Cos’è il cambiamento climatico?

«Per “cambiamenti climatici” si intendono i cambiamenti a lungo termine delle temperature e dei modelli meteorologici. »

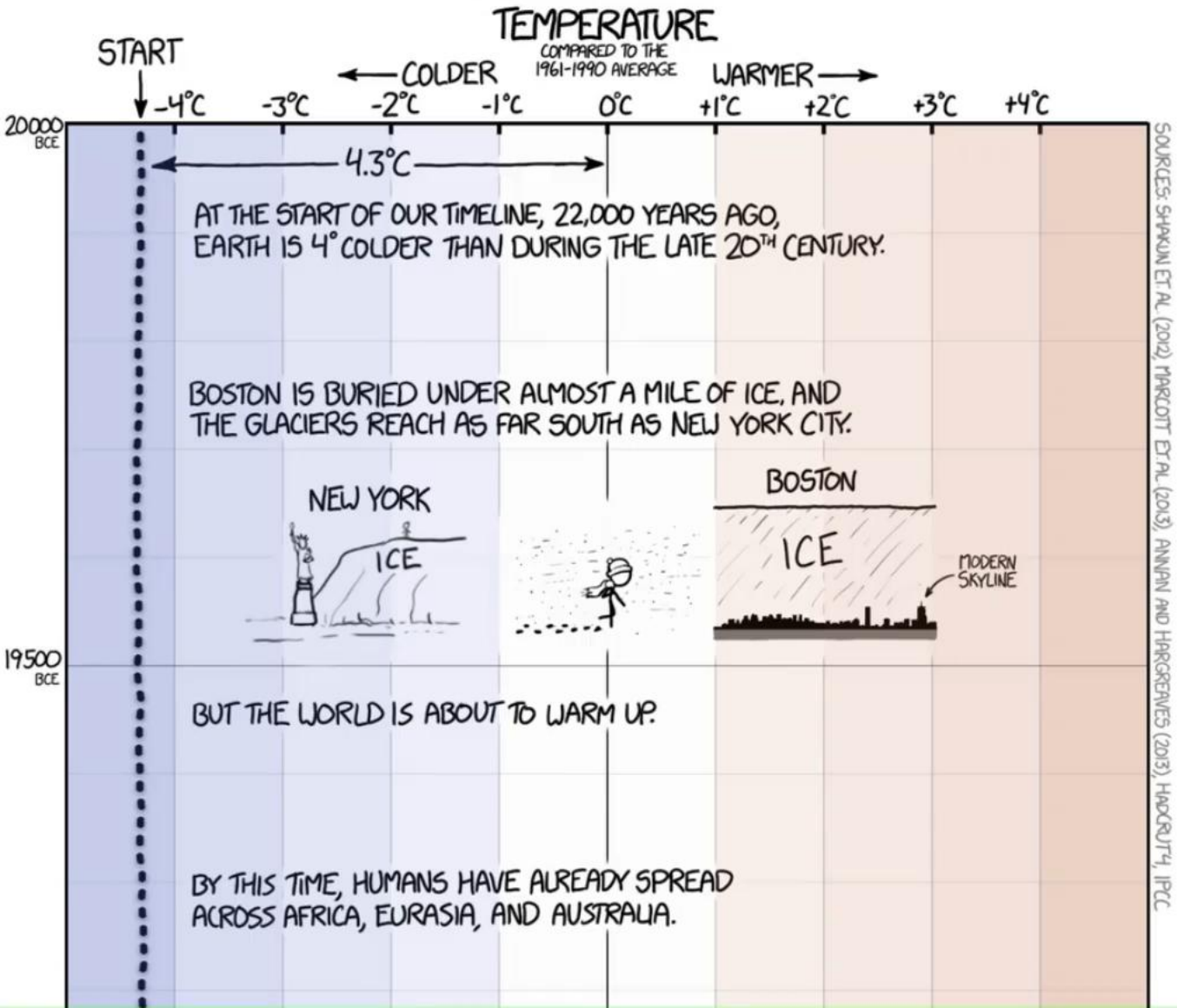
Cit. Nazioni Unite - Centro Regionale di Informazioni

https://unric.org/it/che-cosa-sono-i-cambiamenti-climatici/

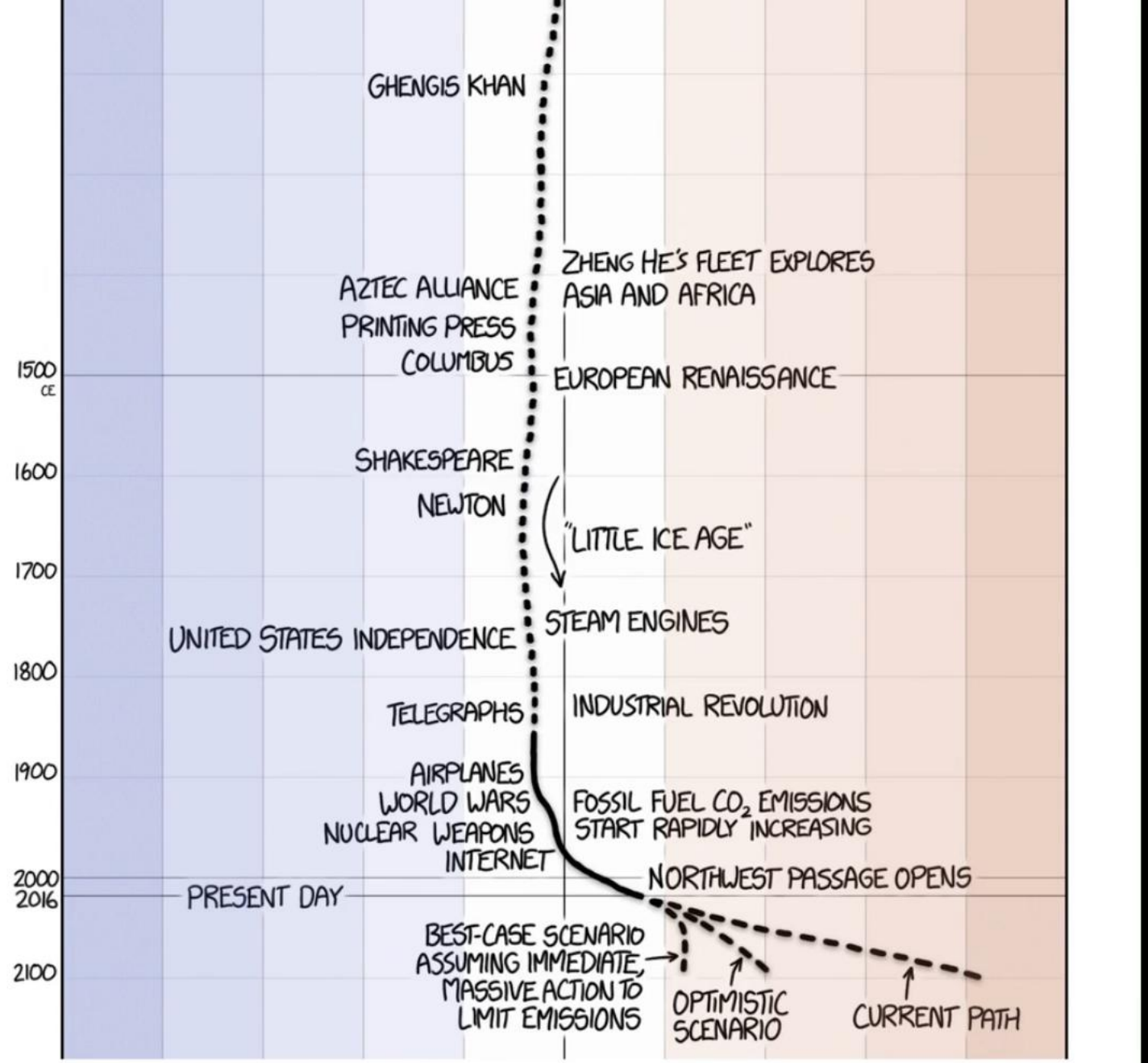
A TIMELINE OF EARTH'S AVERAGE TEMPERATURE

SINCE THE LAST ICE AGE GLACIATION

WHEN PEOPLE SAY "THE CLIMATE HAS CHANGED BEFORE,"
THESE ARE THE KINDS OF CHANGES THEY'RE TALKING ABOUT.

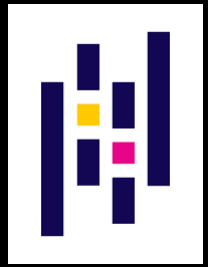


https://xkcd.com/1732/

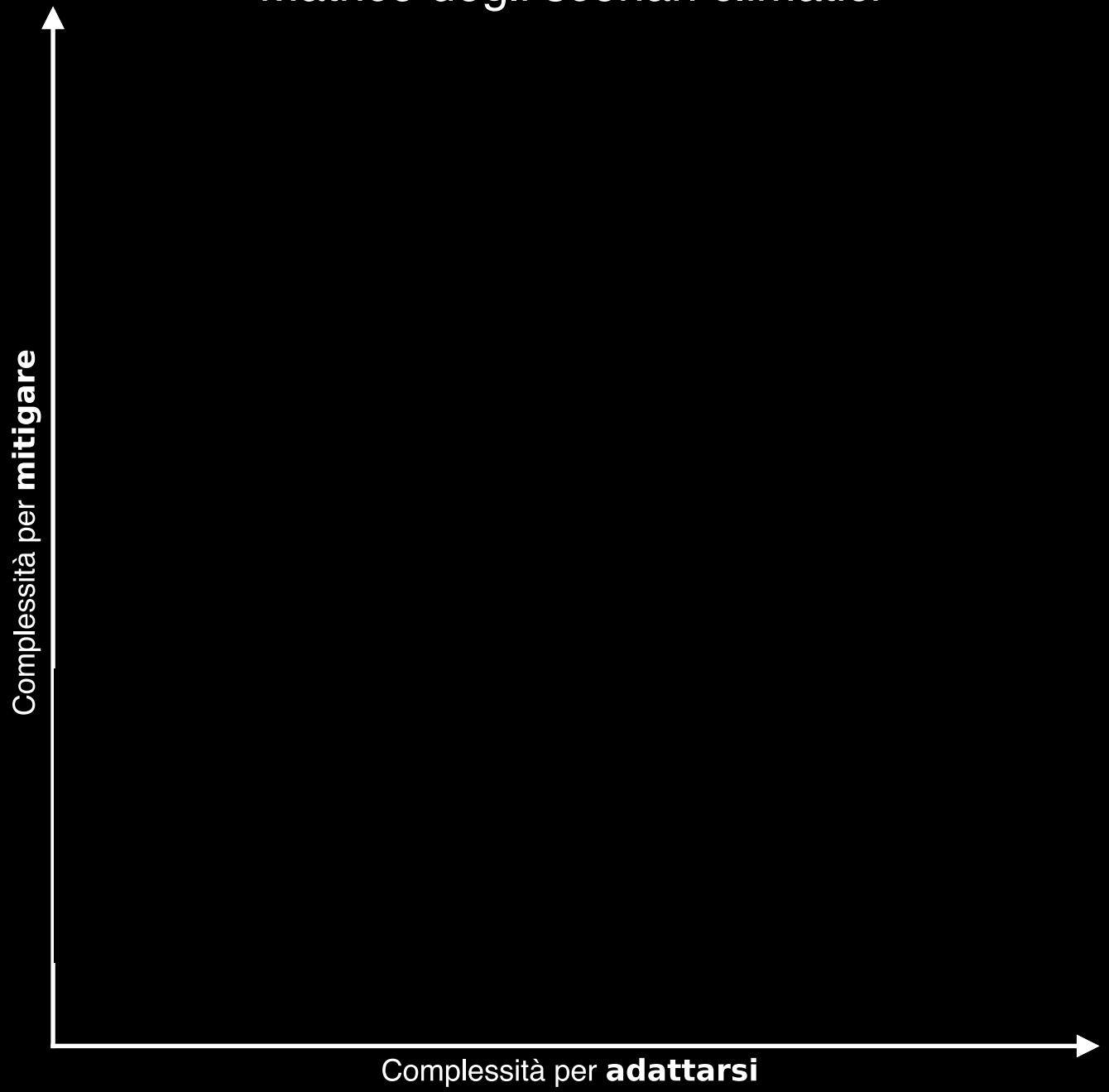


https://xkcd.com/1732/

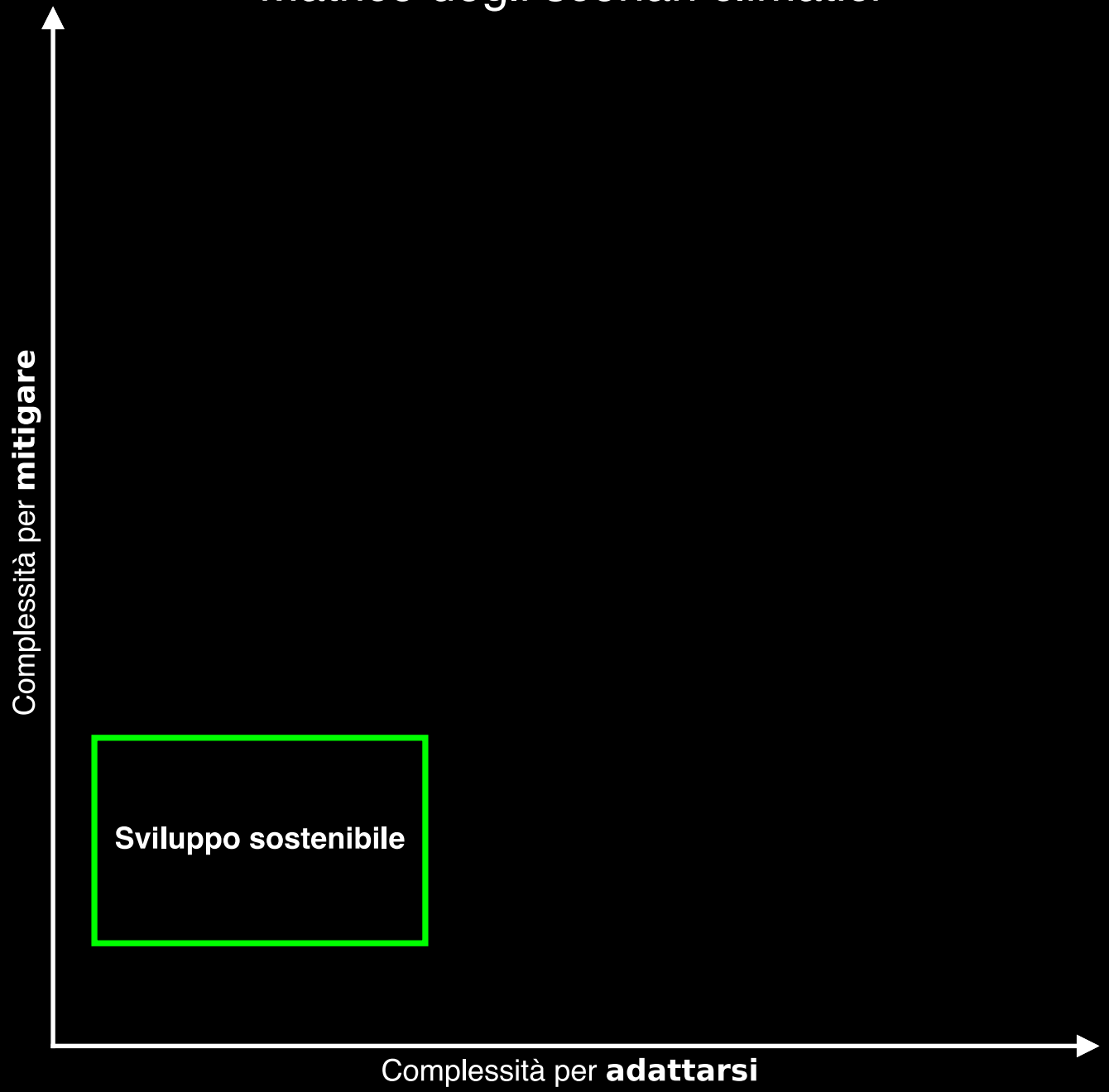
- 🖼️ Framework scientifico
- 📩 Reperire i dati
- ⚙️ Analizzare/processare i dati
- 🗺️ Visualizzare i risultati
- 🤔 Interrogarsi sui risultati



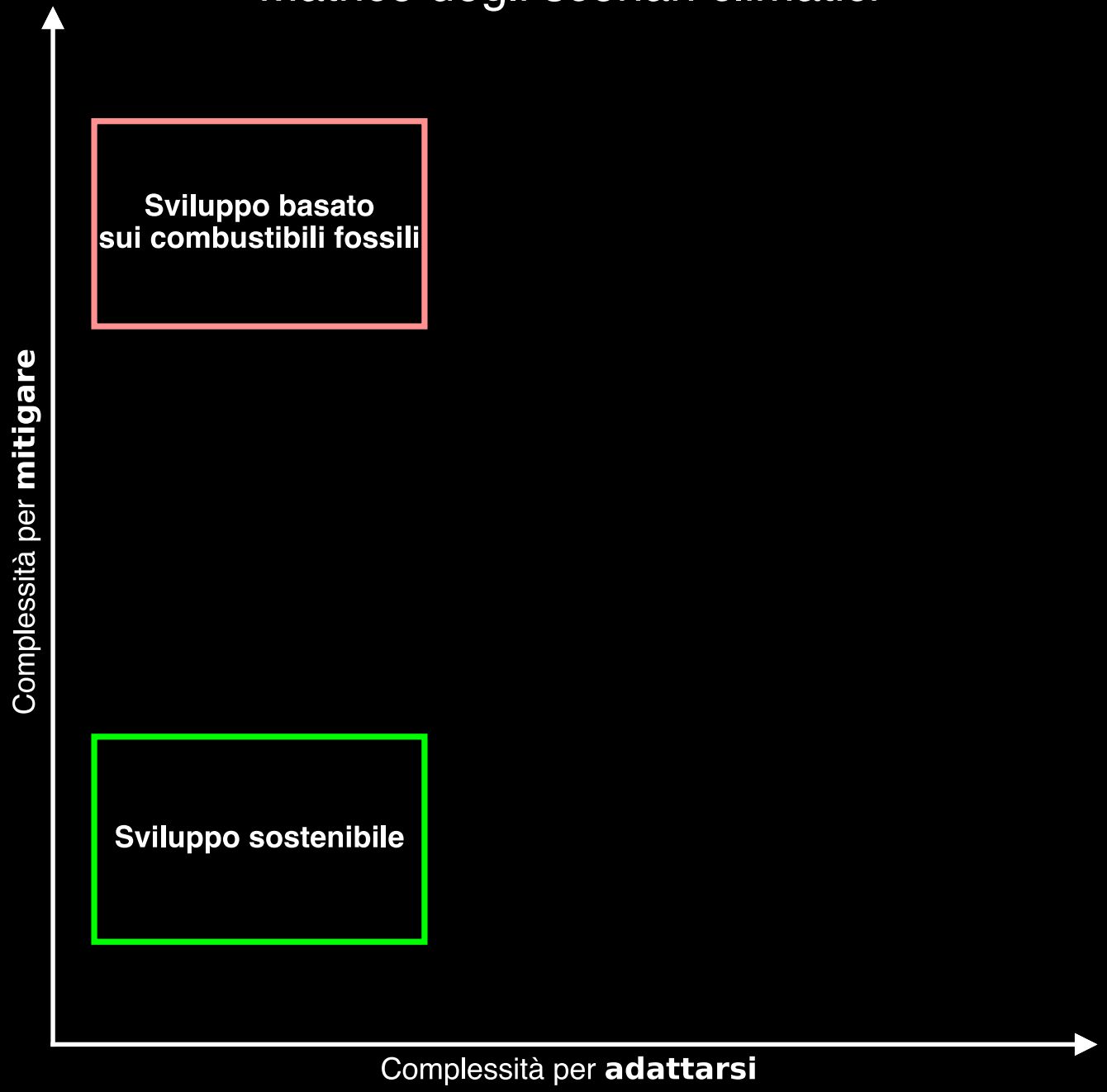
Matrice degli scenari climatici



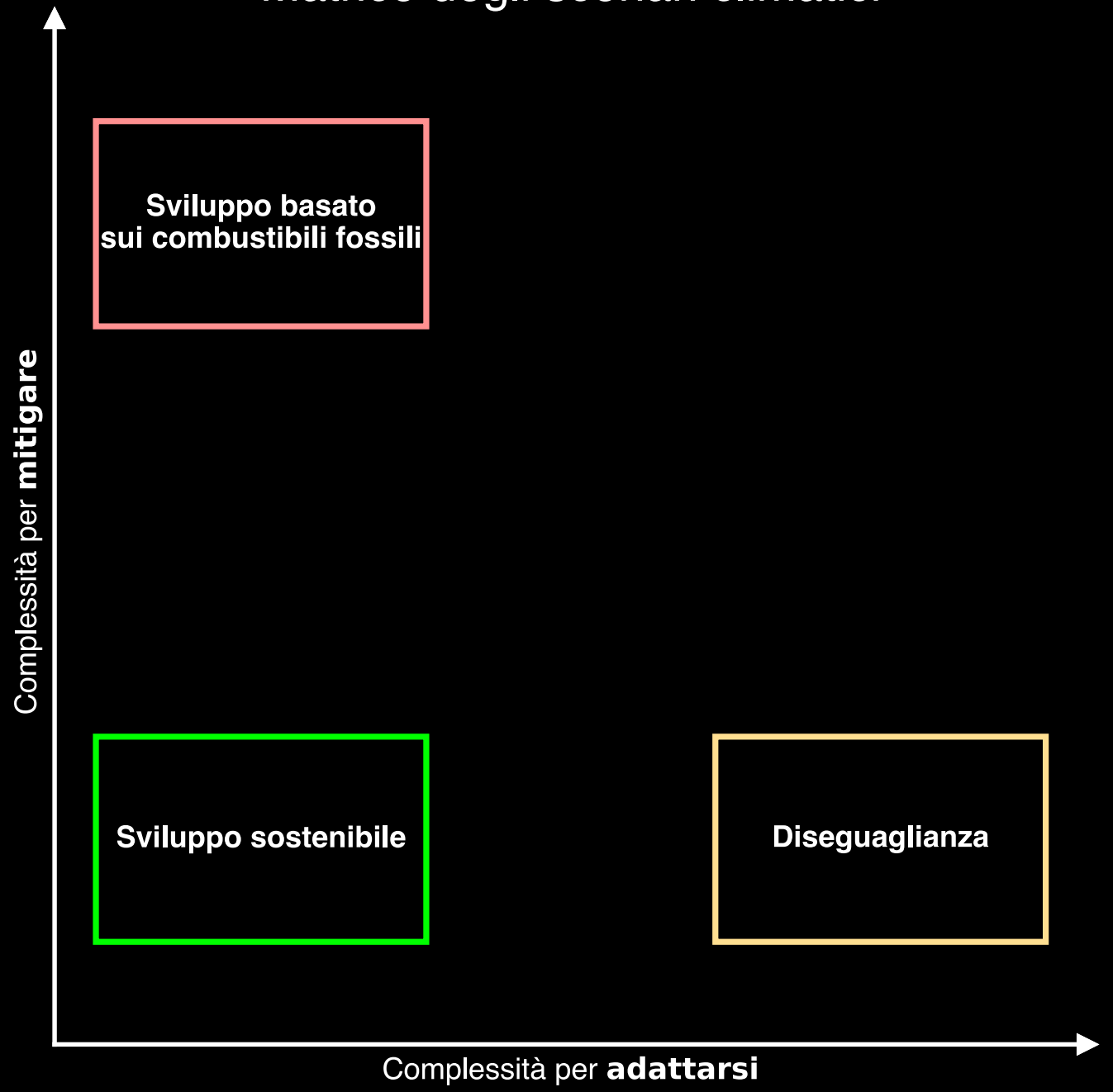
Matrice degli scenari climatici



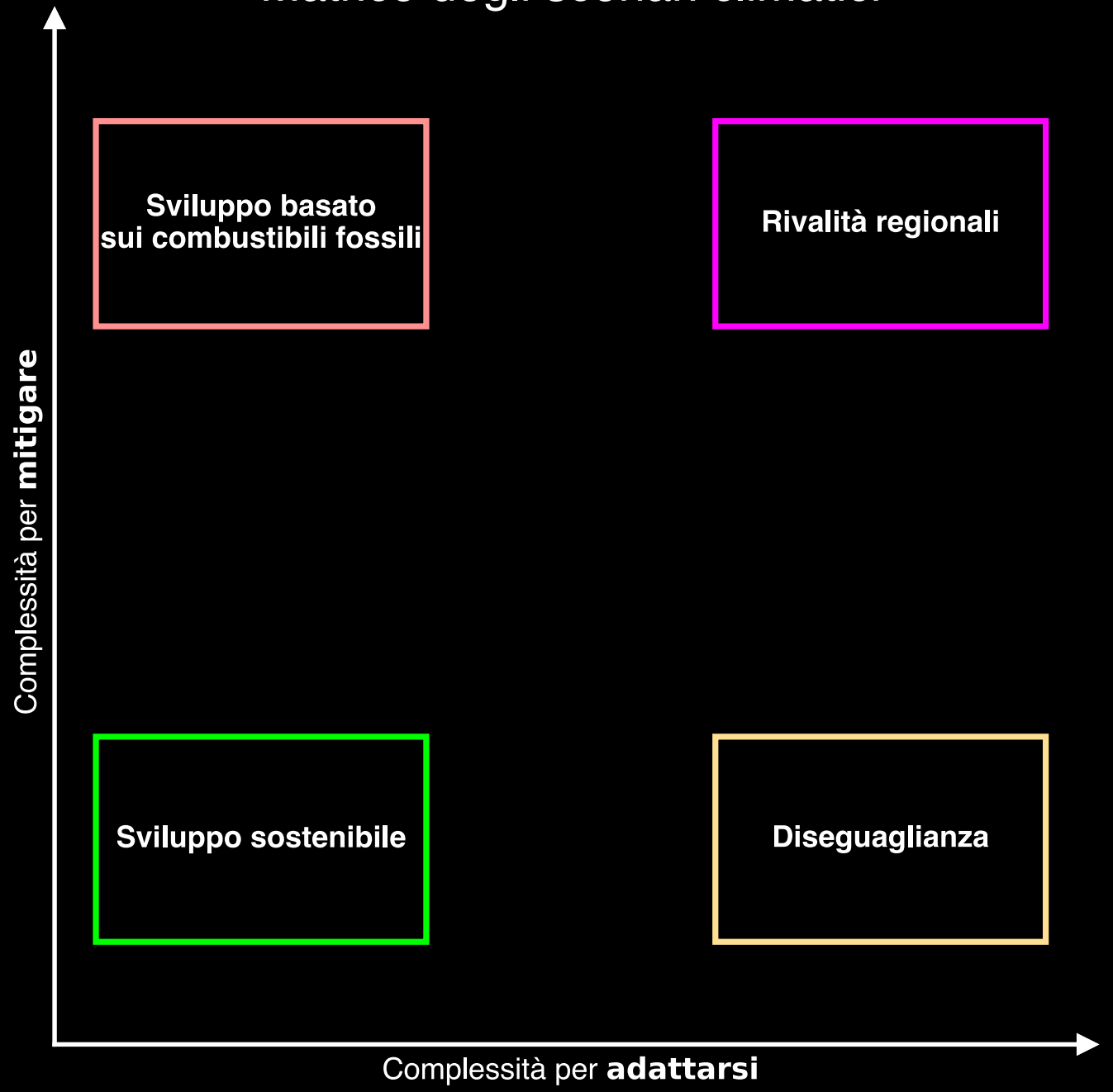
Matrice degli scenari climatici



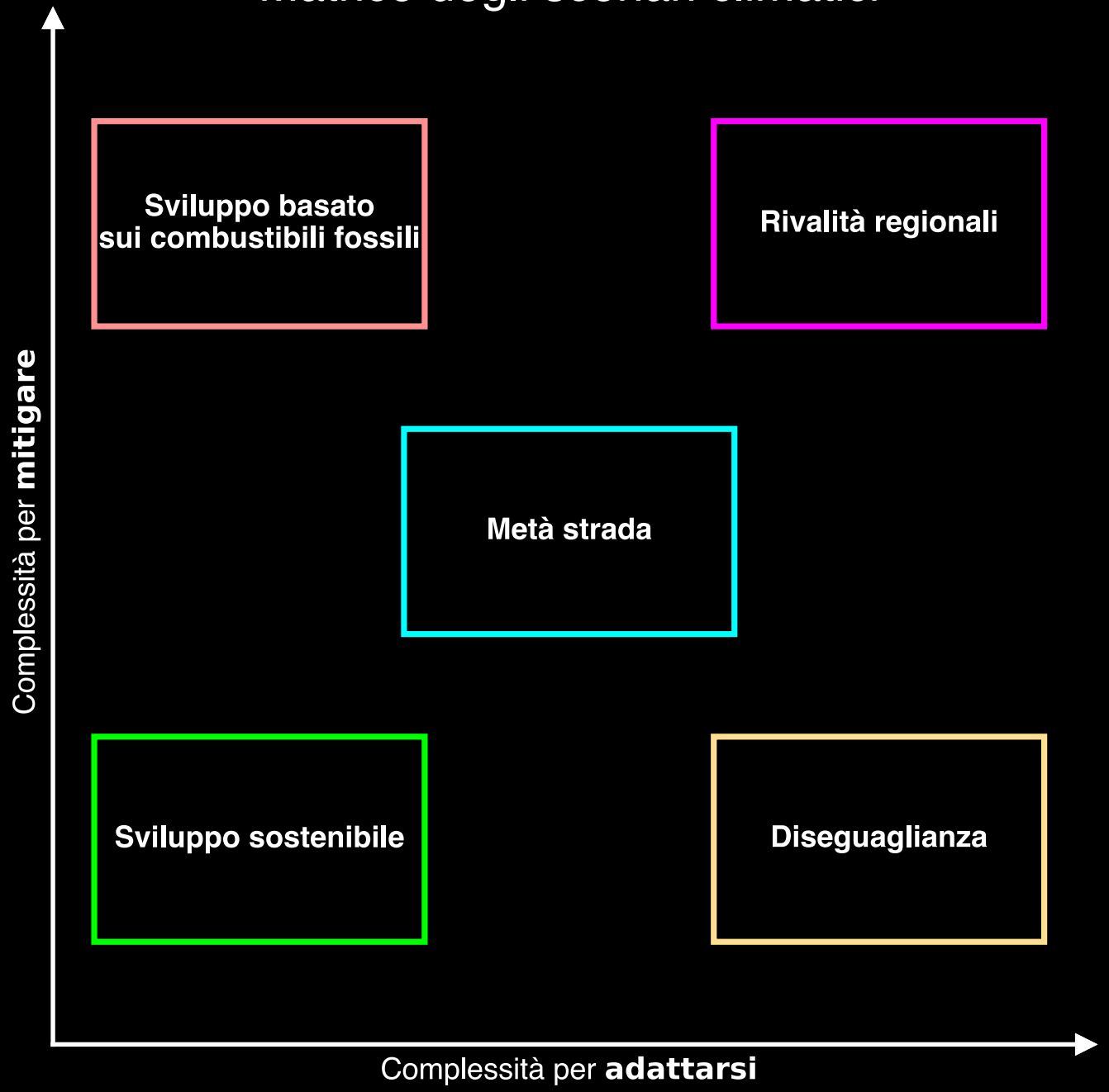
Matrice degli scenari climatici



Matrice degli scenari climatici



Matrice degli scenari climatici



https://data.ece.iiasa.ac.at/ssp/#/downloads

Downloads

Data access using Python or R

You can query the SSP Scenario Explorer database using the open-source Python package pyam using the follo

```python
import pyam

# by default, you receive the latest SSP projections (2024 release)
df = pyam.read_iiasa("ssp", region="World")

# you can also query the data of the 2013 SSP projections release
```

Read this tutorial for more information!

```python
import pyam

connection_name = "ssp"
conn = pyam.iiasa.Connection(connection_name)
```

```python
import pyam

connection_name = "ssp"
conn = pyam.iiasa.Connection(connection_name)

model = "IIASA-WiC POP 2023"
variable = "Population"
region = "World"
scenario = ["SSP1", "SSP2", "SSP3", "SSP4", "SSP5"]

raw_population = conn.query(
    variable=variable,
    model=model,
    scenario=scenario,
    region=region,
).as_pandas()
```

```python
import pyam

connection_name = "ssp"
conn = pyam.iiasa.Connection(connection_name)

model = "IIASA-WiC POP 2023"
variable = "Population"
region = "World"
scenario = ["SSP1", "SSP2", "SSP3", "SSP4", "SSP5"]

raw_population = conn.query(
    variable=variable,
    model=model,
    scenario=scenario,
    region=region,
).as_pandas()
```

```python
import pyam

connection_name = "ssp"
conn = pyam.iiasa.Connection(connection_name)

model = "IIASA GDP 2023"
variable = "GDP"
region = "World"
scenario = ["SSP1", "SSP2", "SSP3", "SSP4", "SSP5"]

raw_gdp = conn.query(
    variable=variable,
    model=model,
    scenario=scenario,
    region=region,
).as_pandas()
```

Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - “CO_2 and Greenhouse Gas Emissions” Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

https://github.com/owid/co2-data

Our World in Data

Browse by topic Data Insights Resources About

CO_2 and Greenhouse Gas Emissions

By: Hannah Ritchie, Pablo Rosado, and Max Roser

Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

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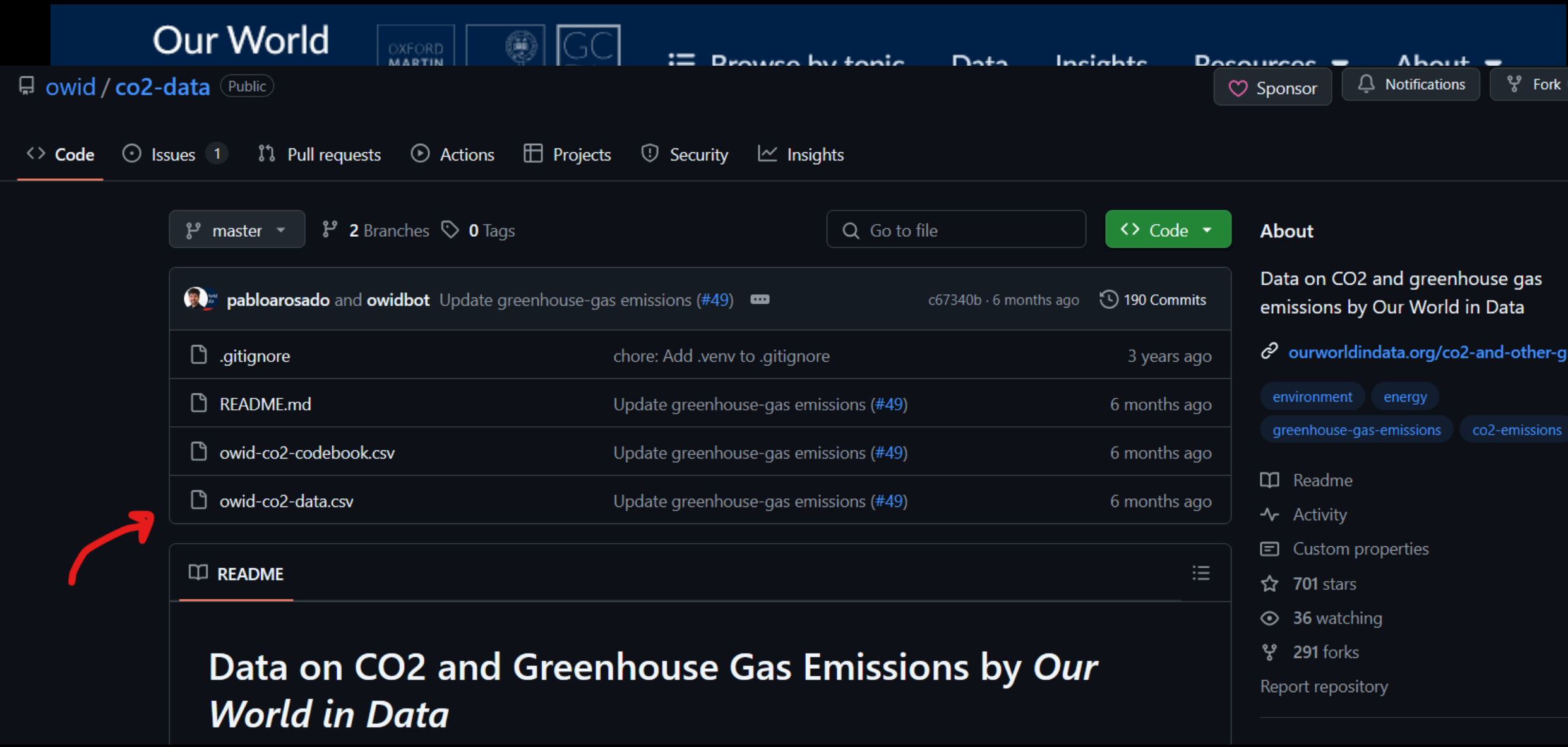

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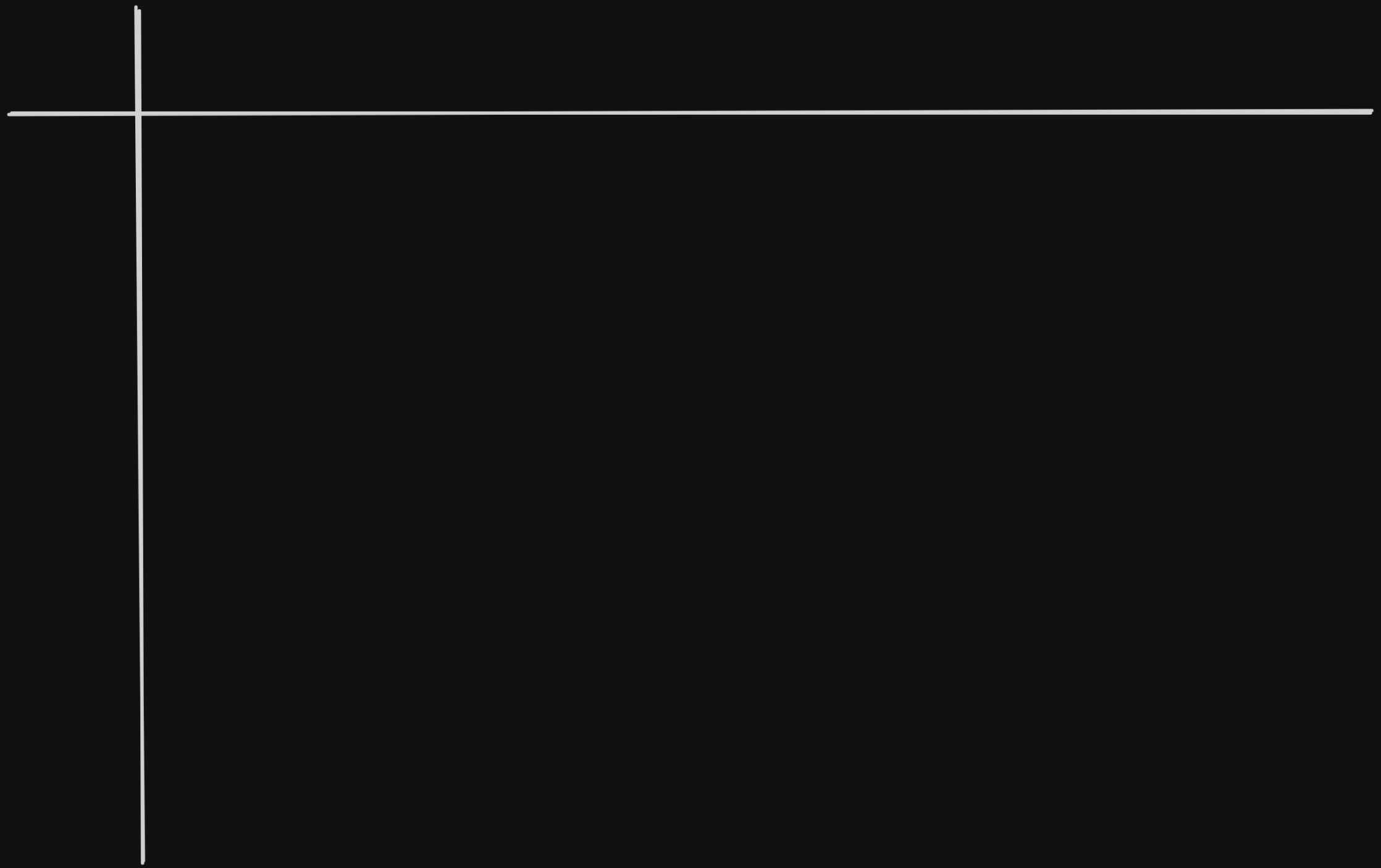
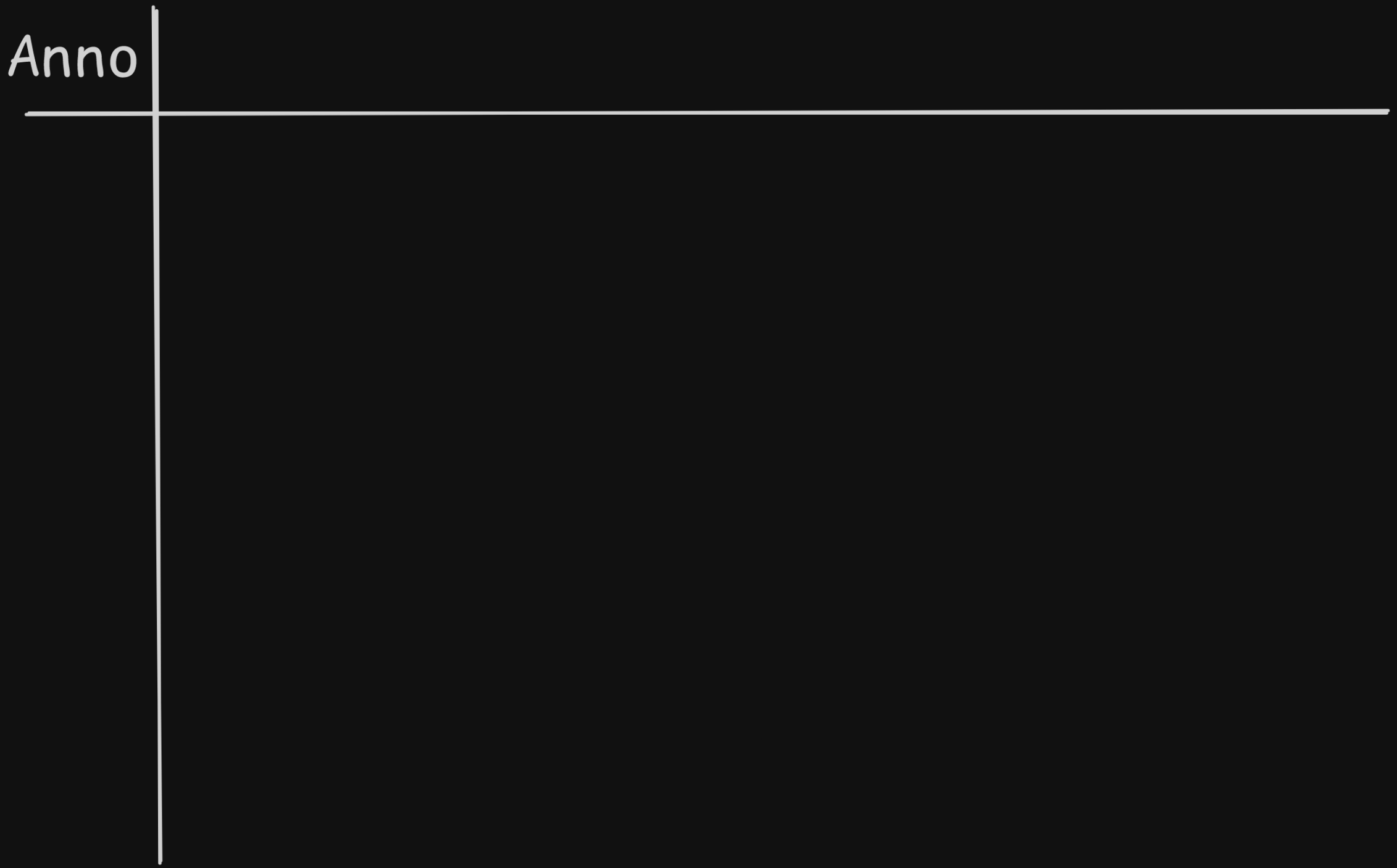
```python
import io
import pandas as pd
import requests
```

```python
import io
import pandas as pd
import requests

data_url = "https://raw.githubusercontent.com/owid/co2-data/master/owid-co2-data.csv"
response = requests.get(data_url)
raw_data = pd.read_csv(
    io.BytesIO(response.content),
    index_col=False,
    header=0,
)
```




Anno

Anno	
1950	
1951	
1952	
...	
2014	
2015	
2016	
...	
2099	

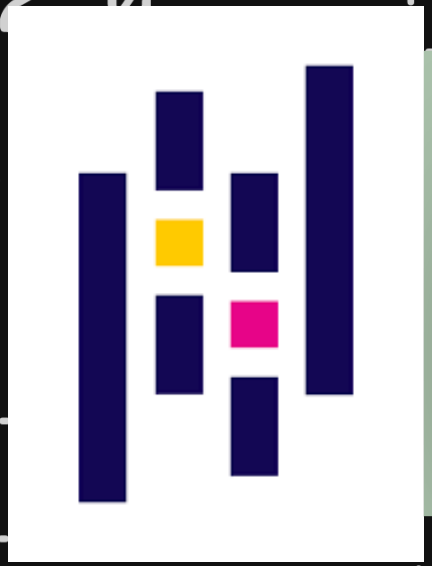
Anno	Storico	Svil. sostenibile	...
1950			
1951			
1952			
...			
2014			
2015			
2016			
...			
2099			

Anno	Storico	Svil. sostenibile	...
1950	2.0		
1951	2.0		
1952	2.1		
...			
2014	7.5		
2015	7.5		
2016	7.6		
...			
2099	---		

Anno	Storico	Svil. sostenibile	...
1950	2.0	---	
1951	2.0	---	
1952	2.1	---	
...			
2014	7.5	---	
2015	7.5		
2016	7.6		
...			
2099	---		

Anno	Storico	Svil. sostenibile	...
1950	2.0	---	
1951	2.0	---	
1952	2.1	---	
...			
2014	7.5	---	
2015	7.5	7.5	
2016	7.6	7.6	
...			
2099	---	7.3	

Anno	Storico	Svil. sostenibile	...
1950	2.0	---	
1951	2.0	---	
1952			
...			
2014			
2015			
2016	7.6	7.6	
...			
2099	---	7.3	



```
1 pd.DataFrame().pivot()
```

```python
import matplotlib.pyplot as plt

fig, axs = plt.subplots(1, 2, figsize=(10, 5))

population.plot(ax=axs[0])

axs[0].set_title("Popolazione mondiale")
axs[0].set_xlabel("Anno")
axs[0].set_ylabel("Popolazione (mld persone)")

plt.show()
```


Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

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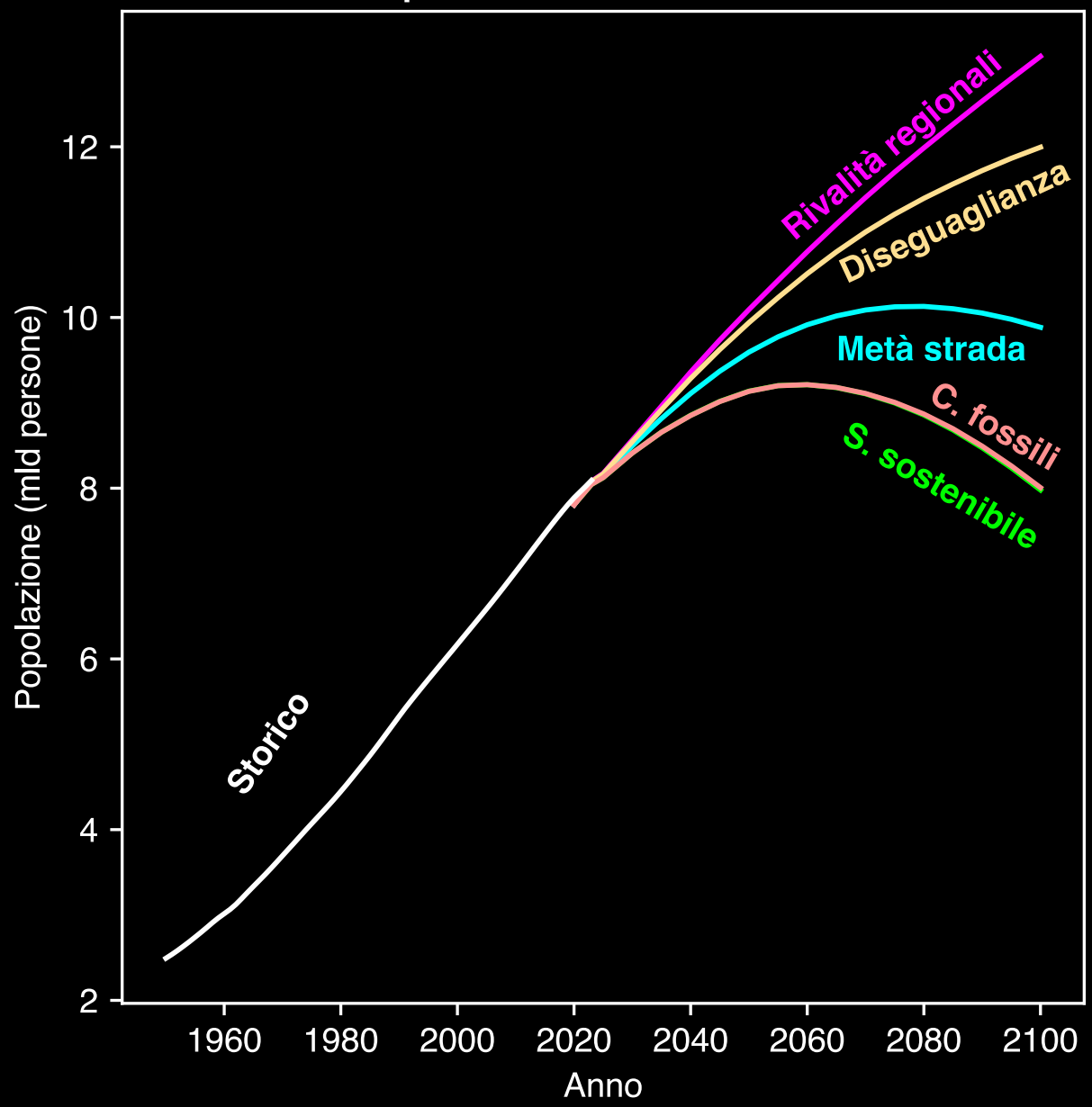
```



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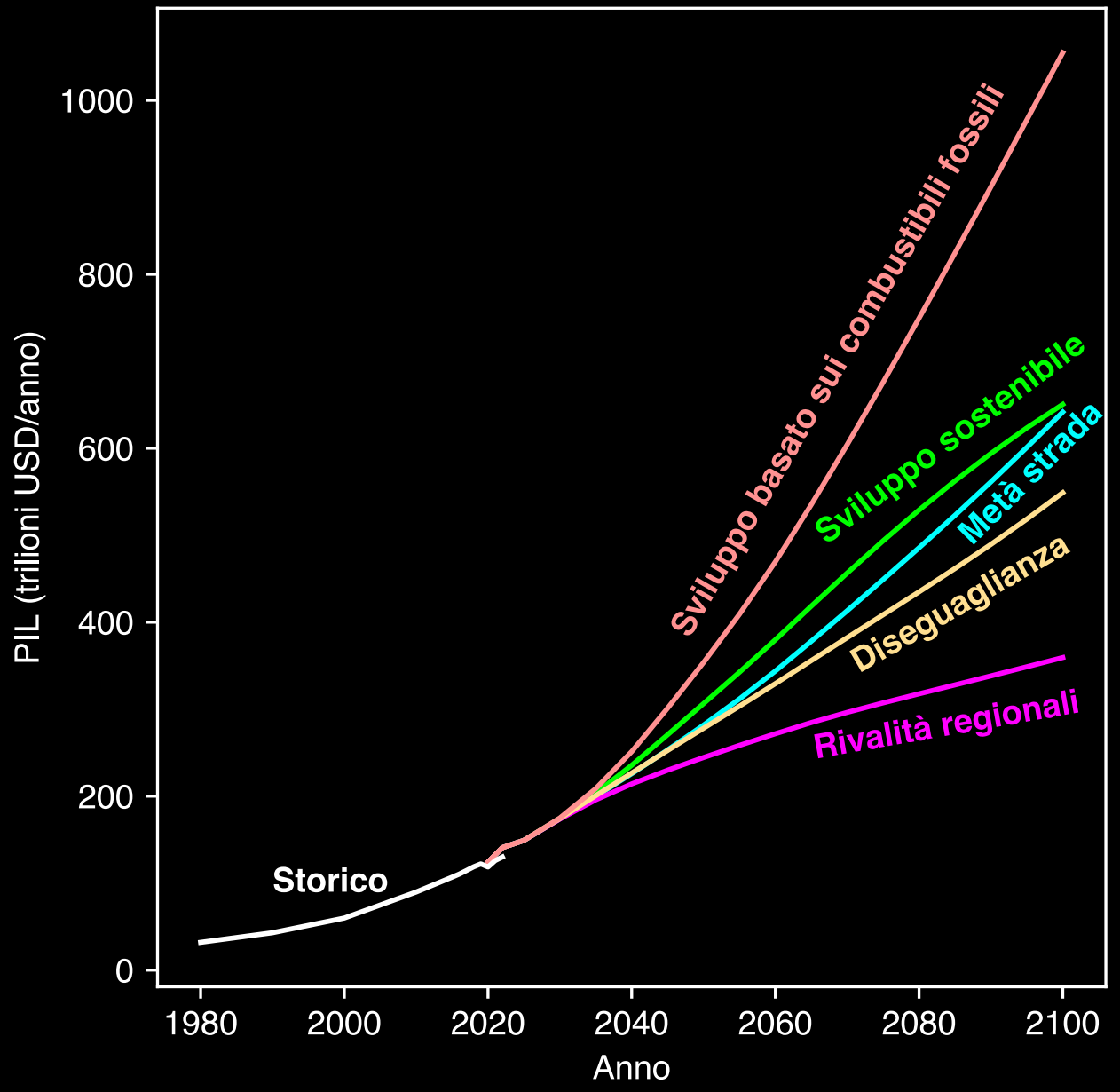
matplotlib

```
1 pil.plot(ax=axs[1])
2
3 axs[1].set_title("Produzione Interna Lorda a livello globale")
4 axs[1].set_xlabel("Anno")
5 axs[1].set_ylabel("PIL (trilioni USD/anno)")
6
7 plt.show()
```


Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

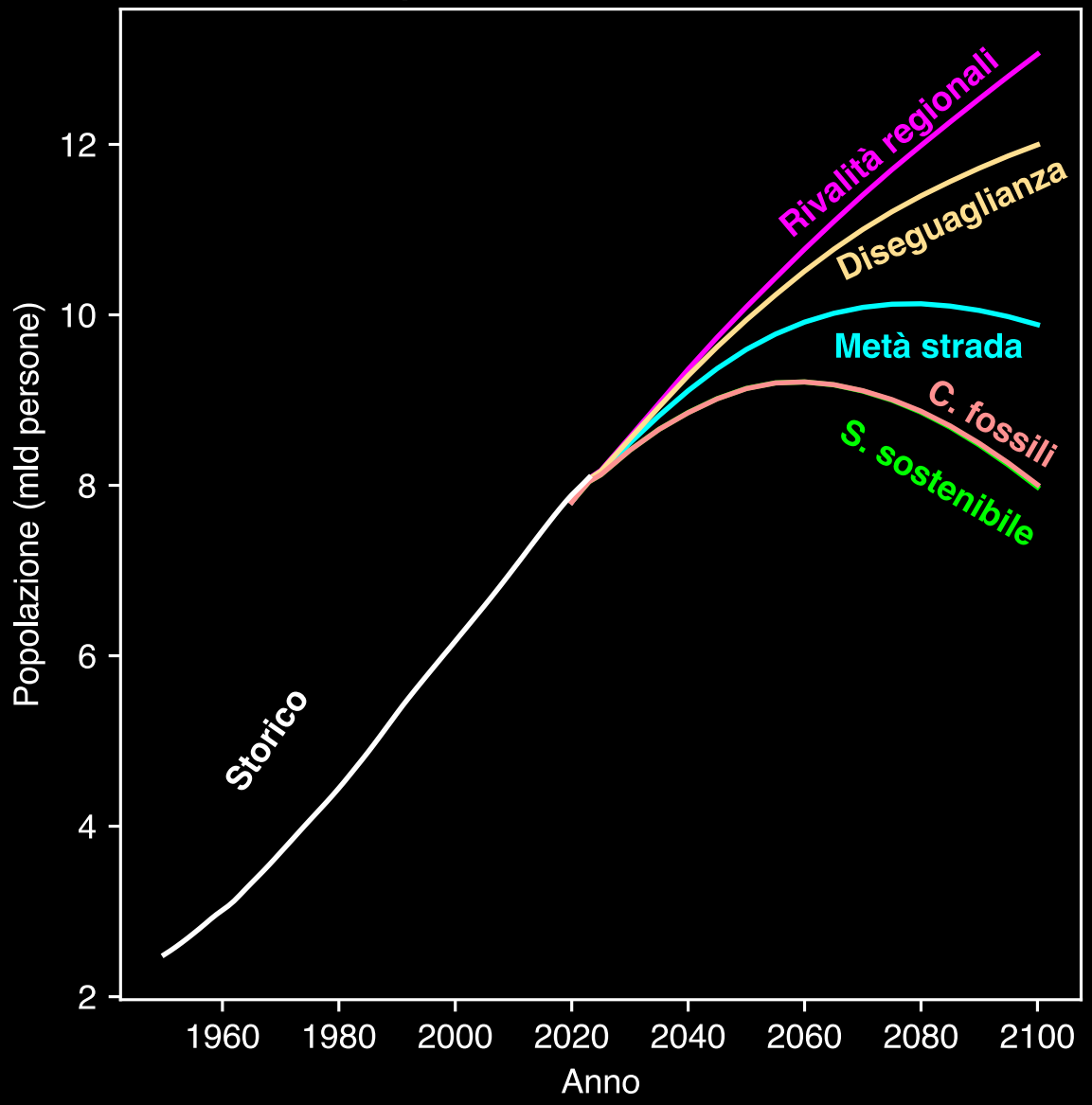
matplotlib

```
1 pil.plot(ax=axs[1])
2
3 axs[1].set_title("Produzione Interna Lorda a live
4 axs[1].set_xlabel("Anno")
5 axs[1].set_ylabel("PIL (trilioni USD/anno)")
6
7 plt.show()
```

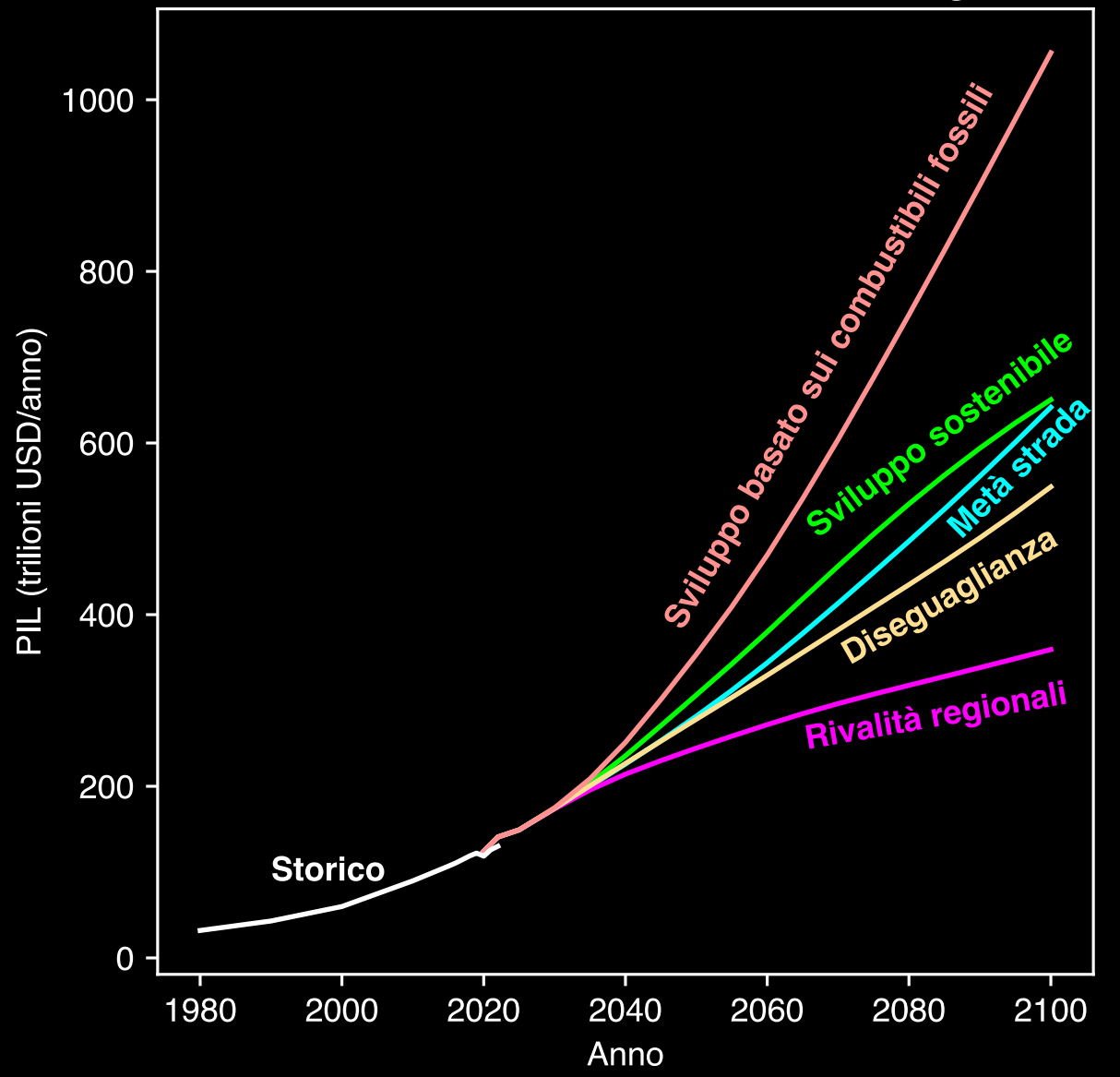


Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

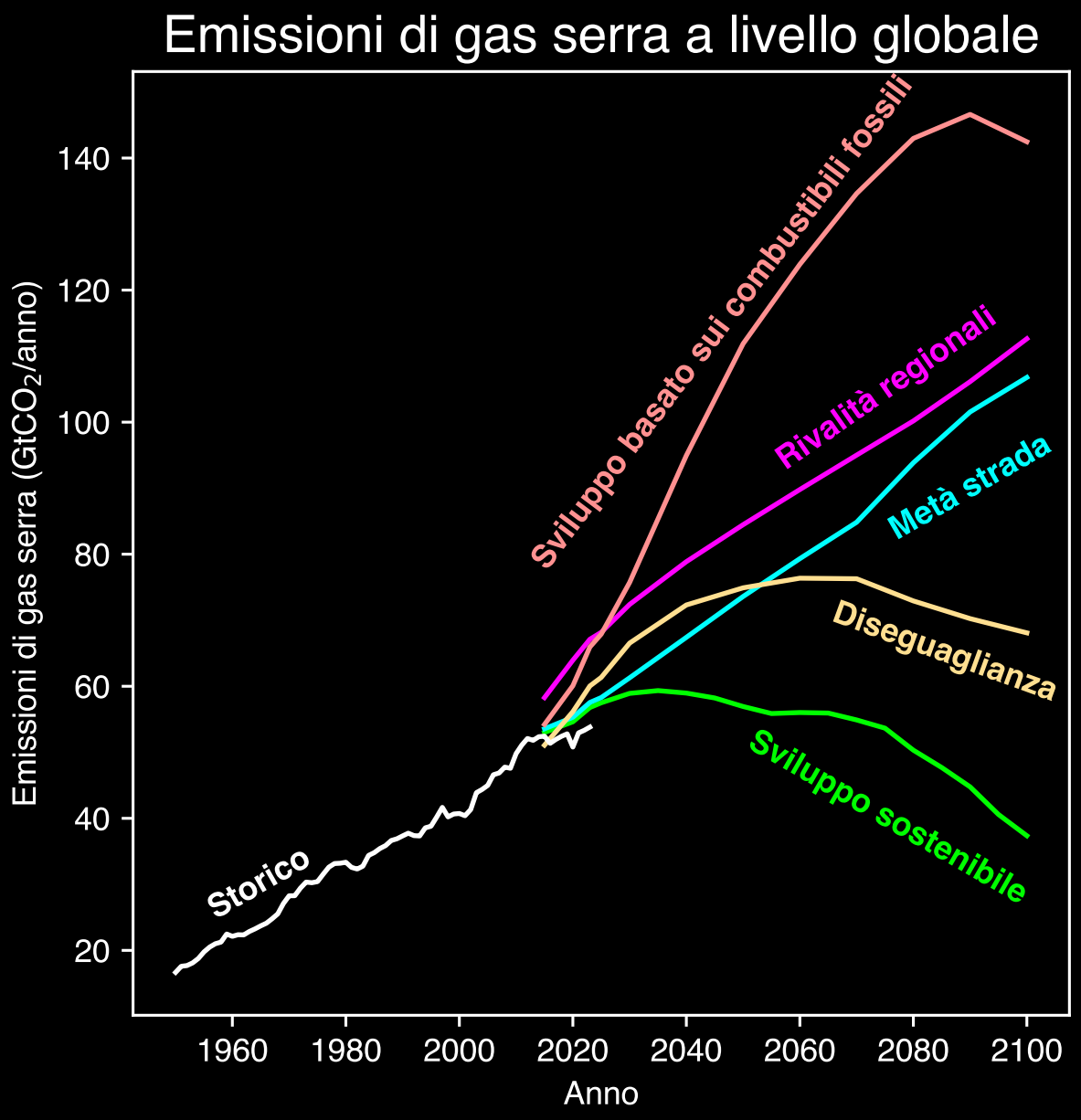
Popolazione mondiale



Produzione Interna Lorda a livello globale

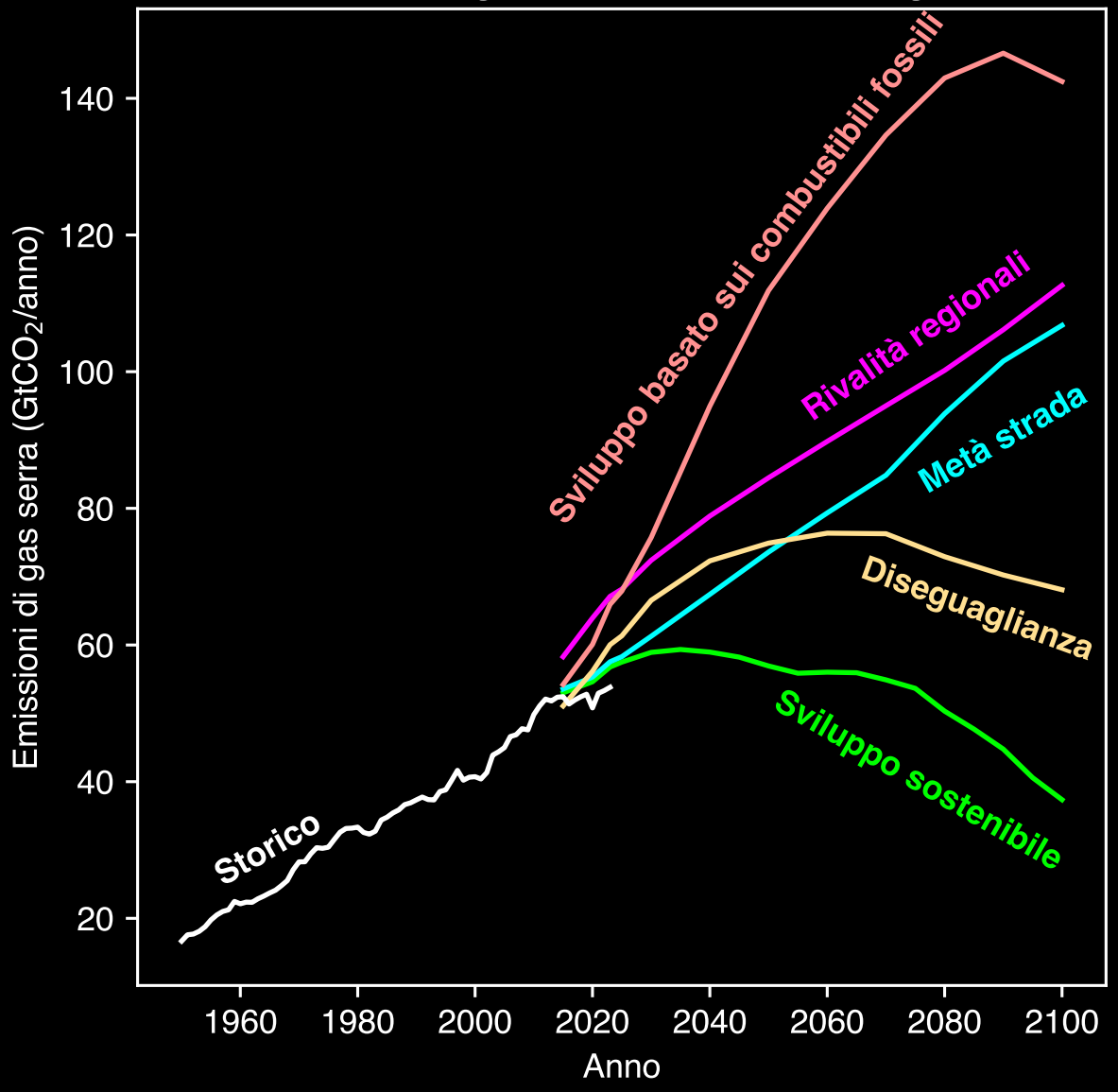


Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

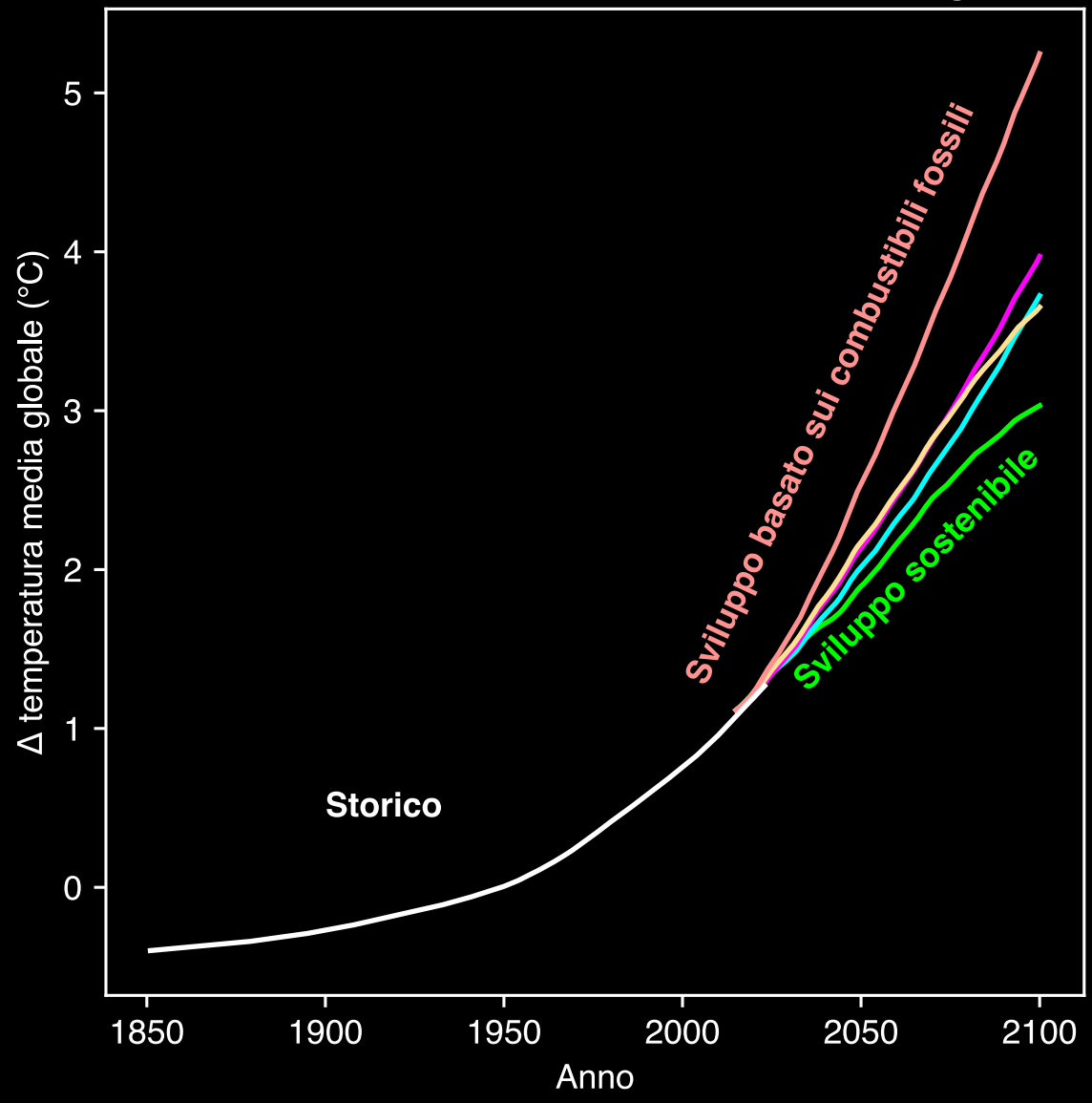


Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

Emissioni di gas serra a livello globale

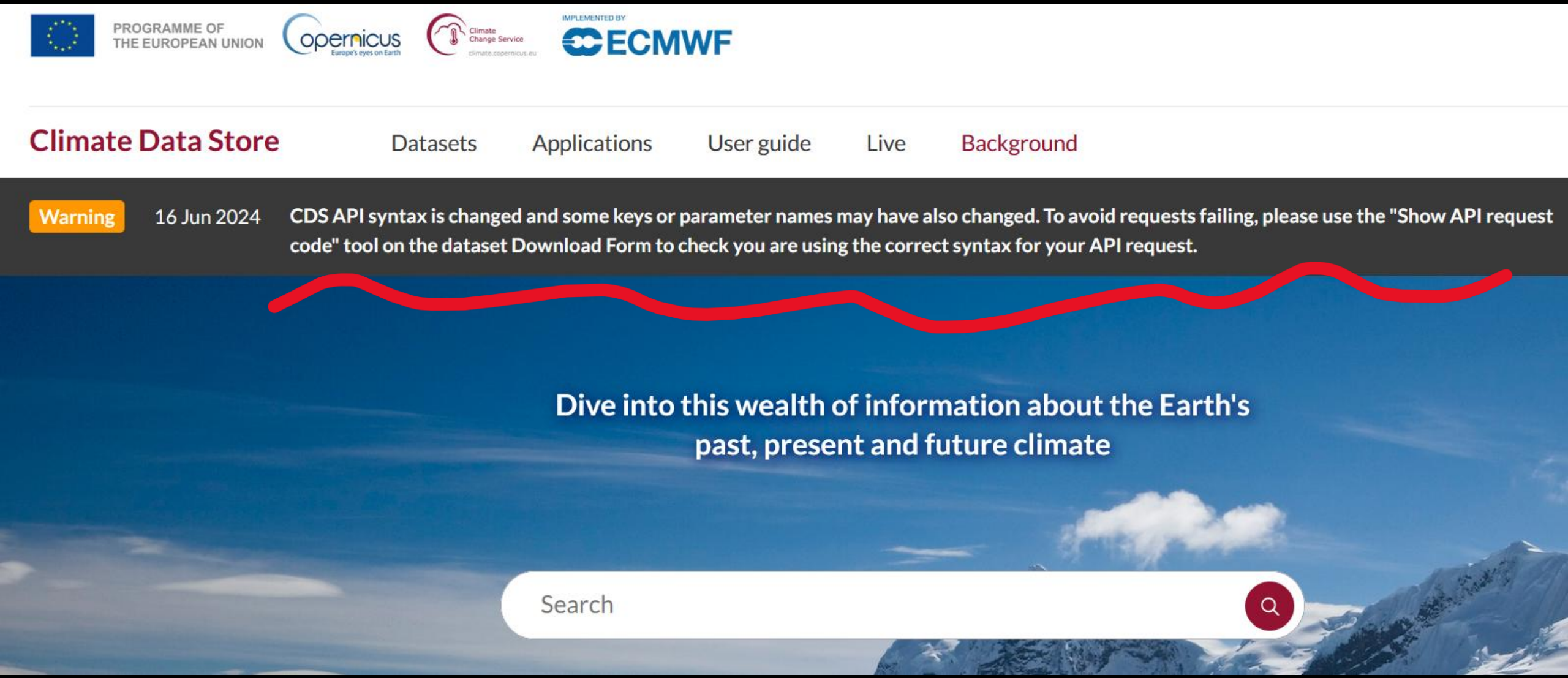


Variazione della temperatura media globale



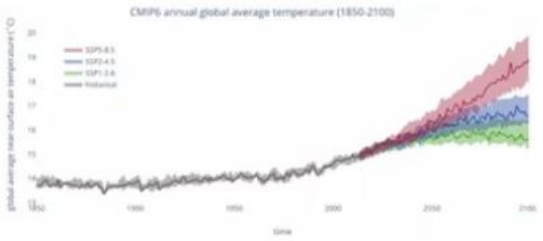
Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO_2 and Greenhouse Gas Emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/co2-and-greenhouse-gas-emissions' [Online Resource]

https://cds.climate.copernicus.eu/



CMIP6 climate projections

This catalogue entry provides daily and monthly global climate projections data from a large number of experiments, models and time periods computed in the framework of the sixth phase of the Coupled Model Intercomparison Project (CMIP6).



CMIP6 data underpins the Intergovernmental Panel on Climate Change 6th Assessment Report. The use of these data is mostly aimed at:

- addressing outstanding scientific questions that arose as part of the IPCC reporting process;
- improving the understanding of the climate system;

Quality Assurance

Data Management
Data records
Metadata
Documentation

References

Citation and attribution

DOI: 10.24381/cds.c866074c

Projection	Regular latitude-longitude grid, ocean grid
File format	NetCDF4
Horizontal coverage	Global
Horizontal resolution	Varies between models
Temporal coverage	From 1850 to 2014 for historical experiments From 2015 to 2100 for SSP experiments
Temporal resolution	Monthly, daily, fixed (no temporal resolution)
Vertical coverage	Single levels, pressure levels (1 - 1000 hPa)
Conventions	Climate and Forecast (CF) Metadata Convention CF-1.7 CMIP-6.2
Versions	Latest version of the data is provided

Main variables

Search

Name	Units	Description
Air temperature	K	Temperature in the atmosphere. It has units of Kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting

API request

Please go to the documentation page for information as to how to use the CDS API.

Hide API request code

Incomplete request

```
import cdsapi

dataset = "projections-cmip6"
request = {
    "temporal_resolution": "monthly",
    "experiment": "ssp5_8_5"
}

client = cdsapi.Client()
client.retrieve(dataset,
request).download()
```

Copy

Request validation

Request size

- Temporal resolution ✓
- Experiment ✓
- Variable ⚠
- Level ⚠
- Model ⚠
- Year ⚠
- Month ⚠
- Day
- Geographical area
  - Whole available region
  - Sub-region extraction

Login/register to submit request

Clear all fields

Please check mandatory fields. Go to first mandatory field ↑

```python
from pathlib import Path
import cdsapi

def fetch_cmip6_data(scenario: str, output_folder: Path) → Path:
```

```python
from pathlib import Path
import cdsapi

def fetch_cmip6_data(scenario: str, output_folder: Path) -> Path:
    client = cdsapi.Client()
    dataset = "projections-cmip6"

    match scenario:
        case "historical":
            years = list(str(year) for year in range(1950, 2015))
        case "ssp1_2_6" | "ssp2_4_5" | "ssp3_7_0" | "ssp4_6_0" | "ssp5_8_5":
            years = list(str(year) for year in range(2015, 2100))
```

```python
from pathlib import Path
import cdsapi

def fetch_cmip6_data(scenario: str, output_folder: Path) -> Path:
    client = cdsapi.Client()
    dataset = "projections-cmip6"

    match scenario:
        case "historical":
            years = list(str(year) for year in range(1950, 2015))
        case "ssp1_2_6" | "ssp2_4_5" | "ssp3_7_0" | "ssp4_6_0" | "ssp5_8_5":
            years = list(str(year) for year in range(2015, 2100))

    request = {
        "temporal_resolution": "monthly",
        "experiment": scenario,
        "variable": "surface_temperature",  # 🔥 ❄️
        "model": "mri_esm2_0",  # a model among many
        "month": list(f"{month:02d}" for month in range(1, 13)),
        "year": years,
        "area": [47, 5, 35, 20],  # Italy
    }
    output_filepath = output_folder / f"{scenario}.nc"
```

```python
from pathlib import Path
import cdsapi

def fetch_cmip6_data(scenario: str, output_folder: Path) -> Path:
    client = cdsapi.Client()
    dataset = "projections-cmip6"

    match scenario:
        case "historical":
            years = list(str(year) for year in range(1950, 2015))
        case "ssp1_2_6" | "ssp2_4_5" | "ssp3_7_0" | "ssp4_6_0" | "ssp5_8_5":
            years = list(str(year) for year in range(2015, 2100))

    request = {
        "temporal_resolution": "monthly",
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        "variable": "surface_temperature",  # 🔥 ❄️
        "model": "mri_esm2_0",  # a model among many
        "month": list(f"{month:02d}" for month in range(1, 13)),
        "year": years,
        "area": [47, 5, 35, 20],  # Italy
    }
    output_filepath = output_folder / f"{scenario}.nc"

    client.retrieve(dataset, request).download(output_filepath)

    return output_filepath
```
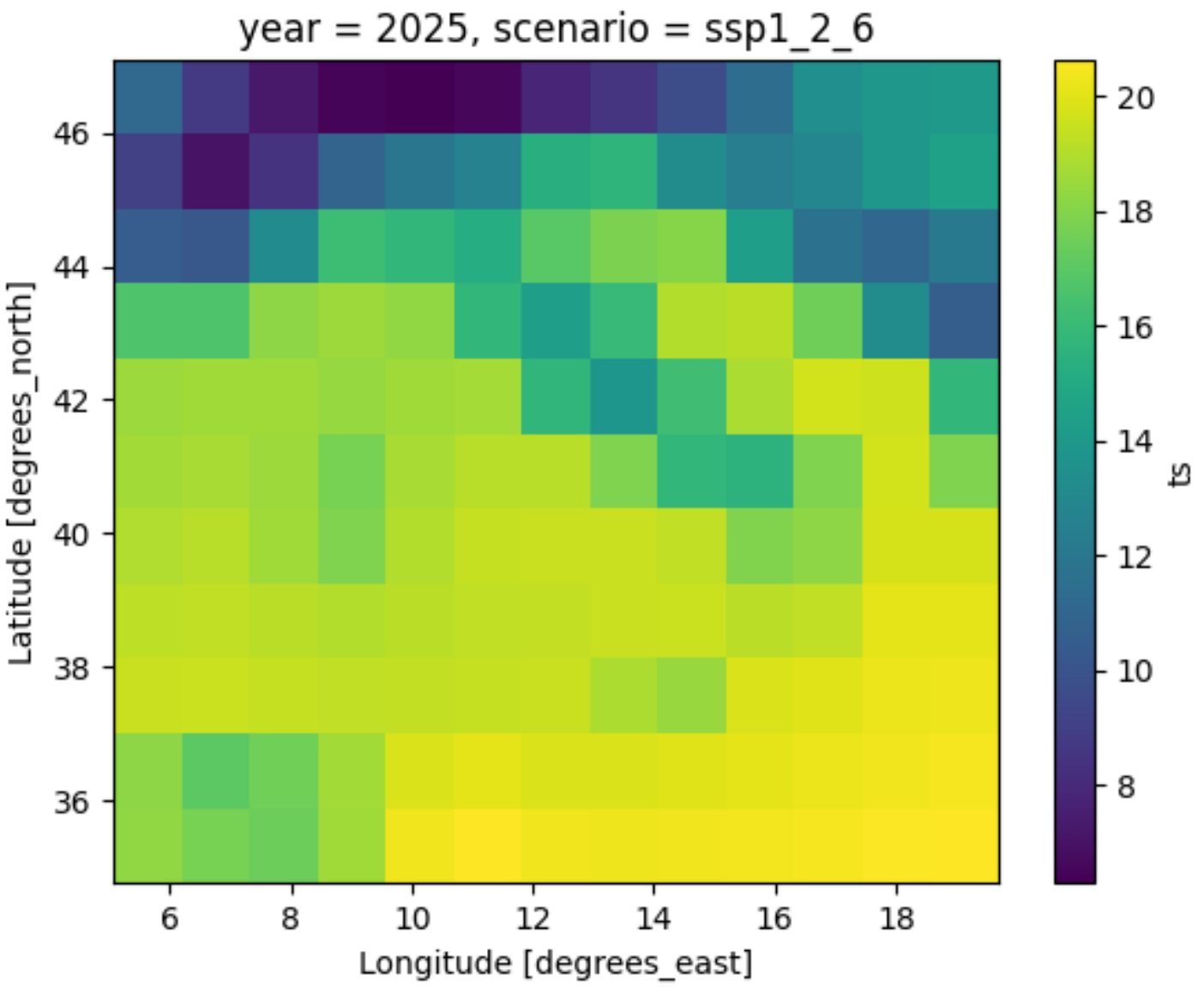

```
# beware, it can take some minutes!
nc_filepaths = {}

scenarios = [
    "historical",
    "ssp1_2_6",  # sviluppo sostenibile
    "ssp2_4_5",  # metà strada
    "ssp3_7_0",  # rivalità regionali
    "ssp4_6_0",  # diseguaglianza
    "ssp5_8_5",  # sviluppo basato sui comb. foss.
]

for scenario in scenarios:
    nc_filepaths[scenario] = fetch_cmip6_data(
        scenario,
        output_folder = NETCDF_FOLDER
    )
```


```python
import xarray as xr

ds_svilsost = xr.open_dataset(nc_filepaths["ssp1_2_6"])
da_svilsost = ds_svilsost.ts
da_svilsost = da_svilsost.groupby("time.year").mean()
da_svilsost = da_svilsost - 273.15  # kelvin to celsius

da_svilsost.sel(year=2025).plot()
```

```
1 impor
2
3 ds_sv
4 da_sv
5 da_sv
6 da_sv
7
8 da_sv
```

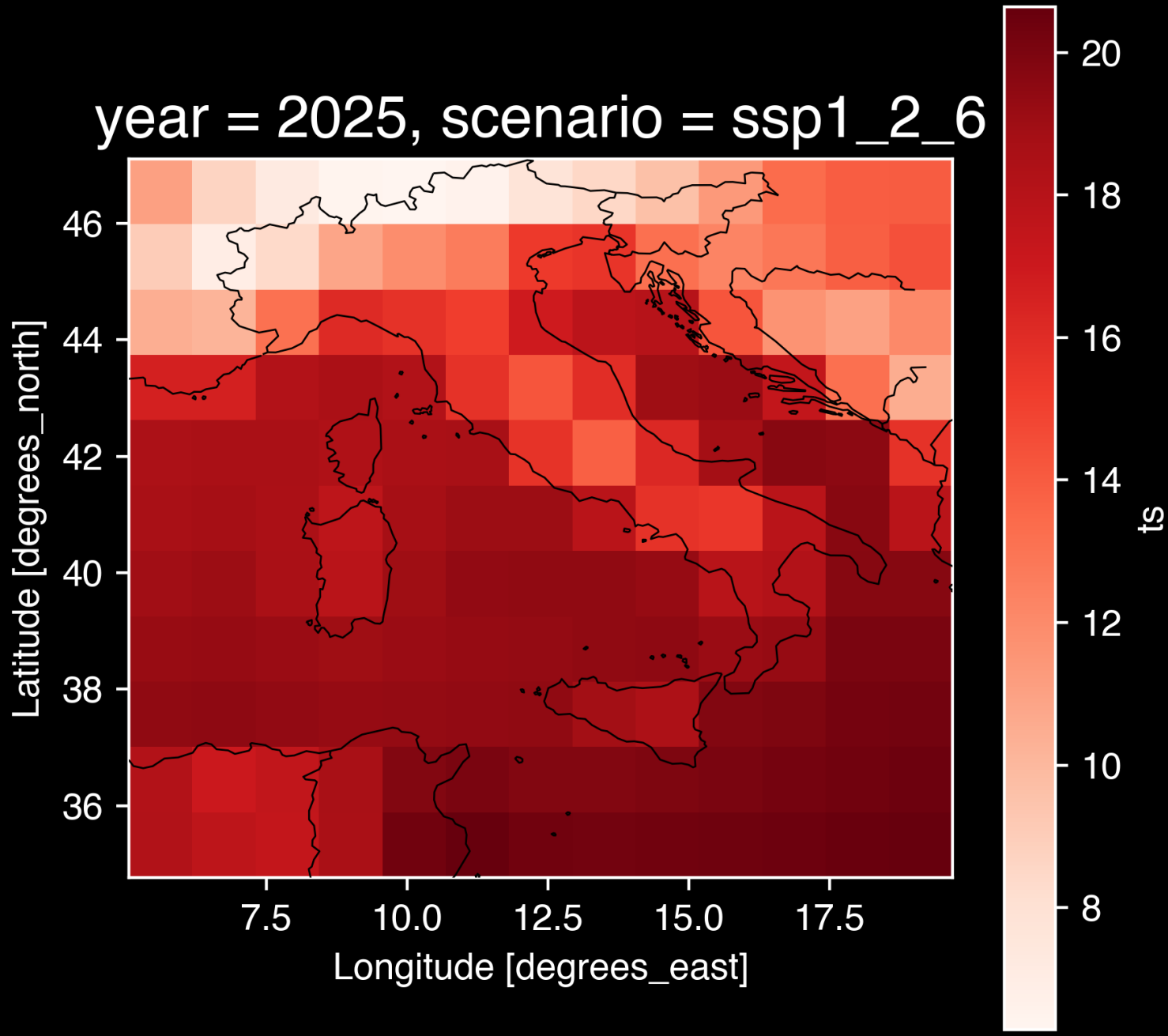
```
_2_6"])

ean()
celsius
```

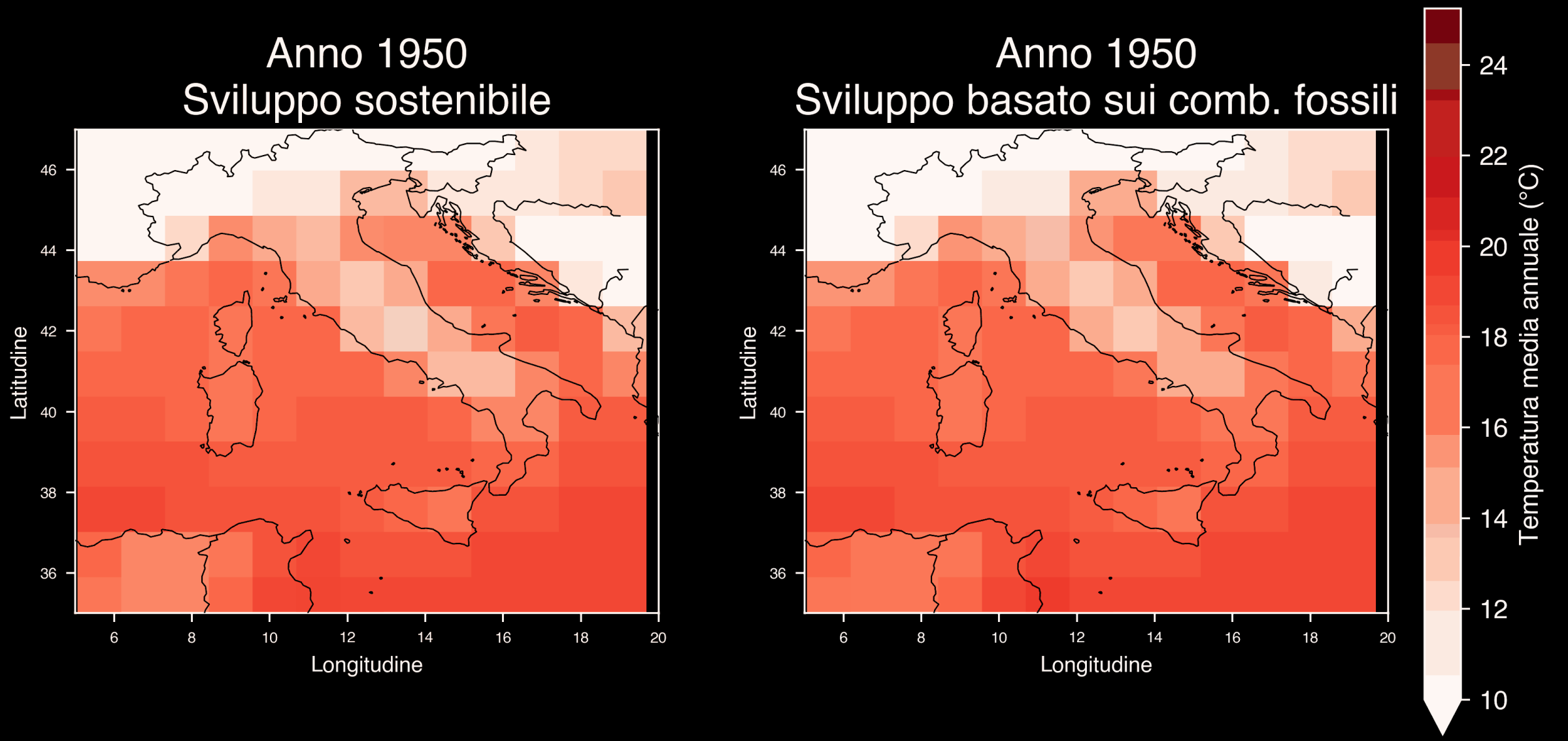


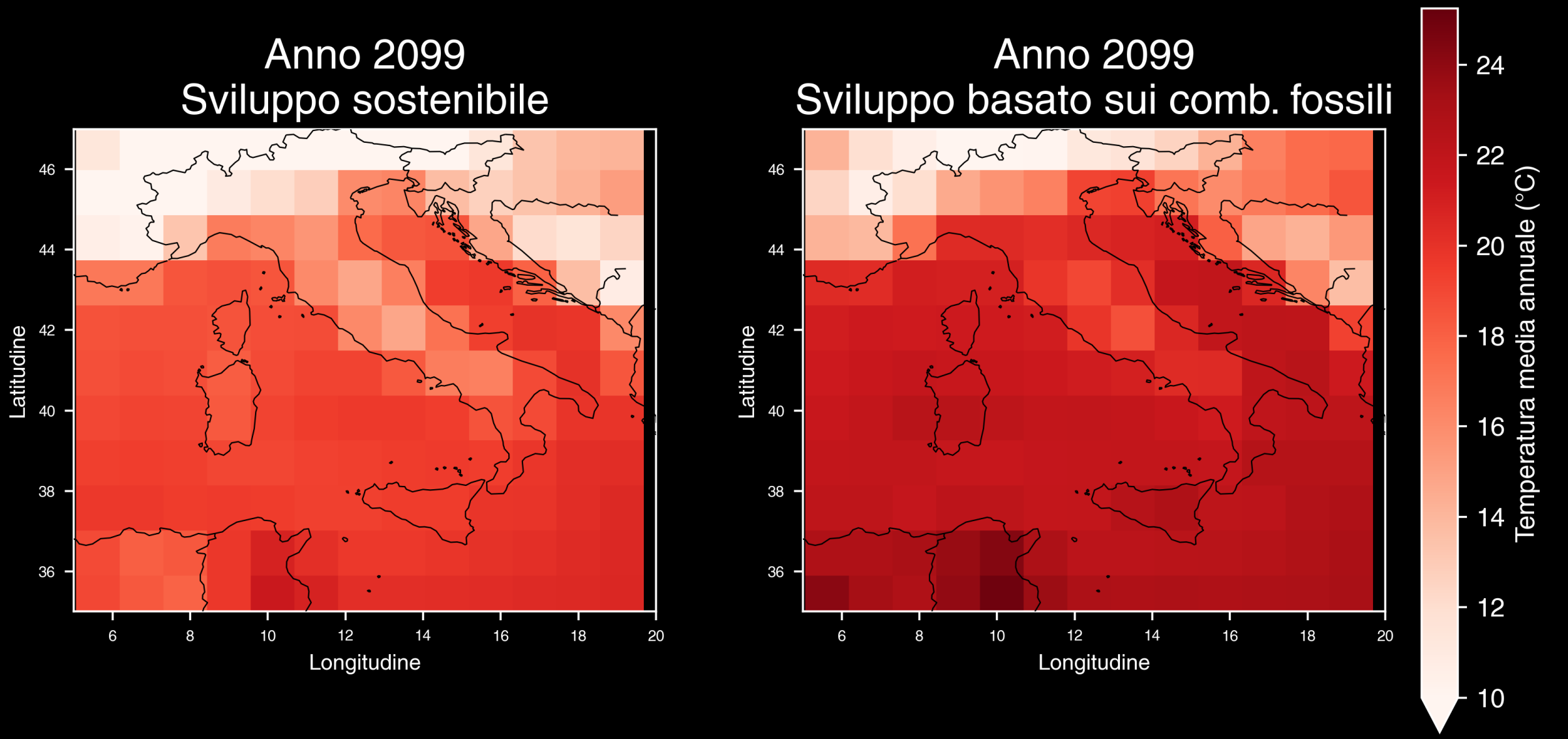

```python
import geopandas as gpd

mediterranean_countries = gpd.read_file(med_countries_vectorial)

fig, ax = plt.subplots(figsize=(5, 5))
mediterranean.plot(ax=ax, color="black", zorder=5, linewidth=0.5)
da_svilsost.sel(year=2025).plot(ax=ax, cmap="Reds")
```

```
1 import g
2
3 mediterr
4
5 fig, ax
6 mediterr
7 da_svils
```

```
ectorial)

width=0.5)
```




Anno 1950
Sviluppo sostenibile
Anno 1950
Sviluppo basato sui comb. fossili
Latitudine
Longitudine
46
44
42
40
38
36
6
8
10
12
14
16
18
20
Temperatura media annuale (°C)
24
22
20
18
16
14
12
10


Anno 2099
Sviluppo sostenibile
Anno 2099
Sviluppo basato sui comb. fossili
Latitudine
Longitudine
46
44
42
40
38
36
6
8
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Temperatura media annuale (°C)
24
22
20
18
16
14
12
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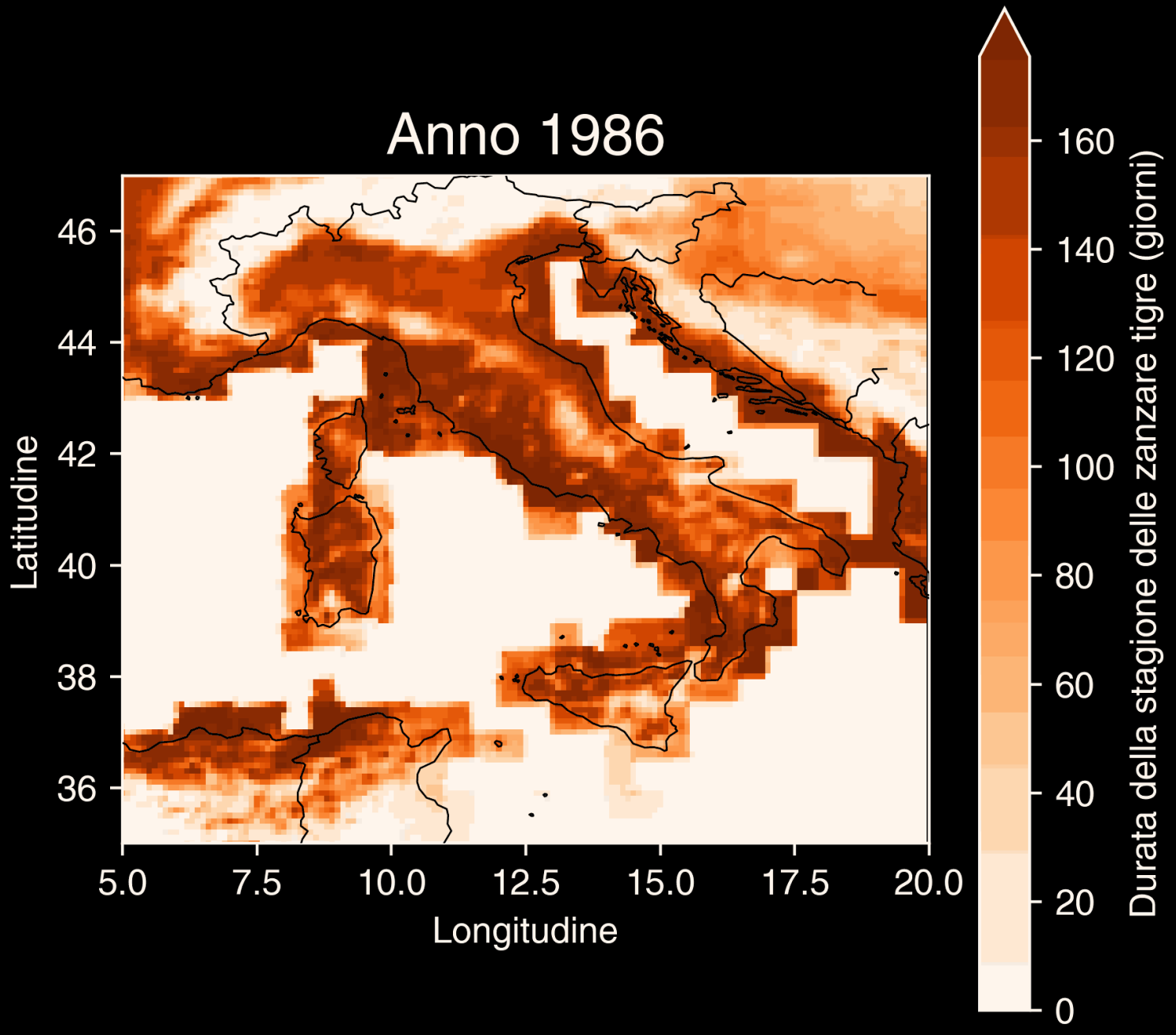
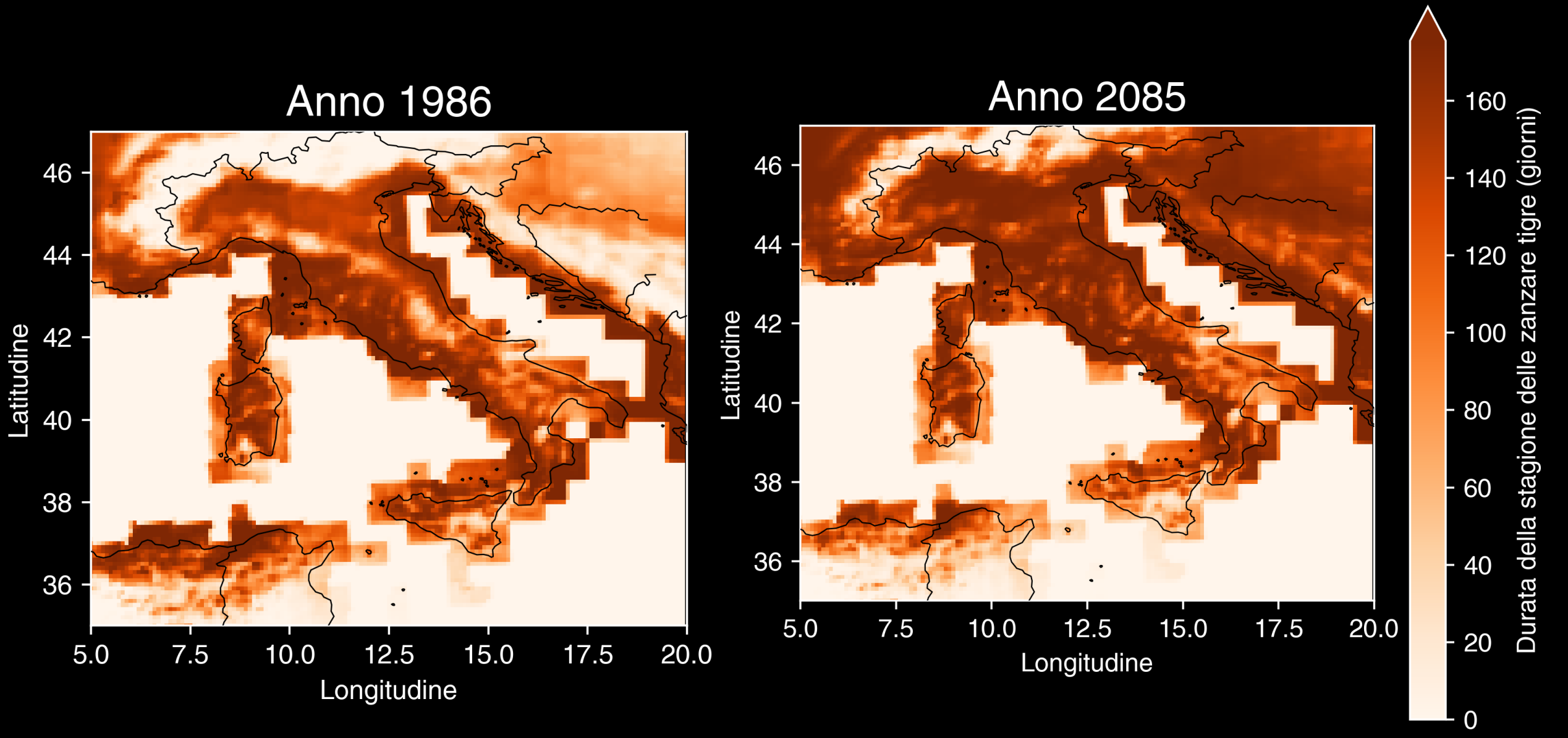


Copernicus Climate Change Service, Climate Data Store, (2019): Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). DOI: 10.24381/cds.d08ed09a



Copernicus Climate Change Service, Climate Data Store, (2019): Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). DOI: 10.24381/cds.d08ed09a

Le nostre scelte
definiscono
il cambiamento climatico

Mangiamo consapevolmente.

 Mangiamo consapevolmente.

 Muoviamoci leggeri/e.

 Mangiamo consapevolmente.

 Muoviamoci leggeri/e.

 Seguiamo la Protezione Civile locale.

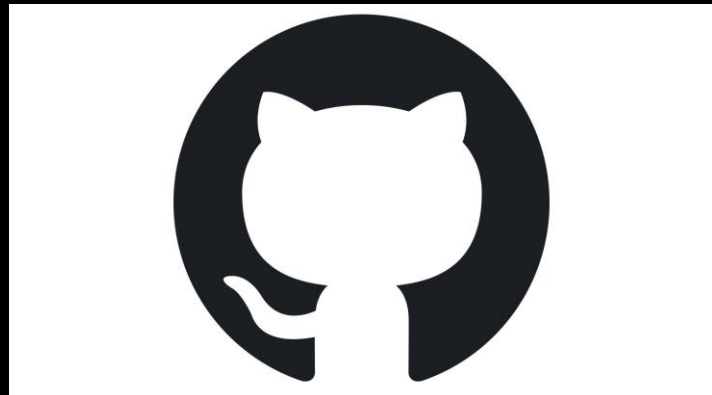

Mangiamo consapevolmente.


Muoviamoci leggeri/e.


Seguiamo la Protezione Civile locale.


Ricordiamo l’importanza del nostro voto.

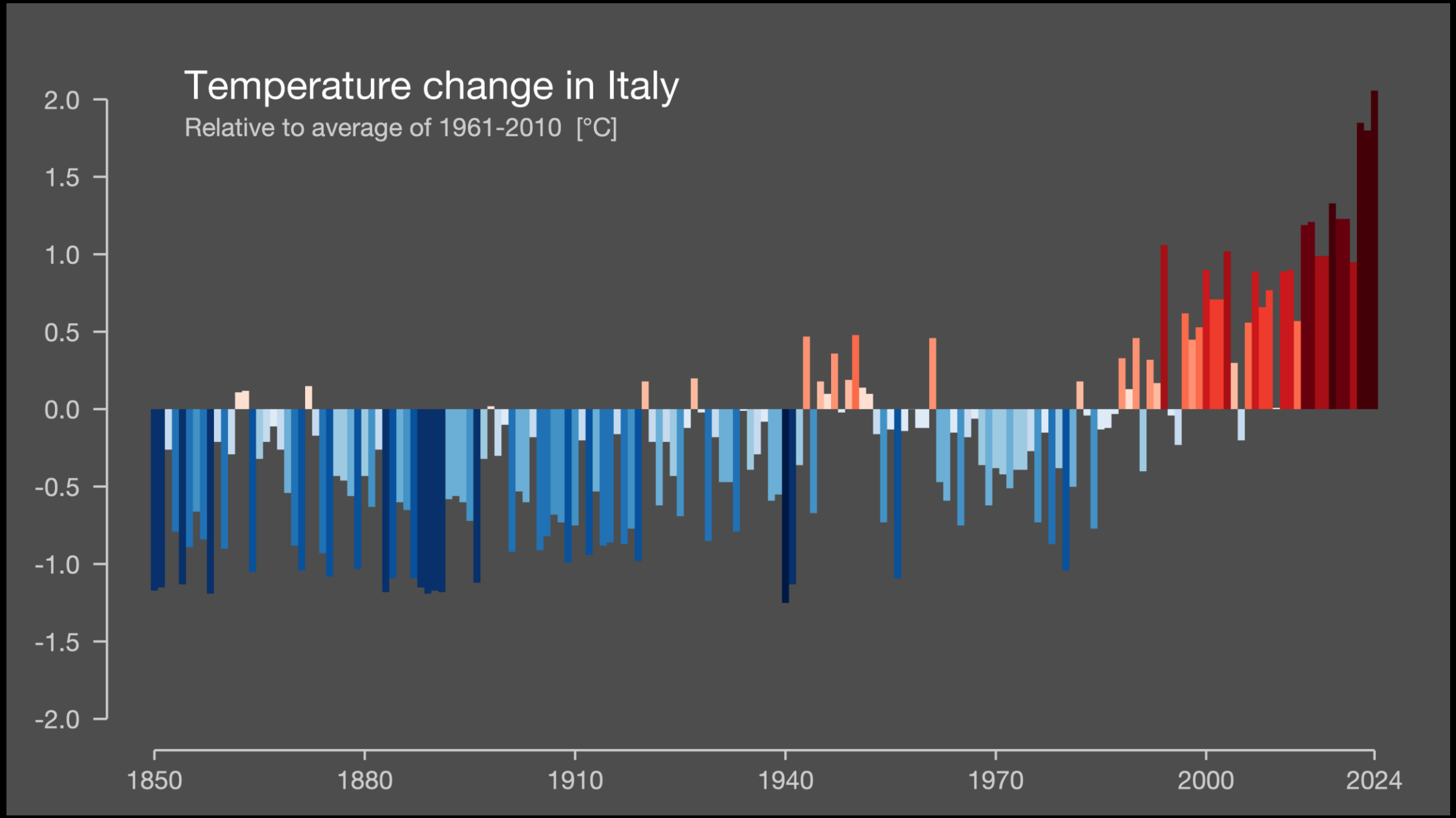
https://github.com/Robin-Castellani/pyconit25-future-climate-change



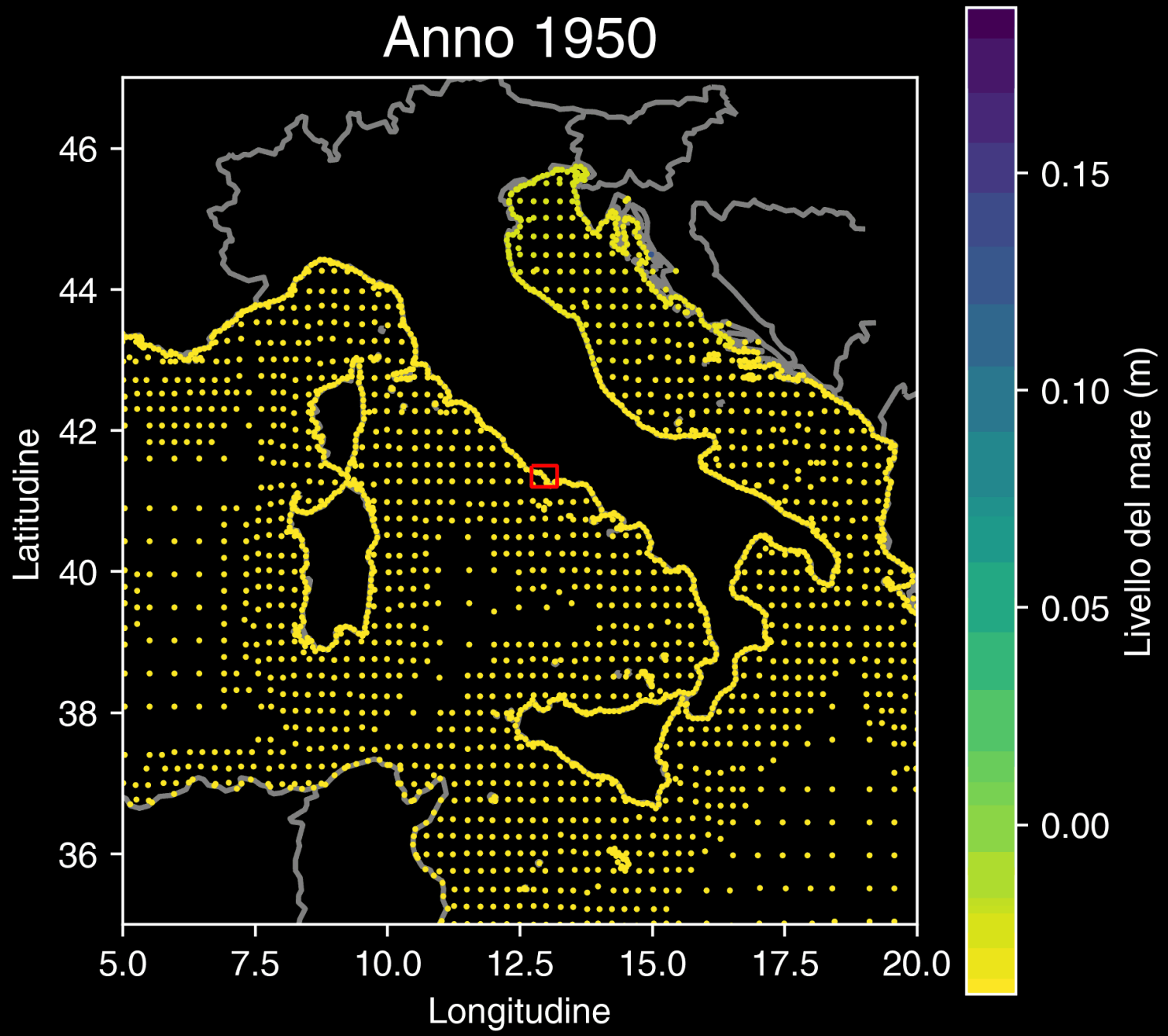
Feedback 👐

Qualcosa in più...

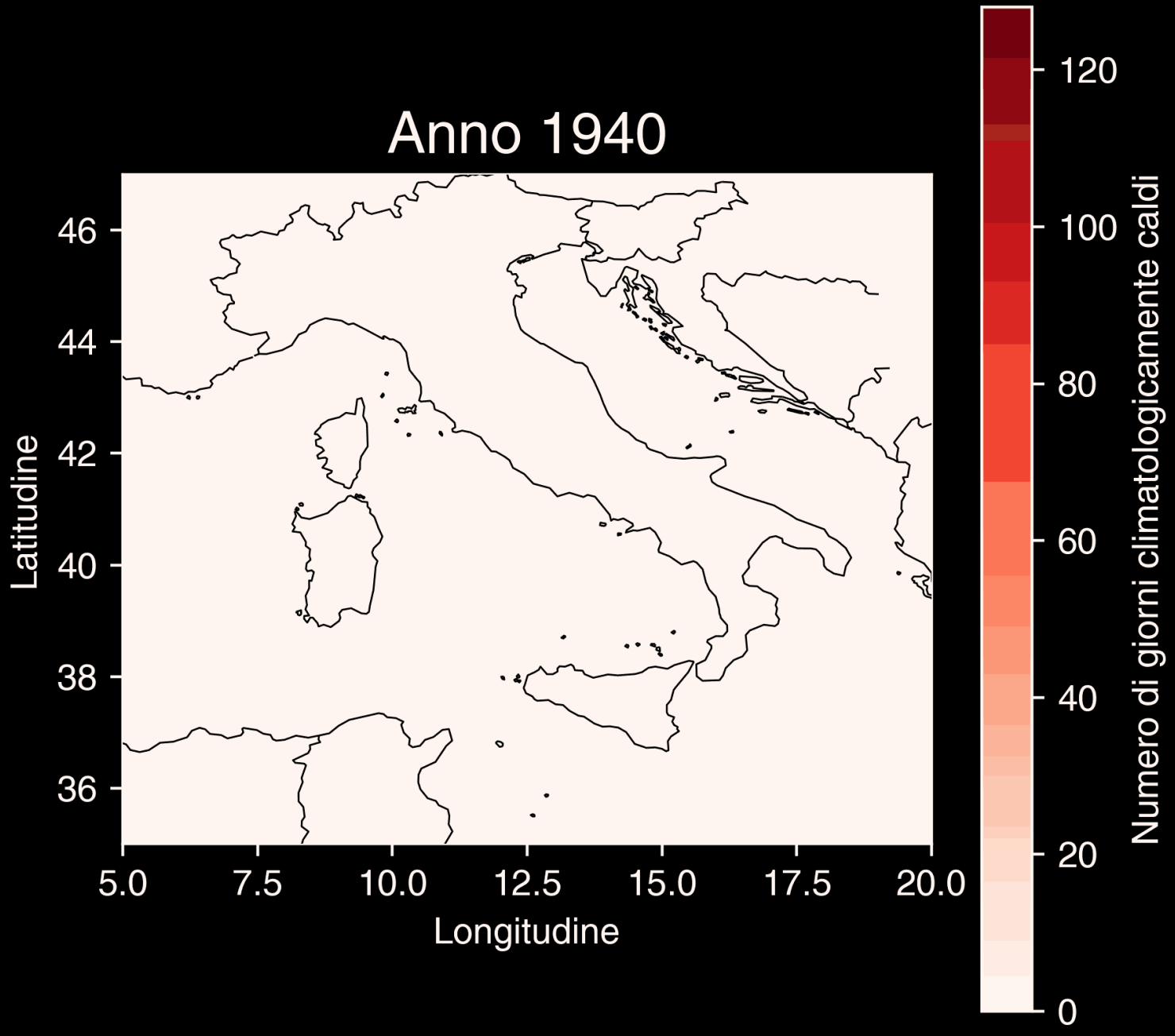
Perché non si sa mai...



Showyourstripes.info by Ed Hawkins, University of Reading

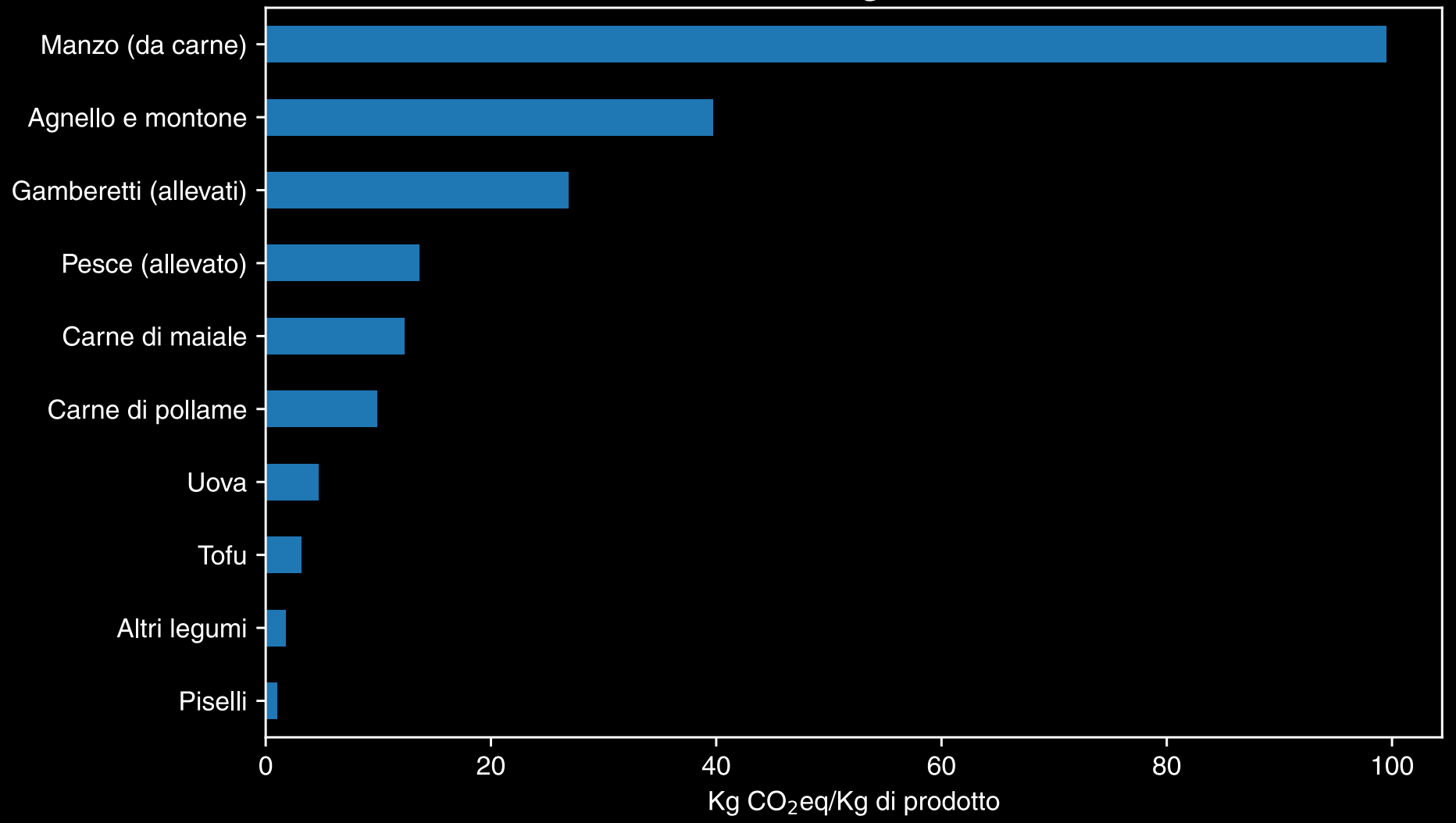


Copernicus Climate Change Service (2022): Global sea level change indicators from 1950 to 2050 derived from reanalysis and high resolution CMIP6 climate projections. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). DOI: 10.24381/cds.6edf04e0



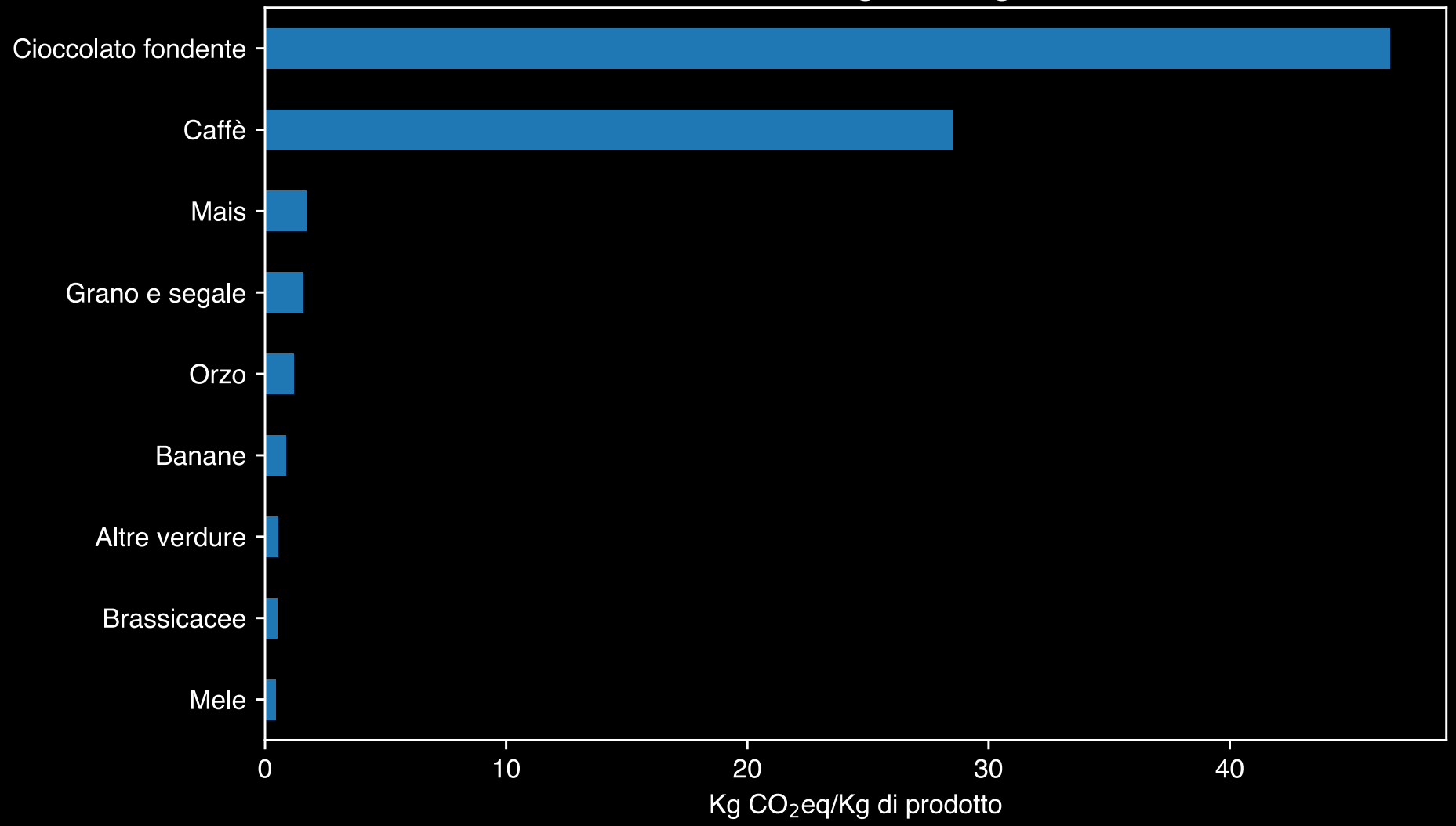
Copernicus Climate Change Service (C3S), Climate Data Store (CDS), (2024): Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections, Copernicus Climate Change Service (C3S) Climate Data Store (CDS).

Emissioni della catena di produzione alimentare
-
Prodotti di origine animale



Hannah Ritchie, Pablo Rosado and Max Roser (2022) - “Environmental Impacts of Food Production” Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/environmental-impacts-of-food' [Online Resource]

Emissioni della catena di produzione alimentare
-
Prodotti di origine vegetale



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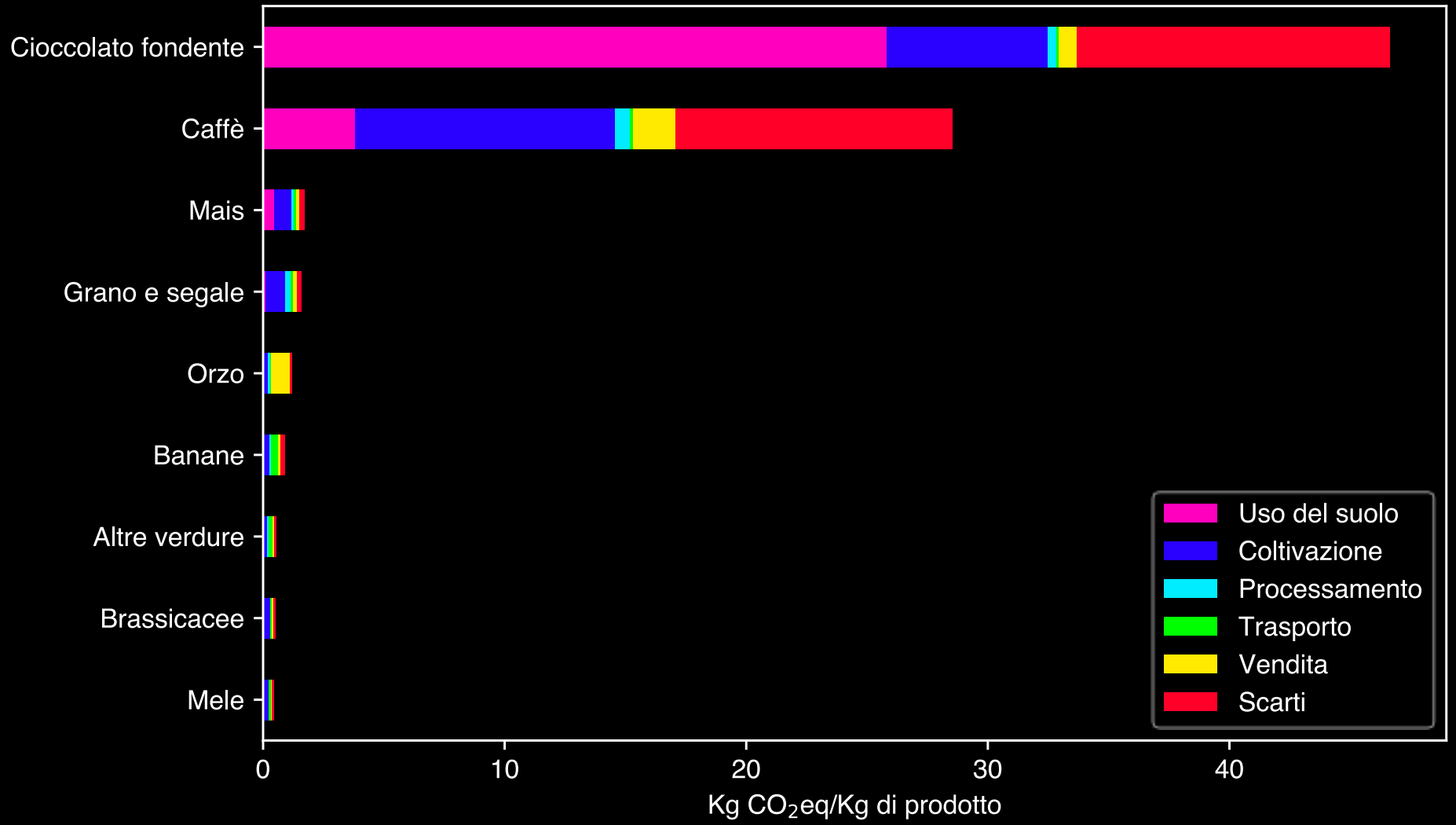
Emissioni della catena di produzione alimentare
-
Prodotti di origine vegetale



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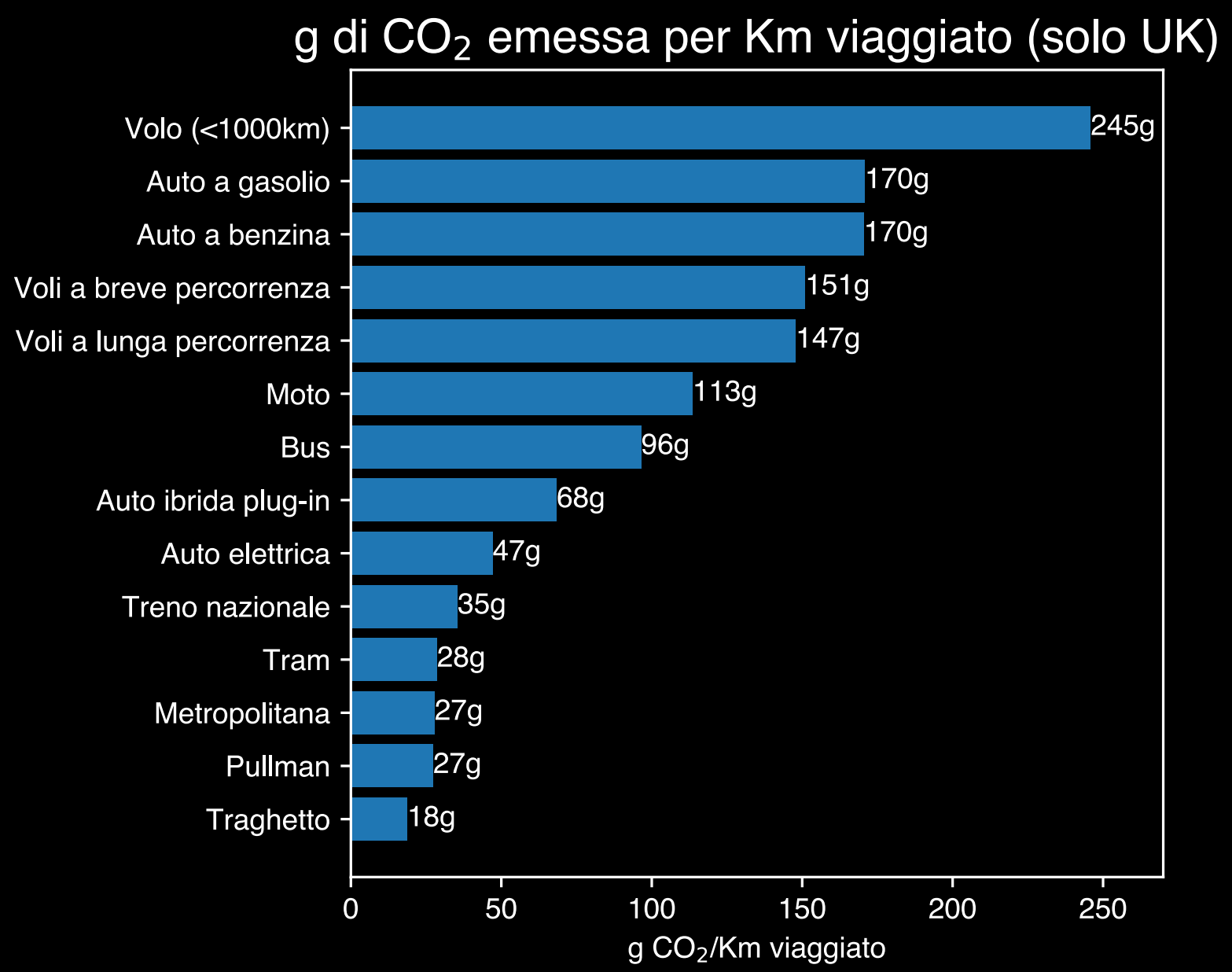

Hannah Ritchie (2023) - “Which form of transport has the smallest carbon footprint?” Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/travel-carbon-footprint' [Online Resource]