LUH2

1 OVERVIEW OF LAND USE FORCING DATA (850-2100)

In preparation for sixth phase of the Coupled Model Intercomparison Project (CMIP6), a new set of global gridded land-use forcing datasets are being developed to link historical land-use data and future projections in a standard format required by climate models. This new generation of "land use harmonization" (LUH2) builds upon past work from CMIP5, and includes updated inputs, higher spatial resolution, more detailed land-use transitions, and the addition of important agricultural management layers. These datasets are being developed as a contribution of the Land-Use Model Intercomparison Project (LUMIP) to the Forcings Group for CMIP6. The datasets, and details of their major attributes, can be found on the LUH2 website: http://luh.umd.edu

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LUH2 v2f
2 DESCRIPTION OF ADDED TREE COVER DATA (2015-2099)

LUH2 v2f is a release of the future harmonized land-use forcing dataset, and covers the period 2015-2100. It transitions continuously from the new gridded historical dataset (LUH2 v2h), to 8 new future scenarios identified in ScenarioMIP for CMIP6 and provided by Integrated Assessment Models (IAMs). While it is primarily a *land-use* dataset, LUH2 does also provide a simple estimate of forest cover. However, LUH2 estimates of positive forest cover gain (i.e. afforestation / reforestation) severely underestimate that of corresponding IAMS for SSP1 RCP2.6 (from IMAGE), SSP2 RCP4.5 (from MESSAGE-GLOBIOM), and SSP1 RCP1.9 (from IMAGE). This is likely due to many differences between models and forest definitions. A remedy for ESMs using LUH2 landcover was identified as urgently needed in October 2018 at the LandMIP meeting.

To address this issue, a solution was developed to achieve 80% or more of forest gain, match the spatial pattern of forest gain from IAMs, preserve existing harmonized land-use transitions, and that could be implemented relatively easily in ESMs.

For each scenario, a supplementary file was created with a data variable called 'added_tree_cover'. The variable specifies the added tree cover that needs to be planted in each grid cell each year to better represent the corresponding IAM

estimates. For the other IAM scenarios that are not affected by this issue, added_tree_cover values are set to 0.

To produce these files, the spatial pattern of differences in forest cover between LUH2 and each corresponding IAM were computed annually for 2015-2100. For each year, each grid cell, if the difference could be met on LUH2 classified non-forest land, that difference was noted as 'added_tree_cover' in the new file. If the gain could not be met on the LUH2 non-forest area, the change was applied on nearby cells up to 4 grid cells away.

This method is able to capture >80% of the afforestation signal in the IAMs in offline LUH2 diagnostics. Finally, to ensure this method could potentially work in an ESM, these supplementary files were implemented in CESM for each afforestation scenario to verify that these datasets reproduced the desired forest gain signal within that model.

Added tree cover files are now available for these scenarios:
- SSP1 RCP1.9 (from IMAGE)
- SSP1 RCP2.6 (from IMAGE)
- SSP2 RCP4.5 (from MESSAGE-GLOBIOM)
- SSP4 RCP3.4 (from GCAM) *
- SSP4 RCP6.0 (from GCAM) *
- SSP3 RCP7.0 (from AIM) *
- SSP5 RCP8.5 (from REMIND-MAGPIE) *
- SSP5 RCP3.4 OS (from REMIND-MAGPIE) *
  * These files contain all zeros.

Note: These supplementary files are intended for models relying on LUH2-land cover, per se. All LUH2 land-use states and transitions previously made available for these scenarios remain the same. Although these supplementary datasets prescribe the addition of trees to non-forested lands, for consistency those non-forested grid-cell fractions remain classified as primary and/or secondary non-forest land in the LUH2 datasets (along with all transitions to/from those land-use states).

<u>2.1 Files</u>

Files can be downloaded from: http://luh.umd.edu/

Note: The Land-Use Harmonization 2 (LUH2) datasets are made freely available for use by the scientific community, with attribution. Please use the following citation in any presentations or publications that result from, or include, the use of the LUH2 datasets:

Hurtt, G., L. Chini, R. Sahajpal, S. Frolking, et al. "Harmonization of global land-use change and management for the period 850-2100". Geoscientific Model Development (In prep).

The datasets are comprised of the following netCDF files:
* added_tree_cover.nc

<u>2.2 Variable Names and Units</u>

Added_tree_cover: (units fraction of grid cell)
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added_tree_cover: added tree cover that should be planted
in each grid cell each year
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