Title	Consolidation of the updated VA services by RIs
Work package n°	5
Deliverable n°	5.7
Lead beneficiary	NILU
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Accepted by	
Comments	The deliverable was delayed by a few months to integrate the latest developments from the interactive training team.

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ATMO ACCESS
Access to Atmospheric Research Facilities

Table of Content

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Introduction

The aim of this report is to provide an overview of the ATMO ACCESS Virtual Access services developed partly and further improved throughout the ATMO ACCESS project. All services, including tools for data curation archiving and access, trajectory and footprint analysis, time series analysis and MOOC, are tailored to various user needs. Extensive outreach has promoted these services at numerous events, fostering awareness and user engagement. Scientifically, the services have already demonstrated a significant impact by supporting research collaborations, publications, and the development of new data products, even though the services have not been available for a long period.

The ATMO ACCESS Virtual Access Portal

Type of service	1. Unified entry to all ATMOS ACCESS VA services 2. API for gathering user statistics
Type of access	Request scheme on a web page.

The ATMO ACCESS VA portal is accessible from the ATMO ACCESS web site and through the direct link https://www.atmo-access.eu/virtual-access/#/.

Figure 1 Entry page of the ATMO ACCESS Virtual Access portal

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At the entry page, users need to login first. For this the VA portal redirects to the Single Sign On facility of the French national data portals AERIS and Data Terra. Here users can login using a local account, ORCID, eduGAIN or ENVRI ID account.

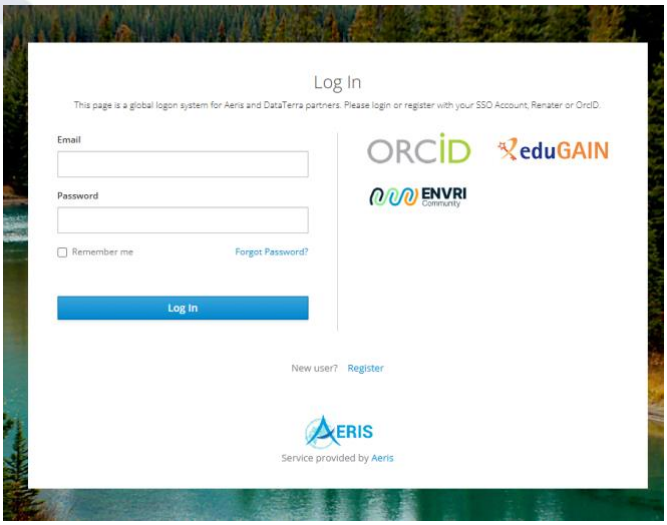

Figure 2 Single Sign on screen for the ATMO ACCESS Virtual Access services

After successful login the user will have the choice for the different services through a set of large icons, guided by a short description of the services. The page also allows the user to directly provide feedback on the VA tool through a link in a highlighted button and a QR code.

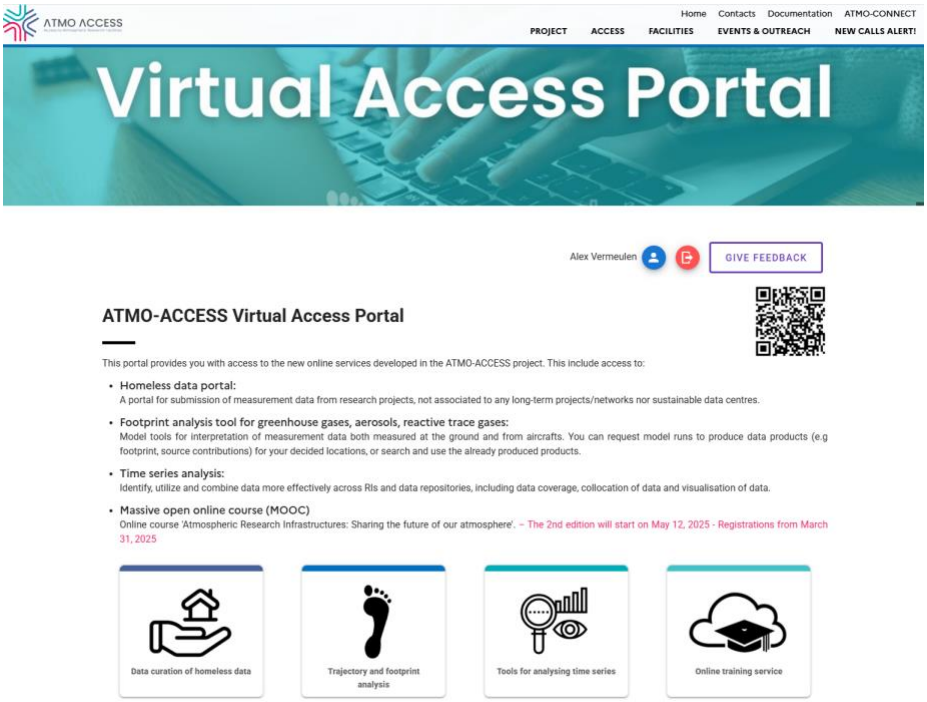

Figure 3 Entry page for all ATMO ACCESS VA services after login

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The Homeless Data Portal

Type of service	1. Data processing procedures provided by experts through helpdesk. 2. Long-term storage of and access to well described data.
Type of access	Request scheme on a web page.

Description of service

The Homeless Data Portal is a data curation system providing long-term storage of atmospheric measurement data. The portal is set up to serve scientists producing atmospheric measurements and time series resulting from research campaigns and TNA activities that are normally not covered by any data management or data curation system or activity. Depending on the needs, the portal routes the user requests to the corresponding RI system and experts, where the RI experts will provide training, tools for data curation/submission, quality control tests, store the data in long-term databases and make the data available for end-users through data portals and by assigning the data set(s) DOI(s). A detailed description of the service can be found in D5.3 – Report describing data curation service.

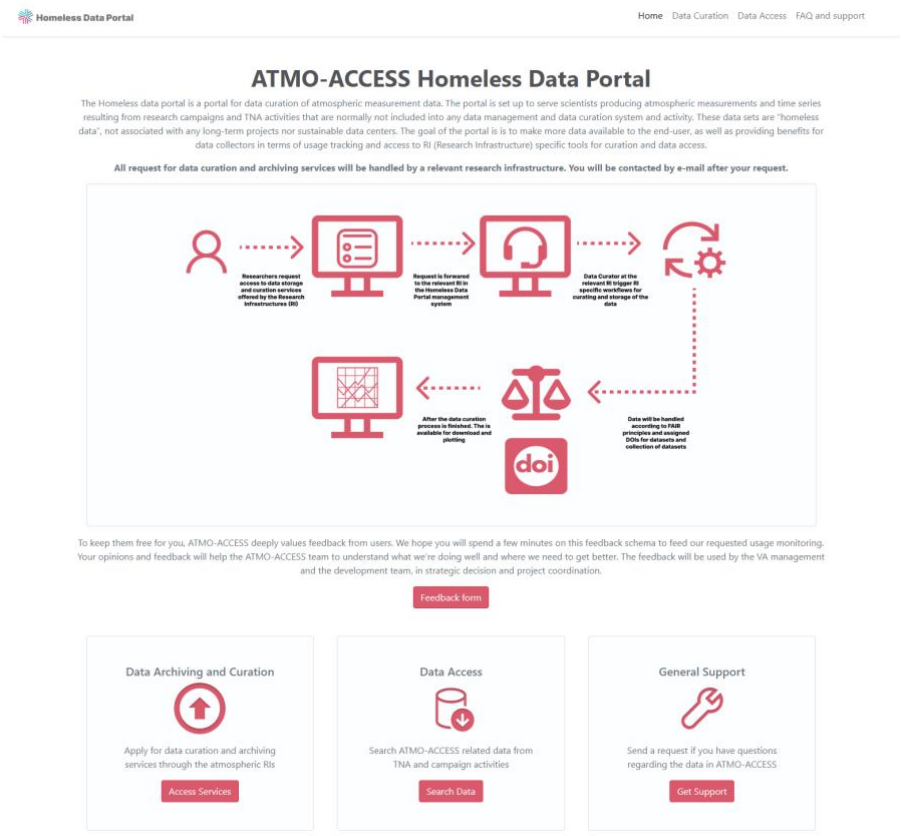

Figure 4 The starting page of the ATMO ACCESS Homeless data portal

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Trajectory and footprint analysis tools

Three atmospheric footprint services are offered, each catering to different requirements for the different components measured and analyses carried out with the data.

In the VA Portal the users can therefore select one of the three available virtual tools for footprint analysis.

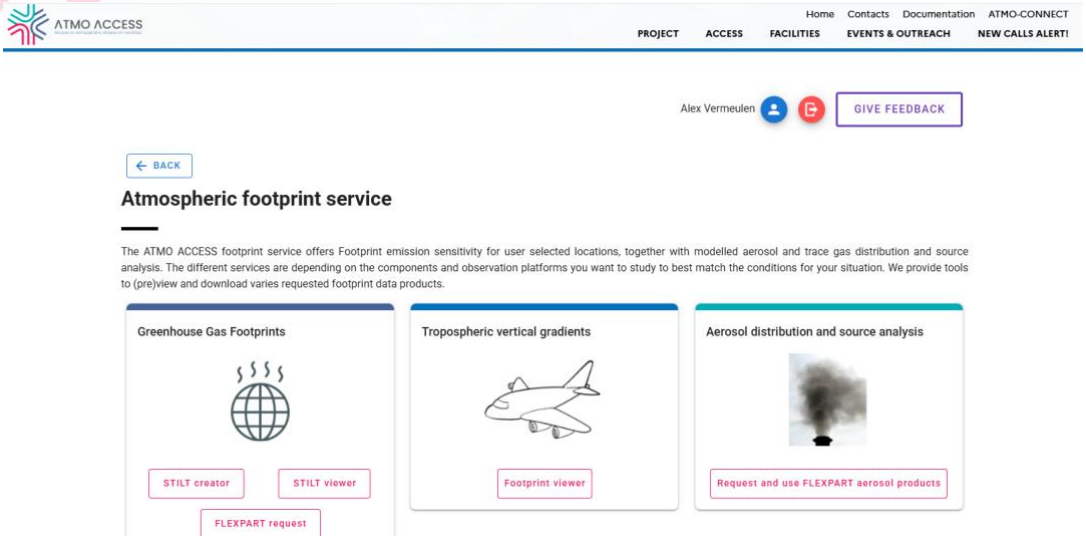

Figure 5 Screenshot of the Atmospheric footprint main menu, enabling the user to choose between Greenhouse Gas, Vertical gradients and Aerosol footprint services and to provide feedback

Trajectory and footprint analysis tools – Greenhouse gases

Type of service	1. Requests of model runs by experts. 2. Serve users accessing online products.
Type of access	1. Model request on a web page. 2. Webpage with powerful visualizations 3. Download of model runs already available.

Description of service

The ICOS Footprint Analysis Service for greenhouse gases provides a comprehensive platform for analyzing and visualizing greenhouse gas concentrations and their source footprints at ground-based stations across Europe. The service includes the STILT Results Viewer, which enables users to access and explore footprint data stored in the repository. Users can visualize the footprints as animations, paired with modeled CO_2 or CH_4 concentrations and contributions from various source categories. For ICOS stations and some selected European stations, measured concentrations are also available, allowing for direct comparisons with model

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outputs. Results can be packaged and downloaded directly for the selected station and period. Results are available for CO_2 and CH_4.

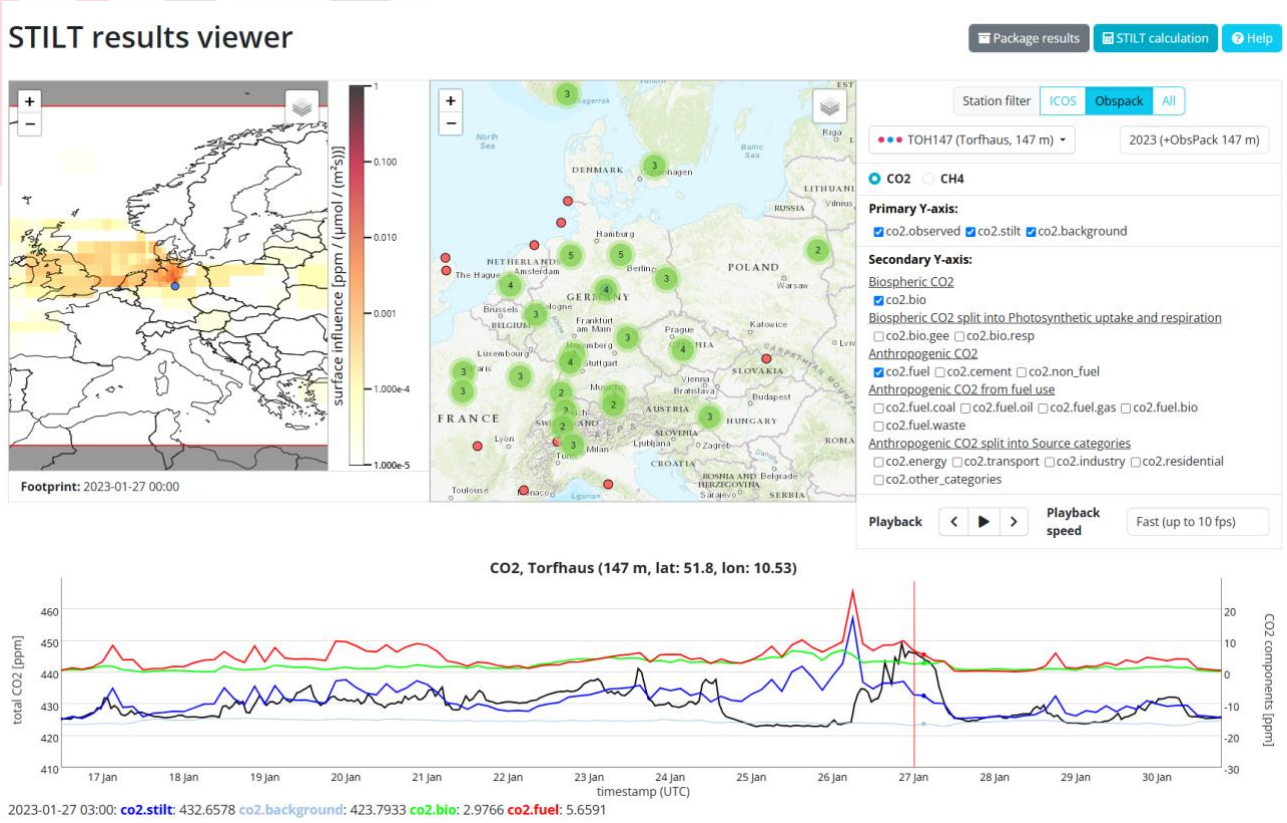

Figure 6 STILT viewer, here showing results available for stations for which Obspack observations exist. Selected is Torfhaus station at 147 m elevation and the year 2023. The user zoomed in to a period in January and can compare modelled and measured CO_2 values over the plot while at the same time the corresponding footprint is shown. Animation over time are also possible. Contributions from different source categories can be shown, net to measured and background values.

Additionally, the service offers a STILT Calculation Service, which allows users to initiate new STILT model runs for specific locations within the model domain. This feature enables users to input details such as station ID, name, and country, ensuring that the outputs are relevant and tailored to specific research needs. By supporting both pre-calculated and on-demand model results, the service provides flexibility for diverse research applications. The ICOS Footprint Analysis Service plays a crucial role in helping researchers understand greenhouse gas dynamics and source contributions, making it an essential tool for environmental science and monitoring.

The greenhouse gas footprint service also allows users to request a set of FLEXPART footprint calculations for one or more stations and specified time intervals through a simple web form. These requests are handled manually and results are packaged according to the user preferences.

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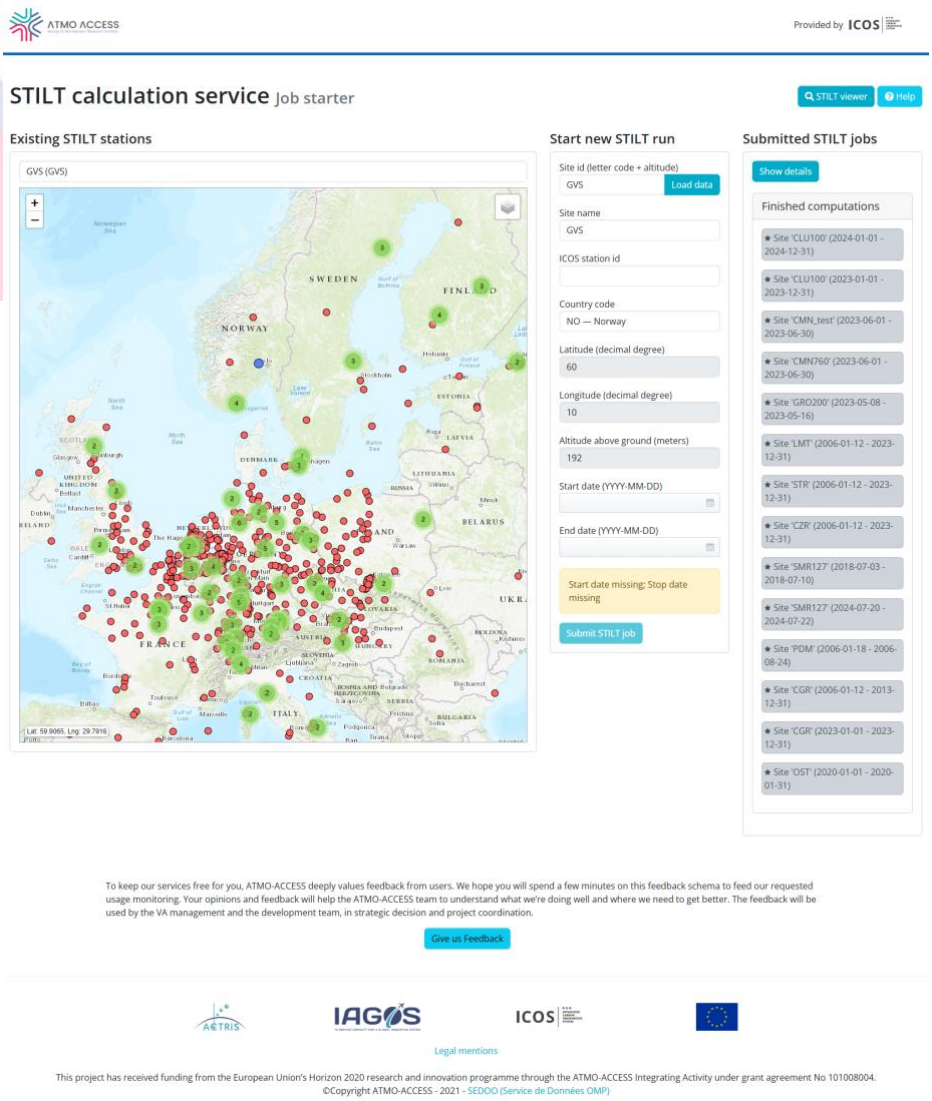

Figure 7 STILT calculation service to order new footprints for any known or new station

Trajectory and footprint analysis tools – Tropospheric vertical gradients

Type of service	Access to Near Real Time Pre-generated products online
Type of access	API requests through a web interface including webpage visualizations

Description of service

The IAGOS footprint analysis service combines the viewer of FLEXPART footprints and modelled SOFT-IO CO contributions and allows users to explore tropospheric vertical profiles of carbon monoxide mixing ratios (measured by IAGOS) in conjunction with source attribution data

(calculated using the SOFT-IO model). The vertical profiles are from airports visited by commercial aircraft equipped with IAGOS' instrumentation. The SOFT-IO model is based on coupling the FLEXPART backward footprint (with the receptor points located along the profile) with emission inventory databases. The service provides a visualization of the above-mentioned data via a simple and easy to follow interface.

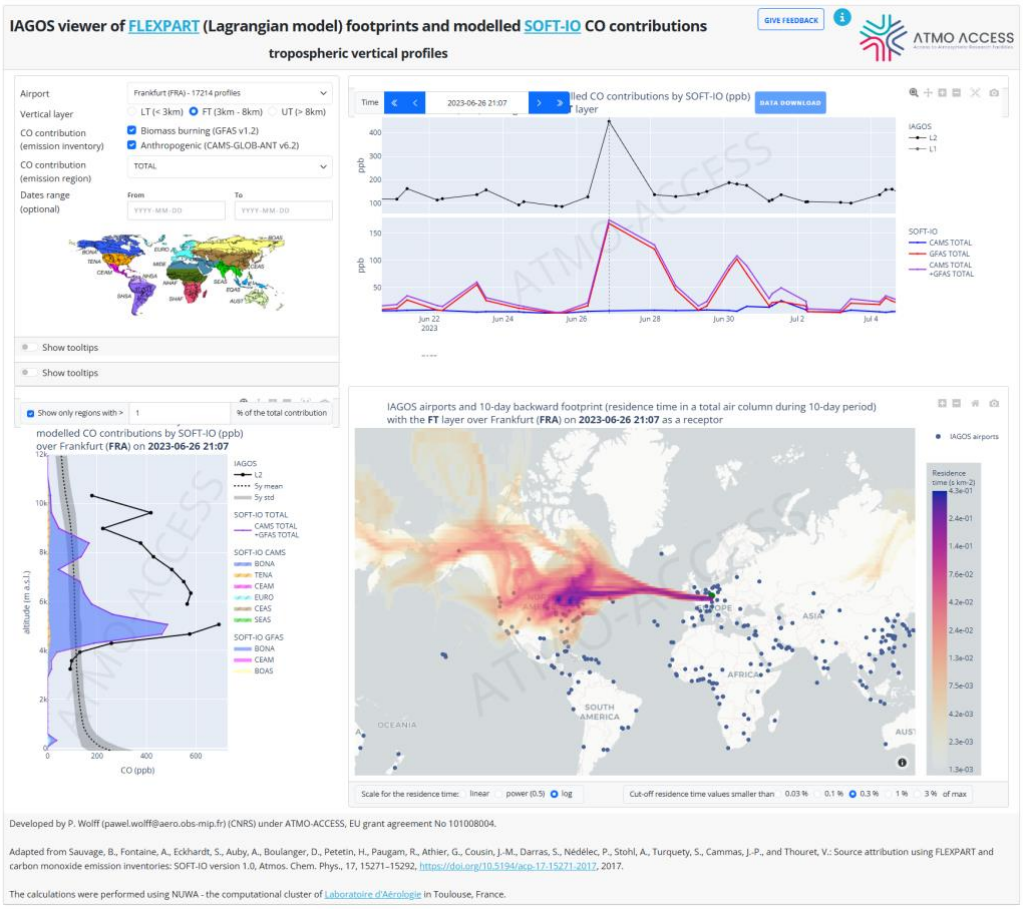

Figure 8 Screenshot of the IAGOS footprint viewer showing analysis of the 26 June 2023 event where wildfires from Eastern Canada caused elevated CO levels at the middle and upper troposhere detected by IAGOS and the SOFT-IO model above Frankfurt airport.

Trajectory and footprint analysis tools - Aerosol distribution and source analysis

Type of service	1. Request of model runs by experts. 2. Serve users accessing online products.
Type of access	1. Request scheme on a web page. 2. Webpage visualizations. 3. Download of model run already available.

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Description of service

The trajectory and footprint analysis tools - Aerosol distribution and source analysis service provide advanced modeling tools to interpret ground-based aerosol and trace gas observations. The service operates in two modes, offering both customized analyses and access to pre-existing datasets. Users can request tailored model runs through a request form, by specifying parameters such as location, timeframe, and type of product. The FLEXPART team uses this to generate the products and provide training and support for the use of the products. These products, based on the FLEXPART model, provide detailed insights into air mass trajectories and source contributions to variables like black carbon and dust. The service supports both retrospective and near-real-time analyses, with data spanning up to 20 days backward or a 1-day forecast. A variety of tailored products are available, including those for black carbon, dust events, land-use changes, and microplastic measurements.

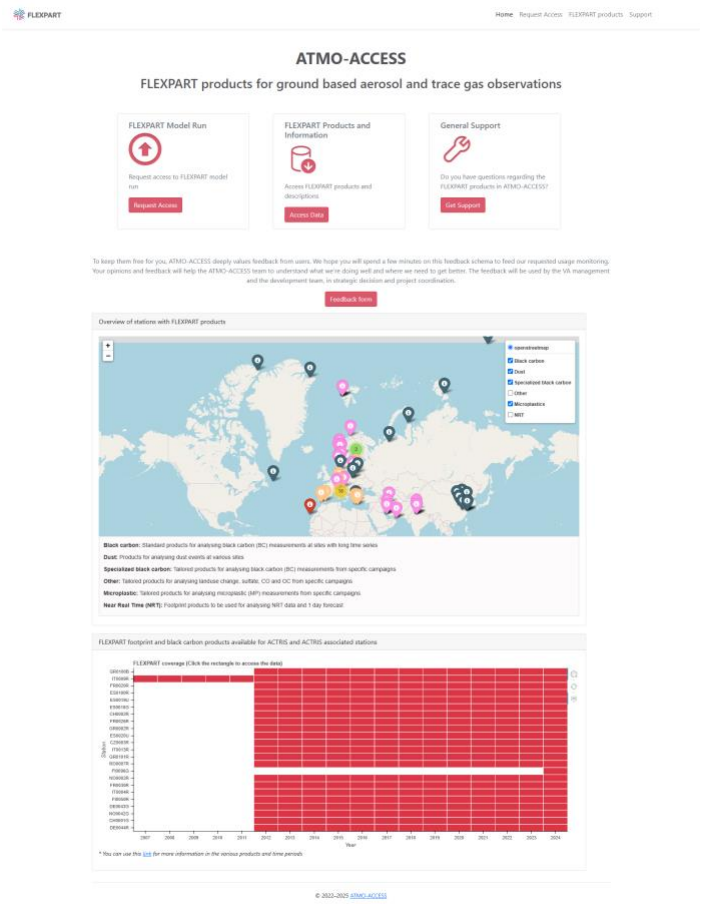

Figure 9 Screenshot of the main interface of the FLEXPART footprint service for aerosols and trace gases. User can select pre-calculated data from a selection of stations and periods, or request additional model runs.

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Furthermore, the service provides immediate access to pre-computed datasets, through an intuitive station map at https://flexpart-request.nilu.no/data-access. Users can explore and download these products through the web-interface.

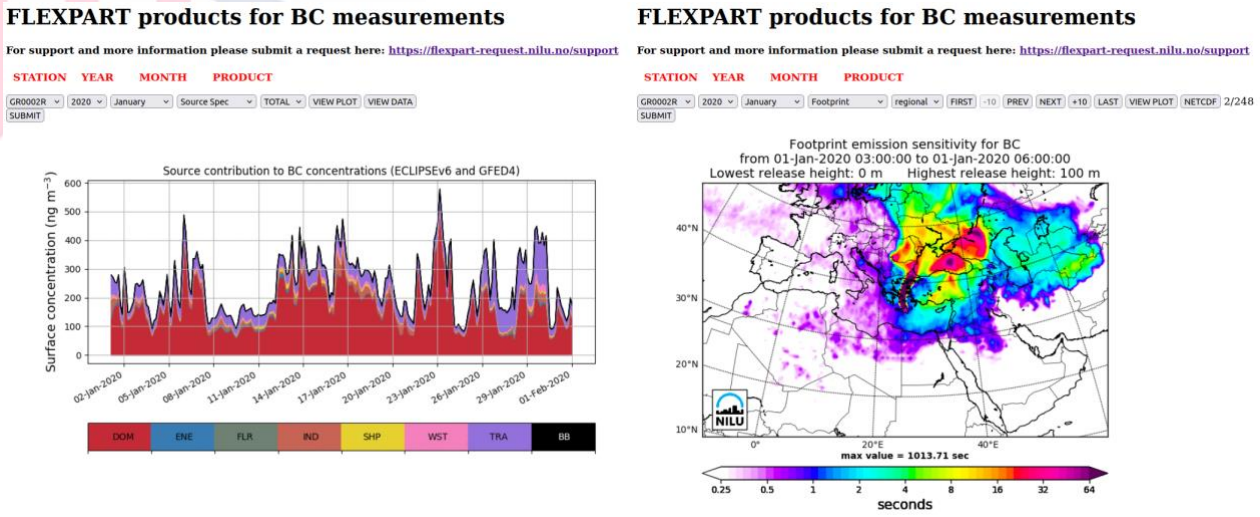

Figure 10 An example FLEXPART product, here for Black Carbon at station Finokalia (GR) for January 2020, showing calculated concentrations and contributions from the different source categories as well as footprint emission sensitivity at a 3 hour time interval.

Time Series Analysis

Type of service	On the fly analysis and visualization of time series data
Type of access	API requests through a web interface

Description of service

The Time Series Analysis service provides users with a tool to identify, use and combine data across RIs and data repositories. It aims at serving a large variety of users (students, academics, private or public organizations, NGOs, communities of projects, etc.) by providing a dedicated Virtual Research Environment (VRE) for facilitating their exploration of multiple in situ datasets with long time series of different variables. The service provides access to the most commonly used basic metrics (e.g. means, percentiles) and statistical analysis (e.g. trends), as well as visualization tools to view e.g. 2D or 3D scatter plots. The combination of different variables important for climate and air quality recorded by ACTRIS, IAGOS and ICOS allows users to explore relevant cross-cutting issues.

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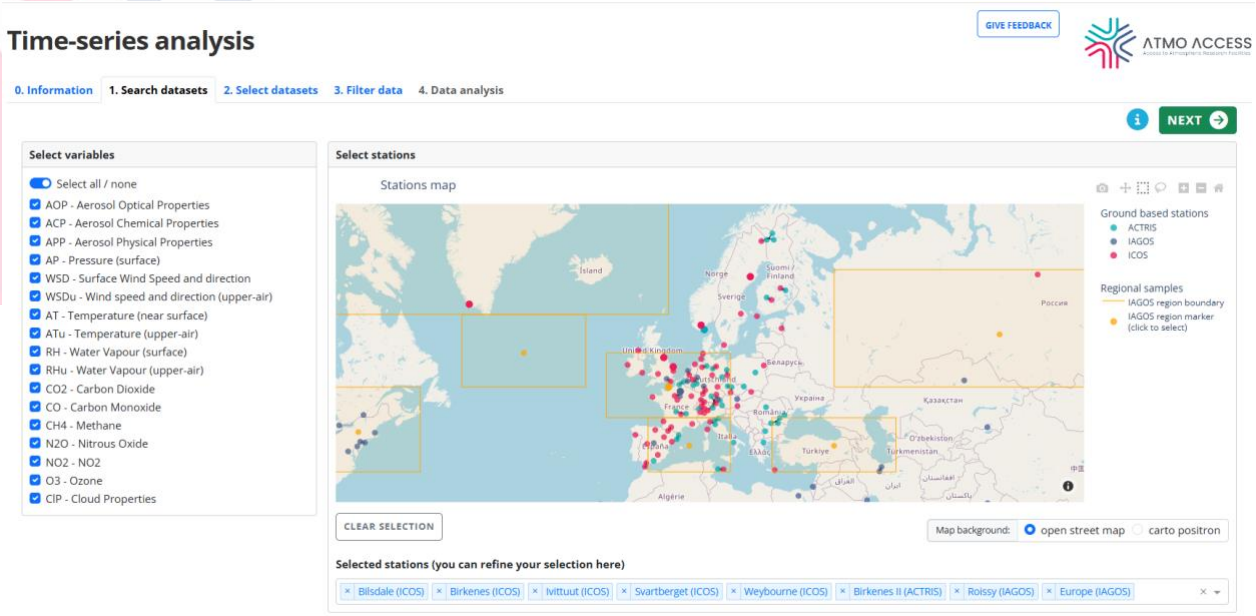

Figure 11 Step 1 of the Time Series Analysis is to define the datasets to be analysed by selecting variables and stations, assisted by a map of stations

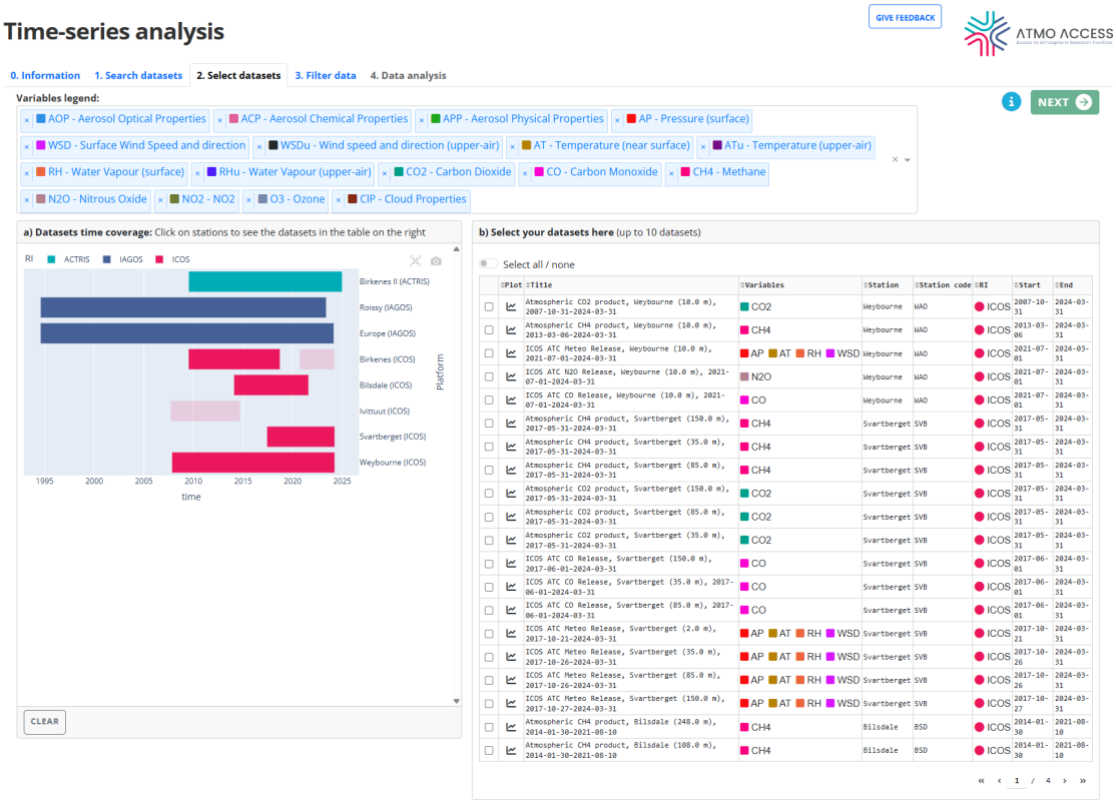

Figure 12 In step 2 of the Time series analysis service one can see the time coverage of the selected datasets per station and select the ones to analyse, for example because they overlap in time coverage. On the right panel the user can select which exact time series to use in the next step. Time series can already be previewed from this page by clicking on the RI circle as shown in the next figure.

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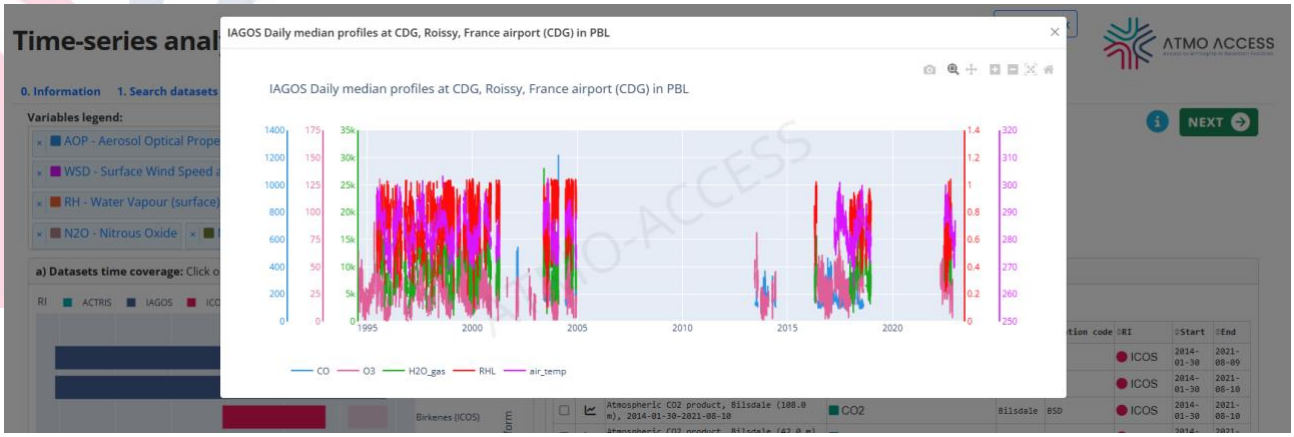

Figure 13 Example preview of the available time series for a station and RI

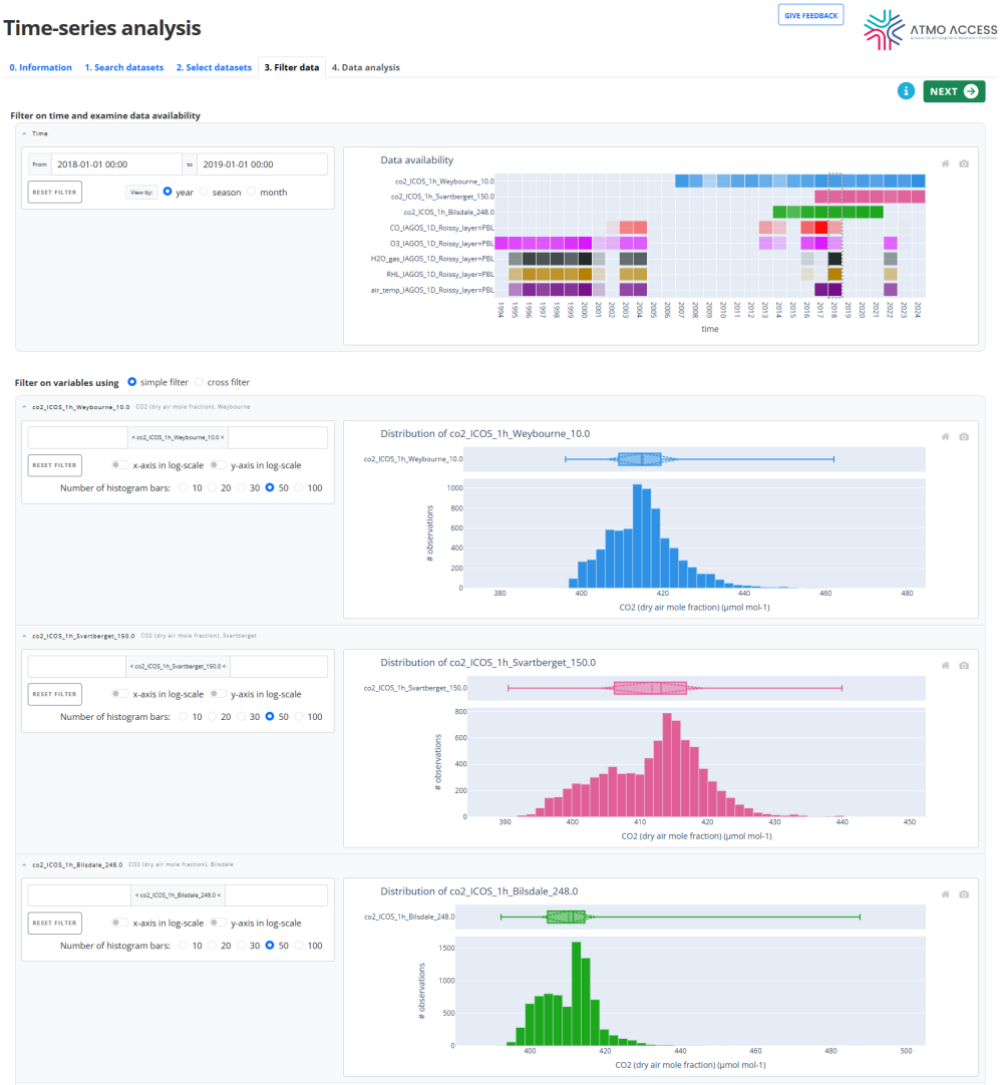

Figure 14 In the next step one can define a time interval, either by filling in start and end time, or by drawing a period on the right top panel. Here one can define filters to remove either low or high values, guided by the frequency distribution diagrams per dataset, to enable better analysis in the final step.

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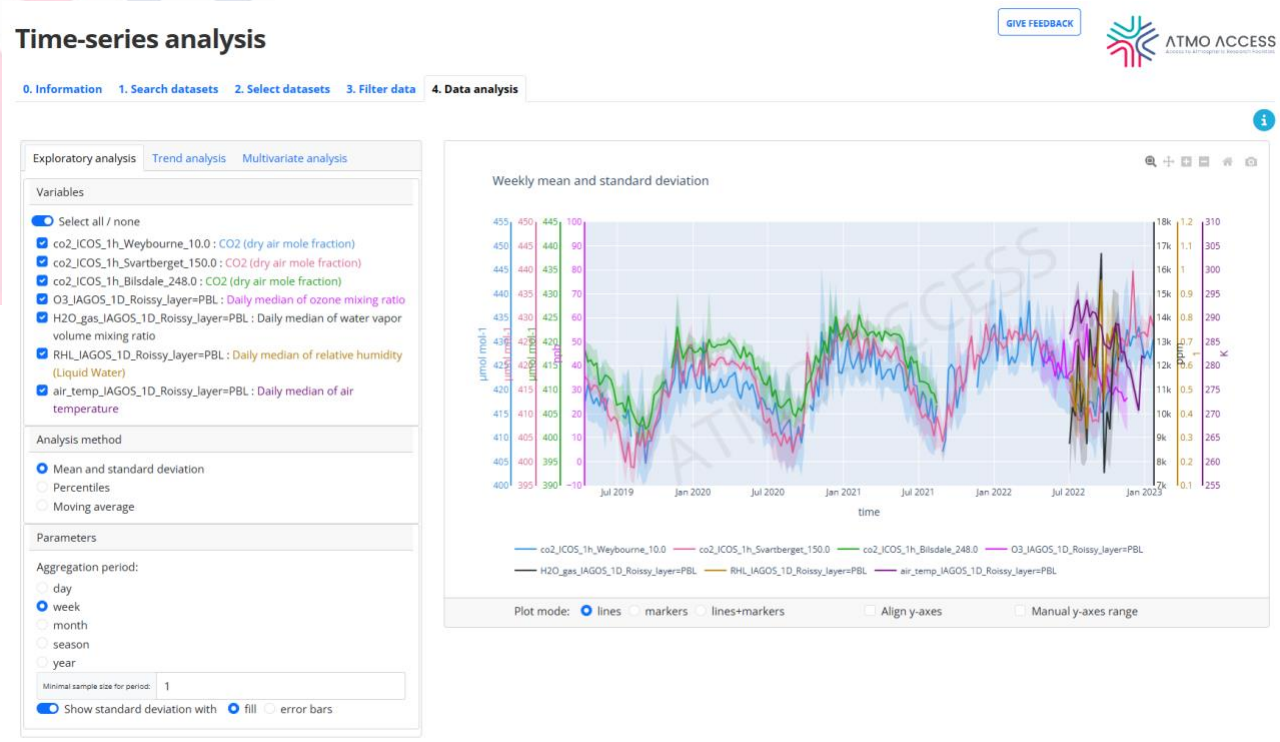

Figure 15 In the final Data analysis step one can further explore the dataset, and show aggregated data by day, week, month, season and year, and perform a trend analysis as shown for CO2 below

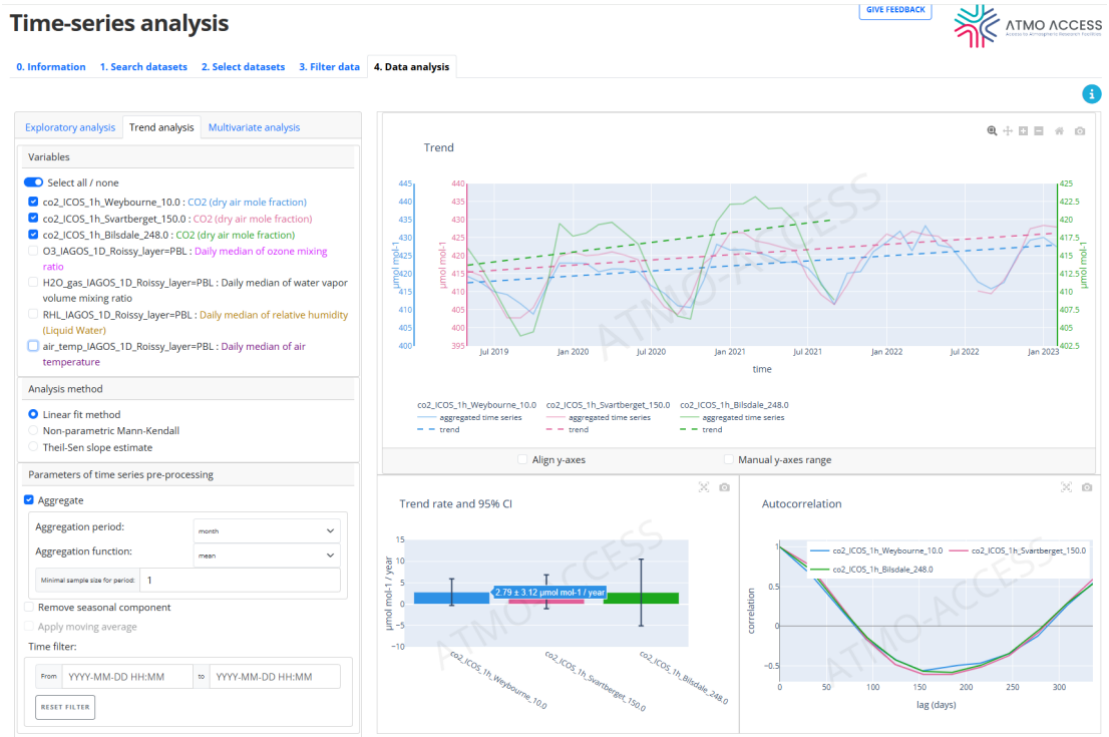

Figure 16 Trend analysis for CO2 at three ICOS stations for the period 2019-2023. The trend calculated is 2.7 -2.9 ppm/year, which corresponds well with the annual mean global trend in this period.

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Massive Open Online Course (MOOC)

Type of service	Educational e-learning program
Type of access	Virtual, open access

Description of service

The ATMO Access VA portal also offers access to a Massive Open Online Course (MOOC) developed in the project notably the ATMO-ACCESS MOOC titled "Atmospheric Research Infrastructures: Sharing the Future of Our Atmosphere" (see figure 17 below). The course has been developed in WP4 and WP10 and will be described in more detail there.

This course is a free, two-week online program designed to educate participants on the challenges of air pollution and climate change. The course highlights the significance of atmospheric research and provides insights into the operations of three key Research Infrastructures:

- ACTRIS: Aerosol, Clouds and Trace Gases Research Infrastructure
- IAGOS: In-service Aircraft for a Global Observing System
- ICOS: Integrated Carbon Observation System

The first course edition started on January 20, 2025, with registrations having opened on December 2, 2024. The second edition opened on May 9, 2025 with registrations having opened on April 1st, 2025. It is conducted in English (with subtitles in several languages) and is accessible to anyone with a basic understanding of general chemistry and an undergraduate-level background in science. This virtual training resource is enriched with a set of tutorial videos (spring 2025) and a serious game (summer 2025 – see figure 18)

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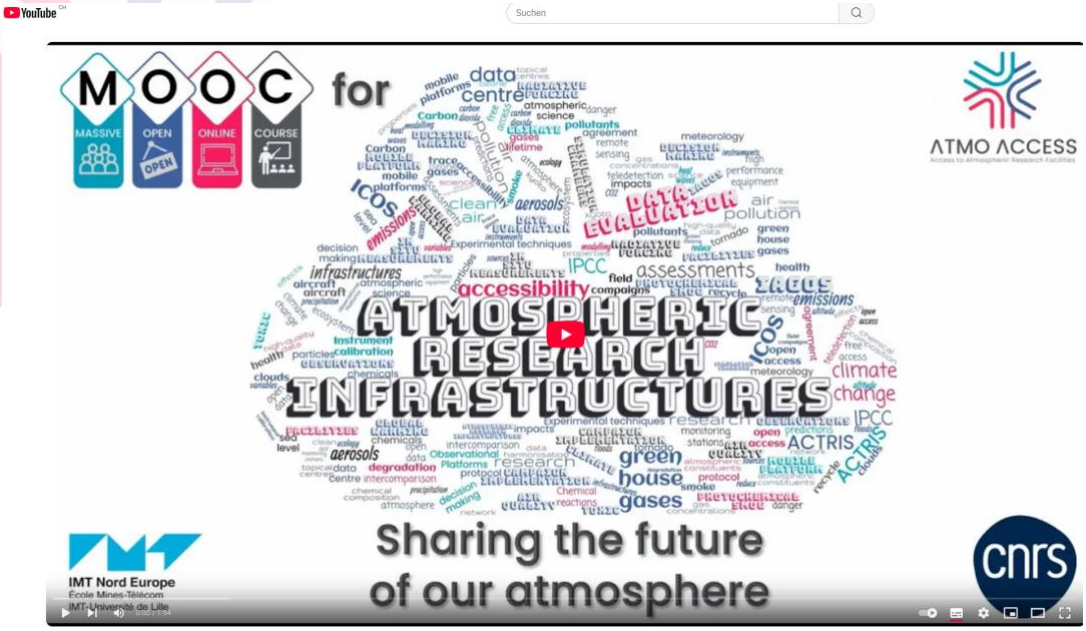

Figure 17 Start page of the MOOC on Atmospheric research Infrastructures

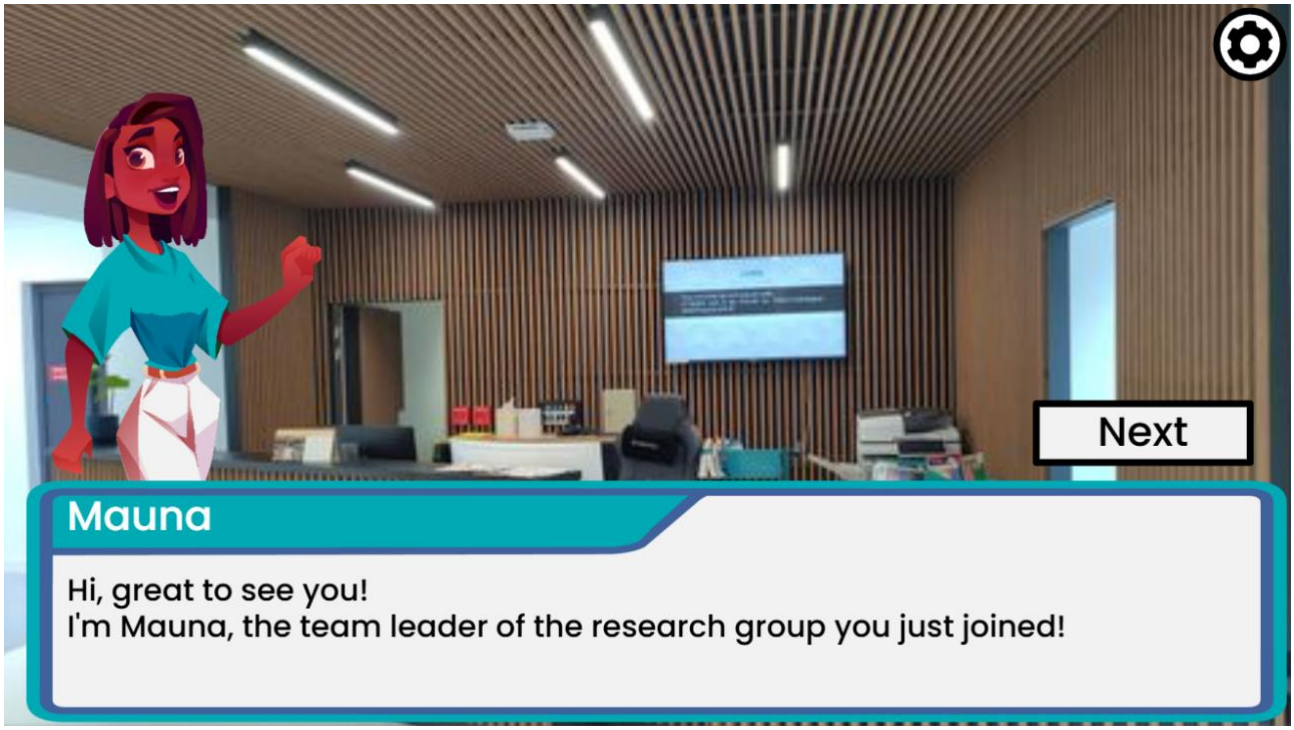

Figure 18 Start page of the serious game "What's going on in the air?"

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