ГЛОБАЛЬНАЯ СИСТЕМА НАБЛЮДЕНИЙ ЗА КЛИМАТОМ
НЕУСТАННО СЛЕДИМ ЗА КЛИМАТОМ

SYSTÈME MONDIAL D'OBSERVATION DU CLIMAT
NOUS VEILLONS SUR LE CLIMAT

النظام العالمي لرصد المناخ
لنضع المناخ نصب أعيننا

全球气候观测系统
密切监视气候

SISTEMA MUNDIAL DE OBSERVACIÓN DEL CLIMA
SIEMPRE VIGILANDO EL CLIMA

GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

CO_2 requirements from GAW, GEO and the GCOS-IP

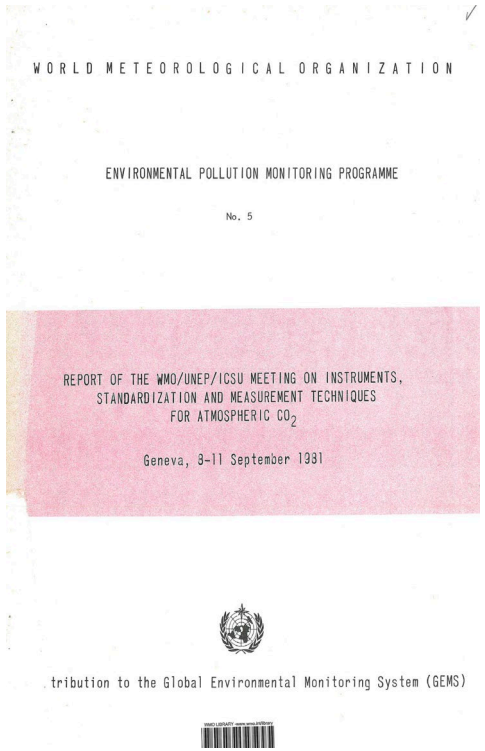
Han Dolman
Royal NIOZ & GCOS

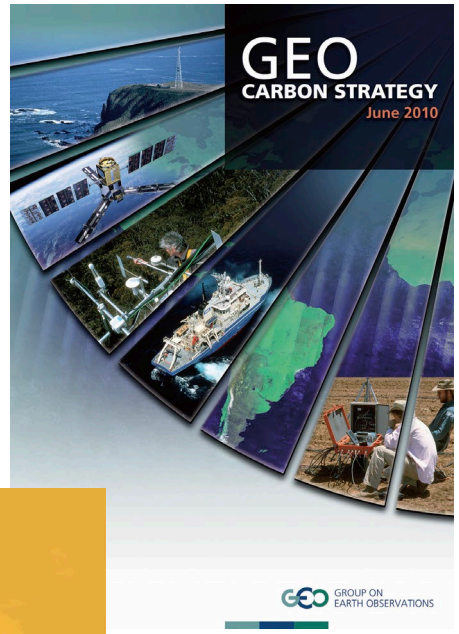
GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

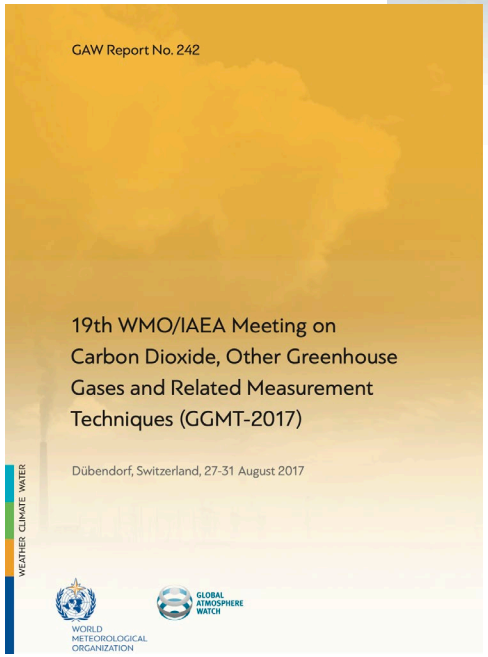
WMO IOC International Science Council UN environment

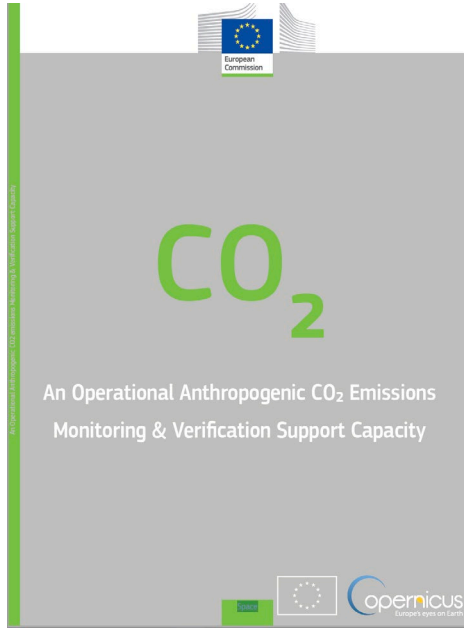
Supported by the European Union
Copernicus Europe's eyes on Earth

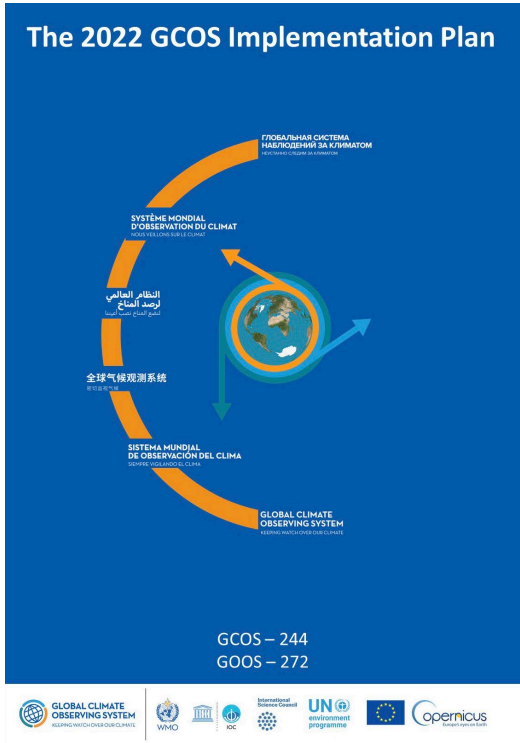
A short history of relevant documents











Reviews of Geophysics®

REVIEW ARTICLE

10.1029/2021RG000736

Key Points:

- Anthropogenic CO_2 emissions would have produced larger atmospheric increases if ocean and land sinks had not removed over half of this CO_2
- Uptake by both ocean and land sinks increased in response to rising atmospheric CO_2 levels, maintaining the airborne fraction near 45%
- Improved and sustained measurements and models are needed to track changes in sinks and enhance the scientific basis for carbon management

How Well Do We Understand the Land-Ocean-Atmosphere Carbon Cycle?

David Crisp[1], Han Dolman[2,3], Toste Tanhua[4], Galen A. McKinley[5], Judith Hauck[6], Ana Bastos[7], Stephen Sitch[8], Simon Eggleston[9], and Valentin Aich[9]

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GCOS WMO IOC International Science Council UN environment

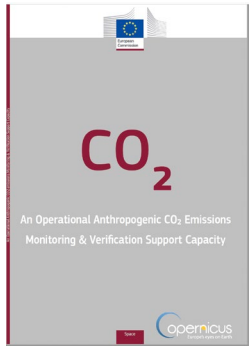
What do we want?

- **Detection of hot spots.** This can be a large power plant, a megacity or any other activity characterized by strong CO_2 emissions with different time evolution;

- **Monitoring the emissions of hot spots**. The accuracy of consecutive measurements must ensure the capability to attribute CO_2 emissions anomalies relative to the CO_2 concentration background level;

- **Assessing emission changes against local reduction targets**. This concerns the monitoring of the implemented emission reduction strategies on the hot spots, which all add up to achieve NDC targets including megacities with peak emissions of transport and buildings;

- **Assessing the national emissions and changes** with 5 year time steps. This requires the entire screening of the full area covered by the country, in order to account for changes in emission patterns with new or occasional hotspots.



Action F5: Develop an Integrated Operational Global GHG Monitoring System	
Activities	The overall aim here is to develop an integrated operational global greenhouse gas monitoring infrastructure. The first steps are: 1. Design and start to implement a comprehensive global set of surface-based observations of CO_2, CH_4 and N_2O concentrations routinely exchanged in near-real time suitable for monitoring GHG fluxes. 2. Design a constellation of operational satellites to provide near-real time global coverage of CO_2 and CH_4 column observations (and profiles to the extent possible). 3. Identify a set of global modelling centres that could assimilate surface and satellite-based observations to generate flux estimates. 4. Improve and coordinate measurements of relevant ECVs at anthropogenic emissions hotspots (large cities, powerplants) to support emission monitoring and the validation of tropospheric measurements by satellites.
Issue/Benefits	The Paris Agreement requests Parties to regularly provide estimates of anthropogenic emissions by sources and removals by sinks of greenhouse gases, and information necessary to track progress made in implementing and achieving their nationally determined contribution under Article 4. The proposed global greenhouse gas monitoring infrastructure would support the development of these estimates (i.e. emission inventories); validate national and regional achievement of Parties' commitments in their NAPs; and monitor changes to the cycles of GHG that may impact the achievement of the temperature goal of the Paris Agreement. Monitoring of hot-spots via dedicated observations to validate specific point-source emissions and identify missing sources form emission inventories. Remote monitoring of atmospheric composition can quantify and identify major emission sources. Anthropogenic emission hotspots like cities and industrial facilities and power plants contribute strongly to the global GHG emissions and to emission of key ozone and aerosol precursors (SO_2, VOCs). Reliable remote observations of these emission hotspots in synergy with source detection models can contribute to verifying emission estimates and monitor and guide mitigation efforts (link to Flux ECV).

Recommendations Workshop

- Consensus on the need for a fully integrated, globally coordinated [Greenhouse Gas Watch - *still to be named*] that encompasses:
  - Integrated observing systems, surface-based and space-based assets and activity data;
  - Multi-centre modelling and data assimilation systems (ESM-driven transport models, including geospatially disaggregated land and ocean sources and sinks terms);
  - A tiered approach of modelling systems (spatially, temporally, in terms of coupling) including global and regional centres linked to national entities;
- Consensus that the World Weather Watch would be a useful starting point for large parts of such a framework; however:
  - This will require close coordination with entities outside WMO to entrain needed expertise, e.g. in land surface and ocean observations and modelling;
- WMO to call for round table discussion with relevant parties (tbd) to establish the need for a high-level coordination mechanism among all data providers:
  - Involvement of GCOS and WCRP and entities such as UNFCCC, IOC, UNEP, FAO, GEO, CEOS, CGMS, IPCC (TSU), etc., as well as regional and national entities (e.g. Copernicus), will be key;
  - A comprehensive “landscape analysis” of roles and responsibilities in greenhouse gas monitoring should be undertaken;
  - Invite GCOS to lead consideration of whether the Carbon Cycle observations set out in its latest IP are comprehensive in terms of observational requirements for such an overall GHG Watch;

System architecture

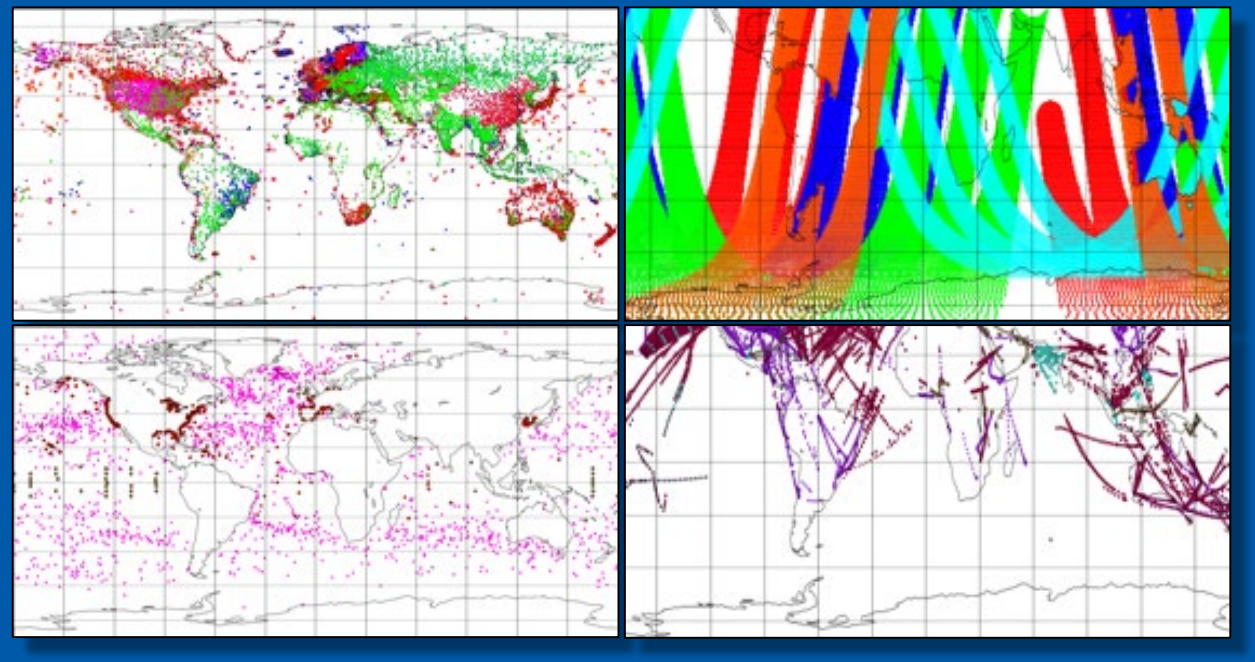
- System architecture to be designed with the aim of improving our fundamental understanding of global biogeochemical cycles (CO_2, CH_4, N_2O);
- Scope to intercompare products between service centres, as well as comparison/coherence of input data/models; WMO to support systematic verification of products, and intercomparison of skills measures (cf NWP);
- Need for modelling systems consistent with a capability for reanalysis at different timescales, e.g. to perform:
  - Longer reanalysis back to least 1990 (emissions baseline);
  - Shorter reanalyses linking different GST cycles;
- Priors provide an important link to the Inventory Community, i.e. their direct contribution to the system;
- Satellite observations, positive coordination efforts (CEOS/CGMS), however an expansion of currently planned capabilities towards a comprehensive space-based operational constellation is required;
  - Activities on GHG and AFOLU in CEOS/CGMS are going in right direction;
  - Systematic delivery of carbon cycle products = beyond ECVs;
  - Next generation Biosphere/AFOLU/LULUCF products (CEOS AFOLU Roadmap, GEO);
  - Further improvements in data quality and acceptance.

Way forward

- Clarify the requirements intended to be met by the [GGW], including the primary target applications (e.g., anthropogenic fluxes, natural sources/sinks);
- Develop a time-line for the establishment of the overall infrastructure;
- Develop roadmap for design of comprehensive, integrated global GHG observing system consisting of both surface- and space-based assets, incorporating and building upon existing and already planned capabilities;
- Engage key organizations/entities performing GHG modeling and inversion activities (lessons learned from NWP centers and WGNE) and provide a framework for overall coordination and inclusiveness;
- Engage actively with stakeholders from developing countries; formulate capacity development activities - leveraging and coordinating ongoing activities GAW, GCOS, etc.;
- Develop pilot programs in two directions:
    - Early advanced users/countries
    - Developing countries .. use of new infrastructure applications aided by working with development agencies in the region
- Immediate actions:
    - WMO to call for round table discussion with relevant parties;
    - Seek to expand observing networks in priority regions including the tropics, the Southern Ocean and the Arctic;
    - Establish collaboration between existing GHG modeling centers to provide access to common observational datasets and opportunities for intercomparison (lessons learned from NWP, Air Quality forecasts, …);
    - Initiate activities to support the current UNFCCC assessment cycle.

GCOS and AOPC

- Building blocks are there (GAW, Copernicus, IPCCC, GCOS)
- Individual ECV, task requirement setting GCOS IP okay, pnels to work together on this
- They are not yet analysed and asssessed in a coherent assimilation framework
- Need to define the key goals (hot spots, countries etc) and time frame
- Setup a priority list
- Need to involve non-traditional WMO institutions



Thank you

https://gcos.wmo.int/en/gcos-status-report-2021

https://apps.ipcc.ch/comments/gcos/fod/register.phpgl

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