in August, and its most southern, lat. 1° N., in February. Its breadth varies from 3° to 8°, and it lies generally parallel to the equator. It is to be noted that, in the Atlantic, the region of calms is at all seasons north of the equator.

North and south trades also prevail in the Pacific Ocean, separated by a region of calms, which would appear, however, to be of less breadth and to be less clearly defined than is the region of calms in the Atlantic. In the eastern portion of the Pacific the region of calms lies at all seasons to the north of the equator, but in the western division it is considerably south of the equator during the summer months of the southern hemisphere, this southerly position being in all likelihood occasioned by the extraordinarily high pressure in Asia in its relations to the low pressure in the interior of Australia at this season. During the summer months of the northern hemisphere the region of calms wholly disappears from the Indian Ocean and from the western part of the Pacific Ocean, there being then an unbroken diminishing pressure from the latitude of Mauritius and Central Australia northwards as far as the low pressure of Central Asia.

Regions of light and variable winds and calms occur at the higher limits of the north and south trades. Except in the Pacific, where, owing to the greater breadth of that ocean, they spread over a considerable extent, these regions appear but in circumscribed patches, such as characterize the meteorology of the North and South Atlantic about latitudes 26° to 36°. Of these regions of calms the most important is that marked off by the high pressure in the North Atlantic, between the United States and Africa. This is the region of the Sargasso Sea, where the weather is characterized by calms and variable winds, and the ocean by its comparatively still waters. These are known to seamen as the "horse latitudes," and are essentially different from the equatorial region of calms. The latter, as has been stated, is the region of low pressure at the meeting of the north and south trades, where the climate is distinguished for its general sunlessness and heavy rainfall. On the other hand, the calm regions in the Atlantic and Pacific Oceans about the tropics have an atmospheric pressure abnormally high, clear skies, and the weather generally sunny and bright, with occasional squalls.

Numerous observations made in all parts of the globe establish the fact that, while the surface winds within the tropics are directed towards the equatorial region of calms in such a manner that the general intertropical movements of the atmosphere or prevailing winds are easterly, the prevailing winds of the north and south temperate zones are westerly. The westing of these great aerial currents is due to the same cause that gives easting to the trade-winds, viz., the rotation of the earth round its axis. For, as an aerial current advances into higher latitudes, it is constantly arriving at regions having a less rotatory velocity than itself; it thus outstrips them and leaves them behind; in other words, it blows over these places as a westerly wind.

While, however, the general prevalence of westerly winds has been established over the extratropical regions of Europe, Asia, Africa, America, and Australia, the directions which in different seasons and at different places are actually found to prevail often differ very widely from west. An examination of the winds at one hundred and fifteen places pretty well distributed over the northern hemisphere reveals the instructive fact that almost every place shows two maximum directions from which winds blow more frequently than from the other directions, and that one of these two directions shows a considerable excess over the other. Thus, for example, the following are, on a twenty years' average, the number of days at Greenwich each wind prevails during the year:—N., 41; N.E., 49; E., 23; S.E., 21; S., 34; S.W., 103; W., 38; N.W., 24; and calms, 32. Hence S.W. and N.E. winds are there more prevalent than winds from any other direction, and of these two winds the greater maximum direction is S.W. If the two maximum directions be sorted into groups, then the greater maximum direction occurs as follows:—

from	S.S.W.	to	W. at	47 places
,,	W.N.W.	,,	N. ,,	33 ,,
,,	N.N.E.	,,	E. ,,	19 ,,
,,	E.S.E.	,,	S. ,,	16 ,,

and the other maximum direction is

from	S.S.W.	to	W. at	20 places
,,	W.N.W.	,,	N. ,,	22 ,,
,,	N.N.E.	,,	E. ,,	38 ,,
,,	E.S.E.	,,	S. ,,	32 ,,

This result of observation, so different from what was long accepted as being in accordance with the generally received theory of the movements of the atmosphere, teaches the important lesson that the region towards which the extra-tropical winds of the northern hemisphere are directed is not the region of the north pole.

Prevailing Winds in January.—On examining fig. 14, which shows the distribution of atmospheric pressure in January, it is seen that pressure is abnormally low over the northern portion of the Atlantic—the lowest occurring between Iceland and South Greenland—from which it rises as we proceed in a S.W. direction towards America, in a S. direction over the Atlantic, and in a S.E. and E. direction over Europe and Asia. Now what influence has this remarkable atmospheric depression on the prevailing winds over this large and important part of the earth's surface? The arrows in the figure, which indicate the prevailing winds, and which have been laid down from observations, answer this question.

At stations on the east side of North America the arrows show a decided predominance of north-west winds; at the more northern places the general direction is more northerly, whereas farther south it is more westerly. In the Atlantic between America and Great Britain, in the south of England, in France and Belgium, the direction is nearly S.W. In Ireland and Scotland it is W.S.W.; in Denmark and the north-west of Russia S.S.W.; from St Petersburg to Tobolsk S.W.; on the west of Norway generally S.S.E.; and in Greenland, the north of Iceland, and about Spitzbergen N.E. Hence all the prevailing winds in January over this extensive portion of the globe may be regarded as the simple expression of the difference of atmospheric pressure which prevails over the different parts of the region. In truth the whole appears to flow vorticosely, or in an in-moving spiral course, towards the region of low pressure lying to the south-west of Iceland, and extending eastward over the Arctic Sea north of Russia. The only marked changes in these directions of the wind thus broadly sketched out are the deflexions caused by the various mountain systems which lie, so to speak, embedded in these vast aerial currents; of these the winds in the south of Norway afford excellent illustrations.

The influence which this peculiar distribution of the pressure over the north of the Atlantic exercises in absolutely determining the winter climates of the respective countries is most instructive. It is to this low pressure, which draws over the British Islands W.S.W. winds from the warm waters of the Atlantic, that the open, mild, and, it must be added, rainy winters of these islands are due. The same region of low pressure gives Russia and Western Siberia their severe winters; and it is the same consideration that fully explains the enormous deflexion of the isothermal lines from Norway eastwards and south-

eastwards over the Old Continent. Finally, the same low pressure draws over British America and the United States, by the N.W. winds which it induces, the intensely dry cold air-current of the Arctic regions. At Portland, Maine, which is swept by these cold north-westerly winds, the normal temperature in January is 23°·6, whereas at Corunna, on the coast of Spain, in nearly the same latitude, where south-westerly winds from the Atlantic prevail, the mean temperature of the month is 49°·1, or 25°·5 higher.

The region of low atmospheric pressure in the north of the Pacific is accompanied by prevailing winds over the region embraced by it and by climatic effects in all respects similar to the above. In Vancouver Island the prevailing winds in January are S.W., at Sitka E.S.E., on Great Bear Lake E.N.E., in Alaska N.E., in Kamchatka N.N.E., and in Japan N.W. In accordance with these winds the winter climate of Vancouver and adjoining regions is mild and humid, and that of the north-east of Asia dry and intensely cold.

On the other hand, abnormally high pressure rules over the continent of Asia at this season, and as regards this region of high pressure the arrows represent the winds as blowing outwards from it in all directions. Over the interior of Asia, where the highest normal pressures are, observations show a marked prevalence of calms and light winds, but around this central region the prevailing winds in January are—at Calcutta N., at Hong-Kong E.N.E., at Peking N.W., on the Amur W.N.W., S.E. at Nijni-kolynisk and S.S.W. at Ustjansk (in the north of Siberia), and at Bogoslovsk S.W. Hence from this extensive region, where pressure is abnormally high, or where at this season there is a large surplus of air, the prevailing winds flow outwards in all directions towards the lower pressure which surrounds it. Owing to the excessive dryness of the air of Central Asia, terrestrial radiation is less obstructed there than anywhere else on the globe, and consequently the temperature falls very low, the mean of January at Werchojansk being – 55°·8, which is the lowest mean monthly temperature known to occur on the earth's surface. And, since the winds blow outwards from the dry cold climates of the interior, temperatures are low, even on the coasts. Of this China affords good illustrations. Thus the mean January temperature of Peking is 22°·7 and of Zi-ka-Wei, near Shanghai, 35°·4, whereas at Corfu and Alexandria the normal temperatures for January are respectively 50°·9 and 58°·0, or 28°·2 and 22°·6 higher than in corresponding latitudes on the coast of China.

The winds of the United States in winter, taken in connexion with the peculiar distribution of pressure already described, are very interesting. There are two regions of high pressure, one in the south-eastern States and the other and larger one in the region around Utah; and between these there is interposed a trough of lower pressure extending from Chicago to the south-west of Texas. On the western side of this depression the winds are north westerly, but to the east of it they become W., W.S.W., and in some places S.W., and again on nearing the Atlantic seaboard they become north-westerly. In connexion with the region of higher pressure in the west, the prevailing winds are seen to flow outward from it. The normal pressure diminishes everywhere to southward of a line drawn from the Canaries to Bermuda, thence westward in nearly the same latitude to Texas, and then to west-north west to San Francisco. The tract of lowest pressure stretches from the basin of the Amazon in the direction of the isthmus of Panama in about latitude 8° N., and thence is continued westward for a considerable distance into the Pacific in nearly the same latitude. It follows from this distribution of the pressure that the north trades in a more or less modified form prevail over South America to the north of the Amazon, and in the Pacific to the north of lat. 8° N., probably as far to westward as long. 150° W.

The low-pressure systems which prevail during the summer months in South America and South Africa have each its corresponding system of winds all round. It is, however, in Australia, as being the most compact and isolated continent, that the influence of the summer sun in lowering the pressure is best illustrated. In that continent the lowest pressure occurs in the region situated about midway between the north coast and the tropic of Capricorn, over which the normal pressure does not exceed 29·80 inches. Further, everywhere in Australia pressure diminishes from the coast on advancing upon the inland districts. It follows from this disposition of the pressure that all round the island the prevailing winds in summer blow from the sea towards the interior, and accordingly it is in these months that the greater part of the rain falls. From the low pressure of the interior southwards to Bass's Straits pressure rises continuously, the increase in the normal over this space being about 0·200 inch. To northward it also rises continuously to beyond the north of China, the increase on this side being about ¾ of an inch. In this case the greater part of the increase occurs over the continent, the rate of increase from the north of Australia to the Philippine Islands being only about the rate of increase which obtains southward towards Bass's Straits. It will be shown when the subject of the rainfall is examined that it is the relative excess of these high pressures, the one in the south of Australia and the other in the south-east of Asia, that determines the position of the area of low pressure in Australia in particular years, and with that position the degree and extent to which the whole of the northern portion of Australia is watered by the rainfall. Thus, when pressure is more than usually high in the south-east of Asia, and either low or not excessive in the south of Australia, then the low-pressure region is pushed farther southward into the interior, and with it the rainfall spreads inland over a wider area and to a greater depth.

Prevailing Winds in July.—In the winter of the southern hemisphere, the geographical distribution of pressure is exactly the reverse in Australia of what obtains during the summer months. Everywhere all round it increases on advancing from the coast into inland districts. The lowest pressure, about 30·00 inches, occurs on the north coast, and the highest over the basin of the Murray river and its affluents, where it rises generally to 30·18 inches. On the south coast it is generally about 30·12 inches, falling, however, at Gabo Island, in the extreme south-east, to 30·050 inches, and to 29·836 in the south of New Zealand. From the Murray river the diminution of pressure is continuous to the north, even to the low pressure of Central Asia. From this arrangement of the pressure, the prevailing winds blow from the interior towards the surrounding ocean all round Australia, with the single exception of the extreme south-west of the continent, where the prevailing winds are south-westerly, being here essentially an outflow of the high pressure which overspreads the Indian Ocean to the westward. As these S.W. winds are from the ocean, the rainfall at Perth in July is fully 6 inches, and it is high over south-western districts of West Australia. The prevailing winds round Australia are S.E. on the north coast, S.W. at Brisbane, W.N.W. at Sydney, N. at Melbourne, N.E. at Adelaide. These all represent an outflow from the high-pressure regions of the interior modified by the influence of the earth's rotation, and, in correspondence with the reversal of the distribution of the pressure, are directions the reverse of the prevailing winds of January

In July the central and southern parts of Asia are

highly heated by the summer sun, and, besides, the rainfall over southern parts is excessive. Consequently atmospheric pressure is very low, being fully 0·40 inch lower in the Punjab than it is in the south of Ceylon. From the interior pressure rises continuously on advancing to the eastward, southward, westward, and northward, and from all these directions the prevailing winds of summer flow inwards upon the interior, and these bring rain or parching drought according to the vapour they bring from the ocean they have traversed, and according as they advance into warmer or colder regions. The prevailing summer winds of Asia, being an inflow inwards upon the interior, have, generally speaking, exactly the reverse direction of that prevailing in winter.

The winds of Europe are mainly determined by the extraordinarily high pressure of the Atlantic in its relations to the low-pressure systems of Central Asia and Central Africa at this time. The winds in the Spanish Peninsula are north-west: in the north of Africa they are northerly, and again north-westerly in Syria. The winds of the British Islands and western Europe have less southing and more northing than the prevailing winds of winter, and to the east of long. 40° E. they become decidedly north-west. It is to the Atlantic origin of these winds that the summer climates of these large and important regions owe the comparatively large rainfall of this season, it being at this time that the rainfall reaches the annual maximum. The bearing of the low-pressure areas and mountain systems of the north of Italy and Scandinavia on the climates of these countries will be afterwards referred to.

The centre of lowest pressure in North America is over the district about Utah, from which it rises all round, least to northward and most in south-easterly and north-westerly directions. In California N.W. winds necessarily blow inwards upon this central low-pressure area; and, as these winds pass successively over regions the temperature of which constantly increases, the summer climate is rainless. On the other hand, southerly and south-easterly winds from the Gulf of Mexico blow up the western side of the basin of the Mississippi inwards upon the low-pressure area of the centre, depositing in their course, in a rainfall more or less abundant, the moisture they have brought from the Gulf. To the north of lat 50°, and to westward of Hudson's Bay, the prevailing winds become easterly and north-easterly, distributing over Manitoba, Saskatchewan, and neighbouring regions, as they continue their westerly course towards the low-pressure area, the rainfall they have transported thither from the wide expanse of Hudson's Bay. An attentive examination of the arrows of fig. 17 shows that the prevailing winds over all the States to the east of the Mississippi river are rather to be regarded as an outflow from the region of very high pressure over the Atlantic to south-eastward. Thus in Florida the winds are S.E., in the southern States S., and in the lake region, in the New England States, and on the Atlantic seaboard S.W. Since the origin of these winds is thus essentially oceanic, and since in their course northwards no mountain range crosses their path, the whole of this extensive region enjoys a large but by no means excessive rainfall, which, taken in connexion with the temperature, renders the summer climate of these States one of the best to be met with anywhere on the globe for the successful prosecution of agricultural industries.

The remarkable protrusion of high pressures from the southern hemisphere, where they are massed at this time of the year, northwards into the Atlantic is, as has already been referred to, one of the outstanding features of the meteorology of the summer months of the northern hemisphere. In the central area of this large region the climate is remarkable for its prevailing calms, light winds, occasional squalls, and clear skies. From this comparatively calm space the wind blows outwards in all directions towards and in upon the surrounding regions of low pressure. These winds, owing to the high temperature, clear skies, and strong sunshine of the region from which they issue, carry with them a great amount of vapour near the surface, by which to a large extent the north of South America, the east of North America, the greater part of Europe, and a large portion of Africa are watered. The prevailing winds over this region are further interesting, not merely from the striking illustration they give of the intimate relation of the winds to the distribution of the pressure, but as being of no small importance in determining the best routes to be taken over this great highway of commerce, and the more so inasmuch as the currents of the ocean are coincident with these prevailing winds.

In the Antarctic regions, or rather to the south of lat. 45° S., the normal atmospheric pressure is low at all seasons, there being a gradual diminution of pressure to 29·20 inches about lat. 60° S. Pressure is probably even still lower nearer to the south pole, as seems to be indicated by the observations made by Sir James C. Ross, and in the "Challenger" and other expeditions. Over this zone the prevailing winds are W.N.W. and N.W. This is the region of the "brave west winds," the "roaring forties" of sailors, which play such an important part in navigation, and which determine that the outward voyage to Australia be round the Cape of Good Hope and thence eastward, and the homeward voyage eastward round Cape Horn, the globe being thus circumnavigated by the double voyage. That the general drift of these winds is inwards upon the south pole is strongly attested by the existence of the enormously thick wall of ice which engirdles these regions, from which are constantly breaking away the innumerable icebergs that cover the Southern Ocean, none of which is ever seen of a calculated thickness less than 1400 feet. The snow and rainfall which must take place in the south polar regions for the formation of icebergs of such a thickness must be peculiarly heavy, but not heavier than might be expected from the strength and degree of saturation of the "roaring forties" which unceasingly precipitate their moisture over these regions.

To sum up:—so far as the prevailing winds are concerned, it has been shown that where pressure is high, that is to say, where there exists a surplus of air, out of such a region winds blow in all directions; and, on the other hand, where pressure is low, or where there is a deficiency of air, towards such a region winds blow from all directions in an in-moving spiral course. This outflow of air-currents from a region of high pressure upon a region of low pressure is reducible to a single principle, viz., the principle of gravitation. Given as observed facts the differences of pressure, it is easy to state with a close approximation to accuracy what are the prevailing winds, before calculating the averages from the wind observations. Indeed so predominating is the influence of gravitation where differences of pressure, however produced, exist that it may practically be regarded as the sole force immediately concerned in causing the movements of the atmosphere. If there be any other force or forces that set the winds in motion independently of the force called into play by differences of mass or pressure, their influence must be altogether insignificant as compared with gravitation.

It has been abundantly proved that the wind does not blow directly from the region of high towards that of low pressure, but that, in the northern hemisphere, the region of lowest pressure is to the left of the direction towards which the wind blows, and in the southern hemisphere to the right of it. This direction of the prevailing wind with reference to the pressure is in strict accordance with Buys

Ballot's Law of the Winds, which may be thus expressed:—the wind neither blows round the centre of lowest pressure in circles, or as tangents to the concentric isobaric curves of storms or cyclones, nor does it blow directly towards the centre; but it takes a direction intermediate, approaching, however, more nearly to the direction and course of the circular curves than of the radii to the centre. The angle formed by a line drawn to the centre of lowest pressure from the observer's position and a line drawn in the direction of the wind is not a right angle, but an angle of from 60° to 80°.

From its importance in practical meteorology Buys Ballot's law may be stated in these two convenient forms. (1) Stand with your back to the wind, and the centre of the depression or the place where the barometer is lowest will be to your left in the northern hemisphere, and to your right in the southern hemisphere. This is the rule for sailors by which they are guided to steer with reference to storms. (2) Stand with the high barometer to your right and the low barometer to your left, and the wind will blow on your back, these positions in the southern hemisphere being reversed. It is in this form that the prevailing winds of any part of the globe may be worked out from the isobaric charts (figs. 14 and 17).

From the all-important consequences which flow from the geographical distribution of the pressure it is evident that the regions of low and of high normal pressure must be regarded as the true poles of the prevailing winds on the earth's surface, towards which and from which the great movements of the atmosphere proceed. From the unequal distribution of land and water, and their different relations to solar and terrestrial radiation, it follows that the poles of pressure and of atmospheric movements are, just as happens with respect to the poles of temperature, very far from being coincident with the north pole. Thus during the winter months the regions to which the origin of the great prevailing winds of the northern hemisphere are to be referred are Central Asia, the region of the Rocky Mountains, and the horse latitudes of the Atlantic, and the regions towards and in upon which they flow are the low-pressure systems in the north of the Atlantic and Pacific Oceans, and the tract of low pressure within the tropics towards which the trade-winds blow In the summer months the reversed conditions of pressure-distribution then observed are attended with corresponding changes in the prevailing winds; and, generally speaking, if the south polar region be excepted, the poles of highest and lowest pressure and atmospheric movements are at no time coincident with the north pole. It is this consideration which affords the true explanation why prevailing winds at so large a proportion of stations in the northern hemisphere do not blow in the directions in which true equatorial and polar winds should blow.

The causes which bring about an unequal distribution of the mass of the earth's atmosphere are mainly these two—the temperature and the moisture of the atmosphere considered with respect to the geographical distribution of land and water. Owing to the very different relations of land and water to temperature, as already stated, the summer temperature of continents greatly exceeds that of the ocean in the same latitudes. Hence the abnormally high temperature which prevails in the interior of Asia, Africa, America, and Australia during their respective summers, in consequence of which the air, becoming specifically lighter, ascends in enormous columns thousands of miles in diameter. On arriving at the higher regions of the atmosphere it flows over neighbouring regions where the surface temperature is lower, and thus the atmospheric pressure of the highly heated regions is diminished.

Surface winds set in all round to take the place of the air removed from the continents by these ascending currents, and since these necessarily are chiefly winds from the ocean they are highly charged with aqueous vapour, by the presence of which, and by the condensation of the vapour into cloud and rain, the pressure over continents at this season is still further and very largely diminished. Air charged with vapour is specifically lighter than when without the vapour; in other words, the more vapour any given quantity of atmospheric air has in it the less is its specific gravity, and, further, the condensation of vapour in ascending air is the chief cause of the cooling effect being so much less than that which would be experienced by dry air. From these two principles, which were established by Dalton, Joule, and Sir William Thomson, it follows that the pressure of vapour in the air, and its condensation, exercise a powerful influence in diminishing the pressure. The great disturbing influences at work in the atmosphere are the forces called into play by its aqueous vapour; and it is to these, co-operating with the forces called into play by the differences of temperature directly, that the low normal pressure of the continents during the summer is to be ascribed. The degree to which the lowering of the pressure takes place is, as was to have been expected, greatest in Asia, the largest continent, and least in Australia, the smallest continent, while in America it is intermediate.

The influence of the aqueous vapour in diminishing the pressure is well seen in the belt of calms in the tropics between the north and the south trade-winds. Since these winds import into the belt of calms the vapour they have taken up from the sea on their way thither, the climate is characterized by a highly saturated atmosphere and heavy rains. Again the air in regions near the Atlantic contains much more vapour and is of a higher temperature during winter than is observed at places in the interior of continents in the same latitudes. It follows thus that the air over the north of the Atlantic and the regions adjoining is specifically lighter than in the regions which surround them. We have here therefore the physical conditions of an ascending current; and it is plain that the strength of this current will not merely be kept up but increased by the condensations of the vapour into cloud and rain which take place within it, by which a higher temperature and a greater specific lightness are maintained at the surface of the earth and at various heights in the atmosphere than exist over surrounding regions at the same heights. Accordingly it is seen from the winter isobars that an enormous diminution of pressure occurs over these regions, and also over the north of the Pacific and the Antarctic, as compared with the continents.

Since, on the other hand, dry and cold air is specifically heavy, the winter isobars show that where temperature is low and the air very dry pressure is high. Of this Asia and North America are striking examples during December, January, and February, and Australia, South Africa, and South America during June, July, and August.

Since vast volumes of air are thus poured into the region where pressure is low without increasing that pressure, and vast volumes flow out of the region where pressure is high without diminishing that pressure, it necessarily follows that the volumes of air poured into the region of low normal pressure do not accumulate over that region, but must somehow escape away into other regions, and that the volumes of air which flow out from the region of high normal pressure must have their place supplied by fresh accessions of air poured in from above. That the same law of relation observed between sea-level pressures and surface winds obtains between pressures at different heights and winds at the same heights is simply a necessary inference. We are therefore justified in expecting that

ascending currents will continue their ascent till a height is attained at which the pressure of the air composing the currents equals or just falls short of the pressure over the surrounding regions at that high level. On reaching this height the air, no longer buoyed up by a greater specific levity than that of the surrounding air, will cease to ascend, and expanding horizontally will thenceforth flow over as an upper current towards those regions which offer the least resistance to its course; that is to say, it will flow over upon those regions where, at that height, pressure happens at the time to be least. Now from the known densities of air of different temperatures and humidities it is evident that the overflow of the upper current will take place towards and over that region or regions the air of which in the lower strata of the atmosphere happens to be colder and drier than that of the other surrounding regions,—because, being denser, a greater mass of air is condensed or gathered together in the lower strata of the atmosphere, thus leaving a less mass of air, or a diminished pressure, in the higher region of the upper current.

If this be so, then the extraordinarily high pressure of Central Asia during winter is to be ascribed to these two causes:—(1) the low temperature and excessive dryness of the air of this extensive region; and (2) its relative proximity to the low pressure of the Atlantic to the north-west, the low pressure of the Pacific to the north-east, and the low pressure of the belt of calms to the south. Similarly, since in summer the temperature of air resting over the Atlantic between Africa and the United States is much lower than that of the land, the ascending currents which arise from the heated lands of Africa, Europe, and North and South America, as well as from the region of calms immediately to the south, all of which are remarkable for a low normal pressure, will on reaching the upper regions of the atmosphere flow towards this part of the Atlantic, because there, the temperature being lower and the density of the air composing the lower strata being greater, pressure in the upper regions is less. And, since the surface winds are constantly flowing outwards from this region of abnormally high pressure, thus draining away the air poured down upon it by the upper currents which converge upon it, extreme saturation does not take place, and the air consequently is relatively dry and cool. That this view generally represents the movements of the upper currents has been strongly confirmed within the last few years by Professor Hildebrandsson and Clement Ley in their researches into the upper currents of the atmosphere based on observations of the cirrus cloud.

From these considerations it may be concluded that the winds which prevail near the earth's surface are known from the isobaric lines, the direction of the wind being from regious where pressure is high towards regions where it is low, in accordance with Buys Ballot's law; and that the upper currents may be inferred from the isobaric lines taken reversely, together with the isothermal lines taken directly. In other words, the regions of lowest pressure, with their ascending currents and relatively higher pressure at great heights as compared with surrounding regions, point out the sources or fountains from which the upper currents flow; and the isothermals, by showing where on account of the relatively low temperatures the greater mass of the air is condensed in the lower strata of the atmosphere and sea-level pressure consequently is high, thus diminishing the pressure of the upper regions, point out the regions towards and upon which these upper currents of the atmosphere flow. The facts of the diurnal oscillations of the barometer in the different regions already discussed afford the strongest corroboration of these views.

The term "monsoon" has long been applied to the prevailing winds in southern Asia which blow approximately from S.W. from April to October, and from N.E. from November to April. The term is now, however, generally applied to those winds connected with continents which are of seasonal occurrence, or which occur regularly with the periodical return of the season. Since they are caused immediately by the different temperatures and pressures which form marked features of the climates of continents in winter and summer respectively, they are most fully developed round the coast of Asia, owing to the great extent of that continent. The monsoons of different parts of the coasts of Asia differ widely in direction from each other. Thus in winter and summer respectively they are W.N.W. and E.N.E. at the mouth of the Amur, N. and S.S.E. at Shanghai, N.E. and S.W. at Rangoon, N. and W.S.W. at Bombay, N.W. and S.W. at Jerusalem, and S.S.W. and N.N.E. at Archangel. The Indian winter monsoon generally begins to break up in March, but it is not till about the middle of May, when the normal pressure has been decidedly diminished over the heated interior, that the summer monsoon acquires its full strength and the heavy monsoonal rains fairly set in. In October, when the temperature has fallen considerably and with the falling temperature the pressure of the interior has risen, the summer monsoon begins to break up, and this season is marked by variable winds, calms, and destructive hurricanes. As the temperature continues to fall and pressure to rise, the winter monsoon again resumes its sway. Monsoons, equally with the trade-winds, play a most important part in the economy of the globe. The relatively great force and steadiness in the direction in which they blow, and the periodical change in their direction, give facility of intercourse between different countries; and, besides, by the rainfall they bring they spread fertility over extensive regions which otherwise would be barren wastes.

The winds of Australia are also strictly monsoonal, but owing to the small extent of that continent, and consequently the smaller differences there are between the normal pressure of the interior and that of the surrounding coasts in summer and winter respectively, they are less strongly marked than are the monsoons of southern Asia, and particularly they neither blow with the same force nor so steadily from the same point of the compass. For the same reason the Australian climates are characterized by the occurrence of more frequent droughts than are the climates of southern Asia, and the same remark applies to the climates of southern Africa.

Since the Malay archipelago lies during the summer of the northern hemisphere between the high pressure of central Australia and the low pressure of Asia, and during the winter between the high pressure of Asia and the low pressure of central Australia, it follows that the winds of these islands are eminently monsoonal in their character, being in summer southerly and in winter northerly. The result of this peculiar wind system of the archipelago is to give to these islands a singular diversity of climates, which will be more particularly referred to under rainfall.

At Zanzibar the prevailing wind in July is S.E., but in January, when the low pressure of the interior is situated much farther to southward, it is N.E.; and the same influence is felt, though in a greatly modified degree, as far as Mauritius, where the S.E. trade changes nearly into E. during the summer. On the other side of Africa the S.E. trade of the South Atlantic is changed into a S.W. monsoon on the coast of the Gulf of Guinea.

In the southern, central, western, and northern regions of North America the prevailing winds have a well-marked monsoonal character. The prevailing winds of winter and summer respectively are N.E. and S.S.E. at New Orleans, N.W. and S.W. in Utah, N. and S. at Fort Yuma (California), E.S.E. and N.W. at Portland (Oregon), and S. and E.N.E. at Fort York, Hudson Bay. These winds are readily accounted for by the distribution of pressure over the continent in winter and summer. On the Atlantic seaboard of the United States the prevailing winds of winter vary from N.W. in the New England States to W. in South Carolina; whereas in summer they vary generally from S.S.W. in South Carolina to S.W. in the New England States. Hence over the eastern States the summer winds are not directed towards the low-pressure region of the interior of the continent, but are determined by the relations of their pressure to the high pressure of the Atlantic to the eastward, and to the lower pressure overspreading the Atlantic to the N.E. This influence of the Atlantic may be considered as felt westward through the States as far as the Mississippi.

Though not so decidedly marked, the winds of Europe, except the extreme south, are also monsoonal. In winter they flow from the land towards the region of low pressure in the north of the Atlantic; but in summer the arrows, representing the prevailing winds, show that all but the extreme south of Europe is swept by westerly winds, which flow in a vast continuous stream from the Atlantic towards the central regions of the Old Continent, and which deposit in their course the rains they have brought from the ocean.

Similarly, monsoons prevail on the coasts of Brazil, Peru, North Africa, and many other regions which happen to lie between other regions whose temperatures, and therefore pressures, differ markedly from each other at different times of the year.

These are the chief prevailing winds of the globe when the differences of the normal atmospheric pressure are such as to cause a decided and steady movement of the atmosphere over a large portion of the earth's surface, resulting in well-marked prevailing winds. But there are other winds which are greatly influenced by local causes, such as the nature of the ground, whether covered with vegetation or bare; the physical configuration of the surface, whether level or mountainous; and the vicinity of extensive sheets of fresh or salt water. An important characteristic of winds in their practical relations to climate is their quality,—they being warm or cold, dry or moist, according to their direction and the nature of the earth's surface over which they have just passed. Thus in the northern hemisphere southerly winds are warm and moist, while northerly winds are cold and dry. In Europe south-westerly winds are moist and easterly winds dry, while in the New England States and Canada north-easterly winds are cold and raw and north-westerly winds cold and dry.

In particular regions certain meteorological conditions occur at stated seasons intensifying these effects, resulting in excessive drought, heavy rains, intense or great heat, thus giving rise to the following among other well-known winds. The east winds of the British Islands occur chiefly in spring, but also in a less degree in November, being in the latter case often accompanied with fog. The winds here referred to are dry and parching, and their deleterious influence on the health is seen, not merely in the discomfort and uneasiness they impart to the less robust of the population, but also in the largely increased mortality which they cause from consumption and all other diseases more or less connected with the nervous system. In the countries bordering on the north of the Atlantic, atmospheric pressure reaches the annual maximum in May, and it is above the average during the other two spring months. In these months the normal pressure approaches nearer to what obtains farther south, and an examination of daily weather maps shows that this is due to the repeated occurrence in spring of very high pressures in the north of Europe while pressures much lower prevail to southward. Now these east winds are simply the outflow from these regions of high pressure to northward. Northerly and even westerly winds which are truly outflows from what may be styled Arctic anticyclonic areas bring with them qualities as noxious as those of the east wind itself, and prove as injurious to health and vegetation. The cold dry wind of April 29, 1868, which blasted and shrivelled up vegetation in Scotland, particularly in the western counties, as effectually as if a scorching fire had passed across them, was a west wind.

In the south of Europe, during the winter and early spring, peculiarly dry, cold, and violent northerly winds are of occasional occurrence. Of these winds the "mistral" is one of the most notorious, which is a steady, violent, and cold north-west wind blowing from central and eastern France down on the Gulf of Lyons. It is particularly trying while it lasts to invalids who are spending the winter at the various popular sanataria which are scattered along this part of the Mediterranean coast. The great cold that took place in the north of Italy and south of France in the beginning of 1868 was a good example of the mistral. The meteorological conditions under which it occurred were unusually low pressure over the Mediterranean to southward (29·450 inches), whilst at the same time pressure rose steadily and rapidly on proceeding northward to 30·905 inches in the north of Russia. From this geographical distribution of the pressure, northerly winds swept southwards over Europe, carrying with them the low temperatures of the higher latitudes, and became still colder and drier on crossing the Alps before they made the descent on the shores of the Mediterranean. The cold tempestuous winds which descend from the Julian Alps and sweep over the Adriatic, and the dreaded "gregale" of Malta, which is a dry cold north-east wind, are in their character and origin quite analogous to the mistral.

The "northers," or "nortes," are peculiarly dry cold strong winds which repeatedly occur from September to March in the States bordering on the Gulf of Mexico, and are perfectly analogous to the mistral. The conditions under which they occur are a pressure lower than usual to the south or south-east over the Gulf of Mexico, together with a pressure even higher than the high normal which is so marked a feature of the meteorology of the Rocky Mountains during the colder months. When, as most frequently happens, they occur in the wake of a storm, their disagreeable qualities of extreme dryness, cold, and violence are all intensified. From a temperature of upwards of 80° experienced as the storm comes up the thermometer rapidly falls to 18° or even lower; and, as the low temperature often occurs with a wind blowing with great violence, the northers prove most deleterious. A violent wind with a temperature of 18° is altogether unknown in the British Islands.

The "pampero" is a strong, dry, cold wind which blows across the pampas of the River Plate of South America, occurring at all seasons, but most frequently during the spring and summer from October to January. They are preceded by easterly winds, a falling pressure, a rising temperature, and increased moisture. A pampero is described by Dr D. Christison, and its appearance figured, in the *Journal of the Scottish Meteorological Society*, vol. v. p. 342, as seen advancing on the morning of November 28, 1867, in central Uruguay. In the early morning the wind blew rather strongly from north-east, and by and by clouds were seen moving very slowly from the west, throwing out long streamers eastwards. As they advanced, two dense and perfectly regular cloud-masses appeared in front, one behind the other, in close contact yet not intermingling,—the one being of a uniform leaden grey, while the other was as black as the smoke of a steamer. On arriving overhead, the front, though slightly wavy in appearance, was seen to be quite straight in its general direction, and the bands were of uniform breadth. They rushed forward at great speed under the other clouds without uniting with them, preserving their forms unbroken, being borne onward by an apparently irresistible force, as if composed of some solid material rather than vapour. They extended probably 50 miles in length, but as they took only a few minutes to pass their breadth was not great, and they appeared to diminish to mere lines in the distant horizon. At the instant the first cloud-band arrived overhead, the wind chopped round from north-east to north and then to south-west; a strong cold blast at the same time seemed to fall from the leaden cloud, and continued to blow till both bands had passed. No rain or thunder occurred at this time, but in the confused rabble of clouds which followed low thunder continued to roll, and in a quarter of an hour rain fell, and for some hours thereafter wind, rain, and thunder continued, but only to a moderate degree. The low temperature and rising barometer and change of wind are the constant and most striking characteristics of the pampero. On one occasion the temperature fell 44° in fourteen hours, and on another occasion the fall was only 4°. Rain is a usual accompaniment, but on rare occasions the pampero passes off and no rain falls.