

METEOROLOGY OF SOUTH AFRICA. AN INVESTIGATION
INTO THE LAND AND SEA BREEZES CONDITIONS AT
PORT ELIZABETH.

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(Communicated by L. PÉRINGUEY, F.R.S.S.Afr.)

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(Plate IV.)

The object of this paper is preliminary, as it is merely the outcome of an investigation of the 8 a.m. and 8 p.m. directions of wind at Port Elizabeth during the four years 1876 to 1879 inclusive. The facts it proves being merely deduced from two observations per day may or may not be borne out when an investigation is made having data from self-recording instruments, but enough has been elucidated to show that the results of the four years tabulations go to prove that all winds at Port Elizabeth were more or less governed by a diurnal influence analogous to land and sea breezes.

That land and sea breezes are experienced along all coasts in the world is admitted; the reasons why they should exist have also been established, so nothing need be stated here in this connection other than the effect of these conditions in South Africa.

Sometimes disturbances break into the sequences of these breezes, but an investigation of wind directions at morning and evening, extending over long periods, can always bring their existence to light.

Sometimes they are masked to a certain extent by prevailing winds, which is often the case with South Africa, but even here a careful analysis will disclose their presence.

Port Elizabeth has been chosen as a station for investigation as it is one on the high-pressure "col" between two permanent high-pressure areas, and its prevailing winds are west and east; the observer there has always been reliable, and his observations are continuous, and were made at 8 a.m. and 8 p.m.

It is well known that as the earth revolves the sun progresses *vertically* from east to west, and that a heat wave follows, having diurnal maxima and minima. But there is this difference, namely, whereas the atmosphere over the sea follows the movement of the sun and arrives at its maximum at or soon after the solar noon, that over the land attains to its

maximum much later, this lag being governed by the nature of the land surface, being later over sandy plains and earlier over forests.

It will thus be seen that there is a constant state of instability between the air over the sea and that over the land. At sunrise the air above the land has cooled much below that over the sea, and the tendency is for the prevailing wind to shift a point or two so as to blow more seawards. As the day advances the temperature of the air in general increases, and at the solar noon the maximum is reached over the sea. By this time the air temperature over the land and sea are on an equal footing. After the solar noon, however, unstable conditions set in again; the air temperature over the sea begins to fall, but that over the land continues to rise, and in due course the prevailing wind shifts so as to blow more shorewards than in the morning.

These are the broad lines of argument to apply to any investigation of this kind.

The present investigation was the result of pure accident on the part of the author. He was about to ascertain the mean direction of wind at various stations in South Africa, and for this purpose utilised the Reports of the Meteorological Commission for 1876 to 1879 inclusive. Of all the Reports of the Commission these are the only four which give bi-daily observations of wind directions, and these had to suffice, for the present at any rate.

Port Elizabeth was the first station dealt with, and it was soon seen that some winds blew more persistently of a morning than of an evening, while the reverse was the case with others. This brought up the thought of land and sea breezes, so the original object was abandoned for a time, and the present paper was the result.

In dealing with this question the wind rose has been divided into eight points: north winds include those from the NNW. and NNE.; west winds those from the WNW. and WSW.; south winds those from the SSW. and SSE.; and east winds those from the ESE. and ENE.

Pairs of wind directions will be considered separately; the argument as to what should take place will first be stated, and thereafter the proof or otherwise *deducted* from actual observations and tabulations applied. This is a correct scientific mode of procedure.

NORTH AND SOUTH WINDS.

The north is a decided land wind and the south a sea one; of that there is no doubt, and we should expect to find more of the former of a morning and of the latter of an evening. Such, in fact, is borne out by the observations, for the north wind blew at 8 a.m. upon 169 out of 212 occasions, while the south wind was blowing at 8 p.m. upon 57 out of 87 occasions.

The north 8 a.m. observations compared with the 8 p.m. ones are placed side by side on the following table:—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M. ...	6	1	8	13	26	29	26	26	11	11	9	3	169
P.M. ...	0	1	0	4	2	5	8	13	6	2	1	1	43

An examination of this table shows that the north wind was more prevalent during the winter months, May to August, than during the rest of the year.

A further examination shows that the following were the wind directions on the previous evenings:—

Followed.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	C.	Total.
Times	14	12	95	20	3		16	2	2	169

It is noteworthy to notice that the west wind changed to north more than any other wind.

The south 8 a.m. and 8 p.m. observations are also placed side by side for comparison:—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M. ...	1	4	6	5	1	0	0	4	2	0	3	4	30
P.M. ...	7	4	8	5	2	3	2	3	4	6	7	6	57

This is not so marked as the north wind, but the excess of evening observations over the morning ones can be traced. In this case there are more winds from this direction during summer than during the winter months, which is natural.

A further examination is made, as in the case of the north wind, showing the wind directions on the previous mornings:—

Followed.	N.	NW.	W.	SW.	E.	SE.	E.	NE.	C.	Total.
Times	2	3	16	14		3	5	3	5	57

The principal previous directions are from the west and south-west; this is the true evening veer.

NORTH-WEST AND SOUTH-WEST WINDS.

The former, blowing off the land, should be a morning wind, and the latter, off the sea, should be an evening one. If the normal direction be west it is evident that the cooling of the air over the land will cause a backing to the north-west, but when the land is heated a south-west will blow.

The 8 a.m. and 8 p.m. observations for the north-west wind were as follows:—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M.	3	11	11	9	16	12	15	18	16	17	6	12	146
P.M.	0	1	2	3	13	7	11	3	2	6	1	2	51

These show a great preponderance of winds from this direction of a morning as against those of an evening.

Similar observations for the south-west wind were as follows :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M....	6	6	6	2	1	5	2	2	4	5	7	3	49
P.M....	24	15	17	10	10	7	6	12	8	9	17	11	146

Here the excess rests with the evening observations.

Both these show the influences of land and sea breeze conditions.

An examination of the morning north-west observations shows that the following were the wind directions on the previous evenings :—

Followed.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	C.	Total.
Times	8	22	92	7	1	5	4	7	0	146

A similar examination of the south-west observations shows that the following were the previous morning directions :—

Followed.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	C.	Total.
Times	16	13	52	17	4	1	18	11	14	146

It will be seen from those two tables that in the majority of cases the wind either veered or backed from the west, this being the prevailing wind.

Looking at the evening north-west and the morning south-west winds, namely, those outside the land and sea breeze influence, it will be seen that the north-west was more prevalent during winter than during summer, but that there was a slight indication that the reverse was the case with the south-west winds.

SOUTH-EAST AND NORTH-EAST WINDS.

The former, blowing from the sea, should be an evening wind, and the latter, blowing from the land, a morning one. The 8 a.m. and 8 p.m. observations were as follows :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M....	2	6	6	2	2	1	3	0	8	7	4	3	44
P.M....	17	21	17	9	8	9	7	12	13	17	22	19	171

The evening observations are vastly in excess of the morning ones.

Similar observations for the north-east wind are now given :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M....	6	8	11	23	32	35	37	22	11	12	8	4	209
P.M....	0	3	0	3	15	14	16	5	2	0	4	0	62

These were more numerous of a morning than of an evening. These two sets of observations clearly show the effect of land and sea breeze influences.

An examination of the winds at the previous observations gives the following results :—

For the South-East Winds.

Followed. Times	N.	NW.	W.	SW.	S.	SE.	E.	NE.	C.	Total.
	11	2	10	10	4	24	76	21	13	171

For the North-East Winds.

Followed. Times	N.	NW.	W.	SW.	S.	SE.	E.	NE.	C.	Total.
	5	8	88	15	3	15	39	31	5	209

The result is peculiar, for while the south-east followed the east in the majority of cases, the north-east followed that on 39 occasions, but 88 times it was preceded by a west wind. This latter is evidently due to the influence of the Mozambique hot sea current, which, by heating the air above it, influences the coastal winds to a considerable extent; this has been found to be the case from observations of barometric pressure. The west is a land wind in the true sense of the term, but the north-east is only one in relation to the east or south-east winds, which are strictly sea winds; so it will be better not to take notice of the swing from west to north-east in studying a question of this kind.

Looking at the south-east evening observations, there is a falling off from April to September inclusive, the full effect of this wind being felt during summer. The north-east evening observations are the reverse of this, for they are more numerous in winter than in summer, as are also the morning observations. In fact, taken as a whole, the summer majority rests with the south-east, and the winter one with the north-east winds.

To fully appreciate to what an extent the Mozambique sea current effects the coastal wind directions, the following table comprising all the observations of winds during the four years, has been prepared; and it will be seen that in the great majority of cases, both morning and evening the wind was blowing from the west. The east wind comes next in importance, and these two can be called the normal directions, the others being more or less land and sea breezes, oscillating therefrom.

Total Wind Observations during Four Years.

	N.	NW.	W.	SW.	S.	SE.	E.	NE.
A.M. ...	169	146	415	49	30	44	274	209
P.M. ...	43	51	643	146	57	171	229	62
Totals...	212	197	1058	195	87	215	503	271

WEST AND EAST WINDS.

These, as before stated, can be considered as normal directions, but still there is a difference between them. At Port Elizabeth the east wind is a sea wind and the west a land one, so one would expect to find more observations of the former of an evening and of the latter of a morning.

Here are the tables of the 8 a.m. and 8 p.m. observations:—

East Wind.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M.	38	22	27	21	16	9	14	19	22	28	31	27	274
P.M.	21	17	17	30	22	16	18	19	18	24	17	10	229

West Wind.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A.M.	49	44	39	34	18	20	18	20	34	38	41	60	415
P.M.	51	47	55	48	42	54	49	58	62	55	50	72	643

The fact brought out is that neither the west nor the east wind can be said to be in any way influenced by land and sea breeze conditions as compared with one another. There is, however, a decided tendency for the east wind to blow more as an evening one during the winter months, from April to August; but otherwise these are purely normal in their directions, and blow quite contrary to the land and sea breezes.

We can now tabulate the foregoing facts as follows:—

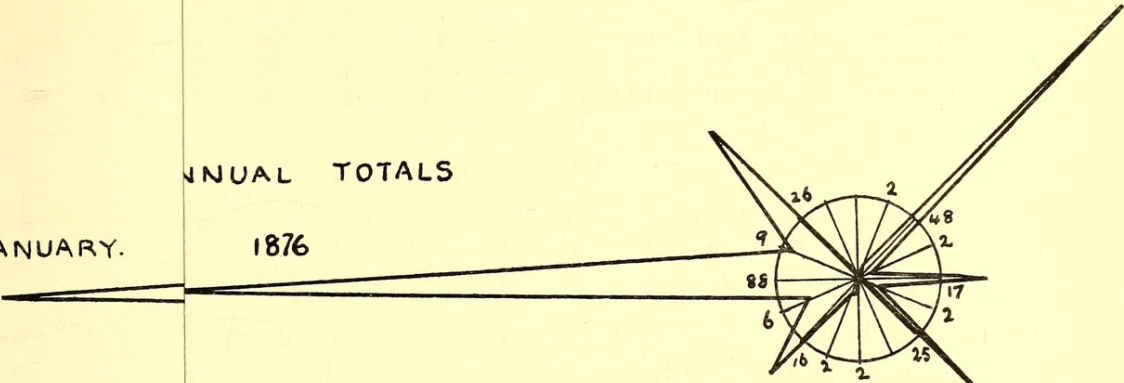
Number of times the W. and NW. winds went to the SW. of an evening	65
Number of times the SW. and W. winds went to the NW. of a morning	99
Number of times the SW. continued	17
Number of times the NW. continued	22
	203
Total number of SW. night winds	146
Total number of NW. morning winds... ..	146
	292

So that true displacing land and sea breezes blew upon 203 occasions out of 292.

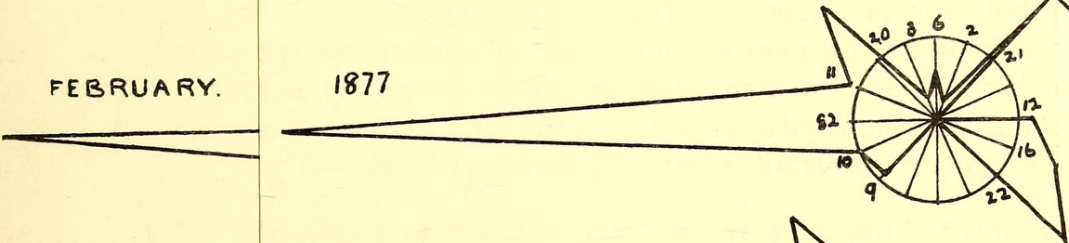
Number of times E. and NE. winds went to the SE. of an evening	97
Number of times the SE. and E. winds went to the NE. of a morning	54
Number of times the SE. continued	24
Number of times the NE. continued.....	31
	206
Total number of SE. night winds	171
Total number of NE. morning winds	209
	380

ANNUAL TOTALS

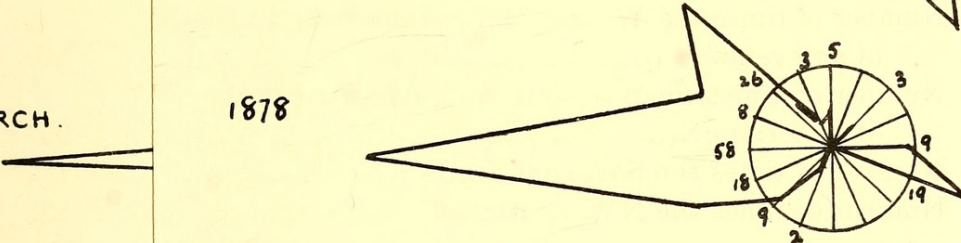
JANUARY. 1876



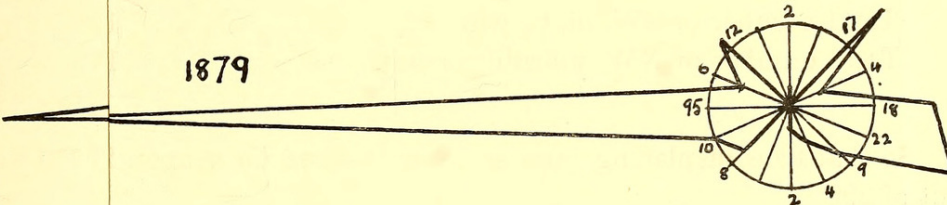
FEBRUARY. 1877



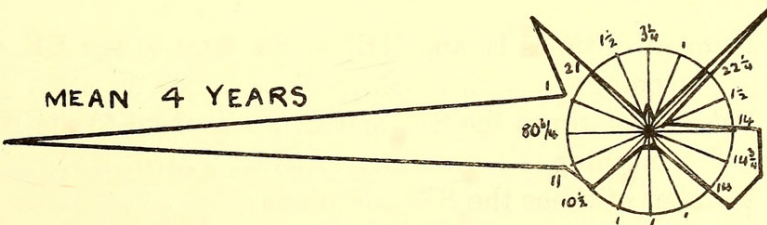
MARCH. 1878



APRIL. 1879

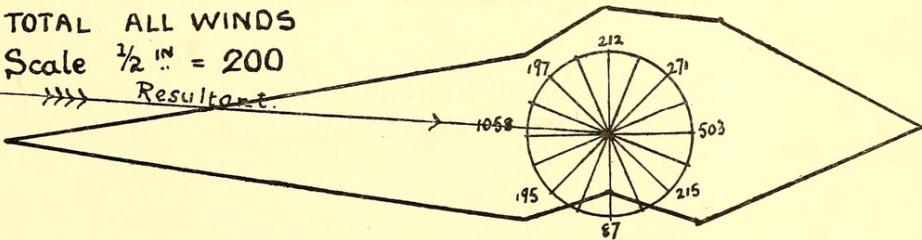


MAY. MEAN 4 YEARS



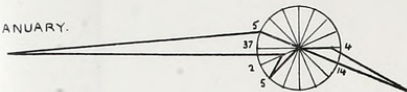
JUNE.

TOTAL ALL WINDS
Scale $\frac{1}{2}$ in. = 200
Resultant.

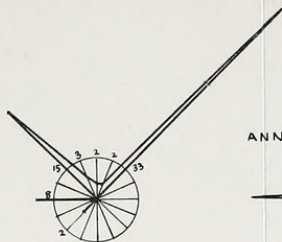


WIND PERSISTENCY ROSE, PORT ELIZABETH
MONTHLY TOTALS, 1876-1879.
Scale 1 in. = 15.

JANUARY.



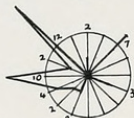
JULY.



FEBRUARY.



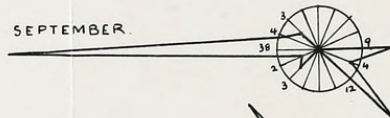
AUGUST.



MARCH.



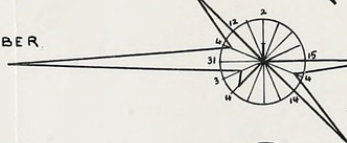
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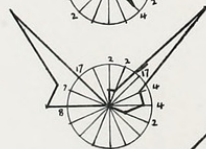
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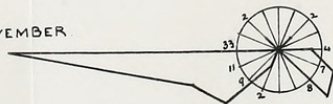
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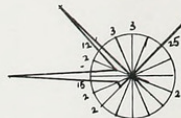
MAY.



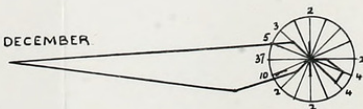
NOVEMBER.



JUNE.

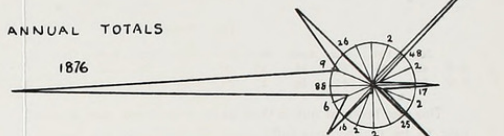


DECEMBER.

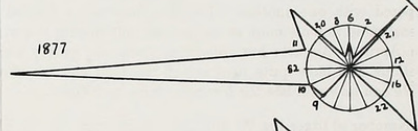


ANNUAL TOTALS

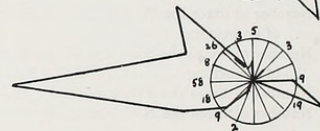
1876



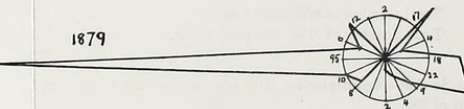
1877



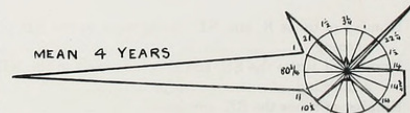
1878



1879



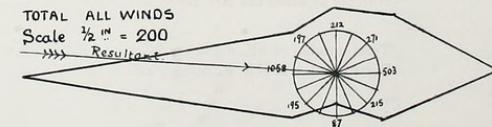
MEAN 4 YEARS



TOTAL ALL WINDS

Scale 1/2 in. = 200

Resultant



So that true displacing land and sea breezes blew upon 206 occasions out of 380.

Both these are high percentages.

At present nothing can be stated as to the time of day when a wind changed, and until an investigation of self-recording instruments has been made the matter must remain in abeyance.

Taking the east and west components together, we get :—

Total number of night winds	171 + 146 = 317
Total number of morning winds.....	209 + 146 = 355
	672

Total number of veering and backing winds, 409.

$$409 = 60.86 \text{ per centum of } 672.$$

We will tabulate our facts in another form :—

Normal Winds.

	A.M.	P.M.
Number of times for west winds	415	643
Number of times for east winds	274	229

Morning, or Land Winds.

Number of times for NW. winds	146	51
Number of times for NE. winds	209	62
Number of times for N. winds.....	169	43
	524	156

Evening, or Sea Winds.

Number of times for SW. winds	49	146
Number of times for SE. winds	44	171
Number of times for S. winds	30	57
	123	374

Although the west and east winds have been defined as normal, still if they displace winds from other directions, and are not continuous, this may be the result of land and sea breeze influence ; that is to say, with the morning west winds and the evening east ones the continuous winds will represent normal conditions, and the remainder those influenced as before stated.



Howard, A G and Péringuey, Louis. 1910. "METEOROLOGY OF SOUTH AFRICA. AN INVESTIGATION INTO THE LAND AND SEA BREEZES CONDITIONS AT PORT ELIZABETH." *Transactions of the Royal Society of South Africa* 2, 161–171.
<https://doi.org/10.1080/00359191009519371>.

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