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## Multidisciplinary MOOC implemented and publicly available

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## Introduction

The main objective of the task 4.3 'Development and application of training through Virtual Access' is to test new ways of training beyond the remote and/or physical access via Trans National Access (TNA). In this way, the basis for innovative trainings related to TNAs are built and could be enhanced in the future within the atmospheric research community.

The pilot resources and specifically the MOOC (Massive Open Online Course) aim to add the training dimension to RI accesses, by using virtual access and show how tools for training and education can be further developed and applied within the RIs for different user communities in a sustainable framework.

## General information

The 1<sup>st</sup> session of the pilot MOOC 'Atmospheric Research Infrastructures: Sharing the future of our atmosphere' has opened on Jan 20, 2025 until Feb 16, 2025, on the FUN (France Université Numérique) MOOC platform on this [page](#).

The course consisted of a 2-week self-paced session, with a commitment of approximately 2 hours per week. The MOOC was open for a duration of 4 weeks in total, allowing more flexibility for registered participants.

At the beginning of each of the 1<sup>st</sup> two weeks, new content is released. Participants joining on the 3<sup>rd</sup> and 4<sup>th</sup> weeks have all the material readily accessible.

<b>Topic</b>	Atmospheric observations in European Research Infrastructures (RI)
<b>Goal</b>	Provide knowledge and skills to optimise the use of Atmospheric Research Infrastructures
<b>Target user groups</b>	<ul style="list-style-type: none"><li>➤ Young scientists</li><li>➤ Broader community of users concerned by climate change and air quality issues</li><li>➤ Operators of atmospheric RI facilities</li></ul>





## Communication (related to WP2)

Ahead of the MOOC release, several resources have been produced and actions taken for communication purposes (related to *WP2: Integrated modalities for engaging users, enhancing awareness and monitoring the success of access strategies*), such as a [teaser](#) and a [flyer](#).

The teaser was shown ahead of time at several scientific conferences such as the EGU General Assembly 2023, the ACTRIS Science Conference, and specific events relative to each RI, such as the ACTRIS weeks 2023 and 2024, training activities such as the '[ACTRIS training on organic tracers and aerosol constituents](#)' and '[Training school related to sensor applications on the ground](#)'.

It was also presented for a wider audience on the YouTube pages of the [ATMO-ACCESS](#) project and the RIs [ACTRIS](#) and [IAGOS](#), and published on the FUN MOOC platform during the registration period, as well as on social media, such as LinkedIn and X.

Once registrations were opened (beginning of December 2024), the MOOC was further promoted at the [AGU Annual Meeting 2024](#), on social media (see *Annex | Examples of the use of social media to communicate about the MOOC*), by the three RI newsletters, and by the FUN MOOC platform itself through a dedicated [article](#). It was also shared with wider networks notably in the [ENVRI community website](#) and newsletter and in the Global Atmosphere Watch (GAW) [newsletter](#).

The flyer was also distributed, mostly by IMT staff, at meetings and events which they attended such as the European Research Course on the Atmosphere ([ERCA](#)) winter school in January 2025, or various PhD defenses during the month of December 2024.

## MOOC content

### Video specifications

The 2-week course consisted of 8 **interactive videos**. These interactions allow viewers to actively engage with the video through clickable areas, transforming passive video watching into a more dynamic experience. They are ideal for e-learning since they enhance learning by providing more effective learning outcomes and better retention of information. They can be true false or multiple-choice questions, buttons to access more information, images and activities. The following screenshot shows how interactions keep learners engaged and facilitate knowledge acquisition.





The screenshot shows a video player interface for a video titled "What is the fate of the compounds emitted into the atmosphere?". The video content is a diagram of the atmosphere showing the following elements:

- Physical Processes:** Elevation in the stratosphere, Accumulation in the troposphere, and Transportation.
- Chemical Degradation:** Photolysis, Homogeneous reactions with oxidants, and Heterogeneous interactions with surfaces (clouds - aerosols).
- Pollutants:** Primary Pollutants (SO<sub>2</sub>, NO<sub>x</sub>, N<sub>2</sub>O, VOCs, Biogenic, Forest fires, Vegetation, Agriculture, Industries, Fossil fuels, Solvents, Urban areas, Transport) and Secondary Pollutants (PAN, Carbonyls, OH, RO, NO<sub>2</sub>, UV, RO<sub>2</sub>, HO<sub>2</sub>, NO, CO<sub>2</sub>, CFCs, CH<sub>4</sub>).
- Processes:** VOCs, PAN, Carbonyls, OH, RO, NO<sub>2</sub>, UV, RO<sub>2</sub>, HO<sub>2</sub>, NO, CO<sub>2</sub>, CFCs, CH<sub>4</sub>.

Interactive elements include a search bar with "Which are the main tropospheric oxidants?", a bookmark icon with "Check here the VOC oxidation scheme", and a video player control bar at the bottom showing 1:46 / 12:59.

These interactive videos possess bookmarks. By clicking a selected bookmark, the participants can quickly access to the specific chapter. Thus, the bookmarks direct the learners immediately to the part of their interest. The screenshot below illustrates how bookmarks create a structured video course and facilitate access to relevant information.

The screenshot shows a video player interface for a video titled "What is the problem?". The video content is a diagram illustrating the relationship between air pollution and climate change:

- Air pollution:** The release of pollutants such as gases & particles into the air that is harmful to human health and the environment.
- Climate change:** The long-term increase in the earth's average surface temperature and the large-scale changes in global, regional, and local weather patterns.
- Diagram:** Shows the sun, ozone layer, aged particles scatter & absorb, greenhouse gases trap heat, and aerosol & trace gases emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, O<sub>3</sub>, CFCs).

A "Bookmarks" menu is overlaid on the left side of the video player, listing the following chapters:

- What is the problem?
- What does the Intergovernmental Panel on Climate Change (IPCC) tell us?
- What are the consequences across the globe?
- How does it affect us?
- Is it important?
- What do we do now? How does air pollution contribute to climate change and in turn, climate change impacts air pollution.
- What should we keep in mind?

The video player control bar at the bottom shows 1:25 / 5:25.





For the benefit of non-native English speakers and people with some disabilities, the 8 interactive videos are provided with **subtitles** in English, French, German, Greek, Portuguese, and Spanish. Here are some examples of how interactions provide access to additional resources and facilitate understanding through native-language subtitles.

**How can we mitigate air quality and climate change issues?**  
MOOC / RIs / 4th course  
Air quality and climate change management requires a multifold synergetic approach

Click to answer the true/false question

Science & Research | Accurate data | Assessments | Decision making

Atmospheric Physical and Chemical Processes  
Green house gases  
Clouds  
Oxidants  
Aerosols  
Trace gases  
Pollutant emissions

Successful Ozone layer recovery  
Montreal Protocol

If you need more information for The Agreement That Saved Life on Earth... Watch this dedicated video.

για την προστασία της στιβάδας του όζοντος σε όλο τον πλανήτη μας.

**The IAGOS perimeter**  
MOOC / IAGOS / 6th course

Since August 1994

65,000 flights

19 aircraft | 330 visited airports

12 associated airlines

450 peer reviewed publications | 8 research institutes

Are you interested in learning about the CONTRAIL project? A Japanese aircraft observation project.

Sie fragen sich wahrscheinlich, wie viel Arbeit, Vorbereitung und Zeit es braucht, um ein Flugzeug für die Überwachung vorzubereiten?





## First week

The first week 'Air pollution and climate change, what is happening in our atmosphere and what should we do?' contains **4 interactive videos of 36 minutes** of material in total. The videos are designed to build upon concepts presented in earlier sections. Therefore, watching them in the correct sequence is crucial for effective learning.

Video topic	Length (min)
Air pollution vs. Climate change	5:25
Aerosols and Clouds	10:58
Trace gases and Greenhouse gases	12:59
Atmospheric Research Infrastructures	7:11

At the end of each interactive video, participants can consult a brief **summary** and test their knowledge with an **optional quiz of 5 questions**. This optional quiz is used for practising and preparation for the final quiz. Participants can take these quizzes as many times as they want since they're a great way to reinforce learning. Below is an example of an optional quiz question.

Test your knowledge with our fun, optional quiz! Take it as many times as you'd like – it won't affect your grade and is a great way to review!

(1/1 point)

1. Which of the following is NOT a primary source of aerosols?

Volcanic eruptions

Seaspray

Photochemical smog ✓

Desert dust

### EXPLANATION

Primary aerosols are emitted directly into the atmosphere. Photochemical smog is a mixture of pollutants that are formed when nitrogen oxides and volatile organic compounds (VOCs) react in the presence of sunlight, creating a brown haze above cities.

CHECK

HIDE ANSWER



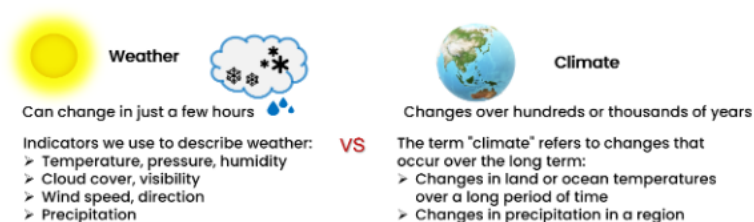


At the end of the first week, participants can go further and explore **8 critical questions and answers** on air pollution and climate change. The screenshot below offers an example of one of these questions. The list of all the questions addressed can be found in *Annex | MOOC content, 1st week: To go further.*

#### What is the difference between weather and climate?

Weather and climate refer to local conditions in a specific area, but the main difference between them is a matter of time.

Weather refers to the local conditions on the scale of minutes, hours, days, and even months to years. Climate is an average of weather conditions over 30 years or more and can be assessed for a single location, a large area, or globally. Climate therefore influences the average weather conditions over a long period of time. The methods used to predict changes in weather and climate are also different. Because weather changes from day to day, current weather forecasts are reliable for about ten days. Climate, on the other hand, can be thought of as the average weather, integrating the weather variability over much longer time horizons.



## Second week

The **second week** 'Three Atmospheric Research Infrastructures on the way to addressing atmospheric issues' incorporates **3 interactive videos of 32 minutes** of material in total. Participants are free to choose the order in which they watch the 3 RI videos.

Video topic	Length (min)
ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure)	10:28
IAGOS (In-service Aircraft for a Global Observing System)	8:43
ICOS (Integrated Carbon Observation System)	9:09
The workflow and benefits of a coordinated approach	3:22

Similar to the first week, each interactive video concludes with a brief **summary** and an **optional quiz of 5 questions** for participants to assess their knowledge. This screenshot illustrates the concluding summary of an interactive video.





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The eighth ATMO-ACCESS video concludes the two-week online course and emphasises the critical workflow that ensures the collection, processing, and dissemination of accurate and high quality data. Key steps in this workflow include:

- **Standardisation of experimental methods:** Techniques and instrumentation are harmonised across each research infrastructure (RI) to ensure consistent and reliable measurements.
- **Calibration and intercomparison:** Instruments undergo rigorous calibration and cross-checking to maintain accuracy.
- **Data collection:** Data are collected from a variety of facilities, including mobile and fixed platforms, aircraft, and ground stations, in different environments.
- **Data processing and evaluation:** Collected data are subjected to quality control and thorough evaluation to ensure they meet the required scientific standards.
- **Data access:** The processed data are made openly available in accordance with the FAIR principles (Findable, Accessible, Interoperable, Reusable) principles, enabling further research and policy-making.

The data generated by these infrastructures benefit a wide range of users, from researchers and policy makers to the private sector and the general public. These initiatives foster interdisciplinary collaboration across different scientific fields. However, ensuring data interoperability remains a key challenge, with efforts needed to standardise data formats and vocabularies across disciplines.



This project has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement N° 101008004

At the end of the week, participants can watch **staff interviews** of about **20 minutes of material in total** to further explore the three RIs.

<b>Interviews</b>	<b>Interviewees</b>	<b>Length (min)</b>
<a href="#">Meet ACTRIS</a>	Eija Juurola, Suzanne Crumeyrolle, Stefan Reimann	8 :30
<a href="#">Meet IAGOS</a>	Hannah Clark, Thibaut Lebourgeois, Romain Blot, Julie Patuel	4:13
<a href="#">Meet ICOS</a>	Elena Saltikoff	6:34

More information about the interviewees is presented in *Annex | MOOC content, 2nd week: Interviews*.



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[atmo-access.eu](https://atmo-access.eu)



### Additional material

In addition to the weekly content, a section '**Additional material**' on this [page](#) contains useful information such as a glossary (41 entries), a list of abbreviations and nomenclature (chemical families, chemical compounds, ATMO-ACCESS facilities), and a selection of recent scientific publications and websites related to the three atmospheric research infrastructures ACTRIS, IAGOS and ICOS.

All the additional material present on the FUN platform is listed in the *Annex | Additional material*.

### Final Graded Quiz (evaluation)

The final quiz consists of 15 questions and counts for 100% of the final grade. In order to successfully complete the course and obtain the open badge, an average grade of 67% or higher is required (10 out of 15 correct answers). The screenshot below presents the first question of the quiz and its answer.

#### QUESTION 1 (1/1 point)

What is the relationship between air pollution and climate change?

- Air pollution and climate change are entirely unrelated phenomena.
- Air pollution mitigates climate change by cooling the planet through the formation of a protective ozone layer.
- Air pollution contributes to climate change by releasing greenhouse gases and aerosols that alter the Earth's atmosphere. ✓
- Climate change reduces air pollution because warmer temperatures clean up the atmosphere naturally.

#### EXPLANATION

Air pollution and climate change are interconnected through the emission of harmful substances into the atmosphere. Greenhouse gases such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), released by anthropogenic activities, trap heat in the Earth's atmosphere. These gases are a major driver of climate change, contributing to global warming by enhancing the greenhouse effect. Air pollution also includes aerosols—tiny particles suspended in the air. Some, like black carbon (soot), absorb heat and contribute to warming. Others, like sulfate aerosols, can temporarily reflect sunlight and create a cooling effect, but they also disrupt weather patterns and can harm human health and ecosystems.

HIDE ANSWER

You have used 2 of 2 submissions





## General discussion & Technical issues

The platform provides a forum, which is, in the case of this MOOC, dedicated to **questions about the course or technical aspects of the FUN platform** in order to reply to possible participant issues. Participants can post and have further information and help. The following screenshot shows an example of the General discussion page.

The screenshot displays the ATMO ACCESS forum interface. At the top, there are navigation tabs: Courseware, Course Info, **General Discussion**, Progress, FAQ, Extra material, and Instructor. Below the tabs is a breadcrumb trail: Home / Technical issues / not finding the answer. A search bar is present with a 'Search' button and a link to 'Advanced search'. The main heading of the thread is 'not finding the answer'. The first post is by 'SuruchiSuruchi' on Feb. 3, 2025, at 7:28 p.m. The post content reads: 'I encountered a question during the exam that I was unable to answer. Despite my best efforts, no option appeared to be correct, and I am unsure whether it is an issue with the question or if I am missing something on my side. I would greatly appreciate your help in clarifying this matter. The question is: *What is the effect of aerosols on cloud formation? (select all that apply)* They can reduce the amount of rain. They can act as cloud condensation nuclei. They can decrease cloud albedo. They can reinforce stratospheric ozone depletion.' The second post is a reply by 'AntoniaZ' on Feb. 3, 2025, at 9:19 p.m. The reply content reads: 'Dear Suruchi, Thanks for participating in the course! This is the fifth and final question in the optional quiz for the second module 'Aerosols & Clouds'. There's no problem with the question itself. You can try answering it as many times as you like—it won't affect your grade. Feel free to use the "Show the Answer" button to review the correct choices and explanations.' Below the reply, a quiz question is shown: '5. What is the effect of aerosols on cloud formation? (select all that apply)'. The options are: 'They can reduce the amount of rain.' (checked), 'They can act as cloud condensation nuclei.' (checked), 'They can decrease cloud albedo.' (unchecked), and 'They can reinforce stratospheric ozone depletion.' (checked). An 'EXPLANATION' section follows, stating: 'As the seeds from which clouds form, aerosol particles can either lead to ice nucleation (providing surfaces for water vapour to condense) or to more but smaller cloud droplets, which can reduce the amount of rain falling from the cloud. They can also change the way clouds reflect and absorb sunlight, increasing cloud albedo by altering the size of cloud particles. In addition, aerosols can increase stratospheric ozone depletion through the formation of Polar Stratospheric Clouds.'





## Other motivational resources

### Weekly messages

At the beginning of each week, a motivational message is sent to all registered participants, aiming at encouraging them to complete the MOOC. As of Feb. 10, 2025, four weekly messages have been sent and can be found below.

<b>Release date Title</b>	<b>Message content</b>
January 20, 2025  Welcome!	<p>Hello everyone,</p> <p>Thank you for joining us for a self-paced session of this online course focused on Atmospheric Research Infrastructures. Our course starts today!</p> <p>The content of each chapter is described on <a href="#">this page</a>.</p> <p>At the end of each chapter, you can test your knowledge with an optional quiz. You will receive a free badge if you pass the final quiz with 10 out of 15 correct answers.</p> <p>We would also like to know more about your motivations. Please answer <a href="#">our short survey</a> to help us learn more about you.</p> <p>We will begin by introducing you to the basics of air pollution and climate change. Your main instructors will be Prof. Veronique RIFFAULT and Dr. Antonia ZOGKA, who are introduced on <a href="#">this page</a>.</p> <p>Enjoy this course, we are thrilled to have you there!</p> <p>The 'MOOC Atmospheric Research Infrastructures: Sharing the Future of Our Atmosphere' Team</p>
January 27, 2025  Week 2	<p>Dear all,</p> <p>If you have successfully completed Week 1 – Well done! If you have just joined us – a warm welcome! You still have plenty of time to catch up and finish this 2-week course, as it will remain open until February 16.</p> <p>In Week 1, we covered the crucial topics of air pollution and climate change. By now, you should feel confident in explaining the difference between these two issues, understanding the complex interactions within the atmosphere, and recognizing the importance of data sharing and experimental results in advancing atmospheric research.</p> <p>Now, let's dive into Week 2! This week, we will explore three major European research infrastructures focused on atmospheric monitoring: ACTRIS, IAGOS, and ICOS.</p> <p>By the end of the week you will be able to:</p>





- Understand how these 3 RIs operate and how they support policy makers and global efforts to tackle environmental challenges,
- Get an overview of the technical aspects of these RIs, including data collection principles,
- Evaluate the essential contribution of these RIs to atmospheric research, air quality, climate change, civil aviation, weather and climate predictions, and future mitigation strategies.
- Explore a virtual journey through atmospheric simulation chambers and field measurement stations, through a selection of representative photos,
- Watch interviews with scientists from each RI, where they discuss their roles, motivations, and the importance of atmospheric research

\*\*\*\*\*

A quick reminder:

If you have not completed our [introductory survey](#) yet, please take a moment to fill it out. Your feedback is invaluable for improving future sessions.

\*\*\*\*\*

Finally, looking ahead: At the end of the course, you will have the opportunity to fill out [two brief surveys](#). These will help us improve the course content for future learners and also contribute to the ATMO-ACCESS project yourself, by providing invaluable feedback on the value and limitations of virtual resources for training on the topics of research infrastructures and atmospheric issues.

Enjoy Week 2, and thank you for your engagement!

The ATMO-ACCESS MOOC team

February 3, 2025

(none)

Dear all,

A huge congratulations to everyone who's already completed the first two weeks of the course! And a warm welcome to those just joining us. If you're just getting started or still catching up, don't worry – the course materials will be available until February 16th, so there's plenty of time to get up to speed.

This course highlights the importance of atmospheric science in tackling climate change and explores how research infrastructures help scientists monitor the atmosphere, share data, and coordinate global efforts. In Week 1, we cover air pollution, climate change, and their connections, while Week 2 focuses on three key European research infrastructures: ACTRIS, IAGOS, and ICOS.

By the end of this course, you'll be able to:

- assess the complex interactions within the atmosphere,





	<ul style="list-style-type: none"><li>• recognise the importance of data sharing and experimental results in advancing atmospheric research,</li><li>• describe different means of monitoring the atmosphere,</li><li>• summarise the goals, the framework and the workflow of three Research Infrastructures (RIs): ACTRIS, IAGOS and ICOS,</li></ul> <p>You can test your knowledge with the “Final Graded Quiz” of 15 questions. Once you’ve achieved a passing grade of 67%, you can claim your badge by submitting <a href="#">the Open Badge request</a>.</p> <p>In the "Ending this MOOC" section, you'll find <a href="#">two short surveys</a>. Your feedback will help us improve the course for future learners and contribute valuable insights to the ATMO-ACCESS project, particularly on the effectiveness of virtual resources for training in research infrastructures and atmospheric science.</p> <p>And don't forget to relax and enjoy our behind-the-scenes <a href="#">“making of”</a> video! 😊</p> <p>Thank you all for your dedication and engagement! We wish you a productive and enjoyable learning experience.</p>
February 10, 2025  Last week	<p>Dear all,</p> <p>A huge congratulations to those of you who’ve already completed the course and earned your badge — well done! 🎉! Welcome aboard for those of you just joining us!</p> <p>The course is officially closing soon — February 16th is your last chance to wrap things up. Don't worry, there's still time! In just 4 hours, you can discover the world of atmospheric research and the workflows behind Research Infrastructures.</p> <p>Once you hit a 67% passing grade on the Final Graded Quiz, you'll earn your badge! 🏆 Don't forget to claim it — just click <a href="#">here</a> to submit your open badge request.</p> <p>But that's not all — your feedback matters! If you haven't already, please take a moment to complete our <a href="#">short surveys</a>. 🙌 Your insights are crucial to making future courses even better, and we'd love to hear from you.</p> <p>Thank you for your participation throughout. We can't wait to see you cross that finish line!</p> <p>Cheers, The ATMO-ACCESS MOOC Team</p>

### [Making of video](#)

A short behind-the-scenes [“making of”](#) video of about 2 min was released after two weeks, to relax and cheer up the participants.





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## Feedback assessment

An introductory and two final surveys are proposed to the participants to get their feedback and provide material for *WP10: VA01 - Implementing virtual access to on-line data, computing and training service*.

The **introductory survey** consisted of 20 questions. Among the goals of this survey, there are questions:

- to know more about the participant motivations.
- to understand better the participant educational level and experience.
- to identify different groups of learners with varying needs and preferences.
- to tailor the course to better meet the needs of all participants.
- to enhance learner experience, and achieve better learning outcomes.
- to ensure the course remains relevant and engaging.

Below is a short part of this initial survey.



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**Why are you interested in this MOOC?**

- Because I enjoy learning new things
- Because I am particularly interested in this topic
- Because in my opinion it could be an asset in my career (or my future career)
- To help me with my professional integration
- In order to access a better job
- It is a personal challenge to complete this course
- I have no particular reason
- Other:

\*

**What is your "level" on the subject of this MOOC?**

- Beginner
- Intermediate
- Advanced
- Expert

\*

**How many hours per week do you expect to spend working on the MOOC?**

- Less than 1 hour
- 1h to 2h
- 2h to 3h
- 4h to 5h
- More than 5h

At the end of the MOOC, participants were invited to answer **two final surveys**: one was the follow-up survey dedicated to the **ATMO-ACCESS** project consisting of 15 questions; the second





was part of the FUN platform and consists of 17 questions. **Participant feedback is crucial in improving the quality of the course in future sessions.** It is an essential tool for any course to continuously be refined and improved based on learner feedback. Some of the main goals were:

- to pinpoint what aspects of the course worked well and which ones need improvement. This includes content, delivery methods, materials, assignments, and overall organisation.
- to determine if the course effectively achieved its learning objectives. Thus, if the participants gain the intended knowledge and skills.

The list of the ATMO-ACCESS questions can be found in *Annex | Final survey*. The survey is still ongoing and the analysis of the replies will be done in D10.6 "Third report with feedback from users and statistics on use of the services".

**For the moment (as of Feb. 10)**, 759 participants are registered, and more than 85 of them have already completed the course successfully and obtained their free badge. In addition, we count about 1820 total views for the interactive videos and the teaser.

<b>Video topic</b>	<b>Views (as of Feb. 6, 2025)</b>
Teaser	185
Air pollution vs. Climate change	361
Aerosols and Clouds	296
Trace gases and Greenhouse gases	190
Atmospheric Research Infrastructures	183
ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure)	134
IAGOS (In-service Aircraft for a Global Observing System)	123
ICOS (Integrated Carbon Observation System)	106
The workflow and benefits of a coordinated approach	77
Meet ACTRIS	68
Meet IAGOS	32
Meet ICOS	34
Making of	28







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## Annexes

### Examples of the use of social media to communicate about the MOOC

- LinkedIn post of the ATMO-ACCESS project

The screenshot shows a LinkedIn post from the organization ATMO-ACCESS. The post header includes the ATMO ACCESS logo, the name 'ATMO-ACCESS', '567 abonnés', and '4 sem. • 🔒'. The main text of the post reads: 'Registrations to our ATMO-ACCESS #MOOC are still open! Enroll by 20 Jan and learn more about #atmospheric research infrastructures !'. Below this is a link: 'https://lnkd.in/d/dSEQtd'. The post also features a hashtag '#EU\_RIs' and a description of the 'ACTRIS-RI IAGOS\_RI ICOS - Integrated Carbon Observation System ENVRI community'. It mentions that the virtual access programme is supported by '#H2020 EU Science, Research and Innovation European Research Executive Agency (REA)'. At the bottom, there is a button 'Afficher la traduction' and a featured image. The featured image is a circular word cloud with the text 'Atmospheric Research Infrastructures: Sharing the future of our ...' and 'fun-mooc.fr'. The word cloud includes terms like 'AGOS', 'cos', 'atmospheric research infrastructures', and 'Sharing the future of our atmosphere'.





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- LinkedIn post of IMT Nord-Europe (in French)

**IMT Nord Europe**  
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- X post from the Project leader, primary instructor

**Véronique RIFFAULT** @VRiffault

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#aerosols #clouds #TraceGases #GHG #ScienceEducation #scicomm

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## MOOC content, 1<sup>st</sup> week: To go further

**List of the 8 critical questions and answers** on air pollution and climate change to go further and explore.

- How do the concentrations and distributions of aerosols and trace gases vary in space and time?
- How do clouds, aerosols and trace gases affect the Earth's radiation balance and atmospheric chemistry?
- What is the difference between weather and climate?
- How do climate feedback mechanisms affect atmospheric composition and chemistry?
- What is driving climate change? Are there other factors causing climate change?
- How do scientists predict the future climate? What is a climate model?
- Could global warming be beneficial?
- Can aerosols be beneficial for climate change mitigation? Should we explore increasing their levels as a possible strategy?

## MOOC content, 2<sup>nd</sup> week: Interviews

The following table summarizes key information about the interviewees.

RI	Interviewee	Gender	Actual position	Institution
ACTRIS	Eija Juurola	F	General Director	ACTRIS ERIC Head Office
	Suzanne Crumeyrolle	F	Associate Professor	University of Lille, LOA
	Stefan Reimann	M	Principal Investigator	EMPA, Climate Gases
IAGOS	Hannah Clark	F	Executive Secretary	IAGOS AISBL
	Thibaut Lebourgeois	M	PhD Student	IAGOS, LAERO
	Romain Blot	M	Technical Manager	IAGOS, LAERO



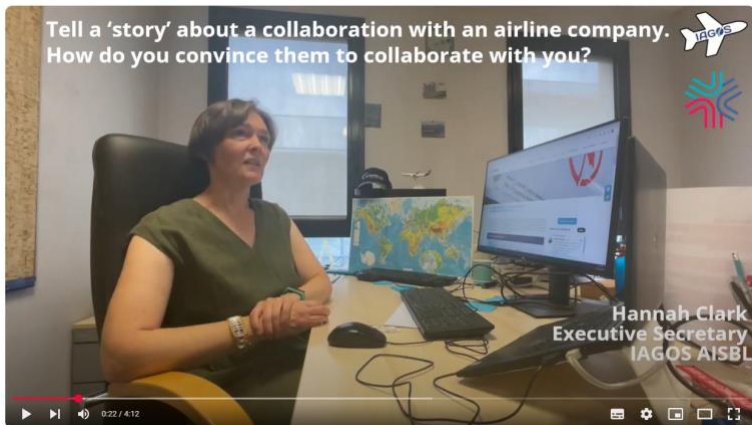


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	Julie Patuel	F	Scientific Researcher	IAGOS, LAERO
ICOS	Elena Saltikoff	F	Head of Operations	ICOS Head Office

The following screenshots provide illustrations of the 3 RIs interviews.



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## Additional material

- Glossary (41 entries)

### **Aerosols**

Solid or liquid particles (in the nanometre to micrometre range) suspended in the air, which can scatter or absorb the Sun's radiation. They may be harmful when inhaled.

### **Air monitoring station**

A site at which the concentration of one or more pollutants is monitored.

### **Aitken particles**

Aerosol particles between 10 and 100 nanometers in diameter. These are generally the most numerous among all particles in the air. However, due to their small size, Aitken particles contribute little to the total mass concentration of all aerosol particles, which is mostly determined by particles of diameter above 100 nm.

### **Anthropogenic**

Produced by human activities.

### **Boundary layer**

The well-mixed region close to the ground in the lower atmosphere, in which convection induced by the upward heat flux originating from the solar-heated Earth's surface creates turbulences. During the afternoon it can often extend from 1 to 5 km in height.

### **Calibration gas mixture**

A gas mixture of known composition, generally comprising one or more calibration components and an inert gas.

### **Carbon Footprint**

The amount of carbon dioxide (or its equivalent if other greenhouse gases are concerned) released into the atmosphere as a result of the activities of a particular individual, organisation or community.

### **CFCs (Chlorofluorocarbons)**

This class of molecules has been used extensively since the 1950s in refrigeration, "aerosol" spray cans, the manufacture of insulation, etc. The lifetime of many chlorofluorocarbons is very long in the troposphere. For example, the lifetime of  $\text{CClF}_3$  and  $\text{CCl}_2\text{F}_2$  is a few hundred years. The major destruction of these species occurs in the stratosphere where photodecomposition of the halocarbons produces Cl atoms which are involved in pathways to deplete stratospheric ozone. They were banned in 1987 according to the Montreal Protocol.

### **Cloud**

An atmospheric aerosol which is made of enough water droplets or ice crystals in the micrometre range to be visible to the eye.

### **Deposition**

A process by which aerosols and gases in the air are deposited on the Earth's surface (soil, water, rock, plants, etc.). Wet deposition involves the scavenging of chemicals by water droplets or snow crystals as they form and fall through the atmosphere. Dry deposition occurs through turbulence, diffusion, impaction, and sedimentation.

### **Diel variations**

Variations that follow a distinct pattern in a 24-hour cycle.





### **Diurnal variation**

Variations occurring in the daytime.

### **Emission**

The total rate at which a solid, liquid, or gaseous pollutant is emitted into the atmosphere from a given source; usually expressed as mass per unit of time. Primary emissions are substances emitted directly into the atmosphere (e.g., NO, SO<sub>2</sub>). Secondary emissions are formed from the primary emissions through thermal or photochemical reactions (e.g., ozone, aldehydes, ketones, sulfuric acid, nitric acid).

### **Flux**

The number or mass of particles or molecules which pass through a given unit surface area per unit time. The net vertical flux of a species is the difference between the downward and upward flux of that species.

### **Fossil fuels**

Fuels such as coal, oil, and natural gas that have formed over many years by the decomposition of deposited vegetation under the extreme pressure of an earth overburden.

### **Greenhouse gas**

A gas that absorbs and emits thermal radiation, contributing to the greenhouse/blanket effect.

### **In situ measurements**

Measurements that are performed directly on site. In the context of ACTRIS, in situ measurements of aerosol, cloud, and reactive trace gas properties refer to techniques that characterise a sampling point. They can be performed from observational platforms near the surface, mobile surface-based or airborne platforms, atmospheric simulation chambers and laboratories.

### **IPCC**

The Intergovernmental Panel on Climate Change (IPCC) is a scientific body that reviews and assesses scientific, technical and socioeconomic information on climate change.

### **IR**

The infrared spectrum refers to the range of wavelengths where the absorption of radiation is associated with vibrational transitions in molecules, typically cited in wavenumbers between 200 and 4000 cm<sup>-1</sup>.

### **Keeling curve**

The Keeling curve presents the trend of increasing carbon dioxide concentration with time, which began in the 1950s. The original record is made on a volcano in Hawaii (Mauna Loa), and the measurements are made by non-dispersive infrared spectroscopy. Levels are over 410 ppm (parts per million) in the year 2024.

### **Lifetime**

The period of time required for the decay of a given species of initial concentration [A]<sub>0</sub> to [A]<sub>0</sub>/e (e = 2.7183).

### **Monitoring**

Repeated and regular measurements of pollutants to follow their changes over a period of time. Usually in relation to some standard or in order to assess the effectiveness of a system of regulation and control.

### **NASA**

The National Aeronautics and Space Administration is the United States of America's civil space program and the global leader in space exploration.





### **NO<sub>x</sub>**

NO<sub>x</sub> refers to the sum of nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), the two oxides of nitrogen that are most significant in atmospheric chemistry near the ground level. The term specifically does not include nitrous oxide (N<sub>2</sub>O).

### **Observational platform**

In the context of ACTRIS, an observational platform represents a fixed ground-based station that acquires reliable high-quality data.

### **Oxidant**

In the context of atmospheric chemistry, the term oxidant includes all trace gases having an oxidation potential greater than oxygen (ozone, peroxyacetyl nitrate, hydrogen peroxide, organic peroxides, NO<sub>3</sub>, etc.). They are natural detergents, responsible for removing the majority of trace gases emitted into the atmosphere either via natural processes or human activities. The hydroxyl radical (OH), a neutral species containing one hydrogen and one oxygen atom, is the main one. It has one unpaired electron (hence by definition a radical) and is highly reactive.

### **Particle (atmospheric)**

A small discrete mass of solid or liquid matter.

### **Particulate matter**

A general term used to describe airborne solid or liquid particles of all sizes. The term aerosol is recommended for general use in describing airborne particulate matter.

### **Pollutant (atmospheric)**

A gaseous substance or particulate material that has been introduced into the air, either by human activity or natural processes, in sufficient concentration to produce a measurable negative effect on humans, animals, vegetation, or materials.

### **Photochemical reaction**

A reaction which occurs following light absorption of sufficient energy per quantum (usually ultraviolet or visible radiation) by a molecule or an atom, leading to an electronically excited state. In electronically excited species, one or several types of photochemical reaction may occur: photodecomposition into molecular fragments or radicals, photodecomposition into stable, smaller products, photoisomerization, intersystem crossing (a singlet to triplet state, etc.), internal energy conversion (e.g., excited singlet to vibrationally excited, singlet ground state), fluorescence, phosphorescence, electronic or vibrational energy quenching, etc.

### **Photochemical smog**

The resulting mix of ozone, peroxyacetyl nitrate, aldehydes and other oxidation products of hydrocarbons, oxides of nitrogen, aerosols, etc., which form in highly polluted urban atmospheres under conditions of stagnation and high sunlight intensity. Large cities frequently show some degree of photochemical smog. The characteristics of photochemical smog include eye irritation, visibility reduction, damage to certain sensitive plants and trees, and possible pulmonary and other health-related problems in humans and animals.

### **Primary pollutant**

A pollutant emitted directly into the air from identifiable sources (e.g., SO<sub>2</sub>, NO, hydrocarbons). Secondary pollutants, such as ozone, are generated within the atmosphere through chemical changes in primary pollutants.





### **Radiation**

General term for electromagnetic waves which reach the Earth's atmosphere from space, or are reflected/scattered by Earth and its atmosphere. Wavelengths stretch from radiowaves (very long wavelengths) through microwaves, infrared, visible, ultraviolet, X-rays and gamma radiation.

### **Radiative forcing**

The difference between energy from the Sun absorbed by the Earth and energy from the Sun reflected by the Earth, given in  $W/m^2$ .

### **Remote sensing measurements**

Measurements from a distance, by means of instruments not in immediate physical contact with the sample being examined, typically using satellites or radars. In the context of the ARIs, remote sensing measurements refer to active and passive atmospheric remote sensing techniques for the observation of aerosols, clouds, and trace gases. They can be applied at observational sites and on mobile platforms.

### **Sample probe**

A sample probe is a sampling device that penetrates a gaseous environment to obtain a sample. It features a connection point for attaching a sampling line or a container for collecting the extracted gas.

### **Sink**

In atmospheric chemistry, the sink is the receptor for material which is removed from the atmosphere. Because of long-range transport of many pollutants, the sink region can be many hundreds of kilometres from the source region of the pollutants.

### **Smog**

The term originated in Great Britain as a popular derivation of "smoke-fog" and appears to have been in common use before World War I. It originally referred to the heavy pollution derived largely from coal burning. Nowadays in the 2020s, it corresponds to an oxidising atmosphere containing ozone and other oxidants, appearing in cities.

### **Solar radiation**

The electromagnetic radiation emitted by the Sun. The total range of wavelengths of light emitted by the Sun (99.9% in the range from 150 to 4000 nm) is filtered on entering the Earth's atmosphere, largely through absorption by oxygen, ozone, water vapour, and carbon dioxide. Near sea level only light of wavelengths longer than 290 nm is present. The light from 290-400 nm is effective in inducing important photochemical processes since absorption by important trace gases, such as ozone, nitrogen dioxide, aldehydes, ketones, etc., is significant in this region.

### **Source**

In atmospheric chemistry, a source is any process or mechanism that releases gases or particles into the atmosphere. It can be also a place, places, or group of sites or areas where a pollutant is released.





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### **Tracer**

A foreign substance mixed with or attached to a given substance, enabling the distribution or location of the latter to be determined subsequently. For example, the composition of aerosols in the troposphere has been used as a qualitative tracer of air masses. There are several types of tracers which are used: a) physical tracers are attached by physical means to the object being traced; b) chemical tracers have properties similar to those of the traced substance with which it is homogeneously mixed; c) isotopic tracers are unique isotopes, either radioactive or an enriched, uncommon stable isotope, of the element to be traced; d) radioactive tracers are physical or chemical tracers having radioactivity as their distinctive property, which allows their detection at small concentrations and hence after large transport distances.

- Abbreviations and nomenclature

This section of the platform contains a list of chemical families (7 entries) and chemical compounds (22 entries) mentioned in the MOOC, the ATMO-ACCESS facilities included in the project (split into observational platforms – 29 entries, atmospheric simulation chambers – 14 entries, mobile exploratory platforms – 5 entries, central laboratories – 13 entries, and IAGOS facility members – 8 entries), and a list of general abbreviations (57 entries).





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## Chemical families

Name	Abbreviation	Comments or external links
Chlorofluorocarbons	CFCs	EEA* glossary: <a href="https://www.eea.europa.eu/help/glossary/eea-glossary/chlorofluorocarbon">https://www.eea.europa.eu/help/glossary/eea-glossary/chlorofluorocarbon</a>  <a href="https://earthdata.nasa.gov/topics/atmosphere/chlorofluorocarbons">https://earthdata.nasa.gov/topics/atmosphere/chlorofluorocarbons</a>
Hydrofluorocarbons	HFCs	EEA glossary: <a href="https://www.eea.europa.eu/help/glossary/eea-glossary/hydrofluorocarbon">https://www.eea.europa.eu/help/glossary/eea-glossary/hydrofluorocarbon</a>
Non-Methane HydroCarbons	NMHCs	Compounds with the molecular formula C <sub>x</sub> H <sub>y</sub> , excluding methane (x=1, y=4)
Nitrogen oxides	NO <sub>x</sub>	Corresponds to the sum of nitric oxide (or nitrogen monoxide, NO) and nitrogen dioxide (NO <sub>2</sub> )
Oxygenated Volatile Organic Compounds	OVOCs	VOCs (see definition below) containing one or more oxygen atoms
Volatile Chemical Products	VCPs	Anthropogenic (human-made) VOCs (see definition below)
Volatile Organic Compounds	VOCs	European Union official definition (art. 3 (45)): <a href="https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:02010L0075-20240804%20">https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:02010L0075-20240804%20</a> EEA glossary: <a href="https://www.eea.europa.eu/help/glossary/other-eea-terms/volatile-organic-compound">https://www.eea.europa.eu/help/glossary/other-eea-terms/volatile-organic-compound</a>  US EPA definition: <a href="https://cdxapps.epa.gov/oms-substance-registry-services/substance-details/1846415">https://cdxapps.epa.gov/oms-substance-registry-services/substance-details/1846415</a>

\* EEA: European Environmental Agency, <https://www.eea.europa.eu/>



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## Chemical compounds

Molecular formula	Name	Link to the NIST Webbook of Chemistry
CH <sub>4</sub>	Methane	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Methane">https://webbook.nist.gov/cgi/cbook.cgi?Name=Methane</a>
C <sub>2</sub> H <sub>6</sub>	Ethane	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Ethane">https://webbook.nist.gov/cgi/cbook.cgi?Name=Ethane</a>
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Acetaldehyde">https://webbook.nist.gov/cgi/cbook.cgi?Name=Acetaldehyde</a>
C <sub>3</sub> H <sub>6</sub> O	Acetone	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Acetone">https://webbook.nist.gov/cgi/cbook.cgi?Name=Acetone</a>
C <sub>4</sub> H <sub>8</sub> O	Methacrolein	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Methacrolein">https://webbook.nist.gov/cgi/cbook.cgi?Name=Methacrolein</a>
C <sub>5</sub> H <sub>8</sub>	Isoprene	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Isoprene">https://webbook.nist.gov/cgi/cbook.cgi?Name=Isoprene</a>
C <sub>6</sub> H <sub>6</sub>	Benzene	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Benzene">https://webbook.nist.gov/cgi/cbook.cgi?Name=Benzene</a>
C <sub>7</sub> H <sub>8</sub>	Toluene	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Toluene">https://webbook.nist.gov/cgi/cbook.cgi?Name=Toluene</a>
CO	Carbon monoxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+monoxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+monoxide</a>
CO <sub>2</sub>	Carbon dioxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+dioxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+dioxide</a>
CS <sub>2</sub>	Carbon disulphide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+disulfide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbon+disulfide</a>
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulphide (DMS)	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Dimethyl+sulfide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Dimethyl+sulfide</a>
H <sub>2</sub> O	Water	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Water">https://webbook.nist.gov/cgi/cbook.cgi?Name=Water</a>
H <sub>2</sub> S	Hydrogen sulphide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Hydrogen+sulfide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Hydrogen+sulfide</a>
HCHO	Formaldehyde	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Formaldehyde">https://webbook.nist.gov/cgi/cbook.cgi?Name=Formaldehyde</a>
N <sub>2</sub> O	Nitrous oxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitrous+oxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitrous+oxide</a>
NO	Nitrogen monoxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitric+oxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitric+oxide</a>
NO <sub>2</sub>	Nitrogen dioxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitrogen+dioxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Nitrogen+dioxide</a>
O <sub>3</sub>	Ozone	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Ozone">https://webbook.nist.gov/cgi/cbook.cgi?Name=Ozone</a>
OCS	Carbonyl sulphide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbonyl+sulfide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Carbonyl+sulfide</a>
SF <sub>6</sub>	Sulphur hexafluoride	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Sulfur+hexafluoride">https://webbook.nist.gov/cgi/cbook.cgi?Name=Sulfur+hexafluoride</a>
SO <sub>2</sub>	Sulphur dioxide	<a href="https://webbook.nist.gov/cgi/cbook.cgi?Name=Sulfur+dioxide">https://webbook.nist.gov/cgi/cbook.cgi?Name=Sulfur+dioxide</a>

## ATMO-ACCESS Facilities

(<https://www.atmo-access.eu/facilities/>)

*Observational platforms (fixed ground-based stations)*

Acronym	Facility	Location
AGORA	Andalusian Global Observatry of the Atmosphere	Granada, Spain
ATMOS	AThens MONitoring Supersite	Athens, Greece
ARN	Atmospheric Sounding Station El Arenosillo	Mazagón, Huelva, Spain
BNC	Barcelona Cluster	Barcelona, Spain
CAO	Cyprus Atmospheric Observatory	Agia Marina Xyliatou, Cyprus
CESAR	Cabauw Experimental Site for Atmospheric Research	Lopik, the Netherlands
CIAO	CNR-IMAA Atmospheric Observatory	Tito (Potenza), Italy
CMN-PV	Monte Cimone – Po Valley	Monte Cimone
CO-PDD	Cézeaux-Aulnat Opme Puy de Dôme	Clermont-Ferrand, France
CVAO	Cape Verde Atmospheric Observatory	Calhau, Cape Verde Island
EVASO	EVora Atmospheric Science Observatory	Evora, Portugal
FKL	Finokalia	Finokalia, Crete, Greece.



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FMI SOD	PAL-	Pallas-Sodankylä Atmosphere-Ecosystem Supersite	Muonio, Finland
HTM		Hyltemossa Research Station	Forest in southern Sweden; Nearest small town: Perstorp
JFJ		High Altitude Research Station Jungfrauoch	Jungfrauoch, Switzerland
ISAF		Izana Subtropical Access Facility	La Orotava, Tenerife, Spain
MHD		Mace Head Atmospheric Research Station	Carna, county Galway, Ireland
MEL		TROPOS Research Station Melpitz	Melpitz, Germany
NAOK		National Atmospheric Observatory Košetice	Košetice, Czech Republic
OPAR		Observatoire de Physique de l'Atmosphère à la Réunion	La Réunion Island, France
PANGEA		PANhellenic GEophysical observatory of Antikythera	Island of Antikythera, Greece
RADO		Romanian Atmospheric 3D research Observatory	Magurele, Romania
SBO		Sonnblick Observatory	Salzburg, Austria
SIRTA		Site Instrumental de Recherche par Télédétection Atmosphérique	Plateau de Saclay (Paris), France
SMEAR II		Station for Measuring Ecosystem – Atmosphere Relations II	Juupajoki, Finland
SMEAR EE		Station for Measuring Ecosystem – Atmosphere Relations Estonia	Järvelja, Estonia
VRS		Villum Research Station	North Station, Greenland, Denmark
WOPAS		Wrocław Observatory Platform for Atmospheric Studies	Wrocław, Poland
WOS		Warsaw Observatory Station	Warsaw, Poland



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*Atmospheric simulation chambers*

<b>Acronym</b>	<b>Facility</b>	<b>Location</b>
AIDA	Aerosol Interaction and Dynamics in the Atmosphere	Karlsruhe, Germany
ACD-C and LACIS-T	Aerosol Chamber of the Atmospheric Chemistry Department (ACD-C) and Turbulent Leipzig Aerosol Cloud Interaction Simulator (LACIS-T)	Leipzig, Germany
AURA	Aarhus University Research on Aerosols chamber	Aarhus, Denmark
CESAM	Experimental Multiphase Atmospheric Simulation Chamber	Créteil, France
ChAMBRé	Chamber for Atmospheric Modelling and Bio-Aerosol Research	Genoa, Italy
ESC-Q-UAIC	Environmental Simulation Chamber from the "Alexandru Ioan Cuza" University of Iasi	Iași, Romania
EUPHORE	European PHOto-reactor	Valencia, Spain
HELIOS	Outdoor Atmospheric Simulation Chamber of Orléans	Orléans, France
IASC	Irish Atmospheric Simulation Chamber	Cork, Ireland
KASC	Kuopio Atmospheric Simulation Chambers	Kuopio, Finland
MAC	Manchester Aerosol Chamber	Manchester, United Kingdom
PACS-C2	PSI Atmospheric Chemistry Simulation Chambers	Villigen, Switzerland
QUAREC	Quartz Reactor	Wuppertal, Germany
SAPHIR/SAPHIR-PLUS	Simulation of Atmospheric Photochemistry in a Large Reaction Chamber	Jülich, Germany

*Mobile Exploratory platforms*

<b>Acronym</b>	<b>Facility</b>	<b>Location</b>
AMP Poland	ACTRIS-Poland Mobile Platform	Sosnowiec, Poland
FCoMLab	Finland Combined Mobile Laboratory	Finland
FORTH-MSc	FORTH Mobile atmospheric Simulation Chamber	Patras, Greece
LACROS	Leipzig Aerosol and Cloud Remote Observations System	Leipzig, Germany
USRL	Unmanned Systems Research Laboratory	Nicosia & Orounda, Cyprus





*Central Laboratories*

<b>Acronym</b>	<b>Relevant Research Infrastructure   Facility</b>	<b>Location</b>
ACMCC	ACTRIS   Aerosol Chemical Monitor Calibration Centre	Plateau de Saclay (Paris), France
CARS-CNR	ACTRIS   CNR Lidar calibration centre	Tito (Potenza), Italy
CARS-ES-ISAF	ACTRIS   Centre for Aerosol Remote Sensing at Izaña Subtropical Facility	Tenerife Island, Spain
CCRES-FR	ACTRIS   Centre for Cloud Remote Sensing – France	Plateau de Saclay (Paris), France
CCIce	ACTRIS   Centre for Cloud Ice Nucleation	Karlsruhe, Germany
CCRES-NL	ACTRIS   Centre for Cloud Remote Sensing – NL	Lopik, The Netherlands
CiGAS-CH	ACTRIS   Centre for Reactive Trace Gases In Situ Measurements	Dübendorf, Switzerland
ICOS-ATC	ICOS   Atmospheric Thematic Center	Plateau de Saclay (Paris), France
ICOS-Lab	ICOS   Mobile laboratory	
Isolab – UU	ICOS   Isotope laboratory at Utrecht University	Utrecht, The Netherlands
LiCAL – INOE	ACTRIS   Lidar Calibration Centre	Magurele, Ilfov, Romania
PACC	ACTRIS   Prague Aerosol Calibration Centre	Prague, Czech Republic
WCCAP	ACTRIS   World Calibration Center for Aerosol Physics	Leipzig, Germany

*IAGOS FACILITY MEMBERS*

<https://www.iagos.org/organisation/members/>

<b>Facility</b>	<b>Location</b>
Forschungszentrum Jülich GmbH	Jülich, Germany
Centre National de la Recherche Scientifique	Paris, France
Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.	München, Germany
Météo France	Toulouse, France
University of Manchester	Manchester, U.K.
Deutsches Zentrum für Luft- und Raumfahrt e.V.	Köln, Germany
Leibniz-Institut für Troposphärenforschung e.V.	Leipzig, Germany
Karlsruher Institut für Technologie	Karlsruhe, Germany





*General abbreviation table*

<b>ACTRIS</b>	Aerosol, Clouds and Trace Gases Research Infrastructure
<b>AP</b>	Air Pollution
<b>ARIs</b>	Atmospheric Research Infrastructures
<b>BCP</b>	Backscatter Cloud Probe
<b>CARIBIC</b>	Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container
<b>CC</b>	Climate Change
<b>CCN</b>	Cloud Condensation Nuclei
<b>CFCs</b>	ChloroFluoroCarbons
<b>CTMs</b>	Chemical Transport Models
<b>CiGAS</b>	Centre for Reactive Trace Gases In Situ Measurements
<b>EASA</b>	European Aviation Safety Agency
<b>EMEP</b>	European Monitoring and Evaluation Programme
<b>ENVRI</b>	Environmental Research Infrastructure
<b>ERA</b>	European Research Area
<b>ERF</b>	Effective Radiative Forcing
<b>ERIC</b>	European Research Infrastructure Consortium
<b>ESA</b>	European Space Agency
<b>ESFRI</b>	European Strategy Forum on Research Infrastructures
<b>EU</b>	European
<b>FAIR</b>	Findable, Accessible, Interoperable, Reusable
<b>GAW</b>	Global Atmospheric Watch programme
<b>GHGs</b>	GreenHouse Gases
<b>GSAT</b>	Global mean Surface Air Temperature
<b>HTAP</b>	Hemispheric Transport of Air Pollution
<b>IAGOS</b>	In-service Aircraft for a Global Observing System
<b>ICOS</b>	Integrated Carbon Observation System
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IR</b>	InfraRed
<b>LiDAR</b>	Light Detection and ranging
<b>MOOC</b>	Massive Open Online Course
<b>MSA</b>	Monitoring Station Assembly
<b>NASA</b>	National Aeronautics and Space Administration
<b>NFs</b>	National Facilities
<b>NMHCs</b>	Non-Methane HydroCarbons
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>OVOcs</b>	Oxygenated Volatile Organic Compounds
<b>PBL</b>	Planetary Boundary Layer
<b>PM</b>	Particulate Matter
<b>ppm</b>	Part per million
<b>ppb</b>	Part per billion
<b>ppt</b>	Part per trillion
<b>PTR-MS</b>	Proton-Transfer-Reaction Mass Spectrometry
<b>RF</b>	Radiative Forcing
<b>RI</b>	Research Infrastructure
<b>SATCOM</b>	Satellite Communication datalink
<b>SIA</b>	Secondary Inorganic Aerosols
<b>SOA</b>	Secondary Organic Aerosols
<b>STC</b>	Supplemental Type Certificate





<b>TGs</b>	Trace Gases
<b>UAVs</b>	Unmanned Aerial Vehicles
<b>UFPs</b>	UltraFine Particles
<b>UNFCCC</b>	United Nations' Framework Convention on Climate Change
<b>UTLS</b>	Upper Troposphere Lower Stratosphere
<b>UV</b>	UltraViolet
<b>VCPs</b>	Volatile Chemical Products
<b>VOC</b>	Volatile Organic Compound
<b>WMO</b>	World Meteorological Organisation

- Useful articles and websites

The article page features selected scientific publications (all open access, from 2015 to 2024), as well as a link to databases collecting the published literature related to the three RIs.

The website page advertises the webpages of the project and the three RIs, their data portals, and a few external partners at the global scale





All the scientific publications listed on this page are open access. Additional publications (some open access, others not) are available via the links to the relevant databases.

## Related to Atmospheric Research Infrastructures

Petzold et al. (2024) "Opinion: New directions in atmospheric research offered by research infrastructures combined with open and data-intensive science" - [link](#)

## Related to ACTRIS

- Pandolfi et al. (2018) "A European aerosol phenomenology – 6: scattering properties of atmospheric aerosol particles from 28 ACTRIS sites" - [link](#)
- Laj et al. (2024) "Aerosol, Clouds and Trace Gases Research Infrastructure (ACTRIS): The European Research Infrastructure Supporting Atmospheric Science" - [link](#)
- Doussin et al. (2024) "A Practical Guide to Atmospheric Simulation Chambers" - [link](#)
- [Database](#) of ACTRIS/EARLINET scientific publications
- [Database](#) of ACTRIS/Cloudnet scientific publications

## Related to IAGOS

- Petzold et al. (2015) "Global-scale atmosphere monitoring by in-service aircraft – current achievements and future prospects of the European Research Infrastructure IAGOS" - [link](#)
- Bundke et al. (2015) "The IAGOS-CORE aerosol package: instrument design, operation and performance for continuous measurement aboard in-service aircraft" - [link](#)
- Cohen et al. (2024) "Multi-model assessment of climatologies in the upper troposphere–lower stratosphere using the IAGOS data" - [link](#)
- [Database](#) of IAGOS scientific publications

## Related to ICOS

- Ramonet et al. (2020) "The fingerprint of the summer 2018 drought in Europe on ground-based atmospheric CO<sub>2</sub> measurements" - [link](#)
- Saunois et al. (2020) "The Global Methane Budget 2000–2017" - [link](#)
- Heiskanen et al. (2022) "The Integrated Carbon Observation System in Europe" - [link](#)
- [Database](#) of ICOS scientific publications





# ATMO ACCESS

Access to Atmospheric Research Facilities

## ATMO-ACCESS Project

- Website: <https://www.atmo-access.eu/>
- Virtual Access Portal: <https://www.atmo-access.eu/virtual-access/>

## ACTRIS

- Website: <https://www.actris.eu/>
- Data Portal: <https://dc.actris.nilu.no/>

## IAGOS

- Website: <https://www.iagos.org/>
- Data Portal: <https://iagos.aeris-data.fr/>

## ICOS

- Website: <https://www.icos-cp.eu/>
- Data Portal: <https://data.icos-cp.eu/portal/>

## European Research Infrastructures (ESFRI)

Website: <https://www.esfri.eu/>

## External institutions

- European Environmental Agency - <https://www.eea.europa.eu/en>
- Intergovernmental Panel on Climate Change (IPCC) - <https://www.ipcc.ch/>
- World Meteorological Organisation (WMO)
  - Website: <https://public.wmo.int/en>
  - Global Atmosphere Watch Station Information System: <https://gawsis.meteoswiss.ch/GAWSIS/#/>



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[atmo-access.eu](https://www.atmo-access.eu)



## Final survey

(1/1 point)

Do you find this course useful for learning about state-of-the-art facilities and services in atmospheric RIs?

1 - Not at all

2 -

3 -

4 - ✓

5 - Very much

unanswered

CHECK

(1/1 point)

Does this course help you explore the multidisciplinary use of atmospheric research facilities to address relevant scientific questions?

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

Did you find that the following aspects of the course matched your needs?

(1/1 point)

Calendar (number of weeks)

1 - Not at all

2

3

4

5 - Very much ✓

unanswered





(1/1 point)

Grading (things to do in order to pass the course)

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

Did you appreciate the following elements?

(1/1 point)

Pedagogical design of each course section

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

(1/1 point)

Quality of videos

1 - Not at all

2

3

4

5 - Very much ✓

unanswered





(1/1 point)

Interest of Interactions and questions

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

(1/1 point)

Interest of Interviews

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

(1/1 point)

Utility of additional materials

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK





(1/1 point)  
Quality of quizzes

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

CHECK

(1/1 point)  
The MOOC videos and the interviews are subtitled in additional languages. On a personal level, did you find this:

Useless, my English is good enough.

Useful, I was not sure to understand everything and it motivated me to enroll.

Extremely useful, I would not have been able to understand the course without them. ✓

CHECK

(1/1 point)  
After exploring the multidisciplinary aspect of the RIs, would you be interested in getting involved with an atmospheric RI?

1 - Not at all

2

3

4

5 - Very much ✓

unanswered

I am already involved with an RI

CHECK





# ATMO ACCESS

Access to Atmospheric Research Facilities

(1/1 point)

Which part of the MOOC did you like most and why?



CHECK

(1 point possible)

Would you like to propose ideas to improve the course? For example, by expanding/emphasising a specific subject, or by offering more activities? We welcome your suggestions!

CHECK

(1 point possible)

Would you like to add any general remarks?

CHECK

