How space-based observations can support NDCs, national inventories and the global stocktake

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Joint CEOS / CGMS Working Group on Climate

Addressing Observational Needs of UNFCCC

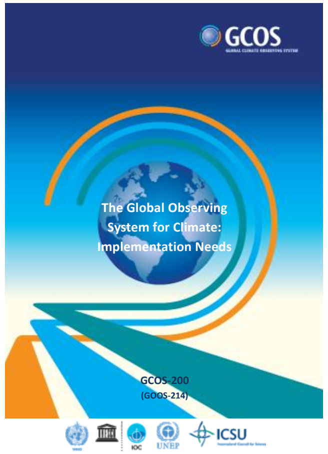
United Nations
Climate Change

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



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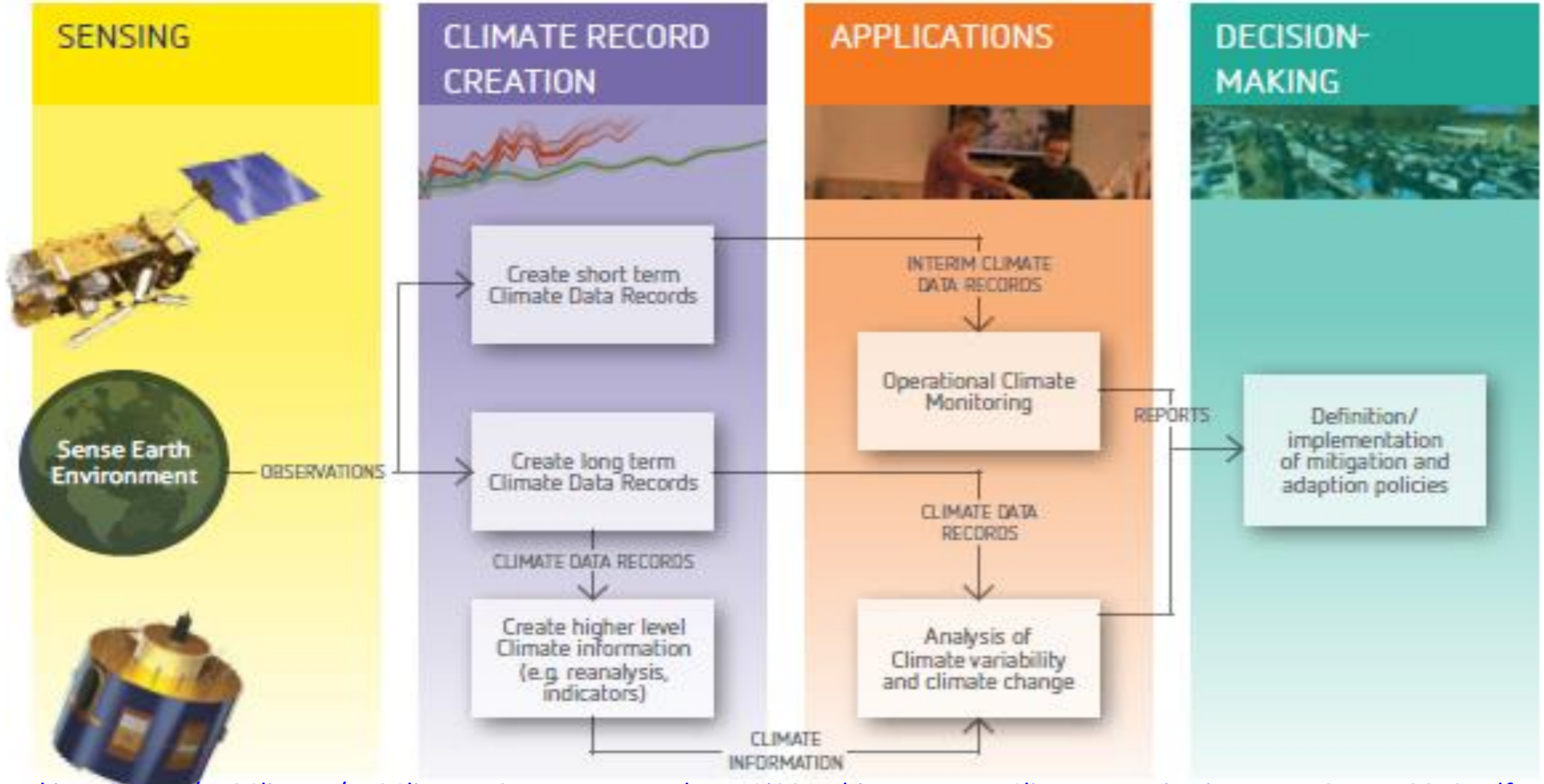
The Architecture for Climate Monitoring from Space



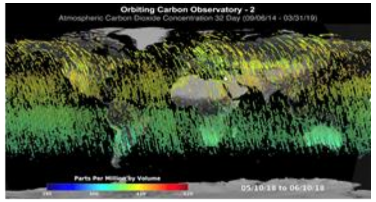
http://ceos.org/document_management/Working_Groups/WGClimate/WGClimate_Strategy-Towards-An-%20Architecture-For-Climate-Monitoring-From-Space_2013.pdf

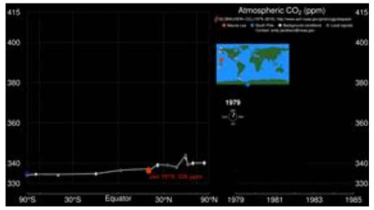
Specific Tailored Information

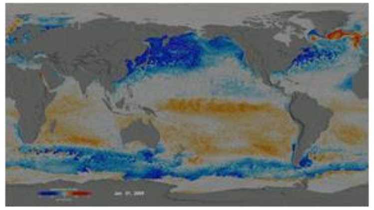
- ***Global Stocktake***
  - Systems approach to deliver Greenhouse Gas inventories (for details see posters: Crisp et al.)
  - CEOS Pilot space-based products on Agriculture, Forestry, and Other Land Use (see poster: Seifert and Ochiai)
- ***Space capabilities for climate***
  - Sustained ECV Inventory approach for Climate Data Records (see poster: Privette et al.)
  - Use cases for application of Climate Data Records (see poster: Su et al.)

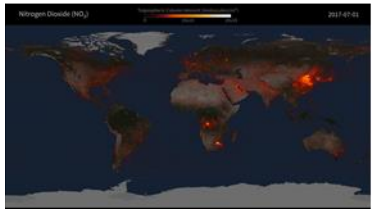
A Systems Approach to Deliver Atmospheric CO_2 and CH_4 Inventories

Committee on Earth Observation Satellites









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

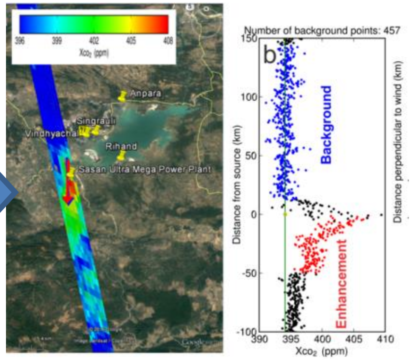
Models
Transport, land & ocean carbon cycle, fossil fuel emissions.

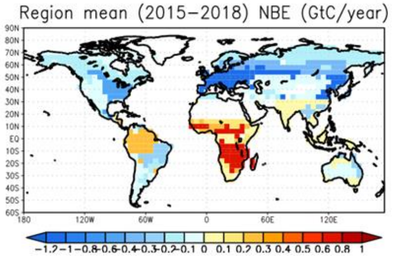
Outputs

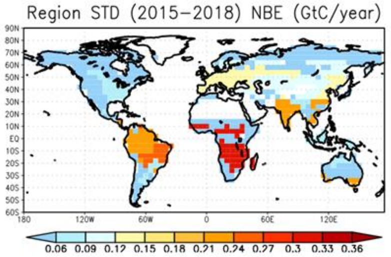
CO_2 and CH_4 emissions & removals from Hot-spots with uncertainties

Country/region CO_2 and CH_4 emissions & removals with uncertainties

Other Carbon Cycle Products







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Supporting the Global Stocktakes

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Global Stock Take 1 using inventories through 2021

Global Stock Take 2 using inventories through 2026

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

- CEOS-CGMS GHG Whitepaper
- Pilot Inventory requirements
- Pilot atmospheric CO_2/CH_4 inventory
- Refined atmospheric GHG requirements
- Initial Operational GHG Constellation Deployment
- Refined atmospheric GHG inventory

Interface to and Feedback from External Communities

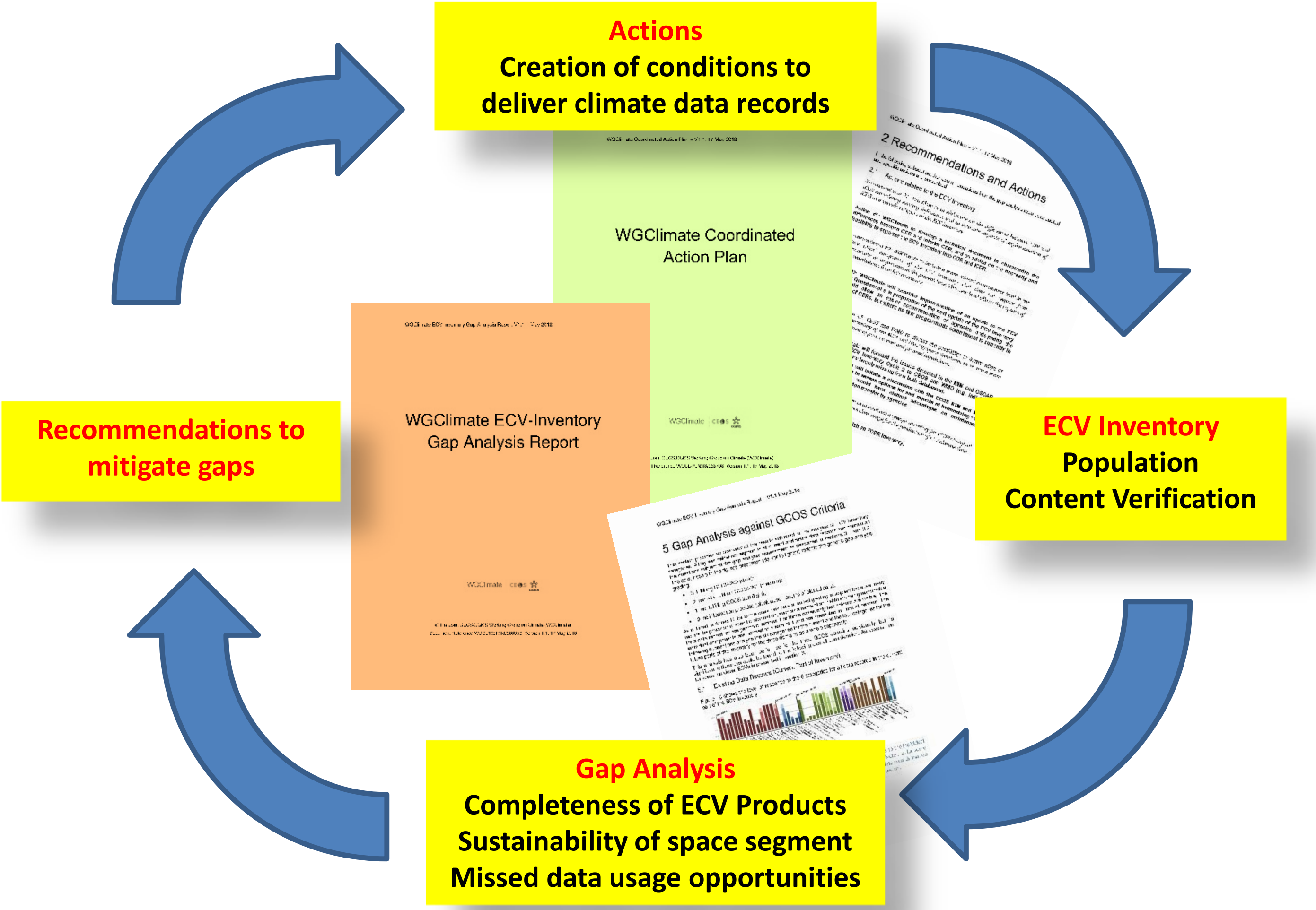
Engagement with external stakeholders and end users is fundamental to the success of the systems approach:

- Engagement with the emission inventory community is critical to the iterative feedback approach
  - 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 TF I
- Engagement with technical 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

CEOS Committee on Earth Observation Satellites

Sustaining Space Capabilities for Climate

CGMS



- The ECV Inventory fully describes current and planned provision of ECVs
- WG Climate gap analysis used to address actions
- Data access is free and open for more than 98% of the data records
- Basis for GCOS Status Report contribution
- The 2021 Inventory fills previously identified gaps for the ECVs including lightning, sea-surface salinity, above ground biomass, and permafrost (latter two support Global Stocktake)
- Analysis of Global Stocktake CDR-related needs may extend the variable set beyond current GCOS-listed ECVs (examples: mangroves, agriculture, a.o.)
- Feedback to GCOS, hence to UNFCCC

https://climatemonitoring.info/ecvinventory/

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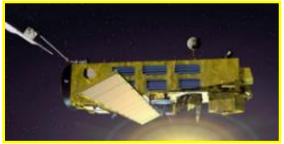
Take Away Messages

- Use of space-based observations of documented quality can support Global Stocktakes by providing evidence for the success of the implementation of the Paris Agreement
- The GHG constellation architecture follows a systems approach, bringing together top-down and bottom-up emission estimates for carbon dioxide and methane. Space agencies and service providers will grant free and open web-based access to the top-down data and derived information for use by Parties in support of the development of their national inventories.
- Space agencies provide long-term observations for 35 of the 37 GCOS ECVs accessible by satellite, including Carbon Cycle ECVs such as GHGs, aboveground biomass, and permafrost. Data access is globally free and open for more than 98% of the data records.
- Analysis-related Global Stocktake will lead to an extension of the ECV inventory portfolio beyond the current GCOS ECV list as supportable by available space-borne observation capabilities

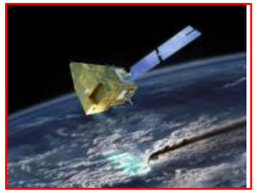
SPARES

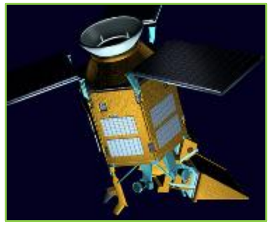
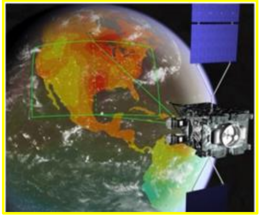
The Space Architecture Exploits the Evolving Fleet of CO_2 and CH_4 Satellites

- **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