In-situ Earth observations: challenges and opportunities for EVE

Graphics: The Guardian

Berlin Summit for EVE, July 3-7, 2023, Berlin, Germany

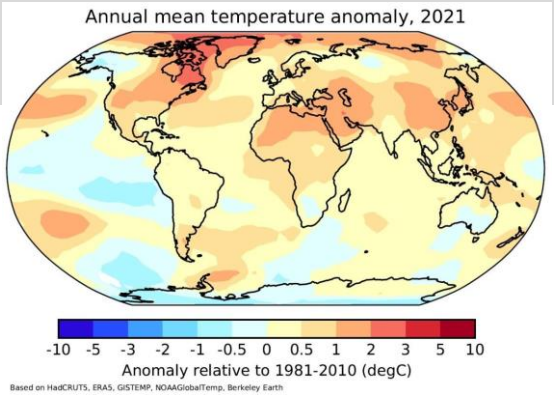
Jaana Bäck
eLTER PLUS coordinator
University of Helsinki
Finland

& input from the Workshop on *'Towards Global Earth Observatory'*, May 8-10, 2023, Hyytiälä, Finland
47 participants, from >30 research infrastructures, global reach

Challenges

“We got a lot of information about how the physical climate is changing, but what people really want to know is *how their lives will change*“ … “it is the ‚so what‘ element in the climate change story“

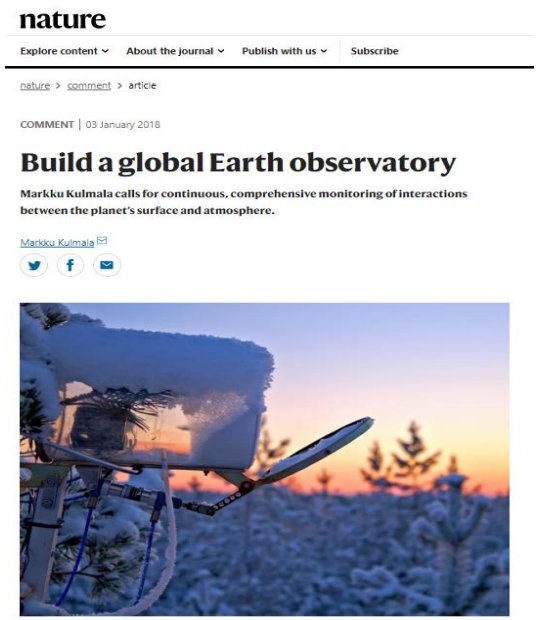
(Debra Roberts, Co-Chair, WG II, IPCC 6. AR, 3/2022)



For that, **continuous, comprehensive observations on interactions between the planet’s surface and atmosphere are urgently needed**

What is the best way to implement an efficient observation system?
What should be observed, how and where?
How to tackle the heterogneity of Earth surface?
Where are the gaps

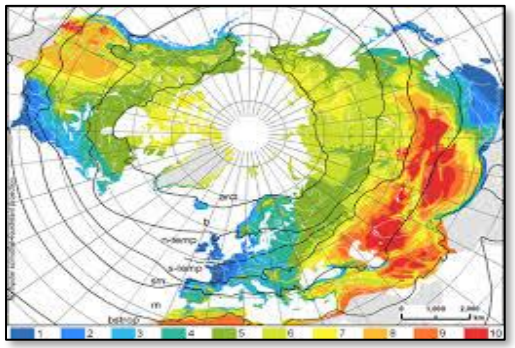
- geographical?
- observational?
- data accessibility?



Integrated Research Challenges for *in-situ* site networks, context to environmental policies

Biodiversity dynamics

EU Biodiversity Strategy, Water Framework Directive, Habitats Directive



Climate change

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

Eutrophication and pollution

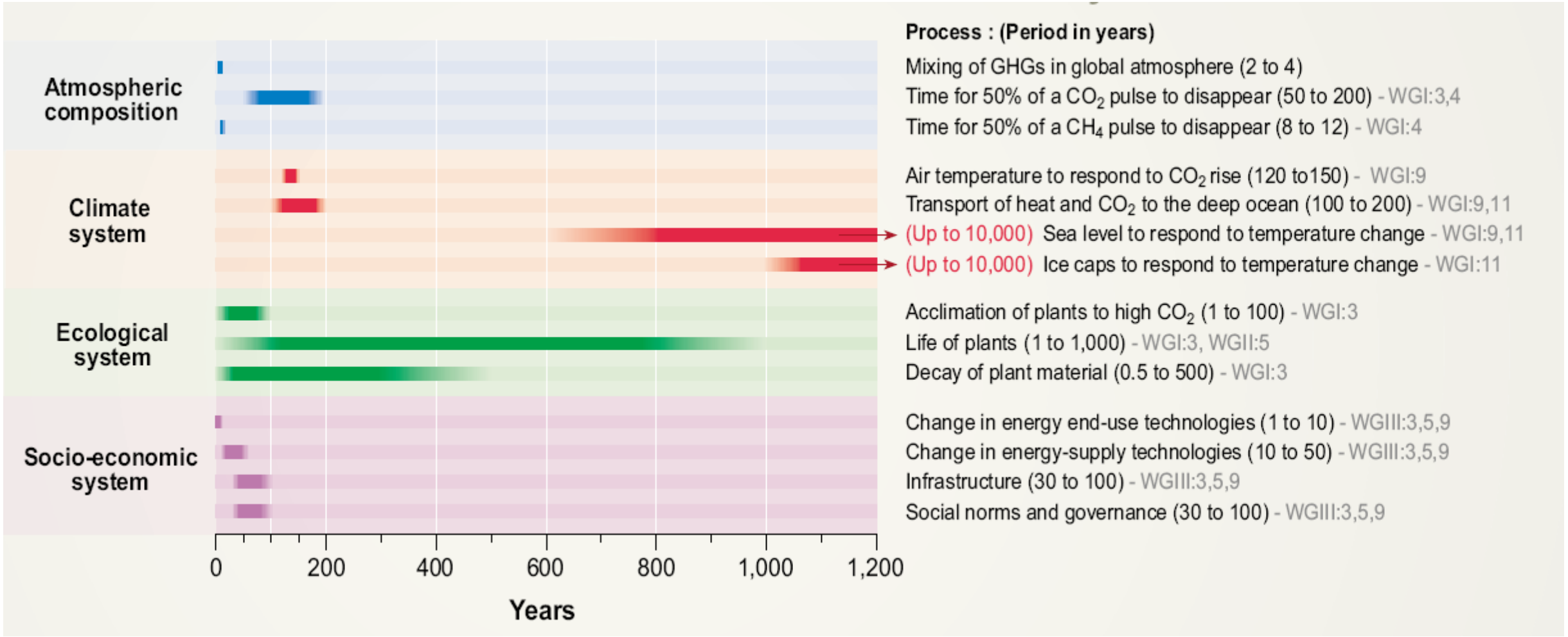
Water Framework Directive, UNECE-CLRTAP

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

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

Challenges: heterogeneity (landscapes, processes)

Challenges: gaps in time and space, scaling



IPCC 2001

Opportunities

GSO framework, updated 2019

GSO

Group of Senior Officials (GSO) on global Research Infrastructures

Core purpose of Global Research Infrastructures

Global Research Infrastructures should address the *most pressing global research challenges*, i.e. those frontiers of knowledge where a global-critical-mass effort to achieve progress is required.

….

e-infrastructure

Global Research Infrastructure initiatives should recognize the utility of the *integrated use of advanced e-infrastructure services for accessing, processing and curating data*, as well as for remote participation (interaction) and access to scientific experiments

Data management

long-term data curation including metadata;
data interoperability;
data access and re-use;
alignment with community standards and practices, including standards for openness, while respecting the “as open as possible, as closed as necessary” principle.

Clustering of Research Infrastructures

schemes for access and mobility of researchers, engineers and technicians through the cluster should be actively encouraged

….

Innovation, Technology Transfer and Intellectual Property

innovation and intellectual property rights management;
sharing, exploitation and utilisation of data and technologies generated by usage of the GRI.

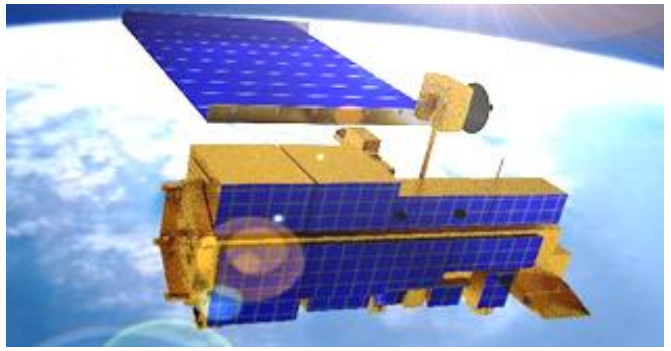
http://www.gsogri.org/wp-content/uploads/2019/12/gso_framework_criteria.pdf

The pillars for addressing climate change

IN-SITU GROUND-BASED, AIRBORNE AND SHIPBORNE DATA

Biology
Chemistry
Physics

REMOTELY OBSERVED DATA



Scaling from points to regions

EARTH SYSTEM STATE
- *initial conditions*
- *assimilation*

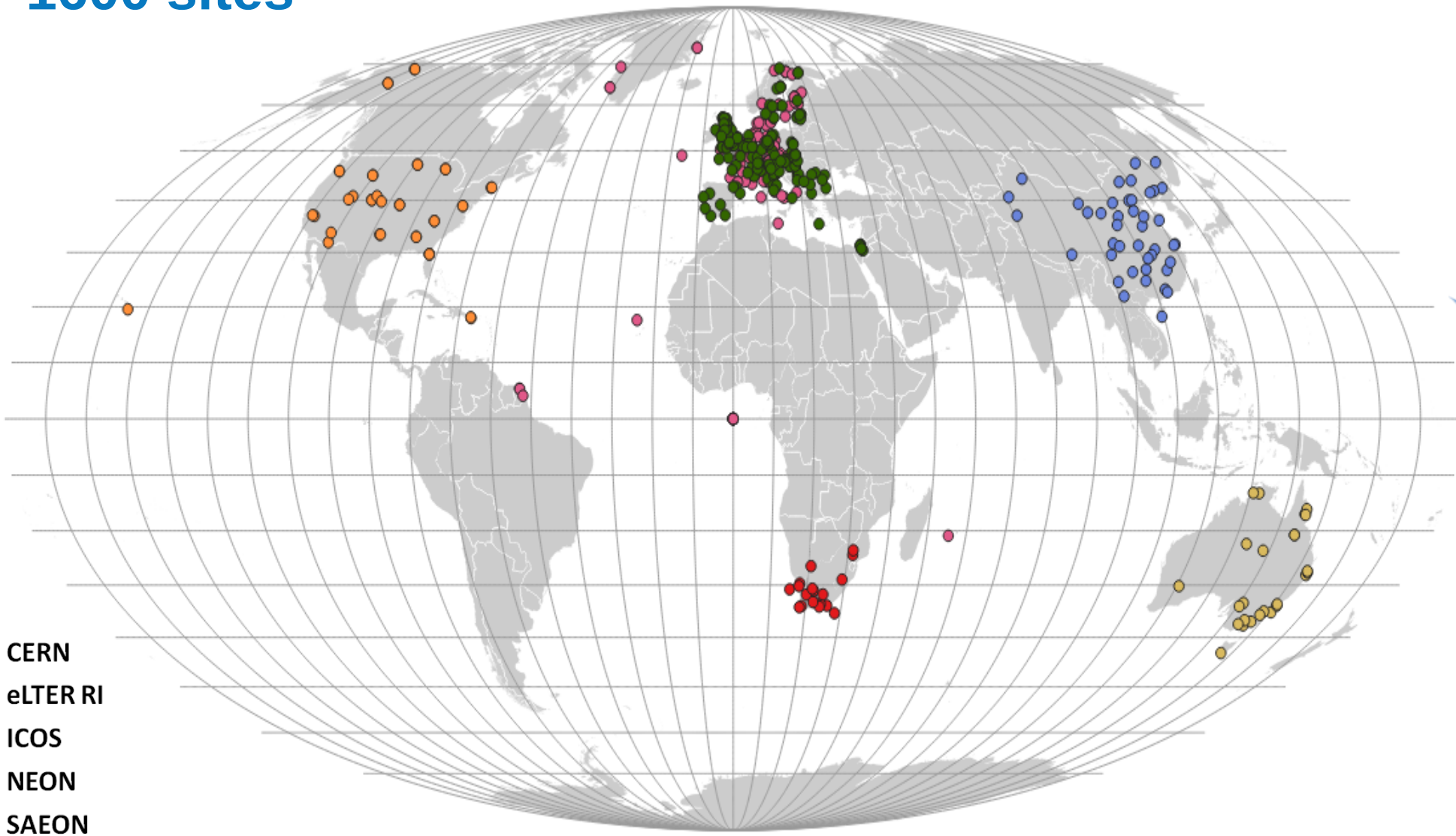
Capturing heterogeneity, verification

Forecasts and predicts

MULTISCALE MODELS

Global Ecosystem Research Infrastructure
> 1600 sites

GERI Global Ecosystem Research Infrastructure



- CERN
- eLTER RI
- ICOS
- NEON
- SAEON
- TERN

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

CERN

NRF SAEON South African Environmental Observation Network

NSF neon Operated by Battelle

eLTER

tern Ecosystem Research Infrastructure

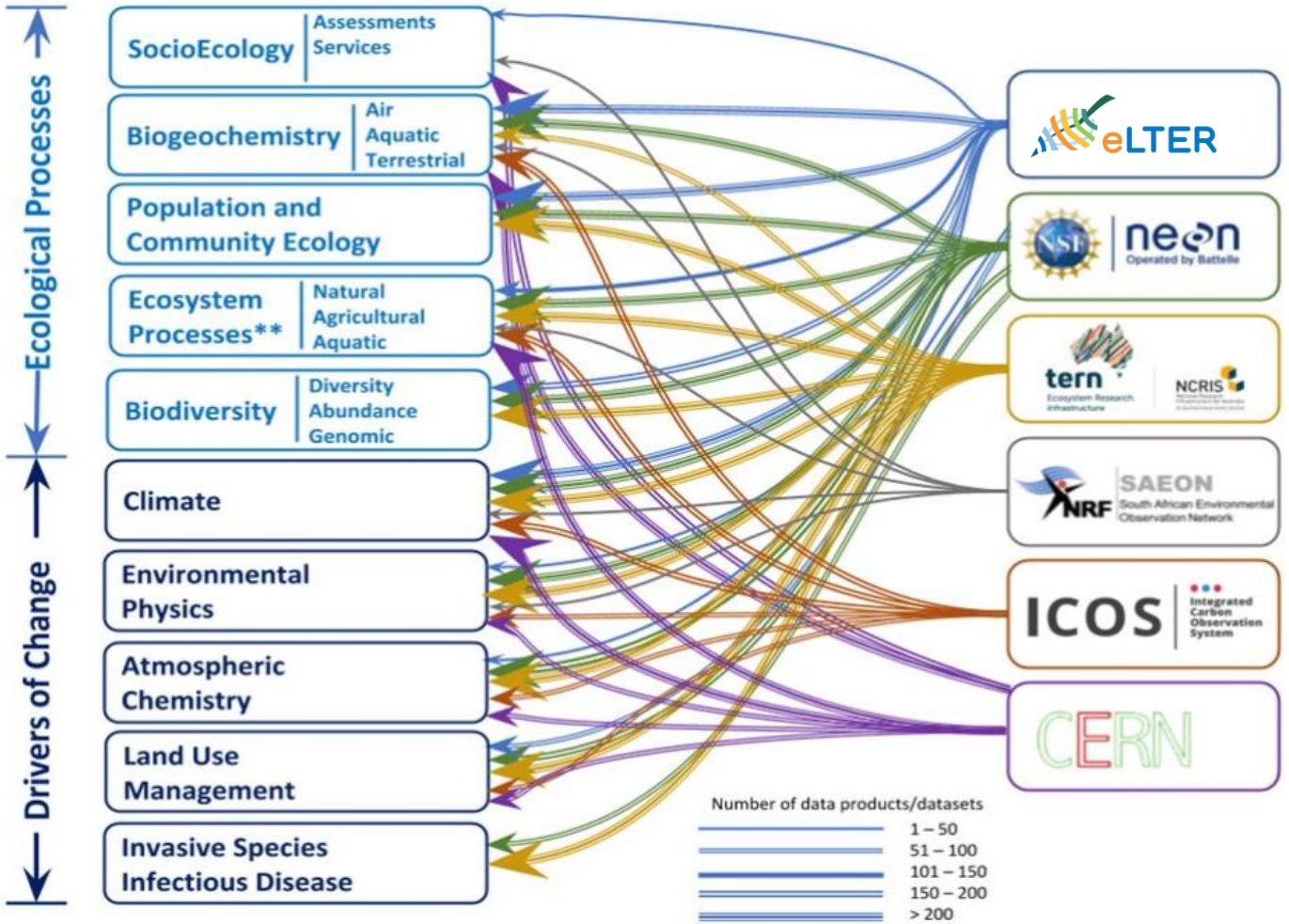
Global Ecosystem Research infrastructure

GERI Global Ecosystem Research Infrastructure

Awarded at $1.6M by U.S. National Science Foundation 2023-26

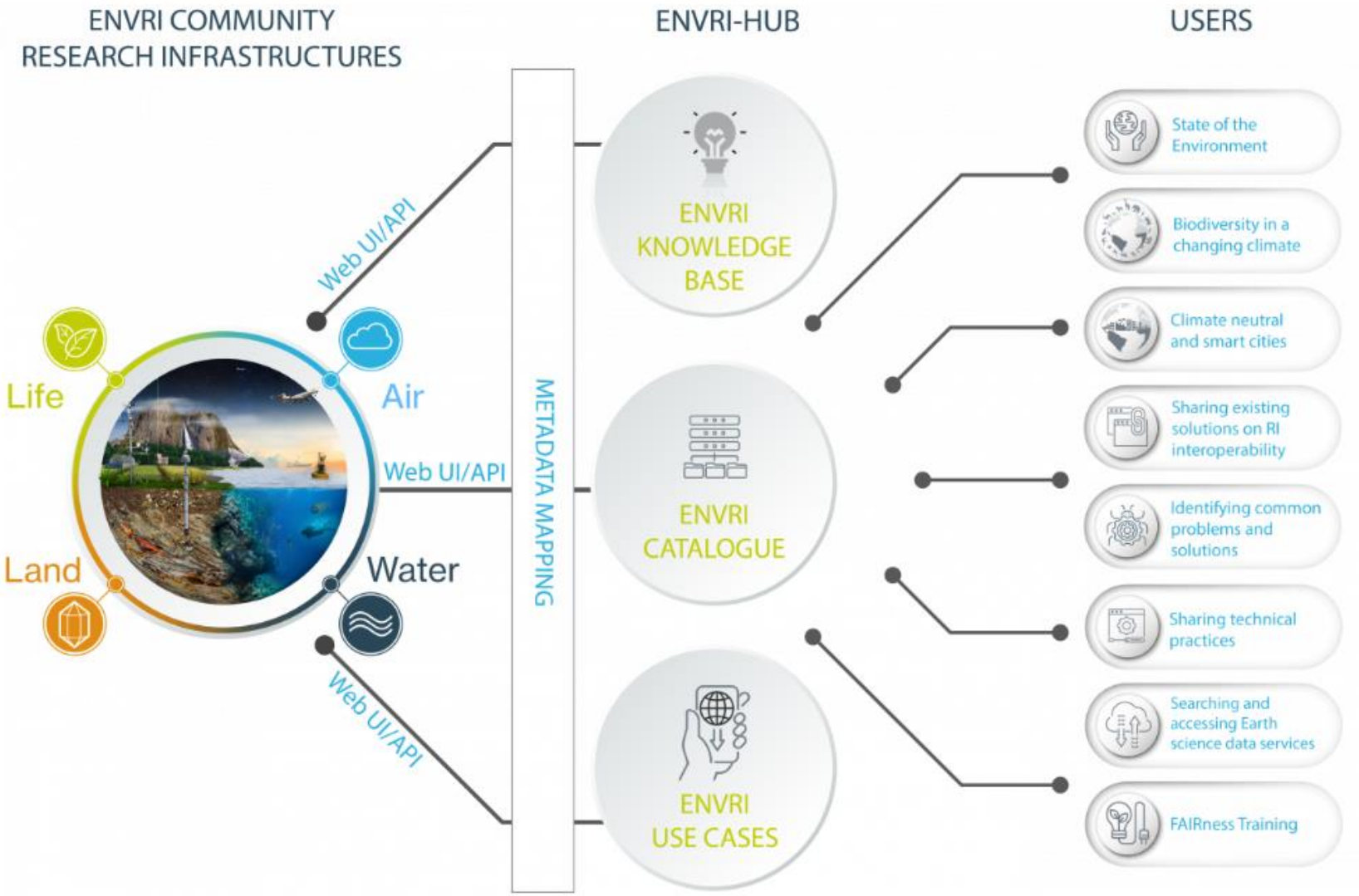
Goals:

1. Further develop and leverage strategic international network to network collaborations.
2. Accelerate scientific discovery by bringing together international stakeholders and researchers to guide the **harmonization of global ecological drought data** as a first focus.
3. Prepare the next generation of researchers in this network-of-network approach via workshops, training, and enhanced opportunities for collaboration.



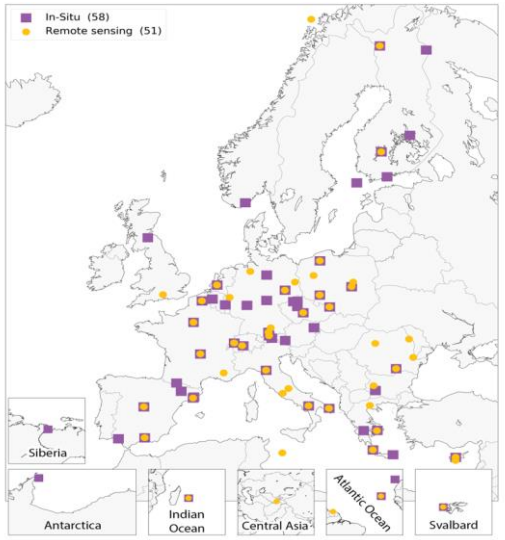

ENVRI
community
Life
Air
Land
Water

ENVRI HUB provides integrated services to all users



Environmental *in-situ* observations in Europe, 4 examples

ACTRiS

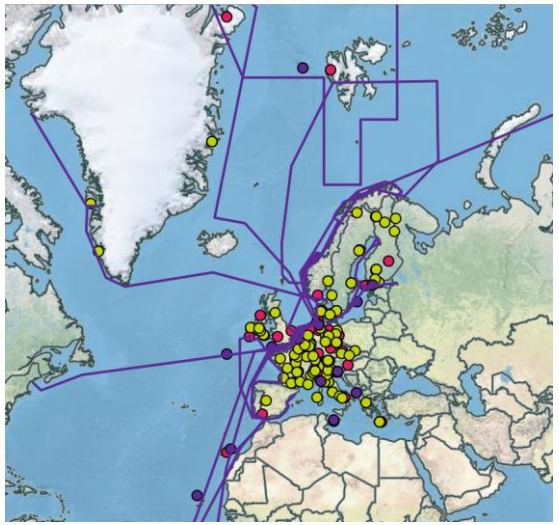


Atmosphere
>100 variables
Total investment 698 M€
Annual operation costs 93 M€

Euro Argo

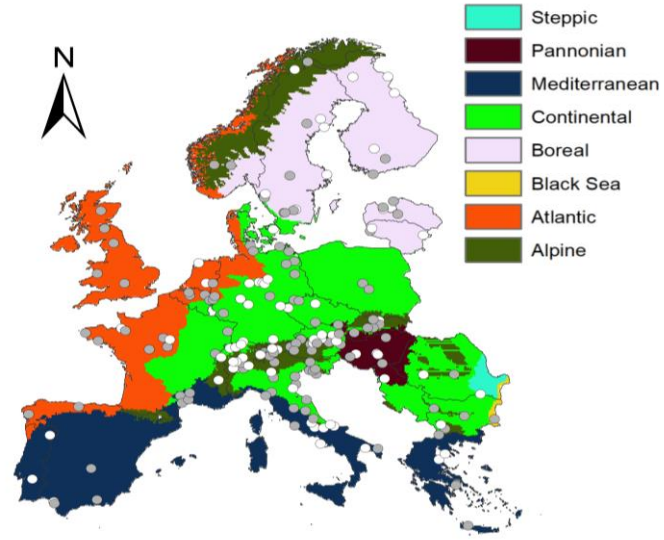
Oceans
8 variables
Total investment 30 M€
Annual operation costs 10 M€

ICOS INTEGRATED CARBON OBSERVATION SYSTEM



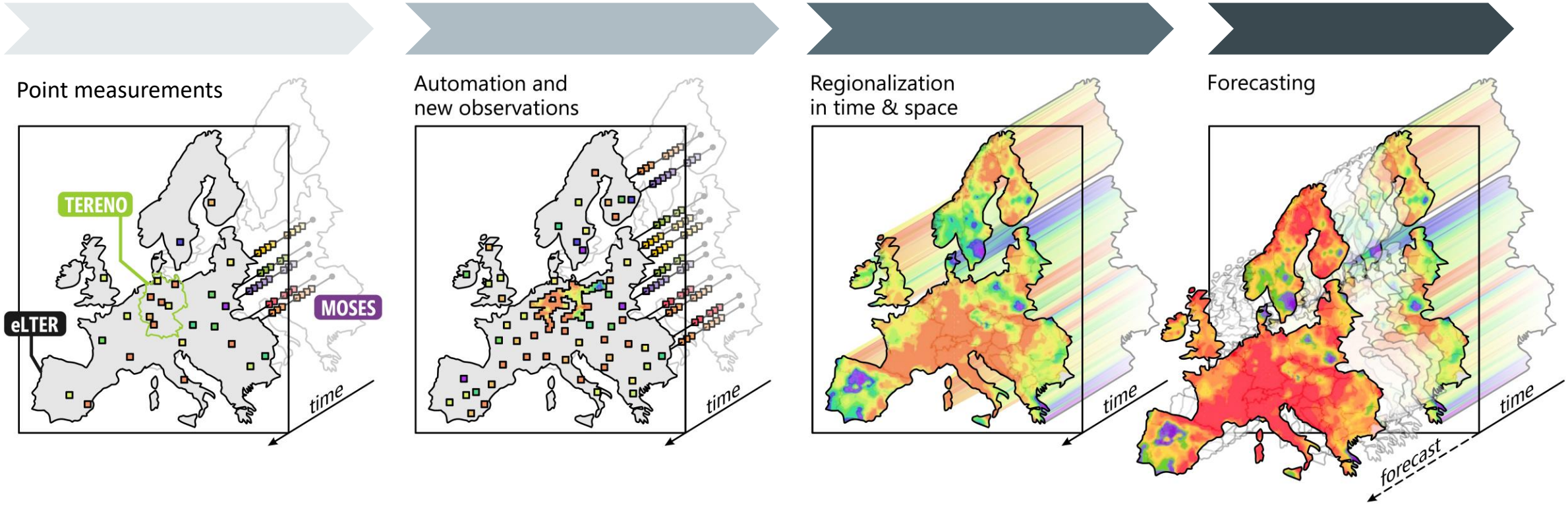
Atmosphere, Oceans, Life
>70 variables
Total investment 116 M€
Annual operation costs 32 M€

eLTER



Atmosphere, Oceans, Life (incl. society)
>80 variables
Total investments 150 M€
Annual operation costs 50 M€

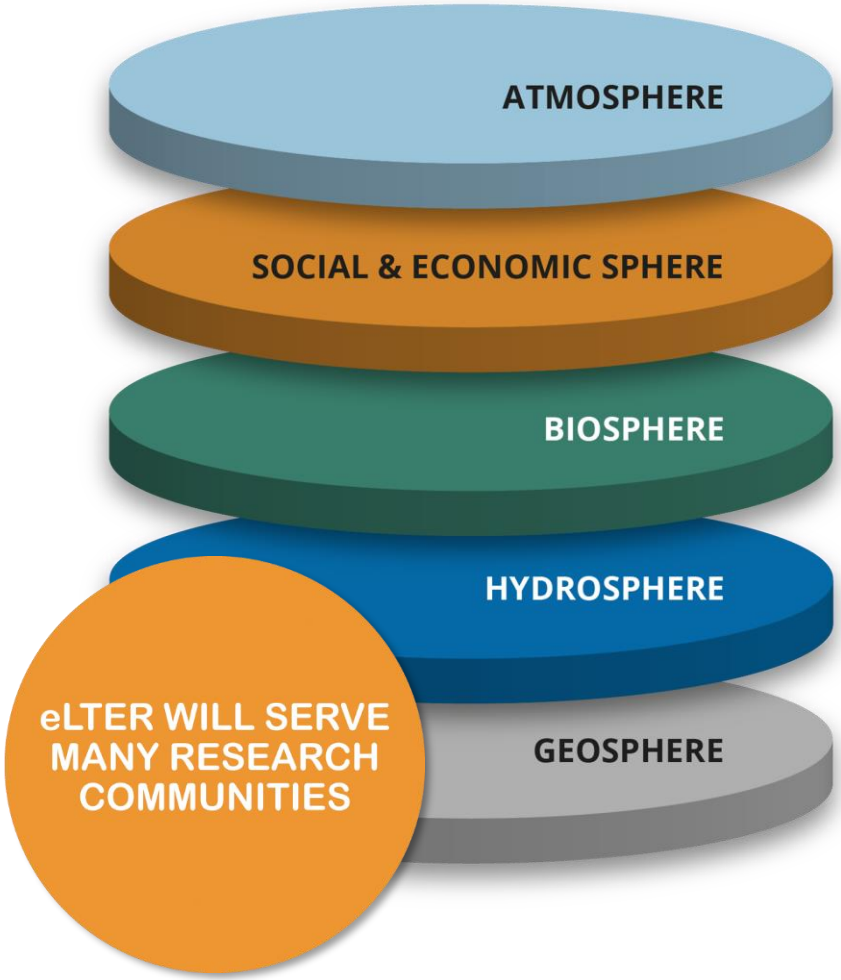
Example: soil drought observations, regionalization and forecasting



Source: M. Schrön (UFZ), TERENO, MOSES, eLTER

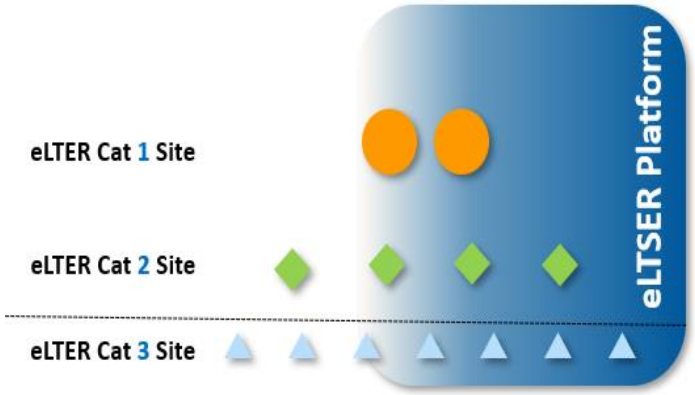
Accounting for all domains (incl human): eLTER

holistic approach, integration and cross-disciplinarity



eLTER design

- Hierarchy of site categories
- Various levels of
  - spatial complexity
  - instrumentation

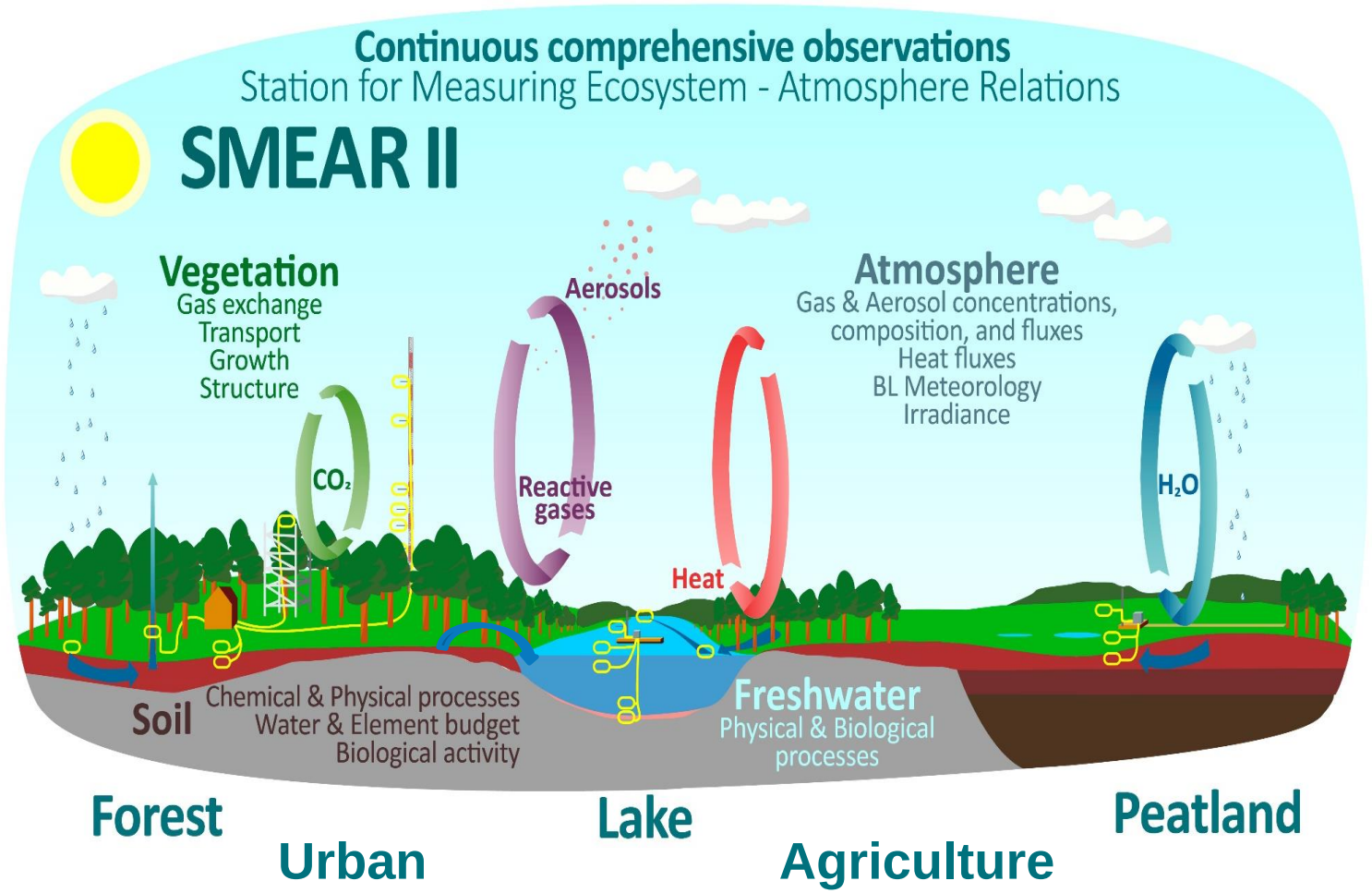


eLTER provides

Access to:

- eLTER facilities
- Information Clusters
  - Standard Observations (“EEVs”)
  - Multiple other data sources (RS, modelling, legacy data)
- Data and data products
- Analytical tools, virtual labs
- Training

Example of a site planned for integration



- Since 1995
- Combining comprehensive ground-based data, remote data and multiscale models
- Contributed to >50 EU projects

- Measuring >1200 parameters
- Data flows 24/7/365
- Big Data
  - 1 min data: > 1e10 points
  - 1 s data: > 7e11 points
  - 10 hz flux data

eLTER ACTRiS ICOS INTEGRATED CARBON OBSERVATION SYSTEM GAW

Towards Global Earth Observatory (Hyytiälä Workshop): outcomes

- Existing assets
    - ESFRIs, Copernicus, GCOS, WMO: GAW, Integrated Global Observing System (WIGOS), GHG Watch, Global Basic Observatory Network (GBON) etc …
    - Clusters like GERI, ENVRI
- Identification of gaps
    - In particular Global South, oceans, biodiversity
    - Global standards, common data access, continuity of datasets

- Improve interoperability, address complexity (granularity)
- Include impacts to human and social systems, citizen science and agent-based modelling
- Added value for the national and multinational investments, optimising network designs
- Demonstrator(s), permanent innovation and expansion with new measurement systems (incl. AI)
- Dialogue with the stakeholders to promote integration, harmonisation and use of data

- **Key message: We need to show how to work towards solutions. RESEARCH INFRASTRUCTURES REPRESENT A MAJOR BUILDING BLOCK OF PRE-INVESTMENTS**

Thank you for all Workshop participants!