



UNIwersYTET
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Climate modeling

Educational subject description sheet

Basic information

Study programme Geohazards and Climate Change		Didactic cycle 2023/24
Speciality -		Subject code 07GCCS.22P.02860.23
Organizational unit Faculty of Geographical and Geological Sciences		Lecture languages English
Study level Second-cycle programme		Course type Obligatory
Study form Full-time		Block Basic subjects
Education profile General academic		
Subject coordinator	Bartosz Czernecki	
Lecturer	Bartosz Czernecki	
Period Semester 2	Activities and hours • Lecture: 15, Graded credit • Laboratories: 15, Graded credit	Number of ECTS points 3

Goals

Code	Goal
C1	Familiarizing students with principles of simulation methods used in atmospheric modeling.
C2	Increase awareness how principles of physics combined with mathematical algorithms may be used to describe and model atmospheric phenomena.
C3	Getting to know contemporary statistical and dynamical (numerical) modeling methods that can be used for atmospheric modeling.
C4	Gaining knowledge and skills for validation, verification and using accuracy measures for short- and long term simulations.
C5	Providing details on using bias correction methods commonly applied for climate models used for contemporary climate projections.
C6	Gaining skills related to proper use of statistical methods for extreme value modeling in estimating probability for occurrence of atmospheric-related extreme events using peaks over threshold (POT) and return period concepts.

Entry requirements

Knowledge and skills in basics of programming, mathematics and statistics. Required previous knowledge about structure of atmosphere, main processes taking place in atmosphere and its relation with other geo-spheres. Fundamentals of atmospheric physics are not mandatory, but might be great help in understanding the concepts of atmospheric modeling.

Subject learning outcomes

Code	Outcomes in terms of	Learning outcomes	Examination methods
Knowledge - Student:			
W1	knows and understands the concepts used in atmospheric science regarding representation of spatio-temporal process on the Earth's surface, possibilities and limitations that it may cause for climate modelling;	GCC_K2_W01, GCC_K2_W02, GCC_K2_W03, GCC_K2_W06, GCC_K2_W07, GCC_K2_W08, GCC_K2_W09, GCC_K2_W11, GCC_K2_W13, GCC_K2_W15, GCC_K2_W17	Written colloquium, Test, Multimedia presentation
W2	understands vocabulary used among climate modeling community and its interdisciplinary use cases;	GCC_K2_W13, GCC_K2_W15, GCC_K2_W17, GCC_K2_W18	Written colloquium, Test, Multimedia presentation
W3	has advanced knowledge of statistics used for interpreting climate model outputs;	GCC_K2_W05, GCC_K2_W07, GCC_K2_W08, GCC_K2_W09, GCC_K2_W10, GCC_K2_W11, GCC_K2_W13, GCC_K2_W15	Written colloquium, Test, Multimedia presentation

Code	Outcomes in terms of	Learning outcomes	Examination methods
W4	knows specialized GIS tools used for coupling global and regional climate models outputs for downscaling processes that can be utilized for environmental modeling;	GCC_K2_W01, GCC_K2_W02, GCC_K2_W03, GCC_K2_W05, GCC_K2_W06, GCC_K2_W07, GCC_K2_W08, GCC_K2_W09, GCC_K2_W10, GCC_K2_W11, GCC_K2_W13, GCC_K2_W15, GCC_K2_W16, GCC_K2_W18	Written colloquium, Multimedia presentation
W5	knows and understands the latest trends in climate modeling and its practical application for studied specialization.	GCC_K2_W15, GCC_K2_W17, GCC_K2_W18	Written colloquium, Test, Multimedia presentation
Skills - Student:			
U1	uses specialized terminology for referring and describing concepts of atmospheric modeling;	GCC_K2_U01, GCC_K2_U03, GCC_K2_U04, GCC_K2_U05, GCC_K2_U06, GCC_K2_U07, GCC_K2_U11, GCC_K2_U12	Written colloquium, Test, Multimedia presentation
U2	uses advanced research methods and research tools used in climate modeling;	GCC_K2_U01, GCC_K2_U02, GCC_K2_U03, GCC_K2_U05, GCC_K2_U08, GCC_K2_U09, GCC_K2_U11, GCC_K2_U14	Written colloquium, Test, Multimedia presentation
U3	uses mathematical and statistical methods for modeling and interpretation of a climate model output;	GCC_K2_U01, GCC_K2_U02, GCC_K2_U03, GCC_K2_U05, GCC_K2_U06, GCC_K2_U12, GCC_K2_U15	Written colloquium, Test, Multimedia presentation
U4	creates robust research plan while working with climate model products in accordance with commonly applied and scientifically recommended conventions;	GCC_K2_U01, GCC_K2_U02, GCC_K2_U03, GCC_K2_U04, GCC_K2_U06, GCC_K2_U08, GCC_K2_U09, GCC_K2_U11, GCC_K2_U12, GCC_K2_U16	Written colloquium, Test, Multimedia presentation

Code	Outcomes in terms of	Learning outcomes	Examination methods
U5	correctly interprets and draw conclusions based on different climate model products that can be used in other applications;	GCC_K2_U06, GCC_K2_U08, GCC_K2_U09, GCC_K2_U11, GCC_K2_U12, GCC_K2_U13, GCC_K2_U14, GCC_K2_U15	Written colloquium, Test, Multimedia presentation
U6	describes the components of the geographic environment and can identify cause-and-relationship between them;	GCC_K2_U02, GCC_K2_U03, GCC_K2_U04, GCC_K2_U09, GCC_K2_U10, GCC_K2_U11, GCC_K2_U12, GCC_K2_U14, GCC_K2_U16	Written colloquium, Test, Multimedia presentation
U7	solves research problem by understanding its importance in a broader scale; understand the meaning of taken action for its own professional career.	GCC_K2_U06, GCC_K2_U07, GCC_K2_U16, GCC_K2_U17	Written colloquium, Test, Multimedia presentation
Social competences - Student:			
K1	is aware of the significance of reliable data sources for critical reasoning and providing unbiased state of the art;	GCC_K2_K01, GCC_K2_K02, GCC_K2_K03, GCC_K2_K04, GCC_K2_K05, GCC_K2_K06, GCC_K2_K07	Written colloquium, Test, Multimedia presentation
K2	is prepared to improve professional skills and understanding of climate processes enriched by an interdisciplinary dimension.	GCC_K2_K04, GCC_K2_K05	Written colloquium, Test, Multimedia presentation

Study content

No.	Course content	Subject learning outcomes	Activities
1.	Introduction to statistical modeling in atmospheric sciences. Statistical methods: linear regression, non-linear regression, multiple regression. Interpretation of the verification measures and the overall quality of the created models. Forecasting and reconstruction possibilities based on statistical models.	W1, W2, W3, W4, W5, U1, U2, U3, U4, U5, U6, U7, K1, K2	Lecture, Laboratories
2.	A simple 0, 1 and 2 - dimensional model of Earth's energy balance budget. Application of a created model to determine the impact individual components for near-surface atmosphere in the past and for climate change projections on a planetary scale.	W1, W2, U1, U2, U3, U4, U5, U6, K1	Lecture, Laboratories
3.	The probability of extreme climate events for a given period of occurrence modeled with advanced statistical tools. Statistical modeling of extreme value distributions (EVD) based on the Fisher-Tippett family of distributions. Its application for atmospheric-related phenomena.	W1, W2, W3, W5, U1, U2, U3, U5, U6, U7, K1, K2	Lecture, Laboratories

No.	Course content	Subject learning outcomes	Activities
4.	Verification measure for assessing the quality of numerical and statistical simulations. Bias correction methods to reduce simulation errors in climate model output.	W1, W2, W3, W4, W5, U1, U2, U3, U4, U5, U6, U7, K1, K2	Lecture, Laboratories

Additional information

Activities	Teaching and learning methods and activities
Lecture	Lecture with a multimedia presentation of selected issues
Laboratories	Problem-based learning, Laboratory method

Activities	Credit conditions
Lecture	The final grade is based on a result obtained for the final test. Grading scale: 1. very good (5,0) – over 90% of points, 2. good+ (4,5) – over 80% of points, 3. good (4,0) – over 70% of points, 4. sufficient+ (3,5) – over 60% of points, 5. sufficient (3,0) – over 50% of points, 6. failing grade (2,0) – below 50% of points.
Laboratories	The final grade is based on a result obtained for the written colloquium (60%) and multimedia presentation (40%) on the chosen topic among predefined list. Grading scale: 1. very good (5,0) – over 90% of points, 2. good+ (4,5) – over 80% of points, 3. good (4,0) – over 70% of points, 4. sufficient+ (3,5) – over 60% of points, 5. sufficient (3,0) – over 50% of points, 6. failing grade (2,0) – below 50% of points

Literature

Obligatory

1. McGuffie K., Henderson-Sellers A., 1997. A climate modelling primer, 2nd edition. John Wiley and Sons Ltd., 253
2. Gilleland E., Katz R.W., 2011. New software to analyze how extremes change over time. Eos, 92(2), 13-14.
3. Gettelman A, Rood R.,B., 2016, Demystifying Climate Models. A Users Guide to Earth System Models. Springer Open

Optional

1. Benestad R., Hanssen-Bauer I., Chen D., 2008. Empirical-statistical downscaling. Singapore: World Scientific.
2. Holton J.R., Hakim G.J. 2013. An introduction to dynamic meteorology.
3. Hyndmann R.J., Athanasopoulos G., 2013, Forecasting: principles and practice, OTexts, Online, Open-access textbooks
4. Stocker T.F., Qin D., Plattner G.K., Tignor M., Allen S.K., Boschung J., Nauels A., Xia Y., Bex B., Midgley B.M. 2013. IPCC5. 2013: Climate Change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change.
5. Wilks D.S., 2008. Statistical methods in the atmospheric sciences. Elsevier, 627.

Calculation of ECTS points

Activities	Activity hours*
Lecture	15
Laboratories	15
Preparation for classes	5
Reading the indicated literature	15
Preparation of a multimedia presentation	10
Preparation for the assessment	20
Student workload	Hours 80
Number of ECTS points	ECTS 3

* academic hour = 45 minutes

Efekty uczenia się dla kierunku

Kod	Treść
GCC_K2_K01	The graduate is ready to implement and popularize actions serving the environmental protection
GCC_K2_K02	The graduate is ready to identify the influence of environmental processes onto the socio-economic processes, and also influence of anthropogenic activities onto the various components of the natural environment in various timescales
GCC_K2_K03	The graduate is ready to communicate, discuss and argue burning issues, hazards and problems associated with the climate, climate and environment changes for wider, non-scientific audience
GCC_K2_K04	The graduate is ready to use reliable sources of information associated with environmental hazards and climate and critical assessments of these sources
GCC_K2_K05	The graduate is ready to prioritize in order to successfully complete of the task
GCC_K2_K06	The graduate is ready to think and act creatively
GCC_K2_K07	The graduate is ready to undertake the cooperation within the crisis management teams and solve the conflicts
GCC_K2_U01	The graduate can vary between natural and anthropogenic causes of climate change and associated environmental changes and geohazards
GCC_K2_U02	The graduate can critically assess future climate change scenarios and associated environmental changes and geohazards
GCC_K2_U03	The graduate can conclude based on the data and information from various sources and geographical and environmental information
GCC_K2_U04	The graduate can formulate the research hypotheses and conduct environmental research: to plan, to manage and to document
GCC_K2_U05	The graduate can an extended degree use the scientific terminology and vocabulary, read the advanced scientific literature with understanding
GCC_K2_U06	The graduate can critically assess the sources of information on climate and environmental change and associated geohazards
GCC_K2_U07	The graduate can look for and select the necessary information from the scientific literature and other written sources and based on that learn and continuously update the knowledge throughout the life
GCC_K2_U08	The graduate can apply advanced laboratory methods and techniques used for environmental research
GCC_K2_U09	The graduate can apply advanced fieldwork methods and techniques used for environmental research
GCC_K2_U10	The graduate can apply health and safety rules and regulations in the office, in the laboratory and in the field
GCC_K2_U11	The graduate can apply mathematical and statistical methods for analysis, interpretation and visualization of the environmental data
GCC_K2_U12	The graduate can apply qualitative methods for solving the human-environment conflicts
GCC_K2_U13	The graduate can use in practice the environmental management principles leading to improvement of quality of life
GCC_K2_U14	The graduate can describe in extended degree environmental components and their relationships
GCC_K2_U15	The graduate can develop in writing scientific problem associated with the climate change and geohazards
GCC_K2_U16	The graduate can transparently and accessibly present the Earth and environmental sciences topics
GCC_K2_U17	The graduate can cooperate in the team, efficiently plan the work for her/himself and the research/task team
GCC_K2_W01	The graduate knows and understands thoroughly, the processes operating in the natural environment, their causes, mechanisms, consequences and associated geohazards

Kod	Treść
GCC_K2_W02	The graduate knows and understands thoroughly, climate functioning and mechanisms of atmospheric processes and the anthropogenic influence on the climate
GCC_K2_W03	The graduate knows and understands thoroughly, endogenic processes, anthropogenic influence on endogenic processes and following from them geohazards
GCC_K2_W05	The graduate knows and understands thoroughly, the causes and the evolution of extreme hydro-meteorological events in global, regional and local scale and their influence on the socio-economical processes
GCC_K2_W06	The graduate knows and understands thoroughly climatic changeability in various time-scales (yearly, decadal, centennial and millennial) and its causes
GCC_K2_W07	The graduate knows and understands thoroughly complex socio-economic processes in the local, regional and global scale and their influence on the occurrence of extreme environmental events
GCC_K2_W08	The graduate knows and understands thoroughly, the influence of the climate change, extreme environmental events and geohazards on the socio-economic processes
GCC_K2_W09	The graduate knows and understands thoroughly, relationship between climate and environmental change and necessity of formulation of the adaptation strategies
GCC_K2_W10	The graduate knows and understands thoroughly, the statistical and mathematical tools and methods necessary for the description and interpretation of environmental processes and forecasting environmental changes
GCC_K2_W11	The graduate knows and understands advanced laboratory methods and techniques used in the research on the elements of the environment and the environmental processes
GCC_K2_W13	The graduate knows and understands advanced remote sensing methods and techniques used for the description of discrete elements of the environment and environmental processes
GCC_K2_W15	The graduate knows and understands advanced vocabulary associated with climate change, natural environment and geohazards
GCC_K2_W16	The graduate knows and understands thoroughly, the rules and regulations associated with protection of intellectual property and copyrights
GCC_K2_W17	The graduate knows and understands thoroughly, the literature in the field of climate change, geohazards as well as basic environmental and social research
GCC_K2_W18	The graduate knows and understands thoroughly, the most up to date trends in science and implementation of the newest scientific achievements in studies field