Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FAKULTÄT
FÜR MATHEMATIK, INFORMATIK
UND NATURWISSENSCHAFTEN

Module Handbook

Master of Science

Ocean and Climate Physics

Universität Hamburg

August, 2022

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Introduction

The Institute of Oceanography within the department of Earth System Sciences at Universität Hamburg offers a master degree (M.Sc.) in Physical Oceanography and Climate Physics. This research oriented four-semester program is directed at students with a B.Sc. degree in Physical Oceanography, Meteorology, Geophysics, Physics or an equivalent subject and provides profound knowledge on the physics of the ocean and its role in the climate system. Students will be educated and prepared for their future research in physical oceanography and climate science. Furthermore, students will be trained to broaden their knowledge of scientific methods and their scientific skills.

The M.Sc. course Physical Oceanography and Climate Physics is divided into the following seven modules:

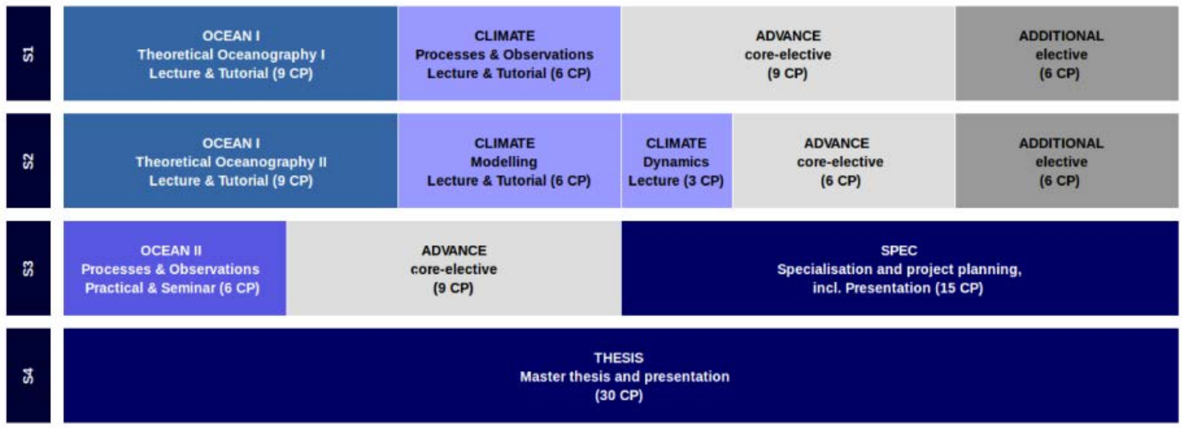
- **OCEAN I:** two core courses provide the fundamentals of ocean physics covering theory and model approximations
- **OCEAN II:** one core course provides the fundamentals of ocean physics in combination with lab experiments as well as modelling and observations
- **CLIMATE:** three core courses provide the fundamentals of climate physics covering processes, dynamics, modelling as well as observations.
- **ADVANCE:** a catalogue of core elective courses covering both scientific and methodological aspects of oceanography and climate physics allow students to deepen their knowledge according to their specific interests.
- **ADDITIONAL:** students can widen their perspective by taking additional elective courses from one or two other subjects of natural sciences.
- **SPECIALIZATION:** deepening the scientific understanding in a specific topic, laying the ground for the subsequent Master's thesis.
- **THESIS:** a research project conducted within a working group and guided by an advisor leading to the written Master's thesis.

The entire M.Sc. degree Physical Oceanography and Climate Physics is taught in English. All respective courses (compulsory, core elective and elective) are therefore also examined in English. In the elective modules, where students attend courses from other degree programs, students may also select courses in German, provided they are in sufficient command of the German language. The workload amounts to 30 credit points per term (formally about 20 contact hours of courses).

For students without any background in physical oceanography we highly recommend to take the course "Introduction to Physical Oceanography" (p. 18) at the beginning of the first term. For students with no or only a small experience in programming we recommend to take the "Scientific Programming in FORTRAN and Python" (p. 22) course and/or "Scientific Programming in Python I + II" (p. 31 - 32).

You find further info on our website, https://www.ifm.uni-hamburg.de/en/education/master. Please also note our FAQs there.

Overview of the "M.Sc. Ocean and Climate Physics"



More information under:
https://www.ifm.uni-hamburg.de/en/education/master/02-curriculum.html

FAQ for current students:
https://www.ifm.uni-hamburg.de/en/education/master/03-for-current-students/faq.html

Please do not hesitate to contact us for further information:

Academic study advisors:
PD Dr. Thomas Pohlmann - thomas.pohlmann@uni-hamburg.de

Chair of the MSc Program and the Examination Board (Prüfungsausschussvorsitz):
Prof. Dr. Dirk Notz – dirk.notz@uni-hamburg.de

Contact e-mail:
ocean-studies.ifm@uni-hamburg.de

Student representatives:
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Academic Services Office for Earth Sciences:
Studienbüro Erdsystemwissenschaften
Bundesstr. 55, 12. OG
20146 Hamburg
Contact: https://www.geo.uni-hamburg.de/en/studium/studienbuero/kontaktformular.html

More information: https://www.geo.uni-hamburg.de/en/studium/studienbuero.html

OCEAN I Module

Module:	**OZ-M-OCEAN1**
Module coordinator	Carsten Eden
Course type:	Compulsory core module
Learning outcomes:	Students have acquired the theoretical-physical fundamentals of the wind-driven and thermo-haline ocean circulation, on the entire spectrum of variability (ranging from periodic processes such as gravity waves, planetary waves via meso-scale eddies to turbulence). Students have gained a deeper understanding of the mechanisms, scales and dynamical balances and their mathematical description.
Courses:	**Theoretical Oceanography I** (9CP) **Theoretical Oceanography II** (9CP)
Exam (type, requirements for registration):	Requirements for exam registration: successful completion of the required course work in every individual courses (= “Übungsabschluss”: pass/fail). Exam: an oral exam for ‘Theoretical Oceanography I’ and ‘Theoretical Oceanography II’. The grade for this module is the mean of the grade for ‘Theoretical Oceanography I & II’ .[1]
Reference semester:	1 & 2

1 Oral exams (in both the OCEAN I and CLIMATE modules) are open scientific discourse on the subject covered in the course(s). The discussion will evolve around the material covered in the lectures, though additional applications/perspectives may also be touched.

Theoretical Oceanography I

<table>
<tr><td>Course number:</td><td colspan="4">63-730 (lecture), 63-731 (exercises)</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Carsten Eden</td></tr>
<tr><td>Course type:</td><td colspan="4">Compulsory core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students are familiar with the fundamental physical description of the ocean circulation, with the common approximations to the basic equations, as well as with fundamental aspects of the wind-driven circulation and the thermohaline circulation</td></tr>
<tr><td>Contents:</td><td colspan="4">Derivation of the Navier-Stokes equations, thermodynamics of seawater, effects of rotations, vorticity and circulation, Boussinesq approximation, hydrostatic approximation, quasi-geostrophic approximation, depth-averaged wind driven circulation, thermocline theory, physics of the meridional overturning circulation, physics of the Southern Ocean.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Seminar/tutorial</td><td>On-campus-study
60 h
30 h</td><td>Self-study

30 h
60 h</td><td>Exam preparation

90 h</td></tr>
<tr><td>Credit points: 9</td><td>90 h</td><td>90 h</td><td>90 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirement for registration: completion of exercises.
Exam: oral exam at the end of the semester.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually during winter term</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in the course.</td></tr>
</table>

Theoretical Oceanography II

<table>
<tr><td>Course number:</td><td colspan="4">63-732 (lecture), 63-733 (exercises)</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Carsten Eden</td></tr>
<tr><td>Course type:</td><td colspan="4">Compulsory core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students are familiar with the most important wave processes, instability and basic small-scale and geostrophic turbulence theory</td></tr>
<tr><td>Contents:</td><td colspan="4">General wave kinematics, WKB theory, sound waves, internal gravity waves, vorticity/planetary waves, effects of boundaries, effects of variables environment, effects of background flow, instabilities, wave turbulence, homogeneous and inhomogeneous small-scale and geostrophic turbulence theory.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Seminar/tutorial</td><td>On-campus-study
60 h
30 h</td><td>Self-study

30 h
60 h</td><td>Exam preparation

90 h</td></tr>
<tr><td>Credit points: 9</td><td>90 h</td><td>90 h</td><td>90 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirement for registration: completion of exercises
Exam: oral exam at the end of the semester.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">2</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually during summer term</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in the course.</td></tr>
</table>

OCEAN II Module

Module:	OZ-M-OCEAN2
Module coordinator	Carsten Eden
Course type:	Compulsory core module
Learning outcomes:	Students have acquired the theoretical-physical fundamentals of the wind-driven and density-driven ocean circulation, on the entire spectrum of variability (ranging from periodic processes such as gravity waves, planetary waves via meso-scale eddies to turbulence). Student have gained a deeper understanding of the mechanisms, scales and dynamical balances and their mathematical description.
Courses:	**Oceanic processes and observations** (6CP)
Exam (type, requirements for registration):	Exam: See course descriptions.
Reference semester:	3
Duration:	1 Semester

Oceanic Processes and Observations

Course number:	63-738 (Lab), 63-739 (Seminar)			
Lecturer:	Carsten Eden, Alexa Griesel			
Course type:	Compulsory core course			
Learning outcomes:	Students gain detailed knowledge of selected processes relevant for the ocean circulation			
Contents:	Practicals and seminar on selected ocean processes such as internal wave generation, shear instability, baroclinic/ barotropic instability using a combination of tank experiments in laboratory, numerical modelling, and analysis of observations.			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Credit points: 6	60 h	60 h	60 h
Exam (type, requirements for registration):	Requirement for registration: none. Exam: graded coursework consists of a poster and/or an oral presentation and/or a final report, to be determined at the beginning of the course.			
Reference semester:	3			
Frequency of offer:	Annually during winter term			
Literature	Will be announced in the course.			

CLIMATE Module

Module:	**OZ-M-CLIMATE**
Module coordinator	Johanna Baehr
Course type:	Compulsory core module
Learning outcomes:	Students will have an in-depth knowledge of the processes and phenomena in the ocean that are relevant for short- and long-term climate variability, at both global and regional scales. Students will be able to describe these processes and phenomena in terms of the oceanic and atmospheric dynamics. Furthers, students know the opportunities and limitations inherent to the description of these processes and phenomena with observations and numerical climate models.
Courses:	**Climate processes and observations** (6 CP) **Climate Modelling** (6 CP) **Climate Dynamics** (3 CP)
Exam (type, requirements for registration):	Requirement for registration: successful completion of the required course work in every individual course (= “Übungsabschluss”: pass/fail) Exam: joint oral module exam (30-45 min.) for all courses by individual appointment.
Reference semester:	1 & 2
Duration:	2 Semesters

Climate Processes and Observations

Course number:	63-734 (lecture), 63-735 (exercise)			
Lecturer:	Johanna Baehr, Armin Köhl			
Course type:	Compulsory core course			
Learning outcomes:	Students will have made themselves familiar with important processes linking the ocean with the rest of the climate system. They will have understood the dynamics of those processes and their role as part of climate feedbacks and climate variability. Students will also have learned how to observe those processes.			
Contents:	Basic information about climate processes in the coupled climate system. This involves large-scale components of the circulation in the ocean, the atmosphere and the cryosphere. Feedbacks between all three components and the land system as well as climate feedbacks. Basic information about a climate observing system involving in-situ and satellite technologies.			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture Seminar/tutorial	60 h 30 h	30 h 30 h	 30 h
	Credit points: 6	90 h	60 h	30 h
Exam (type, requirements for registration):	Requirement for registration: Completion of seminar/tutorial (pass/fail) Exam: Joint module exam at end of second semester. See module description.			
Reference semester:	1			
Frequency of offer:	Annually during winter term			
Literature	Will be announced in the course.			

Climate Modelling

Course number:	63-746 (Lecture), 63-747 (Tutorial)			
Lecturer:	Vimal Koul			
Course type:	Compulsory core course			
Learning outcomes:	Students will have a basic understanding of global coupled climate models: how they work, are developed and how they can advance our understanding of the climate system. Students will be able to discuss advantages as well as the limitations of different model setups and analyses.			
Contents:	The following topics will be covered in lecture and/or tutorial/seminar: - From simple to complex earth system models - Coupling of different components - Choices in model setup and tuning - Control, historical and forced climate (change) simulations - Analysis of simulations and critical discussion of results - Model intercomparison			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture Seminar/tutorial	30 h 30 h	30 h 30 h	 60 h
	Credit points: 6	60 h	60 h	60 h
Exam (type, requirements for registration):	Requirement for registration: Completion of exercises Exam: joint module exam. See module description.			
Reference semester:	2			
Frequency of offer:	Annually in summer			
Literature	Will be announced in the course.			

Climate Dynamics

<table>
<tr><td>Course number:</td><td colspan="4">63-879</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Jochem Marotzke</td></tr>
<tr><td>Course type:</td><td colspan="4">Compulsory core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students have a thorough understanding of the theoretical basics of climate dynamics, and know the art and science of constructing conceptual models of the climate system.</td></tr>
<tr><td>Contents:</td><td colspan="4">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 time scales 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 onthe 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.</td></tr>
<tr><td>Recommended prerequisites:</td><td colspan="4">Formal: None
Recommended Prerequisites: Standard calculus and ordinary differential equations, some knowledge of the atmosphere and oceans is useful but not necessary.</td></tr>
<tr><td rowspan="3">Workload/ Credit points:</td><td></td><td>On-campus-study</td><td>Self-study</td><td>Exam preparation</td></tr>
<tr><td>Lecture</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Credit points: 3</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Exam (requirements for registration):</td><td colspan="4">Requirement for registration: Completion of exercises
Exam: Joint module exam at end of second semester. See module description.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">2</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually during summer term</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in the course.</td></tr>
</table>

ADVANCE Module – Overview

The goal of this module is to gain a deeper scientific or methodological expertise in areas of physical oceanography or climate physics. Therefore the Institute of Oceanography offers a range of courses:

Winter term	Summer term
• 63-720 Introduction to Physical Oceanography (3 CP) • 63-721 Scientific Programming in FORTRAN / Python (3 CP) • 63-741 Predictions & Predictability of Climate (3 CP) • 63-761 Sea ice physics, observation and modelling I (6 CP) • 63-768 Machine Learning in Climate Science (3 CP) • 63-769 Practical Measurement Electronics and Interfaces in Ocean Science (3 CP)	• 63-764 Data Assimilation (6 CP) • 63-761b Sea ice physics, observation and modelling II (6 CP) • 63-887 Numerical Prediction of the Atmosphere and Ocean (6 CP) • 63-736 Ice mechanics (3 CP) • 63-768 Practical Deep Learning with Climate Data (6 CP)
Without a specific reference semester:	
• Sea-going Experience (up to 6 CP, more information see p. 28) • 63-767 Research Seminars in Ocean Physics and Climate Research • Studying abroad (More information see p. 39, and e.g. Air-Ice-Sea Interaction (15 CP))	

In addition to the courses offered by IfM, students might also choose suitable courses from other curricula at the Universität Hamburg, such as the MSc ICSS physics track and MSc Meteorology curricula. Here, we list some of the courses for which we have officially asked the other degree for access. However, to attend additional courses, students should (i) get in contact with both the chairperson of the examination board to find out whether the course can be accredited in this module, and (ii) ask the lecturer of the course for admission.

Here are some example courses for other courses offered at Universität Hamburg:

Winter term	Summer term
• 63-954 Tracer Transport Simulation Lab (3 CP) • 63-835 Urban Climatology (3 CP) • 63-916 Atmospheric Circulation Systems: Part I (3 CP)[1] • 63-911 Introduction to numerical approaches (3 CP) • 63-435 Advanced Topics in Fluid Dynamics & 65-436 Exercise class: Advanced topics in Fluid Dynamics	• 63-932 Weather and Climate Risk (3 CP) • 63-863 Earth System Science, Paleoclimatology (3 CP) • 66-878 Hochleistungsrechnen in der Physik: Grundlagen der Entwicklung paralleler Anwendungen • 63-931 Atmospheric Circulation Systems: Part II (3 CP) • 63-877 Data Analysis in Atmosphere and Ocean using Python

1 Note that for this course, the admission via STiNE is only possible in the last registration period, since this course is designed particularly for MSc ICSS first semester students, who will only be able to register from October onwards. MSc OCP students can register for this course in the third registration period.

ADVANCE Module – Overview

Additionally to the courses offered at Universität Hamburg, there is the possibility to take courses at University Kiel due to a cooperation agreement between both universities. More on this cooperation agreement can be found here:
https://www.uni-hamburg.de/campuscenter/studienangebot/kooperation-uni-kiel.html

For the ADVANCE Module within the MSc OCP only courses from the Specialization Module of the "Physical Climate: Meteorology and Physical Oceanography" master program are suitable.

A list of possible example courses at Kiel University:

- Modern Aspects in Oceanography I: Tropical Ocean Dynamics (climPOTROPIC) (5 CP)
- Modern Aspects in Oceanography III: The El Nino-Southern Oscillation (climPOENSO) (5 CP)
- Modern Aspects in Oceanography IV: Shallow water analogues of ocean/atmosphere processes (climPOSHALLOW) (5 CP)
- Modern Aspects in Oceanography V: Ocean General Circulation Modelling (climPOOGCM) (5 CP)
- Modern Aspects in Physical Oceanography VI: the modelled wind-driven and thermohaline circulation (climPOMODCIRC) (5 CP)

ADVANCE Module

Module:	OZ-M-ADVANCE
Module coordinator:	Chairperson of examination board
Course type:	Compulsory core module with elective courses
Learning outcomes:	Students have gained a deeper scientific or methodological expertise in the areas of physical oceanography and climate physics. Students can select from a list of courses announced at the beginning of the respective teaching term; the courses listed below are examples.
Possible Courses:	See page 15.
Exam (type, requirements for registration):	Exams: each course will be graded individually following the regulation of the respective course, as announced at the start. As a general rule, courses are graded, with two exceptions: 1. for students that take up this MSc without a background in physical oceanography from their previous degree, 'Introduction to Physical Oceanography' is offered at the beginning of the first term, 2. individually arranged active participation in a scientific cruise can be credited - depending on the duration of the cruise and the kind of work conducted aboard - with up to 6 CPs by prior approval of the chairperson of the examination board.
Special Information:	Students wanting to sign up for ADVANCE Module courses should get in contact with the corresponding lecturer to confirm the availability of a spot for them. In case students wish to select a courses which is not listed in the Module Handbook, they should contact the chairperson of the examination board to get the respective courses approved.
Reference semester:	1 & 2 & 3
Duration:	3 semesters

Data Assimilation

<table>
<tr><td>Course number:</td><td colspan="4">63-764</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Detlef Stammer, Armin Köhl and Nuno Serra</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students will have made themselves familiar with the theory and methods of inverse modelling and data assimilation. The focus of applications will be on oceanographic problems, but will include also assimilation approaches in the coupled climate system.</td></tr>
<tr><td>Contents:</td><td colspan="4">The theory and methods of time-invariant inverse modelling and time-dependent data assimilation. Least-squares solutions, generalized inverse, sequential data assimilation, optimal interpolation, Kalman filter, adjoint methods, state estimation and parameter estimation.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Seminar/tutorial</td><td>On-campus-study

45 h
45 h</td><td>Self-study

30 h
30 h</td><td>Exam preparation

30 h</td></tr>
<tr><td>Credit points: 6</td><td>90 h</td><td>60 h</td><td>30 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">As announced in course.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">2</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Biannually during summer term</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in course.</td></tr>
</table>

Introduction to Physical Oceanography

Course number:	63-720			
Lecturer:	Annika Jersild			
Course type:	Elective core course			
Learning outcomes:	Students have a background in all aspects of physical oceanography.			
Contents:	This lecture series gives a broad overview of basic physical oceanography: geomorphology of the sea floor, the physical (and chemical) properties of seawater and ice, external forcing (heat, freshwater and momentum including tides), basic hydrodynamics (Navier-Stokes Equations and relevant approximations: geostrophy, hydrostatics, thermal wind), surface mixed layer dynamics, wind-driven circulation (Ekman theory, upwelling, westward intensification), stratification and thermohaline circulation, waves (surface and internal gravity waves, barotropic and baroclinic Rossby waves), as well as fronts and current instabilities.			
Formal/ recommended prerequisites:	This course is only available for credits for students who have a Bachelor's degree which is not related to oceanography.			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Credit points: 3	30 h	30 h	30 h
Exam (type, requirements for registration):	Requirements for registration: none Exam: Written exam (pass/fail)			
Reference semester:	1			
Frequency of offer:	Annually in winter			
Literature	Lecture notes including a reference list.			

Machine Learning in Climate Science

Course number:	63-768			
Lecturer:	Christopher Kadow, David Greenberg, Marc Rautenhaus, Johanna Baehr			
Course type:	Elective core course			
Learning outcomes:	Students will have an insight into the current state of the rapidly evolving field of machine learning in climate science; including an understanding of the basic terminology, potential applications, and the strengths, challenges and limitations of different approaches. In addition, students will have deep knowledge of a self-selected example study from the literature.			
Contents:	Machine learning enables more and more progress in many sub-areas of climate research. However, we are probably only at the beginning of a rapidly changing hybrid field. There are still barriers to entry, both for machine learning and the climate sciences - from content, to understanding, to technical uncertainties. This course attempts to build a bridge and give students an interdisciplinary overview of methods, applications and research fields. In the first part of the course, various scientists give an insight into their current research focus or research intersections around ML in climate sciences. In the second part of the course, students' will present examples of personal interest from the literature.			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Seminar/tutorial	30 h	30 h	30 h
	Credit points: 3	30 h	30 h	30 h
Exam (type, requirements for registration):	As announced in course.			
Reference semester:	3			
Frequency of offer:	Annually in winter			
Literature	Will be announced in course.			

Predictions and Predictability of Climate

<table>
<tr><td>Course number:</td><td colspan="4">63-741 (lecture), only on demand: 63-742 (seminar, 3CP)</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Leonard Borchert</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students will be familiar with the techniques used to investigate predictability and the methods used to make predictions of climate variability at seasonal to decadal timescales with a focus on coupled ocean-atmosphere processes.</td></tr>
<tr><td>Contents:</td><td colspan="4">Introduction to predictability of climate; Lorenz model; determination of predictability; ensemble forecasting; forecast initialization; ensemble initialization; error propagation and assessment of forecast reliability/ quality; present understanding of the processes that determine predictability; seasonal to decadal predictions of the climate system.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="3">Workload/ Credit points:</td><td></td><td>On-campus-study</td><td>Self-study</td><td>Exam preparation</td></tr>
<tr><td>Seminar/tutorial</td><td>30 h</td><td>20 h</td><td>10 h</td></tr>
<tr><td>Credit points: 3</td><td>30 h</td><td>20 h</td><td>10 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirement for registration: completion of exercises.
Exam: as announced in course.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1 & 3</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually in winter</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in the course.</td></tr>
</table>

Research Seminars in Ocean Physics and Climate Research

<table>
<tr><td>Course number:</td><td colspan="4">63-767</td></tr>
<tr><td>Course coordination:</td><td colspan="4">Johanna Baehr</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students will get familiar with different current research questions about ocean physics and climate research. With this they will gain knowledge about how scientific talks are structured.</td></tr>
<tr><td>Contents:</td><td colspan="4">For this course students need to attend 24 different seminars or talks given at the Institute of Oceanography about current research. Seminars can be attend during the entire duration of the degree.

The talks and seminars can be selected from the mostly weekly program of the:
- Joint Seminar (Tuesday or Wednesday)
- KlimaCampus Kolloquium
- Relevant project seminars, such as TRR181 Seminar
- Doctoral thesis presentations

Confirmation of attendance and more information can be found on: https://www.ifm.uni-hamburg.de/en/education/master/07-lectures.html</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">Students need to apply for this course before starting to take it at the course co-ordinator. As the attendance can be partitioned over several semesters, students should only formally register for the course via STiNE in the term that they expect to finish the course.</td></tr>
<tr><td rowspan="3">Workload/ Credit points:</td><td></td><td>On-campus-study</td><td>Self-study</td><td>Exam preparation</td></tr>
<tr><td>Seminar/Talk</td><td>40 h</td><td>50 h</td><td></td></tr>
<tr><td>Credit points: 3</td><td>40 h</td><td>50 h</td><td></td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirement for registration: certified attendance of 24 selected talks/seminars, including a one paragraph summary (which includes at least three references).</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1 – 4</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Every semester</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in the course.</td></tr>
</table>

Scientific Programming in FORTRAN and Python

<table>
<tr><td>Course number:</td><td colspan="4">63-721</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Nuno Serra und Remon Sadikni</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students have gained basic knowledge of Fortran 90/95 concepts, structure and syntax. They are able to formulate and solve fundamental mathematical problems by writing new or extending existing Fortran code. During the course they will create their own collection of sample routines that can be used as a starting point for writing more complex programs.</td></tr>
<tr><td>Contents:</td><td colspan="4">The course covers the following aspects of Fortran90/95: Basic Fortran elements, character set, data types and declarations, assignments, arithmetic and logical operators, control constructs, input and output, external files, arrays, array and matrix operations, string manipulation, statement functions and subroutines, intrinsic functions. In addition, conversion from fixed form Fortran (F77) to free source form Fortran will be addressed. Examples are taken from the areas of statistics, data analysis and numerical modelling.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">formal: none
recommended: prior experience with Unix/Linux, basic knowledge in maths and numerics

Only students taking “Introduction to Physical Oceanography” are eligible to take this course into the “ADVANCED module”. Otherwise it can be used in the “ADDITIONAL module”.</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Seminar/tutorial</td><td>On-campus-study

15 h
15 h</td><td>Self-study

15 h
15 h</td><td>Exam preparation

30 h</td></tr>
<tr><td>Credit points 3 CP</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Exam (type, language, requirements for registration):</td><td colspan="4">Requirements for registration: 80 % participation
Exam: running and correct code for a sample problem (pass/fail)</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually in winter</td></tr>
<tr><td>Literature</td><td colspan="4">Lecture notes including a reference list.</td></tr>
</table>

Sea ice physics, observations and modeling I

<table>
<tr><td>Course number:</td><td colspan="4">63-761</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Dirk Notz</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">This course provides a hands-on introduction into the physics of sea ice and its interaction with the atmosphere and the ocean. The students will learn how sea-ice related processes are observed in-situ and from satellite, and how these processes can be modelled numerically. They will gain experience in planning an observational campaign, analysing field and laboratory data, carrying out lab experiments, and presenting research findings.</td></tr>
<tr><td>Contents:</td><td colspan="4">Overview of sea ice in the Earth System; the polar climate system; sea-ice dynamics and thermodynamics; snow on sea ice; techniques of in-situ and remote sensing observations; modelling sea ice; analysing field and laboratory data.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Seminar/tutorial</td><td>On-campus-study

28 h
28 h</td><td>Self-study

32 h
32 h</td><td>Exam preparation

60 h</td></tr>
<tr><td>Credit points: 6</td><td>56 h</td><td>64 h</td><td>60 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirements for registration: none
Exam: Written exam</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1 or 3</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually in winter</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced during the course</td></tr>
</table>

Sea ice physics, observations and modeling II

Course number:	63-761b			
Lecturer:	Dirk Notz, Stefan Kern			
Course type:	Elective core course			
Learning outcomes:	This course provides a hands-on introduction into the physics of sea ice and its interaction with the atmosphere and the ocean. Particular focus will be on the scientific methods used to explore sea ice, including satellite remote sensing, scientific instrumentation and large-scale climate modelling. We will examine how the different methods are ideally combined to provide robust insights into the functioning of sea ice, and thus use sea ice as a proxy to gain experience in working as a climate researcher.			
Contents:	Large-scale forcing of the Arctic and Antarctic sea-ice cover; impact of internal variability and external forcing; seasonal, decadal and centennial predictions and projections; techniques of in-situ and remote sensing observations; modelling sea ice; analysing field and laboratory data; writing scientific reports.			
Formal/ recommended prerequisites:	Previous participation in Sea ice physics, observations and modelling I is highly recommended.			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture Seminar/tutorial	28 h 28 h	32 h 32 h	 60 h
	Credit points: 6	56 h	64 h	60 h
Exam (type, requirements for registration):	Requirements for registration: none Exam: usually reports			
Reference semester:	2			
Frequency of offer:	Annually in summer			
Literature	Will be announced during the course			

Ice mechanics

Course number:	63-736			
Lecturer:	Franz von Bock und Polach			
Course type:	Elective core course			
Learning outcomes:	Students are familiar with ice formation processes and understand their influence on the mechanical behavior of ice. They have an understanding of the varying ice response depending on the loading direction and are able to assess and understand problems involving ice mechanics.			
Contents:	- Ice formation processes and their impact on the mechanical behavior. - Mechanical models relevant for ice mechanics - Microscopic and macroscopic deformation processes - Mechanical behavior / response of ice under different loads and possible consequences for structures. - Physical methods for mechanical ice property tests - Scaling and an introduction to physical and numerical modeling (incl. possible excursion to HSVA ice tank) - Recent developments in ice mechanics research			
Formal/ recommended prerequisites:	PHY1, (PHY2), MATH1, (MATH2)			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture	30 h	30 h	30 h
	Credit points: 3	30 h	30 h	30 h
Exam (type, requirements for registration):	Requirements for registration: Preparation of a short presentation on an agreed topic. Exam: Oral exam			
Reference semester:	4			
Frequency of offer:	Annually in summer			
Literature	Will be announced in the course			

ADVANCE: Practical Deep Learning with Climate Data

<table>
<tr><td>Course number:</td><td colspan="4">63-768</td></tr>
<tr><td>Lecturer:</td><td colspan="4">David Greenberg</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students will have understood fundamental neural network approaches to classification and regression problems. They will have written programs implementing multiple neural network architectures and trained them on simulations and observations of the atmosphere and ocean. They will have hands-on experience in designing and executing a deep learning-based research project.</td></tr>
<tr><td>Contents:</td><td colspan="4">This course will prepare students to effectively use deep learning to solve classification and regression problems. Lectures will cover the conceptual and mathematical aspects of deep learning, while weekly programming exercises will provide hands-on experience in applying these ideas to data from the geosciences, using Python, NumPy and Pytorch. This course aims to give students a broad hands-on competence in deep learning fundamentals, including optimization, autodiff, convolution, recurrence, self-attention, autoencoders and deep generative models. The course will conclude with individual projects to be presented in class.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">Formal: none
Recommended: Calculus, linear algebra, and basic probability theory</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Tutorial</td><td>On-campus-study

30 h
30 h</td><td>Self-study

30 h
30 h</td><td>Exam preparation

30 h
30 h</td></tr>
<tr><td>Credit points: 6</td><td>60 h</td><td>60 h</td><td>60 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">As announced in course</td></tr>
<tr><td>Reference semester:</td><td colspan="4">2</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually in summer</td></tr>
<tr><td>Literature</td><td colspan="4">To be announced in course.</td></tr>
</table>

ADVANCE: Practical Measurement Electronics and Interfaces in Ocean Science

<table>
<tr><td>Course number:</td><td colspan="4">63-769</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Dirk Notz, Markus Ritschel, Niels Fuchs</td></tr>
<tr><td>Course type:</td><td colspan="4">Elective core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students will have understood fundamental principles of data acquisition electronics and interface technology. They will have learned how to assemble their own scientific measurement instrument based on a microcontroller platform, how to program it with respect to fundamental measurement strategies and gained experience with common communication protocols. They will have collected hands-on experience in comprehending, designing, and troubleshooting electric circuits and interfaces.
The overarching aim of the course is to improve the student's ability and confidence in working with scientific instruments.</td></tr>
<tr><td>Contents:</td><td colspan="4">Lectures will cover conceptual and practical aspects of electronic circuits, communication between modules, the integration and programming of microcontrollers in measurement devices, and basic measurement strategies. Building on the knowledge the students gained during their practicals in their studies, the course deepens their understanding of working with a broad spectrum of scientific instruments used in ocean science. Students will build their own temperature logger, based on an Arduino microcontroller. This will comprise the design of the logger and the electronic circuit as well as assembling and programming of the microcontroller. Finally, they will deploy their logger in jointly designed scientific experiments.
We will do simulations and programming exercises on the computer. Students can work in pairs. But bringing their own laptop is recommended.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">Formal: none
Recommended: basic programming skills, basic electrophysics</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Lecture
Tutorial</td><td>On-campus-study

10 h
20 h</td><td>Self-study

30 h</td><td>Exam preparation

30 h</td></tr>
<tr><td>Credit points: 3</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Written report: technical documentation for the assembled datalogger (further details will be given in the course)</td></tr>
<tr><td>Reference semester:</td><td colspan="4">1 or 3</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">winter semester</td></tr>
<tr><td>Literature</td><td colspan="4">To be announced in course.</td></tr>
</table>

Sea-going Experience

Students can participate in research cruises offered by the Institute of Oceanography or other institutions, but the IfM cannot guarantee participation in cruises. Students who wish to participate in such a cruise should inform themselves about the cruise with enough time in advance since student slots are not guaranteed and usually quickly filled. Individually arranged active participation in such a cruise can, with prior approval of the chairperson of the examination board, be credited with up to 6 CPs, pending on lengths of cruise.

To get the prior approval of the chairperson of the examination board please contact the chairperson and include the following information:

- Details about the cruise (time, duration, chief scientist, research area, ...)
- What is the general plan of the cruise?
- What will be the students´ tasks during the cruise?

After the cruise, students need to submit a statement by the chief scientist, which includes the duration, research area and a sentence about the students' tasks on board to gain 3 CP for their cruise participation.
For 6 CP a comprehensive documentation about the students work on board needs to be submitted, e.g. a report. This should be discussed with the chairperson.

ADDITIONAL Module – Overview

The goal of this module is to offer students the possibility to widen their perspective and choose courses to complement their studies in ocean and climate physics. To actively encourage students to look for a broader experience, the Institute of Oceanography only offers the following courses at the moment:

Winter term	**Summer term**
• 63-721 Scientific Programming in FORTRAN and Python (3 CP)	

Every course form the IfM displayed for the ADVANCE module (see p. 14) can also be taken as part of the ADDITIONAL module.

In addition to the courses offered by IfM, students might also choose suitable courses from other programs such as:

- **Meteorology**
- **MSc ICSS**
- **Geophysics**
- **Biological Oceanography**
- **Computational Science**
- **Physics**
- **Mathematics**
- **Marine Biology**

The following table displays courses outside of the IfM which were taken by other students to get credit points for the ADDITIONAL module.

Winter term	**Summer term**
• 63-902 Introduction to Statistics (3 CP) • 63-967 Scientific Programming in Python I (1.5 CP) • 63-968 Scientific Programming in Python II (1.5 CP)	• Dynamics of Marine Ecosystems (3CP) • The Role of Biota in the Climate System (3 CP)

There is also the possibility to take external courses (such as summer schools and workshops) in this module, as longs as the courses require active participation.

ADDITIONAL Module

Module:	OZ-M-ADD
Module coordinator:	Chairperson of examination board
Course type:	Elective module
Learning outcomes:	Students have widened their perspective by taking additional courses from one to two other subjects that complement their studies in ocean and climate physics, typically subjects from the natural sciences. The courses selected within this module should result in a self-contained unit, consistent in level and content. The selection of courses needs to be approved by the examination board.
Courses:	Students are encouraged to select subjects that both suit their interests and open up their view. For examples see page 28.
Exam (type, requirements for registration):	The grades for these courses do not count towards the final grade. Students can select courses that are offered as ‘pass/fail’.
Reference semester:	1, 2
Duration:	2 semester

Scientific Programming in Python I

Course number:	63-967 (ICSS-M-2.5.1)			
Lecturer:	Remon Sadikni			
Course type:	Elective core course			
Learning outcomes:	Students have learned the programming language Python from scratch. They got in touch with common scientific libraries for analysing and plotting geoscientific data.			
Contents:	Introduction to Python: data types, control flow statements, data structures, functions, input/output, modules, errors and exceptions, classes. Introduction to scientific libraries like numpy, scipy and matplotlib. This course is designed for novice programmers and will focus on the basics of programming.			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture	28 h	17 h	0 h
	Credit points: 1.5	28 h	17 h	0 h
Exam (type, requirements for registration):	Requirements for registration: none Exam: Practicals pass/fail, regular participations (>80 %)			
Reference semester:	1			
Frequency of offer:	Annually in winter			
Literature	Will be announced during the course			

Scientific Programming in Python II

Course number:	63-968 (ICSS-M-2.5.2)			
Lecturer:	Remon Sadikni			
Course type:	Elective core course			
Learning outcomes:	Students have learned the programming language Python from scratch. They got in touch with common scientific libraries for analysing and plotting geoscientific data.			
Contents:	Introduction to Python: data types, control flow statements, data structures, functions, input/output, modules, errors and exceptions, classes. Introduction to scientific libraries like numpy, scipy and matplotlib. This course is designed for novice programmers and will focus on the basics of programming.			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture	28 h	17 h	0 h
	Credit points: 1.5	28 h	17 h	0 h
Exam (type, requirements for registration):	Requirements for registration: none Exam: Practicals pass/fail, regular participations (>80 %)			
Reference semester:	1			
Frequency of offer:	Annually in winter			
Literature	Will be announced during the course			

Sea-going option from BSc program

Module:	GO-GBPRA-S
Module coordinator:	Martin Gade
Course type:	Elective module
Learning outcomes:	Students learn the basics of sea-going oceanography within this module. During the seminar students are supposed to identify a research question, prepare the scientific background and later analyse the results from their research cruise. The cruise normally takes place during one week in the North Sea.
Courses:	• 63-623 Seminar zum Berufs- und Seepraktikum (Ozeanographie) (3 CP) • 63-622 Berufs- und Seepraktikum (Ozeanographie) (5 CP)
Exam:	To finish the module students need to write a cruise report and give a presentation about their results within a public institute presentation (talk and posters).
Special Information (requirements for registration and more):	Note that this module is a mandatory module for Bachelor students of the Oceanography program offered – in German - by the institute. Therefore, master students are only allowed to participate if free places are available and need to check availability before the term starts. Also students need to be familiar with the content of two courses that are taught within the winter term before: • 63-705 Messmethoden und Fernerkundung (3 CP) • 63-706 Übungen zu den Messmethoden, Fernerkundung und Seepraktikum (1 CP) Please make sure to check with the course coordinator.
Reference semester:	2
Duration:	1 semester

SPECIALIZATION Module – Overview

The goal of this module is a preparation for the THESIS module and with this for writing your own Master's thesis. Note that one (of two) supervisors must be a professor teaching in the MSc OCP.

Therefore students decide on an IfM working group and a supervisor with which they would like to write their thesis. For an overview of research at the institute see:

https://www.ifm.uni-hamburg.de/en/workareas.html

Conducting a thesis at another university or research institute is by prior approval also possible. Please note that in this case also a professor teaching within the MSc OCP has to agree to co-supervise the SPEC and THESIS modules. Note on how to register an MSc OCP-external second supervisor can be found on page 37.

Possible working groups and the head of the working groups are:

Institute of Oceanography:

- Climate Modelling, lead by Prof. Dr. Johanna Baehr
- Coastal Research, lead by Prof. Dr. Corinna Schrum
- Experimental Oceanography, lead by Prof. Dr. Eleanor Frajka-Williams
- Sea Ice, lead by Prof. Dr. Dirk Notz
- Theoretical Oceanography & Marine Ecosystem Modelling, lead by Prof. Dr. Carsten Eden
- Remote Sensing & Assimilation, lead by Prof. Dr. Detlef Stammer

Institute of Mathematics:

- Numerical Methods in Geoscience, lead by Prof. Dr. Jörn Behrens

Forschungsstelle für Nachhaltigkeit und Klimarisiken.

- Climate extremes and climate risks, lead by Prof. Dr. Jana Sillmann

SPECIALIZATION Module

<table>
<tr><th>Module:</th><th colspan="4">OZ-M-SPECIALIZATION</th></tr>
<tr><td>Module coordinator:</td><td colspan="4">Chairperson of examination board</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Working group leaders</td></tr>
<tr><td>Course type:</td><td colspan="4">Compulsory core module</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">Students have acquired – through an extensive literature research and discussions within their working group – an in-depth understanding of a special topic in ocean or climate physics, which will also form the framework for the MSc thesis. Through active participation in a research group, students have also learned how to apply the necessary tools to conduct their MSc thesis research. Together with their MSc thesis advisor, they have shaped a concept and schedule for the upcoming MSc thesis, which students are able to present to a scientific audience and summarize in writing.</td></tr>
<tr><td>Contents:</td><td colspan="4">Courses:
- Specialization and Project Planning (12 CP)
- Seminar (3CP, Course number: 63-744)

Content of courses:
- Acquisition of knowledge of methods
- Application of methods
- Design of MSc thesis project (scientific question, methods, literature)
- Presentation of thesis proposal in seminar</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="2">Workload/ Credit points:</td><td>

Project Planning
Seminar</td><td>On-campus-study

30 h
30 h</td><td>Self-study

330 h
30 h</td><td>Exam preparation

0
30 h</td></tr>
<tr><td>Credit points:
12 + 3 CP</td><td>60 h</td><td>360 h</td><td>30 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">Requirement for registration for students: Completion of the modules OCEAN 1 and CLIMATE
Exam: report and presentation (seminar); ‘pass/fail’</td></tr>
<tr><td>Reference semester:</td><td colspan="4">3</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Summer & winter term</td></tr>
<tr><td>Duration:</td><td colspan="4">1 Semester</td></tr>
</table>

SPEC: Seminar

<table>
<tr><td>Course number:</td><td colspan="4">63-744</td></tr>
<tr><td>Lecturer:</td><td colspan="4">Johanna Baehr, Dirk Notz</td></tr>
<tr><td>Course type:</td><td colspan="4">Compulsory core course</td></tr>
<tr><td>Learning outcomes:</td><td colspan="4">At the end of the seminar students are able to present a research proposal for a master thesis.</td></tr>
<tr><td>Contents:</td><td colspan="4">The seminar centers around the presentation of a potential MSc thesis. Particular attention will be payed on how to derive the research question/problem from the existing literature, and how to present a coherent storyline for the proposed research. To practice, both short research abstracts and test proposal talks will be presented by the students and discussed within the class.</td></tr>
<tr><td>Formal/ recommended prerequisites:</td><td colspan="4">None</td></tr>
<tr><td rowspan="3">Workload/ Credit points:</td><td></td><td>On-campus-study</td><td>Self-study</td><td>Exam preparation</td></tr>
<tr><td>Seminar</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Credit points: 3</td><td>30 h</td><td>30 h</td><td>30 h</td></tr>
<tr><td>Exam (type, requirements for registration):</td><td colspan="4">As announced in course.</td></tr>
<tr><td>Reference semester:</td><td colspan="4">3</td></tr>
<tr><td>Frequency of offer:</td><td colspan="4">Annually in winter and summer</td></tr>
<tr><td>Literature</td><td colspan="4">Will be announced in course.</td></tr>
</table>

THESIS Module

Module:	OZ-M-THESIS			
Module coordinator:	Chairperson of examination board			
Lecturer:	Working group leaders			
Course type:	Compulsory core module			
Learning outcomes:	In the MSc thesis, students show that they can independently investigate a scientific question within the overall topic of ocean and climate physics using scientific methods, including a sub-sequential documentation following standard scientific practice. Starting from the current scientific understanding, students first demonstrate potential ways to tackle the scientific problem, which they then also apply. The scientific results are adequately described using both figures and text, and their limitations critically discussed. The module is completed by a presentation and open discussion at the Institute of Oceanography.			
Contents:	• Literature review • Analysis of data with adequate scientific methods • Preparation of scientific visualizations • Thesis writing • Oral presentation			
Formal/ recommended prerequisites:	None			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Credit points: 30	60 h	840 h	0 h
Exam (type, requirements for registration):	Exam: submission of written thesis and approximately 30 min. presentation with subsequent discussion			
Reference semester:	4			
Frequency of offer:	Winter & summer term			
Duration:	1 Semester			

Registering a 2nd supervisor for your MSc THESIS

One of the two supervisors needs to be a professor within the MSc OCP program (see list of possible supervisors on page 34). In case the second supervisor is not teaching in the MSc OCP, an application has to be written by the student and submitted together with the thesis registration. Please follow the guidelines below.

A person may be appointed as examiner for the MSc thesis in the MSc Ocean and Climate Physics by the Examination Board if

(i) they possess at least the qualification to be determined by the examination or an equivalent qualification,

(ii) they are involved in supervising the MSc thesis or teach in the MSc OCP,

(iii) they are professionally qualified in the subject area of the thesis.

These criteria must be addressed in a written application that is usually submitted by the student when they register their thesis at the study office. Please submit the application for a second supervisor together with the form for registering your thesis. It is fine so submit both the filled form and the application at the same time.

In the application, the student proposes the examiner/reviewer and gives reasons for their choice. The examination board reviews the proposal, and seeks to follow the suggestions, wherever possible and justifiable.

For the latter, it is helpful to supply the board with the relevant information. In particular:

- provide a short summary of the education, position and background of the potential supervisor/examiner: 2-3 sentences stating at which institution and at which kind of position they work, when they obtained a PhD and what their main research topics are. Typically, this information should be available on a personal website.

- if the potential supervisor/examiner is teaching in the MSc OCP, no application is necessary. Otherwise, briefly explain (again, 2-3 sentences) how your envisaged supervision team looks like, and how the work is shared. Any previous involvement in the SPEC project should be clearly stated.

- provide a short summary statement on the nature of your thesis topic. Specifically, state the topic you plan to work on, and describe (2-3 sentences) how the expertise of the potential supervisor/examiner links to this topic. It can be helpful to cite two or three of their relevant papers in the broader subject area here.

Studying abroad

There are several different options to go to another country and university during your MSc studies. Formally, we suggest to complete the courses required in the ADVANCED and ADDITIONAL modules. Before you plan and go abroad we recommend consulting the Chair of Examination Board well in advance (about 1 year or so ahead), whether your planned courses fit the requirements for the ADVANCED and ADDITIONAL modules.

An example of a module studied abroad is shown below.

ERASMUS

The European exchange program supports students who want to study in another European country. The program offers several advantages, e.g. tuition fee exemption at the host university, monthly stipend, and administrative support.

Currently, the Institute of Oceanography has a direct partnership with the University of Utrecht, which offers two programs to choose courses from ("Marine Sciences" and "Climate Physics"). The ERASMUS contact for this partnership is Sonja Kanemaki (Geomatikum, Bundesstraße 55 20146 Hamburg, E-Mail: *sonja.kanemaki@uni-hamburg.de*).

Another option, which can be used by MSc OCP students, is to study at the "University Centre in Svalbard (UNIS)". The Institute of Meteorology has an ERASMUS partnership with the University of Tromsø to get access to the UNIS courses. The contact person for this ERASMUS partnership is Prof. Dr. Bernd Leitl (Geomatikum, Bundesstraße 55 20146 Hamburg, E-Mail: *bernd.leitl@uni-hamburg.de*)

Please note that the course 'Air-Ice-Sea Interaction (15 CP)' can only be taken at UNIS.

The above listed opportunities are just examples of the most commonly explored ERASMUS partnerships. We are actively working on an expansion of this list, and are grateful for any suggestions. There are further possibilities through partnerships from Institute for Meteorology, Institute of Geophysics and Institute of Geography to study abroad, e.g. in Bergen.

Beyond ERASMUS

Some Master students study in Svalbard at UNIS without applying and using the ERASMUS program. To organize it this way, you will need to directly apply at UNIS.

Please be aware the students council (Fachschaftsrat, FSR) is a good reference point to find out which students have recently spent a semester abroad.

Air-Ice-Sea Interaction

Course number:	63-777			
Lecturer:	Dirk Notz			
Course type:	Elective core course, in conjunction with University Centre in Svalbard			
Learning outcomes:	Students obtain an understanding of the processes involved in the interaction between sea ice, the ocean and the atmosphere in regions totally or partly covered with sea ice.			
Contents:	Thermodynamic aspects of freezing and melting of sea ice; the fine-scale structure of sea ice; the formation and deformation of ice-cover caused by thermodynamic processes and influence of wind, currents and wave action; turbulent boundary layer, field work on Arctic sea ice			
Formal/ recommended prerequisites:	This module is part of course AGF-211 carried out by the University Centre in Svalbard. The students must apply for AGF-211 directly at the University Centre in Svalbard (http://www.unis.no)			
Workload/ Credit points:		On-campus-study	Self-study	Exam preparation
	Lecture Seminar/tutorial Field work	60 h 20 h 7 days	32 h 32 h	 60 h
	Credit points: 15	80 h	64 h	60 h
Exam (type, requirements for registration):	As announced by University Centre in Svalbard. Usually combination of report and oral exam			
Reference semester:	1 or 2			
Frequency of offer:	Annually from January until June			
Literature	Will be announced during the course			

Helpful additional information for first semester students

- **Living in Hamburg:**
  - Welcome in Hamburg
    https://www.hamburg.com/welcome/
  - Accomodation in Hamburg
    https://www.uni-hamburg.de/en/campuscenter/campus-leben/wohnen.html

- **Studying at University of Hamburg:**
  - Checklist for first semester students
    https://www.uni-hamburg.de/en/campuscenter/studienorganisation/erstsemester/checkliste-erstsemester.html
  - Information for foreign students at University of Hamburg
    http://www.uni-hamburg.de/firststeps