Title	Serious game, tutorial videos and second version of MOOC implemented and publicly available
Work package n°	4
Deliverable / Milestone n°	D4.4
Lead beneficiary	2 - IMT
Author(s)	Véronique Riffault (IMT), Antonia Zogka (IMT/CNRS)
Deliverable Type	Report
Dissemination Level	Public
Estimated delivery date	M42
Actual delivery date	M49 (April 2025): Xact tutorial M50 (May 2025): MOOC guide tutorial M50 (May 2025): 2nd MOOC edition from 12 May 2025 to 09 June 2025 M50 (May 2025): Time Series Analysis tool tutorial M51 (June 2025): VolcPlume platform tutorial M52 (July 2025): Serious game
Version	1
Reviewed by	Ariane Dubost, Zhuoqun Wu (Project Office)
Accepted by	
Comments	Task 4.3 and its related outputs were delayed because of issues related to the work contract of the one key scientists in charge of developing the resources.

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

ATMO ACCESS
Access to Atmospheric Research Facilities

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1. Introduction

This deliverable reports on the implementation and dissemination of three key training resource types: the second edition of the MOOC *Atmospheric Research Infrastructures: Sharing the Future of Our Atmosphere*, a suite of tutorial videos, and the serious game *What's Going on in the Air?*

Each resource has been made publicly available to a broad audience.

Links to the resources

MOOC: https://www.atmo-access.eu/massive-open-online-course-mooc/

or https://www.fun-mooc.fr/en/courses/atmospheric-research-infrastructures-sharing-the-future-of-our-a/

Tutorials: https://www.atmo-access.eu/tutorial-videos/

Serious Game: https://www.atmo-access.eu/serious-game-whats-going-on-in-the-air/

2. Second improved edition of the MOOC

The pilot edition of the MOOC attracted significant engagement and yielded valuable feedback. The 2-week, self-paced session required approximately 2 hours of commitment per week and was open from Jan 20, 2025 to Feb 16, 2025 on the FUN (France Université Numérique) platform. A **detailed report** (**D4.3**; https://hal.science/hal-05206923v1) has already been published on the first MOOC edition.

The second edition (open from May 12, 2025 to June 9, 2025) incorporated user feedback gathered from the open questions in the first edition's final survey. Approximately 30 minutes of content per week were added, and the learner experience was refined. An analysis of the user feedback will be included in the D10.6 project report.

Several significant changes were introduced. **Structural modifications** integrated the interviews and Q&A sessions into the main modules, rather than leaving them as optional additions. The videos were enhanced in terms of quality, subtitles, and navigation features, to improve clarity and accessibility. The **final graded quiz** was revised to ensure balance and fairness, and a **short tutorial** video called *The Ultimate Guide to This MOOC* was created to help participants navigate the course more easily. **New interactive exercises** were also introduced alongside a modified **'To go further' section**, providing advanced resources for participants wishing to deepen their knowledge. A new video describing the use of atmospheric simulation chambers in the ACTRIS research infrastructure was produced, as this aspect was not fully covered in the first edition. Links to other virtual resources developed within the project (e.g.

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tutorials and tools) were also added. A complete overview of the changes is included in the Annex section.

The impact of these changes can be seen in the **engagement statistics**. 92 participants responded to the survey (17.7% of the 518 enrolled). For example, the proportion of learners watching interview videos increased significantly compared to the first edition. The **MEET ACTRIS** video was viewed by 92% of participants (up from 72%), while the number of participants viewing the **MEET IAGOS** and **MEET ICOS** videos increased rose from 38% to 64% and from 35% to 47%, respectively. **Completion rates** were well above the average for this type of e-learning resource across the two editions. In the first edition, 174 badges were awarded to 811 registered participants, giving a completion rate of 21.45%. In the second edition, 86 badges were requested, giving a completion rate of 16.7%.

3. Tutorial videos

1) General description

The tutorial videos were developed to **explore innovative training methods** that extend beyond traditional remote or physical access through Transnational Access (TNA). Their goal is to demonstrate how such tools can be further developed and integrated into RIs to support diverse user communities within a sustainable framework. These videos lay the foundation for future digital training initiatives within the atmospheric research community.

The following table provides a detailed breakdown of the software applications used to develop the tutorial videos, clarifying the exact role of each one.

Role	Software used
Illustrations	Power point
Screen recording	ScreenPal, TeamViewer and Zoom
Video and voice editing	Active Presenter
Subtitles	Aegisub
Interactions and bookmarks	H5P

Designed as **accessible and effective** learning tools, the videos cover a **broad range of topics and applications** in atmospheric science. As shown in the figure below, four tutorials were created to **address specific needs** and fill existing gaps within the atmospheric RI landscape, benefiting from the help and expertise of various ATMO-ACCESS partners.

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Despite their late release, the number of views on Youtube as of mid-August 2025 suggests that there is strong interest in this kind of resource within the user community.

Tutorial video	Month of online availability	Video length (min)	Views (as of Aug. 18, 2025)
MOOC guide [a]	May 2025	5	153
Xact instrument	April 2025	15	234
Time Series Analysis tool	May 2025	14	222
VolcPlume platform [b]	June 2025	11	118

[a] Direct link: https://www.youtube.com/watch?v=BKFPwgCiwBs

[b] Developed outside of the project but allows for the integration of various types of data related to volcanic emissions in the atmosphere (in situ measurements and remote sensing, from ground-based stations and satellite)

These tutorial videos feature **interactions** that provide access to additional resources. The following screenshot, for example, displays three buttons leading to the AERONET, ACTRIS, and

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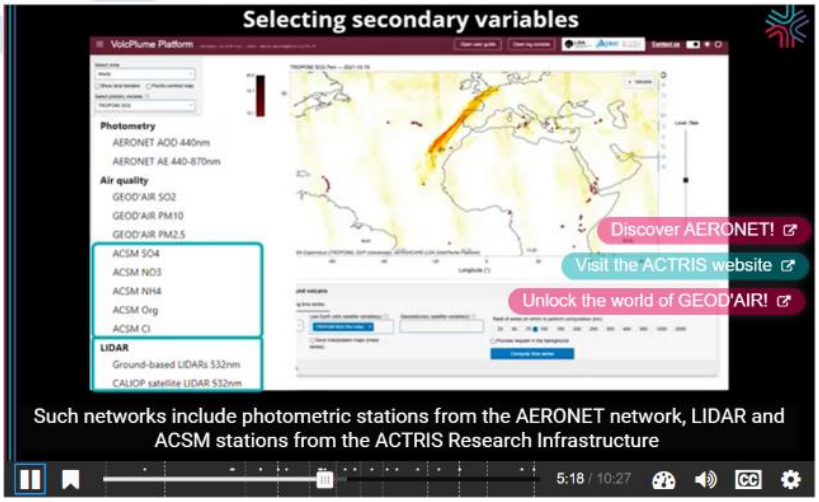
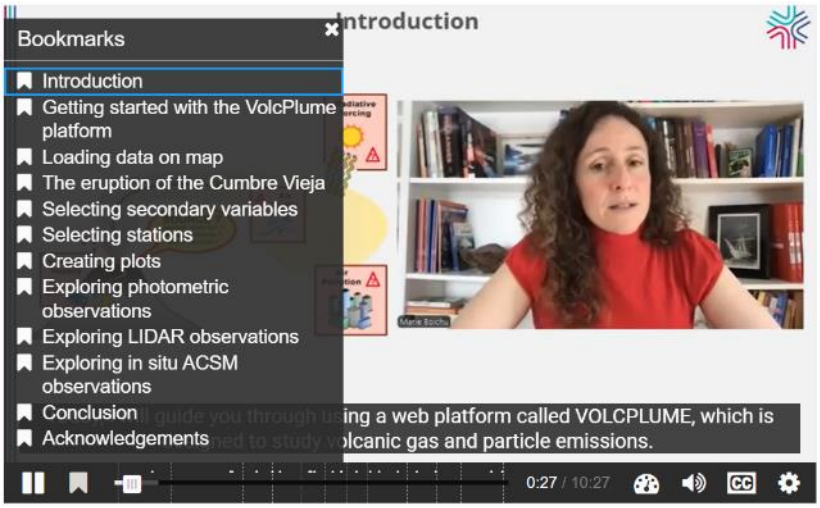
French GEOD'AIR websites, which offer more specific details and can address the needs of various users.



Due to their length, **bookmarks** are also provided for the tutorial videos except for the MOOC guide, to allow viewers to quickly access a specific chapter. The screenshot below shows how bookmarks can be used to create a structured video course and facilitate access to relevant information.



Finally, to enhance **inclusivity** and **accessibility**, the tutorial videos are recorded in English and include **subtitles** in seven languages: English, French, German, Greek, Portuguese, Spanish, and Simplified Chinese. The subtitles were initially generated using AI-based automatic translation and subsequently reviewed by experts in the field to ensure the accuracy of the technical terminology used. Furthermore, native speakers of each language are available within the resource development partner organization to provide assistance or interaction in those languages if required.

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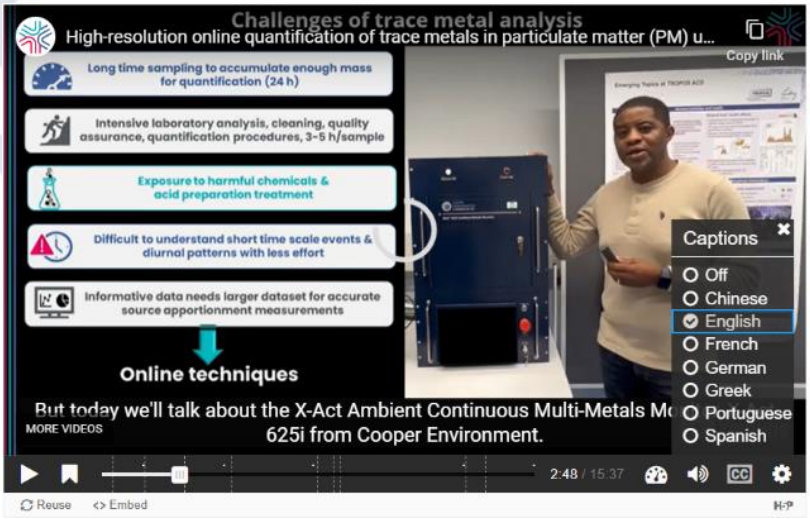

Please note that, due to the technical specifications of the YouTube platform, only the subtitles are present when watching the videos directly on this platform. All these features are however available when watching the videos through the ATMO-ACCESS website.

The following sections explain how each tutorial encourages learners to engage with this pedagogical material in a more active and approachable way.

2) MOOC guide tutorial video

This 5-minute tutorial, presented by Antonia Zogka (CNRS/IMT), serves as a **practical guide for participants of the Massive Open Online Course (MOOC)** *Atmospheric Research Infrastructures: Sharing the Future of Our Atmosphere*. Aimed at MOOC participants, including young scientists and the broader community interested in climate change and air quality, the video offers step-by-step guidance on **navigating the FUN-MOOC platform**. It introduces key course components such as the toolbar menu, courseware, and interactive videos, while also providing helpful tips and strategies to support participants' success throughout the course.

It is directly available at this link: https://www.youtube.com/watch?v=BKFPwgCiwBs.

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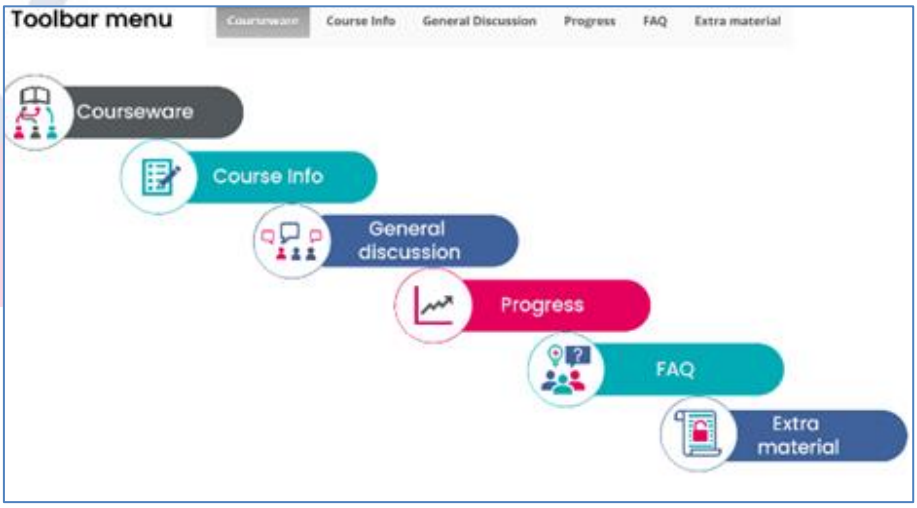

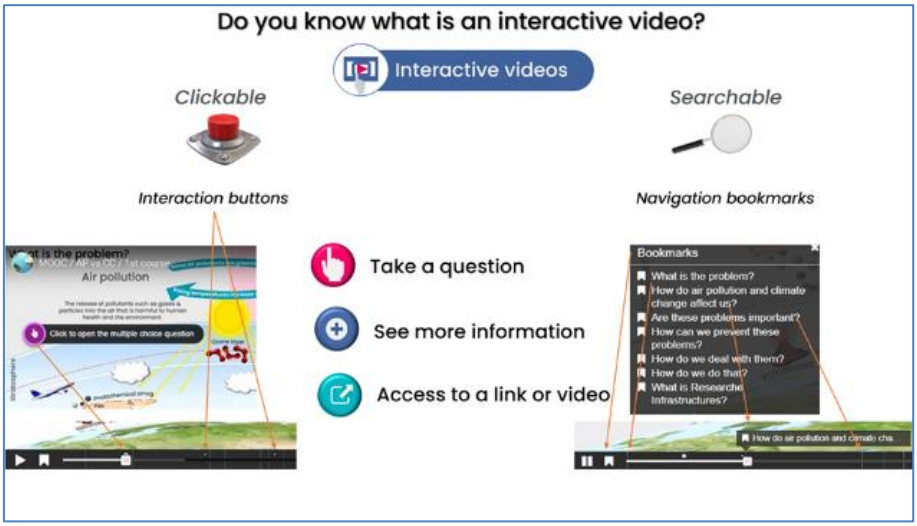

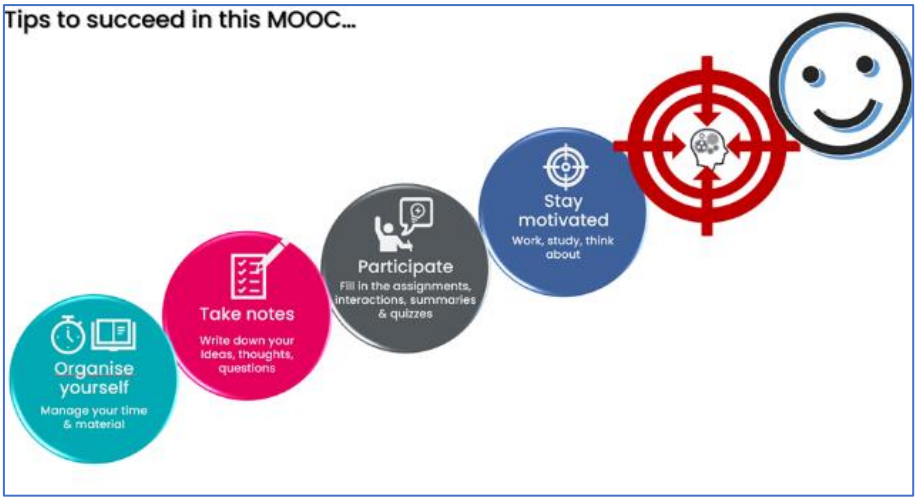

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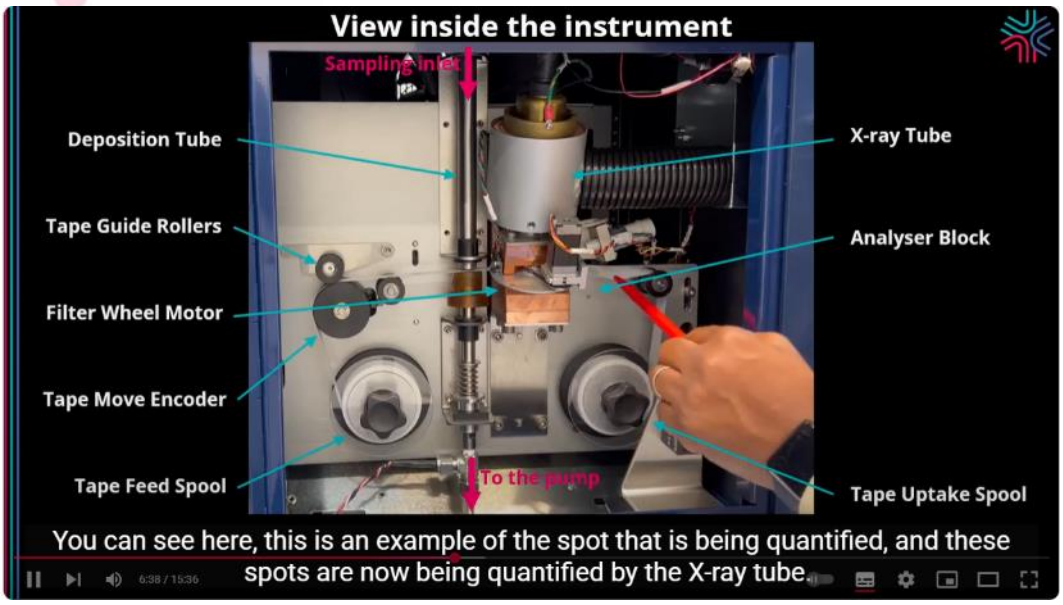
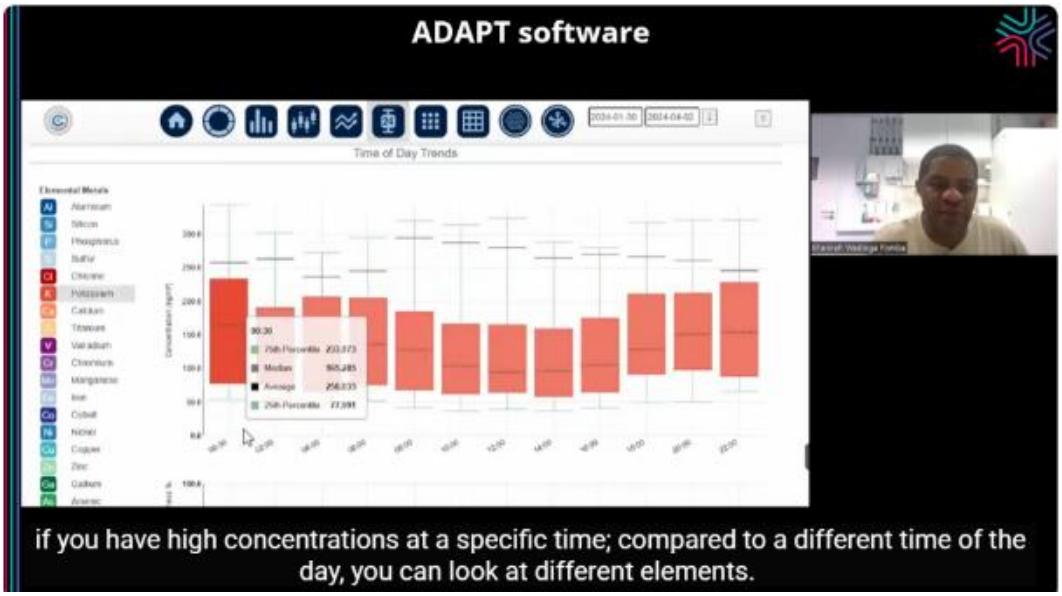
3) X act instrument tutorial video

This 15-minute tutorial, presented by Khanneh Wadinga Fomba (TROPOS), focuses on high-resolution, real-time quantification of trace metals in particulate matter (PM) using the 625i Ambient Continuous Multi-Metals Monitor Xact®. The video introduces the relevance and challenges of **trace metal analysis**, provides an **overview of the Xact® instrument**, including its internal and external components, and offers a step-by-step guide to its operation.



A hands-on demonstration of the ADAPT software is included, allowing viewers to follow along at their own pace by pausing, rewinding, or replaying specific instructions. The tutorial concludes with a discussion of the instrument's advantages and limitations, providing a comprehensive introduction to its capabilities and practical use in atmospheric research.



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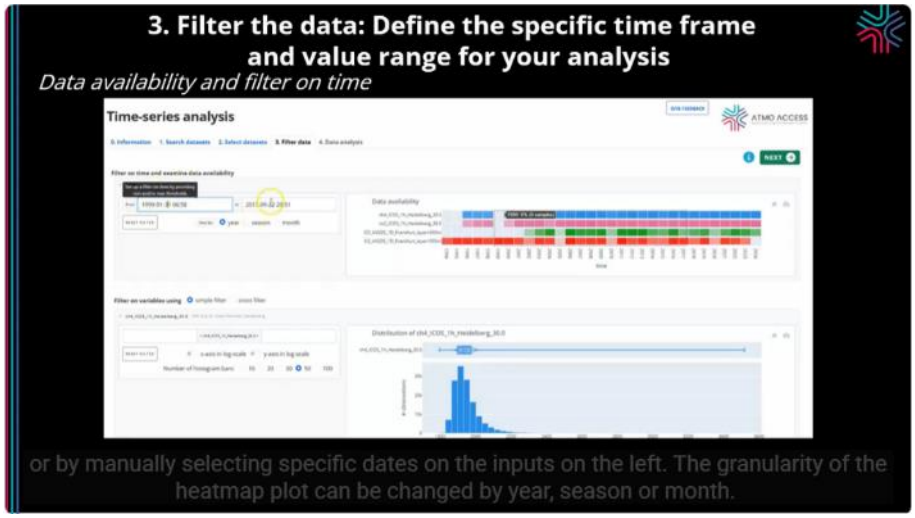
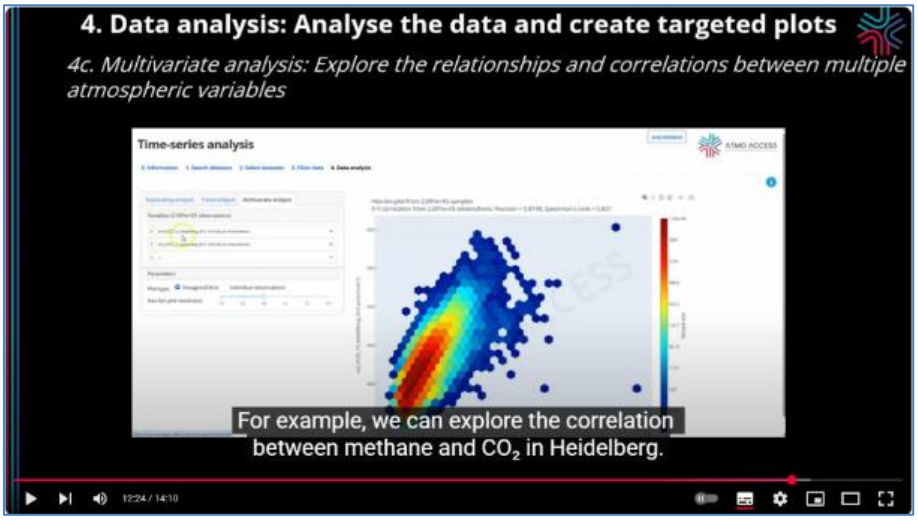
4) Timeseries analysis tool tutorial video

This 14-minute tutorial video, presented by Hannah Clark (IAGOS) with contributions from experts Damien Boulanger and Valérie Thouret (CNRS LAERO), provides a step-by-step guide to using the **Time Series Analysis service developed within ATMO-ACCESS**. Aimed at helping users access and analyze observational data from the ACTRIS, IAGOS, and ICOS research infrastructures, the tutorial walks through the full process, from identifying datasets to conducting exploratory, trend, and multivariate analyses. Viewers are guided through the platform interface, including dataset selection, filtering options, and interactive visualization tools. Designed for hands-on use, the video allows users to follow the workflow at their own pace by pausing, replaying, or replicating steps in parallel with the instruction.





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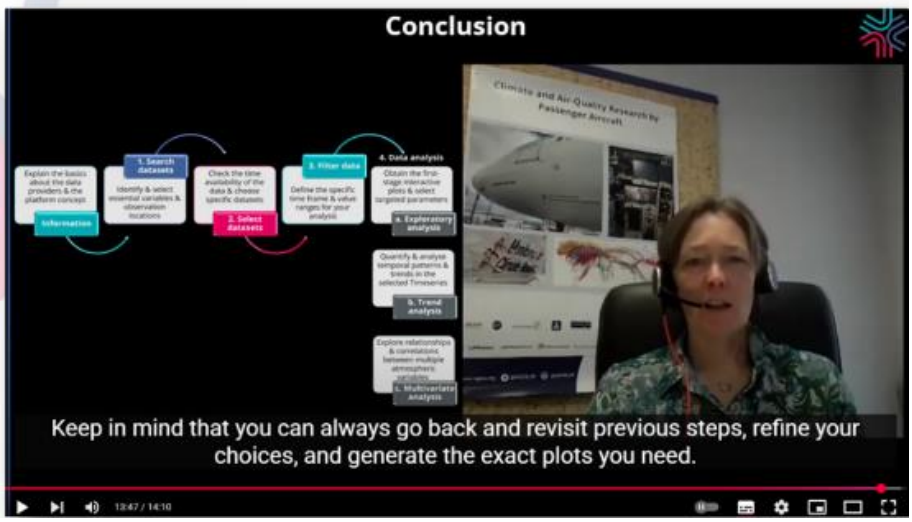
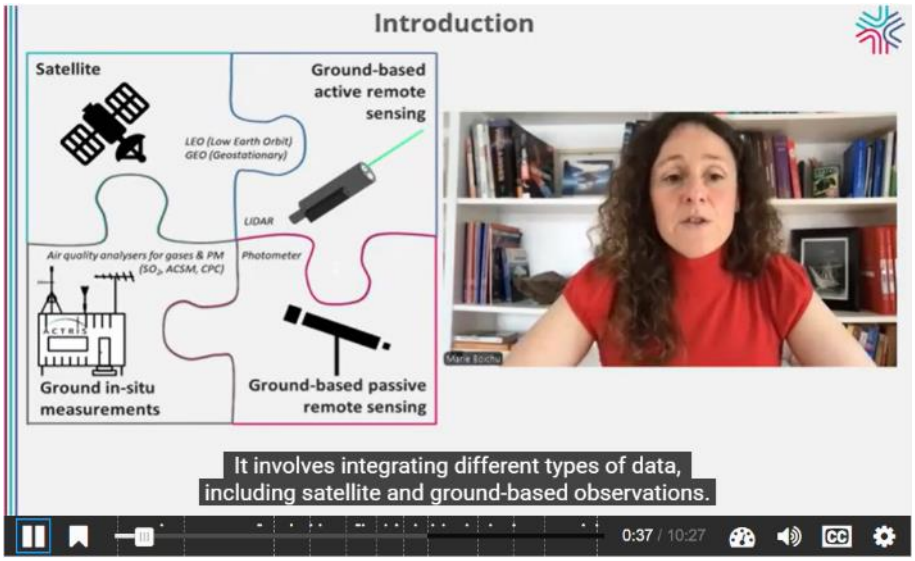


5) VolcPlume platform tutorial video

This 10-minute tutorial, presented by Marie Boichu (CNRS LOA), offers a step-by-step guide to the VolcPlume web platform, developed for the study of **volcanic gas and particle emissions**. Aimed at researchers in atmospheric and earth sciences, including volcanologists, geologists, and atmospheric chemists, the video demonstrates **how to access, visualize, and analyze data interactively using a multi-scale, multi-source approach**. Viewers are guided through the platform's features using a real-case study of the Cumbre Vieja eruption on La Palma, showcasing the integration of satellite, ground-based remote sensing, and in situ observations. The tutorial provides practical insights into the platform's applications, making it a valuable tool for both research and operational purposes in fields such as air quality, climate science, and aviation safety.



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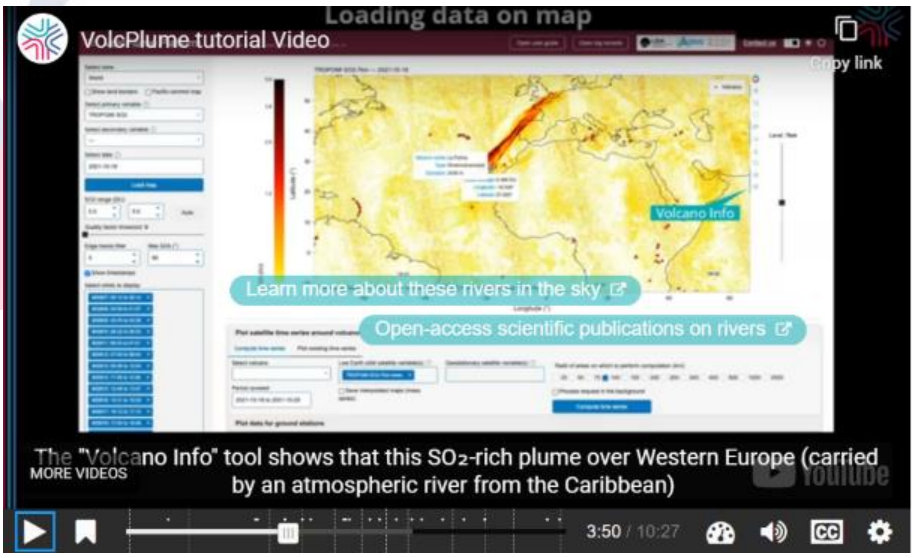

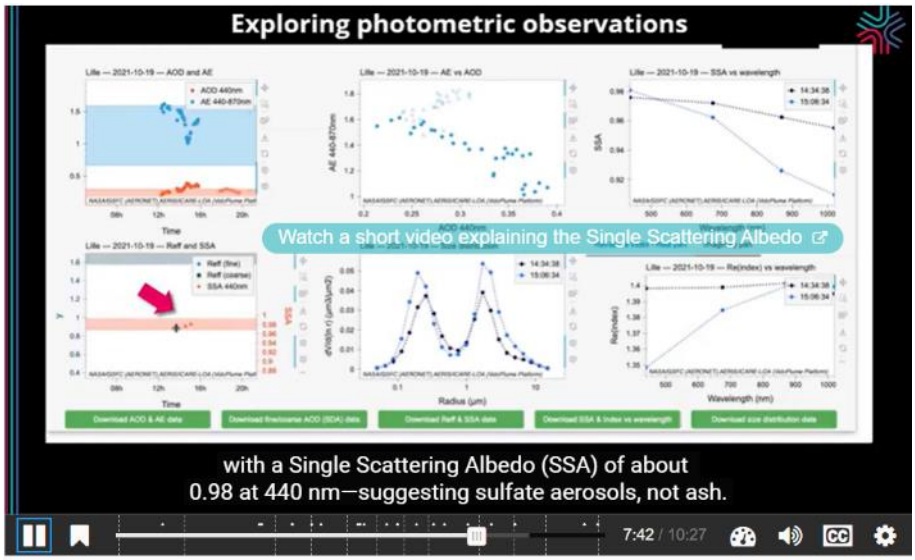

4. Serious game

The serious game *What's Going on in the Air?* was designed as an educational resource to provide an engaging and interactive way to **learn aerosol science and remote sensing**. The game places the player in the role of a young scientist investigating a real aerosol event at the ATOLL observatory in Lille, France, over two virtual days. The scenario encourages the player to identify different aerosol types, interpret LIDAR profiles, combine LIDAR and sun photometer data, and estimate aerosol mass concentrations.

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The scientific content was created by Véronique Riffault (IMT) and Antonia Zogka (CNRS/IMT), who benefited from the help and scientific expertise of Philippe Goloub and Ioana Popovici (CNRS LOA) and the technical support of Marc-Olivier Buisson and Gaëlle Guigon (IMT). The Serious Game is currently only available in English and provided freely under the CC-BY-NC-SA licence.

The game takes approximately 30 to 40 minutes to complete and was targeted at undergraduate and graduate students, early-career researchers, operators of research infrastructure facilities, and professionals. It also appeals to a broader audience interested in air quality and climate change. The main educational purpose of the game is to introduce the fundamentals of aerosol science, teach the interpretation of atmospheric remote sensing data, and foster problem-solving skills in a realistic scientific context.

1) Technical details

The following table provides a detailed breakdown of the software applications used to develop the serious game, clarifying the exact role of each one.

Role	Software/Website
Illustrations and exercises	Power Point
Game programming	Active Presenter
Mini-game	Godot
Images	CIMEL and https://pixabay.com
Music	https://freemusicarchive.org

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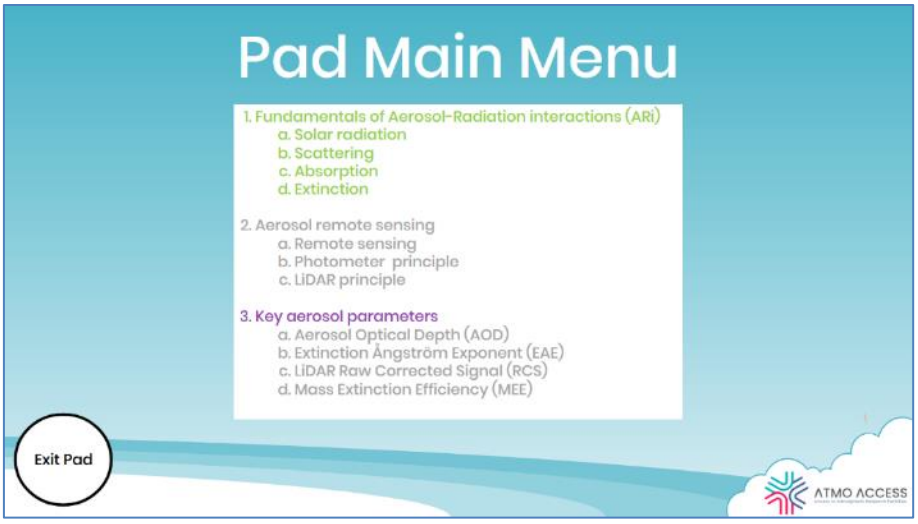
The serious game features two central characters who guide and interact with the player throughout the learning experience. The **Player** takes on the role of a young scientist or researcher recently hired at the ATmospheric Observatory of LiLLe (ATOLL), embarking on their first tasks within a cutting-edge research environment where he/she is facing a real case event through an interactive and engaging experience. This learning experience incorporates simulated environment, realistic design and two animated characters. **Mauna**, a **scientific expert** from the French National Centre for Scientific Research, serves as a mentor figure, asking questions and encouraging the player to critically apply their atmospheric science knowledge. Complementing this guidance, **Max**, the **technical support staff member**, offers practical assistance by providing key explanations and hints related to the operation and understanding of scientific instruments used during the game. Together, these characters create a dynamic and supportive environment for immersive, scenario-based learning.

All of the theoretical knowledge provided throughout the game is compiled in a pad that can be accessed with the button located at the top left of the screen.



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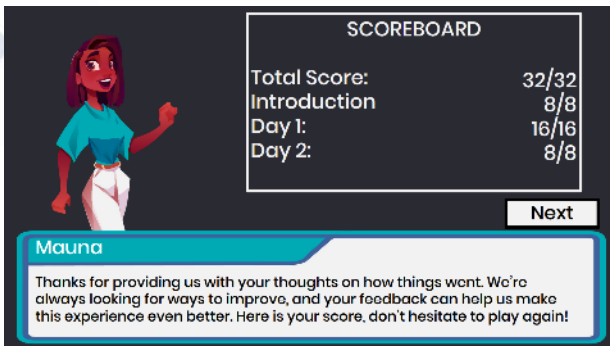
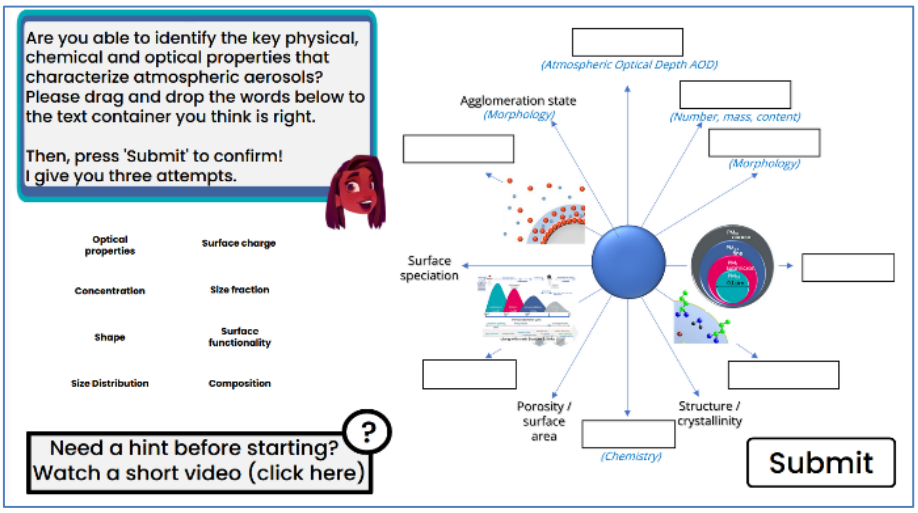
Each science question is worth up to 4 points: 4 points for a correct answer on the first try, 2 points on the second, and 0 on the third. Each game also awards a 2-point bonus. The maximum possible score is 32 points.



2) Educational purposes

The serious game is designed to provide basic knowledge about aerosols through short, interactive exercises.



It progressively introduces the principles and instrumentation of sun photometers and LIDAR, helping players build a strong foundational understanding through a progressive approach describing the instrumentation if they are non-experts.

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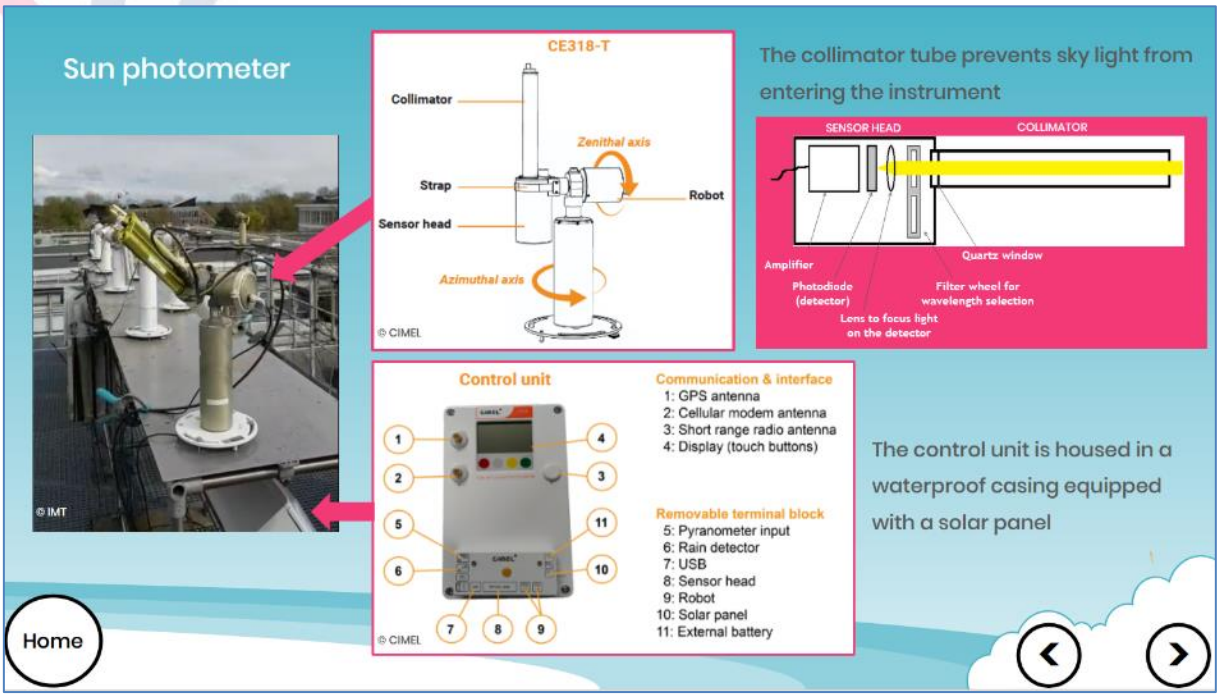
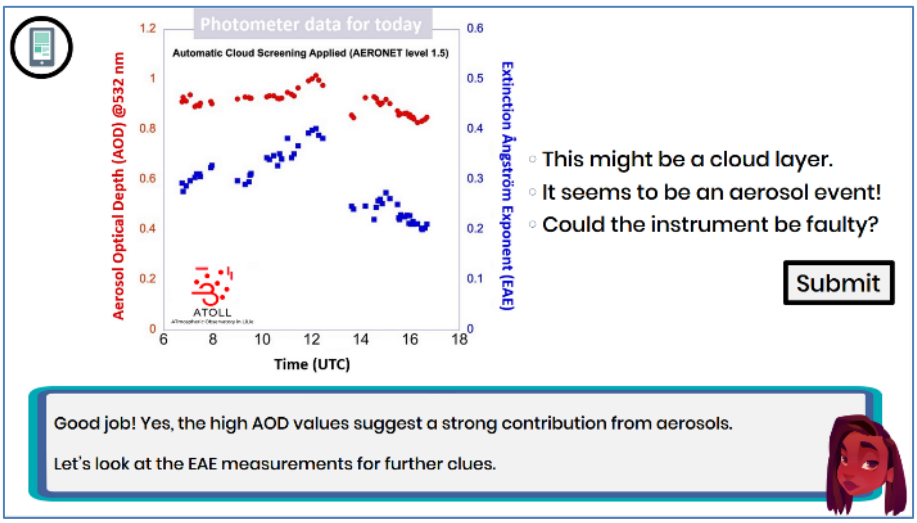


Players learn to access and interpret aerosol properties using remote sensing data, identify different aerosol types and their origins through backtrajectory analysis, and develop the skills needed to interpret atmospheric backscatter profiles from real LIDAR data collected at ATOLL.



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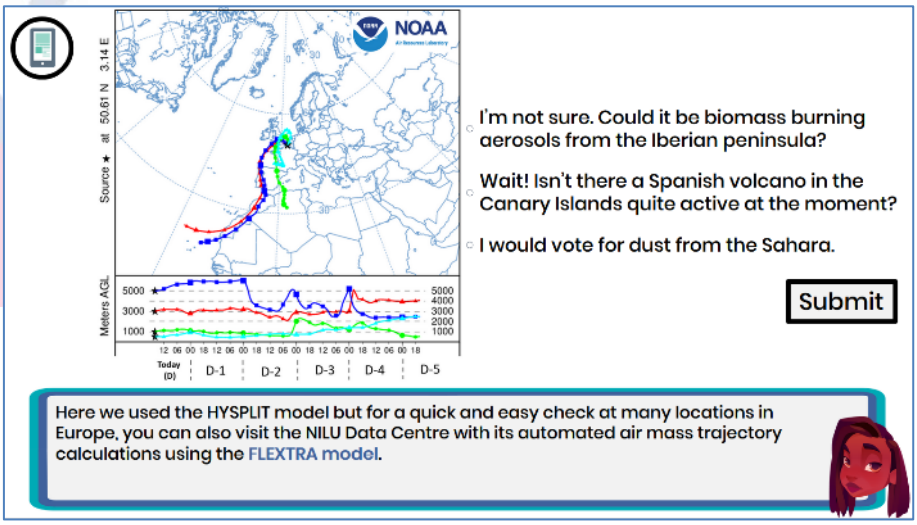

Finally, the game also guides users in combining LIDAR and sun photometer data to determine aerosol mass concentration profiles.

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Annex: Detailed overview of the changes introduced in the second MOOC edition

Note: Since the MOOC is not currently open, screenshots are provided hereafter to give the reader a better idea of the changes that have been made.

1) Minor technical changes

Interactive video enhancement

The **visual quality of the videos** was improved following feedbacks, including improved **synchronisation** in some videos, more space and minor corrections for the **subtitles**, **subscript** additions in chemical formulas for subtitles and optional questions, and the use of **bullet points** instead of dense paragraphs to help participants retain information more effectively

To boost the learner experience, some **technical aspects of video interactions** were upgraded. This includes refining their **visuals** (e.g., color) for greater clarity and enriching their content (see below) to be more comprehensive. We also standardized **button labels** to English (e.g., "check," "continue," "show the answer") for consistent navigation. Finally, for multiple-choice and true/false questions, **feedback** now offers both descriptive insights and scores.

Links to other resources were better highlighted by adding a colour code for all of them (pink).

The **ACTRIS logo** was updated throughout the MOOC.

Revision of the final graded quiz

Following an analysis of participant success rates, the questions on the Erreur ! Source du renvoi introuvable. were revised. Difficult questions were simplified, and too easy questions were either improved or expanded with additional detail. One question was replaced with a new one regarding the new video 'MEET the ASCs' (see new content below).

A Erreur ! Source du renvoi introuvable. was added on the end survey concerning the user participation or not in the first edition of the course.

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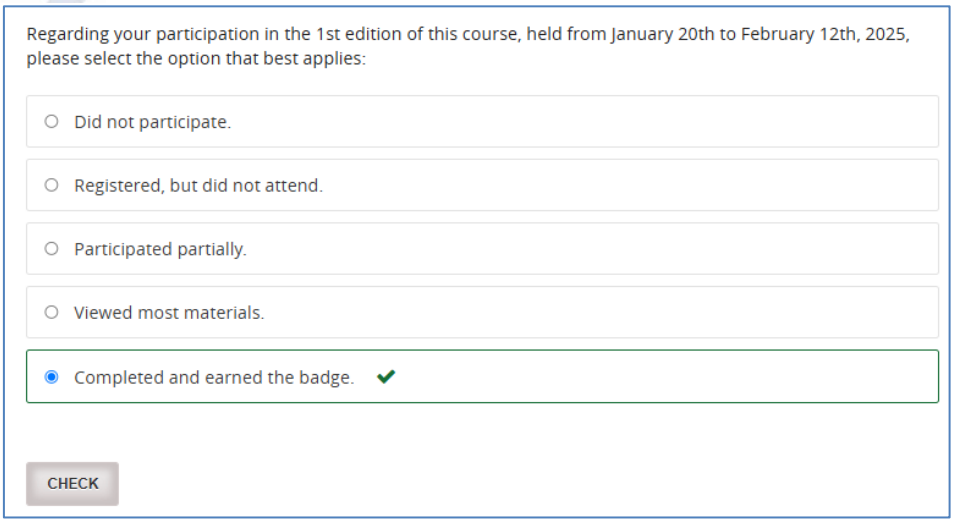

Navigation enhancement in the 'Read this first' section

Since the FUN (France Université Numérique) platform comes from France, most of the courses as well as parts of the platform guidelines were given in French or in poorly translated English. Modifications were essential for participants. The English translation was improved and some **screenshots** of the specific course in English were added to better guide participants through the platform menu and options.

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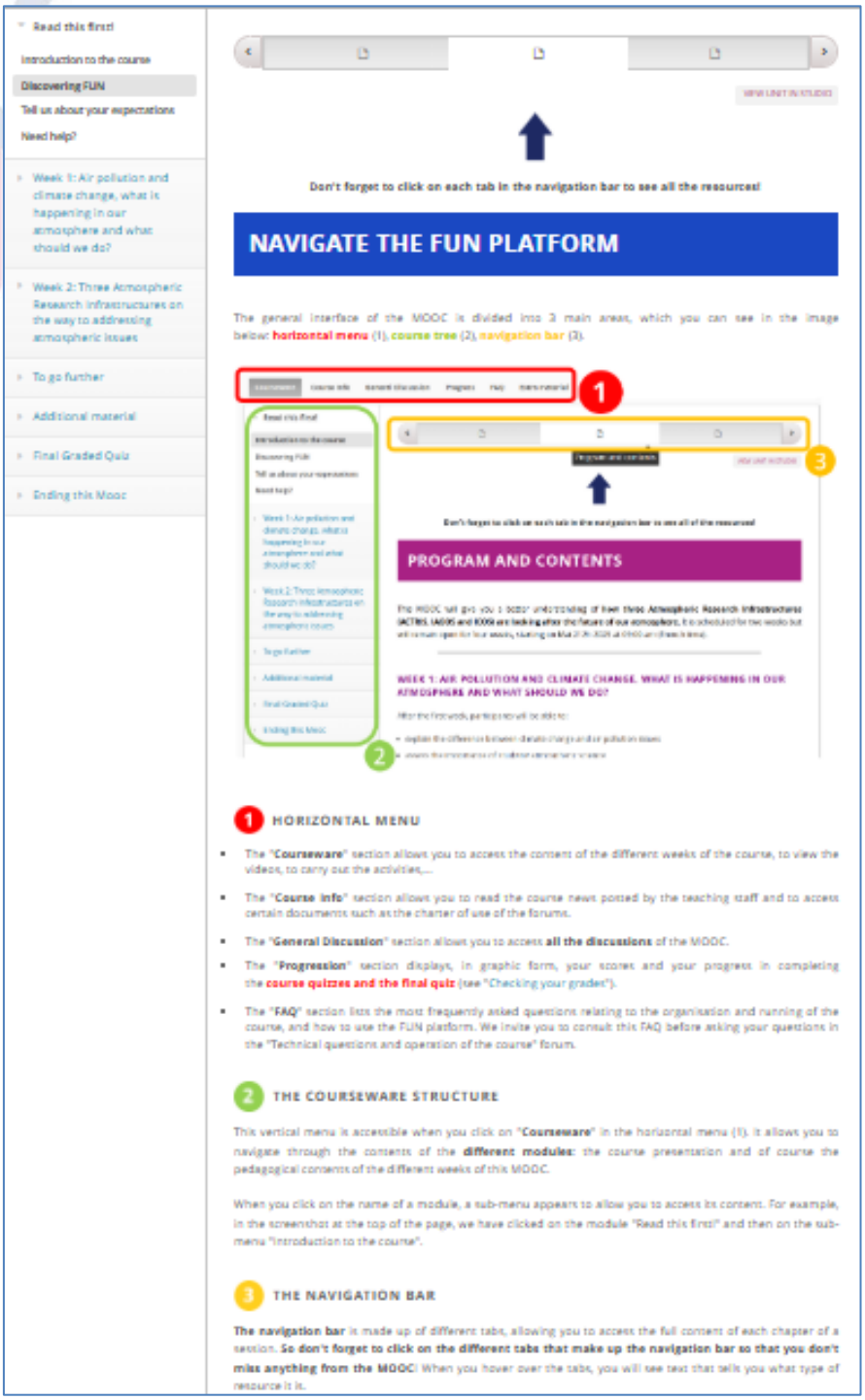

Additionally, a 5-minute **tutorial video** **'MOOC guide tutorial** was created. More details can be found in the Tutorial section of this report.

2) New scientific content

Video: Aerosols and Clouds

An interaction was added on the atmospheric layers with a quick drag-and-drop exercise.

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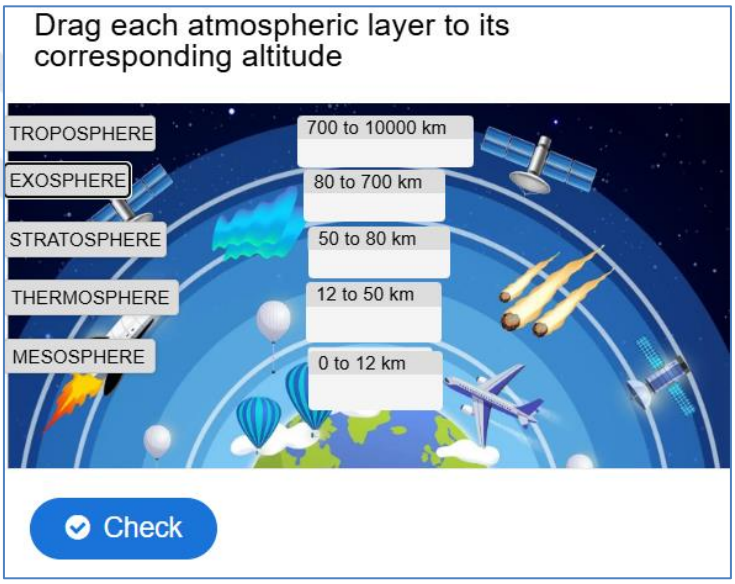
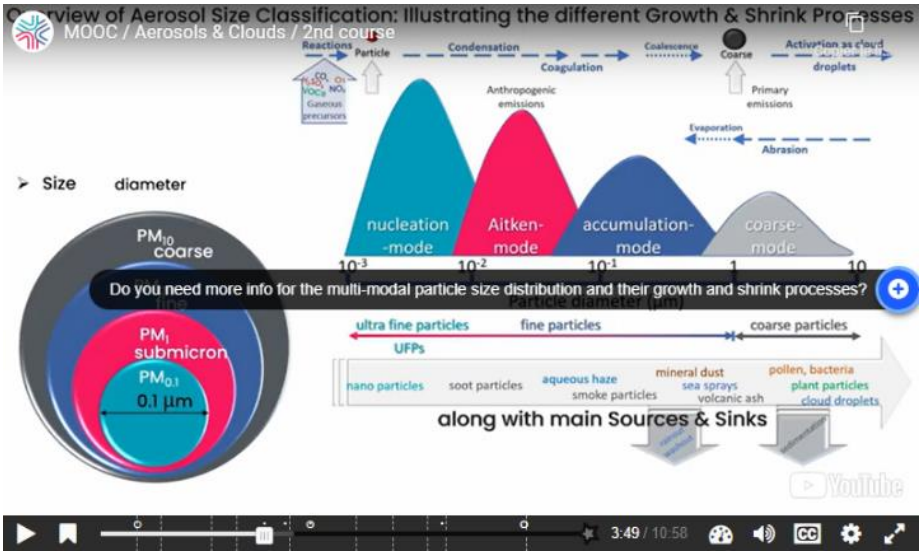


A new text interaction was added to explain the growth and shrink processes.



Two interactions were added concerning the energy budget of the planet with a text and a quick drag-and-drop exercise.

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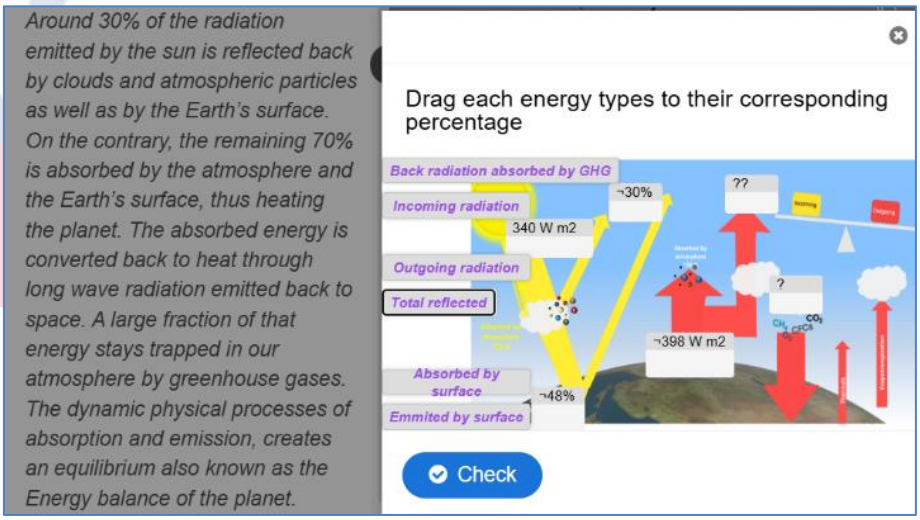
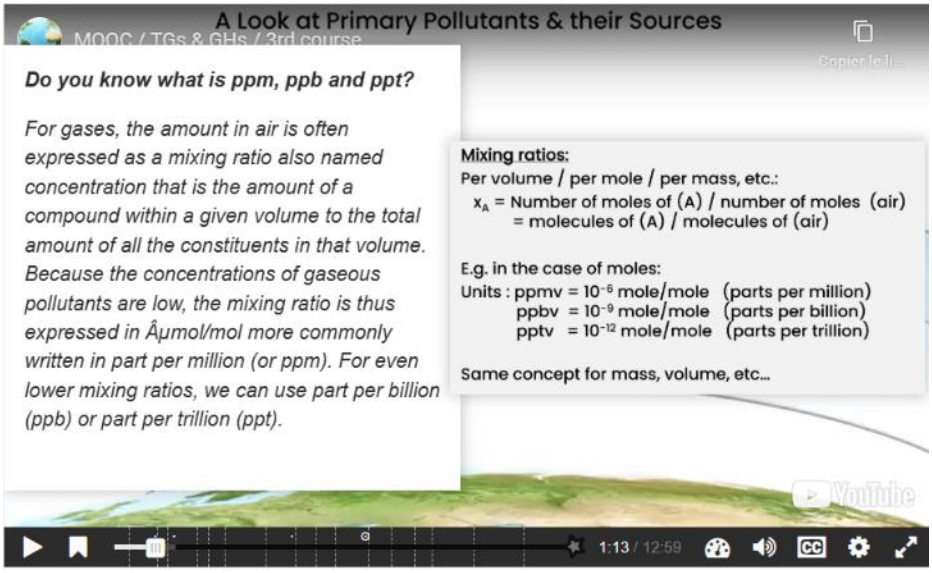


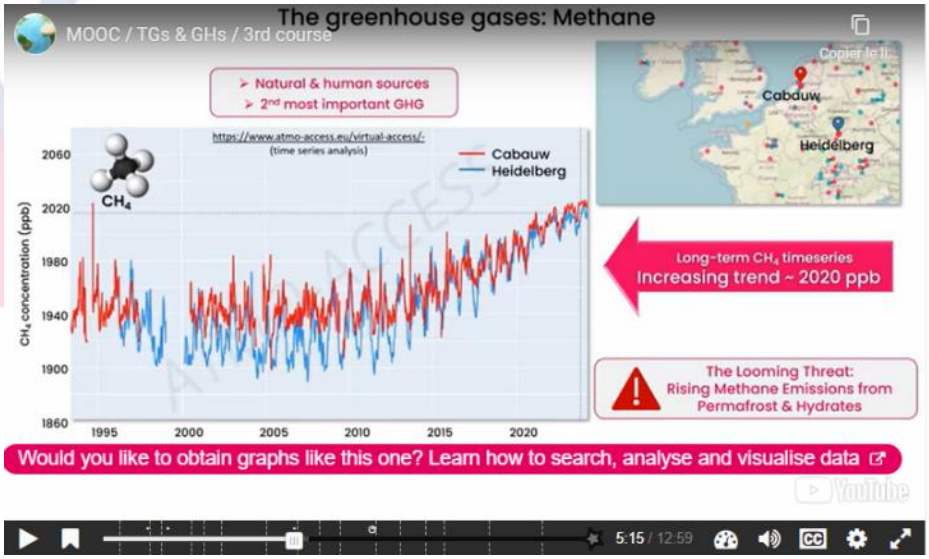
Video: Trace gases and Greenhouse gases

The interaction explaining the mixing ratios was improved.



A link interaction was added to the tutorial video for Timeseries analysis tool, as requested by some participants in the first MOOC edition interested in data analysis guidance.

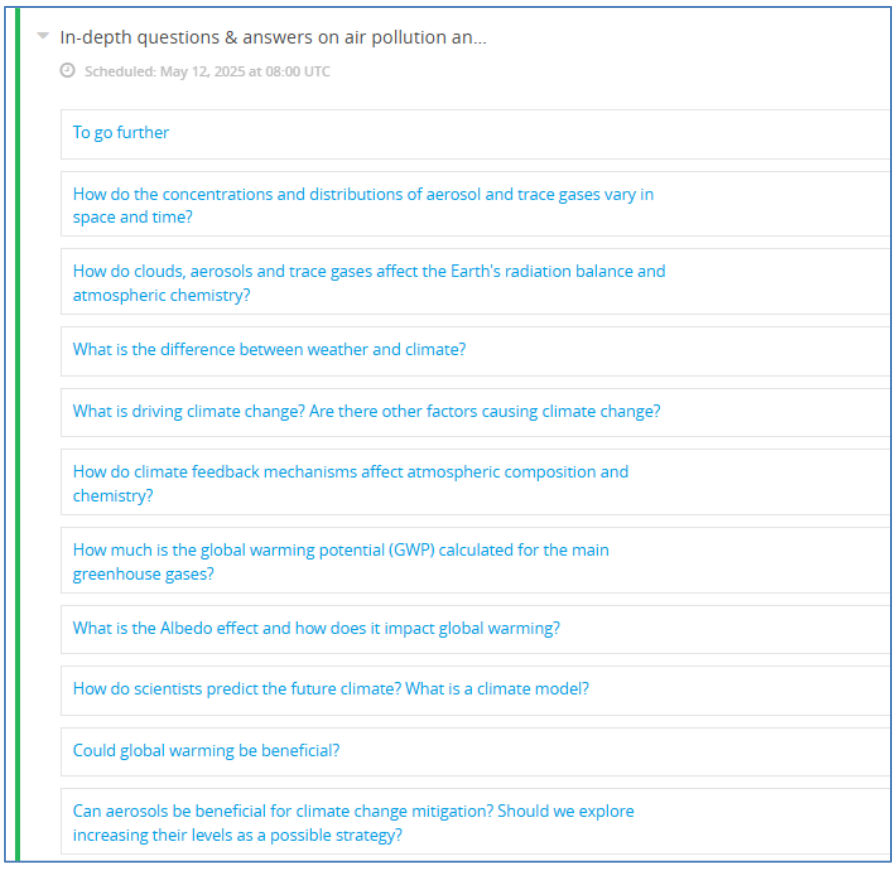
This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004



The image interaction about GWP was removed and used in the 'In-depth questions & answers on air pollution and climate change' section.

In-depth questions & answers on air pollution and climate change

Two additional in-depth **critical questions & answers** on air pollution and climate change were added to the existing ones, related to **Global Warming Potential (GWP)** and **albedo**.



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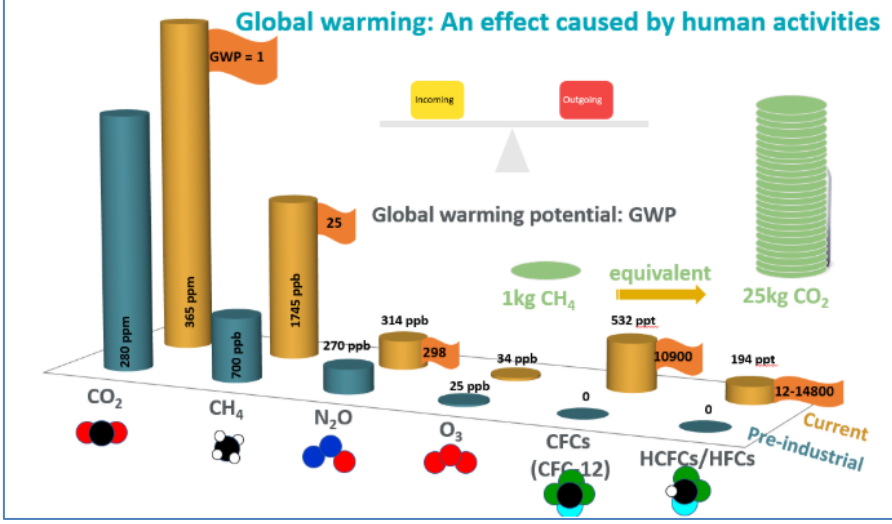
How much is the global warming potential (GWP) calculated for the main greenhouse gases?

Although CO_2 is the most prominent green house gas involved in global warming, other natural green house gases have seen their concentrations influenced by human activities, as well as other man-made compounds such as Chlorofluorocarbons (also called CFCs), Hydro-chlorofluorocarbons (or HCFCs) and hydro-fluorocarbons (HFCs) that were used as refrigerants and propellants in spray cans.

A comparison between pre-industrial concentrations (shown as blue bars) and the ones measured in 2010 (as golden bars) highlight historical trends. The combustion of fossil (fuels), agricultural activities, and other anthropogenic sources led to a massive increase in the concentrations of green house gases.

Consequently, the energy balance of the planet is disturbed. More energy is trapped in our atmosphere driving the system out of equilibrium toward higher surface temperatures. In order to estimate the importance of each green house gas compared to carbon dioxide, a global warming potential (or GWP) can be calculated for each species over a given period. The GWP of carbon dioxide is set at one. Over a period of 100 years, the GWP of other greenhouse gases vary from 25 for methane up to more than 10,000 for some CFCs and their alternatives.

In short, releasing only 1 kg of CH_4 into the atmosphere is about equivalent to releasing 25 kg of CO_2.



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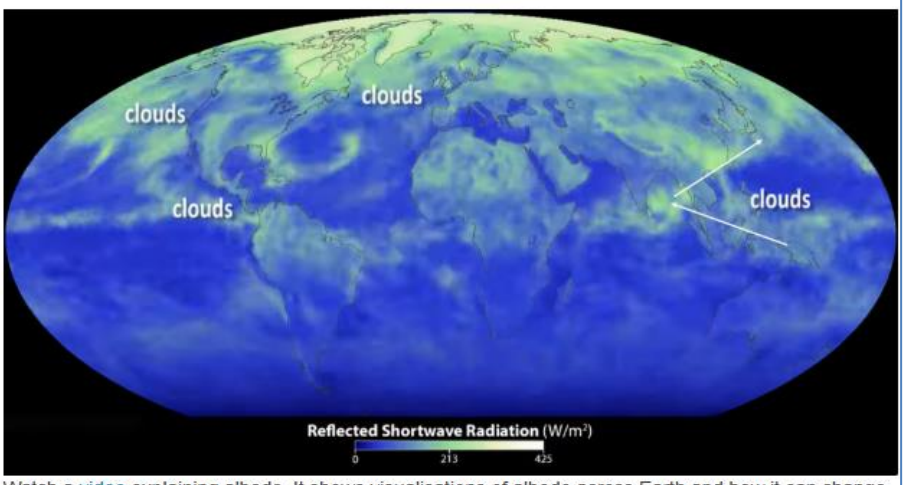
What is the Albedo effect and how does it impact global warming?

The albedo effect refers to the ability of different surfaces to reflect sunlight back into space, also known as planetary albedo. Light-colored surfaces are considered to have a high albedo, efficiently reflecting a large portion of incoming solar radiation, acting like a mirror to the sun's rays. Conversely, dark-colored surfaces possess a low albedo, absorbing more of the incoming solar radiation. This phenomenon, also termed incident radiation, is evident in everyday scenarios, such as the significant temperature difference between a black and a white car parked under the sun, where the black car's low albedo leads to greater heat absorption compared to the white car's reflective high albedo surface.

The albedo effect plays a crucial role in influencing the climate. Surfaces with a higher albedo reflect more sunlight, which tends to cool the surrounding air, while surfaces with a lower albedo absorb more sunlight, leading to a warming of the adjacent air. The global average albedo, resulting from the combined reflectivity of all Earth's surfaces, has historically been indicative of a stable global climate. However, this balance is delicate, as shifts in either global climate or albedo can influence the other, potentially creating feedback loops. The Earth's diverse landscapes, from the highly reflective polar ice caps to the absorptive dark forests and oceans, each contribute uniquely to the planet's overall climate, with phenomena like the ice albedo feedback in the Arctic Ocean demonstrating how changes in reflective surfaces can amplify warming.



Watch a video explaining albedo. It shows visualisations of albedo across Earth and how it can change.

Video: ACTRIS

A link to the ACTRIS website was added at the beginning, and a text interaction was added to introduce and highlight the new chapter on ASC.

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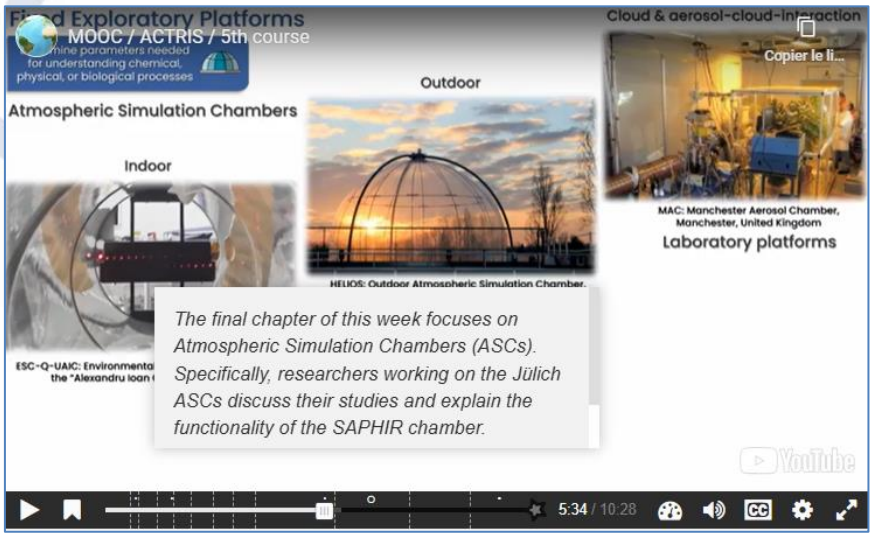

Video: IAGOS

Two link interactions were added to encourage the visit of the IAGOS website and to the real-time position and trajectory of IAGOS aircraft.

Video: ICOS

A link to the ICOS website was added at the end of the video.

Video: Workflow

Three interactions were added with links to the RI databases.

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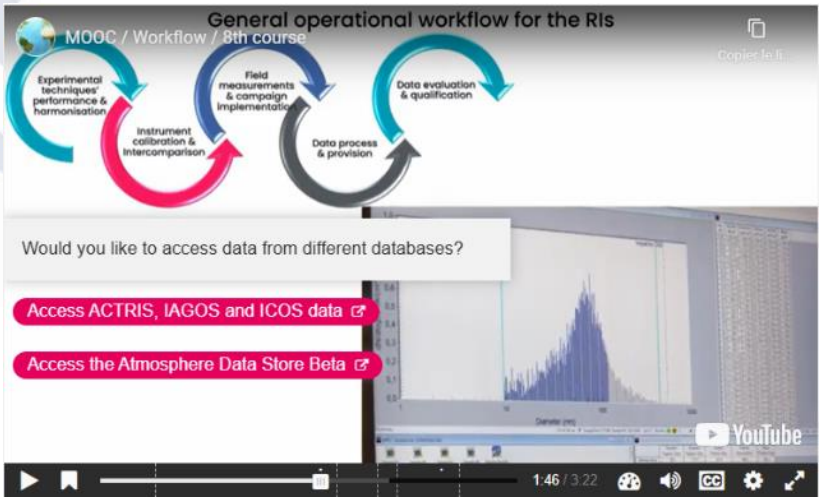
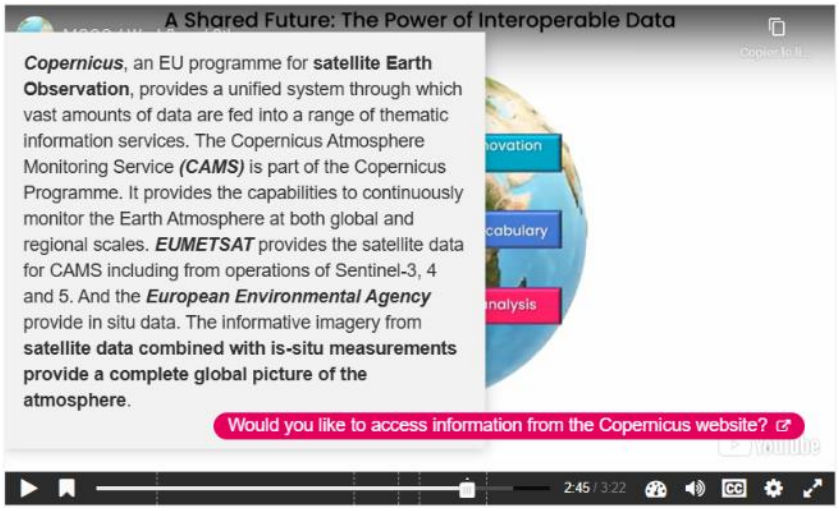


Two interactions were added related to Copernicus: a link to its website and a text explaining its goals.



Optional quizzes

An additional multiple-choice question has been added to the optional quiz for each interactive video. Each question has at least four options and an explanation of the correct answer to provide feedback for learners.

'To go further' optional section

A new 'To go further' **optional section** was added to provide deep understanding and practise, which includes: (1) the **tutorial video** for the **Timeseries analysis tool** tutorial videoservice to guide participants step by step to data analysis. Details can be found in the Tutorial section; (2) a few **mind-bending activities** *'A journey into Atmospheric Science and You'* to encourage the participants to think deeper **about the atmosphere and themselves.**

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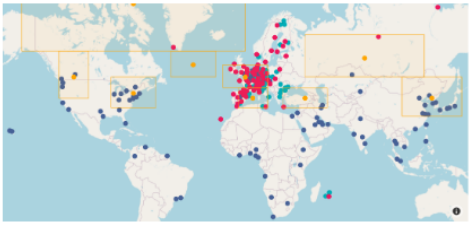
ATMO ACCESS
Access to Atmospheric Research Facilities

- **What is your carbon footprint? -** Click on the image to find out
  Food for thought: What can you do to reduce it?

carbon footprint™

The ATMO-ACCESS project is actively working to reduce its carbon footprint to help society tackle climate change. Learn more about the ATMO-ACCESS sustainable approach.

- **What are the levels of pollutants, including carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), nitrous dioxide (NO_2), ozone (O_3) and particulate matter (PM), in your area?** - Click on the image to check the most recent measurements closest to you
  Food for thought: How can data be kept accessible and long-lived?



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