

Global Greenhouse Gas Watch (G3W)

The CLIMATE-CHANGE Mitigation Leg of CLIMATE-ACTION at WMO

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Presented to the GCOS-AOPC

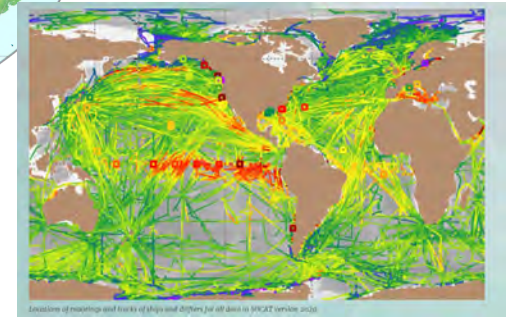
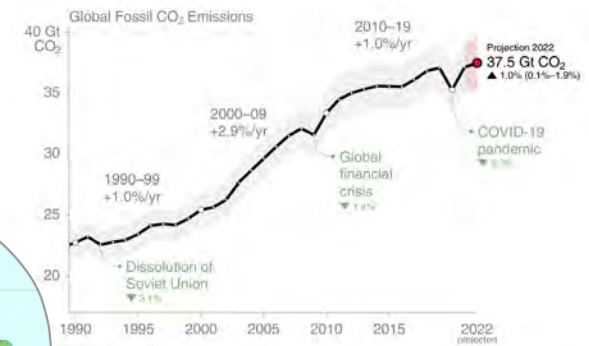
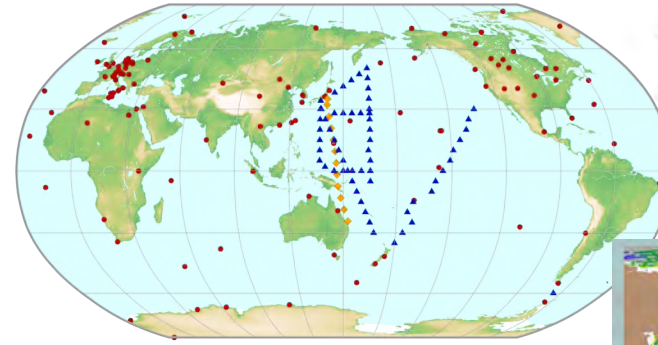
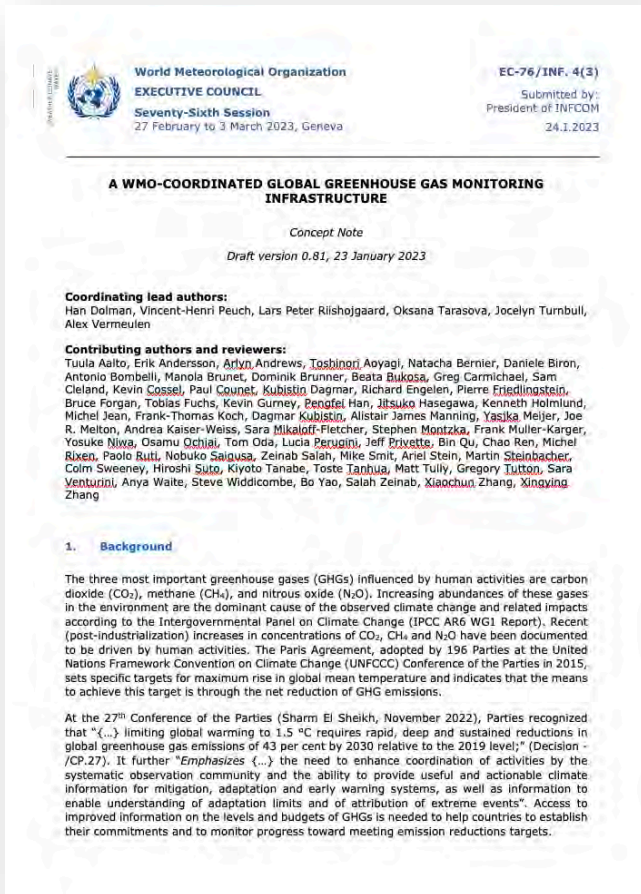


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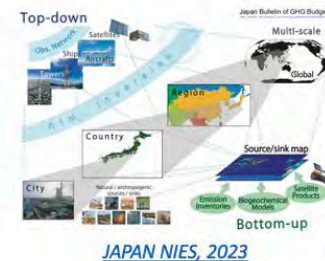
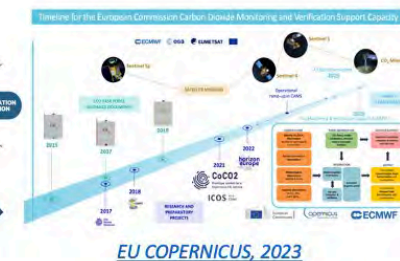
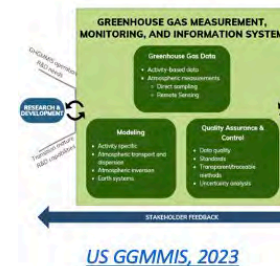
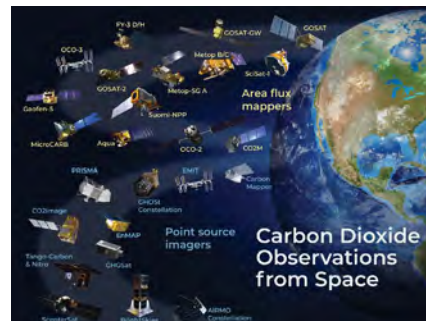
The vision and concept behind G3W

Global Greenhouse Gas Watch presented to EC-76, adopted by Cg-19 Congress and **endorsed by EC-78**.



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

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



G3W Plan in Action

In 2023 three key events

- 1st **WMO GHGs Monitoring Symposium**
G3W reaches broad science support
- 19th **World Meteorological Congress**
intergovernmental agreement approved **G3W**
proceeds with development
- **COP28** raised the profile of the **Global Greenhouse Gas Watch – G3W**
 - **WMO prominent exposure at COP28** in particular at the **Earth Information Day**
 - **G3W is noted by 196 Nations** in the [SBSTA-59](#), providing a **successful closure of COP28 for G3W**



In 2024 two key event

- **INFCOM3 endorse G3W** plan & governance to be presented to **WMO Executive Council**
- **EC-78 endorsed G3W**. Implementation begins!



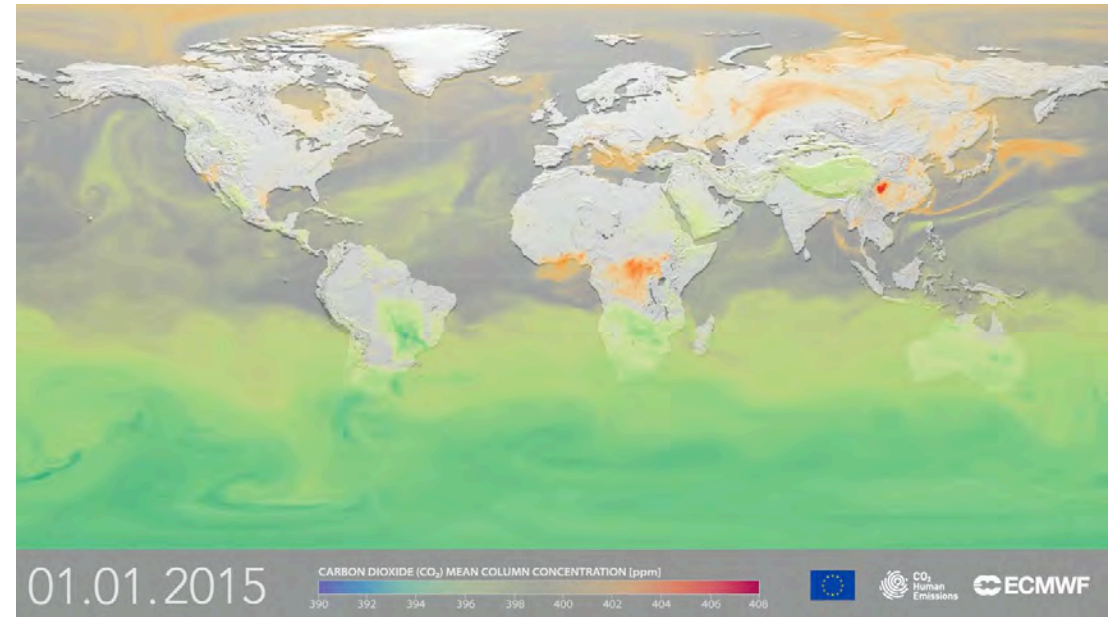
The “What, How & Why” for the G3W Flagship

What: The Global Greenhouse Gas Watch - **G3W** fills critical information gaps on greenhouse gases (GHGs), via an integrated **operational framework** that optimally combine **Earth Observations** with **Earth System Models** using **Data Assimilation & Artificial Intelligence** techniques to **reduce uncertainty** in assessing the efficacy of **Climate Action**.

How: a **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



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

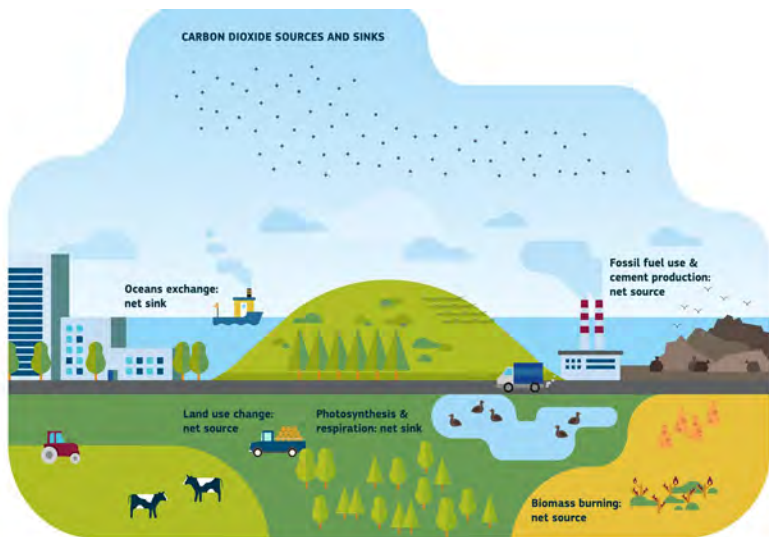
Initial Monitoring Systems

GST-2
COP33

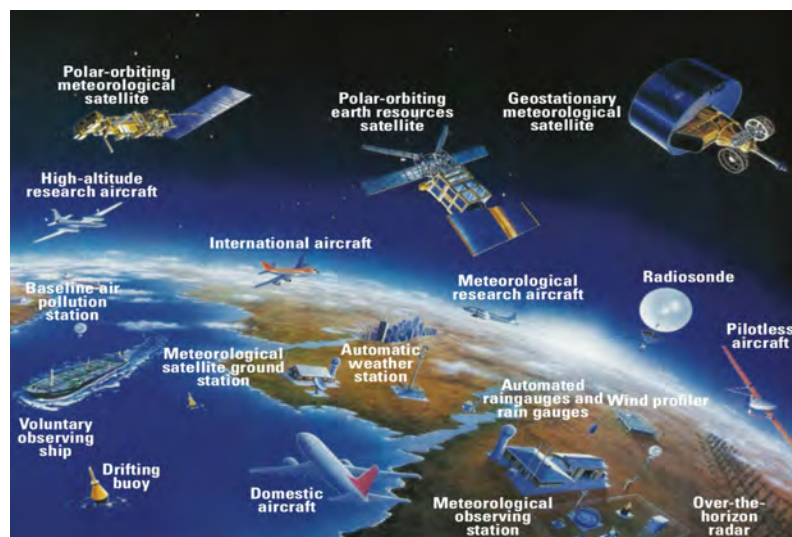
Enhanced Systems

GST-n
ETF, NDCs

“for Measuring, Understanding, and Managing the Earth’s Climate”



CO₂, Carbon dioxide



GHGs Earth's Observing Systems is building on Weather experience

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

UNFCCC
COP-SBSTA

WMO
WIGOS-WIS-WIPPS

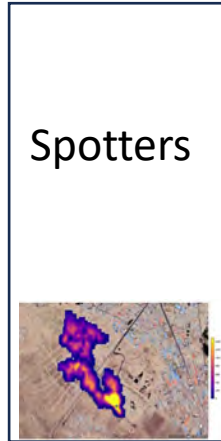
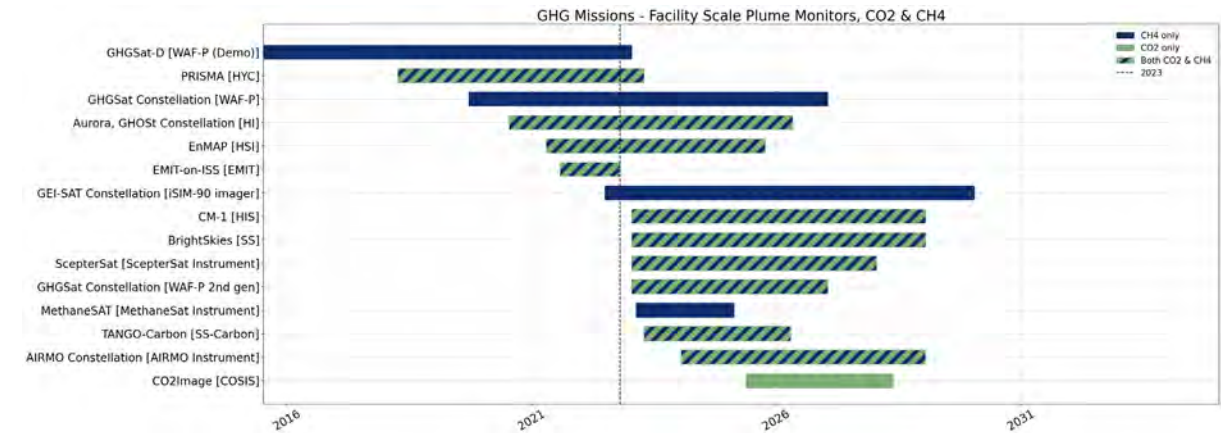
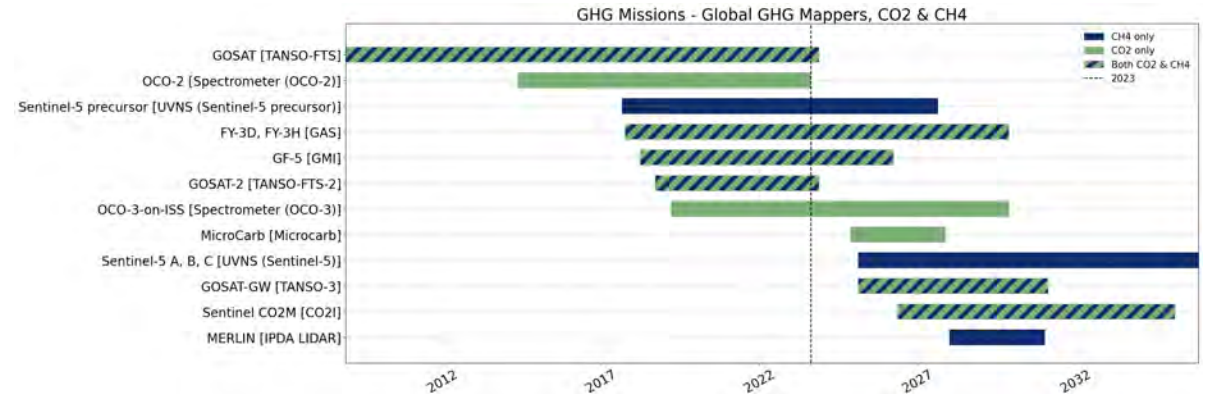
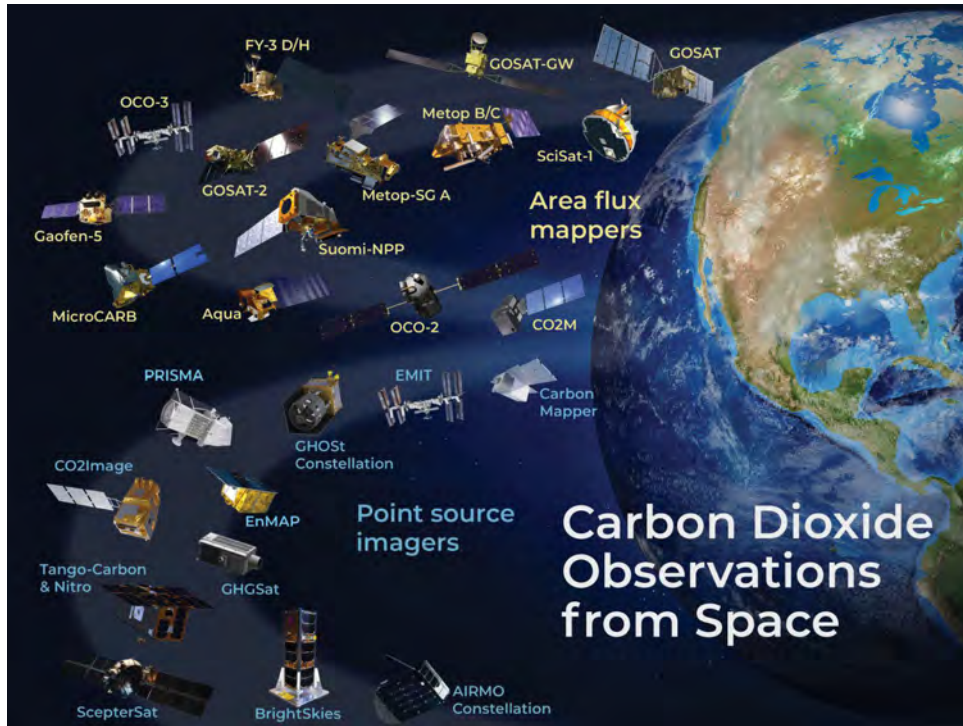
Public-Private Partnerships



G3W longer-term plans & vision

G3W is synchronizing with Space Agencies

- In 2024-27 the **G3W IPP Implementation and Pre-operational Phase**, it is crucial for the global coverage of local relevance that **G3W Space Remote Sensing** components are well coordinated.
- This is thanks to **CEOS** and to **CGMS**



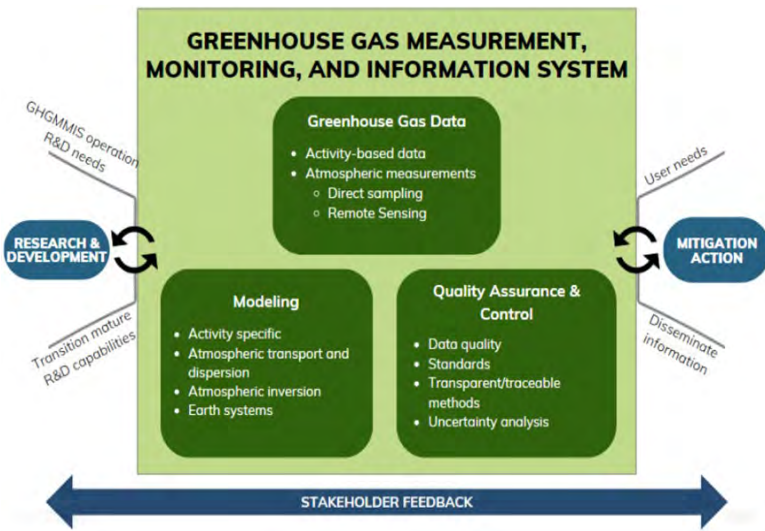
CEOS – Committee on Earth Observations Satellites



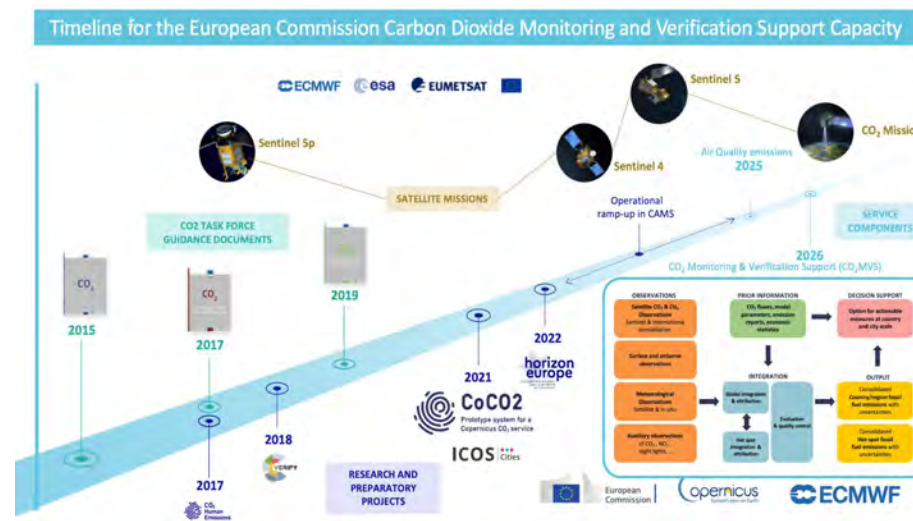
CGMS – Coordination Group on Meteorological Satellites

G3W is synchronizing with National & Regional efforts

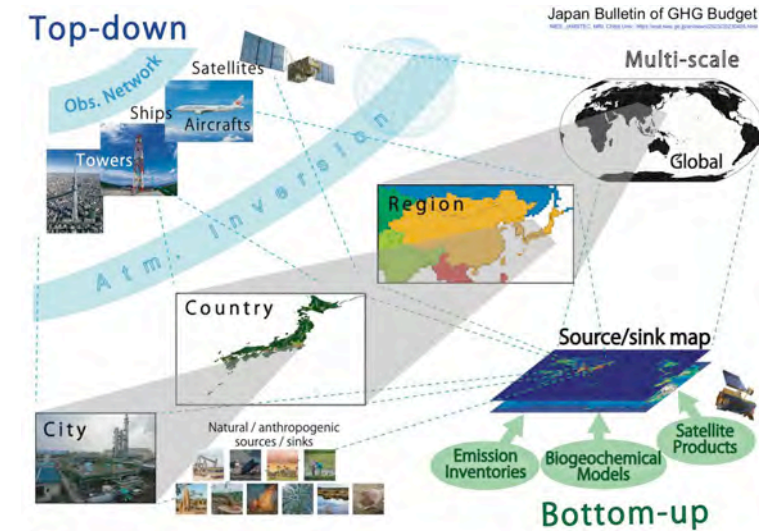
- In 2024 the **G3W Implementation Plan**, the **G3W Sustainability Strategy** documents.
- In 2025 & 2026 the **Ramp up Operations** with sustained funding sources (WMO + External).
- This is in good alignment with fast-track GHGs information efforts, such as in EU, JAPAN, US, ...



US GHGMMIS, 2023



EU COPERNICUS, 2023



JAPAN NIES, 2023



G3W Implementation in 2024-2027: The Methane case

COP28 Global Methane Pledge – 155 Countries

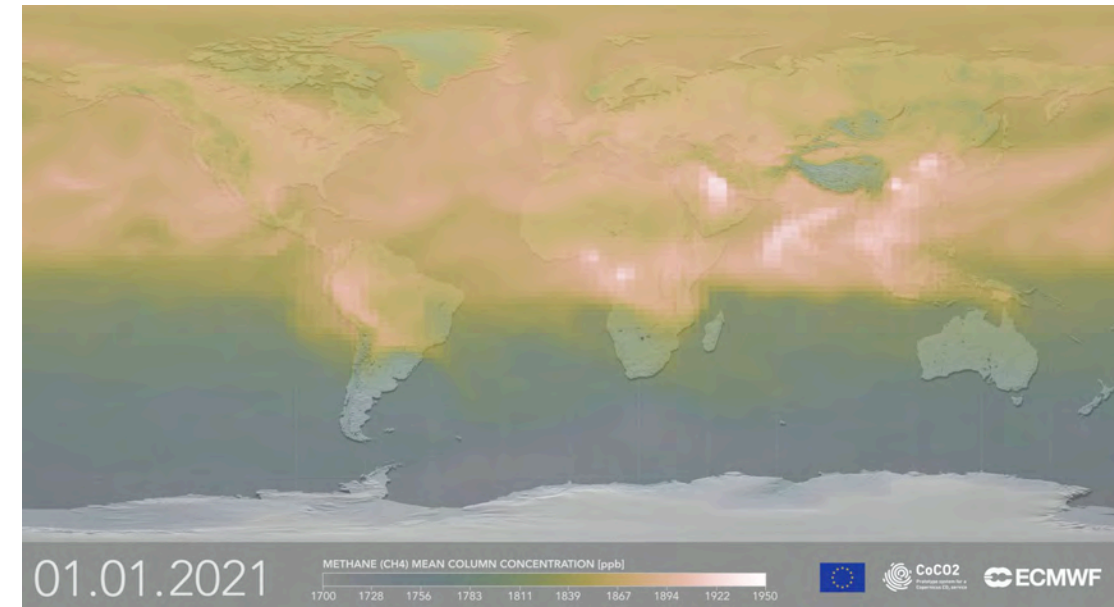
- <https://www.globalmethanepledge.org>

What: The Global Greenhouse Gas Watch – Surface-based and Satellite-based observation infrastructure can benefit from the COP28-COP29-COP30 momentum.

How: a **Public-Private Partnership** on GHGs concentrations and fluxes can tackle Methane as a IPCC priority to preserve the remaining Carbon budget for Paris Agreement goals.
A collaboration UNEP-IMEO, Global Methane Hub, CCAC, GMI, G3W.

Why : a Win-Win-Win approach in which Science-Economy-Society benefit from rapidly curbing emissions with both **Agility** of Private Sector investment and **Sustainability** of Public Long-Term Goals and UN SDGs framework.

Methane is crucially connected to Climate-Change via the Cryosphere (eg. Permafrost melting linking G3W with GCW and GCOS ECVs)



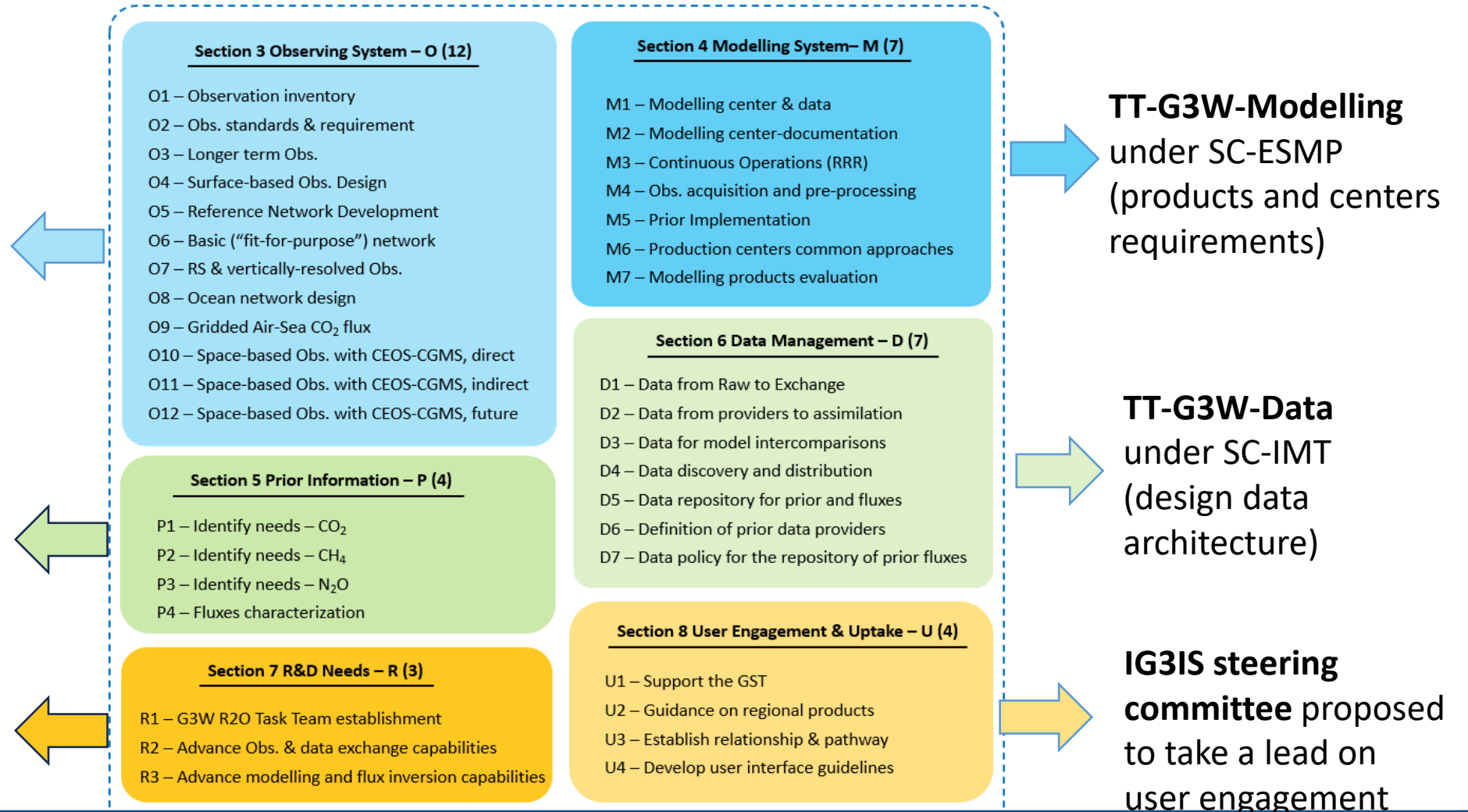
Animation source: Copernicus Earth Observation Programme / ECMWF CAMS

G3W implementation steps

TT-G3W-networks
under SC-ON
(network design)

Covered under
TT-G3W-Data

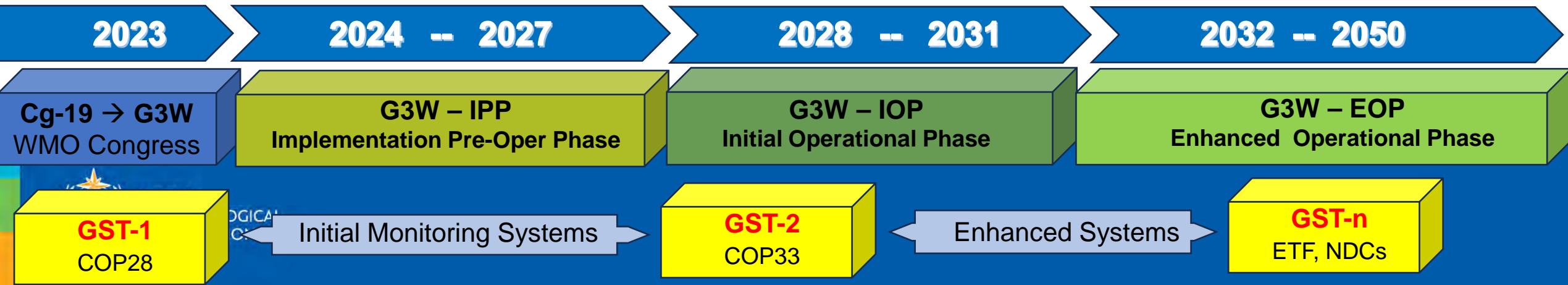
TT-G3W-Research under
the Research Board
(R2O & O2R strategy)



G3W@GCOS -Take Home: G3W adds hope to ClimateAction

The G3W Plans (approved + endorsed) provides a vision for GHGs to add an operational ambition. What next?

- Priority Activities in the plans need to establish partnerships (eg. IPCC/GCOS/CEOS/CGMS/IOC started)
- The G3W efforts are integral part of a Climate Infrastructure to support Science & Services, and interact via WMO channels, with the 193 Members (NMHSs), UN-Family, UNFCCC, IPCC, States/non-States actors
- G3W plan to be Operational on the path of the Weather enterprise with strong engagements of all Nations
- Measuring GHG is a necessary step for managing GHG effectively realising the goal of Climate Neutrality.

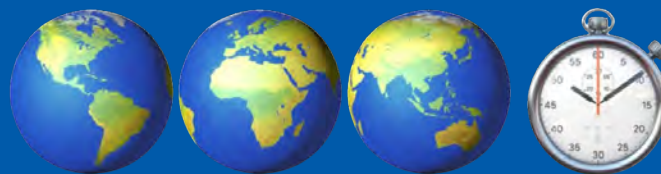


G3W – A co-design & co-development effort from the start

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.

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Thank you



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Take Home 🏠 message

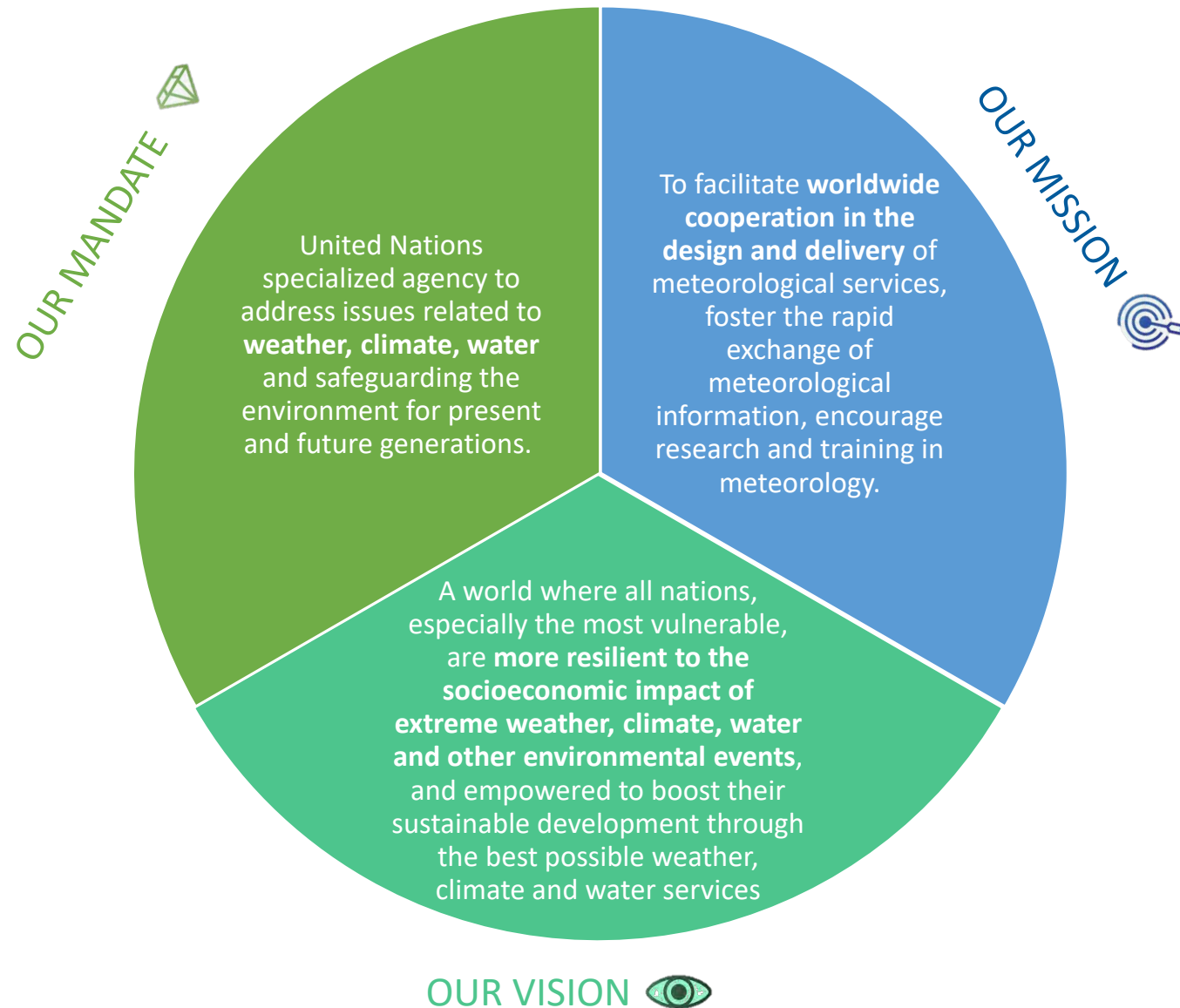
CLIMATE ACTION NEEDS

SCIENCE DRIVEN – CONSENSUS BASED

CLIMATE DATA – INFORMATION - KNOWLEDGE

g3w-gov@groups.wmo.int

WMO – the World Meteorological Organization in a



WMO plays a role as a **global coordinator** for Member countries, harmonizing and supporting the work done across National Meteorological and Hydrological Services around:

Protection of Life and Property
Safeguarding the Environment

Contributing to **Sustainable Development**

Monitoring the earth system (collecting and sharing **Data & Information**)

Defining **Best Practices**

Promoting targeted **Science** to improve **Infrastructure, Service** delivery and supporting **Policymaking**

Contributing to **Capacity development**, seeking to reduce the development gaps

WMO convention

WMO has 193 Members, including 187 Member States and 6 Territories

G3W – the Global Greenhouse Gas Watch Flagship in a

The G3W Flagship respond to UN sustainability's call, via **Climate Action** (mitigation) for **Climate Neutrality Goal**

- **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 Financial Sustainability**

WMO-RMS the Resources Mobilisation Strategy for **G3W**

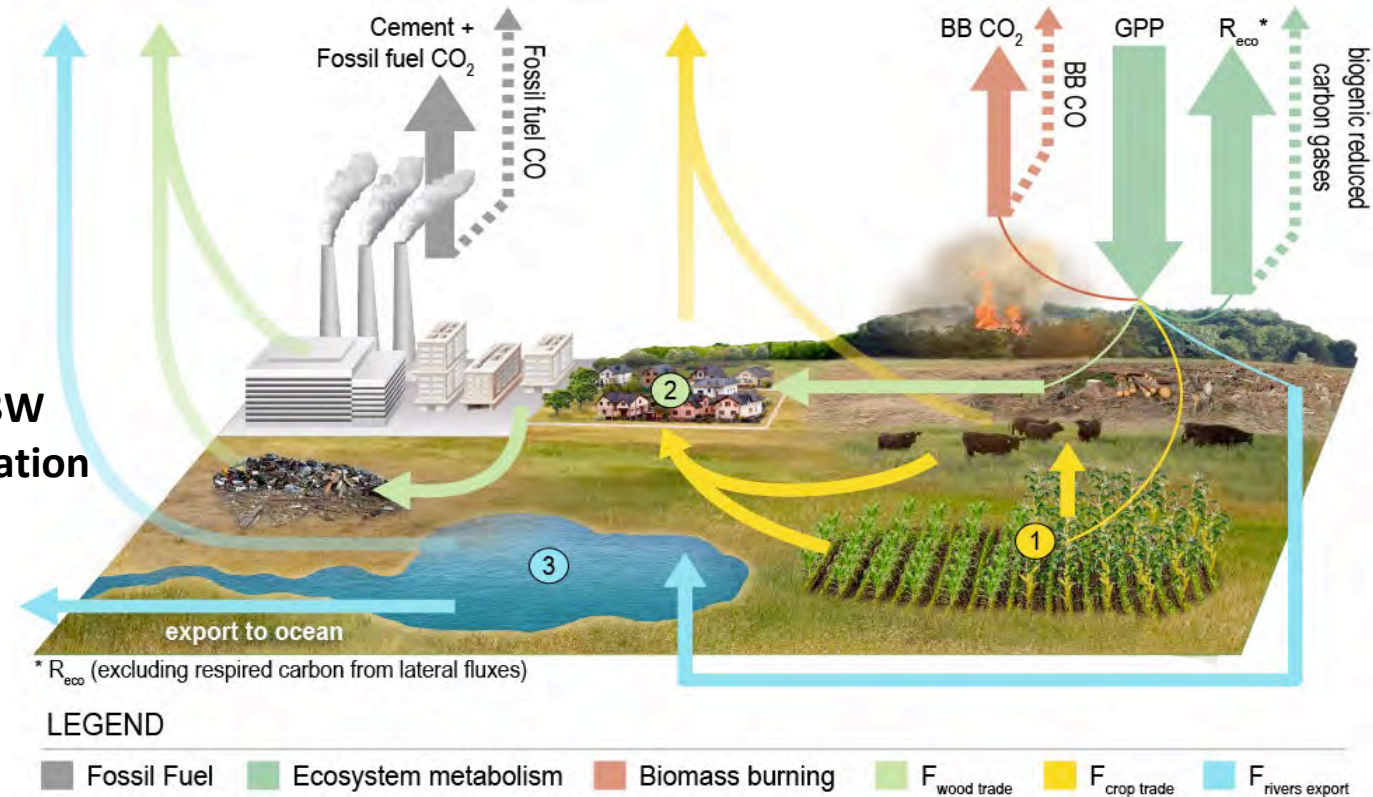
\$1B : 70% Observations, 29% Integration, 1% Coordination

- **G3W Working Structure**

- INFCOM-SC-ET Expert Teams

- AG-G3W joint INF / RB / SER

- WIGOS / WIPPS / WIS synergy



Byrne et al. 2022 ESSD



EW4All –the Early Warning for All Flagship in a



The EW4All Flagship will ensure every person on Earth is protected by lifesaving early warning systems by 2027

Early Warnings for All



The delivery of Early Warnings for All requires scale up and coordinated investments and action across the four essential pillars of end to end, people-centred Multi-Hazard Early Warning Systems

How?



Pillar 2 is focused on delivering 5 outcomes:

- Increased availability of quality observation data to assess and monitor priority hazards.
- Enhanced data exchange and access for forecasting and warning systems.
- Increased capabilities to forecast all priority hydrometeorological hazards.
- Impact-based forecasts and warnings are produced for all priority hazards.
- Strengthened relevant policy, institutional mechanisms, and stakeholder engagement processes in place to support MHEWSs

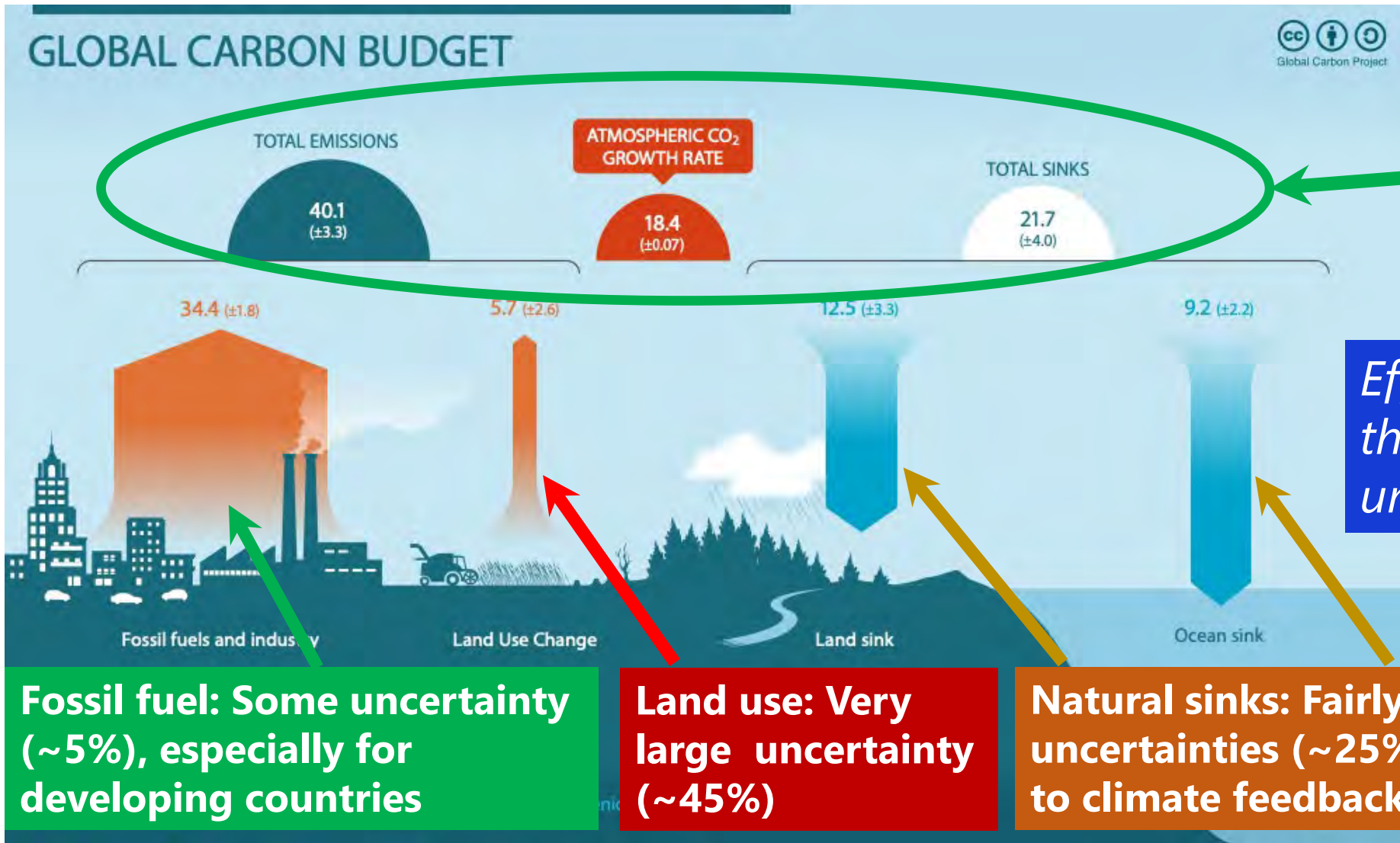


Global Status of Multi-Hazard Early Warning Systems 2023



Where are CO₂ fluxes uncertainties? How to reduce them?

(Graphic by the Global Carbon Project)



Top level global budget is understood

Efforts are needed on the areas with large uncertainties!

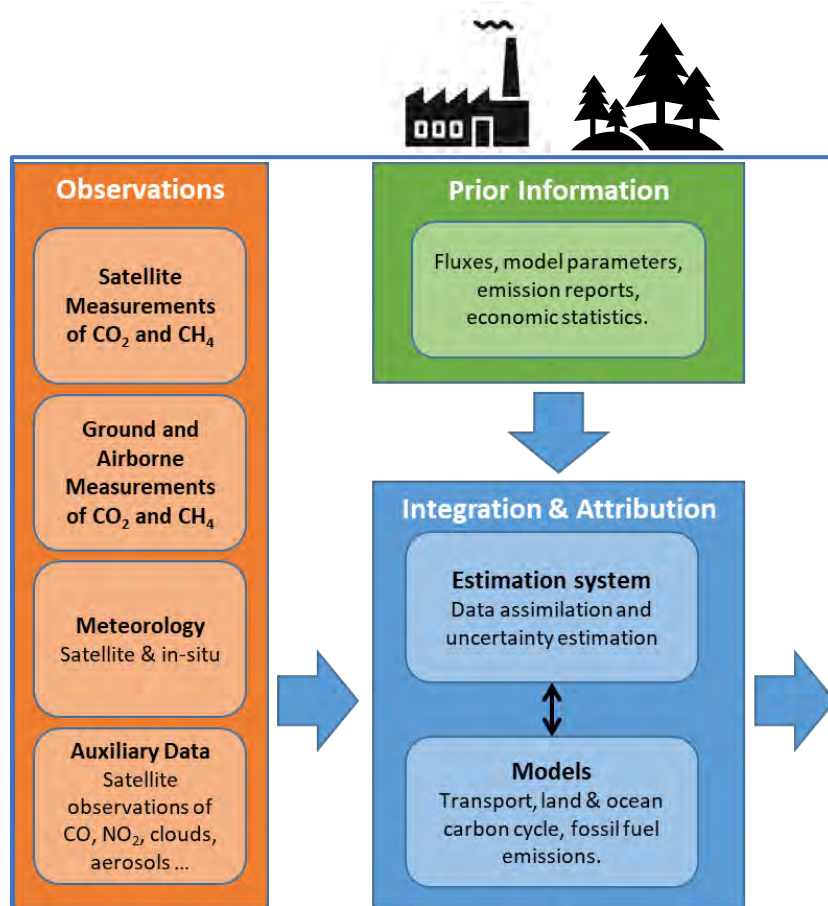
Fossil fuel: Some uncertainty (~5%), especially for developing countries

Land use: Very large uncertainty (~45%)

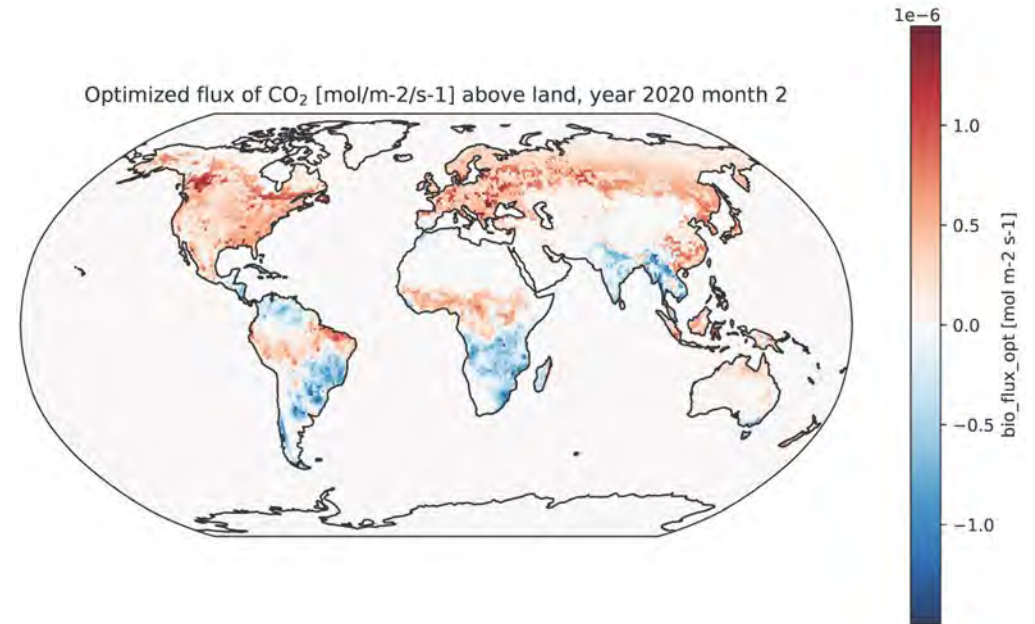
Natural sinks: Fairly large uncertainties (~25%); subject to climate feedbacks

G3W – the Global Greenhouse Gas Watch

An integrated Earth system operational approach



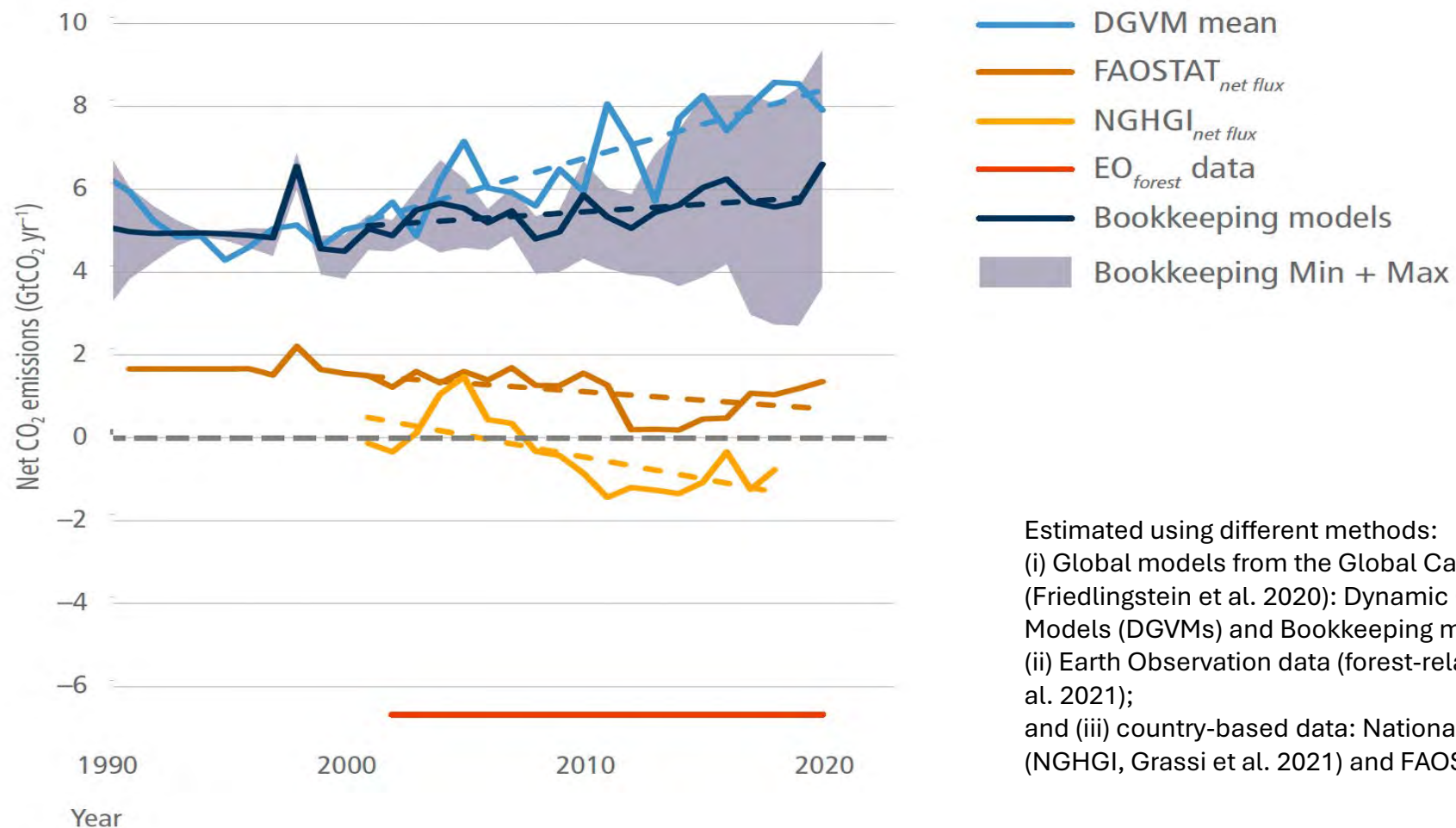
Outputs: Globally gridded monthly net fluxes of CO₂ and CH₄ (and N₂O)



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



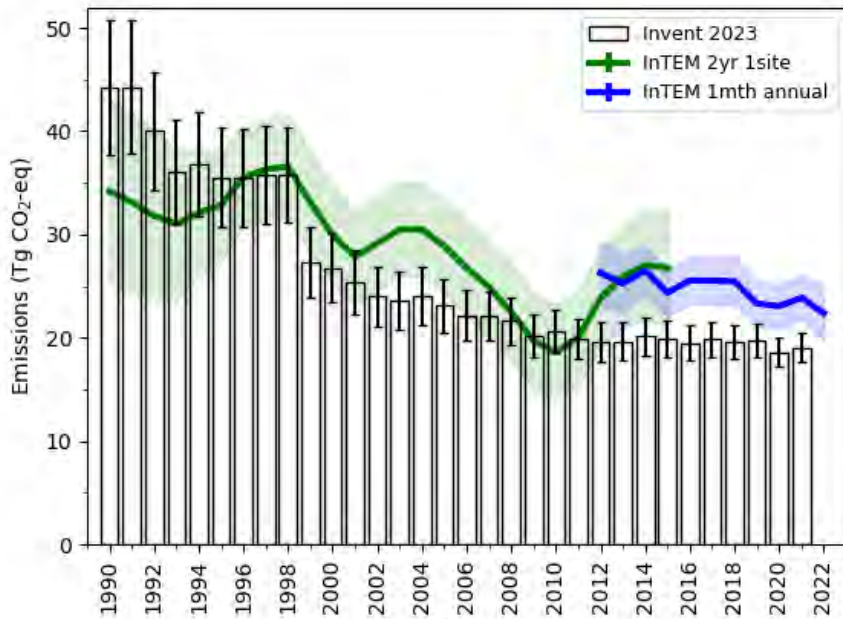
The gap in land use emissions affects EO-based GST uptake



- Global net LULUCF CO₂ flux in the WGIII contribution to the IPCC AR6 (Nabuurs et al. 2022)

Lessons learned through the work with UNFCCC: National emission reporting

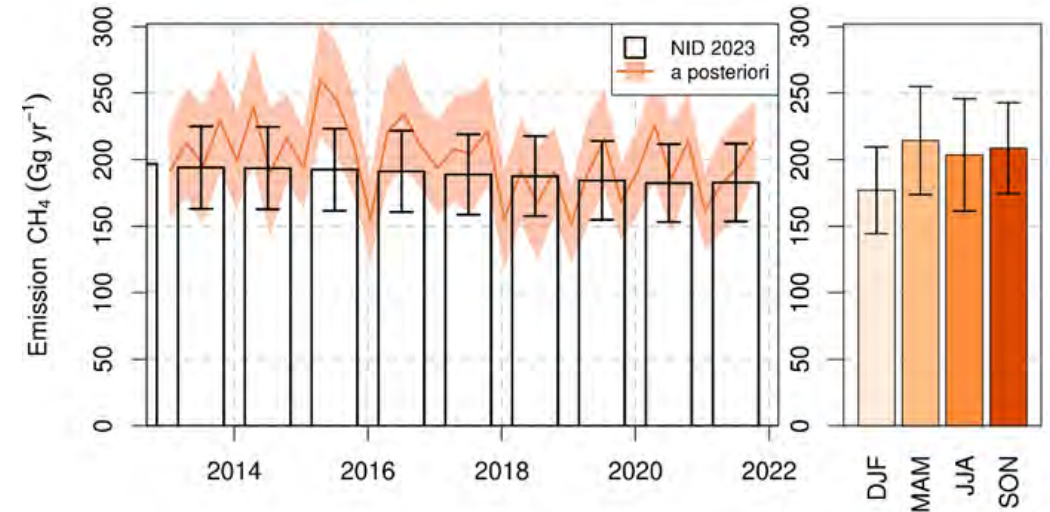
N₂O Emissions of the UK



Included in the
National submission

Additional
information

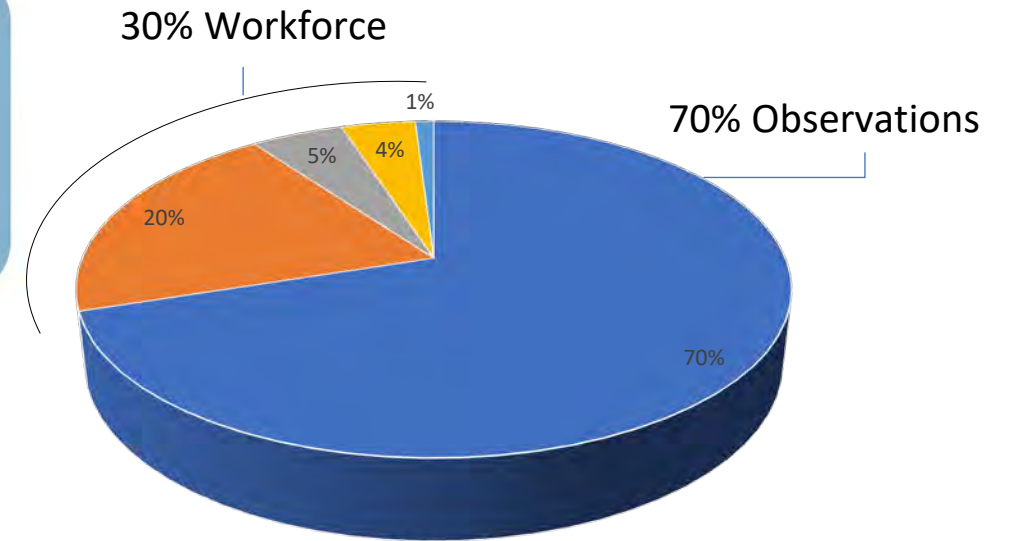
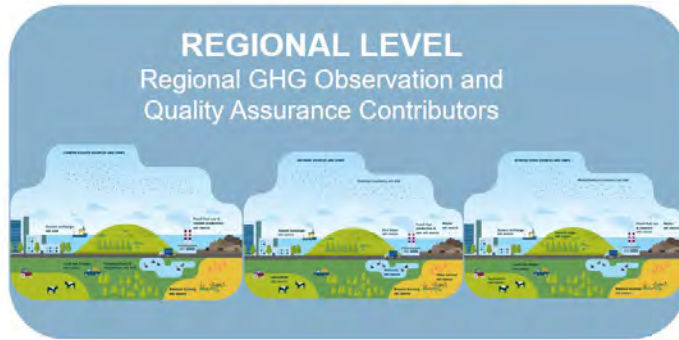
CH₄ emissions of Switzerland



- Additional information to inventory builders to improve emission reporting to UNFCCC
- Improved timeliness and availability of the information to support tracking of the impact of emission reduction actions and to help guide national GHG policy and regulations



G3W Sustainability and Focus : A Region First Approach



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

The estimated costs in 3 scenarios (1 B\$, 500 M\$, 300 M\$)

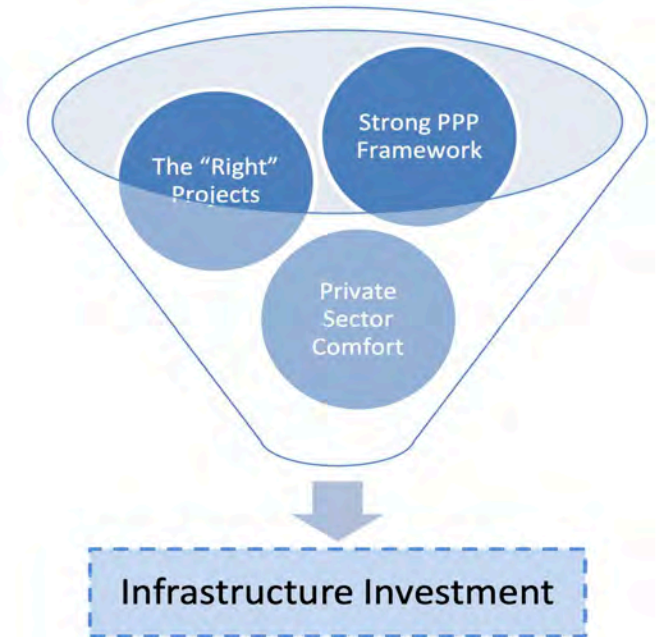
- Observing system surface-based infrastructure
- Observing systems integration, modelling and data management
- Capacity building and capacity development for G3W input and uptake
- Regional Pilot Projects and supporting research for G3W emerging priorities
- Central coordination by WMO secretariat including public-private-partnerships (PPP) development

Synchronizing Public & Private Funding Opportunities

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

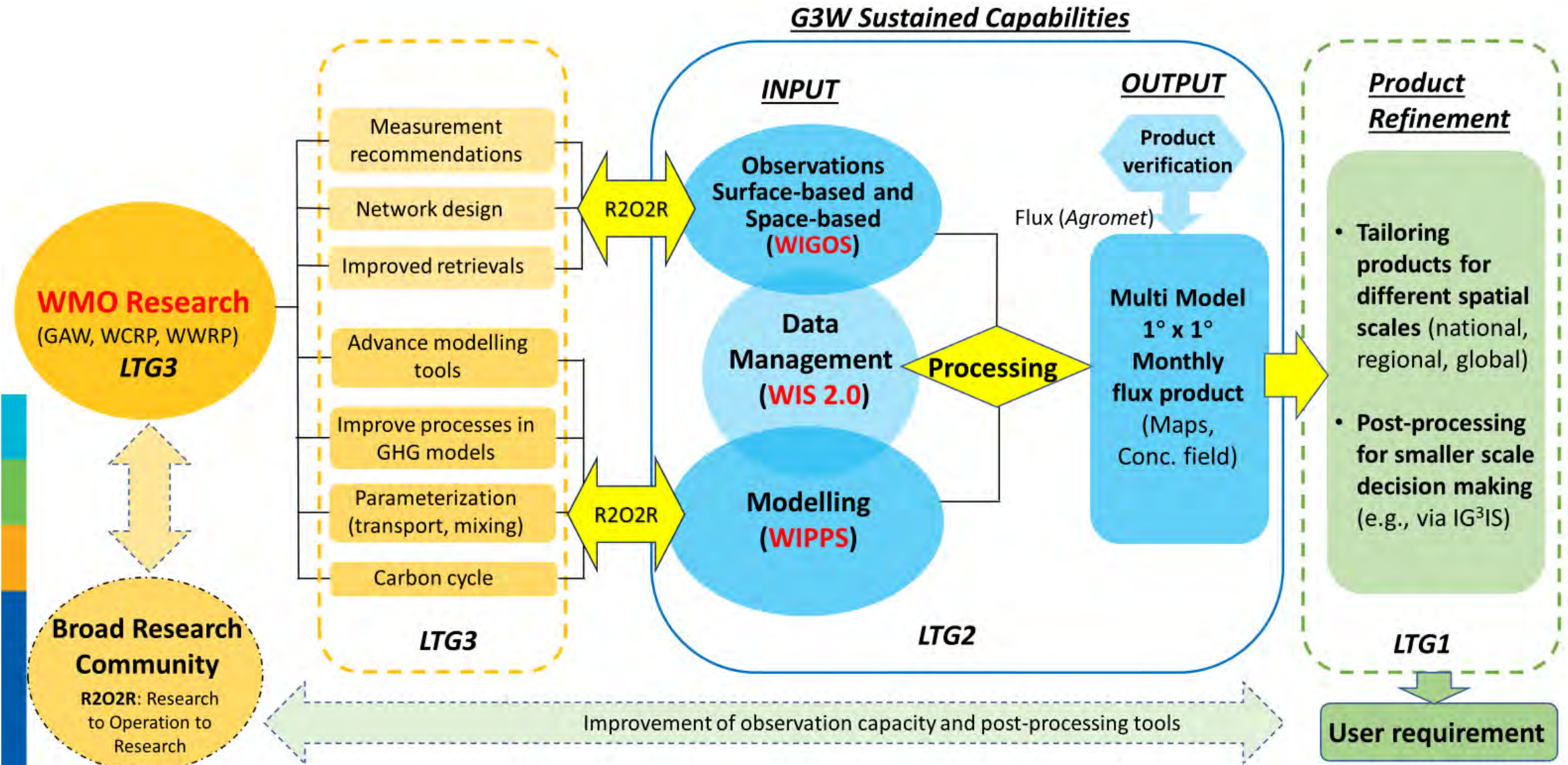
Funding mechanisms include 3 pathways:

- **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.



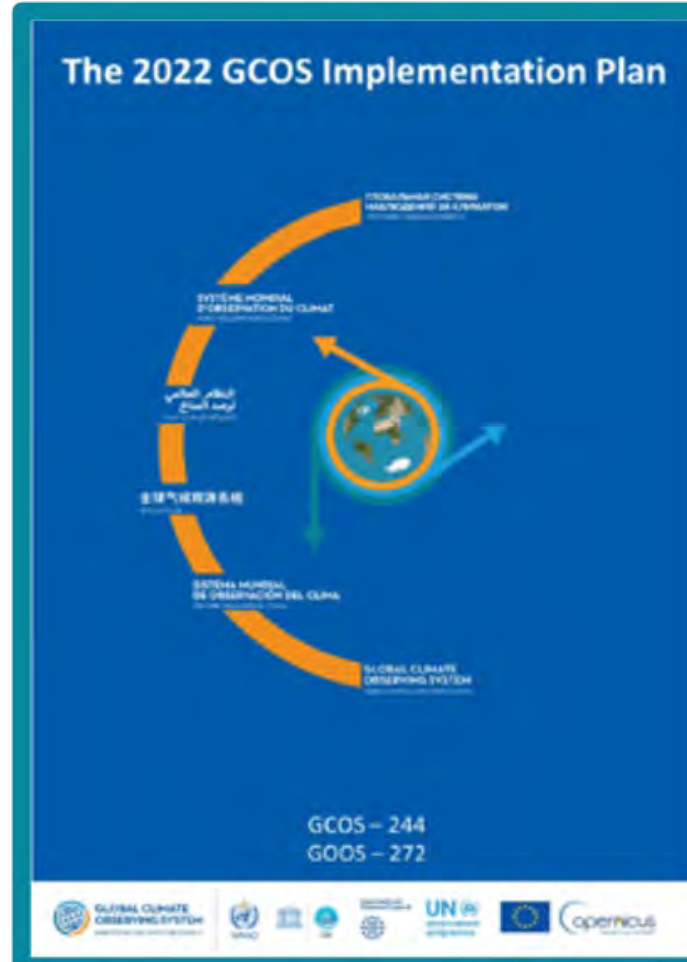
[World Bank, 2016a, #3553](#)

Synchronizing within the WMO shared Governance & Goals



G3W GCOS GAW shared efforts

- 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



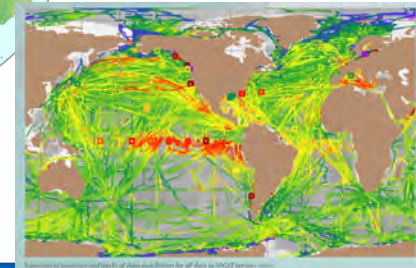
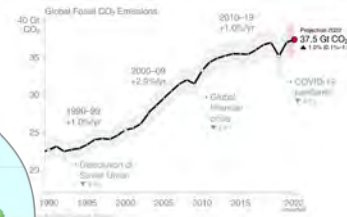
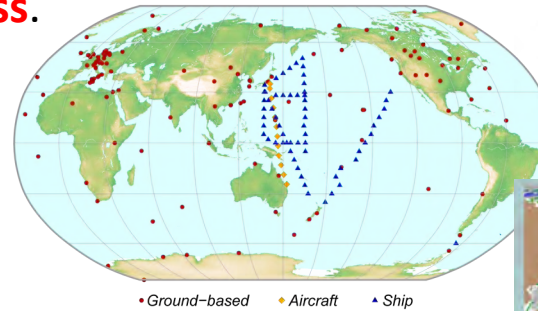
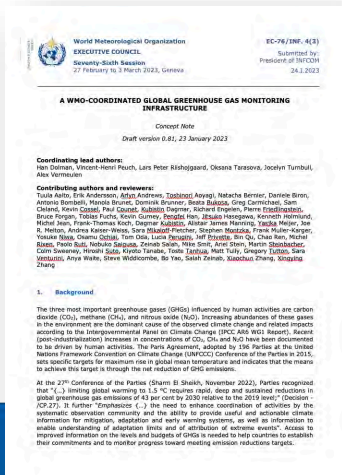
Action F5: Develop an Integrated Operational Global GHG Monitoring System	
Activities	<p>The overall aim here is to develop an integrated operational global greenhouse gas monitoring infrastructure. The first steps are:</p> <ol style="list-style-type: none"> 1. Design and start to implement a comprehensive global set of surface-based observations of CO₂, CH₄ and N₂O 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 CO₂ and CH₄ 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	<p>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.</p> <p>Monitoring of hot-spots via dedicated observations to validate specific point-source emissions and identify missing sources from emission inventories.</p> <p>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 (SO₂, 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).</p>
Implementers	<ol style="list-style-type: none"> 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.



G3W Implementation Plan: Progress up to Q2/2024

- A 1st complete draft of G3W IP with WMO RMS contribution on the 18th of January 2024.
- G3W-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 and approved in the week of the 15th of April 2024.
- G3W presented to WMO EC-78 and endorsed on the 10th of June 2024.

A successful WMO journey from the concept note presented to EC-76 **adopted by the 19th Meteorological Congress.**



To a WMO flagship endorsed by the 78th WMO Executive Council.

G3W Implementation & Pre-operational Phase 2024-2027

