# RECCAP-2 Attribution: Balancing the global land carbon budget and elucidating its regional drivers

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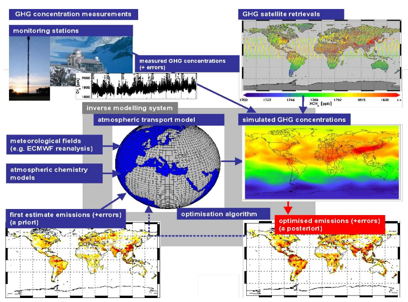
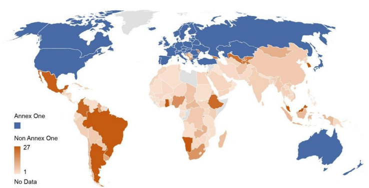
**Goals** : Enable the scientific community to make a significant step forward in the **attribution of the global land carbon sink** to land use change, fire and harvest disturbances & recovery, as well as climate effects using ECV data from ESA CCI, and **attribution of the global $CH_4$ budget** to natural (wetlands) & anthropogenic sources

## WP1 Global Stock Take assessment of national budgets for the three GHGs using satellite & in-situ atmospheric inversions



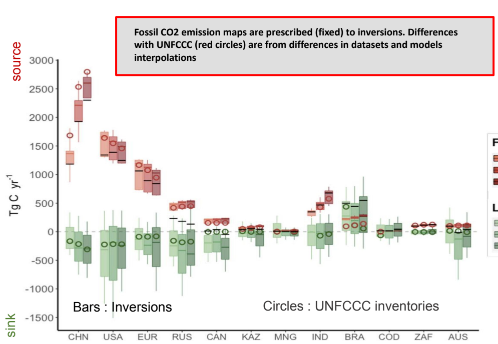
Atmospheric inversions use atmospheric measurements, a transport model and a prior map of fluxes. They provide optimized monthly fluxes of $CO_2$, $CH_4$, $N_2O$.



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

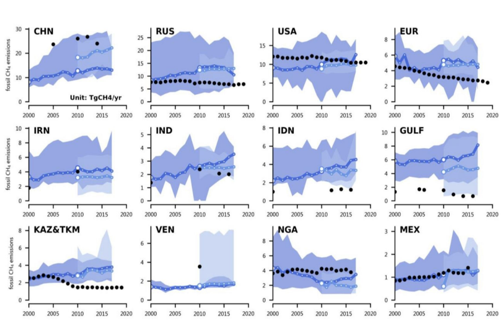
### Fossil $CO_2$ emissions and land sinks

We separated natural from anthropogenic emissions, and transformed $CO_2$ fluxes into terrestrial C stock changes using additional bottom-up information.
For $CO_2$, we found a global land carbon sink of 2.5 Pg C $y^{-1}$ compared to only 0.3 Pg C $y^{-1}$ 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



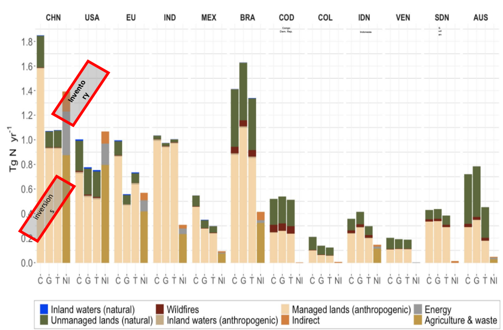
- Northern countries have a larger sink than inventories
- Tropical forested countries are small sources in inversions

### Fossil $CH_4$ emissions

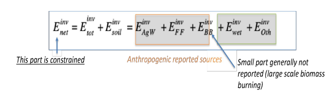


For $CH_4$, we found a fair agreement between inversions & inventories for anthropogenic sources of large emitters : EU, US, China, but more fossil $CH_4$ emissions than reported by inventories in oil and gas countries : Russia, Central Asia, Persian Gulf region, Indonesia (IDN)

### $N_2O$ emissions



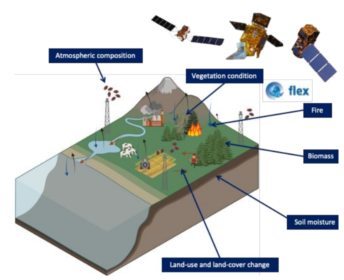
For $N_2O$, we found higher emissions in tropical countries than inventories, but significant natural emissions from unmanaged lands make the separation of anthropogenic fluxes difficult

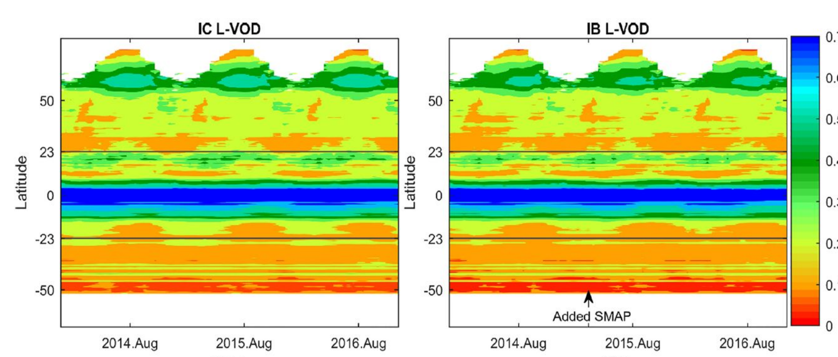


## WP2: Inferring poorly-constrained carbon fluxes from satellite-based estimates of annual above-ground biomass changes & inversions.

Some fluxes are poorly constrained by in-situ observations or difficult to scale globally (soil fluxes, land-use and management, natural disturbances, …).

The combination of above-ground biomass estimates with carbon fluxes by atmospheric inversions and other remote-sensing datasets (e.g. fires) allow to improve understanding about the processes underlying regional budgets and their changes.

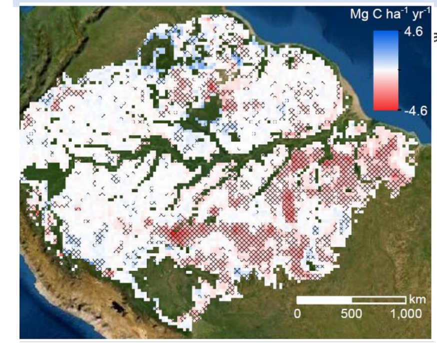




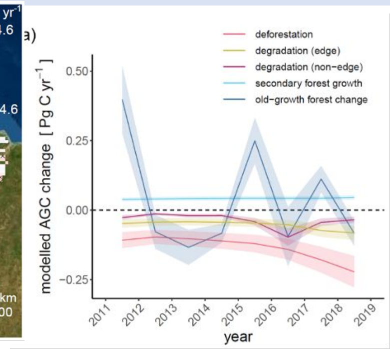
We developed the first merged SMOS/SMAP product of both "soil moisture" and "L-VOD". SMOSMAP L-VOD shows a very good consistency in terms of trends and seasonal variations (see adjacent Hovmoller diagram) with individual SMOS-IC and SMAP-IB L-VOD. ‣We used the mono-angular retrieval algorithm of SMAP-IB (INRAE-Bordeaux), minutious filtering of SMOS TB observations, and SMOS/SMAP TB inter-calibration.
‣SMOSMAP L-VOD takes the best of individual products: long time series of SMOS and accurate RFI filtering of SMAP.

*Li et al., The first global soil moisture and vegetation optical depth product retrieved from fused SMOS and SMAP L-band observations, Rem. Sens. of Environment, 2022, DOI:10.1016/j.rse.2022.113272*

## WP3: Regional hotspots and driving processes of biomass change from Earth Observation, by the SMOS vegetation optical depth



Trends in Amazon AGC (2011-2019)



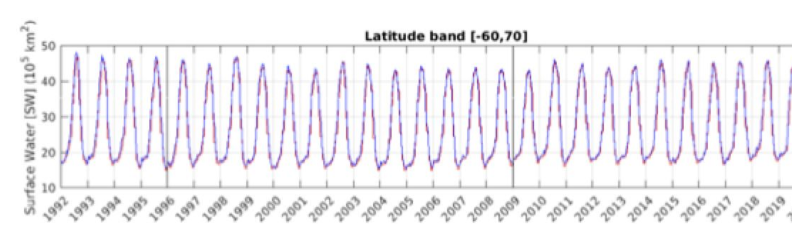
Time series of Amazon AGC changes

We use coarse-resolution (0.25°) satellite L-Band Vegetation Optical Depth (L-VOD) data to estimate of biomass carbon to track changes over 2011-2019 (Fig 1), and high resolution annual maps of forest cover and disturbances with biomass maps (ESA CCI 2017) to attribute aboveground carbon (AGC) changes. Results show a reduction in Amazon biomass through deforestation, degradation and loss of the intact forest sink which outweighs gains through secondary forests regrowth. Degradation accounted for 40% of gross losses, yet forest degradation caused by fires, selective logging, and edge effects is not explicitly reported in national inventories and is not considered in commitments to reductions of greenhouse gas emissions (Silva Junior et al., 2021).

*Fawcett, D., et al., Cascading Negative Impacts of Deforestation on the Amazon Carbon Balance, Global Change Biology, in press.*

## WP4 Reducing uncertainties of the global CH4 budget by updating the Global Inundation Extent from Multi-Satellites (GIEMS) dataset

The GIEMS time series has been extended to 2020. Ancillary information is being added to the dataset, to create a methane-centric wetland extent, and facilitate the modeling of methane natural emissions.



Time series of the surface water extent from satellite data, for the globe, from 1992 to 2020

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