Comparing national greenhouse gas budgets reported in UNFCCC inventories against atmospheric inversions

Publication from the ESA CCI RECCAP-2 project: Deng et al. 2021

‘Atmospheric inversion’ is the calculation of surface-to-atmosphere emissions using atmospheric measurements, a gas transport model and a prior map of fluxes. They provide optimized monthly fluxes of CO₂, CH₄, N₂O. We used an ensemble of 6 models for CO₂, 22 for CH₄ and 3 for N₂O from recent synthesis of the Global Carbon Project.

We compiled and harmonized a dataset of annual national emissions for all countries from UNFCCC (annual inventories, Biennial Update Reports, National Communications).

We separated natural from anthropogenic emissions, and transformed CO₂ fluxes into terrestrial C stock changes using additional ground-based information.

For CO₂, we found a global land carbon sink of 2.5 Pg C yr⁻¹ compared to only 0.3 Pg C yr⁻¹ in inventories. This is explained by unmanaged lands not counted by inventories in some large forested countries, environmental factors partly counted in inventories & other uncertain fluxes like soil carbon change.

- Northern countries: larger carbon sink than inventories.
- Tropical forested countries: small sources of carbon in inversions.

For CH₄, we found a fair agreement between inversions and inventories for anthropogenic sources of large emitters: EU, US, China. But more fossil CH₄ emissions than reported in inventories in key oil and gas countries: Russia, Central Asia, Persian Gulf region and in Indonesia (IDN).

For N₂O, we found higher emissions in tropical countries than inventories, but significant natural emissions from unmanaged lands make the separation of anthropogenic fluxes difficult.

Contact: Philippe.ciais@lsce.ipsl.fr