Course descriptions

TABLE OF CONTENTS

COURSE DESCRIPTION

Academic year: 2025/2026

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID: FMFI.KAFZM/2-cMET-242/24	**Course title:** Aviation Meteorology

Educational activities:
Type of activities: lecture
Number of hours:
per week: **per level/semester:** 24s
Form of the course: on-site learning

Number of credits: 0

Recommended semester:

Educational level: N

Prerequisites:

Course requirements:
Preliminary evaluation: individual work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
The result of the training is a preparation of experts for the meteorological provision of civil aviation, as the largest user of meteorological services.

Class syllabus:
Basics of aeronautical meteorology. Significant meteorological phenomena in aviation. Airplane navigation. Air transport services. Aircraft operation. Organization of aviation meteorological services at international level. Meteorological observations and information distribution systems for airports. Meteorological observations at airports. Significant weather information. Distribution of information. Data archiving and quality control. Activities of the Meteorological Office.

Recommended literature:
Letecká meteorologie / Petr Dvořák. Cheb : Svět křídel, 2004
Slovenský letecký slovník : terminologický a výkladový / Milan Nedelka ...[et al.]. Bratislava : Magnet Press, 1998

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
16,67	16,67	16,67	50,0	0,0	0,0

Lecturers: Mgr. Alexandra Varsányiová
Last change: 13.06.2024
Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-cMET-109/25	**Course title:** General Climatology
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 30s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Course requirements: Preliminary evaluation: - Final exam: oral Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 0/100	
Learning outcomes: By completing the course, the student will gain a comprehensive knowledge of the theory and the physics of the global climate system and the theory of formation and development of specific climatic patterns in the individual Earth's regions	
Class syllabus: Earth's global climate system, climate forming factors and processes and their interactions. Sources utilized in climatology. Radiative and circulation climate forming factors. Climatic patterns for selected climatic elements. Climate and its peculiarities in the individual Earth's regions. Dynamic climatology. Climate changes and variability. Climate changes in the geological and historical past of the Earth. Anthropogenic impacts on climate. Climate modeling. Climatic scenarios for the 21st century. Climate change impacts.	
Recommended literature: Bluthgen, J., Weischet, W.: Algemeine Klimageographie, 3.Ed., Walt de Gruyter, Berlin 1980, 882 pp. Chrgian, A.Ch.: Fizika atmosfery, Tom 1 a 2., Gidrometeoizdat, Leningrad 1978, 247 a 319 pp. Okolowicz, W.: General Climatology Polish Sci.Pub., Warszawa 1976, 422 pp. Netopil, R. et al.: Fyzická geografie 1. SPN, Praha 1984, 272 pp. Peixoto, J.P., Oort, A.H.: Physics of Climate. AIP Press, Springer, New York 1992, 520 pp.; Lapin, M., Tomlain, J.: Všeobecná a regionálna klimatológia. Vyd. UK Bratislava, Bratislava 2001, 184 pp.; Pedlosky, J.: Ocean Circulation Theory. Springer, Berlin 1998, 455 pp.; Dobrovolski, S.G.: Stochastic Climate Theory. Springer, Berlin 2000, 282 pp.	

The newest information from the INTERNET-u and journals.

Languages necessary to complete the course:
Slovak in combination with English.

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
0,0	66,67	16,67	16,67	0,0	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Marián Melo, PhD.

Last change: 23.09.2025

Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-cMET-113/24	**Course title:** Physics of Clouds and Precipitation
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 24s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Course requirements: Preliminary evaluation: Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 0/100	
Learning outcomes: The student will gain basic knowledge about the mechanisms of cloud formation and precipitation, microstructure and cloud macrostructure, special cloud and precipitation problems.	
Class syllabus: Thermodynamics of phase transitions. Condensation nuclei and mechanisms of their action. Methods of calculating vertical speeds in the atmosphere. Vertical flows in the boundary layer of the atmosphere. Condensation of water vapor in the ground layer of the atmosphere. Thermodynamic conditions of the formation of masses. Convection in the atmosphere, macrostructic and layered cloud cover, CAPE and CIN quantities. Cloud microstructure and physical processes in the clouds. Theory of condensation growth of cloud drops and ice particles. Coalescence in the atmosphere and coalescent growth of cloud drops. The theory of the origin of precipitation (Bergeron and Findeisen's theory, the coalescent theory). Physical conditions for precipitation in the ground layer of the atmosphere. Precipitation measurement errors. Physical aspects of the formation and changes of snow cover. Electrical and optical properties of clouds and precipitation. Artificial interventions in clouds and precipitation.	
Recommended literature: Řezáčová, D., Novák, P., Kašpar, M., Setvák, M. (2007): Fyzika oblaků a srážek. Academia, Praha, 574 s. Khvorostyanov V.I. a Curry J.A. (2014): Thermodynamics, kinetics and microphysics of Clouds, Cambridge Press, Oxford Wang et al (2013): Physics and Dynamics of Clouds and Precipitation, Cambridge Press, Oxford	

Chrgijan, A., Ch. (1978): Fizika atmosfery, Tom 1, 2, Gidrometeoizdat - Leningrad, 247 s. a 319 s.
Pruppacher H.R., Klett J.D. (1997): Microphysics of Clouds and Precipitation. Kluwer Academic Publishers, Oxford

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
50,0	16,67	33,33	0,0	0,0	0,0

Lecturers: RNDr. Ingrid Damborská, CSc.

Last change: 13.06.2024

Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2- cMET-249/24	**Course title:** Physics of Convective Phenomena
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 24s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Recommended prerequisites: Synoptic Meteorology (1) (2-FMK-107/22); Synoptic Meteorology (2) (2-FMK-102/00); Physics of Lower Atmospheric Layers (2-FOZ-107/15)	
Course requirements: Preliminary evaluation: case study analysis Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 20/80	
Learning outcomes: Students will be able to understand the basic physical processes related to deep moist convection and recognize the environment in which storms and their individual accompanying severe phenomena occur. They also will be able to identify the typical characteristics of these environments and their relationship with convective mode. Students will gain a basic overview of current research methods of convective phenomena.	
Class syllabus: Basic physical quantities, parameters and equations describing the development of deep moist convection. Pressure perturbation gradient force, vorticity equation, vertical wind shear and its significance. Parcel theory and its shortcomings, potential energy, CAPE and CIN index. Spectrum of convective modes - ordinary convective cell, mesoscale convective systems, supercells - lifecycle, typical environment, features on radar and satellite images, gust front, RKW theory, typical accompanying phenomena, real cases. Severe phenomena: heavy rain, large hail, severe wind and downburst, tornado - typical environments and their prediction, connection with convective modes. Currently used prediction methods: e.g. ingredient-based method and explicit prediction of convective phenomena by high resolution models. Situation analysis through observations, radar and satellite data in combination with numerical models, interpretation of outputs from aerological soundings and identification of basic environmental properties, influence of synoptic scale	

processes, convective forecast indices and their limitations, hodographs, electrical activity of thunderstorms and its relation to the intensity of accompanying phenomena. Influence of orography on the environment of convective phenomena.
Application of knowledge in practice - short-term prediction of severe convective phenomena and nowcasting in a real atmosphere. Early warning methods against severe convective phenomena.
Modern research methods of deep convection (machine learning, explicit convection modeling, research and operational numerical models and their possibilities, probabilistic prediction).

Recommended literature:

Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Burgess, D. W., , and L. R. Lemon, 1990: Severe thunderstorm detection by radar. Radar in Meteorology, D. Atlas, Ed., Amer. Meteor. Soc., 619–647.
Coffer, B. E., and Parker, M. D., 2017: Simulated Supercells in Nontornadic and Tornadic VORTEX2 Environments. Monthly Weather Review 145, 1, 149-180.
Davies-Jones, R., 2015: A review of supercell and tornado dynamics. Atmos. Res., 158–159, 274–291.
Dennis, E.J. and Kumjian, M.R., 2017. The impact of vertical wind shear on hail growth in simulated supercells. Journal of the Atmospheric Sciences, 74(3), pp.641-663.
Doswell, C.A., H.E. Brooks, and R.A. Maddox, 1996: Flash Flood Forecasting: An Ingredients-Based Methodology. Wea. Forecasting, 11, 560–581.
Fritsch, J.M. and G.S. Forbes, 2001: Mesoscale Convective Systems. Meteorological Monographs, 50, 323–358.
Klemp, J.B., 1987. Dynamics of tornadic thunderstorms. Annu. Rev. Fluid Mech. 19, 369–402.
Kuchera, E.L. and Parker, M.D., 2006. Severe convective wind environments. Weather and forecasting, 21(4), pp.595-612.
Marion, G. R., Trapp, R. J., 2019: The dynamical coupling of convective updrafts, downdrafts, and cold pools in simulated supercell thunderstorms. Journal of Geophysical Research: Atmospheres, 124(2), 664-683.
Markowski, P., Richardson, Y., 2010: Mesoscale meteorology in midlatitudes. Wiley-Blackwell.
Markowski, P. M., and Richardson, Y. P., 2014: The Influence of Environmental Low-Level Shear and Cold Pools on Tornadogenesis: Insights from Idealized Simulations. Journal of the Atmospheric Sciences 71, 1, 243-275.
Mulholland, J. P., Nesbitt, S. W., Trapp, R. J., Peters, J. M., 2020: The Influence of Terrain on the Convective Environment and Associated Convective Morphology from an Idealized Modeling Perspective, Journal of the Atmospheric Sciences, 77(11), 3929-3949.
Peters, J. M., Nowotarski, C. J., Morrison, H., 2019: The Role of Vertical Wind Shear in Modulating Maximum Supercell Updraft Velocities, Journal of the Atmospheric Sciences, 76(10), 3169-3189.
Púčik, T., Groenemeijer, P., Rýva, D., Kolář, M., 2015: Proximity soundings of severe and nonsevere thunderstorms in central Europe. Monthly Weather Review, 143(12), 4805-4821.
Rotunno, R., J.B. Klemp, and M.L. Weisman, 1988: A Theory for Strong, Long-Lived Squall Lines. J. Atmos. Sci., 45, 463–485.
Taszarek, M., Brooks, H. E., Czernecki, B., 2017: Sounding-Derived Parameters Associated with Convective Hazards in Europe. Monthly Weather Review 145, 4, 1511-1528.
Taszarek, M., Allen, J.T., Púčik, T., Hoogewind, K., Brooks, H., 2020: Severe Convective Storms across Europe and the United States. Part II: ERA5 Environments Associated with Lightning, Large Hail, Severe Wind, and Tornadoes. Journal of Climate, 33, 10263-10286.

Thompson, R. L., Smith, B. T., Grams, J. S., Dean, A. R., Broyles, C., 2012: Convective modes for significant severe thunderstorms in the contiguous United States. Part II: Supercell and QLCS tornado environments. Weather and forecasting, 27(5), 1136-1154.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
16,67	16,67	16,67	16,67	16,67	16,67

Lecturers: Mgr. Miroslav Šinger, PhD.

Last change: 13.06.2024

Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-cMET-107/24	**Course title:** Physics of Lower Atmospheric Layers
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 48s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Course requirements: Preliminary evaluation: independent work Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 20/80	
Learning outcomes: To explain the elementary knowledge of atmospheric dynamic.	
Class syllabus: The horizontal flows and their classification. The advective changes of temperature by geostrophic wind. The ageostrophic wind. The altitude change of geostrophic wind in the various oriented thermobaric field. The time changes of temperature and air pressure in the dependence to direction and changes of geostrophic wind by altitude. Thermal wind. Slope of isobaric and frontal surfaces. Frontogenesis and frontolysis. Speed of frontal line. Continuity equation and pressure tendency equation, Vorticity equation. Bjerknes, Kelvin circulation theorem.	
Recommended literature: Pechala, F., Bednář, J.:Příručka dynamické meteorologie. Academia, Praha, 1991, 372s. Holton, J.R.: An Introduction to Dynamic Meteorology. Academic Press, London, 1992, 511p. Tomlain, J., Damborská, I.: Fyzika hraničnej vrstvy atmosféry. Vyd.UK Bratislava, Bratislava, 1999, 132s. Bluestein, H.B.: Synoptic-Dynamic Meteorology in Midlatitudes, Vol.1, Oxford Univ.Press., 1992, 431 pp.	
Languages necessary to complete the course: Slovak in combination with English (some of the suggested readings are in English).	
Notes:	

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
0,0	0,0	50,0	16,67	16,67	16,67

Lecturers: doc. RNDr. Martin Gera, PhD.

Last change: 13.06.2024

Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-cMET-202/24	**Course title:** Satellite and Radar Observations of Meteorological Phenomena
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 24s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Course requirements: Preliminary evaluation: 2 tests Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 80/20	
Learning outcomes: Gain knowledge about the principles of observing meteorological phenomena using meteorological satellites and radars.	
Class syllabus: History of meteorological radars. Radar block scheme. Radar signal propagation through the atmosphere. Radar equation. Quantities measured by radar. Meteorological phenomena detectable by radar. Problems and their solutions in meteorological radar measurements. Radar measurement products. Meteorological radar network of the Slovak Republic and international data exchange. Electromagnetic spectrum. Physical laws of radiation. Changing the intensity of radiation by passing through a layer. Two stream approximation. Schematic equation for radiation intensity measured by satellite. Types of sensors. Orbits of satellites and meteorological satellites. Sensor signal processing. Principles of RGB composites. Detection of meteorological phenomena using meteorological satellites. EUMETSAT.	
Recommended literature: Current sources of literature, scientific journals and Internet information will be available from the lecturer on an ongoing basis. Older literature: Carlsson, C.G.: An Introduction to Remote Sensing in Meteorology. SHMI, Sweden, Norrkoping 1997,315 pp. Reinhart, R.E.: Radar for Meteorologists. 2nd ed., North Dakota, USA, 1992, 334 pp. Doviak, R.J., Zrnic, D.S.: Doppler Radar and Weather Observations, Academic Press, London, 1992, 562 pp.	

Rao, P.K. at all.: Weather Satellites – Systems, Data and Environmental Applications, 2nd ed. AMS USA, Boston, 1994, 503 pp
Feranec, J. a kol: Slovensko očami satelitov, Veda, Bratislava, 2010, 263s.
Feranec, J. a kol: Meniace sa Slovensko očami satelitov +DVD, Veda, Bratislava,2012, 74

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
50,0	50,0	0,0	0,0	0,0	0,0

Lecturers: Mgr. Marián Jurášek

Last change: 13.06.2024

Approved by: doc. RNDr. Martin Gera, PhD.

COURSE DESCRIPTION

Academic year: 2025/2026	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-cMET-102/24	**Course title:** Synoptic Meteorology
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** **per level/semester:** 48s **Form of the course:** on-site learning	
Number of credits: 0	
Recommended semester:	
Educational level: N	
Prerequisites:	
Course requirements: Preliminary evaluation: - Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 0/100	
Learning outcomes: Students will be able to describe and identify objects of synoptic analysis on thermobaric maps - especially atmospheric fronts and pressure systems. They will learn to explain the basic physical mechanisms affecting their development, movement and typical features in various stages of development, based on which they will be able to explain the current state and changes in weather and describe the synoptic situation and its development with emphasis on central European conditions. Students will understand the interrelationships of atmospheric fronts, pressure systems and the frontal zone and the processes that affect them and the influence of other spheres of the climate system (orography, surface properties ...) on the development of the weather situation. It is a direct continuation of the lecture Synoptic Meteorology (1) and it uses the knowledge from the lecture Physics of Lower Atmospheric Layers. Students will learn to use the acquired knowledge in Synoptic Meteorology Practice (2).	
Class syllabus: The lecture consists of a basic description of conceptual models and physical processes in the troposphere on a synoptic scale with their demonstration in real situations. Atmospheric fronts - basic quantities, classification, features on thermobaric maps, horizontal and vertical sections, slope of the frontal area, accompanying weather at the crossing of individual fronts depending on the air mass. Frontogenesis and frontolysis, diagnostics and use. Frontal zone and jet stream. Cyclones and anticyclones of mid-latitudes, their structure, properties in individual stages of development using quasi-geophrophic theory, displacement and regeneration, cyclogenesis and anticyclogenesis, rapid cyclogenesis, the relationship of the developmental phase with atmospheric fronts and the frontal zone. Local effects, influence of orography on thermobaric fields, atmospheric fronts and pressure systems. PV method and its use.	

Recommended literature:

Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Browning, K. A. and Roberts, N. M., 1994: Structure of a frontal cyclone. Q. J. R. Meteorol.Soc., 120, 1535–1557.
Buzzi, A., Davolio, S., Fantini, M., 2020: Cyclogenesis in the lee of the Alps: a review of theories. Bulletin of Atmospheric Science and Technology. 1. 1-25.
Holton JR. 2004: An Introduction to Dynamic Meteorology, 4 ed. Elsevier Academic Press: London, UK.
Hoskins, B. J., Draghici, I., Davies, H. C., 1978: A new look at the omega-equation, QJ Roy. Meteorol. Soc., 104, 31–38.
Hoskins, B. J. and Hodges, K. I., 2002: New perspectives on the Northern Hemisphere winter storm tracks. J. Atmos. Sci., 59, 1041–1061.
Markowski, P., Richardson, Y., 2010: Mesoscale meteorology in midlatitudes. Wiley-Blackwell.
McGinley, J., 1982: A Diagnosis of Alpine Lee Cyclogenesis. Mon. Wea. Rev., 110, 1271–1287.
Pechala, F., Bednář, J., 1991: Příručka dynamické meteorologie. Academia-Ministerstvo životního prostředí ČR.
Shapiro, M. A.., and D. Keyser, 1990: Fronts, jet streams and the tropopause. Extratropical Cyclones, The Erik Palmén Memorial Volume, C. W. Newton and E. O. Holopainen, Eds., Amer. Meteor. Soc., 167–191.
Schultz, D. M., Keyser, D., and Bosart, L. F., 1998: The Effect of Large-Scale Flow on Low-Level Frontal Structure and Evolution in Midlatitude Cyclones. Monthly Weather Review 126, 7, 1767-1791.
Schultz, D. M., and Vaughan, G., 2011: Occluded Fronts and the Occlusion Process: A Fresh Look at Conventional Wisdom. Bulletin of the American Meteorological Society 92, 4, 443-46.
Schultz, D. M., and Sienkiewicz, J. M., 2013: Using Frontogenesis to Identify Sting Jets in Extratropical Cyclones. Weather and Forecasting 28, 3, 603-613.
Stull, R., 2011: Meteorology for Scientists & Engineers, 3rd Edition. Univ. of British Columbia. 938 p.
Wallace, J., Hobbs, P., 2006: Atmospheric science: an introductory survey, 2nd ed. Elsevier.
Williams, J., 2009: The AMS Weather Book: The Ultimate Guide to America's Weather. Amer. Meteor. Soc., 316 pp.
Zverev, A.S, 1986: Synoptická meteorológia. Alfa, Bratislava, 712 s.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 6

A	B	C	D	E	FX
16,67	16,67	0,0	33,33	33,33	0,0

Lecturers: Mgr. Miroslav Šinger, PhD.

Last change: 13.06.2024

Approved by: doc. RNDr. Martin Gera, PhD.