
# How GCOS will contribute to the Global Stocktake and the GCOS Implementation Plan

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GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

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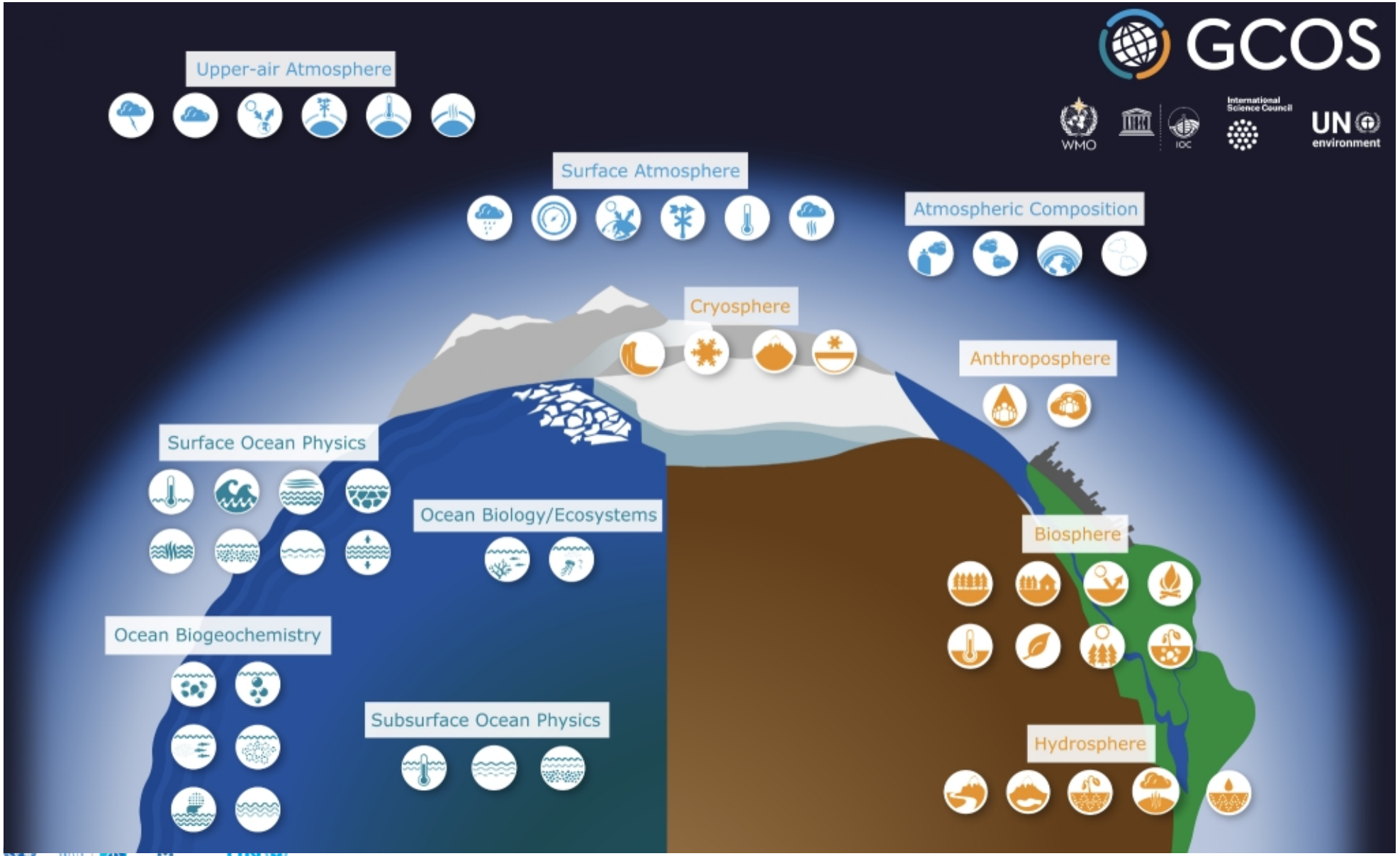
Supported by the European Union
Copernicus Europe's eyes on Earth

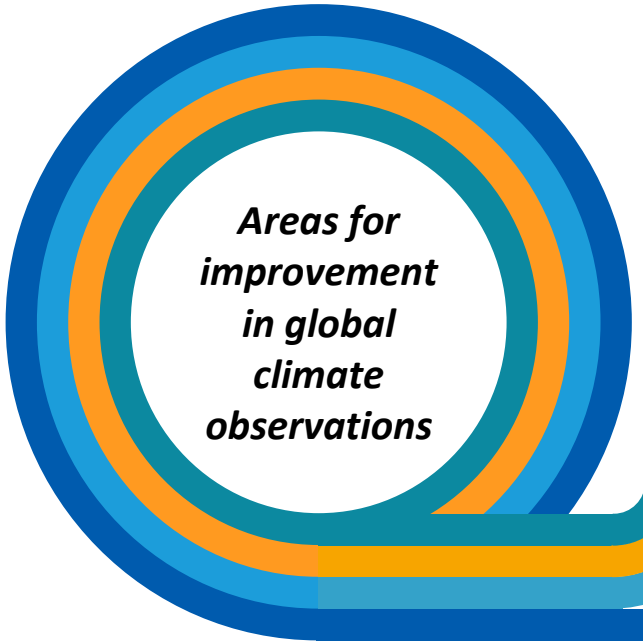
- Every 5 years, Implementation Plans are prepared to address gaps and improvements in the observing system. This will be the fourth such plan and submitted to the UNFCCC before COP27

- It provides guidance to the component observing systems that contribute to global climate monitoring e.g. WMO, GOOS, WGClimate, Global Terrestrial Networks …

# GCOS ECVs “monitor” the Earth’s water, energy and carbon cycle



# Themes for action identified in the GCOS IP




Sustainability

Gaps

Data Stewardship, Archiving and Access

New needs and requirements

A. Ensuring Sustainability

B. Filling Data Gaps

C. Improving Data Utility

D. Managing Data

E. Engaging with countries

F. Emerging Needs

Recommended Actions

GCOS Status Report

GCOS IP

# IP Actions with relevance for Space Agencies

**Theme A: Ensuring Sustainability**

Action A2: Address gaps in satellite observations likely to occur in the near future

Action A3: Prepare follow-on plans for critical satellite missions

Action B1: Development of reference networks (in situ and satellite Fiducial Reference Measurement (FRM) programs)

Action B3: New Earth observing satellite missions to fill gaps in the observing systems

Action B5: Implementing global hydrological networks

Action B6: Expand and build a fully integrated global ocean observing system

Action B7: Augmenting ship-based hydrography and fixed-point observations with biological and biogeochemical parameters

Action B9: Improve estimates of latent and sensible heat fluxes and wind stress

Action B10: Identify gaps in the climate observing system to monitor the global energy, water and carbon cycles

**Theme B: Filling Data Gaps**

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# IP Actions with relevance for Space Agencies

**Theme C: Improving Data Utiliy**

Action C1: Develop monitoring standards, guidance and best practices for each ECV

Action C2: General Improvements to Satellite Data Processing Methods

Action C5: ECV-specific Satellite Data Processing Method Improvements

**Theme D: Magaging Data**

Action D4: Create a database of co-located in situ cal/val observations and satellite data for quality assurance of satellite products

**Theme F: Emerging needs**

Action F1: Responding to user needs for higher resolution, near real time data

Action F2: Improved ECV satellite observations in polar regions

Action F3: Improve monitoring of coastal and Exclusive Economic Zones

Action F5: Develop an Integrated Operational Global GHG Monitoring System

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# Actio F5: Develop an operational global greenhouse gas monitoring system

- 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.

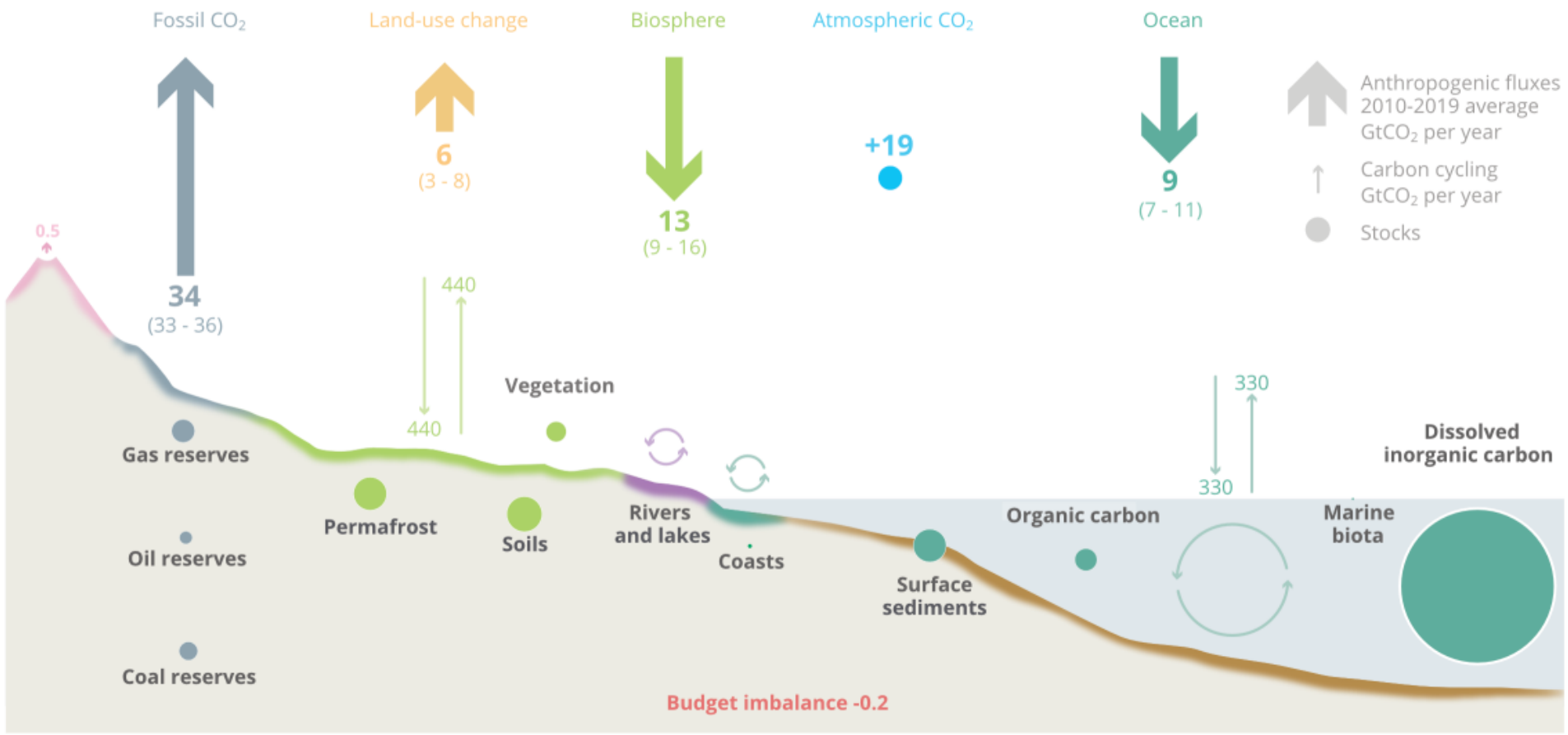
- Design a constellation of operational satellites to provide near-real time global coverage of CO2 and CH4 column observations (and profiles to the extent possible).

- Identify a set of global modelling centres that could assimilate surface and satellite-based observations to generate flux estimates.

- 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.

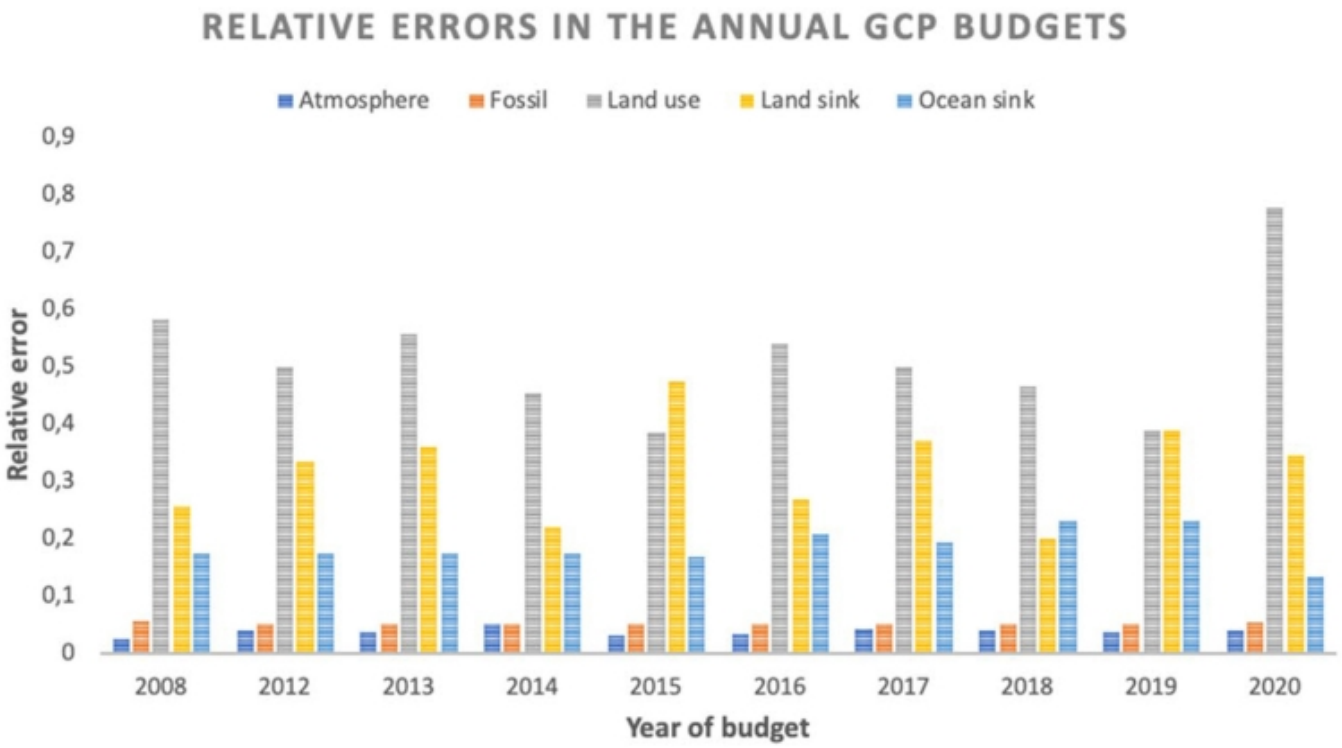
# The Carbon Cycle, Anthropogenic Perturbations on a Natural Cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2010–2019 ($GtCO_2$/yr)




GCB, Friedlingstein et. al., 2020

# GCOS Carbon cycle error assessment

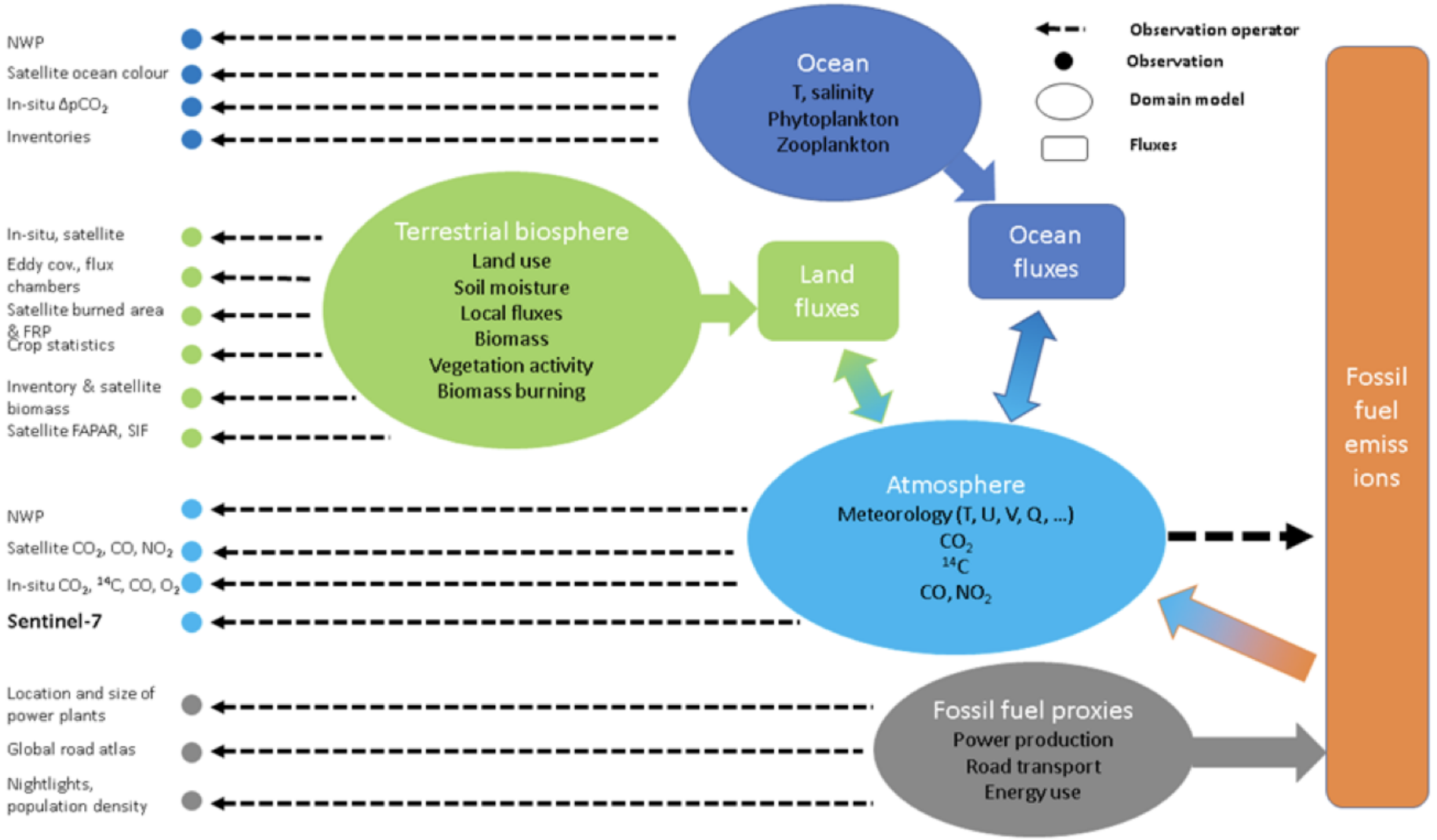


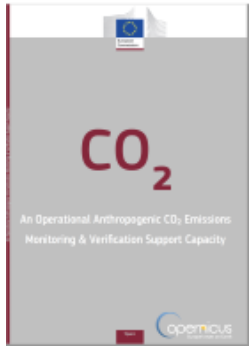

Crisp et al., 2022 Rev. Geophys. 2022

https://gcos.wmo.int/en/gcos-status-report-2021

- The discrepancy in observations of the carbon cycle between sources and sinks, reflects the overall uncertainty of observations and is 0.4 Gton C yr-1, or 3% of the global emissions.
- This uncertainty is caused by uncertainty in both the *land sink and land use change*. This hampers our ability to detect interannual changes and reduction impact
- **One cannot observe the anthropogenic cycle without knowing the natural cycle.**

# An assimilation system requires many inputs…



# Proposed $CO_2$ mole fraction and column average requirement IP2022

### 3.1.2 ECV Product

| Name | $CO_2$ mole f |
|---|---|
| Definition | 3D field of a constituent |
| Unit | ppm |
| Note | |
| | |
| **Item needed** | **Unit** |
| Horizontal Resolution | km |
| Vertical Resolution | km |
| Temporal Resolution | hr |
| Timeliness | day |
| Required Measurement Uncertainty (2-sigma) | ppm |
| Stability | ppm/decad |
| Standards and References | GAW Repor Measureme Organizatio https://libra |

### 3.1.3 ECV Product: $CO_2$ column average dry air mixing ratio

| Name | $CO_2$ column average dry air mixing ratio | | | | |
|---|---|---|---|---|---|
| Definition | 2D column integrated number of molecules of the target gas (CO2) divided by that of dry air expressed in mole fraction | | | | |
| Unit | µmol/mol. | | | | |
| Note | | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation, References and Standards** |
| Horizontal Resolution | km | | G | 1 | imaging |
| | | | B | 5 | ~OCO-2/3 |
| | | | T | 10 | $CO_2$M, CEOS document - LEO, GEO |
| Vertical Resolution | N/A | | G | | |
| | | | B | | |
| | | | T | | |
| Temporal Resolution | hr | | G | 1 | geostationary |
| | | | B | 12 | Blue report |
| | | | T | 72 | $CO_2$M |
| Timeliness | day | | G | 1 | |
| | | | B | 7 | |
| | | | T | 14 | |
| Required Measurement Uncertainty (2-sigma) | ppm | | G | 0.6 | 1-sigma: 0.3ppm<br>TCCON / Green report |
| | | | B | 1 | 1-sigma: 0.5ppm<br>Expert judgment based on improving $CO_2$M requirements |
| | | | T | 1.6 | 1-sigma: 0.8ppm<br>$CO_2$M requirements, WMO Report #242 |
| Stability | ppm/decade | | G | 0.1 | Within accuracy / 5 |
| | | | B | 0.2 | Within accuracy / 5 |
| | | | T | 0.3 | Within accuracy / 5 |
| Standards and References | • Blue Report, 2015: Towards a European Operational Observing System to Monitor Fossil $CO_2$ emissions https://www.copernicus.eu/sites/default/files/2019-09/CO2_Blue_report_2015.pdf<br>• Red Report, 2017: Baseline Requirements, Model Components and Functional Architecture https://www.copernicus.eu/sites/default/files/2019-09/CO2_Red_Report_2017.pdf<br>• Green Report, 2019: Needs and High Level Requirements for in situ Measurements https://www.copernicus.eu/sites/default/files/2019-09/CO2_Green_Report_2019.pdf<br>• $CO_2$M https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_High_Priority_Candidates | | | | |

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# Ocean Carbon and $CO_2$

| Name | Total alkalinity (TA) | | | | |
|---|---|---|---|---|---|
| Definition | total concentration of alkaline substances | | | | |
| Unit | µmol $kg^{-1}$ | | | | |
| Note | | | | | |
| | | | | Requirements | |
| Item needed | Unit | Metric | [1] | Value | |
| Horizontal Resolution | km | | G | 1000 Coastal: 100 | |
| | | | B | | |
| | | | T | 2000 Coastal: 1000 | |
| Vertical Resolution | | | G | | |
| | | | B | | |
| | | | T | | |
| Temporal Resolution | | | G | seasonal | |
| | | | B | | |
| | | | T | decadal | |
| Timeliness | Months | | G | 6 | |
| | | | B | | |
| | | | T | 12 | |
| Required Measurement Uncertainty (2-sigma) | µmol $kg^{-1}$ | | G | 2 | |
| | | | B | | |
| | | | T | 2 | |
| Stability | | | G | | |
| | | | B | | |
| | | | T | | |
| Standards and References | Requirements based on characteristic scales and m the EOV Specification Sheet for details and referenc<br><br>Additional requirements based on the Global Ocean (GLODAP; www.glodap.info); for pH based on the C (GOA-ON) Implementation Strategy (http://goa-on Surface Ocean $CO_2$ Atlas (SOCAT; www.socat.info). | | | | |

| Name | $pCO_2$ | | | | |
|---|---|---|---|---|---|
| Definition | surface ocean partial pressure of $CO_2$ | | | | |
| Unit | µatm | | | | |
| Note | | | | | |
| | | | | Requirements | |
| Item needed | Unit | Metric | [1] | Value | Derivation, References and Standards |
| Horizontal Resolution | km | | G | 100 | |
| | | | B | | |
| | | | T | 1000 Coastal: <1000 | |
| Vertical Resolution | | | G | | |
| | | | B | | |
| | | | T | | |
| Temporal Resolution | | | G | monthly | |
| | | | B | | |
| | | | T | decadal | |
| Timeliness | Months | | G | 6 | |
| | | | B | | |
| | | | T | 12 | |
| Required Measurement Uncertainty (2-sigma) | µatm | | G | 2 | |
| | | | B | | |
| | | | T | 2 | |
| Stability | | | G | | |
| | | | B | | |
| | | | T | | |
| Standards and References | Requirements based on characteristic scales and magnitude of signal of phenomena to observe. See the EOV Specification Sheet for details and references (www.goosocean.org/eov).<br><br>Additional requirements based on the Global Ocean Data Assimilation Project (GLODAP; www.glodap.info); for pH based on the Global Ocean Acidification Observing Network (GOA-ON) Implementation Strategy (http://goa-on.org/about/strategy.php); for p $CO_2$ from the Surface Ocean $CO_2$ Atlas (SOCAT; www.socat.info). | | | | |

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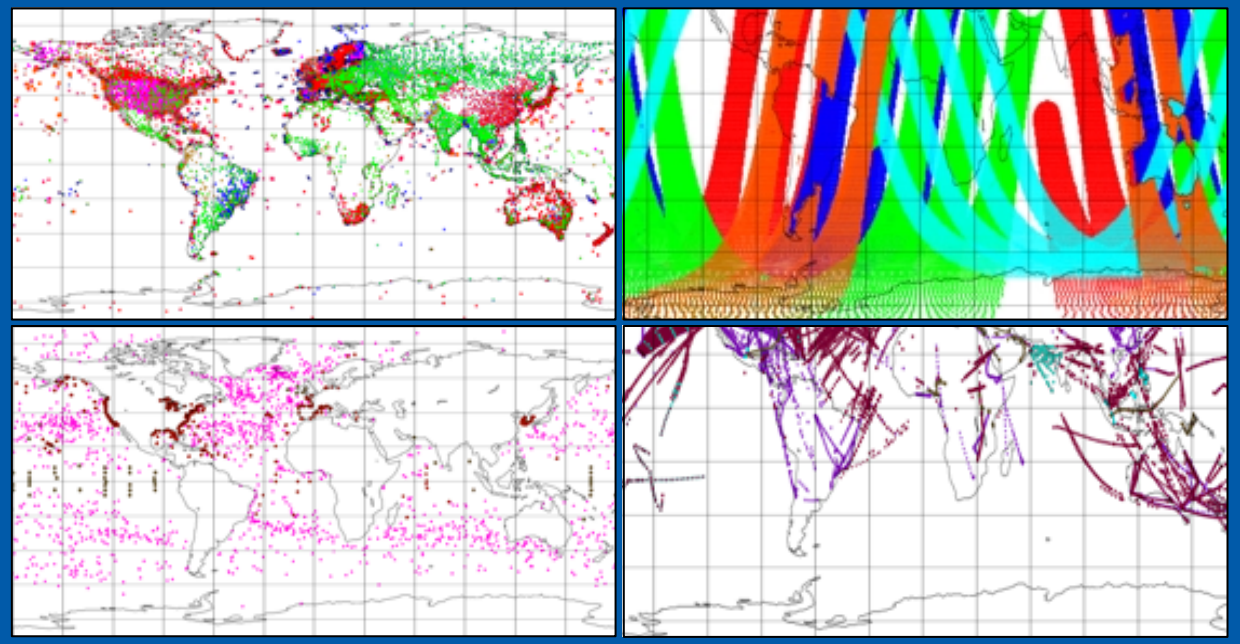
# Conclusions

- Building blocks are there (GAW, Copernicus, IPCCC, GCOS)
- Individual ECV, task requirement setting GCOS IP okay
- They are not yet analysed and asssessed in a coherent assimilation framework
- Need to define the key goals (hot spots, countries etc) and time frame
- Setup a priority list
- Need to involve non-traditional WMO institutions



# Thank you

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