Towards a European operational observing system to monitor fossil CO₂ emissions

Y. Meijer(1), M. Drinkwater(1), B. Pinty(2), B. Veihelmann(1)

14/10/2016

(1) ESA, Noordwijk, The Netherlands
(2) EC, DG GROW, I.2 Unit, Brussels, Belgium
Mitigating Climate Change requires **reducing GHG emissions**, in particular CO₂ (IPCC AR 5)

**Ambitious plans** from the EU Member States for reduction targets at horizon 2020 and 2030 through COP-21

CO₂ emission reporting is based on bottom up approach using national statistics (mainly on fuel consumption) in Kyoto-Annex I countries. **Independent** datasets would help improving periodicity & reliability as well as reducing uncertainty of the self-reporting exercise

Support countries in evaluating their Nationally Determined Contributions in the CO₂ budget and the **effectiveness of their CO₂ emission reduction strategies**
Opportunity for a CO₂ space capacity

Political context & challenges

European Parliament
2014-2019

TEXTS ADOPTED
Provisional edition

P8_TA-PROV(2015)0359
Towards a new international climate agreement in Paris
European Parliament resolution of 14 October 2015 on Towards a new international climate agreement in Paris (2015/2112(INI))

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 CO₂ and CH₄; 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:
ESA proposed to its member states a **generic roadmap** for the evolution of the Copernicus Space Component.

CO₂ monitoring is in the top priority list and used as first case to explore implementation, see **CO₂ Roadmap**.

ESA and the European Commission jointly established by nomination a **CO₂ Monitoring Task Force** of experts (Task A on space component).

The system requires a broad international support and in the task force involves other space agencies.

---

**Annex 1a - CSC Evolution DRAFT CO₂ Roadmap**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>CO₂ Report published by DG GROW</td>
<td>COM</td>
</tr>
<tr>
<td>2016</td>
<td>Nomination of Task Force of experts</td>
<td>COM/ESA</td>
</tr>
<tr>
<td>Apr.</td>
<td>Draft CO₂ Mission MRD</td>
<td>COM/ESA</td>
</tr>
<tr>
<td>Dec.</td>
<td>Detailed technical requirements for the overall CO₂ System</td>
<td>ESA/EUM/ECMWF</td>
</tr>
<tr>
<td>2018</td>
<td>Phase A/B1</td>
<td>ESA</td>
</tr>
<tr>
<td>2019</td>
<td>Phase B2</td>
<td>ESA</td>
</tr>
<tr>
<td>2020</td>
<td>Instrument QM development</td>
<td>ESA</td>
</tr>
<tr>
<td>2022</td>
<td>Procurement of recurrent units of CO₂ Mission</td>
<td>ESA</td>
</tr>
<tr>
<td>2024/25</td>
<td>First (Pre-) operational CO₂ mission launched</td>
<td>ESA</td>
</tr>
<tr>
<td>2030</td>
<td>Constellation of operational CO₂ missions launched</td>
<td>ESA</td>
</tr>
</tbody>
</table>
The **Copernicus programme** constitutes the appropriate frame for supporting an operational European CO₂ space initiative. Possibly implementing it as one of its Sentinel missions.

Providing the European Union a **unique and independent** source of actionable information, which would address multiple stages of the policy cycle.

EU wants to be independent to assess the impact of the international climate agreements.
Atmospheric CO$_2$ from space for fossil CO$_2$ emissions monitoring:

- 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 openly available to monitor man-made CO$_2$ emissions and therefore support national/local emission reduction strategies

Primary mission objective: support to monitoring of fossil CO$_2$ emissions

Operational mission: ensure robustness & reliability
Space based CO₂ measurement objectives

Proposed strategy

Independent verification of emissions
Improved UNFCCC reporting
Assess effectiveness of voluntary emission reductions (regions, cities)
Carbon management

XCO₂ sounders (GOSAT, OCO2)

Precursor mission XCO₂ imager LEO

Decision Support system

Constellation of LEO imagers

GEO

In-situ urban CO₂ + ¹⁴C monitoring infrastructure

Operational Inverse modeling of emissions

In-situ rural CO₂ stations (ICOS, GAW)

Pilot urban CO₂ networks

Systematic ¹⁴C isotope monitoring infrastructure

Urban CO₂ networks

Global & regional transport models

Inversion system

High resolution Global transport models

Inversion system

Operational Emissions maps per sector + errors (≈ 1km / hourly)

Rarely updated global emissions maps with no temporal dynamics
≈ 10 km

Frequently updated Global emissions maps
With temporal dynamics
≈ 1km / hourly

Operational Robust emission maps + uncertainties

Phase 1

2015

research

Phase 2

2025

Pre-operational

Phase 3

2030-35
By **2025** a possible European carbon mission delivering column CO\(_2\) (with high resolution, high accuracy and imagery).

By **2030** an end-to-end operational system to monitor fossil CO\(_2\) emissions (an integrated system using all available European and non-European data).

*Conditioned by appropriate financing beyond 2020 (next MFF)*

Nomination of a **CO\(_2\)** monitoring task force with two interactive WPs:

- **Task A** (co-convened by ESA-EC): Focus on the space component - more specifically a CO\(_2\) pre-operational mission;

- **Task B** (convened by EC): Focus on ground-based infrastructure – an end-to-end operational emission monitoring system.
Take home

1. European Union intends to establish an operational CO$_2$ emission monitoring system by 2030. This system should support countries in monitoring their efforts to reduce CO$_2$ emissions down to the scale of major cities and power plants.

2. This system will require bottom-up emission maps, an operational Fossil Fuel Data Assimilation System and adequate space-based and in-situ CO$_2$ observations, being pre-operational with a first satellite CO$_2$ imagery mission launched around 2025.

3. This system should be part of the Copernicus programme, and will be complementing similar efforts of third parties and be the European contribution to an international CO$_2$ monitoring framework ("virtual constellation") at global level.