UCLouvain

lphys2269

2026

Remote sensing of climate change

5.00 credits	30.0 h	Q2

This biannual learning is being organized in 2026-2027

Teacher(s)	Dekemper Emmanuel ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Basic training in physics and mathematics (level of bachelor in sciences or applied sciences).
Main themes	Physico-chemical characteristics of the upper atmosphere and of radiative transfer of solar radiation ; ground-based and space-borne spectroscopic methods ; data processing algorithm and inverse methods.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1)** AA1: A1.1, A1.5 AA2: A2.5 **b. Expected learning outcomes** At the end of this teaching unit, the student will be able to : 1. describe the main processes defining the trace gas composition of the upper atmosphere ; 2. understand the basic principles of atmospheric remote sensing: geometry, spectral domains and observation methods ; 3. understand the inverse problems related to ground-based and space-borne observations ; 4. assess the error budgets for several remote sensing modes and identify their intrinsic limitations ; 5. understand the design principles of a space remote sensor and its operational use.
Evaluation methods	The final mark will be calculated based on the following aspects: • the execution by the student of a number of mini applied projects during the semester (10 points), • an oral exam during which the student will be evaluated on his/her understanding of the themes developed during the course by presenting a scientific article related to the field (10 points)
Teaching methods	The course will be mostly given in a classical way, supported by slides. The students will be regularly invited to work by themselves on concrete problems. Several lessons will be dedicated to numerical simulations with computational softwares (Matlab, Octave, python, ...). The students will be invited to take an active part in the resolution of the problems (each student is expected to develop his/her own code). The purpose of these numerical exercises is to familiarize the student to numerical computations, and to the resolution of concrete problems in atmospheric science.
Content	The course will tackle the following topics: **Radiative equilibrium of the Earth system** • total and spectral solar irradiance: definition, observations from space, trends, ... • terrestrial radiative equilibrium: thermal absorption and emissions, observations from ground and from space, trends, ... • radiative transfer in the atmosphere: absorption and scattering of UV, visilbe, and IR light, chemical composition of the atmosphere • remote sensing of pressure and temperature profiles in the upper atmosphere **Instrumentation for the teledetection of atmospheric composition** • diffraction gratings • interferometry (Michelson, Fabry-Pérot, ...) • filters **Remote sensing techniques from space for the measurement of the atmospheric composition** • observation geometries: nadir, limb, solar/stellar occultations, ... • space instruments for radiative budget assessment • space instruments for the remote sensing of the atmospheric composition

	• observations and trends of the ozone layer **Atmospheric composition** • ozone, and its depleting substances • other reactive gases **Mathematical methods for solving inverse problems in atmospheric sciences** • optimal estimation • regressions • influence of instrumental errors • regularization techniques **Concrete applications, and examples** • simulation of the performance of a spectrometer based on a diffraction grating • simulation of thermal infrared emissions by the atmosphere • retrieval of temperature profiles from observations in the thermal infrared • retrieval of nitrogen dioxyde concentration profiles with the DOAS method • ...
Other infos	Knowing a programming language is an asset, but the fact that everyone has a different level regarding numerical tools will be taken into account. The goal of the course is not only to address atmospheric remote sensing in general, but also to offer the students the chance to face practical problems encountered by researchers of the field. Acquiring new skills is what truly matters.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Geography : Climatology	CLIM2M	5		
Master [60] in Physics	PHYS2M1	5		
Master [120] in Physics	PHYS2M	5		