Universität Bremen

Faculty 1 Physics/Electrical Engineering

Summersemester 26

Module Guide

for the study of

Environmental Physics

Masterstudiengang

valid in connection with the examination regulations MPO v. 15.07.2020/15.05.2024

This module guide describes the syllabus of the M.Sc. degree course in Environmental Physics for informational purposes. The legally binding rules are found in the subject specific examination regulations for the M.Sc. in Environmental Physics.

Generated: April 7, 2026

Degree Curriculum / Master Program Environmental Physics

		Compulsory Modules, 69 CP			Master Thesis, 30 CP	Elective Modules, 21 CP	∑ 120 CP CP/Semester
1. Year	**1.Sem.**	AMMDA Applied Mathematical Methods and Data Analysis, 6 CP	AtC Atmospheric Chemistry, 6 CP	AtPhy Atmospheric Physics, 6 CP			30
		Dyn1 Dynamics I, 6 CP	PhyO1 Physical Oceanography I, 6 CP				
	2.Sem.	CliS1 Climate System I, 3 CP	Dyn2 Dynamics II, 3 CP	MeTe Measurement Techniques, 6 CP		Elective Modules as per attachment 2.3 to the exam reg., 12 CP	30
		MES Modelling of the Earth System, 3 CP	RemS Remote Sensing, 3 CP				
2. Year	**3.Sem.**	PresT Presentation Techniques in Environmental Physics, 3 CP	PrEPhy Preparatory Project, 18 CP			Elective Modules as per attachment 2.3 to the exam reg., 9 CP	30
	4.Sem.				MTEPhy Master Thesis, 30 CP		30

CP (credit points) / Sem. (semester)

Index by areas of study

1) Compulsory Modules (69 CP)

Compulsory modules of the 1st, 2nd and 3rd semester covering a total of 69 CP.

2) Elective Modules (21 CP)

Elective modules are recommended for the 2nd and 3rd semester and can be chosen from this list of modules. Students have to achieve a total of 21 CP out of elective modules.

3) Master Thesis (30 CP)

4) Additional Courses

Module 01-PHY-MA-AMMDA: Applied Mathematical Methods and Data Analysis
Applied Mathematical Methods and Data Analysis

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The course lectures cover the theoretical and practical basis of the following subject areas:

PART A:

- Calculus I (Functions, theorems)
- Calculus II (Differentiations, applications of derivatives, approximations, errors)
- Calculus III (Integrations, applications of integrals)
- Calculus IV (Series, convergence, divergence)
- Differential equations I (ordinary first, second and higher-order differential equations - ODE)
- Differential equations II (partial differential equations - PDE)
- Exercises on all the above

PART B

- Introduction to Python (Installation, build-in functions, arrays, data loading, handling, visualizing)
- Hands – on examples (numerical approximations, differential equations)

References:

- Thomas Calculus 13th or 14th edition (Hass, Heil, Weir) Pearson
- Mathematical Methods in the Physical Sciences (Boas) Wiley

Learning outcomes / competencies / targeted competencies:
Introduction to essential and advanced mathematical methods (Part A) and applying these using the Python programming language. In the example classes (part B), students will learn how to apply the taught knowledge, both analytically and numerically. In order to facilitate the latter, students will learn the basics of the Python programming language and how to use Python to solve real-world problems from the course's topic areas.

Calculation of student workload:
56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Mihalis Vrekoussis

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Applied Mathematical Methods and Data Analysis

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-AtC: Atmospheric Chemistry
Atmospheric Chemistry

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The history and evolution of the composition of the earth's atmosphere; thermodynamics, thermochemistry and chemical equilibria; photochemistry; kinetic theory of reactions and reaction rate coefficients; chain reactions; key atmospheric photochemical and chemical reactions; catalytic cycles and transformations in the thermosphere, mesosphere, stratosphere and the troposphere.

References:

- John H. Seinfeld, Spyros N. Pandis Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 3rd Edition
- Finlayson-Pitts B. J. and J. N. Pitts, Atmospheric Chemistry
- Ann M. Holloway and Richard P. Wayne, Atmospheric Chemistry, RSC Publishing, 2010
- John M. Wallace and Peter V. Hobbs Atmospheric Science (Second Edition): An Introductory Survey
- R.P. Wayne, Chemistry of Atmospheres, third edition, Oxford University Press

Learning outcomes / competencies / targeted competencies:
The learning outcomes are that students obtain an adequate knowledge of the following:

a) the evolution of the chemical composition of the atmosphere and its origins;

b) chemical equilibrium, chemical kinetics, photochemistry, and chain reactions;

c) the key photochemical, chemical reactions and mechanisms, which determine chemical composition in the different regions of the atmosphere

Calculation of student workload:
68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Mihalis Vrekoussis

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer).

Module courses

Course: lecture + example classes Atmospheric Chemistry

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-AtPhy: Atmospheric Physics
Atmospheric Physics

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The origin of the solar system and the earth's atmosphere; the physical parameters, which determine the conditions in the atmosphere (e.g. temperature, pressure, and vorticity); the physical laws, which describe electromagnetic radiation; the interaction between electromagnetic radiation and matter (absorption, emission and scattering); atmospheric radiative transport; radiation balance, climate change; atmospheric thermodynamics and the hydrological cycle; aerosols and cloud physics; an introduction into atmospheric dynamics (kinematics, circulation etc.).

References:

- Houghton, J.T., The physics of atmospheres, Cambridge University Press, 1977, ISBN 0 521 29656 0.
- Wallace, John M. and Peter V. Hobbs, Atmospheric Science, An Introductory Survey, Academic Press, 2nd Edition 2005, ISBN 0-12-732951-x

Learning outcomes / competencies / targeted competencies:
An adequate understanding of the fundamentals of atmospheric physics.

This addresses

a) gaining an understanding of the laws of physics, which determine the behaviour of the earth system, which comprises the sun, the atmosphere and earth surface

b) learning the ability to apply the laws of physics to calculate parameters and forecast conditions in the atmosphere.

This knowledge is required for subsequent advanced courses in the M.Sc. program. These learning outcomes provide essential knowledge required for success in the following areas:

a) research in the atmospheric, environmental and climate sciences, meteorology, earth observation and remote sensing form ground based ship, aircraft and space based instrumentation,

b) employment in earth observation, meteorology, and education by industry, governmental and space agencies.

Calculation of student workload:
56 h SWS / presence time / working hours
56 h Preparation / follow-up work
68 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Hartmut Bösch

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 23/24 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Atmospheric Physics

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-CliS1: Climate System I
Climate System I

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Greenhouse climate
- Climate feedbacks
- Energy transport in the climate system
- Ocean's role in climate
- Physical attribution of ongoing climate change and the 1.5° warming threshold

References:

- Pierrehumbert, R.T.: Principles of Planetary Climate, Cambridge University Press, 2010
- more references will be provided in the course

Learning outcomes / competencies / targeted competencies:
- Understanding of the physical basis of climate change
- Energy balance models (without and with transport)
- Implementation of climate feedbacks in simple energy balance models
- Understanding of the physics behind ongoing climate change
- Understanding of the IPCC framework for attributing climate change
- Computation of equilibrium temperature from energy balance models, feedbacks, etc.
- Computation of oceans role in climate (heat uptake and AMOC change)

Calculation of student workload:
28 h SWS / presence time / working hours
34 h Exam preparation
28 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Torsten Kanzow

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Climate System I

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Climate System I (Lecture)

Module 01-PHY-MA-Dyn1: Dynamics I
Dynamics I

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Governing equations
- Basic conservation laws
- Balances
- Elementary applications of the basic equations
- Circulation and vorticity
- Planetary boundary layer and large-scale dynamics
- Rossby waves

References:

- Holton: An Introduction to Dynamic Meterorology, Elsevier Academic Press
- Marshall and Plumb: Atmosphere, Ocean, and Climate Dynamics, An Introductory Text, Academic Press, 2008
- Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Academic Press

Learning outcomes / competencies / targeted competencies:
Understanding of the basic dynamical processes in atmosphere and ocean; learning how to interpret physical equations physically

Calculation of student workload:
56 h Preparation / follow-up work
56 h SWS / presence time / working hours
68 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Thomas Jung

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Dynamics I

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-Dyn2: Dynamics II
Dynamics II

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
Fluid dynamics, ocean circulation, wind-driven and thermohaline circulation; atmosphere dynamics, dynamical system theory, non-dimensional parameters, bifurcations and instabilities; Gravity, Rossby and Kelvin waves; Conceptual models, Analytical and Programming techniques; Time series analysis.

References:

- Holton, J.R., Introduction to Dynamical Meteorology, Academic Press
- Gill, A., Atmosphere-Ocean Dynamics, Academic Press
- Dutton, J.A., The Ceaseless Wind, Dover
- Olbers, D.J., et al., Ocean Dynamics, Springer
- Cushman-Roisin, B. & Beckers, J.-M., Introduction to Geophysical Fluid Dynamics: Physical and Numerical Aspects

Learning outcomes / competencies / targeted competencies:
Advanced dynamics of the ocean and atmosphere, applications in the fields of climate dynamics and fluid mechanics. Programming skills (R studio) and usage of the climate data operators. Theoretical concepts in physics of climate, temporal and spatial scales of climate dynamics.

Calculation of student workload:
36 h SWS / presence time / working hours
10 h Exam preparation
44 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. rer. nat. Gerrit Lohmann

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Course performance: portfolio (series of exercise sheets, calculation on blackboard)

Module courses

Course: lecture + example classes Dynamics II

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
3,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Dynamics II (Lecture)

Module 01-PHY-MA-MeTe: Measurement Techniques
Measurement Techniques

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
Participation in the university's safety instructions and the fire drill is mandatory before getting access to the laboratories.

Learning content:
A set of practical experiments on atmospheric trace gases, ocean currents, the Earth's surface, ice thickness, and numerical modelling of transport and chemistry of the atmosphere using different techniques is performed by the students under the supervision of tutors. The results obtained in the lab will then be analysed, and the experiment, its background, and the results, as well as their interpretation, will be documented in a written report. The available topics will be presented at the beginning of the semester. Students form groups of two and choose four experiments which they perform on assigned days.

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants learn to perform measurements and modelling central to Environmental Physics using scientific techniques and methods. They learn to analyse measurements and to document the results in a written report. Self-exploration of new topics and teamwork are needed and practiced.

Calculation of student workload:
42 h SWS / presence time / working hours
54 h Exam preparation
84 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
PD Dr. Andreas Richter

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam

Course performance: portfolio (series of successful experiments with accepted reports)

Module courses

Course: lecture + laboratory Measurement Techniques

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Laboratory class

Associated module examination:
Kombinationsprüfung

Associated module courses

Measurement Techniques (Lecture)

Module 01-PHY-MA-MES: Modelling of the Earth System
Modelling of the Earth System

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:

1. Types of models, linear vs. non-linear, box & complex models
2. Finite differences and spectral methods
3. Examples: waves, diffusion, boundaries
4. Model coupling (atmosphere and ocean)
5. Data assimilation (Kalman filters etc)
6. High-performance computing in modelling (scalability)
7. Cryosphere (Sea ice, ice sheets, and permafrost)
8. Earth system models including tracers and dynamical vegetation
9. Chemistry Transport Models
10. Inverse methods in chemistry

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Theoretical concepts of Earth models; Applications

Calculation of student workload:
28 h Preparation / follow-up work
28 h SWS / presence time / working hours
34 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
PD Dr. Martin Werner

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 25 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Modelling of the Earth System

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Modelling of the Earth System (Lecture)

Module 01-PHY-MA-PhyO1: Physical Oceanography I
Physical Oceanography I

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
External forcing (radiation, winds, tides), global distribution of important dynamic and physical parameters, water mass formation, wind-driven 3D circulation, geostrophy, meridional overturning, role of ocean in climate change

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Understand fundamentals of physical oceanography

Calculation of student workload:
68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Joke Lübbecke

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Physical Oceanography I

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-RemS: Remote Sensing
Remote Sensing

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The course introduces the theoretical background of remote sensing methods (interaction of electromagnetic radiation with matter (spectroscopy), radiative transfer, principles of satellite remote sensing). Mostly passive (thermal emission, backscattered light) but also active (radar used in sea ice) remote sensing techniques and their data analysis (retrievals) are explained. This is illustrated by a large number of examples available and in use in the different research groups in the Institute of Environmental Physics (IUP).

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Basics of radiative transfer, spectroscopy, retrieval techniques. Overview of remote sensing from satellite, ground and airborne platforms in MW, IR and UV-VIS spectral range. Techniques in atmospheric remote sensing, sea ice remote sensing, ocean color remote sensing

Calculation of student workload:
28 h SWS / presence time / working hours
30 h Exam preparation
32 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Astrid Bracher

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Remote Sensing

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Remote Sensing (Lecture)

Module 01-PHY-MA-PresT: Presentation Techniques in Environmental Physics
Presentation Techniques in Environmental Physics

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
Structure and content of oral presentations, layout and organization of slides, how to give good oral presentations (content, presentation style, body language, …), how to deal with questions and answers, how to prepare a poster for a conference, how to write an extended abstract, how to do a literature research, how to cite and how to use bibliographic software.

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
How to prepare and give oral presentations, posters, and extended abstracts on topics of Environmental Physics.

Calculation of student workload:
40 h Preparation / follow-up work
28 h SWS / presence time / working hours
22 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
PD Dr. Andreas Richter

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 2 / -

Language(s) of instruction:
English

Description:
Examination performance: 1 poster or 1 extended abstract (4 pages)

Course performance: 2 oral presentations (participation in discussion of all presentations)

Module courses

Course: proseminar Presentation Techniques in Environmental Physics

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Seminar

Associated module examination:
Kombinationsprüfung

Module 01-PHY-MA-PrEPhy: Preparatory Project
Preparatory Project

Assignment to areas of study:
- Compulsory Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
Working in the laboratories of the IUP / AWI. The content is related to the respective area of research of the preparatory project.

Responsible lecturers: Prof. Dr. Hartmut Bösch, Prof. Dr. Justus Notholt, Prof. Dr. Joke Lübbecke, Prof. Dr. Annette Ladstätter-Weißenmayer, Prof. Dr. Mihalis Vrekoussis, Prof. Dr. Veronika Eyring, Prof. Dr. Christian Haas, Prof. Dr. Thomas Jung, Prof. Dr. Torsten Kanzow, Prof. Dr. Gerrit Lohmann as well as further university lecturers of the IUP (Institute of Environmental Physics) / AWI (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research) depending on the area of research.

A list of references will be provided.

Learning outcomes / competencies / targeted competencies:
- Transfer of a scientific problem/question into an experimental and/or theoretical study
- Successful strategies for the planning and conducting of scientific studies
- Summarize and present preliminary scientific results in a project report

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Hartmut Bösch

Frequency:
winter semester, yearly

Duration:

The module is valid since / The module is valid until:
WiSe 23/24 / -

Credit points / Workload:
18 / 540 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Project report

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:

- successful assessment of the preparatory project
- preparation of a project report on a research project which can be conducted within the context of the master's thesis
- students have 12 weeks to work on their preparatory project and to prepare the final project report
- the project report has to be written in English and by one person alone (not a group)
- the project report will be evaluated by two examiners

Module 01-PHY-MA-AtCM1: Atmospheric Chemistry Modelling: Part 1 (Theory)
Atmospheric Chemistry Modelling: Part 1 (Theory)

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements

Learning content:
- Concept of chemistry transport models
- Atmospheric Chemical Composition/Processes
- Model equations and numerical approaches focusing on the:
  a) formulation of atmospheric rates
  b) numerical methods for chemical systems
- Surface fluxes/emissions
- Observations and model evaluations
- Applied Mathematical Methods and Data Analysis for atmospheric chemistry

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants will have the chance to:

- get a theoretical overview of the concepts of numerical atmospheric chemistry modelling
- review fundamentals of atmospheric chemistry and physics
- formulate model equations and numerical (differential) approaches for various systems focusing on atmospheric chemistry mechanisms
- assess the role of chemistry transport models as components of the atmospheric observing system

Concepts of inverse modelling will be also presented

Calculation of student workload:
28 h SWS / presence time / working hours
20 h Exam preparation
42 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Mihalis Vrekoussis

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Atmospheric Chemistry Modelling: Part 1 (Theory)

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-AtCM2: Atmospheric Chemistry Modelling: Part 2 (Laboratory)
Atmospheric Chemistry Modelling: Part 2 (Laboratory)

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- introduction to the moguntia model
- explanation input files manipulation and analysis of results
- study of interhemispheric transports
- study the budget of simulated CO
- simulate the growth of CO2 mixing ratios
- simulate the concentrations of methyl chloroform
- simulate the methyl-chloroform/OH constrains

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants will have the chance to:

Have a hands-on experience on how atmospheric chemistry models work, prepare the input needed by a model, run the model and process the output of the model in order to come to scientific conclusions

Calculation of student workload:
42 h Preparation / follow-up work
20 h Exam preparation
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Mihalis Vrekoussis

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Atmospheric Chemistry Modelling: Part 2 (Laboratory)

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Atmospheric Chemistry Modelling: Part 2 (Laboratory) (Lecture)

Module 01-PHY-MA-AtSp: Atmospheric Spectroscopy
Atmospheric Spectroscopy

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The lecture will discuss the basics of atmospheric spectroscopy. Atmospheric spectroscopy is directly related to molecular physics. Therefore, molecular physics will also play an important role in the lecture. Topics will be:

- What is light?
- Prism and grating spectrometer, Fourier Transform spectrometer
- Boltzmann distributions
- Uncertainty principle
- Rotation of molecules
- Vibration of molecules
- Electronic energy levels
- Transitions, transition rules, intensities
- Line widths
- Ground-based and satellite observations
- Retrieval of trace gas concentrations or temperature

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Basics of spectroscopy, basics of molecular spectroscopy. Understanding and interpretation of measured spectra with regard to the structure of the molecules. Basics of prism, grating and FTIR-spectroscopy, understanding of remote sensing methods.

Calculation of student workload:
28 h SWS / presence time / working hours
34 h Exam preparation
28 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. rer.nat. Justus Notholt

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written or oral exam (as announced by the respective lecturer)

Module courses

Course: lecture Atmospheric Spectroscopy

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture

Associated module examination:
Modulprüfung

Associated module courses

Atmospheric Spectroscopy (Lecture)

Module 01-PHY-MA-BGC: Biogeochemistry
Biogeochemistry

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements

Learning content:
- Global biochemical cycles of elements
- Important biophysical processes in atmosphere and ocean
- Carbon, methane, nitrogen and water cycles
- Greenhouse gases

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Advanced biogeochemistry

Calculation of student workload:
28 h SWS / presence time / working hours
34 h Exam preparation
28 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Annette Ladstätter-Weißenmayer

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Biogeochemistry

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Biogeochemistry (Lecture)

Module 01-PHY-MA-CliM1: Climate Modelling: Part 1
Climate Modelling: Part 1

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements

Learning content:
Introduction to Climate Modelling
Types of Climate Models
Components of Atmosphere Ocean General Circulation Models (AO-GCMs)
Fundamentals and representation in GCMs: Radiation
Fundamentals and representation in GCMs: Dynamics of the Atmosphere
Fundamentals and representation in GCMs: Ocean and sea ice component
Fundamentals and representation in GCMs: Land component
Parametrizations in climate models
Steps in climate model formulation
Frequently Asked Questions IPCC Assessment Reports
Introduction to the ICON climate model
Computational exercises with the ICON model: running a climate model
Computation exercises in Python: plotting ICON model output

A list of references will be provided in the course.

This course is given as a block course.

Learning outcomes / competencies / targeted competencies:
Overview how a climate model works and how to set up a climate model simulation (without covering all details); getting some first experience with running a climate model and plotting its output using python

Calculation of student workload:
42 h Preparation / follow-up work
28 h SWS / presence time / working hours
20 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Veronika Eyring

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam or oral exam (as announced by the respective lecturer)

Module courses

Course: block course (lecture + example classes) Climate Modelling: Part 1

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Climate Modelling: Part 1 ()

Module 01-PHY-MA-CliM2: Climate Modelling: Part 2
Climate Modelling: Part 2

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
Climate Modelling: Part 1

Learning content:
Components of Earth System Models (ESMs)

Fundamentals and representation in ESMs: carbon cycle

Fundamentals and representation in ESMs: atmospheric chemistry

Fundamentals and representation in ESMs: aerosols

Earth system model evaluation with observations

Earth system feedbacks and projections

Understanding and modelling the Earth System with Machine Learning

Computational exercises with the Earth System Model Evaluation Tool (ESMValTool, http://www.esmvaltool.org/) and interpretation of ESM results

Computational exercises hands-on Machine Learning

A list of references will be provided in the course.

This course is given as a block course.

Learning outcomes / competencies / targeted competencies:
Overview how an Earth system model works and learn about results of current models regarding climate change; first experience how to analyse Earth system model output with the ESMValTool and how to use machine learning techniques to better understand and model the Earth system

Calculation of student workload:
20 h Exam preparation
42 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Veronika Eyring

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 20 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam or oral exam (as announced by the respective lecturer)

Module courses

Course: block course (lecture + example classes) Climate Modelling: Part 2

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Module 01-PHY-MA-CliS2: Climate System II
Climate System II

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The climate system and its changes during the past, climate models, possibilities and limitations to observe climate change, ice ages and orbital variations, Holocene, glacial-interglacial variability, Cenozoic climate, abrupt climate change, climate scenarios, sea level, environmental archives, paleoclimate data, biogeochemical cycles, feedbacks, Spectra and time series analysis, Modes of variability, climate models

References:

- Bradley, Paleoclimatology-Reconstructing climates of the Quaternary, 1999
- Saltzman, Dynamical Paleoclimatology - A generalized theory of global climate change, Academic Press, San Diego, 2002
- Ruddiman, Earth's Climate Past and Future
- Paleoclimate, Global Change and the Future, 2003 by Keith D. Alverson, Raymond S. Bradley, Thomas F. Pedersen (Editors)
- Archer & Pierrehumbert, The Warming Papers, The Scientific Foundation for the Climate Change Forecast

https://www.ipcc.ch/documentation/

https://paleodyn.uni-bremen.de/gl/climate.html

Learning outcomes / competencies / targeted competencies:
Advanced climate course: Theories, models, observations.

Past-present-future climate changes

Calculation of student workload:
42 h Preparation / follow-up work
28 h SWS / presence time / working hours
20 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
PD Dr. Martin Werner

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam

Module courses

Course: lecture Climate System II

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture

Associated module examination:
Modulprüfung

Module 01-PHY-MA-DIP: Digital Image Processing
Digital Image Processing

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Digital images, sampling
- Grey level transformations, color images
- Image enhancement using filters
- Image analysis methods using segmentation, feature extraction and classification
- Fourier transformation of digital images, linear filters in spatial and frequency domains
- Data compression, image coding, image formats

References:

- K. R. Castleman: Digital Image Processing. Prentice Hall, Englewood Cliffs, 1996.
- R. C. Gonzalez, R. E. Woods: Digital Image Processing. Addison-Wesley, Second Edition, 2002.
- B. Jähne: Digital Image Processing. Springer, 6th edition, 2005.
- J.C. Russ and F.B. Neal: The Image Processing Handbook. CRC Press, 7th edition, 2017. ISBN 9781315214115. doi: 10.1201/b18983.
- R. A. Schowengerdt: Remote Sensing, Models and Methods for Image Processing. Academic Press, 1997.

Learning outcomes / competencies / targeted competencies:
Fundamentals, basic concept and methods of digital image processing, enabling the students to identify and understand image processing problems (encountered in Environmental Physics, Space Science etc.) and to find appropriate solutions

Calculation of student workload:
28 h Preparation / follow-up work
28 h SWS / presence time / working hours
34 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Gunnar Spreen

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Digital Image Processing

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Digital Image Processing (Lecture)

Module 01-PHY-MA-EGSR: Emerging Geoengineering Solutions and Risk
Emerging Geoengineering Solutions and Risk

Assignment to areas of study:

- Elective Modules

Content-related prior knowledge or skills:

Programming skills in python is a plus

Learning content:

Various governmental agencies around the world are developing plans around climate geoengineering. Geoengineering is the deliberate modification of the Earth's climate to reduce the negative impacts of global warming. This course covers emerging geoengineering concepts with a broad polar focus and provides students an opportunity to evaluate climate model outputs on solar modification (SRM), evaluate impacts of pumping sea water on sea ice to thicken it and impacts of ocean fertilization. Students will come away with a better understanding of geoengineering concepts and their associated climate implications.

References:

https://www.ipcc.ch/report/ar6/wg1/

https://www.nature.com/articles/d41586-025-01389-1

https://www.annualreviews.org/content/journals/10.1146/annurev-environ-112321-081911

https://www.annualreviews.org/content/journals/10.1146/annurev-earth-031920-083456

https://onlinelibrary.wiley.com/doi/10.1111/gcb.16854

https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2016EF000410

This course is given as a block course.

Learning outcomes / competencies / targeted competencies:

The students will gain an understanding of some of the current efforts to offset global warming risks, explore their feasibility and consequences, work with climate model datasets and develop a simple sea ice model in python. Each lesson provides hands-on-activities on emerging geoengineering concepts.

Knowledge

- Describe the main risks of global warming for the cryosphere
- Explain current efforts to offset global warming by Earth-cooling geoengineering projects
- Present current geoengineering efforts to reduce CO_2 concentration in the atmosphere
- Explain current efforts to reduce ice melting at the poles

Skills

- Explain the feasibility of current efforts to counteract the effects of global warming
- Discuss the consequences of geoengineering concepts for the climate system
- Analyze climate model data of Arctic sea ice, temperature and precipitation

General competencies

- Develop and run a simple conceptual model to test geoengineering hypothesis
- Debate challenges and risks of geoengineering
- Work in a team

Calculation of student workload:
28 h SWS / presence time / working hours
32 h Exam preparation
30 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Julienne Stroeve

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 25/26 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Project report

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: project report

Course performance: oral presentation

Module courses

Course: lecture + example classes Emerging Geoengineering Solutions and Risk

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Module 01-PHY-MA-FES: Fortran for Environmental Sciences
Fortran for Environmental Sciences

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Introduction to programming languages and differences between compiled/interpreted languages
- Structure of a serial Fortran code
- Implicitly, variables, intrinsic functions
- Input/output of a program
- Loops in coding and their use
- Logical statements
- Subroutines/modules
- READ-WRITE-PRINT-FORMAT
- Makefiles

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants will have the chance to:

Learn the basic structure and rules of Fortran and apply this knowledge in computing complex environmentally relevant systems.

Calculation of student workload:
42 h Preparation / follow-up work
28 h SWS / presence time / working hours
20 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Nikolaos Daskalakis

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (successful assessment of an environmental problem using programming or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Fortran for Environmental Sciences

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Fortran for Environmental Sciences (Lecture)

Module 01-PHY-MA-FVTT: Fundamentals of Volcanology and Tephra Transport
Fundamentals of Volcanology and Tephra Transport

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
Introduction to volcanology

The volcanic system

Magma composition and types of eruptive activity

Volcanic plumes and volcanic hazards

Volcanic emissions transport and deposition

Introduction to tephra observation and modelling

Tephra ground deposits

Tephra morphology and aggregation

Airborne tephra observations

Volcanic ash and the climate

Volcanic gas emissions

Operational aspects of volcanology

Operational tephra monitoring and forecasting

Volcanic hazard and risk assessment

Lab - Numerical modelling techniques

Modelling volcanic plumes

Modelling tephra transport

Source parameter estimation techniques

References:

[Introductory Reading] Fundamentals of Physical Volcanology, Parfitt and Wilson, 2008

[Main] Volcanic Ash Hazard Observations, Mackie et al, 2016

[Extra Reading] The Encyclopedia of Volcanoes, Houghton et al, 1999

Learning outcomes / competencies / targeted competencies:
Students will develop an understanding of fundamental concepts in volcanology and get hands-on experience with applied modelling. The module will give students relevant skills that will allow them to look for employment opportunities in volcano observatories, airports, and volcanic ash advisory centres around the world.

Calculation of student workload:
28 h SWS / presence time / working hours
28 h Preparation / follow-up work
34 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Alexandros-Panagiotis Poulidis

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 21/22 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: 1 essay

Course performance: 1 oral presentation

Module courses

Course: lecture + examples classes Fundamentals of Volcanology and Tephra Transport

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Module 01-PHY-MA-GCC: Global Carbon Cycle
Global Carbon Cycle

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- working of the natural and anthropogenic greenhouse effect
- existence and magnitude of the different reservoirs of carbon in the earth system, and their role on different climatic time-scales
- role of carbon in the chemistry of the ocean and in setting its pH
- changes in the carbon cycle over glacial-interglacial cycles
- carbon isotopes as tool to understand the cycling of carbon
- influence of weathering and volcanism on the carbon cycle over geological time-scales
- understanding of feedback interaction between the physical climate state and the carbon cycle, and possible implications for future climate

References:

- Principles of Planetary Climate: Raymond Pierrehumbert
- Ocean Biogeochemical Dynamics: Jorge L. Sarmiento & Nicolas Gruber
- Earth's Climate: Past and Future: William F. Ruddiman

Learning outcomes / competencies / targeted competencies:
Knowledge of the different carbon reservoirs on earth, and their role on different timescales, from current to geological. Understanding that the cycling of carbon between those reservoirs is related to global climate by a number of feedbacks.

Calculation of student workload:
28 h Preparation / follow-up work
34 h Exam preparation
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr.rer.nat. Christoph Völker

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Module courses

Course: lecture Global Carbon Cycle

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture

Associated module examination:
Modulprüfung

Module 01-PHY-MA-IMBRS: Ice Mass Balance and Remote Sensing
Ice Mass Balance and Remote Sensing

Assignment to areas of study:

- Elective Modules

Content-related prior knowledge or skills:

No formal requirements.

- Fitness for mountain hikes of 4-5 hours and 1000 m elevation gain, with heavy backpack
- Some experience with outdoor activities in exposed rock and ice alpine environment

Learning content:

- Glacier mass balance
- Measurements of radiation balance
- Snow pit studies of snow properties
- Surface elevation measurements with laser scanner and drone
- Optical and radar remote sensing of glaciers

References:

- Cuffey&Patterson, Physics of Glaciers, 2010
- Bamber&Payne, Mass Balance of the Cryosphere, 2004
- Lubin&Massom, Polar Remote Sensing, 2006
- http://glaziologie.de/vernagt/vernagt.html

More will be provided in the course.

This course is given as a block/field course (field course 48 h + data processing/analysis 32 h).

Learning outcomes / competencies / targeted competencies:

- Understanding of energy and surface mass balance of ice and snow
- Understanding of optical and radar remote sensing of ice and snow
- Acquisition and analysis of geocoded data

Calculation of student workload:

10 h Exam preparation
80 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Christian Haas

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

SoSe 24 / -

Credit points / Workload:

3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: preparation of final report (participation in the field course is mandatory for taking the exam).

Course performance: data processing and analysis.

Module courses

Course: block/field course Ice Mass Balance and Remote Sensing

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Field trip

Associated module examination:
Kombinationsprüfung

Associated module courses

Ice Mass Balance and Remote Sensing

Module 01-PHY-MA-ITE: Instrumental Techniques for Environmental Measurements
Instrumental Techniques for Environmental Measurements

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
Theoretical aspects on analytical methods including spectroscopic and chromatographic techniques. Introduction to the principle of operation and design of instruments used in environmental analysis.

References:

Quantitative chemical analysis, 9th edition, (Daniel C. Harris)

Learning outcomes / competencies / targeted competencies:
Students are expected to enhance their knowledge on the theoretical aspects, design and operation of a number of instruments used in environmental analysis. Ultimately, students will improve their analytical thinking by recognizing and understanding the advantages and disadvantages of the environmental instrumental methods to be used depending on the material under investigation.

Calculation of student workload:
34 h Exam preparation
28 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Mihalis Vrekoussis

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Instrumental Techniques for Environmental Measurements

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Instrumental Techniques for Environmental Measurements (Lecture)

Module 01-PHY-MA-IEPhy: Isotopes in Environmental Physics
Isotopes in Environmental Physics

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
This module includes the use of stable and radioactive isotopes in environmental sciences. We cover the forms of radioactive decay and the use of radioisotopes for geochronology, as well as the fractionation processes between stable isotopes, and their use for source characterization and paleoclimatology. Finally, the module communicates measurement techniques to derive isotope ratios.

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
The students ...

- understand and can explain core processes (radioactive decay, fusion, fission)
- know radio carbon dating and can explain its importance for climate change
- can create and analyse isochron plots for exemplary measurements
- understand the processes behind the fractionation of stable isotopes
- know fractionation processes in the global water and carbon cycle
- can create and analyse keeling plots for two source systems

Calculation of student workload:
28 h Preparation / follow-up work
34 h Exam preparation
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Thorsten Warneke

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Course performance: 1 presentation (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Isotopes in Environmental Physics

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Isotopes in Environmental Physics (Lecture)

Module 01-PHY-MA-MRS: Microwave Remote Sensing
Microwave Remote Sensing

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Microwaves: Definition, physical quantities to describe them
- Microwave antennas, working principle of radiometers and radars
- Interaction of microwaves with the atmosphere and the earth surface, radiative transfer
- Retrieval of geophysical parameters from microwave measurements
- Current microwave instruments and satellites

References:

- Elachi, C., and J. van Zyl: *Introduction to the physics and techniques of remote sensing.* Wiley – Interscience, second edition, ISBN 978-0-471-47569-9, 552 pages, 2006.
- C. Mätzler, editor. *Thermal Microwave Radiation: Applications for Remote Sensing,* volume 52 of IET Electromagnetic Wave Series. Institution of Engineering and Technology, Stevenage, Hertfordshire, UK, ISBN 0-86341-573-3 / 978-086341-573-9, 2006.
- Woodhouse, I.H.: Introduction to Microwave Remote Sensing. CRC Press, Taylor & Francis Group, 2006.
- Janssen, M.A. (ed.): *Atmospheric Remote Sensing by Microwave Radiometry*, Wiley & Sons, 1993.
- Ulaby, F. T, R.K. Moore, A.K. Fung: *Microwave Remote Sensing, Active and Passive. Vol. 1: Microwave Remote Sensing Fundamentals and Radiometry; Vol. 2: Radar Remote Sensing and Surface Scattering and Emission Theory; Vol. 3: From Theory to Applications. Artech House,* 1981 (Vol. 1), 1982 (Vol. 2), 1986 (Vol. 3).

Learning outcomes / competencies / targeted competencies:
Knowledge of basic concepts and methods of microwave remote sensing, enabling the students to appropriately deal with microwave remote sensing data, understand and interpret them

Calculation of student workload:
34 h Exam preparation
28 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Gunnar Spreen

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Microwave Remote Sensing

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Module 01-PHY-MA-OOOC: Ocean Optics and Ocean Color Remote Sensing
Ocean Optics and Ocean Color Remote Sensing

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
First, the course covers the principles of ocean optics. Topics included are basic physics of light and interaction of light with matter in water. This includes the theory behind inherent and apparent optical properties and the radiative transfer equation, e.g., the light field within the ocean is explained and the water-leaving radiance and remote-sensing reflectance terms are introduced. The effect of the various seawater constituents' (absorption, scattering, fluorescence) on ocean reflectance is presented. Optical instrumentation and measurement techniques to measure the relevant parameters are introduced. Secondly, the lecture focuses on ocean color remote sensing. This includes the principles of ocean color remote sensing, an overview of the technology of the instruments commonly used as ocean color satellite sensors and their satellite platforms. But also the streams of the data processing from raw data to the final geophysical product. Especially explained are various atmospheric correction methods and retrieval techniques of ocean color data products, such as phytoplankton biomass, phytoplankton photosynthetic activity, major phytoplankton groups, other particulates, coloured disolved organic matter and light penetration depth. Finally, also validation techniques of ocean color data products and the application of these data in global ecosystem and climate studies and marine and coastal management are presented.

References:

- C. D. Mobley „Light and Water“, 1994
- J. T. O. Kirk „Light and Photosynthesis in Aquatic Ecosystems“, 1994
- S. Martin “An Introduction to Ocean Remote Sensing“, 2008
- Ocean Optics Webbook: http://www.oceanopticsbook.info/
- Lecture Material from IOCCG Training Courses (https://ioccg.org/what-we-do/training-and-education/lectures/)
- M. A. Soppa, A. Bracher, M. Hieronymi (2023) "Spaceborne imaging spectroscopy of aquatic ecosystems - Water Optics and Water Color Remote Sensing", HYPERedu, EnMAP education initiative, February 2023, AWI and Hereon. https://eo-college.org/resource/spaceborne-imaging-spectroscopy-of-aquatic-ecosystems/

Learning outcomes / competencies / targeted competencies:
Basics of radiative transfer in water (inherent and apparent optical properties) and ocean color remote sensing, ocean optics measurement techniques, atmospheric correction, empirical, semi-analytical, neural network retrieval techniques to determine water constituents and radiation in the water, validation of algorithms and sensors and potential of such data for application in ecosystem and climate studies and marine and coastal management.

Calculation of student workload:
33 h Exam preparation
28 h SWS / presence time / working hours
29 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Astrid Bracher

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 2 / -

Language(s) of instruction:
English

Description:
Examination performance: written or oral exam (as announced by the respective lecturer)

Course performance: 1 rapport on one lecture and lab tour (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Ocean Optics and Ocean Color Remote Sensing

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Module 01-PHY-MA-PhyO2: Physical Oceanography II
Physical Oceanography II

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements

Learning content:
The topics of the lecture vary from year to year and will be announced at the start of the course. Topics include small and large scale ocean processes, ocean-atmosphere interactions, and the ocean in a changing climate.

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Insightful knowledge into processes important for the ocean's role in the climate system.

Calculation of student workload:
28 h Preparation / follow-up work
34 h Exam preparation
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Joke Lübbecke

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Examination performance: written or oral exam (as announced by the respective lecturer)

Module courses

Course: lecture + example classes Physical Oceanography II

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung

Associated module courses

Physical Oceanography II (Lecture)

Module 01-PHY-MA-PoOc: Polar Oceanography
Polar Oceanography

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
- Properties of cold sea water
- Models of thermodynamic sea ice formation
- Ice dynamics
- Ocean - sea ice interaction (ocean boundary layer processes)
- Arctic Ocean hydrography & circulation
- Southern Ocean hydrography & circulation

References:

- Willy Weeks: **On Sea Ice**. University of Alaska Press (2010)
- Peter Wadhams: **Ice in the Ocean**. Gordon and Breach Science Publishers (2000)
- Miles McPhee: **Air-Ice-Ocean Interaction: Turbulent Ocean Boundary Layer Exchange Processes**. Springer (2008)

Learning outcomes / competencies / targeted competencies:
- Assessment of non-linearity of the equation of state
- Computation of thermodynamic sea ice growth
- Analysis of observational ice-ocean data
- Understanding of density flux and ocean mixed layer evolution
- "double estuary" water mass framework of the Arctic Ocean
- Concept of residual overturning in the southern ocean

Calculation of student workload:
28 h Preparation / follow-up work
34 h Exam preparation
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Torsten Kanzow

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 20/21 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Oral

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: oral exam (or as announced by the respective lecturer)

Course performance: portfolio (discussion of research papers or series of exercise sheets)

Module courses

Course: lecture + example classes Polar Oceanography

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Kombinationsprüfung

Associated module courses

Polar Oceanography (Lecture)

Module 01-PHY-MA-PPO: Practical Physical Oceanography
Practical Physical Oceanography

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements.

Learning content:
The students will join the research vessel "Heincke" in Heligoland. During day trips in the North Sea around Helgoland the instructors will first demonstrate the usage of oceanographic measurement equipment. The students will subsequently handle the equipment themselves under supervision. Technically, this includes: software preparation, equipment preparation, decision regarding sampling strategy, hardware demobilization, data recovery, data conversion, data analysis.

The investigated topics include:

- Ocean stratification and water masses based in hydrographic measurements;
- Ocean circulation based on ocean current measurements (underway + mooring);
- Ocean forcing: Meteorological measurements;
- Ocean surface processes: Underway surface measurements;
- Biological sampling

A list of references will be provided in the course.

This course is given as a block/field course (field course 40 h + preparatory meetings 5 h).

Learning outcomes / competencies / targeted competencies:
- Familiarity with modern way of performing observations from a research vessel.
- Organization of field work including interdependence of different physical oceanographic and interdisciplinary measurement techniques.
- Skills regarding data acquisition, analysis, and interpretation.
- Skills with reporting on field work.

Calculation of student workload:
45 h SWS / presence time / working hours
25 h Exam preparation
20 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Torsten Kanzow

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
English

Description:
Examination performance: preparation of final report/essay (participation in the field course is mandatory for taking the exam).

Course performance: processing of a task incl. presentation of results.

Module courses

Course: block/field course Practical Physical Oceanography

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Field trip

Associated module examination:
Kombinationsprüfung

Associated module courses

Practical Physical Oceanography

Module 01-PHY-MA-RSOC: Remote Sensing of Ocean and Cryosphere
Remote Sensing of Ocean and Cryosphere

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
-

Learning content:
- Concepts for satellite remote sensing of the ocean and cryosphere
- Microwave radar and radiometer observations of sea and land ice and of sea surface temperature and salinity
- Altimetry for sea surface height, circulation, sea level and ice thickness change
- Optical satellite data for ocean color and sea ice
- Error analysis and statistics
- Practical examples and applications to use satellite data sets from oceanography and cryosphere
- Satellite data processing

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:
Students gain knowledge in basics and application of remote sensing of sea ice extent, type, drift and thickness, ice shelves and glaciers, sea surface height, winds over the ocean, waves, ocean color, surface temperature and salinity, sea level rise, ocean color and other remote sensing applications for ocean and cryosphere.

Calculation of student workload:
56 h Preparation / follow-up work
56 h SWS / presence time / working hours
68 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Gunnar Spreen

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
SoSe 24 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Prüfungsleistung

Type of examination:

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
- / - / -

Language(s) of instruction:
English

Description:
ACHTUNG: Gemäß MPO-Space-ST-02-24, Prüfungstyp = Teilprüfung; Anzahl Studienleistung: 1, Anzahl Prüfungsleistung: 1

Prüfungsleistung: 3 CP

Studienleistung: 3 CP

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Module examination: Studienleistung

Type of examination:

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
- / - / -

Language(s) of instruction:
English

Description:
ACHTUNG: Gemäß MPO-Space-ST-02-24, Prüfungstyp = Teilprüfung; Anzahl Studienleistung: 1, Anzahl Prüfungsleistung: 1

Prüfungsleistung: 3 CP

Studienleistung: 3 CP

Module courses

Course: Remote Sensing of Ocean and Cryosphere

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
4,00

Literature:
A list of references will be provided at the start of the semester.

Teaching format(s):

Associated module examination:
Prüfungsleistung
Studienleistung

Associated module courses

Remote Sensing of Ocean and Cryosphere (Lecture)

Module 05-GW-MA-MMG-CC2: Climate Change 2: Models and Data
Climate Change 2: Models and Data

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
Contents of module Climate Change I

Learning content:
This second module introduces to the reconstruction and modeling of abrupt climate changes, provides an overview of paleo and historical climate changes (from the role of oceanic gateways in the Cenozoic through Pleistocene climate cycles to natural climate variability during the Holocene) and presents an outlook on future climate changes in response to projected anthropogenic climate forcings. Available evidence for past climate changes (from ice and marine sediment cores) as well as current climate change (from historical and instrumental data) is discussed. Computer lab exercises with conceptual climate models and results of comprehensive climate models are used throughout to investigate the processes that cause those climate changes.

Learning outcomes / competencies / targeted competencies:
to become familiar with the reconstructed climate variations for selected time intervals of the Cenozoic
to gain an understanding of the dynamics of abrupt climate changes
to analyze proxy data and compare them to the results of numerical climate models
to become able to assess the respective roles of natural and anthropogenic climate variations in past and future climate changes

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Michael Schulz

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 23/24 / -

Credit points / Workload:
6 / 180 hours

Module examinations

Module examination: Climate Change 2: Models and Data

Type of examination: module exam

Form of examination:
Announcement at the beginning of the semester

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
100 % oral exam

Module courses

Course: Abrupt, Past and Future Climate Changes

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
5,00

Literature:
Alley et al.: Abrupt Climate Change: Inevitable Surprises. National Academy Press, Washington, DC, 238 pp., 2002.
Ruddiman, W.F.: Earth's climate: past and future. W.H. Freeman, 3rd revised edition, 464 p., 2013.

Teaching format(s):
Lecture
Tutorial

Associated module examination:
Modulprüfung MMG-CC2 Climate Change 2: Models and Data

Associated module courses

Abrupt, Past and Future Climate Changes (Lecture)

Module 08-GEO-MA-PG-EA-FB1: Lakes and lacustrine sediments
Lakes and lacustrine sediments

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements

Learning content:
- Introduction into lake systems
- Basics of limnology
- Field and laboratory tools in limnogeology
- Particle dynamics and processes in lakes
- Imaging of the lake floor and the sediments
- Lake sediments as paleoclimate archives
- Different proxies in lake sediments and basic statistics
- Dating methods and age model generation
- Case studies of different lake systems

Learning outcomes / competencies / targeted competencies:
The students will obtain knowledge about
- abiotic and biotic processes of sediment formation in lakes
- lake sediments as paleoclimate and paleoenvironmental archives

Calculation of student workload:
28 h SWS / presence time / working hours
37 h Preparation / follow-up work
25 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Dr. Christian Ohlendorf

Frequency:
winter semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 17/18 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: written exam

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Module courses

Course: Lakes and lacustrine sediments

Frequency:
winter semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Literature:
Bradley R.S. 2015. Paleoclimatology: reconstructing climates of the quaternary. Academic Press, Elsevier, Amsterdam [u. a.], 675 pp.

Cohen, A.S., 2003: Paleolimnology: The History and Evolution of Lake Systems. Oxford University Press, USA, 485 pp

Developments in Paleoenvironmental Research. Series Editor: Smol, J.P. (several specialised volumes)

Håkanson L. and Jansson M. 1983. Principles of Lake Sedimentology. Springer, Berlin, Heidelberg, New York, Tokyo, 313 pp.

Wetzel R.G. 2001. Limnology: lake and river ecosystems. 3rd ed., Acad. Press, San Diego, Calif, [u.a.] 1006 pp.

Teaching format(s):
Lecture

Associated module examination:
written exam

Module 08-GEO-MA-PG-CL2-FB1: Sea-level Change
Sea-level Change

Assignment to areas of study:
- Elective Modules

Content-related prior knowledge or skills:
No formal requirements for PEP students

Learning content:
Sea-level Change:

- steric and dynamic sea-level change
- exchange of mass with glaciers, ice sheets, and terrestrial water reservoirs; associated gravitational, rotational, tectonic effects
- tides and storm surges
- erosion, transportation, and sedimentation in coastal environments
- methods of sea-level reconstruction and projection

Learning outcomes / competencies / targeted competencies:
- The students understand processes and mechanisms responsible for global mean and regional sea-level change on multimillennial to hourly time scales
- they understand the basic processes that dynamically shape the coastal landscape
- they know about methods of reconstructing and projecting global and regional sea-level changes

Calculation of student workload:
15 h Exam preparation
28 h SWS / presence time / working hours
47 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Benjamin Marzeion

Frequency:
summer semester, yearly

Duration:
1 semester[s]

The module is valid since / The module is valid until:
WiSe 17/18 / -

Credit points / Workload:
3 / 90 hours

Module examinations

Module examination: Written exam

Type of examination: module exam

Form of examination:
Written examination

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Module courses

Course: Sea-level Change

Frequency:
summer semester, yearly

Language(s) of instruction:
English

Contact hours:
2,00

Literature:
Will be announced in the respective course.

Teaching format(s):
Lecture

Associated module examination:
Written exam

Associated module courses

Sea-level Change (Lecture)

Module 01-PHY-MA-MTEPhy: Final Module (Master's Thesis and Colloquium)
Master Thesis

Assignment to areas of study:
- Master Thesis

Content-related prior knowledge or skills:
As per §6 (2) of the subject-specific examination regulations, 66 CPs and thus passing all the compulsory modules except the module Presentation Techniques in Environmental Physics are required for the registration of the master thesis.

Learning content:
The content is related to the respective area of research of the Master's Thesis.

Responsible lecturers: Prof. Dr. Hartmut Bösch, Prof. Dr. Justus Notholt, Prof. Dr. Joke Lübbecke, Prof. Dr. Annette Ladstätter-Weißenmayer, Prof. Dr. Mihalis Vrekoussis, Prof. Dr. Veronika Eyring, Prof. Dr. Christian Haas, Prof. Dr. Thomas Jung, Prof. Dr. Torsten Kanzow, Prof. Dr. Gerrit Lohmann as well as further university lecturers of the IUP (Institute of Environmental Physics) / AWI (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research) depending on the area of research

A list of references will be provided.

Learning outcomes / competencies / targeted competencies:
- Transfer of a scientific problem/question into an experimental and/or theoretical study
- Successful strategies for the planning and conducting of scientific studies
- Ability for a critical evaluation, assessment and discussion of own scientific results
- Summarize and present scientific results in a Master's Thesis

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:
English

Responsible for the module:
Prof. Dr. Hartmut Bösch

Frequency:
summer semester, yearly

Duration:

The module is valid since / The module is valid until:
WiSe 23/24 / -

Credit points / Workload:
30 / 900 hours

Module examinations

Module examination: Kolloquium

Type of examination: module exam

Form of examination:
Colloquium

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Successful colloquium to the Master's Thesis (graded)

Master's Thesis and colloquium are marked in a common grade; grade master's thesis will be considered with 2/3 and grade for colloquium with 1/3

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Module examination: Masterarbeit

Type of examination: module exam

Form of examination:
Master Thesis

The examination is ungraded?
no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
English

Description:
Successful assessment of the Master's Thesis (graded)

Module 01-PHY-MA-0 PEP: Additional courses master program PEP
Additional courses master program PEP

Assignment to areas of study:
- Additional Courses

Content-related prior knowledge or skills:
none

Learning content:

Learning outcomes / competencies / targeted competencies:
In this "module", which is not part of the examination regulations, we inform you about courses that would otherwise no longer be visible in StudIP due to the new display structure. These may be seminars, information events etc..

Calculation of student workload:

Are there optional courses in the modules?
yes

Language(s) of instruction:
English

Responsible for the module:
N.N.

Frequency:

Duration:

The module is valid since / The module is valid until:
WiSe 23/24 / -

Credit points / Workload:
0 / 0 hours

Module examinations

Module examination: ohne Prüfung

Type of examination: module exam

Form of examination:
See description

The examination is ungraded?
yes

Number of graded components / ungraded components / prerequisites of the examination:
- / - / -

Language(s) of instruction:
English

Module courses

Course: Additional courses master program PEP

Frequency:

Language(s) of instruction:
English

Contact hours:
0,00

Teaching format(s):

Lecture
Tutorial
Seminar
Self-study unit

Associated module examination:

Associated module courses

IUP/AWI Blockseminar (Seminar)

Safety training including Fire Drill, SoSe 2026 (Brandschutz) ()