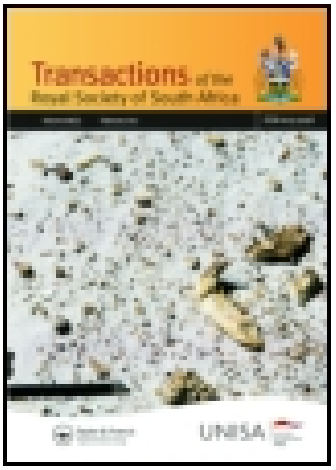

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THE RAINFALL OF SOUTH AFRICA. THE POSSIBILITY OF PREDICTION OVER THE SOUTH-WEST.

By A. G. Howard, M.S.A.

(Communicated by L. Péringuey.)

(Read May 19, 1909.)

If we take Clanwilliam, the Royal Observatory, and L'Agulhas, we have a triangle covering the south-west of Cape Colony, and as weather over that portion of South Africa forms a prelude to that all along the coast, it is evident that if we can ascertain beforehand what is in store within this triangle, we have the key to forecasting for the whole of the Colony. The position of L'Agulhas is one of great importance, and the movements of the barometer there in relation to those at the other two stations will indicate to a great extent what further atmospheric movements are impending.

By the kind courtesy of the Acting Secretary to the Meteorological Commission, during the absence of the Secretary in England, I have had access to the records of the morning simultaneous readings for several years, and have arranged them in groups, wherein each triad of readings bear a relationship to each other.

As I consider Cape L'Agulhas of such importance, I have taken into consideration the wind there, without reference to that at the other two stations; in fact, the wind records at these two stations are not of much value, especially when taken at 8.30 a.m.

In registering the rainfall I have given that recorded at the Royal Observatory, but inasmuch as the indications refer to a wide field, it may be that in some instances rain fell away from that station, and although the forecast would appear to be a failure, still, had records from all places in and around the triangle been taken, we might have seen a verification of the forecast.

In an investigation of this kind the first question to be asked is: "What amount of rainfall should be considered as constituting wet weather?" I should say that anything beyond 0·05 of an inch would

meet the case. But if we are dealing with conditions indicating wet weather we are justified in taking any fall at all—even 0·01 in.—as showing a verification of the forecast. If, however, we are dealing with conditions indicating dry weather, we shall be quite in order if we take all falls between 0·01 in. and 0·05 in. as of no importance. The atmospheric conditions governing rainfall are so very erratic that we will be justified in this course of action; for instance, suppose the indications are for rain and only 0·01 in. falls, the slightest change in the atmosphere, all indications of which are present, will give a greater fall—it is a mere accident that the fall is so slight; but if the indications are for dry weather and a fall of 0·05 in. follows, this also is accidental, and any atmospheric difference will make for less fall or none at all. In some cases when no rainfall is recorded at the Royal Observatory, it is seen to have fallen at L'Agulhas; this might be considered if the conditions are for rain, as it is not due to accidental circumstances; but if the reverse be the case and still rain falls at L'Agulhas, then it may be due to causes further afield than those indicated by the triad of readings, and is thus outside our investigation.

Taking, now, the barometric readings at the three stations, let us see how we can reduce them to a tabulated form. In the first place, we will divide them into primary groups: (I.) Where the general pressure is decreasing; and (II.) Where it is increasing. In some cases a single station's barometer may have a reverse movement to the other two, but this will not upset our argument.

In each of these two groups we can arrange for the following subgroups:—

(A) L'Agulhas most, Clanwilliam least.
(B) L'Agulhas most, Royal Observatory least.
(C) L'Agulhas most, other two equal.
(D) Royal Observatory most, Clanwilliam least.
(E) Royal Observatory most, L'Agulhas least.
(F) Royal Observatory most, other two equal.
(G) Clanwilliam most, L'Agulhas least.
(H) Clanwilliam most, Royal Observatory least.
(I) Clanwilliam most, other two equal.
(J) Clanwilliam and Royal Observatory equally most.
(K) Clanwilliam and L'Agulhas equally most.
(L) Royal Observatory and L'Agulhas equally most.
(M) All three moving simultaneously and equally.

In one or two cases the whole of the readings remained steady for 24 hours, but these I have not taken into consideration. It must be borne

in mind that in my tables I take the changes which have occurred in the pressure during 24 hours.

Each morning, when the readings are plotted down on a chart, one of them will be actually lower or higher than the others, contingent on the group we have under consideration, and this condition is of importance in dealing with the question of prediction. We can thus divide each of our sub-groups into three divisions, namely :—

(1) Where the L'Agulhas barometer has the actual lowest or highest reading.
(2) Where that at the Royal Observatory is the lowest or highest.
(3) Where such is the case at Clanwilliam.

In my investigations I have taken the relative importance of the three stations, as far as actual pressure is concerned, in the following order: First, L'Agulhas; second, Clanwilliam; third, the Royal Observatory, and where two of these are equally lower or higher, as the case may be, I have given the benefit to the most important station of the two.

Under Group I., with a falling barometer, the station having the actual lowest reading must be taken, but under Group II., with a rising barometer, the reverse will be the case.

Again, the height of the barometer at the lowest or highest station, as the case may be, has a bearing on the prediction, and must be borne in mind. Here I have separated each division thus into sections :—

(a) Readings below 29·95 in. as low.
(b) Readings between 29·95 in. and 30·05 in. as mean.
(c) Readings above 30·05 in. as high.

Finally, the direction of the wind at L'Agulhas is a factor which must receive consideration, and one's common sense will have to be exercised to decide whether an existing direction of wind is likely to change or not. This I have been unable to go into, as it is a matter of purely local observation and knowledge gained by experience, but I trust that some one else will take it up.

In the foregoing manner I have tabulated all the triads of readings—which were perfect—for the years 1902, 1904, 1905, 1906, and 1907. The reason for omitting 1903 was that the readings from Clanwilliam were not taken for four months, and I did not desire to include an imperfect year.

GROUP I.—GENERAL PRESSURE DECREASING.

SUB-GROUP (A).

If the triangle be examined it will at once be recognised that a condition like this means that a depression is advancing from the south-west, a typical winter one, and that if no other influence is at work the usual sequence of weather for such a depression will follow, and if the glass goes down low enough rain will come for certain. The influences which may upset the sequence are those brought about by a depression passing to the north of the triangle at the same time as the one from the south-west is affecting us. This can be seen by an examination of the actual differences of the barometrical pressure at the time; thus, if the reading at L'Agulhas be the lowest of the three, there is no doubt about it being a winter type depression, uninfluenced in any way; if, however, the reading at Clanwilliam be lowest, it is evident that there is a counter depression to the north which may drive away the rain and upset the prediction. Again, suppose the reading at the Royal Observatory be the lowest, then it is evident that there is either a summer type depression or a secondary to the north-west, and rain may not fall.

DIVISION (1).

Section (a).—During the 5 years, rain followed within 24 hours at the Royal Observatory on 79 occasions out of 110, while it did not on 31 days; on 61 days out of the 79 the wind was in the west, while out of the 31 days it was westerly on 16 occasions. Again, with wind in the east rain followed on 13 days and dry weather on 12. We are, therefore, justified in considering this as a rain-bringing condition. Out of the 31 cases only 3 were absolute failures as against the prediction for rain. In 16 cases rain fell, either at L'Agulhas or was delayed at the Royal Observatory or L'Agulhas until the following day. In 12 cases there would have been an element of doubt in issuing predictions, the conditions being such that we could only have stated that there was a probability of rain. In several of the successful 79 predictions a similar element of doubt existed, and we should have been justified in expressing such doubt and only predicting probable rainfall; in most of the cases no doubt existed.

Reducing the foregoing to percentages we get—110 days, total number.

95 days, rain followed; being 86 per cent.

15 days, no rain followed; being 14 per cent.

PREDICTION.—Wind westerly; almost certain rain. Conditions of doubt—Clanwilliam lower than the Royal Observatory—or pressure uniform at all stations.

Wind easterly; doubtful if rain will follow, unless it is seen that there is every probability of a change to the west.

Wind north or south; very uncertain if rain will follow or not.

Section (b).—Out of 36 cases, 21 were followed by rain at the Royal Observatory within 24 hours, and 15 not. It was blowing westerly on 15 days out of the 21, and on 9 out of the 15; the easterly element being unimportant. Out of the 15 days rain fell either at L'Agulhas on that or the next day, or else there was rainfall at the Royal Observatory within 48 hours upon 6 occasions, leaving only 9 days when no rain at all followed. We thus get—36 days, total number.

27 days, rain followed; being 75 per cent.

9 days, no rain followed; being 25 per cent.

PREDICTION.—Great probability of rain.

Section (c).—This condition existed on 23 occasions, and only on 5 of these did rain follow at the Royal Observatory within 24 hours. The wind was north-west and west on all the 5 wet days, the balance being 17 days north to east and 1 day calm.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—Wind was easterly on all but one occasion. In 6 cases rain followed and in 6 dry weather; only on 4 days did rain in excess of 0·05 in. fall.

PREDICTION.—Dry weather, unless rain has already fallen, when, no doubt, it will continue.

Section (b).—This only happened on 5 occasions during the 5 years, so it is not an important condition; on 2 occasions rain followed and on 3 it did not; the wind was easterly each time: only upon 1 day did rain beyond 0·05 in. fall.

PREDICTION.—Dry weather.

Section (c).—During the 5 years this occurred upon 9 occasions, and in no instance did rain follow.

PREDICTION.—Dry weather.

DIVISION (3).

Section (a).—There was a total of 28 cases, of which 7 were followed by rain and 21 by dry weather; on 20 days the wind was easterly; on 4 days less than 0·05 in. of rain fell, and only on 3 days was the prediction for wet weather fulfilled by more than this amount falling.

PREDICTION.—Dry weather, or less than 0·05 in. of rainfall.

Section (b).—This condition prevailed upon 8 occasions, and on 6 of them no rain followed; in all cases the wind was easterly; on both the remaining days the falls were below 0·05 in.

PREDICTION.—Dry weather.

Section (c).—This happened upon 8 occasions, and on none of them did rain follow; wind was easterly on each of them.

PREDICTION.—Dry weather.

SUB-GROUP (B).

Two reasons can be assigned for this condition; either a depression is coming up from the south or a local secondary is deepening over the land. In each case an area of high pressure exists to the west, which is against the formation of rain clouds. At the same time a depression from the south has a tendency to bring rain, but one deepening over the land has the reverse effect. These two conditions can be separated when the actual readings of the barometers are examined, for if that at L'Agulhas be lowest there is no doubt whatever about there being a depression advancing from the south, but if the lowest reading be at Clanwilliam it is more than likely that a secondary is deepening over the land.

DIVISION (1).

Section (a).—During the 5 years under review, rain followed within 24 hours at the Royal Observatory on 13 occasions out of 19; wind was from some point of west upon 14 occasions.

PREDICTION.—Wet weather.

Section (b).—This condition occurred upon 8 occasions, rain following upon 4 of them; on all but 1 day the wind was from some point of west.

PREDICTION.—If due to a winter type depression, then rain to follow; but if it be a general deepening over the land look out for dry weather.

Section (c).—This condition existed upon 7 occasions, and on 3 of these rain followed; the rain bringing winds were westerly, but the dry weather was divided equally between west and east winds. Only on 1 occasion was the fall over 0·05 in.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a), (b), and (c).—During the whole 5 years such a condition never occurred.

DIVISION (3).

Section (a).—This condition occurred on 7 occasions; wind was south to east each time, except on 2 calm days. Rain followed upon 3 occasions only, and on 2 of these it was under 0·05 in.

Section (b).—This happened upon 3 occasions, and dry weather followed each.

Section (c).—This happened upon 4 occasions, and dry weather followed each.

PREDICTION for Division.—Dry weather.

SUB-GROUP (C).

This condition can be brought about by a depression to the south or east surging back, or to a secondary deepening over the land and moving down past L'Agulhas. When L'Agulhas is actually lowest rain may or may not come, but with either of the other stations lowest it is almost certain that dry weather will follow.

DIVISION (1).

Section (a).—This condition was present upon 29 occasions; on 21 rain followed, and upon 8 it did not; on each of the 21 days when rain followed, the conditions, with few exceptions, were brought about by the advent of winter type depressions. Rain fell at L'Agulhas on 6 of the 8 occasions, so we have only 2 complete failures.

PREDICTION.—If the barometer reads lower at Clanwilliam than at the Royal Observatory, rain very doubtful. Otherwise—wet weather.

Section (b).—This happened upon 13 occasions, and on 6 of them rain followed. No particular wind can be called as prevailing for wet weather, but most of the dry weather came with west winds. The condition is one indicating rain, either at the Royal Observatory or at L'Agulhas.

PREDICTION.—Probable wet weather.

Section (c).—This happened upon 17 occasions, and only on 5 of them did rain follow at the Royal Observatory; wind was westerly for rain, and divided between easterly and westerly for dry weather; the condition is for dry weather, and only upon rare occasions is this not so; there must be a reason, but at present I cannot discover it.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This happened upon 2 occasions; we shall not be safe in issuing any prediction until we have more cases to guide us. This also applies to Sections (b) and (c), under each of which only 1 case occurs.

PREDICTION (Provisional).—Dry weather, but uncertain.

DIVISION (3).

Section (a).—This happened upon 12 occasions, and rain followed only upon 2; wind was generally easterly.

Section (b).—This happened upon 3 occasions, and no rain followed; wind was easterly.

Section (c).—This occurred 9 times and rain followed only upon 1.

PREDICTION for Division.—Dry weather.

SUB-GROUP (D).

This may be the prelude to a falling glass at L'Agulhas, due to a winter type depression, or it may be the result of a summer type one low down on the triangle, skirting a high pressure to the north and south. In the former case the reading at L'Agulhas will be actually lowest, and the fall at the Royal Observatory will be due to a southern depression. In the latter case the reading at the Royal Observatory will be lowest. If a summer type depression is affecting us the lowest readings will be at Clanwilliam, and this will bring down the glass at the Royal Observatory, but the influences will be for dry weather.

DIVISION (1).

Section (a).—We have 14 cases in the 5 years, and on 8 of them rain followed; on the other 6 rain should have followed. Wind was westerly in the majority of cases, both for wet and dry weather.

PREDICTION.—Wet weather.

Section (b).—This only happened upon 4 occasions, and after 3 of them rain followed. Wind was northerly.

PREDICTION.—Wet weather.

Section (c).—This only happened upon 3 occasions, and only on 1 of them did 0·02 in. of rain fall.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This happened upon 5 occasions, and rain followed only upon 1 of them, and then only 0·02 in. fell.

Section (b).—This happened upon 4 occasions, and after each dry weather followed.

Section (c).—This condition came upon 5 occasions, but only after 1 of them did rain follow, and then only 0·01 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This happened upon 10 occasions, and upon only 1 of them did rain follow, but no rain was to have been expected.

Section (b).—This happened only upon 4 occasions, without any rain following.

Section (c).—Only 3 cases, with no rain following.

PREDICTION for Division.—Dry weather.

SUB-GROUP (E).

This condition is brought about by a summer type depression, or a secondary to either a summer or a winter type one, passing L'Agulhas. Should the actual reading at L'Algulhas be the lowest, then there may be a prospect of rain. Should Clanwilliam actually be the lowest, then there is little prospect of rain, as it is a summer type depression, uninfluenced. The same applies if the Royal Observatory be the lowest.

DIVISION (1).

Section (a).—This happened upon 4 occasions, and rain followed 2 of them; wind was west for rain, but divided between west and east for dry weather. On one of the two dry days rain was expected and came at L'Agulhas.

PREDICTION.—Wet weather.

Section (b).—We have no cases of this condition.

Section (c).—Here we get only 4 cases; rain followed upon 2 with west wind, and dry weather upon 2 with north winds. In neither of the 4 cases was rain expected.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This only happened upon 1 occasion, and dry weather followed.

Section (b).—There were only 3 cases and 2 were followed by dry weather. All were with easterly winds.

Section (c).—This happened upon 10 occasions, and only upon 1 of them did rain follow, and then only 0·01 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This came about upon 17 occasions, and only upon 1 did rain follow, but no rain was expected—in fact it was abnormal.

Section (b).—This happened upon 16 occasions, and on 3 of them rain followed, but did not reach 0·05 in.

Section (c).—This happened upon 22 occasions, and rain followed only 1 of them; no rain was expected.

PREDICTION for Division.—Dry weather.

SUB-GROUP (F).

Similar phenomena to those mentioned in Sub-Group (E) can bring about this condition, and we must be guided by studying the aspects when one or other station has the lowest reading. If L'Agulhas is the lowest it shows that the previous reading must have been higher than that at Clanwilliam, and it is evident that a depression to the south is affecting us. Then rain may follow. But under other conditions dry weather is almost certain.

DIVISION (1).

Section (a).—This happened upon 8 occasions, and on 6 of these rain followed with westerly winds, the dry winds being easterly.

PREDICTION.—Wet weather.

Section (b).—This happened upon 4 occasions, and on 3 of them rain followed. Upon the occasion when dry weather followed some rain would have been expected, and it did rain at L'Agulhas.

PREDICTION.—Wet weather.

Section (c).—This happened upon 6 occasions, and upon 4 of them rain followed, with westerly winds; but although rain followed upon these days, this condition is not one for wet weather.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This only happened once, and dry weather followed.

PREDICTION.—Uncertain.

Section (b).—This happened 4 times with westerly winds, and dry weather followed 3 of them. The exception was only a fall of 0·03 in.

PREDICTION.—Dry weather.

Section (c).—This occurred upon 4 occasions, and dry weather followed each; wind was from the east.

PREDICTION.—Dry weather.

DIVISION (3).

Section (a).—This occurred upon 16 occasions, and only upon 2 of them did rain follow.

Section (b).—Here we have 10 cases, and rain followed only upon 2 of them.

Section (b).—We have 6 cases, and only 1 day's rain.

PREDICTION for Division.—Dry weather.

SUB-GROUP (G).

By referring to the triangle, it will be evident that when pressure yields the most at Clanwilliam it must be due to summer type conditions. Pressure may have been so low at L'Agulhas that even with Clanwilliam falling the most the actual reading will be lowest at the former. This may lead to rain at the Royal Observatory. But under other conditions we should not expect rain. Possibly some might fall at L'Agulhas, but this would be purely coastal or Eastern Province rainfall.

DIVISION (1).

Section (a).—This happened upon 3 occasions, and on each rain followed.

PREDICTION.—Wet weather.

Section (b).—This occurred upon 4 occasions; on 2 rain followed, and on 2 it did not; rain was expected on each occasion.

PREDICTION.—Probable wet weather.

Section (c).—This happened upon 4 days, and dry weather followed all of them.

PREDICTION.—Dry weather.

DIVISION (2).

We have only 1 case, so can offer no comment.

DIVISION (3).

Section (a).—Three days followed by rain, 12 dry.

Section (b).—No days followed by rain, 15 dry.

Section (c).—Two days followed by rain, 12 dry.

PREDICTION for Division.—Dry weather.

SUB-GROUP (H).

The atmospheric movements bringing about this condition are similar to those mentioned under Sub-Group (G), and the arguments given thereunder hold good. It is purely a summer type condition, and rain is only probable when pressure is actually lowest at L'Agulhas.

DIVISION (1).

Section (a).—This happened upon 6 occasions, and rain followed 5 of them; wind was westerly on each occasion.

PREDICTION.—Wet weather.

Section (b).—Here we have but 1 case, when dry weather followed.

Section (c).—Five cases occurred under this condition; on 3 dry weather followed and on 2 rain; but on one of these days only 0·02 in. fell; wind was westerly on each occasion.

PREDICTION.—Dry weather.

DIVISION (2).

No cases at all.

DIVISION (3).

Section (a).—This happened upon 4 occasions and dry weather followed each.

Section (b).—Here we have 4 cases and dry weather followed each.

Section (c).—We have only 1 case, followed by dry weather.

PREDICTION for Division.—Dry weather.

SUB-GROUP (I).

The reasons which can be assigned for this condition are the same as in the former two groups; it is practically a condition due to the passage of smaller type cyclones or the prevalence of anticyclones. Only when L'Agulhas is actually lowest is there a probability of rain.

DIVISION (1).

Section (a).—2 cases, 1 followed by rain.

Section (b).—One case, followed by rain.

Section (c).—One case, followed by rain.

PREDICTION for Division.—Wet weather.

DIVISION (2).

No cases at all.

DIVISION (3).

Section (a).—This happened upon 5 occasions, and only on one did rain follow, but this was purely abnormal.

Section (b).—Here we have 6 cases, and dry weather followed each.

Section (c).—This happened upon 4 occasions, 2 being followed by rain, but in neither case did the fall reach 0·05 in. Wind was westerly.

PREDICTION for Division.—Dry weather.

SUB-GROUP (J).

This is an important group; it is not rain-bringing unless actual pressure is lowest at L'Agulhas. By reference to the triangle it will be seen that this is brought about by summer conditions, that is to say by a depression approaching from the north-west and passing to the north of the peninsula. When L'Agulhas is actually lowest the other two stations may have been abnormally high the day before and thus have obscured the actual condition, in which cases rain may be probable, but with Clanwilliam actually lowest rain is very improbable. Of course when a deep summer depression passes, rain may fall with a southerly wind.

DIVISION (1).

Section (a).—This happened upon 4 occasions with westerly winds, followed twice by dry weather and twice by rain.

PREDICTION.—It is a very difficult condition to predict from. We are only certain when there are signs of a depression having moved across the north to the south-east, and then dry weather can safely be predicted. Otherwise it will be better to predict rain.

Section (b).—This happened upon 7 occasions, wind being westerly; rain followed 3 times. On the remaining 4 occasions rain fell either at L'Agulhas or at the Royal Observatory within 48 hours.

PREDICTION.—Wet weather.

Section (c).—We have 7 cases, 3 followed by rain and 4 by dry weather; wind was westerly. A similar argument holds here as in Section (b).

PREDICTION.—Wet weather.

Exception; minor fluctuation in an anticyclone.

DIVISION (2).

Only one case occurs.

DIVISION (3).

Section (a).—This took place upon 24 occasions, and after 6 of them rain followed, but in no case was it expected.

Section (b).—Here we have 20 cases, and rain followed only 1 of them.

Section (c).—There were 22 cases, and only 1 day's rain.

PREDICTION for Division.—Dry weather.

SUB-GROUP (K).

This may be brought about by a decrease of pressure over the land between Clanwilliam and L'Agulhas; sometimes the barometer rises at the Royal Observatory, due to the approach of an anticyclone. It is not rain-bringing, except in special cases.

DIVISION (1).

Section (a) —This occurred 6 times, and was followed by rain upon 2 of them.

PREDICTION.—Dry weather; but if there is any indication that conditions which appear under Sub-group (A) are manifest, then there will be a great probability of rain.

Section (b).—There are no cases.

Section (c).—Here we have 5 cases, only 1 of which was followed by rain.

PREDICTION.—Dry weather.

DIVISION (2).

No cases.

DIVISION (3).

Section (a).—No cases.

Section (b).—Here we have 4 cases and no rain.

Section (c).—There are only 2 cases, 1 followed by rain and 1 by dry weather. Rainfall was only 0·06 in.

PREDICTION for Division.—Dry weather.

SUB-GROUP (L).

This is an important condition; it can be brought about by an advancing winter type depression, or by one pushing down from the north after the centre has passed Clanwilliam. It can also happen when an existing depression to the south surges back by deepening. When L'Agulhas is actually lowest and the glass is low, a winter type depression is sure to be affecting us and rain is almost certain, but when the glass is either mean or high a depression from the north is more than likely the cause of the disturbance, when rain is not likely to fall. With the barometer lowest at the Royal Observatory or Clanwilliam, summer type conditions may be prevailing and rain not probable.

DIVISION (1).

Section (a).—This condition came about upon 27 occasions, and dry weather followed only 5 of them; wind was generally from a westerly direction. Looking at these 5 cases I find that each was in connection with a winter type depression, and that rain would have been predicted. In 4 cases rain did come as an accompaniment to the depression, but not under 48 hours.

PREDICTION.—Wet weather.

Section (b).—Here we have 11 cases with westerly winds prevailing; only on 3 did rain follow, in 1 instance being only 0·02 in.

PREDICTION.—Dry weather.

Section (c).—This happened upon 14 occasions, and rain followed 4 of them; no rain would have been looked for as following any of these 4 cases.

PREDICTION.—Dry weather. At the same time the glass and sky should be carefully watched, to see if there is any indication that the yielding pressure is due to an advancing winter type depression, when slight rain is probable.

DIVISION (2).

Section (a).—2 cases; dry weather followed.

Section (*b*).—2 ,, ,, ,, ,,

Section (c).—4 ,, ,, ,, ,,

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This happened upon 14 occasions, and only upon 2 did rain follow; wind was generally easterly.

Section (b).—Here we have 8 cases, and only 1 of them followed by rain.

Section (c).—There are 4 cases, each followed by dry weather.

PREDICTION for Division.—Dry weather.

SUB-GROUP (M).

By "simultaneous" I mean a difference among all barometers not exceeding 0·02 in. Thus, if the falls be 0·06 in., 0·06 in., and 0·08 in. respectively, this would be placed here; but should the falls be 0·06 in., 0·07 in., and 0·09 in. respectively, it would be put down under Sub-Group (J).

This condition is brought about by a very widespread yielding of pressure, and may be due to many causes—the passing away of an anticyclone; the diminution, temporarily, of an anticyclone; the general deepening of a large depression, &c.

DIVISION (1).

Section (a).—This happened upon 3 occasions, rain following 1 of them, when 0·35 in. fell at the Royal Observatory, and none at L'Agulhas; however, on the 2 remaining occasions rain did come within 48 hours.

PREDICTION.—Probable wet weather.

Section (b).—This happened upon 6 occasions, and upon 2 of them rain followed. The argument under Section (a) holds good in this one.

PREDICTION.—Probable wet weather.

Section (c).—We have 8 cases, 3 of which were followed by rain, but the falls were slight and unexpected.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—Only 2 cases.

Section (b).—Only 1 case.

Section (c).—Only 2 cases.

The majority of these cases were followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Out of 7 cases, only 2 were followed by rain; wind was easterly.

Section (b).—Here we have 11 cases, rain following only after 1 of them.

Section (c).—Out of 10 cases, only 2 were followed by rain, and then not more than 0·02 in. fell.

PREDICTION for Division.—Dry weather.

By applying the result of the foregoing investigation to the rainfall returns of 1908, I arrive at the following:—

Under this group there were 191 cases, 15 of which I included as failures, being 7·8 per cent. But inasmuch as upon 5 occasions our common sense would have made us relegate some of the cases to other sub-groups, we get the total number of absolute errors, or failures, as 10, making 5·23 per cent. of the total number of cases. I think this is proof enough of the value of the argument.

GROUP II.—GENERAL PRESSURE INCREASING.

SUB-GROUP (A).

By examining the triangle, it will be seen that when pressure increases at L'Agulhas more than at the other two stations, it is either due to an anticyclone passing to the south of the Cape or to the fact that increase of pressure generally is retarded by summer conditions to the north. This is more noticeable when Clanwilliam has the least increase. Sometimes the barometer at Clanwilliam actually falls when the other two are rising, and this brings the condition into relationship with that under Sub-Group 1, (G).

In this Sub-Group the actual highest pressure bears a direct influence on the following weather; the normal condition is a rising barometer at each station, with the actual lowest reading at Clanwilliam and the highest at L'Agulhas; such denote pure summer type conditions, and it depends entirely upon the height of the barometer whether these conditions are due to a depression to the north or an anticyclone to the south. Should the actual reading be lowest at L'Agulhas, it is evident that winter type conditions are making themselves felt, possibly a depression has just passed with a very low reading at that station, so that the excess of increase in pressure is only apparent; in such a case rain would be probable. In all predictions this condition must be taken into account, and if it exists the probability of rainfall should be mentioned.

DIVISION (1).

Section (a).—Here we have only 3 cases, 1 being followed by rain and the other 2 by dry weather; the former was a fall of 0·13 in. following a deep summer type depression, where no rain would have been expected.

Section (b).—There are 10 cases, 2 being followed by rain; on 1 of these only 0·02 in. fell, and the other was due to a winter type depression.

Section (c).—This happened upon 83 occasions, and only upon 3 did rain follow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Here we have 2 cases, followed by dry weather.

Section (b).—Here are 14 cases, and rain followed upon 5 of them. The rainfall on each of these 5 occasions was entirely due to a recently passed winter type depression.

Section (c).—This condition came upon 86 occasions, and on 78 of them dry weather followed; on 4 of the wet days less than 0·05 in. fell, so we have only 4 actual failures.

PREDICTION for Division.—When pressure is mean at L'Agulhas and a winter type depression has just passed, look out for rain, both at the Royal Observatory and at L'Agulhas; in all other cases prepare for dry weather.

DIVISION (3).

Section (a).—1 case followed by rain.

Section (b).—1 case followed by rain.

Section (c).—Out of 22 cases, 12 were followed by rain and 10 by dry weather; this is an unnatural condition, blending winter with summer types, the rapid rise at L'Agulhas being the summer type and the high barometer at Clanwilliam the winter one.

PREDICTION for Division.—When a winter type depression is passing off and the glass is low at L'Agulhas, rain can be expected; otherwise prepare for dry weather.

SUB-GROUP (B).

This can be brought about by a wedge of high pressure pushing up from the south of L'Agulhas, reaching to Clanwilliam. Or, again, a recovery of pressure at the rear of a depression may be interfered with by a secondary to the west or north-west of the Royal Observatory.

DIVISION (1).

Section (a).—No cases.

Section (b).—We have only 2 cases, followed by dry weather.

Section (c).—This happened upon 34 occasions, and only once did rain fellow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There were only 2 cases, 1 followed by rain.

Section (c).—Here we have 5 cases, only 1 being followed by rain, and then only 0·03 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—This happened upon 9 occasions, and rain followed 7 of them; on the 2 excepted days pressure was very high and no rain would have been looked for. In the cases where rain followed, although pressure was high at Clanwilliam, it fell towards L'Agulhas, and was akin to winter type conditions.

PREDICTION for Division.—Wet weather. Exception.—High pressure all over.

SUB-GROUP (C).

This can be brought about by a high-pressure area pushing up from the south, or a depression to the north-west preventing proper recovery after a winter type depression has passed.

DIVISION (1).

Section (a).—No cases.

Section (b).—Here we have 6 cases, each followed by dry weather.

Section (c).—This happened 48 times, and only after 1 of them did rain follow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There are only 2 cases, each followed by dry weather.

Section (c).—Here we have 12 cases, 10 of which were followed by dry weather; on the remaining days only 0·02 in. fell on each day.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—We have but 3 cases, 2 followed by rain.

Section (c).—This condition prevailed upon 13 occasions; after 7 of them rain fell, and after 6 dry weather followed. From a consideration of all the cases, I have come to the conclusion as follows:—

PREDICTION for Division.—

Pressure at Clanwilliam below 30·10 in., wet.
" " " 30·10 in. to 30·20 in., doubtful.
" " " above 30·20 in., dry.

SUB-GROUP (D).

This would be brought about by an advancing high-pressure area moving from the west and just skirting Clanwilliam. Of course the actual increase in pressure at the Royal Observatory may only be apparent, and other conditions may be at work causing rain; these will be considered in their places, but the main influence of the group leads to fine, dry weather.

DIVISION (1).

Sections (a), (b).—No cases.

Section (c).—Here we have 5 cases, and dry weather followed each.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—There are 3 cases, each followed by dry weather.

Section (b).—There are 9 cases, each followed by dry weather.

Section (c).—This happened upon 35 occasions, and upon 27 of them dry weather followed. Of the 8 remaining, less than 0·05 in. fell upon 6 days, and on the remaining 2 days rain would not have been expected.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—There are only 2 cases, 1 followed by dry, and the other by wet weather.

Section (c).—We have 8 cases, 6 being followed by rain; on the 2 other occasions clearing-up showers after a winter type depression would have been looked for.

PREDICTION for Division.—Wet weather.

SUB-GROUP (E).

This can be brought about by a high-pressure area approaching from the west or north-west, leaving the gradient at L'Agulhas open to the south and south-east. Of course, as in other groups, pressure might have been exceptionally low to the west or north-west, causing the rapid rise to appear as a bank of approaching high pressure, when such was not the case.

DIVISION (1).

One case in each section, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Here we have 3 cases; 2 were followed by dry weather, and 1 by rain; the conditions were not for rain, and only 0·05 in. fell, although it rained at L'Agulhas.

Section (b).—This happened upon 16 occasions, rain following only twice; on one of these occasions the fall was only 0·02 in.

Section (c).—This condition was present upon 26 occasions, and after 20 of them dry weather followed; out of the 6 exceptions only 1 was abnormal, and no rain would have been predicted; the other 5 were due to the fact that winter type depressions had just passed, and the glass at L'Agulhas was low; in none of these 5 cases did much rain fall at the Royal Observatory, but in each rain fell at L'Agulhas.

PREDICTION for Division.—Dry weather. Exception.—Winter depression at L'Agulhas.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (F).

Similar conditions to those affecting Sub-Group (E) can bring about this, with a high-pressure area pushing from the west or south-west and wedging across the peninsula.

DIVISION (1).

Section (a).—Only 1 case.

Section (b).—No cases.

Section (c).—There were only 3 cases, 2 being followed by very slight rainfall.

PREDICTION for Division.—(Provisionally)—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—Here we have 4 cases, followed by dry weather.

Section (c).—This happened upon 18 occasions, and after 13 of them dry weather followed; out of the 5 exceptions the falls were below 0·05 in. 3 times, and the other 2 were abnormal, and no rain was expected.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Sections (a), (b).—No cases.

Section (c).—There were 6 cases, and only 1 followed by dry weather; on this day rain was expected.

PREDICTION for Division.—Wet weather.

SUB-GROUP (G).

Here we have conditions bearing a relationship to Sub-Group 1, (A); where L'Agulhas falls most and Clanwilliam least. In some cases it will be seen that the barometer at L'Agulhas actually falls while others rise, and these will be specially considered. This condition is one which succeeds the passing of a winter type depression, or the advance of high-pressure areas from the north or north-west; sometimes a high-pressure area is pushing down from the north or north-west while a depression is affecting the south, and we have thus a complication.

DIVISION (1).

Section (a).—Only 1 case.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Only 2 cases, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—There are only 2 cases, 1 followed by dry weather, and 1 by a fall of only 0·01 in.

Section (b).—Here we have 4 cases, 1 of which was followed by rain; but only 0·06 in. fell.

Section (c).—There were 12 occasions when this condition occurred, and after 3 of them rain followed, but in each case it was less than 0·05 in.

PREDICTION for Division.—Dry weather. Exception.—A winter depression at L'Agulhas.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (H).

This can be brought about by the formation of a high-pressure area to the north, retarded by a disturbance to the west of the Royal Observatory.

DIVISION (1).

Sections (a) (b).—No cases.

Section (c).—We have 5 cases, each followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

No cases.

DIVISION (3).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by rain.

Section (c).—Here we have 4 cases, followed by dry weather only on 1 of them.

PREDICTION for Division.—Wet weather.

SUB-GROUP (I).

Similar conditions to those under Sub-Group (H) are here indicated.

DIVISION (1).

Section (a).—There are only 2 cases, followed by dry weather.

Section (b).—Only 3 cases, 1 followed by rain.

Section (c).—There were 5 occasions with this condition, and only on 1 day did 0·01 in. of rain fall.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Here we have 4 cases, 1 being followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Only 1 case, followed by rain.

Section (b).—We have 5 cases, 4 being followed by rain; on the excepted day rain was expected, and it rained at L'Agulhas.

Section (c).—This happened upon 5 occasions, 3 being followed by rain and 2 by dry weather; the 2 exceptions were due to the fact that the movement was merely a fluctuation in an anticyclone in each case.

PREDICTION for Division.—Dry weather. Exception.—Fluctuation in an anticyclone.

SUB-GROUP (J).

This is a condition which can follow in the rear of a winter type depression, or it may be that such a depression is still at L'Agulhas and pressure banking up to the north-west. Again, it may be due to the banking up on the north-west of an existing high-pressure area. It is akin to Sub-Group (G).

DIVISION (1).

Section (a).—There is only 1 case.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Here we have 5 cases, only 1 of which was followed by rain, and then none was expected.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—We have 9 cases, only 2 of which were followed by rain.

Section (c).—This happened upon 18 occasions, and rain followed only upon 2 of them; the falls were 0·03 in. and 0·02 in. respectively.

PREDICTION for Division.—Dry weather.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (K).

This can be brought about by the formation of an anticyclone or the fact that the high-pressure area following a depression is affected by some disturbance to the north-west or west.

DIVISION (1).

Sections (a), (b).—No cases.

Section (c).—Here we have 14 cases, all followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—Only 1 case.

Section (c).—There are 8 cases, of which only 1 was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—There were 3 cases, 1 followed by rain and 2 by dry weather; each case was a rain-bringing one, as a winter type depression had just passed and pressure was low at L'Agulhas.

PREDICTION.—Wet weather.

Section (c).—Here we have 4 cases, 1 being followed by rain.

PREDICTION.—Dry weather.

SUB-GROUP (L).

This is due principally to the banking up of pressure to the south-west, and it is sometimes accompanied by the presence of a summer type depression to the north. It is also brought about through recovery of pressure after a winter type depression has passed.

DIVISION (1).

Section (a).—No cases.

Section (b).—There are 5 cases, each followed by dry weather.

Section (c).—Here we have 8 cases, only 1 of which was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—There are 12 cases, and only 2 were followed by rain.

Section (c).—Here we have 21 cases, and of these 16 were followed by dry weather; of the remaining 5 cases, 1 had a fall of 0·05 in. and the other 4 less.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Only 2 cases, 1 followed by rain.

Section (b).—This happened upon 11 occasions, and after 7 of them rain followed; the weather conditions of the remaining 4 were such as would have caused one to look for rain.

Section (c).—Here we have 11 cases, 6 followed by rain and 5 by dry weather; in each of these cases a winter type depression had just passed, and clearing up showers would have been looked for.

PREDICTION for Division.—Probable wet weather.

SUB-GROUP (M).

This can come about at the rear of a depression, or when an anti-cyclone or low-pressure area alters its level generally.

DIVISION (1).

Section (a).—3 cases, 1 followed by rain and 2 by dry weather; the rainfall was only 0·05 in.

Section (b).—2 cases, followed by dry weather.

Section (c).—6 cases, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There are 7 cases, 2 only being followed by rain, but in neither case did the fall go beyond 0·02 in.

Section (c).—There are 13 cases, and only 1 of them was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—2 cases, 1 followed by rain and 1 by dry weather; in the latter case rain should have followed.

PREDICTION.—Wet weather.

Section (b).—4 cases, 2 followed by rain.

PREDICTION.—When a winter type depression is passing away, look for wet weather. When a summer type depression is passing, predict dry weather.

Section (c).—There are 9 cases, 3 followed by rain and 6 by dry weather. Of the 3 cases the falls were 0·01 in. and 0·02 in. respectively upon 2 days; the other case was abnormal.

PREDICTION.—Dry weather.

We now come to an important group, namely, Division (3) from each of the Sub-Groups (E), (G), and (J); these we must place together, owing to their similarity of conditions.

Let us first get at the actual facts.

SUB-GROUP (E).

Section (a).—2 cases, 1 followed by rain.

Section (b).—3 cases, each followed by rain.

Section (c).—5 cases, each followed by rain.

SUB-GROUP (G).

Section (a).—5 cases, rain following only after 1.

Section (b).—24 cases; on all but 1 wind was west; on 13 days rain followed and after 11 dry weather.

Section (c).—22 cases, 12 followed by rain and 10 by dry weather; on 19 days wind was westerly.

SUB-GROUP (J).

Section (a).—3 cases, followed by dry weather.

Section (b).—8 cases, 5 followed by rain.

Section (c).—13 cases, 8 followed by dry weather and 5 by rain.

I have considered each one of these cases, and have been able to place them under the following heads :—

(T) When a winter type depression is approaching from the south-west, and an area of high pressure is forming to the north.
(U) When a winter type depression has passed on the previous day.
(V) When a winter type depression has passed two days previously.
(W) When the centre of such a depression is at L'Agulhas, but recovery set in elsewhere.
(X) When a summer type depression has passed from the north to L'Agulhas.
(Y) Anticyclonic movements.
(Z) When a winter type depression impinges on an anticyclone.

By tabulating all cases we get the following :—

Case	T	U	V	W	X	Y	Z
Wet	—	13	2	22	4	1	2
Dry	1	7	3	5	17	6	1
Prediction	Dry	Wet	?	Wet	Dry	Dry	Wet

If we now apply the results of our investigation to the rainfall returns of 1908 we arrive at the following :—

Under this group there were 166 cases, 18 of which were apparently failures, making 10·9 per cent. (say, 11 per cent.) of the total number of cases. At the same time it is worth mentioning that of the 18 cases of failure, 14 were such as might, by exercising a little common sense, have been relegated to other sub-groups, and at any rate have considerably modified the predictions.