European Commission

CHE General Assembly

Reading, 05-07 February 2018

Towards an operational capacity to monitor fossil fuel CO_2 emissions

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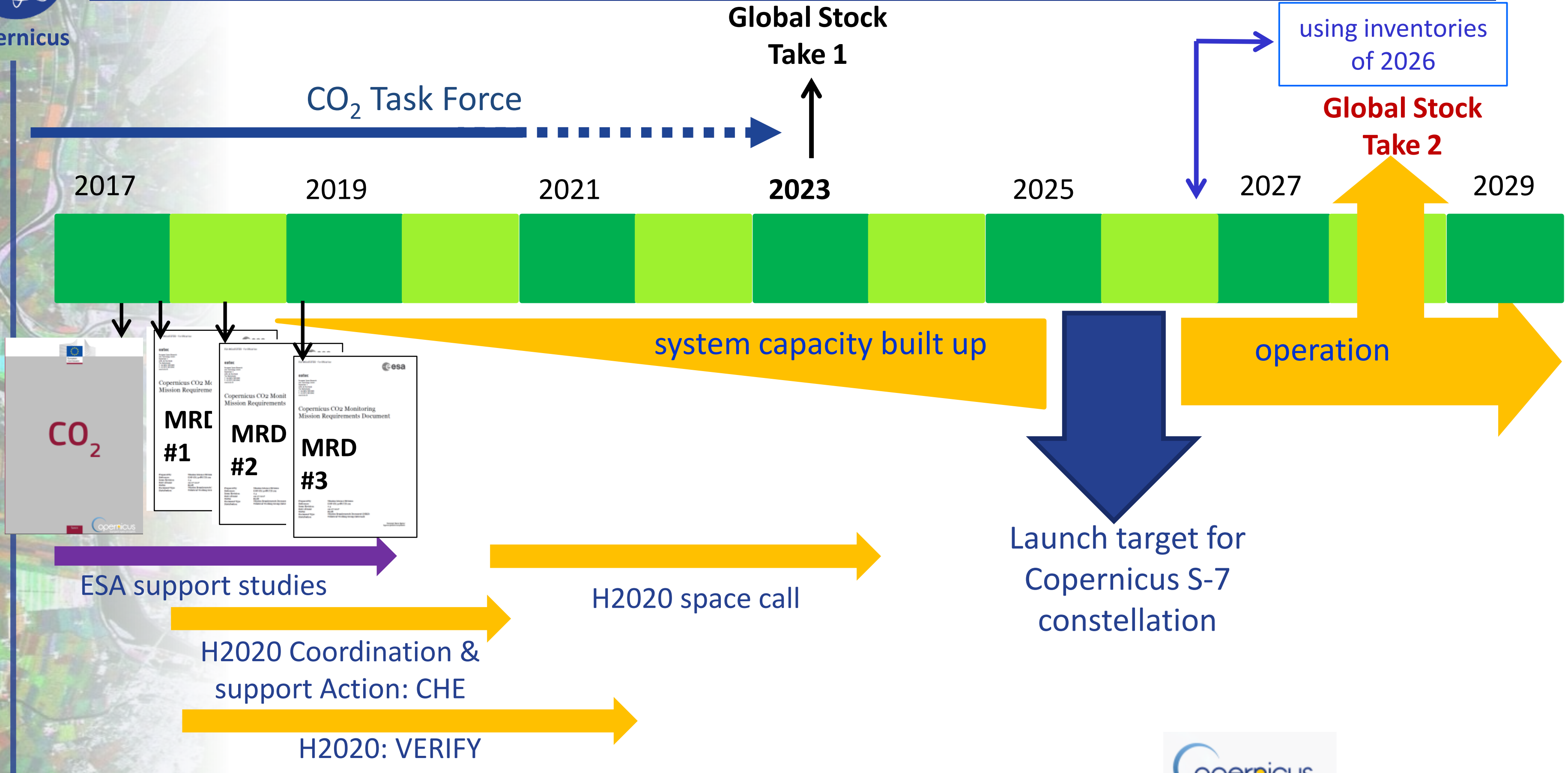
Towards an anthropogenic CO_2 Monitoring & Verification Support Capacity



High Level Requirements for the System

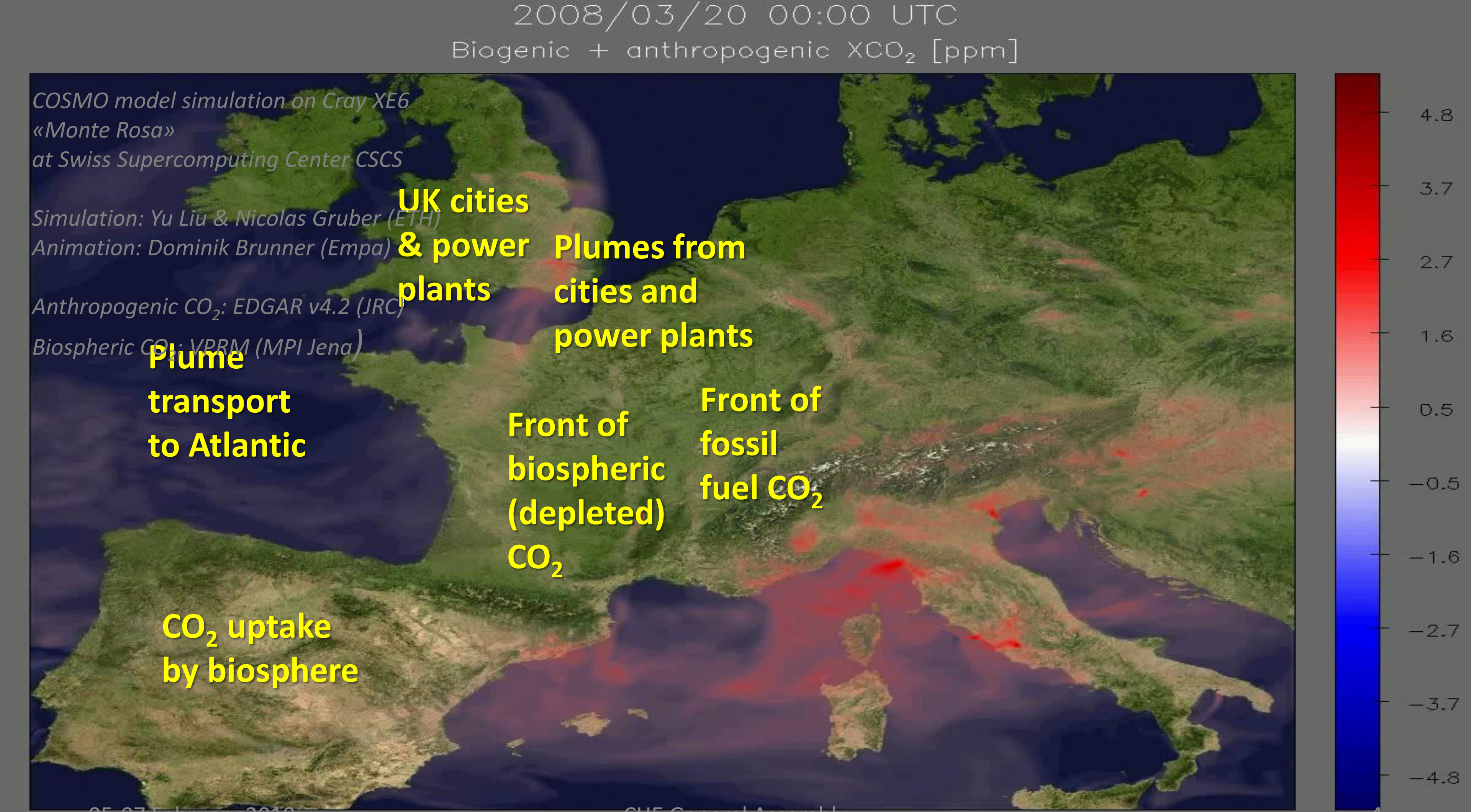
km & daily scales

1. **Detection of emitting hot spots** such as megacities or power plants.
2. **Monitoring the hot spot emissions** to assess emission reductions/increase of the activities.
3. **Assessing emission changes against local reduction targets** to monitor impacts of the NDCs.
4. **Assessing the national emissions and changes** in 5-year time steps to estimate the global stock take.

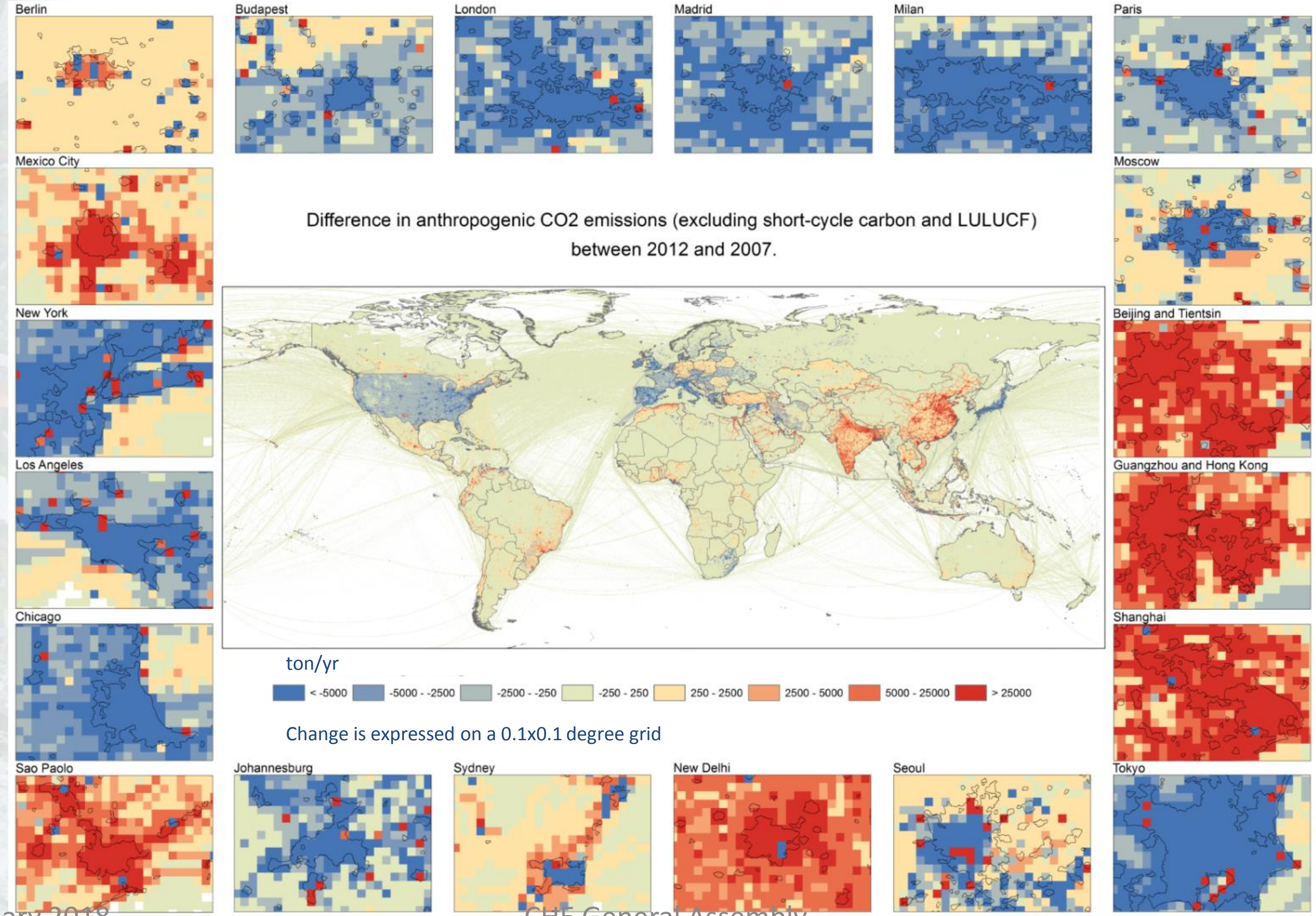
Accuracy

Space & Time Resoltuion

200-400 ton/year


2008/03/20 00:00 UTC
Biogenic + anthropogenic XCO_2 [ppm]
COSMO model simulation on Cray XE6
«Monte Rosa»
at Swiss Supercomputing Center CSCS
Simulation: Yu Liu & Nicolas Gruber (ETH)
Animation: Dominik Brunner (Empa)
Anthropogenic CO_2: EDGAR v4.2 (JRC)
Biospheric CO_2: VPRM (MPI Jena)
UK cities & power plants
Plumes from cities and power plants
Plume transport to Atlantic
Front of biospheric (depleted) CO_2
Front of fossil fuel CO_2
CO_2 uptake by biosphere
4.8
3.7
2.7
1.6
0.5
−0.5
−1.6
−2.7
−3.7
−4.8

Fossil CO_2 Emission Difference 2012-2007



CO_2 Monitoring Task Force Status

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- **Sub-task A** (lead by EC-GROW & ESA):
  - Group of experts focusing on the space component
  - 5 meetings since June 2016
  - Output: Mission Requirements Document & Supporting Studies
- **Sub-task B** (lead by EC-GROW & EC-JRC):
  - Group of experts focusing on the end-to-end monitoring system
  - Output: user requirements and preliminary high-level system architecture
  - Output #1: Report on "Baseline requirements, model components and functional architecture for an operational Anthropogenic CO_2 Emission Monitoring & Verification Support Capacity"

Requirements (RQs) logic/sequence:

User RQs	→ product RQs	←→ satellite product RQs	←→ observation RQs	←→ instrument
Policy	→ level 4	←→ level 2	←→ level 1	←→ level 0

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Functional Architecture – Basis for Future Implementation

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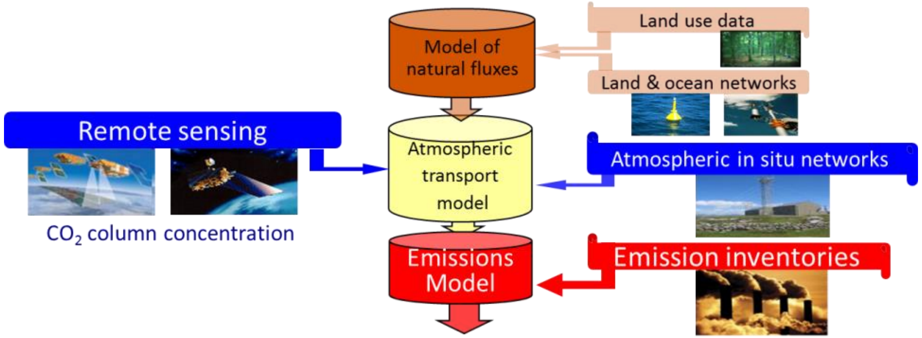
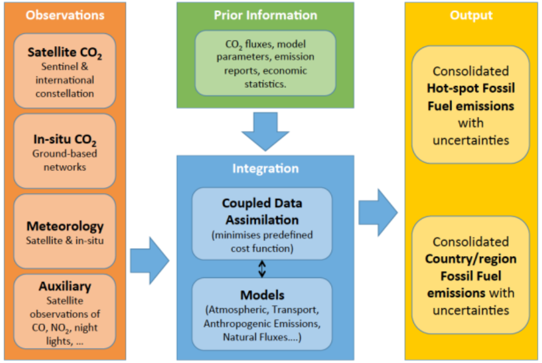
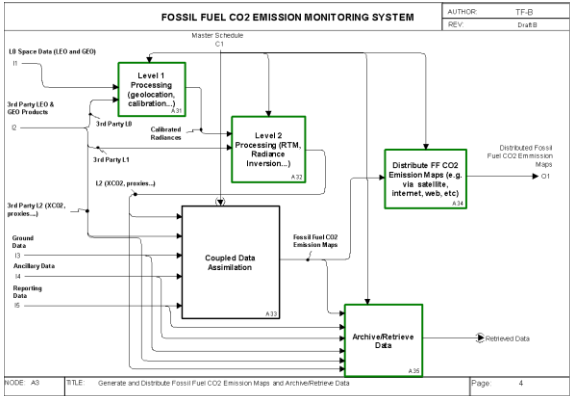
2015



2017



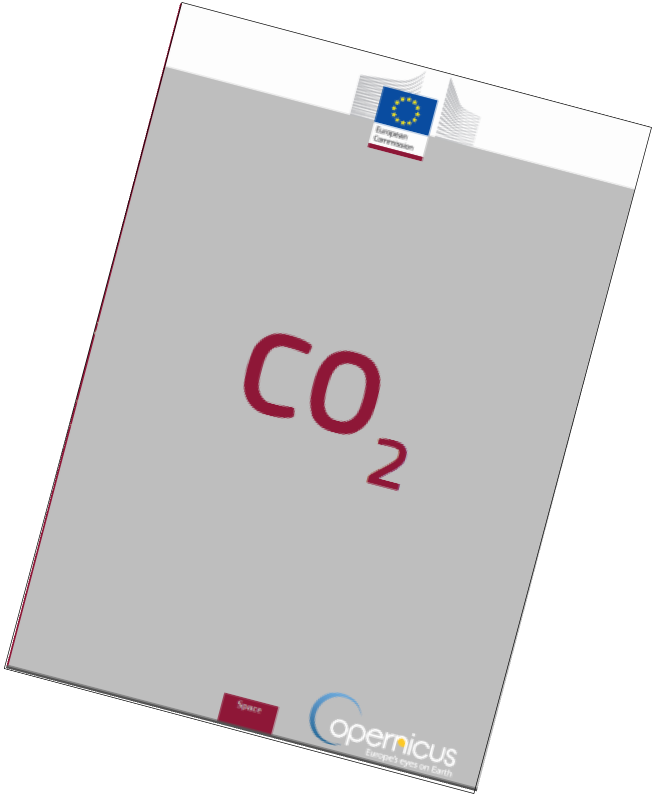


http://copernicus.eu/news/report-operational-anthropogenic-co2-emissions-monitoring

http://edgar.jrc.ec.europa.eu

CO_2 Red Report from sub-task B

- **Executive Summary**
- **Background and Rationale**
- **Section 1: Emissions and Policy Requirements**
  - Input from National Inventory Agencies
  - Scenario to assess the required CO_2 sensitivity
  - Global versus regional versus local scales
  - Needs and capabilities for a CO_2 MVS
- **Section 2: System Overview and Architecture**
  - Architecture
  - System functional elements
  - Prior information
  - Data access, archiving and distribution
- **Way Forward**
- **References**
- **list of abbreviations and definitions**
- **Annexes**
- **List of contributors**



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Way Forward for sub-Task Force B

- Reviewing inputs from system simulations to assess the system performance.
- Apportionment of requirements between system elements.
- Identifying critical issues affecting the system design.
- Engage stakeholders on the further adjustment of the requirements, including the functionality needed for decision-making – basis for decision support system.

1

- Outlining options for the physical realisation of the functional architecture, including conducting a survey of existing capabilities, need for developments, re-use.
- Make initial assessment of options of governance arrangement for a system.
- Implementation planning .

2

- Provide a detailed assessment of activities and infrastructure requirements for in-situ observations (taking advantage of current EU investments and international partnerships)
- Provide a overview of a strategy for calibration and validation of the system and it's implications on the observing component

3

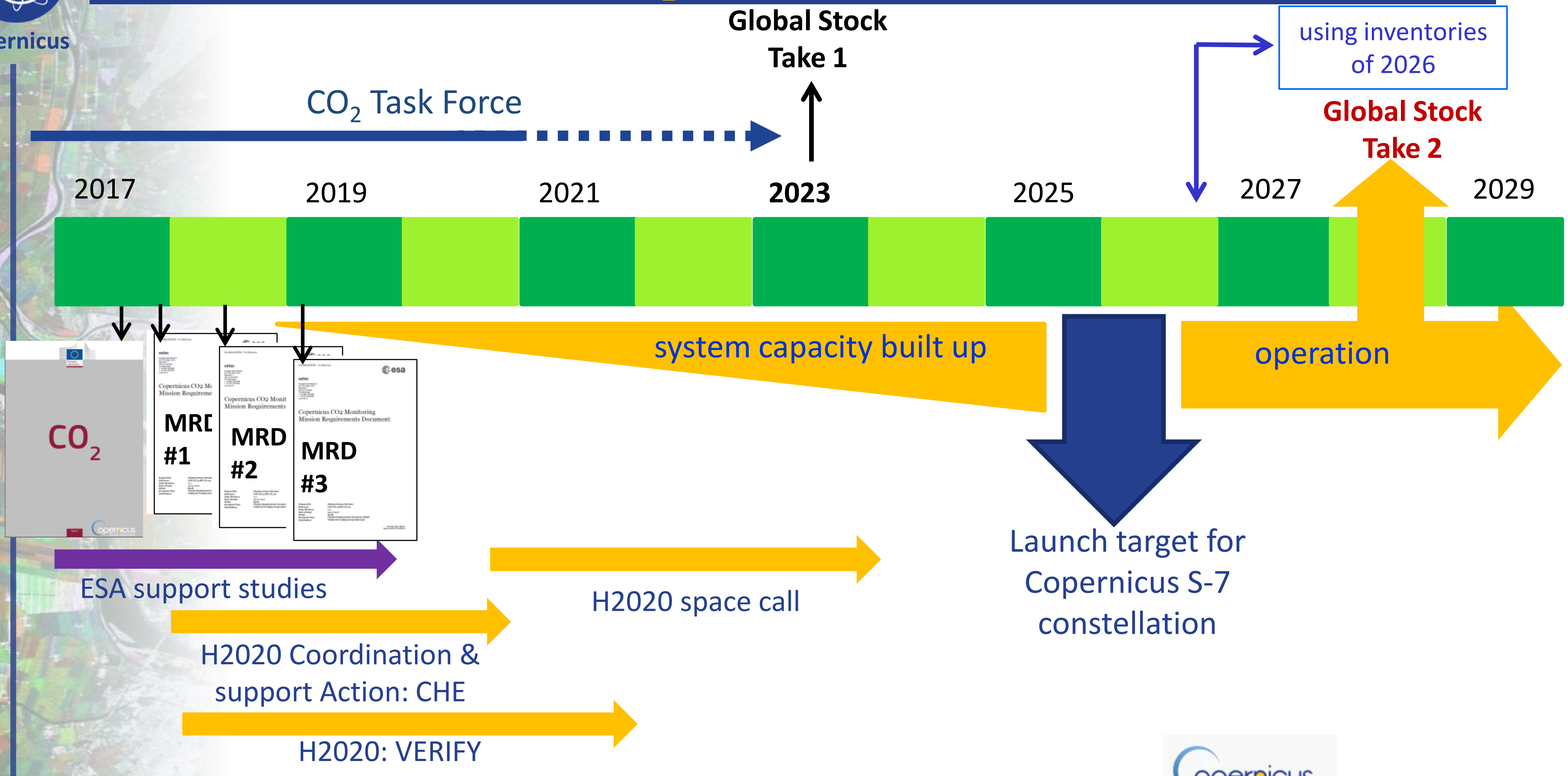
CHE main features of this coordination & support action

Main Objective: Preparation for a European capacity to monitor CO2 anthropogenic emissions

- Reconciling Top down and bottom up estimates
- Library of simulations for emissions and atmospheric transport
- Uncertainty trade-off for fossil fuel emissions
- Attributing CO_2 emissions from in-situ measurements

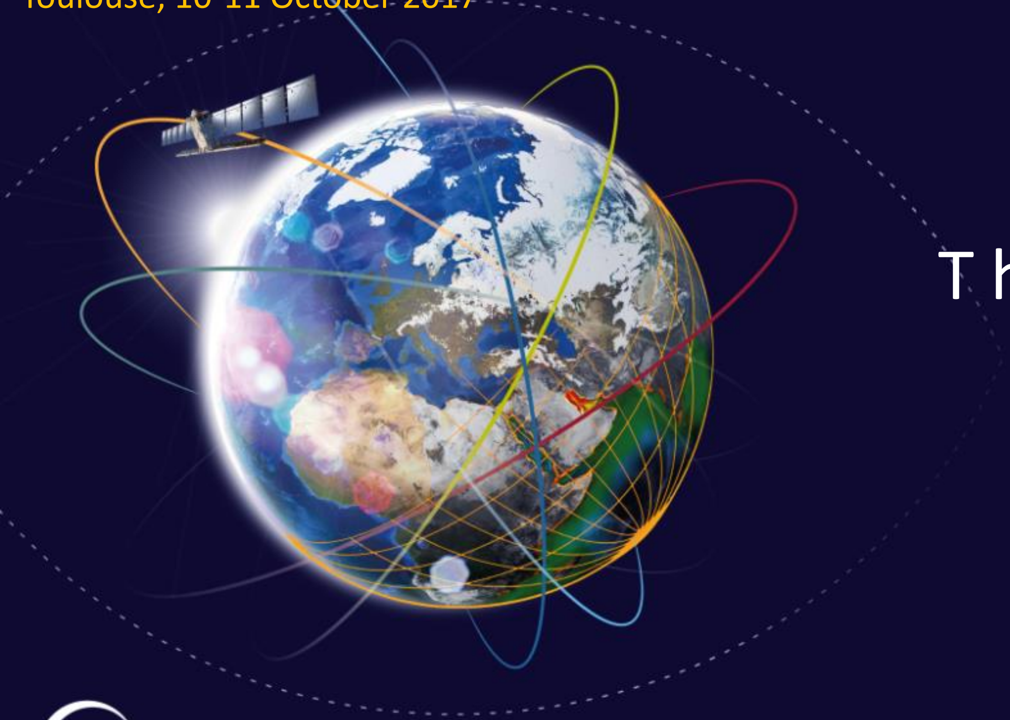
Expected Impact: **The proposal is expected to lay the mature foundation for an independent space-borne observation capacity for CO_2 in the context of Europe's Climate Change challenges. Coordination and networking efforts are expected to lay the foundation for the operational integration** of all relevant European capacities **as a subsequent step.**

Towards an anthropogenic CO_2 Monitoring & Verification Support Capacity



The Climate needs Space
Toulouse, 10-11 October 2017

European Commission



Thank you

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Political Context and Challenges

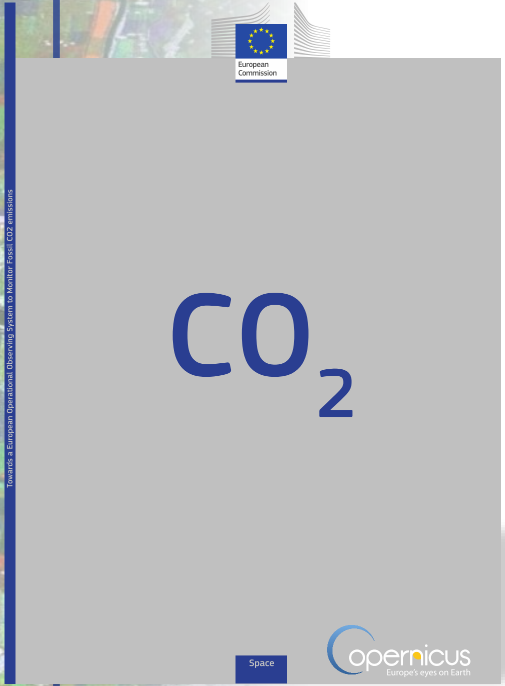
- UNFCCC Parties agreed for an "enhanced transparency framework" to be implemented bottom-up through national inventory reports (Paris Agreement, 2015) and complemented by a global CO2 Monitoring and verification support capacity to fill in gaps of data.

- The global CO_2 budget needs to provide input to the 5-yearly global stocktake exercise established under the Paris Agreement.

- Analysis at local/regional level may help countries in evaluating the effectiveness of their CO_2 emission reduction strategies and possibly in defining revised Nationally Determined Contributions of the UNFCCC Parties.

- Need to provide independent evidence on and verification of nationally reported anthropogenic CO2 emissions and help assessing the uncertainties and gaps associated with the emission inventories.

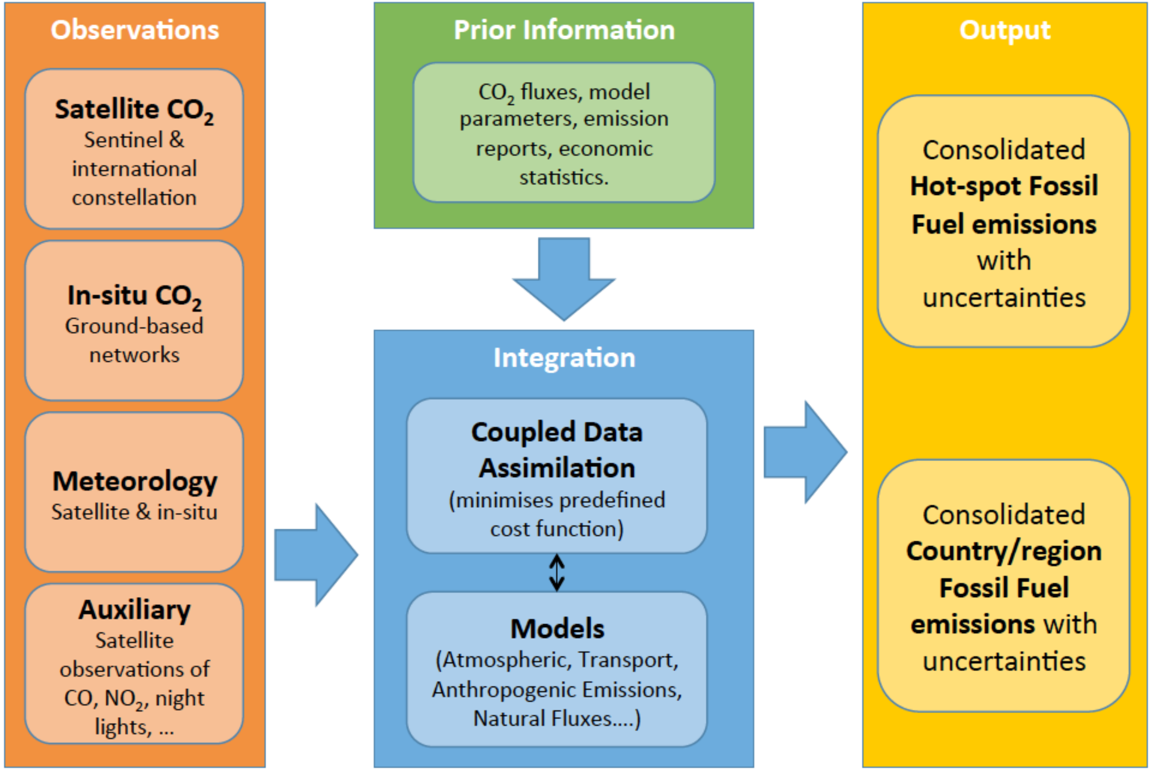
Copernicus Context: CO_2 Report –November 2015



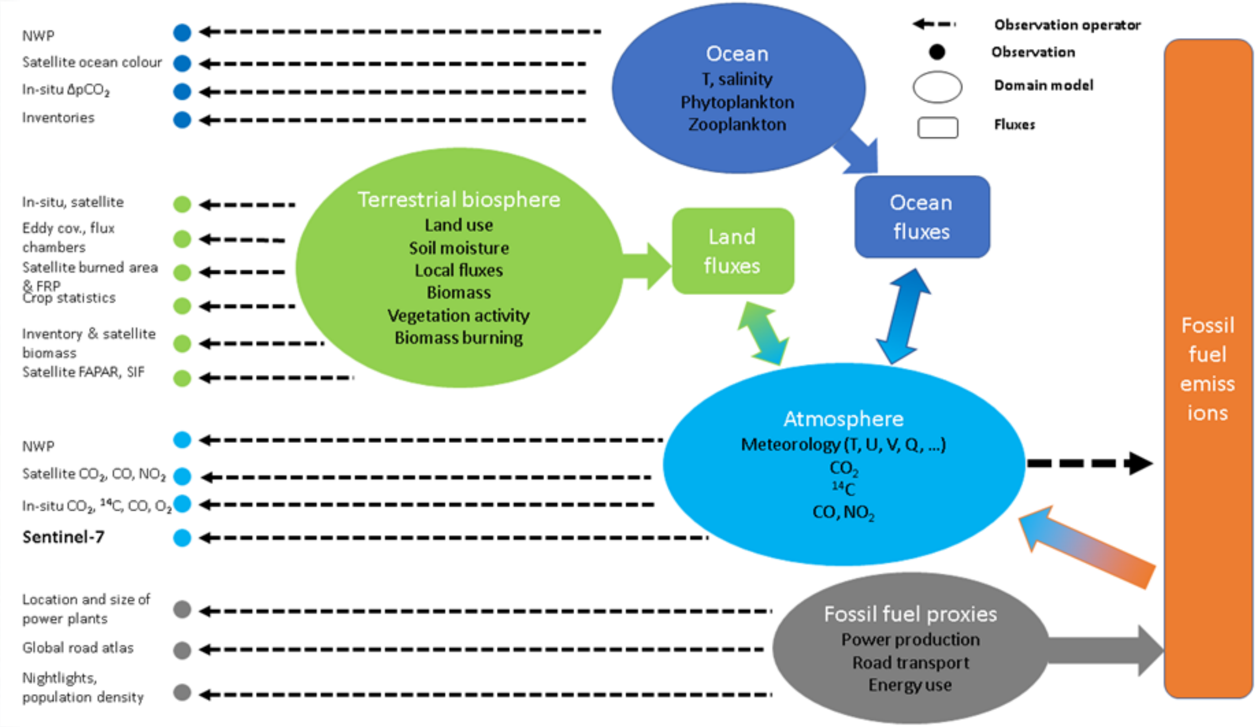
'Towards a European Operational Observing System to Monitor Fossil CO_2 Emissions'

- Emphasis on systems: inventories, space-borne and in-situ observations, data assimilation framework, inversion system, transport models, decision support system
- Emphasis on operational intent – from the outset
- Fundamentally underpinned by strong user requirements based on international commitments and corresponding EU Policy implementation
- Fundamental added value of international engagement on multiple aspects of system implementation/development

Overview of the Core Elements of the Anthropogenic CO_2 Emission Monitoring & Verification Support (MVS) capacity



Models of the Sub-Systems



Overview of a fossil fuel emission inversion system with the model blocks as well as the potential observations that can be used to constrain the system

Objectives and Requirements from the Space Component

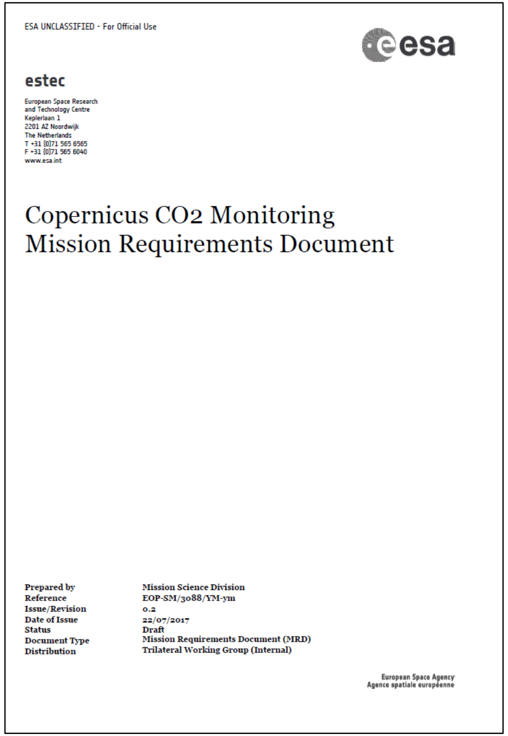
- Consolidation of baseline users and observations requirements (from sub-task B):

  ⟶ red report

- Identification of mission objectives and mission requirements (from sub-task A):

  ⟶ Mission Requirements Document (MRD)

  - Version 0 being finalised by Q3 2017
  - Version 1 finalized by Q4 2017
  - Need to address unconsolidated requirements



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Copernicus CO2 Monitoring
Mission Requirements Document

Prepared by	Mission Science Division
Reference	EOP-SM/3088/YM-ym
Issue/Revision	0.2
Date of Issue	22/07/2017
Status	Draft
Document Type	Mission Requirements Document (MRD)
Distribution	Trilateral Working Group (Internal)

European Space Agency
Agence spatiale européenne

CO_2 Monitoring – Primary Observation Requirements (preliminary)

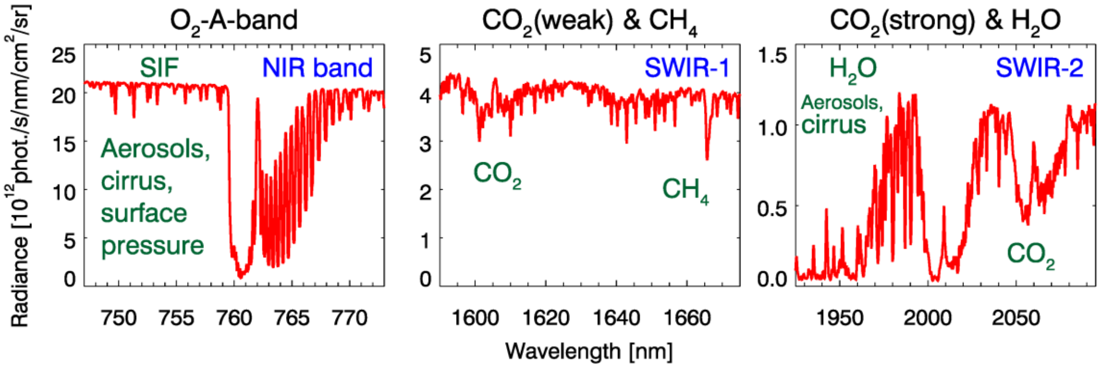
- XCO_2 precision: **0.5 – 0.7 ppm**
- Systematic bias **< 0.5 ppm**
- Spatial resolution about **4 km^2**
- Continuously sampled swath width **> 200 km**
- Revisit around **3 days** (poleward of 40 deg), over land & ocean (by a constellation of **N** satellites)
- Orbit equator crossing time **11:00 – 12:00 hrs**

Band	Spectral range [nm]	Spectral resolution [nm]	SNR at reference radiance
NIR	747–773	0.1	400 - 600
SWIR-1	1590–1675	0.3	300 - 500
SWIR-2	1925–2095	0.55	200 - 400

* Radiometric uncertainty < 3%
* Relative radiometric accuracy < 0.5%

Consolidating Requirements: Main Open Points

- Complementary **NO_2** and/or **CO** observations for attribution of anthropogenic emission sources → Y/N?
- Complementary **aerosol/cloud observations** for light path correction → Y/N?
- Temporal/spatial coverage → **how many satellites**?
- Required precision → **SNR and spectral sizing**?



ESA-initiated Support Studies

Study	Sys.	Prod.	Obs.	Ins.	Start	End	Prime
Study on CCFFDAS	XX	X			Q3 2017	Q1 2019	Inversion lab
Study on PMIF	X	XX			Q2 2017	Q4 2018	LSCE
Study on NO_2-CO	X	XX	XX		Q1 2017	Q2 2018	EMPA
Study on aerosol		XX	XX		Q2 2017	Q4 2018	SRON
Study on spectral sizing			XX	X	Q3 2016	Q2 2018	SRON
Study on E2ES			X	XX	Q4 2016	Q2 2018	IUP Bremen
Sys. & ins. pre-dev			X	XX	Q1 2016	Q3 2017	Various
ACADIA – airborne sys.		X	X	XX	Q3 2017	TBD	OHB

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Activity 1

- It includes activities such as the requirements apportionment throughout the systems as well as observation system simulations
- It will depend considerably on the timing and output from the (H2020) research programme projects
- We also need to establish the best mechanism interact/provide input requirements from the TF to the projects
- Importantly, this also include item on DSS which is ill-defined in last report and which is required to complete the Architecture definition
- First output should be a cumulative roadmaps of Research projects deliverable (and TF/Programme needs) – up and including the definition of a sandbox version of the system

Activity 2

- It addresses the further development of the Architecture to identify it's physical realization (later iterative process with Activity 1)
- It should start with a current capability and infrastructure assessment across European institution
- It should address various options for governance of the system, involving all relevant European Institutions

Activity 3

- It includes two sub-elements:

  – detailed assessment of the need for the operational system of in-situ observations and network, identify existing infrastructure and gaps, both with the EU and not.

  – to define a first order strategy for cal/val and quality control of the system (which should be mission independent) and highlight the main resources/infrastructure needs to implement this strategy

- It should also identify a first order budget requirement for the In-situ and cal/val elements