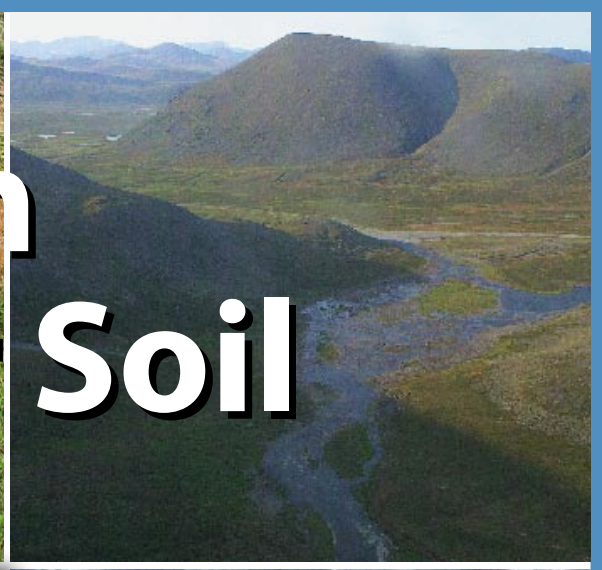
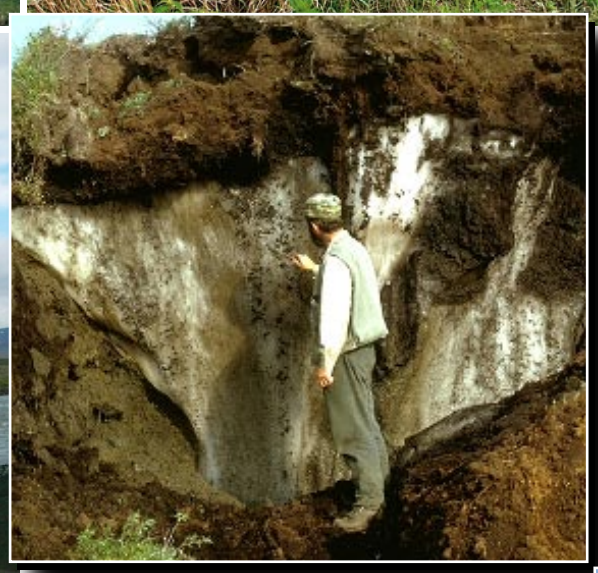
2008

Northern Circumpolar Soil

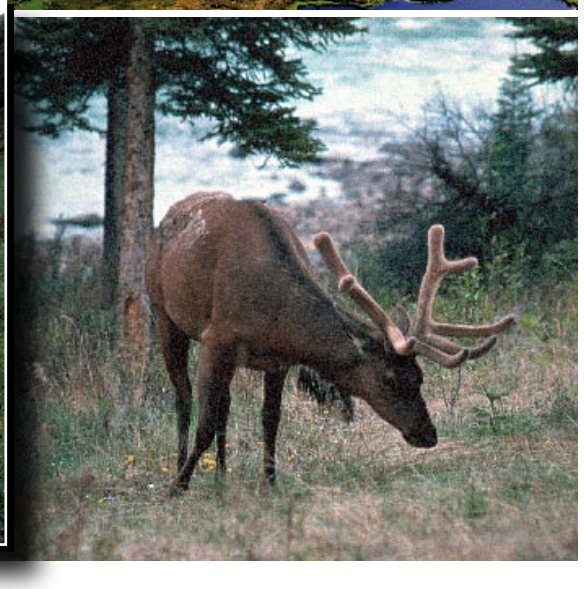













Supporting the International Polar Year 2007-2008

INTERNATIONAL POLAR YEAR 2007 2008

JRC
EUROPEAN COMMISSION

Soil in northern latitudes

Soil is one of the fundamental components for supporting life on the planet.

Plants and crops are dependent on soil for the supply of water, nutrients and as a medium for growing.

Soil stores, filters, buffers and transforms substances that are introduced into the environment. This capability is crucial in producing and protecting water supplies and for regulating greenhouse gases.

Soil is a provider of raw materials.

Soil is also an incredible habitat and gene pool: in excess of 5 tonnes of live organisms can exist in a hectare of arable soil.

Soil is a fundamental component of our landscape and cultural heritage.

Cryoturbation moves peat, litter and other kinds of organic matter from the surface into deeper, colder and less biologically active soil layers. A mechanism for the long-term preservation of organic matter in the permafrost zone.

The **International Polar Year** is a scientific programme that is focused on the Arctic and the Antarctic from March 2007 to March 2009 (two years are needed to cover all seasons in the northern and southern hemispheres!).

The polar regions are sensitive barometers of climate change, presently warming faster than any other region on the Earth. Rising temperature is particularly evident by the widespread shrinking of snow and ice that was previously regarded as stable. In addition, the polar regions have a profound influence on the global environment, in particularly, on the oceanic and atmospheric circulation systems.

Being sensitive to environmental changes, soil in northern regions is projected to undergo substantial modification as a result of global warming. In addition to altering the general characteristics of soil, a marked rise in temperatures in the Arctic regions would potentially lead to the release of significant quantities of greenhouse gases from decomposing organic matter, currently trapped in frozen soil.

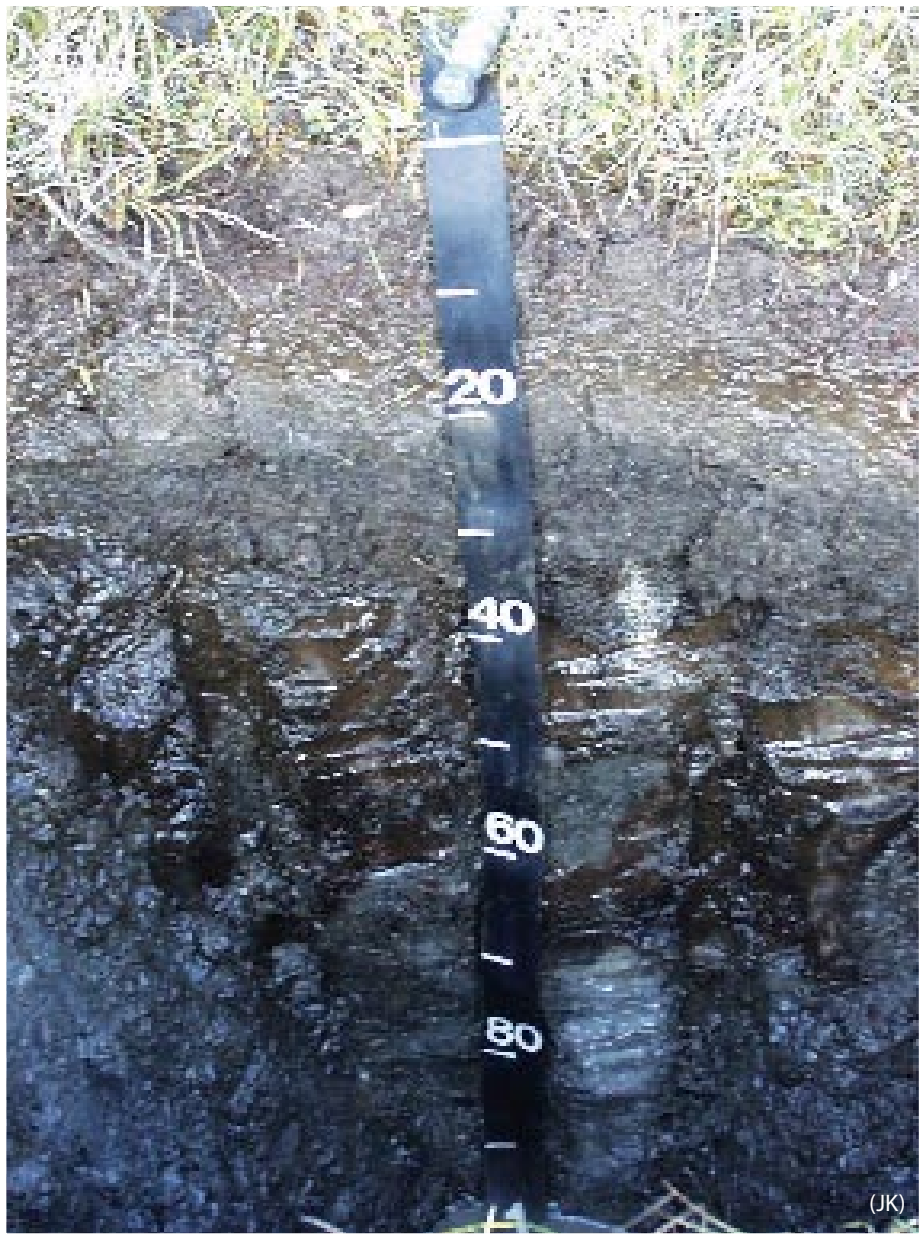
This calendar highlights the diversity and richness of soil in northern regions and aims to help the reader understand better the characteristics of soil that is currently permanently or seasonally frozen.

Soil characteristics change significantly with depth. Colour differences identify soil horizons reflecting variations in the distribution of diverse materials. In the above example, a surface horizon containing high levels of decaying vegetation residues overlays a much paler horizon where the organic matter, aluminium and iron minerals have been leached (moved by water) downwards and redeposited to form the reddish iron-rich horizon. The sandy nature of the parent material from which the soil is formed is clearly evident at the base of the profile. The name for this type of soil is an Albic Podzol, one of the most widespread soil types in northern latitudes.

For more information on the European Union's Thematic Strategy for Soil Protecion, please visit: http://ec.europa.eu/environment/soil/index.htm

Cryosols

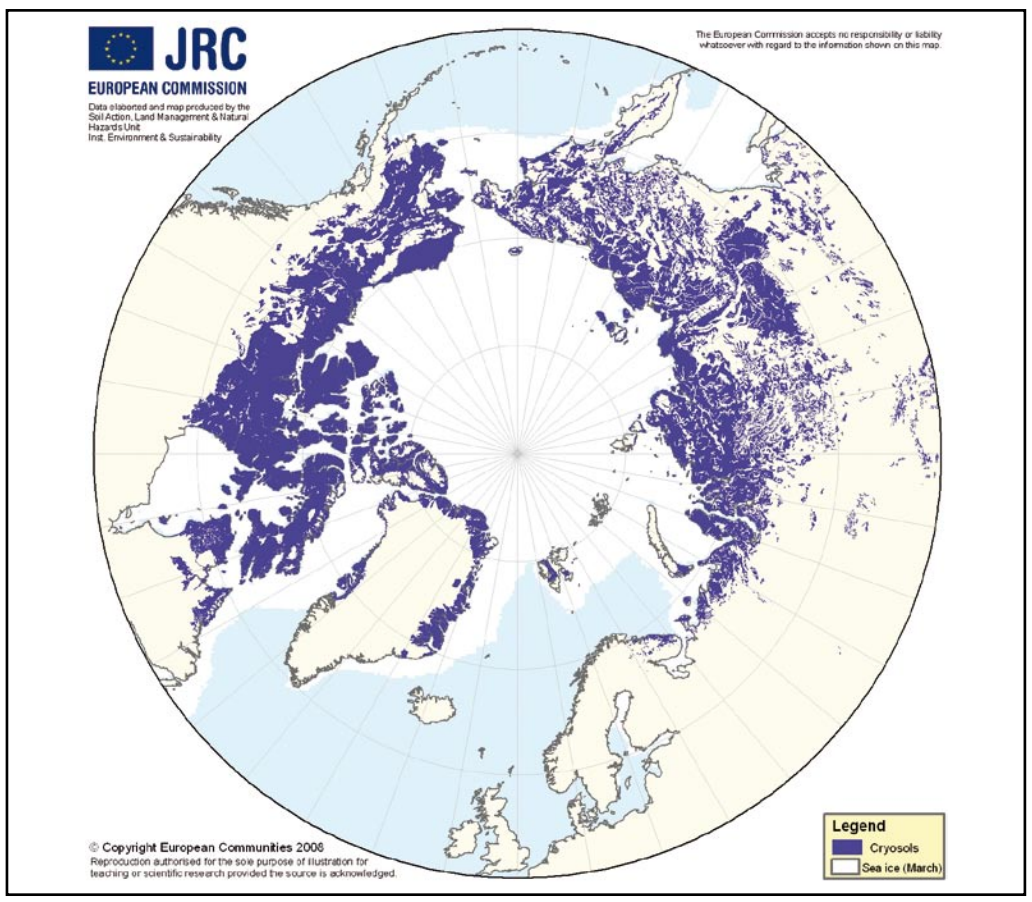
(from the Greek, *kraios*, meaning cold or ice)



Cryosols develop in cold regions where permanently frozen subsoil (permafrost) is found. In this type of soil, water occurs primarily in the form of ice and cryogenic processes such as freeze-thawing cycles, cryoturbation (warping), frost heave, cryogenic sorting, cracking and ice segregation are the dominant soil forming processes that result in distorted horizons and patterned ground. They correlate with Gelisols (Soil Taxonomy), Cryosols (Canada) and Cryozems (Russia). This profile from Russia shows a shallow permafrost table at 25 cm depth represented by the presence of horizontal lenses of ice in the soil. The profile appears dark due to the melting of the permafrost as a result of digging the pit. An ice-wedge can be seen to the right of the tape measure. Vertical cracks, filled with organic material, are a common feature.

January 2008

Palsa degradation in the tundra near the town of Vorkuta (Russia). As the ice core melts, the palsa sinks into the ground producing a collapse scar. The peat can now quickly decompose releasing carbon dioxide and methane to the atmosphere.



The map shows the location of areas where Cryosols are the dominant soil. Cryosols cover around 25% of the circumpolar region shown on the map.

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Chernozems

(from the Russian, *chern*, black, and *zemlja*, earth)

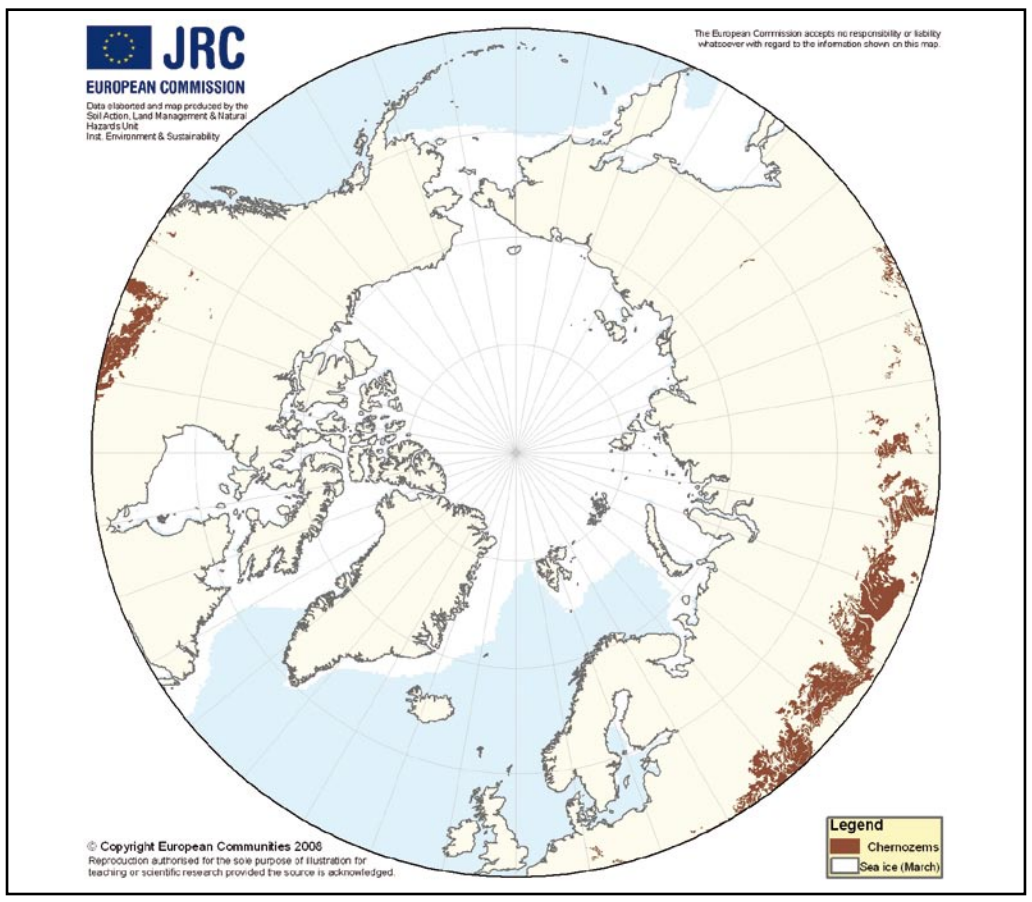

(VD)

Soil having a very dark brown or blackish topsoil with a significant accumulation of organic matter, a neutral pH and having calcium carbonate deposits within 50 cm of the lower limit of the humus-rich horizon. Chernozems show high biological activity and are typically found in the long-grass steppe (prairie). Chernozems are among the most productive soil types in the world. They correlate with Mollisols (Soil Taxonomy), Chernozems (Canada) and Humic-accumulative soil (Russia). This profile shows a typical Gelic Chernozem from Yakutia in Siberia. The dark surface soil horizon is broken by frost crack with abundant features of cryoturbation in the subsoil.

February 2008


(EM)

The main source of the high organic content of Chernozems is the abundant roots of grasses.



The map shows the location of areas where Chernozems are the dominant soil. Chernozems cover around 4% of the circumpolar region shown on the map.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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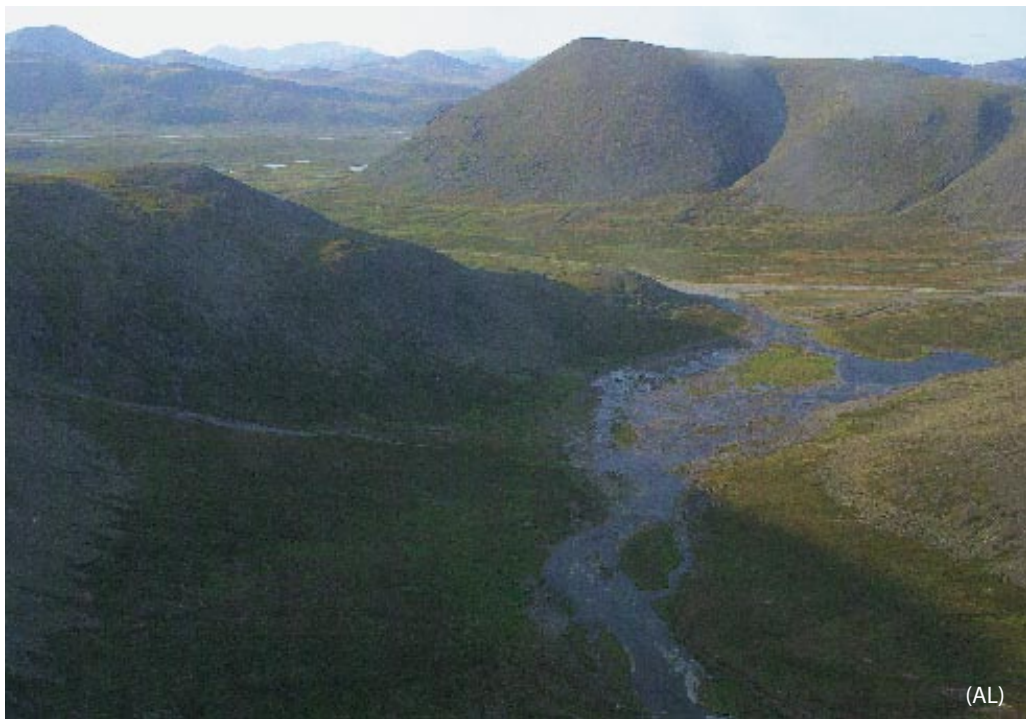
Cambisols

(from the Latin, *cambire*, meaning to change)

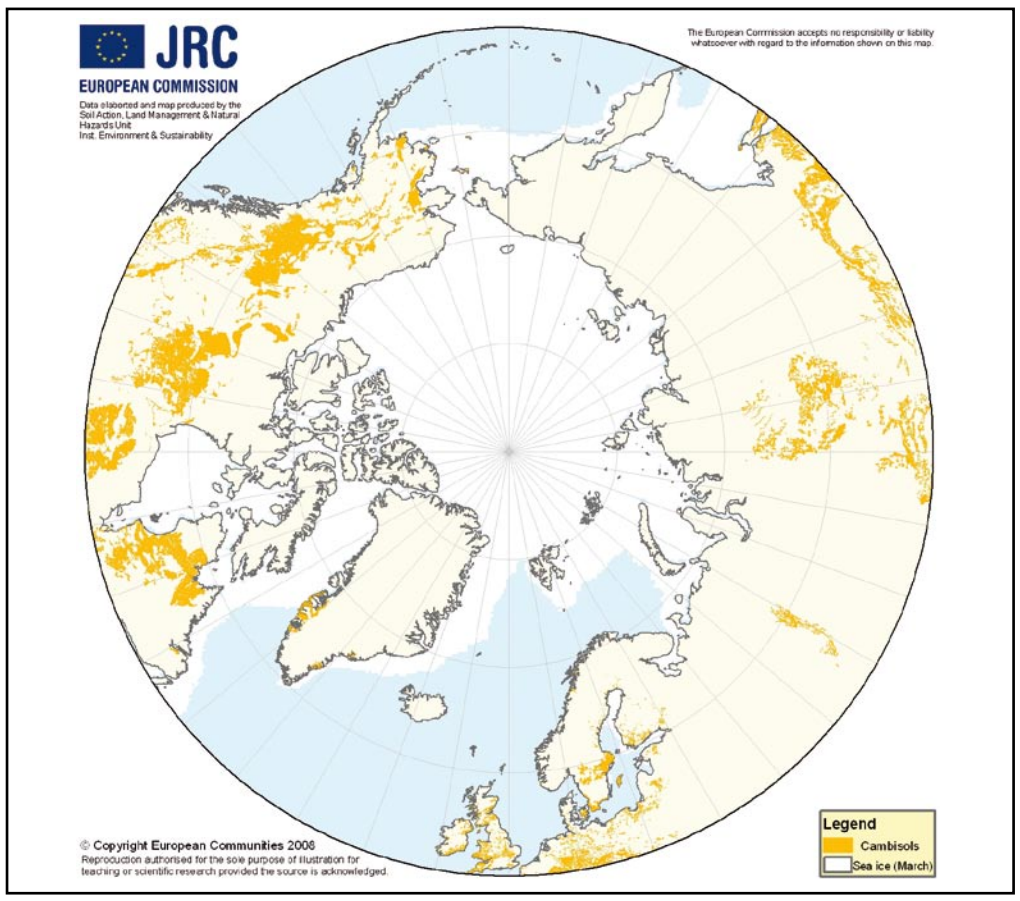

(AL)

A Cambisol is a young soil. Soil forming processes are evident from variations in colour and/or the development of structure below the surface horizon. This type of soil occurs in a wide variety of climates around the world and under all kinds of vegetation. They correlate with Inceptisols (Soil Taxonomy), Brunisols (Canada) and Metamorphic soil (Russia). This profile shows a Cambisol in a stony moraine (a glacial deposit) in the Ural Mountains of Russia. The brown colour of the upper part of the soil is the result of a soil process known as brunification which involves the leaching of base cations and alteration of iron-oxides in iron-rich parent material.

March 2008


(AL)

A landscape in the Ural Mountains with Cambisols and Leptosols on the slopes and Cryosols and Histosols in the valleys.



The map shows the location of areas where Cambisols are the dominant soil. Cambisols cover around 10% of the circumpolar region shown on the map and are typical of large parts of the territory.

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Andosols

(from the Japanese, *an*, meaning black and *do*, meaning soil)

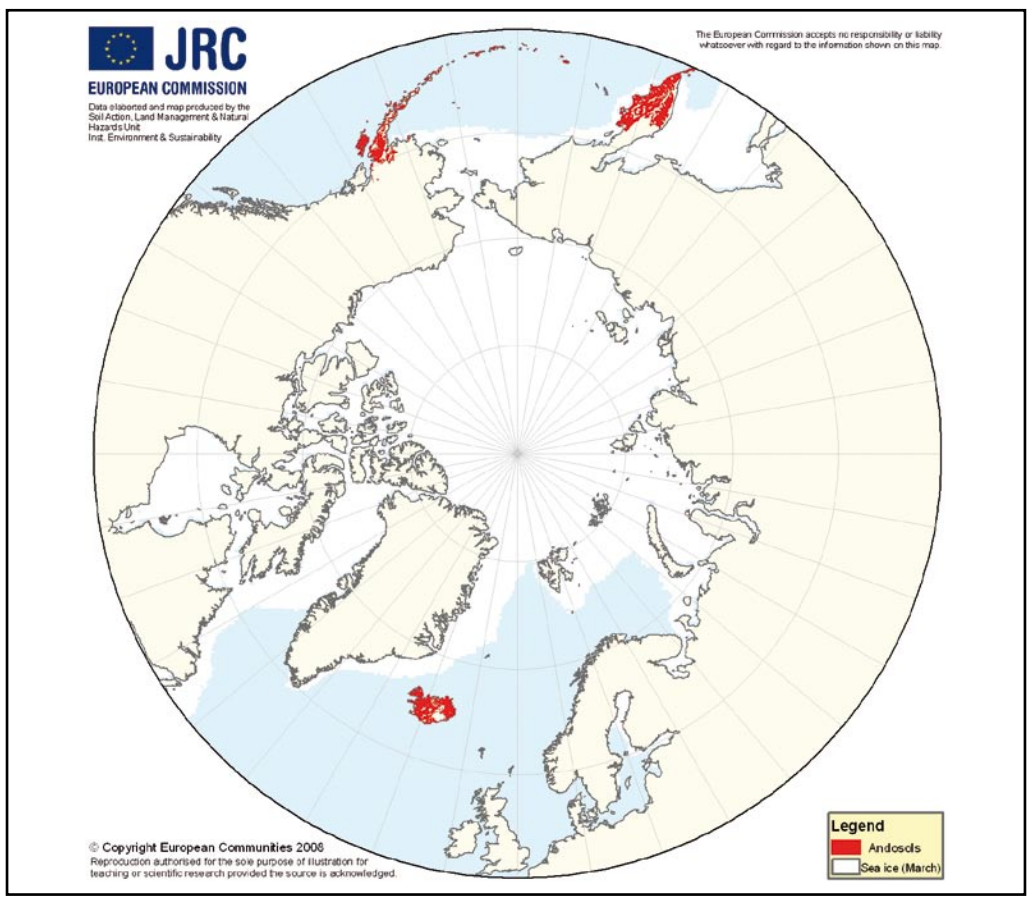
(OA)

Andosols form from volcanic ash, pumice, cinder and related parent materials. Many Andosols develop a thick, dark topsoil as a result of the fixing of organic substances by aluminium that is released from volcanic minerals. Due to low temperatures, Andosols in Arctic regions are only moderately weathered. They correlate with Andisols (Soil Taxonomy) and Volcanic soil (Russia). This profile shows Andosols from Iceland, represented by layered deposits. The reddish colour is due the weathering of iron-rich minerals in the volcanic material.

April 2008


(OS)

Much of Iceland consists of gently undulating, grass-covered glacial plains and volcanic mountain ranges, overlain by wind-blown volcanic ash deposits.



The map shows the location of areas where Andosols are the dominant soil. Covers around 1% of the circumpolar region shown on the map.

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Albeluvisols

(from the Latin, *albus*, meaning white and *eluere*, meaning to wash out)

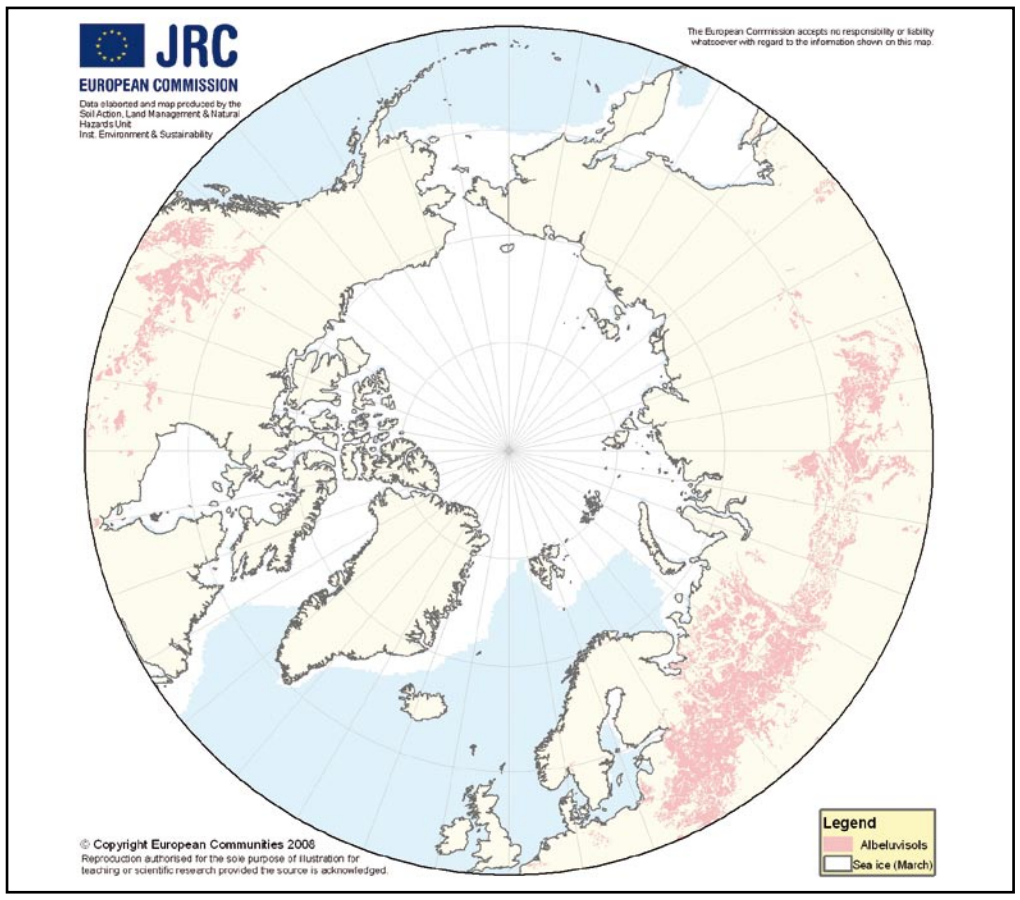
(EM)

Albeluvisols display an accumulation of clay within the subsoil with an irregular or broken upper boundary and deep penetrations or 'tongues' of bleached soil material into the clay-rich (illuviated) horizon. These 'albeluvic tongues' are formed as a result of cracks in the soil during freeze-thaw processes under periglacial conditions which are later infilled by the overlaying bleached material. Albeluvisols occur mainly in humid and cool temperate regions. They correlate with Alfisols (Soil Taxonomy), Luvisols (Canada) and Texture-differentiated soil (Russia). The above profile shows the polygonal patterns in the base of the pit formed by the infilling of relict cracks in the once frozen soil (see December).

May 2008


(OS)

Albeluvisols are generally covered by forests. This picture of a wind blown tree on an Albeluvisol shows how the root system has developed along the polygonal features in the soil.



Albeluvisols are relatively common and are often associated with Luvisols. Covers around 9% of the circumpolar region shown on the map.

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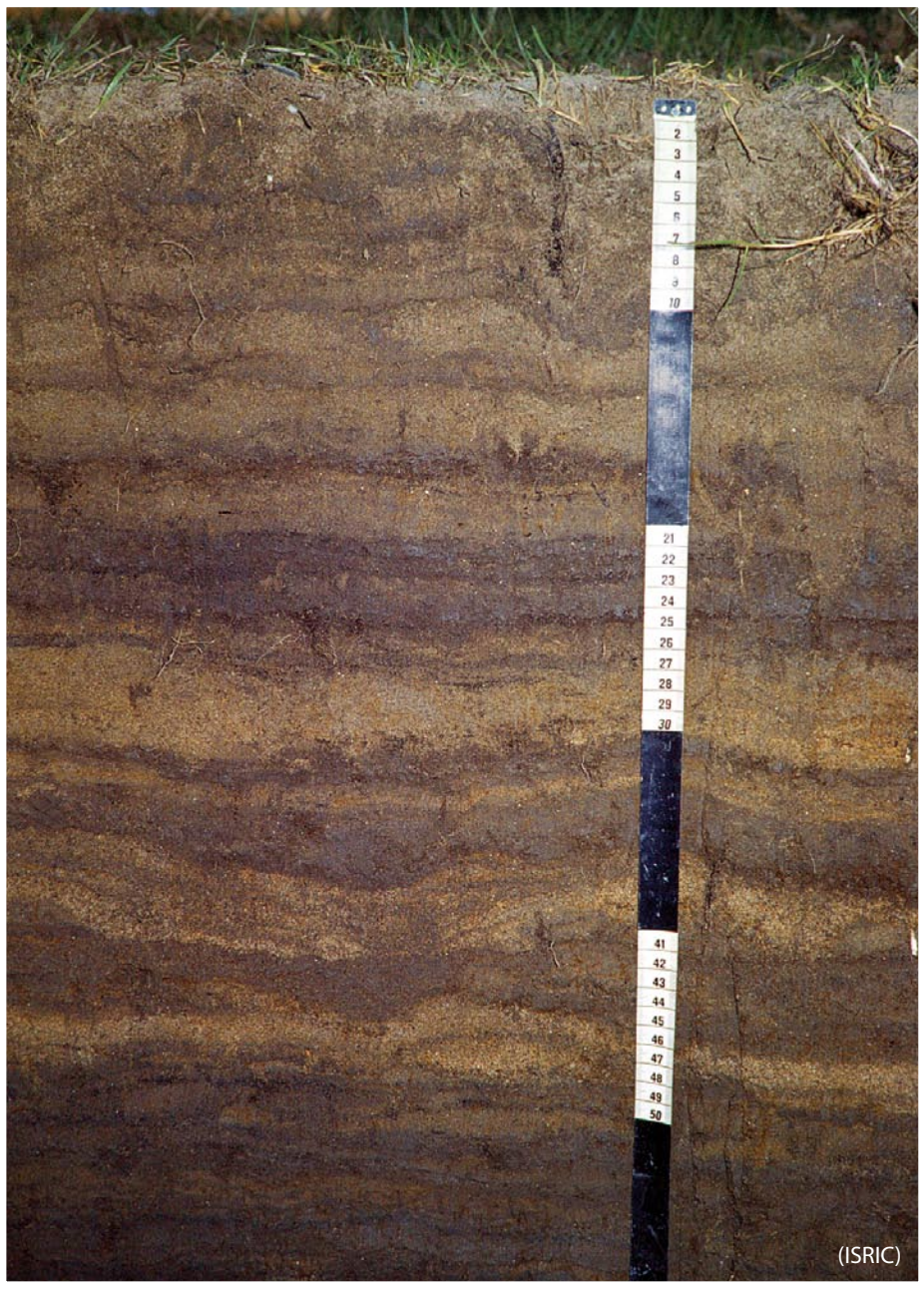
Fluvisols

(from the Latin, *fluvius*, meaning river)



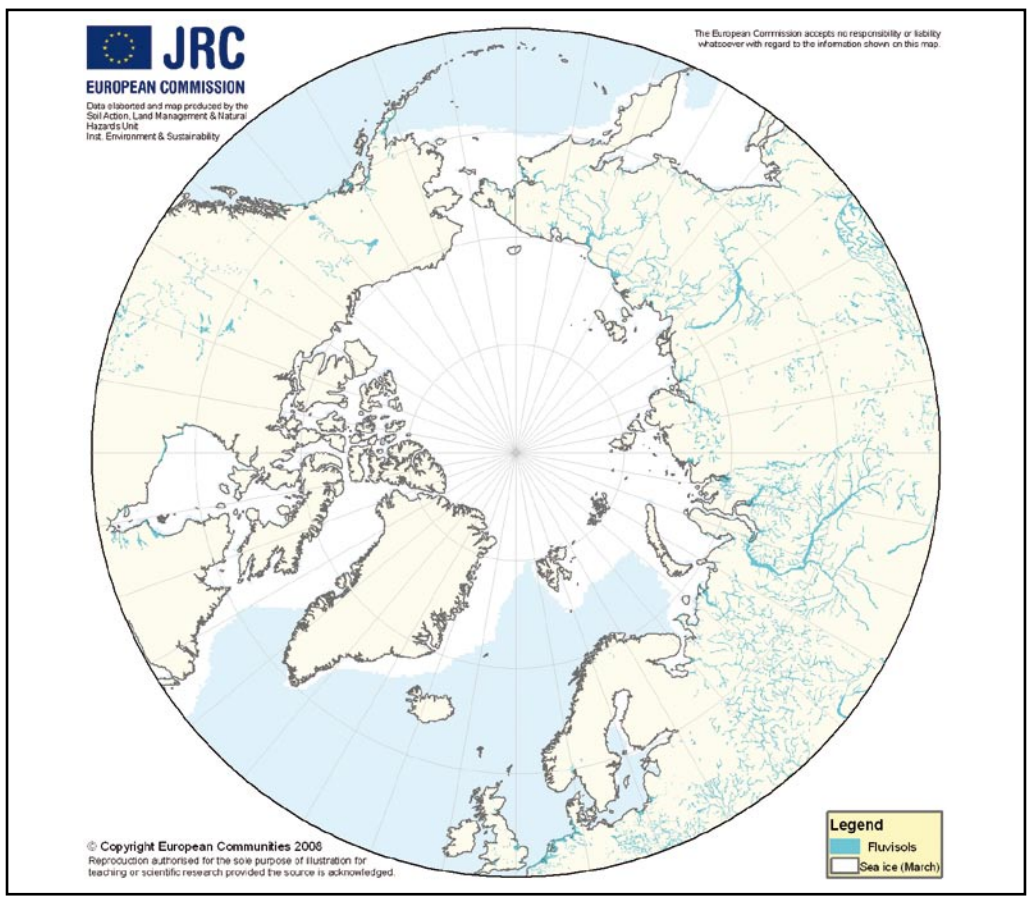
(ISRIC)

Fluvisols are common in periodically flooded areas such as alluvial plains, river fans, valleys and tidal marshes, existing on all continents and in all climate zones. Fluvisols show a layering of sediments with pedogenic horizons. Their characteristics and fertility depend on the nature and sequence of the sediments and length of periods of soil formation after or between flood events. They correlate with Entisols (Soil Taxonomy), Regosols (Canada) and Alluvial soil (Russia). This profile shows the layering of soil and sediments. Occasionally flow patterns can be observed, as in the picture at around 40 cm depth.

June 2008


(ISRIC)

Fluvisols develop due to the coexistence of soil forming processes and the deposition of sediments following floods. This aerial photograph shows a meandering river in a glaciated landscape in Canada.



The map shows the location of areas where Fluvisols are the dominant soil. Fluvisols cover around 4% of the circumpolar region shown on the map. The map clearly shows the location of large river floodplains.

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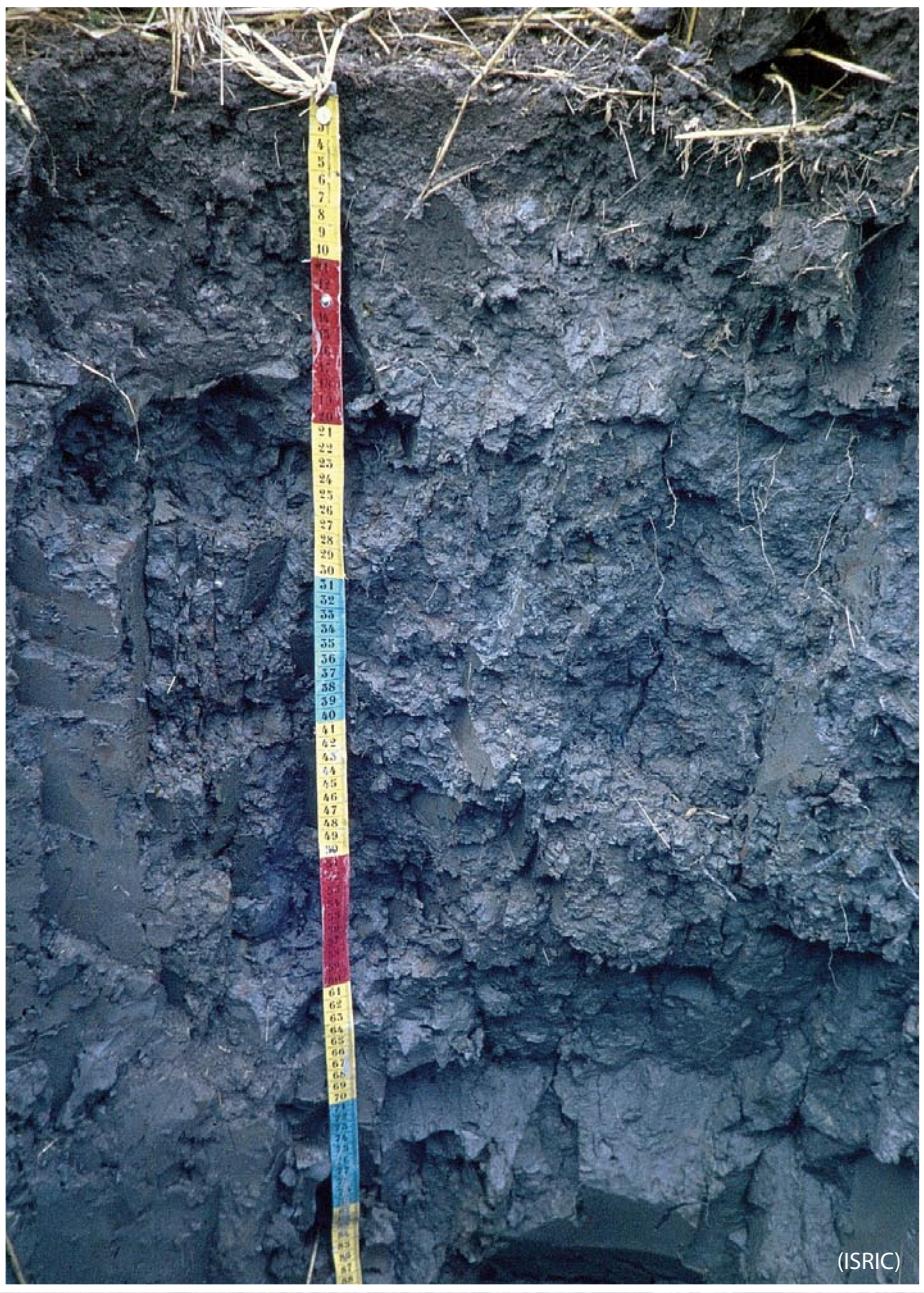
Gleysols

(from the Russian, *gley*, meaning mucky mass)

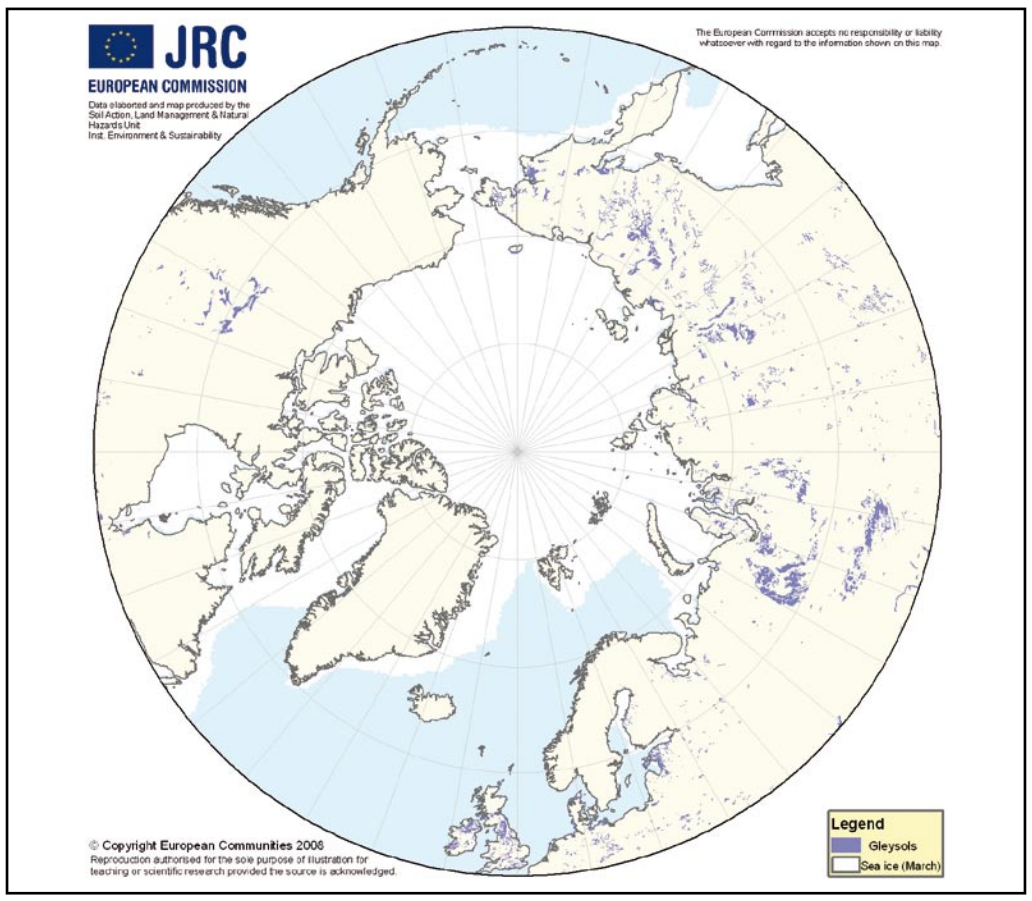

(ISRIC)

Gleysols occur mainly in lowland areas where the groundwater comes close to the surface and the soil is saturated with water for long periods of time. Conditioned by excessive wetness at shallow depth, this type of soil has oxygen deficit for considerable periods (known as a reduced state) which gives a typical bluish /greenish/ grayish colour to the soil. Gleysols correlate with Inceptisols (Soil Taxonomy), Gleysols (Canada) and Gleyzems (Russia). Gleysols tend to show undecomposed plant remains on the surface in cold climates. This example comes from Finland.

July 2008


(VD)

Gleysols are poorly drained and need intensive drainage before they can be used. The above landscape shows Gleysols under meadows and ephemeral lakes in the Alas depression of Yakutia (Siberia).



The map shows the location of areas where Gleysols are the dominant soil. Gleysols cover around 3% of the circumpolar region shown on the map, indicating low-lying or poorly draining areas in the landscape.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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Histosols

(from the Greek, *histos*, meaning tissue)

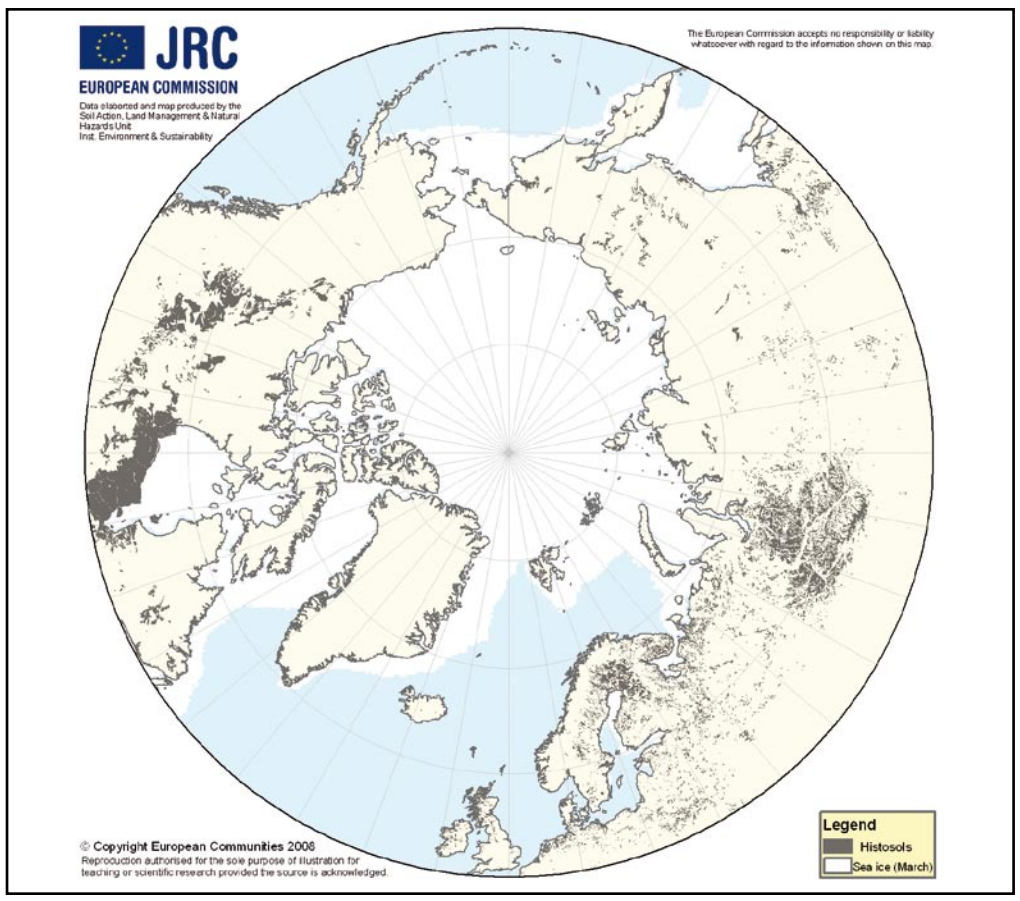
(AL)

Histosols are composed of organic material. During the development of the soil, the organic matter production exceeds the rate of decomposition which is slowed down by low temperatures or anaerobic (low oxygen) conditions. This results in the accumulation of partially decomposed organic matter. Histosols occur throughout the boreal and sub-arctic regions. They correlate with Histosols (Soil Taxonomy), Organic soils (Canada) and Peat (Russia). Histosols are usually black or very dark brown and as seen in the above example from Russia, contain the recognizable remains of plants. The sharp divide in the profile at 80 cm depth is the boundary of the permafrost.

August 2008


(AL)

Histosols are common in the boreal and sub-arctic regions. The photograph shows a raised peat bog on the tundra of northern Russia.



The map shows the location of areas where Histosols are the dominant soil. Histosols cover around 7% of the circumpolar region shown on the map.

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Leptosols

(from the Greek, *leptos*, meaning thin)

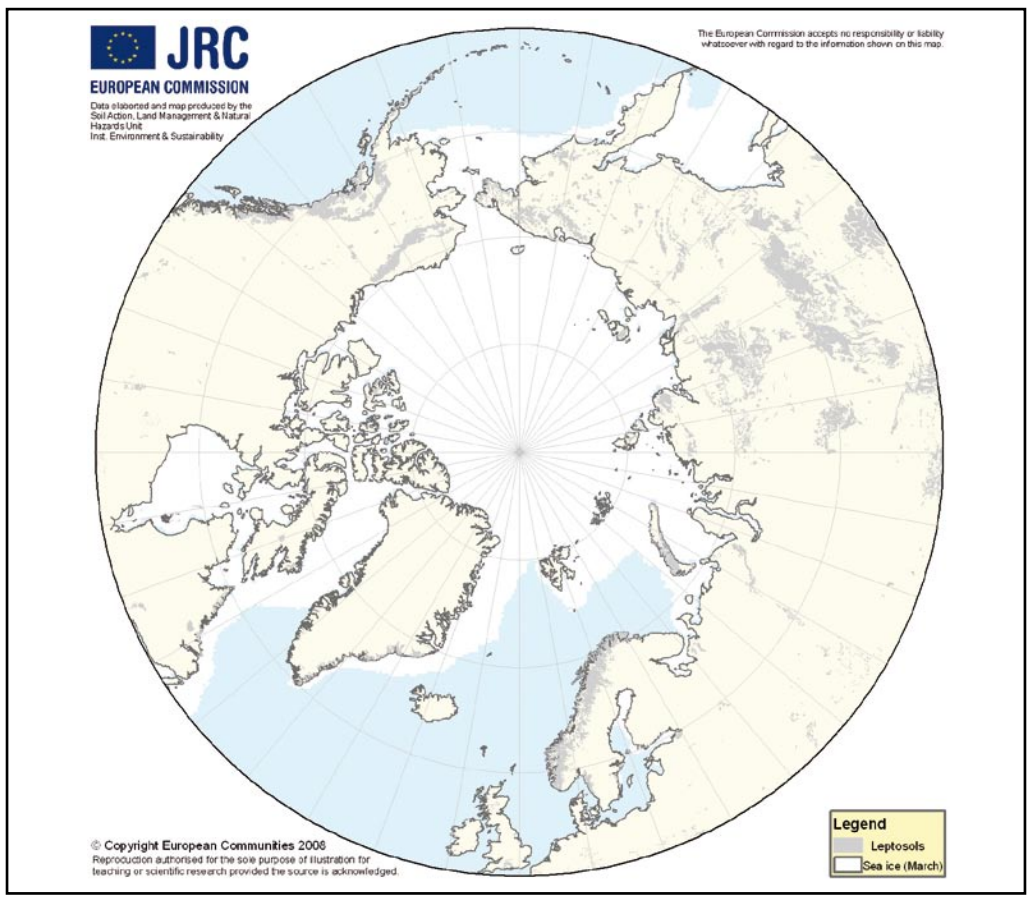

(OS)

A Leptosol is a shallow soil over hard rock, very gravelly material or highly calcareous material. They are found mainly in mountainous regions or in areas where hard rock comes close to the surface. Because of a limited pedogenic development, Leptosols have a weak soil structure. On a global scale, Leptosols are very extensive. Leptosols correlate with Entisol (Soil Taxonomy), Regosols (Canada) and Shallow weakly-developed soil (Russia). The above photograph shows how rock debris forms a foothold for vegetation. Through chemical, physical and biological processes, the soil slowly develops.

September 2008


(OS)

In Leptsols, rocks are often close to the surface and many outcrops are visible. Leptosols are typically found in mountains where physical disintegration of rocks due to frost and heating are the main soil forming processes.



The map shows the location of areas where Leptosols are the dominant soil. Leptosols cover around 8% of the circumpolar region shown on the map.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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Luvisols

(from the Latin, *luere*, meaning to wash)

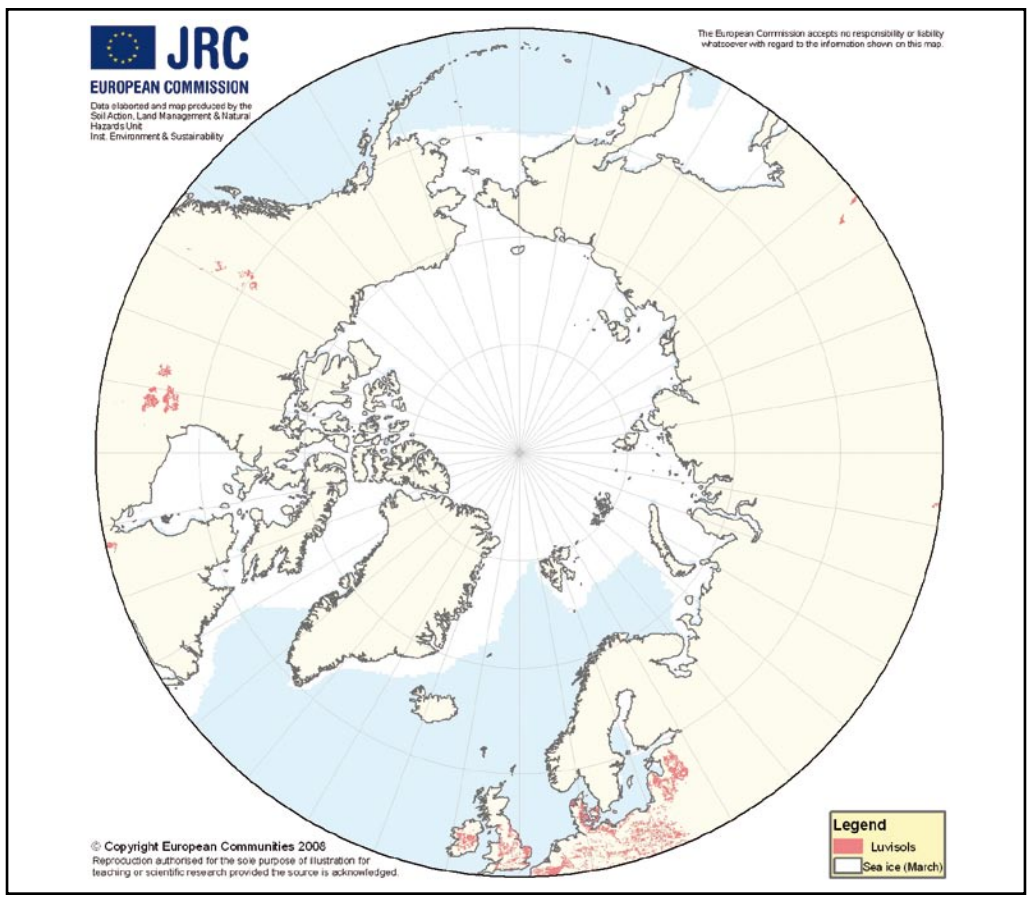
(OS)

Luvisols posses a clay-enriched horizon (argic) in the middle part of the soil profile as a result of the removal of clay from the topsoil. A wide range of parent materials and environmental conditions lead to a great diversity in this Reference Soil Group. They correlate with Alfisols (Soil Taxonomy), Luvisols (Canada) and Texture-differentiated soil (Russia). In the above profile the marked textural differentiation between the surface and subsurface horizons is clearly visible.

October 2008


(OS)

Luvisols generally develop under forest vegetation on well drained landscapes. This picture comes from Norway and shows the conversion of forestry to agricultural land.



The map shows the location of areas where Luvisols are the dominant soil. Luvisols cover around 1% of the circumpolar region shown on the map.

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Podzols

(from the Russian, *pod*, for under, *zola*, meaning ash)

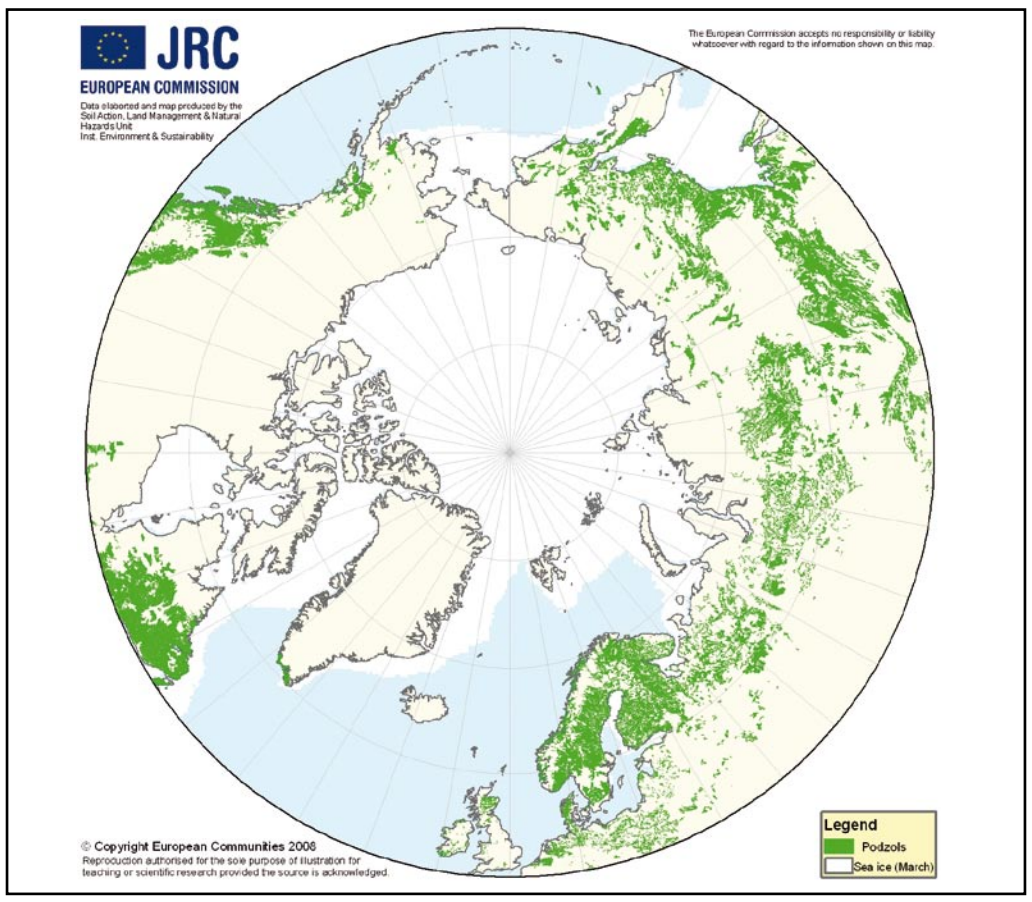
(OS)

Under coniferous forests, aggressive organic acids react with minerals in the soil to produce compounds of aluminium and iron. As a result of percolating rainwater, these organic-mineral products are leached from the topsoil, leaving it bleached, and are then accumulated in a lower, reddish-coloured layer (known as a B-horizon). Most Podzols develop on quartz-rich, coarse-textured deposits in humid, well drained areas, particularly, in the Boreal and Temperate Zones. They correlate with Spodosols (Soil Taxonomy), Podzols (Canada) and Al-Fe-Humic soil (Russia). This striking example shows the typical contrasting leached and accumulation horizons of a Podzol – note the presence of a reddish 'iron-organic pan' at the base of the bleached horizon.

November 2008

(OS)

The vegetation associated with Podzols often provides important habitats for wild animals. This reindeer is from Canada.



The map shows the location of areas where Podzols are the dominant soil. Podzols cover around 15% of the circumpolar region shown on the map.

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Palaeosols

(from the Greek, *paleo*, meaning ancient soil)

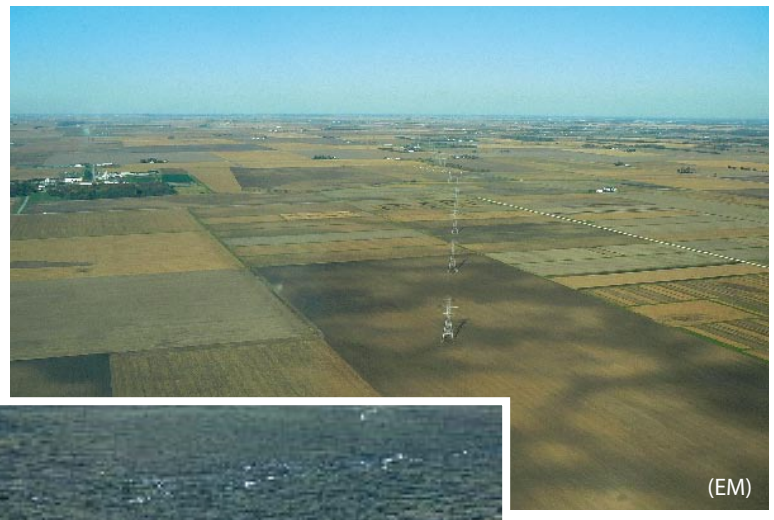
December 2008

(EM)

Palaeosol is a soil that was formed a long time in the past and has no relationship to the present-day soil forming processes. Palaeosols generally preserve changes in the Earth's climate and are usually conserved by being buried by wind-borne, sedimentary (water-borne) or volcanic deposits.

The above picture taken in Latvia, shows a well preserved cryoturbated soil that has been overlain by loess, a fine wind-blown deposit. The distorted and cracked reddish horizons indicate that at one time, the soil had been subjected to freeze-thaw cycles that are typically associated with permafrost or periglacial conditions. Today, the location has a much milder climate!

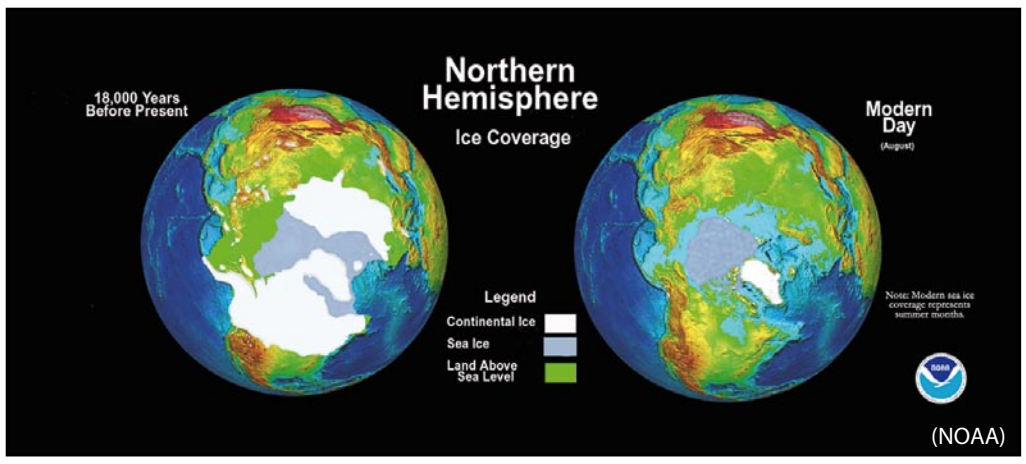
Relict polygonal features in the North American prairies are a sign of colder climates in the past.


(EM)


(CT)

Patterned ground from the present day tundra of Canada.

There are many examples in northern areas of landscapes that have been created during cold or glacial periods in the past. Comparison of these relict landforms with equivalent features in the present day cold regions allows scientists to understand past environments and possibly explain the processes behind climate change.



(NOAA)

A reconstruction of the maximum extent of the last ice age. Much of North America and northern Eurasia were covered by thick ice with permafrost extending considerably further south than today.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	2	3	4	5 World Soil Day	6	7
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The Atlas of Northern Circumpolar Soil

To raise awareness of the general public, policy makers and other scientists of the global perspective and importance of soil in northern latitudes, particularly, for global climate change and the carbon cycle, the European Commission's Joint Research Centre (located in Ispra, Italy) has collaborated with soil scientists from all northern latitude countries (see back page) to produce the first ever ATLAS OF NORTHERN CIRCUMPOLAR SOIL. The atlas links the theme of soil with other relevant IPY activities and at the same time support the goals of the EU Thematic Strategy for Soil Protection in conserving a threatened natural resource that is vital to human existence.

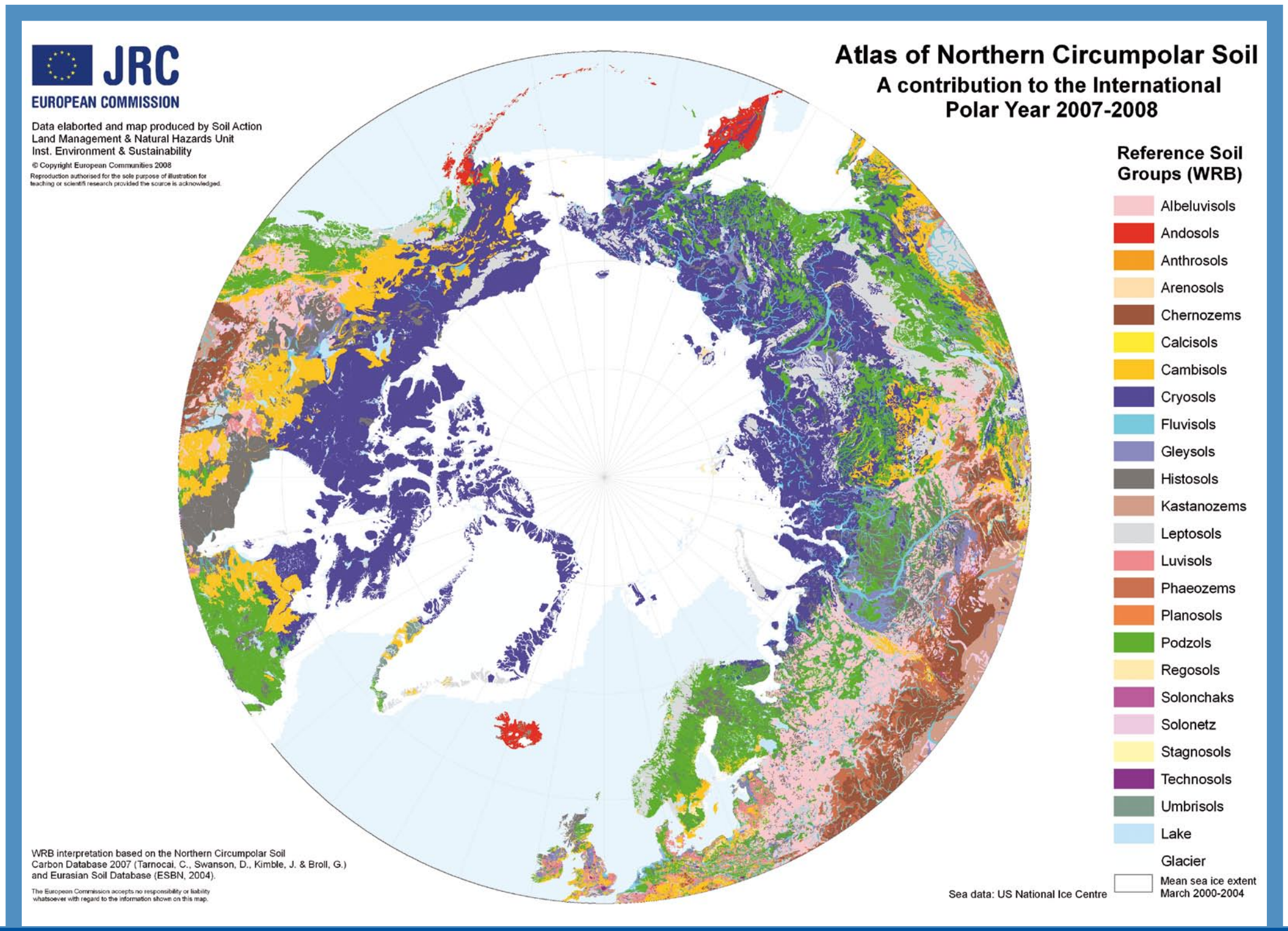
The atlas illustrates the diversity of soil in the permafrost and seasonally frozen environments through a series of maps supported by explanatory texts, high quality photographs and descriptive graphics. The atlas presents the reader with a series of maps that show the variation of soil in a circumpolar context and from a polar perspective, allowing comparisons to be made across international boundaries. Through supporting texts, the atlas describes the major soil types found in northern latitudes, together with their principal characteristics and the main soil forming processes. Special attention is given to the relationship between climate change and soil.

For more details and how to obtain a copy, please see http://eusoils.jrc.ec.europa.eu/library/maps/Circumpolar/index.html

Distribution of major soil types in the northern circumpolar region.

This striking map below shows the dominant Reference Soil Groups according to the international WRB correlation/classification for the northern circumpolar region. The map is the updated output of a project to compile a soil database covering the United States, Canada and the European Soil Geographical Database on Greenland, Iceland, European Union, Russia, Mongolia, and Kazakhstan. The overall idea of the WRB application is an integration of national soil classifications (e.g., US Soil Taxonomy, Canadian, Russian) based on common soil characteristics. This map below illustrates a conversion of the database into the WRB system.

The map clearly shows the zonal arrangement of soils around the North Pole. The blue indicates the Cryosols, covering the arctic deserts, tundra and the forest-tundra zones. The green mosaic of the Podzols developed from course-textured rich in quartz deposits under coniferous boreal forests. The pink fragments of the Albeluvisols originated from fine-textured loose deposits under boreal coniferous and mixed forests zones. The dark brown Chernozems and Phaeozems formed from fine-textures loams under temperate forests and the prairie vegetation zones. The gray-blue spots of the Histosols and blue tones of the Gleysols are widely spread through all soil zones indicating a wide distribution of the wetlands in the northern circumpolar region with accumulations of peat. The red colour on the map shows the Andosols of Iceland, the Kamtchatka Peninsula and the Aleutian Islands, clearly indicating the main areas of volcanic activity in the region.



JRC
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As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

Europe faces public concern about complex issues such as food contamination, genetic modification, chemical hazards, global change, environment and health and nuclear safety. The Joint Research Centre (JRC) supports EU policy makers in the conception, development, implementation and monitoring of policies to tackle such trans-national and global problems.

More than 25% of EU legislation has a technical or scientific basis and this trend is likely to grow as increasingly policies cut across several disciplines. The JRC, as the Commission's in-house research based policy support centre, works to provide such support throughout the policy process, while maintaining a strong science base.

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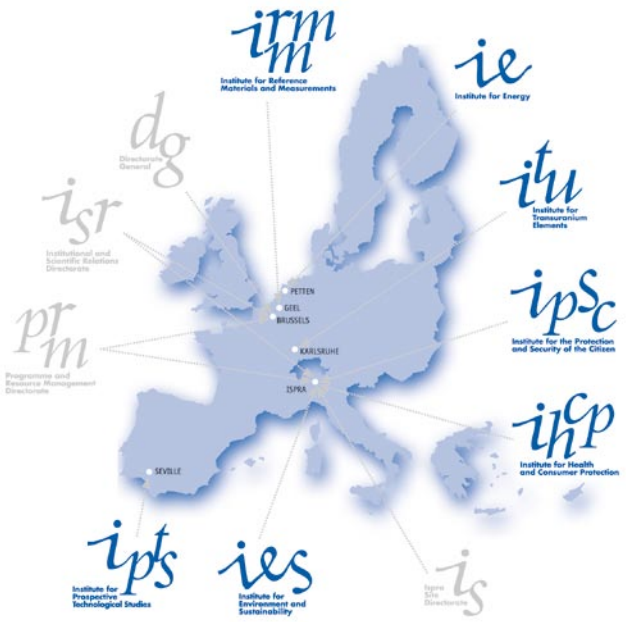

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In line with the JRC mission, the aim of IES is to provide scientific and technical support to European Union strategies for the protection of the environment contributing to a sustainable development. IES works in close collaboration with official laboratories, research centres and industries of the EU's Member States, creating a bridge between the EU's policies and the European citizen.

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Institute for Environment and Sustainability
Joint Research Centre of the European Commission
Via Fermi I-21027 Ispra (VA), Italy
http://ies.jrc.ec.europa.eu

The authors of this calendar, Arwyn Jones[1], Vladimir Stolbovoy[1] , Otto Spaargaren[2], Gabriele Broll[4], Erika Micheli[3] and Luca Montanarella[1] gratefully acknowledge all contributions, in particular:

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1: European Commission Joint Research Centre, IES, Land Management & Natural Hazards Unit, SOIL Action

2. International Soil Reference and Information Centre (ISRIC) - World Soil Information, Duivendaal 9, 6701 AR Wageningen, The Netherlands

3. Szent Istvan University, Department of Soil Science and Agricultural Chemistry, Godollo. HUNGARY

4. University of Vechta, D-49364 Vechta, Germany

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Construction on Cryosols is difficult and costly. Movements in the soil caused by repeated freezing and thawing cycles cause the ground to become distorted. Such movements have resulted in the warped railway tracks that are visible in this picture from Northern Russia where trains must travel very slowly. The same processes can cause buildings to collapse and pipes buried in the ground to break.