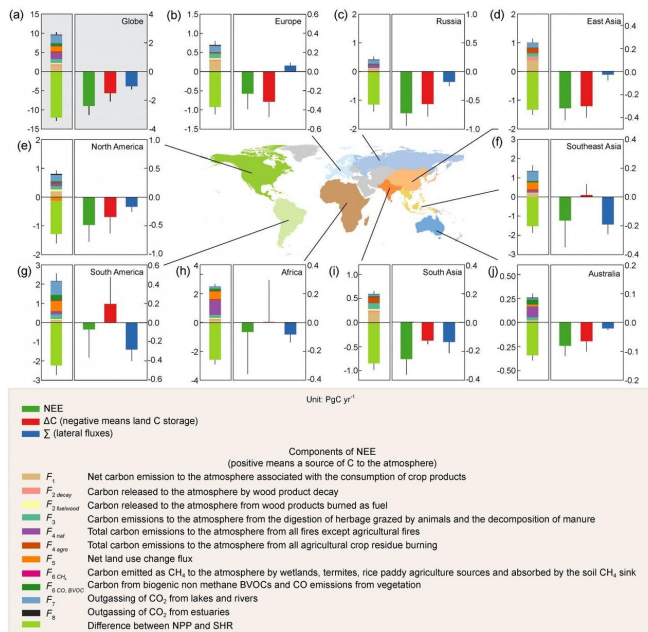


Solving the jigsaw puzzle of regional carbon budgets

27 July 2020



Carbon storage change from inventories (ΔC in red) and lateral fluxes from trade and riverine carbon export to the ocean for different regions of the globe (in blue) for the 2000s. The resulting bottom-up net land atmosphere C flux from the sum of ΔC and lateral fluxes is given in dark green. An atmospheric convention is used, so that a negative ΔC denotes an increase of land carbon stocks, and a negative net flux is also a net uptake of atmospheric CO₂. The upper stacked bars on the left show the sub-components of the net land-atmosphere carbon balance of each region and the resulting imbalance between net primary production and soil heterotrophic respiration, a negative value indicating that soil heterotrophic respiration is smaller than net primary production. Credit: Science China Press

Accurate regional carbon budgets are critical for informing land-based mitigation policy and tracking mitigation progress. For nine regions covering the globe, inventory estimates of carbon stock changes were collected and complemented by satellite estimates of biomass changes where inventory data are missing. The net land-

atmospheric carbon exchange was then calculated by taking the sum of the carbon stock changes measured by inventories and lateral carbon fluxes from crop and wood trade and riverine carbon export to the ocean.

Summing up estimates from all regions, the first global "bottom-up" terrestrial carbon budget of anthropogenic CO₂ uptake was obtained, giving a net sink of $-2.2 \pm 0.6 \text{ Pg C yr}^{-1}$ (one Pg C being one billion tons of carbon) during the period from 2000 to 2009 consistent with the independent top-down budget derived in previous IPCC assessment reports from observations of the CO₂ growth rate and fossil fuel emissions. This new estimate set up an important milestone for global carbon cycle studies.

By decomposing the net land-atmosphere carbon flux of each region into incoming and outgoing fluxes, scientists showed that a significant part of the carbon fixed in terrestrial ecosystems by plant productivity is moved away from harvest and export to rivers or lost by fires and by emissions of reduced biogenic carbon species like biogenic volatile compounds and methane. In other words, carbon delivered to the soil as litter and available as a substrate for microbial decomposition is a smaller fraction of productivity that previously estimated by carbon models that ignore lateral export processes.

The implication is that global soil heterotrophic respiration, the amount of CO₂ released annually from soil microbial processes, is only of 39 Pg C yr^{-1} compared to Net Primary Productivity inputs of 50 Pg C yr^{-1} . In the study, researchers examined the consequences of a smaller heterotrophic respiration for the residence time of carbon and future projections of the carbon cycle and temperature. They found a positive feedback of 15 parts per million in the future CO₂ concentration: that is, an additional warming of 0.1 °C.

More information: Philippe Ciais et al, Empirical estimates of regional carbon budgets imply reduced global soil heterotrophic respiration, *National Science Review* (2020). [DOI: 10.1093/nsr/nwaa145](https://doi.org/10.1093/nsr/nwaa145)

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