INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

European strategy in meteo, hydro, atmospheric composition and ecosystems monitoring

18.11. 2021

(remote)

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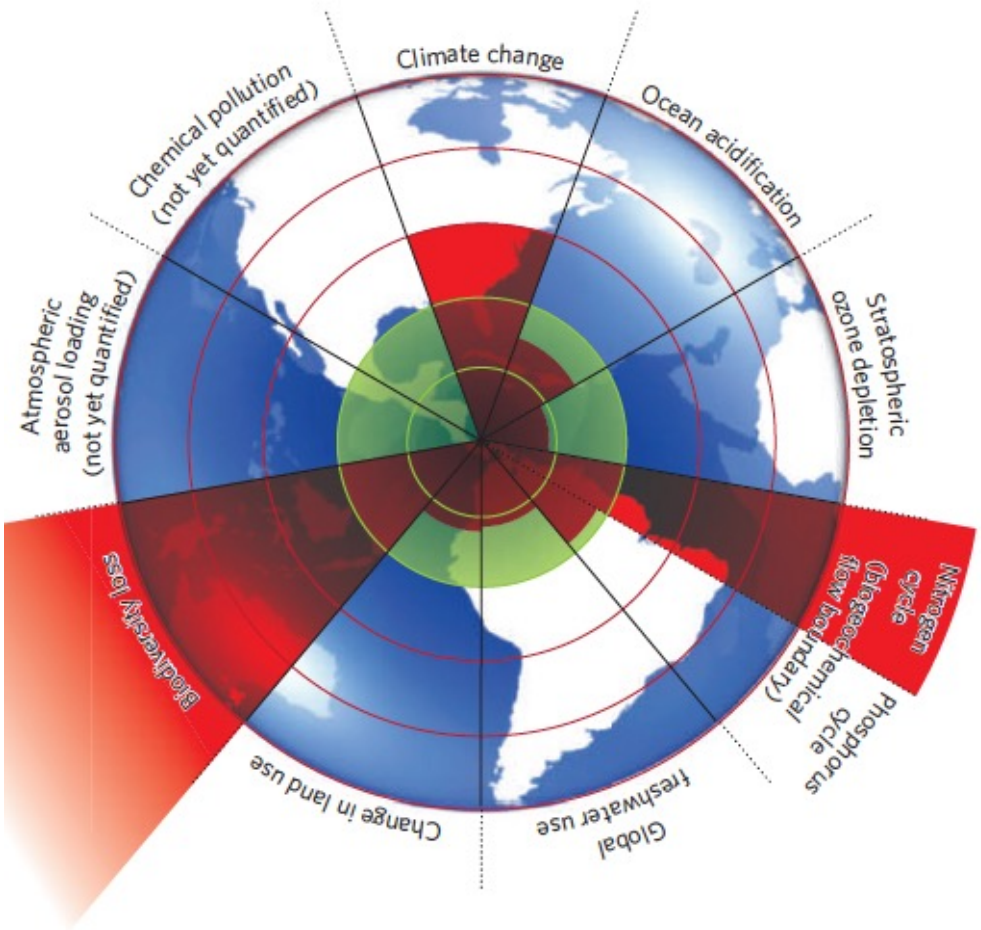
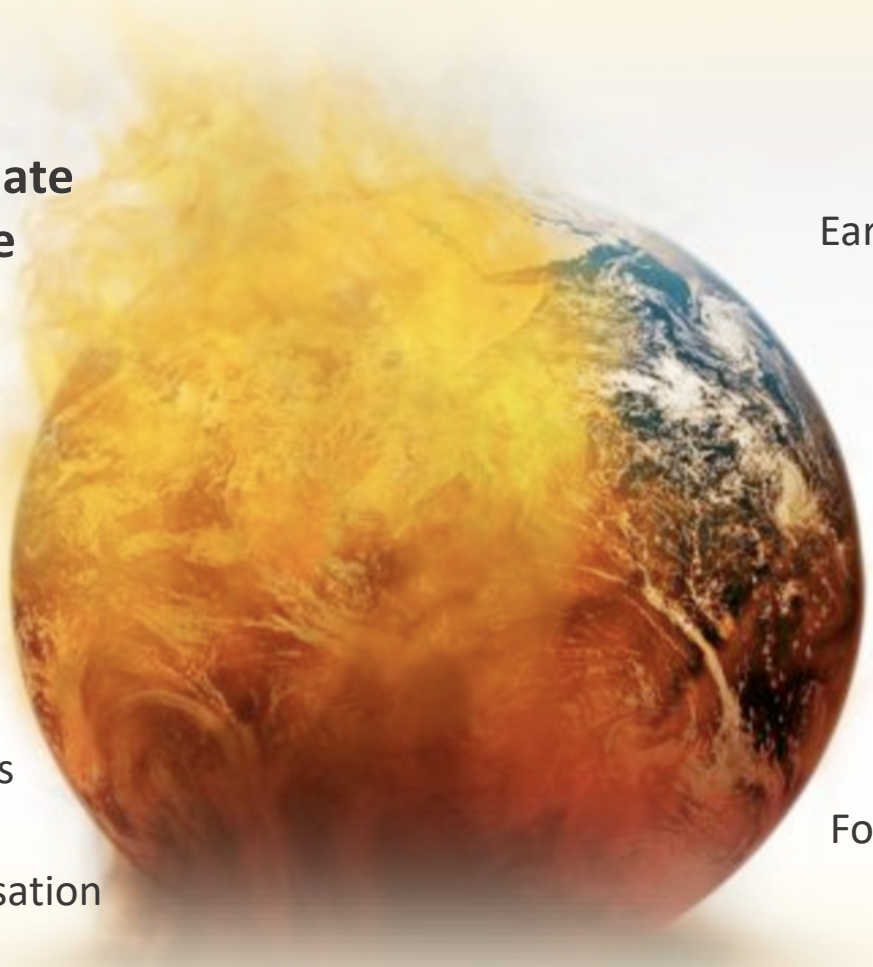
A safe operating space for humanity



Rockström et al. (2009) A safe operating space for humanity, Nature 461, 472-475.

Contribution to solving grand challenges



Climate change

Volcanoes

Energy

Biodiversity loss

Epidemic diseases

Chemicalisation

Earthquakes

Air quality

Fresh water

Ocean acidification

Deforestation

Food supplies

Demography / Population / Urbanization

DISCIPLINES

Natural Sciences

Social Sciences

Economy; Medicine;

Technology etc

PEEX / IEAS / AASCO

Science Diplomacy

WMO/GAW
Global SMEAR

From ideas to implementation

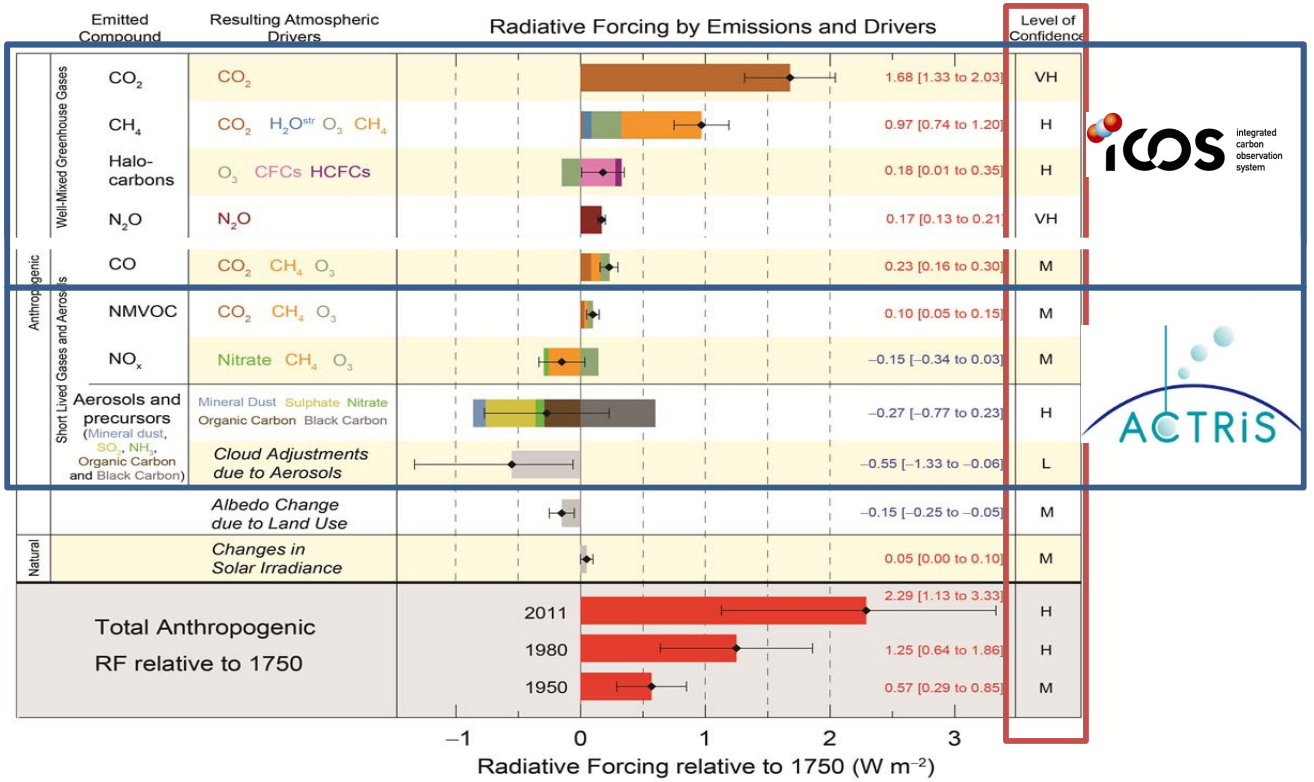
INTEGRATED APPROACH:
THE GLOBAL EARTH OBSERVATORY / GLOBAL SMEAR

Current observations (see IPCC 2013) are fragmented:

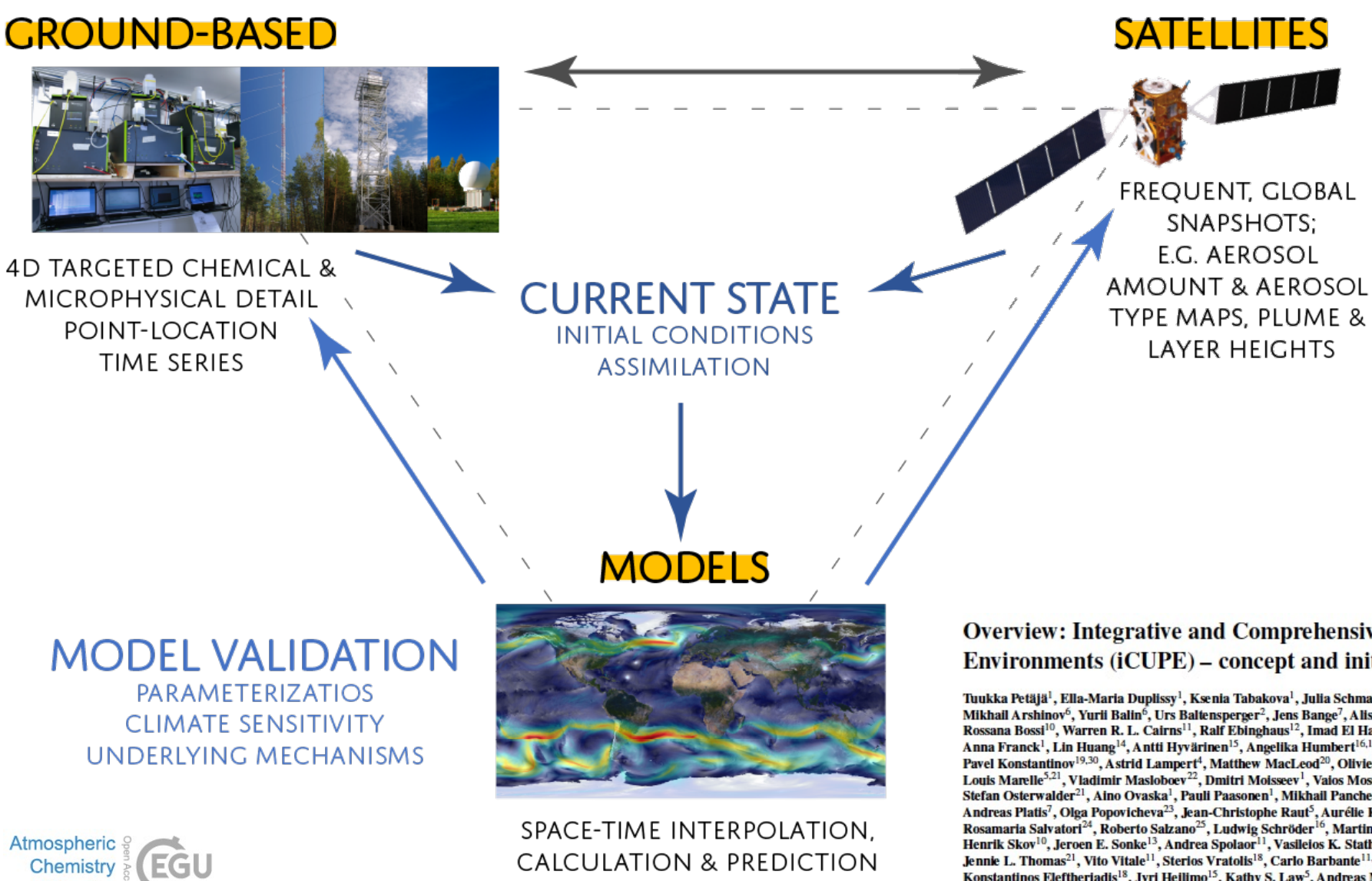
1) Greenhouse gases
2) Aerosols
3) Air quality
4) Ecosystems
5) Climate
6) …

Future aspiration: Integrated approach

- **To understand feedbacks**
- **To reduce uncertainties**
- **To mitigate and adapt effectively**



IPCC, 2013



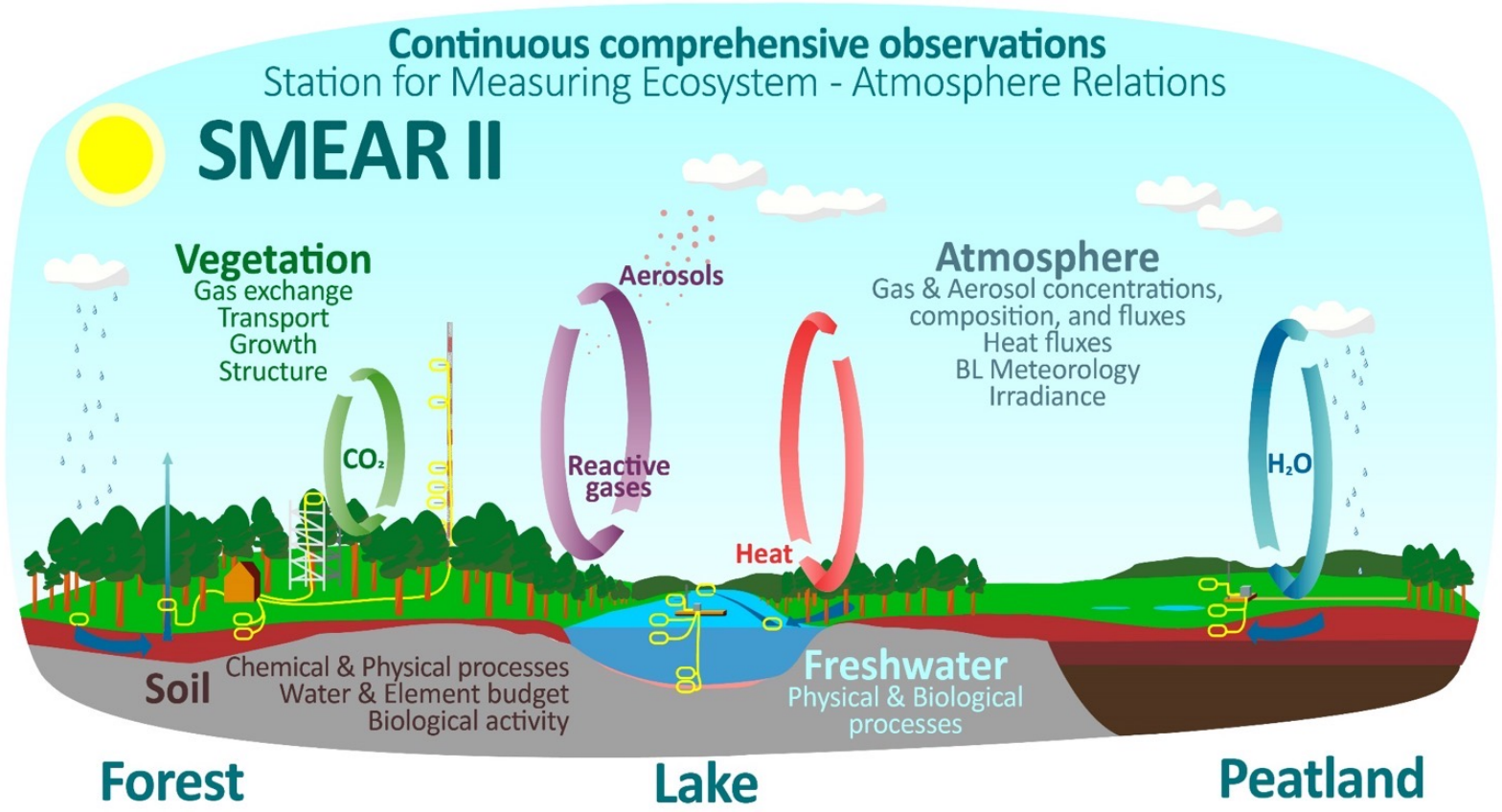
Atmospheric Chemistry and Physics Open Access EGU

Overview: Integrative and Comprehensive Understanding on Polar Environments (iCUPE) – concept and initial results

Tuukka Petäjä[1], Ella-Maria Duplissy[1], Ksenia Tabakova[1], Julia Schmale[2,3], Barbara Altstädter[4], Gerard Ancellet[5], Mikhail Arshinov[6], Yurii Balin[6], Urs Baltensperger[2], Jens Bange[7], Alison Beamish[8], Boris Belan[6], Antoine Berchet[9], Rossana Bossi[10], Warren R. L. Cairns[11], Ralf Ebinghaus[12], Imad El Haddad[2], Beatriz Ferreira-Araujo[13], Anna Franck[1], Lin Huang[14], Antti Hyvärinen[15], Angelika Humbert[16,17], Athina-Cerise Kalogridis[18], Pavel Konstantinov[19,30], Astrid Lampert[4], Matthew MacLeod[20], Olivier Magand[21], Alexander Mahura[1], Louis Marelle[5,21], Vladimir Masloboev[22], Dmitri Moisseev[1], Vaios Moschos[2], Niklas Neckel[16], Tatsuo Onishi[5], Stefan Osterwalder[21], Aino Ovaska[1], Pauli Paasonen[1], Mikhail Panchenko[6], Fidel Pankratov[22], Jakob B. Pernov[10], Andreas Platis[7], Olga Popovicheva[23], Jean-Christophe Raut[5], Aurélie Riandet[9,a], Torsten Sachs[8], Rosamaria Salvatori[24], Roberto Salzano[25], Ludwig Schröder[16], Martin Schön[7], Vladimir Shevchenko[26], Henrik Skov[10], Jeroen E. Sonke[13], Andrea Spolaor[11], Vasileios K. Stathopoulos[18], Mikko Strahlendorff[15], Jennie L. Thomas[21], Vito Vitale[11], Sterios Vratolis[18], Carlo Barbante[11,27], Sabine Chabrillat[8], Aurélien Dommergue[21], Konstantinos Eleftheriadis[18], Jyri Heilimo[15], Kathy S. Law[5], Andreas Massling[10], Steffen M. Noe[28], Jean-Daniel Paris[9], André S. H. Prévôt[2], Ilona Riipinen[20], Birgit Wehner[29], Zhiyong Xie[12], and Hanna K. Lappalainen[1,15]

SMEAR II station in Hyytiälä, Finland

Over **1200** different variables



Flagship site for integration: combines all IPCC components.

Contributes to :

ACTRiS

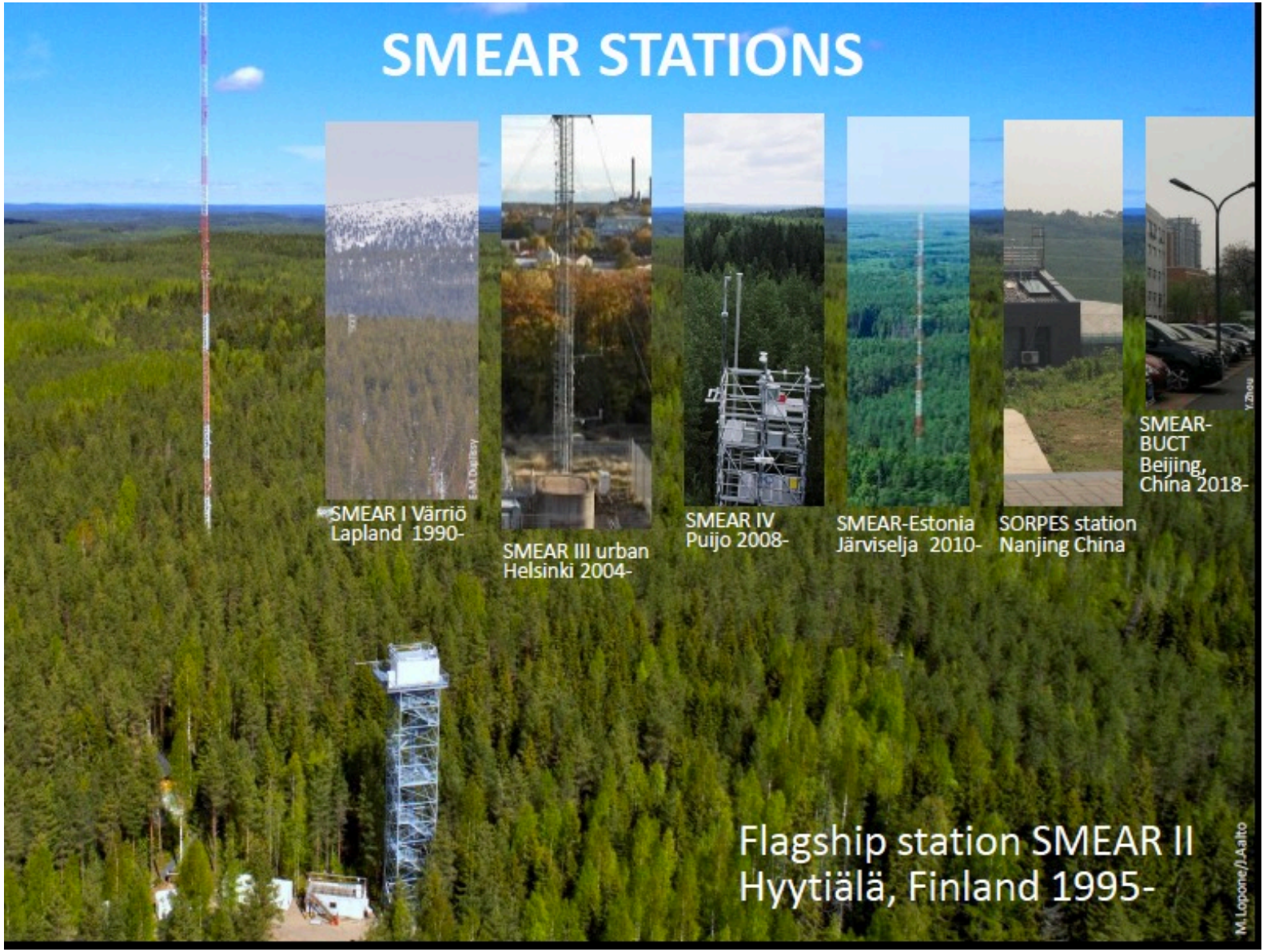
ICOS INTEGRATED CARBON OBSERVATION SYSTEM

AnaEE Analysis and Experimentation on Ecosystems

LTER europe

Pan-Eurasian Experiment PEEX

World Meteorological Organisation


SMEAR STATIONS
SMEAR I Värriö
Lapland 1990-
SMEAR III urban
Helsinki 2004-
SMEAR IV
Puijo 2008-
SMEAR-Estonia
Järviselja 2010-
SORPES station
Nanjing China
SMEAR-
BUCT
Beijing,
China 2018-
Flagship station SMEAR II
Hyytiälä, Finland 1995-

Flagship station SMEAR II

N 61° 50.845', E 24° 17.686', altitude 180 m a.s.l.

Instrument cottage

Instruments on mast (130m) and towers to measure at different heights

Eddy Covariance systems

Aerosols

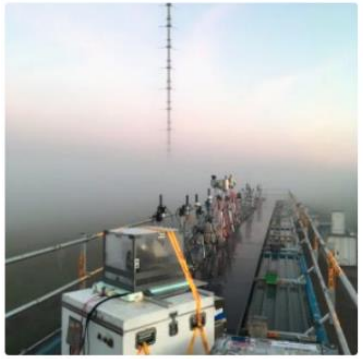
Shoot-level flux chamber

Lake raft housing instruments

What is the Aerosol, Clouds and Trace Gases Research Infrastructure?

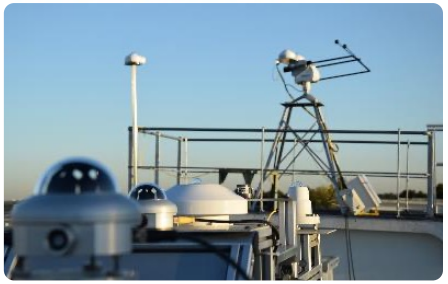
Supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115.

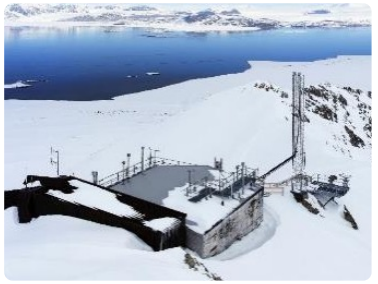
What is ACTRIS?



ACTRIS is a pan-European research infrastructure producing high-quality data and information on short-lived atmospheric constituents and on the processes leading to the variability of these constituents in natural and controlled atmospheres.

ACTRIS is key to supporting scientific advances in the field of atmospheric research





ACTRiS
Exploring the Atmosphere

@ACTRISRI

Short-lived atmospheric constituents

135 atmospheric variables

24 atmospheric data products

Composition
Properties
Processes
Emissions
Transport
Removal
Trends

@ACTRISRI

Overcoming current knowledge gaps will require:

- Improved knowledge of emission intensity and source attribution
- Improved capacity for characterizing intrinsic properties of aerosol and clouds
- Improved capacity for a 4D approach of multi-component interactions

Short-lived atmospheric constituents

135 atmospheric variables

24 atmospheric data products

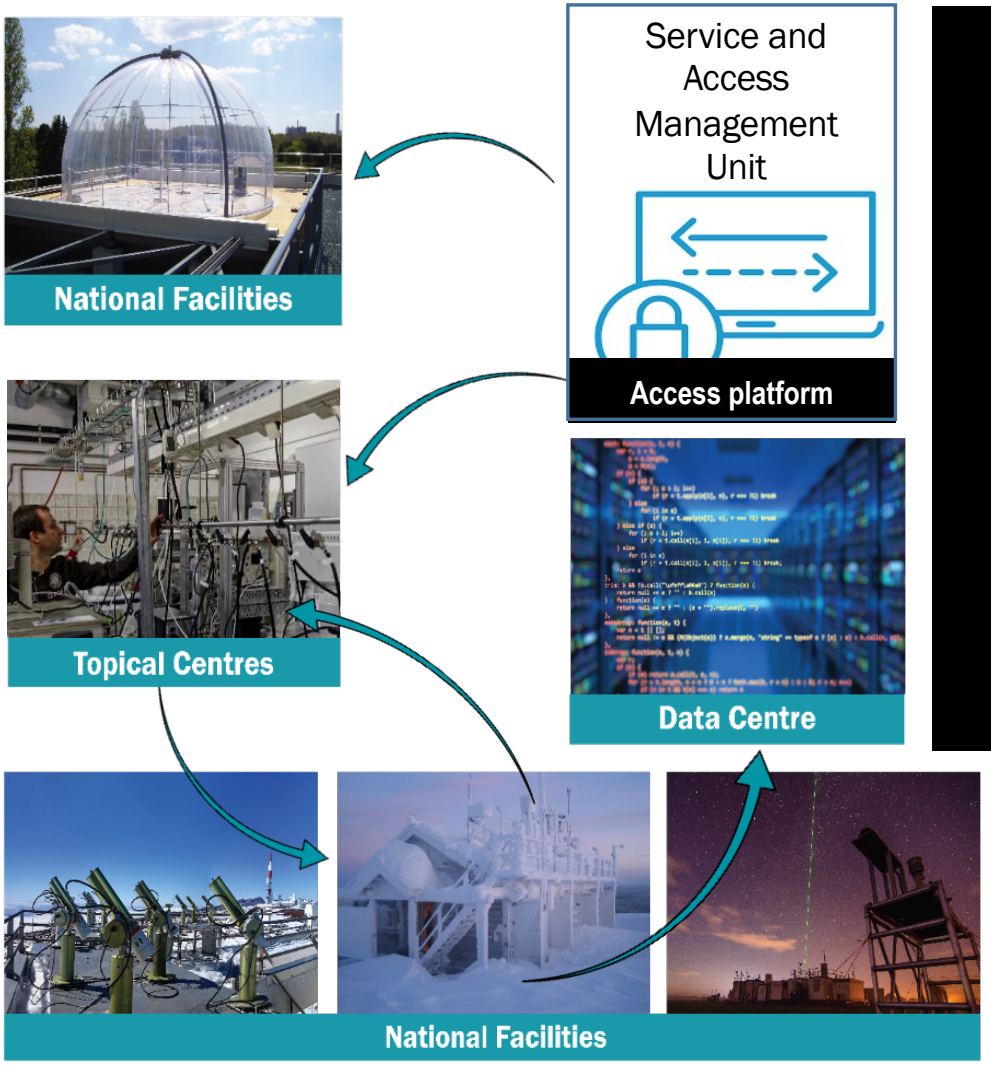
Composition
Properties
Processes
Emissions
Transport
Removal
Trends

HEALTH

AIR QUALITY

CLIMATE

@ACTRISRI



ACTRIS services = support for researchers

Physical Access

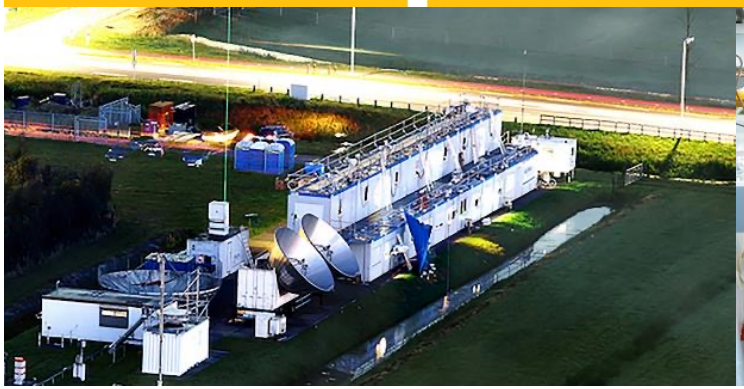
Research access
Instrument calibration
Industry Services
Training services

Virtual Access

ACTRIS data products
ACTRIS VRE with tools and computing

ACTRiS
Exploring the Atmosphere

European level Central Facilities	Head Office
	Data Centre
	Centre for Aerosol In Situ Measurements Centre for Aerosol Remote Sensing Centre for Cloud In Situ Measurements Centre for Cloud Remote Sensing Centre for Reactive Trace Gases In Situ Measurements Centre for Reactive Trace Gases Remote Sensing
National Facilities	Observational Platforms Exploratory Platforms



European level:
~ 150 scientists & technicians
working in ACTRIS

National level:
~ 800 scientists and technicians

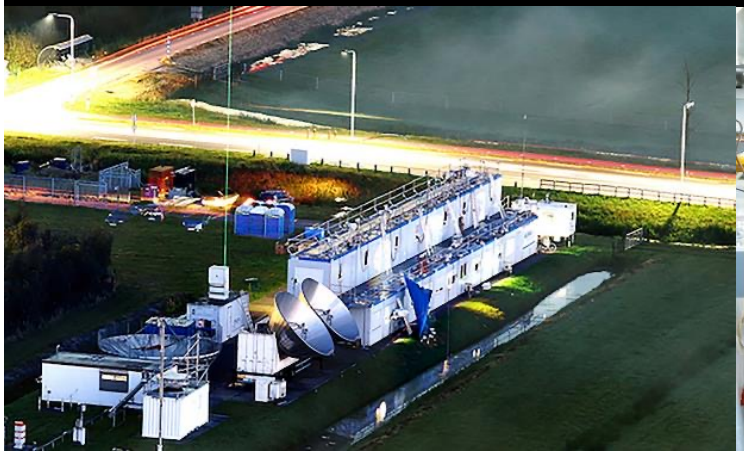
Target timeline

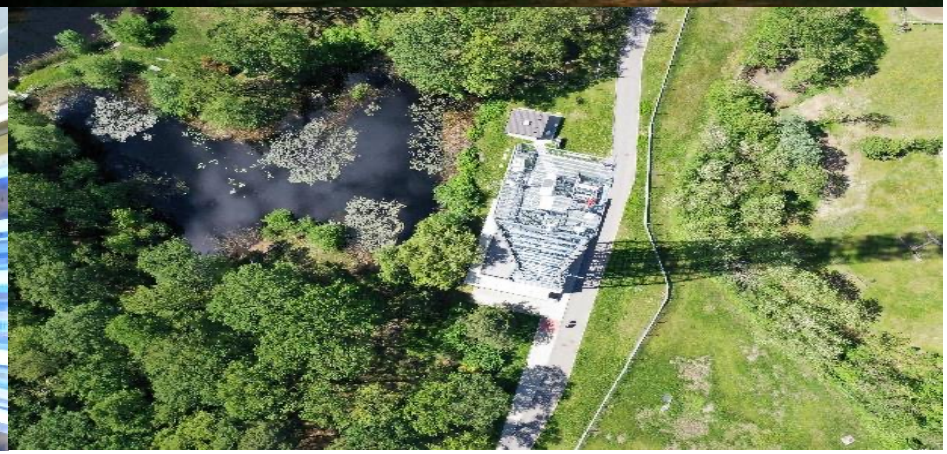
2025 Operational Phase

2021 ACTRIS ERIC

2020 Implementation Phase

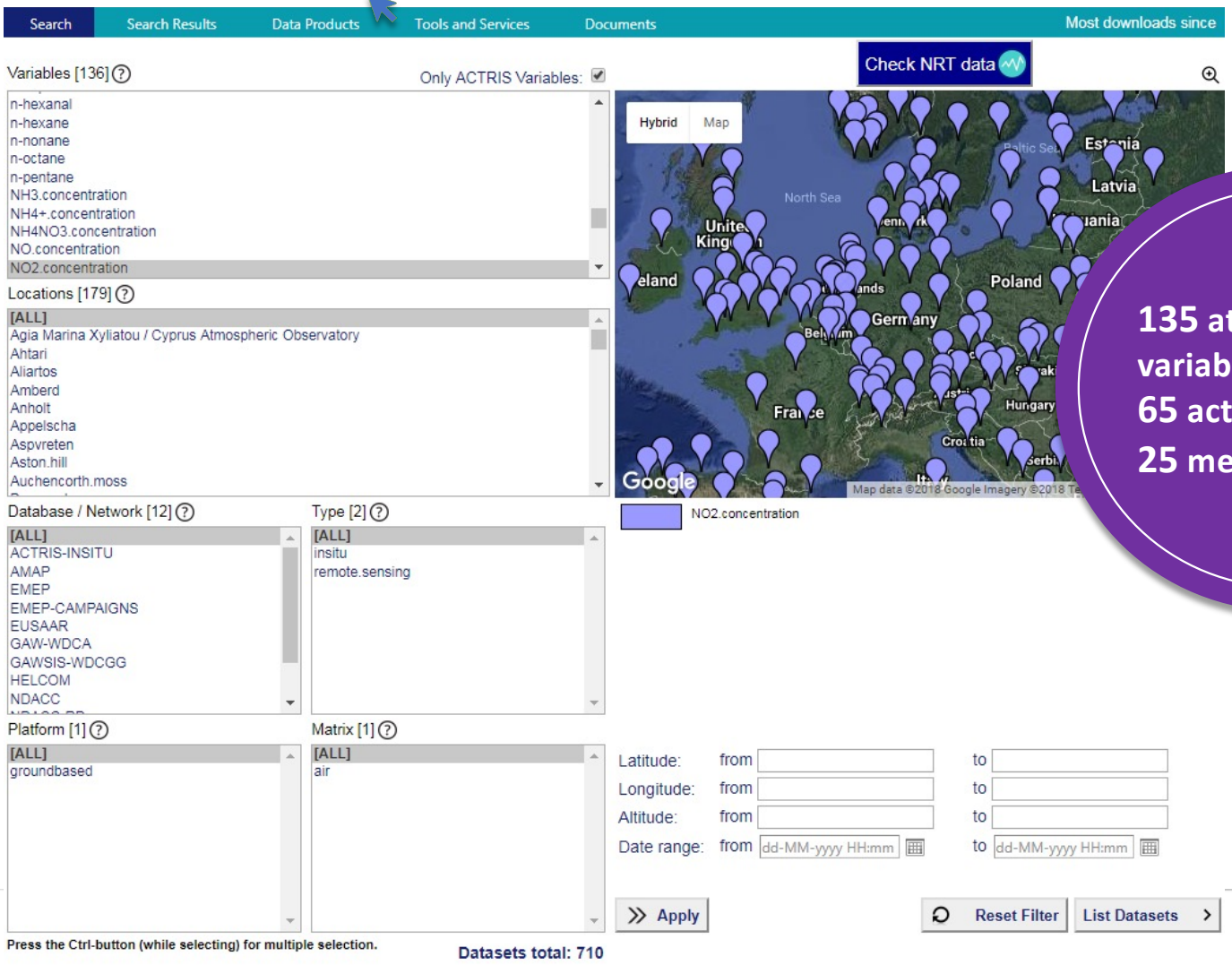
2017 - 2019 Preparatory phase





ACTRIS Data Centre – an atmospheric data portal

www.actris.net → ACTRIS data: actris.nilu.no *(currently)*



135 atmospheric variables
65 active sites
25 methodologies

ACTRiS
Exploring the Atmosphere

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Open Calls, Opportunities & Activities

https://www2.helsinki.fi/en/inar-institute-for-atmospheric-and-earth-system-research/infrastructure/transnational-access

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Exploring the Atmosphere

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eLTER

Integrated European
Long-term Ecosystem, critical zone and
socio-ecological Research

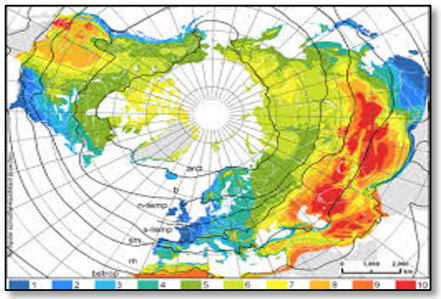
Filling a critical gap for top-class science at the continental scale

Long-term ecosystem observations for understanding the change: eLTER

•**Jaana Bäck**

•University of Helsinki

The eLTER Research Challenges and examples of related European/global policies



Climate change

European Green Deal, Strategy on adaptation to Climate Change, UNFCCC Paris Agreement

Biodiversity dynamics

EU Biodiversity Strategy, Water Framework Directive, Habitats Directive

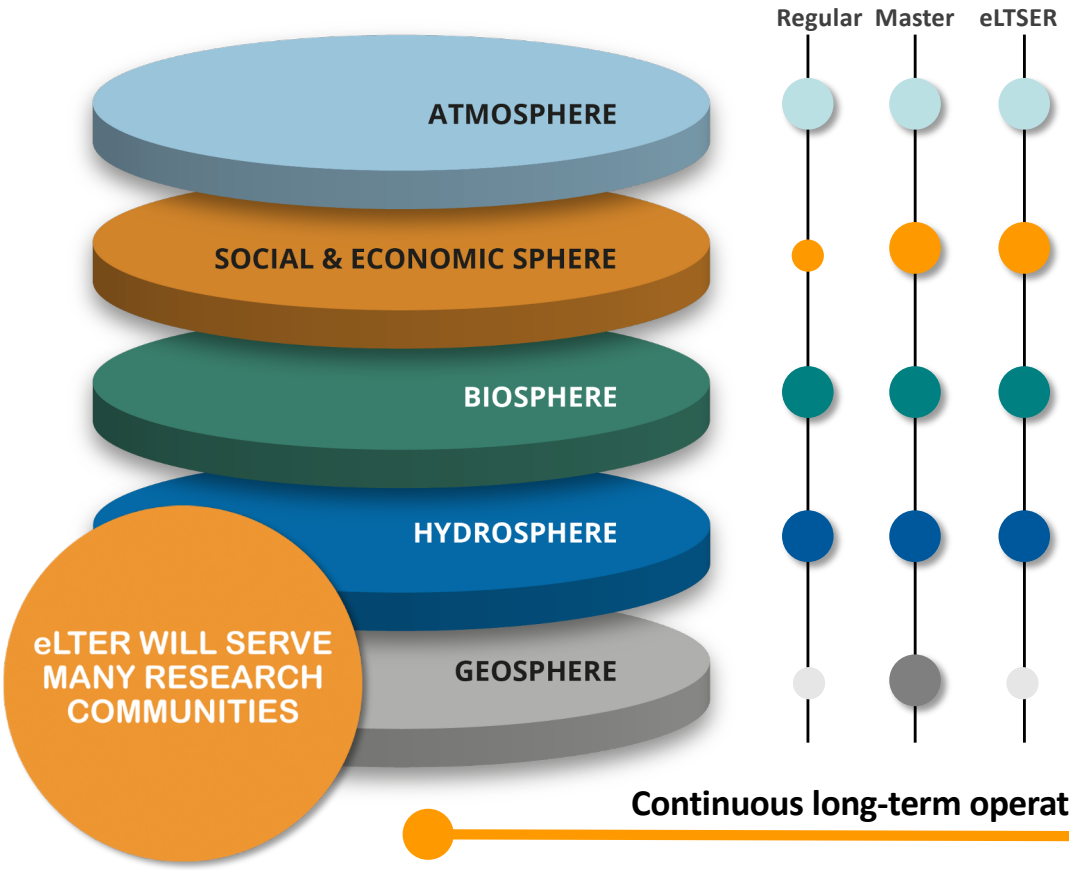
Eutrophication and pollution

Water Framework Directive, UNECE-CLRTAP

Socio-ecology - Environmental protection, sustainable management of natural resources, water, soils, biodiversity & ecosystems

CAP, Strategy on adaptation to Climate Change, Soils thematic strategy

eLTER concept: Whole System -Approach



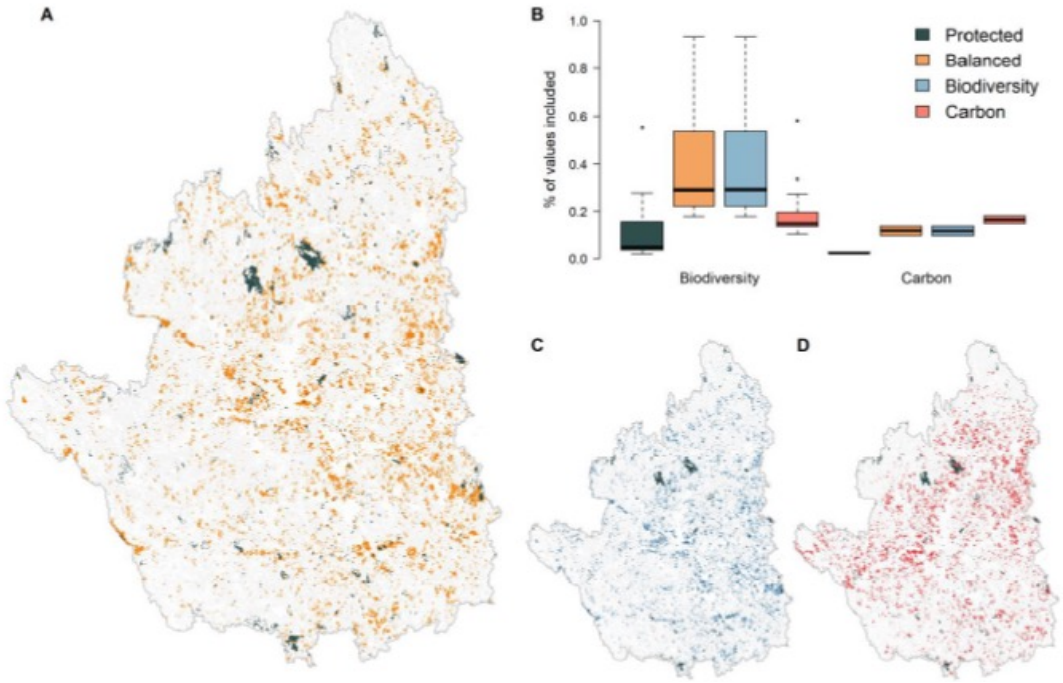
Site categories
differ in their focus on different system layers

eLTER provides

- Basic site infrastructure
- Information Clusters
  - Standard Observations on site (“EEVs”)
  - Multiple other data sources (RS, modelling)
- User access to data
- Site access

Continuous long-term operation of ~200 innovative hubs

Whole system approach in practice: simultaneous analysis of climate change and biodiversity



Forsius et al 2021

Maximise both biodiversity and carbon pools and fluxes

Maximise biodiversity

Maximise carbon pools and fluxes

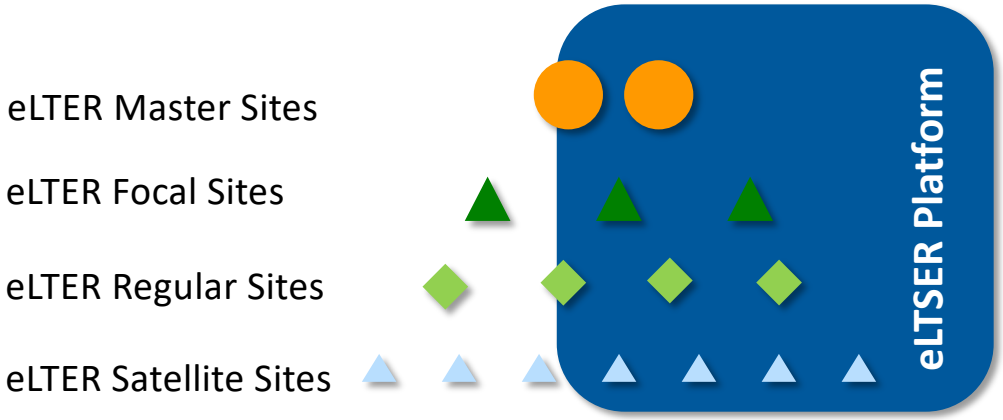
Example of “Whole system” SMEAR II

Input
energy, matter, water

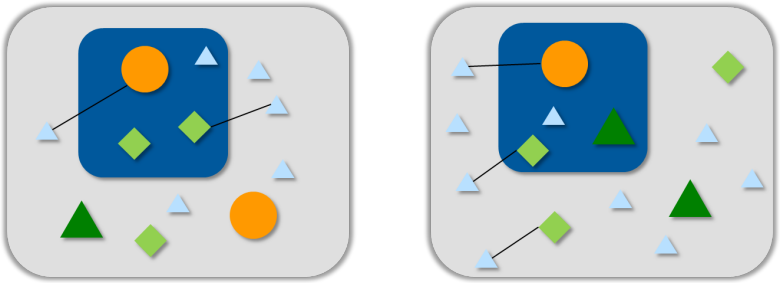
Output
energy, matter, water

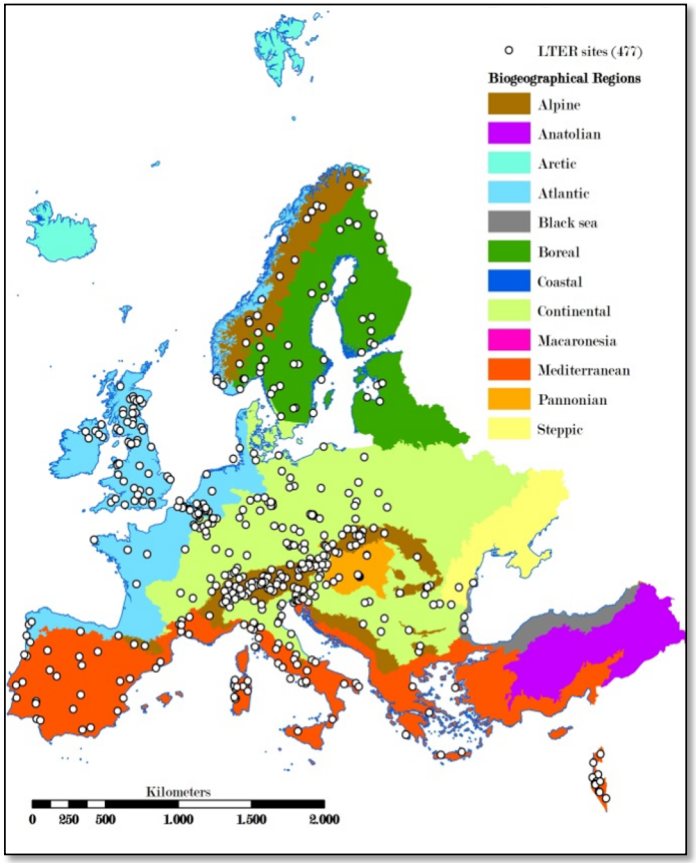
Ecosystem Change
Vegetation, soil, catchments, fluxes, biodiversity, habitats, population, land use, …

eLTER RI Design – The Modular Structure of Site Categories (2021)



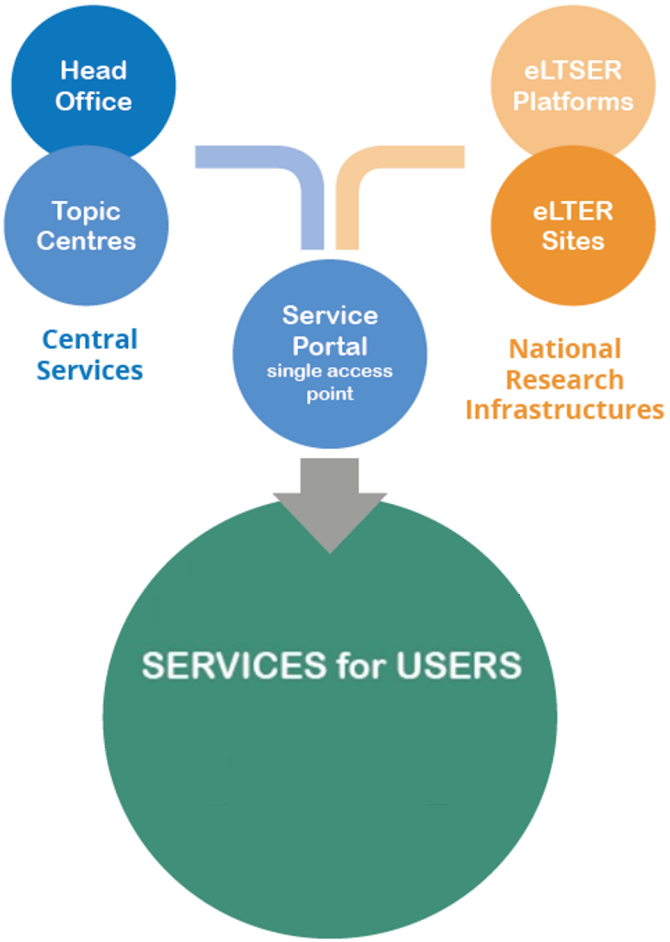
Theoretical examples of NRI specific spatial assemblage



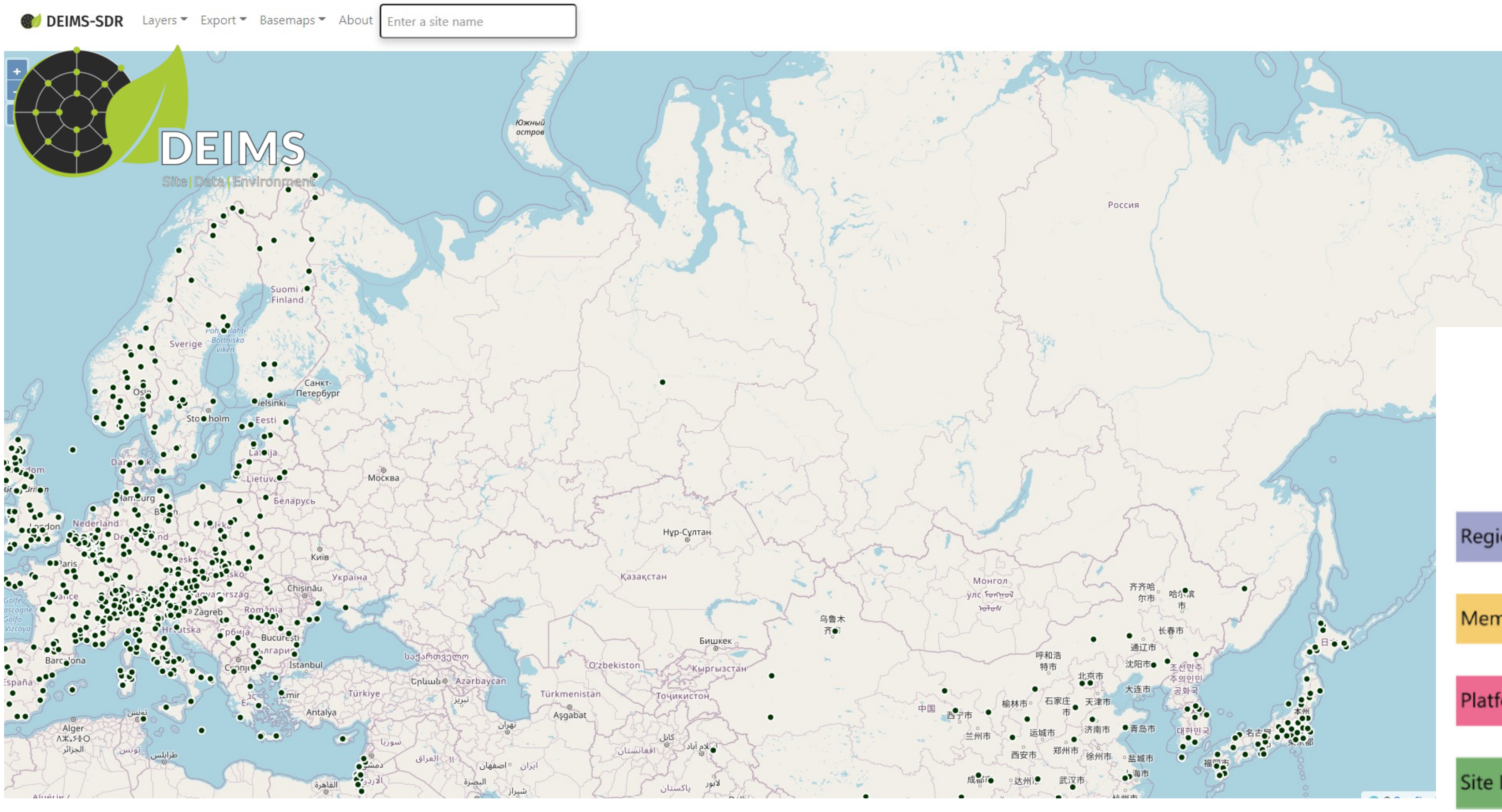


Overview of eLTER services

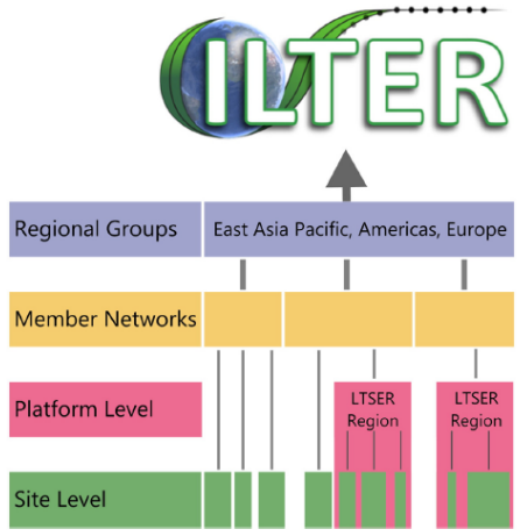
- ACCESS
  - Research site access
  - Long-term in-situ data (legacy, Standard Observations)
- DATA & ANALYSES
  - Integration of data from various sources (RS, national statistics, modelling, mapping)
  - Analytical tools, virtual labs etc.
  - High-level data products tailored to inform policy
- SUPPORT
  - Research project design support
  - Research technology/ R&D
  - Education & training



The long-term ecosystem observation sites in Eurasia



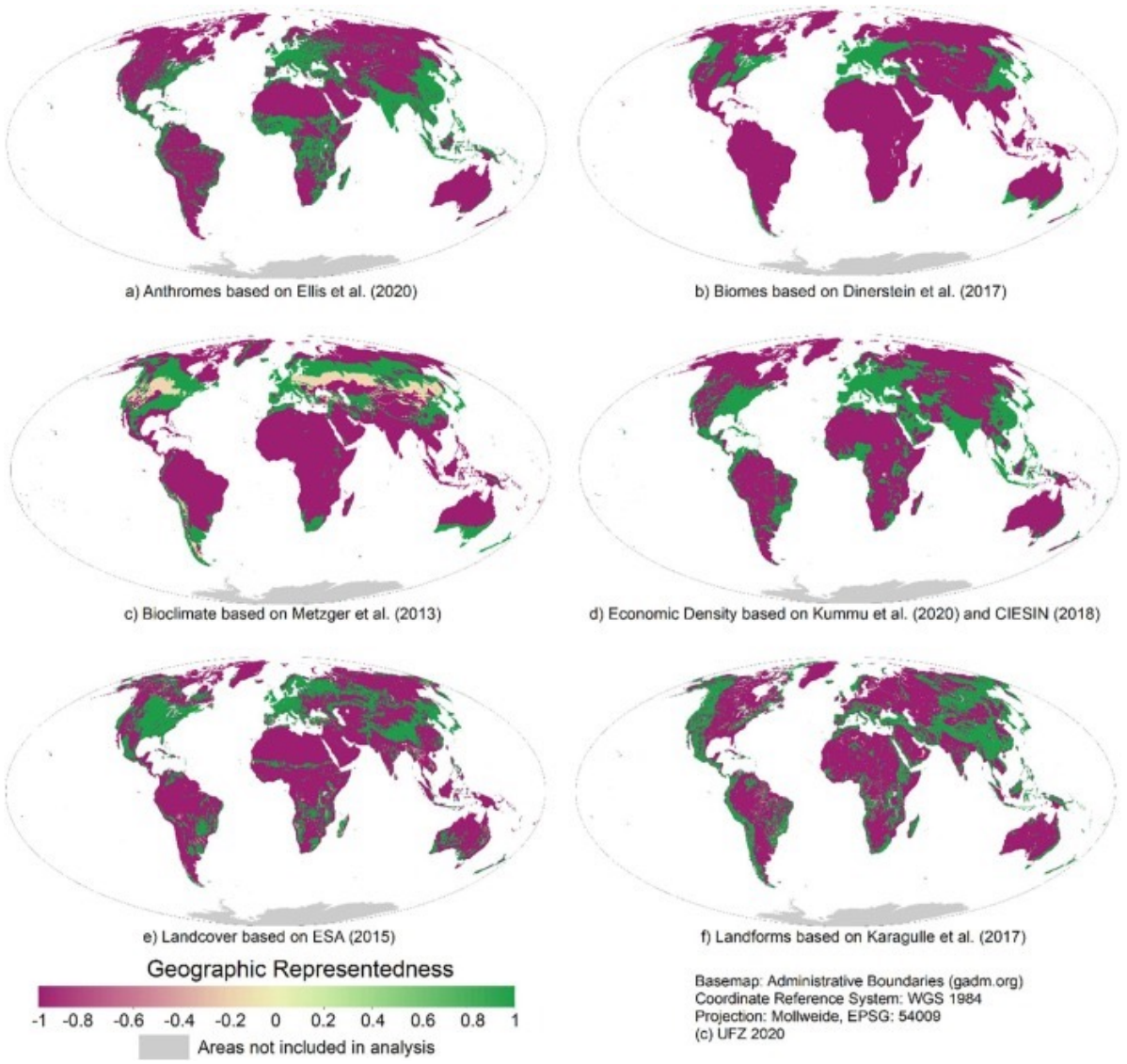
Deims.org

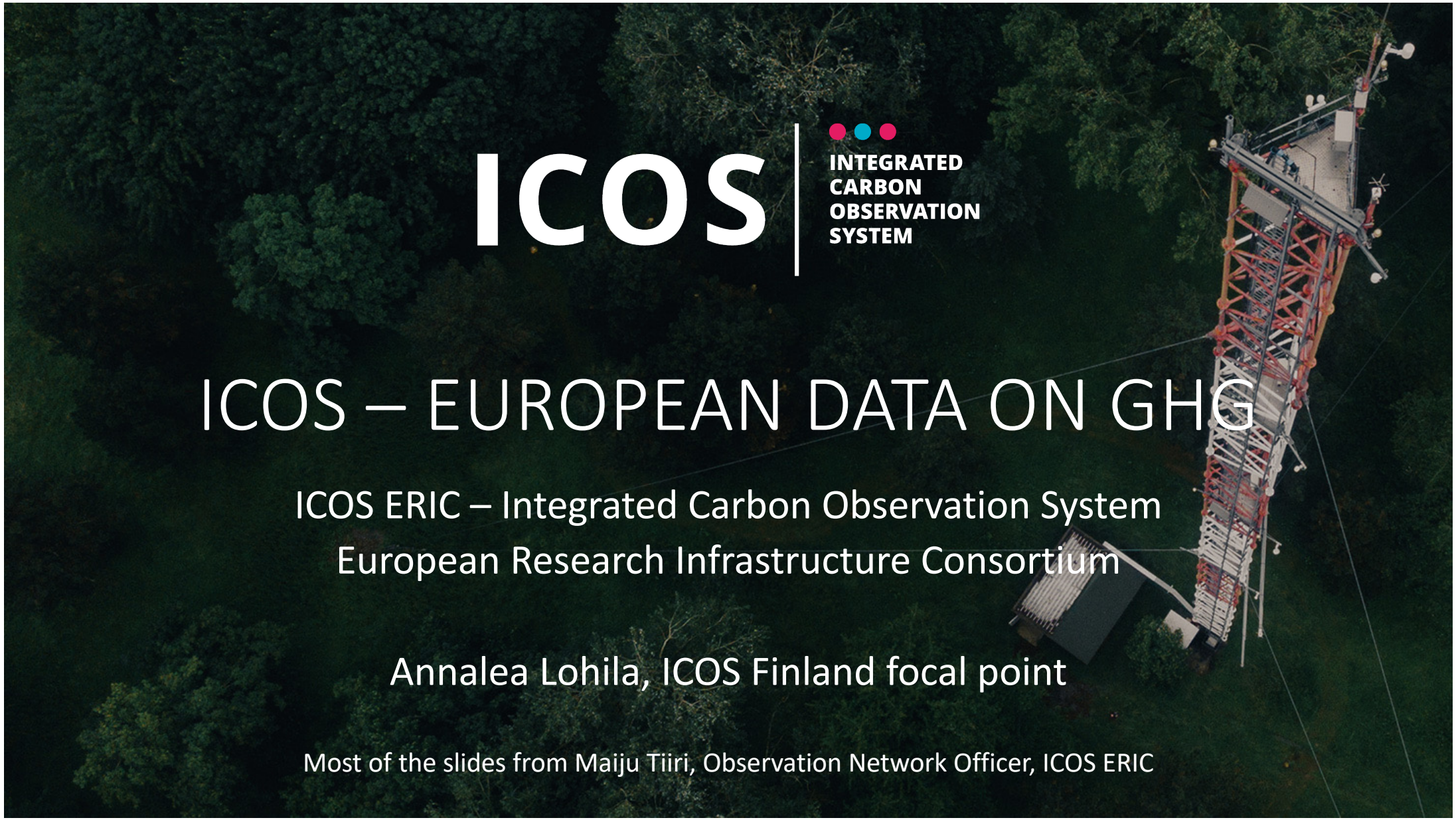


Representativeness of ILTER sites

- Dense coverage in Northern temperate regions and anthropogenic zones in the US, Europe and East Asia
- Gaps in wide areas in western Asia, Africa, S-America

Wohner et al 2021





ICOS – EUROPEAN DATA ON GHG

ICOS ERIC – Integrated Carbon Observation System
European Research Infrastructure Consortium

Annalea Lohila, ICOS Finland focal point

Most of the slides from Maiju Tiiri, Observation Network Officer, ICOS ERIC

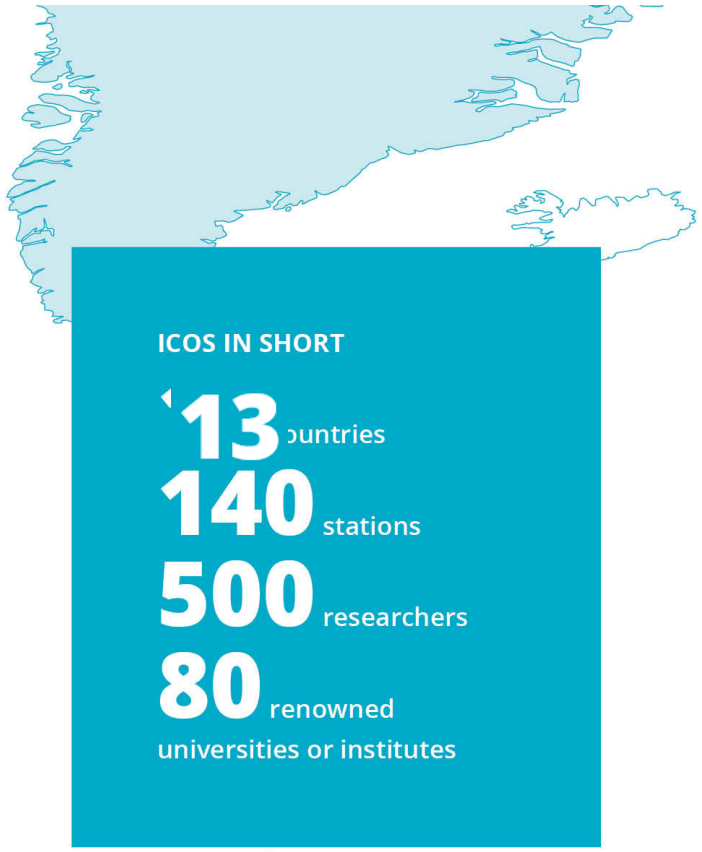
Agreements require the best available science on GHG

- ICOS as a benchmark on measurement standardisation and open data distribution
- ICOS is the European pillar for global GHG observations, strengthening Europe as a global influencer in GHG observations and research

How to measure GHG emissions – sources and sinks?

- Variety of technologies in place
- One of the most important ones especially for the ecosystem measurements is the Eddy Covariance method
- https://www.youtube.com/watch?v=CR4Anc8Mkas

ICOS ERIC* is an European research infrastructure producing standardised greenhouse gas data



- Measurements at **atmosphere**, **ecosystem** and **ocean** stations
- Data is open and free for all, used by policymakers and scientists alike
- ICOS ERIC established in 2015
- **Countries:** Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom
- Head Office in Finland

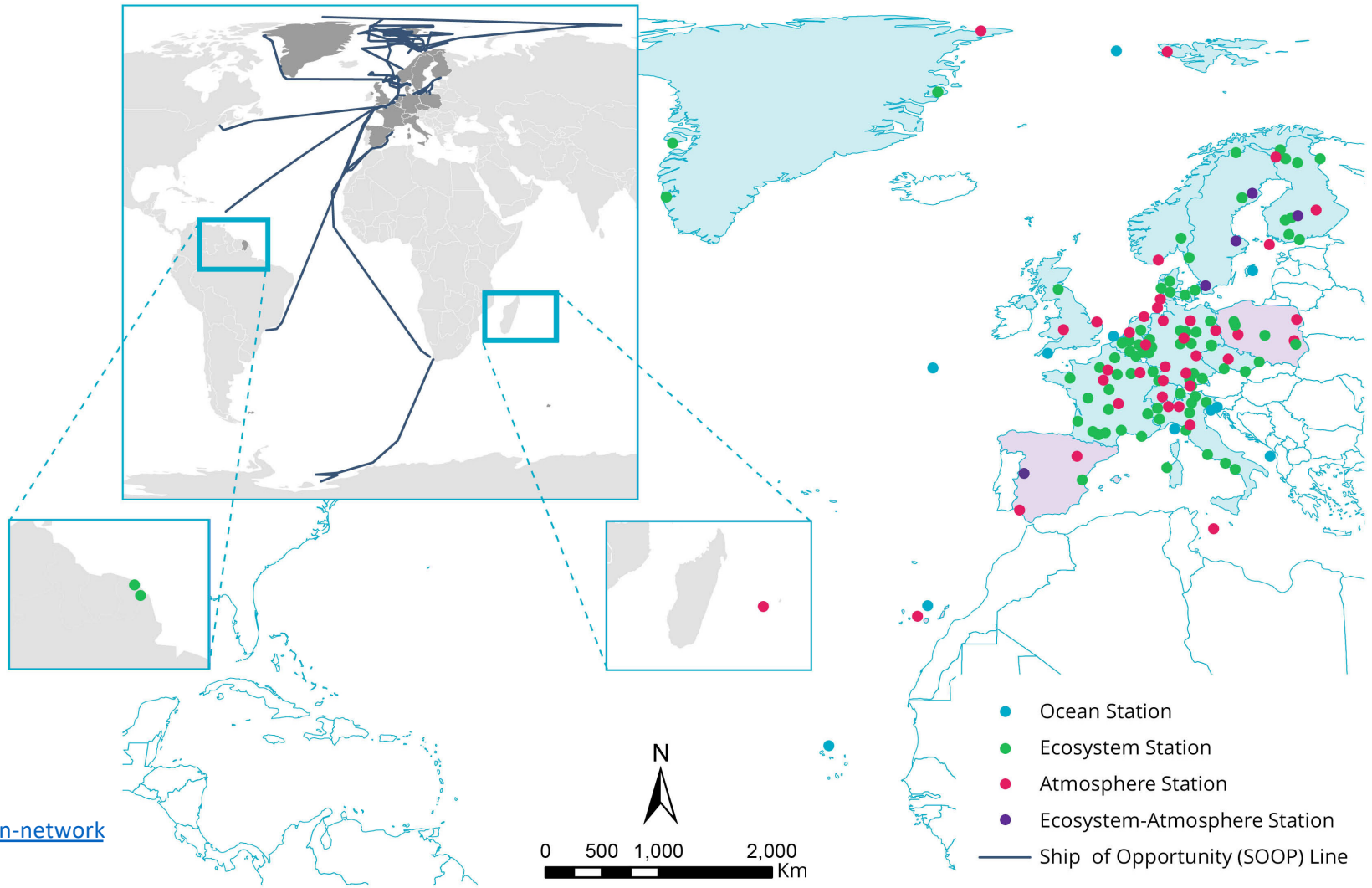
*ERIC=European research infrastructure consortium; **European joint-ventures** (based in multiple countries) and **established to provide data and carry out research programmes and projects**.

ICOS Station Network

Atmosphere stations: 38

Ecosystem stations: 86

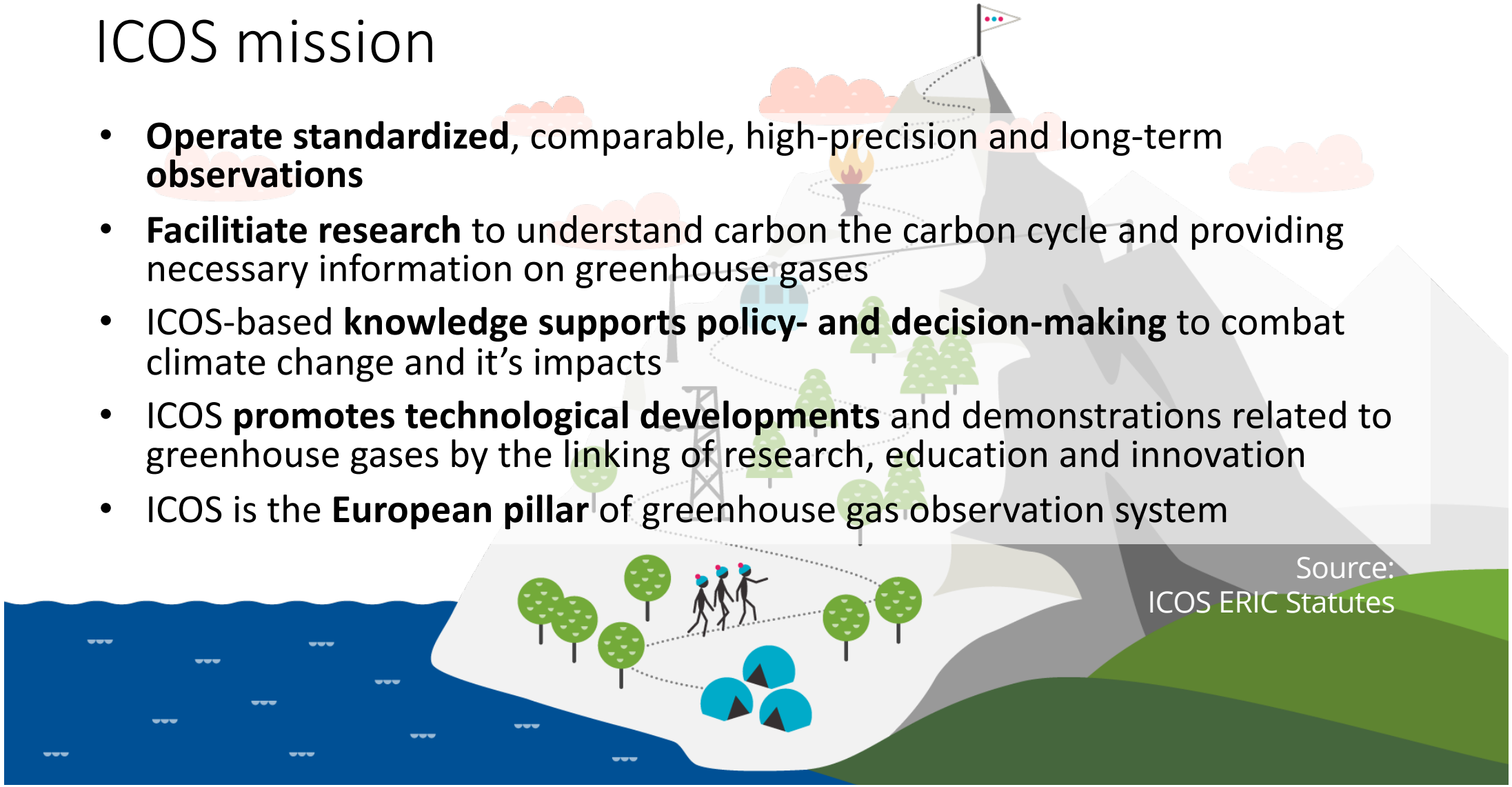
Ocean stations: 23



www.icos-cp.eu/observations/station-network

ICOS mission

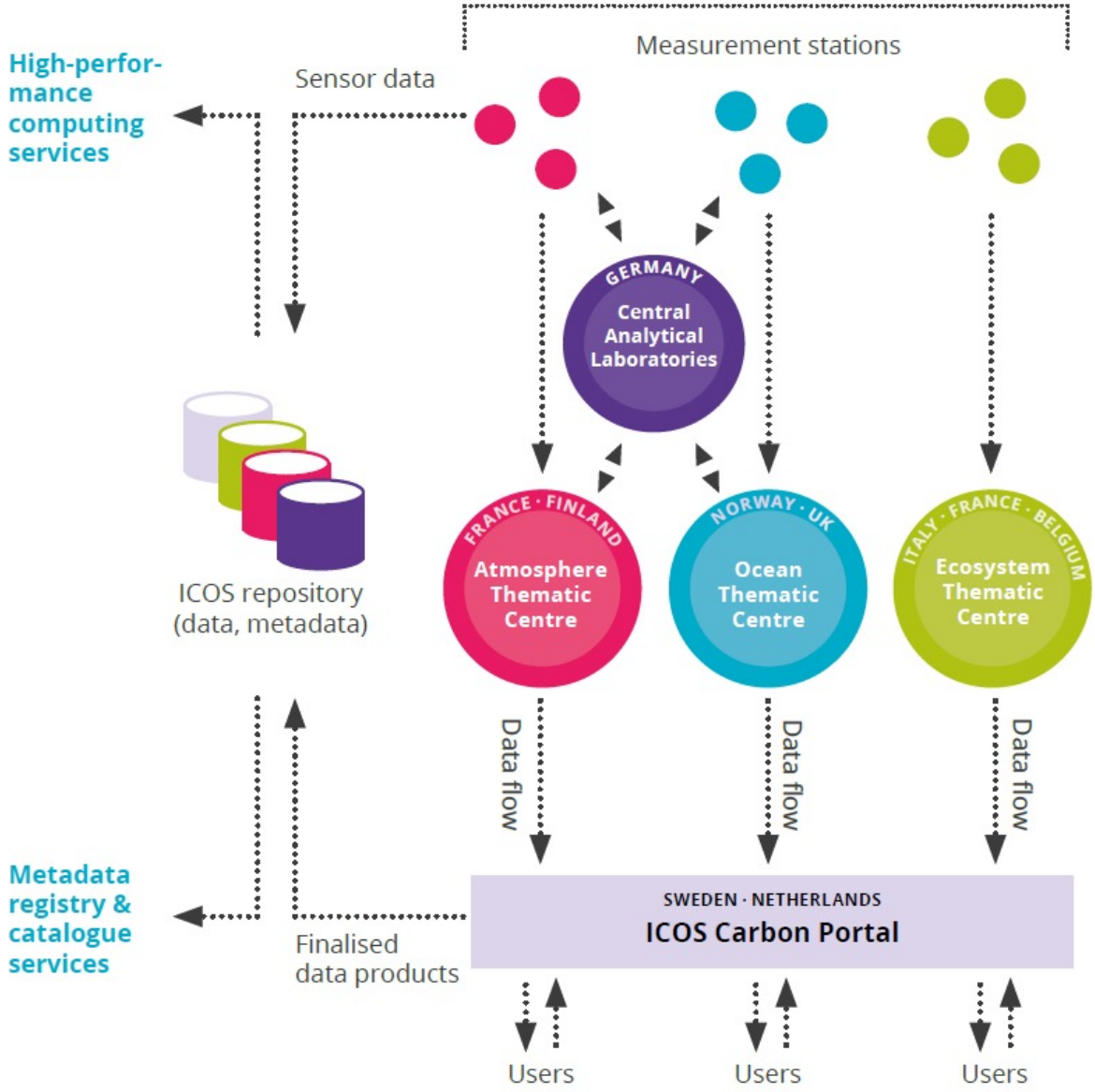
- **Operate standardized**, comparable, high-precision and long-term **observations**
- **Facilitiate research** to understand carbon the carbon cycle and providing necessary information on greenhouse gases
- ICOS-based **knowledge supports policy- and decision-making** to combat climate change and it's impacts
- ICOS **promotes technological developments** and demonstrations related to greenhouse gases by the linking of research, education and innovation
- ICOS is the **European pillar** of greenhouse gas observation system

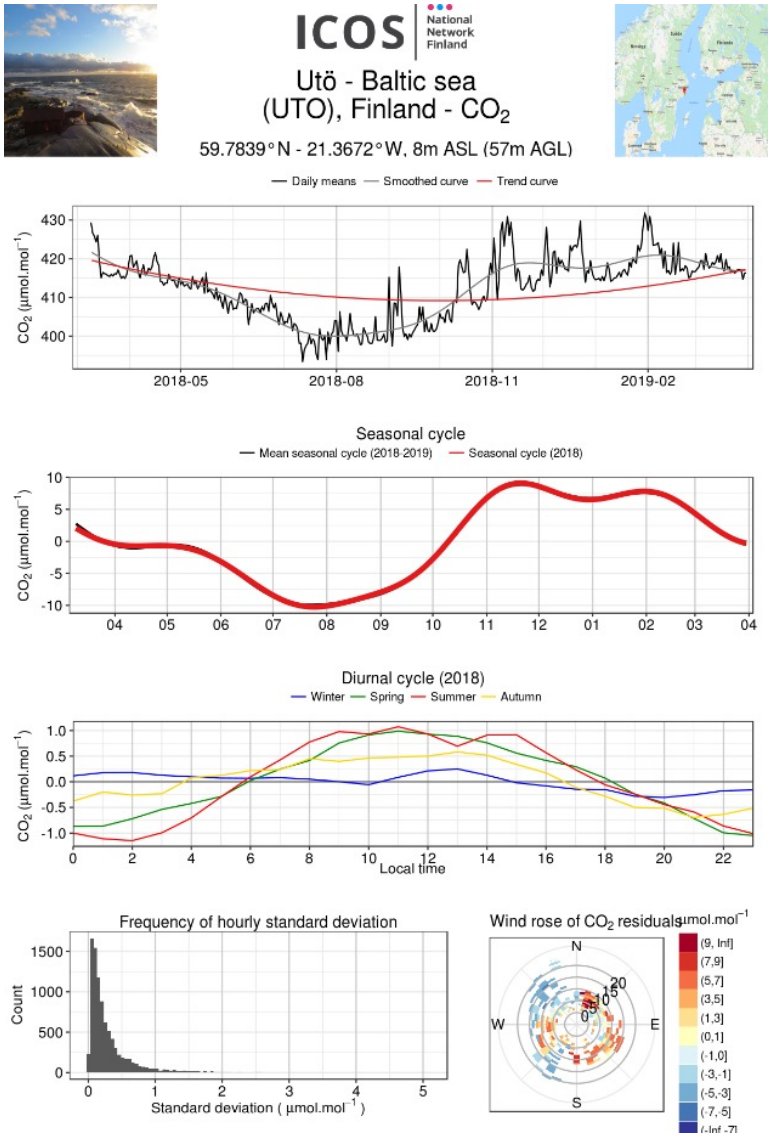


Source:
ICOS ERIC Statutes

Distributed organisation producing high-quality data

- Standardized measurements in measurement stations across Europe
- Standardized data processing and quality control in **Thematic Centres**
- Centralized data provenance, curation and archiving in **ICOS Carbon Portal**





A very rigid standardisation and compliance policy

The steps of the ICOS station labelling:

The applicant sends a formal application via www.icos-cp.eu

Step 01 — ICOS evaluates the station location and technical requirements.

ICOS Head Office creates links between the station personnel and the respective Thematic Centre, which helps the station in the work.

Step 02 — Constructing and upgrading the station, evaluation and testing.

The station needs to meet ICOS standards, the Thematic Centre personnel can advise.

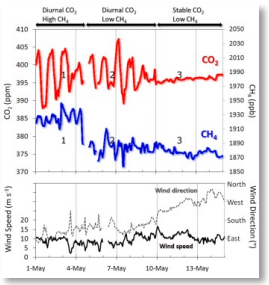
Step 03 — The ICOS General Assembly awards the ICOS label to the station.

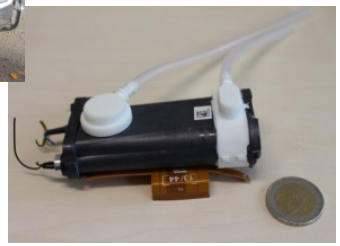
The whole labelling process might take anything up to a year.

Left: example of a labelling facts sheet

Atmosphere measurements

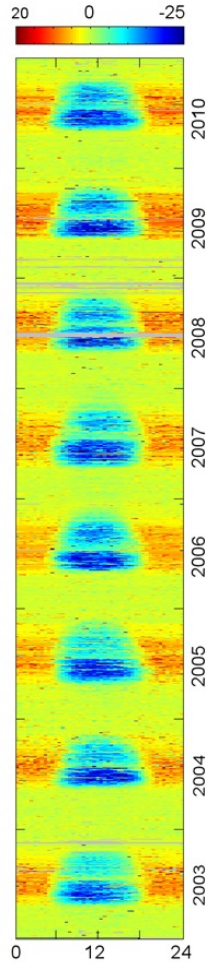
CATEGORY	GASES, CONTINUOUS SAMPLING	GASES, PERIODICAL SAMPLING	METEOROLOGY, CONTINUOUS	EDDY FLUXES
Class 1 Mandatory parameters	CO_2, CH_4, CO: at each sampling height	CO_2, CH_4, N_2O, SF_6, CO, H_2, ^{13}C and ^{18}O in CO_2: sampled every three days at highest sampling height ^{14}C (radiocarbon integrated samples): at highest sampling height	Air temperature, relative humidity, wind direction, wind speed: at highest and lowest sampling height* Atmospheric Pressure Planetary Boundary Layer Height**	
Class 2 Mandatory parameters	CO_2, CH_4: at each sampling height		Air temperature, relative humidity, wind direction, wind speed: at highest and lowest sampling height* Atmospheric Pressure	
Recommended parameters***	^{222}Rn, N_2O, O_2/N_2 ratio CO for Class 2 stations	CH_4 stable isotopes, O_2/N_2 ratio for class 1 stations: weekly sampled at highest sampling height		CO_2: at one sampling height





Ecosystem measurements

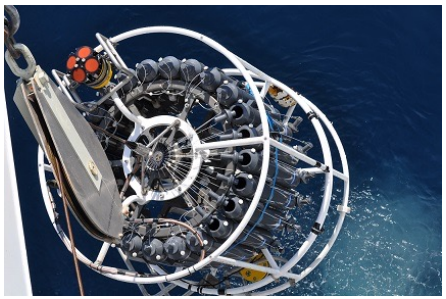
VARIABLES	FOREST	GRASS-LAND	CROP-LAND	WET-LAND*	MA-RINE**	LAKES**
CO_2, H_2O and H fluxes (eddy covariance, including profile for storage)	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2
CH_4 and N_2O fluxes (eddy covariance, including profile for storage)	1	1	1	1	1	1
Air H_2O concentration	1	1	1	1	1	1
Incoming, outgoing and net SW and LW radiations	1 & 2	1 & 2	1 & 2	1 & 2	1	1
Incoming SW radiation (high quality)	Fac	Fac	Fac	Fac	Fac	Fac
Incoming PPFD	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2
PPFD below canopy + ground reflected	Fac	Fac	Fac	N.R.	N.R.	N.R.
Outgoing PPFD	1 & 2	1 & 2	1 & 2	1 & 2	Fac	Fac
Diffuse PPFD and/or SW radiation	1	1	1	1	Fac	Fac
Spectral reflectance	Fac	Fac	Fac	Fac	Fac	Fac
Soil heat flux	1 & 2	1 & 2	1 & 2	1 & 2	N.R.	N.R.
Air temperature and humidity profile	1 & 2	1 & 2	1 & 2	1 & 2	Fac	Fac
Backup meteo station (TA, RH, SW_IN, precipitation)	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2

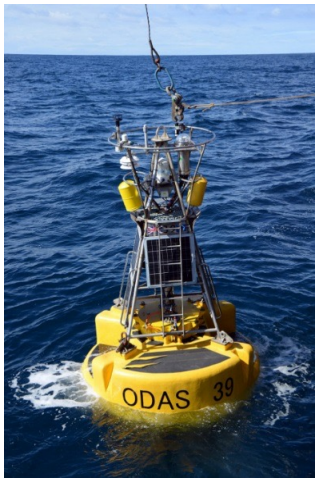


Ocean measurements

VARIABLE	FREQUENCY	ACCURACY
Sea surface fCO_2	Quasi-continuous	± 2 µatm
Intake temperature (SST)	Continuous	± 0.05 °C
Equilibrator temperature	Continuous	± 0.05 °C
ΔT (Intake/Equilibrator temperature difference)	Continuous	< 1.5 °C (normal) < 3 °C (ice-edge)
Water vapour pressure*	Continuous	± 0.5 mbar
Equilibrator pressure	Continuous	± 2.0 mbar
Atmospheric pressure/sea level pressure	Continuous	± 1.0 mbar
Sea surface salinity (SSS)	Continuous	± 0.1 PSU
Dissolved oxygen	Continuous	± 2%
Total alkalinity (TA)**	***	± 10 µmol kg^{-1}
Dissolved inorganic carbon (DIC)**	***	± 5 µmol kg^{-1}

* If the analysed headspace gas is not dried completely prior to measurement.
** At least one of these variables must be provided.
*** The frequency of these additional variables will be decided on during the labelling process based on the area where the station is operating.

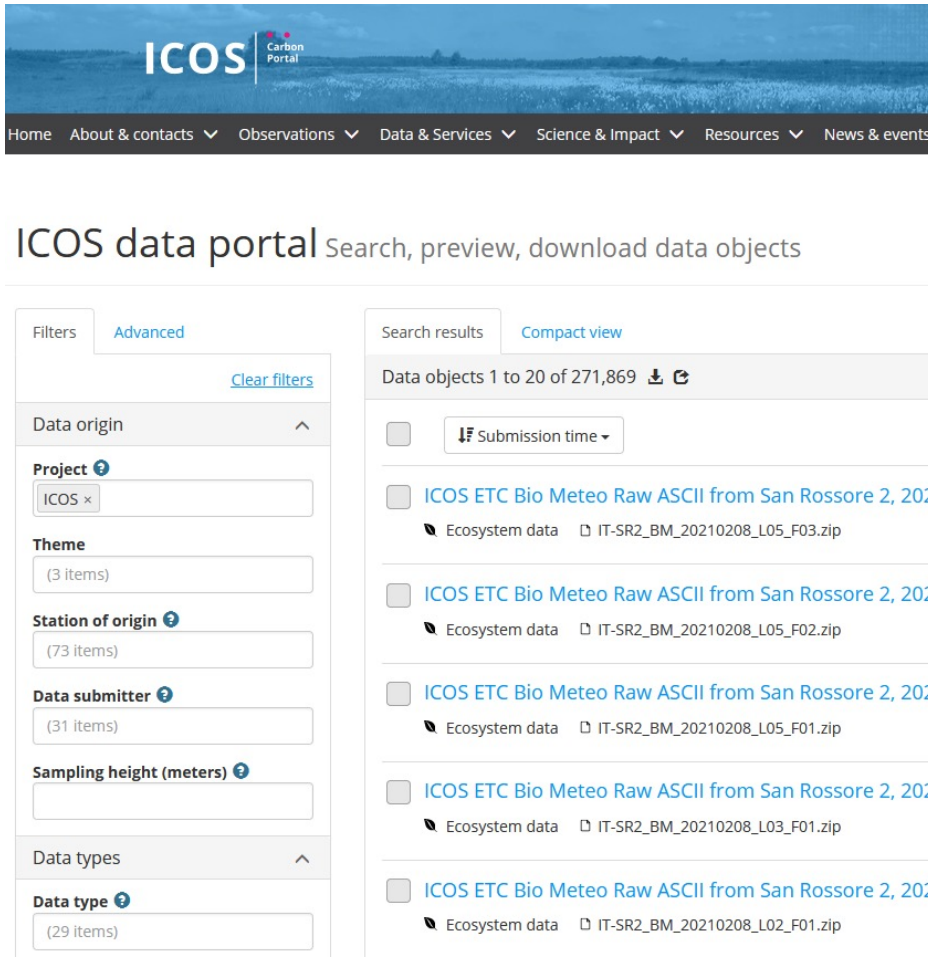




ICOS Carbon Portal – ICOS data center

A website offering users:

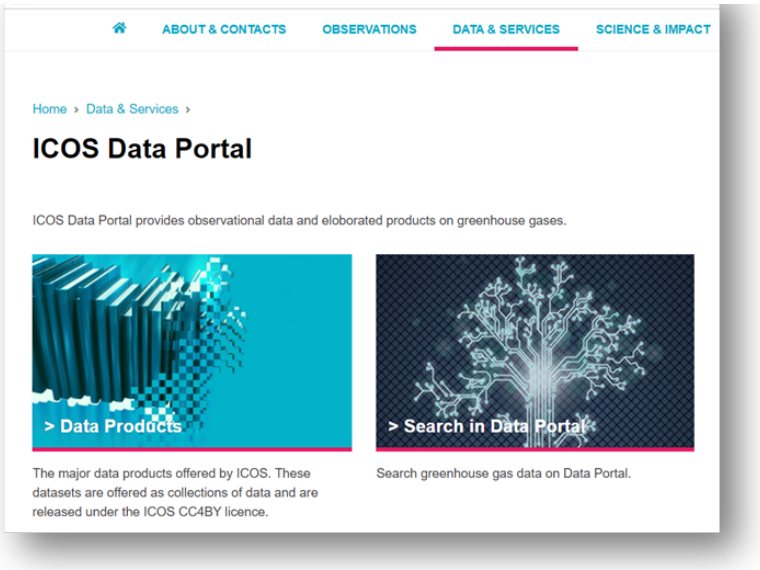
- Open and free of charge access to ICOS data products
- Search, visualisation, download service for data and products
- Statistics and comparison tools
- Synthesis reports and educational materials
- Community platform for elaborated products
- **https://data.icos-cp.eu/portal**

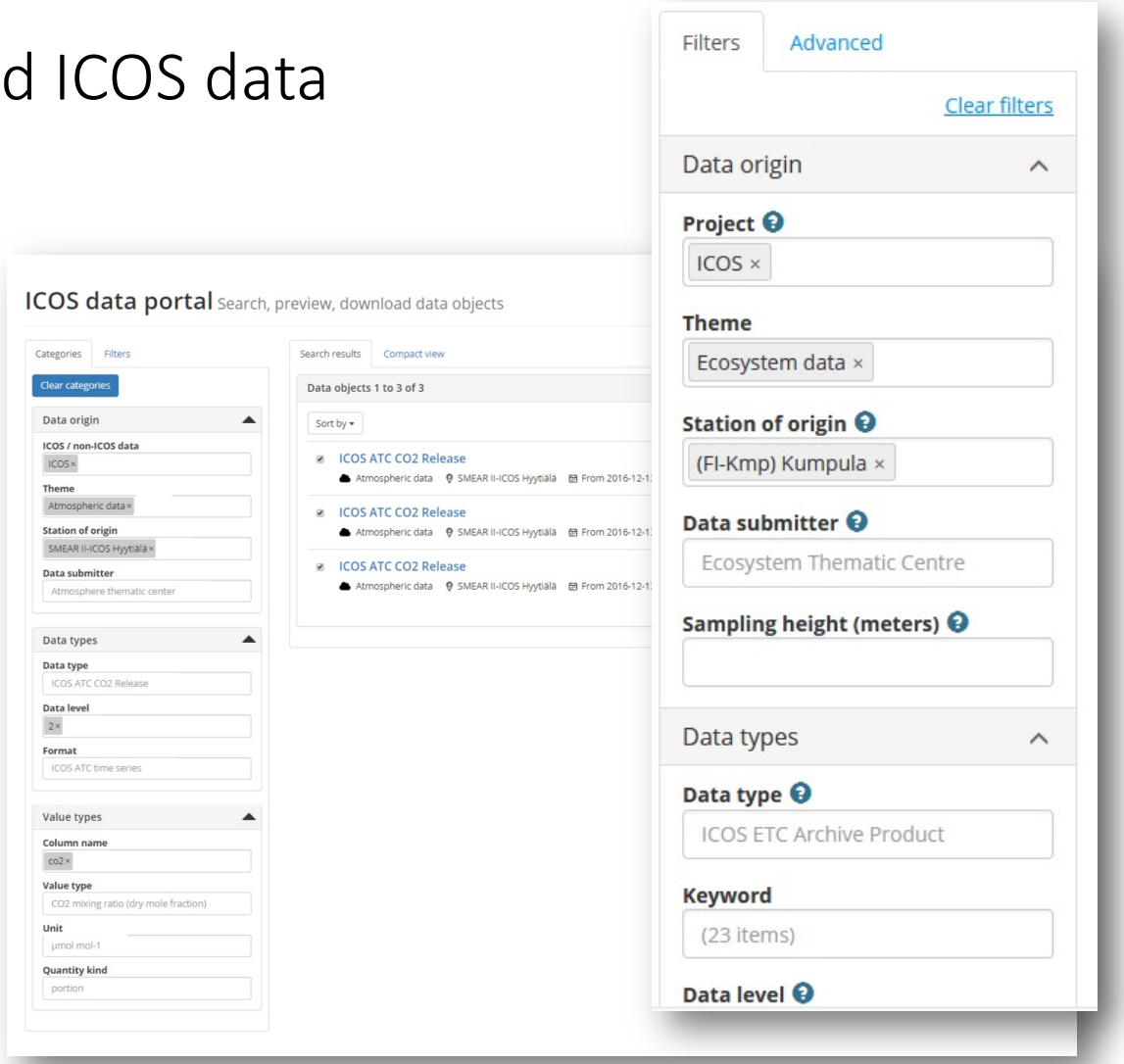


Find, preview and download ICOS data

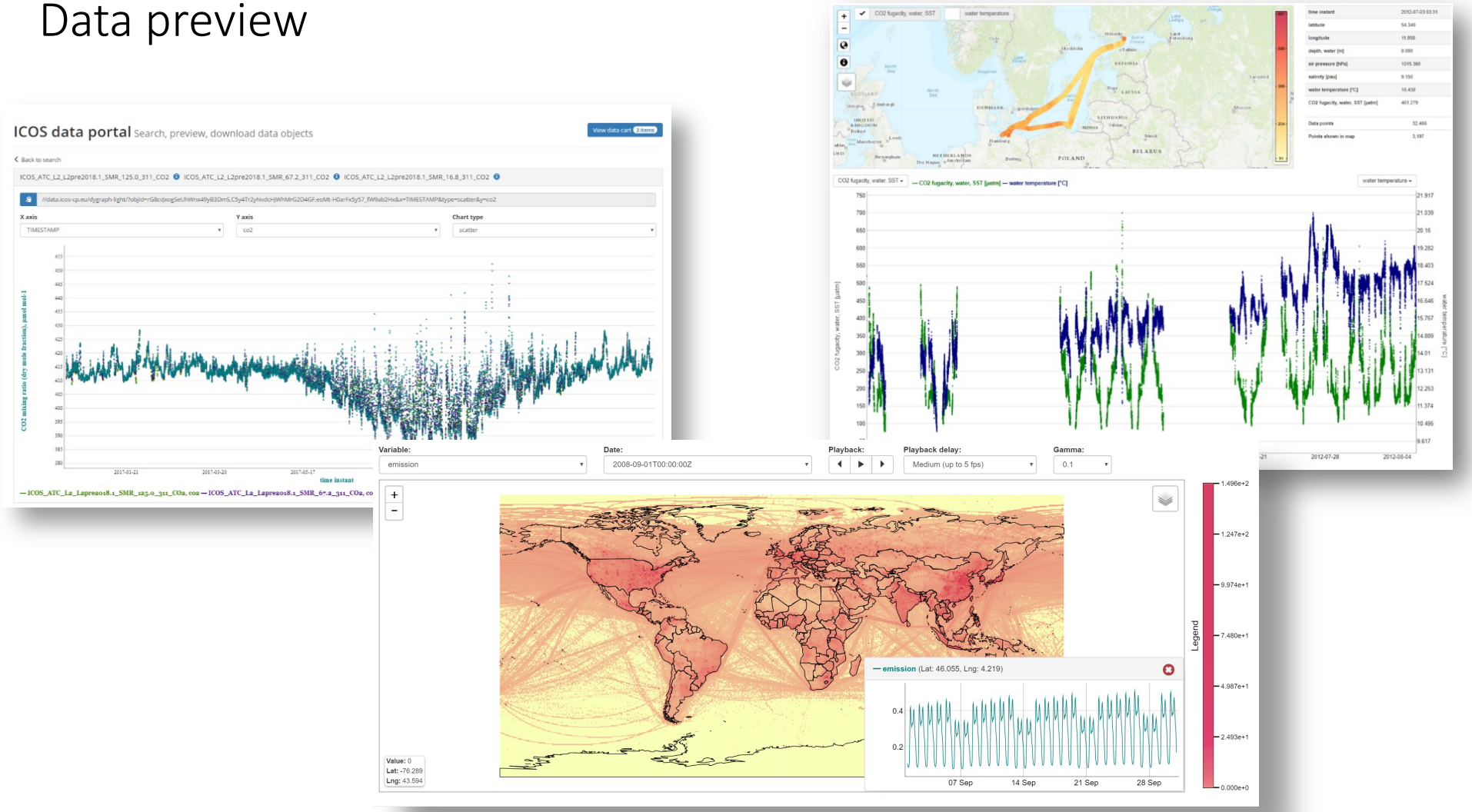
https://data.icos-cp.eu/portal

- >200 000 visible data objects
- Download/preview count
  - Per data object
  - Per domain
  - Per contributor
  - Per country etc.





Data preview



Thank you!

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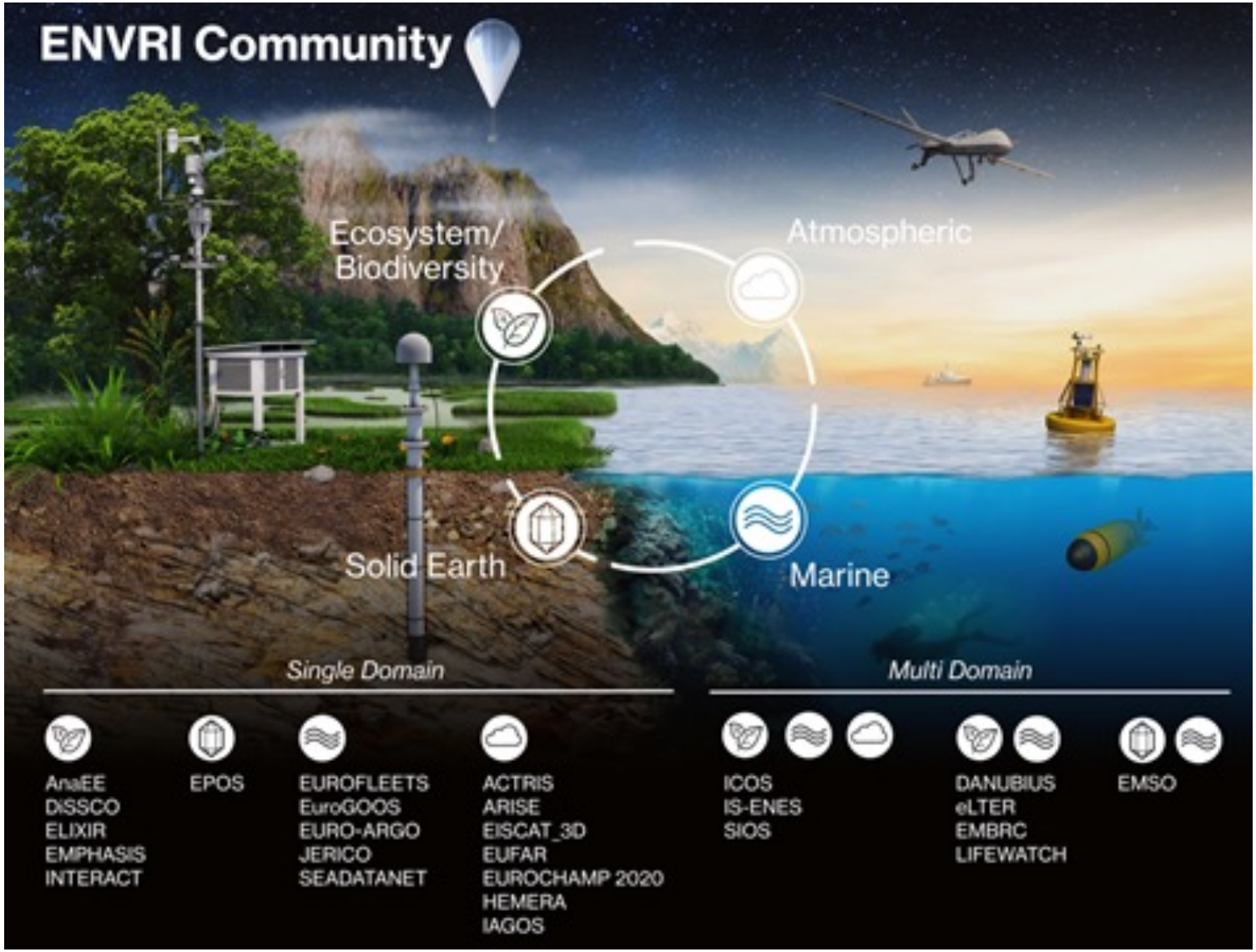
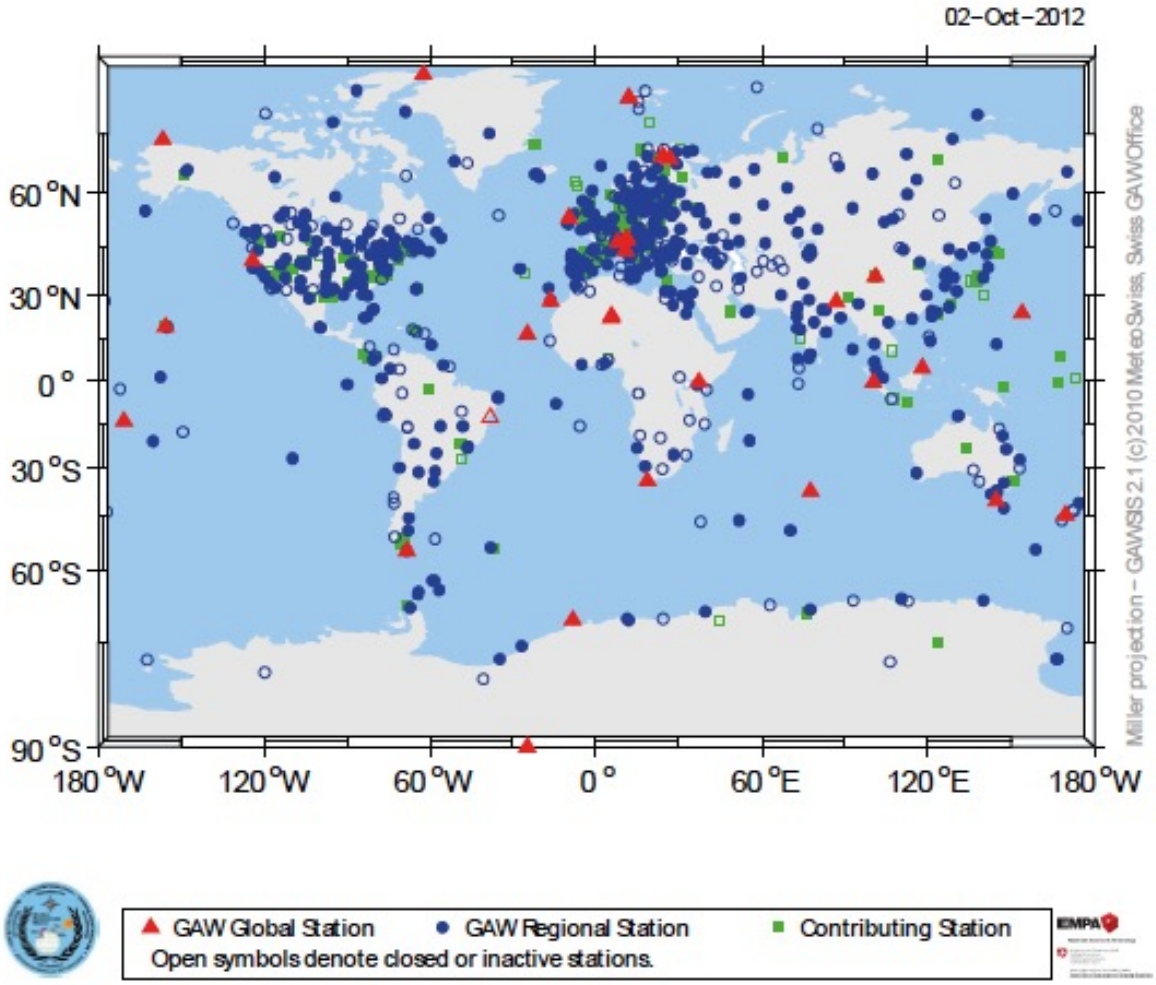
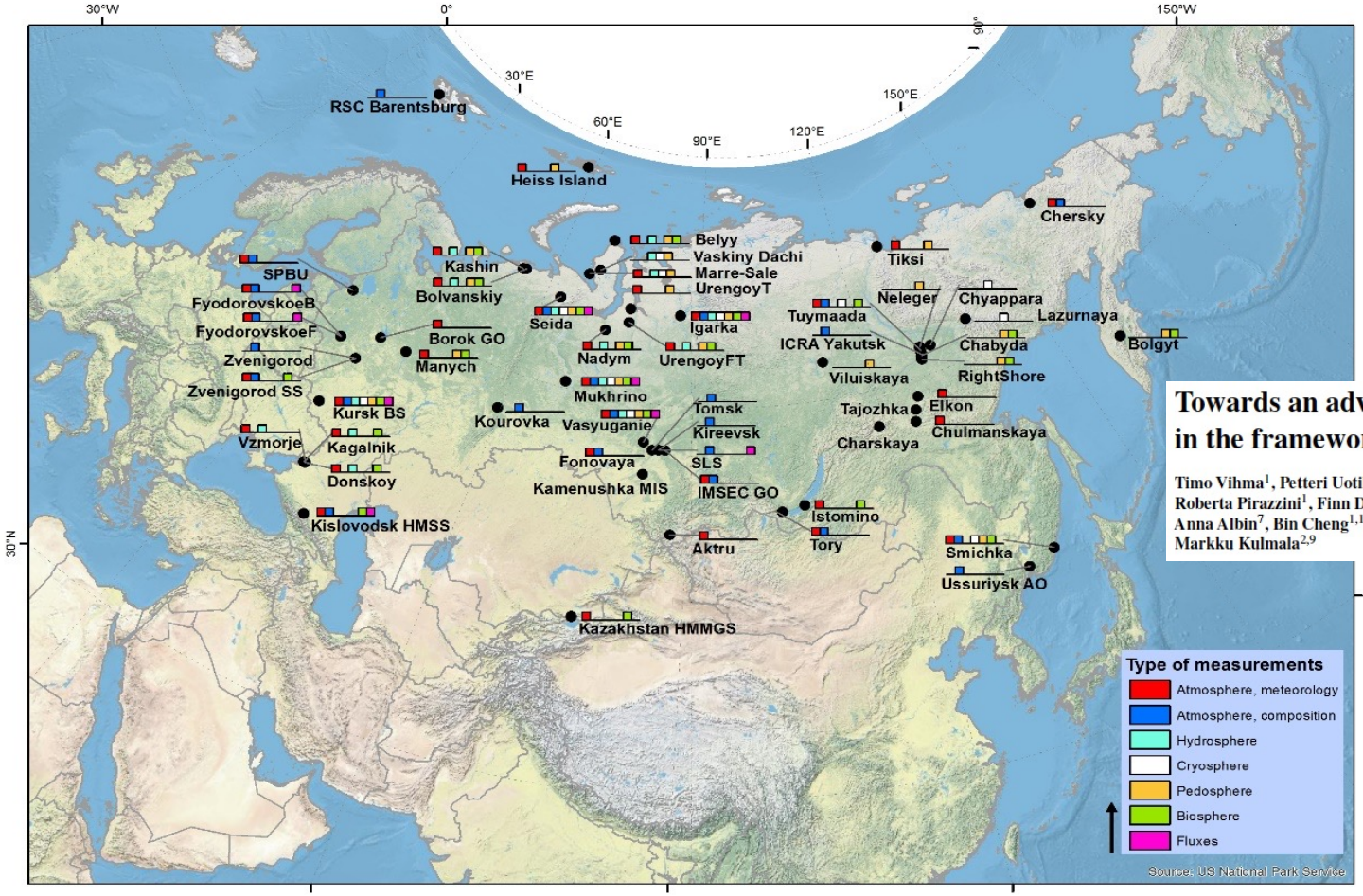
European Environmental RI landscape

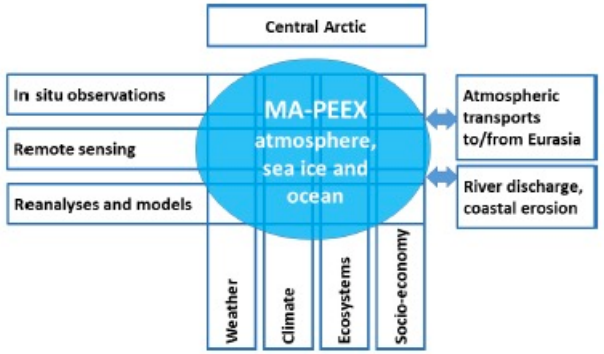


The Global Atmospheric Watch (GAW) Network



Pan Eurasian Experiment (PEEX) analysis of existing capacity → capacity building in education, training, instruments, new stations for regional representation





Towards an advanced observation system for the marine Arctic in the framework of the Pan-Eurasian Experiment (PEEX)

Timo Vihma[1], Petteri Uotila[2], Stein Sandven[3], Dmitry Pozdnyakov[4], Alexander Makshtas[5], Alexander Pelyasov[6], Roberta Pirazzini[1], Finn Danielsen[7], Sergey Chalov[8], Hanna K. Lappalainen[2,9], Vladimir Ivanov[5,8,10], Ivan Frolov[5], Anna Albin[7], Bin Cheng[1,11], Sergey Dobrolyubov[8], Viktor Arkhipkin[8], Stanislav Myslenkov[8,10], Tuukka Petäjä[2,9], and Markku Kulmala[2,9]

GROUND-BASED STATION NETWORK IN ARCTIC AND SUBARCTIC EURASIA: AN OVERVIEW

DOI: 10.15356/2071-9388_02v09_2016_06

Pavel Alekseychik*[1], Hanna K. Lappalainen[1], Tuukka Petäjä[1], Nina Zaitseva[2], Martin Heimann[3, 1], Tuomas Laurila[4], Heikki Lihavainen[4], Eija Asmi[4], Mikhail Arshinov[5], Vladimir Shevchenko[6], Alexander Makshtas[7], Sergey Dubtsov[8], Evgeny Mikhailov[9,10], Elena Lapshina[11], Sergey Kirpotin[12], Yulia Kurbatova[13], Aijun Ding[14], Huadong Guo[15], Sungbin Park[3], Joost V. Lavric[3], Friedemann Reum[3], Alexey Panov[16], Anatoly Prokushkin[16], Markku Kulmala[1]

WG: T. Petäjä, I.Bashmakova, A.Borisova, P. Alekseychik, H.K. Lappalainen, A. Mahura, N. Altimir, S. Chalov, P. Kontantinov, N. Zaitseva + many active stations

An enclosure for measuring gas exchange between plants and the atmosphere at a station in Finland.

Build a global Earth observatory

Markku Kulmala calls for continuous, comprehensive monitoring of interactions between the planet's surface and atmosphere.

Nature Comment (2018), Nature 553, 21–23

Many developing countries, such as Mongolia, have rural economies, so projects that can provide farmers with up-to-date agricultural information are crucial.

Steps to the digital Silk Road

Sharing big data from satellite imagery and other Earth observations across Asia, the Middle East and east Africa is key to sustainability, urges **Guo Huadong**.

Nature Comment (2018), Nature 554, 25-27

BIG EARTH DATA
https://doi.org/10.1080/20964471.2021.1936943

Taylor & Francis

OPEN ACCESS Check for updates

Atmospheric and ecosystem big data providing key contributions in reaching United Nations' sustainable development goals

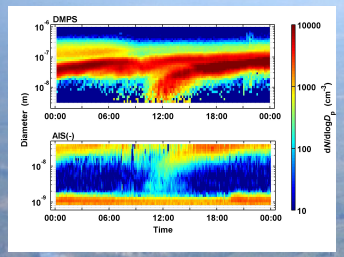
Markku Kulmala[a,b,c,d,e,f], Anna Lintunen[a,g], Ilona Ylivinkka[a], Janne Mukkala[a], Rosa Rantanen[a], Joni Kujansuu[a,b,c,f], Tuukka Petäjä[a,b,c,e] and Hanna K. Lappalainen[a,e,h]

Sharing big data from satellite imagery and other Earth observations

Global SMEAR and Digital Belt & Road - DBAR

Academician, Academy Professor **Markku Kulmala**
University of Helsinki, Faculty of Science
Institute for Atmospheric and Earth System Research
markku.kulmala@helsinki.fi

Academician, Professor **Guo Huadong**
Chair of DBAR
The Institute of Remote Sensing and Digital Earth
Chinese Academy of Sciences
guohd@radi.ac.cn



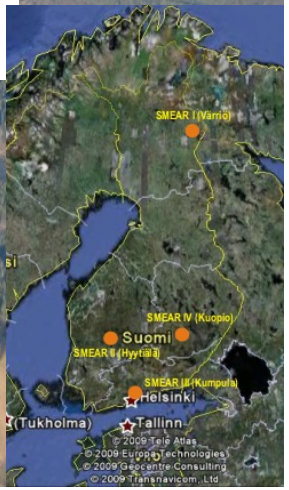
Main message:

1) **Commitment to comprehensive and continuous environmental observations**

2) **Continuous method development (instrumentation, models)**

3) **Active and open collaboration across various boundaries**

4) **Willingness to tackle and solve grand challenges together**



SMEAR II station
(boreal) 1995 -

https://www.helsinki.fi/en/inar-institute-for-atmospheric-and-earth-system-research

Thank you! Спасибо!

https://www.atm.helsinki.fi/peex

Vipuvoimaa EU:lta 2014–2020

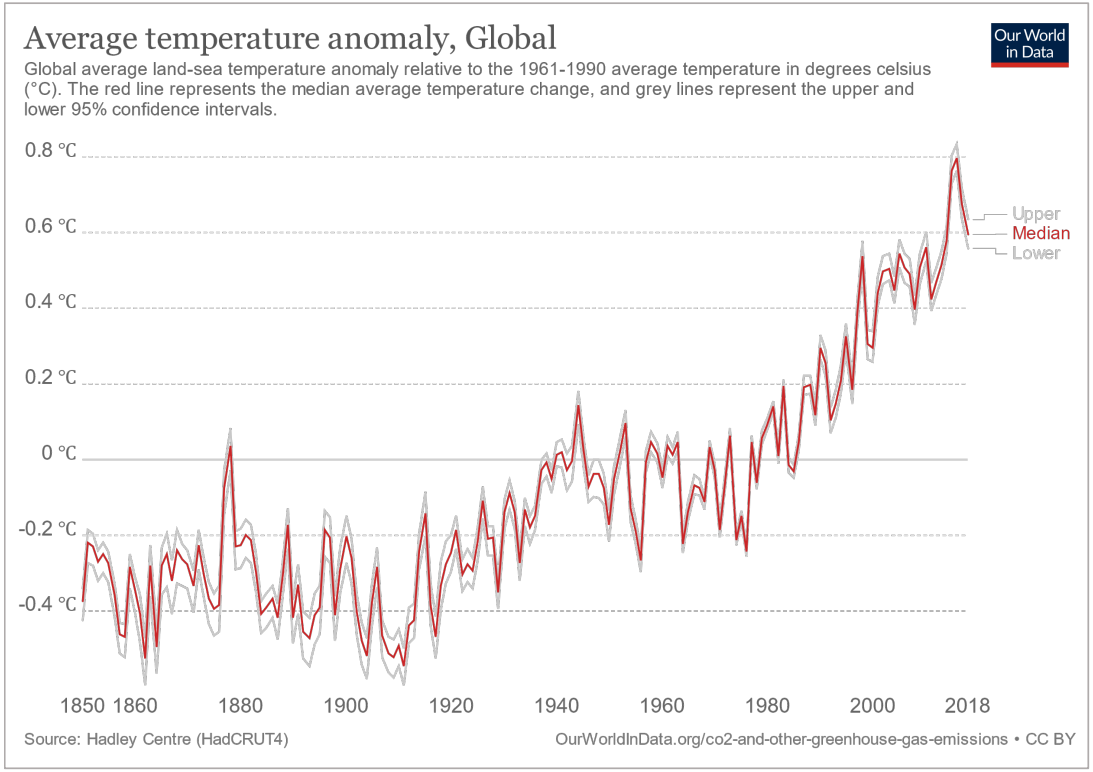
Euroopan unioni
Euroopan aluekehitysrahasto

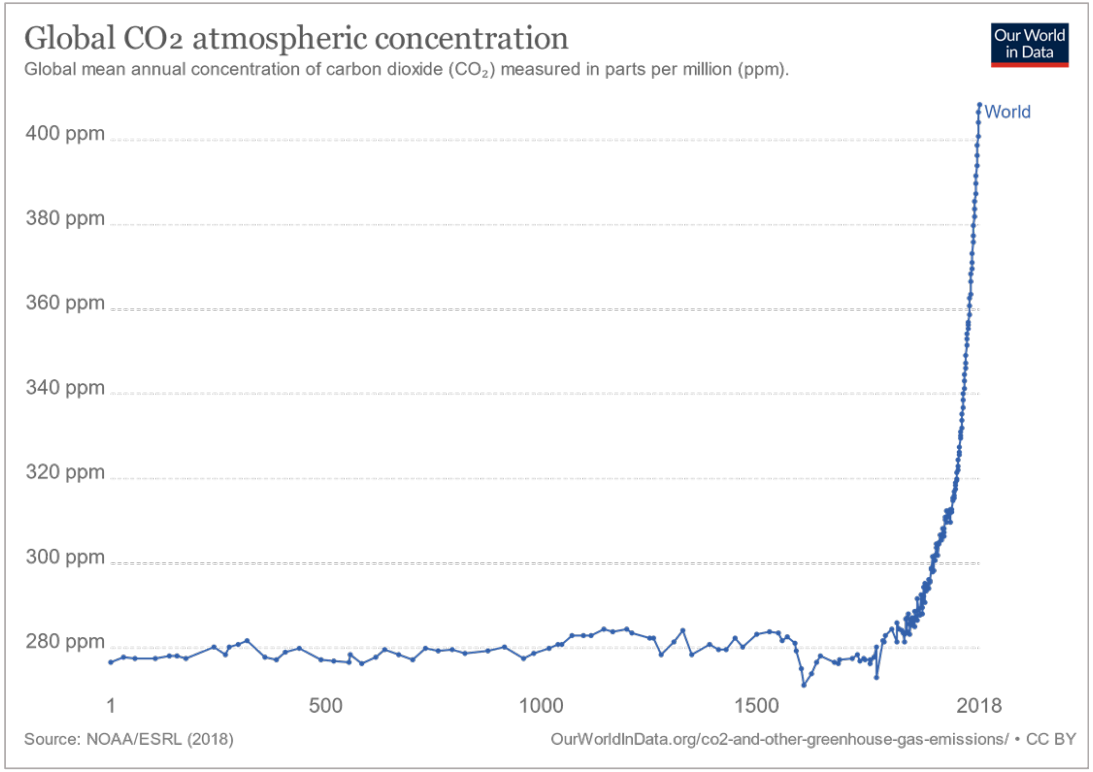
Contact:
Prof. Tuukka Petäjä, University of Helsinki
tuukka.petaja@helsinki.fi
+358 50 41 55 278

Support from Academy of Finland, European Commission, Regional Council of Lapland, Helsinki-Uusimaa Regional Council, and Business Finland are gratefully acknowledged.

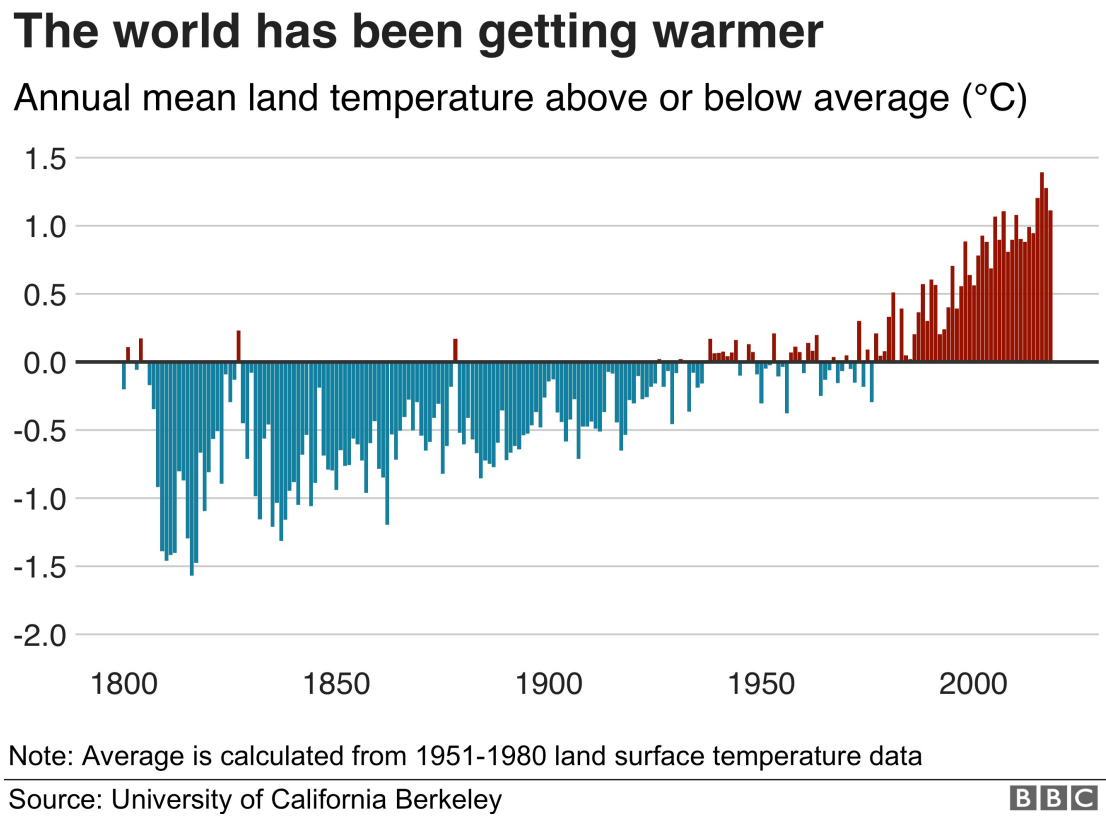
Extra material

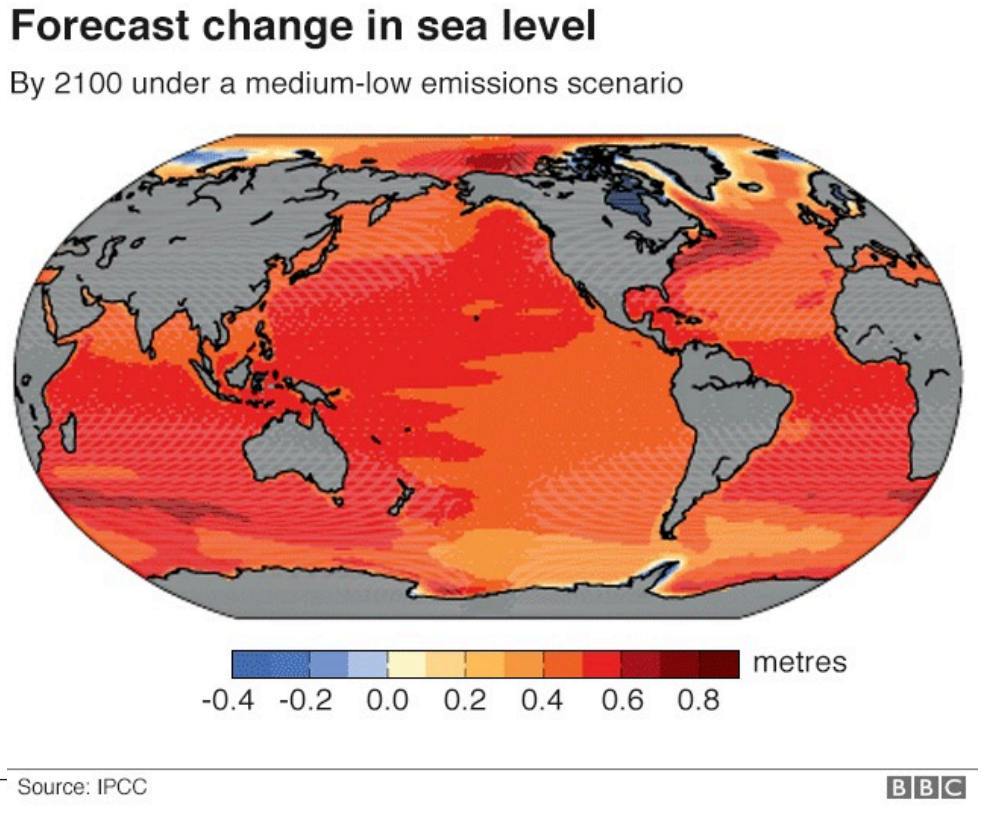
World is getting warmer: continuous rise in global average temperature and atmospheric CO_2 concentration





Changes in GHG alter the near-surface temperature & sea level





Fate of anthropogenic CO_2 emissions (2008–2017)

Sources

34.4 $GtCO_2$/yr

87%

13%

5.3 $GtCO_2$/yr

=

Sinks

17.3 $GtCO_2$/yr

44%

Atmosphere

29%

11.6 $GtCO_2$/yr

Ecosystems

22%

8.9 $GtCO_2$/yr

Oceans

Not all emissions stay in the atmosphere!

Budget Imbalance:
(the difference between estimated sources & sinks)

5%
1.9 $GtCO_2$/yr

GLOBAL CARBON PROJECT

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

Paris Agreement signed in 2015

- Goal is to keep the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C
- The EU wishes to reduce GHG emissions by at least 40% by 2030 compared to 1990
- Finland has agreed to be carbon neutral in 2035

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE


How is ICOS data utilised?
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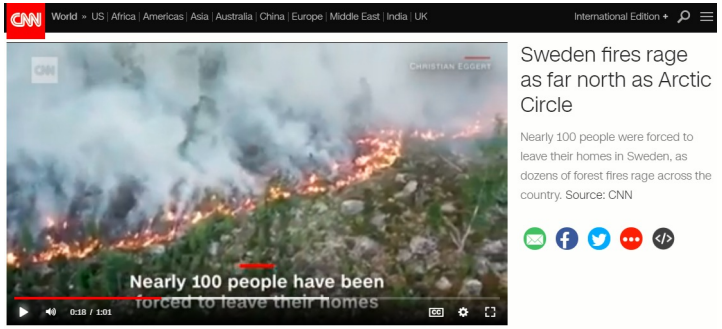
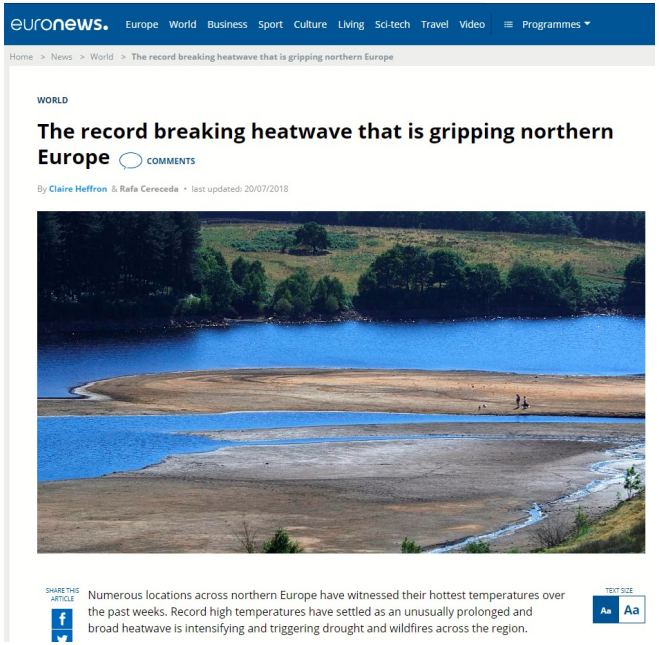
- ICOS organizes a scientific conference every other year, **showcasing climate science and use of ICOS data**
- Latest one was held on **September 2020** entirely online
- More than 1000 participants, almost 200 presentations during three days
- https://www.youtube.com/watch?v=0wHEFBGLr5o

The 2018 summer drought in Europe

- Higher mortality of elderly
- Forest fires
- Crop failures (up to 80%)
- Increased pests in forests
- Biggest algae bloom in the Baltic
- Shutdown of nuclear reactors
- Electricity grid failures
- Relieve funds for farmers compensating crop yield loss





Extreme events - Drought 2018

Summer 2018
Heats record-high

11/2018
Scientists from all ICOS fields meet re data and publications

2019

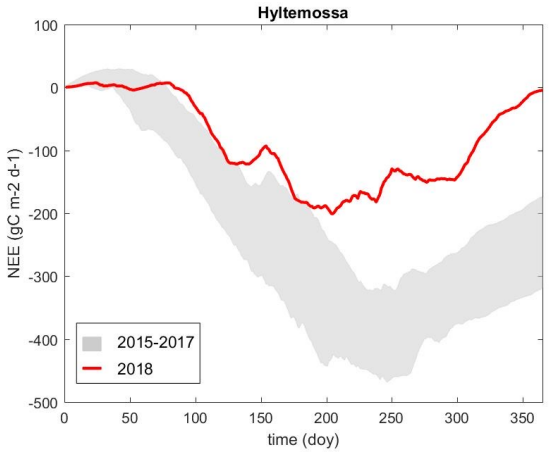
Spring 2019
Data processing, manuscript drafting

08/2019
First datasets released, 30 stations, period 1989-2018

11/2019
Second datasets released, 70 stations

2020

9/2020
The analyses were published in a special issue, 20 publications.



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© Phil. Trans. R. Soc. B

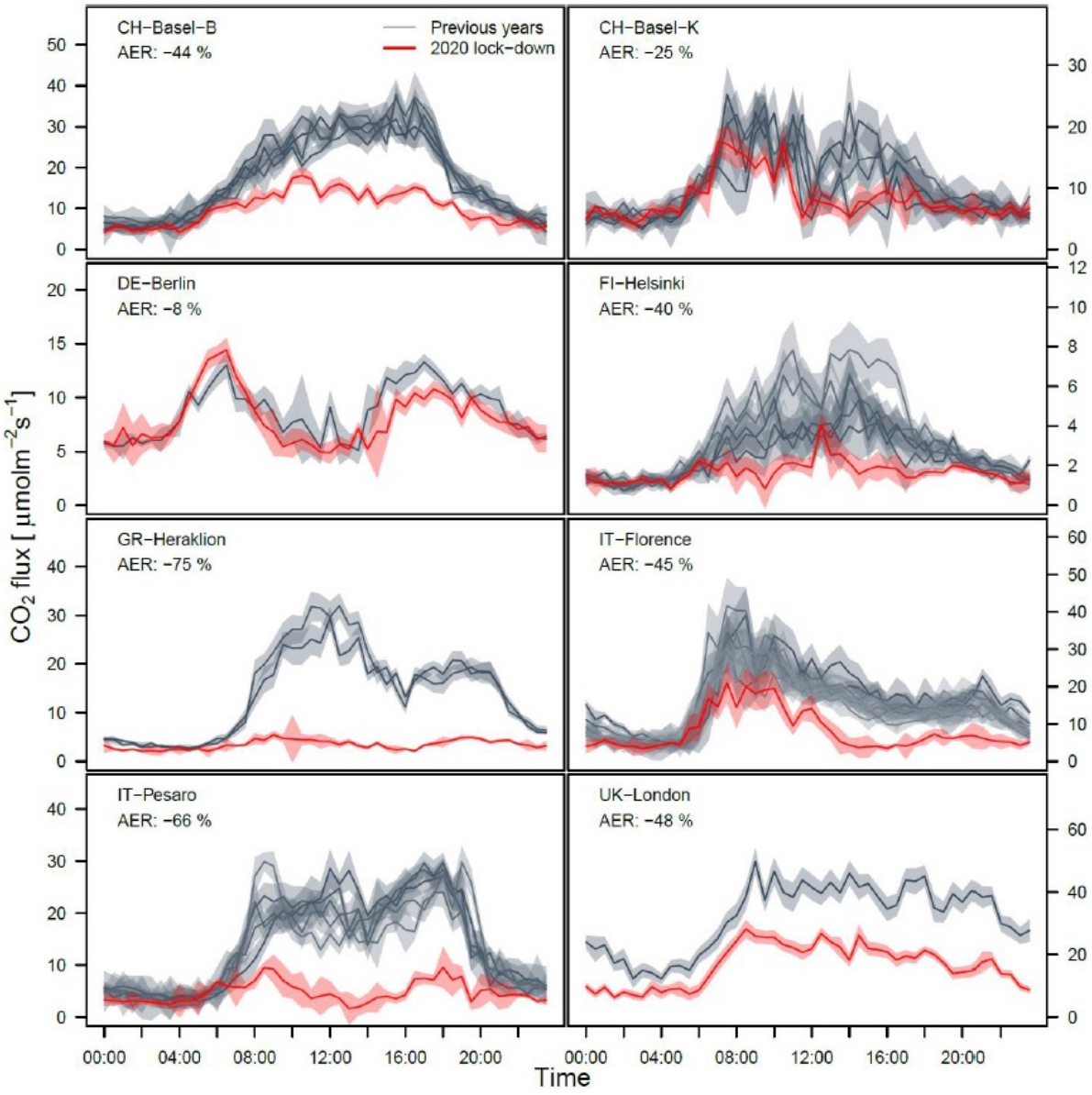
Using ICOS data – 2018 Drought studies

- Drought in Europe decreases carbon uptake and crop yields
- Forest carbon sinks decreased, crops were lost, and grasslands browned down
- Joint research effort of over 200 top scientists
- Results published in The Philosophical Transactions B: ‘Impacts of the 2018 severe drought and heatwave in Europe: from site to continental scale’ https://royalsocietypublishing.org/toc/rstb/375/1810

Using ICOS data to detect COVID effects on emissions

ICOS Data shows reduction in urban CO_2 emissions due to COVID-19 lockdown across Europe (1/2)

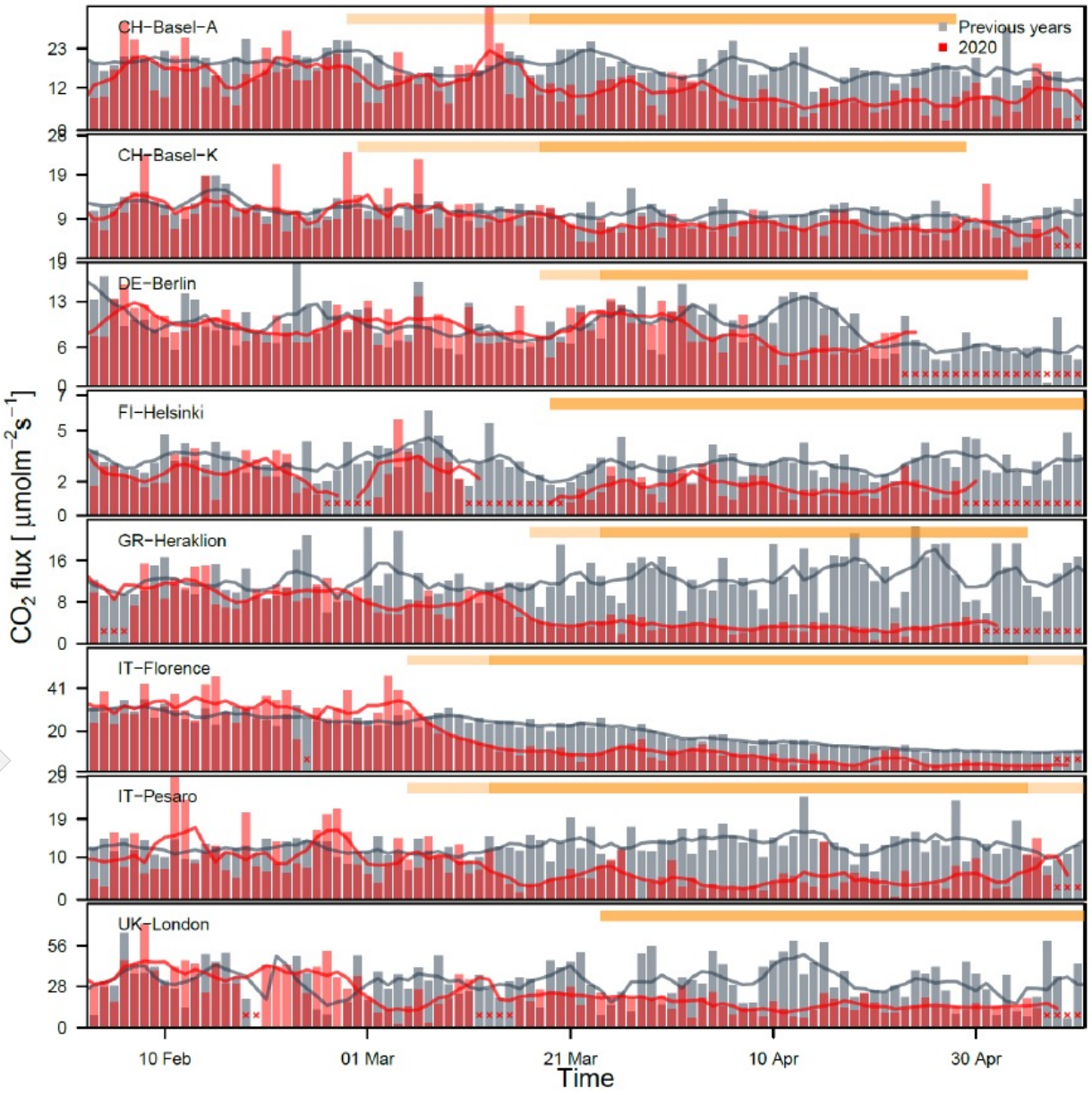
CO_2 flux diurnal cycles from February 5th to May 6th 2020



Using ICOS data to detect COVID effects on emissions

ICOS Data shows reduction in urban CO_2 emissions due to COVID-19 lockdown across Europe (2/2)

Average daily CO_2 flux from February 5th to May 6th 2020

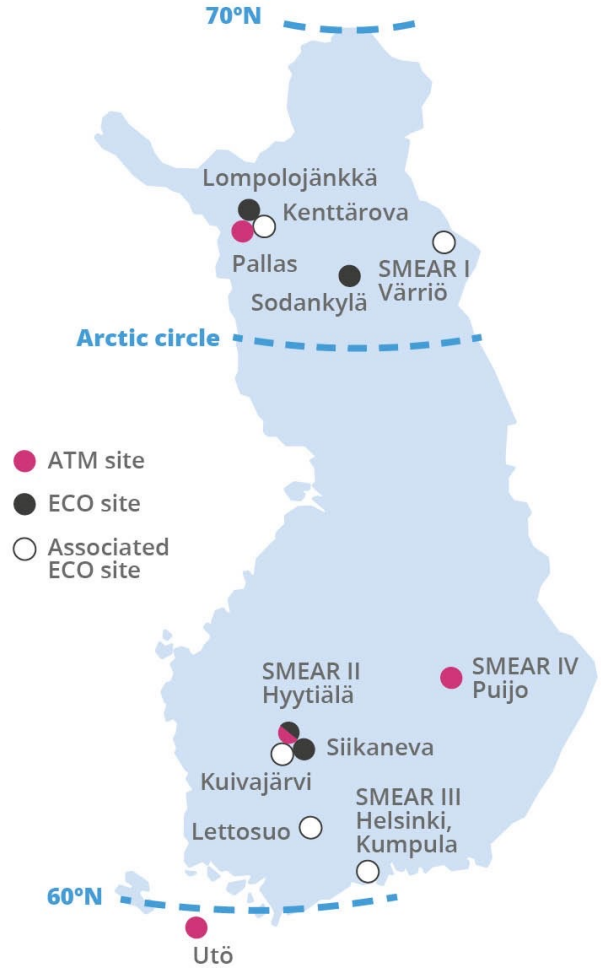


ICOS Finland

- ICOS Finland network is maintained by the University of Helsinki, Finnish Meteorological Institute and University of Eastern Finland

- The network has in total 13 stations:
- 4 Atmosphere stations,
- 4 Ecosystem stations,
- 5 Associated Ecosystem stations.

- These stations provide good representatives of boreal and subarctic Eurasian environment in a transition zone from marine to continental climate



ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Long-term greenhouse gas concentrations – Pallas ICOS ATM station in 68°N