ICOS | INTEGRATED CARBON OBSERVATION SYSTEM

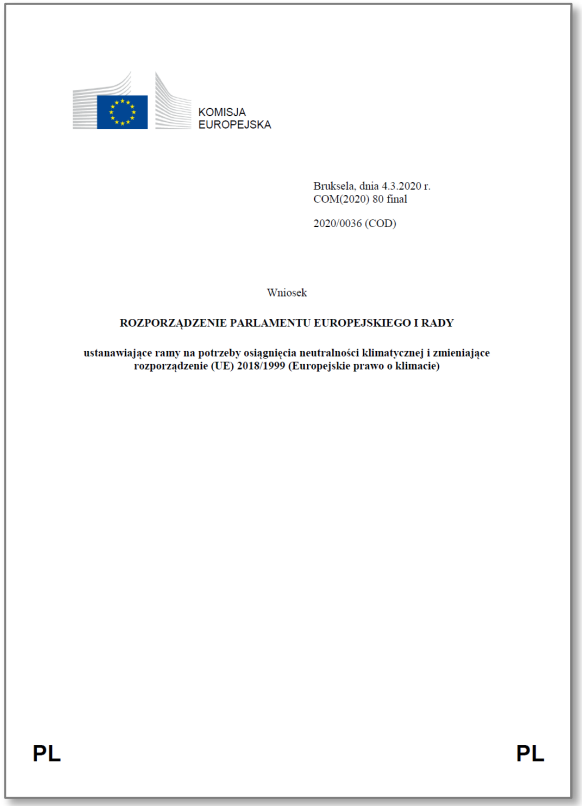
THE INTEGRATED CARBON OBSERVATION SYSTEM EUROPEAN GREENHOUSE GAS RESEARCH ACROSS LAND, OCEAN AND ATMOSPHERE

Werner L Kutsch, Director General ICOS ERIC

“Zero Emission Poland – Challenges of the Future”
30.3.2022

The European Climate Law (Europejskie prawo o klimacie)

The European Council has set building a climate-neutral, green, fair and social Europe as one of the main four priorities in its Strategic Agenda for 2019–2024. In its conclusions of 12 December 2019, the European Council, **in the light of the latest available science** and of the need to step up global climate action, endorsed the objective of **achieving a climate-neutral EU by 2050**, in line with the objectives of the Paris Agreement.



KOMISJA EUROPEJSKA

Bruksela, dnia 4.3.2020 r.
COM(2020) 80 final

2020/0036 (COD)

Wniosek

ROZPORZĄDZENIE PARLAMENTU EUROPEJSKIEGO I RADY

ustanawiające ramy na potrzeby osiągnięcia neutralności klimatycznej i zmieniające rozporządzenie (UE) 2018/1999 (Europejskie prawo o klimacie)

PL **PL**

Direct link to document

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Cel neutralności klimatycznej

Artykuł 2

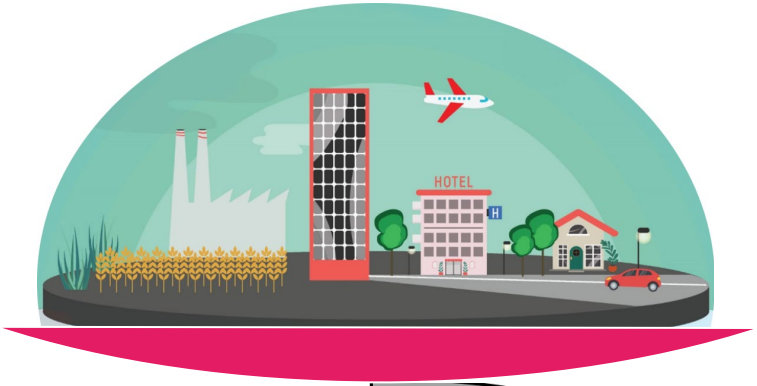
Cel neutralności klimatycznej

1. Emisje i pochłanianie gazów cieplarnianych w całej Unii, uregulowane przez prawo Unii, należy zrównoważyć najpóźniej do 2050 r., tym samym zmniejszając emisje do poziomu zerowego netto w tym terminie.

2. Właściwe instytucje Unii i państwa członkowskie wprowadzają odpowiednio na poziomie unijnym i krajowym środki niezbędne, by umożliwić wspólne osiągnięcie celu neutralności klimatycznej określonego w ust. 1, z uwzględnieniem znaczenia wspierania sprawiedliwości i solidarności między państwami członkowskimi.

Emissions – Removals = ΔConcentration

Emissions



Removals

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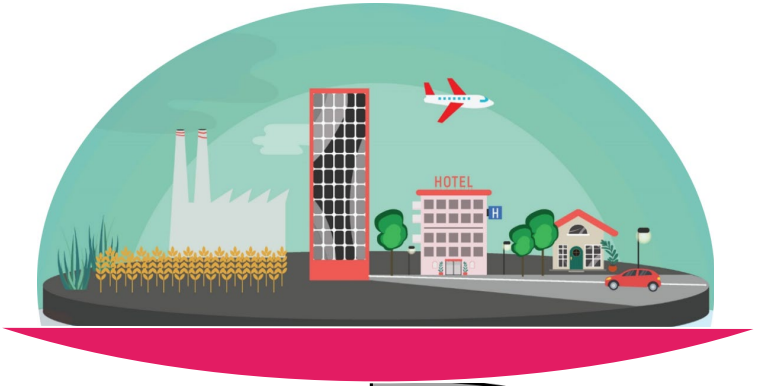
Emissions – Removals = ΔConcentration

Emissions



Removals

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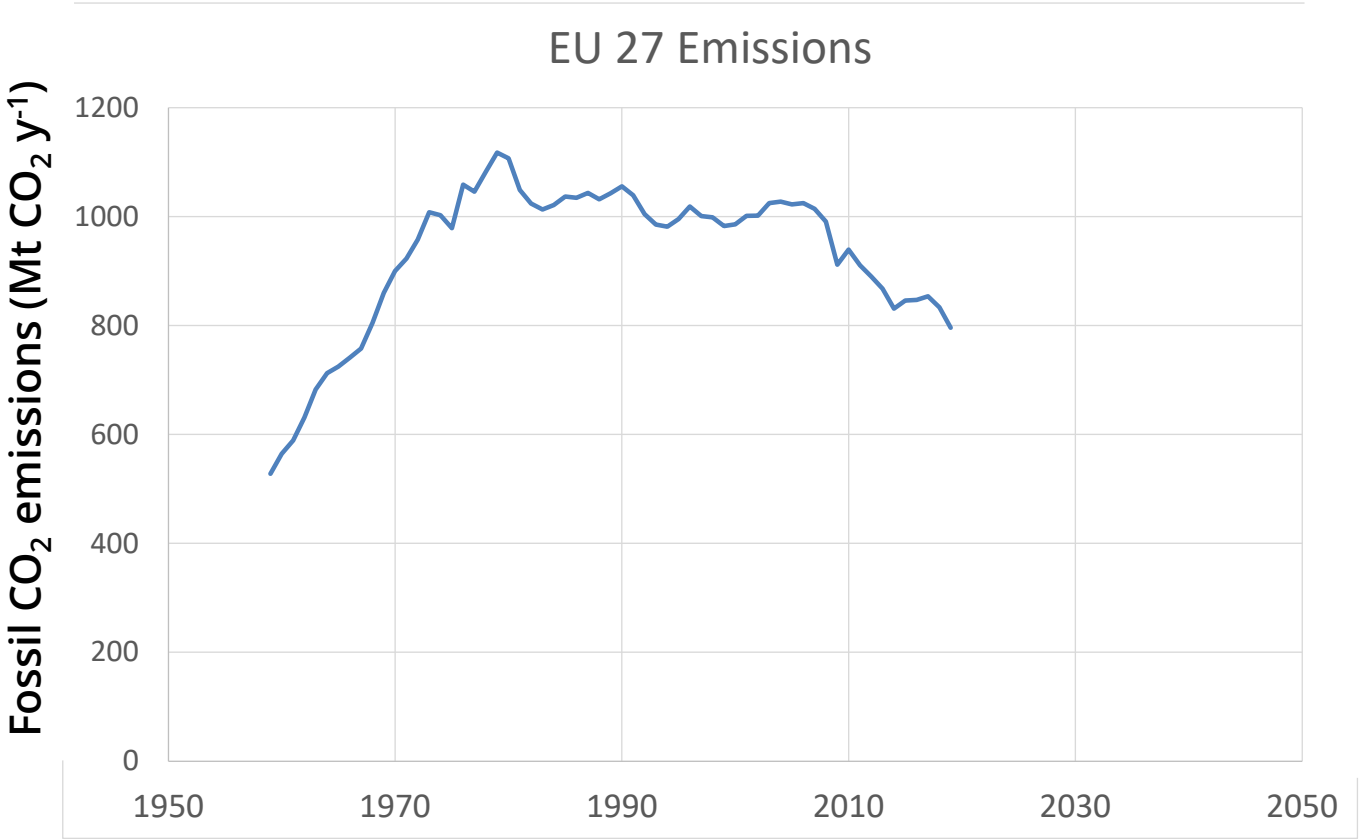
The need to enhance the EU's carbon sink



data doi:
10.18160/gcp-2020

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

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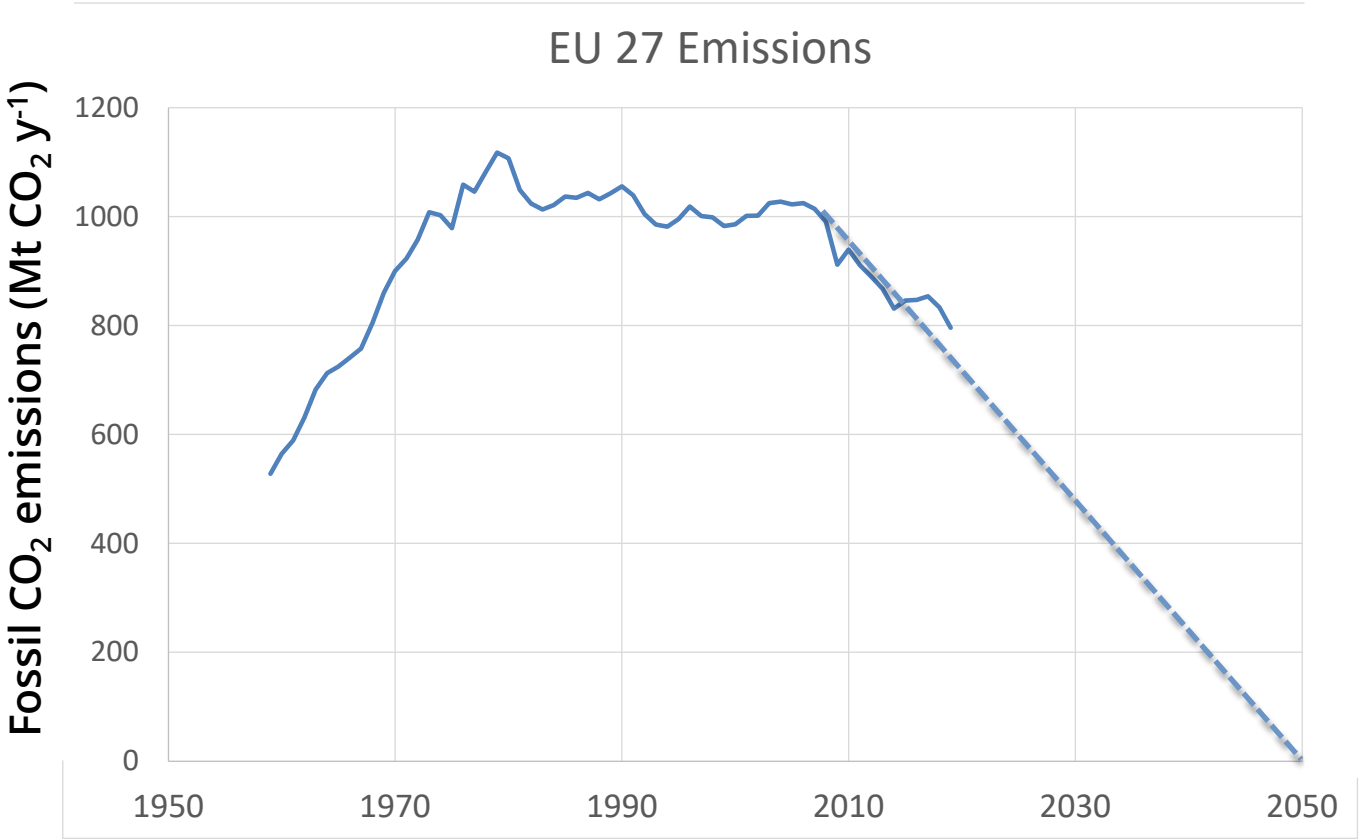

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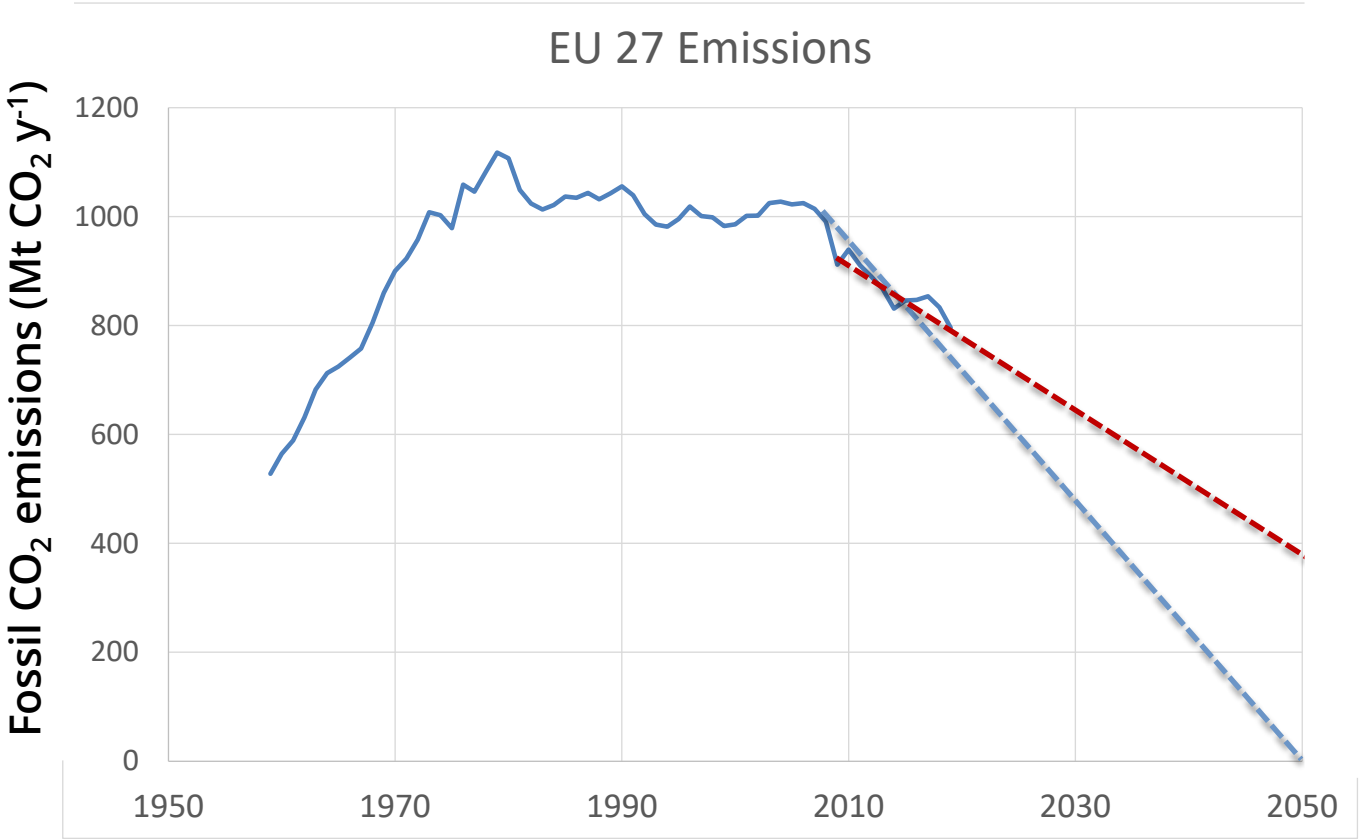
The need to enhance the EU's carbon sink



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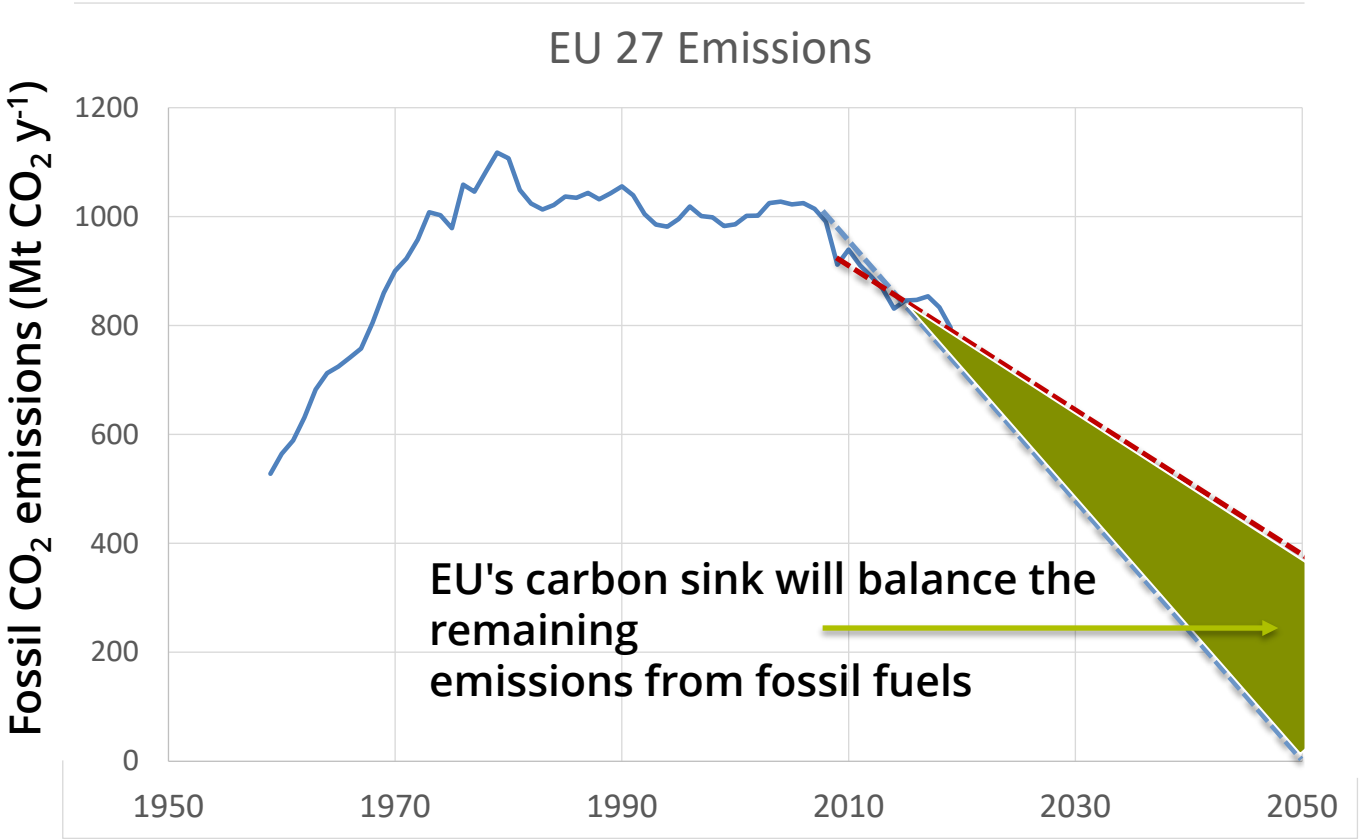
The need to enhance the EU's carbon sink



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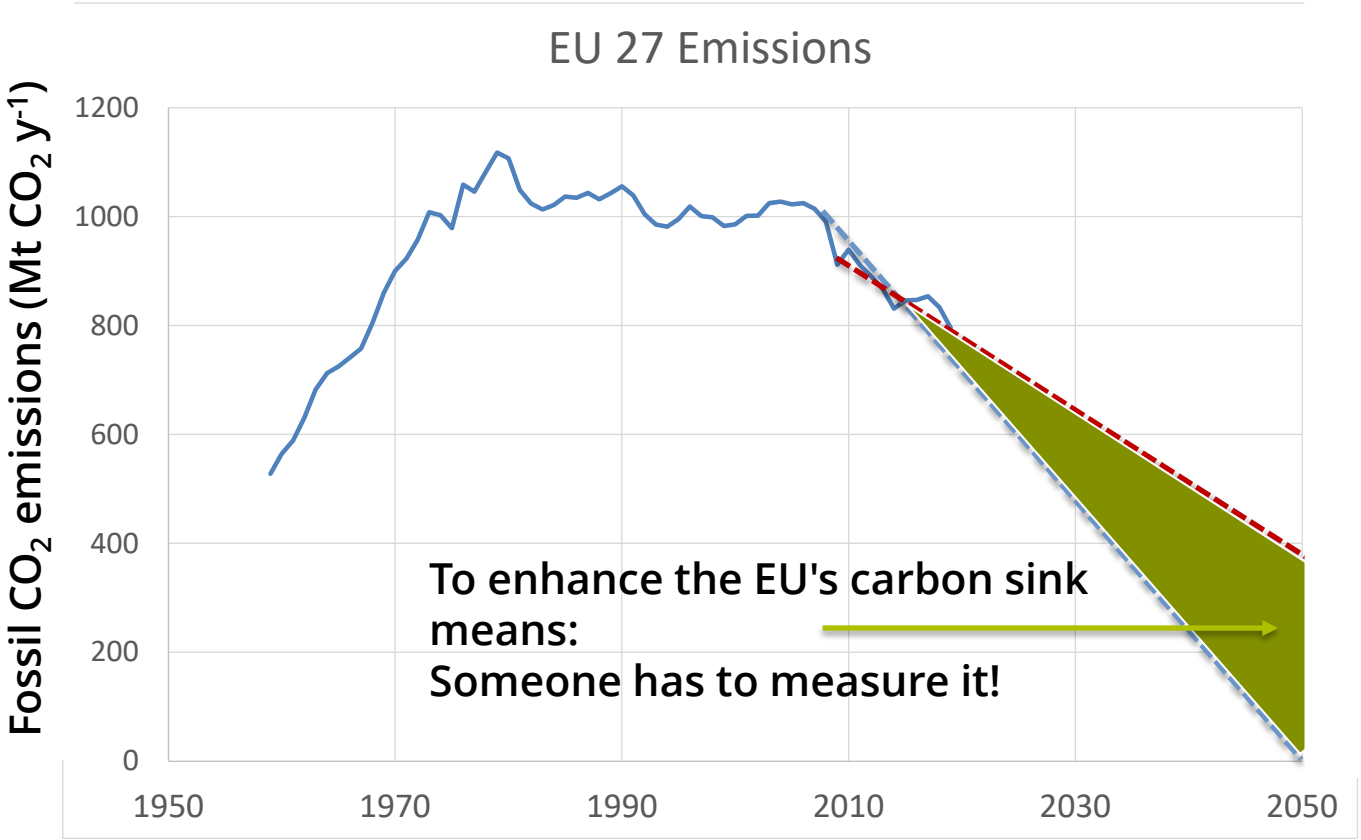

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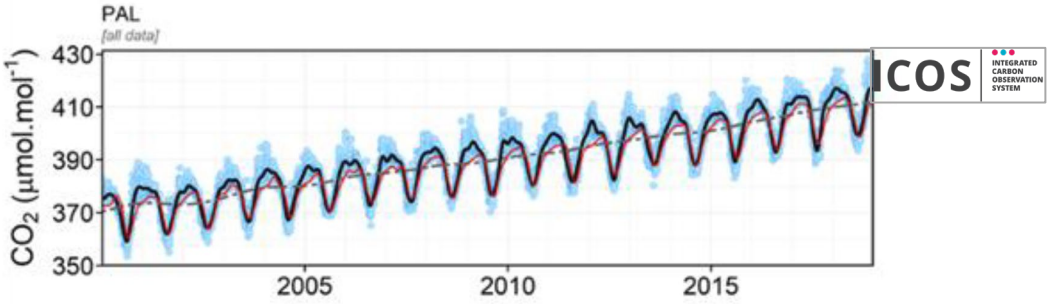
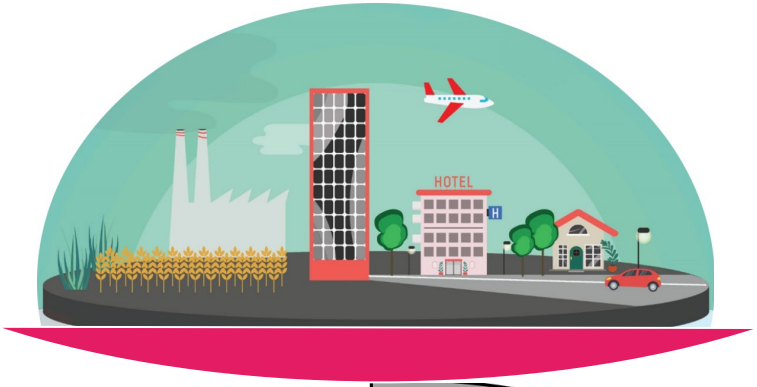
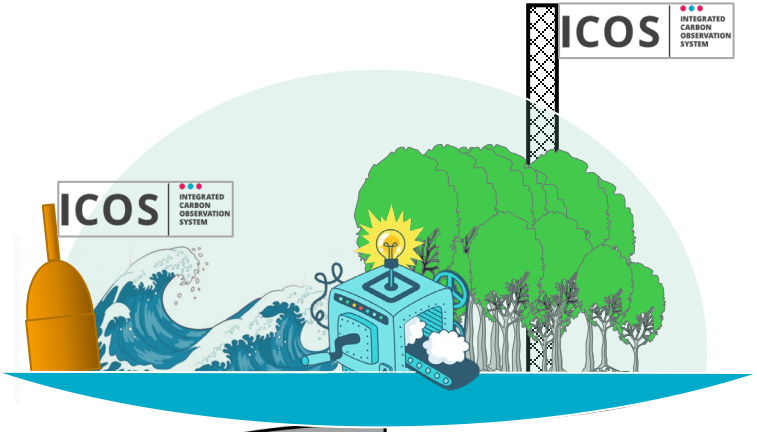


Emissions



Removals



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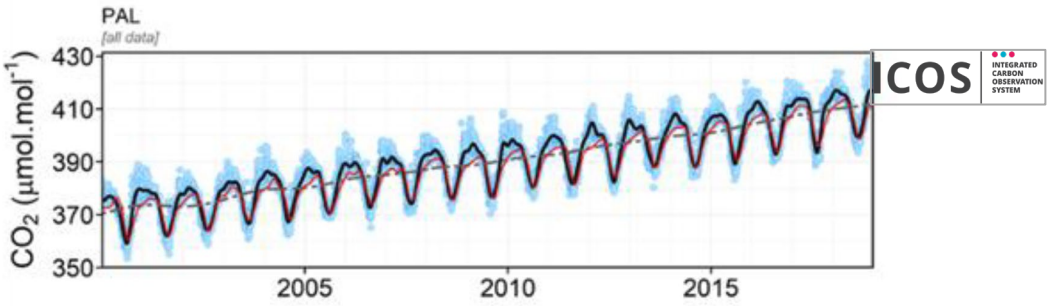
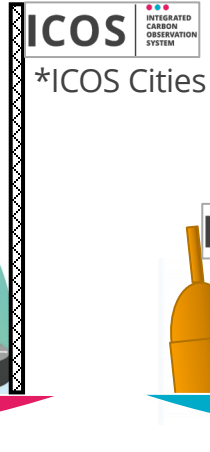
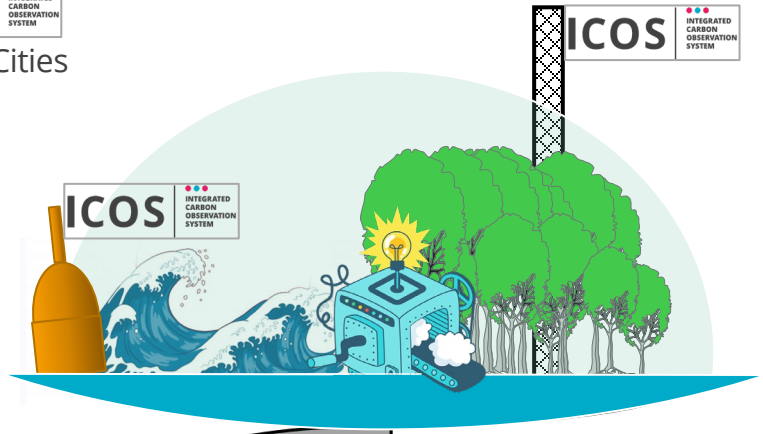


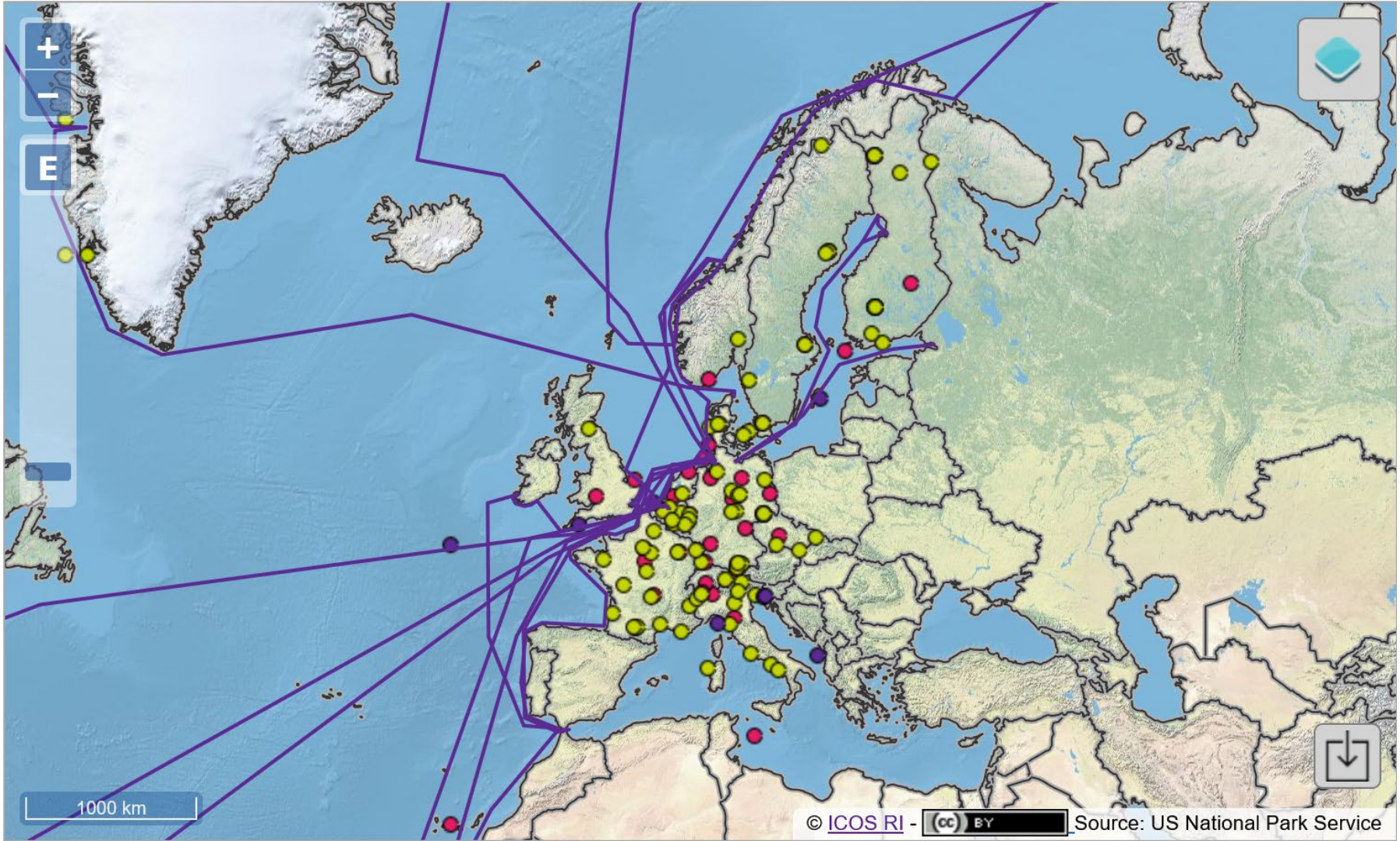
Emissions



Removals

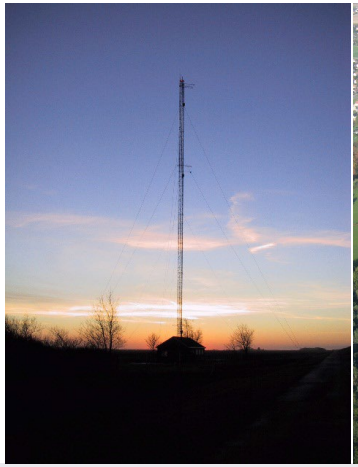


ICOS


+
−
E
1000 km
© ICOS RI - CC BY Source: US National Park Service

What does ICOS do?
Methods
ICOS
INTEGRATED
CARBON
OBSERVATION
SYSTEM

In situ atmosphere measurements



ICOS Carbon Portal

Home Data Other services About Help

Discover our data

Discover our data

Here you can search for ICOS data. Below you can pre-select if you want to search for **observational** data from the ecosystem, atmosphere and ocean stations or **elaborated products** produced from ICOS or other data, before coming to the Data Portal. After selecting data sets in the Portal you can preview the data. Put the data sets you like into a cart. From there, you can visualize again or download all or parts of the data set contents. A more detailed description of the data download process is given under getting started.

Station of the day is Hyltemossa:

HTM 150m co2

Sampled 2019-09-21

405.2 ppm mean

402 min Preview

409 max Download

Day Month Year

ICOS

HTM 150m ch4

Sampled 2019-09-21

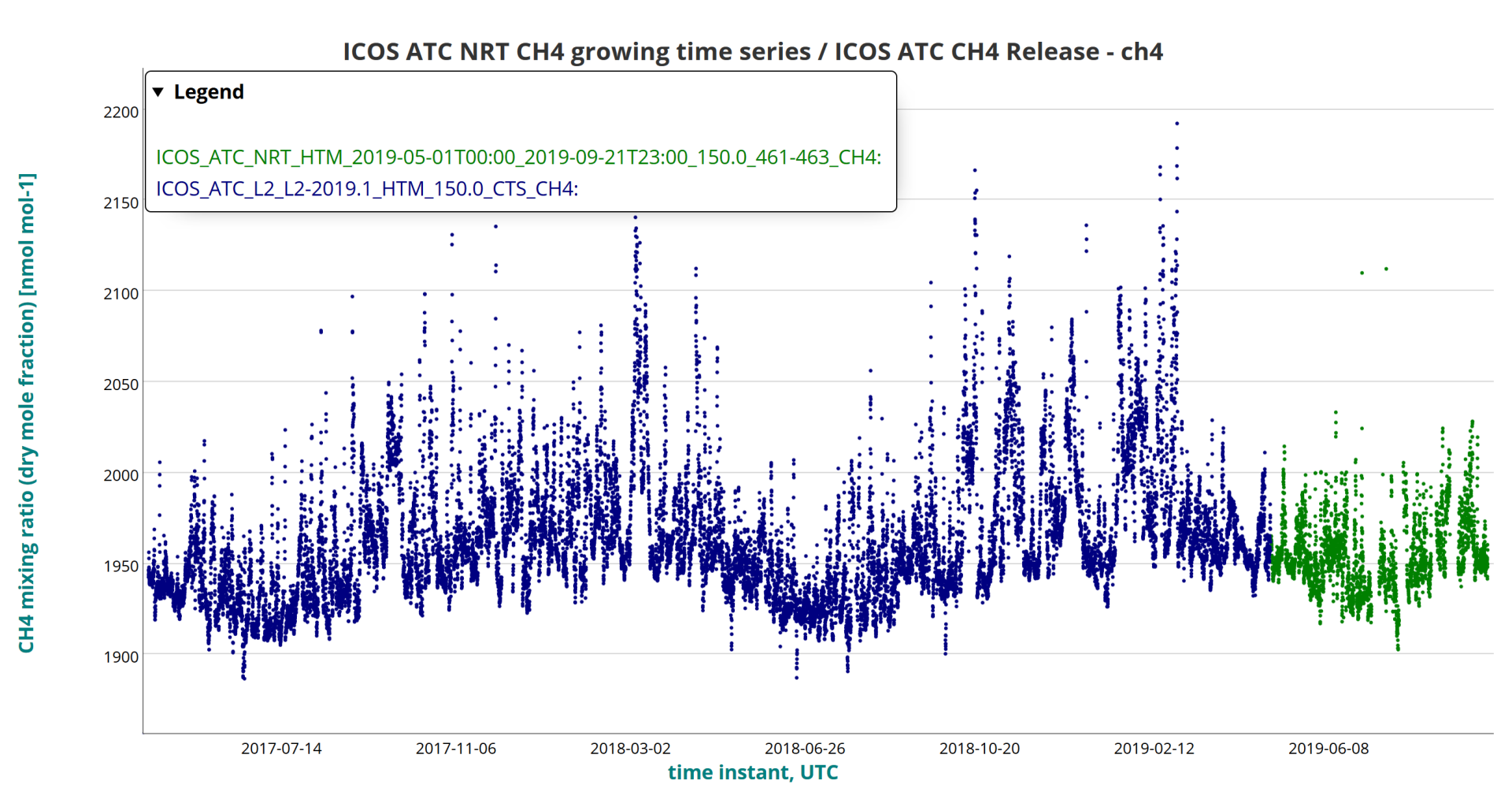
1950.9 ppb mean

1942 min Preview

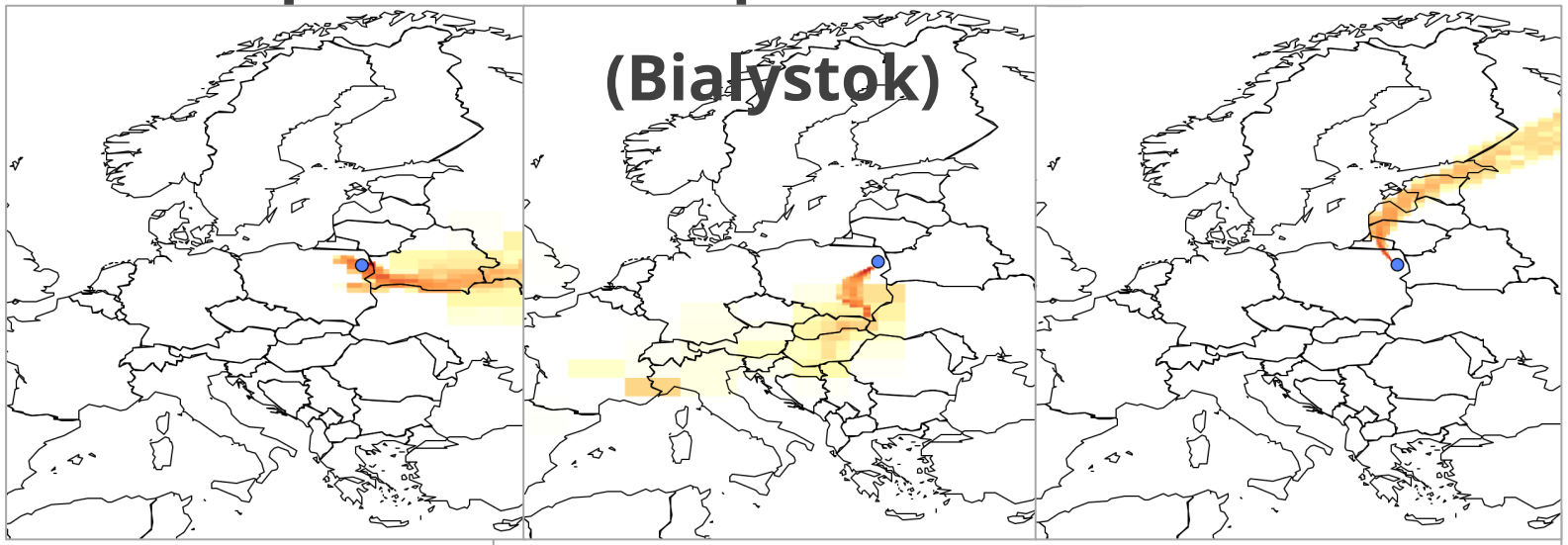
1961 max Download

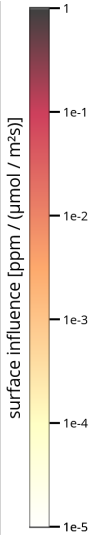
Day Month Year

ICOS


ICOS ATC NRT CH4 growing time series / ICOS ATC CH4 Release - ch4
Legend
ICOS_ATC_NRT_HTM_2019-05-01T00:00_2019-09-21T23:00_150.0_461-463_CH4:
ICOS_ATC_L2_L2-2019.1_HTM_150.0_CTS_CH4:
CH4 mixing ratio (dry mole fraction) [nmol mol-1]
2200
2150
2100
2050
2000
1950
1900
2017-07-14
2017-11-06
2018-03-02
2018-06-26
2018-10-20
2019-02-12
2019-06-08
time instant, UTC

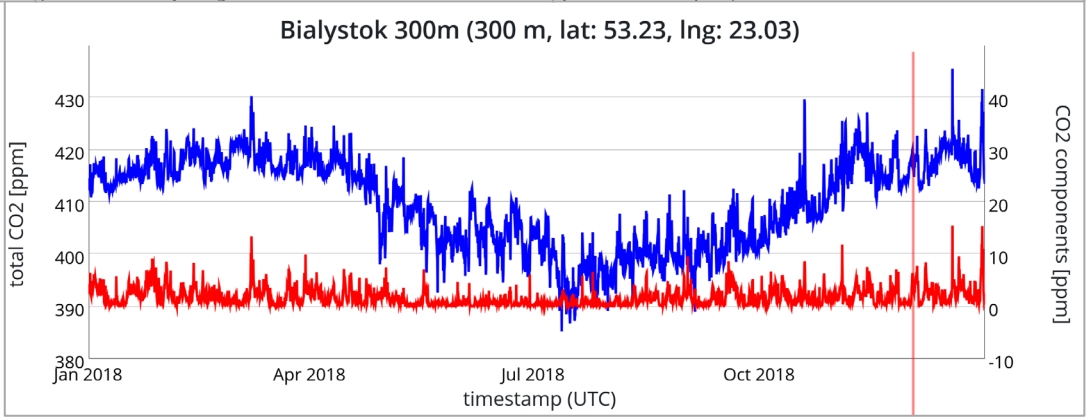
Footprint of atmosphere measurements





Calculated by using an atmospheric transport model (STILT)

https://stilt.icos-cp.eu/viewer/



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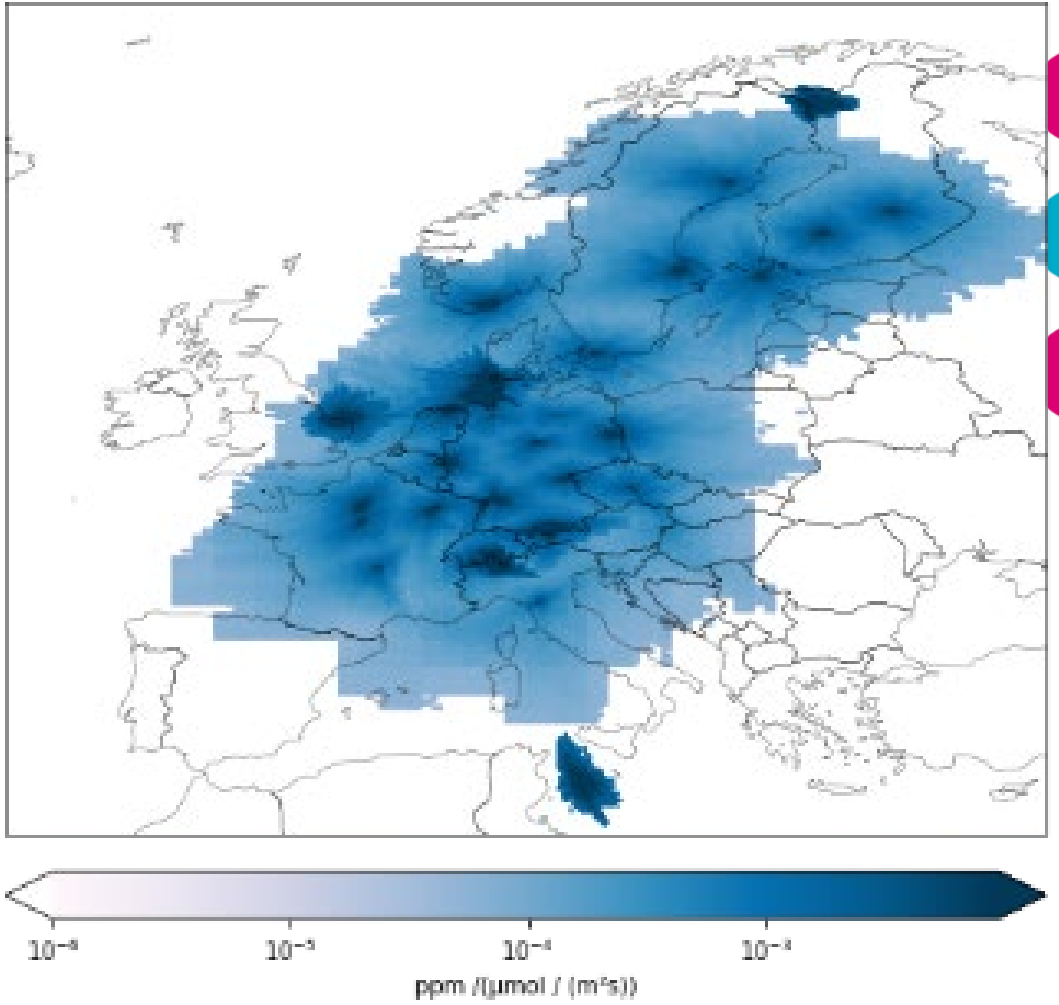
The overall footprint of the current ICOS network of labelled stations



→ important input to inverse models

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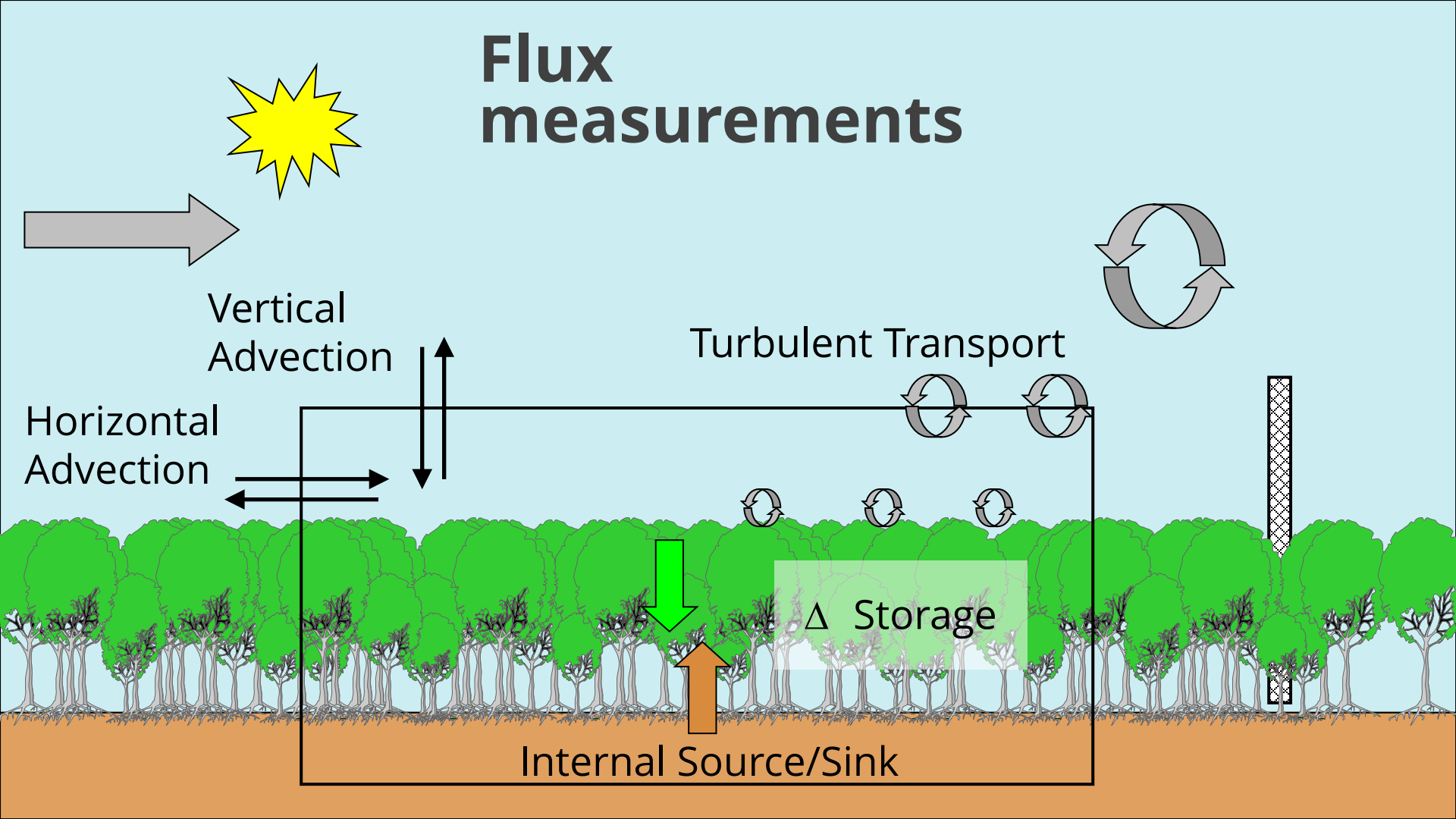
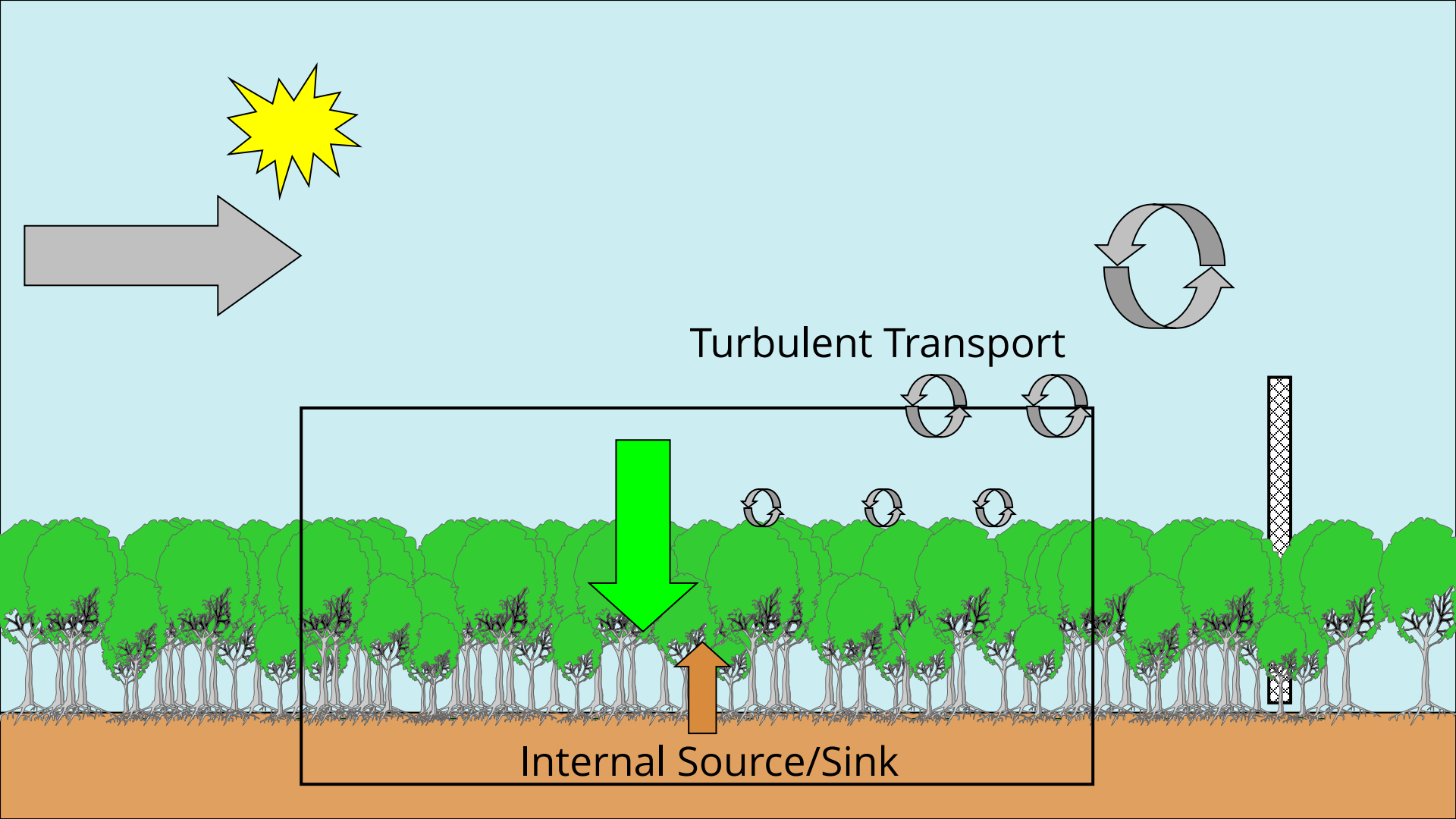
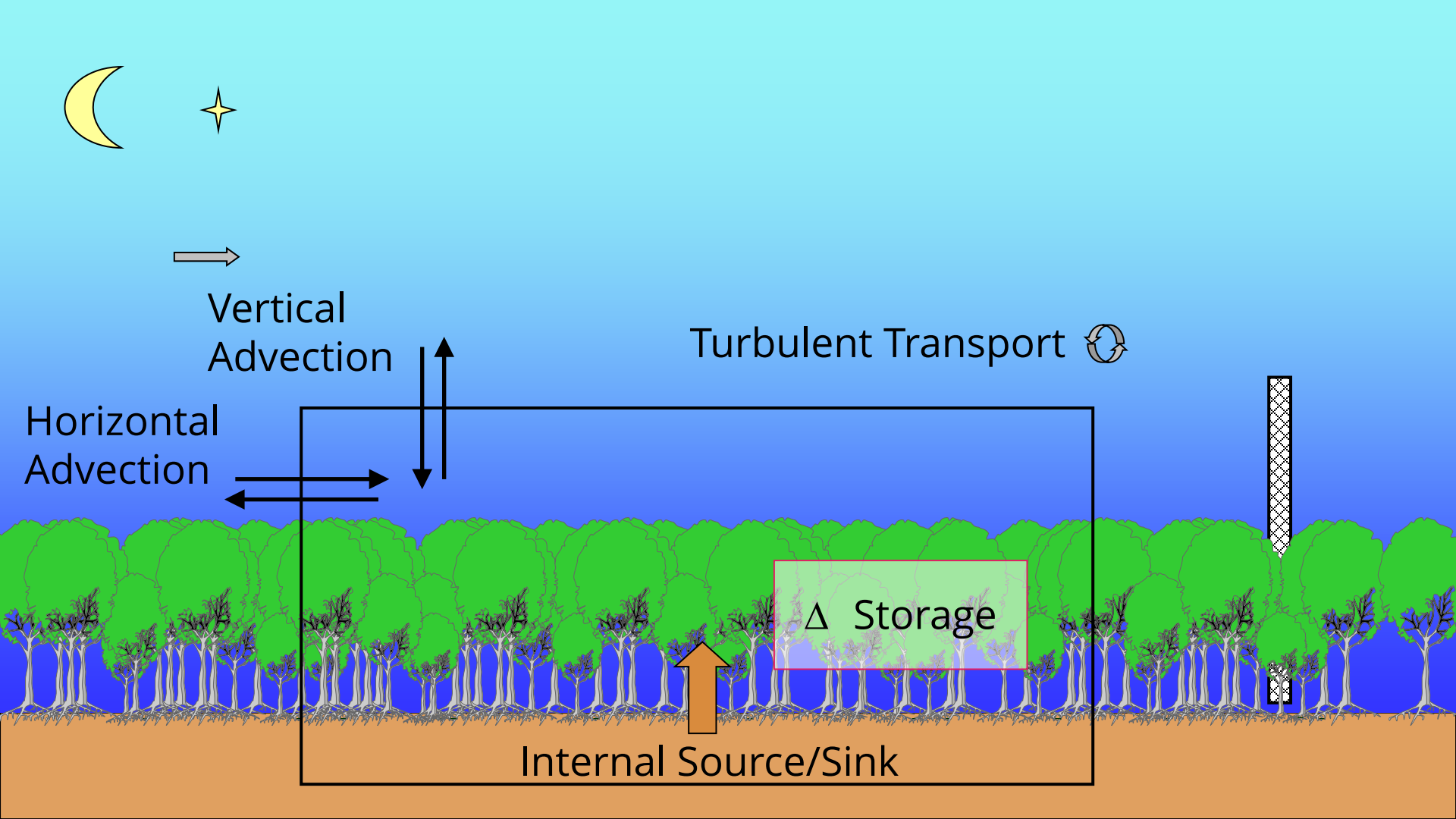
In situ ecosystem measurements


Flux measurements
Vertical Advection
Turbulent Transport
Horizontal Advection
Δ Storage
Internal Source/Sink

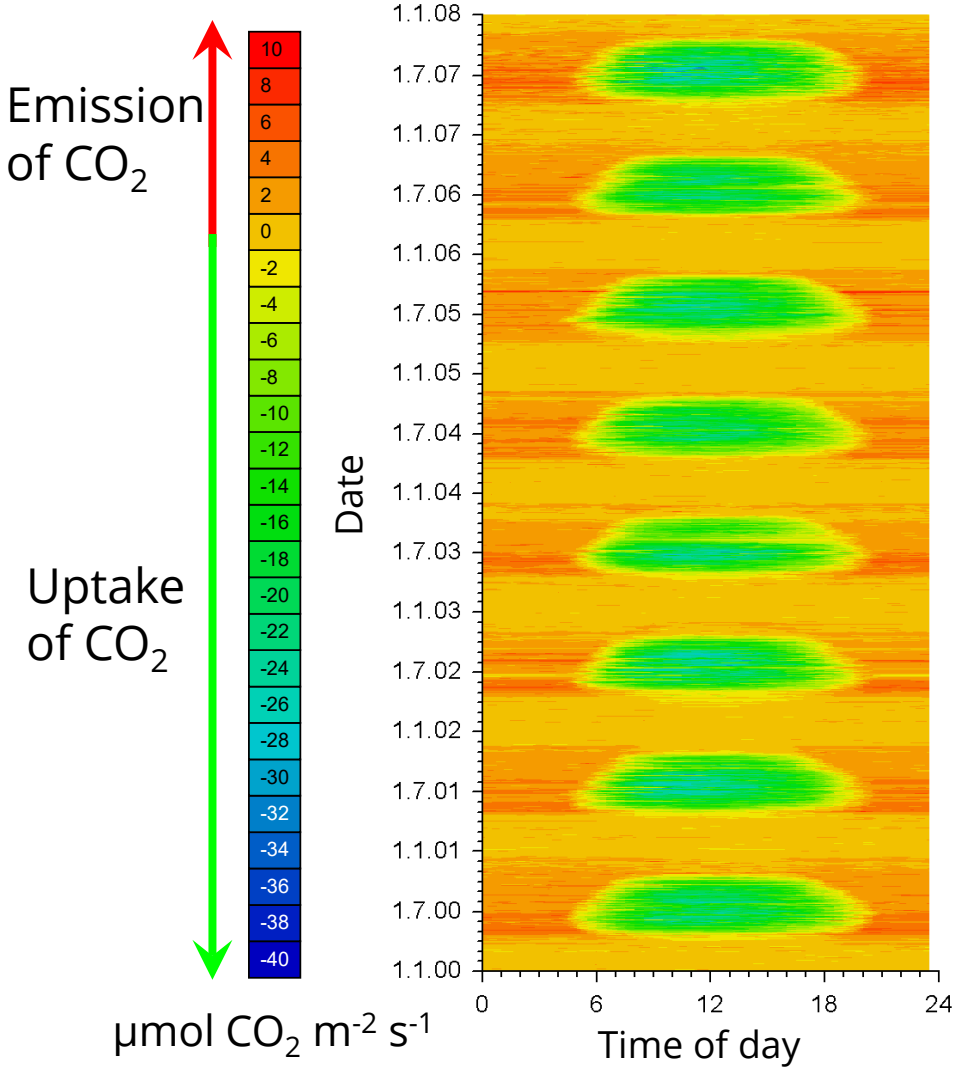

Turbulent Transport
Internal Source/Sink


Vertical
Advection
Turbulent Transport
Horizontal
Advection
Δ Storage
Internal Source/Sink

A flux fingerprint

- Shows for every day uptake and release of CO_2.
- Makes specific patterns visible (e.g. impact of drought in 2003)

Long-term observations enable the detection of trends (e.g. CO_2 fertilisation or decreasing productivity with age).



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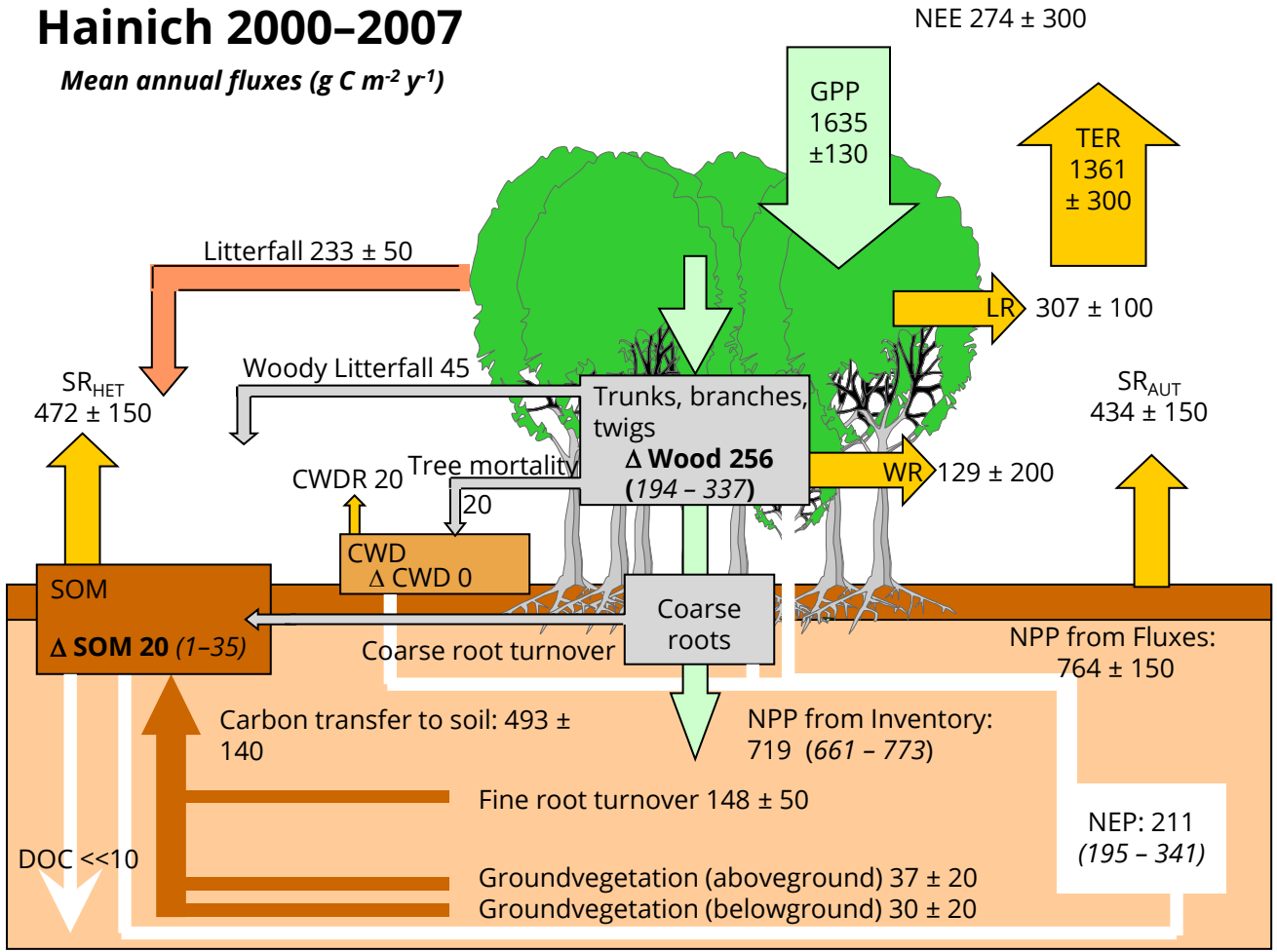
Integrated carbon balance Hainich 2000–2007

Mean annual fluxes (g C m^{-2} y^{-1})



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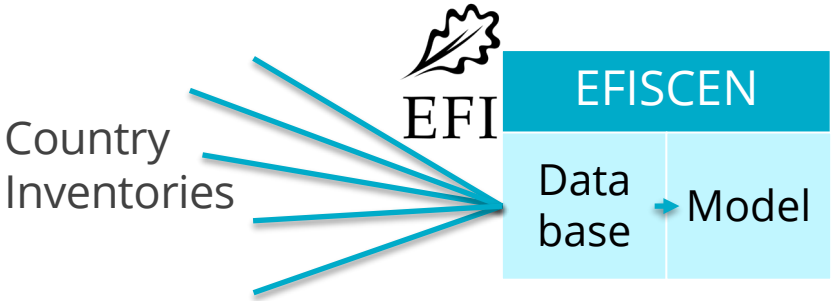
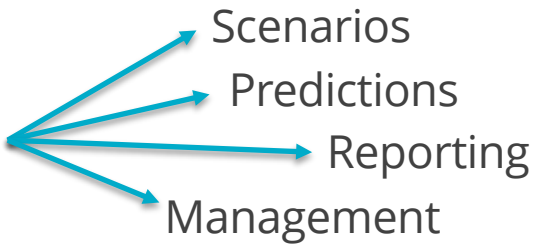
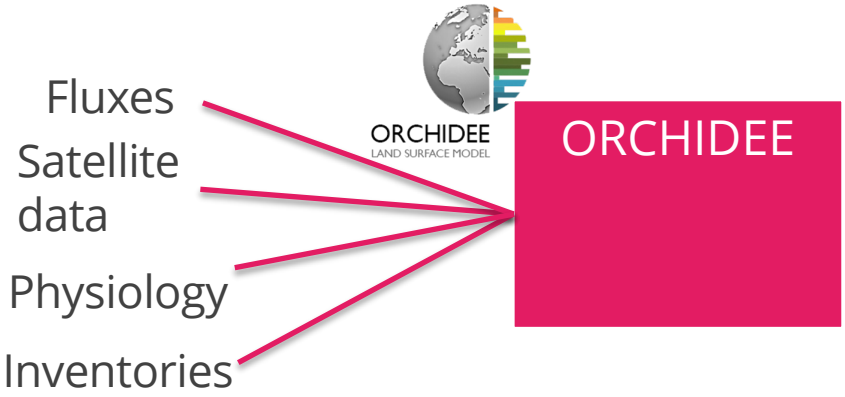
Models (two examples)



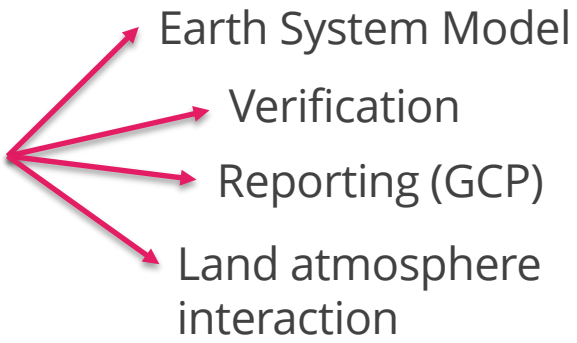
EFISCEN is a matrix model, where the state of the forest is represented in matrices as an area distribution over age and volume classes.



https://efi.int/knowledge/models/efiscen



ORCHIDEE is a global land surface model, that solves the water-energy-carbon budget at a half hour time step, represents ecosystems as Plant Functional Types, represents vegetation with a big leaf approach



https://orchidee.ipsl.fr/

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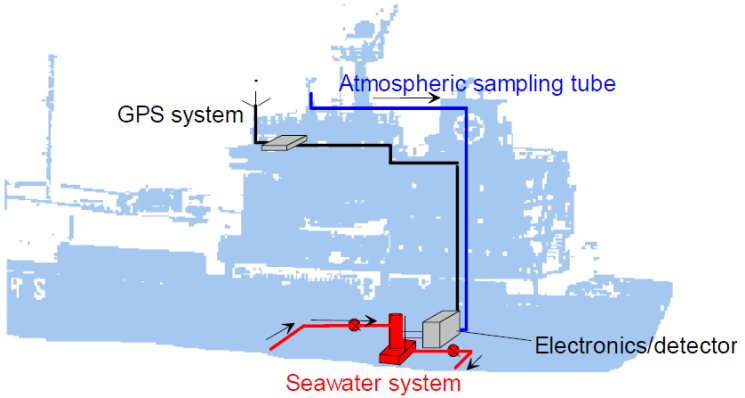
The Ocean component in ICOS and the Ocean sink



Fugacity of CO_2 (fCO_2) and partial pressure of CO_2 (pCO_2)

$fCO_2 = \gamma\ pCO_2 = [CO_2] / K'0$

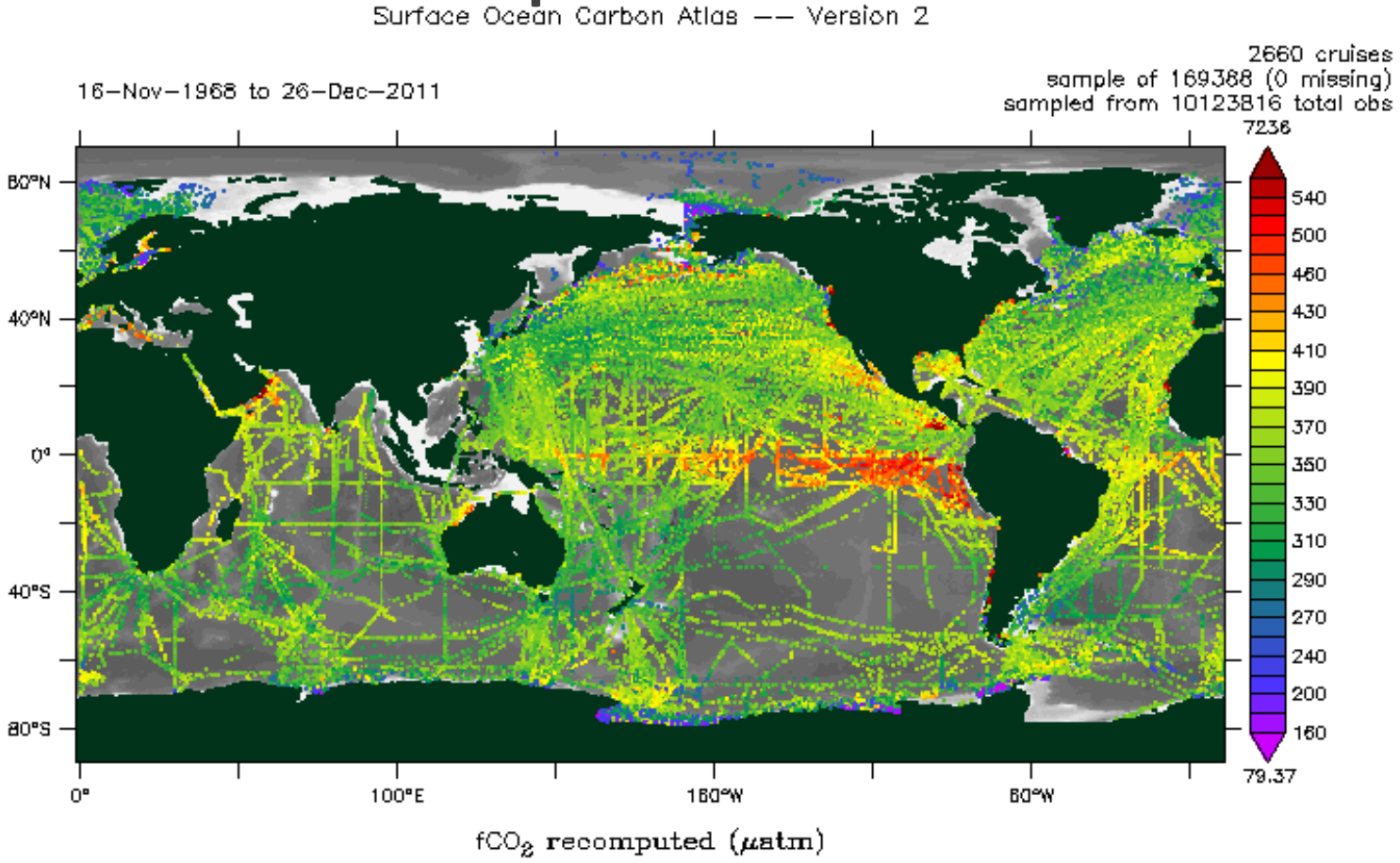
($\gamma \sim 0.996\text{-}0.997$)

ICOS

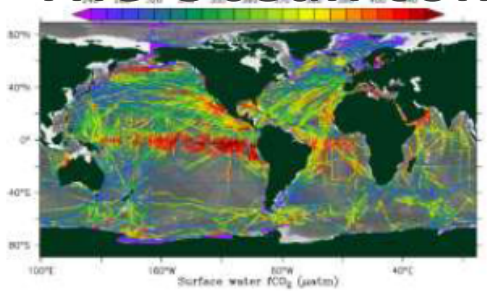
[curtesy: Dorothee Bakker]

Schuster and Watson (2007) JGR

The Ocean component in ICOS and the Ocean sink

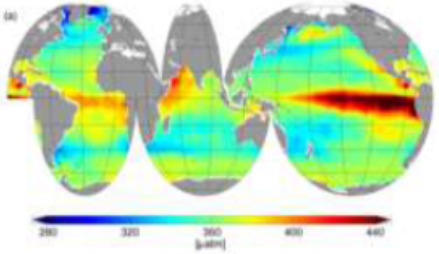


The Ocean component in ICOS and the Ocean sink



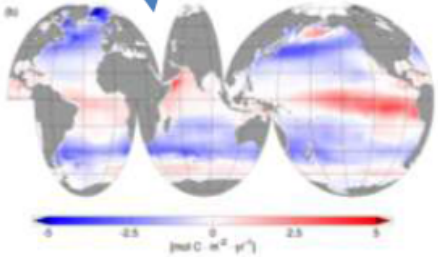
A SOCAT data product
(synthesis or gridded)

A mapping method



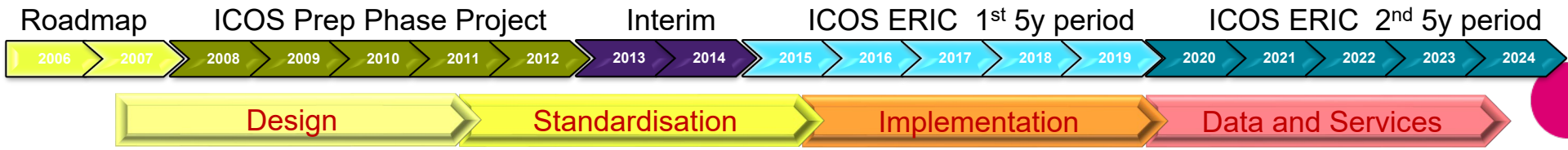
Surface water fCO_2
(here 1998-2011)

Gas transfer parameterisation,
wind speed

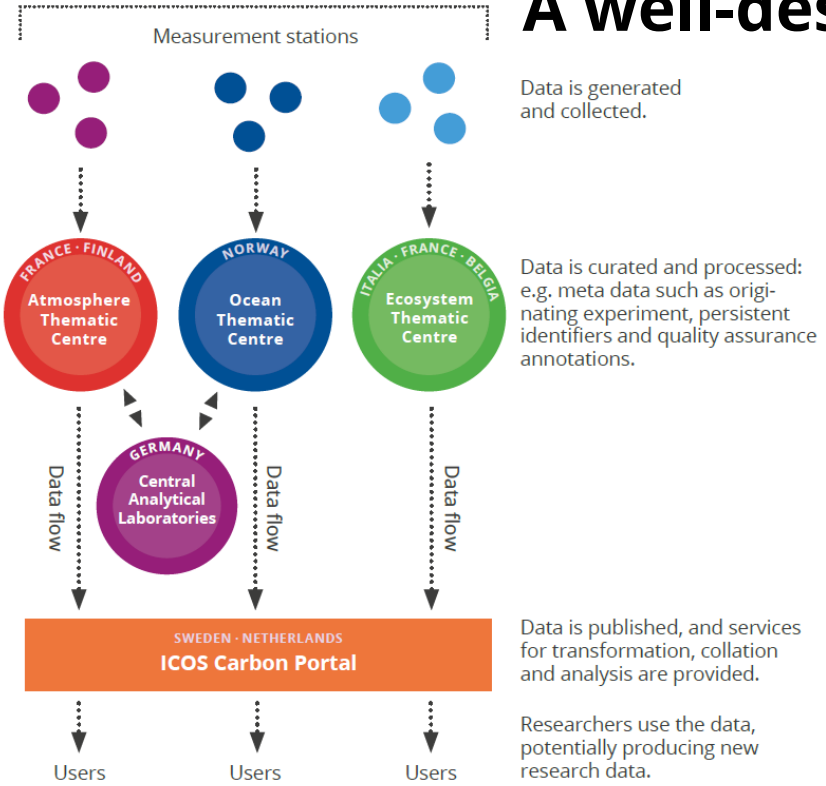


Air-sea CO_2 flux
(here 1998-2011)

The (spatial/temporal) variability in data-based air-sea CO_2 flux estimates can improve land CO_2 flux estimates by atmospheric inversion (Rödenbeck et al., 2014). (Figures Bakker et al., 2014; Landschützer et al., 2014).



A well-designed reliable data life cycle



Data is generated and collected.

Data is curated and processed: e.g. meta data such as origi-nating experiment, persistent identifiers and quality assurance annotations.

Data is published, and services for transformation, collation and analysis are provided.

Researchers use the data, potentially producing new research data.

- ✓ Standardized measurements
- ✓ Standardized data processing
- ✓ Centralized quality control
- ✓ Data provenance, curation and archiving
- ✓ Clear open data license
- ✓ Data citation

Services and Innovation
ICOS
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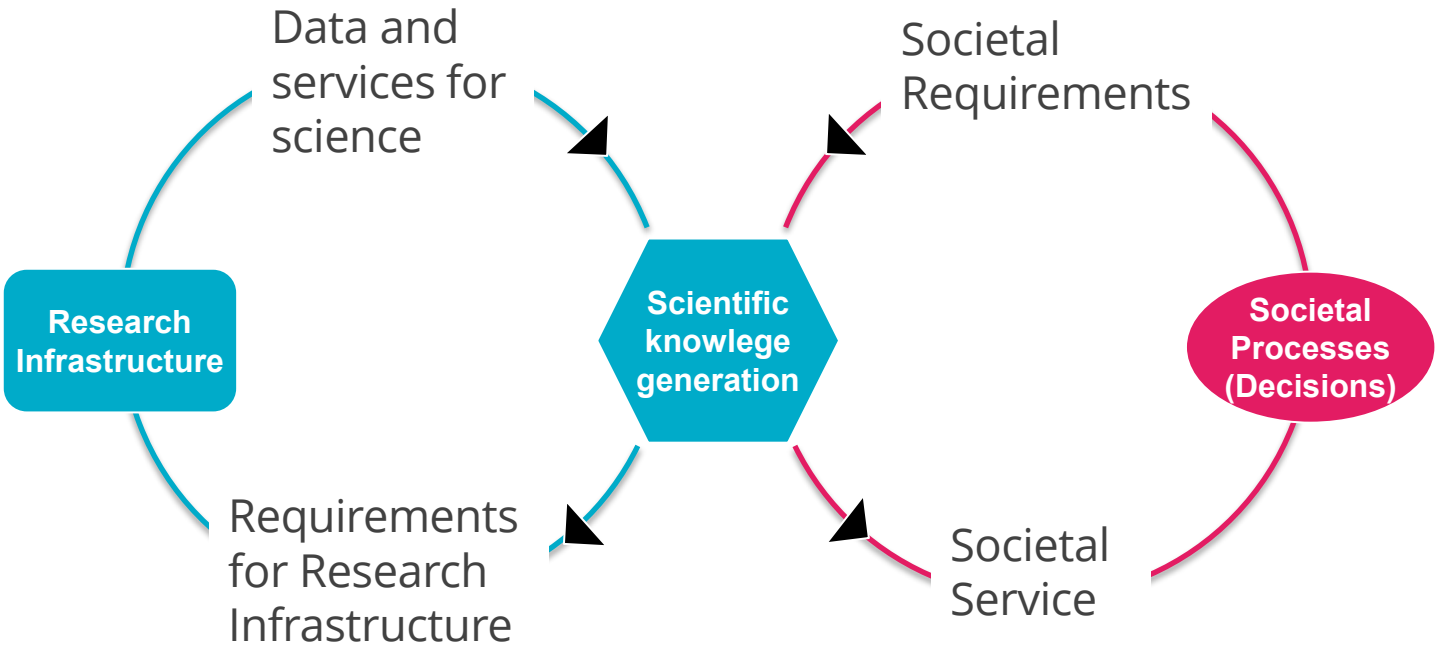
CARBON
OBSERVATION
SYSTEM

Suggestion for a new approach of societal value generation (ICOS Cities)



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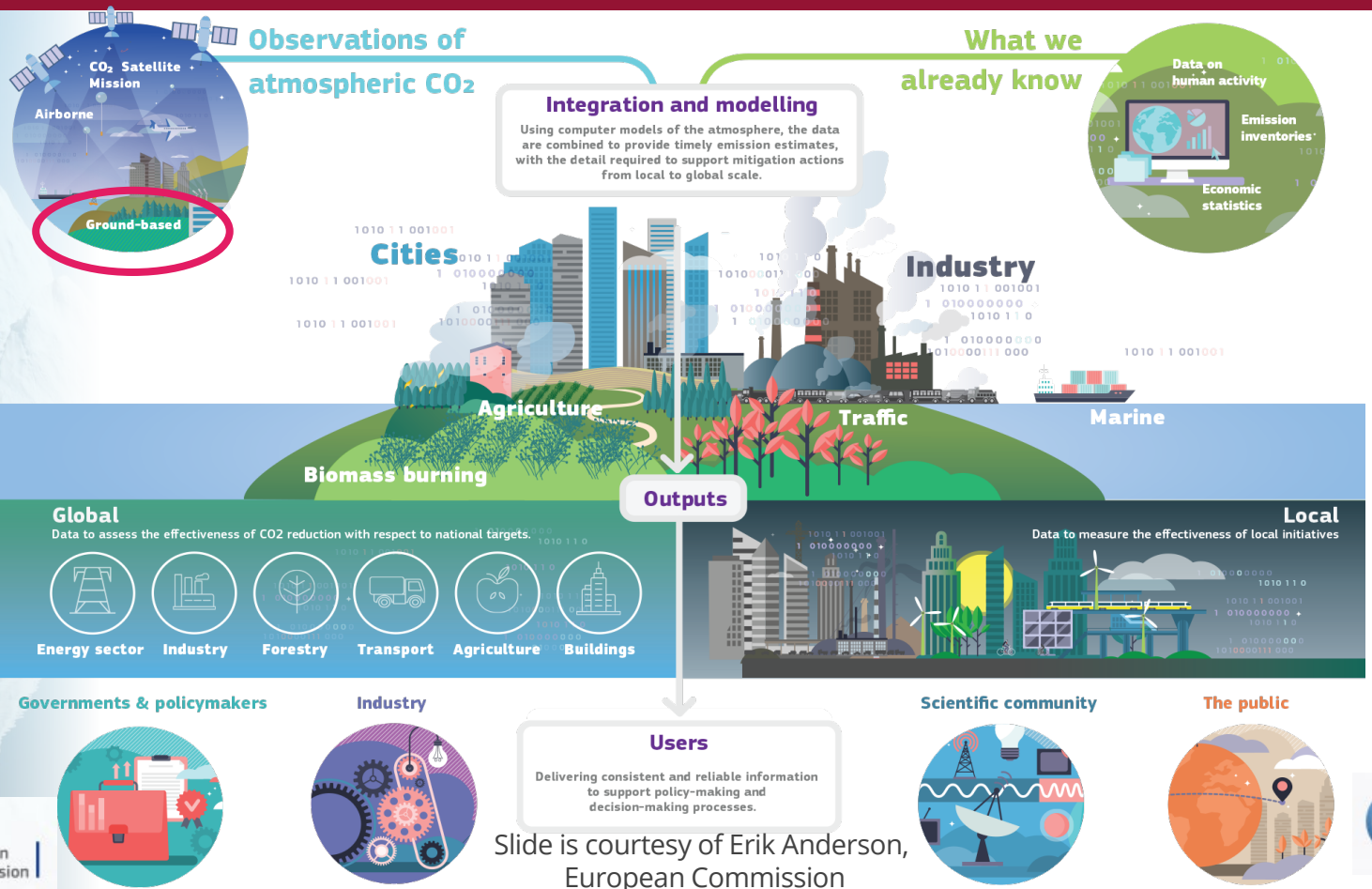
COPERNICUS CO_2 EMISSIONS MONITORING & VERIFICATION SUPPORT CAPACITY

Climate Change



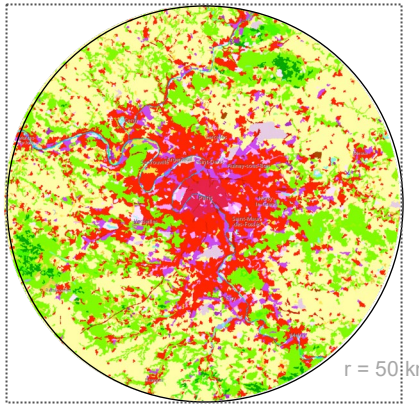
Slide is courtesy of Erik Anderson, European Commission

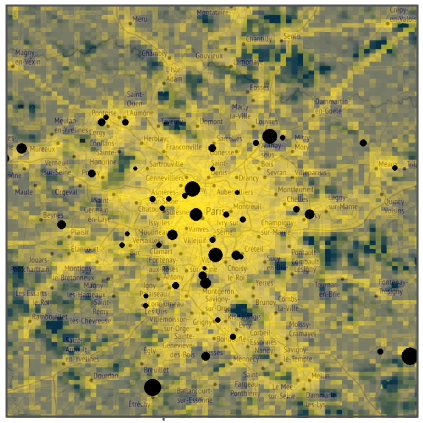
European Commission

Copernicus Europe's eyes on Earth

Paris

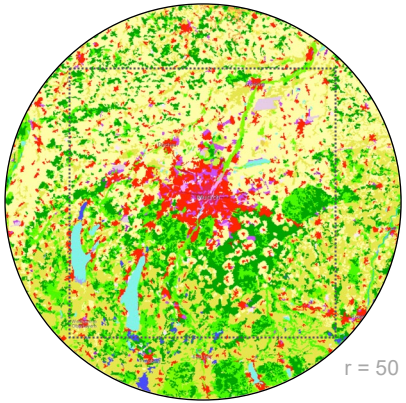
Metro 12.6 Mio Inh.
Urban 10.7 Mio Inh.

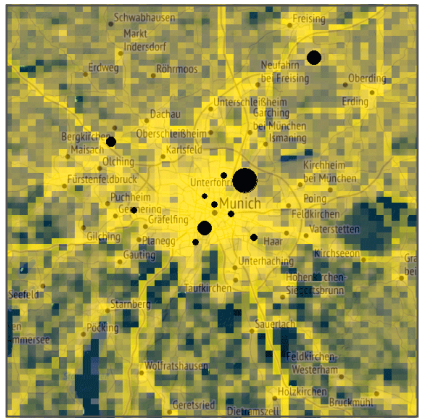




Munich

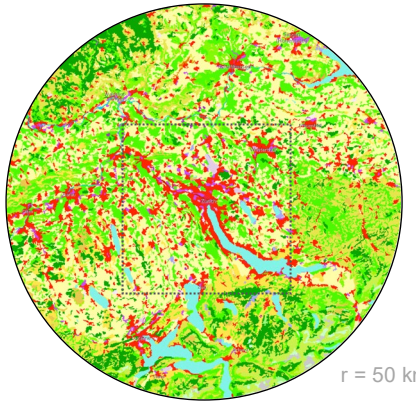
5.9 Mio Inh.
2.6 Mio Inh.

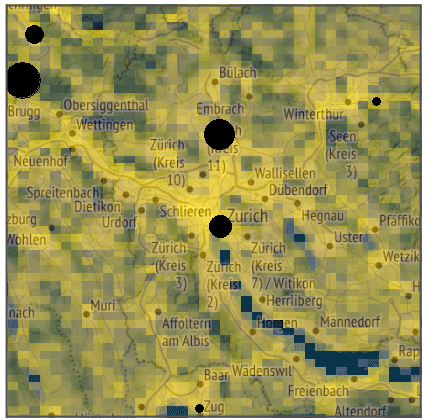




Zurich

1.6 Mio Inh.
0.4 Mio Inh.





Land cover

- Urban fabric
- Industrial / commercial
- Transportation
- Croplands
- Pastures
- Broad-leafed / mixed forest
- Coniferous forest
- Water bodies

$ffCO_2$ Emissions

kg yr^{-1} km^{-2}

1e+08
1e+06
1e+04
1e+02

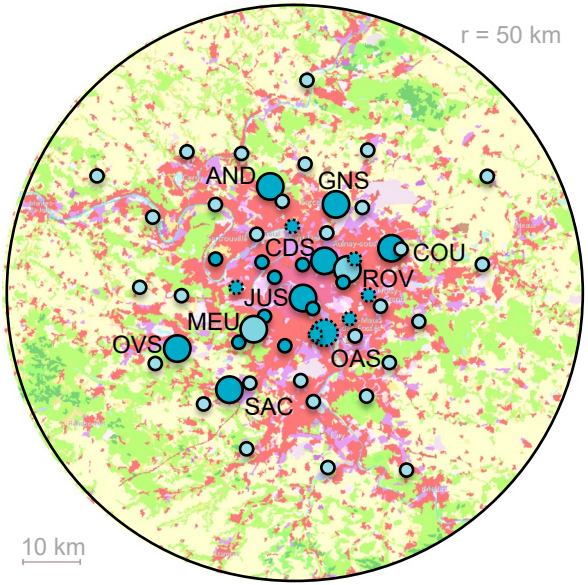
$ffCO_2$ Point sources

kg yr^{-1}

1e+06
1e+07
1e+08
1e+09

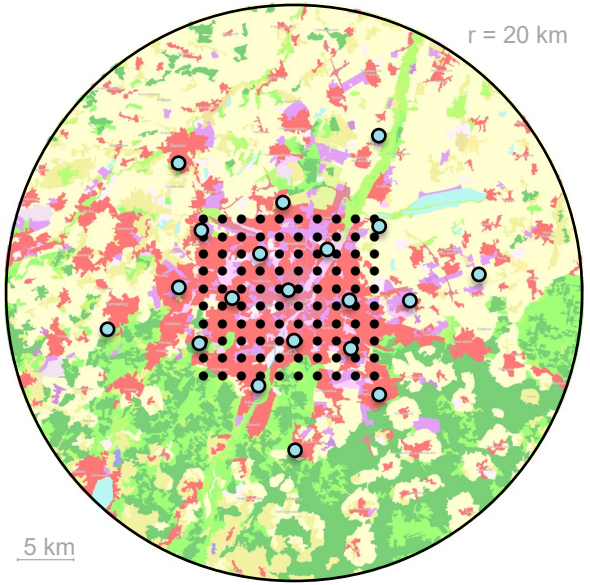
Paris

10 high-precision sites
30 roof-level sensors



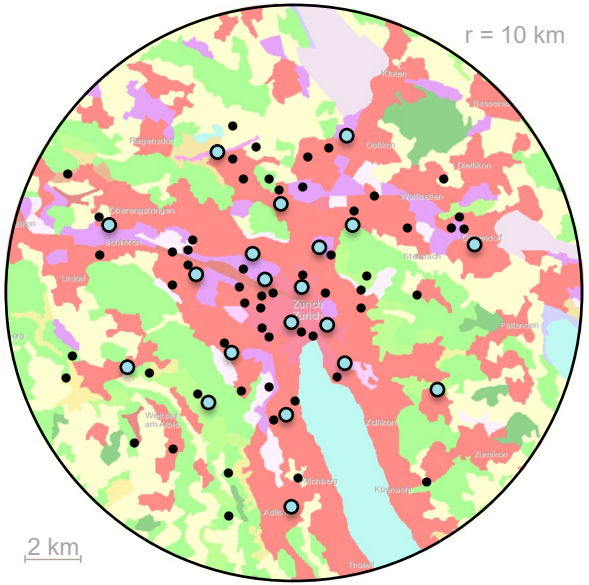
Munich

20 roof-level sensors
100 street-level sensors



Zurich

20 roof-level sensors
60 street-level sensors



Existing
Otherwise funded
New

Tall tower or elevated high-precision system (WP 3.1)

Roof-level sensor network sites (WP 3.2)

Street-level sensor network (WP 3.2)

(a) Atmospheric in situ concentrations

Paris

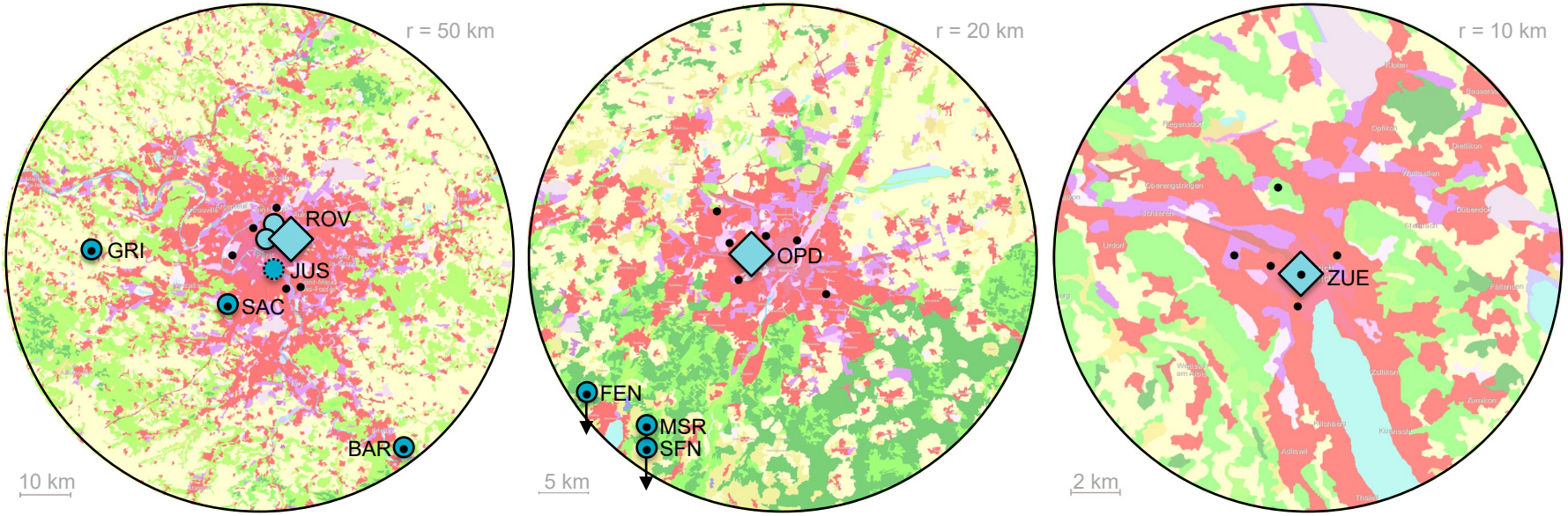
1 Tall-tower EC, 6 local-scale EC
8 soil and 6 sap-flow sites

Munich

1 Tall-tower EC
7 soil and 6 sap-flow sites

Zurich

1 Tall-tower EC
6 soil and 6 sap-flow sites



Existing / Otherwise funded / New

Tall tower eddy covariance site (WP 3.4)

Local-scale eddy covariance site (WP 3.4)

Biospheric and soil sites (WP 3.5)

(b) Eddy covariance and biospheric sites

Paris

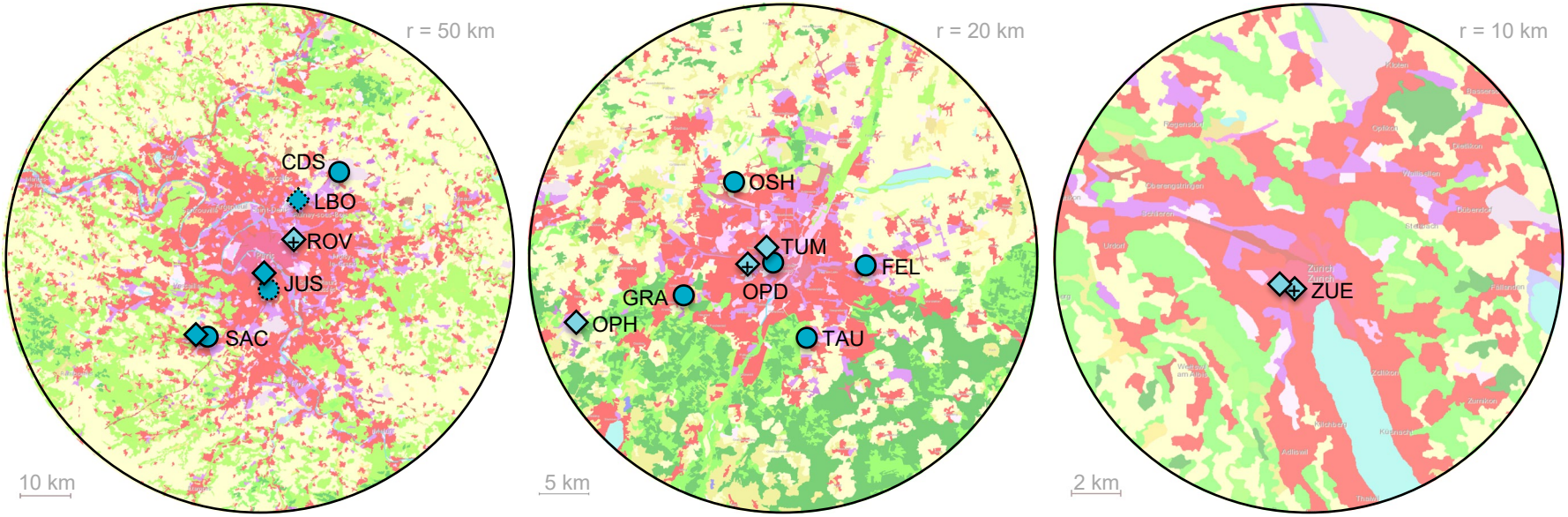
3 total column CO_2
4 Doppler wind LIDARS

Munich

5 total column CO_2
3 Doppler wind LIDARS

Zurich

2 Doppler wind LIDARS



Existing
Otherwise funded
New

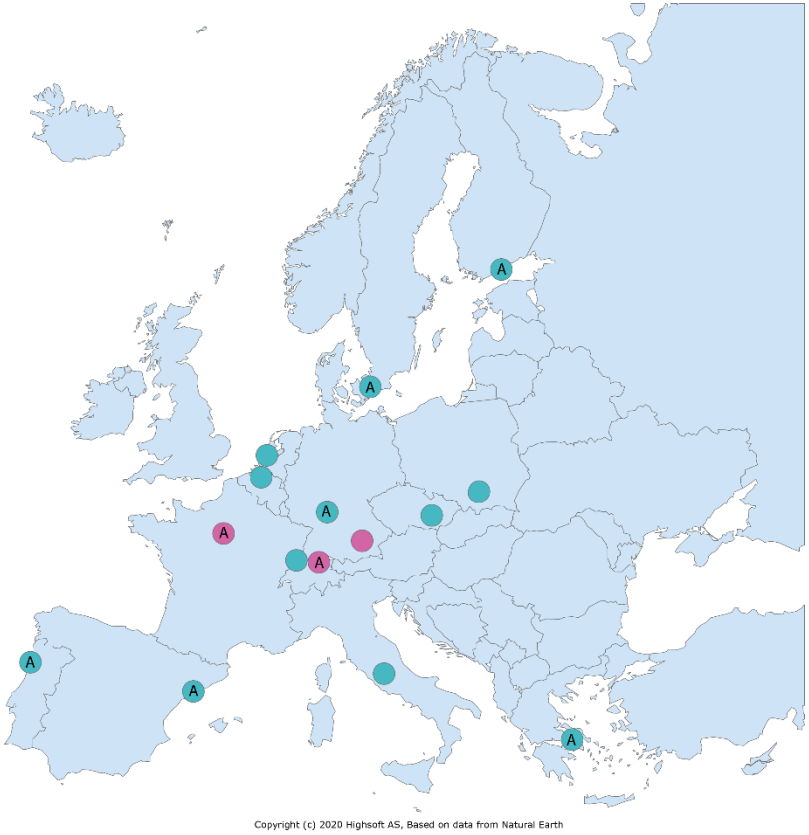
Total column observation site (WP 3.3)

Doppler wind LIDAR (WP 3.6)

mini wind LIDAR

(c) Ground-based remote sensing

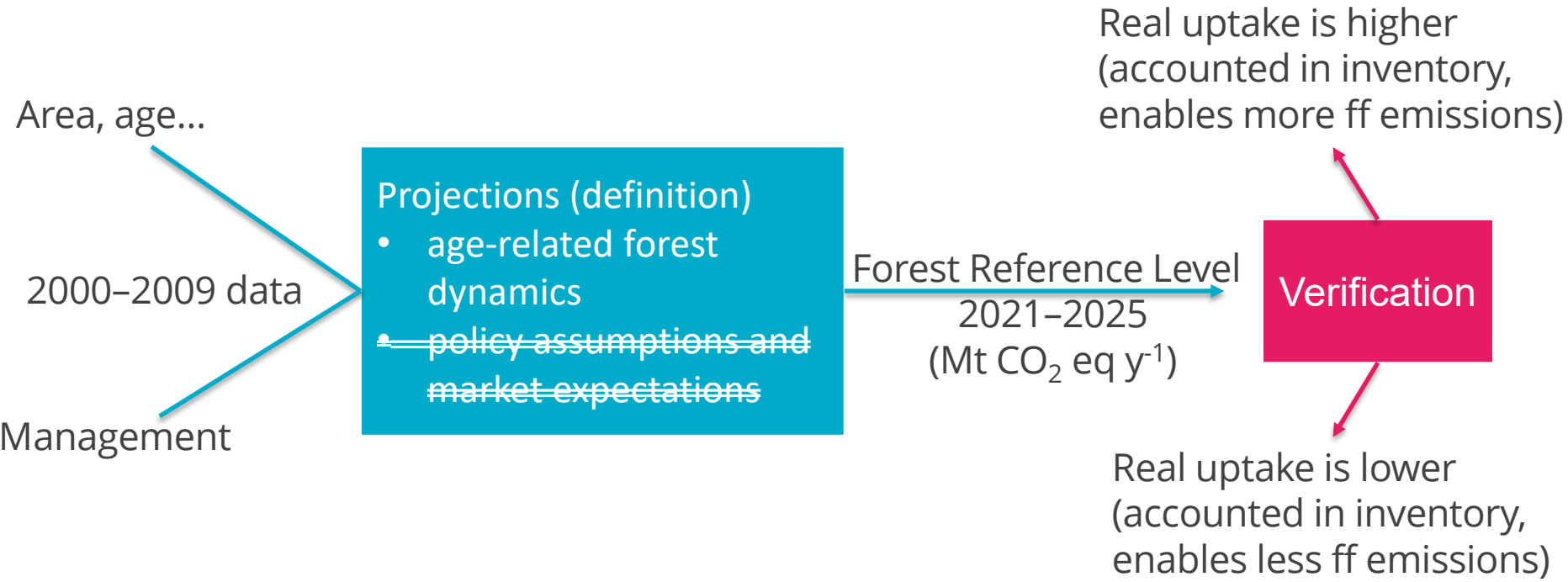
The PAUL City Network



- 3 pilot cities (Munich, Zurich, Paris).
- 12 additional cities to increase the representativeness, collect more demands and disseminate results.
- Important support for establishing a sustainable long-term infrastructure perspective.
- Important communication and citizen science connection.

Contributing to a very important topic of the European Climate Law
Forest carbon sinks
ICOS
INTEGRATED CARBON OBSERVATION SYSTEM

The system of Forest Reference Levels



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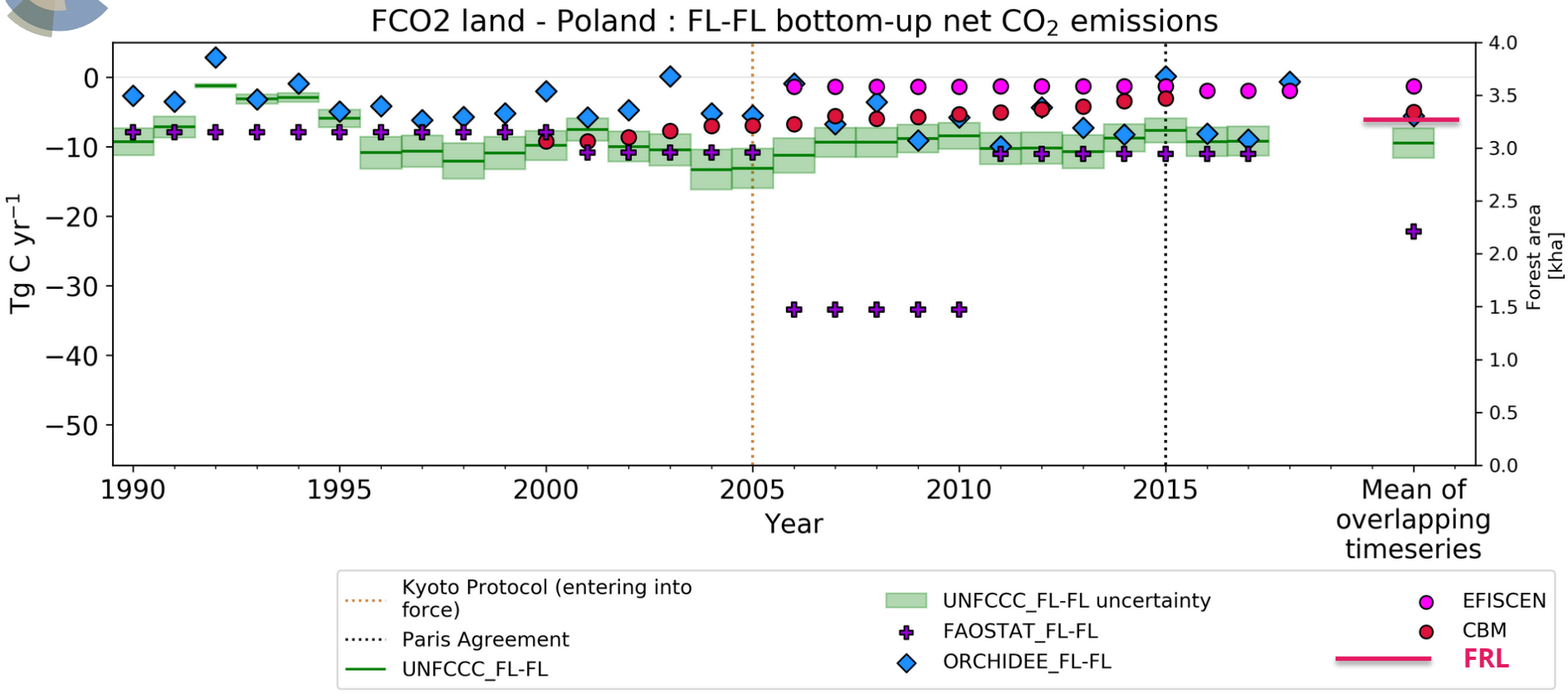
Integration of information



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VERIFY Project

https://verify.lsce.ipsl.fr/

The VERIFY project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776810.

Conclusions

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Conclusions for Poland

- Unique opportunity to contribute to and to be part of a well-developed ESFRI research infrastructure;
- Contributing to an observational network that supports the European Climate Law;
- Becoming part of a strong and highly-competitive scientific community;
- Getting access to services that support climate action.

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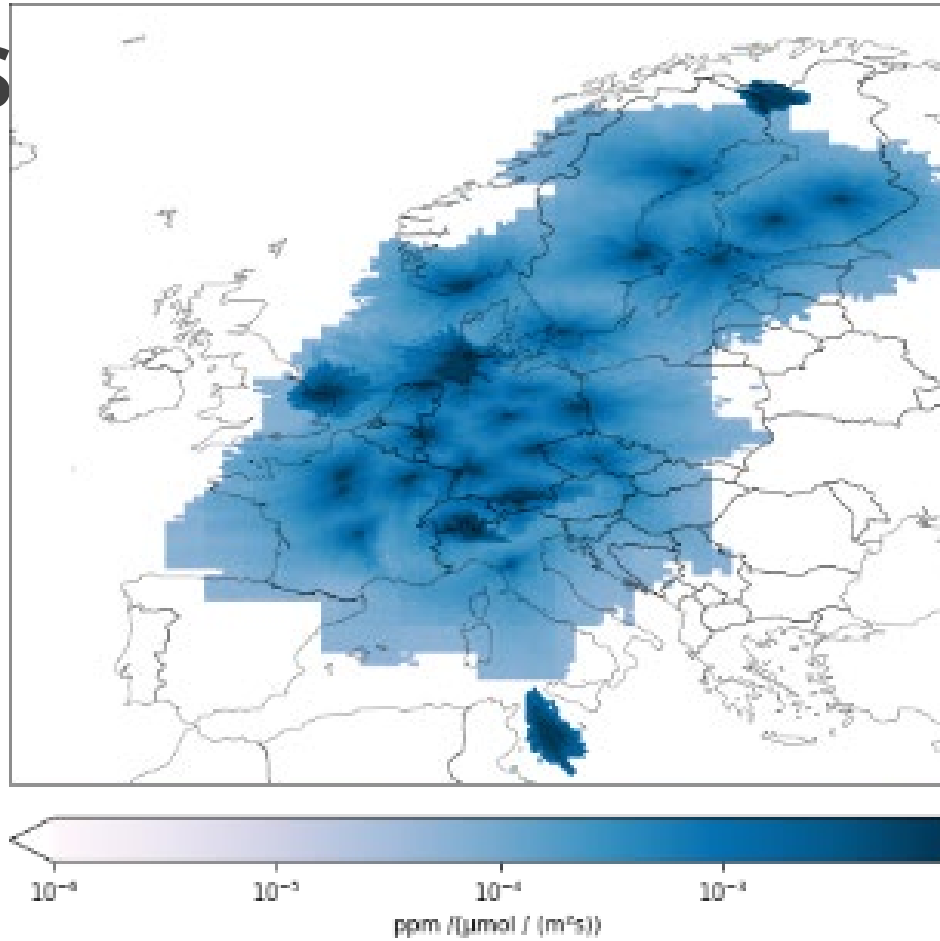
Conclusions for ICOS

- Observational coverage depends on ESFRI mechanism of country membership;
- The better the coverage, the better the knowledge services that support the European Climate Law

We cordially invite you and we would like to serve you!



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Questions welcome!

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