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Patterns of Aerial Photo Weather in Canada.

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Surveys and Mapping Branch
Direction des levés
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DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES
OTTAWA, CANADA.

TECHNICAL REPORT NO. 70-12

PATTERNS OF AERIAL PHOTO WEATHER IN CANADA

by

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ABSTRACT

Weather suitable for high altitude aerial survey photography is defined in terms of cloud cover, horizontal visibility, and solar altitude. With these criteria established, relevant weather observation data stored in the electronic archive of the Meteorological Service of Canada were isolated and used to compute a single figure value for each observation station, each month, for each of two minimum solar altitudes. Isopleths were then plotted on suitable base maps to depict the mean frequency of occurrence of observations meeting the criteria over a 10-year period.

During the study of the accumulated data it became apparent that four major areas which exhibit distinctive zonal photo weather patterns are to be found in Canada. Possible reasons for the existence of these zonal distributions are discussed in terms of their regional and local, geographical and meteorological characteristics.

The information presented in this report is statistical and standard deviations from mean values in the data were not possible. This and other limitations on the application of the data to specific cases is discussed.

PATTERNS OF AERIAL PHOTO WEATHER IN CANADA

INTRODUCTION

The acquisition of air survey photography, particularly from very high altitudes, is very much dependent upon the occurrence of suitable weather of a type that occurs infrequently over much of Canada. The rarity of such weather is not generally realized among those not closely involved in air survey operations. Hence some indication of the overall pattern of distribution and frequency of occurrence of "photo weather" should prove useful to planners in Federal, Provincial and commercial mapping and other data-collecting agencies.

The imminent application of earth resources satellite data will also require some means of assessing the probable rate and pattern of data acquisition in order to assist the formulation of plans to utilize the data most effectively.

No comprehensive Canadian climatological information has been prepared from the specialized point of view of air survey photography, although some investigations have been carried out in support of specific operations (Thomas 1963, Chang 1969, Krick 1956). Recognizing the need for objective statistical data, the Interdepartmental Committee on Air Surveys at its annual general meeting in December 1968 authorized the expenditure of I.C.A.S. funds for the purchase of basic data.

SOURCE OF PHOTO WEATHER DATA

A tremendous volume of raw data on which to base a study of photo weather exists in the archives of the Meteorological Service of Canada (M.S.C.), in the form of records of hourly observations of several meteorological parameters compiled over many years. The sheer volume of information makes it a formidable task to isolate those observations that are relevant to air survey photography. Only modern data-processing equipment makes it practical.

For several years the M.S.C. has been recording the hourly weather observations on punched cards at an increasing number of observing stations. Periodically the data is transferred to magnetic tape or disc storage in a central data bank, in which form it is accessible to modern data-processing techniques (Cudbird 1968). Unfortunately, not all data from all observing stations is yet available in this convenient form. All current data is being stored thus, and M.S.C. is transcribing historical data similarly, working in reverse chronological order through decades of hand-written records.

As of late 1968, a ten-year history of hourly observations was available from just over 100 stations in Canada covering the years 1957 to 1966 inclusive. These stations are sown fairly thickly across southern and central Canada, but are few and far between in the North.

DEFINITION OF PHOTO WEATHER

In order to select from the mass of data available (in this case, nearly nine million sets of observations) that information which is relevant to air survey photography, it is necessary to define "photo weather" in terms of the meteorological parameters recorded each hour at observing stations. A consensus was sought among the opinions of experienced photo-navigators of member companies of the Canadian Association of Aerial Surveyors. The definition finally applied is perhaps more of an arithmetic average than a consensus, and is biased in the direction of conditions deemed necessary for very-high-altitude photography, since such conditions are assumed necessary also for satellite photography. Because of the stringent definition applied, it is a reasonable assumption that weather suitable for less demanding photography (i.e. from more modest altitudes over smaller areas) has occurred more frequently.

Thus for the purposes of this study photo weather is considered to exist when the total reported cloud does not obscure more than 2/10ths of the sky, no lower or middle cloud is reported, (i.e. cirrus only), and horizontal visibility is 10 miles or greater, while the sun is 20° or more above the horizon. Although vertical survey photography is affected more by vertical than by horizontal visibility, only the latter is observed and reported hourly. Most navigators agree that when atmospheric haze, smoke or other obstruction to vision reduces visibility to less than 10 miles, the likelihood of securing high-altitude vertical photography of acceptable quality on panchromatic film is remote.

Given the foregoing definition, the M.S.C. devised a program to search its electronic archives for the period 1957 to 1966 inclusive, extracting monthly totals of the number of observations meeting the established criterion, which was designated Condition A by M.S.C. To include solar altitude limitations at this stage would have entailed an uncomfortable degree of complexity in the computer program and reduced the flexibility of the output. Thus the data delivered by M.S.C. consisted of a complete page of data for each station, listing month by month the total number of observations at each hour of the 24-hour day, which met Condition A. Obviously those observations made during hours of darkness are of no relevance to air survey photography, but in this form we may enclose the relevant portions of the data within an envelope of any solar altitude of our choosing. Alternatively, relevant to a sun-synchronized satellite orbit, we may examine the data for any hour of the day.

ISOLATION OF OBSERVATIONS RELEVANT TO PHOTO WEATHER

To determine the number of observations of significance to air survey photography, solar altitude envelopes were computed for each station and a summation of the observations within each envelope carried out. This resulted in a single figure for each station for each month for each of two minimum solar altitudes. These figures were plotted on a series of maps illustrating the mean frequency of occurrence of observations meeting the specified definition of photo weather over the 10-year period under study. To facilitate use within the Surveys and Mapping Branch the isopleths have been prepared on maps of Canada on which has been overlaid a grid representing the basic framework of the National Topographic System of numbering maps. Where the density of data is too diffuse to justify the construction of isopleths, the average number of observations of photo weather has been plotted beside some of the stations.

Minimum solar altitudes of 20° and 30° were selected as being of greatest probable interest. Canadian experience has been that acceptable survey photography from medium and high altitudes can be procured when the sun is only 20° above the horizon if there is no high relief, extensive forest cover or built-up area to cast long shadows over significant detail. Over mountainous, forested or built-up areas, particularly when using colour films or minus-blue filters, 30° is considered the minimum useful solar altitude to minimize loss of information in shadowed areas. Between 30° and 20°, luminous density (Brock 1952) drops sharply, but sufficient light is available to permit adequate exposure of surfaces in direct sunlight with air survey cameras and monochrome films in current use. Below 20° the very rapid decrease of illumination coupled with the extreme length of shadows almost invariably results in under-exposure at the shutter speeds necessary to limit image motion in air photography.

The procedure of enclosing the data within envelopes of solar altitude necessarily involves some interpolation. The method of interpolation chosen for the sake of simplicity probably results in some anomalies which are likely to be most pronounced in the data for those mid-winter months just preceding and following the winter solstice. Since this is also the season of extensive snow cover, short days, low solar altitudes and long shadows, when aerial photographic activity is at a minimum, maps are not included for November, December and January for a minimum solar altitude of 30°, nor for December in the case of the 20° minimum.

HOMOGENEOUS ZONES

Because of the discontinuous nature of the observations and of the phenomenon under study, it is perhaps surprising that any coherent pattern has emerged. However, it was found possible to draw isopleths at intervals of 10 observations dividing southern Canada into zones that are assumed to have been more or less homogeneous as to frequency of occurrence of photo weather. In all cases, the mean values at stations enclosed between a given pair of lines lie between the limiting values defined by the respective lines; however, it is questionable whether it is safe to assume the converse-- i.e. that all other points between the same lines would also have observed frequencies within the same limits. Such assumption is however implicit in an isoplethic map.

FOUR MAJOR ZONES OF PHOTO WEATHER

Certain characteristics of the observed patterns of distribution throughout the normal photo season are worth noting. There appear to be four major zones of photo weather across southern and central Canada. The westernmost zone extends from about the Great Divide of the Rocky Mountains to the Pacific coast. East of the Rockies the influence of the mountains appears to affect the pattern as far east as Winnipeg and Lake of the Woods, from which point the influence of the Great Lakes seems to dominate the pattern as far as Montreal. East of Montreal the influence of the Atlantic seaboard apparently takes over.

PHOTO CHARACTERISTICS OF THE MAJOR ZONES

PACIFIC. The Pacific zone is characterized by a minimum along the spine of the Rockies extending up to Whitehorse and a maximum in the southwest around Victoria extending up the Lower Fraser and into the Okanagan Valley. Terrace in the Skeena Valley reports a higher frequency than Smithers which is only about 60 miles farther inland. Spring Island on the northwest coast of Vancouver Island reports photo weather with up to three times the frequency of Port Hardy which lies only about 60 miles north, but on the other side of the island. In the north, Whitehorse has regularly reported less photo weather than Teslin, while in the south, a comparison of data from Vancouver and Victoria supports the most blatant propaganda of the latter city's Chamber of Commerce.

PRAIRIE. Within the Prairie zone, the maximum frequency occurs around Medicine Hat, with a narrow tongue or ridge extending northward towards Lac la Biche along a line approximately paralleling the strike of the Rocky Mountains. Over the ten-year period examined, Lac la Biche has consistently reported photo weather with a significantly higher frequency than either Cold Lake which lies only about 80 miles ESE or Edmonton, almost 100 miles SW.

One might be inclined to wonder whether Lac la Biche had been blessed with a series of optimistic weather observers were it not for the fact that observations from Vermilion, Coronation and North Battleford tend to confirm the real existence of this ridge of good photo weather. It is tempting to assume that subsidence in the lee of the Rockies plays a major role in creating the ridge, since both photo weather and lee waves tend to exist under conditions of atmospheric thermal stability. It requires the exercise of only a little imagination to interpret the patterns of the Prairie zone in terms of a series of lee waves of increasing wave lengths extending their influence downwind as far as Winnipeg.

In the Lake of the Woods region the transition between the Prairie and Great Lakes zones is defined by a minimum that may be due to the presence of many extensive water surfaces lying between the Inter lake regions of Manitoba and the Lakehead, providing the moisture and surface-temperature differences to generate diurnal cloud.

GREAT LAKES. Within the Great Lakes zone the maximum amount of photo weather seems to occur along an axis through White River, Gore Bay, Muskoka and Killaloe, decreasing markedly towards the industrial areas of southern Ontario and the northern U.S. and more gradually towards James Bay and Hudson Bay. North Bay is a persistent anomaly in the general pattern, always reporting less photo weather than Sudbury to the west or Muskoka and Killaloe to the south and east, possibly due to being located downwind from Sudbury's smelters.

Muskoka and Killaloe which are approximate termini of the axis of the Haliburton Highlands of Central Ontario have always reported photo weather with much higher frequency than Ottawa which is just about 90 miles east of Killaloe.

ATLANTIC. East of Montreal the pattern in the Atlantic zone becomes diffuse and difficult to interpret, and it must be conceded that the configuration of lines here (and elsewhere) owes at least as much to Art as to Science. One consistent bright spot in the Maritimes is Yarmouth on Nova Scotia's southwestern extremity which usually reports a much higher frequency than anywhere else in the Maritime Provinces.

SEASONAL SHIFT OF OPTIMUM PHOTO WEATHER CONDITIONS

It has long been generally appreciated among Canadian survey navigators that photo weather occurs most frequently on the southern Prairies. But over the 10-year period studied it appears that during the months of March, April, May and June, photo weather has occurred most frequently in Ontario in the area centred generally about Gore Bay on Manitoulin Island. The maximum frequency of occurrence has shifted to the Prairies only in July. However, since Northern Ontario may be snow-covered until mid-May or later, the high frequency of occurrence of photo weather in that area cannot always be exploited.

LIMITATIONS IN EVALUATING PHOTO WEATHER CONDITIONS

Most observing stations are located on airports with an unrestricted view of the entire hemisphere of the sky. Some stations however may be located at points from which the entire hemisphere is not visible. For example, Penticton, B.C. is located in the Okanagan Valley with a long field of view to the north and south along the valley; but the field of view to the east and especially to the west is restricted to a few miles by adjacent mountains. Other stations may be similarly limited as to the field of view from the station. To some extent such limitations have been considered in interpolating isopleths in mountainous country, and minima assumed over mountain ridges although not always supported by observational data.

The data collected over the 10-year period 1957 to 1966 may not be relevant to current conditions due to the increasing pollution of our atmosphere. Air survey navigators of long experience are conscious of a steady deterioration in the frequency of occurrence and duration of photo weather, largely due to increasing incidence of haze, particularly in those parts of Canada that lie downwind from the industrial areas of southern Canada and northern United States.

The information presented here, being statistical in nature, should be interpreted with a"grain of salt"in any attempt to apply it to particular cases. Unfortunately the data have been derived in a form that does not facilitate calculation of standard deviations from the mean values on which the charts are based. In any particular year large deviations from the mean, in either direction, are to be expected. However, consistent use of the data over an extended period (i.e. 5 to 10 years) should result in a record of being more often right than wrong.

MEAN MONTHLY

NUMBER OF

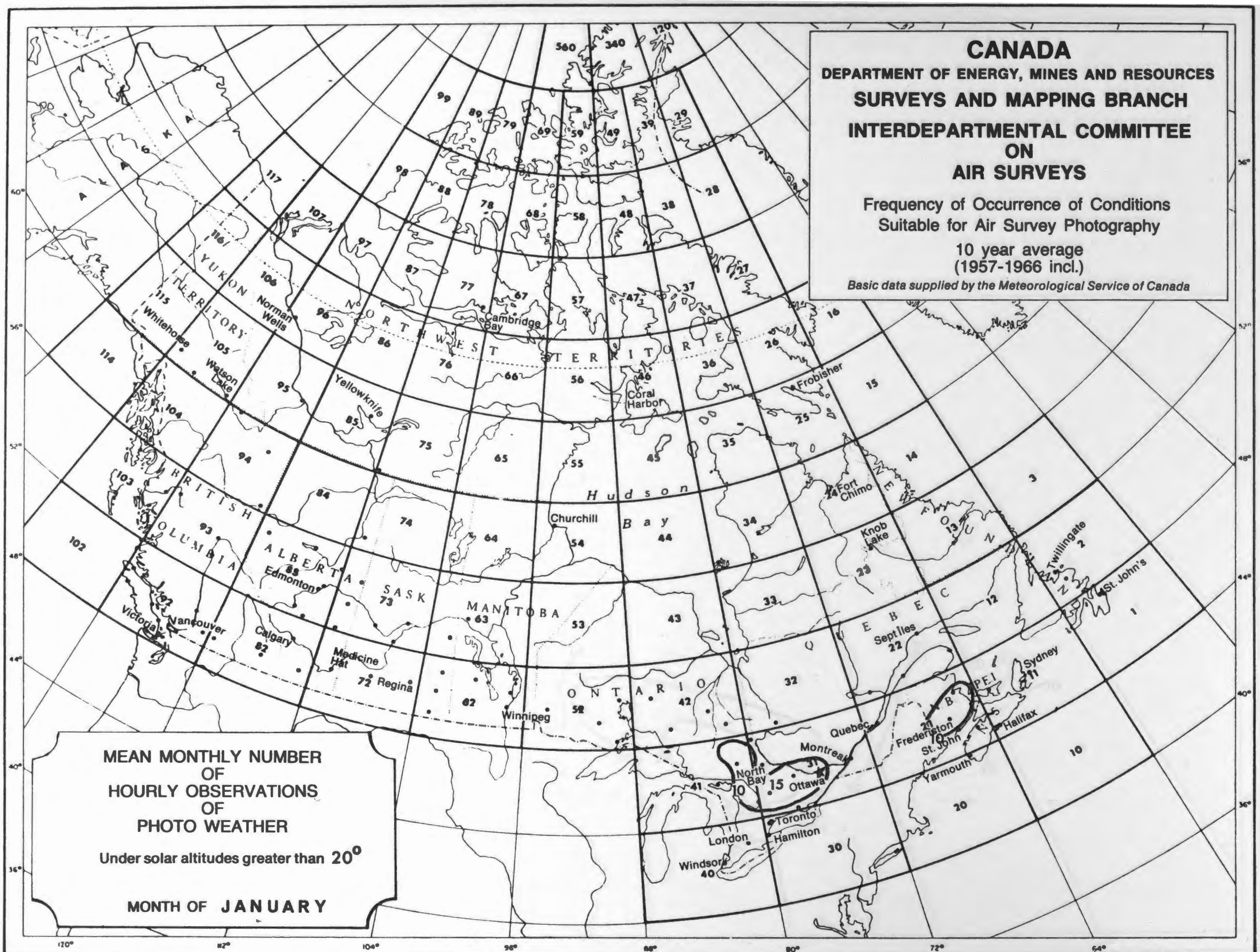
HOURLY OBSERVATIONS

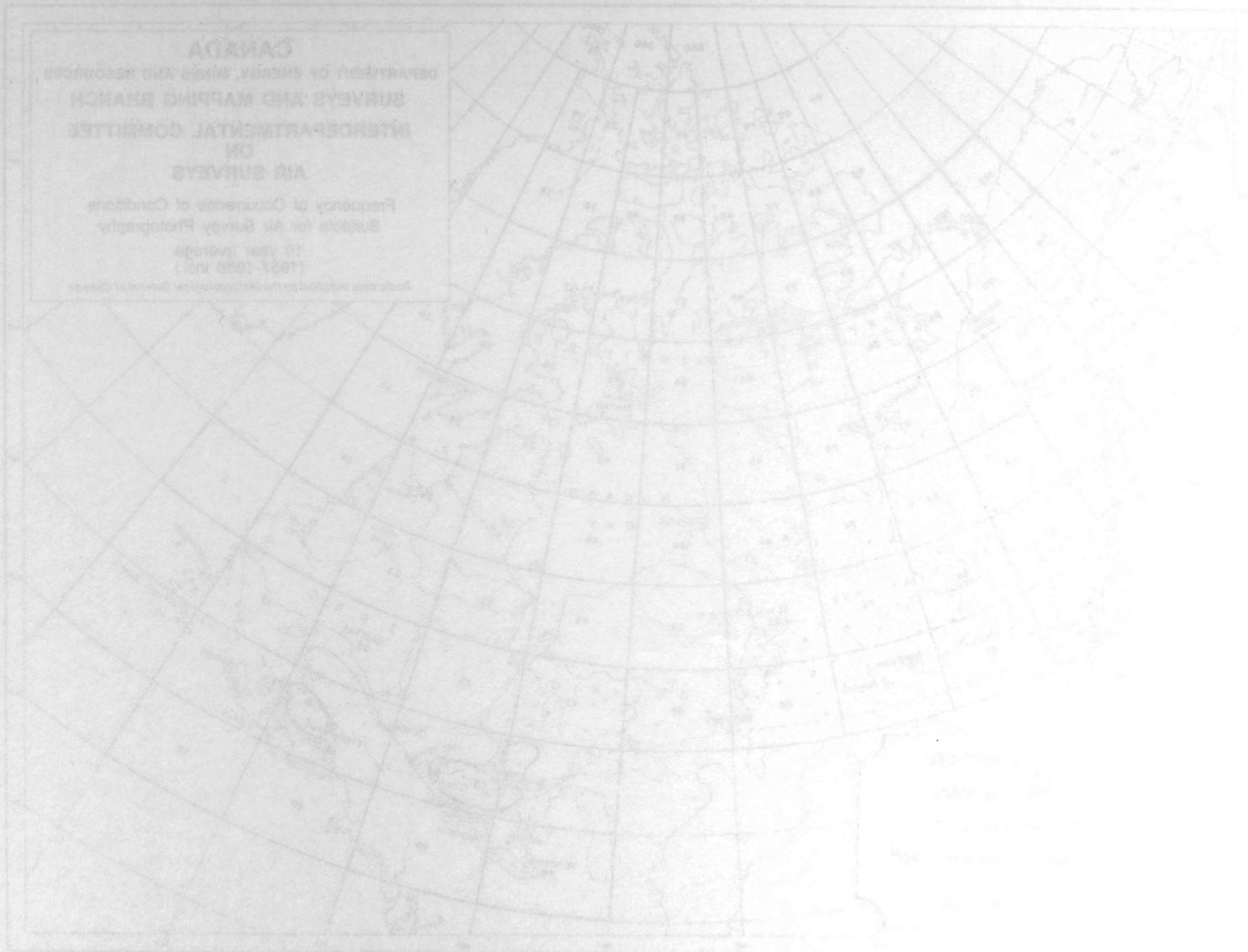
OF PHOTO WEATHER

Under Solar Altitudes

Greater than 20°

The isoplethic map for December is omitted. For explanation, see paragraph three on page three of this report.


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF JANUARY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N.B.
N.S.
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
Sept Iles
Twillingate
St. John's
Sydney
Halifax
Fredericton
St. John
Yarmouth
Quebec
Montreal
Ottawa
North Bay
Toronto
Hamilton
London
Windsor
120°
112°
104°
96°
88°
80°
72°
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
Frequency of Occurrence of Conditions Suitable for Air Survey Photography
10 year average (1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER OF HOURLY OBSERVATIONS OF PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF FEBRUARY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N.B.
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Medicine Hat
Regina
Winnipeg
Vancouver
Victoria
North Bay
Ottawa
Montreal
Quebec
Toronto
Hamilton
London
Windsor
Sept Iles
Fredericton
St. John
Halifax
Yarmouth
Sydney
Twillingate
St. John's
120°
112°
104°
96°
88°
80°
72°
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
Frequency of Occurrence of Conditions Suitable for Air Survey Photography
10 year average (1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER OF HOURLY OBSERVATIONS OF PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF MARCH
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Medicine Hat
Regina
Winnipeg
Victoria
Vancouver
North Bay
Ottawa
Montreal
Quebec
Toronto
Hamilton
London
Windsor
Sept Iles
Fredericton
St. John
Yarmouth
Halifax
Sydney
P.E.I.
N.B.
Twillingate
St. John's


CANADA
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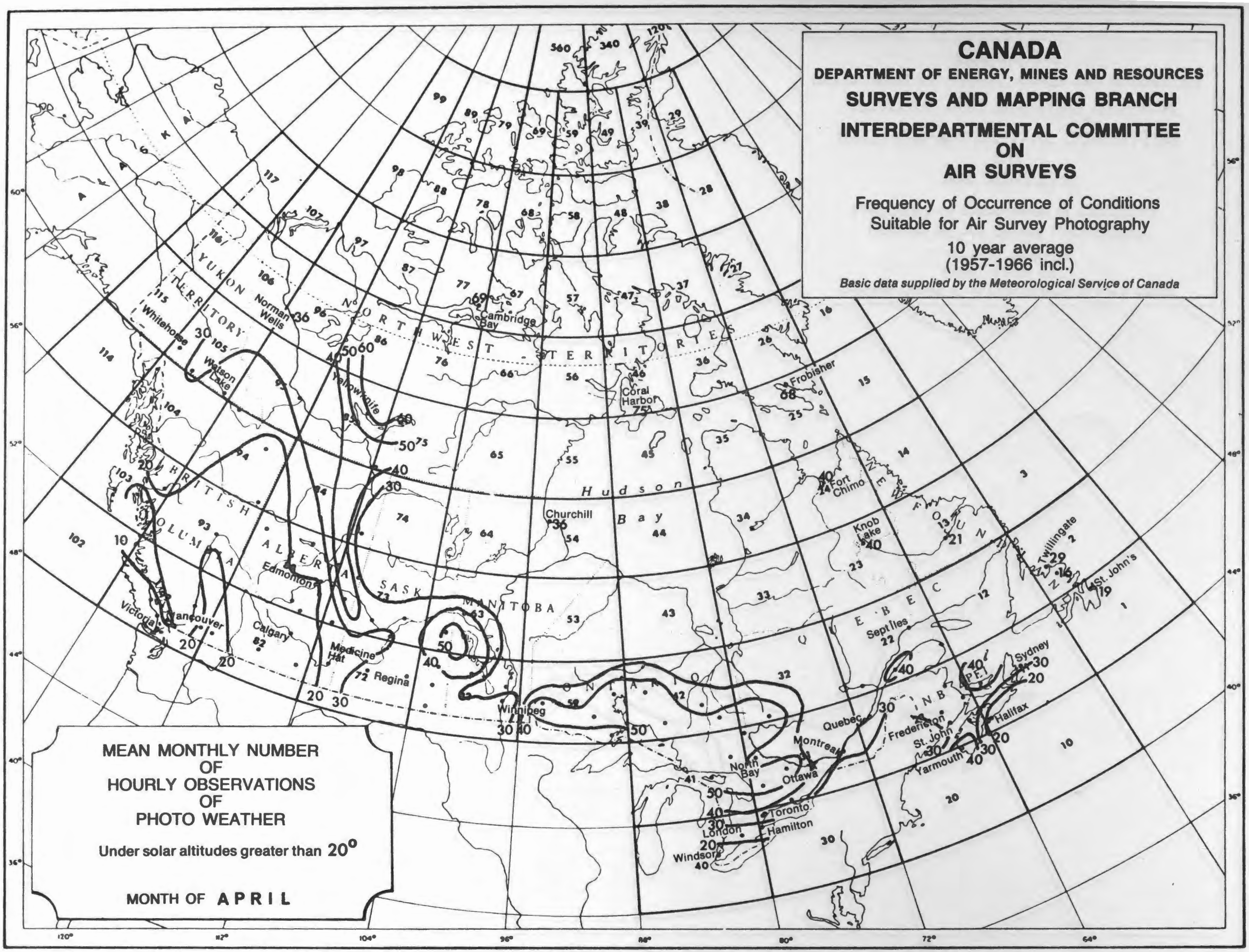
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)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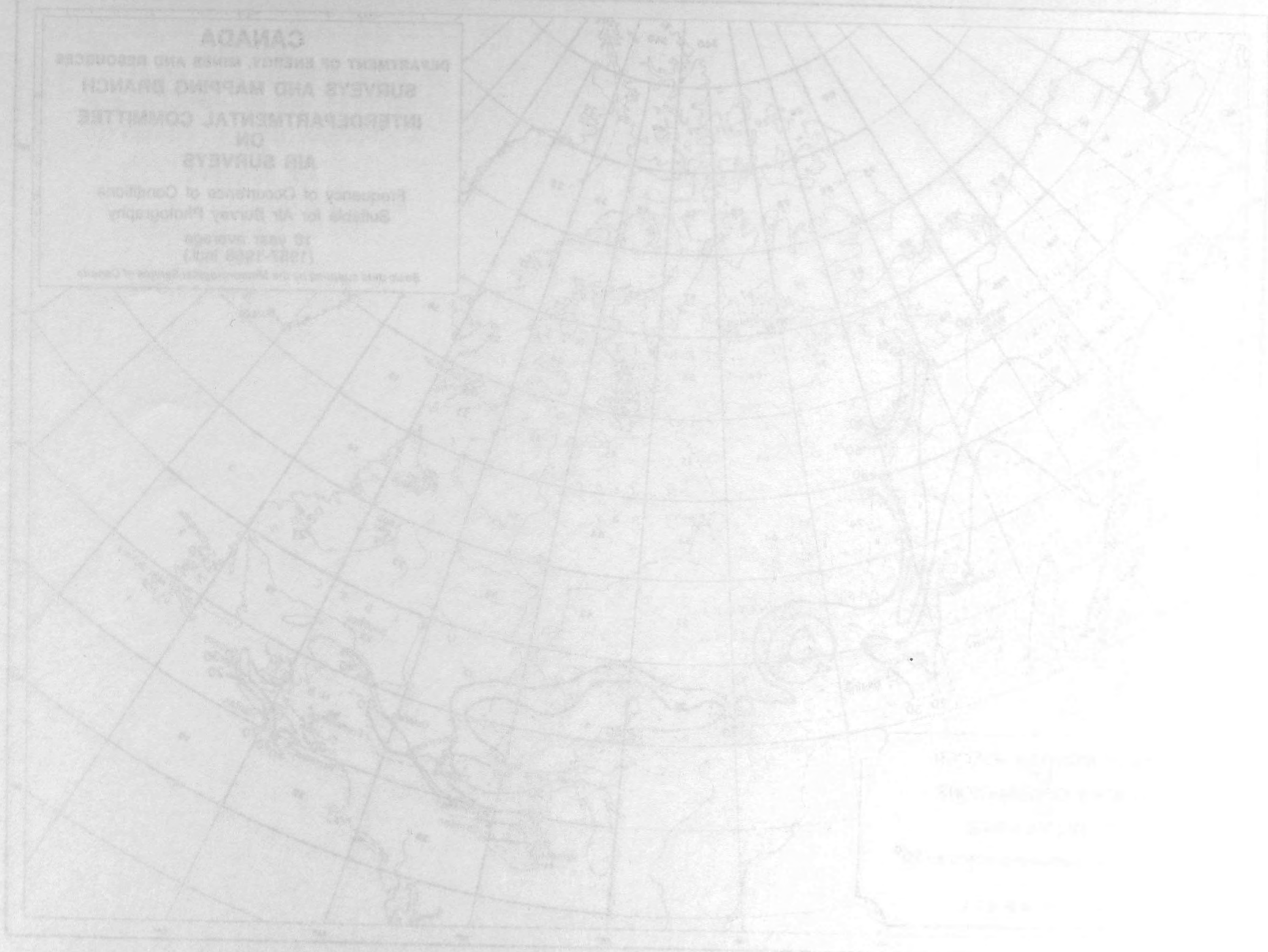
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
Frequency of Occurrence of Conditions Suitable for Air Survey Photography
10 year average (1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER OF HOURLY OBSERVATIONS OF PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF APRIL
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Churchill
Knob Lake
Twillingate
St. John's
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
Sept Iles
Sydney
Halifax
Quebec
Fredericton
St. John
Yarmouth
Montreal
Ottawa
North Bay
Toronto
Hamilton
London
Windsor
120°
112°
104°
96°
88°
80°
72°
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
12 year average
(1957-1968 incl.)
Basic data supplied by the Meteorological Service of Canada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INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF MAY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Sept Iles
Toronto
Hamilton
London
Windsor
Fredericton
St. John
Yarmouth
Halifax
Sydney
Twillingate
St. John's
120°
112°
104°
96°
88°
80°
72°
64°


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AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)


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Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
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Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF J U N E
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
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Vancouver
Victoria
Medicine Hat
Regina
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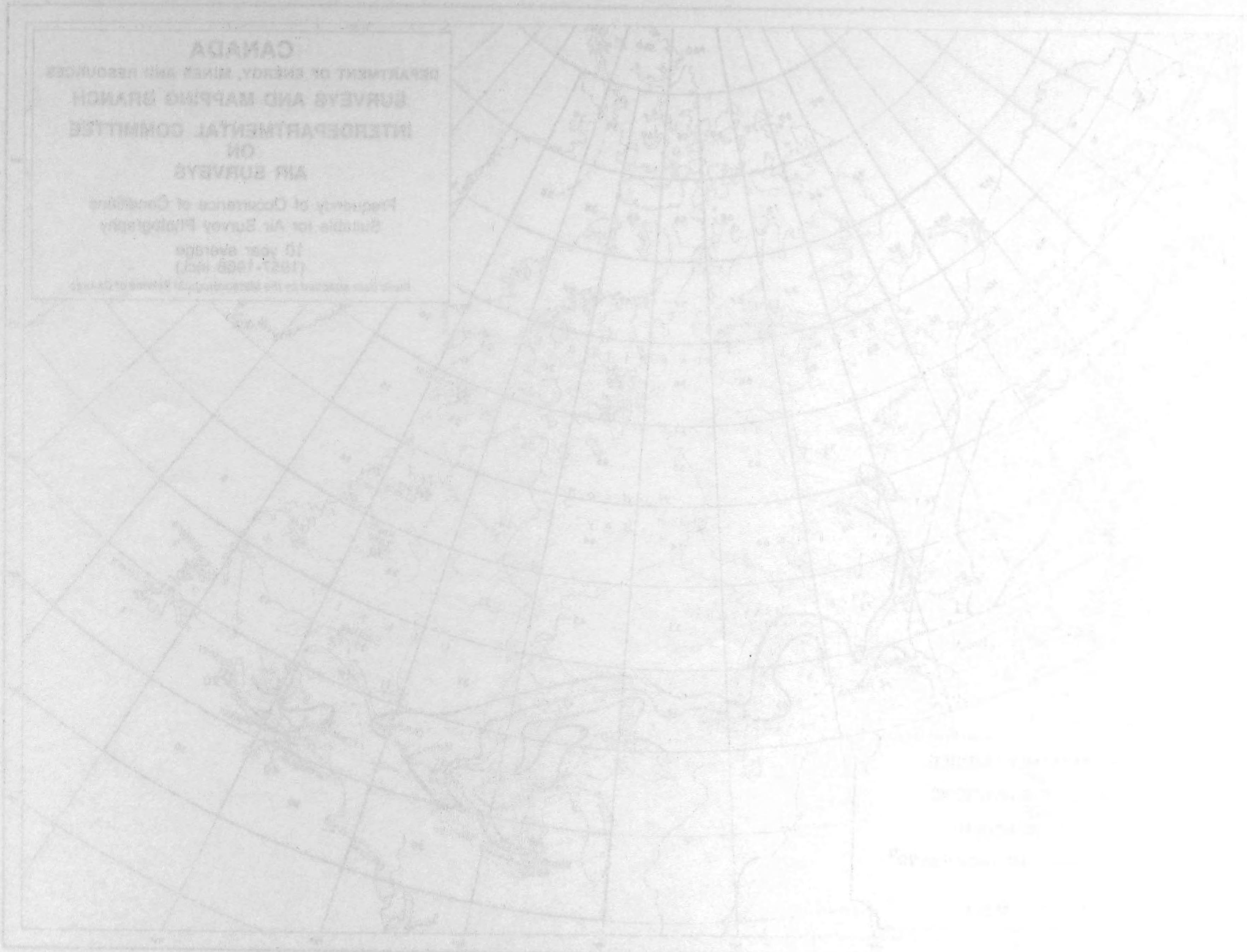
Sydney
Twillingate
St. John's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DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
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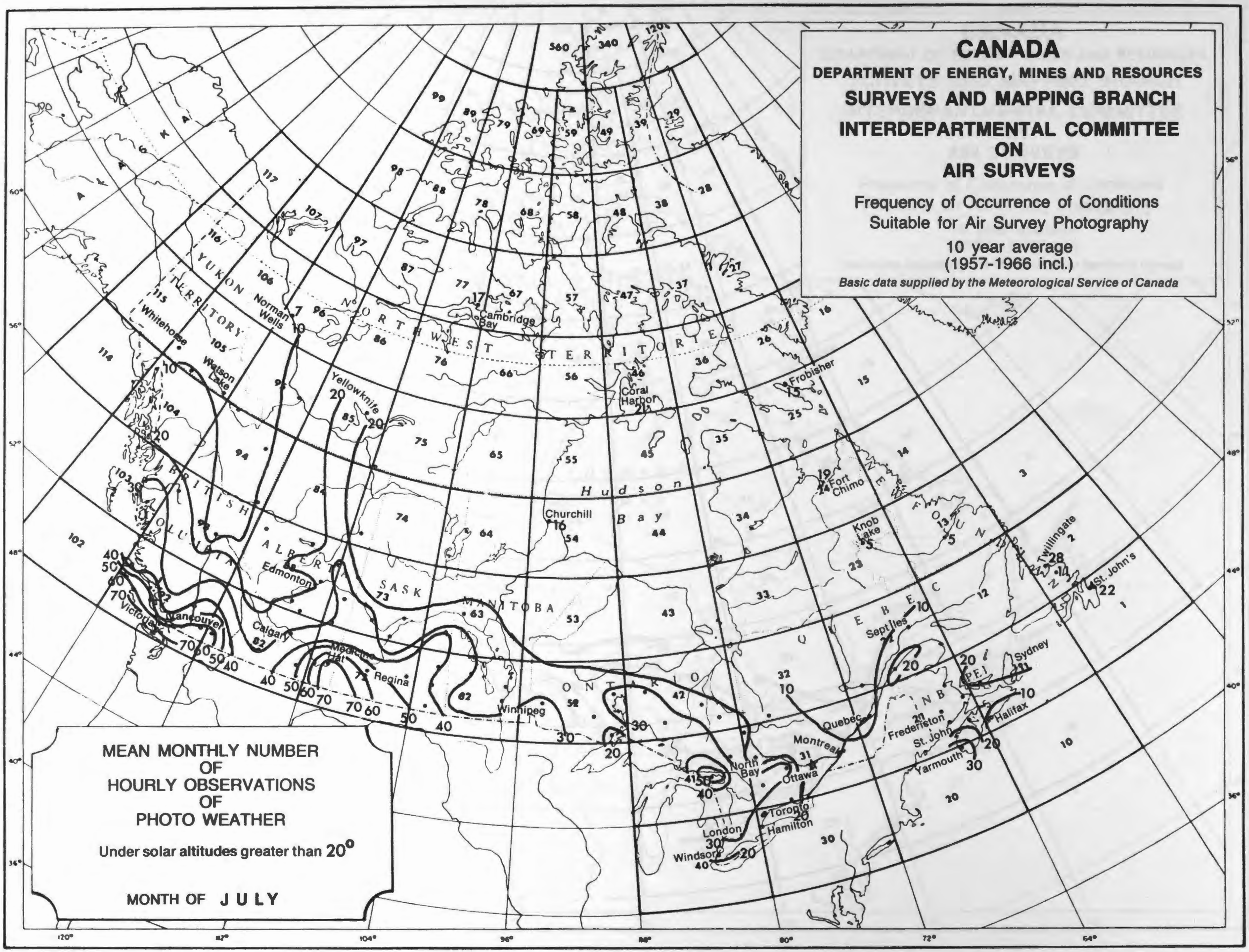
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)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AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF JULY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
P.E.I.
Hudson Bay
Whitehorse
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Yellowknife
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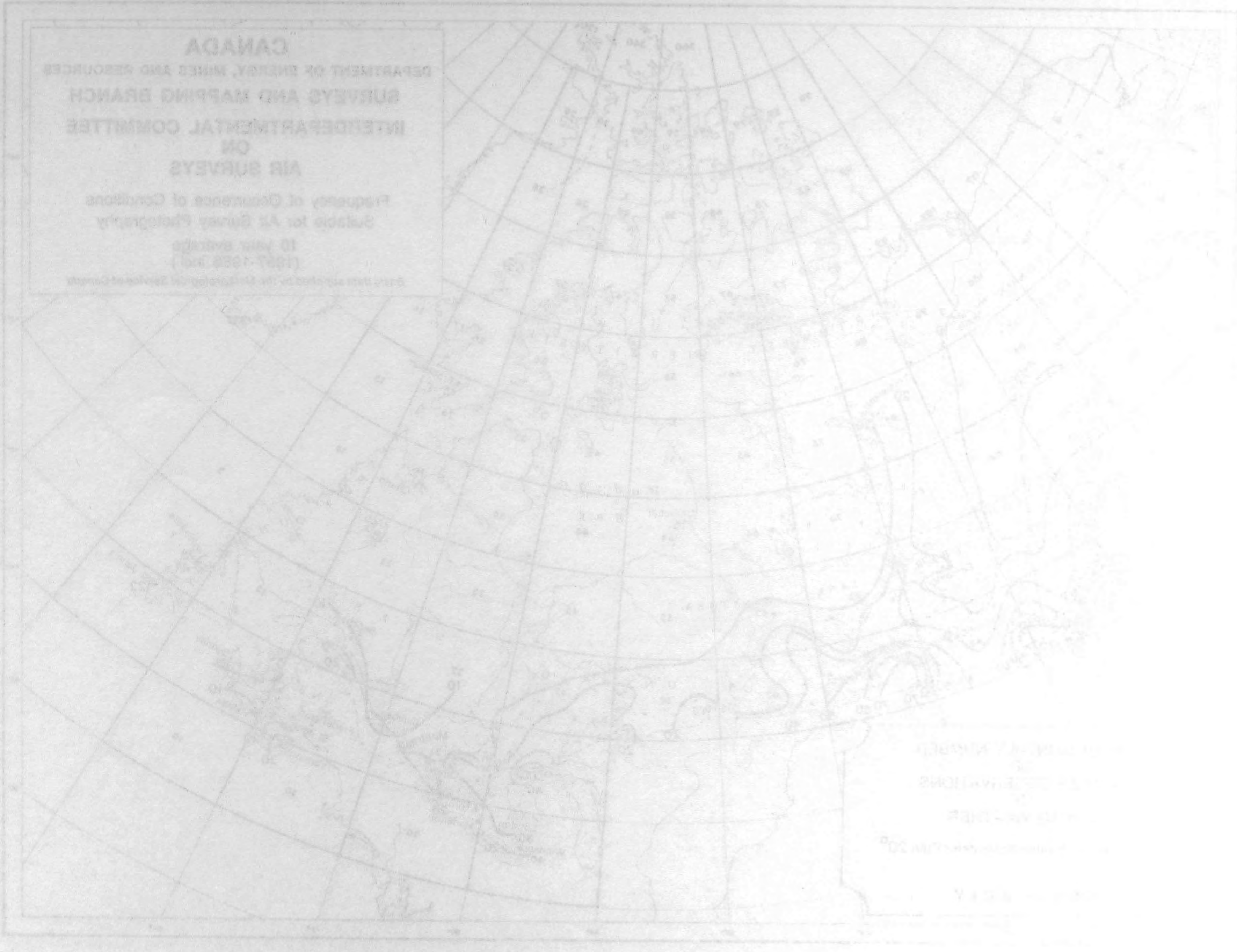
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Frequency of Occurrence of Conditions
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MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF AUGUST
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
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Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
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Frobisher
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Calgary
Vancouver
Victoria
Medicine Hat
Regina
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Montreal
Quebec
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Hamilton
London
Windsor
Fredericton
St. John
Halifax
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120°
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80°
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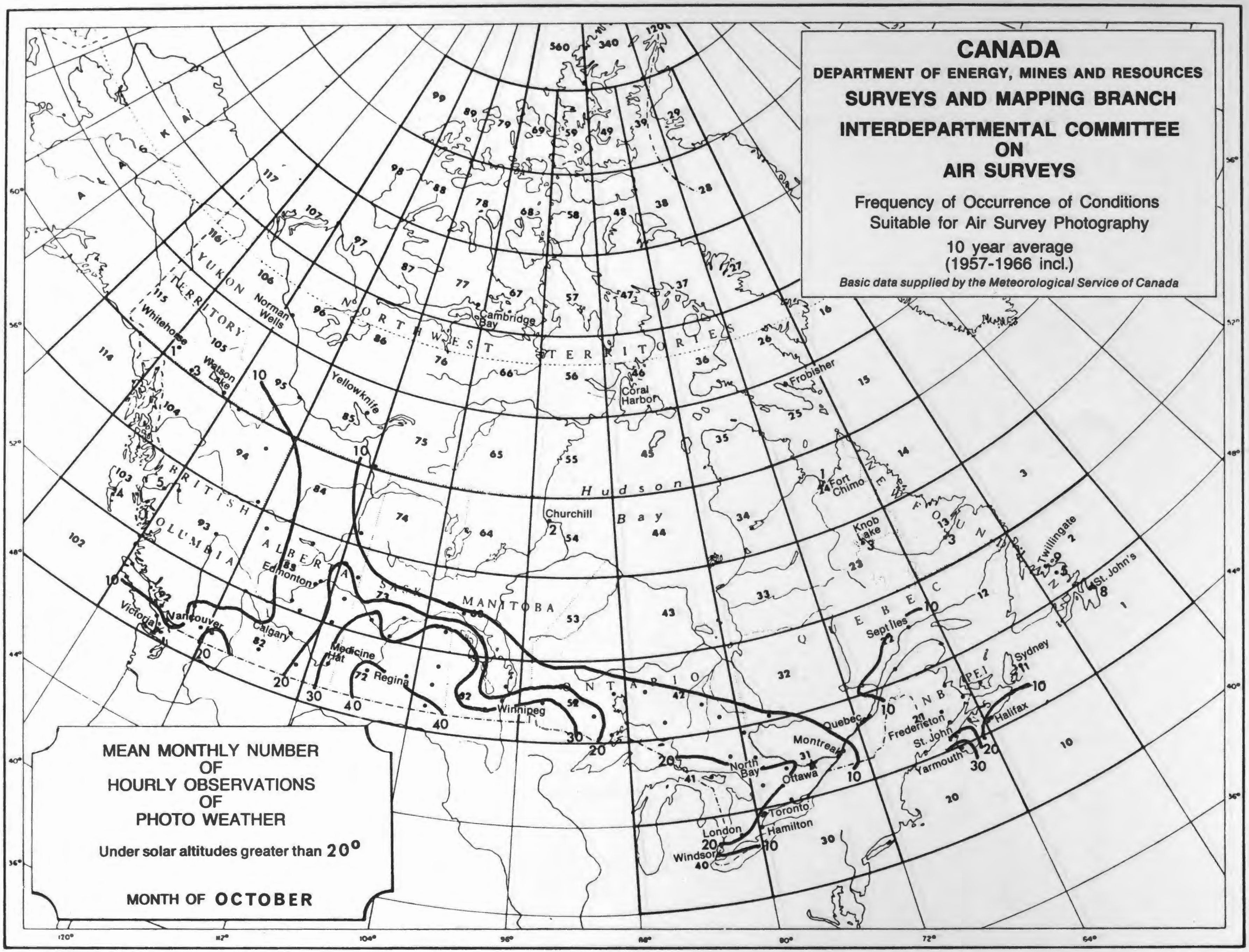
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF SEPTEMBER
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
N.B.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Toronto
Hamilton
London
Windsor
Sept Iles
Fredericton
St. John
Yarmouth
Halifax
Sydney
Twillingate
St. John's


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF OCTOBER
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Cambridge Bay
Yellowknife
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Medicine Hat
Regina
Winnipeg
Vancouver
Victoria
Sept Iles
Twillingate
St. John's
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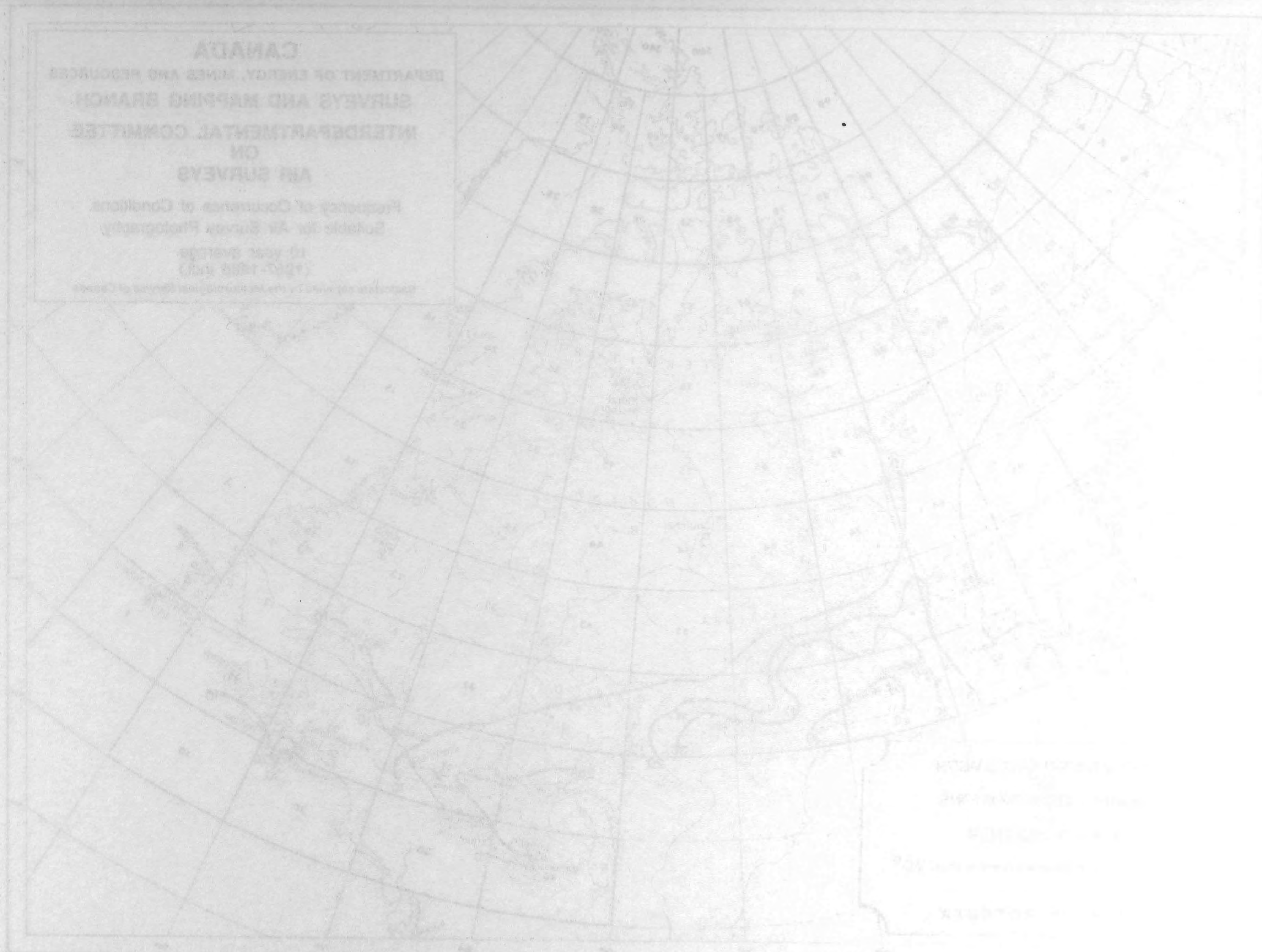
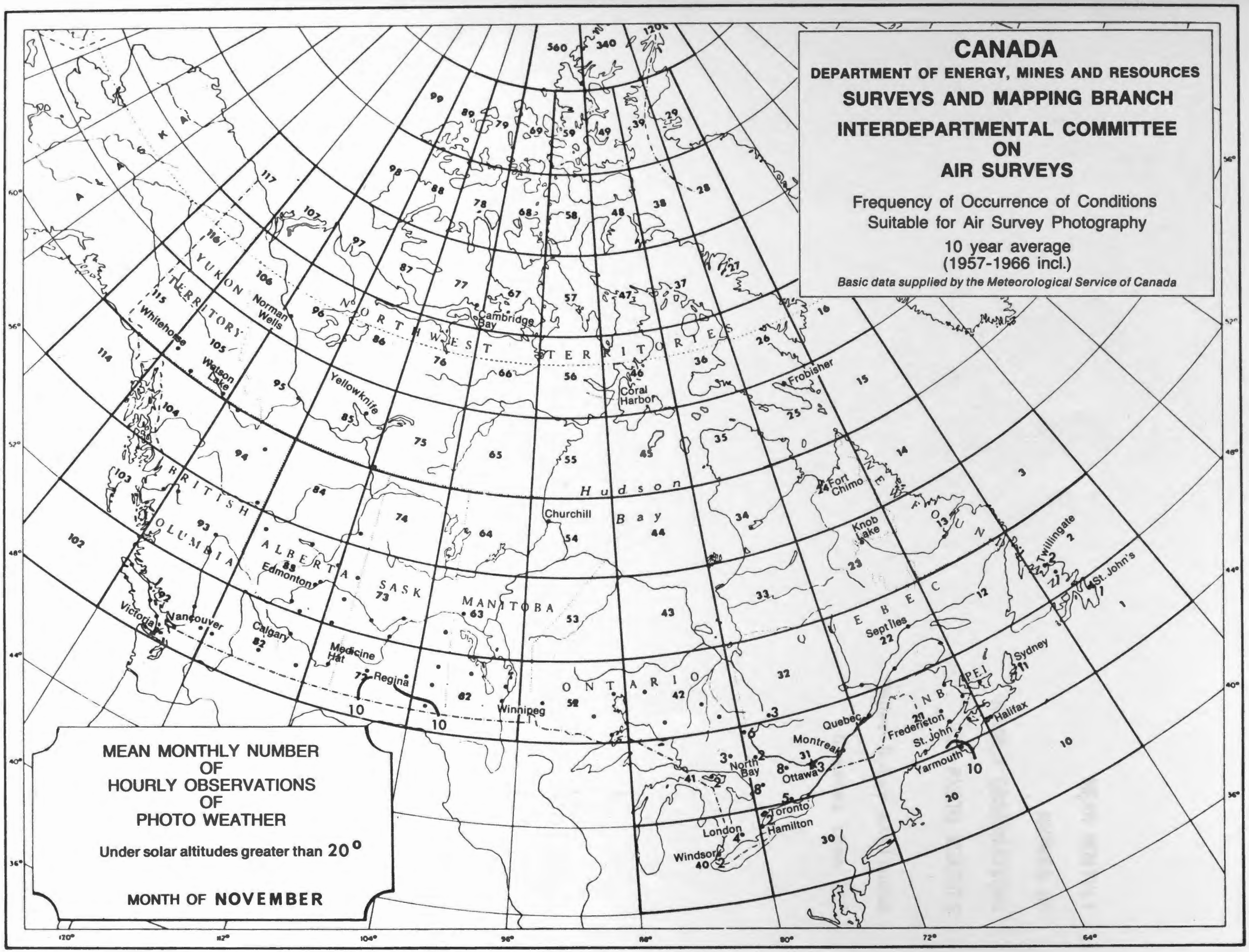
North Bay
Toronto
Hamilton
London
Windsor
Fredericton
St. John
Yarmouth
Halifax


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 20°
MONTH OF NOVEMBER
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Toronto
Hamilton
London
Windsor
Sept Iles
Fredericton
St. John
Yarmouth
Halifax
Sydney
Twillingate
St. John's

MEAN MONTHLY

NUMBER OF

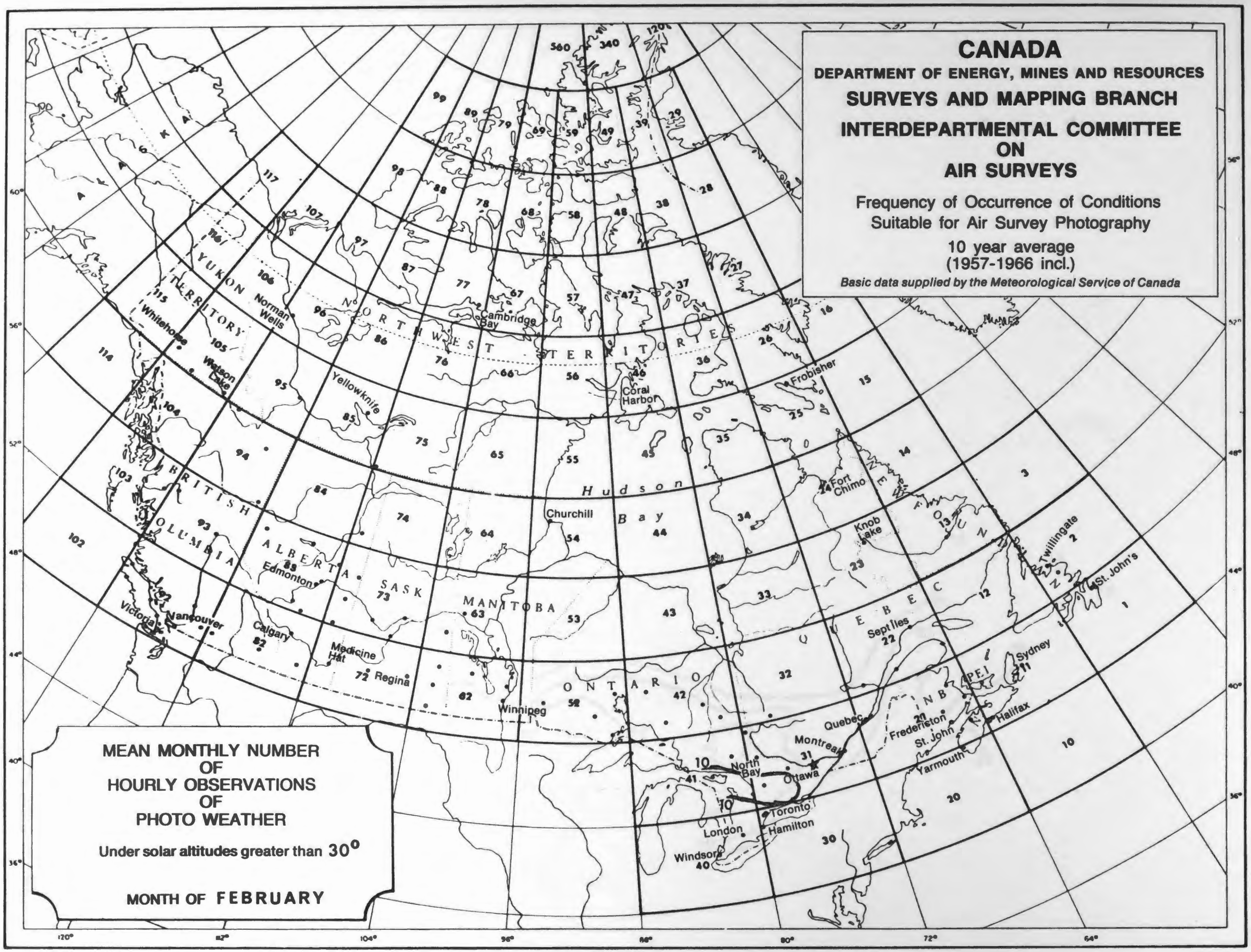
HOURLY OBSERVATIONS

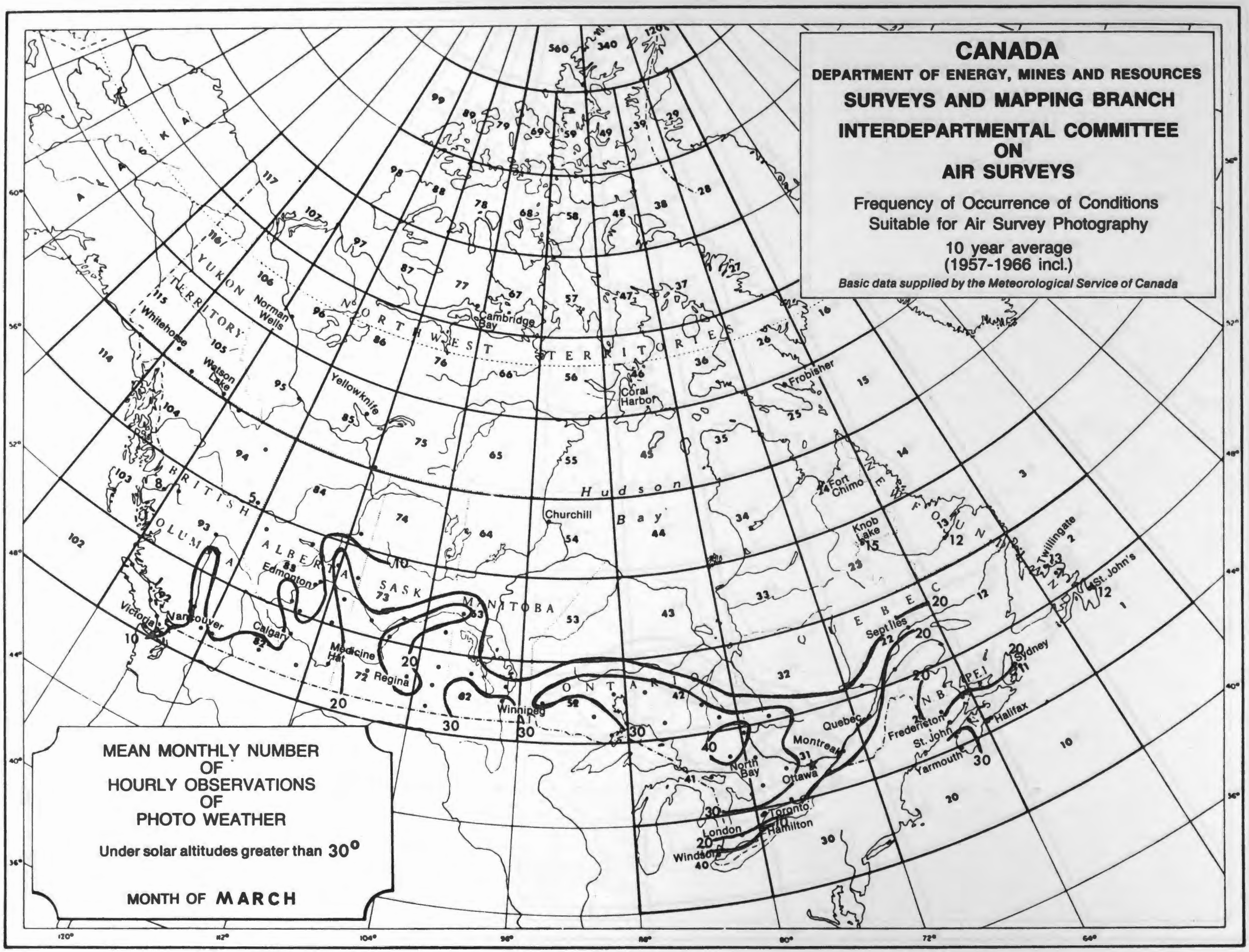
OF PHOTO WEATHER

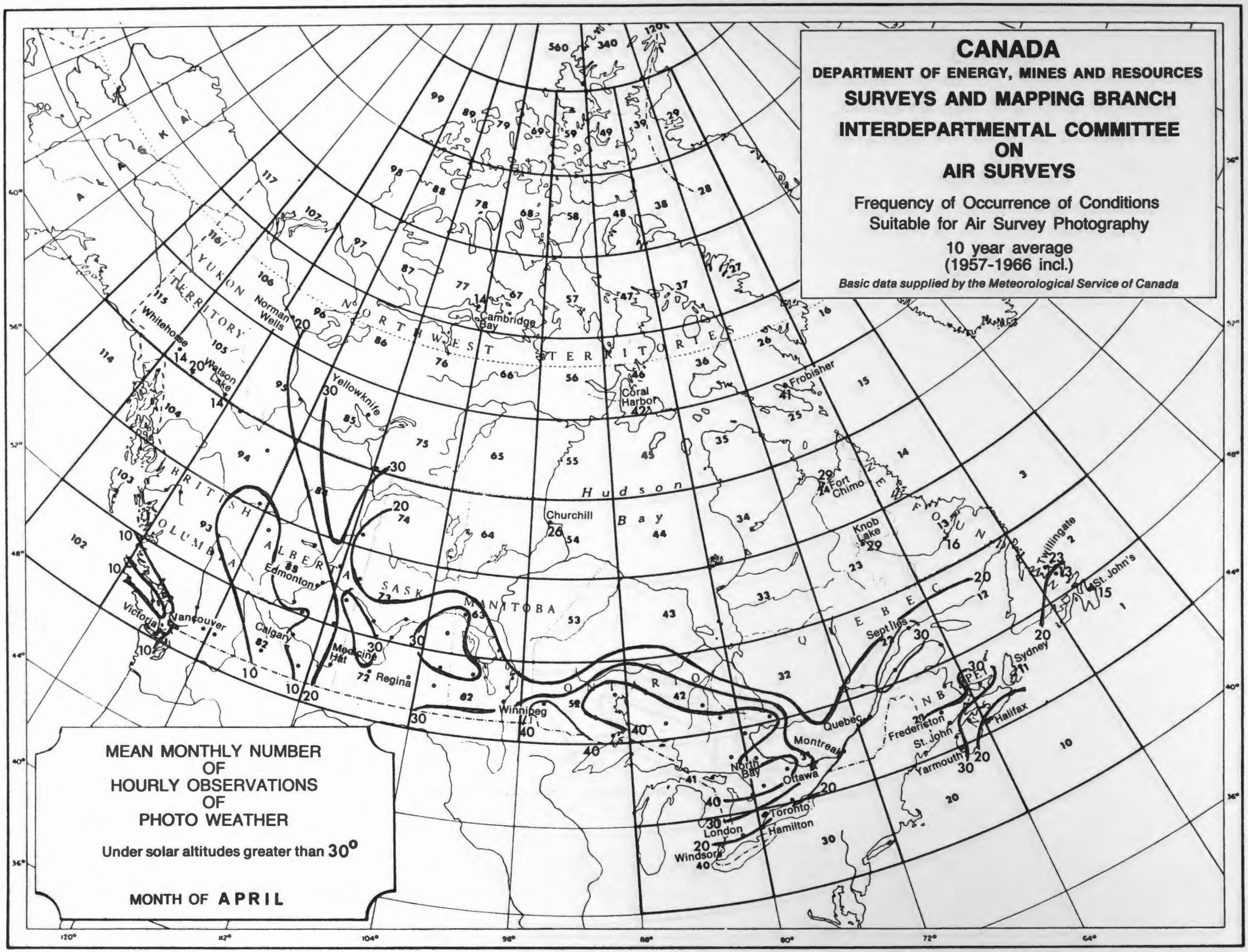
Under Solar Altitudes

Greater than 30°

The isoplethic maps for January, November, and December are omitted. For explanation, see paragraph three on page three of this report.


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF FEBRUARY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Medicine Hat
Regina
Winnipeg
Vancouver
Victoria
North Bay
Ottawa
Montreal
Quebec
Toronto
Hamilton
London
Windsor
Sept Iles
Fredericton
St. John
Yarmouth
Halifax
Sydney
Twillingate
St. John's
120°
104°
96°
88°
80°
72°
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF MARCH
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
N.B.
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Sept Iles
Fredericton
St. John
Yarmouth
Halifax
Sydney
St. John's
Twillingate
Toronto
Hamilton
London
Windsor
120°
112°
104°
96°
88°
80°
72°
64°


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF APRIL
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N.B.
P.E.I.
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Medicine Hat
Regina
Winnipeg
Vancouver
Victoria
Sept Iles
Twillingate
St. John's
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St. John
Fredericton
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Windsor
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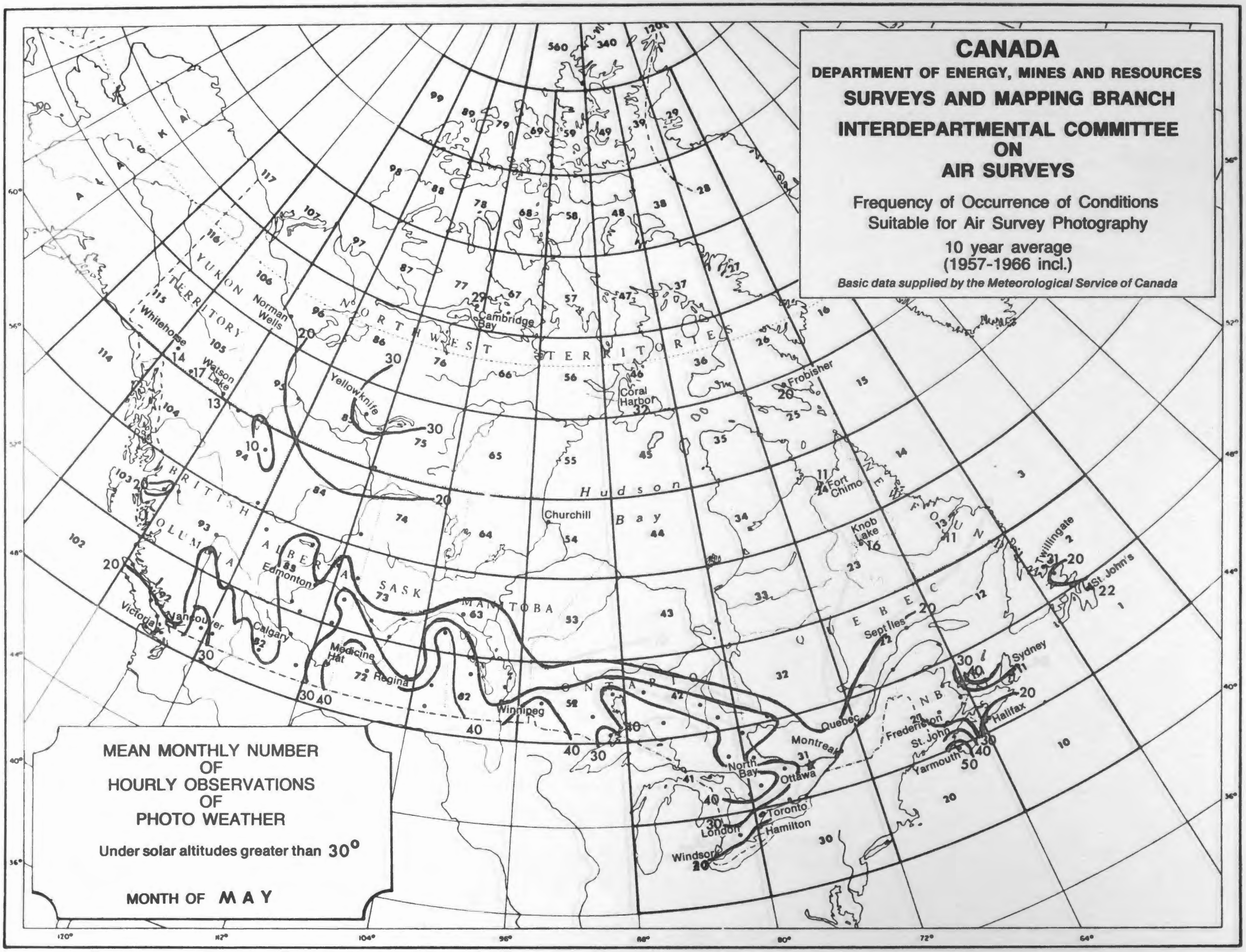
CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF MAY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
NB
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Sept Iles
Toronto
Hamilton
London
Windsor
Fredericton
St. John
Yarmouth
Halifax
Sydney
Twillingate
St. John's
120°
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CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
Frequency of Occurrence of Conditions Suitable for Air Survey Photography
10 year average (1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER OF HOURLY OBSERVATIONS OF PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF JUNE
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
N B
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Twillingate
St. John's
Churchill
Edmonton
Calgary
Medicine Hat
Regina
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Vancouver
Victoria
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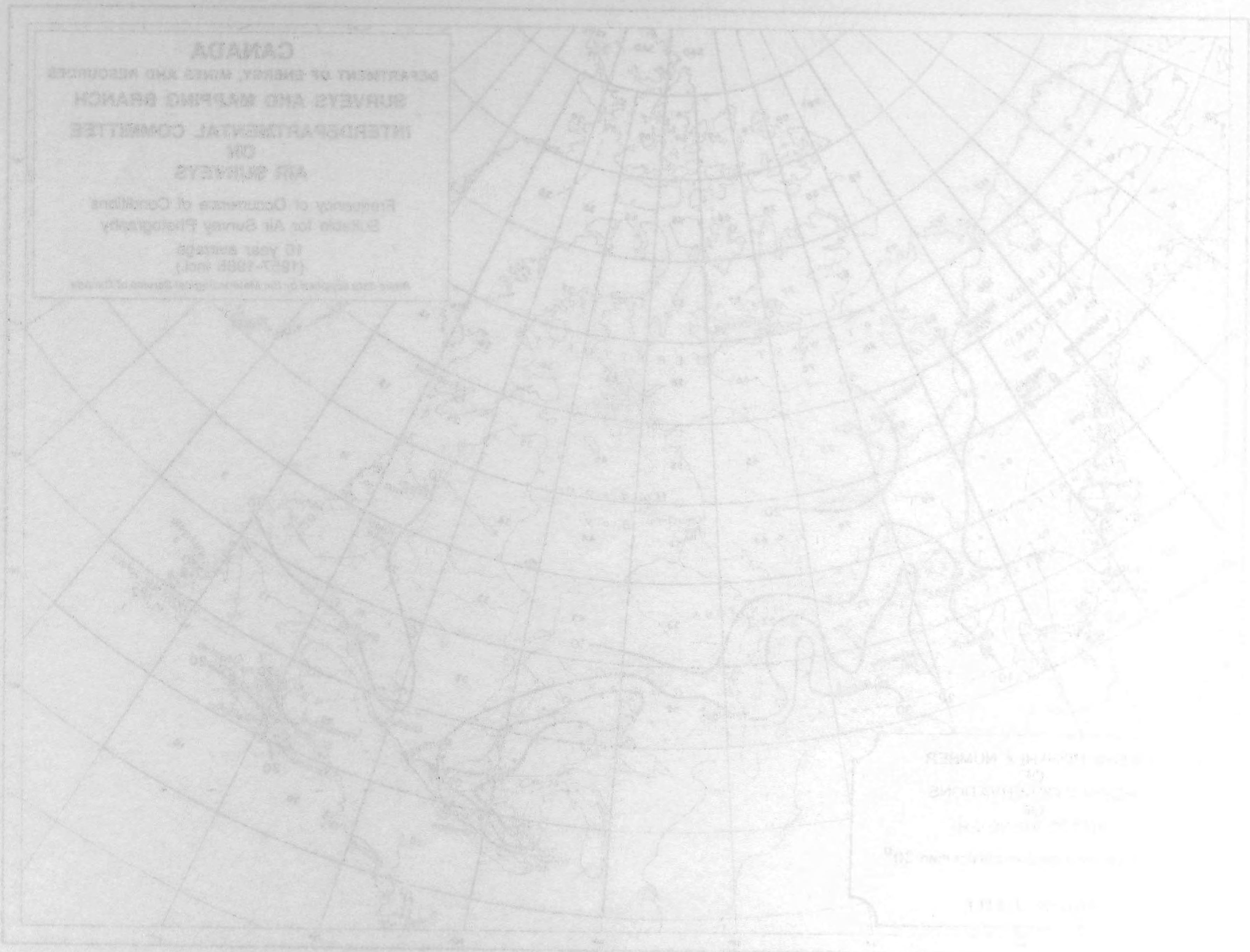
Sydney


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF JULY
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
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Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
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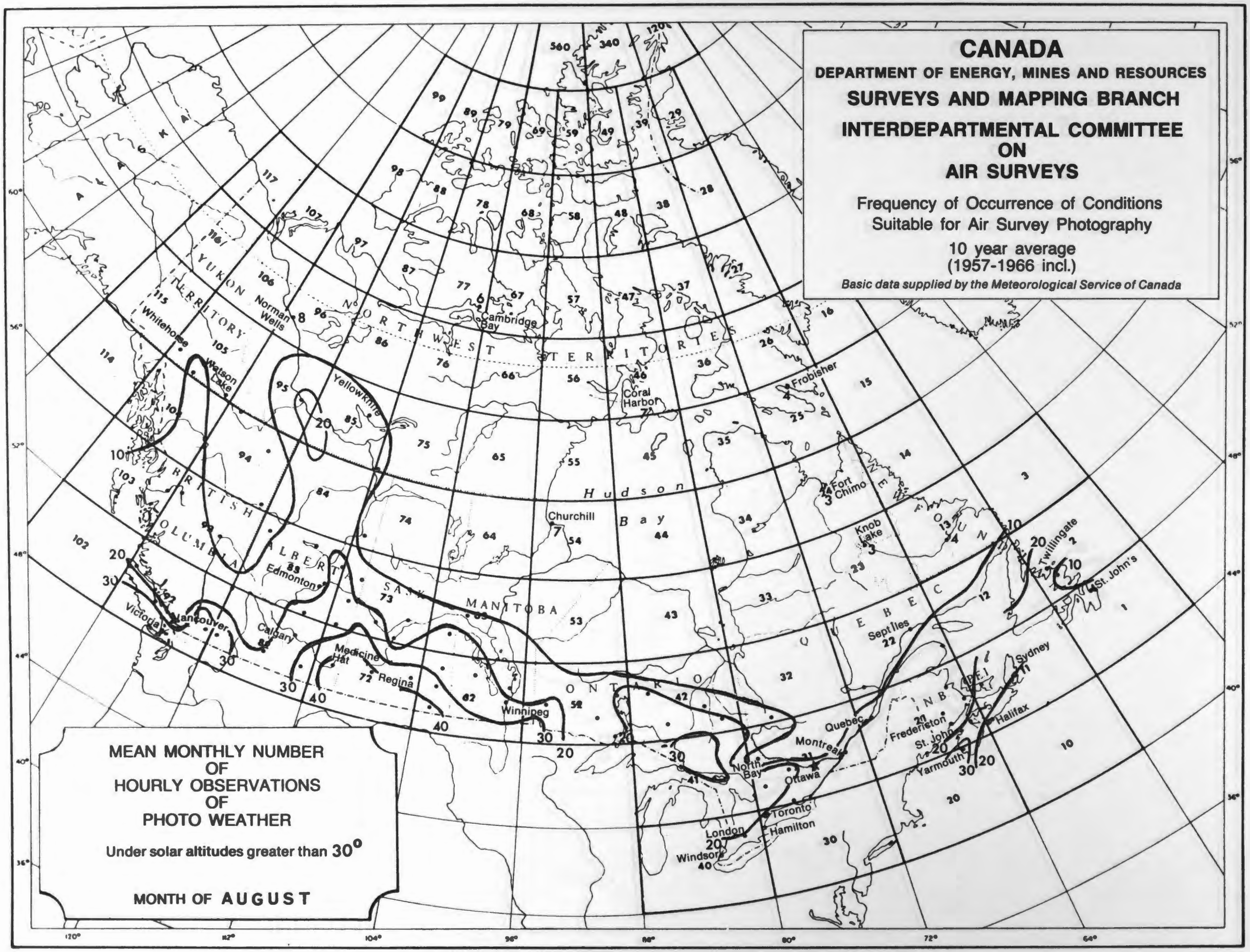
Twillingate
St. John's


CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE ON AIR SURVEYS
Frequency of Occurrence of Conditions Suitable for Air Survey Photography
10 year average (1957-1966 incl.)
Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER OF HOURLY OBSERVATIONS OF PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF AUGUST
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
Fort Chimo
Knob Lake
Churchill
Edmonton
Calgary
Vancouver
Victoria
Medicine Hat
Regina
Winnipeg
North Bay
Ottawa
Montreal
Quebec
Sept Iles
Toronto
Hamilton
London
Windsor
Fredericton
St. John's
Yarmouth
Halifax
Sydney
Twillingate
St. John's
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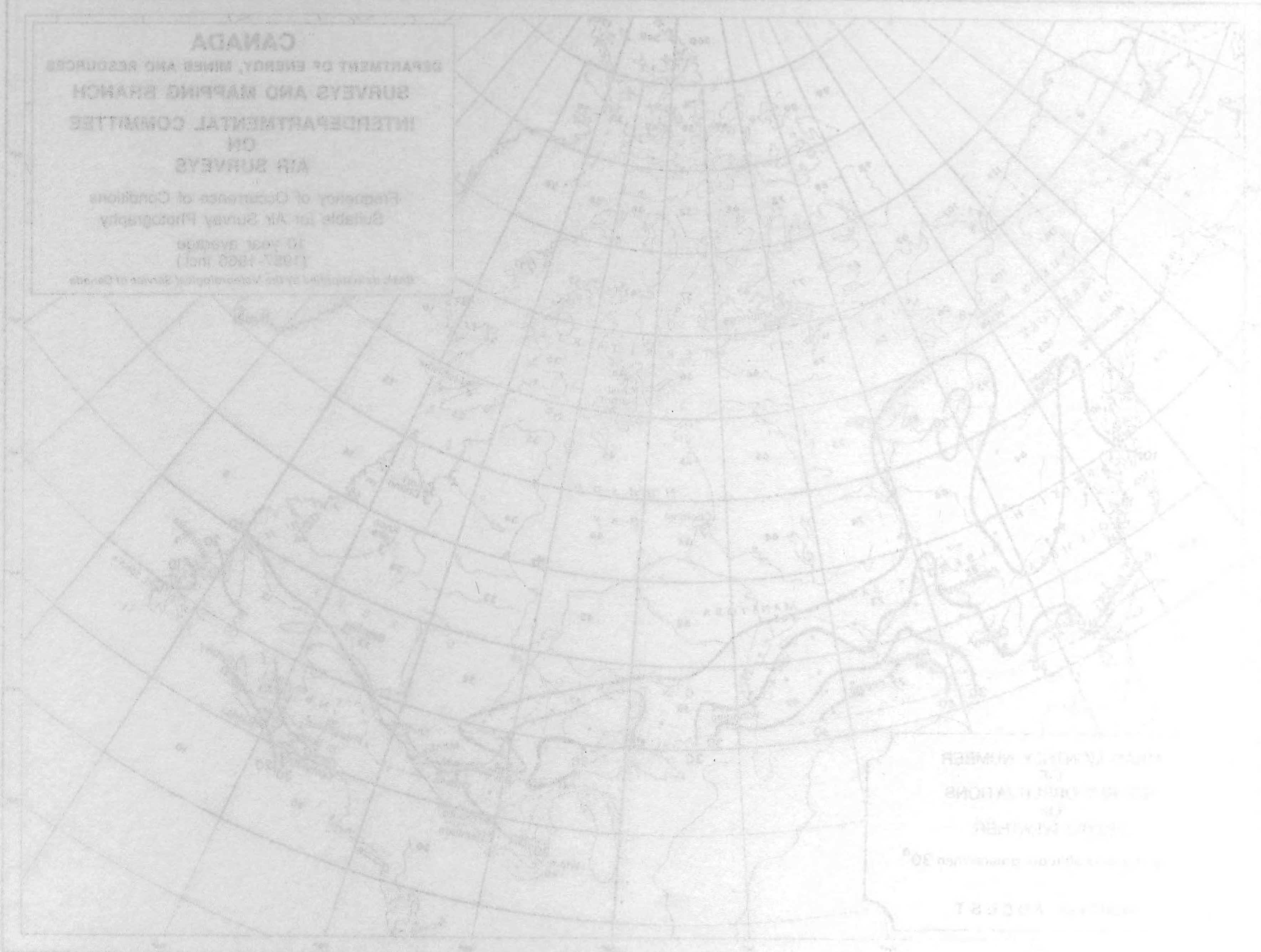
CANADA
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SURVEYS AND MAPPING BRANCH
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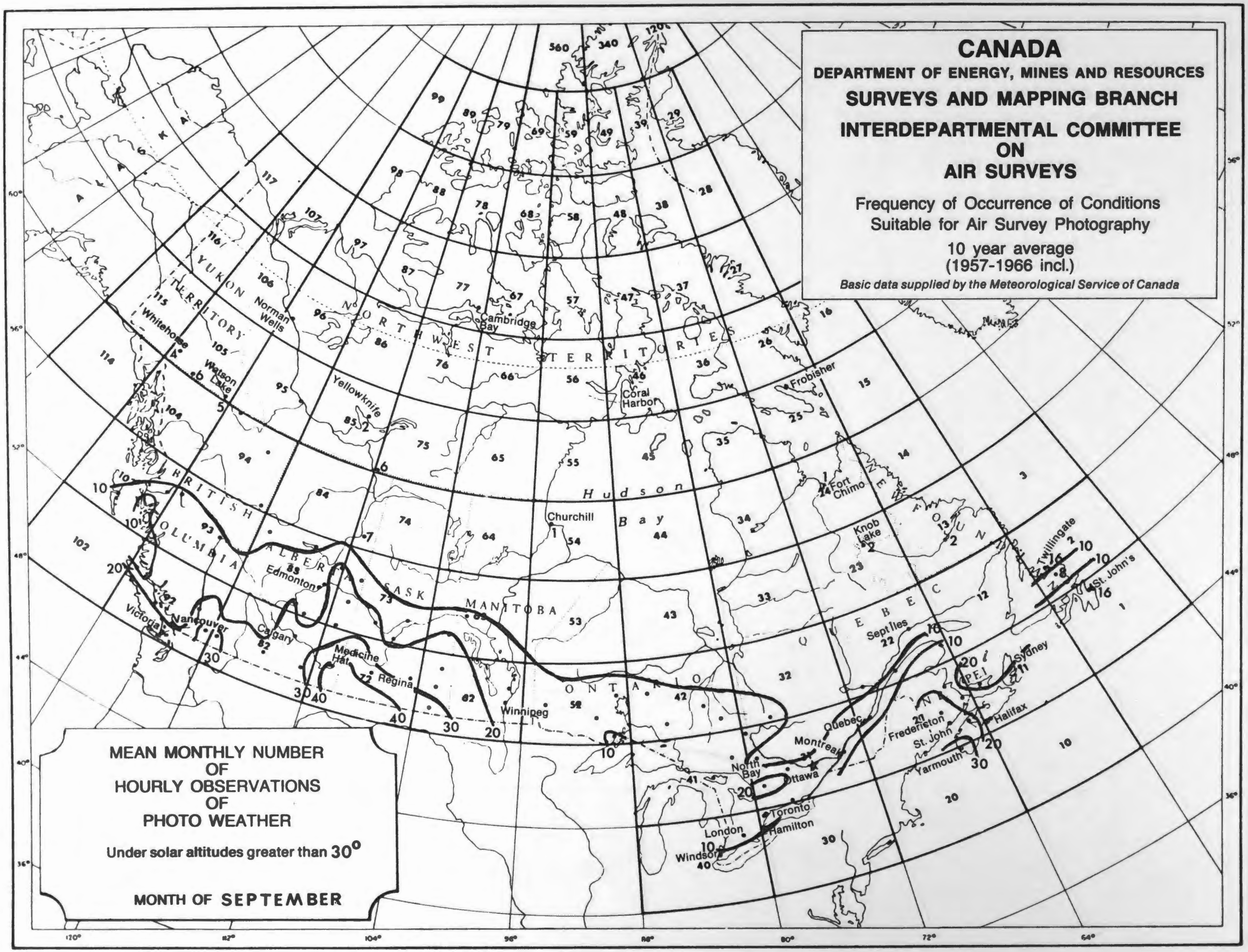
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
Suitable for Air Survey Photography
10 year average
(1957-1966 incl.)
AUGUST


CANADA
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SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
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10 year average
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Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF SEPTEMBER
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
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Yarmouth
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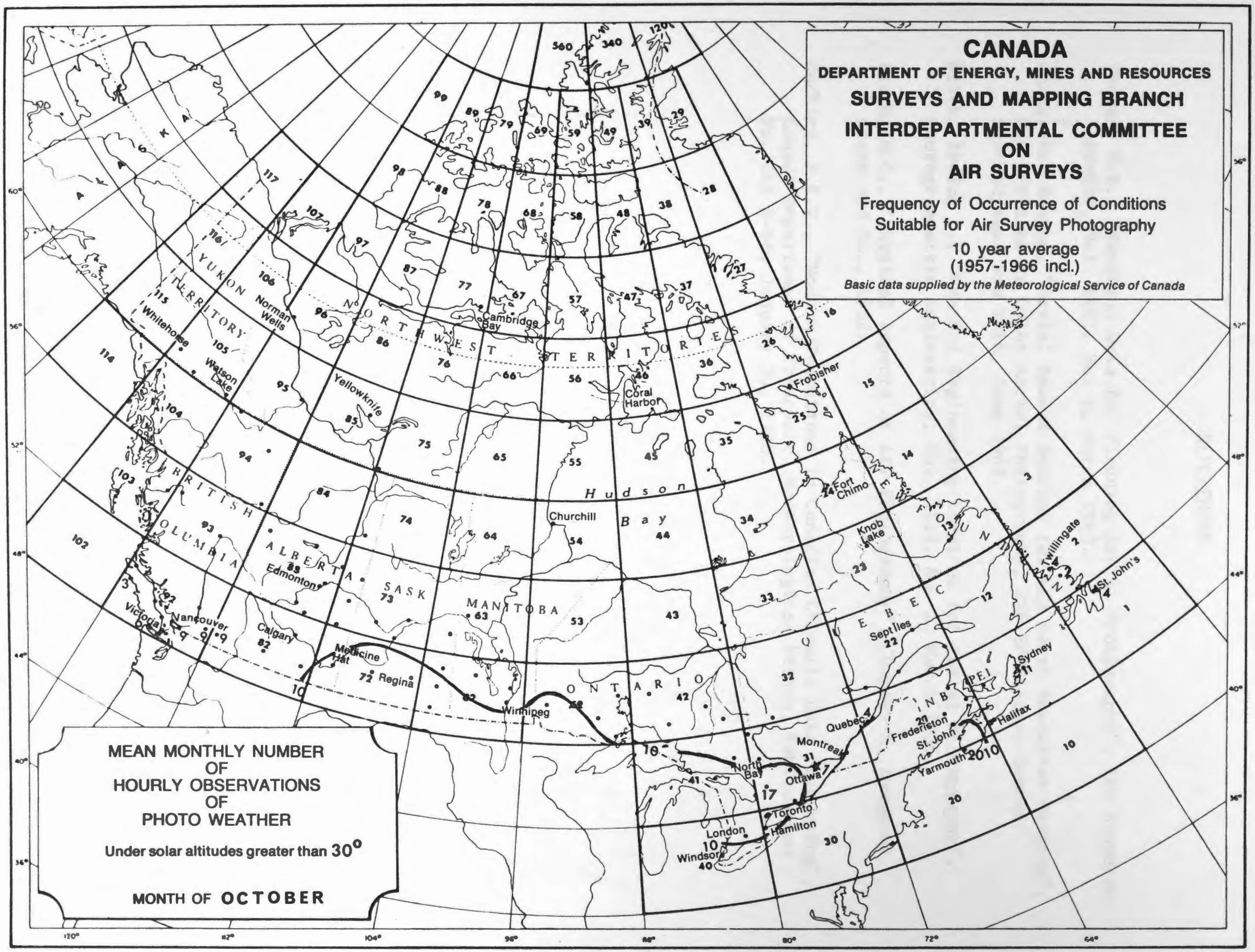
CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
SURVEYS AND MAPPING BRANCH
INTERDEPARTMENTAL COMMITTEE
ON
AIR SURVEYS
Frequency of Occurrence of Conditions
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10 year average
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Basic data supplied by the Meteorological Service of Canada
MEAN MONTHLY NUMBER
OF
HOURLY OBSERVATIONS
OF
PHOTO WEATHER
Under solar altitudes greater than 30°
MONTH OF OCTOBER
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
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P.E.I
Hudson Bay
Whitehorse
Watson Lake
Norman Wells
Yellowknife
Cambridge Bay
Coral Harbor
Frobisher
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Yarmouth
Halifax
Sydney
Twillingate
St. John's

REFERENCES

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