Physics

Climate Physics

Admission to the degree Physics

Applicants should possess:

- Solid basic knowledge in the relevant fields of physics specified for the Climate Physics programme below, as well as in the mathematics required for the study of these topics at an advanced bachelor level;
- The ability to work independently as well as in groups on solving physical problems and presenting the results and to read (English) physics literature at the level of graduate textbooks;
- The ability to write a research report in English, such as a bachelor thesis, is strongly advised.

Degrees that most probably these requirements are
- A BSc degree in Physics,
- A BSc degree in Physics and Astronomy,
- A BSc degree with a major in Physics,
- A major in Science with a strong component in physics.

Admission to the programme

Students admitted to the Physics degree qualify for admission to this programme if they possess the following skills and knowledge:

1. Solid basic knowledge in classical physics, especially fluid dynamics, as well as in the mathematics required for the study of such topics at an advanced level.
2. The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks.
3. Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants with a BSc and background in related fields like chemistry, earth sciences, geophysics, mathematics can be admitted if their background level in physics and mathematics is sufficient.

In case the student has not taken one of the above mentioned subjects, it can be taken as part of the MSc programme to remedy this deficiency (at most 15 EC). The programme director will decide which topics need to be followed.

Premaster's programme

A premaster of at most 30 EC is possible and will be designed by the programme director depending on the student's prior knowledge (deficiencies in physics and/or mathematics of more than 15 EC). The premaster's programme should be finished (i.e. all courses passed) before entry into the Climate Physics programme is allowed.

Learning outcomes

The graduate of the master's programme in Climate Physics:

Knowledge and understanding	
1.	has knowledge of the physics of the climate system, as is described in the specific aims of the courses of the programme;
2.	has a thorough understanding of the dynamics of atmosphere, ocean and climate.
3.	has knowledge of important developments in the field of global climate models and of

	process-oriented models and is able to state the relevance of these developments for the research field and society;
4.	has knowledge of the scientific literature in one of the five research themes of the programme.
Applying knowledge and understanding	
1.	is able to define a scientific problem, formulate a research question and design a basic strategy to solve this problem;
2.	is able to conduct research in climate physics under supervision of a scientific staff member and report on it in a manner that meets the customary standards of the discipline;
3.	is able to analyse and interpret the acquired materials and/or data according to scientific standards.
4.	is able to develop a numerical model, and to use and improve (parts of) existing numerical models of different degrees of complexity;
5.	is able to analyse, process and interpret data from measurements and numerical modelling.
Making Judgements	
1.	is able to discuss scientific aspects of the climate at a professional level;
2.	is able to indicate the relevance of the research field;
3.	is able to critically reflect on his/her own results, as well as on published scientific literature in the field of climate dynamics.
Communication	
1.	is able to transfer knowledge and results of scientific research in the field of climate physics to both a specialised and a more broadly interested audience, both in oral and written form;
2.	is able to professionally act in a (possibly multi-disciplinary and international) research team.
Learning skills	
1.	has the skills to reflect upon his/her learning process and, if necessary, adjust this process;
2.	has developed an effective and result-driven working method that enables him/her to function in a self-reliant manner on the labour market;
3.	has acquired sufficient scientific knowledge and skills to conduct independent scientific research, or to conduct other discipline-related work;
4.	has the qualifications to enroll in a PhD programme in Climate Physics;
5.	is qualified to acquire a position as a professional in a (semi) public or commercial organisation.

Contact hours

The average number of contact hours for a student of the programme (number of scheduled contact hours for the different courses and, in addition, the scheduled or standardised supervision time) is: **900** hours for the whole programme excluding the research part. The number of contact hours for a student in the research part of the programme is specified in individual application forms.

Contents

Mandatory courses	37.5 EC
Primary Electives	22.5-37.5 EC
Secondary Electives	0-15 EC
Research part	45 EC
Total	**120 EC**

Mandatory courses

- Dynamical Oceanography	(NS-MO401M, 7.5 EC)
- Dynamical Meteorology	(NS-MO402M, 7.5 EC)
- Atmospheric Composition and Chemical Processes	(NS-MO405M, 7.5 EC)
- Simulation of Ocean, Atmosphere and Climate	(NS-MO501M, 7.5 EC)
- Making, Analyzing and Interpreting Observations	(NS-MO502M, 7.5 EC)

Primary Electives

At least 22,5 EC has to be chosen from the following list of courses

- Ocean Waves	(NS-MO428M, 7.5 EC)
- Ice and Climate	(NS-MO427M, 7.5 EC)
- Current Themes in Climate Change	(NS-MO434M, 7.5 EC)
- Boundary layers, Transport and Mixing	(NS-MO408M, 7.5 EC)
- Marine Masters Summer Course	(NS-MO446M, 3.75 EC)
- Turbulence in Fluids*	(NS-376B, 7.5 EC)
- Wave attractors	(NS-MO477M, 7.5 EC)
- One of the following courses:	
Morphodynamics of Tidal Systems	(GEO4-4435, 7.5 EC)
Morphodynamics of Wave-Dominated Coasts	(GEO4-4434, 7.5 EC)

* Selection of this course requires permission of the programme director and of the exam committee.

The course NS-MO477M (Wave attractors) is labelled as Complex Systems course. Students enrolled in the year 2016-2017 and earlier may use NS-MO428M as Complex Systems course, but only if NS-MO428M was completed in the year 2016-2017 or earlier.

Secondary electives

1. At most 15 EC may be chosen from all MSc course offered by the Graduate School of Natural Sciences.
2. For other courses, e.g. the BSc course Geophysical Fluid Dynamic (NS-353B), approval by the programme director and by the exam committee is required.
3. Secondary electives may be used for courses required to fulfill the admission requirements in the case of deficiencies.

Research part

Students who have not yet passed all primary electives or who have more than 15 EC still open can only start with the research part after approval by the programme director or the programme coordinator.
Before starting the research project a meeting with the programme coordinator is mandatory to check the (planned) study program.

The research part is split as follows:
Master introduction (*introducing natural sciences*; GSNS-INTRO): 0.5 EC,
Dilemmas of the scientist (FI-MHPSDIL): 0.5 EC,
Thesis project part 1 (NS-MO551M): 14 EC,
Thesis project part 2 (NS-MO552M): 30 EC.

Research is done under the supervision of a staff member of the Institute for Marine and Atmospheric Research. This research is concluded with a written master´s thesis.

Research can be done in the following directions:

1. Ice and Climate;
2. Ocean Circulation and Climate;
3. Atmospheric Physics and Chemistry;
4. Atmospheric Dynamics and the Hydrological Cycle;
5. Coastal and Shelf Sea Dynamics.

Students must have concluded at least two of the three mandatory courses:

1. Dynamical Oceanography (NS-MO401M),
2. Dynamical Meteorology (NS-MO402M)
3. Atmospheric Composition and Chemical Processes (NS-MO405M)

before commencing the master research project.

Labour market perspectives and scientific integrity

Both aspects are discussed during the master introduction days. Besides, students attend two additional mandatory sessions on scientific integrity in their first and second year. Information about labour market perspectives is also given in several courses, as well as during sessions between student and programme coordinator and during research projects and internships.

Profiles (Educational/Complex Systems/Applied Data Science)

Instead of the regular programme described above, the student may choose to replace 30 EC of the regular programme with a *profile*. The contents and further description of a profile, including entry requirements to specific courses, is described in a separate appendix. In order to still meet the learning outcomes of the master's programme, the remaining 90 EC must be filled in as described below. Note that if the student fails to succesfully complete the profile, the admissible curriculum conditions for the student revert to the regular (120 EC) programme structure.

Mandatory courses	37.5 EC
Primary electives	22.5 EC
Secondary electives	0 EC
Research part	30 EC
Total	**90 EC**

The research is split into master introduction (0.5 EC), Dilemmas of the scientist (0.5 EC), thesis part 1 (NS-MO551M, 14 EC) and thesis part 2 (NS-MO552M, 15 EC).
Remark: in this programme it is permitted to combine the research part of the profile Complex Systems (15 EC) with the research part (30 EC) in the table above, but the two research parts will be separately assessed.

Special provisions for students who enrolled in the programme Meteorology, Physical Oceanography & Climate in the year 2015-2016 and earlier

The courses *Introducing Natural Sciences* (GSNS-intro, 0.5 EC), *Dilemmas of the scientist* (FI-MHPSDIL; 0.5 EC) and the thesis split components part 1 and part 2 are not mandatory for students enrolled into this programme prior to 1 September 2016.

This provision ends 31 August, 2018.