Grassi et al, 2023. Harmonising the land-use flux estimates of global models and national inventories for 2000-2020: background data and processing steps

This document outlines the protocol used to filter the results of DGVMs with maps of intact and non-intact forest

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Step (1) Create an auxiliary file of intact and non intact forest "IntactAndNonIntactForest_0.5deg.nc"

The following steps are done in Google Earth Engine (GEE) platform:

1. Convert tree cover (30m spatial resolution) from Hansen et al (2013) to forest cover.
   To do this, FAO definition of forest (more than 20% tree cover per grid cell and a minimum continuity of 0.5 ha) is used. Using this method allows us to get, in general, similar forest area with what countries are reporting except over Russia where our estimate is smaller. To overcome this problem we used 10% instead of 20% over Russia.
2. Intact and Non-Intact "Forest" masks came from Potapov et al. (2017) except over Canada and Brazil, two countries with large areas of unmanaged forest, this study uses the national gridded map used in the respective National Greenhouse Gas Inventories (Canada, 2021; Brazil, 2020).
   ==> Popatov mask was updated over Brazil and Canada
3. Merge the two datasets to get the Intact and Non-Intact forest area per grid cells of around 30m spatial resolution.
4. Regrid the data to 0.5 degree spatial resolution (sum the area of all forest grid cells present inside the 0.5 degree). Because of the computational issue, this has been done in two steps. From 30m to 0.01 degree, then from 0.01 to 0.5 degree.
5. The 0.5 degree Intact and Non-Intact forest area is saved in "IntactAndNonIntactForest_0.5deg.tif" tif file using the JavaScript code "IntactAndNonIntactForest_0.5deg_script.js" available in Zenodo
6. This last step is done outside GEE. We compute the ratio between observed forest cover and the median forest cover coming from the 10 TRENDY S2 models that provide information on land cover fraction per plant functional type (variable/file: landCoverFrac). This ratio is used in Step (5). The final maps are available in Zenodo in NetCDF format.
   Models are:'CLASSIC','YIBs','CABLE-POP','JSBACH', 'LPX-Bern','OCN','JULES','VISIT','VISIT-NIES','SDGVM'.
   Forest pfts per model are: {'ORCHIDEE':[1,2,3,4,5,6,7,8],'JSBACH':[2,3,4,5],'CLASS-CTEM':[0,1,2,3,4],'DLEM':[4,5,6,7,8,9,10,11], 'OCN':[1,2,3,4,5,6,7,8],'CABLE-POP':[0,1,2,3],'ISAM':[0,1,2,3,4,13,14,15,16,17,19,23], 'SDGVM':[6,7,8,9],'JULES':[0,1,2,3,4],'CLASSIC':[0,1,2,3,4], 'VISIT':[0,1,2,3,4,5,6,7],'YIBs':[0,1,2],'LPX-Bern':[0,1,2,3,4,5,6,7],'CLM5.0':[1,2,3,4,5,6,7,8],'LPJ':[0,1,2,3,4,5]}

References

Potapov et al. The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. https://www.science.org/doi/10.1126/sciadv.1600821, 2017.

Brazil: National Communication 3, https://unfccc.int/documents/66129 , 2020.

Canada. National Inventory Report (NIR), https://unfccc.int/documents/271493 , 2021.

TRENDY simulations are available via request to S.A.Sitch[at]exeter.ac.uk

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Step (2) select dates and do annual mean

For all models we

1. extract nbppft, nbp and landCoverFrac files (if available) over 1990-2021
2. do annual mean

nbppft = nbp per plant functional type

Step (3) Intact and Non Intact forest NBP from models that provide nbppft.

- The models are: 'CLASSIC','YIBs','CABLE-POP','JSBACH', 'ISBA-CTRIP'
- ISBA-CTRIP is not yet uploaded in the server at the time of writing this but the method is included here

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1. From landCoverFrac and nbppft we computed mean forest nbp (kg/m2/s) for each grid cell.
    - ForestNBP= Sum(ForestPFTfrac * Forestnbppft)/sum(ForestPFTfrac)

2. Compute mean forest nbp for ISBA-CTRIP model.
    - nbpTree=nppTree-rhTree-DisturbancesTree
    - where: DisturbancesTree=fCleach+fFire
    - We assume most of fFire and fCleach originates from forest, if forest exists in the gridcell.
    - we then do same as 1) above.

3. If low spatial resolution regrid into 0.5x0.5 deg using conservative remapping approach.

4. Since the unit of forest NBP is kg/m2/s we multiply it by Intact and NonIntact forest area that came from the NetCDF file described in "Step (1)" and number of seconds in the year to get "kg/gridcell/yr".

Step (4) Intact and Non Intact forest NBP from models that did not provide nbppft but provide landCoverFrac.

- The models are: 'LPX-Bern','OCN','JULES','VISIT','VISIT-NIES','SDGVM'

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1. If low spatial resolution regrid nbp and landCoverFrac into 0.5x0.5 deg.
2. for each model and gridcell, we compute the ratio between observed and TRENDY-v11 S2 (from landCoverFrac) forest cover. Some models did not provide S2 landCoverFrac but did it for S3. In this case we used the first year of S3 landCoverFrac.
3. multiply simulated nbp by this ratio, land area and number of seconds in the year ==> from kg/m2/s to kg/gridcell/yr
4. Split into Intact and Non-Intact forest NBP using "IntactAndNonIntactForest_0.5deg.nc" "see step (1)".

Step (5) Intact and Non Intact forest NBP from models that provide neither nbppft nor landCoverFrac.

- The models are: 'IBIS','CLM5.0','ORCHIDEE','ISAM','DLEM','LPJ-GUESS','LPJ'

NB: LPJ-GUESS provide landCoverFrac but because of the specificity of this model we used it in this step. Indeed, the sum of PFTs fraction is equal to 1 in all TRENDY models except LPJ-GUESS which allow having different PFts in the same place. For example, grass bellow small tree and small tree below tall tree. To be coherent with other models they provide landCoverFrac file that represent an estimate of the foliage projected cover for each PFTs. However, this file should not be used to scale any of the LPJ-GUESS data.

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1. If low spatial resolution regrid into 0.5x0.5 deg
2. We use the ratio between observed forest cover and median of the 10 TRENDY S2 models (See Step (1.7)).
3. multiply simulated nbp by this ratio, land area and number of seconds in the year ==> from kg/m2/s to kg/gridcell/yr
4. Split into Intact and Non-Intact forest NBP using "IntactAndNonIntactForest_0.5deg.nc", see step (1).
5. We sum over all grid cells to obtain the global estimates for fluxes in intact and non-intact forests.

NB: We also used this method to estimate forest soil carbon sink. To do so, we used "cSoil" variable which is the variable that represents simulated soil carbon stock. We computed soil carbon sink as the difference between the annual mean stock of two consecutive years