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DUPLICATE

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CLIMATOLOGICAL SERVICES (Met 0 3)
CLIMATOLOGICAL MEMORANDUM No.58

THE CLIMATE OF CENTRAL AYRSHIRE

by

F.H. Dight, O.B.E., B.Sc.



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P R E F A C E

This memorandum is one of a series dealing in some detail with the differing climates of various regions of Scotland. The boundaries of the regions as delineated in the areal maps are artificial, but for convenience they coincide with areas for which the Macaulay Institute for Soil Research are currently engaged on preparing a series of Memoirs of the Soil Survey of Great Britain. This memorandum, and the others in the series are being used as a basis for the chapters on "Climate" in the corresponding memoirs of the Soil Survey.

It is hoped that the design of the memoranda is such as to be useful to a wide variety of interests. The approach is not purely one of presenting in consolidated form the data available in the Meteorological Office, but in some degree a more dynamic approach in relating cause and effect has been adopted.

The policy has been to build the climatic picture round the analysed data available from climatological stations which have been in operation over a long period of years and to supplement this information not only from the observations at stations now no longer operative but also by the inclusion of data from the many stations that have come into being during the past 10 years or so and for which a useful summary can now be made. Data for stations outside the nominal boundaries of the regions have been exploited where it is considered that these add representative detail to the picture or where it gives an important lead, especially in the absence within the boundaries of the region of a station with a similar exposure.

The periods on which the climatic tabulations have been constructed are given. The averages of the major elements, temperature, rainfall and sunshine (unless otherwise stated) are those for the standard 30 or 35 year periods currently in use but for the climatological summaries the observations up to and including those for 1964 have normally been utilised. When a station has suffered breaks in its records, either partially or completely and where these breaks are considerable, or otherwise appear important, a suitable annotation is made. It is relevant to remember that at meteorological offices at defence establishments and civil airports the weather watch is continuous for most or all of the 24 hours and the staff have opportunities for noting phenomena which the observer at a climatological station might miss.

In order to keep the tabulations within reasonable limits, full climatic data are normally given for long term stations, but for subsidiary stations some items, even where available, e.g. the number of rain days, are not given unless they show significant variations or there are other specific reasons for not presenting the figures as comparative data. Annual averages which are normally large, e.g. numbers of rain days, days of ground frost etc. are rounded off to the nearest whole number.

In accordance with official Meteorological Office policy, temperatures are usually given in degrees Celsius. Practically all the temperature data are recorded however, in degrees Fahrenheit and for this reason °F have been retained for individual extreme readings.

These maxima and minima were originally recorded in whole degrees °F obtained by throwing to the odd so that a recorded 32°F could be any value from 31.6°F to 32.4°F, and a recorded 33°F could be any value from 32.5°F to 33.5°F and so on. Recorded values of 32°F are important in relation to the frequency of frost. An air frost is currently defined as a day when the screen minimum fell below 32.0°F (0.0°C) but until 1st January 1963 a screen minimum which was recorded as 32°F (i.e. 32.4°F or less) was counted as a day of air frost. The average frequencies are therefore a little higher than they would be had the present more precise definition been operative.

/Statistics

Statistics of "ground frost" given in the climatological tables also need some qualification. Formerly a "ground frost" was recorded when the near surface temperature fell to 30.4°F and this criterion applies to practically all the observations on which the statistics are based. "Ground frosts" are not now recorded, the term being reserved for use in forecasting only. In their place grass minimum temperatures below 0.0°C are recorded. The average number of "ground frosts" given in the tabulations based on the former criterion are comparable among themselves and are not yet significantly affected by the new procedure.

The following key is applicable to the headings of the climatological summaries:-

R	=	a day with 0.01 in. or more of rain (09-09h GMT)
W	=	" " " 0.01 in. or more of rain
S	=	" " " snow or sleet falling
SL	=	" " " snow lying (snow covering one half or more of the ground representative of the station at 0900h GMT)
H	=	" " " hail
T	=	" " " thunder heard
F	=	" " " fog at 09h GMT
AF	=	" " " air frost
GF	=	" " " ground frost
G	=	" " " gale

} - for criteria see above

In the areal maps, stations are indicated as follows:-

■	=	Meteorological Office stations
▲	=	Co-operating climatological stations
●	=	Rainfall stations

For purposes of comparison with other localities and regions, the following publications may be consulted:-

M.O. 735	Averages of temperature for Great Britain and Northern Ireland 1931-60	H.M.S.O.
M.O. 743	Averages of bright sunshine for Great Britain and Northern Ireland 1931-60	"
M.O. 635	Averages of rainfall for Great Britain and Northern Ireland 1916-50	"
M.O. 421	Averages of Humidity for the British Isles	"
M.O. 488	Climatological Atlas of the British Isles	"

*Climatological Memoranda No.38, 1931-60
Averages of temperature and sunshine
for stations not included in M.O.735

*No.40, Frequencies of snow depth for given
ranges at selected stations in Scotland

* Available from Meteorological Office (Met O 3c) Bracknell

/*Hydrological

*Hydrological Memoranda

No. 1 (Revised) Part II - Monthly averages of rainfall for Scotland and Northern Ireland, 1916-50, for MWR stations.

- " 26 Rainfall, 1916-50, over the areas of Solway, Ayrshire and Clyde
- " 27 Rainfall, 1916-50, over the areas of Kintyre and S.W. Islands, Add, Awe, Etive, Lochy and Linnhe
- " 28 Rainfall, 1916-50, over the areas of Shield, Alsh, Maree, Inner and Outer Hebrides and Laxford
- " 29 Rainfall, 1916-50, over the areas of Naver, Thurso and Wick Water to Conan
- " 30 Rainfall, 1916-50, over the areas of Beaully and Ness, Banff, Moray and Nairn
- " 31 Rainfall, 1916-50, over the areas of Dee and Don, N & S. Esk and Tay
- " 32 Rainfall, 1916-50, over the areas of Forth, Lothians and Tweed

* Available from Meteorological Office (Met O 3c) Bracknell

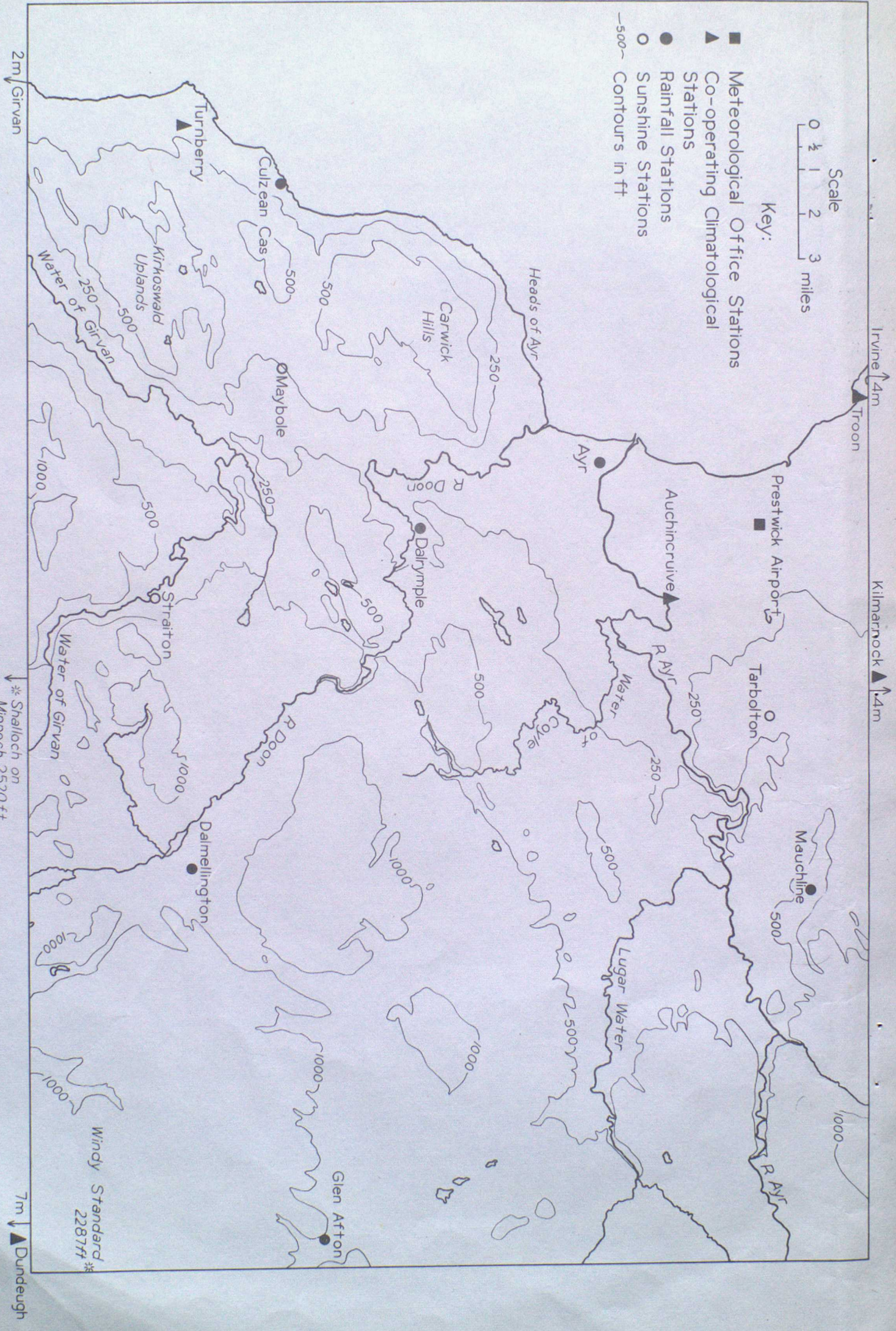


Fig 1 Central Ayrshire

THE CLIMATE OF CENTRAL AYRSHIRE

by

F.H. Dight, O.B.E., B.Sc.

Introduction

Ayrshire, the largest county in Scotland outside the Highland area, crescent shaped and reminiscent of the "first quarter" moon erect on its tip, is fully open to the relatively warm waters of the Firth of Clyde which wash the concave edge of the crescent and lies protected for the most part by the Southern Uplands around the convex eastern side (Fig. 1).

The Ayrshire Plain proper, extending coastwise from the lower reaches of the rivers Garnock and Irvine in the north to the Heads of Ayr and inland for some 12 to 15 miles to the eastward, rarely rises to a height of 500 ft. Sizeable valleys extend further inland, northwards along the course of the R. Garnock, and eastwards along the courses of the Irvine and the Ayr and its tributary the Lugar Water, like huge tentacles penetrating the fastnesses of the Southern Uplands. Crossing the R. Doon the major extension of the Plain to the southwest comprises the wide Maybole basin narrowing to the vale of the Water of Girvan. The flat featureless coastal plain meets the sea, for the most part, in gently sloping beaches and sand dunes. Landwards the plain rises slowly to form a low plateau area, often of undulating character, broken by the several rivers and streams. Most of the rivers, except the Garnock and the Irvine which have wide flood plains, have steep banks in the picturesque glens through which they flow.

At about the 750 ft contour the plain has given place to the steeper escarpments of the hill country beyond. The northwestern edge of the Southern Uplands fills the whole southeastern sector and broken areas exceeding 1000 ft, give place to more extensive areas reaching 2000 ft or more near the county boundary. The high ground to the northeast and north of the plain is less bold; often the slope is gentle as it rises to the moorland plateau with its low hills rising to 1000 ft or so. South of the Heads of Ayr are the Carvick Hills and the Kirkoswald Uplands where the highest points approach 1000 ft.

General Climate

Ayrshire lies mainly within the influence of the North Atlantic storm centres, and especially those "Hebridean" systems which pass close to the Hebrides approaching either from the west, from the southwest or even occasionally from the south. The lush dairy-farming lands owe much to the predominance of the maritime climate common to much of Western Scotland and the Isles. The depressional westerly winds off the warm waters of the western coasts have easy access to the main Ayrshire Plain itself and can also penetrate well inland along the river valleys, bringing mild weather in the winter half year. Occasionally, for periods in late winter and more frequently in spring when high pressure centres are apt to persist near Northern Scotland, the semi-continental conditions characteristic of Eastern and Central Scotland prevail. Their hold however is often precarious and is easily broken by a veer of the wind to beyond south bringing in the "soft" air from the sea.

Winters on the low ground are, on the whole, mild or rather mild with little snow, but frosty periods can be sharp indeed; summers are rather cool and, in the second half, wet. Rainfall is frequent and mainly plentiful for much of the year, but, in the plain at least, is not usually excessive. A harsher winter climate is experienced in the hill country of the east and south.

Winds

The wind regime shows some anomalies for a region located so near to the zone of depressional activity responsible for the well-known storminess off the coasts of West Scotland and North Ireland. The evidence is that Central Ayrshire is a distinctly less windy area than its location might suggest (vide Table 7 - number of days of gales).

/ The

The analysis of the anemograph records from Prestwick Airport for the years 1957-64 illustrated in Fig. 2 must give a fair representation of the wind distribution over much of the Ayrshire Plain and the foothills. It is immediately noticeable that over the year as a whole there is no "prevailing" wind in the usual sense. Whilst it is true that westerlies predominate, the frequency of winds in the sector 230 to 310 degrees is only about 6% in excess of the frequency of the corresponding easterly (050-130 degrees) and southerly (140-220 degrees) sectors, each of which is credited with rather more than 22% of all winds. (See also note at * in paragraph on seasonal distribution below). Over the year however the predominance of winds off the open sea in the quadrant 220-310 degrees is rather more marked if the analysis is restricted to winds exceeding 10 kt (moderate strength and above).

This lack of a "prevailing" wind at near surface levels in the Plain is in sharp contrast to the probable distribution in the free air over the area. The anemograph records for Lowther Hill (2373 ft)† just beyond the Ayrshire county boundary with Lanarkshire, indicate that at some 2000 to 2500 ft, 50% of the winds are distributed nearly equally over the sector 220 to 310 degrees. It is to be expected that the wind pattern should gradually change as one ascends to higher ground from that of the Plain to something approximating that at Lowther Hill.

The low level pattern is to a considerable extent due to the modifications imposed by the extensive encirclement of the Plain from northwest through east to southwest by the hill country and the convenient channels for the airflow provided by the several river valleys.

Interesting seasonal trends are clearly shown in the directional frequency diagrams of Fig. 3. The development of the normally strong depressional activity of northwest Britain in the autumn is reflected in the high frequency of winds in the sector from southeast through south to west, and particularly by the southerly wind with a frequency of 13%. The pattern persists into the winter season but there now develops a considerable frequency of winds from an easterly point at the expense of the westerlies. The easterly regime of the spring period, normally a feature of the climate, especially in March and May is well marked. The summer period shows a complete reversal with a very high frequency of westerlies - nearly 50% of winds in the sector 230-310 degrees.

*It is to be noted that the seasonal diagrams of Fig. 3 relate to the four year period 1961-64 only. This was a period of persistently poor summers and it also includes the long, very cold winter of 1962-63. Thus it seems likely that the frequency of the summer westerlies, as shown, is too high. Normally too, some of the easterlies shown for the winter season could well be shifted to the spring regime.

Gales

The southerly (SE to SW) winds, associated with the approach of the storm centres in winter which bring the gales to the western coasts of Scotland and the adjacent waters, lose much of their force when they descend to the Ayrshire Plain after crossing the high land to the south, and the Plain largely escapes much of the fury of the storms in so far as sustained gales are concerned, but gale gusts occur with some frequency. Strong winds (22-33 kt.) in the sector S-W have an average frequency of about 4.5% in December and the gale frequency (34 kts or more) is small. The most violent winds are those from a westerly point which arrive with and after the passage of the cold fronts and occlusions of the Atlantic depressions, and in these gales, gust speeds of 60 kt. (69 mph) or more are likely to occur. Over the 16-year period of observations, gust speeds at Prestwick Airport have reached 77 kt. (89 mph) and 74 kt. (85 mph) in January 1958 and January 1954 respectively; a gust of 72 kt. (83 mph) occurred with a squall in May 1954. An exceptionally early gale on 16th September 1961 attained a mean hourly speed of 36 kt. (41 mph) during a five and a half hour southerly blow with a maximum gust speed of 61 kt. (70 mph).

/ The

† Climatological Memorandum No. 52 - The Climate of Southwest Ayrshire and North Kirkcudbrightshire.

PRESTWICK AIRPORT AYRSHIRE

Lat 55°31'N Long 04°36'W

Height above M.S.L. 30ft

Annual frequencies of hourly winds
exceeding 3kt. Jan 1957-Dec 1964

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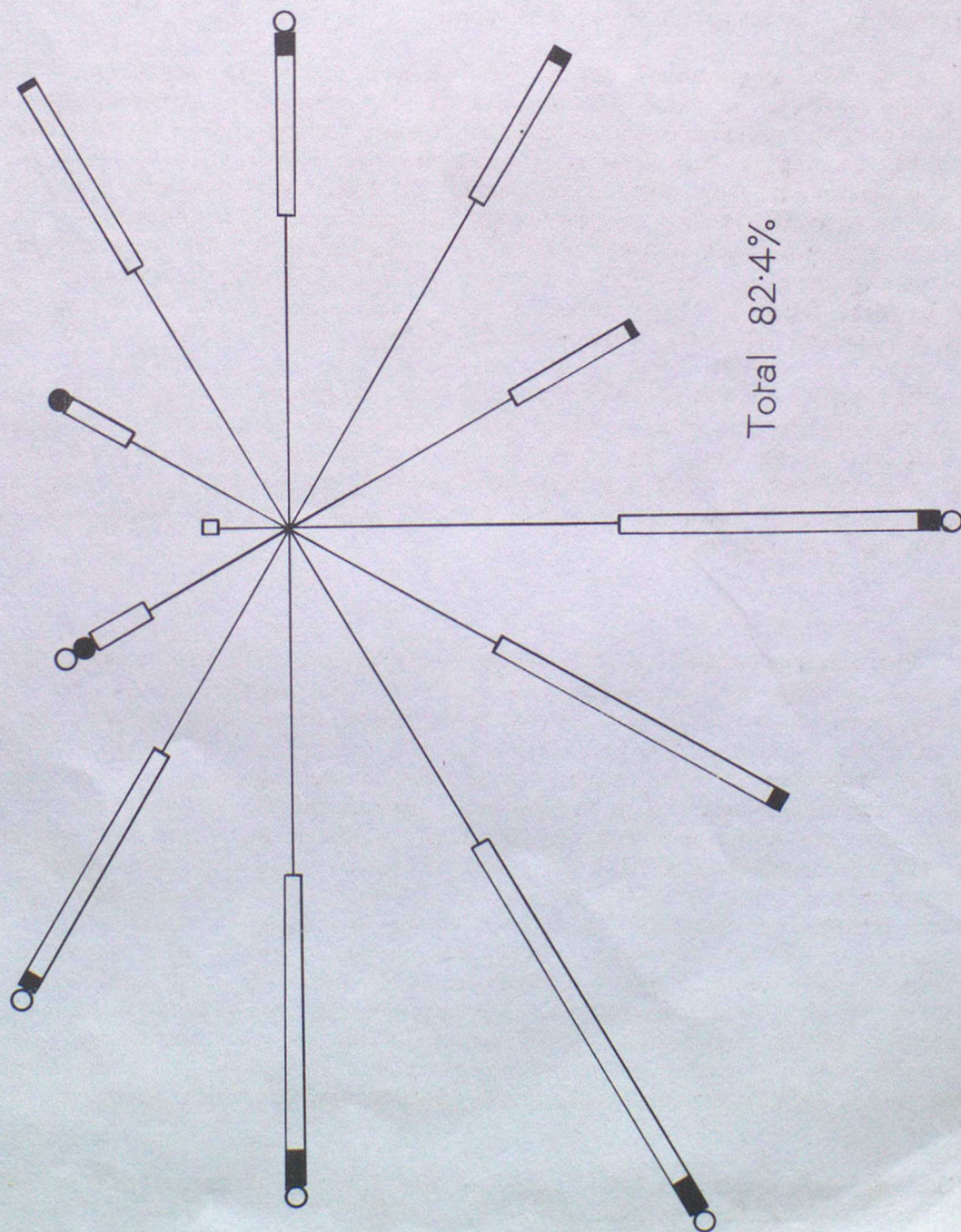
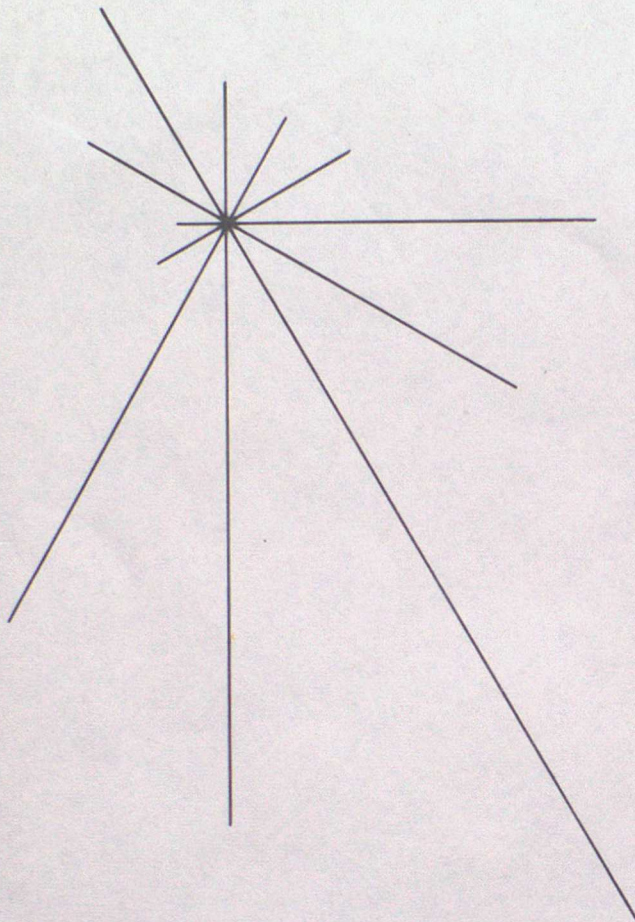


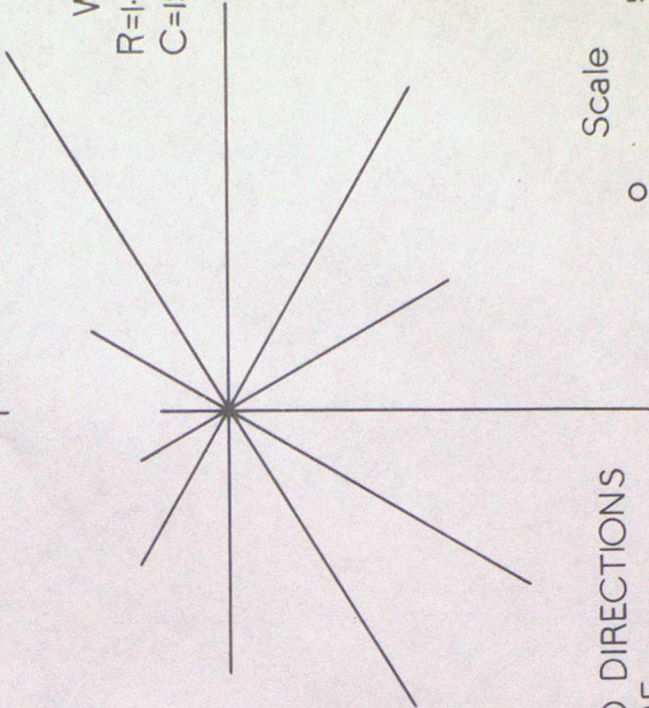
Fig 2

PRESTWICK AIRPORT 1961 - 1964

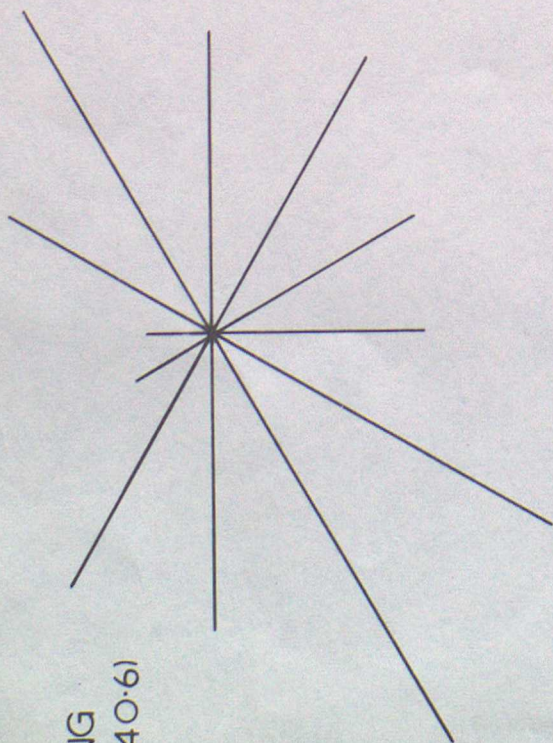
SUMMER
R=1.2 (48.0:39.0)
C=11.6%



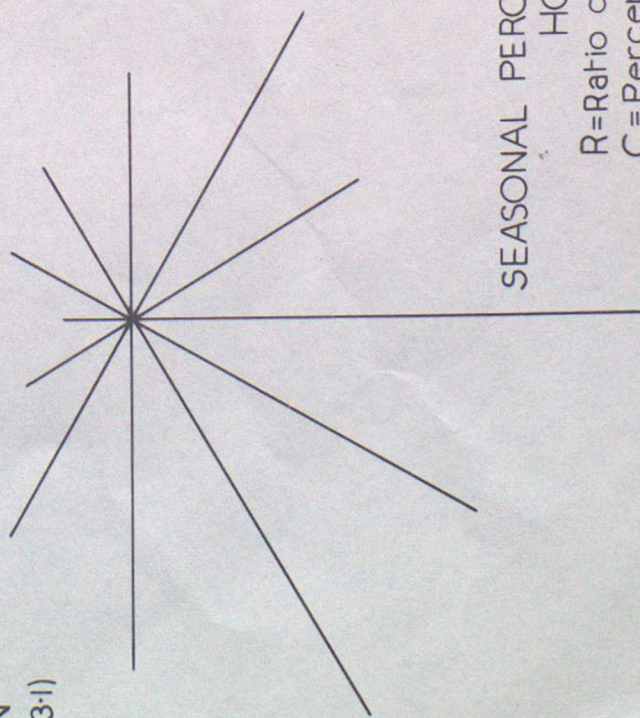
WINTER
R=1.1 (41.7:37.9)
C=15.3%



SPRING
R=1.1 (43.8:40.6)
C=13.0%



AUTUMN
R=1.5 (49.1:33.1)
C=14.7%



SEASONAL PERCENTAGE DISTRIBUTION OF WIND DIRECTIONS
HOURLY WINDS OF 4 kt OR MORE
R=Ratio of winds of speeds 4-10kt to those of 11-21kt
C=Percentage of calms and light air (0-3kt)

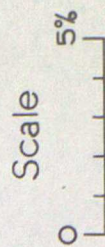


Fig 3

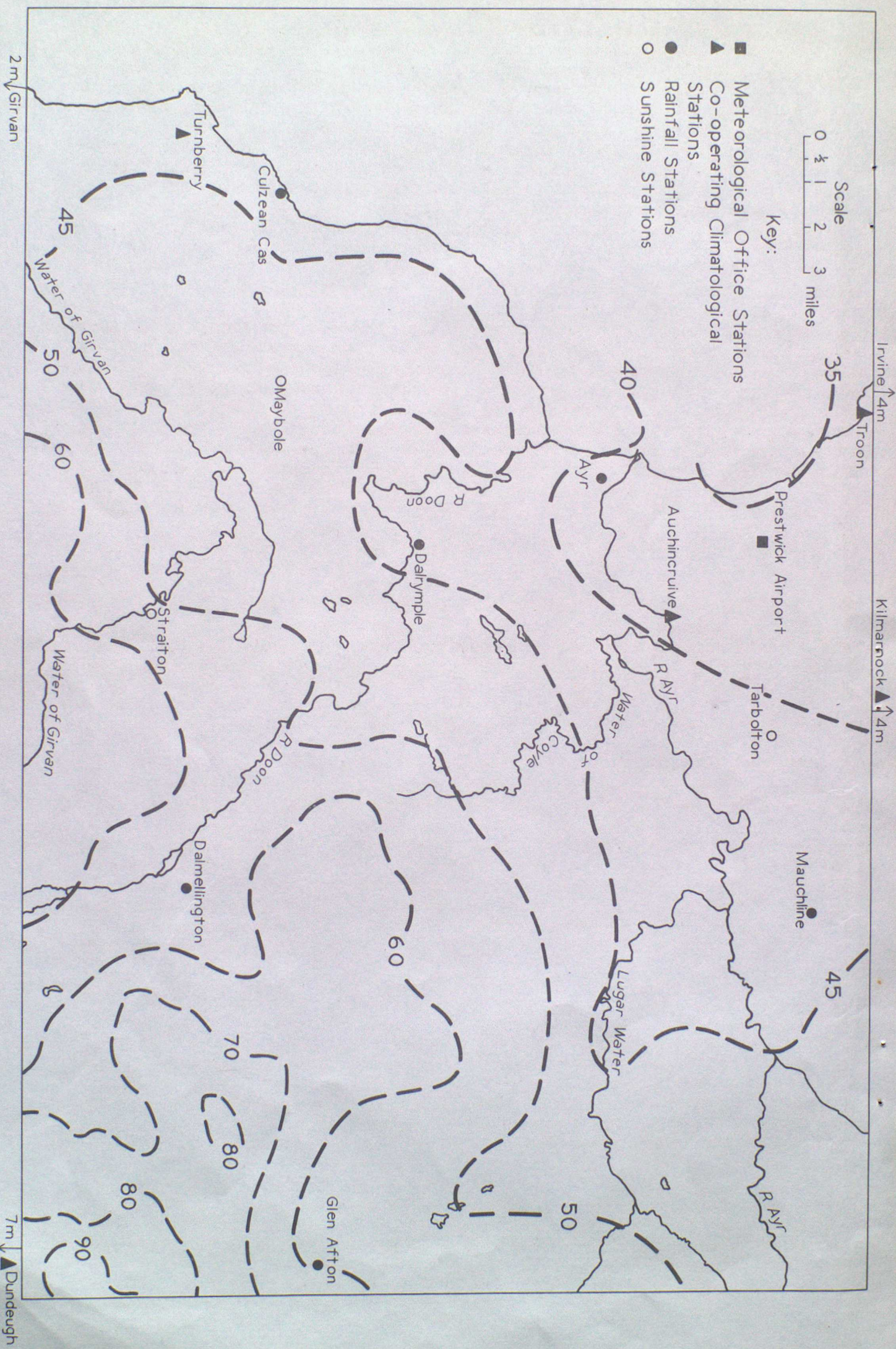


Fig 4 Average Annual Rainfall (inches) for the period 1916-50 over Central Ayrshire

At the coast the average number of wet days per annum (rainfall ≥ 0.04 in.) is around 150 and increases gradually with distance from the sea and with altitude (Table 7). The late autumn and early winter rains give some 15 to 17 wet days per month; there is a sharp drop in February and in the drier months March to June a further decrease reduces the figure to between 9 and 12 days according to location. Dunbar's figures for Kilmarnock⁽¹⁾ indicate that in the Plain two days on average during the wetter half of the year are liable to have from one to one and a half inches of rain. The highest general areal rainfall over the past 60 years or so was perhaps that of 7th August 1949 when 3.46 in. was recorded at Kilbirnie (height 377 ft), this exceptional downpour causing widespread damage and flooding. Other heavy falls in one day include 2.53 in. at Kilmarnock (17 July 1920) and 2.44 in. at Prestwick (16 September 1940).

Snow

The greater part of Ayrshire is probably the most snow-free area of Scotland, with the exception of the Western Isles, the extreme western coastal fringe and possibly Wigtownshire, thanks to almost complete shielding from the usual snow-bearing north to northeasterly winds. The records over the past 25 years or so (Table 7) indicate an annual expectation of some 12 to 14 days with snow or sleet reaching the ground at lower levels (at Prestwick Airport, with its continuous weather watch, the annual average is 22 days). The frequency of snowfall was distinctly less during the mild winter regimes of the late 1920's and early 1930's. The more economically important statistic of "snow lying" at 09h GMT (S.L. vide Preface) averages only 7.5 days per season, this low value reflecting the ease with which the maritime effect may be re-established, and also suggesting a complete absence of snow in some years. Thus in the seven seasons 1956-1963 snow to a depth of 3 in. or more has been recorded on only seven days at Auchincruive with a maximum depth of 7 in. (once). Even at 1000 ft the average number of days of "snow-lying" probably does not exceed 30 days. The apparent tendency in the area is for the snow to come in moderate or substantial amounts with the developments of a changing pressure distribution signalling the end of a cold spell, and the snow melts quickly with the onset of winds from the sea.

Temperature

The temperature regime is controlled to an appreciable extent by the "warm" waters of the North Atlantic drift current and warm water from rather lower latitudes carried via the Irish Sea to the North Channel. All winds from between SW and NW come directly off the sea, flood over the Plain, and can penetrate far eastwards along the main river valleys in the northern half of the county, and reasonably easily into the Maybole basin. The upper Girvan valley and the valley of the Doon are perhaps rather less easily accessible to these off-shore winds. The pattern of the mean isotherms (reduced to sea level) is thus somewhat concave over the plain relative to the coast and convex over the southern section of the county with temperature decreasing southeastwards.

The average range of mean monthly temperature during the year over much of the Plain is some 11°C , from around 3.3°C in January, the coldest month, to 14.4°C or so in July and August. The range is rather less in the coastal strip because of the milder winter nights and rather lower day maxima in summer. At the turn of the year the average day maximum is 6.7°C on the coast and falls only slowly across the Plain to the east. By April afternoons are normally warmer inland than on the coast, and by July and August the average daily maximum of 18.9°C at inland locations is about one degree warmer than the coastal values. The variations in mean temperature through the year are shown in Table 2.

Night temperatures in the colder months are subject to wider variations than day maxima as indicated by a January mean daily minimum of 1.7°C on the coast when the value at Kilmarnock is near freezing point. At heights above 500 ft the mean daily minimum temperature is probably below freezing for some two to three months.

/ Table 2

The sea breeze is liable to invade the coastal strip in quiet warm weather from March to October but is frequently masked during the summer when any development of the sea breeze proper tends only to strengthen the normal gradient wind.

Rainfall

The Ayrshire Plain is not only the driest area of Western Scotland, but one of the driest areas of its size adjoining the western coasts of the United Kingdom, lying very effectively in the "rain shadow" of the Southern Uplands. The map of average rainfall (Fig. 4) illustrates how the uplands extract a high percentage of the moisture from the major rain-bearing winds from between SE and SW. Northwesterly winds are robbed of a proportion of their moisture by the Renfrew Heights, whilst the high ground to the eastward almost completely neutralises any threat of precipitation from easterly regimes. The heavier rains often come with the westerlies behind cold fronts, which frequently produce extensive heavy rainstorms, euphemistically described as showers!

Table 1. Average Monthly and Annual Rainfall (Inches)
(Period 1916-1950)

<u>Station</u>	<u>Ht.</u> <u>ft.</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Year</u>
Ayr (Cemetery)	40	3.79	2.44	2.17	1.99	2.31	2.38	3.04	3.15	3.42	4.09	3.48	3.64	35.90
Culzean Castle	138	4.68	2.90	2.77	2.64	2.73	2.77	3.29	3.64	4.07	4.94	4.33	4.59	43.35
Auchincruive	147	4.18	2.68	2.41	2.17	2.52	2.60	3.35	3.47	3.75	4.50	3.83	3.98	39.44
Dalrymple (W. Wks.)	287	4.69	2.95	2.64	2.43	2.69	2.82	3.47	3.73	4.12	4.95	4.33	4.51	43.33
Mauchline (Hillhead)	564	4.82	3.17	2.77	2.50	2.63	2.86	3.53	3.88	4.29	5.18	4.46	4.55	44.64
Dalmellington (Mosssdale Filters)	752	6.13	3.92	3.24	3.03	2.93	3.14	3.87	4.13	4.87	5.97	5.44	5.65	52.32
Glen Afton (Ayrshire Hosp.)	833	6.92	4.39	3.69	3.43	3.38	3.13	4.03	4.28	5.06	6.47	6.06	6.61	57.45

On the latest assessments of average rainfall (Table 1), practically the whole of the Plain receives less than 45 in. annually; there is less than 40 in. over the area west of the line Irvine-Tarbolton-Ayr, decreasing to 35 in. in the coastal strip from Prestwick to Troon. The Maybole basin and the Girvan valley are also relatively dry. The increase in average rainfall with height is relatively slow toward the Eaglesham heights, but over the southeastern half of the region it is much more rapid. At an altitude of 500 ft, there is about 50 in. and then a steady increase to 80 in. to 90 in. annually at the highest levels of round 2000 ft at Windy Standard (2287 ft) and, beyond Straiton, to 100 in. at Shalloch an Minnoch (2520 ft). Relatively dry tongues however extend inland along the upper reaches of the river valleys.

The highest average monthly rainfall occurs in October with the onset of the stormy season, but this is followed by some easement before a secondary maximum in January. A drop of 1.5 to 2.0 in. to the February average is the prelude to the moderately dry period of spring and early summer, the driest month being April, when Ayr has less than 2 in. Thereafter, to the October maximum, the monthly averages increase successively. Long-term averages of 3.5 in. to 4 in. in July and particularly in August indicate a sufficiency of rain at this season in most years for grass for the dairy farmer. To the horticulturist the implied tendency to rather wet summers is at least a nuisance, to the agriculturist it is a plague with the continuing threat to the harvesting of the later maturing crops and to the tourist it can be a disappointment. The possibility of a lengthy dry spell in summer is barely worth considering whereas the low averages for the earlier months suggest a recurring risk of lack of moisture detrimental to growing crops. For some reason the Tourist Agencies fail completely to capitalise the late spring and early summer period often of mainly dry weather, very long daylight, powerful sunshine and excellent visibility.

/ At

Table 2 Averages of temperature, 1931-60, and extremes

	KILMARNOCK 115 ft †								AUCHINCRAIVE 147 ft							
	Average				Extremes Ø				Average				Extremes Ø			
	Max	Min	Mean	Max	Year	Min	Year		Max	Min	Mean	Max	Year	Min	Year	
	°C	°C	°C	°F		°F			°C	°C	°C	°F		°F		
Jan	6.0	0.3	3.2	57	1957	2	1940		6.3	0.6	3.5	58	1950	5	1940	
Feb	6.9	0.7	3.8	57	'58	10	'47		6.9	0.9	3.9	56	'58	12	'47	
Mar	9.4	2.1	5.7	71	'28	6	'47		9.3	2.3	5.8	68	'39	10	'47	
Apr	12.0	3.7	7.8	73	'53				11.7	3.7	7.7	70	'46	21	'36	
May	15.8	5.9	10.8	84	'48	25	'15		15.2	5.9	10.5	79	'39	24	'35	
Jun	18.2	9.0	13.6	87	'40	30	'28		17.7	8.8	13.3	85	'41	30	'36	
Jul	18.9	10.9	14.9	90	'48	36	'35		18.5	10.9	14.7	87	'36	37	'35	
Aug	19.1	10.5	14.8	87	'48	33	'15		18.5	10.6	14.5	82	'48	35	'55	
Sep	16.7	8.7	12.7	79	'47				16.4	9.0	12.7	79	'47		'44	
Oct	12.9	6.0	9.5	76	'34	24	'15		12.9	6.4	9.6	72	'43	27	'64	
Nov	9.4	3.0	6.2	62	'59	19	'26		9.5	3.2	6.4	62	'34	23	'43	
Dec	7.2	1.6	4.4	58	'43	13	'31		7.4	1.8	4.6	57	'59	20	'39	
					'19								'46		'37	
					'51	8	'50						'52		'52	
					'54								'38		'38	
					'57								'49		'49	
	12.7	5.2	9.0	90	'48	2	'40		12.5	5.3	8.9	87	'48	5	'40	

† 130 ft Prior to 1950

	TURNBERRY 63 ft *								DUNDEUGH* 390 ft		
	Average				Extremes Ø				Average		
	Max	Min	Mean	Max	Year	Min	Year		Max	Min	Mean
	°C	°C	°C	°F		°F			°C	°C	°C
Jan	6.7	1.8	4.3	56	1932	12	1947		5.3	-0.9	2.1
Feb	7.1	1.8	4.4	58	'57	15	'36		6.1	-0.8	2.7
Mar	9.3	2.9	6.1	69	'18	19	'21		8.5	-0.4	4.5
Apr	11.4	4.5	8.0	71	'45	22	'60		11.1	1.8	6.4
May	14.7	6.6	10.6	80	'21	29	'17		14.8	3.9	9.3
Jun	16.7	9.6	13.1	84	'19	34	'51		17.5	7.3	12.4
Jul	17.8	11.5	14.7	86	'36	40	'53		18.1	9.5	13.8
Aug	17.9	11.4	14.7	82	'48	36	'17		17.8	8.9	13.3
Sep	16.1	9.8	12.9	77	'53	33	'44		15.7	7.6	11.6
Oct	12.9	7.6	10.2	74	'55	25	'20		12.2	4.6	8.4
Nov	9.8	4.7	7.3	61	'34	20	'50		8.9	2.0	5.5
Dec	7.9	3.3	5.6	58	'59	20	'52		6.8	0.4	3.6
					'27		'19				
					'43						
					'32		'25				
					'55						
	12.3	6.3	9.3	86	'48	12	'47		11.9	3.7	7.8
					'53						

Ø see Preface for explanation of use of °F

Extreme values for periods:-

Kilmarnock 1914-64
Auchincruive 1932-64
Turnberry 1914-61
(some breaks in record)

* 30 ft Prior to 1945

* Provisional Derived Computation

Extreme Temperatures

Very mild spells tend to occur in winter during which temperatures rise well above 50°F (10°C). In January individual readings of 59°F have been recorded at Prestwick Airport in recent years and 58°F at Auchincruive. This latter figure has been more widely recorded in December. An occasional very warm day in early spring will see the mercury hovering near 70°F (21°C) and in April 1921 73°F was registered at Kilmarnock. The warmest day has an afternoon maximum of 80°F (26.7°C) or more on the average in about two years in five (at Auchincruive in 13 years out of 33 ending 1964 - although 80°F has not been reached there during the past 7 years). Over a much longer period (51 yrs) Kilmarnock has recorded 84°F in May and an absolute maximum of 90°F in July 1948.

In sharp contrast to the mild winter spells referred to above are the frosty spells which are equally apt to occur chiefly in the late winter and early spring. With the development of high pressure in northern latitudes the harsh "semi-continental" conditions, common to much of the remainder of Scotland, invade Ayrshire. The northeasterly winds, robbed by the shielding hills of the cloud and precipitation which bedevil Eastern and Central Scotland, bring crisp bright weather to Ayrshire - and some 12 to 15 degrees of frost Fahrenheit (8 to 9.5 degrees below zero Centigrade). The absolute minimum temperature at the lower levels during such visitations is probably that of 2°F recorded at Kilmarnock in January 1940. In spite of the much greater frequency of night frosts in the higher level country it is probable that the extreme temperatures there are not as low as those in the Plain, except in the bottoms of the glens and valleys and other obvious "frost hollows".

The Kilmarnock records give a good indication of the incidence and duration of the season of night air-frosts. Here the average date of the first autumn air-frost is 12th October, and the season is normally over by 7th May. Night frost has however occurred as early as 9th September and as late as 27th May. The number of "freezing days" - defined as those on which the arithmetic mean value of the day-maximum and the night-minimum is less than 0.3°C - offers some indication of the severity or otherwise of the winter climate. An average number of 12.5 such days per season at Auchincruive over the 32 seasons 1932-64, shows that "freezing days" in the plain are distinctly less frequent than in similar areas on the eastern side of Scotland (e.g. the East Lothian plain). These freezing days are nearly twice as frequent in January as in either December or February, they are very occasional in March and rare in November. The variation from year to year can be considerable; there were 37 in the notorious winter period of January to March 1947, with a sequence of 23 consecutive days in late February and early March.

Plant Growth

Growing Season

The most generally accepted threshold temperature for initiating growth is 5.6°C (42°F) and in Ayrshire mean daily temperatures normally attain this value early in March near the coast and maintain it until mid-December. A few miles inland (e.g. at Auchincruive) the season opens a fortnight later and is effective until the last week in November. The season shortens progressively by nearly two months with increasing distance from the sea and with altitude, and at the practical limit for useful cropping is effective from mid-April to early-November. Its average length ranges from 287 days at Turnberry, through 260 days at Auchincruive to only 216 days in the colder elevated districts.

Growth rates are indicated by the "Accumulated Temperatures" above the 5.6°C (42°F) datum and values based on 29 years of Auchincruive data and calculated by a method due to Shellard⁽²⁾ are given below as being of fairly general application in the Ayrshire Plain. They are expressed in "degree-day" units. The sharp increase during May and June contrasted with the much slower decline in autumn will be noted.

Average value of "Accumulated Temperature" - Auchincruive

	<u>J.</u>	<u>F.</u>	<u>M.</u>	<u>A.</u>	<u>M.</u>	<u>Ju.</u>	<u>Jul.</u>	<u>A.</u>	<u>S.</u>	<u>O.</u>	<u>N.</u>	<u>D.</u>	<u>Year</u>
No. of degree-days	62	51	107	137	267	417	511	499	387	229	95	65	2827

/ Earth

Earth and Soil Temperatures

Root development and health being intimately associated with the temperature of their environment, it is appropriate to refer to the available soil temperature records. Different soils react differently to rain and sunshine and it is unwise to expect too close a correspondence between temperature regimes at different places. However the Auchincruive observations provide a good indication of temperatures through a medium loam. The Meteorological Office estimates of the long period "normals" (1921-50) based on the average monthly values of temperatures at 0900 GMT at a depth of one foot under a short grass surface (conveniently known as "earth temperatures") are given in Table 3. Periods of sustained warmth or cold at this level are indicated by the inclusion of the highest and lowest mean values for each month.

Mean monthly temperatures in the soil at depths of 4 in. and 8 in. below a bare soil surface at 0900h GMT over the period 1957-62 are also given in the table and the extreme individual daily values are indicated as well as highest and lowest monthly means. The temperature at both depths is subject to large diurnal variations which make these once-daily readings difficult to interpret, but the 09h reading at 4 in. in the summer half year is a reasonable guide to the mean for the day at that depth. The soil temperature at 4 in. below a bare soil surface responds fairly quickly to sunshine and rainfall, and a soil which is horticulturally, termed a "light" soil doubtless owes part of its value to the relatively high daytime temperature attained in the surface layers in response to sunshine, but the data presented give little indication of this daytime response.

However, the complete data clearly indicate a definite tendency for the considerable penetration of frost into the soil in the area during periods of hard winter weather and emphasise the comparative absence of protective snow covering during cold spells as compared with other districts in Scotland. The most severe wintry spells of the present century provide some interesting statistics on this aspect. For all practical purposes the ground at Auchincruive was frozen to a depth of at least one foot for 26 days from 24th February 1947. Although the monthly mean temperatures at one foot in January and February 1963 were lower than they were in 1947, the actual daily values never quite fell to freezing point. In the 1963 spell, the soil was intermittently frozen at the 8 in. depth over a period of 38 days, which included unbroken periods of 13 and 15 days. Frost was probably continuous for 58 days (9th January to 5th March) at 4 inches. There are no soil temperatures for the 1947 cold spell.

Evapo-transpiration

It is interesting to consider the loss of soil moisture by evaporation and transpiration by growing crops. A useful method, devised by Penman, uses mean windspeed, temperature and vapour pressure data to compute the "Potential Transpiration" (P.T.) from a grass-covered surface for any district. His formula finds use in problems concerning plant growth in relation to soil moisture and notably, in conjunction with rainfall data, in problems of irrigation need and procedures. The calculated values of the potential losses in the growing season and over the year published by the Ministry of Agriculture and Fisheries⁽³⁾ show the loss for Ayrshire to be the highest in Scotland, and these are set out below:- (Tab. 4)

Table 4 Average Values of Potential Evapotranspiration (P.T.) in inches

	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Summer</u>	<u>Winter</u>	<u>Year</u>
P.T.	1.85	3.25	3.60	3.30	2.60	1.50	16.10	2.85	18.95

The sharp rise in May and the June maximum reflect the high probability of fine weather with long hours of sunshine at this season. When compared with average rainfall data the figures show that whilst a marked soil moisture deficit may build up early in the season, it is only in exceptional years that a deficit is likely later on in the growing season.

/ Table 3

Table 3 Earth and Soil Temperatures at 09h GMT in °C

AUCHINCRAIVE

	Earth at 1 ft				Soil at 4 in.				Soil at 8 in.			
	Est. Normal 1921-50	Monthly Mean		Mean 1957-64	Monthly Mean		Mean 1957-64	Daily Values Highest Lowest	Monthly Mean		Mean 1957-64	Daily Values Highest Lowest
		Highest	Lowest		Highest	Lowest			Highest	Lowest		
Jan	4.3	5.8	1.4	1.8	3.6	-0.9	1.8	7.6 -3.3	4.2	0.6	3.1	7.1 -0.2
Feb	4.1	5.4	0.7	2.5	4.7	-0.9	2.5	7.8 -2.3	5.2	0.3	3.4	7.1 0.0
Mar	5.0	7.2	1.2	4.2	7.1	1.8	4.2	9.4 -1.6	7.3	2.8	4.7	8.8 0.0
Apr	7.2	8.7	5.4	7.2	8.2	6.1	7.2	11.7 2.2	8.6	6.2	7.3	10.2 2.8
May	9.9	11.9	8.4	11.0	12.6	9.7	11.0	16.7 7.1	12.0	9.1	10.6	14.8 7.3
Jun	13.1	14.4	11.8	14.2	15.7	13.2	14.2	19.4 10.6	14.8	12.4	13.2	17.7 9.9
Jul	14.7	16.0	13.3	14.9	15.8	13.8	14.9	20.0 11.7	15.2	13.4	14.2	17.6 12.1
Aug	14.8	16.9	13.1	14.1	15.6	13.1	14.1	17.2 11.7	15.3	13.1	14.1	16.9 12.1
Sep	12.9	14.3	12.2	12.2	13.6	10.7	12.2	16.1 6.4	13.9	11.7	12.4	15.6 9.0
Oct	10.0	11.8	9.1	9.3	10.3	9.9	9.3	12.9 4.3	11.1	9.2	10.1	13.1 6.3
Nov	7.0	8.7	5.6	5.8	6.4	5.4	5.8	10.5 0.8	7.4	6.4	6.8	10.1 3.3
Dec	5.5	7.3	3.2	3.1	4.5	2.2	3.1	8.4 -1.6	5.3	3.2	4.3	8.1 -0.1
Year	9.0	16.9	0.7	8.4	15.8	-0.9	8.4	20.0 -3.3	15.3	0.3	8.7	17.7 -0.2

Table 7

Climatological Summaries - Average Number of Days per Month of Occurrence
of Specified Phenomena - Period as Indicated
 (for explanation of headings, see Preface)

KILMARNOCK 1914-64 (45-51 years)									
	W	S	SL	H	T	F	AF*	GF	G
JAN	15.7	3.2	3.0	1.2	0.2	1.9	14.2	17.4	1.4
FEB	12.6	2.6	1.7	1.0	0+	1.6	12.6	15.5	1.2
MAR	11.6	1.9	0.9	0.6	0.2	1.0	5.8	13.5	0.5
APR	11.3	0.8	0.2	0.8	0.3	0+	3.0	10.5	0.4
MAY	11.3	0.1	0	0.3	0.6	0+	0.4	4.9	0.2
JUN	11.2	0	0	0.1	0.8	0+	0	0.5	0.3
JUL	13.5	0	0	0+	1.3	0+	0	0+	0+
AUG	14.4	0	0	0+	0.9	0.1	0	0+	0.1
SEP	14.3	0	0	0+	0.6	0.2	0	1.8	0.3
OCT	15.4	0.1	0	0.6	0.3	0.8	0.9	5.7	0.7
NOV	15.1	0.7	0.1	0.7	0.2	2.5	5.3	12.4	0.8
DEC	16.2	1.5	1.4	1.0	0.4	2.4	11.2	14.9	1.0
YEAR	163	10.9	7.3	6.3	5.8	10.5	53.4	97.1	6.9

PRESTWICK AIRPORT 1942-64 (22-23 years)									
	W	S	SL	H	T	F	AF*	GF	G
JAN	13.2	6.4	1.9	3.2	0.2	0.3	14.7	14.5	1.2
FEB	11.1	6.5	1.7	2.1	0.2	0.4	12.7	13.3	1.1
MAR	9.5	3.3	1.0	1.3	0+	0.3	6.5	10.7	0.5
APR	10.7	0.8	0	1.4	0.1	0	3.4	6.6	0.5
MAY	10.5	0.2	0	0.6	1.2	0	0.2	2.7	0.1
JUN	11.7	0	0	0.2	0.9	0+	0	0.2	0.1
JUL	12.2	0	0	0	1.2	0+	0	0	0
AUG	12.6	0	0	0.1	1.2	0+	0	0.1	0.2
SEP	14.4	0	0	0.3	1.0	0+	0.2	0.7	0.4
OCT	13.3	0	0	1.0	0.6	0.1	0.3	2.9	0.7
NOV	14.1	1.3	0+	1.7	0.2	0.2	5.7	8.6	0.8
DEC	15.0	3.7	0.7	3.0	0.5	0.3	10.3	11.4	1.2
YEAR	148	22.2	5.3	14.9	7.3	1.6	54.0	71.7	6.8

* Period 1956-64

0+ denotes < .05

/ Table 7 (cont.)

Table 6 Summary of Observations of Relative Humidity at Prestwick Airport - 1957-61
(Frequency of occurrence within limits indicated)

		Relative Humidity Ranges - per cent								
		<u>100-95</u>	<u>100-90</u>	<u>89-80</u>	<u>79-70</u>	<u>69-60</u>	<u>59-50</u>	<u>49-40</u>	<u>39-30</u>	<u>29-20</u>
<u>Growing Season</u> April - September	Early Forenoon	4.5	25.8	38.8	23.3	9.7	2.0	0.4	0+	
	Middle of Day	1.0	7.0	18.8	25.7	26.6	15.2	4.9	1.5	0.3
	Late Afternoon	1.4	8.6	22.6	31.1	23.8	9.9	3.2	0.7	0.1
<u>Transition Seasons</u> March and October	Early Forenoon	5.1	27.4	45.2	21.1	4.7	1.5	0	0.1	
	Middle of Day	0.9	9.5	25.9	28.2	18.1	12.4	5.1	0.8	
	Late Afternoon	2.7	14.8	34.4	26.6	18.3	4.6	1.3	0	
<u>Dormant Season</u> November - February	Early Forenoon	7.9	35.9	47.5	14.1	2.1	0.4			
	Middle of Day	3.5	16.7	39.8	28.4	12.1	2.6	0.3	0.1	
	Late Afternoon	4.6	25.5	47.8	21.1	4.9	0.6	0.1		

Table 7 (cont.)

Climatological Summaries - Average Number of Days per Month
of Occurrence of Specified Phenomena - Period as Indicated

(for explanation of headings, see Preface)

AUCHINCRAIVE 1932-64 (33 years)									
	W	S	SL	H	T	F	AF*	GF	G
JAN	13.4	3.7	2.7	1.7	0.1	0.6	14.0	19.2	1.4
FEB	11.0	4.1	1.5	1.3	0.2	0.5	13.1	17.0	0.7
MAR	10.4	2.3	0.8	1.0	0+	0.2	6.9	15.5	0.3
APR	10.5	0.9	0	1.0	0.3	0	3.9	11.9	0.5
MAY	9.8	0.1	0	0.6	0.8	0+	0.7	7.2	0.1
JUN	10.6	0	0	0.2	0.9	0	0	1.7	0+
JUL	13.5	0	0	0+	1.5	0	0	0.2	0+
AUG	13.3	0	0	0+	0.9	0+	0	0.4	0.1
SEP	14.6	0	0	0.2	0.7	0	0.2	2.1	0.4
OCT	14.9	0.1	0	1.4	0.6	0.2	0.6	6.2	0.5
NOV	13.9	0.4	0+	1.5	0.2	0.3	5.4	13.4	0.9
DEC	15.3	2.4	1.4	1.9	0.3	0.5	11.4	16.7	1.2
YEAR	154	14.0	6.4	10.8	6.5	2.3	56.2	111.5	6.1

* Period 1956-64

0+ denotes $< .05$

Sunshine

In an average year the Ayrshire Plain receives rather more than 1300 hours of bright sunshine, and nearer 1400 hours on the coast. May and June, in that order are the best months. The tendency for spells of bright weather in the first six months of the year is reflected by an excess of 12% in the average sunshine total for these months as compared with the average total for the six months July to December.

Table 5 Averages of Sunshine (hours) - Period 1931-60

	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Year</u>
Troon (12 ft)	45	69	110	153	209	195	167	153	118	81	50	31	1381
Kilmarnock (115 ft)	43	67	102	146	203	186	157	144	115	79	47	30	1319
Auchincruive (147 ft)	45	68	105	146	197	181	150	144	113	79	51	34	1314

Hail

Hail is fairly common, occurring with the showery weather off the sea in association with the cold fronts of Atlantic depressions. December to February are the most likely months but with a significant number in March and April combining to account for most of the average 11 to 16 days per annum on which hailstones are noted in the Plain. Only very occasionally is hail experienced from June to September.

Thunder

It will be noted from Table 7 that thunder can occur in all months - but only very occasionally in most months. The greatest frequency is attained in July and August when a fair proportion of the storms are degenerating high-level storms brought up from England. Also at this season thunderstorm clouds may be seen building up over the high ground, but a fair proportion of these storms drift away eastwards and leave the low-lying Plain unaffected. As in most other parts of Scotland summer thunderstorms are rarely accompanied by hail.

Humidity

Table 6 shows the variations in relative humidity during the day in the growing, transition and dormant seasons respectively, and is based on an analysis of hourly readings at Prestwick Airport over a five-year period. They are a guide to "drying out" periods in the Plain, not far from the sea. The figures probably underestimate the possibilities, especially in the growing season, for localities further inland than the airport, and are probably underestimates for moderate latitudes also. The low frequencies of near saturation conditions (95-100%) are interesting in view of the fact that Prestwick Airport has the reputation of being the most fog-free airfield in the British Isles.

The Plain area is not very subject to fog. There is relatively little industrial pollution generated locally and the area is cut off from invasions of external pollution by the high ground.

References

- (1) W. Dunbar, "Thirty years' rainfall at the West of Scotland, College of Agriculture, Kilmarnock". British Rainfall 1931.
- (2) H.C. Shellard, "Averages of Accumulated Temperature and standard deviation of monthly mean temperature over Britain 1921-50". Met. Off. Prof. Notes No. 125
- (3) "Irrigation". Bulletin No. 138 (1962)., M.A.A.F., H.M.S.O.

~~/~~Table 6