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Potential Consequences of Climate Mitigation for Land Use Change in the 21st Century

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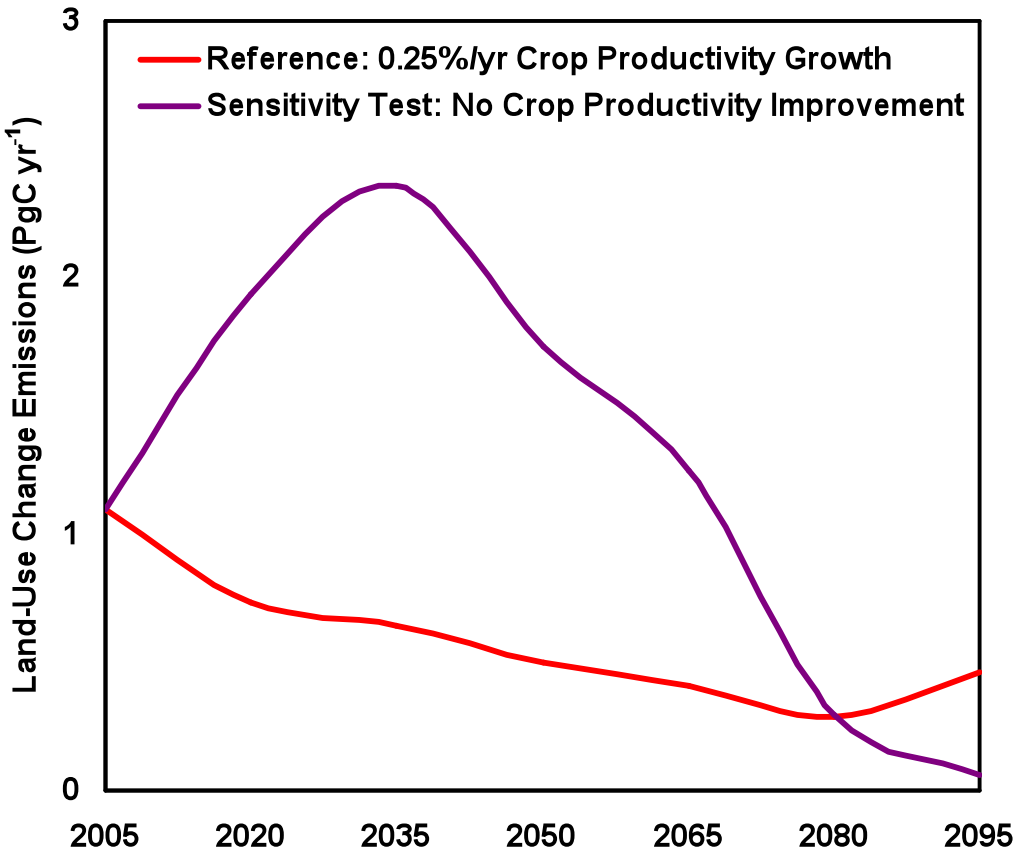
Overview

- Typical disciplinary split allows for studies of
  - Mitigation (e.g. biofuels, soil C sequestration), assuming plants not impacted by climate change and resources not diverted for adaptation
  - Adaptation (e.g. changing crop management), assuming land resources are not affected by mitigation
- Both assumptions are false, but sometimes necessary to simplify individual studies.
- Can global models provide insights into the significance of these assumptions?
- Here we test a land use factor of interest for both migitation and adaptation - **agricultural productivity growth** - in a simulated global mitigation policy.

Crop productivity and land use

- Crop yields are expected to continue to increase over time (FAO), however this is:
  - Uncertain, and also
  - Sensitive to the impacts of climate change
- Improving agricultural crop productivity reduces deforestation pressure.
  - Cumulative land-use change emissions 2005 to 2095: **72 PgC.**



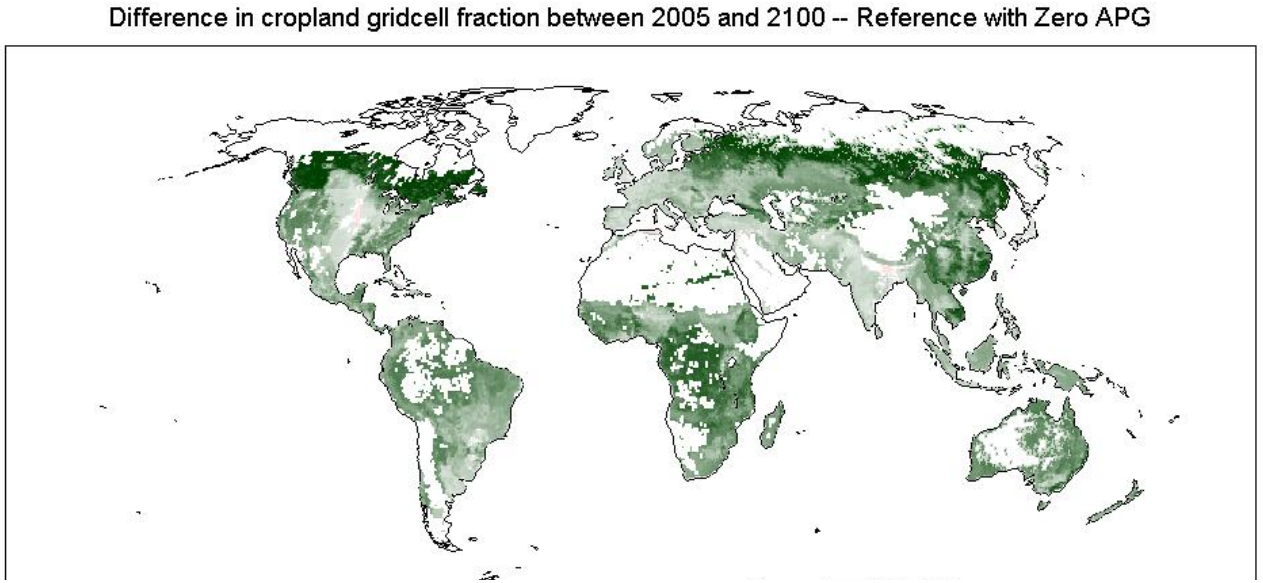
GCAM simulations with no mitigation

Scenario design

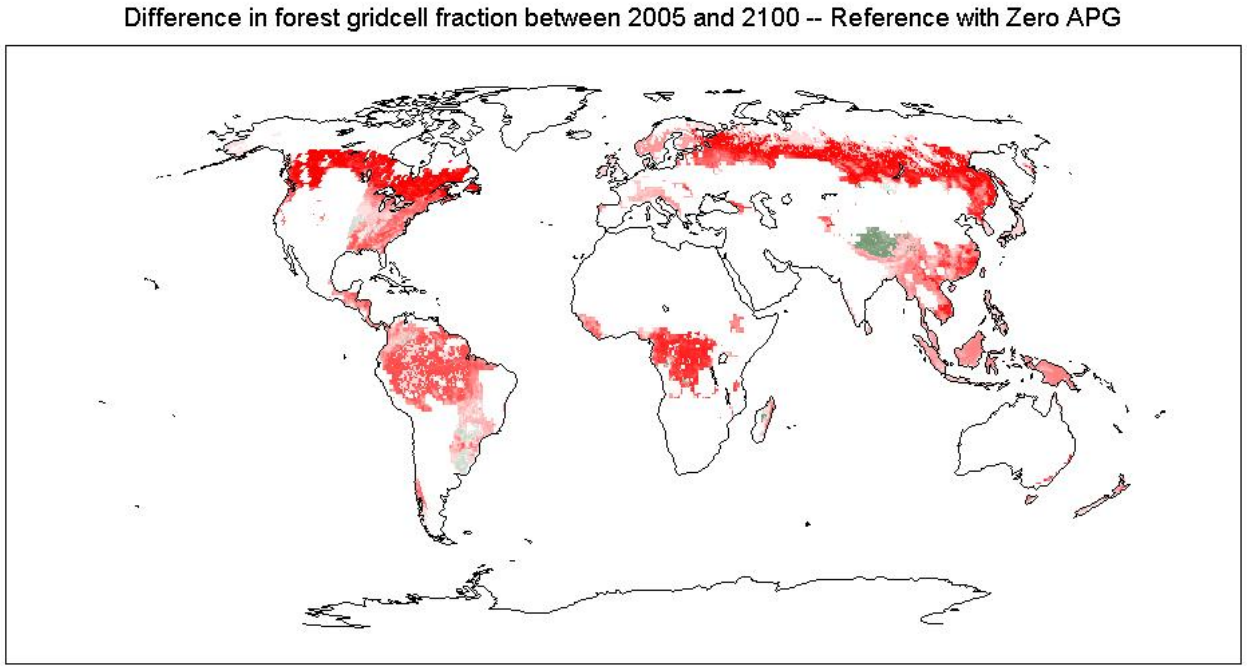
- Apply the GCAM model used in emissions scenario simulation and analysis of mitigation policies.
  - Considers future growth in population and income, and future transformations in energy technology
  - No climate impacts are simulated
  - Land use simulated at the global scale for 14 regions and downscaled to a grid
- Mitigation policy discussed here is the RCP4.5 stabilization case:
  - ~650 ppm CO_2-e in 2100
  - Emissions price applies equally to emissions from land use as well as emissions from energy and industrial processes.
- Simulations conducted with two set of exogneous parameters on agricultural productivity growth (APG)
  - Standard: Follows FAO to 2030 and converges to 0.25%/year
  - zAPG: Held constant at 2005 yields

Change in crop and forest land from 2005 to 2100 when agricultural productivity DOES NOT increase

Reference Case (zAPG)



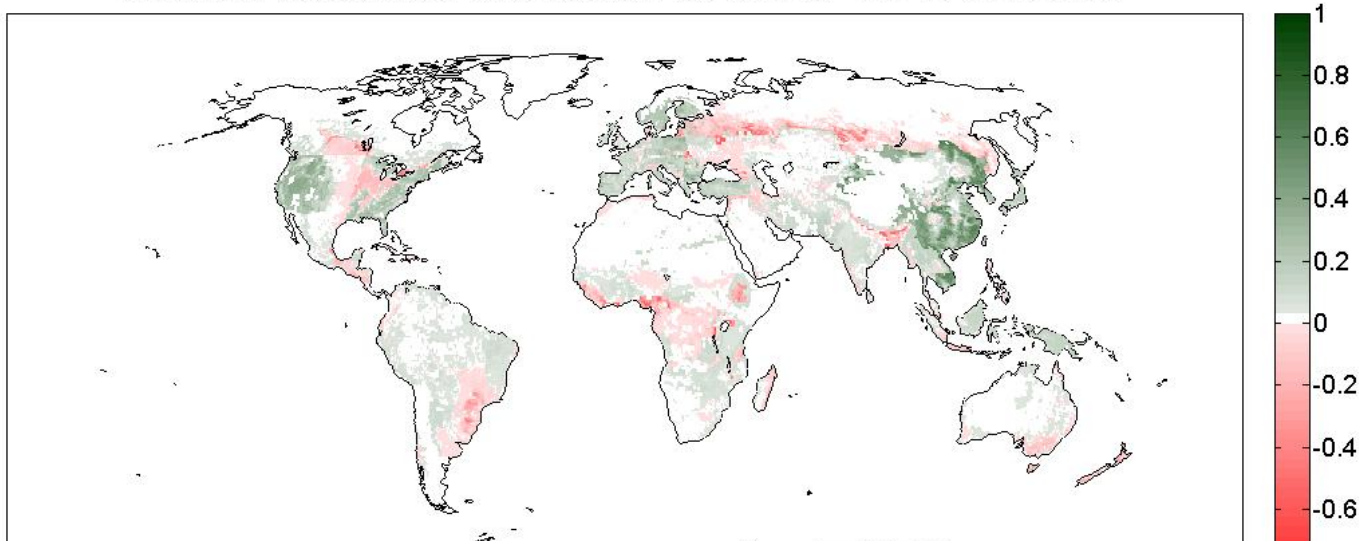
Cropland



Forest

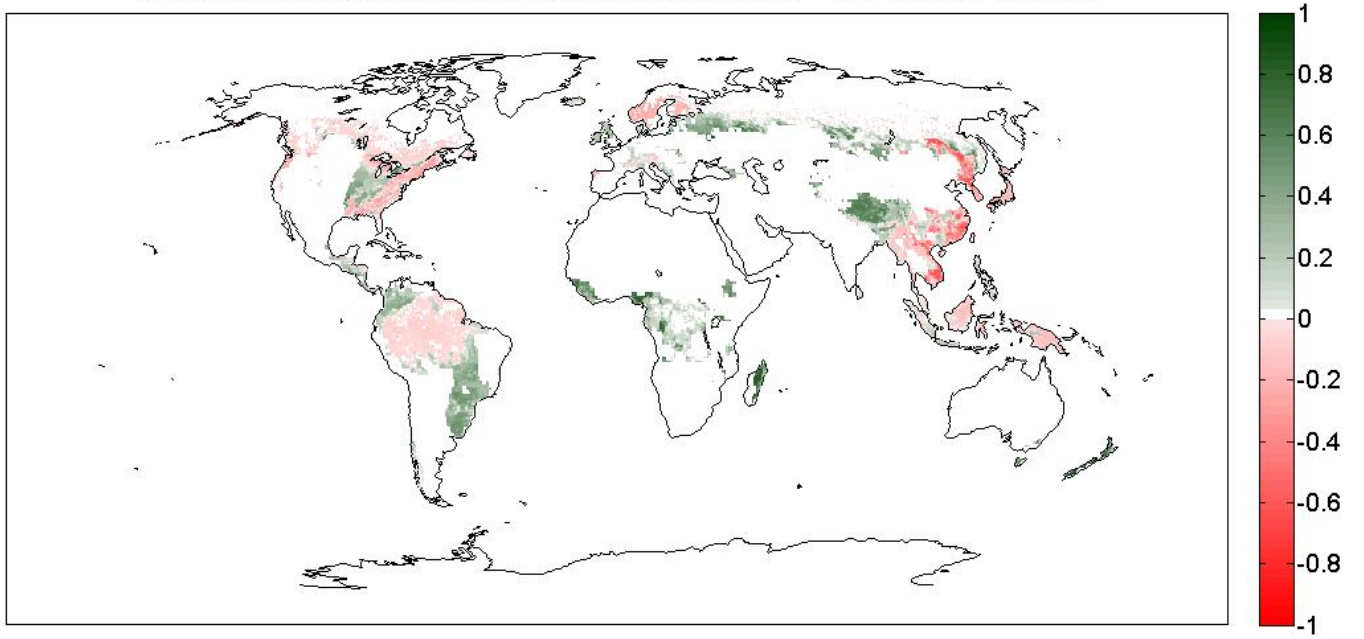
Climate Mitigation Scenario (zAPG)

Difference in cropland gridcell fraction between 2005 and 2100 -- RCP4.5 with Zero APG



Cropland

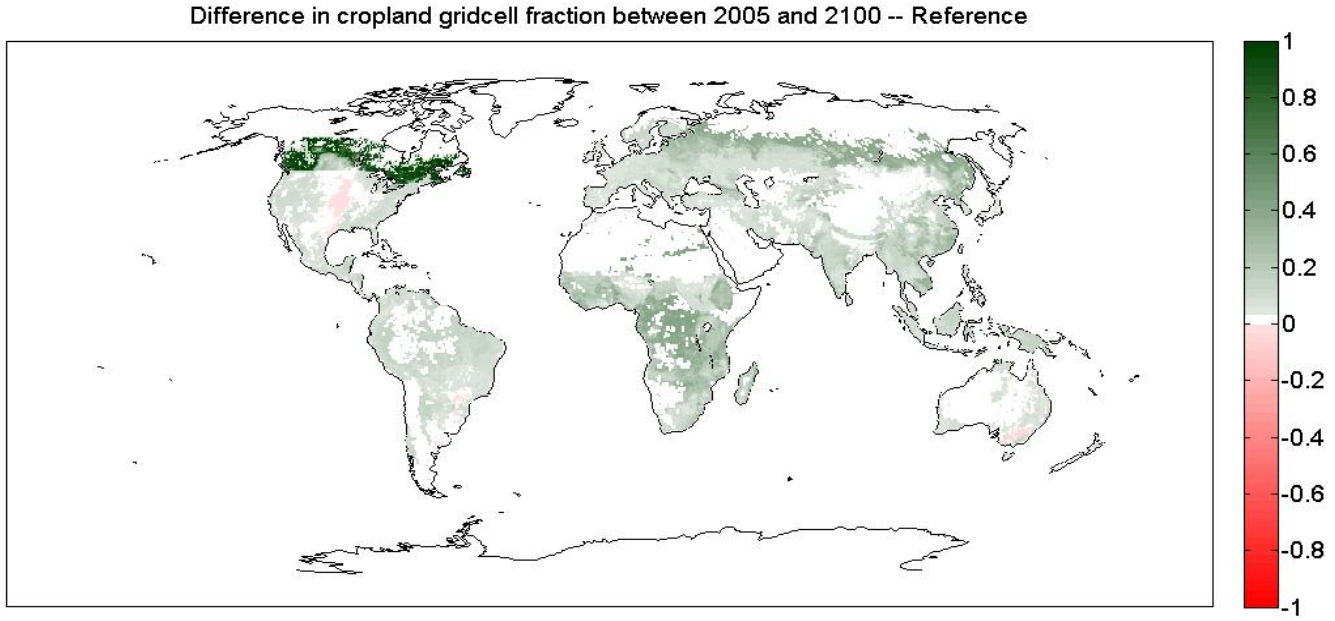
Difference in forest gridcell fraction between 2005 and 2100 -- RCP4.5 with Zero APG



Forest

Change in crop and forest land from 2005 to 2100 when agricultural productivity DOES increase

Reference Case



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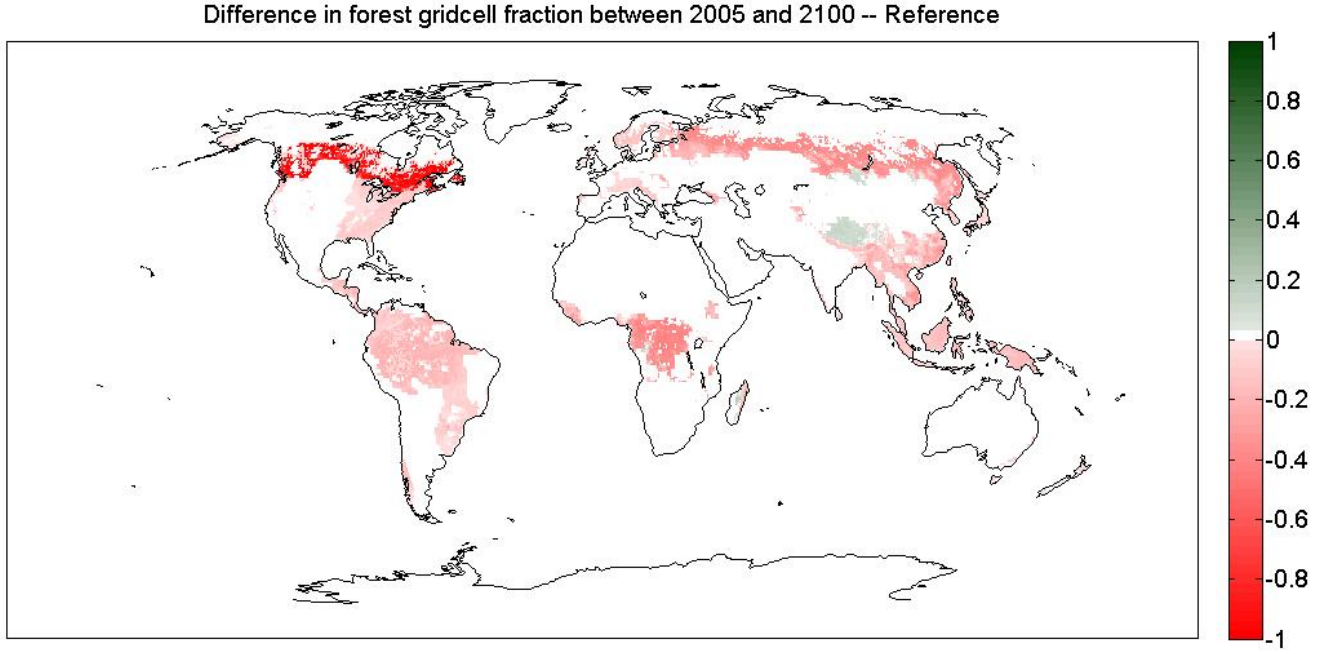
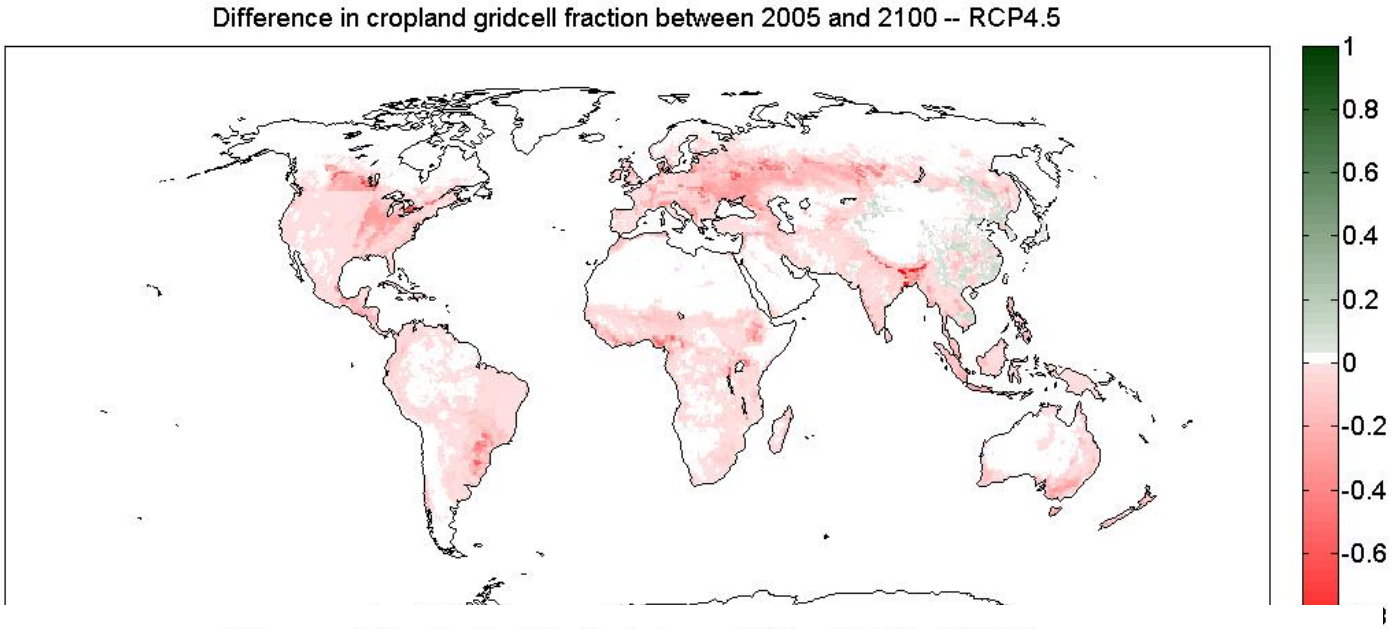


Forest

Climate Mitigation Scenario (RCP4.5)



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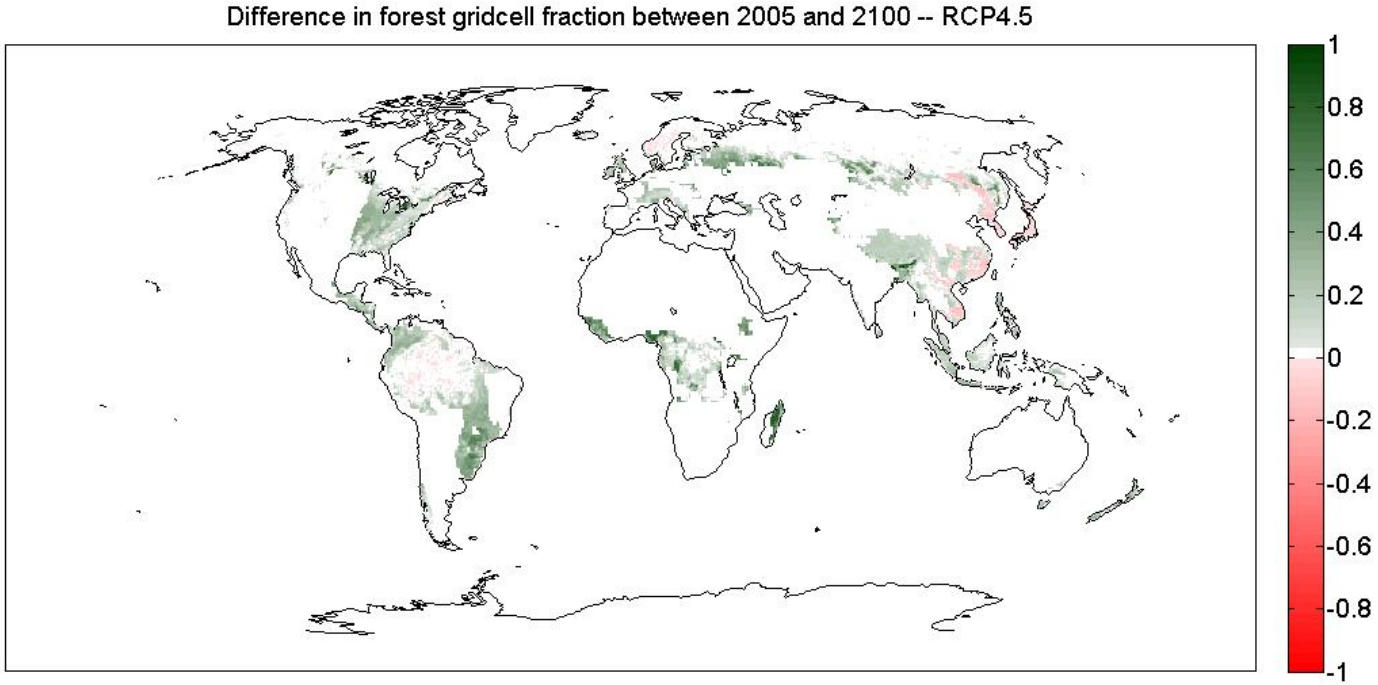
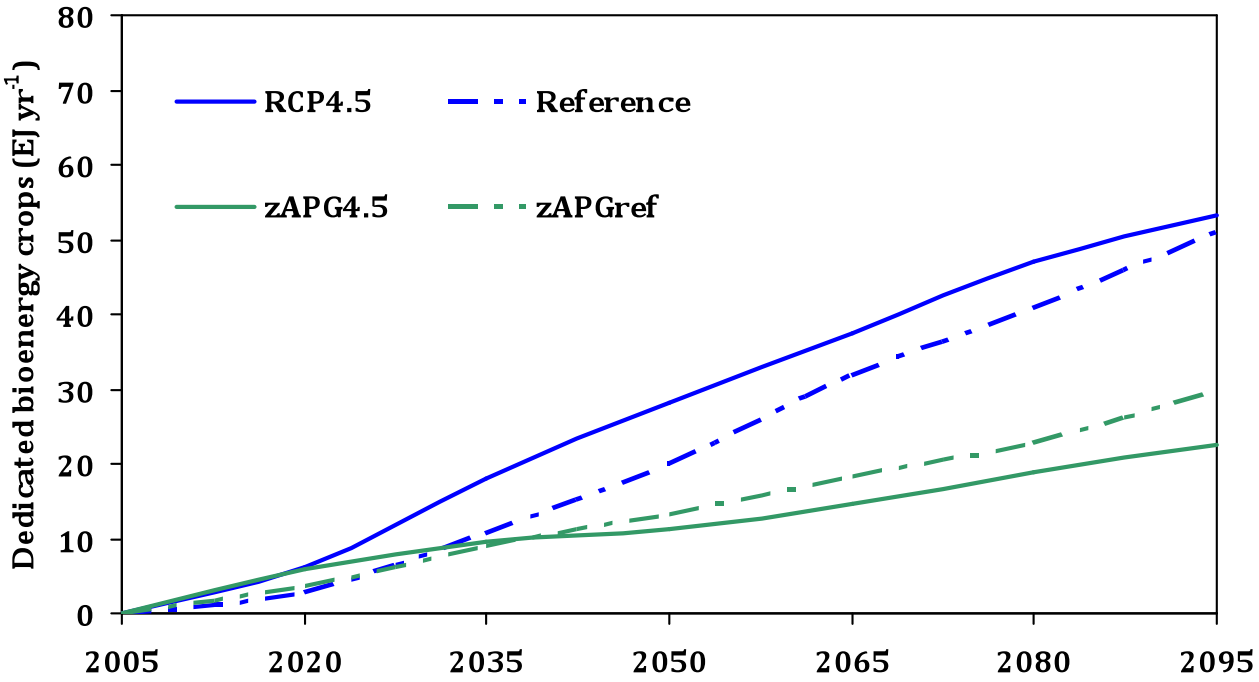


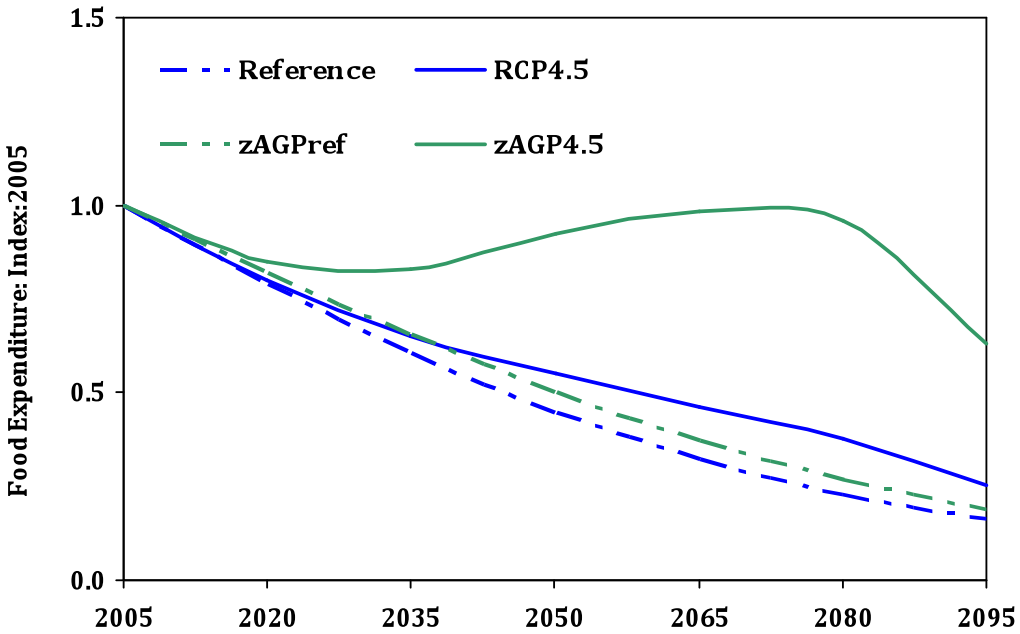
Forest

Bioenergy Supply – mitigation indicator



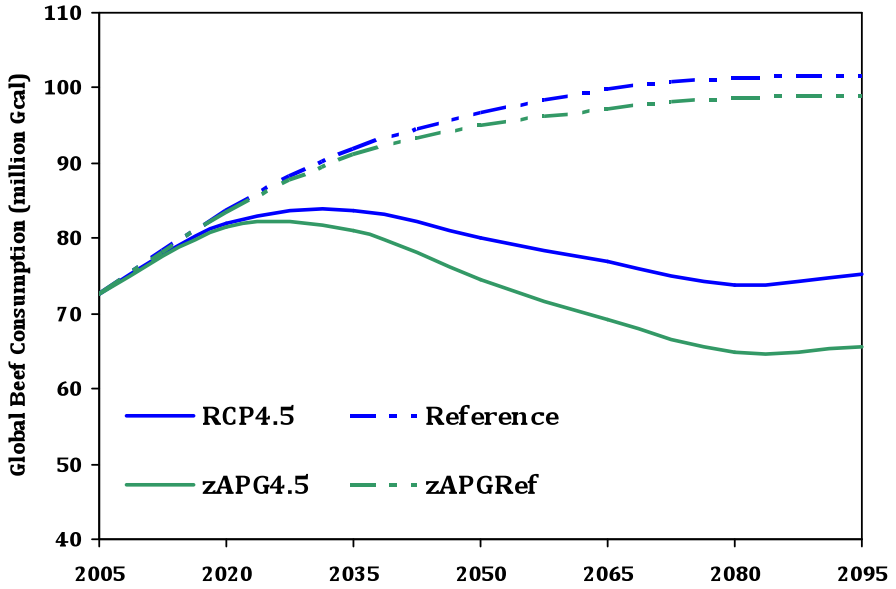
- Mitigation preference for forested land results in less bioenergy crop production than a corresponding *reference* case.
  - Causes higher prices in the energy sector and makes mitigation policies more difficult

Food Supply – adaptation indicator



Cost of food produciton increases Food expenditure (as a fraction of income) declines.

Terrestrial C policies encourage a shift away from beef consumption; lower APG has a similar, although smaller, influence.



Findings

- Potential land use change associated with mitigation is large and an important consideration in adaptation planning.
- Pressure to expand crop land is greater when
  - Agricultural crop productivity does not increase
  - No terrestrial C valuation policy is in place.
- Agricultural productivity improvements can be seen as **both** an **adaptation** and **mitigation** priority.
  - Keep the cost of food production low
  - Make land available for bioenergy and reforestation

Questions?