EGU General Assembly 2024

EGU24-218, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-218
EGU General Assembly 2024

Aligning climate scenarios to emissions inventories shifts global benchmarks

Matthew Gidden[1], Thomas Gasser[1], Giacomo Grassi[2], Nicklas Forsell[1], Iris Janssens[1], William Lamb[3], Jan Minx[3], Zebedee Nicholls[1,4], Jan Steinhauser[1], and Keywan Riahi[1]

[1]International Institute for Applied Systems Analysis, Energy, Climate, and Environment Group, Laxenburg, Austria (gidden@iiasa.ac.at)

[2]European Commission, Joint Research Centre, Ispra, Italy

[3]Mercator Research Institute on Global Commons and Climate Change, Berlin, Germany

[4]University of Melbourne, Melbourne, Australia

Global mitigation pathways play a critical role in informing climate policies and targets that are in line with international climate goals. However, it is not possible to directly compare modelled results with national inventories used to assess progress under the UNFCCC due to differences in how land-based fluxes are accounted for.

National inventories consider carbon flux on managed land using an area-based approach with managed land-areas determined by nations. Emissions scenarios consider a different managed land area and are calibrated against data from detailed global carbon cycle models that account for natural (indirect) and anthropogenic (direct) fluxes separately by design.

To disentangle the direct and indirect components of land-based carbon fluxes, we use a reduced complexity climate model with explicit treatment of the land-use sector, OSCAR, one of the models used by the Global Carbon Project. We find the discrepancy between model and NGHGI-based accounting methods globally to be 4.4 ± 1.0 Gt CO2 yr-1 averaged over the 2000-2020 time period, which is in line with existing estimates. We then apply OSCAR to the set of pathways assessed by the IPCC to quantify how this gap evolves over time and estimate how key mitigation benchmarks change.

Across both 1.5°C and 2°C scenarios, LULUCF emissions pathways aligned with NGHGI accounting practices show a strong increase in the total land sink until around mid-century. However, the 'NGHGI alignment gap' decreases over this period, converging in the 2050-2060s for 1.5°C scenarios and 2070s-2080s for 2°C scenarios. The convergence is primarily a result of the simulated stabilization and then decrease of the CO2-fertilization effect as well as background climate warming reducing the overall effectiveness of the land sink, which in turn reduces the indirect removals considered by NGHGIs. These dynamics lead to land-based emissions reversing their downward trend in most NGHGI-aligned scenarios by mid-century, and result in the LULUCF sector becoming a net-source of emissions by 2100 in about 25% of both 1.5°C and 2°C scenarios.

Assessing emission pathways using LULUCF definitions from national inventory accounting results in downward revisions to emissions benchmarks derived from scenarios. NGHGI-aligned pathways result in earlier net-zero CO_2 emissions by around 2-5 years for both 1.5°C and 2°C scenarios, and 2030 emission reductions relative to 2020 are enhanced by about 5 percentage points for both pathway categories. When incorporating the additional land removals considered by NGHGIs, the assessed cumulative net CO_2 emissions to global net-zero CO_2 also decreases systematically by 15-18% for both 1.5°C and 2°C scenarios.

We find that increasing removals from direct fluxes in 1.5C scenarios overtake estimated removals using NGHGI conventions in the near term. However, by midcentury, the strengthening of direct removals is balanced by weakening of indirect removals, meaning that, on average, carbon removal on land accounted for using NGHGI conventions in 1.5C scenarios results in about half of the LULUCF removals in current policy scenarios.

We discuss the implications of our results for future Global Stocktakes and market mechanisms under the Paris Agreement.