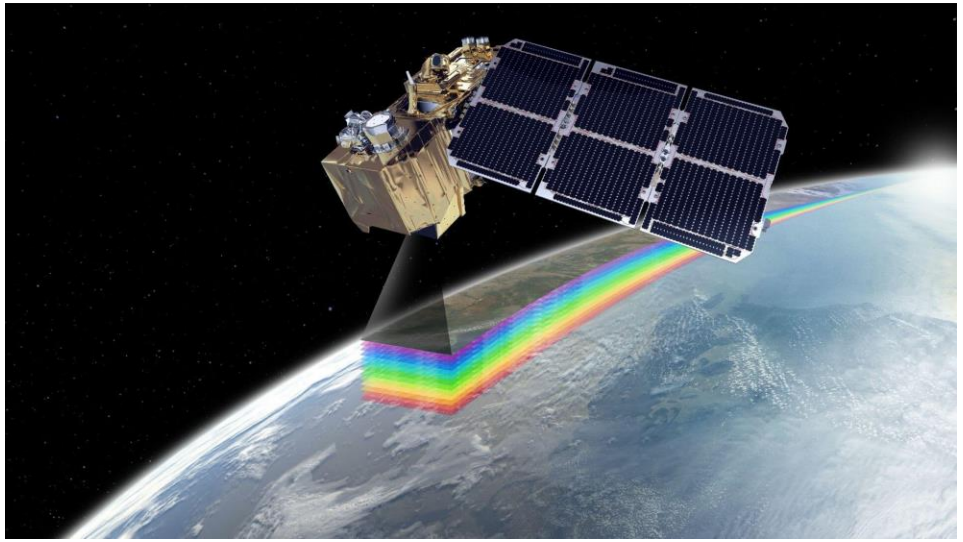
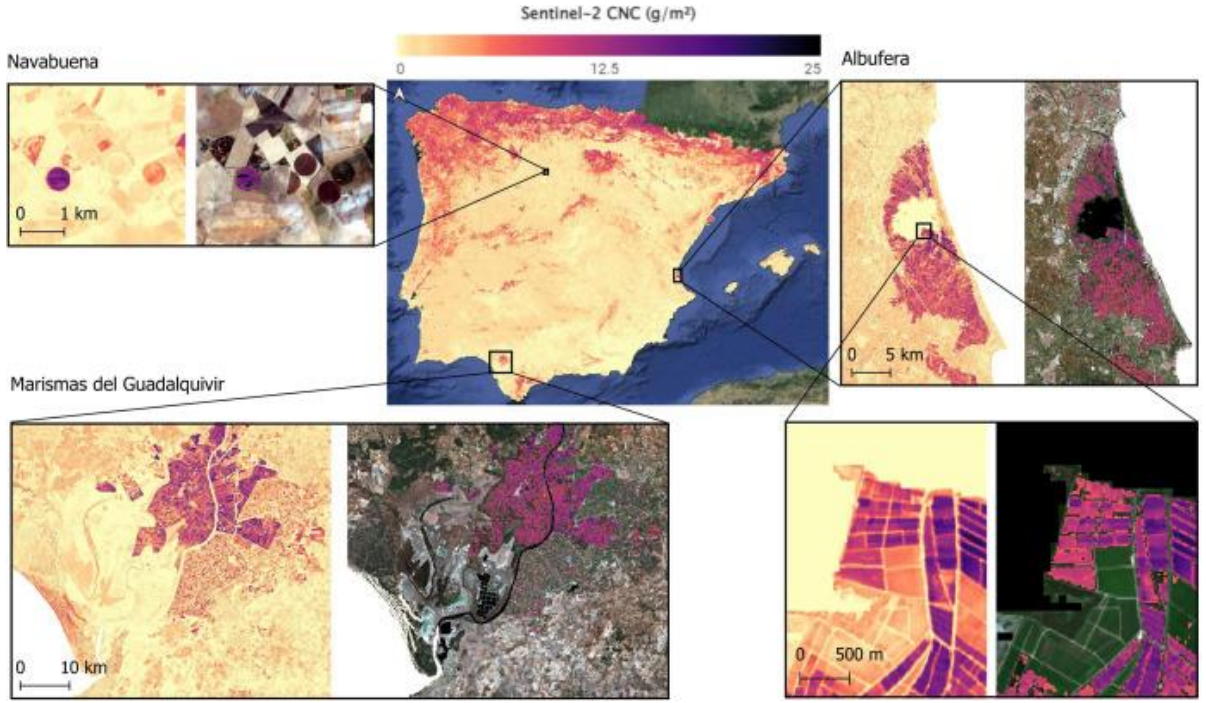
HYBRID MODELS FOR AGRICULTURE

EMMA DE CLERCK





VNIVERSITAT DE VALÈNCIA

Laboratory for Earth Observation

ABOUT ME

- PhD student at University of Valencia in Remote Sensing
- Master in Bioscience Engineering

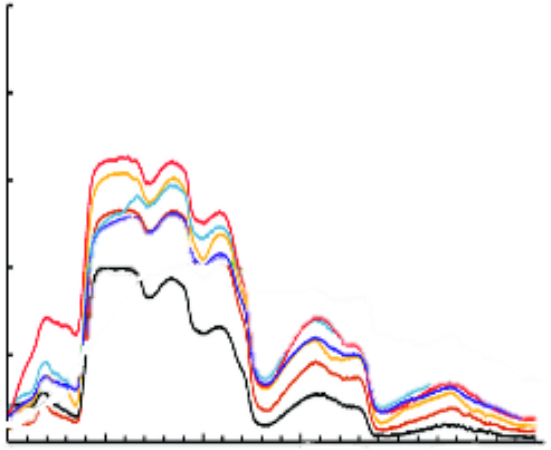
- Experience in:
  - Sentinel-2 and Sentinel-3 satellite data
  - Radiative Transfer Modelling
  - Machine Learning
  - Hybrid model optimisation and application

VNIVERSITAT DE VALÈNCIA

INTRODUCTION

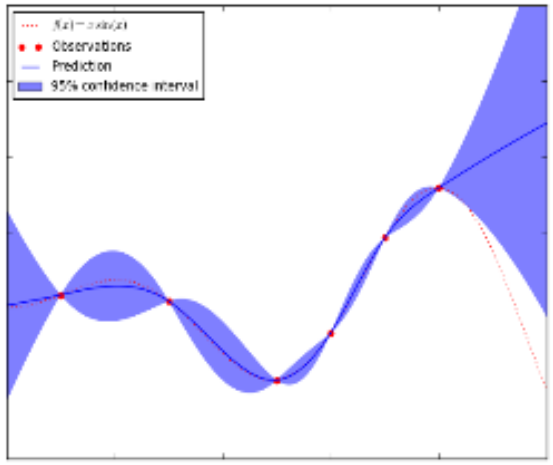
- Machine learning model for variable estimation:

Training data



Spectra and variable(s)

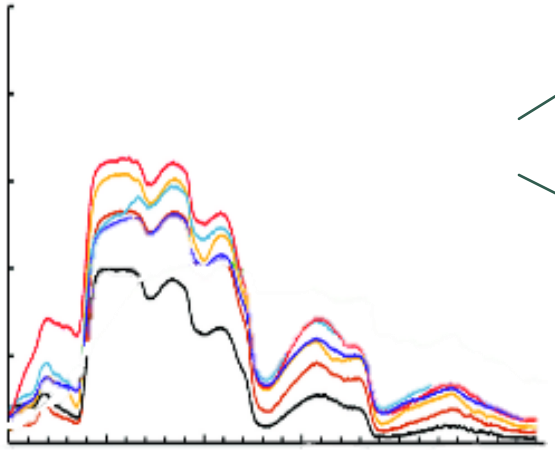
Trained model



Input: spectra from satellite
Output: estimate + uncertainty

HYBRID MODEL CONSTRUCTION

- Training data



Empirical: spectra + variable measurements

+ good measurements result in good model

- model trained for specific region, time etc. so low transferability

Theoretical: radiative transfer model (simulate spectra for variable distributions)

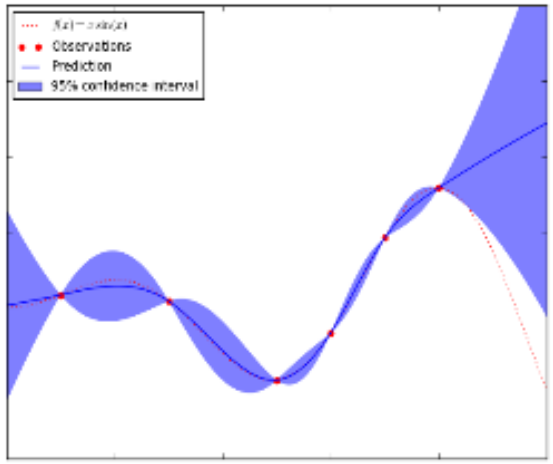
+ if variable distribution general, then general model with good transferability

Optimisation:

- Active Learning
- Adjust spectra, add manually

HYBRID MODEL CONSTRUCTION

- Model training



Gaussian Processes Regression

Several machine learning algorithms (MLRA):

ARTMO

Automated Radiative Transfer Modelling Operator

Hybrid model: RTM + MLRA

Export model:

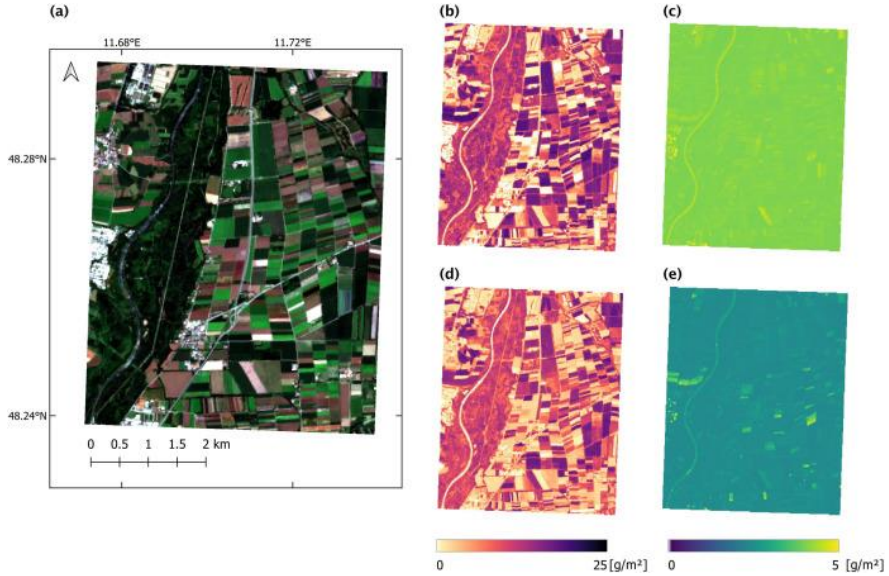
1. for local processing
2. for cloud processing with Google Earth Engine
3. for cloud processing with OpenEO

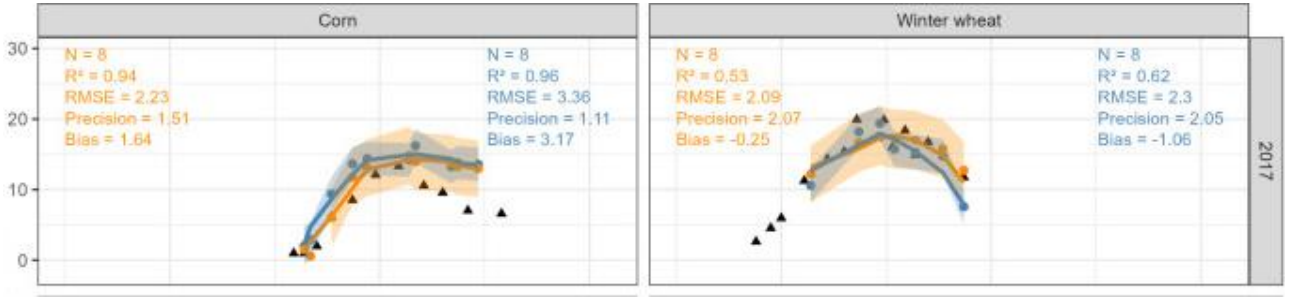
PyEOGPR

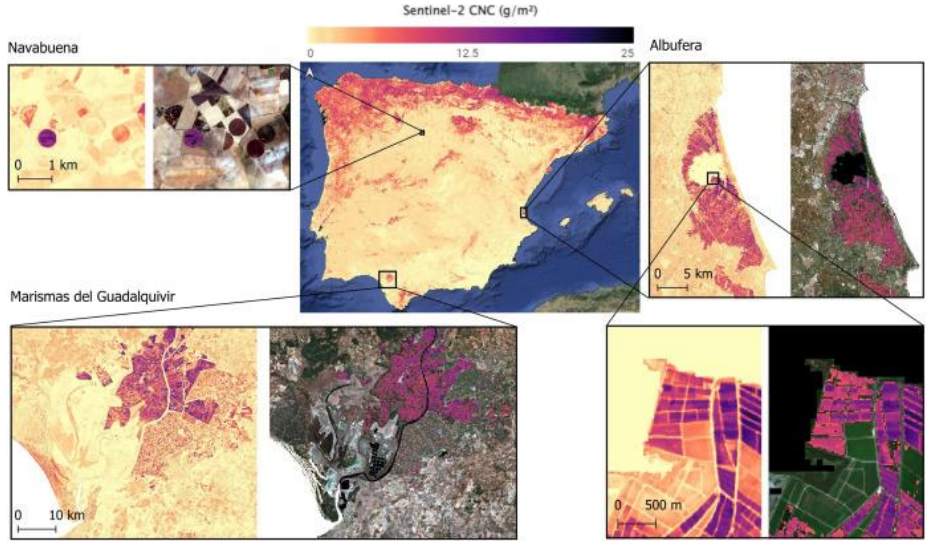
VNIVERSITAT DE VALÈNCIA

HYBRID MODEL APPLICATION

- **Canopy Nitrogen Content**
  - Trained with PROSAIL-PRO data for Sentinel-2 bottom-of-atmosphere reflectance
  - Model with protein-LAI & model with chlorophyll-LAI

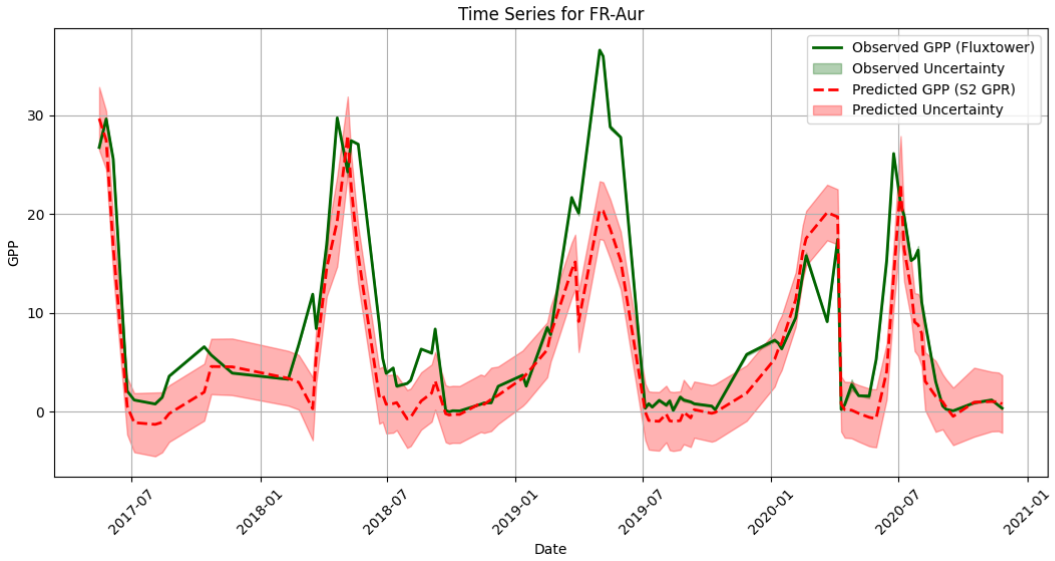


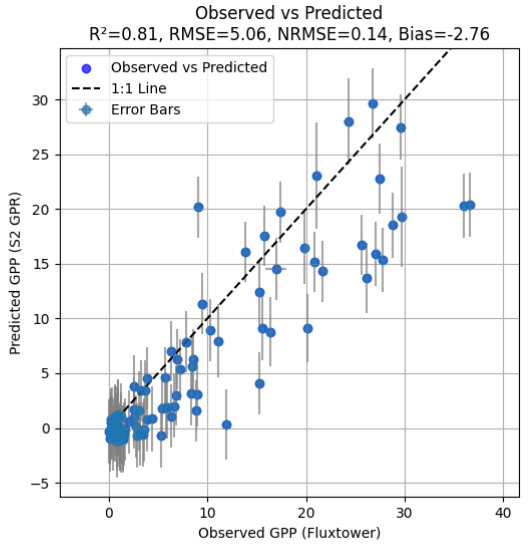




HYBRID MODEL APPLICATION

- **Gross Primary Productivity**
  - Trained with SCOPE data for Sentinel-2 bottom-of-atmosphere reflectance
  - Validation against flux towers in Europe
  - Work in progress…





VNIVERSITAT DE VALÈNCIA

HYBRID MODEL APPLICATION

- **PyEOGPR**
  - Python package for running GPR models in cloud computing platforms Google Earth Engine and OpenEO
  - Pre-trained hybrid models for vegetation trait mapping
  - Minimal coding skills required

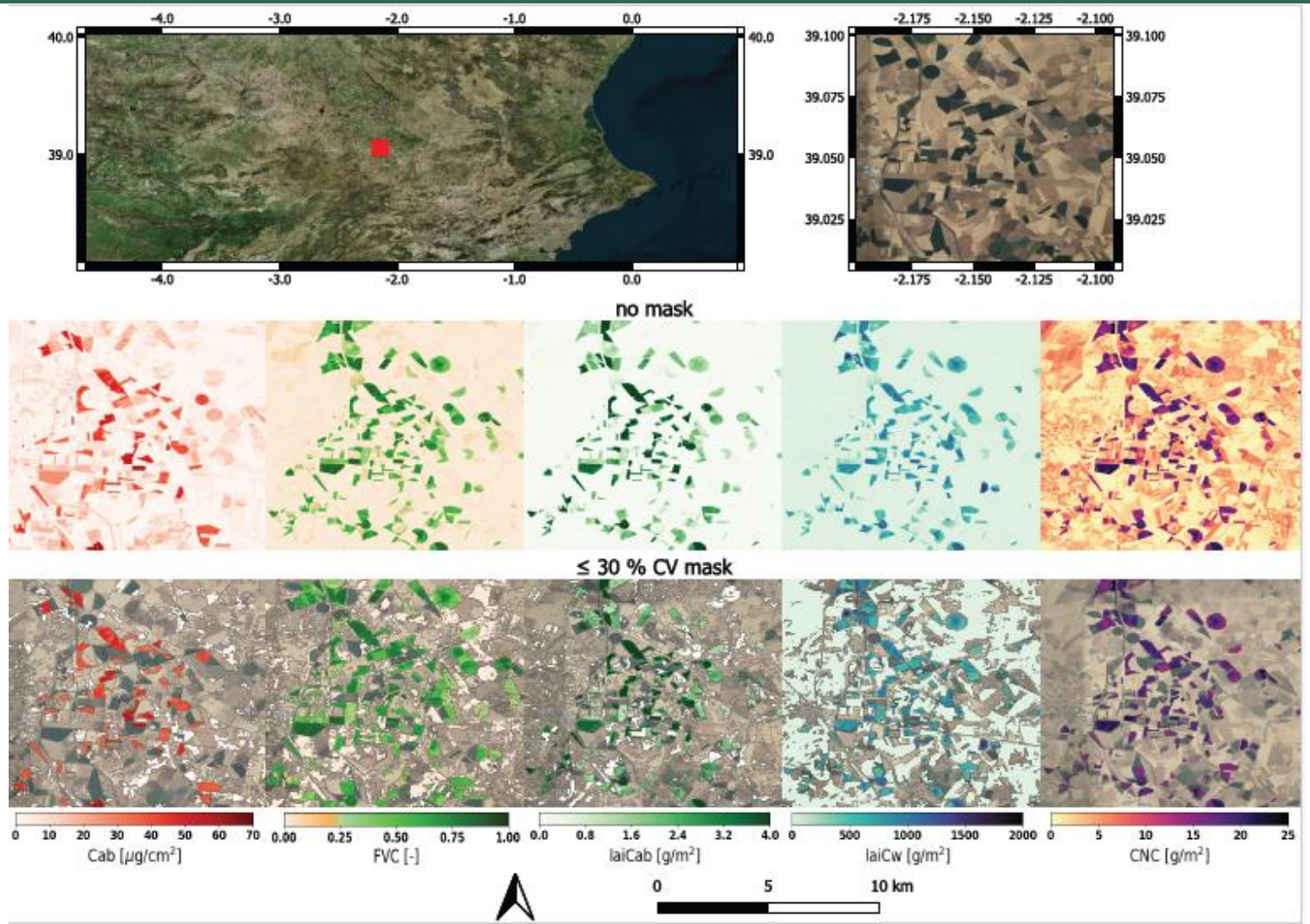
Model selection

Region and time

```
from pyeogpr import DataCube, EarthEngine

DC/EE = Datacube/EarthEngine(projectID  = <ee-USERNAME>, #if DataCube object no projectID needed
                  sensor = "SENTINEL3_L1B",
                  biovar = "FVC",
                  bounding_box = [17.836, 46.553, 18.368, 46.935], #west,south,east,north
                  temporal_extent =  ["2021-07-01", "2021-07-08"],
                  spatial_resolution  = 300, # in meters
                  cloudmask = True,
                  bands = None)

DC.construct_datacube("week")
EE.construct_datacube(composite = 7) # in days

DC.process_map(gapfill=True, fileformat="nc")
EE.process_map(assetpath = "projects/<ee-USERNAME>/assets/MyImageCollection/")
```

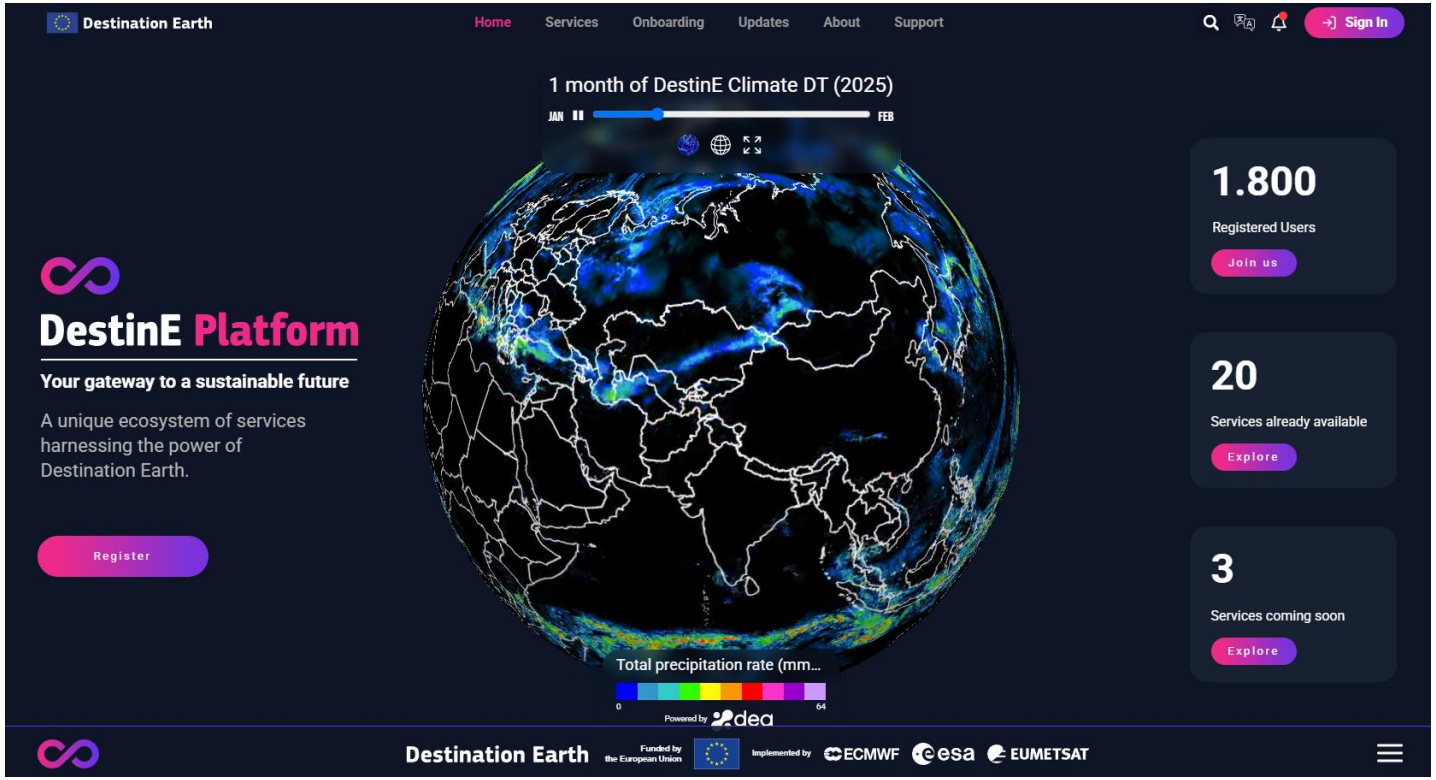
HYBRID MODEL APPLICATION

- **PyEOGPR**



HYBRID MODEL APPLICATION

- **SaveCrops4EU**
  - models for cropland
  - implementation in DestinE platform



VNIVERSITAT DE VALÈNCIA

QUESTIONS?

EMMA.CLERCK@UV.ES