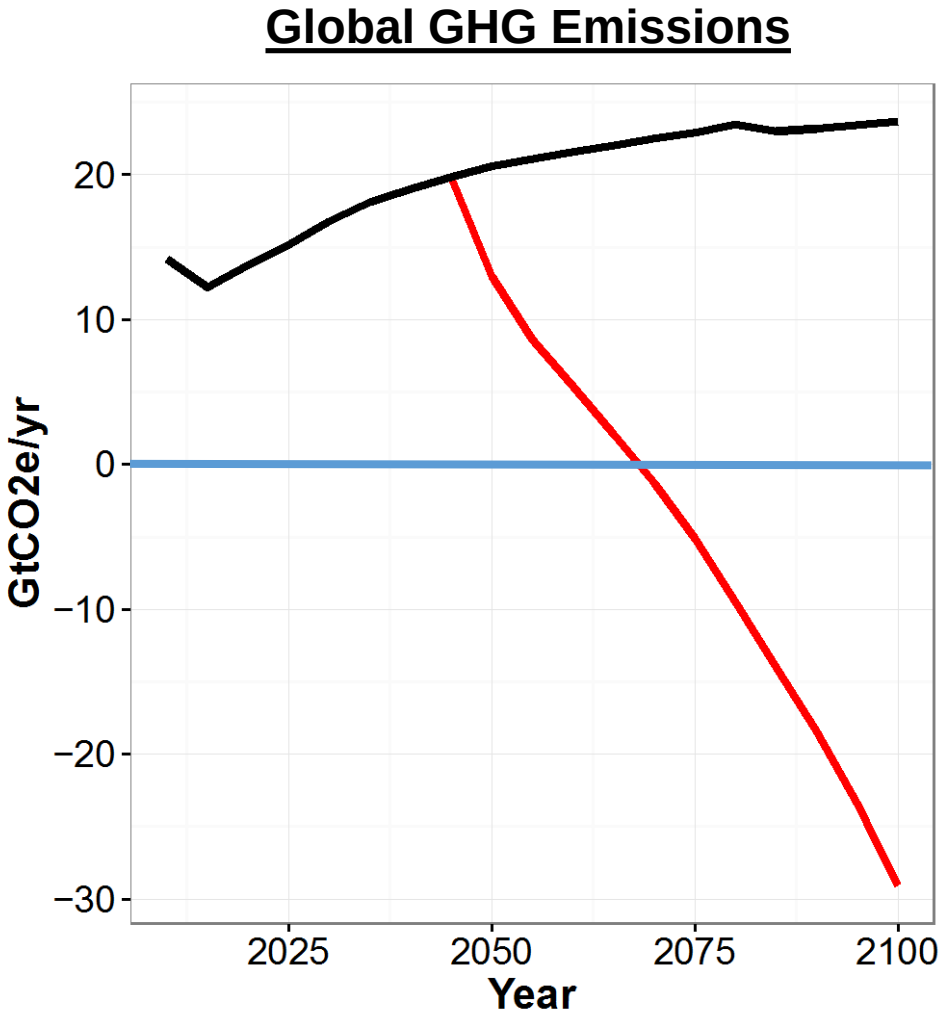
Science Questions

- What are the implications of mitigating to 1.5°C on the economy, energy, agriculture, and land use sectors?

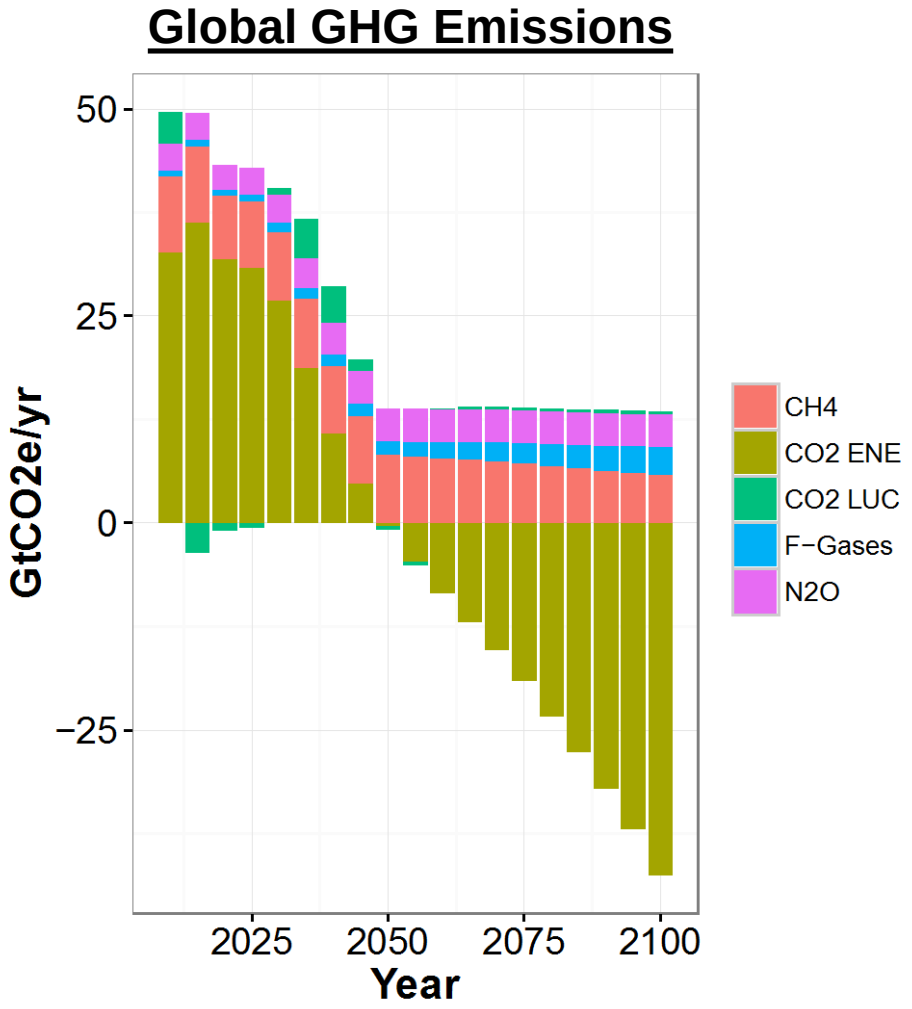
- How sensitive are our results to changes in underlying assumptions?

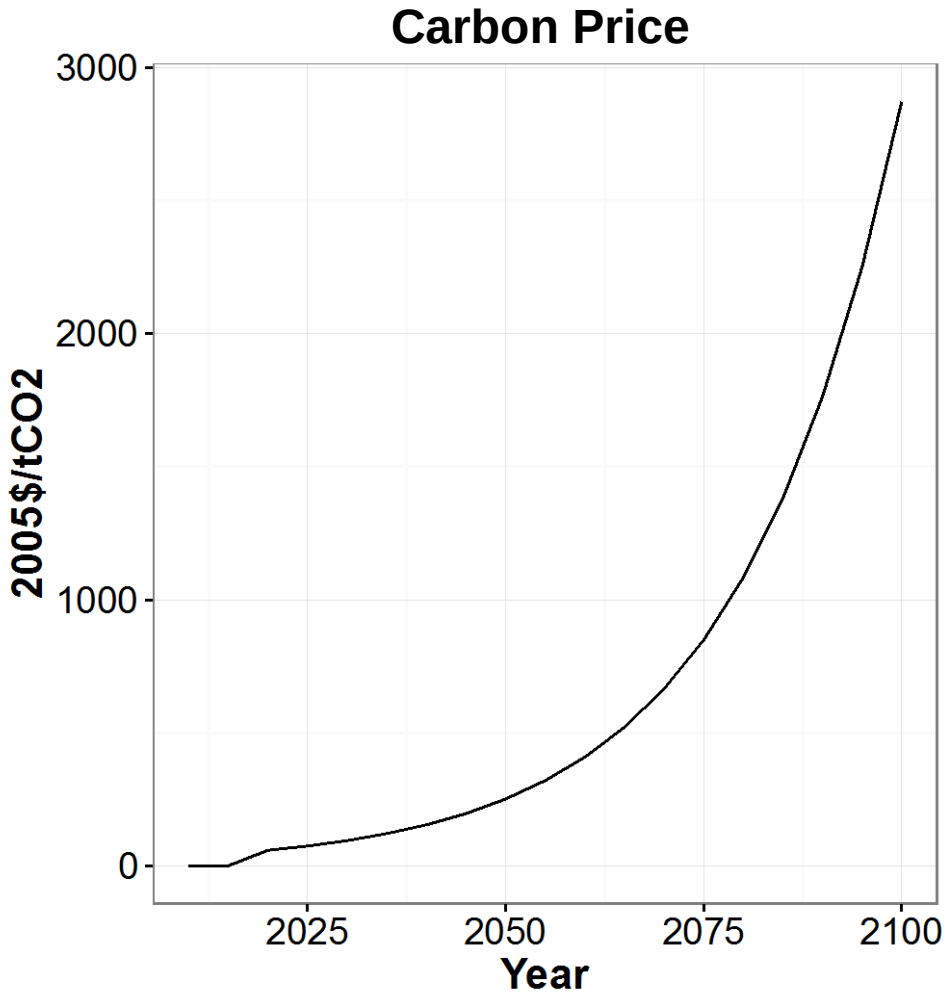
Limiting temperature to 1.5C requires a significant decrease in emissions.

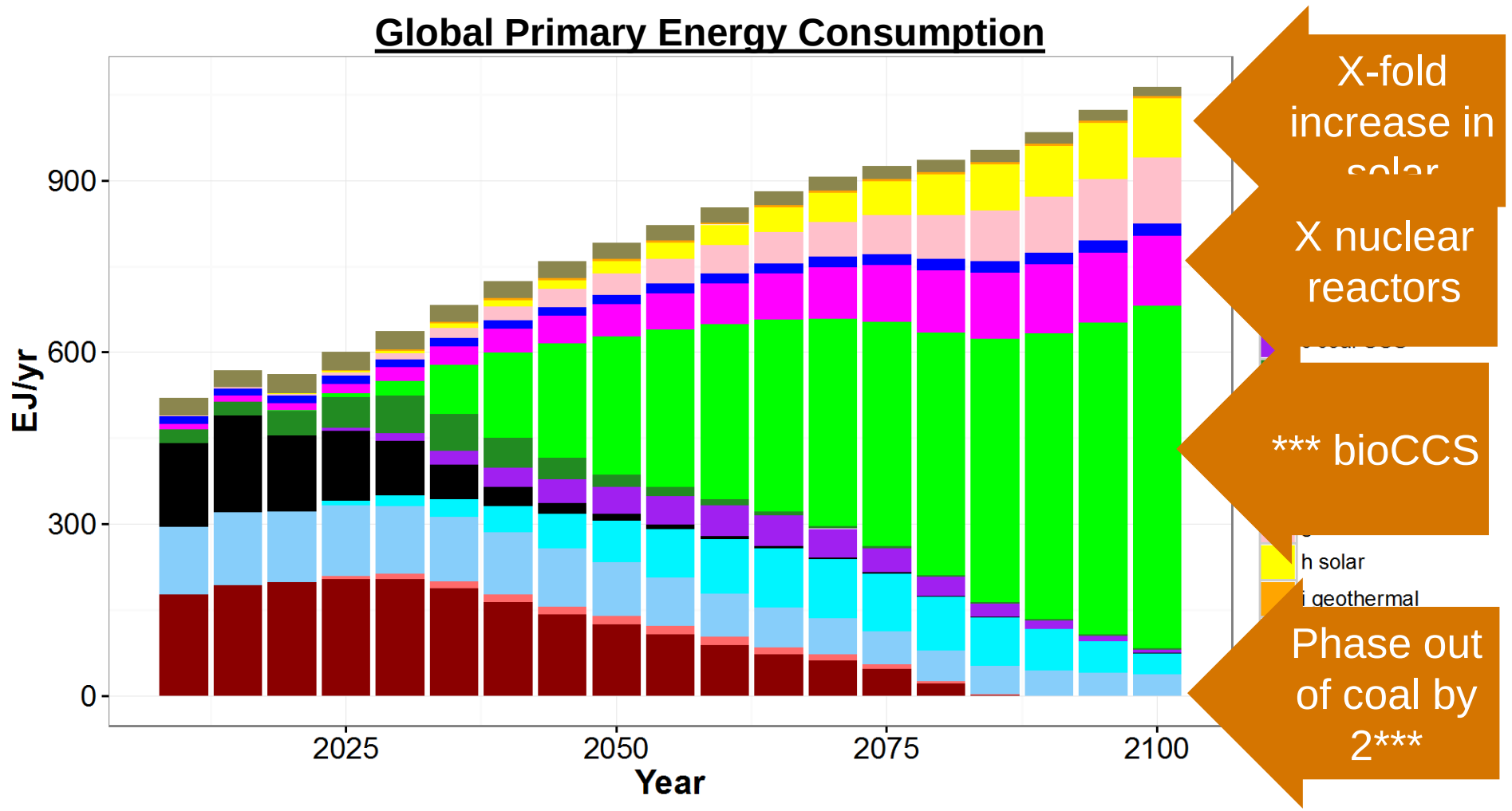




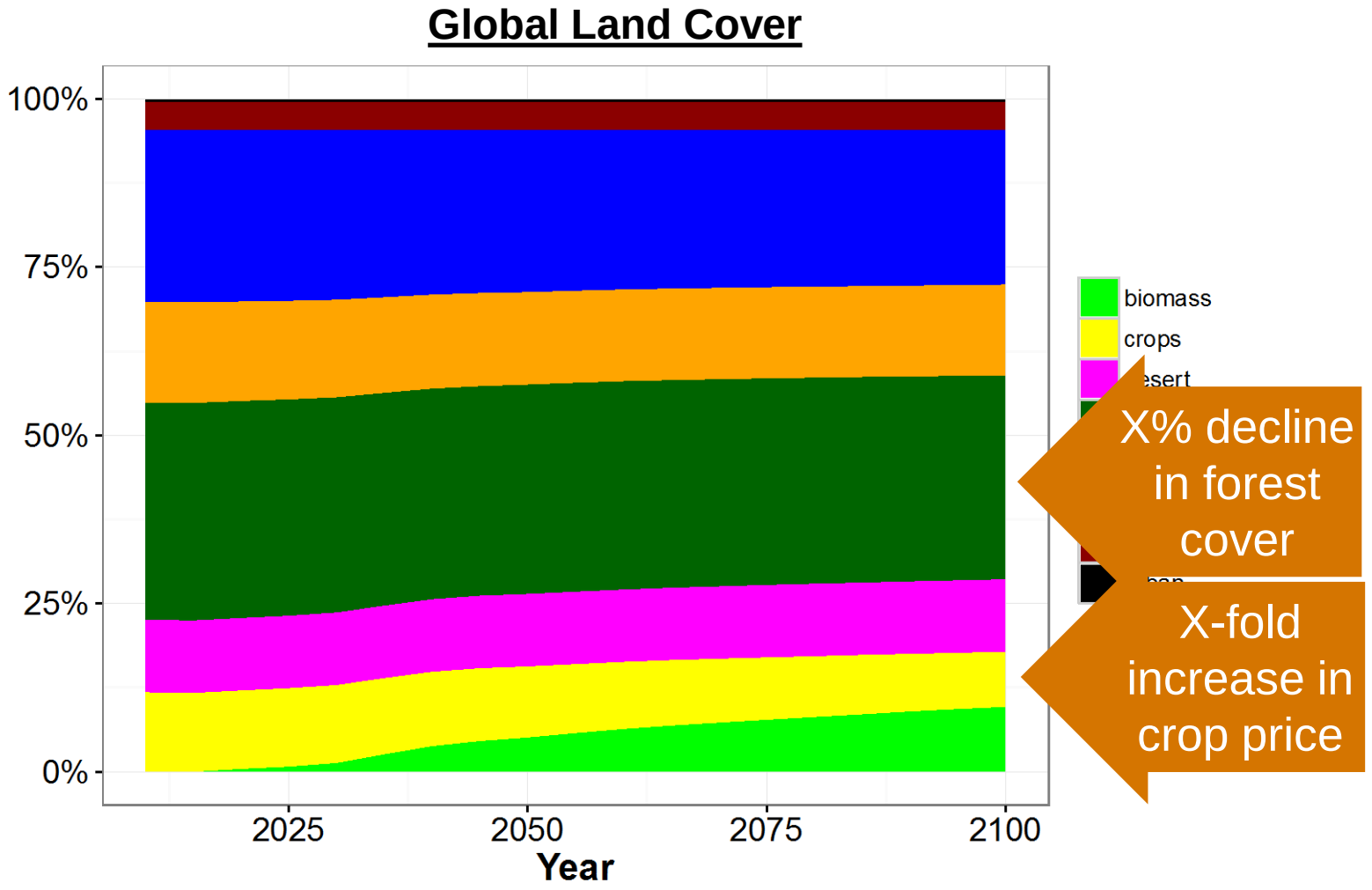
Global energy system CO_2 emissions are net negative beginning in 2050.






Global Primary Energy Consumption
EJ/yr
900
600
300
0
2025
2050
2075
2100
Year
X-fold increase in solar
X nuclear reactors
*** bioCCS
h solar
i geothermal
Phase out of coal by 2***

Producing this bioenergy requires x% of land to be devoted to bioenergy in 2100.



Science Questions

- What are the implications of mitigating to 1.5°C on the economy, energy, agriculture, and land use sectors?

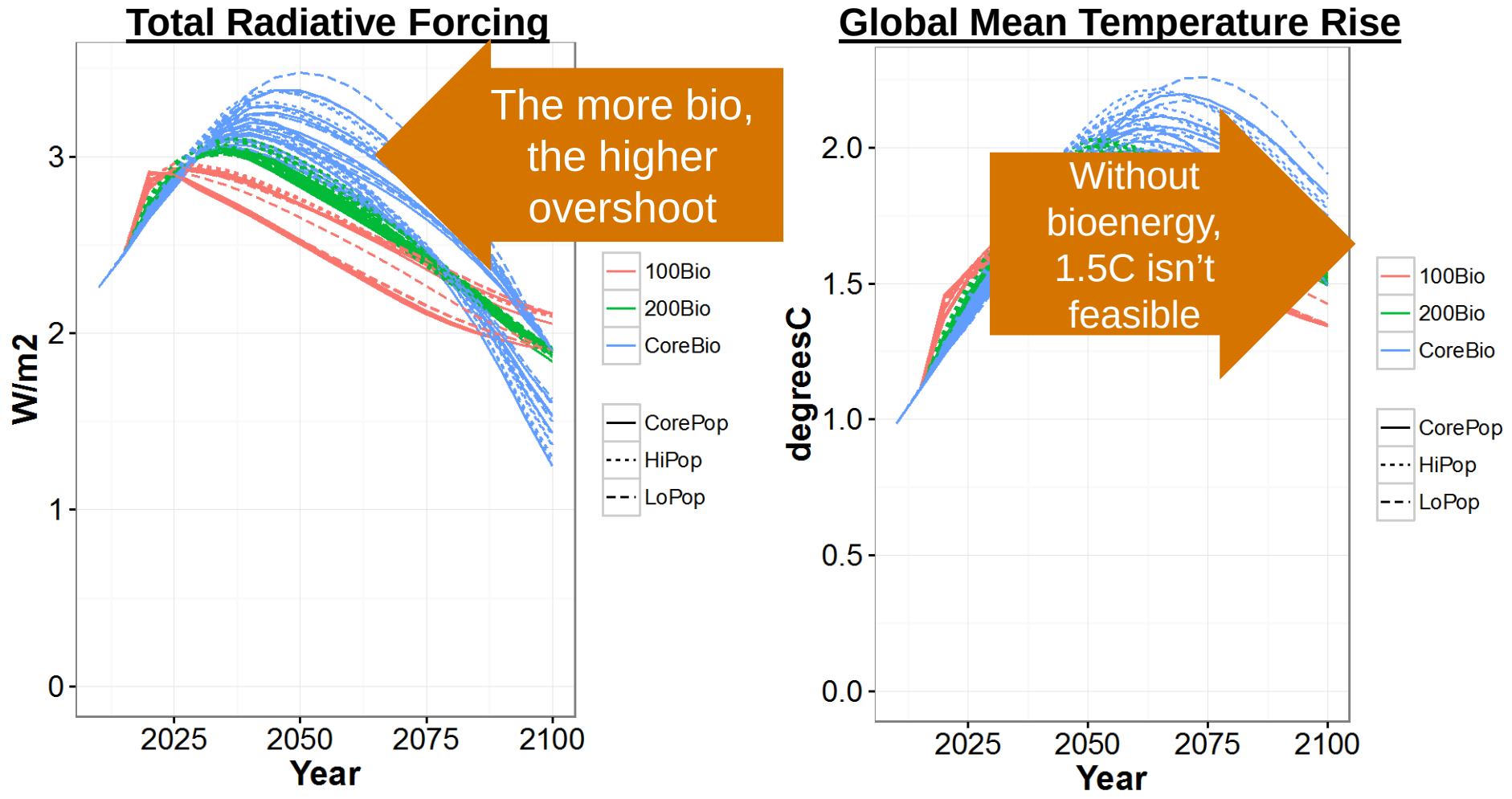
- How sensitive are our results to changes in underlying assumptions?

We varied five different assumptions within GCAM to test sensitivity of reaching 1.5°C.

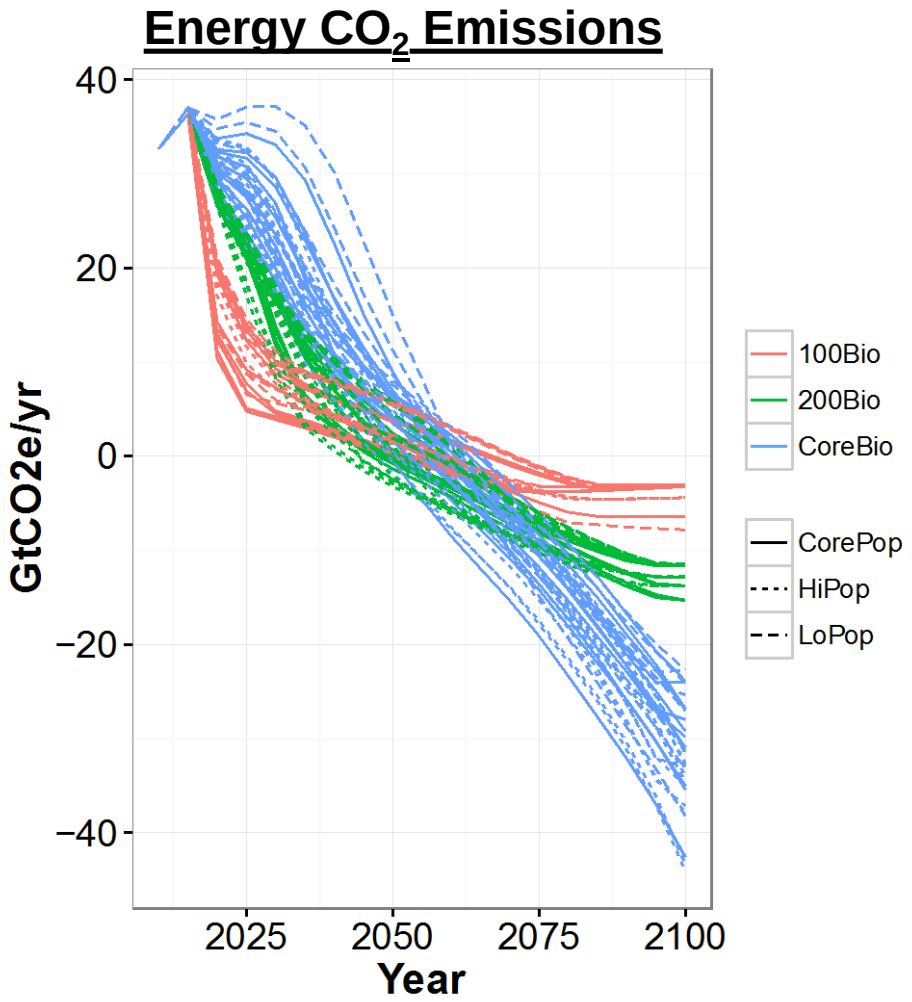
- Socioeconomics (SSP1, **SSP2**, SSP3) — **3**
- Land Policy (None, **Protect**, Afforest, 50% Afforest, Bio Tax) — **x 5**
- Bioenergy Availability (**No constraint**, 0 EJ/yr, 100 EJ/yr, 200 EJ/yr) — **x 4**
- Agricultural Productivity (**Reference**, Low) — **x 2**
- Climate Target (**1.5°C**, 1.9 W/m^2) — **x 2**

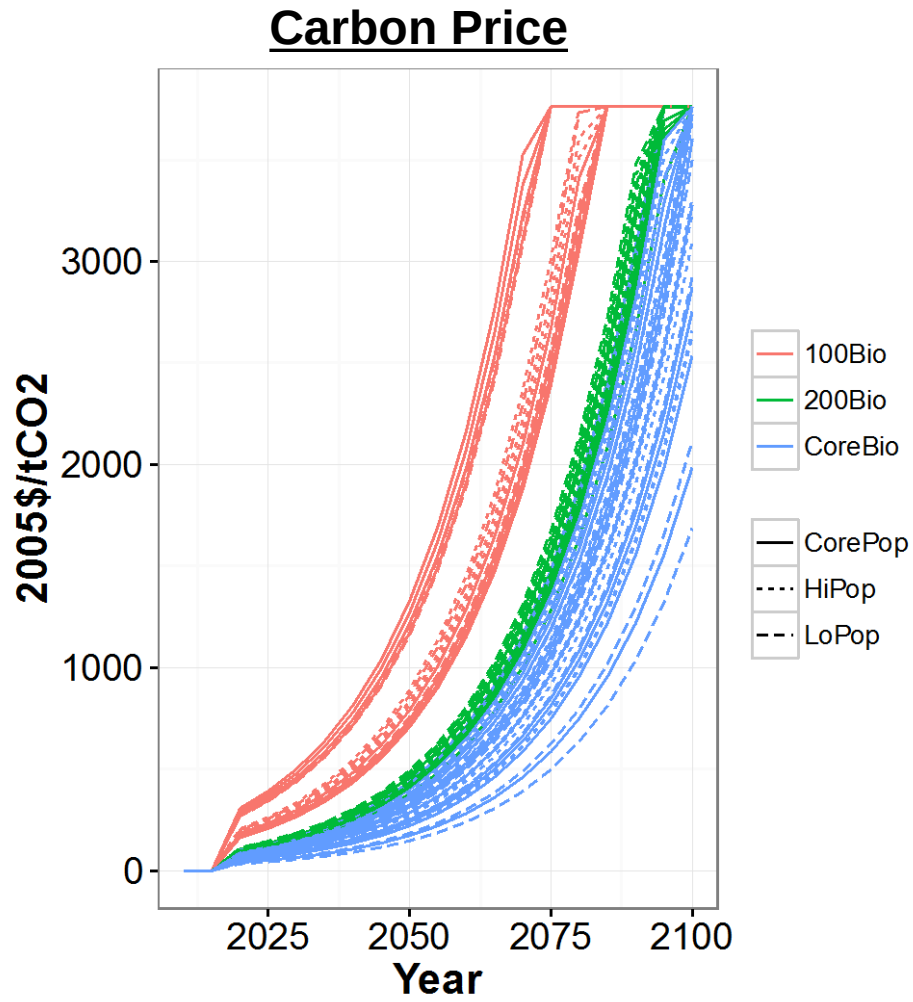
240

Of the 240 simulations attempted, 76 were successful



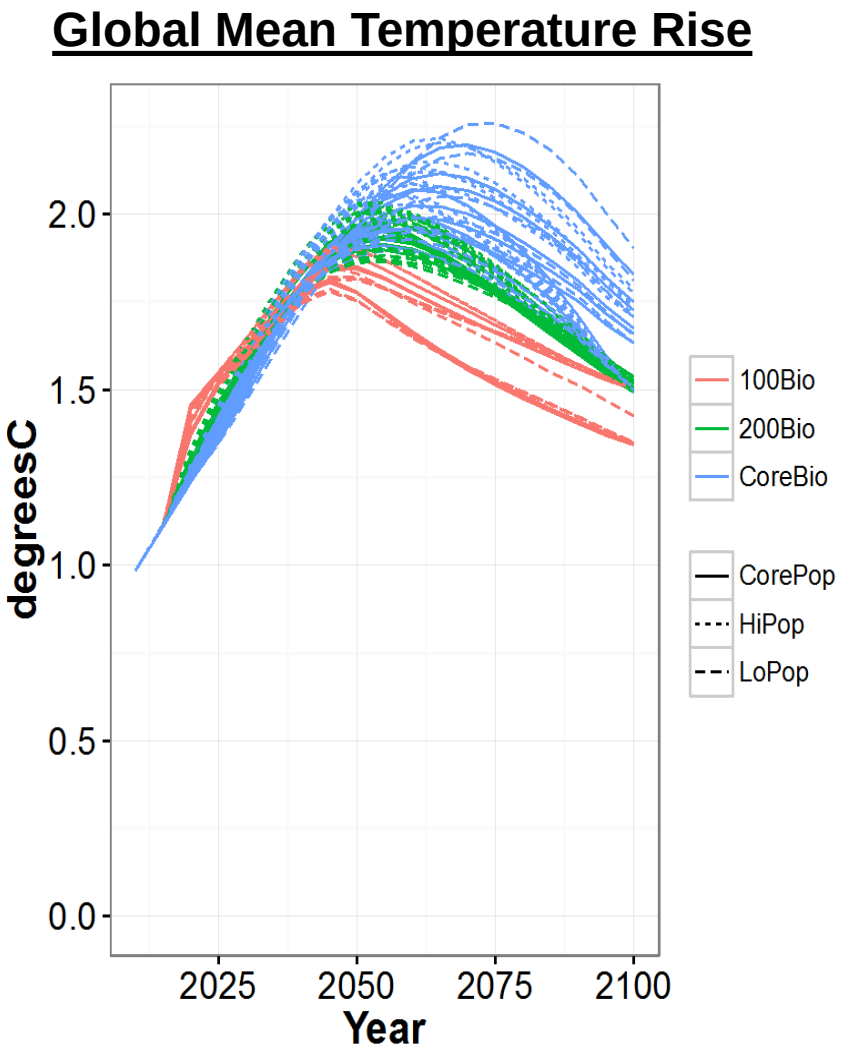
Limiting bioenergy results in more rapid emissions reductions and higher carbon prices.





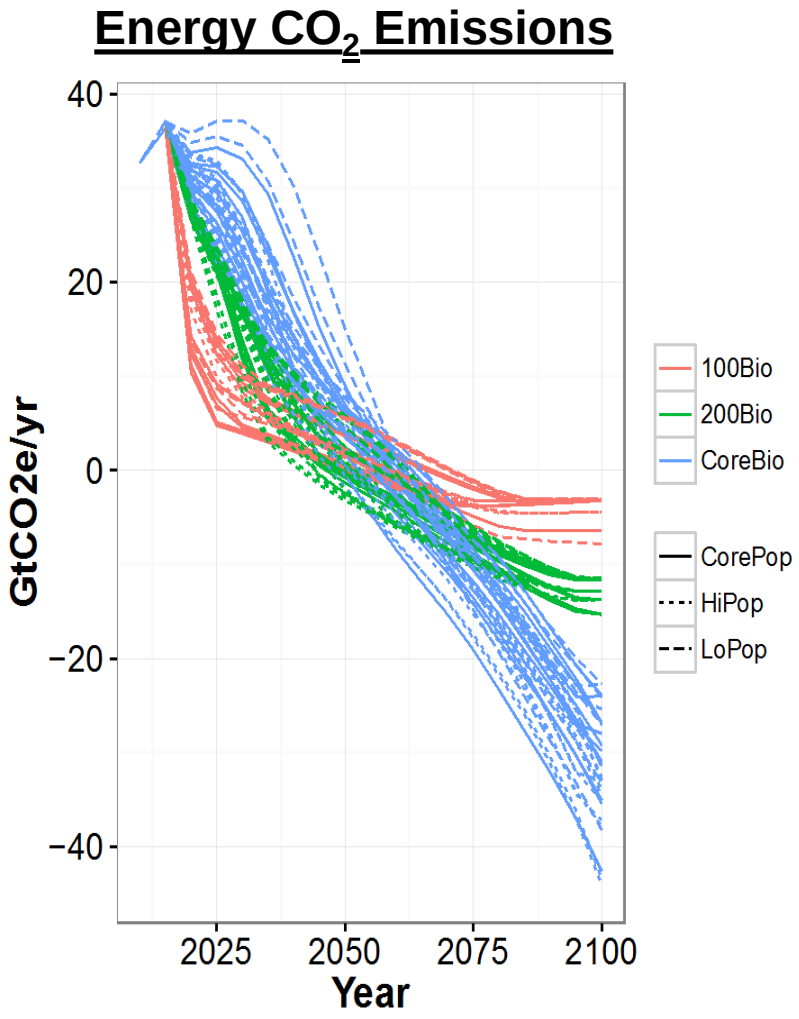
Major Caveats

- **Limited sensitivity experiment**
  - We only varied five assumptions: socioeconomics, land policy, bioenergy availability, agricultural productivity, climate target.
  - There are many other uncertainties that should be explored (e.g., technology cost, near-term climate policy).
- **Model choice**
  - We are only using a single IAM.
  - We are not capturing structural uncertainty at all.



Major Caveats (continued)

- **Feasibility**
  - We have defined feasibility in a technical manner. We haven't examined economic or political feasibility.
  - In some ways, we are probably too optimistic. In other ways, too pessimistic.
- **Definition of 1.5 degrees**
  - We only looked at 1.5°C and 1.9 W/m^2 in 2100 as targets.
  - How you define 1.5°C will matter, e.g., in what year, with what likelihood, with which climate model?



DISCUSSION