

Learning Material

Canada – Snow, Ice and Sea

Grade 7-9

Accompanying Commentary

Project Information

These learning materials were developed within the project „Columbus Eye – Live Imagery from the ISS in schools“. „Columbus Eye“ is funded by the German Air and Space Center with funds of the Ministry of economy and energy based on decision by the German Bundestag according to the funding code 50JR1307.

The overall project objective consists of the development of comprehensive digital learning materials for use in schools. This offer embraces interactive

learning tools and working sheets which are accessible via the portal on the web.

<http://www.columbuseye.uni-bonn.de>



Overview

Grade 7-9

Level ● ● ● ● ●

Time needed 1 - 2 Lessons

Authors Valerie Graw,
Henryk Hodam,
Andreas Rienow

Objectives
Pupils...

- Get to know earth observation by the ISS,
- improve spatial orientation with the help of the ISS-panorama,
- identify different land surfaces due to different colour values and derive a thematic map by classification of the respective pixels

Topics

Maps

Land Cover and Land Use

Earth Observation from Space

Thematic Maps

Material

Accompanying Commentary

Online Tool

Exercises

Sample Solutions

Accompanying Commentary

Incorporation in curriculum and realization of learning unit

Maps represent a key element in geography classes as they serve as a tool for spatial orientation. Important is also the generation of maps which thereby includes the use of remote sensing or aerial photography from which information can be derived for a map.

Two sorts of competencies are addressed by the development of maps and their integration in schools:

- **Spatial Orientation Expertise:** Pupils learn to orientate in the geographical space leading to topographical knowledge.
- **Map Expertise:** The perception of geographical space of pupils will be trained. Knowledge on the decent interaction with maps is gained and moreover, topographic overview charts and simple maps can be developed by the pupils themselves.

The objective of the following learning unit “Canada - Snow, Ice and Sea” is to allow pupils to generate a thematic map starting from a digital image with the help of a simple analysis tool. This helps to explain land surface compositions based on the resulting map.

The learning unit uses the integration of computers to transfer knowledge aided by animation and interaction. A computer-based and interactive learning tool leads to the practical examination of this topic. The analysis tools in this learning unit are implemented in Flash and adjusted to a design for the pupils’ understanding.

Moreover, the computer-based learning unit considers the following aspects:

- The structure of the unit is research-oriented and, therefore, encourages the propaedeutic studying of research.
- The learning unit promotes the organization of lessons which focus on a strong autonomous activity and self-dependence of the pupils.
- The learning unit bears in mind the everyday reality of the pupils.
- As means of labor the computer is integrated here to not only serve as simple device to gather information and entertainment but also to be used as tool. Moreover, the dealing with new media and the media competence of the pupils is strengthened.

Content-related background

A map is an abstracting model of the earth surface. It can represent a simple and clear reality but its analysis has to be trained to afterwards value the presented contents and reflect about them. By this, the learning unit “Canada - Snow, Ice and Sea” focuses on the abstraction of complex information to generate a map as a key competence. For this learning unit on Canada images of the flyover of the ISS – the International Space Station – of the 7th of January 2015 were used. This ISS-panorama provides a continuous depiction of the earth surface over parts of Canada. With an experienced view of such an image and the interpreting of structures and colors, certain land components can be distinguished from each other.

The “classification”, which is later on conducted online using the provided tool, is based on mathe-

mathematical operation as known in remote sensing. Here, colour values of aerial and satellite images can be assigned to discrete classes. Based on their similarity, these are then linked to semantic information. With the tool the pupils are conducting a classification on the ISS-panorama in several steps. By this out of a white colored pixel in the derived map the surface "ice" can be generated, while a grey pixel is classified as "cloud" and so on. The map and its classification depends on how the pupils interpret the landscape as shown in the panorama and how the value the similarity of the pixel in this image.

The initial learning unit consists of the following parts:

- Spatial orientation and location of the ISS-panorama.
- Identification of different land surfaces and their occurrence in the area.
- Selection of training samples for the classification and discussion of the land cover in its spatial origin.
- Classification of the ISS-panorama.

Earth Observation from the ISS

The core of this tool is represented by an image taken during an overflight of the ISS. The International Space Station is the biggest artificial object in the orbit. Every day, the space station circuits the Earth 16 times. The duration of one circulation is 90 minutes.

The term remote sensing describes the general remote observation of the Earth's surface with sensors attached to planes or satellites or – as in this case – to a space station. Via images of the Earth's surface, conditions of ecosystems and their surroundings can be analyzed by observing the different surfaces. Also changes in land surfaces can be detected with earth observation if a certain

area is crossed multiple times within a certain time frame and several images are provided for analysis. Therefore, an important aspect of remote sensing compared to general field measurements is the more cost effective possibility to gather information without being in situ.

Image detection – how is an image created and what is a "pixel"?

The ISS is equipped with four HD-cameras which cover three perspectives embedded in the NASA Experiment on High Definition Earth Viewing (HDEV). One of the cameras owns the so-called nadir-position and is thereby the most important for our project as this position is most relevant for earth observation. Nadir-position means that the camera is picturing images vertical to the earth surface. The cameras of Columbus Eye contain so-called CMOS-sensors. These refer to two-dimensional images as known from digital cameras.

An image, like the ISS-panorama used in this learning unit, consists out of many equally sized pixel. If you zoom into the image single pixel can be identified. Figure 1 shows a Landsat scene – one image of the sensor Landsat – from 2014 close to Düsseldorf, a city in Germany located north of Cologne in central-western Germany.



Figure 1 An image consists of many equally sized pixel. This figure shows an example out of a Landsat Scene located close to Düsseldorf.

The resolution of the image is 2.1 megapixels. In combination with the flight altitude which is at 400km (~250 miles) this results in a spatial resolution of around 500m on the ground. This means, every pixel has a measurement of around 500m by 500m.

Content, Structure and Targets of the learning unit

Overall, the learning unit “Canada – Snow, Ice and Sea” consists of two parts. The first part gives the information that is needed for basic understanding and leads to the second part which deals with the interaction. In the second part the pupils actively create a map using the foregoing classification. The tool and the learning unit based on it can be accomplished in one to two school lessons.

Structure of the learning unit

Via the Columbus Eye Website (www.columbuseye.uni-bonn.de) the Observatory can be accessed. Here, all learning units using images of the ISS can be found. They will help pupils to transfer their knowledge and to provide sustainable knowledge.

The Observatory is found below the tab “class” on the website of Columbus Eye (Figure 2).

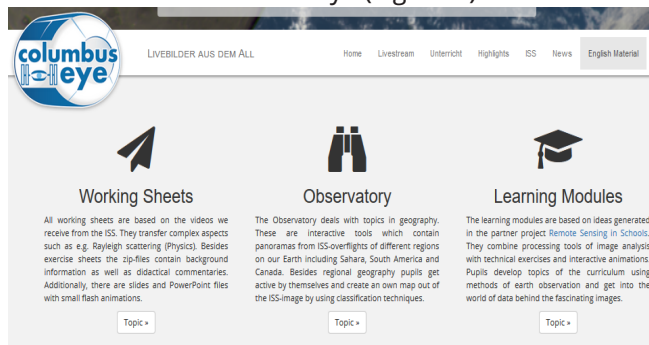


Figure 2 Where to find the observatory on the Columbus Eye website.

In the Observatory the respective learning units can be found. Maps for orientation next to the unit show the overflight of the ISS with an added orange line which marks the flight path. Clicking on “Panorama” below the overflight path documentation the respective learning unit is chosen. Here, we choose Canada. The pupils will get to the unit directly. The interactive work is conducted online within the main window of the learning unit.

Here, also information about the ISS-panorama and the pictured regions can be accessed. Besides that, the main component – the classification – can be conducted which finally results in a self-created map.

Additional information can be accessed via “info points” within the image. By clicking on them a window pops up giving better insights in the area or a certain process occurring here. These points can also help to deepen knowledge on e.g. climate zone which might have been already discussed in one of the classes. Moreover, the pupils get more information on life in cold regions for humans and animals.

1. ISS-Panorama

When opening the tool “Canada”, the ISS-panorama will appear, showing the region Saskatchewan and the almost fully frozen Tobin Lake. Moving eastwards you will spot the Lake Winnipeg as well as partly ice- and snow-covered regions until you reach Fjord Saguenay in the east, located north of Québec. A video of formerly 9 minutes - the time it took for the ISS to fly over this region - was used to create this panorama.

In the beginning, pupils will get the superordinate assignment to familiarise with the image of the overflight of the ISS. It is important to identify the different surfaces and assign them to the different climatic zones. Different tools which are listed and explained below the image again will help conducting the analysis.

In the left upper corner of the image a compass shows the orientation of the ISS-panorama. The north arrow in this map is not leading to the top as seen by looking at the compass. By clicking the north arrow, one can look at the flight path of the overflight as well as the area which is crossed, explaining the position of the north arrow. In the upper right corner of the image two tools can be found to zoom in (+) and out (-) of the image. With these you have the possibility to get more details of an image or rather get an overview of the area.

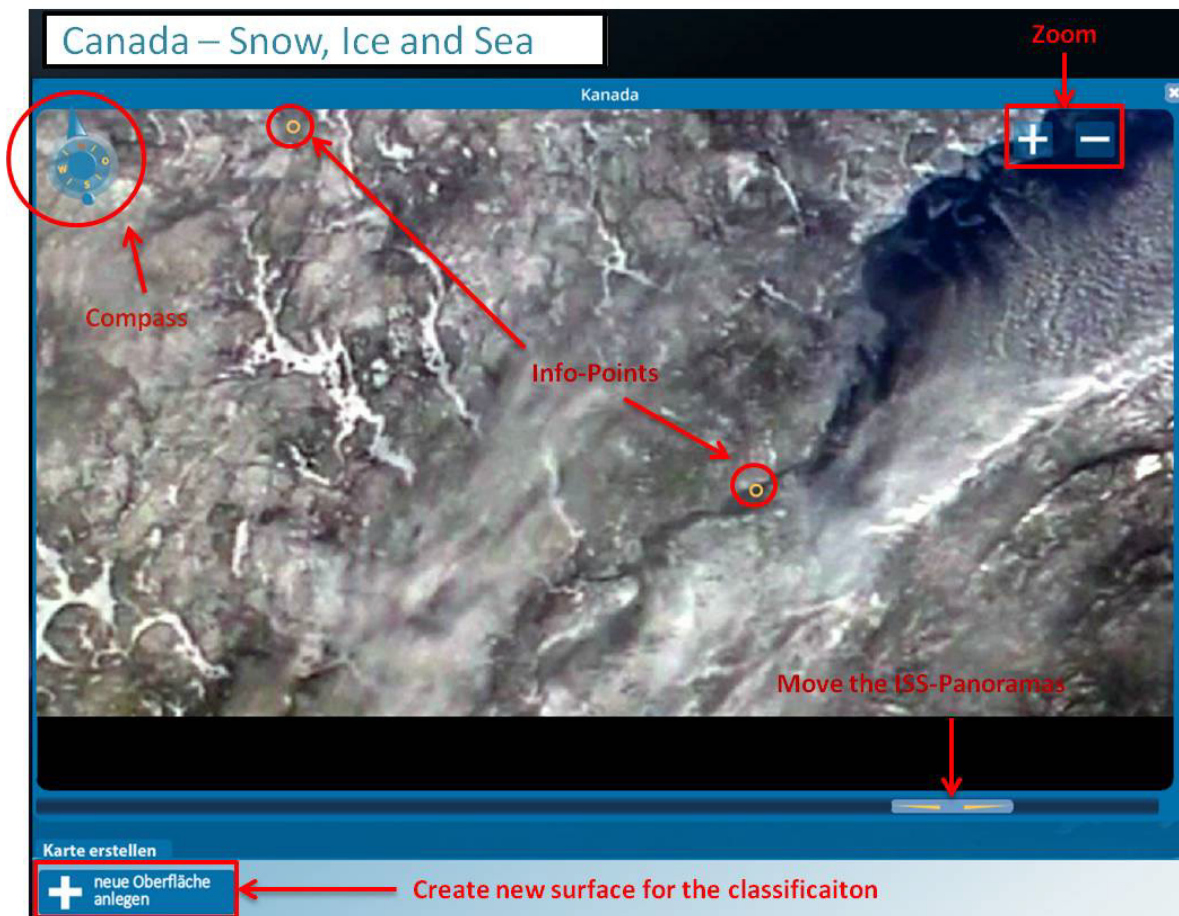


Figure 3 Main view and tools of the panorama

Moreover, at the bottom right of the image sliders are located to navigate the image to the west (top) and east (right).

If you take a closer look, certain yellow circles are visible on the map which represent information points. If you click on those points, another window - the information box - pops up (Figure 4) which provides more detailed information for the viewers.

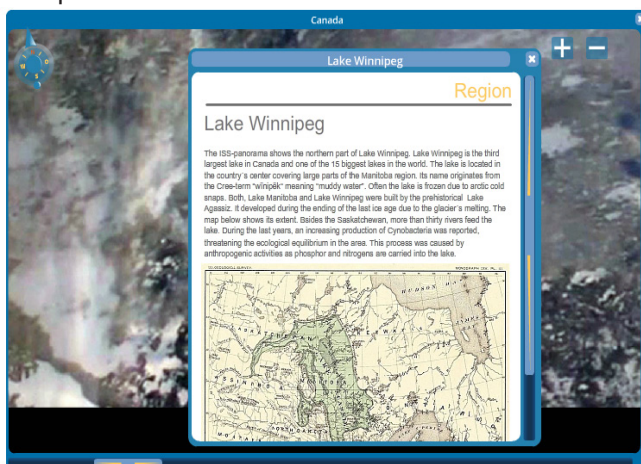


Figure 4 Information Points

In total, this learning unit has eight information points to be found in the map. The information points are divided into region and phenomenon. Table 2 shows the regions and phenomena that can be found in the panorama.

Besides Lake Winnipeg and the artificial reservoir Tobin Lake further information on the life in cold regions can be gathered. By this, pupils get insights in the culture of Canada but also animals and their environment, such as ice bears. Regions and phenomena are also integrated in the exercises. The information points support the discussion of reoccurring topics. Each group covers four topics. During the online "overflight" pupils can detect the region with its geo-ecological and socio-economic processes and natural phenomenon. By this, they will also recognize how land surfaces change and distinguish between clouds and snow cover.

Table 2 List of regions and phenomenons to be found in the information points of the panorama

Region	Phenomenon
<ul style="list-style-type: none"> • Tobin Lake • Lake Winnipeg • Lac Mistassini • Lac Manicouagan • Fjord Saguenay 	<ul style="list-style-type: none"> • Canadian Culture • The Cree Tribe • Ice Bears on a floe

Summary of the learning unit

1. ISS - Panorama

Targets

- Link images of the earth surface to the spatial context.
- Get to know the High Definition Earth-Viewing experiment (HDEV)
- Explain the terms: remote sensing and classification
- Detect landscape elements in the ISS-Panorama

Contents

- The ISS
- Earth observation of the ISS
- Spatial orientation with the use of earth observation
- Climatic zones

2. Classification

Targets

- Allocating color characteristics of the land surfaces to environmental elements
- Derive thematic maps from images of the earth surfaces
- Identify and assign certain land surfaces in cold regions to areas in the ISS-panorama
- Explain principles of image classification based on color characteristics and similarities
- Measure area extents of single land surfaces

Contents

- Distinguish colors in an image based on different colors based on different spectral characteristics
- Classification: link color information with semantic information
- Distinguish surfaces based on their different colour pixel (e.g. open and icebound lake surfaces)
- Interpretation of created map

Class Design Assistance

Learning Tool: Canada - Snow, Ice and Sea

Note: The here described class design is made for orientation and is not binding. Amplifications, supplementation or omission can be made according to classes and based on prior knowledge. The learning tool can be a component for around 1-2-hours depending on the aim to discuss further topics within the learning unit.

Phase	Content + Objective	Implementation/ Material
Einführung	<ul style="list-style-type: none"> • Explanation of learning tool • Introduction to topic - What is the ISS und what is HDEV? • Structure of an image (raster / color characteristics) • Work order: <ul style="list-style-type: none"> • Identify land cover • Recognize and describe characteristics of climate zones • Create a thematic map based on classification 	<ul style="list-style-type: none"> • Lehrervortrag • Computer, Unterrichtstool
Preparation	<ul style="list-style-type: none"> • Structure of the image • Spatial orientation due to visual analysis of the ISS-Panorama, content-wise orientation due to the info points located in the image • Distinguishing land surfaces and allocation of climatic zones • Creation of training samples for the classification in order to generate a thematic map 	<ul style="list-style-type: none"> • Group work (pairwise) • Material: Computer, learning tool



Columbus Eye – Live-Imagery from the ISS in Schools

Remote Sensing Research Group (RSRG), Department of Geography, University of Bonn, Funding BMWi funding code: 50 JR 1307

Saving Results	<ul style="list-style-type: none">• Save map• Allocation of map to ISS-Panorama• Listing land surfaces as derived from image• Completion of exercise sheets to get more insights in classification topics as well as regional characteristics	<ul style="list-style-type: none">• Group work (pairwise)• Material: Computer, learning tool
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