Appendix 4: Modules

Comments

This appendix lists only modules imported from other study programmes which are not listed in appendix 2. The module handbook of the Master's programme Meteorology contains descriptions of the imported modules; these correspond to the module descriptions in the originating study programmes.

1. Compulsory Modules MSc Meteorology

AGS	***Group seminar***	**Compulsory module**	**6 CP**
1.	**Contents**		
	In-depth overview of a current research area in meteorology as addressed by one of the research groups of the institute.		
2.	**Goals and competences**		
	Students acquire in-depth knowledge in a special field. They gain insights into the current state of research for a subsection of meteorology and can put it into its proper scientific context. They are able to summarise it in an appropriate manner, prepare an appropriate presentation within a limited time frame and in a comprehensible manner, and engage in critical discourse.		
3.	**Course prerequisites**		
	none		
4.	**Course format**		
	Seminar		
5.	**Study record (as a prerequisite for examination, where applicable)**		
	Attendance record: Continuous and active participation (§ 15), presentation of seminar talk, not graded		
	Performance record: none		
	Prerequisite for examination: none		
6.	**Examination**	**Type/duration**	
	Final module exam consisting of:		
7.	**Grades**		

SPE	*Specialisation*	Compulsory module	15 CP

1. Contents

Scientific and methodological specialisation for a specific research topic or field.
The class includes personal meetings with the supervisor on a weekly basis for discussion of progress and planning of activities.

2. Goals and competences

Students acquire in-depth scientific and methodological knowledge in a specialist field as an introduction for the subsequent project exposé and Master's thesis. They learn to apply specialist methods and to work independently in the specialist field. They acquire an overview of the relevant literature and of the current state of research. They are able to carry out literature searches, identifying the relevant literature and exploiting it for their work.

3. Course prerequisites:

none

4. Course format

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: none

Performance record: none

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	none

7. Grades

PR	*Project*	Compulsory module	15 CP

1. Contents

Written exposé and preparatory work for the Master´s thesis in a current research topic.
This module follows the general introduction to the research topic (module SPE) and directly precedes the actual Master´s thesis (module MA). Guided by their Master's thesis supervisor, students work independently on a scientific project that may serve to prepare the subsequent Master's thesis. The module is completed by writing up the scientific basis of the specific topic as an introduction for the Master´s thesis. The scientific questions that motivate the Master´s thesis are developed and formulated and the specific goals as well as the methods and proceedings for achieving the goals of the Master´s thesis are described. This module includes personal meetings with the supervisor on a weekly basis for discussion of progress and planning of activities.

2. Goals and competences

The students gain competences with respect to the scientific and systematic approach to a comprehensive scientific topic. They increase their competence to present scientific contents in a precise and logical structure.
They are able to reproduce the current state of research in their research area and they can integrate their research question into the broader scientific context. They acquire specialist methods (e.g. experimental procedures, mathematical methods, modelling, etc.) that will be applied during their Master's thesis work. An exposé is developed that will be used as the draft concept of the Master's thesis; this way, students learn how to structure and organise a larger subject area.

3. Course prerequisites:

Module SPE

4. Course format

Lectures/tutorials

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: none

Performance record: none

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	Written report, ca. 15 pages

7. Grades

graded

MA	*Master‘s thesis*	Compulsory module	30 CP

1. Contents

Independent scientific project work on a current research topic that is agreed with a supervisor. The project work is guided by the supervisor. The Master’s thesis is an essential part of the academic and scientific training. Students demonstrate that they are able to accomplish a well-defined scientific task in a specific subject area by applying scientific methods, by working independently and adhering to the rules of good scientific practice. They acquire competences in designing, carrying out and writing a complete scientific thesis. It is mandatory that each student handle a current research question. The thesis work is guided by a personal scientific supervisor.

2. Goals and competences

Students gain competences with respect to the scientific and systematic approach to a comprehensive scientific topic. They learn how to treat a scientific research question and gain methodological competences as well as competences in evaluating the quality of research results. By completing their Master’s thesis the students gain fundamental competences in conducting research and communicating their research results.

3. Course prerequisites:

Module SPE and PR

4. Course format

5. Study record (as a prerequisite for examination, where applicable)

Attendance record none

Performance record: none

Prerequisite for examination: none

6. Examination	Type/duration
Final module exam consisting of:	Master´s thesis, ca. 60-90 pages

7. Grades

graded

2. Elective modules of the Master's programme Meteorology

2.1 Wahlpflichtbereich / Elective area 1

MG	*Boundary Layer Meteorology*	Elective module	12 CP

1. Contents

Boundary Layer Meteorology 1: Introduction to the atmospheric boundary layer and turbulence and how to model these. Mathematical description and analysis of turbulent flows. Introduction to turbulence parameterisation. Similarity theory. The convective and stable boundary layer. Simple models and diurnal variation of the ABL.
Boundary Layer Meteorology 2: Advanced and current topics in boundary layer meteorology.
Potential lecture topics are, for example:
- Important turbulence parameterisation schemes
- Modelling of the coupled land-atmosphere system (boundary layer)
- Moist processes and boundary-layer clouds
- The boundary layer over complex terrain: slope and valley wind systems
- Land surface heterogeneity and internal boundary layers
- Current research topics in the boundary layer research group

2. Goals and competences

Goals: The module serves both to achieve a further specialisation in the field and to expand fundamental knowledge in meteorology. It treats basic and advanced topics in the description and modelling of the atmospheric boundary layer and other small-scale phenomena. At the same time it gives an introduction into research topics in the research group "Boundary Layer Meteorology".
Competences: Students expand their knowledge of the structure and dynamics of the atmospheric boundary layer, their abilities in the conceptual and numerical modelling of the atmosphere and the climate system, and the scientific discussion of complex concepts and connections. In the tutorials, students practice working in a group and learn how to share and communicate their own (pre-existing or acquired) knowledge, and the practical use of material studied in the lectures. This also includes acquiring programming techniques.

3. Course prerequisites:

BL1: Modules EMetB and MetThA from the BSc Meteorology
BL2: BL1

4. Course format

Lectures/tutorials

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: Continuous and active participation in all the tutorials of the module (§15)

Performance record: Successful completion of the tutorials

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	Oral exam (30 min.) or written exam (120 min.),

7. Grades

graded

ME	*Experimental Atmospheric Science*	Elective module	12 CP

1. Contents

Atmospheric physics and chemistry II:
Gas phase II (distribution, budgets and life cycles of trace gases, reaction kinetics, stratospheric chemistry and circulation, atmospheric thermodynamics and thermochemistry)
Aerosols II (aerosol thermodynamics; aerosol nucleation; electrical effects; optical properties; aerosol composition)
Clouds II (cloud chemistry; radiative properties; electrical properties; cloud processing; cloud classification)
Experimental methods of atmospheric research: Introduction to various experimental methods of atmospheric research, e.g. trace gas detection using mass spectrometry, gas chromatography; methods for characterisation of aerosol particles and clouds; optical methods; observational platforms; sampling techniques.

2. Goals and competences

The module offers an advanced approach to the physical (esp. microphysical) and chemical processes of the atmosphere as well as an introduction to experimental methods of atmospheric research. An introduction to current research topics of the experimental research groups of the Institute for Atmospheric and Environmental Sciences is provided.
Students gain an understanding of the essential microphysical and chemical processes of the atmosphere. They acquire mathematical techniques and programming competences to adequately describe atmospheric chemical reactions, chemical cycles and equilibria; and they gain an overview of experimental techniques applied in current atmospheric research.

3. Course prerequisites:

PCA I

4. Course format

Lectures/tutorials

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: PCA II: continuous and active participation in the tutorials

Performance record: PCA II: Successful completion of the tutorials;
Experimental methods of atmospheric research

Prerequisite for examination: none

6. Examination	Type/duration
Final module exam consisting of:	Oral exam (30 min) or written exam (120 min)

7. Grades

graded

MK	*Climate system & processes*	Elective module	12 CP

1. Contents

Global climate processes: In-depth introduction to the global climate system, its components, their interactions and modelling. Simple to very complex research models are discussed and worked on, with topics such as Daisyworld, El Niño, and global warming.
Regional climate processes: This module introduces special regional processes of the climate system and their modelling. Examples of such processes are convection, land-atmosphere interaction, orographic precipitation, and foehn phenomena. In addition to the modelling and parameterisation of these processes, relevant observation systems and scale questions are also discussed.

2. Goals and competences

Goals: The module serves to provide thematic specialisation, but also to broaden the students' basic knowledge of meteorology. It deals with advanced topics to aid understanding, describing and modelling the global and regional climate system. Current research topics in the working group "Mesoscale Meteorology and Climate" will be introduced.
Competences: Students expand their knowledge of the global climate system and regional processes as well as their skills in conceptual and numerical modelling in meteorology and climatology and in the scientific discussion of complex interrelationships. In the tutorials, students practice working in a group and learn how to share and communicate their own (pre-existing or acquired) knowledge, as well as the practical handling of the lecture material. This also includes acquiring programming techniques.

3. Course prerequisites:

none

4. Course format

Lectures/tutorials

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: continuous and active participation in all exercises of the module (§15)

Performance record: Successful completion of the tutorials

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	One oral exam (30 min) or written exam (120 min) on both courses

7. Grades

graded

MT	*Theory*	Elective module	12 CP

1. Contents

Advanced theory of atmospheric dynamics and climate 1:
Introduction to methods and content of a topic in current research on the theory of the fundamentals of atmospheric dynamics and climate. Possible topics are, e.g.,
- Numerical methods of geophysical fluid dynamics
- Stochastic approaches to the description of atmospheric processes
- Dynamical-systems theory applied to the atmosphere

Advanced theory of atmospheric dynamics and climate 2:
Advanced treatment of a topic in current research on the theory of the fundamentals of atmospheric dynamics and climate. Possible topics are, e.g.,
- Dynamics of the middle atmosphere
- Gravity waves
- Turbulence
- Climate variability

2. Goals and competences

Goals: The module serves to provide an advanced specialisation, but also a broadening of basic knowledge of meteorology. It treats advanced topics in the theory of atmospheric dynamics and climate, giving a focused introduction into research topics addressed by the research group "Atmospheric Dynamics and Climate".
Competences: Students expand their skills in formulating theoretical models in meteorology, and in discussing complex theoretical relations. In the tutorials, students practice working in a group and learn how to share and communicate their own (pre-existing or acquired) knowledge, and the practical application of acquired knowledge. This also includes programming techniques.

3. Course prerequisites:

none

4. Course format

Lectures/tutorial

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: regular and active participation in the tutorials pursuant to § 15

Performance record: Successful completion of the tutorials

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	One oral exam (30 min) or written exam (120 min) on both courses

7. Grades

graded

2.2 Wahlpflichtbereich / Elective area 2

SPV1	*Advanced courses 1*	Elective module	6 - 16 CP

1. Contents

Contents depend on the chosen coursework:

Physics and chemistry of the middle atmosphere: This class covers the fundamental processes of chemistry, transport and radiation in the middle atmosphere, with a focus on the stratosphere. The fundamentals of the physics and chemistry of the mesosphere are also covered, as well as the Brewer-Dobson circulation as the dominant large-scale meridional circulation pattern of the stratosphere and the mesosphere. There will be an introduction to, and discussion of, various concepts of the tropopause as well as of the chemical processes that explain the ozone layer. There will also be discussions about long-term changes in the stratosphere caused by anthropogenic influences, in particular changes to the ozone layer.

Atmospheric Electricity: Introduction to the global electrical circuit (ionospheric charging, fair weather electricity, atmospheric ion drift); history of atmospheric electricity; cloud electricity (characteristics of thunderstorm clouds, lightning, lightning trigger, ionising particle production, charge separation mechanism); fair-weather sources of atmospheric ioto (ionising radiation range, solar wind, aurora, solar energetic particles, galactic cosmic rays (GCRs), terrestrial radioactivity, cloud charged droplet evaporation); electrical effects on atmospheric processes (evolution of ions in the atmosphere, ion-induced nucleation, cloud microphysics, atmospheric ion chemistry, instruments, CLOUD experiment at CERN); Observations of solar-GCR-climate variability (GCR archives, solar variability, global electric circuit variability, geo-magnetic field variability, GCR-climate mechanisms); future research prospects.

Air Quality and Emission Control (lecture): The lecture focuses on emissions of air pollutants, especially the issue of particulate matter and nitrogen oxide pollution, air quality monitoring, emission control and emission permits, relations between air pollutants and nature conservancy as well as between air quality and climate change.

Air Quality (seminar): Special topics from the lecture air quality and emission protection will be discussed.

Atmospheric chemistry (practical): The aim of the practical is for students to learn experimental methods; students develop these methods and apply them using measuring instruments. They will measure trace gases in the atmosphere. A focal point is placed on gas chromatography and mass spectrometry, paying particular attention to specific aspects of atmospheric measurements (gaseous samples; low concentration).

Practical programming: Introduction to the programming languages FORTRAN, Labview or IGOR. Acquisition of programming techniques.

English for Natural Scientists 1 and 2: Reading, writing and evaluation of specialist scientific texts; key vocabulary, expressions and phrases for scientific writing, presentation of scientific topics in English.

This module allows combinations of the lectures described above. It is also possible to include lectures from elective area 1, provided they are not used there or in SPV2.
Further lectures on a special field in meteorology can be included, on application to and permission by the Examination Committee MSc Meteorology.

2. Goals and competences

Students gain a broad and competent view of problems and topics in meteorology (e.g. climate variability, weather prediction, atmospheric chemistry). This also enables them to conduct competent research in the field.

English for Natural Scientists 1 and 2: Students improve their English language skills in all four areas: reading, writing, speaking and listening. Upon completion of the course they should be able to follow presentations and lectures in English, write about their research in English and be able to report on and discuss their work in English.

3. Course prerequisites:

none

4. Course format

Lectures/tutorials/practicals

5. Study record (as a prerequisite for examination, where applicable)

	Attendance record: none
	Performance record: *Physics and chemistry of the middle atmosphere:* successful completion of the tutorials *Atmospheric electricity:* successful completion of the tutorials *Air quality and emission control:* successful completion of the tutorials *Air quality (seminar):* seminar presentation *Practical programming:* successful completion of the tutorials *Atmospheric chemistry (practical):* successful completion of report of practical work *English for natural scientists 1 and 2:* successful completion of the tutorials
	Prerequisite for examination: none

6.	**Examination**	**Type/duration**
	Final module exam consisting of:	The module examination is class-related: Within this module, students can choose a class amounting to ≥ 4CP. The exam tests both the specific content of this class and the overall module goals. All other module classes attended by the student are completed with the performance records listed above. Oral exam (30 min.) or written exam (90 min.)

7.	**Grades**
	As a rule not graded, however for students who do not take a minor subject, this module's grade counts for the final Master's grade (15 per cent of the final Master's grade as weighted mean of the grades from SPV1 and SPV2).

SPV2	*Advanced courses 2*	Elective module	5 - 15 CP

1. Contents

Atmospheric radiation: After revisiting the laws of radiation, the module deals with the various processes of absorption, emission and atmospheric scattering. There are discussions on the problem of radiation transfer and spectral integration as well as the mathematical treatment thereof, on the parametrisation of radiation processes in predictive models and on the interaction between radiation and other processes (cloud formation, convective flows). The content of this module is embedded in aspects of the global energy budget, measurement of radiation and remote sensing.

Numerical Methods: The lecture gives an introduction into the numerical basics of weather forecasting and climate simulations. A treatment of the numerical solution of ordinary equations (stability, consistency, convergence, Runge Kutta, multi-step methods, implicit methods) is followed by a discussion of methods for the solution of one- and multi-dimensional fluid equations (stability and convergence, finite differences, numerical dissipation and dispersion, treatment of diffusion and sources). The course provides the theoretical foundations for the module lecture on the *Numerical Simulation of Weather and Mesoscale Processes*.

Stochastic Methods: The lecture gives an introduction to the fundamentals of the theory of stochastic dynamic systems. An introduction to concepts of probability is followed by a treatment of Markov processes and an extensive discussion of Ito calculus and its applications.

Atmospheric Dynamics 4: The lecture gives an introduction to the theory of the general circulation and covers wave-mean-flow interactions, followed by a discussion of the mean circulation.

Numerical simulation of weather/mesoscale phenomena: Students work with a simple atmospheric model (e.g. idealised 2D model) to discuss and research various aspects of numerics, dynamics, physical parametrisation and their coupling.

English for Natural Scientists 1 and 2: Reading, writing and evaluation of specialist scientific texts; key vocabulary, expressions and phrases for scientific writing, presentation of scientific topics in English.

This module allows combining the lectures described above. It is also possible to include lectures from elective area 1, provided they are not used there or in SpV1.
Further lectures on a special field in meteorology can be included, on application to and permission by the Examination Committee MSc Meteorology.

2. Goals and competences

Students gain a broad and competent view of problems and topics in meteorology (e.g. climate variability, weather prediction, atmospheric chemistry). This also enables them to conduct competent research in the field.

English for Natural Scientists 1 and 2: Students improve their English language skills in all four areas: reading, writing, speaking and listening. Upon completion of the course they should be able to follow presentations and lectures in English, write about their research in English and be able to report on and discuss their work in English.

3. Course prerequisites:

none

4.	**Course format**	
5.	**Study record (as a prerequisite for examination, where applicable)**	
	Attendance record: none	
	Performance record: *Atmospheric radiation:* successful completion of the tutorials *Numerical Methods:* successful completion of the tutorials *Stochastic Methods:* successful completion of the tutorials *Atmospheric dynamics 4:* successful completion of the tutorials *Numerical simulation of weather/mesoscale phenomena:* successful completion of the tutorials *English for natural scientists 1 und 2:* successful completion of the tutorials	
	Prerequisite for examination: none	
6.	**Examination**	**Type/duration**
	Final module exam consisting of:	The module examination is class-related: Within this module, students can choose a class amounting to ≥ 4CP. The exam tests both the specific content of this class and the overall module goals. All other module classes attended by the student are completed with the performance records listed above. Oral exam (30 min.) or written exam (90 min)
7.	**Grades**	
	As a rule not graded; however for students who do not take a minor subject, this module's grade counts for the final Master's grade (15 per cent of the final Master's grade as weighted mean of the grades from SPV1 and SPV2).	

EXK	*Excursion*	Elective module	4 CP

1. Contents

Students visit important potential employers for meteorologists, such as research institutes, regional authorities and meteorological services. On site, they will receive information about the relevant area of work, and they will prepare presentations on the contents of the excursion and summarise the essential elements of what they have learned in written reports.

2. Goals and competences

Students will become familiar with the areas of work open to meteorologists. They gain knowledge of the job market and insights into practical work, and learn about the requirements set by potential employers. They have direct contact with potential employers, which will help them make informed decisions about their future employment.

3. Course prerequisites:

none

4. Course format

variable

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: Participation in the excursion and writing up a report

Performance record: none

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	Written report, ca. 10-20 pages

7. Grades

not graded

INT	*Internship*	Elective module	6 CP

1. Contents

Practical work experience: This internship runs for a duration of 4 weeks. At their place of training – any institution outside university that is related to the field of meteorology – students will gather experiences in the practical application of meteorology. They are expected to find and organise their placement independently, however teachers will advise and support their search.

2. Goals and competences

Students gain concrete insights into the work of a meteorologist. They experience practical work processes, learn to evaluate their content, and acquire key qualifications in communications and cooperation.

3. Course prerequisites:

none

4. Course format

5. Study record (as a prerequisite for examination, where applicable)

Attendance record: none

Performance record: none

Prerequisite for examination: none

6. Examination	**Type/duration**
Final module exam consisting of:	Written report, ca. 5 pages

7. Grades

not graded

2.3 Minor subject area

Students can choose one or two minor subjects in the minor subject area. It is possible to complete the Master's study without choosing any minors. Upon application by a student, the Examination Committee can admit further minor subjects and imported modules as part of the minor subject area. This requires consultation with, and consent of, the dean of the originating study programme. The imported modules in the minor subject area can be offered in English or in German. It is not necessary to study a minor subject as a whole; students can choose one or several modules from a minor subject. Within the minor subject area, students can choose modules amounting to at least 8 CP and at most 24 CP. The provisions of the Study Regulations of the originating study programme apply.

Students can also choose an optional module (credited with up to 5 CP) from courses offered by other faculties as part of the open orientation studies programme.

Students must accumulate an aggregate sum of 30 CPs from the modules in elective area 2 (8-30 CP), minor subject area (0-24 CP) and optional module (0-5 CP).

OPT	***General studies***	**Elective module**	**Up to 5 CP**
1.	**Contents**		
	Course work from other faculties (up to 5 CP) The general studies module allows students to broaden their academic and professional interests, to sharpen their academic profile, and to visit lectures and other classes from other disciplines and faculties. Upon written request to the Chair of the Examination Committee, the participation in the annual meeting of meteorology students (StuMeTa) or the participation in university committees can also be credited with up to 2 CP each.		
2.	**Goals and competences**		
	The general studies module allows students to obtain insights into the course work and subject areas from another subject or faculty of the university. The academic perspective is broadened and students can follow their personal and professional interests when selecting this module. Complementary competences are acquired, such as communicating about scientific contents with academics from other disciplines.		
3.	**Course prerequisites:**		
	none		
4.	**Course format**		
	variable		
5.	**Study record (as a prerequisite for examination, where applicable)**		
	Attendance record: variable		
	Performance record: variable		
	Prerequisite for examination: variable		
6.	**Examination**	**Type/duration**	
		Examination is based on the module descriptions of the originating study programme under which the module is offered.	
7.	**Grades**		
	not graded		