CYA | Syllabus

ESCI 378 | The Air We Breathe: Unlocking the Secrets of the Atmosphere
Fall 2026

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Course Description

Course Overview: The Stories in the Air

Though unseen, the air around us is alive with movement, memory, and meaning. It carries whispers of distant deserts across oceans, paints sunsets with the traces of wildfires, and holds within it the invisible threads that link every city, ecosystem, and life on Earth. The atmosphere is not an empty space but it is instead a dynamic, ever-changing force that shapes our climate, influences our health, and connects us all in ways both subtle and profound.

In this course, students will step into the role of investigators of this hidden world. They will uncover how air pollutants are created, how they transform and travel through the atmosphere, and how they impact both human health and the environment. Through hands-on projects, students will not only learn the science of the air but they will also begin to see their place within it, empowered to understand and address some of the most pressing environmental challenges of our time.

Course Approach

A Hands-On Approach

In this course, students move beyond traditional classroom learning and take on the role of environmental investigators. Critical thinking, hypothesis-driven inquiry, and innovative problem-solving are fundamental to this program. Working with real-world atmospheric measurements, students will move beyond theory and into discovery. They will learn to operate portable air quality instruments, design and carry out their own monitoring experiments, and investigate both indoor and outdoor environments through hands-on sampling. In doing so, they will not just collect data, they will uncover the hidden patterns of the air around them, building the skills to observe, question, and understand the invisible forces that shape the world they live in. By examining how air quality varies across different environments, students will develop a deeper understanding of how pollution influences human exposure and health. Throughout the learning process, students are encouraged to think critically about environmental challenges and approach scientific problems with curiosity and imagination. Teamwork and science communication are also essential elements of the course, as students practice sharing ideas and collaborating toward common scientific goals in a cooperative environment.

Field Visit to the Atmospheric Pollution Monitoring Station, National Centre for Scientific Research (NCSR) "Demokritos"

A defining experience of the course is an exclusive visit to the fully operational atmospheric sampling station at the NCSR "Demokritos" (ENvironmental Radioactivity & Aerosol technology for atmospheric and Climate impacT (ENRACT) Laboratory). This is not simply a field trip; it is an immersion into a space where science actively serves society. Within a real research environment, students will encounter the sophisticated instruments that monitor the invisible chemistry of the air around us. They will observe how data is collected in real time, how precision and verification underpin trustworthy results, and how raw measurements are transformed into evidence that informs policy, public health decisions, and environmental protection strategies. By engaging directly with authentic datasets, students will begin to see themselves not only as learners, but as emerging contributors to a broader scientific conversation. Through experiments, guided dialogue, and real-life case studies, they will explore urgent questions: How does atmospheric pollution shape human health and social inequality? How do our collective choices influence air quality? How does outdoor pollution enter our homes and schools? And how can rigorous scientific research empower communities to respond responsibly? This experience bridges knowledge and action. It invites students to recognise that atmospheric science is not abstract, it is deeply connected to daily life, civic responsibility, and the protection of future generations. In stepping inside a working research station, students step into the role of informed citizens who understand how evidence, ethics, and engagement come together to build a more sustainable world.

Learning Objectives

By the end of this course, students will be able to:

- Analyze Real-World Data: Interpret environmental data using real-time measurements to understand how atmospheric science exploits experimental observations to provide evidence-based solutions to environmental problems.
- Master Scientific Equipment: Operate portable air quality instruments and collect accurate samples from

varying indoor and outdoor environments.
- Investigate Health & Environmental Links: Evaluate how specific pollutants affect human health and how human activities directly impact overall air quality.
- Communicate Science Effectively: Translate complex atmospheric science principles into engaging narratives, developing the confidence to explain critical environmental issues to a non-scientific audience.
- Collaborate Like Scientists: Work effectively in teams to design experiments, share ideas, and achieve common scientific goals in a professional-style environment

Course Requirements

This course focuses on a variety of activities based on hands-on research work, enhancing critical thinking, cooperation, and creativity. The main requirements and assignments are listed below:

- General Requirements

Students are expected to be physically present in the classroom at all times, actively participating, taking notes during class activities, and attending outdoor field activities.

- Reading Requirements

Slide presentations and the required bibliography provide the necessary knowledge and aim to build a scientific background, which will boost students' confidence to participate in class discussions and activities.
Additional optional bibliography is provided for students who are interested in exploring the subject in greater depth.

- Assignments

Students are required to complete a series of assignments, including writing an abstract based on a given paper, preparing and presenting a poster presentation, and a final presentation based on their own results.
The abstract writing assignment will take place during a class session in the midterm exam week. The poster presentation must be submitted and presented on November 10th, and the final presentation must be submitted and presented on December 10th.

Class Field Work and CYA Field Study

Fieldwork complements the theoretical knowledge and, through hands-on activities, enables students to better understand the scientific topic and actively participate in the research process. Students will conduct their own experiments and collect their own data, which they will analyse in real time.

Class Field Work

During the fall semester, the following fieldwork activities will be conducted:

- Field Visit to the Atmospheric Pollution Monitoring Station, National Centre for Scientific Research (NCSR) "Demokritos": Students will have the opportunity to learn about atmospheric aerosol monitoring methods and instrumentation used in atmospheric science.
- Urban background and traffic site measurements: By conducting their own experiments, students will obtain data from an urban background environment (National Garden of Athens) and from a traffic site (Athen's city center), assessing the influence of different environments on atmospheric measurements.

Evaluation and Grading

Your grade for this course will be based on the following distribution:

Class and Field Participation (15%)
Students are required to attend and actively participate in the course. Each absence without a valid reason will reduce the final grade by 5%.

Hands-on Engagement (20%)
Students will process all their data during class hours under our supervision and guidance in order to fully understand how datasets can be efficiently analysed and presented.

Midterm Exam – Written Assignment (20%)
During the midterm exam week, students will receive, a short and easy to understand, scientific paper and will be requested to write an abstract (250–500 words) including the aim, methodology, and main conclusions.

Poster Presentation (20%)
Students will present the results of their own measurements obtained from urban background and traffic sites, explaining the differences between these environments and the possible pollution sources.

Final Presentation (25%)
Students will use mobile devices for a few days to collect their own data. After analyzing the data during class, they will present the results of their personal measurements, assessing their individual exposure and identifying possible indoor and outdoor sources to which they were exposed.

Evaluation Criteria - Course Assignments

Hands-on Engagement
- Criteria 1: critical thinking
- Criteria 2: active and consistent participation

Midterm Exam - Written Assignment
- Criteria 1: scientific accuracy
- Criteria 2: clear structure
- Criteria 3: paper understanding

Poster Presentation
- Criteria 1: scientific accuracy
- Criteria 2: clarity, visual design
- Criteria 3: creativity, imagination
- Criteria 4: teamwork, engagement
- Criteria 5: critical analysis
- Criteria 6: presentation skills

Final Presentation
- Criteria 1: scientific accuracy
- Criteria 2: clarity, visual design
- Criteria 3: creativity, imagination
- Criteria 4: teamwork, engagement
- Criteria 5: critical analysis
- Criteria 6: presentation skills

CYA Regulations and Accommodations

Attendance Policy

Attendance and punctuality are essential to learning in CYA courses, which rely on in class and on-site interaction. Faculty is required to record absences and either the Academic Advisor (on academic issues) or Student Affairs (on wellness issues) will check-in with students who have repeated absences.
This policy applies to all scheduled class meetings and on-site activities (Athens sessions and school-wide Field Studies).

1. Punctuality
Students are expected to arrive on time; instructors have a corresponding obligation to begin on time.

2. Recording & Outreach
Instructors must record absences at every class/on-site session. In the case of repeated absences, the Academic Advisor (for academic issues) or Student Affairs (for wellness issues) will check in with the student. 3. What Counts as an Excused Absence

3.1. Illness
The student must report the illness via the Illness Reporting Form to Student Affairs. If illness requires missing more than one session per class, the student must submit a signed and stamped doctor's note to Student Affairs and remain in communication with them.
Remote [online] appointments and retroactive doctor's notes will not be accepted.

3.2. Other Exceptional Circumstances
Excused absences for non-illness exceptional circumstances require prior approval from the Academic Director (not the course instructor).

3.3. Accommodations
If the student has an academic accommodation that relates to their attendance and has been filed with CYA, they should follow the procedure outlined on the accommodation form that they agreed upon with their professor.
3.4. Timing
The student must seek approval as soon as the problem arises, not retroactively, in order for the absence to be excused
3.5. Academic priority
Students are notified that class attendance takes precedence over other student appointments, travel, volunteering, or visiting
friends/family, and missing class for these reasons is not excused. Students are responsible for avoiding such conflicts.
4. How can students request an excused absence
Before the class submit the relevant form or request (for illness the Student Affairs form; for exceptional circumstances the Academic Director). Notify the instructor that a request has been submitted, and learn what material will need to be made up and how to do so.
Provide documentation if required to administration, not the professor (e.g. doctor's note for multi-session illness).
Await the decision from the appropriate office. Professors do not grant excused absence status.
5. Unexcused Absences & Consequences
Three (3) unexcused absences in any class automatically lower the final course grade.
More than three (3) unexcused absences in a class may lead to: a) the placement of a student on academic probation, and potentially b) the student receiving a failing grade for the course depending on course requirements
6. Make-Up Work & Grading
Students must make up missed work for any absence (excused or unexcused) and communicate with instructors about requirements. Failure to complete missed work will result in the reduction of minimum one letter grade. It is the responsibility of the instructor to provide them with make up options. Quizzes, exams, and in-class assessments missed due to an unexcused absence may receive a zero (0) grade, per course requirements as outlined in the syllabus.
Because participation is integral to learning at CYA, a high number of excused absences may still affect the course grade, per the course's participation policy. Course syllabi specify how attendance and participation affect the final grade.

ePolicy on Original Work and Use of Artificial Intelligence

Unless otherwise specified, all submitted work must be your own original work. Any ideas taken from the work of others must be clearly identified as quotations, paraphrases, summaries, figures etc., and accurate internal citations and/or captions (for visuals) as well as an accompanying bibliography must be provided.

The use of generative AI tools is a new, undeniable reality. In this course, the guiding principle for their productive use is that you must always remain the primary author and critical thinker behind all submitted work. AI may be used ethically as a tool for development, but never as a substitute for your own intellectual effort.

Permitted Uses: You may use AI for brainstorming, clarifying concepts and passages, editing your original prose, debating ideas, formatting (not generating from scratch) citations and bibliography sections, or reviewing a completed draft. You may also request a generic outline to organize initial thoughts, provided you substantially modify and expand it into your own work. *In all cases, you are required to review, verify and take full responsibility for the final output*.

Prohibited Uses: It is academic dishonesty to use AI to generate drafts, paragraphs, or answers to assignments, to complete in-class or reflective work, or to submit AI-generated content without your significant intellectual transformation and synthesis.

To ensure the integrity of submitted work, I reserve the right to ask students to orally explain or defend the content and reasoning behind any submission. Such a request comprises a standard check, not an accusation. **If a student is unable to do so, I may require the work to be revised and resubmitted. A persistent inability to adequately explain the work may be treated as a violation of academic integrity.**

It is imperative to understand that AI can produce incorrect or biased information. Your critical judgment is essential. You are responsible for fact-checking all content and ensuring your final work reflects your own understanding. Specific applications and citation practices will be further discussed in class. When in doubt, ask for clarification!

Use of Laptops

In-class or onsite use of laptops and other devices is permitted if this facilitates course-related activities such as note-taking, looking up references, etc. Laptop or other device privileges will be suspended if devices are not used for class-related work.

Class Schedule

Class Day	Day/Date/Place (if applicable)	Topic / Readings / Assignments Due
1	Tue Sep 08	**Welcome to the Invisible World** *Description* Welcoming students Understanding the Atmosphere: The hidden structure of the air we breathe *Optional Reading* Chapter 1 (1.1, 1.2) from "Chemistry of the nature atmosphere" by Peter Warneck
2	Thu Sept 10	**When Particles Change History** *Description* What were the most significant atmospheric pollution events that shaped our world, and what makes these tiny, invisible particles so impactful? *Required Reading* Chapter 1 (pages 1 – 5) form "Air quality: Aerosol and Biomonitoring" by Šerbula, Snežana M. *Optional Reading* Chapter 1 from "The urban atmosphere and its effects" by Peter Brimblecombe and Robert L. Maynard
3	Tue Sept 15	**Air Across the World: Outdoor Pollution in Europe and Beyond** *Description* What are the atmospheric conditions around the world? Which cities are pollution hotspots, and what are the environmental consequences? *Required Reading* "Introduction to ambient air pollution" by World Health Organization (WHO), web report *Optional Reading* "Impacts of air pollution on ecosystems" from "Air quality in Europe 2022" by European Environment Agency (EEA), wed report
4	Tue Sept 22	**Breathing Risk: How Atmospheric Aerosols Affect Human Health** *Description* How do airborne particles enter the human body? Which biological mechanisms cause health problems, and how do these particles affect our overall health? *Required Reading* "Health effects of air pollution: a general overview" by World Health Organization (WHO), web report *Optional Reading* Chapter 2 from "The urban atmosphere and its effects" by Peter Brimblecombe and Robert L. Maynard
5	Thu Sept 24	**From Measurement to Protection: Why do we need Air Quality Guidelines** *Description* How are limits for specific atmospheric parameters decided? How do these standards influence pollution levels and air quality management around the world? *Required Reading* "Air quality status report 2025" by European Environment Agency (EEA), wed report *Optional Reading* Chapter 1-4 from "Global air quality guidelines" by World Health Organization (WHO), web report
6	Fri Sept 25	**A Particle's Story: Formation, Growth, Transport, and Removal** *Description* How do atmospheric particles form, grow, and travel through the air? What processes remove them, and how do these dynamics affect air quality and the environment? *Required Reading* Chapter 1 (pages 6 – 13) form "Air quality: Aerosol and Biomonitoring" by Šerbula, Snežana M. *Optional Reading* Chapter 7 from "Chemistry of the nature atmosphere" by Peter Warneck

7	Tue Sept 29	**Combustion Aerosols: Black Carbon in the Atmosphere** *Description* What are the aerosol particles released by fires, engines, and smoke? How do these tiny particles shape the atmosphere and impact human health? *Required Reading* "Decoding black carbon" (pages 8 – 10) from "COMBATING BLACK CARBON FOR CLEAN AIR AND CLIMATE" by Archana Shankar *Optional Reading* Chapter 13 from "Particulate Matter: Sources, Emission Rates, and Health Effects" by Henrik Knudsen and Niels Rasmussen
8	Thu Oct 01	**Measuring Airborne Particles: Instruments and Methods** *Description* Which are the main instruments and methods used to measure particulate matter in the air? What are the basic principles behind how they operate? *Required Reading* "An Overview of Particulate Matter Measurement Instruments" by Simone Simões Amaral et al., 2015
9	Tue Oct 06	**Field Visit to the Atmospheric Pollution Monitoring Station, National Centre for Scientific Research (NCSR) "Demokritos"**
10	Wed Oct 07	**Hands-on 1: Identifying Possible Sources Affecting the Urban Background NCSR 'Demokritos' Station Using Real-Time Data**
11	Tue Oct 13	**Characterization of Aerosol Emission – Source Apportionment** *Description* What are atmospheric particles really made of, and how does their composition depend on their sources? How can we identify the main emission sources for each component, and what are the implications for air quality and health? *Required Reading* Chapter 1 (pages 14 – 32) form "Air quality: Aerosol and Biomonitoring" by Šerbula, Snežana M. *Optional Reading* "Sources emissions of air pollutants in Europe" from "Air quality in Europe 2022" by European Environment Agency (EEA), wed report, and Chapter 2 from "Particulate Matter: Sources, Emission Rates, and Health Effects" by Henrik Knudsen and Niels Rasmussen
12	Thu Oct 15	**Sampling Day – Urban Background Site: Collecting Real-Time Data on Key Atmospheric Aerosol Parameters, National Garden of Athens**
13	Tue Oct 20	**Hands-on 2: Data Analysis from Urban Background Site; Is the National Garden of Athens a Nature-Based Solution**
14	Thu Oct 22	**Written Assignment: Abstract**
15	Tue Nov 03	**Sampling Day – Traffic Site: Collecting Real-Time Data on Key Atmospheric Aerosol Parameters, Athen's city center**
16	Thu Nov 05	**Hands-on 3: Processing Data from the Traffic Sampling Site, Comparing Results to the Urban Background Site**
17	Tue Nov 10	**Poster Presentation**
18	Tue Nov 17	**Indoor Air Quality** *Description* Why do we care about indoor air quality, and what factors influence it? How do indoor pollutants affect human health and well-being? *Required Reading* "Introduction to household air pollution" by World Health Organization (WHO), web report *Optional Reading* Chapter 1-2 from "Indoor Air Pollution" by R. E. Hester and R. M. Harrison, and Chapter 1 from "Particulate Matter: Sources, Emission Rates, and Health Effects" by Henrik Knudsen and Niels Rasmussen

19	Thu Nov 19	**Personal Exposure** *Description* Which indoor and outdoor environments have the highest pollution levels, and where are we most at risk? How does the amount of time spent in a space influence our personal exposure levels? *Required Reading* "Personal Exposure Monitoring of Particulate Matter, Nitrogen Dioxide, and Carbon Monoxide, including Susceptible Groups" by R. M. Harrison et al., 2002 (pages 671-679)
20	Tue Nov 24	**Hands-on 4: Processing Data from Personal Mobile Measurements**
21	Tue Dec 01	**Hands-on 5: Estimating Personal Exposure and Identifying Main Emission Sources**
22	Thu Dec 03	**Science Communication** *Description* How can you effectively communicate your science topic to others? How can you make your message engaging and accessible for audiences of different ages, educational backgrounds, and cultural contexts?
23	Tue Dec 08	**Oral Presentation by Dr. Olga Zografou, Postdoctoral Researcher at EPFL**
24	Thu Dec 10	**Final Presentation**

N.B.: The course schedule, in terms of subjects and readings, may be subject to change to benefit student learning and to keep up to date with current research.

COURSE BIBLIOGRAPHY

Required Bibliography

1. Šerbula Snežana M., "Air quality: Aerosol and Biomonitoring", Air, Water and Soil Pollution Science and Technology, 2016, Chapter 1
2. "Introduction to ambient air pollution" by World Health Organization (WHO), web report, https://www.who.int/publications/m/item/WHO-HEP-ECH-AQE-2024-3
3. "Health effects of air pollution: a general overview" by World Health Organization (WHO), web report, https://www.who.int/publications/m/item/WHO-HEP-ECH-AQE-2024-5
4. "Air quality status report 2025" by European Environment Agency (EEA), wed report, https://www.eea.europa.eu/en/analysis/publications/air-quality-status-report-2025
5. Archana Shankar, "COMBATING BLACK CARBON FOR CLEAN AIR AND CLIMATE", Centre for Science and Environment, 2003, "Decoding black carbon" (pages 8 – 10)
6. Simone Simões Amaral, João Andrade De Carvalho, Jr., Maria Angélica Martins Costa, and Cleverson Pinheiro, An Overview of Particulate Matter Measurement Instruments, Atmosphere 2015
7. "Introduction to household air pollution" by World Health Organization (WHO), web report, https://www.who.int/publications/m/item/WHO-HEP-ECH-AQE-2024-4
8. R. M. Harrison, C. A. Thornton, R. G. Lawrence, D. Mark, R. P. Kinnersley, J. G. Ayres, Personal Exposure Monitoring of Particulate Matter, Nitrogen Dioxide, and Carbon Monoxide, including Susceptible Groups, Occupational and Environmental Medicine, 2002 (pages 671-679)

Optional Bibliography

1. Peter Warneck, Chemistry of the nature atmosphere, International Geophysics Series, 1988, Chapter 1 and 7
2. Peter Brimblecombe and Robert L. Maynard, The urban atmosphere and its effects, Air Pollution Reviews, 2001, Chapter 1 and 2
3. "Impacts of air pollution on ecosystems" from "Air quality in Europe 2022" by European Environment Agency (EEA), wed report, https://www.eea.europa.eu/en/analysis/publications/air-quality-in-europe-2022/impacts-of-air-pollution-on-ecosystems
4. Chapter 1-4 from "Global air quality guidelines" by World Health Organization (WHO), web report, https://www.who.int/publications/i/item/9789240034228
5. Henrik Knudsen and Niels Rasmussen, "Particulate Matter: Sources, Emission Rates, and Health Effects", Pollution Science, Technology, and Abatement, 2012, Chapter 1, 2, 13
6. "Sources emissions of air pollutants in Europe" from "Air quality in Europe 2022" by European Environment Agency (EEA), wed report, https://www.eea.europa.eu/en/analysis/publications/air-quality-in-europe-2022/sources-and-emissions-of-air-pollutants-in-europe
7. R. E. Hester and R. M. Harrison, Indoor Air Pollution, Issues in Environmental Science and Technology, 2019 Chapter 1, 2