Evaluating CMIP5 and CMIP6 land use forcings for ACME v1

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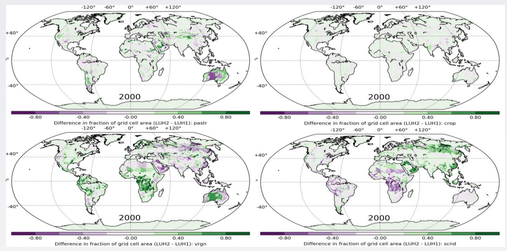
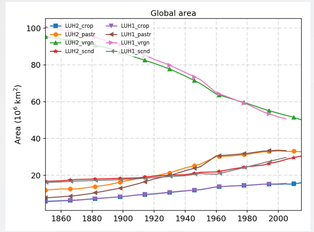
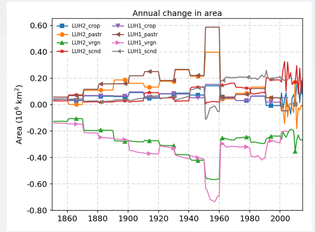
Issue: Uncertainty in Land-Use Effects on Climate

Human land-use activities have influenced the Earth's climate system by significantly altering biogeochemical and biogeophysical properties at local to planetary scales. **Yet the *precise magnitude and character of land-use effects on climate remain uncertain, and this uncertainty in turn limits the accuracy of future projections.*** To address this issue, we have developed a new set of global gridded land-use forcing datasets to link historical land-use data and future projections in a standard format required by climate Models (fig. 1). The global climate modeling community recognizes these effects, and the Coupled Model Intercomparison Project (CMIP6) recently made land-use a required forcing, and the land-use harmonization dataset (LUH2, lead by George Hurtt, and supported by separate DOE-SciDAC award), an entry card for participating in CMIP6 runs. For CMIP6, land-use has become a required forcing and use of the land-use harmonization dataset is designated as an entry card for participating in CMIP6 experiments. The second generation land-use harmonization (LUH2) product expands on the land-use forcing dataset generated for CMIP5 and includes new land-use states (and all transitions between them), updated inputs, and new management layers.

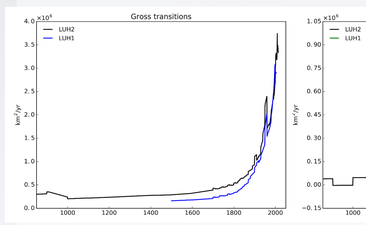
As a first step towards understanding the impacts of different land-cover datasets on the Earth climate system, we compared the land-cover information generated from two versions of the land-use harmonization products (LUH1 and LUH2). Understanding these differences will eliminate major sources of within model uncertainty, and will give ACME a unique capability among global models.

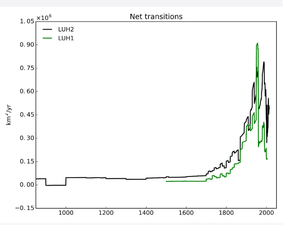


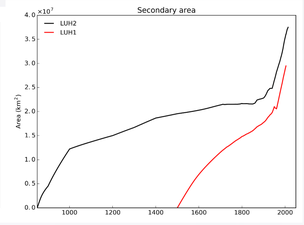


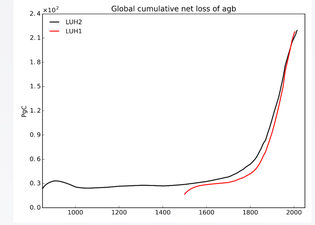


- While aggregate land use totals are very similar for LUH2 and LUH1, considerable spatial differences exist.
- LUH2 fixes the 'pasture anomaly' observed in LUH1, around the year 1950.









- LUH2 reduces the 'pasture anomaly' observed in LUH1, and this can be seen from the smaller peak for net transitions around 1950.
- LUH2 has a higher amount of secondary land in present-time, partly because of an earlier start date to the model (850 Vs 1500 for LUH1).
- Both LUH2 and LUH1 experience a similar amount of global cumulative net loss of AGB (~240 Pg C) by 2005.

Using expanded Land-Use Change dataset in ACME

L2-27: Provide CMIP6 land use forcings for ACME v1

For CMIP6, the new required land-use harmonization dataset (LUH2) is updated and *contains ~50x the information used in CMIP5*. This new information is at higher resolution over longer time domain, and includes additional new land-use states (fig 2), land-use transitions (fig. 3), crop types, and agriculture management information not previously available in LUH1.

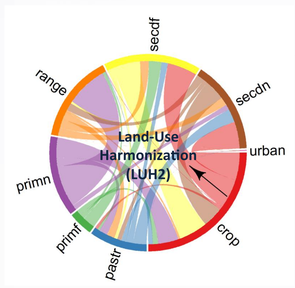


Figure 1. Conceptual diagram of Land-Use Harmonization (LUH2) Product

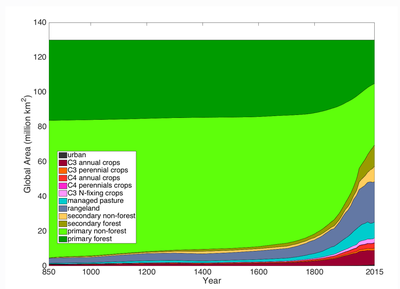


Figure 2. Area occupied by land-use states over time

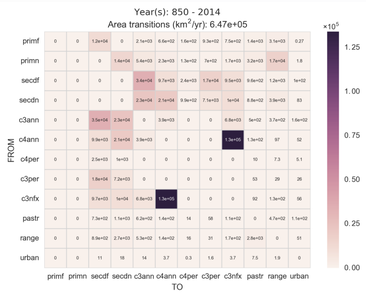
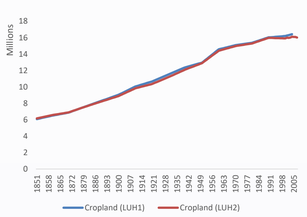


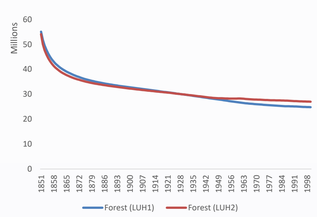
Figure 3. Area transitioning between land-use states (850 – 2015)

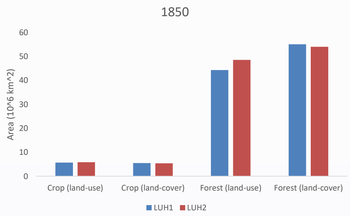
Diagnosing conversion of land-use to land-cover

L2-106: Run LUH2 through land-use translator to produce Makesurfdat on ne30_oECv3 grid

As a first step towards understanding the impacts of different land-cover datasets on the Earth climate system, we compared the land-cover information and surface datasets generated from two versions of the land-use harmonization products (LUH1 and LUH2). This process involved converting the latest version of the land-use harmonization dataset (LUH2) into the land-use harmonization (LUH1) dataset format by mapping the thematically and spatially more resolved LUH2 land use states and transitions to the LUH1 land use states. Our results indicate that the land-use areas embedded in LUH1 and LUH2 are faithfully conveyed to the Land-cover datasets. In subsequent work, we plan to run ACME v1 model with surface datasets derived from LUH1 and LUH2, and eventually also run ACME v2 with surface datasets derived from both these land-use datasets.







ACME Accelerated Climate Modeling for Energy

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