



U.S. DEPARTMENT OF
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Impacts analysis in GCAM

Kate Calvin, Mohamad Hejazi, Yuyu Zhou, Leon Clarke, Jiyong Eom, Page
Kyle, Pralit Patel, Jae Edmonds

Joint Global Change Research Institute (JGCRI)
Utrecht, Netherlands

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Impact Analysis in GCAM



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- ▶ Buildings Impacts
- ▶ Water Supply Impacts
- ▶ Agricultural Impacts
- ▶ Thermoelectric Impacts
- ▶ Wind Supply Impacts
- ▶ Solar Supply Impacts

Impact Analysis in GCAM



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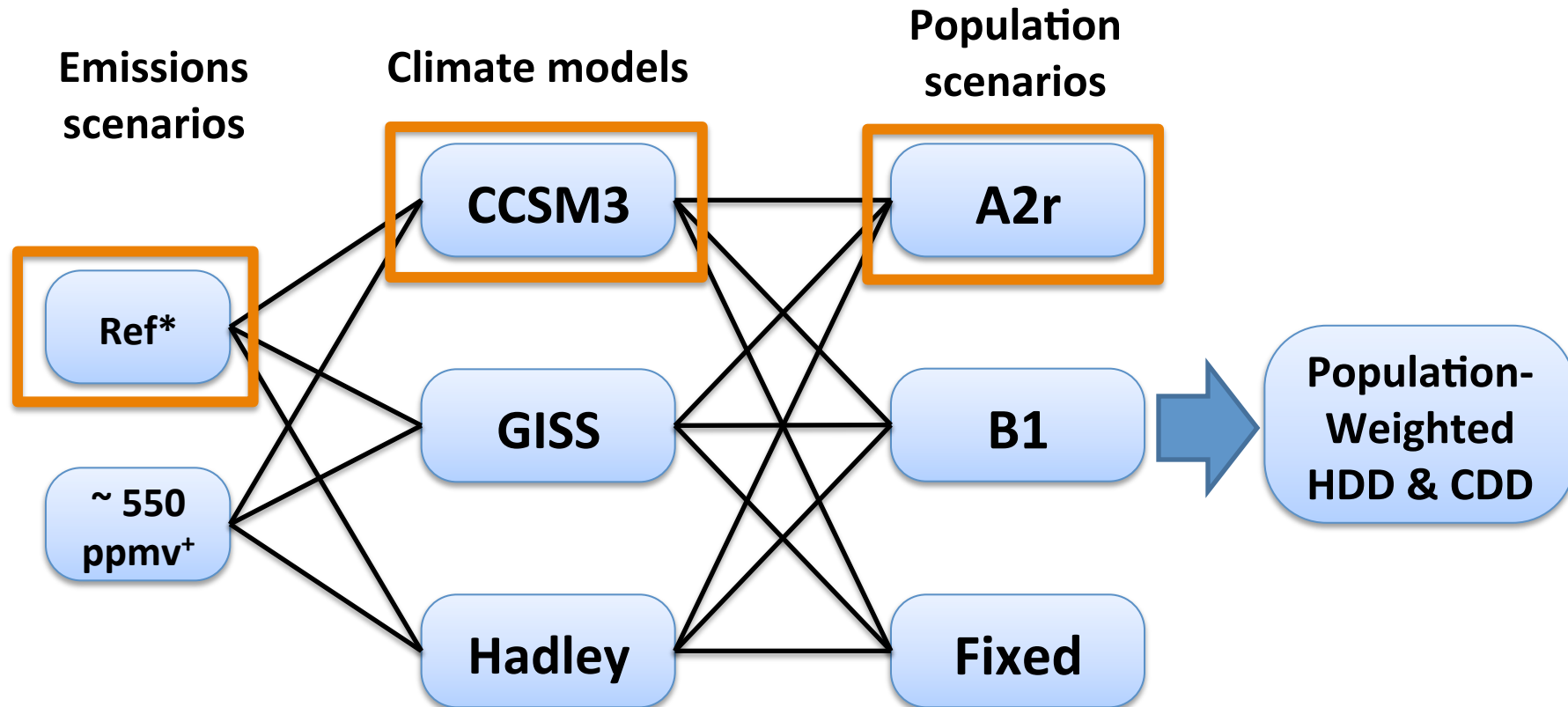
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BUILDINGS IMPACTS

- ▶ Climate changes affects the **demand** for **heating** and **cooling**.
 - Temperature rise leads to more demand for cooling and less demand for heating.

- ▶ Heating and cooling demand in GCAM are a function of temperature and income.
 - HDD and CDD exogenously specified

Scenarios design



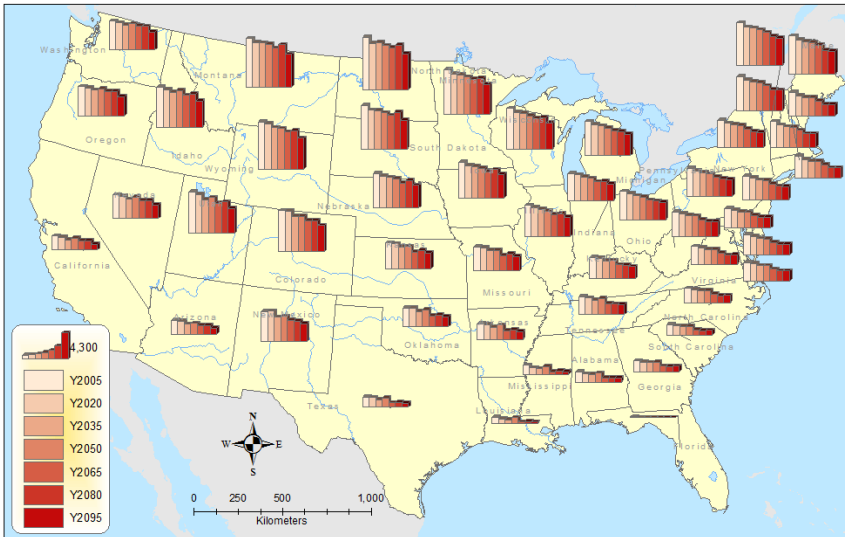
* Reference represented by IPCC SRES A2 scenario

⁺ 550 ppmv scenario represented by IPCC SRES B1 scenario

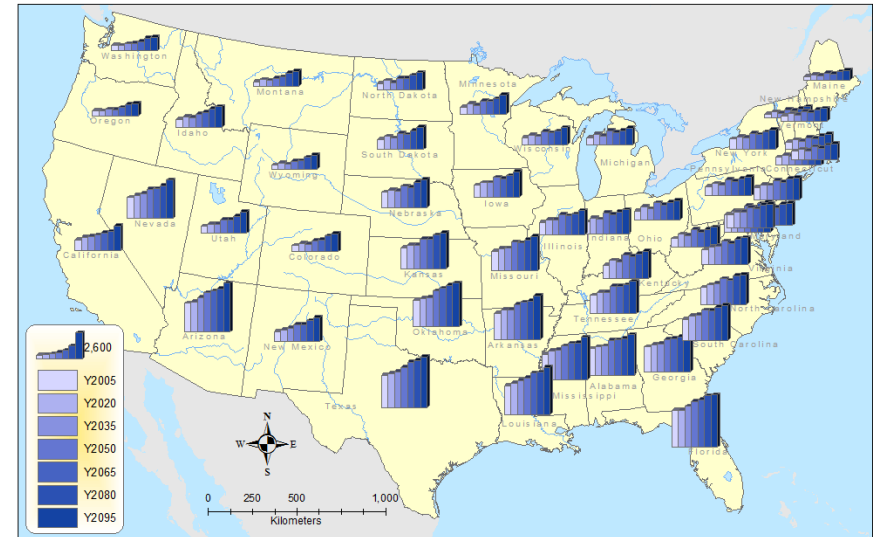
State HDD/CDDs (CCSM A2)

Heating Degree Days

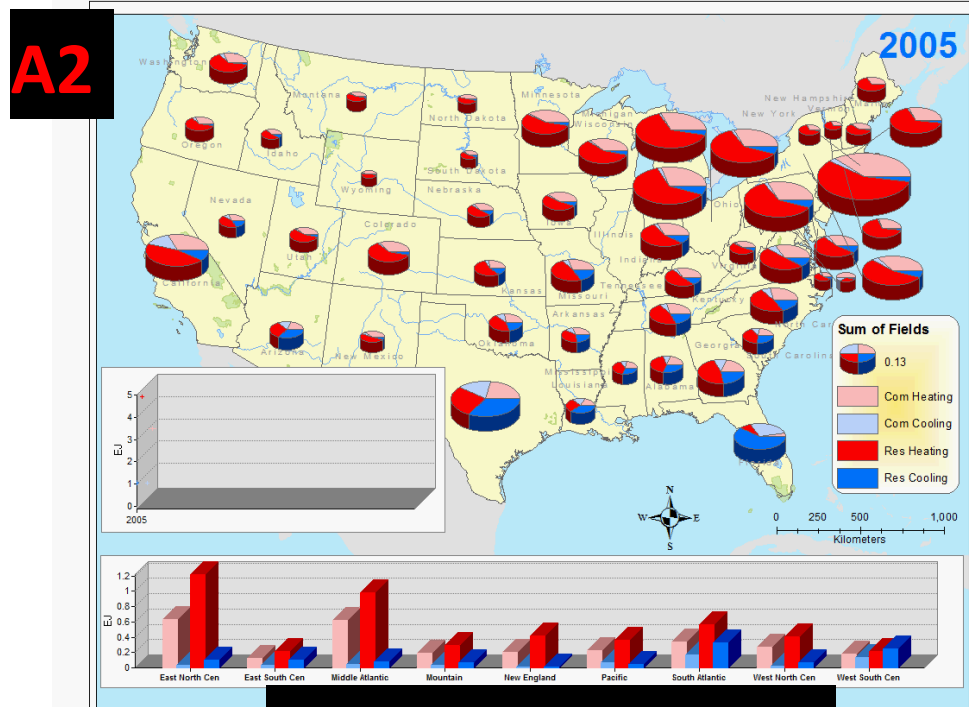
A2



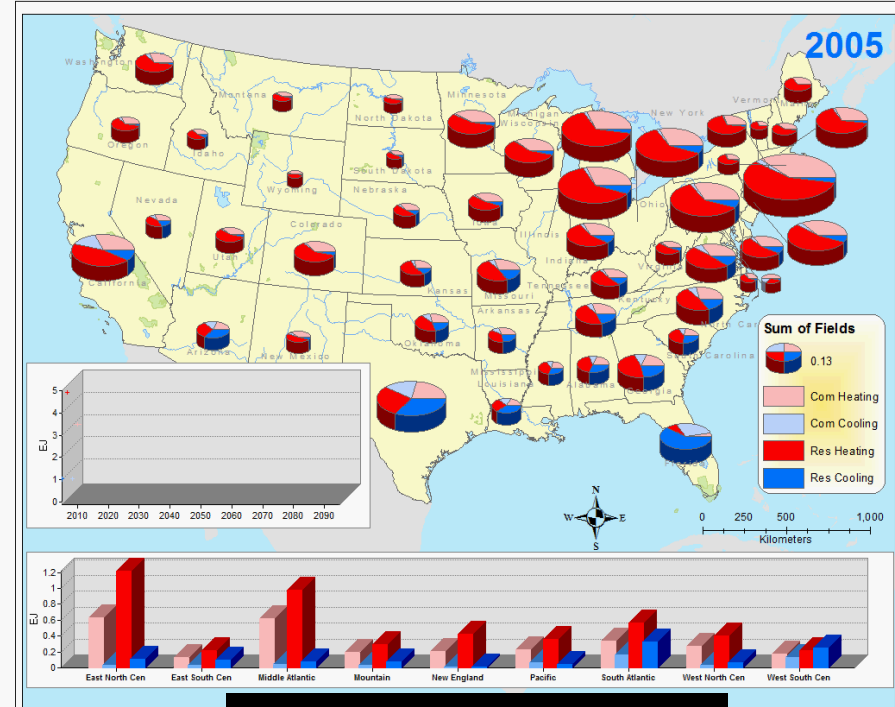
Cooling Degree Days



State level energy use



Without Climate Feedback



With Climate Feedback

Impact on Fuel Use (State)



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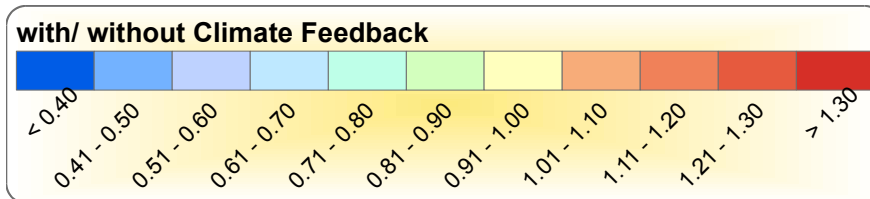
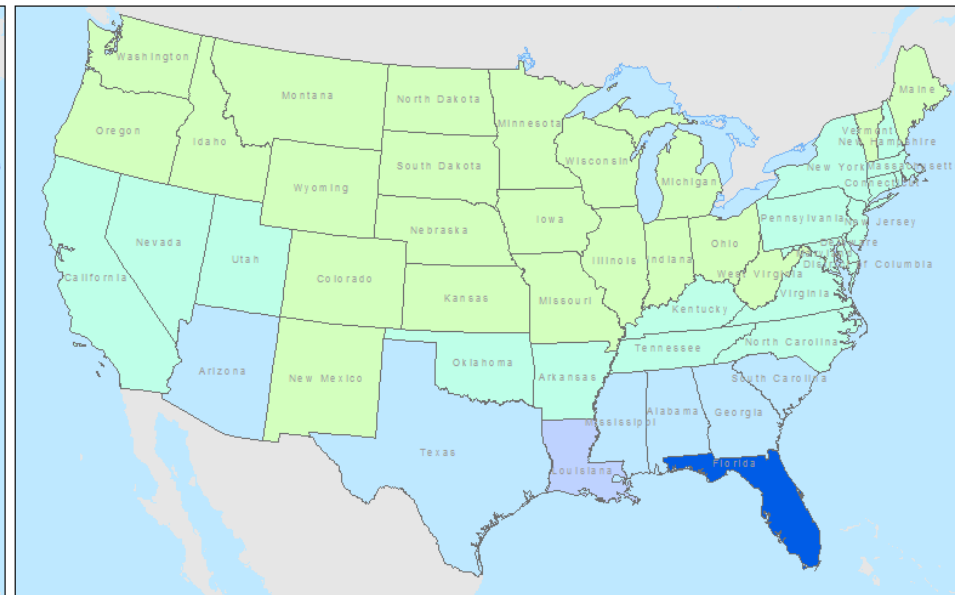
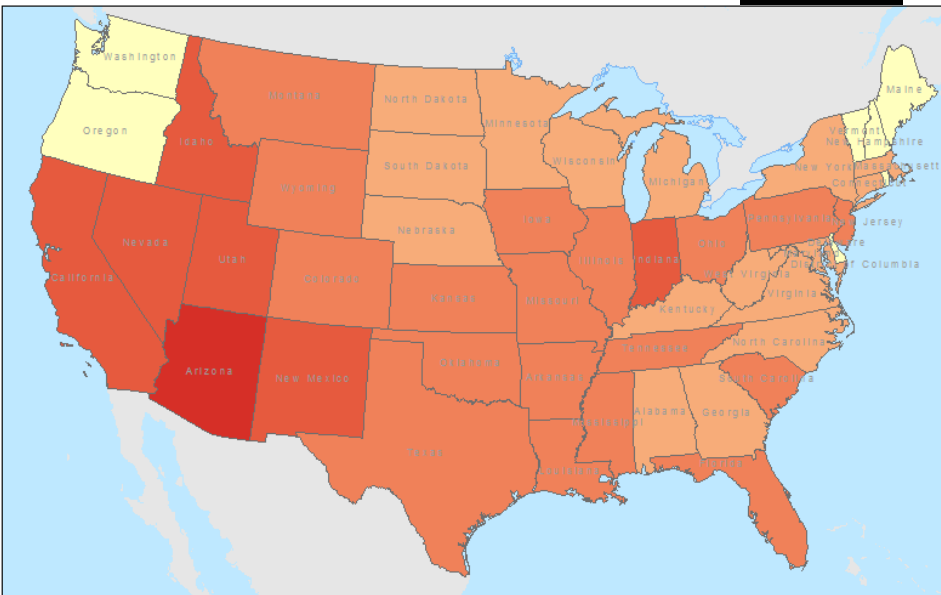
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Research and Development for a Sustainable Future

A2

Elec.

Gas





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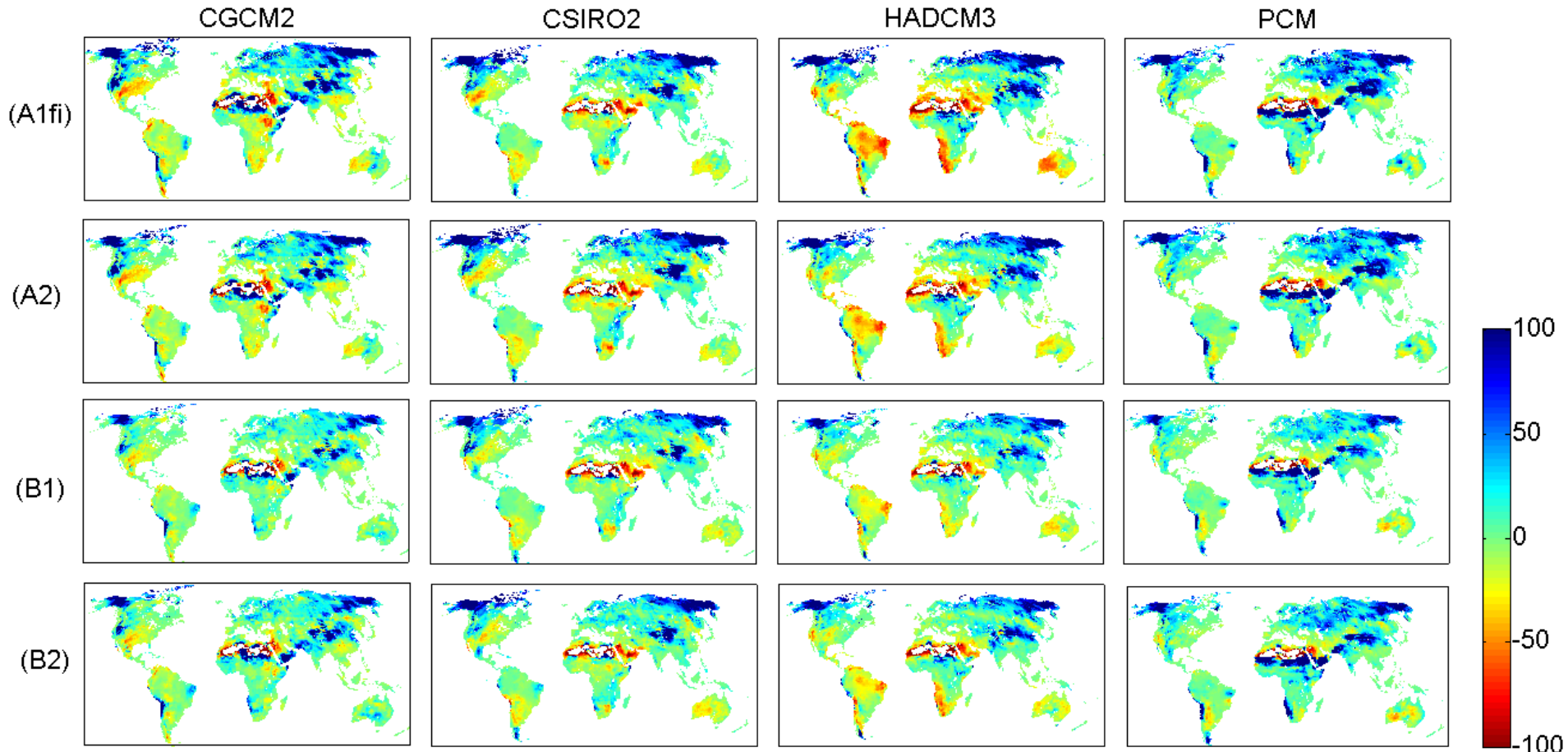
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WATER IMPACTS

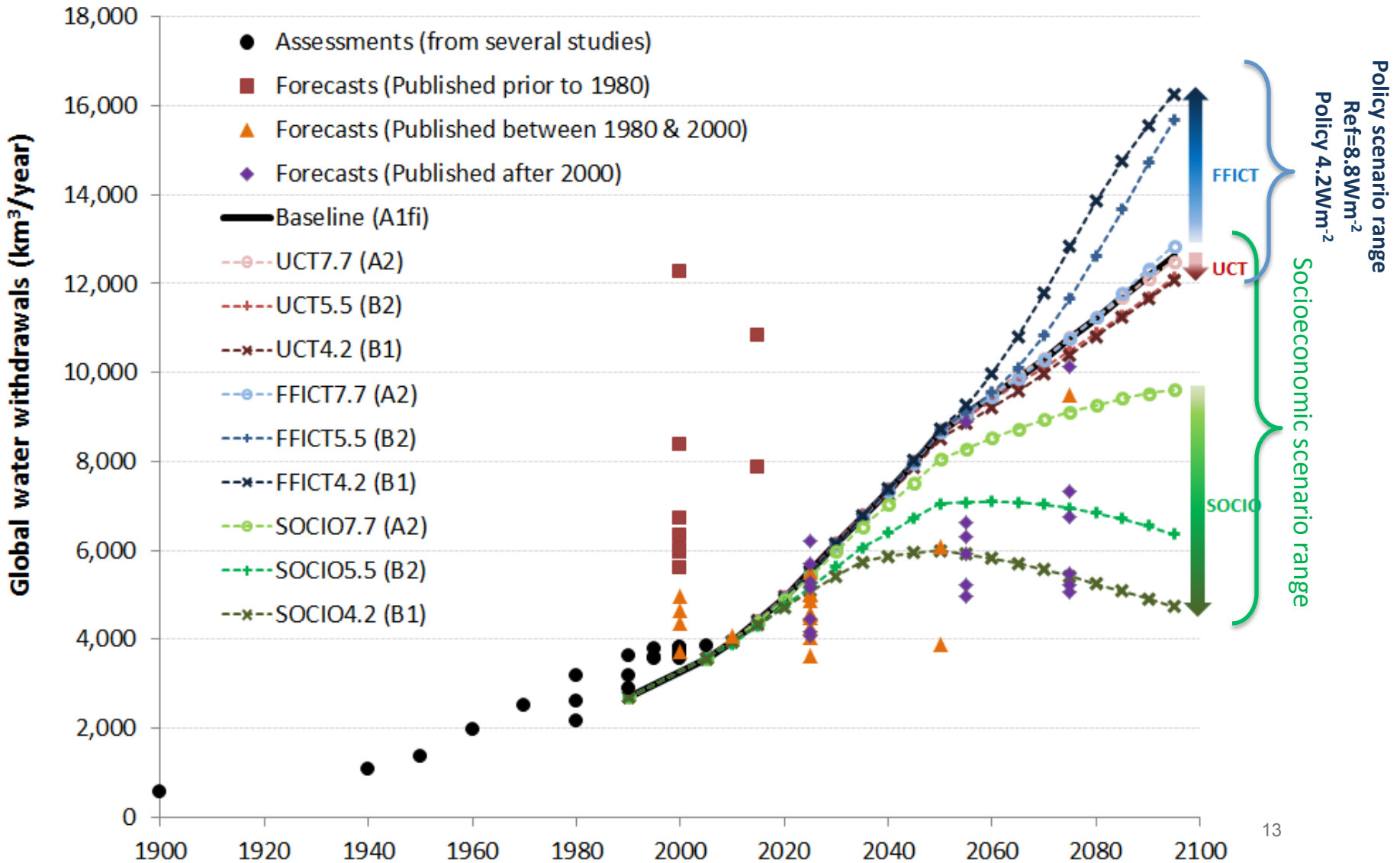
- ▶ Climate changes affects both the **supply** and **demand** for water.

- ▶ For this analysis, we are only considering the effect of climate on water supply.
 - The GCAM Water Supply model takes in climate data as input and can compute a difference in runoff.
 - Currently, water demand in GCAM is done through an accounting method. We are not capturing changes in demand due to climate in this analysis. (However, we do have differences in water demand due to socioeconomic and policy changes)

The Effects of Climate Change on Runoff (Percent Change between 2095 & 2005)

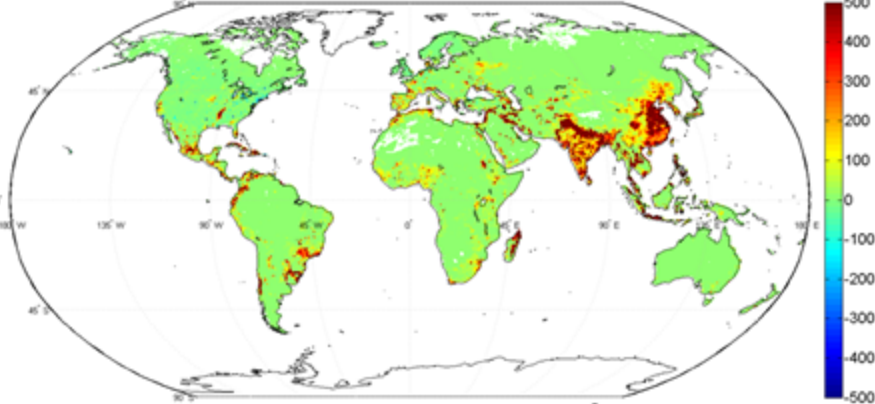


Future Global Water Demands



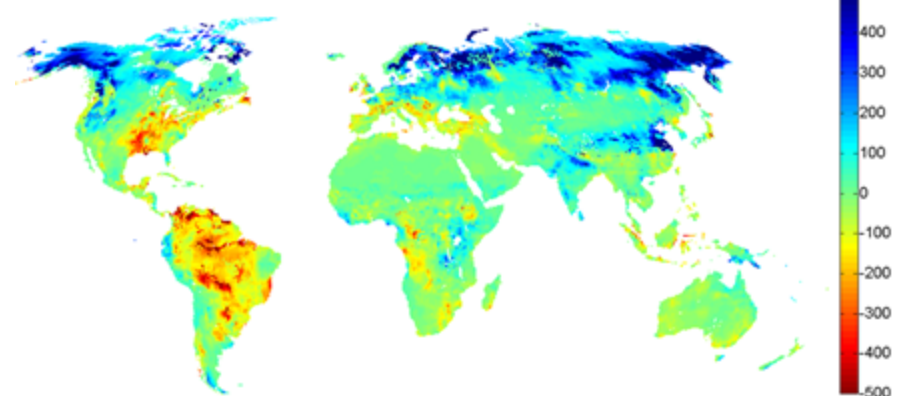
Change in Water Scarcity

Change in Total Water Demand ($TWD_{2095} - TWD_{2005}$)

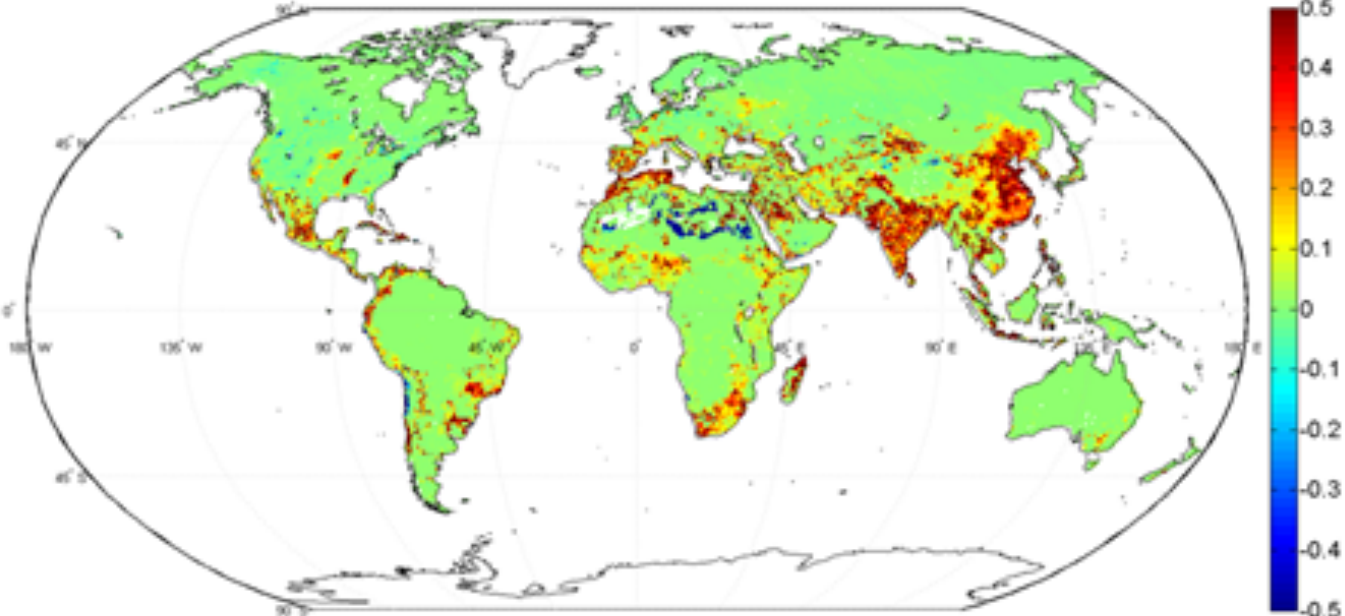


Reference Scenario (A1Fi) ($RF_{2095} = 8.8 \text{ W/m}^2$)

Change in Ensemble Mean Annual Runoff ($Q_{2095} - Q_{2005}$) (mm/yr)



Change in Water Scarcity Index ($WSI_{2095} - WSI_{2005}$)



Reference Scenario (A1Fi) ($RF_{2095} = 8.8 \text{ W/m}^2$)



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AGRICULTURAL IMPACTS

Agriculture and Forestry Impacts

- ▶ Climate changes affects both the **yield** of crops and the **carbon density** of different ecosystems.
 - CO₂ fertilization tends to increase these values
 - Temperature & precipitation have a mixed effect

- ▶ Both yield and carbon density are exogenously specified in GCAM.
 - We read these parameters in for each land cover type (e.g., corn, rice, wheat, pasture, forest, etc.) and each of the 151 regions.

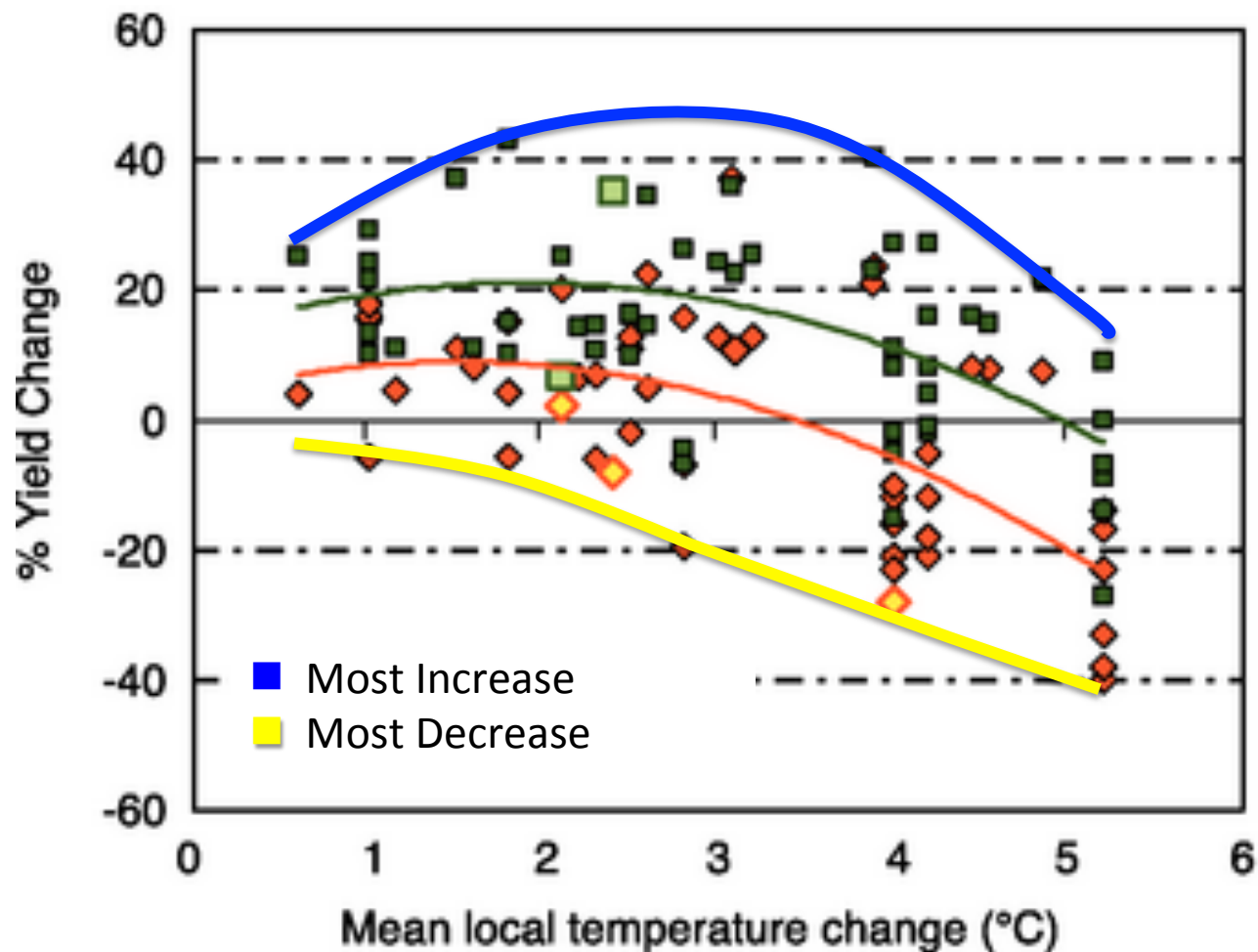
- ▶ Adjusting yield and carbon density will affect:
 - The profitability of land – this will result in different land allocations.
 - The carbon storage of land – this will result in different land use change emissions

Exogenously Specified Yield Change: Approach

- ▶ Exogenously specified yield changes:
 - We adjusted yields based on a study that linked temperature rise to crop yield.
 - We only considered agricultural commodities.
 - We only adjusted yields.
 - Data was only provided for two regions and three crops. We mapped these changes to all regions and crops.

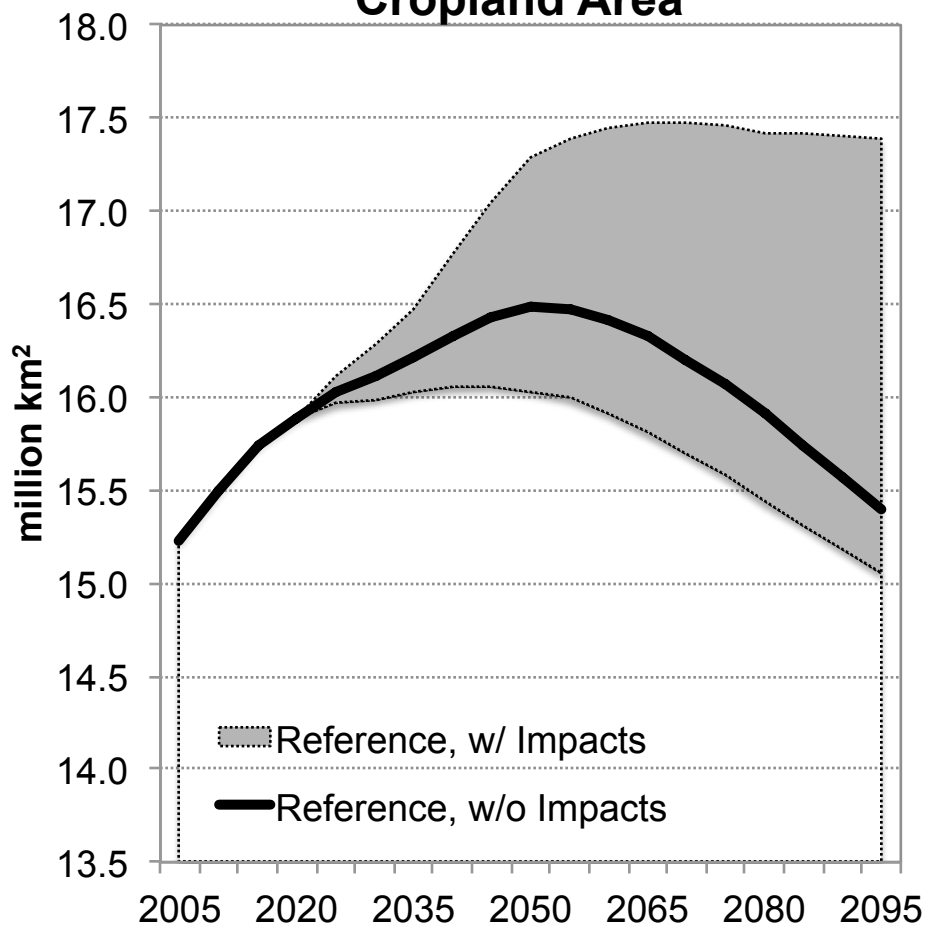
Exogenously Specified Yield Change: Input Assumptions

Change in Yield for Mid- to High-Latitude Wheat

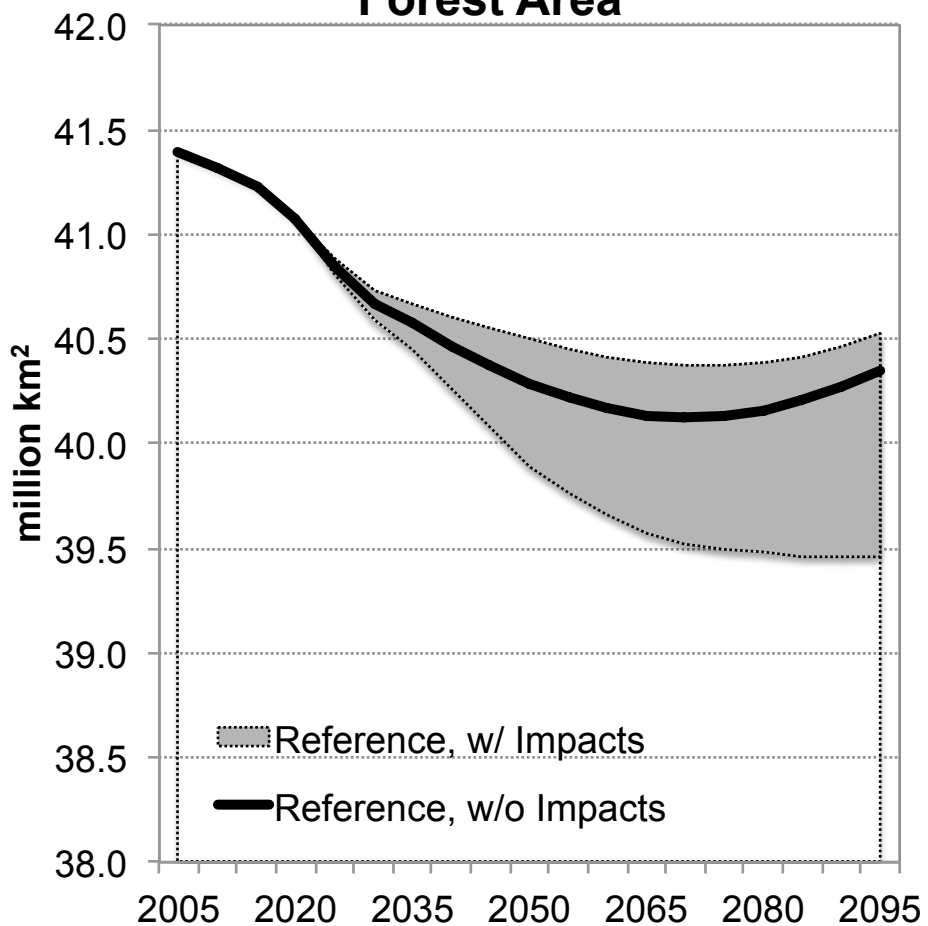


Exogenously Specified Yield Change: Results

Cropland Area

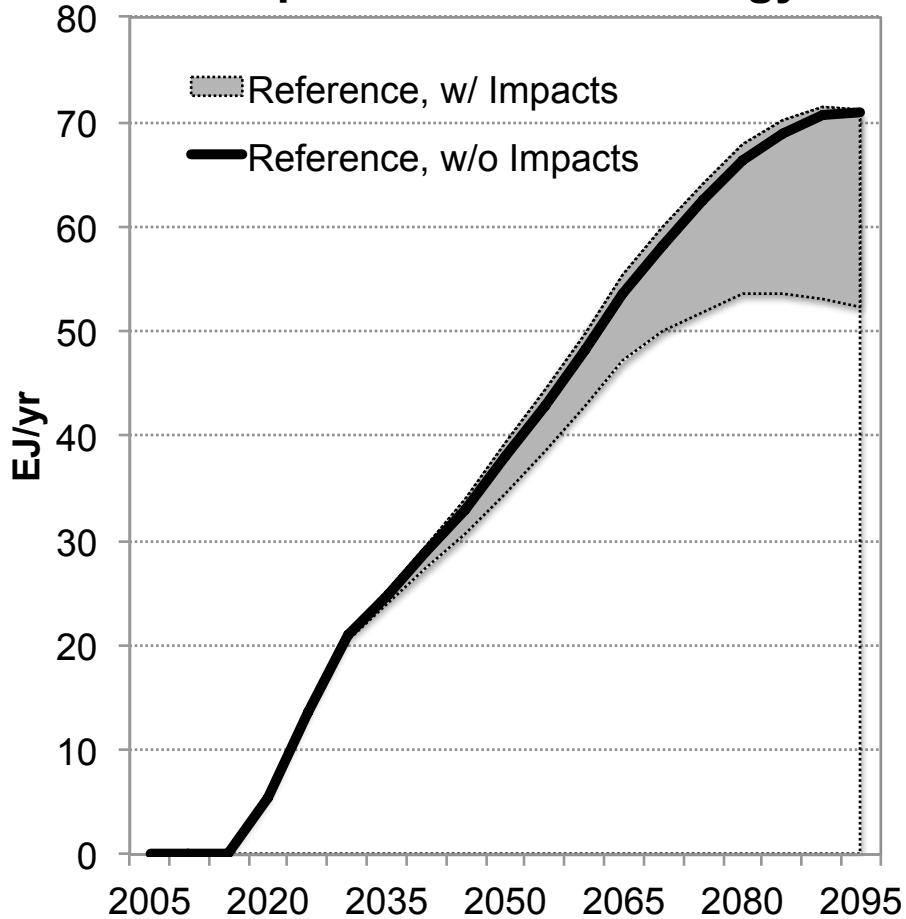


Forest Area

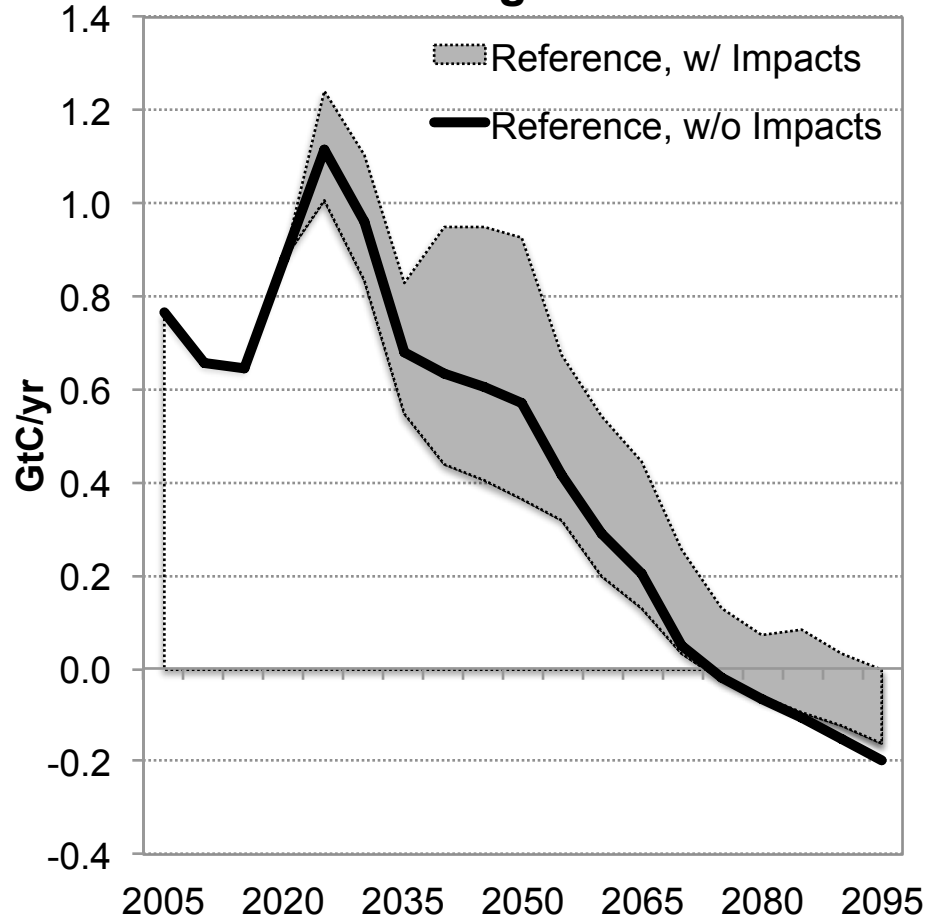


Exogenously Specified Yield Change: Results

Purpose Grown Bioenergy

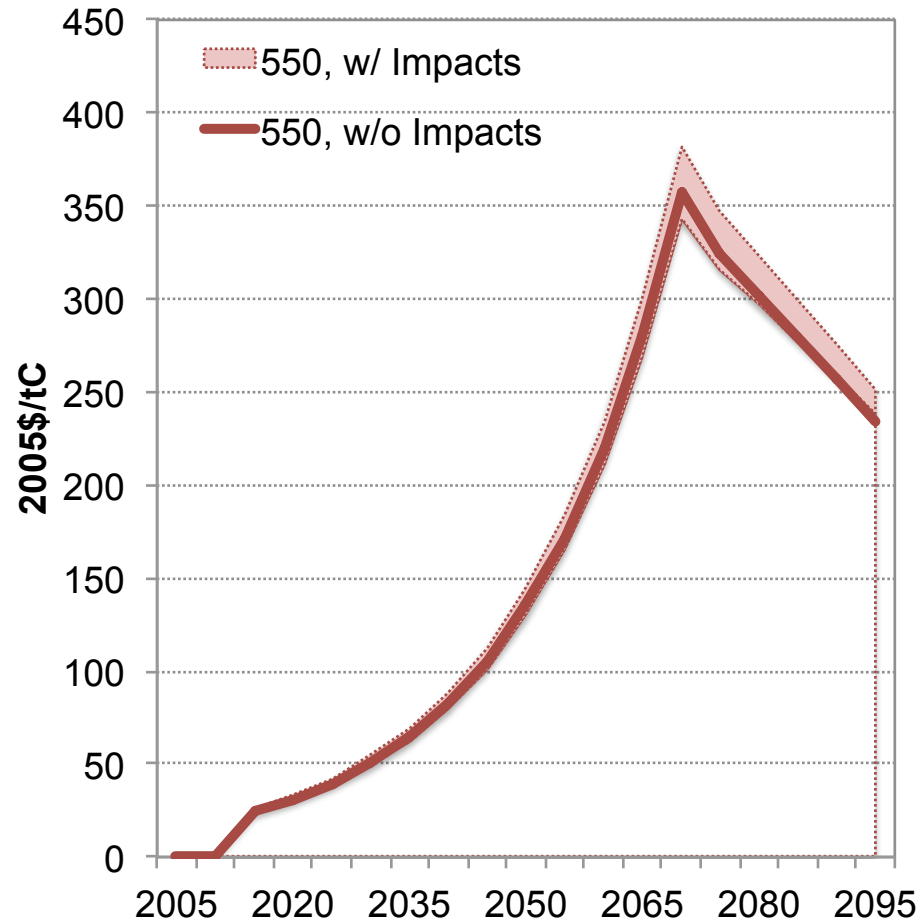


Land-Use Change Emissions



Exogenously Specified Yield Change: Results

CO₂ Prices



Other approaches to Ag Impacts in GCAM

- ▶ iESM:
 - (Bill's presentation yesterday)
 - Uses spatial data on change in productivity from CLM to adjust yield and carbon density

- ▶ AgMIP:
 - (Dominique's presentation today)
 - Uses change in yield from different combinations of climate model, crop model, emissions scenario

- ▶ CIRA:
 - (Jim's presentation today)

- ▶ Other?



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DISCUSSION