



ICOS

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INTEGRATED
CARBON
OBSERVATION
SYSTEM

DATA FROM ICOS – AN OPPORTUNITY TO PEEK INTO THE CAUSES OF CLIMATE CHANGE

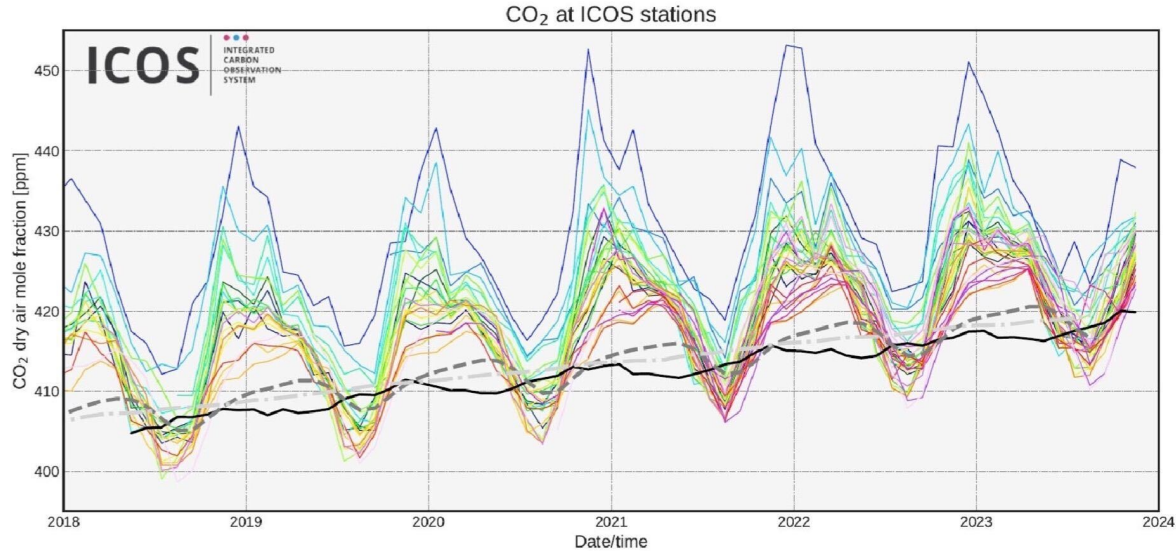
Elena Saltikoff
Head of Operations
ICOS ERIC

What is ICOS



- The Integrated Carbon Observation System, ICOS, provides standardised and open data from ca.180 measurement stations across 16 European countries.
- **Greenhouse gas** concentrations, carbon fluxes in three domains: Atmosphere, Ecosystem and Ocean.

More CO₂ every year – regional differences



— HPB131	— JUE120	— NOR100	— SAC100	— TRN180	— PUY10	— SNO85	— ZEP15
— BIR75	— KIT200	— OPE120	— SMR125	— CMN8	— SSL12	— UTO57	— RUN6
— GAT216	— KRE250	— OXK163	— STE187	— JFJ14	— ZSF3	— WAO10	— Global average (NOAA)
— HTM150	— LIN98	— PUI84	— SVB150	— PAL12	— HEL110	— WES14	— Global trend (NOAA)
— IPR100	— LUT60	— RGL90	— TOH147	— PRS10	— LMP8		

Stations in
Europe
+ Reunion
+ global
average

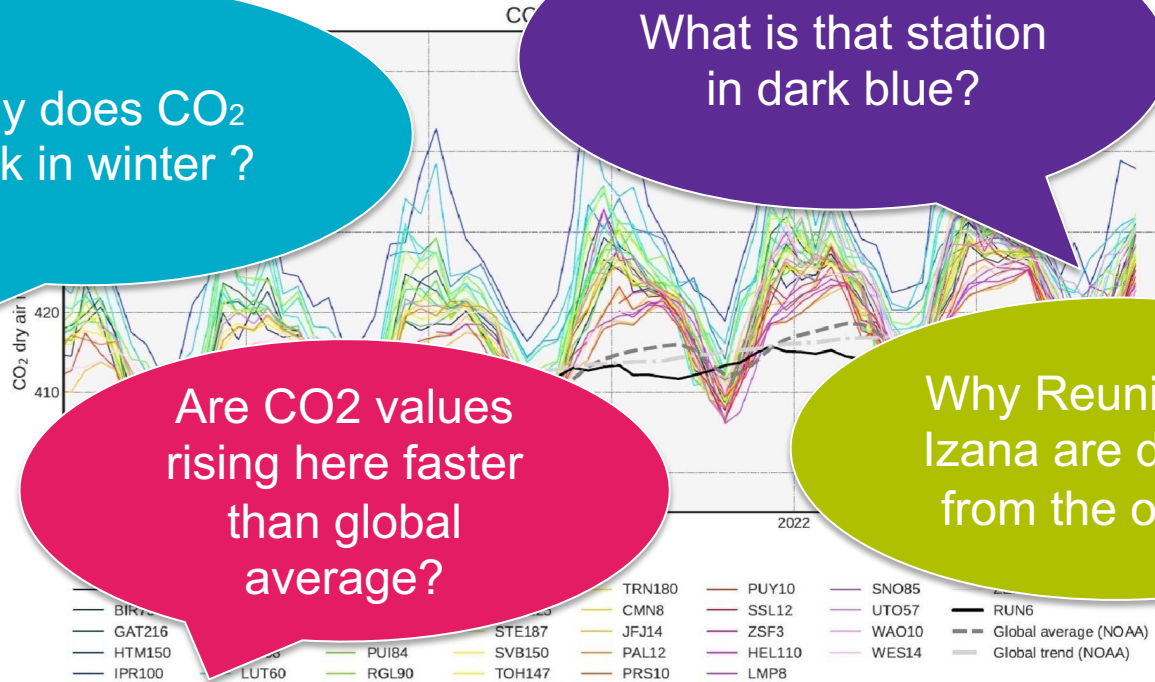
Interdisciplinary questions

Why does CO₂ peak in winter ?


What is that station in dark blue?

Are CO₂ values rising here faster than global average?

Why Reunion and Izana are different from the others?



Our ICOS Data



FAIR and open
Available near real time
Long time series

The future scientists
and decision makers
who you teach
can use in their exercises and essays
the same up-to-date data
we provide to the top scientists today

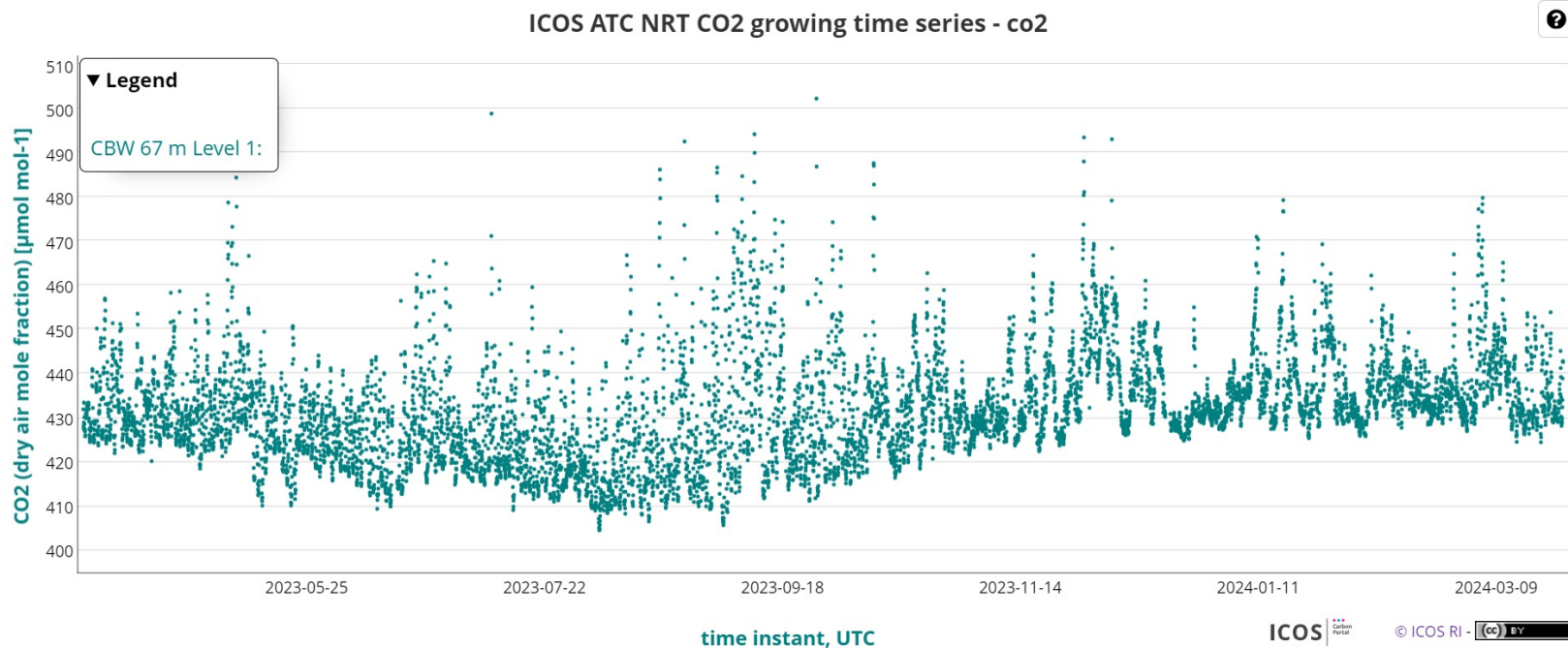
How to access ICOS data

- ICOS data can be **previewed** and **downloaded** from the ICOS Carbon portal. Alternatively, it can be used as part of Jupyter notebooks.
- <https://icos-cp.eu> -> Observations - > Station network

Id	Name	Theme	Station class	Location	Country	PI names	Site type	Elevation above sea	Labeling date
Hyttemossa	Hyttemossa	Atmosphere	1	(56.0976, 13.4189)	Sweden (SE)	Biermann Hellasz	tall tower	115.0	2018-05-31
Hyttemossa	Hyttemossa	Ecosystem	2	(56.09763, 13.41897)	Sweden (SE)	Hellasz	evergreen needleleaf forests	115.0	2018-05-31

Link to **data** and **metadata**

Browse data / Data > NRT CO2 Growing time series from Cabauw, 67 meters > Preview



Our stations

- Different climates
- Different environments
- #ExploreICOS
(this is where I will show videos)

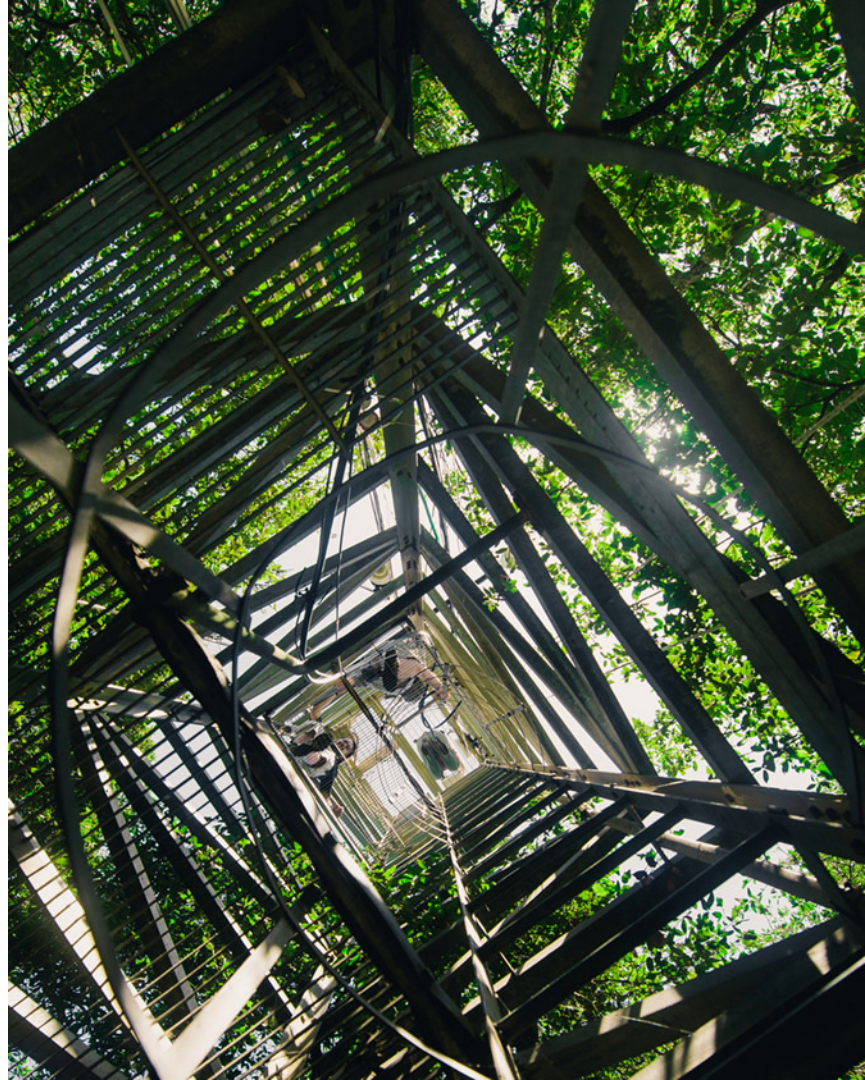


Atmosphere
stations measure
concentrations,
Ecosystem and
Ocean stations
measure fluxes


Two recent examples from classrooms

A task in ICOS Cities project developed and piloted a module for teachers, test use in Switzerland with 6th graders

An optional class in Finland Upper secondary school (gymnasium, 16-18 year old)



Goals in ICOS Cities project task in schools

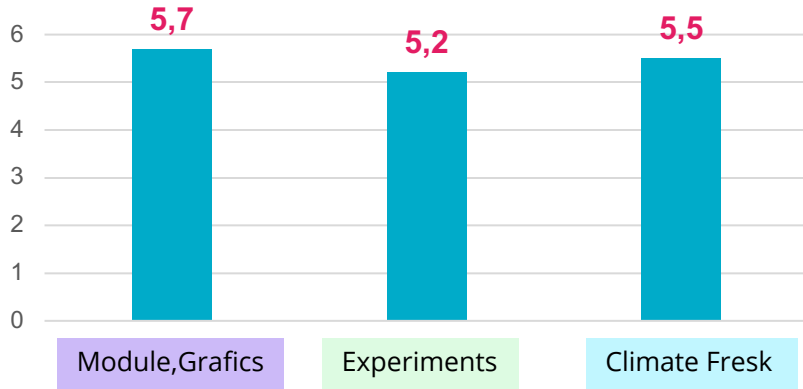
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- **Teach the teachers**
 - **Understanding basics of climate change**
 - **Trust in science**
 - **Facts and fakes**
 - **It is important**

Students:

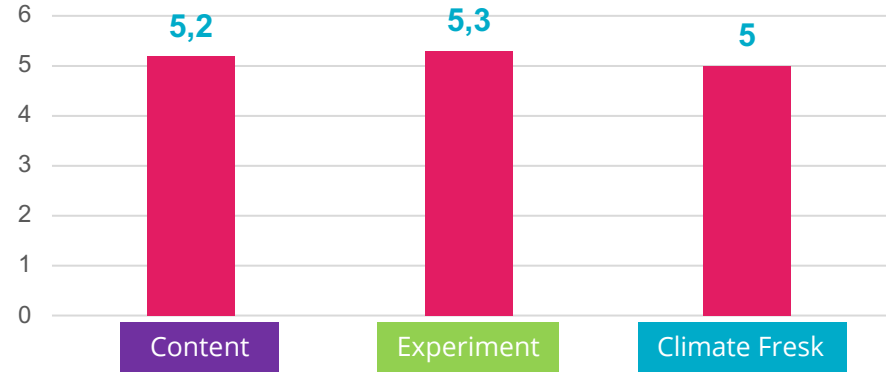
- Understand how emissions of CO₂ are generated
- understand relationship between CO₂ and global warming
- recognize the danger of global warming.
- understand CO₂ will not disappear on its own.
- can uncover common fake statements
- know ways to reduce CO₂
- think about own CO₂ footprint.

Feedback: Statistics (1..6=Excellent)

Rating by Teachers



Rating by Students

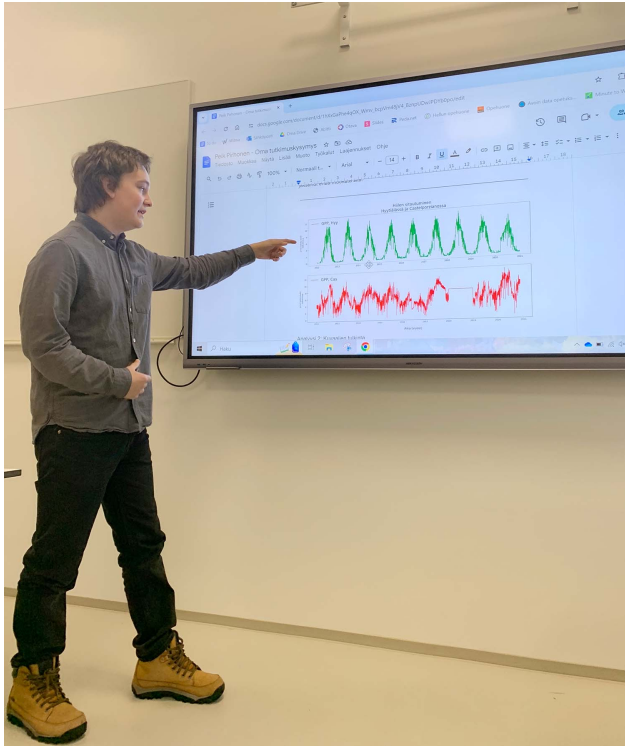


Pilot in Helsinki Upper Secondary School of Natural Sciences

- Optional class of physics/biology/computer science/society
- Buffet of different elements you can combine to earn credits
 - Lecture by ICOS scientists: Carbon cycle and what do we measure
 - Research /Programming exercise using ICOS data
 - Field trip to ICOS station
 - ClimateFresk game session



Real research programming



- Based on lecture, pick your research question.
- Modify a given Jupyter notebook to find the answer in data
- Present it to the audience
- Questions they had included:
 - Does annual variability of NPP relate to temperature ?
 - What is annual variability in methane in different locations?
 - Trend in CO₂ in different parts of Europe ?

Example code to modify

(Python in Jupyter notebook)

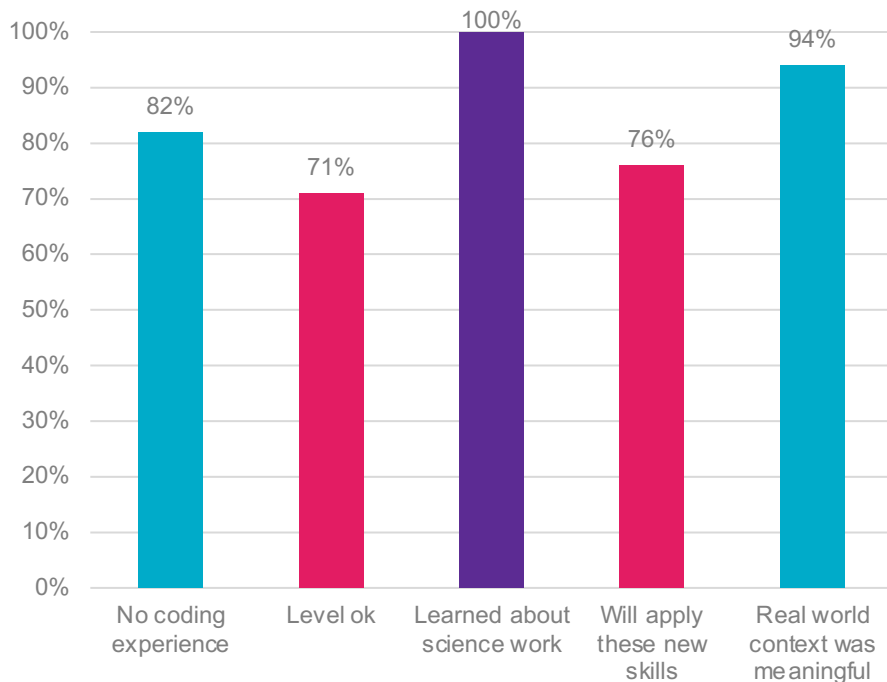
- Combined teaching of science and computing
- Programming as a tool, not as a goal itself
- Commands to plot values, calculate trend -> students to change which station, which parameter...
- Student reactions:



Excitement
Neutral
Fear

```
[ ] # Sovitetaan ylös alas sahaaviin havaintoihin yleiskuvaa tasoittava trendiviivakin.  
  
plt.figure(figsize = (20, 10))  
  
# Havainnot  
  
plt.plot(HyyCO2["TIMESTAMP"], HyyCO2["co2"], label = "Hyytiälä", c = "g", alpha = 0.5)  
plt.plot(IzaCO2["TIMESTAMP"], IzaCO2["co2"], label = "Izana", c = "b", alpha = 0.5)  
  
# Hyytiälän trendi  
  
x = np.arange(HyyCO2['TIMESTAMP'].size)  
y = HyyCO2["co2"].copy()  
y[np.isnan(y)] = y[~np.isnan(y)].mean()  
  
z = np.polyfit(x, y, 1)  
p = np.poly1d(z)  
plt.plot(HyyCO2['TIMESTAMP'], p(x), c = "black", linestyle = "dashed", label = "Hyytiälä")  
  
# Izañan trendi  
  
q = np.arange(IzaCO2['TIMESTAMP'].size)  
w = IzaCO2["co2"].copy()  
w[np.isnan(w)] = w[~np.isnan(w)].mean()  
  
v = np.polyfit(q, w, 1)  
pf = np.poly1d(v)  
plt.plot(IzaCO2['TIMESTAMP'], pf(q), "r--", label = "Izana", alpha = 0.7)  
  
# Selitteet
```

Feedback after the programming class



ClimateFresk session



- Brought together concepts they had heard of in different contexts
- Based on IPCC report
- Allowed to build a wholistic picture of what-links-to-what
- Potential for climate angst, hence session ended in exercise “what we can do to mitigate climate change”

It's not about the resulting graph, it is about discussions on our way there



The IPCC report illustrated, highlighting causal connections

Useful links

- <https://www.icos-cp.eu/observations/station-network>
- <https://www.icos-cp.eu/science-and-impact/education/icos-jupyter-notebooks-for-education>
- <https://www.icos-cp.eu/data-services/tools/jupyter-notebook>
- <https://www.icos-cp.eu/projects/icos-cities>
- <https://climatefresk.org/>
- Notebooks with comments in Finnish
- <https://opendata-education.github.io/Tyopajat/harjoitukset/KestavyysHarjoitus.html>
- <https://github.com/opendata-education/Tyopajat/blob/main/materiaali/harjoitukset/KestavyysHarjoitus.ipynb>

Contributors

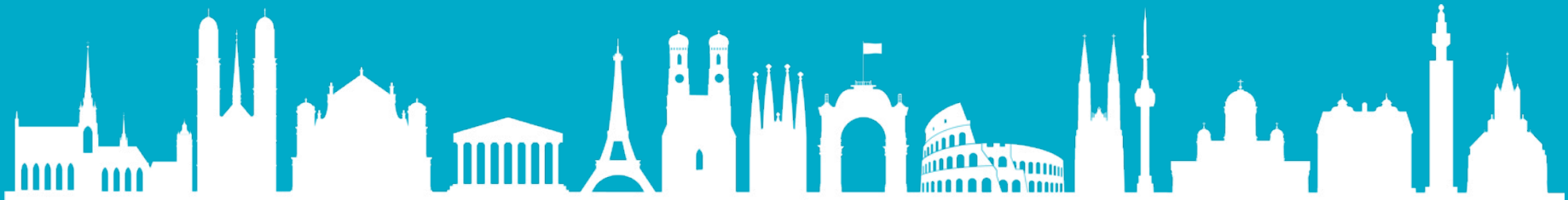
- Astrid Hügli, ICOS Cities Project Task 5.2 <astridhuegli@hispeed.ch>
- Peitsa Veteli, Helsinki Institute of Physics (the Jupyter notebooks)
- Ville Kasurinen ICOS ERIC (observation expert)
- Liisa Ikonen ICOS ERIC (ClimateFresk facilitator)
- Charlotta Henry ICOS ERIC (photographs)

- Elena Saltikoff -- elena.saltikoff@icos-ri.eu



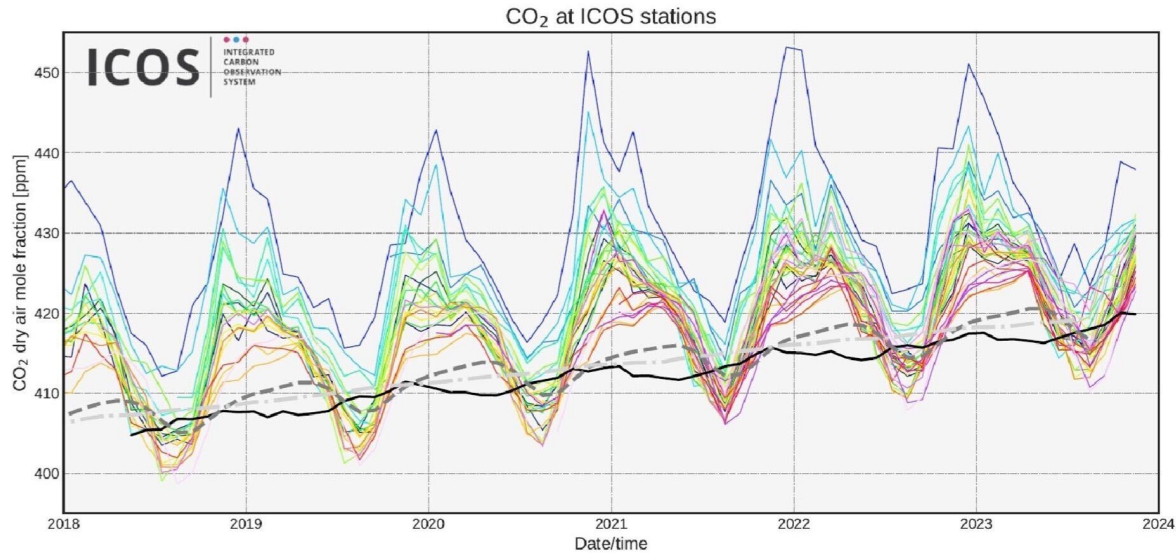
**“Cities are where the climate battle
will largely be won or lost.”**

António Guterres, Secretary-General, United Nations
Speech at C40 World Mayors Summit (Copenhagen), 11.10.2019



**Can you do this in your school?
Would you like to try?**

Questions emerging from this?



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Stations in Europe + Reunion + global average

What everyone needs to know about climate change

- It is real
 - It is caused by humans
 - It is serious
 - With immediate action, it can be solved
 - Later is too late
-
- (Quote from Katharine Hayhoe)

