Towards an Operational Capacity to Monitor Anthropogenic CO_2 Emissions

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(*) detached from **DG JRC**

with contributions from
many experts & major international institutions

Earth InfoDay, COP22
Marrakech,
08 November, 2016

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Space

Opportunity for a CO_2 Space Capacity

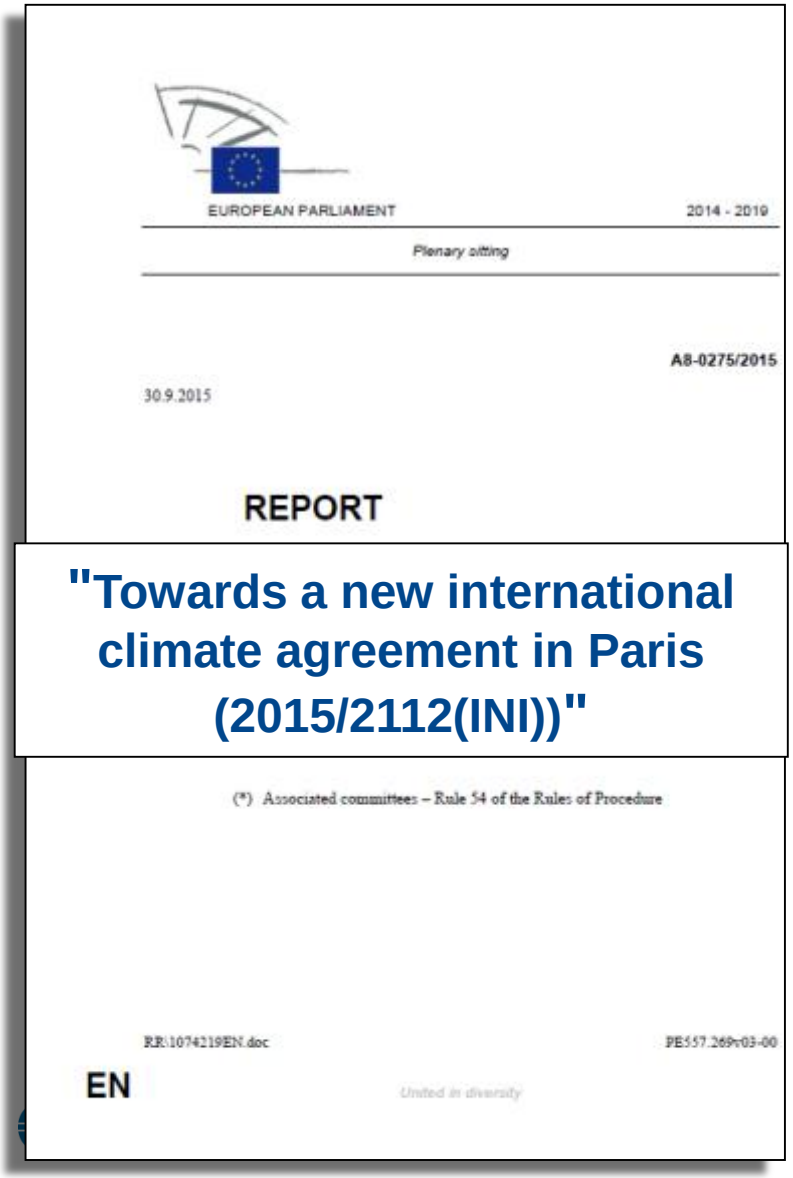
European Commission

Political context & challenges

- Fighting Climate Change requires **reducing the GHG emissions**, in particular CO_2 (IPCC AR 5).
- **Ambitious plans** from the EU Member States for reduction targets at horizon 2030.
- CO_2 emission reporting is based on bottom up approach using national statistics (mainly on fuel consumption) in ex-Kyoto-Annex I countries. **Independent** datasets would help improving periodicity & reliability as well as reducing uncertainty of the self-reporting exercise.
- The impact of Nationally Determined Contributions (NDCs) on CO_2 budget needs to be estimated to help countries in evaluating the **effectiveness of their CO_2 emission reduction strategies**.

Needed Capabilities

EP Resolution on COP21



EUROPEAN PARLIAMENT 2014 - 2019

Plenary sitting

A8-0275/2015

30.9.2015

REPORT

"Towards a new international climate agreement in Paris (2015/2112(INI))"

(*) Associated committees – Rule 54 of the Rules of Procedure

RR\1074219EN.doc PE557.269v03-00

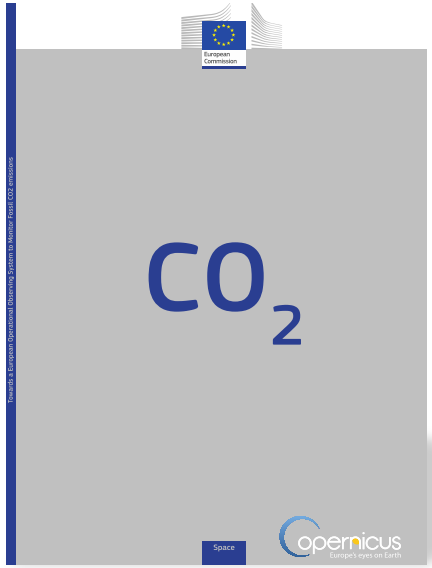
EN United in diversity

53. Points out that the **use of space-based assets should be considered** in the implementation of measures aimed at mitigating and adapting to climate change, particularly through the **monitoring and surveillance of GHG emissions**;

Urges the Commission to actively contribute to **a global monitoring system for CO_2 and CH_4**;

Calls on the Commission to promote efforts towards developing an **EU system of measuring GHG emissions** in an autonomous and non-dependent manner, **using and expanding the missions of the Copernicus programme**;

Support a set of recommendations for EC about:
"Need and opportunity for an independent European satellite-borne observation capacity for CO_2 to monitor the impacts of international climate agreements."



CO_2 report: 'Towards a European Operational Observing System to Monitor Fossil CO_2 Emissions'

http://www.copernicus.eu/main/towards-european-operational-observing-system-monitor-fossil-co2-emissions

CO_2 Report

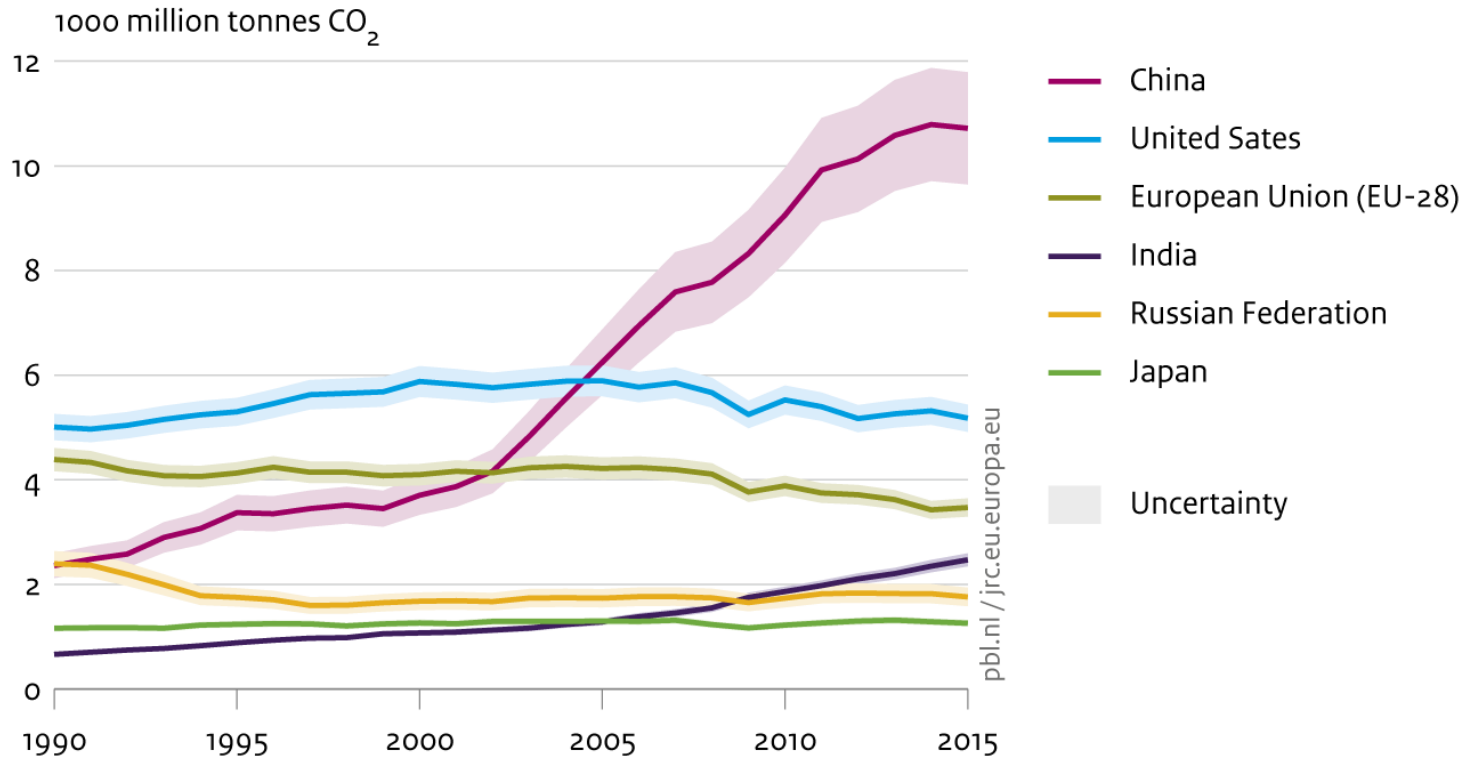
European Commission

Questions adressed

1. What are the **critical uncertainties** and limitations of **current inventories** of anthropogenic CO_2 emissions based on fuel use statistics?
2. How could inventories be improved using independent **space-borne measurements of atmospheric CO_2?**
3. What are the **current capabilities** of space-borne and in-situ ground-based measurements of atmospheric CO_2 in Europe and worldwide?
4. How should these **capabilities be optimized into an operational system** for independent monitoring of anthropogenic CO_2 emissions and for improving current estimates at the global, European and country scales?
5. What are the critical elements and a **possible road map** for setting up such a system enabling first operational exploitation at the **horizon of the 2030s?**

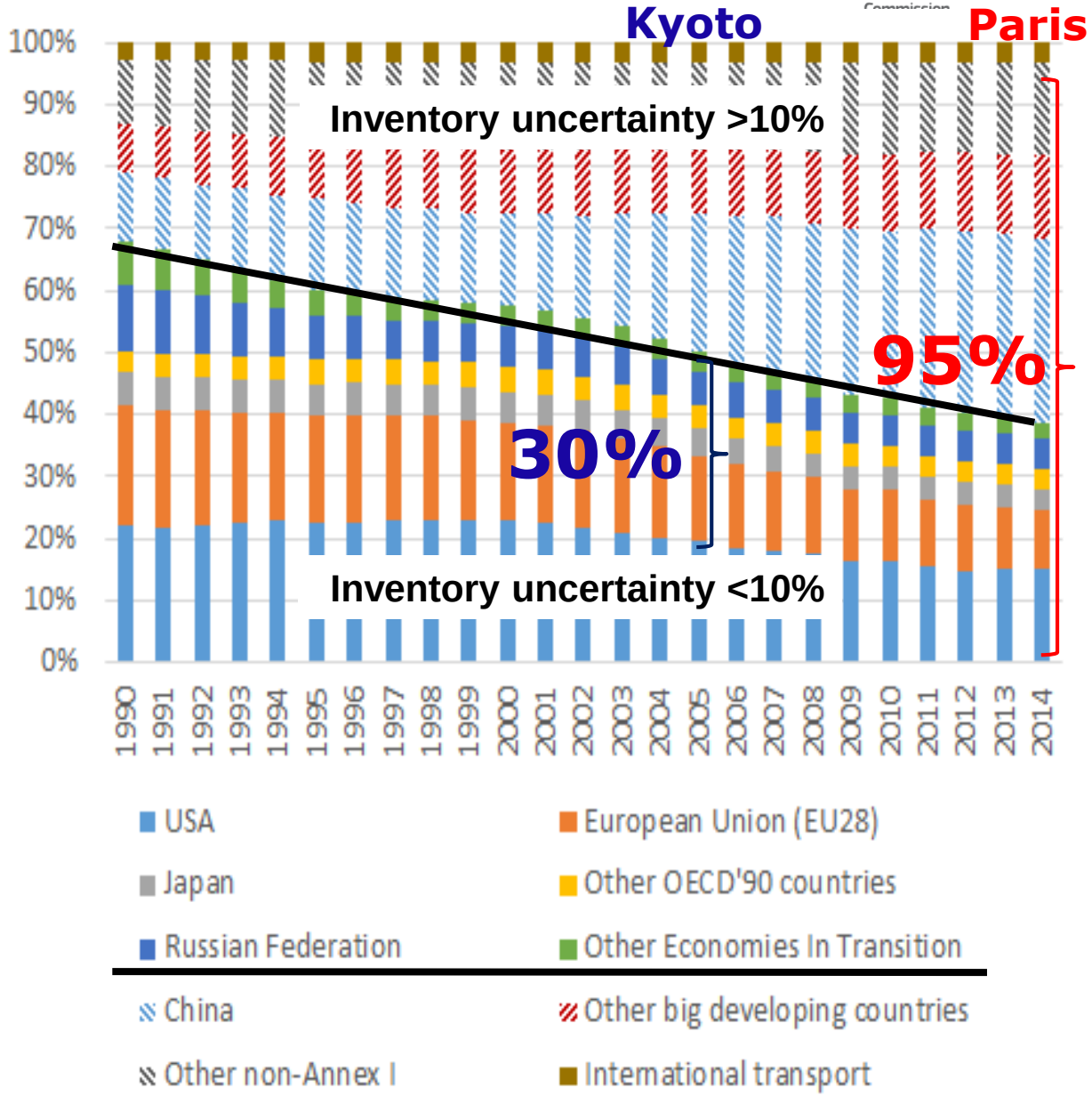
CO_2 not yet significantly decreasing

CO_2 emissions from fossil-fuel use and cement production in the top 5 emitting countries and the EU



Source: EDGAR v4.3.2 FT2015 (JRC/PBL 2016: IEA 2014 (suppl. with IEA 2016 for China, BP 2016, NBS 2016, USGS 2016, WSA 2016, NOAA 2016)

Critical uncertainties in CO_2 inventories



Emissions uncertainties on the rise

- During the last decade, **emerging countries** have become the largest emitters.
- The global emissions **uncertainty is increasing** with time : we are losing our reference baseline.
- No **reliable information** about spatial & temporal patterns.
- This is a **limitation** to mitigation policy.

The top-down atmospheric approach

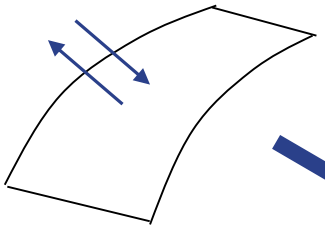
Improving emissions inventories

Top-down

Measurement systems for atmospheric CO_2

Inverse modeling

Sources and sinks for CO_2 on a gridded basis with temporal changes



Bottom-up

Emission inventories from statistical data

Maps of emissions per sector of human activity

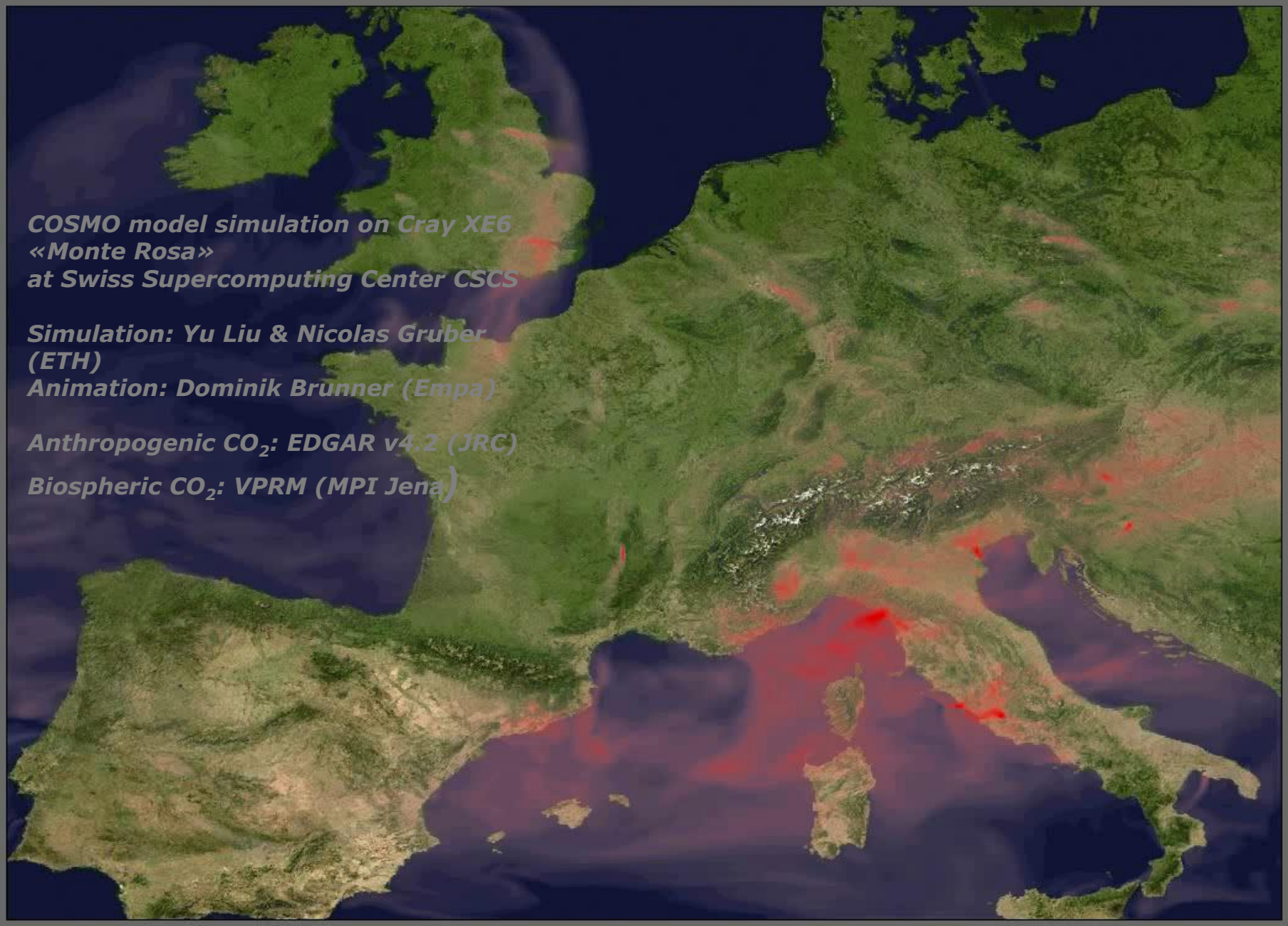
Improved Inventories

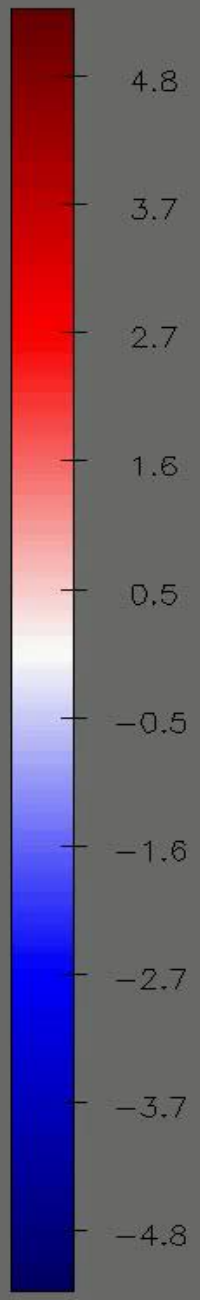
- UNFCCC Parties
- Regional authorities
- Industry in Emissions Trading System
- Citizen and farmer in Effort Sharing Decision

CO_2 emissions of subnational governments / regions need also to be mapped within a regionally complete picture (covering all human activities).

2008/03/20 00:00 UTC

Biogenic + anthropogenic XCO_2 [ppm]





Independent monitoring of fossil CO_2 emissions using inverse modeling and atmospheric measurements is feasible:

- **Dense sampling of selected emissions hotspots**, such as megacities and major industrial areas, large power plants.

⇒ *This can be achieved with satellites measuring column CO_2*

- **Separate the fossil CO_2 component from the natural fluxes at regional scale**, by measurements of additional trace species, such as radiocarbon (^{14}C in CO_2) , carbon monoxide and/or nitrogen dioxide.

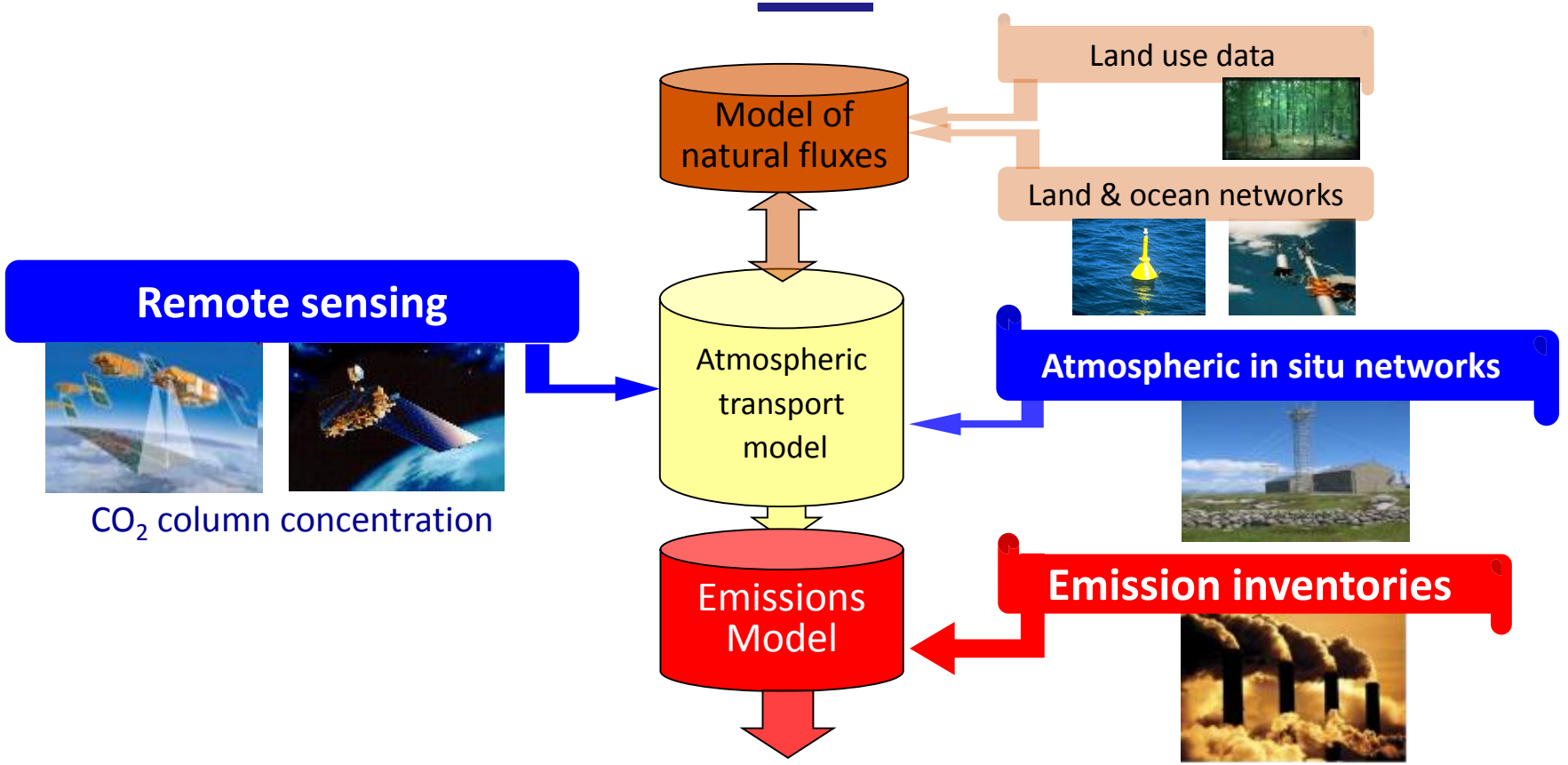
⇒ *This could be achieved in Europe by making ^{14}C measurements at existing CO_2 monitoring tall towers (ICOS and national in-situ networks).*

Increasing the density and spatial resolution of atmospheric CO_2 measurements is needed to quantify emissions.

Needed Capabilities

European Commission

Fossil Fuel Data Assimilation System



Frequent maps of fossil fuel emissions
Attribution to the different human activities, regional drivers
Uncertainties & Trends

Space

Copernicus | Europe's eyes on Earth

Space based CO_2 measurement objectives

Specific measurements of atmospheric CO_2 from space needed for fossil CO_2 emissions monitoring in particular:

- to verify the **trends of the emissions** of emitting hot spots at global scale
- to detect newly **upcoming hot spots** (e.g. new oil production sites)
- to assess whether the **global emission reduction** promised by the "stocktake" is actually measurable in the atmosphere.
- to acquire uniform, homogeneous and indisputable global datasets made available to monitor man-made CO_2 emissions and therefore **support the national/local emission reduction strategies**.

Opportunity for a CO_2 Space Capacity

The Copernicus context

- The **Copernicus programme** constitutes the appropriate frame for supporting an operational European CO_2 space initiative through its space component and its **Climate Change Service** (C3S) and **Atmosphere service** (CAMS)components**.**

- The CO_2 initiative is integrated in the context of the **Copernicus Space Component evolution plan** (supported by ESA through EOEP-4 & 5 programmes.

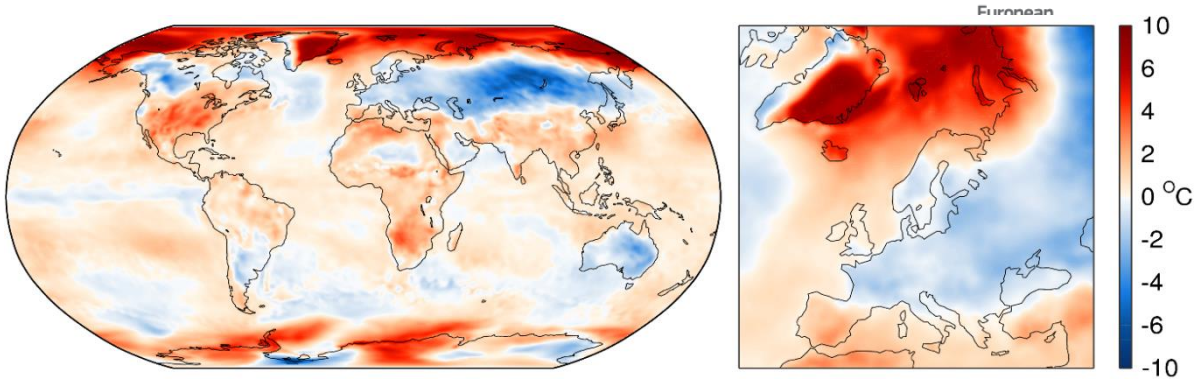
- A **CO_2 monitoring task force** has been nominated to address the **space component** and the required **ground-based infrastructure** –an end-to end operational emission monitoring system- (involving a few DGs, ESA, Eumetsat, ECMWF & world class experts).

- This task force is supporting the **consolidation of technical requirements**.

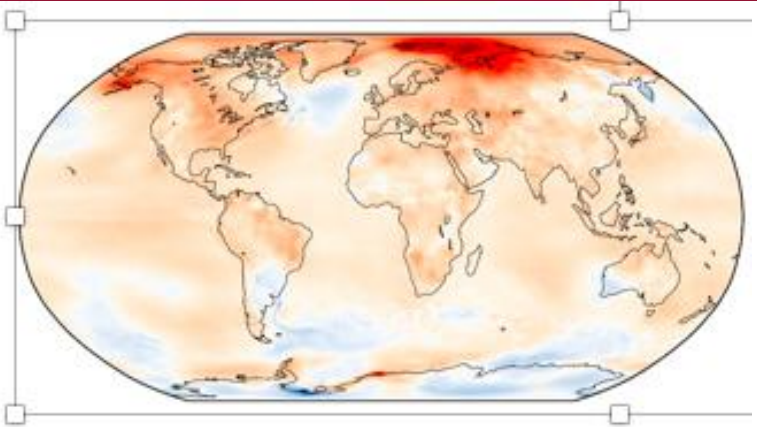
Conditioned by appropriate political & financing decisions beyond 2020.

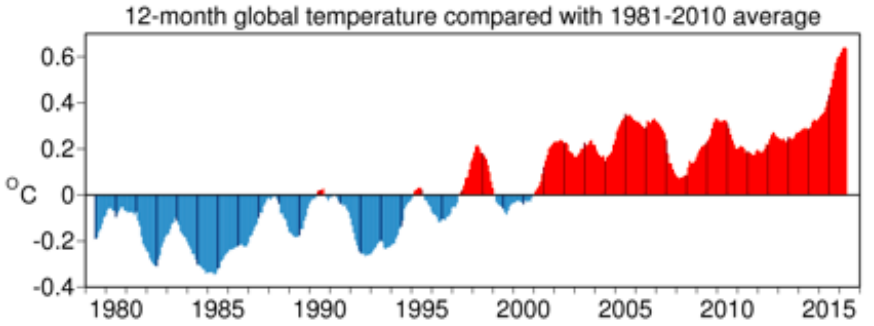
Copernicus Climate Change Service

Surface air temperature and anomalies



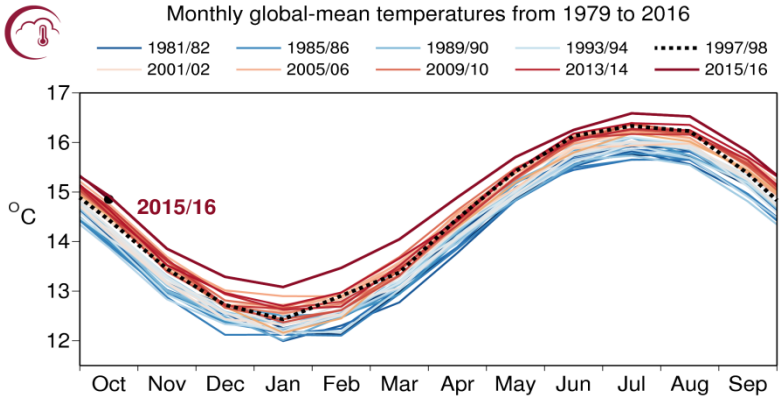
Average surface air temperature October 2016





Average surface air temperature anomalies for the last 12 months (Nov 2015 until Oct 2016)

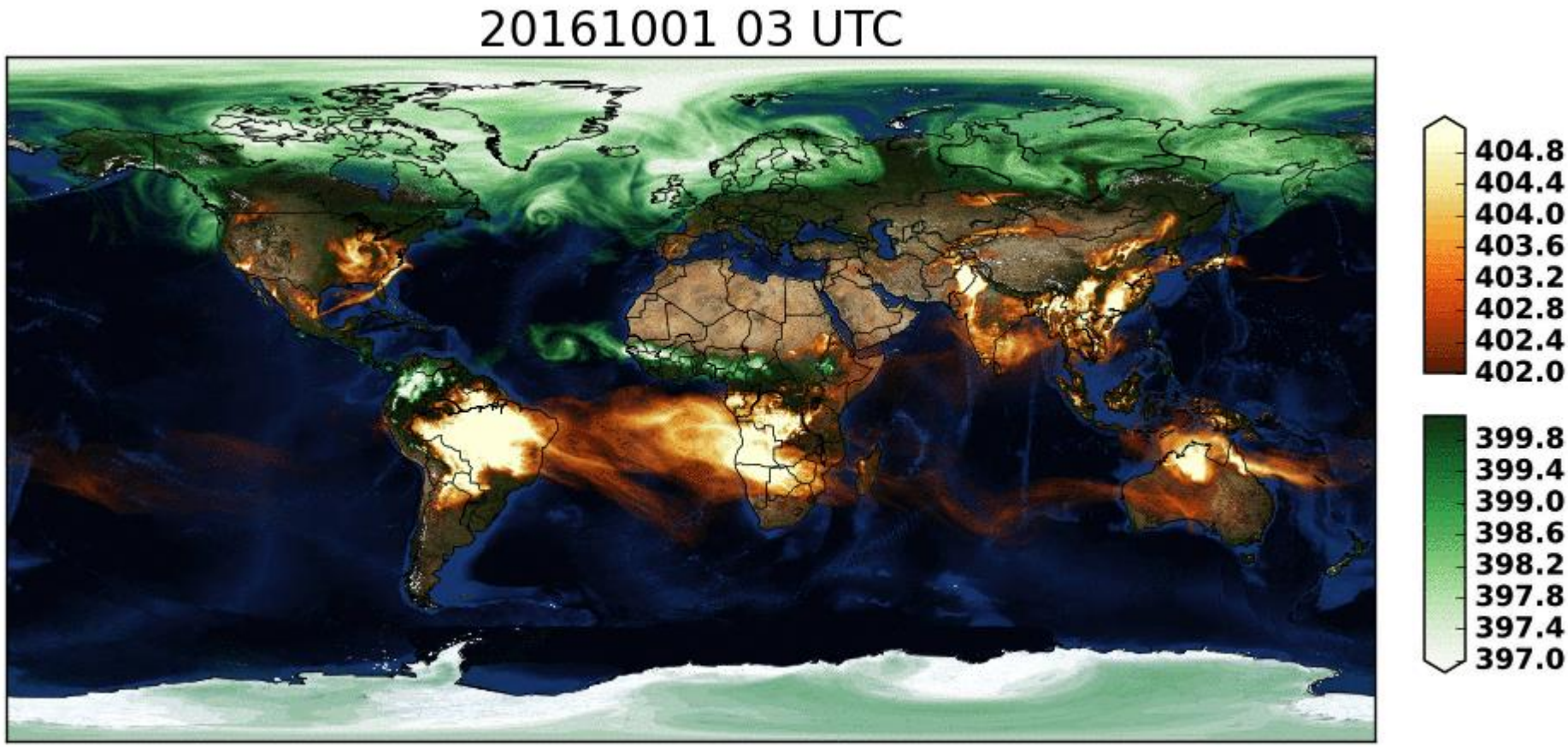
- **October 2016: 0.57°C higher relative to October average for 1981-2010**
- **12 last months (November 2015 to October 2016): 0.64°C higher relative to 1981-2010**



Copernicus Atmosphere Monitoring Service

European Commission

Column-averaged dry-air mole fraction of CO_2



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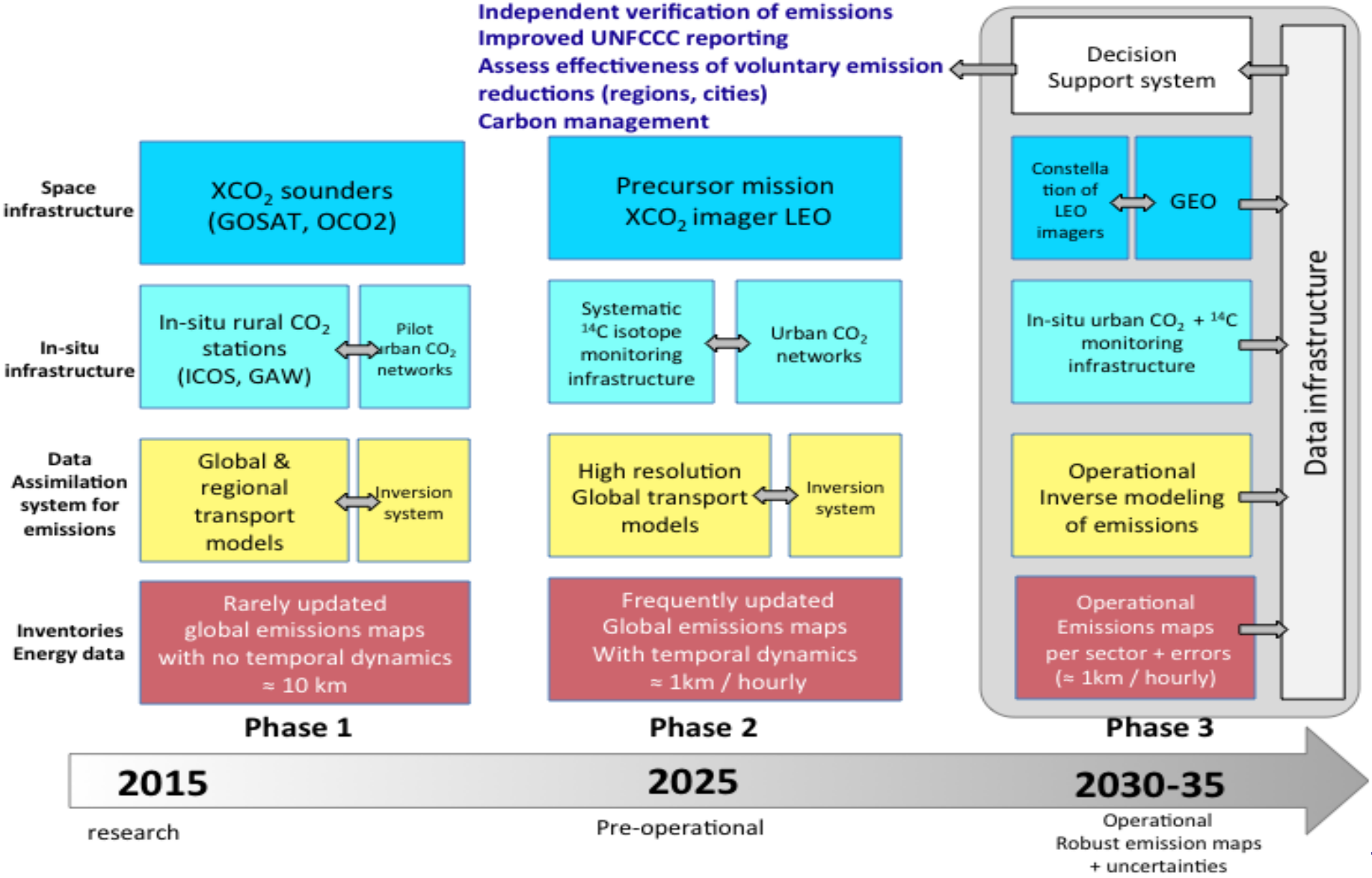
Space based CO_2 measurement objectives

Proposed Strategy



1.2. Advancing the EU space programmes and meeting new user needs

- *Additional services will be considered to meet emerging needs in specific priority areas, including (i) climate change and sustainable development, **to monitor CO2 and other greenhouse gas emissions**, land use and forestry, and changes in the Arctic with Copernicus;*

- *In addition, the Commission will use EU space programmes to contribute to and benefit from international efforts through initiatives such as the **Global Earth Observation System of Systems (GEOSS)** and the **Committee on Earth Observation Satellites (CEOS)** with Copernicus or the Search and Rescue initiative (COSPAS-SARSAT) with Galileo. It will also support the EU's neighbourhood and development policies, **as it already does in Africa** with Copernicus and EGNOS, and the monitoring of sustainable development goals.*

Take home

1. **Limitations of current inventories** to assess the effectiveness of mitigation policy.
2. **Inverse modeling** with dense atmospheric CO_2 measurements makes it possible to improve the reporting on fossil fuel CO_2 emissions.
3. Current capabilities need to be expanded to refine **the four pillars** of a future operational CO_2 emission monitoring system by 2030.
4. This system will require frequently updated bottom-up emission maps, an operational Fossil Fuel Data Assimilation System and adequate space-based and in-situ CO_2 observations, with a **first space instrument launched before 2025**.
5. The **Copernicus programme** provides the appropriate frame for such a system development.

Copernicus Atmosphere Monitoring Service

European Commission

Column-averaged dry-air mole fraction of CO_2