DECIMAL INDEX
551.582(414)

METEOROLOGICAL OFFICE

CLIMATOLOGICAL SERVICES (Met O 3)

CLIMATOLOGICAL MEMORANDUM No.49

by

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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	=	" " " 0.04 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)
		) - for criteria see above
GF	=	" " " ground frost)
G	=	" " " gale

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

= Mateorological 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 Beauly 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

THE CLIMATE OF EAST LOTHIAN AND NORTH BERWICKSHIRE

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

Introduction

The area under review is shown in fig. 1 and includes the whole of East Lothian westward to Prestonpans, the northeastern spur of Berwickshire north of Berwick-on-Tweed and the first few miles southward from the crest of the Lammermuir Hills - the extreme northern strip of the main area of Berwickshire. The most northerly section of the area - very approximately triangular in shape with North Berwick at the apex - is the coastal plain mainly at an altitude of less than 250 ft and meeting the sea in a series of sandy beaches. The Lothian Plain lies immediately to southward, with the terrain rising slowly toward the 500 ft level in the Lothian Platform. This section of foothills extends eastward to the coast in the vicinity of St. Abb's Head and then recurves southwestwards. Immediately east of the line of recurvature are the Border Lowlands where the level again falls gently to less than 250 ft to the Eye valley and the coast at Eyemouth. In the extreme southeast corner of the area, Lamberton Moor rises rather steeply from the coast. Finally the Lammermuir Hills - so called because of their smooth curvaceous outlines unbroken by protruding outcrops of harsh rock - occupy the central and southwestern sections of the area. This hill country is oriented WSW to ENE and rises somewhat above 1700 ft in Lammer Law and Meikle Says Law, with the north face rising rather sharply with some steep slopes in contrast to the relatively moderate general down slope into Berwickshire on the south side. Nevertheless the detailed configuration of the southern slopes is much more rugged and erratic than that of the northern face.

North of the Lammermuirs the only drainage system is that of the River Tyne flowing through Haddington to the sea north of Dunbar. A multiplicity of burns and streams feed the main rivers of the Dye, Eye, Whiteadder and Blackadder, but all for the most part flow southeastwards to join the River Tweed, except the Eye which turns northeast to the sea in the final few miles.

General Climate

The East Lothian Climate is very broadly similar to that of other agricultural areas of East Scotland but with the wide expanse of the cold water of the Forth estuary to the north, the hill country to the south and southwest and the Lowland gap to the west, significant differences in detail are inevitable.

Much of the area is definitely dry over the year as a whole but the late summer can be disappointingly wet. The promise of many a warm summer day fails to mature fully as the sea breeze slowly penetrates unhindered across the Lowlands from early afternoon onwards to give cool evenings. Spring is normally a rather harsh and over-dry season but the autumn is frequently mild and prolonged. The winters are usually not without some sharp, even severe, spells of weather - especially in more recent years - but are often graced with a fair proportion of sunny, if crisp, days expecially following the occasional, but mainly light, snowfall.

Winds

The alignment of the Lammermuir range conforms to the general line of the Forth-Clyde valley and in spite of the northward protrusion of the similarly aligned Pentland Hills immediately to the westward, there is no major barrier between the East Lothian plain and the west coast of Scotland. The configuration is important in view of the frequency with which the isobaric control is associated with the advance and passage of North Atlantic depressions, particularly those whose centre approach the Hebrides. The S to SW winds, whcih develop with the advance of the depressions have to negotiate the formidable barrier of the Cheviots/Southern Uplands complex

/where

where the flow is distorted and momentum lost. With the subsequent veer toward west, or even beyond, the Clyde-Forth valley provides a "funnel" through which the winds have direct access to East Lothian. Consequently the frequency of occurrence of winds in the SW to W sector through the year as a whole is distinctly higher than 40% over East Lothian, and a more detailed analysis shows the WSW winds to be predominant. These westerlies, usually arriving with the cold front or occlusion are, for the most part, unstable and turbulent. Their speed tends to be increased in the "funnel" but there is a compensatory reducing effect as they "fan out" over the rapidly broadening estuary of the Forth. Inland in East Lothian the latter effect appears the more effective but there the reduction in speed is undoubtedly helped by the shelter belts which have been developed over the years. Over the water off the north coast the airflow has largely re-adjusted itself to the geostrophic control so that there is a narrow but marked transition zone in which these winds, blowing parallel to the coast, decrease appreciably in speed from the coast itself to within a quite short distance inland.

The salient features of the wind distribution are shown in the velocity wind roses of Figs. 2 and 3. The annual and seasonal roses for the Fidra Lighthouse (off North Berwick), an exposure presumably free from any marked topographical effects, and based on four observations daily and eight compass points, give a good indication of the free airflow (Fig. 2). The seasonal roses show clearly the marked increase of the northeasterlies in spring and summer and to some extent the increase of the rain bearing southeasterlies of autumn and early winter. In Fig. 3 the annual rose for the East Fortune airfield - an open exposure in the Lothian plain - based on hourly observations from 16 points reveals, by the marked increase of the W winds at the expense of those from SW, the topographical (funnel) effect which ensures that winds from WSW are more frequent over East Lothian than those directly either from SW or W.

Over the northward extension of Berwickshire in the extreme east of the area under review the regime is somewhat changed. The district is appreciably shielded from the westerlies by the Lammermuirs and the overall topography here dictates southeasterly winds with southerly gradients in the free air and in the neighbourhood of St. Abb's Head, for example, the frequency of occurrence of winds from S to SE is as high as 25%. The set of the trees in this coastal zone testify to the frequency and strength of the winds from this sector. To the north along this coastal zone a further backing of the wind is noticeable and in the Barns Ness/Dunbar area the southeasterly wind is nearly twice as frequent as the southerly. It would seem that the southern slopes of the Lammermuirs also experience this rather high frequency of S to SE winds particularly in view of the favourable orientation of the re-entrant valleys.

The seasonal pattern is also relevant to the climate of the area, and here winds from a northeasterly point are of considerable import. These winds have a very marked tendency to recur in spells during spring and early summer in association with the development of high pressure systems in northern latitudes - a development which has become more frequent or over persistent since about the middle 1940's. (It is a fact of observation that around the Forth Eastury winds are requently excessively backed to the northeast on a prevailing E to SE isobaric gradient). Northerly winds are not very frequent, requiring as they do a rather unusual pressure distribution with low pressure over the North Sea, or even over the Baltic. When they occur however they are very apt to bring strong to gale winds, to which much of East Lothian is fully exposed. These occasional storms undoubtedly account for the fact that the north coastal zone is composed fundamentally of blown sand. Quite recently measures have been adopted to protect parts of the coast from further incursions of sand notably round Gullane.

Gales

Major gales, as might be expected, are apt to blow from between WSW and WNW, but with some qualification in respect of the extreme southeast section (from Coldingham and the Eye Valley and Lamberton Moor) which is exposed to gales from the east and southeast. An easterly gale on this localised stretch of coast, although comparatively rare, is liable to cause considerable damage. The high frequency of gales at St. Abb's Head (Tab. 11) is mainly associated with southeast winds and is doubtless partly topographical.

Autumn to early winter is the principal period for gales, but "out of season" summer gales are not uncommon. The gales are somewhat less severe and slightly fewer in number as compared with districts immediately to the westward (e.g. Edinburgh). In the absence of anemometer records from East Lothian some guide to the possibilities there of particularly severe gales may be obtained from Shellard's[1] analysis of extreme wind speeds over neighbouring areas (Shellard "reduces" the actual recorded values to the standard height of 33 ft above ground). At Leuchars, Fife, in a location not greatly dissimilar to the East Lothian plain, a gust speed of 83 m.p.h. (72 kt) from WNW in December 1951 - and the highest speed for the decade 1949-59 - was superseded by one of 85 m.p.h. (74 kt) in February 1962 in a westerly gale raging at a sustained speed of 53 m.p.h. (46 kt). During one of the rare northerly gales, a cup anemometer at St. Abb's Head Lighthouse indicated a gust speed of 104 m.p.h. (90 kt) in October 1959. As a guide to the possibilities around exposed low hill sites the gust speed of 101 m.p.h. (88 kt) recorded at Blackford Hill Observatory, Edinburgh on December 12 1964 may be noted.

A general assessment suggests that gust speeds of 70 to 75 m.p.h. (61-65 kt) during severe westerly gales are not unduly rare in East Lothian.

Rainfall

The annual areal distribution of rainfall and its variability through the year are shown in Fig. 4 and Table 1 using the standard 35 year period normals 1916-50.

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

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
North Berwick (51 ft)	2.12	1.48	1.61	1.45	2.11	1.94	2.68	3.06	2.43	2.65	2.34	1.82	25.69
Dunbar (75 ft)	1.99	1.38	1.48	1.38	1.90	1.73	2.37	2.71	2.11	2.41	2.18	1.81	23.45
East Fortune Hosp. (101 ft)	2.24	1.44	1.57	1.49	2.04	1.84	2.50	2.82	2.24	2.54	2.24	1.94	24.90
St. Abb's Head (245 ft)	2.29	1.71	1.79	1.62	2.15	2.01	2.78	3.20	2.45	2.92	2.62	2.01	27.55
Donolly Res. (532 ft)	2.82	1.93	1.96	1.93	2.44	2.08	2.82	3.34	2.73	3.19	2.88	2.51	30.63
West Hopes Res. (810 ft)	3.48	2.46	2.35	2.35	2.90	2.42	3.26	3.70	3.19	3.80	3.56	3.19	36.66
Whitchester (838 ft)	3.03	2.36	2.12	2.02	2.43	2.36	3.34	3.78	2.86	3.54	3.24	2.63	33.71

/The

The rainfall pattern is closely linked with the wind regimes. The climate is distinctly on the dry side with much of the area below the 500 ft contour, and especially the agricultural and horticultural districts, having an average annual rainfall of less than 30 in. At least half of this area averages little more than 25 in., matching closely some of the eastern counties of England, e.g. Yorkshire (East Riding). Above 500 ft on the north side of the Lammermuirs, the annual average increases steadily with altitude to over 35 in. at about 1000 ft, west of the upper reaches of the river Whiteadder above its confluence with the river Dye, and above the 1700 ft level the figure exceeds 40 in. Even at 1000 ft, however, there is less than 35 in. per annum on Monynut Edge in the eastern Lammermuirs, the whole of this side having a fairly uniform distribution which falls away only slowly to about 27 in. toward the coast.

The distribution of rainfall through the year is not the most propitious for agriculture. Normally, dry springs follow not over-wet winters and are followed by summers with a pronounced tendency to over-much rain in the second half. These trends are clearly shown in Table 1. On balance April is the driest month everywhere, being slightly drier on average than February; May shows an appreciable rise, but there is a falling away again in June. The low averages for the months of March to June and high potential evapo-transpiration (Table 8) indicate the too frequent liability to spring dry spells which may be prolonged. The situation is only partially relieved by the drought resisting character of some of the clayey soils and the moisture provided by haar (see sections on Dry and Wet Spells, and Haar). The rain which does come is often cold; consequently the soil remains cool and not only is germination delayed and often reduced but growth of all kinds is slowed down, especially on the lighter soils. In such conditions the need for irrigation is obvious and in this context East Lothian is badly placed in that the free water from the relatively scantly rains (and such snow melt as may be available) is for the most part shed southwards towards the river Tweed. Normally ample rain in July builds up to the monthly maximum of 3 in. or more in August and October is almost as wet as August. September may bring dry periods, reflected in the lower averages for this month, but harvest difficulties increase in the less favourable years when the August and October maxima tend to run together.

Synoptically the incidence of the rainfall is of interest. The rain shadow effect of the extensive hill country to the south and southwest is extreme. The steady downpours of "warm" rain associated in most areas of Britain with the periodical and often frequent invasions of mild humid south to southwest winds are almost entirely inhibited. What threatens to be a wet day in East Lothian usually becomes merely a day of intermittent light rain when the general gradient is southerly and what might have been much needed appreciable warm gentle rain is lost. North Berwickshire is often little better served. With the passage of the cold front and an associated wind veer beyond SW the showers sweep up the Clyde-Forth valley and probably acquire increased intensity by forced ascent imposed by the Pentland and Lammermuir Hills. Thus the spring rains, whether from the east or west, are often rather cold, whereas in autumn and early winter, the rain benefits from the maritime effects around western Scotland and is relatively warm, so helping to prolong the growing season. This "softness" of the autumn after the harshness of the spring is a characteristic of the climate.

A day of steady rain requires, in general, synoptic conditions in which the prefrontal wind gradients are backed towards SE, with surface winds backing to E or NE. Then the rain is often prolonged but the North Sea ensures that conditions are generally raw and cold for the season. Depressions whose centres move across northern England provide the classical examples, notably in the period of the Lammas Floods. R. Mossman[2] (1896) has established this period as a recurrent meteorological event over some 200 years giving a very wet period in the Edinburgh area around mid August.

/Another

Another characteristic of the summer rainfall, contributing particularly to the sharp increase in July, derives from the development of thunder shower activity in the hill and mountain areas toward midday and in the early afternoon (see Section of Thunder). The resulting cloud formations tend to amalgamate into extensive rain areas which drift to this area of southeast Scotland by late afternoon and early evening.

Invasions of cold air from northerly latitudes are not uncommon in late winter and early spring and bring showery weather on the N to NE winds. The northeast and east coast districts and the Lammermuirs are particularly affected and can have frequent and prolonged showers of rain, hail or snow.

Wet and Dry Spells

Notable very wet periods are associated with the Lammas Flood period. Although the major effects of these recurrent rains have been felt in the Tweed valley so many times over the years as to be known historically as "Border Floods" the heavy rainfalls affect much larger areas. The "Border Floods" of 1948 and 1956 are cases in point. During the rainy periods 6-12 August 1948 the Tweed valley and surrounding districts suffered an areal rainfall of 5.4 in. (approx. 550 tons/acre) of which 3.2 in. fell in 24 hours from 9 a.m. on the 12. Rainfall totals for the month of August included 9.75 in. at St. Abb's Head, 9.57 in. at Marchmont and 8.02 in. at North Berwick. In 1956 similar deluges occurred in the four days 25-28 August when Whitchester had 5.73 in., and monthly totals were again approximately three times the normal (Marchmont 10.9 in., Haddington 7.7 in.) but the coastal zone from St. Abb's Head to North Berwick fared better than in 1948.

The low average rainfalls for the first half of the year suggest that lengthy periods of serious lack of rainfall may occur from time to time. An outstanding occurrence was that of the period January to September 1959 when over the whole nine months only 6.29 in. was measured at Haddington, 7.02 in. at Dunbar and, in the hills at Whitchester only 6.64 in. from January to June inclusive. The drought conditions of that year in the East Lothian plain are probably without parallel over most of 200 years. (From Mossman's data it is established that the 9½ in. in the Edinburgh area over this period was the lowest total for the nine months back to 1785!)

Short period occurrences of a week or more without appreciable rainfall are a relevant statistic and Table 2 gives an indication of such occurrences when the rainfall on any one day has not exceeded 0.01 in. at Haddington and Whitchester. In 1959 there were ten qualifying periods at Haddington meeting the strict criterion, with maximum durations of 23 days (28 August-19 September), 22 days (30 January-20 February) and 18 days in May; at Whitchester there were six spells with a maximum of 19 days in August/September. The late summer dry period persisted for 35 days at Marchmont, and for 26 days at North Berwick. Several rainless periods lasting for more than a week were experienced also in 1953; a spell of 32 days was noted at Whitchester (15 February-24 March) and one of 27 days at North Berwick and Dunbar.

Table 2. Summary of "Practically Dry Periods"

Station and Period	Average No. per yr	Maximum No. in yr	Average Duration	Maximum Duration
Haddington (162 ft) (1956-64)	5.6	10 (1959)	11.6 days	23 days (1959)
Whitchester (838 ft) (1953-64)	4.4	9 (1955)	11.2 days	32 days (1953)

/Snow

Snow

Evanescent coverings of snow on the hills, occurring sometimes in late autumn or early winter but more particularly late in the winter season, emphasize the cold character of the precipitation in this corner of Scotland. The cold showery weather of late winter and spring is largely responsible for these coverings and sometimes gives light coverings at lower levels, and may even bring moderate falls, more particularly to the eastern side. General snowfall over the area usually results from the onset of an air mass of polar origin and in view of the delicate balance as between rain and snow, a substantial fall may occur with little warning with a North Sea depression.

The area is not on the whole a snowy one. It is computed that some 5 to 6% of the relatively low annual precipitation falls in the solid form in the low plains and some 15 or perhaps 20% at altitudes around 1200 to 1500 ft. The average number of days per season on which falling snow is reported is some 14 to 15 days in the plain and some 20 days or so at 500 ft, but with a large variability from year to year. The proximity of the sea tends to keep the coastal strip practically free of snow and helps to prevent much accumulation on the lower ground. General snowfall is however more often followed by a spells of clear frosty weather than is the case further west or south and even a thin covering can be rather persistent at times from December to early or mid March. Snow does not normally lie in November and April. The chances of snow cover are greater in March than in December, but in January and February snow may lie for a week or a fortnight at levels below 500 ft and correspondingly longer at higher altitudes.

Days of "snow lying" (see preface) are of practical importance. These average out at about ten annually (not necessarily consecutive) below 250 ft and the figure increases with altitude fairly rapidly; on the southern side of the Lammermuirs the average is 25 days at 500 ft, and is probably higher on the northern slopes. Derived estimates suggest an average increase of one day per year for every 30 or 35 ft of altitude - in reasonably open level exposures.

With such exposures, and generally on the plains, a level depth of six inches or more of undrifted snow is unusual. The Marchmont records over the years rarely contain a reference to a depth greater than five inches. The most interesting remarks relate to three exceptionally snowy periods during the present century which have acquired notoriety as the years of "The Border snows" - the early months of 1917, 1937 and 1947. In 1917 the maximum impact (in the Borders area) came as late as April; in 1937 around mid-March and in 1947 the blizzard of late February was the precursor of another visitation in March. Maximum depths measured at Marchmont were 14 in. in April 1917 and 12 in. in March 1937. Drifting and snow blown from the higher hill tops however cause much deeper accumulations in topographically favourable sites in the folds in the hills. There are several references to drifts of up to four to five feet in the glens in the past 10 years or so in the records from West Hopes reservoir (736 ft). The Whitchester record for February 1947 reads "43 in. of snow fell during the month" - and this almost certainly relates to the cumulative total of fresh snowfalls. No information on the maximum depth of lying snow is available for the area but the ground was continuously under snow for 58 days.

Temperature

There is scope for appreciable climatic variation over an area where quite half the ground lies above the 500 ft contour, and temperature is the most significant parameter of the change from the relatively pleasant early summer of the low plain and the coastal zone to the severe winter conditions at about 1200 ft. Because of the inadequacy of long term meteorological records within the area, recourse has to be made to the records of stations just outside it (e.g. Marchmont and Edinburgh) for a satisfactory picture of the variations. Recently S.E.A. Landale, has made available a series of careful daily observations taken at Whitchester near Duns in a fold

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Table 3. AVERAGES OF TEMPERATURES 1931-60 (EXCEPT WHERE OTHERWISE INDICATED) AND EXTREMES

	NORTH BERWICK (118ft.)							DUNBAR (75 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	
JANUARY	6.0	0.5	3.3	58	1957	9	1941	6.3	0.9	3.6	59	1932	10	1941
FEBRUARY	6.6	1.0	3.8	60	'26	6	'29	6.7	1.3	4.0	61	'60	15	'55 '56
MARCH	8.7	2.1	5.4	69	'45	14	'47	8.6	2.4	5.5	70	'45	9	'47
APRIL	11.5	3.8	7.6	69	'46	23	'44	10.8	4.1	7.4	69	'46	26	'44
MAY	13.9	5.9	9.9	75	'39 '48	26	'42	13.0	6.2	9.6	74	'37 '45	29	'46
JUNE	16.9	8.6	12.8	85	'33	34	'32	16.3	9.0	12.7	85	'33	36	'55 '62
JULY	18.8	10.8	14.8	88	'43	39	'54	18.1	11.0	14.6	88	'43	39	'47
AUGUST	18.4	10.6	14.5	84	'55	38	'32	17.8	10.7	14.3	83	'53	39	'38 '41
SEPTEMBER	16.5	9.0	12.8	80	'49	28	'54	16.1	9.2	12.6	75	'33 '61	31	'43
OCTOBER	12.8	6.4	9.6	75	'59	25	'26	12.8	6.8	9.8	73	'59	29	'46
NOVEMBER	9.4	3.6	6.5	63	'27 '46	21	'47 '52	9.4	4.0	6.7	65	'46	21	'47 '52
DECEMBER	7.3	2.1	4.7	60	'48	16	'27	7.5	2.4	4.9	60	'42	17	'61
YEAR	12.2	5.4	8.8	88	'43	6	'29	11.9	5.7	8.8	88	'43	9	'47

Ø See Preface for explanation of use of °F

	MARCHMONT (498ft.)							HADDINGTON* (162ft.)						
	Average			Extremes Ø				Average			Estimes 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	
JANUARY	5.1	-0.4	2.3	55	1921 '32 '37	5	1918	5.4	-0.9	2.3	57	1957	2	1963
FEBRUARY	5.8	-0.2	2.8	59	'60	11	'56	6.3	-0.2	3.1	60	'60	7	'63
MARCH	8.2	1.1	4.7	70	'29	11	'17	8.5	1.3	4.9	62	'61	11	'58
APRIL	11.0	2.9	6.9	74	'14	14	'17	11.7	3.2	7.4	67	'62	23	'58
MAY	14.1	5.2	9.7	78	'19 '47	26	'27	14.2	5.3	9.7	74	'60	29	'61
JUNE	17.2	8.1	12.7	84	'25	34	'62	17.6	8.2	12.9	80	'59	31	'62
JULY	18.8	10.2	14.5	86	'33	36	'19	19.2	10.3	14.7	80	'59	38	'57 '62
AUGUST	18.3	9.9	14.1	84	'55	37	'21	18.5	10.1	14.3	83	'59	35	'63
SEPTEMBER	15.9	8.0	11.9	79	'26	28	'54	16.7	8.1	12.4	76	'59	34	'59
OCTOBER	12.1	5.3	8.7	75	'59	25	'31	12.7	5.4	9.1	74	'59	25	'56
NOVEMBER	8.4	2.4	5.4	65	'46	12	'19	8.9	2.2	5.6	58	'59	19	'63
DECEMBER	6.3	1.0	3.6	57	'45	16	'61	6.6	0.9	3.7	55	'56 '64	6	'61
YEAR	11.8	4.5	8.1	86	'33	5	'18	12.2	4.5	8.3	83	'59	2	'63

* Provisional computed means

	WHITCHESTER+ (838ft.)						
	Average			Extremes			
	Max	Min	Mean	Max	Year	Min	Year
	°C	°C	°C	°F		°F	
JANUARY	3.9	-1.3	1.3	51	1948 '58	10	1846
FEBRUARY	4.2	-1.6	1.3	57	'60	7	'55
MARCH	6.6	0.2	3.4	68	'57	8	'47
APRIL	10.3	2.1	6.2	71	'46 '49	22	'53 '58
MAY	13.4	4.5	8.9	80	'52	26	'51
JUNE	16.0	7.6	11.8	85	'50	29	'55
JULY	17.5	9.3	13.4	84	'48	35	'55 '63
AUGUST	16.9	8.9	12.9	80	'53	35	'64
SEPTEMBER	14.9	7.4	11.2	78	'59	28	'54
OCTOBER	11.3	4.9	8.2	73	'59	23	'46
NOVEMBER	7.4	1.8	4.6	59	'46	14	'52
DECEMBER	4.9	-0.3	2.3	54	(-)	14	'61
YEAR	10.6	3.6	7.1	85	'50	7	'55

(-) 1948, '53, '54, '55, '56

+ Averages for 1946-64

Extreme values for periods:-

NORTH BERWICK	1923-64
DUNBAR	1930-47, 1950-64
MARCHMONT	1914-64
(but see section on extreme temperatures)	
HADDINGTON	1956-64
WHITCHESTER	1946-64

in the Lammermuirs over a period of nearly 20 years. Extensive shelter belts have been planted and developed over a considerable area over a long period of years and some of the summarised data has been included in Table 3 as an aid to assessment of the upland climate.

In the plains, the range of average daily mean temperature over the year is some 11°C increasing from about 3.3°C in the coldest month, January, to nearly 15°C in July (Table 3). The coastal zone is a little warmer especially in winter but the difference is small. The cold North Sea and easterly winds impose a very definite check on the rate at which temperature rises in spring and early summer and puts the seasonal increase somewhat out of phase with the increasing heat of the sun and the lengthening days. The progression of the mean afternoon temperatures from 6.1°C in January to 18.3°C in July and of the night temperatures from around 0.6°C to 10.6°C in the same period is asymmetrical with the autumnal regression which is definitely slower than might be expected because of the dominance of winds from the warm North Atlantic at that season.

The effect of altitude is noticeable in that at about 500 ft ascending the Lothian Plain the mean temperature at the coldest part of the year is around 1°C lower than that in the coastal plain and the mean minimum at the close of the year and in the early weeks of the New Year falls very close to freezing point.

The Whitchester observations indicate the much more severe cold experienced in the depths of the winter at about 800 ft with average night minimum temperatures well below freezing for both January and February. Naturally summer is less warm at this altitude than in the plains but the difference in mean temperature is not so large as in the winter and the rapid recovery in the early spring to make up some of the leeway is an interesting feature of the data. The recovery is probably partly due to topography which limits the penetration and duration of haar but it may well indicate also the beneficial effect of the shelter belts against the easterly winds.

The night cold strengthens on the southern slopes of the Lammermuirs where the terrain is markedly favourable to the descent of the cold air and its accumulation in pools where, almost certainly the coldest winter nights occur. On the other hand the southern slopes have rather warmer days in summer and altitude seems less effective.

<u>Extreme Temperatures</u>

Spells of really warm weather are not frequent. The warmest spells tend to come early in the warmer half of the year but warm afternoons often give place to cool evenings because of the ease with which the sea breeze is generated, to penetrate unhindered across the lowlands.

In any year there is an even chance that the thermometer will record 80°F (26.7°C) at inland locations at all altitudes up to at least 500 ft. This figure has been reached or exceeded in 15 summers over the 42 years 1923-64 even on the coast. Extreme maxima recorded are 88°F at North Berwick and Dunbar in July 1943; 85°F in the hills at Whitchester in June 1950 (cf. 89°F at Marchmont in July 1873).

During frosty spells an air temperature minimum around 20°F (-7°C) is a good average figure for the colder nights in reasonably open localities; in severe weather minima may be as low as 10°F (-12°C), 22°F of frost but probably in the frost pockets of the river valleys they are even lower. Extreme values include 1°F at Marchmont in December 1879, 6°F at North Beriwck in February 1929 and 7°F at Whitchester in February 1955.

Additional information on the duration of the frost season, supplementary to the average number of night (air) frosts shown in Table 12 is given below where the dates of the first and last frosts are given together with the mean date of occurrence:-

/Table 4.

Table 4. Duration of Frost Season

Station	Period Covered	First Frost Date		Last Frost Date	
		Earliest	Mean	Latest	Mean
North Berwick	1926-64	27 Sept 1943, 1954	27 Oct	25 May 1948	23 April
Smeaton	1901-32	1 Sept 1931	11 Oct	23 May 1927	26 April
Whitchester	1946-64	14 Sept 1952	-	9 June 1955	-
Marchmont	1901-64	3 Sept 1923	20 Oct	23 May 1927	3 May

Freezing Days

Freezing days are defined as those on which the arithmetic mean of the maximum and minimum temperatures does not exceed 0.3°C (originally 32.4°F when these temperatures were reported in whole °F). Comparing figures from the station at Smeaton House with those from a suitable station just outside the area, an estimated figure can be obtained for the 20 winters 1927/28 to 1946/47. The estimated total is 340 days, or about 17 days per year for the Lothian Plain. Admittedly there is a wide annual variation from about 50 in the exceptional winter of 1946/47 to only one or two in the abormally mild ones of 1931/32 and 1933/34. Normally a spell of four or five consecutive freezing days can be expected in most winters.

Plant Growth

The Growing Season

The growing season is defined as that period of the year during which on the average the mean daily temperature is 42°F (5.6°C) or above. In the most favoured districts the season usually begins about March 21 and lasts until well after the middle of November giving a length of from 225 to 250 days. At the 500-600 foot level the start is delayed until about April 1 and the end comes about the second week in November; above this the length falls off steadily to about 190 days at 1000 feeet.

Accepting that all plants require a minimum number of "heat units" to attain maturity, an indication of the potential for frowth in the average year may be given by the averages of "Accumulated Temperature" above a datum of 42°F (5.6°C). Values for the area under review expressed in "degree days" are given in Table 5. The slow rate of accumulation of warmth in the spring and the reluctance of autumn to give place to winter dormancy should be noted.

Table 5. Accumulated Temperatures above 42°F (5.6°C) in Degree Days

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Length of Season - Days
North Berwick (118 ft)	50	48	93	135	242	387	515	499	387	229	87	65	2737	251
Haddington (162 ft)	28	39	84	129	233	399	499	499	363	201	57	50	2581	234
Whitchester (838 ft)	17	14	53	90	195	339	449	425	306	155	39	20	2102	211
Marchmont (498 ft)	34	37	62	100	211	375	496	468	333	167	48	40	2472	228

/Earth

Earth and Soil Temperatures

Soil temperatures cannot altogether be divorced from air temperatures in their effect on crop growth. Most of the data however consists of one observation daily at 09h GMT and the diurnal variation at depths of 1 ft and less is such that means are subject to some reservations. Averages of earth temperatures at a depth of one foot for Smeaton (100 ft) for the period 1921-50, computed in the Meteorological Office, are reproduced in Table 6 where those for Boghall (Midlothian - 639 ft) are given merely as an indication of changes with altitude.

Table 6. Average Earth Temperatures (°C) at 1 foot below surface at 9h GMT

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Smeaton (100 ft)	3.2	3.4	4.5	7.6	10.8	13.6	15.4	15.2	13.1	9.6	6.3	4.3	9.0
Bognall (639 ft)	2.6	2.7	3.8	6.2	9.6	13.1	14.6	14.2	11.9	8.6	5.2	3.5	8.0

The individual monthly means vary considerably from year to year, and at Smeaton the difference between the warmest and coldest December is as much as 3.7°C.; for June 2.9°C.; August and September show least variability. At Smeaton no cases are recorded of the ground freezing at a depth of one foot; at Boghall this has happened in each of the first three months of the year.

As well as the "earth" temperatures referred to above which are taken under a sward of short grass, "soil" temperatures for depths of four inches and eight inches below a bare soil surface are sometimes measured. Since there are no observations of this type for the East Lothian plain some indication of conditions may be gleaned from the seven year series of soil temperatures from East Craigs (200 ft) western outskirts of Edinburgh. The monthly mean values are given in Table 7:-

Table 7. Mean monthly values of "soil" temperatures at 09h GMT at East Craigs - period March 1958-February 1965 (°C)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
4 in.	1.1	1.9	3.4	6.7	10.8	14.2	15.1	13.8	12.9	8.1	4.4	1.9	7.8
8 in.	1.7	2.4	3.7	6.3	10.1	13.7	14.8	14.1	12.1	8.9	5.3	2.6	8.0

At these depths under bare soil there is a marked diurnal variation on fine sunny days especially when the soil is dry as opposed to the practically constant temperature prevailing on dull days with a wet soil. From some recent continuous recording at East Craigs daily ranges of 6.5 to 8.3°C have been registered for the 4 in. depth and up to 5°C at 8 in. in a very mediocre summer (maximum temperature 18°C). At the other extreme, the soil was frozen at 4 in. depth for 54 days continuously (12 Jan-6 Mar) and at the 8 in. depth for 15 days (17-31 Jan) during the severe winter of 1962-63. The 0900h GMT observation is, by the large, near to the daily minimum. In the middle of the year at the latitude of East Craigs, the minimum of the daily cycle normally occurs about two to three hours before the time of the daily reading at at the turn of the year about one to two hours later than the observation time.

Evapo-transpiration

Concomitant with the rainfall - the income side of the water balance sheet - may be considered the water loss due to evaporation and transpiration. The latest figures for practical working given in "Irrigation"(3) and reproduced in Table 8 include the estimates for winter loss. Most of the

/loss

loss in the winter half year is attributed to October and March. The estimated loss in winter in East Lothian and Berwickshire is practically three inches, a loss which may not always be compensated for by the late winter rains, so that the growing season may open in April with a deficit. (Rainfall in excess of that necessary to bring the soil holding up to field capacity goes directly or by drainage to run off, to cause waterlogging, or to replenish underground water supplies and is lost to vegetation). From April the potential evapo-transpiration rates increase steadily to the June/July monthly maximum of three inches or so, as can be seen from Table 8. By the end of June in a normal rainfall year the soil water deficit in the Lothian Plain is about two inches and considerably more on the Coastal Plain. The effects may be lessened, though not fully overcome by haar. In most years the balance is redressed by the rains of late summer. As an indication of the variation from year to year, estimates for a good summer and a poor summer are given in Table 9. Berwickshire Merse is included since the data covers the contrasting summers of 1954 and 1955.

Table 8. Averages Values of Potential Evapo-transpiration in East Lothian and Berwickshire

	Winter Oct-Mar	Summer						Summer Total	Annual Total
		Apr	May	June	July	Aug	Sep		
East Lothian	2.90 in.	1.75	2.75	3.30	3.1	2.50	1.45	14.90	17.80
Berwickshire	3.00 in.	1.75	2.60	3.25	2.95	2.50	1.55	14.60	17.60

Table 9. Values of Potential Evapo-transpiration

	Year	Apr	May	June	July	Aug	Sep	Summer in.
Haddington (1956-64)	1959	1.89	2.73	3.26	3.33	2.66	1.61	15.48
	1963	1.66	2.83	2.76	3.26	2.19	1.59	14.29
Berwickshire Merse (1945-64)	1955	1.96	2.79	3.15	3.97	2.66	1.73	16.26
	1954	1.96	2.33	2.75	2.96	2.17	1.61	13.78

Sunshine

Sunshine averages rather more than 1,300 hours per annum over the area as a whole, but from the monthly averages it is seen that the total for the first six months of the year exceeds that for the remaining six months by some 100 hours, the excess being spread roughly proportionately over each of the months (Table 10). June with about 10 hours more than its nearest rival May is the sunniest month with nearly 200 hours; both are appreciably sunnier than July.

Table 10. Averages of Sunshine (hours) - Period 1931-60

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
North Berwick (118 ft)	40	69	104	149	180	189	168	145	122	86	50	32	1334
Dunbar (75 ft)	56	79	112	159	190	199	179	157	139	99	63	48	1480
Marchmont (498 ft)	44	61	97	142	172	180	155	142	117	76	47	36	1269

/There

There is substantial evidence suggesting that over a relatively broad arc the yearly sunshine approximates more nearly to the high average enjoyed by Dunbar than to the mean areal value suggested by the above figures. The northern boundary probably runs from about the Tyne estuary to south of Haddington and thence curves more westerly, with the other boundary in the northern foothills of the Lammermuirs dependent on the screening effect of the hills. In the appropriate conditions of the general airflow, the lee effect of the hills dissipates or breaks up the cloud sheet which then re-forms a few miles downwind.

Haar

Haar, the inflow of fog or extremely low cloud from the North Sea is a phenomenon of considerable climatic importance to East Lothian.

Associated exclusively with winds from an easterly point, this unpleasant phenomenon can occur, theoretically, at any time during the year when the general pressure distribution is such that intrinsically warm air cooled by the cold North Sea to the fog point, or nearly so, is drifted inland. There is however, a tendency to restrict the term haar to this occurrence during otherwise fine weather situations in spring and summer. Haar is capricious in its onset and in its degree of penetration inland. Sometimes it persists for at least two or three days, expecially toward the coast, but more generally it clears coastwards from the inland edge of penetration as the heat of the sun gains the ascendancy, re-foreming and spreading in again as the sun goes down. The haar robs appreciable areas of much needed direct solar warmth, and adds insult to injury by upsetting in varying degree the diurnal run of temperatures. Penetration is less easy south of the Lammermuirs. But the haar is not wholly bad; the mist provides growing plants (especially seedlings) with a quota of condensed moisture at the root, often sufficient to keep the plant alive in the dry spells of spring.

The statistical incidence of haar is difficult to assess. As fog or mist, the haar is usually worst from late evening until after dawn, but with the short nights in these latitudes, the obscurity very frequently lifts off the surface before the observational hour at the climatological stations (09h GMT). The potential incidence is suggested by the frequency of fog at St. Abb's Head (Table 12). A further indication is available from summaries of the more frequent observations from the stations on either side of the area, viz. Leuchars (Fife), Acklington (Northumberland) and Turnhouse, Edinburgh. A cloud base below 600 ft in the forenoon during the critical months March/April to August is very likely, although not necessarily, due to haar. The figures given below relating to the percentage frequency of occurrence of cloud base below 600 ft have been extracted for the hours etc. shown from independently compiled cloud height summaries for the three stations:-

Leuchars	06h GMT	12h GMT	Acklington	07h GMT	12h GMT	Turnhouse	06h GMT	12h GMT
Mar-May	9.8	6.8	Apr-May	9.8	8.2	Apr-May	4.9	2.9
June-Aug	12.3	5.3	June-Aug	9.8	5.4	June-Aug	10.0	3.0

The figures suggest not only the approximate frequency of haar, but indicate the increased rate of clearance with the advance of the season and with increasing distance from the sea (Leuchars and Acklington are both "near coast" stations for easterly winds).

Radiation Fog

The radiation type of fog is infrequent or only short lived. Very occasionally a radiation fog polluted by effluents from the industrial belt in the Clyde/Forth valley drifts into East Lothian, usually when the wind freshens after a calm frosty spell.

/Hail

Hail

The relative frequency of hail indicated in Table 12 is based on the reports which include, withough distinction, the hard hailstone and the "soft hail" generally a phenomenon of the colder months. The former is frequently a localised visitation. A small but significant frequency of occurrence is shown from October onwards into spring with the coastal zone most likely to be affected during the colder months. Hailstorms occur most frequently in April but the probability diminishes rapidly in May, with the southern flank of the hills seemingly less affected than East Lothian. It is interesting to note that it is unusual for the summer thunderstorms to be accompanied by hail.

Thunder

Thunder is rarely heard from October to March. In May and June the average expectancy rises to about one day per month. The more thundery months are July and August but even then the average frequency is only rather more than two per month. Mossman gives a total of 549 summer storms in the Edinburgh area over the 127 years 1770-1896, giving an average of 4.3 storms per summer, in good agreement with the incidence of recent years.

Although occasionaly "medium" or "high level" storms move up from the south, the thundery tendency with its contribution to the rather high summer rainfall is usually associated with the development of thunderstorms in the Perthshire hills. These storms drift down on the rather frequent NW winds of the summer period, and many degenerate over the Forth Eastuary to survive in East Lothian only as extensive rain areas without violent manifestations. Some however are maintained and others resuscitated or even initiated by the Pentland, Moorfoot and Lammermuir group of hills with the result that north Berwickshire experiences more storms than East Lothian.

Humidity

Observations of relative humidity which are available for the war-time airfield at East Fortune in East Lothian can be adapted to give a more detailed picture of variations of humidity during daytime throughout the year to supplement the average values of the parameter which are available for certain standard hours in the official publication (see preface).

The observations used to compile Table 11 are those recorded at 07 and 10 hours 13 and 16 hours and 18 hours GMT over two and a half years and then at one hour earlier (except 18h) for the following year and a half, and these time grouping can conveniently be designated "Early Forenoon", "Middle Day" and "Early Evening" (winter) or "Late Afternoon" (summer), bearing in mind the incidence of Summer Time. The observations have been reduced to give the percentage frequency of occurrence of relative humidities within 10 per cent ranges as an aid to the assessment of day to day operations. Further simplification has been effected by "seasonal" groupings, since the detailed monthly analysis shows that the curves of variation are very similar for the months which have been grouped together. The approach of spring is reflected in the curve for March which differs significantly from those for the months from November to February whilst the transition from autumn to winter is marked by a significant change in the curve for October. Through the "growing season" April to September the pattern of variation is much the same, with the important proviso that from April to June there is a greater tendency for low humidities to occur (below 65 per cent) than later in the season; the April to June figures have been included to emphasize this point.

Relative humidities below 50% indicate air of unusual dryness, and it seems likely that East Lothian very occasionally enjoys a "föhn" effect - the only agency that can produce very dry surface air at low altitudes in an oceanic island. Almost certainly the values below 40 per cent must be attributed to temporary föhn, a conclusion supported by the cloud formations frequently observed on such occasions.

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(1) Shellard Met. Mag. Vol. 91. 1962. pp. 39-47

(2) Mossman R. Meteorology of Edinburgh. Trans. Roy. Soc. Edinburgh. 38. 1896.

(3) "Irrigation " Bulletin No. 138 (1962). M.A.A.F. H.M.S.O.

Table 11. Summary of Observations of Relative Humidity at East Fortune. Jan 1942-Dec 1945.

(frequency of occurrence within limits indicated)

		Relative Humidity - Percent									
		100-95	100-90	89-80	79-70	69-60	59-50	49-40	39-30	29-20	No. of Obs.
Dormant Period Nov-Feb	Early Forenoon	17.9	42.2	39.9	15.1	2.8	-	-	-	-	900
	Middle-Day	9.0	25.8	39.8	25.7	8.0	0.7	-	-	-	914
	Early Evening	12.7	34.9	42.0	19.8	3.1	0.2	-	-	-	455
Transition Months Mar and Oct	Early Forenoon	22.1	42.9	30.1	22.0	2.9	1.9	0.2	-	-	481
	Middle-Day	7.7	17.5	24.9	29.7	19.4	6.3	1.7	0.4	-	478
	Early Evening	15.0	32.5	32.9	24.6	6.7	2.5	0.8	-	-	240
Growing Season Apr-Sept	Early Forenoon	14.2	27.8	27.3	23.6	15.1	5.3	0.8	0.1	-	1438
		(9.4)	(20.5)	(24.2)	(26.3)	(18.9)	(8.0)	(1.7)	(0.3)	-	710
	Middle-Day	5.1	11.7	15.7	20.4	26.8	19.0	5.5	0.7	0+	1424
		(3.7)	(9.3)	(12.4)	(18.0)	(26.8)	(23.6)	(8.3)	(1.4)	(0+)	695
	Late Afternoon	8.8	18.9	20.2	22.9	26.2	9.8	1.5	0.4	-	713
		(5.4)	(14.0)	(15.4)	(20.3)	(31.2)	(15.8)	(2.3)	(0.9)	-	349

N.B. Values in brackets are for months April-June

Table 12. CLIMATOLOGICAL SUMMARIES - average number of days of occurrence of specified phenomena

(For explanation of headings see Preface)

	DUNBAR 1930-1948; 1950-64 (32-34 yrs)									NORTH BERWICK 1923-64 (40-42 yrs)								
	R	W	S	SL	H	T	F	AF	GF	R	W	S	SL	H	T	F	AF	G
JAN	15.6	10.2	4.1	2.8	1.0	0.1	0.3	9.8	16.2	16.1	11.2	3.9	3.3	0.4	0+	0.6	11.9	1.4
FEB	12.4	7.8	4.1	3.4	0.8	0	0.2	10.3	12.9	13.5	8.7	3.7	3.6	0.4	0+	0.6	11.4	0.8
MAR	12.3	8.1	3.2	1.7	0.6	0+	0.2	3.8	10.9	13.2	8.4	2.7	1.8	0.4	0.1	0.8	5.0	0.6
APL	11.9	7.6	0.8	0+	0.4	0+	0.3	1.1	5.5	12.7	7.9	0.8	0	0.6	0.2	0.5	1.8	0.6
MAY	12.0	8.2	0.2	0+	0.2	0.7	0.8	0	1.5	13.5	9.2	0+	0	0.4	0.8	0.9	0	0.2
JUN	11.9	8.5	0+	0	0+	0.8	0.6	0	0+	12.8	9.4	0	0	0+	0.9	0.8	0	0.4
JUL	14.6	10.6	0	0	0.1	1.4	0.3	0	0	15.4	10.9	0	0	0+	1.5	0.6	0	0+
AUG	14.2	10.5	0	0	0+	0.9	0.3	0	0+	16.1	11.3	0	0	0+	0.9	0.7	0	0+
SEP	13.3	9.8	0	0	0+	0.5	0.4	0	0.1	15.0	10.4	0	0	0+	0.6	0.6	0	0.2
OCT	14.2	11.1	0.1	0	0.1	0.1	0.2	0.1	1.6	15.6	10.8	0.1	0	0.2	0+	0.3	0.3	0.5
NOV	15.0	11.0	0.3	0	0.3	0	0.4	2.4	6.5	16.2	11.5	0.4	0+	0.3	0+	0.5	3.7	0.7
DEC	15.5	10.6	1.9	0.6	0.5	0.1	0.4	7.8	11.6	16.4	11.2	2.2	1.3	0.5	0+	0.2	10.4	0.8
YEAR	163	114	14.7	8.5	4.0	4.6	4.4	35.3	67	177	121	13.8	10.0	3.2	5.0	7.1	44.5	6.2

	MARCHMONT 1914-64 (51 yrs)							
			(40-42 yrs)		(28-33 yrs)		(8-9 yrs)	
	R	W	S	SL	H	T	F	AF
JAN	18.6	13.5	5.0	7.5	0.4	0+	0.9	17.2
FEB	16.4	11.0	4.4	6.4	0.3	0	0.7	15.3
MAR	16.5	10.7	3.5	4.8	0.3	0+	2.1	8.2
APL	15.6	9.7	2.5	0.6	1.2	0.2	0.6	4.4
MAY	14.9	10.4	0.4	0+	0.4	1.2	0	0.6
JUN	13.7	10.1	0	0	0+	1.3	0.3	0
JUL	16.1	11.7	0	0	0.1	2.2	0.4	0
AUG	17.6	12.3	0	0	0+	1.4	0.3	0
SEP	16.0	11.3	0+	0+	0+	0.5	0.3	0
OCT	18.7	13.3	0.4	0.2	0.1	0.2	1.7	0.3
NOV	18.8	13.5	1.5	1.3	0.2	0+	1.2	8.0
DEC	19.1	12.9	3.2	3.1	0.4	0+	0	15.4
YEAR	202	140	20.9	23.9	3.5	7.0	8.5	69.4

0+ denotes < .05

Table 12a. CLIMATOLOGICAL SUMMARIES - average number of days of occurrence of specified phenomena

(For explantion of headings see Preface)

	HADDINGTON 1956-64 (8-9 yrs)									ST. ABB'S HEAD 1937-51; 1953-64 (26-27 yrs)						WHITCHESTER 1946-64; (17-19 yrs)		
	W	S	SL	H	T	F	AF	GF	G	H	T	F	AF	GF	G	W	S	AF
JAN	8.8	4.1	6.5	1.9	0	0.1	16.0	21.5	0.6	2.3	0+	0.9	6.2	11.1	3.5	13.9	9.2	21.0
FEB	6.9	5.1	5.9	0.7	0.1	1.0	13.3	18.0	1.0	1.4	0	0.8	8.6	12.1	3.6	12.0	9.9	18.9
MAR	7.6	3.0	0	1.9	0	0.2	7.1	12.4	0.5	2.4	0	2.3	4.0	6.7	2.6	11.3	5.7	14.4
APL	6.4	0.9	0	0.4	0.3	0.7	4.7	6.4	0.2	1.0	0.1	1.7	0.7	3.9	1.7	10.3	2.5	8.4
MAY	8.7	0	0	1.0	0.7	0.1	1.3	3.3	0.3	0.5	1.1	2.6	0	1.0	0.6	10.2	0.3	2.6
JUN	9.1	0	0	0.6	1.7	0.7	0.1	0.3	0.2	0.2	1.1	2.3	0	0.4	0.5	10.8	0	0+
JUL	13.6	0	0	0	1.3	0.6	0	0	0.2	0	1.4	2.3	0	0	0.3	10.9	0	0
AUG	9.7	0	0	0	1.3	0.3	0	0.1	0	0+	0.9	2.5	0	0	0.7	12.6	0	0
SEP	10.4	0	0	0.1	0.8	0.7	0.1	0.2	0.3	0+	0.5	1.8	0	0	1.4	11.9	0	0.3
OCT	9.9	0	0	0.1	0	0.6	1.0	3.8	0.2	0.1	0.1	1.4	0	0.5	2.7	12.0	0.5	2.9
NOV	11.7	1.0	0	0.3	0.1	0.7	8.6	12.6	0.4	0.5	0+	0.8	1.1	3.5	2.3	13.7	1.9	9.8
DEC	11.0	3.8	2.0	0.6	0	0.4	14.0	19.2	1.1	1.8	0+	0.6	4.3	8.3	3.5	14.7	6.6	18.8
YEAR	114	17.9	14.4	7.6	6.3	6.1	66.2	97.8	5.0	10.2	5.2	20.0	24.9	47.5	23.4	144	36.6	97.1

0+ denotes <.05

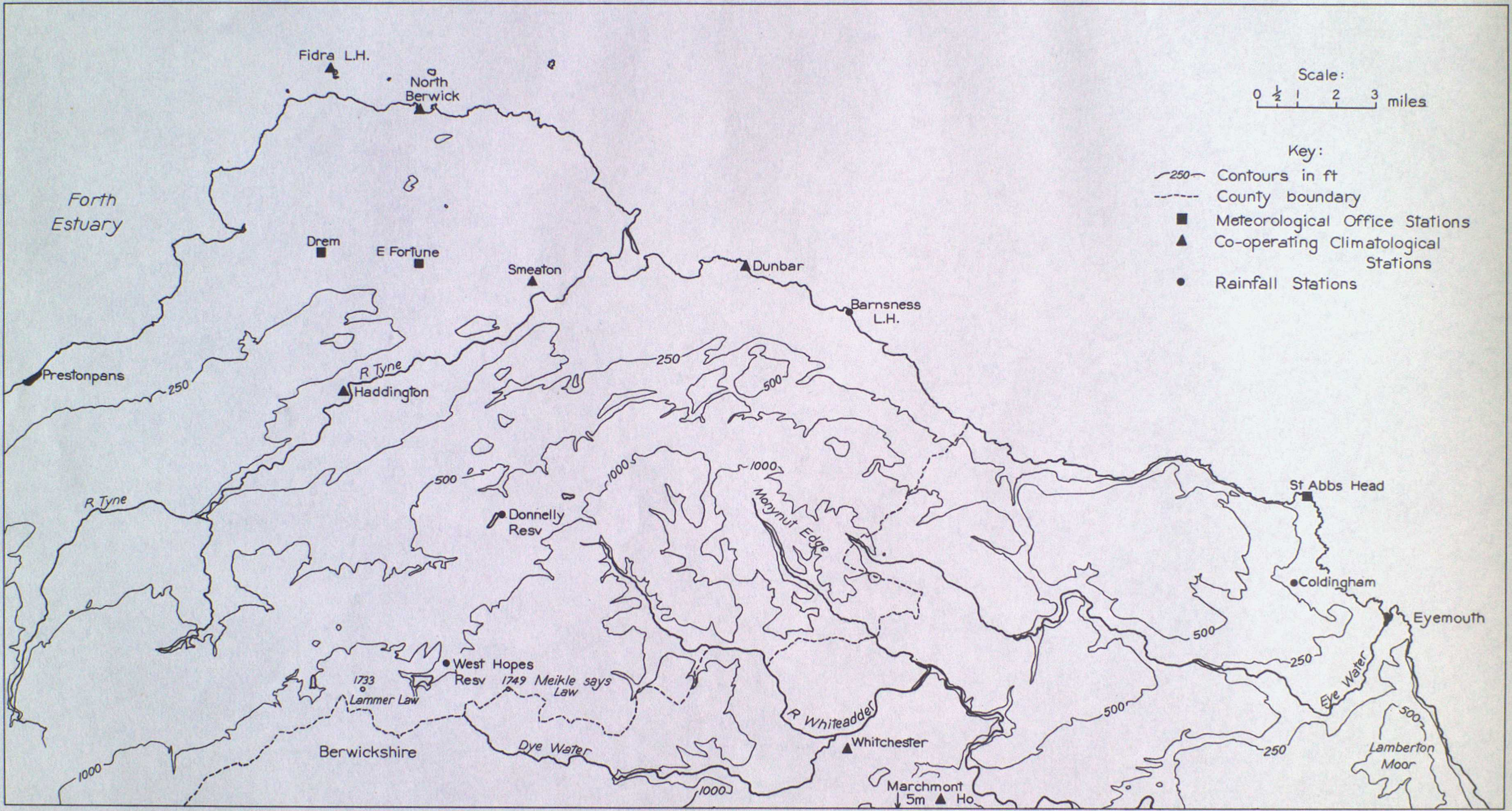


Fig 1. East Lothian and North Berwickshire

Fig 2 FIDRA LIGHTHOUSE

Frequencies of wind velocities exceeding 3kt 1950-9

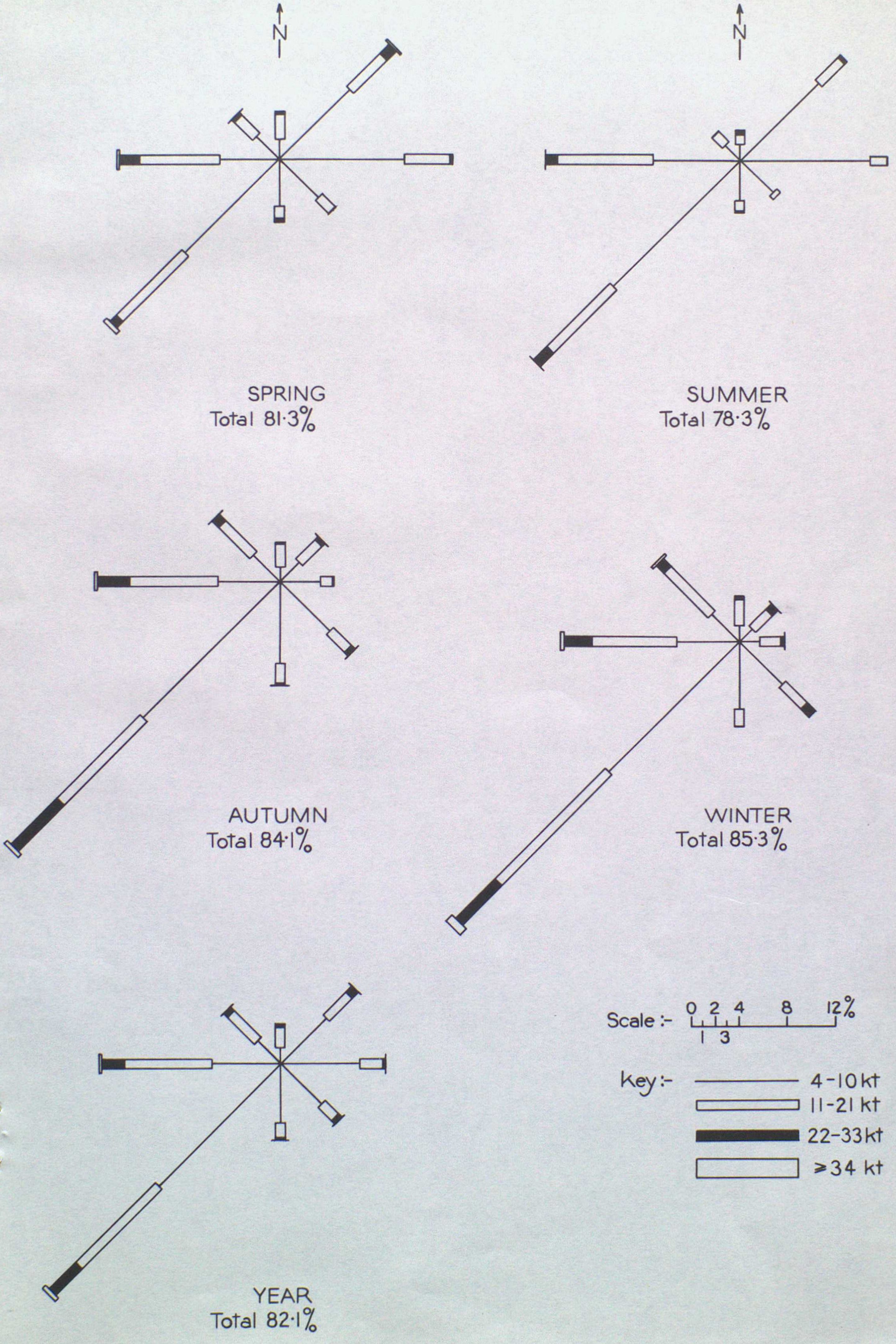
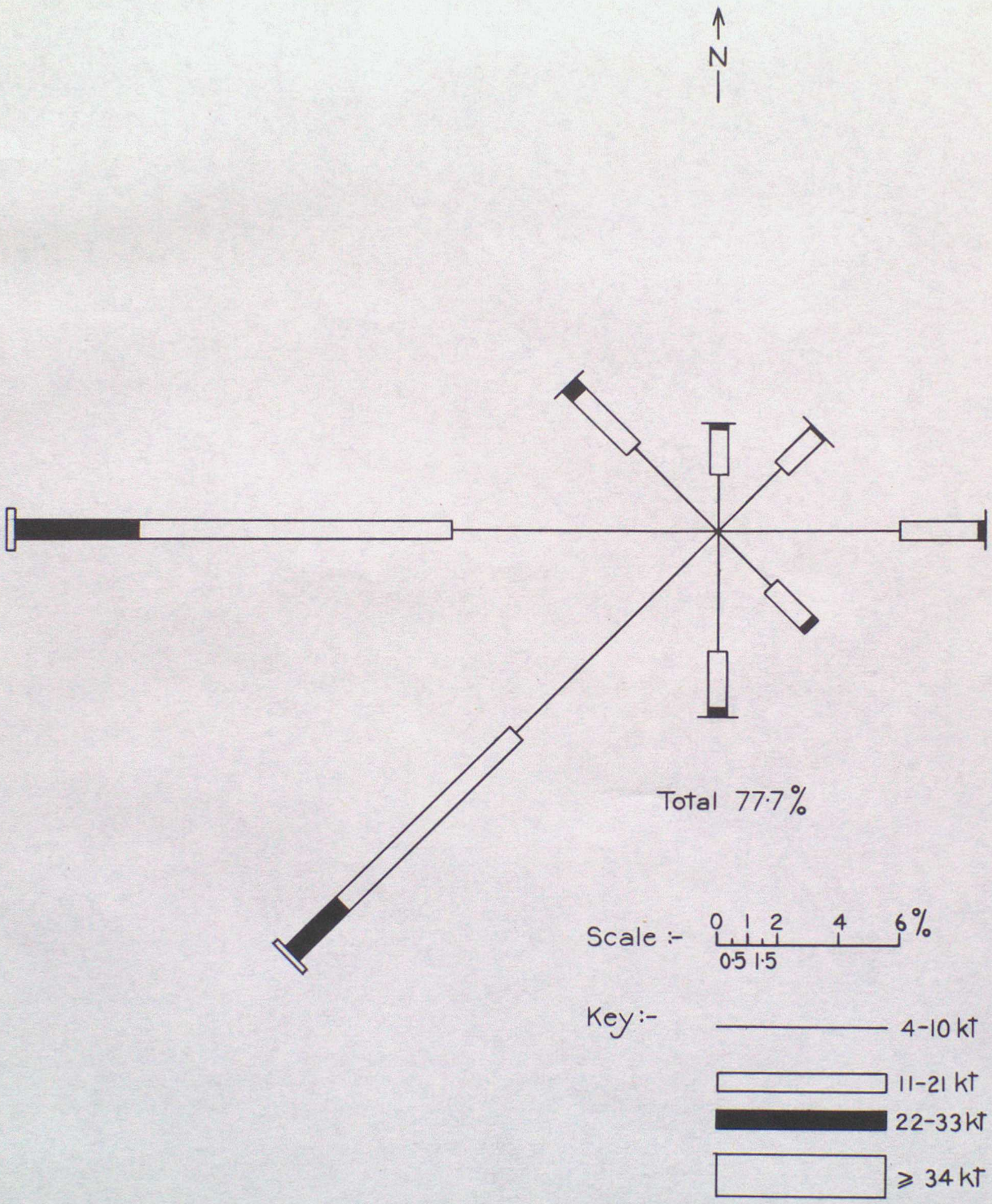


Fig 3 EAST FORTUNE AIRFIELD

Annual frequencies of hourly winds exceeding 3kt 1942-5



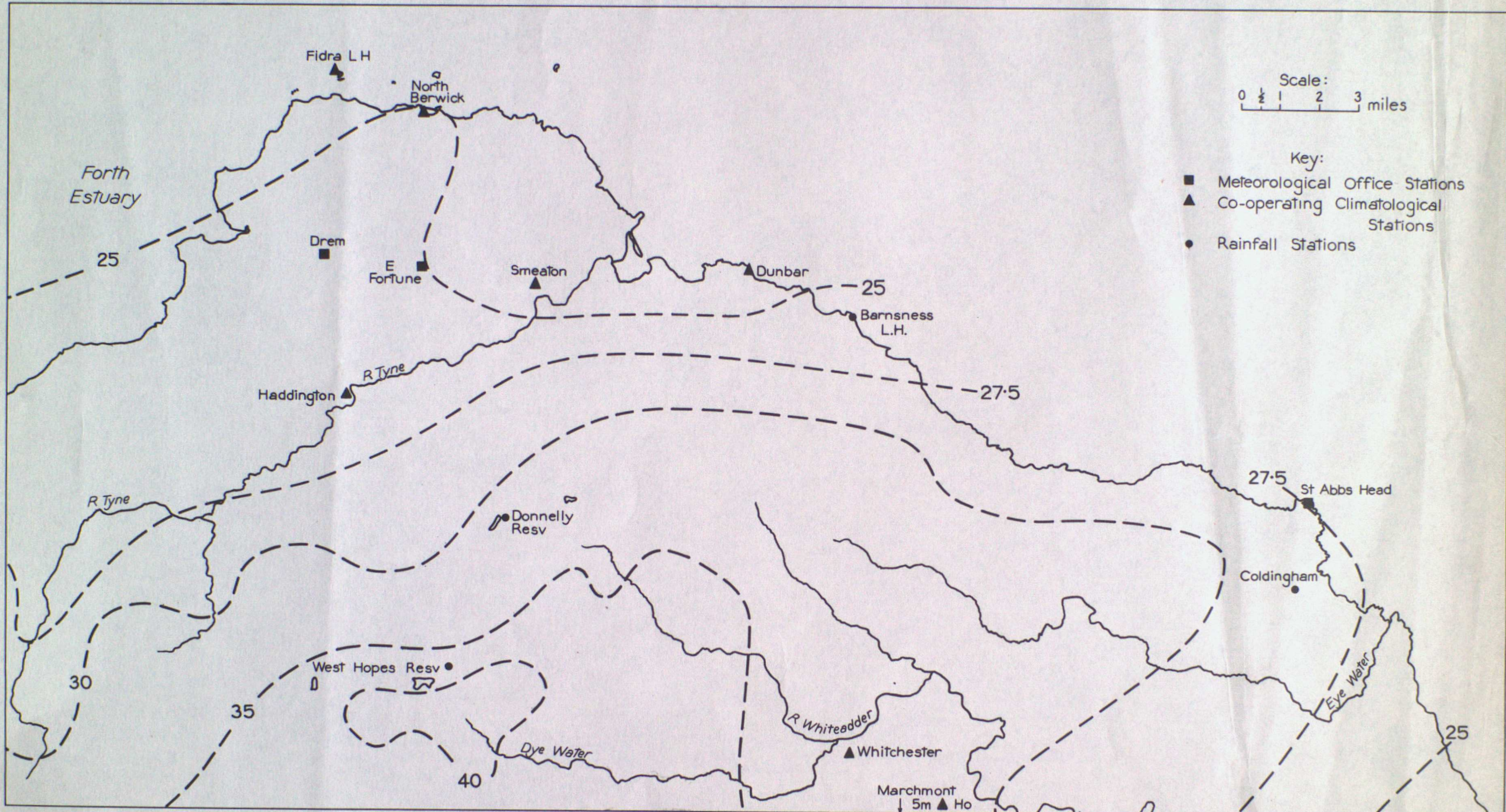


Fig 4. Average Annual Rainfall (Inches) for the period 1916-50 over East Lothian and North Berwickshire