DEPARTMENT OF TRANSPORT AND POWER
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AIR FROSTS IN LATE SPRING AND EARLY SUMMER

BY

M. J. CONNAUGHTON, M. Sc.

U.D.C.
551.524.37(415)

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Information on the occurrence of air frost in late Spring and early Summer may be used to advantage in assessing the suitability of particular areas for the production of frost-sensitive crops and also in calculating the possible economic benefits in installing frost-protection equipment where late frost is known to be a problem.

In order to investigate the general pattern of the occurrence of late air frosts in Ireland, temperature records from standard meteorological stations were examined and analysed. For each station, which has been in operation for at least five years and whose temperature records have not been unduly influenced by such local effects as urbanisation or over-exposure, the last date in each Spring or Summer on which the air temperature, as measured at four feet above the ground in a louvred screen, dropped to $0^{\circ}C$ or less, was regarded as being the date of last air frost. The mean date of the last air frost over the twenty-five year period, 1944-1968 (inclusive), was calculated for each station; these mean dates are given in the Table on pages 4 and 5.

Group A stations have been in operation during the full twenty-five year period. For these stations, extreme dates (earliest and latest) as well as mean dates of last air frost are shown.

Stations in Groups B and C have been in operation for less than twenty-five years. The available information for these stations has been adjusted by comparison with the nearest appropriate long-term stations in arriving at mean dates valid for the 25-year period.

Since the occurrence of air frost is greatly influenced by local factors of topography and shelter, the dates of last frosts given in the Table apply, strictly speaking, only to the stations listed. For this reason, the map in Figure 1, which is based on interpolation between these stations, is subject to error where such local effects are likely to cause large deviations from the general pattern of frost occurrence. For example, in deep sheltered valleys the mean date of last air frost may be several days, or even weeks, later than that indicated on the map, while on elevated, exposed sites the last air frost will occur, on average, much earlier. It is emphasised, then,

that the map is intended only as a general illustration of the variation in the mean dates of last air frosts over the country and that it should be used in assessing the risk of late frosts in a particular location only after careful consideration of the physical features of the site concerned.

The variability of the date of last air frost from year to year was also investigated. It was found that the variation was about the same for all stations and that roughly two-thirds of the dates for each station were within three weeks of the mean date. In statistical terms, the frequency distributions of the dates of last air frosts for all stations were approximately normal with standard deviation of twenty-one days. Using this information, a general rule governing the probability of the occurrence of air frost after specified periods of time after the mean date was established and is shown in the box beside the map in Figure 1. By applying this rule to areas along the south coast, for example, it may be seen that, subject to the limitations discussed in the last paragraph, air frost may be expected to occur in only two years in ten after March 19. In an average site in some Midland areas, air frost is likely in five years in ten after May 15 and in three years in ten after May 26.

Although mean daily temperature is usually regarded as decreasing with altitude at the rate of $1^{o}C$ per 500 feet, this relationship does not hold in the case of minimum temperature. In fact, because of the tendency for cold air to gravitate into valleys and depressions, it is found that the lowest minimum temperatures, under "radiation" conditions of clear skies and little wind, are experienced in such locations. Since almost all late air frosts are of the radiation type, it is not surprising to find that there is little correlation between the mean date of last air frost and the altitude of the stations listed in the Table on pages 4 and 5; in the case of nine coastal stations the correlation coefficient is -0.07 and for thirty-six inland stations the coefficient is -0.02. The frost-risk of a site is dependent on its height relative to the surrounding area rather than on its absolute height above sea-level.

It is sometimes contended, especially after a run of three or four seasons of particularly late frosts, that a change in temperature regime has taken place and that frosts are occurring much later now than in former years. This question of trend was investigated by considering the five-year "running" means of dates of last air frost for each of the stations listed in Group A of the Table on page 4 . The means for four stations, which are fairly typical of their respective provinces, are shown in Figure 2.

While these graphs show no evidence of a general trend in the lateness of air frosts over the past twenty-five years, they indicate that, after a period of general "lateness" in the late 1950's, last frosts tended to occur earlier in the first half of the present decade. This trend has been reversed during the past five years or so and although very late frosts have occurred in individual years since 1965, the mean date of last air frost over the five years 1964 to 1968 is within a week of the long term mean date at almost all stations.

Acknowledgment: Temperature records for some northern stations were kindly supplied by the British Meteorological Office.

Table: Dates of last air frosts 1944 - 1968

Group A (25-year stations)

Station	County	Mean Date	Earliest Date	Latest Date
Claremorris	Mayo	April 29	April 3	June 1
Tuam	Galway	May 7	March 25	June 10
Shannon Airport	Clare	April 23	Feb. 21	May 26
Valentia Observatory	Kerry	March 8	Jan. 14	April 17
Ballinacurra	Cork	April 12	March 8	May 7
Clonsast	Offaly	May 21	April 19	June 18
Peamount	Dublin	May 1	March 31	June 1
Rathfarnham	Dublin	April 20	March 16	May 24
Glasnevin	Dublin	April 27	March 21	May 27
Phoenix Park	Dublin	May 4	April 4	June 1
Dublin Airport	Dublin	April 5	Feb. 3	May 15
Hillsborough	Down	April 28	March 9	June 1
Aldergrove Airport	Antrim	May 7	April 2	June 26
Moneydig	Derry	May 4	April 2	June 15
Malin Head	Donegal	March 14	Jan. 16	May 3

Group B (10- to 24-year stations)

Station	County	Mean Date	Station	County	Mean Date
Bellacorrick	Mayo	May 4	Tycor	Waterford	April 2
Belmullet	Mayo	March 17	Rosslare	Wexford	March 14
Mallaranny	Mayo	March 24	Enniscorthy	Wexford	April 21
Glenamoy	Mayo	April 22	Johnstown Castle	Wexford	April 4
Pallaskenry	Limerick	April 12	Rathdrum	Wicklow	April 30
Tralee	Kerry	April 30	Arklow	Wicklow	April 25
Roche's Point	Cork	Feb. 24	Carlow	Carlow	May 1
Mallow	Cork	May 23	Kilkenny	Kilkenny	April 30
Thurles	Tipperary	May 5	Mountmellick	Laois	May 6

Group B (Continued)

Station	County	Mean Date	Station	County	Mean Date
Castleforbes	Longford	April 24	Creighton's Green	Down	April 7
Derrygreenagh	Offaly	May 8	Lough Gall	Armagh	May 7
Birr	Offaly	May 5	Lisburn	Antrim	April 25
Boora	Offaly	May 13	Parkmore	Antrim	May 7
Lullymore	Kildare	May 11	Castlerock	Derry	April 14
Kells	Meath	May 6	Ballykelly	Derry	April 27
Warrenstown	Meath	May 6	Castle Archdale	Fermanagh	April 24
Clones	Monaghan	April 22	Lislap	Tyrone	May 2
Kilkeel	Down	April 1	Glenties	Donegal	May 11
Stormont	Down	April 3			

Group C (5+ to 9-year stations)

Station	County	Mean Date	Station	County	Mean Date
Ballinamore	Leitrim	April 20	Newcastle	Wicklow	April 15
Ballinrobe	Mayo	May 2	Kinsealy	Dublin	April 11
Ballinahinch	Galway	April 19	Casement Airport	Dublin	May 4
Cork Airport	Cork	April 9	Ballybrittas	Laois	May 14
Drinagh	Cork	April 27	Dunsany	Meath	May 14
Fermoy	Cork	May 18	Helen's Bay	Down	March 26
Rathluirc	Cork	April 12	Larne	Antrim	March 30
Clogheen	Tipperary	May 6	Somerset	Derry	May 1
Dungarvan	Waterford	April 21	Lough Bradan	Tyrone	April 26
Mooncoin	Kilkenny	April 25	Milford	Donegal	April 15

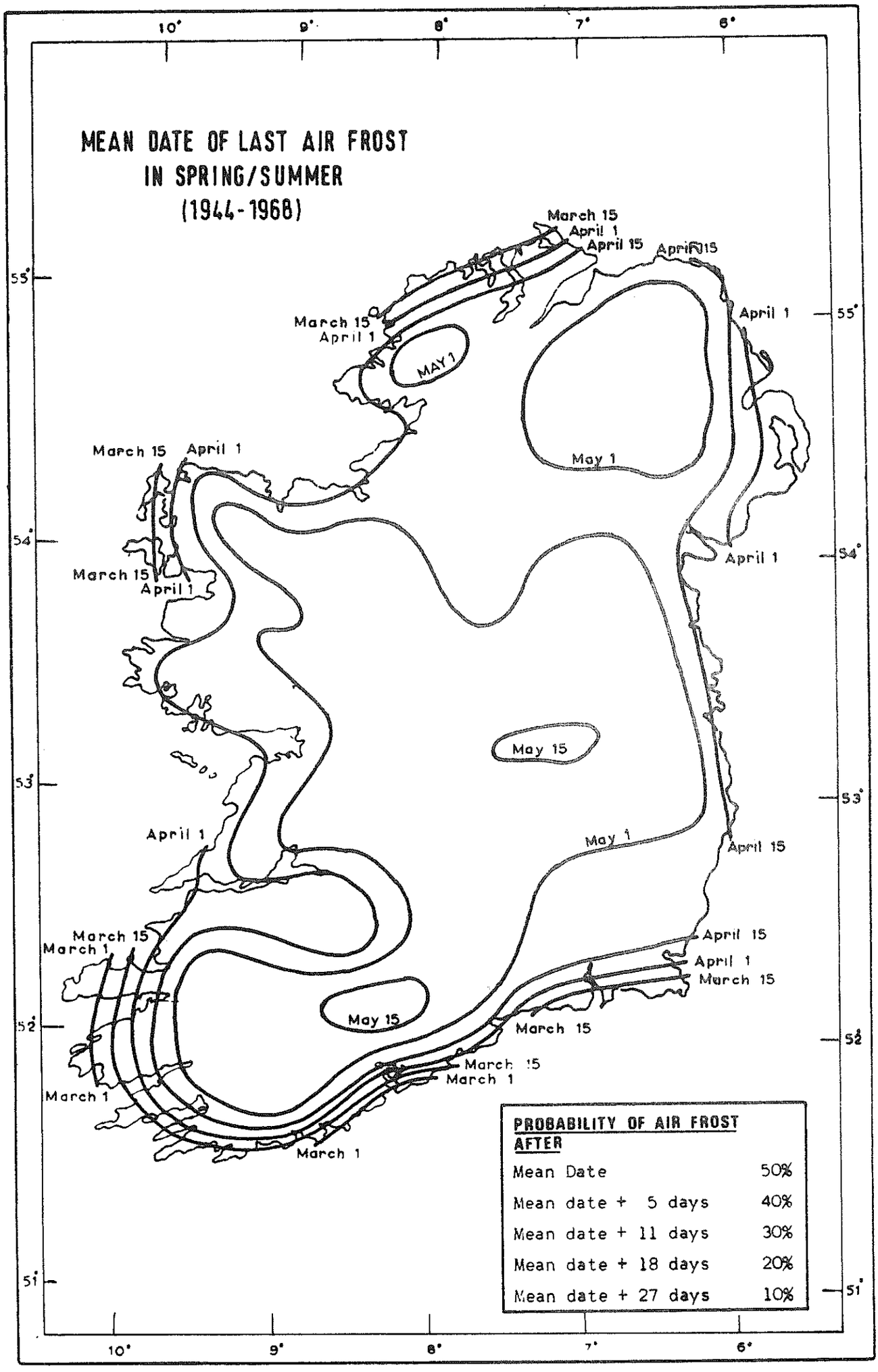
MEAN DATE OF LAST AIR FROST
IN SPRING/SUMMER
(1944-1968)
10°
9°
8°
7°
6°
55°
54°
53°
52°
51°
March 15
April 1
April 15
MAY 1
May 1
May 15
March 1
PROBABILITY OF AIR FROST AFTER
Mean Date 50%
Mean date + 5 days 40%
Mean date + 11 days 30%
Mean date + 18 days 20%
Mean date + 27 days 10%

Fig. 1.

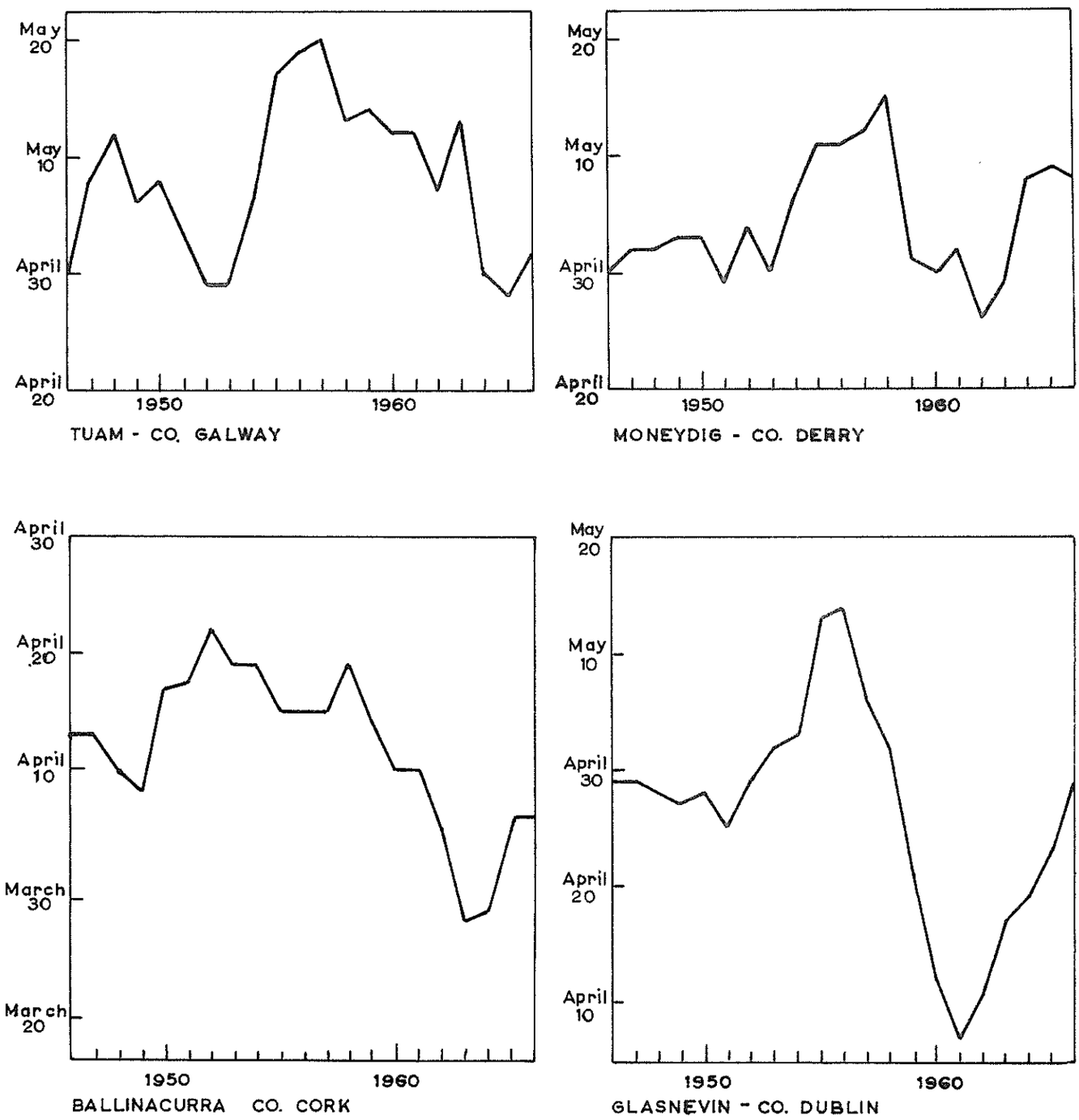

Fig. 2. Five-year running means of dates of last air frosts. (mean date corresponding to 1946 refers to the period 1944 - 1948, that corresponding to 1947 refers to the period 1945 - 1949, etc.)