Committee on Earth Observation Satellites

CGMS

Global Greenhouse Gas Watch – G3W

In the context of WMO GHGs activities

Gianpaolo BALSAMO, WMO

WGClimate-22 & GHG-TT-5

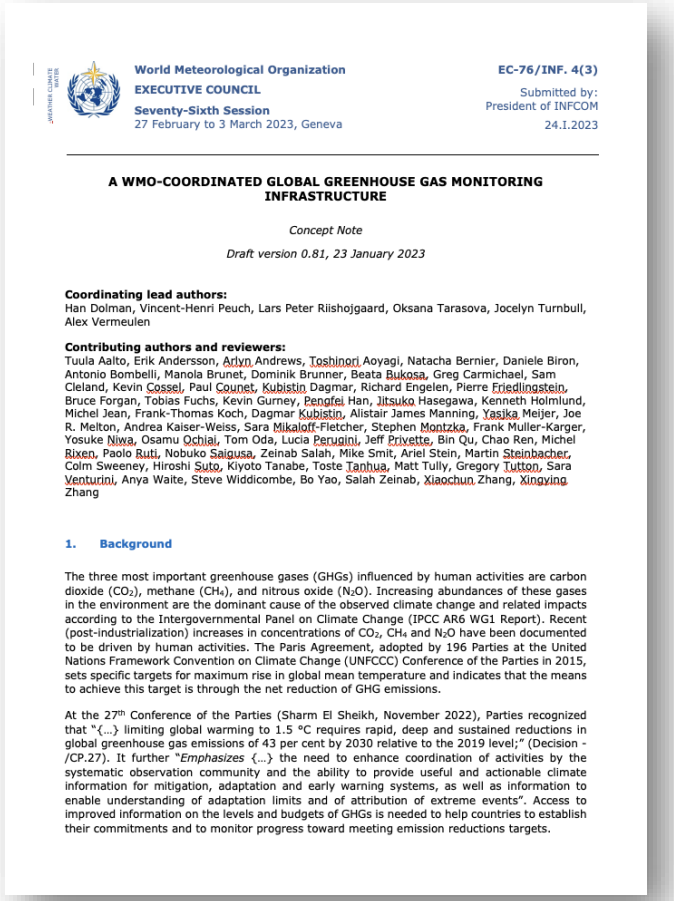
11 - 13 February, 2025
ESA ECSAT, Harwell, UK

Agenda Item 5.1

WGClimate
The Joint CEOS-CGMS Working Group on Climate

The vision and concept behind G3W

The concept has been presented to EC-76 and **adopted by the 19th Meteorological Congress**.



World Meteorological Organization
EXECUTIVE COUNCIL
Seventy-Sixth Session
27 February to 3 March 2023, Geneva

EC-76/INF. 4(3)
Submitted by:
President of INFCOM
24.I.2023

A WMO-COORDINATED GLOBAL GREENHOUSE GAS MONITORING INFRASTRUCTURE

Concept Note

Draft version 0.81, 23 January 2023

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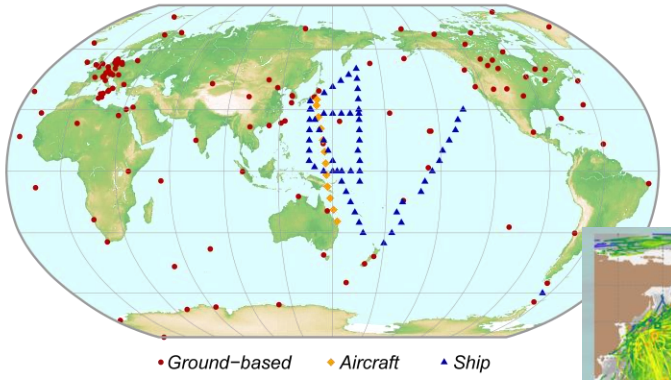
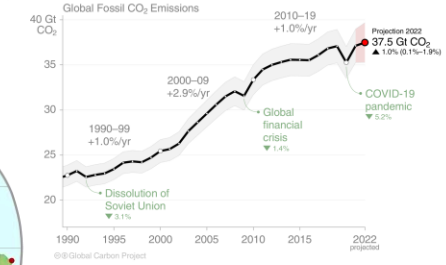
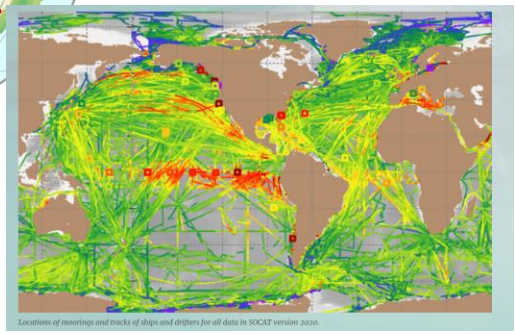
1. Background

The three most important greenhouse gases (GHGs) influenced by human activities are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Increasing abundances of these gases in the environment are the dominant cause of the observed climate change and related impacts according to the Intergovernmental Panel on Climate Change (IPCC AR6 WG1 Report). Recent (post-industrialization) increases in concentrations of CO_2, CH_4 and N_2O have been documented to be driven by human activities. The Paris Agreement, adopted by 196 Parties at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties in 2015, sets specific targets for maximum rise in global mean temperature and indicates that the means to achieve this target is through the net reduction of GHG emissions.

At the 27th Conference of the Parties (Sharm El Sheikh, November 2022), Parties recognized that "{...} limiting global warming to 1.5 °C requires rapid, deep and sustained reductions in global greenhouse gas emissions of 43 per cent by 2030 relative to the 2019 level;" (Decision -/CP.27). It further "*Emphasizes* {...} the need to enhance coordination of activities by the systematic observation community and the ability to provide useful and actionable climate information for mitigation, adaptation and early warning systems, as well as information to enable understanding of adaptation limits and of attribution of extreme events". Access to improved information on the levels and budgets of GHGs is needed to help countries to establish their commitments and to monitor progress toward meeting emission reductions targets.

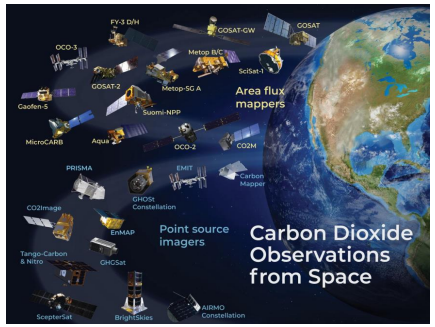


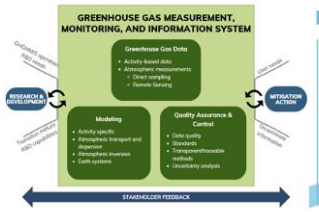




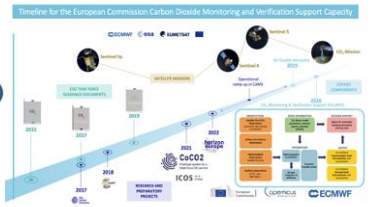
Substantial **research efforts** have been on-going and will remain **essential**, but **transition to sustained operations** is a necessity in the context of climate risks.

There is good alignment with **fast-track GHGs information efforts**, such as in EU, JAPAN, US... and **large investments in the space sector**.

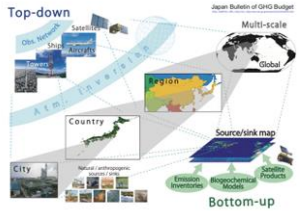




US GGMMIS, 2023



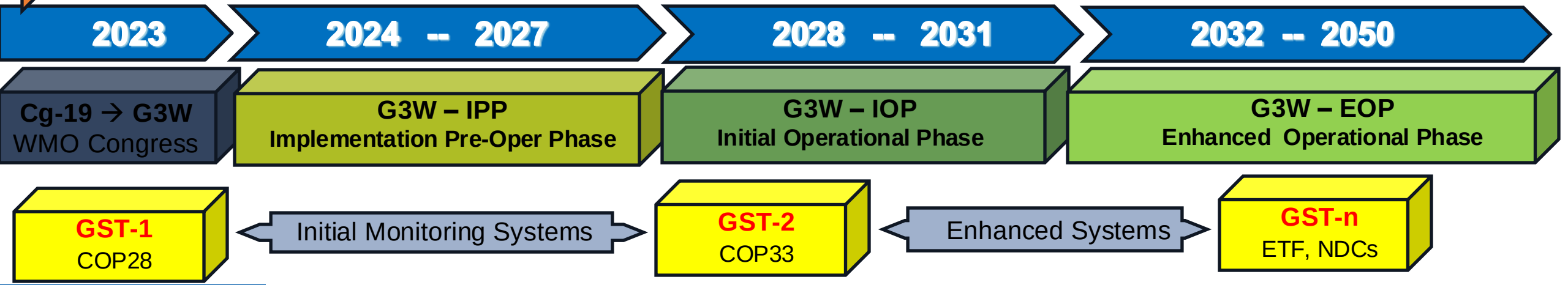
EU COPERNICUS, 2023



JAPAN NIES, 2023

G3W progress made in 2024

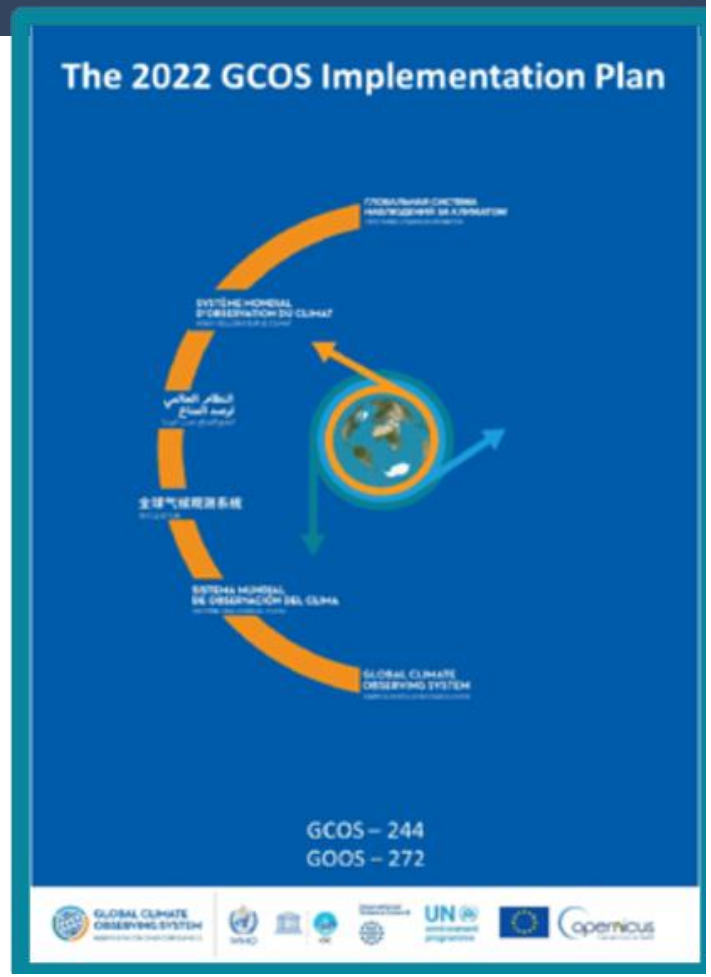
- **A 1st complete draft of G3W IP** with **WMO RMS** contribution on the **18th of January 2024**.
- **GHG-SG & G3W-Team** worked to consolidate the **G3W IP** up to the **22nd of January 2024**
- **G3W IP v1.0** published on the web, for an **Open-Community-Review** on the **23rd of January 2024**
- **G3W IP v2.0** presented to **INFCOM-Management** on the **7th of February 2024.**
- **G3W** presented to WMO **INFCOM-3** in the week of the **15th of April 2024.**
- **G3W** endorsed by WMO **EC-78** in the week of the **10th of June 2024.**
- **G3W Implementation and Pre-Operational Phase G3W-IPP officially starts.**
- **G3W Advisory Group and Task Teams (Modelling, Networks, Data) are formed.**
- **G3W Presented at Earth Information Day** and **Progress noted** by SBSTA **SB61** in COP29 **11th and 16th November 2024.**



WGClimate
The Joint CEOS-CGMS Working Group on Climate

G3W-GCOS-GAW links

- **G3W follow-on to Action F5 in the 2022 GCOS Implementation Plan**
- **G3W** concept follows **GCOS**: Developing an
  - **Integrated**
  - **Operational**
  - **Global**
  - **GHGs**
  - **Monitoring System**
- **GAW Programme & IG3IS Research are key**
- **G3W will aim at R2O – O2R**



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 National Adaptation Plans (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).
Implementers	1. **WMO (INFCOM, GAW and IG3IS).** 2. **Space agencies**, National agencies, Research organizations, Academia. 3. **WMO (INFCOM, GAW and IG3IS)**, National agencies. 4. **GCOS,** Space agencies, National agencies.

Greenhouse Gases in focus at COP29 - EID:

WMO GHG bulletin

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION | GLOBAL ATMOSPHERE WATCH

WMO GREENHOUSE GAS BULLETIN

The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2023

No. 20 | 28 October 2024

ISSN 2078-0796

The WMO Global Atmosphere Watch (GAW) Greenhouse Gas (GHG) Bulletin has been informing policy and the public on the composition of GHGs in the global atmosphere since 2006. The first edition reported that in 2004, the carbon dioxide (CO_2) level was 377.1 parts per million (ppm)[1]. In 2023, the level was 420.0 ppm. This is an increase of 42.9 ppm, or 11.4%, in just 20 years.

Atmospheric carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas driving climate change [1]. From 2022 to 2023, the annual mean CO_2 in the global surface atmosphere increased by 2.3 ppm (Figure 1). This increase marked the twelfth consecutive year with an increase greater than 2 ppm, continuing an already significant trend. CO_2 is accumulating in the atmosphere faster than at any time during human existence. The current atmospheric CO_2 level is already 51% above that of the pre-industrial (before 1750) era.

A detailed analysis (Figure 2) of within-year variability demonstrated that the within-year increase of CO_2 in 2023 was 2.8 ppm [1], which is the fourth largest within-year annual increase since modern CO_2 measurements started in the 1950s.

The reason behind this decade-long significant increase in CO_2 is historically large fossil fuel CO_2 emissions in the 2010s and 2020s. It is estimated that global fossil fuel carbon emissions in 2023 were 10.0±0.5 Pg C yr^{-1},

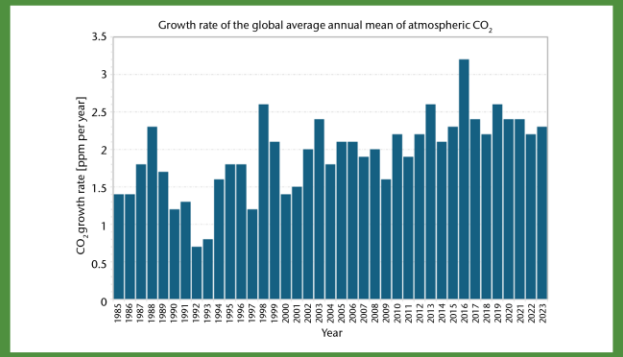
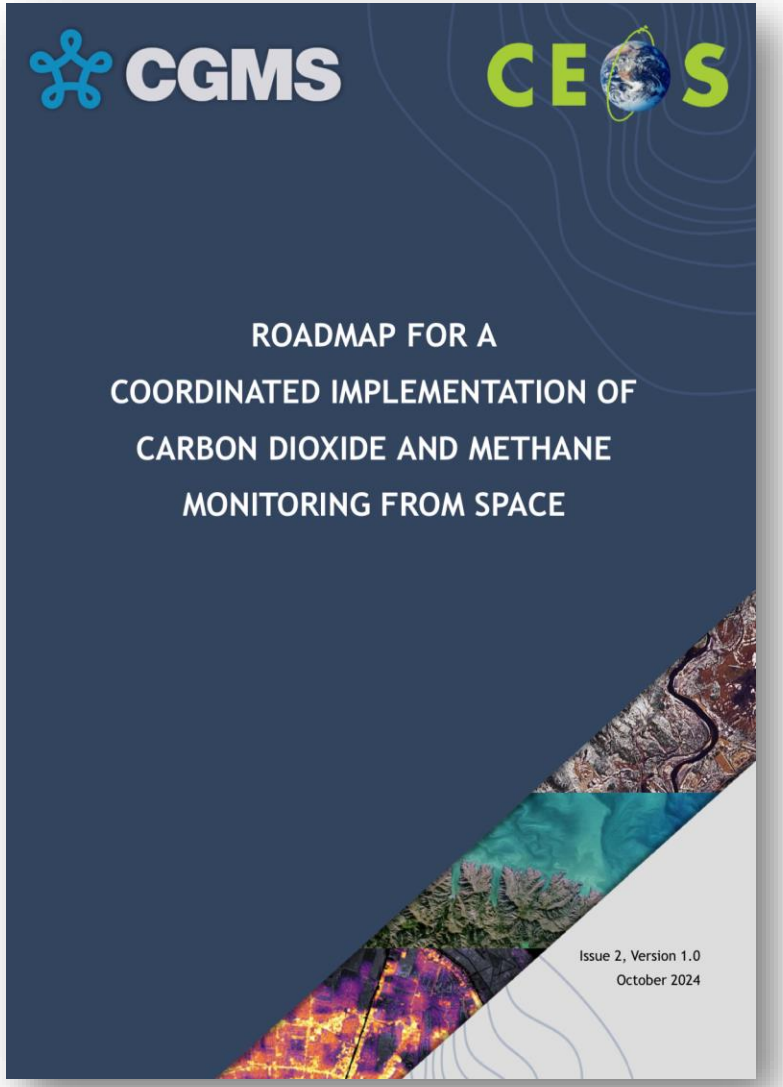


Figure 1. Growth rate of the annual global mean atmospheric CO_2, calculated from WMO GAW network observations for the period 1985–2023 following the method described in [2].

CEOS/CGMS roadmap



G3W

World Meteorological Organization
EXECUTIVE COUNCIL
Seventy-Eighth Session
10 to 14 June 2024, Geneva

EC-78/Doc. 3.2
Submitted by: Chair
11.VI.2024
APPROVED

AGENDA ITEM 3: **STRATEGIC PRIORITIES**

AGENDA ITEM 3.2: **Global Greenhouse Gas Watch**

IMPLEMENTATION PLAN FOR THE GLOBAL GREENHOUSE GAS WATCH

DRAFT RESOLUTION

Draft Resolution 3.2/1 (EC-78)

Implementation Plan for the Global Greenhouse Gas Watch

THE EXECUTIVE COUNCIL,

Recalling the WMO Strategic Plan 2024–2027,

Recalling also Resolution 5 (Cg-19) – Global Greenhouse Gas Watch, which requested the Commission for Observation, Infrastructure and Information Systems (INFCOM), the Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM), and the Research Board (RB), via the joint Study Group, to further develop the concept of the Global Greenhouse Gas Watch (G3W) through a detailed implementation plan, building on existing capabilities and ongoing activities under the Global Atmosphere Watch (GAW), including the Integrated Global Greenhouse Gas Information System (IG³IS), and other relevant international framework, and bring the draft plan to the Executive Council for its review and approval,

Recalling further the observing network design principles, in particular, principle 13: Advancing Environmental Sustainability, in the *Manual to the WMO Integrated Global Observing System* (WMO-No. 1160), Appendix 2.1,

Having examined Recommendation 7.2/1 (INFCOM-3),

Recognizing the WMO role as a coordinator of activities undertaken by Members built on its neutral position on national governments' climate change policies including their efforts to estimate and reduce greenhouse gas (GHG) emissions,

Recognizing also the significant policy implications of greenhouse gas monitoring data; it is thus recommended for any greenhouse gas monitoring to be carried out with full transparency, in accordance with Resolution 1 (Cg-Ext(2021)) – WMO Unified Policy for the International Exchange of Earth System Data, and its call for free and unrestricted international exchange of Earth system data,

Recognizing further the disparities in Greenhouse Gas observation capabilities among Members, the implementation plan underscores the importance of enhancing technology and expertise globally,

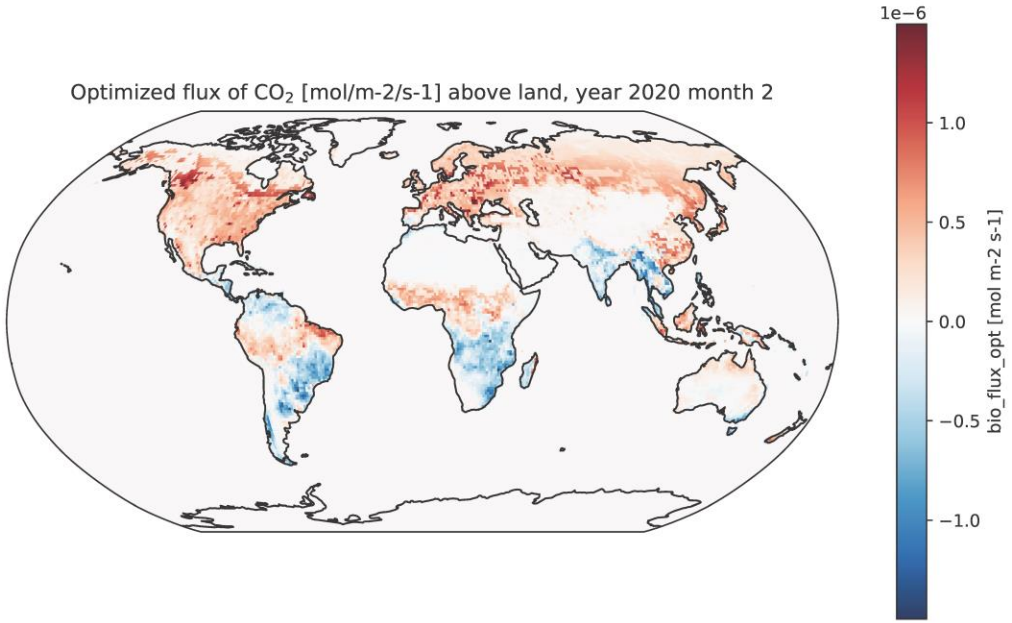
The Global Greenhouse Gas Watch (G3W):

Following the Cg-19 approved concept note

The G3W routine and sustained output include:

- Monthly CO_2 and CH_4 net fluxes between the Earth surface and the atmosphere with 1x1 degree horizontal resolution delivered with a maximum delay of one month
- 3D fields of atmospheric CO_2 and CH_4 abundance with hourly resolution and the latency to be defined through user requirements and further consultation (tentatively on the order of a few days).
- N_2O abundances and net fluxes with resolution and latency still to be defined.

G3W will be supported by several global modelling centers (similar to World NWP Center)



Progress with the system was noted in the SBSTA conclusion at COP-29

The G3W Actions plan

- Create inventory of observations
- Carry out observational network design

- Create inventory of prior data products

- Develop the supporting R&D strategy
- Identify the highest priority research needs for the operational systems

Section 3 Observing System – O (12)

- O1 – Observation inventory
- O2 – Obs. standards & requirement
- O3 – Longer term Obs.
- O4 – Surface-based Obs. Design
- O5 – Reference Network Development
- O6 – Basic ("fit-for-purpose") network
- O7 – RS & vertically-resolved Obs.
- O8 – Ocean network design
- O9 – Gridded Air-Sea CO_2 flux
- O10 – Space-based Obs. with CEOS-CGMS, direct
- O11 – Space-based Obs. with CEOS-CGMS, indirect
- O12 – Space-based Obs. with CEOS-CGMS, future

Section 4 Modelling System– M (7)

- M1 – Modelling center & data
- M2 – Modelling center-documentation
- M3 – Continuous Operations (RRR)
- M4 – Obs. acquisition and pre-processing
- M5 – Prior Implementation
- M6 – Production centers common approaches
- M7 – Modelling products evaluation

Section 5 Prior Information – P (4)

- P1 – Identify needs – CO_2
- P2 – Identify needs – CH_4
- P3 – Identify needs – N_2O
- P4 – Fluxes characterization

Section 6 Data Management – D (7)

- D1 – Data from Raw to Exchange
- D2 – Data from providers to assimilation
- D3 – Data for model intercomparisons
- D4 – Data discovery and distribution
- D5 – Data repository for prior and fluxes
- D6 – Definition of prior data providers
- D7 – Data policy for the repository of prior fluxes

Section 7 R&D Needs – R (3)

- R1 – G3W R2O Task Team establishment
- R2 – Advance Obs. & data exchange capabilities
- R3 – Advance modelling and flux inversion capabilities

Section 8 User Engagement & Uptake – U (4)

- U1 – Support the GST
- U2 – Guidance on regional products
- U3 – Establish relationship & pathway
- U4 – Develop user interface guidelines

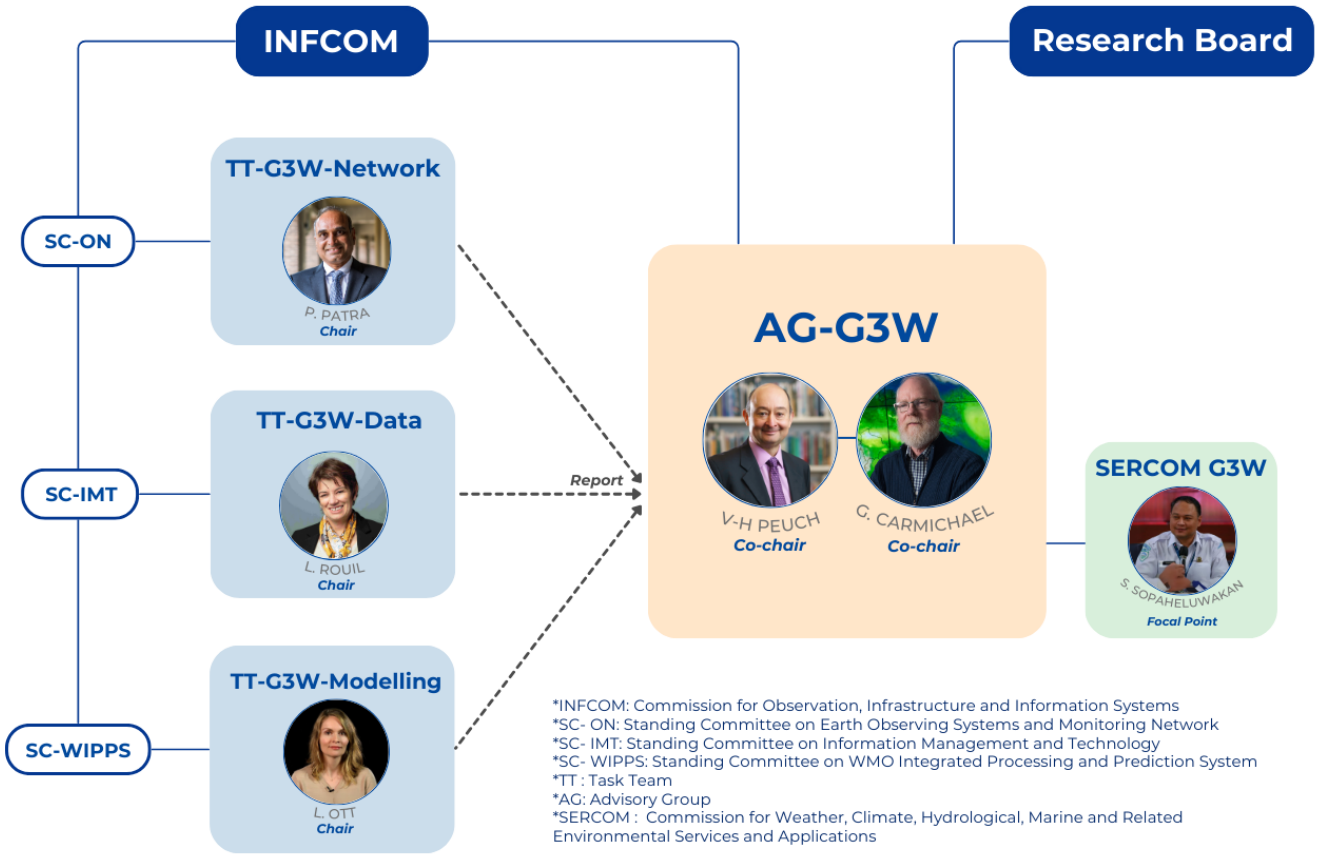
- Definition of the output products and system requirements

- Evaluate applicability of WIS2.0 for G3W required data exchange
- Connect existing observations to WIS

- Identify requirement for the products
- Provide recommendations on the use of G3W outputs

G3W Implementation Plan: priority deliverables

G3W delivery in 2025



*INFCOM: Commission for Observation, Infrastructure and Information Systems
*SC- ON: Standing Committee on Earth Observing Systems and Monitoring Network
*SC- IMT: Standing Committee on Information Management and Technology
*SC- WIPPS: Standing Committee on WMO Integrated Processing and Prediction System
*TT : Task Team
*AG: Advisory Group
*SERCOM : Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications

TT-G3W-Network:

- Comprehensive inventory of the GHG Obs, and a Network-design presented to the INFCOM.

TT-G3W-Modelling:

- WIPPS manual is updated to include G3W operations and recommendations on the methods and protocols for the quality control and verifications of infrastructure outputs are established and presented to the INFCOM.

TT-G3W-Data:

- Mapping of the current practices related to GHG data characterization, data exchange, data management and data policies.
- Design of the architecture for global data sharing in support of G3W.

Relevant information from TT-G3W Networks

GHG Tasks connecting to WIGOS-WIS-WIPPS

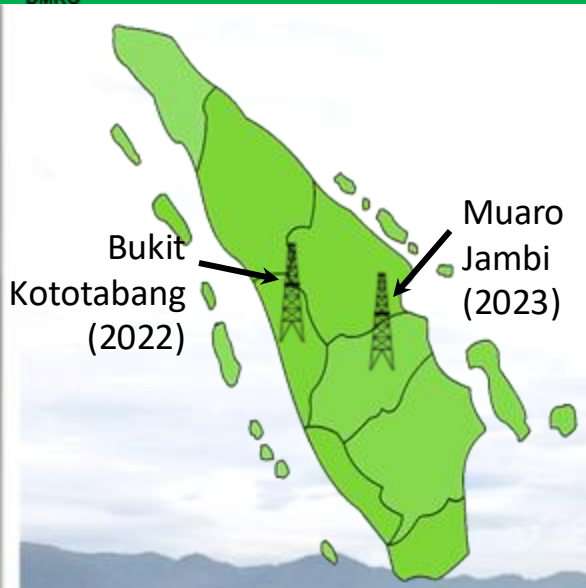
- Existing inventories of the observations
- **OSCAR** requirements provided for the atmospheric domain (coordination G3W-GAW) and related statement of guidance (2.6 App)
- Outputs of the modelling comparisons (global)
- Regional/national network designs
- **WIGOS** vision 2040 and WIGOS network design principles
- INFCOM recommendations on Tiered-Networks

Deliverables for INFCOM-4

- Comprehensive inventory of the GHG observations
- Network design

First TT-G3W-Networks meeting took place on 25 November 2025

INDONESIA - IMPLEMENTATION OF GHG TALL TOWER



BMKG's GHG tall-tower measurement program for GHG in Bukit Kototabang and Muaro Jambi

Eddy Covariance measurement at 30-m tower (2024)

thanks to Dr. Ardhasena Sopaheluwakan

Bukit Kototabang, West Sumatra Province

Measurement is conducted at three height levels (30 m, 70 m, dan 100 m)

Muaro Jambi, Jambi Province

INDONESIA - ACCELERATED PROJECT IMPLEMENTATION

Republic of Indonesia


thanks to Dr. Ardhasena Sopaheluwakan

Funding Opportunity for 2026 - 2028

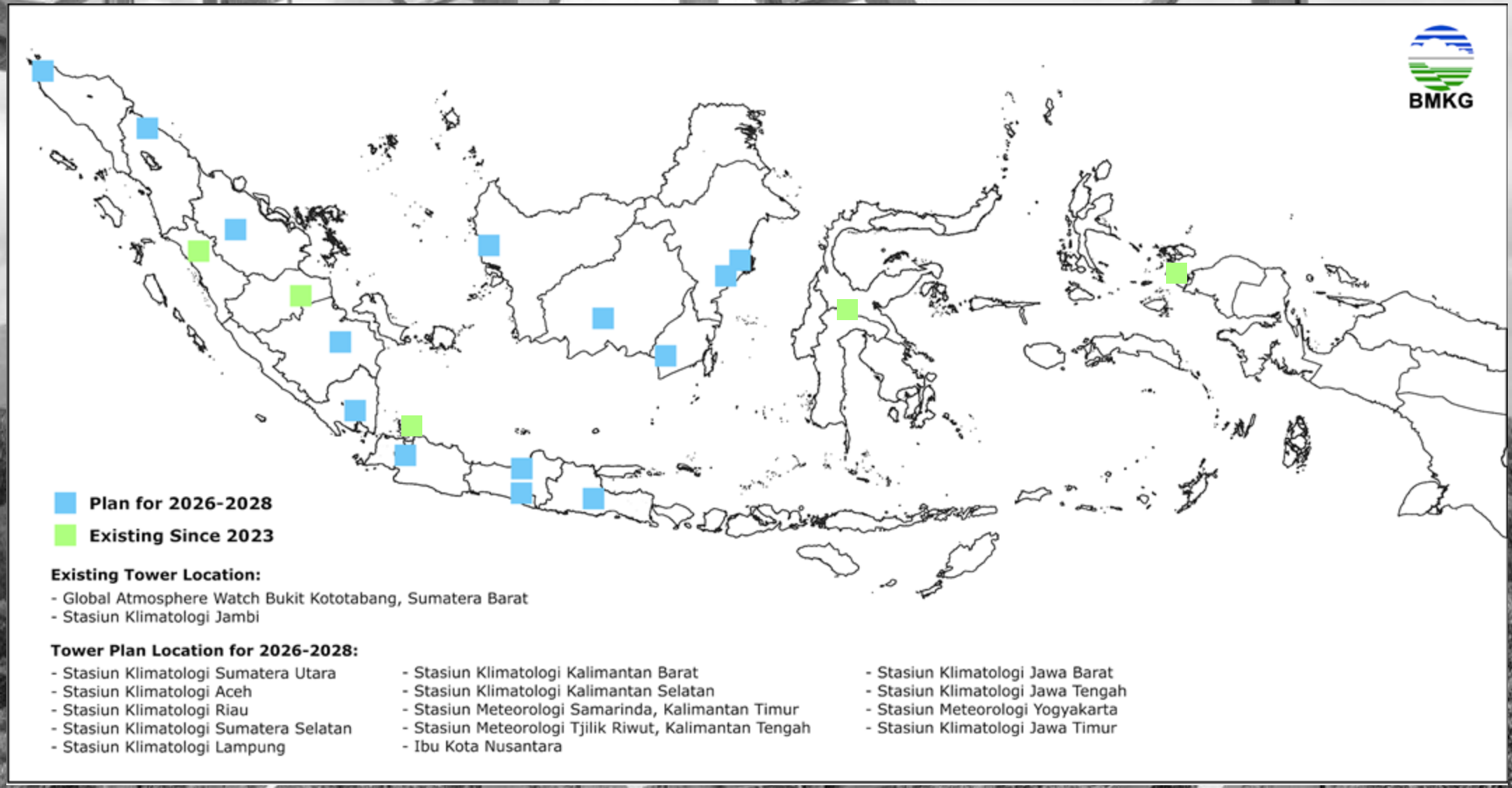
Strengthening The Capacity Of Greenhouse Gas Monitoring In Indonesia

Objectives

- Integrated GHG Data
- Top down GHG Emission Inventory Estimate
- Supporting Estimation of Economic Value of Carbon
- Supporting implementation of Low Carbon Development

Status: IN CONSULTATION, EARLY 2025

UPSCALING PROJECT 2026-2028: EXTENSION TO OTHER REGIONS IN INDONESIA



Upscaling plan for FY 2026 – 2028, for 4 – 14 GHG monitoring sites, presently under negotiation with MoF and subject to funding availability.

GHG CAPACITY BUILDING IN THE ASIA-PASIFIC REGION

Hands-on Training on
Greenhouse Gas Measurement
A collaboration between WMO and BMKG

The training was held from **30 September to 4 October 2024** at the Global Atmospheric Watch (GAW) Station in Bukit Kototabang, Indonesia.

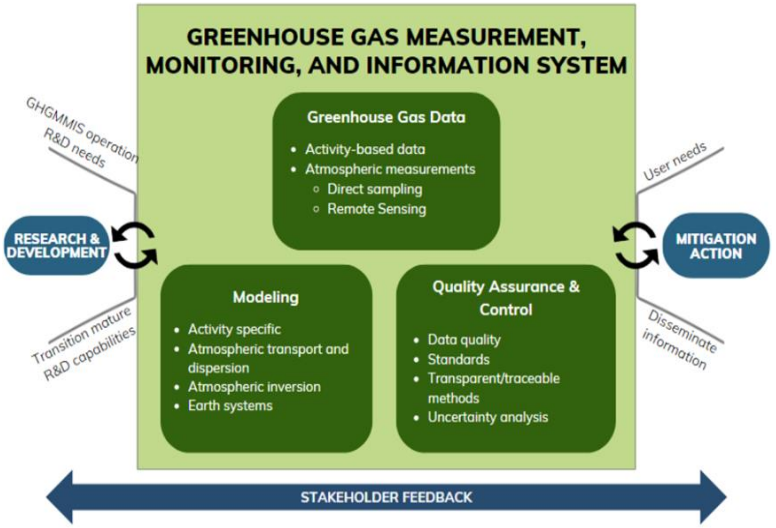
The aim was to improve the technical capacity of professionals from diverse countries.

Participants were from 14 countries: **Bangladesh, Bhutan, Brunei, Fiji, India, Malaysia, Maldives, Mongolia, Nepal, New Zealand, Pakistan, Russia, Vietnam, and Indonesia**, providing them with in-depth knowledge and hands-on experience in GHG measurement, data analysis, and quality assurance techniques.

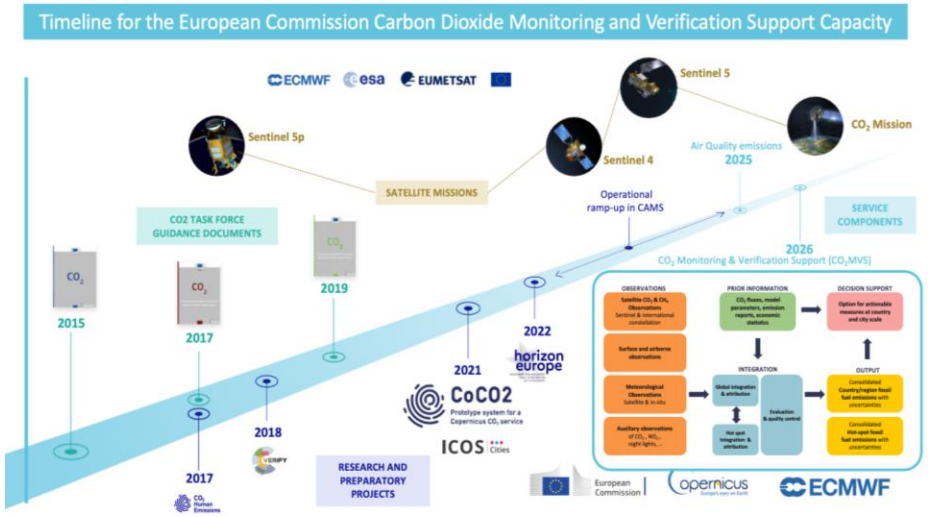
thanks to Dr. Ardhasena Sopaheluwakan

G3W is synchronizing with National & Regional efforts

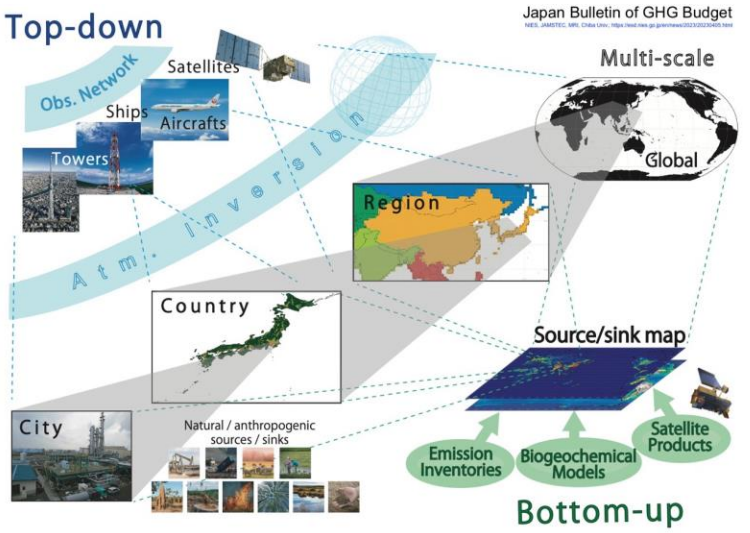
- In 2024 the **G3W Implementation Plan** endorsed, with at least 3 clearly defined systems.
- Good alignment with the **fast-track GHGs information systems**, such as in Europe, Japan, USA.



[US GHGMMIS, 2023]



[EU COPERNICUS, 2023]



[JAPAN NIES, 2023]

G3W Data Providers Workshop (by invitation)

Geneva, Switzerland and online on 5-7 March 2025

Members of the TT-G3W-Modelling and TT- G3W-Data

The topics addressed by the workshop included:

- Detailed description/characteristics of the output of the G3W system, requirements to the spatial and temporal resolution, requirements to the input data, comparison protocols an evaluation of the model performance
- Requirements for the centers that can deliver identified products and provisions for their integration in WIPPS
- Identification of the data streams (input data, including observations and priors; data exchange for the models intercomparison and quality control, output data) and their characterization
- Initial thinking about architecture and requirements for the data flow for the inclusion in WIS data exchange

Section 4 Modelling System– M (7)

M1 – Modelling center & data
M2 – Modelling center-documentation
M3 – Continuous Operations (RRR)
M4 – Obs. acquisition and pre-processing
M5 – Prior Implementation
M6 – Production centers common approaches
M7 – Modelling products evaluation

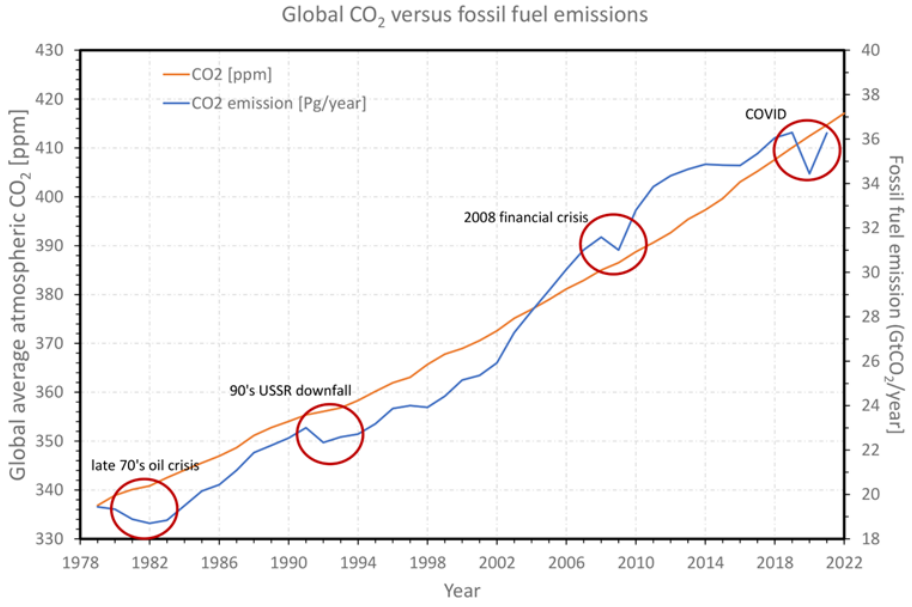
Section 6 Data Management – D (7)

D1 – Data from Raw to Exchange
D2 – Data from providers to assimilation
D3 – Data for model intercomparisons
D4 – Data discovery and distribution
D5 – Data repository for prior and fluxes
D6 – Definition of prior data providers
D7 – Data policy for the repository of prior fluxes

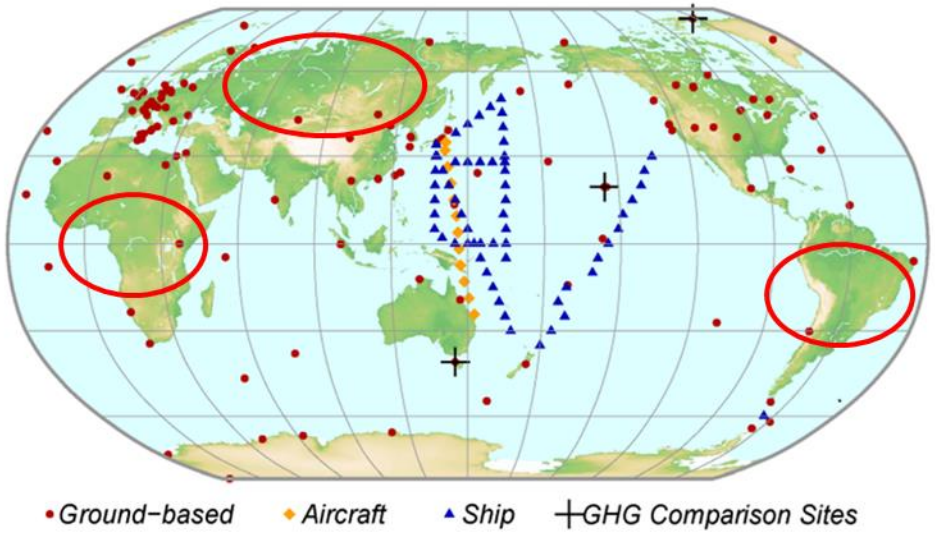
WORLD METEOROLOGICAL ORGANIZATION

1950-2025 SCIENCE for ACTION

How to bridge the gap between global GHG average & Timely decision-relevant-scale applications ?

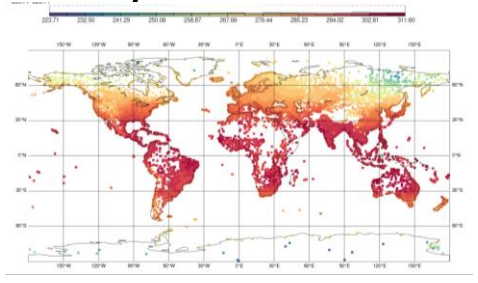


- Global averages Carbon dioxide concentrations show constant increase
- Societal impact is detectable on emissions



146 CO2 measuring stations

- Research funded observations have sustainability issues
- Gaps need to be filled on a systematic operational basis
- Timely measurements allow to expand climate services



Temperature stations

Connecting global outputs & local/regional applications

Nature of the application first needs to be identified, and could include:

- Establishment of baseline emissions for the globe, a nation or a region.
- Establishment of overall emission trends
- Detection of large point sources (hot spots) and anomalies
- Quantification of emissions from hot spots
- Emission attribution to specific sectors

Section 8 User Engagement & Uptake – U (4)

U1 – Support the GST

U2 – Guidance on regional products

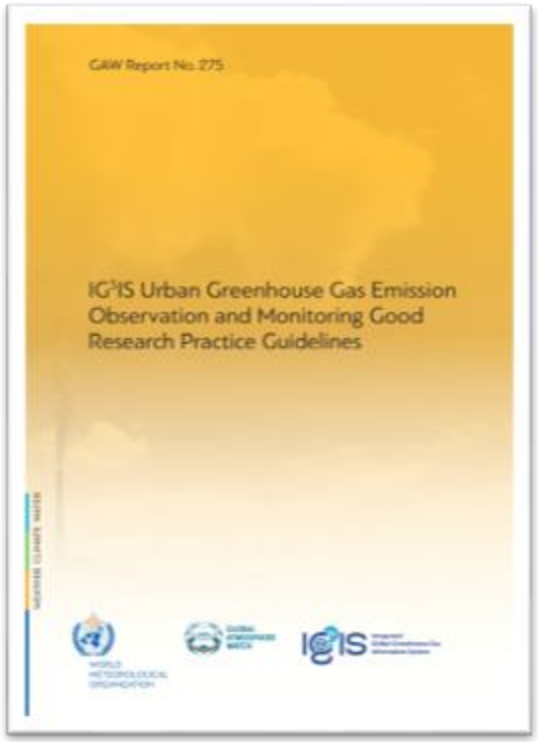
U3 – Establish relationship & pathway

U4 – Develop user interface guidelines

modelled global GHG concentration fields at 1x1° resolution, and modelled monthly surface fluxes at 1x1° resolution (G3W output)

Harmonized and standardized user-tailored products on a decision-relevant scale

Addressing Urban dimension within IG³IS - GAW



- **Revision of the Urban Good Practices** *(under community review until 28 February 2025*)

Urban Greenhouse Gas Conference and Stakeholder Summit 2025

START DATE
07 April 2025

END DATE
09 April 2025

LOCATION
Geneva, Switzerland

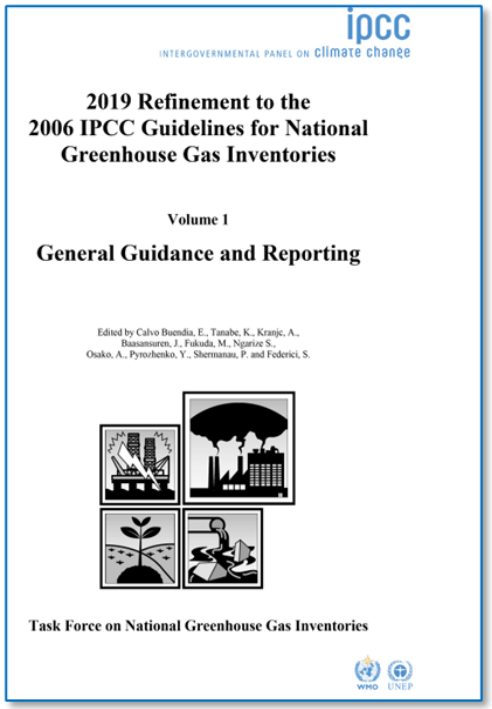
The event is jointly hosted by WMO Integrated Global Greenhouse Gas Information System (IG³IS) and ICOS Cities project

Event Highlights

- Showcase the latest findings from urban greenhouse gas researchers
- Workshop sessions to review and finalize the draft IG³IS Urban Good Practice Guidelines (open for public comment here)
- Dedicated day to connect scientists and stakeholders

- **Development of the National Good Practices**

(based on the material already included in the 2019 Refinement of IPCC TFI National Emission Inventory (Chapter 6 “Quality Assurance/Quality Control and Verification”), *technical workshop in June 2025* will include national emission compilers)



WORLD METEOROLOGICAL ORGANIZATION

1950-2025 SCIENCE for ACTION

2023	2024 -- 2027	2028 -- 2031	2032 -- 2050
Cg-19 → G3W WMO Congress	**G3W – IPP** **Implementation Pre-Oper Phase**	**G3W – IOP** **Initial Operational Phase**	**G3W – EOP** **Enhanced Operational Phase**

GST-1
COP28

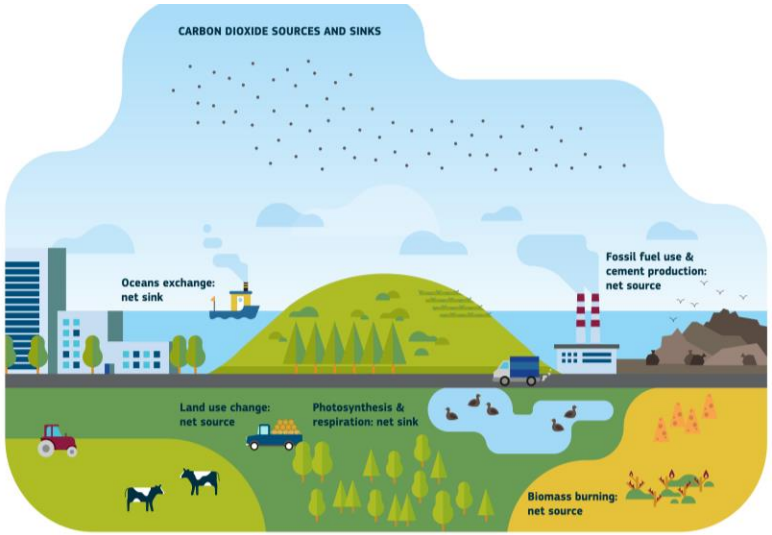
Initial Monitoring Systems

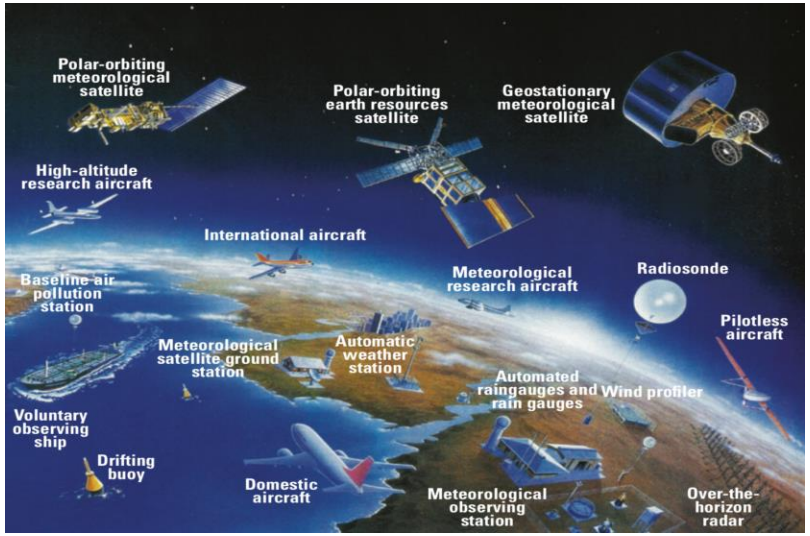
GST-2
COP33

Enhanced Systems

GST-n
ETF, NDCs

"for Measuring, Understanding, and Managing the Earth's Climate"





UN family
IPCC-IOC-
UNEP-UNFCCC-
WHO-WMO-WTO

UNFCCC
COP-SBSTA

WMO
WIGOS-WIS-WIPPS

Public-Private Partnerships

CO_2, Carbon dioxide

GHGs Earth's Observing Systems is building on Weather experience

Implementation plan: G3W stages and timeline

Summary and Outlook

- G3W advances in 2024-25 entering implementation
- G3W welcomes and needs the support of WG-Climate
- Support of EU commission via projects appreciate
- Uncertainties on G3W funding 2026-onwards
- Letters of support for the G3W welcome
- G3W to be discussed EC-79 and Congress-Ext.

G3W – A co-design & co-development effort from the start

G3W Implementation Plan - Coordinating lead authors: Greg Carmichael, Vincent-Henri Peuch, Frederic Chevallier, Shanna Combley, Vanda Grubišić, Tom Kralidis, Alistair Manning, Yasjka Meijer, Lesley Ott, Yosuke Sawa, Adrienne Sutton, Jocelyn Turnbull, Alex Vermeulen, Oksana Tarasova, Gianpaolo Balsamo.

G3W IP - Contributing authors and reviewers (in alphabetic order):
Tuula Aalto, Anna Agusti-Panareda, Clement Mathieu Jacques, Mihai Alexe, Erik Andersson, Arlyn Andrews, Kyle Arndt, Nicola Arriga, Dorothee Bakker, Annett Bartsch, Ana Bastos, Daniele Biron, Antonio Bombelli, Kevin W. Bowman, Stephen.A. Briggs, Manola Brunet, Rui Cheng, Eric Choi, Steve Cohn, Shanna Combley, Kevin Cossel, Paul Counet, Chris Davis, Steven J Davis, Phil DeCola, Thomas Diehl, Richard Engelen, Onoriode Esegbue, Shuangxi Fang, Andreas Fix, Bruce Forgan, Pierre Friedlingstein, Tobias Fuchs, Thanos Gkritzalis, Lifeng Guo, Judith Hauck, Maria Hood, Sander Houweling, Ophery Ilomo, Tatiana Ilyina, Shutler Jamie, Michel Jean, Junli Jin, John Stephen Kayode, Joerg Klausen, Ernest Koffi , Thelma Krug, Dagmar Kubistin, Akihiko Kuze, Casper Labuschagne, Siv K Lauvset, Sung Ching Lee, Christian Lessig, Ian Lisk, Ingrid Luijkx, Marta Magnani, Salah Mahmoud Zeinab, Shamil Maksyutov, Giselle Lujan Marincovich, Amanda Maycock, Yasjka Meijer, Joe Melton, John Miller, Tillmann Mohr, Gary Morris, Jonas Mphepya, Frank Muller-Karger, John Mund, Ray Nassar, Yosuke Niwa, Ronnie Noonan-Birch, Kevin O'Brien, Osamu Ochiai, Tom Oda, Dario Papale, Lucia Perugini, Wouter Peters, Jan Polcher, Joanna Post, Benjamin Poulter, Ben Poulter, Bin Qu, John Remedios, Chao Ren, Markus Repnik, Marie-Helene Rio, Michel Rixen, Karen Rosenlof, Paolo Ruti, Zeinab Salah, Richard Sanders, Susanne Schödel, Marko Scholze, Frank Martin Seifert, Alexey Shiklomanov, Stephen Sitch, Ward Smith, Kieran Stanley, Martin Steinbacher, Tobias Steinhoff, Wenying Su, Hiroshi Suto, Colm Sweeney, Toste Tanhua, Maciej Telszewski, Rona Thompson, Bronte Tilbrook, Matt Tully, Jocelyn Turnbull, Peter van Oevelen, Anya Waite, Rik Wanninkhof, Brad Weir, Ray Weiss, Martin Wooster, John Worden, Irène Xueref-Remy, Melaku Yigiletu, Xiaochun Zhang, Xingying Zhang

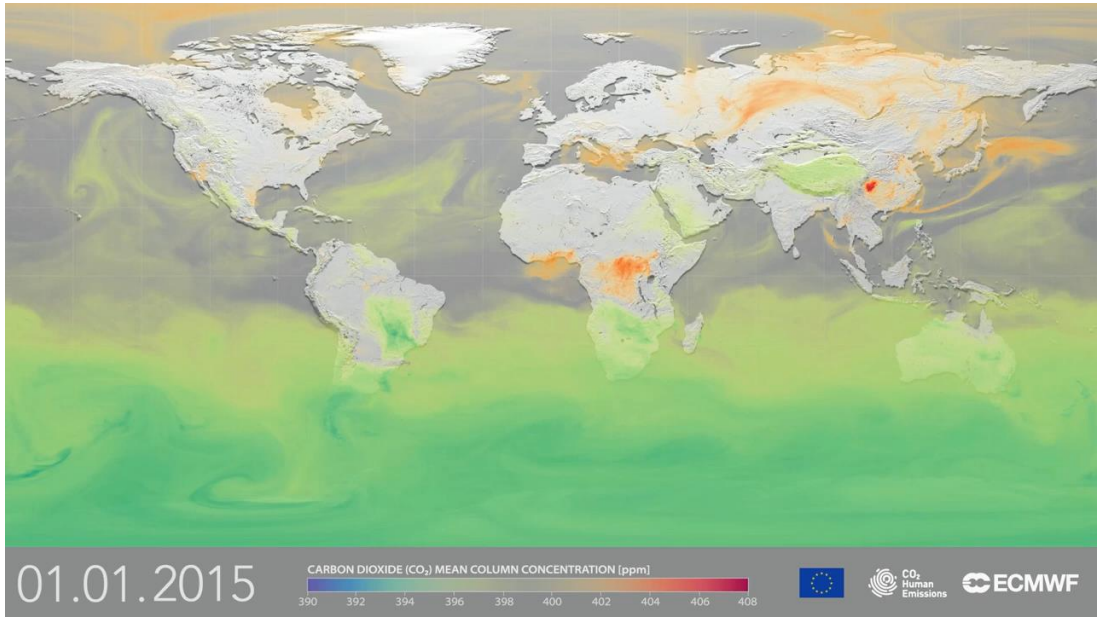
The G3W Flagship in a

What: The **Global Greenhouse Gas Watch** - **G3W fills critical information gaps** optimally combining **Earth Observations** with **Earth System Models** to **reduce the uncertainty in** assessing the efficacy of **Climate Action.**

How: **Timely Policy-relevant information** on GHGs concentrations and fluxes allowing to assess both the **Natural** & **Human** influence on climate change https://wmo.int/activities/global-greenhouse-gas-watch-g3w

Why : an **Earth System Approach** is a must-have because **Earth's climate responds to the laws of Climate Physics** and depends Atmospheric GHGs, NOT on Claimed Offset of Carbon emissions or to Good-will of Pledges.

"We can not manage what we do not measure" – GHG needs to be handled



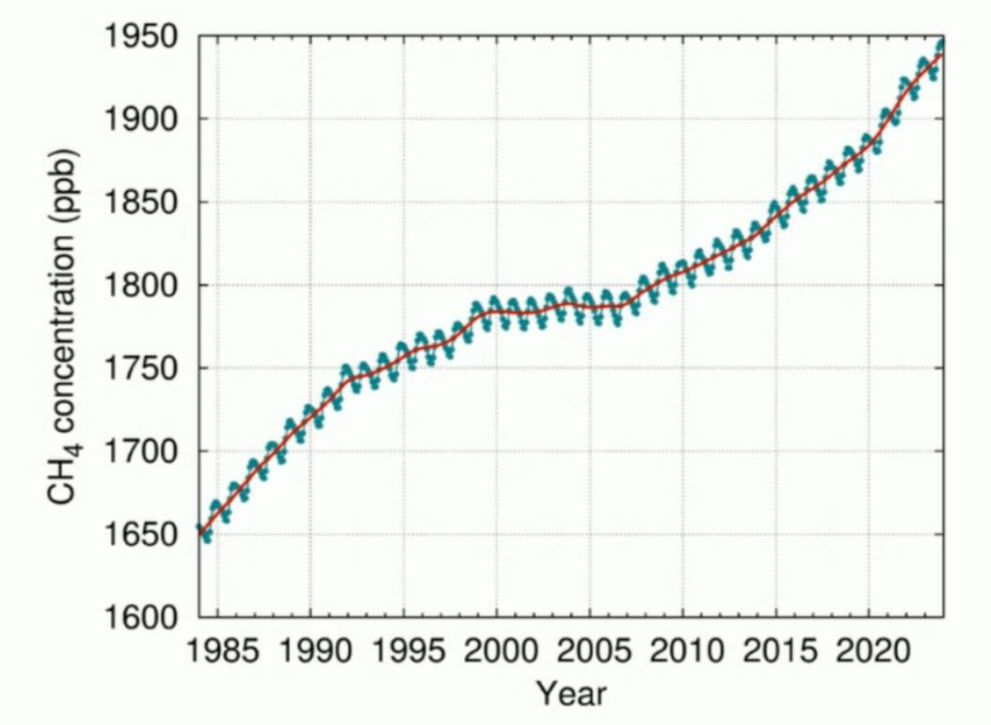
Animation source: Copernicus Earth Observation Programme / ECMWF CAMS

G3W : leveraging Climate Action partnerships on Methane

COP28 Global Methane Pledge – 155 Countries

- https://www.globalmethanepledge.org

COP29 and COP30 must raise the urgency.



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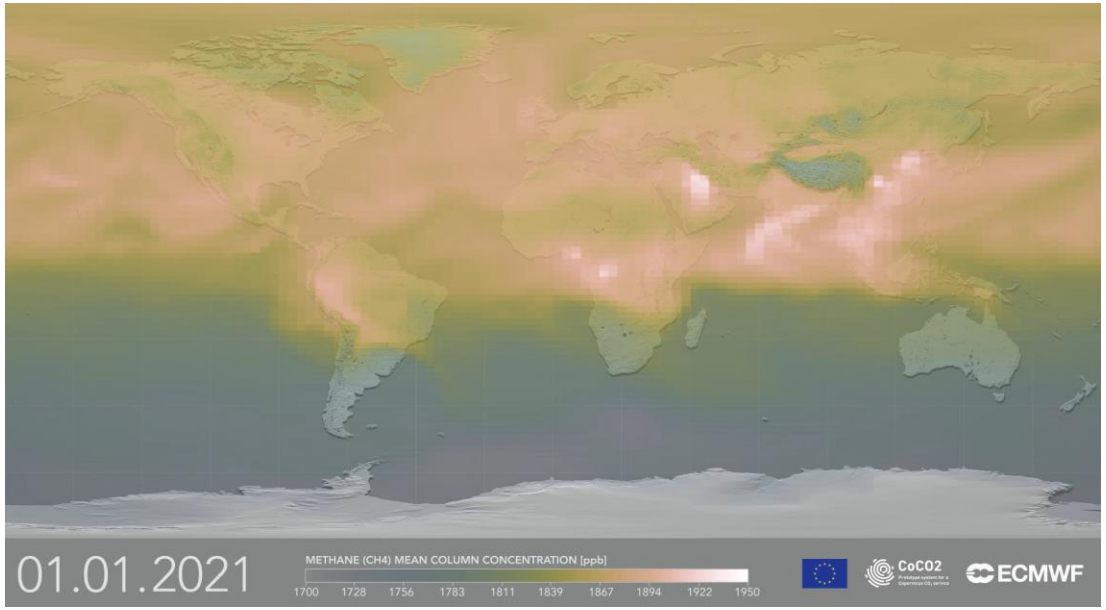


Animation source: Copernicus Earth Observation Programme / ECMWF CAMS

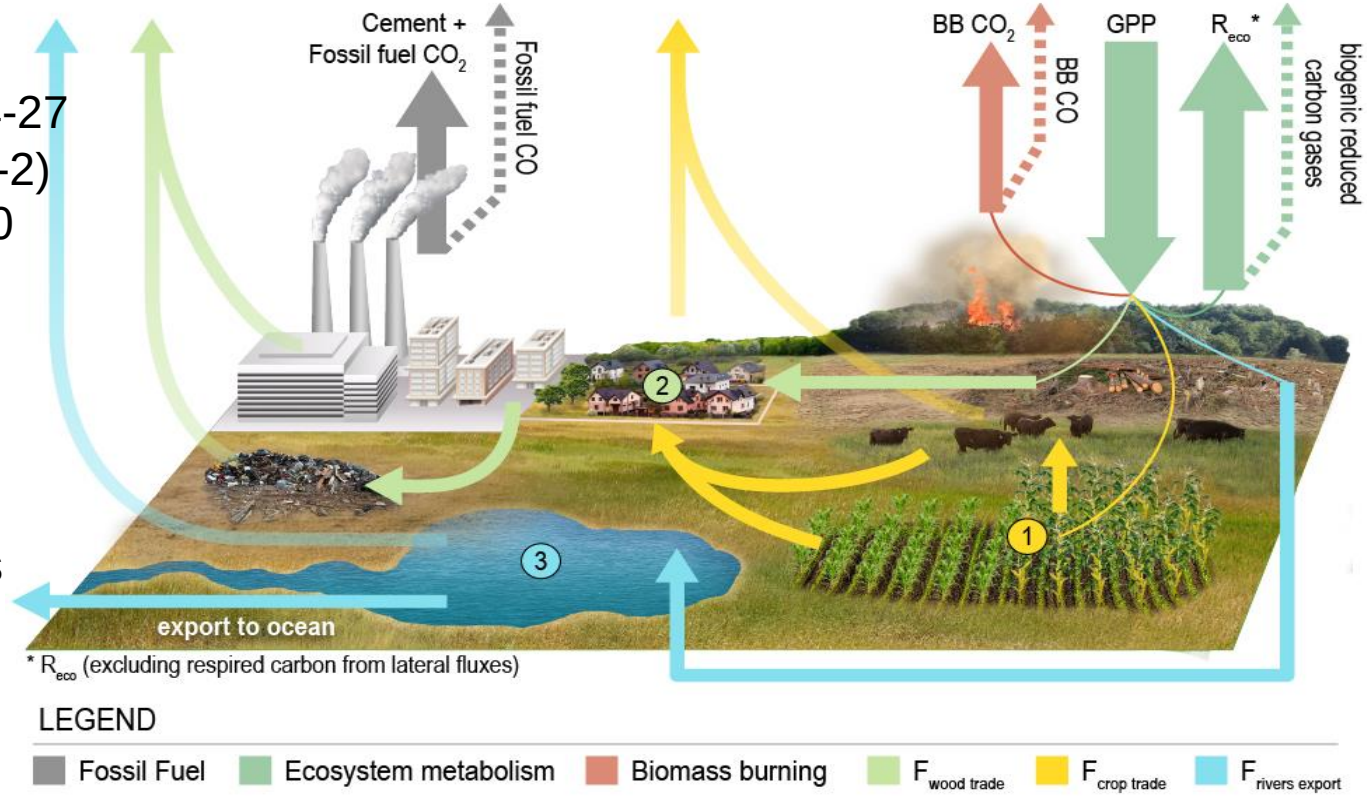
G3W Long-Term Vision

The G3W vision 2024-2050 is articulated in its master-plan, sustainability strategy, and working structure

- **G3W Master-Plan**
  - **G3W-IPP** Implementation & Pre-Oper Phase 2024-27
  - **G3W-IOP** Initial Operational Phase 2028-31 (GST-2)
  - **G3W-EOP** Enhanced Operational Phases 2032-50

- **G3W Sustainability Strategy**
  - **WMO-RMS** the WMO Resources Mobilisation Strategy contains the **G3W-RMS**

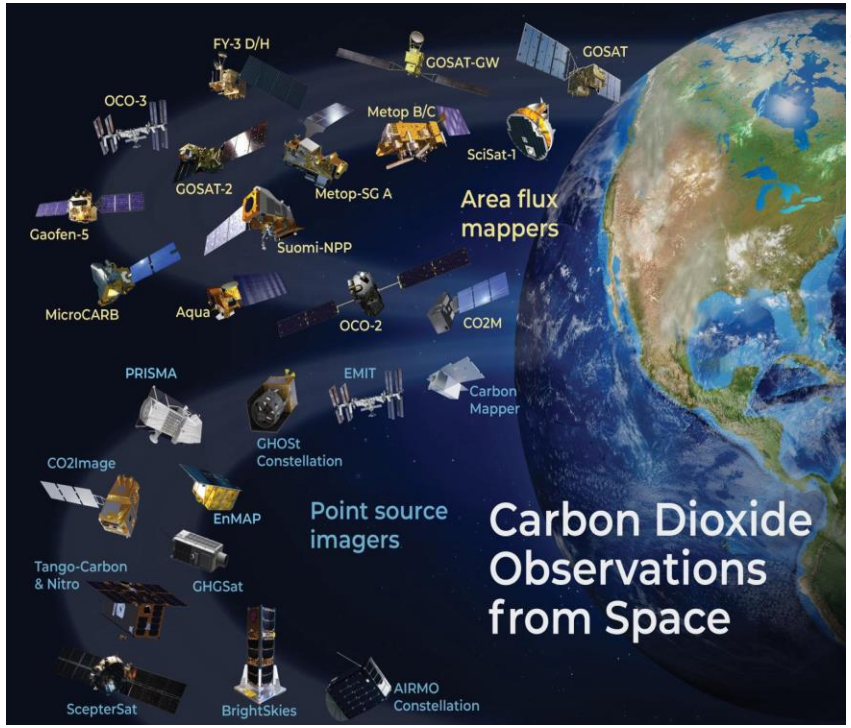
- **G3W Working Structure**
  - **INFCOM-SC-ET/TT** Expert Teams & Task Teams
  - **G3W-AG** from the **WMO-G3W-SG**
  - **WIGOS / WIPPS / WIS synergy**

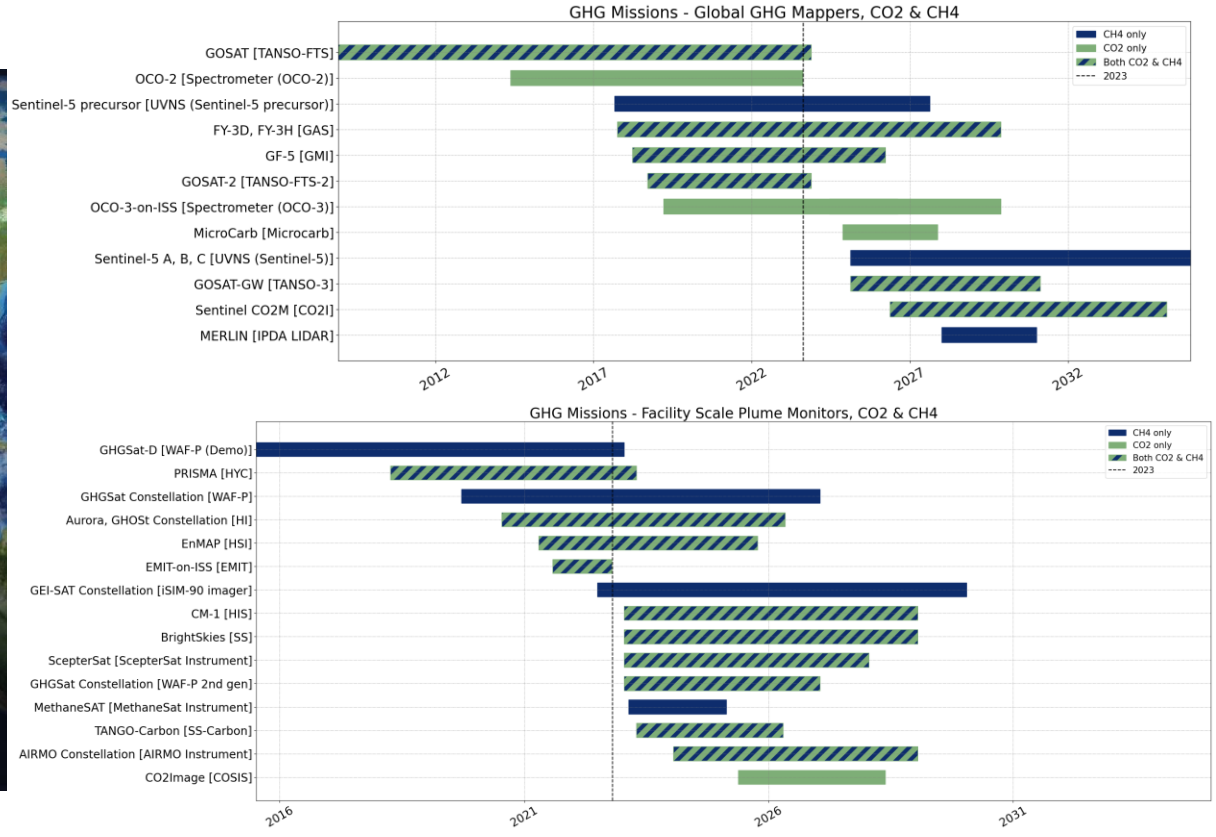


Byrne et al. 2022 ESSD

G3W is synchronizing with Space Agencies investments

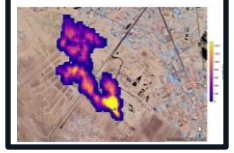
- The **G3W Implementation and Pre-operational Phase**, link with **Space-based Remote Sensing** efforts.
- Thanks to Satellites Coordination mechanism.



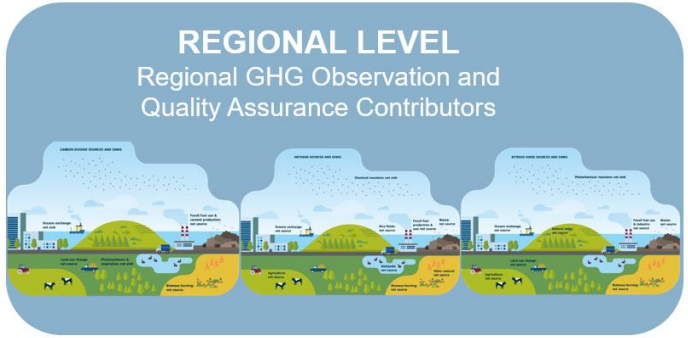


Mappers

Spotters

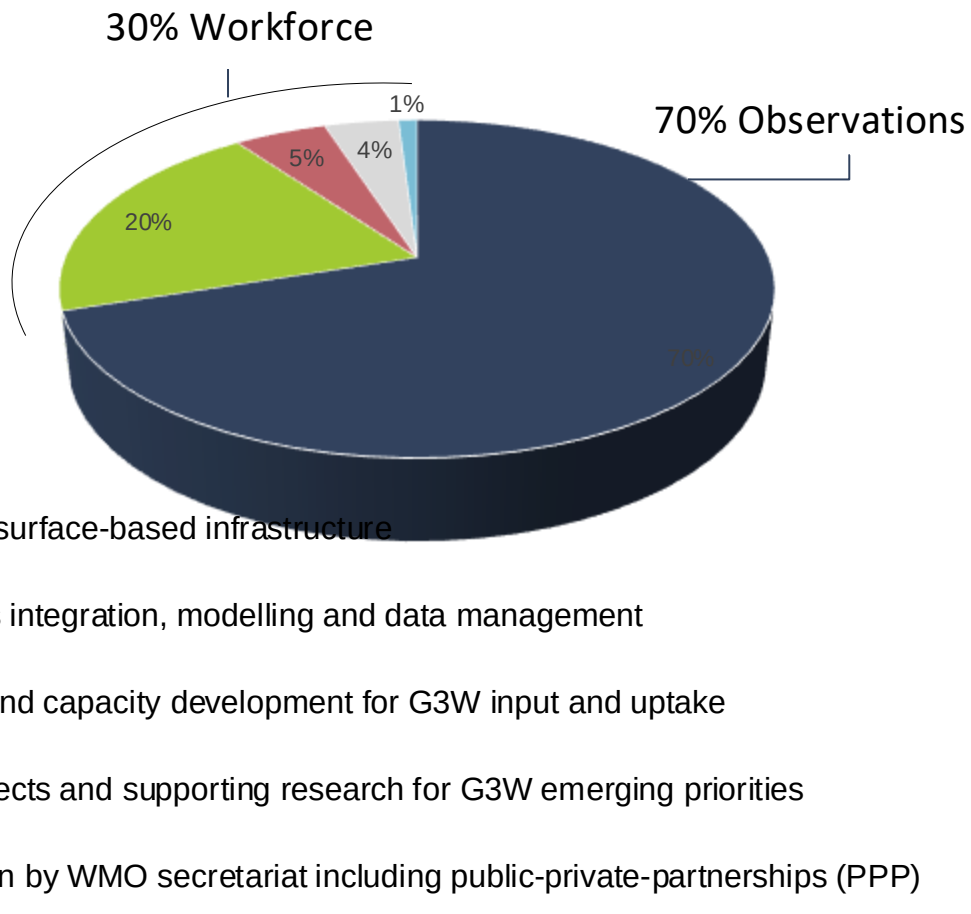


G3W financial needs: A Region-First Approach



The G3W initiative aims at supporting the systematic observations and monitoring infrastructure for Greenhouse Gases

The costs estimate is **1 B$** over 2024-27 (with targets at 500 M$, 300 M$)

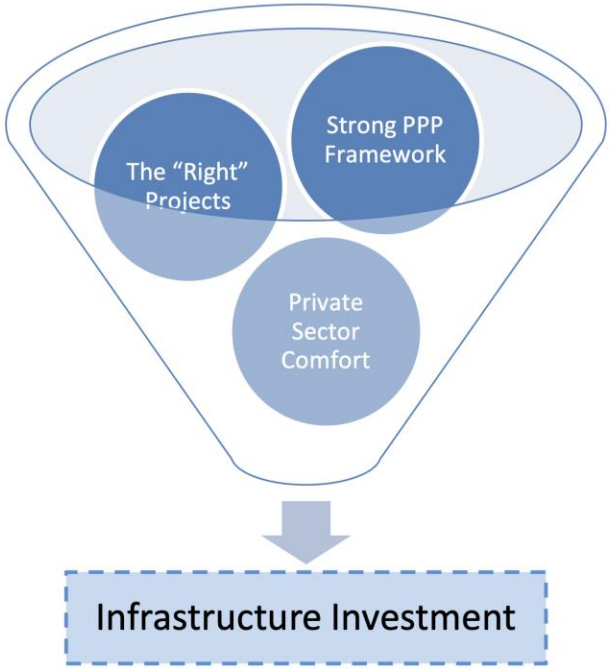


G3W Financial Sustainability

To address infrastructure / service needs G3W aims at **significant resources increase in 2024-2027**.

Funding mechanisms include 3 pathways:

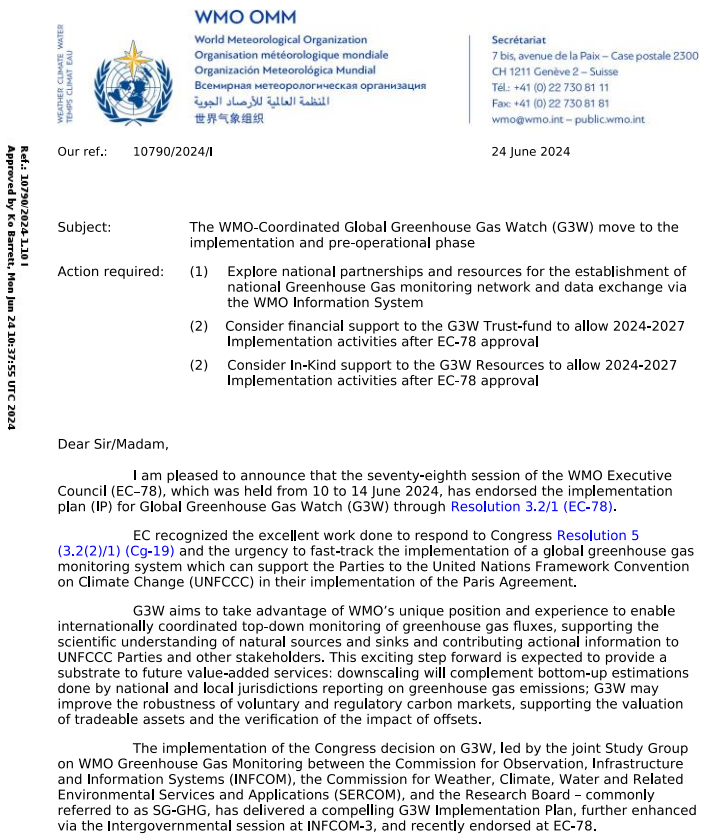
- **G3W initial WMO-funds**, approved by the 19th World Meteorological Congress (Cg-19) **Resolution 5** of in 2023.
- **G3W trust-fund**, managed by WMO, with two Champions Nations contributing in 2023 and more expected from Public & Private sources from 2024.
- **Specialized G3W financial vehicle** to facilitate wider private sector contributions and activities, such as impact investing, that can be hosted outside of the UN system.



World Bank, 2016a, #3553

G3W Circular Letter to All WMO Members Q3/2024

Deputy Secretary General Ko Barrett has issued a new Circular Letter **highlight G3W Call for Action in**



WMO OMM

World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

Secrétariat
7 bis, avenue de la Paix – Case postale 2300
CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11
Fax: +41 (0) 22 730 81 81
wmo@wmo.int – public.wmo.int

Our ref.: 10790/2024/I 24 June 2024

Ref.: 10790/2024/1.10 I
Approved by Ko Barrett, Mon Jun 24 10:37:55 UTC 2024

Subject: The WMO-Coordinated Global Greenhouse Gas Watch (G3W) move to the implementation and pre-operational phase

Action required:
(1) Explore national partnerships and resources for the establishment of national Greenhouse Gas monitoring network and data exchange via the WMO Information System
(2) Consider financial support to the G3W Trust-fund to allow 2024-2027 Implementation activities after EC-78 approval
(2) Consider In-Kind support to the G3W Resources to allow 2024-2027 Implementation activities after EC-78 approval

Dear Sir/Madam,

I am pleased to announce that the seventy-eighth session of the WMO Executive Council (EC–78), which was held from 10 to 14 June 2024, has endorsed the implementation plan (IP) for Global Greenhouse Gas Watch (G3W) through Resolution 3.2/1 (EC-78).

EC recognized the excellent work done to respond to Congress Resolution 5 (3.2(2)/1) (Cg-19) and the urgency to fast-track the implementation of a global greenhouse gas monitoring system which can support the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in their implementation of the Paris Agreement.

G3W aims to take advantage of WMO's unique position and experience to enable internationally coordinated top-down monitoring of greenhouse gas fluxes, supporting the scientific understanding of natural sources and sinks and contributing actional information to UNFCCC Parties and other stakeholders. This exciting step forward is expected to provide a substrate to future value-added services: downscaling will complement bottom-up estimations done by national and local jurisdictions reporting on greenhouse gas emissions; G3W may improve the robustness of voluntary and regulatory carbon markets, supporting the valuation of tradeable assets and the verification of the impact of offsets.

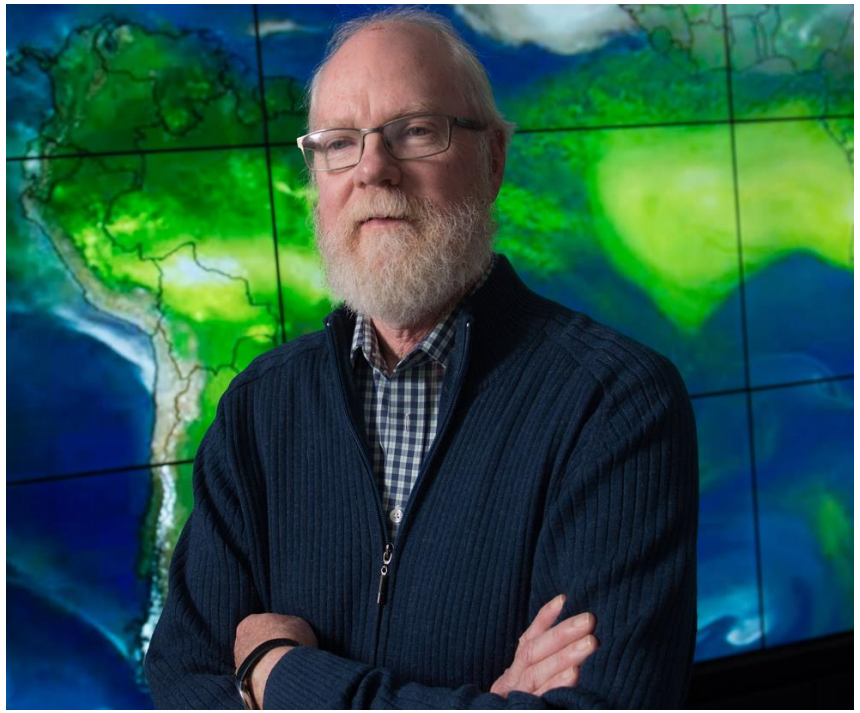
The implementation of the Congress decision on G3W, led by the joint Study Group on WMO Greenhouse Gas Monitoring between the Commission for Observation, Infrastructure and Information Systems (INFCOM), the Commission for Weather, Climate, Water and Related Environmental Services and Applications (SERCOM), and the Research Board – commonly referred to as SG-GHG, has delivered a compelling G3W Implementation Plan, further enhanced via the Intergovernmental session at INFCOM-3, and recently endorsed at EC-78.

- **National GHGs observing networks** including data sharing
- **G3W Trust-Fund** call for support of Priority activities.
- **G3W In-kind contributions** experts seconded or dedicated to provide expertise in one of the G3W building blocks.

Letter translated & dispatched: 2nd of July 2024

G3W Advisory Group Co-Chairs

- The G3W AG has been under establishment since the EC-78



Gregory Carmichael (U. Iowa)

Vincent-Henri Peuch (ECMWF)

G3W AG Members & SCs Task Team Chairs

Lesley Ott (NASA)
(TT-Modelling)

Laurence Rouil (ECMWF-CAMS)
(TT-Data WIS2G3W)

Prabir Patra (JAMSTEC)
(TT-Network)

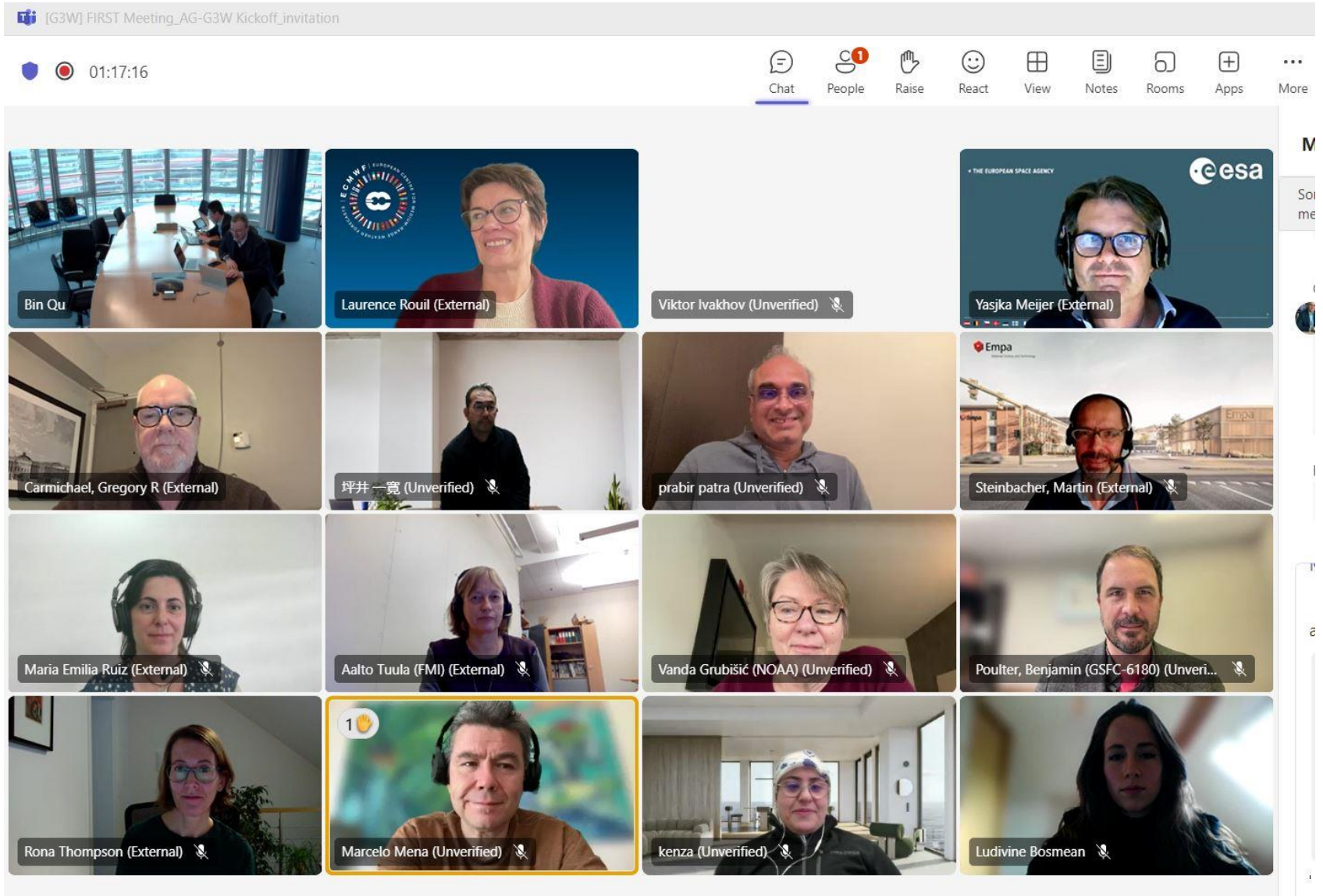
Sena Sopaheluwakan (BKMG)
(SERCOM-G3W)

G3W Moving Forward with the Tasks Teams Q4/2024

TT-G3W-Modelling Kickoff (online)
TT-G3W-Networks Kickoff (online 25/11)
TT-G3W-Data Kickoff (planned)

AG-G3W kickoff (mid Dec, onlir

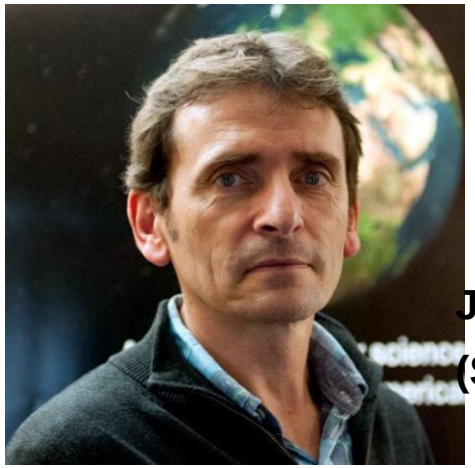
G3W Advisory Group KickOff Q4/2024



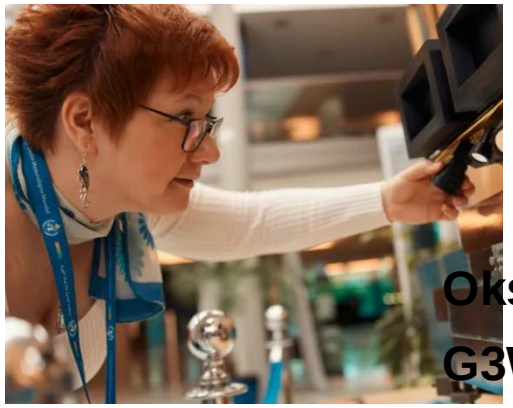
G3W Team in WMO secretariat

Q4/2024

Gianpaolo BALSAMO
(Director, G3W)



Jean-Noel Thépaut
(Senior Advisor – 30d)



Oksana Tarasova
G3W/P5

Bin QU
G3W/P2

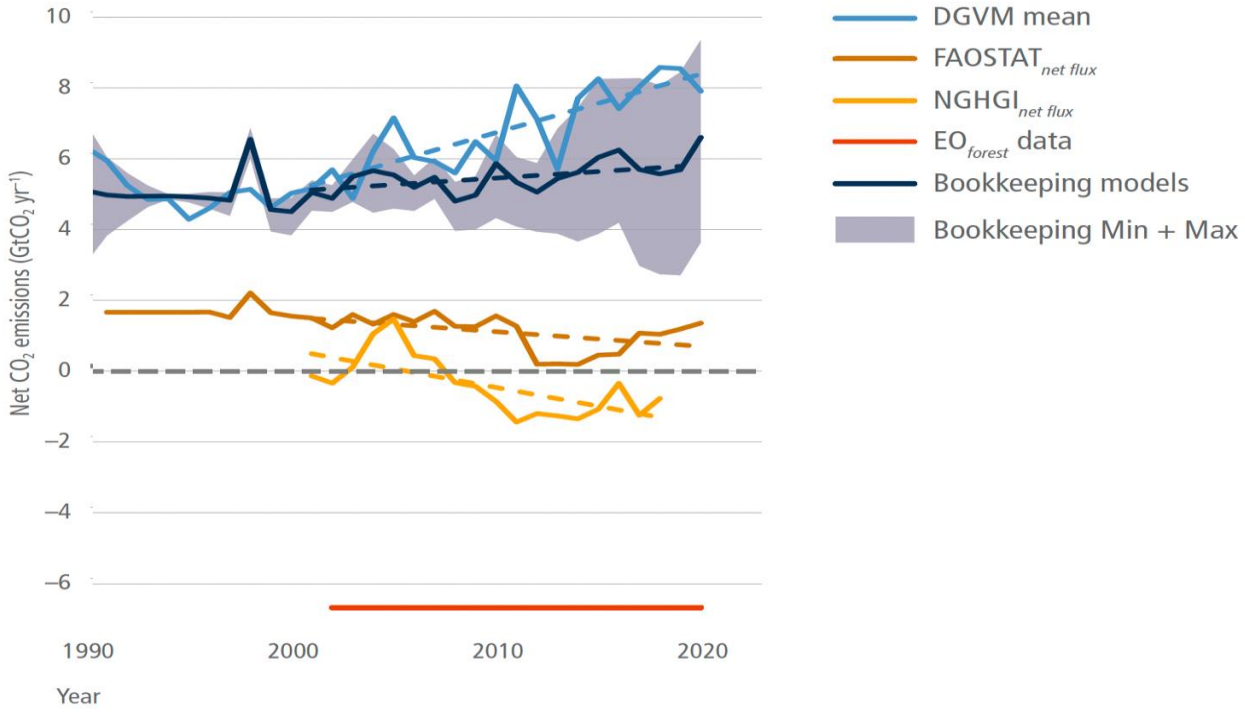
Ludivine Bosmean
G3W/Intern

G3W Communication Q3-Q4/2024

G3W presented at CMA
for Mt Waliguan 30-y celebration
G3W featured at COP29
Earth Information Day
G3W website has launched
(http://g3w.wmo.int) **during COP29**

G3W presented at IPCC TFI meeting in Q3/2024

- **G3W** presented to **July 2024 at JRC-Ispra**



Estimated using different methods:
(i) Global models from the Global Carbon Budget (Friedlingstein et al. 2020): Dynamic Global Vegetation Models (DGVMs) and Bookkeeping models;
(ii) Earth Observation data (forest-related fluxes only, Harris et al. 2021);
and (iii) country-based data: National GHG Inventories (NGHGI, Grassi et al. 2021) and FAOSTAT (Tubiello et al. 2020).

G3W progress discussed at CEOS-SIT-39 CGMS-52 in Q2/2024

- **G3W** presented to **WG-Climate, CEOS-SIT-39 in April 2024** and to **CGMS-52 in June 2024.**
- **A WMO delegation in Tokyo and Washington DC, and Online** ensured G3W presence.

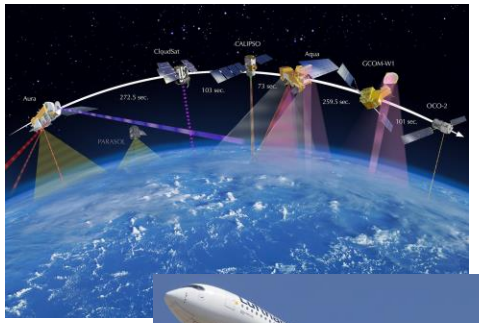

CEOS-SIT-39 Tokyo

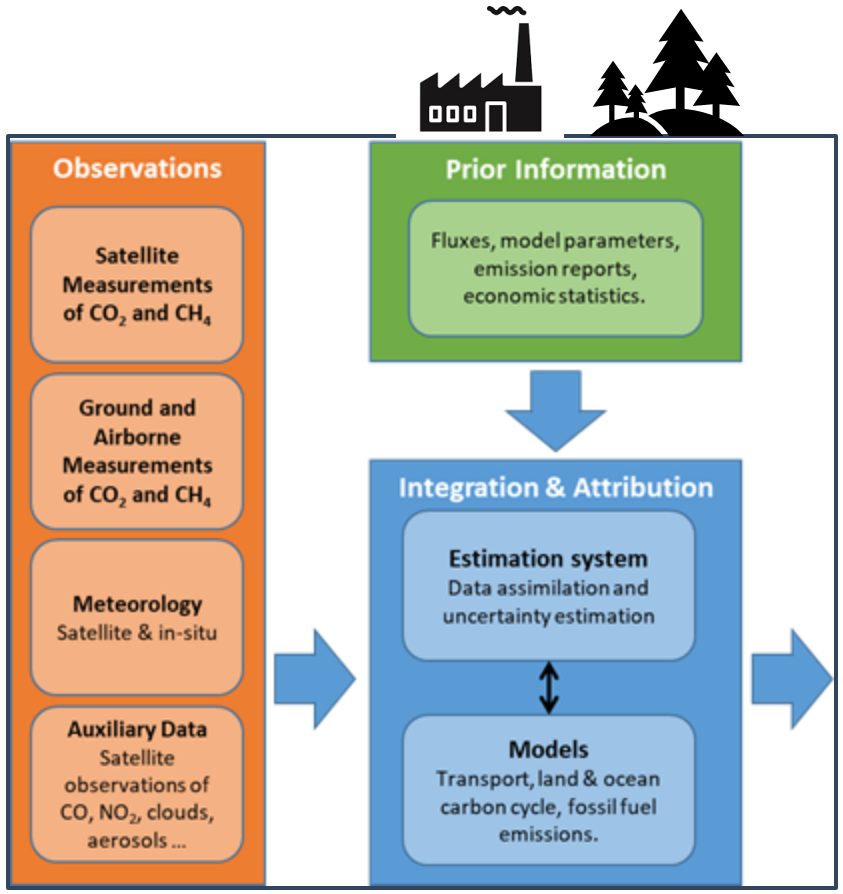
CGMS-52 Washington DC

WMO Cross-coordination with Space Agencies in Q1/2024

- **G3W** discussed at **CM15**, 15th Session of Consultative Meetings on High-Level Policy on Satellite Matters
- **G3W** will be soonpresented to **CEOS** and to **CGMS in April 2024**

General principles of the Earth Observations-based emission estimates





Core principle of the system is free and unrestricted data exchange

Policy and decision relevant information based on consensus

Example of the conceptual architecture of the system (implemented by the European Commission)

Section 3 Observing System – O (12)

O1 – Observation inventory
O2 – Obs. standards & requirement
O3 – Longer term Obs.
O4 – Surface-based Obs. Design
O5 – Reference Network Development
O6 – Basic ("fit-for-purpose") network
O7 – RS & vertically-resolved Obs.
O8 – Ocean network design
O9 – Gridded Air-Sea CO_2 flux
O10 – Space-based Obs. with CEOS-CGMS, direct
O11 – Space-based Obs. with CEOS-CGMS, indirect
O12 – Space-based Obs. with CEOS-CGMS, future

Section 4 Modelling System– M (7)

M1 – Modelling center & data
M2 – Modelling center-documentation
M3 – Continuous Operations (RRR)
M4 – Obs. acquisition and pre-processing
M5 – Prior Implementation
M6 – Production centers common approaches
M7 – Modelling products evaluation

Section 6 Data Management – D (7)

D1 – Data from Raw to Exchange
D2 – Data from providers to assimilation
D3 – Data for model intercomparisons
D4 – Data discovery and distribution
D5 – Data repository for prior and fluxes
D6 – Definition of prior data providers
D7 – Data policy for the repository of prior fluxes

Section 5 Prior Information – P (4)

P1 – Identify needs – CO_2
P2 – Identify needs – CH_4
P3 – Identify needs – N_2O
P4 – Fluxes characterization

Section 8 User Engagement & Uptake – U (4)

U1 – Support the GST
U2 – Guidance on regional products
U3 – Establish relationship & pathway
U4 – Develop user interface guidelines

Section 7 R&D Needs – R (3)

R1 – G3W R2O Task Team establishment
R2 – Advance Obs. & data exchange capabilities
R3 – Advance modelling and flux inversion capabilities

Section 9 Capacity Building – C (5) *(Overarching)*

C1 – Technical participation framework
C2 – Continuously capacities evaluate
C3 – Members' capacities in data use
C4 – Capacity development programs for Member
C5 – National capacities development

G3W Building Blocks

- **Section 3 – Section 8** outline the technical building blocks, actions, overarching activities
- **Section 9** presents the Capacity Building
- **Section 10 – Section 11** are on the G3W funding and resources mobilization needed to cover workforce & infrastructure costs within G3W.

Section 10 Financial estimates & Funding sources

– Highly centralized / low regionalized investment
– Medium centralized / regionalized investment
– Low centralized / highly regionalized investment

Section 11 Resource Mobilization

– G3W initial WMO-funds
– G3W trust-fund
– Specialized G3W financial vehicle

G3W-Related Projects with Operating Centres in Q2/2024

G3W ongoing funded projects include

Facilitation of Implementation of the WMO Integrated Global Greenhouse Gas Information System (IG3IS)
Principal Investigator: Dr. Oksana Tarasova, Infrastructure department, WMO
IG3IS P2 : Miss Jarin Tasneem Oyshi (S&I)

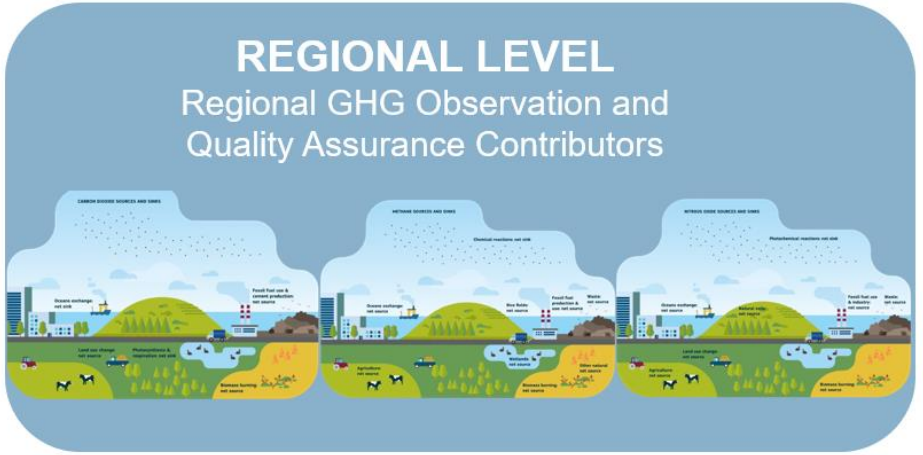
To further advance IG3IS activities considering the June 2023 decision by the 19th World Meteorological Congress to initiate the implementation of the new Global Greenhouse Gas Watch (G3W).

iClimateAction (International Climate Action Coordination of ECVs Integrated Observation Networks) a new Coordination and Support Action of Horizon Europe led by WMO
Principal Investigator: Dr. Gianpaolo Balsamo, Infrastructure department, WMO

To improve the international alignment across organisations that can crucially support climate action. WMO in partnerships with organisations as GEO and GCOS, as well as with the Intergovernmental Panel on Climate Change (IPCC), can support the expansion uptake and exploitation of Earth Observation data, research, products, and operational services.

G3W in Practice: A Region First Approach

The G3W will develop strategic actions to fund systematically infrastructure+workforce, beyond opportunity-based and development-based funding mechanisms.



The G3W Flagship-level costed plan identified as top priority
70% of the investment in the **surface-based observations**
14% in **observations integration, modelling** and **data management**
10 % in **regional demonstration projects**
7% in **additive research to support G3W emerging priorities**
3 % in **public-private-partnership (PPP) development**
1% in the **central coordination by WMO secretariat**

G3W fully integrated in WMO Resource Mobilisation Strategy from EC-78

World Meteorological Organization
EXECUTIVE COUNCIL
Seventy-Eighth Session
10 to 14 June 2024, Geneva

EC-78/INF. 8(4)
Submitted by:
Secretary-General
25.IV.2024

WMO RESOURCE MOBILIZATION STRATEGY

Executive summary

To help achieve the long-term goals and objectives of the WMO Strategic Plan, WMO has developed a vision to mobilize voluntary contributions and partnerships for technical assistance and capacity development and effectively leverage them, in cooperation with stakeholders, to help WMO Members better provide weather, climate, water and related environmental services that allow people, property and livelihoods to stay safe and thrive.

To achieve the vision, resource mobilization will be pursued across three spheres of engagement:

(1) Secretariat extrabudgetary projects and activities;

(2) WMO flagship initiatives (Early Warnings for All initiative (EW4All), Global Greenhouse Gas Watch (G3W) and Global Basic Observing Network (GBON));

(3) Support to Members through partners and by assisting Members' resource mobilization. Three cross-cutting objectives will be pursued across these spheres: whole-of-institution support to Members, promoting global public goods and research advances, and leveraging partners and Members for impact.

Resource mobilization activities will be prioritized and pursued according to a set of institution-wide principles that promote alignment with WMO Strategic Priorities and flagship initiatives, including ownership and engagement of Members, leveraging of diverse and effective partnership's reliability, transparency, accountability, sustainability, and the criticality of capacity building.