
GEOGRAPHICA BERNENSIA
CLIMANDES
Information booklet
Climate science
e-learning course

CLIMANDES climate science e-learning course
by

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Welcome message

Welcome to the CLIMANDES climate science e-learning course.

This course was developed for the CLIMANDES project, which is a collaboration between Peruvian and Swiss government, research, and education institutions. The aim of this e-learning material is to strengthen education in climate sciences at the higher education and professional level.

There are eight individual modules of the course that each offer approximately 2 hours of individual learning material, as well as several hours of additional learning activities. Overall, over 50 hours of learning material are provided by this course. The modules can be integrated into university lectures, used as single units in workshops, or be combined to serve as a full course.

The material in this course is based on the Large Scale Climate Variability course taught by Professor Dr. Stefan Brönnimann for the Climate Science curriculum at the Oeschger Centre for Climate Change Research (OCCR) at the University of Bern. The course presents a broad spectrum of topics in climate science, including an introduction to climatology, atmospheric and ocean circulation, climate forcings, climate observations and data, working with data products, and climate models.

We hope that you enjoy this course. Please share it freely, and contact us if you are interested in adding on to the material – we can provide you with our template and help you get started.

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Who are we?

Many people have contributed to the creation and editing of this e-learning material throughout its development. The main contributors are:

Professor Stefan Brönnimann: *project leader*
- professor and presenter of the e-learning videos
- provided content based on his courses and latest book, "Climatic Changes Since 1700"

Alena Giesche: *module creator*
- developed modules 1. Climatology, 2. Atmospheric circulation, 3. Ocean - atmosphere, 4. Climate forcings, 8. Climate models
- created several graphics used throughout the course
- coordinated the completion of the project (editing, formatting, and distribution)

Stefan Hunziker: *module creator*
- coordinated adaptations of WBTExpress e-learning software
- recorded the video podcasts from the Large Scale Climate Variability course
- developed modules 5. Climate observations, 6. Climate data, 7. Data products
- developed the online version of the Great Climate Poker -Tutored Activity 4.1
- led two test sessions to assess pilot modules

Martín Jacques-Coper: *coordinator*
- Spanish subtitling of videos and lexicon
- communication with Peruvian partners and MeteoSwiss
- led two test sessions to assess pilot modules

There are **eight** modules within this course. Although each module can be used independently, some modules are closely related in their content. For example, Modules 1-3 (Unit 1) form a close group describing how Earth's energy balance drives atmospheric and ocean circulation. Modules 5-7 (Unit 2) cover topics ranging from observing the climate to interpreting the final data products. Below, we will present the main topics covered in each of the eight modules.

Unit 1
- **1. Climatology**
- **2. Atmospheric circulation**
- **3. Ocean - atmosphere**
- **4. Climate forcings**

Unit 2
- **5. Climate observations**
- **6. Climate data**
- **7. Data products**
- **8. Climate models**

1. Climatology

In this module, students learn how to define **climate variability** and identify the **spatial** and **temporal scales** of various climatic processes. Students read about the basic **statistical methods** applied to climate data. In the second part of this module, students are introduced to the **energetics** of the climate system, which includes the **global energy balance** and the main energy **fluxes**. Students understand how the **atmosphere** plays a crucial role in redistributing energy, and how daily, seasonal, and orbital **cycles** can affect the global energy balance. This module **provides a foundation** for the topics discussed in later modules. This module features an exercise in the programming tool R, on the topic of **detrending** a carbon dioxide time series.

2. Atmospheric circulation

In the atmospheric circulation module, students find out **how much energy** is **transported** by the atmosphere and the ocean at different latitudes. They study the basic **composition** of the atmosphere, as well as the main features of **global atmospheric circulation**. Students gain an understanding of **meridional heat exchange** and **waves** in the extratropics, and take a closer look at some of the unique processes that occur in the **stratosphere** and affect weather on the ground.

3. Ocean - atmosphere

The circulation unit comes to a close with a look at the **interactions** occurring between the ocean and the atmosphere. Students learn about the **basic properties** of the ocean, including its **wind driven** and **density driven currents**. The most prominent **variability modes** in the atmosphere and ocean are examined in detail, along with the concept of **teleconnections**. Finally, students take a closer look at **monsoon systems** and the interactions of **sea ice**, ocean, and atmosphere. This module features an exercise in R on the topic of **discriminant** and **clustering** analyses of an El Niño time series.

4. Climate forcings

What role do external forcings play, and on what **time scale** do they act? Which of these forcings occur **naturally**, and which ones are **influenced by humans**? These are just a few of the questions students explore in module 4. Students examine the climatic effects of **aerosols**, **volcanic** eruptions, **solar** variability, **greenhouse gases**, **ozone**, and **land surface** changes. Finally, students get to enjoy speculations about **geoengineering**: what kinds of proposals exist and how effective might they be? This module features an exercise using a game developed for this course, **The Great Climate Poker**, to better understand the **global effects** of various climate forcing mechanisms.

5. Climate observations

This module gives students an overview of the **history of atmospheric observations** from **early records** to modern day **satellite observations**, and explains the current **observing system** and the different platforms measuring atmospheric parameters. Students learn that it is crucial to follow **measurement standards** to get **meaningful** and **comparable** data. They examine **how** automatic measurement instruments work and what considerations should be taken into account when you **site a new station**. Finally, students are asked to consider and discuss: are modern **automatic measurement systems** better than **conventional methods**? This module also features an exercise examining observation difficulties in the atmosphere, using the **discovery of the ozone hole** as a case example.

6. Climate data

In this module, students focus on **uncertainties** of atmospheric data derived from weather stations. The procedures of **quality assurance** and **quality control** are briefly outlined, and students are asked to reflect on what exactly is a **good data set**. Students examine the importance of documenting data creation by having complete and accurate **metadata**. Potential **sources of error** are discussed, as these may lead to **inhomogeneities** in data sets. Students learn about **data homogenization**, which is the process of detecting and removing artificial effects in climate measurements. They can practice their skill in **detecting** and **adjusting breakpoints** in a time series by completing two exercises.

7. Data products

This module discusses the steps leading from **climate data** to **gridded data products**. Students learn about various **interpolation** techniques and the role that **resolution** plays when using data. The second half of the module introduces **data assimilation**, which is a combination of **measurement data** with **numerical models**. Students learn to ask the right questions about the **quality** of data products – how **suitable** is the product for your purpose, and what **assumptions** rest behind the various procedures? A special focus of this section is on **reanalysis** data sets, which are very common in atmospheric and climate science. This module features three exercises: one about **data assimilation** using radioactive decay as an example, another on data from **reanalysis products**, and a **practical** exercise using data products to find the best site for a planned airport.

8. Climate models

In this module, students learn about the **uses** of climate models and how they have **developed** over time. Various **types** of models are introduced, as well as important kinds of **experiments** that are often performed. Students examine common **parameterizations** and **boundary conditions** used for models. The basic **variables** and **equations** for deriving **atmospheric flow** are described and illustrated by a brief simulation. On a philosophical note, students are asked to consider how models are **evaluated**, and if they actually provide scientists with new information about the climate system. This module features an exercise called **The Human Supercomputer**, where students play the roles of the actual grid cells of a weather prediction model.

The USB stick included with this packet contains the course and all extra materials needed for the tutored activities. You can open the file called “Climandes course” using a regular web browser such as **Firefox** or **Explorer** (please note that Google Chrome does not work!). For Linux users, Iceweasel is a good option. You do not need an internet connection to use this course. However, some pages include links to online material offered by other educational websites.

Each of the 8 modules offers a series of learning opportunities:

Introduction page – here students find out about the content of the module, the learning goals, and the time needed to work through the material.

Learning pages – the next 5-10 pages are the core of this course: subtitled videos, texts, graphics, and interactive diagrams that illustrate the material. Some of the pages feature small quizzes to test your understanding of the material periodically.

Conclusion page – this page summarizes the main points of the module.

Quiz section – several questions are provided to give students an opportunity to check their understanding of the material after finishing the entire module. If the questions are answered incorrectly, students are referred back to a page in the module.

Further material – this page provides longer excerpts of video lectures, videos with relevant additional information, as well as links to other online e-learning material on similar topics. This connects students to a vast amount of existing information and literature!

Discussion page – this page is set up for seminars by suggesting 2-3 online scientific papers for the students to read and discuss in smaller groups. Students are then asked to present their findings and discuss the conclusions of the papers.

Tutored activities – these are included in some of the modules as extended exercises (often in a group setting) where a tutor leads students through a practical exercise. These are great ways for students to interact with their classmates and experience the material in a hands-on way.

Language help

This course features a Spanish lexicon for the most complex words in the text. Such words are colored in blue. When you mouse over them, the Spanish translation pops up! In addition, all of the videos on the learning pages have English and Spanish subtitle options.

Navigation

The welcome page of the course features a section that describes how to navigate through the course and how to use the various interactive features. Using the course is very intuitive and you will figure it out quickly after you begin the first module. Often, symbols are used to indicate special features, such as when you are able to: enlarge a graphic (zoom symbol), read the background story of a particular image (book symbol), discuss an issue with your classmates (speech bubbles symbol), or show/add parts of an interactive graphic (moving mouse symbol). Please take some time to read through the navigation help section so you can benefit from all of the features offered by this course.

Thank you for reading this information booklet, and enjoy using the course! If you have any questions, please contact us at: climandeselearning@gmail.com

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