Module Handbook
for the Master of Science programme
Physical Geography: Environmental History

Universität Bremen

Content

Fachbereich FB 08
Sozialwissenschaften

GEOGRAPHIE
UNIVERSITÄT BREMEN

Introductory remarks

The module handbook describes the M. Sc. study programme “Physical Geography: Environmental History” at the Institute of Geography (Faculty 8/Social Sciences of the University of Bremen).

This master programme consists of four phases (see the structure of the master programme on page 8): the introductory phase (first semester), the advanced studies phase (second semester) and the individualisation phase (third semester). The final phase (fourth semester) concludes with the master thesis. The M. Sc. in “Physical Geography: Environmental History” consists of modules which are organised as lectures, seminars, exercises, laboratory and field courses, field trips and projects:

- Lectures comprehensively cover the scientific foundations, i.e. core knowledge, specialised knowledge, and concepts of selected areas.
- In seminars the students are familiarised with specialised topics by reading original literature, presenting their topics to fellow students and producing final papers.
- During exercises students carry out hands-on activities, often in the laboratory or on the computer.
- In the context of laboratory and field courses theoretical knowledge is applied to specific research questions.
- In projects the students acquire the ability to solve problems and jointly apply and train methods and techniques developed in exercises, laboratory and field courses.

Validity

This module description serves as a first orientation for students. Legally binding is the German version of the valid Examination Regulations for the M.Sc. in Physical Geography: Environmental History. The module handbook will be updated regularly. However, modifications with respect to staff change and/or adaption of the content may occur.

Editorial remarks

With regard to content-related aspects please contact Bernd Zolitschka (zoli@uni-bremen.de) as the responsible person for the master course.

Version #1.6
2019-05-02

Description of the M. Sc. “Physical Geography: Environmental History”

The M. Sc. “Physical Geography: Environmental History" is a research-oriented master programme in physical geography focusing on the understanding and reconstruction of environmental and climatic history. This master programme is innovative and unique in Germany due to its distinct interdisciplinary approach including courses in physical and human geography, archaeology, geosciences, palaeobiology and environmental physics. To ensure high academic quality and practical orientation, the programme draws on both, expertise within the University of Bremen as well as partnerships with regional scientific institutions in Bremen and Lower Saxony. All classes are taught in English, thereby adding to the international visibility and attractiveness of this M. Sc. programme.

Introduction

The current debate about the reasons and effects of climate change illustrates the need for experts who can understand and explain the complex interrelations that lead to environmental changes through time. Meeting this demand, the consecutive M. Sc. “Physical Geography: Environmental History" will complement and complete the educational concept at the Institute of Geography. So far, the Institute of Geography offers the bachelor degrees B. A. (with a focus on human geography) and B. Sc. (with a focus on physical geography). A master programme in Urban and Regional Development has been established for human geography**.** Now the Institute of Geography uses a window of opportunity to design a research-based master programme to bridge this gap.

Objectives

The M. Sc. “Physical Geography: Environmental History" focusses on the reconstruction of environmental and climatic history because scientific expertise in this field is paramount today. The programme provides physical-geographical knowledge and skills that enable students to analyse, interpret and evaluate the complex effects of natural and anthropogenic environmental changes on nature and society. Global environmental changes are one of the biggest social, political and cultural issues of the 21st century. In order to cope with their complexity, it is important to develop innovative and interdisciplinary approaches in teaching and research to qualify students for linking natural and anthropogenic phenomena. The new M. Sc. accepts this challenge by offering a study programme with social scientific components from archaeology and human geography.

Information about the past, obtained from natural, archaeological and historical archives as well as from instrumental data, enables graduate students to understand how global climate and environmental changes affect natural and socioeconomic systems and to investigate the future of our environment. Students learn to develop their own scientific questions in close contact to ongoing national and international research projects. They work in an interdisciplinary manner through research-based education and in close co-operation with research institutions in Bremen and Lower Saxony. All modules are characterised by strong links between teaching and research while the concluding project and internship modules as well as the master thesis focus on own research. Furthermore, all classes are taught in “English” to explicitly address international students and to prepare graduates for an increasingly international job market. Methodological training in the field, in the laboratory and on the computer including geographical information systems (GIS) qualifies graduates for different applied labour markets, e. g. public administration, planning offices, adult education as well as media sectors and information technology.

Structure

After two years of instruction, the M. Sc. “Physical Geography: Environmental History" leads to the degree Master of Science (M. Sc.) with at least 120 credit points (CP/ECTS). The study programme is designed to accept students at the beginning of each winter term. The start of this master programme is scheduled for the winter term 2016/17.

The study programme consists of four compulsory modules and 16 elective modules (including

the internship), of which six or more elective modules must be selected. Not included in the module structure are the study abroad, the “General Studies” and the master thesis. Since teaching is not spread over the entire third semester but taught in compact form within larger time blocks before and after the teaching term, students can spend a semester abroad without extending the duration of their master studies. On the one hand, studies at foreign universities can be used to complement the technical and vocational skills. On the other hand, the concept of this master programme also enables students to complete parts of the project module and/or the internship abroad. Graduates are encouraged to study abroad by making use of the numerous active contacts with international universities and research institutions.

The new master programme is structured in four phases with different teaching and learning methods in order to meet the heterogeneous needs of its national and international students:

- The *introductory phase* takes into account the different levels of knowledge and provides basic courses in the form of compulsory lectures and seminars as Consecutive Core Subjects in the disciplines of climatology, environmental physics, geosciences, limnogeology, prehistoric archaeology and vegetation history and archaeobotany. In addition, an introduction to the current literature is given and presentation techniques are applied.
- In the *advanced study phase* the Consecutive Core Subjects are continued, closely interconnected and consolidated by means of research-based and hands-on training, particularly in the framework of field and laboratory exercises. Furthermore, computer-based analyses and visualization techniques of spatio-temporal data and processes are conveyed.
- The *individualisation phase* involves project work (Research Process II) as well as additional modules from the compulsory Additional Core Subjects with specialised lectures, exercises and field trips in the disciplines of marine environmental archives, soil science and regional environmental history. Graduates combine these options with an internship and/or the study abroad. This results in deeper insight into the research practice of environmental and climate reconstruction. Intensive course guidance by the teaching staff ensures that the project module, the internship and the final master thesis are combined in a meaningful way. During this individualisation phase, the teaching contacts between students and scientists from regional research institutes have a positive impact and lead to an intensive research experience. The options for specialisation allow students to develop an individual study profile tailored to support their intended professional career.
- In the *final phase*, the students work on their master theses. If successful, the academic degree "Master of Science" (M. Sc.) is awarded.

The concept of this study programme with a focus on the environment and climate is unique for Germany. Only the University of Mainz has a comparable master programme (“M. Sc. Climate and Environmental Change”), albeit in German language. In Europe, some programmes deal with environmental history, however, prioritising social sciences. For instance in the UK, the “Master of Research in Environmental History” at the University of Stirling focusses on history, politics and biological sciences, whereas the “Master Programme in Global Environmental History” at the University of Uppsala in Sweden concentrates on history, archaeology, human geography and sustainable development.

Educational concept

Four professors are responsible for the M. Sc. “Physical Geography: Environmental History" (Prof. B. Zolitschka and Prof. B. Marzeion, both physical geographers), Prof. M. Flitner (human geography) and Prof. U. Halle (archaeology). In addition, teaching imports from within the University of Bremen are arranged with the Institute of Environmental Physics (Faculty 1), the Department of Geosciences (Faculty 5) and with the central scientific units “Sustainability Research Center” (artec) and “Center for Marine Environmental Sciences” (MARUM). More teaching import is assured from other research institutions in Bremen (State Archaeology of Bremen, Alfred-Wegener Institute, Bremerhaven) and Lower Saxony (University of Oldenburg, Lower Saxony Institute for Historical Coastal Research, Wilhelmshaven).

Guidance for this study programme is offered by the Central Student Advisory Service of the University of Bremen. Decentralized academic counselling is provided by the teaching staff at the

Institute of Geography and at cooperating institutions as well as by the Coordinator for Internships and Internationalization of the Institute of Geography and the Faculty 8.

Requirements

The admission to the master programme requires a completed bachelor programme with 180 CP/ECTS or another comparable scientific study programme with a relation to the M. Sc. “Physical Geography: Environmental History”. In addition to undergraduate degrees in bachelor programmes related to physical geography also degrees in geology, Earth sciences or geosciences (with a focus on sedimentology and Quaternary geology) or archaeology (with a focus on geoarchaeology) are accepted. Master applicants must draft a letter of motivation, in which they explain their interests as well as their academic or professional background. A further requirement is the proof of language skills in English at the level C1 of the European Framework of Reference for Languages (or any equivalent certificate). Basic knowledge of the German language is desirable.

Guiding principles

The M. Sc. “Physical Geography: Environmental History" consistently implements the guiding principles of the University of Bremen. A *high quality of teaching* is ensured by accreditation of the study programme and by the implemented quality cycle in teaching at the Faculty 8 (Social Sciences). A *high quality of research* is achieved by attempting to publish results of the master theses in international scientific journals. Moreover, the master programme also benefits from the excellent reputation of the cooperating research institutions. *Multi- and transdisciplinary orientation* is provided by interdisciplinary cooperation between the participating natural and social scientists. *Social responsibility and good environmental performance* go without saying in a study programme that focuses on global climate and environmental change and its impacts on natural and socioeconomic systems. The goal of *gender equality* is successfully implemented in all study programmes at the Institute of Geography with male and female students roughly balanced. In addition, the students can benefit from established facilities at the Institute of Geography, such as office hours for students with children.

The high level of *internationalisation in teaching and research* results from teaching in English. Additionally, the structurally integrated option to complete studies abroad during the third semester with a prior definition of a learning agreement and/or to carry out an internship abroad are both possible without extending the period of study. Teaching is based on international standards and draws on ongoing international research of all participating institutions. International collaborations already exist with official partner universities of the University of Bremen, which can be used either to study abroad or for further qualification through field work or projects.

Responsible person for the master course

Bernd Zolitschka (zoli@uni-bremen.de) is the responsible person for the master course in “Physical Geography: Environmental History”.

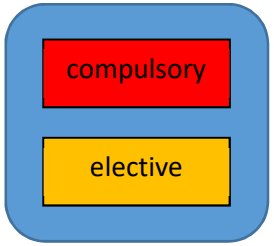
Teaching staff

Family name	First name	Title	Affiliation	email
Bickert	Torsten	Dr.	MARUM	tbickert@marum.de
Bittmann	Felix	Prof. Dr.	FB 8, IfGeo; NIhK	bittmann@uni-bremen.de
Bracher	Astrid	Prof. Dr.	FB 1, IUP	bracher@iup.physik.uni-bremen.de
Burrows	John	Prof. Dr.	FB 1, IUP	burrows@iup.physik.uni-bremen.de
Flitner	Michael	Prof. Dr.	FB 8, IfGeo; artec	flitner@uni-bremen.de
Gebhardt	Catalina	Dr.	AWI	catalina.gebhardt@awi.de
Giani	Luise	Prof. Dr.	Univ. Oldenburg	luise.giani@uni-oldenburg.de
Halle	Uta	Prof. Dr.	FB 8, IfG	halle@uni-bremen.de
Marzeion	Benjamin	Prof. Dr.	FB 8, IfGeo	ben.marzeion@uni-bremen.de
Mennenga	Moritz	Dr.	NIhK	moritz.mennenga@nihk.de
Mulitza	Stefan	Dr.	FB 5	smulitza@uni-bremen.de
Ohlendorf	Christian	Dr.	FB 8, IfGeo	ohlen@uni-bremen.de
Palm	Mathias	Dr.	FB 1, IUP	mathias@iup.physik.uni-bremen.de
Paul	Andre	Dr.	MARUM	apaul@marum.de
Schefuß	Enno	Dr.	FB 5	schefuss@uni-bremen.de
Schulz	Michael	Prof. Dr.	MARUM	mschulz@marum.de
Siegmüller	Annette	Dr.	NIhK	siegmueller@nihk.de
Stein	Rüdiger	Prof. Dr.	AWI	rstein@awi-bremerhaven.de
Thiele	Michael	Dipl.-Geogr.	FB 8	thiele@uni-bremen.de
Tkaczick	Tobias	Dipl.-Geogr.	FB 8, IfGeo	tkaczick@uni-bremen.de
Venzke	Jörg	Prof. Dr.	FB 8, IfGeo	jfvenzke@uni-bremen.de
von Dobeneck	Tilo	Prof. Dr.	FB 5	dobeneck@uni-bremen.de
Völker	Christoph	Dr.	FB 1, IUP; AWI	christoph.voelker@awi.de
Warneke	Thorsten	Dr.	FB 1, IUP	warneke@iup.physik.uni-bremen.de
Wolters	Steffen	Dr.	NIhK	wolters@nihk.de
Zabel	Matthias	Dr.	FB 5	mzabel@uni-bremen.de
Zolitschka	Bernd	Prof. Dr.	FB 8, IfGeo	zoli@uni-bremen.de

Module coordinators

Module Name	Module Acronym	CP/ ECTS	Coordinator	Deputy
Research Process I	PG-1-RP1	3	B. Zolitschka	B. Marzeion
Climatology I	PG-1-CL1	9	B. Marzeion	B. Zolitschka
Lacustrine Environmental Archives I	PG-1-EA1	9	C. Ohlendorf	B. Zolitschka
Vegetation History and Archaobotany I	PG-1-VA1	9	F. Bittmann	B. Zolitschka
Archaeology I	PG-1-AR1	9	U. Halle	B. Zolitschka
Environmental Physics I	PG-1-EP1	9	B. Zolitschka	B. Marzeion
Climate Change I	MAR-1-C1	9	M. Schulz	A. Paul
Climatology II	PG-2-CL2	6	B. Marzeion	B. Zolitschka
Lacustrine Environmental Archives II	PG-2-EA2	6	C. Ohlendorf	B. Zolitschka
Vegetation History and Archaobotany II	PG-2-VA2	6	F. Bittmann	B. Zolitschka
Archaeology II	PG-2-AR2	6	B. Zolitschka	U. Halle
Environmental Physics II	PG-2-EP2	6	B. Zolitschka	B. Marzeion
Climate Change II	MAR-2-C7	6	M. Schulz	A. Paul
Computer-based Analyses	PG-2-CBA	6	B. Marzeion	B. Zolitschka
Historical Political Ecology	PG-2-HPE	6	M. Flitner	B. Zolitschka
Research Process II	PG-3-RP2	12	B. Marzeion	B. Zolitschka
Internship	PG-3-INS	12	M. Thiele	B. Zolitschka
Marine Environmental Archives	MAR-3-C2	9	T. v. Dobeneck	T. Bickert
Bodenkunde	PG-3-BOK	6	B. Zolitschka	B. Marzeion
Regional Environmental History	PG-3-REH	6	B. Zolitschka	B. Marzeion

Structure of the study programme and overview of modules



1. Semester – Introductory Phase

PG-RP1 Research Process I (3 CP)					
PG-CL1 Climatology I (9 CP)	PG-EA1 Lacustrine Environ-mental Archives I (9 CP)	PG-VA1 Vegetation History and Archaeobotany I (9 CP)	PG-AR1 Archaeology I (9 CP)	PG-EP1 Environmental Physics I (9 CP)	MAR-C1 Climate Change I (9 CP)

2. Semester – Advanced Study Phase

PG-CL2 Climatology II (6 CP)	PG-EA2 Lacustrine Environ-mental Archives II (6 CP)	PG-VA2 Vegetation History and Archaeobotany II (6 CP)	PG-AR2 Archaeology II (6 CP)	PG-EP2 Environmental Physics II (6 CP)	MAR-C7 Climate Change II (6 CP)
PG-CBA Computer-based Analyses (6 CP)	PG-HPE Historical Political Ecology (6 CP)				

3. Semester – Individualisation Phase

PG-RP2 Research Process II (12 CP)	PG-INS Internship (12 CP)	MAR-C2 Marine Environmental Archives: Methods (9 CP)	PG-BOK Bodenkunde (Soil Science) (6 CP)	PG-REH Regional Environmental History (6 CP)	Study Abroad (max. 18 CP)
					General Studies (max. 6 CP)

4. Semester – Final Phase

Master-Thesis

(30 CP)

Module descriptions

Introductory phase (first semester – winter term)

Name of the module Acronym	Research Process I 08-PG-1-RP1
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-RP1-1 Orientation and Introduction (exercise: 1 hpw, blocked) 08-PG-1-RP1-2 Graduate Reading Seminar (seminar: 2 hpw)
Compulsory / Elective	Compulsory
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the first semester
Workload/ Calculation of Credit points (CP)	This module is rated with 3 CP (90 hours): ▪ 42 h seminar and exercise ▪ 18 h oral presentation of completed own studies ▪ 30 h reading assignments and oral presentation of one current scientific paper
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	Students obtain ▪ an understanding of the structure of the M. Sc. Programme embedded in administration needs, library, international office and central examination office at the University of Bremen, ▪ an advanced training in reading and discussing up-to-date literature in relevant fields of science, ▪ an advanced training in oral presentation of published data and information, ▪ an advanced training in oral presentation of own data and scientific results.
Contents	▪ Introduction to the University of Bremen in general and the M. Sc. programme in particular. ▪ Preparation of two oral presentations: (a) own data and results and (b) reporting a current scientific publication. ▪ Preparation of one short excerpt not related to the own presentation (ca. 2 pages) where main results are outlined (ca. 0.5 pages) and the applied methods and the structure of the paper are discussed. ▪ Approaching the current state of scientific discussion by reading up-to-date literature.
Study and examination achievements, Forms of examination	Oral presentation and excerpt
References	Will be announced in the seminar

Name of the module Acronym	Climatology I 08-PG-1-CL1
Module coordinator	Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de
Teaching staff	Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de Beatriz Recinos +49-(0)421-218.67174; recinos@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-CL1-1 Introduction to Climatology (lecture, 2 hpw) 08-PG-1-CL1-2 Methods in Climatology (seminar/exercise; 3 hpw)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the first semester
Workload/ Calculation of Credit points (CP)	This module is rated with 9 CP (270 hours): ▪ 70 h lectures and seminar/exercise ▪ 150 h self-revision of lectures and additional complementary material, working on exercises and preparation of seminar presentation ▪ 50 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	The students know and understand the ▪ key concepts of climatology ▪ causes and mechanisms of the most important phenomena in the coupled climate system, and can explain the variability of climate on timescales of years to centuries ▪ principle methods of climatology; they can assess the power and limitations of different methods, and are able to identify approaches suitable for addressing particular climatological problem sets.
Contents	Introduction to Climatology: ▪ the planetary energy balance ▪ the general circulation of the atmosphere as a consequence of radiative forcing ▪ variability in the radiative forcing – natural (orbital, solar, volcanic) and anthropogenic (greenhouse gases, aerosols, land use change) ▪ the global ocean circulation as a consequence of exchange of energy, momentum, and matter with the atmosphere ▪ mechanisms of internal, coupled variability ▪ mechanisms of natural, forced variability ▪ anthropogenic climate change in the coupled system ▪ climate models as a laboratory of climate science – concepts, validation, application Methods in Climatology: The first 9 weeks of the semester, students will work on small scientific projects, continuously advised by the teaching staff. The topics of these projects will be aligned with current scientific questions, and can be of experimental/practical nature (e.g., analysis of data from a weather station), of theoretical nature (e.g., analysis of a simple, conceptual model), or based on a review of recent literature. During the remaining 5 weeks of the semester, the projects will be presented and discussed among all students.
Study and examination achievements, **Forms of examination**	50 % written exam, 50 % written paper on, and presentation of, the project.
References	References will be announced at the beginning of the courses.

Name of the module Acronym	Lacustrine Environmental Archives I 08-PG-1-EA1
Module coordinator	Dr. Christian Ohlendorf +49-(0)421-218.67153; ohlen@uni-bremen.de
Teaching staff	Dr. Catalina Gebhardt +49-(0)471-4831.1946; catalina.gebhardt@awi.de Dr. Christian Ohlendorf +49-(0)421-218.67153; ohlen@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-EA1-1 Lakes and lacustrine sediments (lecture, exercise: 2 hpw) 08-PG-1-EA1-2 Methods in Limnogeology (lecture, exercise; 3 hpw)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the first semester
Workload/ Calculation of Credit points (CP)	This module is rated with 9 CP (270 hours): ▪ 70 h lectures and practicals ▪ 150 h self-revision of lectures and additional complementary material (exercises and data processing, preparation of oral and poster presentation) ▪ 50 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	The students will obtain knowledge about ▪ abiotic and biotic processes of sediment formation in lakes ▪ lake sediments as paleoclimate and paleoenvironmental archives ▪ state-of-the-art destructive and non-destructive methods for sediment analysis ▪ state-of-the-art tools for data analysis and interpretation
Contents	▪ 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
Study and examination achievements, **Forms of examination**	Oral examination and oral/poster presentation
References	▪ 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) ▪ Schönborn, W., 2003. Lehrbuch der Limnologie. Verlag E. Schweizerbart, 588 S. ▪ Schwoerbel J. , Brendelberger H., 2013. Einführung in die Limnologie. 10. Aufl., Elsevier Spektrum Akademischer Verlag, 326 S.

Name of the module Acronym	Vegetation History and Archaeobotany I 08-EH-1-VA1
Module coordinator	Prof. Dr. Felix Bittmann +49-(0)4421-915.146; bittmann@uni-bremen.de
Teaching staff	Prof. Dr. Felix Bittmann +49-(0)4421-915.146; bittmann@uni-bremen.de Dr. Steffen Wolters +49 (0)4421-915.147; wolters@nihk.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-VA1-1 Vegetation history of Central Europe: Introduction to pollen analysis and related palaeoecological methods (lecture: 1 hpw) 08-PG-1-VA1-2 Pollen analytical practical (exercise; 7 days, blocked)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the first semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 9 CP (270 hours): ▪ 70 h lectures and practical ▪ 150 h self-revision of lectures and additional complementary material (exercises, data processing, textbooks, etc.) ▪ 50 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	The students will obtain knowledge about ▪ Late- and post-glacial vegetation development in Central Europe based on pollen analyses ▪ Basic knowledge about additional (related) palaeoecological methods (e.g., Chironomidae, Cladocera, Diatomeae, macrofossils, non-pollen palynomorphs) ▪ Basic knowledge in plant systematics and pollen morphology ▪ Anthropogenic indicators ▪ Dating methods
Contents	Lecture: ▪ Introduction to vegetation and vegetation history of central Europe ▪ Introduction to palaeoecological methods used for reconstructions of former environments Exercise: ▪ Microscopic pollen analytical studies (pollen morphology, identification, counting, data processing, graphical display) ▪ Fieldwork (coring of peat profiles)
Study and examination achievements, Forms of examination	Protocol including an extended description of a certain aspect/problem of pollen analysis (oral presentation of the latter)
References	▪ Smol J.P. (Series Editor) Developments in Paleoenvironmental Research (several specialised volumes) ▪ Faegri K., Iversen J., Kaland P.E., Krzywinski K., 1992. Text book of pollen analysis, 4th edition, Wiley ▪ Beug H.-J., 2004. Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete. F. Pfeil, München ▪ Moore P.D., Webb J.A., Collinson M.E.. 1994. Pollen Analysis. Wiley-Blackwell ▪ Berglund B.E. (ed.), 1986 (reprinted 2003). Handbook of Holocene Palaeoecology and Palaeohydrology, Blackburn ▪ Elias S.A. (ed.), 2007. Encyclopedia of Quaternary Science. Elsevier, Amsterdam ▪ Punt W. et al.. 1976-2003. The Northwest European Pollen Flora (NEPF) Vol. I (1976), Vol. II (1980), Vol. III (1981), Vol. IV (1984) Vol. V (1988), Vol. VI (1991), Vol. VII (1996), Vol. VIII (2003), Vol. IX (2009). Elsevier, Amsterdam ▪ Lang G., 1994. Quartäre Vegetationsgeschichte Europas. Gustav Fischer, Jena ▪ Firbas F., 1949/52. Spät- und nacheiszeitliche Waldgeschichte Mitteleuropas nördlich der Alpen. Bd. 1: Allgemeine Waldgeschichte, Bd. 2: Waldgeschichte der einzelnen Landschaften. Gustav Fischer, Jena

Name of the module Acronym	Archaeology I 08-PG-1-A1
Module coordinator	Prof. Dr. Uta Halle +49-(0)421-361.14238; halle@uni-bremen.de
Teaching staff	Prof. Dr. Uta Halle +49-(0)421-361.14238; halle@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-A1-1 Introduction to European Prehistoric Archaeology (lecture: 2 hpw) 08-PG-1-A1-2 Methods of European Prehistoric Archaeology (exercise: 5 days, blocked with one field trip to megalithic graves and burial-mounds in the surroundings of Bremen)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the first semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 9 CP (270 hours): ▪ 80 h lectures and practicals ▪ 140 h self-revision of lectures and additional complementary material (exercises, textbooks, etc.) ▪ 50 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	The students should have an overview and first understanding of ▪ Chronology, ▪ Material culture and major socio-economic issues, ▪ Interpretative themes relating to prehistoric Europe. They should be ▪ able to identify some of the principal monuments and key types of artefacts from prehistoric landscapes, ▪ aware of some of the regional cultures of prehistoric times, ▪ familiar with relevant terminology.
Contents	▪ Development of European prehistory as a discipline; ▪ Earliest occupation of Europe; ▪ European Neanderthals; ▪ Arrival of modern humans in Europe; ▪ Origins of farming and its spread across Europe; ▪ Neolithisation of the north; ▪ Emergence of elites and the development of long-distance connections; ▪ Development of metallurgy and hierarchical societies in the Bronze Age and the Iron Ages; ▪ Impact of Rome on European societies ▪ Rural Settlement and graveyards of the 5th and 11th centuries AD ▪ Growth of (pre-)urban centres in Europe ▪ Conversion to Christianity, church and monasteries ▪ Development of trading and manufacturing settlements and later of defended towns
Study and examination achievements, **Forms of examination**	Oral or written examinations: term papers, presentations, reports, project reports, excerpts, test
References	▪ Evans, J., O'Connor, T., 1999. Environmental Archaeology. Principles an Methods, Stroud ▪ Fehring, G.P., 2015. The Archaeology of Medieval Germany. An Introduction. London: Routledge Library Editions: Archaeology, 22 ▪ Renfrew, C., Bahn, P., 2000. Archaeology. Theories, Methods and Practice; London ▪ Silberman, N.A., 2012. The Oxford companion to archaeology. 2nd ed., New York: Oxford University Press

Name of the module Acronym	Environmental Physics I 08-PG-1-EP1
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Prof. Dr. John P. Burrows burrows@iup.physik.uni-bremen.de Dr. Christoph Völker christoph.voelker@awi.de
Related courses, teaching format and hours per week (hpw)	08-PG-1-EP1-1 Atmospheric Physics (lecture, exercise: 4 hpw) 08-PG-1-EP1-2 Global Carbon Cycle (lecture, exercise: 2 hpw)
Mandatory/ Compulsory	Compulsory
Related to the study programme	Teaching import from the M. Sc. Environmental Physics to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the first semester of study (winter term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 9 CP (270 hours): ▪ 84 h lectures and practicals ▪ 130 h self-revision of lectures and additional complementary material (exercises, textbooks, etc.) ▪ 56 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	▪ The students become familiar with the physical fundamentals of the atmosphere. ▪ The most important measuring techniques will be introduced. ▪ 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.
Contents	Atmospheric Physics: ▪ Survey of the Atmosphere ▪ Radiation in the Atmosphere ▪ Climate Change ▪ Atmospheric Thermodynamics and the role of Water Vapour ▪ Introduction to Dynamics of the Atmosphere Global Carbon Cycle: ▪ 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
Study and examination achievements, **Forms of examination**	Module exam (combined mark): Partial exam for Atmospheric Physics: 2 hours written or oral exam (67%; prerequisite to take part in the exam: passed with at least 75% from 10 exercises and acted at least once as rapporteur) Partial exam for Global Carbon Cycle: Written exam/oral exam (will be announced by the respective lecturer) (33%)
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, Academic Press, 1977, ISBN 0-12-732950-1 ▪ Pierrehumbert, R.: Principles of Planetary Climate ▪ Sarmiento, J.L. & Gruber, N.: Ocean Biogeochemical Dynamics ▪ Ruddiman, W.F.: Earth's Climate: Past and Future

Name of the module Acronym	Climate Change I: Fundamentals 05-MAR-1-C1
Module coordinator	Dr. André Paul +49-(0)421-218.65450; apaul@marum.de Prof. Dr. Michael Schulz +49-(0)421-218.65500; mschulz@marum.de
Teaching staff	Dr. André Paul +49-(0)421-218.65450; apaul@marum.de Prof. Dr. Michael Schulz +49-(0)421-218.65500; mschulz@marum.de Prof. Dr. Rüdiger Stein +49-(0)471-4831.1576; rstein@awi-bremerhaven.de
Related courses, teaching format and hours per week (hpw)	05-MAR-1-C1-1 Earth System Modelling (lecture, exercise: 3 hpw) 05-MAR-1-C1-2 The Role of High Latitudes Oceans in Climate Change (lecture, exercise: 2 hpw)
Compulsory / Elective	Elective
Related to the study programme	Teaching import from the M. Sc. Marine Geosciences to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the first semester (winter term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 9 CP (270 hours): ▪ 70 h lectures and practicals ▪ 150 h reading assignments, homework, self-revision of lectures and additional complementary material (exercises, textbooks, etc.) ▪ 50 h study time for the final exam
Requirements for participation	▪ Basic computer skills (Windows OS) ▪ For this module at the Department of Geosciences we have restricted access for up to 8 students
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	▪ Students obtain a basic understanding of the physics of the climate system with special emphasis on high latitude processes. ▪ They become familiar with the mathematical and physical concepts underlying Earth-system models and obtain programming and data-analysis skills (Matlab)
Contents	▪ Introduction to numerical Earth system models ▪ Palaeoclimatic history of polar regions and their role in global climate evolution
Study and examination achievements, **Forms of examination**	Modul exam (one mark): oral exam
References	Will be announced in the different courses

Module descriptions

Advanced study phase (second semester – summer term)

Name of the module Acronym	Climatology II 08-PG-2-CL2
Module coordinator	Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de
Teaching staff	Dr. Inga Labuhn +49-(0)421-218.67173; labuhn@uni-bremen.de Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-CL2-1 Palaeoclimatology (lecture: 2 hpw) 08-PG-2-CL2-2 Sea-level Change (lecture: 2 hpw)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the second semester
Workload/ Calculation of Credit points (CP)	This module is rated with 6 CP (180 hours): ▪ 56 h lectures and practicals ▪ 80 h self-revision of lectures and additional complementary material (exercises and data processing, textbooks, etc.) ▪ 44 h study time for the final exam
Requirements for participation	Module Climatology I
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	▪ The students know the main features of the climatic development of Earth during the recent past. ▪ They understand the basic mechanisms of climate variability on time scales exceeding 100 years and ▪ they understand the most important methods of reconstructing past climate. ▪ 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, and ▪ they know about methods of reconstructing and projecting global and regional sea-level changes.
Contents	Palaeoclimatology: ▪ methods of reconstructing past climates; proxies and dating techniques ▪ causes and mechanisms of climate variability ▪ causes and mechanisms of climate variability on orbital time scales ▪ glacial variability (Dansgaard-Oeschger cycles, Heinrich events) ▪ last glacial maximum, sequence and mechanisms of the deglaciation ▪ Holocene climate and climate variability ▪ applications of numerical models in paleoclimatology 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
Study and examination achievements, Forms of examination	Module exam (combined mark): ▪ written exam for CL2-1 (50%) ▪ written exam for CL2-2 (50%)
References	▪ Bradley, R.S., 2014. Paleoclimatology: Reconstructing Climates of the Quaternary. 3rd edition, Elsevier, Amsterdam, 696 pp. ▪ Cronin, T.M., 2010. Paleoclimates – understanding climate change past and present. Columbia University Press, 441 pp. More references will be provided as necessary.

Name of the module Acronym	Lacustrine Environmental Archives II 08-PG-2-EA2
Module coordinator	Dr. Christian Ohlendorf +49-(0)421-218.67153; ohlen@uni-bremen.de
Teaching staff	Dr. Catalina Gebhardt +49-(0)471-4831.1946; catalina.gebhardt@awi.de Dr. Christian Ohlendorf +49-(0)421-218.67153; ohlen@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-EA2-1 Field Course in Limnogeology (exercise: 1 week, blocked) 08-PG-EA2-2 Laboratory Course in Limnogeology (exercise: 1 week, blocked)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the second semester (summer term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 90 h participation ▪ 45 h additional complementary material (exercises, data analyses, etc.) ▪ 45 h preparation of oral/poster presentation
Requirements for participation	Module Lacustrine Environmental Archives I
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	Students will obtain ▪ basic practical skills in water column and sediment sampling ▪ basic practical skills in geoacoustic methods ▪ knowledge about sediment core treatment, lithological description and subsampling in the laboratory ▪ knowledge on standard physical and geochemical measurements of sediments, their processing and interpretation
Contents	▪ Field course focussing on water column analyses, sediment coring techniques and geoacoustic measurements ▪ Laboratory course focussing on core splitting and description, non-destructive core logging and scanning techniques (physical properties, core images, XRF scanning), destructive techniques (grain-size analysis, CNS analysis, water content, loss on ignition)
Study and examination achievements, **Forms of examination**	Oral and poster presentation of own results during a self-organised student conference
References	▪ 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) ▪ Schönborn, W., 2003, Lehrbuch der Limnologie. E. Schweizerbart, 588 S. ▪ Schwoerbel, J., Brendelberger, H., 2013. Einführung in die Limnologie. 10. Aufl., Elsevier Spektrum Akademischer Verlag, 326 S. ▪ Tucker, M.E., 1996. Methoden der Sedimentologie. Spektrum Akademischer Verlag, 366 S., (English version: Techniques in Sedimentology, 1988, Blackwell Scientific Publications, 294 pp).

Name of the module Acronym	Vegetation History and Archaeobotany II 08-PG-2-VA2
Module coordinator	Prof. Dr. Felix Bittmann +49-(0)4421-915.146; bittmann@uni-bremen.de
Teaching staff	Prof. Dr. Felix Bittmann +49-(0)4421-915.146; bittmann@uni-bremen.de Dr. Steffen Wolters +49 (0)4421-915.147; wolters@nihk.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-VA2-1 Introduction to the History of Cultural Plants (lecture: 1 hpw) 08-PG-2-VA2-2 Laboratory Course in Archaeobotany (exercise; 1 week, blocked)
Compulsory /Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the second semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 54 h lectures and practical ▪ 80 h self-revision of lectures and additional complementary material (exercises, data processing, textbooks, specialised articles) ▪ 46 h study time for the final exam
Requirements for participation	Module Vegetation History and Archaeobotany I
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	The students will obtain knowledge about ▪ Domestication processes ▪ Preconditions for domestication ▪ Domestication centres ▪ Chronological developments – origin and spread of cultural plants ▪ Field methods ▪ Identification of botanical macroremains
Contents	▪ Introduction to the history of cultural plants ▪ Introduction to seed morphology ▪ Identification of macroremains (cultural plants and related species) ▪ Sample preparation (e.g., floating, sieving) ▪ Wood and charcoal analysis
Study and examination achievements, **Forms of examination**	Protocol including an extended description of a certain aspect/problem of plant domestication and spreading (oral presentation of the latter)
References	▪ Zohary, D., Hopf, M., Weiss, E., 2012. Domestication of plants in the Old World. The origin and spread of domesticated plants in Southwest Asia, Europe and the Mediterranean Basin. 4th ed., Oxford University Press ▪ Cappers, R.T.J., Bekker, R.M.. Jans, J.E.A., 2006. Digital Seed Atlas of the Netherlands. Groningen Archaeological Studies 4, Barkhuis Publishing, Eelde ▪ Cappers, R.T.J., Neef, R., Bekker, R.M., 2010. Digital Atlas of Economic Plantsthe Netherlands. Groningen Archaeological Studies 9, Barkhuis Publishing, Eelde ▪ Jacomet, S., Kreuz, A., 1999. Archäobotanik. Aufgaben, Methoden und Ergebnisse vegetations- und agrargeschichtlicher Forschung. Ulmer, Stuttgart ▪ Körber-Grohne, U., 1987 (2. Aufl. 1994). Nutzpflanzen in Deutschland. Kulturgeschichte und Biologie. Stuttgart

Name of the module Acronym	Archaeology II 08-PG-2-AR2
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Dr. Moritz Mennenga +49-(0)4421-915.124; moritz.mennenga@nihk.de Dr. Annette Siegmüller +49-(0)4421-915.114; siegmueller@nihk.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-AR2-1 Introduction into the practical methods of settlement and maritime archaeology (exercise: 1 hpw, blocked) 08-PG-2-AR2-2 Introduction to field archaeology and excavation techniques (field course, exercise: 3 weeks, blocked)
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the second semester of study (summer term)
Workload/ Calculation of Credit points (CP)	This module is rated with 6 CP (180 hours): ▪ 134 h participation in exercise and field course ▪ 26 h self-revision of exercise and additional complementary material ▪ 20 h preparation of the protocol for the field course
Requirements for participation	Module Archaeology I
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	Students will obtain ▪ basic skills in methods of settlement and maritime archaeology ▪ basic skills in excavation techniques ▪ basic knowledge about the material culture of the focused area and period of investigation ▪ knowledge about salvage and documentation of archaeological finds, features and structures ▪ basic skills in sampling strategies ▪ practical experience in scientific technical drawing, photography and photogrammetry as well as measurement techniques using different equipment ▪ knowledge on processing and interpretation of the gained information
Contents	▪ The exercise focusses on the methodology of Settlement and Maritime Archaeology and its practical implementation on sites in different environments, of different character and different chronological setting. ▪ The field course in archaeological practice focusses on survey, excavation, documentation and salvaging strategies and techniques. In addition, the course introduces into gathering and evaluation of archaeological data as well as on find registration and find classification (on-site and off-site) and their scientific interpretation against the background of their particular historical setting.
Study and examination achievements, **Forms of examination**	▪ Protocol (ca. 5 pages, to be written during the field course)
References	▪ Aston, M., 1985. Interpreting the landscape. Landscape Archaeology in local studies. London. ▪ Evans, J., O'Connor, T., 2001. Environmental Archaeology: Principles and Methods. Stroud. ▪ Flemming, N.C., Çağatay, N., Chiocci, F.L., Galanidou, N., Jöns, H., Lericolais, G., Missiaen, T., Moore, F., Rosentau, A., Sakellariou, D., Skar, B., Stevenson, A., Weerts, H., 2014. Land beneath the waves: research strategies in submerged landscapes and sea level change – A joint geoscience-humanities research strategy for European Continental Shelf Prehistoric Research. Chu, N.C. & McDonough, N. (eds), Position paper 21 of the European Marine Board, Ostend. ▪ Renfrew, C., Bahn, P., 2000. Archaeology. Theories, Methods and Practice. London.

Name of the module Acronym	Environmental Physics II 08-PG-2-EP2
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Prof. Dr. Astrid Bracher bracher@iup.physik.uni-bremen.de Dr. Mathias Palm mathias@iup.physik.uni-bremen.de Dr. Thorsten Warneke warneke@iup.physik.uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-EP2-1 Remote Sensing I (lecture, exercise: 3 hpw) 08-PG-2-EP2-2 Isotopes in Environmental Physics (lecture, exercise: 2 hpw)
Compulsory / Elective	Elective
Related to the study programme	Teaching import from the M. Sc. Environmental Physics to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the second semester of study (summer term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 70 h lectures and practicals ▪ 70 h self-revision of lectures, protocols for exercises and experiments ▪ 40 h study time for the final exam
Requirements for participation	No
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	▪ The students become familiar with the techniques of remote sensing in environmental physics. ▪ They get a better understanding of the state of our environment and its change. ▪ Understanding isotopic fractionation, radiactive decay and the use of isotopes in paleoclimatology and for source characterization
Contents	Remote Sensing: ▪ Remote sensing of the atmosphere, especially with passive methods ▪ Measurement techniques from satellites, aircrafts or from the ground ▪ Radiation transfer Isotopes in Environmental Physics: ▪ Stable and radioactive isotopes, Isotopic fractionation: Processes and examples for their occurence in the environment ▪ Radioactive decay and emitted radiation ▪ Measurements of isotopic composition ▪ Examples for the use of isotopes (Source characterization, Paleoclimatology)
Study and examination achievements, **Forms of examination**	Module exam (combined mark): Partial exam for Remote Sensing (50%): written or oral exam (80% of the final grade; a prerequisite to take part in the exam is to pass the 10 exercises with at least 75% and to act at least once as a rapporteur in the lecture which accounts for 20% of the final grade) Partial exam for Isotopes in Environmental Physics (50%): Written exam/oral exam (will be announced by the respective lecturer) and course performance (Successful assessment of example classes and/or successful writing of an essay)
References	▪ Elachi, Wiley, C., 1987. Introduction to the Physics and Techniques of Remote Sensing, Wiley. ▪ Stephens, G.L., 1994. Remote Sensing of the Lower Atmosphere, Oxford University Press. ▪ Seelye, M., 2004. An Introduction to Ocean Remote Sensing, Cambridge University Press, ISBN 13: 9780521802802 More literature will be announced in the different courses.

Name of the module Acronym	Climate Change II: Models and Data 05-MAR-2-C7
Module coordinator	Dr. André Paul +49-(0)421-218.65450; apaul@marum.de Prof. Dr. Michael Schulz +49-(0)421-218.65500; mschulz@marum.de
Teaching staff	Dr. Stefan Mulitza +49-(0)421-218.65536; smulitza@uni-bremen.de Dr. André Paul +49-(0)421-218.65450; apaul@marum.de Prof. Dr. Michael Schulz +49-(0)421-218.65500; mschulz@marum.de
Related courses, teaching format and hours per week (hpw)	05-MAR-2-C7-1 Abrupt Climate Changes (lecture, exercise, seminar: 2 hpw) 05-MAR-2-C7-2 Modelling Past and Future Climate Changes (lecture, exercise: 2 hpw)
Compulsory / Elective	Elective
Related to the study programme	Teaching import from the M. Sc. Marine Geosciences to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the second semester of study (summer term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 56 h lectures and practicals ▪ 80 h homework, self-revision of lectures and additional complementary material (exercises, textbooks, etc.) ▪ 44 h study time for the final exam
Requirements for participation	▪ Contents of module Climate Change I: Fundamentals. ▪ For this module at the Department of Geosciences we have restricted access for up to 8 students.
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	▪ The students become familiar with the reconstructed climate variations for selected time intervals of the recent geological past. ▪ They gain an understanding of the dynamics of abrupt climate changes and are enabled to assess the role of natural and anthropogenic climate variations in future climate change.
Contents	▪ Reconstruction and modelling of millennial-scale climate variability during the last glacial cycle ▪ Overview of historical climate variations and predictions of future climate change
Study and examination achievements, **Forms of examination**	Module exam (one mark): oral exam
References	Will be announced in the different courses

Name of the module Acronym	Computer-Based Analyses 08-PG-2-CBA
Module coordinator	Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de
Teaching staff	Beatriz Recinos +49-(0)421-218.67174; recinos@uni-bremen.de Tobias Tkaczick +49-(0)421-218.67411; tkaczick@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-CBA-1 Data Analysis and Visualisation (lecture, exercise: 2 hpw) 08-PG-2-CBA-2 Geographical Information System (GIS) (lecture, exercise; 2 hpw)
Compulsory / Elective	Compulsory
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ Winter or summer semester	One semester / This module is scheduled for the second semester
Workload/ Calculation of Credit points (CP)	This module is rated with 6 CP (180 hours): ▪ 56 h lectures and practicals ▪ 90 h self-revision of lectures and additional complementary material, working on exercises in data processing ▪ 34 h preparation of final assessment and project
Requirements for participation	No
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	Students will be able to ▪ process geospatial and time series data provided in the most common data formats, ▪ perform basic and common analyses of these data types using state-of-the-art software, ▪ generate effective visualisations of the results of analyses. ▪ They will obtain knowledge about the principal use of vector-based geographical information systems and ▪ will be able to capture, store, manipulate, analyse, manage and present spatial data.
Contents	Data Analysis and Visualisation: ▪ The course provides practical training in data processing, analysis, and visualisation. Emphasis will be given on techniques and methods that allow the detection of patterns and trends in complex data sets, as well as on tests for statistical significance. Different concepts of the display of quantitative data will be discussed and applied. ▪ Methods: lecture, and practical exercises at the PC. Data are provided in commonly used formats; the students are then given realistic examples of scientific questions to be answered using the data. Following these examples, the students will work through data processing and analysis, and finally identify and implement a visualisation of their results suitable to answer the scientific question. Geographical Information System: Basic theoretical concepts: ▪ geographical information systems ▪ characteristics of spatial data ▪ methods of geoprocessing Practical exercises: ▪ user interface of ArcGIS ▪ spatial geodatabases ▪ georeferencing raster datasets ▪ digitizing features ▪ joining attributes ▪ attributive and spatial selection methods ▪ basic methods of spatial data analysis ▪ cartographic map design
Study and examination achievements, Forms of examination	Module exam (combined mark): ▪ Continuous and successful participation in exercises and delivery of assignments for CBA-1 (50%) ▪ Final project for CBA-2 (50%)
References	References will be announced at the beginning of the courses.

Name of the module Acronym	Historical Political Ecology 08-PG-2-HPE
Module coordinator	Prof. Dr. Michael Flitner +49-(0)421-218.61800; flitner@uni-bremen.de
Teaching staff	Prof. Dr. Michael Flitner +49-(0)421-218.61800; flitner@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-2-HPE Historical Political Ecology (seminar: 2 hpw)
Compulsory / Elective	Mandatory
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the second semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 28 h seminar participation ▪ 70 h self-revision of seminar and additional complementary reading ▪ 82 h preparation of oral presentation and essay
Requirements for participation	None
Frequency of module	Annual (summer term)
Language	English

Learning Outcome	The students will ▪ gain knowledge about key approaches and topics in political ecology and ▪ basic knowledge about major theoretical traditions in human, cultural and political ecology; ▪ make exemplary practical experience in historical political ecology research and ▪ develop critical awareness of the theoretical and methodological challenges in carrying out historical studies in political ecology or closely related fields.
Contents	▪ Text-centred course focussing on classical publications as well as on recent developments in historical political ecology ▪ Theoretical and methodological issues in historical studies of environmental problems in the social sciences ▪ Exemplary library or archival work regarding regional issues of historical political ecology
Study and examination achievements, **Forms of examination**	Oral presentation of self-revised materials during seminar, written essay
References	▪ Biersack, A., (ed.), 2006. Reimagining political ecology. Duke University Press. ▪ Offen, K.H., 2004. Historical political ecology: an introduction. Historical Geography 32, 19-42. ▪ Peet, R., Robbins, P., Watts, M.J., (eds.), 2011. Global Political Ecology. Routledge. ▪ Robbins, P., 2012. Political ecology: a critical introduction. 2nd ed. Wiley-Blackwell.

Module descriptions

Individualisation phase (third semester – winter term)

Name of the module **Acronym**	**Internship** **08-PG-3-INS**
Module coordinator	Michael Thiele +49-(0)421-218.67001; thiele@uni-bremen.de
Teaching staff	Organisation of the colloquium by the module coordinator Evaluation of reports: Teaching staff of the M. Sc. programme
Related courses, teaching format and hours per week (hpw)	Colloquium
Compulsory / Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	8 weeks during the summer break before the third semester or during the third semester. In the latter case it should be combined with the module "Research Process II". The internship can also be carried out earlier, e.g. before starting the M. Sc. programme. It is recommended to complete the internship before the end of the third semester.
Workload/ **Calculation of** **Credit points (CP)**	12 CP (360 hours) ▪ equivalent to 8 weeks full time work (320 hours) ▪ preparation of written report and presentation in colloquium (40 hours)
Requirements for participation	None
Frequency of module	Annual

Language	English
Learning Outcome	Students should be able to: ▪ Broaden their understanding of the possible range of employment opportunities, ▪ Help to choose their best possible career path, ▪ Reflect on the tasks and personal development experienced during the internship, ▪ Summarize their experiences in a reflective final report, ▪ Critically assess their personal and professional development, ▪ Articulate a deepened knowledge of transferable skills and their applicability in both academic and workplace settings.
Contents	Internships provide students with a structured introduction to the contexts of professional practice. Emphasis is placed on the identification and negotiation of learning objectives, activities and outcomes in relation to a professional context. Students are required to find a suitable position, complete eight weeks of work and prepare and present their experience to their supervisors and peers.
Study and examination achievements, **Forms of examination**	Module exam (one mark): ▪ Written final report, ca. 10 pages (50%) ▪ Oral and/or poster presentation, ca. 20 minutes (50%)
References	For detailed rules refer to the official “Internship Regulations” (Praktikumsordnung) to the M. Sc. in “Physical Geography: Environmental History”

Name of the module Acronym	Marine Environmental Archives: Methods 05-MAR-1-C2
Module coordinator	Dr. Torsten Bickert +49-(0)421-218.65535; tbickert@marum.de Prof. Dr. Tilo von Dobeneck +49-(0)421-218.65310; dobeneck@uni-bremen.de
Teaching staff	Dr. Torsten Bickert +49-(0)421-218.65535; tbickert@marum.de Prof. Dr. Tilo von Dobeneck +49-(0)421-218.65310; dobeneck@uni-bremen.de Dr. Stefan Mulitza +49-(0)421-218.65536; smulitza@uni-bremen.de Dr. Enno Schefuß +49-(0)421-218.65526; schefuss@uni-bremen.de Dr. Matthias Zabel +49-(0)421-218.65103; mzabel@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	05-MAR-1-C2-1 Marine Ecosystems as Environmental Indicators (lecture, exercise: 1 hpw) 05-MAR-1-C2-2 Environmental Magnetism (lecture, exercise, seminar: 1 hpw) 05-MAR-1-C2-3 Terrigenous Signals (lecture, seminar: 1 hpw) 05-MAR-1-C2-4 Stable Isotopes and Trace Elements in Palaeoenvironmental Research (lecture, exercise: 2 hpw)
Compulsory / Elective	Elective
Related to the study programme	Teaching import from the M. Sc. Marine Geosciences to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the third semester of study (winter term)
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 9 CP (270 hours): ▪ 70 h presence in lectures and practicals ▪ 50 h self-study of proxy principles and applications ▪ 55 h self-study exercises, preparation of case studies ▪ 45 h reading assignments, self-revision of lectures and additional complementary material (exercises, textbooks, etc.) ▪ 50 h study time for the final exam

Requirements for participation	▪ Undergraduate expertise in chemistry, geochemistry and marine geology is required. Additional basic understanding in biology and expertise in scientific calculation is advantageous. ▪ For this module at the Department of Geosciences we have restricted access for up to 8 students.
Frequency of module	Annual (winter term)
Language	English
Learning Outcome	The students will ▪ become familiar with proxy development and application ▪ gain an understanding of the most important processes in palaeoenvironmental change ▪ be able to apply the methods to case studies of actual research
Contents	▪ This module on marine palaeoenvironmental archives aims at introducing and applying the most important methods to describe the marine environment in the past and to understand the processes of environmental change. ▪ Proxy implementation follows the stages of proxy development, validation and application. ▪ Proxy research is strongly interdisciplinary. ▪ This module, therefore, integrates geochemical, geological, geophysical and paleontological methodologies. ▪ Stratigraphic methods are very helpful in environmental studies and therefore introduced in an extra course.
Study and examination achievements, Forms of examination	Module exam (one mark): written exam
References	Will be announced in the different courses

Name of the module Acronym	Bodenkunde (Soil Science) 08-PG-3-BOK
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Prof. Dr. Luise Giani +49-(0)441-798.3335; luise.giani@uni-oldenburg.de
Related courses, teaching format and hours per week (hpw)	08-PG-3-BOK-1 Bodenkunde (Soil Science) (lecture: 1 hpw – in German) 08-PG-3-BOK-2 Geo-ökologische Prozesse (Geoecological Processes) (lecture: 2 hpw – in German) 08-PG-3-BOK-3 System Erde – Teil: Einführung Bodenkunde (Earth System – Part: Introduction to Soil Science) (lecture: 1 hpw – in German)
Compulsory / Elective	Elective
Related to the study programme	Teaching import from the B. Sc. Umweltwissenschaften and from the M. Sc. Landschaftsökologie at the University of Oldenburg to the M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the third semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 56 h seminar ▪ 90 h self-revision of seminar and additional complementary reading ▪ 34 h oral presentation of selected topics for BOK-3
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	All lectures in German

Learning Outcome	The students will gain knowledge about ▪ fundamentals of soil sciences ▪ intensified knowledge about pedo-diversity and chemical/physical processes in soils ▪ formation, classification and distribution of major soils of the world
Contents	(BOK-1) Bodenkunde und (BOK-3) System Erde – Teil: Einführung Bodenkunde (in German) ▪ Genese von Böden Mitteleuropas und Bodenklassifikation ▪ Transformations- und Translokationsprozesse ▪ Physikalisch-chemische Prozesse in Böden (BOK-2) Geo-ökologische Prozesse (in German): ▪ Böden in Stoffkreisläufen ▪ Physikalisch-chemische Prozesse in Böden ▪ Nährstoffe und Schadstoffe ▪ Bodenschutz, Bodenbewertung, Bodensanierung ▪ Gefährdung und Schutz von Böden in unterschiedlichen Landschaften
Study and examination achievements, **Forms of examination**	Oral examination (30 minutes)
References	▪ Scheffer, F., Schachtschabel, P., 2009. Lehrbuch der Boden-kunde. Spektrum Akademischer Verlag, 16. Aufl., Stuttgart ▪ Stahr, K., Kandeler, E., Herrmann, L., Streck, T., 2008. Boden-kunde und Standortlehre – Grundwissen Bachelor. Ulmer, Stuttgart. ▪ Blum, W.E.H., 2012. Bodenkunde in Stichworten. Hirt, 8. Aufl., Stuttgart ▪ Blume, H.-P., Brümmer, G.W., Horn, R., Kandeler, E., Kögel-Knabner, E., Kretschmar, R., Stahr, K., Wilke, B.-M., 2015. Soil Science. Spektrum Akademischer Verlag, Heidelberg ▪ Schroeder, D., 1984. Soils, facts and concepts. Hirt, Stuttgart.

Name of the module Acronym	Regional Environmental History 08-PG-3-REH
Module coordinator	Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Teaching staff	Prof. Dr. Jörg Friedhelm Venzke jfvenzke@uni-bremen.de Other lecturers depend on the offered courses.
Related courses, teaching format and hours per week (hpw)	08-PG-3-REH-1 Regional Environmental History (seminar: 2 hpw, blocked) 08-PG-3-REH-2 One to three field trips (in total: 5-10 days)
Compulsory /Elective	Elective
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the third semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 6 CP (180 hours): ▪ 90 h seminar and field trips ▪ 40 h self-revision of seminar and additional complementary reading for seminar and field trips ▪ 50 h oral and written presentation of the seminar paper and protocols of field trips
Requirements for participation	No
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	The students will be introduced into the ▪ regional environmental history mainly of Northern Germany but occasionally also about other European regions and ▪ interpretation of historical, physical geographical and cartographical data.
Contents	Aspects of environmental history such as: ▪ Cultivation and protection of the tidal coastal landscapes of the Southern North Sea, ▪ Transformation of Holocene woodlands and bog landscapes by agriculture, ▪ Mining and water management as well as ▪ Industrialisation and urbanization.
Study and examination achievements, **Forms of examination**	▪ Oral and written presentation of seminar paper ▪ Written protocol of field trip(s)
References	▪ BPGre, K.-E., 2008. Landschaftsgeschichte Norddeutschlands. Umwelt und Siedlung von der Steinzeit bis zur Gegenwart. Wachholtz Verlag, Neumünster, 308 S. ▪ Blackbourn, D., 2007. Die Eroberung der Natur. Eine Geschichte der deutschen Landschaft. Deutsche Verlags-Anstalt, München, 592 S. ▪ Küster, H., 2010. Geschichte der Landschaft in Mitteleuropa. Von der Eiszeit bis zur Gegenwart. 4. Aufl., Verlag C.H. Beck, München, 424 S.

Name of the module Acronym	Research Process II 08-PG-3-RP2
Module coordinator	Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de
Teaching staff	Dr. Inga Labuhn +49-(0)421-218.67173; labuhn@uni-bremen.de Prof. Dr. Benjamin Marzeion +49-(0)421-218.67170; ben.marzeion@uni-bremen.de Dr. Christian Ohlendorf +49-(0)421-218.67153; ohlen@uni-bremen.de Prof. Dr. Bernd Zolitschka +49-(0)421-218.67150; zoli@uni-bremen.de
Related courses, teaching format and hours per week (hpw)	08-PG-3-RP2 Project (blocked seminars; 4 hpw; independent studies)
Compulsory / Elective	Compulsory
Related to the study programme	M. Sc. Physical Geography: Environmental History
Duration of module/ **Winter or summer semester**	One semester / This module is scheduled for the third semester
Workload/ **Calculation of** **Credit points (CP)**	This module is rated with 12 CP (360 hours): ▪ Conception and preparation (step 1: 40 hours until October 31st) ▪ Project work (step 2: 200 hours until January 15th) ▪ Documentation and written report (step 3: 80 hours until March 1st) ▪ Oral presentation of results (step 4: 40 hours during last week of March)
Requirements for participation	Project-specific knowledge and skills
Frequency of module	Annual (winter term)
Language	English

Learning Outcome	▪ The project trains practical skills of a professional and general research character and prepares for the master thesis. ▪ It enables the students to realize own conceptions, to acquire additional fields of competence and to establish contacts, which may improve the chances on the job market. ▪ It fosters personal initiatives and „learning by doing“, but also represents a supervised and output-oriented project documented by written reports as well as oral presentations. ▪ Students will have acquired knowledge to develop and defend a thesis proposal and to obtain a thorough understanding of methods and literature relevant to their thesis projects.
Contents	▪ The module introduces students to the processes involved in planning, developing and presenting research projects. Topics are selected in collaboration with prospective thesis advisors ▪ A large extent of independence and teamwork is expected for development and presentation of the project by every student. ▪ The project can be field or laboratory work or related to a technical development, a school or media project or a contribution to a national or international scientific investigation. ▪ Team projects with well-defined task sharing are favoured. ▪ Techniques of scientific inquiry and sound scientific conduct are communicated and discussed. <u>Conception and preparation (step 1):</u> ▪ An introduction to the module is scheduled for the Orientation Week in early October. Step 1 is carried out until the end of October. ▪ Students develop a concept for their project work. ▪ The scientific state-of-the-art and the conception of the chosen subject is based on current topics in the geosciences. ▪ Discussed and developed are: scientific rationale, research questions, hypotheses, methodological approach and work plan for the proposed study. ▪ Step 1 ends with a written exposé including scientific rationale and research questions or hypotheses which is presented to the advisor until October 31st. <u>Project work (step 2):</u> ▪ During the practical part of the project students apply their knowledge gained during the preceding two semesters and exercise their skills with a high degree of self-responsibility. ▪ Step 2 ends with an updated and revised exposé handed in to the project advisor until January 15th. <u>Documentation and written report (step 3):</u> ▪ Finally, step 1 and 2 are combined as a written report including a scientific discussion in context with the state-of-the-art and an outlook. ▪ The written report (due March 1st) should be written in the form of a scientific publication and submitted to the advisor. <u>Oral presentation of results (step 4):</u> ▪ In the last week of March, an oral presentation of results is given during a blocked seminar in the presence of all fellow students and the advisor.

Study and examination achievements, Forms of examination	Module exam (combined marks): ▪ Exposé (work required) ▪ Revised exposé (15 %) ▪ Written project report (50 %) ▪ Oral presentation (35 %)
References	Case-dependent - will be provided by the teaching staff