METHODS OF CLIMATE CLASSIFICATION

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

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Summary

The problem of climatic classification and its history is briefly described, and the structure of basic methods of climate classification is discussed. Special attention is paid to the group of methods that considers climate as an element of geographical environment. Some little-known classifications are examined in detail.

1. Introduction

Climate is a complex abstract concept, and, since the appearance of climatology as a science, many definitions of the concept have been given. In this chapter, when speaking about the climate of an area, we shall mean the naturally determined regime that creates the weather sequence in the area, conditioned by solar radiation, underlying surface, atmospheric circulation and other controlling factors. To characterize climate quantitatively, it is necessary to use data on different meteorological elements, such as air temperature, precipitation, humidity, atmospheric pressure, cloudiness, wind, and various atmospheric phenomena. As a result of the large number of factors that have an influence on climatic patterns, there are no two parts of the earth with absolutely identical climates. Nevertheless, it is evident that many well separated regions of the world have quite similar climatic conditions.

Classification of the climate of the Earth is an attempt to systematize enormous volumes of meteorological data on weather phenomena in different parts of the Earth. Climate classification is aimed at defining climatic types and to find similarity and distinctions in climatic patterns as observed in different regions of the world. The scientific and practical significance of climate classification is in both comprehension of physical

mechanisms affecting climate and evaluation of climatic potentialities and aspects of their utilization in the various regions of the Earth.

Most classification schemes are concerned with macroclimates, i.e. with typification of climates of the world as a whole, or typification of climates of continents, conditioned by interaction of large-scale processes. Using results of such classification, it is necessary to take into account that there are processes of other scales—from tens to hundreds of kilometers—having essential influence on the values of individual meteorological elements and creating the mesoclimate of the area. In turn mesoclimate is apparent in the variety of microclimates, caused by physical processes at scale of tens of meters. Meso- and microclimates depend on local height, kind of slopes, type of vegetation, presence of water bodies, urbanization, etc. These questions are considered in detail in *Local Climate.*

Climate classification assumes, on one hand, the identification of areas with distinctive climatic patterns. On the other hand, it provides the possibility of finding climatic similarities in different parts of the world.

At the end of the nineteenth century and in the early twentieth century, when climatology was in its first stage of its development, the most popular approach was one which stressed the question of discriminating areas (climatic provinces) with differing climatic conditions, i.e. one that concentrated on the first side of the problem of classification.

The earliest attempts at scientific climate classification were made in the 1870s. In particular, the work of the French scientist de Candolle appeared to realize the idea of classification of climates through their effect on vegetation. In accordance with this system, the terrestrial surface of the world was divided into vegetation zones that were dependent on the type of climate conditions. De Candolle identified five zones, and to a large extent these were related to subsequent climatic classifications: (1) a zone with vegetation needing high air temperatures, (2) a zone with vegetation experiencing systematic moisture deficit, (3) a zone with vegetation needed moderate air temperature, (4) a zone with vegetation requiring little heat, and (5) a zone with vegetation experiencing negative temperatures throughout most of the year. This classification recognized the basic features of natural geographical zonality.

The next advance was when Wladimir Koeppen developed his vegetation-based classification. In 1900 he proposed a system of climatic classification founded on the principle of similarity, and he gradually improved it until 1940. According to this principle, study of the climate of the Earth requires division of the Earth's surface into domains with different climates and recognition of unlike climates in separated areas of the world. This provided a basis for identifying the factors that lead to similar climates. Koeppen was the first to introduce the concept of "climatic type".

2. General structure of methods of climate classification

Modern science divides climatic classifications into two groups. The first group is the so-called *genetic classifications*, which are based on natural laws of climate formation,

and not only covers characteristics of climatic types, but also explain the reasons for the existence of climatic patterns in different regions of the world. Classifications of the second group, which can be named descriptive, distinguish climatic types using criteria which are not connected with genesis of climates. *Descriptive classifications* manipulate by formal criteria and often attribute climates of quite distinctive origins to the same type.

Among climatic classifications we shall pay particular attention to those which have well-expressed applications. There are many classifications developed for use in agriculture, the building industry, public health services and other domains. This aspect of classification is considered in detail in *Applied Classifications of Earth's Climate*.

Genetic classifications have different approaches as the basis.

The most widespread classifications are those which differentiate climate on the basis of fundamental features of atmospheric circulation. Firstly, classifications based on the concept of "air mass" can be attributed to this type. By air mass one usually means a large air body having comparatively homogeneous characteristics of temperature, humidity, etc. in the horizontal. It is believed that regional weather regimes are determined by features of the prevailing air mass at the time. The classification proposed by the Russian scientist B.P. Alisov in 1936, can be regarded as the first of this type. The American climatologist A.N. Strahler, in his 1951 work on grouping climates, and later J. Oliver, used similar principles.

The second significant class of genetic classifications includes those which employ concepts connected with Earth's energy balance. The use of classification principles based on characteristics of the heat balance of the earth surface is associated with the name of the Russian scientist M.I. Budyko. In these systems solar radiation characteristics, which are closely related with temperature of the warm season, are of direct use, and circulation factors are taken into account indirectly through quantitative characteristics of precipitation and moistening regime. The activity of the American geographer W.H. Terjung, who devised a climatic classification (1970) on the basis of a combination of characteristics of incoming radiation, should also be mentioned. Genetic approaches to classifying climate are considered in detail in *Genetic Classifications of Earth's Climate.*

Descriptive climatic classifications were developed in response to the demands of various sciences and spheres of economic activity. Methodologically, they involve several stages: (1) fixing and determining essential differences between regions (with respect to the field in consideration), (2) developing indices to characterize the climate and to explain the observed distinctions, and (3) realizing a classification scheme on the basis of the indices. Success relies to a considerable extent on the choice of basic indices. However, not all classifications are methodologically complete.

Some classifications, which can be assumed as reasonable from the point of view of the chosen indices, failed in reality through lack of observation data or calculation methods to find the needed climatic parameters.

Descriptive classifications can be divided, in turn, into two groups. The first group includes *objective empiric classifications* devised on the basis of definite criteria using data of meteorological observations. Koeppen's classification can be attributed to this type. Although at first Koeppen discriminated botanical zones influenced by climates, he later determined the boundaries of climatic zones and types on the base of meteorological indices, despite certain discrepancies of climate and vegetation zones. The advantage of this approach is in the objectivity of classification, and its shortcoming is its extra-formality. Classification schemes based on objective criteria and using the data of meteorological observations are discussed in *Objective Empiric Classifications of Earth's Climate.*

The second group of descriptive climatic systematizations is based on *geographical* (landscape-botanical, soil, hydrological and other) classifications, which are developed, in essence, on the basis of characteristics derived from climate. In these classifications the question of correspondence between landscapes (types of soils, rivers) and characteristics of thermal and precipitation regime is of prime importance. However, even if a direct connection is established there can still be a lack of strict formalized criteria, and the consequences of climate influence on the environment are used as the basis of classification, rather than data from meteorological observations. As they are descriptive, these classifications are of great value for the development of science by establishing interrelations between climate and the most important macro-scale geographical concepts.

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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 studies in meteorology and climatology, she received the scientific degree of Candidate in Maths & Physics. Since 1998 she has held a position of 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.