Land-use experiments to meet multiple needs for CMIP6

Andrew D Jones
Lawrence Berkeley National Lab

William D Collins, Margaret S Torn, Katherine Calvin, Jae Edmonds, and many more

AGCI MIPfest, Aug 5 2014
Future Projections of Land Use Differ Widely

Future Projections of Land Use Differ Widely

Demographics

Ag Technology

Dietary Preferences

Climate Adaptation

Mitigation Policy (e.g. biofuels, afforestation)
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The **Integrated Earth System Model (iESM)**

- GCAM and GLM
- Economics
- Demographics
- Energy System
- Ag System

- **Atmosphere Models**
- **Ocean Models**
- **Sea Ice Models**
- **Land Models**

**CESM Coupler**
Do all RCP4.5 policies lead to same climate?

Two Scenarios: 2005-2100

Universal Carbon Tax (**UCT**)  
Fossil Fuel and Industrial Carbon Tax (**FFICT**)  

**Identical forcing from greenhouse gases and aerosols**
Do all RCP4.5 policies lead to same climate?

Two Scenarios: 2005-2100

Universal Carbon Tax (UCT)

Fossil Fuel and Industrial Carbon Tax (FFICT)

Change in Forest Cover from 2005 to 2100

Very different patterns of land use change
Global Mean Temp Change

Temperature change from first (2005-2015) to last (2091-2100) decade
RCP4.5 UCT

RCP4.5 FFICT
Temperature difference $FFICT-UCT$
(decadal mean, 2090-2100)

Annual Mean

NH Summer

NH Winter
Important Notes

• Concentrations forced
• Therefore isolates biophysical effects
• Range forest cover may exceed SSP range
• Only one IAM, one ESM
Temperature change from first (2005-2015) to last (2091-2100) decade
RCP4.5 UCT

RCP4.5 FFICT

Actually RCP 3.9!
Accounting for land-use forcing within GCAM
Forcing from Land-Use Change
Regional Differences Matter
Forcing range is smaller in new GCAM

![Diagram showing forest cover (M km²) from 2000 to 2095. The graph compares GCAM forst cover in old and new versions of UCT and FFICT scenarios.](image-url)
To what extent is land-use forcing equivalent to GHG forcing?

- non-radiative (e.g. hydro) effects
- spatially concentrated effects
Three Simulations

Equilibrium response relative to pre-industrial

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Pattern of Deforestation

Widespread deforestation of approximately 50% based on Integrated Assessment Model (GCAM)
Temperature Effects
Pattern Scaling of Land Use Effects

\[ a \star + b \star \]

Requires:

- response additivity
- linear scaling of responses
- knowledge of the responses
Need an Atlas of Land-use Climate Response Relationships

biofuels

fragmentation

deforestation

irrigation

degradation
Key Questions for Land-use Pattern Scaling

• How resolved in space is sufficient?
• How resolved in process is sufficient?
• Which teleconnections scale?
• When does linearity break down?
• Which interactions are most important?
• Does scaling hold for metrics of extremes?
• Does it work for multi-model ensembles?

• How would we design a simulation protocol to support emulation / p-scaling?
Plausible Land and Aerosol Scenarios

- **ScenarioMIP**
  - how much do different SSPs matter?

- **LUMIP**
  - how much do plausible land ranges matter?

- **AerChemMIP**
  - how much do plausible emissions ranges matter?
## Plausible Land and Aerosol Scenarios

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Forest Cover across SSPs and original RCP4.5
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Thank You!

contact: adjones@lbl.gov

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