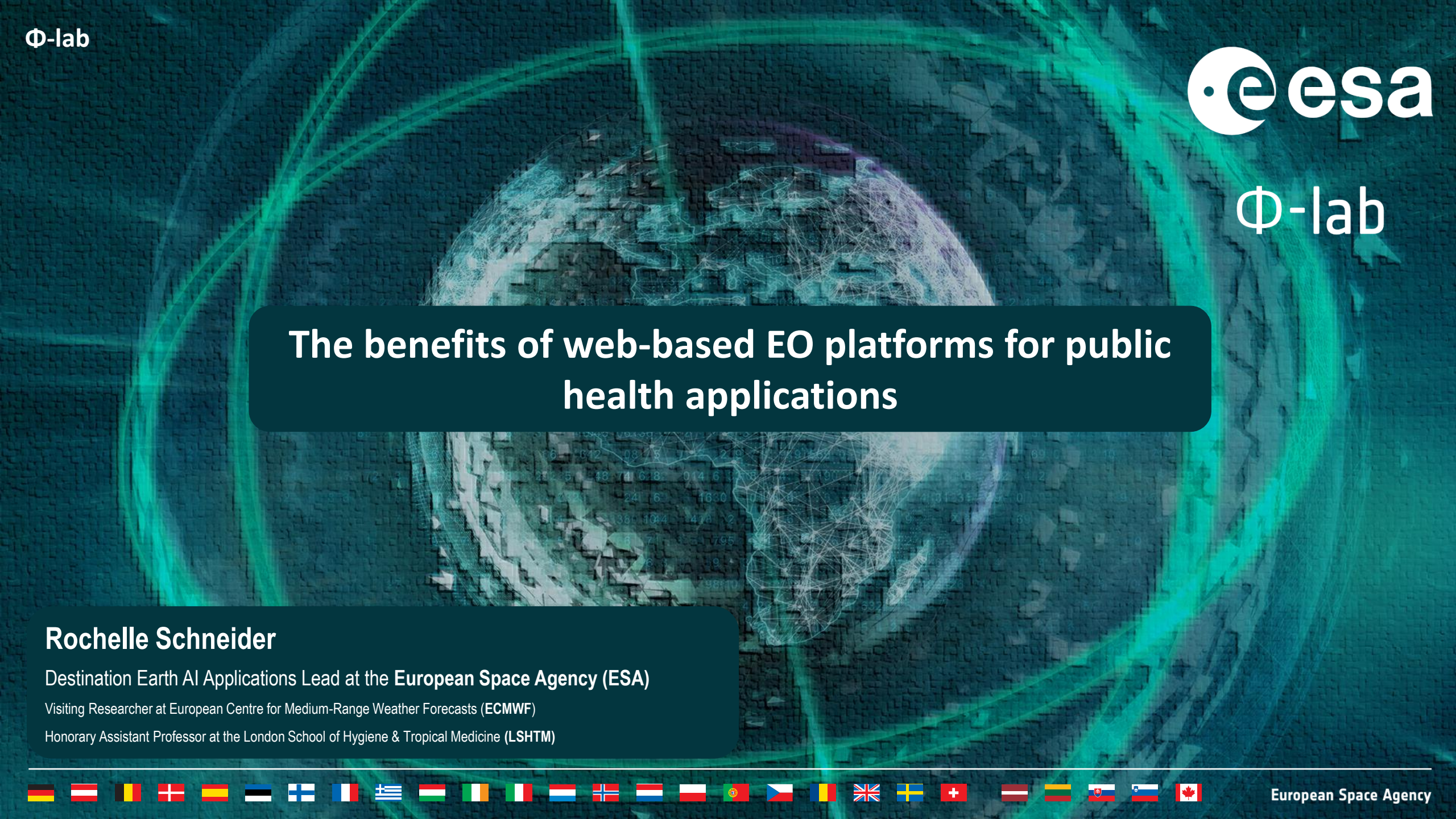


The benefits of web-based EO platforms for public health applications

Rochelle Schneider

Destination Earth AI Applications Lead at the **European Space Agency (ESA)**

Visiting Researcher at European Centre for Medium-Range Weather Forecasts (**ECMWF**)

Honorary Assistant Professor at the London School of Hygiene & Tropical Medicine **(LSHTM)**

Artificial Intelligence

AI4EO4Health

Earth Observation

European Space Agency

Φ-lab

esa

Φ-lab

unicef for every child

giga

Ministério da Saúde

FIOCRUZ

Fundação Oswaldo Cruz

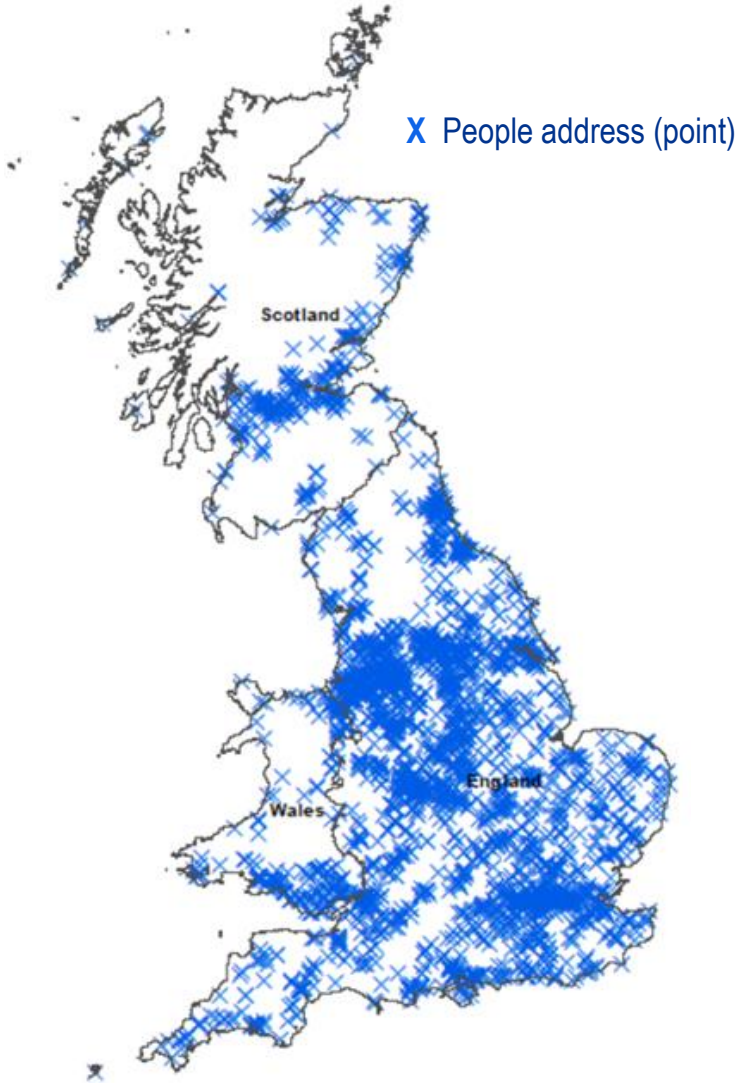
cidacs

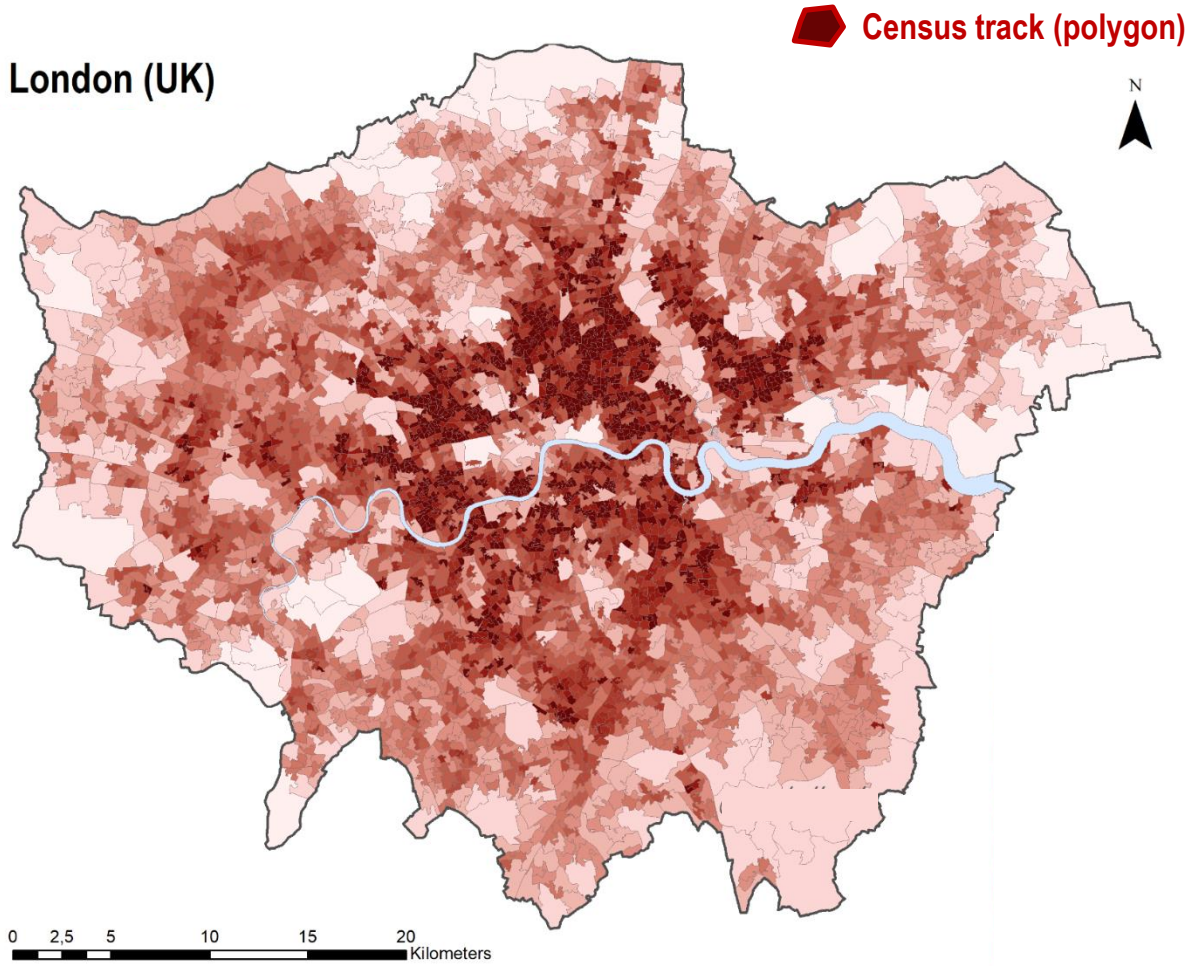
Centro de Integração de Dados e Conhecimentos para Saúde

FIOCRUZ

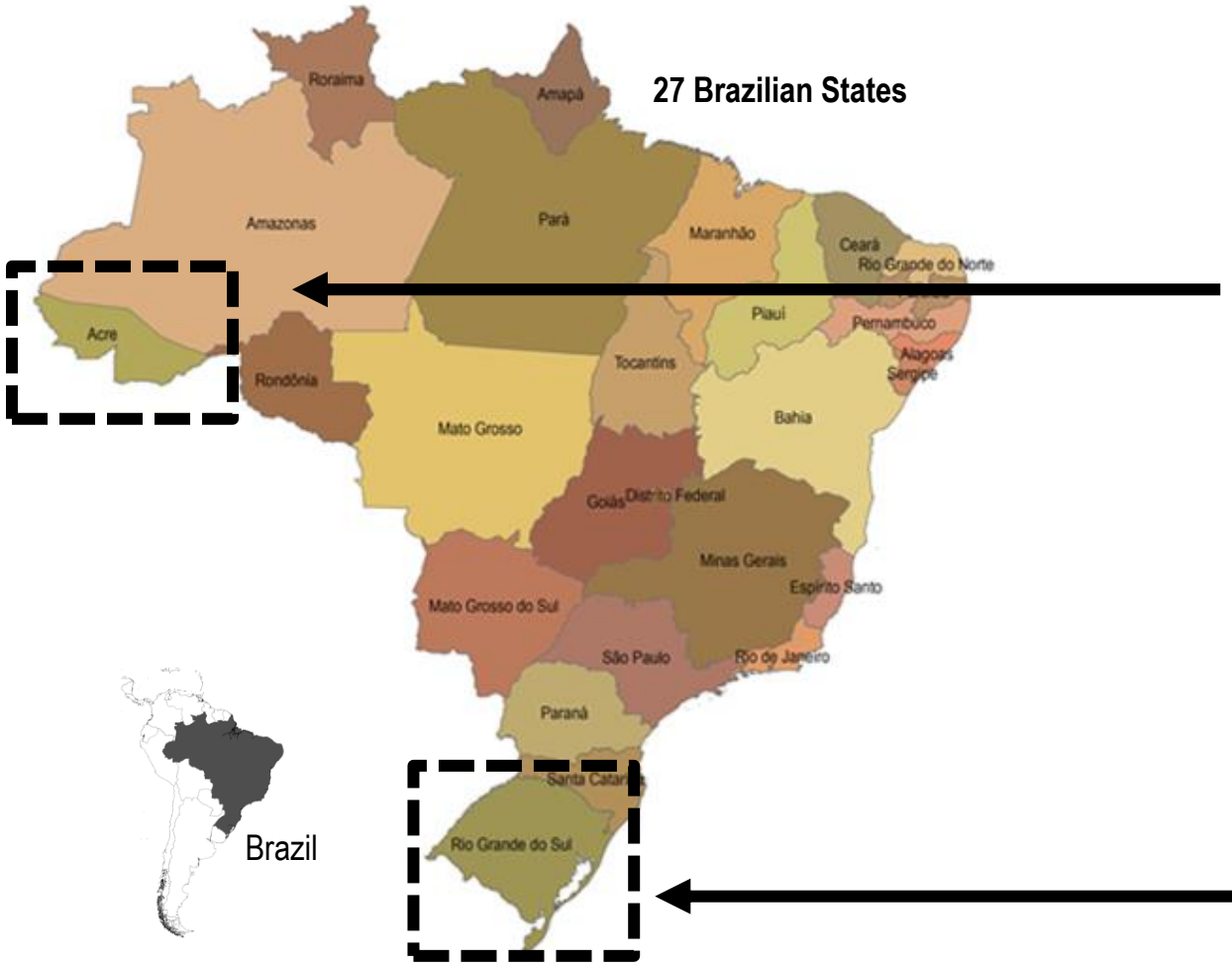
SUSTAINABLE DEVELOPMENT GOALS

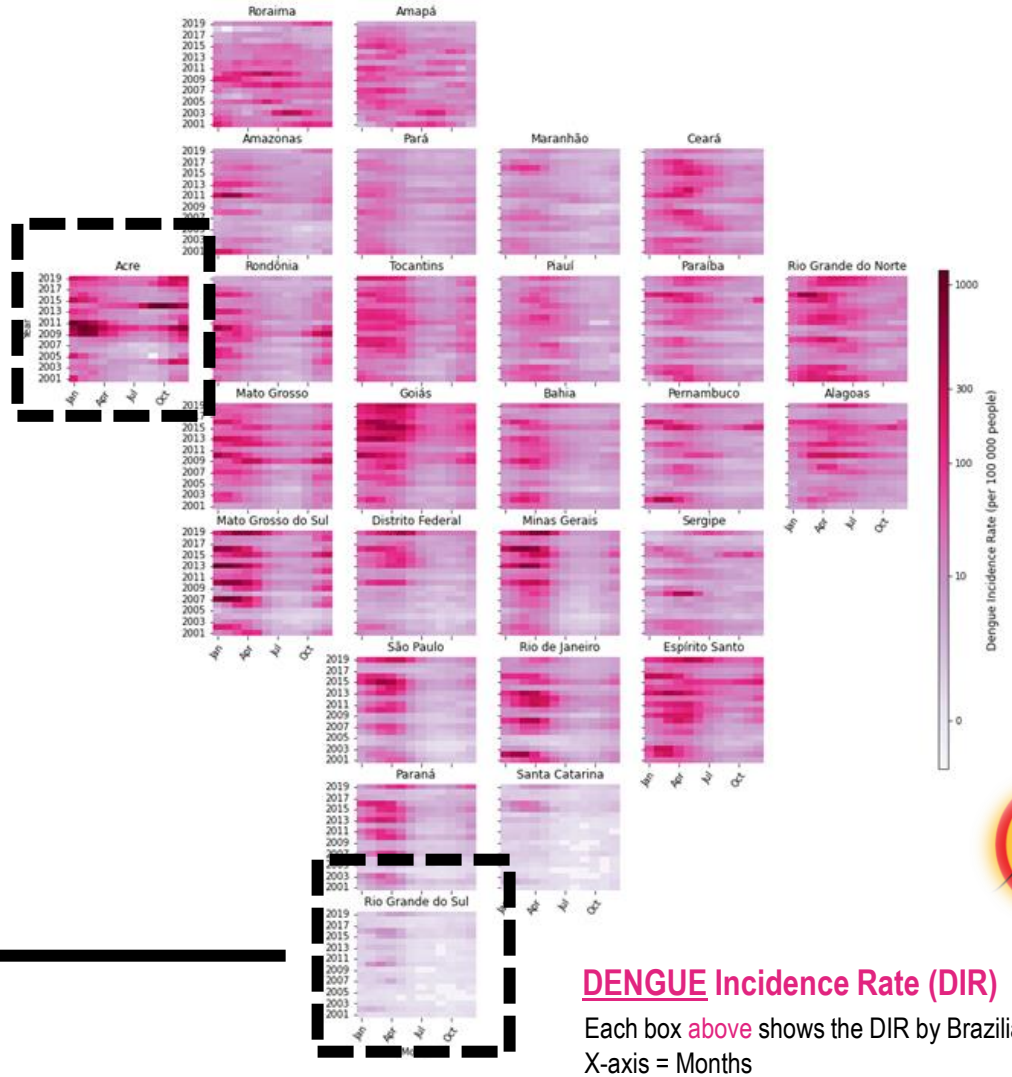
Health data format





Health data format

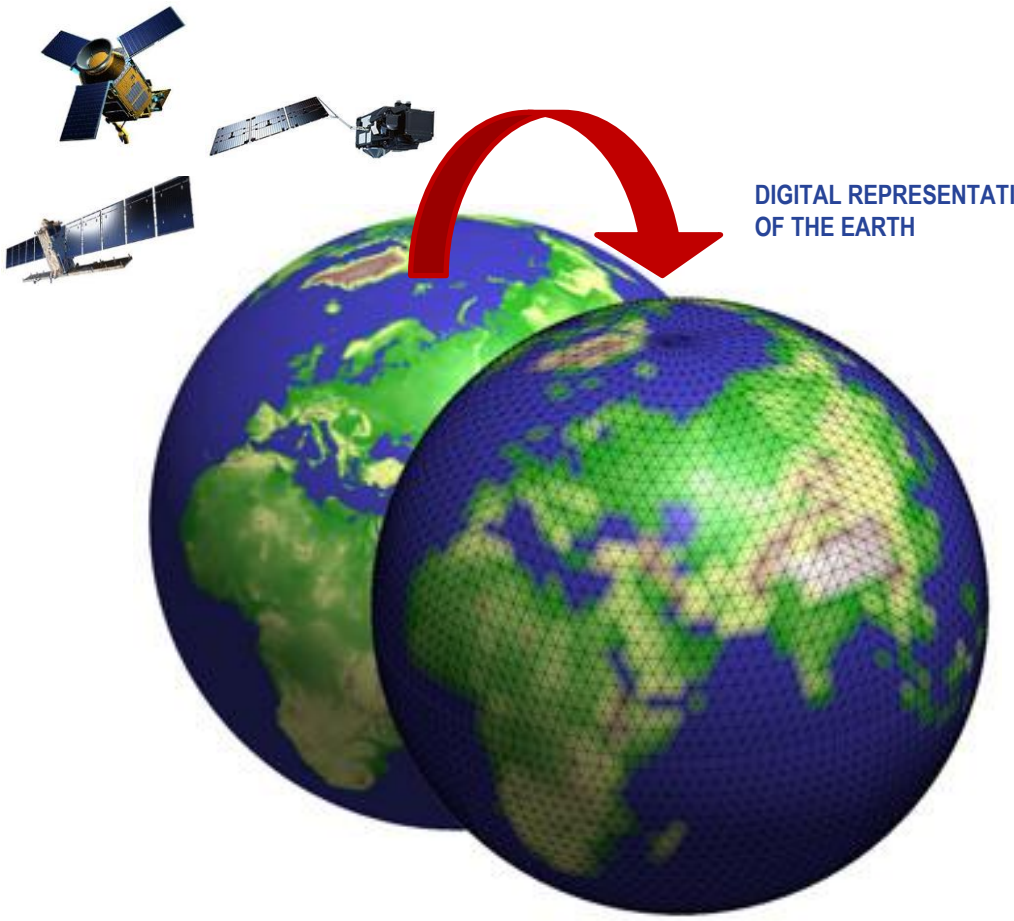




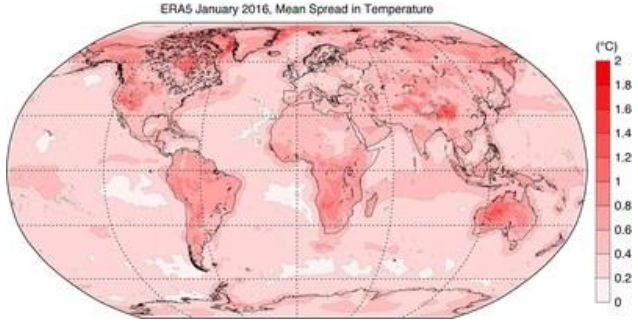
DENGUE Incidence Rate (DIR)

Each box above shows the DIR by Brazilian State.
X-axis = Months
Y-axis = Years

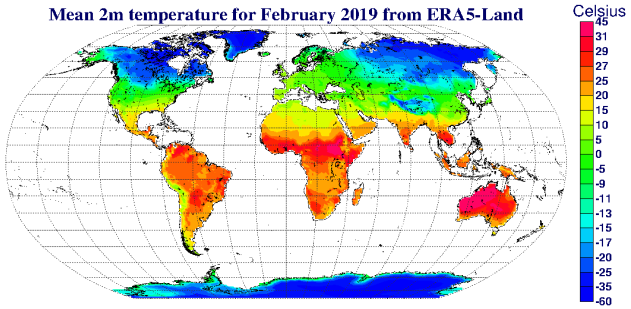
SATELLITE-BASED MODELLED DATA



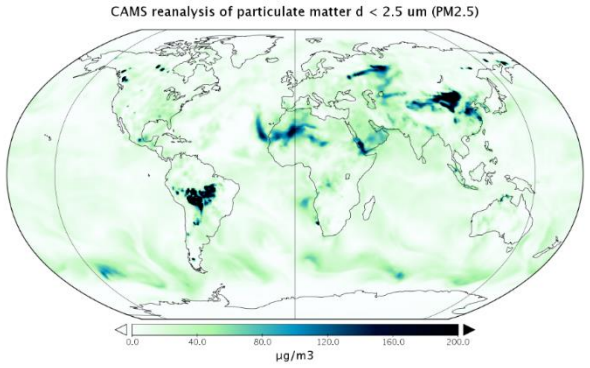
DIGITAL REPRESENTATIONS
OF THE EARTH



Model: ERA 5
(~ 25 x 25 km)



Model: ERA 5 Land
(~ 9 x 9 km)

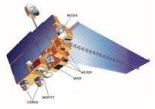


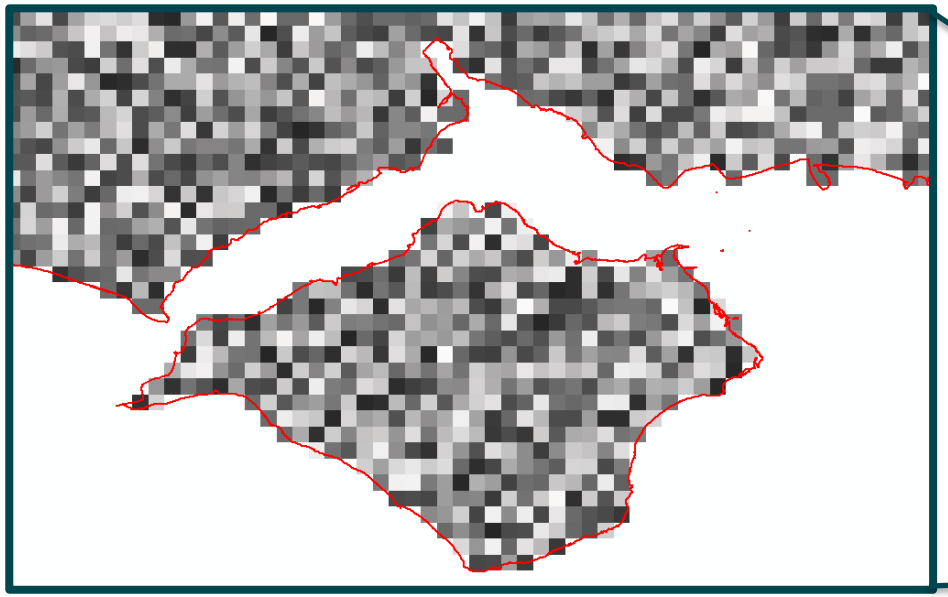
Model: GLOBAL CAMS
(~ 40 x 40 km)
(~ 80 x 80 km)

Source: ECMWF

Satellite and Satellite-based data format

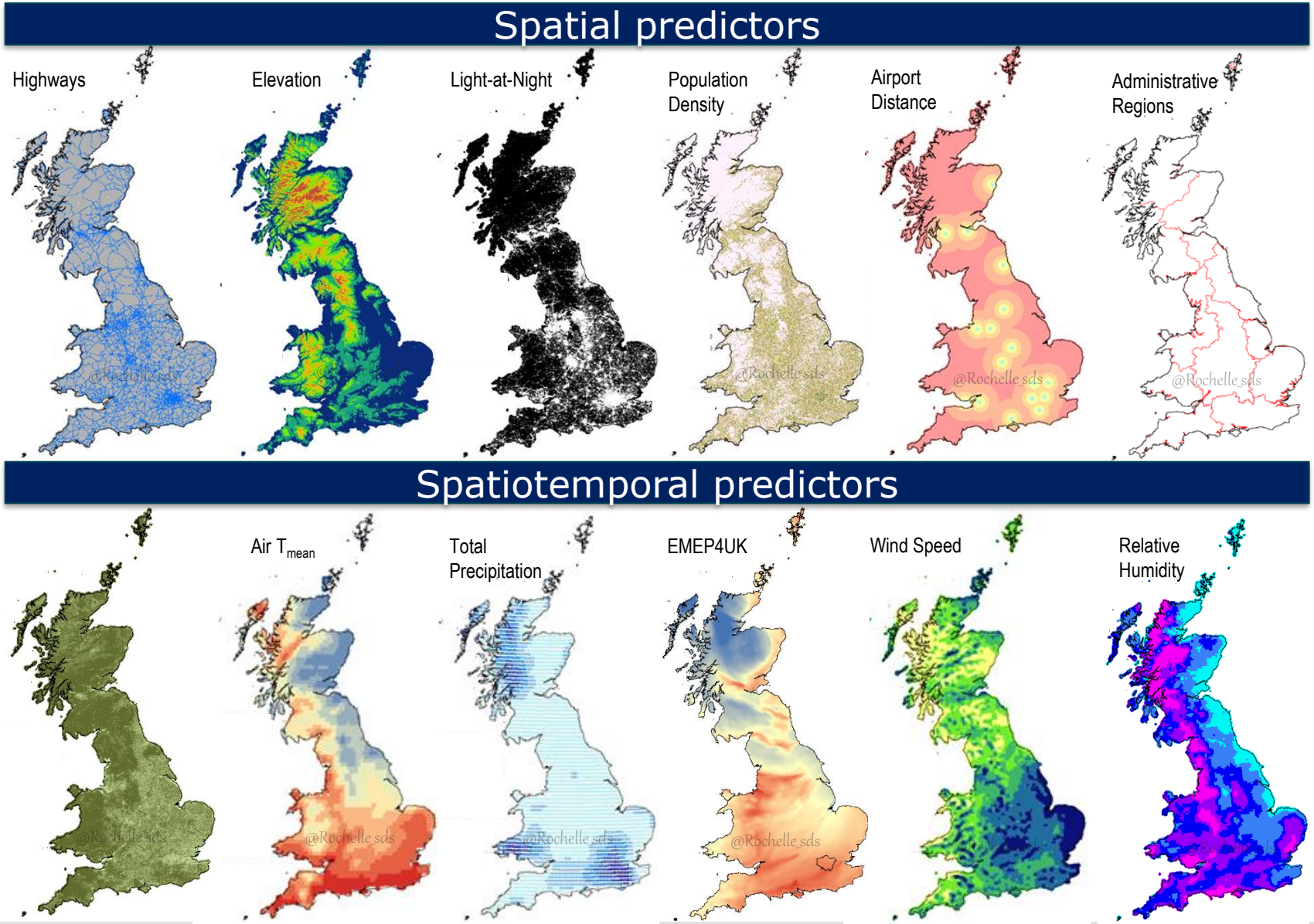
MODIS needs two scenes to fully cover the UK





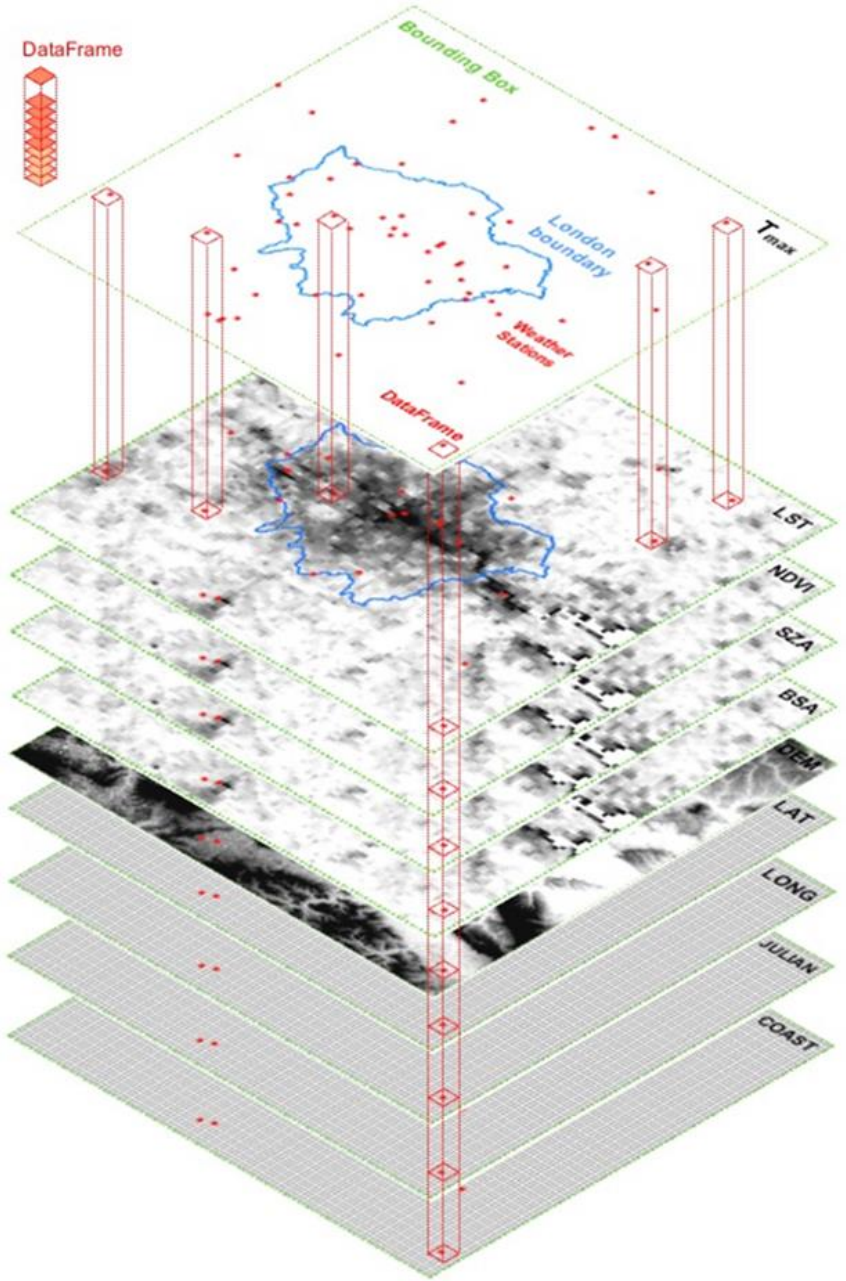
Great Britain = 234.429 pixels of 1 x1 km
London = ~1.830 pixels

Spatial and spatiotemporal variables



By pixel (Great Britain - 234.429 pixels of 1 x1 km)
By product
By day/month/year

Data synchronisation



SATELLITE + SATELLITE-BASED MODELLED DATA

AEROSOL – Satellite

[Aerosol Optical Depth – AOD*]

Resolution: 1 km

Source: NASA - MODIS (Terra/Aqua)

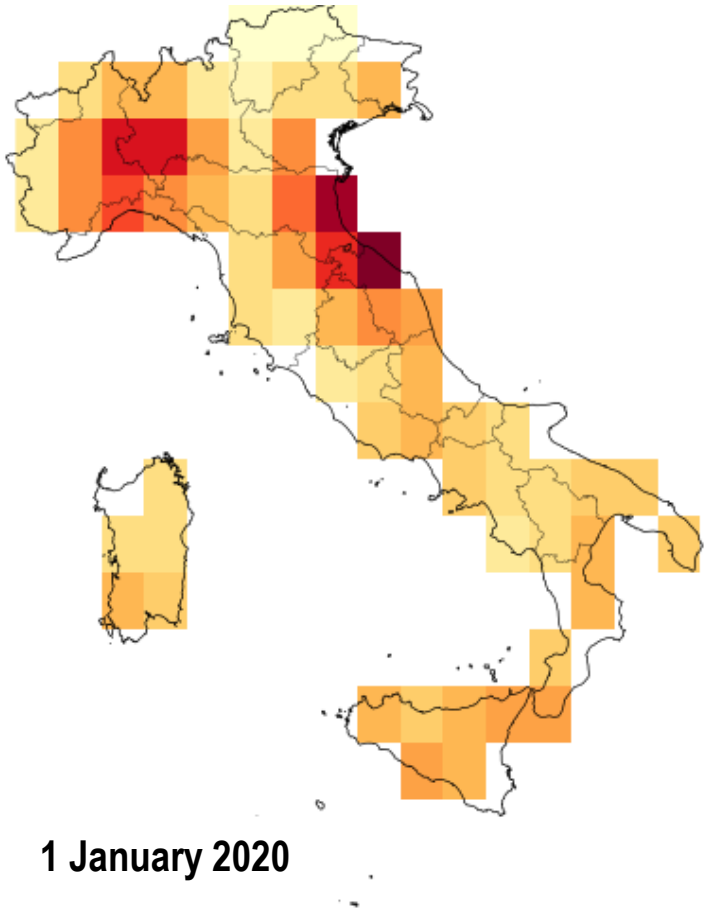
1 January 2020

AEROSOL – Modelled

[Aerosol Optical Depth –AOD*]

Resolution: 10 km

Source: CAMS Europe



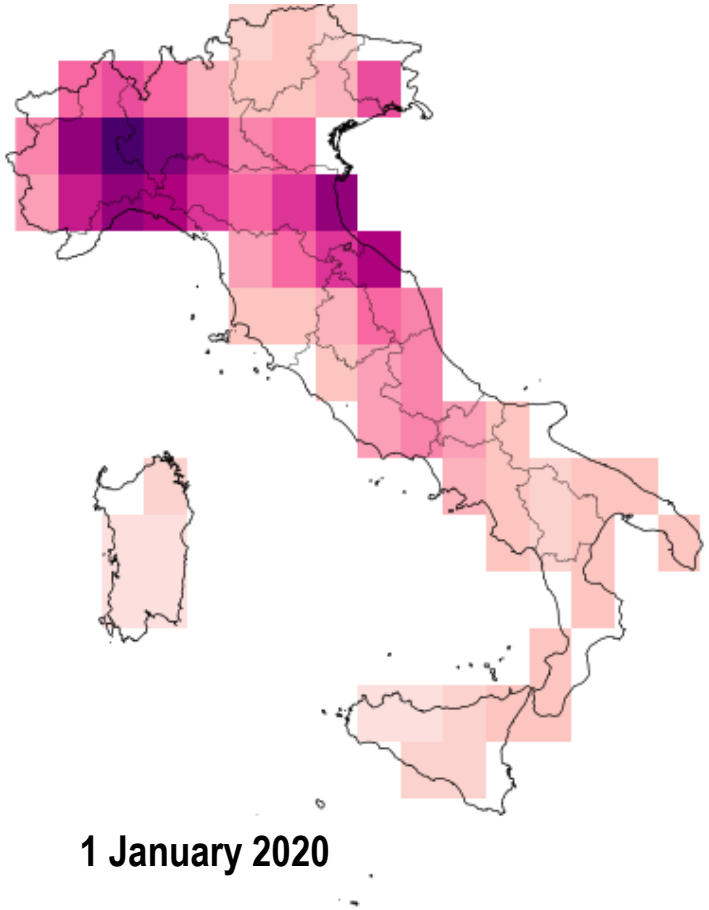
1 January 2020

$PM_{2.5}$ – modelled

[Fine Particulate Matter]

Resolution: 10 km

Source: CAMS Europe



1 January 2020

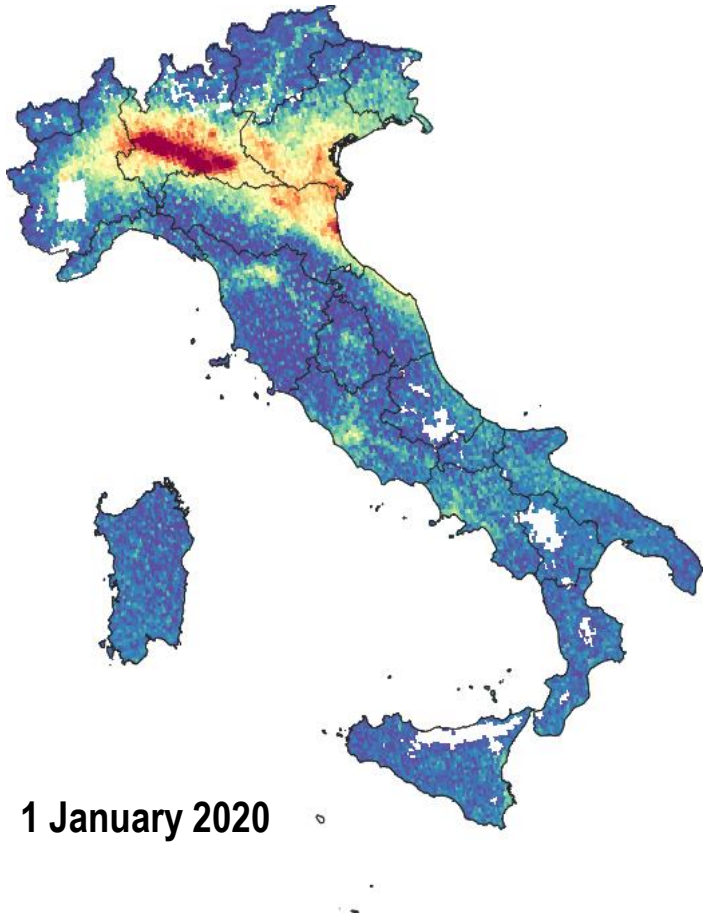
*AOD: Used as a $PM_{2.5}$ mg/m^3 reference

SATELLITE + SATELLITE-BASED MODELLED DATA

NITROGEN DIOXIDE – Satellite

[Tropospheric Column, 0-10 km]

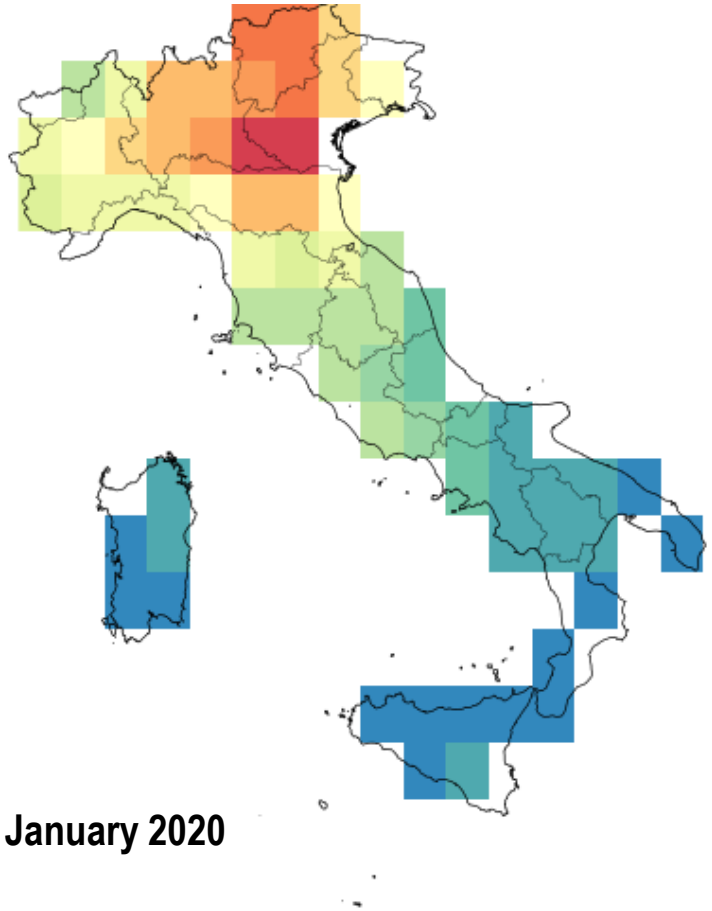
Resolution: 3.5 x 5.5 Km
Source: ESA Sentinel 5P



NITROGEN DIOXIDE – Modelled

[Tropospheric Column, 0-10 km]

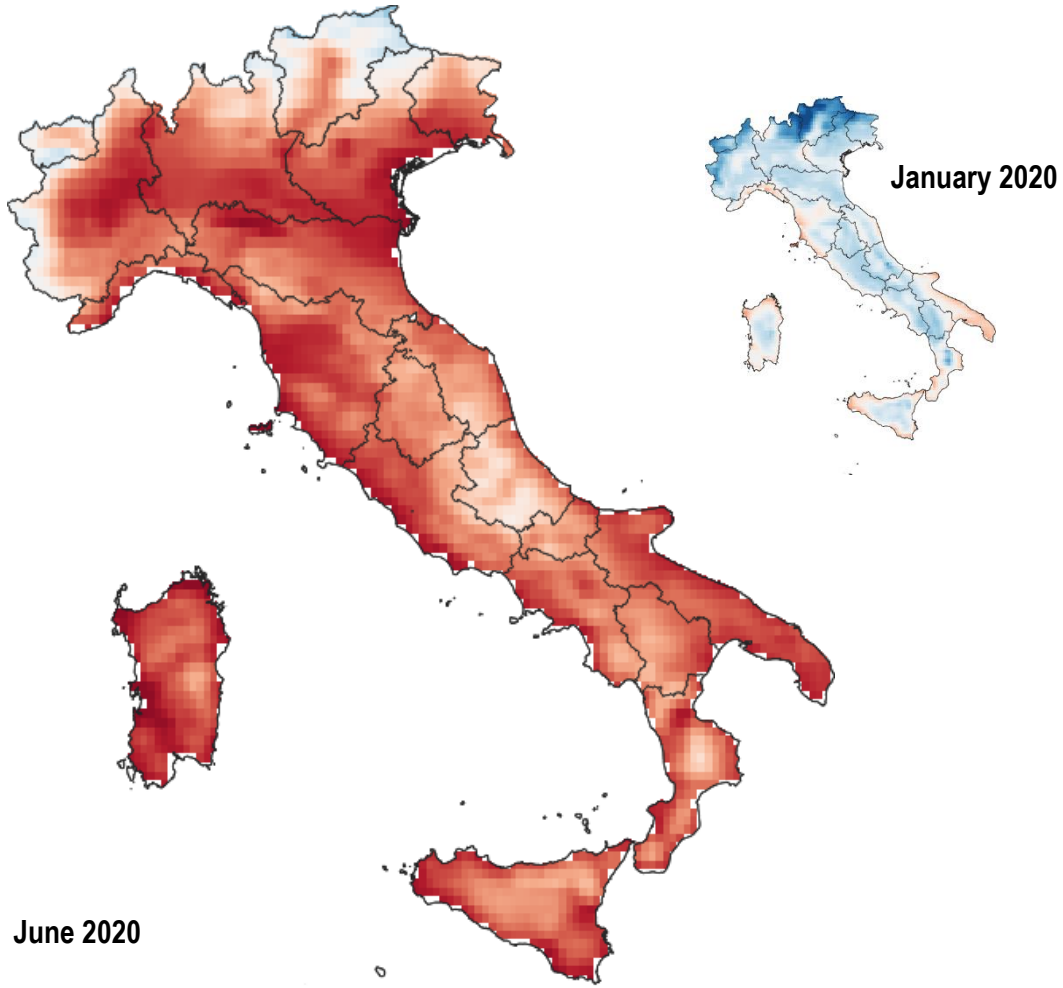
Resolution: 10km
Source: CAMS Europe



SATELLITE-BASED MODELLED DATA

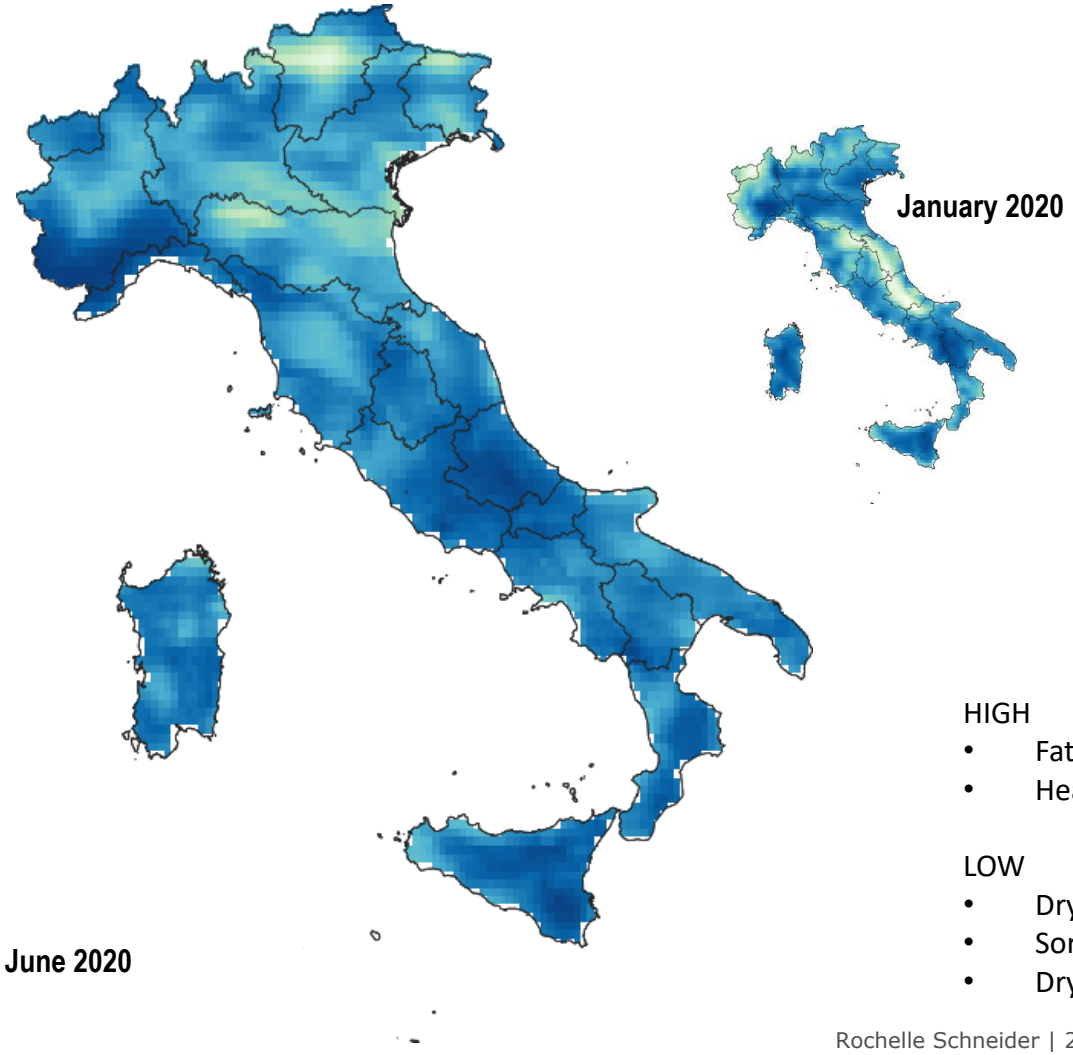
AIR TEMPERATURE

Resolution: 9 km
Source: Copernicus ERA 5 Land



HUMIDITY

Resolution: 9 km
Source: Copernicus ERA 5 Land



HIGH
- Fatigue
- Heat exhaustion

LOW
- Dry skin
- Sore throat
- Dry nose

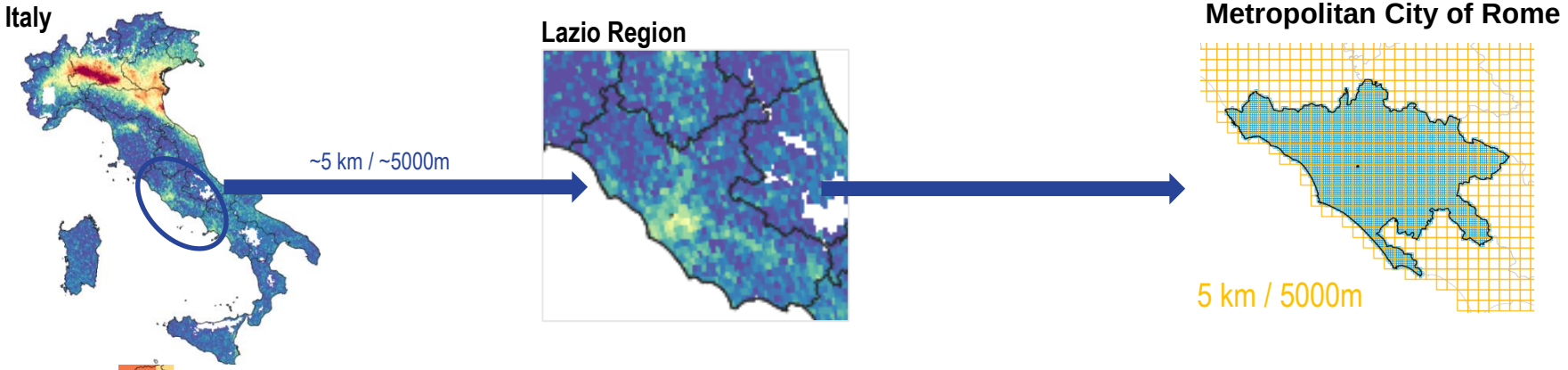
ENVIRONMENT – HEALTH DATA SYNCHRONISATION

European Space Agency

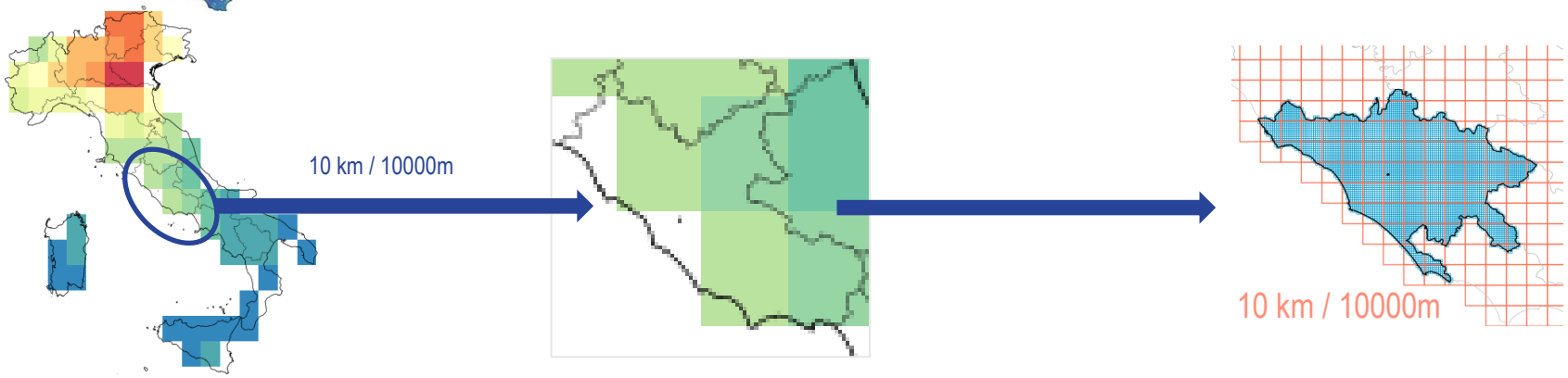
Φ-lab

Copernicus
Europe's eyes on Earth

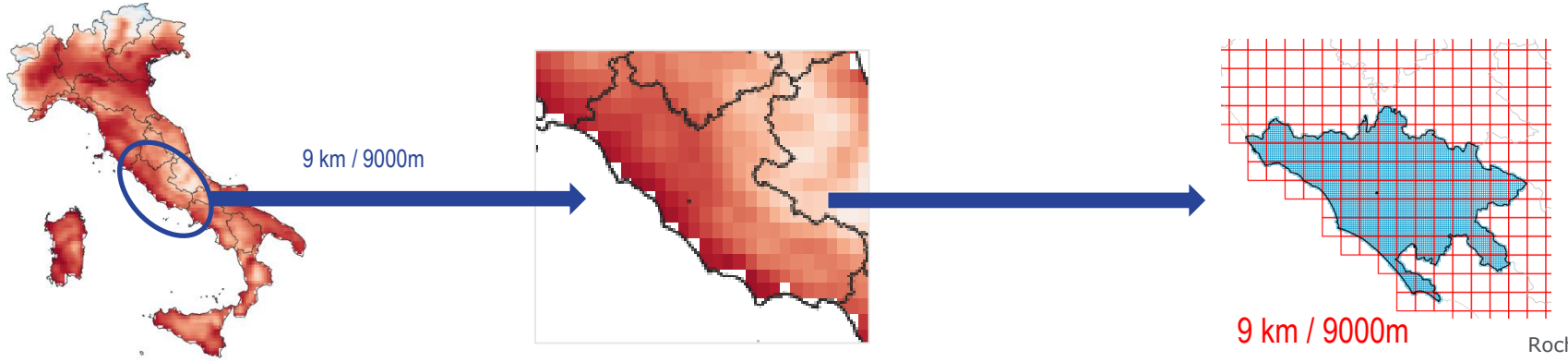
NITROGEN DIOXIDE
Copernicus Sentinel 5P



NITROGEN DIOXIDE
CAMS Europe



AIR TEMPERATURE
Copernicus ERA 5 Land



1 km / 1000m

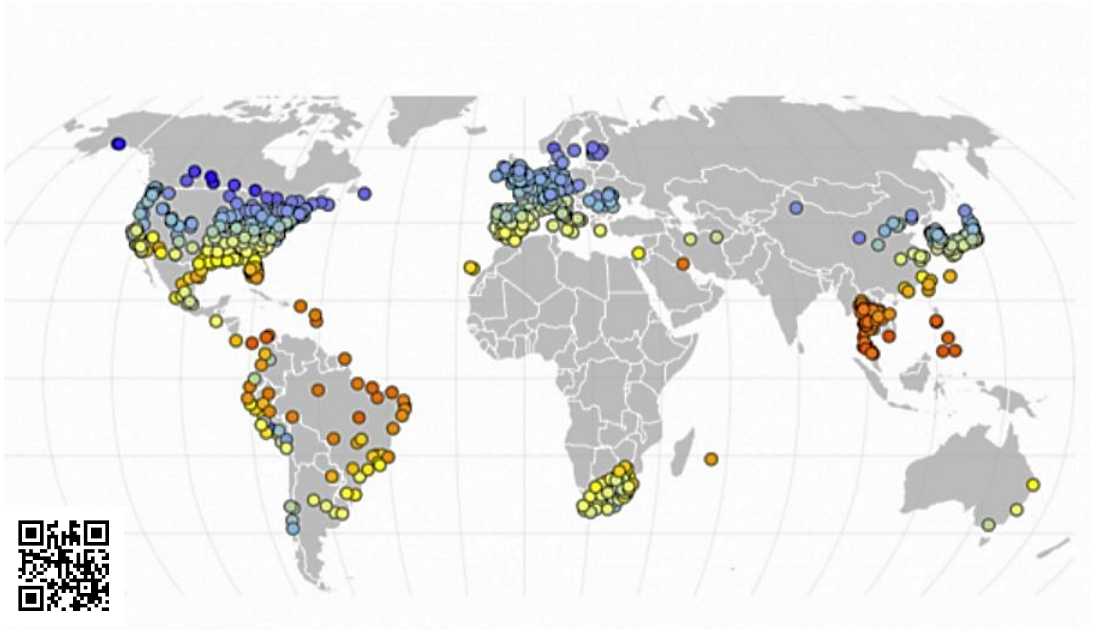
QUICK WEB-SERVICE PLATFORM LOOK:

ENVIRONMENT – HEALTH DATA SYNCHRONISATION

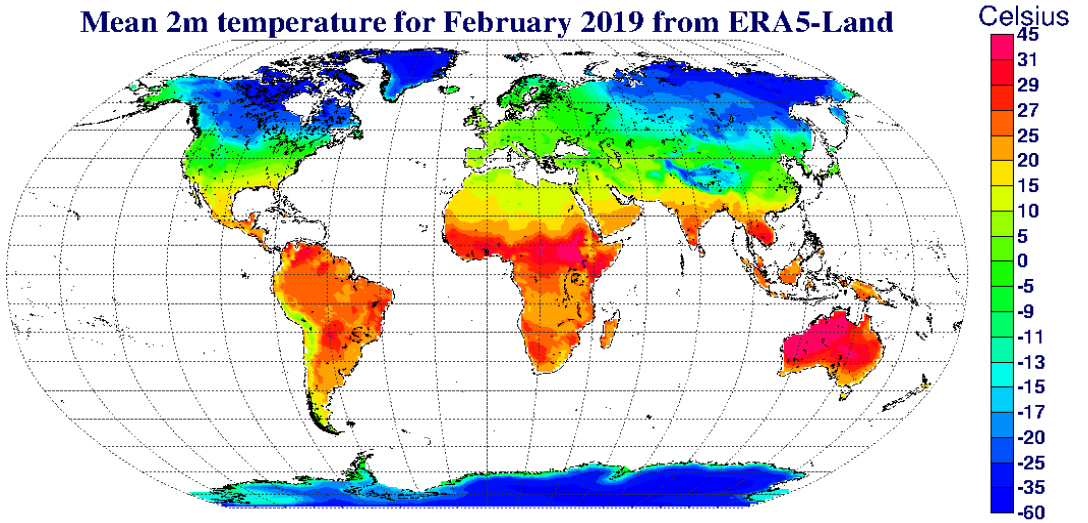
European Space Agency

Φ-lab

Daily deaths by urban area



Daily mean air temperature by 9x9 km



The MCC Network

Currently including data on environmental stressors, climate, and health over **768** cities/communities from **44** countries, representing a wide range of climates worldwide.

768 urban areas
44 countries

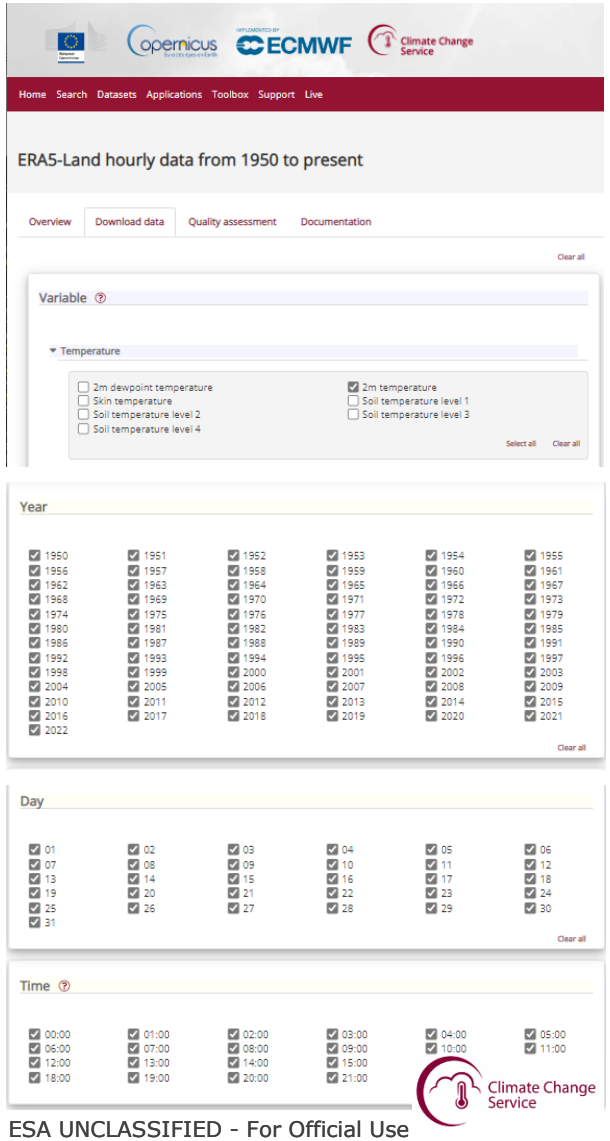
Copernicus Europe's eyes on Earth

Climate

Where should I download/work? Daily mean temperature by urban area

European Space Agency
Φ-lab

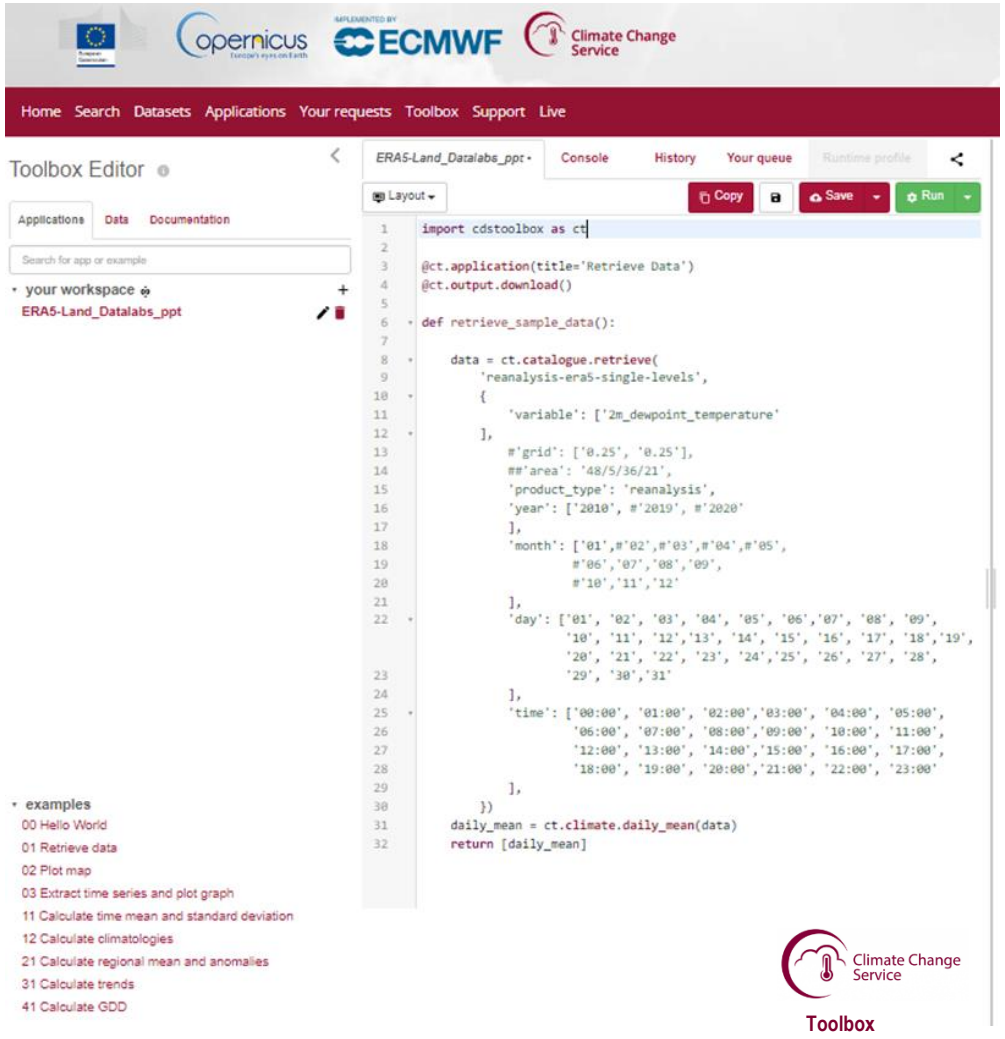
OPTION 1 – Directly on C3S webpage



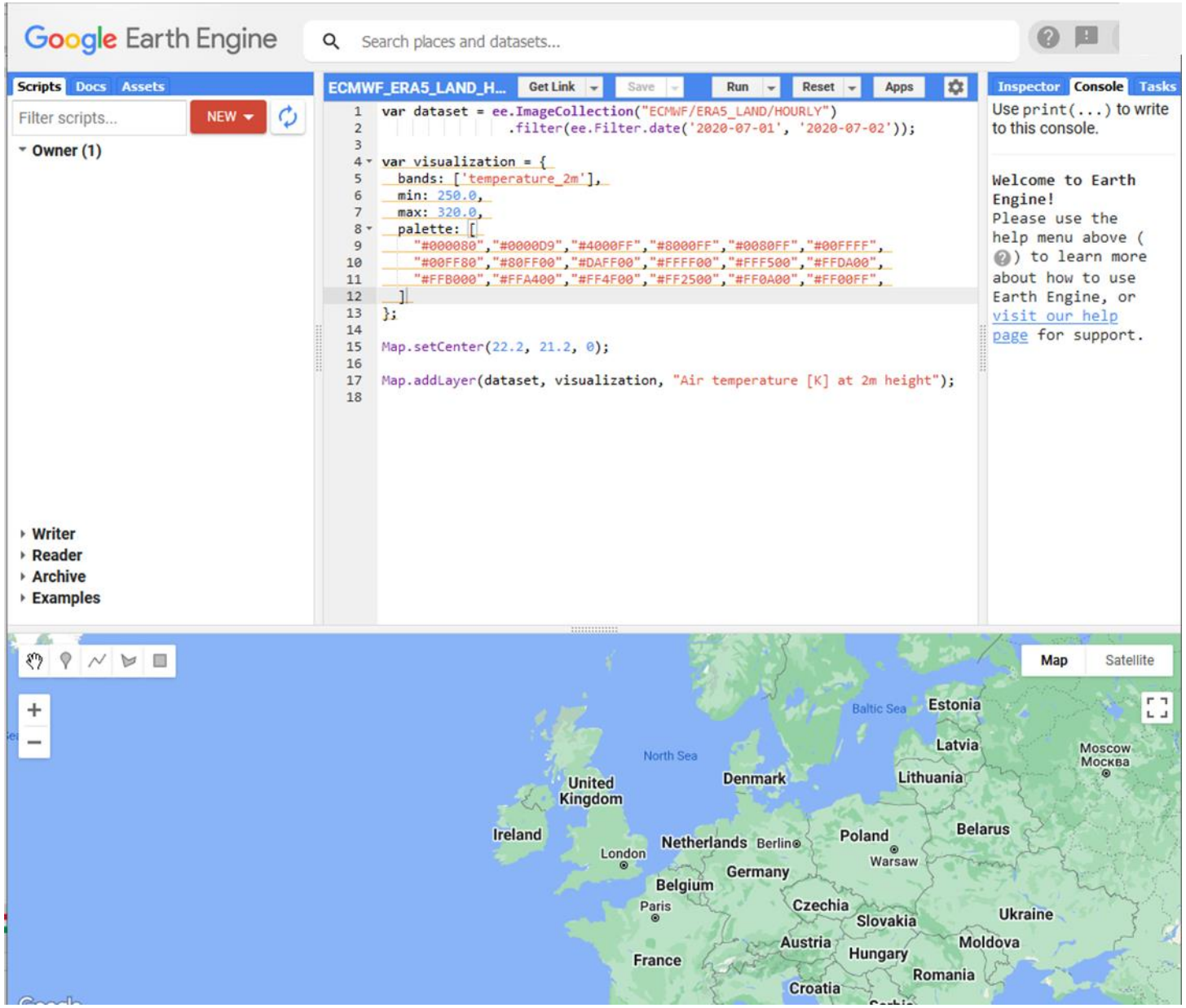
OPTION 2 – Via API request on Python/R

```python
import cdsapi

## TEMPERATURE
c = cdsapi.Client()

c.retrieve(
  'reanalysis-era5-land',
  {

    'format':'netcdf',
    'area': '60/-10/50/5',
    'variable':'2m_temperature',
    'year':[
      '2003','2004','2005',
      '2006','2007','2008',
      '2009','2010','2011',
      '2012','2013','2014',
      '2015','2016','2017',
      '2018'
      ],
    'month':[
      '01','02','03',
      '04','05','06',
      '07','08','09',
      '10','11','12'
      ],
    'day':[
      '01','02','03',
      '04','05','06',
      '07','08','09',
      '10','11','12',
      '13','14','15',
      '16','17','18',
      '19','20','21',
      '22','23','24',
      '25','26','27',
      '28','29','30',
      '31'
      ],
    'time': [
      '00:00', '01:00', '02:00',
      '03:00', '04:00', '05:00',
      '06:00', '07:00', '08:00',
      '09:00', '10:00', '11:00',
      '12:00', '13:00', '14:00',
      '15:00', '16:00', '17:00',
      '18:00', '19:00', '20:00',
      '21:00', '22:00', '23:00',
      ],
  },
  'ERA5_land_2mtemp_0h_12h_2003_2018.netcdf')
```

OPTION 3 – C3S Toolbox (Java script)



Where should I download/work? Daily mean temperature by urban area



Google Earth Engine

→ **Activities** →

Artificial Intelligence
AI4EO4Health
Earth Observation

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

MONITORING AIR QUALITY TO ESTIMATE HUMAN-RISK TO AIR POLLUTION EXPOSURE

esa

Φ-lab

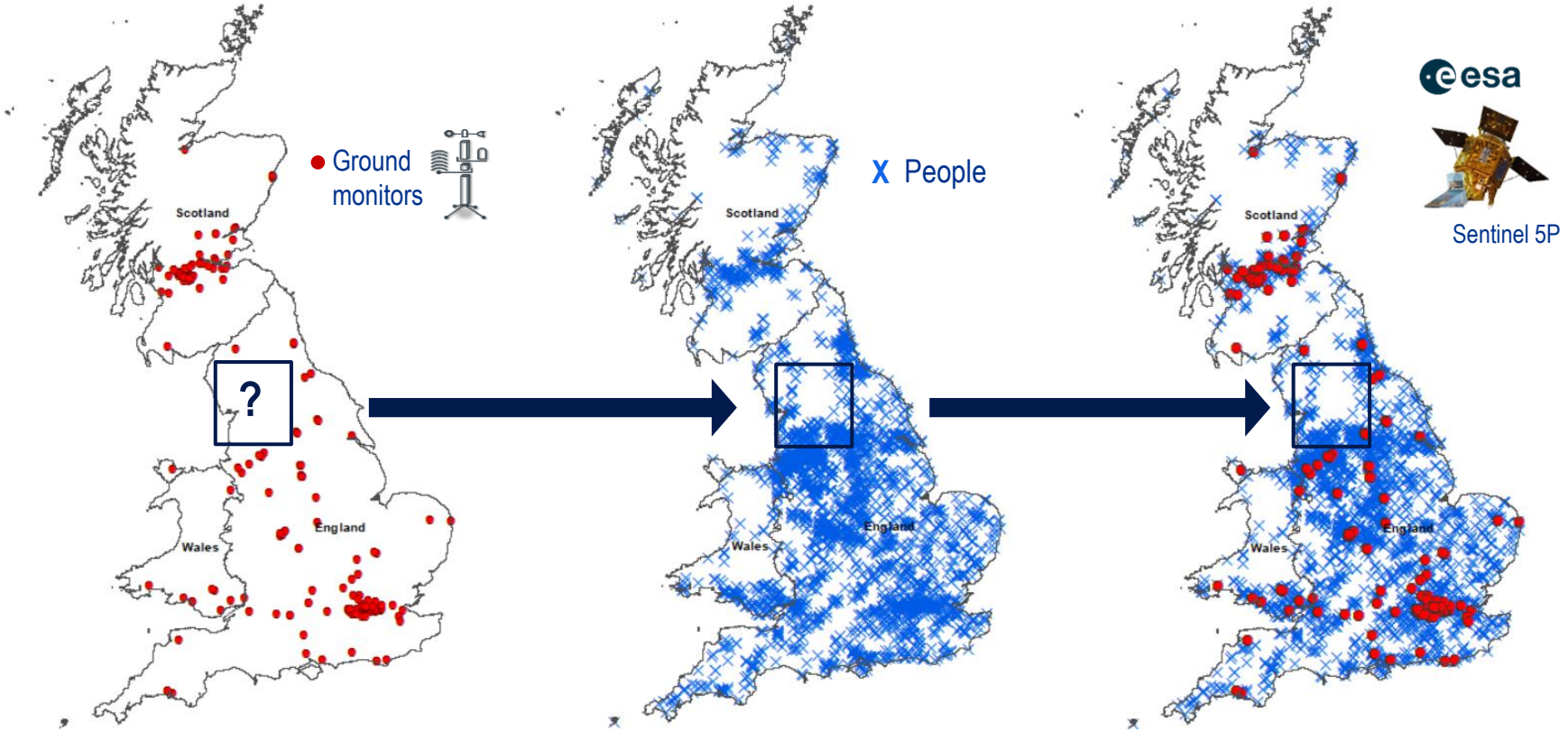
MONITORING AIR QUALITY TO ESTIMATE HUMAN-RISK TO AIR POLLUTION EXPOSURE

European Space Agency

Φ-lab

SUSTAINABLE DEVELOPMENT GOALS

Air quality (AQ) monitors	Epidemiological studies	AQ monitor vs Epi studies locations



- Epidemiological studies on the health effects of air pollution usually rely on observations from ground monitors, which provide discontinuous spatiotemporal records.
- It is possible to reconstruct daily human-level exposure to NO_2 using ML, supported by the Copernicus EO products.

DATA

“Platforms”:

API request

Google Earth Engine

Climate Change Service Toolbox | API

Atmosphere Monitoring Service API

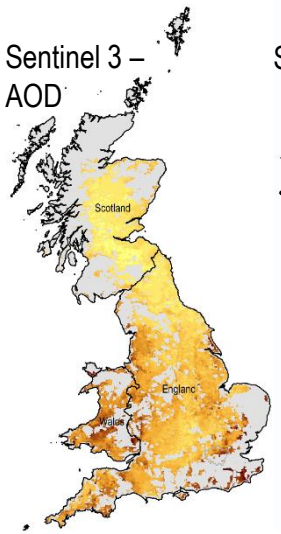
GES DISC

LAADS DAAC

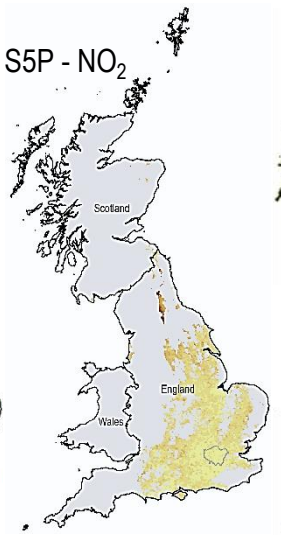
Sources:

SATELLITES

Sentinel 3 – AOD



S5P - NO_2

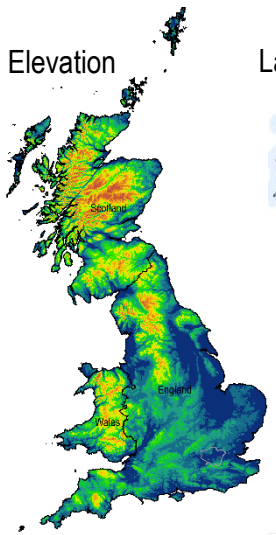


NDVI

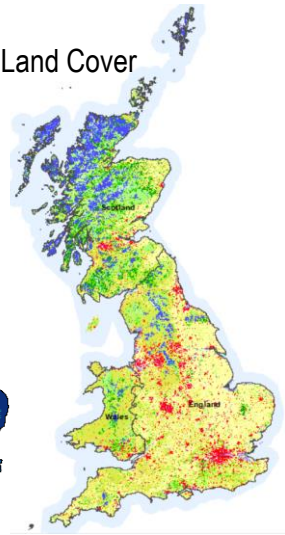
SATELLITE-BASED LAND MONITORING

Land

Elevation



Land Cover

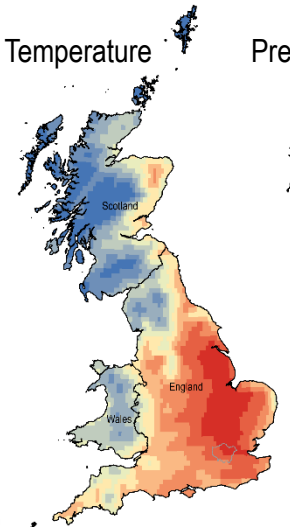


CLIMATE AND ATMOSPHERIC REANALYSIS MODELS

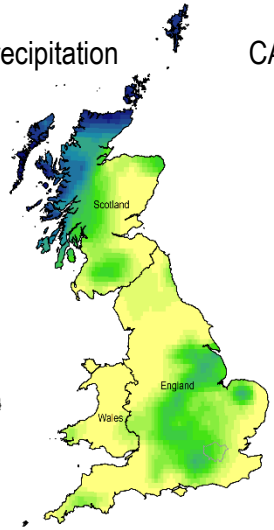
Climate

Atmosphere

Temperature

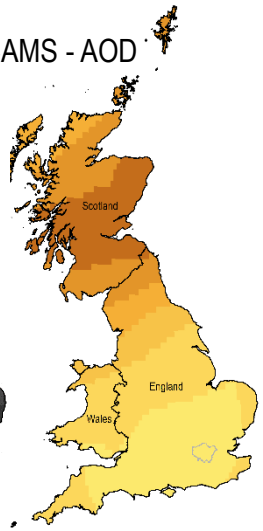


Precipitation



CAMS $PM_{2.5}$

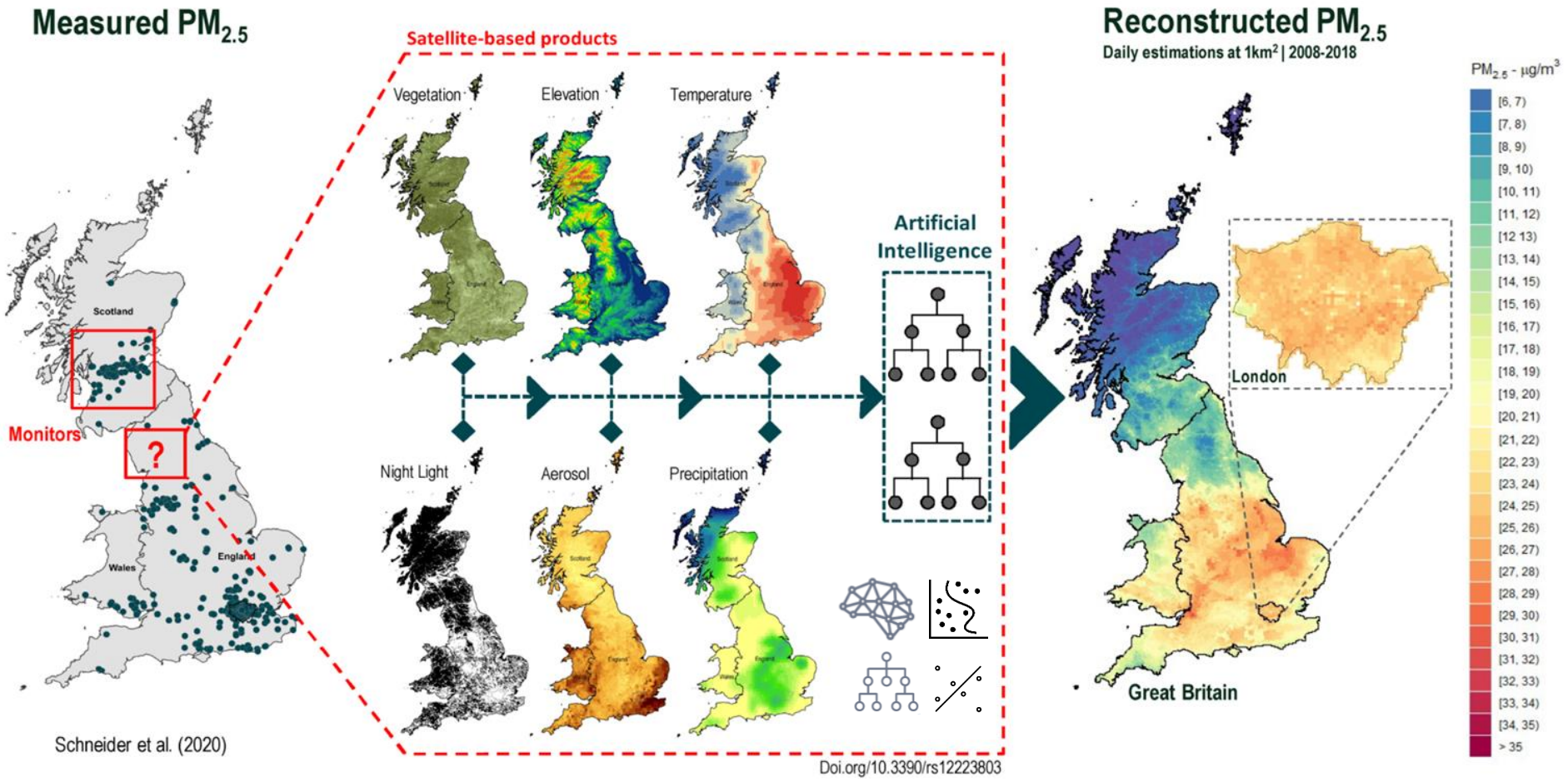
CAMS - AOD



SATELLITE-BASED MACHINE LEARNING FRAMEWORK

European Space Agency
Φ-lab

PREVIOUS AQ MODELLING RECONSTRUCTION – PARTICULATE MATTER 2.5 ($PM_{2.5}$)



Journal paper

remote sensing

Media coverage

The Telegraph

FORECASTING DENGUE USING EO DATA AND MACHINE LEARNING

ESA Φ-lab: Rochelle Schneider, Alessandro Sebastianelli, Raquel Carmo, James Wheeler

UNICEF Giga: Do-Hyung Kim

UNICEF Latin America and Caribbean Regional Office: Hanoch Barlevi, Zoraya El Raiss Cordero

Italian Space Agency / Sapienza University of Rome: Dario Spiller

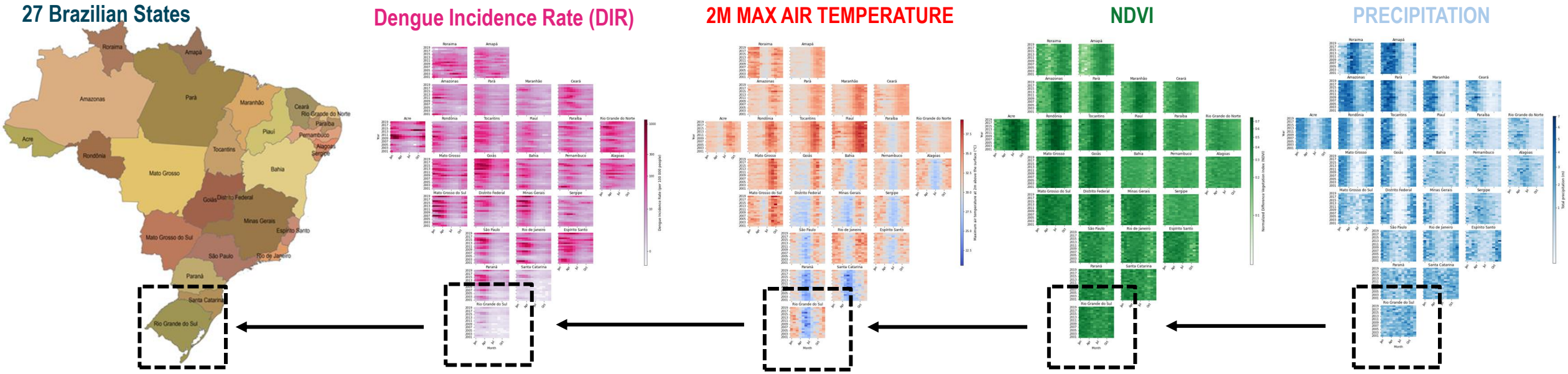
Warsaw University of Technology: Artur Nowakowski

Fluminense Federal University: Ludmilla Viana Jacobson

Wellcome Trust: Felipe de Jesus Colon Gonzalez

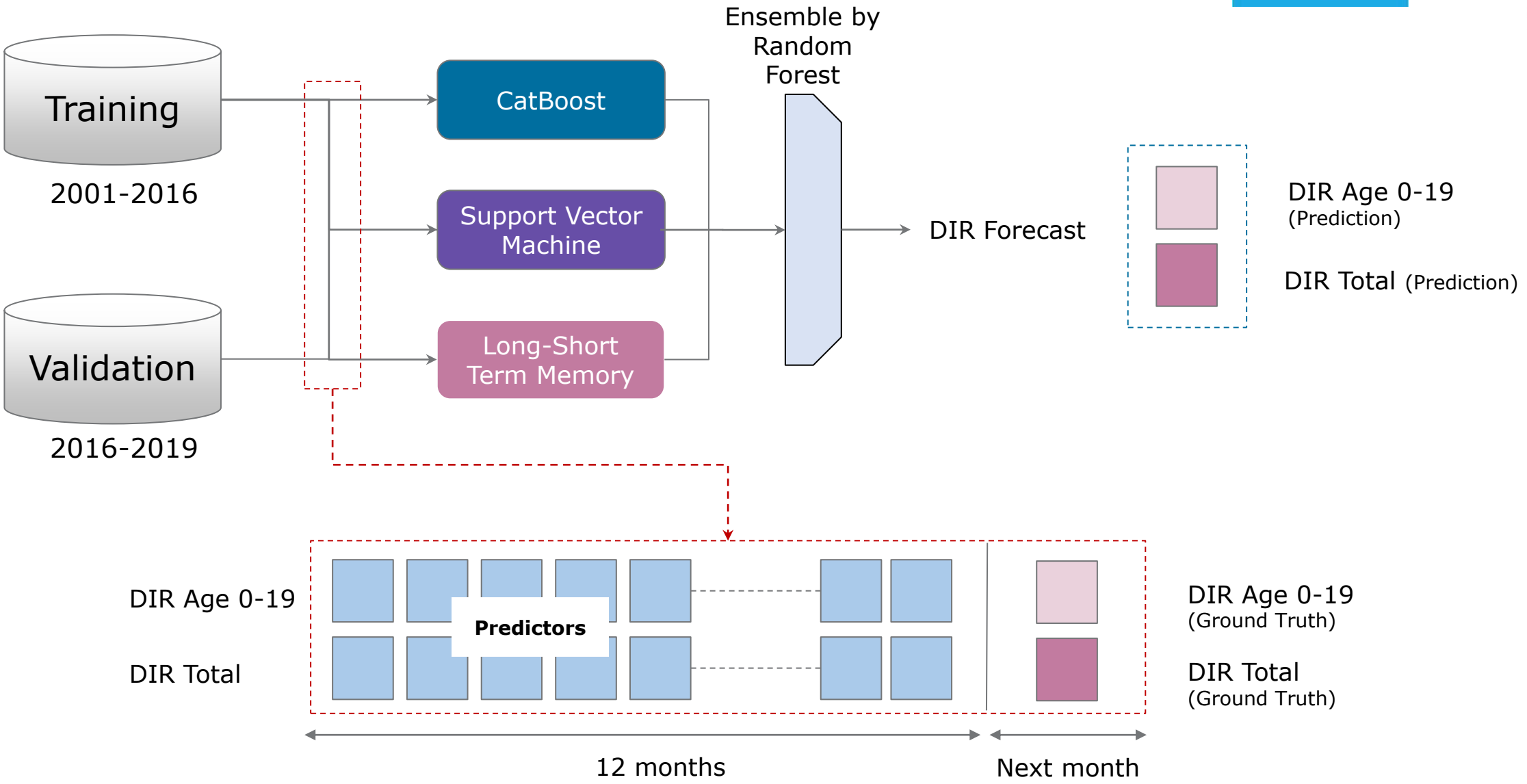
Barcelona Supercomputing Centre: Rachel Lowe

SATELLITE AND SATELLITE-BASED PRODUCTS



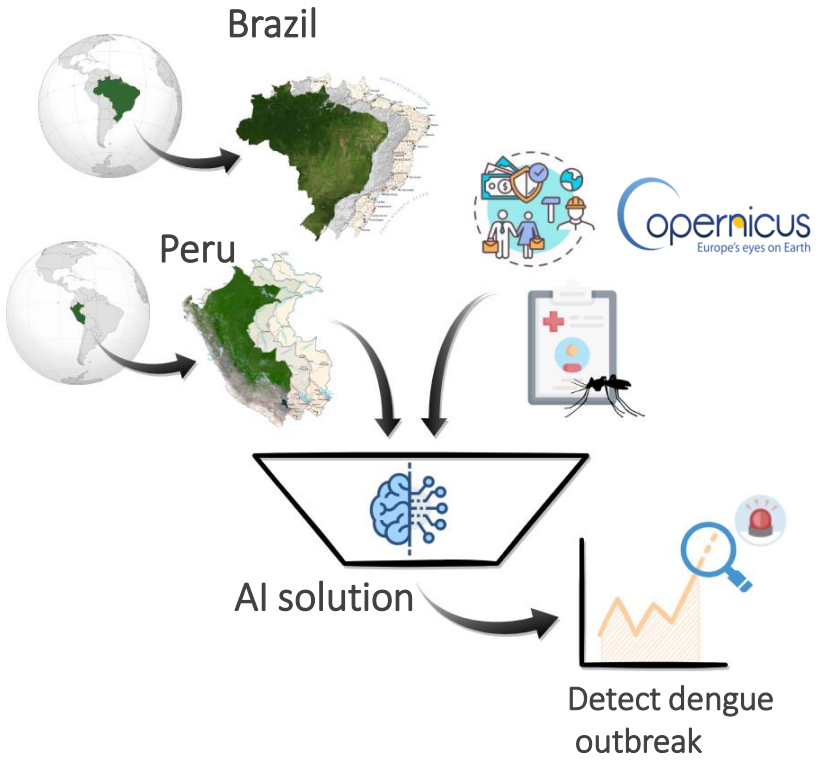
Each box shows the EO products by Brazilian State.
X-axis = Months
Y-axis = Years

AI FRAMEWORK



ESA-UNICEF COLLABORATION FOOTPRINT

1 Develop an AI model to detect dengue outbreaks



2 Develop a 'do-it-yourself' guidebook: a fully-reproducible framework

Replicable AI solution

GitHub

*"This project is a **perfect example** of **collaboration** between a humanitarian organisation and a research entity to support the UN SDGs."*

Dohyung Kim
Data Scientist at the UNICEF Office of Global Innovation.

3 **Multi-Award Winning Project**

1 – UNESCO – IRCAI

United Nations Educational, Scientific and Cultural Organization · International Research Centre of Artificial Intelligence under the auspices of UNESCO

GLOBAL TOP 100 AI solutions for SDGs

2 - Best of UNICEF Research

showcase the most rigorous, innovative and impactful research produced by UNICEF offices worldwide

3 – Wellcome Trust support

wellcome

Wellcome trust is an independent charitable foundation

EGU General Assembly
#EGU23
23 - 28 April 2023

DEADLINE: 10th JANUARY 2023

ESSI1.5 AI applications for Digital Twins in Earth Science

Convener: Rochelle Schneider (ESA)
Co-conveners: Bertrand Le Saux (ESA), Matthew Chantry (ECMWF), Mariana Clare (ECMWF)

A digital twin of the Earth (DTE) is an interactive, dynamic digital replica of our planet which combines observations with simulations from physical models. It aims to replicate the Earth's complex ecosystem, allowing us to estimate our planet's response to changes under both the current climate state and future climate projections. These digital simulations create a system capable of performing what-if scenarios before they occur, which is crucial for natural hazard mitigation and adaptation plans (e.g., floods, heatwaves, wildfires, droughts, etc).
The benefits of AI applications are seen across all DTE domains, including but not limited to: (i) accelerating High-Performance Computing (HPC), (ii) acting as full or partial surrogates to Earth System models, (iii) optimising data streams (i.e., quality control, compression, AI-ready dataset creation), (iv) emulating missing variables and unresolved physical processes, and (v) correcting or quantifying model imperfections (i.e., error estimation and bias correction).

This session aims to provide a venue to demonstrate where and how AI tools have been a key aspect for the success within the DTE workflow including, but not restricted to:

- **HPC acceleration** for DTE architectures;
- **Computer infrastructure** to move virtual data from DTE repositories to service platforms;
- **Surrogate models** for missing observations and unresolved physical processes;
- **Hybrid AI** / physics based modelling;
- **Extreme** value predictions;
- **Explainable AI** for DTE;
- **Uncertainty** quantification and representation;
- **Reasoning** and AI for **Causality** discovery;
- **Post-processing** (event detection and downscaling/super-resolution).

Φ-lab *is hiring!*

European Space Agency
Φ-lab

Φ-lab also have visiting schemes, hosting PhD students, postdocs, and industry-fellows from a period of weeks to months.

Soon more Φ-lab opportunities

Internal Research Fellow (PostDoc) in Earth Observation (EO) and Computer Science for Climate

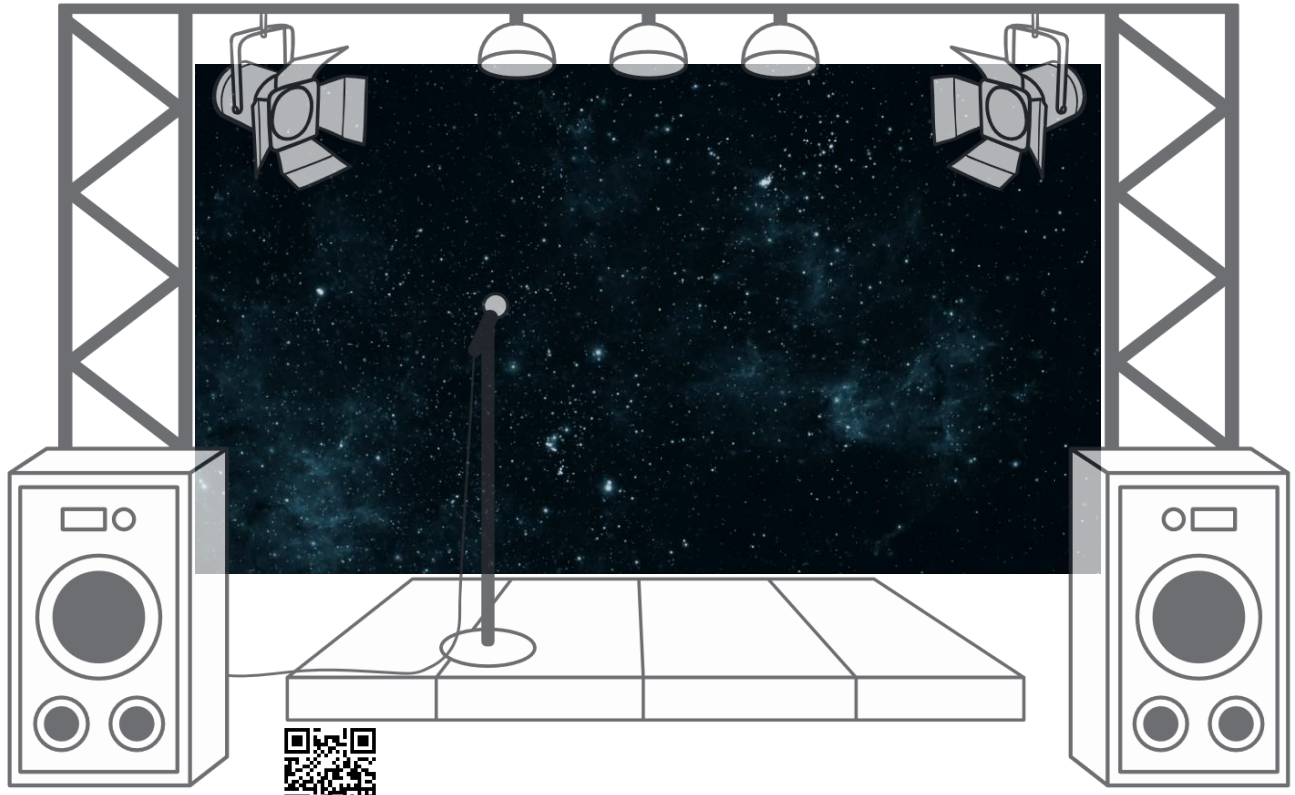
Job Req ID: 17067
Closing Date: 7 December 2022 23:59 CET/CEST
Publication: External Only
Vacancy Type: Internal Research Fellow
Date Posted: 9 November 2022

Closed.

Internal Research Fellow (Post-Doctoral) in AI and the use of Earth Observations for Climate

Job Req ID: 16263
Closing Date: 9 November 2022 23:59 CET/CEST
Publication: External Only
Vacancy Type: Internal Research Fellow
Date Posted: 12 October 2022

Closed.



Full video about Φ-lab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