

THE WEATHER OF ATLANTIC CANADA AND EASTERN QUEBEC



GRAPHIC AREA FORECAST 34

NAV CANADA

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Bob Robichaud and John Mullock



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The Weather of Atlantic Canada and Eastern Quebec Graphic Area Forecast 34 Atlantic Region

Preface

For NAV CANADA's Flight Service Specialists (FSS), providing weather briefings to help pilots navigate through the day to day fluctuations in the weather is a critical role. While available weather products are becoming increasingly more sophisticated and at the same time more easily understood, an understanding of local and regional climatological patterns is essential to the effective performance of this role.

This Atlantic and Eastern Quebec Local Area Knowledge Aviation Weather manual is one of a series of six publications prepared by Meteorological Services of Canada for NAV CANADA. Each of the six manuals corresponds to a specific graphic forecast area (GFA) Domain, with the exception of the Nunavut – Arctic manual which covers two GFA Domains. This document forms an important part of the training program on local aviation weather knowledge for FSS working in the area and a useful tool in the day-to-day service delivery by FSS.

Within the GFA domains, the weather shows strong climatological patterns controlled either by season or topography. This manual describes the Domain of the GFACN34 (Atlantic – Eastern Quebec). This area offers beautiful skies and landscapes for flying but can also provide harsh flying conditions. As most pilots flying the region can attest, these variations in weather can take place quiet abruptly. From the fjords of Labrador to the cold summer waters of the Bay of Fundy, local topography plays a key role in determining both the general climatology and local flying conditions in a particular region.

This manual provides some insight on specific weather effects and patterns in this area. While a manual cannot replace intricate details and knowledge of Atlantic and Eastern Quebec that FSS and experienced pilots of the area have acquired over the years, this manual is a collection of that knowledge taken from interviews with local pilots, dispatchers, Flight Service Specialists, and MSC personnel.

By understanding the weather and hazards in this specific area, FSS will be more able to assist pilots to plan their flights in a safe and efficient manner. While this is the manual's fundamental purpose, NAV CANADA recognizes the value of the information collected for pilots themselves. More and better information on weather in the hands of pilots will always contribute to aviation safety. For that reason, the manuals are being made available to NAV CANADA customers.

Acknowledgements

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This endeavour could not have been as successful without the contributions of many people within the aviation community. We would like to thank all the participants that provided information through interviews with MSC, including flight service specialists, pilots, dispatchers, meteorologists and other aviation groups. Their willingness to share their experiences and knowledge contributed greatly to the success of this document.

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January, 2002

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S E R V I N G A W O R L D I N M O T I O N

A U S E R V I C E D ' U N M O N D E E N M O U V E M E N T

TABLE OF CONTENTS

PREFACE	.....	i
ACKNOWLEDGEMENTS	.....	ii
INTRODUCTION	.....	v
CHAPTER 1	BASICS OF METEOROLOGY	1
	Heat Transfer and Water Vapour	1
	Lifting Processes	2
	Subsidence	3
	Temperature Structure of the Atmosphere	4
	Stability	5
	Wind	6
	Air Masses and Fronts	6
CHAPTER 2	WEATHER HAZARDS TO AVIATION	9
	Introduction	9
	Icing	9
	Types of Aircraft Ice	10
	Meteorological Factors Affecting Icing	11
	Aerodynamic Factors Affecting Icing	14
	Other Forms of Icing	15
	Visibility	16
	Types of Visibility	16
	Causes of Reduced Visibility	17
	Wind, Shear and Turbulence	19
	Stability and the Diurnal Variation in Wind	19
	Wind Shear	19
	Relationship Between Wind Shear and Turbulence ..	21
	Low Levels Jets - Frontal	21
	Low Levels Jets - Nocturnal	22
	Topographical Effects on Wind	22
	Lee Waves	28
	The Formation of Lee Waves	29
	Characteristics of Lee Waves	29
	Clouds Associated with Lee Waves	30
	Fronts	31
	Frontal Weather	32
	Frontal Waves and Occlusions	33
	Thunderstorms	35
	The Life Cycle of a Thunderstorm	35
	Types of Thunderstorms	37
	Severe Thunderstorms	39
	Thunderstorm Hazards	40
	Cold Weather Operations	42
	Volcanic Ash	44

	Deformation Zone	44
CHAPTER 3	WEATHER PATTERNS	47
	Introduction	47
	Geography of the GFACN 34 Domain and Its Effect on Climate	48
	Gaspé Peninsula	50
	Newfoundland	51
	North Shore of Quebec and Anticosti Island	52
	Labrador and Eastern Ungava Bay Area	54
	Ocean Currents	56
	The Mean Atmospheric Circulation System	57
	Upper Troughs and Upper Ridges	58
	Semi-Permanent Surface Features	60
	Migratory Systems	62
	Winter Storms	62
	Summer Storms	62
	Hatteras Lows	63
	Gulf of Mexico Lows	65
	Great Lakes Lows	65
	Hudson Bay Lows	65
	Polar Lows	65
	Highs	66
	Tropical Depressions, Tropical Storms and Hurricanes ..	66
	Cold Lows	67
CHAPTER 4	SEASONAL WEATHER & LOCAL EFFECTS ...	71
	Introduction	71
	Maritimes Including the Gaspé Peninsula	72
	Southwest Nova Scotia - Yarmouth to Halifax and Vicinity	73
	Offshore Nova Scotia - Sable Region	75
	Halifax to Chedabucto Bay	77
	Annapolis Valley and the Fundy Region of Nova Scotia	78
	Northern Nova Scotia - Cape Breton	81
	Prince Edward Island - Northumberland Strait	84
	Fundy Region of Nova Scotia and New Brunswick ..	87
	Southeastern New Brunswick	
	Moncton to Miramichi	89
	Northeastern New Brunswick	
	Miramichi and Vicinity to Charlo	91
	Central and Northwestern New Brunswick	92
	Gulf of St. Lawrence - Les Iles-de-la-Madeleine-	
	Anticosti Island	95

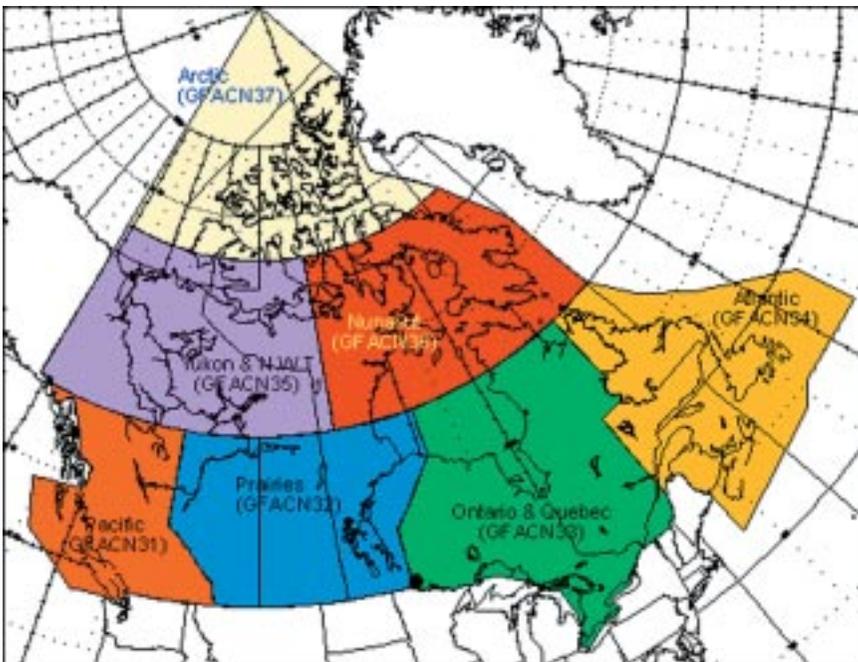
	Gaspé Peninsula	97
	Lower St Lawrence - La Pocatière to Rimouski	99
	Newfoundland	101
	Deer Lake and Vicinity to Port-aux-Basques	103
	Port-aux-Basques to the Burin Peninsula	107
	Placentia Bay and Southern Avalon Peninsula	109
	Offshore Newfoundland - Grand Banks	111
	Northern Avalon Peninsula - St. John's and Vicinity	113
	Avalon Peninsula to Gander	116
	Gander and Vicinity to White Bay	118
	Central Newfoundland	120
	Northern Peninsula - St. Anthony and Vicinity	122
	North Shore of Quebec and Anticosti Island	124
	Tadoussac to Baie-Comeau	125
	Baie-Comeau to Sept-Iles	127
	Baie-Comeau/Sept-Iles to Labrador	128
	Sept-Iles to Natashquan including Anticosti	130
	Natashquan to Blanc Sablon	131
	Labrador and Eastern Ungava Bay Area	132
	Wabush and Vicinity	134
	Wabush to Churchill Falls	135
	Churchill Falls to Goose Bay	137
	Goose Bay and Vicinity/Lake Melville	137
	Goose Bay to Cartwright	139
	Blanc Sablon to Mary's Harbour/Strait of Belle Isle	140
	Mary's Harbour to Black Tickle	141
	Black Tickle to West Bay	143
	Groswater Bay to Hamilton Inlet	144
	Groswater Bay to Makkovic and Vicinity	145
	Makkovic to Nain and Vicinity	146
	Nain To Killiniq Island/Northern Torngats	148
	Ungava Bay Area to Schefferville	150
	Schefferville to Wabush	152
CHAPTER 5	AIRPORT CLIMATOLOGY	155
GLOSSARY	. . . . .	185
TABLE OF SYMBOLS	. . . . .	191
APPENDIX	. . . . .	192
MAP INDEX	Chapter 4 Maps	195

Introduction

Meteorology is the science of the atmosphere, a sea of air that is in a constant state of flux. Within it storms are born, grow in intensity as they sweep across sections of the globe, then dissipate. No one is immune to the day-to-day fluctuations in the weather, especially the aviator who must operate within the atmosphere.

Traditionally, weather information for the aviation community has largely been provided in textual format. One such product, the area forecast (FA), was designed to provide the forecast weather for the next twelve hours over a specific geographical area. This information consisted of a description of the expected motion of significant weather systems, the associated clouds, weather and visibility.

In April 2000, the Graphical Area Forecast (GFA) came into being, superseding the area forecast. A number of Meteorological Service of Canada (MSC) Forecast Centres now work together, using graphical software packages, to produce a single national graphical depiction of the forecast weather systems and the associated weather. This single national map is then partitioned into a number of GFA Domains for use by Flight Service Specialists, flight dispatchers and pilots.



GFA Domains

This Atlantic and Eastern Quebec Local Area Knowledge Aviation Weather Manual is one of a series of six similar publications. All are produced by NAV CANADA in partnership with the MSC. These manuals are designed to provide a resource for Flight Service Specialists and pilots to help with the understanding of local aviation weather. Each of the six manuals corresponds to a Graphical Area Forecast (GFA) Domain, with the exception of the Nunavut - Arctic manual which covers two GFA Domains. MSC aviation meteorologists provide most of the broader scale information on meteorology and weather systems affecting the various domains. Experienced pilots who work in or around it on a daily basis, however, best understand the local weather. Interviews with local pilots, dispatchers and Flight Service Specialists, form the basis for the information presented in Chapter 4.

Within the domains, the weather shows strong climatological patterns that are controlled either by season or topography. For example, in British Columbia there is a distinctive difference between the moist coastal areas and the dry interior because of the mountains. The weather in the Arctic varies strongly seasonally between the frozen landscape of winter and the open water of summer. These changes are important in understanding how the weather works and each book will be laid out so as to recognize these climatological differences.

This manual describes the weather of the GFACN34 (Atlantic - Eastern Quebec). This area often has beautiful flying weather but can also have some of the harshest flying conditions in the world. As most pilots flying in the region can attest, these variations in flying weather can take place quite abruptly. From the fjords of Labrador to the cold summer waters of the Bay of Fundy to the high cliffs of southern Newfoundland, local topography plays a key role in determining both the general climatology and local flying conditions in a particular region. Statistically, approximately 30% of aviation accidents are weather related and up to 75% of delays are due to weather.

This manual is “instant knowledge” about how the weather behaves in this area but it is not “experience”. The information presented in this manual is by no means exhaustive. The variability of local aviation weather in Atlantic Canada and Eastern Quebec could result in a publication many times the size of this one. However, by understanding some of the weather and hazards in these areas, pilots may be able to relate the hazards to topography and weather systems in areas not specifically mentioned.

Chapter 1

Basics of Meteorology

To properly understand weather, it is essential to understand some of the basic principles that drive the weather machine. There are numerous books on the market that describe these principles in great detail with varying degrees of success. This section is not intended to replace these books, but rather to serve as a review.

Heat Transfer and Water Vapour

The atmosphere is a "heat engine" that runs on one of the fundamental rules of physics: excess heat in one area (the tropics) must flow to colder areas (the poles). There are a number of different methods of heat transfer but a particularly efficient method is through the use of water.

Within our atmosphere, water can exist in three states depending on its energy level. Changes from one state to another are called phase changes and are readily accomplished at ordinary atmospheric pressures and temperatures. The heat taken in or released during a phase change is called latent heat.

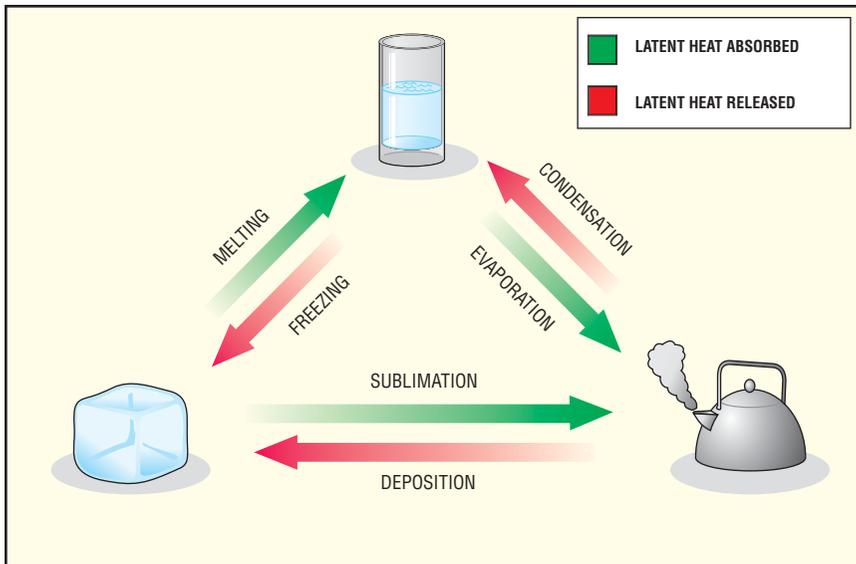


Fig. 1-1 - Heat transfer and water vapour

How much water the air contains in the form of vapour is directly related to its temperature. The warmer the air, the more water vapour it can contain. Air that contains its maximum amount of water vapour, at that given temperature, is said to be saturated. A quick measure of the moisture content of the atmosphere can be made

by looking at the dew point temperature. The higher (warmer) the dew point temperature, the greater the amount of water vapour.

The planetary heat engine consists of water being evaporated by the sun into water vapour at the equator (storing heat) and transporting it towards the poles on the winds where it is condensed back into a solid or liquid state (releasing heat). Most of what we refer to as “weather,” such as wind, cloud, fog and precipitation is related to this conversion activity. The severity of the weather is often a measure of how much latent heat is released during these activities.

Lifting Processes

The simplest and most common way water vapour is converted back to a liquid or solid state is by lifting. When air is lifted, it cools until it becomes saturated. Any additional lift will result in further cooling which reduces the amount of water vapour the air can hold. The excess water vapour is condensed out in the form of cloud droplets or ice crystals which then can go on to form precipitation. There are several methods of lifting an air mass. The most common are convection, orographic lift (upslope flow), frontal lift, and convergence into an area of low pressure.

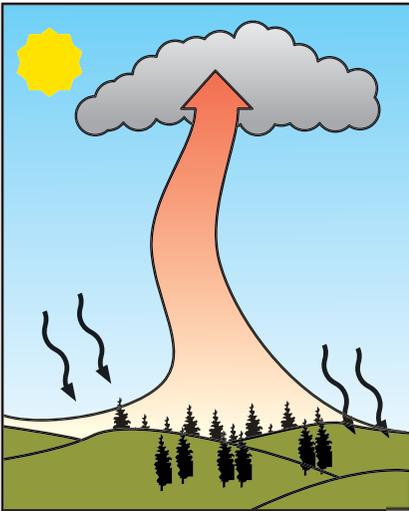


Fig. 1-2 - Convection as a result of daytime heating

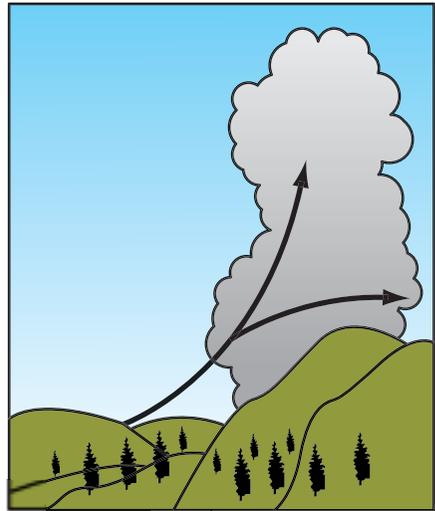


Fig.1-3 - Orographic (upslope) lift

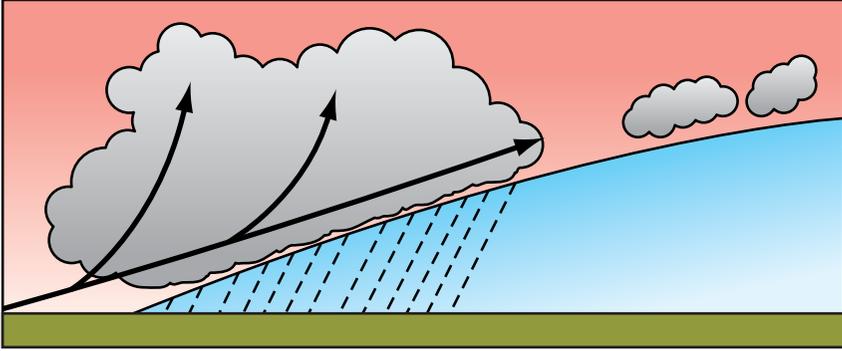


Fig.1-4 - Warm air overrunning cold air along a warm front

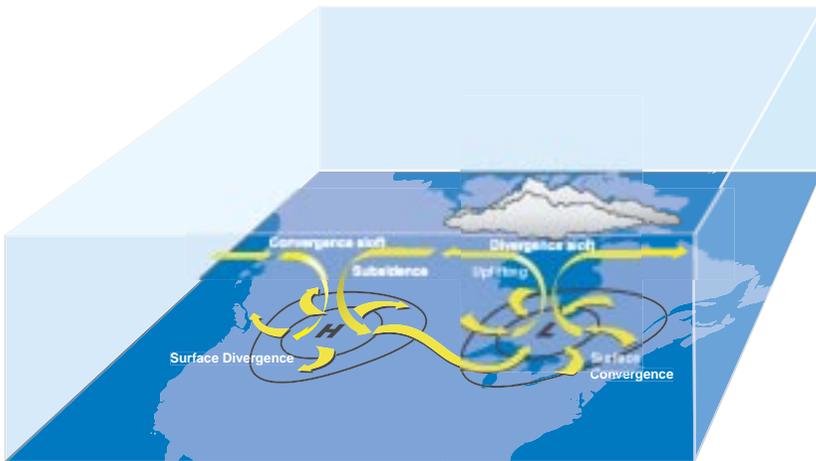


Fig. 1-5 - Divergence and convergence at the surface and aloft in a high low couplet

Subsidence

Subsidence, in meteorology, refers to the downward motion of air. This subsiding motion occurs within an area of high pressure, as well as on the downward side of a range of hills or mountains. As the air descends, it is subjected to increasing atmospheric pressure and, therefore, begins to compress. This compression causes the air's temperature to increase which will consequently lower its relative humidity. As a result, areas in which subsidence occurs will not only receive less precipitation than surrounding areas (referred to as a "rain shadow") but will often see the cloud layers thin and break up.

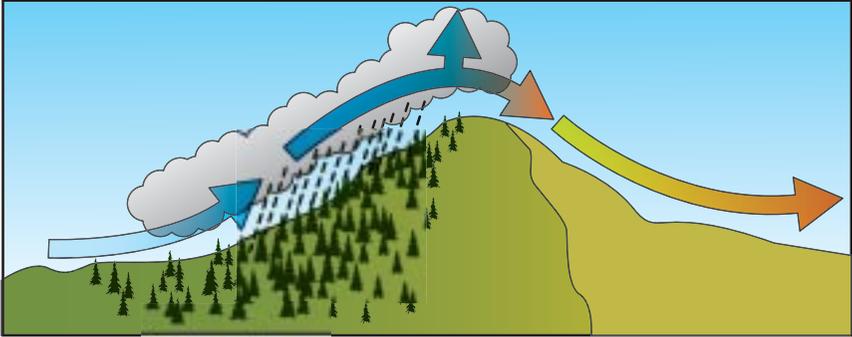


Fig.1-6 - Moist air moving over mountains where it loses its moisture and sinks into a dry subsidence area

Temperature Structure of the Atmosphere

The temperature lapse rate of the atmosphere refers to the change of temperature with a change in height. In the standard case, temperature decreases with height through the troposphere to the tropopause and then becomes relatively constant in the stratosphere.

Two other conditions are possible: an inversion, in which the temperature increases with height, or an isothermal layer, in which the temperature remains constant with height.

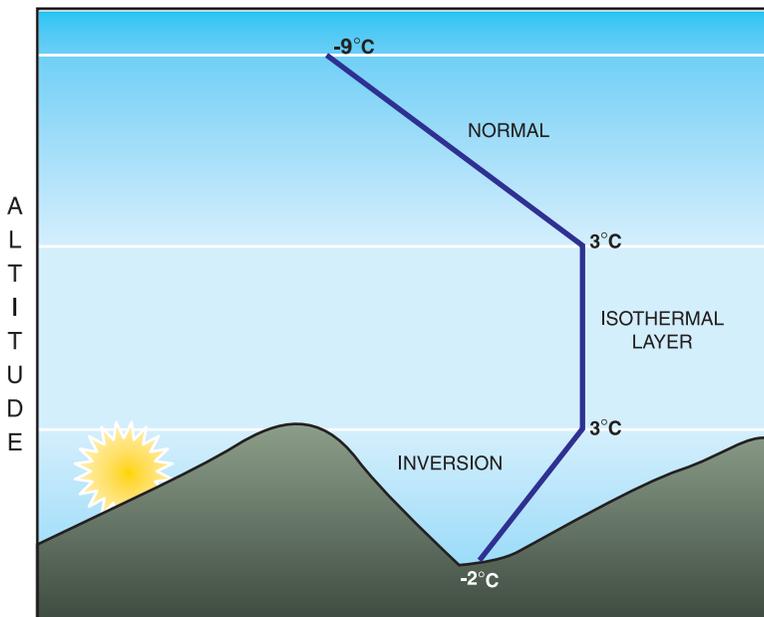


Fig. 1-7 - Different lapse rates of the atmosphere

The temperature lapse rate of the atmosphere is a direct measurement of the stability of the atmosphere.

Stability

It would be impossible to examine weather without taking into account the stability of the air. Stability refers to the ability of a parcel of air to resist vertical motion. If a parcel of air is displaced upwards and then released it is said to be unstable if it continues to ascend (since the parcel is warmer than the surrounding air), stable if it returns to the level from which it originated (since the parcel is cooler than the surrounding air), and neutral if the parcel remains at the level it was released (since the parcel's temperature is that of the surrounding air).

The type of cloud and precipitation produced varies with stability. Unstable air, when lifted, has a tendency to develop convective clouds and showery precipitation. Stable air is inclined to produce deep layer cloud and widespread steady precipitation. Neutral air will produce stable type weather which will change to unstable type weather if the lifting continues.

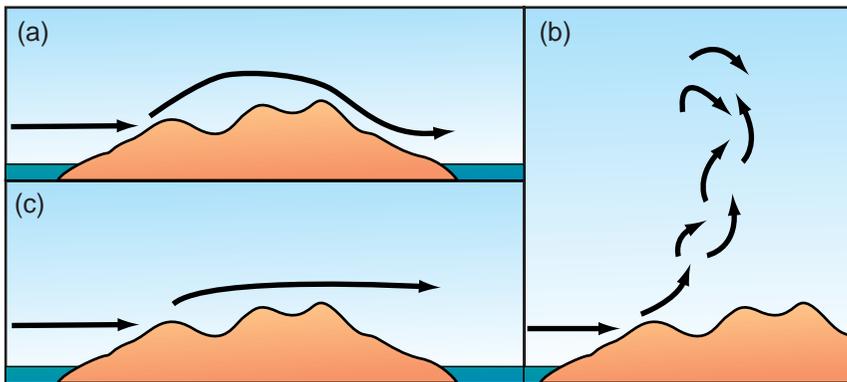


Fig. 1-8 - Stability in the atmosphere - (a) Stable (b) Unstable (c) Neutral

The stability of an air mass has the ability to be changed. One way to destabilize the air is to heat it from below, in much the same manner as you would heat water in a kettle. In the natural environment this can be accomplished when the sun heats the ground which, in turn, heats the air in contact with it, or when cold air moves over a warmer surface such as open water in the fall or winter. The reverse case, cooling the air from below, will stabilize the air. Both processes occur readily.

Consider a typical summer day where the air is destabilized by the sun, resulting in the development of large convective cloud and accompanying showers or thunder-showers during the afternoon and evening. After sunset, the surface cools and the air mass stabilizes slowly, causing the convective activity to die off and the clouds to dissipate.

On any given day there may be several processes acting simultaneously that can either destabilize or stabilize the air mass. To further complicate the issue, these competing effects can occur over areas as large as an entire GFA domain to as small as a football field. To determine which one will dominate remains in the realm of a meteorologist and is beyond the scope of this manual.

Wind

Horizontal differences in temperature result in horizontal differences in pressure. It is these horizontal changes in pressure that cause the wind to blow as the atmosphere attempts to equalize pressure by moving air from an area of high pressure to an area of low pressure. The larger the pressure difference, the stronger the wind and, as a result, the day-to-day wind can range from the gentlest breeze around an inland airfield to storm force winds over the water.

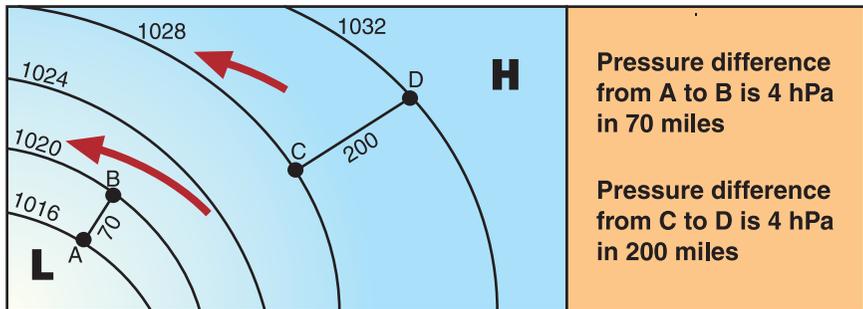


Fig.1-9 - The greater pressure changes with horizontal difference, the stronger the wind

Wind has both speed and direction, so for aviation purposes several conventions have been adopted. Wind direction is always reported as the direction from which the wind is blowing while wind speed is the average steady state value over a certain length of time. Short-term variations in speed are reported as either gusts or squalls depending on how long they last.

Above the surface, the wind tends to be relatively smooth and changes direction and speed only in response to changes in pressure. At the surface, however, the wind is affected by friction and topography. Friction has a tendency to slow the wind over rough surfaces whereas topography, most commonly, induces localized changes in direction and speed.

Air Masses and Fronts

Air Masses

When a section of the troposphere, hundreds of miles across, remains stationary or moves slowly across an area having fairly uniform temperature and moisture, then the

air takes on the characteristics of this surface and becomes known as an air mass. The area where air masses are created are called "source regions" and are either ice or snow covered polar regions, cold northern oceans, tropical oceans or large desert areas.

Although the moisture and temperature characteristics of an air mass are relatively uniform, the horizontal weather may vary due to different processes acting on it. It is quite possible for one area to be reporting clear skies while another area is reporting widespread thunderstorms.

Fronts

When air masses move out of their source regions they come into contact with other air masses. The transition zone between two different air masses is referred to as a frontal zone, or front. Across this transition zone temperature, moisture content, pressure, and wind can change rapidly over a short distance.

The principal types of fronts are:

<p>Cold Front - The cold air is advancing and undercutting the warm air. The leading edge of the cold air is the cold front.</p>		
<p>Warm front - The cold air is retreating and being replaced by warm air. The trailing edge of the cold air is the warm front.</p>		
<p>Stationary front - The cold air is neither advancing nor retreating. These fronts are frequently referred to quasi-stationary fronts although there usually is some small-scale localized motion occurring.</p>		
<p>Trowal - Trough of warm air aloft.</p>		

Table 1-1

More will be said about frontal weather later in this manual.

Chapter 2

Aviation Weather Hazards

Introduction

Throughout its history, aviation has had an intimate relationship with the weather. Time has brought improvements - better aircraft, improved air navigation systems and a systemized program of pilot training. Despite this, weather continues to exact its toll.

In the aviation world, 'weather' tends to be used to mean not only "what's happening now?" but also "what's going to happen during my flight?". Based on the answer received, the pilot will opt to continue or cancel his flight. In this section we will examine some specific weather elements and how they affect flight.

Icing

One of simplest assumptions made about clouds is that cloud droplets are in a liquid form at temperatures warmer than 0°C and that they freeze into ice crystals within a few degrees below zero. In reality, however, 0°C marks the temperature below which water droplets become supercooled and are capable of freezing. While some of the droplets actually do freeze spontaneously just below 0°C , others persist in the liquid state at much lower temperatures.

Aircraft icing occurs when supercooled water droplets strike an aircraft whose temperature is colder than 0°C . The effects icing can have on an aircraft can be quite serious and include:

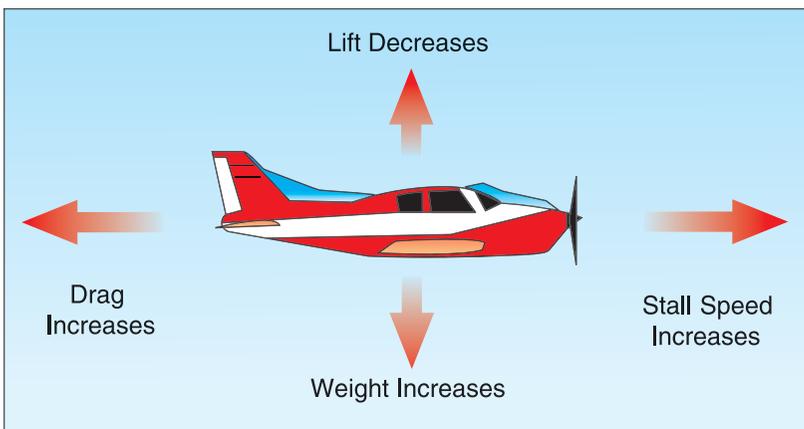


Fig. 2-1 - Effects of icing

- disruption of the smooth laminar flow over the wings causing a decrease in lift and an increase in the stall speed. This last effect is particularly dangerous. An “iced” aircraft is effectively an “experimental” aircraft with an unknown stall speed.
- increase in weight and drag thus increasing fuel consumption.
- partial or complete blockage of pitot heads and static ports giving erroneous instrument readings.
- restriction of visibility as windshield glazes over.

The Freezing Process

When a supercooled water droplet strikes an aircraft surface, it begins to freeze, releasing latent heat. This latent heat warms the remainder of the droplet to near 0°C, allowing the unfrozen part of the droplet to spread back across the surface until freezing is complete. The lower the air temperature and the colder the aircraft surface, the greater the fraction of the droplet that freezes immediately on impact. Similarly, the smaller the droplet, the greater the fraction of the droplet that freezes immediately on impact. Finally, the more frequent the droplets strike the aircraft surface, the greater the amount of water that will flow back over the aircraft surface. In general, the maximum potential for icing occurs with large droplets at temperatures just below 0°C.

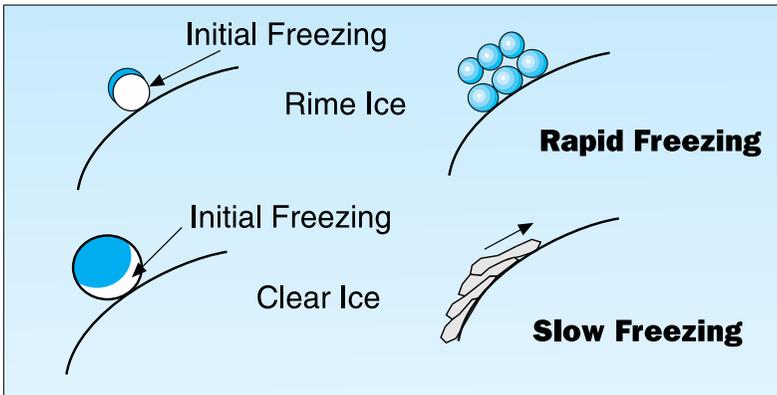


Fig. 2-2 - Freezing of supercooled droplets on impact

Types of Aircraft Ice

Rime Ice

Rime ice is a product of small droplets where each droplet has a chance to freeze completely before another droplet hits the same place. The ice that is formed is opaque and brittle because of the air trapped between the droplets. Rime ice tends to form on the leading edges of airfoils, builds forward into the air stream and has low adhesive properties.

Clear Ice

In the situation where each large droplet does not freeze completely before additional droplets become deposited on the first, supercooled water from each drop merges and spreads backwards across the aircraft surface before freezing completely to form an ice with high adhesive properties. Clear ice tends to range from transparent to a very tough opaque layer and will build back across the aircraft surface as well as forward into the air stream.

Mixed Ice

When the temperature and the range of droplet size vary widely, the ice that forms is a mixture of rime ice and clear ice. This type of ice usually has more adhesive properties than rime ice, is opaque in appearance, rough, and generally builds forward into the air stream faster than it spreads back over the aircraft surface.

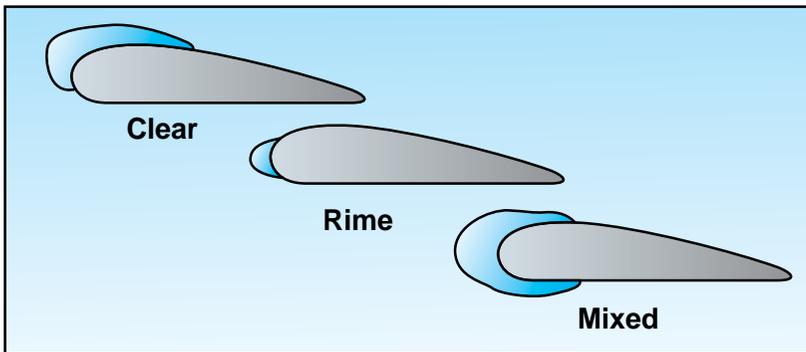


Fig. 2-3 - Accumulation patterns of different icing types

Meteorological Factors Affecting Icing

(a) Liquid Water Content of the Cloud

The liquid water content of a cloud is dependent on the size and number of droplets in a given volume of air. The greater the liquid water content, the more serious the icing potential. Clouds with strong vertical updrafts generally have a higher liquid water content as the updrafts prevent even the large drops from precipitating.

The strongest updrafts are to be found in convective clouds, clouds formed by abrupt orographic lift, and in lee wave clouds. Layer clouds tend to have weak updrafts and are generally composed of small droplets.

(b) Temperature Structure in the Cloud

Warm air can contain more water vapour than cold air. Thus, clouds that form in

warm air masses will have a higher liquid water content than those that form in cold air.

The temperature structure in a cloud has a significant effect on the size and number of droplets. Larger supercooled droplets begin to freeze spontaneously around -10°C with the rate of freezing of all size of droplets increasing rapidly as temperatures fall below -15°C . By -40°C , virtually all the droplets will be frozen. The exceptions are clouds with very strong vertical updrafts, such as towering cumulus or cumulonimbus, where liquid water droplets can be carried to great heights before freezing.

These factors allow the icing intensities to change rapidly with time so that it is possible for aircraft only minutes apart to encounter entirely different icing conditions in the same area. Despite this, some generally accepted rules have been developed:

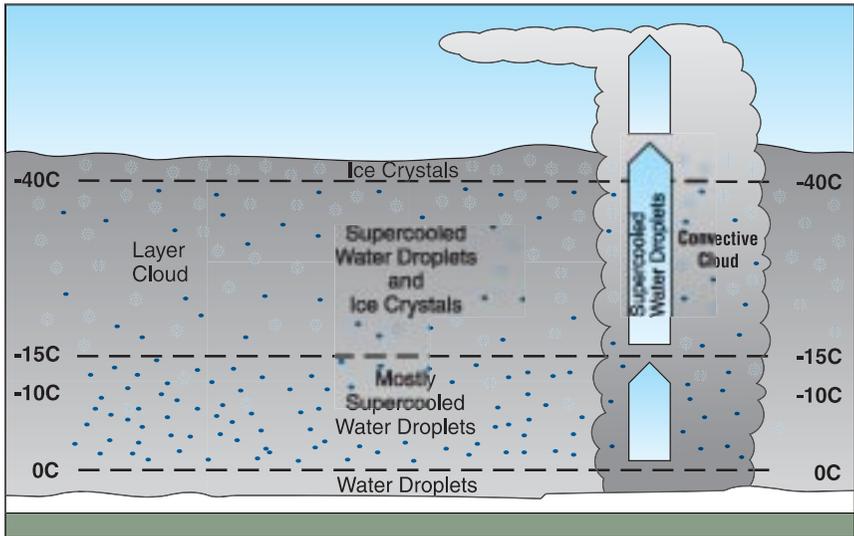


Fig. 2-4 - Distribution of water droplet-ice crystals in cloud

(1) Within large cumulus and cumulonimbus clouds:

- at temperatures between 0°C and -25°C , severe clear icing likely.
- at temperatures between -25°C and -40°C , light rime icing likely; small possibility of moderate to severe rime or mixed icing in newly developed clouds.
- at temperatures below -40°C , little chance of icing.

(2) Within layer cloud:

- the most significant icing layer is generally confined to the 0°C to -15°C temperature range.

- icing is usually less severe than in convective cloud due to the weaker updrafts and smaller droplets.
- icing layers tend to be shallow in depth but great in horizontal extent.

(3) Situations in which icing may be greater than expected:

- air moving across large unfrozen lakes in the fall and winter will increase its moisture content and destabilize rapidly due to heating from below. The cloud that forms, while resembling a layer cloud, will actually be a convective cloud capped by an inversion with relatively strong updrafts and a large concentration of supercooled drops.
- thick layer cloud formed by rapid mass ascent, such as in an intensifying low or along mountain slopes, will also have enhanced concentrations of supercooled drops. Furthermore, there is a strong possibility that such lift will destabilize the air mass resulting in embedded convective clouds with their enhanced icing potential.
- lenticular clouds can have very strong vertical currents associated with them. Icing can be severe and, because of the droplet size, tend toward clear icing.

Supercooled Large Drop Icing

Supercooled large drop (SLD) icing has, until fairly recently, only been associated with freezing rain. Several accidents and significant icing events have revealed the existence of a deadly form of SLD icing in non-typical situations and locations. It was found that large cloud drops, the size of freezing drizzle drops, could exist within some stratiform cloud layers, whose cloud top is usually at 10,000 feet or less. The air temperature within the cloud (and above) remains below 0°C but warmer than -18°C throughout the cloud layer. These large drops of liquid water form near the cloud top, in the presence of light to moderate mechanical turbulence, and remain throughout the cloud layer. SLD icing is usually severe and clear. Ice accretion onto flight surfaces of 2.5 cm or more in 15 minutes or less have been observed.

There are a few indicators that may help announce SLD icing beforehand. SLD icing-producing stratiform clouds often occur in a stable air mass, in the presence of a gentle upslope circulation, sometimes coming from a large body of water. The air above the cloud layer is always dry, with no significant cloud layers above. The presence of freezing drizzle underneath, or liquid drizzle when the surface air temperature is slightly above 0°C, is a sure indication of SLD icing within the cloud. Other areas where this type of icing is found is in the cloud to the southwest of a low pressure centre and behind cold fronts where low level stratocumulus are common (cloud tops often below 13,000 feet). Constant and careful attention must be paid when flying a holding pattern within a cloud layer in winter.

In the Maritime Provinces, SLD icing-producing clouds are common in valleys, such as the Annapolis Valley of Nova-Scotia, where a stratiform cloud layer covers the

valley and lies near mountain or hill tops. These low-level clouds often produce drizzle or freezing drizzle. They are also common over the Gulf of Saint Lawrence, over the Grand Banks and over portions of Newfoundland.

The Glory: A Warning Sign for Aircraft Icing



Photo 2-1 - Glory surrounding aircraft shadow on cloud top credit: Alister Ling

The glory is one of the most common forms of halo visible in the sky. For the pilot it is a warning sign of potential icing because it is only visible when there are liquid water droplets in the cloud. If the air temperature at cloud level is below freezing, icing will occur in those clouds that produce a glory.

A glory can be seen by looking downwards and seeing it surround the shadow that your aircraft casts onto the cloud tops. They can also be seen by looking upwards towards the sun (or bright moon) through clouds made of liquid droplets.

It is possible to be high enough above the clouds or fog that your shadow is too small to see at the center of the glory. Although ice crystals often produce other halos and arcs, only water droplets form bullseyes.

Aerodynamic Factors Affecting Icing

There are various aerodynamic factors that affect the collection efficiency of an aircraft surface. Collection efficiency can be defined as the fraction of liquid water droplets that actually strike the aircraft relative to the number of droplets encountered along the flight path.

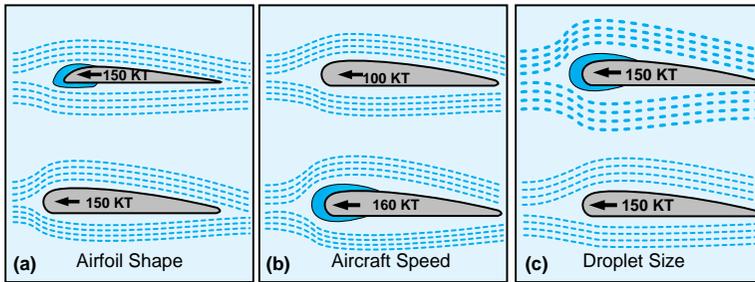


Fig. 2.5 -Variations in collection efficiency

Collection efficiency is dependent on three factors:

- (a) The radius of curvature of the aircraft component. Airfoils with a big radius of curvature disrupt the airflow (like a bow wave) causing the smaller supercooled droplets to be carried around the airfoil by the air stream. For this reason, large thick components (thick wings, canopies) collect ice less efficiently than thin components (thin wings, struts, antenna).
- (b) Speed. The faster the aircraft the less chance the droplets have to be diverted around the airfoil by the air stream.
- (c) Droplet size. The larger the droplet the more difficult it is for the air stream to displace it.

Other Forms of Icing

(a) Freezing Rain and Ice Pellets

Freezing rain occurs when liquid water drops that are above freezing fall into a layer of air whose temperature is colder than 0°C and supercool before hitting some object. The most common scenario leading to freezing rain in Eastern Canada is “warm overrunning”. In this case, warm air (above 0°C) is forced up and over colder air at the surface. In such a scenario, rain that falls into the cold air supercools, resulting in freezing rain that can last for hours. When the cold air is sufficiently deep, the freezing raindrops can freeze completely before reaching the surface causing ice pellets. Pilots should be aware, however, that ice pellets at the surface imply freezing rain aloft. Such conditions are relatively common in the winter and tend to last a little longer in valleys than over flat terrain.

(b) Freezing Drizzle or Snow Grains

Freezing drizzle is different from freezing rain in that the water droplets are smaller. Another important difference is that freezing drizzle may develop in air masses whose entire temperature profile is below freezing. In other words, freezing drizzle can occur without the presence of a warm layer (above 0°C) aloft. In this case, favourable areas for the development of freezing drizzle are

in moist maritime air masses, preferably in areas of moderate to strong upslope flow. The icing associated with freezing drizzle may have a significant impact on aviation. Similar to ice pellets, snow grains imply the presence of freezing drizzle aloft.

(c) Snow

Dry snow will not adhere to an aircraft surface and will not normally cause icing problems. Wet snow, however, can freeze hard to an aircraft surface that is at subzero temperatures and be extremely difficult to remove. A very dangerous situation can arise when an aircraft attempts to take off with wet snow on the flight surfaces. Once the aircraft is set in motion, evaporational cooling will cause the wet snow to freeze hard causing a drastic reduction in lift as well as increasing the weight and drag. Wet snow can also freeze to the windscreens making visibility difficult to impossible.

(d) Freezing Spray

Freezing spray develops over open water when there is an outbreak of Arctic air. While the water itself is near or above freezing, any water that is picked up by the wind or is splashed onto an object will quickly freeze, causing a rapid increase in weight and shifting the centre of gravity. Such conditions may cause significant problems for offshore helicopter operations.

(e) Freezing Fog

Freezing fog is a common occurrence during the winter. Fog is simply “a cloud touching the ground” and, like its airborne cousin, will have a high percentage of supercooled water droplets at temperatures just below freezing (0°C to -10°C). Aircraft landing, taking off, or even taxiing, in freezing fog should anticipate rime icing.

Visibility

Reduced visibility is the meteorological component which impacts flight operations the most. Topographic features all tend to look the same at low levels making good route navigation essential. This can only be done in times of clear visibility.

Types of Visibility

There are several terms used to describe the different types of visibility used by the aviation community.

- (a) Horizontal visibility** - the furthest visibility obtained horizontally in a specific direction by referencing objects or lights at known distances.
- (b) Prevailing visibility** - the ground level visibility which is common to one-half or more of the horizon circle.
- (c) Vertical visibility** - the maximum visibility obtained by looking vertically upwards into a surface-based obstruction such as fog or snow.

- (d) **Slant visibility** - visibility observed by looking forward and downwards from the cockpit of the aircraft.
- (e) **Flight visibility** - the average range of visibility at any given time forward from the cockpit of an aircraft in flight.

Causes of Reduced Visibility

(a) Lithometers

Lithometers are dry particles suspended in the atmosphere and include haze, smoke, sand and dust. Of these, smoke and haze cause the most problems. The most common sources of smoke are forest fires. Smoke from distant sources will resemble haze but, near a fire, smoke can reduce the visibility significantly.

(b) Precipitation

Rain can reduce visibility, however, the restriction is seldom less than one mile other than in the heaviest showers beneath cumulonimbus clouds. Drizzle, because of the greater number of drops in each volume of air, is usually more effective than rain at reducing the visibility, especially when accompanied by fog.

Snow affects visibility more than rain or drizzle and can easily reduce it to less than one mile. Blowing snow is a product of strong winds picking up the snow particles and lifting them into the air. Fresh fallen snow is easily disturbed and can be lifted a few hundred feet. Under extreme conditions, the cockpit visibility will be excellent during a landing approach until the aircraft flares, at which time the horizontal visibility will be reduced abruptly.

(c) Fog

Fog is the most common and persistent visibility obstruction encountered by the aviation community. A cloud based on the ground, fog, can consist of water droplets, supercooled water droplets, ice crystals or a mix of supercooled droplets and ice crystals.

(i) Radiation Fog

Radiation fog forms over land early in the morning, usually under clear skies with light winds. As the land surface loses heat and radiates it into space, the air above the land is cooled and loses its ability to hold moisture. If an abundance of condensation nuclei is present in the atmosphere, radiation fog may develop before the temperature-dewpoint spread reaches zero. After sunrise, the fog begins to burn off from the edges over land but any fog that has drifted over water will take longer to burn off.

(ii) Sea Fog

Sea fog forms when warm, moist air moves over colder sea water. If the air is cooled to its dewpoint, condensation will occur and fog will develop. The sea-surface temperature must be a few degrees cooler than the dewpoint temperature for fog to develop. Unlike radiation fog, which requires light winds, sea fog may form when winds are quite strong. Fog has been reported

in St. John's in winds of more than 40 knots, for instance. Also, unlike land fog, sea fog is much less affected by sunshine. As a rule, sea fog only clears by a significant change of air mass. Also called advection fog, this fog is most prevalent in spring and summer.



Photo 2-2 - Fog banks in Halifax Harbour.

credit: Republished with permission from The Halifax Herald Limited.

(iii) Precipitation or Frontal Fog

Precipitation fog, or frontal fog, forms ahead of warm fronts when precipitation falls through a cooler layer of air near the ground. The precipitation saturates the air at the surface and fog forms. Breaks in the precipitation usually results in the fog becoming thicker.

(iv) Steam Fog

Steam Fog forms when very cold arctic air moves over relatively warmer water. In this case moisture evaporates from the water surface and saturates the air. The extremely cold air cannot hold all the evaporated moisture, so the excess condenses into fog. The result looks like steam or smoke rising from the water, and is usually no more than 50 to 100 feet thick. steam fog, also called arctic sea smoke, can produce significant icing conditions.

(v) Advection Fog

Fog that forms when warm moist air moves across a snow, ice or cold water surface.

(vi) Ice Fog

Ice fog occurs when water vapour sublimates directly into ice crystals. In conditions of light winds and temperatures colder than -30°C or so, water vapour from manmade sources or cracks in ice-covered rivers can

form widespread and persistent ice fog. The fog produced by local heating systems, and even aircraft engines, can reduce the local visibility to near zero, closing an airport for hours or even days.

(d) Snow Squalls and Streamers

Snow squalls are relatively small areas of heavy snowfall. They develop when cold arctic air passes over a relatively warm water surface, such as the Gulf of St. Lawrence or the Bay of Fundy. An injection of heat and moisture from the lake into the low levels of the atmosphere destabilizes the air mass. If sufficient destabilization occurs, convective clouds begin to develop with snow beginning shortly thereafter. Snow squalls usually develop in bands of cloud, or streamers, that form parallel to the direction of flow. They are typically 1 to 15 miles in width and 30 to 60 miles long with maximum tops near 10,000 feet.

Movement of these snow squalls can generally be tied to mean winds between 3,000 and 5,000 feet. Not only can snow squalls reduce visibility to near zero but, due to their convective nature, significant icing and turbulence are often encountered within the clouds.

Wind, Shear and Turbulence

The “why” of winds are quite well understood. It is the daily variations of the winds, where they blow and how strong, that remains a constant problem for meteorologists to unravel. The problem becomes even more difficult when local effects such as wind flow through coastal inlets or in mountain valleys are added to the dilemma. The result of these effects can give one airport persistent light winds while another has nightly episodes of strong gusty winds.

Stability and the Diurnal Variation in Wind

In a stable weather pattern, daytime winds are generally stronger and gustier than nighttime winds. During the day, the heating from the sun sets up convective mixing which carries the stronger winds aloft down to the surface and mixes them with the slower surface winds. This causes the surface wind to increase in speed and become gusty, while at the same time reducing the wind speeds aloft in the mixed layer.

After sunset, the surface of the earth cools which, in turn, cools the air near the surface resulting in the development of a temperature inversion. This inversion deepens as cooling continues, ending the convective mixing and causing the surface winds to slacken.

Wind Shear

Wind shear is nothing more than a change in wind direction and/or wind speed over the distance between two points. If the points are in a vertical direction then it is called vertical shear, if they are in a horizontal direction than it is called horizontal shear.

In the aviation world, the major concern is how abruptly the change occurs. If the change is gradual, a change in direction or speed will result in nothing more than a minor change in the ground speed. If the change is abrupt, however, there will be a rapid change of airspeed or track. Depending on the aircraft type, it may take a significant time to correct the situation, placing the aircraft in peril, particularly during takeoff and landing.

Significant shearing can occur when the surface wind blowing along a valley varies significantly from the free flowing wind above the valley. Changes in direction of 90° and speed changes of 25 knots are reasonably common in mountainous terrain. Deer Lake and Greenwood are good examples of this condition.

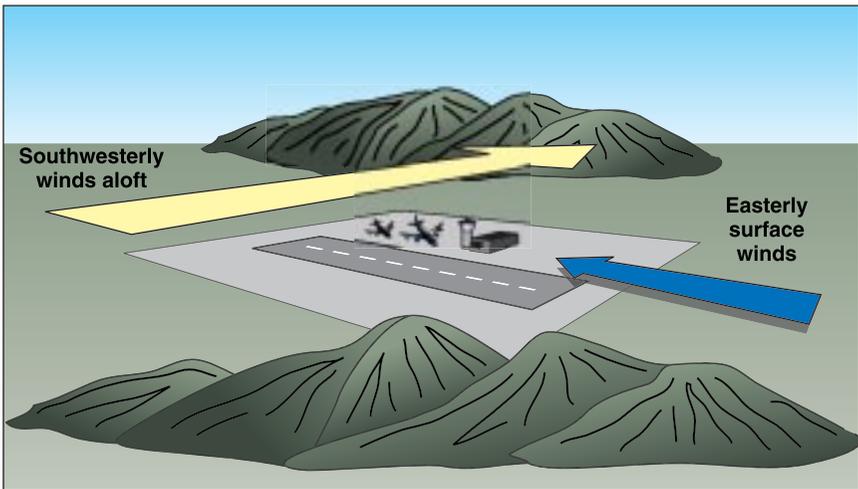


Fig. 2-6 - Wind shear near the top of a valley

Updrafts and downdrafts also induce shears. An abrupt downdraft will cause a brief decrease in the wing's attack angle resulting in a loss of lift. An updraft will increase the wing's attack angle and consequently increase the lift, however, there is a risk that it could be increased beyond the stall angle.

Shears can also be encountered along fronts. Frontal zones are generally thick enough that the change is gradual, however, cold frontal zones as thin as 200 feet have been measured. Significant directional shears across a warm front have also been observed with the directional change greater than 90 degrees over several hundred feet. Pilots doing a take-off or a landing approach through a frontal surface that is just above the ground should be wary.

Mechanical turbulence is a form of shear induced when a rough surface disrupts the smooth wind flow. The amount of shearing and the depth of the shearing layer depends on the wind speed, the roughness of the obstruction and the stability of the air.

The Relationship Between Wind Shear and Turbulence

Turbulence is the direct result of wind shear. The stronger the shear the greater the tendency for the laminar flow of the air to break down into eddies resulting in turbulence. However, not all shear zones are turbulent, so the absence of turbulence does not infer that there is no shear.

Low-Level Jets - Frontal

In developing low pressure systems, a narrow band of very strong winds often develops just ahead of the cold front and above the warm frontal zone. Meteorologists call these bands of strong winds “low-level jets”. They are typically located between 500 and 5,000 feet and can be several hundred feet wide. Wind speeds associated with low-level jets can reach as high as 100 knots in more intense storms. The main problem with these features is that they can produce severe turbulence, or at least significant changes in airspeed. Critical periods for low-level windshear or turbulence with these features are one to three hours prior to a cold frontal passage. These conditions are made worse by the fact that they occur in the low levels of the atmosphere and affect aircraft in the more important phases of flight - landing and take off. An example of a pilot report of an aircraft encounter with a low-level jet is shown below.

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APRCH DUE “SVR” TURBC /RM ALMOST LOST CONTROL OF AIRCRAFT**

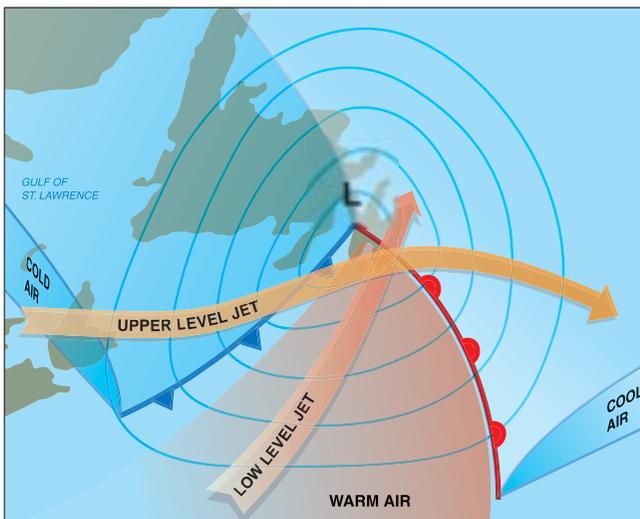


Fig. 2-7 - Idealized low and frontal system show the position of the low-level and upper-level jet

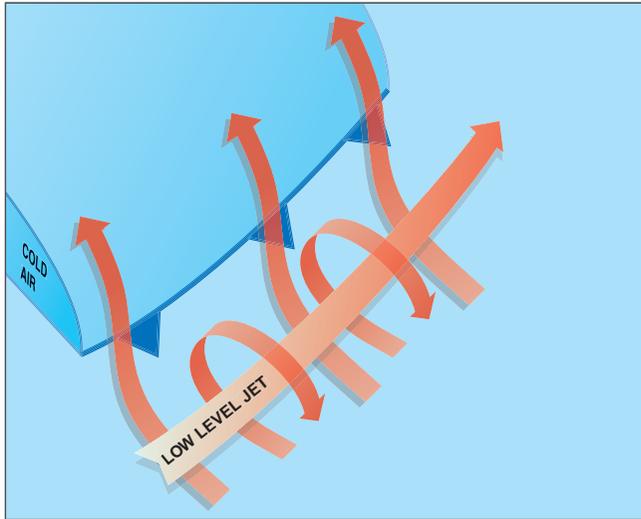


Fig. 2-8 - Complex winds around low-level jet can result in significant wind shear and turbulence

Low-Level Jets - Nocturnal

There is another type of low-level jet known as “the low-level nocturnal jet”. This jet is a band of relatively high wind speeds, typically centred at altitudes ranging between 700 and 2,000 feet above the ground (just below the top of the nocturnal inversion) but on occasion can be as high as 3,000 feet. Wind speeds usually range between 20 and 40 knots but have been observed up to 60 knots.

The low-level nocturnal jet tends to form over relatively flat terrain and resembles a ribbon of wind in that it is thousands of miles long, a few hundred feet thick and up to hundreds of miles wide. Low-level nocturnal jets have been observed in mountainous terrain but tend to be localized in character.

The low-level nocturnal jet forms mainly in the summer on clear nights (this allows the inversion to form). The winds just below the top of the inversion will begin to increase just after sunset, reach its maximum speed a couple of hours after midnight, then dissipate in the morning as the sun’s heat destroys the inversion. Low-level nocturnal jets have been observed over Chatham and Gagetown.

Topographical Effects on Wind

(a) Lee Effects

When the winds blow against a steep cliff or over rugged terrain, gusty turbulent winds result. Eddies often form downwind of the cliff face, which create stationary zones of stronger and lighter winds. These zones of strong winds are fairly predictable and usually persist as long as the wind direction and stability of the air stream do not change. The lighter winds, which occur in areas called

wind shadows, can vary in speed and direction, particularly downwind of higher cliffs. An example of this is the turbulence encountered on approach to St. John's Airport in Newfoundland. Beneath the cliffs the wind is usually gusty and the wind direction is often completely opposite to the wind blowing over the top of the cliff. Smaller, reverse eddies may also be encountered close to the cliffs.

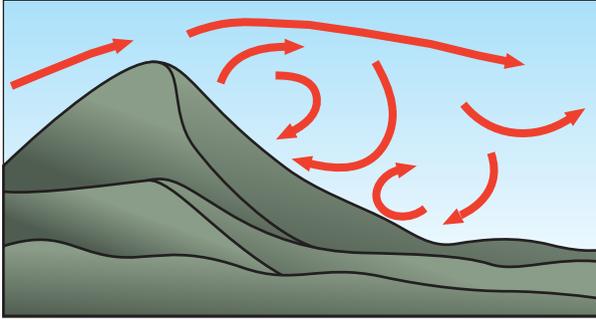


Fig. 2-9 - Lee effects

(b) Friction Effects

The winds that blow well above the surface of the earth are not strongly influenced by the presence of the earth itself. Closer to the earth, however, frictional effects decrease the speed of the air movement and back the wind (turns the wind direction counter-clockwise) towards the lower pressure. For example, a southerly wind becomes more southeasterly when blowing over rougher ground. There can be a significant reduction in the wind speed over a rough terrain when compared to the wind produced by the same pressure gradient over a relatively smooth prairie.

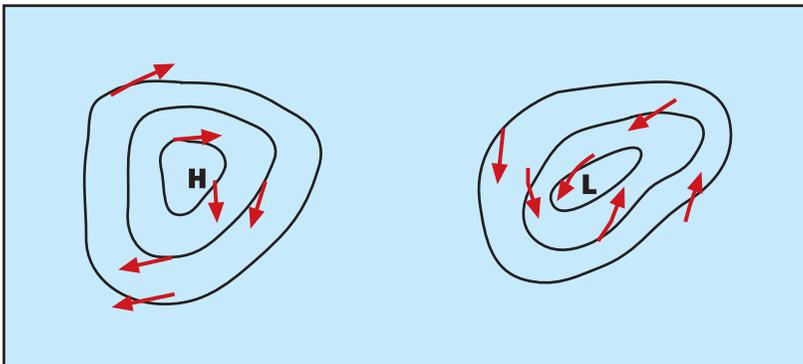


Fig. 2-10 - Friction effects

(c) Converging Winds

When two or more winds flow together or converge, a stronger wind is created. Similar effects can be noted where two or more valleys come together. Another

example of this occurs along the coast when the different angles of the surface winds over land and water cause the air streams to converge. This convergence creates a band of wind that is about 25 percent stronger within a few miles of the shore. Such a situation develops along the West Coast of Newfoundland in a southwesterly wind.

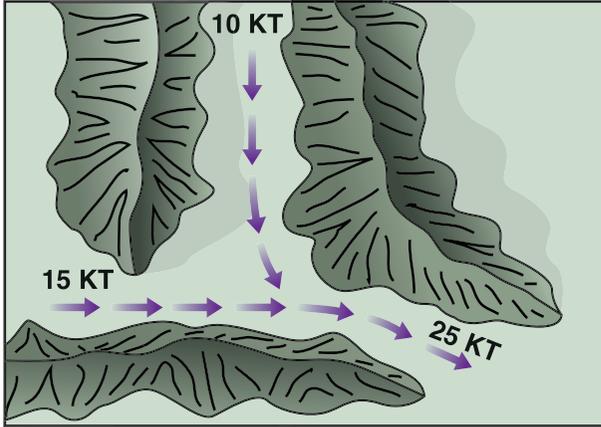


Fig. 2-11 - Converging winds

(d) Diverging Winds

A divergence of the air stream occurs when a single air stream splits into two or more streams. Each will have a lower speed than the parent air stream.

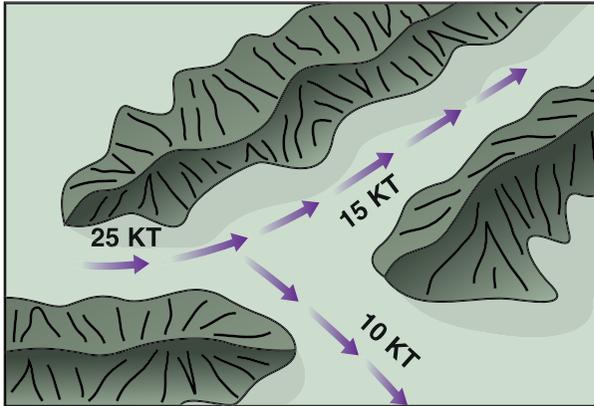


Fig. 2-12 - Diverging winds

(e) Corner Winds

When the prevailing wind encounters a headland, there is a tendency for the wind to curl around the feature. This change in direction, if done abruptly, can result in extreme turbulence. An example of this is near Cape Race on the Avalon Peninsula of Newfoundland.

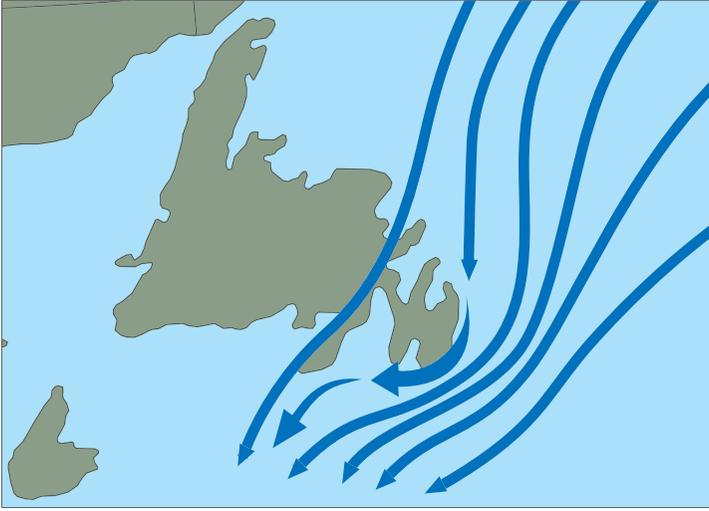


Fig. 2-13 - Cornering winds on the Avalon Peninsula

(f) Funnelled or Gap Winds

When winds are forced to flow through a narrow opening or gap, such as an inlet or narrow section of a pass, the wind speed will increase and may even double in strength. This effect is similar to pinching a water hose and is called funnelling. It can be observed in the St. Lawrence River Valley and in the Strait of Belle Isle between Quebec and Newfoundland.

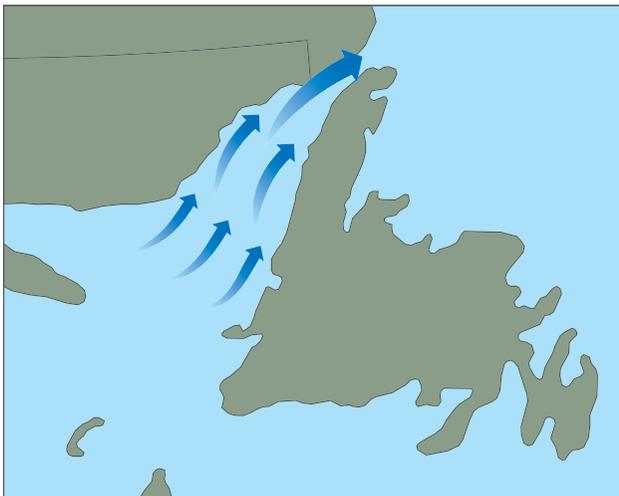


Fig. 2-14 - Funnelled winds in the Strait of Belle Isle

(g) Channelled Winds

The topography can also change the direction of the winds by forcing the flow along the direction of a pass or through a strait. This is referred to as channelling. For example, winds at Deer Lake are almost always northeasterly or southwesterly, along the Humber Valley. Channelled winds are also common through the Torngat Mountains in Labrador.

(h) Sea and land Breezes

Sea and land breezes are only observed under light wind conditions, and depend on temperature differences between adjoining regions.

A sea breeze occurs when the air over the land is heated more rapidly than the air over the adjacent water surface. As a result, the warmer air rises and the relatively cool air from the water flows onshore to replace it. By late afternoon, the time of maximum heating, the sea breeze circulation may be 1,500 to 3,000 feet deep, have obtained speeds of 10 to 15 knots and extend as far as 50 nautical miles inland.

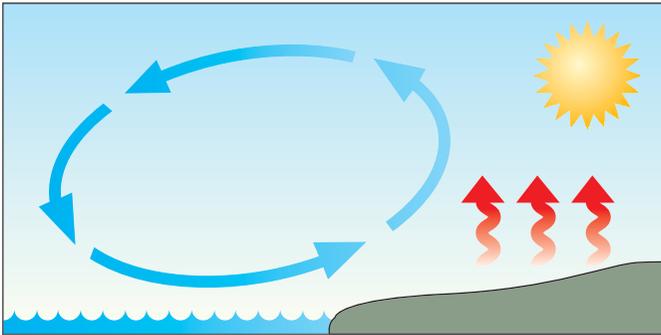


Fig. 2-15 - Sea breeze

During the evening the sea breeze subsides. At night, as the land cools, a land breeze develops in the opposite direction and flows from the land out over the water. It is generally not as strong as the sea breeze, but at times it can be quite gusty.

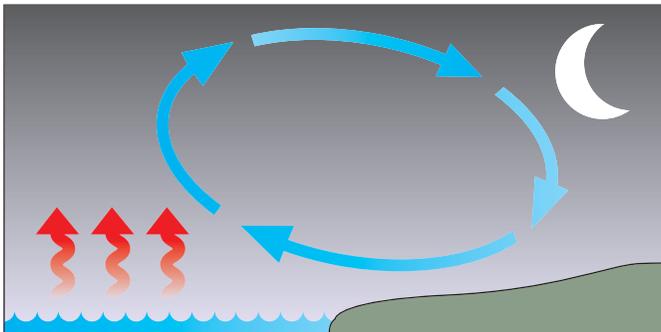


Fig. 2-16 - Land breeze

Both land and sea breezes can be influenced by channelling and funnelling resulting in almost frontal-like conditions, with sudden wind shifts and gusty winds that may reach up to 50 knots. A good example of this is along the northern coast of Labrador where there are large temperature differences between land and sea. Easterly sea breezes enter the fjords along the coast and are enhanced by channelling and funnelling.

(i) Anabatic and Katabatic Winds

During the day, the sides of the valleys become warmer than the valley bottoms since they are better exposed to the sun. As a result, the winds blow up the slope. These daytime, upslope winds are called anabatic winds. Gently sloped valley sides, especially those facing south, are more efficiently heated than those of a steep, narrow valley. As a result, valley breezes will be stronger in the wider valleys. An anabatic wind, if extended to sufficient height, will produce cloud. In addition, such a wind offers additional lift to aircraft and gliders.

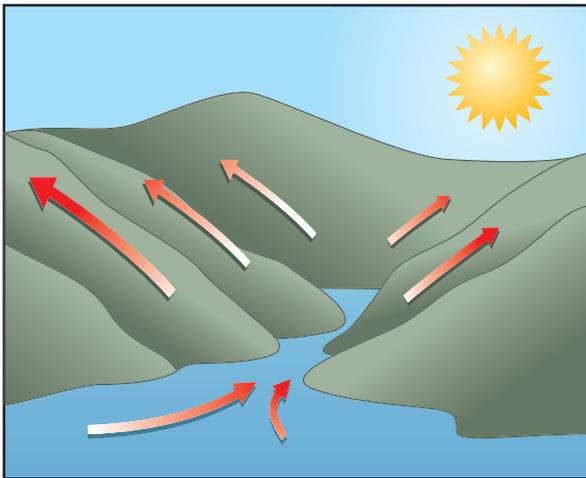


Fig. 2-17 - Anabatic winds

At night, the air cools over the mountain slopes and sinks to the valley floor. If the valley floor is sloping, the winds will move along the valley towards lower ground. The cool night winds are called drainage winds, or katabatic winds, and are often quite gusty and usually stronger than anabatic winds. Some valley airports have windsocks situated at various locations along their runways to show the changeable conditions due to the katabatic flow. Katabatic winds are observed frequently in locales such as Deer Lake and Stephenville.

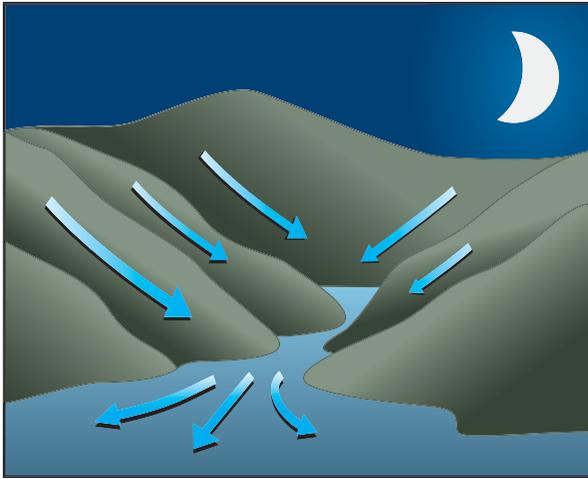


Fig. 2-18 - Katabatic winds

(j) Glacier Winds

Under extreme cooling conditions, such as an underlying ice cover, the katabatic winds can develop to hazardous proportions. As the ice is providing the cooling, a shallow wind of 80 knots or more can form and will persist during the day and night. Katabatic winds are easily funnelled resulting in winds of unexpected directions and strengths in narrow passes such as found in the Torngat Mountains.

Lee Waves

When air flows across a mountain or hill, it is disturbed the same way as water flowing over a rock. The air initially is displaced upwards across the mountain, dips sharply on the lee side, then rises and falls in a series of waves downstream. These waves are called “mountain waves” or “lee waves” and are most notable for their turbulence. They often develop on the lee side of the Torngat, Long Range and Appalachian Mountains.

The Formation of Lee Waves

The development of lee waves requires that several conditions be met:

- (a) the wind direction must be within 30 degrees of perpendicular to the mountain or hill. The greater the height of the mountain and the sharper the drop off to the lee side, the more extensive the induced oscillations.
- (b) wind speed should exceed 15 knots for small hills and 30 knots for mountain ridges. A jet stream with its associated strong winds below the jet axis is an ideal situation.

- (c) the wind direction should be constant while increasing in speed with height throughout the troposphere.
- (c) the air should be stable near the mountain peaks but less stable below. The unstable layer encourages the air to ascend and the stable layer encourages the development of a downstream wave pattern.

While all these conditions can be met at any time of the year, winter wind speeds are generally stronger resulting in more dangerous lee waves.

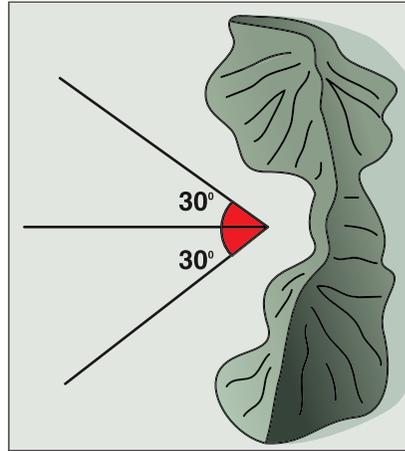


Fig. 2-19 - Angles for lee wave development

Characteristics of Lee Waves

Once a lee wave pattern has been established, it follows several basic rules:

- stronger the wind, the longer the wavelength. The typical wavelength is about 6 miles but can vary from as short as 3 miles to as long as 15 miles.
- position of the individual wave crests will remain nearly stationary with the wind blowing through them as long as the mean wind speed remains nearly constant.
- wave amplitude can exceed 3,000 feet.
- layer of lee waves often extends from just below the tops of the mountains to 4,000 to 6,000 feet above the tops but can extend higher.
- induced vertical currents within the wave can reach values of 4,500 feet per minute.
- wind speed is stronger through the wave crest and slower through the wave trough.
- wave closest to the obstruction will be the strongest with the waves further downstream getting progressively weaker.
- a large eddy called a “rotor” may form below each wave crest.
- mountain ranges downstream may amplify or nullify induced wave patterns.
- downdrafts are frequently found on the downwind side of the obstruction. These downdrafts typically reach values of 2,000 feet per minute but downdrafts up to 5,000 feet per minute have been reported. The strongest downdraft is usually found at a height near the top of the summit and could force an aircraft into the ground.

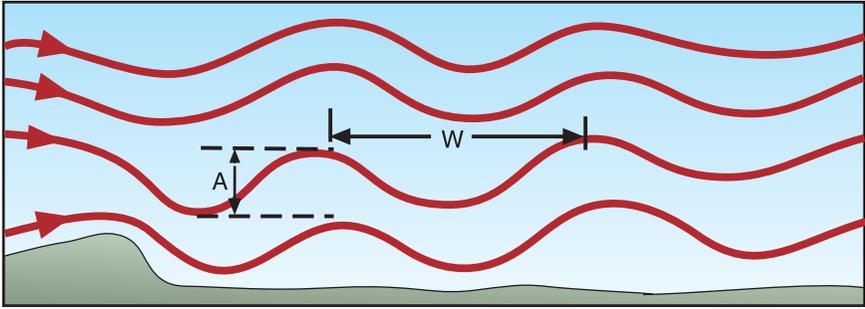


Fig. 2-20 - Amplitude (A) and wavelength (W) in lee waves

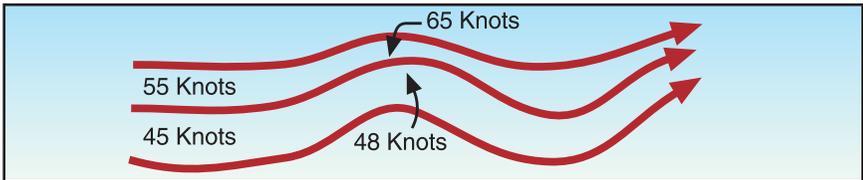


Fig. 2-21 - Stronger wind in wave crest in lee waves

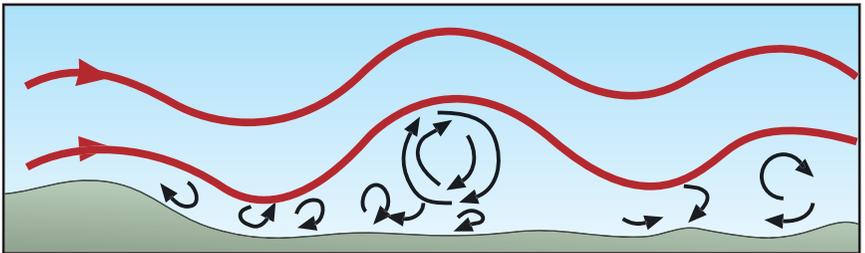


Fig. 2-22 - A rotor may form beneath wave crests

Clouds Associated with Lee Waves

Lee waves involve lift and, if sufficient moisture is available, characteristic clouds will form. The signature clouds may be absent, however, due to the air being too dry or the cloud being embedded within other clouds and not visible. It is essential to realize, nevertheless, that the absence of lee wave clouds does not mean that there are no lee waves present.

(a) Cap cloud

A cloud often forms over the peak of the mountain range and remains stationary. Frequently, it may have an almost “waterfall” appearance on the leeward side of the mountain. This effect is caused by subsidence and often signifies a strong downdraft just to the lee of the mountaintop.

(b) Lenticular clouds

A lens shaped cloud may be found at the crest of each wave. These clouds may be separated vertically with several thousand feet between each cloud or may

form so close together they resemble a “stack of plates.” When air flows through the crest it is often laminar, making the cloud smooth in appearance. On occasion, when the shear results in turbulence, the lenticular cloud will take on a ragged and wind torn appearance.

(c) Rotor cloud

A rotor cloud may form in association with the rotor. It will appear as a long line of stratocumulus, a few miles downwind and parallel to the ridge. Its base will be normally below the peak of the ridge, but its top can extend above it. The turbulence associated with a rotor cloud is severe within and near the rotor cloud.

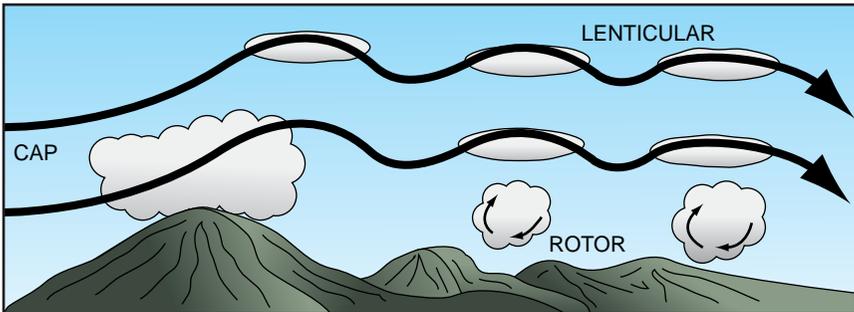


Fig. 2-23 - Characteristic clouds formed by lee waves

Fronts

A front is the transition or mixing zone between two air masses. While only the surface front is shown on a weather map, it is important to realize that an air mass is three-dimensional and resembles a “wedge”. If the colder air mass is advancing, then the leading edge of the transition zone is described as being a cold front. If the colder air mass is retreating, then the trailing edge of the transition zone is described as being a warm front.

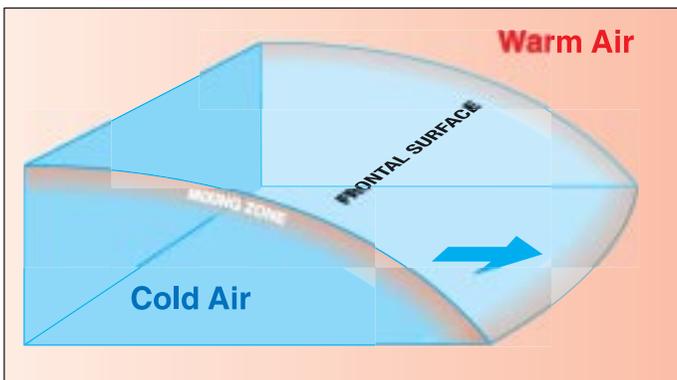


Fig. 2-24 - Cross-section of a cold front

The movement of a front is dependent on the motion of the cold air nearly perpendicular to the front, both at the surface and aloft. When the winds blow across a front, it tends to move with the wind. When winds blow parallel to a front, the front moves slowly or even becomes quasistationary. The motion of the warm air does not affect the motion of the front.

On surface charts, fronts are usually drawn as relatively straight lines. In reality, this is seldom so. Cold air flows across the surface like water. When advancing, it readily moves across level ground but in hilly or mountainous terrain it is held up until it either finds a gap or deepens to the point where it can flow over the barrier. Cold air also readily accelerates downhill resulting in rapid motion along valleys. When retreating, cold air moves slowly and leaves pools of cold air in low-lying areas that take time to modify out of existence.

Frontal Weather

When two different air masses encounter each other across a front, the cooler, denser air will lift the warm air. When this happens, the weather at a front can vary from clear skies to widespread cloud and rain with embedded thunderstorms. The weather occurring at a front depends on:

(a) amount of moisture available

Sufficient moisture must be present for clouds to form. Insufficient moisture results in “dry” or “inactive” fronts that may be marked by only changes of temperature, pressure and wind. An inactive front can become active quickly if it encounters an area of moisture.

(b) stability of the air being lifted

The degree of stability influences the type of clouds being formed. Unstable air will produce cumuliform clouds accompanied by showery weather and more turbulent conditions. Stable air will produce stratiform cloud accompanied by steady precipitation and little or no turbulence.

(c) slope of the front

A shallow frontal surface such as a warm front produces widespread cloud and steady precipitation. Such areas are susceptible to the formation of low stratus cloud and fog and may have an area of freezing precipitation. Passage of such a front is usually noted by the end of the steady precipitation, followed by a slow reduction in the cloud cover.

A steep frontal surface, such as is seen in cold fronts, tends to produce a narrow band of convective weather. Although blustery, the period of bad weather is short-lived and the improvement behind the front is dramatic.

(d) speed of the front

A fast-moving cold front enhances the vertical motion along the front, which, in turn, causes the instability to be accentuated. The result is more vigorous

convective-type weather and the potential for the development of squall lines and severe weather.

Frontal Waves and Occlusions

Small-scale changes in pressure along a front can create localized alterations in the wind field resulting in a bending of the front. This bending takes on a wave-like appearance as part of the front begins to move as a warm front and another part moves as a cold front. Such a structure is known as a frontal wave. There are two types of frontal waves:

(a) Stable Waves

The wave structure moves along the front but does not develop beyond the wave appearance. Such features, known as stable waves, tend to move rapidly (25 to 60 knots) along the front and are accompanied by a localized area of heavier cloud and precipitation. The air mass stability around the wave determines the cloud and precipitation type. Since the wave moves rapidly, the associated weather duration tends to be short.

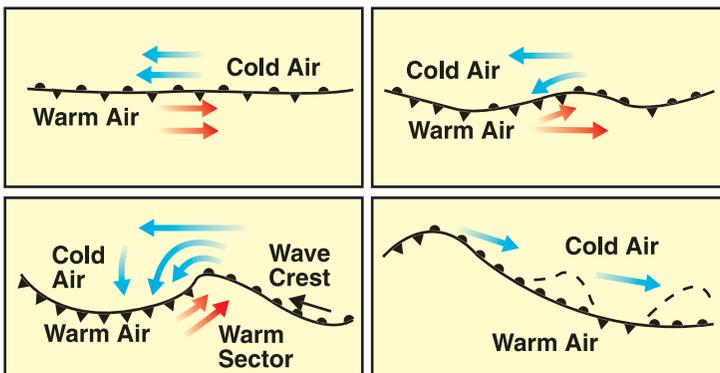


Fig 2-25 - Stable wave

(b) Unstable (Occluding) Waves

Given additional support for development, such as an upper trough, the surface pressure will continue to fall near the frontal wave, causing the formation of a low pressure centre and strengthening winds. The wind behind the cold front increases causing the cold front to accelerate and begin to wrap around the low. Eventually, it catches up with the warm front and the two fronts occlude or “close together.” At this point, the low is at maximum intensity.

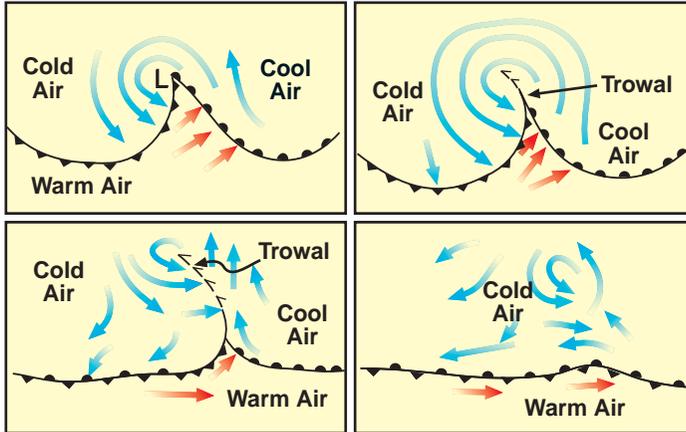


Fig. 2-26 - Formation of an occluding wave

Occlusions occur because the air behind the cold front is colder and denser than the cool air mass ahead of the warm front. Thus, it undercuts not only the warm sector of the original wave but also the warm front, forcing both features aloft. As the warm sector is lifted higher and higher, the surface portion becomes smaller and smaller. Along the occlusion, the weather is a combination of a warm front and a cold front; that is, a mix of layer clouds with steady precipitation and embedded convective clouds with enhanced showery precipitation. Such a cloud mass should be approached with caution as both icing and turbulence can be quite variable. Eventually, the frontal wave and occlusion both move away from the low, leaving only an upper frontal band curling back towards the low. This upper structure continues to weaken as it moves further and further away from the low that initially formed it .

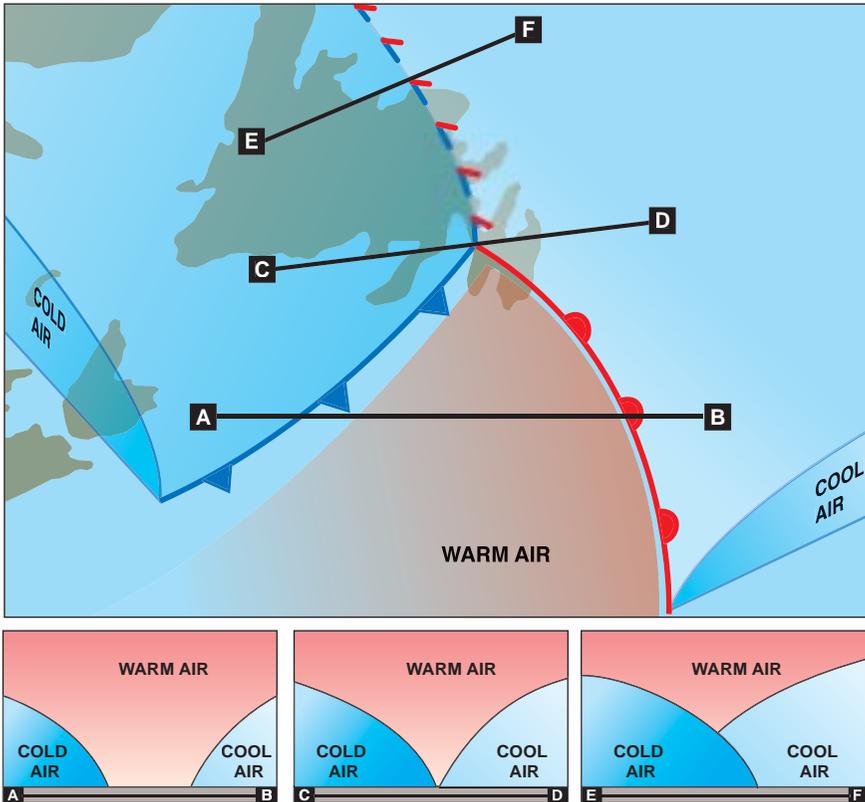


Fig. 2-27 - Frontal cross-sections

Thunderstorms

No weather encountered by a pilot can be as violent or threatening as a thunderstorm. Thunderstorms produce many hazards to the aviation community and, since they are so common on the prairies in summer time, it is important that pilots understand their nature and how to deal with them. To produce a thunderstorm, there are several ingredients which must be in place. These include:

- an unstable airmass
- moisture in the low levels
- something to trigger them, e.g. daytime heating, upper level cooling
- for severe thunderstorms, wind shear.

The Life Cycle of a Thunderstorm

The thunderstorm, which may cover an area ranging from 5 miles in diameter to, in the extreme case, as much as 50 miles, usually consists of two or more cells in different stages of their life cycle. The stages of life of individual cells are:

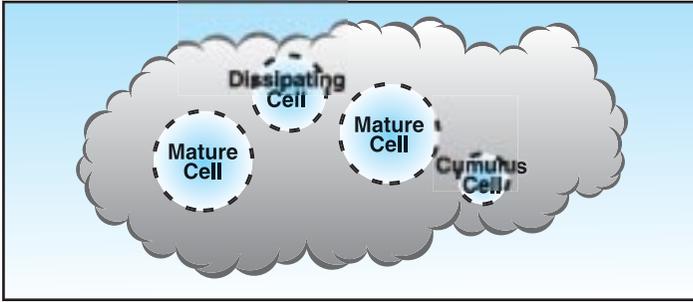


Fig. 2-28 -Top-down view of a thunderstorm "family" containing cells in different stages of development.

(a) Cumulus Stage

The cumulus stage is marked by updrafts only. These updrafts can reach values of up to 3,000 feet per minute and cause the cloud to build rapidly upwards, carrying supercooled water droplets well above the freezing level. Near the end of this stage, the cloud may well have a base more than 5 miles across and a vertical extent in excess of 20,000 feet. The average life of this stage is about 20 minutes.

(b) Mature Stage

The appearance of precipitation beneath the base of the cell and the development of the downdraft mark the transition to this stage. The downdraft is caused by water drops which have become too heavy for the updraft to support and now begin to fall. At the same time, the drops begin to evaporate as they draw in dry air from the edge of the cloud, and then fall through the drier air beneath the base of the cloud. This evaporation causes the air to cool and become denser, resulting in a downwash of accelerating cold air. Typical downdraft speeds can reach values of 2,500 feet per minute.

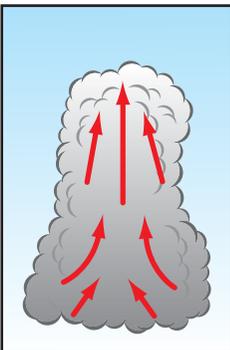


Fig. 2-29 - Cumulus stage

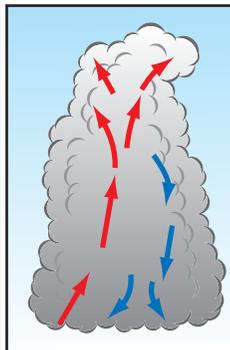


Fig. 2-30 - Mature stage

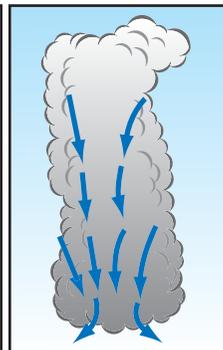


Fig. 2-31 - Dissipating Stage

The downdraft, when it hits the ground, spreads out in all directions but travels fastest in the direction that the storm is moving. The leading edge of this cold air is called the "gust front" and can extend ten to fifteen miles, or even further, when channelled along mountain valleys in front of the storm. A rapid drop in

temperature and a sharp rise in pressure characterize this horizontal flow of gusty surface winds.

At the same time, the updrafts continue to strengthen until they reach maximum speeds, possibly exceeding 6,000 feet per minute. The cloud reaches the tropopause which blocks the updraft, forcing the stream of air to spread out horizontally. Strong upper winds at the tropopause level assist in the spreading out of this flow in the downwind direction, producing the traditional anvil-shaped top. This is classically what is referred to as a cumulonimbus cloud (CB).

The thunderstorm may have a base measuring from 5 miles to more than 15 miles in diameter and a top ranging from as low as 20,000 to more than 50,000 feet. The mature stage is the most violent stage in the life a thunderstorm and usually lasts for 20 to 30 minutes.

Near the end of the mature stage, the downdraft has increased in size so that the updraft is almost completely “choked off,” stopping the development of the cell. However, at times, the upper winds increase strongly with height causing the cell to tilt. In such a case, the precipitation falls through only a portion of the cell, allowing the updraft to persist and reach values of 10,000 feet per minute. Such cells are referred to as “steady state storms” that can last for several hours and produce the most severe weather, including tornadoes.

(c) Dissipating Stage

The dissipating stage of a cell is marked by the presence of downdrafts only. With no additional flow of moisture into the cloud from an updraft, the rain gradually tapers off and the downdrafts weaken. The cell may dissipate completely in 15 to 30 minutes, leaving clear skies or patchy cloud layers. At this stage the anvil, which is formed almost exclusively of ice crystals, often detaches and drifts off downwind.

Types of Thunderstorms

(a) Air Mass Thunderstorms

These thunderstorms form within a warm, moist air mass and are non-frontal in nature. They are usually a product of diurnal heating, tend to be isolated, reach maximum strength in the late afternoon, are seldom violent, and usually dissipate quickly after the setting of the sun. There is also a second form of air mass thunderstorm that is created by cold advection. In this case, cold air moves across warm land or water and becomes unstable. Of these two, it is the movement of cold air over warm water that results in the most frequent occurrence of this type of thunderstorm. Since the heating is constant, these thunderstorms can form at any time of day or night.

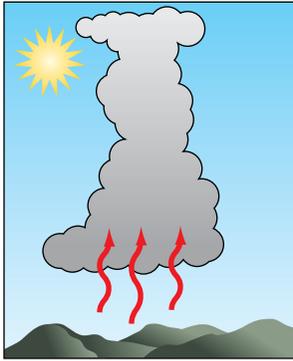


Fig. 2-32 - Air heated by warm land

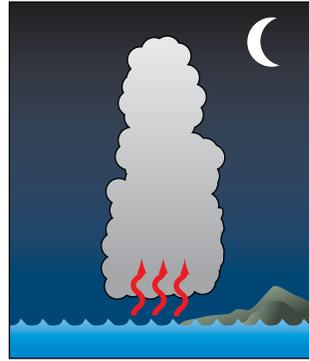


Fig. 2-33 - Cool air heated by warm water

(b) Frontal Thunderstorms

These thunderstorms form either as the result of a frontal surface lifting an unstable air mass or a stable air mass becoming unstable, as a result of the lifting. Frontal thunderstorms can be found along cold fronts, warm fronts and trowals. These thunderstorms tend to be numerous in the area, often form in lines, are frequently embedded in other cloud layers, and tend to be active during the afternoon and well into the evening. Cold frontal thunderstorms are normally more severe than warm frontal thunderstorms.

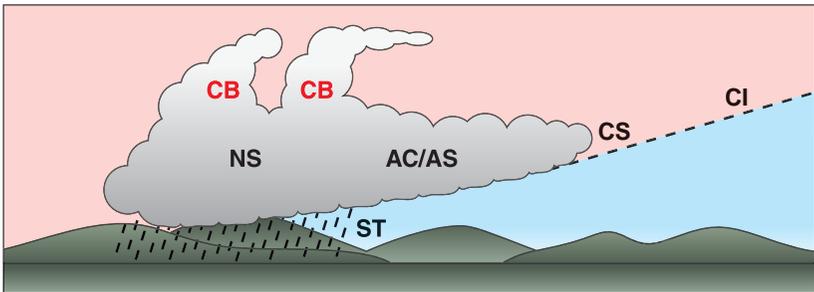


Fig. 2-34 - Warm frontal thunderstorms

(c) Squall Line Thunderstorms

A squall line (or line squall) is a line of thunderstorms. Squall lines can be several hundred miles long and have lower bases and higher tops than the average thunderstorm. Violent combinations of strong winds, hail, rain and lightning makes them an extreme hazard not only to aircraft in the air, but also to those parked uncovered on the ground.

Squall line thunderstorms are most often found 50 to 300 miles ahead of a fast-moving cold front but can also be found in accompanying low pressure troughs, in areas of convergence, along mountain ranges and even along sea breeze fronts.

(d) Orographic Thunderstorms

Orographic thunderstorms occur when moist, unstable air is forced up a hill or mountain slope. The amount of lift required varies with the amount of moisture present in the air. This type of thunderstorm is most common during the afternoon and early evening, and is usually isolated. However, on occasion, these thunderstorms will form a long, unbroken line along a mountain slope.

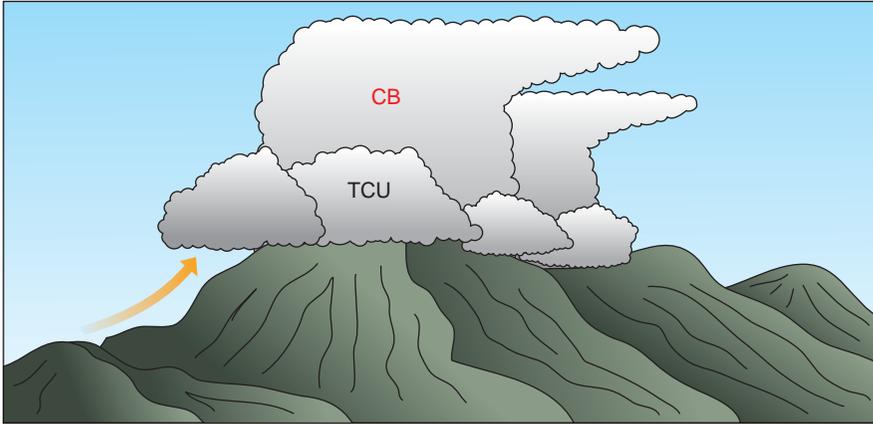


Fig. 2-35 - Orographic thunderstorms

(e) Nocturnal Thunderstorms

Nocturnal thunderstorms are those that develop during, or persist, all night.

Usually, they are associated with an upper level weather feature moving through the area, are generally isolated, and tend to produce considerable lightning.

Severe Thunderstorms

The discussion of the life cycle of a thunderstorm does not fit the case of those that seem to last for extended periods of time and are most prolific in producing tornadoes and large hail. A particular type of severe thunderstorm is known as a “Supercell”.

The Supercell storm typically begins as a multi-cellular thunderstorm. However, because the upper winds increase strongly with height, the cell begins to tilt. This causes the descending precipitation to fall through only a portion of the cell, allowing the updraft to persist.

The second stage of the supercell life cycle is clearly defined by the weather. At this stage, the largest hail fall generally occurs and funnel clouds are often observed.

The third and final stage of supercell evolution is the collapse phase. The storm’s downdrafts increase in magnitude, and extend horizontally, while the updrafts are decreasing. It is at this time that the strongest tornadoes and straight-line winds occur.

While Supercells do occur over the Southern Prairies, Southern Ontario and Southwestern Quebec, they are rare elsewhere in Canada.

Thunderstorm Hazards

The environment in and around a thunderstorm can be the most hazardous encountered by an aircraft. In addition to the usual risks such as severe turbulence, severe clear icing, large hail, heavy precipitation, low visibility and electrical discharges within and near the cell, there are other hazards that occur in the surrounding environment.

(a) The Gust Front

The gust front is the leading edge of any downburst and can run many miles ahead of the storm. This may occur under relatively clear skies and, hence, can be particularly nasty for the unwary pilot. Aircraft taking off, landing, or operating at low levels can find themselves in rapidly changing wind fields that quickly threaten the aircraft's ability to remain airborne. In a matter of seconds, the wind direction can change by as much 180°, while at the same time the wind speed can approach 100 knots in the gusts. Extremely strong gust fronts can do considerable damage on the ground and are sometimes referred to as "plow winds." All of this will likely be accompanied by considerable mechanical turbulence and induced shear on the frontal boundary up to 6,500 feet above the ground.

(b) Downburst, Macrobust and Microburst

A downburst is a concentrated, severe downdraft which accompanies a descending column of precipitation underneath the cell. When it hits the ground, it induces an outward, horizontal burst of damaging winds. There are two types of downburst, the "macrobust" and the "microburst".

A macroburst is a downdraft of air with an outflow diameter of 2.2 nautical miles, or greater, with damaging winds that last from 5 to 20 minutes. Such occurrences are common in the summer but only rarely hit towns or airports.

On occasion, embedded within the downburst, is a violent column of descending air known as a "microburst". Microbursts have an outflow diameter of less than 2.2 nautical miles and peak winds lasting from 2 to 5 minutes. Such winds can literally force an aircraft into the ground.

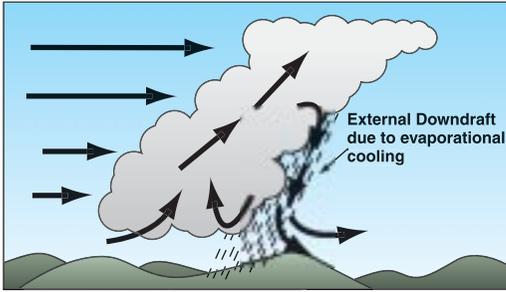


Fig. 2-36 - "Steady state" tilted thunderstorm

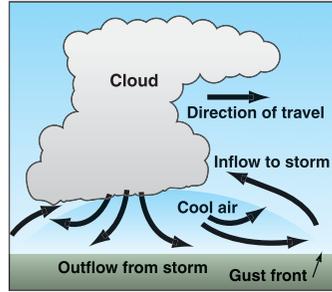


Fig. 2-37 - The gust front

(c) Funnel Cloud, Tornado and Waterspout

The most violent thunderstorms draw air into their base with great vigor. The incoming air tends to have some rotating motion and, if it should become concentrated in a small area, forms a rotating vortex in the cloud base in which wind speeds can exceed 200 knots. If the vortex becomes strong enough, it will begin to extend a funnel-shaped cloud downwards from the base. If the cloud does not reach the ground, it is called a funnel cloud. If it reaches the ground, it is referred to as a tornado and if it touches water, it is a waterspout.

Wind speeds in tornadoes have been categorized on a scale, developed by T. Fujita, from F0 to F5 with 0 being the weakest and 5 the strongest. The area with the highest probability of funnel clouds or tornadoes in Eastern Canada is over central New Brunswick. Even here, however, tornadoes seldom exceed F1 intensity.

Any severe thunderstorm should be avoided by a wide margin as all are extremely hazardous to aircraft.



Photo 2-3 - Severe thunderstorm

credit: Alister Ling

F-Scale Number	Intensity Phrase	Wind Speed (kts)	Type of Damage Done
F0	Weak Tornado	35-62	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate Tornado	63-97	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Strong Tornado	98-136	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	Severe Tornado	137-179	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating Tornado	180-226	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large-object missiles generated.
F5	Incredible Tornado	227-285	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-inforced concrete structures badly damaged.

Table 2-1 - The Fujita Scale

Waterspouts tend to be a coastal phenomenon and occur more often than tornadoes because of the frequency of which cold air is projected over the warm water, enhancing the instability. The first sign that a waterspout may form is the cloud sagging down in one area. If this bulge continues downward to the sea surface, forming a vortex beneath it, water will be carried aloft in the lower 60 to 100 feet. Waterspouts are most common in the Gulf of St. Lawrence in the fall.

Cold Weather Operations

Operating an aircraft in extremely cold weather conditions can bring on a unique set of potential problems.

Temperature Inversion and Cold Air Outbreaks

Low-level inversions are common in most areas during the fall and winter due to very cold outbreaks and strong radiational cooling. When cold air moves out over the open water, it becomes very unstable. Cloud can be seen to almost be “boiling” off the waters surface and vortices of cloud have been witnessed to rotate upwards off the water into the cloud. Such a condition can be very turbulent and there is a significant risk of serious icing. At the same time, the convection enhances any snowfall resulting in areas of extremely poor visibility.

Looming

Another interesting effect in cold air is the bending of low angle light rays as they pass through an inversion. This bending creates an effect known as “looming,” a form of mirage that causes objects normally beyond the horizon to appear above the horizon.

Ice Fog and Ice Crystals

Ice fog occurs when water vapour sublimates directly to ice crystals. In conditions of light winds and temperatures colder than -30°C or so, such as those that might be found in Labrador, water vapour from anthropogenic sources (man-made) can form widespread and persistent ice fog or ice crystals. In light winds, the visibility can be reduced to near zero, closing an airport for hours.

Blowing Snow

Blowing snow can occur almost anywhere where dry snow can be picked up by strong winds. As winds increase, the snow begins to bluster and can, in extreme conditions, reduce horizontal visibility at runway level to zero.

Whiteout

“Whiteout” is a phenomena that can occur in such places as Labrador when a layer of cloud of uniform thickness overlays a snow or ice-covered surface, such as a large frozen lake. Light rays are diffused when they pass through the cloud layer so that they strike the surface from all angles. This light is then reflected back and forth between the surface and cloud, eliminating all shadows. The result is a loss of depth perception, the horizon becoming impossible to discern, and dark objects seeming to float in a field of white. Disastrous accidents have occurred under such conditions where pilots have flown into the surface, unaware that they were descending and confident that they could see the ground.

Altimetry Errors

The basic barometric altimeter in an aircraft assumes a standard change of temperature with height in the atmosphere and, using this fact, certain pressure readings by the altimeter have been defined as being at certain altitudes. For example, a barometric altimeter set at 30.00" would indicate an altitude of 10,000 feet ASL when it senses the outside pressure of 20.00".

Cold air is much more dense than the assumed value used in the standard ICAO atmosphere. For this reason, any aircraft that is flying along a constant pressure surface will actually be descending as it moves into areas of colder air, although the indicated altitude will remain unchanged. Interestingly enough, a new altimeter setting obtained from a site in the cold air will not necessarily correct this problem and may increase the error.

Consider:

A pilot obtained an altimeter setting of 29.85" and plans to maintain a flight level of 10,000 feet enroute. As the aircraft moves into an area with a strong low-level inversion and very cold surface temperatures, the plane descends gradually as it

follows the constant pressure surface corresponding to an indicated altitude of 10,000 feet. A new altimeter setting, say 30.85 inches, is obtained from an airport located in the bottom of a valley, deep in the cold air. This new setting is higher than the original setting and, when it is entered, the altimeter will show an increase in altitude (in this case the change is one inch and so the altimeter will show an increase from 10,000 to 11,000 feet). Unaware of what is happening, the pilot descends even further to reach the desired enroute altitude, compounding the height error.

If the aircraft were operating in cloud-shrouded mountains, an extremely hazardous situation can develop. There is no simple solution to this problem, other than to be aware of it and allow for additional altitude to clear obstacles.

Volcanic Ash

A major, but fortunately infrequent, threat to aviation is volcanic ash. When a volcano erupts, a large amount of rock is pulverized into dust and blasted upwards. The altitude is determined by the severity of the blast and, at times, the ash plume will extend into the stratosphere. This ash is then spread downwind by the winds aloft in the troposphere and the stratosphere. The dust in the troposphere settles fairly rapidly and can limit visibility over a large area.

Of greater concern is the volcanic ash that is ingested by aircraft engines at flight level. Piston-driven engines have failed due to plugged air filters while turbine engines have “flamed out.”

The volcanic dust also contains considerable pumice material. Leading edges such as wings, struts, and turbine blades can all be abraded to the point where replacement becomes necessary. Windscreens have been abraded until they become opaque.

For the most part, volcanic ash is not a problem in Eastern Canada. On occasion, the ash from an eruption in Iceland will drift eastward along the easterly branch of an upper trough or “cut-off” low over the North Atlantic.

Deformation Zone

A deformation zone is defined as “an area in the atmosphere where winds converge along one axis and diverge along another. Deformation zones (or axis of deformation as they are sometimes referred to) can produce clouds and precipitation.” More simply put, we are referring to areas in the atmosphere where the winds flow together (converge) or apart (diverge), resulting in areas where air parcels undergo stretching along one axis and contraction along another axis. Meteorologically, this is an area where significant cloud amounts, precipitation, icing and turbulence can occur to in the induced vertical currents.

For meteorologists, the most common form of deformation zones are the ones

associated with upper lows. Northeast of the upper low, a deformation zone usually forms in which the air is ascending. In this area, thick cloud layers form giving widespread precipitation. Depending on the temperatures aloft, this cloud may also contain significant icing. During the summer, the edges of this cloud area will often have thunderstorms develop in the afternoon. If this area of cloud is slow moving, or should it interact with terrain, then the upslope areas can see prolonged precipitation. Winds shear in the ascending air will often give turbulence in the middle-and higher-levels.

A second deformation zone exists to the west and northwest of these lows. In this case the air is descending, so that widespread higher clouds usually only consist of whatever cloud is wrapped around the low. Precipitation here tends to be more intermittent or showery. Wind shear can also cause turbulence but most often it is confined to the low-levels.

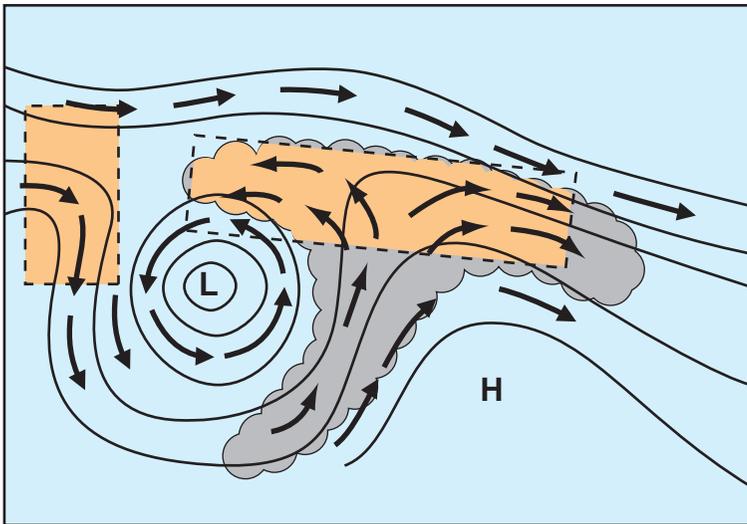


Fig. 2-38 - Deformation zones

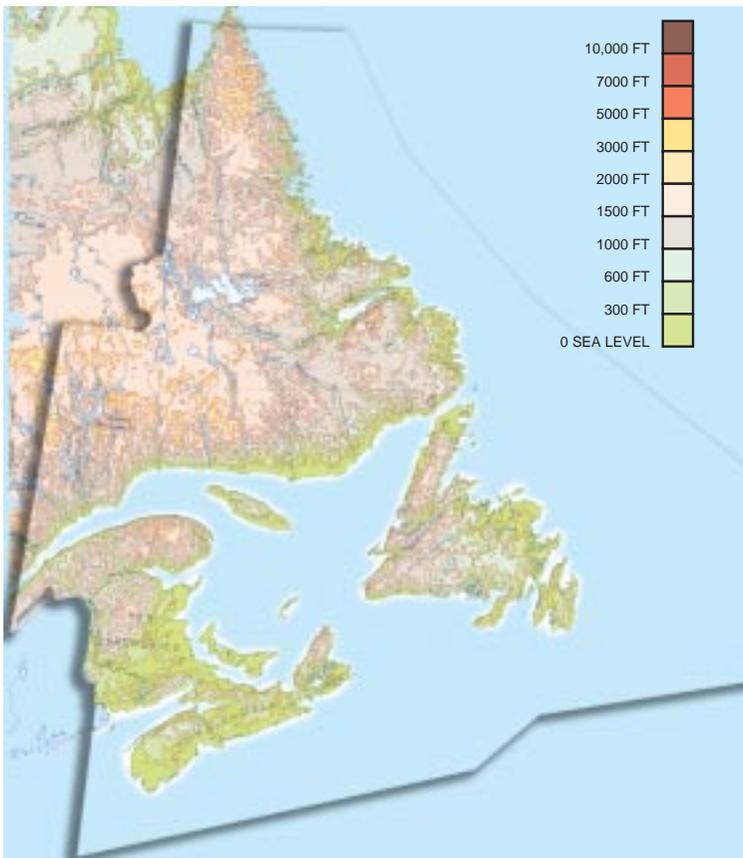
Chapter 3

Weather Patterns

Introduction

“Weather is what you get; climate is what you expect.” - (anon.)

Weather is what happens. Weather is also transitory, seldom lasting more than a matter of hours. Climate speaks to the weather history of a location. It is how and why the weather varies between seemingly identical locations. Why is Stephenville open when all other airfields in Newfoundland are closed in fog and drizzle? What are the predominant winds at Halifax? Meteorologists use their knowledge of both weather and climate when producing forecasts. This constant conflict between “what you expect” and “what you get” is unending; it is a problem that becomes much more difficult when you have to take elevated terrain and large bodies of water into account.



Map 3-1 - Topography of GFCN 34 Domain

Geography

Maritimes



Map 3-2 - New Brunswick, Nova Scotia and Prince Edward Island

The climatology of the Maritimes is highly dependent on the physical geography of a particular location and the presence of the Atlantic Ocean. Since no place in the Maritimes is farther than 100 n. miles from the coast, it is obvious that this region is highly influenced by the water.

The coastline of the Bay of Fundy is somewhat irregular and characterized by mountains on both the New Brunswick and the Nova Scotia sides of the bay. The highest elevations (as high as 1,400 feet) are found on the New Brunswick side with somewhat lower elevations over the Cobequid Mountains and the North and South Mountains. The Bay of Fundy has a strong influence on the flying weather in this region due to its relatively cold temperatures in the summer and comparatively warm temperatures in the winter. High tides averaging near 30 feet occur in the Minas Basin and the highest tide in the world was registered here at nearly 53 feet. These enormous tidal ranges cause the bay to be flushed out daily and prevent the water from being either heated or cooled significantly.

The remainder of Nova Scotia has many coastal bays and inlets, some of which extend far inland. The undulating to rolling coastal landscape rises from sea level to the Cobequid Mountains, which run generally in an east-northeast to west-southwest direction through the northern part of the province. The average height of these mountains is 700 to 1,000 feet.

Cape Breton Island, located at the southern edge of the Gulf of St. Lawrence, oriented along a general northeast to southwest line, is divided into two main sections by Bras d'Or Lake and St. Andrews Channel. The Cape Breton Highlands to the north rise to an average height of 1,000 to 1,500 feet with the highest peak being 1,748 feet in the Cape Breton Highlands National Park. Over the southern portion of the island, the hills west of Sydney range from 800 to 1,100 feet with the terrain gradually sloping towards the Atlantic Ocean.

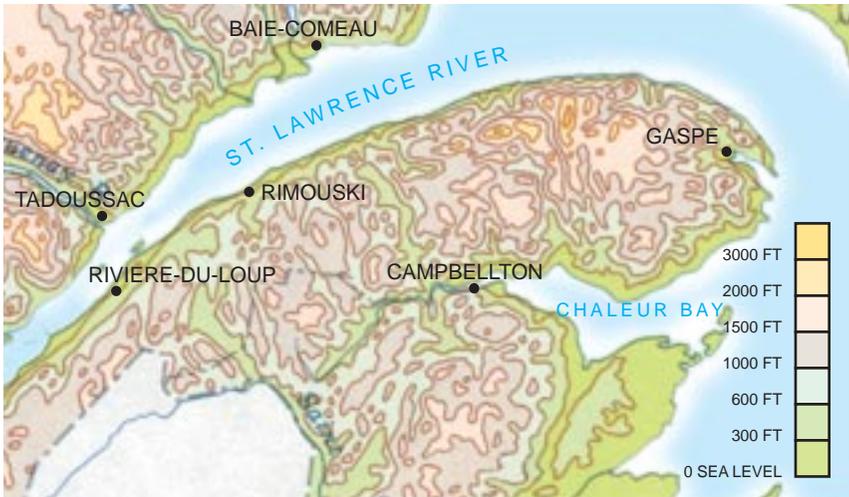
The eastern coastline of New Brunswick is fairly uniform and exhibits a gentle rise towards the west, although there are some cliffs along Chaleur Bay. Over the Acadian Peninsula the terrain gently slopes upward towards the west to an elevation of about 600 feet. Along the coast from Bathurst to Campbellton, however, the terrain rises somewhat more abruptly until reaching the New Brunswick Highlands. Ice in Chaleur Bay usually forms in mid-to-late December and usually melts by late April.

Western New Brunswick is characterised by rolling mountainous terrain in the north that slopes into rolling hills to the south and east. The Highlands to the northwest, which are an extension of the Appalachian Mountain range, contain the highest elevations in the Maritime Provinces, with Mount Carleton rising to 2,690 feet. The Saint John River Valley extends from Saint John up through Fredericton and northward along the New Brunswick and Maine border. The relatively flat topography, along the southern portion of the Saint John River Valley, extends eastward from the Fredericton Airport to the Grand Lake area.

The topography over Prince Edward Island consists for the most part of gently rolling hills; the highest elevation is about 470 feet just west of Hunter River. Some areas of the sandy coastline are interrupted by rocky sandstone cliffs. An important feature of this area is the water temperature in the Northumberland Strait. Water temperatures here are some of the warmest summer sea-surface temperatures observed in the Maritime Provinces.

The Gulf of St. Lawrence is generally frozen from the beginning of January to the beginning of April. In extreme cases the gulf may freeze over in mid December and become ice-free as late as the end of April or early May. During this time, the ice is not necessarily solid throughout but is broken up by tides, currents, strong winds and temporary thaws that occur during winter. The Iles-de-la-Madeleine, or Magdalen Islands, located in the middle of the Gulf of St. Lawrence, are mostly flat to gently rolling hills which rise from sea level to an average elevation of 300 feet. The highest peak is 543 feet just south of Fatima.

Gaspe Peninsula

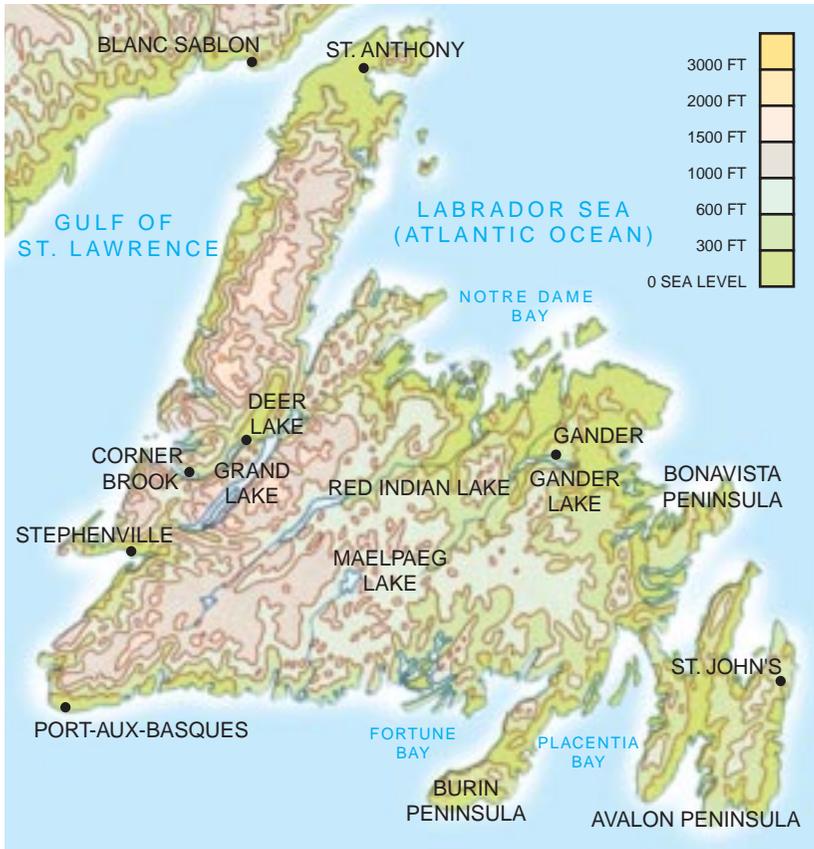


Map 3-3 - Gaspé Peninsula

The Gaspé Peninsula, an extension of the Appalachians, is generally comprised of mountainous terrain which runs east-northeast to west-southwest. The entire northern shore borders the St. Lawrence River while the southern section borders Chaleur Bay and northern New Brunswick. The Notre Dame Mountain Range runs the length of the peninsula and rises from sea level along the St. Lawrence coast to approximately 3,500 to 4,000 feet. The highest elevation is Mont Jacques-Cartier, rising to 4,190 feet above sea level. The terrain slopes somewhat more gently southward towards Chaleur Bay. Several rivers pass through hard-cut valleys and travel in a general north-south direction. Two major river valleys are the Madawaska, which flows into the St. John River, and the Matapédia flowing southward into Chaleur Bay. The St. Lawrence River, which ranges from 15 to 75 n. miles in width along the peninsula, plays a major role in the aviation weather of the peninsula.

Farther up the south shore of the St. Lawrence River Valley, the region known as the Lower St. Lawrence is considerably flatter than on the north shore. It is generally a low plain and is comprised of forest and agricultural land rising gently towards hillier terrain to the southeast. Elevations as high as 2,325 feet are located near the Quebec-Maine border.

Newfoundland



Map 3-4 - Newfoundland

As with most areas in Newfoundland, the topography of the northeastern part of the island plays a significant role in local weather conditions. The terrain gently slopes upwards from the coast towards the southwest reaching elevations as high as 2,000 feet. The surface is predominantly bare and rocky with several bogs, ponds, and rivers. There are also many small islands along the coast from the Bonavista Peninsula to White Bay.

The Avalon Peninsula, located on the east end of Newfoundland, along a north to south line is elevated some 800 to 1,000 feet above sea level. While some areas of the peninsula do slope gradually to rocky beaches, steep cliffs that drop off into the Atlantic Ocean mark most of the coastline. The coast is fairly irregular with numerous bays, inlets, and smaller peninsulas.

The south coast of Newfoundland runs in a general east to west direction and is fairly regular from Port-aux-Basques to the Hermitage Bay area. Further east, the

coastline gets more irregular with several bays and the Burin and Avalon Peninsulas. Steep cliffs run parallel to the western portion of the coast with several narrow, steep-sided north-south running bays that produce gap winds in a northeast circulation. Terrain rises towards the north with the highest peaks over the mountains along the southwest part of the coast.

The West Coast and Northern Peninsula of Newfoundland are characterized by the Long Range Mountains that provide some of the most majestic aerial views on the island. The mountains are at their highest along the mid part of the West Coast and rise to a maximum elevation of 2,672 feet over the Lewis Hills, the highest point on the island. The terrain is for the most part exposed bedrock with little or no surface sediment. Ice starts to form in the extreme northeastern part of the Gulf of St. Lawrence, on average, the last week of December or first week of January to cover most of the northeast Gulf area by late March. It usually becomes ice-free by late April. Along the west coast of the Northern Peninsula, the immediate coastline is fairly flat and somewhat marshy. However, beyond these areas mountainous terrain prevails with peaks ranging from 2,000 to 2,500 feet. The Strait of Belle Isle lies to the west of the peninsula while the Labrador Sea (Atlantic Ocean) is found on the east side.

North Shore of Quebec and Anticosti Island



Map 3-5 - North Shore of Quebec and Anticosti Island

This area of coastline extends from the La Malbaie area to Blanc Sablon at the Quebec-Labrador border. The coast from La Malbaie to the Sept-Iles region rises abruptly above the St. Lawrence River to the 1,500 to 3,000 foot range. The Saguenay River empties into the St. Lawrence River just south of Tadoussac and is a prominent waterway along this stretch of coastline. The tall cliffs along the lower section of the Saguenay River Valley are known to produce strong gap winds and low-level turbu-

lence. The Manicougan is another important river that empties into the St. Lawrence just north of Baie-Comeau. Northeast of the mouth of the Saguenay River, the St. Lawrence River gradually widens until reaching Baie-Comeau, where it begins to narrow up to Pointe-des-Monts, causing gap winds here as well. The river begins to widen rapidly again east of Pointe-des-Monts.

The terrain along the coast from Sept-Iles to Blanc Sablon is somewhat flatter in the immediate vicinity of the coast. Hills in the 1,500 to 3,000 foot range also exist along this section of the coast but are generally farther inland. Downslope winds from the northwest usually causes low cloud to break up as it descends from the higher terrain to the north. Airports along the coast, like Sept-Iles and Natashquan, will tend to have better conditions than northern areas in cool moist north or northwesterly circulations. The coast is mostly devoid of soils and trees providing an excellent opportunity for the formation of a number of inlets. Small islands become more and more numerous over the eastern section of the St. Lawrence coast.

Away from the coastline, the terrain rises and becomes more rugged with deeply incised river valleys that flow southward into the St. Lawrence River. This area is characterized by the Manicougan Reservoir, which is a large ring shaped meteorite crater. Elevations in this region range from 2,500 to 3,500 feet, with the higher peak reaching 3623 feet at Mont Veyrier, just northeast of the Manicougan Reservoir. This region is comprised of dark, dense forests, which extend from the St. Lawrence northward to the tundra in Labrador.

Anticosti Island, situated in the northern part of the Gulf of St. Lawrence, is an outlier of the boreal forest. The island is oriented along a northwest to southeast direction and is about 110 n. miles long, with a maximum width of approximately 30 n. miles. The relief is generally low, with elevations seldom reaching 500 feet, with the exception of a 1,025-foot peak near the central part of the southern coast. Wave-cut terraces up to 200 feet in elevation occur on both north and south shores, being generally wider on the south side.

Labrador and Eastern Ungava Bay Area



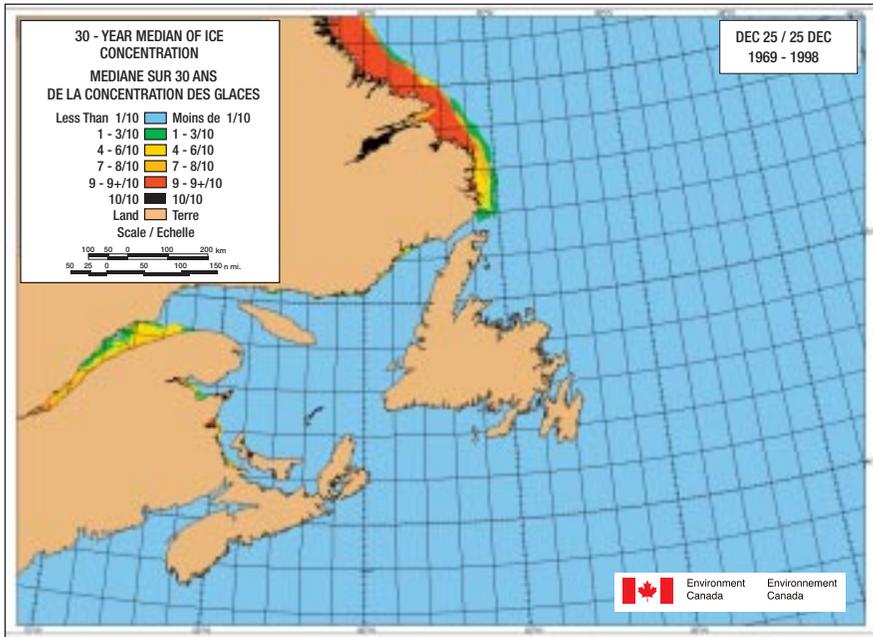
Map 3-6 - Labrador and Eastern Ungava Bay Area

Labrador has a steep and rugged coastline, which is dotted with numerous small islands, bays and east-west oriented inlets. The terrain becomes more mountainous with fjordic inlets north of Cape Harrigan. This topography results in drastic local effects due to funnelling and channelling. Here, the Torngat Mountains are prominent and by far contain the highest peaks in the entire GFA domain. Of these mountains, Mount Caubvick, or Mont D'Iberville as it is called in Quebec, is the highest peak at nearly 5,430 feet.

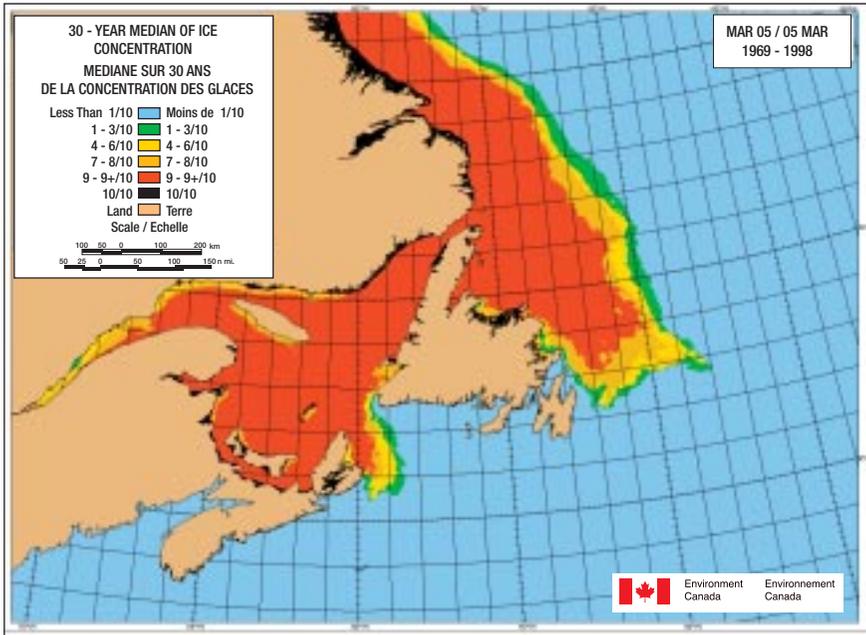
South of the Ungava Basin, the terrain remains mountainous over the western Torngats but becomes flatter along the north-south oriented George River Valley. The Smallwood Reservoir and the eastward flowing Churchill River are prominent farther south. The Smallwood Reservoir freezes in the colder months but is often a source of moisture for cloud, or fog, to develop in the spring and fall.

The terrain south of the Churchill River ranges in elevation from 2,000 to 3,000 feet and is mostly peat covered with a few conspicuous eskers and areas of exposed bedrock. The Mealy Mountains south of Lake Melville are the highest peaks in this area (as high as 3,900 feet) and play an important role on the weather at Goose Bay Airport. The landscape also contains numerous lakes and rivers, most of which freeze over during winter months.

The waters along the Labrador coast are cold. Ice tends to form along the north Labrador coast by late November and moves quickly southward to cover the south coast by early to mid-December. Melting usually begins in May or June. Coastal sections of Ungava, Bay along the Quebec side of the Torngats, slope upward more gently than on the east side along the Labrador coast. This coastline is also indented with several long northwest to southeast oriented inlets and fjords. Coastal ice in Ungava Bay exists for long periods in the summer and is usually ice free by late summer.



Map 3-7 - Average Ice Coverage in Late December



Map 3-8 - Average Ice Coverage in Early March

Ocean Currents

The role ocean currents play on weather in Eastern Canada cannot be over emphasized. The two major ocean currents that have the most effect on weather in this part of the country are the Gulf Stream and the Labrador Current. The Gulf Stream is a very warm ocean current that flows northward along the east coast of the United States and northeastward through the Grand Banks.

The Labrador Current, on the other hand, is a cold ocean current originating in the Arctic. It flows southward along the coast of Labrador and the east coast of Newfoundland, where it branches out into smaller currents. The distribution of these different ocean currents determines the weather on both small and large scales.



Fig. 3-1- Gulf Stream and Labrador Current

Mean Atmospheric Circulation

The mean atmospheric circulation aloft over Eastern Canada and the western North Atlantic is generally west to east. In the summer, the winds aloft at all levels are predominantly from the west, with the jet stream lying between 45 and 60 degrees north latitude.

Upper level winds in the winter months can be as much as 60 percent stronger than in the summer months, due to the stronger temperature gradient that exists between northern and southern latitudes. The strength of the jet stream, which is proportional to this temperature gradient, is stronger and much better defined during this period.

A larger scale trough in the mean flow also characterizes the circulation aloft in winter over Eastern Canada. This contributes to the development of surface low pressure systems that move up the coast of the United States and into Eastern Canada.

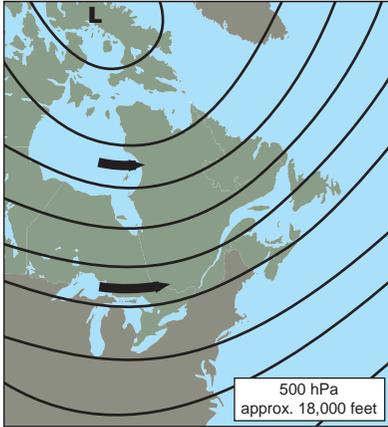


Fig. 3-2 - Mean Summer Upper Wind Pattern

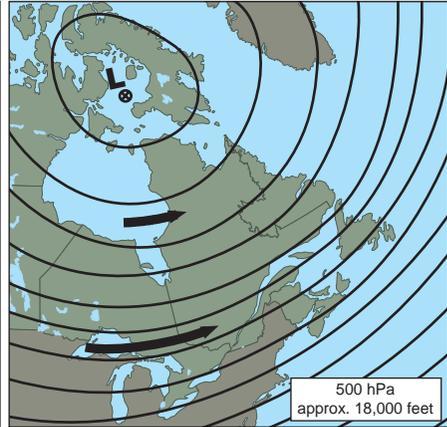


Fig. 3-3 - Mean Winter Upper Wind Pattern

Upper Troughs and Upper Ridges

The most common features that move with the upper flow are the upper ridges and upper troughs. Over Eastern Canada, upper ridges usually bring good weather while upper troughs will usually bring relatively bad weather.

That being said, the position of the upper ridge plays a significant role in the impact it will have on the weather. When the upper ridge lies directly over the region, it forces the travelling storms to pass either to the north or south of the area. In such cases, the weather becomes stagnant with very light winds at all levels. In the summer, hot, dry, sunny conditions dominate while in the winter the skies are clear.

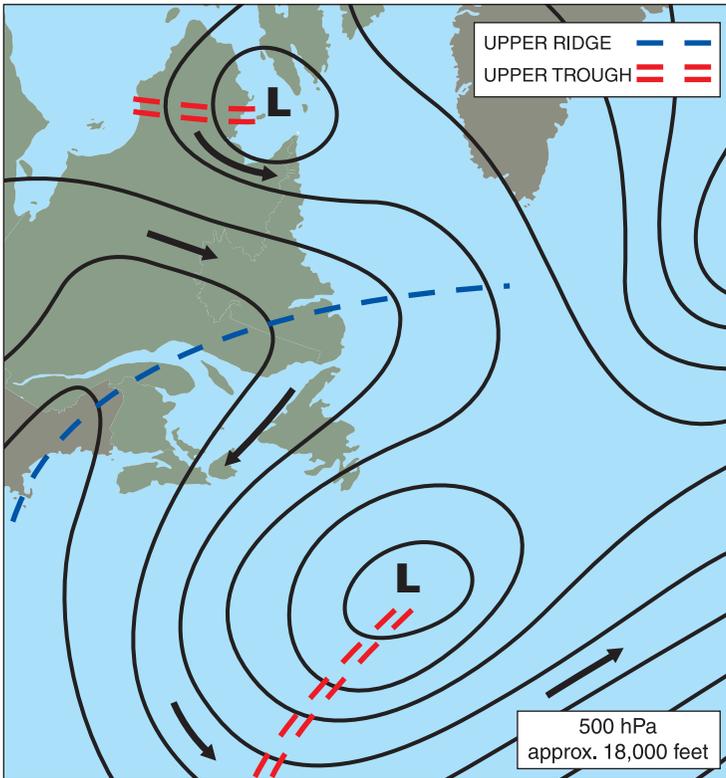


Fig. 3-4 - Typical Upper Ridge Pattern showing upper ridge and upper troughs.

The upper ridge may also lie over the North Atlantic, thereby causing low pressure systems to either track across Eastern Canada or become stalled south of Newfoundland or Nova Scotia. While the weather may be good over western sections of the domain, eastern areas may be under the influence of a persistent easterly flow with rain, drizzle and fog. Meteorologists often call this a “blocking pattern” or “omega block” since the ridge has the shape of the Greek letter omega (Ω).

Upper troughs, because of the induced vertical lift, are areas of cloud and precipitation. Upper troughs tend to be strongest in the winter and often have broad cloud shields and widespread precipitation, particularly in upslope areas. During the summer months, the cloud shields associated with upper troughs are narrower, usually quite convective and produce mainly showers and thundershowers. Upper troughs may have a surface low pressure system or a frontal system associated with them, further enhancing the cloud and precipitation. Clearing behind an upper trough can be gradual but tends to be quite rapid in the summer.

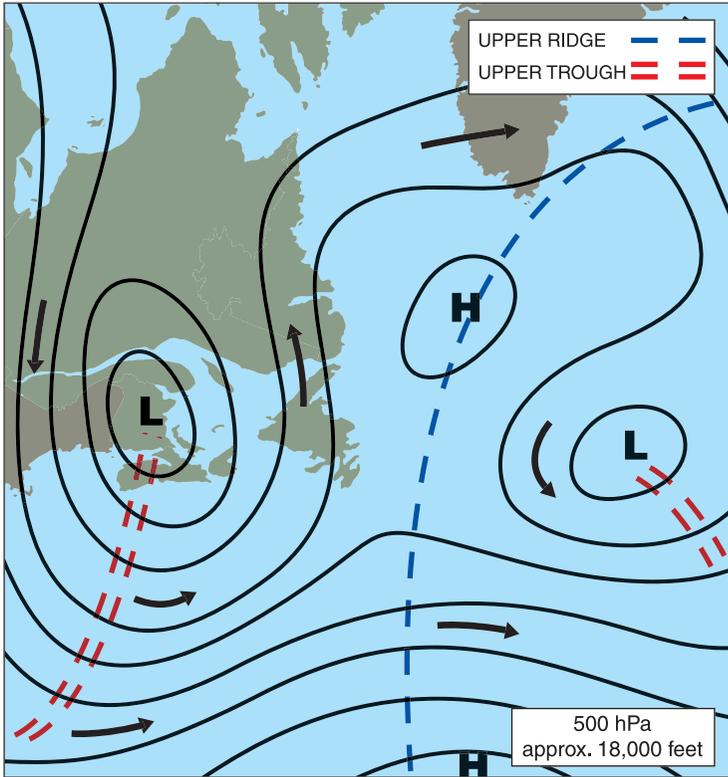


Fig. 3-5 - Omega Block - a blocking pattern that can cause an upper low to stall over Eastern Canada

Semi-Permanent Surface Features

An examination of the average sea level pressure distribution over a number of years shows the presence of relatively fixed features in the winter and summer pressure patterns. The Icelandic Low is located near, or just west of, Iceland with a trough extending from Scandinavia southwestward to the Davis Strait. As low pressure systems deepen and move northeastward in the North Atlantic, they become occluded and decelerate significantly; some even remain almost stationary for extended periods of time. This accounts for the presence of the Icelandic Low, which is much deeper and more extensive in the winter.

The Bermuda High or Azores High, on the other hand, is located farther south and is usually elongated east to west with the major axis near 35 degrees north. This feature is more prominent in the summer and accounts for the warm south or south-westerly flow over the GFACN34 domain in the summer months.

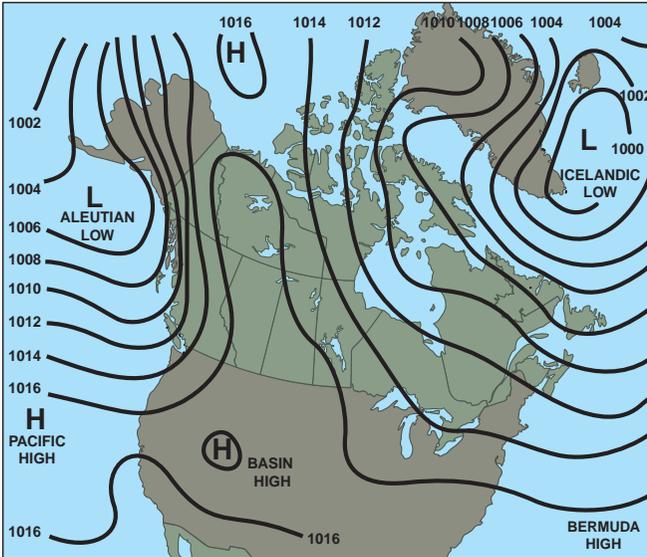


Fig. 3-6 - January mean sea level pressure

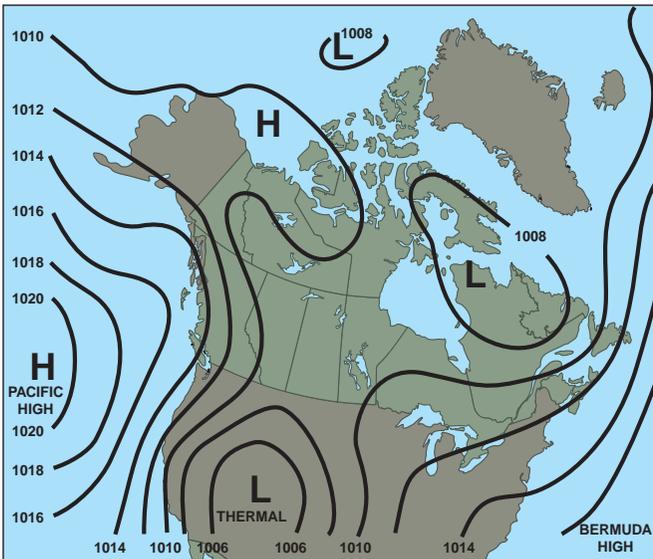


Fig. 3-7 - July mean sea level pressure

Migratory Systems

The mean surface patterns discussed above are a result of frequent motion of individual low and high pressure systems. Low pressure systems can be classified as extra-tropical (systems originally forming over the mid-latitudes) and tropical (those that develop near the tropics). Of these, it is the extra-tropical lows that affect this area the most. The majority of these features develop south or west of the region and move east or northeastward. As they track through the region, these storms usually intensify and then eventually become occluded, then begin to slow down significantly or even “retrograde” (move slowly westward).

Winter Storms

Winter storms are more frequent and also more intense due to the greater temperature differences between northern and southern latitudes. Lows that develop usually move northeastward and bring snow, freezing rain and high winds, depending on the specific track. There are several locations that are most favourable for winter storm development or intensification.

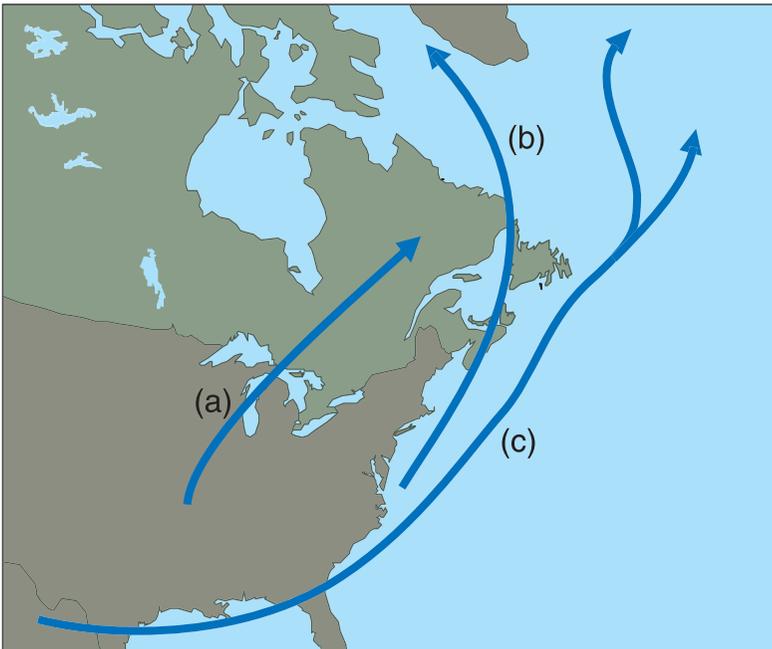


Fig.3-8 - January Storm Tracks - (a) Great Lakes Lows; (b) Cape Hatteras Lows; (c) Gulf of Mexico Lows

Summer Storms

In the summer months, the frequency and severity of the storms are reduced and low pressure areas follow a more northerly track as they cross the region. This north-

ward shift pushes the main storm track over the Gulf of St. Lawrence and southern Labrador. South of this track, minor frontal systems, upper troughs and thunderstorms produce most of the weather.

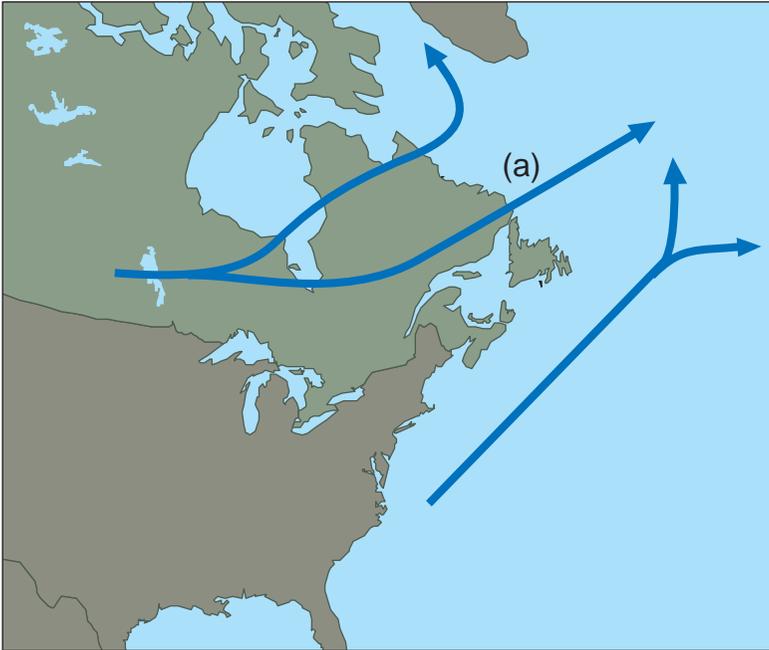


Fig. 3-9 - July Storm Tracks - (a) Hudson Bay Lows

Hatteras Lows

Hatteras Lows develop just off the coast of Cape Hatteras, North Carolina where the Gulf Stream causes a rapid increase in water and air temperature as you move offshore. When cold air plunges southeastward off the Carolinas and meets the warm, moist air over the Gulf Stream, the perfect ingredients are in place for development of intense storm systems. During the winter, when these temperature differences are at their peak, very intense storm systems, called “bombs”, will develop in this region. “Bombs” are defined as storms that deepen, or intensify, at least 24 hPa in 24 hours. They usually cause severe winter weather conditions along the northeast United States and Eastern Canada and are often difficult to forecast.

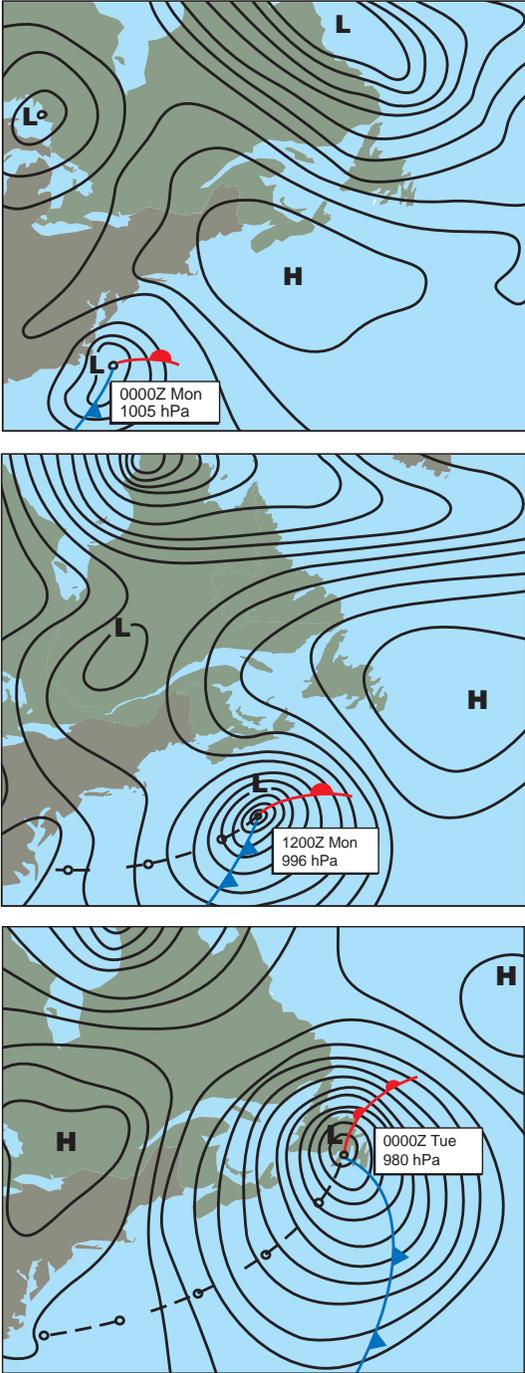


Fig. 3-10 - Typical track and development of an East Coast Bomb

Gulf of Mexico Lows

Another location that favours winter storm development is over the warm waters of the Gulf of Mexico. As cold air sweeps down over the southeast United States, it interacts with the warm, moist air of the Gulf region and a strong temperature contrast is created. In these situations, lows will develop in the same manner as they do off Cape Hatteras. Lows forming in this area get caught in the upper level circulation and track north or northeastward up into Eastern Canada. If a particular low's track brings it over the Gulf Stream, it will often undergo significant intensification.

Great Lakes Lows

The Great Lakes area is yet another favourable location for low pressure development. Heat and moisture from the lakes are injected into the lower levels of the atmosphere causing lows to either form here or intensify as they approach from the west or southwest. These systems tend to be less intense than coastal lows but can still give widespread poor conditions and strong, gusty winds. Great Lakes lows usually follow two main tracks, with one bringing the systems north or northeastward up into Quebec and Labrador, and the other bringing the systems east off the coast of the United States where they normally intensify.

Hudson Bay Lows

A frequent storm track in both summer and winter is for lows developing over Hudson Bay to move eastward across Quebec and Labrador. These lows are even less intense than Great Lakes lows or east coast lows. While flying conditions will remain generally good, areas of low ceilings and poor visibility in light rain or snow will occur over the northern areas. In winter, the air masses associated with these systems are usually very dry and conditions usually improve rapidly in their wake. However, considerable moisture is acquired in the lower levels during the summer causing stratocumulus ceilings to develop even well after the lows move away from the region.

Polar Lows

Although less frequent than frontal systems, polar lows also affect the area. A polar low is an intense maritime polar cyclone ranging from 60 to 600 miles across, with surface winds exceeding 30 knots. These lows are mostly found over the coastal waters of Labrador during very cold outbreaks when air-sea temperature differences are at least 20 degrees. At the mature stage, heavy snowshowers and blowing snow with reduced visibilities can be expected with rapidly changing wind direction, occasional lightning and severe aircraft icing. They often move very fast with speeds of 30 to 40 knots and dissipate rapidly as soon as they move over land or ice packs. Because of their relatively small size and rapid formation, polar lows are very difficult to forecast.

Highs

Areas of high pressure found over the domain have a wide variety of tracks. The ones that move eastward off the American continent are usually cold domes and, in the winter, these weaken or disappear after they reach the warmer waters of the Atlantic. When the center of the high is west of the area, a cold Arctic outbreak will develop and west or northwesterly flow will generally give snow squall activity to onshore areas. In summer, they usually merge with the Azores or Bermuda High. Occasionally, a high moving eastward off the Labrador coast will continue to build for two or three days and spread, more or less, straight to Europe.

Tropical Depressions, Tropical Storms and Hurricanes

During the late summer and early fall, tropical cyclones originating over the tropical latitudes move westward with the trade winds, turn towards the north and usually weaken as they accelerate northward. In the Atlantic Ocean, storms with sustained winds of 20 to 33 knots are referred to as “tropical depressions,” 34 to 63 knots are called “tropical storms,” and winds with 64 knots or more are known as “hurricanes.” Once a storm has reached hurricane strength, it is classified according to the Saffir-Simpson scale (see Glossary).

Tropical cyclones that affect Eastern Canada form north of the equator over warm waters (at least 26°C). They often begin as disturbances off the coast of Africa and, if conditions are favourable, will intensify as they move westward. Conditions that are favourable for development include an unstable atmosphere, very little or no wind shear, and a building area of high pressure in the upper levels above the storm. The main fuel for the storms, however, is the warm water of the tropics. The warm water helps drive the convection within the storm where a large amount of water vapour is condensed, releasing latent heat. That, in turn, provides energy for the storm. As long as the storm stays over warm water, it will have enough energy to survive. Tropical cyclones have a tendency to travel along common paths until they dissipate and their individual movement is determined by the steering currents in the atmosphere. When tropical storms or hurricanes reach the Caribbean or southeast United States, some continue westward, however, most make a northward turn and head up the coast or out to sea.

On average, 4 to 5 tropical cyclones threaten Eastern Canada each year with the highest frequency being in Newfoundland. Since Atlantic Canadian waters are much cooler than tropical waters where hurricanes are formed, approaching cyclones usually lose their energy source and most begin the decaying stage of their life cycle. Storms that have moved inland also weaken rapidly because they are removed from their source of energy and are weakened by the frictional drag of the land. Although no longer visible on a weather map, the energy of a dissipated storm can continue to move through the atmosphere. Heavy rain from the very moist tropical air may con-

tinue to fall over the region. As well, tropical storm force, or even hurricane force winds often remain above the boundary layer even after the storm has moved well inland. Often, a tropical cyclone will undergo a post-tropical transition - a change from a tropical cyclone to a mid-latitude frontal storm - while it is in the proximity of Atlantic Canada. As these storms move into the stronger air streams and cooler air temperatures of the middle latitudes, their rain and wind patterns change as they accelerate. The heaviest rains shift to the left side of the accelerating storm while the strongest winds are found on the right side. Because of these pattern changes, land areas in Atlantic Canada frequently witness the heavy rains, but seldom experience the strongest winds.

Although there are regular research and reconnaissance flights into hurricanes, these storms are clearly no place for commercial or general aviation. Virtually every type of aviation weather hazard exists in these storms. Care must also be taken by aircraft on the ground with the approach of tropical cyclones. Torrential rains and very strong winds can usually be expected with these storms and can easily damage aircraft that have not been properly sheltered.

Cold Lows

A cold low, or “cut-off” low, is a large, nearly circular area of the atmosphere in which temperatures get colder towards the centre, both at the surface and aloft. It is the final stage in the development of a low and is not reached by all storms. While a surface low pressure centre may or may not be present beneath the cold low, its true character is most evident on upper charts. The significance of cold lows is that they produce large areas of cloud and precipitation, tend to persist in one location for prolonged periods of time and are difficult to predict.

Cold lows can occur at any time of the year. They tend to occur more frequently over southern latitudes in the spring, while occurring more frequently over northern latitudes in the winter. During these periods, low pressure systems will approach the region from the south or southwest and sometimes become “cut-off” from the prevailing circulation aloft as cold air becomes completely wrapped around the low pressure centre. The overall effect is to produce a widespread area of cool, unstable air in which bands of cloud, showers and thundershowers occur. Cold lows are also a favourable location for aircraft icing. Along the deformation zone to the northeast of the cold low, the enhanced vertical lift will thicken the cloud cover and produce widespread, steady precipitation. Eventually, the low will either weaken to the point that it is no longer detectable on the upper charts, or will be pushed out by stronger systems approaching from the west.

Vertical structure of a Cold Low

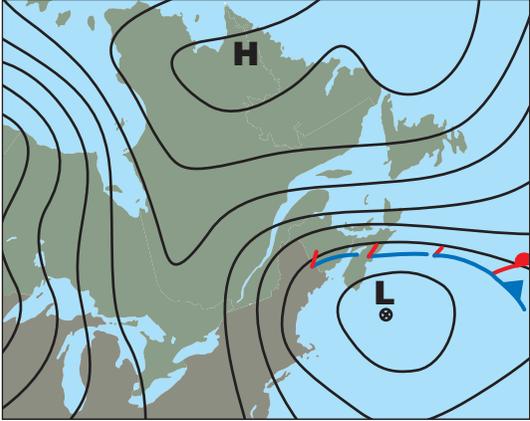


Fig. 3-11 - Surface Analysis

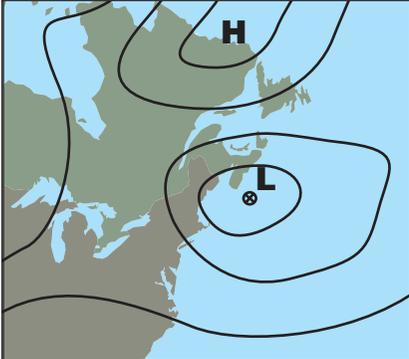


Fig. 3-12 - 850 hPa Analysis (about 5,000 feet)

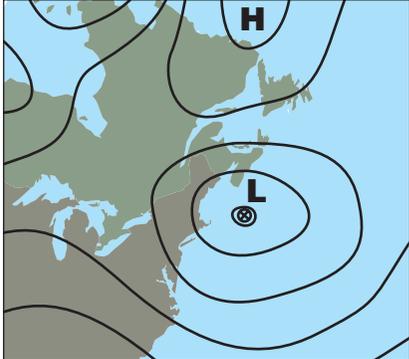


Fig. 3-13 - 700 hPa Analysis (about 10,000 feet)

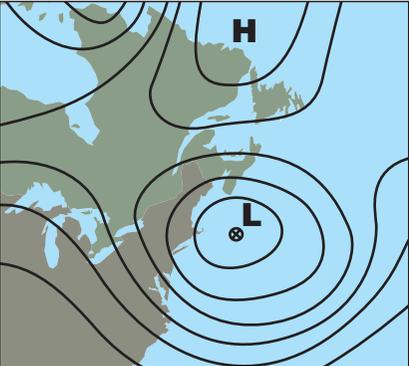


Fig. 3-14 - 500 hPa Analysis (about 18,000 feet)

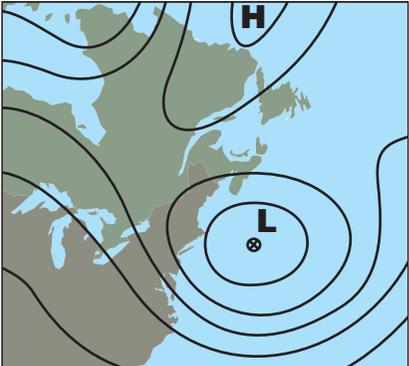


Fig. 3-15 - 250 hPa Analysis (about 34,000 feet)

Table 3: Symbols Used in this Manual

	<p>Fog Symbol (3 horizontal lines) This standard symbol for fog indicates areas where fog is frequently observed.</p>
	<p>Cloud areas and cloud edges Scalloped lines show areas where low cloud (preventing VFR flying) is known to occur frequently. In many cases, this hazard may not be detected at any nearby airports.</p>
	<p>Icing symbol (2 vertical lines through a half circle) This standard symbol for icing indicate areas where significant icing is relatively common.</p>
	<p>Choppy water symbol (symbol with two wavelike points) For float plane operation, this symbol is used to denote areas where winds and significant waves can make landings and takeoffs dangerous or impossible.</p>
	<p>Turbulence symbol This standard symbol for turbulence is also used to indicate areas known for significant windshear, as well as potentially hazardous downdrafts.</p>
	<p>Strong wind symbol (straight arrow) This symbol is used to show areas prone to very strong winds and also indicates the typical direction of these winds. Where these winds encounter changing topography (hills, valley bends, coastlines, islands), turbulence, although not always indicated, can be expected.</p>
	<p>Funneling / Channelling symbol (narrowing arrow) This symbol is similar to the strong wind symbol except that the winds are constricted or channeled by topography. In this case, winds in the narrow portion could be very strong while surrounding locations receive much lighter winds.</p>
	<p>Snow symbol (asterisk) This standard symbol for snow shows areas prone to very heavy snowfall.</p>
	<p>Thunderstorm symbol (half circle with anvil top) This standard symbol for cumulonimbus (CB) cloud is used to denote areas prone to thunderstorm activity.</p>
	<p>Mill symbol (smokestack) This symbol shows areas where major industrial activity can impact on aviation weather. The industrial activity usually results in more frequent low cloud and fog.</p>
	<p>Mountain pass symbol (side-by-side arcs) This symbol is used on aviation charts to indicate mountain passes, the highest point along a route. Although not a weather phenomenon, many passes are shown as they are often prone to hazardous aviation weather.</p>

Chapter 4

Seasonal Weather and Local Effects

Introduction

This chapter is devoted to local weather hazards and effects observed in the GFACN34 area of responsibility. After extensive discussions with weather forecasters, FSS personnel, pilots and dispatchers, the most common and verifiable hazards are listed.

Most weather hazards are described in symbols on the many maps along with a brief textual description located beneath it. In other cases, the weather phenomena are better described in words. Table 3 provides a legend for the various symbols used throughout the local weather sections.



Map 4-1 - Topographical overview of the GFACN 34

Maritimes Including the Gaspé Peninsula

(a) Summer

In the summer the frequency and intensity of storms that affect this area decreases significantly. (see fig. 3-9) As a result, air masses tend to remain over the region for longer periods of time and become stagnant. At the same time, the Bermuda High becomes more prominent causing the prevailing circulation to become southwesterly over the Maritimes and the Gaspé Peninsula. These winds tend to advect pollution from the northeast United States and, combined with the stagnant air masses, will often reduce prevailing visibility in haze.

Advection sea fog is also very common during this time of the year, especially in the early summer months. As the prevailing circulation shifts to the southwest, warm, moist air is pushed northward and cools from below causing fog to develop over the water along the Atlantic coast and the Bay of Fundy areas. This fog often moves inland during the evening hours and usually burns off in the morning.

Thunderstorms are most prevalent over northern and central New Brunswick, as well as over the Gaspé Peninsula. They either form in these regions or they will develop over Maine and then move eastward. New Brunswick and the Gaspé Peninsula have thunderstorm activity occurring, on average, between 10 to 20 days a year while Nova Scotia and Prince Edward Island receive only about half of this number, or less.

The Maritimes and the Gaspé Peninsula have many miles of coastline giving rise to an onshore sea breeze circulation on warm, sunny days. These onshore sea breezes occasionally get funnelled along the coast especially over the Gaspé Peninsula.

By late summer and early fall, tropical cyclones become a threat to the southern Maritimes. They tend to pass south of Nova Scotia but can still produce strong winds and heavy rains over inland areas. Occasionally, a hurricane or tropical storm will move northward and may even make landfall over Nova Scotia or southern New Brunswick, as was seen with hurricane Hortense in 1991.

(b) Winter

The general circulation over the Maritimes and the Gaspé Peninsula is stronger in the winter and predominantly from the west or northwest. Storms are also more powerful and occur at greater frequencies during this time of year with their track being further south than in the summer. (see fig. 3-8)

The first snowfalls usually occur over the higher terrain of the Gaspé Peninsula in mid to late fall and gradually extend southward as winter approaches. Three major snow belts can be found in this region. The first is found over the northern half of the Gaspé Peninsula, the second over northwest and north central New Brunswick and

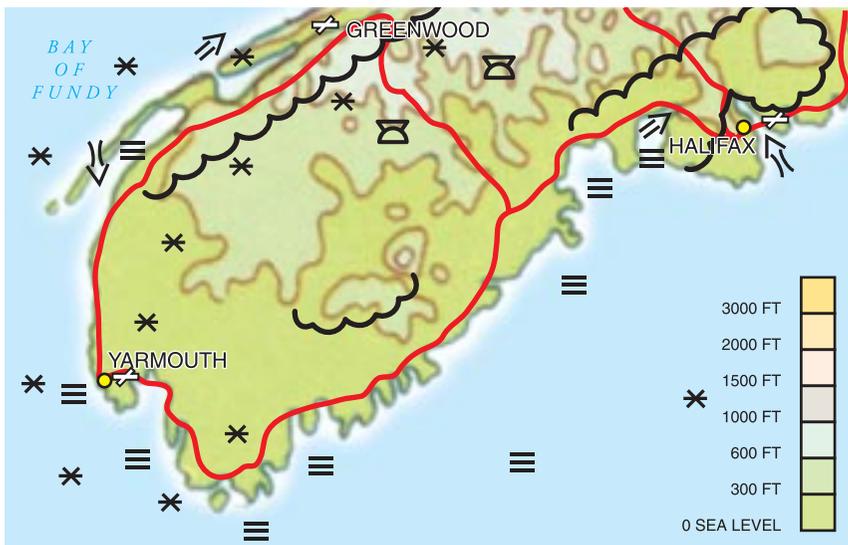
the third over southeast New Brunswick and northern Nova Scotia/Cape Breton. These snow belts are a result of both system snowfalls and onshore snow squall events. Snow squalls and streamers often develop in the wake of low pressure systems especially during the early winter. The areas most prone to this are the Annapolis Valley and northern Nova Scotia including the Cape Breton Highlands, Prince Edward Island and Les Iles-de-la-Madeleine.

Freezing precipitation can also be a problem during the winter months. Freezing rain and ice pellets will often develop ahead of approaching warm fronts resulting in very hazardous icing conditions. Onshore flow will also cause freezing drizzle to develop over the Gulf of St. Lawrence and near the coast, such as in eastern New Brunswick and northern Nova Scotia, where winds blow onshore. These conditions are most prevalent early in the season when the gulf is relatively ice-free.

Although thunderstorms can occur at any time of year, they tend to be quite rare in the winter. One exception is over the extreme southern portion of the region. Here, the relatively warm water heats the colder air, creating a very unstable situation that allows thunderstorms to develop along the various winter frontal systems that migrate through the area.

(c) Local Effects

Southwest Nova Scotia - Yarmouth to Halifax and Vicinity



Map A-2 - Yarmouth to Halifax

During the summer, dense fog is a frequent problem. Here, warm, moist, southwest winds combine with the relatively cold ocean waters to create advection fog that can

blanket the ocean and coastline. When the winds are light, the fog will usually retreat 2 or 3 miles offshore by early afternoon only to move in again in the evening. Some local pilots refer to this as the “duty fog bank”. Under similar conditions, it will move in and out at roughly the same time each day and remain just off shore all day long. The tops of these fog banks are often not very thick, ranging from 500 to 1,000 feet. For example, the towers south of the Bedford Basin are often visible through the fog.

A typical fog event in this area would be near zero visibility along the coast up to Halifax International Airport. Low stratus cloud of 500 to 800 feet can then be found as far north as Greenwood and Debert. Conditions will clear out at Greenwood and Debert first, then gradually burn off southward. Typical timing for the clearing is shortly after sunrise for the northern stations, 9 or 10 a.m. local time for Halifax and Liverpool, and around noon or shortly after for Shearwater. When fog remains over coastal sections in these conditions, it is usually only within 10 miles or so and better conditions will be found farther inland. When the winds are stronger, or when there is thick higher cloud present, the diurnal improvement is less pronounced and is usually negligible if rain develops.

Strong easterly winds tend to develop over this area ahead of a low pressure system approaching from the southwest. Coastal convergence, however, will cause these winds to be generally stronger and back to northeasterly direction in a band several miles wide just off the coast.

On warm summer days, sea breezes usually develop all along the coast and can be funnelled and channelled in the bays that mark the coastline. A strong sea breeze reaching 20 to 25 knots can develop at Lawrencetown Beach, for example. During these sea breeze conditions, light turbulence can be expected along the coast. Also, when sea breezes develop in the afternoon and there is fog just offshore, the south or southwest sea breeze can advect the fog onshore earlier than expected, but this will generally burn off within a few miles inland.

Fog or stratus cloud can develop over the inland lakes, such as Lake Rossignol and Lake Shubenacadie, and then drift over Liverpool and Halifax International Airport respectively. However, this fog or low cloud will burn off fairly quickly after sunrise. A similar condition, known as the Mahone Bay or St. Margarets Bay effect, develops when winds are from 210 to 240 degrees and between 15 and 25 knots. Fog develops in the bay and gets pushed onshore and upslope, reaching Halifax International Airport shortly afterwards.

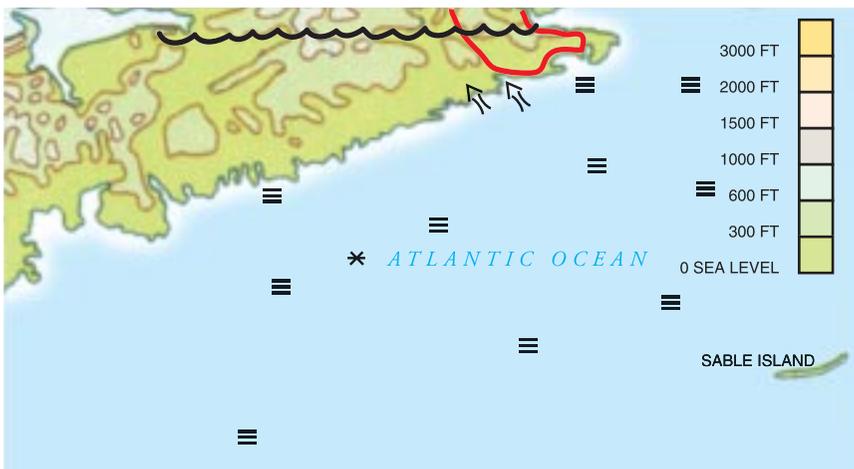
In the winter, snow showers that develop over the Fundy region can reach as far south as the coast, depending on the wind speed and direction. A related occurrence is for the snow showers to dissipate before reaching the coast, but snowflakes and ice crystals continue to be blown southward by the winds. This usually reduces visibility downwind although there is no actual cloud present. When the air is cold enough and

is pushed sufficiently southward, convective snow showers will redevelop off the Atlantic coast and reach Sable Island. When these snow shower outbreaks develop, significant icing and turbulence can be encountered within these clouds. Stratocumulus cloud originating over the water will be very conducive for icing conditions.

Freezing rain can sometimes be a problem in the Halifax International Airport area with the approach of a warm front. Temperatures along the coast, at Shearwater for example, will modify rapidly, helped by the warm ocean waters. Meanwhile, temperatures at the Halifax Airport will remain colder for a longer period of time, causing a delay in the changeover from freezing rain and ice pellets to rain.

A common route to and from Halifax in bad weather is from Mahone Bay northward to the Annapolis Valley via Panuke Lake. Another route to the north is to follow the Shubenacadie River Valley up to Cobequid Bay. From here, pilots can usually proceed west over the water or north through the Wentworth Valley.

Offshore Nova Scotia - Sable Region



Map 4-3 - Offshore Nova Scotia

Whether it is fishing surveillance, helicopter operations for the offshore oil industry or military exercises, the Sable and offshore area of Nova Scotia definitely has its share of air traffic. As over most marine areas, very strong winds are common here, especially during the winter. At the very least, this causes a nuisance as the strong winds can result in very slow groundspeeds. Mechanical turbulence is usually not a problem over the water, however, but can become significant near the coast.

Fog is another factor in this area and has the greatest impact on helicopter flights to the oilrigs. Fog can be a problem any time of year but is most prominent in May,

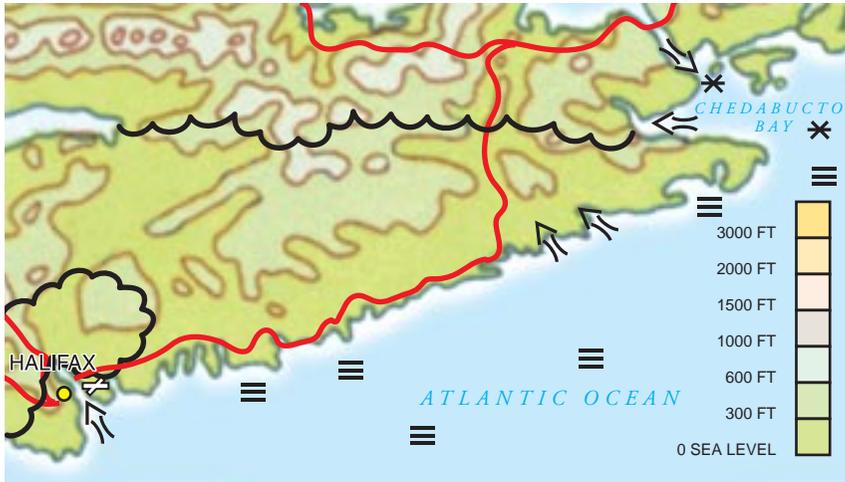
June and July. As mentioned earlier, fog banks will usually develop over the Atlantic Ocean when warm moist air masses move over the colder water. These fog banks, known collectively as the “duty fog bank”, will burn off over land in the daytime but will remain over the water, until there is a change in the large-scale weather pattern. The fog is usually based at the surface and is typically only topped at 300 to 700 feet, but tops in the 1,200 to 1,500 foot range are not entirely uncommon.

The fog tops will often have a tendency to undulate or exhibit a wave-like structure. Helicopter pilots have landed on the oil platforms in clear conditions with the fog lurking just below the helicopter deck, only to be shrouded in fog within 15 minutes and then in the clear again 15 minutes later.

The horizontal extent of the fog may vary as well, especially near and south of Sable Island. Warm pools of water, called warm rings or warm eddies, break off from the Gulf Stream and move northward embedded within the colder water. This results in rapidly changing water temperatures in relatively short distances. Fog can be expected over the colder water with clear areas over the warm eddies. Pilots concerned about fog will often study sea surface temperature charts and look for these warm eddies before heading offshore.

In the winter, icing becomes the worst problem in this area. Marine stratus and stratocumulus cloud will be extremely moist and contain lots of supercooled water droplets when temperatures are below freezing. Icing studies off the east coast of Canada have shown that the prime temperature range for icing conditions in marine cloud is between 0°C and -11°C. It should be noted, however, that icing has been encountered in temperatures as low as -24°C. Pilots who regularly fly here indicate that if icing conditions are encountered, it is usually possible to get out of it by descending closer to the water where the air temperature will usually be just above freezing. Another winter hazard common to this area is snow squall activity during very cold outbreaks. These snowsqualls can cause turbulence, icing and near zero visibilities locally. They generally persist until the wind diminishes in advance of a high pressure system.

Halifax to Chedabucto Bay



Map 4-4 - Halifax to Chedabucto Bay

Conditions in this region are very similar to those experienced in the previous area. Problems with fog exist in the spring and summer in moist, southerly winds. Fog moves inland at night and retreats to the coast during the daytime. Several bays that run northwest to southeast characterize the coastline, causing funnelling and channelling when winds are from these directions. East to northeast winds are generally stronger just off the coast, due to coastal convergence. Sea breezes are common here in the summer as well. These usually start off as southerly, and shift to southwest by mid to late afternoon.

When stratocumulus cloud hangs over the coast, ceilings tend to be lower between Sheet Harbour and Guysborough, than farther west. Conditions are usually better between Halifax and Musquodoboit Harbour. A common route for helicopter pilots inbound from the oilrigs is to follow Porter's Lake up to Halifax International Airport. Farther east, lower cloud and shower activity is often encountered at Chedabucto Bay and near the Strait of Canso, in northwest or southeast winds.

The terrain is somewhat more rugged in this region and, therefore, mechanical turbulence is more prevalent from the Halifax area eastward to Chedabucto Bay, when winds are 20 to 25 knots or more.

Snow squall activity from the Bay of Fundy generally does not reach this area when the winds are out of the northwest. When winds are more northerly however, snow squalls from the Northumberland Strait and the Gulf of St. Lawrence routinely cross Nova Scotia and can reach the coast. Again, these snow showers can reduce visibility to a quarter mile, or so, and contain significant icing and turbulence. Stratocumulus cloud will also signify icing conditions in the colder months.

In north or northwest winds in any season, fog, low cloud and occasional showers often develop over St. Georges Bay, which can then drift over the land all the way to Chedabucto Bay. Weather is often reported as being worse and winds stronger here than in surrounding areas. Pilots call this the “Port Hawkesbury Wall” and will often be the worst part of the trip between Halifax and Sydney.

Annapolis Valley and the Fundy Region of Nova Scotia



Map 4-5 - Bay of Fundy

Local flying weather in this area is, for the most part, determined by two major topographic features. The bay itself is the biggest factor, with the mountains south and east of the bay also playing an important role. Pilots indicate that the flying weather at Greenwood is generally a good representation of the weather in the entire Annapolis Valley.

Very high tides occur in the Minas Basin and in the Bay of Fundy. These tides have an average of 30 feet with the highest tide in the world registered here at an impressive 52 feet. The enormous tidal ranges cause the bay to be flushed out daily and prevent the water from being heated or cooled significantly. Consequently, the water remains relatively cold in the summer and warm in the winter.

Fog is a big problem in the Bay of Fundy area in spring and summer as warm, moist air from the south is cooled from below by the bay waters. It will typically blanket the area from Yarmouth, or just offshore, all along the coast to Chignecto Bay and Cobequid Bay, especially in southwest winds. This fog is often not very thick, as Isle Haute at the entrance of Minas Channel and Cape Split will protrude out of the fog on a typical day. From Minas Basin towards Cobequid Bay, fog or low stratus can also penetrate about 10 to 20 miles inland. This often produces very poor flying weather near and south of Debert Airport. During the daytime, there is marked improvement in the ceilings and visibilities at or near low tide.

Fog from the Bay of Fundy generally does not reach the Annapolis Valley due to the North Mountains. When the winds in this area are more southerly, they tend to be offshore and, as a result, fog will not be as bad here as on the New Brunswick side of the bay. Fog can, however, move into St. Mary's Bay and the Annapolis Basin through Digby Gut. Fog events in the Bay of Fundy become somewhat less frequent late in the summer when the water temperatures are at their highest. Early morning radiation fog, however, is more common in the valley, especially in the spring and early summer. In moderate southerly flow, fog from the south coast of Nova Scotia often reaches the valley well after midnight, usually as stratus cloud based at 500 to 1,000 feet, but burns off rapidly after sunrise.

Thunderstorms often form south of the Annapolis valley and along the Cobequid and South Mountains. Sometimes thunderstorms will develop over the hills on the New Brunswick side of the bay, or the Cobequid Mountains, and drift southeastward over Chignecto Bay and Minas Channel. Cape Split has a high percentage of lightning strikes because, as thunderstorms cross over the Minas Basin, the cape is the highest point in the vicinity and often gets struck first. Cape Split is also a favourable location for turbulence, according to local pilots.

In the winter time, with the approach of a winter warm front, cold air will tend to remain entrenched in the Annapolis Valley, causing freezing rain or ice pellets to persist longer than in surrounding areas. This effect will also cause strong wind shear in the valley and may give problems for aircraft on approach to Waterville, Greenwood and, to a lesser extent, Digby. A good indicator is to look at the REMARK section of the Greenwood METAR as it includes the winds at the top of Windy Hill (just to the north). A comparison of the surface winds at Greenwood and the Windy Hill winds will usually tell the story.

Turbulence is quite common in the Annapolis Valley, especially when the winds blow perpendicular to the valley. In north or northwesterly winds, the air will sometimes flow down the south side of the valley and then continue northward along the valley floor. Pilots on approach to Greenwood in these situations will report a northerly crosswind until reaching the height of the mountains, then somewhat turbulent conditions down to the runway, where a light southerly crosswind can be expected. Turbulence is also particularly noticeable at the west end of the runway at Waterville, especially in a southerly wind.

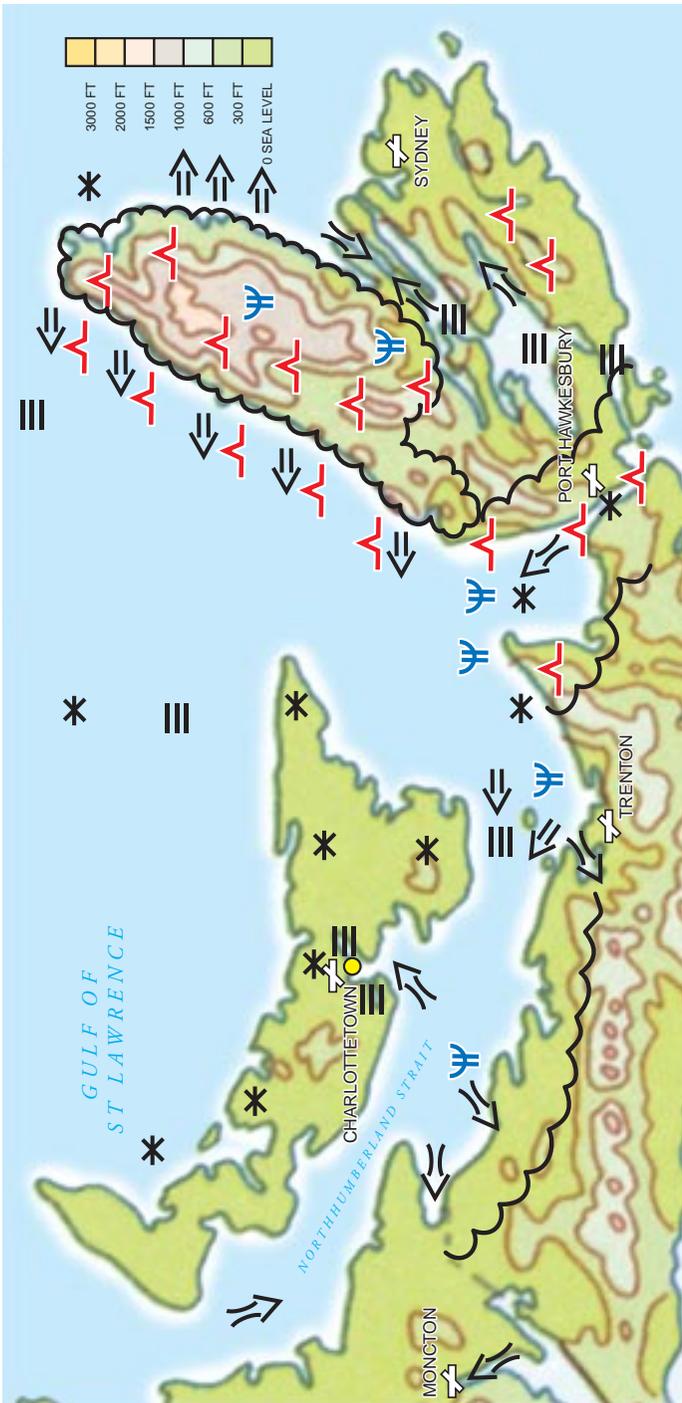
Snow showers and streamers are another major problem in the Bay of Fundy region and are appropriately referred to as "Fundy Flurries" by local pilots. As mentioned earlier, the tides in the bay prevent the water from getting too cold in the winter and, therefore, the bay does not freeze. During cold outbreaks, snow showers and streamers will develop over the relatively warmer water and give local blizzard conditions on the Nova Scotia side of the bay. This usually develops 6 to 12 hours after the passage

of a cold front and will continue as long as the winds are moderate to strong and are aligned up to about 9,000 feet. Streamers are more prone to develop in a west-northwest wind than a northerly wind because of the greater fetch over the water. From the air, these snow squalls look like a wall of fast moving snow and can easily surprise an unsuspecting pilot.

Southwest winds are funnelled into Chignecto Bay and tend to be very strong in Cumberland Basin. Northwest winds are also quite strong in this area. Likewise, funnelling is common in Digby Gut in northwest winds and is noticeable even in a 15-knot wind.

A common “bad weather route” going north or east is to follow the valley out to the Minas Basin, then follow the Parrsboro River Valley northward. Another option is to continue eastward to the Wentworth Valley, then turn north. Pilots indicate, however, that if the Parrsboro route is impassable, it will usually not be possible to proceed north via any route.

Northern Nova Scotia - Cape Breton



Map 4-6 - Northern Nova Scotia - Cape Breton

The Cobequid Mountains in northern Nova Scotia are quite prone to cloudiness and shower activity. The mountains run east to west and winds with any kind of northerly or southerly component will be upslope here, causing cloud to develop. Even when skies are clear elsewhere, scattered cumulus or stratocumulus cloud will top these hills. Likewise, when scattered cloud is reported elsewhere, broken to overcast cloud will be encountered over the hills, with possible shower activity as well. Although this is a common occurrence, this effect is quite local and often will not be explicitly forecast. Pilots on low level cross-country flights between Halifax and Moncton should be aware of this effect. Cloud may be close to the tops of the hills but conditions will generally be good on either side. Pilots should also expect icing conditions within these clouds in the colder months, especially in northerly winds before the Northumberland Strait freezes over. This is also an area where precipitation tends to be heavier during storms.

Other areas where cloud and showery conditions are frequent are the Strait of Canso and St. Georges Bay, as far west as Tracadie. Northwest winds will generally pick up lots of moisture from the Gulf of St. Lawrence and the topography in these areas will enhance upward vertical motion, causing cloud to develop or linger. Pilots report that weather changes very quickly in this area, especially near the causeway. Strong gap winds occur in the Strait of Canso in both southeasterly and northwesterly winds but are more pronounced in the northwesterlies. During late fall and early winter, these northwest winds can be accompanied by snow squalls causing very treacherous flying conditions.

Although large portions of the Gulf of St. Lawrence freeze over in the winter, this does not generally occur until mid winter and, even then, open areas are usually present. When very cold, arctic air flows over the water, snow showers and streamers develop and are pushed onshore, only to end when the wind dies down. Like in the Bay of Fundy area, the true snow squall activity will not start immediately after a cold frontal passage, but 6 to 12 hours afterwards. The area that is most prone to heavy snow squall activity extends from Tatamagouche to the Strait of Canso.

Mechanical turbulence is generally not a big problem in this area but can be encountered over the Cobequid Mountains in strong, gusty winds. The Cape George area is also known to be somewhat turbulent on windy days. Low-level wind shear and turbulence is also often encountered on approach from the east at Trenton Airport, especially when the winds are above 30 knots.

As mentioned in the last section, the Parrsboro and Wentworth Valley routes may be an option to pilots caught in bad weather. If transiting between Prince Edward Island and the Annapolis Valley in similar situations, it may also be possible to get through between Baie Verte and the Cumberland Basin. The terrain is quite low here, although power lines and towers are significant hazards.

Cape Breton often experiences some of the worst turbulence encountered in the Maritime Provinces. One of the best known local effects in eastern Canada occurs over the Cape Breton Highlands. Southeast winds ahead of low pressure systems will be quite violent here, due to mountain waves developing off the highlands. This effect is similar to the “Wreckhouse” winds in Newfoundland and is referred to locally as “les suêtes”, derived from the French word for southeasterlies. They occur near Cheticamp and extend out to about 3 miles from the mountain peak. Here severe turbulence, downdrafts (as much as 1,000 feet/min) and wind speeds as much as double those of surrounding areas can be expected. The downdrafts on the northwest side of the mountains will hit the water and flow outward, much like microbursts, producing patterns on the water that are readily seen from the air. Local pilots call these patterns “cat tracks” or “cat paws”. Even when the winds are as light as 10 to 12 knots at Sydney, the Highlands can be quite turbulent. The vertical extent of the turbulence depends on the wind speed, but pilots will typically be out of the worst conditions above 4,000 ft.

Within the mountain valleys, shadows on one side of the valley will cause the air to cool faster than the opposite side. This cooler air tends to sink to the bottom of the valley causing local downslope drainage winds, some of which may be quite difficult to overcome. Turbulence and wind shear induced airspeed changes are also often reported by pilots on approach from the west at Sydney Airport.

As in the northern part of Mainland Nova Scotia, snow squall activity is very common here in the late fall and early winter, especially from Inverness northward. The Cape Breton Highlands are not only a favourable location for snow showers, but also for heavier precipitation associated with organized low pressure systems. That is to say that pilots flying in rain or snow caused by a low will normally encounter heavier precipitation near the highlands. This will usually be on the north side when a low is approaching.

Even if precipitation does not develop, cloud will often top the mountains north of Sydney, while Sydney may be clear. This is most prominent from the fall to the spring seasons and can sometimes cause a problem for pilots heading to Cape North from Newfoundland. This is the shortest distance across the Cabot Strait and pilots transiting this route should expect cloud near the hills and at Cape North, in northeast to northwest winds. Lower cloud is also often found on the north side of the highlands. Pilots note, however, that in a northeast flow, conditions are markedly better southwest of Margaree than surrounding areas, due to downslope flow.

When conditions are good elsewhere and temperature-dew point spreads are only a few degrees, low stratus cloud occasionally forms near the Sydney Airport due to emissions from a power plant located north of the field. This cloud is usually between 800 and 1,200 feet and, when it forms, will often drift over the airport. The most

common time of occurrence of this effect is in the evening hours. Fog or low stratus sometimes forms over the Mira River in the fall and spring and can cause localized low ceilings for aircraft en route from the southwest, but rarely causes problems at Sydney Airport. Winds from the northeast to southeast generally bring the lowest ceilings over most of Cape Breton in any season. Thunderstorm activity tends to be more frequent north of the Bras d'Or Lakes and north of Sydney.

Fog and low stratus cloud will often form over the Bras d'Or Lakes especially in the spring and fall seasons. The fog will generally dissipate rapidly in a southwest wind and usually will not reach Sydney. When cloud is widespread in the area, VFR pilots should try to stay on the upwind side of the lakes, to stay away from the lower cloud.

In the previous scenario, the low cloud can linger in an east or southeast wind and move into Port Hawkesbury, where the weather is often significantly different than at Sydney. Pilots indicate that an easterly or southeasterly wind at Port Hawkesbury will generally bring in low flying conditions within 6 to 12 hours but the deterioration will be gradual. This, however, is not the case for a northwesterly wind where cloud and shower activity can move in very quickly from the Strait of Canso. Northwesterly winds can also cause turbulence for light aircraft on approach from the southeast at Port Hawkesbury.

Prince Edward Island - Northumberland Strait



Map 4-7 - Prince Edward Island - Northumberland Strait

Prince Edward Island's weather is highly affected by the Gulf of St. Lawrence and the Northumberland Strait. Probably the most pronounced effect is enhanced snow-fall during winter storms and onshore circulation snow squalls in the late fall and winter. When cold arctic air meets the open sea of the gulf, areas of cumulus and towering cumulus cloud develop with locally heavy snow squalls. This generally happens in north to northwest winds but can also develop in cold west or southwesterlies before the Northumberland Strait freezes over.

Conditions can become especially bad on the eastern end of the island, east of a line from Tracadie Bay to Wood Islands. The snow squalls here can result in almost continuous snow and blowing snow until the wind direction changes. This is due to the air being squeezed between the Gaspé Peninsula and Anticosti Island far to the north, and being forced to rise. This upward forcing produces a band of snow showers, or streamers, that stretches all the way down to Prince Edward Island. Strong winds are common here, as well, and can cause significant reduced visibilities in drifting snow, even when snow is not falling.

When low pressure systems pass near or to the south of the island during the winter, freezing precipitation becomes a threat. Freezing rain can develop ahead of an approaching warm front and, depending on the speed of the low, can last for several hours. Freezing drizzle is also common in persistent easterly or northeasterly winds off the ice covered Gulf of St. Lawrence.

Fog is one of the biggest problems during the spring as the ice begins to break up and warmer air masses begin to move up over the Maritimes. Low stratus can also develop in northerly winds off the gulf. In winds from the north-northeast, the Charlottetown Airport will often get stratus spilling over the hills to the north and move in at about 200 feet. This happens frequently in the spring and develops very fast. Cloud will also often move up from the Bay of Fundy in southwest winds. This can occur any time of year but is most prevalent in the summer when there is fog in the Fundy area. The cloud will be advected over the lower terrain north of the Cobequid Mountains and move into the Northumberland Strait and Prince Edward Island, as stratus or stratocumulus cloud based between 800 and 2,000 feet.

Although Prince Edward Island can be quite windy, turbulence is generally not a problem due to the flat terrain. The approach from the northeast at Summerside Airport can be somewhat turbulent on hot summer days or cool nights, due to the difference in terrain near the shoreline of Malpeque Bay. Sea breezes can develop, especially over eastern areas of the island, because of the colder Gulf of St. Lawrence. During the early summer, thunderstorms moving east from New Brunswick tend to die out as they cross the cooler waters of the Northumberland Strait. Later in the season, though, the water becomes warm enough to sustain or even strengthen thunderstorms as they move across the strait into Prince Edward Island.

Convection in the Northumberland Strait does not have to reach the thunderstorm stage to cause problems for aviators. By the fall into early winter, cumulus and towering cumulus regularly form on calm, cool nights over the strait from Cape Wolfe to near East Point, due to the relatively warm waters. They usually develop shortly after sunset and dissipate 2 to 3 hours after sunrise. Pilots flying cross-country across the strait should keep this in mind during this time of year, as no cloud will be present in the evening and skies may be clear at Moncton and Charlottetown during the night. The cloud over the strait will likely be difficult to detect and may be inadvertently flown into. By late fall and early winter, snow showers may develop as well, adding to the hazard.

Fundy Region of New Brunswick



Map 4-8 - Fundy Region of New Brunswick

As most local pilots are already aware, fog can be a major problem here in the spring and summer. It develops over the cold Bay of Fundy in warm, moist, southwest winds and is then advected onshore. It tends to be prevalent throughout the entire bay in these situations, but will creep farther inland on the New Brunswick coast than it will on the Nova Scotia side of the bay.

Fog typically extends inland to Grand Bay and can push as far north as Oak Point, in the Saint John River Valley, and also as far as Hampton. To the west, the fog will extend as far as the imaginary line that can be drawn between Oak Point and St. Stephen whereas, to the east, 1,400 foot hills will have a tendency to act as a barrier and prevent the fog from penetrating inland. Pilots report that when fog does move in from the bay, it always does so very rapidly and can remain, with little diurnal variation near the coast, as long as the flow is from the southwest. Thicker fog will usually extend from Pennfield to just east of St. Martins along the coast. It can also push farther east into Chignecto Bay and Shepody Bay, but usually burns off north of Hopewell Cape and Dorchester.

A good indicator as to whether or not fog will develop is to look at the forecast winds at 3,000 and 6,000 feet. When these winds parallel the bay, fog can usually be expected until the winds shift significantly. A common tool in timing the fog at Saint John Airport is to look at the tide tables for the Saint John Harbour. Fog often moves into the airport 30 to 40 minutes prior to high tide. Another good predictor of fog development is to look at coastal stations along the coast of Maine. If fog is observed at Bar Harbour and Rockland, fog in the bay is almost guaranteed.

Loch Lomond Reservoir to the northeast of the Saint John Airport will also have an effect on weather in the area, as will several smaller nearby lakes. In the spring time, when the reservoir and lakes are still cold, fog or low stratus will form and drift over the airport. This is not Bay of Fundy fog and is much more localized at the airport.

Pollution is another restriction to visibility and occurs frequently in the summer. It moves up the Saint John River Valley from the south, with typical visibilities around 6 miles in haze, as far north as Hampton, Kennebecasis River and up to Belle Isle Bay. The height of the worst pollution is about 300 to 400 feet and is generally yellowish in colour.

Also in the summer, thunderstorm activity will often remain north of the sea breeze front, or over the hills to the northeast. They may, however, reach the Saint John Airport when associated with a frontal system.

Sea breezes and coastal convergence are common here and can produce bands of strong southwest winds. Winds are also channelled around Kennebecasis Island in a southerly wind. The air flows around the island and converges on the north side, producing gusty winds and possible low level turbulence. Pilots also report turbulence over the hills northeast of the Saint John Airport in northerly winds, and, along the shoreline in south to southwest winds. Conditions typically smooth out above about 3,500 feet. Strong winds often develop on the west side of Grand Manan Island as prevailing winds get funnelled and channelled between the island and the mainland.

Another effect that is seen on the New Brunswick side of the bay is variations in the types of precipitation during the approach of low pressure systems. The warm

water will tend to keep the lower levels of the atmosphere warm, causing snow to change over to rain or freezing rain sooner than is forecast. Local pilots also indicate that significant icing conditions exist in stratocumulus cloud over the Bay of Fundy in the winter.

Southeastern New Brunswick - Moncton to Miramichi



Map 4-9 - Southeastern New Brunswick

West or northwest winds over eastern New Brunswick generally bring good flying weather in any season. Winds from the easterly quadrants are another matter, however. These winds are onshore and upslope here and will tend to give low cloud or fog. This will result in icing conditions within the cloud in the colder months. This onshore cloud tends to be based higher once the Northumberland Strait is frozen.

Often, after the passage of a cold front in any season, southeast New Brunswick will be slow in clearing out if winds are from the north or north-northeast. Conditions will generally not improve until there is no easterly component to the 3,000 and 6,000-foot winds. This may be several hours after clearing has taken place everywhere else in the province. This effect is more pronounced south of Miramichi. During the winter, the Petitcodiac River does not freeze completely leaving a moisture source for fog or cloud to develop. When the winds are light and temperatures are cold, fog will form over the river with the incoming tide. This fog occasionally drifts over the airport at Moncton, reducing ceilings and visibility. The Moncton METAR will often indicate the presence of fog over the city in the REMARK section an hour or so before it reaches the airport. This can also occur in the spring and early summer as warmer air flows over the colder water. In this case, the City of Moncton could be clear while the airport could be shrouded in fog.

Storms tracking to the south will generally give east to northeasterly winds to this area, which will usually result in low ceilings and visibility, especially from late fall to spring. Local pilots know that as soon as the winds go northeast at Moncton or Miramichi, it will not be long before ceilings between 800 and 1,200 feet will move onshore. When rain is falling, ceilings come down even further to about 400 feet. Strong winds associated with storms moving up the coast in winter will give heavy snow and blowing snow over the entire area. The southeast coast of New Brunswick is known as a snow belt area, as snowfall is enhanced by the moisture in the Gulf of St. Lawrence and the upslope flow.

In the summer time, fog from the Bay of Fundy will occasionally come up through Shepody Bay and the Petitcodiac River at night, but will quickly burn off shortly after sunrise. Moncton is sheltered by the Albert County Hills and does not experience the extended fog events that Saint John does, but will get stratus fractus cloud based between 1,000 and 1,500 feet. These hills will also act as a barrier to low-level jets ahead of cold fronts during winter storms. Pilots on final approach to Moncton will occasionally report a sudden loss of airspeed below 400 feet when a cold front lies to the west. In a southwesterly wind, these hills will also induce shower activity which tend to remain south of the Moncton Airport. Haze can also cause reduced visibilities to about 6 miles during the summer months.

Sea breezes are a fact of life along this part of the coast especially during the spring and early summer but tend to be less frequent in late summer, due to the relatively warm waters of the Northumberland Strait.

Most of the thunderstorm activity in this part of the province actually originates farther west over central and northwestern New Brunswick. The strongest storms are those associated with frontal systems. Air mass thunderstorms are usually scattered and tend to break up as they approach Moncton, with some passing to the north and some to the south.

Northeastern New Brunswick - Miramichi and Vicinity to Charlo



Map 4-10 - Northeastern New Brunswick

The flying weather along this part of the coast is in many ways similar to the southeast coast of New Brunswick. Southeast to northeast winds will bring the lowest conditions, especially in the spring to fall months, when there is a large temperature contrast between the water and the land. Ceilings will generally be lower farther inland if precipitation develops under these circumstances. Pilots say that when ceilings at Miramichi, Bathurst and Charlo are 300 to 500 feet, ceilings at Pokemouche Airport, which is closer to the coast, will almost always be 700 to 900 feet.

Fog or stratus fractus is common over the Miramichi River in the spring or fall and may even roll in towards the airport early in the morning. Stratocumulus cloud and local flurry activity are also common over the Acadian Peninsula in the fall and early winter. This cloud usually develops in colder air over the Bay of Chaleur and is advected inland by north or northwest winds. This cloud is typically based between 1,500 and 3,000 feet.

Also in the winter, freezing precipitation can also be a problem either ahead of warm fronts or in onshore winds along the coast. When the winds are out of the east or northeast, cloud associated with these winds will tend to be very moist and will be prone to icing conditions. Freezing drizzle will often be reported in these situations

as well. Freezing precipitation associated with warm fronts will often last longer at Miramichi, and especially at Charlo, due to local topography. Winter storms often track to the south or southeast of this area, resulting in periods of heavy snowfall. Onshore winds also tend to enhance the snowfall along the coast and even blizzard conditions are not uncommon here, especially over the Acadian Peninsula.

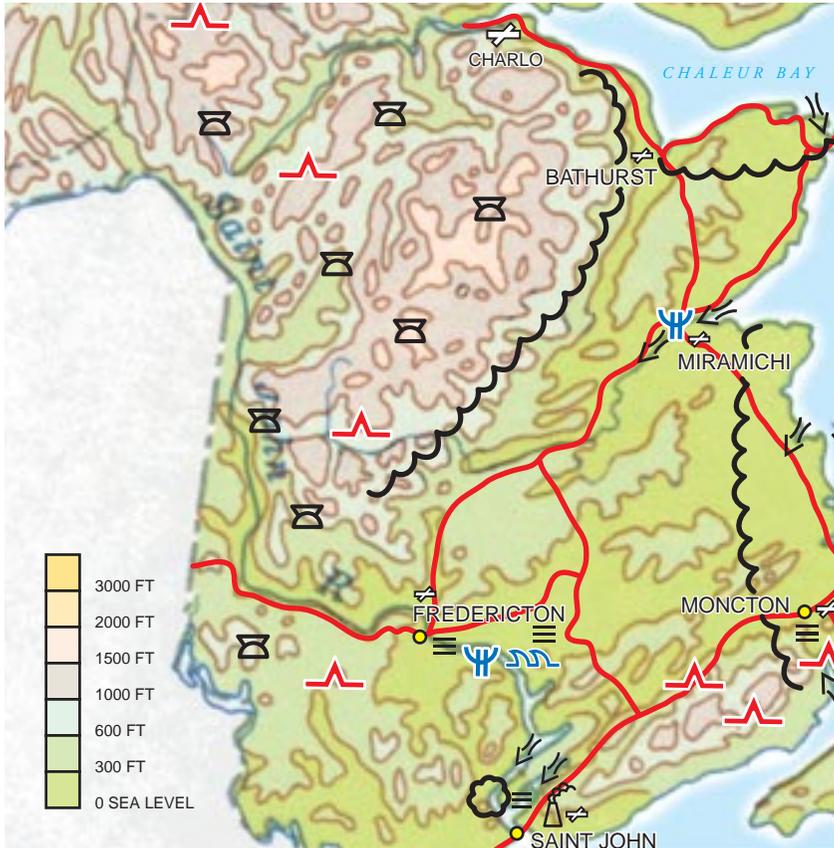
In the summer, sea breezes usually develop along the Gulf of St. Lawrence coast and along the Bay of Chaleur coast, east of Dalhousie. They typically develop around 11 am or noon local time and tend to be from the east or southeast, turning a pleasant sunny morning into a cool afternoon. Often fog will lie just offshore and, once the sea breeze develops, the fog will be pushed onshore. During mid afternoon, the sun will normally be strong enough to keep the fog at bay. Once the sun starts to set, however, the fog will start to roll in, usually as stratus based around 800 feet. Ceilings usually continue to descend until it is actually fog by about 9 or 10 p.m. local time.

Most of the thunderstorm activity develops farther inland but, when the air is sufficiently unstable, scattered thunderstorms can develop by mid afternoon due to surface heating. It is often possible to circumnavigate the storms but, when they become too widespread, one possible out is to head east towards the coast. Often by mid afternoon, a sea breeze will have developed along the coast “cutting off” any convection and producing an area of clear skies from Miscou Island to Moncton. This is often readily seen on satellite imagery.

Central and Northwestern New Brunswick

This area has some of the best flying weather in the Maritimes. Westerly to northerly winds are downslope and will generally provide good conditions. Winds from the south to the east will be upslope and tend to give lower ceilings and visibilities. The Saint John River Valley is prominent in this area and winds have a tendency to be channelled through the valley. Patches of radiation fog are common all along the river valley from spring to early fall, during clear nights. The fog, which is typically 500 to 1,000 feet thick, usually develops over the river shortly before dawn and gradually spreads outward to about 3 to 5 miles on either side of the river, often reaching the Fredericton and St. Leonard Airports. This fog usually burns off within 2 to 4 hours after sunrise.

Fog forming south of this area in the Bay of Fundy rarely reaches this far north but can extend up to Fredericton as low stratus cloud. It will usually take rain to bring the ceilings down further to result in fog. Low cloud and drizzle, or freezing drizzle in the winter, often develops when a high pressure system lies to the north and a low is to the south or southwest.



Map 4-11 - Central and Northwestern New Brunswick

Morning fog and stratus will often form over Grand Lake in any season but most often in the spring and fall. This usually burns off quickly but may also drift southward over the Gagetown training area. Fog may also form over the headpond of Mactaquac Dam in the fall and slowly drift towards the City of Fredericton and the airport. Over northwestern sections, radiation fog will form in the valleys in the summer but this burns off very quickly and is usually not a problem for visual navigation.

With a persistent high southeast of the Maritimes in the summer, southwest winds will bring pollutants up from the northeast United States and southern New Brunswick. This, along with haze, will typically reduce the visibility to 6 to 10 miles over a wide area, with local areas being diminished to as low as 2 to 3 miles. This haze has been observed at altitudes of up to 10,000 feet.

Northwest New Brunswick experiences the highest incidences of thunderstorms in the entire region. Convective activity first tends to develop over Maine or northwest New Brunswick due to orographic lift, then moves east or southeastward. When the air is sufficiently unstable, a typical day would start off sunny but somewhat hazy in

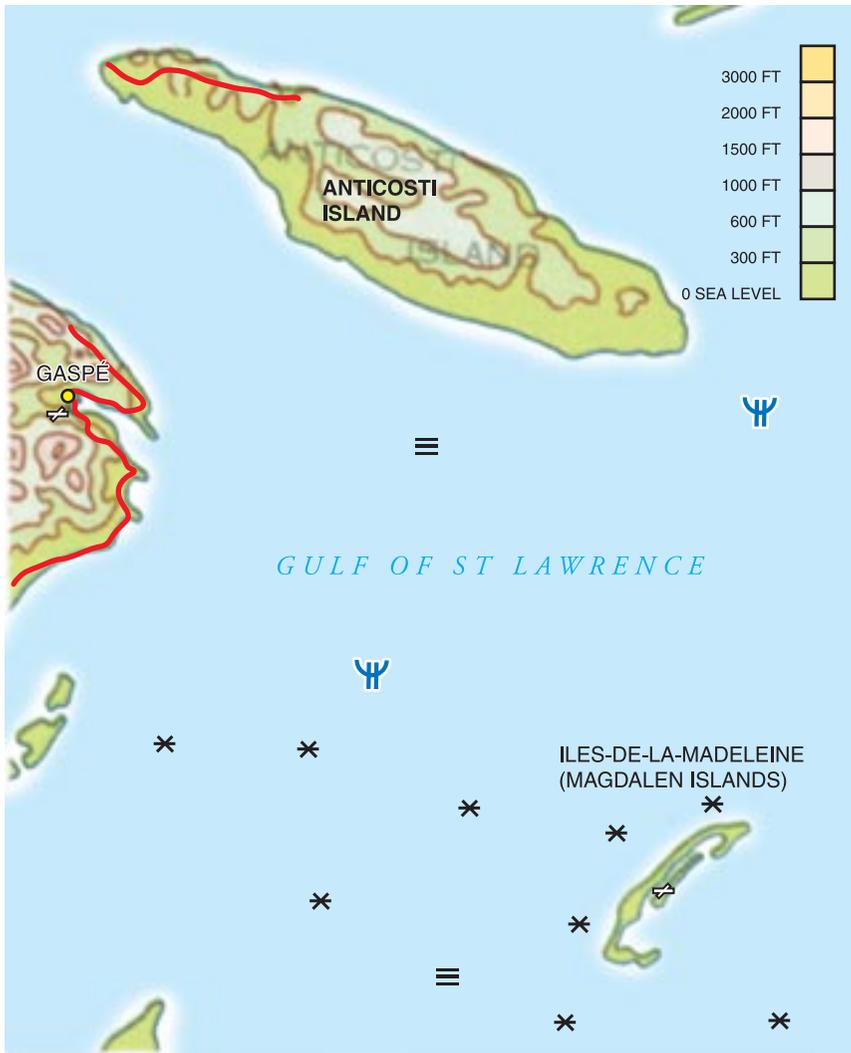
the morning. Scattered cumulus cloud would begin to develop by 11 a.m. local time and grow to towering cumulus by early to mid afternoon. Shortly after this, the first thunderstorms are observed west and northwest of Fredericton. As the afternoon progresses, thunderstorm activity will increase and move in a general easterly direction. Thunderstorms will tend to break up as they approach Fredericton and pass north and south of the city, often missing the airport. Although not always the case, this effect occurs quite often. In fact, local pilots refer the area north of Fredericton as “thunderstorm alley”.

Often, when only scattered cloud will be present over southern and eastern New Brunswick, stratocumulus ceilings will develop over the higher terrain in northern New Brunswick, causing problems for low-level traffic heading north from southern New Brunswick, or west from Miramichi, Bathurst or Charlo. This occurs quite often and in any season. Turbulence is also much more prominent over these mountainous terrain as well. Pilots also notice that turbulence can be significant on approach from the east at Fredericton Airport on hot, sunny days, due to differential heating between the land and the Saint John River.

Fronts approaching from the west will often slow down as they cross over Maine and western New Brunswick, due to the rough terrain. Local pilots also report that, as low pressure systems pass over southern New Brunswick and a changeover from snow to rain is forecast, central areas of the province will often be slow in changing over. Freezing rain or ice pellets will tend to last longer than over southern or southeastern areas of the province. North of Florenceville, snow rarely changes over to freezing rain or rain, as long as the low passes to the south.

Pilots and radiosonde technicians at CFB Gagetown often report low-level nocturnal jets over central New Brunswick in the fall and spring. Strong inversions will develop after sunset and surface winds of 4 or 5 knots may increase to 50 knots at about 800 to 1,000 feet. This is observed on a fairly regular basis on otherwise clear nights.

Gulf of St. Lawrence - Les Iles-de-la-Madeleine



Map 4-12 - Gulf of St. Lawrence - Iles-de-la-Madeleine

Flying weather in the Gulf of St. Lawrence is highly dependent on the season and whether or not ice is present in the gulf. Freeze-up usually starts in the northern part of the gulf by mid to late November and progresses southward to cover much of the western areas by late January. There usually is, however, ample open water over the gulf for instability snow showers and streamers to develop, especially in the early part winter.

The best winds for instability snow showers and streamers over the Gulf of St.

Lawrence are from the west-northwest to northerly. These winds will provide a large enough fetch while ushering in ample cold air. Cold southwest winds can also give rise to snow flurries but there is often too much shear in the low to mid levels for true snow squalls to develop. Westerly winds are more conducive but the snow squalls will tend to form farther out in the gulf. In west-northwest to northerly winds, provided there is enough open water, streamers will develop south of Anticosti Island. A favourable source for the development of streamers is between Anticosti Island and the Gaspé Peninsula as the air is forced upwards. The best direction for streamers to affect Les Iles-de-la-Madeleine is from the northwest. Typical conditions in snow showers would be a visibility above 6 miles and ceilings between 1,000 and 3,000 feet, with brief periods of 1/4-mile visibility in snow and vertical visibility near 100 feet.

When snow squalls develop over the gulf, significant icing and turbulence can be expected. The worst conditions are not uniform, however, and pilots often break out into clear skies within a few miles. It is often better to go up and fly over these snow showers, as they are usually confined to altitudes below 8,000 feet.

Les Iles-de-la-Madeleine Airport can be quite difficult to get into in the winter. Not only do snow squalls cause problems, but difficulties are often encountered even when snow is not falling. In the wake of low pressure systems, the winds are usually quite strong and gusty but the direction may not be favourable for streamers at the airport. The winds will, however, cause heavy drifting snow in the lowest 50 feet. Pilots may be in clear skies for most of the approach but, when descending into this shallow layer of drifting snow, it is often impossible to see the runway, necessitating an overshoot. Turbulence can also be moderate to severe in these situations.

Also during the winter and early spring months, freezing drizzle can become a significant icing hazard in this area. When the gulf is mostly ice covered, east to north-east winds will be most conducive for this to develop. With other wind directions, freezing drizzle will often be encountered downwind of any patches of open water. Pilots flying low-level over the Gulf of St. Lawrence would be advised to examine ice cover charts to locate these open water areas.

Ice usually starts to melt in the gulf by late March or early April. Once ice break-up has begun, fog becomes a factor over the gulf. Northern areas are more prone to fog because the water is deeper and tends to be colder than southern sections. During the late spring and summer, it usually takes precipitation to saturate the lower levels for fog or low stratus to develop over the gulf. The extent will depend on the precipitation pattern over the area. Although the usual thickness is about 1,000 to 2,000 feet, when the fog or stratus is very thin, it will burn off during the day but may leave behind an area of haze over the gulf with reduced visibilities. When fog is prevalent over the Atlantic Ocean south of Nova Scotia, it may enter through the Cabot Strait and affect eastern areas of the gulf. Cape Breton Island and mainland Nova Scotia usually shelter western areas of the gulf from this effect.

Thunderstorms moving eastward off the New Brunswick coast will usually die out once over the Gulf of St. Lawrence. The exception occurs when the convection is associated with a front, or in cold outbreaks in the late summer or fall, when the water is relatively warm. In the latter case, waterspouts may even develop as on one day in late August 2000, when the weather observer at Les Iles-de-la-Madeleine reported 5 waterspouts.

Gaspe Peninsula



Map 4-13 - Gaspé Peninsula and St. Lawrence River

The Gaspé Peninsula is quite mountainous which brings about a lot of turbulence in windy conditions. When winds are above 25 knots, moderate mechanical turbulence becomes widespread over the peninsula and can progress to severe at times when the air is unstable. Turbulence is not restricted to mechanical, however, but convective as well. Pilots report that on hot sunny days, flying over the Gaspé Peninsula can be very rough up to 5,000 or 6,000 feet, especially over the Notre Dame Mountains. These mountains are in the 3,500 to 4,000 foot range and rise abruptly from the St. Lawrence River. Mountain waves are also frequent in northwest winds behind cold fronts. Gaspé Airport, for instance, is reported as being very turbulent on approach, especially when the surface winds are from the east and the upper winds are strong southerly. Marsoui, which is just east of St-Anne-des-Monts, is also notorious for whirlwinds and severe turbulence. Drainage winds can develop in the narrower river valleys at night, resulting in strong southerly surface winds near the coast with strong wind shear in the low levels.

Another effect that can cause significant turbulence in this area is strong southerly winds that often develop when a low approaches from the southwest and passes north of the St. Lawrence. These winds are associated with low-level jets and often reach the surface south of the warm front. This effect is most dramatic at Cap-Chat and

St-Anne-des-Monts. From late fall to early spring, these strong low-level jets are much stronger and even more common. They are usually from the southwest when low pressure systems track to the north of the St. Lawrence River Valley, and from the northeast when the lows' tracks are to the south. Turbulence and significant wind shear should be expected with these features, and tends to be worse over ice-free areas on the St. Lawrence.

Funnelling and channelling are more pronounced from Rimouski eastward due to the higher mountains on both sides of the river. The orientation of the valley tends to channel the winds in either a northeast or southwest direction. Winds are also stronger between Matane and Cap-Chat due to coastal convergence and funnelling between this area and Pointe-des-Monts on the North Shore. A series of wind turbines have been installed here for this very reason and can be a hazard when low cloud is present. As long as the St. Lawrence River is open, upslope north or northwest winds will tend to cause cloud to develop over the mountains, capping the tops. This can occur in any season, but is most prevalent when the temperature difference between the water and the land is greatest. Funnelling also occurs in southeasterly and northwesterly winds in the Honguedo Strait, between the eastern end of the Gaspé Peninsula and Anticosti Island.

Convective activity is quite common in the mountains over the Gaspé Peninsula. The same convective currents that cause turbulence often continue to grow, making this area a favourable location for thunderstorm development in the summertime. Even when thunderstorms do not develop, shower activity is frequent in the hills while good conditions prevail elsewhere. In the fall, when the freezing levels get lower, snow flurries can be encountered in the mountains while only showers, or even no precipitation, will be reported at the coastal airports.

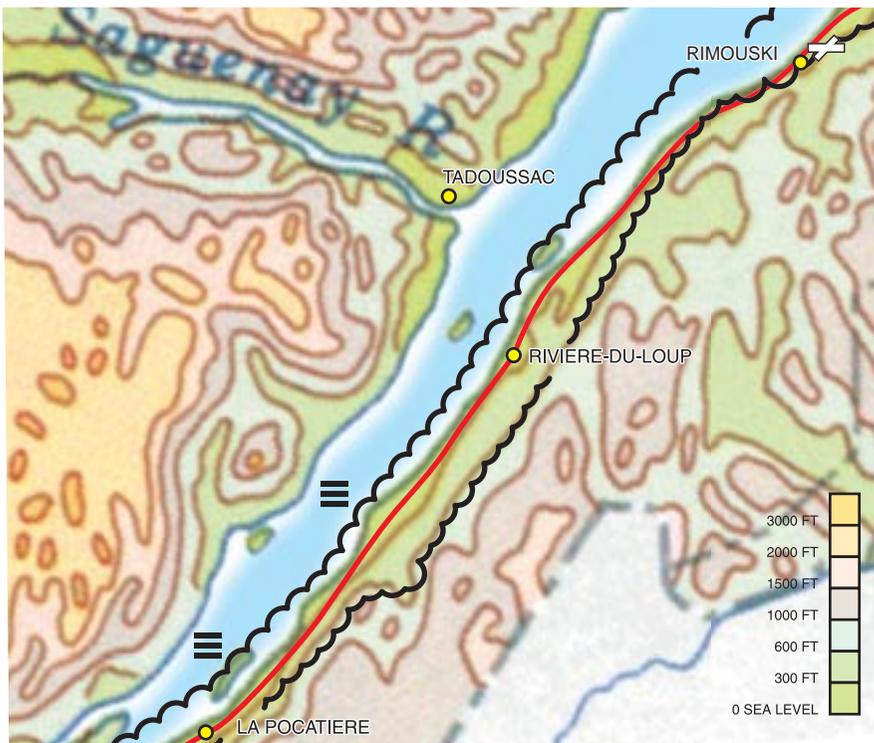
Snowfall is usually heavier in the Parc-de-la-Gaspésie and Murdochville areas. When the St. Lawrence River is open and winds are from 250 to 290 degrees, the Gaspé Peninsula is prone to onshore snow squall activity up to Cap-des-Rosiers. This occurs more often in the late fall and early winter. The combination of falling snow and blowing snow can cause local visibility to deteriorate briefly, to as low as 1/4-mile. The area south of Cap-des-Rosiers is somewhat sheltered from the worst flurry activity, however, snowfall associated with winter storms tends to be heavier here due to the added moisture from the Gulf of St. Lawrence. Precipitation type can also vary greatly in relatively short distances and different elevations. For example, when light rain is observed at the Rimouski Airport, freezing rain or freezing drizzle can be reported at Mont-Joli Airport and snow a few miles inland. This is especially common in the fall or spring.

The southeastern part of the Gaspé Peninsula tends to be adversely affected by the same weather as does northeastern New Brunswick. East to southeast winds generally bring the lowest conditions. Fog and low stratus are more common in the fall and

spring when the land-sea temperature difference is higher. Pabok and Bonaventure Airports may have a ceiling of 800 to 1,200 feet, but hills to the north and northwest will be capped. In west-northwest to northerly winds, these airports may have good ceilings, or even just scattered cloud, but unless the air is very dry, stratocumulus ceilings will be encountered in the mountains to the north and west.

Several “bad weather routes” exist between the Gaspé Peninsula and New Brunswick, but two of the better known ones are the Cascapedia River Valley and the Matapedia River Valley. The Cascapedia River Valley is not as wide as the Matapedia River Valley but has much less in the way of power lines.

Lower St Lawrence - La Pocatiere to Rimouski



Map 4-14 - Lower St. Lawrence - La Pocatiere to Rimouski

Along the Lower St. Lawrence, from La Pocatiere to Rimouski, the river tends to narrow somewhat, but funnelling is kept to a minimum due to the relatively flat terrain. This area also has better ceilings and visibilities in southerly winds associated with storms, due to the downslope effect of the mountains to the south. Even in north or northwesterly winds, any stratocumulus ceilings that develop will likely be higher in this area, although visibilities can often be reduced in snow squalls in the late fall or early winter. Snowfall also tends to be heavier and linger behind weather systems in the St-Louis-du-Ha-Ha and the St-Honore areas.

When the general circulation is from the northwest, the winds get funnelled out of the Saguenay River Valley at high speeds and shift towards the east. This results in a band of strong southwest winds on the south shore of the Lower St. Lawrence up to Ile Bicquette, but not quite reaching Rimouski.

Fog, usually topped between 500 and 1,000 feet, is common over the water if warm moist air moves up from the southwest in the summer. This fog can sometimes drift inland with minor shifts in wind direction. Low ceilings and visibilities are also common all along the coast in east or northeast winds, often reaching below landing thresholds when precipitation is falling

Newfoundland

It is no surprise that wind is the biggest factor in determining local weather in Newfoundland. Winds are rarely calm and are always onshore somewhere on the island, regardless of the direction. The predominant flow is from the northwest in the winter and southwest in the summer. Because of the wind patterns in Newfoundland, the weather is extremely variable and can change more rapidly than almost anywhere in the country.

(a) Summer

During the summer months, low pressure systems have a tendency to be weaker than in the winter months, however, they still follow preferred tracks. (See Fig. 3-9) Most systems will track across southern Labrador or the North Shore of Quebec and then cross north of Newfoundland. A second and less frequent track carries lows south of the island and then out to sea. In both cases, fronts associated with these systems are diffuse and little contrast exists between air masses. Precipitation tends to be of the showery type although steadier rains occur with the slower, more developed systems.

Summer weather across Newfoundland is as variable as in any other season. Seldom will all areas of the island experience good flying weather. The best synoptic situation for good flying weather is a strong ridge of high pressure off the coast of Nova Scotia and a southwest flow over the island. If the southwest flow is moist enough, that is, the dew points associated with the air mass are higher than the temperature of the surrounding waters, fog will develop and be pushed onshore. Fog will often be observed all along the south and west coasts of the island in these situations.

In the late summer and early fall, tropical storms that have spawned near the equator may bring windy, wet weather while they pass to the southeast of the island before dying, or redeveloping, in the North Atlantic. A common pattern is for a tropical system to approach Atlantic Canada, interact with a front and then begin to develop extra-tropical characteristics. These systems will move very rapidly and can produce strong winds and heavy rains, much like a tropical system.

Although not frequent, thunderstorms do occur in Newfoundland and can occur in any season. The highest occurrence of thunderstorms on the island is in the central and northeastern part of the province.

(b) Winter

Local weather conditions in the winter are highly dependent on the track of synoptic weather systems. (See fig. 3-8) There are significant differences in the effects of these systems, depending on where a particular station is located relative to the system's centre. In the winter, lows are more intense, more frequent and have fronts that

are much more distinct. Similarly, high pressure systems are also stronger in the winter.

Three basic weather patterns that occur frequently in the winter are lows passing to the south or southeast of the island, lows passing to the west or northwest of the island, and high pressure systems approaching Newfoundland from the west.

The strongest lows are those that approach from the south or southwest and pass either over or just to the south of the island. Lows following these tracks spend extended periods of time over the water where they have ample time to develop and gain energy.

A typical scenario that occurs as a low pressure system approaches the island from the south is for winds to gradually increase from the east or southeast. Occasionally, flurries will develop ahead of the primary areas of snowfall, reducing visibility to approximately 5 miles. Flurries, however, usually cease before the onset of the main area of snow, which, when it develops, will rapidly drop the visibility to 1/2 to 2 miles. Snow and blowing snow will then often persist for several hours depending on the speed of the low. East of the low's track the snow may become mixed with, or change to, ice pellets usually between about 60 to 100 miles ahead of the warm front. Closer to the warm front, freezing rain may be observed before it changes to rain south of the warm front. West of the low's track, precipitation will generally remain as snow. The heavier snow will be found within approximately 120 miles west of the storm's track. Once the low passes and the cold front swings across the island, a strong west to northwest flow is established and precipitation will typically end over the inland areas, while snow showers may persist in onshore flow.

Another favoured track has the low pressure centre approach from the southwest and pass to the west or northwest of the island. Such a trajectory keeps the low over land for much of its journey. With the absence of the water to provide energy to develop, these lows generally do not become as deep as those that track over the ocean. It should be said, however, that even these storms can bring bad flying weather to the entire island.

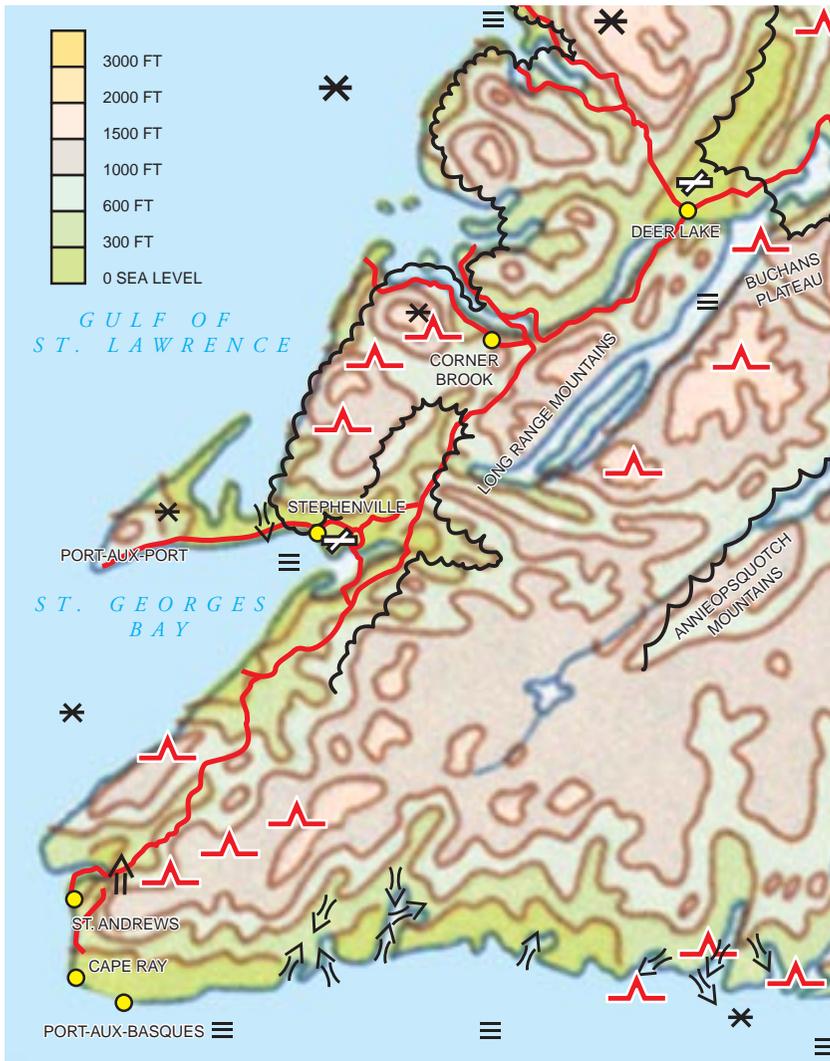
As storms move away from the island, high pressure systems tend to build to the west and move east or southeastward towards Newfoundland. Ahead of these high pressure areas, cold arctic air will flood the region producing instability snow showers or "streamers" over the water and to places where winds blow onshore.

A different situation becomes apparent when a high pressure area over Labrador and a slow moving low east of the island are present. In this case, a northerly flow will persist for several hours or even days. These persistent, northerly winds will be very moist and result in freezing drizzle along northern coastal sections until the winds subside.

Periods of extended freezing precipitation are common in Newfoundland. The area between St. John's and Gander is especially prone to prolonged periods of freezing precipitation that can last for several hours or, intermittently, for two days or more. This area receives, on average, 175 hours of freezing precipitation each winter. This number is almost twice the average for anywhere else on the continent, making it the worst area for aircraft icing in North America.

(c) Local Effects

Deer Lake and Vicinity to Port-aux-Basques



Map 4-15 - Deer Lake to Port-Aux-Basques

The area from Deer Lake to Port-aux-Basques is wide open to the effects of the Gulf of St. Lawrence in both the summer and the winter. In the fall months, as the air that passes over the Gulf becomes colder and the water remains comparatively warm, there is an increase in the instability occasioned by the surface heating resulting in flat, stratocumulus clouds with relatively good ceilings. By the latter part of November, snow showers and streamers develop in cold west to northwest winds and reduce the ceilings and visibility. Local visibility of 1/4 - mile and vertical visibility of 100 feet are not uncommon, but have a tendency to be intermittent in nature. The extent to which these streamers are pushed inland is completely dependent on the wind speed; the stronger the wind speed, the farther inland the streamers will extend. Pilots in the area report, however, that the stronger snow showers usually do not penetrate past the Buchans Plateau and the Annieopsquotch Mountains. The occurrence of streamers in the winter subsides in the latter part of the season, as ice forms over the gulf.

A particular phenomenon called the “Anticosti Shadow Effect” occurs when winds are from the west-northwest. In this situation, Anticosti Island acts as a barrier for the development of snow shower activity and an area of predominant clear skies is found downwind. This area of clear skies is roughly the width of Anticosti Island and can extend as west far as the coast of Newfoundland. Often, this narrow area of good weather will cover the Stephenville Airport and therefore, weather reports from this airport will frequently not be indicative of the weather in the surrounding area. In such cases, while Stephenville Airport is reporting scattered cloud, possible heavy snow showers will exist north and south of the field.

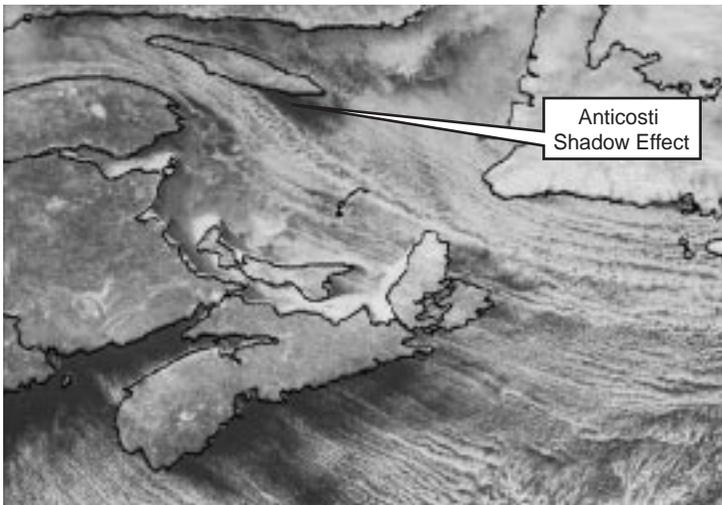


Photo 4-1 - Snowsqualls over the Gulf of St. Lawrence credit: Unknown

Fog in the Gulf of St. Lawrence becomes quite frequent by mid spring and remains so until late summer. Air masses approaching from the southwest are warmer and, thus, have higher moisture contents. Since the water is still fairly cold (with an average of about 4°C for May) the warm, moist air is cooled from below, causing thick fog to become widespread. The southwest winds usually move the fog into the bays and inlets along this part of the coast. When fog is pushed into St. George's Bay, it will usually move into the Stephenville Airport giving very low ceilings and visibility. There is ordinarily some diurnal variation at Stephenville and conditions are generally much better a few miles inland. At times the cooling of the air, due to passage over the water, will not be quite sufficient enough to result in condensation during the day. However, the added cooling at night will cause fog to develop, especially in the presence of precipitation, since precipitation hastens formation. Even after a wind shift, fog in the bay will tend to linger for several hours longer due to the sheltering effect of the bay. Southwesterly or westerly winds of about 15 knots seem to be most conducive to fog or stratus formation at Stephenville.

When the winds are light, a light drainage wind from the northeast sometimes occurs, hindering the movement of fog onto the airfield.

As a result of the heating of the air due to downslope flow, winds from directions other than west or southwest at Stephenville Airport will provide good ceilings and visibility, even when the eastern and southern portions of the island are "fogged in". Incidentally, when Stephenville is closed due to fog or stratus with west or southwest winds, Gander or St. John's will almost always have good ceilings and serve as an alternate and vice versa.

Often in onshore flow when ceilings are good at Stephenville and Deer Lake, cloud will still top the hills all along the coast. When this occurs, it is possible to follow the coast to or from Stephenville. When approaching from the north, it may also be possible to fly through the narrow isthmus at Port-au-Port although this route may be quite turbulent, especially in northerly flow. If this is impassable, it may still be possible to get to Stephenville by following the Port-au-Port Peninsula coastline.

Fog also commonly occurs along the southern part of this coastline. In south or southwest flow, fog is reported to be more frequent at Port-aux-Basques than up the coast at Cape Ray. However, when showery conditions exist in west to northwest flow, the weather is often much better at Port-aux-Basques.

A well-known hazard exists in east to southeast winds from St. Andrews to Cape Ray. These extremely strong, downslope winds, called "the Wreckhouse Winds", cause severe turbulence near and below the crests of the hills on the lee side. Funnelling may further enhance these winds. The most treacherous conditions occur just west of the ridgeline or on the lee side. Severe turbulence in strong whirlwinds and downdrafts can be expected in these areas, which local pilots agree, may cause

light aircraft to break up in flight. It is usually best to fly over the ridge if there is no cloud capping the hills. Even in a 30-knot wind the top of the ridge will be fairly smooth. However, when pilots stray just west of the peaks they will encounter severe turbulence. If cloud caps the hills, it may be possible to fly about 2 to 5 miles offshore where the turbulence will be much less severe. Westerly winds are usually pretty good as far as turbulence is concerned for the “Wreckhouse” area.

Port-aux-Basques to the Burin Peninsula



Map 4-16 - Port-Aux-Basques to the Burin Peninsula

Probably the main aviation weather hazard on this part of the island is thick fog along the coast and offshore. The water off the south coast of Newfoundland does not freeze in the winter but can cool to temperatures of near 0°C. The cold water tends to cool the warm, moist air masses from below resulting in the development of fog throughout the year. However, this is much more prevalent in the spring and summer when the air to sea temperature difference is at its maximum. When winds are from the south or southwest during this time of year, fog can be expected all along the coast and is usually pushed into the numerous bays and inlets. The distance the fog extends inland is highly dependent on the strength of the wind. If rain is present in this situation, fog will generally extend far into central Newfoundland and even up toward the northeast coast with no diurnal improvement. During the summer when precipitation and higher cloud are absent, fog will typically extend about 60 to 80 n. miles inland and lift, near noon local time, to approximately 500 feet or so. This will sometimes make it possible to sneak into the coast via the valleys. Caution should be used, however, since fog will quickly move in again by late afternoon. A related hazard reported by pilots flying in these conditions is the high level of bird activity.

Belle Bay, just west of the Burin Peninsula, will often have better conditions than other bays in the area since it is sheltered from almost every direction. Helicopter pilots report that visibility in Belle Bay is usually better and winds lighter than in Fortune Bay in southwesterly flow.

The south coast of Newfoundland is oriented along a rough east to west line and has steep cliffs with numerous bays and inlets oriented in a north to south direction. This causes a variety of local wind patterns and low-level turbulence up and down the coast. In northeasterly flow, winds are channelled and funnelled through Bay de Loup just to the northeast of Burgeo, producing very strong winds at the mouth of the bay. Burgeo has recorded winds as high as 85 knots in these situations. Whirlwinds can also be expected near and south of Burgeo causing low-level turbulence generally below 2,000 feet. This is only one example of this effect that occurs at several locations along the coast.

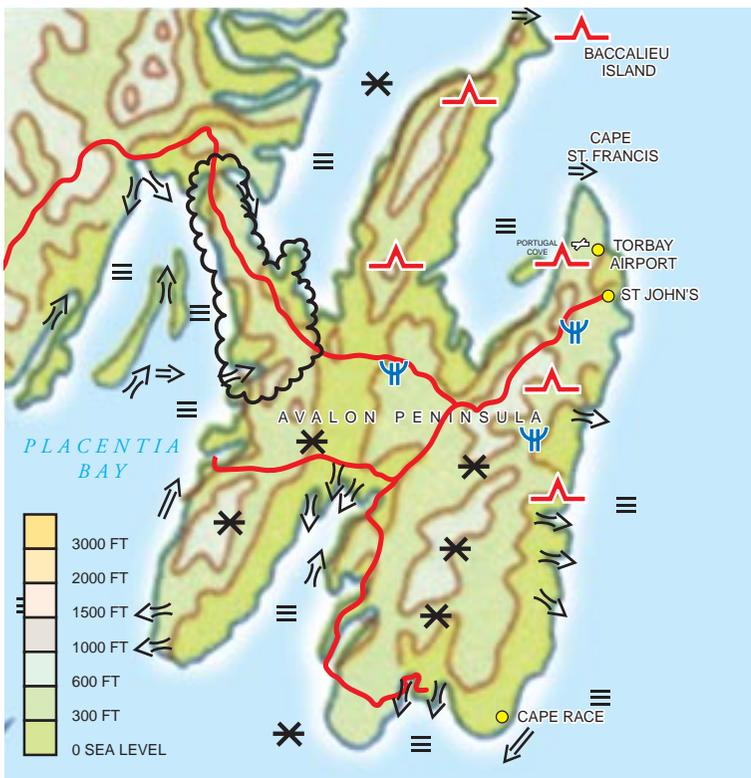
From Port-aux-Basques to Hermitage Bay, winds out of the north will cause down-drafts near the coast and will presumably result in problems for helicopter operations, especially near Francois and Grey River. Northerly winds also get funnelled down White Bear Bay between the steep cliffs and can be very strong at the mouth of the bay, causing turbulence and whirlwinds around Bear Island. In the summer, cool and gusty drainage winds from the north are common in the early morning hours at the mouths of the bays along this stretch of coastline.

From winter to late summer, warm southerly winds will often push the colder air northward where it becomes trapped against the steep cliffs of the coast. The warm southerly winds ride up over this colder air which brings about an easterly circulation

near the coast. In winter, a layer of cold air, generally below freezing, will remain from the coast up to 15 miles offshore and will extend almost to the top of the cliffs. Although confined to the extreme low levels, this may result in freezing precipitation and icing conditions within this layer of colder air. This effect can often be confirmed by checking the winds from Burgeo and Sagona Island, which would be from the east and south respectively.

As mentioned earlier, the seas off the south coast usually do not freeze in the wintertime. This will cause snow showers and streamers to develop during cold arctic outbreaks. In northwest winds, the flow is offshore and streamers will generally not develop near land. However, when cold west or southwest winds develop, heavy snow showers will be quite prevalent along the coast and often result in blizzard conditions over the Burin Peninsula, which protrudes out into the path of the snow showers. Visibility will often be reported as zero in snow and blowing snow and strong, gusty winds will be experienced over the peninsula while only scattered cloud and isolated flurries will be reported inland.

Placentia Bay and Southern Avalon Peninsula



Map 4-17 - Avalon Peninsula

Placentia Bay is extremely susceptible to fog in south to southwest winds in every season, although it occurs more frequently in the spring and summer. The fog here forms very rapidly, as soon as the air mass is cooled to its dew point due to the cooler waters, and is usually very thick, exhibiting very little diurnal improvements. When frontal fog develops and floods Trepassy, St. Mary's and Placentia Bays, it will usually linger in the bays for several hours behind the cold front, after the winds shift to westerly.

When Torbay Airport at St. John's, which lies to the northeast of the area, falls below one mile of visibility in fog and the surface winds are southeast through northeast, low cloud and fog will advect into the area. Ceilings from 600 to 800 feet and visibility from 3 to 5 miles can be expected over the eastern coast of Placentia Bay approximately 6 to 8 hours later, although this time will vary depending on the strength of the winds. If the above conditions at Torbay persist over 10 to 12 hours, the ceilings and visibility along the coast will usually lower to between 200 to 400 feet and the visibility from one to 2 miles.

A band of stronger winds is often reported near the coast on the east side of Placentia Bay in a southwesterly flow. This is due to coastal convergence and also occurs on the west side of the bay in a northeasterly flow.

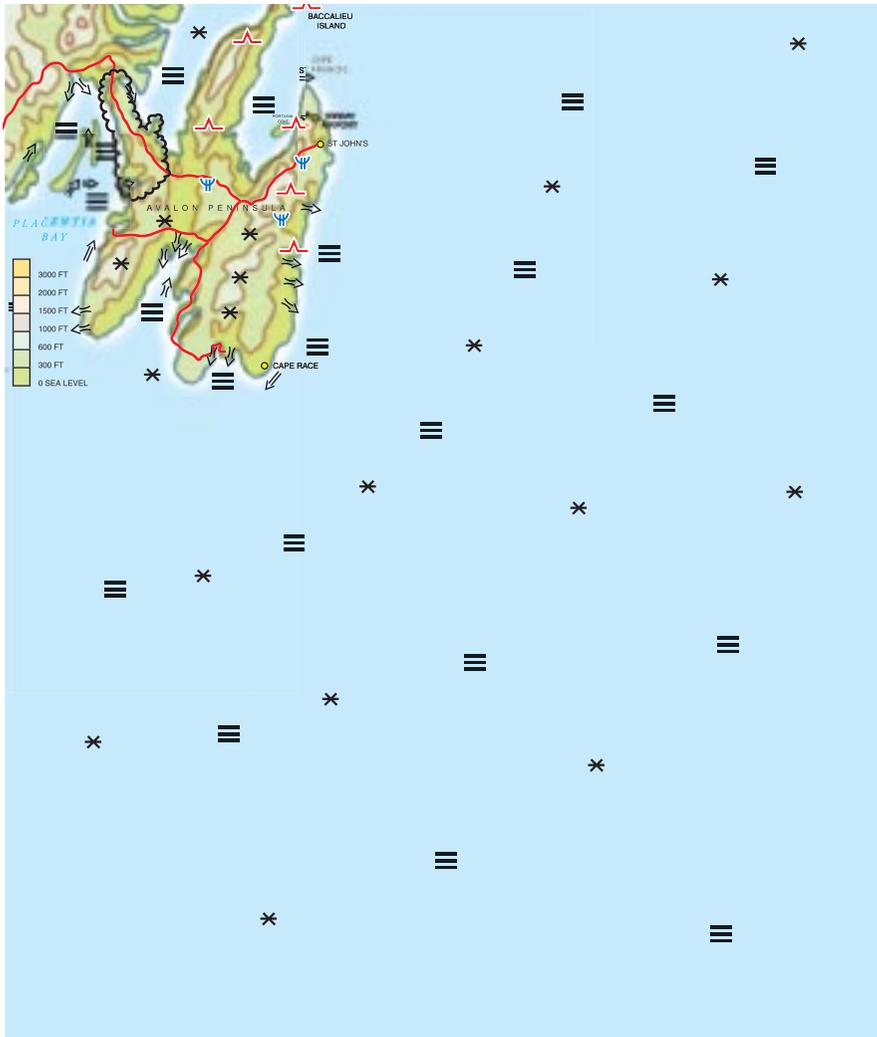
When the winds are from the east, they pass over the hills that are found on the southwestern tip of the Avalon Peninsula and become funnelled through the valleys, producing very strong gap winds along the coast at St. Brides.

In the winter, winds behind cold fronts will often be from the west or southwest for a period of time before eventually shifting to northwest. In these cold west or southwest winds, snow showers and streamers will develop and will usually have no difficulty in crossing the southern part of the Avalon, resulting in relatively brief periods of low ceilings and visibility.

The southern part of the Avalon Peninsula is relatively flat, barren and wide open to the fury of storms approaching from the south. Accordingly, this area is prone to winds as high as 80 knots when deep low pressure systems come up the eastern seaboard.

The cornering of winds occurs at several locations along the coast of Newfoundland. The most extreme and well-known case is along the southeastern part of the Avalon Peninsula at Cape Race. Cornering and coastal convergence act together in northeasterly flow to produce winds as high as 25 knots stronger than the rest of the area.

Offshore Newfoundland - Grand Banks



Map 4-18 - Offshore Newfoundland - Grand Banks

From an aircraft operations standpoint, the Grand Banks has one of the world's harshest environments. Fog and icing conditions are the two greatest challenges that aircraft operators face on an almost daily basis.

Fog can and does occur any time of year but is a bigger problem in the spring and summer. July is the worst month with visibilities of one half-mile occurring about 50 percent of the time. The fog is also much more persistent during this time of year with almost 60 percent of the fog occurrences lasting more than six hours. Advection sea fog is the predominant type over the Grand Banks and occurs most frequently in a southeast to southwesterly flow. During the summer months, there is usually a notice-

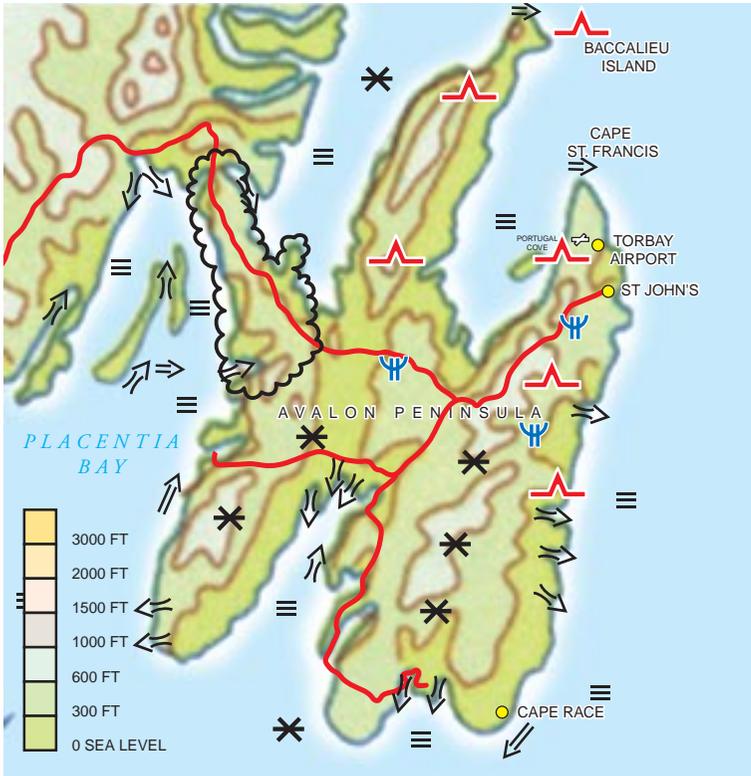
able improvement during the daytime hours. Unless there is precipitation occurring or a thick layer of higher cloud present, the fog will often lift to low stratus cloud based at 200 to 600 feet by noon or 1 p.m. local time. By late afternoon, though, the stratus deck will again lower to the surface resulting in widespread fog.

Similar to the Sable region south of Nova Scotia, the fog and low stratus is extremely variable here. Fog patches can develop and dissipate quickly and have a relatively wide range of tops. Helicopter pilots flying to the Hibernia Platform have noted they can be five miles away and have the platform in sight, only to have it shrouded in fog by the time they reach the platform.

During the winter, the focus turns to icing. Stratocumulus decks are quite common over the water from late fall to early spring. As cold air floods the region, cumulus clouds start to build and eventually spread out into a gray, stratocumulus overcast. These cloud decks are usually thicker over the water, reaching as high as 8,000 feet or more, and contain lots of supercooled water droplets. Pilots should expect at least light to moderate icing within the clouds with the worst icing conditions found near the top of the clouds. Aircraft with low rates of climb are particularly susceptible when climbing through the clouds. The best place to be is usually on top of the cloud deck or well below it.

Another problem that faces pilots heading offshore is lightning. As storm systems move up the coast, they tend to be in the developing stage when they reach the Grand Banks and often have thunderstorms embedded within them. A contributing factor to this problem is the fact that lightning strikes so far offshore may not be detected by the Canadian Lightning Detection Network, thus rendering the forecaster's task of confirming the presence of thunderstorm activity very difficult.

Northern Avalon Peninsula - St. John's and Vicinity



Map 4-19 - Avalon Peninsula

It is no great revelation that fog is a major problem to aviation around the Avalon Peninsula. April, May and June have the highest frequency of thick fog over the northern part of the Avalon Peninsula while September, October and November have the lowest number of occurrences. When fog occurs during the winter months, it is usually associated with low pressure systems and warm, moist southerly flows. For this reason, and the fact that the sun is low in winter, there is very little in the way of diurnal variation in fog. It isn't until well into spring that there is some diurnal improvements. The worst time of the day for fog is usually just prior to sunrise.

Because of sharp upsloping terrain and exposure to the ocean, very low ceilings and visibility are frequent when the winds are from the northeast to southeast. Ceilings from zero to 400 feet and corresponding visibilities are found if the air temperature is warmer than the water temperature east of Newfoundland. A slight diurnal improvement will occur if the flow from this sector is not prolonged. If the flow is very weak, breaks in the lowest cloud layer may even occur. When conditions are low on the east coast of the Avalon Peninsula, they are often somewhat better on the western side,

along the Conception Bay coast. The helicopter base at Long Pond always reports better ceilings than St. John's in these situations.

In winter, south winds usually provide operational ceilings. However, very low conditions can occur if the flow is weak and fog blankets the water south of the Avalon Peninsula, such as in advance of a warm front. Winds from the south-southwest to westerly give operational ceilings, although in a warmer air mass, areas of low stratus cloud and poor visibility in fog or mist will exist. Good ceilings and visibilities occasionally occur when the winds are from northeast especially when the air is cold in the winter. In this case scattered, light snow flurries may occur.

A cold, unstable southwesterly flow is an excellent producer of snow showers reducing local ceilings and visibility. These snow showers tend to be widespread over the Southern Avalon Peninsula but occasionally snow showers will also make it to the northern part including Torbay.

Winds from the west-northwest to north yield fairly good flying conditions although snow showers may be frequent in a cold flow and fog and drizzle may persist in an extended mild and moist flow. Broken to overcast stratus may last for a period of four hours at a height of 200 to 400 feet after the passage of a cold front. Troughs of low pressure or cold fronts advancing from the north usually become weaker before reaching Torbay, however a brief period of low conditions in stratus or either snow or freezing drizzle sometimes occurs.

Icing conditions in freezing drizzle are common over northern sections of the peninsula during the winter and spring months, whenever the winds are from the north to the northeast. Cool, moist air flows over the cold water or ice creating an inversion in the low levels. Freezing drizzle or snow grains usually develop below this inversion and can persist for days as long as the flow remains from these directions. This is a very common occurrence when low pressure systems stall east of Newfoundland. Often there will be occasions when freezing drizzle does not occur, yet a thick layer of stratocumulus cloud will still be present in the area and out over the water. These clouds will usually be quite moist and will be a favourable location for aircraft icing.

Frontal depressions passing through the area or to the south bring low conditions in snow or rain, drizzle and fog with easterly winds. If an occluding low stalls to the east or southeast of the Avalon Peninsula, these conditions can persist as long as the low remains, with little diurnal improvement noted. This feature of the weather develops mostly in the spring season when western Atlantic blocks are present. Torbay may not become operational until these blocks break down, which can be several days.

The summer is a gentler season. Sea breezes are common when the gradient winds

are light. When winds shift to easterly due to a sea breeze, any fog offshore will usually be advected over land either as low stratus cloud or fog. Sea breezes are not frequent on the east side of Trinity Bay due to the high cliffs along that coast, yet can reach 20 to 25 knots on the western side of the bay.

When winds are light to moderate from the west, they usually increase and become quite gusty in the afternoon due to instability created by daytime heating. Funnelling through the numerous east to west bays and inlets will cause these winds to increase even further. This effect can extend out as far as ten miles and can create turbulence near the coast.

The terrain over the northern half of the Avalon Peninsula is somewhat more rugged and, consequently, mechanical turbulence is much more prevalent here than on the southern part of the peninsula. Generally, winds of 20 knots will result in moderate turbulence to helicopters and lighter aircraft. Above 20 knots, a great deal of turbulence is usually experienced over the northern Avalon Peninsula and around Torbay airport. Once pilots get over land, all the approaches are reported as being rough, however, the ILS for runway 16 is the worst. Pilots often encounter severe turbulence below 2,200 feet to approximately 300 feet above ground level. This is most likely due to steep cliffs from Portugal Cove to Cape St. Francis. Southeast winds will "fall off" the cliffs, often causing whirlwinds, while westerly winds will crash up against them producing severe turbulence in both cases. Many pilots prefer to use another runway and take the crosswind rather than to shoot the approach for runway 16. This turbulence is so common that it is mentioned in the Canadian Flight Supplement under CAUTION.

Baccalieu Island, just east of the Bay De Verde Peninsula, can be quite treacherous in northerly winds. Helicopter pilots often report severe downdrafts at the southern tip of the island.

Avalon Peninsula to Gander



Map 4-20 - Avalon Peninsula to Gander

Pilots heading from the Avalon Peninsula westward generally like to follow the isthmus joining the Avalon to the rest of the island and then proceed westward. This often creates difficulties since the isthmus is prone to low cloud, especially in south or southeast winds. Conditions are particularly bad when fog or low stratus cloud is present in Placentia Bay. If there is a moderate, southerly flow the fog will remain over the isthmus all day. However, in summer, when the flow is light, conditions usually

improve by 10 or 11 a.m. local time and start deteriorating again by 4 p.m. Local pilots try to cross over the isthmus by 4 p.m. local time when trying to get back to the other side. After 4 p.m. chances of getting through are small. When heading west and cloud is going to be a problem over the isthmus, Chapel Arm will usually be the point where low-level traffic will be forced to turn around. This cloud may also develop in north to northeast flow but is usually not as bad. In a northwest wind the isthmus will generally be open.

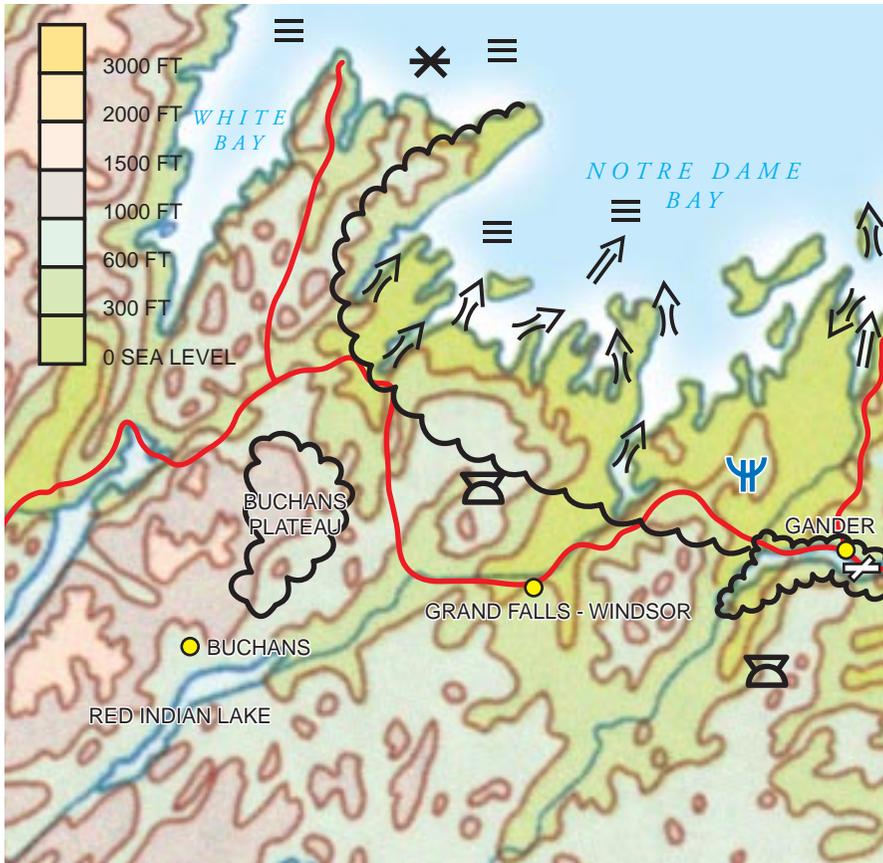
Trinity Bay usually has good conditions in southwest winds but, when thick fog is present in Placentia Bay in spring or early summer and the isthmus is capped in, fog or low stratus may spill over into the southern part of Trinity Bay. Low-level pilots on their way to St John's from Gander normally turn back if there is low cloud or fog in Trinity Bay.

This area is one of the most favourable locations for thunderstorm activity on the island. A typical case is for air mass cumulus and towering cumulus cloud, originating in the southwest corner of the island, to continue to grow as they move north-eastward. They usually reach the cumulonimbus stage just southwest of Gander and continue to move towards the Bonavista Peninsula.

In the mid to late summer, when the water in Bonavista Bay reaches its highest temperature, fog usually remains off the coast from about 15 miles east of Cabot Island to 30 miles northeast of Cape Bonavista. When east or northeast winds advect the fog into the bay and onshore, the warm water of the bay tends to lift the fog and, therefore, low stratus cloud is likely in the bay and along the coast.

This area is also prone to freezing drizzle in north-northwest to northeast winds. The worst area for this effect is between the Bonavista Peninsula and Fogo Island and typically extends to approximately 50 miles inland, depending on the winds. The stronger the winds, the farther inland the freezing drizzle will extend.

Gander and Vicinity to White Bay



Map 4-21 - Gander to White Bay

Similar to the two previous areas, this region is also extremely prone to significant icing conditions in freezing drizzle in the winter and spring. North to northeast winds that have had a large trajectory over the water will almost always generate incidences of freezing drizzle. It should be noted that although freezing drizzle becomes less frequent west of Fogo Island, it still poses a significant hazard.

Flying weather here can vary significantly not only with season, wind direction and time of day, but even with the type of weather feature producing the wind. During the winter months, a north to northwest flow associated with a high pressure system will generally produce a broken to scattered layer of stratocumulus cloud based at 1,500 to 2,500 feet. However, if the flow is associated with a low pressure system, then stratus cloud will give ceilings of 200 to 300 feet and a visibility of one-half to three miles in freezing drizzle or snow grains. In either case, there is usually noticeable daytime improvement by mid-winter into spring, but daytime improvements are often negligible in the early winter.

Rapid deterioration to stratus ceilings of 200 to 500 feet and visibilities of one-quarter to two miles in light snow or freezing drizzle can be expected with the passage of a front or trough of low pressure from the north. If the system is strong, conditions may fall to near zero visibility in snow and blowing snow. These conditions usually persist for two to five hours then, if the flow is stable, the ceilings usually lift as the wind backs to northwest.

When winds are from the north-northeast to east-southeast in the winter, rapid deterioration can be anticipated with the approach of a warm front. Precipitation usually commences as snow but, as the frontal wave nears the area, a rapid change to rain after a brief period of freezing rain or ice pellets often occurs if the low passes to the west. When these winds are associated with a high pressure system, stratocumulus ceilings of 1,200 to 1,500 feet and occasional snow showers are common. In this case, if the flow persists, stratus ceilings of 300 to 500 feet and a visibility of one to three miles in light snow and snow grains can be expected.

In the spring and summer, a north to northwest flow will typically produce an area of cloud near Norris Arm, which gets progressively lower as you head east. The cloud usually starts off as stratocumulus based near 2,000 feet AGL, at or just west of Norris Arm, and can gradually become stratus ceilings of zero to three hundred feet, with a visibility of zero to one mile in drizzle and fog at Gander Airport. Daytime improvement to stratocumulus ceilings of 300 to 600 feet usually occurs over eastern areas by mid summer.

During the summer and early fall, the passage of a front or trough of low pressure from the north may result in two to four hours of stratus ceilings of 200 to 400 feet and a visibility of one to three miles. When the flow is from this direction and associated with a high pressure system, scattered to broken stratocumulus based at 2,000 to 3,000 feet can be expected.

If north-northeast to east-southeast winds are caused by a blocking low in the spring and summer, then ceilings will fall to 100 to 300 feet in fog and stratus. The visibility will diminish to zero to one mile in fog and drizzle, or freezing drizzle. Daytime improvement to stratus ceilings of 500 to 800 feet is common, but if the flow persists for several days, improvement becomes negligible. Such a flow is common ahead of an approaching warm front and fairly rapid deterioration in flying conditions usually occurs once precipitation begins.

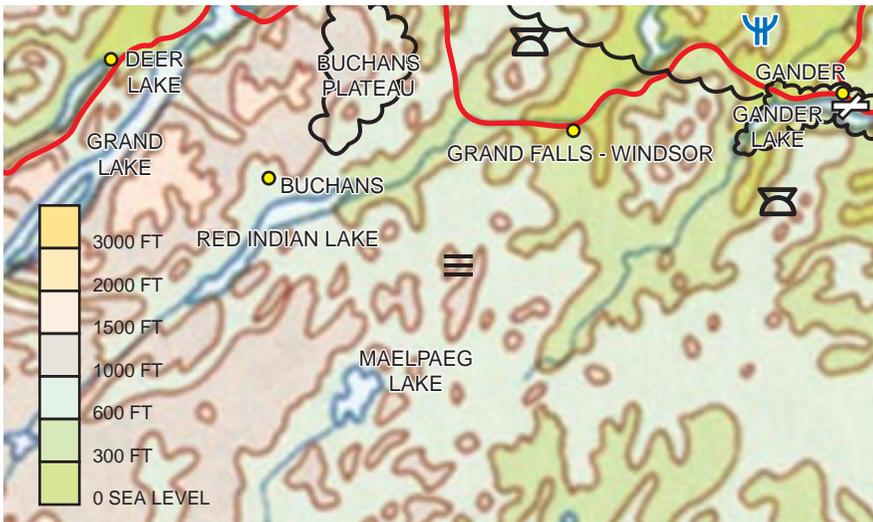
South to southeast winds will frequently result in near zero ceilings and visibilities at night in moist, stable flow but during the day ceilings will usually be variable near 300 feet, with a visibility around four to eight miles. The approach of a warm front in the summer will also bring deteriorating conditions, especially after dusk, causing ceilings and visibilities to fall to near zero. The ceiling and visibility usually improves rapidly after its passage. When fog is widespread along the south coast of

Newfoundland, low stratus cloud will often make its way across the island and may reach as far as Gander a few hours after midnight.

Southwest to west-northwest winds generally provide the best weather. These winds typically give clear to broken stratocumulus cloud based at about 1,500 to 2,500 feet. In the moist, warm sector of a low in the summer, stratus ceilings of 400 to 600 feet and a visibility of 3 to 6 miles in showers and mist can be expected. However, there is usually rapid clearing behind the cold front. Fog from Gander Lake occasionally moves over Gander Airport as stratus cloud based between 600 and 800 feet, during the night, but this is usually variable and burns off quickly at sunrise.

As mentioned earlier, this area is prone to thunderstorm activity in the summer time. Thunderstorms tend to develop farther to the southwest and move towards Gander and often either pass to the northwest or southeast of the airport.

Central Newfoundland



Map 4-22 - Central Newfoundland

The numerous ponds and lakes in this area cause patchy stratus cloud to develop shortly after sunset in the late spring and summer when otherwise clear skies are being observed.

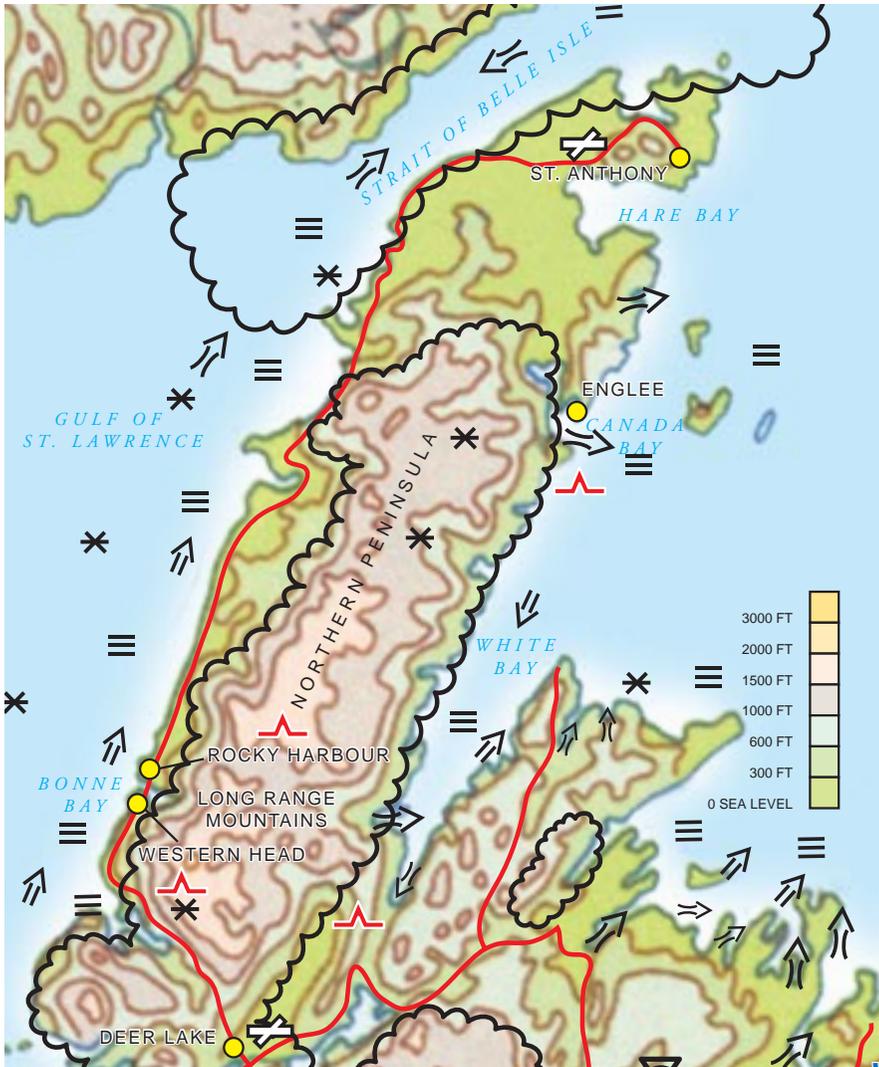
For example, fog or low stratus may develop over Red Indian Lake in the spring and summer, but this effect is quite local and generally does not cause problems for pilots flying in the area during the day.

Where these ponds and lakes may be a hazard is at night. With the lack of reference points at night, pilots can easily become disoriented if they inadvertently fly into

these patches of cloud. Unless reported, these patches are difficult to detect and, therefore, difficult to forecast. Pilots flying visually at night should be aware of this even when the temperature-dew point spreads are large.

Pilots heading to the west coast of the island from the east will often encounter lower ceilings near the Topsail Hills or Buchans Plateau area. Cloud here will tend to linger behind as low pressure systems move away. Unless the air is very dry and stable, afternoon instability cloud will also develop and cap in the hills. A report of scattered cloud during the morning hours at Deer Lake will often mean that broken to overcast stratocumulus cloud will top the hills by the afternoon. This is also a favourable area for thunderstorm development.

Northern Peninsula - St. Anthony and Vicinity



Map 4-23 - Northern Peninsula

Although the Northern Peninsula experiences some of the harshest weather on the island, there is often one side of the peninsula that is better than the other depending on the wind direction. In a northwest to southwest wind, the west side will tend to be worse than the east side, while the reverse is true if the winds are from the northeast to southeast. Because of this, pilots flying low-level to and from St. Anthony generally stay on the downwind side of the mountains. The west side of the Northern Peninsula is a preferred route since there is plenty of lower ground near the

coast whereas the east coast is characterized by steep cliffs that do not offer any place to let down in case of an emergency.

The east coast from White Bay to St. Anthony can be particularly hazardous in the late winter and early spring when winds are from the east or northeast. Winds from these directions tend to be quite moist and, as the air is pushed up against the steep cliffs that line this section of the coast, it is cooled from below by the ice pack. The cold air will remain trapped against the high cliffs and often produce freezing precipitation all along the coast with temperatures hovering just above and below the freezing point. During these situations, icing will usually be restricted to the lower 2,500 feet and above freezing temperatures will be found above this level.

When winds are from the western quadrant in the late fall and winter, snow squalls can become a problem. Snow squalls are especially frequent in west to northwest winds from Port au Choix southward. By about mid January, the snow showers become less frequent as that part of the Gulf of St. Lawrence and the Strait of Belle Isle become ice covered. During the summer, southwest winds will bring fog to the Strait of Belle Isle and the west coast of the peninsula while the east coast will often be clear.

Once the winds reach about 20 knots, mechanical turbulence is common below 4,000 feet. Mountain waves are also customary over the Long Range Mountains both in easterly or westerly winds and can cause severe turbulence downwind and near the mountaintops.

A well-known local effect occurs at the mouth of Canada Bay in a west or northwest wind. These winds are channelled and funnelled through the cliffs that line the bay and produce winds two to three times stronger at Englee than those reported further north.

Fog is common in and around Hare Bay and will often drift over the airport at St. Anthony as fog or low stratus cloud in south or southeast winds. A moderate westerly wind will usually keep the fog away from the airport. Pilots who regularly fly to St. Anthony will often ask whether there is any fog in the bay when getting a weather briefing. When fog is present in the Strait of Belle Isle, a strong southwest wind can sometimes push stratus cloud into St. Anthony Airport.

On the west side of the peninsula, fog can creep into the mouth of Bonne Bay almost as far as Rocky Harbour. This occurs in the spring and summer in a west or southwest wind. High terrain around Western Head prevents the fog from pushing further into the bay but low cloud will often cap the hills to the southeast all the way to Deer Lake.

North Shore of Quebec and Anticosti Island

(a) Summer

The storm tracks that affect the North Shore of Quebec and Anticosti Island are similar to those that affect southern Labrador (See fig. 3-9). One track the weather systems take during this time of year is through central Quebec, into southern Labrador and then out to sea. The second track tends to carry systems across northern Labrador leaving a trailing cold front to move southeastward through the area. In both cases, these systems tend to be much smaller in area and much weaker in strength. Weather associated with these frontal systems is usually more of the showery type.

The strengthening of the Bermuda High over the Atlantic also plays a role in the summer weather pattern. This causes a shift in the prevailing winds direction from northwest to a more southerly, or southwesterly, direction. This means that warm, moist air gets pushed farther northward and often results in fog along the North Shore, especially east of Anticosti Island. Another scenario for low cloud and fog is a persistent easterly wind. In such a case, there will often be precipitation in the form of rain or drizzle, which will help contribute to the poor flying conditions over the region.

Thunderstorm activity during the summer is most often associated with frontal systems although, occasionally, air mass thunderstorms will develop in moist and unstable conditions. The air mass thunderstorms that develop in this area are mostly over the mountains and near the Labrador border.

(b) Winter

Storms tend to follow a more southerly track during the winter season (See fig. 3-8). Similar to Labrador and Newfoundland, one of the main storm tracks brings frontal systems up from the south or southwest through the Gulf of St. Lawrence. A second major track is for systems to approach from the west and cross over the North Shore of Quebec as they head towards Newfoundland. The first scenario tends to be the track that brings the major winter storms to this area. When low pressure systems remain to the south over the Gulf of St. Lawrence, heavy snowfalls can often be expected, especially in over the mountains north of the coastline due to upslope flow.

Storms passing to the west will usually have a warm front pushing northward to the right of the low's track. In these cases, an area of rain or freezing rain will often affect the coast. Freezing drizzle occasionally develops along the North Shore of Quebec, in east or southeast winds, if the Gulf of St. Lawrence is partly free of ice. Otherwise, freezing precipitation in this region is relatively short lived and is associated with migrating pressure systems.

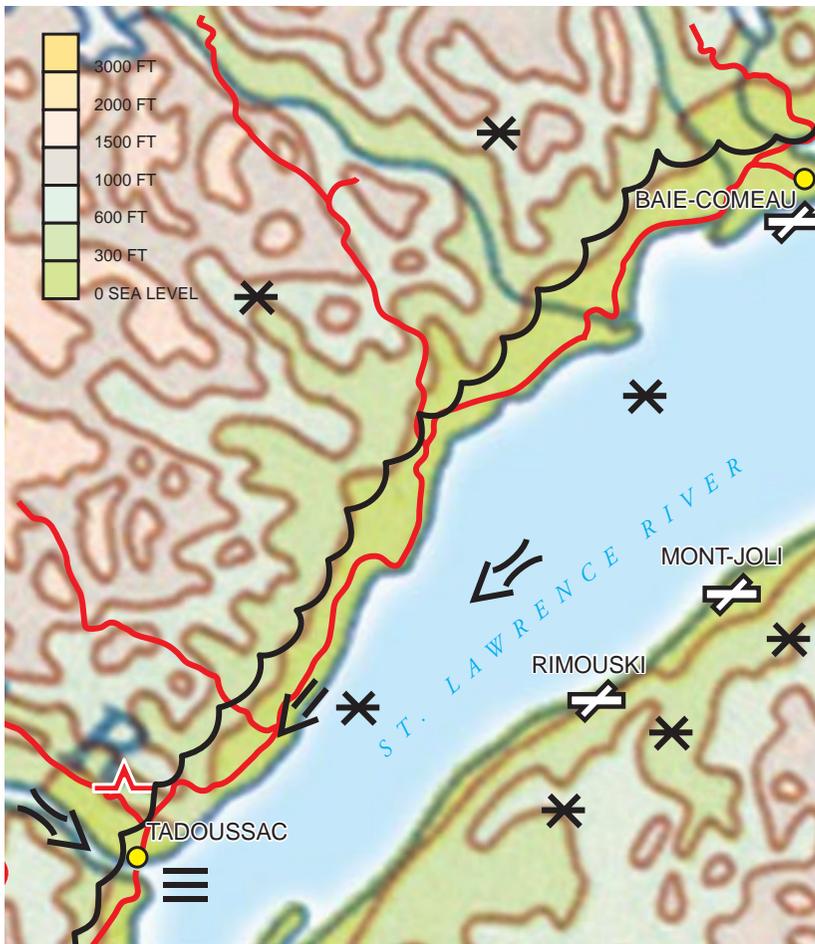
Cold continental air normally floods the region in the wake of these passing lows and is often accompanied by strong and gusty winds. This will often produce wide-

spread drifting snow, especially south of the mountains. The air is significantly colder north of the mountains than it is along the coast. Occasionally, ice crystals can develop when the air reaches -30°C or colder. As in Labrador, if enough of the crystals are present, aggregation will occur producing a snow-like precipitation in the absence of cloud.

Along the North Shore of Quebec, ice begins to form in December in the St. Lawrence River and the small bays along the coast. By mid January, ice covers most of the St. Lawrence River and a large portion of the Gulf of St. Lawrence. The ice pack here will usually peak by March then start to break up with the approach of warmer temperatures.

(c) Local Effects

Tadoussac to Baie-Comeau



Map 4-24 - Tadoussac to Baie-Comeau

Winds along this part of the North Shore and Gulf of St. Lawrence get funnelled along the coast and become either southwesterly or northeasterly, depending on the prevailing direction. Near Tadoussac, west-northwest to northwest winds will often produce strong gap winds along the Saguenay River Valley and may cause turbulence at the mouth of the river valley.

From late fall to early spring, strong wind shear can be expected at altitudes as low as 300 to 500 feet in strong north to northwest winds. The strongest winds often tend to “skip” the North Shore, but will reach the surface a mile or so off shore. The strong winds just above the surface will not be observed at the surface along the coast. Turbulence and significant wind shear can be expected in such conditions on approach to Baie-Comeau, for instance.

In the summer and early fall, southwest winds tend to be stronger and gustier at Baie-Comeau Airport on warm, sunny days due to daytime heating. Light to moderate low-level convective turbulence can also be expected under these conditions.

Low stratus cloud will be most prevalent in northeast winds with the worst conditions occurring when rain is falling. Ceilings can be somewhat lower near the mouth of the Saguenay River in the fall and spring seasons. Northeast winds will also cause a band of stronger winds up to two miles wide off the coast, due to coastal convergence.

In the winter, flurries developing over the St. Lawrence River will generally be more prominent downwind from this stretch of the coast and do not cause problems, although Baie-Comeau occasionally is affected in a cold southwesterly wind. With the approach of storms, however, the opposite will be true. This area will be prone to heavier snowfalls than will the south shore, due to upslope flow.

Baie-Comeau to Sept-Iles



Map 4-25 - Baie-Comeau to Sept-Iles

Funnelling due to the St. Lawrence River occurs here as well, although not as pronounced as farther west. In spring and early summer, low stratus cloud and poor visibility is common all along the coast with the approach of low pressure systems from the south. A common place for fog to linger is in the Pointes-des-Monts area where it usually takes a good wind shift to the northwest for conditions to improve. Pilots report that the weather is often worse between Pointes-des-Monts and Sept-Iles than it is from Pointes-des-Monts to Baie-Comeau in these situations. Katabatic winds are common all along this stretch of coastline, due to the numerous valleys perpendicular to the coast, and may cause strong winds and turbulence up to 3,000 feet at night.

In north or northwest winds, there is often stratocumulus cloud over the hills to the north but ceilings usually are better near the coast in these situations, due to downslope flow. When broken stratocumulus ceilings hinder low-level traffic along the coast, it will often be better just offshore where the stratocumulus cloud will thin into a scattered condition.

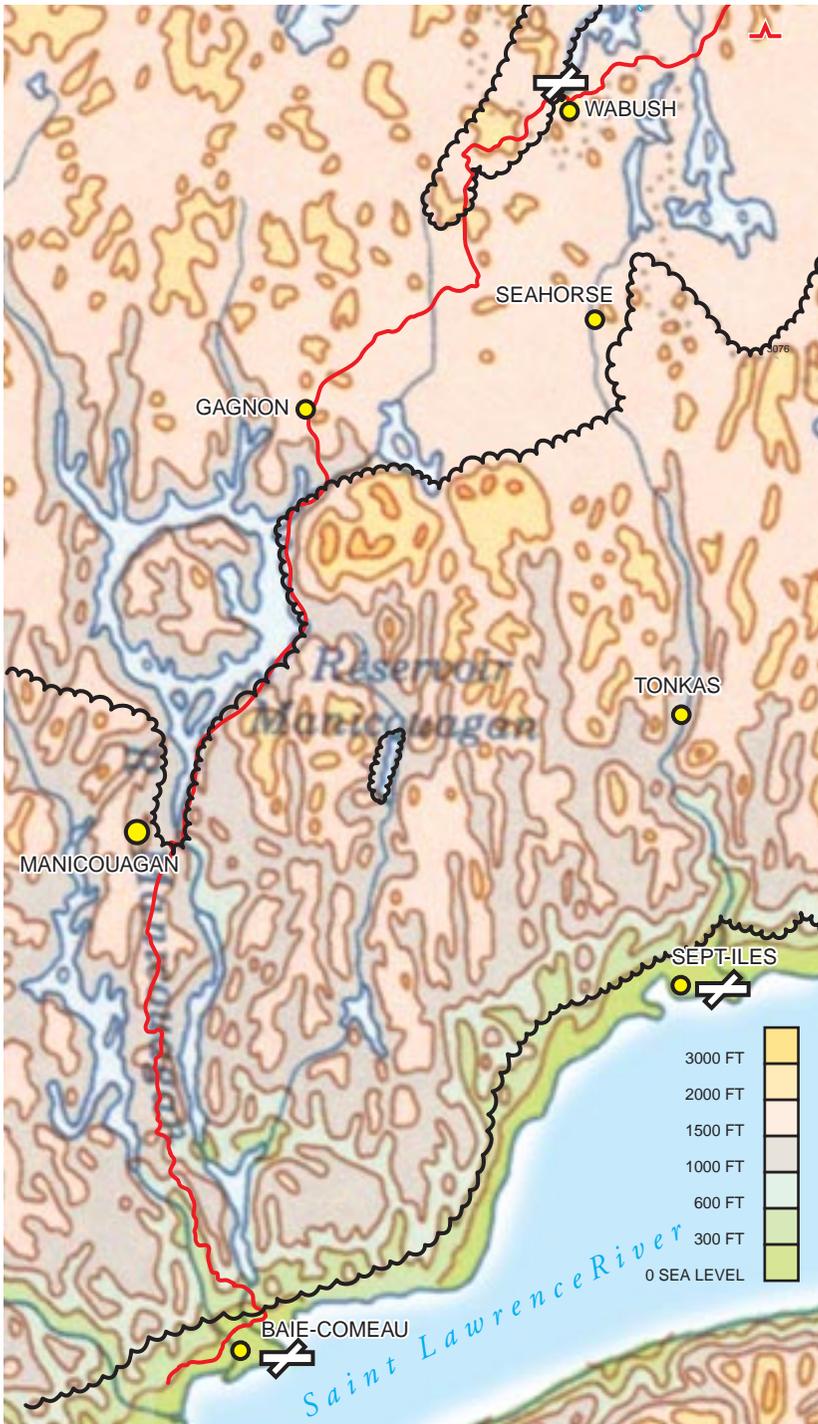
Sea breezes are common along the coast in spring and summer. After a sea breeze develops, it keeps growing and can reach up to 15 miles inland. Pilots should expect significant and rapid windshifts causing low-level turbulence and possible runway changes when sea breezes develop.

Baie-Comeau/Sept-Iles to Labrador (See map next page)

Common routes in this area are the Baie-Comeau and Sept-Iles to Labrador routes. In northeast to southeast winds, low ceilings and visibilities generally render this route very difficult, if not impossible, for low-level traffic. Winds from other directions will bring better flying conditions although upslope cloud is often encountered over the mountains to the north. Northerly or northwest winds usually cause cloud to develop over these hills. Sept-Iles and Baie-Comeau can have good ceilings due to the downslope nature of these winds, but if you can't see the mountains from Sept-Iles due to cloud, it definitely will not be possible to maintain low-level flight over the mountains to Labrador. In the winter, snow flurry activity will often be encountered in these situations within about 10 miles inland. Turbulence will also be encountered with winds above 20 or 25 knots in any season. This turbulence is always worse when the air is unstable.

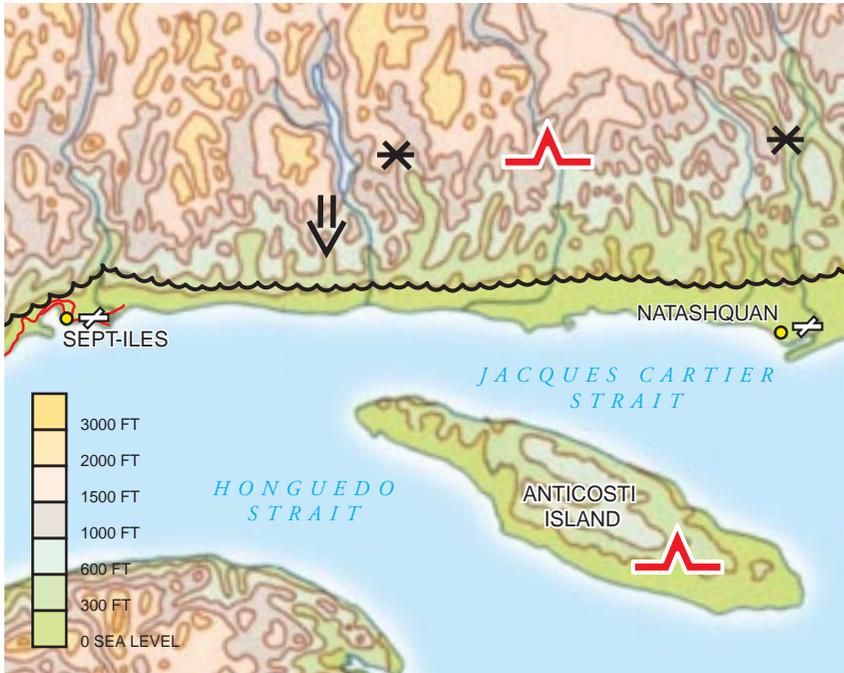
Pilots who follow the railroad tracks or power lines indicate that low cloud tends to form and linger at several places. Along the railway from Sept-Iles at Mile Douze (mileage marker twelve) is one area prone to low cloud, but usually only if it rains. Another area that is prone to low cloud or scud is a one or two mile stretch along the railroad just south of Tonkas. Radiation fog with typical tops around 500 feet often develops in the valleys from late spring to the fall, especially along the St. Marguerite River Valley up to SM3 (Sainte-Marguerite-3). This fog generally burns off rapidly after sunrise.

Another area of concern for pilots transiting to and from the North Shore to Labrador is the Seahorse area. Seahorse, just north of the Labrador-Quebec border on the railway from Sept-Iles to Churchill Falls, is known as an area that is prone to icing conditions in the fall and winter.



Map 4-26 - Labrador Routes from Sept-Îles to Baie-Comeau

Sept-Iles to Natashquan including Anticosti Island



Map 4-27 - Sept-Iles to Natashquan including Anticosti Island

This area experiences its worst conditions in east to southeast winds. Moist eastlies or southeasterlies will typically usher in stratus cloud based at about 500 feet. Any precipitation will lower the ceilings further. As long as the winds are from the east or southeast, conditions along the coast will not improve.

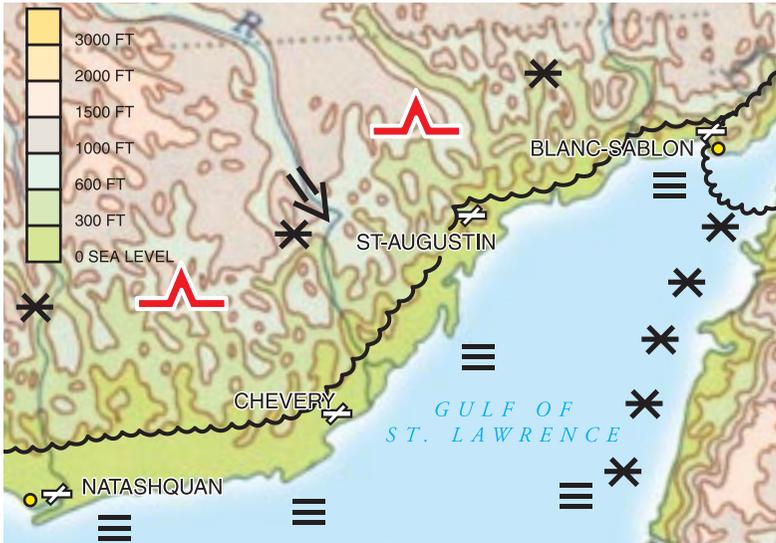
Once the winds shift to northerly or northwesterly, conditions tend to improve along the coast, although stratocumulus ceilings will still likely be encountered farther inland. In the winter, these winds will often cause flurry activity near Anticosti Island. Turbulence can also become significant around Anticosti Island in windy conditions. Turbulence is also often encountered when approaching from the east at Sept-Iles.

With approaching storms, there tends to be more cloud and intense precipitation southeast of Sept-Iles due to low-level convergence. As the winds are funnelled and channelled in the Jacques-Cartier Strait between the coast and Anticosti Island, they converge with southeast wind through the Honguedo Strait, resulting in enhanced vertical motion in this area. Up and down drafts can also be encountered when flying along the coast in these conditions.

In late spring and summer, fog and low stratus are very common in this part of the Gulf of St. Lawrence. As warm, moist air approaches from the south, it is cooled by the relatively cold waters over the gulf causing fog to develop and become widespread.

Since southwesterly winds will bring the lowest conditions, this area of the coast will generally not experience the worst ceilings because of the sheltering effect of Anticosti Island.

Natashquan to Blanc-Sablon



Map 4-28 - Natashquan to Blanc-Sablon

Fog that forms in warm, moist southwest winds tends to be worse along the coast, from just east of Natashquan up to Blanc-Sablon. This area tends to stay shrouded in fog for days as long as the winds are out of the southwest in the spring and summer. It usually takes a significant change in wind direction for conditions to improve. It is not uncommon for Chevery and Blanc-Sablon to be below minimums in fog or low stratus all day. St Augustin is somewhat more protected and will sometimes get better conditions.

The Gulf of St. Lawrence provides ample moisture in a southerly flow even when fog does not develop. The onshore and upslope nature of southerly winds will result in significant cloud along the coast with even lower ceilings inland over the mountains.

Southerly low-level jets associated with storm systems tend to remain aloft near the coast but may reach the surface over the higher terrain inland. This tends to create strong low-level wind shear which pilots should be aware of on approach to coastal airports.

Katabatic winds are common all along this stretch of coastline, also due to the valleys perpendicular to the coast, and may cause strong winds and turbulence up to 3,000 feet at night.

Labrador and Eastern Ungava Bay Area

(a) Summer

Two major storm tracks affect Labrador and Eastern Ungava Bay Area during the summer season (See Fig. 3-9). One track carries the weather systems through central Quebec eastward over southern Labrador and then out to sea. The second, more northerly track, brings systems originating over Hudson Bay eastward across northern Labrador. In both cases, given the reduced north-to-south temperature difference compared to winter, these systems tend to be much smaller in area and much weaker in strength. Weather associated with these frontal systems is usually more of the showery type, although periods of rain lasting several hours may occur. With the passage of the cold front precipitation ceases fairly quickly.

Behind the cold front, the winds will tend to be from the westerly quadrants and will be unstable and somewhat moist, due to the numerous lakes and ponds in this area. This often results in the development of broken to overcast cumulus or stratocumulus with daytime heating. Where the flow is upslope, scattered showers may also develop. Clearing generally will occur when the air becomes drier or when the flow weakens sufficiently for the cloud to “burn off”.

When warm, moist air moves out over the cold waters off the Labrador coast an inversion will form. Under this inversion, extensive areas of sea fog and marine stratus are quick to form. Westerly winds will generally hold the fog and stratus offshore but any flow from the southeast to northeast quadrants will allow it to move into coastal stations. If the prevailing winds over the area are light, even from a westerly direction, easterly sea breezes will often develop along the coast and may advect the fog and stratus towards the coast, turning a pleasant summer morning into a cool, foggy afternoon. Depending on the strength of the prevailing winds, the fog and stratus may persist throughout the night.

Most of the thunderstorms in this area are associated with frontal systems although occasionally air mass thunderstorms will occur in moist and unstable conditions. The area of highest thunderstorm frequency in this region is in central Labrador with most occurring in the late afternoon to early evening. A secondary problem related to thunderstorm activity is forest fires caused by lightning strikes. Smoke from these forest fires will generate near zero visibility near the fire and may produce widespread poor visibilities especially when the winds are light.

(b) Winter

During the winter season, migratory frontal systems tend to track farther south than during the summer (See Fig. 3-8). One of the two main winter storm tracks brings frontal systems up from the south or southwest through the Gulf of St. Lawrence up into southeastern Labrador or out to sea. The second major track is for

systems to approach from the west and cross over the North Shore of Quebec or the Gulf of St. Lawrence before heading towards Newfoundland. Although not as common, low pressure systems approaching from the south can also head northeast towards Newfoundland and curve north or even northwestward and stall just off the coast of Labrador. In these situations, a prolonged period of poor weather will affect coastal sections of Labrador with marginal conditions further inland.

Cold continental arctic air is the predominant air mass over Labrador and the Eastern Ungava Bay area during winter. After freeze-up of the lakes and ponds, this air mass is, for the most part, stable and will give generally clear skies. Stratocumulus ceilings sometimes develop in areas of upslope flow, however, conditions always improve on the other side of the hills or mountains. When conditions are particularly cold, $-30\text{ }^{\circ}\text{C}$ or colder, an interesting form of precipitation is observed frequently. Water vapour from moisture sources such as mines, mills and fast flowing rivers will condense directly into ice crystals. If enough of the crystals are present, aggregation will occur producing a snow-like precipitation although the actual sky conditions may be reported as clear.

Freezing precipitation along the Labrador coast is a frequent problem in the winter. With extended periods of east or northeasterly winds, the air becomes very moist. As this moisture reaches the coast, it is cooled by the ice pack and forced upward causing freezing drizzle or light freezing rain all along the coast. Conditions usually do not improve until the winds shift around to west or northwesterly.

Since the different pressure systems that affect the region are stronger in the wintertime, it follows that the winds are stronger during this part of the season as well. As weather systems track across the Gulf of St. Lawrence or move up into the Labrador Sea, the winds will gradually increase to east or northeast before shifting to northwesterly as the systems passes. The northwesterly winds behind these systems tend to be fairly strong and can reach 60 to 80 knots along the Labrador coast in the more intense winter storms. The winds are also affected by the countless variations in local terrain, especially in the Torngat Mountains.

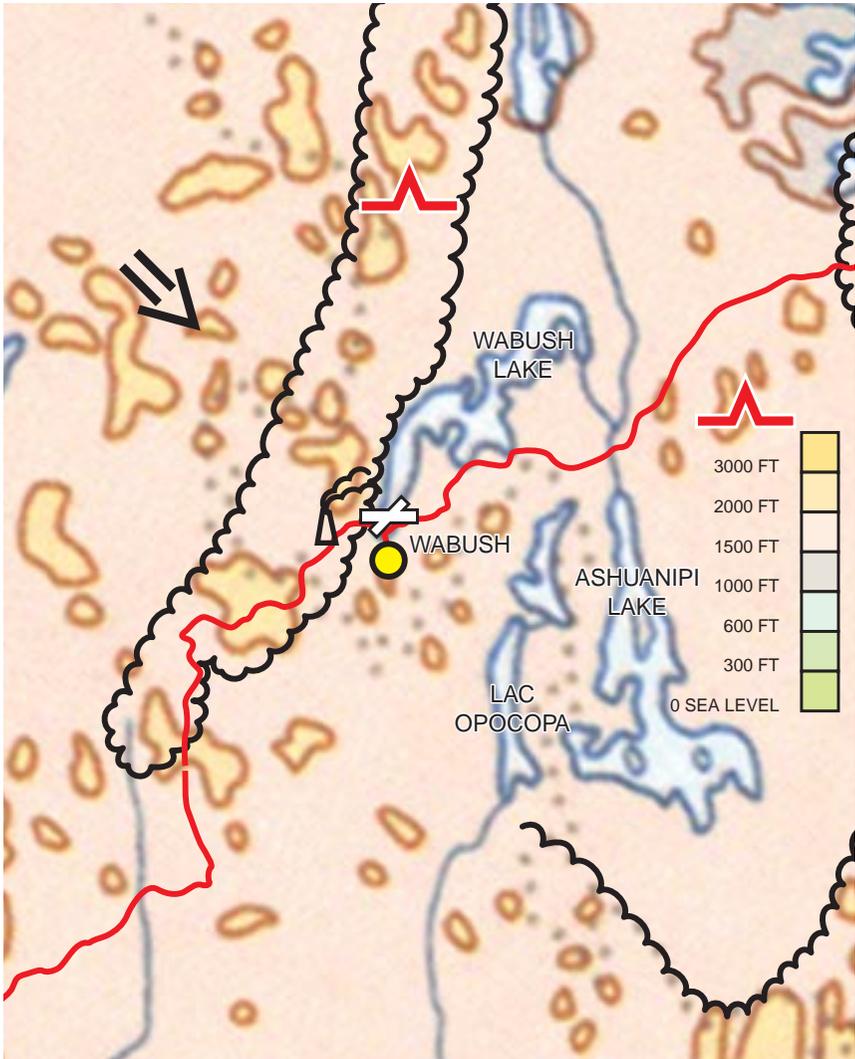
Ice coverage is an important factor when it comes to determining local weather conditions. Starting in late November, ice begins to form along the Labrador coast in the inlets, fjords and sheltered bays. In December, the ice pack continues to spread southward, almost totally covering Lake Melville by early-to-mid month and the rest of the southeast coast of Labrador by the first of January. The ice pack usually reaches a maximum by March or April then begins to break up. On average, the entire south coast of Labrador including Lake Melville is mostly ice free by mid June and the north coast by mid July.

Spring and fall are basically considered transition periods between winter and summer. In the fall, the land is still fairly warm and there is still a considerable amount of open water to affect cold air masses invading the region. In such a situation, it is com-

mon for sufficient instability to develop with daytime heating to produce cumulus cloud and scattered shower activity. As the colder air flows over relatively warm water, steam, fog or low stratus will often develop and give lower ceilings and reduced visibility. These conditions will tend to occur near sunrise, under clear skies with light winds, until freeze-up.

(c) Local Effects

Wabush and Vicinity



Map 4-29 - Wabush and Vicinity

Local weather conditions in western Labrador are for the most part continental in nature. In summer however, the numerous lakes and rivers do provide moisture to the

low levels. Along the 2,000 to 2,500 foot hills west of Wabush, upslope flow will cause these clouds to become broken or overcast and prevent low-level traffic from proceeding over the hilltops.

A localized but potentially very hazardous problem occurs in dry, windy conditions near Wabush Airport. Iron ore tailings from the nearby mine get picked up by the wind and become suspended in the lower 2,000 to 5,000 feet near the airport. These tailings consist predominantly of extremely fine particles that are rejected from the mining process. They tend to form a dark, ominous cloud that can sometimes drift over the end of the runways and cause problems for aircraft on approach or take-off. A check of the Wabush METAR during a dry, windy day will always provide some insight as to whether this situation is occurring. An example is shown below:

**METAR CYWK 231800Z 02015G25KT 15SM VCBLDU FEW200 22/04 A3009
RMK C12 VSBY SE 2MI**

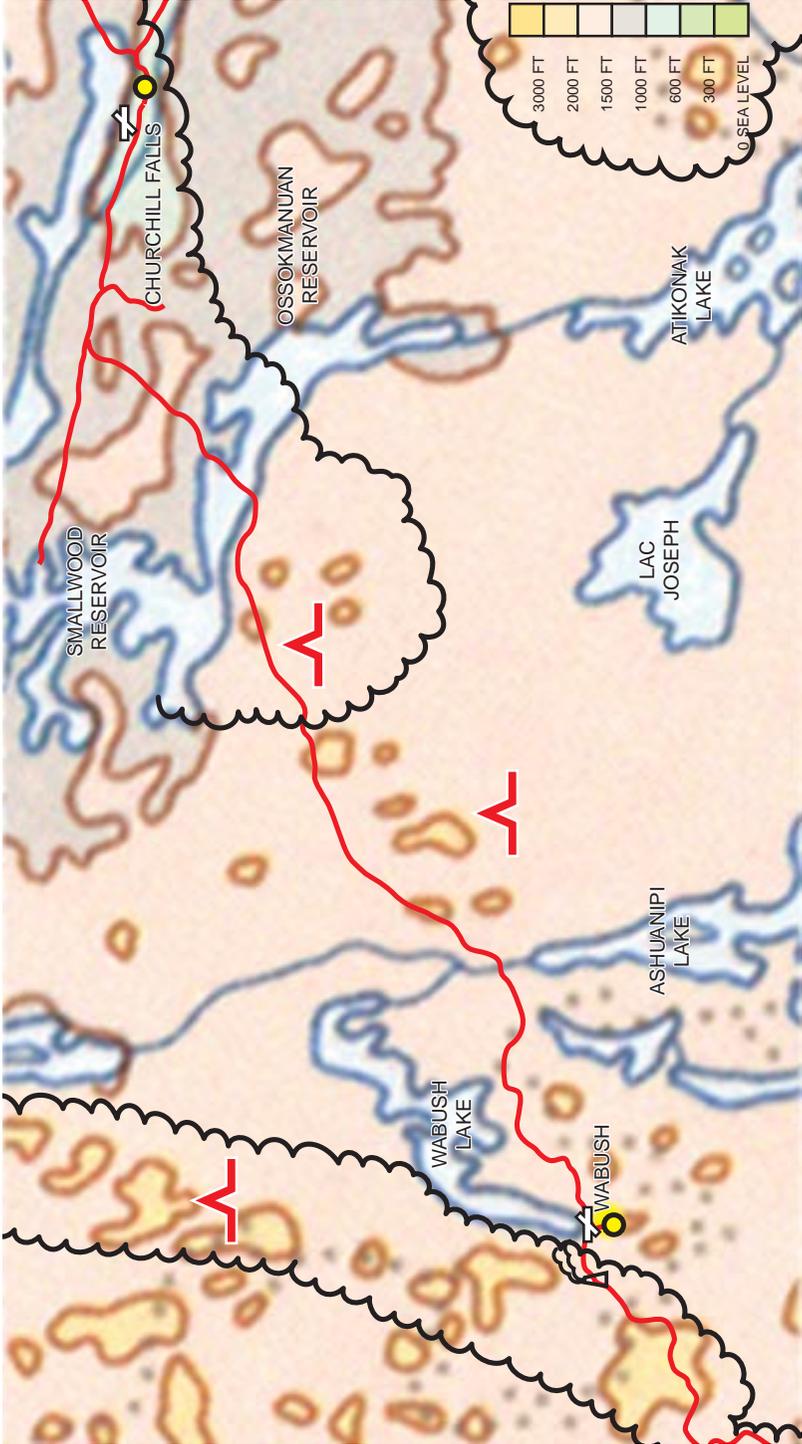
Southward from Wabush

See data for these routes as described in a previous section under Baie-Comeau/Sept-Iles to Labrador.

Wabush to Churchill Falls (See map next page)

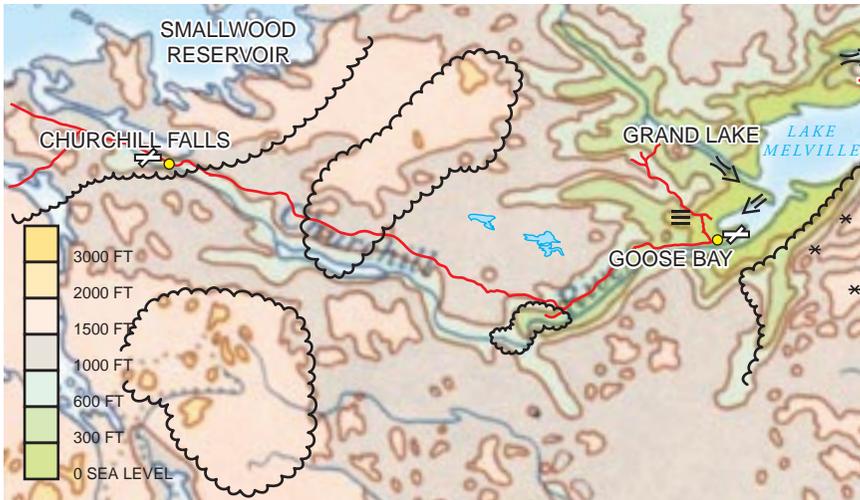
Pilots flying low-level from Wabush to Churchill Falls, or vice versa, often prefer to follow the power lines. Strong northwest winds will tend to pick up moisture from Smallwood Reservoir and cause stratocumulus ceilings over most of this route until freeze-up. In lighter north or northwest winds, fog may develop over the reservoir and drift slowly southward. Northeast to southeast winds will also generally give 1,000 to 2,000-foot stratus or stratocumulus ceilings along this route. Pilots find that they often get through by following the river valley, although this can be tricky since there is always a lot of “scud” in the valley in these situations.

Radiation fog in the summer is a common occurrence in the river valley and will sometimes reach the airport in Churchill Falls. In the winter, ice crystals often occur in the area during cold arctic outbreaks. Small waterfalls and fast flowing rivers that do not freeze in the winter provide the moisture source needed for this phenomenon to develop.



Map 4-30 - Wabush to Churchill Falls

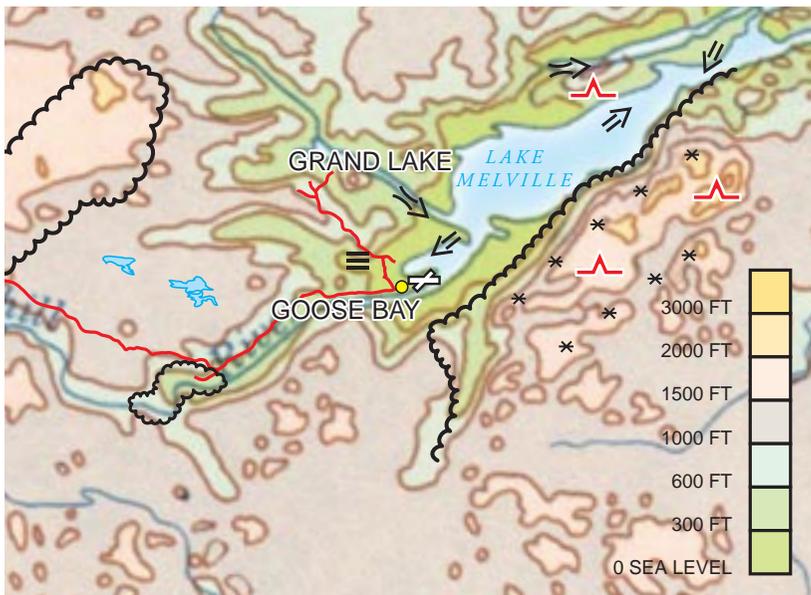
Churchill Falls to Goose Bay



Map 4-31 - Churchill Falls to Goose Bay

Very similar conditions exist on the route from Goose Bay to Churchill Falls as do from Churchill Falls to Wabush. Most pilots flying this route like to follow the power lines as well. Upslope cloud will generally be worse over the hills midway between Goose Bay and Churchill Falls.

Goose Bay and Vicinity/Lake Melville



Map 4-32 - Goose Bay and Vicinity

The Goose Bay area experiences some of the best flying weather in Labrador. The fact that air masses approaching from any direction except the northeast must subside means that Goose Bay Airport has more sunshine and less precipitation than surrounding uplands. The cool temperatures and fog so typical of the Labrador coast rarely penetrate beyond the Narrows at Rigolet. Winds in this area tend to be strongest from the northeast and southwest due to funnelling and channeling. Southwest winds will bring excellent flying conditions while northeast winds will bring low ceilings and poor visibility. This holds true for any season although the lowest conditions due to the northeast winds occur during spring.

As winter or fall storms approach from the south, it usually takes longer for strong winds to develop here due to the valley and the Mealy Mountains to the south. Winds will often be light in an otherwise strong southeasterly gradient and only increase once the gradient becomes more easterly. At this point, the winds usually increase and shift quite abruptly to northeasterly as they get funnelled down the valley.

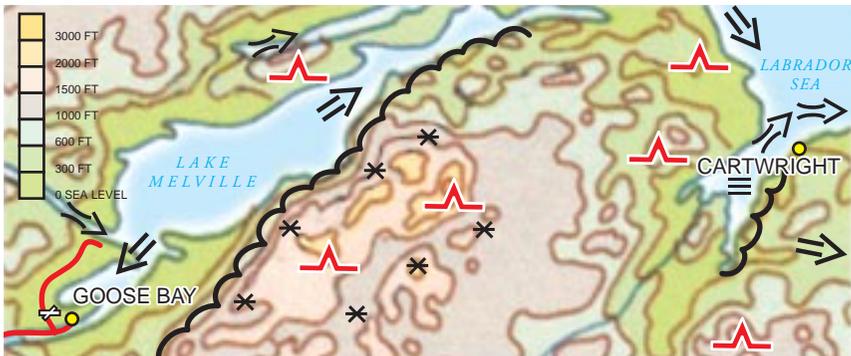
In the warmer months, there will often be radiation fog and low stratus in and around Goose Bay and in the river valley in the morning. It is not uncommon to have ceilings of 100 feet all around the airport in the early morning hours, however this is usually more of a problem for float planes at Otter Creek and rarely reaches the airport in Goose Bay. These low ceilings usually improve by 8 or 9 am local time. Sea breezes also develop on warm sunny days and are most noticeable when winds are light.

On clear days, winds will often increase and become quite gusty in the afternoon due to the rugged terrain and differential surface heating. This will usually cause turbulence up to the 3,000 to 5,000 foot level until the evening hours. Lenticular cloud formations associated with standing waves are frequently observed over and to the lee of the surrounding ridges. Occasional severe turbulence at low levels to the lee and below the crest of the Mealy Mountains can develop in south or southeast winds in any season.

Strong northwest winds in the wake of cold fronts will also cause mechanical turbulence over the surrounding area. Often in cool north or northwesterly flow, upslope cloud will develop over the Mealy Mountains preventing traffic from heading directly southeast towards the coast from Goose Bay.

On average, Goose Bay airport gets about 7 thunderstorm days during the summer with most of them being associated with frontal systems. Thunderstorm activity tends to die out once over a lake and are rarely a problem north of Goose Bay and Lake Melville.

Goose Bay to Cartwright



Map 4-33 - Goose Bay to Cartwright

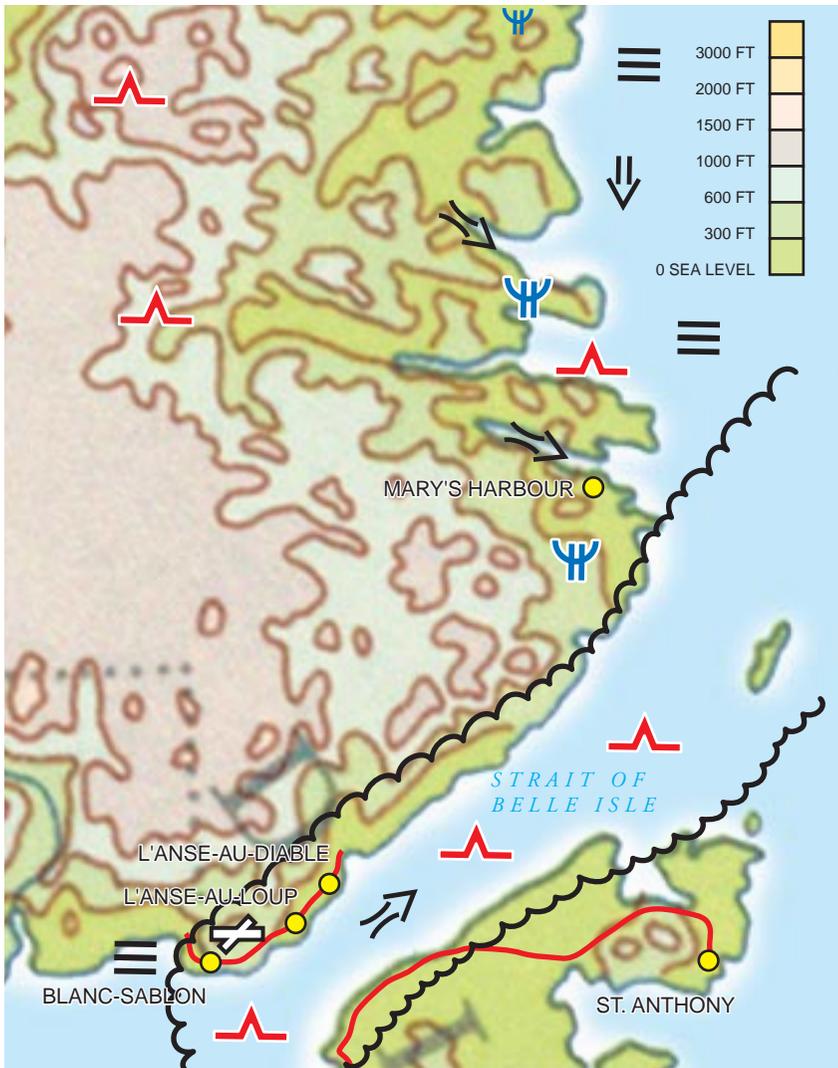
A common route in southeastern Labrador is from Goose Bay to Cartwright. The preferred route is to go direct, however, it is often necessary to fly around the Mealy Mountains. Cloud will often develop over these mountains in north or northwest winds, especially when Lake Melville is free of ice. Upslope cloud can also develop when the winds are out of the south or southeast. Furthermore, shower activity is common in and around the Mealy Mountains when the air is sufficiently moist. Conditions are usually better on the leeward side of the mountains although it should be kept in mind that in strong southerly or southeasterly winds, significant turbulence can be expected on the north side of the mountains.

When it is not possible to make the Goose Bay-Cartwright route direct, one frequently used route is to follow the Kenamu River Valley until south of the Mealy Mountains, proceeding eastward to the Eagle River and then following it directly to Sandwich Bay and into Cartwright. Another option is to head northeast from Goose Bay along the south shore of Lake Melville to Frenchman Point, following the English River to the North River, which can then be tracked right to the coast. These two routes are frequently used since cloud is often present around the Mealy Mountains. When conditions are too low to use these routes, helicopter pilots will generally follow Lake Melville, head through The Narrows out to the coast, and then proceed to Cartwright. One location along this route where problems may occur is in The Narrows where low cloud is often encountered.

While south or southwest winds will generally give ceilings and visibilities above 2,500 feet and 6 miles respectively in any season, northeast to north-northwest winds will yield the lowest conditions at Cartwright from the fall through to spring. One of the major hazards at Cartwright, and all along the coast for that matter, is icing due to freezing drizzle when winds are from the east to northeast in the winter and spring.

The weather observations for Cartwright are taken off-site, about one n. mile north of the runway.

Blanc-Sablon to Mary's Harbour/Strait of Belle Isle



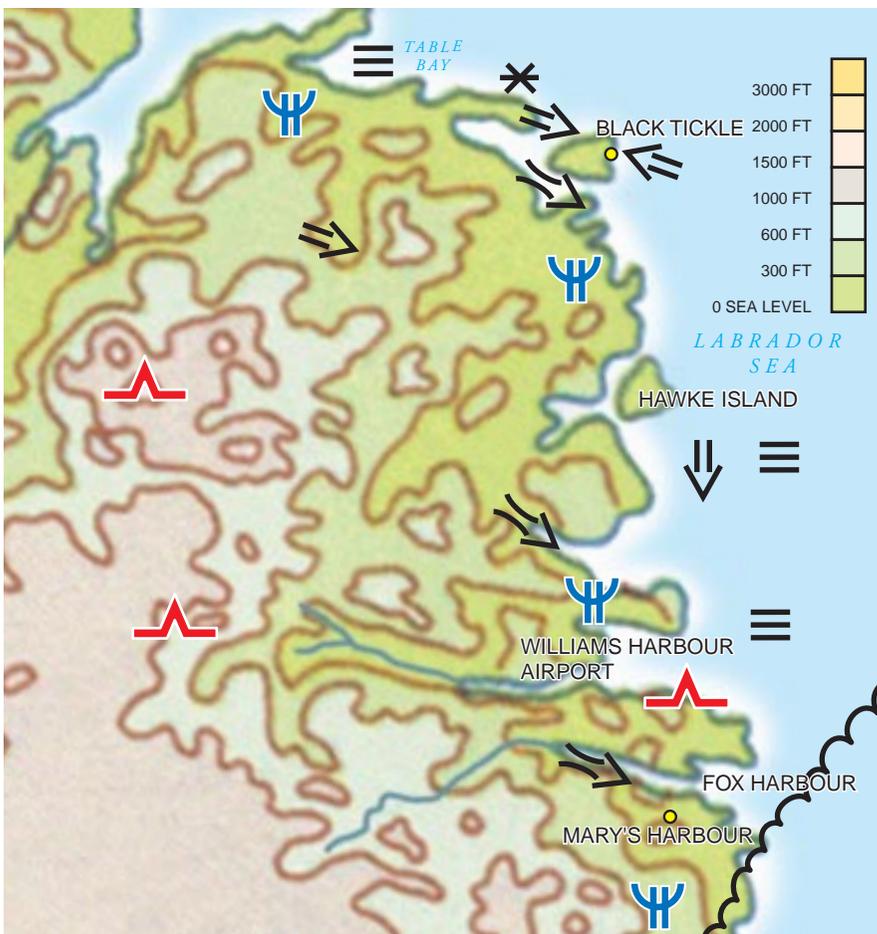
Map 4-34 - Blanc-Sablon to Mary's Harbour

The Strait of Belle Isle is well known for its gap winds. In southwesterly or north to northeasterly flow, air is funnelled through the strait producing strong gap winds, especially between L'Anse-au-Loup and Blanc-Sablon. For example, light southwest winds in the Gulf of St. Lawrence can easily increase to 30 to 40 knots between these two locations. Similarly, northeasterly winds will increase substantially between these two locations. Turbulence can also develop in this area due to funnelled and channelled winds forcing the air upwards over the strait. Pilots report that the turbulence is usually worse on the Labrador side to about half way across the strait. Strong updrafts and downdrafts are also reported and extend as high as 5,000 feet.

In warm and moist southwesterly flow, fog will either form in this area or will be advected up into the Strait of Belle Isle from the Gulf of St. Lawrence and often persist for several days. Since Blanc-Sablon Airport is directly in the path of west or southwesterly winds, fog is usually more prevalent here than at L'Anse-au-Loup and points eastward. This fog generally does not extend more than two or three miles inland. It usually takes several hours after the passage of a front for conditions to improve since low cloud tends to linger in the strait.

Katabatic winds at L'Anse-au-Diable produce strong northerly gusts and can extend up to 1 1/2 miles from the coast. A valley to the north channels the airflow southward until it reaches the steep cliffs at the coast. Frictional effects along the cliffs can cause whirlwinds and significant turbulence in this area.

Mary's Harbour to Black Tickle



Map 4-35 - Mary's Harbour to Black Tickle

In the summer, a warm southwesterly flow will give good flying conditions although dense fog usually sits offshore over the cold water. Sea breezes are also common along the coast and may advect the fog or sea stratus onshore. Some of the more experienced pilots indicate that when flying into the coastal stations in the afternoon, the presence of haze will most likely mean that these same coastal stations will be below minimums in fog or stratus by evening. These conditions will usually be observed only four or five miles inland but can extend further inland with a strong onshore wind.

Southeast to northeast winds will almost guarantee low ceilings and visibility along this stretch of coastline. Drizzle is also very common but usually poses no hazard to aviation. Freezing drizzle, however, becomes a significant problem in the spring and winter months. The low ceilings and visibility combined with the severe icing conditions in freezing drizzle can render coastal areas extremely dangerous in these situations.

Although not entirely weather related, Fox Harbour has a problem with seagull activity in the vicinity of the airport, made worse in a southerly wind. A fish plant near the airport tends to attract these seagulls, especially when winds are out of the south, and local pilots must take great care when coming in from the north.

Williams Harbour Airport, whose runway is oriented southeast to northwest, is built up and lies on a plateau where there tends to be a lot of eddy activity due to the configuration of the airport. Pilots will often report significant downdrafts on approach to either runway.

Westerly winds tend to blow stronger north of Hawke Island because the land near the coast is low and barren. Without any barriers to slow the wind down, the wind is free to increase as it blows across the barrens. Northwest winds are particularly strong at Black Tickle. Pilots say a 10 to 20 knot wind at Cartwright will always mean a 25 to 35 knot wind at Black Tickle. This effect is also observed in a southeast wind. Another hazard at Black Tickle occurs as northeast winds tend to be enhanced by cornering from the eastern end of Spotted Island. The runway is oriented northwest to southeast, therefore strong crosswinds will accompany the low ceilings and visibility.

Black Tickle to West Bay



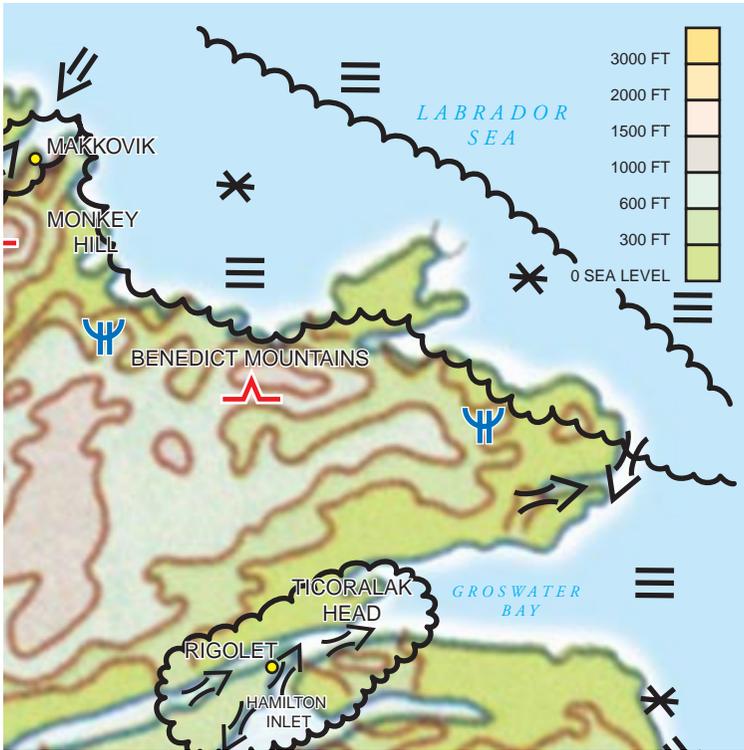
Map 4-36 - Black Tickle to West Bay

This particular stretch of coastline is oriented northwest to southeast and is fully exposed to northeasterly winds, hence, very low ceilings and visibility are commonplace in such conditions. In winter and spring, severe icing due to freezing drizzle can be expected when the winds are onshore.

Between North River and West Bay, northwest winds experience coastal convergence that causes a band of stronger winds to develop along the coast. Low-level turbulence can also be expected just south of Woody Point where the local terrain that rises to almost 1,200 feet creates mountain waves. Another effect that occurs here during fall, or winter when the ice pack is pushed just offshore, is for scattered flurries to develop near the coast.

Fog and stratus tend to linger in Table Bay and Sandwich Bay, especially during spring and fall. It is not uncommon to see the fog or stratus drift in over the airport at Cartwright.

Groswater Bay to Hamilton Inlet



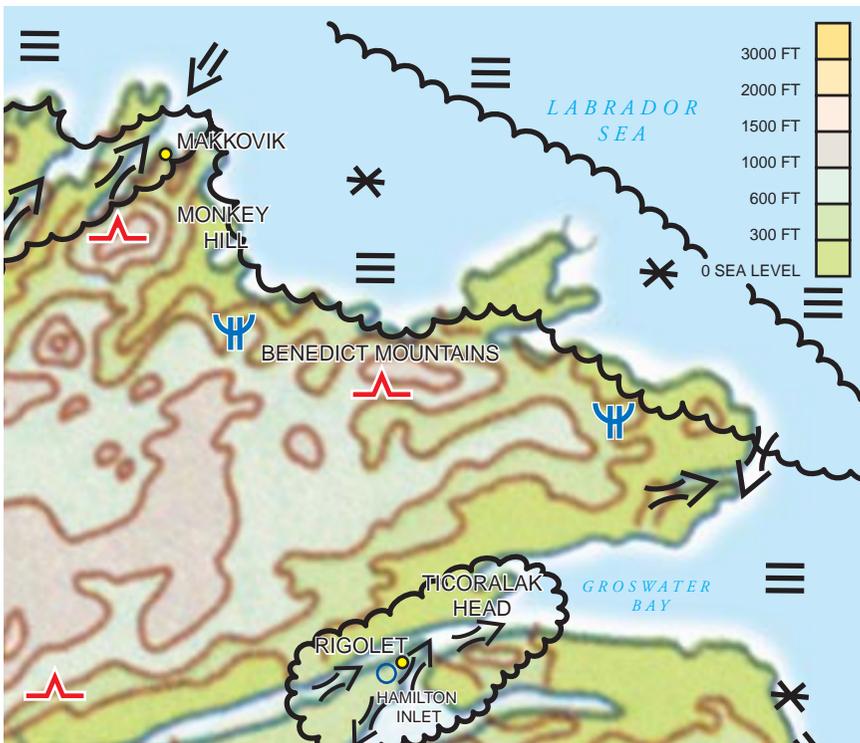
4-37 - Groswater Bay to Hamilton Inlet

Groswater Bay is wide and open towards the east and susceptible to very low ceilings and visibility in drizzle and fog when winds are from the southeast or northeast, in any season. Of these, the worst conditions occur in northeast winds. Freezing drizzle becomes a problem in the spring and winter. Funnelling and channelling occur at the mouth of the bay and into Hamilton Inlet due to numerous small islands and The Narrows. In the fall and winter, storms bring very strong winds and heavy precipitation to this area.

At the head of Groswater Bay, northeast and southwest winds tend to be funnelled at Tioralak Head and cause winds to increase as much as 15 knots.

Strong tidal currents in The Narrows generally prevent winter freeze-up thus providing a good source of moisture for cloud to develop. This cloud is usually based around 1,500 feet and may cause problems getting into Rigolet due to steep, hilly terrain in the vicinity. Fog is often a problem here in the spring.

Groswater Bay to Makkovic and Vicinity



Map 4-38 - Groswater Bay to Makkovic

Although somewhat more rugged than farther south, this coastline is also oriented northwest to southeast and is fully exposed to northeasterly winds. Local pilots keep a close eye on the forecast wind direction since conditions deteriorate very rapidly after the onset of onshore northeasterlies in any season. During spring, these northeast winds can be quite persistent and usually shut down operations with below minimum ceilings and visibilities. During winter, snowfall tends to be heavier here due to the enhancement from the Atlantic Ocean. Coupled with very strong winds that occur here in winter (up to 80 knots at times), blizzard conditions are not uncommon and can persist for days as strong low-pressure systems stall off the coast. Severe icing in freezing drizzle is also a major problem in both spring and winter, although this becomes less of a threat further inland.

Turbulence is often encountered over and to the lee of the Benedict Mountains and tends to be worse in either southwest or northeast winds. Turbulence is also a problem at Makkovic and near Monkey Hill in south or southwest winds. Pilots going into Makkovic airport report lots of mechanical turbulence and downdrafts off the hills to the south of the field when winds are from the south or southwest. Makkovic's winds are often stronger than those at nearby airports but only about half the strength

of the wind at the top of Monkey Hill. A typical combination would see Makkovic's winds at 20 to 25 knots, Postville at about 10 to 15 knots while 50 to 60 knots are blowing at the top of Monkey Hill. In winter, local pilots will often look at the drifting snow on the top of the hill as an indication of the severity of the turbulence and downdrafts they can expect on approach to Makkovic.

In late spring, fog becomes a problem as soon as the ice begins to break up and, by summer, extensive fog banks generally sit just offshore. Southwest winds generally keep the fog and sea stratus offshore but onshore winds will advect the fog inland. Sea breezes are common here and often push the fog onshore. Pilots often find, however, that conditions at Makkovic airport are not particularly representative of the main conditions along the coast and that many locations are not as bad.

Northwest winds here will generally bring improving conditions as far as precipitation, ceilings and visibilities are concerned. Ceilings and visibilities will improve rapidly during winter but may take somewhat longer in other seasons

Makkovic to Nain and Vicinity



Map 4-39 - Makkovic to Nain

West or southwest winds bring good flying weather along this part of the coast although these winds will be funnelled and channelled along the southwest to north-

east axis of the inlets. Localized areas of strong gap winds occur at the mouth of these inlets. Winds from the southwest to northwest quadrants, however, tend to be fairly turbulent.

During winter, similar problems exist here as do over southern coastal sections, with enhanced snowfall and severe icing conditions in onshore flow. Blizzard conditions with near zero visibility are also fairly common in winter when deep low-pressure systems lie to the southeast. That being said, however, occurrences of freezing drizzle tend to diminish somewhat as you head north.

Several long, narrow bays bordered by steep, hilly terrain and oriented southwest to northeast exist along the coast. Funnelling, channelling and coastal convergence cause strong winds along the length of the bays. Where the bays are narrow, such as in Kaipokok Bay, strong gap winds occur. Between Postville and Post Hill, whirlwinds and significant low-level turbulence can accompany these winds. With the very cold Labrador Current just offshore, strong temperature contrasts exist between the land and water during the daytime. Even moderate offshore winds in the morning can give way to a cold, 10 to 15 knot northeasterly sea breezes in the afternoon. As these sea breezes enter the bays and inlets, funnelling causes these winds to increase further, turning a 10 to 15 knot wind outside the bay to a 25 knot wind just inside the bay. Fog may also be advected inland with these winds.

It should be noted here that this effect occurs not only from Makkovic to Nain but all the way up the coast.

From spring to fall, low cloud pushed far inland by onshore winds between Makkovic and Davis Inlet will have a tendency to linger in the lower terrain between these two sites. Cloud may linger as far southwest as Nipishish Lake depending on the winds. Quite often this area will be covered by cloud but the coastal stations will be better.

Makkovic airport will often be lower than other locations along the coast. As far as ceilings and visibility are concerned, Nain will usually be the best station along this part of the North Labrador Coast when winds are onshore, as the numerous islands to the east of the airport tend to have a sheltering effect. On the other hand, Makkovic will generally have the lowest conditions, with Hopedale and Davis Inlet lying somewhere in between. Typical conditions will be an 800 foot ceiling at Nain, while Davis Inlet and Hopedale will be at 400 feet and Makkovic at 300 feet.

Although ceilings tend to be better at Nain, the mountainous terrain in the vicinity gives rise to very turbulent conditions at the airport. Many pilots regard Nain as the worst airport for turbulence along this stretch of coastline. West to northwest winds will be funnelled down Nain Bay and the Tikkoatakak River Valley and are enhanced further by cornering around the hills west of the field. Pilots will often

encounter strong tailwinds on approach from the north or northeast and will also encounter strong downdrafts near the end of either runway. Pilots say that there are two windsocks near the end of each runway and they will often both point in opposite directions. Similar, but less severe, conditions exist at Davis Inlet where downdrafts are often encountered at the end of runway 32 in southwest winds.

Nain To Killiniq Island/Northern Torngats



Map 4-40 - Nain to Killiniq

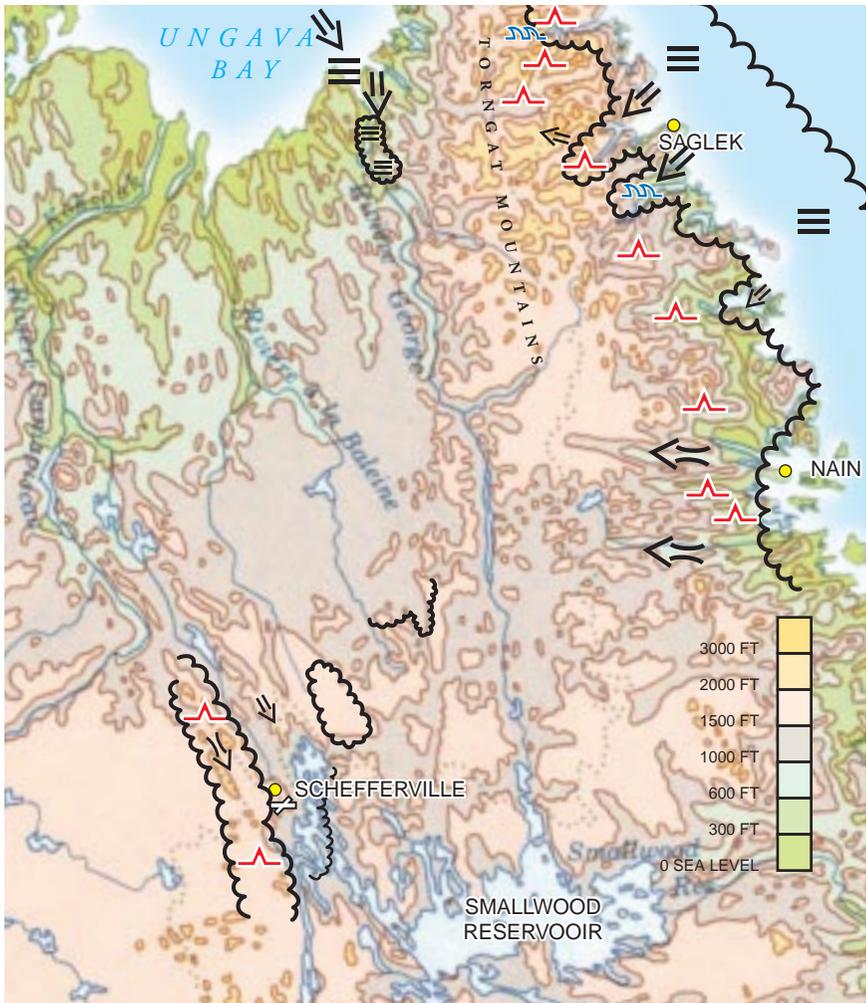
Although this may be the most exciting and most scenic place to fly in the GFACN34 domain, it is without a doubt one of the most dangerous and unforgiving places to fly into as well. More and more pilots are discovering the hidden treasures of the Torngat Mountains, as evidenced by the marked increase in traffic in this area over the past few years. Very limited data exists for this area and pilots are urged to be extremely cautious when flying here. Pilots new to the area should talk to the more experienced local area pilots regarding specific hazards.

The Torngat Mountains north of Nain are usually quite windy even in relatively light pressure gradients. Saglek for example, is a particularly bad location. Gusts spreads here are often quite high, causing problems for helicopter operations in the area.

With stronger winds, turbulence becomes a major problem, especially over the Torngats due to the rugged terrain. Numerous mountains and fjord-like valleys cause an array of local effects such as funnelling, channelling and cornering. Severe updrafts and downdrafts are also encountered in the deep valleys and fjords. Local pilots indicate that it is also preferable to fly the mountain passages and fjords at mid height to remain clear of the worst turbulence.

From Nain to Killiniq, which is Innu for "land's end", southeast to northeast winds will generally give low ceilings and poor visibility conditions and will often penetrate deep into the valleys and fjords, depending on the wind. The lowest conditions generally occur in the spring and early summer. Freezing drizzle in onshore flow is somewhat of a problem as well but is worse in spring rather than winter. Low-level flight over the water is not an option here due to the presence of numerous icebergs that protrude out of the water. Also, the greater the ice cover and number of icebergs in this area, the greater the incidences of fog and low stratus, especially north of Nachvak Fjord. One of the most difficult areas to fly through is Killiniq due to the frequent fog and low cloud in the vicinity.

Ungava Bay Area to Schefferville



Map 4-41 - Eastern Ungava Bay Area to Schefferville

During summer, ice in Ungava Bay begins to melt in June and is usually gone by late summer. This is likely the worst time for low stratus or fog. Westerly winds are particularly prone to spreading upslope cloud along the coast. Low stratus may even penetrate deep into the northern valleys. If temperatures at higher elevations are at or below freezing, considerable rime or even clear icing in cloud may be encountered. This can occur during any season.

Heading south from Ungava Bay, the terrain is generally flat, although it does rise slowly from west to east, until you reach the foot of the Torngats where it rises much more abruptly. From summer to late fall, winds from the west to northwest will pick

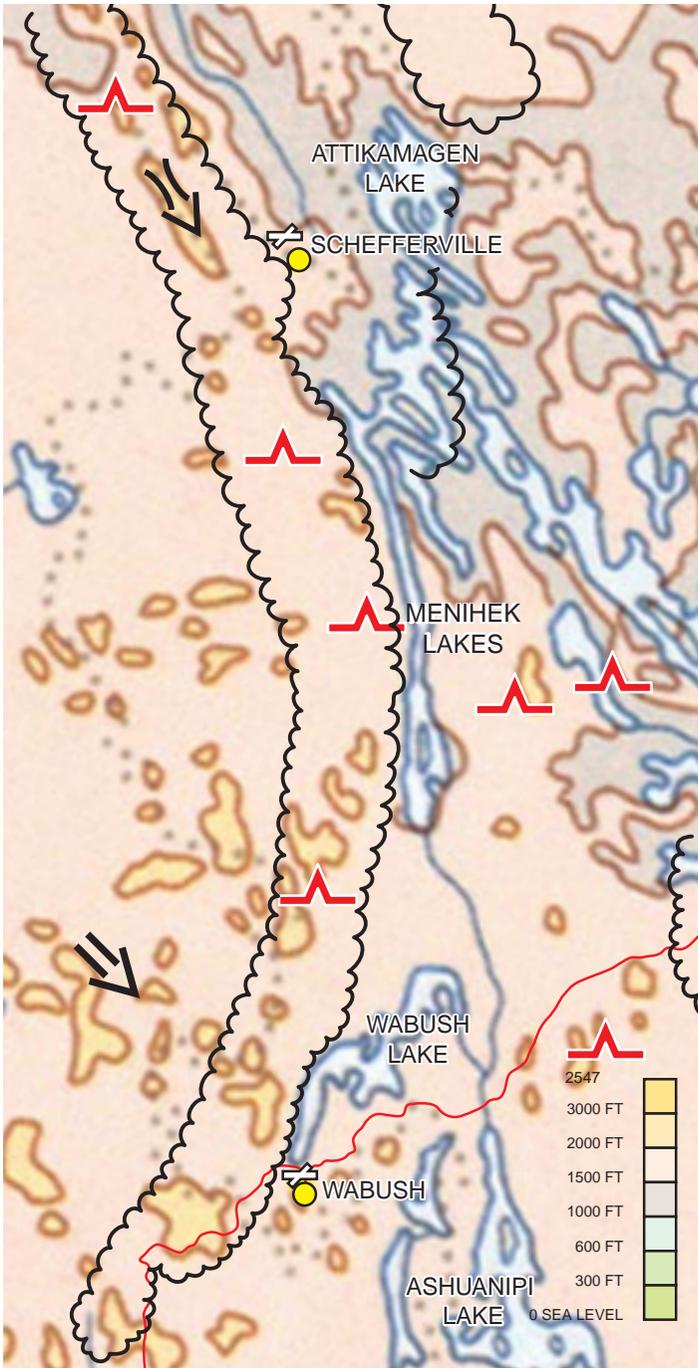
up moisture from the lakes and give widespread upslope cloud in this area. Ceilings are typically in the 2,000 to 3,000-foot range although there are usually local areas of low stratus cloud. If fog or low stratus ceilings inland do not improve significantly between 10 a.m. and 2 p.m., local pilots generally won't fly because the ceilings will usually start to come down again by 3 p.m. local time. Pools of warmer water also exist along the Ungava coast due to drainage from the numerous rivers into the bay. This gives rise to highly variable conditions and patches of very dense fog along the coast.

Winds from the east or northeast will be a downslope flow off the Torngats and will tend to produce better conditions than similar winds elsewhere in Labrador. It should be noted that persistent rain can, however, produce widespread low ceilings in this area.

Water landings on Ungava Bay are usually not an option due to the high tidal ranges in the bay (up to 40 to 50 feet in some areas). These high tides also cause the weather to change quite rapidly as well.

When departing from Kangiqsualujjuaq or Barnoin Camp on the Barnoin River, pilots sometimes observe lenticular clouds over the mountains. When these lenticular clouds are visible, pilots will not fly the Torngats since severe turbulence will always be associated with them. The updrafts and downdrafts associated with these features can easily cause a rise of 500 feet followed by a 500-foot drop within a few seconds. Occasionally rotor clouds can be seen particularly near the mountain tops.

Schefferville to Wabush



Map 4-42 - Schefferville to Wabush

The Schefferville-Wabush route is another common route. The best flying conditions occur in southwesterly flow in any season. Even when precipitation is present, ceilings will generally be quite good. Once the winds go to west or northwesterly after a winter storm, cloud usually clears out quite rapidly as cold, dry, arctic air floods southward. Schefferville is usually one of the first stations to indicate a wind shift and subsequent clearing trend after a storm.

Northeast to southeast winds will generally give the lowest conditions over this route. Ceilings will be marginal, at best, when no precipitation is falling but will quickly deteriorate after the onset of rain. Snow will have more of an effect, causing poor visibility, rather than low ceilings. South to southeast winds accompanied by rain will always give low ceilings and poor visibility along this route.

In westerly flow, upslope cloud will develop along the hills to the west of the route from Schefferville to Wabush. Quite often this cloud will extend right up alongside the airport at Schefferville.

Northwest winds are always stronger at Schefferville than Wabush. Local pilots report that you can always add 15 to 20 knots to the Wabush wind in a northwest flow to get an idea of the winds near Schefferville.

Chapter 5

Airport Climatology

(a) Deer Lake

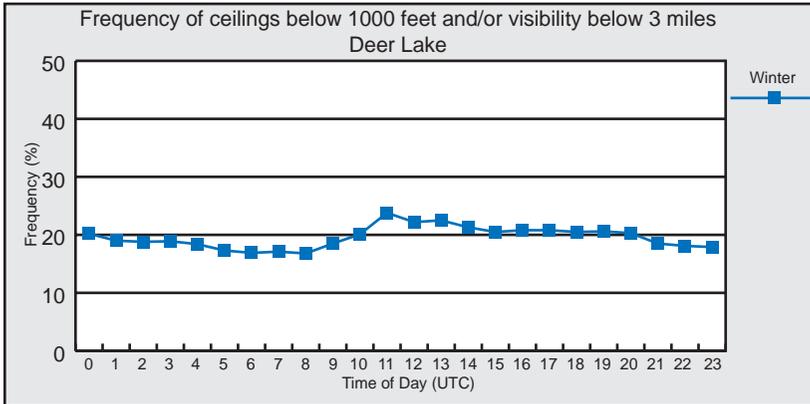


Deer Lake Airport is located in the Humber River Valley just northeast of Deer Lake. The 1500 to 2300 foot hills on either side of the northeast-southwest oriented valley play an important role in the wind direction at the airport throughout the year, as is evident from the wind rose diagrams. Stronger winds are channelled in either a southwest or northeast direction while winds from other directions are usually lighter.

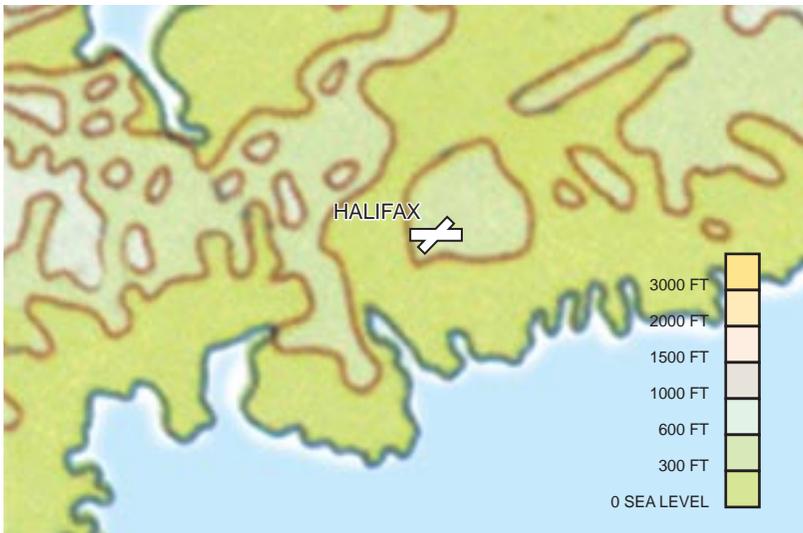
Almost any wind from the western quadrant will be channelled in the valley and result in a southwesterly wind at the airport. During the summer the winds are generally lighter and somewhat more variable than in the winter. This is due to the air cooling in the valley on summer nights, often causing an inversion to develop and winds to become very light or even calm.

Although the general circulation shifts to a more westerly direction in the winter, the winds at the airport are still predominantly from the southwest due to channelling in the valley. There is also a slight increase in the incidence of northeast winds in the wintertime because of the increased frequency and intensity of low pressure systems affecting the island.

When the general flow crosses the hills at or near right angles, surface winds tend to be light at the airport due to the sheltering effect of the hills. This accounts for the very low incidences of east to southeast or northwest winds at Deer Lake. Northwest winds are usually more unstable than southeast winds and, as a result, will usually be more noticeable at the airport. It is also important to note that significant windshear occurs in these situations.



(b) Halifax



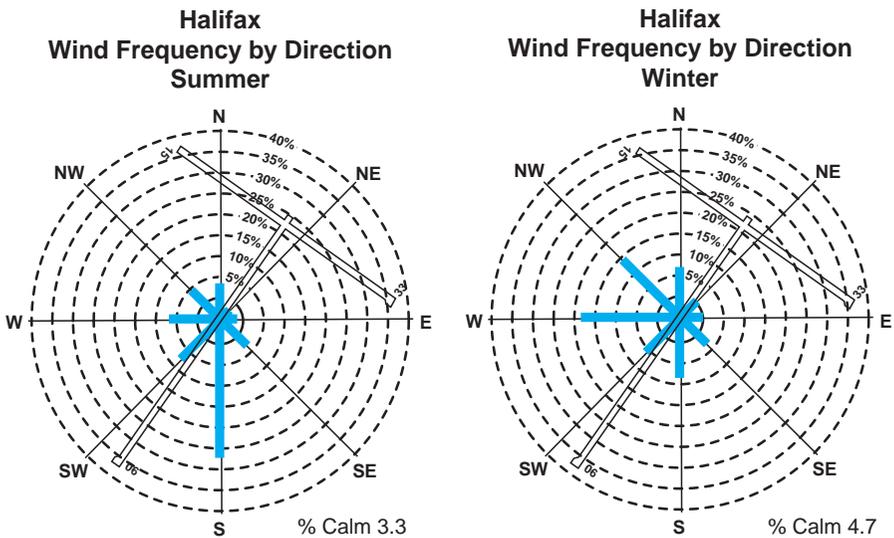
Halifax International Airport is located on an east-northeast to west-southwest running ridge 15 miles from the city of Halifax. The terrain in the vicinity of the airport is characterized by rolling hills with an overall slope towards the Atlantic Ocean, located approximately 16 miles to the south. There is also a gentle slope towards Cobequid Bay 26 miles to the north.

The wind direction at the airport largely depends on the season. Winter winds will blow predominantly from the west or northwest and tend to be stronger than during any other season. This is due to the higher intensity of weather systems that affect this region during this time of year.

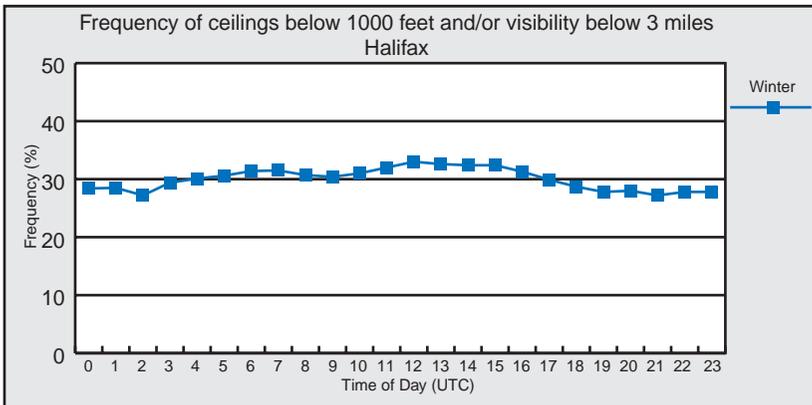
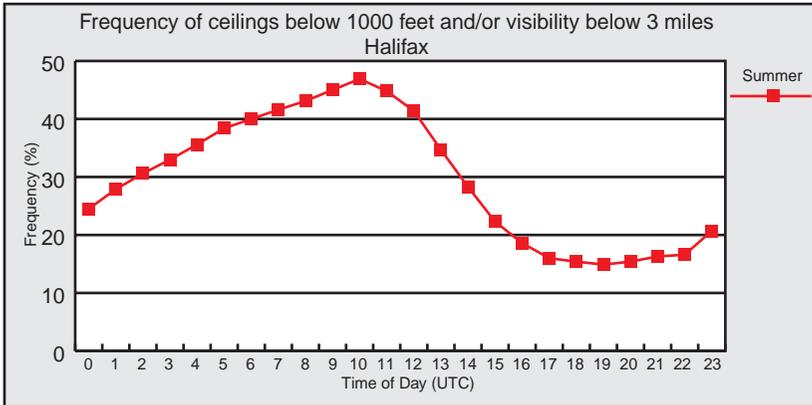
During the summer, the prevailing wind undergoes a drastic shift to the south. These southerly winds occur with a frequency more than double that of winds from

any other direction. This is mainly due to the strengthening of the Bermuda High over the Atlantic Ocean that causes a southerly shift in the large-scale wind patterns.

The effects of the Atlantic Ocean on the aviation climatology of Halifax are indisputable. Like Torbay Airport in St John's, Halifax is well known for its frequent fog. Although fog can and does occur at any time of the year, the spring and summer months are by far the worst. As the prevailing winds shift to a more southerly direction in the spring, they bring with them warm, moist air from the south that is then cooled from below, causing fog to develop. The prevailing southerlies push the fog inland resulting in higher frequencies of IFR weather at the airport. It is evident from the spring and summer graphs of IFR conditions that the fog usually burns off during the daytime but moves in again during the evening hours. This is an extremely common occurrence here during summer as IFR conditions are reported almost 50% of the time during the nighttime hours. Although other types of fog occur at Halifax, this advection fog is what is experienced in this area most frequently.



By the fall, water temperatures over the ocean are such that fog becomes less of a problem for airport operations. In the winter, IFR conditions develop due to a number of other weather situations including snow, fog and low cloud which remains fairly constant throughout all hours of the day.



(c) Gaspé

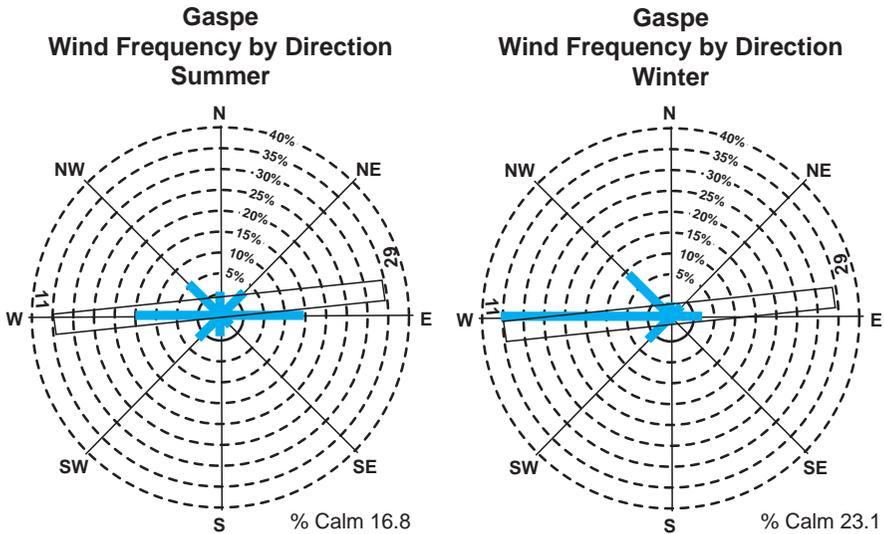


The Gaspé Airport is located 3.5 miles west of the town of Gaspé on the eastern tip of the Gaspé Peninsula. York River and the St. Jean River both flow eastward and

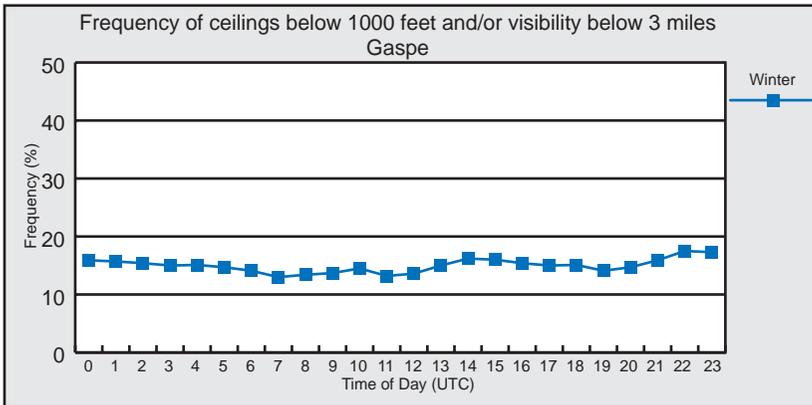
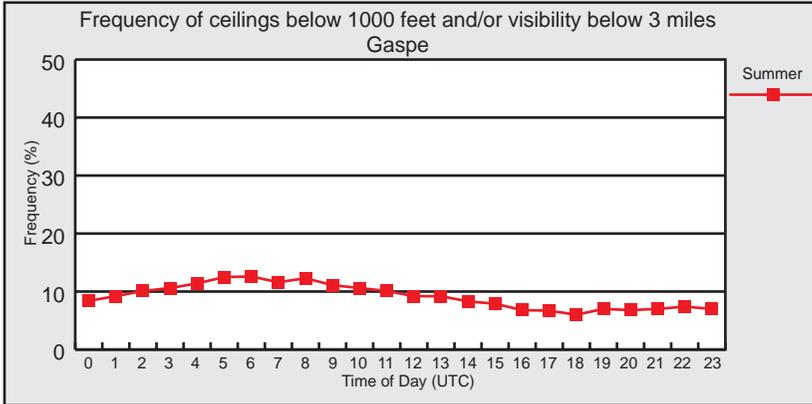
are located to the north and south of the airport respectively. The terrain surrounding the airport generally rises in every direction except towards Baie de Gaspé to the east. This rise is fairly abrupt and reaches the 2000 foot level within about 5 miles.

The wind patterns at Gaspé are closely related to the topography around the airport. Although the general circulation in the winter is from the northwest, the valley channels these winds resulting in a predominant westerly flow at the airport. Drainage winds also contribute to the westerlies which blow 42% of the time during the winter.

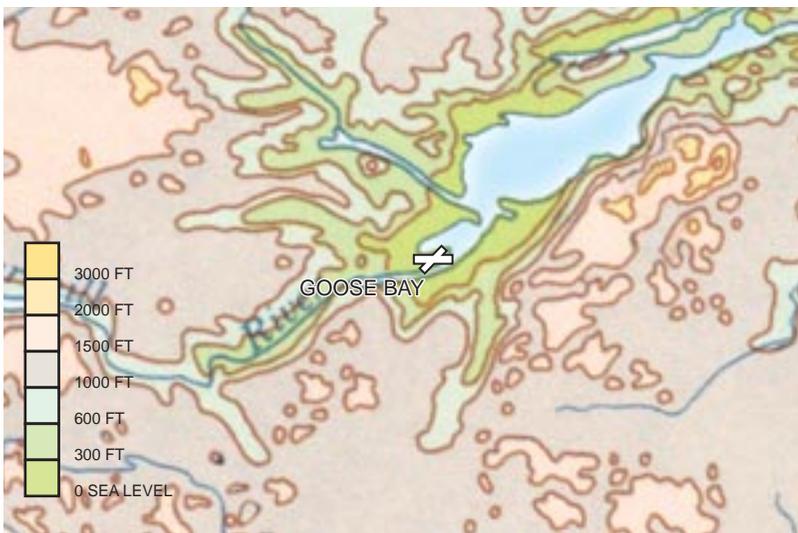
Although the predominant winds are from the west in the summer time as well, they blow from this direction only half as frequently as they do during the winter. This can be attributed to the frequent easterly sea breeze circulation during these warmer months.



Flying weather at Gaspé is actually quite good. While the highest frequency of IFR conditions occurs in April, the summer months experience the largest diurnal variation as fog or low stratus at night usually burns off during the day. Most of the IFR weather in the winter is caused by reduced visibility in snow. Blowing snow is less of a factor here due to the sheltering effect of the valley.



(d) Goose Bay

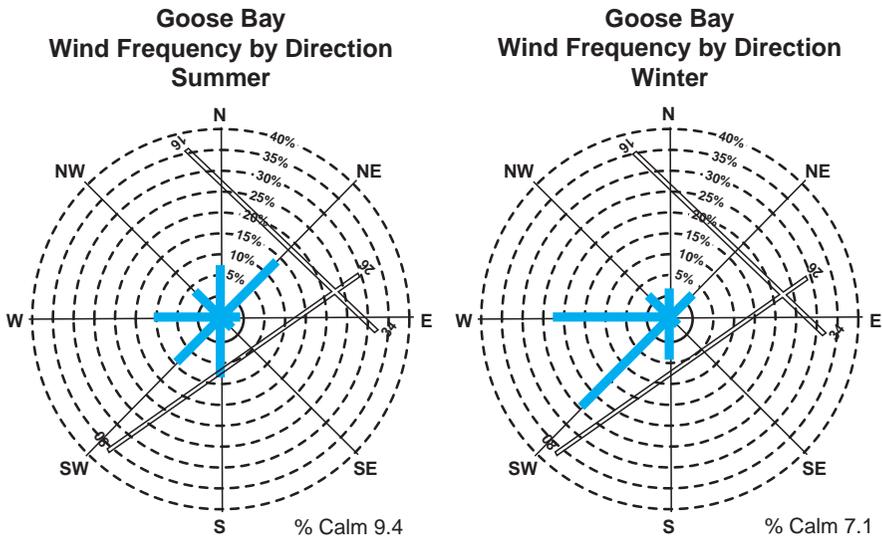


Goose Bay Airport is located on a plateau surrounded by the Goose River to the north, the eastward flowing Churchill River to the south and Goose Bay to the north-east. Beyond the lower terrain that almost surrounds the airport, hills and mountains in the 1,500 to 2,500 foot range will result in downslope conditions in all directions, except to the northeast. The winds at Goose Bay tend to be channelled by the north-east-southwest oriented Hamilton Inlet, the Mealy Mountains and the Hamilton River Valley.

Winds during the winter months are predominantly (almost 60% of the time) from the west or southwest. Southeast winds here are quite rare due to the sheltering effect of the Mealy Mountains and the fact that, due to channelling, east or southeast gradients will result in a northeast wind at the airport. Northwest winds are as frequent as northeast winds in the winter, but the nature of these winds are quite different. Northwest winds are generally stronger than northeast winds and have a tendency to be gustier during the winter months.

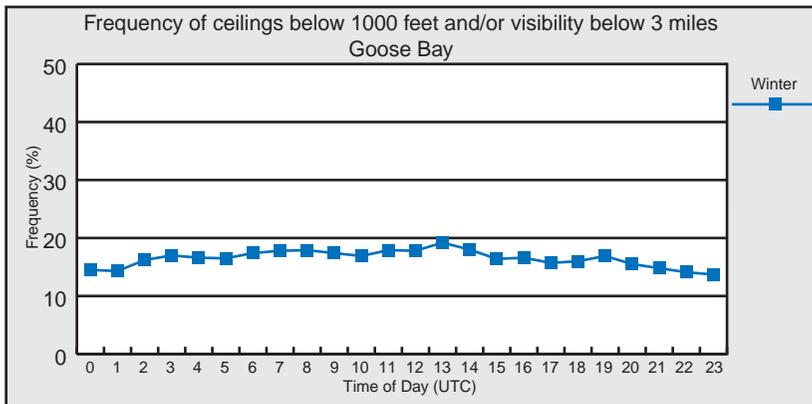
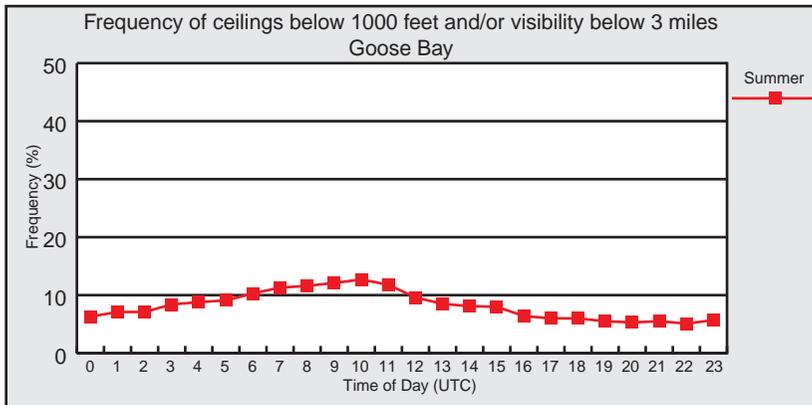
As the transition from winter to summer begins, the storms take on a more northerly track and more prolonged periods of northeast winds develop at Goose Bay.

Summertime winds here, although still predominantly from the west or southwest, are noticeably more variable than in the winter. The fact that northeast winds are steadier in the winter does not hold true for the rest of the year. Winds can be gusty from any direction in the summer because of the destabilizing effect of daytime heating. Warm summer days, consequently, tend to be quite windy but the winds usually diminish by mid evening.



Goose Bay experiences IFR weather an average of 15 to 20 percent of the time during the winter season. Most of these cases are caused by reduced visibility in snow and blowing snow. Since the start and stop times of this type of precipitation are independent of the time of day, there is remarkably very little diurnal variation in IFR weather in the winter. During spring, the IFR conditions can be a combination of both snow/blowing snow and fog related to northeast winds. Ceilings and visibility usually improve somewhat under foggy conditions and, thus, a more pronounced diurnal variation is evident here.

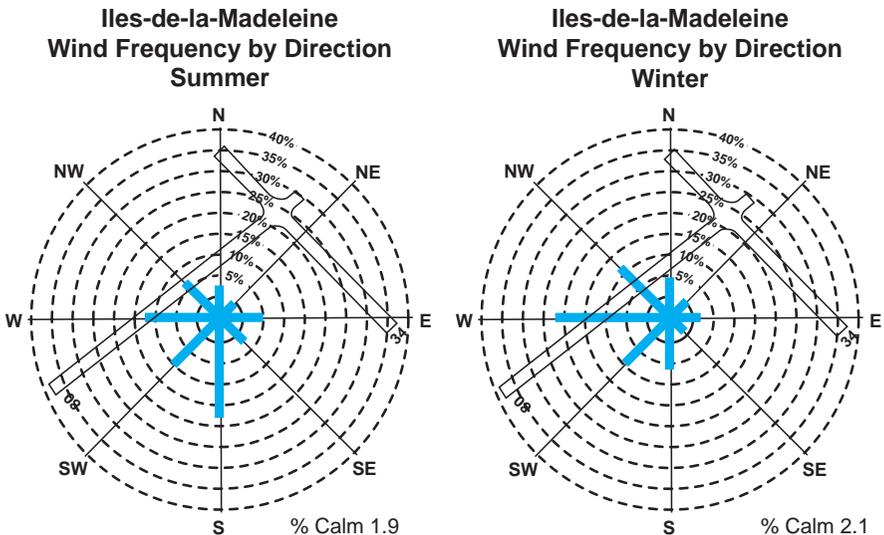
In the summer the IFR conditions are mostly caused by low ceilings rather than low visibility. Since the airport lies on a plateau, radiational cooling will cause colder air to drain into the valleys during summer nights. This hampers the formation of radiation fog at the airport. When ceilings are IFR at night, daytime heating usually produces an improvement until sunset.



(e) Iles-de-la-Madeleine



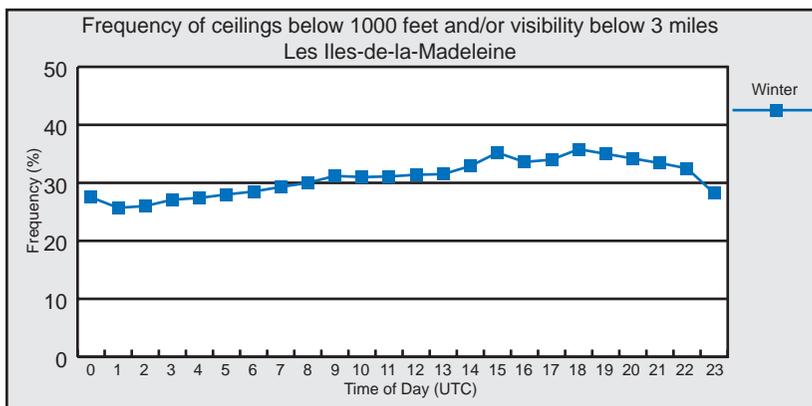
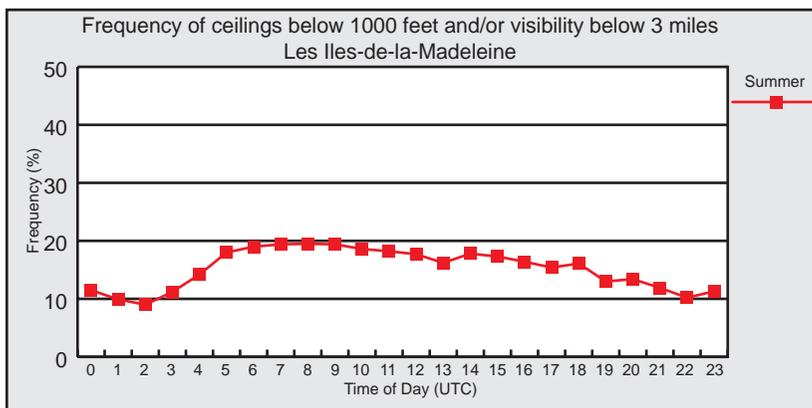
The Iles-de-la-Madeleine, or Magdalen Islands, are located in the middle of the Gulf of St. Lawrence, isolated from the mainland. The Iles-de-la-Madeleine Airport is located on Ile du Havre-aux-Maisons, 1.7 miles northeast of the village of Cap-aux-Meules (Grindstone), near the centre of the island complex. Terrain immediately surrounding the airport is flat to the northeast but experiences a rise to the south. The Buttes Pelees reach a height of 362 feet to the south, with the highest the peak of 543 feet located 7 miles to the southwest.



Les Iles-de-la-Madeleine are well known for being quite windy. In the winter, winds here blow predominantly from the west with speeds approximately 50% higher than in the summer. Winds during the winter also tend to be quite gusty due to the relative instability and the surrounding terrain.

The prevailing wind in the summer exhibits a shift to the south, which is directly attributed to the circulation around the stronger high pressure system far to the southeast.

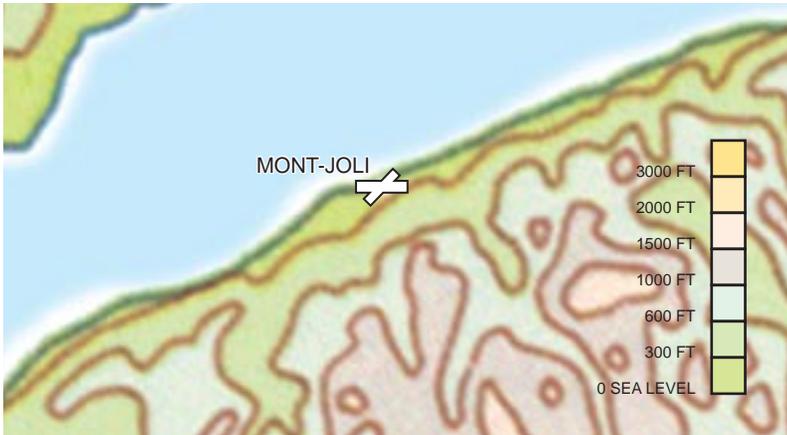
Although the terrain around the airport is conducive to turbulence, it has little affect on the prevailing wind directions throughout the year.



IFR weather at the airport is quite common here especially in the winter and spring seasons. Most of the bad flying weather during the winter season can be attributed to snow and blowing snow. Snow associated with low pressure systems, as well as snow squall activity, frequently reduces visibility to below IFR thresholds. In the spring, on the other hand, fog and low stratus are the culprits. Sea fog will form over the gulf as warmer, moist air starts to move up from the south and is cooled from

below by the cold water. It is usually necessary for an area of rain to saturate the lower levels for widespread fog to form in the gulf. Once formed, however, the fog will remain here until drier air is ushered in from the west. Any diurnal improvements at the Iles-de-la-Madeleine Airport will be in the form of fog lifting to low stratus. Although fog also happens in the summer, it tends to occur less frequently, reaching a minimum in the fall.

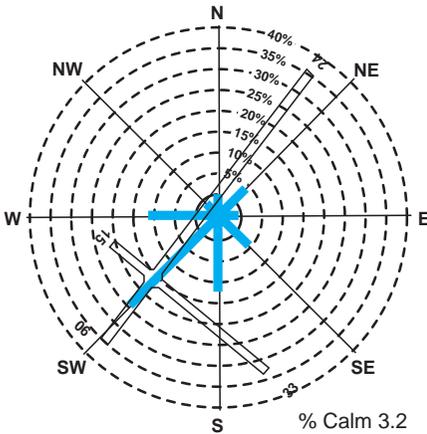
(f) Mont-Joli



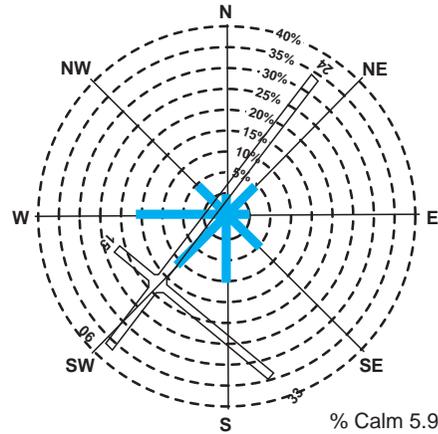
The airport at Mont-Joli is located 1.5 miles north of the town at an elevation of 172 feet. Located just one mile north of the airport, the southwest-northeast oriented St. Lawrence River is about 23 miles wide at this point along the coast and plays an important role in the climatology at the airport. The northward flowing Mitts River is a much smaller river located 3 miles to the east. The airport is built on a plateau with surrounding terrain being rolling in nature and rising more abruptly further to the south and southeast.

At Mont-Joli, the winter winds are predominantly out of the west or southwest. A secondary, albeit smaller, peak in wind direction occurs with northeasterlies, especially during the late winter. These preferred wind directions are a direct result of channelling in the St. Lawrence River Valley.

**Mont-Joli
Wind Frequency by Direction
Summer**



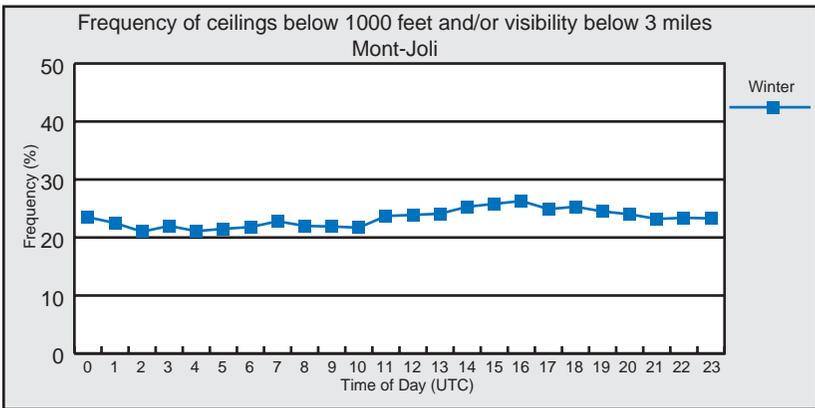
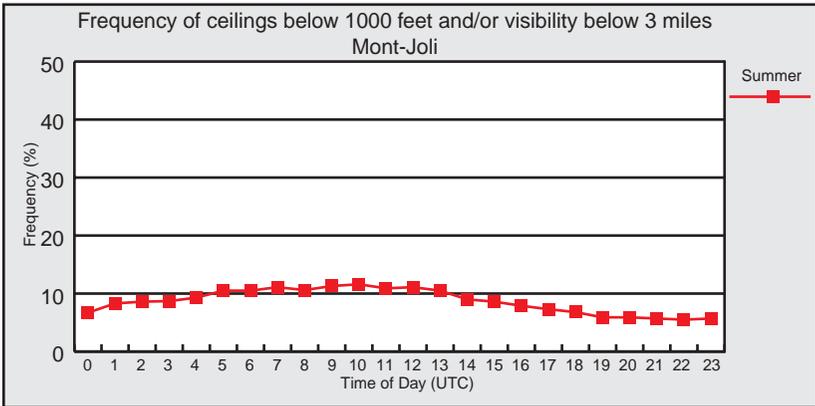
**Mont-Joli
Wind Frequency by Direction
Winter**



The summer time winds take on a similar pattern to those seen in the winter but tend to be lighter. The two main wind axes are southwest and northeast although the southwesterlies in the summer are almost twice as frequent as they are in the winter. This is due to the change in the general circulation pattern in the summer which shifts towards the south or southwest.

The prevailing wind at Mont-Joli gives rise to excellent flying weather. By far the best season is during the fall when IFR conditions occur only about 10% of the time. Snowstorms cause most of this IFR weather in the winter, although visibility can briefly drop below IFR limits in snow showers when cold, onshore northwesterlies develop. Winter is generally the season that IFR weather is most frequent.

Springtime weather is generally better than winter weather, however, low ceilings tend to be more frequent during this time of the year. Summer time brings even more good flying weather with occasional early morning fog or low stratus generally burning off quite quickly. Thunderstorms often develop over the mountains to the south and southwest and then move over the airport. Mont-Joli experiences an average of 11 days with thunderstorm activity each year, with July being the most active.

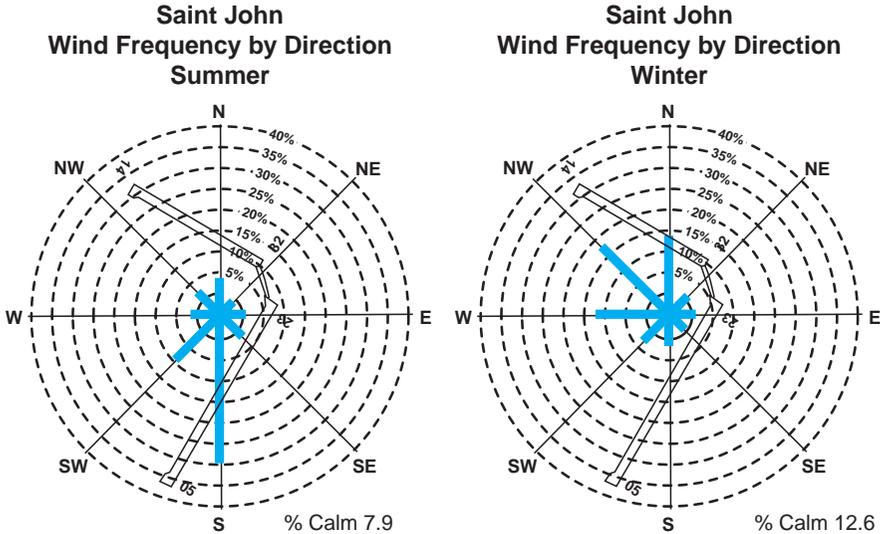


(g) Saint John



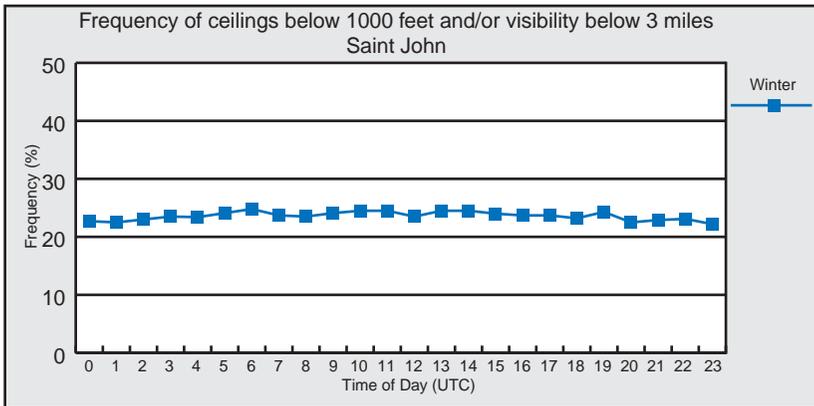
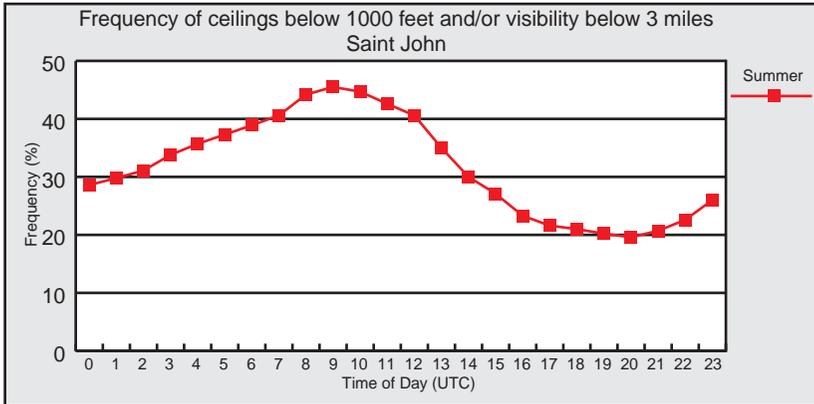
The Saint John Airport is located 8 miles east-northeast of the city, at an elevation of 357 feet. The immediate area around the airport is characterized by rolling hills in the 500 to 1,000 foot range with the highest hills located to the northeast. Several

bodies of water surround the airport: Loch Lomond Reservoir to the north; Kennebecasis Bay and the Saint River to the west; and, last but not least, the Bay of Fundy to the south. The Bay of Fundy has the biggest impact on the climatology at Saint John.



As with other areas in the Maritimes, the larger scale pressure patterns in the winter are such that the prevailing winds in the winter are from the northwest; the summer, however, is another matter. The general circulation during the summer is from the southwest, yet these winds tend to back somewhat due to friction over the land. Sea breezes are also frequent here in the spring and summer. Both effects result in a prevailing southerly wind at the airport.

The IFR graph for the winter season shows a uniform occurrence of IFR weather at Saint John. The prevailing northwesterly winds experienced in the winter are, for the most part, very dry, resulting in clear weather. A secondary maximum of IFR conditions occurs with north to northeast winds but is limited to the winter months and can be attributed to snowstorm situations. The occurrences of IFR weather in these situations are mostly due to transiting low pressure systems and are not dependent on the time of day.

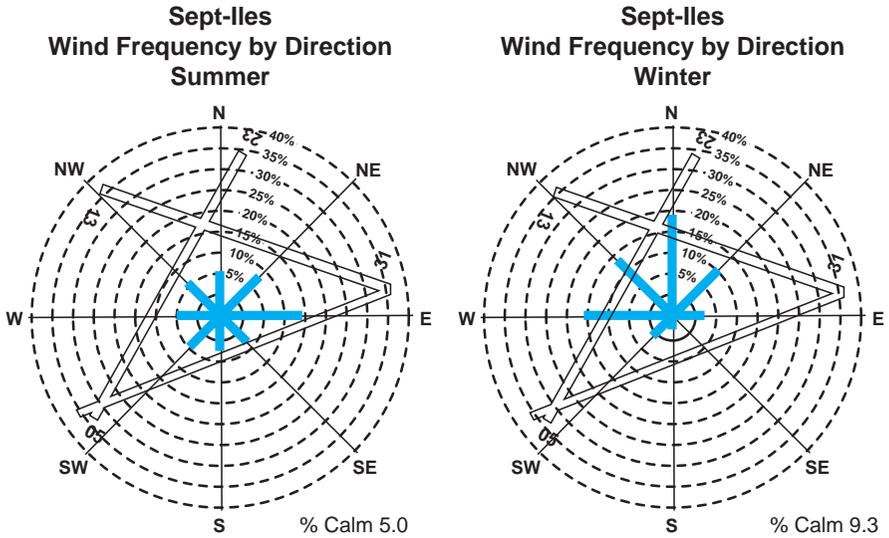


The most frequent constraints to flight operations occur during the late spring and summer when stable inversions are formed by warm, moist air flowing over the cold Bay of Fundy. Fog usually forms under this inversion and, given Saint John Airport’s elevation, significant orographic lift and onshore winds keep the airport shrouded in fog.

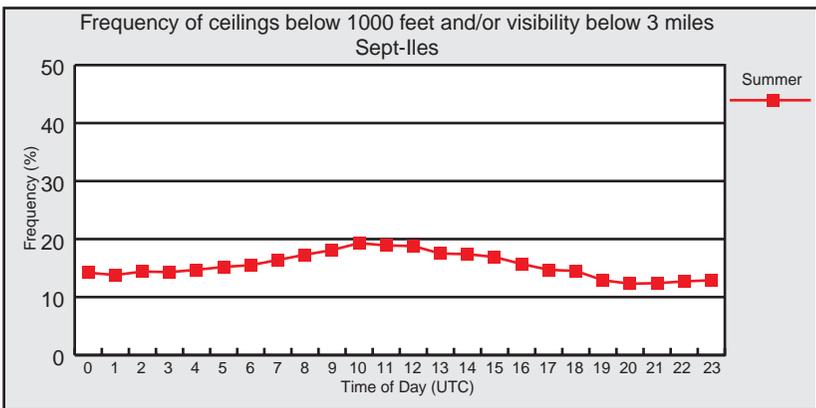
(h) Sept-Iles

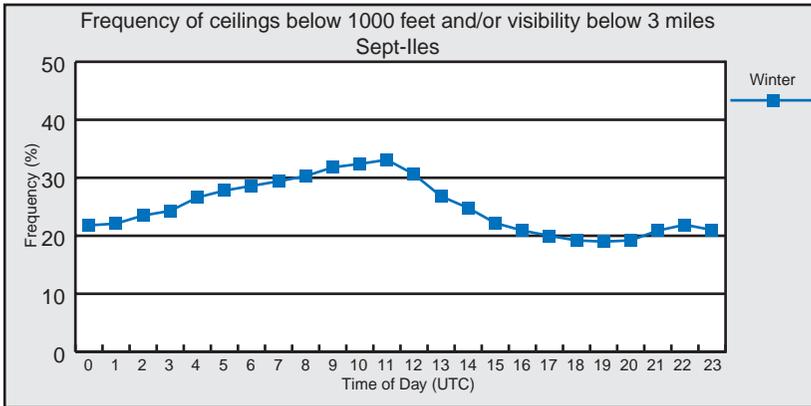
The airport at Sept-Iles is located on the North Shore of the St. Lawrence River, 4.5 miles east of the town. Several bays are located south of the airport along the St. Lawrence. Baie-de-la-Boule is located just a half mile to the south and Baie-des-Sept-Iles lies 5 miles to the west. The latter is protected by seven islands, which give the town its name. For the most part, the terrain around the airport is flat with several marshy areas. The topography rises more abruptly to the 1,500 to 2,000 foot range 10 to 15 miles to the north.

The winds at Sept-Iles show a definite seasonal dependency. During the winter months, the winds are predominantly from the north but are also frequently from the west and northwest. During the summer, the winds are generally lighter and much more evenly partitioned. Winds blow from most directions about 10% of the time, yet winds from the east occur 18% of the time. This is due to the larger scale channelling of the general circulation winds in the Jacques-Cartier Strait between the North Shore and Anticosti Island.



On average, Sept-Iles experiences almost an equivalent amount of IFR weather in the winter and in the spring. More of a daytime improvement is apparent, however, during the colder months. As the prevailing wind begins to shift towards the east in the springtime, the incidences of fog also increase. By summer, fog remains somewhat of a problem but mostly restricts operations early in the morning and evening. The fall months of the year bring with them some of the best flying weather for this location.





(i) St. John's (Torbay) Airport

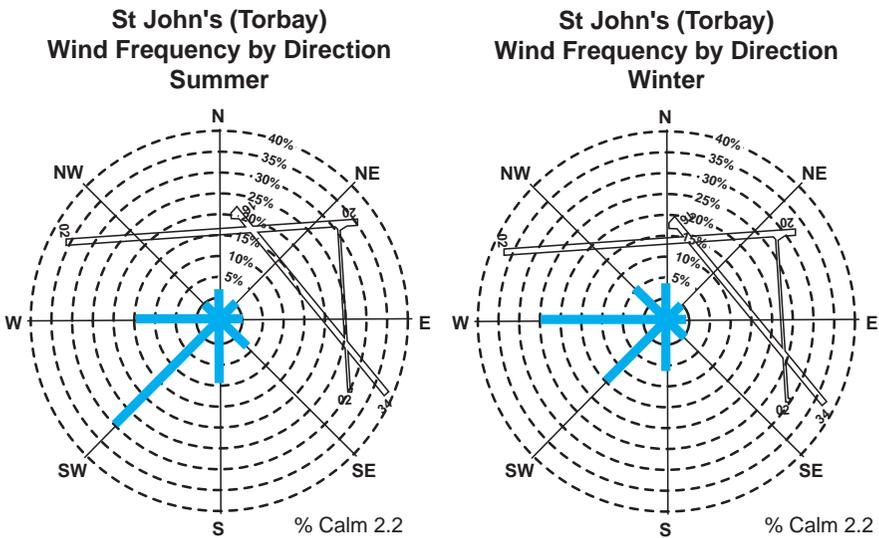


St. John's Airport is located in the northeast corner of the Avalon Peninsula and is in close proximity to water in almost every direction. The elevation of the Airport is about 450 feet and the terrain slopes steadily downward towards Torbay, reaching sea level. To the east, cliffs rise to over 500 feet at the ocean edge. Marshland, at an elevation of 200 or 300 feet, lies beyond these cliffs.

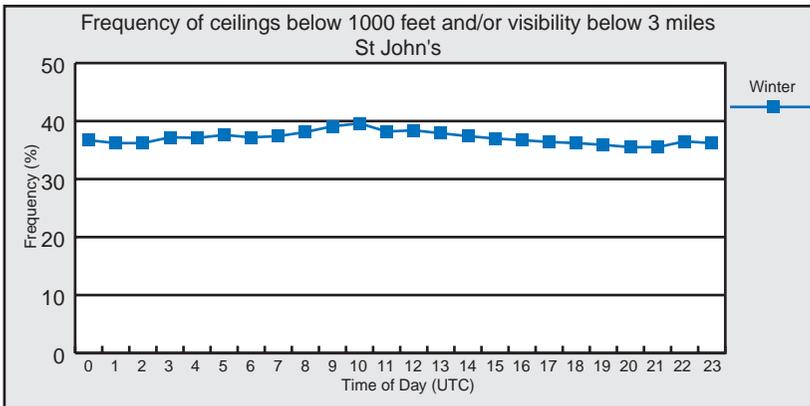
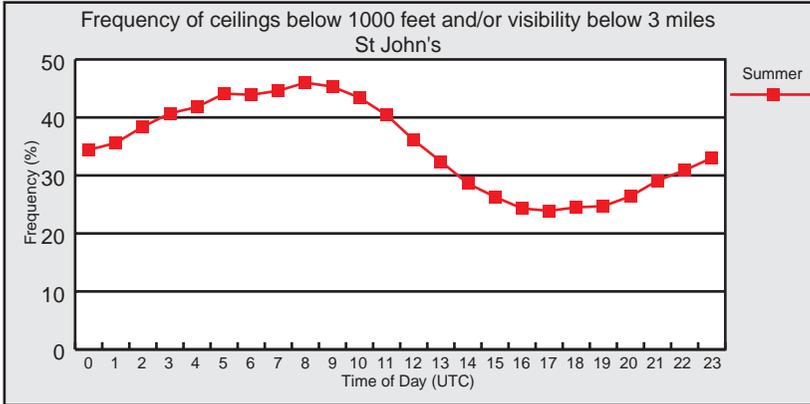
The winds at St. John's are, for the most part, determined by large-scale weather systems. The prevailing wind direction is from the western quadrant but does vary slightly from season to season. Winds during the winter are predominantly from the west, whereas summer winds exhibit a shift to a more southwesterly direction due to

the strengthening of the Bermuda High over the Atlantic Ocean. The stronger winds generally occur in the winter and are always associated with storms moving north-eastward near Newfoundland. Gusts of up to 35 knots occur frequently at St. John's and often persist for prolonged periods of time. Winds with gusts to 35 knots or more occur most frequently from the southwest. Very strong winds with gusts to 60 knots or more occur mostly with very deep, low pressure systems that pass to the west of the Avalon Peninsula. Calm winds, on the other hand, only occur about 2% of the time.

Although sea breeze activity does occur at St. John's, its overall effect on the prevailing wind direction is small. Even if the water temperatures are favourable for the development of sea breezes, the prevailing wind speed and direction are often such that any sea breeze formation will be suppressed. When they do develop, sea breezes at St. John's tend to be between 120 and 150 degrees or between 40 and 60 degrees.



St. John's Airport has a reputation for being one of the foggiest airports in Canada. The worst cases by far occur during the spring. Low ceilings and visibility are extremely common when winds are from the northeast to southeast. This is due to the upslope nature of the terrain and the air's prolonged exposure to the ocean when winds are from these directions. As seen from the winter diagram, when IFR conditions are present, there is very little diurnal variation. In the summer time, sea fog may move inland at night, however, it often burns off during the day accounting for the more pronounced improvement after about 1000 UTC on the summer diagram.



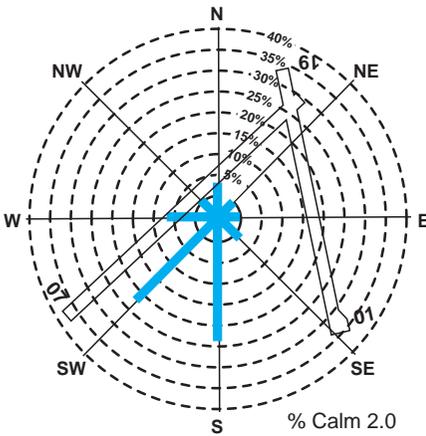
The fall is more stable at St. John's in that IFR conditions are generally less frequent during this time than during all other seasons. Although very low conditions sometimes exist in mild flow, particularly if fog blankets the water south of the Avalon Peninsula, operational ceilings usually exist in the winter especially when winds are from the western quadrant. IFR conditions in this season are often due to snow and blowing now and can be quite variable. A particular hazard to aviation that develops frequently at St. John's is freezing precipitation, which occurs an average of 175 hours each year.

(j) Sydney

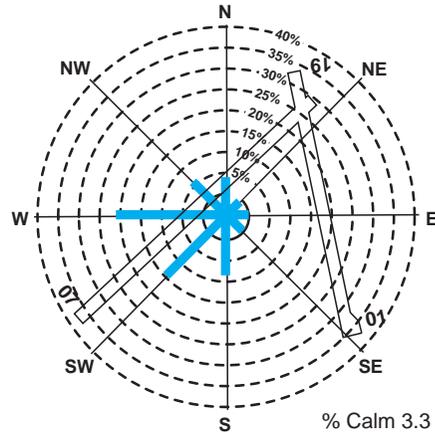
Sydney Airport is located 5 miles east-northeast of the city of Sydney. The terrain within about 10 miles of the airport is mostly composed of undulating hills, several small lakes and some marshland. Hills in the 500 foot range lie beyond this area to the west and southwest. The airport is in fairly close proximity to water in all directions except to the southwest.

The summer winds at Sydney Airport are predominantly from the south or southwest. Other wind directions are much less frequent and are mostly associated with low pressure systems transiting through the area.

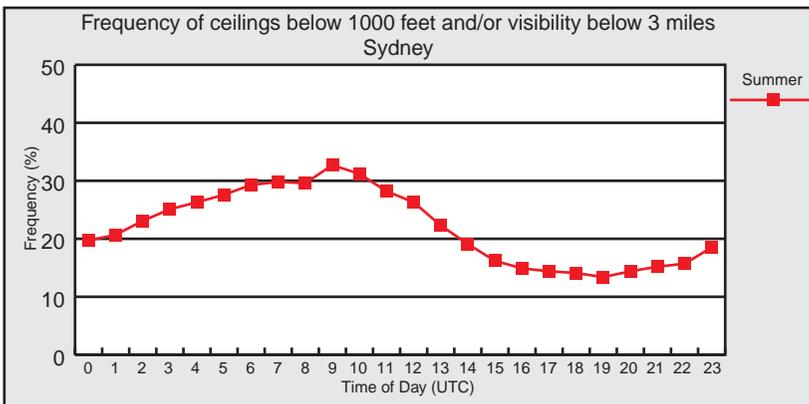
Sydney
Wind Frequency by Direction
Summer

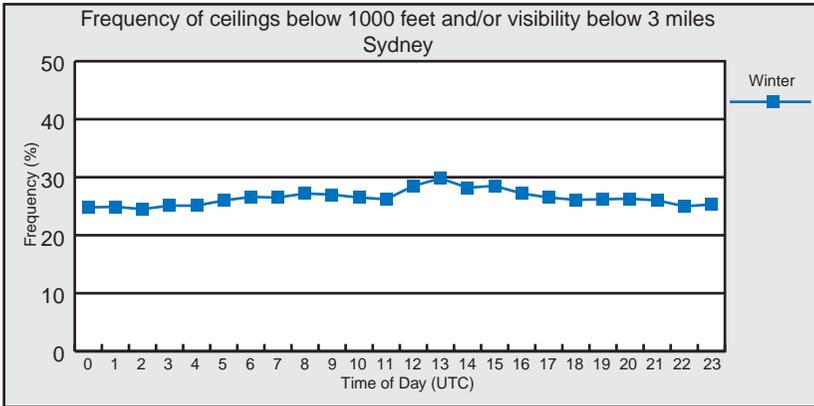


Sydney
Wind Frequency by Direction
Winter



In the winter, the prevailing winds shift to a more westerly direction due to the southward shift in storm tracks. As winter storms cross the Maritimes, the winds at Sydney will often have an easterly component until the low passes to the east of the airport. At this time, the winds will shift to westerly or northwesterly and can then persist for days until the approach of the next pressure system. This is a common scenario during the winter and accounts for the corresponding westerly shift in prevailing wind direction.





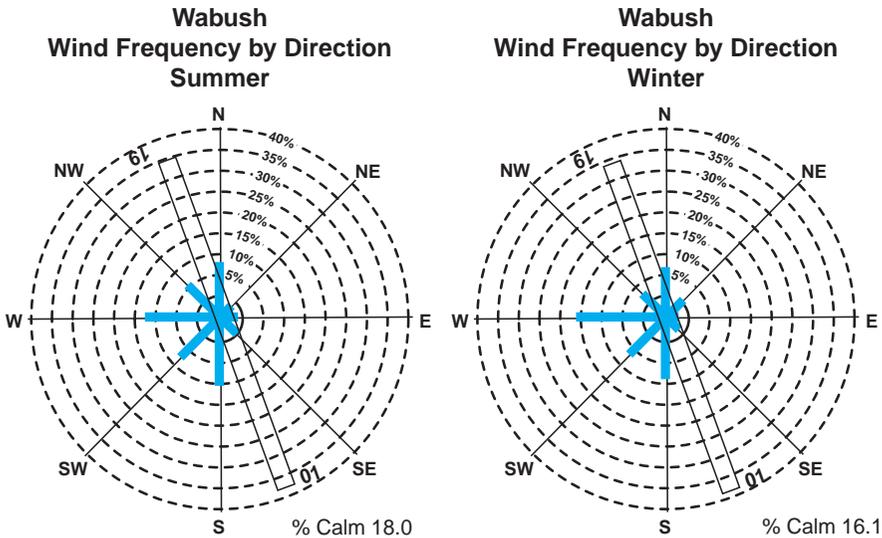
The effect of the ocean is quite apparent for all four seasons when looking at the IFR condition charts. The spring has the highest frequency of IFR weather at Sydney due to the change in pressure patterns from winter to summer. Blocking patterns are much more prevalent during the spring and cause prolonged periods of east or north-east winds, compared to other seasons. These winds are onshore at Sydney and result in low stratus cloud and reduced visibility in fog. In the spring, this occurs an average of 10 days each month. Although the hills to the southwest of the airport tend to block off the fog that forms over the ocean in the summer, low stratus sometimes spills over the hills causing brief IFR ceilings. Freezing precipitation is also fairly common at the airport occurring most frequently in mid to late winter.

(k) Wabush

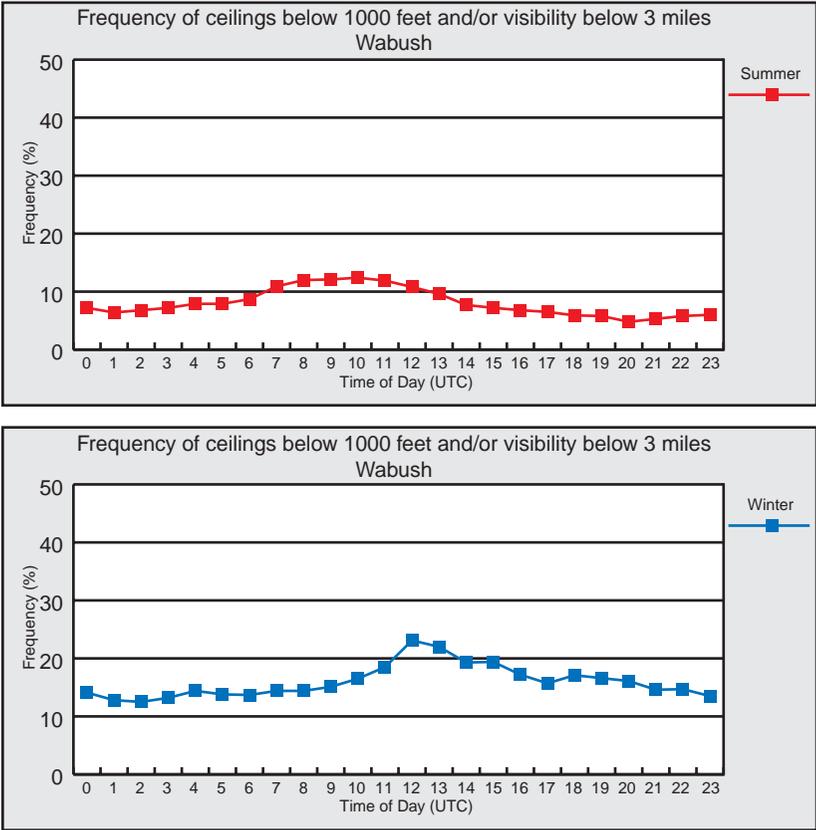


The airport at Wabush is located one mile northeast of the town and just south of Wabush Lake. Hills to the west and northwest of the airport will result in subsidence when the winds are from a general westerly direction.

Prevailing winds at Wabush are mostly influenced by the larger scale pressure patterns found over Atlantic Canada. In the winter, winds clearly blow more frequently from the west and southwest than from any other direction. Secondary peaks in wind frequency occur from the north and south due to the orientation of the valley. This part of Labrador is also subject to extremely cold temperatures during the winter. This causes substantial low-level inversions and results in very light winds at the surface. Calm winds are reported at Wabush airport almost 20% of the time during the winter months.

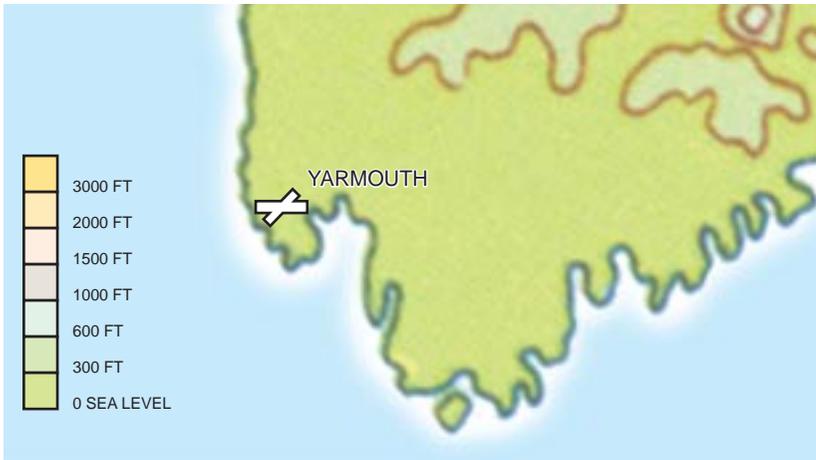


During the summer months, the winds are more variable but still blow from a predominantly westerly direction. The secondary, northerly and southerly peaks in wind frequency are apparent in the summer as well. Calm winds are also relatively frequent in the summer but occur mostly in the early morning hours. Summer time winds usually become fairly gusty by the afternoon.



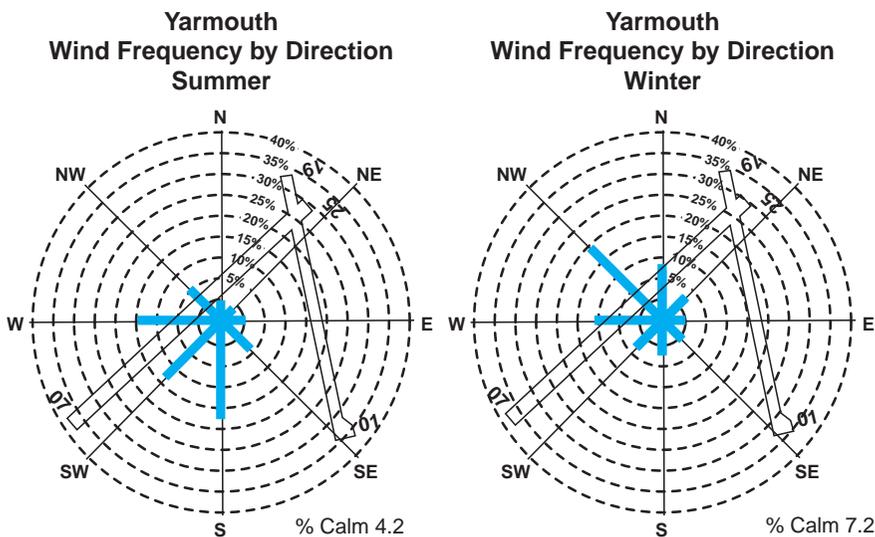
The combination of prevailing downslope winds throughout the year, and the fact that the Wabush airport is quite far from the ocean, results in generally good ceilings and visibility. Fog can develop at the airport during any season but is most common in the late summer and fall. The best flying weather at Wabush is in the summer with IFR conditions occurring quite infrequently. Most of the IFR conditions during this time of year are due to low ceilings, which usually improve during the daytime even in the worst of situations. The fall and spring months, on the other hand, usually bring the worst weather. Winds are often northeasterly during this time of year and happen to be upslope at Wabush.

(l) Yarmouth



Yarmouth Airport is located just east of the town of Yarmouth and lies no farther than 4 miles from the Atlantic Ocean from the west to the south. The terrain in the vicinity of the airport is mostly composed of flat and gently rolling hills.

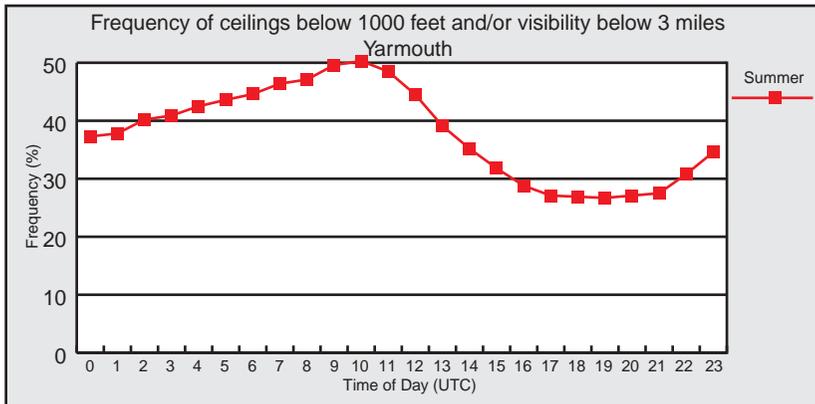
The average wind at Yarmouth is strongest in the winter and blows anywhere between the westerly and northerly directions almost two thirds of the time. The most prevalent wind is from the northwest. As a low pressure system deepens and tracks over the Maritimes, winds increase out of the east ahead of the low and then shift to northwesterly in its wake. These northwesterlies often persist for a few days following the passage of a low, resulting in a high occurrence of winds from this direction.

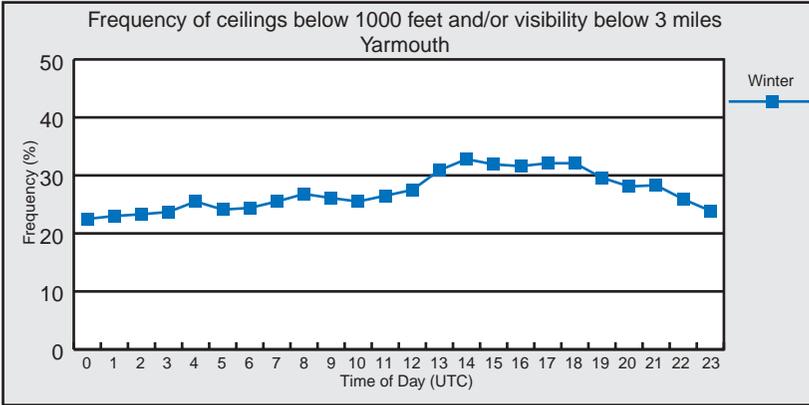


Two main forces drive the winds during the summer. The larger scale wind pattern is such that the general flow will be from the south. Sea breezes from a southerly to a westerly direction are also common here in the summer time.

When flying weather at Yarmouth is restricted it is usually either due to fog, low clouds or snow. Fog occurs here an average of 120 days out of the year, second only to Halifax and St. John's. Like Halifax, the major problem here is advection fog during the spring and summer. There is usually some diurnal improvement in the daytime but it is less pronounced due to the airport's height and proximity to the water. As the prevailing wind begins to shift back to a more northwesterly direction in the fall, the weather becomes more conducive to flying.

By winter, snow becomes the major restriction to visibility. Although precipitation associated with winter storms usually starts off as snow, it often changes over to rain at Yarmouth. The real problem with snow here occurs once the storm has passed and very cold air is ushered in from the west or northwest. The snow squall activity that results is usually worse in the daytime and can give extended periods of IFR ceilings and visibility at the airport.





Glossary of Weather Terms

- anabatic wind** - a local wind which blows up a slope heated by sunshine.
- advection** - the horizontal transportation of air or atmospheric properties.
- air density** - the mass density of air expressed as weight per unit volume.
- air mass** - an extensive body of air with uniform conditions of moisture and temperature in the horizontal.
- albedo** - the ratio of the amount of solar radiation reflected by a body to the amount incident on it, commonly expressed as a percentage.
- anticyclone** - an area of high atmospheric pressure which has a closed circulation that is anticyclonic (clockwise) in the Northern Hemisphere.
- blizzard** - a winter storm with winds exceeding 40 km/h, with visibility reduced by falling or blowing snow to less than one kilometre, with high windchill values and lasting for at least three hours. All regional definitions contain the same wind speed and visibility criteria but differ in the required duration and temperature criterion.
- cat's paw** - a cat paw-like, ripple signature on water given by strong downdrafts or outflow winds. A good indication of turbulence and wind shear.
- ceiling** - either (a) the height above the surface of the base of the lowest layer of clouds or obscuring phenomena (i.e. smoke) that hides more than half of the sky; (b) the vertical visibility into an obstruction to vision (i.e. fog).
- chinook** - a warm dry wind blowing down the slopes of the Rocky Mountains and over the adjacent plains.
- clear air turbulence (CAT)** - turbulence in the free atmosphere not related to convective activity. It can occur in cloud and is caused by wind shear.
- clear icing** - the formation of a layer or mass of ice which is relatively transparent because of its homogeneous structure and smaller number and size of air spaces; synonymous with glaze.
- climate** - the statistical collection of long-term (usually decades) weather conditions at a point; may be expressed in a variety of ways.
- cold front** - the leading edge of an advancing cold air mass.
- convection** - atmospheric motions that are predominately vertical, resulting in the vertical transport and mixing of atmospheric properties.
- convergence** - a condition that exists when the distribution of winds in a given area is such that there is a net horizontal inflow of air into the area; the effect is to create lift.
- cumuliform** - a term descriptive of all convective clouds exhibiting vertical development.

cyclone - an area of low atmospheric pressure which has a circulation that is cyclonic (counterclockwise) in the Northern Hemisphere.

deepening - a decrease in the central pressure of a pressure system; usually applied to a low. Indicates a development of the low.

deformation zone - an area in the atmosphere where winds converge along one axis and diverge along another. Where the winds converge, the air is forced upward and it is in these areas where deformation zones (or axes of deformation as they are sometimes referred to) can produce clouds and precipitation.

disturbance - applied loosely: (a) any small-sized low pressure system; (b) an area where the weather, wind, and air pressure show signs of cyclonic development; (c) any deviation in flow or pressure that is associated with a disturbed state in the weather; and (d) any individual circulatory system within the primary circulation of the atmosphere.

divergence - a condition that exists when the distribution of winds in a given area is such that there is a net horizontal outflow of air from the area.

downdraft - a small scale downward current of air; observed on the lee side of large objects that restrict the smooth flow of air or in or near precipitation areas associated with cumuliform clouds.

downburst - an exceptionally strong downdraft beneath a thunderstorm usually accompanied by a deluge of precipitation.

filling - an increase in the central pressure of a pressure system; applied to a low.

Föhn wind (foehn wind)- a warm dry wind on the lee side of a mountain range, whose temperature is increased as the wind descends down the slope. It is created when air flows downhill from a high elevation, raising the temperature by adiabatic compression.

front - a surface, interface or transition zone of discontinuity between two adjacent air masses of different densities.

Fujita Scale - a scale used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure (see Table 1).

F-Scale Number	Intensity Phrase	Wind Speed (kts)	Type of Damage Done
F0	Weak Tornado	35-62	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate Tornado	63-97	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Strong Tornado	98-136	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	Severe Tornado	137-179	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating Tornado	180-226	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large-object missiles generated.
F5	Incredible Tornado	227-285	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-inforced concrete structures badly damaged.

funnel cloud - a tornado cloud or vortex cloud extending downward from the parent cloud but not reaching the ground.

gust - a sudden, rapid and brief increase in wind speed. In Canada, gusts are reported when the highest peak speed is at least 5 knots higher than the average wind and the highest peak speed is at least 15 knots.

gust front - the leading edge of the downdraft outflow ahead of a thunderstorm.

high - an area of high barometric pressure; a high pressure system.

hurricane - an intense tropical weather system with a well defined circulation and maximum sustained winds of 64 knots or higher. In the western Pacific, hurricanes are called “typhoons,” and similar storms in the Indian Ocean are called “cyclones” (see Table 2 for hurricane intensities).

Table 2 - Saffir-Simpson Hurricane Scale

Category #	Sustained Winds (kts)	Damage
1	64-82	Minimal
2	83-95	Moderate
3	96-113	Extensive
4	114-135	Extreme
5	>155	Catastrophic

icing - any deposit of ice forming on an object.

instability - a state of the atmosphere where the vertical distribution of temperature is such that a parcel displaced from its initial position will continue to ascend.

inversion - an increase of temperature with height - a reversal of the normal decrease of temperature with height.

isothermal layer - equal or constant temperature with height.

jet stream - a quasi-horizontal stream of wind concentrated within a narrow band; generally located just below the tropopause.

katabatic wind - downslope gravitational flow of colder, denser air beneath the warmer, lighter air. Also known as “drainage wind” or “mountain breeze”. Strength can vary from gentle to extremely violent winds.

knot - a unit of speed equal to one nautical mile per hour.

lapse rate - the rate of change of an atmospheric variable (usually temperature) with height.

lee wave - any stationary wave disturbance caused by a barrier in a fluid flow; also called mountain wave or standing wave.

lightning - any and all forms of visible electrical discharge produced by a thunderstorm.

low - an area of low barometric pressure; a low pressure system.

meridional flow - airflow in the direction of the geographic meridians, i.e. south-north or north-south flow.

meteorology - the science of the atmosphere.

mixed icing - the formation of a white or milky and opaque layer of ice that demonstrates an appearance that is a composite of rime and clear icing.

occluded front - a front that is no longer in contact with the surface.

orographic - of, pertaining to, or caused by forced uplift of air over high ground.

outflow - a condition where air is flowing from the interior land area through mountain passes, valleys and inlets onto the coastal areas; used most commonly in winter when cold Arctic air spreads onto the coastal area and adjoining sea.

overrunning - a condition when warm air overtakes or is lifted by colder denser air.

parcel - a small volume of air, small enough to contain uniform distribution of meteorological properties, and large enough to remain relatively self-contained and respond to all meteorological processes.

plow wind - usually associated with the spreading out of a downburst from a thunderstorm; a strong, straight-line wind in advance of a thunderstorm that often results in severe damage.

precipitation - any and all forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the surface.

quasi-stationary front - a front that is stationary or nearly so; commonly called stationary front.

ridge - an elongated area of relatively high atmospheric pressure; also called ridge line.

rime icing - the formation of a white or milky and opaque granular deposit of ice formed by the rapid freezing of supercooled water droplets.

saturation - the condition in the atmosphere where actual water vapour present is the maximum possible at the existing temperature.

shower - precipitation from cumuliform cloud; characterized by suddenness of beginning and ending, by rapid changes in intensity, and usually by rapid changes in the appearance of the sky.

squall - essentially gusts of longer duration. In Canada, a squall is reported when the wind increases by at least 15 knots over the average speed for a duration of at least 2 minutes and the wind reaches a speed of at least 20 knots.

squall line - a non-frontal line or narrow band of active thunderstorms.

stability - a state of the atmosphere where the vertical distribution of temperature is such that a parcel will resist displacement from its initial position.

stratiform - term descriptive of clouds of extensive horizontal development; flat, lacking definition.

stratosphere - the atmospheric layer above the tropopause; characterized by slight increase in temperature from base to top, very stable, low moisture content and absence of cloud.

subsidence - the downward motion of air over a large area resulting in dynamic heating.

supercooled water - liquid water at temperatures below freezing.

thunderstorm - a local storm invariably produced by a cumulonimbus cloud, and always accompanied by lightning and thunder.

tornado - a violently rotating column of air, shaped from a cumulonimbus cloud, and nearly always observed as “funnel-shaped;” other names are cyclone and twister.

tropopause - the transition zone between the troposphere and the stratosphere; characterized by an abrupt change in lapse rate.

troposphere - the portion of the earth's atmosphere from the surface to the tropopause; characterized by decreasing temperature with height and appreciable water vapour. Often referred to as the weather layer.

trough - an elongated area of relatively low atmospheric pressure; also called trough line.

trowal - a trough of warm air aloft; related to occluded front.

turbulence - any irregular or disturbed flow in the atmosphere.

updraft - a localized upward current of air.

upper front - any frontal zone which is not manifested at the surface.

virga - water or ice particles falling from a cloud, usually in wisps or streaks, and evaporating completely before reaching the ground.

warm front - the trailing edge of retreating cold air.

weather - the instantaneous conditions or short term changes of atmospheric conditions at a point; as opposed to climate.

wind - air in motion relative to the earth's surface; normally horizontal motion.

wind direction - the direction from which the wind is blowing.

wind speed - rate of wind movement expressed as distance per unit time.

wind shear - the rate of change of wind direction and/or speed per unit distance; conventionally expressed as vertical and horizontal wind shear.

zonal wind - a west wind; conventionally used to describe large-scale flow that is neither cyclonic or anticyclonic; also called zonal flow.

Table 3: Symbols Used in this Manual

	<p>Fog Symbol (3 horizontal lines) This standard symbol for fog indicates areas where fog is frequently observed.</p>
	<p>Cloud areas and cloud edges Scalloped lines show areas where low cloud (preventing VFR flying) is known to occur frequently. In many cases, this hazard may not be detected at any nearby airports.</p>
	<p>Icing symbol (2 vertical lines through a half circle) This standard symbol for icing indicate areas where significant icing is relatively common.</p>
	<p>Choppy water symbol (symbol with two wavelike points) For float plane operation, this symbol is used to denote areas where winds and significant waves can make landings and takeoffs dangerous or impossible.</p>
	<p>Turbulence symbol This standard symbol for turbulence is also used to indicate areas known for significant windshear, as well as potentially hazardous downdrafts.</p>
	<p>Strong wind symbol (straight arrow) This arrow is used to show areas prone to very strong winds and also indicates the typical direction of these winds. Where these winds encounter changing topography (hills, valley bends, coastlines, islands), turbulence, although not always indicated, can be expected.</p>
	<p>Funnelling / Channelling symbol (narrowing arrow) This symbol is similar to the strong wind symbol except that the winds are constricted or channeled by topography. In this case, winds in the narrow portion could be very strong while surrounding locations receive much lighter winds.</p>
	<p>Snow symbol (asterisk) This standard symbol for snow shows areas prone to very heavy snowfall.</p>
	<p>Thunderstorm symbol (half circle with anvil top) This standard symbol for cumulonimbus (CB) cloud is used to denote areas prone to thunderstorm activity.</p>
	<p>Mill symbol (smokestack) This symbol shows areas where major industrial activity can impact on aviation weather. The industrial activity usually results in more frequent low cloud and fog.</p>
	<p>Mountain pass symbol (side-by-side arcs) This symbol is used on aviation charts to indicate mountain passes, the highest point along a route. Although not a weather phenomenon, many passes are shown as they are often prone to hazardous aviation weather.</p>

Appendix



The Maritimes and Gaspé Peninsula



Newfoundland



The North Shore of Quebec and Labrador

