

Satellites improve national reporting of greenhouse gases

April 14 2022



ESA's Climate Change Initiative Regional Carbon Cycle Assessment and Processes Phase-2 (RECCAP-2) project supports and accelerates the analysis of regional carbon budgets based on the results of data-driven models and process-oriented global dynamic vegetation models. Credit: Pixabay

With the climate crisis continuing to tighten its grip, nations around the world are making efforts to reduce emissions of climate warming gases. To track action, countries report their greenhouse gas emissions to the UNFCCC—the body responsible for driving global action to combat

climate change. While accurate and consistent reporting is crucial, very few countries exploit Earth observation satellite data to check and improve their estimates. Scientists have now devised new ways of comparing national greenhouse gas inventories with independent measurements taken from space.

Reducing emissions of greenhouse gases, such as [carbon dioxide](#) and methane, is clearly paramount to avoiding the worst impacts of climate change. But to understand if mitigation strategies are actually meeting reduction targets, accurate measurements of emissions are key.

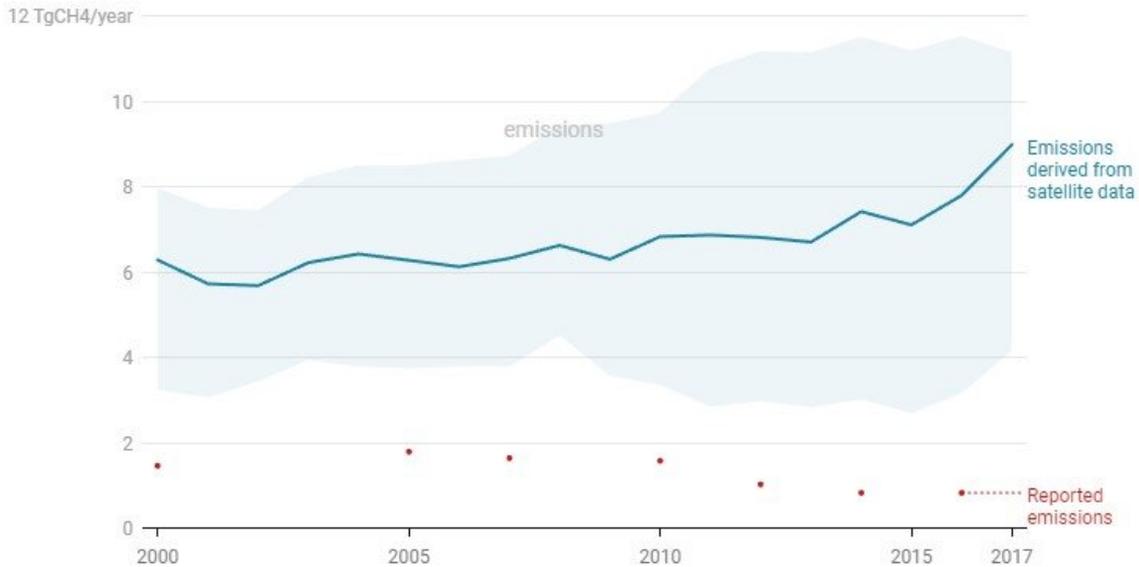
Countries use estimates of sector-based activity to compile their national greenhouse gas reports and to show progress towards delivering on their carbon reduction commitments under the Paris Climate Agreement. Registries of [greenhouse gas emissions](#), as well as the flux of carbon dioxide between the atmosphere and the ground over managed land, are based on national statistics following IPCC guidelines.

New research, published in *Earth System Science Data*, describes how scientists working within the Regional Carbon Assessment and Processes (RECCAP-2) project, supported by ESA, combined satellite measurements of atmospheric carbon dioxide and methane, and in-situ measurements of nitrous oxide, with a model that factors in the movement or "flux" of these greenhouse gases between the land surface and atmosphere.

This "inversion method" allowed the authors to determine emissions to the atmosphere of three greenhouse gases for a selection of high-emitting countries, as well as the overall flux of carbon dioxide over managed land. The managed land flux accounts for the absorption of carbon dioxide from the atmosphere due to the growth of crops and trees, their export and import across borders, and the anthropogenic component of rivers carrying carbon across borders, as well as [carbon](#)

[dioxide emissions](#) from managed land owing to fires and other disturbances.

Methane emissions from the fossil fuel sector in Gulf states



Gulf states: Saudi Arabia, Iraq, Kuwait, Oman, United Arab Emirates, Bahrain, Qatar Credit: Chart: ESA Source: Deng et al. 2021

Significant discrepancies between these inversion values and the corresponding national reports were found.

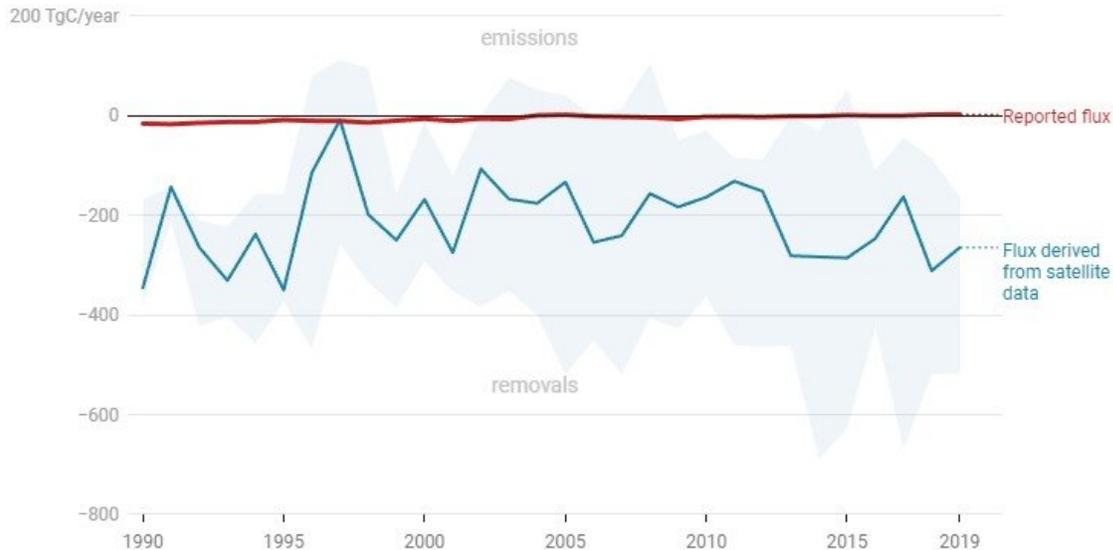
Methane emissions were found to be higher using the inversion method compared to most national reports. In particular, emissions from oil and gas extracting states in Central Asia and the Gulf were several times higher than officially reported.

The interactive graph above shows these discrepancies for the Gulf states between 2000 and 2016.

Absorbing 1.4 billion tons of carbon per year, the observed size of the global land carbon sink comprising ecosystems in both managed and unmanaged land, was several times larger than the 0.3 billion tons of carbon per year obtained by summing up countries' reports.

Underreporting of this carbon sink was most evident for temperate and northern hemisphere countries, such as Canada and across the European Union.

Carbon dioxide flux from managed land in Canada



Carbon dioxide absorbed by the land is counted negatively, while carbon dioxide emitted to the atmosphere is counted positively. Credit: Chart: ESA Source: Deng et al. 2021

In part, the disparity is explained by the carbon stored by unmanaged ecosystems that fall outside the inventory reporting protocol, while the full picture is observable from space.

The interactive graph below shows these discrepancies for Canada between 1990 and 2019.

With global temperatures having already risen by 1.1°C relative to pre-industrial levels, it is critical that policymakers have an accurate picture of emissions at both national and global scale.

Current guidelines used to compile national greenhouse gas inventories have their limitations. For example, they are usually based on scaled-up, sector-specific activity and rigid emission factors. Therefore, major emission sources, such as those from unmanaged land, fall out of scope. And, importantly, countries are only encouraged, but not required, to verify inventories against independently observed measurements.

In contrast, the new inversion method harnesses satellite data and in-situ observations to give a full picture of emissions that accumulate in the atmosphere.

Unlike national reporting guidelines, the inversion method captures seasonal and interannual extremes, such as drought and major wildfires, which are expected to increase in both frequency and severity as [global temperatures](#) ratchet upwards.

Philippe Ciais, from the Université Paris-Saclay, said, "The proposed method of using atmospheric inversions paves the way for countries and the global community to improve checks and consistency of national inventories to more accurately reflect global emissions.

"If regularly applied, this will not only improve transparency in the accounting process but will also improve the effectiveness of mitigation policy and progress by individual countries to meet their pledges as part of the Paris Climate Agreement."

New satellite missions launched in the coming years will provide a much denser sampling of atmospheric carbon dioxide and methane. ESA is currently developing the Copernicus Anthropogenic Carbon Dioxide mission, which will be the first to measure how much carbon dioxide is released into the atmosphere specifically through human activity. The mission will provide the European Union with a unique and independent source of information to assess the effectiveness of policy measures, and to track their impact towards decarbonizing Europe and meeting national emission reduction targets.

More information: Zhu Deng et al, Comparing national greenhouse gas budgets reported in UNFCCC inventories against atmospheric inversions, *Earth System Science Data* (2022). [DOI: 10.5194/essd-14-1639-2022](https://doi.org/10.5194/essd-14-1639-2022)

Provided by European Space Agency

Citation: Satellites improve national reporting of greenhouse gases (2022, April 14) retrieved 20 April 2024 from <https://phys.org/news/2022-04-satellites-national-greenhouse-gases.html>

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