# "The Behaviour of the Short-Period Atmospheric Pressure Variation over the Earth's Surface."

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[PLATES 12 AND 13.]

In a paper which we communicated to the Society in June, 1902,* we drew attention to the fact that in our investigation dealing with the percentage frequency of prominences and changes in atmospheric pressures, we found that the pressures in India and Cordoba behaved in an opposite manner, the short period variations of one being the inverse of those of the other; both, however, were closely associated with the prominence frequency.

In a subsequent paper† we showed that these two regions, in which these inverse pressure-variation conditions were clearly distinguishable, were, as far as had then been investigated, of considerable extent, the Indian region extending to Ceylon, Java, Mauritius and Australia, and that of Cordoba to the southern part of the United States.

The facts there collected were stated to be so suggestive that the inquiry was being continued by collecting and discussing observations made in other areas on the earth's surface, so as to note the extent of these similar pressure areas.

The present communication contains the results that have so far been obtained.

The greater portion of the facts here collected has been discussed some time, but as it was considered desirable, before communicating the present paper, to include as many regions on the earth's surface as could be obtained, a longer delay than was anticipated has taken place; even now there are many regions which we have been unable to include. The regions for which further observations are desired include the west coast of Africa, the northern part of South America, and the north-western portion of North America, and Polynesia in the South Pacific Ocean.

In our previous papers we have pointed out the advisability of dividing the year into groups of months according as the pressure is above or below the mean value for the year. In this way the high or the low pressure months can be dealt with separately, if necessary, and any excess or deficiency from a mean value exhibited in either or both of these from year to year can be closely followed.

Such a division of the year can be accurately determined for places

* 'Roy. Soc. Proc.,' vol. 70, p. 500.
† 'Roy. Soc. Proc.,' vol. 71, p. 134.

which have a regular and pronounced annual pressure variation, such as India, and where the yearly barometric range is of far greater magnitude than any other aperiodic fluctuation.

In those regions where the mean yearly curve is more misleading than otherwise, the division, according to the two seasons included in the two groups of months, April to September and October to March, is best adapted.*

The system adopted in the present investigation was to take the pressure variations over India and Cordoba as the chief types of each region, denoting those of the former by the symbol (+), and those of the latter by (−). The pressure curve of any other place was then taken and compared with each. If, for example, it was found that the curve extending over several years exhibited an excess pressure at those epochs when the Indian pressure curve was in excess, then it was classified as being similar to the Indian type and represented by a (+). If it was seen that although it was more like the Indian curve than that of Cordoba, but yet not quite the exact counterpart of India, then it was denoted by (+ ?). In a similar way pressure curves like Cordoba were classified as (−), and those more like Cordoba than India as (− ?).

In some regions the pressure variation curves were distinctly a mixture of both the Indian and Cordoba types, and it was difficult to classify them satisfactorily by the above method. The symbol adopted for these cases was (± ?). Again, there were further some curves in which even this mixed type of symbol was not sufficient to exhibit the relationship of their variations to the other curves, so a special symbol (?) denoting ambiguity was used.

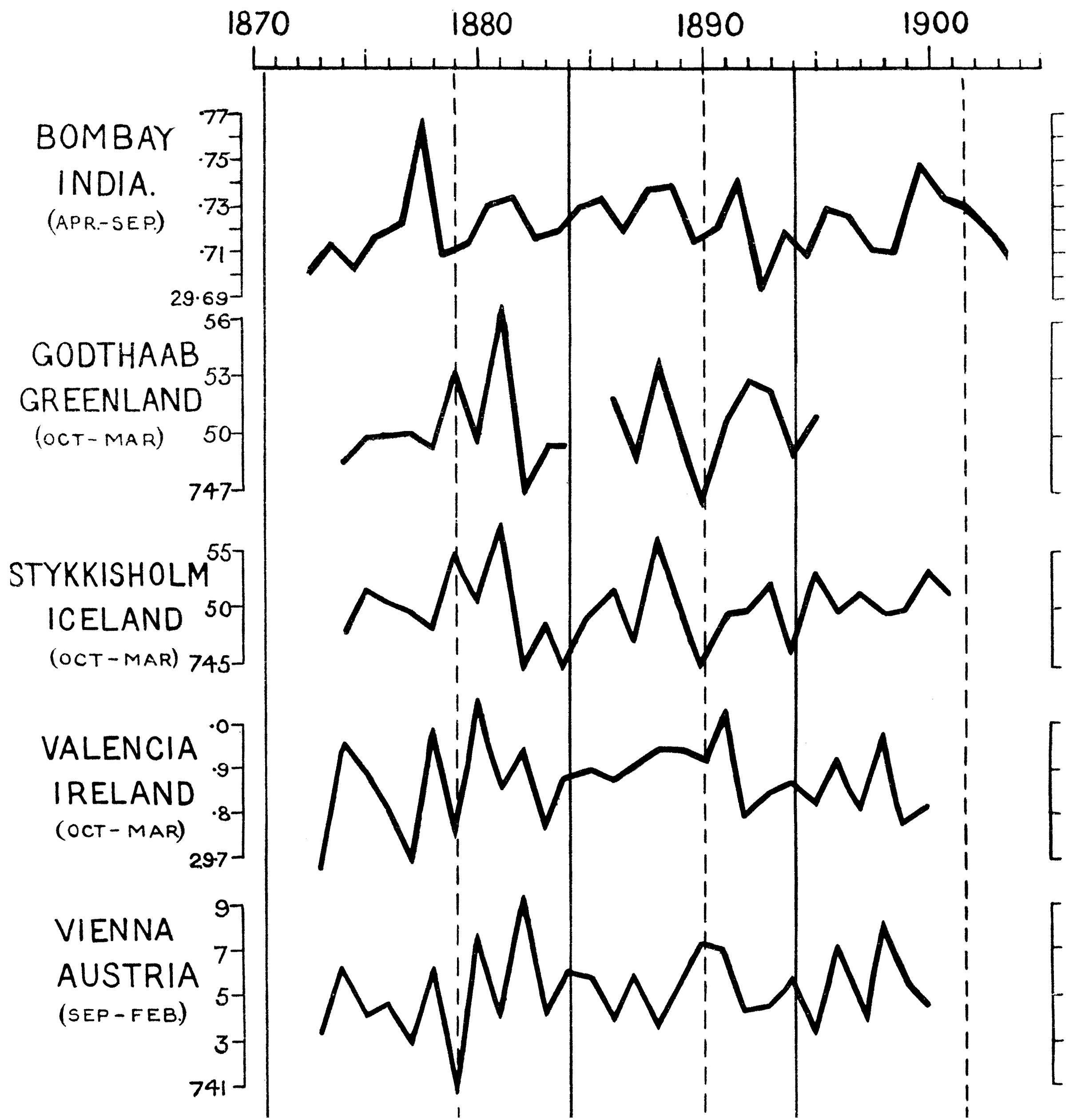
In the present investigation of this similarity or dissimilarity of atmospheric pressure changes over large areas, it was found that the special types were apparent sometimes in the yearly curves, sometimes in those for one or other of the high or low pressure groups of months, or sometimes in both of these. It did not, however, appear to follow that, because the type was distinguishable in the yearly curves, it was necessarily apparent in both the curves of the high and low pressure months.

The accompanying table, although yet somewhat incomplete, gives a tabulated statement of the data employed in the present survey.

The table explains itself, but it may be remarked that in Columns 6

* To show the misleading nature of the mean annual pressure-variation curve over, for example, the British Isles, it is only necessary to plot the actual monthly values of pressure for any one year on this mean curve and draw a curved line through them, when it will be seen that there is practically no relationship whatever between the two curves. If, on the other hand, the actual monthly pressure values during any one year be plotted on the mean annual pressure-variation curve for India, the former follow very closely the swing and amplitude of the latter.

Roy. Soc. Proc., vol. 73, Plate 12.



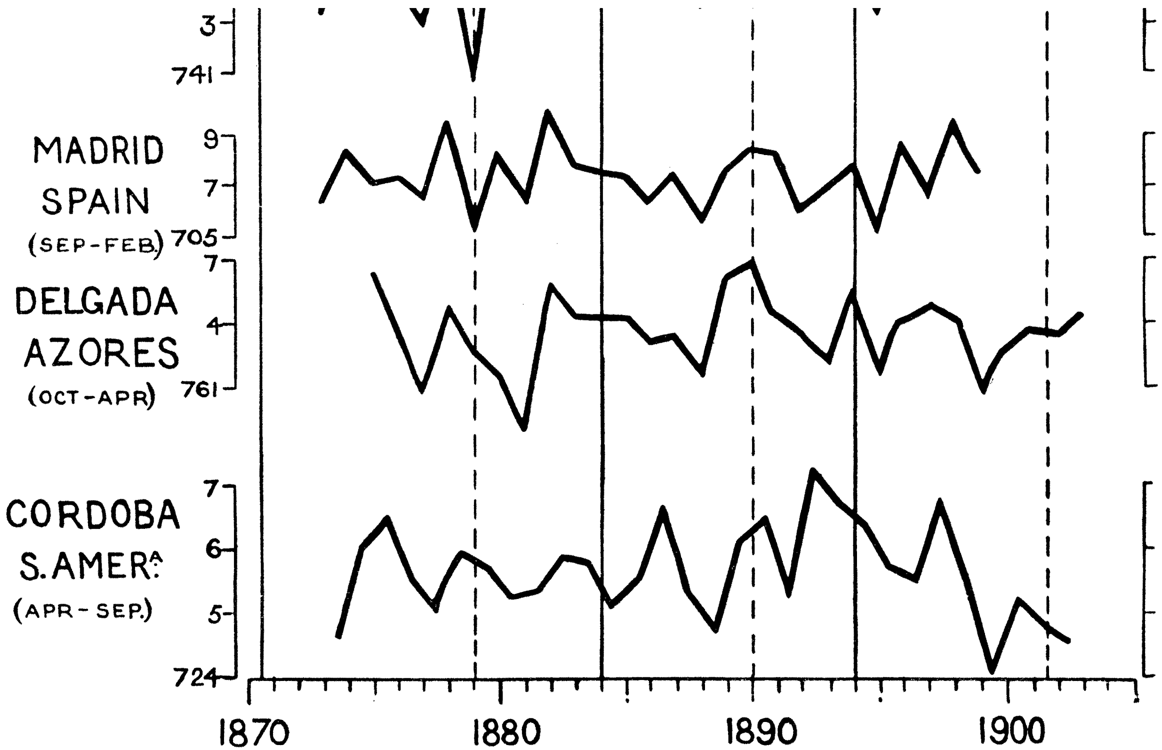
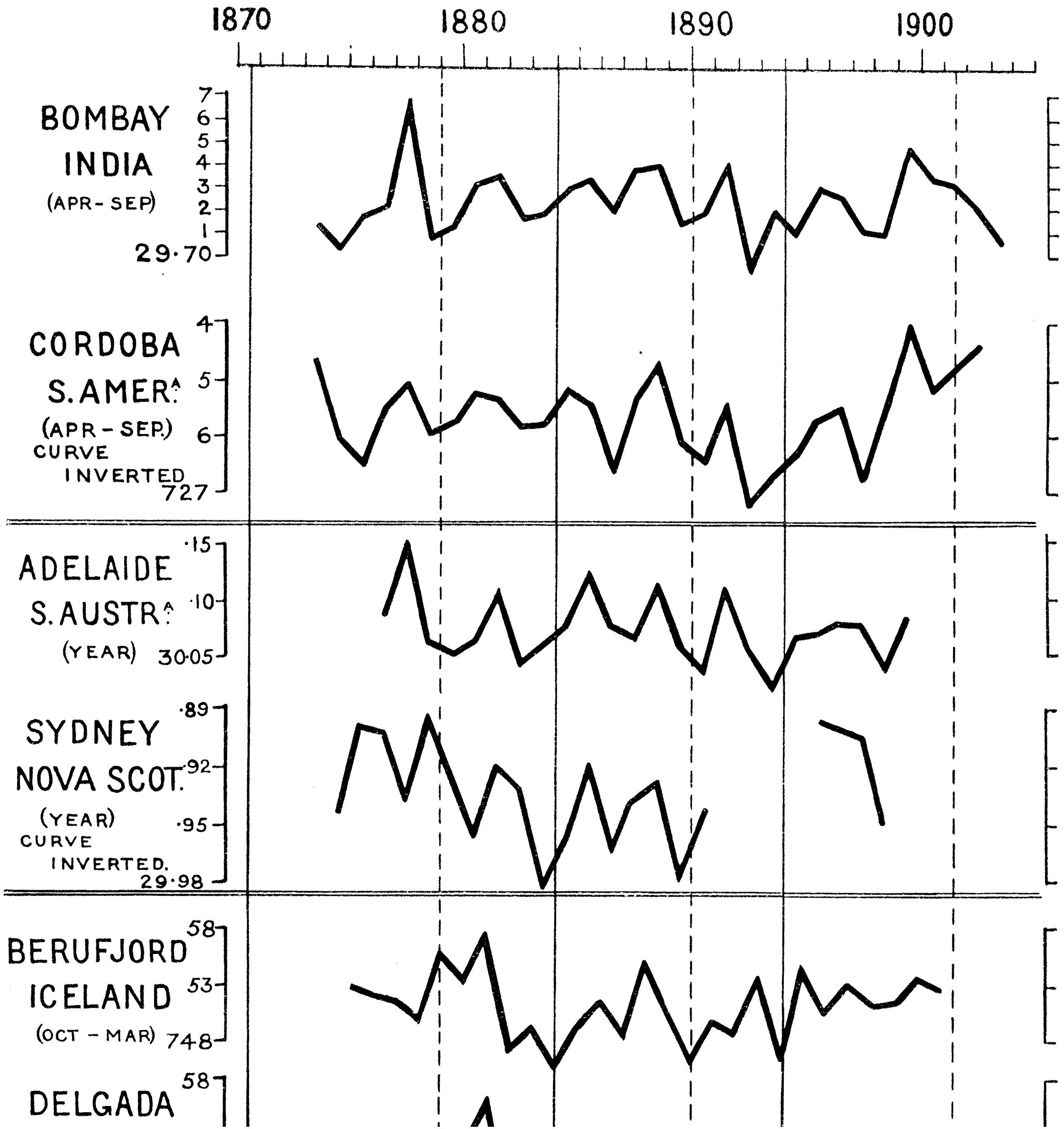



PLATE 12.—Shewing the Relationship between the Short Period Pressure Variations for places in Western Europe, and the two Main Types of Pressure Variations, namely: India (+) and Cordoba (−). This Plate should be studied in relation to the map in fig. 1. *Note.*—The continuous and broken vertical lines denote the epochs of sunspot maxima and minima as determined from the mean daily areas of both hemispheres of the sun.

Roy. Soc. Proc., vol. 73, Plate 13.



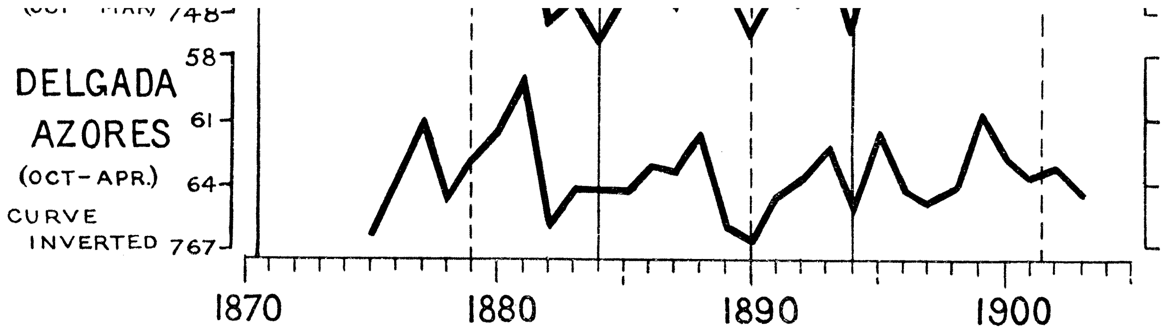



PLATE 13.—Three pairs of Curves to illustrate Reverse Pressure Conditions at stations widely separated geographically, such as India and Cordoba (S. America), Adelaide (S. Australia) and Sydney (Nova Scotia), and at two stations near each other, as Berufjord (Iceland) and Delgada (Azores). In each case the second curve has been reversed. *Note.*—Vertical lines same as in Plate 12.

and 7 are given the groups of months (whether high or low pressure months) in each case for which the pressure curves examined afforded the greatest resemblance to the types which form the basis of the classification. In cases in which the curves of the mean yearly values alone have been utilised, these columns have been left blank and reference made in the column headed "General Remarks."

Although the above classification gives a very fair idea on the whole of the types of pressure variations from one region to another, minor peculiarities have been met with which have tended to add a certain amount of difficulty.

These remarks apply principally to places in the more northern latitudes.

Thus, for instance, Greenland and Iceland have been classified as of the (+?) type, the British Isles, Germany, and Spain of the (±?) type, and the Azores of the (−?) type. From a glance at the accompanying plate (Plate 12), which shows the relation to each other of some of the pressures over these areas, the changes from a (−?) to a (+?) type can be observed.

It will be seen that although practically the same groups of months have been taken in each case, pressure in excess of the mean value in Greenland or Iceland corresponds to a deficiency of pressure over the area covered by Great Britain, Austria and Spain, the curves being in the main the reverse of each other. Again, the pressure curve for the Azores follows more nearly the (−) type, as will be seen by comparing it with the Cordoba curve, but it has a certain similarity to those of Madrid, Vienna, etc., to which it must therefore be closely connected.

While the western portion of Europe is of this (±?) type, the eastern portion gradually assumes the (−?) type, and this region extends not only probably to Norway and Sweden, but right across European and Asiatic Russia. The European Russian type of curve has an undoubted similarity to those of more Western Europe, but there are variations which indicate that the type is more like that of Cordoba than India.

Again, another region in which rather mixed types of pressures are met with is that of Eastern and North-eastern Canada. Curiously enough Prince Edward Island and Sydney (Nova Scotia) correspond very closely to the (−) type, if allowance be made for the differences about the year 1877.

The inverted curve for the latter with the Adelaide (Australia) pressure curve for comparison is shown in an accompanying plate (Plate 13).

In addition to illustrating this reversal between Adelaide (+) and Sydney (Nova Scotia) (−?), this plate shows also, to serve as examples, curves for two other sets of reverse pressure conditions. Thus

Analysis of

| Country. | Station. | Type. | Remarks on type. | Period of observations. |
|---|---|---|---|---|
| India ....... | Bombay ............ | + | Chief (+) type, see Plate 13 | 1860—1903 |
| | Madras ............. | + | .. .. | 1861—1902 |
| | Calcutta ............ | + | .. .. | 1860—1902 |
| | Nagpur ............. | + | .. .. | 1869—1903 |
| | Darjeeling .......... | + | .. .. | 1875—1901 |
| Ceylon ....... | Colombo ............ | + | .. .. | 1881—1900 |
| Persia ....... | Bushire ............. | + | .. .. | 1879—1887 |
| Arabia ....... | Aden ............... | + | .. .. | 1883—1899 |
| Indian Ocean | Seychelles ........... | + | .. .. | 1885—1898 |
| | Rodriguez .......... | + ? | .. .. | 1885—1898 |
| | Mauritius ........... | + | .. .. | 1875—1901 |
| East Indies... | Batavia ............ | + | .. .. | 1866—1898 |
| Philippines... | Manila ............. | ± ? | .. .. | 1883—1901 |
| Malay Penin. | Singapore .......... | + | .. .. | 1869—1902 |
| Australia .... | Perth .............. | + | Slight differences ....... | 1876—1900 |
| | Adelaide ............ | + | Remarkably pronounced, see Plate 13 | 1876—1899 |
| | Sydney ............. | + | .. .. | 1860—1899 |
| New Zealand | Dunedin ............ | ? | Difficult to classify ...... | 1866—1898 |
| | Auckland ........... | ? | ,, ,, ...... | 1867—1903 |
| Africa ....... | Zanzibar (Island) .... | + ? | .. .. | 1880-3—1891-7 |
| | Durban ............ | + | .. .. | 1884—1903 |
| | Capetown ........... | + ? | .. .. | 1860—1899 |
| | Cairo .............. | + ? | .. .. | 1869—1898 |
| | Alexandria ......... | ± ? | .. .. | 1870—1896 |
| | Biskra ............. | ± ? | .. .. | 1874—1884 |
| | Sierra Leone ......... | − ? | .. .. | 1876—1900 |
| | St. Thomas (Island) .. | (+ ?) | .. .. | 1874—1883 |
| | Kimberley .......... | + ? | .. .. | 1876—1899 |
| | St. Paul de Loando... | + ? | .. .. | 1880—1895 |
| South America | Cordoba ............ | − | Chief (−) type, see Plate 13 | 1873—1902 |
| | Tugumen ........... | − | Distinctly like Cordoba .. | 1885—1897 |
| | Goya .............. | − | Exactly like Cordoba .... | 1877—1897 |
| | Santiago ........... | − | .. .. | 1874—1884 |
| | Rio de Janeiro ...... | − ? | .. .. | 1860—1899 |
| West Indies .. | Jamaica ............ | − ? | .. .. | 1866—1900 |
| | Barbadoes .......... | ? | .. .. | 1865—1900 |

Pressure Types.

| Months in which types are most conspicuous. | | Source of data. | General remarks. |
|---|---|---|---|
| Apr.—Sept. | Low press. | Indian Monthly Weather Reviews | Type equally prominent in curve for year. |
| ,, | ,, | ,, ,, | ,, ,, |
| ,, | ,, | ,, ,, | ,, ,, |
| .. | .. | ,, ,, | Yearly curve only examined. |
| .. | .. | ,, ,, | ,, ,, |
| Apr.—Sept. | Low press. | ,, ,, | Type equally prominent in curve for year. |
| Oct.—Mar. | High press. | ,, ,, | Record very short. |
| Apr.—Sept. | Low press. | ,, ,, | Equally prominent in yearly and Oct.—Mar. curves. |
| .. | .. | Mauritius Met. Obsns. ........ | Yearly curve alone examined. |
| .. | .. | ,, ,, ....... | Short and uncertain record. Yearly curve examined. |
| May—Oct. | High press. | ,, ,, ....... | Prominent in yearly curve. |
| June—Oct. | ,, | Meteorological Office ........ | ,, ,, |
| .. | .. | Report of Philippine Commission | |
| .. | .. | Met. Obsns. at Straits Settlements | ,, ,, |
| Apr.—Sept. | High press. | Met. Obsns. at Perth and district | |
| ,, | ,, | Met. Obsns. at Adelaide...... | Very prominent in yearly curve. |
| ,, | ,, | Met. Obsns. in New South Wales | ,, ,, |
| .. | .. | New Zealand Statistics (Met.) | 1877 pulse absent. |
| .. | .. | Met. of New Zealand ...... | |
| Nov.—Apr. | Low press. | Indian Monthly Weather Reviews | Record very broken and short. |
| Oct.—Mar. | ,, | Report of Govt. Astronomer, Natal | |
| Apr.—Sept. | High press. | Meteorological Office ........ | Broken record, 1871—1877. |
| ,, | Low press. | Met. Report of Abassia Obsy., Cairo | |
| ,, | ,, | Met. Zeitschrift, 1897 ....... | |
| Oct.—Feb. | High press. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | Record too short. |
| .. | .. | Army Medical Dept. Reports | Yearly curve alone examined. |
| Nov.—May | Low press. | Lisbon Met. Obsns. .......... | Record too short. |
| .. | .. | .. .. .. | Yearly curve alone examined. |
| .. | .. | Supplement to Annals of Lisbon Observatory and Loanda Met. Obsns. | ,, ,, |
| Apr.—Sept. | High press. | Anales de l'Oficina Met. Argentina, vol. xiii | |
| ,, | ,, | Anales de l'Oficina Met. Argentina | Broken record. |
| ,, | ,, | ,, ,, | Continuous good record. |
| May—Oct. | ,, | Kong Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | |
| May—Sept. | ,, | Meteorological Office ........ | |
| .. | .. | Army Medical Dept. Reports | Yearly curve alone examined. Two short breaks in record. |
| .. | .. | ,, ,, | ,, ,, |

Analysis of Pressure

| Country. | Station. | Type. | Remarks on type. | Period of observations. |
|---|---|---|---|---|
| North America | Jacksonville | – | Some slight differences .. | 1873—1899 |
| | Mobile | – | ,, ,, .. | 1873—1899 |
| | Pensacola | – | ,, ,, .. | 1880—1899 |
| | Nashville | – ? | Marked differences | 1873–1899 |
| | San Diego | – | Slight differences | 1873—1899 |
| | St. Louis | – ? | Marked differences | 1873—1899 |
| | Bismarck | – ? | ,, ,, | 1875—1899 |
| | Kansas City | ± ? | .. .. | 1890—1899 |
| | Boise | – ? | .. .. | 1878—1890 |
| | Salt Lake City | – ? | Slight differences | 1874—1899 |
| | Santa Fé | – | Close resemblance | 1873—1899 |
| | Denver | – ? | .. .. | 1863—1899 |
| | Portland | ± ? | Equally like both types .. | 1873—1899 |
| | Galveston | – | Some slight differences... | 1873—1899 |
| | Alpena | ± ? | Difficult to determine.... | 1873—1899 |
| | Buffalo | ± ? | ,, ,, .... | 1873—1899 |
| | Pikes Peak | ± ? | ,, ,, .... | 1874—1887 |
| | Ft. St. Michaels (Alaska) | + ? | .. .. | 1874—1884 |
| Atlantic Ocean | Bermuda | – | Undoubtedly this type... | 1866—1899 |
| Canada | Toronto | ± ? | .. .. | 1874—1890 |
| | Fort Garry (Manitoba) | ± ? | .. .. | 1874—1891 |
| Nova Scotia .. | Sydney | – ? | See Plate 13 | 1874—1898 |
| Sandwich Isles | Honolulu | – | 1877 Indian pulse present | 1873—1901 |
| Tahiti | Papeete | ± ? | Like India, one year in advance | 1876—1891 |
| Greenland | Jacobshavn | ? | .. .. | 1873—1897 |
| | Godthaab | + ? | Very like Jacobshavn, see Plate 12 | 1873—1895 |
| Iceland | Stykkisholm | + ? | Very slight differences, 1877 present, see Plate 12 | 1874—1901 |
| | Berufjord | + ? | Very slight differences, 1877 present, see Plate 13 | 1874—1901 |
| Europe | Tromso | ± ? | .. .. | 1874—1898 |
| | Vardo | – ? | .. .. | 1870—1898 |
| | Aalesund | + ? | .. .. | 1861—1898 |
| | Stornoway | ± ? | 1877 pulse absent | 1863—1903 |
| | Aberdeen | ± ? | Very slight differences, 1877 absent | 1869—1899 |
| | Armagh | ± ? | ,, ,, | 1869—1903 |
| | Stonyhurst | ± ? | .. .. | 1885—1902 |
| | Valencia | ± ? | See Plate 12 | 1868—1899 |
| | Palermo | ± ? | .. .. | 1874—1884 |
| | Madrid | ± ? | Remarkable likeness to (–) at times, see Plate 12 | 1860—1899 |
| | Gibraltar | – ? | Like Oct.—Apr., Azores.. | 1864—1900 |
| | Lisbon | – ? | .. .. | 1860—1896 |
| | Vienna | ± ? | See Plate 12 | 1860—1901 |
| | Constantinople | + ? | .. .. | 1874—1884 |

Types—*continued.*

| Months in which types are most conspicuous. | | Source of data. | General remarks. |
|---|---|---|---|
| Nov.—Feb. | High press. | Report of Chief of Weather Bureau, U.S.A. | |
| Oct.—Mar. | ,, | ,, ,, | |
| Nov.—Mar. | ,, | ,, ,, | |
| Sept.—Feb. | ,, | ,, ,, | |
| Nov.—Apr. | ,, | ,, ,, | |
| (Mar.—Aug.) | (Low press.) | ,, ,, | |
| Apr.—Sept. | Low press. | ,, ,, | |
| .. | .. | ,, ,, | Short record. |
| Oct.—Mar. | High press. | ,, ,, | ,, |
| May—Oct. | Low press. | ,, ,, | |
| Dec.—May | .. | ,, ,, | Record broken, 1882—1885. |
| June—Nov. | High press. | ,, ,, | |
| .. | .. | ,, ,, | Yearly mean curve alone examined. |
| Oct.—Mar. | High press. | ,, ,, | |
| .. | .. | ,, ,, | ,, ,, |
| .. | .. | ,, ,, | ,, ,, |
| .. | .. | ,, ,, | Short record. |
| .. | .. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | Yearly curve alone examined. Broken record. |
| Dec.—Mar. | High press. | Army Medical Dept. Reports | Record somewhat broken. |
| .. | .. | Report of Met. Service of Dom. of Canada | Yearly curve alone examined. |
| .. | .. | ,, ,, | ,, ,, |
| Aug.—Nov. | High press. | ,, ,, | Record broken after 1891. |
| Aug.—Feb. | Low press. | Met. Obsns., Honolulu ....... | Record twice broken. |
| .. | .. | Met., Zeitschrift, 1892 ...... | Yearly mean curve examined. |
| .. | .. | Danish Met. Aarbog ......... | Record broken, 1883—1887. |
| Oct.—Mar. | Low press. | ,, ,, | ,, 1874—1875. |
| Apr.—Sept. | High press. | ,, ,, | |
| ,, | ,, | ,, ,, | |
| Sept.—Mar. | Low press. | Met. Aarbog Norsk | |
| ,, | ,, | ,, ,, | |
| Apr.—July | High press. | ,, ,, | |
| .. | .. | MSS. Met. Office Records .... | Yearly curve alone examined. |
| Apr.—Sept. | High press. | ,, ,, | |
| ,, | ,, | ,, ,, | |
| .. | .. | Results of met. and mag. observations, Stonyhurst | ,, ,, |
| Apr.—Sept. | High press. | MSS. Met. Office Records .... | |
| .. | .. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | |
| Mar.—Aug. | Low press. | Madrid Met. Obsns. ......... | |
| .. | .. | Army Medical Dept. Reports. | ,, ,, |
| .. | .. | Lisbon Met. Obsns. ......... | |
| .. | .. | Denkschriften Kaiserlichen Ak. de Wissenschaften | |
| Apr.—Sept. | Low press. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3. | Short record of definite type. |

Analysis of Pressure

| Country. | Station. | Type. | Remarks on type. | Period of observations. |
|---|---|---|---|---|
| North Atlantic | Azores | − ? | Remarkable, undoubted (−), see Plates 12 and 13 | 1874—1903 |
| | Las Palmas | − ? | .. .. | 1882—1892 |
| Russia | St. Petersburg | − ? | .. .. | 1870—1899 |
| | Moscow | − ? | .. .. | 1870—1899 |
| | Tarchankut | ? | Difficult to classify | 1874—1884 |
| | Lugansk | − ? | .. .. | 1872—1899 |
| | Orenbourg | − ? | .. .. | 1870—1899 |
| | Catherinbourg | − ? | .. .. | 1870—1899 |
| | Arkangel | − ? | .. .. | 1871—1899 |
| Siberia | Tomsk | − ? | .. .. | 1874—1899 |
| | Barnaoul | − ? | .. .. | 1870—1899 |
| | Nertchinsk | − ? | .. .. | 1870—1899 |
| China | Pekin | ? | .. .. | 1874—1881 |
| | Zi-ka-wei | + ? | .. .. | 1874—1884 |
| | Hong-Kong (Island) | − | Exactly like Cordoba | 1884—1903 |
| Japan | Tokio | ± ? | .. .. | 1873—1895 |
| | Kioto | ± ? | .. .. | 1883—1899 |

Bombay (+) is compared with the Cordoba (−) pressure curve (inverted), and is an example of the adopted types of pressure variation. Iceland is compared with that of the Azores (inverted), and shows the reverse conditions that prevail between a (+ ?) type and (− ?) type.

A fact to which attention was very often drawn in attempting to classify the pressure curves was that some curves after following very closely for many years the Cordoba (−) or Indian (+) type of pressure, as the case may be, would revert back to the opposite type for a period of years. Thus to take the case of one station alone, namely, Sydney (Nova Scotia) as an instance, the pressure curve follows very closely that of India from 1875—1882, after which up to 1890 it has a very close resemblance to the Cordoba type. The behaviour of this Sydney (Nova Scotia) pressure curve can be compared with the Adelaide (Australia) curve in Plate 13, but it must be noticed that the former has here been *inverted*.

There is another important fact which this study has brought to

Types—*continued.*

| Months in which types are most conspicuous. | | Source of data. | General remarks. |
|---|---|---|---|
| Oct.—Apr. | Low press. | Annales de l'Obsy. do Infante D. Luiz | Prominent in yearly curve. |
| .. | .. | Resumé de las Obs. Met. de Provinces (Spanish) | 1886 no record. |
| .. | .. | Annales de l'Obsy. Cent. Phys. de Russe | Yearly curve alone examined. |
| Sept.—Feb. | High press. | " " | |
| .. | .. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | |
| Oct.—Mar. | High press. | Meteorological Office ........ | |
| .. | .. | Annales de l'Obsy. Cent. Phys. de Russe | Break in record 1875—1887. Yearly curve alone examined. |
| .. | .. | " " | Yearly curve alone examined. |
| Jan.—June | High press. | Meteorological Office ........ | |
| Oct.—Mar. | " | " " | Prominent in yearly curve. |
| " | " | " " | " " |
| Apr.—Sept. | Low press. | " " | |
| .. | .. | Annales de l'Obs. Cent. Phys. de Russe | |
| Oct.—Mar. | High press. | Kong. Sv. Vet. Ak. Handlingar, vol. 29, No. 3 | Short record. Prominent in yearly curve. |
| Apr.—Sept. | Low press. | Met. Zeitschrift, 1886, and Observations made at Hong-Kong Observatory | Visible in yearly curve. |
| " | " | Met. Zeitschrift, 1899........ | |
| .. | .. | Report of Cent. Met. Obsy. of Japan. | All the curves for the half-yearly and yearly values show similar variations. |

light and which plays most probably an important *rôle* with regard to the pressure variations at places which exhibit a mixed type of pressure. The earth's surface as has been shown may be divided mainly into two regions, one portion showing excess pressures at certain epochs, while the other shows deficient pressure at the same epochs. If the former region exhibits a greater excess than usual (as an example, the Indian region in 1877), then the region over which this type of pressure occurs may probably be more extensive, and the boundary dividing the two chief types of pressure will necessarily be pushed away from this region. Stations, therefore, that were just on the fringe of this boundary may at these epochs become enveloped in this more extensive high-pressure area, and will exhibit the Indian type of pressure variation.

Should the Cordoba region become more extensive than usual owing to a similar cause, then the border stations will assume the Cordoba type of pressure variation. It is not proposed to enter here into detail on this point, as the subject requires very close examination, but

mention may be made of the very great area which was covered by the continuous excessive high pressure that prevailed over the Indian region from the end of 1876 to about the middle of 1878.

On fig. 1 is given a map of the world on which are marked the types of pressure variations in each region which is included in this barometric survey.

An attempt has been made by means of a neutral line to show approximately the mean lines of separation of these two chief pressure types, although it must be remembered that this line is liable to a probable small oscillation about its mean position.

As far as can at present be determined, one line commencing to the west of Alaska, separating this region from Siberia, passes easterly along about the 60° parallel of latitude and runs in a south-easterly direction between South-west Greenland and North-east Canada. It then crosses the North Atlantic, passing to the north of the Azores, and skirts the south-western portion of Portugal. It then strikes down towards the Equator, cutting North-west Africa, as far as can be judged from the scant pressure values available, through the middle of the Sahara. It leaves Africa near the Gold Coast, passes into the South Atlantic, where it cannot be traced further owing to lack of observations in this southern ocean.

The other boundary or neutral line passes to the north-east of Greenland and north of Iceland, crosses the southern portion of Norway and Sweden, and traverses Southern European Russia. It then takes a course somewhat more easterly, skirting the northern part of the Caspian Sea and Turkestan, passes between Tibet and Mongolia, and through China. It then leaves the Continent a little to the south of the Yellow Sea, and passes into the North Pacific Ocean. Here its path cannot be traced, but it evidently passes well to the east of the Philippine Islands, and Solomon Islands, takes a new south-westerly course, skirting the eastern side of Australia and passing between Tasmania and New Zealand. Its track is then again lost in the Southern Pacific Ocean.

Although too much weight must not at present be given to the positions of these neutral lines throughout their whole length, it is interesting to note that they are fairly symmetrical to one another although no attempt has been made to make them so.

Both lines apparently cross the equator at about antipodal points, and both appear to have a similar trend in northern and southern latitudes.

We seem then to be in presence of a general law relating to the pressures which occur simultaneously in two different regions of the globe, separated and defined more or less by a neutral line, this neutral line forming a fulcrum about which see-saws of pressure from one region to another take place. Special cases of such reverse pressure variations have been previously detected.

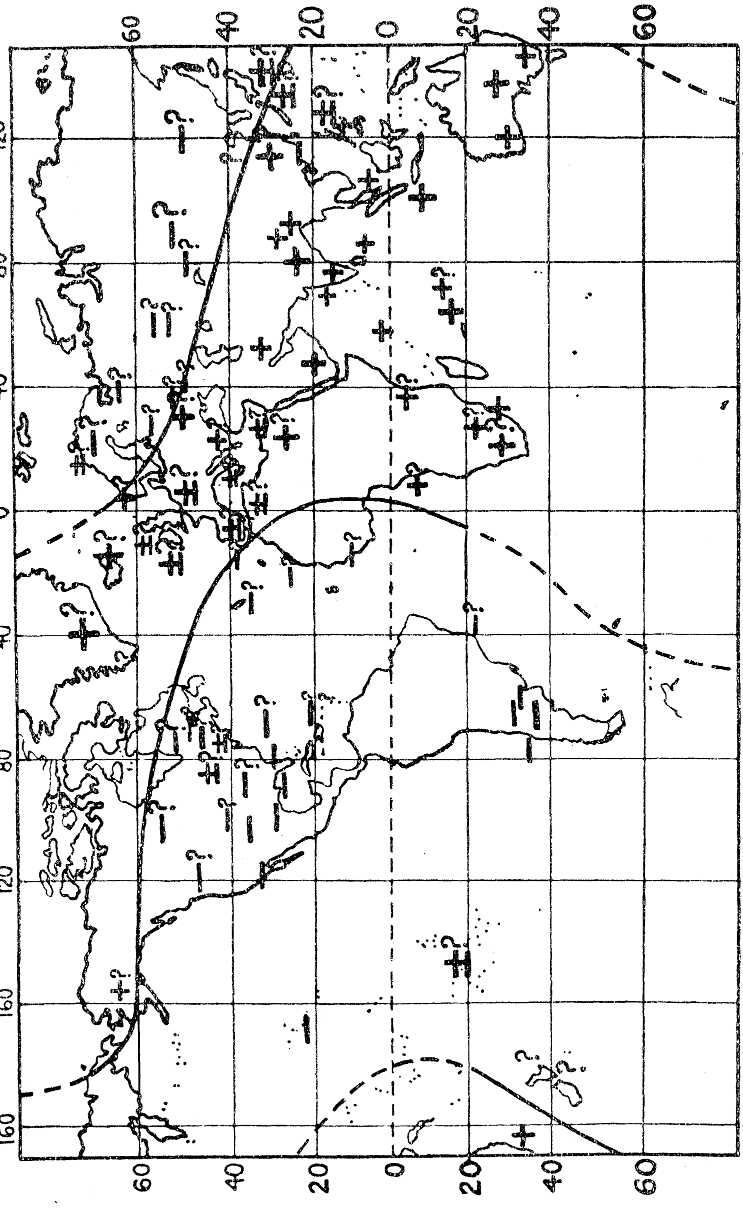



Fig. 1.—Illustrating the Distribution of the two Main Types of Atmospheric Pressure Variations. The symbols signify:—(+) like India, (+ ?) more like India than Cordoba, (−) like Cordoba, (− ?) more like Cordoba than India, (± ?) mixture of India and Cordoba, (?), difficult to classify.

Thus as long ago as 1879 Blanford,* from a discussion of the secular variations of barometric pressure over the wide area covering Siberia, Indo-Malaysia and Australia, pointed out that there existed a kind of long-period see-saw of a character that, while the pressure at the tropical stations was low, that in Siberia was high, and *vice versâ*. This fact, it will be seen, is quite in harmony with the pressure-type distribution, as shown in the accompanying map (fig. 1).

Hildebrandsson† has discussed the relation between the pressure variations of numerous places mainly situated in the chief centres of action of the atmosphere widely distributed on the earth's surface for the period 1874—1884. In this valuable communication, some of the chief results which he was led to deduce were that there were several regions which exhibited opposite types of pressure variations.

The following places are those to which he calls attention, and for comparison we give the types in brackets which have been allotted according to the method adopted in the present paper; where no type is added the region has not been examined :—

The Azores (– ?) and Iceland (+ ?); Siberia (– ?) and Alaska (+ ?), especially in winter; Tahiti (± ?) and Tierra del Fuego; India (+) and Siberia (– ?); Greenland (+ ?) and Key West (Florida) (–); Buenos-Ayres (– ?) and Sydney (Australia) (+).

It is interesting to note that these results agree well in the main with the present distribution of the regions which have been examined.

Again Hann‡ has recently drawn attention to the fact that there exists a see-saw between the Azores and Iceland, and he showed that in 80 per cent. of cases the largest positive pressure variations at Stykkisholm (Iceland), corresponded to negative pressure variations at Ponta Delgada (Azores), and that the largest negative pressure variations at Stykkisholm were in 87 per cent. of cases positive variations at Ponta Delgada.

This result obtained from the observations extending from 1846—1900 endorses Hildebrandsson's previous conclusion deduced from observations over the period 1874—1884, and confirms the position of the neutral line shown on fig. 1, dividing the two large types of pressure areas.

Quite recently Professor Bigelow§ has published a map of the world on which he has indicated the distribution of the pressure types according as they follow the Indian (or direct type, as he calls it) or the Cordoba (indirect) pressure variations.

Professor Bigelow has also found that there are many regions in

* 'Report of the Meteorology of India in 1878,' pp. 2—35.

† "Quelques Recherches sur les Centres d'Action de l'Atmosphère," 'Kongl. Svenska Velenskaps-Akad. Handlingar,' vol. 29, No. 3.

‡ 'Kaiserliche Akademie der Wiss. in Wien,' January 7, 1904.

§ 'Monthly Weather Review,' p. 509, November, 1903.

which it is very difficult to say exactly which type is followed, and as he says there may be "differences of opinion as to the assignment of some of these curves, but the reader can make any different arrangement that he prefers."

In most of the main features, however, his map suggests a somewhat similar distribution of these pressure types to that given here. Thus, he finds that "the region around the Indian Ocean gives direct synchronism, South America and North America give inverse synchronism, while Europe and Siberia give an indifferent type. Greenland and Iceland seem to have direct type like the Indian Ocean . . . .

"The eastern hemisphere tends to direct synchronism, except in Europe and Russia where the indifferent type prevails, and the western hemisphere to the inverse type."

It may be further pointed out that regions which are the reverse of one another as regards these secular pressure variations should very probably experience opposite kinds of abnormal weather, while those over which the same type of pressure variation exists should have weather of an abnormal but similar nature.

That this is inclined to be so as regards the latter statement has been recently* very forcibly pointed out by Sir John Eliot with respect to the Indian area. He writes:—

"The drought of 1895—1902 was a more or less general meteorological feature of the whole area, including Abyssinia, East and South Africa, Afghanistan, India, probably Tibet, and the greater part or whole of Australia."

The whole of this region, as will be seen from the accompanying map (fig. 1), is embraced by the (+) type of pressure.

In the light, therefore, of the existence of these large regions of opposite pressure types, it is vital in the interest of long-period forecasting that observations from all portions of the globe should be included in any discussion.

Several years ago Eliot† drew attention to these oscillations of pressure of long period, other than the diurnal and annual oscillations in India. In this important memoir he pointed out that "they are directly related to the largest and most important features of the weather in India, viz., the character and distribution of the precipitation of rain and snow in the Indian monsoon area."

There is reason, therefore, to believe that this short period pressure variation will in the future be of considerable assistance in helping

* 'Broad Views,' p. 193; 'The Meteorology of the Empire during the Unique Period 1892—1902,' by Sir John Eliot, K.C.I.E., F.R.S.

† "A Preliminary Discussion of certain Oscillatory Changes of Pressure of Long Period and of Short Period in India," 'Indian Met. Memoirs,' vol. 6, part 2, 1895.

meteorologists to form a more definite idea of the prospects of approaching seasons.

We wish to express our thanks to Dr. W. N. Shaw, F.R.S., who has kindly assisted the work by permitting us to utilise the valuable collection of pressure data deposited in the archives of the Meteorological Office.

We also owe a debt of gratitude to Messrs. W. Moss and T. F. Connolly, who have shown great zeal in completing the necessary computations and drawing the numerous curves which were required for the different stations that have been investigated.

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"The Spectrum of the Radium Emanation." By Sir William Ramsay, K.C.B., F.R.S., and Professor J. Norman Collie, F.R.S. Received May 18,—Read May 19, 1904.

Attempts have been made since July, 1903, to see and map the spectrum of the emanation from radium, for at that date the conversion of the emanation into helium was observed by Ramsay and Soddy, and during the first discharge of the induction current through the emanation, it was believed that a peculiar spectrum was noticed; indeed, three lines were persistent, and were mentioned in the communication on the subject in these 'Proceedings.'

But such attempts have uniformly failed; at the first moment of the discharge, indeed, a brilliant spectrum has twice been observed, which soon became confused and indistinct. It faded before it was possible to map it, and owing to the presence of impurities, generally carbon monoxide, nitrogen, or hydrogen, the special spectrum was obscured. All that could be said was that it appeared to present some brilliantly green lines.

These experiments, however, have not been fruitless; they have led to better knowledge of the precautions which it is necessary to take to eliminate impurities. The arrangement of the apparatus, too, has been simplified, and the manipulation made easier. As it is possible that others may wish to repeat the experiments, and may perhaps have even better success in mapping the spectrum, we think it well to enter into the details of the manipulation somewhat minutely, and to give a woodcut of the apparatus employed.

The stock of radium bromide (about 109 milligrammes) dissolved in about 10 c.c. of water in two small bulbs was attached by sealing to a small Töpler's pump. Between the pump and the bulb there was a stop-cock, greased, of course, to insure freedom from leakage; but in order to prevent the long contact of the emanation with the stop-cock, and its possible contamination with carbon dioxide, the mercury from

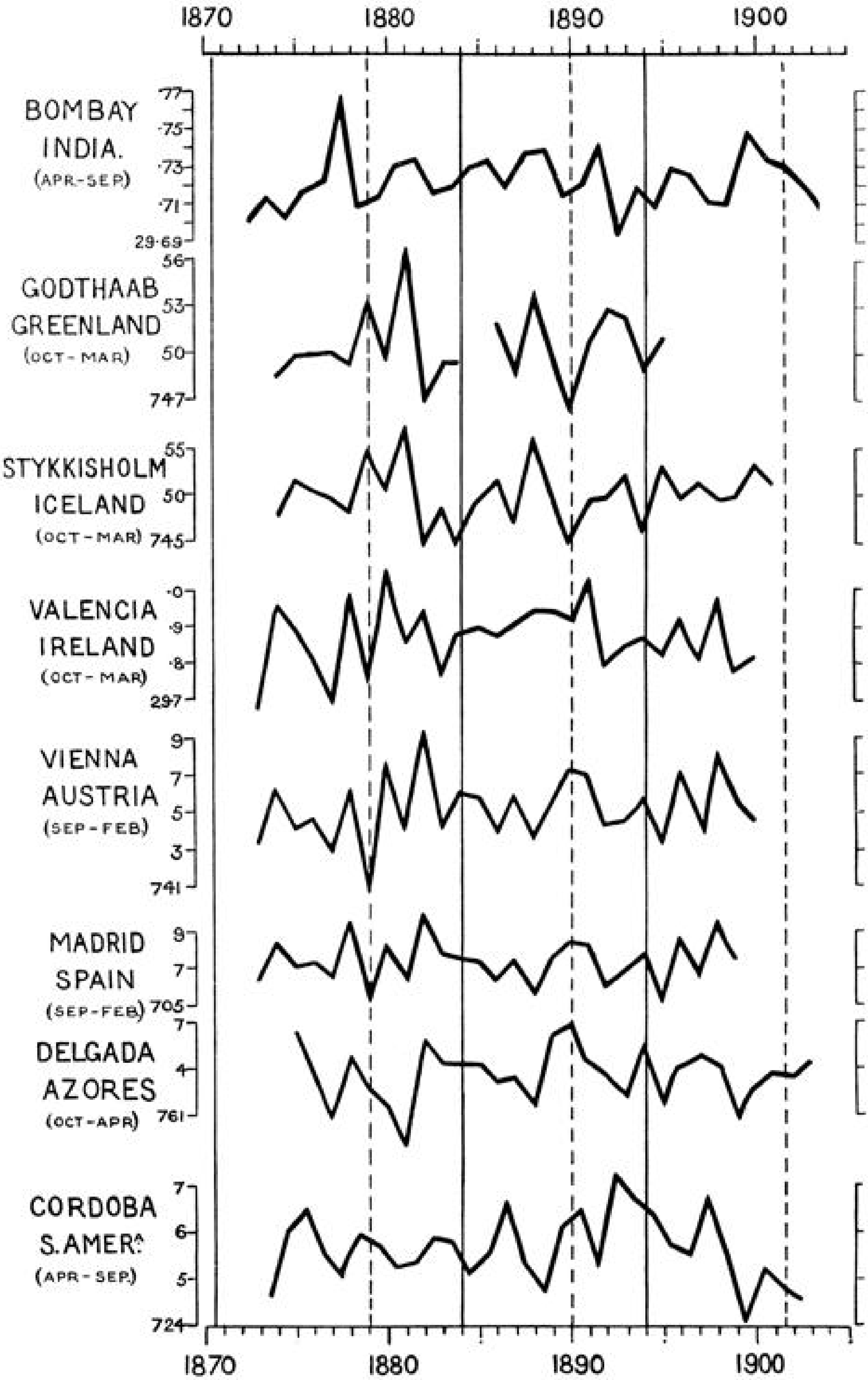


PLATE 12.—Shewing the Relationship between the Short Period Pressure Variations for places in Western Europe, and the two Main Types of Pressure Variations, namely: India (+) and Cordoba (−). This Plate should be studied in relation to the map in fig. 1. *Note.*—The continuous and broken vertical lines denote the epochs of sunspot maxima and minima as determined from the mean daily areas of both hemispheres of the sun.

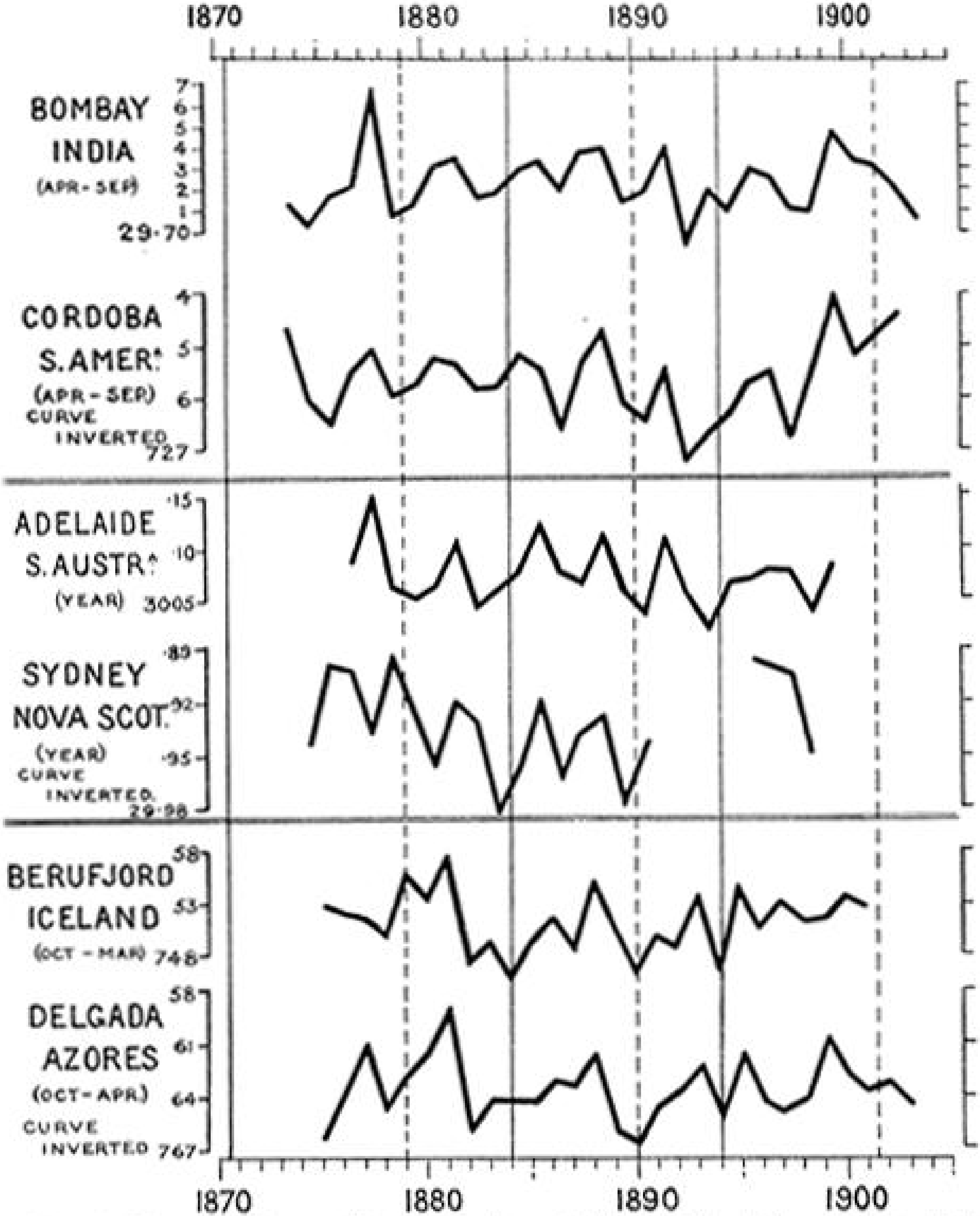


PLATE 13.—Three pairs of Curves to illustrate Reverse Pressure Conditions at stations widely separated geographically, such as India and Cordoba (S. America), Adelaide (S. Australia) and Sydney (Nova Scotia), and at two stations near each other, as Berufjord (Iceland) and Delgada (Azores). In each case the second curve has been reversed. *Note.*—Vertical lines same as in Plate 12.