D4.7: Monitoring system documentation with manual

(*Public*)

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Project Title:

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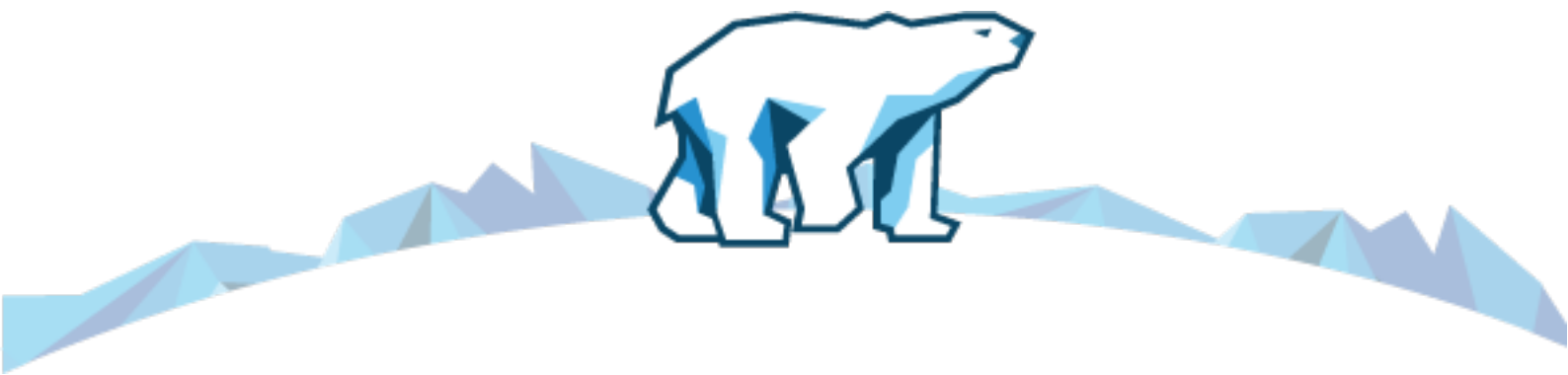
EXECUTIVE SUMMARY

The current report pertains to the Deliverable D4.7 ***Monitoring system documentation with manual.*** The report relates to the Task 4.6 Monitoring system, described in the Annex 1, PART A, of the REA/EC GA, within WP4: EDU-ARCTIC EDUCATIONAL PROGRAM.

The environmental monitoring system **is one of five key elements** provided within the EDU-ARCTIC educational program. All schools in Europe are invited to: participate in a program based on meteorological and phenological observations in schools' surroundings; to report these observations on a web based portal; to have access to accumulated data. The monitoring system is available via: http://edu-arctic.eu/program/#measurements.

The document contains detailed information on the objectives of monitoring proposed within the EDU-ARCTIC project, general rules of reporting within the system, and implementation assumptions. It presents details on technological solutions. **The most important part is a manual for teachers with detailed information on what and how to report, with widely illustrated field guides.**



1. Objectives of monitoring system

An important part of the activities offered to schools and youths in the EDU-ARCTIC project is the monitoring system. All schools in Europe are invited to participate in a program based on monitoring of meteorological and phenological observations in schools' surroundings, to report these observations on a web portal and to have access to accumulated data. **Accumulated information gathered by schools and polar stations will be available for downloading from the web portal and thus available for all participants.** This data can be used widely **in multidisciplinary teaching**, e.g. biology, chemistry, physics and mathematics classes. It can be combined and it can certainly contribute to an increase in awareness and understanding of often complicated contexts. For instance, it could serve for simplified modelling weather variability effect on fitophenology, following shifting birds' migration patterns in response to climate change, drawing conclusions regarding relations between temperature and insects' appearance or understanding the influence of Arctic sea ice extent on weather conditions in moderate latitudes.

The monitoring tool enables European students to observe nature in their vicinity, participate in science in their own surroundings, and to get a sense of what research is. It is also an important mean ***of building up a feeling of being part of larger common efforts in increased understanding of our environment, in a changing world.***

The data collected by students themselves from the school observation monitoring system and data made available from the polar stations **will provide a very solid base to increase young people's awareness of and interest in their surrounding environment.** Schools in Europe will get access to new and important data covering a substantial part of Europe to be used in educational activities. These activities are suitable for interdisciplinary studies including several topics, such as: mathematics, statistics, and various scientific disciplines (both natural and social sciences). This will help to improve students' and teachers' skills in drawing conclusions from larger data-sets (to the collection of which they have contributed themselves), to find background information and to try to find explanations as well as to present data processed by themselves. **The important links between their own activities in the monitoring system and the use of new IT-technologies and mathematics will create enthusiasm for STEM topics while allowing participants to broaden their grasp of societal challenges.** The potential for, thereby, developing a more holistic understanding of global environmental issues among participants will increase considerably. The monitoring system can be an important part in increasing the interest in STEM (science, technology and mathematics) in school among European students, which is considered as a decisive aim for future development of our societies.

Moreover, the proposed solution will have **an important role in building up a solid base for an active role of citizens in science**. Public participation in scientific research is important and cost-efficient. It provides the extensive data input needed in Europe's efforts to find solutions for societal challenges. It is also an important tool to raise awareness of such societal challenges. [1]

[1] 'Science for Environment Policy, Environmental Citizen Science' by the University of the West of England, Bristol UK, in-depth report produced for the European Commission DG Environment, 2013: http://ec.europa.eu/environment/integration/research/newsalert/pdf/IR9.pdf)

2. General description of monitoring system

The EDU-ARCTIC monitoring system is dedicated to **meteorological** and **phenological parameters**. Within meteorological observations and measurements there are two types of reports: report on **actual values** (air temperature, cloud cover, atmospheric precipitation, visibility reduction, and wind force) and report on **phenomena**, which occurred since the last observation (lightning, flood, whirlwind, avalanche, aurora, rainbow, glazed frost, ice on lakes and rivers and snow cover). **Biological observations cover five species of plants** (Birch, Lilac, Rowan, Bilberry, Rosebay willowherb), **five species of insects** (Bumble bee, Mosquito, Ant, Common brimstone and European peacock), and **four species of birds** (Arctic tern, Common cuckoo, White wagtail, Crane).

Due to the large variation through the entire European continent some of the parameters and variables can be difficult to observe throughout Europe. However, we tried to propose monitoring of species, which are occurring all the way from the Mediterranean Sea in the south to the Barents Sea in the north, and some of the parameters may be valid for European Arctic (like Svalbard). If particular species are not observed in schools' surroundings, teachers may just leave the box empty, but still provide other information. The full list of parameters with options to be chosen by each one is provided in the **Appendix A**.

The main suppliers of data should be students, whereas teachers will have the role as inspirers, mentors and as part of data quality ensuring. **Data will primarily be collected in the vicinity of schools, preferably along the phenology trail or an observation area, or by children during spare time,** e.g. in their own living neighbourhood etc. **Data will be registered by teachers, who have active accounts on the portal** (for details see section 3).

Observations may be reported **each Monday. The observations started on 1st February 2017**. Teachers may also report data on Tuesdays, but **provided information should appertain to the values accurate for the previous day.** Every registered observation is being displayed on the map. One may check several of the provided data by selecting each school location (by clicking on the displayed icons on the map). One may also choose any parameter of his/her interest, select the date range and press the "play" button on the menu to see the parameters' change over time.

Moreover, measurements or observations from the polar stations will be made available on the thematic maps on our website (http://edu-arctic.eu/program/#measurements) in order to provide information to schools and stakeholders. This will allow students and other users to understand **how different natural phenomena occur and are spread across the European part of the Arctic**. **A very well recognized phenomenon in the Arctic is the changing of the ice cover in the Arctic Ocean, which not only has a huge impact on the weather and circulation, but also influences the lives of many biological species**. Consequently, it is **very important not only for the Arctic itself, but it reaches far into the zone of moderate climate and shapes many processes in the European sector of the Arctic**, where the greatest variability is observed in recent years.

On the EDU-ARCTIC portal the second map presented in the monitoring part shows the current ice conditions in the Arctic. It is updated daily and enables to analyse ice coverage far North (source: https://seaice.uni-bremen.de/amsr2/Arctic_AMSR2_visual.png). The Consortium will organise some lessons with experts, who will explain, how one may predict weather using information on ice coverage in the Arctic. **An interesting addition is a graphical chart** (next to the map), **presenting the**

changes in the sea ice extent within years in comparison to average change over past 45 years (source: https://seaice.uni-bremen.de/amsr2/extent_n_running_mean_amsr2_previous.png).

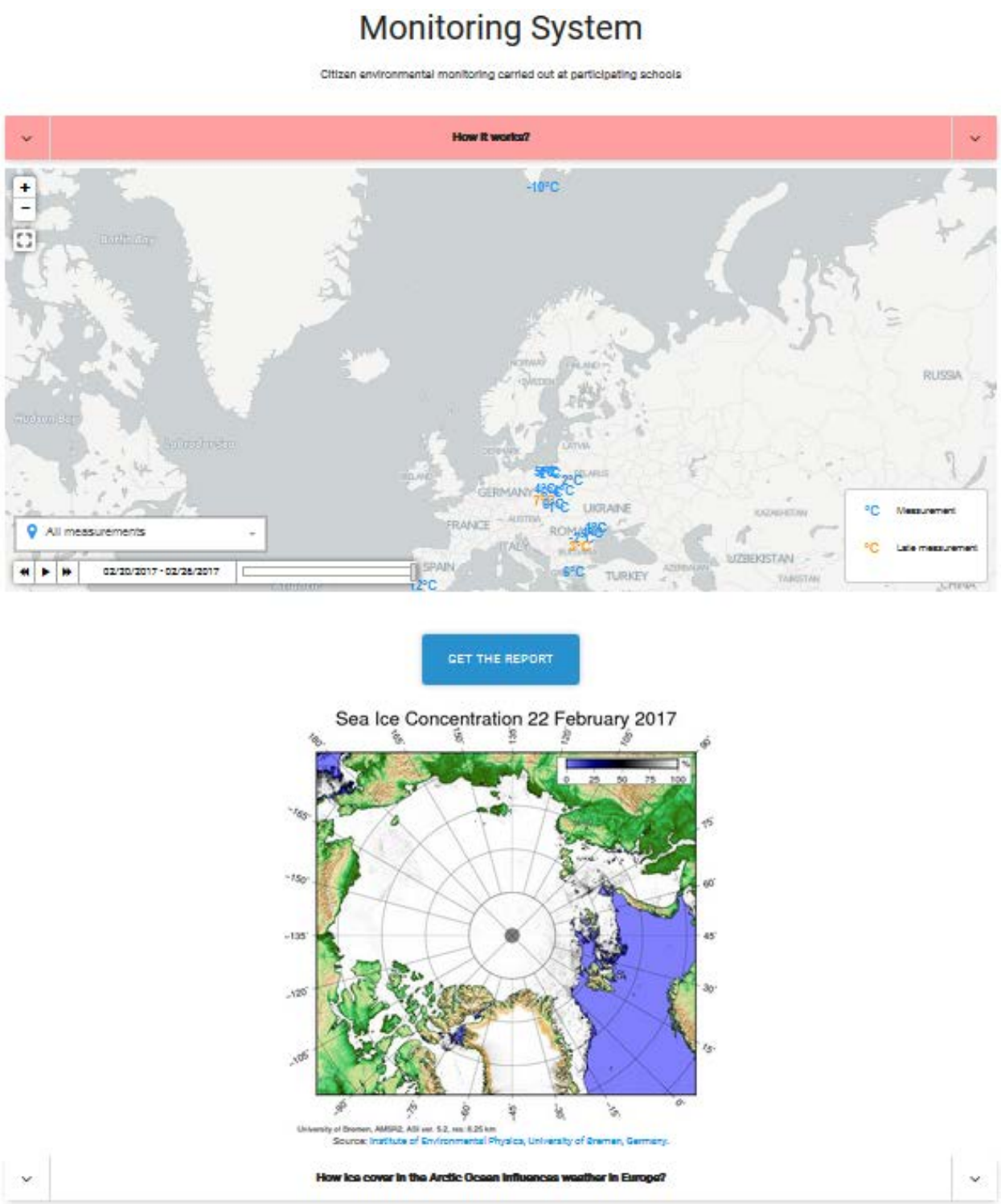


Fig. 1 – View on the monitoring system on the EDU-ARCTIC portal

3. Descriptions and manuals for users

Data will mainly be collected by students, verified and registered by teachers. This registration will be initially done to the web-based portal before they enter the database. The structure and design of the monitoring system is simple and self-explaining. **Main language is English, but manual for teachers will be also available in other national languages** (Polish version will come first, as Polish teachers represent the biggest group of registered users).

Online descriptions are short and concise (see: *How it works* section on: http://edu-arctic.eu/program/#measurements). The reporting part contains graphical descriptions for each option for all parameters. The collected data from the monitoring system are available at two levels: one level is open to the public, where basic information is available, all data are presented on maps, manual with field guides may be downloaded; The next level may be accessed by registered users only (by password), who will have possibility to provide reports on observations and to download all data for further use in mathematics or other STEM subjects at schools. Moreover, within the EDU-ARCTIC program some additional activities will be organised (e.g. online lessons) in order to provide more information on monitoring rules and what may be obtained from observations. More information for teachers to use in their lectures, such as spreadsheets, graphs, maps and other tools for the education, which will be developed through the project, will be also distributed to users.

Monitoring manual is available as PDF file at the portal along with the monitoring system and **is free for download by students, teachers and public** (in open section, without necessity to register). The manual may be printed by teachers or schools on their own demand. The manual contains information about the monitoring parameters and variables, general rules, technical instructions, as well as widely illustrated field guides. The full text of the manual is available in **Appendix B**. The manual may be updated, if needed. The current version will be always available on the EDU-ARCTIC portal http://edu-arctic.eu/program/uploads/ckeditor/attachments/33/MONITORING_MANUAL.pdf.

4. Implementation of monitoring system

Implementation of the monitoring system was foreseen in a few steps:

- **Gathering requirements** – This step helped in defining the requirements and gave a general overview of how the module will look, and what functionalities of the module are needed. Suggestions gathered in the first survey provided for teachers in order to get their requirements were taken into account. For details see **D3.2** ***Requirement analysis;***
- **Deciding on the variables to be observed and reported** – this step was important for designing the tool and graphical presentation of the system;
- **Deciding on the general rules** of conducting observations and reporting;
- **Designing phase** – technical production and internal tests;
- **Preparation of manual for teachers** – at this stage English version is ready. Polish version will be available within one month. Other beneficiaries will be requested to translate manual, if schools show interest in having national versions;
- Launching of the monitoring system;
- Gathering comments on the tool;
- Implementation of changes, if needed, further development (if possible and recommended).

Moreover, there are **some promotional actions to be taken in order to encourage as many schools as possible to take part in monitoring observations.**
Monitoring system is being promoted **via different channels**:

- detailed information on the tool during introductory webinars for teachers;
- article on the EDU-ARCTIC website;
- EDU-ARCTIC social media;
- newsletter to all registered users.

A big challenge is to encourage teachers to provide regular reports within monitoring system. Therefore, a part of gamification activities (EDU-GAME) is dedicated to the monitoring system. Teachers get extra EDU-points for active participation (for registration to the system – 50 points, for each report 10 points).

5. Technical description

EDU-ARCTIC monitoring system was created by the project beneficiary American Systems. They based on experiences from monitoring program proposed e.g. in the EDUSCIENCE[2] project.

The monitoring system operates as a module on http://edu-arctic.eu/program/ and can be found at: http://edu-arctic.eu/program/#measurements. Description of the technical solutions is presented in detail in **Appendix C**.

In order to access the Monitoring system, the end-users (teachers, educators, etc.) will need to register to the EDU-ARCTIC portal and confirm school's location. System recognizes the user after filling the registration form in the first step.

For registration on EDU-ARCTIC portal, users will need to provide their name, surname, address, name of school, town, country and sex. **The required range of data is not excessive, but fully justified and strictly limited to data necessary for the proper implementation of EDU-ARCTIC.**

Detailed registration justification is as follows:
• **name and surname** – to identify each teacher, to address him/her properly, to assess the scale of the project and its impact;
• **e-mail address** – to contact the teachers, send information about the project, invitations and individual access to webinars;
• **name of school, town, country** - to report the achievement of project results, established in the Grant Agreement (REA/EC GA), and to verify if the schools exist and meet the requirements (only if necessary);
• **sex** - due to the nature of the project and one of its objectives, referring to the increase in women's involvement in STEM education, to assess more accurately the project's impact and **address gender issues, whenever necessary**.

[2] EDUSCIENCE was the biggest innovative Polish project in the field of STEM education, conducted by IGF PAS as a leader in 2011-2015 and funded within European Social Fund. More information on the project may be found on its website: www.eduscience.pl

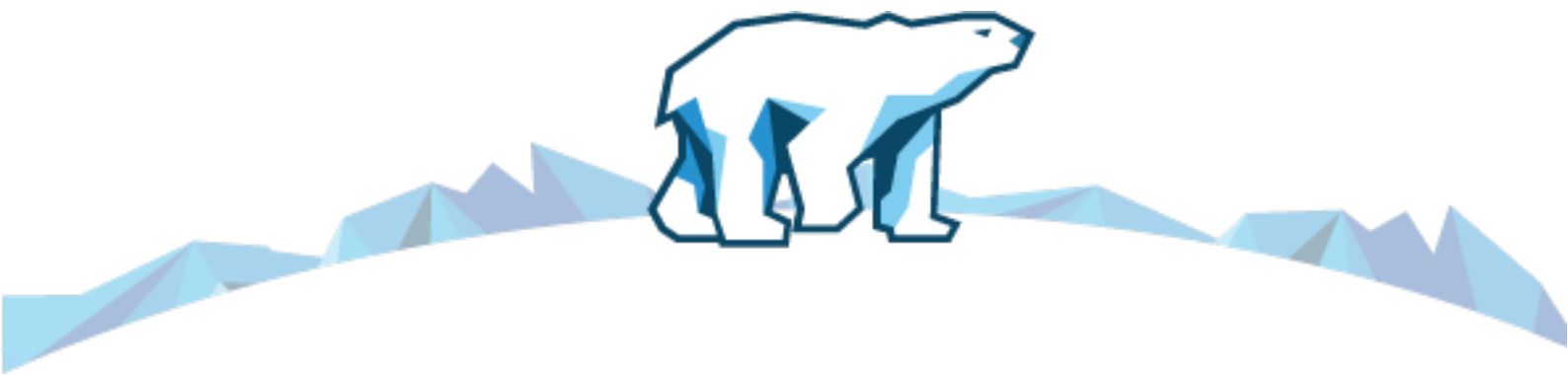
Users are requested to certify that they are 18 years of age or over, **in order to be sure that they are able to give their consent.** Thereafter, **they will be requested to give consent as to their participation in the EDU-ARCTIC programme and consent to the processing of their personal data by American Systems sp. z o. o. Consent will be given by ticking the appropriate box**. The template of the consent page on the portal is presented in **D1.1 H – Requirement No. 1** (Appendix No. 1).

Participants will be asked to read and agree to the Rules of participation and Data Use Policy. The texts of the Rules of participation and Data Use Policy are presented in **D1.1 H – Requirement No. 1** (Appendices Nos. 2 and 3); **both of them feature on the information sheet for registered portal users**.

6. Final conclusions

It must be stated that the Monitoring system may be developed in future. The Consortium is principally open **for further changes and development based on comments and suggestions provided by the end-users.** Comments may be provided by teachers and educators via various channels:

1) **EDU-FORUM** – online forum available for registered users;
2) **e-mails** to EDU-ARCTIC support services;
3) **Educators' Forum** – 3 workshops for teachers, where feedback and suggestions for improvements will be gathered from end-users;
4) **Evaluation surveys**, which will be sent to registered users in January 2018.



Appendix A. List of Variables

The reporting includes **actual values** - at the time of observation (once a week, on Monday at 12:00 local time) for some parameters, and since last reporting for others. The parameters and their variables that should be observed are given below. The large variation through the entire European continent leads to that several of the parameters and variables can be difficult to observe throughout Europe. Anyhow, the variables chosen are more or less occurring all the way from the Mediterranean Sea in the south to the Barents Sea in the north, and some of the parameters may be valid for European Arctic (like Svalbard). Event though, as many as possible should be observed and noted.

Meteorology (point observations, at school, or as close to school as possible)

1. Air temperature (measured in degrees Celsius with one decimal)
2. Cloud cover (none, partly, completely)
3. Atmospheric precipitation (none, showers, continuous)
4. Types of atmospheric precipitation (drizzle, rain, snow, hoar-frost, hail)
5. Visibility reduction (none, mist, fog, smog)
6. Wind force (none, light wind, gusty wind, hurricane)
7. Lightning (none, lightning inside clouds, lightning strikes the ground)
8. Extreme atmospheric phenomena (flood, whirlwind, avalanche)
9. Other atmospheric phenomena (aurora, rainbow, glazed frost)
10. Ice on lakes (none, lake surface is freezing, lake surface is melting, complete ice cover)
11. Ice on rivers (none, partly covered, complete ice cover)
12. Snow cover (none, first snow, snow accumulation, stable snow cover, snow melting)

Plants (phenology trail at school, and individual observations during/before/after school time)

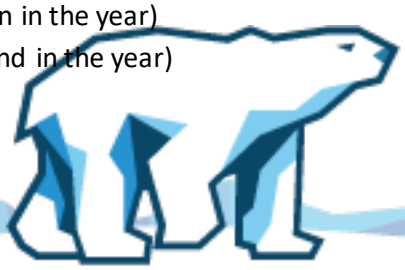
13. Birch (started to flower, opened buds, leaves started colouring, leaves started falling down, all leaves fallen down)
14. Lilac (opened buds, started to flower, all leaves fallen down)
15. Rowan (opened buds, started to flower, ripen berries, leaves started colouring, leaves started falling down, all leaves fallen down)
16. Bilberry (blue berry) (started to flower, ripen berries)
17. Rosebay willowherb (started to flower, seeds ready)

Insects (observations by one person or group at school time, before, or after school time)

18. Bumble bee (first observation in the year)
19. Mosquito (first observation in the year)
20. Ant (first observation in the year)
21. Common brimstone (first observation in the year)
22. European Peacock butterfly (first observation in the year)

Birds (observations by one person or group at school time, before, or after school time)

23. Artic Tern (first observation in the year)
24. Common Cuckoo (first observation in the year)
25. White wagtail (first observation in the year)
26. Crane (first observation of sound in the year)



Appendix B. Monitoring manual with field guides (English).

Introduction – how to be a scientist?

Would you like your students to learn first-hand about the weather, climate, water, biology and effects of global climate change on the natural world?

Consider lending a hand to scientists by observing the world around you and reporting what you spot. Information that you and your students will collect as **observers** in **monitoring programme** can be used in numerous investigative studies and are a foundation of the comprehensive climatological study. This data are increasing in importance as the world faces more challenges posed by climate change. Those challenges include: higher temperatures, prolongation of warm seasons, more frequent storms, floods, droughts, and other forms of natural disasters. Even slight change in air temperature and precipitation can upset the delicate balance of ecosystems, and affect plants and animals that inhabit them. Rising temperatures and changing patterns of precipitation are influencing for example time and place of particular plant species occurrence.

Observations taken at fixed locations and fixed time, together with standardized recording format will give accurate data for comparison. Different regions of Europe have different phenological patterns depending on their latitudes, longitudes and heights. Even at the same location, the phenological pattern observed in the past may be quite different from the present.

Although, scientists nowadays have access to data from radars, satellite images, and surface weather stations, technology cannot detect every instance of hazardous weather and phenological change. Observers can help fill in the gaps by reporting hail, strong wind, flooding, heavy snow and storms. Scientists need observers to report when and how storms and other hydrometeorological and phenological phenomena are impacting their area.

As an observer you and your students can act as scientific eyes and ears in the field. Your reports can help meteorologists and climatologists by providing direct, timely, accurate, and detailed observations. Reports also provide critical verification, by confirming the information detected by other instruments or meteorological models. Archived meteorological data can help improving our knowledge and influence the future warning services and climatological modelling.

Remember that personal safety is the primary objective of every observer.

General rules

- ✓ Even though you – as registered **teachers** – are supposed to **report observations on portal**, your **students should play a crucial role, make observations and provide you with data required**.
- ✓ We invite you to report observations conducted by your students in schools' surroundings **each Monday.** If you are unable to report it on Monday, no worries: you may still do that on Tuesday, but **remember to provide information on values accurate for the previous day**.
- ✓ Actual values should be reported for **12:00 (Monday) local time.**
- ✓ Please note that the system accepts only **one report from one location (SCHOOL) per week**, therefore if more than one teacher is willing to register data from the same school, there should be e.g. an internal schedule of reporting (who reports when – e.g. every 2 weeks).
- ✓ For biotic elements: it may occur that particular species are not observed in your surroundings, in such case you may just **leave the box empty**, but still provide other information.
- ✓ Remember, you get extra points in EDU-GAME: **50 points for registration and 10 points weekly for regular, active participation**.

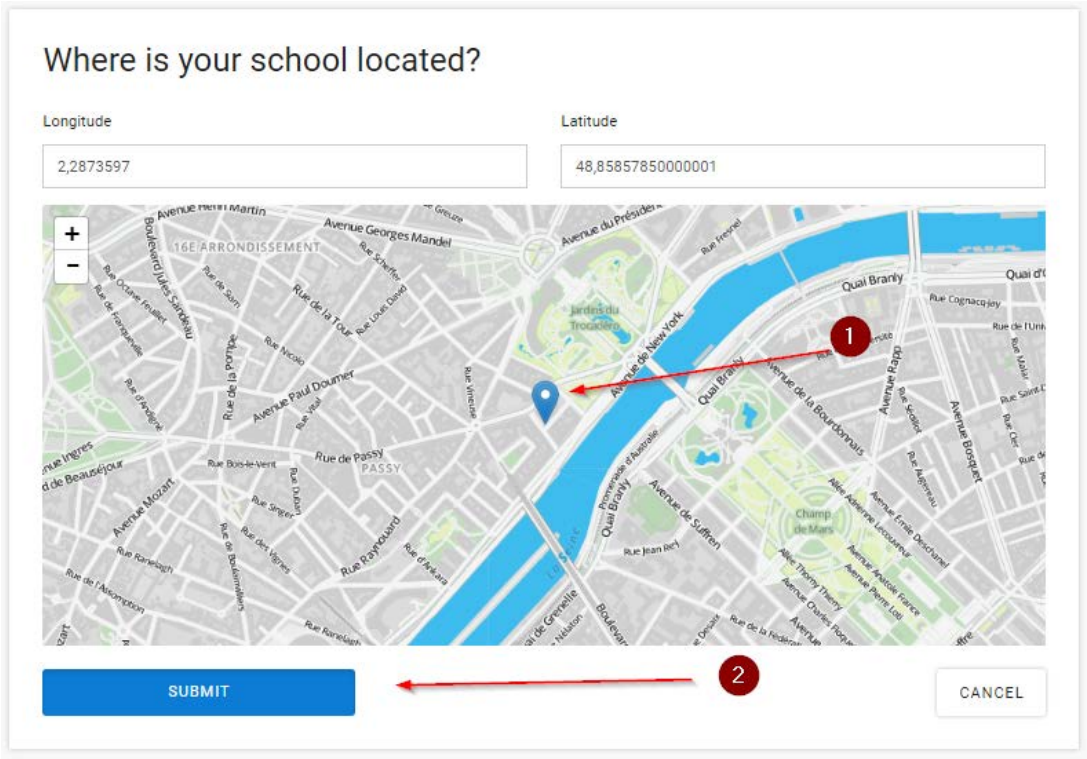
How does it work?

How to register data in the EDU-ARCTIC monitoring system

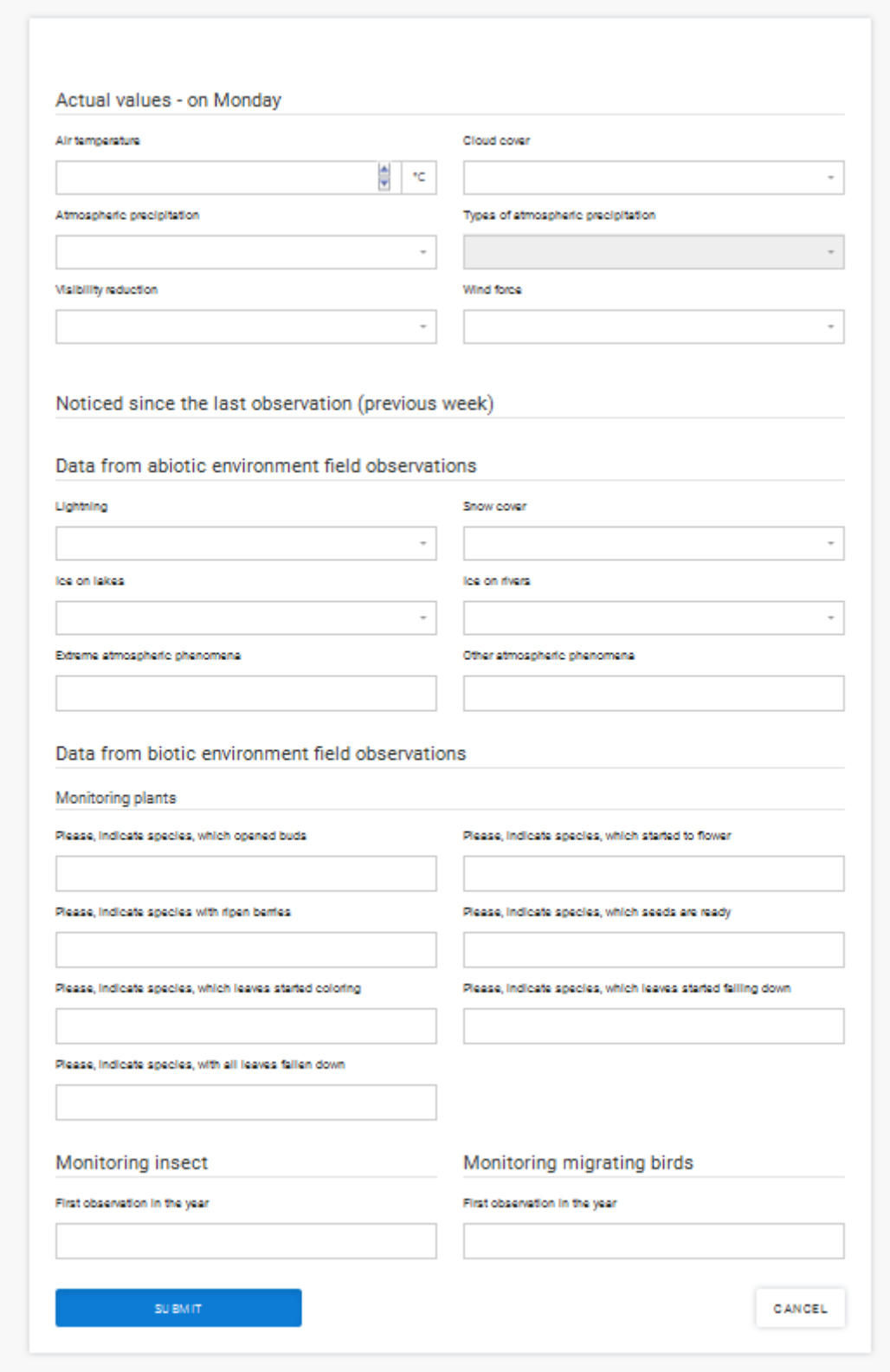
In order to register data in the EDU-ARCTIC monitoring system please visit the website: http://edu-arctic.eu/program/#measurements and press the “New Measurement” button.

Once you have pressed, the system will ask you to perform the following actions:

- sign in (if you are not logged in) or sing up (if you don’t have account)
- confirm your school location - please mark the correct location on the map and press “submit” (please see example below).

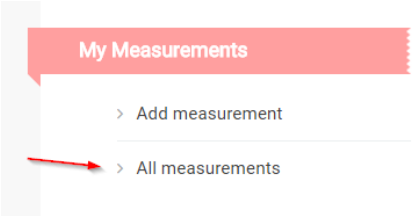


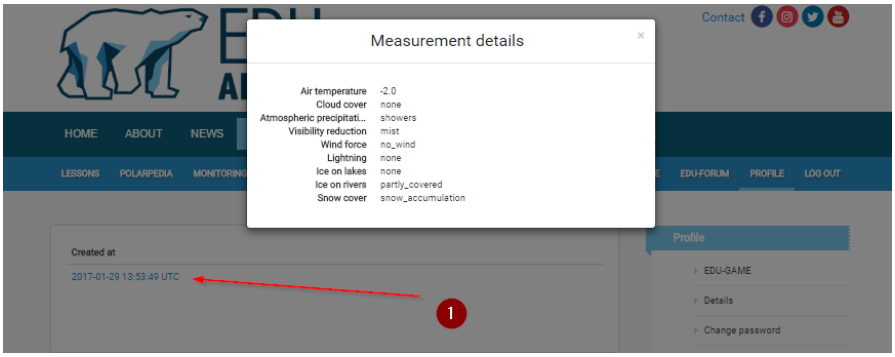
Once done, you will see the form ready for your regular observations. Please fill in that regularly (every Monday) and compare the results provided by other schools.



Once you have filled in, please press the “submit” button.

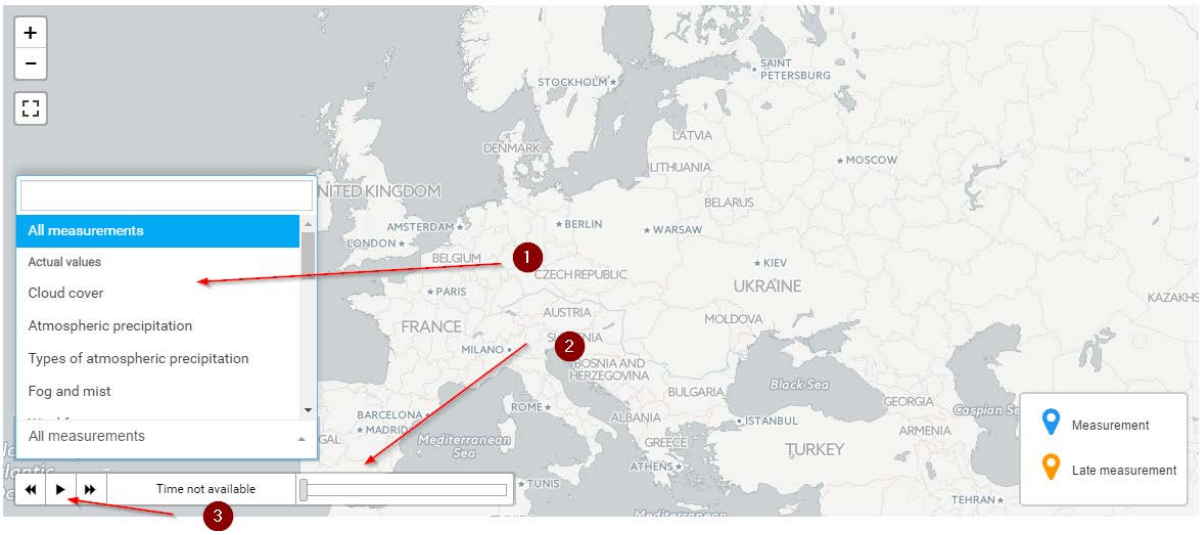
You may check your observation on the map by clicking on your school location. You will also find every of your registered observation in the PROFILE → My Measurements section.





Every registered observation is being displayed on the map. You may check various of provided data by selecting each school location (by clicking on the displayed icons on the map).

You may also choose any parameter of your interest, select the date range and press the “play” button on the menu.



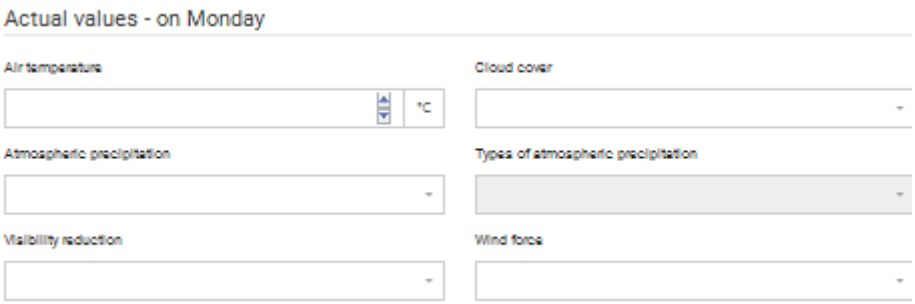
If you would like to compare data, observe variability etc., you can generate reports (.xls format):

GET THE REPORT

Parameters to be observed and reported:

- ✓ **Actual values**
- ✓ **Abiotic environment**
- ✓ **Biotic environment – plants, insects, birds**

Actual values on Monday



Air temperature (data presented in degrees Celsius).

The air temperature is measured by an ordinary thermometer in degrees Celsius °C. At the meteorological stations thermometers are placed 2 m above the ground in a special white shelter (a Stevenson screen) to shield them against precipitation and direct sunlight, allowing air to circulate freely around them, to provide a standardized environment in which to measure air temperature.

By measuring the temperature of the air we need to remember these tips:

- The correct measurement of the air has to be done outdoor, in the shade, ~2m above the ground,

- At school or in the house put a thermometer outside the window on the north side.


Phot. 1. Ordinary thermometer is placed inside a Stevenson screen.

Cloud cover (none, partly, completely)

Cloud cover

Cloud is an aggregate of very small water droplets, ice particles or a mixture of both. Cloud cover (or cloudiness) refers to the fraction of the sky obscured by clouds when observed from a particular location. Total cloud amount is the fraction of the sky covered by cloud of any type or height above the ground. Okta is the usual unit of measurement of the cloud cover – from 0 to 8, although for monitoring purpose choose one of the following:

None - represents the complete absence of clouds, when the sky is completely clear	None		*Phot. 2. Stonehengesteinane during beautiful, clear weather (southern Spitsbergen)*
Partly cloudy - represents a cloud amount higher than zero but not full cloud cover, so type it if you can see blue sky between clouds	Partly cloudy		*Phot. 3. Sørkapp Land (southern Spitsbergen) and cumuliform clouds above*
Complete cloud cover – full cloud cover with no breaks or sky obscured by fog or other meteorological phenomena, no sky visible	Complete cloud cover		*Phot. 4. Full cloud cover above Hohenlohefjellet (Svalbard)*

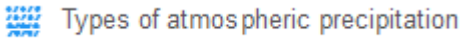
Atmospheric precipitation (none, showers, continuous)

Atmospheric precipitation

Precipitation is water in a solid or liquid form that falls from clouds to the Earth's surface under the influence of gravity. Depending on duration of this phenomena choose one of the following:

None - no precipitation observed	None		*Phot. 4. High clouds above meteorological site next to Polish Polar Station Hornsund on Spitsbergen*
Showers – precipitation begins and ends suddenly. Relatively short-lived, but may last half an hour. Often, but not always, separated by blue sky. Showers come from puffy clouds or cumuliform clouds, like cumulus or cumulonimbus	Showers		*Phot. 5. Showers above Billefjorden*
Continuous – precipitation which does not cease after half an hour, or ceases only briefly. May last up to few hours	Continuous		*Phot. 6. A view from Fugleberget during rain (southern Spitsbergen)*

Types of atmospheric precipitation (drizzle, rain, snow, hoar-frost, hail)



Drizzle - fairly uniform precipitation composed exclusively of very small water droplets (less than 0.5 mm in diameter) very close to one another. Can be felt on the face but produces little runoff from roads or roofs. Drizzle is produced by low-level stratiform clouds.	 Drizzle		*Phot. 7. Drizzle falls from low clouds.*
Rain - precipitation of liquid water drops greater than 0.5 mm in diameter. Mostly falls from stratiform (layer) or cumuliform clouds	 Rain		*Phot. 8. Drops of rain on the lake surface*
Snow - is formed from solid water ice crystals that agglomerate together becoming flakes. Big ones form near freezing and small ones form at colder temperatures.	 Snow		*Phot. 9. Snowfall at the main entrance to the Polish Polar Station Hornsund*

Hoar-frost - is the coating or deposit of ice that may form in humid air in cold conditions, usually overnight. It is deposited on the ground or loosely attached to exposed objects such as wires or tree branches	 Hoar frost		*Phot. 10. Hoar-frost deposited on rock*
Hail - is a form of solid precipitation that consists of balls or irregular lumps of ice, each of which is called a hailstone. Hail is possible within most thunderstorms as it is produced by cumulonimbus	 Hail		*Phot. 11. Hail (source: CC BY-SA 3.0 by 59Ballons)*

Visibility reduction

 Visibility reduction

Meteorological visibility is a measure of the distance at which an object or light can be clearly seen.

None – good visibility, more than 10 km	 None		*Phot. 12. Mountains and glaciers of western Spitsbergen seen from the distance*
Mist - restricts visibility to between 1 to 10 km.	Mist		*Phot. 13. Mist above Hornsundfjord*

Fog - restricts visibility to 1 km or less	Fog		*Phot. 14. Fog in Revdalen (southern Spitsbergen)*
Smog – a fog in which smoke and other forms of atmospheric pollutants have an important part in causing the fog to thicken, and can have dangerous physiological effects.	Smog		*Phot. 15. Smog above Warsaw*

Wind force (none, light wind, gusty wind, hurricane)

Wind force

Wind is the horizontal movement of the air mass caused by differences in the atmospheric pressure in the neighboring areas. When a difference in atmospheric pressure exists, air moves from the higher to the lower pressure area. The greater the pressure difference, the higher the wind speed. Wind speed usually is given in meters per second (m/s), in kilometers per hour (km/hr) or on the Beaufort scale (in °B). Choose one of the following:

Phot. 16. Flags on the masts of Hornsund station during windy weather

None – calm conditions, smoke from chimneys rises vertically	No wind
Light wind - weak wind that lightly moves leaves on trees	Light wind
Gusty wind – moves branches on the trees, sways small trees in leaf. Dust and loose paper raise	Gusty wind
Hurricane - strong wind that causes damage to nature and households.	Hurricane

Noticed since the last observation (previous week) - data from abiotic environment field observations. Collect information on meteorological and hydrological phenomena:

Data from abiotic environment field observations

Lightning | Snow cover

Ice on lakes | Ice on rivers

Extreme atmospheric phenomena | Other atmospheric phenomena

Lightning (none, lightning inside clouds, lightning strikes the ground)

Lightning

Lightning is a sudden electrostatic discharge between electrically charged regions of a cloud, between two clouds, or between a cloud and the ground, that occurs during thunderstorm. The best shelter from lightning is inside a large enclosed structure, such as your home or school. Avoid contact with the windows. No place outside is safe during a thunderstorm.

Cumulonimbus clouds often form thunderstorms

Phot. 17. Towering vertical cloud. Cumulonimbus seen above Bieszczady Mountains in Poland.

None – lightning did not appear	None	-	-
Lightning inside clouds - happens completely inside the cloud, jumping between different charge regions in the cloud or between separate clouds	Lightning inside clouds		*Phot. 18. Lightning inside the clouds (source: CC BY-SA 3.0 by 350z33)*
Lightning strikes the ground - lightning that occurs between the cloud and the ground	Lightning strikes the ground		*Phot. 19. Lightning strikes the ground (source: CC BY 3.0 by Unfortunately Named)*

Extreme atmospheric phenomena (none, flood, whirlwind, avalanche)

Extreme atmospheric phenomena

Report any extreme events that happened in previous week in your area (city, town, district) and caused damage on property and nature.

None – lack of extreme events	None	-	-

Flood - overflow of water that submerges land which is usually dry	Flood		*Phot. 20. Flood in Alaska (source: Diocese of Alaska)*
Whirlwind - a weather phenomenon in which a vertically oriented rotating column of air forms	Whirlwind		*Phot. 21. Whirlwind (source: CC BY-SA 3.0 by NJR ZA)*
Avalanche - a rapid flow of snow down a sloping surface	Avalanche		*Phot. 22. Avalanche on the slope (source: CC BY-SA 3.0 by Scientif38)*

Other atmospheric phenomena (none, aurora, rainbow, glazed frost)

Other atmospheric phenomena

None – lack of other noticeable events	None	-	-
Aurora - is a natural light display in the sky, produced when the magnetosphere is sufficiently disturbed by the solar wind	Aurora		*Phot. 23. Northern lights during polar night (Hornsund)*

Rainbow - a meteorological phenomenon in the form of a multicoloured arc, caused by reflection, refraction and dispersion of light in water droplets resulting in a spectrum of light appearing in the sky	 Rainbow		*Phot. 24. Rainbow above Polish Polar Station Hornsund*
Glazed frost - ice coating occurring when freezing rain or drizzle hits a surface	 Glazed frost		*Phot. 25. Glazed frost covering frozen tundra*

Ice on lakes (none, lake surface is freezing, lake surface is melting, complete ice cover)

 Ice on lakes

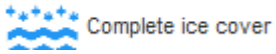
None – lack of ice on the lake surface	 None		*Phot. 26. Tundra lake in summer*
Lake surface is freezing – air temperature is below 0°C, ice forms on the top of a lake	 Lake surface is freezing		*Phot. 27. Tundra lake in autumn*

Lake surface is melting - air temperature is above 0°C, ice on the top of a lake melts	Lake surface is melting		*Phot. 28. Tundra lake in spring*
Complete ice cover – surface of lake completely covered by ice	Complete ice cover		*Phot. 29. Tundra lake in winter*

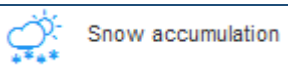
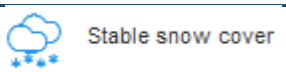
Ice on rivers (none, partly covered, complete ice cover)

Ice on rivers

None – lack of river ice	None		*Phot. 30. River in summer (Girdwood, Alaska)*
Partly covered – part of river surface is frozen	Partly covered		*Phot. 31. Ebba river partly covered by ice (central Spitsbergen)*

Complete ice cover – river surface is covered with ice			*Phot. 32. Complete ice cover over Revelva in Revdalen (Spitsbergen)*

Snow cover (none, first snow, snow accumulation, stable snow cover, snow melting)

None – no trace of snow on the ground			*Phot. 33. Reindeer on tundra during summer*
First snow – first observation of snow in autumn (beginning of winter)			*Phot. 34. First snow in Denali National Park (Alaska)*
Snow accumulation – snowfall observed in previous 7 days, increase of snow cover thickness compared to that of previous week			*Phot. 35. Snow accumulation*
Stable snow cover – remained almost unchanged to that from previous observation with no (settled and consolidated but did not melt)			*Phot. 36. Tracks of female polar bear with the cub and arctic fox*

Snow melting – decline of snow, surface runoff produced from melting snow	Snow melting		*Phot. 37. Measurements of runoff from melting snow*

Noticed since the last observation (previous week) - data from biotic environment field observations. Collect information on selected common spieces of plants (birch, lilac, rowan, bilberry, rosebay willowherb). Observe and note the most important phenological phases – lifecycle events, influenced by seasonal and interannual variations in climate, as well as habitat factors (such as elevation). This will give approximate dates of first occurrence of biological events in their annual cycle.

Monitoring plants

Please, indicate species, which opened buds

Please, indicate species, which started to flower

Please, indicate species with ripen berries

Please, indicate species, which seeds are ready

Please, indicate species, which leaves started coloring

Please, indicate species, which leaves started falling down

Please, indicate species, with all leaves fallen down

Birch *(Betula pendula)*

Birch

Medium sized tree with white peeling bark (like tissue paper) on the trunk. It's a pioneer tree with low demands. Native to and common in Northern Europe. Its range extends into Siberia, China and

southwest Asia in the mountains of northern Turkey, the Caucasus and northern Iran. In southern Europe it appears at higher altitudes. The twigs are slender, reddish brown and noticeably drooping and the leaves are roughly triangular with doubly serrate margins and turn yellow in autumn before they fall. Its drooping branches give it a "weeping willow" appearance. Buds are slender, pointed, green and brown.

In early Celtic mythology, the birch symbolised renewal and purification. Bundles of birch twigs were used to drive out the spirits of the old year.

Phot.39: Birches avenue; http://pixabay.com

Started to flower – male flowers (catkins) are long and yellow-brown in colour, and hang in groups of two to four at the tips of shoots, like lambs' tails, producing yellow pollen. Female catkins are smaller, short, bright green and erect.	 Started to flower		*Phot. 40 male catkins Wikipedia*
Opened buds – buds are small, pointed, sticky resin that covers and permeates the entire bud, open into bright green, sticky, nice-smelling leaves	 Opened buds		*Phot. 41. Paula Gordon, 2013, https://dbaplanbpix.wordpress.com/tag/spring-buds/*

Leaves started coloring - The foliage is a pale to medium green and turns yellow earl y in the autumn befo re the leaves fall (approx.5 - 10% of foliage)	Leaves started coloring		*Phot. 42: By Famartin - Own work, CC BY-SA 4.0, https://commons.wiki media.org/w/index.php ?curid=36954291*
Leaves started falling down - it starts shedding leaves to survive harsh weather conditions (up to 10% of foliage)	Leaves started falling down		*Phot .43: Stephen Rowlings, http://lossofthenight.bl ogspot.de/2014/12/arti ficial-light-and-trees.html*
All leaves fallen down - goes dormant for the winter months	All leaves fallen down		*Phot. 44: http://unsplash.com*

Lilac *(Syringa vulgaris)*

Lilac

Lilac is a shrub or a small tree, with greyish bark on multiple stems and simple oval leaves. Purple or white flowers grow in large panicles, and are extremely fragrant. Lilac is native to woodland in southeastern Europe to eastern Asia, and widely and commonly cultivated in temperate areas elsewhere.

The wood of lilac is close-grained, diffuse-porous, extremely hard and one of the densest in Europe. The sapwood is typically cream-coloured and the heartwood has various shades of brown and purple. **Lilac wood has traditionally been used for engraving, musical instruments, knife handles.**

Opened buds when the first leaves push out of the bud and unfold completely	Opened buds		*Phot. 45 http://pixabay.com*
Started to flower- the flower buds for the following year are set in the fall before the lilac shrub goes dormant. The flowers grow in clusters 10 cm – 20 cm (4 – 8 in.) long.	Started to flower		*Phot.46 http://pixabay.com*
All leaves fallen down lilac needs a cold-dormant time of year to rejuvenate for spring flowers and greenery	All leaves fallen down		*Phot. 47 Lilac in winter*

Rowan *(Sorbus aucuparia)*

Rowan

Rowan is a typically small and slender tree with a greyish-brown bark. As the leaves emerge they are a mid green colour. In early to mid autumn the leaves turn yellow to orange and fall off. The flowers appear in mid-May as sprays of cream to white. They have a slightly sweet scent. The fruits appear in late summer, and are initially green, they quickly ripen to a bright red in very early

September. Birds love them and often trees are stripped of their ripening fruit within a few days, especially if the weather turns cold. Rowan is native to most of Europe and parts of Asia, as well as northern Africa. The range extends from Madeira and Iceland to Russia and northern China, but mostly inhabits cool to cold areas.

Rowan trees can live up to an impressive 100 years or more.

Opened buds – Buds are small (up to 1,7cm), egg-shaped, grey, covered by bright short hairs.	 Opened buds		*Phot. 48* *https://commons.wikimedia.org/wiki/Sorbus_aucuparia#/media/File:Sorbus_aucuparia_lateral_bud.jpg*
Started to flower – Small white flowers, borne in dense corymbs, each flower contains 5 petals	 Started to flower		*Phot. 49* *https://commons.wikimedia.org/wiki/Sorbus_aucuparia#/media/File:Sorbus_aucuparia_no.JPG*
Ripen berries Its fruits are small, orange, bright red or red	 Ripen berries		*Phot. 50* *https://commons.wikimedia.org/wiki/Sorbus_aucuparia#/media/File:Jodlowka_Tuchowska_Brzanka_jarzebina_1.jpg*
Leaves started coloring – The foliage is medium green and turns gold-yellow and gold-red in the autumn before the leaves fall	 Leaves started coloring		*Phot.51* *https://commons.wikimedia.org/wiki/Sorbus_aucuparia#/media/File:Arbre_avc_fruits.JPG*

Leaves started falling down-it starts shedding leaves to survive harsh weather conditions (up to 10% of foliage)	Leaves started falling d		*Phot. 52 https://commons.wikimedia.org/wiki/Sorbus_aucuparia#/media/File:Arbre_avc_fruits.JPG*
All leaves fallen down - goes dormant for the winter months	All leaves fallen down		*Phot. 53 https://upload.wikimedia.org/wikipedia/commons/8/8a/Ancient_rowan_tree_at_site_of_old_croft_on_ridge_above_Divach_-_geograph.org.uk_-_1220522.jpg*

Bilberry *(Vacciunium myrtillus)*

Bilberry

Bilberry (also known as Blueberry, Whortleberry, Huckleberry, Hurtleberry) is a small shrub (up to 40 cm) growing mainly at the northern parts of the Northern Hemisphere (known as the taiga zone and the subarctic zone) *Vaccinium myrtillus* is found natively in Europe, northern Asia, Greenland, Western Canada, and the Western United States. It occurs in the wild on heathlands and acidic soils. Small, elliptic, green leaves are finely toothed and prominently veined on the lower surface. Flowers are pink and urn-shaped. Fruits are dark blue, with dark red, strongly fragrant flesh and red juice that turns blue in basic environments.

Bilberries are very healthy and are recommended to lower blood glucose, reportedly they have anti-inflammatory and lipid-lowering effects, and promote antioxidant defense and lower oxidative stress. Bilberry juice was used as a dye for food and clothes.

Started to flower Blueberries produce small, pink-green or pink-white flowers, single or paired on the brush	Started to flower		*Phot. 54 CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=160910*
Ripen berries Bilberries grow small fruits, ripen ones are dark purple or even near black	Ripen berries		*Phot. 55 By Marek Silarski - from de.wikipedia [1], CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=638397*

Rosebay willowherb *(Chamerion angustifolium)*

Rosebay willowherb

Rosebay willowherb is also known as willow herb. It has reddish stems, which are simple, erect, smooth and tall (up to 2 m). The leaves of this plant are unique in that the leaf veins are circular and do not terminate on the edges of the leaf, but form circular loops and join together inside the outer leaf margins. This feature makes the plants very easy to identify in all stages of growth. The flowers are 2 to 3 cm in diameter, with four pink petals and four narrower pink sepals behind. It inhabits light-filled forest heaths, broad-leaved forests, rich mixed swamps, burned areas, disused fields, railway embankments, banks, wasteland, often used to reestablish vegetation. It is native throughout the temperate Northern Hemisphere, including large parts of the boreal forests, in a variety of arctic ecosystems.

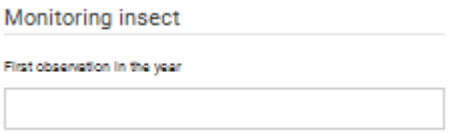
Rosebay willowherb has been believed in Finland to increase the milk production in cattle, and was thus often added to feed. In Russia flowers/leaves were traditionally used to make tea. The plant is also called "fireweed" or "bomb weed", as it was said that it only bloomed in London after the Great Fire of 1666 and after the bombings during WW2.

Phot. 56: Lateral leaf veins have a unique quality – they do not extend to the outer edge of the leaf, but loop together near the margin. This makes it easy to identify before it flowers. Source: http://wildfoodsandmedicines.com

Started to flower	Started to flower		*Phot.57 http://pixabay.com*

Seeds ready Seeds have a plume of hairs and are wind dispersed	Seeds ready		*Photo. 58 Dcrjsr (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons*

Noticed since the last observation (previous week) - data from biotic environment field observations. Collect information on selected insects (Bumble bee, Mosquito, Ant, Common brimstone, European peacock). Observe and note the very first appearance in your neighborhood.



Why is it so important and what does it actually say? See the dates of insect appearance and activity in Britain shown in relation to temperature variables:

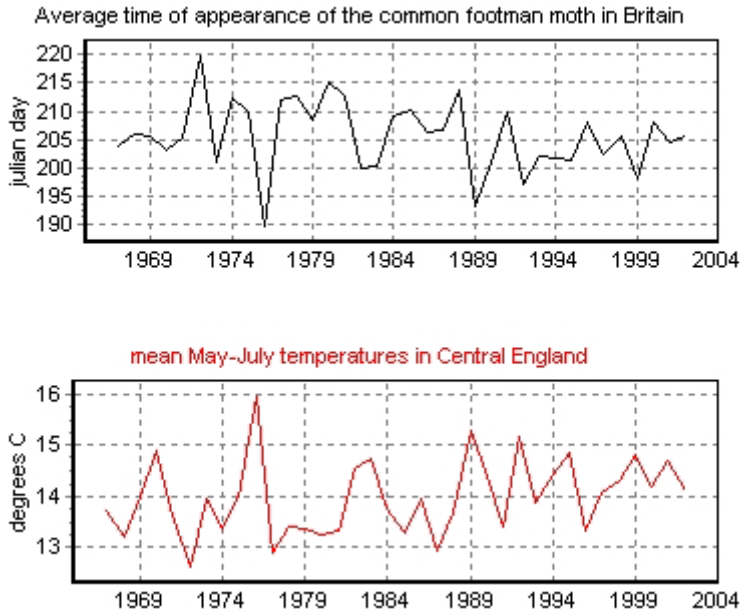


Fig.1 source: http://www.ecn.ac.uk/iccuk/indicators/27.html

The activity of insects is related to many important environmental factors. In winter, they hibernate, and wake up in early spring/late winter to lay eggs. The interannual variability of their appearance, number etc. is subject to scientific observations and research.

Bumble bee *(Bombus)*

Bumble bee

Bumble bee is a large insect with round body covered in soft hair often consisting of contrasting bands of colour (many are **black and yellow**) making it appear and feel fuzzy. They feed on nectar, using their long hairy tongues to lap up the liquid. Bumblebees are typically found in temperate climates, and are often found at higher latitudes and altitudes than other bees, some range into very cold climates, e.g. *B. polaris* occurs in the high Arctic. This is the most northernmost occurrence of any **eusocial insect**. One reason for their presence in cold places is that bumblebees can regulate their body temperature, via solar radiation, internal mechanisms of "shivering" and radiative cooling from the abdomen.

Many bumble bees are social insects that form colonies with a single queen. Bumble bees are important pollinators of wild flowering plants and agricultural crops like tomatoes, peppers, and cranberries.

First observation in the year	First observation in the year		*Phot. 59* *http://unsplash.com*

Mosquito *(Culex)*

Mosquito

Mosquitoes have two pairs of wings, but their second pair of wings is reduced to short, peg-like structures. Mosquitoes have thin, long bodies and three pairs of extremely long legs. They have scales along the veins of their wings and long beak-like, sharp sucking mouth parts. Mosquitoes feed on sweet nectar, fruit, and other sugary substances. Mosquito eggs require water in order to develop. Females of some mosquito species also feed on blood, which they need in order for their ovaries to mature and for their eggs to develop. Female mosquitoes detect their blood hosts (not only humans, but also other mammals, birds, lizards etc.) partly through the sense of smell and partly by sight from up to 30 meters. They live on almost every continent and habitat and serve important functions in numerous ecosystems (as pollinators or parts of a food chain), although some researchers claim that if extinct, they could be easily replaced by other spieces.

The oldest known mosquito with an anatomy similar to modern species was found in 79-million-year-old Canadian amber.

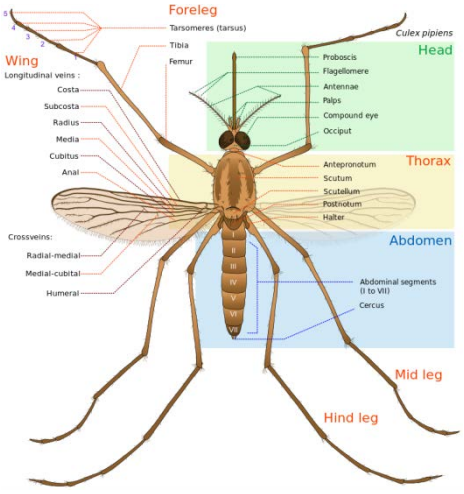


Fig. 2 Source: Wikipedia

First observation in the year	First observation in the year		*Phot. 60 https://commons.wikimedia.org/wiki/File:Diptera-komar-moscow.jpg*

Ant *(Formica)*

Ant

Ants are very capable, busy insects 2 to 25 mm long (larger ants occur in tropical regions). Ants have a narrow "waist" between the abdomen and thorax, large head, elbowed antennae, and powerful jaws. Ants can lift and carry more than three times their own weight. Enthusiastically social insects, ants typically live in structured nest communities (typically with one queen-with wings, female workers care for the queen's offspring, work on the nest, protect the community, and perform many other duties and males destined only to mate with the queen), that may be located underground, in ground-level mounds, or in trees. Ants communicate and cooperate by using chemicals that can alert others to danger or lead them to a promising food source. They typically eat nectar, seeds, fungus, or insects. Ants can be found everywhere on the planet except for permanently icebound northern and southern areas of the globe.

Ants play a key role in global ecosystem and have a big impact on their local environment as a result of their activity as 'ecosystem engineers' and predators.

First observation in the year	First observation in the year		*Phot. 61 http://unsplash.com*

Common brimstone *(Gonepteryx rhamni)*

Common brimstone

Common brimstone is a butterfly living in Europe, North Africa and Asia. Despite its opened-wing brilliant colour they are masters of disguise when closed as their under-wing colour and shape provide camouflage for resting and hibernating adults. Brimstones are common bright yellow butterflies and are often cited as the first butterflies of the year because adults hibernate over winter in woodlands and emerge on warm spring days. Males have sulphur-yellow fore and hindwings with an orange central spot, the females' wings are a more delicate yellow or pale green. The eggs are laid singly on the leaves of either common buckthorn *(Rhamnus cathartica)* or alder buckthorn *(Rhamnus frangula)* – the only two food plants – and females will wander far and wide

in search for these particular shrubs. Brimstone butterflies spend the summer feeding on nectar to build up energy reserves for the winter and by the end of August they are already beginning their long sleep.

The name "butterfly" is believed to have originated from the brimstone — which was called the butter-coloured fly by early British naturalists.

First observation in the year	First observation in the year		*Phot. 62 http://pixabay.com*

European peacock *(Inachis io)*

European peacook

This remarkably beautiful butterfly is rather common in temperate Eurasia, inhabiting woodlands and gardens. The base colour of the wings is a rusty red and there is a distinctive blue eye on each wingtip. The underside of the wings is a dark greyish brown, giving the butterfly perfect camouflage against a branch or tree trunk. The male and female have identical markings. Host plants for the caterpillars are first of all the stinging nettle, *Urtica dioica*, and sometimes Common hop, *Humulus lupulus*.

It is no coincidence that the European Peacock's markings resemble staring eyes. When the butterfly opens it swings, it is these staring eyes that scare off predators.

First observation in the year	First observation in the year		*Phot. 63 http://pixabay.com*

Noticed since the last observation (previous week) - data from biotic environment field observations. Collect information on selected spieces of birds (arctic tern, common cuckoo, white wagtail, crane). All of them are migratory birds, and fly hundreds and thousands of kilometers to find the best ecological conditions and habitats for feeding and breeding. Observe and note the very first appearance in your neighborhood. This will give approximate schedule and routes of their return.

Monitoring migrating birds

First observation in the year

Arctic tern *(Sterna paradisaea)*

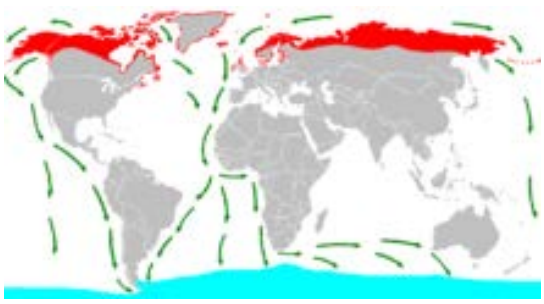
Arctic tern

Arctic tern is a medium-sized, slender white bird with black cap, deeply forked, long tail and white wings with some dark at tips, well known for its long yearly migration. Its travel from its Arctic breeding grounds to its wintering grounds of Antarctica may cover perhaps 40,000 km (25,000 mi), and is the farthest yearly journey of any Bird. The birds survive the vast journey by dipping down to the sea surface to catch fish and other food (invertebrates) as they ravel. It nests once every one to three years (depending on its mating cycle); once it has finished nesting it takes to the sky for another long southern migration. The Arctic tern has a continuous worldwide circumpolar breeding distribution.

Arctic terns can live for 15 to 30 years, meaning the record-breaking tern could fly as far as 3 000 000 kilometres over its lifetime, the rough equivalent of four round trips to the moon.

Distribution of Arctic tern.

Fig. 3. Source: Wikipedia



Red –breeding area

Blue – feeding area

First observation in the year	First observation in the year		*Phot. 64 http://pixabay.com*

Common cuckoo *(Cuculus canorus)*

Common cuckoo

Common cuckoo can be actually difficult to spot, as it's more often heard than seen. The familiar and unforgettable 'cuck-oo cuck-oo' call heralds the beginning of spring when they return to European forests from wintering in sub-Saharan Africa and south east Asia. As one of the most infamous brood parasites, cuckoos lay their eggs in the nests of other birds with precision timing. Once hatched, the chick ejects the legitimate occupants and then gets fed by its new and unsuspecting foster parents. Although its eggs are larger than those of its hosts, the eggs in each type of host nest resemble the host's eggs! The adult too is a mimic, in its case of the sparrowhawk; since that species is a predator, the mimicry gives the female time to lay her eggs without being seen to do so. Cuckoos are quite large (up to 34 cm long, 60 cm of wingspan), the plumage is greyish with a slender body and long tail and can be mistaken for a falcon in flight, where the wingbeats are regular. During the breeding season, common cuckoos often settle on an open perch with drooped wings and raised tail.

Cuckoos are insectivorous, and in particular are specialised in eating larger insects and caterpillars, including noxious hairy types avoided by other birds, they are able to shake the toxins out of hairy caterpillars before eating them.

First observation in the year	First observation in the year		*Phot. 65 Chris Romeiks Vogelart.info http://commons.wikimedia.org/wiki/File:Cuculus_canorus_vogelartinfo.jpg*

White wagtail (*Motacilla alba*)

White wagtail

White wagtail is a rather tiny bird (length up to 19 cm, wingspan up to 25 cm). White wagtail is instantly recognisable thanks to its distinctive black and white plumage, loud *tsli-vitt* call, and characteristic habit of constantly bobbing the tail, hence the common name 'wagtail'. It is mostly an aquatic bird, but this species can be common in various types of habitats, as well near water to hunt as in urban parks and cities for roosting in trees, so they are often seen running across lawns, car parks and other flat areas in pursuit of insects. These birds flock together to roost at warm sites such as reed beds and sewage farms.

This species breeds in much of Europe and Asia and parts of north Africa. It is resident in the mildest parts of its range, but otherwise migrates to Africa.

First observation in the year	First observation in the year		*Phot. 66* http://pixabay.com

Crane *(Grus grus)*

Crane

Crane is large and impressive waterbird with a long neck, beak and legs. The plumage is mainly slate grey, with black flight feathers , the innermost of which are greatly elongated, forming a drooping, bushy 'cloak' over the tail. In contrast, the neck, chin and throat are dark grey to black, with a black forehead and a distinctive white stripe that runs from behind the eye, down the neck and to the upper back. The top of the head bears a red patch of bare skin, and the eye is also bright red or reddish-brown. Cranes eat mostly plants (roots, seeds, berries-like cranberry), insects, snails, amphibians etc. Common crane is breeding from Western Europe to Siberia. Monogamous pairs reinforce their bond with a series of calls and elaborate head jerks. Together the pair builds a ground nest within their wetland habitat from a mound of swampy vegetation. The job of incubating their two eggs is also shared. They breed near water (marshy wetlands, swampy openings etc.). Cranes are quite social - flocks of up to 400 birds may be seen flying together during migration to/from southern Europe, Africa or northern India. Before spotting it, you can hear its piercing call from considerable distance.

During incubating eggs, adults sometimes embark on the fascinating behaviour of 'painting' their upper bodies and wings with reddish mud, which is thought to provide camouflage.

First observation in the year	First observation in the year		*Phot. 67 Flock of cranes during flight* *http://pixabay.com*
			*Phot. 68 Common crane* *http://pixabay.com*

Conclusions

We hope you and your students will enjoy conducting measurements, making observations and reporting. We encourage you to observe our maps, to compare your results with schools from all over Europe and to draw conclusions.

We strongly advise to discuss your results and experience regarding MONITORING on our EDU-FORUM (dedicated 'Monitoring' section).

Please don't hesitate to contact us in case of any problems or questions. For technical issues, please contact our support. For scientific issues, please contact Institute of Geophysics Polish Academy of Sciences (IGF PAS).

And remember: "To acquire knowledge, one must study, but to acquire wisdom – one must observe". **So keep calm and …**

Programming language and used technologies on Monitoring system:

- programming language Ruby, version 2.3;
- framework Ruby on Rails, version 5.0
- database PostgreSQL, version 9.5.

More technical information:

Development platform	• The programming language Ruby 2.3 (EDU-ARCTIC portal); • Environment for running container: Docker 1.12, together with the environment to run applications: Docker Compose 1.7
Development environment	• Atom
Database software	• PostgreSQL 9.5 (EDU-ARCTIC portal);
Web server	• Nginx 1.11 (EDU-ARCTIC portal)
Server operating system	• Ubuntu 16.04.1 LTS (Xenial Xerus)
Email server	• Production environment: Action Mailer 5.0 • Development environment: Mailcatcher
Deployment	Deployment is facilitated by Docker, who manages all the containers required by the production environment: • app: main application container; • app_db: main application database: PostgreSQL with PostGIS extenstion; • app_worker: Sidekiq, background processing framework; • redis: Redis, the server that stores the data structures; • mailcatcher: SMTP server that intercepts e-mails sent by the application; • cache: Memcached, distributed memory object caching system

The Monitoring system **is built based only on technologies for further use and development without having to purchase a license.**

Nr	Name	Version	Period of validity	Type of license
1	Ruby on Rails	4.2	Without a time limit	MIT License
2	PHP	5.6	Without a time limit	PHP License
3	Docker	1.12	Without a time limit	GPL
4	Docker Compose	1.7	Without a time limit	Apache License
5	Ubuntu	16.04	Without a time limit	MIT License
6	PostgreSQL	8.3	Without a time limit	PostgreSQL Licence
7	PostGIS	2.3.1	Without a time limit	GPL
8	MariaDB	10	Without a time limit	GPL
9	Nginx	1.11	Without a time limit	Nginx License
10	Apache	2.2	Without a time limit	Apache License
11	Redis	3.0	Without a time limit	BSD License
12	Memcached	1	Without a time limit	Memcached License
13	Mailcatcher	0.6.4	Without a time limit	MIT License
14	jQuery	2.2.4	Without a time limit	MIT License
15	Moment.js	2.10.3	Without a time limit	MIT License
16	Font Awesome	4.2	Without a time limit	SIL OFL 1.1 (GPL compatible)
17	Puma	3.0	Without a time limit	BSD
18	uglifier	1.3	Without a time limit	MIT License
19	coffee-rails	4.2	Without a time limit	MIT License
20	jbuilder	2.6	Without a time limit	MIT License
21	country_select	2.5	Without a time limit	MIT License
22	enum_help	0.0.16	Without a time limit	MIT License
23	devise	4.2	Without a time limit	MIT License
24	devise-i18n	1.1	Without a time limit	MIT License
25	turbolinks	5	Without a time limit	MIT License
26	date_validator	0.9	Without a time limit	MIT License
27	recaptcha	4.0	Without a time limit	MIT License
28	awesome_print	1.7	Without a time limit	MIT License
29	will paginate-bootstrap	1.0.1	Without a time limit	MIT License
30	sidekiq	4.2	Without a time limit	LGPL
31	dalli	2.7	Without a time limit	MIT License
32	web-console	3.31	Without a time limit	MIT License
33	spring	1.7.2	Without a time limit	MIT License
34	acts_as_list	0.8	Without a time limit	MIT License
35	pg_search	1.0	Without a time limit	MIT License
36	axlsx_rails	0.5.0	Without a time limit	MIT License

Other software required for EDU-ARCTIC portal and monitoring system:

- Server HTTP nginx, version 1.4.6
- Docker, version 1.12
- Docker Compose, version 1.7
- Database extension PostGIS, version 2.3.1
- In-memory data structure store Redis, version 3.0
- Memory object caching system Memcached 1
- Server SMTP Mailcatcher, version 0.6.4
- Version control system Git, version 2.1.