

Reproducing the open weather forecast charts using Python and Jupyter notebooks



Milana Vučković

Forecast Department, ECMWF, Reading, United Kingdom
milana.vuckovic@ecmwf.int @VuckoMilana

Introduction

Following the Council decisions, ECMWF started the move towards serving data to users beyond operational forecasters in Member states and commercial customers for a charge. So far, this move included opening hundreds of web forecast charts and making archived data available under a Creative Commons open licence and the production of open subset of real time medium range forecast.

In order for the data to be more FAIR (Findable, Accessible, Interoperable and Reusable), additional development work is being done. This work includes the design of an API to easily download the data, and the development of open-source Python libraries to process and visualise it.

To present these new tools and help users understand how to retrieve and process ECMWF data, a set of Jupyter notebooks was created, each of them reproducing workflow for one open weather forecast chart from the downloading the data to the visualisation.

ECMWF open data: real-time forecasts

From January 2022, ECMWF made a wide range of ensemble and high-resolution forecast data openly available

- Real-time Open Data is provided with an open licence (CC-BY-4.0). It can be accessed via the public ECMWF web site or using a public API.
- It is a subset of the full Catalogue of ECMWF Real-time Products and are based on the medium-range and seasonal forecast models.
- All the data in this data set is available at 0.4° horizontal resolution
- The files are in GRIB 2 format, except for trajectories which are in BUFR edition 4 format.

Currently, these data are available from two different locations:

- ECMWF, with ROOT set to <https://data.ecmwf.int/forecasts/>
- Microsoft's Azure, with ROOT set to "https://ai4edataeuwest.blob.core.windows.net/ecmwf"

Full list of parameters in Open Data set can be found [in the documentation](#) or by scanning QR code:



New Python libraries for downloading, processing and visualising ECMWF data

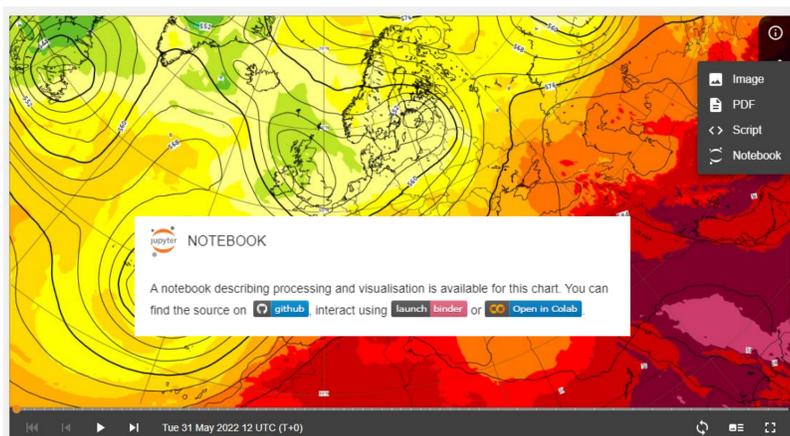
For many years Metview can be used to download, process and visualise ECMWF data. Even though Metview is very powerful and has Python interface, we wanted to give users the flexibility to combine ECMWF libraries with other libraries from Python ecosystem. As the work on these new libraries has just started in 2021, they are all in the early stage of development, we welcome any feedback from the users.

- Download the open data using **ecmwf-opendata** Python API:
 - ✓ It is easy to use and has an interface and language very similar to MARS and dissemination.
 - ✓ The data can be downloaded from either ECMW or Microsoft Azure servers.
 - ✓ Entire files can be downloaded using wget and curl, but for downloading parts of the data set, such as a few parameters, ecmef-opendata API is much more convenient.
- Process the GRIB data using **ecmwf-data** Python library:
 - ✓ It can be used to load one or more GRIB files into a Fieldset
 - ✓ Easy to use for quick inspection of GRIB data, especially in Jupyter notebooks
 - ✓ It has powerful data filtering capabilities and numerical operations between Fieldsets and numbers, as well as Fieldsets and other Fieldsets.
- Visualise the GRIB data using **Magpye** Python library:
 - ✓ New visualisation Python library designed to be more Pythonic and easy to use, especially for users coming from other Python visualisation libraries
 - ✓ It has built in automatic styles for many meteorological parameters
 - ✓ Its documentation contains gallery of styles, so users can find the appropriate one for their data.



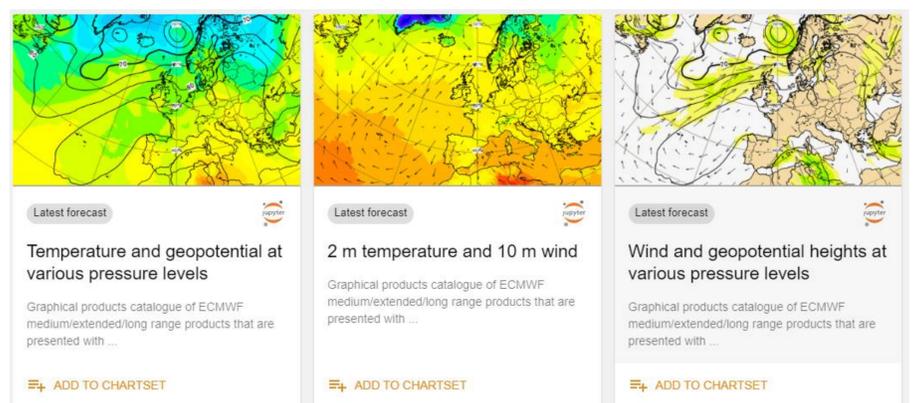
Production of Jupyter notebooks

- To present these new tools and help users understand how to retrieve, explore and process ECMWF data, a set of Jupyter notebooks was created, each of them reproducing one open weather forecast chart.
- A set of 50 Jupyter notebooks was produced so far. The plan is to continually add new ones.
- This work also serves to review and improve the products.
- Open charts products were divided in groups by type of visualisation and complexity of processing needed. A template was made for each group which made a production of each notebook much faster.
- Products which have Jupyter notebooks available can be recognized by Jupyter icon in the catalogue. Notebooks are available to view on GitHub and to try on MyBinder and Google Colab service.



Maintaining the Jupyter notebooks and future work

- Presented libraries are very young and significant changes are expected in future. The work on new postprocessing libraries has also begun.
- Due to this, and the number of open charts products which is over 200, these notebooks need to be easily updatable.
- Luckily, Jupyter notebooks are in fact json files, so Python scripts can be used to update them in bulk and new notebooks can easily be made from templates.



All produced notebooks can be found on GitHub on this link:

<https://github.com/ecmwf/notebook-examples/tree/master/opencharts>

Or by scanning the QR code:

