

# The activities of WMO related to greenhouse gases monitoring



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# WMO coordination of the environmental /atmospheric composition issues

- Global O<sub>3</sub> Observing System (**GO<sub>3</sub>OS**) established in 1957 (IGY)
- Background Air Pollution Monitoring Network (**BapMoN**) formed in 1967 (including CO<sub>2</sub>)
- Both merged into the GAW Programme in 1989 (41<sup>st</sup> Session of EC, based on the recommendation of the EC panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry)
- The first WMO coordinated meeting of experts on Greenhouse Gas and Related Tracer Measurement Techniques was held in the Scripps Institution of Oceanography, United States, in 1975 (since then happens every two years)

Atmospheric composition and broader environmental issues has been dealt with by the WMO Commission on Atmospheric Sciences



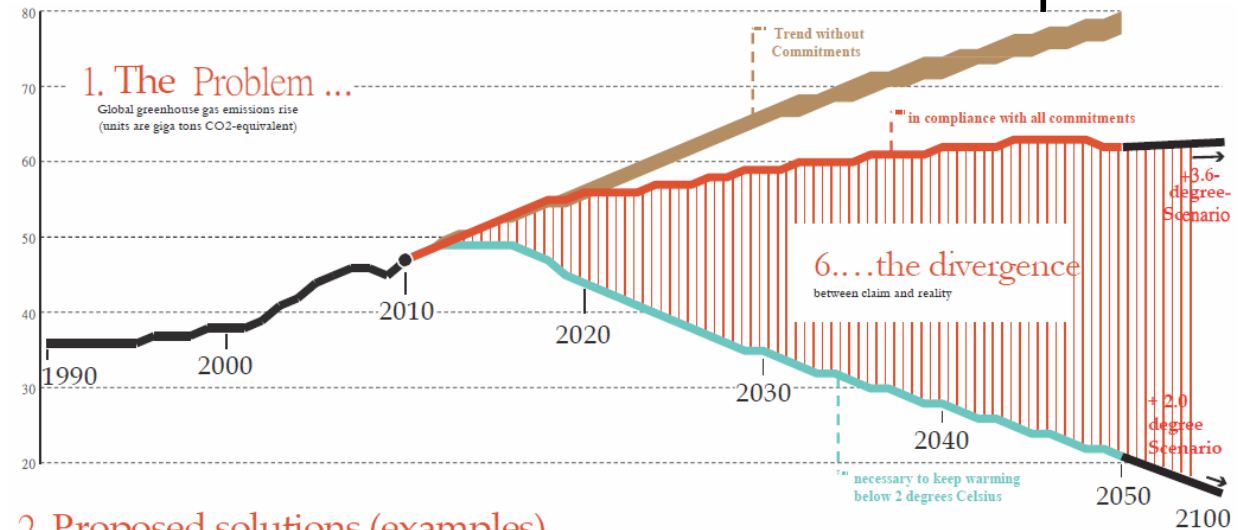
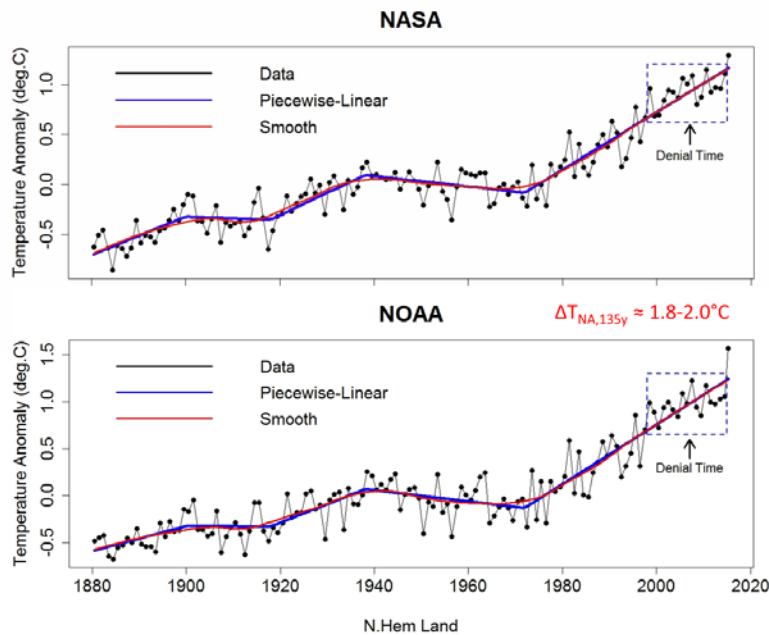
**Figure 5.** Stations with Dobson type spectrophotometers 1951-1956. From less than 12 (before 1951) with the efforts of IO<sub>3</sub>C they were increased to 32 just by the start of the IGY (currently they are more than 100). Observations made before IGY are mostly sporadic and of unreliable quality for trends analysis.



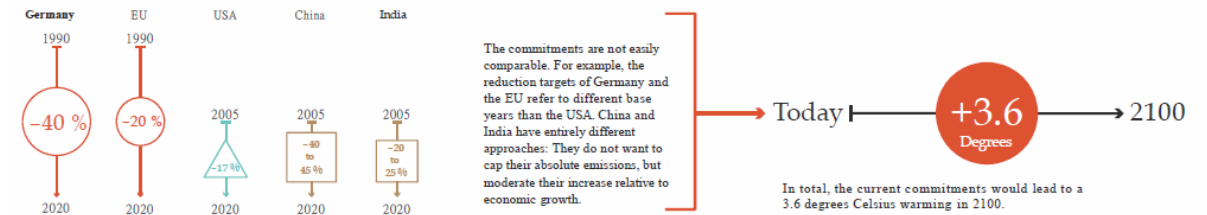
# The context of international climate policy

- IPCC was created by WMO and UNEP in 1988 (completed first assessment report in 1990)
- UNFCCC was signed in 1992 and is in effect since March 1994

## Tricks of climate politics

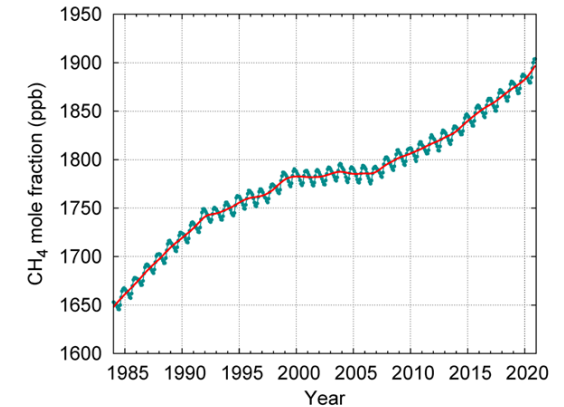
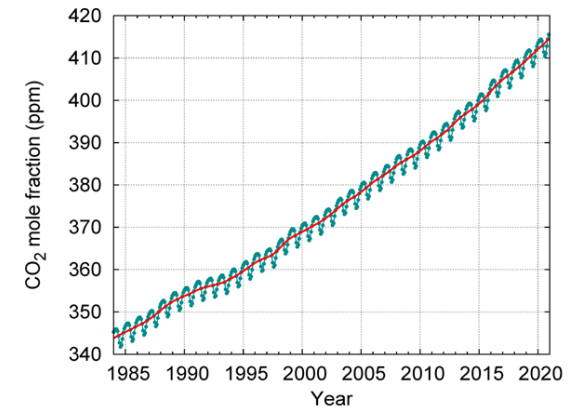
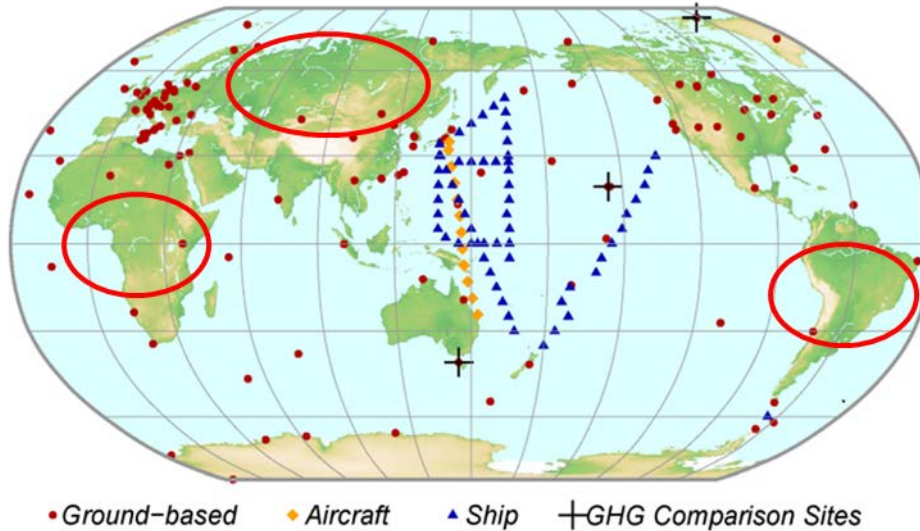
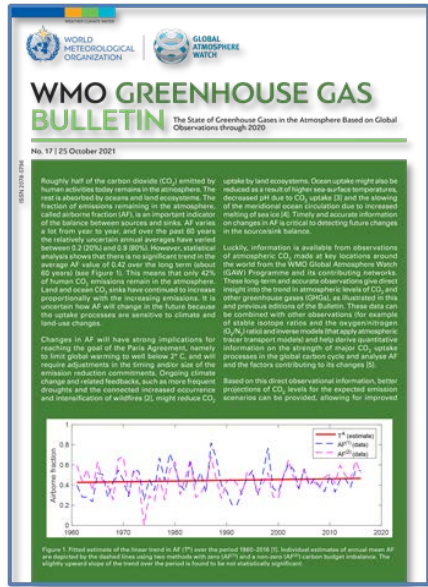


## 2. Proposed solutions (examples)



World went into denial phase!

# WMO continued coordination of GHG observations



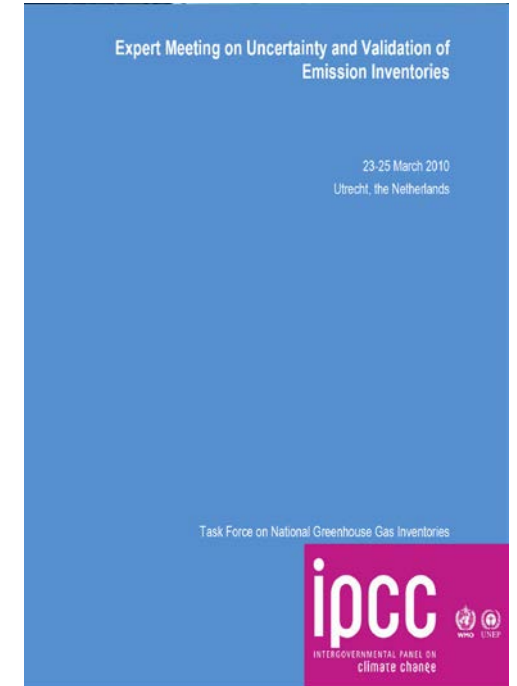
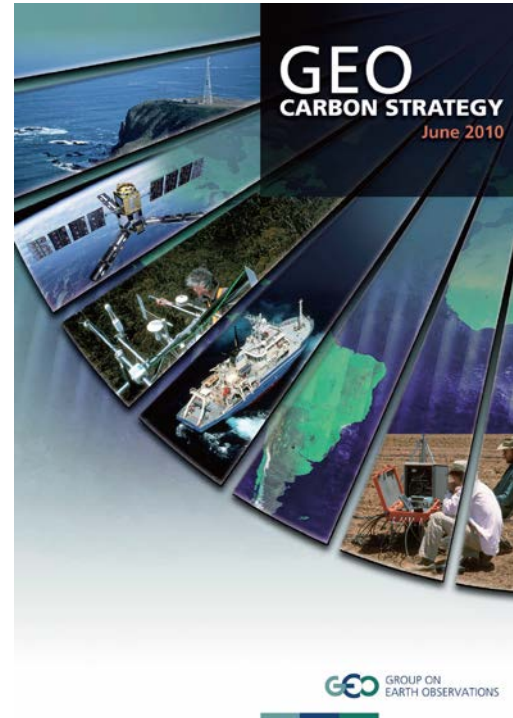
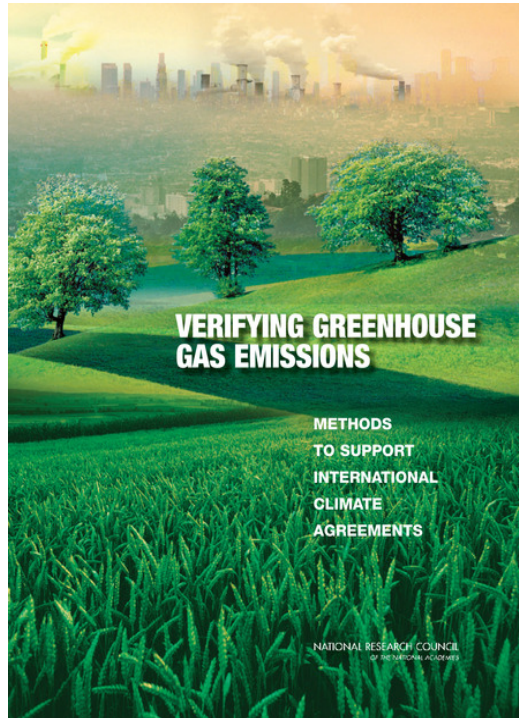
- Number of GHG stations in GAW increased and quality of observations has improved;
- Through the regular bi-annual meetings the data quality objectives and the good measurement practices are established and revised by the community;
- Long-term GHG observational data are openly available in the World Data Center for Greenhouse Gases supported by Japan Meteorological Agency



- Critical gaps in observations
- Data are global in nature and difficult to use in support of decision making

# Can atmospheric measurements and analyses “verify” inventories?

GHG monitoring and reporting in 2010: atmospheric “top-down” versus inventory “bottom-up”



WMO hosted GEO Carbon Symposium in 2009 but did not propose leadership in the implementation at that time

# Efforts of the WMO Commission on Atmospheric Sciences to improve GHG monitoring and research

CAS Management Group (2013) – initial idea of the «science for services» and relevant GHG monitoring (lead by NOAA, Jim Butler, CarbonTracker as a model)

Commission for Atmospheric Sciences – Sixteenth session (CAS-16), Antalya, Turkey, 20–26 November 2013: “Integrated Greenhouse Gas Information System” is recognized as one of the **10-year priorities of CAS** (agenda 9.3)

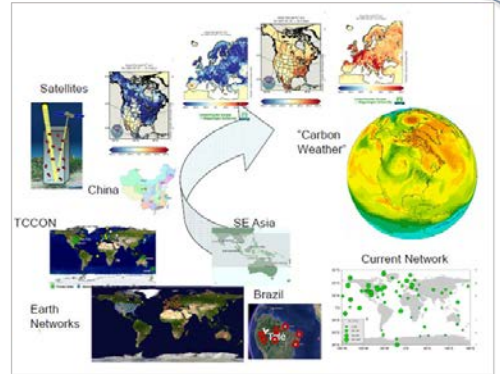
EC-66 (June 2014): request development of the plan for IGIS

4.5.37 The Council appreciated the on-going developments to establish an Integrated Greenhouse Gas Information System (IGIS), building on current activities. In order to move this activity forward, the Council requested for the CAS Environmental Pollution and Atmospheric Chemistry (EPAC) Scientific Steering Committee (SSC) to consider the development of a project plan for IGIS.

Happened even before Paris was adopted

*“We cannot manage what we cannot measure . . .”*

*Existing surface-based networks, emerging networks in developing countries, and new aircraft-based measurements and satellite observations will make a difference. Additional observations are critical.*



From observations to networks to satellites; we need improved transport models with enough observations assimilated to constrain the models and improve reanalysis. This will produce the checks and balances needed to responsibly manage greenhouse gases in the atmosphere.

# Establishment of the Integrated Global Greenhouse Gas Information System

17<sup>th</sup> World Meteorological Congress (June 2015) established Integrated Global Greenhouse Gas Information System through Resolution 46 (Cg-17)

IG<sup>3</sup>IS was adopted before the Paris agreement was in place

First national consultations were organized in WMO in **2016** with Morocco, South Africa and Brazil with support of ICOS, Switzerland and UK

## Requests Members:

- (1) To give all possible support to the development, improvement and modernization of networks for observations of greenhouse gases and co-emitted species;
- (2) To carry out greenhouse gas observations in accordance with GAW quality assurance principles;
- (3) To ensure submission of observational data as well as metadata to the dedicated WMO/GAW Data Centre as well as the GAW Station Information System within the period of time required to support IG<sup>3</sup>IS, as will be documented in the specification of requirements through the WMO Integrated Global Observing System and its Observing Systems Capability Analysis and Review Tool/Requirements catalogue;
- (4) To cooperate on development of modelling tools for inverse modelling and anthropogenic greenhouse gas flux attribution;
- (5) To collaborate with organizations and institutions that address the carbon budget of biosphere and ocean;

## Requests the president of the Commission for Atmospheric Sciences:

- (1) To encourage Members represented in the Commission to support implementation of IG<sup>3</sup>IS;
- (2) To stimulate and coordinate research and development activities and studies of carbon cycles to increase potential benefits of IG<sup>3</sup>IS implementation for Members;
- (3) To work together with other technical commissions on implementation of IG<sup>3</sup>IS;

## Requests the regional associations to implement IG<sup>3</sup>IS on a regional scale;



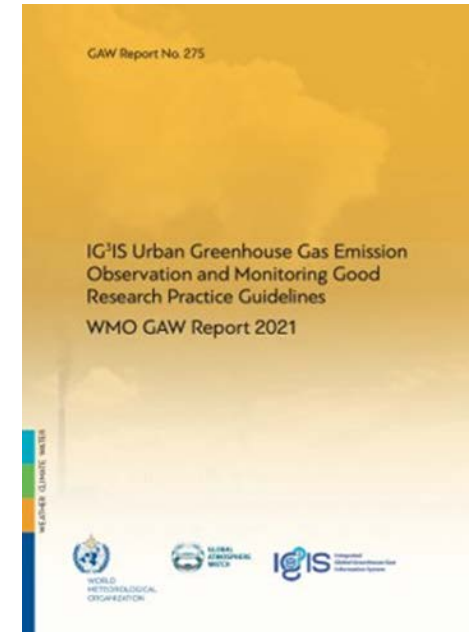
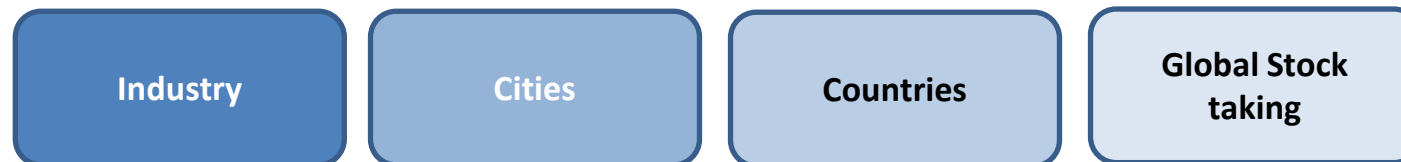
# Integrated Global Greenhouse Gas Information System (IG<sup>3</sup>IS) is



... a common framework for provision of the **systematic services to user community** who intend to reduce its greenhouse gas emissions

- Support the use of atmospheric concentration data to improve emission and/or uptake estimates
- Consensus on a coherent set of good-practice methods and guidelines
- Quality control (**benchmarking**)

Range of scales





# Integrated Global Greenhouse Gas Information System implementation principles



- Combine *atmospheric concentration measurements* with socioeconomic inventory data to *better quantify and attribute greenhouse gas emissions*.
- *Stakeholders are entrained from the beginning* to ensure that information *products* are *co-developed* and meet user needs and the foreseen value proposition.
- IG<sup>3</sup>IS will serve as an international coordinating mechanism and establish and propagate *consistent methods and standards* (**BIPM/GAW** partnership).
- Success-criteria are that the information *guides additional and valuable emission-reduction actions*.
- IG<sup>3</sup>IS must mature *in concert with evolution of policy and technology*.



# Further IG<sup>3</sup>IS development in WMO

**EC-68 (June 2016):** IG<sup>3</sup>IS is included in Resolution 1 («WMO Support to the Paris Agreement»), Decision 19 (EC-68) adopts IG<sup>3</sup>IS Concept note

**EC-69 (May 2017):** Decision 51 (EC-69) adopted IG<sup>3</sup>IS Implementation plan



Reference: Science/Executive/2017/JMcG/VF/yo

2 March 2017

Dear Sir/Madam,

The Intergovernmental Panel on Climate Change concluded in its Fifth Assessment Report that anthropogenic greenhouse gas emissions are extremely likely being the dominant cause of the recent climate change. Long-term observations drove this conclusion and led the Parties to the United Nations Framework Convention on Climate Change to focus on mitigating and adapting to climate change.

The implementation of the Paris Agreement requires governments to limit atmospheric concentrations of greenhouse gases. The agreement calls for transparency mechanisms to be established. The ability to implement policies that limit greenhouse gas concentrations in the atmosphere would be greatly enhanced by an Integrated Global Greenhouse Gas Information System, jointly implemented by the World Meteorological Organization and the United Nations Environment Programme. Such a system will use atmospheric observations, relevant socio-economic data and modelling to provide information about sources and sinks of greenhouse gases at policy-relevant temporal and spatial scales.

The implementation of this system requires much deeper collaboration between meteorological and environmental communities and allocation of considerable amount of resources by Members. Such collaboration was promoted by Decision 20 taken by the sixty-eighth session of the World Meteorological Organization Executive Council. Strengthened cooperation with the Intergovernmental Panel on Climate Change will also be key. Only through joint efforts will it be possible to fully realize the potential of such an information system in guiding additional mitigation options, reducing uncertainties in national emission inventories and raising situational awareness on the progress toward national emission reduction commitments. We therefore encourage you to establish such collaboration within your country, and would be pleased to provide further information and advice if needed on this matter.

We would like to express our appreciation for your continued support in promoting joint activities of the World Meteorological Organization and the UN Environment. We look forward to working together.

Yours sincerely,

Petteri Taalas  
Secretary-General  
World Meteorological Organization

Erik Solheim  
Executive Director  
UN Environment

To: Permanent Representatives of Members of WMO (PR-0000)  
Committee of Permanent Representatives to UNEP



# Initial IG<sup>3</sup>IS recognition by SBSTA



United Nations



Framework Convention on  
Climate Change

FCCC/SBSTA/2017/L.21

Distr.: Limited  
12 November 2017

Original: English

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**Subsidiary Body for Scientific and Technological Advice**

**Forty-seventh session**

**Bonn, 6–15 November 2017**

Agenda item 8

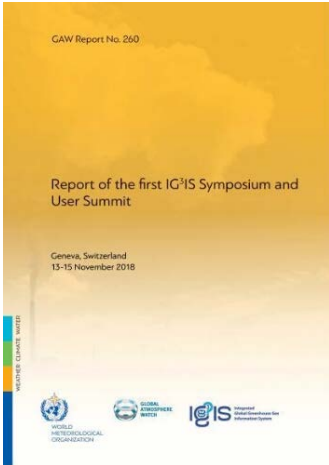
**Research and systematic observation**

## **Research and systematic observation**

12. The SBSTA noted the increasing capability to systematically monitor greenhouse gas concentrations and emissions, through in situ as well as satellite observations, and its relevance in support of the Paris Agreement.<sup>18</sup>

<sup>18</sup> See the section titled “Decision 51 - IG3IS Implementation Plan” in the WMO submission, referred to in paragraph 4(a) above, and the summary report on the Earth Information Day, paragraphs 30 and 31 and 73–86, referred to in paragraph 3 above.

# Further IG<sup>3</sup>IS development in WMO



January 2018 WMO signed MoU with UNFCCC, cooperation on IG<sup>3</sup>IS implementation is included as Annex 3

November 2018 – First IG<sup>3</sup>IS Symposium and User Summit

Agreement signed with 3 Swiss donors for the period 2018-2020 regarding establishment of the IG<sup>3</sup>IS office in WMO. Total support provided is 500'000 CHF. This agreement had unfunded extension to cover 2021-2023 period. Additional contributions (in total 75k USD) were received from Norway until 2023.

**Unfortunately, IG<sup>3</sup>IS office had to be closed due to the lack of commitments from WMO Executive Management**

Annex 3  
Under the  
Framework Memorandum of Understanding between  
the secretariat of the United Nations Framework Convention on Climate Change, the  
Kyoto Protocol and the Paris Agreement and the  
World Meteorological Organization

1. Memorandum of Understanding

This document, when duly signed, forms a part of the Framework Memorandum of Understanding (the MoU) concluded between the secretariat of the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement (the UN Climate Change secretariat) and the World Meteorological Organization (the WMO), collectively referred to as the Parties, on 6 November 2017. Obligations set out in the MoU apply to this specific Collaboration Project. Terms used but not defined in this Collaboration Project have the meaning given to them in the MoU.

2. Basic Collaboration Project Information

Project name:	Observations-based tools for improved national greenhouse gas emission estimates
Project duration:	4 years
Start date:	January 2018
Target deadline for completion:	December 2021
Geographical scope (if applicable):	Global
Substantive scope:	Development and use of observation-based tools for improved national greenhouse gas emission estimates

3. Objective

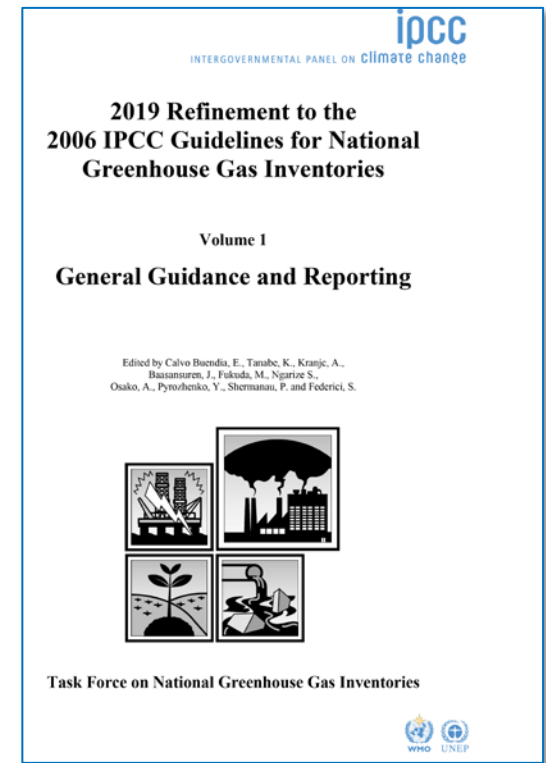
In recognition of the progress that has been made in atmospheric research, measurement and modelling, WMO has initiated the development of an Integrated Global Greenhouse Gas Information System (IG<sup>3</sup>IS). The IG<sup>3</sup>IS serves as an international coordinating mechanism under the auspice of WMO to establish and propagate globally consistent methods and standards to help assess emission reduction actions. It promotes use of atmospheric observations and inverse modelling techniques and, by combining them spatially and temporally with socioeconomic emission inventory data, it improves information and management of emission reduction policies and measures.

Under the UNFCCC, developed countries provide annual national GHG inventories covering emissions and removals of direct GHG emissions from the energy sector, industrial processes, solvents, agriculture, the waste sector, and land use, land use change, and forestry (LULUCF), and for all years from the base year or period to the most recent year.

# IG<sup>3</sup>IS recognition in the policy process

## SBSTA 50 (2019)

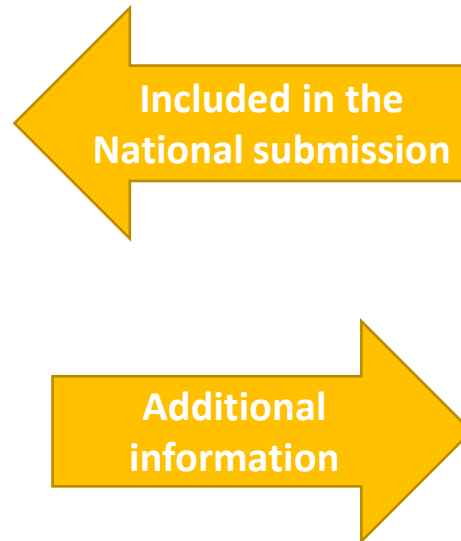
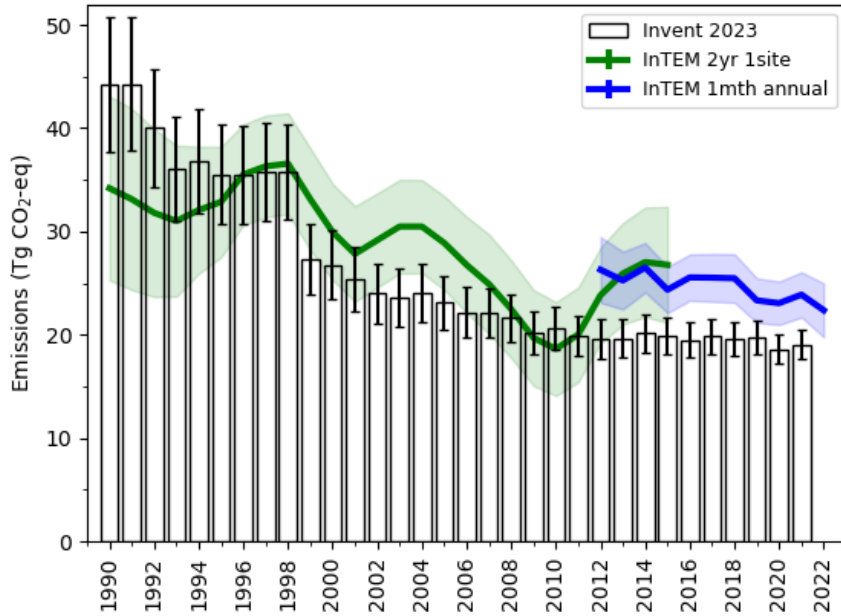
“ 59. The SBSTA welcomed the adoption by the WMO Executive Council at its seventieth session of the science implementation plan for a new IG<sup>3</sup>IS. **The SBSTA recognized that IG<sup>3</sup>IS is an innovative science-based framework** that supports the needs of a broad range of users by combining atmospheric observations with other sources of information to enhance understanding of GHG concentrations and fluxes at multiple spatial scales, and **encouraged the use of the framework.**”



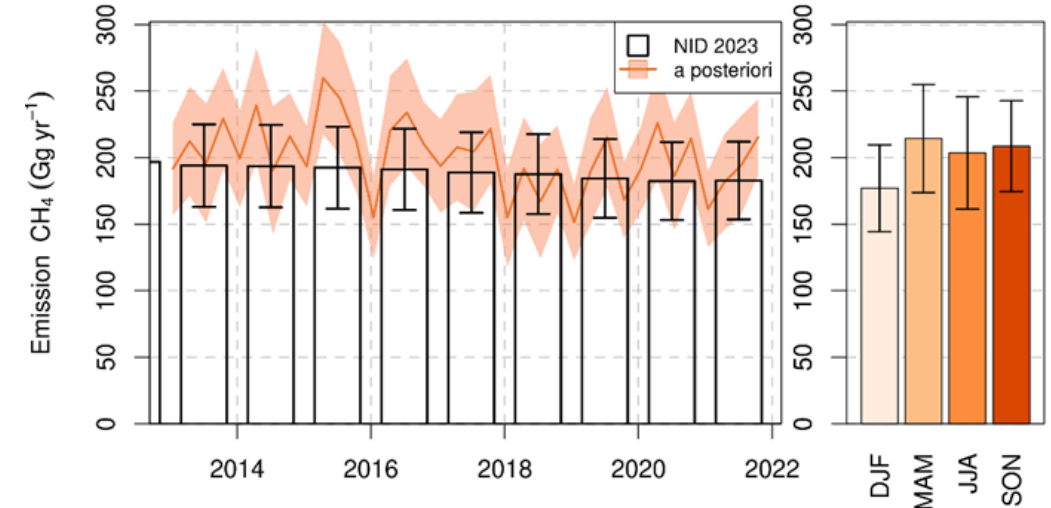
- IG<sup>3</sup>IS was included in the IPCC TFI National Emission Inventory refinement (in Chapter 6 “Quality Assurance/Quality Control and Verification”), approved in May 2019

# Lessons learned from IG<sup>3</sup>IS implementation: National scale

## N<sub>2</sub>O Emissions of the UK



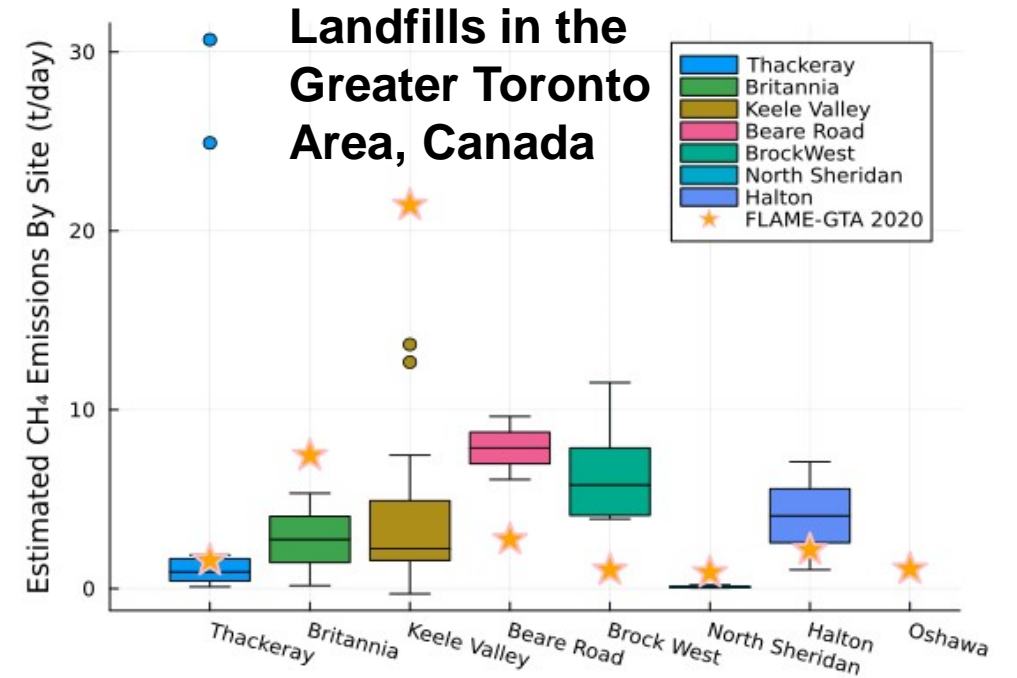
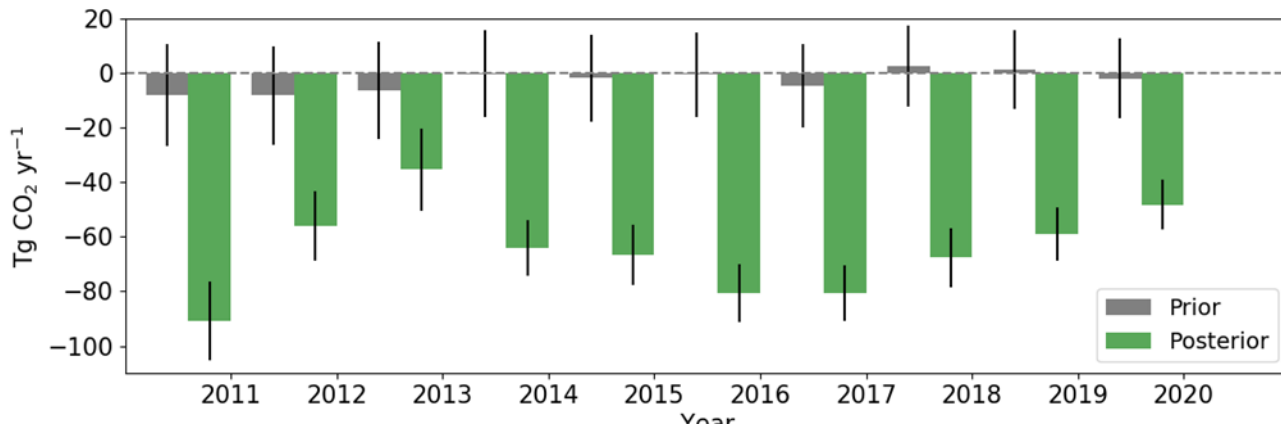
## CH<sub>4</sub> emissions of Switzerland



- Additional information to inventory builders to **improve quality** of 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

# Lessons learned from IG<sup>3</sup>IS implementation: Subnational scale and sectoral application

LULUCF in New Zealand



- High resolution information for emission/uptake quantification for non-state actor to evaluate and guide emission reduction policies;
- Location and quantification of previously unknown emission reduction opportunities;
- Improved characterization of carbon sinks (especially in the context of nature-based solutions)

# Where things went awry

- During the constituent bodies reform that started by Cg-18 in June 2019 all research programmes were transferred under the Research Board, which is not intergovernmental body, hence does not have the same «power» as two technical commissions
- The Science and Innovation Department changed 3 Directors in transition
- COVID-19 did not allow the Research Board to establish its operations (as a new construct it was in a much more disadvantage than new technical commissions)
- IG<sup>3</sup>IS officer left the position in 2021
- Head of GAW made several presentations to the Committee of Directors in 2021 regarding sustainability of IG<sup>3</sup>IS and the need to scale up the implementation. Respective Concept was agreed with CAMS and submitted to DSG in Nov.2021.

The Washington Post publishes the paper on 7 Nov 2021 with large contribution from atmospheric sciences community

The UN SG requests the respective UN agency to tackle the issue





# Initiation of the Global Greenhouse Gas Monitoring Infrastructure

- December 2021 – Management Retreat: **WMO Secretariat decided** that GHG monitoring is a priority for WMO Members. Leadership is taken by the INF department due to lack of leadership in Science and Innovation

GGMI tries to take a full Earth System approach with the NWP operational analogy in mind (similar to GEO Carbon strategy)

## Workshop at WMO, May 10-12; “The case for a coordinated Global Greenhouse Gas (GHG) Monitoring Infrastructure”

- **Very good engagement;**
  - **More than 20 external invited experts participated in person; 80 additional participants registered online;**
- **Surface- and space based observing systems;**
- **Ocean carbon;**
- **Land surface observation and modeling;**
- **Cryosphere;**
- **Modeling, data assimilation;**
- **Program and project managers and coordinators;**
- **WMO Permanent Representatives and staff;**



# WMO Executive Council 75, June 2022:

Initial concept of GGGW is presented to EC, that:

Decided to form a joint Study Group between INFCOM, SERCOM and the Research Board, with **appropriate involvement** of external stakeholders, to undertake the following tasks:

(1) *To develop the concept, including identifying the future vision for WMO-coordinated GHG-related activities, its outputs and expected contributions from and benefits for Members, **leveraging synergies with existing frameworks such as the Global Atmosphere Watch (GAW) and the Integrated Global Greenhouse Gas Information System (IG<sup>3</sup>IS)**;*

(2) *To submit a final proposal of the concept for its architecture with identified key gaps between Members' operational needs and **existing relevant WMO activities** to the 19<sup>th</sup> World Meteorological Congress in 2023;*

Members had a strong feeling that the new initiative is a duplication of existing efforts

SG took decision to cut the position of the Head of the GAW Programme; the incumbent is offered 1-year probational contract with a condition on extension "approval of the concept note by Cg-19"

# Joint Study Group on GHG Monitoring Infrastructure

To address the decision of the Executive Council (June 2022) and develop a concept to be presented to the World Meteorological Congress in 2023, the Study Group has established task groups to address four main aspects:

- Landscape analysis;
- Core GHG monitoring system capabilities and output data;
- Input data requirements (*observational data requirements, data gaps, observing network design, financial support mechanisms*);
- System output: Downstream applications and user services (*user community, postprocessing and connection to services*) – *this group directly connects to IG<sup>3</sup>IS.*

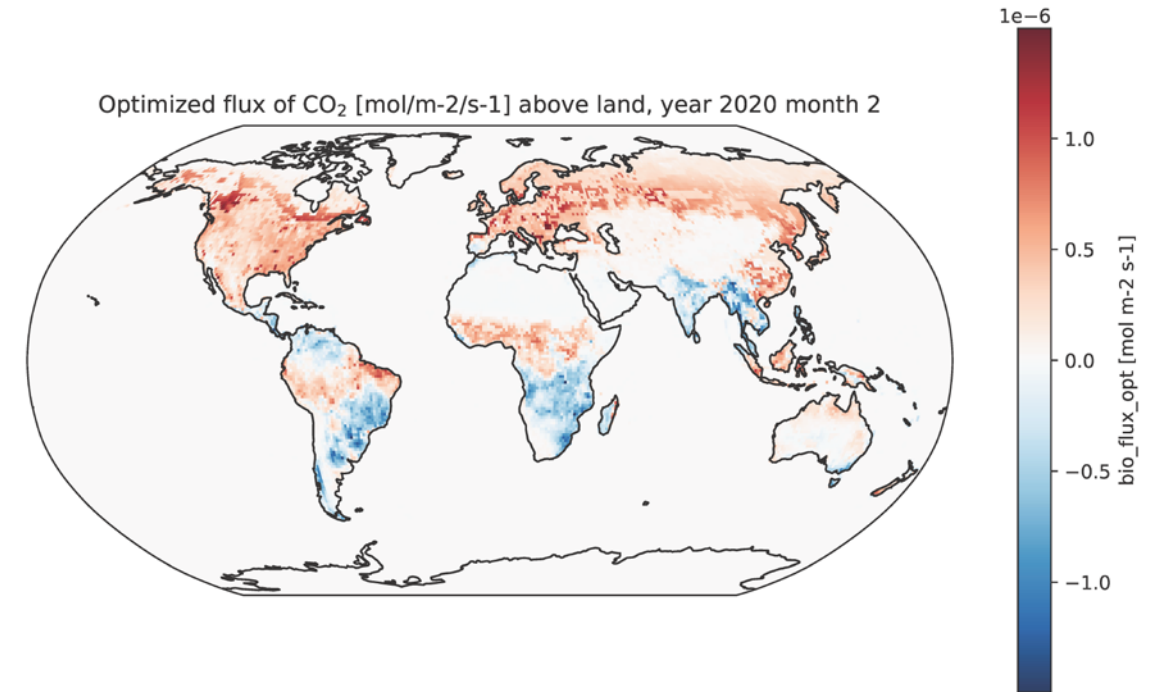


# Global Greenhouse Gas Watch (GGGW)

The following outputs will be generated by GGGW on a routine and sustained basis:

- Monthly CO<sub>2</sub> and CH<sub>4</sub> 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<sub>2</sub> and CH<sub>4</sub> 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<sub>2</sub>O abundances and net fluxes with resolution and latency still to be defined.

GGGW will be supported by several global modelling centers



GGGW does not produce user specific applications

# Connecting global scale and 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

Data created through pilot projects and **exchanged internationally** will contribute to the advances of global system



Can support creation of new local/national services which will contribute to business model for NMHS through the connection with non-traditional users

modelled global GHG concentration fields at 1x1° resolution, and modelled monthly surface fluxes at 1x1° resolution



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

# Important events in 2023

WMO International Greenhouse Gas Monitoring Symposium, January 30 - February 1, 2023: discussion of the GGGW concept

The IG<sup>3</sup>IS Stakeholder consultations and User Summit, 2-3 February 2023



**Scale up efforts MUST include both elements (operational global infrastructure AND IG<sup>3</sup>IS type of innovative services) as both are “WMO activities” for the external World**



Greg Tutton organizes the first non-state partners forum

«The Secretary General of the World Meteorological Organization (WMO) has the pleasure of inviting you to an «invitation only» event that will take place at the WMO Headquarters in Geneva, Switzerland, on 22 February 2023 from 11:30 to 14:30 CET.»



In 2023 NASA grant for \$987,185.00 was approved to further facilitate IG<sup>3</sup>IS implementation

# Cg-19 Resolution: call for the development of the implementation plan

- (1) Emphasis on WMO's unique role in **establishing best practices** for measurement, data, and reporting standards, validation and intercomparison of information products, and other best practices needed to support global greenhouse gas monitoring infrastructure and actionable information services;
- (2) Emphasis on the science for services element, e.g. **via use of the IG<sup>3</sup>IS framework** to support stakeholder and user engagement and capacity-building to enhance the information uptake related to the greenhouse gas monitoring decision and policy needs. In particular, **the plan should elaborate on how the Global Greenhouse Gas Watch and IG<sup>3</sup>IS initiatives can deliver relevant information to other UN bodies including UNFCCC, IPCC, and the United Nations Environment Programme (UNEP)**, including in support of the Paris Agreement Global Stocktake, as well as to other national and subnational government, academia and private sector entities, including avenues through which Members can supply best available data inputs for modelling and data assimilation capabilities used to generate the information;

# Cg-19 Resolution: call for the development of the implementation plan

- (3) Clear articulation of **WMO's role as a coordinator** of activities undertaken by Members and as a provider of technical standards and guidance, that built on its neutral position on national governments' climate change policies, including their efforts to estimate and reduce GHG emissions and on its role as a provider of avenues through which Members can supply relevant data inputs to these systems to reduce uncertainties in their results over time;
- (4) **Integration of the components** of the Global Greenhouse Gas Watch within appropriate WMO-coordinated systems, the WMO Integrated Global Observing System (WIGOS), the WMO Information System (WIS), and the WMO Integrated Processing and Prediction System (WIPPS);
- (5) **Acknowledgement** that all operational components of the Global Greenhouse Gas Watch will be managed by Members;

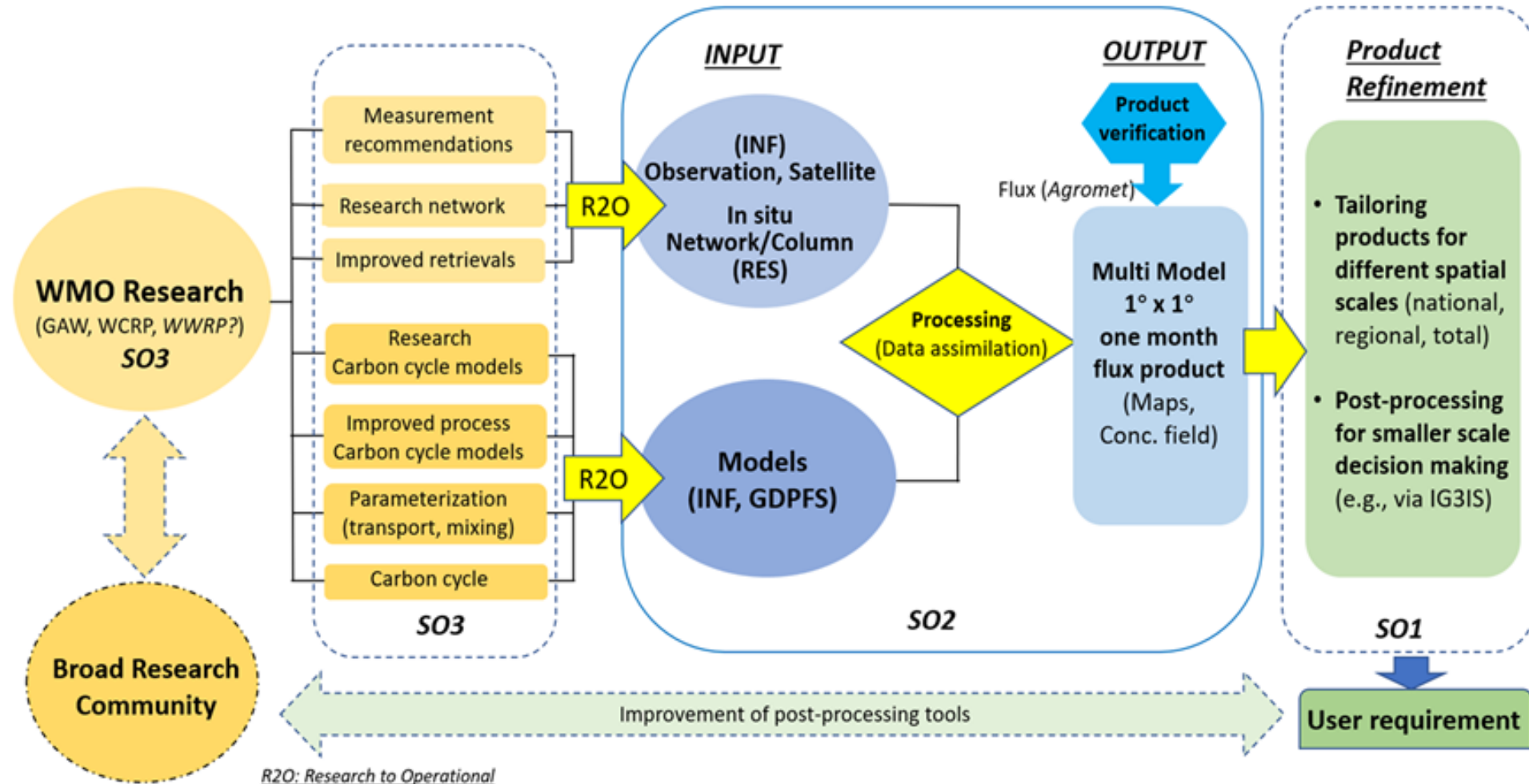


# Cg-19 Resolution: call for the development of the implementation plan

- (6) **Assurance** that the plan will support Members in bringing the coordinated Global Greenhouse Gas Watch into a normal operational status at the end of a defined implementation phase;
- (7) A detailed analysis of the **expected cost of implementation** of the various elements of the Global Greenhouse Gas Watch, distinguishing between costs to the WMO Secretariat, costs to Members, and an **estimate of expected extra-budgetary resources**, including sources;
- (8) An implementation timetable with proposed metrics of success and Key Performance Indicators (KPIs);
- Urges** Members to contribute to the ongoing development of the plan, through the work of INFCOM, SERCOM and the RB via the Joint Study Group and in consultation with their UNFCCC and Paris Agreement national focal point;

# WMO Internal

## INF (Sustained Capabilities)



# Thank you



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[wmo.int](http://wmo.int)