READING VERSION OF MODULE DESCRIPTIONS
The module descriptions are not part of the Regulations; they are integrated into the First Amendment to the Module Catalog.

GEW-RCM01: Remote Sensing of the Environment				Number of credit points (CPs): 6
Module type (mandatory or elective):	Mandatory module			
Content and Objectives of Module	**Content** Introduction to remote sensing and its application concepts. Foundations of electromagnetic waves and data processing; satellite systems and other observation systems; processing optical and radar data; concepts and algorithms of image classification; applications of earth systems sciences. **Objective** The students can understand digital observation systems and develop self-reliant plans to apply them to relevant questions in earth system sciences.			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture (lecture)	2	-	-	-
Tutorial on selected topics (tutorial)	2	-	Practice assignments (80%)	-
Offered:	Winter semester			
Prerequisite for taking the module:	None			
Teaching unit:	Earth sciences			

GEW-RCM02: Earth System Science		Number of credit points (CPs): 6
Module type (mandatory or elective):	Mandatory module	
Content and Objectives of Module	**Content** Introduction to earth system theory including basic processes and concepts of the atmosphere, oceans, biosphere, and geosphere. The module places a special focus on interactions and feedback effects in the earth as a system. **Objective** The students have a sound understanding of the natural processes that significantly affect the earth's surface and human habitats.	
Module examinations (number, form, scope):	One exam in the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min	
Independent study time (in hours):	120	

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Earth System Science (lecture)	3	-	-	-
Seminar on selected topics (seminar)	1	-	Practice assignments (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-RCM03: Data Analysis and Statistics	Number of credit points (CPs): 6
Module type (mandatory or elective):	Mandatory module
Content and Objectives of Module	**Content** Introduction to a higher-level programming language such as Python or MATLAB; overview of data types and methods; one-, two-, and multivariable statistics; time series analysis; statistics for spatial and directional data; numerical procedures; image processing and analysis. **Objective** The students are capable of self-reliantly planning, executing, and presenting a data analysis project.
Module (partial) examination (number, form, scope):	Portfolio exam (presentation of the results of the digital data analysis project, 10–15 minutes, with accompanying report, 10–12 pages)
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	3	-	Practice assignments (80%)	-
Seminar	1	-	-	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-RCM04: Geoinformation Systems	Number of credit points (CPs): 6
Module type (mandatory or elective):	Mandatory module

Content and Objectives of Module	**Content** Foundations of geo-information systems, underlying mathematical theory, and practical applications of geo-information and image processing. Combining and analyzing various applications of remote-sensing data using data gathered in the field or in the lab in order to extract, classify, and quantify relevant information. Foundations of projecting, geo-referencing, and digitalizing scientific data and incorporating it in systems. The practical calculations and the incorporation of remote-sensing systems are based on linear algebra and matrix image processing and are carried out using Python, MATLAB, or R. **Objective** The students are capable of creating thematic maps in 2D and 3D.			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Oral exam, 30 min.			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Geo-information systems (lecture and tutorial)	2L + 2T	-	Worksheets (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-RCM05: Visualization and Communication			Number of credit points (CPs): 6
Module type (mandatory or elective):	Mandatory module		
Content and Objectives of Module	**Content** The module syllabus includes literature and data research, identifying scientific and controversial material, drafting a data analysis project, using modern visualization techniques, and presentation techniques for an expert or lay audience as well as decision-makers. This module consists of a weekly seminar with invited lecturers from the earth and environmental sciences. **Objective** Students will: – Identify attractive and current research topics – Be able to outline personal projects on these topics using the latest data analysis methods – Be able to present these projects' results appropriately and professionally		
Module (partial) examination (number, form, scope):	Portfolio exam (poster, 2 m x 1 m, with presentation, 10-12 minutes, and essay on same topic, approx. 2000 words)		
Independent study time (in hours):	120		
Courses (type of teaching)	Contact time:	Supplementary exam work (number, form, scope)	(Partial) module exams

	(in semester hours)	For completing the module	For admission to the module exam	accompanying coursework (number, form, scope)
Visualization and Communication (lecture and tutorial)	1L + 2T	-	-	-
Visualization and Communication (seminar)	1	-	-	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-RSM01: Optical Remote Sensing				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** Introduction to optical and hyperspectral satellite instruments and measurement methods for remote sensing on land. Overview of data processing and information retrieval from optical remote-sensing data, including accommodation for atmospheric and geometric corrections, classification, and multi-temporal analyses. Practical applications of optical remote-sensing data, for example vegetation and natural hazards. **Objective** The students have a foundational understanding of optical remote sensing on land using digital data processing systems and data analysis applications.			
Module (partial) examination (number, form, scope):	Written exam, 90 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Basics in Optical Remote Sensing (lecture and tutorial)	2L + 2T	Report on a project with remotely sensed data (10-12 pages)	Practice assignments (50%)	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences/GFZ		

GEW-RSM02: Terrestrial and Airborne Lidar and Photogrammetry Systems		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	

Content and Objectives of Module	**Content** Introduction to lidar data, photogrammetry, and 3D point clouds. The module includes the theoretical and practical use of lidar data, how to classify point clouds, how to create digital terrain and surface models, and how to determine the uncertainty of digital terrain models. **Objective** The students possess a fundamental understanding of high definition spatial 3D point clouds and their applications in geo-systems research.
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and seminar	2L + 2T	-	Practice assignments (80%)	-

Offered:	Summer semester
Prerequisite for taking the module:	Recommended: GEW-RCM01 Remote Sensing of the Environment and GEW-RCM03 Data Analysis and Statistics.
Teaching unit:	Earth sciences

CHE-RSM03: Remote Chemical Sensing	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** The module covers the foundational concepts of the interactions between light and matter in view of applications of optical sensing in gaseous and condensed phases. It introduces current experimental methods and techniques with locational and temporal resolution at various scales along with their underlying principles and discusses their capabilities and limitations using thematic examples. Laser- and fiber-based optical chemical sensing receives special attention. The module discusses fundamental physical/chemical relationships in thermodynamics and kinetics as well as their usefulness for optical remote sensing and for sensing the atmosphere, hydrosphere, and pedosphere. **Objective** Students will: – Be familiar with the capabilities and limitations of modern optical techniques for remote-sensing-assisted analytics – Be familiar with tools for gathering experimental data – Acquire the prerequisites to understand and interpret experimental data
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min.
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Remote Chemical Sensing (lecture and seminar)	2L + 2T	Presentation (20 min)	-	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Chemistry		

GEW-RSM04: Earth Surface Deformation and Radar Satellite Interferometry (InSAR)	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** Introduction to radar data processing with a special focus on radar interferometry. Satellite-assisted radar interferometry (InSAR) is a new, increasingly popular method in science and industry for observing ground deformations. The syllabus includes the concept and signal of a radar antenna and its various areas of application; advantages and limitations of InSAR; atmospheric correction; steps for processing raw data to achieve a deformation map (including focusing, co-registration, geocoding, filtering, multi-looking, coherence, and unwrapping). **Objective** Students will: – Possess sound knowledge of radar data processing and interferometry. The focus is on application aspects. – Be capable of creating their own interferograms.
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block or lecture with tutorial (lecture and tutorial)	2L + 1T	-	Practice assignments (80%)	-
Seminar	1	Presentation (20 min) or written elaboration (10 pages)	)	-
Offered:		Every two years (winter semester)		
Prerequisite for taking the module:		Recommended to have knowledge of the basics of digital data processing and programming.		
Teaching unit:		Earth sciences		

GEW-RSM05: Advanced Topics of Remote Sensing				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** Module on current research questions in earth systems research and methodological developments in remote sensing. Presents these topics in a lecture or consists of discussions of current scientific papers during a seminar. **Objective** The students have a foundational understanding of the new and developing research fields, methods, and applications.			
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course or lecture (lecture)	2	-	-	-
Seminar or tutorial (seminar or tutorial)	2	-	Exercise assignments (80%) or presentation (20 minutes) or written elaboration (10 pages)	-
Offered:	Every two years (winter semester)			
Prerequisite for taking the module:	None			
Teaching unit:	Earth sciences			

GEE-OBS01: Soilscape Processes		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	
Content and Objectives of Module	**Content** The module describes the basic processes of weathering, nutrient transport, and soil formation in the context of Earth systems sciences. The key process area is the “critical zone”: the area between plant cover and groundwater in which biocritical transport and alteration processes take place. The influences of climate change, changes in vegetation cover, and anthropogenic landscape use are possible control factors affecting the “critical zone.” **Objectives** Students possess: – Sound knowledge of soil science – A sound understanding of processes occurring near the earth’s surface	
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min	
Independent study time (in hours):	120	

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and seminar	2L + 2T	-	Practice assignments (80%)	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Geo-ecology		

GEW-OBS02: Erosion and Earth Surface Dynamics	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** This module covers the physics and chemistry of Earth surface processes relating to the production and transportation of sediment. These processes are viewed separately, but with a special focus on the interrelationships and feedback effects between them. The module investigates the effects of tectonics, climate, and biological processes and events on landscapes and habitats, but also considers longer timescales such as the implications of erosion and the accumulation of surface materials on mountain formation, the formation and filling of basins due to sediment, changes in atmospheric composition, and the dynamics of ecosystems and biological productivity. **Objective** The students have sound knowledge of transportation processes on the earth's surface.
Module (partial) examination (number, form, scope):	Term paper, 10-12 pages
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Erosion and Earth Surface Dynamics (lecture and seminar)	3L + 1T	-	Presentation on assigned reading (10-15 minutes)	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences/GFZ		

BIO-OBS03: Biosphere of the Earth	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module

Content and Objectives of Module	**Content** The students are familiarized with various ecosystems on the earth, their main ecological problems, and scientific approaches for their protection and sustainable use. **Objectives** Students will: – Be able to identify system-specific and trans-system ecological mechanisms of impact – Identify current problems and ecological challenges – Be able to develop proposed solutions
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 10 pages Written exam, 90 min Oral exam, 30 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Seminar or tutorial on the earth's biosphere (seminar or tutorial)	2	-	-	-
Lecture on the earth's biosphere (lecture)	2	-	-	-

Offered:	1st part: winter semester, 2nd: part: Summer semester
Prerequisite for taking the module:	None
Teaching unit:	Biology/biochemistry

GEW-OBS04: Remote Sensing of Permafrost Regions	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** The module gives students level-appropriate foundational knowledge of methods of remote sensing and spatial data analysis that are useful for characterizing and analyzing changes within permafrost regions. The range of methods covers various spectral regions, spatial resolutions, platforms, and processing techniques. **Objectives** Students will: – Be familiar with remotely detectable properties and dynamics of permafrost regions – Acquire foundational familiarity with remotely detectable characteristics and landscape processes conditioned by permafrost formation, seasonal freezing and thawing processes, and permafrost thawing – Develop and present a project topic self-sufficiently
Module (partial) examination (number, form, scope):	Written exam, 90 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Remote Sensing of Permafrost Regions (lecture and tutorial)	3	-	-	-
Seminar on project progress (seminar)	1	-	Presentation (30 min)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-OBS05: Earthquake and Volcano Deformation	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** This module gives an introduction to volcanic and tectonic deformation processes with the focus on superordinate disciplines such as geological field observations, geodesic monitoring, and geophysical evaluation procedures. It discusses processes associated with loading, spreading, gravitational tectonics, magma tectonics, intrusion of lodes, and cooling. The students develop interpretations of deformation data in experimental and computer-assisted models. **Objective** The students possess knowledge of deformation processes in volcanic and tectonic environments and their interrelationships.
Module (partial) examination (number, form, scope):	Presentation, 15 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and seminar	2L + 2T	-	Practice assignments (80%)	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences/GFZ		

GEW-OBS06: Earth's Magnetic Field and Physics of the Upper Atmosphere	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module

Content and Objectives of Module	**Content** Describe the structure, temporal variability, and primary sources of the earth's magnetic field and present basic processes in empirical magnetic field modeling. Describe the main physical laws governing the emergence and behavior of the upper atmosphere and ionosphere. Interpret the geometry and strengths of electrical forces in near-earth space that contribute to earth's weather and geomagnetic storms. **Objective** The students possess knowledge of the global methods for measuring the earth's magnetic field using networks of ground-based stations and satellites.			
Module (partial) examination (number, form, scope):	Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course (lecture)	2	-	-	-
Seminar or tutorial on selected topics (seminar or tutorial)	2	Term paper (10 pages)	-	-
Offered:		Every two years (summer semester)		
Prerequisite for taking the module:		Recommended to have basic programming skills in any chosen programming language.		
Teaching unit:		Earth sciences/GFZ		

PHY-OBS07: Introduction to Climate Physics	Number of credit points (CPs): 6		
Module type (mandatory or elective):	Elective module		
Content and Objectives of Module	**Content** The module covers the basic physics of dynamic climate systems with a focus on climate change. The students learn about and analyze relationships and feedback processes in the earth's system with applications in the realms of sea level fluctuations, the radiation budget, and albedo effects. Conceptual and mathematical/physics models are used to represent and explain quantitative relationships. **Objectives** Students will: – Be familiar with the effect of climate change on earth as a system and the complex feedback processes – Possess the necessary tools to analyze complex feedback processes		
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 10 pages Written exam, 90 min Oral exam, 30 min		
Independent study time (in hours):	120		
Courses (type of teaching)	Contact time:	Supplementary exam work (number, form, scope)	(Partial) module exams

	(in semester hours)	For completing the module	For admission to the module exam	accompanying coursework (number, form, scope)
Lecture (lecture)	2	-	-	-
Seminar or tutorial (seminar or tutorial)	2	-	Practice assignments (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Physics		

GEW-OBS08: Planetary Remote Sensing				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module teaches the physics and methodological foundations of planetary remote sensing using examples from investigations into the inner solar system. Topics covered include the photo geological investigation of planetary surfaces using passive and active methods; spectrophotometric analysis for categorizing matter and minerals; gamma and neutron spectroscopy; measuring particles and fields; and the spectral investigation of planetary atmospheres. The module also covers the corresponding sensors for planetary remote sensing. The lecture is supplemented by a two-day excursion to the DLR in Berlin's Adlershof district. Students build on the excursion by practicing their computer-assisted work with planetary remote-sensing data in order to reinforce their skills at self-sufficiently processing such data and to help them develop level-appropriate basic skills in designing, developing, and operating planetary remote sensors. **Objectives** Students will: – Have an understanding of the methods, principles, and tools of planetary remote sensing – Be able to apply this set of methods to investigating the inner solar system – Be able to successfully carry out a project including an appropriate written report			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min.			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Planetary Remote Sensing (lecture and tutorial)	2L + 2T	-	Practice assignments (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-OBS09: Planetary Physics				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module teaches the basics of planetary physics and comparative planetology. It also provides in-depth knowledge about the outer solar system and exoplanets. Models on the formation of the solar system are discussed The lecture is supplemented by a two-day excursion to the DLR in Berlin's Adlershof district. Students build on the excursion by practicing their computer-assisted work with planetary remote-sensing data. **Objectives** Students will: – Acquire skills at self-sufficiently processing remote-sensing data – Possess level-appropriate basic skills in designing, developing, and operating planetary remote sensors.			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	2L + 2T	-	Practice assignments (80%)	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEE-GV01 is already part of MK MNF – however: Title changed in English!

GEW-OBS10**: Atmospheric Science in the Anthropocene**		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	

Content and Objectives of Module	**Content** The course gives an overview of the main topics in atmospheric science within the context of the global shift. It includes: Basic principles of meteorology (meteorological elements, primitive equation sets, and the horizontal and vertical structure of the atmosphere); atmospheric dynamics; weather systems; atmospheric composition and chemistry; chemical-climactic feedback effects; and more specialized topics such as extreme air pollution, climate engineering, and the connection between atmospheric science and society. This seminar presentations will be based on the IPCC WG-1 report, Recommended textbook: *Atmospheric Science: An Introductory Survey* by Wallace and Hobbs. (The book will be used primarily in the first half of the lecture, after which it will focus more on specialized literature.) **Objectives** *1. Subject competencies* The students have mastered the basics of Earth systems relevant processes in the interrelationships between the components of Earth's system (discipline-specific theoretical knowledge). The prerequisite is a foundational background in mathematics, physics, and chemistry. However, the lecture is designed so that students outside the field at the master's level or higher can easily follow along with the broad strokes of the lecture. (The significance of the individual stages is graded even if the details of the reasoning are not always understood.) *2. Methodological competencies* The students actively participate in the scientific discussion in the lecture and the seminar. By the end, the students should be able to understand (information and knowledge management), analyze (analytical skills) and explain (presentation skills) the aspects of atmospheric science (physics and chemistry) presented in the lecture as well as their relationships to the topics of global transformation (such as climate change, air pollution). *3. Social competencies* The students are able to present and defend their seminar topic in front of the seminar group in a presentation using appropriate presentation media, then lead the discussion (communication skills). *4. Personal competencies* For their seminar topic, the students are able to communicate the current state of research based on the provided literature and other independently sought literature (largely in English) (self-sufficient work, learning skills) and prepare them as draft presentations in time for the meetings with the seminar supervisors (self-discipline, time management, creativity).
Module (partial) examination (number, form, scope):	Written exam, 90 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and seminar	4	Presentation (30 min)	-	-

Offered:	Every two years (winter semester)
Prerequisite for taking the module:	None
Teaching unit:	Geo-ecology

GEW-OBS11: Advanced Topics of Objects of Observations				Number of credit points (CPs): 120
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** Module on current research questions in earth systems research and methodological developments in remote-sensing. Presents these topics in a lecture with discussions of current scientific papers during the seminar. **Objective** The students have a foundational understanding of the new and developing research fields, methods, and applications.			
Module (partial) examination (number, form, scope):	Written exam, 90 min			
Independent study time (in hours):	6			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course or lecture (lecture)	2	-	-	-
Seminar or tutorials (seminar or tutorial)	2	-	Exercise assignments (80%) or presentation (20 minutes) or written elaboration (10 pages)	-
Offered:	Every two years (summer semester)			
Prerequisite for taking the module:	None			
Teaching unit:	Earth sciences			

MAT-DAP01: Bayesian Inference and Data Assimilation				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module teaches the basics of stochastic processes, computer-assisted statistics, Bayesian inference, and data simulation. The applications comprise simple models in meteorology and seismology. **Objective** The students acquire an understanding of the basics of computer-assisted quantification of projection uncertainties and how to assimilate data in order to improve projections and models.			
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time:	Supplementary exam work (number, form, scope)		(Partial) module exams

	(in semester hours)	For completing the module	For admission to the module exam	accompanying coursework (number, form, scope)
Lecture (lecture)	3	-	-	-
Exercises (tutorial)	1	-	Worksheets (9)	-
Offered:		Every two years (winter semester)		
Prerequisite for taking the module:		Recommended to have basic skills in statistics and analysis and elementary programming skills (e.g. Matlab, R, or Python).		
Teaching unit:		Mathematics		

GEW-DAP02: Nonlinear Data Analysis Concepts				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** Introduction to the basic concepts of nonlinear dynamics and chaos theory and how these may be used to analyze complex systems, spatial-temporal data, and nonlinear relationships in the earth sciences. The focus is on methods of information theory, recurrence properties, and complex networks. **Objective** Students will: – Be familiar with the foundations of statistical tests in nonlinear dynamics and chaos theory – Have knowledge of how such tests can be constructed appropriately			
Module (partial) examination (number, form, scope):	Term paper, 10-12 pages			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and seminar	2L + 2T	-	Exercise assignments (80%) and presentation on assigned reading (10-15 minutes)	-
Offered:		Winter semester		
Prerequisite for taking the module:		Recommended to have completed GEW-RCM3 Data Analysis and Statistics or have basic skills in statistics and analysis and elementary programming skills (e.g. MATLAB, R, or Python).		
Teaching unit:		Earth sciences		

GEW-DAP03: Big Data Analytics		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	

Content and Objectives of Module	**Content** This module is about preparing large data sets as a prerequisite for rapid, high-performance analysis, but also about modern data mining techniques for analysis in general. The lecture uses current applications to demonstrate underlying problems in data mining. The lecture's focus is on data mining algorithms for information extraction, working through each step of the knowledge discovery in databases (KDD) process. It presents the fundamental issues with data mining along with various algorithmic solutions from each area. In addition, it presents general evaluation methods to assess these data mining solutions for concrete applications. **Objective** The students acquire advanced skills in analyzing large data sets.			
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	2L + 2T	-	Worksheets (5)	-
Offered:		Winter semester		
Prerequisite for taking the module:		Recommended to have basic skills in statistics and analysis and elementary programming skills (e.g. Matlab, R, or Python).		
Teaching unit:		Earth sciences		

GEW-DAP04: Spatial Data Analysis with Numerical Methods		Number of credit points (CPs): 6		
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module provides an overview of the various ways the Python programming language can be applied in the earth sciences. It covers fundamental methods and concepts for numerical data analysis and allows students to practice finding practical solutions to scientifically relevant problems. **Objective** The students possess a deeper understanding of the entire software development process in the context of numerical data analysis for the earth sciences using the Python programming language.			
Module (partial) examination (number, form, scope):	Presentation on the results of a collaborative project (30 min)			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	2L + 2T	-	Worksheets (5)	-

Offered:	Every two years (summer semester)
Prerequisite for taking the module:	Recommended to have basic skills in statistics and analysis.
Teaching unit:	Earth sciences

GEW-DAP05: Advanced Topics of Data Analysis and Programming				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** Module on current research questions in data analysis and methodological developments in programming. Presents these topics in a lecture or consists of discussions of current scientific papers during a seminar. **Objective** The students have a foundational understanding of the new and developing research fields, methods, and applications.			
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min Presentation, 15 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course or lecture (lecture)	2	-	-	-
Seminar or tutorial (seminar or tutorial)	2	-	Exercise assignments (80%) or presentation (20 minutes) or written elaboration (10 pages)	-
Offered:	Every two years (winter semester)			
Prerequisite for taking the module:	None			
Teaching unit:	Earth sciences			

GEW-GIS01: Analysis of Digital Elevation Models		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	

Content and Objectives of Module	**Content** Introduction to tectonic geomorphology and the analysis of digital terrain models. This course describes the theoretical foundations and useful concepts of quantitative geomorphology and digital metrics and techniques for measuring landscapes using digital terrain models. The module also employs landscape development models. The students learn how to perform quantitative analysis on digital terrain models using MATLAB, ArcGIS, and Python. **Objective** The students will be able to: – Extract information from digital terrain models – Work with high-resolution models			
Module (partial) examination (number, form, scope):	Portfolio exam (presentation, 10-12 min) plus term paper (10 pages) on the same topic			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	1L + 2T	-	-	-
Seminar	1	-	-	-
Offered:		Winter semester		
Prerequisite for taking the module:		Recommended to have programming skills (MATLAB, Python).		
Teaching unit:		Earth sciences/GFZ		

GEW-GIS02: Mapping and Geoinformation Systems			Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module		
Content and Objectives of Module	**Content** Drafting and developing a GIS project; GIS content management; data exchange; integrating modeling results; analyzing linear surface data; analyzing altitude/depth data; extracting information from satellite and aerial images; computing spatially derived parameters; data exchange, administration, and presentation via a GIS server; 3D visualization. **Objective** The students are able to self-sufficiently design, execute, and apply a GIS project.		
Module (partial) examination (number, form, scope):	Presentation, 30 min		
Independent study time (in hours):	120		
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)	(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module / For admission to the module exam	

Mapping and Geoinformation Systems (seminar)	2	-	-	-
Mapping and Geoinformation Systems (lecture and tutorial)	1L + 1T	-	Practice assignments (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-GIS03: Environmental Spatial Statistics and Models			Number of credit points (CPs): 6	
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module is devoted to the analysis and processing of spatial environmental data by preparing, restructuring, and linking large environmental data sets. The module has a strong practical link because the content is applied practically (usually in the open-ended programming environment of R or Python). The module also covers how to link statistics software (such as R, Python, MATLAB) with various GIS applications. The goal is to teach the students the most important procedures for systematically analyzing spatial data (including larger data sets). **Objectives** *1. Subject competencies* Students will: – Be familiar with the most important procedures for systematically analyzing spatial data – Be able to select a method from a set of methods in order to approach complex scientific issues – Be able to process large environmental data sets. *2. Methodological competencies* Students will: – Master the most important methods for analyzing spatial data sets – Be able to select appropriate procedures for the research question, execute them independently, and critically assess the results – Be able to implement the procedures they have learned in the R statistics software *3. Performance competencies* The capabilities and skills the students have acquired enable them to systematically isolate, identify, and review changes in environmental systems. They can model spatial structures and landscapes and gauge their implications for environmental processes.			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, approx. 15 pages Written exam, 90 min			
Independent study time (in hours):	105			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Basic Geostatistics (lecture or tutorial)	2	-	-	-

Advanced Geostatistics (lecture or tutorial)	2	-	Practice assignments (80%)	-
Spatial Data – Storage, Processing and Visualization (tutorial)	1	-	Practice assignments (80%)	-
Offered:		Winter semester		
Prerequisite for taking the module:		None		
Teaching unit:		Geo-ecology		

GEW-GIS04: GIS, Geohazards, Georisks				Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module teaches methods and applications of Geographical Information Systems in researching natural hazards and risks. It conveys the foundations and presents methods of spatial analysis and projection using sample data sets and project exercises. These methods include spatial queries, spatial statistics, interpolation and geostatistics, analysis of digital altitude models, and the analysis and classification of optical remote-sensing data. **Objectives** Students will: – Be familiar with basic methods of spatial analysis and projection – Be able to apply these methods independently and in a group and interpret and discuss their results – Be able to visualize, present, and communicate the results of their work			
Module (partial) examination (number, form, scope):	Project presentation, 15 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Lecture and tutorial	2L + 2T	-	Project presentations (2)	-
Offered:		Summer semester		
Prerequisite for taking the module:		Recommended to have basic skills in the earth sciences (BS); basic geo-information systems; knowledge of a higher-level programming language (MATLAB, R, Python).		
Teaching unit:		Earth sciences		

GEW-GIS05: Advanced Topics of Geographic Information Systems		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	

Content and Objectives of Module	**Content** Module on current research questions in data analysis and methodological developments in programming. Presents these topics in a lecture or consists of discussions of current scientific papers during a seminar. **Objective** The students have a foundational understanding of the new and developing research fields, methods, and applications.			
Module examinations (number, form, scope):	One exam of the following formats: Term paper, 20 pages Written exam, 90 min Oral exam, 30 min			
Independent study time (in hours):	120			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course or lecture (lecture)	2	-	-	-
Seminar or tutorial (seminar or tutorial)	2	-	Exercise assignments (80%) or presentation (20 minutes) or written elaboration (10 pages)	-
Offered:		Every two years (winter semester)		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-VCM01: Examples of Visualization and Communication Methods	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	Module on current research questions in visualization and communication. This module comprises participation in the colloquium of the Department of Earth and Environmental Sciences. In an accompanying seminar, the colloquium presentations attended are discussed in terms of the quality of the visualization and presentation technology used and, when the presenters consent to this, feedback is given with suggestions for improvement. The third component of the module is participating in an employee seminar of a working group of the student's choice. In this seminar, the student presents a draft of the outlined master's project (working hypotheses, research questions) on one occasion before beginning actual work on the project.
Module (partial) examination (number, form, scope):	Presentation (20 min)
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	

Seminar or tutorial (seminar or tutorial)	4	-	-	-
Offered:		Summer semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-VCM02: Industry Internship or Practical Application			Number of credit points (CPs): 6	
Module type (mandatory or elective):	Elective module			
Content and Objectives of Module	**Content** This module allows students to complete an internship in the industry or a research project on an assigned topic at a research institution or university. Internships must last at least three weeks. An inherent component of this module is writing a report and presenting the research results. Internships must be approved by the Examining Board. **Objective** The students are familiar with a working environment or can conduct a self-sufficient research project with guidance.			
Module (partial) examination (number, form, scope):	Portfolio exam (internship report (20 pages) with presentation (15 minutes)), ungraded			
Independent study time (in hours):	60			
Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Internship (3 weeks minimum) (internship)	Betreuung: 2 semester hours	-	-	-
Offered:		Every semester		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		

GEW-VCM03: Extended Industry Internship or Practical Application		Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module	
Content and Objectives of Module	**Content** The module allows students to complete a second independent internship or research project. Alternatively, it allows them to complete a continuing or follow-up internship or research project. Internships must last at least three weeks. Objective The students are familiar with a working environment or can conduct a self-sufficient research project with guidance. They can document and present research results.	
Module (partial) examination (number, form, scope):	Portfolio exam (internship report (20 pages) with presentation (15 minutes)), ungraded	
Independent study time (in hours):	60	

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Internship (3 weeks minimum) (internship)	Betreuung: 2 semester hours	-	-	
Offered:		Every semester		
Prerequisite for taking the module:		Recommended to have completed VCM02 Industry Internship or Practical Application		
Teaching unit:		Earth sciences		

GEW-VCM04: Advanced Topics of Visualization and Communication Methods	Number of credit points (CPs): 6
Module type (mandatory or elective):	Elective module
Content and Objectives of Module	**Content** Module on current research questions in visualization and communication. Presents these topics in a lecture with discussions of current scientific papers during the seminar. **Objective** The students have a foundational understanding of the new and developing research fields, methods, and applications.
Module examinations (number, form, scope):	One exam of the following formats: Written exam, 90 min Oral exam, 30 min Presentation, 15 min
Independent study time (in hours):	120

Courses (type of teaching)	Contact time: (in semester hours)	Supplementary exam work (number, form, scope)		(Partial) module exams accompanying coursework (number, form, scope)
		For completing the module	For admission to the module exam	
Block course or lecture (lecture)	2	-	-	-
Seminar or tutorial (seminar or tutorial)	2	-	Exercise assignments (80%) or presentation (20 minutes) or written elaboration (10 pages)	-
Offered:		Every two years (summer semester)		
Prerequisite for taking the module:		None		
Teaching unit:		Earth sciences		