

## Course: Clouds, Aerosols, and Changes in the Climate System

Total duration: 60h

*Version 1*



Language: English and Portuguese

Lecturers: **Prof. Ilan Koren, Weizmann Institute of Science, Israel,**

Prof. Weber Gonçalves, Prof. Judith Hoelzemann, Prof. Danielle Torres,  
and Prof. Cristiano Prestrelo, PPGCC/UFRN, Brazil

## Course Outline

Why clouds are responsible for the largest uncertainty in the climate system?

Why aerosol – solid or liquid particles suspended in the atmosphere, are important? And how the two questions above are linked?

The first part of this course will cover basic cloud physics. We will learn how cloud form, how rain is initiated as well as aerosol formation, transport, and sinks. Clouds and aerosols are tightly linked in series of complex feedbacks that make their research challenging. We will learn about cloud aerosol interactions and why to explore such complex systems. About 1/4 of the present course will be devoted to the cloud and rain aspects and will be given as a condensed course. Another 1/4 will be devoted to aerosol types and properties, formation, transport, and climate effects.

The second part of the course will be devoted to student group projects on a selected broader range of topics related to climate and/or anthropogenic signatures on climate data.

At the end of this course the students will:

1. Understand basic processes related to formation, sinks and transport of atmospheric aerosol
2. Be familiar with aerosol types and how we affect them and being affected by the aerosol composition
3. Understand basic processes in cloud physics
4. Be familiar with the main complexities in measuring and modeling cloud-aerosol interactions
5. Demonstrate understanding of the role of clouds and aerosols in the climate system
6. Know why the water vapor, cloud feedbacks are considered the critical response of the climate systems to global warming
7. Learn how to process and analyze new climate data sets and find significant effects or changes on/in trends

It is expected that **all registered students actively participate in 100 % of the course program**, which includes the delivery of the final assignment and active participation in the planned review article preparation. Those participants who fulfill these criteria will receive a certificate and co-authorship in the planned review article. During the scheduled course activities, absolute priority should be given to the attendance over the usual lectures of the program.

## Planned Course Schedule

**Tuesday, May 17, 2022:**

<b>Until 12:00h, deadline for students</b>	<p><b>Course registration deadline for students.</b>  <b>– Fill in and send google form:</b>  <b><u><a href="https://forms.gle/mZb9HRjYP1yQEWZY7">https://forms.gle/mZb9HRjYP1yQEWZY7</a></u></b></p> <p>(All interested students of PPGCC. A limited number of well-advanced students of the bachelor course in Meteorology may be admitted to the course)</p>
<b>Until 22:00h, deadline for PPGCC professors/researchers</b>	<p><b>PPGCC / DCAC Scientific Discussion Day registration deadline for professors and other researchers to present their research during a 20 min talk.</b>  <b>– Fill in and send google form:</b>  <b><u><a href="https://forms.gle/eVvKhaafDnXAhSVr5">https://forms.gle/eVvKhaafDnXAhSVr5</a></u></b></p> <p>(All researchers/lecturers of PPGCC and/or DCAC)</p>
<b>Until 22:00h</b>	Information by course organizers to participants whether their registration has been approved and on group attributions

**Wednesday afternoon, May 18, 2022 (3h):**

<b>14:00h – 15:00h</b>	Introduction to the course: Time schedule, course project, data sets and mission. Division into groups (see google form) (Judith / Weber / Ilan)
<b>15:00h - 16:00h</b>	Introduction of remote sensing data sources and how to use them (Weber / Judith / Ilan)
<b>16:00h – 17:00h</b>	Familiarization with computers at the LISC – Lab and technical assistance with R installation and internet access (Cristiano, Danielle, + other members of PPGCC, IT service CCET).

**Sunday, May 22, 2022 (8h):**

<b>Until 18:00h, deadline for students</b>	Suggestion by groups of variable(s) to explore in data sets, and of initial scientific question(s) to be investigated (send email to <judith.hoelzemann@ufrn.br>)
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**Monday morning, May 23, 2022 (4h):**

<b>08:00h - 08:30h</b>	Introduction to the <b>PPGCC Scientific Discussion Day</b> (Judith/Weber) <b>Observation:</b> All course participants should be present during this event, as it is part of the course.
<b>09:00h – 12:00h</b>	Presentations and discussions on ongoing research at the graduate program for Climates Sciences (PPGCC) at UFRN (20 min talks by professors/researchers of PPGCC)
<b>12:00h – 14:00h</b>	Lunch at NAU restaurant for those who wish to chat a bit more with Ilan Koren

**Tuesday morning May 24, 2022 (4h):**

<b>08:00h - 10:00h</b>	Lecture 1: The role of clouds in the climate system (Ilan)
<b>10:00h - 12:00h</b>	Assisted hands-on session (All)

**Wednesday morning, May 25, 2022 (4h):**

<b>08:00h - 10:00h</b>	Lecture 2: Atmospheric aerosols in the climate system, cloud-aerosol interactions, and cloud feedbacks (Judith/Weber)
<b>10:00h - 12:00h</b>	Assisted hands-on session (All)

**Thursday, May 26, 2022 (4h):**

<b>08:00h - 10:00h</b>	Lecture 3: Selected topics in cloud physics. We will understand why clouds are so complex, and why they are responsible for the largest climate uncertainty as well as discuss new research venues in cloud physics. (Ilan)
<b>10:00h - 12:00h</b>	Student group's progress report and answering questions (All)
<b>18:00h – open end</b>	Student's Happy Hour to have a chat with Ilan in a relaxed place – location to be announced

**Monday, May 30, 2022 (4h):**

<b>08:00h - 10:00h</b>	Student groups presentation: First questions asked, initial findings and feedback (All)
<b>10:00h - 12:00h</b>	Advanced Topics, Planning of review article and Closing (All)

**May 31 – July 22, 2022:**

Finalization and submission of course assignments/projects (**29h**)

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## **Outline for practical exercise projects during the hands-on sessions and the final assignment**

**Title: Climate change and/or anthropogenic signatures - A collective efforts in finding significant effects or changes on climate data**

In the recent years, high quality data from remote sensing, models and reanalysis are becoming open and freely available to anyone. These days we have access to information that 20 years ago we could not even dream of. Our role as climate scientists is to find the best way to use this data in order to better understand the system.

In this project each group of students will choose their type of data and to explore signatures of climate change and/or of anthropogenic effects. The data can be of any variable from the ocean, land, or atmosphere. It can be from models, reanalysis, or observations. The analysis could be at any desired spatial/temporal scale and resolution. Each group will have to check if indeed they see signatures and if they are significant. We wish to collect the successful projects into a joint review paper.

During the course we will devote time to introduce the data sources and the analytical tools that are available. The students will be asked to choose the fields they want to analyze carefully and to do a primary check to see if they can find dynamical, climate or anthropogenic signatures that are significant. Development of new analytical approaches would be highly appreciated.

We encourage the course participants to use NASA's data sets provided by the **Giovanni** tool (<https://giovanni.gsfc.nasa.gov/giovanni/>), requires free registration at Earthdata, see initial pop-up window when accessing the link above. The data suite comprises both satellite-, model-, and reanalysis data. Other data sets may be used, as long as the scientific question asked is well posed, interesting and within the topic of climate and/or anthropogenetic effects on the earth system.

Together with the use of NASA's **Worldview** tool (<https://worldview.earthdata.nasa.gov/>) the data set options can be explored, and interesting and original data selections may be made by each group.

The last day of the course (May 30) will be dedicated to group presentations of their initial results. Each presentation will be followed by a discussion and feedbacks from all the participants. The deadline for the project completion will be a few weeks after the course and the successful projects will be collected into a joint review paper.