

ISLAND CLIMATES

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Summary

The features of the island local climates depend on the significant differences between the heat balance structures of land and sea. Consequently, about 90% of oceans' radiation balance is spent for water mass heating and evaporation, and only 10% - for turbulent heat flow into the atmosphere. Therefore the air heating over oceans is insignificant and almost identical in the daytime and at night, while it noticeably varies over the land during a day.

There is a local circulation (breezes) in littoral region because of the temperatures difference between land and sea. It refers first of all to the tropical latitudes, where breezes are observed the whole of the year and distinct daily course of wind speed and direction takes place. The relief features of the concrete islands have an influence on the breeze penetration inland. The differences between land and sea heat properties determine also the temperature and humidity regimes.

The annual and daily air temperature amplitudes decrease and the humidity increases in comparison with continents. The precipitation distribution is determined by the island relief. The precipitation annual sums on the low flat islands decrease because of a small island surface roughness. The greatest precipitation sums fall out on the windward slopes of mountainous islands. On these slopes the factor of roughness increase acts in parallel with the factor of great water content in the air mass coming from ocean. The precipitations on islands are influenced considerably by the presence of cold or warm currents washing an island. The cold currents promote the stable air stratification formation and make for precipitation decrease. The warm currents, on the contrary, intensify air convection and increase precipitation sums.

1. Introduction

Islands occupy about 9.9 millions km². Along with very large islands with the area of several hundred thousands kilometers (Greenland, New Guinea, Kalimantan, Madagascar) there are many small islands with the area less than 1 km². According to the location, islands are divided into oceanic, sea, river ones. As to the origin, there are two large islands groups: continental (coastal, shelf and islands of a continental slope) and independent (volcanic and coral) ones. Islands size, location, origin and relief significantly influence on their local climate and determine a degree of ocean and land impact in the formation of island climate in the given area. We will consider climatic features of islands according to their belonging to certain climatic zones on climates classification by B. P. Alisov. First of all let us consider local climate of ocean and sea islands, and after that - the local climates of lake and river islands.

2. Ocean and Sea Islands

For the analysis of ocean island climates we can choose the local climate of island groups located in the Pacific and the Arctic Oceans. So we have an opportunity to consider most completely the island climates in all climatic zones.

2.1. Surface Air Temperature

In equatorial and subequatorial zones the ocean influence has insignificant effect on the monthly mean air temperature. Annual temperature amplitude both on continents and on islands does not exceed 3°C. However the daily temperature amplitudes on small islands and in coastal areas of larger islands are about 2°C lower, than in continental areas. This difference can be caused by higher absolute air humidity over the ocean. Thus the counter radiation of the atmosphere increases and air temperature doesn't fall even at clear nights.

Though the heat regime on equatorial islands is almost identical, and there is minimal orography influence, nevertheless mountain relief can form local features of the air temperature distribution. As an example we can consider meteostation Dili environs which is situated on Timor Island. This station is surrounded by the mountains on the side of southeast tradewind which carries wet tropical air masses. The "shadow" location of Dili is characterized by the increase of daily air temperature amplitudes about 2°C. At the same time maximal air temperature increases and minimal air temperature decreases approximately by 1°C as compared to the neighbor islands.

On the islands of tropical and subtropical zones the differences between summer and winter air temperatures are already quite great. The ocean influence of temperature regime becomes more appreciable. The annual air temperature amplitudes on islands in these latitudes rise when moving off the equators, and also when approaching the continent coast. For example, the annual temperature amplitudes increase from 6 to 10°C in the tropics and up to 20°C in subtropics, when moving along the Japan-Philippine island chain from south to north.

On the Hawaiian islands located in the central part of the ocean, the annual amplitude

does not exceed 4°C. The daily temperature amplitude on islands in these latitudes is most greatly affected by the distance from coast, height of the place above sea level and the size of the island.

The less the island area, the less is the ground temperature fluctuation influence air temperature regime. For example, in Manila, located on ocean coast of the large Luzon Island (Philippines), the daily air temperature amplitudes are about 3°C larger, than in Honolulu, which is situated on the small island Oahu (Hawaiian Islands). The air temperature daily course on islands in tropical latitudes is appreciably influenced by breeze circulation. It can be appreciable on the distance of 10 up to 100 km from the coast. Usually breeze circulation reduces the daily maximal air temperature from 3 to 6°C (depending on the distance). Often after the morning temperature reduction caused by the sea breeze beginning, air is heated up again due to the daytime heating. In the evening the temperature begins to fall, but after the see breeze slowdown some increase of air temperature can be observed.

In the middle latitudes the seasonal air temperature fluctuations become great. So the heat regime on the concrete islands is most various. It depends in the greater degree, than in tropics, on the closeness of continent, the character of atmospheric circulation, orography, warm or cold currents washing the island. Geographical latitude plays the subordinate role particularly in the cold period. Table 1 presents the monthly mean air temperatures on islands located in the middle latitudes of the Pacific Ocean. These data were calculated for the period from 1948 to 1980.

Area	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Inland areas of Sakhalin	-	-	-	-2.1	5.0	11.3	15.4	15.6	10.3	1.7	-9.1	-
	24.2	19.8	12.3									19.1
The east coast of Sakhalin	-	-	-	-2.4	1.7	5.9	10.2	12.4	9.8	3.2	-6.0	-
	18.3	16.5	10.7									13.6
The west coast of Sakhalin	-	-	-7.1	-0.3	4.7	10.0	14.4	16.3	12.6	5.1	-4.1	-
	15.8	13.1										11.2
Kuril Islands (the central part)	-6.3	-6.2	-4.5	-0.9	1.5	4.9	8.2	10.9	9.1	5.6	0.9	-3.6
Komandorskie Islands	-2.3	-2.4	-2.0	-0.2	2.2	5.1	8.7	10.6	8.9	5.0	0.9	-1.3

Table 1: The monthly mean air temperatures on islands in the middle latitudes of the Pacific Ocean (°C)

For example, the Island of Sakhalin is located near the continent and consequently is under its strongest influence. It is especially appreciable in winter, when monsoon brings very cold air from continent. Nevertheless the western, i.e. nearest to the continent, coast is warmer, than the east one. It is explained by the fact that there is warm Tsushima Current in the Tatar Strait. Along the east coast the cold waters of Sea of Okhotsk move to the south (Okhotsk current). The currents influence on the air temperature is felt both summer, and winter. Sakhalin is rather great (78 000 km²) and has mountain systems extended along meridian, i.e. almost perpendicularly to prevailing

winds. Therefore there is an appreciable difference between the local climates of its coasts and internal area. In winter in the central part of Sakhalin the air temperature is approximately 6°C lower, than on the coasts. In summer, because of cloudy weather, the temperature differences are less: the internal area is about 3°C warmer than the coasts.

The Kuril Islands are located much further from the coast of Asia. So cold winter monsoon hasn't almost the influence on their local climate. Besides, Aleutian Low promotes the permanent clouds formation. So winter air temperature on Kuril Islands is much higher, and in summer it is lower, than on Sakhalin. The transition of minimal monthly air temperature from January to February, and maximal one - from July to August indicates the prevailing ocean influence on the Kuril Islands heat regime. Despite of the small islands sizes the difference between the temperature regimes of north-west and south-east coasts is great. The different vegetation species prove this fact. It is so because of neighborhood of very cold Sea of Okhotsk and the rather warm Pacific Ocean. The local climate of Komandorskie Islands which are in Bering Sea, has most distinct oceanic character. Despite its more northern location the winter air temperature is about 5°C higher, than on Kuril Islands and about 20°C higher, than on Sakhalin. In summer the influence of geographical latitude has a stronger effect. Therefore summer temperatures are from 4 to 6°C less, than on Kuril Islands and Sakhalin. Besides, the cool summer is promoted by cold Kamchatka current washing Komandorskie Islands. The daily mean air temperatures on islands, in middle latitudes shown in Table 2, increase with the increase of climate continentality. These data were calculated for the period from 1948 to 1980.

Area	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Inland areas of Sakhalin	14.3	15	15.2	11.2	11.7	12.9	12.2	10.6	10.5	10.4	11	12.9
The east coast of Sakhalin	8.6	9.3	9.4	7.7	8.3	8.7	8.1	7.7	7.9	7.4	6.5	7.4
Kuril Islands (the central part)	4.7	5.1	4.6	4	5.4	6.1	6.6	6.6	5.6	5.1	4.2	4.5
Komandorskie Islands	4.4	4.4	4.5	3.6	3.9	4	4.1	3.8	4.3	4.7	4.5	4.6

Table 2: The daily mean amplitudes of air temperature on islands in the middle latitudes of the Pacific Ocean ($^{\circ}\text{C}$)

The heat regime of islands in the middle latitudes near western coasts of the ocean differs considerably from one in their east parts.

Queen Charlotte Islands are located on the latitude of Komandorskie Islands and have the same size and relief. However near the coast of Northern America the air temperature of the coldest month is 2°C , and of the warmest month - 14°C . Higher temperature sums during the vegetation period promote here pine wood growing, while on Komandorskie Islands only bushes can grow. The warm Alaska current is the factor raising the air temperature.

The island climates in the high latitudes are determined first of all by the annual radiation balance, the atmosphere circulation and sea currents, as well as by the island

sizes, the distance from the continent and the presence of glaciers.

The annual radiation balance of the Arctic seas and the seas surrounding the Antarctic Continent is on the whole positive. It is negative only on islands covered with glaciers, for example, in Greenland. On these islands, despite of very large radiation income in summer the surface and air temperature are about 0°C . It is so because of large albedo of snow and ice and great heat losses for thawing. On islands, where the in summer snow thaws completely, the summer air temperatures increase up to 5°C .

The highest air temperatures in polar areas are observed on islands in the Atlantic-European Sector of Arctic Region. Here the influence of warm Gulf Stream is the strongest. So, in the north of Spitsbergen (Green Harbor) the mean air temperature in January is -16°C , and in July is 5°C .

On islands located near the continents of Asia and Northern America winter is much colder, and summer almost the same as on Spitsbergen. For example, on Novosibirsk Islands the mean air temperature of the coldest month (February) -30°C , and one of the warmest (July) is 3°C .

However, not only the island location is important for the heat regime formation, but also its size and height. The larger the island, the stronger it is cooled in winter. The ocean is a source of heat in these latitudes. Therefore most severe conditions are created in Greenland, the largest island of the world. Greenland occupies the area of 2176 000 km^2 80% and is covered with glacier. The ice thickness in its central part exceeds 3000 m. Large height above sea level promotes the decrease of air temperature and formation of continental local climate. In the internal area (meteostation Aismitte) the mean air temperature in January is -49°C , in July is -14°C . In the coastal areas in the south of island where there are no glaciers and warm currents pass, the mean air temperature of the coldest month (February) is -15°C , and warmest (July) is 10°C .

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Biographical Sketch

Kobysheva Nina Vladimirovna, Dr. of geogr. Sci., Professor, Honored Scientist, Head of the technical climatology laboratory of MGO, Professor of St-Petersburg University. Fields of scientific interests are statistical methods in climatology, applied climatology. Author of 7 monographs, 3 text-books, Building Standards and Rules "Building Climatology", more than 200 papers. Supervisor and editor of Scientific-Applied reference book. About 25 Candidate's dissertation were defended under her guidance. A member of working group of WMO, working group № 13 CIB, working group № 75 of International Electrotechnical Commiaion. Was conferred a medal of National Exhibition of economy achievements, medal "Honored expert of hidro-meteo service", Voeikov's prize, International WMO and CCL certificate.

Was born in 1925 in Omsk city. Was graduated from the Odessa Hydrometeorological Institute in 1948. In 1955 has defended the candidate dissertation after finishing the post-graduate course of Main Geophysical Observatory.