Module description „Master Biogeoscience of the Anthropocene“

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Module **MBGSA101** Interdisciplinary Work in the Biogeoscience of the Anthropocene	
Module Code	MBGSA101
Module title (German)	Interdisciplinary Work in the Biogeoscience of the Anthropocene
Module title (English)	Interdisciplinary Work in the Biogeoscience of the Anthropocene
Module Coordinator	Dr. Dirk Merten
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	seminar (2 SWS, block course during first week), seminar (1 SWS, every 2. week), colloquium (1 SWS, every 2. week), reflection seminar (2hrs in the last lecture week) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	The module starts with an introductory week giving insight into Jena and the Friedrich-Schiller-University as the place of study, additionally covering oral presentations of the students about the contents and applied methods of their Bachelor thesis. The lecture series “Perspectives of Biogeosciences of the Anthropocene” comprises talks of internal expert lecturers in the field of Biogeosciences in the Anthropocene introducing their research and possible fields of specialization. The BioGeoColloquium covers talks of external researchers working in the cutting area of Biology, Geosciences and Chemistry. The module is concluded by a reflection seminar at the end of the lecture period.

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Intended learning outcomes	Upon successful completion of the module, students will have strengthened their scientific and communication skills. They will have gained a clear understanding of the goals and structure of the study program as well as potential fields of specialization. They will have acquired in-depth knowledge of current research topics at the intersection of Biology, Geosciences, and Chemistry, with a particular focus on Biogeosciences in the Anthropocene. By engaging with lectures from internal and external experts, they will have developed a broader perspective on different methodological approaches and application areas. They will have practiced scientific discussions, critically reflected on various research approaches and applied their acquired knowledge to their own research projects. Additionally, they will have enhanced their presentation skills through talks about their Bachelor's theses and gained insights into the academic culture of Friedrich Schiller University Jena.
Prerequisites for assessment	Regular attendance is mandatory to achieve the intended learning outcomes
Requirements for awarding credit points (type of examination)	Written and/or oral test (100 %). Type and scope will be announced at the beginning of the course. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA102** Scientific Work & Scientific Conduct	
Module Code	MBGSA102
Module title (German)	Scientific Work & Scientific Conduct
Module title (English)	Scientific Work & Scientific Conduct
Module Coordinator	Prof. Dr. Kai Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), exercises (1 SWS), skill adaption (1 SWS)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	Students are familiarized with the advanced skills and ethical principles of scientific work to develop a deep understanding of the processes, methods, and ethical aspects of research in environmental sciences. The module is composed of two parts: (1) skills assessment and harmonization, (2) and scientific work and conduct. In part 1, the individual study- and subject-relevant skills and competencies are determined and harmonized within an individually tailored program composed of methodological, practical, and theoretical learning units taught by experts from the relevant fields. Part 2 is devoted to the theoretical foundations and paradigms of environmental sciences, excursing into historical and philosophical perspectives, and on the ethical dimension of science. Topics covered include the importance of scientific integrity, data handling, plagiarism, intellectual property rights, and the writing of ethical applications. The introduction to basic scientific work techniques and methods includes literature research, e-science, sampling and experimental design, data analysis and management, modelling, and scientific writing. Practical exercises and teamwork support the acquisition

	of skills in applying scientific working methods and promote critical thinking.
Intended learning outcomes	Upon successful completion of the module, students will be able to apply advanced scientific methods in environmental sciences and conduct independent research while upholding high scientific and ethical standards. They will have developed a critical understanding of research ethics, including scientific integrity, data handling, and intellectual property. Additionally, they will be proficient in essential scientific techniques such as literature research, e-science, experimental design, data analysis, modeling, and scientific writing. Through practical exercises and teamwork, they will have strengthened their analytical and critical thinking skills, enabling them to apply scientific methods effectively in research settings.
Prerequisites for assessment	Regular attendance is mandatory to achieve the intended learning outcomes
Requirements for awarding credit points (type of examination)	Written exam (100%). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	This module is aimed at master's students in environmental sciences who are preparing for a career in research, industry, or the public sector. Combining theoretical foundations, practical exercises, and ethical reflection, it offers a holistic view of the challenges and responsibilities in the environmental sciences.
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA103** Geomicrobiology and Global Change	
Module Code	MBGSA103
Module title (German)	Geomicrobiology and Global Change
Module title (English)	Geomicrobiology and Global Change
Module Coordinator	Prof. Dr Kirsten Küsel
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: MBGSA204
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	Lecture Geomicrobiology (2 SWS), Seminar Microbial Responses to Global Change (2 SWS)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	This module explores the fundamental role of microbes in shaping Earth's geochemical cycles, from the origins of life to their present-day impact on planetary processes. The Geomicrobiology lecture provides insights into microbial evolution, biomineralization, deep subsurface life, and the role of microbes in key element cycles, including iron cycling and electrochemical processes. The Microbial Responses to Global Change seminar focuses on microbial contributions to greenhouse gas fluxes, genetic adaptability to environmental stressors, and feedback mechanisms in the context of anthropogenic change.
Intended learning outcomes	Upon successful completion of the module, students will, through interdisciplinary discussions and case studies, gain a comprehensive understanding of microbial functions in Earth system dynamics and their relevance in a rapidly changing world. They will develop the ability to analyze microbial contributions to geochemical cycles, greenhouse gas fluxes, and environmental feedback

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	mechanisms, enhancing their critical thinking and scientific assessment skills.
Prerequisites for assessment	Literature search, preparation of a seminar talk
Requirements for awarding credit points (type of examination)	Written exam (50 %), oral presentation (50 %). All partial examinations must be graded at least 'sufficient'. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	The selection of subjects for the seminar talks is presented in the first meeting.
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA104** Element-Microbe Dynamics in the Soil-Plant-System	
Module Code	MBGSA104
Module title (German)	Element dynamics in the Soil-Microbe-Plant-System
Module title (English)	Element dynamics in the Soil-Microbe-Plant-System
Module Coordinator	Prof. Dr Erika Kothe
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), seminar (2 SWS)
ECTS credits	5
Work load (in hours): • Classes • independent study	150 h 60 h 90 h
Module content	The role of interfaces (minerals, organic matter or biological surfaces) and their characteristics are a key to understanding element dynamics in natural systems. The lectures will give the fundamentals to these surfaces, their stability and dynamics controlling attachment and/or release of elements (nutrients & toxic elements). This knowledge is the basis to the mechanistic understanding of the interaction and the design of successful remediation strategies. The seminar combines talks of guest speakers that show different potential applications and their relevance on the job market connected to "Element dynamics in the Soil-Microbe-Plant-System" with talks on chosen subjects from the participants.
Intended learning outcomes	Upon successful completion of the module, students will understand the interconnectedness of soil, water, and biological components in element cycles within terrestrial systems, including contaminated environments. They will be able to analyze surface interactions that influence element mobility and stability, forming the basis for remediation strategies. Guest lectures will provide insights

	into potential career paths related to element dynamics in the Soil-Microbe-Plant-System.
Prerequisites for assessment	Selection, literature search, and preparation of a seminar talk
Requirements for awarding credit points (type of examination)	Oral presentation (100 %). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	The selection of subjects for the seminar talks is presented in the first meeting. The students' seminar talks are presented in the second half of the semester.
Recommended reading list	none
Language of instruction	English

Module **MBGSA105** Fluid Flow and Reactive Transport I: Physicochemical Aspects of Transport and Flow Modeling	
Module Code	MBGSA105
Module title (German)	Fluid-Flow and Reactive Transport I: Physicochemical Aspects of Transport and Flow Modeling
Module title (English)	Fluid-Flow and Reactive Transport I: Physicochemical Aspects of Transport and Flow Modeling
Module Coordinator	Prof. Dr. Kai Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: MBGSA206
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	Lecture (4 SWS): Physicochemical Aspects of Reactive Transport exercises (2 SWS): Modeling flow through permeable media
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 90 h 60 h
Module content	The phenomena of mass transport in natural permeable systems are introduced. Types, characteristics and properties of natural permeable systems, e.g., soils, sediments, rocks, and aquifers are presented. Processes and interactions of dissolved and colloidally dispersed substances are also explored with a view to mathematical modeling. Key process properties such as nonlinearity and rate limitation, as well as properties of naturally permeable media such as heterogeneity, variability, and diversity, are discussed in a problem-oriented manner. The fundamentals and most important techniques of mathematical modeling of flow processes of incompressible fluids, with a particular focus on water in natural permeable media, are developed.

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Intended learning outcomes	Upon successful completion of the module, students will understand the core physicochemical principles of mobile dissolved and colloidal substances in permeable media. They will acquire advanced knowledge of the phenomena, processes, and mechanisms that control the dispersion and fate of dissolved, colloidally dispersed, or particulate suspended substances in water-saturated, porous media. Additionally, students will be adept at using mathematical and numerical tools for modeling fluid flow, making them capable of quantitatively describing flow in natural, permeable systems, whether fully or partially saturated. Students will achieve mastery in utilizing modeling as a tool for planning and forecasting, enabling them to precisely quantify fluid dynamics in natural systems that are either fully or partially permeable.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Written exam (100%). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	Will be given at the beginning of course.
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA106** Conservation Palaeobiology	
Module Code	MBGSA106
Module title (German)	Conservation Palaeobiology
Module title (English)	Conservation Palaeobiology
Module Coordinator	Apl. Prof. Dr. Peter Frenzel
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	Lecture (2 SWS), exercises (2 SWS) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	Using the knowledge and methods of palaeontology to protect and restore biodiversity and ecosystem services: Effects of climate and environmental change on species, communities and ecosystems. Extinction risks. Distinguishing natural and anthropogenic environmental changes. Reconstruction of the palaeoenvironment and natural reference states. Ecological assessment of habitats. Systemic and art-based future scenarios. Geoarchaeological aspects.
Intended learning outcomes	Upon successful completion of this module, students will have developed a thorough understanding of long-term environmental changes and processes. They will be capable of distinguishing between changes in the environment that occur naturally and those that result from human activities. Additionally, they will have acquired the skills necessary to conduct simple paleoenvironmental analyses using fossils, underpinned by a basic knowledge of paleoecology. Furthermore, students will be equipped to apply their acquired

	knowledge, insights, and problem-solving skills to new and unfamiliar challenges within the fields of paleontology, geosciences, and biology. This capability extends to a broader context, enabling them to effectively navigate and contribute to multidisciplinary projects and studies.
Prerequisites for assessment	Regular attendance of exercises.
Requirements for awarding credit points (type of examination)	Oral exam (100 %). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Louys, Julien. (2012). Paleontology in ecology and conservation. Springer. Bottjer, D. J. (2016). Paleoecology: past, present and future. John Wiley & Sons. Smol, J. P. et al. (eds.) (2001): Tracking Environmental Change Using Lake Sediments. Springer. Weckström et al. (eds) (2017) Applications of Paleoenvironmental Techniques in Estuarine Studies. Springer.
Language of instruction	English

Module **MBGSA107** Terrestrial Microbiology	
Module Code	MBGSA107
Module title (German)	Terrestrial Microbiology
Module title (English)	Terrestrial Microbiology
Module Coordinator	Prof. Dr. Erika Kothe
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	Practical course (5 SWS)
ECTS credits	5
Work load (in hours): • Classes • independent study	150 h 75 h 75 h
Module content	Isolation and identification of soil microbes is essential to understand physiological processes and interactions between microbes, hosts and environment. Thus, techniques in soil microbiology and modern methods of genomics are introduced and working with genetically modified organisms will be learned. The protocol is written in the format of a journal article to gain essential knowledge.
Intended learning outcomes	Upon successful completion of the module, the students gain knowledge in identification of microbes, assessing their physiological properties and learn molecular biology techniques. Regulations for working with GMOs are introduced, and writing a scientific contribution is conveyed.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Protocol (100 %). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.

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Additional information on the module	Will be given at the beginning of the module.
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA108** Biomineralogy	
Module Code	MBGSA108
Module title (German)	Biomineralogy
Module title (English)	Biomineralogy
Module Coordinator	Prof. Dr. Juraj Majzlan
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), exercises (2 SWS), 0.5 day field trip (SWS stands for hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 65 h 85 h
Module content	This module introduces the keystones and key concepts of geochemistry and mineralogy, including the description and identification of the minerals and rocks with greatest relevance to the field of biogeosciences. Topics included will be chemical and mineralogical composition of rocks, including trace elements and isotopes, accumulation and dispersion of elements in the crust and in the environment, and cycling of the material on Earth, both natural and anthropogenic. Selected aspects of biomineralogy, including biologically induced weathering of minerals, biologically driven mineral formation and transformation, biologically controlled mineralization, pathogenic mineralogy, mineralogy of soils, and clay mineralogy will be used to deepen the knowledge of mineralogy and geochemistry.
Intended learning outcomes	Upon successful completion of the module, the students will be able to identify and describe common minerals and rocks. They will understand their formation and

	transformation, both abiotic and biologically-driven, and distinguish the principal features of those two cases. They will be able to comprehend the basics of the literature that deals with mineralogical aspects of biogeosciences and express this information in their own writing. The students will realize the common features of biominerals in both induced and controlled biomineralization. They will learn the most abundant examples of biominerals and their chemical and physical relationship to the abiotic nature.
Prerequisites for assessment	Acceptable term paper and participation in the field trip.
Requirements for awarding credit points (type of examination)	Written exam (75 %), term paper (25 %). All partial examinations must be graded at least 'sufficient'. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA109** The Anthropocene – Historical Perspectives and Earth System Dynamics	
Module Code	MBGSA109
Module title (German)	The Anthropocene – Historical Perspectives and Earth System Dynamics
Module title (English)	The Anthropocene – Historical Perspectives and Earth System Dynamics
Module Coordinator	Prof. Dr. Ricarda Winkelmann, MPI GA
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), seminar (2 SWS), Excursion (1day) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 75 h 75 h
Module content	This interdisciplinary module explores the scientific, historical, and socio-ecological dimensions of the Anthropocene – the proposed geological epoch characterised by significant human impact on Earth's geology and ecosystems. Drawing on the specialised expertise of the teaching team, the module provides master's students with advanced knowledge of the historical development of the Anthropocene concept, the emergence and dynamics of the technosphere, transformations in land use and urbanisation patterns, and critical climate tipping points that define our current epoch. Topics include the origins and evolution of the Anthropocene concept, stratigraphic markers, and key debates around periodisation. The technosphere is

	examined in terms of its material structure, energy flows, and interactions with the biosphere. The module also addresses historical and contemporary patterns of land-use change, urbanisation as a biogeochemical force, and the ecological implications of urban systems. It concludes with an exploration of major climate tipping points, their early warning signals, and consequences for ecosystems.
Intended learning outcomes	Upon successful completion of this module, students will be able to: - Critically evaluate the historical development of the Anthropocene concept and its scientific validity and Critical analysis of a specific aspect of Anthropocene biogeosciences (Research paper) - Collaborative investigation of an Anthropocene-related phenomenon (Group project) - Analyze the technosphere as a defining element of the Anthropocene and its interactions with Earth systems and communicate the research results and findings to peers (Presentation) - Assess the complex dynamics of land-use change and urbanization processes as key anthropogenic drivers and understand and evaluate climate tipping points and their significance for Earth system stability (Participation in discussions and activities, Group project, research paper and presentation)
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Research paper (40%), Group project (30%), presentation (30%). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MGEO304** Cosmochemistry and Planetology	
Module Code	MGEO304
Module title (German)	Cosmochemistry and Planetology
Module title (English)	Cosmochemistry and Planetology
Module Coordinator	Prof. Dr. Falko Langenhorst, Dr. habil. Alexey Potapov
Prerequisite modules	039 M.Sc Geowissenschaften: none xxx M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	039 M.Sc Geowissenschaften: none xxx M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	039 M.Sc Geowissenschaften: Module of the study direction „Mineralogie“ in the elective module catalogue „Geowissenschaftliche Spezialisierung”. xxx M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	039 M.Sc Geowissenschaften: required elective module xxx M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 Semester
Components/Types of courses	Lecture/exercise (2 SWS), Seminar (1 SWS), Field Work (3 days à 8 hours)
ECTS credits	6 LP
Work load (in hours): • Classes • Independent study	180 h 70 h 110 h
Module content	History of the molecular universe; environmental conditions and key chemical processes in space; main laboratory astro-chemistry techniques; chemistries in specific cosmic environments; exogeneous hypothesis of the origin of life on Earth; formation of the Solar System, the planets, their moons, asteroids, and comets; geological-mineralogical properties and development of small planetary bodies and terrestrial planets;

	high-speed impacts on planets and geology of impact craters; mineralogy and petrology of meteorites and impact rocks.
Intended learning outcomes	Upon successful completion of the module, students will learn the history of the universe from the Big Bang to the formation of Earth. They will acquire knowledge on the environmental conditions and physico-chemical processes in various astrophysical environments, (exo)planet atmospheres, and the Solar System. They will learn the basic identification features for recognizing and understanding the significance of meteorites and impact rocks/structures. They will acquire in-depth knowledge in the field of the formation and development of planetary systems in the cosmos and can place the unique development of the Earth in this context. From this large-scale perspective, students can assess the formation of plate tectonics, the hydrosphere and life, as well as the habitability of the Earth and the threat posed by impact events. Overall, students deepen their understanding of the interactions of global processes on large length and time scales.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Semester-related work (100%): field work report, presentation, oral examination. The scope and type of semester-related work will be announced at the beginning of the module. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	Regular attendance of the lectures and seminars is strongly recommended in order to successfully pass the module examination.
Recommended reading list	A. Tielens, The Physics and Chemistry of the Interstellar Medium, Cambridge University Press, 2005, 495 p.; H. J. Melosh, Planetary Surface Processes, Cambridge University Press, 2011, 500p.; H. Y. McSween & G. R. Huss, Cosmochemistry, Cambridge University Press, 2010, 549 p.; H. Y. McSween, Meteorites and Their Parent Planets, Cambridge University Press, 1999, 310 p.
Language of instruction	English

Module **MBGSA201** Biogeoscientific Field Exercise	
Module Code	MBGSA201
Module title (German)	Biogeoscientific Field Exercise
Module title (English)	Biogeoscientific Field Exercise
Module Coordinator	Prof. Dr. Kai Uwe Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	seminar (2 SWS), 5 days field excersise
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 80 h 70 h
Module content	The interdisciplinary field course is conducted at various long-term exploration sites belonging to the disciplines involved in the program. Students gain practical experience in complementary biogeoscientific field techniques related to a specific scientific question and in the practical application of these techniques in the field. The research question and the steps for addressing it (objectives, planning, implementation requirements, necessary techniques, and evaluation) are developed in the accompanying seminar in all aspects. Students are familiarized with various practical field methods for probing, exploration, and sampling (soil, rock, water, organisms), including core drilling, continuous observation, and drone- and app-based close-range exploration. Students practice practical skills in collecting complementary data in the field, which are then integrated into the accompanying exercises. If necessary, materials will be examined in supplementary laboratory tests using instrumental analytical techniques (advanced module).

	The results will be presented and critically discussed in seminar lectures.
Intended learning outcomes	Upon successful completion of the module, students will become proficient in interdisciplinary biogeoscientific methods, learning to collect, analyze, and critically evaluate data in relation to specific scientific questions. They will also develop the ability to effectively communicate their findings within the scientific community. Collaboration on research projects will enhance their social and leadership skills, preparing them to thrive in both scientific research and team-based environments.
Prerequisites for assessment	Participation in the seminar and field exercises.
Requirements for awarding credit points (type of examination)	Oral presentation in seminar (60 %); oral presentation of results during field excercise, group effort (40%). All partial examinations must be graded at least 'sufficient'. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA202** Envirometrics and Applied Geostatistics: Quantifying Environmental Change	
Module Code	MBGSA202
Module title (German)	Envirometrics and Applied Geostatistics: Quantifying Environmental Change
Module title (English)	Envirometrics and Applied Geostatistics: Quantifying Environmental Change
Module Coordinator	Prof. Dr. Anke Hildebrandt
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (1,5 SWS) Envirometrics: quantifying change lecture (1,5 SWS) Applied Geostatistics practical exercises (1,5 SWS) colloquium (1 SWS; 2 h every 2. week)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 83 h 67 h
Module content	Introduction to Geostatistics. Point-measured data as a starting point for spatial interpolation. Statistical methods for characterizing spatially correlated data (correlation functions, variograms, etc.). Spatial correlations utilized for statistical interpolation methods – the Kriging method. In the exercises, data sets are spatially interpolated using both non-statistical and the statistical interpolation method Kriging. The results are compared with the results of non-statistical interpolation methods. Introduction to envirometrics. Properties of natural systems: Variability – Heterogeneity – Diversity. Properties of natural processes and states: Nonlinearity – Non-equilibrium – Transient states. Mathematical foundations of statistics. Hypothesis formation.

	Fundamentals of experimental design and analysis. Descriptive and inferential statistics. Data representation. Meaning of the normal distribution. Distributions/test distributions. Data preparation and transformation. Outlier and extreme value analysis. Error calculation and error propagation. Test procedures. Correlation and regression. Introduction to time series analysis. The BioGeoColloquium covers talks of external researchers working in the cutting area of Biology, Geosciences and Chemistry.
Intended learning outcomes	Upon successful completion of the module, students will develop a solid foundation in the mathematical principles underlying geostatistics, gaining the capability to apply these methods to real-world case studies. They will acquire methodological skills essential for designing, executing, and interpreting investigations and experiments on environmental subjects, both in the lab and the field, with a rigorous and systematic mathematical approach. The course will also focus on enhancing students' understanding of the unique features of natural systems and environmental segments, along with sharpening their ability to manage and analyze measurement uncertainties. Colloquium: The students get aware of and strengthen their scientific and communicational skills. They get deep insights into research in the cutting area of Biology, Geosciences and Chemistry, practise scientific discussions and can transfer the gained knowledge to research projects they are involved in.
Prerequisites for assessment	Regular attendance in the colloquium is mandatory to achieve the intended learning outcomes.
Requirements for awarding credit points (type of examination)	Written exam (100 %). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA203** Radio- and Chemotoxic Elements in the Environment	
Module Code	MBGSA203
Module title (German)	Radio- and Chemotoxic Elements in the Environment
Module title (English)	Radio- and Chemotoxic Elements in the Environment
Module Coordinator	Prof. Dr. Thorsten Schäfer
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), 3 days field training (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 54 h 96 h
Module content	This module is designed to teach students the theoretical and practical aspects of environmental geology. The module provides an interdisciplinary overview of the protection and use of natural resources and the careful handling of waste including disposal options. The water/water constituents interaction with organic and inorganic surfaces (soil and rocks) and the aspect of microbiology is examined and measures for assessment and, if necessary, remediation are dealt with. In particular, the focus is on assessing the hazard potential of radiotoxic waste disposal. Natural radioisotopes (NORM) and their distribution; fundamentals of the nuclear cycle; waste sources of low, medium and high-level radioactive waste; interim storage and disposal options. Behaviour of radioactive waste under final disposal conditions; basics of the chemical behaviour of radionuclides. Fundamentals of radiochemical analysis methods. Overview of substances hazardous to water and their toxic effects with a special focus on radioactive substances and radiation protection aspects.
Intended learning outcomes	Upon successful completion of this module:

	- Students gain an in-depth understanding of the physical and chemical principles of environmental geology. - They will be able to explain the most important geochemical processes in low-permeability systems (clay, granite) and their groundwater/pore water. - Students understand the relationships between hydrogeochemical boundary conditions and the mobility of radio- and chemotoxic pollutants in low-permeability systems including microbial aspects. - Students know the structure and effect of geochemical barriers and understand the basics of the hydrogeochemistry of the technosphere. They can analyze the suitability of various multi-barrier systems for isolating chemo- and radiotoxic materials for geological formations (host rocks). - Students know and understand waste streams, categories, environmental hazard potentials and disposal options for nuclear residues. - Students will be able to describe the safety-relevant characteristics of low, medium and high-level radioactive waste with regard to their behaviour in interim storage facilities and repositories.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Written exam (66%), report for one excursion topic (34 %) All partial examinations must be graded at least 'sufficient'. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA204** Metaomics in action: From Data to Discovery	
Module Code	MBGSA204
Module title (German)	Metaomics in Action: From Data to Discovery
Module title (English)	Metaomics in Action: From Data to Discovery
Module Coordinator	Prof. Dr. Kirsten Küsel
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: MBGSA103
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	Lecture (2 SWS), exercise (2 SWS)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	This module provides students with a comprehensive introduction to metaomics technologies and their application in studying microbial communities from environmental samples. The course integrates metagenomics, metatranscriptomics, metaproteomics, and metabolomics to unravel microbial diversity, functional potential, and metabolic activity in response to environmental change. Through a series of focused lectures, students will gain an overview of the latest sequencing and bioinformatics approaches used to study microbial communities and their dynamics. Following this theoretical foundation, students will engage in hands-on data analysis, working with real-world metaomics datasets in a small independent project.
Intended learning outcomes	Upon successful completion of this module, students will gain hands-on experience in big data processing, visualization, and interpretation using modern bioinformatics workflows. By the end of the module, participants will be equipped with essential skills in multi-

	omics analysis, enabling them to address fundamental questions in microbial ecology and global change biology. Through practical exercises, students uniquely develop essential bioinformatics and data analysis competencies, vital for tackling real-world environmental and microbial ecology challenges.
Prerequisites for assessment	Regular attendance in exercises.
Requirements for awarding credit points (type of examination)	Term paper (100 %) The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA205** Global Biogeochemical Cycles and Climate Change	
Module Code	MBGSA205
Module title (German)	Global Biogeochemical cycles and Climate Change
Module title (English)	Global Biogeochemical cycles and Climate Change
Module Coordinator	Prof. Dr. Söhnke Zaehle, Director MPI BGC
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), seminar (1 SWS), exercises (1 SWS) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	Biogeochemistry is the study of how the elements essential to life are distributed among the components of the Earth system - atmosphere, biosphere, lithosphere, land, and oceans. The lecture introduces these basic 'spheres' of the earth and provides an in-depth overview of the global material cycles. The connection and interrelationship of the material cycles (of carbon, oxygen, nitrogen, sulphur and phosphorus in particular) with the water and energy cycles of the energy cycle of the earth system are presented. The essential physical, chemical and biological conversion processes, as well as the main sources and sinks are discussed. The lecture focusses on biogeochemical cycles in the face of ongoing global environmental change and the recognition that they are linked to past and current climate change. Selected aspects are presented in the accompanying seminar by the students as part of a keynote speech and discussed in the discussed in plenary.

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Intended learning outcomes	Upon successful completion of the module, students will understand the complex interrelationships of global material cycles and global energy flow and can assess the influence of humans on these interrelationships. They are able to critically and competently deal with the complex problems of global change. They are able to write a topic-orientated written work and present well-founded opinions on the topic the public.
Prerequisites for assessment	Literature search and seminar talk
Requirements for awarding credit points (type of examination)	Written exam, e. g. paper or other (100 %) The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA206** Fluid-Flow and Reactive Transport II: Biological Aspects and Transport Modelling	
Module Code	MBGSA206
Module title (German)	Fluid Flow and Reactive Transport II: Biological Aspects and Transport Modelling
Module title (English)	Fluid Flow and Reactive Transport II: Biological Aspects and Transport Modelling
Module Coordinator	Prof. Dr. Kai Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: MGBSA105
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS) Biological aspects of transport; lecture (2 SWS) transport modelling; exercises (1 SWS) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 75 h 75 h
Module content	The most important processes of mass transport are presented. Biological phenomena, processes, and their properties, as well as modeling, are discussed. Biological processes such as transformation, formation, and decomposition/degradation, as well as interactions of dissolved and colloidally dispersed substances with organisms, are examined with a view to modeling. The essential techniques for mathematical modeling of transport processes, taking biological processes in porous media into account, are presented.
Intended learning outcomes	Upon successful completion of the module, students understand biological processes of reactive transport of mobile dissolved and colloidal substances in permeable

	media and can explain and differentiate these processes. They can classify and evaluate phenomena, processes, and mechanisms that control the dispersion and fate of dissolved, colloidally dispersed, or particulate suspended substances in water-(partially) saturated porous media. They can apply mathematical tools for transport modeling and capable to independently model transport in (partially) saturated permeable natural systems.
Prerequisites for assessment	Regular attendance at the exercises.
Requirements for awarding credit points (type of examination)	Written exam (100 %) The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA207** Thermodynamics and Kinetics of Natural Systems	
Module Code	MBGSA207
Module title (German)	Thermodynamics and Kinetics of Natural Systems
Module title (English)	Thermodynamics and Kinetics of Natural Systems
Module Coordinator	Prof. Dr. Juraj Majzlan
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (2 SWS), exercises (2 SWS) (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	Introduction in thermodynamics and kinetics of natural, low-temperature systems. Definition of thermodynamic functions of pure substances and solutions, especially of aqueous nature. Application of the concepts for prediction of reaction directions and construction of phase diagrams. Simple geochemical simulations in computer. Definition and characteristic properties of natural porous systems, such as nonlinearity, physicochemical and structural heterogeneity, hysteresis, diversity, spatial structure. Connection between non-equilibrium, dynamic boundary conditions and transient states. Consequences for the extent and speed of interactions and reactions in natural systems. Introduction to the kinetics of natural, especially porous systems (soils, aquifers, sediments) for biogeoscientists. Definition and characteristic properties of natural systems, e.g., nonlinearity, heterogeneity, hysteresis, diversity, spatial structure. Differentiation of technical systems. Examples of natural porous systems. Structural

	causes and exogenous factors of rate limitation. Physicochemical and structural variability and heterogeneity. Relationship between nonequilibrium, dynamic boundary conditions, and transient states. Consequences for the extent and rate of interactions and reactions in natural systems. Interaction and interdependence of physical, chemical, and biological processes.
Intended learning outcomes	Upon successful completion of the module, students will be able to understand and apply basic concepts of geochemical thermodynamics and kinetics in low-temperature aqueous systems, as opposed to technical systems. They should grasp the fundamental importance of physical chemistry for understanding and describing the direction, rate, and extent of reactions and interactions in natural systems. They will perceive the available numerical data from a critical perspective and strive to comprehend their accuracy and precision. Students will be sensitized to the special features and specific characteristics of natural, particularly porous, systems as distinct from technical systems. Students will understand the fundamental importance of physical chemistry for understanding and describing the rate and extent of biochemical and physicochemical reactions and interactions in natural porous systems and will hone their theoretical and methodological skills in understanding the consequences of these properties.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Written exam (100 %). The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA208** Geobiology of Wadden Sea	
Module Code	MBGSA208
Module title (German)	Geobiology of Wadden Sea
Module title (English)	Geobiology of Wadden Sea
Module Coordinator	Prof. Dr. Falko Langenhorst
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	Lecture/exercise/seminar (2 SWS), Field Work (5 days à 8 hours)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 70 h 80 h
Module content	Introduction to coastal hydrography, protection and tides of the North Sea; quaternary geology and geoarcheology at the coast of North Germany; ecosystem and climate of the Wadden sea, and the effects of climate change and environmental pollution on biodiversity and appearance of new species.
Intended learning outcomes	Upon successful completion of the module, students will have a thorough understanding of the formation and development of the Wadden Sea, as well as its current hydrological, geological, biological, and climatic conditions, and potential future scenarios. They will be able to analyze the complex interactions between physical and biological processes within the Wadden Sea and comprehend the sensitivity of this habitat to climate change and other anthropogenic influences.
Prerequisites for assessment	none

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Requirements for awarding credit points (type of examination)	Oral presentation and field work report (100 %). All partial examinations must be graded at least ‘sufficient’. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA209** Weathering, Pedogenesis and Ecosystem Change in the Anthropocene	
Module Code	MBGSA209
Module title (German)	Weathering, Pedogenesis and Ecosystem Change in the Anthropocene
Module title (English)	Weathering, Pedogenesis and Ecosystem Change in the Anthropocene
Module Coordinator	Prof. Dr. Kai Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 semester
Components/Types of courses	lecture (3 SWS), field exercise (1 SWS) - 2 days field exercise (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h 60 h 90 h
Module content	Presentation and introduction of the concept of the "critical zone." Description and derivation of the essential significance of this zone for humans, society, and the economy. Global and regional transformational change and climate change. Processes and factors of weathering and soil formation. Process areas of weathering and mineral regeneration and formation, humus and microstructure formation. Soils as a component of terrestrial ecosystems and anthropogenically influenced landscapes. Soil types and soil forms. Soil development sequences and their significance for climate impact assessment. Consequences of climate and transformational change for processes and factors of weathering and soil formation. Aspects of adaptation to and mitigation of the unavoidable consequences of transformational change and climate change.

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Intended learning outcomes	Upon successful completion of the module, students will be able to explore the relationship between weathering factors, regolith, saprolite, and soil formation within a regional context, and document the formation of soil profiles resulting from the interaction of soil formation factors. They will be capable of assessing the impacts of climate change on weathering, soil formation, and ecosystem functions and services, while being able to predict potential future developments. Students will also gain practical skills in soil surveys, utilizing a genetic classification and mapping system, and will acquire fundamental methodological knowledge for describing and classifying soil properties and functions in the field under conditions of global and transformative change.
Prerequisites for assessment	Participation in the field exercise.
Requirements for awarding credit points (type of examination)	Written exam (80 %), written report field excercise (20%). All partial examinations must be graded at least 'sufficient'. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MGEO112** Ecohydrology and Subterranean Ecosystems	
Module Code	MGEO112
Module title (German)	Ecohydrology and Subterranean Ecosystems
Module title (English)	Ecohydrology and Subterranean Ecosystems
Module Coordinator	Prof. Dr. Anke Hildebrandt
Prerequisite modules	039 M.Sc Geowissenschaften: none XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	Fundamentals of Physics, applied Mathematics, Ecology, physical geography
Prerequisite for what other modules	039 M.Sc Geowissenschaften: The module can be completed as a specialisation in the interdisciplinary compulsory elective area. XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	039 M.Sc Geowissenschaften: required elective module XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 Semester
Components/Types of courses	Lecture (2 SWS), exercises (1 SWS): Plants in the water cycle lecture (2 SWS), Seminar (1 SWS): Subsurface ecosystems
ECTS credits	6 LP
Work load (in hours): Classes independent study	180 h 90 h 90 h
Module content	Vertical exchange in the soil-plant-atmosphere continuum. Relationships between energy, water, and carbon balances. Impact of root water uptake and redistribution of precipitation in plant canopies on soil water balance. Evapotranspiration from leaf to ecosystem scale. Atmospheric boundary layer and cloud formation. Feedbacks. The "Critical Zone." Fundamentals of ecology. Types of aboveground and belowground ecosystems and ecotones. Natural belowground systems as complex systems in the critical zone. Properties and specifics of belowground ecosystems. Habitat conditions. Biodiversity.

	Functions of belowground systems and ecosystem services. Threats and vulnerability.
Intended learning outcomes	Upon successful completion of the module, students will recognize the "critical zone" as both a habitat and a sphere of influence for life, understanding it as the central area of exchange between soil and atmosphere. They will be able to interpret current research and observations in the critical zone, focusing on the interactions between energy, element, and water cycles, as well as ecosystem dynamics. Through engagement with specialist literature, students will be able to independently consolidate and deepen their knowledge and methodological skills, and transfer findings across disciplines.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Semester-related work (100%): graded exercises, short oral and/or written tests. The scope and type of semester-related work will be announced at the beginning of the module. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	None
Recommended reading list	Begun/Howarth/Townsend (2017): Ökologie. Springer-Spektrum Gilbert/Culver (2009): Groundwater Ecology; Wiley Blackwell Brutsaert (2005): Hydrology: An Introduction; Cambridge Further readings will be recommended at beginning of the module.
Language of instruction	English

Module **MGEO202** Computational Geophysics	
Modulcode	MGEO202
Module title (German)	Computational Geophysics
Module title (Englisch)	Computational Geophysics
Module coordinator	Prof. Dr. Nina Kukowski
Prerequisite modules	039 M.Sc Geowissenschaften: none XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	Basic knowledge with regard to differential and integral calculus as well as programming
Prerequisite for what other modules	039 M.Sc Geowissenschaften: none XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	039 M.Sc Geowissenschaften: required elective module XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every second semester (beginning in summer semester)
Duration of module	1 Semester
Components/Types of courses	mainly hands-on exercises (3 SWS) to gain knowledge in programming, mainly Python, but also Fortran or Matlab; Lectures and hands-on exercises (3 SWS) as introduction in the finite element methods
ECTS credits	6 LP
Work load (in hours) ▪ Classes ▪ independent study	180 h 90 h 90 h
Module content	Syntax and example scripts (Jupyter notebooks) of Python (and Fortran) to solve tasks which are typical for research related to the study program, mainly practical work in the computer lab. Concept of finite elements methods (Taylor series, types of elements, implementation of boundary conditions, solvers), using (free source) codes mainly dealing with thermal and fluid flow related tasks and research.

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Intended learning outcomes	Upon successful completion of the module, students will be able to work with scripts, codes, and Jupyter notebooks, modify existing code, and write short programs independently. They will be proficient in using simulation codes and applying simulation tools to address research topics, demonstrating the ability to work autonomously with computational resources.
Prerequisites for assesment	None (participation in practice in the computer lab is strongly recommended)
Requirements for awarding credit points (type of examination)	Semester-related work (100%): Solving short programming tasks and working on a term task, i.e. to perform own simulations. The scope and type of semester-related work will be announced at the beginning of the module. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Modul **MCEU2.3** Environmental Analytics	
Modulcode	MCEU2.3
Modultitel (deutsch)	Umweltanalytik
Modultitel (englisch)	Environmental Analytics
Modul-Verantwortliche/r	Prof. Dr. Georg Pohnert, PD Dr. Wolf von Tümpling
Voraussetzung für die Zulassung zum Modul	532 M.Sc. Chemie-Energie-Umwelt: Keine XXX M.Sc. Biogeoscience of the Anthropocene: none
Empfohlene bzw. erwartete Vorkenntnisse	532 M.Sc. Chemie-Energie-Umwelt: Keine XXX M.Sc. Biogeoscience of the Anthropocene: none
Verwendbarkeit (Voraussetzung wofür)	532 M.Sc. Chemie-Energie-Umwelt: Voraussetzung für die Anfertigung der Masterarbeit
Art des Moduls (Pflicht-, Wahlpflicht- oder Wahlmodul)	532 M.Sc. Chemie-Energie-Umwelt: Pflichtmodul XXX M.Sc. Biogeoscience of the Anthropocene: elective module
Häufigkeit des Angebots (Modulturnus)	jedes 2. Semester (ab Sommersemester)
Dauer des Moduls	1 Semester
Zusammensetzung des Moduls / Lehrformen (V, Ü, S, Praktikum, …)	2 SWS Vorlesung/lecture, 1 SWS Seminar/seminar, 3 SWS Praktikum/laboratory course
Leistungspunkte (ECTS credits)	5 LP
Arbeitsaufwand (work load) in: - Präsenzstunden - Selbststudium (einschl. Prüfungsvorbereitungen)	150 h 90 h 60 h
Inhalte	Einführung in die Umweltanalytik, Grundbegriffe der Ökotoxikologie; Grundlagen der Umweltüberwachung; Grundlagen der Spurenanalyse; Spezifika des umweltanalytischen Prozesses; Moderne Methoden der Umweltanalytik (spektroskopische, elektroanalytische und chromatographische Methoden); Analytische Chemie wichtiger Umweltkompartimente, Methoden der Vor-Ort-Analytik./ Introduction to environmental analysis, basic concepts of ecotoxicology; fundamentals of environmental monitoring; principles of trace analysis; specific aspects of the environmental analytical process; modern methods of environmental analysis (spectroscopic, electroanalytical and

	chromatographic methods); analytical chemistry of major environmental compartments; on-site analytical methods.
Lern- und Qualifikationsziele	Mit erfolgreichem Abschluss des Moduls verfügen die Studierenden über spezifische analytische Kenntnisse, um Besonderheiten und Probleme der Umweltanalytik zu erkennen und eine Lösung vorzuschlagen. Sie können wichtige Umweltkompartimente untersuchen und problemorientierte Anwendungen vorstellen./ Upon successful completion of the module, students possess specific analytical knowledge enabling them to identify particular features and challenges in environmental analysis and to propose appropriate solutions. They are able to investigate key environmental compartments and present application-oriented approaches to problem-solving.
Voraussetzung für die Zulassung zur Modulprüfung	Keine/none
Voraussetzung für die Vergabe von Leistungspunkten (Prüfungsform)	Praktikum mit schriftlicher Versuchsauswertung (50%), Klausur / mündliche Prüfung zum vermittelten Stoff aus Vorlesung und Praktikum (50%)/ Laboratory course with written evaluation of experiments (50%), written or oral examination covering content from the lecture and laboratory course (50%).
Zusätzliche Informationen zum Modul	Ein nicht bestandenes Praktikum kann einmal wiederholt werden. Das Modul wird ggf. in englischer Sprache durchgeführt, sollten Studierende des Austauschprogramms der Université Nantes oder Studierende des Masters Biogeoscience daran teilnehmen./ A failed laboratory course may be repeated once. The module may be conducted in English if students from the Université de Nantes exchange programme or from the M.Sc. Biogeoscience of the Anthropocene are participating. Participation for students of the M.Sc. Biogeoscience of the Anthropocene may be limited due to capacity.
Empfohlene Literatur	Literaturhinweise werden zu Beginn der Lehrveranstaltung gegeben./ Reading recommendations will be provided at the beginning of the course.
Unterrichtssprache	Deutsch, ggf. Englisch

Module **MBGSA301** Scientific Project	
Module Code	MBGSA301
Module title (German)	Scientific Project
Module title (English)	Scientific Project
Module Coordinator	Prof. Dr. Thorsten Schäfer
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: Master's thesis
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every second semester (beginning in winter semester)
Duration of module	1 semester
Components/Types of courses	50 hrs (Scientific seminar (2 SWS) and coaching by supervisors (approx. 2hrs/week) within the group offering the project). (SWS stands for, hours per week per semester)
ECTS credits	15
Work load (in hours): ▪ Classes ▪ independent study	450 h 50 h 400 h
Module content	The biogeoscientific project module prepares students for scientific work and aims to intensify students' practical and methodological skills in biogeoscientific work through active participation in a research project or supervised conduction of a research project. The focus is on the direct application of advanced methods and techniques, the independent conduct of experiments or measurements, the critical examination of experimental challenges, and the professional documentation and presentation of results. The module serves as a direct skill development and is not a preparation for or a substitute for the master's thesis.
Intended learning outcomes	Students will have acquired the ability to apply their knowledge in biogeosciences to analyze problems and transfer solutions effectively. Students can apply advanced scientific research methods and techniques independently and precisely. They are proficient in the

	proper conduct of experiments or data collection and can systematically record, process, and prepare raw data for analysis. They are able to effectively use appropriate software and tools for data analysis and visualization. They are able to critically reflect on which methodological approaches are most effective in the context of their project and can document scientific experiments and results in detail and comprehensibly. They can competently communicate their practical procedures and results in a scientific presentation. The students will gain skills documenting and curating collected data according to FAIR principles, as well as processing and interpreting data.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Written report or poster presentation (100%). will be agreed upon at start of module with the respective supervisor. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA302** Specialisation Module	
Module Code	MBGSA302
Module title (German)	Specialisation Module
Module title (English)	Specialisation Module
Module Coordinator	Dr. Dirk Merten
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: Master's Thesis
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every semester
Duration of module	1 semester
Components/Types of courses	Individual project (SWS stands for, hours per week per semester)
ECTS credits	10
Work load (in hours): ▪ Classes ▪ independent study	300 h 0 h 300 h
Module content	This module enables students to specialize in a selected field of biogeoscience. Students will deepen their skills and abilities in areas such as experimental work, instrumental techniques, field studies, exploratory data analysis, or the development and application of scientific models. This project serves as preparation for the subsequent master's thesis and enables students to apply their knowledge in practice under the guidance of experts in the respective field, to develop their methodological skills, and to learn solution strategies for scientific questions. Great emphasis is placed on integrating the latest research findings and methods and on imparting skills essential for successful scientific work.
Intended learning outcomes	Upon successful completion of the module, students have broadened their skills in critical thinking, problem identification, and the development of innovative solutions. They have acquired in-depth methodological

	skills, which, depending on their specialization, include conducting experimental work, planning and implementing field studies, applying advanced data analysis techniques, or developing and applying computer-aided models. Through intensive engagement with a specific research project, students have deepened their specialist knowledge and methodological skills, preparing them for the successful completion of their subsequent master's thesis. They have developed the ability to work efficiently and goal-oriented, both independently and in teams.
Prerequisites for assessment	none
Requirements for awarding credit points (type of examination)	Term paper, poster report and presentation or written report with oral presentation (100 %). The Type of exam will be agreed on with the supervisor at the beginning of the module. The type of repeat examination may differ from the first exam. The exact scope and type of the examination will be announced at the beginning of the course.
Additional information on the module	none
Recommended reading list	Will be recommended at the beginning of the module.
Language of instruction	English

Module **MBGSA303** Wildcard	
Module Code	MBGSA303
Module title (German)	Wildcard
Module title (English)	Wildcard
Module Coordinator	Dr. Dirk Merten
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: none
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: required elective module
Frequency of offer	Every semester
Duration of module	1 semester
Components/Types of courses	Depending on the elected courses (SWS stands for, hours per week per semester)
ECTS credits	5
Work load (in hours): ▪ Classes ▪ independent study	150 h xxx h xxx h
Module content	Courses offered for students of other Master courses at Friedrich Schiller university can be combined with 4 or 8 hpw and after a mandatory consultation heard as an extra module. Please note that there may be capacity restrictions that prevent you from selecting the courses. The subjects must complement the subjects of the master program Biogeoscience of the Anthropocene.
Intended learning outcomes	To be agreed in advance
Prerequisites for assessment	To be agreed in advance
Requirements for awarding credit points (type of examination)	To be agreed in advance, depending on the selected courses
Additional information on the module	Agreement on eligibiltiy has to be achieved before attending the module with both the Module coordinator of the selected courses and the Module coordinator of the Wildcard module.
Recommended reading list	Will be recommended at the beginning of the courses.

Stand: 26.8.2025

Language of instruction	English; if applicable German

Module **MBGSA401** Master's Thesis	
Module Code	MBGSA401
Module title (German)	Master's Thesis
Module title (English)	Master's Thesis
Module Coordinator	Prof. Dr. Kai Uwe Totsche
Prerequisite modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Recommended or expected prior knowledge	XXX M.Sc. Biogeoscience of the Anthropocene: MBGSA301, MBGSA302
Prerequisite for what other modules	XXX M.Sc. Biogeoscience of the Anthropocene: none
Type of module (compulsory module, required elective module)	XXX M.Sc. Biogeoscience of the Anthropocene: compulsory module
Frequency of offer	Every semester
Duration of module	6 months
Components/Types of courses	Individual project; 50 h (Scientific seminar (2rs/week) and coaching by supervisors (2hrs/week) within the group offering the master theme). (SWS stands for, hours per week per semester)
ECTS credits	30
Work load (in hours): ▪ Seminars ▪ independent study	900 h 50 h 850 h
Module content	The master's thesis concludes the master's program and serves as proof of the candidates capability to work on a scientific question independently, but under supervision, within a specified time frame, according to methodological, professional, and ethical standards. Students choose a research project that reflects the current state of science and addresses relevant scientific problems within the field of the Biogeosciences of the Anthropocene. This can include experimental laboratory work, field research, computer-based simulation, or theoretical work. The goal is to generate new insights or further develop existing theories and methods. The thesis also includes a comprehensive literature review to place the research question in the context of existing knowledge, as well as the application of appropriate

	scientific methods for data collection and analysis obeying the general rules of scientific conduct.
Intended learning outcomes	The Master's thesis enables students to identify complex problems in their field and develop independent solutions. Graduates demonstrate their ability to conduct independent scientific work, think critically, and apply ethical principles in research. They possess the competence to communicate scientific results clearly and comprehensibly, both in writing (Master thesis) and orally during the defence. Through the successful planning and implementation of the research project, they have demonstrated their ability to conduct scientific projects and work effectively both in a team and independently. They can critically evaluate scientific findings and place them in their scientific context. This qualifies them for leading positions in science and research, as well as in related professional fields where analytical and methodological skills are required.
Prerequisites for assessment	None
Requirements for awarding credit points (type of examination)	Written theses report (75%), Scientific oral presentation with defence (25%) during the last two month of the master's thesis. The oral presentation should be at least 30 minutes. The total duration of the defence (oral presentation and discussion) should not be longer than 60 mins
Additional information on the module	none
Recommended reading list	In consultation with the supervising person.
Language of instruction	English