

Draft of the module description of MSc Integrated Climate System Sciences (MSc ICSS)



MSc Integrated Climate System Sciences					
Specializations: Physics of the climate system. Biogeochemistry of the climate system. Economics and social sciences.					
Term 4 (SS)	4.0 MSc thesis "Climate System Sciences" with examination CP 30				
Term 3 (WS)	3.1 Seminar CP 3	3.2 Climate System Sciences Lab CP 9	3.3 Climate System Observations 2 CP 6	3.4 Additional of economics, social sciences and natural sciences CP 9	3.5 Soft skills 2 CP 3
Term 2 (SS)	2.1 Climate System 2 CP 9		2.2 Climate System Specialization CP 12		2.3 Climate System Observations 1 CP 6
Term 1 (WS)	1.1 Introduction CP 3	1.2 Climate System 1 CP 12		1.3 Climate Processes CP 9	1.4 Climate System Additional CP 6
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="display: flex; align-items: center;"> Compulsory</div> <div style="display: flex; align-items: center;"> Optional / Specializations</div> <div style="display: flex; align-items: center;"> MSc Thesis</div> </div>					

Each 1.5 credit point (CP) corresponds to 1 lecture hour per term (SWS)

Specializations:

- Physics of the climate system ICSS-P.
- Biogeochemistry of the climate system ICSS-B.
- Economics and social sciences ICSS-ES.

Term 4	Msc Thesis and Examination				
Term 3	Seminar	Lab	Observations 2	Additional of Economics, Social and Natural Sciences	Soft skills 2
Term 2	Climate System 2		Specialization		Observations 1
Term 1	Intro-duction	Climate System 1		Climate Processes	Climate System Additional
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="display: flex; align-items: center;"> Compulsory</div> <div style="display: flex; align-items: center;"> Optional / Specializations</div> <div style="display: flex; align-items: center;"> Research</div> </div>					

MSc Integrated Climate System Sciences, Module 1.1

Module no.	1.1
Module identifier	CLINTRO
Module title	Introduction to Integrated Climate System Sciences including Orientation Unit
Module type	Compulsory
Coordinator	Dilly
Lecturers	Emeis, Pfeiffer, Stammer, Engels
Aim	Approaches and knowledge of key disciplines in climate system sciences in research and at work. Orientation unit (OE) to introduce the interdisciplinary scope and the specialization tracks of the MSc 'Integrated Climate System Sciences'. Track 1: Physics of the climate system ICSS-P. Track 2: Biogeochemistry of the climate system ICSS-B. Track 3: Economics and social sciences ICSS-ES.
Content	Introduction of basic facts and approaches and also peculiarities of climate system sciences. Overview and principles of the disciplines involved in climate system sciences. Outline of needs and potentials of interdisciplinary collaboration and profiling considering environmental topics, economics and social sciences. Short 1-day excursion is included to give a first insight into a large research facility or an excavation of regional importance with reference to integrative climate system sciences.
Teaching and learning methods	L, S, E
Language	English
Requirements for participation	None
Usability	Semester 1 of ICSS; reference semester 1; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation at lectures and excursion; major course assessment (exam) with study work or excursion protocol in English
Work load (parts) with Credit Points CP	3.0 CP with 0.75 CP for OE, 1.5 CP for Lecture and 0.75 CP for Excursion
Frequency	Annually in winter semester
Duration	1-week block during the first week of the semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.2

Module no.	1.2
Module identifier	CLISYS1 - Overview
Module title	Climate System 1
Module type	Compulsory
Coordinator	Stammer
Lecturers	Baehr, Behrens, Blender, Engels, von Storch
Aim	Knowledge of the fundamentals and integrated perspectives of climate system components and its response to the natural and human-driven perturbations.
Content	<p>Fundamental physical, chemical and biological components of the climate system with the meteorological, oceanographic, terrestrial and also economic and social science issues. Particular insights will be given to general physics and dynamics of the Earth's climate system.</p> <p><u>4 lectures, each with 3 CP:</u></p> <p>1.2.1 Physics of the climate system; L [Baehr] 1.2.2 Climate statistics; L [Blender] 1.2.3 Introduction to numerical approaches; L [Behrens] 1.2.4 Climate and society; L, S [Scheffran]</p>
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	12.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.2.1
Module identifier	CLISYS1 - 1
Module title	Physics of the climate system
Module type	Compulsory
Lecturers	Baehr
Aim	Overview of the components of the climate system and their interaction as a single climate system on an introductory level.
Content	Description of the components of the climate system, and their interaction with particular emphasis on atmospheric and oceanic processes. Cycles and budgets of the climate system, e.g. energy budget, energy transports in ocean and atmosphere. Timescales of variability in the climate system.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.2.2

Module no.	1.2.2
Module identifier	CLISYS1 - 2
Module element title	Climate statistics
Module unit	Compulsory
Lecturers	Blender
Aim	Knowledge of the statistics required to analyze and interpret climate time series. This includes the knowledge of fundamental statistical methods and principles and their application to climate data and climate models.
Content	Stochastic processes and stochastic variables, probability density functions, estimation of parameters, hypothesis testing, analysis of time series and trend testing; spectral analysis; multivariate climate variability analysis; extreme events.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 1; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester or block

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.2.3

Module no.	1.2.3
Module identifier	CLISYS1 - 3
Module element title	Introduction to numerical approaches
Module unit	Compulsory
Lecturers	Behrens
Aim	Fundamentals of numerical approaches used in climate models. This includes the underlying basic equations, the principle of numerical discretization and an understanding of uncertainties of climate models.
Content	The module will encompass: (1) first principles of the climate system; (2) principles of numerical discretization and modeling; (3) building a numerical model.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; optional for related MSc programs, dependent on capacities and schedule. The module is basis for the climate modeling lab.
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.2.4

Module no.	1.2.4 (earlier '3.4.4)
Module identifier	CLISOCENV - 4
Module title	Climate and Society - Climate security, natural resources and conflict geography
Module type	Optional courses of the specialization track
Lecturers	Scheffran, Brzoska, Ossenbrügge
Aim	To understand the complex relationships between climate stress, environmental change, human security, societal stability and conflict, illustrated by regional hot spots of climate change.
Content	Based on a conceptual framework of climate-society interaction, including water, food, migration and disasters, a particular focus will be on the geographical dimensions of natural resource scarcity and environmental conflict in climate hot spots.
Teaching and learning methods	L
Language	English
Requirements for participation	None
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Joint examen for all module elements, typically written. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Computer classes C. Excursion E. Project work W.

Module no.	1.3
Module identifier	CLIPROC - Overview
Module title	Climate Processes
Module type	Compulsory
Coordinator	Emeis, Hartmann
Lecturers	Emeis, Frisius, Hartmann, Hense, Kutzbach, Schmiedl
Aim	Knowledge of key processes in the climate system including energy, matter and water budgets. Understanding of climate change processes on long time scales as well as recent global and local human impact.
Content	Introduction and specific case studies of the global biogeochemical cycles. Foci on key processes of atmospheric, in connection with marine and terrestrial systems <u>3 lectures, each with 3 CP:</u> 1.3.1 Geophysical fluid dynamics; L [Beckmann] 1.3.2 Global biogeochemical cycling and the climate system; L [Hartmann, Kutzbach] 1.3.3 Integrated climate-economic modelling; L [Held]
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	9.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.3.1NEU
Module identifier	CLIPROC - 1
Module element title	Geophysical Fluid Dynamics
Module type	Compulsory
Lecturers	Beckmann
Aim	To obtain a theoretical understanding of aspects of the general atmospheric and oceanographic circulation
Content	<p>Mathematical description of dynamical processes (waves, boundary layer dynamics, hydrodynamic instabilities)</p> <ul style="list-style-type: none"> * Hydrodynamic System of Equations, Earth's rotation * Boundary conditions, approximations * Ekman layers * Linear barotropic waves * Potential vorticity, barotropic instability * Large scale wind-driven ocean circulation * Baroclinic waves * Quasigeostrophy, baroclinic instability * Large scale atmospheric circulation * Internal waves * Topographic Effects
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.3.2
Module identifier	CLIPROC - 2
Module element title	Global biogeochemical cycling and the climate system
Module type	Compulsory
Lecturers	Hartmann, Kutzbach, Emeis, Schmiedl
Aim	Understanding of the processes controlling the major global cycles of biogeochemical matter between the atmosphere, ocean and land.
Content	Biogeochemical processes relevant on the global scale. This includes explanation of marine, hydrologic, atmospheric, extraterrestrial, geologic, biologic, and human causes of and response to environmental change on time scales of tens, thousands, and millions of years.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	ICSS-3.4.6
Module identifier	
Module title	Integrated climate-economic modelling for global mitigation policies
Module type	
Lecturers	Hermann Held
Aim	Providing an overview on integrated climate-economic modelling that supports an assessment of how, when, and to what extent global warming could be mitigated.
Content	The status of the scientific arguments behind global warming mitigation targets and instruments is reviewed, covering competing schools within climate economics. The necessary modelling tools are introduced together with a module-adjusted short course on resource economics and economic growth theory. Special attention is given to the fact that in the end, society must take decisions under partial uncertainty. Scientific instruments to reflect this instance will be outlined accordingly.
Teaching and learning methods	L
Language	English
Requirements for participation	Bachelor-level of applied mathematics, climate dynamics, and scientific English. No prior knowledge on economics is required.
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Marks will be given upon participation and a written examination covering all topics of the course.
Work load (parts) with Credit Points CP	2SWS = 3CPs
Group size	
Frequency	Singular event; selective overview version of a future annual 2-semester course that will start in the summer term.
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.4

Module no.	1.4
Module identifier	CLIAD - Overview
Module title	Climate System Additional
Module type	Optional / Elective
Coordinator	Kaleschke, Hort
Lecturers	Hartmann, Kaleschke, Kutzbach, Leitl, Langmann, Müller-Navarra, Pfeiffer, Schlünzen
Aim	To complete the scientific basics and key research field for a holistic view on the earth system and the climate system; key contributions from other MSc and MA programs
Content	<p>Complementing key topics of climate system sciences from other tracks and related MSc programs can be selected.</p> <p>1.4.1 Aerosols; L [NN, Langmann]</p> <p>1.4.2 Sea ice 1; L, P [Kaleschke]</p> <p>1.4.3 Chemistry of natural waters; L, P [Hartmann]</p> <p>1.4.4 Urban climate; L [Leitl, Schlünzen]</p> <p>1.4.5 Permafrost soils and landscapes in the climate system; L [Kutzbach, Pfeiffer]</p> <p>1.4.6 Aquatic ecology; L, S [Müller-Navarra]</p> <p>1.4.7 Communication climate change - practitioners' perspectives; S, P [Schäfer]</p> <p>1.4.8 Open source scripting for geoscientific data analysis; P [Kaleschke]</p> <p>1.4.9 Selected topics in climate- and agro-economics, L, P, S [Held]</p>
Teaching and learning methods	L, S, P
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	6.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.4.1
Module identifier	CLIAD - 1
Module title	Aerosols
Module type	Optional / Elective
Lecturers	Langmann
Aim	Knowledge of aerosols in the climate system.
Content	Aerosol sources and formation processes. Characterisation of atmospheric aerosols. Aerosol modification in the atmosphere. Aerosol impact on climate. Spatial and temporal variations of aerosols in the climate system.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	1.5
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.4.2

Module no.	1.4.2
Module identifier	CLIAD - 2
Module title	Sea ice 1
Module type	Optional / Elective
Lecturers	Kaleschke
Aim	The participants will learn about the physical basics of sea ice and about the role of sea ice in the climate system.
Content	Sea ice phenomenology and nomenclature; sea ice phase diagram; growth and melt of sea ice; surface heat balance; interaction with the ocean and the atmosphere; electromagnetic properties; measurement techniques; sea ice climatology
Teaching and learning methods	L, P
Language	English or German
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.4.3
Module identifier	CLIAD-3
Module title	Chemistry of natural waters
Module type	Optional / Elective
Lecturers	Hartmann
Aim	Processes that control the chemical composition of natural waters (surface waters and groundwaters). The approach is to combine background theory (e.g., thermodynamics, carbonate system (CO ₂), dissolution/precipitation of matter, physics of water-air gas exchange, etc.) with case studies from the literature.
Content	Chemical background, equilibrium thermodynamics, activity-concentration relationships, the carbonate system and pH control, clay minerals and cation exchange, adsorption processes, organic compounds in natural waters, redox equilibria, redox conditions in natural waters, kinetics, weathering and water chemistry, isotopes, marine water chemistry.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Good knowledge in geosciences
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.4.4

Module no.	1.4.4
Module identifier	CLIAD - 4
Module title	Urban climate
Module type	Optional / Elective
Lecturers	Leitl, Schlünzen
Aim	Improvement of meteorological expertise.
Content	Urban climatology including key aspects on atmospheric chemistry, earth system research, and climate processes
Teaching and learning methods	L
Language	German; English only after joint approval.
Requirements for participation	None
Usability	Semester 1 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.4.5
Module identifier	CLIAD - 5
Module title	Permafrost soils and landscapes in the climate system
Module unit	Optional / Elective
Lecturers	Kutzbach, Pfeiffer
Aim	Knowledge on the high-latitude (arctic, subarctic, boreal, antarctic, sub-antarctic) landscapes, soils and vegetation and their role in the climate system
Content	High-latitude terrestrial processes, permafrost, periglacial processes, permafrost-affected soils, cryoturbation, cryogenic weathering, upland and lowland tundra, boreal forests and peatlands, tree- and shrubline dynamics, role of high-latitude terrestrial systems in the global climate system, impact of climate and land use change on arctic and boreal ecosystems and permafrost
Teaching and learning methods L	
Language	English
Requirements for participation	Good knowledge in geosciences
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Joint examen for all module elements of the module 1.4 (or alternative 2.2.2), typically written. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	1.5
Frequency	Annually in winter semester
Duration	If in winter semester: half of lecture period, 2 hours per week (or alternatively if in summer semester: whole lecture period, 1 hour per week)

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.4.6

Module no.	1.4.6
Module identifier	CLIAD - 6
Module title	Aquatic ecology
Module type	Optional / Elective
Lecturers	Müller-Navarra
Aim	Overview of ecological processes in aquatic ecosystems which interrelate with climate. The focus will be on lakes, rivers and estuaries, and wetlands.
Content	Origin and characterization of systems as lakes and rivers, including estuaries and wetlands. Introduction into their habitats and biological players. Both, biological and ecological processes that control biomass production and biogeochemical cycles, as well as biocoenotic processes impacted by climate will be covered.
Teaching and learning methods	L, S
Language	English
Requirements for participation	Basic knowledge in biology
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral examination, or oral or written report. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.4.7
Module identifier	CLIAD - 7
Module title	Communicating climate change - practitioners' perspectives
Module type	Optional courses of the specialization track
Lecturers	Schäfer
Aim	The course will provide insights into mass media communication of climate change from a practical point of view. After a brief introduction in which communication models and aims of communication will be discussed, representatives of different organizations from the wider field of communication on climate issues will present their views and experiences. This will enable students to better understand the logic and, also, the specific difficulties of mass media communication on climate change.
Content	Journalists from different media and scientists as well as spokespeople from NGOs and enterprises will talk about communicating climate change in this course. They will share their practical experience, talk about the routines of their work, possible problems and positive experiences and will discuss them with the participants of the course. Students will have to prepare and chair discussion sessions.
Teaching and learning methods	S, P
Language	English
Requirements for participation	See specific announcements
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Oral
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.4.8
Module identifier	CLIAD - 8
Module title	Open source scripting for geoscientific data analysis
Module type	Optional courses of the specialization track

Lecturers	Kaleschke
Aim	The participants will learn how to work in an open source environment for scientific programming and data analysis. The course is recommended as a preparation for the follow-up course "satellite image processing and analysis".
Content	The Python programming language will be introduced as a licence-free alternative to systems like Matlab or IDL. In combination with modules and tools such as scipy, the Geospatial Data Abstraction Library (GDAL), the NCAR Command Language (NCL) or the Generic Mapping Tools (GMT), Python becomes a flexible system for data processing and analysis.

Teaching and learning methods P

Language	English or German
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation and project report. Basic programming skills are required.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter.
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 1.4.9

Module no.	1.4.9
Module identifier	CLIAD - 9
Module title	Practical training units for climate system 1
Module type	Optional courses of the specialization track
Lecturers	Behrens, Scheffran
Aim	To gain in-depth practical experience related to subjects of course of climate system 1
Content	Practical training units e.g. related to numerical modeling, climate and society
Teaching and learning methods	P
Language	English or German
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation and project report. Basic programming skills are required.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter.
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.1

Module no.	2.1
Module identifier	CLISYS2 - Overview
Module title	Climate System 2
Module type	Compulsory
Coordinator	Claussen
Lecturers	Claussen, Marotzke, NN
Aim	In-depth insights in the climate system dynamics and further specialization on disciplinary knowledge and methods in physics, biogeochemistry and also economics and the social sciences.
Content	2.1.1 Climate Dynamics; L [Marotzke] 2.1.2 Dynamical Palaeoclimatology; L [Claussen] 2.1.3 Introductory course on sustainability; L, S [NN]
Teaching and learning methods	L, S
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; reference semester 4; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation, homework assignments, handing in of course report based on work with a simple climate model. Types of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	9.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.1.1
Module identifier	CLISYS2 - 1
Module element title	Climate dynamics
Module unit	Compulsory
Lecturers	Marotzke
Aim	Concepts and models are introduced that help us to understand fundamental aspects of the Earth's climate, such as global mean temperature, global-scale temperature differences, and what might cause these to vary on timescales of decades and longer. Particular emphasis will be placed on oceanic and coupled ocean-atmosphere processes. While we cover observed elements of the climate system and a hierarchy of models ranging from the simplest models to general circulation models, the focus will be on the art and science of constructing simplified models that help us obtain conceptual understanding. Discussing what is not understood, and hence identifying areas of current and future research, will be a crucial element of the course.
Content	<ul style="list-style-type: none"> * Introduction and Atmospheric Observations * Simple Climate Models I + II * Ocean Data and Dynamics I: Passive Ocean Models * Ocean Data and Dynamics II: Thermohaline Circulation (THC) and Salinity Effects * Ocean Data and Dynamics III: Surface Boundary Conditions * Ocean Data and Dynamics IV: Box Models - Multiple Equilibria & Interhemispheric Flow * Coupled Box Models I: Formulation and Steady States * Coupled Box Models II: Time-dependence and Feedbacks * THC Theory * General Circulation Models: Multiple Equilibria of the Global THC
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; reference semester 4; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation, homework assignments, handing in of course report based on work with a simple climate model. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.1.2
Module identifier	CLISYS2 - 2
Module title	Dynamical palaeoclimatology
Module type	Compulsory
Lecturers	Claussen
Aim	An important aim of this lecture is the discussion of externally forced climate variability and internal climate variability at time scales of centuries and longer. This is put into a perspective of the discussion of current climate change.
Content	<p>A brief overview of climate variations and climate change since the beginning of Earth some 4.6 billion years ago is given. Climate reconstructions from palaeo records are physically interpreted by using conceptual and comprehensive climate system models.</p> <ul style="list-style-type: none"> * Precambrian: the snow-ball earth * Phanerozoic: effects of long-term plate tectonics and development of the biosphere * Mesozoic and early Cenozoic: greenhouse climate and Tertiary cooling * Quaternary: Ice ages, Milankovich cycles * Pleistocene: sub-Milankovich cycles * Holocene: interglacial climate, little ice age * Anthropocene: external greenhouse gas emissions, land-cover change
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; reference semester 4; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.1.3

Module no.	2.1.3
Module identifier	CLISYS2 - 3
Module title	Introductory course on sustainability
Module type	Compulsory
Lecturers	NN
Aim	Knowledge on sustainability including the 3 pillars (environmental, social and economic issues) and cross-cutting problems
Content	Definition of sustainability in environmental, social and economic disciplines. Impact assessment of policies on sustainability. Importance of stakeholder involvement for sustainable development.
Teaching and learning methods	L, S
Language	English
Requirements for participation	None
Usability	Semester 2 of ICSS; reference semester 4; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation, homework assignments, handing in of course report based on work with a simple climate model. Types of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.2
Module identifier	CLISPEC - Overview
Module title	Climate System Specialization
Module type	Optional courses of the specialization track
Coordinator	Stammer, Emeis, Funke
Lecturers	Braun-Thürmann, Baehr, Borth, Dilly, Engels, Funke, Gerber, Hartmann, Hense, Holler, Kaleschke, Kalinowski, Knoblauch, Koehl, Kutzbach, Lunkeit, Neverla, Pohlmann, Schäfer, Scheffran
Aim	Knowledge and method application in the field and in the lab and further specialization on disciplinary knowledge and methods.
Content	<p>To gain in-depth knowledge in climate system sciences in one specialization. Three module elements need to be selected from one specialization track and one module element from another track or an interdisciplinary seminar can be taken.</p> <p><u>Track ICSS-P.</u></p> <p>2.2.1.1 Sea ice 2 (Ocean-atmosphere-ice interaction); L, P [Kaleschke] 2.2.1.2 Fundamentals of climate modeling; L, S, P [Baehr] 2.2.1.3 Conceptual models of complex systems: Development, application and analysis; L, P [Frisius] 2.2.1.4 Advanced numerical methods for climate modeling, LP [Behrens] 2.2.1.5 Scientific programming, L, P [Behrens] 2.2.1.x Introduction to climate modeling; L, P [NN, Lunkeit, Borth, Pohlmann, Koehl]</p> <p><u>Track ICSS-B.</u></p> <p>2.2.2.1 Land-ocean transport of biogeochemical matter; L [Hartmann] 2.2.2.2 Soil, water and vegetation processes and their coupling to the atmosphere; L [Kutzbach, Knoblauch] 2.2.2.3 Dynamics of marine ecosystems; S [Hense]</p> <p><u>Track ICSS-ES.</u></p> <p>2.2.3.1 Society, innovations and climate change; S [Braun-Thürmann] 2.2.3.2 The economics of climate change and climate policy; L, S [NN] 2.2.3.3 Media Representations of Climate Change; S [Schäfer] 2.2.3.4 Climate policy, law and institutions; L, P, S [Scheffran, Kalinowski, NN] 2.2.3.5 Public choice; L, S [Holler]</p> <p><u>Plus</u></p> <p>2.2.4 Interdisciplinary seminar related to climate system sciences, offers given by the different disciplines; S [Dilly]</p>
Teaching and learning methods	L, S, P
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	12.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.3.3
Module identifier	CLIPROC - 3
Module element title	Marine ecosystem dynamics
Module type	Compulsory
Lecturers	Hense
Aim	To have an overview about biological-physical processes and interactions in the ocean on different temporal and spatial scales.
Content	Spatial and temporal distribution patterns and variability in biological, nutrient and physical fields in the ocean are presented. Examples include coastal regions, upwelling systems, fronts and oligotrophic oceans. Factors and processes regulating marine primary production and transfer to higher trophic levels are explained.
Teaching and learning methods	L
Language	English
Requirements for participation	None
Usability	Semester 1 of ICSS; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.1.1

Module no.	2.2.1.1
Module identifier	CLISPEC - 1
Module title	Sea ice 2 (Ocean-atmosphere-ice interaction)
Module unit	Optional courses of the specialization track
Lecturers	Kaleschke
Aim	The participants will learn about special topics of the ocean-atmosphere-ice interaction and numerical sea ice modeling.
Content	Special topics of the ocean-atmosphere-ice interaction: polynyas and leads, the atmospheric boundary layer over the ice covered ocean, and sea ice physicochemical exchange processes.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Participation in the course 'Sea ice'
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.1.2

Module no.	2.2.1.2
Module identifier	CLISPEC - 2
Module title	Fundamentals of climate modeling
Module unit	Optional courses of the specialization track
Lecturers	Baehr
Aim	Explore the advantages and realize the limitations of numerical models to enhance our understanding of the climate system
Content	Run and analyze a simple atmosphere-ocean box model. To answer both given and novel research questions.
Teaching and learning methods	L, S, P
Language	English
Requirements for participation	Module 1.2; see specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.2.1.3
Module identifier	CLISPEC - 3
Module title	Conceptual models of complex systems: Development, application and analysis
Module unit	Optional courses of the specialization track
Lecturers	Frisius
Aim	This module conveys skills in development of conceptual mathematical models for complex systems. Such models comprise the essential dynamics and provide a deeper understanding of the systems. The students will be able to code such models, to perform numerical simulations and to carry out dynamical system analysis. The approach is multidisciplinary and, therefore, the student will be able to adapt the technique to the numerous fields in integrated climate system sciences.
Content	This lecture gives an introduction to model development, simulation and dynamical system analysis. The focus will be on conceptual models of complex systems containing only the essential processes. The approach is applicable for the broad spectrum of disciplines in integrated climate system sciences. Models will be formulated as dynamical systems, i.e. a closed set of ordinary differential equations. The students will obtain the opportunity to create their own template for a numerical model of any dynamical system. This forms a basis for the development of a system zoo which contains numerous conceptual models with varying complexity in the area of physics, climate, ecosystems, society and resources. Simulations with various initial conditions will be performed to gain a first overview of the dynamics by plotting trajectories in phase space. More insight can be obtained by dynamical system analysis. This analysis comprises determination of steady states or limit cycles, studying their stability by linearization, variation of model parameters to detect bifurcations, characterization of the system attractors by determination of Lyapunov exponents, and construction of a regime diagram. Finally, this lecture presents simple world models and discusses various scenarios for saturation of growth in the future development of humankind. The lecture will be accompanied by practicals where the students learn to program the models in Fortran language, to handle them and to do dynamical system analysis.
Teaching and learning methods	L, P
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.2.1.4
Module identifier	CLISPEC - 4
Module title	Advanced numerical methods for climate modeling
Module unit	Optional courses of the specialization track
Lecturers	Behrens
Aim	To gain insight into advanced numerical methods for climate modeling, especially methods for conservation laws, efficient parallel solvers for large linear systems of equations, multi-level methods, etc.
Content	<p>Introduction to numerical methods for conservation laws:</p> <ul style="list-style-type: none"> - introduction to structure of conservation laws - finite volume methods, discontinuous Galerkin methods, conservative Finite-Elements - advanced time integration schemes - issues in high performance computing <p>Parallel solution of large systems of linear equations:</p> <ul style="list-style-type: none"> - introduction to parallel architectures and HPC systems - iterative solution of large systems of equations: Krylov subspace methods, multi-level methods - efficient pre-conditioners
Teaching and learning methods	L, P
Language	English
Requirements for participation	Numerical Approaches
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Exam in English
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer term
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.2.1.5
Module identifier	CLISPEC - 5
Module title	Scientific Programming
Module type	Optional courses of the specialization track
Lecturers	Behrens
Aim	To learn software engineering methods for programming, to be able to use programming related tools, to become aware of state of the art planning and documentation in software development
Content	<p>Introduction to software engineering:</p> <ul style="list-style-type: none"> - software life cycle - facts about software engineering - mapping software to hardware <p>Version Control:</p> <ul style="list-style-type: none"> - introduction to versioning - using version control systems <p>Project management:</p> <ul style="list-style-type: none"> - ticketing and release planning - using wikis for documentation <p>Verification and Validation:</p> <ul style="list-style-type: none"> - testing methodology - automated builds - debugging and how to use debuggers <p>Technical Documentation:</p> <ul style="list-style-type: none"> - types of documentations - tools for in-line documentation
Teaching and learning methods	L, P
Language	English
Requirements for participation	Knowledge of a higher programming language (C/C++ or Fortran90 preferred)
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Exam in English
Work load (parts) with Credit	3.0
Points CP	
Group size	20 max.
Frequency	Annually in summer semester break
Duration	1-week block course

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.1.x

Module no.	2.2.1.x
Module identifier	CLISPEC - x
Module title	Introduction to climate modeling
Module unit	Optional courses of the specialization track
Lecturers	NN, Lunkeit, Borth, Pohlmann, Koehl
Aim	Advanced knowledge about climate modelling
Content	Spectral and gridpoint models of the atmosphere, the ocean, the shelf seas and land and also sea ice.
Teaching and learning methods	L, P
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.2.1

Module no.	2.2.2.1
Module identifier	CLISPEC - 5
Module title	Land-ocean transport of biogeochemical matter
Module unit	Optional courses of the specialization track
Lecturers	Hartmann
Aim	Principles of lateral transport of biogeochemical matter (C, Si, N, P). This includes mobilization of matter on the terrestrial system, transformation during transport to the coastal zones. Role of lateral transports in the climate system should be understood. This unit provides the overview on topics explained in depth in additional courses
Content	Mobilization of biogeochemical matter from the terrestrial land system into river systems; transformation of the biogeochemical matrix during transport including photosynthesis, respiration of organic matter and hydrochemical dissolution of matter; water-air gas exchange (CO ₂ , CH ₄) in context of biogeochemical processes; coastal zones as filters of transported matter; the role of the land-ocean fluxes in context of global cycles of biogeochemical matter
Teaching and learning methods	L
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.2.2.2
Module identifier	CLISPEC - 6
Module title	Soil, water and vegetation processes and their coupling to the atmosphere
Module unit	Optional courses of the specialization track
Lecturers	Kutzbach, Knoblauch
Aim	<p>Knowledge on the biogeochemical and biophysical processes in soils and the vegetation, the complex interactions between soils, vegetation and the atmosphere, and the close coupling between energy, water and carbon fluxes.</p> <p>Understanding of the impact of soils and vegetation on the microclimate and of the control of soil and vegetation processes by atmospheric driving forces.</p>
Content	<p>Atmospheric boundary layer characteristics, wind and turbulence, mass and energy exchange, soil heat and water budget, evapotranspiration, organic matter mineralization, cycles of C, N, S and Fe in soils, plant microorganism interactions, CO₂ exchange processes: photosynthesis, autotrophic respiration, heterotrophic respiration, methane-related soil processes: production, oxidation and soil-atmosphere transport mechanisms, coupling of energy, water and carbon exchange processes, instrumentation for biometeorological measurements.</p>
Teaching and learning methods	L
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.2.3

Module no.	2.2.2.3
Module identifier	CLISPEC - 7
Module title	Dynamics of marine ecosystems
Module unit	Optional courses of the specialization track
Lecturers	Hense
Aim	The aim of this unit is to provide students an overview about biological-physical processes and interactions in the ocean on different temporal and spatial scales.
Content	Spatial and temporal distribution patterns and variability in biological, nutrient and physical fields in the ocean are presented. Examples include coastal regions, upwelling systems, fronts and oligotrophic oceans. Factors and processes regulating marine primary production and transfer to higher trophic levels are explained.
Teaching and learning methods	S
Language	English
Requirements for participation	BSc in geosciences, physics, meteorology, oceanography, biology or related degree
Usability	See specific announcements
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.3.1

Module no.	2.2.3.1
Module identifier	CLISPEC - 8
Module title	Society, innovations and climate change
Module unit	Optional courses of the specialization track
Lecturers	Braun-Thürmann
Aim	Introduction into the innovations studies. Theories and empirical knowledge concerning the origins and consequences of technological and social innovations. Exercises in the analyses of innovation systems and processes.
Content	Introduction into basic concepts of innovations processes, the relevant actors, and the institutional structure. Concepts of "innovation policy" and "innovation management"
Teaching and learning methods	S
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Final essays as individual or team achievement. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.3.2

Module no.	2.2.3.2
Module identifier	CLISPEC - 9
Module title	The economics of climate change and climate policy
Module unit	Optional courses of the specialization track
Lecturers	NN
Aim	Understanding of significant economic factors under global climate change processes
Content	The course introduces economic issues underlying the threat of global climate change, and the institutions engaged in negotiating an international response.
Teaching and learning methods	L, S
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.3.3

Module no.	2.2.3.3
Module identifier	CLISPEC - 10
Module title	Media representations of climate change
Module unit	Optional courses of the specialization track
Lecturers	Schäfer
Aim	Understand the logic of public communication outside science, learn about specifics of media coverage of climate change issues.
Content	Communication research on climate and climate change. The logic of the mass media and their construction of scientific and environmental issues. Climate issues at a global, European and national dimension.
Teaching and learning methods S	
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation including oral presentation, essay
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.3.4

Module no.	2.2.3.4
Module identifier	CLISPEC - 11
Module title	Energy and climate policy
Module unit	Optional courses of the specialization track
Lecturers	Kalinowski, Scheffran, Singer
Aim	Provide an understanding of the key factors, mechanisms and institutions in energy and climate policy on national and international levels.
Content	Introduction to alternative energy systems, energy resources and international war, civil-military ambivalence of nuclear energy, CO ₂ -emissions from energy production, climate mitigation and adaptation strategies, comparative analysis of energy and climate policy regimes and institutions, including negotiation processes.
Teaching and learning methods	L
Language	English
Requirements for participation	BSc in any field relevant to the topic of this class.
Usability	Semester 2 of ICSS; optional for related MSc programmes, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written exam.
Work load (parts) with Credit Points CP	3
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.3.5

Module no.	2.2.3.5
Module identifier	CLISPEC - 12
Module title	Public choice
Module unit	Optional courses of the specialization track
Lecturers	Holler
Aim	To demonstrate the variability of public choices in the field of philosophy, economics and politics
Content	Analysis of political institutions; special focus will also be given to institutions that are involved in the development of climate policies e.g. United Nations Framework Convention on Climate Change (UNFCCC)
Teaching and learning methods	L, S
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Presentations and exercises. Written exam. Language of the exam is English.
Work load (parts) with Credit Points CP	4.5
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 2.2.4

Module no.	2.2.4
Module identifier	CLISPEC - 13
Module title	Seminar of topics on climate system specialization
Module unit	Optional courses of the specialization track
Lecturers	Dilly and all lecturers
Aim	To get in-depth views of the specialization track and interdisciplinary discussions related to key topics of the climate system
Content	Actual topics related to the specialization tracks related to climate system sciences; e.g. Geophysical colloquium, Actual topics of earth system sciences, clisap colloquiums
Teaching and learning methods	S
Language	English
Requirements for participation	See specific announcements
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3

Module no.	2.3
Module identifier	CLIOBS1 - Overview
Module title	Climate System Observations 1
Module type	Optional courses of the specialization track
Coordinator	Stammer
Lecturers	Emeis, Gouretski, Knoblauch, Kutzbach, Quadfasel, Stammer, Schmiedl, Velazco, Eschenbach
Aim	Application of scientific and methodological knowledge in the field and the lab
Content	To gain practical experience in climate system sciences exemplified by the following offers 2.3.1 Climate Observations and Earth Remote Sensing; L [Gouretski, Quadfasel, Stammer, Velazco] 2.3.2 Field course on soil, water and atmospheric processes; P [Eschenbach, Gröngröft, Kutzbach, Knoblauch] 2.3.3 Marine geological practices and carbonate system; E [Emeis, Hartmann, Schmiedl] 2.3.4 Application of stable isotopes in terrestrial ecosystems; P [Knoblauch] 2.3.5 Satellite image processing and analysis; P [Kaleschke]
Teaching and learning methods	L, P, E
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	6.0
Frequency	Annually in summer semester
Duration	1 semester or block

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3.1

Module no.	2.3.1
Module identifier	CLIOBS1 - 1
Module title	Climate Observations and Earth Remote Sensing
Module type	Optional courses of the specialization track
Lecturers	Gouretski, Quadfasel, Stammer, Velazco
Aim	Knowledge about basic climate observations and how they are being collected. Also uncertainties of observations are addressed.
Content	Basis climate observations and observing system. In situ observations. Proxy and paleo data. Remote sensing.
Teaching and learning methods	L
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 Semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3.2

Module no.	2.3.2
Module identifier	CLIOBS1 - 2
Module title	Field course on soil, water and atmospheric processes
Module type	Optional courses of the specialization track
Lecturers	Eschenbach, Gröngröft, Kutzbach, Knoblauch
Aim	To advance experience with design and realization of field measurement campaigns, soil-hydrological, micrometeorological, soil-biogeochemical and plant-ecophysiological measurements, and data analysis for investigating soil-vegetation-atmosphere interactions on the landscape scale.
Content	Experiment design; spatial and temporal variability of environmental variables and biogeochemical fluxes, scaling problem; hydrological, soil-biogeochemical, micrometeorological, and plant-ecophysiological measurements; closed-chamber approach to measure CH ₄ and CO ₂ exchange, gross photosynthesis and ecosystem respiration; eddy covariance approach to measure exchange fluxes of energy, water, CO ₂ , and CH ₄ ; soil gradients of gas concentrations, data analysis and presentation; 4 seminar days and 5 field work days
Teaching and learning methods	P
Language	English and German, as a rule English
Requirements for participation	Basic knowledge in geosciences
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Written report on conducted practical work and data analysis. Active participation. Language of the exam is English.
Work load (parts) with Credit Points CP	6.0
Frequency	Annually in summer semester
Duration	block (9 eight-hour days) after the end of the lecture period (July or August)

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3.3

Module no.	2.3.3
Module identifier	CLIOBS1 - 3
Module title	Marine geological practices and carbonate system
Module type	Optional courses of the specialization track
Lecturers	Emeis, Hartmann, Schmiedl
Aim	In-depth knowledge of coastal and marine geology. Skills for planning, management and dissemination of an excursion; e.g. analysis of the carbonate system (CO ₂).
Content	Dependent on the type of excursion: acoustic methods for sediment analysis, fundamentals of seismic stratigraphy, geographical information systems, sampling of solid and liquid samples in the Elbe Estuary. Sedimentological and micropalaeontological analysis. Samples pre-conditioning and analysis in the hydrochem lab (CO ₂ , alkalinity, DIC, nutrients, etc.). Handling of key analysis equipment will be trained and results analysed in context of the climate system, i.e. comparison with larger data sets. Evaluation, interpretation and presentation of data of marine topics.
Teaching and learning methods	E
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 Semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3.4

Module no.	2.3.4
Module identifier	CLIOBS1 - 4
Module title	Application of stable isotopes in terrestrial ecosystems
Module type	Optional courses of the specialization track
Lecturers	Knoblauch, NN
Aim	Overview of the potentials of stable isotope measurements for studying element fluxes in terrestrial ecosystems. The focus will be on isotope effects in the carbon cycle with special emphasis on climate relevant trace gases (carbon dioxide, methane). Students will learn both the use of natural isotope signatures and stable isotope tracer techniques.
Content	Analysis of carbon turnover processes in terrestrial ecosystems and their regulation using stable isotope techniques. Application of stable isotope tracers to quantify carbon fluxes in the environment. Analysis of stable isotope data.
Teaching and learning methods	P
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	Block

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 2.3.5

Module no.	2.3.5
Module identifier	CLIOBS1 - 5
Module title	Satellite image processing and analysis
Module type	Optional courses of the specialization track
Lecturers	Kaleschke
Aim	The participants will learn to practically work with satellite image data and to develop image processing algorithms to derive geophysical information from the satellite data. Organized as a group project, the participants will further learn the principles of project management and shared software development.
Content	Satellite image processing and analysis techniques, depending on the project, for example: interpolation, geometrical transformation, smoothing and edge detection filters, object motion, segmentation, classification
Teaching and learning methods	P
Language	English and German, as a rule English
Requirements for participation	BSc in geosciences, physics, meteorology, oceanography and related degree
Usability	Semester 2 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation and project report. Basic programming skills are required. The participation in the course "open source scripting for scientific data analysis" is recommended. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Computer classes C. Excursion E. Project work W.

Module no.	2.4
Module identifier	CLISOFT1
Module title	Soft Skills 1
Module type	Optional / Elective
Coordinator	Dilly
Lecturers	NN
Aim	To support the individual development of soft skills and competences for working and scientific career.
Content	The students will develop a range of essential research and work skills, including literature search and review, formulating a research hypothesis, project planning, seminar and poster presentation and writing research papers. We will also consider the program of the Career Center of the University of Hamburg. SICSS will offer the following courses: 2.4.1 Design of presentations and giving talks; S [NN] 2.4.2 Computer literacy; S [NN]

Teaching and learning methods S

Language	English
Requirements for participation	None

Usability	PhD program of SICSS and IMPRS-ESM
Type, pre-requisites and language of the exam	Active participation. Written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit	3.0
Points CP	
Frequency	Annually in summer semester
Duration	Block or distributed over one semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	2.4.1
Module identifier	CLISOFT1
Module title	Research skills
Module type	Optional / Elective
Coordinator	Dilly
Lecturers	Baehr
Aim	To prepare junior students for some of the commonly faced challenges.
Content	<p>In each class, one topic will be introduced by an senior/ guest and/or the organizer, with plenty of time for a subsequent discussion. Students are asked to prepare the discussions by sending questions to the organizer in advance.</p> <p>Examples for potential topics: Thesis panel, choosing thesis topic(s), experimental set-up, scientific writing, publishing, paper reviews (doing and receiving), network, careers, conferences, oral presentations, posters, mentoring, advisor, time management, working interdisciplinary, work-life-balance, ...</p> <p>Participants can be both PhD students or senior MSc students planning to pursue a PhD. Each participant should (co)lead one discussion. Therefore, the course is limited to 24 students.</p>
Teaching and learning methods	S
Language	English
Requirements for participation	None
Usability	PhD program of SICSS and IMPRS-ESM
Type, pre-requisites and language of the exam	Active participation. Written report. Type of exam will be fixed at the beginning of this module. E.g. - Participation (at least 80 % of the lectures), - Preparation of one discussion, - Write up of the prepared discussion
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in summer semester
Duration	Block or distributed over one semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 3.1

Module no.	3.1
Module identifier	CLISEM
Module title	Seminar on Integrated Climate System Sciences
Module type	Compulsory
Coordinator	Dilly, Spitzy
Lecturers	SICSS members
Aim	Identification of the objective of the MSc thesis, presentation and discussion of the concept of the MSc thesis, planning and management of the MSc thesis
Content	Active participation of presentations with references to research and work issues related to climate system sciences with discussions.

Teaching and learning methods S

Language	English; with exception also German or other languages
Requirements for participation	None

Usability	Semester 3; reference semester 3
Type, pre-requisites and language of the exam	Active participation and report on the structure of the presentations in the seminar. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Each semester; compulsory in Semester 3
Duration	Distributed over the semester; retreats also as block

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 3.2

Module no.	3.2
Module identifier	CLILAB - Overview
Module title	Climate System Sciences Lab
Module type	Optional courses of the specialization track
Coordinator	Stammer, Hartmann, Bassen
Lecturers	Baehr, Fraedrich, Kirk, Borth, Lunkeit, Kaleschke, Stammer, Hense, Hartmann, Drobnič, Zöllner, Bassen
Aim	Application of scientific and methodological knowlegde in the field and the lab
Content	To gain practical experience in climate system sciences exemplified by the following offers: <u>Track ICSS-P:</u> 3.2.1.1 Climate modeling lab; P [Fraedrich, Lunkeit, Kirk, Borth] 3.2.1.2 Data assimilation in ocean and shelf sea modeling; L, P [Baehr, Stammer, NN] <u>Track ICSS-B.</u> 3.2.2.1 Marine biogeochemical and ecosystem modeling; L, P [Hense] 3.2.2.2 Hydrochemical modeling; L, P [Hartmann] 3.2.2.3 Modeling of terrestrial ecosystem and biogeochemistry pocesses within the earth system models [Brovkin, Kleinen] <u>Track ICSS-ES.</u> 3.2.3.1 Multivariate research methods; L, S [Drobnič] 3.2.3.2 European Corporate Govenance; L, S [Zöllner, Bassen] 3.2.3.3 Estimating sustainability; S [Schneider]
Teaching and learning methods	L, S, P, C, W
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	9.0
Frequency	Annually in winter semester
Duration	1 semester or block

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.2.1.1

Module no.	3.2.1.1
Module identifier	CLILAB - 1
Module title	Climate Modeling Lab
Module type	Optional courses of the specialization track
Lecturers	Fraedrich, Lunkeit, Kirk, Borth
Aim	The module will provide a practical introduction into climate modeling. Based on the PLASIM modeling environment it will allow students to test climate models in specific settings, test sensitivities and through both learn how to run climate models.
Content	Run and analyze ocean-atmosphere-ice-land climate models; identify and explore useful applications; explore limits.
Teaching and learning methods	P
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.2.1.2

Module no.	3.2.1.2
Module identifier	CLILAB - 2
Module title	Ocean data assimilation
Module type	Optional courses of the specialization track
Lecturers	Stammer, Baehr
Aim	The module will provide practical experiences in combining ocean circulation models with observations and will thereby allow students to gain first experiences in the field of data assimilation.
Content	Run simple assimilation examples, including box inversions; Kalman filter and smoother; adjoint estimation approaches.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.2.2.1
Module identifier	CLILAB - 3
Module title	Marine biogeochemical and ecosystem modeling
Module type	Optional courses of the specialization track
Lecturers	Hense
Aim	The aim of this unit is to provide students the theoretical knowledge and practical skills needed to understand, apply and modify aquatic biogeochemical and ecosystem models.
Content	The basics of model structures are explained, including factors and processes which are generally considered in aquatic ecosystem and biogeochemical models. Focus will be put on plankton dynamics: growth and mortality processes of phytoplankton and zooplankton. Examples of biogeochemical models based on carbon and nitrogen are presented.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Good knowledge in geosciences
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3222
Module identifier	CLAS_4
Module title	Hydrochemical modeling
Module type	Optional courses of the specialization track
Lecturers	Herrmann
Aim	To understand hydrogeochemical models to analyze natural as well as man-made impacts on the aquatic system. A special focus will be set on the modeling of climate relevant matter (e.g. CO ₂).
Content	Theory of hydrochemical equilibrium models and application of PHREEQC to solve scientific questions related to the climate system. This includes determination of saturation indices, adjustment of equilibrium constants for minerals and gases, mixing of waters (for example in the coastal zone), modeling the effect of temperature, stoichiometric reactions, reactions in open and closed systems, sorption & surface complexation, inverse modeling, reactive transport.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Good knowledge in geochemistry
Usability	Semester 3 of ICSS, optional for related MSC programs, dependent on specifications and schedule.
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report, overall test and component testing. Type of exam will be fixed at the beginning of the module. Language of the exam is English.
Work load (parts) with Credit	30
Points CP	Annually in winter semester
Frequency	Annually in winter semester
Duration	1 semester

ICSS

Abbreviations: Lecture L, Practical training P, Seminar S, Examination E.

Module no.	3.2.2.3
Module identifier	CLILAB - 8
Module title	Terrestrial ecosystem processes within earth system models
Module type	Optional courses of the specialization track
Lecturers	Brovkin, Kleinen
Aim	To provide students with the theoretical knowledge and practical skills needed to understand and utilize terrestrial biosphere models used for future climate projections
Content	Introduction into models for large-scale vegetation dynamics. Explanation of basic structure of land carbon cycle models used on a global scale. Examples of modelling of landuse effects on terrestrial ecosystem and biogeochemistry, modelling of vegetation dynamics under changed climate; assessment of feedbacks between terrestrial ecosystems and climate on multiple spatial and scales. Biogeophysical and biogeochemical effects of land cover and landuse change on projected atmospheric CO2 concentration and climate change
Teaching and learning methods	L, S
Language	English
Requirements for participation	Good knowledge in mathematics and geosciences
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	1.5? (3 x 2 hours lectures + 2 hrs seminar)
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.2.3.1
Module identifier	CLILAB - 5
Module title	Multivariate research methods
Module type	Optional courses of the specialization track
Lecturers	Drobnič
Aim	(1) to enhance the student's awareness of various methods in design and analysis of various social science problems; (2) to introduce students to different methods and techniques for analyzing quantitative data; (3) to develop the skills necessary to critically evaluate published work in social sciences; (4) to develop students' skills in modeling and carrying out their own research; (5) to learn how to interpret results of statistical analyses; (5) to prepare students for more advanced courses in statistical methods
Content	This module provides an introduction to the logic of statistical control and multivariate statistical models, as they are commonly applied in the social science disciplines. The course emphasizes the understanding of statistical concepts and uses of statistics rather than mathematical formulas. Although the lectures are at the core of this course, they will be supplemented by seminar-type discussions about published papers. This course will be accompanied by weekly computer lab sessions (Übung) in which students will learn through hands-on experience to analyze data and interpret their results.
Teaching and learning methods	L, S
Language	English
Requirements for participation	Students are expected to have a solid command of the basic social science methodology and statistics, including inferential statistics and familiarity with SPSS (or some other large statistical package).
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written final exam. Language of the exam is English or German.
Work load (parts) with Credit Points CP	9.0 CP (4+2 SWS)
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.2.3.2
Module identifier	CLILAB - 6
Module title	European Corporate Governance
Module type	Optional courses of the specialization track
Lecturers	Zöllner, Bassen
Aim	The course intends to give students an overview of the various perspectives of and the trends in Corporate Governance in Europe, covering one of the most intensively discussed topics in finance and management today. The course develops a common understanding of Corporate Governance from a financial perspective, as well as its mechanisms and current regulatory reforms.
Content	The course "European Corporate Governance" comprises among others the following topics: <ul style="list-style-type: none"> • Corporate Governance Around the World – Theory and Practice • Mechanisms of Corporate Governance • Convergence and Divergence of Transatlantic Corporate Governance All topics will be covered in lecturing and have to be interpreted in presentations.
Teaching and learning methods	L, S
Language	English
Requirements for participation	Good knowledge of English, basic knowledge of Finance
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Marks will be given upon the presentation (outline and slides to be handed in) and an oral examination covering all topics of the course.
Work load (parts) with Credit Points CP	4.0 CP (2 SWS)
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.2.3.3

Module no.	3.2.3.3
Module identifier	CLILAB - 7
Module title	Estimating sustainability
Module type	Optional courses of the specialization track
Lecturers	Schneider
Aim	Exploring sustainability with special attention to land use and climate change
Content	This course addresses the sustainability of human activity, e.g. for provision of food and ecosystem services, sustainable land use for food, water and energy production.
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge of English, basic knowledge of finance
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Marks will be given upon the presentation (outline and slides to be handed in) and an oral examination covering all topics of the course.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	
Module identifier	
Module title	Communicating Climate Change - Practicioners' Perspectives
Module type	P
Lecturers	Jun.-Prof. Dr. Mike S. Schäfer
Aim	The course will provide insights into mass media communication of climate change from a practical point of view. After a brief introduction in which communication models and aims of communication will be discussed, representatives of different organizations from the wider field of communication on climate issues will present their views and experiences. This will enable students to better understand the logic and, also, the specific difficulties of mass media communication on climate change.
Content	Journalists from different media and scientists as well as spokespeople from NGOs and enterprises will talk about communicating climate change in this course. They will share their practical experience, talk about the routines of their work, possible problems and positive experiences and will discuss them with the participants of the course. Students will have to prepare and chair discussion sessions.
Teaching and learning methods	P
Language	English
Requirements for participation	Active participation, preparation of discussions, chairing a discussion
Usability	
Type, pre-requisites and language of the exam	Oral
Work load (parts) with Credit	3 CP
Points CP	
Group size	TBD
Frequency	weekly
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 3.3

Module no.	3.3
Module identifier	CLIOBS2 - Overview
Module title	Climate System Observations 2
Module type	Optional courses of the specialization track
Coordinator	Stammer, Pfeiffer
Lecturers	Kaleschke, Loew, Emeis, Schmiedl, Kutzbach, Pfeiffer, NN
Aim	Application of scientific and methodological knowlegde in the field and the lab
Content	To gain practical experience in climate system sciences exemplified by the following offers 3.3.1 Selected topics of applied remote sensing; S, P [Kaleschke, Loew] 3.3.2 Stable isotopes; L, P [Emeis, Schmiedl] 3.3.3 Data handling and analysis in geoecosystem research; L, P [Kutzbach] 3.3.4 Soils and land use of wetlands; E [Kutzbach, Pfeiffer]

Teaching and learning methods L, P, E

Language English

Requirements for participation Good knowledge in math and physics

Usability Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule

Type, pre-requisites and language of the exam Active participation. Protocol. Type of exam will be fixed at the beginning of this module.

Work load (parts) with Credit 6.0

Points CP

Frequency Annually in winter semester

Duration 1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 3.3.1

Module no.	3.3.1
Module identifier	CLIOBS2 - 1
Module title	Selected topics of applied remote sensing
Module type	Optional courses of the specialization track
Lecturers	Kaleschke, Loew
Aim	Learning practical work with satellite image data and to develop image processing algorithms to derive geophysical information from the satellite data. Processing of satellite images.
Content	Remote sensing of essential climate variables, retrieval techniques, image processing skills. Satellite image processing and analysis techniques, depending on the project, e.g. interpolation, geometrical transformation, smoothing and edge detection filters, object motion, segmentation, classification. The participants will also get experience in project and group management and shared software development.
Teaching and learning methods	S, P
Language	English
Requirements for participation	Basic programming skills are required. The participation in the course "open source scripting for scientific data analysis" is recommended.
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation and project report.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MS Integrated Climate System Sciences, Module 3.3.2

Module no.	3.3.2
Module identifier	CLIOBS2 - 2
Module title	Stable isotopes
Module type	Optional courses of the specialization track
Lecturers	Emeis, Schmiedl
Aim	In-depth knowledge of the application of isotopes in climate system sciences. Understanding processes under changing isotopic characteristics. Use of isotopic signatures for early diagnosis and also palaeotemperature and age estimation
Content	Application of modern approaches using isotopic characteristics for the analysis of geological and anthropogenic processes. Stable and non-stable isotopes. Methods of age estimations including radio carbon dating
Teaching and learning methods	L, P
Language	English and German, as a rule English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Protocol. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.3.3

Module no.	3.3.3
Module identifier	CLIOBS2 - 3
Module title	Data handling and analysis in geocosystem research
Module type	Optional courses of the specialization track
Lecturers	Kutzbach
Aim	To improve handling and analysis of data from soil-hydrological, micrometeorological and plant-ecophysiological measurements
Content	Data handling with typical softwares. In-depth analysis of closed-chamber and eddy covariance data (Matlab, EdiRe). Multivariate statistics, empirical statistical modelling such as Matlab. Error propagation, statistical hypothesis testing, estimation of uncertainties.
Teaching and learning methods	L, P
Language	English
Requirements for participation	Good knowlege in geosciences
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Written report on conducted practical work and data analysis. Active participation.
Work load (parts) with Credit Points CP	1.5
Frequency	Annually in winter semester
Duration	half of lecture period, 2 hours per week

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.3.4

Module no.	3.3.4
Module identifier	CLIOBS2 - 4
Module title	Soils and land use of wetlands
Module type	Optional courses of the specialization track
Lecturers	Pfeiffer, Kutzbach
Aim	Knowledge on the geomorphology, soil genesis, hydrology, biogeochemical fluxes, and vegetation at wetlands. To provide an understanding of the ecological and also economic and social functions of wetlands and of their response to land use change.
Content	Marshes and tidal flats, bogs and fens, river floodplains; (near-)pristine anthropogenically disturbed wetlands; wetland geomorphology, soil profile description and evaluation; soil genesis and ecology, hydrology, biogeochemical fluxes, especially CO ₂ and CH ₄ exchange; wetland vegetation; ecophysiology of wetland-adapted plants; ecological and socio-economic functions; impact of past and present land use change; 2 full days lectures and seminar; 4 full days excursion to selected wetlands.
Teaching and learning methods	E
Language	English
Requirements for participation	Good knowledge in geosciences
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Written examen for this specific course. Seminar Talk and active participation.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	Block; 3.5 days at the end of the semester (March)

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.4

Module no.	3.4	
Module identifier	CLISOCENV - Overview	
Module title	Additional of economics, social sciences and natural sciences	
Module type	Optional courses of the specialization track	
Coordinator	Scheffran	
Lecturers	Scheffran, Kalinowski, Kollek, Köhl, Krug, Kenter, Ossenbruegge, NN	
Aim		9.00
Content	<p>Courses can be selected such as</p> <p>3.4.1 Natural sciences, society and responsibility; L, S [NN, Kollek, Scheffran, Kalinowski]</p> <p>3.4.2 Health and climate change; L, S [NN].</p> <p>3.4.3 The IPCC Process; L, S [Köhl, Krug, Kenter]</p> <p>3.4.4 Climate security, natural resources and conflict geography; L [Scheffran, Brzoska, Ossenbrügge]</p> <p>Also courses of module 1.4 can be studied here if not taken previously.</p>	
Teaching and learning methods	L, S	
Language	English	
Requirements for participation	Good knowledge in math and physics	
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule	
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module.	
Work load (parts) with Credit Points CP	9.0	
Frequency	Annually in winter semester	
Duration	1 semester	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.4.1

Module no.	3.4.1
Module identifier	CLISOCENV - 1
Module title	Natural sciences, society and responsibility
Module type	Optional courses of the specialization track
Lecturers	NN, Kollek, Scheffran, Kalinowski
Aim	To analyse long-term impacts of technologies in the social and interdisciplinary context
Content	Awareness raising. Exemplification of impacts of environmental technologies on the society. Development of tools for problem-oriented and trans-disciplinary exchange and negotiations.
Teaching and learning methods	L, S
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 3.4.2

Module no.	3.4.2
Module identifier	CLISOCENV - 2
Module title	Health and climate change
Module type	Optional courses of the specialization track
Lecturers	NN
Aim	To address the impact of climate change (e.g. increase in temperature) on human and ecosystem structures and functioning
Content	The concept of human and ecosystem health will be introduced. The importance of stability and variability of biotic tissues and complex organisms will be analysed and the impact of climate change and specific scenarios on human and ecosystem health will be discussed.
Teaching and learning methods	L, S
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	1.5
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.4.3
Module identifier	CLISOCENV - 3
Module title	The IPCC Process
Module type	Optional courses of the specialization track
Lecturers	Köhl, Kenter, Krug
Aim	Increase the understanding of international political process and negotiations related to mitigating climate change effects and the understanding of Framework Convention on Climate Change (FCCC) and Kyoto GHG reporting schemes.
Content	Historical development of the UN-Framework Convention on Climate Change (FCCC) and the Kyoto Protocol, Assessment of carbon budgets in terrestrial ecosystems, including reliability analysis, in-depth analysis of Intergovernmental Panel on Climate Change (IPCC) information and reporting approaches and the relation to climate change mitigation strategies.
Teaching and learning methods	L, S
Language	English
Requirements for participation	None
Usability	Semester 3 of ICSS; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	1.5
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.4.5
Module identifier	CLISOCENV - 5
Module title	Soils of the world: Their services for the climate system
Module type	Optional courses of the specialization track
Lecturers	Pfeiffer, Dilly
Aim	Understanding the fundamental soil characteristics as the interface between atmosphere, biosphere, lithosphere, hydrosphere and anthrosphere and with reference to climatic conditions world-wide
Content	<p>Lectures and practical training units about soil types and key soil characteristics and their controls by climatic conditions. This course will help to understand the importance of soils in the global climate system for sustainable development and their services e.g for sustainable land-use. Global pattern and in particular case studies and sensitive regions are analysed. The following topics are addressed:</p> <ul style="list-style-type: none"> - The pedosphere as the 7th sphere in the climate system - Fundamentals in soil ecology from tropical to polar regions - Temperature and water controls of soil characteristics - Soil structures and texture - Soil metabolism and energetics - Resilience of soil properties - Soil conservation and multifunctional land-use - Sustainable soil and land-use
Teaching and learning methods	L
Language	English
Requirements for participation	None
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Joint examen for all module elements, typically written. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Computer classes C. Excursion E. Project work W.

MSc Integrated Climate System Sciences, Module 3.4.7

Module no.	3.4.7
Module identifier	CLISOCENV - 7
Module title	Selected topics in climate- and agro-economics
Module type	Optional courses of the specialization track
Lecturers	Held
Aim	Exploring global warming mitigation and adaptation options under different metrics of sustainability
Content	This course addresses the potential of various mitigation and adaptation options in terms of their effectiveness, their costs and their performance under various, sometimes conflicting sustainability standards.

Teaching and learning methods S

Language	English
Requirements for participation	Bachelor-level of applied mathematics, climate dynamics, biogeochemistry and scientific English. No prior knowledge in economics is required, yet the willingness to acquire topic-specific elementary knowledge on economics is expected.
Usability	Semester 1 of ICSS; reference semester 3; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Marks will be given upon one presentation (slides to be handed in) and a written examination covering all topics of the course. The presentations can optionally be about (a) selected literature, or (b) on a prior presentation by an external or internal guest with subsequent in-depth discussion, and priorly circulated material.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.5
Module identifier	CLISOFT2
Module title	Soft Skills 2
Module type	Optional / Elective
Coordinator	Dilly
Lecturers	NN
Aim	To support the individual development of soft skills and competences for working and scientific career.
Content	The students will develop a range of essential research and work skills, including literature search and review, formulating a research hypothesis, project planning, seminar and poster presentation and writing research papers. We will also consider the program of the Career Center of the University of Hamburg. SICSS will offer the following courses: 3.5.1 Scientific writing and proposal writing; S [NN] 3.5.2 Communicating scientific topics to the public; S [NN]

Teaching and learning methods S

Language	English
Requirements for participation	None
Usability	PhD program of SICSS and IMPRS-ESM
Type, pre-requisites and language of the exam	Active participation. Written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit	3.0
Points CP	
Frequency	Annually in winter semester
Duration	Block or distributed over one semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	3.5
Module identifier	CLISOFT2
Module title	Writing skills
Module type	Optional / Elective
Coordinator	Dilly
Lecturers	Baehr, Murphy
Aim	To learn academic writing iteratively
Content	The course is based on the idea that writing can be learned best by writing and re-writing. Basic philosophy: (a) writing is an iterative process, and (b) writing problems are 'thinking problems'. Structuring a piece of writing is as important as the actual words used. The skills learned will be fully transferable to scientific writing. Students bring their essays, e.g. from research. It is intended that these essays will be compiled in a student's handbook on 'how to achieve a significant written piece of work = thesis' Using the essays from the course has the advantage that everyone has something to take from. The essays are shorter than scientific papers, and in turn more participants are involved Further the topics of the essays are familiar to cross-disciplinary participants - reading the work of the classmates, and providing constructive criticism is an essential part of the course.

Teaching and learning methods S

Language	English
Requirements for participation	None
Usability	PhD program of SICSS and IMPRS-ESM
Type, pre-requisites and language of the exam	Active participation. Written report. Type of exam will be fixed at the beginning of this module.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	Block or distributed over one semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module 4.0

Module no.	4.0
Module identifier	CLIEX
Module title	MSc Thesis „Climate System Sciences“ with Examination
Module type	Compulsory
Coordinator	Dilly
Lecturers	All lecturers
Aim	To demonstrate the ability to elaborate and to present an innovative MSc thesis in a specific field of climate system sciences
Content	The student will carry out an in-depth study of a chosen topic in climate system sciences under the co-supervision of a member of staff and a researcher within the KlimaCampus Hamburg. The study will involve a critical review of the topic and/or the original research, will show the significance of the chosen topic for integrated climate system sciences and lead to an extended dissertation.

Teaching and learning methods

Language	English
Requirements for participation	BSc, completion of 60 CP of the MSc ICSS
Usability	Semester 4
Type, pre-requisites and language of the exam	MSc thesis (80%), oral presentation and defense in English (20%)
Work load (parts) with Credit Points CP	30.0
Frequency	---
Duration	6 months

Module no.	1.2.4
Module identifier	CLISYS1 - 4
Module element title	Climate and Society
Module unit	Compulsory
Lecturers	Engels
Aim	Knowledge of key components of society that interact with the climate system including the economy, systems of innovation, institutions of governance and the mass media
Content	Introduction to basic facts and approaches of the social sciences that are needed to understand human-climate-interactions. Overview of societal factors that influence the development and use of technologies.
Teaching and learning methods	L, S
Language	English
Requirements for participation	None
Usability	Semester 1 of ICSS; reference semester 1; optional for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Module no.	1.3.1
Module identifier	CLIPROC - 1
Module element title	Atmospheric general circulation - Theoretical meteorology
Module type	Compulsory
Lecturers	Frisius
Aim	Overview of the cycles of energy, momentum and water in the atmospheric climate system and processes involved.
Content	Balance equations for energy, momentum and water. Earth radiation budget. Observed fluxes of energy, momentum and water. Processes determining these fluxes at different time and space scales. Conceptual models of the atmospheric general circulation .
Teaching and learning methods	L
Language	English
Requirements for participation	Good knowledge in math and physics
Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule
Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report; overall test and component testing. Type of exam will be fixed at the beginning of this module. Language of the exam is English.
Work load (parts) with Credit Points CP	3.0
Frequency	Annually in winter semester
Duration	1 semester

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

MSc Integrated Climate System Sciences, Module Table

Module No.	Semester, Module type and Teaching and Learning Methods	Work Load	SWS	CP
	Compulsory Pt. Optional WP. Lecture VL. Exercise Ü. Seminar S. Practices P. Excursion E.			
1. Semester (Winter semester = WS)				
1.1	Interdisciplinary Introduction (OE), Pt; VL, E	90	2	3
1.2	Climate System 1, Pt; VL, Ü, S	360	8	12
1.3	Climate Processes, Pt; VL, Ü, S	270	6	9
1.4	Climate System Additional, WP; VL, S, Ü, E	180	4	6
	Sum	900	20	30
2. Semester (Summer semester = SS)				
2.1	Climate System 2, Pt; VL, Ü, S, P, E	270	6	9
2.2	Climate System Specialisation, WP; VL, Ü, S, P	360	8	12
2.3	Climate System Observations 1, WP; VL, Ü, P, E	180	4	6
2.4	Soft skills 1, WP; VL, Ü, S, P	90	2	3
	Sum	900	20	30
3. Semester (Winter semester = WS)				
3.1	Interdisciplinary seminar, Pt; S	90	2	3
3.2	Climate System Lab, WP; VL, Ü, S, P	270	6	9
3.3	Climate System Observations 2, WP; VL, Ü, P, E	180	4	6
3.4	Additional of economics, social sciences and natural sciences, WP; VL, Ü, S, P, E	270	6	9
3.5	Soft skills 2, WP; VL, Ü, S, P	90	2	3
	Sum	900	20	30
4. Semester (Summer semester = SS)				
4.0	MSc Thesis „Climate System Sciences“ with Examination, Pt	900	20	30
	Sum	900	20	30
Total Sum for MSc Integrated Climate System Sciences		3600	80	120

MSc Integrated Climate System Sciences
General

	Module no.				
	Module identifier	Identification of the module			
Modultitel	Module title	Title of the module			
Modultyp	Module type	Compulsory	Compulsory selective // Compulsory with options for selection	Optional / Elective	Optional courses of the specialization track
	Coordinator				
	Lecturers				
Qualifikationsziele	Aim	Content, competences and qualifications to be achieved			
Inhalte	Content				
Lehrformen	Teaching and learning methods	Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.			
Unterrichtssprache	Language	English			
Voraussetzungen für die Teilnahme	Requirements for participation	BSc in geosciences, physics, meteorology, oceanography and related degree	None	Good knowledge in math and physics	
Verwendbarkeit des Moduls	Usability	Semester 1 of ICSS; reference semester 3; optional course for related MSc programs, dependent on capacities and schedule	Semester 2 of ICSS	Semester 3 of ICSS	
Art, Voraussetzungen und Sprache der(Teil)- Prüfung	Type, pre-requisites and language of the exam	Active participation. Written or oral exam, or oral or written report. Type of exam will be fixed at the beginning of this module.	See specific announcements		
Arbeitsaufwand (ggf. Anteil Teilleistungen)	Work load (parts) with Credit Points CP	3.0			
Teilgruppengröße	Group size	20	Not limited		
Häufigkeit des Angebots	Frequency	Annually in winter semester	Annually in summer semester		
Dauer	Duration	1 semester	Block	Block or over 1 semester	
Introduction		3.0			
Track independent		30.0			
Specialisation	#WERT!				
Softskills and Seminar		9.0			
Thesis & Exam	30.0				
		120.0			

MSc Integrated Climate System Sciences, Module list

Module list	Term	CP
1.1 Introduction to Integrated Climate System Sciences including Ori	1	3
1.2 Climate System 1	1	12.0
1.3 Climate Processes	1	9.0
1.4 Climate System Additional	1	6.0
2.1 Climate System 2	2	9.0
2.2 Climate System Specialization	2	12.0
2.3 Climate System Observations 1	2	6.0
2.4 Soft Skills 1	2	3.0
3.1 Seminar on Integrated Climate System Sciences	3	3.0
3.2 Climate System Sciences Lab	3	9.0
3.3 Climate System Observations 2	3	6.0
3.4 Additional of economics, social sciences and natural sciences	3	9.0
3.5 Soft Skills 2	3	3.0
4.0 MSc Thesis „Climate System Sciences“ with Examination	4	30.0
		3
