Co-ordinated by ECMWF

CO_2 Human Emissions

THE CHE PROJECT

Science to deliver Services

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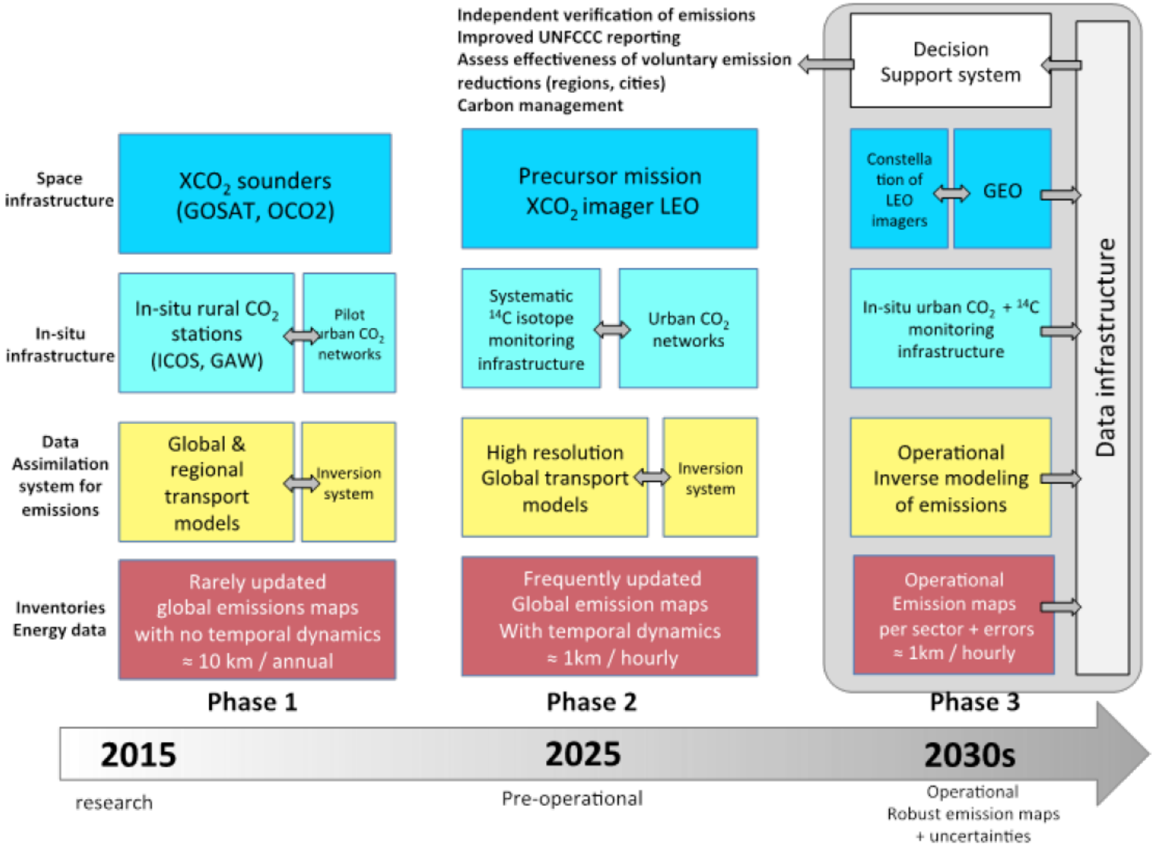
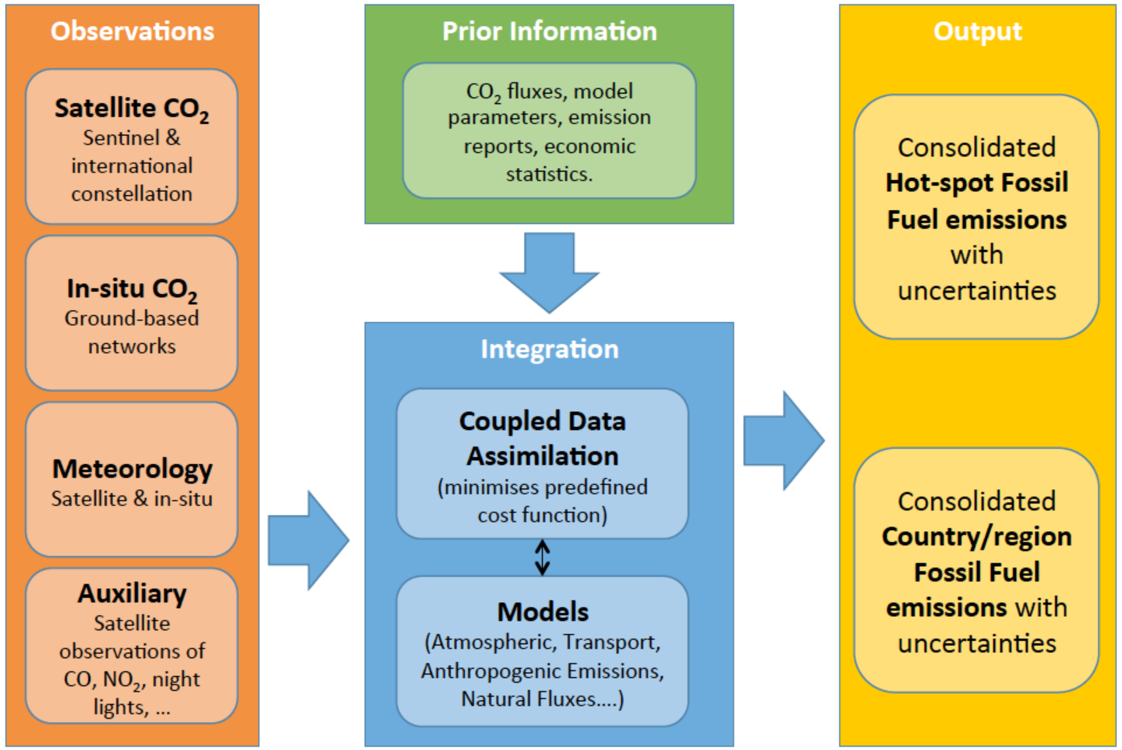
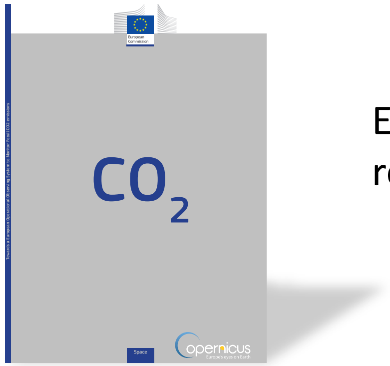
CHE Project Coordination @ECMWF

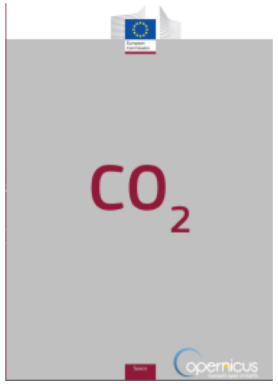
Towards a Copernicus CO_2 Service





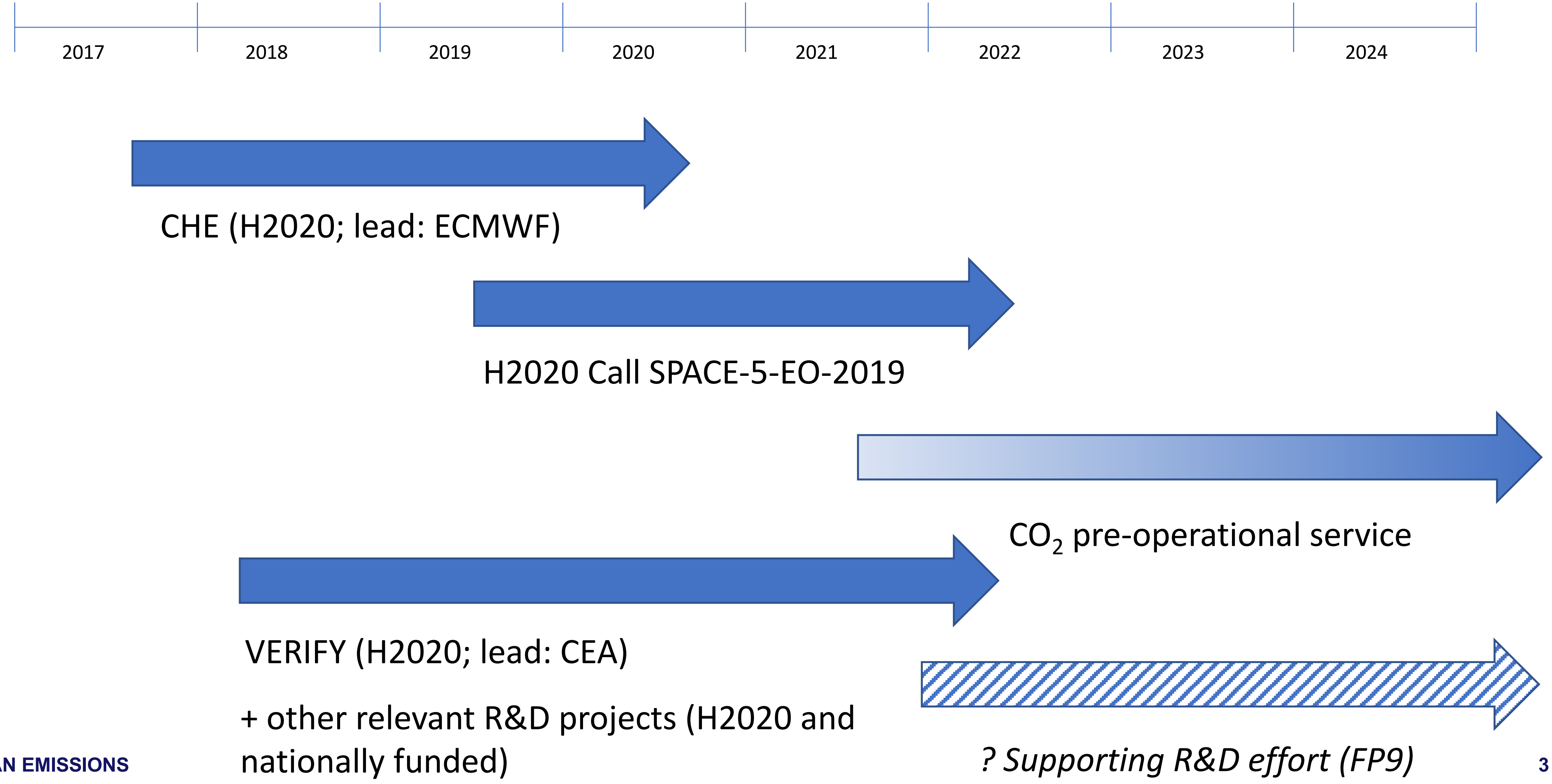


European Commission Task Force reports



Towards an operational service

International context: IG3IS, GEOCARBON, GCOS, CEOS...



Envisaged top-level outputs

Precision & Accuracy

Detection of emitting hot spots such as megacities or power plants

Monitoring the hot spot emissions to assess emission reductions of the activities

Assessing emission changes against local reduction targets to monitor impacts of the NDCs

Assessing the national emissions and changes in 5-year time steps to estimate the global stock take

Spatial and temporal resolution

CHE-CO2 Human Emission Project (& its numbers)

Aim:
Towards a European monitoring & verification support capacity for anthropogenic CO_2 emissions

How:
Monitoring/Verification System (MVS) driven by Earth observations, from remote sensing and in-situ, combined with enhanced modelling systems, that includes CO_2 fossil fuel emissions, along with other natural and anthropogenic CO_2 emissions & transport.

Why:
To support the Paris Climate Agreement and its implementation

Project Duration:
39 month

Project Funding:
3.75 ME (1.25 ME/year)

Consortium Numbers
22 partners Institutes

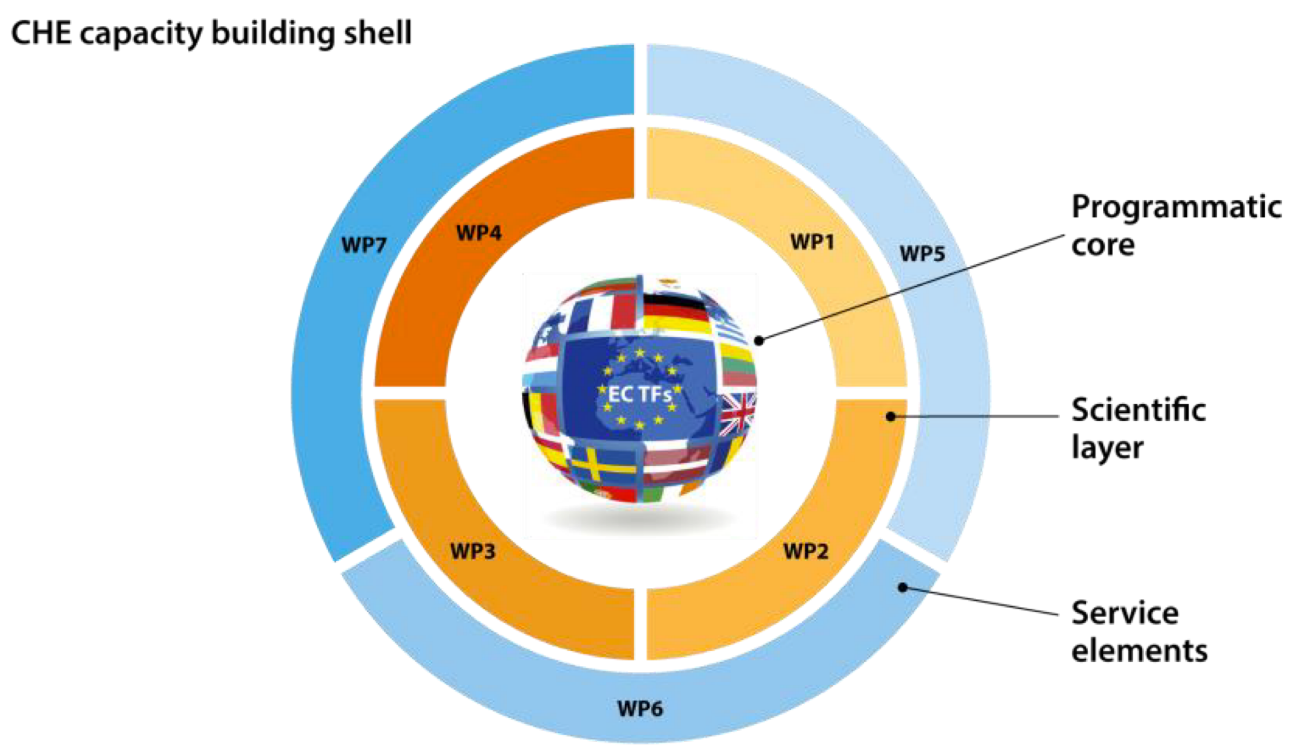
Work Content Numbers
7 work-packages:
5-Science development, **1**-International liaison, **1**-Management & Coms
7 Milestones
45 Deliverables

344.25 Person Month
(Eq 8.8 FTE)

3 Project Reviews
(M15, M27Tech, M39)

CHE Structure and Work Package Breakdown

CHE, H2020-Coordination and Support Action



CHE WBS

WP1 Coordinating Efforts on **Reconciling top-down and bottom-up estimates**, led by UEA

WP2 Coordinating Efforts on **Library of simulation**s for emissions and atmospheric transport, led by EMPA

WP3 Coordinating Efforts on **Uncertainty trade-off** for fossil fuel emissions, led by ULUND

WP4 Coordinating Efforts on **Attributing CO2 emissions from in-situ** measurements, led by CEA

WP5 Towards a prototype of a European anthropogenic emission monitoring system, led by ECMWF

WP6 International Stakeholder Coordination and Liaison, led by ECMWF

WP7 Project Management, Dissemination and Communication, led by ECMWF

T5.1 Requirements and integration options for observing system

Led by Frederic Chevallier
(LSCE)

- What are the observations required to characterize and monitor fossil fuel signal associated with emission hotspots?

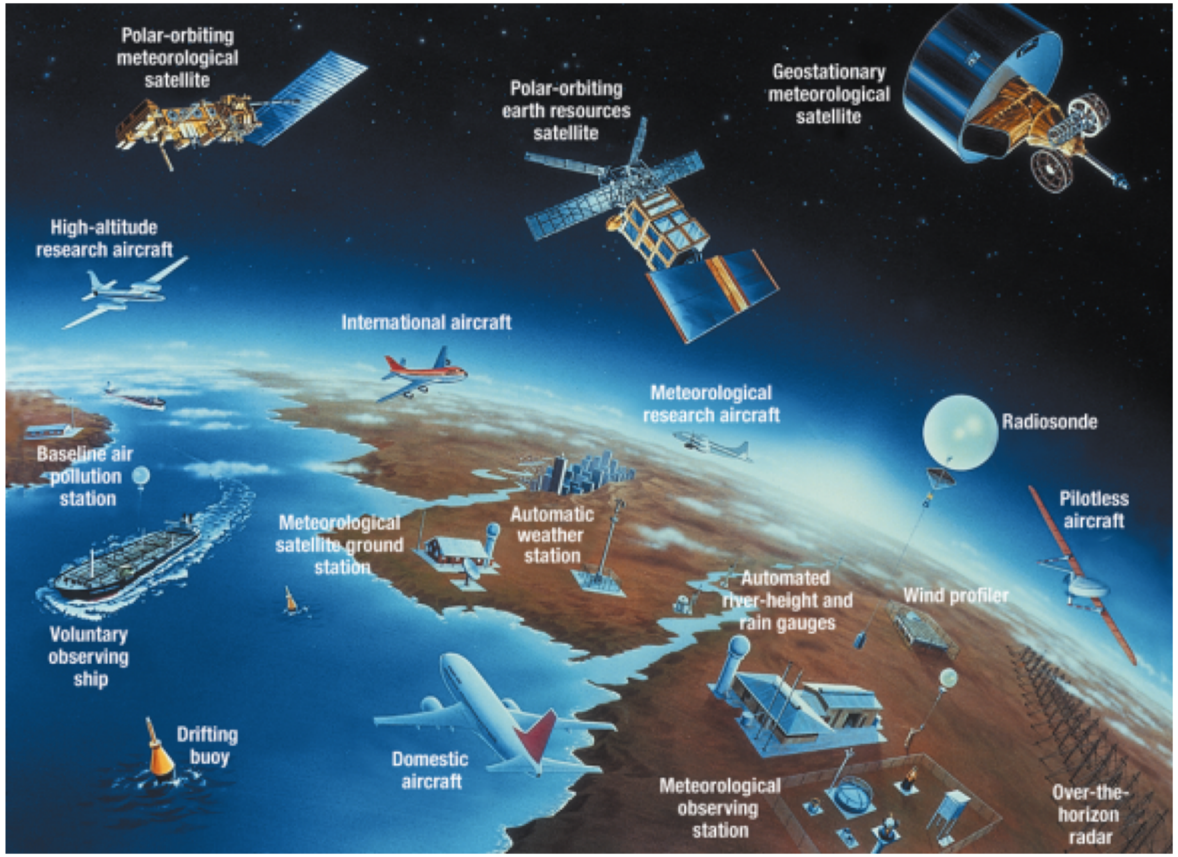
  Instrument sensors, satellite orbits and ground-based networks

- Can we design an observing system to monitor fossil fuel signal with homogeneous temporal and spatial sampling at global scale given sun-lit and cloud-free requirements of current satellites?

  Spatial and temporal coverage and resolution

- How can we monitor random and systematic errors in the observing system?

  Independent evaluation and calibration



WMO Integrated Global Observing System (WIGOS)
(Graphic: WMO)

T5.2 Requirements and integration options for CO_2 emission and transport models

Led by Anna Agusti-Panareda (ECMWF)

- What are the processes and model resolution required to interpret assimilated observations ?

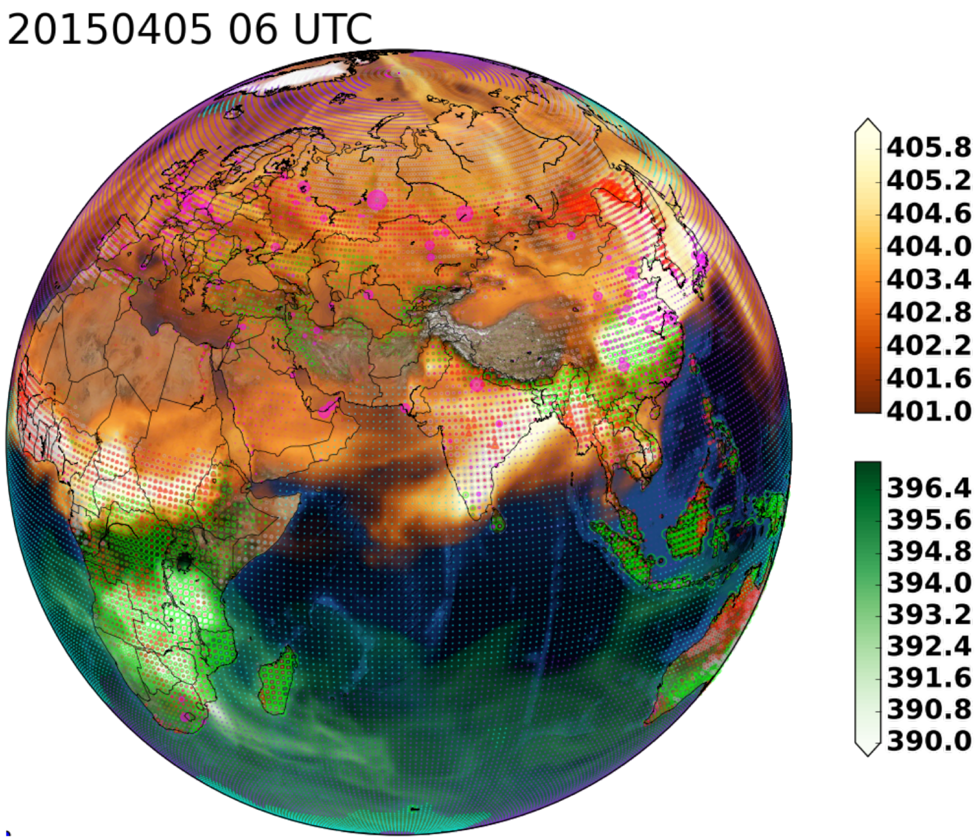
  Complexity and information in models

- How do we couple the different model components to ensure consistency and synergy between them?

  Online versus offline model components and their interactions

- How can we monitor random and systematic errors of different model components?

  Independent evaluation of model biases, mass conservation, impact of averaging/interpolation/gridding and sub-gridscale variability



Simulation of XCO_2 [ppm] from CAMS CO_2 forecast (Graphic: ECMWF)

T5.3 Requirements and integration options for data assimilation (DA) methodology

Led by Wouter Peters (Wageningen University)

- Can we estimate atmospheric CO_2 concentrations, CO_2 fluxes and model parameters relevant to fossil fuel emissions in the same DA system ?

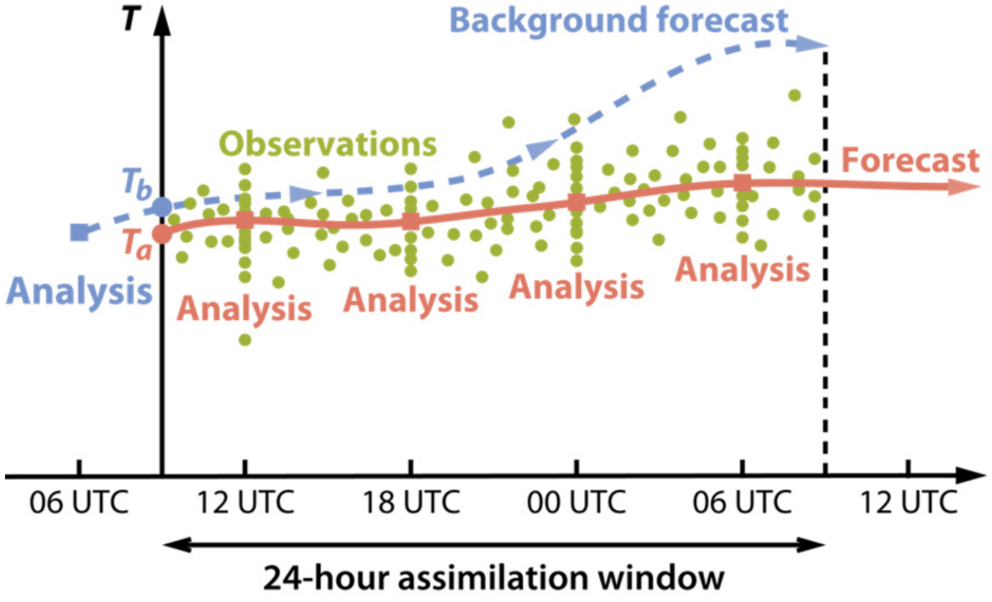
  Specification of control vector

- What is the optimal DA window considering linearity of required observation operators and potential integration with NWP?

  Optimal length of assimilation window

- How can we integrate assimilation of CO_2 and related tracers into NWP methodology ?

  Requirements for time/space discretization, covariances between weather + trace gases, weighting of different data volumes+frequencies



Schematic form of the ERA-CLIM data assimilation (Graphic: ECMWF)

T5.4 Representation of uncertainty in the integrated monitoring system

Led by Marko Scholze (Lund University)

- How can we ensure that the prescribed errors and their covariances are realistic and consistent for all system components?

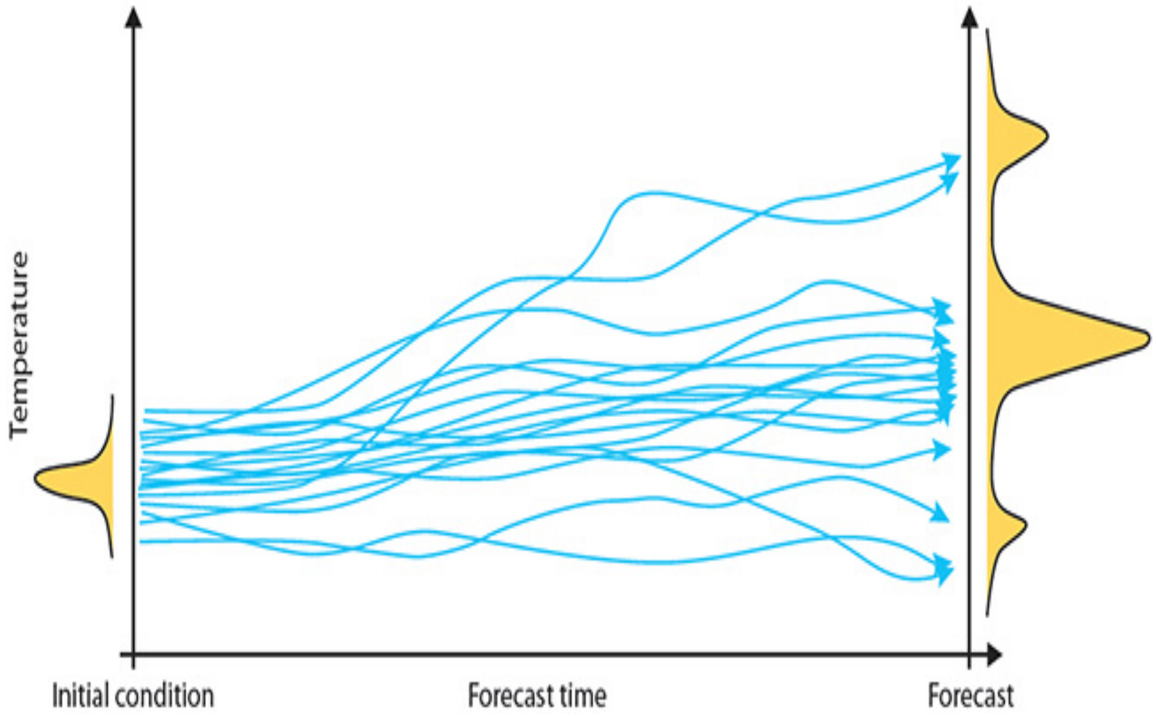
  Error characterization and monitoring of input priors, forcing data, observations, observation operators, and output posterior estimates; comparison against independent observations

- How can we deal with systematic errors?

  Online versus offline bias corrections

- Are there any assumptions/limitations in the uncertainty propagation in FFDAS ?

  Linearity and missing processes in models



An ensemble of forecasts produces a range of possible scenarios. The distribution of the ensemble members gives an indication of the likelihood of occurrence of those scenarios.
From Sarah-Jane Lock (Graphic: ECMWF)

T5.5 Service elements of end-to-end monitoring system

Led by Gianpaolo Balsamo (ECMWF)

- Can we propose a distributed/consistent processing chain integrating all building blocks?

  Blueprint of integrated end-to-end monitoring system

- What are the key performance indicators of input/output channels and verification process of monitored target ?

  Verification strategy

- Is there any bottleneck that could hamper operational implementation and efficiency of monitoring system?

  Operational constraints, e.g. computing resources, data access, timeliness in delivery

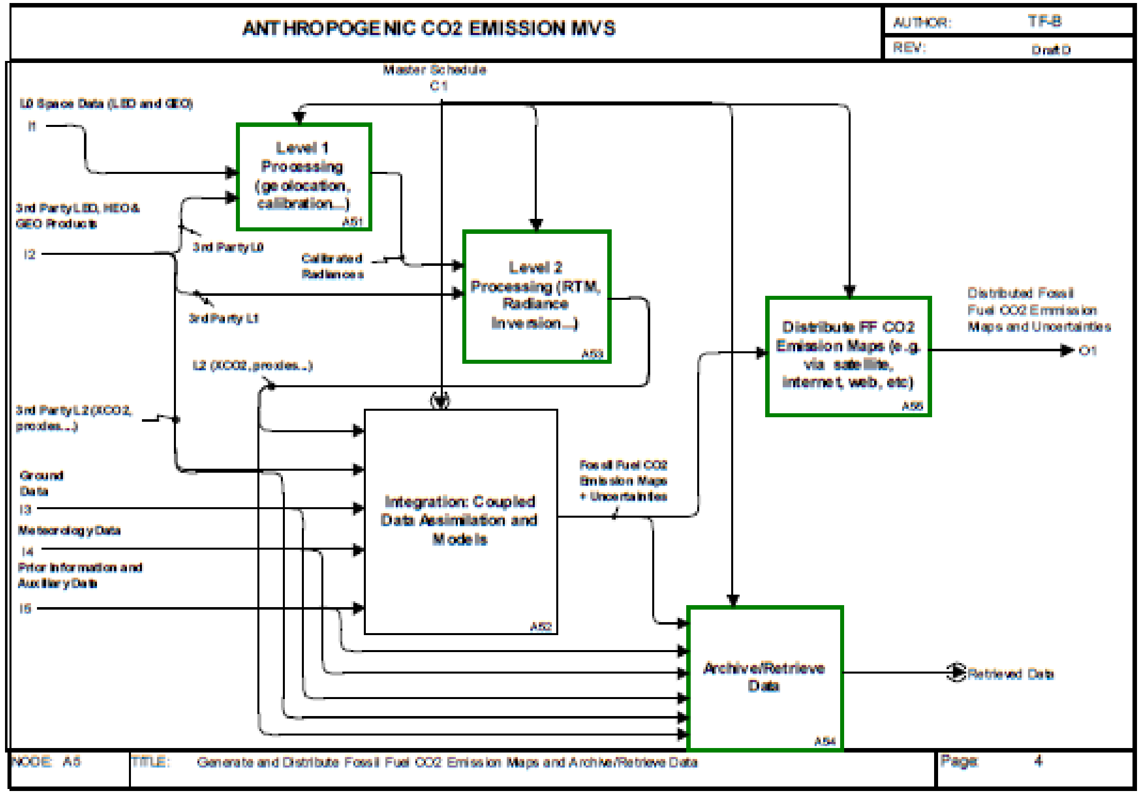


Diagram of Anthropogenic CO_2 emission Monitoring and Verification Support (MVS) from report by CO_2 monitoring Task Force – sub-task B (Graphic: European Commission)

CHE Connectivity & Stewardship

CHE Project steering is further ensured by the following roles:

External Advisory Board (EAB) and External Expert Group (EEG)

EAB Han Dolman (Chair of EAB, VU NL), Pierre-Yves Le Traon (CMEMS, France), Sonia Seneviratne (ETH, Switzerland), Guy Brasseur (WCRP, Germany),Werner Kutsch (ICOS, Finland)

EEG Peter Rayner (Chair of EEG, U MELBOURNE, AU), Kevin Gurney (ARIZONA SU, US), Kevin Bowman (NASA JPL, US), Ning Zeng (U Maryland), Arlyn Andrews (NOAA, US), David Crisp (NASA JPL, US), Pep Canadell (CSIRO, AU), Saroja Polavarapu (ECCC, Canada), Jing M. Chen (U NANJING, China, U TORONTO, Canada), Lu Daren (CAS, Tansat-PI, China), Chris O'Dell (CSU, US), Shamil Maksyutov (CGER/NIES, Japan), Paul Palmer (EDINBURGH, UK), Heather Graven (IMPERIAL, UK), Alex Vermeulen (Carbon Portal, Sweden)

European Commission

esa

EUMETSAT

ECMWF

Copernicus
Europe's eyes on Earth

CO_2 Task Force

WORLD METEOROLOGICAL ORGANIZATION
WEATHER CLIMATE WATER

GAW

IG³IS

GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC INTERNATIONAL COUNCIL FOR SCIENCE UN environment

CEOS Committee on Earth Observation Satellites

GEO

United Nations
Framework Convention on Climate Change

European Commission

HORIZON 2020
The EU Framework Programme for Research and Innovation

VERIFY

TRACE
TRAcking Carbon Emissions

Others...

EU Member States

CHE Project Coordination – ECMWF

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