CLIMATE THROUGH THE AGES (revised edition). C. E. P. Brooks. London: Ernest Benn Ltd., 1949. Demy 8vo, 395 pages, 36 diagrams. 21*s*.

In this revision of his important and comprehensive study of the earth's climatic history, first published in 1926, Dr. Brooks supplements his original material with an account of the fairly copious additions to knowledge of the subject made since then and also discusses critically many theories and hypotheses, new and old, put forward to explain the glaciations and warm epochs which fell to our planet's lot in remote times. His own creed, which has found wide acceptance during the last 20 years, remains fundamentally unaltered. This is so well summarized in its essentials on pages 377–78 that full citation seems desirable:

> "1. The major climatic oscillations, lasting millions of years, are due to the major cycles of mountain-building and degradation, and their geographical effects in the widest sense, which possibly include variations in the amount of carbon dioxide and volcanic dust in the atmosphere.
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> "2. Climatic oscillations of the second order, lasting thousands or tens of thousands of years, are due to two or possibly three causes:
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> "(*a*) Minor changes in the land and sea distribution, caused partly by the shifting of the load on the earth's crust by erosion and partly by the isostatic effects of the growth and decay of the ice-sheets themselves. These were mainly effective during periods of high orography.
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> "(*b*) Astronomical changes—eccentricity of the earth's orbit, obliquity of the ecliptic, precession of the equinoxes and possibly other causes. These are continuously effective and can be traced in some of the warm periods. They may have caused the succession of glacial and interglacial periods.
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> "(*c*) Possibly long period variations of solar activity. Climatic oscillations of a few hundred years appear to be related to solar changes and it is a reasonable inference that the range of solar activity in the course of tens of thousands of years has been greater than the range during the Christian era. If such changes did occur, they must have caused considerable changes of precipitation.
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> "3. Climatic oscillations lasting a few hundred years. So far as the evidence goes, these seem to be due mainly to variations of solar activity.
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> "4. Climatic oscillations lasting for shorter periods, up to a hundred years or so. These may be due in part to variations of solar activity but there is evidence that they are often due to changes in the general circulation of the atmosphere which may have no external cause. They result from the interaction of the winds, ocean currents and floating ice-fields which we know to occur, but which, in the present state of our knowledge, is incalculable. These changes must always have occurred, but were probably on a smaller scale during the warm periods, when there were no polar ice-caps, than during the glacial periods."

An interesting theoretical consideration for glaciologists is Dr. Brooks's demonstration, in Chapter I, that if, over an open sea, the mean winter temperature at the pole should fall from a trifle above the freezing point of sea water to only 0·6° F. (0·33° C.) below that value an ice field would form which would soon extend rapidly until it reached a latitude of about 78°, and then, in the absence of a land mass or other unfavourable conditions, more slowly to about latitude 65°. The ultimate lowering of winter temperature engendered by the initial decrease of less than 1° F. (0·56° C.) may, it is calculated, amount to some 45° F. (25° C.) in such circumstances.

Two of the more curious hypotheses mentioned (without approval) by Dr. Brooks as having been invoked quite recently to account for certain major climatic changes are (*a*) that in Palaeozoic times a small satellite of the earth, either original or captured, was disrupted by tidal and other forces to form a cincture of fragments round the equator, similar to Saturn's rings; (*b*) that on several occasions, separated by intervals of 250 to 350 million years, the sun has suffered "nova" outbreaks causing short-lived thousandfold increases in radiation, followed by general cooling of terrestrial climates consequent on the resultant diminution in solar mass and radiative output. Perhaps the most plausible of the relevant modern astronomical hypotheses outlined in the book is that on its journey through space the sun from time to time encounters clouds of interstellar

matter whose particles, on being absorbed, have their kinetic energy converted into heat. It may be recalled that long before the discovery of these cosmic clouds Newton envisaged the possibility that an accession of extraneous meteoric or cometary fuel to the sun might lead, sooner or later, to the extinction of all life on the earth.

E. L. HAWKE

HANDBUCH DER GLETSCHERKUNDE UND GLAZIALGEOLOGIE. R. VON KLEBELSBERG. Vienna: Springer-Verlag. Vol. 1 (1948), 403 pages, 55 illustrations; Vol. 2 (1949), 602 pages, 38 illustrations. Price £11 12*s.* 6*d.*

GLACIAL recession, which has been so remarkable during the last twenty years, has given a new impulse to research on snow and glaciers. Numerous works on special glaciological subjects and problems have been published in all parts of the world. Nevertheless, owing to the Second World War, much work remained unreported or, when reports were made, many were not easily accessible. It was therefore desirable that the latest results of research should be collected into one work and so made more readily available to science. The older works, such as Albert Heim's *Handbuch der Gletscherkunde* (Stuttgart 1885), and Hans Hess's *Die Gletscher* (Braunschweig 1904), are either out of print or partly out of date. Now, within a few years of each other, two works have been published—first *Gletscherkunde* by E. von Drygalski and F. Machatschek (Vienna 1942) and now the subject of this review. In it the latest knowledge and research are brought together in two volumes, and are illustrated and discussed in masterly fashion. One feels that the author is not merely a theorist but also a research worker who knows the mountains and their glaciers from a lifetime of accurate observation, and that he has thoroughly studied the pertinent literature. It is good to note that in this work there is no trace of any narrow-minded nationalism. The work of glaciologists is treated purely in regard to its scientific value and authors are given full credit for their findings.

The first volume, the *Allgemeiner Teil*, deals with the general aspects of glacier study and glacial geology. We are reminded how this branch of science originated in Switzerland and at the hands of Swiss workers. Nevertheless it soon spread to other parts of the Alps and to the mountains of other countries, bringing under its spell research workers of many nations, not least of whom were the English. The author describes with clarity the formation of glaciers above the snow line, the conversion of snow into firn and glacier ice, and the structure, stratification, foliation and other phenomena of the glaciers. He shows how research on the physical properties of glacier and other ice has occupied scientists for decades, and that nevertheless no definite conclusion has been reached even up to the present day. An important chapter is devoted to glacier movement. This influences not only the morphology of the glacier grains, but also in many respects the banks and the bed of the ice stream and thus impresses its characteristic shapes on glaciated country. It is natural that some readers may find passages in this work where they will differ from the author, but this will seldom occur. Von Klebelsberg describes the morphology of the irregular glacier grains, which are separated from each other by very fine capillary spaces or by films of moisture. He believes (p. 41) that the knotty protuberances on the surfaces of the glacier grains is contrary to the assumption of rolling motion as postulated by Streiff-Becker. The latter on the other hand thinks that such a movement nevertheless does take place, just as in a storage bin coarse-grained, sharp-edged materials, such as coal or broken stones, roll down because the surface protuberances of the grains are worn away. In the case of ice there is the further consideration that particles subjected to heavy pressure not only partly break but change their aggregate state, at least on their surfaces, *i.e.* melt and freeze again.

The great diversity of the relief of the earth's surface and of the climate, causes great diversity