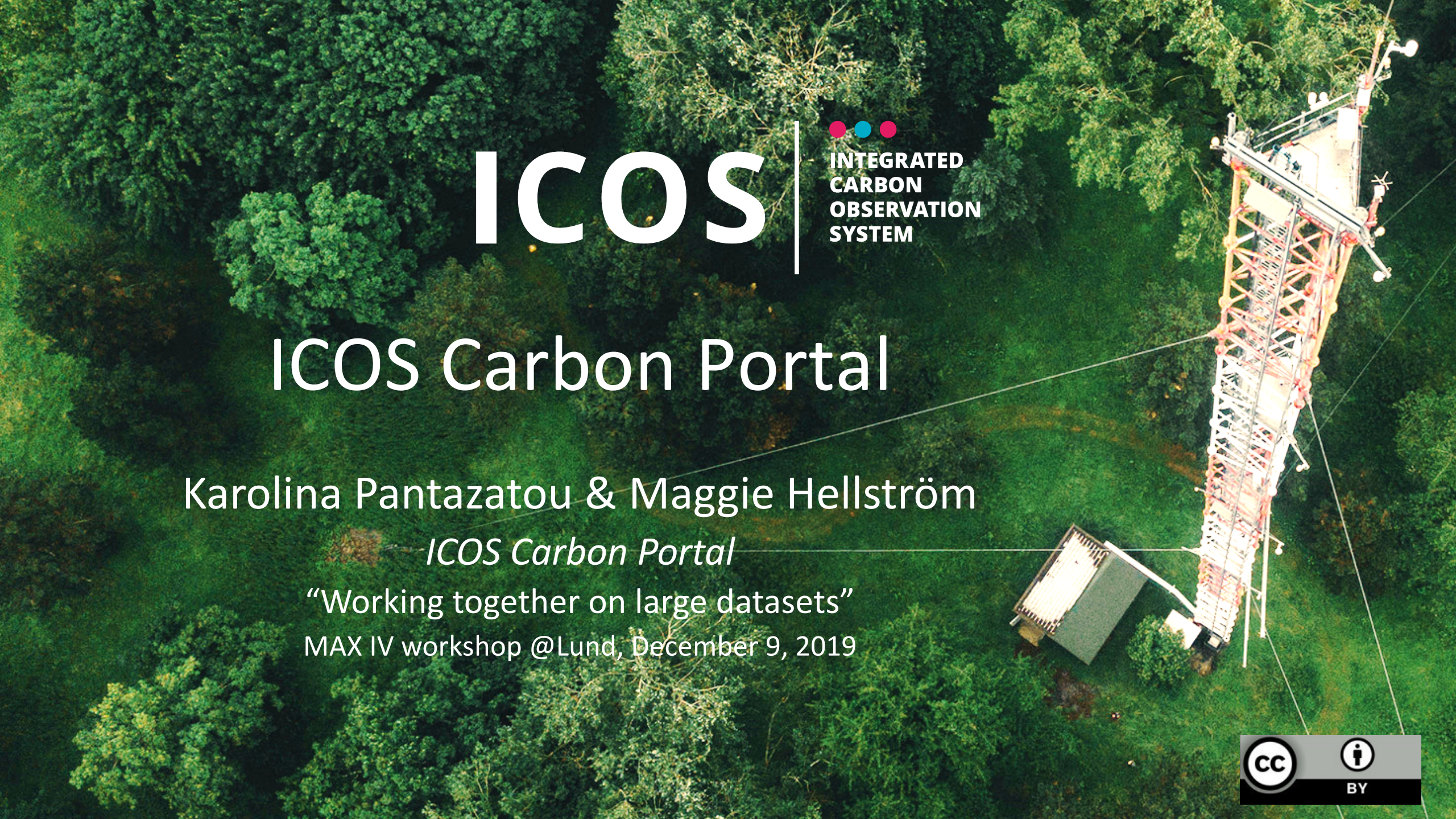


ICOS Carbon Portal

Karolina Pantazatou & Maggie Hellström

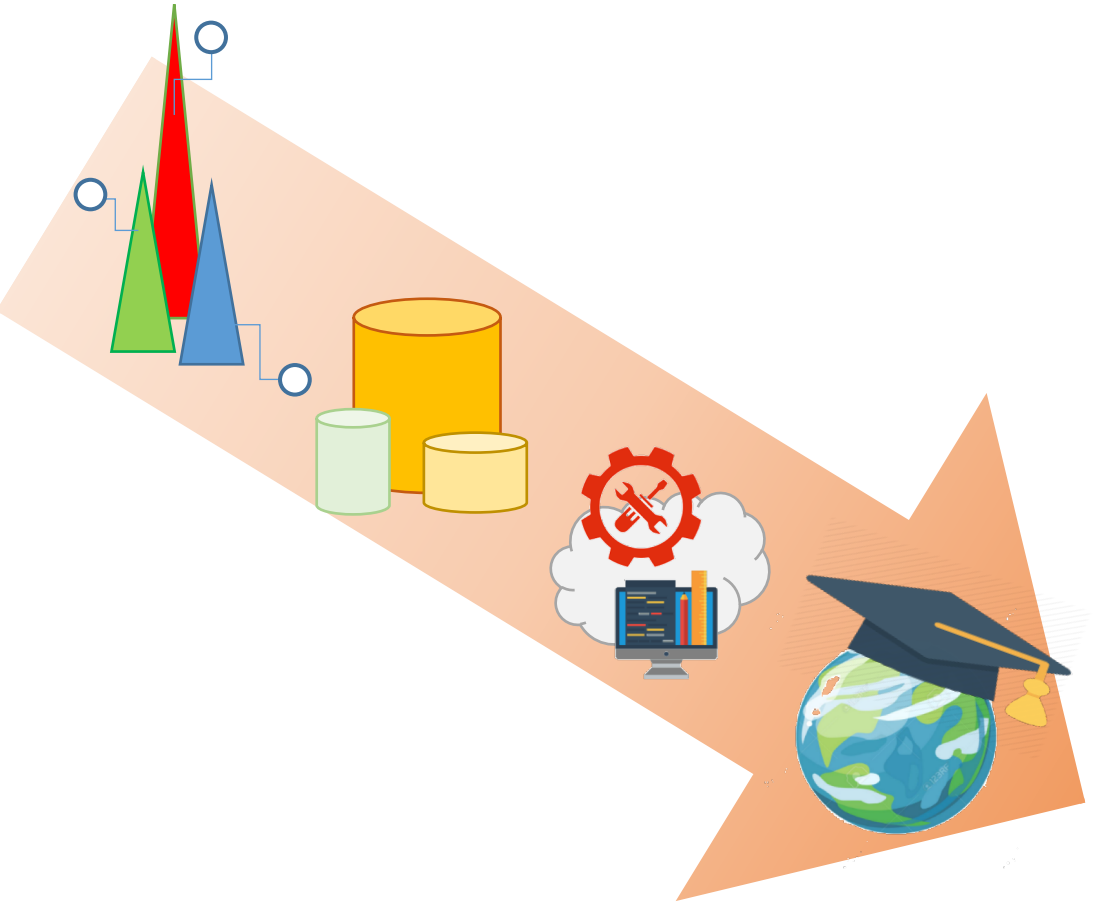
ICOS Carbon Portal

"Working together on large datasets"

MAX IV workshop @Lund, December 9, 2019

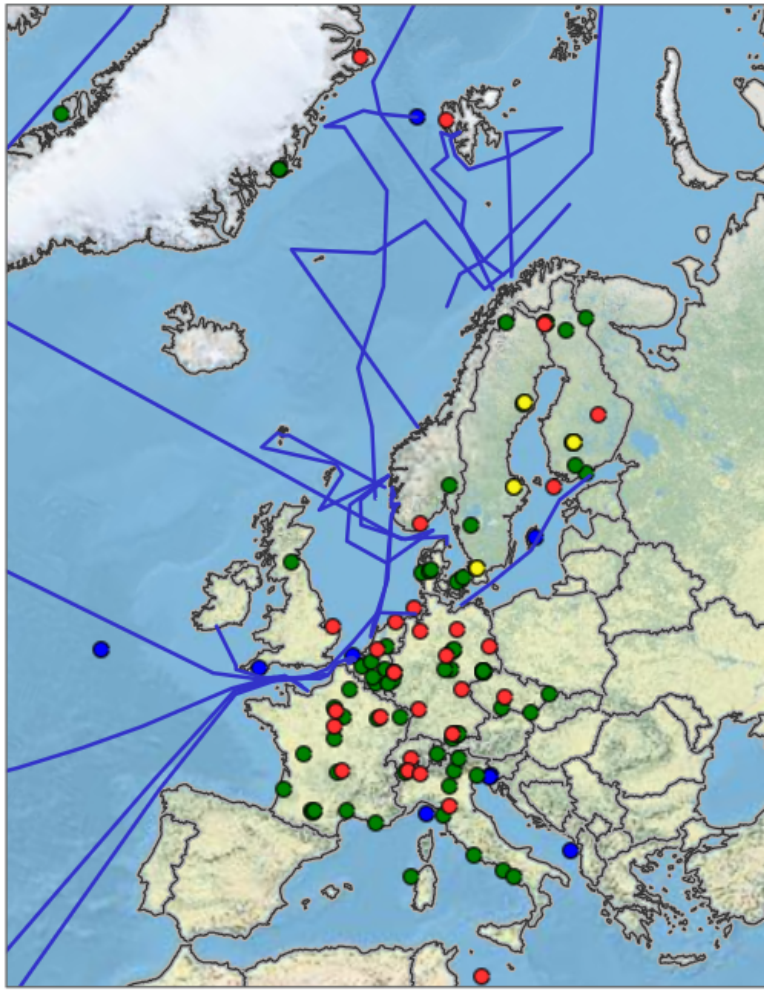
What is ICOS?

ICOS | INTEGRATED CARBON OBSERVATION SYSTEM

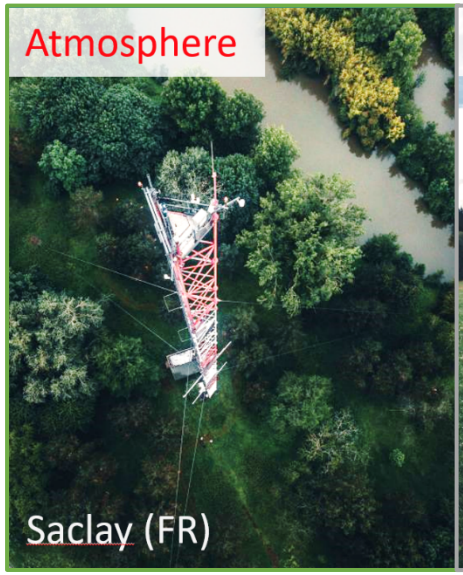


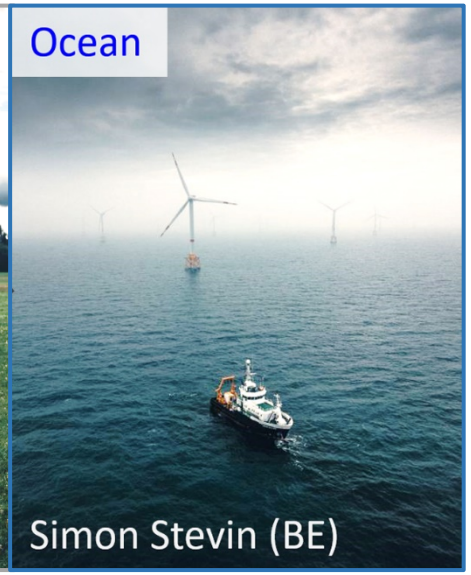
- Integrated Carbon Observation System (ICOS) is a European Research Infrastructure in the environmental & climate domain
- ERIC in 2015, ESFRI flagship in 2018
- ICOS missions are to
  - collect high-quality, standardised observational data & share this with anyone who wants to use it
  - provide services that support end-users to make the best possible science based on ICOS data
  - inform stakeholders, policy makers and the public about ongoing trends in greenhouse gas concentrations and fluxes

Our observation networks



- ICOS has 12 member countries
- We operate three observation station networks:
  - Atmosphere – 33 stations (•)
  - Ecosystem – 80 stations (•)
  - Ocean – 21 stations & ships (• and ---)
- Each domain has a dedicated Thematic Centre



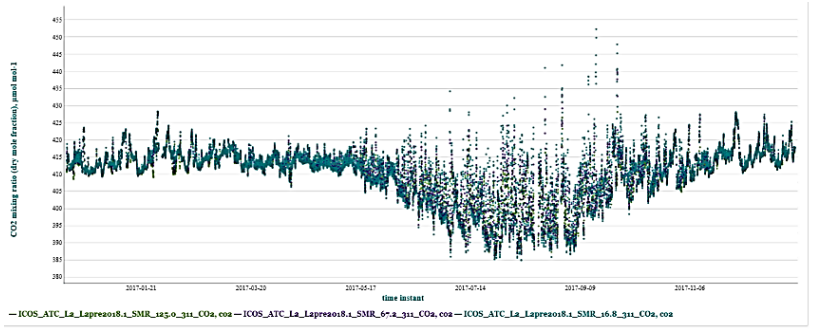


Producers of ICOS data

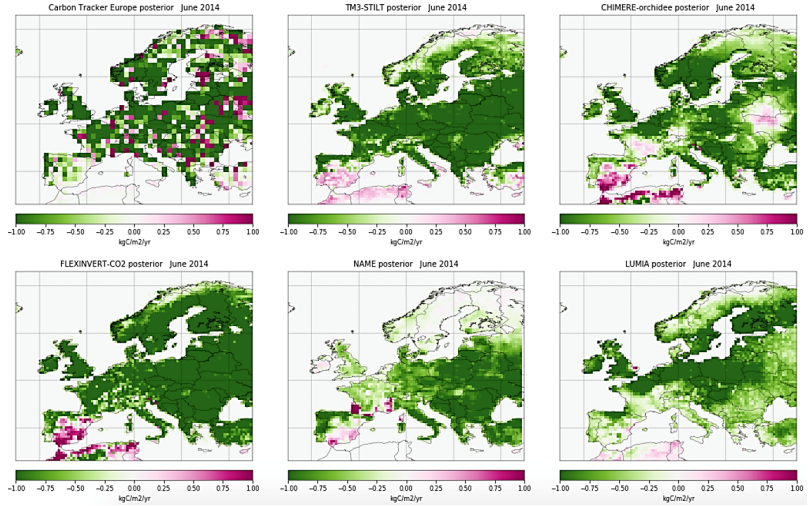
- **National Measurement Networks**
  - Atmospheric, Ecosystem and Marine observation stations
  - Produce raw time series data, often at “high frequency” (10-20 Hz)
- **Thematic Centers**
  - One each for Atmospheric, Ecosystem and Marine observation networks
  - QA/QC: Quality Control and Assurance
  - Calculate fluxes of energy and greenhouse gases (GHGs)
  - Produce aggregated time series of half-hourly or hourly averages
- **GHG research community**
  - Apply models that use ICOS observational data
  - Produce elaborate products, such as “flux maps”

ICOS data products

- **Quality-controlled observational data**
  - Greenhouse gas concentrations – CO_2, CH_4, N_2O
  - Other trace gases & isotopes (CO, C-14, …)
  - Greenhouse gas and energy fluxes
  - Meteorological parameters & ecosystem variables



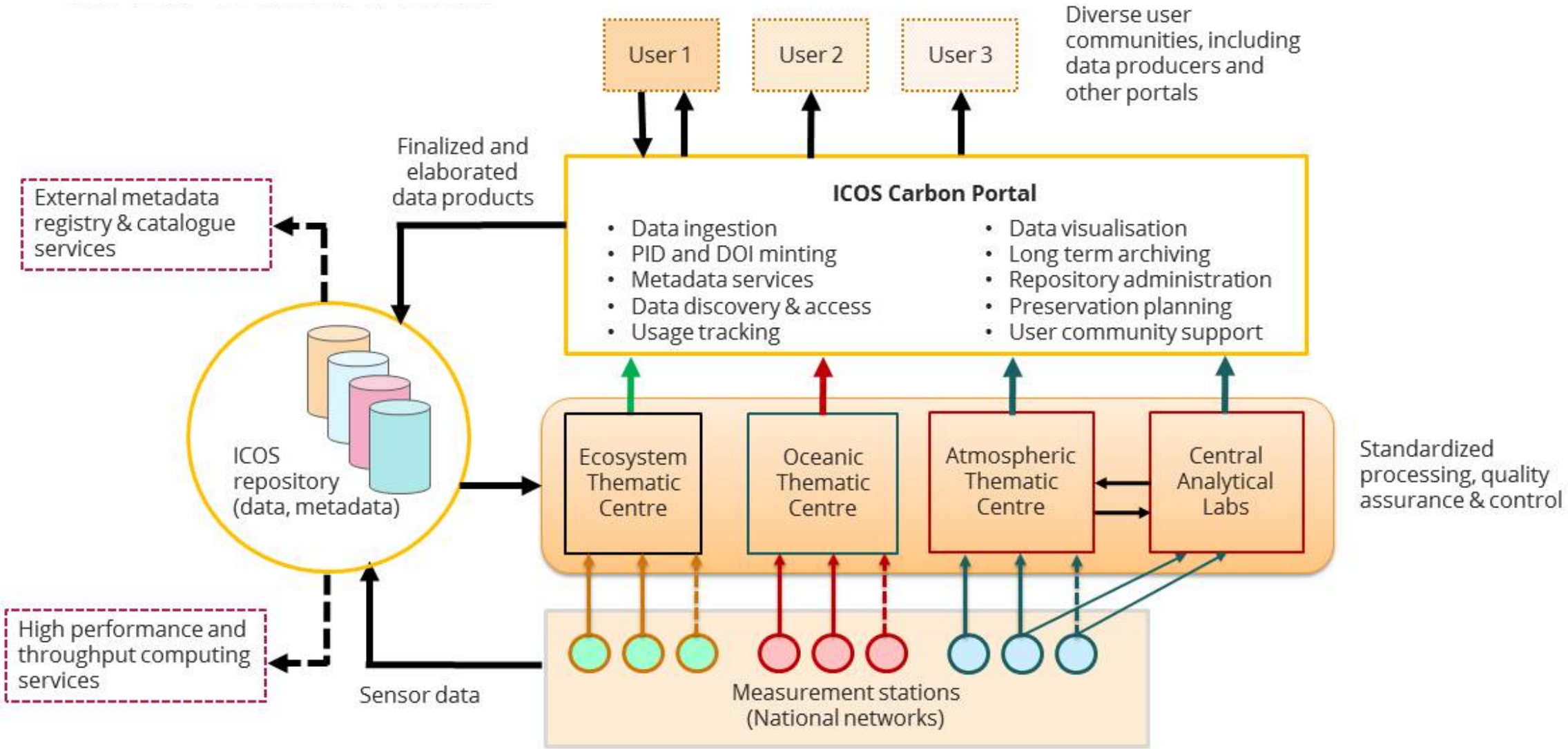
- **Elaborated (model) products**
  - Advanced visualisations
  - Flux maps in time & space (inverse modelling)
  - Other model output (ecosystem, vegetation,…)
  - Station “footprints” (spatial & temporal origin of measured GHG concentrations)



Users of ICOS data

- Our data producers (station PIs & staff)
- **International and national Operational Centres assimilating atmospheric composition data (Copernicus)**
- **Research communities (atmosphere, ecology, biogeochemistry, biogeophysics, climatology, …)**
- Commercial users
- The general public interested in greenhouse gas emissions and global climate change

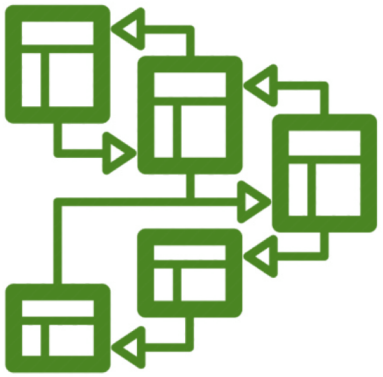
ICOS data flow



ICOS data storage

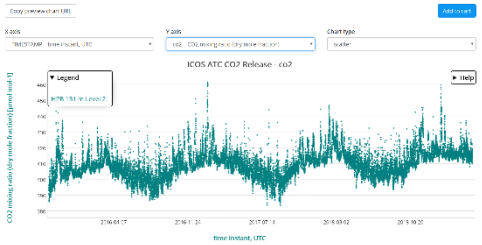
- **Data**
  - Data stored in two places: locally & external trusted repository
  - Data stored as a sequence of bytes (Blob) on the disk
  - File name based on encrypted hash sum (SHA256)
  - Hash sum-based unique persistent identifier (PID) for every file

- **Metadata**
  - Stored in an RDF triplestore (Linked Open Data)
  - Metadata acquisition through SPARQL endpoint
  - ICOS Search Interface runs with SPARQL queries

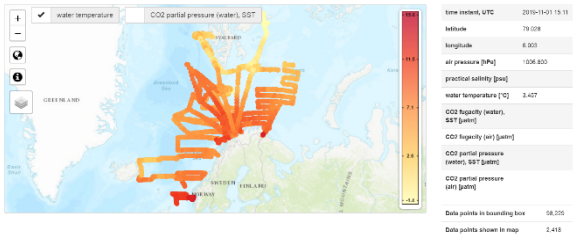


ICOS services: some examples

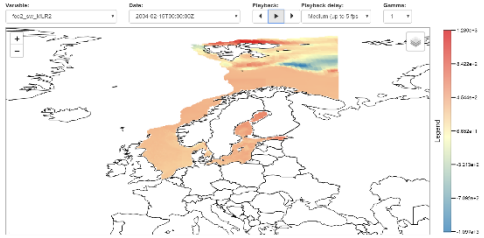
- **Carbon Portal for data discovery**
- **Data Preview**



Time Series

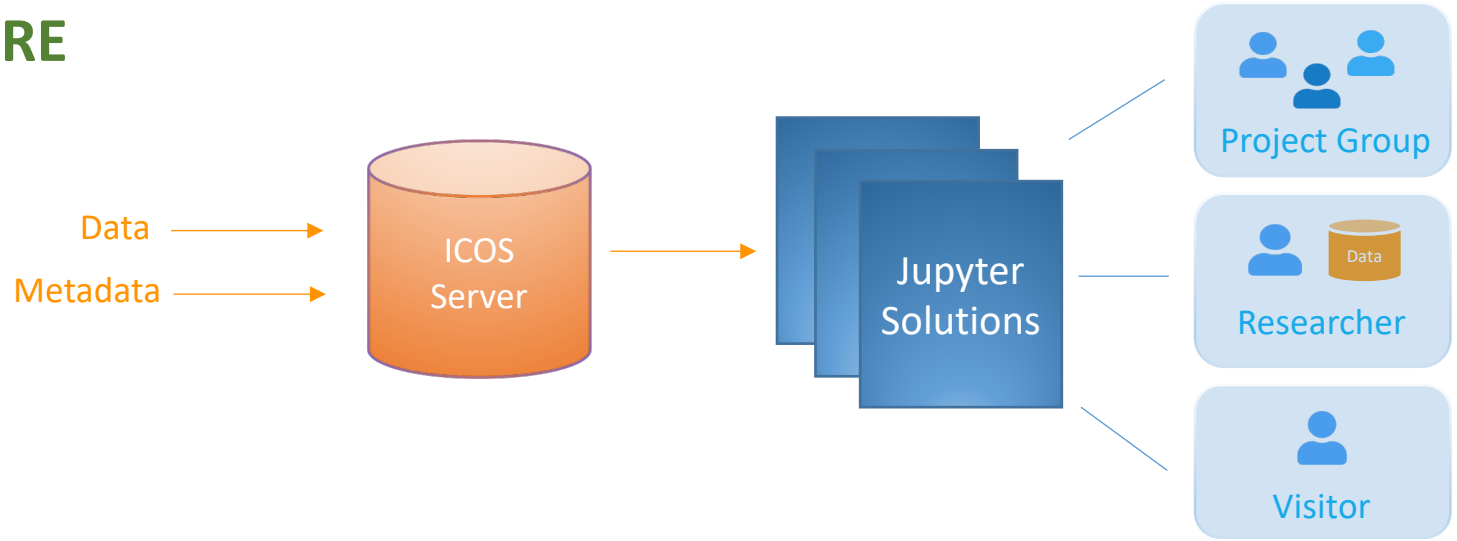


Time Series



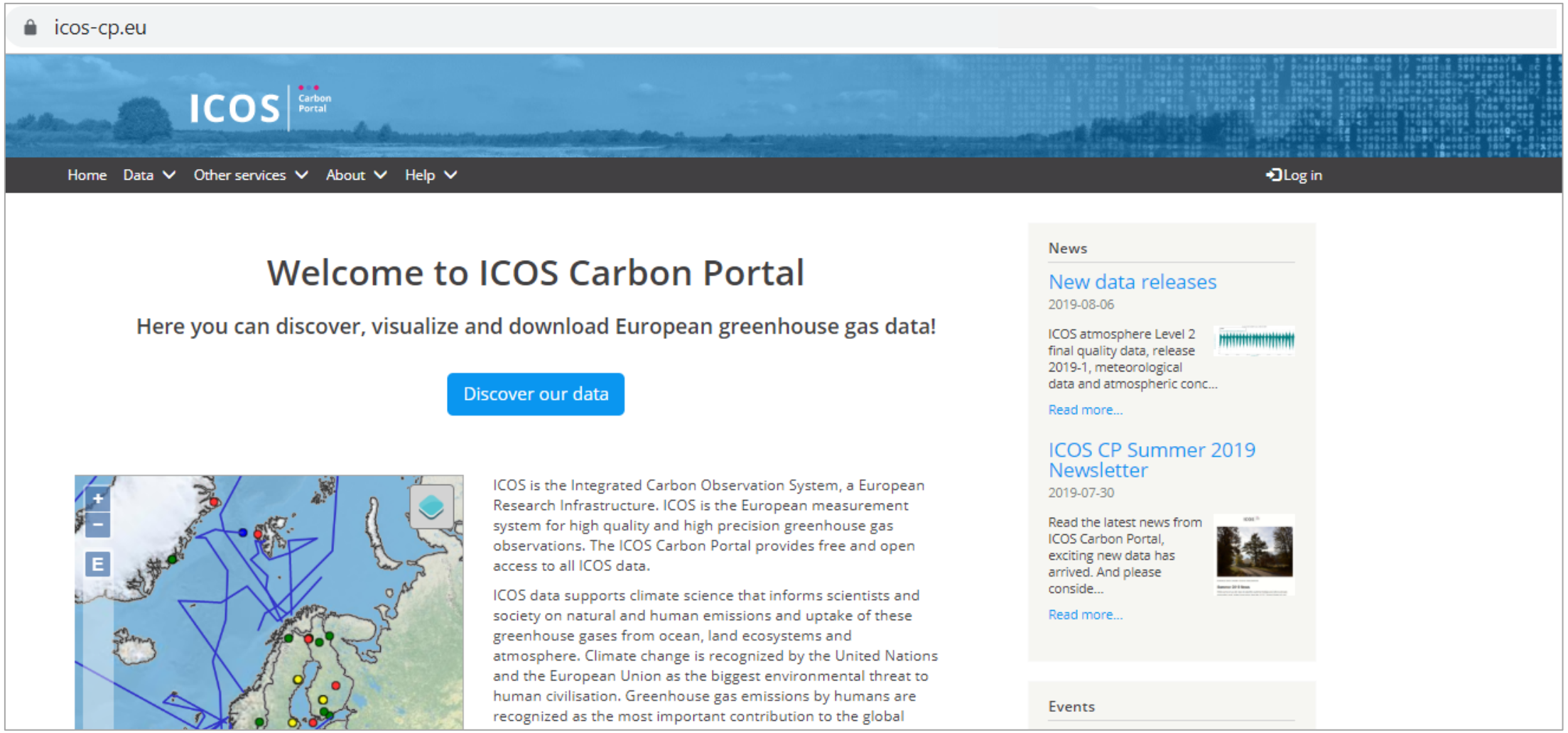
NetCDF

- **Jupyter VRE**



ICOS Carbon Portal

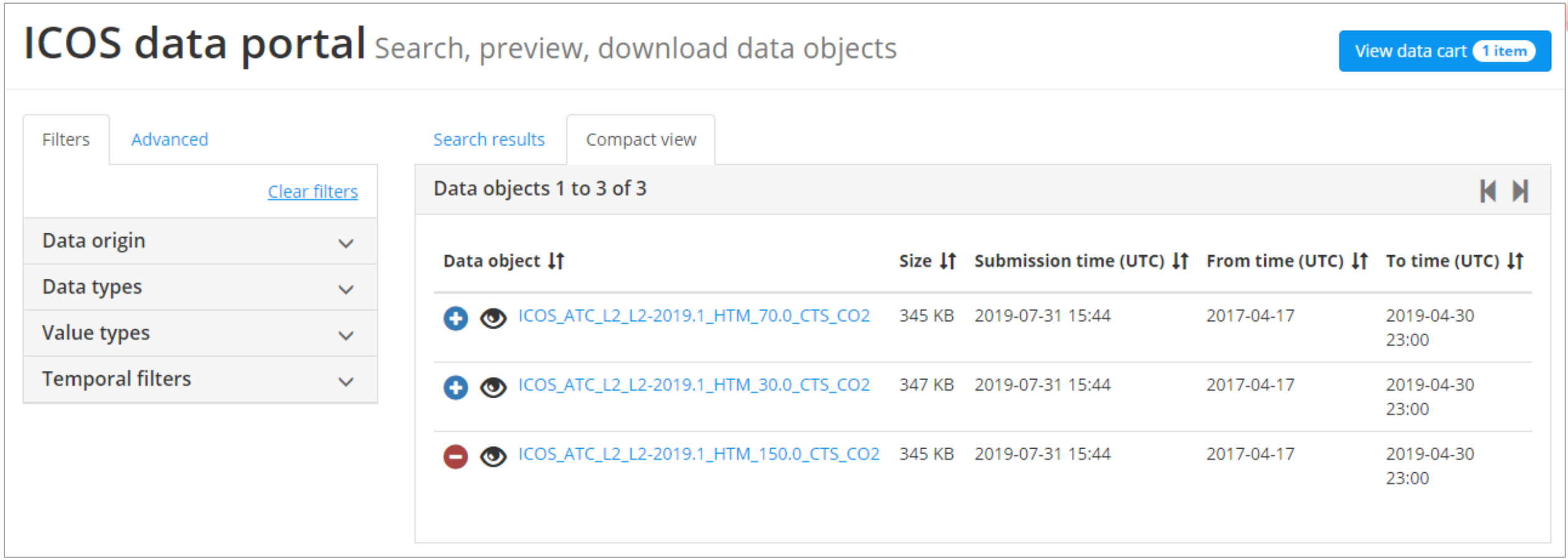
https:/www./icos-cp.eu/



Search interface

Facetted search interface, dynamically updated by SPARQL calls to metadata triple store

ICOS + Atmospheric data + HTM (Hyltemossa) + ICOS ATC CO2 Release



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

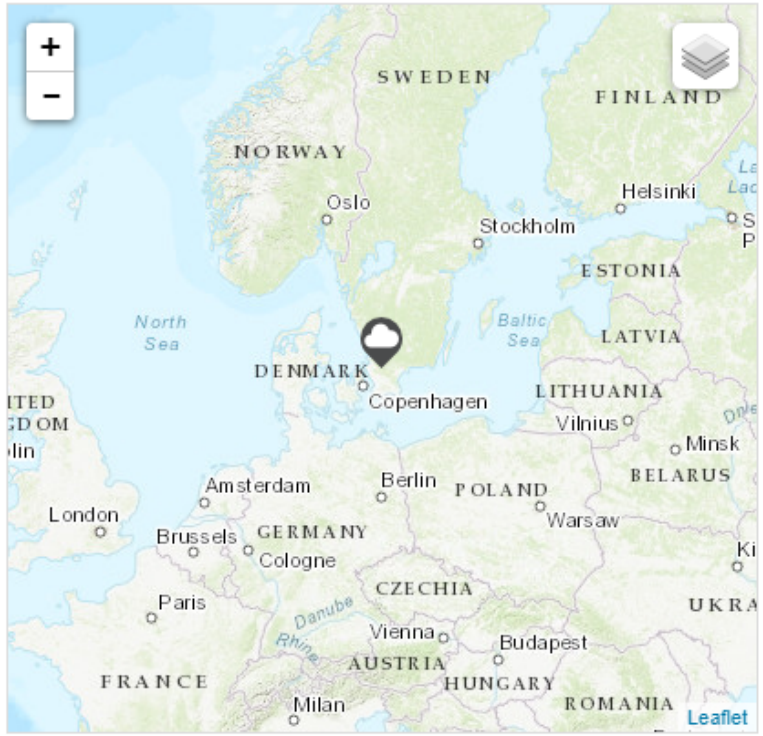
Dataset landing page

ICOS ATC CO2 Release from Hyltemossa

View data cart 1 item

2017-04-17 – 2019-04-30

PID	11676/l0ysHf3ENUx1MIouesbfFAnG
Affiliation	ICOS
Type	ICOS ATC CO2 Release
Level	2
File name	ICOS_ATC_L2_L2-2019.1_HTM_150.0_CTS_CO2.zip
Size	345 KB
Station	Hyltemossa
Time coverage	2017-04-17 00:00:00 – 2019-04-30 23:00:00
Instruments	ATC_463, ATC_461
Sampling height	150 m
Citation	ICOS RI, 2019. ICOS ATC CO2 Release, Hyltemossa (150.0 m), 2017-04-17–2019-04-30, https://hdl.handle.net/11676/l0ysHf3ENUx1MIouesbfFAnG
Previous version	View previous version
Previous version	View previous version
Made by	Atmosphere thematic center
Host organization	Atmosphere thematic center
Creation date	2019-07-31 15:44:27



Metadata

HTML landing page • JSON • RDF/XML • RDF/TURTLE

Dataset preview

ICOS_ATC_L2_L2-2019.1_HTM_150.0_CTS_CO2

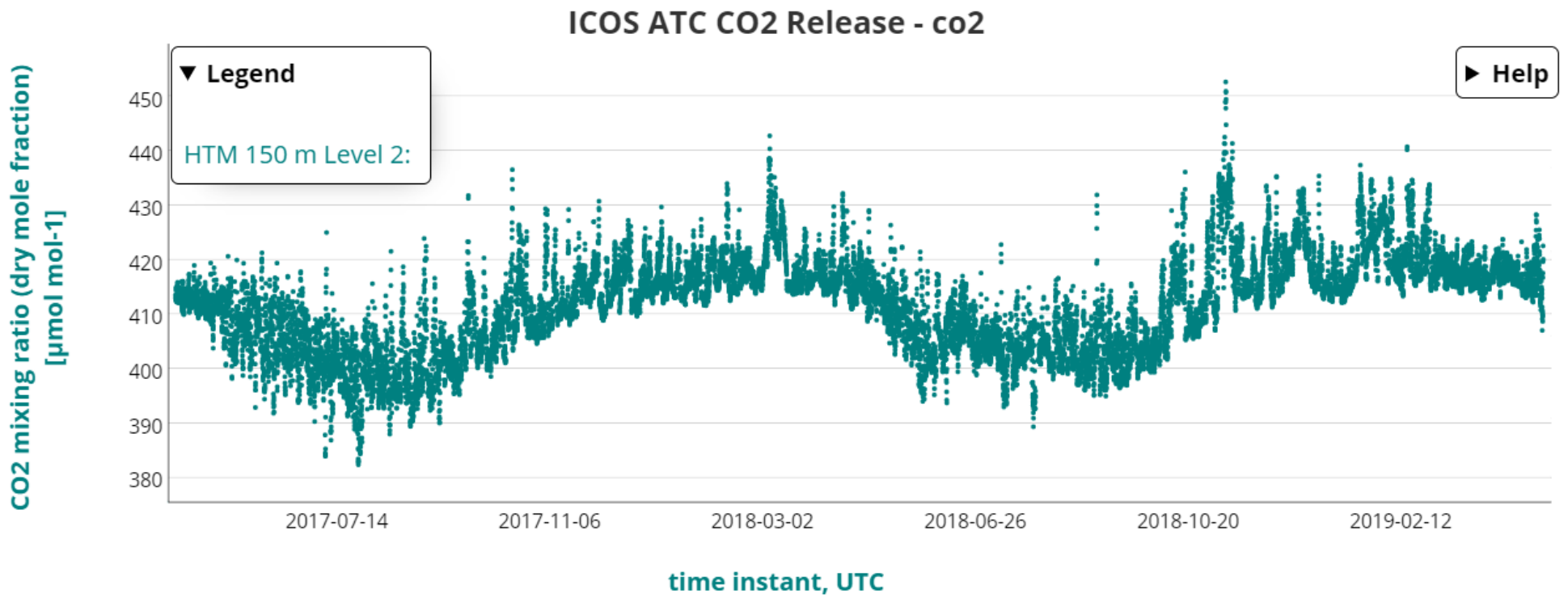
Copy preview chart URL

Remove from cart

X axis: TIMESTAMP—time instant, UTC

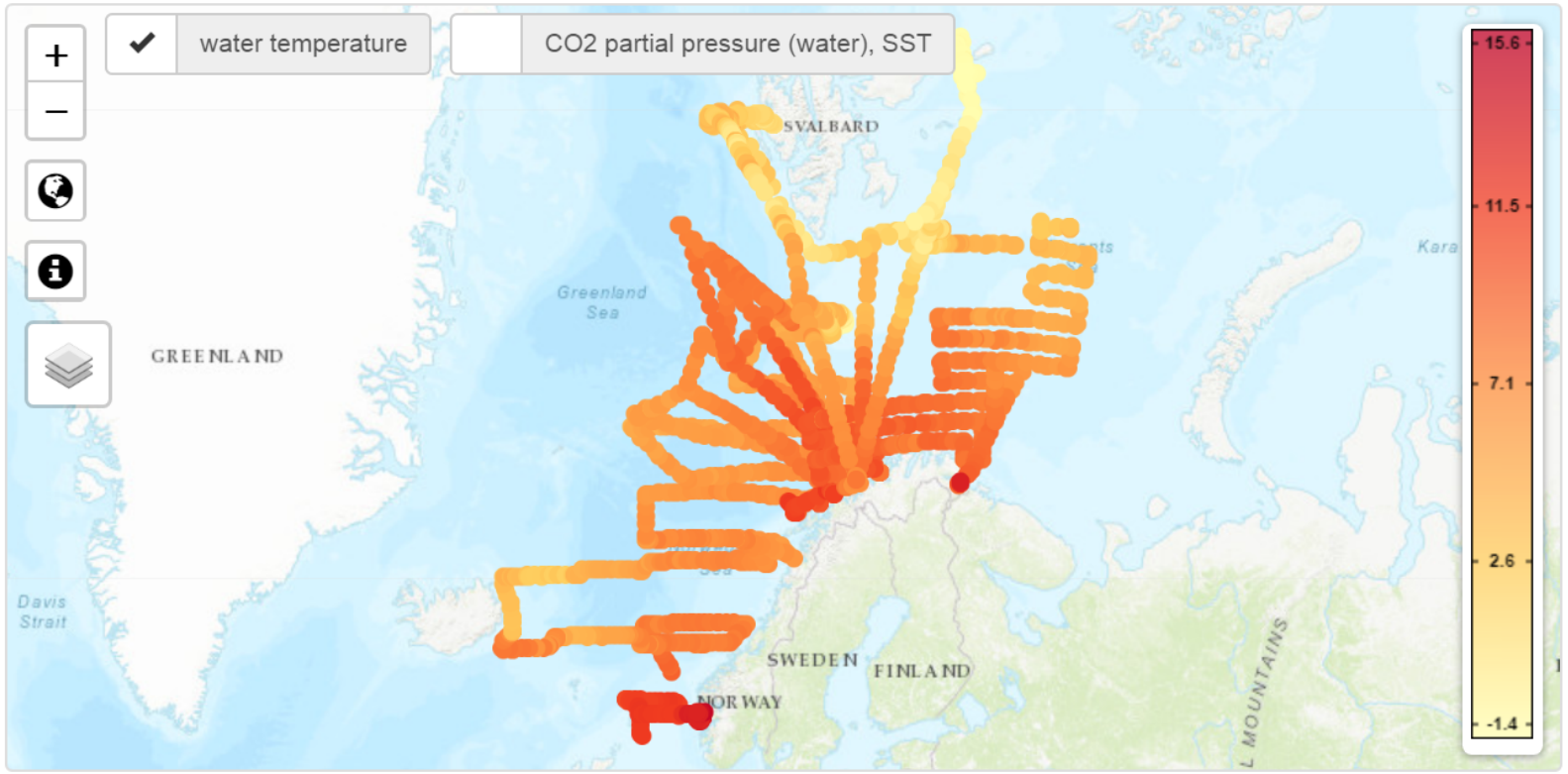
Y axis: co2—CO2 mixing ratio (dry mole fraction

Chart type: scatter



ICOS preview – time series (cont.)

- **Water temperature – ocean station**

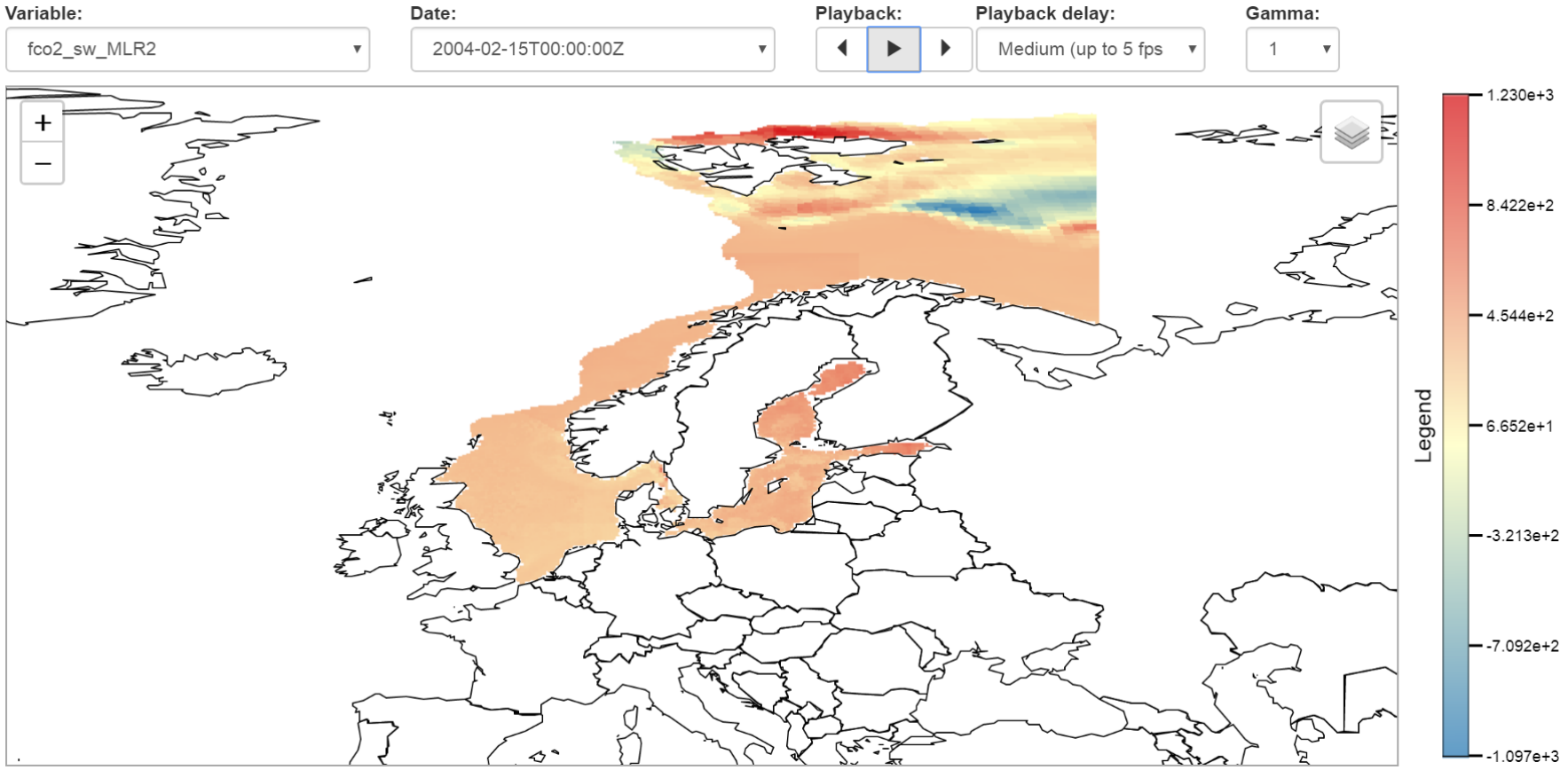


time instant, UTC	2019-11-01 15:11
latitude	79.028
longitude	6.003
air pressure [hPa]	1006.800
practical salinity [psu]	
water temperature [°C]	3.457
CO2 fugacity (water), SST [µatm]	
CO2 fugacity (air) [µatm]	
CO2 partial pressure (water), SST [µatm]	
CO2 partial pressure (air) [µatm]	
Data points in bounding box	98,229
Data points shown in map	2,418

https://data.icos-cp.eu/map-graph/3UoSdkoud7jWMGeH8M4YcPNL#{"objId":"3UoSdkoud7jWMGeH8M4YcPNL","y1":7,"y2":13,"map":7,"center":{"lat":72.82248019446818,"lng":14.31549999999998},"zoom":3}

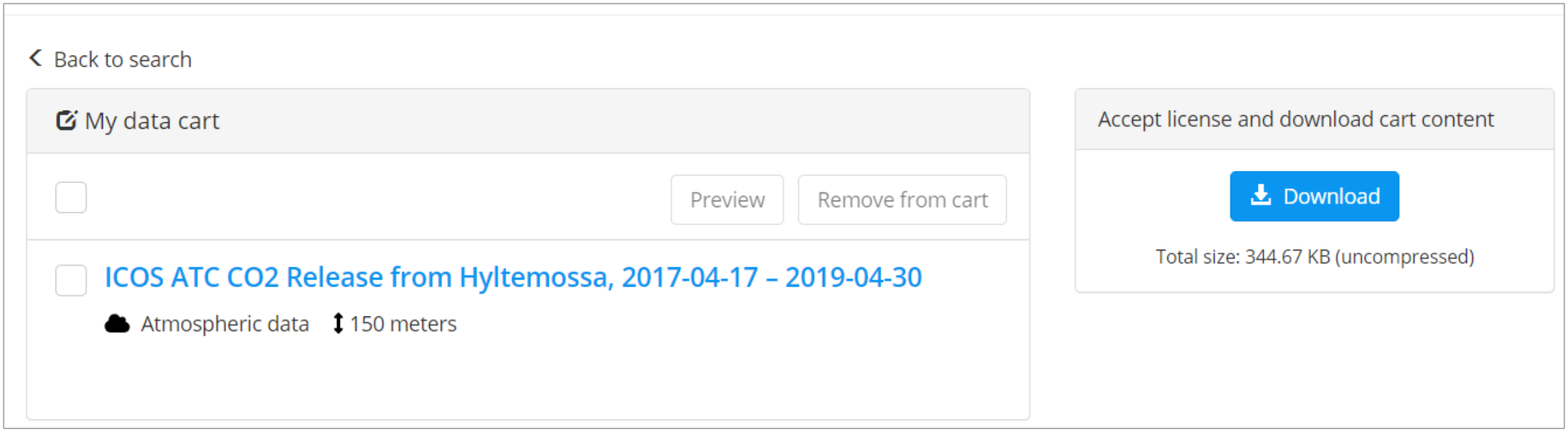
ICOS Preview – NetCDF

- **Monthly coastal CO2-fluxes (1997 - 2016)**



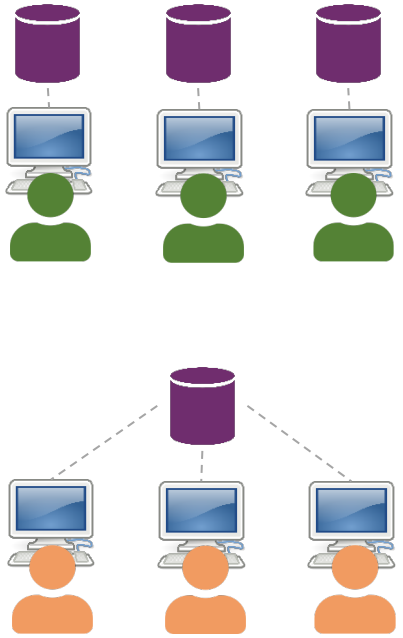
https://data.icos-cp.eu/portal/#%7B%22route%22%3A%22preview%22%2C%22preview%22%3A%5B%22n7cB5kS4U1E5A3mXKtEUCF9s%22%5D%7D

Data cart



ICOS Jupyter

- **Jupyter Hub**
  - User accounts for registered users
  - Collaboration between users with shared directories (access to directories on server)
  - Users may upload data (all work is saved)
  - One docker container
- **Exploredata – “Anonymous” Jupyter Service**
  - Testing platform for conferences & “hands-on“ sessions
  - Content deleted after log-out or after 15 min of inactivity
  - One docker container per user
- **Voilá (upcoming service)**
  - Displaying notebooks “live” on portal (no code visible)
  - Interaction with plots using widgets



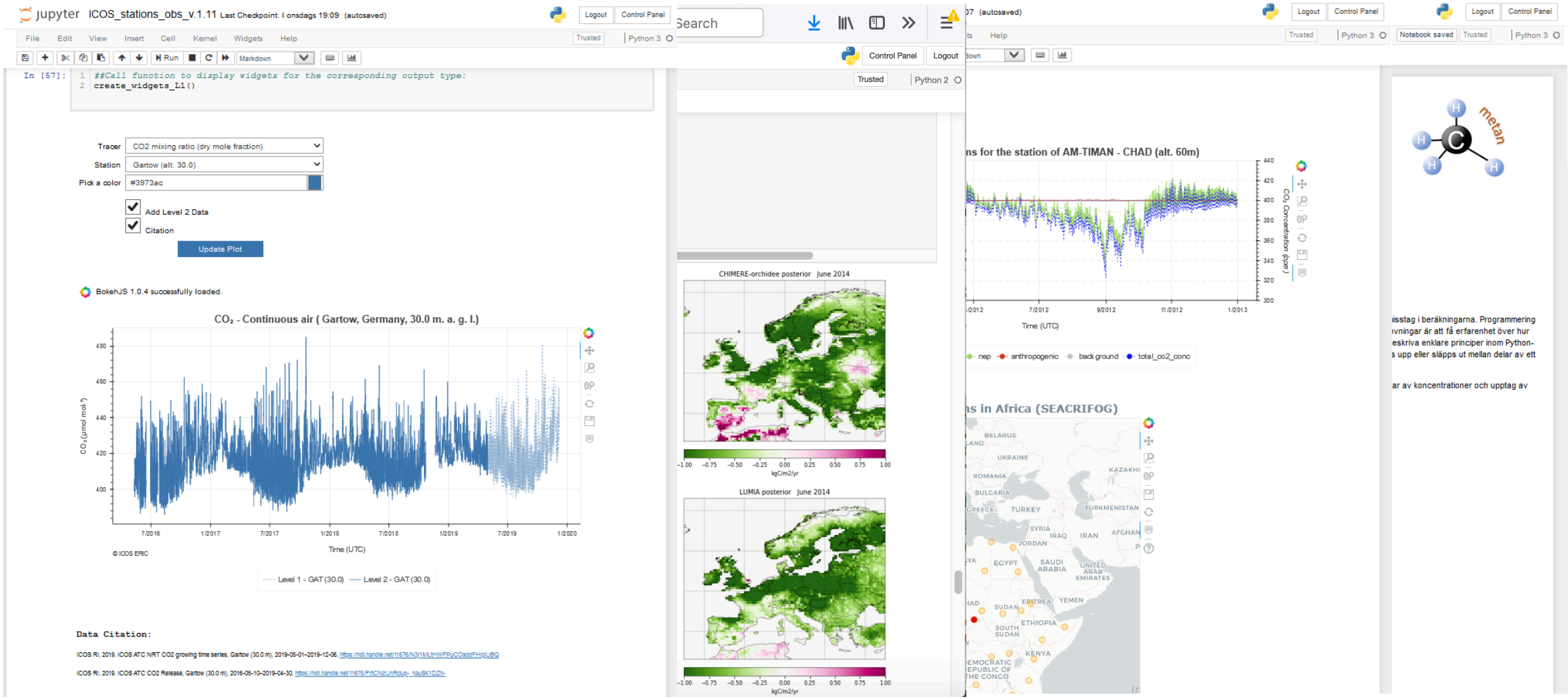
ICOS Jupyter Notebooks

- **Project Specific Jupyter Notebooks** *(not yet openly available to the public)*
  - Analysis of simulated fossil fuel CO2 time series (RINGO)
  - Evaluation of sampling strategies (RINGO)
  - inversion intercomparison (EUROCOM)

- **Open Access Jupyter Notebooks** *(openly available to the public)*
  - Explore ICOS Atmospheric Data
  - Compare atmospheric model results (STILT) to ICOS Atmospheric Data

- **Educational Jupyter Notebooks** *(openly available to the public)*
  - Introduction to Carbon Cycle & Python Programming *(Swedish Science Centres)*
  - Drought 2018 & Python Programming *(Highschool pupils & BSc students)*

Examples of ICOS Jupyter Notebooks



Access to ICOS Jupyter Notebooks

- **ICOS Carbon Portal Jupyter Hub**

  Send an email to exploredata@icos-cp.eu with a request for an account

- **Open Access Jupyter Notebooks**

  https://exploredata.icos-cp.eu

- **GitHub**

  https://github.com/ICOS-Carbon-Portal/jupyter

ICOS in numbers

- **Data**
  - Data file size: 22 bytes - 3 GB !
  - Number of files: 136,324
  - Total size: 1.3 TB

- **Services**
  - Jupyter Hub: 35 user accounts
  - Jupyter Hub docker container: 35 GB RAM allocated (out of 128 GB available on the server)
  - Exploredata: support for max 25 users at the same time

Thanks for listening!

Questions or comments?

Ask now, or get in touch later:

- send an e-mail
  - karolina.pantazatou@nateko.lu.se
  - margareta.hellstrom@nateko.lu.se
- visit the ICOS Carbon Portal
  - virtually: https://www.icos-cp.eu
  - IRL: Geocentrum II (2nd floor)