HIGH-LATITUDE CLIMATE ZONES AND CLIMATE TYPES

E.I. Khlebnikova
Main Geophysical Observatory, St.Petersburg, Russia

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Summary

The description of the high-latitude climate zone and types is given according to the genetic classification of B.P. Alisov (see Genetic Classifications of Earth's Climate). In dependence on air mass, which is in prevalence in different seasons, Arctic (Antarctic) and subarctic (subantarctic) belts are distinguished in these latitudes. Two kinds of climates are considered: continental and oceanic. Examples of typical temperature and precipitation regime and other meteorological elements are presented.

1. Introduction

In the high latitudes of each hemisphere two climatic belts are distinguished: subarctic (subantarctic) and arctic (antarctic).

The regions with the prevalence of arctic (antarctic) air mass in winter, and polar air mass in summer, belong to the subarctic (subantarctic) belt.

As a result of the peculiarities in distribution of continents and oceans in the northern hemisphere, two types of climate are distinguished in this belt: continental and oceanic. In the southern hemisphere there is only one type - oceanic.

The northern boundary of the subarctic belt over the continents is usually superposed with the July isotherm +10 °C. This isotherm is the southern boundary of tundra, which displays prevalence of arctic air even in summer.

The winter location of the arctic front is the southern boundary of the belt. Arctic air is formed in the subarctic belt in winter. Being transformed in summer in these regions, Arctic air assumes features of mid-latitude air.

It’s difficult to determine the boundaries of the subantarctic belt, because of the lack of systematic observations in the southern hemisphere. It may be indicated approximately that the northern boundary lies at about 60 °C, and the southern boundary is situated on the coast of the Antarctic continent.

The main features of the subarctic climate are determined by specific distinction of radiation processes. Radiation balance is negative in winter and does not differ much from the radiation balance of the Arctic Region. The underlying surface is deeply frozen and loses a great amount of heat by radiation. Due to the prevalence of an anticyclone weather regime, snow cover is thin, promoting deep freezing of the soil. In summer, radiation balance sharply increases, due to long duration of daylight and increasing height of the Sun. On warming up, the upper layers of the soil thaw and become a source for air warming.

2. Climate types of subarctic and subantarctic belts

2.1. Continental climate

Continental climate is observed in the northern part of Asia and in North America. A notable feature of the continental climate is the greatest annual temperature range in the world. This peculiarity is especially distinct in Asia, where average annual range reaches 60 to 65 °C (see Figure 1, top left).

Subarctic continental winter is very severe. In Oimyakon, Yakutia (Russia) the record temperature for the northern hemisphere was fixed (about –70 °C).

Mean temperatures of the coldest month range from –28 °C to –50 °C in this belt. Inversions of temperature often occur in surface boundary air layers in winter. Summer is short, but rather warm. In summer in Asia monthly mean temperatures are 12 to 18°C with 8 to 10 °C night minima. At locations with low relief frosts are likely, but due to the short nights they are not prolonged.

On the American continent the climate of the subarctic belt is less continental than the similar climate of Asia, and not only on account of the warmer winter, but also the cooler summer.

The wind regime of continental regions with a subarctic climate is characterized by the prevalence of weak wind in winter and high frequency of calm weather (from 30 to 40% of all observations are with calm weather). A marked anticyclone weather regime is expressed in winter not only in the extremely low temperatures and weak winds, but also in the dryness of the winter months.

.Water vapor pressure in the air does not exceed a few tenths of a millibar. Annual precipitation total is rather low, 200-300 mm, and at the cold part of the year less than half of this amount is received (see Figure 1, top left). Clouds are mostly formed at high altitudes and do not have high density. Low cloudiness is infrequent.

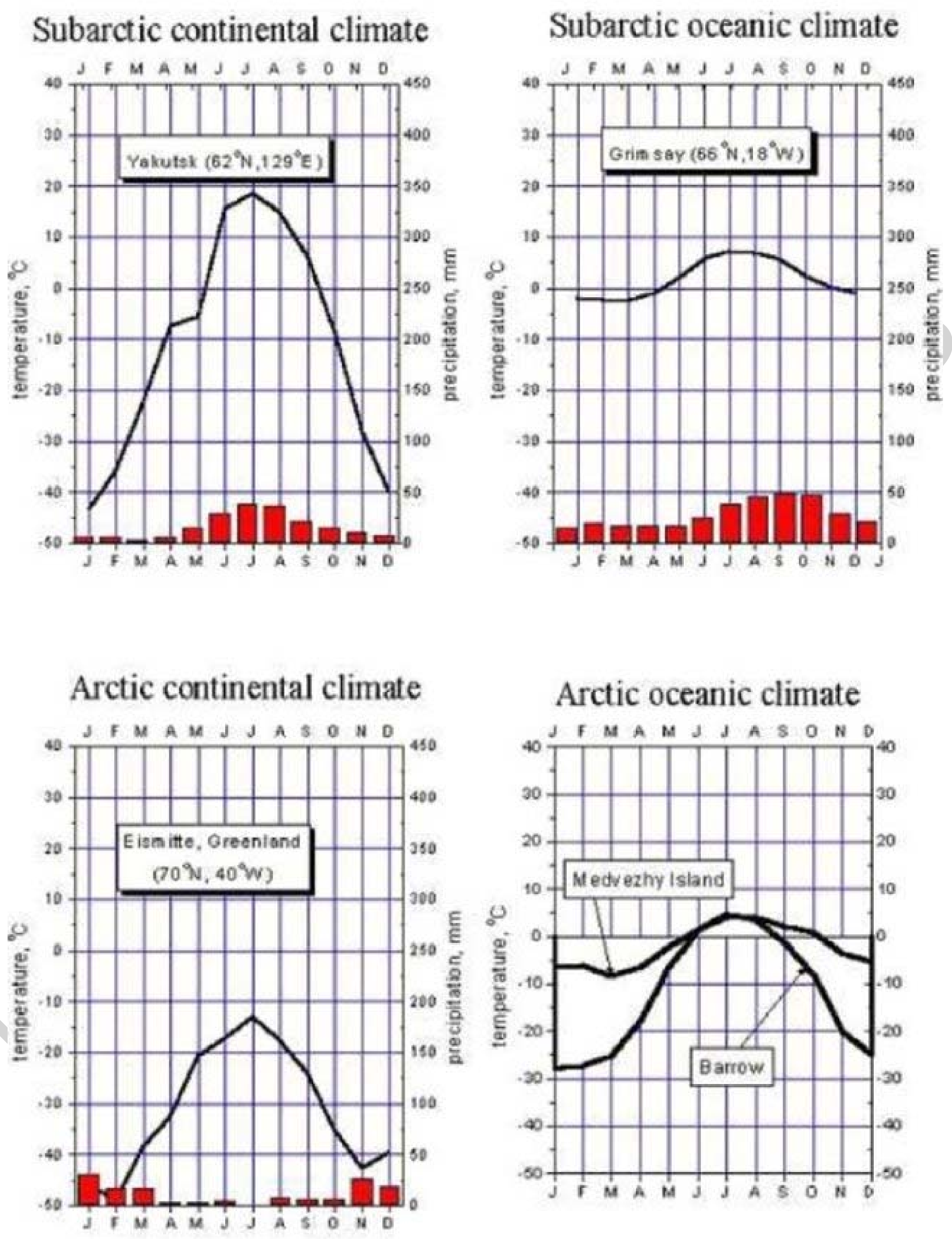

Figure 1. Monthly mean temperature and precipitation in the Arctic and subarctic zones**.**

In summer, cloudiness increases and reaches its maximum in July. Summer precipitation falls mostly as weak daily showers of short duration.

A distinguishing feature of continental climate in the subarctic zone is the combination of low absolute humidity with high frequency of winter fogs and haze under inversion.

Thus, in Yakutia on average there are 15 days with fog in January. Fogs are caused by strong radiation cooling in conditions of windless and clear weather and powerful temperature inversion in winter. Usually fogs occur near heavily populated areas, over which the air contains a high of condensation nuclei. Haze and fogs over the cities are so dense that the earth's surface can often not be seen from above. It can be an obstacle for flights.

Such atmospheric phenomena as snowstorms and thunderstorms are extremely rare for the subarctic belt. Snowstorms occur mainly at the edges of continental area of the subarctic belt (the Far East, the coast of the Hudson Bay).

2.2. Oceanic climate

Oceanic subarctic (subantarctic) climate is observed over the oceans along the north and south polar circles, and also on islands and continental coasts in latitudes 60 to 70°.

The climate of these regions is considerably influenced by cyclonic activity, which is very intensive during the year here.

The oceanic climate type differs from the continental type in the lower annual temperature ranges. Over the oceans temperature ranges do not exceed 15 to 16 °C. Near the coasts they may reach 20 to 35 °C.

Winter temperatures are higher than on the continent, but at the same time higher air humidity and great wind speeds are observed here. In January, mean temperatures over the oceans are usually not less than -10 °C, but in summer they are noticeably lower than over the continent. An example of the progression of average annual temperature is given in Figure 1 (top right).

Intensive cyclonic activity results in great variability of wind direction, frequent storms, considerable cloudiness and increased precipitation amount. One of the cloudiest regions of this belt is situated over the sea near Greenland. Annual precipitation volume reaches 500 mm, and at some locations even higher. The precipitation maximum usually occurs at the end of summer and at the beginning of autumn.On turning to summer processes, cyclonic activity gradually weakens. Summer temperatures grow slowly, because of cloudiness and loss of heat by melting of the ice. In the Bering Sea and in the cold water of the Labrador Current there are ice floes even in summer. Usually monthly mean temperatures do not exceed 10 °C. Frequent fogs and high relative humidity (more than 70%) are typical for summer.

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Biographical Sketch

E.I. Khlebnikova was born in 1945 in Leningrad, USSR. In 1963 she entered Leningrad State University, Mathematics and Mechanics Faculty, and in 1968 graduated from the Dept. of Theory of Probabilities and Mathematical Statistics of this University. In 1968 she began to work at the Main Geophysical Observatory in the Dept. of Climatology and in 1975, after postgraduate studyies in meteorology and climatology, received a scientific degree of Candidate in Math & Physics. Since 1998 she has been a leading scientist in the Dept. of Applied Climatology. Dr. Khlebnikova has thirty years of experience in climatology including research on statistical modeling of meteorological processes, methodology of climate monitoring and different aspects of statistical interpretation of meteorological and other observations. She has more than 50 publications in these fields.