WORLD METEOROLOGICAL ORGANIZATION

GLOBAL GREENHOUSE GAS WATCH

The Global Greenhouse Gas Watch (GGGW) will establish internationally coordinated top-down monitoring of greenhouse gas fluxes to support the provision of timely and actionable information to the United Nations Framework Convention on Climate Change (UNFCCC) Parties and other stakeholders. The GGGW was endorsed by the Nineteenth World Meteorological Congress in May 2023.

Rationale:

- Atmospheric concentrations of CO_2 and other key greenhouse gases continue to rise; the implementation of the Paris Agreement is not currently on track for the world to stay below 2.0 °C mean warming.
- Carbon offsetting remains poorly regulated and inadequately monitored; its effectiveness as a tool for climate change mitigation is now questioned.
- Not enough is known about the response of natural greenhouse gas fluxes to anthropogenic emissions and induced climate change.
- Monitoring of Paris Agreement implementation relies primarily on activities-based emission estimates – however such estimates are not linked directly to atmospheric concentrations.
- Top-down monitoring using atmospheric observations combined with atmospheric modelling systems can identify when and where greenhouse gases enter and exit the atmosphere; this information is critically needed to support mitigation action.
- Top-down monitoring could be implemented by WMO and the public sector alone, but it will be slow; public–private partnerships can help substantially accelerate this.

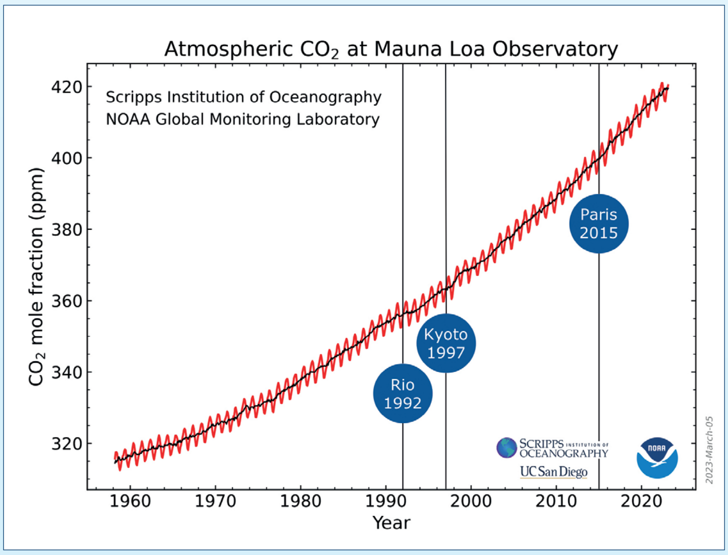


Figure 1. Sixty years of rising CO_2 background concentrations at the Mauna Loa Observatory.

The climate change seen especially over the past 50 years, which is unprecedented in human history, represents a generational challenge for all of humanity. This change is being driven primarily by increasing atmospheric concentrations of greenhouse gases due to human activity, especially fossil fuel consumption. The rise in CO_2 concentrations has been steadily accelerating over the last 60 years (Figure 1), and the steps taken under the UNFCCC thus have not yet been sufficient to curb the increase.

Climate change mitigation

This lack of success to date in curbing emissions may be linked to a lack of actionable information. Emissions from fossil fuel burning

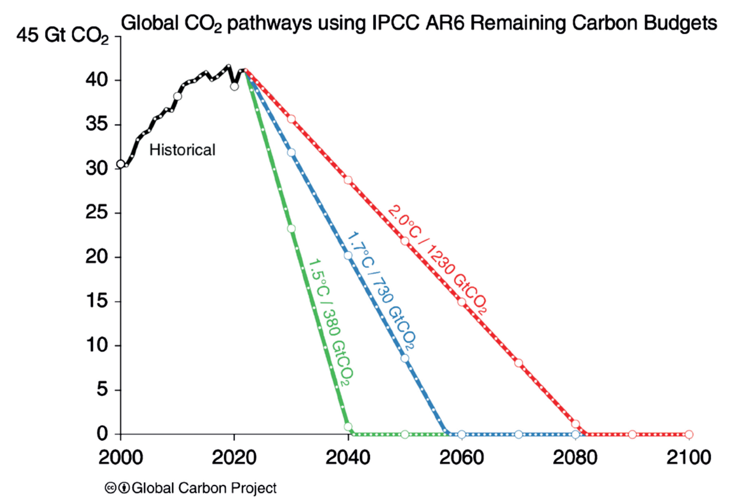


Figure 2. Anthropogenic emissions since 2000 (black). In order to stay within a warming of maximum 1.5 °C, future net anthropogenic emissions need to follow the green line, becoming zero in 2040.
Source: Global Carbon Project

are well documented in the developed world, but that is not the case for emissions due to biomass burning, agriculture, landfills, etc. Both "negative emissions" such as carbon removals, and avoided emissions, claimed in offsetting approaches, are poorly defined, largely unregulated and unmonitored, and there is no centralized accounting in place to help prevent double counting.

Equally problematic is our lack of knowledge about natural sources and sinks of greenhouse gases. In the pre-industrial era, natural sources and sinks were largely in balance, leading to relatively stable greenhouse gas concentrations over the last 800 000 years. However, in the industrial era, natural sources and sinks have been changing, in response partly to human emissions, partly to induced climate change, and we do not fully understand how, why or where this is happening.

Systematic global monitoring of greenhouse gas concentrations and fluxes is needed in order to reduce uncertainties, improve our understanding of the greenhouse gas budgets, and improve our ability to design and assess the effectiveness of mitigation action.

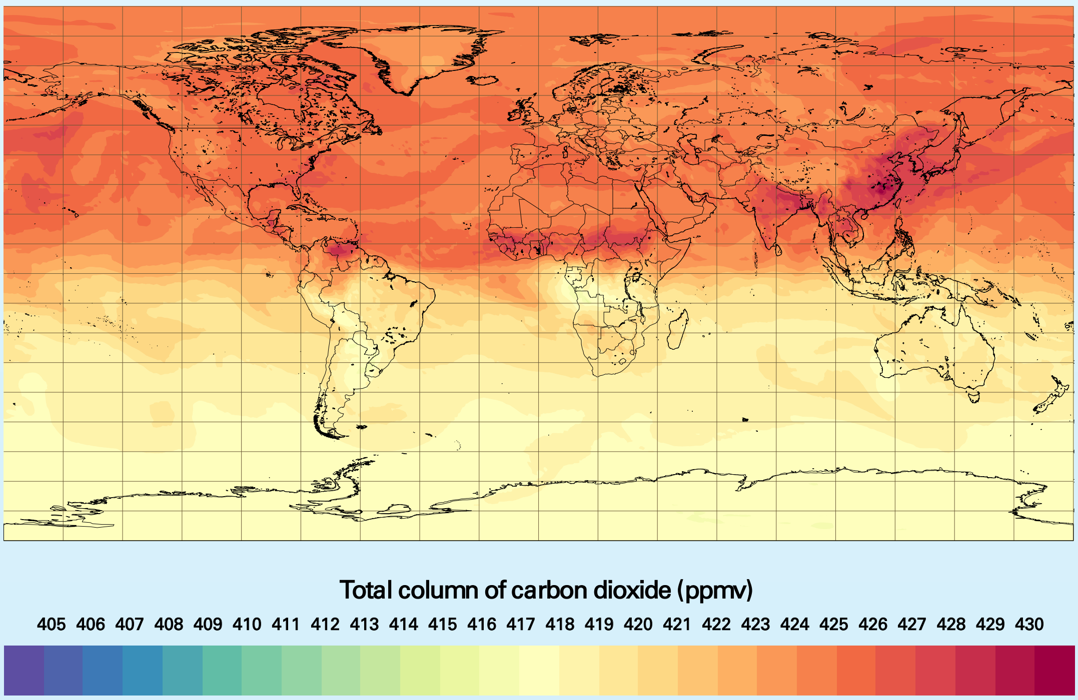


Figure 3. Global map of the Earth's CO_2 field.
Source: Copernicus Atmosphere Monitoring Service, European Centre for Medium-Range Weather Forecasts (ECMWF)

The Global Greenhouse Gas Watch

In support of efforts to combat the continued increase in atmospheric greenhouse gas concentrations, WMO and its partners are developing the GGGW to establish internationally coordinated, routine, top-down monitoring of greenhouse gas fluxes.

The main output will be consolidated monthly estimates of greenhouse gas fluxes everywhere on the globe, initially at 100 km by 100 km grid resolution, aiming for 1 km by 1 km within the current decade. The goal is to provide high-quality, authoritative, timely information about greenhouse gas fluxes at spatial and temporal scales that are directly relevant for decision-making by UNFCCC Parties and other public and private sector stakeholders, and to help bring our scientific understanding of the processes that determine greenhouse gas fluxes onto a more solid footing.

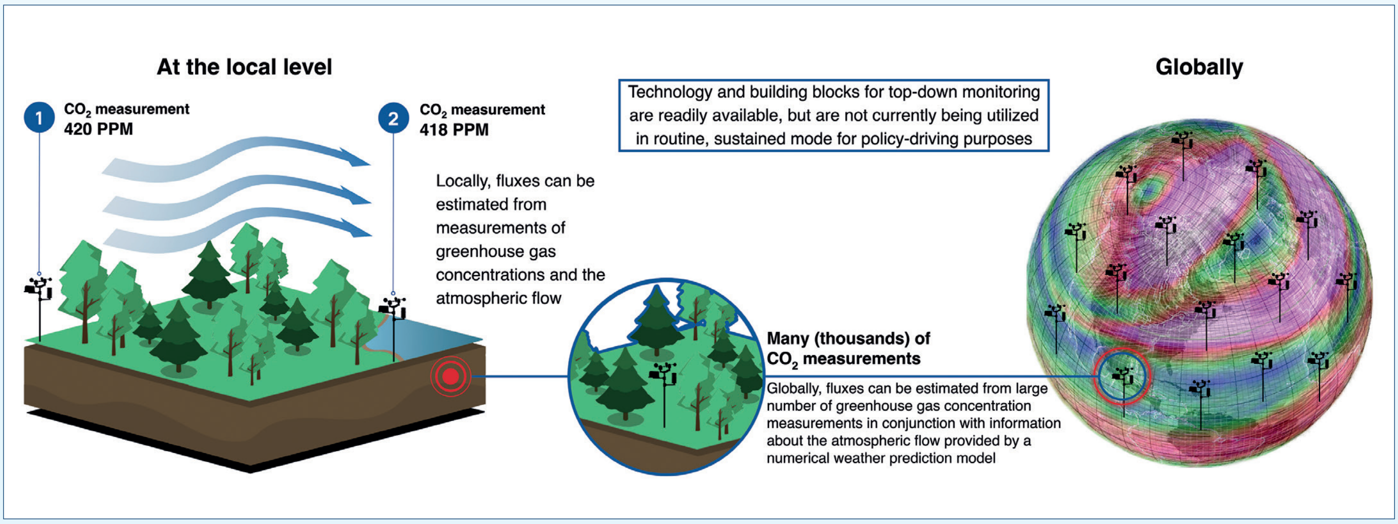


Figure 4. Estimation of greenhouse gas fluxes via the systematic comparison between model-predicted and observed greenhouse gas concentrations. The quality of the flux estimates will depend on the quality of the atmospheric transport fields and the observational data coverage.

The monitoring system will build on existing capabilities and on WMO's experience in coordinating international activities in operational numerical weather prediction, climate analysis and greenhouse gas research. The main components will be:

- An integrated global greenhouse gas observing system, using both surface- and space-based platforms;
- Routine modelling and assimilation of greenhouse gas observations for flux estimation;
- Free and unrestricted international exchange of both input and output data under the WMO Unified Data Policy;
- Routine intercomparisons and quality assessments of model outputs.

Applications

Processing of the outputs of the GGGW system can enable a number of applications relevant to the implementation of the Paris Agreement by:

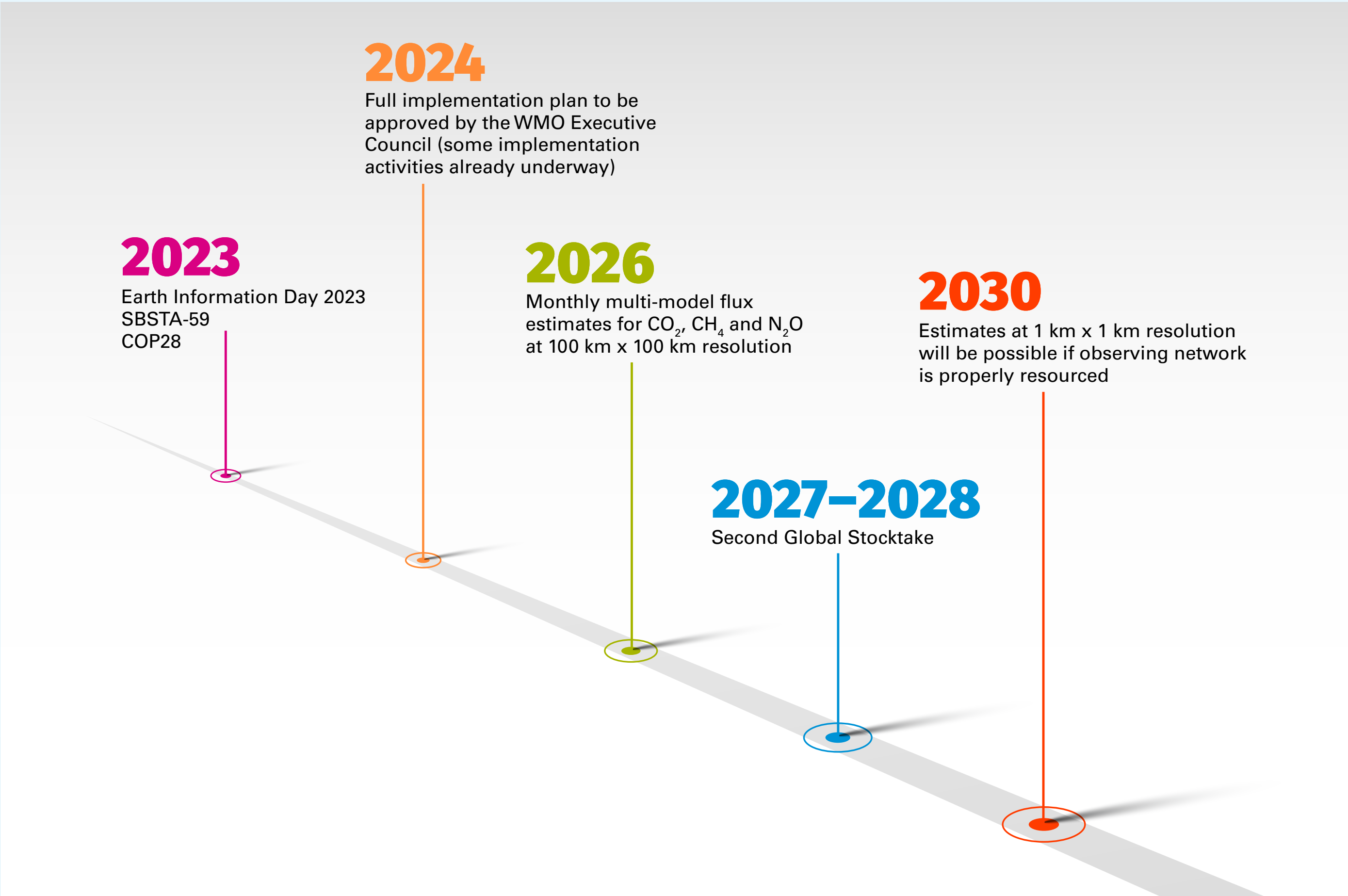
- Providing input to the:
  - Global Stocktake
  - Enhanced Transparency Framework;
  - Implementation of Article 6.
- Complementing bottom-up estimation done by national and local jurisdictions reporting on greenhouse gas emissions via downscaling, for example using IG^3IS approach.
- Voluntary and regulatory carbon markets; verification of the impact of offsets, supporting the valuation of tradeable assets.

Greenhouse gas emission and sink estimates: bottom-up and top-down approaches

There are two basic approaches to estimating when, where and why greenhouse gas concentrations change. Both will be needed:

Bottom-up estimation consists of adding up all the known contributions – positive as well as negative – of human activities to greenhouse gas emissions, for example, from fossil fuel consumption and other economic activities, agriculture, ranching, forestry, etc. Bottom-up estimation works well in developed countries where the required activity data are widely available. However, it is difficult to use in developing countries due to a lack of data, and it is even more difficult to apply to natural systems which do not report and – in the case of the ocean – partly fall outside national borders. Currently, almost all greenhouse gas reporting mandated under the Paris Agreement as well as voluntary offsetting approaches rely on bottom-up approaches.

In top-down estimation, real-time, model-generated estimates of greenhouse gas concentrations are continuously compared to atmospheric measurements, and the discrepancy is used to calculate estimates of net greenhouse gas fluxes. Global top-down flux estimates can be linked directly to the atmospheric concentrations shown in Figure 1, which drive climate change. The required infrastructure – observations, modelling and data assimilation, international exchange of input and output data – closely parallels the infrastructure developed over the past 60 years under the WMO World Weather Watch, which underpins all currently available weather and climate information irrespective of delivery agent.



The World Meteorological Organization is a specialized agency of the United Nations responsible for the international coordination of technical and scientific activities in weather prediction and climate monitoring. The Organization has 193 Member States and territories, and its history in international coordination of meteorology goes back to the establishment of its predecessor, the International Meteorological Organization, in 1873.