THURSDAY, JUNE 11, 1874

METEOROLOGY—PRESENT AND FUTURE

METEOROLOGY has been happily divided by Dr. Balfour Stewart into two great sections, viz. physical meteorology and climatic meteorology.* The object of physical meteorology is to obtain a knowledge of the physics of the earth's atmosphere and surface; whereas climatic meteorology is properly the practical application of this knowledge in investigating the temperature, humidity, and movements of the air, together with the other atmospheric conditions which make up the climate of a place.

Owing to the complexity of the subject, the first step in meteorological inquiry is to lay down on the globe for each month of the year lines marking out the mean temperature, mean pressure, mean wind-direction, and mean rainfall. Roughly approximate averages are all that are required to begin with in order to mark strongly the broad features of the geographical distribution of these fundamental elements, from a knowledge of which the guiding principles of future inquiry can alone be safely obtained. Thanks chiefly to the labours of Dove, Buchan, and the Admiralties of Holland, the United States, and Great Britain, this preliminary information has been collected and placed in a handy diagrammatic form before the public; not, it is true, with the desired fulness, since considerable portions of the globe are still either not at all or very imperfectly represented. Nevertheless, enough is known to form a good basis for future action.

It is curious to note an undertone running through the works of nearly all writers on climate to the effect that if, for any place, the *mean* temperature, pressure, humidity, aqueous precipitation, and movements of the atmosphere be stated, its climate is thereby known. Nothing can be more fallacious, the truth being that such information does not enable us to define the distinctive characteristics of any climate. To do this we must have exact observations of, at least, the daily range of temperature, and humidity, the rate of movement of the wind over the place, the drying qualities of the air, the degree of cloudiness of the sky, and the manner, whether in drizzling or in heavy showers, in which the rain falls. And since the climate of a place cannot be properly defined except by comparison with the climates of other places, absolute uniformity of instruments, and their position, and in the methods of observation at different places is indispensable; for if this be not attended to, their climates cannot be compared.

Those conversant with the subject are aware how little has really been done towards making comparable and exact observations of atmospheric temperature and humidity, and wind, and towards laying down sound methods of discussing the observations so as to deduce results which will define numerically the distinctive features of climate. For instance, even as regards such striking facts as the arresting of the growth of trees, seen at so many points round the British coasts, we are not yet in a position to say whether the results be due to mechanical, chemical, or more purely climatic influences. To take a much simpler illustration, no one could venture to institute, on the basis of the temperature observations as at present made in different parts of the British Isles, a comparison of the climates of Shetland and Cornwall, Ayrshire and Kent, &c., in respect of their most essential characteristic, viz. the daily range of temperature, owing to the want of uniformity in the methods of observation.

In truth meteorology can as yet scarcely be said to have done more than collect the rough materials for future action, or rear the scaffolding for the future building. But the time has surely come when something more ought to be attempted. Researches in physical meteorology ought now to be systematically undertaken, and climatic meteorology prosecuted with more rigorously uniform methods of observation than has yet been done. We shall briefly indicate a few of the more important lines of research to be followed under these heads.

There is no question in meteorology calling so urgently for extensive, elaborate, and necessarily expensive, experiments and observations as that of the vapour of the atmosphere. Indeed, upon the right investigation and discussion of this element the great problem of weather changes depends. The vapour of the atmosphere as an absorbent and radiant of heat, and the relation of the pure gases of the atmosphere to the solar rays, are questions imperatively calling for investigation. Intimately bound up with the same inquiry is the temperature of the sky at different heights above the horizon and at different hours of the day, and the temperature of the clouds in connection with their formation and classification—all questions of the utmost importance, particularly in their bearing on the vital subject of terrestrial radiation.

Continuous observations with reference to the heating and actinic rays of the sun in order to ascertain the law of their periodicity and their relation to the sun-spot period already ascertained, and photographic and spectroscopic observations of the sun, are also clearly essential to the progress of meteorology, there being an intimate connection between sun observations on the one hand, and meteorology, as well as terrestrial magnetism, on the other. The electricity of the atmosphere also requires special and extensive investigation.

There is another large and difficult field of inquiry, which yields in practical importance to none, viz. investigations by which are sought to be attained the means of valuing scientifically the observations made at stations of the second order, to which alone we can look for carrying out the practical problems of the science in their bearings on health, agriculture, commerce, and other great national interests. Since the observations at these stations are not made by accomplished scientific men or skilled manipulators, it is indispensable that the instruments and methods of observation be of the simplest description. Only those refined methods of observation which are consistent with great simplicity are admissible for general adoption at ordinary stations. Thus observations of atmospheric temperature can be carried on at these stations with instruments and methods of observing which are strictly uniform with each other. But a question arises, how near do the results approximate to the true mean temperature of the air at the times of observation? The answer to this important question can only be obtained by special physical researches undertaken for the purpose. Again, it is highly probable that

* NATURE, vol. i. p. 101.

the dry and wet bulb hygrometer will, from its great simplicity and on the whole very satisfactory working, continue to be the most suitable instrument to put into the hands of ordinary observers for observations of the humidity of the atmosphere; and since the dew-point, elastic force of vapour, and humidity are not directly observed by this instrument, but are only deductions from the observations, it is most desirable that the methods of reducing the observations be the best attainable. The tables at present in use, while tolerably good for the temperatures ordinarily observed in this country, are very inaccurate for times of great drought and heat. Indeed it is essential to the development of this important branch of meteorology that the tables for the reduction of the hygrometric observations be submitted to a thorough revision, since reductions by different methods now in use give in extreme cases, from observations of the same air, dew-points differing fully 20°·0 from each other. Extensive experiments and observations are also required in order to ascertain the conditions of a good position for the anemometer, to devise some means for comparing velocity anemometers, and to determine the relation of the velocity of the wind to the pressure which it exerts. These important practical questions, of which we are at present altogether ignorant, can only be adequately investigated at an observatory devoted to researches in physical meteorology.

In order to complete the preliminary meteorological survey of the earth's atmosphere and surface it is indispensable that measures be taken to obtain observations from the less frequented regions of the ocean, from Arctic and Antarctic regions, large portions of British America, South America, Africa, and Polynesia; as well as observations of underground temperature obtained by improved methods at greater depths and from a more extended area of the earth's surface than have hitherto been made; and observations of the temperature of lakes at the surface, at great depths, and at their outflow. Till this be done our knowledge of terrestrial physics must be very imperfect. The extent of the British dependencies, the regions into which British commerce penetrates, and the readiness British "exiles" show to forward meteorological inquiries, point out that it is mainly to Great Britain we are to look to fill up the present blanks in the meteorology of the globe.

In working out the great national question of *local climates* it is absolutely indispensable that uniformity as regards instruments and methods of observation be secured at the different stations. This many-sided problem admits of different methods of treatment according as the inquiry is directed to agriculture, commerce, public health, or any of those other interests or pursuits which are more or less influenced by weather and climate. In investigating local climate in these relations new lines of inquiry must be set on foot. The nature and importance of some of these inquiries may be illustrated by referring to two lines of research recently taken up by the Scottish Meteorological Society, and noticed in NATURE at the time. It is proposed to inquire into the influence of the sea on climate, particularly the extension inland of this influence, which has so marked an effect on animal and vegetable life and such important bearings on the national prosperity, by establishing strings of stations from different points on the coast, and extending from the sea-shore to about two miles inland. It is further proposed to investigate certain of the more important practical problems—such as the relation of wind-force to the barometric gradient—by thickly planted *storm-stations*, radiating in lines in various directions from Edinburgh.

If meteorology is to be built on the solid ground of rigorously attested facts, it is imperative that measures be taken for the prosecution of such lines of investigation as those now indicated. To those who have given any consideration to the matter it is unnecessary to add that in no other way can the meteorology of the British Isles be placed on a thoroughly sound and satisfactory footing.

With reference to the means by which these physical and climatic researches in meteorology are to be carried on, it may be suggested whether, considering the local influence and knowledge which are absolutely essential for the successful prosecution of inquiries into local climates, it would not be the best as well as most economical course for the Government to avail itself of the assistance of the Meteorological Societies. On the other hand, the physical researches we have indicated, together with storm warnings, ocean meteorology, and some other departments of climatic meteorology beyond the power of Societies, can only be undertaken by the Government. In the future development of the meteorology of the British Isles, the co-operation of the Meteorological Societies with the Central Department is necessary, each having its own separate sphere of action, and each being to a large extent dependent on the other.

RECENT FRENCH GEOLOGICAL WORKS

Principes de Géologie Transformiste. Par Gustave Dolfuss. (Paris, Savoy, 1874.)

Eléments de Géologie et de Paléontologie. Par Ch. Contjean. (Paris, Baillière et Fils.)

THESE two recent French publications connected with Geology we propose to notice briefly together. In M. Dolfuss's earnest and suggestive little book another proof is given of the way in which the views of the Evolution School are permeating the minds of the rising generation of students in every branch of Science. If we may judge of the author from a perusal of his work, he is an enthusiastic palæontologist, who, drinking at the fountains of Darwinism, seeing clearly enough the tendency of modern thought, and full of dreams about the great future of his favourite science, has with the eagerness of a neophyte rushed forward to preach the creed which he so firmly believes. Whether or not this surmise be a true one, the book has much of the earnestness, ambition, vagueness, and inexperience of an early literary venture of an aspirant to fame. The real downright earnestness of the writer is one of the best features of the book. But we imagine that this quality would not have been impaired by a little delay in publication. The historical summary shows how limited is the author's range of reading. He speaks, for example, of Hutton having attributed everything in geology to the action of fire—an utter misconception and misstatement of the doctrines of the great philosopher.

He very properly claims for Constant Prevost a high