

## Instructions for using ECMWF Reanalysis v5 (ERA5) model wind data in mDOAS

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### ECMWF Reanalysis v5 (ERA5)

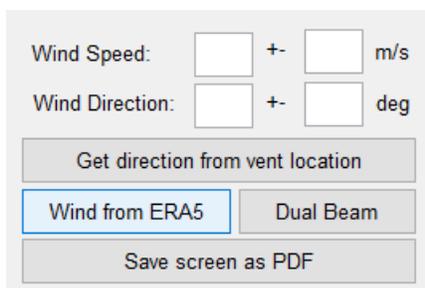
*ERA5 is the fifth generation European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis of the global climate covering the period from January 1940 to present. ERA5 is produced by the Copernicus Climate Change Service (C3S) at ECMWF.*

*ERA5 provides hourly estimates of a large number of atmospheric, land and oceanic climate variables. The data cover the Earth on a 30km grid and resolve the atmosphere using 137 levels from the surface up to a height of 80 km.*

Source: <https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5>

### Accessing ERA5 from mDOAS

As of this writing, the ERA5 global model wind product is regarded by the scientific community to be the most accurate global re-analysis product available. Therefore, functionality for importing wind information from ERA5 has been implemented in mDOAS in versions 3.17 and higher. If other, more accurate information on wind speed is not available for a given DOAS measurement, the ERA5 repository can be queried with a single click on the 'Wind from ERA5' button in the Results section of the mDOAS Spatial Dialog.



The screenshot shows a user interface for wind data input. It features two rows of input fields: 'Wind Speed' and 'Wind Direction'. Each row has a text input box, a '+-' symbol, and a unit label ('m/s' for speed and 'deg' for direction). Below these are four buttons: 'Get direction from vent location', 'Wind from ERA5' (highlighted with a blue border), 'Dual Beam', and 'Save screen as PDF'.

Clicking this button extracts the wind speed and wind direction at the vent location of the selected volcano. If a different location is desired, the user can provide custom coordinates by selecting the 'Custom' volcano and entering geographic coordinates and altitude manually in the appropriate fields.

However, mDOAS does not currently incorporate functions to download ERA5 data from ECMWF servers. This must be done manually, and the data saved locally in NetCDF format for mDOAS to access. The instructions for downloading data and making it available to mDOAS are provided below.

## Downloading ERA5 data from ECMWF

- Go to the ECMWF ERA5 website:  
<https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5>
- On the right side of the screen, under “Explore this dataset”, click on “Climate Data Store”. This will take you to the Copernicus data portal with various flavors of the ERA5 data listed.

The screenshot shows the Copernicus Data Store search results for ERA5 datasets. The search criteria are: ERA5, Reanalysis, Global, Past, Copernicus CDS. The results list several datasets with filters for Product type, Variable domain, Spatial coverage, Temporal coverage, Sector, and Provider. The datasets listed are:

- ERA5-Land hourly data from 1950 to present** (Updated 2023-04-11)
- ERA5-Land monthly averaged data from 1950 to present** (Updated 2023-04-11)
- ERA5 hourly data on pressure levels from 1940 to present** (Updated 2023-04-11)
- ERA5 hourly data on single levels from 1940 to present** (Updated 2023-04-11)
- ERA5 monthly averaged data on pressure levels from 1940 to present** (Updated 2023-04-11)

Each dataset entry includes a brief description and a small thumbnail image. At the bottom of the page, there is a cookie consent banner and a 'Give me more info' button.

- You will need an account to download data. Accounts are free and easily created by clicking on the Login/register field at the top right of the Climate Data Store site.
- Once you have an account and have logged in click on “ERA5 hourly data on pressure levels from 1940 to present”. This will take you to the overview page.
- At the top of this page, click on “Download data” to access the data selection mask.

The screenshot shows the data selection mask for ERA5 hourly data on pressure levels from 1940 to present. The page has a navigation bar with 'Overview', 'Download data', 'Quality assessment', and 'Documentation'. A survey notice is displayed: "To improve our service, we need to hear from you! Please complete this very short survey. Thank you." The selection mask includes:

- Product type:** Reanalysis (checked), Ensemble members, Ensemble mean, Ensemble spread.
- Variable:** A list of variables with checkboxes, including Divergence, Geopotential, Potential vorticity, Specific cloud ice water content, Specific humidity, Specific snow water content, U-component of wind, Vertical velocity, Fraction of cloud cover, Ozone mass mixing ratio, Relative humidity, Specific cloud liquid water content, Specific rain water content, Temperature, V.component of wind, and Vorticity (relative).

On the right side, there is a 'Contact' section with links to the ECMWF Support Portal, Licence, and Publication date (2018-06-14). Below that is a 'References' section with a citation and DOI (10.24381/cds.bd0915c6). At the bottom right, there is a 'Related data' section with a circular icon.

- This mask allows you to select the subset of the > 80 years of global climate data that you are interested in. To generate a useful dataset for use with mDOAS, make the following selections:
  - o Product type: Reanalysis
  - o Variable: U-component of wind & V-component of wind
  - o Pressure level: Here you will need to make appropriate selections that surround the altitude levels that you are interested in. For example, let's assume we are working on data from Cleveland Volcano. Cleveland's vent is at 1700 m above sea level. We can translate this to an approximate pressure using the equation:

$$p = p_0 \cdot \exp\left(-h/H_s\right)$$

Here,  $p_0$  is the pressure at sea level (~1000 hPa) and  $H_s$  is the scale height of the atmosphere (~8 km). Entering  $h = 1.7$  km, we get  $p = 809$  hPa. This is the approximate air pressure at the vent location.

To allow interpolation of the wind speed at the vent location, include at least 2 levels above and below the pressure altitude of the vent. In the example of Cleveland, the vent's pressure altitude is approximately 800 hPa so we would select 750, 775, 800, 825, and 850 hPa.

- o Year, Month, Day, Time: Here you would just select the time period that you are interested in. Be sure to include all data ranging from at least 1 hour prior to the first measurement to 1 hour after the last measurement is finished.
  - o Geographical Area: Specify the edges of the region you are interested in. The region should span at least 1 full degree to all sides of the volcano. Note that the western hemisphere is represented by negative longitude values. In the example of Cleveland (52.825N, 169.944W), we might select North: 54; South: 51; West: -171; East: -168.
  - o Format: NetCDF (experimental)
- When you are finished selecting the subset of data you are interested in, click "Submit Form" at the bottom of the page. If you get an error saying that the selected dataset contains too many points, you will need to reduce your selection, splitting up the data into multiple files for download. The easiest way to do this is typically by selecting only part of the time window, then going back and selecting the next time period, and so on until you have requested all the data you are interested in.
  - Once you have submitted your request, a page will appear which lists all recent requests.

## Your requests

To improve our service, we need to hear from you! Please complete this very short survey. Thank you.

[All](#)
[Queued](#)
[In progress](#)
[Failed](#)
[Unavailable](#)
[Complete](#)

Auto refreshed : 13:52:19

[Delete selected](#)

| Product  | Submission date     | End date            | Duration | Size   | Status                   |
|--|---------------------|---------------------|----------|--------|--------------------------|
| ERAS hourly data on pressure levels from 1940 to present | 2023-04-19 13:52:19 |                     | 0:00:02  |        | Queued                   |
| ERAS hourly data on pressure levels from 1940 to present | 2023-04-19 13:49:09 | 2023-04-19 13:50:21 | 0:01:12  | 1.3 MB | <a href="#">Download</a> |

- Each request will first appear as “Queued”, then “In Progress”. Once the data have been retrieved, a green “Download” button will appear. Click this button to download the dataset. Save it in an accessible folder on your computer, e.g. in C:\mDOAS\_v3.19\ERA5\. It is recommended that you give the file a name that indicates what data it includes, e.g. “Cleveland\_2020-10-03\_to\_2020-10-17.nc”.
- You have successfully downloaded the ERA5 data and can now use these in mDOAS. If you have not already done so, you will first need to tell mDOAS where to find the ERA5 data (described below).

### Setting the ERA5 repository path in mDOAS

- Start mDOAS and open the Spatial Analysis dialog.
- In the File menu at the top of the dialog, click “Set ERA5 Repository Path”.
- Select the directory in which the ERA5 data files that you previously downloaded are stored.
- The repository files will be loaded to memory. mDOAS will remember this location for future use. There is no need to reset the repository path unless you change the location of the ERA5 data files on your computer.