Space-based observation for supporting NDCs, national inventories and the global stocktake

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Addressing Observational Needs of UNFCCC

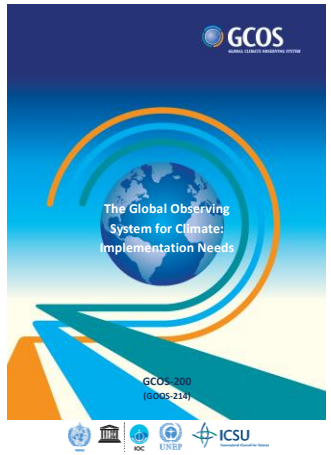
United Nations Climate Change

COP-21 Paris Agreement: Adaptation (Article 7(c)):
Strengthening scientific knowledge on climate, including research, **systematic observation of the climate system** and early warning systems, in a manner that informs climate services and supports decision-making.

Reports on Progress @ SBSTA/COP

Needs and Requirements

Coordinated Response



GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

WGClimate
The Joint CEOS/CGMS Working Group on Climate

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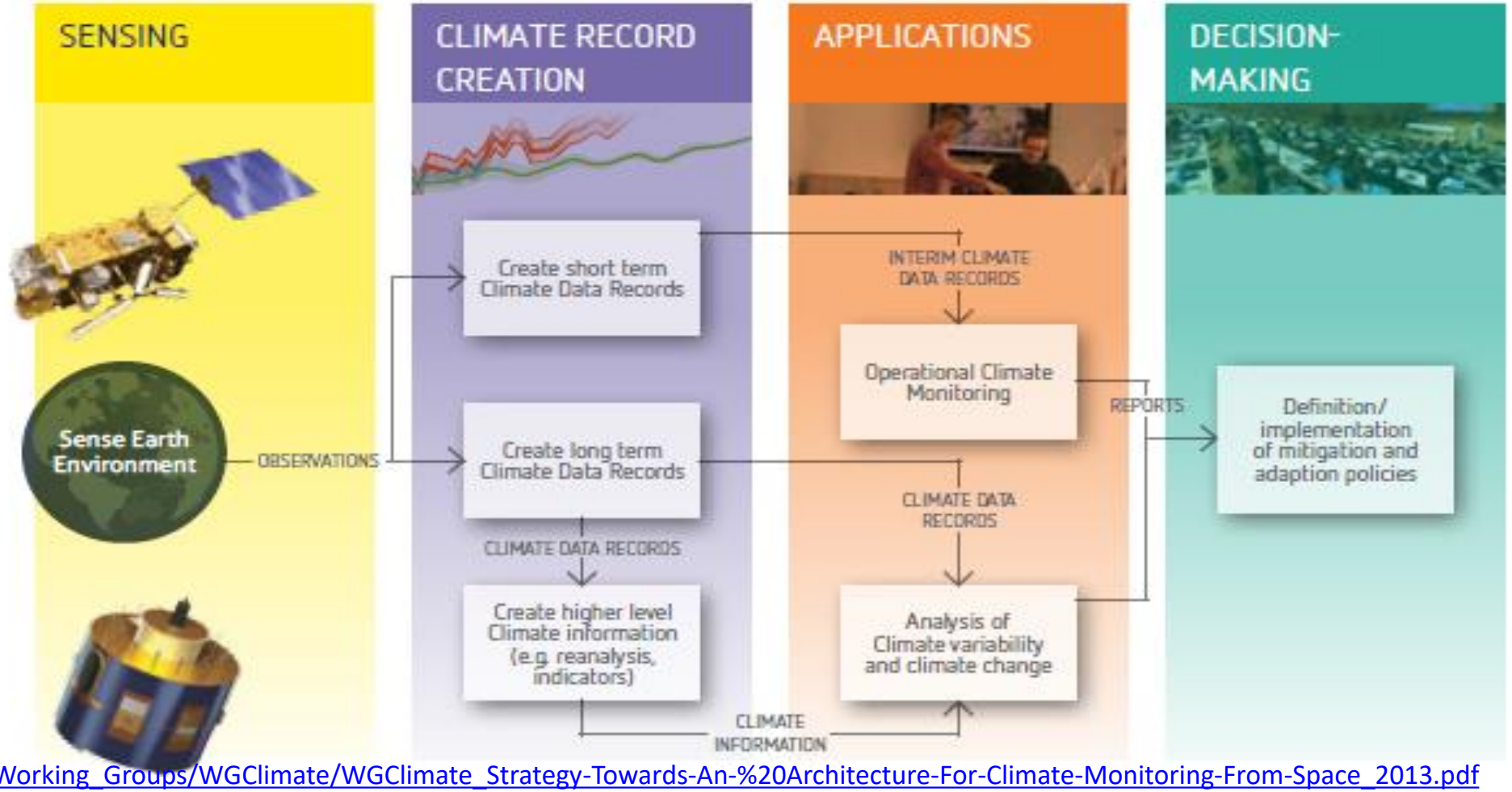
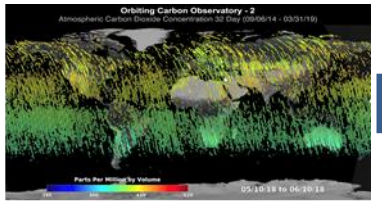
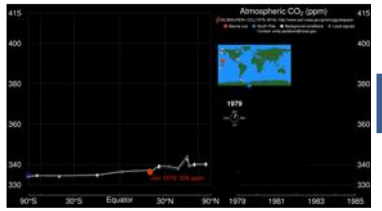
The Architecture for Climate Monitoring from Space

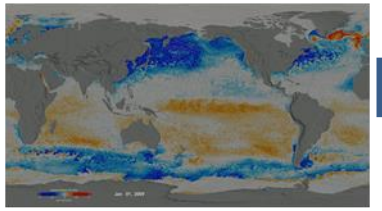


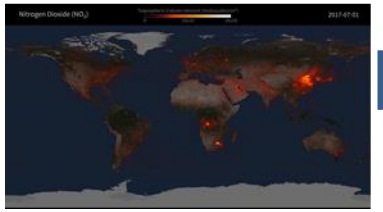
http://ceos.org/document_management/Working_Groups/WGClimate/WGClimate_Strategy-Towards-An-%20Architecture-For-Climate-Monitoring-From-Space_2013.pdf

A System Approach is Adopted to Deliver Atmospheric CO_2 and CH_4 Inventories









Observations

- **Satellite Measurements of CO_2 and CH_4**
- **Ground and Airborne Measurements of CO_2 and CH_4**
- **Meteorology** Satellite & in-situ
- **Auxiliary Data** Satellite observations of CO, NO_2, clouds, aerosols …

Prior Information

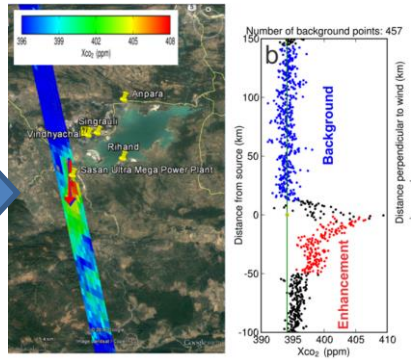
Fluxes, model parameters, emission reports, economic statistics.

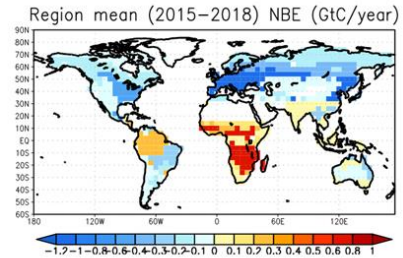
Integration & Attribution

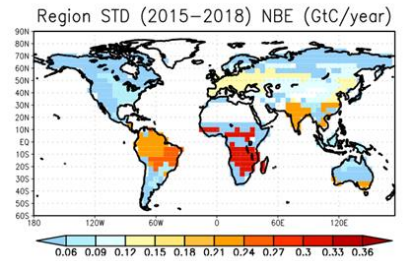
- **Estimation system** Data assimilation and uncertainty estimation
- **Models** Transport, land & ocean carbon cycle, fossil fuel emissions.

Outputs

- **CO_2 and CH_4 emissions & removals from Hot-spots** with uncertainties
- **Country/region CO_2 and CH_4 emissions & removals** with uncertainties
- Other Carbon Cycle Products







Interface to and Feedback from External Communities

Engagement with external stakeholders and end users is fundamental to the success of the implementation of the system approach:

- Engagement with the emission inventory community is critical to the iterative feedback approach, both:
  - Through existing international coordination mechanisms (e.g. Global Emissions InitiAtive - 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 IG^{3}IS and Joint Programmes supporting the Convention, i.e., GCOS, as well as the broader modelling community

Timeline

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

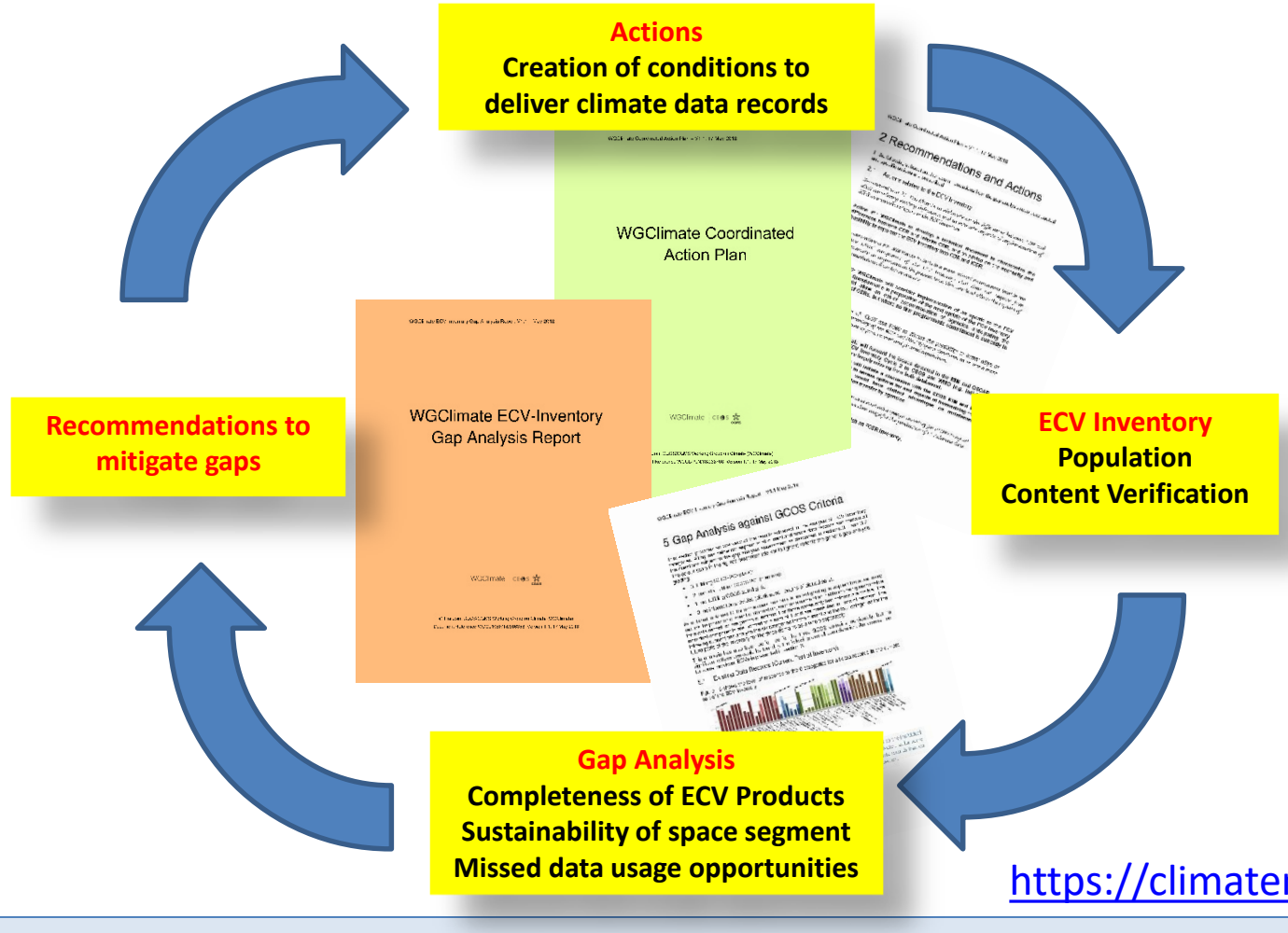
2015 — **2017** — **2019** — **2021** — **2023** — **2026** — **2028**

Global Stock Take 1 using inventories through 2021

Global Stock Take 2 using inventories through 2026

- **2017**: CEOS-CGMS GHG Whitepaper
- **2019**: Prototype Inventory requirements
- **2021**: Prototype atmospheric CO_2/CH_4 inventory
- **2023**: Refined atmospheric GHG requirements
- **2026**: Initial Operational GHG Constellation Deployment
- **2028**: Refined atmospheric GHG inventory

Sustaining Space Capabilities for Climate



- The ECV Inventory fully describes current and planned implementation arrangements for ECVs
- **Data access is globally free and open without any constraint for more than 98% of the data records in the Inventory**
- **Everybody with an internet connection can download the ECV Inventory content for their own analysis**, find direct access points to climate data records in the Inventory, and get access to WG Climate gap analysis results and resulting actions
- The 2019 Inventory **fills previously identified gaps for the ECVs including** lightning, sea-surface salinity, **above ground biomass, and permafrost, the latter two having significance for the study and analysis of the Earth's carbon cycle**.

https://climatemonitoring.info/ecvinventory/

Key Messages

- Use of space-based observations with undoubted quality in global stocktakes, can play a supporting role by providing evidence for the success of the implementation of the Paris Agreement
- The Constellation Architecture for Monitoring Carbon Dioxide and Methane from Space supports the Paris Agreement, including development of national inventories. CEOS and CGMS encourage Parties and relevant organizations to continue to support and develop the constellation architecture
- The GHG constellation architecture follows a system approach bringing together top-down and bottom-up emission estimates for carbon dioxide and methane. Space-agencies and service providers will grant full, free and open access to the top-down data and derived information, which is available for use by all Parties
- Space agencies provide long-term observations for 35 out of 54 GCOS Essential Climate Variables (ECV) (37 being accessible by satellite). Data access is globally full, free and open for more than 98% of the data records
- The 2019 version of the web-based Inventory of climate data records of GCOS ECV observables from space fills previously identified gaps for the ECVs including lightning, sea-surface salinity, aboveground biomass, and permafrost, the latter two having significance for the study and analysis of the Earth's carbon cycle

SPARES

The Architecture Exploits the Evolving Fleet of CO_2 and CH_4 Satellites

- **Space agencies have supported several pioneering space-based GHG sensors**
  - SCIAMACHY on ESA's ENVISAT
  - Japan's GOSAT TANSO-FTS, NASA's OCO-2, China's TanSat AGCS, Feng Yun-3D GAS and Gaofen-5 GMI, Copernicus Sentinel 5 Precursor TROPOMI, Japan's GOSAT-2 TANSO-FTS-2 and NASA's ISS OCO-3
- **Others are under development**
  - CNES MicroCarb, CNES/DLR MERLIN, NASA's GeoCarb
- **Others are in the Planning stages**
  - Japan's GOSAT Follow-on, Copernicus CO2M

A Candidate Operational CO_2/CH_4 Constellation Architecture

The coverage, resolution, and repeat frequency requirements could be achieved with a constellation that incorporates:

- A constellation of 3 (or more) satellites in LEO with
  - Broad (> 250 km) swaths with a footprint size < 4 km^2
  - Single sounding random error < 0.5 ppm
  - Vanishing small regional scale bias (< 0.1 ppm)
  - Ancillary sensors to identify plumes (CO, satellites NO_2)
- A constellation with 3 (or more) GEO satellites
  - Stationed over Europe/Africa, Americas, and East Asia
  - Diurnally varying processes (e.g. rush hours, photosynthetic uptake)
- Possible augmentations include:
  - Active (lidar) satellites in LEO for night-time/polar night coverage
  - Satellites in HEO for improved high latitude coverage and repeat frequency