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Synoptic meteorology of the Polar regions

Fall semester, 2019-2020 (pilot)

Coordinator	**Eduard Podgaiskii** (Russian State Hydrometeorological University, Russia)
Credits	2 ECTS (obligatory course), 28 in-class hours
Lecturers/ Developers	Lyudmila Kolomeyets (Russian State Hydrometeorological University, Russia) (pilot) Olga Toptunova (Russian State Hydrrometeorological University, Russia)
Level	BSc
Host institution	**Russian State Hydrometeorological University**, Meteorological Faculty, Chair of Meteorological Forecasts
Course duration	September 1 – December 31, 2019

Summary

This 2 ECTS course serves as advanced weather circulation patterns overview for the Arctic region. It helps natural science students to discover synoptic aspects of polar meteorology, with regards to Arctic oscillation, Polar lows and semipermanent pressure patterns in high latitudes. The course includes several exercises related to synoptic analysis in the Arctic zone. The course includes several exercises, biogeographical reactions in Arctic zone.

Target student audiences

BSc students in applied hydrometeorology (Polar Meteorology and Climatology minor)

Prerequisites

Required courses (or equivalents):

- Arctic Atmosphere's structure, composition, characteristics,
- Statics of the atmosphere,
- Thermodynamics of the arctic atmosphere,
- Radiant energy in the polar atmosphere,
- Arctic Radiation balance of Earth-atmosphere system,
- Active layer thermal regime of the polar region
- Phase water transitions in the polar atmosphere.
- Basics of atmospheric polar dynamics

Goals and objectives

The purpose of the discipline "Synoptic meteorology of the Polar regions" is the general professional course of bachelors in applied hydrometeorology, it allows students to understand the essence of phenomena and processes occurring in the arctic atmosphere.

This is the special interactive and theoretical discipline studied in the terms of applied and polar hydrometeorology, including lectures, practices.

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The main task of the discipline is to prepare students for the study of special professional disciplines in the field of Applied and Polar Hydrometeorology, focused on Polar regions.

General learning outcomes:

As a result of mastering the discipline "Synoptic Meteorology of the Polar regions", the student will know and understand the following topics:

- Polar atmosphere composition features.
- Arctic air composition.
- Constant and variable polar air components.
- Vertical structure of the polar atmosphere.
- Vertical structure features of the arctic atmosphere. Troposphere, stratosphere, mesosphere, thermosphere, exosphere. Homo- and heterosphere. Ozonosphere. Ionosphere. Border and boundary layer at the Arctic region. Polar Air masses and fronts.
- Forces, acting in the polar arctic atmosphere in the state of equilibrium.
- The equation of statics adopted for polar region, its consequence.
- The concept of local and total derivative of meteorological values.
- Baric gradient and baric level in Arctic region.
- The first principle of thermodynamics applied to the polar atmosphere.
- Adiabatic processes in Arctic region.
- The concept of the non-adiabatic processes for severe Arctic region.
- Particle's vertical motion changes.
- Condensation level in Arctic region.
- Polar Convection level. Energy Instability.
- Winter and summer polar Atmosphere stratification.
- Arctic Electromagnetic radiation.
- Flux, intensity and insolation in polar region.
- The energy distribution in the spectrum and the integrated flux of solar radiation at the surface of arctic region.
- Absorption and scattering of the solar radiation in the arctic atmosphere.
- Features of radiative processes in the dry arctic atmosphere.
- Direct, dissipated and total solar radiation distribution over the polar regions. (Their determining factors).
- Reflection and absorption of solar radiation by the Earth arctic surface.
- Reflection (albedo) and absorption coefficients in Arctic region. Arctic Long-wave radiation distribution.
- Polar Earth's surface and atmosphere radiation.
- Arctic Radiation balance of earth surface.
- Polar Atmosphere radiation balance.
- Factors, determining polar radiation balance, its daily and annual course.
- The equation of the heat balance of the polar earth's surface. Factors affecting the heat balance equation in the Arctic.
- The main thermophysical characteristics of the arctic soil, water and air.
- Basic laws of heat distribution in the arctic soil.

- Polar Earth surface temperature. Vertical distribution of soil temperature in the Arctic.
- Heat flux in the Arctic soil.
- Polar turbulent atmosphere.
- Dynamic factors of the arctic atmospheric turbulence.
- Surface and boundary layer of the arctic atmosphere.
- Polar Wind speed changes with height. The diurnal wind variations in Arctic.
- Heat fluxes in the polar atmosphere.
- The heat flux equation in the arctic atmosphere.
- The heat flux equation in the turbulent polar atmosphere.
- Turbulent exchange and turbulence coefficient in Arctic.
- Diurnal and annual polar temperature variations
- Air temperature changes with height in Arctic.
- Periodic and non-periodic temperature changes in the troposphere in polar region.
- Polar Tropopause height
- Arctic oscillation. Positive and negative phases of the Arctic Oscillation
- Phase water conditions in the polar atmosphere. Polar stratospheric clouds. The equation of water vapor transport in a turbulent polar atmosphere. Level of polar Condensation. Measuring snow, glacier properties and albedo from satellite
- The forces acting in the polar atmosphere.
- Polar vortex
- Formation of polar mesocyclones.

Overview of sessions and teaching methods

The discipline program consists of lecture-type classes (14 hours) and seminars (14 hours). Individual studies (44 hours) are arranged by exploring theoretical course and accomplishing practical tasks. Tasks are developed for both group and individual work (case-studying, various data analysis and generalization). The process of individual studies is very convenient as the students are provided with a diverse range of electronic resources (tutorials, scientific articles, cartographic material, databases, video sessions) enabling them to learn and analyze various information.

The student's independent work should be based on studying educational materials on teacher's recommended lists of basic and additional educational literature, studying an electronic course of lectures in the form of slide presentations, visiting recommended Internet resources, including the official websites of the largest specialized domestic and foreign scientific organizations, studying recommended scientific publications for the preparation of reports at the seminar. Examples of tasks: review of climatic conditions and the main environmental factors determined by them that can affect the human body; review of specifics of life and work in the polar night, etc.

Guidelines about tasks completion and response placement procedure shall be presented in the task description message. The quality point shall be awarded for each assignment (test, interactive lecture, exercise, case analysis) during semester period with all the points summarized in the end. Monitoring of individual studies shall be organized at the time of classroom activities and by means of self-guided learning (tasks attachments, test tasks performance, scientific papers reviews, essays, etc.)

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Estimated workload (hours)
In-class activities			
Lectures	Understanding theories, concepts, methodology and tools	Class participation	14
Moderated in-class discussions	Understanding various policies and management contexts and common problems in communication in environmental governance	Class participation and preparedness for discussions	14
Independent work			
Self-guided learning: - the study of theoretical material and development of group and individual assignments in the online environment	The ability to analyze and interpret data from various information resources, own methods of processing and interpreting environmental information during scientific and industrial research	Class participation, creative and active contribution to discussion	34
Calculation tasks	Solution of calculation tasks, situational tasks using the knowledge gained	Analysis and interpretation of calculation results	10
Total			*72*

Grading

The students' performance will be based on the following:

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- level of readiness to participate in classroom discussions and seminars (50%)
- contribution to group tasks (20%)
- individual calculation tasks (30%)

Course assignments

Course assignments will constitute a multi-part project:

Assignment #1 (mostly in-class) – theoretical seminars focused on atmospheric physics & synoptics in the Arctic region

Assignment #2 (mostly in-class) –Practical tasks realisation: the reconstructive level, allowing to evaluate and analyse the ability to synthesize and summarize factual and theoretical material with the formulation of specific findings, the establishment of cause-effect relationships

Assignment #3 (mostly in-class) – permafrost monitoring and laboratory analysis

Literature

1. N.P. Rusin “Antarctic notebooks”, Saint-Petersburg, 2013
2. As. Brekke “Physics of the Upper Polar Atmosphere”, Springer, 2013