ICOS INTEGRATED CARBON OBSERVATION SYSTEM


The ENVRI Community landscape
Single domain
AnaEE
DiSSCo
EMPHASIS
INTERACT
EPOS
Eurofleets+
Euro-Argo
GROOM RI
JERICO-RI
SeaDataNet
ACTRIS
ARISE
EISCAT3D
EUFAR
HEMERA
IAGOS
Multi domain
EuroGOOS
ICOS
IS-ENES
SIOS
DANUBIUS-RI
eLTER
EMBRC
LifeWatch
AQUACOSM-plus
EMSO

Services provided by the environmental research infrastructures

Data services

- **Open and FAIR environmental data** from the four domains of the Earth system
- **Data offered through specific RI data portals**, and soon also through one ENVRI-hub interface integrated in the European Open Science Cloud
- **Elaborated data products**

Access services

- **Physical, remote, and virtual access** to observational and exploratory platforms, experimental facilities, scientific resources (e.g. samples, specimen, etc.)

Computational services

- **Virtual research environments**
- **Data visualisation tools modelling platforms**
- **Data analysis tools & software**

Support services

- **Education and training**
- **Support for research**
- **Design and planning other practical services**

Readiness levels of the research infrastructures

The research infrastructures in the ENVRI Community have reached different levels of maturity or "readiness levels" (RL), which bear a direct impact both on their practice and/or their capacity to deliver services to their users, as well as on the scope of the delivered services themselves.

The RIs featured in this ENVRI brochure can be at one of the four following stages: in planning, under construction, partially operational, and fully operational. The attribution of the stage to a RI depends on the level of implementation of the Long Term Sustainability (LTS) indicators:

- ensuring scientific excellence
- attracting and training the managers, operators and users of tomorrow
- unlocking the innovation potential of RI
- measuring SocioEconomic Impact of RI
- exploiting better the data generated by RI Framework conditions for effective governance and sustainable longterm funding for RI
- structuring the international outreach of RI

In planning (RL3): LTS prepared with agreed policies in development
Under construction (RL4): LTS under construction and policies in place
Partially operational: some LTS available and operational
Fully operational (RL5): all LTS available and fully operational

Types of research infrastructures: single-sited or distributed

The research infrastructures in the ENVRI Community can be organised in two groups: single-sited or distributed. Single-sited RIs are "research plants" in a single or a few, hardware-dependent site (such as extreme laser sites, for example), designed for user access either in-person or remotely. Distributed RIs are networks of observatories that can be either physical or virtual, consisting of a central hub and interlinked national nodes or networks.

01/ Introduction

ICOS | Integrated Carbon Observation System

MONITORING GREENHOUSE GASES IN EUROPE

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The Integrated Carbon Observation System, **ICOS**

- ICOS provides **standardized**, **high-precision, near-real-time** and **open data**
- **Main greenhouse gases,** concentrations and fluxes in three domains:
  Atmosphere, Ecosystem and Ocean
- A network of **180 measurement stations** across **16 countries in Europe**
- Head Office in **Helsinki**, Finland (~20 pax)
  Carbon Portal in **Lund**, Sweden (~20 pax)
- **FAIR data** (Findable, Accessible, Interoperable, and Reusable) – **Labeled (quality) stations**
- **Long-term datasets** covering the carbon cycle

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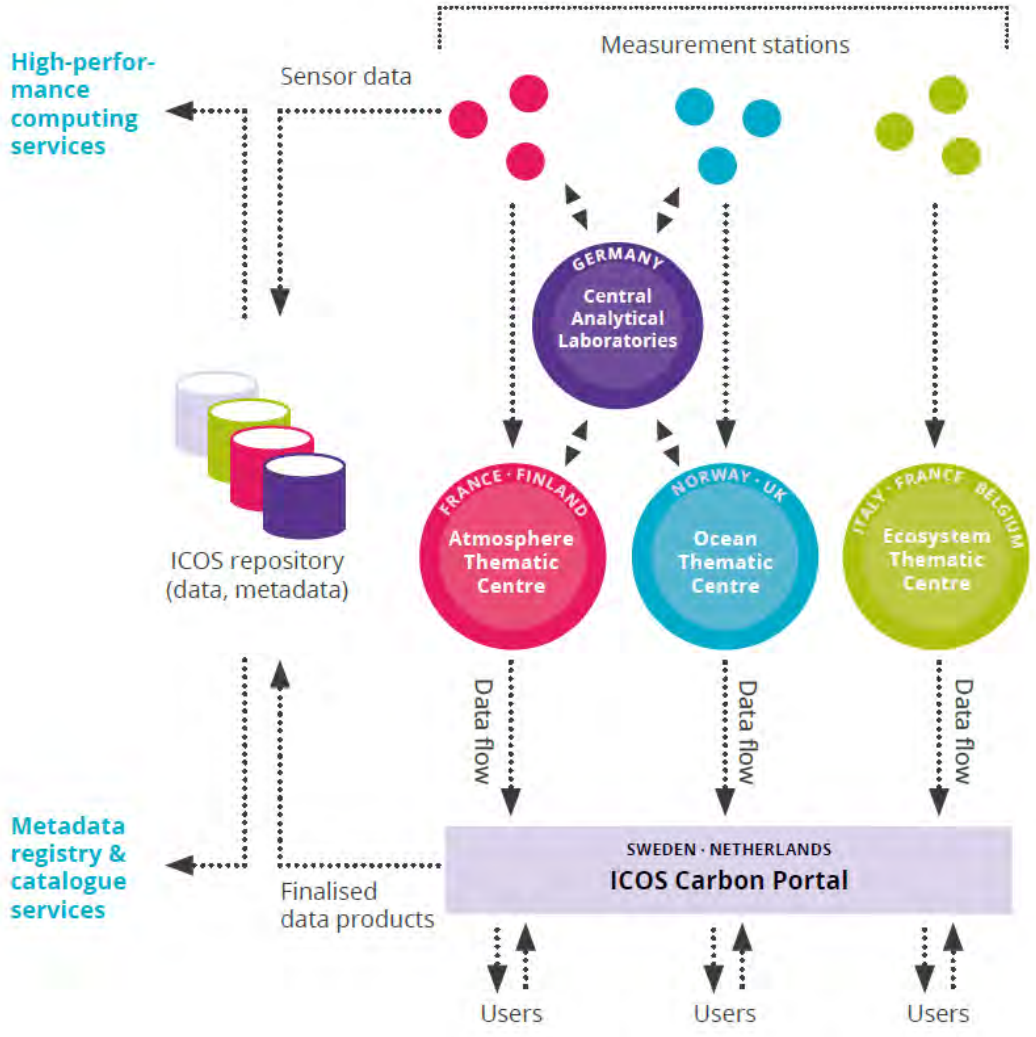
A reliable data life cycle

- **Standardized measurements** in monitoring stations across Europe
- **Standardized data processing** and quality control in Thematic Centres
- **Centralized data provenance, curation and archiving** in ICOS Carbon Portal
- **Data infrastructure from stations to user** (including data analysis tools for scientists)



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Atmosphere measurements

- Continuous sampling of the concentration of CO_2, CH_4 and CO at several heights, optionally N_2O
- Periodic sampling of several other gases, including ^{14}C in CO_2
- Meteorological parameters
- Radon, boundary layer height

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Ecosystem measurements

- Covering a wide range of ecosystem types: forests, grasslands, croplands, wetlands, lakes
- Fluxes of CO_2, H_2O and H_2 using the eddy covariance method
- Meteorological parameters, including air and soil properties, radiation (LW, SW)
- Vegetation measurements

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Ocean measurements

- Stations in buoys, towers and ships of opportunity
- Sea surface pCO_2
- Sea surface temperature, salinity
- Oxygen, alkalinity, dissolved inorganic carbon, nutrients

Direct high precision in situ measurements of sea surface pCO_2 are needed to estimate the ocean carbon sink

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From data to impact

- Data products and services (flux maps, elaborated products)
- Evolution through European projects (HoEU), e.g. urban observations

- Policy support
- Development of MRV support systems (Copernicus, inventory agencies)
- Support for regional networks, e.g. Africa
- Alliances, e.g. Global Ecosystem Research Infrastructure (GERI)
- Connection to global frameworks (WMO/G3W, GEO, UNFCCC/COP…)
- FLUXES, annual publication on topical issues

Useful links

ICOS Handbook 2022
www.icos-ri.eu/resources/brochures

ICOS Science case
https://doi.org/10.1175/BAMS-D-19-0364.1

FLUXES, the European GHG Bulletin
http://fluxes. science

KADI, observations for Africa
www.kadi-project.eu

GERI, Australia, China, South Africa, U.S.
www.global-ecosystem-ri.org

ICOS Cities, urban measurements
www.icos-cities.eu

G3W, Global Greenhouse Gas Watch
www.wmo.int/activities/global-greenhouse-gas-watch

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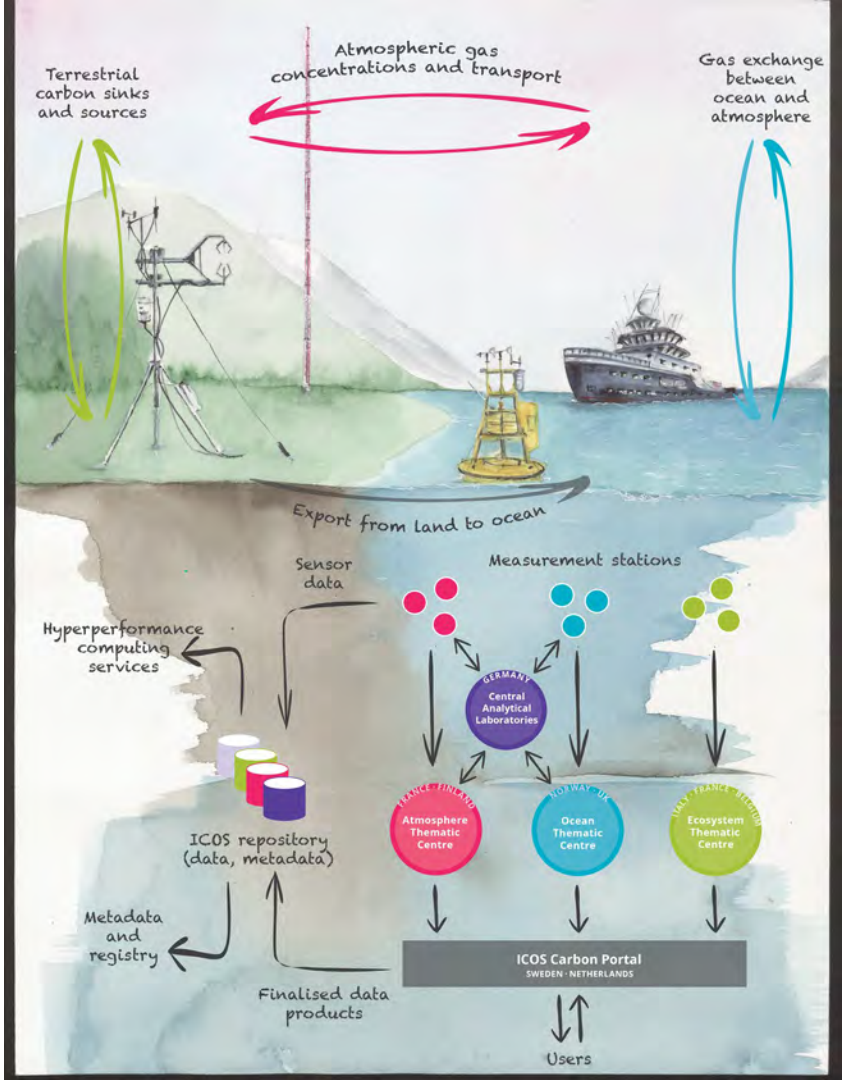

Thank you!

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