

Environment Canada Imaging Cover Page

Report N.:



* T E C - 8 3 1 *

SKP Box Number: 672672428

NON-CIRCULATING



Environment
Canada

Environnement
Canada

Atmospheric
Environment

Environnement
atmosphérique

LIBRARY
AES
4905 DUFFERIN
DOWNSVIEW, ONT., CANADA
M3H 5T4

BIBLIOTHÈQUE
SEA

NON-CIRCULATING

Technical Memoranda

THE EFFECTS OF WIND, WEATHER, SEASON AND TIME OF DAY ON CEILINGS AND VISIBILITIES AT CHATHAM (A), NEW BRUNSWICK

by

M.A. PURVES

ENVIRONMENT CANADA - ATMOSPHERIC ENVIRONMENT SERVICE
4905 Dufferin Street
Downsview, Ontario

THE EFFECTS OF WIND, WEATHER, SEASON AND TIME OF DAY
ON CEILINGS AND VISIBILITIES AT CHATHAM (A),
NEW BRUNSWICK

by

M. A. Purves

ABSTRACT

A computer program has been written to analyze archived weather observations. The aim is to provide the forecaster with climatological data showing the relationships between ceilings and visibilities, wind velocity, weather type, season and time of day for any given station.

Extractions of results from Chatham (A), New Brunswick are presented to illustrate the complex inter-relationships that exist between the variables.

EFFETS DU VENT, DU TEMPS, DE LA SAISON ET DE L'HEURE SUR
LES PLAFONDS ET LA VISIBILITÉ À L'AÉROPORT DE CHATHAM
(NOUVEAU-BRUNSWICK)

par

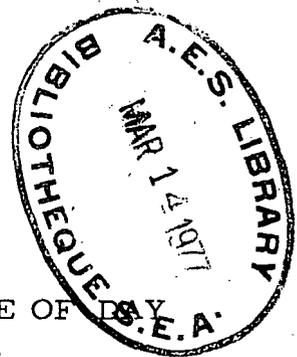
M. A. Purves

RESUME

Un programme machine a été rédigé pour analyser les observations météorologiques en archives. Le programme vise à fournir au prévisionniste des données climatologiques démontrant les relations qui existent entre les plafonds et la visibilité, la vitesse du vent, le type de temps, la saison et l'heure, pour toute station donnée.

L'auteur présente des extraits des résultats obtenus pour l'aéroport de Chatham (Nouveau-Brunswick) pour illustrer les relations complexes qui existent entre les variables.

ATMOSPHERIC ENVIRONMENT SERVICE
DEPARTMENT OF THE ENVIRONMENT - CANADA



ERRATA SHEET

THE EFFECTS OF WIND, WEATHER, SEASON AND TIME OF DAY
ON CEILINGS AND VISIBILITIES AT CHATHAM (A),
NEW BRUNSWICK

by

M. A. Purves

Page 4, 3(b), Note: ii) Change to read -

"The winds from (057-078) degrees pick up moisture from the Gulf of St. Lawrence, while winds from (237-258) degrees undergo considerable downslope flow, resulting in much better conditions".

Page 9, Change Figure caption to read -

Figure 2 - Probability of Spring Rain at Chatham (A), New Brunswick as a Function of Wind Velocity".

Page 10, Change Figure caption to read -

Figure 1 - Probability of weather type at Chatham (a), New Brunswick as a Function of Wind Direction (Spring, Wind Speed 20+ mph)".

U.D.C: 551.509.313

ISSN: 0068-7804

TEC 831

10 June 1976

THE EFFECTS OF WIND, WEATHER, SEASON AND TIME OF DAY
ON CEILINGS AND VISIBILITIES AT CHATHAM (A),
NEW BRUNSWICK

by

M. A. Purves

(Manuscript received October 14, 1975)

1. Introduction

A computer program (No. 10273) has been written to generate five sets of tables of conditional probabilities for any station whose hourly weather observations are stored on magnetic tape with the Atmospheric Environment Service (A.E.S.) Climatological Division's Card Type 1 (Hourly Data) Tape Format.

The tables have been designed with two main uses in mind. The first was for use in day to day forecasting (for which Table 5 was especially formatted). The second was for the purpose of general study (Tables 1 - 4 produced for this purpose are in the usual A.E.S. format).

The program was run using twenty years of hourly data for Chatham (A), New Brunswick. Several results have been extracted from the tables to illustrate various general conclusions, and to give a feeling for the types of results that were found.

It must be stressed that the value of this program lies not in the general conclusions that can be drawn from the results, but rather in the wealth of highly detailed information available to the forecaster for daily use.

2. Method

The program is designed to read the hourly weather sequences stored on magnetic tape, group the observations into the classes shown below, and then produce tables of conditional probabilities based on the number of occurrences of different events.

The seven classes are:

- (a) Weather type
 - i) Nil (Nil or thunder)

- ii) Fog (Fog, smoke, haze or drizzle)
- iii) Rain (Rain or hail)
- iv) Snow (All frozen precipitation except hail)

Note: i) The weather types are shown in order of increasing rank.
ii) When two or more types occur simultaneously, the highest ranking one is chosen.
iii) Blowing snow is ignored, and if it occurs by itself, the observation is skipped.

(b) Wind Direction

- i) There are sixteen equally sized classes with the first one centered on true north.

Note: i) If data amounts are small, the number of wind direction classes can be reduced to eight.

(c) Wind Speed

- i) Calm
- ii) (1 - 9) mph
- iii) (10 - 19) mph
- iv) (20 +) mph

(d) Seasons

- i) Winter (December, January, February)
- ii) Spring (March, April, May)
- iii) Summer (June, July, August)
- iv) Autumn (September, October, November)

(e) Time of Day

- i) Day-time (Sunrise to sunset inclusive)
- ii) Night-time (Strictly between sunset and sunrise)

Note: i) The program automatically calculates mean monthly times of sunset and sunrise using the station's latitude and longitude.

(f) Ceiling

- i) (000 - 100) feet
- ii) (200 - 400) feet
- iii) (500 - 900) feet
- iv) (1000 - 2400) feet
- v) (2500 +) feet

(g) Visibility

- i) (0 - 3/8) miles
- ii) ($\frac{1}{2}$ - 3/4) miles
- iii) (1 - 2 1/2) miles
- iv) (3 - 5) miles
- v) (6 +) miles

Note: i) The ceiling and visibility classes can be re-defined to suit local needs if desired.

3. Discussion of Results

The following description of the topography in the Chatham area is taken directly from Bourque (1). "Chatham airport is located in the flat country near the mouth of the Miramichi River. The airfield elevation is 109 feet and is located two miles south of the town of Chatham. The airfield lies on the edge of a heavily forested area lying to the southwest. To the east and southeast the forest gives way gradually to marshlands until the Gulf of St. Lawrence coastline is reached twenty-five miles east. Miramichi Bay lies directly northeast. The Miramichi Valley runs directly southwest from Chatham for another sixty miles, becoming increasingly less shallow. To the west and northwest, the topography rises until a chain of hills topped generally at two thousand to twenty-five hundred feet is reached at about fifty miles, lying north-south."

Because the amount of data output by the program is large, and limited in application to Chatham (A), only brief extracts are given. The extractions shown below illustrate the complicated effects of weather type, wind direction, wind speed, season and time of day on ceilings and visibilities.

(a) Table A "Effect of Weather Type"

	Ceilings				Visibilities			
	1	2	3	4	1	2	3	4
Nil	0.0	1.0	2.6	9.8	*	*	*	*
Fog	16.4	35.9	16.4	11.7	13.3	22.7	28.1	23.4
Rain	19.4	41.9	21.0	16.1	4.8	30.6	45.2	11.3
Snow	0.4	8.2	28.2	42.5	2.6	15.1	36.6	18.3

- Note: i) The results in this table are for a wind direction of (034-056) degrees true, a wind speed of (1 - 9) mph, in winter.
 ii) The ceiling and visibility classes are those defined above.
 iii) The results represent the number of observations found in each of these classes, expressed as a percentage of the total found in all five.
 iv) In this case, conditions are much worse in fog and rain than in snow. Ceilings below 500 feet occur seventimes as often in rain as in snow.

(b) Table B

"Effect of Wind Direction"

	Ceilings				Visibilities			
	1	2	3	4	1	2	3	4
057-078	3.5	19.2	39.2	29.7	13.8	31.9	29.5	10.5
237-258	0.7	1.3	6.0	28.5	0.0	2.0	19.2	17.9

- Note: i) The results in this table are for a weather type of snow, a wind speed of (10 - 19) mph, in winter.
 ii) The winds from (057 - 078) degrees pick up moisture from (237 - 258) degrees undergo considerable downslope flow, resulting in much better conditions.

(c) Table C

"Effect of Wind Speed"

	Ceilings				Visibilities			
	1	2	3	4	1	2	3	4
Rain								
1 - 9	19.4	41.9	21.0	16.1	4.8	30.6	45.2	11.3
10 - 19	7.5	60.2	24.1	4.5	4.5	18.8	53.4	21.1
20 +	2.4	29.8	67.9	0.0	1.2	4.8	84.5	9.5
Snow								
1 - 9	0.4	8.2	28.2	42.5	2.6	15.5	36.6	18.3
10 - 19	0.9	20.1	36.6	33.3	8.3	27.2	32.2	14.5
20 +	15.3	36.4	28.5	19.8	40.9	25.2	15.3	7.9

- Note: i) Ceilings and visibilities are related directly to wind speed in the case of rain, but indirectly in the case of snow.
 ii) Notice that with strong winds and rain, 84.5% of the time the visibility is 1 - 2 1/2 miles.
 iii) The above results are for a wind direction of (034 - 056)

degrees, in winter.

(d) Table D.

"Effect of Season"

	Ceilings				Visibilities			
	1	2	3	4	1	2	3	4
Rain								
Winter	15.2	28.3	37.0	15.2	15.2	17.4	21.7	19.6
Spring	1.7	22.1	14.5	18.6	2.3	11.0	11.6	18.0
Summer	2.0	7.9	18.7	14.7	1.6	2.8	15.5	26.2
Autumn	6.2	10.9	18.7	23.3	3.1	6.7	17.6	22.8
Snow								
Winter	0.9	5.0	15.3	38.8	1.6	9.8	30.1	21.7
Spring	0.0	6.2	23.8	38.8	0.0	18.1	24.7	16.3
Autumn	0.0	6.1	22.4	30.6	2.0	9.2	23.5	14.5

- Note:
- i) The results in this table are for calm winds.
 - ii) With rain, ceilings and visibilities are lowest in winter due to the cooling effect of snow cover.
 - iii) With snow, on the other hand, ceilings and visibilities are lowest in spring, due to the higher moisture content of maritime air masses, which causes greater snowfall.
 - iv) Note that whereas visibilities in winter are lower with rain than with snow, the reverse occurs in autumn.

(e) Table E

"Diurnal Effects"

Weather Type			Wind Speed			Season		
Nil	N	*	Calm	N	n	Winter	N	d
Fog	N	n	1 - 9	N	n	Spring	N	n
Rain	N	n	10 - 19	N	n	Summer	N	n
Snow	N	d	20 +	N	d	Autumn	N	n

Wind Direction			Wind Direction		
349 - 033	N	d	169 - 213	N	n
034 - 078	N	n	214 - 258	N	n
079 - 123	N	n	259 - 303	D	d
124 - 168	N	n	304 - 348	D	d

- Note:
- i) This table shows whether ceilings (upper case) and visibilities (lower case) are lower during the night (N) or day (D).
 - ii) The results were averaged for the given variables.
 - iii) In nearly all cases conditions are lower during the night than the day.
 - iv) Petterssen (2) states, "At temperatures above -10°C (snow crystals) are often matted together in large flakes." The lower daytime visibilities in snow may be a consequence of this fact. They may also result from the difference between observing dark objects against a light background by day vice transmitted light against a dark background by night.
 - v) The lower daytime visibilities in winter is the result of the effect of snow outweighing those of rain and fog.
 - vi) There appears to be no apparent explanation for the lower daytime ceilings and visibilities occurring with northwest winds.

As a supplement, the program analyzes the dependence of weather type on wind velocity and season, and the effect of season on wind velocity. Rather than include the five pages of data that comprise these results, two graphs are presented as illustrations.

(a) Figure 1 "Probability of Weather Type as a Function of Wind Direction"

- Note:
- i) These results are for winds of 20+ mph in spring.
 - ii) Snow predominates with northerly winds, rain with southeasterlies, and nil weather with southwest winds.

(b) Figure 2 "Probability of Spring Rain as a Function of Wind Velocity"

- Note:
- i) Combined with the strong directional dependence, there is a direct relationship between the likelihood of rain and wind speed.

These few examples should suffice to show that the interactions between wind, weather and time and their effects of ceilings and visibilities are very complex.

4. Conclusions

Ceilings and visibilities have a complicated dependence on wind, weather and time. A computer program has been written which will produce a climatological guide to help the forecaster assess these dependencies. It is suggested that these guides be produced for other stations and be available in a series such as the AES Hourly Data Summaries.

APPROVED,



J. R. H. Noble
Assistant Deputy Minister
Atmospheric Environment Service

References

1. Bourque, C. J., 1971: The Climate of Chatham, New Brunswick (Unpublished).
2. Petterssen, S., 1956: Weather Analysis and Forecasting, Vol. 2, McGraw-Hill Book Company, p. 75.

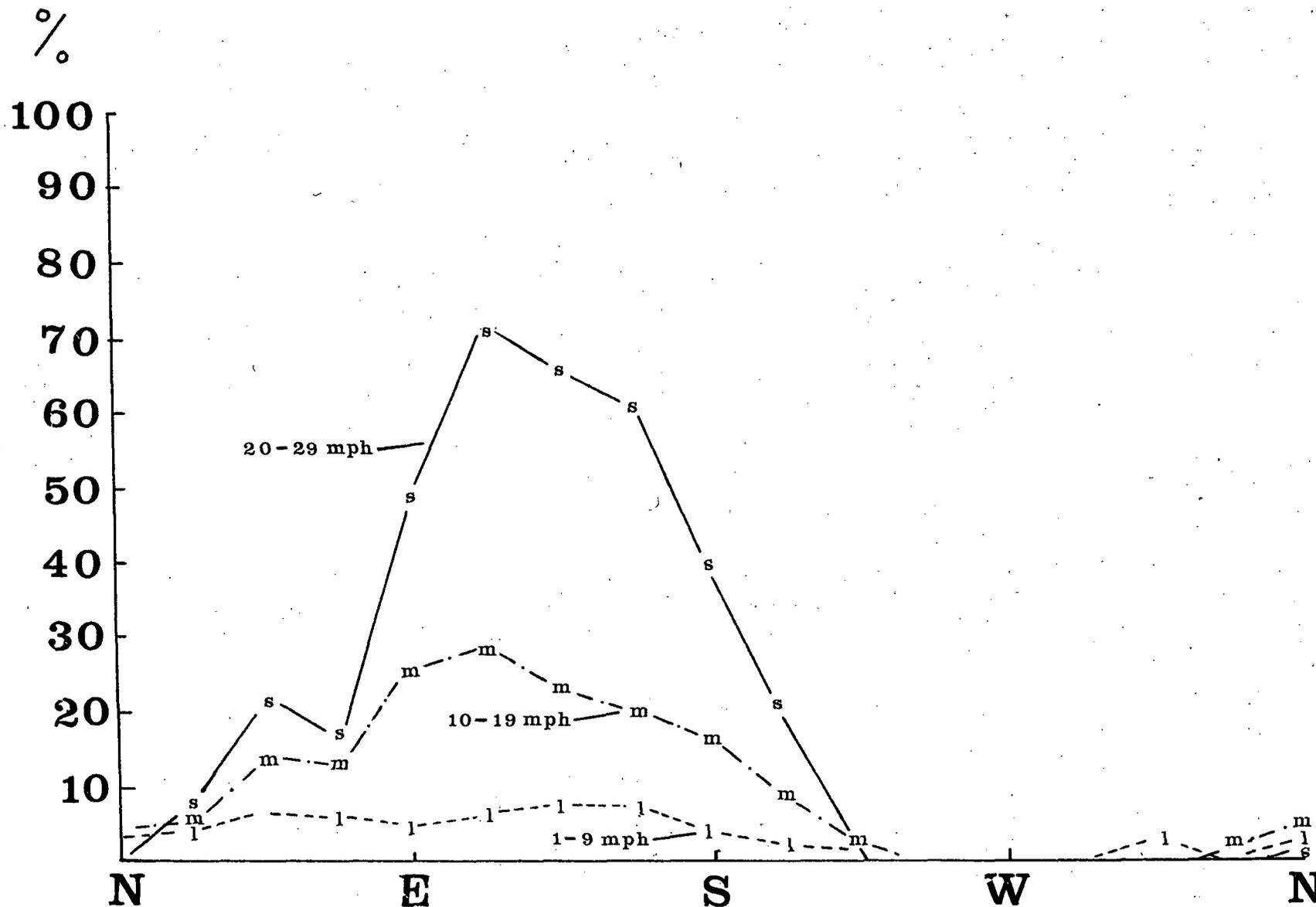


Figure 1 Probability of weather type at Chatham (A), New Brunswick as a Function of Wind Direction (Spring, Wind Speed 20+ mph)

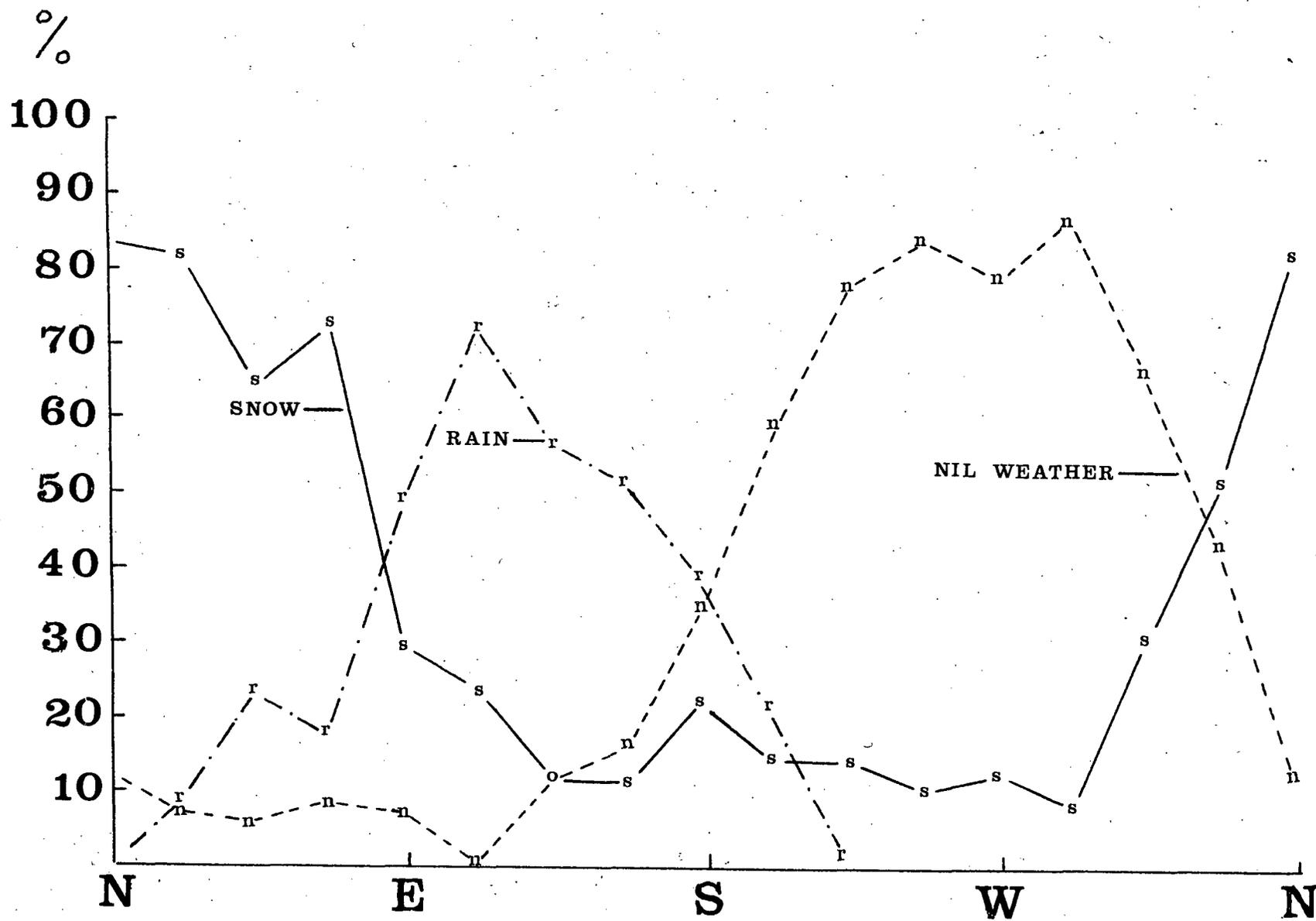


Figure 2 Probability of Spring Rain at Chatham (A), New Brunswick as a Function of Wind Velocity

TEC 831
10 June 1976

UDC: 551.509.313
ISSN 0068-7804

CANADA

Environment - Atmospheric Environment Service
4905 Dufferin Street, Downsview, Ontario

The Effects of Wind, Weather, Season and time of Day
On Ceilings and Visibilities at Chatham (A),
New Brunswick by M. A. Purves

7 pps. 2 figs. 2 refs.

Subject References: 1. Ceilings and Visibilities
2. Numerical Prediction
3. Chatham, New Brunswick

ABSTRACT:

A computer program has been written to analyze archived weather observations. The aim is to provide the forecaster with climatological data showing the relationships between ceilings and visibilities, wind velocity, weather type, season and time of day for any given station.

Extractions of results from Chatham (A), New Brunswick are presented to illustrate the complex inter-relationships that exist between the variables.