Department of Meteorology

Stockholm University

Syllabus

for course at first level

Atmospheric Physics and Chemistry
Atmosfärens fysik och kemi

30.0 Higher Education Credits
30.0 ECTS credits

Course code:	MO4000
Valid from:	Autumn 2016
Date of approval:	2016-02-29
Department	Department of Meteorology
Main field:	Meteorology
Specialisation:	G2F - First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Decision

This syllabus has been approved by the Board of the Faculty of Science at Stockholm University 2016-02-29.

Prerequisites and special admittance requirements

Admission to the course requires knowledge equivalent to:
Mathematics for the Natural Sciences I, 15 hp (MM2002)
Mathematics for the Natural Sciences II, 15 hp (MM4001)
Mathematics II - Analysis, part A, 7.5hp (MM5010)
Mathematics II - Analysis, part B, 7.5hp (MM5011)
Mathematics II - Linear algebra, 7.5hp, (MM5012)
Classical physics, 30 hp (FK3014)
Programming, numerical methods and statistics for physicists, 15 hp (FK4026)
Electromagnetism and waves, 7.5 hp (FK5019)
Quantum mechanics, 7.5 hp (FK5020)
Experimental physics, 7.5 hp (FK5021)

Course structure

Examination code	Name	Higher Education Credits
DYNA	Dynamic Meteorology	10
FLUI	Fluid Dynamics	3
KEMI	Atmospheric Chemistry	4
STRL	Atmospheric Radiation	4
TERM	Atmospheric Thermodynamics	5.5
TILL	Practical Applications in Meteorology	3.5

Course content

Based on fundamental physics, mathematics and chemistry, the course deals with the atmosphere, and to some extent the sea, thermodynamics, composition, energy balance and dynamics. The course consists of six parts:

1. Atmospheric Thermodynamics 5.5 credits 2. Atmospheric Radiation 4 credits 3. Atmospheric Chemistry 4 credits 4. Fluid Dynamics 3 credits 5. Dynamic meteorology 10 credits 6. Practical applications in meteorology, 3.5 credits.

The different parts contain the following:

Part 1, Atmospheric thermodynamics: Thermodynamics of ideal gases, thermal properties of water. Equations of state for the atmosphere and sea water. Thermodynamics of dry and moist air, dry and moist adiabatic processes. Vertical distribution of pressure, temperature and density in the atmosphere at rest. Analysis of mixing and convection, the formation of air masses. Condensation and sublimation, distribution and structure of clouds. Thermodynamic diagrams.
Part 2, Atmospheric Radiation: Basic description of the interaction between matter and radiation. Radiation processes, absorption, diffusion, radiation balance and heat radiation. Earth's radiation balance, greenhouse effect, the role of dust particles and clouds in the radiation balance. Applications with social relevance such as the impact of anthropogenic emissions on the radiation balance, remote sensing. Part 3, Atmospheric Chemistry: Basic description of the structure of atoms and molecules, chemical bonds, chemical reactions in the gas phase and on surfaces. Atmospheric composition, sources and sinks of greenhouse gases. Chemical and physical life cycle of dust particles. Ozone in the troposphere and stratosphere.
Part 4, Fluid Dynamics: Overview of fluid dynamic concepts, laws and principles as preparation for the dynamic meteorology. Flow types in non-rotating fluids. Divergence, vorticity, stream lines and trajectories. Navier-Stokes equations and the continuity equation. Dimensional analysis, Reynolds and Rayleigh numbers, laminar and turbulent boundary layers.
Part 5: Dynamic Meteorology: Application of basic fluid dynamics to atmospheric and oceanographic flow phenomena. Conservation laws for mass, momentum and energy. Synoptic movements in the atmosphere. Balanced flows: geostrophy, gradient wind and thermal wind. Conservation laws for vorticity and circulation. Structure of fronts and jet streams, Ekman layer, the logarithmic wind profile and secondary circulation, sea breeze circulation, coastal convergence in the atmosphere and ocean.
Part 6: Practical applications in meteorology: Analysis of the current weather conditions and weather forecasts using weather maps and other meteorological resources, thermodynamic diagrams. Observations of the atmosphere's chemical composition, analysis with regard to chemical processes, radiation processes, and meteorological conditions. Analysis of atmospheric radiation balance through numerical simulations.

Learning outcomes

Upon completion of the course, students ar expected to be able to:
Part 1-3, Atmospheric thermodynamics, radiation and chemistry:
- account for fundamental concepts about atoms and molecules, about their interaction with radiation and about chemical reactions in the gas phase and on surfaces
- apply the laws of physics to explain and solve problems about the atmosphere's vertical structure, energy transformations and the radiation balance
- explain the composition of the atmosphere and basic chemical processes in the atmosphere
- recognize the importance of radiative processes and chemical processes in the atmosphere for the Earth's climate, climate change and other issues of relevance to the environment and society
Part 4-5: Fluid Dynamics and dynamic meteorology:
- explain and apply basic fluid dynamic concepts and identify fluid dynamic flow types
- explain and apply fluid dynamic theory to analyze flow phenomena in the atmosphere
- interpret simple meteorological observations
Part 6: Applications:
- apply experimental data and theoretical concepts to observe and evaluate the interaction of meteorological and chemical conditions in the atmosphere
- apply numerical methods to calculate and evaluate simple flow processes and earth's radiation balance
- evaluate current weather conditions and weather forecasts through meteorological data and tools

Education

The teaching consists of lectures, exercises and laborations. Participaton in laborations and associated tutorials is compulsory. If there are special reasons, the Examinator may, after consulting the course teacher, allow the student to omit certain parts of the compulsory teaching.

Forms of examination

a. The course is examined as follows: Part 1-3: knowledge assessment takes the form of written and oral examination Part 4-5: knowledge assessment takes the form of written test and written assignments Part 6: knowledge assessment takes the form of written and oral presentations of projects and labs. If the instruction is in English, the examination may also be conducted in English.

b. Grades are on a seven-referenced scale: A = Excellent, B = Very good C = Good D = Satisfactory E = Sufficient Fx = Fail, some more work required F = Fail, much more work is required c. The grading criteria are handed out in the class. d. To pass requires a minimum passing grade on all component parts, as well as participation in compulsory teaching. The final grade calculated by weighing the grades from course sections, where the different parts are weighted in proportion to their extent. e. Students who fail an ordinary examination have the right to undergo further tests as long as the course is given. The number of examinations is not limited. Having sampled all compulsory parts of the course. Students who have passed an

examination may not retake the test for higher grade. A student who has successfully undergone two examinations in a course or part of a class, are entitled to have another examiner appointed, unless there are special reasons to the contrary. Such requests should be made to the Board. The course has at least two examinations for each part per academic year the year of tuition given. Intermediate years are given at least one examination. f. At Fx can be given the opportunity to complete up to grade E. The examiner decides which supplementary tasks to be performed and which criteria to apply in order to pass on the supplement. The addition should take place before the next examination.

Interim

Students may demand that the examination is performed according to this syllabys even after it has ceased to be valid. However, this may be done at most three times during the two years after the course was last given. The request for this should be directed to the Board of the department. The provision also applies in the case of revisions to the course plan.

Limitations

The course may not be included in a degree together with Atmospheric thermodynamics (MO3003), Atmospheric radiation and chemistry (MO3004), Fluid dynamics (MO3005), Dynamic meteorology I (MO3006) or equivalent.

Misc

The course is a part of the Bachelor's programme in Meteorology, but may also be taken as an individual course.

Required reading

The course literature is decided by the Board of the department, and is published at www.misu.su.se at least 2 months before the course starts.