Committee on Earth Observation Satellites

GHG Roadmap Development

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WGClimate, AC-VC, WGCV

CEOS 2019 SIT Technical Workshop

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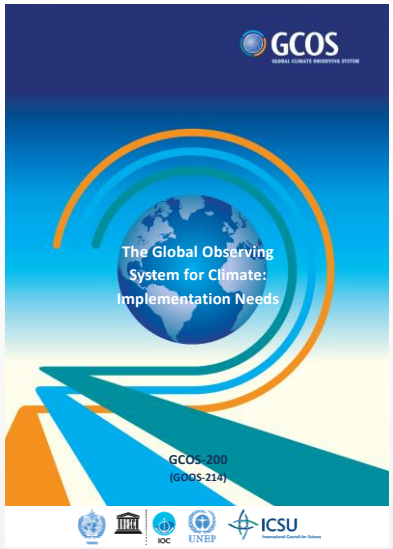
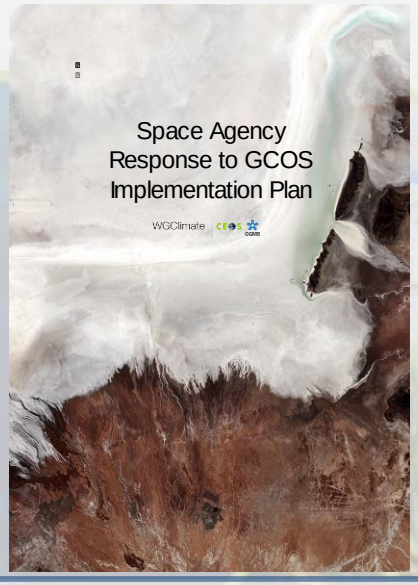
Background
Action T71 from GCOS IP 2016



Action T71:	Prepare for a carbon-monitoring system
Action	Preparatory work to develop a carbon monitoring system to be operational by 2035; Development development of comprehensive monitoring systems of measurements of atmospheric concentrations and of emission fluxes from anthropogenic area and point sources to include space-based monitoring, in situ flask and flux tower measurements and the necessary transport and assimilation models
Benefit	Improved estimates of national emissions and removals
Time frame	Initial demonstration results by 2023 – complete systems unlikely before 2030
Who	Space agencies
Performance indicator	Published results
Annual cost	US$ 10–100 billion



"Specifically CEOS and CGMS will undertake, over the next few years, dedicated preparatory work in a coordinated international context…:

- The definition of an architecture of space component elements to address the requirements of a CO_2 and GHG monitoring system , … This will provide a global holistic perspective both from the point of view of existing and planned space segment assets as well and that for an optimum global constellation.
- The documentation of best practices on the relationships between individual space agencies and their counterparts working on the modelling aspects, the inventories and in-situ data provision, …
- The further consolidation of partnerships and collaborations between the relevant international entities including: the relationship between CEOS and CGMS on the space component aspects, the partnership with the WMO and GEO on the broader framework, … and finally the relationships with GCOS itself, UNFCCC and IPCC TFI process in better defining the role for space-based observation in the inventory guideline process."

Mark Dowell, 6/2018

Foundation for an international CO_2 and GHG monitoring system (2017-2018#)

1. **Completion and follow-on activities of the Atmospheric Composition Virtual Constellation (AC-VC) whitepaper on defining an optimum constellation for CO_2 and GHG monitoring** (joint competences of CEOS and CGMS, CEOS Carbon strategy). [Include updated DOI & Reference]

Whitepaper completed (big thanks to David Crisp) & endorsed, provides baseline for addressing future international coordination and Implementation

2. **Advance the relationships with CGMS for an operationally implemented and sustained observation capability** (formal working relationship between CEOS and CGMS).

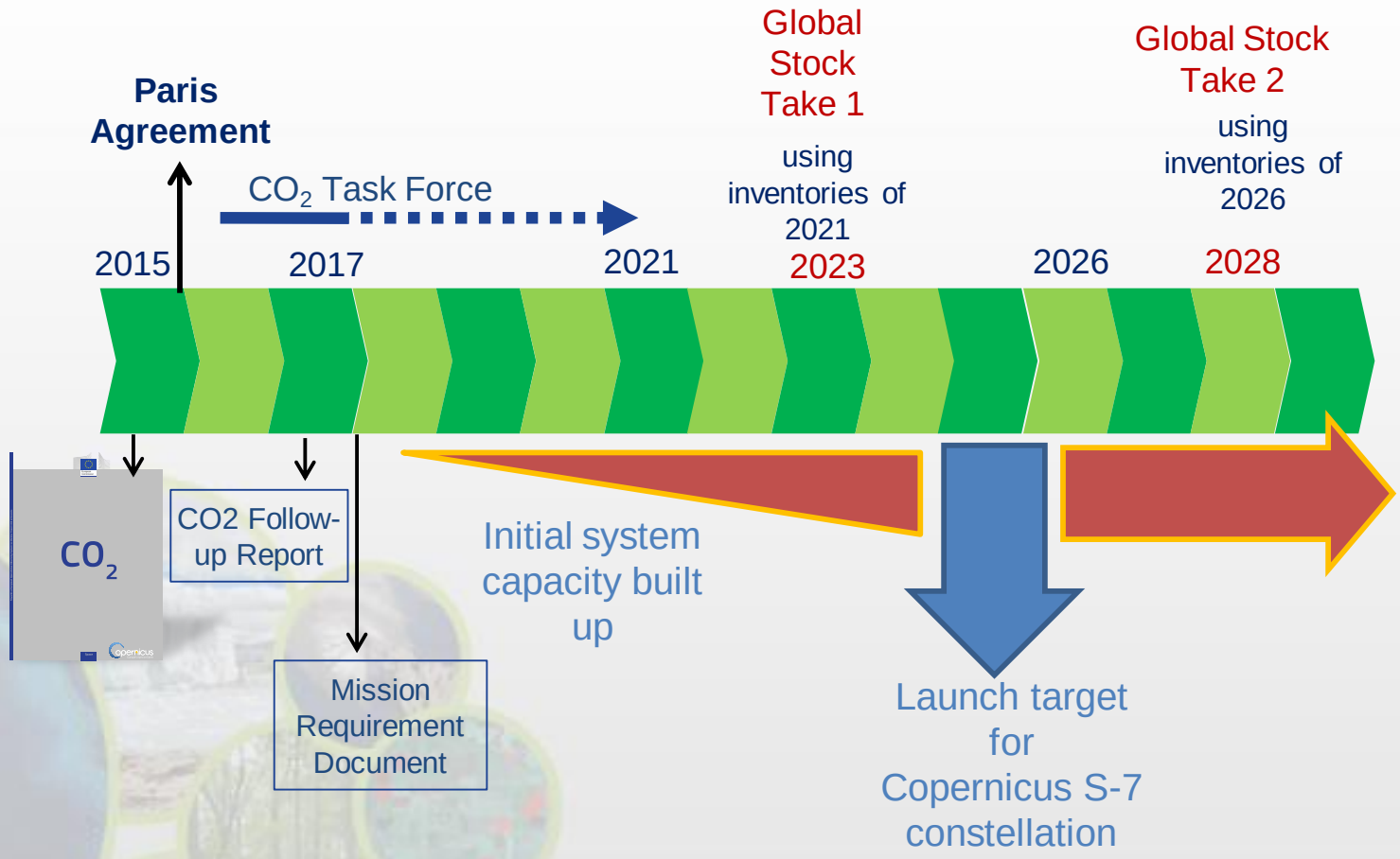
Coordination mechanism defined including both CEOS and CGMS entities, roadmap for implementation being define

3. **Place the space segment in the broader context of a fully sustained system for CO_2 monitoring** (CEOS Agencies have counterparts in their individual countries/regions).

Workshop organized bringing space agencies together with modelling, in-situ and inventory institutions. Priorities and best practices for future interactions identified .

#Under the chairmanship of the European Commission

Timely inputs to Policy context



CEOS GHG Whitepaper Actions

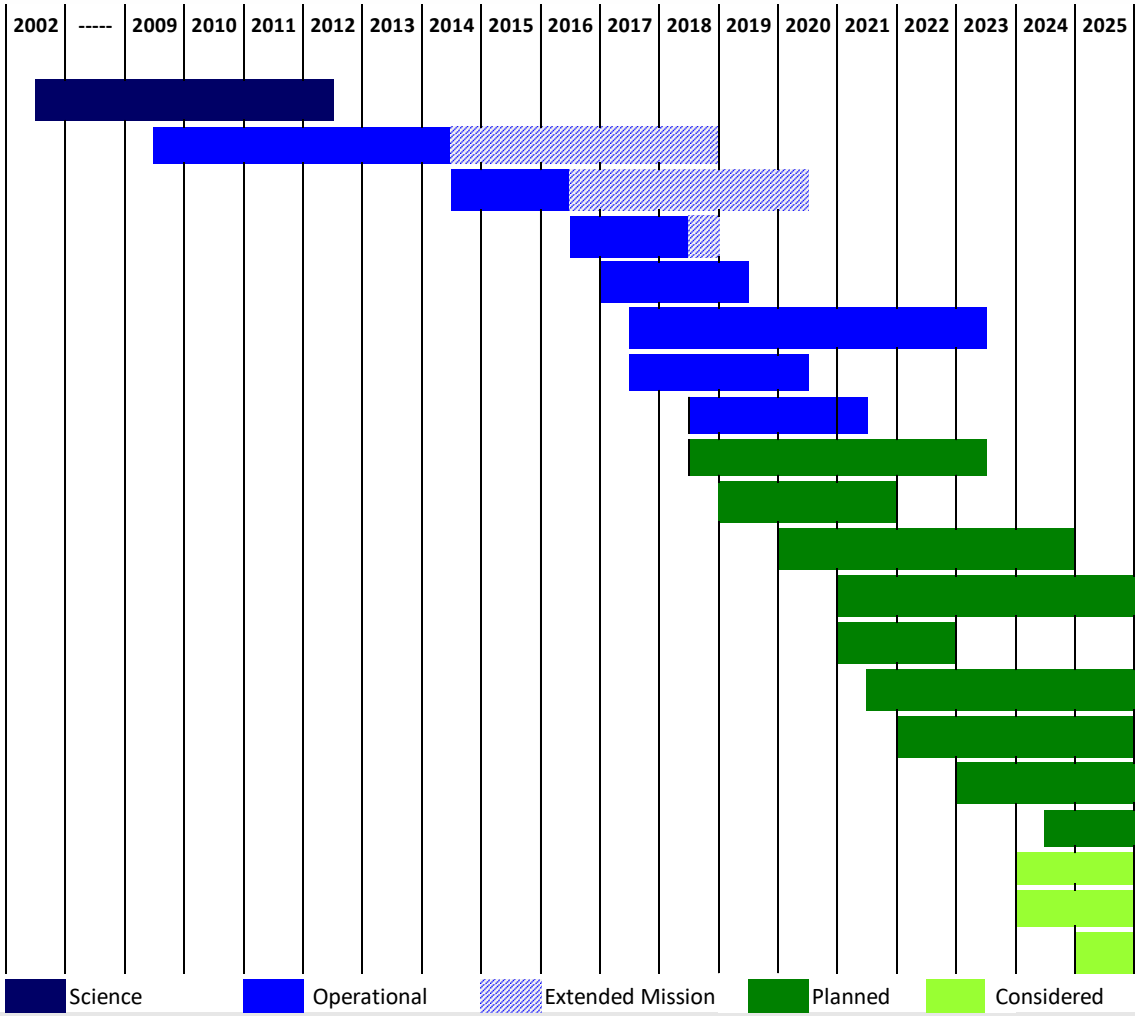
1. Link the atmospheric GHG measurement and modeling communities and stakeholders in the national inventory and policy communities (through UNFCCC/SBSTA), to refine requirements;

2. Exploit the capabilities of the CEOS and CGMS member agencies and the WMO Integrated Global Greenhouse Gas Information System (IG^3IS) to integrate surface and airborne measurements of CO_2 and CH_4 with those from available and planned space-based sensors to develop a prototype, global atmospheric CO_2 and CH_4 flux product in time to support inventory builders in their development of GHG emission inventories for the 2023 global stocktake; and

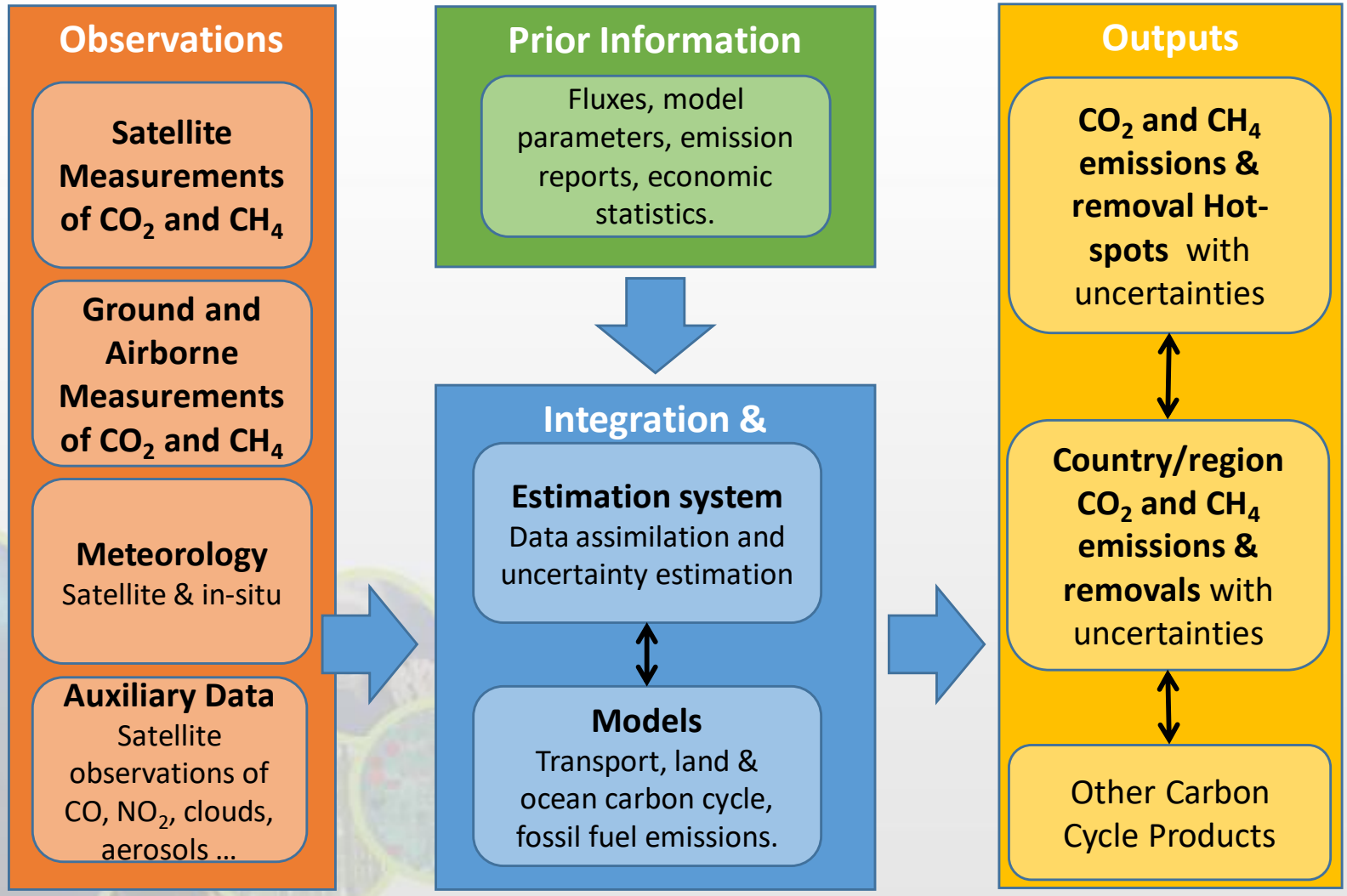
3. Use the lessons learned from this prototype product to facilitate the implementation of a complete, operational, space-based constellation architecture with the capabilities needed to quantify atmospheric CO_2 and CH_4 concentrations that can serve as a complementary system for estimating NDCs in time to support the 2028 global stocktake.

GHG Mission Timeline

Satellite, Instrument (Agencies)	CO_2	CH_4	Swath	Sample
ENVISAT SCIAMACHY (ESA)	●	●	960 km	30x60 km^2
GOSAT TANSO-FTS (JAXA-NIES-MOE)	●	●	3 pts	10.5 km (d)
OCO-2 (NASA)	●		10.6 km	1.3x2.3 km^2
GHGSat (Claire)		●	12 km	0.0004 km^2
TanSAT (CAS-MOST-CMA)	●		20 km	1x2 km^2
Sentinel 5P TROPOMI (ESA)		●	2600 km	7x7 km^2
Feng Yun 3D GAS (CMA)	●	●	7 pts	10 km (d)
GaoFen-5 GMI	●	●	5-9 pts	10 km (d)
GOSAT-2 TANSO-FTS (JAXA-MOE-NIES)	●	●	5 pts	10.5 km (d)
OCO-3 (NASA)	●		11 km	4 km^2
Bluefield Technologies		●	25x20 km	0.0004 km^2
MicroCarb (CNES)	●		13.5 km	40 km^2
MethaneSAT (EDF)		●	200 km	1 km^2
MetOp Sentinel-5 series (Copernicus)		●	2670 km	7x7 km^2
Feng Yun 3G (CMA)	●	●	100 km	< 3 km^2
GEOCARB (NASA)	●	●	2800 km	4x4 km^2
MERLIN (DLR-CNES)		●	100 m	0.14 km (w)
TanSat-2 Constellation	●	●	3x100 km	2x2 km^2
GOSAT-3 (JAXA-MOE-NIES)	●	●	TBD	TBD
CO2 Sentinel (Copernicus)	●	●	3x250 km	2x2 km^2

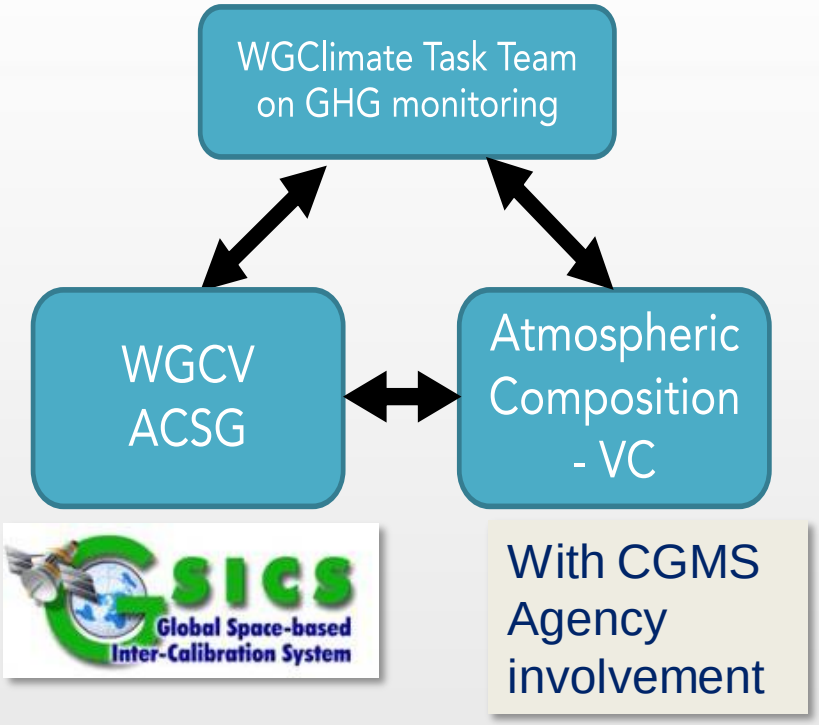


A System-Level Approach for Integrating Atmospheric Data



CEOS/CGMS GHG Roadmap

1. Coordination mechanism proposed and endorsed by CEOS and CGMS Plenaries
2. Contributions from multiple CEOS & CGMS entities (WGClimate GHG Task Team, AC-VC, WGCV/ACSG & GSICS)
3. Addressing Actions on two different time horizons i)Prototype products: 2021 for 2023 Global Stocktake and ii)Pre-operational: 2026 for 2028 Global Stocktake
4. Roadmap meeting in Tokyo (09/06) draft roadmap by CEOS SIT TW in September 2019 present to CEOS 33rd Plenary (October 2019), and send to CGMS, for written endorsement



CEOS/CGMS GHG Roadmap

Tokyo Working Meeting (9th June)

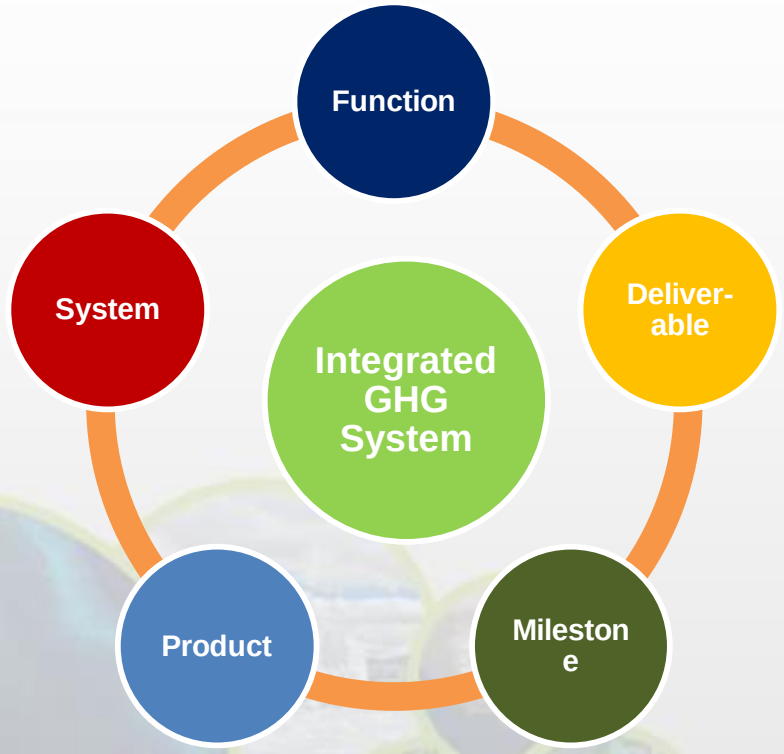
1. **Reviewed proposed objectives for way forward identified in Whitepaper, and known "boundary conditions", in formulating Roadmap**
2. **Discussed approach for implementation of roadmap: iterative versioned approach – with defined iteration cycle**
3. **Reviewed sequences of necessary timeline elements (2019-2023…2026…) with activities from different CEOS and CGMS entities**
   - **Key sub-iterations of prototype products to critical friends/beta-testers from Inventory Community in 2019-2021 period**
4. **Discussed additional resources needed to accomplish work (agency staff, scientific experts, workshops, research needs) to formulate request to CEOS & CGMS Principals**

CEOS/CGMS GHG Roadmap

Report Outline

The roadmap document will be complemented by a representation of the roadmap in a project planning tool that is maintained by the WGClimate Task Team. This allows a close follow up of achievements and emerging risks during implementation.

Iterative Versioned Approach



- Deliverables (CO_2 & CH_4 fluxes)
- Functions (integrated system)
- Products (prototype, operational)
- Milestones (2023, 2028)
- ? Timeline

- Driver: Version delivery requirements
- ⇔ associated delivery schedule and capability
- Each version includes an architecture, potential contributors, main open points/challenges with potential impact on system, decision logic for version clarification, apportionment of requirements to components, and a schedule
- The approach can be applied to „each step“, but also to each „role“

Main Roadmap Actions

- [To Be Added]

Expected Outcomes & Impact

- Space agencies have a «window of opportunity» to make a substantive impact on the implementation of the Paris Agreement through the Global Stocktakes and Enhanced Transparency Framework
- The timeline is very ambitious and demanding – but feasible.
- The ouput of our joint efforts would support the international community in verifying and iteratively improving their emission estimates whilst providing multi-scale perspective to address mitigation option at regional, national and continental scales
- Numerous agencies are developing missions & programmes, but there is systematic recognition that international coordination is a fundamental requirement
- The CEOS/CGMS GHG Constellation Architecture provides the baseline for the development and implementation or activities

[Placeholder] From Whitepaper Conclusion

"… the needs are clear, the architecture implementation, though challenging, is within the means of agencies and the coordination mechanisms. We have a clear understanding of how we fit into the broader system and with which external stakeholders we need to engage. As summarized here, we also understand short-to-mid-term priorities that should be addressed to advance implementation, most importantly we have the necessary competences within CEOS and CGMS, and their technical working groups and other entities as well as their respective agencies, to address these priorities. So, with the appropriate decisions and direction from space agency Principals, we can and should strive to build the necessary constellation and associated system interfaces over the next decade. "

Interface to and Feedback from External Communities

This will be a fundamental aspect of the success for this endeavour:

- Engagement with the emission inventory community, critical in iterative feedback approach, both:
  - Through existing international coordination mechanisms (e.g. GEIA - https://www.geiacenter.org)
  - Through working with champion users – «beta testers»
- Continued engagement with international policy frameworks, i.e. UNFCCC/SBSTA, IPCC TFI
- Engagement with technical implementing entities at international level i.e. WMO IG3IS and Joint Programmes supporting the Convention i.e. GCOS, as well as the broader modelling community

Resource Implications (1/2)

Three broad categories of resources are envisaged and requested for consideration by Agencies:

1. **Staff resources** from CEOS members and external experts supported through Agency programmes & grants
2. **Support for travel and hosting of workshops**, networking activities with inventory community (including inviting inventory experts to some CEOS meetings)
3. [On longer-term] Through internal funding mechanisms **support research, development and infrastructure** for priorities identified by GHG Task Team and Roadmap Implementation (*annual updates will be provided to Agencies*)

Resource Implications (2/2)

On Staff resources specifically, the following guidance is provided:

1. Agencies are ask to continue/increase support to the GHG relevant staff (time & travel) contributing to the technical implementation tasks in AC-VC and WGCV
2. For the new GHG Task Team in WGClimate, the following specific "profiles" are required:
   - Core team ensuring linkages to internal CEOS/CGMS entities (i.e. WGClimate – Dowell/Von Bargen, AC-VC – Crisp, WGCV – Kuze)
   - Agency staff representing GHG missions/programmes
   - Agency Staff/Experts with links to Inventory Community
   - Agency Staff/Experts involved in modelling aspects
3. We would envisage that the GHG Task Team would be a group of ~12 members, typically dedicating 1PM/yr of effort each with those leading specific activities dedicating closer to 2PM/yr. Support should include necessary travel budgets for attending meetings/workshops.

Live Roadmap Text Under Development

- Online draft text of Roadmap Document

https://docs.google.com/document/d/179Uv57tc_0NsNKot4jTCo3xYu4qtKF4OaTtHvc8ftwc/edit?usp=sharing

- Timeline elements

https://drive.google.com/file/d/15KEnyD6WZlr-lZJJ0FlOn1tahjvlx1-1/view?usp=sharing


Thank you