EUMETSAT

PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

Using Jupyter Notebooks in Earth Observation Education @EUMETSAT

Julia Wagemann, Federico Fierli, Simone Mantovani

CEOS WGISS-53 Meeting | 22 March 2022

Executive Summary

Jupyter notebooks @EUMETSAT

LTPy
https://gitlab.eumetsat.int/eumetlab/atmosphere/atmosphere

TrainHub
https://trainhub.eumetsat.int/

Module on dust aerosol detection, monitoring and forecasting
https://dustbook.ltyp.adamplatform.eu

- Earth Observation training @EUMETSAT has to cater for different levels of data, thematic and programming literacy
- EUMETSAT has developed a series of Jupyter notebook trainings on different application areas, e.g. atmospheric composition
  - **Learning Tool for Python** (LTPy) on atmospheric composition consists of over 70 notebooks related to data access, analysis, data discovery, case studies, exercises and thematic modules
  - **TrainHub** – EUMETSAT's Jupyter notebook portal
  - **Jupyterbook** on 'Dust Aerosol detection, monitoring and forecasting'
- Using computational notebooks for training/education brings in a set of additional requirements that require the integration of didactical concepts, instructional design patterns and best practices for coding
- Needed: Defining, sharing and implementing quality standards and best practices on how to make notebooks effective, reproducible and educational
  - Systematic use of recommended Python libraries
  - Modularisation of content, e.g. outsource functions
  - Use of instructional design patterns
  - Follow a naming nomenclature to order notebooks in a specific sequence

Earth Observation training @EUMETSAT

Aim to increase use and overall uptake of EUMETSAT and Copernicus data

Target group and audience

Highly diverse group of EO practitioners

- Can be 'expert' users who would like to learn more about upcoming missions and data
- Also users who just started using EO data products for a specific application
- Coming from different geographical regions

Training types and needs

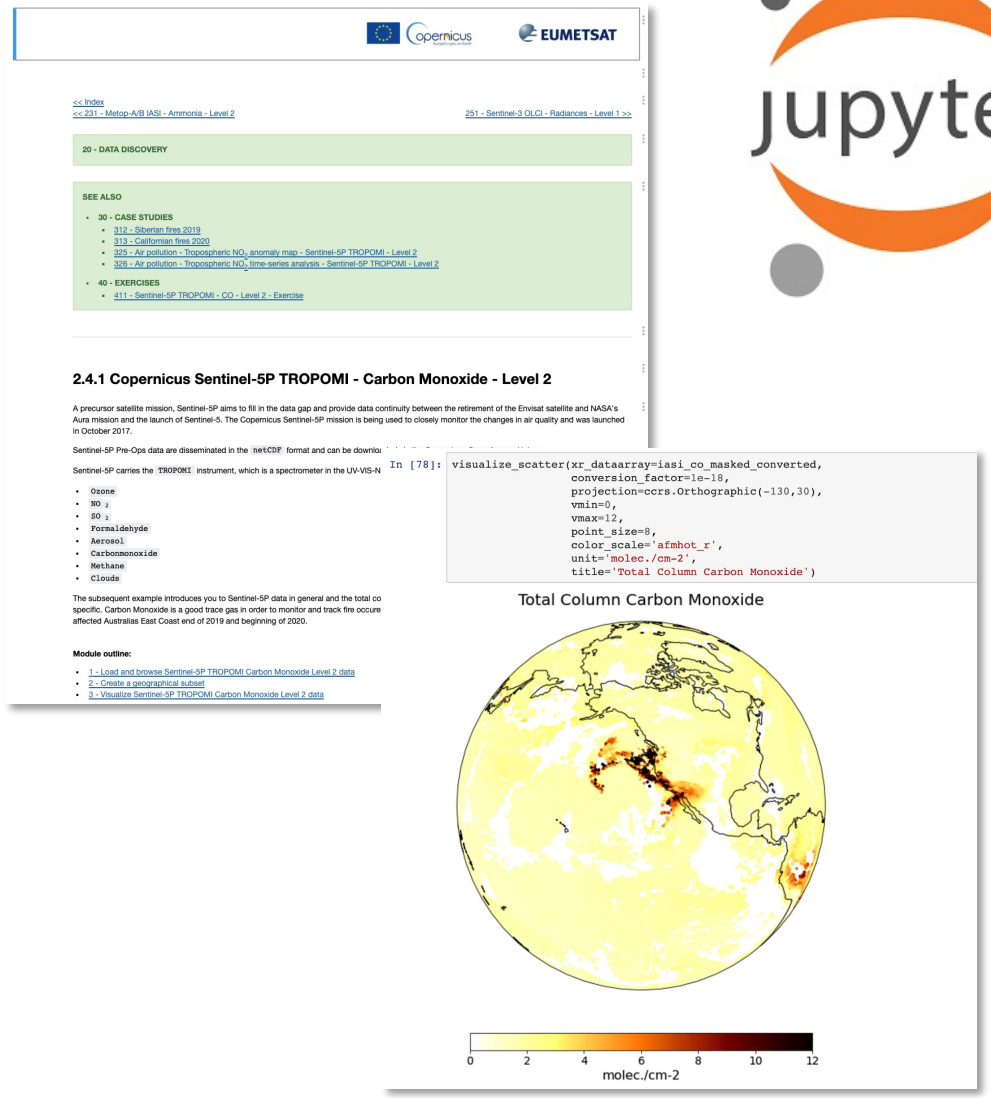
Different training types offered

- Short courses: light-weight introduction to a specific topic, usually 1 to 1.5 hours long
- Thematic expert workshops / training schools: multiple days, aimed at experts and graduate students

Training has to

- cater for different levels of data, thematic and programming literacy
- Offer a high degree of flexibility in terms of how the courses and modules can be taught

Jupyter notebooks – an introduction



Interactive web application that combines code, computational output, explanatory text and multimedia resources

- Became a popular tool for data exploration, analysis and training. In 2021, there are more than 10 million Jupyter notebooks available on Github

Beyond notebooks – the Project Jupyter ecosystem

GitHub

Hosting of Jupyter notebooks

GitLab

Static rendering / sharing of notebooks

jupyter nbviewer

No-setup, customizable, Jupyter Notebooks environment

colab

binder

kaggle

Group and multi-user access to notebooks on a remote server

jupyterhub

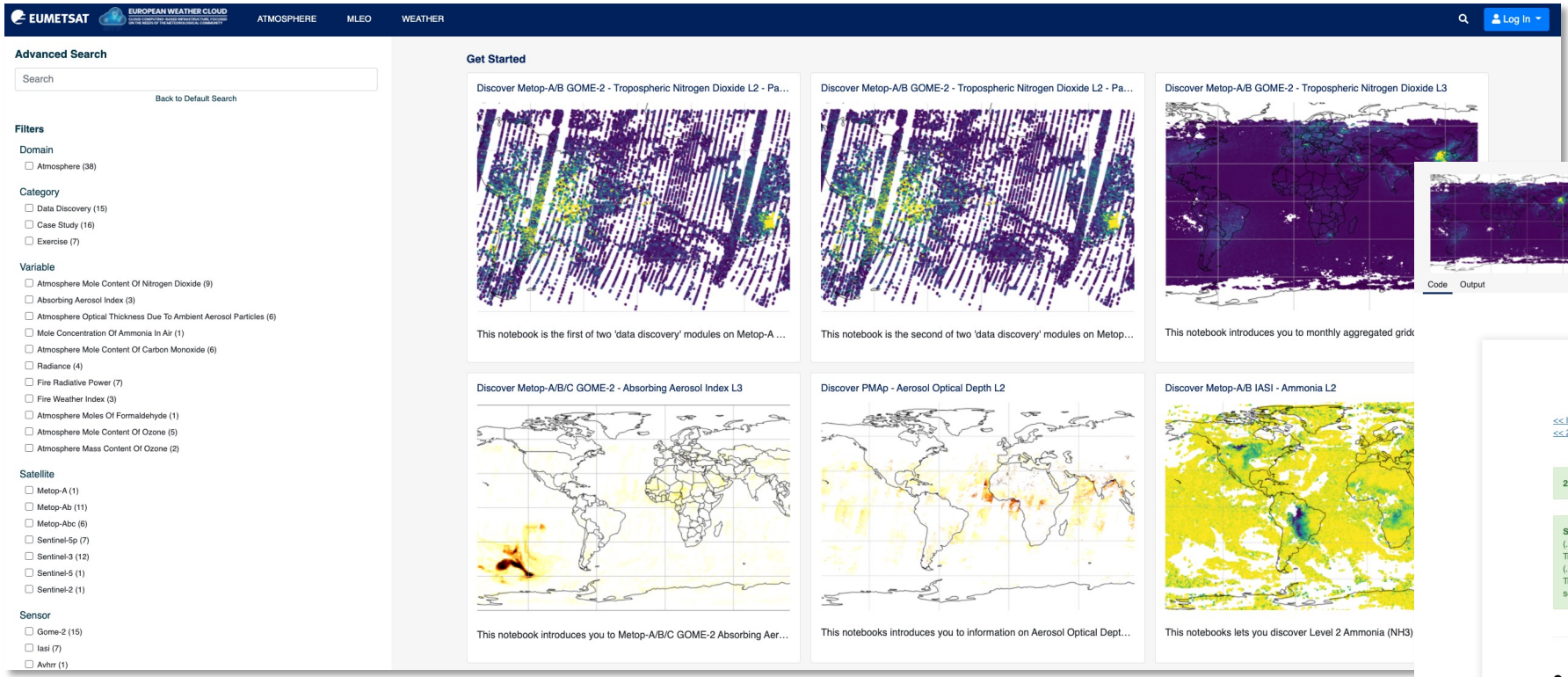
lab

Jupyter notebook examples for EO training @EUMETSAT

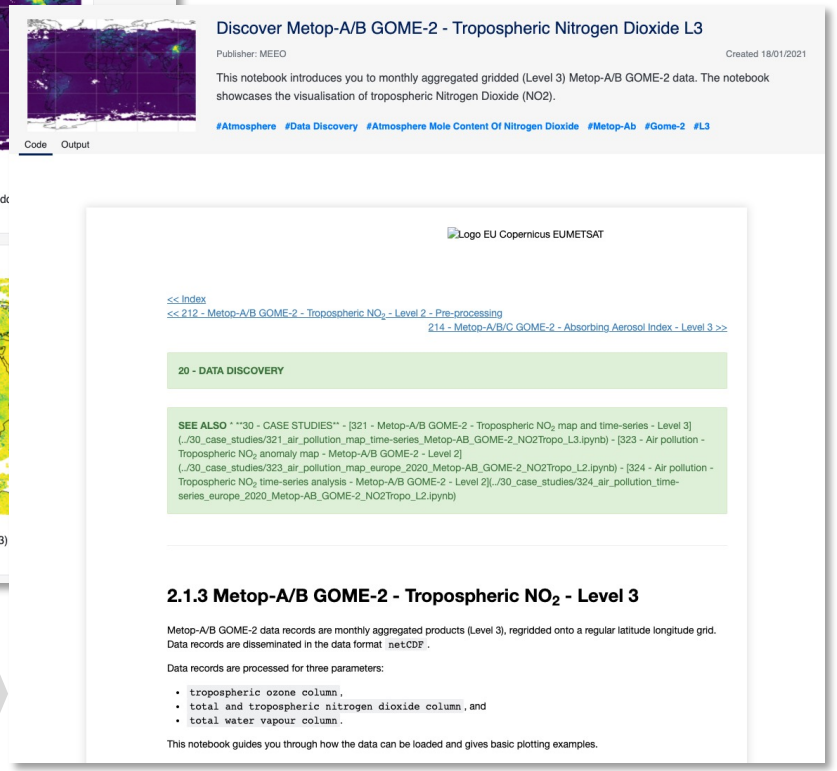
Trainhub – EUMETSAT's Jupyter notebook portal

https://trainhub.eumetsat.int/

Different domains



Login to a Jupyterhub-based processing platform



Search functionality based on notebook metadata

Overview of training notebooks available

Static rendering of the notebook

Jupyter notebook examples for EO training @EUMETSAT

Trainhub – EUMETSAT's Jupyter notebook portal

https://trainhub.eumetsat.int/

No extra database – all information required for the Trainhub protal are **stored on notebook level as metadata**

```
"metadata": {
 "title": "Discover Sentinel-3 OLCI Level 1 data",
 "description": "This notebook introduces you to …",
 "author": "Julia Wagemann",
 "image": "./img/img_04.png",
 "link": "link_to_jupyterhub/notebook.ipynb",
 "github": "link_to_github/notebook.ipynb",
 "tags": {
    "domain": "atmosphere",
    "variable": "toa_reflectance",
    "satellite": "Sentinel-3",
    "sensor": "OLCI",
    "level": "L1"}
 },
```

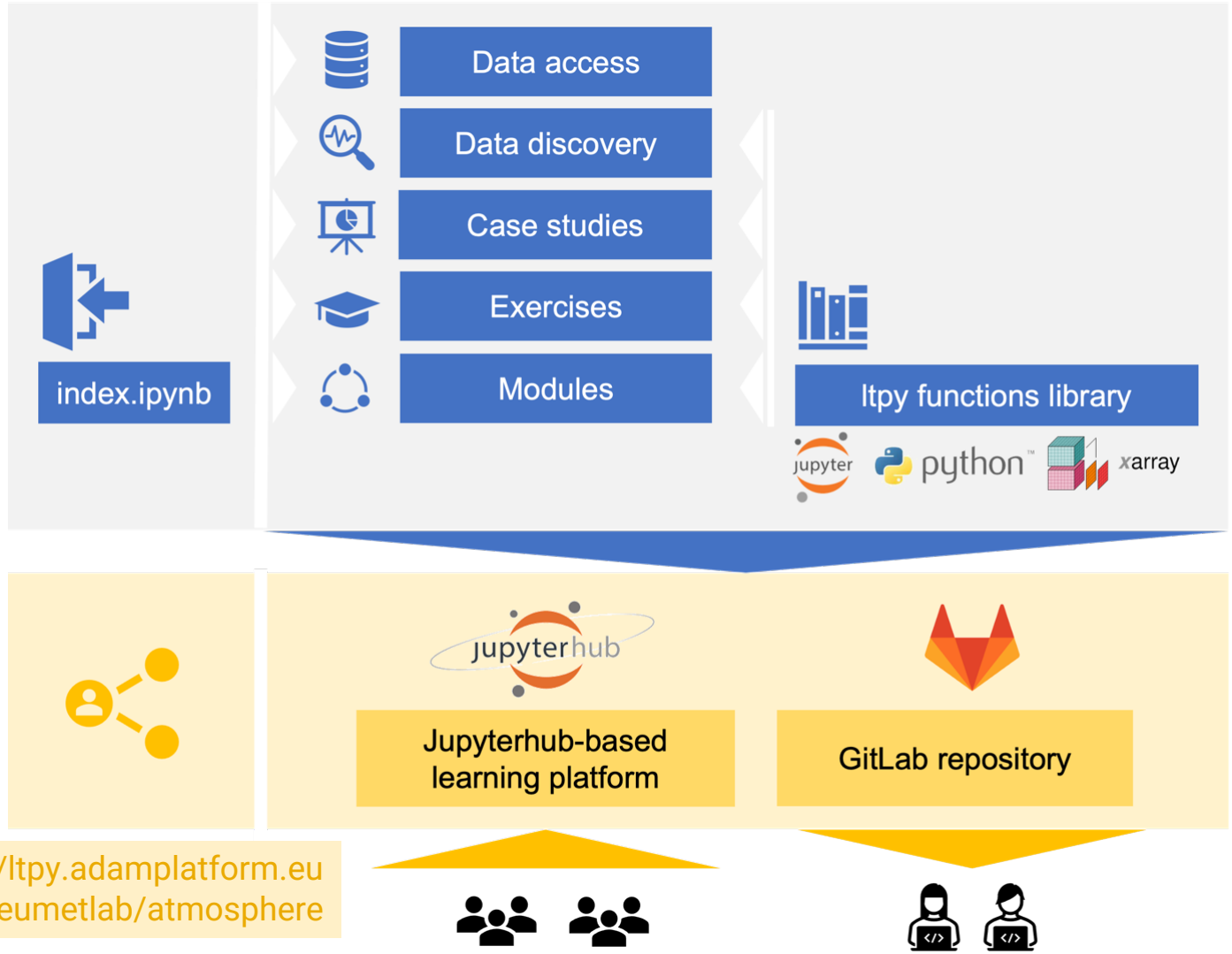
Example: Learning Tool for Python on Atmospheric Composition

Jupyter-based training course on open satellite- and model-based data for atmospheric composition

Data from 6 different satellites and 5 different model-based products

Over 70 notebooks related to (i) data access, (ii) data discovery, (iii) case studies, (iv) exercises and (v) thematic modules

A collection of 14 reusable functions for effective visualization and data handling



https://ltpy.adamplatform.eu
https://gitlab.eumetsat.int/eumetlab/atmosphere

Best practices: A need for ‘educational’ and ‘reproducible’ notebooks

- to make notebooks educational and reproducible
- To cater for different levels of data, thematic and programming literacy

Systematic use of recommended Python libraries for handling EO data

Modularisation of content, e.g. to outsource functions in a separate notebook

Use of instructional design patterns, such as navigation pane or a table of contents

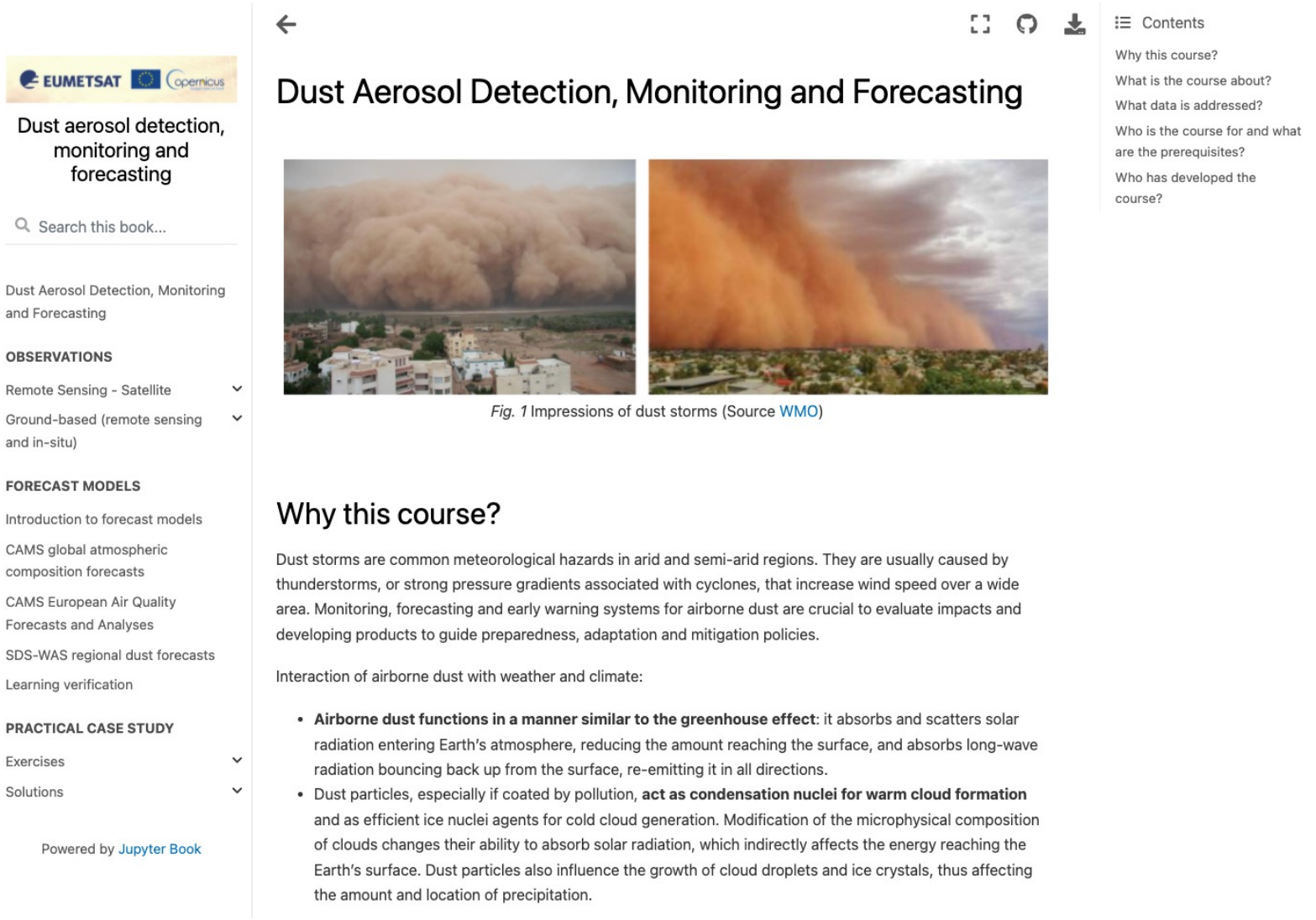
Follow a naming nomenclature, to order notebooks in an expected sequence. Include an index notebook.

Best practices: Making educational notebooks ‘accessible’

Module on ‘Dust Aerosol Detection, Monitoring and Forecasting

Jupyterbook

Work in progress:
https://dustbook.ltpy.adamplatform.eu/



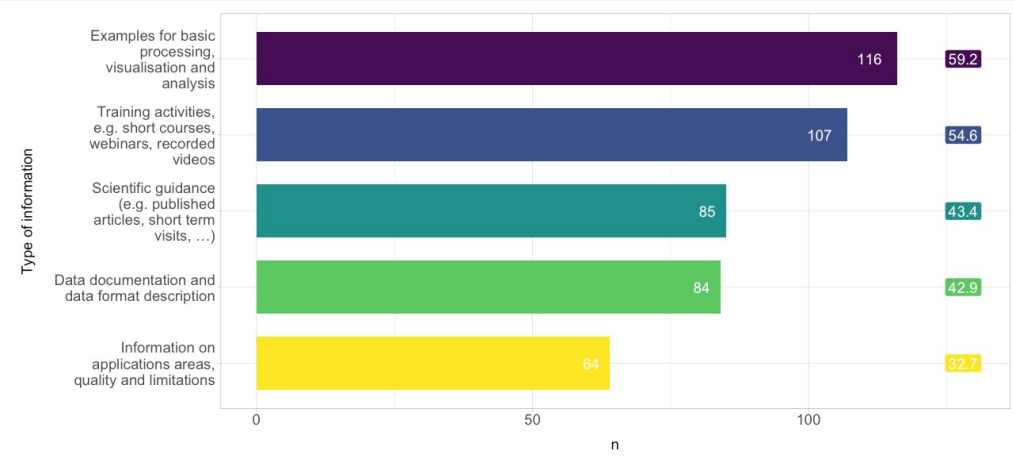
LTPy: Feedback from training participants

Since 2019, 1085 learners trained in 16 training events

Type of training	Number of events	Number of participants
Training schools	6	553
Thematic expert workshops	2	130
Short courses	8	402
Total	**16**	**1085**

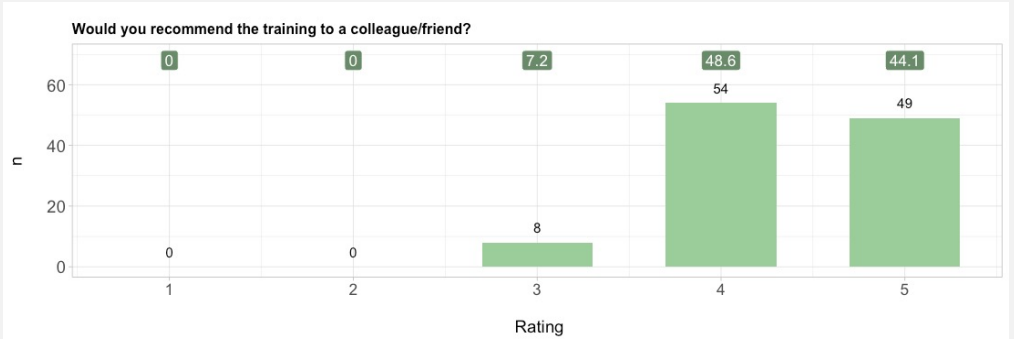
Needs

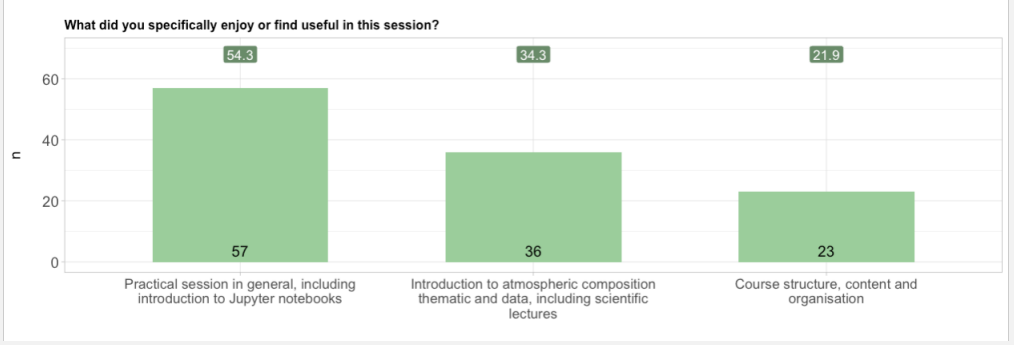
Training in line with user needs. More than half consider *examples for basic processing, visualisation and analysis* and *training activities* as helpful



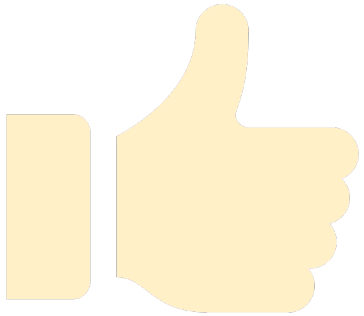
Training feedback

Feedback overall very positive. Practical training part with Jupyter notebooks is particularly useful.





Lessons learned – Things that work well and don't work so well

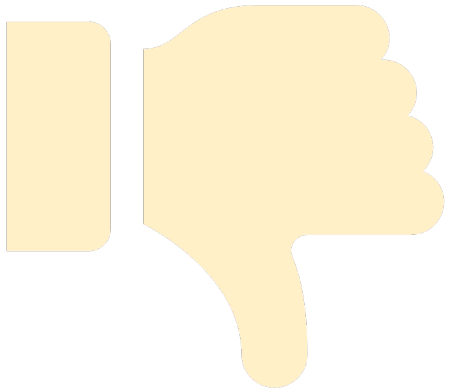


Advantages

- Notebooks remove elements of fear – people are more familiar with a browser than a command line
- Notebooks allow to break up the code into step-by-step workflows and also to describe the workflow in richer ways
- The wider ecosystem, including sharing and hosting notebooks, make notebooks well suited as a teaching tool
- Useful as training material in an instructor-led setting and for self-paced learning alike

- Accessing data and using Python in the browser is a paradigm-change
- Compromise between having a pre-installed Python environment setup vs. learning how to setup the environment
- Compromise between downloading data vs. making data already available on the training platform (fragmentation of data landscape a barrier)

Challenges



Conclusion & Outlook

- In less than a decade, Jupyter notebooks became the de-facto standard to conduct data science, including analysing Earth observation data.
- Jupyter notebooks and the Jupyter ecosystem, such as JupyterLab, will play a significant role in how users of EO data will access and process data in the future
- Using computational notebooks for training/education brings in a set of additional requirements that require the integration of didactical concepts, instructional design patterns and best practices for coding

Next step

Defining, sharing and implementing quality standards and best practices on how to make notebooks effective, reproducible and educational