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CORRELATION IN SEASONAL VARIATIONS OF WEATHER, IX.

A FURTHER STUDY OF WORLD WEATHER.

BY

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CHAPTER I.

Introduction.

In Vol. XXIV, Part IV of these memoirs a preliminary study was made of the relationships between 17 centres of action, of which 15 were centres for pressure and 2 for rainfall. The data examined were in general seasonal, the year being divided into the four quarters December to February, March to May, June to August and September to November: and attention was mainly confined to the conditions during winter and summer. Tables were given of the correlation coefficients between data for each centre of action during both these seasons with the contemporary, previous and succeeding summer or winter seasons at all the other centres.

Since this memoir was published it has been possible to carry the survey of relationships a stage further, and in the following tables will be found data for every quarter o the year ; thus in the table for any one quarter at any station will be found the relationships of conditions there during that quarter with those at other centres during the seasons two and one quarter earlier, during the contemporary quarter, and during the seasons one and two quarters later. An extension has also been made in the centres admitted.

2. Before examining the following tables in detail it is advisable to consider what values we must expect in the correlation coefficients before we can place confidence in them. If we examine the column in section 6 giving the number of years of data used in the correlations with Iceland pressure we shall see that apart from Alaska and Samoa, with 22 and 20 years respectively, the average is about 43 years : and it will be advisable to treat in separate classes coefficients based on 20 and on 43 years, the probable value of

a coefficient based on random data being ·151 and ·103 for the short and the long series respectively. In the Alaska or Samoa tables there will be in the column for contemporary quarters about 17 coefficients with other places, based on data of about 20 years; so that the probable value of the greatest of 17 random coefficients* is ·151 × 3·04, or ·459. The reality of these coefficients may be further discussed by comparing them with the indications of Table IA in which it is given, for example, that the probability of the occurrence of at least one coefficient exceeding ·6, if the data were entirely random, would be ·117; the chance that two random coefficients would exceed this amount is ·0067, and for three coefficients ·00024. Similarly when we are handling relationships between seasons one quarter removed there will be in the tables of Alaska or Samoa about 35 coefficients based on about 20 years' data, and for discussing these we used the figures of Table IB. For relationships between seasons two quarters removed the numbers of coefficients will be the same as for seasons once removed and Table IB is appropriate.

When handling the table of coefficients of a station with a long series it will be simplest to treat the reality of its coefficients with Alaska or Samoa as disposed of in the tables already described; there will then be about 15 coefficients for contemporary quarters based on about 43 years, and about 31 coefficients for seasons one quarter apart as well as for seasons two quarters apart. The corresponding probabilities of the appearance of coefficients of various magnitudes will be found in Tables II A and B. The discussion of the reality of the coefficients in each table will be found after the table, those of Iceland and Alaska, as the first of the long and of the short series, being given at the greatest length.

TABLE I.

Data of 20 years. Probable value of a random coefficient ·151.

A. For 17 random coefficients. Probable value of greatest ·459.
Probability that a number of coefficients will exceed definite amounts.

Number of coefficients.	AMOUNTS.				
	·5	·55	·6	·65	·7
1	·354	·219	·117	·0603	·0293
2	·0683	·0229	·0067	·00175	·00041
3	·0077	·0016	·00024	·00008	..
4	·0012	..	..	..	..

B. For 35 random coefficients. Probable value of greatest ·523.
Probability that a number of coefficients will exceed definite amounts.

Number of coefficients.	AMOUNTS.				
	·5	·55	·6	·65	·7
1	·593	·387	·226	·120	·0593
2	·223	·0851	·0270	·0073	·00175
3	·0592	·0126	·00213	·00029	·00003
4	·0125	·00139	·00012	·000008	·0000005

* See Vol. XXI, Part IX of these memoirs, p. 15.

TABLE II.

Data of 43 years. Probable value of a random coefficient ·103.

A. For 15 random coefficients. Probable value of greatest ·305.
Probability that a number of coefficients will exceed definite amounts.

Number of coefficients.	Amounts.					
	·35	·4	·45	·5	·55	·6
1	·281	·123	·0465	·0155	·0046	·0013
2	·0411	·0074	·0010	·00011	·000012	·000001
3	·0038	·0003	·00002	..	..	...
4	·00025	..	..	..	..	...

B. For 31 random coefficients. Probable value of greatest ·349.
Probability that a number of coefficients will exceed definite amounts.

Number of coefficients.	Amounts.					
	·35	·4	·45	·5	·55	·6
1	·494	·238	·0937	·0318	·0096	·0026
2	·1454	·030	·0044	·00049	·00005	·000003
3	·0293	·0025	·00014	·000005	..	..
4	·0044	·0002	..	..	..	..

3. It will be seen that the probability of a random coefficient diminishes rapidly with growth in its size. For example it follows from Table IA, applicable to Alaska and Samoa, that though it is as likely as not that one of 17 random coefficients will exceed ·46, there is a chance of only about 1 in 3 of the greatest exceeding ·5, 1 in 5 of exceeding ·55, 1 in 9 of exceeding ·6 and 1 in 34 of exceeding ·7. For the other stations this feature is more conspicuous. Thus in Table II B where it is as likely as not that one coefficient will exceed ·35 the chances of exceeding ·4 are only 1 in 4, ·5 only 1 in 31, and ·6 1 in 380.

Again although the occurrence of one coefficient of ·35 affords no presumption of reality whatever, yet two of this size will only occur, owing to accident, once in 7 times, three once in 34 times and four once in 230 times.

4. Certain changes have been made in the list of centres of action discussed in the previous paper. San Francisco has been introduced for the high pressure region of the north Pacific, and Dutch Harbour, in the Aleutian Islands, for the low pressure region there; also Vienna, Tokio and Cairo are in areas otherwise unrepresented. On the other hand the relationships of St. Helena and S. Orkneys have not been carried further as they did not seem sufficiently promising. From Dutch Harbour no long series of pressure data is available; but the temperature records are of great interest, for when the area of low pressure is strongly marked the northerly winds on its northern side send down the temperature at Dutch Harbour and useful relationships may be traced.

5. For a statement of the years for which data of the old centres are available reference may be made to the former paper,*p. 88 ; for the new ones the records of the following years have been utilised :—

Vienna	1875-1917
San Francisco.	1875-1921
Tokio	1883-1920
Cairo	1875-1918
Dutch Harbour	1882-1919

In the tables of correlation coefficients which follow the number of years in which data of both stations are available for use in computing is given in the first column of figures. As a rough indication of reliability coefficients have been printed in heavy type which are greater than the probable value of the largest coefficient produced by pure chance as discussed in section 2 above ; all such coefficients do not indicate a real relationship, just as it cannot be said that all coefficients in thin type are fictitious.

CHAPTER II.

The data.

6. For Iceland (Stykkisholm) the relationships of winter and spring are :—

ICELAND PRESSURE.

		Dec. to Feb.					March to May				
Pressure.	Years of data.	2 qrs. before Icel. J—A	1 qr. before Icel. S—N	Same qr. D—F	1 qr. after Icel. M—M	2 qrs. after Icel. J—A	2 qrs. before Icel. S—N	1 qr. before Icel. D—F	Same qr. M—M	1 qr. after Icel. J—A	2 qrs. after Icel. S—N
Iceland	48	+·06	+·04	+1·00	+·34	+·08	−·02	+·34	+1·00	+·06	−·02
Alaska	22	+·26	−·30	−·18	+·22	0	−·04	−·12	−·20	+·26	+·26
C. Siberia	40	+·24	−·02	**+·34**	+·20	+·14	−·18	+·10	+·02	**+·50**	+·24
Vienna	43	+·10	−·10	**−·52**	+·04	−·02	−·16	−·26	−·28	+·10	−·04
Azores	47	−·10	−·06	**−·54**	−·22	+·02	−·06	−·28	**−·60**	−·06	+·02
Charleston	46	+·04	+·02	**−·32**	−·18	−·12	−·12	−·16	**−·36**	−·24	−·10
San Francisco	47	−·12	−·08	−·20	+·14	−·30	−·12	−·24	+·08	−·34	−·18
Tokio	38	+·04	−·06	**−·38**	−·04	+·32	+·10	−·22	**−·42**	+·32	+·10
Cairo	44	**−·38**	−·26	**−·42**	−·10	−·16	−·12	−·22	−·18	−·06	−·12
Honolulu	38	0	−·20	−·18	+·06	−·06	−·10	−·10	−·06	+·06	−·10
N. W. India	47	+·02	−·08	+·06	0	+·04	+·06	−·06	+·12	+·20	−·06
Port Darwin	40	−·12	−·02	+·06	+·30	0	−·08	−·04	+·02	−·14	−·12
Mauritius	47	+·06	+·24	+·26	+·14	+·06	+·14	+·12	+·04	0	+·10
Samoa	20	−·16	−·24	−·12	+·12	−·18	−·02	−·16	−·02	−·04	−·06
S. E. Australia	46	−·26	+·04	+·08	+·18	+·14	+·04	−·02	+·02	+·04	+·02
Cape	47	−·20	−·10	−·10	−·14	+·08	+·10	+·06	−·02	−·22	+·02
S. America	47	−·20	−·08	+·18	0	+·04	+·02	−·04	−·10	−·12	−·22
Temperature.											
Dutch Harbour	36	..	−·16	+·08	+·16	..	..	+·12	−·02	+·32	..
Rain.											
Peninsula (J—S)	48	+·02	..	..	..	−·04	..	..	..	−·02	..
Java (O—F)	39	..	..	+·26	..	..	..	+·14	..	..	..

* Mem., Ind. Metl. Dept., XXIV, 4(1923).

For summer and autumn the coefficients are :—

ICELAND PRESSURE.

Pressure.	Years of data.	June to Aug. 2 qrs. before Icel. D—F	1 qr. before Icel. M—M	Same qr. J—A	1 qr. after Icel. S—N	2 qrs. after Icel. D—F	Sep. to Nov. 2 qrs. before Icel. M—M	1 qr. before Icel. J—A	Same qr. S—N	1 qr. after Icel. D—F	2 qrs. after Icel. M—M
Iceland	48	+·08	+·06	+1·00	0	+·06	—·02	0	+1·00	+·04	—·02
Alaska	22	+·20	+·14	**+·56**	—·26	+·06	—·22	+·36	+·06	+·42	—·10
C. Siberia	40	+·18	+·04	+·22	—·08	+·02	+·06	—·26	—·20	+·08	—·18
Vienna	43	—·30	—·06	—·10	+·02	+·04	+·16	—·30	**—·46**	—·26	**—·38**
Azores	47	—·06	+·04	**—·48**	+·16	+·12	—·04	+·04	**—·40**	—·10	+·02
Charleston	46	—·20	+·14	—·02	+·02	—·06	+·02	—·10	—·20	+·16	+·10
San Francisco	47	+·02	+·02	+·12	+·08	+·04	+·08	—·20	—·20	—·10	—·04
Tokio	38	+·10	**—·40**	—·22	+·06	+·02	0	—·14	—·06	+·16	+·10
Cairo	44	—·04	+·04	—·18	—·12	+·04	+·08	—·24	0	—·08	—·20
Honolulu	38	—·04	—·16	**—·34**	—·20	0	+·16	—·06	—·12	—·16	+·06
N. W. India	47	+·06	+·08	+·20	+·02	+·12	—·08	+·08	—·06	—·02	0
Port Darwin	40	+·12	+·32	+·22	+·22	+·26	+·18	+·12	+·06	—·12	+·08
Mauritius	47	+·10	—·18	—·30	—·22	—·10	+·32	+·04	+·02	—·10	+·32
Samoa	20	—·06	—·16	—·10	—·06	—·16	+·04	+·30	**+·50**	+·30	+·30
S. E. Australia	46	—·06	+·04	—·12	+·02	+·06	—·12	+·04	—·14	—·08	+·06
Cape	47	+·02	—·30	—·10	—·06	+·02	+·32	+·02	+·26	+·10	—·02
S. America	47	—·02	+·06	—·04	+·08	+·06	+·18	—·04	+·08	—·06	—·16
Temperature.											
Dutch Harbour	36	..	+·12	+·22	+·12	..	..	+·20	0	+·26	..
Rain.											
Peninsula (J—S)	48	..	..	+·06	..	..	..	+·16	..	..	..
Java (O—F)	39	+·18	..	..	..	—·04	..	..	..	+·02	..

7. Let us consider first the contemporary winter relationships. If we had purely random data the probable value of the greatest of the 16 coefficients (from Alaska to Java omitting Alaska and Samoa owing to their short records) is ·309* and 6 of the coefficients exceed this ; there are 3 exceeding ·4 and the probability of this owing to pure chance (Table II A) is only ·0003 ; also the probability that chance would produce the two exceeding ·5 is only 11 in 100,000. The reality of Iceland's contemporary influence is thus established by our criteria. While the relationships with Vienna and the Azores are practically certain, those with Charleston and Tokio are probable in view of their persistence into spring (see the March to May table) : regarding Cairo the chance of accidental production does not exceed ·08 and some belief is justified, but over C. Siberia some uncertainty must be felt until a longer series of data is available. If however we consider relationships with the seasons immediately before or after, the greatest coefficient is —·32 with the Azores as compared with a probable greatest of ·35 due to pure

* It would have been ·305, as given in table II. A, with 15 coefficients.

chance : here no reality can be inferred. Similarly for seasons two quarters apart the biggest coefficient is —·38 with Cairo and no reality can be claimed. In the spring table the only clearly real contemporary relationship is with the Azores ; but Charleston and Tokio are decidedly probable. Of relations with the subsequent summer that of +·50 with C. Siberia must be accepted, the chance of accidental production being only ·032. Of the contemporary relationships in summer and autumn that with the Azores persists ; but that with Vienna is shown only in autumn, becoming inappreciable in summer with the weakening of the low pressure area. The non-contemporary relationships with long-series centres are all uncertain. The large coefficients with Alaska and Samoa will be discussed with the other data of these stations.

On the whole Iceland may be described as showing contemporary opposition with the northern belt of high pressure especially in the colder period of the year ; and this fact will in future be expressed by saying that Iceland shares in the 'N. Atlantic oscillation.' Some effect upon C. Siberia is also probable.

8. We now consider Alaska, and here all the coefficients are based on comparatively short series of years. The tables are :—

ALASKA PRESSURE.

		DEC. TO FEB.					MARCH TO MAY				
Pressure.	Years of data.	2 qrs. before Alaska. J—A	1 qr. before Alaska. S—N	Same qr. D—F	1 qr. after Alaska. M—M	2 qrs. after Alaska. J—A	2 qrs. before Alaska. S—N	1 qr. before Alaska. D—F	Same qr. M—M	1 qr. after Alaska. J—A	2 qrs. after Alaska. S—N
Iceland	21	+·06	+·42	—·18	—·12	+·20	—·10	+.22	—·20	+·14	—·22
Alaska	22	+·04	+·24	+1·00	—·12	—·02	—·16	—·12	+1·00	—·12	**—·54**
C. Siberia	17	—·28	+·50	+·18	+·22	+·32	—·16	—·06	+·30	—·30	+·22
Vienna	17	—·06	—·06	—·36	—·36	+·12	+·24	—·06	—·24	0	—·12
Azores	21	+·08	—·02	+·24	—·14	—·48	+·06	—·88	+·26	+·04	+·16
Charleston	20	0	—·24	+·36	—·42	—·28	+·20	—·82	+·14	+·16	—·32
San Francisco	21	+·24	—·08	—·22	—·48	+·04	+·06	—·12	—·14	+·24	—·28
Tokio	18	—·02	—·18	—·22	—·02	+·10	+·22	0	+·04	—·20	+·14
Cairo	18	+·08	+·36	—·28	—·26	+·12	—·08	—·24	0	—·18	—·26
Honolulu	19	+·22	—·14	**—·70**	—·14	—·12	—·02	—·26	**—·52**	—·44	+·16
N. W. India	21	—·28	+·18	—·08	+·16	—·04	+·20	+·20	+·38	—·18	+·20
Port Darwin	20	—·12	—·24	—·24	+·28	—·24	+·08	+·30	+·32	+·34	+·44
Mauritius	21	—·26	—·10	+·08	+·24	—·22	—·18	+·32	—·18	+·18	+·12
Samoa	4	(+·4)	(+·1)	(—·2)	(—·1)	(—·2)	(—·5)	(—1·0)	(—·7)	(—·7)	(—1·0)
S. E. Australia	21	—·04	—·06	—·14	+·32	—·50	—·20	+·14	+·04	+·36	+·24
Cape	21	—·18	**+·64**	**—·52**	—·42	+·04	—·14	—·04	+·06	+·04	+·04
S. America	21	+·04	+·16	—·08	+·14	—·02	+·02	+·02	—·28	+·06	—·26
Temperature.											
Dutch Harbour	18	..	**+·62**	**+·68**	+·04	..	..	+·22	**+·48**	—·46	+·08
Rain.											
Peninsula (J—S)	22	**+·66**	..	..	..	—·30	..	..	..	—·04	..
Java (O—F)	19	..	..	+·34	..	..	..	—·02	..	..	..

ALASKA PRESSURE.

Pressure.	Years of data.	June to Aug.					Sep. to Nov.				
		2 qrs. before Alaska. D—F	1 qr. before Alaska. M—M	Same qr. J—A	1 qr. after Alaska. S—N	2 qrs. after Alaska. D—F	2 qrs. before Alaska. M—M	1 qr. before Alaska. J—A	Same qr. S—N	1 qr. after Alaska. D—F	2 qrs. after Alaska. M—M
Iceland	22	0	+·26	**+·56**	+·36	+·26	+·26	—·26	+·06	—·30	—·04
Alaska	23	—·02	—·12	+1·00	+·04	+·04	**—·54**	+·04	+1·00	+·24	—·16
C. Siberia	17	+·44	0	+·28	—·52	—·24	—·06	—·08	—·08	0	+·02
Vienna	18	—·32	—·38	+·30	—·26	+·06	+·30	+·02	**+·46**	+·42	—·06
Azores	22	—·14	+·02	—·32	—·18	—·28	—·16	+·24	—·30	+·16	—·06
Charleston	21	+·02	+·06	+·18	—·40	—·14	—·14	—·12	+·32	+·32	—·20
San Francisco	22	—·12	+·14	+·18	—·38	—·10	+·34	—·02	+·30	+·16	—·04
Tokio	19	+·32	—·18	+·04	—·22	—·02	+·10	+·26	—·16	+·18	—·22
Cairo	19	—·12	—·14	—·42	—·24	—·30	+·38	+·30	+·36	+·52	+·20
Honolulu	20	—·04	—·30	—·28	—·24	—·14	+·50	+·42	—·22	—·06	—·08
N. W. India	22	+·02	+·18	—·22	—·08	+·24	—·14	+·20	—·22	0	+·02
Port Darwin	21	—·12	+·14	+·26	+·16	+·18	—·36	—·10	—·30	—·06	—·24
Mauritius	21	0	+·26	+·22	—·22	—·24	+·18	+·08	—·08	—·22	+·20
Samoa	4	(+·1)	(—·5)	(—·4)	(+·2)	(—·4)	(+·2)	(+·4)	(+·9)	(+·4)	(+·7)
S. E. Australia	22	—·34	+·20	+·06	+·10	+·06	—·12	+·22	+·02	—·10	—·32
Cape	22	—·02	+·20	—·04	—·28	+·16	+·14	+·32	+·10	+·06	**+·16**
S. America	22	—·34	+·08	—·06	—·12	—·06	+·04	+·16	—·10	—·12	0
Temperature.											
Dutch Harbour	19	..	—·12	**+·12**	+·24	..	**—·56**	+·10	0	+·10	..
Rain.											
Peninsula (J—S)	22	..	..	—·12	..	..	..	+·30	..	..	..
Java (O—F)	19	+·06	..	..	..	—·08	..	..	..	—·04	..

9. The coefficients with Samoa are inserted in brackets because there are only four years in which the series overlap. Of the contemporary winter coefficients two are about ·7 ; that with Honolulu shows clearly the strong opposition between the areas of high and low pressure in the N. Pacific though at San Francisco and Tokio this is but slightly marked, and the other that accentuation of the N. Pacific low pressure leads to lower temperatures at Dutch Harbour on its northern margin. The coefficients with the Cape in the contemporary and previous quarters involve too much discontinuity for stations so far apart and are doubtful. Of coefficients of seasons separated by one quarter the only other one exceeding ·52, the probable random greatest value, is Dutch Harbour and there the relationship is probably real.

In spring the same relations with Honolulu and Dutch Harbour persist ; and the data of four years comparison with Samoa suggest that the opposition in the Pacific extends southwards across the equator.

In summer the area of low pressure has almost disappeared and the only probable contemporary relationship is one of sympathy with Iceland: the non-contemporary relationships are all uncertain.

In autumn the opposition with Honolulu has not yet developed, and the strong sympathy with Samoa which is suggested by the 4 years of comparison available is not supported by the previous or succeeding quarters. Of the non-contemporary coefficients the biggest of the two groups excluding Dutch Harbour have values of ·50 and ·52, practically identical with that produced by pure chance: these must therefore be ignored.

10. For Central Siberia the coefficients are :—

CENTRAL SIBERIA PRESSURE.

		Dec. to Feb.					March to May				
Pressure.	Years of data	2 qrs. before C. Sib. J—A	1 qr. before C. Sib. S—N	Same qr. D—F	1 qr. after C. Sib. M—M	2 qrs. after C. Sib. J—A	2 qrs. before C. Sib. S—N	1 qr. before C. Sib. D—F	Same qr. M—M	1 qr. after C. Sib. J—A	2 qrs. after C. Sib. S—N
Iceland	40	+·02	+·08	**+·34**	+·10	+·18	—·18	+·20	+·02	+·04	+·06
Alaska	17	—·24	0	+·18	—·06	+·44	+·02	+·22	+·30	0	—·06
C. Siberia	41	**+·36**	**+·42**	+1·00	**+·40**	+·16	+·06	**+·40**	+1·00	+·14	+·08
Vienna	40	+·10	—·02	—·28	—·06	—·12	+·28	—·28	0	—·10	—·08
Azores	40	—·02	—·12	—·02	—·20	—·30	—·30	—·04	—·16	—·16	+·10
Charleston	40	—·16	—·04	—·30	—·34	—·18	+·24	—·32	**—·32**	—·10	+·34
San Francisco	40	—·16	—·18	—·26	—·20	**—·46**	+·06	—·14	—·28	—·04	—·04
Tokio	33	+·24	—·04	—·20	—·18	+·22	—·10	—·12	+·24	**+·36**	—·18
Cairo	40	+·28	+·06	+·14	+·14	—·14	0	+·06	+·16	+·02	—·12
Honolulu	33	—·08	—·14	—·30	+·10	+·06	+·02	+·14	—·02	—·04	+·26
N. W. India	40	**+·36**	+·04	+·02	+·20	**+·36**	+·34	+·34	+·26	+·10	**—·44**
Port Darwin	34	—·08	0	—·08	+·06	**—·40**	**+·38**	+·28	+·18	—·10	—·06
Mauritius	40	+·26}	+·06	+·28	+·16	—·06	+·06	+·28	—·14	—·12	—·06
Samoa	20	—·14	—·06	+·02	+·24	+·10	—·08	+·02	—·36	—·14	0
S. E. Australia	39	+·24	**+·36**	+·02	+·02	—·22	**+·50**	+·28	+·10	—·08	+·04
Cape	40	+·04	—·08	+·02	—·18	+·04	+·04	+·24	—·12	+·02	—·34
S. America	40	—·16	**—·44**	—·04	—·14	+·24	—·16	+·12	—·06	+·06	—·26
Temperature.											
Dutch Harbour	32	..	+·28	+·14	—·04	—·06	..	—·16	+·12	—·14	..
Rain.											
Peninsula (J—S)	40	—·06	..	..	..	+·24	..	..	..	+·14	..
Java (O—F)	36	..	..	—·10	..	..	..	—·10	..	..	..

Central Siberia pressure.

Pressure.	Years of data	June to Aug. 2 qrs. before C. Sib. D—F	1 qr. before C. Sib. M—M	Same qr. J—A	1 qr. after C. Sib. S—N	2 qrs. after C. Sib. D—F	Sep. to Nov. 2 qrs. before C. Sib. M—M	1 qr. before C. Sib. J—A	Same qr. S—N	1 qr. after C. Sib. D—F	2 qrs. after C. Sib. M—M
Iceland	40	+·14	**+·50**	+·22	—·26	+·24	+·24	—·08	—·20	—·02	—·18
Alaska	17	+·32	—·30	+·28	—·08	—·28	+·22	—·52	—·08	+·50	—·16
C. Siberia	41	+·16	+·14	+1·00	+·06	**+·36**	+·08	+·06	+1·00	**+·42**	+·05
Vienna	40	—·06	—·10	**+·38**	—·02	—·04	—·04	—·20	+·10	+·02	+·16
Azores	40	—·12	**—·54**	—·28	+·02	—·06	—·08	+·10	+·22	+·22	+·08
Charleston	40	—·04	—·24	—·26	—·02	**—·36**	—·26	—·22	—·20	+·12	—·20
San Francisco	40	—·18	—·18	—·10	—·22	+·06	**—·44**	—·16	—·08	—·18	—·26
Tokio	33	—·16	—·14	**+·36**	—·14	**—·36**	—·12	0	+·08	—·02	—·20
Cairo	40	0	—·26	**+·32**	—·06	+·08	+·24	+·14	+·24	+·04	—·02
Honolulu	33	**—·38**	—·34	—·16	—·20	—·20	+·24	+·30	**+·42**	—·28	—·22
N. W. India	40	+·12	+·04	**+·36**	+·10	+·08	+·18	+·22	—·10	—·12	+·14
Port Darwin	34	**—·36**	—·16	—·06	+·14	+·10	—·04	—·32	**—·32**	—·24	—·06
Mauritius	40	+·22	—·04	+·08	—·02	+·02	—·06	—·04	+·06	+·28	+·08
Samoa	20	+·02	—·04	—·32	—·26	—·24	+·10	0	—·40	—·12	+·14
S. E. Australia	39	—·12	+·22	+·12	+·28	+·20	—·08	+·04	—·08	—·08	—·06
Cape	40	0	—·28	—·26	—·16	+·32	—·08	—·10	0	—·18	0
S. America	40	—·04	—·24	— 30	—·32	—·02	—·26	0	—·16	—·12	+·16
Temperature.											
Dutch Harbour	32	+·16	+·12	**+·36**	+·06	..	..	+·02	—·08	+·08	..
Rain.											
Peninsula (J—S)	40	..	..	**—·38**	..	..	..	+·02	..	..	..
Java (O—F)	36	+·28	..	..	..	—·10	..	..	..	+·22	..

11. In the winter table it is mainly with two quarters later that significant figures occur. High pressure in C. Siberia in winter is then followed by low pressure in San Francisco and high pressure in Alaska, *i.e.*, by decreased oscillation in the N. Pacific; and there is some evidence of contemporary and subsequent decreased oscillation in the N. Atlantic. There is also a slight tendency two quarters later towards an increase of pressure in S. America and of Peninsula rainfall, and a decrease of pressure in Australia: this is part of the main oscillation described in the previous paper* which will in future be called the 'southern' oscillation.

In the spring table an important point is a clear tendency for high pressure in Australia and India, September to November, to be followed two quarters later by high pressure in C. Siberia.

In summer C. Siberia is fairly typical of the second group of the previous paper,* *i.e.*, low pressure there is associated with low pressure in Iceland, Alaska and N. W. India, low temperature at Dutch Harbour, high pressure at the Azores, Charleston, Samoa and S. America, and increased rain in the Peninsula. None of the coefficients individually is big enough to demonstrate reality, but the group of consistent relationships is too marked to be produced by accident.

* See p. 124.

The only clear relationship between seasons one quarter apart is that with Iceland and the Azores, for which the chance of production by accident is ·0005; an increased N. Atlantic oscillation in spring sends down summer pressure in C. Siberia.

In the autumn table in the contemporary column the two significant coefficients are with Honolulu and Port Darwin; these suggest behaviour as a member of the first group, but not being supported by Samoa must be treated as doubtful. Of non-contemporary relations the chief is that an increase of the N. Pacific oscillation in spring tends to produce low pressure in C. Siberia in autumn.

12. The Vienna data are:—

VIENNA PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data	2 qrs. before Vienna. J—A	1 qr. before Vienna. S—N	Same qr. D—F	1 qr. after Vienna. M—M	2 qrs. after Vienna. J—A	2 qrs. before Vienna. S—N	1 qr. before Vienna. D—F	Same qr. M—M	1 qr. after Vienna. J—A	2 qrs. after Vienna. S—N
Iceland	43	+·04	—·26	—·52	—·26	—·30	—·38	+·04	—·28	—·06	+·16
Alaska	17	+·06	+·42	—·36	—·06	—·32	—·06	—·36	—·24	—·38	+·30
C. Siberia	40	—·04	+·02	—·28	—·28	—·06	+·16	—·06	0	—·10	—·04
Vienna	43	+·10	+·30	+1·00	+·08	0	+·12	+·08	+1·00	0	—·16
Azores	43	—·06	+·24	+·26	+·24	+·22	+·14	—·04	—·10	+·16	—·02
Charleston	43	—·04	—·04	+·24	+·16	+·02	+·32	+·02	+·16	0	+·14
San Francisco	43	—·04	+·04	+·20	—·10	+·14	+·14	+·30	+·16	+·26	+·18
Tokio	35	+·04	—·20	+·10	+·32	+·02	—·04	—·08	+·04	+·16	—·04
Cairo	43	+·10	+·22	+·46	+·14	+·34	—·06	—·14	+·34	+·20	—·12
Honolulu	35	+·10	—·04	—·04	—·14	+·10	+·26	+·10	+·18	+·12	+·16
N. W. India	43	+·02	+·06	—·04	—·04	—·02	—·08	—·06	—·30	—·04	+·10
Port Darwin	36	—·30	—·28	—·24	—·42	+·14	+·04	+·06	—·14	+·04	+·10
Mauritius	43	+·10	+·10	—·08	—·02	+·12	+·22	+·06	—·08	+·12	+·26
Samoa	20	—·06	—·16	—·44	—·34	+·04	—·26	+·46	+·20	+·18	+·12
S. E. Australia	42	+·16	—·16	—·10	—·20	+·06	0	—·10	—·26	—·10	—·04
Cape	43	+·30	—·02	+·02	+·22	+·26	—·14	—·22	+·20	+·14	+·10
S. America	43	+·04	—·04	—·34	—·10	—·10	+·08	+·06	+·24	—·08	+·10
Temperature.											
Dutch Harbour	34	..	—·20	—·16	+·14	..	..	—·24	+·08	+·16	..
Rain.											
Peninsula (J—S)	43	—·12	..	..	..	+·08	..	..	..	+·08	..
Java (O—F)	38	..	..	—·26	..	..	..	+·12	..	..	..

VIENNA PRESSURE.

Pressure.	Years of data	June to Aug. 2 qrs. before Vienna. D—F	June to Aug. 1 qr. before Vienna. M—M	June to Aug. Same qr. J—A	June to Aug. 1 qr. after Vienna. S—N	June to Aug. 2 qrs. after Vienna. D—F	Sep. to Nov. 2 qrs. before Vienna. M—M	Sep. to Nov. 1 qr. before Vienna. J—A	Sep. to Nov. Same qr. S—N	Sep. to Nov. 1 qr. after Vienna. D—F	Sep. to Nov. 2 qrs. after Vienna. M—M
Iceland	43	—·02	+·10	—·10	—·30	+·10	—·04	+·02	**—·46**	—·10	—·16
Alaska	18	+·12	0	+·30	+·02	—·06	—·12	—·26	**+·46**	—·06	+·24
C. Siberia	40	—·12	—·10	**+·38**	—·20	+·10	—·08	—·02	+·10	—·02	+·28
Vienna	43	0	0	+1·00	+·24	+·10	—·16	+·24	+1·00	+·30	+·12
Azores	43	0	—·18	—·26	—·08	—·06	+·06	—·14	—·14	+·16	—·02
Charleston	43	+·30	+·08	+·16	—·12	—·20	+·12	+·10	+·22	—·14	—·02
San Francisco	43	+·26	+·12	+·16	—·04	+·06	+·10	+·16	+·24	+·04	—·02
Tokio	35	+·18	—·10	+·26	—·24	—·22	—·02	0	—·18	+·08	+·24
Cairo	43	—·02	—·02	**+·34**	—·02	+·16	+·12	+·22	+·28	+·24	+·06
Honolulu	35	—·14	**—·40**	—·26	—·30	—·20	+·08	+·12	—·02	+·08	—·10
N. W. India	43	—·12	—·12	0	+·28	+·22	—·18	—·06	+·18	+·12	+·22
Port Darwin	36	—·30	—·18	+·18	+·14	+·22	+·10	+·04	—·02	+·08	—·22
Mauritius	43	—·04	+·02	+·28	0	0	—·02	—·04	—·04	+·06	—·24
Samoa	20	+·04	—·02	**—·46**	—·50	—·26	+·12	—·20	—·42	—·22	—·22
S. E. Australia	42	—·26	+·06	+·28	+·14	+·30	+·30	+·20	+·06	+·06	—·08
Cape	43	—·04	+·20	+·16	0	**+·36**	—·16	+·18	+·20	+·04	0
S. America	43	+·26	—·30	—·24	—·14	+·12	—·30	0	+·16	—·12	+·10
Temperature.											
Dutch Harbour	34	—·14	—·02	—·12	—·02	..	—·14	—·06	—·14	—·10	..
Rain.											
Peninsula (J—S)	43	..	..	—·38	..	..	..	—·16	..	..	..
Java (O—F)	38	+·20	..	..	..	+·06	..	..	..	—·12	..

13. In winter Vienna's contemporary relations are definitely those of the high pressure belt in the N. Atlantic oscillation, with some tendency to a similar position regarding the N. Pacific oscillation. In spring its relationships are insignificant. In summer it is a weak adherent of the second group in the 'southern' oscillation, having negative associa-

tions with Samoa and Peninsula rain. In autumn the opposition to Iceland has already developed, and that to Samoa persists, but otherwise there is little to note; the coefficient with Alaska is not supported by that with Dutch Harbour.

14. The coefficients with the Azores are :—

AZORES PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data	2 qrs. before Azores. J—A	1 qr. before Azores. S—N	Same qr. D—F	1 qr. after Azores. M—M	2 qrs. after Azores. J—A	2 qrs. before Azores. S—N	1 qr. before Azores. D—F	Same qr. M—M	1 qr. after Azores. J—A	2 qrs. after Azores. S—N
Iceland	47	+·12	—·10	**—·54**	—·28	—·06	+·02	—·32	**—·60**	+·04	—·04
Alaska	21	—·28	+·16	+·24	—·38	—·14	—·06	—·14	+·26	+·02	—·16
C. Siberia	40	—·06	+·22	—·02	—·04	—·12	+·08	—·20	—·16	**—·54**	—·08
Vienna	43	—·06	+·16	+·26	—·04	0	—·02	+·24	—·10	—·18	+·06
Azores	47	+·16	+·18	+1·00	+·24	—·02	+·06	+·24	+1·00	+·24	—·06
Charleston	45	—·10	—·14	**+·36**	—·10	+·02	+·02	+·14	**+·52**	**+·38**	—·16
San Francisco	47	+·22	—·06	—·16	—·16	+·06	—·04	+·24	—·02	+·28	—·14
Tokio	38	—·18	—·08	+·14	+·16	—·04	—·14	**+·36**	**+·38**	—·32	—·14
Cairo	44	**+·36**	+·32	**+·34**	—·06	+·06	+·14	+·34	+·14	+·08	+·24
Honolulu	38	—·08	—·02	+·14	—·06	+·08	—·02	+·16	—·14	—·24	—·04
N. W. India	47	+·06	—·02	—·02	+·06	—·10	—·06	—·06	0	—·32	+·26
Port Darwin	40	+·12	+·04	—·08	—·24	—·18	+·22	+·20	+·12	+·32	+·30
Mauritius	46	+·08	—·12	—·04	—·22	—·26	—·32	—·32	—·02	+·04	—·12
Samoa	20	+·18	+·10	—·08	—·06	+·16	+·22	—·02	—·36	—·28	—·22
S. E. Australia	46	+·20	+·18	+·10	—·04	—·34	—·06	+·16	+·04	+·10	+·20
Cape	47	+·04	+·20	+·10	0	0	—·08	+·10	+·12	+·08	+·16
S. America	47	+·04	—·18	+·04	+·22	+·38	—·08	—·16	+·06	+·04	—·04
Temperature.											
Dutch Harbour	36	..	+·02	0	—·24	—·08	..	—·14	+·02	—·14	..
Rain.											
Peninsula (J—S)	47	—·06	..	..	..	+·22	..	..	..	—·02	..
Java (O—F)	42	..	..	—·16	..	..	..	—·16	..	..	..

Azores Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before Azores. D—F	1 qr. before Azores. M—M	Same qr. J—A	1 qr. after Azores. S—N	2 qrs. after Azores. D—F	Sep. to Nov. 2 qrs. before Azores. M—M	1 qr. before Azores. J—A	Same qr. S—N	1 qr. after Azores. D—F	2 qrs. after Azores. M—M
Iceland	47	+·02	—·06	—·48	+·04	—·10	+·02	+·16	—·40	—·06	—·06
Alaska	22	—·48	+·04	—·32	+·24	+·08	+·16	—·18	—·30	—·02	+·06
C. Siberia	40	—·30	—·16	—·28	+·10	—·02	+·10	+·02	+·22	—·12	—·30
Vienna	43	+·22	+·16	—·26	—·14	—·06	—·02	—·08	—·14	+·24	+·14
Azores	47	—·02	+·24	+1·00	+·10	+·16	—·06	+·10	+1·00	+·18	+·06
Charleston	45	+·12	+·12	+·26	—·04	—·04	—·22	—·08	+·12	+·02	—·06
San Francisco	47	—·04	+·08	+·26	—·20	—·18	—·14	+·12	+·20	+·08	+·04
Tokio	38	+·10	+·12	—·10	—·26	+·06	—·14	+·16	+·10	—·04	—·34
Cairo	44	—·14	—·02	0	+·06	—·08	—·04	—·12	0	—·08	—·08
Honolulu	38	+·20	+·06	+·20	—·04	+·16	—·14	+·14	+·20	—·14	—·34
N. W. India	47	—·02	0	—·26	—·02	+·02	+·34	—·14	—·18	—·06	—·12
Port Darwin	40	+·16	—·16	—·08	+·02	—·08	+·02	—·30	—·28	—·18	—·04
Mauritius	46	0	—·04	+·10	+·14	+·06	—·36	—·30	+·08	+·12	—·52
Samoa	20	+·10	+·08	+·34	+·02	—·04	—·34	+·28	—·06	—·32	+·06
S. E. Australia	46	+·28	—·14	—·04	+·10	—·04	—·12	—·34	—·18	—·28	+·18
Cape	47	—·10	+·24	+·02	+·26	—·18	—·20	+·06	—·18	—·26	+·02
S. America	47	+·06	+·24	+·16	—·20	—·04	+·14	+·10	+·08	—·14	+·12
Temperature.											
Dutch Harbour	36	..	—·16	+·12	—·02	..	..	—·04	—·08	+·16	..
Rain.											
Peninsula (J—S)	47	..	..	+·10	..	..	..	+·16	..	..	..
Java (O—F)	42	—·18	..	..	..	—·04	..	..	..	+·16	..

15. In winter in the Azores we have a marked representative of the high pressure belt in the N. Atlantic oscillation, but there are no tendencies in that direction in the N. Pacific: with the southern oscillation it is neutral. In spring the N. Atlantic relation is very strong and includes marked sympathy with Charleston; also high pressure is followed by low

pressure in summer in C. Siberia. In summer and autumn the N. Atlantic relation persists and there is some tendency towards a similar relation with the N. Pacific oscillation.

16. With Charleston the relationships are :—

CHARLESTON PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before Charl. J—A	1 qr. before Charl. S—N	Same qr. D—F	1 qr. after Charl. M—M	2 qrs. after Charl. J—A	2 qrs. before Charl. S—N	1 qr. before Charl. D—F	Same qr. M—M	1 qr. after Charl. J—A	2 qrs. after Charl. S—N
Iceland	46	—·06	+·16	**—·32**	—·16	—·20	+·10	—·18	**—·36**	+·14	+·02
Alaska	20	—·14	+·32	+·36	—·32	+·02	—·20	**—·42**	+·14	+·06	—·14
C. Siberia	40	**—·36**	+·12	—·30	—·32	—·04	—·20	**—·34**	**—·32**	—·24	—·26
Vienna	43	—·20	—·14	+·24	+·02	+·30	—·02	+·16	+·16	+·08	+·12
Azores	45	—·04	+·02	**+·36**	+·14	+·12	—·06	—·10	**+·52**	+·12	—·22
Charleston	47	—·10	0	+1·00	+·22	+·18	+·20	+·22	+1·00	**+·52**	+·06
San Francisco	47	—·08	+·30	+·20	+·18	+·24	+·24	**+·44**	**+·36**	**+·42**	+·06
Tokio	38	—·06	+·08	+·24	0	—·08	—·04	**+·36**	+·10	—·28	+·04
Cairo	44	0	+·24	+·08	—·20	+·10	—·04	+·04	+·06	+·06	—·06
Honolulu	37	+·30	+·22	—·20	—·12	+·10	—·02	+·20	—·08	—·14	**—·40**
N. W. India	45	—·02	**—·42**	**—·52**	**—·46**	—·30	—·22	—·28	**—·36**	—·28	**+·42**
Port Darwin	38	—·30	**—·50**	**—·52**	—·28	—·22	+·04	—·02	—·02	+·34	**+·34**
Mauritius	45	—·02	+·06	—·12	+·10	+·06	—·22	**—·44**	—·06	+·08	—·02
Samoa	20	+·20	+·20	+·28	+·06	0	+·38	+·26	—·12	—·20	—·36
S. E. Australia	44	—·24	**—·38**	—·30	—·28	—·22	—·26	—·16	—·18	+·02	+·08
Cape	45	+·08	+·08	—·26	+·10	+·18	—·12	—·04	+·08	—·12	+·10
S. America	45	+·20	+·14	—·08	+·22	+·08	+·34	+·02	+·12	—·06	+·20
Temperature.											
Dutch Harbour	36	..	—·14	—·08	—·18	..	..	—·34	+·24	+·18	+·26
Rain.											
Peninsula (J—S)	45	+·20	..	..	..	—·10	..	..	..	—·08	..
Java (O—F)	40	..	..	+·20	..	..	..	0	..	..	..

Charleston Pressure.

Pressure.	Years of data.	June to Aug.					Sep. to Nov.				
		2 qrs. before Charl. D—F	1 qr. before Charl. M—M	Same qr. J—A	1 qr. after Charl. S—N	2 qrs. after Charl. D—F.	2 qrs. before Charl. M—M	1 qr. before Charl. J—A	Same qr. S—N	1 qr. after Charl. D—F	2 qrs. after Charl. M—M
Iceland	46	—·12	—·24	—·02	—·10	+·04	—·10	+·02	—·20	+·02	—·12
Alaska	21	—·28	+·16	+·18	—·12	0	—·32	—·40	+·32	—·24	+·20
C. Siberia	40	—·18	—·10	—·26	—·22	—·16	+·34	—·02	—·20	—·04	+·24
Vienna	43	+·02	0	+·16	+·10	—·04	+·14	—·12	+·22	—·04	+·32
Azores	45	+·02	**+·38**	+·26	—·08	—·10	—·16	—·04	+·12	—·14	+·02
Charleston	47	+·18	**+·52**	+1·00	0	—·10	+·06	0	+1·00	0	+·20
San Francisco	47	**+·40**	+·24	**+·48**	—·06	—·04	+·16	+·04	**+·54**	+·34	**+·48**
Tokio	38	**+·36**	+·10	—·08	—·34	0	+·14	+·18	+·14	+·06	—·20
Cairo	44	—·20	—·22	—·14	—·30	—·16	+·06	—·06	—·12	—·04	+·18
Honolulu	37	+·20	+·04	—·08	—·18	+·10	+·30	+·10	—·08	+·04	—·10
N. W. India	45	—·14	—·24	**—·52**	+·20	+·24	—·02	+·04	—·20	—·22	—·32
Port Darwin	38	+·04	—·12	+·12	+·10	+·24	+·06	—·02	0	+·02	—·04
Mauritius	45	—·20	—·14	+·10	—·14	—·06	—·28	—·24	+·14	+·06	—·12
Samoa	20	+·32	—·04	—·22	—·38	—·08	—·26	—·10	+·04	+·24	—·04
S. E. Australia	44	—·04	—·06	—·12	+·06	+·12	—·02	—·26	—·12	—·16	—·18
Cape	45	—·10	—·04	—·16	—·02	+·02	—·06	+·12	—·22	—·16	+·22
S. America	45	+·06	+·10	+·04	+·04	+·44	+·20	+·04	+·22	—·04	+·26
Temperature.											
Dutch Harbour	36	..	—·12	—·20	—·10	..	..	—·04	+·10	—·18	..
Rain.											
Peninsula (J—S)	45	..	..	0	..	..	..	+·12	..	..	..
Java (O—F)	40	—·10	..	..	..	+·06	..	..	..	+·06	..

17. In winter there are, apart from Alaska, four coefficients exceeding the probable value of the greatest random coefficient, and two up to ·30 ; the coefficient with Alaska is of doubtful significance. Thus the position of Charleston in the N. Atlantic oscillation is established : and it is our first northern station to show a definite association with the positive group of the southern oscillation, the coefficients of —·52 with N. W. India and Port Darwin only occurring once in 9,000 times by accident. It is also characteristic of relations with more distant parts of the world that, as we should expect, they persist over longer periods than relations between adjacent areas, and the coefficients of Charleston winter pressure with pressure in N. W. India, Port Darwin and S. E. Australia a quarter before and a quarter after are nearly as prominent as they are for the contemporary quarter. With conditions two quarters before and after the coefficients are of less significance, and are in general indicative of the same relationships.

In spring Charleston continues typical of the high pressure belt in the N. Atlantic oscillation (see its relations with Iceland and the Azores), and its opposition to C. Siberia persists. With the season one before or behind there are 5 significant coefficients, and those for the previous quarter indicate that a strengthening in winter of the N. Pacific oscillation (Alaska, San Francisco, Dutch Harbour) or of the southern oscillation (N. W. India, Mauritius) will cause a rise of pressure at Charleston in spring. In the succeeding quarter the relations are more local. Two seasons before there is some association of high pressure with a strengthening of the southern oscillation, but two seasons later it is with a weakening (*i.e.*, —·40 with Honolulu, —·36 Samoa, +·42 N. W. India and +·34 P. Darwin).

In summer the N. Atlantic relations are weaker, but the similarity with San Francisco and dissimilarity with N. W. India are marked.

In autumn Charleston is more isolated : its only strongly marked relations are with San Francisco in the same quarter and the two subsequent.

18. The coefficients with San Francisco are :—

San Francisco Pressure.

Pressure.	Years of data.	Dec. to Feb.					March to May.				
		2 qrs. before S. Fran. J—A	1 qr. before S. Fran. S—N	Same qr. D—F	1 qr. after S. Fran. M—M	2 qrs. after S. Fran. J—A	2 qr. before S. Fran. S—N	1 qr. before S. Fran. D—F	Same qr. M—M	1 qr. after S. Fran. J—A	2 qrs. after S. Fran. S—N
Iceland	47	+·04	—·10	—·20	—·24	+·02	—·04	+·14	+·08	+·02	+·08
Alaska	21	—·10	+·16	—·22	—·12	—·12	—·04	—·48	—·14	+·14	+·34
C. Siberia	40	+·06	—·18	—·26	—·14	—·18	—·26	—·20	—·28	—·18	**—·44**
Vienna	43	+·06	+·04	+·20	+·30	+·26	—·02	—·10	+·16	+·12	+·10
Azores	47	—·18	+·08	—·16	+·24	—·04	+·04	—·16	—·02	+·08	—·14
Charleston	47	—·04	+·34	+·20	**+·44**	**+·40**	**+·48**	+·18	**+·36**	+·24	+·16
San Francisco	47	+·08	**+·44**	+1·00	**+·38**	**+·44**	**+·36**	**+·38**	+1·00	+·20	**+·36**
Tokio	38	+·28	—·04	+·08	+·08	+·08	+·28	—·02	0	+·08	—·02
Cairo	44	+·04	+·18	+·06	+·32	+·26	0	—·24	+·02	—·24	—·06
Honolulu	39	+·08	+·02	+·14	+·14	+·04	+·10	+·18	+·14	+·22	—·32
N. W. India	47	—·12	—·20	—·24	—·34	—·32	**—·48**	**—·50**	**—·34**	—·34	+·02
Port Darwin	40	—·14	—·10	—·14	—·26	+·12	—·22	—·32	**—·36**	—·18	—·12
Mauritius	46	—·18	+·02	—·26	—·02	+·16	—·02	—·28	—·10	—·10	+·20
Samoa	20	0	+·18	+·22	—·24	—·26	+·24	+·30	+·38	+·12	+·24
S. E. Australia	46	—·22	**—·42**	—·20	—·18	+·10	—·34	**—·40**	—·30	—·18	—·14
Cape	47	0	0	—·12	+·06	—·10	**—·36**	—·34	+·22	—·18	+·30
S. America	47	+·12	+·30	—·10	—·08	—·30	+·22	+·10	**+·46**	+·10	+·30
Temperature.											
Dutch Harbour	36	..	—·06	**—·32**	+ ·02	..	..	—·34	**—·48**	—·04	..
Rain.											
Peninsula (J—S)	47	—·08	..	..	..	—·16	..	..	..	+·12	..
Java (O—F)	42	..	..	+·02	..	..	..	+·12	..	..	..

San Francisco Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before S. Fran. D—F	1 qr. before S. Fran. M—M	Same qr. J—A	1 qr. after S. Fran. S—N	2 qrs. after S. Fran. D—F	Sep. to Nov. 2 qrs. before S. Fran. M—M	1 qr. before S. Fran. J—A	Same qr. S—N	1 qr. after S. Fran. D—F	2 qrs. after S. Fran. M—M.
Iceland	47	—·30	—·34	+·12	—·20	—·12	—·18	+·08	—·20	—·08	—·12
Alaska	22	+·04	+·24	+·18	—·02	+·24	—·28	—·38	+·30	—·08	+·06
C. Siberia	40	—·46	—·04	—·10	—·16	—·16	—·04	—·22	—·08	—·18	+·06
Vienna	43	+·14	+·26	+·16	+·16	—·04	+·18	—·04	+·24	+·04	+·14
Azores	47	+·06	+·28	+·26	+·12	+·22	—·14	—·20	+·20	—·06	—·04
Charleston	47	+·24	+·42	+·48	+·04	—·08	+·06	—·06	+·54	+·30	+·24
San Francisco	47	+·44	+·20	+1·00	+·18	+·08	+·36	+·18	+1·00	+·44	+·36
Tokio	38	+·34	+·16	—·04	—·18	—·10	+·14	+·08	+·26	+·10	—·16
Cairo	44	—·20	+·04	+·18	—·08	—·20	+·10	—·06	+·08	+·02	+·08
Honolulu	39	+·20	0	+·14	+·02	+·14	+·40	+·36	+·26	+·10	+·04
N. W. India	47	+·12	—·10	—·50	+·08	+·28	—·02	0	—·34	—·28	—·26
Port Darwin	40	+·08	—·04	+·18	+·16	+·20	—·12	—·26	—·40	—·30	—·22
Mauritius	46	—·24	—·38	—·12	—·24	—·28	—·38	—·24	+·10	—·16	—·36
Samoa	20	+·38	—·02	0	—·22	+·10	+·16	+·38	+·22	+·38	+·08
S. E. Australia	46	—·10	—·06	—·08	+·18	+·02	—·40	—·32	—·42	—·38	—·26
Cape	47	—·10	—·06	—·02	+·06	—·04	+·02	+·10	—·04	—·24	+·02
S. America	47	+·16	+·14	+·08	+·02	+·42	+·26	+·30	+·54	+·08	+·28
Temperature.											
Dutch Harbour	36	..	—·18	—·12	+·16	..	—·10	—·08	—·04	—·22	..
Rain.											
Peninsula (J—S)	47	..	..	0	..	..	..	+·04	..	..	..
Java (O—F)	42	—·04	..	..	..	+·14	..	..	..	+·50	..

19. San Francisco has little concern with the N. Atlantic oscillation or with that of the N. Pacific in summer and autumn; but in winter and spring it shows marked opposition to the Aleutian low pressure area as shown by Dutch Harbour, the Alaska opposition not being reliably indicated. In spring the opposition to N. W. India persisting through four seasons, and the less marked opposition to Port Darwin and S. E. Australia, all members of the second group of the southern oscillation, are worth noting. In summer there are coefficients of +·48 with Charleston and —·50 with N. W. India, each based on 47 years, with odds of 9,000 to 1 against accidental production; and in autumn there are coefficients

of +·54 with Charleston and S. America, and marked negative coefficients with N. W. India, Port Darwin and S. E. Australia. In autumn therefore there are strong associations with the first group of the southern oscillation ; and these show considerable persistence, occurring with Honolulu in the previous spring and summer, Mauritius for March to May before and after, Samoa one season before and after, S. E. Australia during four seasons, and S. America for some months before. We accordingly are not surprised to find a partial forecast of +·50 of the Java rainfall of the period October to February.

20. For Tokio the tables are :—

TOKIO PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before Tokio. J—A	1 qr. before Tokio. S—N	Same qr. D—F	1 qr. after Tokio. M—M	2 qrs. after Tokio. J—A	2 qrs. before Tokio. S—N	1 qr. before Tokio. D—F	Same qr. M—M	1 qr. after Tokio. J—A	2 qrs. after Tokio. S—N
Iceland	38	+·02	+·16	**—·38**	—·22	+·10	+·10	—·04	**—·42**	**—·40**	0
Alaska	18	—·02	+·18	—·22	0	+·32	—·22	—·02	+·04	—·18	+·10
C. Siberia	33	**—·36**	—·02	—·20	—·12	—·16	—·20	—·18	+·24	—·14	—·12
Vienna	35	—·22	+·08	+·10	—·08	+·18	+·24	+·32	+·04	—·10	—·02
Azores	38	+·06	—·04	+·14	**+·36**	+·10	—·34	+·16	**+·38**	+·12	—·14
Charleston	38	0	+·06	+·24	**+·36**	**+·36**	—·20	0	+·10	+·10	+·14
San Francisco	38	—·10	+·10	+·08	—·02	+·34	—·16	+·08	0	+·16	+·14
Tokio	38	—·34	—·02	+1·00	—·18	—·28	—·30	—·18	+1·00	+·10	—·12
Cairo	36	+·30	+·30	**+·32**	0	—·08	+·04	+·28	+·04	+·26	+·20
Honolulu	38	—·24	+·04	**+·40**	—·20	—·22	—·02	—·02	+·04	+·08	+·24
N. W. India	38	+·28	+·14	+·10	—·10	—·16	+·14	+·22	+·12	—·10	—·10
Port Darwin	38	+·34	+·26	+·24	+·10	+·34	+·18	+·08	—·02	+·14	+·12
Mauritius	38	+·26	0	—·02	—·06	+·02	—·18	—·30	—·02	+·26	+·10
Samoa	20	—·12	+·46	+·02	—·20	—·04	—·14	—·04	—·44	—·26	+·14
S. E. Australia	38	+·12	+·12	+·16	0	+·22	+·08	+·12	+·08	+·14	+·24
Cape	38	+·34	+·08	+·30	+·04	+·16	+·10	+·28	+·08	+·14	—·16
S. America	38	—·22	+·14	—·20	—·20	+·12	—·14	+·16	+·08	0	—·14
Temperature.											
Dutch Harbour	35	..	—·06	+·02	—·04	..	..	—·24	+·02	—·14	..
Rain.											
Peninsula (J—S)	38	—·30	..	..	..	0	..	..	..	—·28	..
Java (O—F)	37	..	..	—·24	..	..	..	—·10	..	..	..

Tokio Pressure.

Pressure.	Years of data.	June to Aug. 2qrs. before Tokio. D—F	1 qr. before Tokio. M—M	Same. qr. J—A	1 qr. after Tokio. S—N	2qrs. after Tokio. D—F	Sep. to Nov. 2qrs. before Tokio. M—M	1 qr. before Tokio. J—A	Same qr. S—N	1 qr. after Tokio. D—F	2 qrs. after Tokio. M—M
Iceland	38	+·32	+·32	—·22	—·14	+·04	+·10	+·06	—·06	—·06	+·10
Alaska	19	+·10	—·20	+·04	+·26	—·02	+·14	—·22	—·16	—·18	+·22
C. Siberia	33	+·22	**+·36**	**+·36**	0	+·24	—·18	—·14	+·08	—·04	—·10
Vienna	35	+·02	+·16	+·26	0	+·04	—·04	—·24	—·18	—·20	—·04
Azores	38	—·04	—·32	—·10	+·16	—·18	—·14	—·26	+·10	—·08	—·14
Charleston	38	—·08	—·28	—·08	+·18	—·06	+·04	—·34	+·14	+·08	—·04
San Francisco	38	+·08	+·08	—·04	+·08	+·28	—·02	—·18	+·26	—·04	+·28
Tokio	38	—·28	+·10	+1·00	—·32	—·34	—·12	—·32	+1·00	—·02	—·30
Cairo	36	—·08	—·08	+·20	—·06	—·02	+·02	—·16	—·14	—·22	—·16
Honolulu	38	—·10	—·06	**+·40**	+·30	—·12	+·22	—·06	—·02	—·02	—·06
N. W. India	38	—·10	—·02	—·10	—·18	—·10	+·14	+·14	—·10	—·20	+·02
Port Darwin	38	—·26	—·34	**—·32**	—·26	—·28	+·32	—·06	—·06	0	—·14
Mauritius	38	—·12	—·06	+·12	+·22	—·12	—·14	—·32	—·26	+·02	**—·40**
Samoa	20	—·06	—·10	+·22	+·12	+·40	+·04	—·28	+·02	+·02	+·14
S. E. Australia	38	—·22	—·16	—·04	+·04	—·12	—·14	—·18	—·18	—·10	—·20
Cape	38	—·18	+·06	+·08	—·10	—·06	—·10	—·20	**—·42**	—·18	+2·8
S. America	38	—·20	+·02	+·16	+·02	—·10	0	+·12	+·22	+·20	+·16
Temperature.											
Dutch Harbour	35	—·16	—·08	+·04	—·08	..	..	+·10	+·26	—·22	..
Rain.											
Peninsula (J—S)	38	..	..	+·10	..	..	..	+·10	..	..	..
Java (O—F)	37	—·04	..	..	..	+·08	..	..	..	+·06	..

21. The position of Tokio on the western shore of the N. Pacific has much in common with that of San Francisco in the east, though it is not so much under the influence of the high pressure area as San Francisco. We will first look at the contemporary relationships. Like San Francisco it has little connection with either of the two northern oscilla-

tions in summer and autumn, but it behaves as a portion of the high pressure belt in the N. Atlantic oscillation during winter and spring; and in summer its sympathy with Honolulu (which is shown also in winter) and its opposition to Port Darwin mark it as in the first group of the southern oscillation, though not to so conspicuous a degree as San Francisco. In autumn the biggest contemporary coefficient is —·42 with Cape Town, and this without support is not big enough to ensure reality. Of the winter non-contemporary relations high pressure then has a tendency to follow a weakening of the southern oscillation two quarters before, *i.e.*, a low barometer in the high pressure area of the Pacific and a high barometer in the low pressure area of the Indian ocean.

22. The Cairo data are:—

CAIRO PRESSURE.

Pressure.	Years of data.	DEC. TO FEB. 2 qrs. before Cairo. J—A	1 qr. before Cairo. S—N	Same qr. D—F	1 qr. after Cairo. M—M	2 qrs. after Cairo. J—A	MARCH TO MAY. 2 qrs. before Cairo. S—N	1 qr. before Cairo. D—F	Same qr. M—M	1 qr. after Cario. J—A	2 qrs. after Cairo. S—N
Iceland	44	+·04	—·08	**—·42**	—·22	—·04	—·20	—·10	—·18	+·04	+·08
Alaska	18	—·30	+·52	—·28	—·24	—·12	+·20	—·26	0	—·14	+·38
C. Siberia	40	+·08	+·04	+·14	+·06	0	—·02	+·14	+·16	—·26	+·24
Vienna	43	+·16	+24	**+·46**	—·14	—·02	+·06	+·14	**+·34**	—·02	+·12
Azores	44	—·08	—·08	**+·34**	+·34	—·14	—·08	—·06	+·14	—·02	—·04
Charleston	44	—·16	—·04	+·08	+·04	—·20	+·18	—·20	+·06	—·22	+·06
San Francisco	44	—·20	+·02	+·06	—·24	—·20	+·08	+·32	+·02	+·04	+·10
Tokio	36	—·02	—·22	**+·32**	+·28	—·08	—·16	0	+·04	—·08	+·02
Cairo	44	**+·38**	+·32	+1·00	**+·36**	**+·40**	+·20	**+·36**	+1·00	**+·44**	**+·58**
Honolulu	36	—·28	—·20	+·20	—·10	—·12	—·10	+·34	+·28	—·06	0
N. W. India	44	+·30	+·04	+·02	+·10	+·30	+·26	+·06	+·28	+·16	+·06
Port Darwin	37	+·22	+·16	+·12	**—·24**	+·14	+·28	+·32	+·10	+·08	+·02
Mauritius	44	+·04	—·16	—·22	+·02	—·02	+·12	+·02	+·18	0	+·02
Samoa	20	—·38	—·08	—·38	**—·54**	—·18	—·32	—·16	—·14	—·12	+·30
S. E. Australia	43	**+·42**	+·10	+·10	—·18	+·24	+·18	+·32	+·02	+·14	+·06
Cape	44	**+·40**	+·16	**+·50**	+·12	+·26	—·12	**+·36**	+·24	+·22	+·18
S. America	44	0	**—·36**	—·26	—·30	—·04	—·22	+·04	—·14	—·20	0
Temperature.											
Dutch Harbour	35	..	—·02	+·02	+·20	..	..	—·02	+·18	+·12	..
Rain.											
Peninsula (J—S)	44	—·18	..	..	..	0	..	..	..	+·14	..
Java (O—F)	39	..	..	**—·34**	..	..	..	—·18	..	..	..

Cairo Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before Cairo. D—F	1 qr. before Cairo. M—M	Same qr. J—A	1 qr. after Cairo. S—N	2 qrs. after Cairo. D—F	Sep. to Nov. 2 qrs. before Cairo. M—M	1 qr. before Cairo. J—A	Same qr. S—N	1 qr. after Cairo. D—F	2 qrs. after Cairo. M—M
Iceland	44	—·16	—·06	—·18	—·24	—**·38**	—·12	—·12	0	—·26	—·12
Alaska	19	+·12	—·18	—·42	+·30	+·08	—·26	—·24	+·36	+·36	—·08
C. Siberia	40	—·14	+·02	+**·32**	+·14	+·28	—·12	—·06	+·24	+·06	0
Vienna	43	+·34	+·20	+**·34**	+**·22**	+·10	—·12	—·02	+·28	+·22	—·06
Azores	44	+·06	+·08	0	—·12	+**·36**	+·24	+·06	0	+·32	+·14
Charleston	44	+·10	+·06	—·14	—·06	0	—·06	—·30	—·12	+·24	—·04
San Francisco	44	+·26	—·24	+·18	—·06	+·04	—·06	—·08	+·08	+·18	0
Tokio	36	—·08	+·26	+·20	—·16	+·30	+·20	—·06	—·14	+·30	+·04
Cairo	44	+**·40**	+**·44**	+1·00	+**·54**	+·38	+**·58**	+**·54**	+1·00	+·32	+·20
Honolulu	36	+·10	+·08	—·06	+·08	+·18	+·18	+·14	+·02	—·02	—·20
N. W. India	44	+·12	+·08	+**·36**	+·34	+·14	+·22	+·24	—·02	—·22	0
Port Darwin	37	+·04	—·02	+·20	+·18	+·10	0	—·20	—·22	—·30	—·30
Mauritius	44	—·12	+·22	+**·34**	—·02	+·02	+·28	—·02	+·02	+·10	0
Samoa	20	—·10	—·18	—·30	+·16	+·14	—·08	+·06	+·14	—·08	0
S. E. Australia	43	+·18	+·02	+**·46**	+**·40**	+·26	+·08	0	—·08	—·10	+·06
Cape	44	+·18	—·10	+**·34**	+·10	+**·38**	+·14	+·30	+**·36**	—·08	—·14
S. America	44	+·06	—**·38**	—·30	—·24	+·02	—·16	—·06	0	—·22	+·08
Temperature											
Dutch Harbour	35	..	+·22	+·14	+·18	..	..	+·04	—·02	+·08	..
Rain.											
Peninsula (J—S)	44	..	..	—**·32**	..	..	..	0	..	..	..
Java (O—F)	39	—·04	..	..	..	—·28	..	..	..	—·04	..

23. Regarding the N. Atlantic oscillation Cairo is a strong member of the high pressure group in winter and in spring a moderate member; but during the rest of the year the relationship is only feebly developed. In the N. Pacific oscillation it plays no part. In the southern oscillation it is a moderate adherent of the second group in winter, but is a

fairly consistent adherent in summer: in spring and autumn this relation almost disappears. The significant non-contemporary relations are of the same character as the contemporary except that of +·52 with Alaska in the winter table, which is not in excess of the expectation due to accident and is probably fictitious.

The reality of Cairo as a centre follows from the existence of six winter contemporary coefficients in excess of the probable biggest random coefficient and in summer of seven. During the other two seasons Cairo is singularly neutral: the largest contemporary coefficient then scarcely exceeds the probable greatest random coefficient.

24. For Honolulu the relationships are :—

HONOLULU PRESSURE.

		Dec. to Feb.					March to May				
Pressure.	Years of data.	2 qrs. before Honol. J—A	1 qr. before Honol. S—N	Same qr. D—F	1 qr. after Honol. M—M	2 qrs. after Honol. J—A	2 qrs. before Honol. S—N	1 qr. before Honol. D—F	Same qr. M—M	1 qr. after Honol. J—A	2 qrs. after Honol. S—N
Iceland	37	0	—·16	—·18	—·10	—·04	+·06	+·06	—·06	—·16	+·16
Alaska	19	—·14	—·06	**—·70**	—·26	—·04	—·08	—·14	**—·52**	—·30	+·50
C. Siberia	33	—·20	—·28	—·30	+·14	**—·38**	—·22	+·10	—·02	—·34	+·24
Vienna	35	—·20	+·08	—·04	+·10	—·14	—·10	—·14	+·18	**—·40**	+·08
Azores	38	+·16	—·14	+·14	+·16	+·20	—·34	—·06	—·14	+·06	—·14
Charleston	37	+·10	+·04	—·20	+·20	+·20	—·10	—·12	—·08	+·04	+·30
San Francisco	39	+·14	+·10	+·14	+·18	+·20	+·04	+·14	+·14	0	**+·40**
Tokio	38	—·12	—·02	**+·40**	—·02	—·10	—·06	—·20	+·04	—·06	+·22
Cairo	36	+·18	—·02	+·20	+·34	+·10	—·20	—·10	+·28	+·08	+·18
Honolulu	39	—·16	+·12	+1·00	**+·44**	+·12	0	**+·44**	+1·00	**+·52**	+·24
N. W. India	38	+·08	+·22	+·14	+·12	+·12	+·04	—·06	—·04	+·24	—·32
Port Darwin	38	**+·46**	**+·48**	**+·38**	+·02	+·12	+·14	+·08	—·06	**—·38**	**—·44**
Mauritius	38	+·30	—·02	—·26	—·06	—·18	+·08	—·30	+·10	—·22	—·12
Samoa	20	+·08	+·38	+·20	0	+·04	+·02	+·38	**+·48**	+·10	**+·60**
S. E. Australia	38	+·28	+·30	**+·32**	—·10	+·20	+·06	+·14	—·14	—·16	—·30
Cape	38	+·16	—·20	+·30	+·10	0	**—·38**	—·04	—·20	—·06	—·06
S. America	38	+·12	+·10	+·06	—·04	+·18	—·06	+·18	+·14	+·24	+·34
Temperature.											
Dutch Harbour	35	..	—·08	—·24	—·16	..	..	—·18	—·22	+·04	..
Rain.											
Peninsula (J—S)	39	**—·42**	..	..	..	+·26	..	..	..	+·30	..
Java (O—F)	36	..	..	**—·32**	..	..	..	—06	..	..	..

Honolulu Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before Honol. D—F	June to Aug. 1 qr. before Honol. M—M	June to Aug. Same qr. J—A	June to Aug. 1 qr. after Honol. S—N	June to Aug. 2 qrs. after Honol. D—F	Sep. to Nov. 2 qrs. before Honol. M—M	Sep. to Nov. 1 qr. before Honol. J—A	Sep. to Nov. Same qr. S—N	Sep. to Nov. 1 qr. after Honol. D—F	Sep. to Nov. 2 qrs. after Honol. M—M
Iceland	38	—·06	+·06	**—·34**	—·06	0	—·10	·20	—·12	—·20	—·10
Alaska	20	—·12	—·44	—·28	+·42	+·22	+·16	—·24	—·22	—·14	—·02
C. Siberia	33	+·06	—·04	—·16	+·30	—·08	+·26	—·20	**+·42**	—·14	+·02
Vienna	35	+·10	+·12	—·26	+·12	+·10	+·16	—·63	—·02	—·04	+·26
Azores	38	+·08	—·24	+·20	+·14	—·08	—·04	—·04	+·20	—·02	—·02
Charleston	37	+·10	—·14	—·08	+·10	+·30	**—·40**	—·18	—·08	+·22	—·02
San Francisco	39	+·04	+·22	+·14	**+·36**	+·08	—·32	+·02	+·26	+·02	+·10
Tokio	38	—·22	+·08	**+·40**	—·06	—·24	+·24	+·30	—·02	+·04	—·02
Cairo	36	—·12	—·06	—·06	+·14	—·28	0	+·08	+·02	—·20	—·10
Honolulu	39	+·12	**+·52**	+1·00	**+·44**	—·16	+·24	**+·44**	+1·00	+·12	0
N. W. India	38	—·28	—·22	**0**	**—·42**	—·30	+·30	+·10	**—·32**	—·22	—·14
Port Darwin	38	—·34	**—·54**	**—·66**	**—·68**	**—·64**	—·04	—·20	—·24	—·30	—·26
Mauritius	38	—·30	—·06	—·22	+·16	—·10	—·24	+·02	+·04	—·12	—·18
Samoa	20	+·46	+·42	**+·74**	+·22	+·50	+·20	+·44	+·42	**+·56**	+·28
S. E. Australia	38	—·24	**—·46**	—·28	**—·38**	**—·54**	—·26	—·04	—·04	—·30	—·18
Cape	38	—·28	—·16	—·08	+·04	**—·42**	—·10	+·02	—·14	—·22	+·06
S. America	38	0	+·30	**+·52**	+·32	—·06	—·02	+·24	**+·32**	—·08	+·28
Temperature.											
Dutch Harbour	35	..	**—·40**	—·04	—·20	..	+·02	—·12	—·22	—·02	..
Rain.											
Peninsula (J—S)	39	..	..	**+·46**	..	..	..	+·02	..	..	..
Java (O—F)	36	—·14	..	..	..	**+·40**	..	..	..	+·30	..

25. In the north Pacific oscillation Honolulu is very prominent in the first half year, its coefficient with Alaska based on 19 years being—·70 in winter and —·52 in spring. In the north Atlantic oscillation its activity is mainly confined to the summer and is relatively weak (— ·34 with Iceland and + ·20 with the Azores). In the southern oscillation it exercises in summer a very strong control as a member of the first group, having coefficients of — ·66, — ·68, — ·64 with pressure at Port Darwin in that season and the two following; and, in addition to high contemporary coefficients with Samoa, S. America and Peninsula rain, it has coefficients with conditions two quarters later (*i.e.*, in the southern summer) of ·50 at Samoa, — ·54 in S. E. Australia,— ·42 at the Cape and +·40 with Java rain. In autumn its influence is less, though it still gives information regarding

some of the conditions in the southern summer. But in winter Honolulu behaves as a not very decided member of the second group of the southern oscillation and has coefficients of + ·38, + ·32, + ·30 and — ·32 with pressure at Port Darwin, S. E. Australia and the Cape, and with Java rain: its associations with conditions two quarters before, + ·46 with Port Darwin and —·42 with Peninsula rain are also of this reversed type. In spring the adherence to the first group is already setting in and there is a forecast of conditions two quarters later of — ·44 with Port Darwin and + ·60 with Samoa, together with smaller coefficients in N. W. India, S. E. Australia and S. America.

26. The correlation coefficients with N. W. India are :—

N. W. India Pressure.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before N. W. Ind. J—A	1 qr. before N. W. Ind. S—N	Same qr. D—F	1 qr. after N. W. Ind. M—M	2 qrs. after N. W. Ind. J—A	2 qrs. before N. W. Ind. S—N	1 qr. before N. W. Ind. D—F	Same qr. M—M	1 qr. after N. W. Ind. J—A	2 qrs. after N. W. Ind. S—N
Iceland	47	+·12	—·02	+·06	—·06	+·06	0	0	+·12	+·08	—·08
Alaska	21	+·24	0	—·08	+·20	+·02	+·02	+·16	+·38	+·18	—·14
C. Siberia	40	+·08	—·12	+·02	+·34	+·12	+·14	+·20	+·26	+·04	+·18
Vienna	43	+·22	+·12	—·04	—·06	—·12	+·22	—·04	—·30	—·12	—·18
Azores	47	+·02	—·06	—·02	—·06	—·02	—·12	+·06	0	0	+·34
Charleston	45	+·24	—·22	—·52	—·28	—·14	—·32	—·46	—·36	—·24	—·02
San Francisco	47	+·28	—·28	—·24	—·50	+·12	—·26	—·34	—·34	—·10	—·02
Tokio	38	—·10	—·20	+·10	+·22	—·10	+·02	—·10	+·12	—·02	+·14
Cairo	44	+·14	—·22	+·02	+·06	+·12	0	+·10	+·28	+·08	+·22
Honolulu	38	—·30	—·22	+·14	—·06	—·28	—·14	+·12	—·04	—·22	+·30
N. W. India	48	+·04	+·66	+1·00	+·52	+·20	+·48	+·52	+1·00	+·28	—·22
Port Darwin	40	+·46	+·56	+·66	+·50	+·48	+·38	+·52	+·38	+·18	+·14
Mauritius	46	+·26	+·16	+·20	—·06	—·02	—·10	+·16	—·16	—·04	—·20
Samoa	20	—·10	—·04	—·40	—·32	—·18	—·56	—·62	—·26	—·08	+·44
S. E. Australia	46	+·38	+·40	+·46	+·40	+·32	+·24	+·38	+·18	+·06	+·26
Cape	47	+·04	+·16	+·56	—·28	+·08	+·16	+·44	—·02	+·14	—·20
S. America	47	—·46	—·24	+·20	—·34	—·14	—·30	+·08	—·22	—·04	—·10
Temperature.											
Dutch Harbour	36	..	+·08	+·18	+·30	..	..	+·34	+·18	—·16	..
Rain											
Peninsula (J—S)	47	—·16	..	..	..	—·04	..	..	..	+·06	..
Java (O—F)	42	..	..	—·32	..	..	..	—·12	..	..	..

N. W. India Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before N. W. Ind. D—F	1 qr. before N. W. Ind. M—M	Same qr. J—A	1 qr. after N. W. Ind. S—N	2 qrs. after N. W. Ind. D—F	Sep. to Nov. 2 qrs. before N. W. Ind. M—M	1 qr. before N. W. Ind. J—A	Same qr. S—N	1 qr. after N. W. Ind. D—F	2 qrs. after N. W. Ind. M—M
Iceland	47	+·04	+·20	+·20	+·08	+·02	—·06	+·02	—·06	—·08	+·06
Alaska	22	—·04	—·48	—·22	+·20	—·28	+·20	—·08	—·22	+·18	+·20
C. Siberia	40	**+·36**	+·10	**+·36**	+·22	**+·36**	**—·44**	+·10	—·10	+·04	+·34
Vienna	43	—·02	—·04	0	—·06	+·02	+·10	+·28	+·18	+·06	—·08
Azores	47	—·10	—·32	—·26	—·14	+·06	+·26	—·02	—·18	—·02	—·06
Charleston	45	—·30	—·28	—·52	+·04	—·02	**+·42**	+·20	—·20	**—·42**	—·22
San Francisco	47	—·32	—·34	**—·50**	0	—·12	+·02	+·08	**—·34**	—·20	**—·48**
Tokio	38	—·16	—·10	—·10	+·14	+·28	—·10	—·18	—·10	+·14	+·14
Cairo	44	+·30	+·16	**+·36**	+·24	+·30	+·06	+·34	—·02	+·04	+·26
Honolulu	38	+·12	+·24	0	+·10	+·08	—·32	**—·42**	**—·32**	+·22	+·04
N. W. India	48	+·20	+·28	+1·00	+·02	+·04	—·22	+·02	+1·00	**+·66**	**+·48**
Port Darwin	40	+·06	+·08	+·04	+·06	—·06	+·22	**+·58**	**+·72**	**+·70**	**+·48**
Mauritius	46	+·12	+·30	+·22	+·18	+·20	+·26	**+·42**	+·24	**+·36**	+·18
Samoa	20	—·02	+·20	+·18	+·50	+·12	—·08	—·38	—·14	**—·86**	**—·70**
S. E. Australia	46	+·06	—·12	+·26	+·10	+·04	+·14	**+·54**	**+·46**	**+·68**	**+·44**
Cape	47	+·18	—·20	+·16	—·20	+·26	—·04	0	+·26	**+·48**	—·16
S. America	47	+·04	—·24	—·26	—·18	—·20	**—·36**	**—·58**	—·08	+·02	**—·38**
Temperature.											
Dutch Harbour	36	..	+·06	+·20	+·14	..	..	+·06	+·26	—·02	..
Rain.											
Peninsula (J—S)	47	..	..	—·10	..	..	..	**—·42**	..	..	..
Java (O—F)	42	+·10	..	..	..	—·16	..	..	..	**—·52**	..

27. India has but little connection with the N. Atlantic oscillation, showing in the spring and summer quarters a slight tendency towards high pressure when that of Iceland is high and that in Charleston, the Azores and Vienna is low. With the N. Pacific oscillation similarly there is in the spring quarter a very slight tendency towards sympathy with the minimum area of Alaska and Dutch Harbour. The main association is with the southern oscillation, in which India behaves like the low pressure areas of the second group ; and it is a paradox that it is when India is at the heart of the biggest area of low pressure on the earth that it shows least character as a low pressure area in the southern oscillation : at that time its biggest coefficient with a station south of the equator is ·26.

but in the cold weather, when it is on the edge of the Asian anticyclone and is nowhere near any centre of action as Teisserenc de Bort understood the term, it has eleven coefficients of ·4 or over with southern stations; and the total number of coefficients exceeding ·45 with places other than N. W. India is ten. The table for March to May contains some large coefficients, especially with the previous quarter, but the closest relations of the year are those between the autumn pressure of India and that of the succeeding quarter in the southern area; forecasting coefficients of ·68, ·70 and ·86 are then to be found.

28. The tables for Port Darwin are :—

Port Darwin Pressure.

Pressure.	Years of data.	Dec. to Feb.					March to May.				
		2 qrs. before P. Dar. J—A	1 qr. before P. Dar. S—N	Same qr. D—F	1 qr. after P. Dar. M—M	2 qrs. after P. Dar. J—A	2 qrs. before P. Dar. S—N	1 qr. before P. Dar. D—F	Same qr. M—M	1 qr. after P. Dar. J—A	2 qrs. after P. Dar. S—N
Iceland	40	+·26	—·12	+·06	—·04	+·12	+·08	+·30	+·02	+·32	+·18
Alaska	20	+·18	—·06	—·24	+·30	—·12	—·24	+·28	+·32	+·14	—·36
C. Siberia	34	+·10	—·24	—·08	+·28	**—·36**	—·06	+·06	+·18	—·16	—·04
Vienna	36	+·22	+·08	—·24	+·06	—·30	—·22	**—·42**	—·14	—·18	+·10
Azores	40	—·08	—·18	—·08	+·20	+·16	—·04	—·24	+·12	—·16	+·02
Charleston	38	+·24	+·02	**—·52**	—·02	+·04	—·04	—·28	—·02	—·12	+·06
San Francisco	40	+·20	—·30	—·14	—·32	+·08	—·22	—·26	**—·36**	—·04	—·12
Tokio	38	—·28	0	+·24	+·08	—·26	—·14	+·10	—·02	—·34	+·32
Cairo	37	+·10	—·30	+·12	+·32	+·04	—·30	—·24	+·10	—·02	0
Honolulu	38	**—·64**	—·30	**+·38**	+·08	—·34	—·26	+·02	—·06	**—·54**	—·04
N. W. India	40	—·06	**+·70**	**+·66**	**+·52**	+·06	**+·48**	**+·50**	**+·38**	+·08	+·22
Port Darwin	41	**+·82**	**+·86**	+1·00	**+·68**	+·34	**+·54**	**+·68**	+1·00	**+·42**	**+·44**
Mauritius	39	+·22	—·16	+·12	—·14	—·10	—·04	+·24	+·10	—·06	—·18
Samoa	20	**—·62**	—·18	**—·58**	**—·60**	—·28	—·14	**—·42**	—·30	—·40	+·14
S. E. Australia	40	**+·48**	**+·54**	**+·74**	+·22	+·18	+·34	**+·50**	**+·52**	+·10	+·18
Cape	40	—·06	—·06	**+·60**	+·26	+·04	+·10	+·32	—·08	—·02	—·06
S. America	40	**—·56**	—·26	+·16	—·32	—·06	—·08	+·22	**—·32**	—·16	—·06
Temperature.											
Dutch Harbour	36	..	+·28	+·10	**+·36**	..	..	+·34	+·28	+·12	..
Rain.											
Peninsula (J—S)	42	**—·46**	..	..	..	—·02	..	..	..	—·32	..
Java (O—F)	38	..	..	**—·46**	..	..	..	+·08	..	..	..

PORT DARWIN PRESSURE.

Pressure.	Years of data.	June to Aug. 2 qrs. before P. Dar. D—F	June to Aug. 1 qr. before P. Dar. M—M	June to Aug. Same qr. J—A	June to Aug. 1 qr. after P. Dar. S—N	June to Aug. 2 qrs. after P. Dar. D—F	Sep. to Nov. 2 qrs. before P. Dar. M—M	Sep. to Nov. 1 qr. before P. Dar. J—A	Sep. to Nov. Same qr. S—N	Sep. to Nov. 1 qr. after P. Dar. D—F	Sep. to Nov. 2 qrs. after P. Dar. M—M
Iceland	40	0	—·14	+·22	+·12	—·12	—·12	+·22	+·06	—·02	—·08
Alaska	21	—·24	+·34	+·26	—·10	—·12	+·44	+·16	—·30	—·24	+·08
C. Siberia	34	—·40	—·10	—·06	—·32	—·08	—·06	+·14	—·32	0	+·38
Vienna	36	+·14	+·04	+·18	+·04	—·30	+·10	+·14	—·02	—·28	+·04
Azores	40	—·18	+·32	—·08	—·30	+·12	+·30	+·02	—·28	+·04	+·22
Charleston	38	—·22	+·34	+·12	—·02	—·30	+·34	+·10	0	—·50	+·04
San Francisco	40	+·12	—·18	+·18	—·26	—·14	—·12	+·16	—·40	—·10	—·22
Tokio	38	+·34	+·14	—·32	—·06	+·34	+·12	—·26	—·06	+·26	+·18
Cairo	37	+·14	+·08	+·20	—·20	+·22	+·02	+·18	—·22	+·16	+·28
Honolulu	38	+·12	—·38	—·66	—·20	+·46	—·44	—·68	—·24	+·48	+·14
N. W. India	40	+·48	+·18	+·04	+·58	+·46	+·14	+·06	+·72	+·56	+·38
Port Darwin	41	+·34	+·42	+1·00	+·90	+·82	+·44	+·90	+1·00	+·86	+·54
Mauritius	39	+·04	—·04	+·24	—·20	0	0	+·30	—·08	+·04	—·06
Samoa	20	—·22	—·46	—·56	—·02	—·30	—·38	—·54	+·10	—·50	—·66
S. E. Australia	40	+·10	+·26	+·72	+·56	+·58	+·30	+·58	+·70	+·70	+·26
Cape	40	+·40	+·10	+·18	+·26	+·54	+·02	—·04	+·08	+·56	+·02
S. America	40	+·14	—·32	—·46	—·16	0	—·24	—·54	—·26	+·02	—·26
Temperature.											
Dutch Harbour	36	..	+·38	+·06	+·28	..	..	+·10	+·30	—·02	..
Rain.											
Peninsula (J—S)	42	..	..	—·40	..	..	..	—·46	..	..	..
Java (O—F)	38	+·18	..	..	..	—·50	..	..	..	—·60	..

29. Port Darwin is the most typical of the second group in the southern oscillation; and although its position is most marked in the quarters from September to February, in each of which there are in the table in all 15 coefficients exceeding ·45 with other stations, yet for the period June to August there are 12 of them, and for March to May 5. With the northern oscillations there are no significant relations.

A remarkable feature is the persistance of pressure after the quarter June to August for two quarters, the coefficients between consecutive quarters being + ·90 and +·86. Another feature is the suggestion of propagation ; in the first quarter there is an indication that reversed pressure waves come from Honolulu, Samoa and S.America in about six months, and in the fourth quarter that a wave arriving then left Honolulu, Samoa and S. America in the previous quarter : at other times the indications are less clear, but there is evidence of a reversed effect of pressure in the second quarter upon Honolulu in the succeeding quarter.

30. The relationships of Mauritius are :—

MAURITIUS PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before Maur. J—A	1 qr. before Maur. S—N	Same qr. D—F	1 qr. after Maur. M—M	2 qrs. after Maur. J—A	2 qrs. before Maur. S—N	1 qr. before Maur. D—F	Same qr. M—M	1 qr. after Maur. J—A	2 qrs. after Maur. S—N
Iceland	47	−·10	−·10	+·26	+·12	+·10	+·32	+·14	+·04	−·18	+·32
Alaska	21	−·24	−·22	+·08	+·32	0	+·20	+·24	−·18	+·26	+·18
C. Siberia	40	+·02	+·28	+·28	+·28	+·22	+·08	+·16	−·14	−·04	−·06
Vienna	43	0	+·06	−·08	+·06	−·04	−·24	−·02	−·08	+·02	−·02
Azores	46	+·06	+·12	−·04	−·32	0	−·32	−·22	−·02	−·04	−·36
Charleston	45	−·06	+·06	−·12	−·44	−·20	−·12	+·10	−·06	−·14	−·28
San Francisco	46	−·28	−·16	−·26	−·28	−·24	−·36	−·02	−·10	−·38	−·38
Tokio	38	−·12	+·02	−·02	−·30	−·12	−·40	−·06	−·02	−·06	−·14
Cairo	44	+·02	+·10	−·22	+·02	−·12	0	+·02	+·18	+·22	+·28
Honolulu	38	−·10	−·12	−·26	−·30	−·30	−·18	−·06	+·10	−·06	−·24
N. W. India	46	+·20	+·36	+·20	+·16	+·12	+·18	−·06	−·16	+·30	+·26
Port Darwin	39	0	+·04	+·12	+·24	+·04	−·06	−·14	+·10	−·04	0
Mauritius	47	+·34	+·60	+1·00	+·22	+·06	+·38	+·22	+1·00	+·52	+·28
Samoa	20	−·08	−·18	−·36	−·08	+·04	+·02	+·10	+·14	+·02	+·34
S. E. Australia	45	+·18	+·20	+·26	+·22	−·02	0	+·08	+·14	+·30	+·12
Cape	46	−·06	+·12	−·04	−·14	+·24	+·12	0	−·02	+·22	+·10
S. America	46	−·48	−·20	−·06	−·08	−·22	−·20	−·22	−·24	−·34	−·26
Temperature.											
Dutch Harbour	36	..	−·06	+·32	+·24	..	..	−·04	+·10	+·22	..
Rain.											
Peninsula (J—S)	47	−·12	..	..	..	+·10	..	..	..	−·18	..
Java (O—F)	41	..	..	−·06	..	..	..	−·16	..	..	..

MAURITIUS PRESSURE.

Pressure.	Years of data.	June to Aug. 2 qrs. before Maur. D—F	1 qr. before Maur. M—M	Same qr. J—A	1 qr. after Maur. S—N	2 qrs. after Maur. D—F	Sep. to Nov. 2 qrs. before Maur. M—M	1 qr. before Maur. J—A	Same qr. S—N	1 qr. after Maur. D—F	2 qrs. after Maur. M—M
Iceland	47	+·06	0	—·30	+·04	+·06	+·10	—·22	+·02	+·24	+·14
Alaska	21	—·22	+·18	+·22	+·08	—·26	+·12	—·22	—·08	—·10	—·18
C. Siberia	40	—·06	—·12	+·08	—·04	+·26	—·06	—·02	+·06	+·06	+·06
Vienna	43	+·12	+·12	+·28	—·04	+·10	+·26	0	—·04	+·10	+·22
Azores	46	—·26	+·04	+·10	—·30	+·08	—·12	+·14	+·08	—·12	—·32
Charleston	45	+·06	+·08	+·10	—·24	—·02	—·02	—·14	+·14	+·06	—·22
San Francisco	46	+·16	—·10	—·12	—·24	—·18	+·20	—·24	+·10	+·02	—·02
Tokio	38	+·02	+·26	+·12	—·32	+·26	+·10	+·22	—·26	0	—·18
Cairo	44	—·02	0	**+·34**	—·02	+·04	+·02	—·02	+·02	—·16	+·12
Honolulu	38	—·18	—·22	—·22	+·02	+·30	—·12	+·16	+·04	—·02	+·08
N. W. India	46	—·02	—·04	+·22	**+·42**	+·26	—·20	+·18	+·24	+·16	—·10
Port Darwin	39	—·10	—·06	+·24	+·30	+·22	—·18	—·20	—·08	—·16	—·04
Mauritius	47	+·06	**+·52**	+1·00	**+·46**	+·34	+·28	**+·46**	+1·00	**+·60**	+·38
Samoa	20	+·26	+·10	+·16	+·32	—·10	+·14	+·42	+·22	—·24	—·02
S. E. Australia	45	+·06	—·06	**+·44**	**+·48**	**+·48**	—·16	+·04	+·04	+·08	+·14
Cape	46	0	+·28	+·16	+·02	+·30	+·22	+·08	+·20	—·02	—·14
S. America	46	—·08	—·30	**—·38**	—·22	—·06	+·12	—·28	—·02	—·18	+·04
Temperature.											
Dutch Harbour	36	..	+·16	—·14	+·04	..	..	—·02	—·20	—·04	..
Rain.											
Peninsula (J—S)	47	..	..	**—·52**	..	..	..	—·14	..	..	..
Java (O—F)	41	+·04	..	..	..	**—·38**	..	..	..	—·04	..

31. Although Mauritius is near the centre of the Indian Ocean it is not as characteristic of that Ocean as India, Australia or S. Africa.

During the first half year it shows some non-simultaneous opposition to the northern high pressure belt—the Azores, Charleston, San Francisco, Tokio and Honolulu. During

June to August there are significant coefficients indicating marked participation with the second group in the southern oscillation, five coefficients exceeding ·4: but from September to November there are no significant coefficients with other centres.

32. For Samoa the tables are :—

SAMOA PRESSURE.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before Samoa. J—A	1 qr. before Samoa. S—N	Same qr. D—F	1 qr. after Samoa. M—M	2 qrs. after Samoa. J—A	2 qrs. before Samoa. S—N	1 qr. before Samoa D—F	Same qr. M—M	1 qr. after Samoa. J—A	2 qrs. after Samoa. S—N
celand	20	—·16	+·30	—·12	—·16	—·06	+·30	+·12	—·02	—·16	+·04
Alaska	4	(—·4)	(+·4)	(—·2)	(—1·0)	(+·1)	(+·7)	(—·1)	(—·7)	(—·5)	(+·2)
Siberia	20	—·24	—·12	+·02	+·02	+·02	+·14	+·24	—·36	—·04	+·10
Vienna	20	—·26	—·22	—·44	+·46	+·04	—·22	—·34	+·20	—·02	+·12
Azores	20	—·04	—·32	—·08	—·02	+·10	+·06	—·06	—·36	+·08	—·34
Charleston	20	—·08	+·24	+·28	+·26	+·32	—·04	+·06	—·12	—·04	—·26
San Francisco	20	+·10	+·38	+·22	+·30	+·38	+·08	—·24	+·38	—·02	+·16
Tokio	20	+·40	+·02	+·02	—·04	—·06	+·14	—·20	—·44	—·10	+·04
Cairo	20	+·14	—·08	—·38	—·16	—·10	0	—·54	—·14	—·18	—·08
Honolulu	20	+·50	+·56	+·20	+·38	+·46	+·28	0	+·48	+·42	+·20
N. W. India	20	+·12	—·86	—·40	—·62	—·02	—·70	—·32	—·26	+·20	—·08
Port Darwin	20	—·30	—·50	—·58	—·42	—·22	—·66	—·60	—·30	—·46	—·38
Mauritius	20	—·10	—·24	—·36	+·10	+·26	—·02	—·08	+·14	+·10	+·14
Samoa	20	+·36	+·32	+1·00	+·62	+·22	+·12	+·62	+1·00	+·46	+·34
S. E. Australia	20	—·14	—·22	—·54	—·30	—·06	—·34	—·52	—·16	—·18	—·12
Cape	20	+·24	—·40	—·38	+·06	—·36	—·46	—·66	—·02	—·10	—·16
S. America	20	+·48	+·32	+·24	+·24	0	+·16	+·22	+·36	+·28	+·48
Temperature.											
Dutch Harbour	18	..	—·62	—·18	—·46	..	..	+·14	—·52	—·10	..
Rain.											
Peninsula (J—S)	20	+·48	..	..	..	—·20	..	..	..	+·16	..
Java (O—F)	19	..	..	+·46	..	..	..	+·34	..	..	..

SAMOA PRESSURE.

Pressure.	Years of data.	JUNE TO AUG.					SEP. TO NOV.				
		2 qrs. before Samoa	1 qr. before Samoa.	Same qr.	1 qr. after Samoa	2 qrs. after Samoa.	2 qrs. before Samoa	1 qr. before Samoa.	Same qr.	1 qr. after Samoa.	2 qrs. after Samoa.
		D—F	M—M	J—A	S—N	D—F	M—M	J—A	S—N	D—F	M—M
Iceland	20	—·18	—·04	—·10	+·30	—·16	—·06	—·06	+·50	—·24	—·02
Alaska	4	(—·2)	(—·7)	(—·4)	(+·4)	(+·4)	(-1·0)	(+·2)	(+·9)	(+·1)	(—·5)
C. Siberia	20	+·10	—·14	—·32	0	—·14	0	—·26	—·40	—·06	—·08
Vienna	20	+·04	+·18	—·46	—·20	—·06	+·12	—·50	—·42	—·16	—·26
Azores	20	+·16	—·28	+·34	+·28	+·18	—·22	+·02	—·06	+·10	+·22
Charleston	20	0	—·20	—·22	—·10	+·20	—·36	—·38	+·04	+·20	+·38
San Francisco	20	—·26	+·12	0	+·38	0	+·24	—·22	+·22	+·18	+·24
Tokio	20	—·04	—·26	+·22	—·28	—·12	+·14	+·12	+·02	+·46	—·14
Cairo	20	—·18	—·12	—·30	+·06	—·38	+·30	+·16	+·14	—·08	—·32
Honolulu	20	+·04	+·10	+·74	+·44	+·08	+·60	+·22	+·42	+·38	+·02
N. W. India	20	—·18	—·08	+·18	—·38	—·10	+·44	+·50	—·14	—·04	—·56
Port Darwin	20	—·28	—·40	—·56	—·54	—·62	+·14	—·02	+·10	—·18	—·14
Mauritius	20	+·04	+·02	+·16	+·42	—·08	+·34	+·32	+·22	—·18	+·02
Samoa	20	+·22	+·46	+1·00	+·42	+·36	+·34	+·42	+1·00	+·32	+·12
S. E. Australia	20	—·30	—·62	—·36	—·38	—·42	—·12	—·02	+·36	—·18	—·02
Cape	20	—·46	+·10	0	+·12	—·46	+·08	—·02	—·06	—·04	—·22
S. America	20	+·10	+·48	+·50	+·50	—·34	+·28	—·06	+·36	—·20	+·16
Temperature.											
Dutch Harbour	18	..	—·24	0	—·16	..	..	+·02	+·20	—·16	..
Rain.											
Peninsula (J—S)	20	..	..	+·36	..	..	..	+·08	..	..	..
Java (O—F)	19	—·08	..	..	..	+·26	..	..	..	—·24	..

33. Samoa is a strongly characteristic representation of the first group of the southern oscillation: and in the first half year it shows strong opposition to Dutch Harbour and to Alaska, the latter having only four years' data in common with Samoa. In each of the tables for the first three quarters it has 7 significant coefficients with other

centres, and for September to November 3: moreover for March to May there are no active coefficients and for June to August only one passive. The control exercised by N. W. India pressure in the period September to November over that in Samoa in the succeeding quarter,— ·86, is the closest in these tables. Nearly all of the close relationships are connected with the southern oscillation. But in the southern summer the sympathy with Honolulu (+·56) in the previous quarter is associated with strong opposition (—·62) with the N. Pacific low pressure as indicated by Dutch Harbour temperature: and in the period September to November there is opposition with Vienna (—·42) and sympathy with Iceland (+·50).

34. The data for S. E. Australia are:—

South East Australia Pressure.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before S.E.Aus. J—A	1 qr. before S.E.Aus. S—N	Same qr. D—F	1 qr. after S.E.Aus. M—M	2 qrs. after S.E.Aus. J—A	2 qrs. before S.E.Aus. S—N	1 qr. before S.E.Aus. D—F	Same qr. M—M	1 qr. after S.E.Aus. J—A	2 qrs. after S.E. Aus. S—N
Iceland	46	+·06	—·08	+·08	—·02	—·06	+·06	+·18	+·02	+·04	—·12
Alaska	21	+·06	—·10	—·14	+·14	—·34	—·32	+·32	+·04	+·20	—·12
C. Siberia	39	+·20	—·08	+·02	+·28	—·12	—·06	+·02	+·10	+·22	—·08
Vienna	42	+·30	+·06	—·10	—·10	—·26	—·08	—·20	—·26	+·06	+·30
Azores	46	—·04	—·28	+·10	+·16	+·28	+·18	—·04	+·04	—·14	—·12
Charleston	44	+·12	—·16	—·30	—·16	—·04	—·18	—·28	—·18	—·06	—·02
San Francisco	46	+·02	—·38	—·20	—·40	—·10	—·26	—·18	—·30	—·06	—·40
Tokio	38	—·12	—·10	+·16	+·12	—·22	—·20	0	+·08	—·16	—·14
Cairo	43	+·26	—·10	+·10	+·32	+·18	+·06	—·18	+·02	+·02	+·08
Honolulu	38	—·54	—·30	+·32	+·14	—·24	—·18	—·10	—·14	—·46	—·26
N. W. India	46	+·04	+·68	+·46	+·38	+·06	+·44	+·40	+·18	—·12	+·14
Port Darwin	40	+·58	+·70	+·74	+·50	+·10	+·26	+·22	+·52	+·26	+·30
Mauritius	45	+·48	+·08	+·26	+·08	+·06	+·14	+·22	+·14	—·06	—·16
Samoa	20	—·42	—·18	—·54	~~—·56~~ -·52	—·30	—·02	—·30	—·16	—·62	—·12
S. E. Australia	47	+·36	+·50	+1·00	+·42	+·08	+·30	+·42	+1·00	+·08	+·24
Cape	46	—·08	+·12	+·52	+·02	0	+·14	+·24	—·22	—·06	—·02
S. America	46	—·56	—·22	+·08	—·34	0	0	—·02	—·30	—·24	—·28
Temperature.											
Dutch Harbour	36	..	+·14	+·08	+·20	..	..	+·16	+·04	0	..
Rain.											
Peninsula (J—S)	48	—·62	..	..	..	+·04	..	..	..	—·20	..
Java (O—F)	42	..	..	—·42	..	..	..	—·02	..	..	..

South East Australia Pressure.

Pressure.	Years of data.	June to Aug.					Sep. to Nov.				
		2 qrs. before S. E. Aus. D—F	1 qr. before S. E. Aus. M—M	Same qr. J—A	1 qr. after S. E. Aus. S—N	2 qrs. after S. E. Aus. D—F	2 qrs. before S. E. Aus. M—M	1 qr. before S. E. Aus. J—A	Same qr. S—N	1 qr. af er S. E. Aus. D—F	2 qrs. after S. E. Aus. M—M
Iceland	46	+·14	+·04	—·12	+·04	—·26	+·02	+·02	—·14	+·04	+·04
Alaska	22	—·50	+·36	+·06	+·22	—·04	+·24	+·10	+·02	—·06	—·20
C. Siberia	39	—·22	—·08	+·12	+·04	+·24	+·04	+·28	—·08	+·36	+·50
Vienna	42	+·06	—·10	+·28	+·20	+·16	—·04	+·14	+·06	—·16	0
Azores	46	—·34	+·10	—·04	—·34	+·20	+·20	+·10	—·18	+·18	—·06
Charleston	44	—·22	+·02	—·12	—·26	—·24	+·08	+·06	—·12	—·38	—·26
San Francisco	46	+·10	—·18	—·08	—·32	—·22	—·14	+·18	—·42	—·42	—·34
Tokio	38	+·22	+·14	—·04	—·18	+·12	+·24	+·04	—·18	+·12	+·08
Cairo	43	+·24	+·14	+·46	0	+·42	+·06	+·40	—·08	+·10	+·18
Honolulu	38	+·20	—·16	—·28	—·04	+·28	—·30	—·38	—·04	+·30	+·06
N. W. India	46	+·32	+·06	+·26	+·54	+·38	+·26	+·10	+·46	+·40	+·24
Port Darwin	40	+·18	+·10	+·72	+·58	+·48	+·18	+·56	+·70	+·54	+·34
Mauritius	45	—·02	+·30	+·44	+·04	+·18	+·12	+·48	+·04	+·20	0
Samoa	20	—·06	—·18	—·36	—·02	—·14	—·12	—·38	+·36	—·22	—·34
S. E. Australia	47	+·08	+·08	+1·00	+·52	+·36	+·24	+·52	+1·00	+·50	+·30
Cape	46	+·38	—·06	+·26	+·20	+·48	—·10	—·02	0	+·34	—·02
S. America	46	+·08	—·52	—·34	—·24	—·16	—·24	—·44	—·38	+·06	—·18
Temperature.											
Dutch Harbour	36	+·12	+·30	+·04	+·14	..	..	+·10	+·22	+·08	..
Rain.											
Peninsula (J—S)	48	..	..	—·28	..	..	..	—·28	..	..	..
Java (O—F)	42	0	..	..	..	—·52	..	..	..	—·46	..

35. With the two northern oscillations S. E. Australia has little concern, but with the southern oscillation it has very close relations especially in the first quarter, December to February, when there are 17 significant coefficients. In the second quarter there are

only 6 significant coefficients, but in the third there are 13 and in the fourth 16; with Port Darwin, owing to its proximity, the coefficients are the highest of all. The evidence of propagation is very similar to that in the case of Port Darwin. The object with which S. E. Australia was added to the list in addition to Port Darwin was that, following Teisserenc de Bort's ideas, Port Darwin would be a centre in the southern summer, when it is the focus of the region of low pressure, and South East Australia in winter, as representing the region of high pressure. In both cases however the influence extends through the year instead of changing sign as it might have done.

36. The relationships with the Cape are :—

Cape Town Pressure.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before C. Town. J—A	1 qr. before C. Town. S—N	Same qr. D—F	1 qr. after C. Town. M—M	2 qrs. after C. Town. J—A	2 qrs. before C. Town. S—N	1 qr. before C. Town. D—F	Same qr. M—M	1 qr. after C. Town. J—A	2 qrs. after C. Town. S—N
Iceland	47	+·02	+·10	—·10	+·06	+·02	—·02	—·14	—·02	—·30	+·32
Alaska	21	+·16	+·06	—·52	—·04	—·02	+·16	—·42	+·06	+·20	+·14
C. Siberia	40	+·32	—·18	+·02	+·24	0	0	—·18	—·12	—·28	—·08
Vienna	43	+·36	+·04	+·02	—·22	—·04	0	+·22	+·20	+·20	—·16
Azores	47	—·18	—·26	+·10	+·10	—·10	+·02	0	+·12	+·24	—·20
Charleston	45	+·02	—·16	—·26	—·04	—·10	+·22	+·10	+·08	—·04	—·06
San Francisco	47	—·04	—·24	—·12	—·34	—·10	+·02	+·06	+·22	—·06	+·02
Tokio	38	—·06	—·18	+·30	+·28	—·18	+·28	+·04	+·08	+·06	—·10
Cairo	44	+·38	—·08	+·50	+·36	+·18	—·14	+·12	+·24	—·10	+·14
Honolulu	38	—·42	—·22	+·30	—·04	—·28	+·06	+·10	—·20	—·16	—·10
N. W. India	47	+·26	+·48	+·56	+·44	+·18	—·16	—·28	—·02	—·20	—·04
Port Darwin	40	+·54	+·56	+·60	+·32	+·40	+·02	+·26	—·08	+·10	+·02
Mauritius	46	+·30	—·02	—·04	0	0	—·14	—·14	—·02	+·28	+·22
Samoa	20	—·46	—·04	—·38	—·66	—·46	—·22	+·06	—·02	+·10	+·08
S. E. Australia	46	+·48	+·34	+·52	+·24	+·38	—·02	+·02	—·22	—·06	—·10
Cape	47	+·08	+·10	+1·00	+·04	+·08	—·24	+·04	+1·00	+·10	+·24
S. America	47	—·48	—·28	+·12	—·42	—·16	+·22	—·08	+·12	—·08	+·10
Temperature.											
Dutch Harbour	36	..	—·04	+·12	+·28	..	..	—·24	—·08	—·18	..
Rain.											
Peninsula (J—S)	49	—·52	..	..	..	0	..	..	..	—·12	..
Java (O—F)	41	..	..	—·34	..	..	..	—·04	..	..	..

Cape Town Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before C. Town. D—F	1 qr. before C. Town. M—M	Same qr. J—A	1 qr. after C. Town. S—N	2 qrs. after C. Town. D—F	Sep. to Nov. 2 qrs. before C. Town. M—M	1 qr. before C. Town. J—A	Same qr. S—N	1 qr. after C. Town. D—F	2 qrs. after C. Town. M—M
Iceland	47	+·08	—·22	—·10	+·02	—·20	+·02	—·06	+·26	—·10	+·10
Alaska	22	+·04	+·04	—·04	+·32	—·18	+·04	—·28	+·10	+·64	—·14
C. Siberia	40	+·04	+·02	—·26	—·10	+·04	—·34	—·16	0	—·08	+·04
Vienna	43	+·26	+·14	+·16	+·18	+·30	+·10	0	+·20	—·02	—·14
Azores	47	0	+·08	+·02	+·06	+·04	+·16	+·26	—·18	+·20	—·08
Charleston	45	+·18	—·12	—·16	+·12	+·08	+·10	—·02	—·22	+·08	—·12
San Francisco	47	—·10	—·18	—·02	+·10	0	+·30	+·06	—·04	0	—·36
Tokio	38	+·16	+·14	+·08	—·20	+·34	—·16	—·10	—·42	+·08	+·10
Cairo	44	+·26	+·22	+·34	+·30	+·40	+·18	+·10	+·36	+·16	—·12
Honolulu	38	0	—·06	—·08	+·02	+·16	—·06	+·04	—·14	—·20	—·38
N. W. India	47	+·08	+·14	+·16	0	+·04	—·20	—·20	+·26	+·16	+·16
Port Darwin	40	+·04	—·02	+·18	—·04	—·06	—·06	+·26	+·08	—·06	+·10
Mauritius	46	+·24	+·22	+·16	+·08	—·06	+·10	+·02	+·20	+·12	+·12
Samoa	20	—·36	—·10	0	—·02	+·24	—·16	+·12	—·06	—·40	—·46
S. E. Australia	46	0	—·06	+·26	—·02	—·08	—·02	+·20	0	+·12	+·14
Cape	47	+·08	+·10	+1·00	—·02	+·08	+·24	0	+1·00	+·10	—·24
S. America	47	—·14	—·08	+·10	—·14	—·38	—·16	—·10	+·06	—·10	—·24
Temperature.											
Dutch Harbour	36	..	+·10	—·20	—·02	..	..	+·06	+·04	+·36	..
Rain.											
Peninsula (J—S)	49	..	..	+·12	..	..	..	—·04	..	..	..
Java (O—F)	41	—·12	..	..	..	—·16	..	..	..	+·10	..

37. In the first quarter of the year Cape Town may be bracketed with Australia as one of the most conspicuous members of the southern oscillation, in which it belongs to the second group : in this table there are 21 significant coefficients. But in the second quarter no such coefficient occurs, and in the third and fourth quarters together there are

only 9; these also indicate adherence to the second group of the southern oscillation. In the last quarter there is an association as a low pressure centre with the subsequent N. Pacific oscillation.

38. With S. America the coefficients are:—

South America Pressure.

Pressure.	Years of data.	Dec. to Feb. 2 qrs. before S. Am. J—A	1 qr. before S. Am. S—N	Same qr. D—F	1 qr. after S. Am. M—M	2 qrs. after S. Am. J—A	March to May. 2 qrs. before S. Am. S—N	1 qr. before S. Am. D—F	Same qr. M—M	1 qr. after S. Am. J—A	2 qrs. after S. Am. S—N
Iceland	47	+·06	−·06	+·18	−·04	−·02	−·16	0	−·10	+·06	+·18
Alaska	21	−·06	−·12	−·08	+·02	−·34	0	+·14	−·28	+·08	+·04
C. Siberia	40	−·02	−·12	−·04	+·12	−·04	+·16	−·14	−·06	−·24	−·26
Vienna	43	+·12	−·12	**−·34**	+·06	+·26	+·10	−·10	+·24	−·30	−·30
Azores	47	−·04	−·14	+·04	−·16	+·06	+·12	+·22	+·06	+·24	+·14
Charleston	45	**+·44**	−·04	−·08	+·02	+·06	+·26	+·22	+·12	+·10	+·20
San Francisco	47	**+·42**	+·08	−·10	+·10	+·16	+·28	−·08	**+·46**	+·14	+·26
Tokio	38	−·10	+·20	−·20	+·16	−·20	+·16	−·20	+·08	+·02	0
Cairo	44	+·02	−·22	−·26	+·04	+·06	+·08	−·30	−·14	**−·38**	−·16
Honolulu	38	−·06	−·08	+·06	+·18	0	+·28	−·04	+·14	+·30	−·02
N. W. India	47	−·20	+·02	+·20	+·08	+·04	**−·38**	−·34	−·22	−·24	**−·36**
Port Darwin	40	0	+·02	+·16	+·22	+·14	−·26	−·32	**−·32**	−·32	−·24
Mauritius	46	−·06	−·18	−·06	−·22	−·08	+·04	−·08	−·24	−·30	+·12
Samoa	20	−·34	−·20	+·24	+·22	+·10	+·16	+·24	+·36	+·48	+·28
S. E. Australia	46	−·16	+·06	+·08	−·02	+·08	−·18	−·34	**−·30**	**−·52**	−·24
Cape	47	**−·38**	−·10	+·12	−·08	−·14	−·24	**−·42**	+·12	−·08	−·16
S. America	47	+·02	−·10	+1·00	+·06	+·10	+·20	+·06	+1·00	+·28	+·22
Temperature.											
Dutch Harbour	36	..	−·14	−·10	−·10	..	..	−·28	**−·44**	+·16	..
Rain.											
Peninsula (J—S)	49	+·02	..	..	..	−·10	..	..	..	**+·38**	..
Java (O—F)	42	..	..	+·28	..	..	..	+·18	..	..	..

South America Pressure.

Pressure.	Years of data.	June to Aug. 2 qrs. before S. Am. D—F	1 qr. before S. Am. M—M	Same qr. J—A	1 qr. after S. Am. S—N	2 qrs. after S. Am. D—F	Sep. to Nov. 2 qrs. before S. Am. M—M	1 qr. before S. Am. J—A	Same qr. S—N	1 qr. after S. Am. D—F	2 qrs. after S. Am. M—M
Iceland	47	+·04	—·12	—·04	—·04	—·20	—·22	+·08	+·08	—·08	+·02
Alaska	22	—·02	+·06	—·06	+·16	+·04	—·26	—·12	—·10	+·16	+·02
C. Siberia	40	+·24	+·06	—·30	0	—·16	—·26	—·32	—·16	—·44	—·16
Vienna	43	—·10	—·08	—·24	0	+·04	+·10	—·14	+·16	—·04	+·08
Azores	47	+·38	+·04	+·16	+·10	+·04	—·04	—·20	+·08	—·18	—·08
Charleston	45	+·08	—·06	+·04	+·04	+·20	+·20	+·04	+·22	+·14	+·34
San Francisco	47	—·30	+·10	+·08	+·30	+·12	+·30	+·02	+·54	+·30	+·22
Tokio	38	+·12	0	+·16	+·12	—·22	—·14	+·02	+·22	+·14	—·14
Cairo	44	—·04	—·20	—·30	—·06	0	0	—·24	0	—·36	—·22
Honolulu	38	+·18	+·24	+·52	+·24	+·12	+·34	+·32	+·32	+·10	—·06
N. W. India	47	—·14	—·04	—·26	—·58	—·46	—·10	—·18	—·08	—·24	—·30
Port Darwin	40	—·06	—·16	—·46	—·54	—·56	—·06	—·16	—·26	—·26	—·02
Mauritius	46	—·22	—·34	—·38	—·28	—·48	—·26	—·22	—·02	—·20	—·20
Samoa	20	0	+·28	+·50	—·06	+·48	+·48	+·50	+·36	+·32	+·16
S. E. Australia	46	0	—·24	—·34	—·44	—·56	—·28	—·24	—·38	—·22	0
Cape	47	—·16	—·08	+·10	—·10	—·48	+·10	—·14	+·06	—·28	+·22
S. America	47	+·10	+·28	+1·00	+·20	+·02	+·22	+·20	+1·00	—·10	+·20
Temperature.											
Dutch Harbour	36	..	—·30	—·10	—·14	..	..	—·06	—·02	—·26	..
Rain.											
Peninsula (J—S)	49	..	..	+·44	..	..	..	+·06	..	..	..
Java (O—F)	42	—·18	..	..	..	+·38	..	..	..	+·28	..

39. S. America resembles the Cape in having one quarter of much greater activity than the rest, but it is the third instead of the first, and in the June to August table will be found 16 significant coefficients ; with Honolulu and every pressure centre south of the equator there is at least one coefficient of ·48 or over : further the future coefficients are

on the whole greater than the contemporary ones, and those with past data are in general unimportant. In the first quarter there are influences exerted two quarters before by Charleston, San Francisco and the Cape. During March to May high pressure is preceded as well as followed by low pressure in N.W. India, Port Darwin and S.E. Australia, and is preceded at the Cape : during this quarter S. America also behaves as a high pressure centre in the N. Pacific oscillation.

40. The tables for temperature at Dutch Harbour are :—

Dutch Harbour Temperature.

		Dec. to Feb.					March to May.				
Pressure.	Years of data.	2 qrs. before Dutch H. J—A	1 qr. before Dutch H. S—N	Same qr. D—F	1 qr. after Dutch H. M—M	2 qrs. after Dutch H J—A	2 qrs. before Dutch H. S—N	1 qr. before Dutch H. D—F	Same qr. M—M	1 qr. after Dutch H. J—A	2 qrs. after Dutch H. S—N
Iceland	36	..	+·26	+·08	+·12	..	..	+·16	—·02	+·12	..
Alaska	18	..	+·10	+·68	+·22	..	..	+·04	+·48	—·12	—·56
C. Siberia	32	..	+·08	+·14	—·16	+·16	..	—·04	+·12	+·12	..
Vienna	34	..	—·10	—·16	—·24	—·14	..	+·14	+·08	—·02	—·14
Azores	36	..	+·16	0	—·14	..	..	—·24	+·02	—·16	..
Charleston	36	..	—·18	—·08	—·34	..	..	—·18	+·24	—·12	..
San Francisco	36	..	—·22	—·32	—·34	..	..	+·02	—·48	—·18	—·10
Tokio	35	..	—·22	+·02	—·24	—·16	..	—·04	+·02	—·08	..
Cairo	35	..	+·08	+·02	—·02	..	..	+·20	+·18	+·22	..
Honolulu	35	..	—·02	—·24	—·18	..	..	—·16	—·22	—·40	+·02
N. W. India	36	..	—·02	+·18	+·34	..	..	+·30	+·18	+·06	..
Port Darwin	36	..	—·02	+·10	+·34	..	..	+·36	+·28	+·38	..
Mauritius	36	..	—·04	+·32	—·04	..	..	+·24	+·10	+·16	..
Samoa	18	..	—·16	—·18	+·14	..	..	—·46	—·52	—·24	..
S. E. Australia	36	..	+·08	+·08	+·16	+·12	..	+·20	+·04	+·30	..
Cape	36	..	+·36	+·12	—·24	..	..	+·28	—·08	+·10	..
S. America	36	..	—·26	—·10	—·28	..	..	—·10	—·44	—·30	..
Temperature.											
Dutch Harbour	36	..	+·10	+1·00	+·42	..	..	+·42	+1·00	+·34	..
Rain.											
Peninsula (J—S)	36	+·14	..	..	..	—·30	..	..	..	—·36	..
Java (O—F)	36	..	..	+·32	..	..	..	—·06	..	..	..

Dutch Harbour Temperature.

Pressure.	Years of data.	June to Aug. 2 qrs. before Dutch H. D—F	1 qr. before Dutch H. M—M	Same qr. J—A	1 qr. after Dutch H. S—N	2 qrs. after Dutch H. D—F	Sep. to Nov. 2 qrs. before Dutch H. M—M	1 qr. before Dutch H. J—A	Same qr. S—N	1 qr. after Dutch H. D—F	2 qrs. after Dutch H. M—M
Iceland	36	..	+·32	+·22	+·20	..	..	+·12	0	—·16	..
Alaska	19	..	—·46	+·12	+·10	..	+·08	+·24	0	+·**62**	..
C. Siberia	32	—·06	—·14	+·**36**	+·02	..	..	+·06	—·08	+·28	..
Vienna	34	..	+·16	—·12	—·06	..	..	—·02	—·14	—·20	..
Azores	36	—·08	—·14	+·12	—·04	..	..	—·02	—·08	+·02	..
Charleston	36	..	+·18	—·20	—·04	..	+·26	—·10	+·10	—·14	..
San Francisco	36	..	—·04	—·12	—·08	..	..	+·16	—·04	—·06	..
Tokio	35	..	—·14	+·04	+·10	..	..	—·08	+·26	—·06	..
Cairo	35	..	+·12	+·14	+·04	..	..	+·18	—·02	—·02	..
Honolulu	35	..	+·04	—·04	—·12	..	..	—·20	—·22	—·08	..
N. W. India	36	..	—·16	+·20	+·06	..	..	+·14	+·26	+·08	..
Port Darwin	36	..	+·12	+·06	+·10	..	..	+·28	+·30	+·28	..
Mauritius	36	..	+·22	—·14	—·02	..	..	+·04	—·20	—·06	..
Samoa	18	..	—·10	0	+·02	..	..	—·16	+·20	—·**62**	..
S. E. Australia	36	..	0	+·04	+·10	..	..	+·14	+·22	+·14	..
Cape	36	..	—·18	—·20	+·06	..	..	—·02	+·04	—·04	..
S. America	36	..	+·16	—·10	—·06	..	..	—·14	—·02	—·14	..
Temperature.											
Dutch Harbour	36	..	+·34	+1·00	+·18	..	..	+·18	+1·00	+·10	..
Rain.											
Peninsula (J—S)	36	..	..	—·08	..	..	..	+·02	..	..	..
Java (O—F)	36	..	..	..	..	..	..	..	..	—·22	..

41. In the first two quarters the coefficients of Dutch Harbour temperature with Alaska pressure are +·68 and +·48, and with San Francisco pressure —·32 and —·48 : so that Dutch Harbour temperature varies with pressure in the Aleutian minimum. In the second quarter there are also coefficients of —·52 and —·44 with Samoa and S. America, suggesting that during this quarter the greater part of the Pacific moves in opposition to the low pressure area of the N. Pacific. In summer Dutch Harbour is unimportant : and in the fourth quarter the contemporary coefficients are not significant ; but those of +·62 and —·62 with conditions in the subsequent quarter are large enough to be real. It may be noted that in the first half year, when the N. Pacific area of low pressure is marked, the significant coefficients with Port Darwin, Mauritius, Samoa, the Cape, S. America and Peninsula rain indicate a distinct participation in the southern oscillation as a member of the second group.

42. For the rain of the Indian Peninsula, June to September, the data are :—

PENINSULA RAIN.

JUNE TO SEP.

Pressure.	Years of data.	2 qrs. before Peninsula. D—F	1 qr. before Peninsula. M—M	Same qr. J—A	1 qr. after Peninsula. S—N	2 qrs. after Peninsula. D—F
Iceland	48	—·04	—·02	+·06	+·16	+·02
Alaska	22	—·36	—·04	—·12	+·30	**+·66**
C. Siberia	40	+·24	+·14	—·38	+·02	—·06
Vienna	43	+·08	+·08	—·38	—·16	—·12
Azores	47	+·22	—·02	+·10	+·16	—·06
Charleston	45	—·10	—·08	0	+·12	+·20
San Francisco	47	—·16	+·12	0	+·04	—·08
Tokio	38	0	—·28	+·10	+·10	—·30
Cairo	44	0	+·14	—·32	0	—·18
Honolulu	39	+·26	+·30	**+·46**	+·02	—·42
N. W. India	47	—·04	+·06	—·10	—·42	—·16
Port Darwin	42	—·02	—·32	—·40	**—·46**	**—·46**
Mauritius	47	+·10	—·18	**—·52**	—·14	—·12
Samoa	20	—·20	+·16	+·36	+·08	**+·48**
S. E. Australia	48	+·04	—·20	—·28	—·28	**—·62**
Cape	49	0	—·12	+·12	—·04	**—·52**
S. America	49	—·10	+·38	+·44	+·06	+·02
Temperature.						
Dutch Harbour	36	—·30	—·36	—·08	+·02	+·14
Rain.						
Peninsula (J—S)	49	..	..	+1·00	..	..
Java (O—F)	44	—·36	..	..	..	+·22

43. Apart from Alaska there are in this table six coefficients exceeding ·45 and all of them affecting the southern region. Unluckily for India, however, four of the six indicate relationships with future conditions outside India, and none refers to past conditions which would be available for use in forecasting the monsoon; the biggest of the forecasting coefficients in the table is ·38 with S. America.

44. The Java rainfall data are:—

JAVA RAIN.

OCT. TO FEB.

Pressure.	Years of data.	2 qrs. before Java. J—A	1 qr. before Java. S—N	Same qr. D—F	1 qr. after Java. M—M	2 qrs. after Java. J—A
Iceland	39	—·04	+·02	+·26	+·14	+·18
Alaska	19	—·08	—·04	+·34	—·02	+·06
C. Siberia	36	—·10	+·22	—·10	—·10	+·28
Vienna	38	+·06	—·12	—·26	+·12	+·20
Azores	42	—·04	+·16	—·16	—·16	—·18
Charleston	40	+·06	+·06	+·20	0	—·10
San Francisco	42	+·14	**+·50**	+·02	+·12	—·04
Tokio	37	+·08	+·06	—·24	—·10	—·04
Cairo	39	—·28	—·04	**—·34**	—·18	—·04
Honolulu	36	**+·40**	+·30	**—·32**	—·06	—·14
N. W. India	42	—·16	**—·52**	**—·32**	—·12	+·10
Port Darwin	38	**—·50**	**—·60**	**—·46**	+·08	+·18
Mauritius	41	**—·38**	—·04	—·06	—·16	+·04
Samoa	19	+·26	—·24	**+·46**	+·34	—·08
S. E. Australia	42	**—·52**	**—·46**	**—·42**	—·02	0
Cape	41	—·16	+·10	**—·34**	—·04	—·12
S. America	42	**+·38**	+·28	+ ·28	+·18	—·18
Temperature.						
Dutch Harbour	36	..	—·22	**+·32**	—·06	..
Rain.						
Peninsula (J—S)	44	+·22	..	..	..	—·36
Java (O—F)	44	..	..	+1·00	..	..

45. In this table there are eight coefficients exceeding ·45 of which none are with subsequent conditions; so that Java is in this respect much more fortunate than India. One interesting feature is the feebly marked contemporary association with high pressure in Iceland and Alaska, high temperature at Dutch Harbour and low pressure at Vienna; so that the Java rain tends to behave as a low pressure region in both the northern oscillations.

The forecast of Java rain given on the 1st September by the pressure data of the quarter June to August for Honolulu, Port Darwin, Mauritius, S. E. Australia and S. America is (Java rain) =+·18 (Honolulu)—·08 (Port Darwin)—·14 (Mauritius)—·32 (S.E. Australia) +·08 (S. America); here the insertion of a quantity in brackets means that we take its proportional departure, *i.e*, the ratio of its departure to the standard deviation. There is a total coefficient of only ·60, although Port Darwin alone has ·50: this is because the coefficients are closely inter-dependent.

46. One of the minor disappointments of this investigation has been that regarding the rainfall of Sierra Leone, which seems to be produced by a west-southwesterly current subsequently crossing Africa and feeding the Nile by beating against the Abyssinian hills. It was natural to imagine that as far as the Nile was concerned Sierra Leone rain would resemble Zanzibar and Seychelles rain in their relation to the Indian monsoon; and that its amount would vary in opposition to the Nile floods; and as these vary with the Indian monsoon I thought Sierra Leone rain would behave as a member of the second group of the southern oscillation. The following table contains the coefficients of Sierra Leone rain, May to October, with the pressure at various centres during the contemporary quarter June to August and St. Helena wind velocity during this same quarter; for the rainfall with which it has been correlated the period is given in the table:—

SIERRA LEONE RAIN.

	May to October. Years of data.	May to October. Coeff. with J A qr.
Pressure.		
Iceland	47	—·06
C. Siberia	40	+·02
Vienna	43	+·08
Azores	47	—·30
Charleston	47	—·26
San Francisco	47	—·30
Tokio	38	+·26
Cairo	44	+·08
Honolulu	39	+·30
N. W. India	47	+·28
Port Darwin	40	—·10
Mauritius	46	+·06
St. Helena	30	—·16
Samoa	20	—·16
S. E. Australia	46	+·16
Cape	47	+·08
S. America	47	—·12
Winds.		
St. Helena	26	+·60
Rain.		
Peninsula (J—S)	47	0
S. Rhodesia (Oct.—April, previous)	23	—·12
Java (October—February, previous)	42	—·02
Nile flood (July to October)	44	+·24

The only conclusion that seems reliable is fairly obvious—that the harder the damp ocean winds beat against the hills near the coast the more rain falls at Sierra Leone.

47. It is worth while to remember the existence of a few centres of the southern oscillation in addition to those in the table which have not as yet been worked out in detail. Thus the May rainfall at Seychelles appears to be a member of the southern oscillation in the second group : with rainfall in north-east India (June to September) its coefficient is —·38, and there are coefficients of +·38 and —·40 with India pressure and Java rain given in the table on page 107 of the previous memoir. The May rainfall of the Zanzibar district also has with the succeeding Peninsula rain (June to September) a coefficient of —·42, though with S. America pressure of April and May the coefficient is only —·16.

Similarly it is likely that the Indian snowfall accumulation in May belongs to the second group : its coefficients of +·44 with Port Darwin pressure, March to May, +·32 with Cape pressure of the previous September to November, —·34 with S. America pressure of April and May, +·34 with Seychelles May rain and —·40 with monsoon rainfall in N.W. India all support this conclusion. But the classification of Rhodesia rainfall is less clear : its coefficients from October to April with the succeeding monsoon rainfall in the Peninsula and N.W. India are —·50 and —·52 ; and with the S. America pressure of April and May —·40 ; but other relationships than those on p. 109 of the previous memoir require examination.

CHAPTER III.

The two northern oscillations.

48. *The N. Atlantic oscillation.*—To the mechanism of the oscillations in the north Atlantic considerable attention has been devoted by Pettersson, Meinardus, Hildebrandsson, Helland-Hansen, Nansen and others, and it is generally recognised that an accentuated pressure difference between the Azores and Iceland in autumn and winter is associated with a strong circulation of winds in the Atlantic, a strong Gulf Stream, high temperatures in winter and spring in Scandinavia[1] and the east coast of the United States, and with lower temperatures in the east coast of Canada and the west of Greenland.[2]

The correlation coefficient of Iceland winter pressure with that of Vardo (1875-1920) accordingly proves to be +·44, and with contemporary Vardo temperature —·64 ; with contemporary winter temperature in the eastern coast of the United States (Charleston+Washington) the coefficient is —·42, that of the following spring —·18 and of summer +·16. The coefficient of Iceland pressure, September to February, with contemporary temperature at Vardo is —·58, and with the quantity of ice at Newfoundland next spring and summer, as given by Meinardus,[3] is —·72. It might be expected that the effect of the flow of icebearing water into the Gulfstream in mid-Atlantic would be to lower its

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[1] See Meinardus Met. Zeit., 1898, pp. 85-105, and Tafel. II, p. 120.

[2] See Behler, Archiv d. D. Seewarte, 40, Heft 3, Taf. 1, Nr. 4, 1922.

[3] Met. Zeit., 1905, p. 405

temperature and thereby to raise pressure in the neighbourhood of Iceland in the succeeding autumn and winter. If this were so the character of the Labrador current in the spring and summer of one year would bring about pressure conditions six months later in the N. Atlantic which would produce the opposite character in the next year's Labrador current, and we should have an explanation of the two-yearly period which has from time to time been claimed: but the correlation coefficient between ice at Newfoundland and pressure at Iceland in the succeeding autumn and winter (1860-1902) is only +·08, an amount which is conclusive against this suggested relationship. This absence of an effect on Iceland pressure is explained by the absence of an effect on temperature in the gulfstream, for the relationship between the amount of Newfoundland ice and the Vardo temperature of the succeeding September to February is —·02.

49. An important contribution to the explanation of the variations in the N. Atlantic has been made by Wiese[1] who has given tables of the amounts of ice in the Greenland sea (April to July), and has shown that this is followed by higher pressure off North Cape and lower pressure in central Europe, where pressure moves in opposition to that off the North Cape. I find coefficients of +·28 and —·46 between the amount of ice and pressures in the subsequent autumn at Vardo and Vienna. With pressure, September to February, at Iceland, which appears to be the most important control of the north Atlantic, the relationship of ice in the Greenland sea of the previous summer is —·04 and of the subsequent summer +·24. Wiese also points out that in summer and autumn an excess of ice drives the cyclone tracks in Europe southwards and affects the temperature and rainfall. A surprising result is the parallelism between temperature in N. W. Siberia (Obdorsk + Turuchansk), September to November, and the temperature at Grimsey in Iceland, April to June, $4\frac{1}{2}$ years later; he obtains with data from 1877 to 1912 a coefficient of +·27, but with the addition of four years I find +·30. Wiese urges that ice formed in N. W. Siberia will spend this long time in transit, but does not give the evidence for this estimate. An alternative interpretation would be that the parallelism is really a contemporary one showing itself to a smaller extent $4\frac{1}{2}$ years later owing to a periodicity of $4\frac{1}{2}$ years. The coefficients have been worked out; and I find that with autumn temperature in Siberia the coefficient of Iceland temperature the same year, five months earlier, is +·28, and in the following year, seven months later, is +·34 which exceeds the coefficient corresponding to the $4\frac{1}{2}$ years interval. I think that as in these coefficients there is a probable error of ·11 a more extensive examination is necessary. With ice in the Greenland sea (April to July) I find coefficients with autumn temperatures in N. W. Siberia in the same year —·26, in the previous year —·12, in the third year previously —·26, and in the fifth year previously —·30. Here again the result is inconclusive.

When discussing these data Wiese finds a coefficient of —·83 with conditions $4\frac{1}{2}$ years apart; but it is based on accumulated temperature and accumulated ice, *i.e.*, the sums of these annual measurements since the first year of the series, and in its calculation influences of previous years are as important as those of contemporary ones. Hence its use appears to require very great care.

[1] Ann. d. Hydrogr. (Berlin) 50, p. 271, 1922.

Though there must inevitably be details in which Wiese's preliminary abstract appears incomplete, and we must await the fuller account which he has promised, we already owe to him what I believe to be the first demonstration of an effect of ice distribution on pressure distribution. Hildebrandsson had from time to time argued that the explanation of relations between pressure at two places, when referring to seasons with a time interval of six months or more between them, must lie in the drifting of ice; and various effects of pressure on the quantity of ice in the Arctic were known; but the converse effects had not been satisfactorily established and the important final link in this chain of causes and effects has been provided by Wiese.

50. A glance at a table or diagram of data from 1877 to 1902 will strongly support the view that the conditions in the north Atlantic are reversed in alternate years; but periods of eight months in the movement of the Iceland minimum and of 4·5 years in the amount of ice off Iceland also have been indicated by Meinardus.[1] Taking the table of 43 years from 1860 to 1902 of the ice conditions of Newfoundland given by Meinardus[2] I find that the amplitude of the 2 yearly period is ·31 while the probable amplitude that would be produced by purely random variations is ·21; for a period of 4·5 years the amplitude is· 51 against a probable random coefficient of ·43. Thus both periods appear doubtful.

In view of the obvious change in the character of the pressure variations in Iceland on including the data before 1877 or after 1902 I have thought it advisable to examine the pressure departures for the critical period of the year, September to February, from 1847 to 1923. When Fourier analysis is performed in the usual manner the amplitude of the two-year period is ·35, while the probable amount produced by a random series of the same standard deviation is ·2. The odds that an amplitude of ·35 would be produced by random figures are about 3 to 1 against, and it would be very dangerous to regard such an alternation as in continual operation. On the other hand it might be that there was a natural oscillation with a period of two years which was excited by some external disturbing agency at one time and after a series of oscillations was checked or reversed by another disturbance; and when the Fourier analysis was applied to a record which included a number of such series of oscillations it might be that one portion cut out another and the resulting amplitude was greatly reduced. In order to test this the correlation coefficient of each year's pressure with the next has been calculated: this should produce negative contributions during each series of oscillations, whether the series happened to be in the same phase as others of the series or not. But the resulting coefficient is only —·02, compared with a probable coefficient produced by chance of ·08. Hence although the years from 1877 to 1903 produce a coefficient of —·26 the belief in a two-year's period must, I think, be abandoned. It cannot be urged that the result is due to unreliability in the earlier data for the coefficient from 1903 to 1923 is +·48, and is directly opposed to a two-yearly period.

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[1] See Ann. Hydrogr., Berlin, 34, pp. 148, 277, 278 (1906). An account of these is given by C. F. P. Brooks and J. Glasspool in Q. J. R. Meteor. Soc. 48, pp. 161-63, 1922.

[2] Met. Zeit., 22, p. 405, 1905.

51. *The north Pacific oscillation.*—The conditions in the north Pacific have at first sight a close resemblance to those of the north Atlantic ; the meteorological charts show corresponding areas of high and low pressure ; and we have the warm Kuroshiwo (or Japanese) current flowing northeastwards from the south of Japan across the Pacific as the equivalent of the Florida or gulf stream,[1] while the cold Oyashiwo current, bearing water from the arctic regions along the northwestern shore of the Pacific, corresponds to the Labrador current. The resemblance does not extend however to a similar collection of meteorological observations. In the absence of an Iceland we are dependent on shore observations on the edge of the low pressure area, and the data from Alaska to the east are, as we have seen, scanty and fragmentary, while the observations from Dutch Harbour to the north are of temperature not pressure. However the pressure data are decisive in establishing the opposition between Alaska, representing the area of low pressure, and Honolulu near the margin of the high pressure area, the coefficients in winter and spring being —·70 and —·52. In his paper of 1922 on the forecasting of the summer temperature and rice crop of northern Japan,[2] Okada says :—' The activity of the (Aleutian) Low is increased when the water is warmer...than usual :' ' the air temperature at Dutch Harbour may be used as the index of the temperature of the sea near the Aleutian Islands.' But as we have seen in the tables there is in winter with Dutch Harbour temperature a coefficient of +·68 with pressure in Alaska, —·32 at San Francisco and —·24 at Honolulu. In spring these become +·48, —·48 and —·22. Clearly therefore if the Alaska depression is unusually low, the Dutch Harbour temperature also will be unusually low and this must be due to unusually strong winds from the colder regions to the north and east : but it still seems probable that the sea in the neighbourhood of the depression is on the whole warmer than usual. We should therefore expect opposition between winter temperatures at Dutch Harbour and at Victoria B. C. on the eastern side of the depression : for the years 1892-1919 in which some Esquimalt data are included the coefficient is —·06, but for 1903-19 it is —·40.

52. On the western margin of the oceans the similarity breaks down : for while the Labrador current is colder when the Atlantic pressure opposition is accentuated, the northerly current on the east coast of Kamchatka is apparently unaffected. Further south, just as the eastern coast of the United States is warmer when Iceland pressure is reduced, so temperature in summer in northern Japan is raised when the Pacific opposition is more marked. Thus I find that the temperature relationships of winter and spring at Dutch Harbour with summer (June to August) at Erimo are —·50 and —·54.

53. In order to verify the interpretation placed on the data of the north Pacific I have verified in terms of them the conclusions reached by Henry[3] regarding rainfall on the north Pacific Coast States. I find a coefficient of —·54 between that rainfall and the December to February pressure at Alaska, while with Dutch Harbour for this period the relationship is —·24 : with Alaska pressure in autumn the relationship is —·20. I have

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[1] See Krümmel, Handbuch d. Ozeanographie, II, p. 702, 1911.
[2] Memoirs of the Imp. Marine Observ., Kobe, No. 1, p 22, 1922.
[3] Washington M. W. R. 49, p. 213, 1921.

also verified that as indicated by Stupart there is a relation between the winter pressure at Alaska and the winter temperature at Winnipeg, the coefficient being —·54.

54. Since the July and August temperatures of northern Japan have been carefully studied by Okada it will be well to summarise his conclusions. After a preliminary paper in 1910[1] on centres of action in the far east Okada worked out in 1916[2] the relationship between the gradients to the east of Zikawei during January to March and the July, August temperatures in northeast Japan, coefficients between ·5 and ·78 being obtained. In 1917[3] he found —·34 between the July temperatures at San Francisco and Erimo and —·53 between the former and April temperature at Irkutsk[4]: he also found —·41 between the variations of January and February pressure at Zikawei and those of July and August pressure at Nemuro. At each of these places pressure and temperature tend to move in opposite directions. Okada next showed[5] that the association of high August temperature in northeast Japan with high pressure in April was shown at Bermuda, Toronto (+·32) and the Azores, there being opposition with April pressure in Iceland.

In the next paper[6] the Japanese August temperatures are found to have coefficients of +·61 with the April pressure difference Azores *minus* Iceland, +·31 with March pressure difference Zikawei *minus* Miyazaki, and +·49 with January pressure at Sydney : these are relations between changes from one year to the next.

In a sixth paper[7] Okada finds between the variations from year to year of S. American pressure, March to May, and August temperature over Hokkaido (the west coast having as good a correlation as the east) a relationship of +·62 : for Tohoku (the northern part of Japan proper) it is +·54. With the March pressure difference Zikawei *minus* Miyazaki the relationships are +·40 and +·41.

In his last paper, of 1922, Okada[8] accepts Dr. Ando's conclusion that in the years 'with abundant ice in the Behring sea and its neighbouring waters the summer in northern Japan is abnormally cool.' Unfortunately the evidence upon which Dr. Ando's conclusion is based is not available here, and against it may be placed the following arguments :—

(*a*) An accentuation of the Aleutian 'low' in winter produces higher not lower temperatures at Nemuro.

(*b*) If the Nemuro temperature is controlled by cold currents from the north we should expect to find the effect most marked when the ice is melting in spring and therefore a close parallelism between the temperatures of Erimo and of Petropavlowsk on the east coast of Kamchatka : I find however an insignificant coefficient of +·16 (based on data of 19 years) during the

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[1] Bull. Centr. Metl. Obsy., Japan, I, No. 4, 1910.

[2] I have used the reprint in the M. W. R., Washington, 1916, p. 17.

[3] M. W. R., Washington, 1917, p. 238.

[4] I find —·30 between the summer temperatures at Erimo and San Francisco and —·26 between the latter and spring temperature at Irkutsk : in the latter I used the data of 25 years against Okada's 21.

[5] M. W. R., Washington, 1917, p. 299.

[6] M. W. R., Washington, 1917, p. 535.

[7] Bull. of Centr. Metl. Observ. of Japan, III, p. 19, 1919.

[8] Memoirs Imp. Marine Obsy., Kobe, I. No 1, p. 19.

season March to May, and Petropavlowsk at that time has a coefficient of —·12 with Dutch Harbour winter temperature instead of a positive coefficient. In winter Petropavlowsk has coefficients of —·08 with temperature in N. E. Siberia (Jakutsk + Verkhoiansk), —·02 with Central Siberia pressure, and + ·04 with Dutch Harbour temperature. Thus, if the data have any value, any southward flow of ice along the coast of Kamchatka seems to be little controlled by conditions in its neighbourhood and to have no effect on temperature to the south.

(*c*) Okada's coefficient of + 63 between S. America March to May pressure and August temperature at Sapporo on the west coast of Okkaido is greater than +·50, that of Nemuro on the east coast. As Sapporo lies in the warm Tsushima current (a branch of the Kuroshiwo), of which a portion flows through the Tsugaru strait,[1] it is indicated that the control lies in the temperature of the Tsushima current rather than the Oyashiwo. Accordingly I find approximately equal coefficients of —·14 and —·13 between Nemuro and Sapporo August temperatures respectively and the winter temperature at Dutch Harbour.

(*d*) The variations of August temperature in the Tsushima current at Sirakamisaki[2] where its waters are passing through the Tsugaru strait are nearly identical during the years 1914-21 with those of the sea at Takasima off the northeast of Hokkaido (freely exposed to any cold northerly current that may exist)[3] and its changes resemble those of Nyudosaki (40° 0′ N, 139° 42′ E) off the west coast of Japan freely exposed to the Tsushima. The Tsushima current certainly flows northeast through the Tsugaru strait, and hence the similarity of these temperatures can only have the one interpretation.

55. Among the conditions preceding high August temperatures in northern Japan are thus :—

(*a*) low winter temperature and so low pressure in the Aleutian ' low.'

(*b*) high pressures (or low temperatures)[4] at San Francisco, the Azores, Zikawei, and S. America, and reversed conditions at the Azores.

In other words the temperature in question is typical (except for the relation with Sydney) of the first group in the classification of my preceding memoir, and we expect to find it associated with increased general air circulation, and increased circulation of the surface sea-currents. It is the latter presumably which produces a greater supply of warm water in the Tsushima current.

The contrast between the strong association of much ice in the Labrador current with low pressure at Iceland and the feeble negative opposition between temperature at Petro-

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[1] See Krümmel, Ozeanographie II, p. 722, 1911.

[2] Memoirs of Imp. Marine Obsy., Kobe, I, 2, p. 75.

[3] Memoirs of Imp. Marine Obsy., Kobe I, 2, p. 73.

[4] Okada establishes this opposition at Zikawei (winter), Nemuro (May). See Bull. Centr. Metl. Obsy., Japan, I, No. 4, 1910

pavlowsk and that of Dutch Harbour obviously lies in the narrowness of the outlet for ice from the Arctic Ocean provided by the Behring Straits compared with that between Iceland and Greenland and across Baffin's Bay in the Atlantic. The ice conditions in the north Pacific are described by Krümmel in his Oceanography,[1] where he says that the Behring Straits form no exit-gate for polar ice-formations, and that heavy ice is limited to the northerly portion of the Behring Sea.

It must also be remembered that the winds in the region between Kamchatka and Hokkaido will be N. W., and when pressure in the Aleutian minimum is lower than usual there will be strong winds tending to draw away into the Pacific Ocean any sea-ice starting from the Behring Sea that might otherwise have drifted along the line of the Kurile Islands to N. Japan. Any diversion of this nature will tend to produce an opposition between the temperatures at Dutch Harbour and in Hokkaido.

56. It might be thought that since Dutch Harbour temperature is opposed to subsequent summer temperature in N. Japan it would vary with summer temperature at San Francisco. The coefficient of winter temperature at Dutch Harbour with the latter however is only +·16 and of spring temperature +·26. The spring temperatures at Irkutsk and Dutch Harbour have a coefficient of —·08, and the winter temperatures at Vardo and Dutch Harbour of —·20. These facts are foreshadowed by the Dutch Harbour Table for March to May which shows that while that station has close relations with other regions in the Pacific, extending down to S. America and Australia it is almost independent of C. Siberia and the pressure oscillations of the N. Atlantic.

CHAPTER IV.

The southern oscillation.

57. By the southern oscillation is implied the tendency of pressure at stations in the Pacific (San Francisco, Tokio, Honolulu, Samoa and S. America), and of rainfall in India and Java (presumably also in Australia and Abyssinia) to increase, while pressure in the region of the Indian Ocean (Cairo, N. W. India, Port Darwin, Mauritius, S. E. Australia and the Cape) decreases. The additional information now available in the tables supports the conclusion previously reached regarding the exceptional character of the control exerted by S. America : in the following table are given the number of significant coefficients of the chief stations in this oscillation, Tokio and Cairo having been omitted for the sake of simplicity : and they have in each season been divided into three groups according as they deal with conditions before, during or after that season ; thus under December to February at Port Darwin the figures 7, 6, 2 mean that there are 7 significant coefficients of pressure at Port Darwin during this season with conditions at other places either one or two seasons *earlier*, 6 with *contemporary* conditions and 2 with conditions either one or two seasons *later*.

[1] Vol. I, pp. 517, 8.

SOUTHERN OSCILLATION.

Significant coefficients within the group excluding itself.

	December to February.			March to May.			June to August.			September to November.			Year.
	Previous.	Contemporary.	Subsequent.	Previous.	Contemporary.	Subsequent.	Previous.	Contemporary.	Subsequent.	Previous.	Contemporary.	Subsequent.	
Pressure.													
San Francisco	1	..	..	4	3	..	1	1	1	4	4	3	22
Honolulu	3	3	..	1	1	4	2	4	8	..	2	1	29
N. W. India	5	4	4	6	2	..	..	1	..	7	4	11	44
Port Darwin	7	6	2	3	4	1	3	5	7	6	3	7	54
Mauritius	2	..	..	1	..	2	..	3	4	..	..	..	12
Samoa	2	3	1	4	1	..	1	3	2	1	..	1	19
S. E. Australia	8	6	3	2	1	3	2	3	6	4	4	4	46
Cape	7	4	5	..	..	..	..	..	1	..	..	2	19
S. America	2	..	..	2	2	3	..	6	9	..	3	..	27
Rain.													
Peninsula	..	..	..	..	..	..	2	4	6	..	..	..	..
Java	9	6	1	..	..	..	..	..	..	..	..	..	..

For S. America it will be seen that the numbers of coefficients in the four seasons are 2, 7, 15 and 3; and in the important winter period there are no stations where previous conditions control S. America while there are 9 where S. America controls the subsequent conditions: S. America may at this time be described as an 'active' rather than a 'passive' centre. The features are emphasised if we consider coefficients exceeding ·45: of these there are none in the summer December to February; with autumn pressure there are two coefficients, one with contemporary conditions and one with those of the next winter; with winter pressure there are three contemporary coefficients, and eight subsequent; and with spring pressure one contemporary coefficient. Thus there are no previous external conditions exercising controls of ·45, while S. America exercises nine controls of ·45 on subsequent external conditions, eight of these being with its pressure in winter.

At the Cape the summer pressure table contains 16 out of the 19 significant coefficients of the year, and of the ten exceeding ·45 all are with the summer pressure.

At other centres there is a marked tendency for June to August to be an active season with 34 coefficients in all against 11, and December to February to be passive, with 37 against 11: March to May is more passive than active with 21 against 10, and September to November, with 22 passive and 27 active coefficients, is undecided.

The natural inference is that S. America in its winter is either one of the original controls or is connected directly with one of the original controls: and the occurrence of this feature in winter which has a coefficient of —·48 with Cape pressure the next summer, during its only active season, suggests that the relation must depend on some feature of a sea current leaving S. America in winter.

Of other centres those which come nearest to S. America in the ratio of the number of their active to that of their passive coefficients are Honolulu (8 : 2), S. E. Australia (6 : 2) and Peninsula rainfall (6 : 2), all during June to August, or June to September for the Indian rainfall.

Ice conditions.

58. We accordingly now give a brief abstract of our knowledge of the ice conditions in the Antarctic. The distinction between pack ice and icebergs must be borne in mind, the former being due to the freezing over of the sea and its ultimate breaking up by winds and tides, while the latter are fragments of glaciers which extend to the sea line. A valuable account of the Antarctic ice will be found in Chapters XI, XII of the volume 'Glaciology' of the British Antarctic Expedition.

Along the coast line easterly winds prevail which set up a westward current,[1] and a glance at a modern map of the Antarctic continent will show that any ice borne by this current will on reaching Graham's Land be thrown right off in a northerly direction[2] and be carried off towards the east by the easterly current which flows round the world in the latitudes from 40° to 60° : a certain amount of ice may at times be thrown off at 170° E. by the western boundary of the Ross Sea, but the shape of the coast is not nearly so well adapted for the purpose as that at 60° W. : thus the pack ice accumulated off Adelie Land and King George V Land from 1911-12 to 1913-14, and is supposed to have blocked the exit of ice from the Ross Sea.[3] Accordingly we find that from the Weddell Sea, round which the current is cyclonic,[4] a cold current flows in a northeasterly direction to the S. Orkneys where 'the influence of the Antarctic drift' is 'the predominant factor affecting climate'[5] : after this the direction of flow becomes easterly. The control of the pack ice may be seen in 1908 when temperature from May to September averaged 5°·3 in excess and during the year 2°·9 owing to the unusual absence of pack ice from the Weddell Sea region although the year was the wettest then recorded.[6] It is in consequence of the northeastward cold current from the Weddell Sea that the neighbourhood of Bouvet Island is the coldest region in the ocean at that latitude : there floes are often to be seen as far as 53° S.[7]

59. The appearance of icebergs in unusual masses appears to be determined by the conditions of the pack ice, the favourable weather conditions being stormy south winds after warmer weather.[8] The route taken by an iceberg and its surrounding pack ice is, according to Krümmel, at first more N.W. than W., then more N. and finally more E. than N.[8]

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[1] Krümmel, Ozeanographie, II, p. 682.

[2] Krümmel, Ozeanographie, II, p. 677, or Stieler's Handatlas, or the charts in the 'British Antarctic Expedition' 1910-13, Meteorology, I, p. 261 (1919); see also Glaciology, pp. 371-73, 389 and Map A (1922), and Scott. Geogr. Mag., XXVI, p. 416, 1910.

[3] Brit. Ant. Exp. Glaciology, p. 389.

[4] See Brennecke. Archiv d. D. Seewarte, XXXIX, p. 155, Hamburg, 1921.

[5] Mossman, Trans. R. S., Edinburgh. XLVII, p. 106.

[6] Mossmann, Scott. Geogr. Mag., XXV, 1909, pp. 411, 2.

[7] Krümmel, Ozeanographie, II, p. 682 ; I, p. 518.

[8] Krümmel, Ozeanographie, I, p. 525.

When icebergs have been met in large numbers in the track of ships passing through the Drake Strait they appear first in the neighbourhood of the Weddell Sea, then some months later to the south of the Cape of Good Hope and still later near Kerguelen: in the neighbourhood of Tasmania they are rarer than west of Kerguelen.[1] The view that Graham's Land throws off many of the icebergs is supported by an examination of their most northward limit, which is further north (35° S.) in the vicinity of the Cape than elsewhere in the southern seas[2]; and this feature also characterises pack ice,[3] though probably not to so great an extent.

60. It will be convenient to collect here such information as is available in this office about the ice conditions in recent years at the S. Orkneys, in the S. Atlantic and in the Ross Sea.

The conditions in the neighbouring seas as observed from an elevated point in the S. Orkneys are summarised by Mossman as follows[4]:—

Summer open ice, 1903-04, 1905-06, 1908-09, 1909-10, 1911-12.
close ice, 1902-03, 1904-05, 1906-07, 1907-08, 1910-11, 1912-13.
Autumn open, 1904, 1905, 1906, 1907, 1908.
close, 1903, 1909, 1910, 1911, 1912.
Winter open, 1908, 1910, 1911.
close, 1903, 1909, 1912.
very close, 1904, 1905, 1906, 1907.
Spring open, 1905, 1908, 1910, 1911.
close, 1903, 1904, 1906, 1907, 1909, 1912.

In the S. Atlantic icebergs—not pack-ice—have since 1890 been reported[5] as very frequent in 1892, 1893, 1908, as moderately frequent in 1894, 1906 and 1910, and as normal or rare in 1890, 1891, 1907, 1909, 1911 and 1912.

In the Ross Sea it may be inferred from the statements in 'Glaciology' on pp. 380, 386, 389, that the summers of 1907-08 and 1914-15, and probably 1901-02, were exceptionally clear of pack-ice, while those of 1910-11, 1911-12, and 1912-13, and probably 1909-10 and 1913-14, were decidedly unfavourable.

It will be noticed that after the open summer of 1907-8 at the Ross Sea the four seasons from autumn 1908 to summer 1908-09 were open at the S. Orkneys; but after the ice-clear summer of 1914-15 there was a cold autumn (—1·6°) at the S. Orkneys and a cold winter (—4·8°). The summer of 1910-11 was cold at the S. Orkneys and thence until the summer of 1912-13 all seasons were close there except the winter and spring of 1911.

Inter-relations of the ice and pressure conditions.

61. The outstanding feature of the pressure distribution of the Antarctic is that as in the northern hemisphere there are areas of low pressure in the north Atlantic and

[1] Ozeanographie, II, pp. 681, 2.
[2] Ozeanographie I, pp. 525, 6.
[3] Scott. Geogr. Mag., XXV, p. 416, 1909.
[4] Ind. Metl. Memoirs, XXIII, Pt. VI, p. 166, 1923.
[5] Ind. Metl. Memoirs, XXI, Pt. VIII, p. 6.

north Pacific, so in the southern region we have them in the Ross Sea, the Weddell Sea and the Bellingshausen Sea (to the east and west of Graham's Land): and just as the Arctic ice is carried round Greenland and along Labrador into the Atlantic near Newfoundland, but finds no outlet through the Behring Straits, so the Antarctic ice is thrown off at Graham's Land into the southern Atlantic, but apparently not in any continuous stream elsewhere, such escape into the eastward current as occurs at other parts of the coast line being probably spasmodic and caused by local disturbances. Also just as in the north Atlantic there is a pressure opposition between the Azores and Iceland, the strengthening of which increases the ice-flow of the Labrador current, so in the south Atlantic, as Mossman's important studies[1] have made clear, there is an opposition between the high pressure belt across Chile and the Argentine on the one hand, and the low pressure areas of the Weddell Sea and the Bellingshausen Sea on the other.

62. When discussing the climate of Chile in 1911 Mossman said :—

> 'If the high-pressure belt is far south, as in the winters of 1903, 1908, 1909 and 1910, then there is a marked decrease in the winter rains all along the littoral between latitudes 30° and 45° S., but if the Graham's Land lobe of the Antarctic anti-cyclone extends northwards, as in the winters of 1902 and 1904, then the theatre of cyclonic activity also spreads northward, bringing heavy rains, strong N. and N. W. winds, much cloud and high temperature between latitudes 30° and 45° S. With these conditions winds at the southern extremity of the coast are light with a marked southerly component, temperature is low, pressure relatively high, and rainfall much under the seasonal normal.
>
> In such years as 1903, 1908-1910, when the Pacific anti-cyclone is far south, a very steep gradient for N.W. winds is set up south of about lat. 45°. These winds blowing with gale force for weeks together bring much rainfall and foul weather over an area stretching from north of Evangelists Islands to the South Shetlands.'[2]

His interpretation of the relation between the northern limit of the pack-ice to the south, southeast and southwest of Cape Horn and the track of the rain-bearing storms just referred to is :—

> 'When the ice is far north the track of the cyclonic storms is far north and when the ice is far south then the cyclonic track is also far south.'[3]

From this follows the association of a northward extension of the limit of pack-ice, and of a close winter at the S. Orkneys, with a rainy winter on the Chile coast from 27° S. to 43° S, and a dry winter in the extreme south at St. Evangelists Island[4]; and *vice versâ*.

On the other hand I should expect the conditions favourable for an outbreak of icebergs would be a general accentuation of pressure differences, with a consequent steepen-

[1] See Trans. R. S. Edin., XLVII, pp. 103-136, 1911; Ind. Metl. Memoirs, XXIII, Pt. VI, pp. 161, 2.

[2] Journ. Scott. Metl., Soc., XV, p. 318; see also 3 below.

[3] Scott. Geog. Mag., XXVI, p. 415, 1910.

[4] Ind. Metl. Memoirs, XXIII, Pt. VI, p. 162, 1923.

ing of the gradients and strengthening of the east wind along the Antarctic coast, accompanied by strong south wind on the west of the Weddell Sea.

It remains to ascertain the nature of the departure of pressure at Santiago, Cordoba and Buenos Ayres (called S. America in this paper) with which these features are associated. Since these places lie approximately on the axis of the high pressure belt a displacement of that belt northwards or southwards without an accentuation of pressure would slightly diminish the pressure but could not increase it. Similarly as Snow Hill lies on the belt of minimum pressure, a northward or southward movement of that belt would very slightly increase the pressure there. In fact however we note that the winter pressure departures of S. America in 1903, 1908, 1909 and 1910, the years of southward displacement, were +·04, +1·20, +1·03 and —·51, averaging +·44 ; so that in general a southward movement of the storm-track is associated with or produced by an accentuation of the high pressure conditions in S. America : again in 1902 and 1904 when the track was farther north than usual the departures were —·38 and —·87, averaging —·62.

On the whole then the association of an open winter at the S. Orkneys is with high pressure in S. America. But, the Antarctic pressure conditions being the same, in order to produce strong gradients we must increase the pressure in the high pressure belt ; so that as pointed out in 1912[1] 'years of much ice (icebergs) off South America tend to be years of high pressure in the Argentine Republic and Chile.' This must be the explanation of the paradox that such a year as 1908, when conditions were phenomenally open in the Weddell Sea area and at S. Orkneys, was associated with 'the extraordinary accession of icebergs reported last winter in the region of Cape Horn and in the S. Atlantic as far north as the 40th degree of south latitude.' 'References to available records would indicate that this recent outburst of ice from the Antarctic is the greatest since the year 1892[2].'

63. The features of the Bellingshausen Sea are exemplified by the seasonal data of 1904 and 1909 for the west coast of Graham's Land obtained from Dr. Charcot's expeditions and given by Mossman,[3] the remainders on subtracting the data for 1909 from those for 1904 being—

	Pressure.			Temperature.		
	Autumn.	Winter.	Spring.	Autumn.	Winter.	Spring.
Graham's Land (in.) .	+·207	+·286	+·177	—3·5	—10·8	—1·0
S. America (mm.) .	—·76	—1·90	—·34			

It will be seen that there is a marked pressure opposition in the two years and that 1909, with the pressure difference increased, was much warmer on the west coast of Graham's Land ; the natural effect of the increased gradient was a diminution in the southerly winds, which were 9 per cent. against 33 per cent. in 1904.

For the Weddell Sea area the base is Snow Hill where the Swedish expedition made observations in 1902-03.[4] Here it is remarkable that in 1902 there was strongly marked opposition to Santiago in the monthly march of the pressure the coefficient being —·75,

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[1] Ind. Metl. Memoirs, XXI, Pt. 8, pp. 6, 7.

[2] Scott. Geog. Mag., XXV, p. 410, 1909.

[3] Scott. Geog. Mag., XXVI, pp. 407-417, 1910.

[4] Wiss. Ergeb. d. Schwed. Südpol. Exped., Bd. II, 1908-10. For the correction for annual variation, see Br. Ant. Exp. Metly. I, p. 199.

but in 1903 the march was on the whole parallel, the coefficient being +·45 : and it is significant that in the former year of marked opposition there appears to have been much more ice flowing northwards from the Weddell Sea.[1] On examining the monthly data of the three periods from March to November 1902, March to October 1903, and March 1902 to October 1903, the relationships of monthly pressures at Snow Hill and Santiago prove to be :—

	Time difference in months, + when Snow Hill earlier				
	+ 2	+ 1	0	— 1	— 2
1902 . .	+·05	+·2	—·75	—·4	—·2
1903 . .	+·05	0	+·45	+·6	+·1
1902,03 . .	+·1	+·2	—·2	0	0

It will be seen that the maximum effect occurs when Santiago is some weeks in advance of Snow Hill, *i.e.*, the oscillations affect S. America before they affect the Antarctic pressure.

In the same way between Snow Hill and Melbourne we have[2]—

	Time difference + when Snow Hill earlier				
	+ 3	+ 2	+ 1	0	—1
1902 . .	—·15	+·55	+·65	+·25	+·5
1903 . .	·2	0	+·1	+·55	+·4
1902,03 . .	—·1	+·35	+·45	+·4	+·35

Here it is conspicuous that in 1902, a year when there appears to have been much pack-ice, Snow Hill exercised a considerable influence two months in advance; and in 1903 when the cyclone track was south of its usual position Melbourne exercised influence on Snow Hill a month in advance.

64. Turning now to the Ross Sea there is, as shown by Simpson,[3] an opposition between the monthly pressure in the Ross Sea and in the southern belt of high pressure; examples of the contemporary coefficients as derived from 4 years' data are —·28 at Melbourne, —·49 Wellington, —·44 Samoa, —·54 Cordoba (Argentina) and —·17 Cape Town.

65. It is accordingly of interest to see how far the coefficients with McMurdo Sound resemble those of Snow Hill in other respects. First of all for the relations between the monthly pressures at these two places we have—

	Time difference, + when Snow Hill earlier		
	+ 1	0	—1
1902 . .	—·05	+·75	—·15
1903 . .	—·15	—·3	—·3
1902,03	—·15	+·25	—·25

[1] "It would appear that the exceptionally severe ice conditions which terminated in the extraordinarily unfavourable summer of 1902-03, embraced the five years beginning with 1898. In all these years the winter rains on the Chilean coast were much heavier than usual; in 1899 and 1902 remarkably so."—Scott. Geog. Mag., XXVI, p. 415, 1910.

[2] In this table 1902 includes the data from February 1902 to January 1903, and similarly for 1903.

[3] Brit. Ant. Expn. Metlgy., I, pp. 201-5.

For the monthly pressure of McMurdo Sound and Santiago,

	Difference + when McMurdo S. earlier.						
	+ 3	+ 2	+1	0	—1	—2	—3
1902 . .	—·1	—·3	0	—·6	—·3	0	—·2
1903 . .	+·2	+·5	+·3	0	—·1	—·3	—·7
1911 . .	+·2	+·1	—·4	—·3	0	—·5	—·2
1912 . .	—·2	+·1	—·3	—·4	—·6	—·1	+·4
All . .	0	+·1	—·2	—·4	—·3	—·2	—·1

For McMurdo Sound and Melbourne we have—

	Difference + when McMurdo S. earlier.				
	+ 3	+ 2	+ 1	0	—1
1902 . .	—·1	+·3	+·5	+·1	+·4
1903 . .	—·1	+·3	—·1	—·2	0
1911 . .	—·1	+·6	—·2	—·4	+·4
1912 . .	+·6	+·2	—·1	—·5	—·4
All . .	+·1	+·3	0	—·3	+·1

66. The departure data of McMurdo Sound suggest that its opposition to Melbourne occurs chiefly during winter and spring, and even then there is marked parallelism with subsequent pressure at Melbourne; on the other hand the contemporary opposition to Santiago is persistent. Thus McMurdo would probably belong to the second group in the south oscillation and a table showing a few of its coefficients has been prepared.

McMurdo Sound Pressure.

	Dec. to Feb.					March to May.				
	2 qrs. before McM. J—A	1 qr. before McM. S—N	Same qr. D—F	1 qr. after McM. M—M	2 qrs. after McM. J—A	2 qrs. before McM. S—N	1 qr. before McM. D—F	Same qr. M—M	1 qr. after McM. J—A	2 qrs. after McM. S—N
Pressure.										
Honolulu	—·7	—·7	+·6	+·9	+·1	—·4	+·3	—·2	0	—·5
N.W. India	—·2	+·6	+·2	+·8	0	+·4	+·7	—·4	+·9	0
Port Darwin	+·7	+·6	+·8	+·8	—·3	+·3	+·1	—·2	0	+·3
Samoa	—·4	—·2	(—1·0)	(—·3)	(0)	+·1	(—·6)	(—·7)	(—·9)	(—1·0)
S. E. Australia	+·4	+·5	+·7	+·1	—·7	+·2	+·1	+·4	+·5	+·4
S. America	+·6	+·1	—1·0	0	+·6	—·9	+·1	—·9	—·8	—·8
Temperature.										
Dutch Harbour	+·5	(+·8)	+·1	+·7	—·1	(—1·0)	—·2	—·2	+·1	(—·5)
Rain.										
Peninsula (J—S)	—·9	..	..	..	+·6	..	..	..	+·2	..
	June to Aug.					Sep. to Nov.				
	D—F	M—M	J—A	S—N	D—F	M—M	J—A	S—N	D—F	M—M
Pressure.										
Honloulu	0	—·5	+·4	—·2	—·5	+·2	—·6	—·6	+·4	+·4
N.W. India	+·6	0	+·9	—·5	—·3	—·7	0	+·9	+·6	+·7
Port Darwin	+·1	—·7	—·1	—·1	—·4	+·8	+·4	+·6	+·7	+·2
Samoa	(—1·0)	(—1·0)	(—·2)	(—·5)	(+·7)	(+·6)	(—·6)	(—·4)	—1·0)	(—·6)
S. E. Australia	+·2	—·2	0	+·3	—·7	+·8	+·7	+·3	+·9	—·8
S. America	+·3	—·4	—·6	—·6	+·2	—·3	—·1	—·2	—·5	—·3
Temperature.										
Dutch Harbour . . .	—·6	—·2	—·1	(—·6)	—·7	—·1	+·5	(+·9)	—·1	+·8
Rain.										
Peninsula (J—S)	..	..	+·4	..	..	..	—·6	..	..	..

The number of years of data is in general 4 ; but for Samoa it is 3 unless the coefficient is given in brackets, when it is 2 ; and for Dutch Harbour it is 4 unless the coefficient is in brackets, when it is 3. These numbers are so small that the figures can be merely regarded as suggestive of the true values ; but there is on the whole opposition to Samoa and S. America, and parallelism with N.W. India, Port Darwin and S. E. Australia (except in winter) : here S. E. Australia stands for the mean of Brisbane, Adelaide and Alice Springs.

67. The information of footnote 44 suggests with reference to the tables of paragraph 64 that in 1902 it was S. America which assumed control and created reversed pressure departures in Australia and Snow Hill, which therefore varied together. In the Ross Sea the Antarctic opposition to S. America brought reversed waves (with coefficient —·6) which produced coefficients of +·5 and +·4 in conditions at Melbourne and McMurdo a month apart; further examination discloses a coefficient of +·5 in contemporary conditions outside the cold weather, but during the period from June to October, when the minimum is in general fully formed, the customary opposition set in and the coefficient was reduced to —·2. In 1911 S. America winter pressure was favourable to the Indian monsoon, and so was the S. Orkneys autumn temperature which ha sa coefficient of +·38 with the succeeding Peninsula rainfall ; but the control seems to have lain in the heavy Java rain two seasons earlier, in the amount of snow lying in the western Himalayas and the Zanzibar rain of May, for the India rains failed badly. Thus conditions in the Indian Ocean seem to have been dominant, with a big opposition between the Ross Sea and S. E. Australia. The chain of causes and effects that came into activity was thus markedly different from that of 1902, the time intervals were different, and the coefficients in the tables for 1911 departed appreciably from those of 1902.[1]

68. We may now attempt to summarise the conclusions reached regarding the southern oscillation. In the first group we have the high pressure centres in the north and south Pacific (San Francisco, Tokio in summer, Honolulu in spring, summer and autumn, Samoa, S. America) and the rainfall in areas bordering the Indian Ocean (India and Java) : and in the second group the centres of relatively low pressure in the region of the Indian Ocean (Cairo, N. W. India, Port Darwin, Mauritius, S. E. Australia and the Cape), the temperature at Dutch Harbour as indicating the pressure in the Aleutian minimum, and Honolulu in winter. Future investigations may add to the first group temperature at the S. Orkneys and to the second group May rainfall at Zanzibar and Seychelles, and the accumulation of N. W. Indian snowfall in May ; and when more data are available pressure in the Antarctic may follow. As noticed in the previous memoir on this subject (paragraph 70), the natural view is that positive departures in the first group and negative in the second suggest an increase in the general circulation ; but, as there indicated, this theory is not free from difficulty, and the fuller information now available shows that the explanation of the reversal between the S. Pacific and the Indian Oceans does not lie wholly in the cold currents from the Weddell Sea to the Cape ; for there are controls of

[1] Attention was drawn by Simpson to the difference between the correlation coefficients in the years 1902, 1903 and the years 1911, 1912 in Brit. Ant. Exp. Metlgy. I, p. 203, 1919.

S. America in the first half-year by previous pressure conditions at San Francisco, the Cape and probably in India, and these controls include reversals just as those exercised by S. America. Conditions in the area of the Indian Ocean affect each other closely, but they exercise comparatively little influence on the region of the Pacific Ocean. It may be that the solution of the general problem will not be found until we have a score of years of monthly means of Antarctic and upper air data available.

There are however grounds for satisfaction in the consistency of the relationships ascertained. Turning to the table in paragraph 57 above, if we examine the 150 significant coefficients between the 11 representative centres there enumerated, we shall find that the classification just given directly explains the sign of 149 of them. The solitary exception is the negative effect of Java rain (October to February) upon the Peninsula rain of the succeeding monsoon. This consistency is very remarkable and supports the view that seasonal forecasting is capable of wider application than at present. For the amount that appears capricious in the relationships is materially less than might have been anticipated; so that when the departures from normal of different regions used in forecasting the rainfall of a country point in the same direction and are strongly marked there is the greater reason for expecting that the conclusion indicated will be realised. To this argument may be added that the rainfalls of Java, India and Rhodesia appear to have far-reaching influence, largely independent of that of the pressures in these areas; and there is every reason for hoping that the tabulation and publication of reliable series of the rainfalls of other large areas, in Australia, America and Africa, will have important results.

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Errata slip to Memoirs of the Indian Meteorological Department, Volume XXIV, Part IX.

Page.	Reference.	*For*	*Read*
285	In Table against Peninsula (J—S) under 1 qr. before Vienna, J—A	·16	—·16
289	Ditto S. America under 2 qrs. after Charl. D—F	+·44	+·44
297	Ditto Iceland under 1 qr. before Honol. J—A	·20	—·20
,,	Ditto Vienna ditto	—·03	—·30
298	Ditto S. America under Years of data	blank	47
,,	Ditto S. America under 2 qrs. before N. W. Ind. J—A	46	—·46
,,	Ditto ditto 1 qr. after N. W. Ind. M—M	·34	—·34
301	Under pressure	America	S. America
303	Against Mauritius under 2 qrs. after Maur. M—M	+·3	+·38
,,	Do. Samoa ditto	—·0	—·02
,,	Do. S. E. Australia ditto	+·1	+·14
,,	Do. Cape ditto	—·1	—·14
,,	Do. S. America ditto	+·0	+·04
304	Under pressure	Siberia	C. Siberia
305	Against Cape under same qr. J—A	blank	0
306	Do. Samoa under 1 qr. after S. E. Aus. M—M	—·58	—·52
307	Do. N. W. India under same qr. S—N	+·46	+·46
312	Under Dec. to Feb. 1 qr. before Dutch H.	—N	S—N
,,	Against Honolulu under 2 qrs. after Dutch H. S—N	+·0	+·02
,,	Do. Mauritius under 1 qr. before Dutch H. S—N	·04	—·04
315	Do. Peninsula (J—S) under 2 qrs. after Java, J—A	—·36	—·36
329	Do. 1903 under +3, coefficient between Snow Hill and Melbourne	·2	+·2
330	Do. Honolulu under 1 qr. before McM. M—M	blank	—·5
,,	Do. N. W. India under 1 qr. before McM. M—M	blank	0
,,	McMurdo Sound pressure under Rain	ninsula	Peninsula
331	Para. 67, line 1st	44	1, page 329
,,	Para. 67, line 2nd	64	63

GIPC—M—IV-5-160—20-3-25—300.