



Committee on Earth Observation Satellites

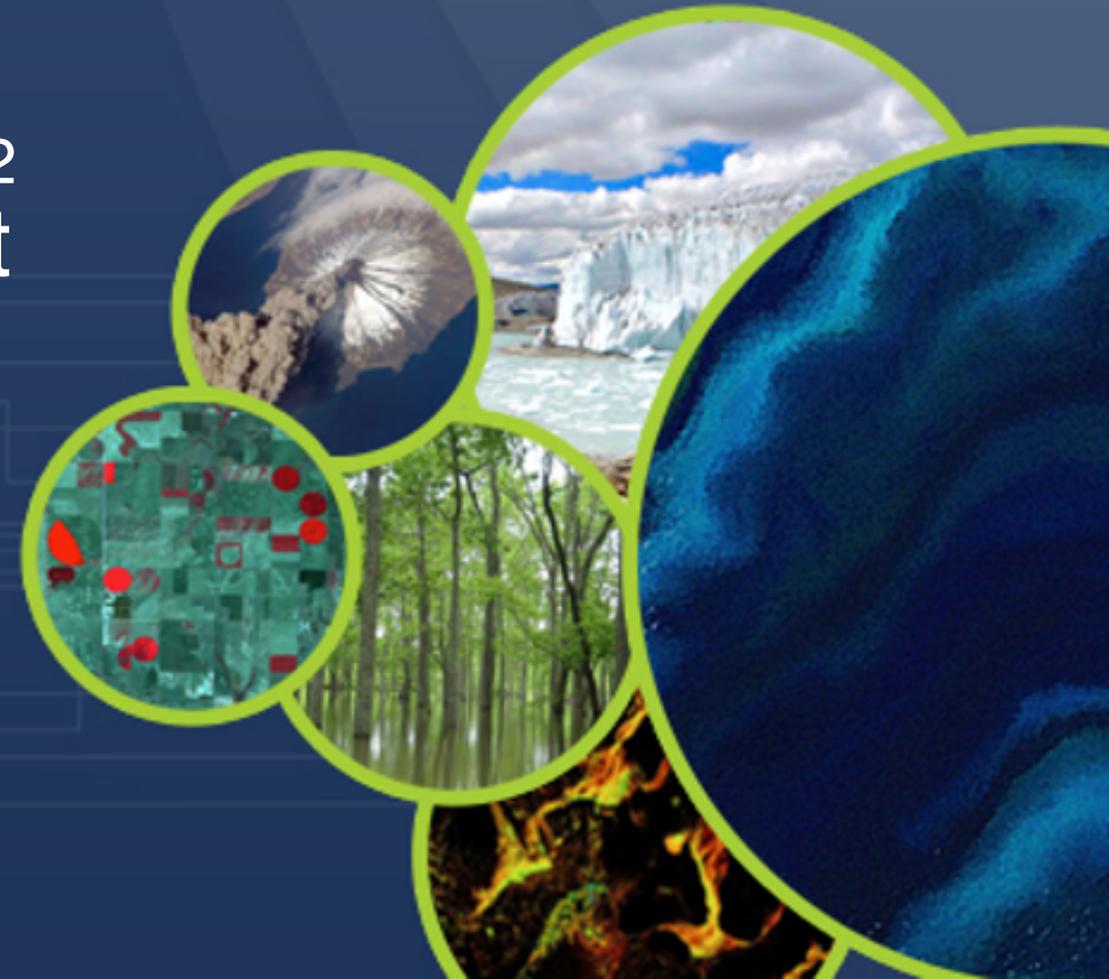
Space-based Atmospheric CO₂ and CH₄ Inventories to Support the Global Stocktake

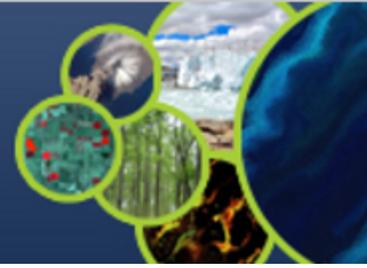
David Crisp

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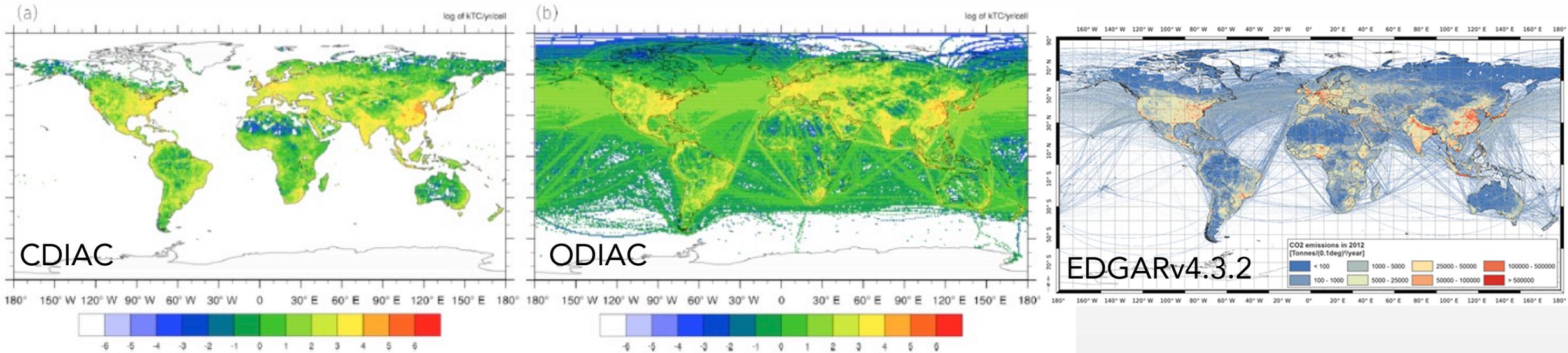
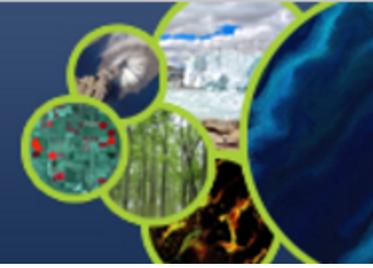
CEOS/CGMS WGClimate Greenhouse Gas Task Team

5 December 2019

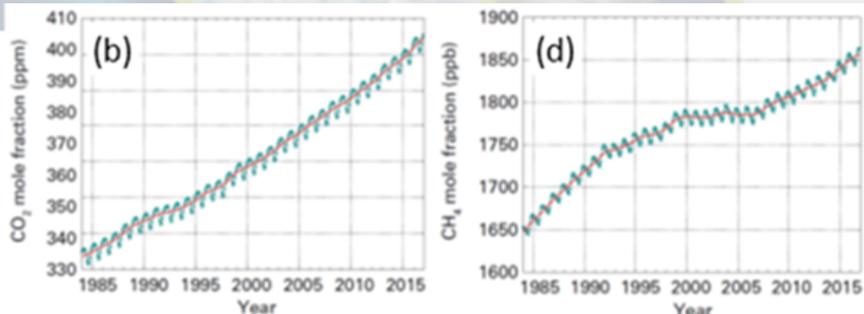
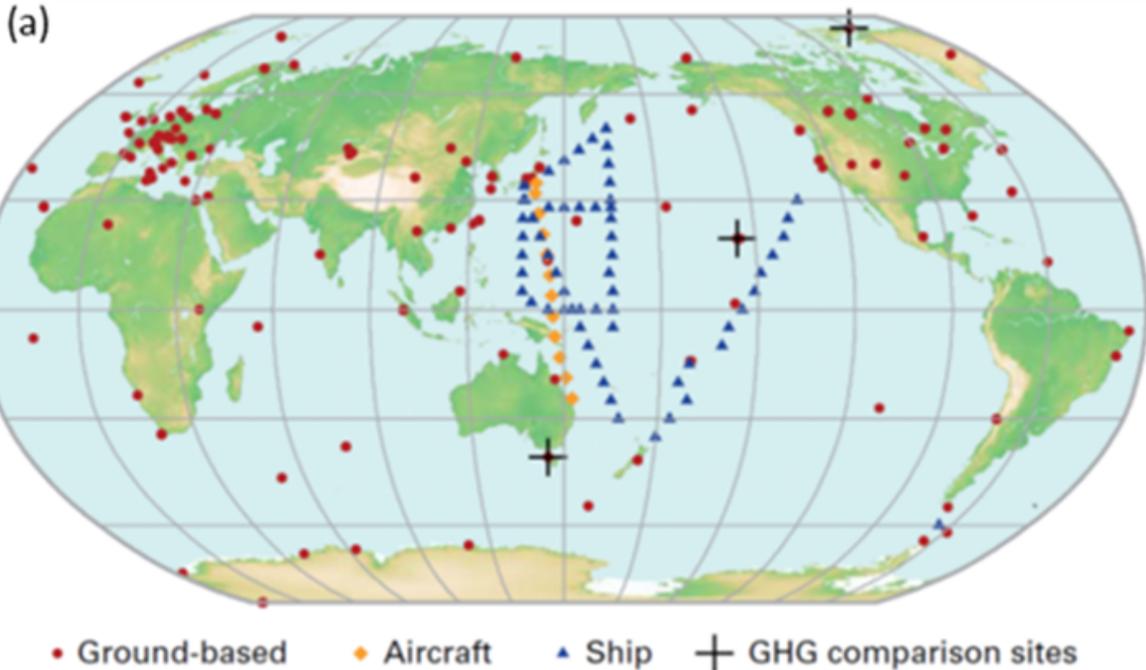
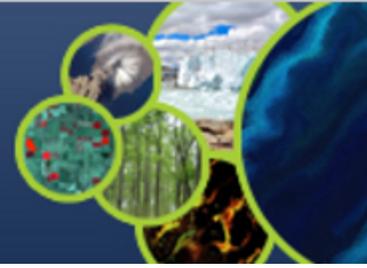




- Ground-based, airborne, and space-based atmospheric CO₂ and CH₄ measurements are now being assimilated into atmospheric transport models to estimate emissions on scales spanning individual large power plants to nations
- The objective is to develop top-down global inventories for these two gases that:
 - reduce uncertainties in national emission inventory reports
 - identify additional emission reduction opportunities
 - provide nations with timely and quantified guidance on progress towards their emission reduction targets and pledges (Nationally Determined Contributions, NDCs), and
 - track changes in the natural carbon cycle caused by human activities (deforestation, degradation of ecosystems, fire) and climate change.

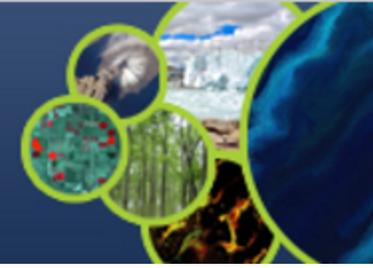


- National statistical and scientific inventories provide source-specific estimates CO₂ and CH₄ emissions into the atmosphere for most, but not all anthropogenic sources.
- They provide less insight into the natural carbon cycle or its changes due to anthropogenic activities and climate change.

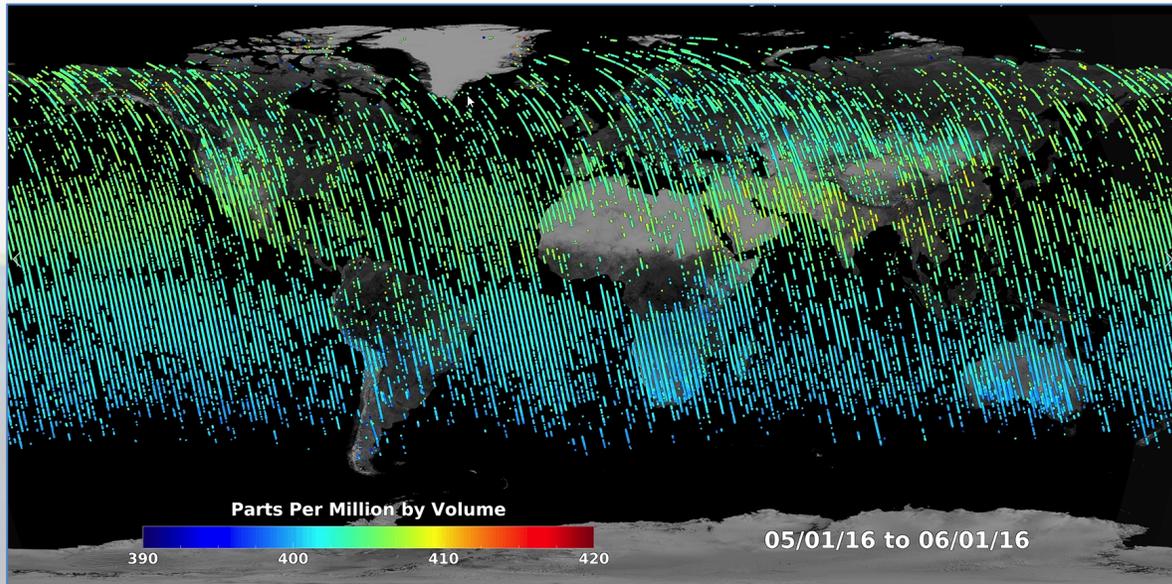


Ground and space-based atmospheric measurements of CO₂ and CH₄ complement Statistical Inventory methods by providing an integral constraint on the net amount of these gases that are added to or removed from the atmosphere by all processes.

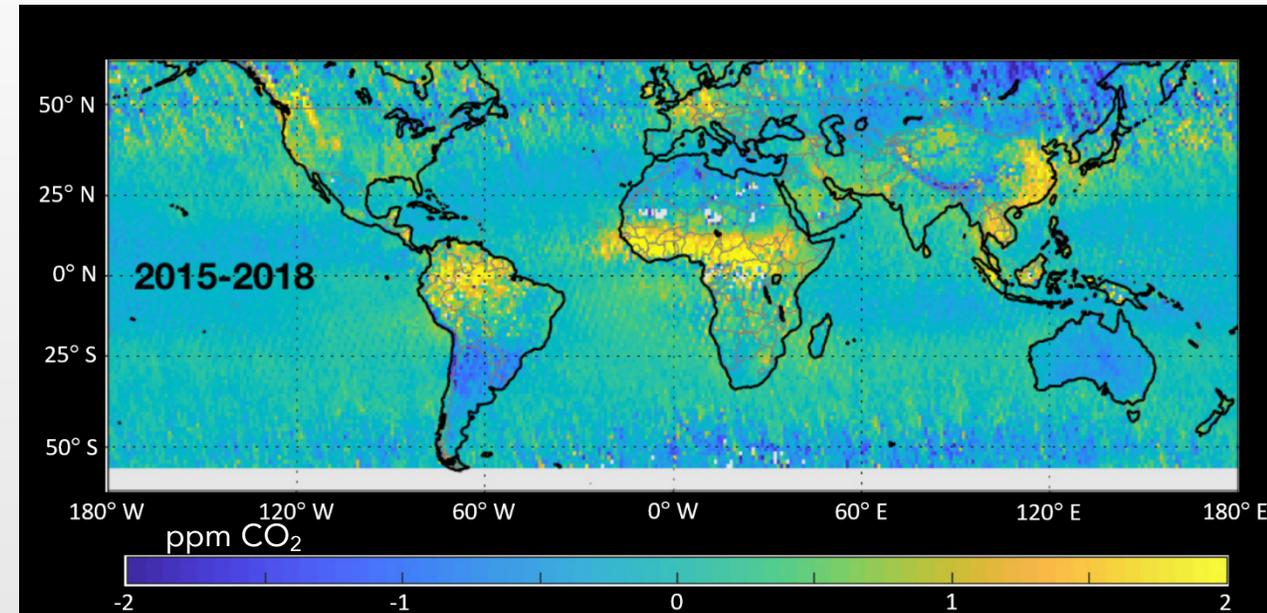
Ground-based measurements from the WMO Global Atmospheric Watch (GAW) Network and its partners provide the most accurate available estimates of atmospheric CO₂ and CH₄ concentrations and their trends on global scales, but their spatial coverage and resolution are limited.



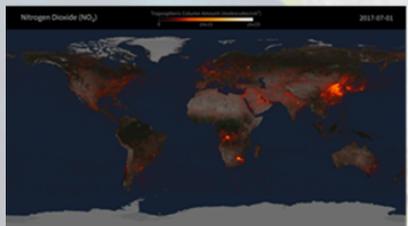
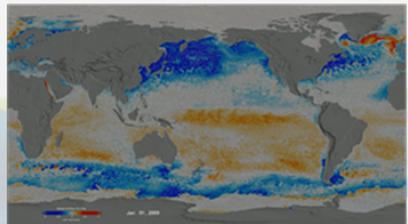
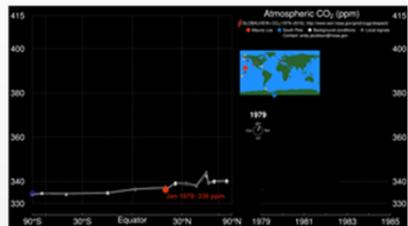
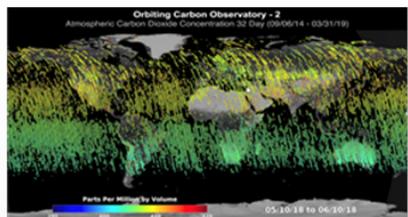
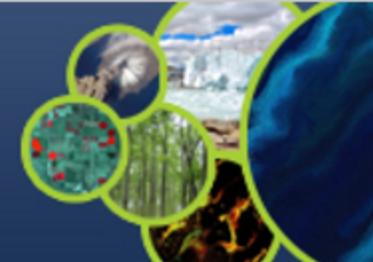
Spatially-resolved estimates of the column-averaged CO₂ and CH₄ dry air mole fractions, XCO₂ and XCH₄, like those from the NASA Orbiting Carbon Observatory-2 are somewhat less precise and accurate but provide high spatial and temporal resolution and greater coverage of the globe.



XCO₂ measurements collected by OCO-2 in May 2016.



Persistent spatial anomalies in the OCO-2 XCO₂ estimates for 2015 – 2018. The yellow regions have persistently high CO₂, indicating strong net sources over this period.



Observations

Satellite Measurements of CO₂ and CH₄

Ground and Airborne Measurements of CO₂ and CH₄

Meteorology
Satellite & in-situ

Auxiliary Data
Satellite observations of CO, NO₂, clouds, aerosols ...

Prior Information

Fluxes, model parameters, emission reports, economic statistics.

Integration & Attribution

Estimation system
Data assimilation and uncertainty estimation

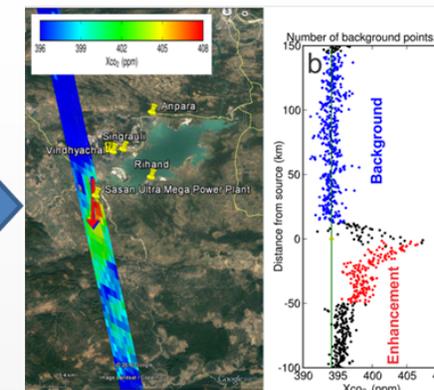
Models
Transport, land & ocean carbon cycle, fossil fuel emissions.

Outputs

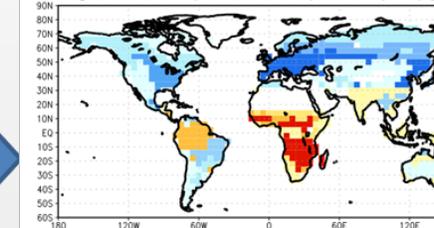
CO₂ and CH₄ emissions & removals from Hot-spots with uncertainties

Country/region CO₂ and CH₄ emissions & removals with uncertainties

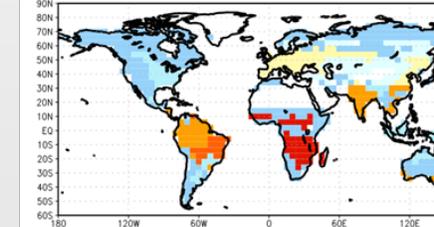
Other Carbon Cycle Products

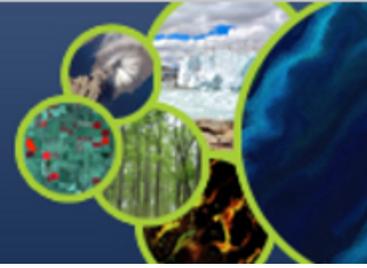


Region mean (2015–2018) NBE (GtC/y)



Region STD (2015–2018) NBE (GtC/y)





1. Refine requirements and implementation plans for atmospheric flux inventories
 - Foster collaboration between the space-based and ground-based GHG measurement and modeling communities and the bottom-up inventory and policy communities
2. Produce a prototype atmospheric CO₂ and CH₄ flux inventory that is available in time to inform the bottom-up inventories for the 2023 global Stocktake
 - Exploit capabilities of CEOS), Coordination Group on Meteorological Satellites (CGMS) and the WMO Integrated Global Greenhouse Gas Information System (IG3IS)
3. Use lessons learned from the prototype flux product to refine requirements for a future, purpose-built, operational, atmospheric constellation that better addresses the inventory process in time to support the 2028 global Stocktake.