DOCTORAL STUDIES COURSE UNIT DESCRIPTION

Name of subject	Scientific Field	Center	Department
Environmental Physics and Chemistry (8 ECTS credits)	Physics N 002	Center for Physical Sciences and Technology	Environmental Research
Student's workload	Hours	Student's workload	Hours
Lectures		Consultations	10
Individual study	190	Seminars	

Course annotation
Aim of the course - to provide a unified, structured environment physics and chemistry course in the doctoral studies level. The main emphasis will be focused on the atmospheric physics and chemistry, as well as anthropogenic pollution of the environment, renewable and environment-friendly energy sources. The course examines in detail the atmospheric aerosol physics and chemistry as well as dynamic factors that directly influence the processes in the atmosphere and affect the climate change. Composition of the atmosphere, pressure, density. Equation of state of the atmosphere. Condensation and ice crystal formation. Full momentum equation. Application of the momentum equation: geostrophic wind, gradient wind and surface wind. Classification of clouds, cloud formation and fog formation. Vertical momentum equations in the cloud. Aerosol particle size distribution. Aerosol emissions. Homogeneous and heterogeneous nucleation. Monodisperse and polydisperse aerosol particles coagulation, Smoluchowski's solution. Condensation, precipitation, evaporation and sublimation of water vapor on the aerosol particles. Aerosol measurement instrumentation. Aerosol particle optical counters. Optical spectrometers and other optical systems. Condensation particle counters. Electrostatic separators. Dynamic bioaerosol measurement methods. Tropospheric photochemistry, OH and HO2 cycle, nighttime nitrogen chemistry, sulphur photochemistry. Stratospheric photochemistry, chlorine and bromine photochemistry, Antarctic ozone depletion. Photochemistry of polluted air, condensation mechanisms of organic chemistry. Aerosol mass spectrometry. High resolution mass spectrometers. Solar radiation spectrum. Light interaction with matter: absorption, ozone filter. Albedo of Earth surface and atmosphere, visibility, optical depth, global climate change. Heat transfer: heat transfer mechanisms. Thermodynamic variables. Heat engines. Internal combustion engines. Energy storage and transmission. Emissions of combustion processes: sulphur, nitrogen and carbon oxides, hydrocarbons, soot particles, thermal pollution. Reduction of atmospheric pollution emissions using the treatment facilities. Inexhaustible and regenerative energy sources. Use of solar energy for heating and electricity production. Wind energy. Ocean wave energy. Bioenergy. Hydropower. Nuclear power. Spread of pollutants in the rivers. Ground water flow. Vertical flows, transport of pollutants. Spread of pollutants in the air, Gaussian equation, spread of pollutants from high chimney.
List of literature
1. Jacobson, M.Z. (2005). Fundamentals of atmospheric modelling. Cambridge University Press. Second edition. 752 p. 2. Boeker, E. and van Grondelle, R. (2011). Environmental Physics: Sustainable Energy and Climate Change. John Wiley & Sons, Inc., Third edition. 456 p.

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<tr><td colspan="4">3. Kulkarni, P., Baron, P. A., and Willeke, K. (2011). Aerosol Measurement: Principles, Techniques, and Applications. Van Nostrand Reinhold. Third edition, 1160 p. DOI: 10.1002/9781118001684
4. Colbeck, I., Lazaridis, M. (2014). Aerosol Science: Technology and Applications. John Wiley & Sons, Inc., 490 p.</td></tr>
<tr><td>Consulting teachers</td><td>Scientific degree</td><td>Pedagogical name</td><td>Main scientific works published in a scientific field in last 5 year period</td></tr>
<tr><td>Vidmantas Ulevičius</td><td>Dr.</td><td></td><td>1. Davuliene L., Jasineviciene D., Garbariene I., Andriejauskiene J., Ulevicius V., Bycenkiene S. Long-term air pollution trend analysis in the South-eastern Baltic region, 1981–2017, Atmospheric Research, Volume 247, 105191, 2021.
2. Pauraite, J., Pivoras, A., Plauškaitė, K., Byčenkienė, S., Mordas, G., Augustaitis, A., Marozas, V., Mozgeris, G., Baumgarten, M., Matyssek, R., Ulevicius, V., Characterization of aerosol mass spectra responses to temperature over a forest site in Lithuania, J. Aerosol Sci., 133, 2019, 56-65, 2019.
3. Plauškaitė K., Špirkauskaitė N., Byčenkienė, S., Kecorius S., Jasinevičienė D., Petelski T., Zielinski T., Andriejauskienė J., Barisevičiūtė R., Garbaras A., Makuch P., Dudoitis V. and Ulevicius V. Characterization of aerosol particles over the southern and south-eastern Baltic Sea, Marine Chemistry, 190, 13-27, 2017.
4. Bozzetti, C., Sosedova, Y., Xiao, M., Daellenbach, K. R., Ulevicius, V., Dudoitis, V., Mordas, G., Byčenkienė, S., Plauškaitė, K., Vlachou, A., Golly, B., Chazeau, B., Besombes, J.-L., Baltensperger, U., Jaffrezo, J.-L., Slowik, J. G., El Haddad, I., and Prévôt, A. S. H. Argon offline-AMS source apportionment of organic aerosol over yearly cycles for an urban, rural and marine site in Northern Europe Atmos. Chem. Phys., 17, 117-141, 2017, doi:10.5194/acp-17-117-2017, 2017.
5. Ulevicius, V., Byčenkienė, S., Bozzetti, C., Vlachou, A., Plauškaitė, K., Mordas, G., Dudoitis, V., Abbaszade, G., Remeikis, V., Garbaras, A., Masalaite, A., Blees, J., Fröhlich, R., Dällenbach, K. R., Canonaco, F., Slowik, J. G., Dommen, J., Zimmermann, R., Schnelle-Kreis, J.,</td></tr>
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			Salazar, G. A., Agrios, K., Szidat, S., El Haddad, I., and Prévôt, A. S. H., Fossil and non-fossil source contributions to atmospheric carbonaceous aerosols during extreme spring grassland fires in Eastern Europe Atmos. Chem. Phys., 16, 5513-5529, 2016.
Steigvilė Byčenkienė	Dr.		1. Davuliene L., Jasineviciene D., Garbariene I., Andriejauskiene J., Ulevicius V., Bycenkiene S. Long-term air pollution trend analysis in the South-eastern Baltic region, 1981–2017, Atmospheric Research, Volume 247, 105191, 2021. 2. Byčenkienė, S., Jasinevičienė, D., Perkauskas, D. Overview of Air Pollution Assessment in Northern Europe (Lithuania) by Passive Diffusion Sampling, Advances in Meteorology, 2018, Article ID 7529043, 11 pages, 2018. 3. Plauškaitė K., Špirkauskaitė N., Byčenkienė, S., Kecorius S., Jasinevičienė D., Petelski T., Zielinski T., Andriejauskienė J., Barisevičiūtė R., Garbaras A., Makuch P., Dudoitis V. and Ulevicius V. Characterization of aerosol particles over the southern and south-eastern Baltic Sea, Marine Chemistry, 190, 13-27, 2017. 4. Bozzetti, C., Sosedova, Y., Xiao, M., Daellenbach, K. R., Ulevicius, V., Dudoitis, V., Mordas, G., Byčenkienė, S., Plauškaitė, K., Vlachou, A., Golly, B., Chazeau, B., Besombes, J.-L., Baltensperger, U., Jaffrezo, J.-L., Slowik, J. G., El Haddad, I., and Prévôt, A. S. H. Argon offline-AMS source apportionment of organic aerosol over yearly cycles for an urban, rural and marine site in Northern Europe Atmos. Chem. Phys., 17, 117-141, 2017, doi:10.5194/acp-17-117-2017, 2017. 5. Ulevicius, V., Byčenkienė, S., Bozzetti, C., Vlachou, A., Plauškaitė, K., Mordas, G., Dudoitis, V., Abbaszade, G., Remeikis, V., Garbaras, A., Masalaite, A., Blees, J., Fröhlich, R., Dällenbach, K. R., Canonaco, F., Slowik, J. G., Dommen, J., Zimmermann, R., Schnelle-Kreis, J., Salazar, G. A., Agrios, K., Szidat, S., El Haddad, I., and Prévôt, A. S. H., Fossil and

			non-fossil source contributions to atmospheric carbonaceous aerosols during extreme spring grassland fires in Eastern Europe Atmos. Chem. Phys., 16, 5513-5529, 2016.
Certified during Doctoral Committee session 02/02/2022, protocol No. (7.17 E) 15600-KT-32			
Committee Chairman prof. S. Juršėnas			