Chapter 4

Regional Weather and Local Effects

Introduction

This chapter delves into the local weather hazards and effects that are commonly observed in the GFACN33 area of responsibility. Listed here are the most common and verifiable weather hazards identified through extensive discussion with weather forecasters, FSS personnel, pilots and dispatchers.

While most weather hazards are described simply by applying symbols to the accompanying maps followed by brief sections of text, some of the more complex weather phenomena are detailed more fully. Table 3 provides a legend for the various symbols used throughout this chapter.

Map 4-1 - Topographic overview of the GFACN33 Domain

Ontario

(a) Summer

Summer offers some of the best flying weather as it brings a decrease in both the number and intensity of storms affecting the GFACN33 domaine. The upper winds diminish in strength, air masses tend to linger and weather in general becomes more persistent. Tropical air masses do make regular intrusions into southern Ontario during the summer. They often bring high temperatures, humidity and afternoon thunderstorms.

Thunderstorms are more prevalent in the south, occurring on average 25 days each year, often triggered by the passage of a cold front in the spring or summer. That number rises to as many as 35 days per year in the corridor through Windsor and London, in southwestern Ontario. Some of the worst thunderstorms, mainly those in the southwest, may be accompanied by tornadoes. Thunderstorm numbers drop to the north, falling to 5 days or less along the shores of Hudson Bay.

Prevailing winds tend to be light in summer and generally they flow out of the southwest. Land and lake breezes are common around the shores of the Great lakes, blowing off the water during the day and off the land at night.

Haze, formed from high concentrations of aerosol and particulate pollutants, is a chronic problem in the summer. With the airmass being cooled from below by the Great Lakes, a haze trapping inversion forms. This haze layer can extend as high as 8,000 feet ASL and lower the visibility to 2 to 3 statute miles.

Summer fog is more common across northern Ontario than in the south, where the foggiest season is the fall and winter. Fog tends to form during the early morning hours with light winds and nighttime cooling of the land. Later in the season steam fog forms over lakes blanketed by cold dry air.

With the approach of fall, the number and vigor of migratory low pressure systems begins to increase, as the region lies in the path of one of the North America's major storm tracks. At this time of year, it is not uncommon for remnants of tropical hurricanes to push northeastward up the Atlantic coast and affect southern and central Ontario with strong winds and periods of moderate or heavy rain. Across the north, where summers are shorter, fall brings colder temperatures and eventually the first accumulations of snow.

(b) Winter

As winter settles in, prevailing winds begin to shift to northwest. The storm track moves southward to lie across the Great Lakes and storms further increase in both frequency and strength. At the same time, cold, dry, Arctic air moves into the northern sections of the domain and makes periodic intrusions into the south, modified by passage over the warmer waters of the Great Lakes.

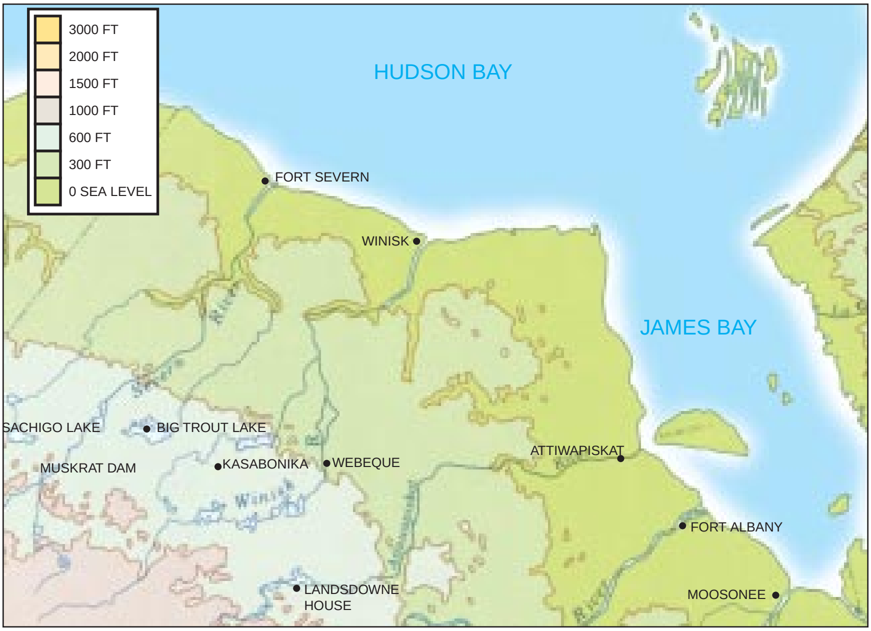
Fog occurs more frequently in the central areas of Ontario, during the fall and winter, than in the north or south. Sudbury and North Bay respectively average 69 and 63 days of fog per year. Locations like Red Lake and Pickle Lake in the northwest average close to 15 days, while 35 days of occurrence are typical across the of south. In spring, fog will sometimes form over lakes, as the cold lake waters cool warm moist air passing over its surface. Fog may continue to develop later in the season if there is overturning of colder water from lower depths.

The first snowfalls usually occur in the Winsk and Severn River areas of northwestern Ontario, in late October or early November, and spread across Lake Superior eastward to Sudbury by mid month. Much of southern Ontario, from London through Kingston, receives snowfall early in December and the extreme southwest, near Christmas. Heavy snowbelts occur along the upland slopes of the Canadian Shield facing Lake Huron, Georgian Bay and Lake Superior where cold air, after picking up heat and moisture from long fetches of open water, is forced to rise over the highlands. These lake effect snowbelts also occur in the vicinity of Parry Sound, to the south of Owen Sound, northeast of Sault Ste Marie, near London and along the St. Lawrence River.

Freezing precipitation can occur throughout the winter months but is most often encountered in the early part of the season. Usually developing ahead of an approaching warm front, freezing precipitation can produce some of the most hazardous of icing conditions. Frequency of occurrence is 5 to 10 days per year across the north and up to 20 days per year in the south.

Local Effects

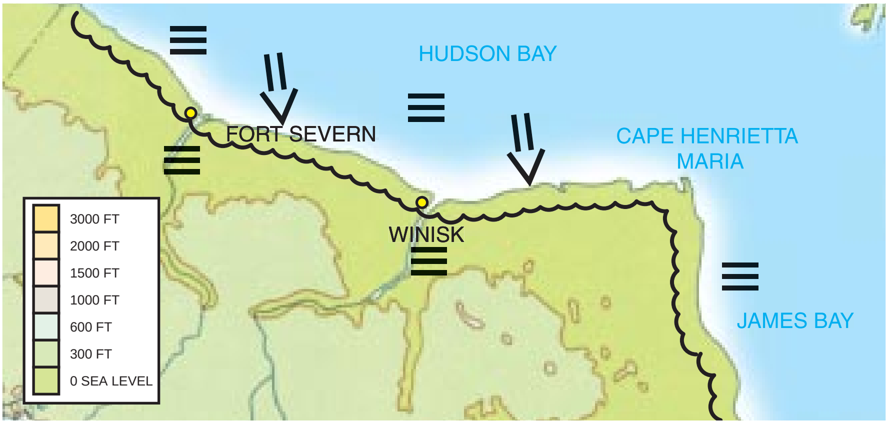
Hudson Bay Coast and Lowlands Fort Severn - Moosonee



Map 4-2 - Hudson Bay Coast and Lowlands Fort Severn - Moosonee

This vast section of the GFACN33 region is one of the most isolated and desolate areas in Canada. The northern coastline of Ontario stretches from the Manitoba border southeastward to Cape Henrietta Maria, south to the mouth of the Attiwapiskat River near Akimiski Island, then southeastward again to the Quebec border on the Ministikawatin Peninsula. A handful of small widely dispersed communities dot the coastline near the mouths of the major rivers which bear their name; Fort Servern, Winisk, Attawapiskat, Fort Albany, Moosonee and Moose Factory.

Fort Severn – Cape Henrietta Maria



Map 4-3 - Fort Severn – Cape Henrietta Maria

This section of coastline and adjacent lowland runs from the Manitoba border east southeastward. Well drained, raised beaches and grass covered tidal flats line much of the coast, which is almost treeless for the first 5 to 10 miles inland from the shore. Further inland, the landscape is relatively flat, with areas of tundra and poorly drained bogs and marshes giving way to sparse trees. The area is home to two small communities, located on the banks of the Severn and Winsk Rivers, just inland from the coast. Prevailing winds across the region are generally from the northwest.

During the summer, when Hudson Bay is ice-free, fog banks and low stratus are common over the cold water. Winds out of the north will often bring these conditions inland causing low ceilings and poor visibility. While fog will sometimes persist along the coastline throughout the day, stratus that has pushed inland will often break up during the afternoon with daytime heating.

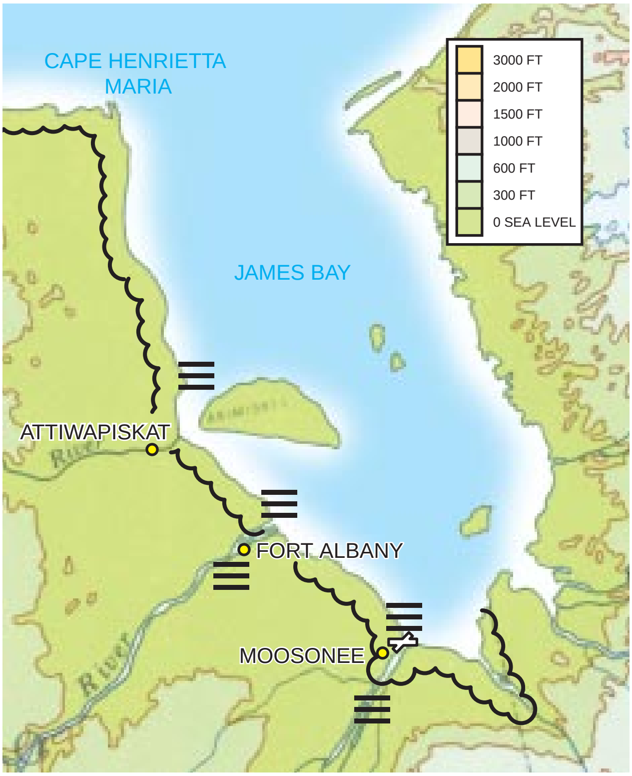
Snow squalls are common during the fall, often developing as cold arctic air (-8°C or less) flows over the open and warmer waters of the Hudson Bay. Ceilings and visibility can be locally reduced to near zero at times in snow squalls, but these conditions are not usually persistent.

During winter, large sections of Hudson Bay begin to freeze over and flying conditions generally improve, as is often the case in January and February. Weather here can change rapidly, however. The passage of frontal systems can bring on periods of snow, strong winds, and sometimes blizzards or whiteout conditions.

Under light winds or in still cold air, ice fog can form and sometimes become persistent near settlements and airstrips, its formation triggered by exhaust from aircraft engines or community chimneys.

With the arrival of longer and warmer days of spring and summer, the last of the ice usually melts off of Hudson Bay by late June or early July.

Cape Henrietta Maria – Moosonee



Map 4-4 - Cape Henrietta Maria – Moosonee

This area of coastline lies along the western side of James Bay. Its sloping shores rise to meet flat, low terrain inland that is sparsely treed within one to five miles of the coast. Farther inland, the landscape gradually becomes more thickly forested and dotted with muskeg and marshes. Several small communities are located near the mouths of the major rivers in the area. They include Attawapiskat, Kashechewan, Fort Albany and Moosonee.

James Bay becomes free of ice between mid June and early July. Summers are short and freeze up generally occurs between mid December or early January. Prevailing winds across the region are generally from the northwest.

Areas of fog and low stratus are common over the cold water waters of James Bay during the summer. Winds out of the northeast will sometimes bring these conditions inland causing low ceilings and poor visibility. Fog will sometimes persist along the coastline throughout the day while stratus that has pushed inland will often break up during the afternoon, with daytime heating.

Snow squalls tend to occur in the fall under a cold north, or northeast, flow over the warmer waters of James Bay. While they can locally reduce visibility and ceilings, they seldom persist for more than a few hours.

By mid winter (January and February) most of James Bay has frozen and, in the absence of open water, flying conditions often improve. Local occurrence of ice fog is not uncommon but, when it does happen, it can be persistent. Ice fog often forms near settlements and airfields where exhaust from aircraft or the moisture from household heating systems can trigger its formation.

Winter weather across this region often changes rapidly, usually with the passage of frontal systems, which can bring periods of snow, strong winds, and sometimes blizzards or whiteout conditions.

Northwestern Ontario

Map 4-5 - Northwestern Ontario

Northwestern Ontario is a vast area, much of which lies on the gently inclining, rocky and forested terrain of the Canadian Shield. A myriad of lakes cover the region and pilots flying it for the first time often find it disorienting, saying that after a period of time “it can all start to look the same.” Broad sections of the Shield are also subject to cloud development under conditions of upslope flow and, while much of the terrain is low in elevation, cloud can engulf power lines and communication towers perched atop the higher hills making them difficult to see.

Convective cloud is common in summer and early winter, especially during the afternoon. Pilots have commented that "this is one of the bumpiest regions to fly across on a convective day" and that " the prolonged jostling can be exhausting."

Convection at this time of year is due, in part, to stronger daytime heating and the fact that moisture is readily available from warm open lakes and rivers. The frequency of thunderstorms is generally lower in northern Ontario than it is in the south

Red Lake – Pickle Lake - Sandy Lake – Big Trout Lake

Map 4-6 - Red Lake – Pickle Lake - Sandy Lake – Big Trout Lake

A north or northwest flow is upslope across much of this region, and at Pickle Lake this is also true for winds out of the west. Winds from these directions can often generate broken cloud cover in the absence of larger scale weather systems. This is frequently the case in late summer or early winter when prevailing winds begin to favour the west or northwest and moisture is still freely available from open water. In addition, because of upslope, this region is often slow to clear following the passage of frontal systems under a west or northwest flow.

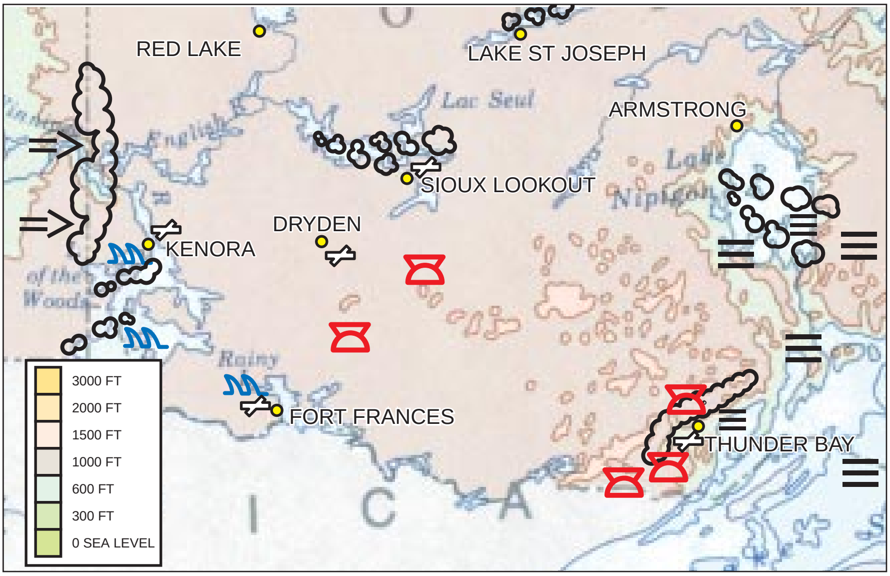
Lake effect convection and precipitation is common to the lee of some of the larger lakes where wind direction favours airflow over longer fetches of open water. This is most pronounced in the late summer and early winter. Lake effect convection can cause marked reduction in local ceilings and visibility, due to showers. Local reports of one half mile to one quarter mile visibility in lake effect snow showers occur relatively frequently and these conditions can persist over several hours.

Thunderstorms, on average, occur 15 to 20 times per season. They commonly develop throughout the summer, peak in frequency during July, and rarely occur outside the period between May and September. Widely spaced air mass thunderstorms are common, however, more organised lines of thunderstorm activity often accompany the passage of cold fronts.

Fog does make an appearance but usually only reduces visibility to less than half a mile 2 or 3 times per month. The occurrence of fog is higher in late summer and early winter while lakes and rivers remain open and much less frequent after freeze up. Radiation fog is the most common, often generating poor visibility within a few hours of sunrise, and rarely lasts until the afternoon. Ice fog will sometimes occur near these communities in the winter, developing from moisture associated with chimney smoke that forms into ice crystals under cold, calm conditions. Aircraft engine exhaust can also quickly trigger local ice fog development and temporarily restrict airport visibility, until ice crystals gradually settle out.

Blowing snow is not a common occurrence but does occur with greater frequency at some of the more exposed sites, like Big Trout Lake.

Kenora – Fort Frances – Dryden -Sioux Lookout – Thunder Bay



Map 4-7 - Kenora – Fort Frances – Dryden -Sioux Lookout – Thunder Bay

The Canadian Shield gradually rises to form a rim, or divide, around the northern shores of Lake Superior. As a result, this section of northwestern Ontario has some of the regions highest and most rugged terrain, reaching elevations of 2,225 feet ASL about 30 nautical miles west of Thunder Bay. Broadly speaking, winds from the southwest through northeast tend to be upslope but, owing to the orientation of terrain, become downslope and subsident at Thunder Bay and other locations around the northwest shore of Lake Superior.

Upslope winds can often generate broken cloud cover and obscure higher terrain in the absence of larger scale weather systems. In addition, they can often delay the improvement of flying weather west of Lake Superior following passage of a frontal sysem. Subsident flows, on the other hand, as is the case with northwest winds at Thunder Bay, tend to dissipate layers of broken cloud and fog that may otherwise delay the onset of low flying conditions.

Lake effect convection and precipitation is common to the lee of some of the larger lakes, including Lake of the Woods and Rainy Lake, especially where wind direction favours airflow over the longer fetches of open water. It is most pronounced in the late summer and early winter, when air temperatures begin to fall but lakes waters remain relatively warm. Lake effect convection can cause marked reduction in local ceilings and visibility due to showers. Local reports of one half mile to one quarter mile visibility in lake effect snow showers are common.

There are, on average, 25 to 35 thunderstorms in this area each year. They tend to develop throughout the summer, peak in frequency during July and August and rarely occur outside the period between April and October. Widely spaced air mass thunderstorms are the most common, however, more organised lines of thunderstorm activity often accompany the passage of cold fronts. During the summer, when the air mass is sufficiently unstable, easterly lake breezes will give rise to thunderstorms along the upslope terrain northwest of Lake Superior. As a result, thunderstorms are a common occurrence to the northwest of Thunder Bay. Some of the heaviest thunderstorm activity in this region occurs along the corridor of upslope terrain, extending from Fort Frances through just south east of Sioux Lookout.

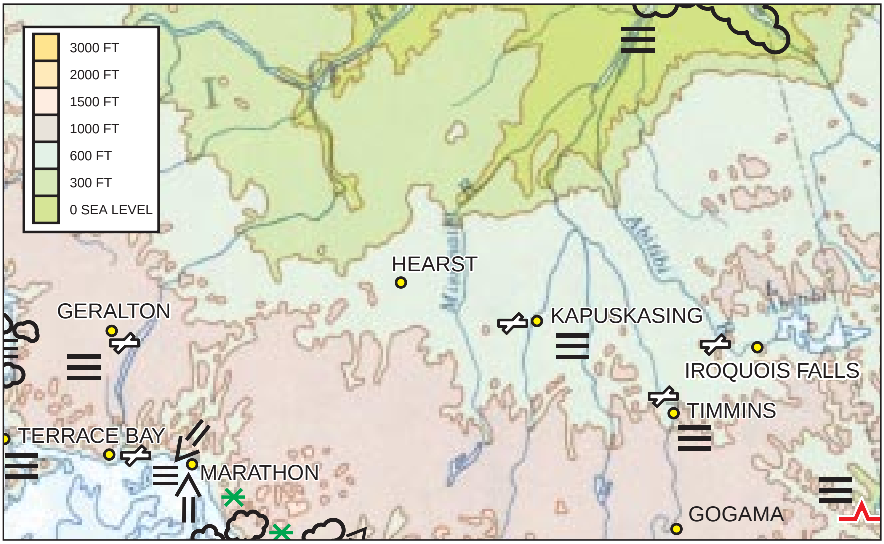
North of Lake Superior, fog, on average, reduces visibility to less than half a mile 2 to 4 times per month. The occurrence of fog is higher in late summer and early winter, while lakes and rivers remain open, and becomes much less frequent after freeze up. Fog occurs more often at Thunder Bay and around the northern shore of Lake Superior where, on average, it occurs 2 to 6 times per month, with the highest rate of occurrence in the summer.

Northeastern Ontario

Map 4-8 - Northeastern Ontario

Northeastern Ontario, like much of the northwest, is a vast and sparsely populated land that gently rises out of the Hudson Bay lowlands to the higher elevations of the Canadian Shield to the south. The land to the north is generally flat, covered in scrub forest, dotted with shallow lakes and muskeg and drained by numerous branching rivers. Farther south, the land is more heavily forested and marked by low rolling hills and rocky outcroppings, but is again interspersed with lakes, rivers and scattered marshes. Pilots have commented that "a handful of power lines and the tracks of the Ontario Northern railroad linking the communities of Moosonnee and Timmins are sometimes the only northern man-made linear landmarks recognizable from the air." Much of this region, while gently sloping, is subject to cloud development under conditions of upslope flow, even in the absence of larger scale weather systems. Pilots have cautioned against complacency while flying south after long flights over the low, unobstructed terrain in the north. As you move south, the terrain rises so that cloud can engulf power lines and communication towers perched atop the higher hills in the south, making them difficult to see.

Kapuskasing – Timmins - Geralton



Map 4-9 - Kapuskasing – Timmins - Geralton

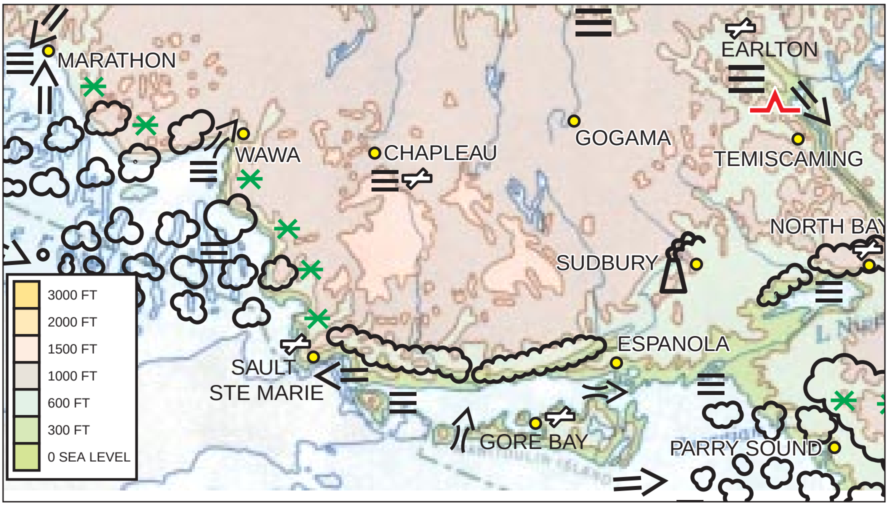
North or northwest winds are generally upslope across northeastern Ontario and can often give rise to areas of broken cloud even in the absence of large-scale weather systems. This is often the case in late summer or early winter when prevailing winds begin shift to the northwest and moisture is still freely available from open water. This can also make the region slow to clear following the passage of frontal systems under a northwest flow.

Lake effect convection and precipitation is common to the lee of some of the larger lakes, where wind direction favours airflow over longer fetches of open water. This is especially true of the area around Lake Nipigon, to the west of Geralton, and to a somewhat lesser extent of the area around Lake Abitibi, east-northeast of Timmins. Lake effect convection and precipitation is most pronounced in the late summer and early winter while lakes are open and their water remains relatively warm in comparison to falling air temperatures. Lake effect convection can cause marked reduction in local ceilings and visibility, due to showers. Local reports of one half mile to one quarter mile visibility in lake effect snow showers are all too common and can persist for several hours.

Thunderstorms, on average, occur 16 to 20 times per season. They commonly develop throughout the summer, peak in frequency during July, and rarely occur outside the period between May and September. Widely spaced air mass thunderstorms are common, however, more organised lines of thunderstorm activity often accompany the passage of cold fronts.

Fog that reduces the visibility to less than half a mile occurs 2 or 3 times per month, on average. The occurrence of fog is higher in late summer and early winter, while lakes and rivers remain open, and much less frequent after freeze up. Radiation fog is the most common, while ice fog will sometimes occur near these communities in the winter under cold calm conditions. Aircraft engine exhaust can quickly trigger local ice fog development and temporarily restrict airport visibility.

North Bay – Sudbury - Sault Ste. Marie – Wawa – Marathon



Map 4-10 - North Bay – Sudbury - Sault Ste. Marie – Wawa – Marathon

The Canadian Shield gradually rises in the south, forming a rim or divide around the northern shores of Lake Superior, Lake Huron and Lake Nipissing. This rugged higher terrain extends eastward toward the Quebec border, where it is deeply cut by the Ottawa River Valley. The highest elevation in Ontario, 2,275 feet ASL, occurs approximately 45 miles to the north of Sudbury.

Broadly speaking, winds out of the northern quadrants are upslope north of the divide, while winds from the southern quadrants are upslope to the south of the divide. Upslope flows frequently generate a broken cloud cover over this higher terrain. Lee subsidence is most pronounced to the south of the divide under a northerly flow and will often cause cloud and fog to dissipate along a corridor to the south of North Bay, through to Sudbury and Sault Ste. Marie. Subsidence effects are much less pronounced at Marathon and Wawa, which are more frequently subject to periods of persistent low cloud and fog.

Prevailing winds are generally from the west or southwest during the summer and shift to northwest in winter, while easterly winds are the least frequent and lighter. A noted exception in this pattern occurs at Sault Ste. Marie where winds are channelled between the rising terrain to the northwest of the airport and the St. Mary's River to the south. This results in both higher wind speeds and a prevailing wind direction out of the east.

Another noted case of channelling winds occurs along the narrowing valley corridor surrounding Lake Timiscaming. Under a northwest flow of 10 to 15 knots at Earlton, pilots will report winds of 25 knots or more and occasional moderate turbulence near the south end of lake as it narrows into the Ottawa River.

Lake effect convection and precipitation can be very strong to the lee of the Great Lakes, especially where prevailing wind direction favours airflow over long fetches of open water. This open water can produce a thermal low or thermal trough where convergence helps create long duration snow showers. This is the case along the northeastern shores of Lake Superior, to the north of Sault Ste. Marie (which receives in excess of 300 centimetres of snowfall annually) and over the rising terrain to the east of Georgian Bay. To a lesser extent, lake effect convection and precipitation occurs along the northern shores of Lake Huron and Lake Nipissing under a south or southwest flow. This pattern will often result in low ceilings and poor visibility from North Bay through to Sault Ste. Marie, with numerous reports of one half mile to one quarter mile visibility in showers and snow showers.

Thunderstorms are more frequent here than in the areas to the north and, on average, occur about 25 times per season. They tend to develop throughout the summer, peak in frequency during July and August and rarely occur outside the period between April and October. During the summer, when the air mass is sufficiently unstable, lake breezes frequently generate convective cloud over the Upper Michigan Peninsula near Sault Ste. Marie and along the upslope terrain to the north of Lake Huron and Lake Nipissing, as well as east of Georgian Bay. Thunderstorms are common to these areas during the afternoon and early evening but usually dissipate by sunset. More widely spaced, air mass thunderstorms usually occur with daytime heating over the northern part of the region, while organised lines of thunderstorm activity often accompany the passage of cold fronts.

The area around the northern and eastern shores of Lake Superior and Lake Huron, as well as the adjacent upslope terrain, is prone to periods of low stratus and fog. On average, fog reduces visibility to less than half a mile 4 to 8 times per month at Marathon and Wawa. The highest rate of occurrence is in late summer and early winter and the fog can be persistent. Fog will typically form over the water of Lake Superior as air temperatures begin to fall in winter. Lake breezes tend to pack fog in along the shore and the rising terrain inland. This is often the case at Marathon and Wawa where visibility less than one miles and ceilings of less than five hundred feet can persist throughout the day, while both forecasters and pilots await expected clearing. Cold, dry katabatic winds flowing downslope and out flowing through valleys overnight tend to erode away areas of fog inland from the lake, but will often cause fog to thicken and bank along the shore, only to be carried inland by lake breezes developing the following day.

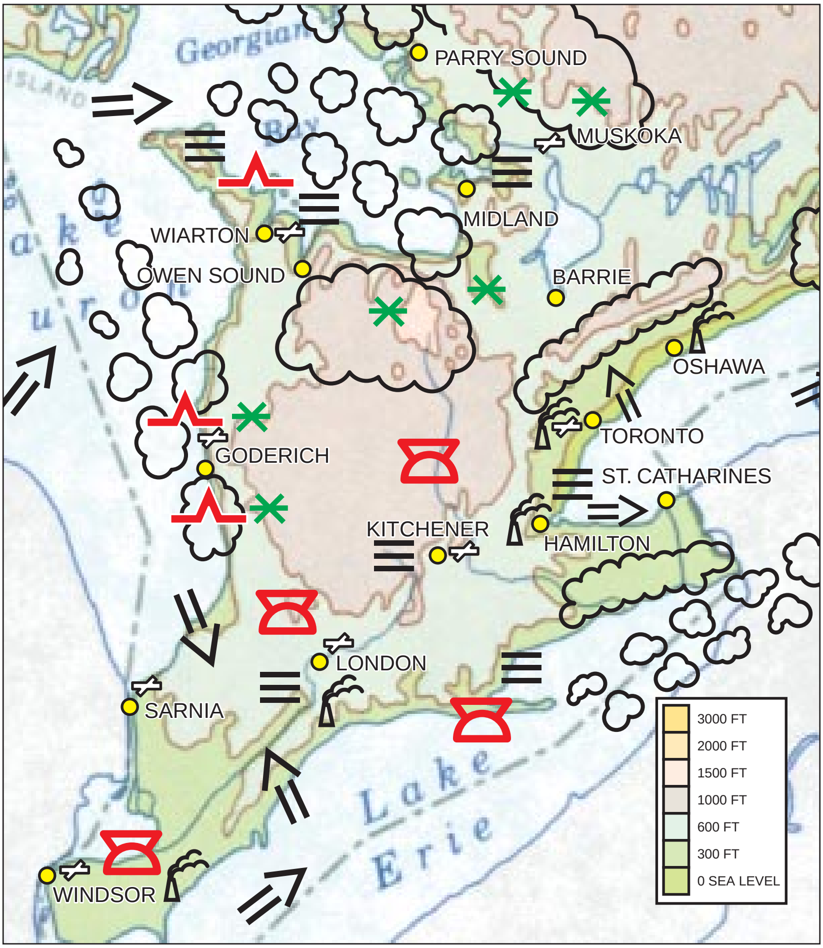
Eastern sections of the region from North Bay through Mattawa have a high occurrence of freezing rain. Typical freezing rain events involve the prior establishment of cold polar air near the surface flowing out from an area of high pressure centred over southern Quebec and along the Ottawa and Mattawa Valleys. With the cold air firmly entrenched, and sustained by surface winds, freezing rain will sometimes develop and persist for several hours as warm air is wedged over subfreezing surface layers ahead and along the frontal boundary of warm fronts.

Southern Ontario

Map 4-11 - Southern Ontario

Southern Ontario shows little of the terrain relief associated with the Canadian Shield northeast and northwest of Lake Superior. Most of the southern region is nearly level or consists of gently rolling hills having little elevation. In fact the only two upland areas rise much above fourteen hundred feet. They are the Ontario Highlands just east of Lake Huron (elevations to 1,790 feet ASL) which includes the ski hills near Collingwood and a section of the Canadian Shield to the east of Georgian Bay, home to Algonquin Park (elevations to 1,925 feet ASL). While the south is fairly densely populated and highly industrialized, offering pilots numerous landmarks, the area of the Canadian Shield in the vicinity of Algonquin Park contains sections of rugged wilderness and few roads or communities. Pilots have commented that one of the most striking and recognizable features of Southern Ontario, both from the ground and air, is the Niagara escarpment. Its bluffs parallel the southern shores of Lake Ontario through to Hamilton, then northward to Collingwood, west to Owen Sound, and north along the Bruce Peninsula to Manitoulin Island. The greatest single influence on weather across the region is the presence of the Great Lakes.

Windsor – London – Hamilton – St. Catharines – Buttonville – Muskoka



Map 4-12 - Windsor – London – Hamilton – St. Catharines – Buttonville – Muskoka

During the winter, lake effect convection and precipitation frequently develops across the upslope terrain to the southeast of Lake Huron and Georgian Bay. Under a northwest flow, before the freeze up of the lakes, these areas can receive periods of heavy snowfall, often in excess of 75 snow days annually. Airports like Muskoka and Barrie lie within this snow belt and pilot reports of visibility less than one half mile in snow showers are common under these conditions. Areas to the lee of the lakes but on the downslope side of higher terrain, such as the eastern half of Algonquin Park toward Pembroke, Toronto and Hamilton, are sometimes subjected to lake effect snowfalls under a strong northwest flow. This occurs much less frequently, however, and these downslope areas tend to receive less than half the annual snowfall of

Muskoka and Barrie. This is also the case for St. Catharines, which, while only thirty miles from Buffalo, receives significantly less snowfall.

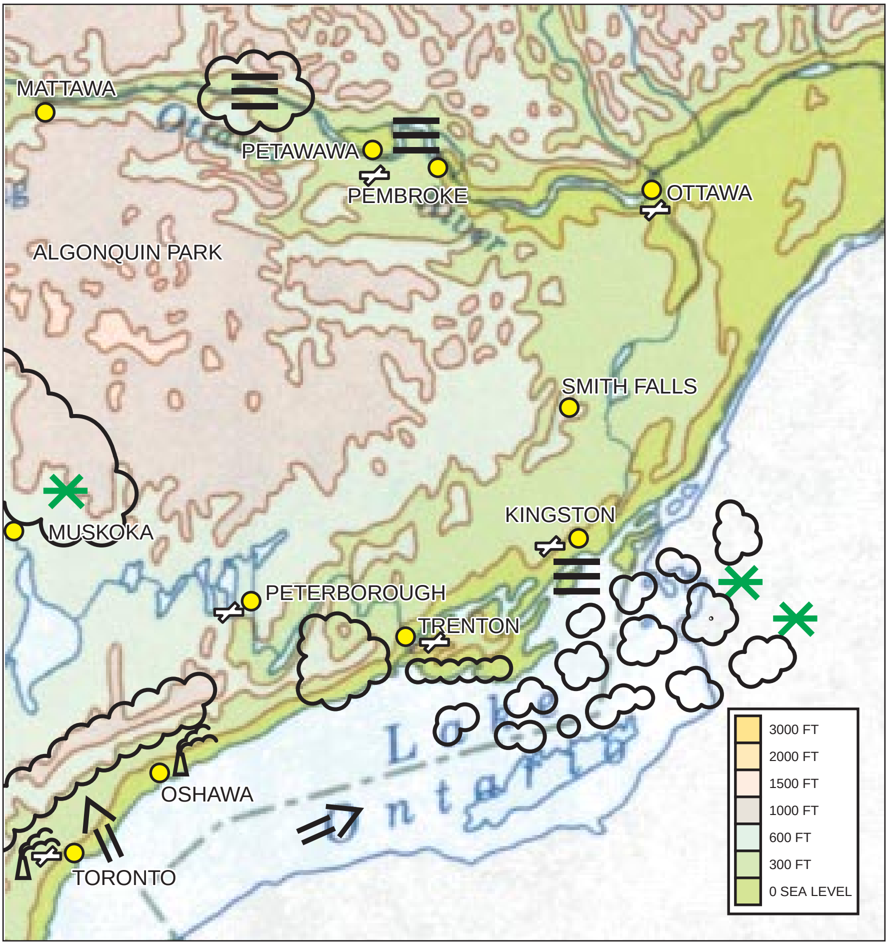
Low ceilings due to stratus cloud tends to prevail in the upslope flow north and east of London. Flights between London and Toronto often encounter lower than expected ceilings as the elevation rises while both Toronto and London are reporting good ceilings and visibility.

Thunderstorms occur more frequently over southwestern Ontario than anywhere else in the region, generally averaging 25 to 30 occurrences per season, and 35 per season along a corridor extending from Windsor through London, to just west of Toronto. Thunderstorms often form in association with lake breeze fronts, as cold lake air along the frontal boundary sweeps inland, lifting the warmer air residing over the land. Lake breeze fronts arriving from Lake Erie to the south and Lake Huron to the north frequently converge over southwestern Ontario, giving rise to the high number and sometimes severe nature of thunderstorms in this area. They tend to develop throughout the summer, peak in frequency during June and July and rarely occur during the rest of the year. Throughout the height of the convective season, severe thunderstorms accompanied by tornados occur here more frequently than anywhere in Canada. Waterspouts also occur, especially over Lake Erie, and are more common in late August and September than any other time of the year. In fact, they are almost unheard of in July.

Haze is a regular occurrence over this region during the summer, frequently reducing visibility to less than 5 miles. Haze often develops under a persistent ridge of high pressure when weak air mass circulation leads to industrial and automotive aerosols and particulates pooling in the stable air overlying the cool waters of Lake Ontario and Lake Erie. Lake breezes carry haze inland and can generate poor visibility while nightime land breezes generally bring some improvement. Haze is usually at its worst after a period of prolonged high pressure and conditions usually improve considerably following the passage of a frontal system. A good example of the hazard that haze can present comes from a pilot who, in flying along the northern side Lake Erie under worsening haze conditions, reported following the Long Point shoreline (south of London) out over the centre of the lake where he lost contact with the surface. This "whiteout" condition occurs when the water and sky become indistinguishable, leading to a loss of horizon.

Fog is at its worst in the late summer and early winter, usually accompanying frontal precipitation or the result of radiation cooling. On average, fog restricts visibility at the region's airports to less than half a mile, 2 to 5 time per month. Steam fog frequently occurs over the lakes with the arrival of cold, dry winter air masses. In addition, fog will sometimes develop over the lakes in spring with warm moist air becoming chilled by cold lake waters.

Peterborough – Trenton – Kingston – Ottawa



Map 4-13 - Peterborough – Trenton – Kingston – Ottawa

Winter can be a nasty time in this part of Ontario. Freezing rain develops infrequently throughout the region of the Great Lakes, usually in the period between December and March and rarely outside of November and April. Almost half of all freezing rain events are of light intensity, relatively large in area, last only an hour or two, and are associated with the passage of a warm front. However, the hazard associated with aircraft icing can be severe. In Ontario, freezing rain occurs most often along a corridor extending form the St. Lawrence Valley through the southwest to the vicinity of Windsor. Within this corridor, the eastern section from Ottawa through to Kingston has the distinction of having highest rate of freezing rain occurrence and the greatest number of prolonged freezing rain events.

While several different scenarios can result in freezing rain, the most common in this region involves the prior establishment of cold air near the surface flowing out from an area of high pressure centred over southern Quebec. As a result, surface winds will usually flow out of the east or southeast, spilling cold air along the St Lawrence and Ottawa Valleys, while winds south of the region will be from the south or southwest. The next step in the scenario involves the approach of a warm front, associated with a migratory low pressure system, arriving along the winter storm track out of the southwest. When a warm front approaches from the southwest, ahead of a migratory low pressure system, freezing rain will usually develop in the vicinity and to the north of the warm frontal boundary.

Several factors are considered to contribute to the more frequent and prolonged freezing rain events over southeastern Ontario, as compared to other areas. To begin with, there is often less moisture available for widespread precipitation across the west, due to the fact that the source of low-level moisture for lows approaching from the southwest is the distant Gulf of Mexico. Secondly, lows arrive over the Great Lakes will often slow, drawing heat and low level moisture from the open water of the Lakes or from the Atlantic coast. This moisture is then fed into the warm frontal airmass rising over air pooling in the St. Lawrence and Ottawa Valleys, prolonging the periods of freezing rain. Finally, both the Ottawa River Valley and St. Lawrence Valley, with the rising Appalachian Mountains to the south, tend to dam and channel the polar air, sustaining the subfreezing surface layer in which freezing rain occurs east of Lake Ontario.

Lake effect convection and precipitation can be very pronounced to the east of Lake Ontario, under a west or southwest flow. Under these conditions, the rising terrain between Cobourg and Trenton as well as much of Prince Edward County to the southeast of Trenton, will often have lower ceilings and poorer visibility in snow showers. This is also the case for the rising terrain to the northeast of Trenton as well as north and northwest of Kingston. The areas where lake effect snow produces the heaviest accumulation and presents the greatest problems to aviation in terms of low ceiling and poor visibility, however, lie to the south of the Canadian border, near Syracuse and Watertown in upstate New York.

Summer brings the return of thunderstorms which occur an average of 24 to 30 times per season across southeastern Ontario. Thunderstorms generally peak in number during July and August and rarely develop between the months of October to April. During this time, lake breezes will frequently initiate an upslope flow along the northern shore of Lake Ontario giving rise to afternoon convective cloud development. When the air mass is sufficiently moist and unstable, afternoon thunderstorms will often develop along the Oak Ridges Moraine and the rising terrain to the northwest of Trenton through Smith Falls. Westerly winds generally cause cells to drift eastward throughout the afternoon. Thunderstorms generally dissipate within a few hours of sunset. Nocturnal thunderstorms are usually associated with the nighttime passage of cold fronts. Pilots have commented that on convective days a fairly clear corridor will generally remain open to east west flight along the shore of Lake Ontario, while flying north will often involve detouring around CBs.

Haze is a common summer occurrence over this region, but is usually worst near the industrial centres along the north shore of Lake Ontario and the St Lawrence. Haze will occasionally reduce visibility to less than five miles but only infrequently to less than three. It usually develops with a persistent ridge of high pressure, when weak air mass circulation leads to industrial and automotive aerosols and particulates pooling in the stable air overlying the cool waters of Lake Ontario, and in the confines of the St. Lawrence Valley. Lake breezes carry haze inland and often cause some of the poorest visibility during the afternoon. Land breezes will generally bring some improvement overnight. Haze is usually worst after a period of prolonged high pressure and conditions will usually improve considerably following the passage of a frontal system.

Fog is at its worst in the late summer and early winter, usually accompanying frontal precipitation or the result of radiation cooling. On average, fog restricts visibility at the regions airports to less than half a mile 2 to 5 time per month. Steam fog frequently occurs over the lakes with the arrival of cold, dry winter air masses. In addition, fog will sometimes develop over the lakes in spring with warm moist air becoming chilled by cold lake waters.

The Great Lakes

Map 4-14 - The Great Lakes

As discussed in Chapter 3, the Great Lakes Basin is one of the more active regions for migratory low pressure systems and, as such, the Great Lakes and the adjacent terrain is home to a great deal of system related weather. The strongest winds over and around the lakes are associated with the more intense lows developing in April and May and again later on in September through November. These lows typically approach from the southwest, deepen over the lakes and produce very strong pressure gradients and active fronts.

Frontal systems are usually the most active over the Lower Lakes in the spring and the Upper Lakes in the fall. Active spring lows passing over Lake Huron carrying warm and cold fronts will often initiate strong southerly winds with their approach and rapidly deteriorating ceilings and visibility in showers and mist. A sharp wind shift to the southwest and improvement in ceilings and visibility typically marks the passage of the warm front. Several hours may pass before squall lines with thunderstorms and strong gusting winds herald the onset of an active trailing cold front. The cold front itself will usually bring further convective cloud, showers and a sharp shift to strong northwest winds. Passage of a cold front over the lakes may not bring the improvement in aviation weather often expected to follow frontal passage over land. With intense fall storms, strong surges of cold polar air behind a cold front can bring some of the storm's greatest winds. In addition, strong convection will often develop as cold polar air sweeps over long stretches of warm open water. This can generate strong turbulence, low ceilings and poor visibility in lake effect snowfall that may extend miles inland downwind of the lakes.

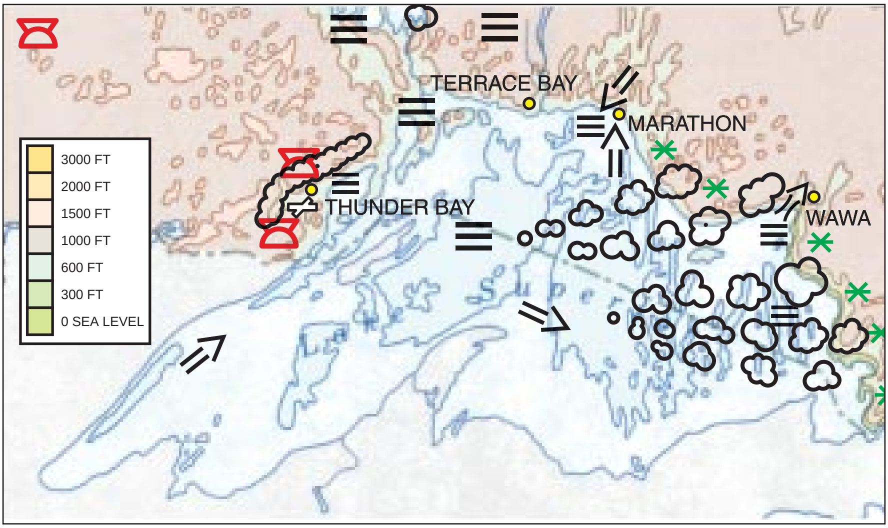
The single weather phenomena most often credited with hampering aviation operations near and around the Great Lakes is fog. From April through November the Great Lakes Basin is affected by fog arising from different processes. Advection or sea fog is the most common, forming when warm, moist air condenses over cold water. This type of fog frequently occurs over Lake Superior and Lake Huron, whose deep waters remain cold throughout the summer due to upwelling. Heavy banks of advection fog tend to form around Lake Superior well into the summer. West or southwest winds will frequently bring these fog banks onto the northern and eastern shore, plaguing locations like Terrace Bay, Marathon and Wawa. Advection fog may persist for several days even under moderate winds but will usually lift following passage of a cold front.

Frontal fog forms in the moist airmass trapped beneath a warm frontal inversion. It is often worse in the more moist air over the lakes than over the surrounding land. Local pilots recommend caution when flying across the lakes from nearby airports under conditions of minimum visibility. Frontal fog will often lift within a few hours following passage of a warm front.

During the winter, usually from mid December through February, steam fog will frequently accompany very cold arctic air as it moves out over open water. Steam fog, also referred to as arctic sea smoke, can extend several hundred feet off the water surface.

Pilots have made the comment that, most of the time, sea smoke hugs the surface and can be avoided but, forced to fly through it by low ceilings, sea smoke can quickly result in visible icing.

Lake Superior



Map 4-15 - Lake Superior

Lake Superior, with a surface area of over 82,000 square kilometres, is the largest and deepest of the Great Lakes. Over the western section of the lake, from Isle Royale to Deluth, prevailing winds are out of the northeast or southwest. The central and eastern sections of the lake from Thunder Bay to Whitefish Bay are subject to prevailing winds out of the northwest. Superior is the coldest of the Great Lakes with water temperatures that warm to only 10 to 14 degrees C°. Fog is common over the cold lake surface throughout the summer, often drifting inland under lake breezes to plague surrounding airports. Fog is at its worst in June with fog banks becoming an almost permanent feature around the lake from Thunder Bay to Sault St Marie.

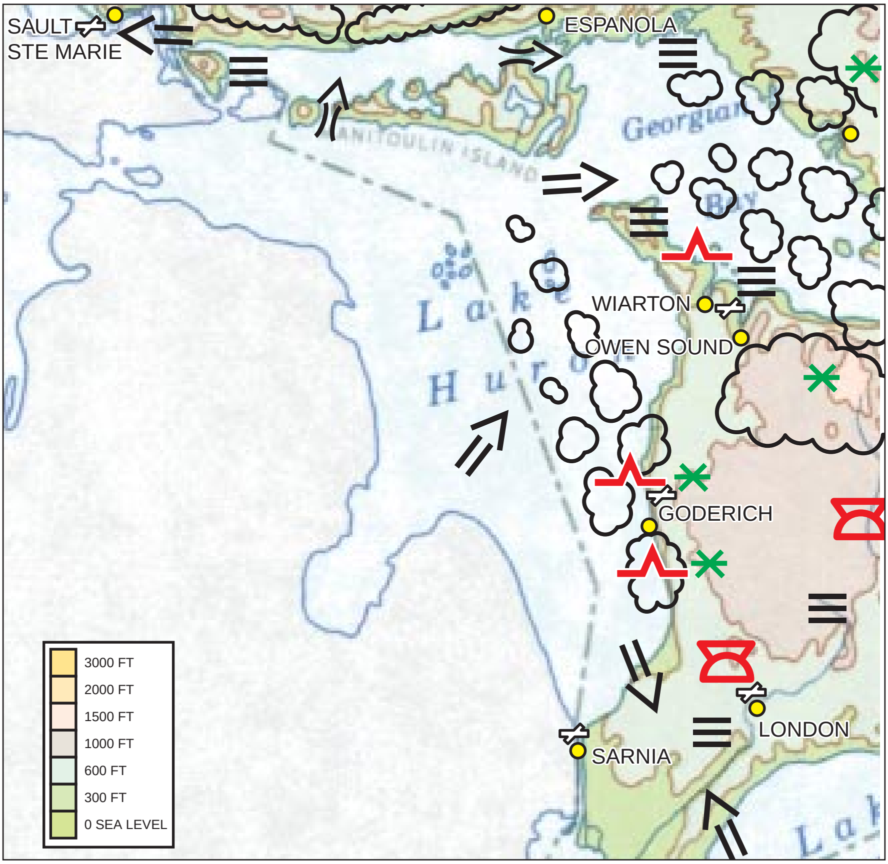
In fall and winter, the winds around the lake are often 10 to 15 knots stronger than over the land, driven by convection developing above the comparatively warm lake surface.

Interacting with the steep rugged terrain of the Canadian Shield rising around the lakeshore, moderate to strong winds will often give rise to areas of low-level mechanical turbulence.

Thunderstorms, while not uncommon across Lake Superior, are usually associated with the passage of cold fronts. Thunderstorms tend to lose their strength or die out entirely as they move off the warmer land and out over the cooler waters of the lake.

Convection along cold fronts, typically moving from west to east across the lake, will usually be much weaker by the time the front reaches the eastern shore.

Lake Huron



Map 4-16 - Lake Huron

Lake Huron has a surface area of over 59,000 square kilometres. Its eastern shores, along Georgian Bay, are dotted with small communities while inland lies the cottage country of Muskoka. Prevailing winds over Georgian Bay are northwesterly but, because of the many islands, channels and inlets near and along the shoreline, local winds show tremendous variability. Wind speeds within the Thirty Thousand Islands often exceed those over the open water, due to funnelling and channelling effects between the islands.

The entrance to Georgian Bay, between Manitoulin and Tobermory, is an area often affected by strong westerly winds, which tend to be funnelled through the channel. The cold waters of the deep central section of the lake frequently generate heavy fog in this area during the spring and summer.

Rugged cliffs mark the eastern side of the Bruce Peninsula down to Wiarton and Owen Sound which lie at the end of deeply cut bays. Strong southwest winds can make a flight over this area fairly bumpy due to low-level mechanical turbulence.

In winter, the upslope areas inland from the south end of Georgian Bay between Meaford and Collingwood through Midland to Parry Sound are subject to strong lake effect snowfalls, low ceilings and poor visibility under a northwest flow.

Thunderstorms over Georgian Bay usually develop in association with the passage of cold fronts. Outbreaks of cold air between August and October may also bring the development of waterspouts.

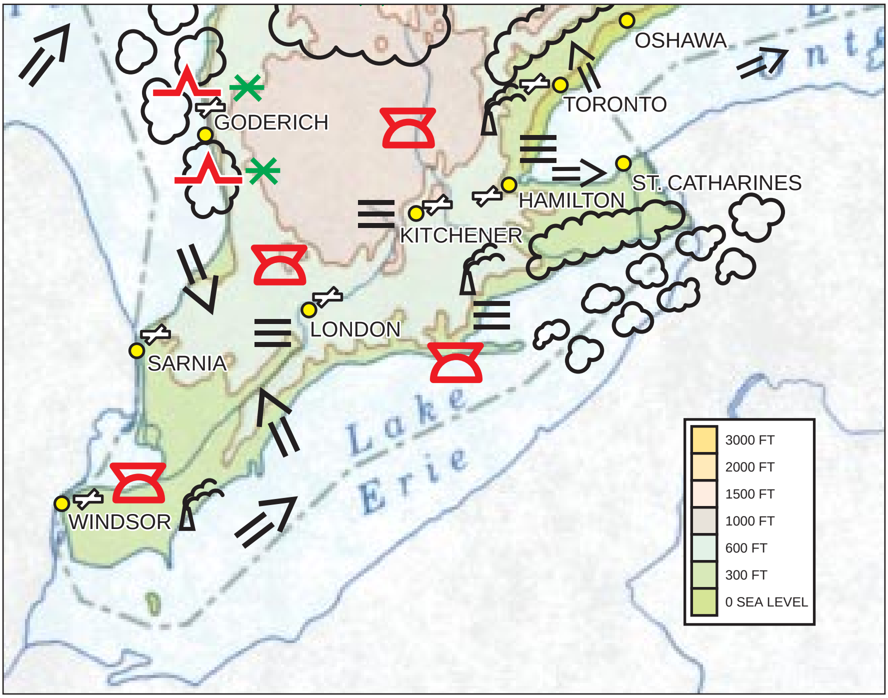
Prevailing winds over Southern Lake Huron are south or southwesterly. The lakeshore from Sarinia through Goderich, Port Elgin and northward along the Bruce Peninsula is exposed to large fetches of the lake. Summer wind speeds average 15 knots but winds may reach as high as 50 knots with the more intense storms of winter. Flights along the coast under strong winds can be bumpy due to low level mechanical turbulence.

Thunderstorms occur more frequently in the area of southern Lake Huron and, due to warmer water temperatures, they tend to maintain most of their intensity. Water spouts are common from August through late October, usually accompanying convection in outbreaks of cold air.

The cold waters of Lake Huron create another interesting effect. For a distance of 20 miles inland from the east shore of Lake Huron, during the late spring and early summer, a lake "shadow" will exist where little cumulus cloud will form, due to the dome of cold air that slides in off the water. Along the eastern edge of this dome, cumulus will begin to form and areas to the east of this line will often see broken cloud, while areas to the west of the line will see scattered or no cloud. Similarly, precipitation is less within the lake shadow during May and June, while the reverse happens in the fall months.

The North Channel and Manitoulin Island are subject to prevailing westerly winds. Winds funnelled through the narrowing terrain between the island and mainland increase significantly in the area around Espanola. This is also the case through Mississagi Strait and Detour Passage of Manitoulin Island; areas surrounded by higher terrain shorelines. Fog is less extensive over the North Channel than over northern Lake Huron, throughout the spring and summer, due to warmer water temperatures. While diminishing the effects of fog, warmer water temperatures support more intense convection and thunderstorms are more common here than over the cold waters of the central sections of the lake.

Lake Erie

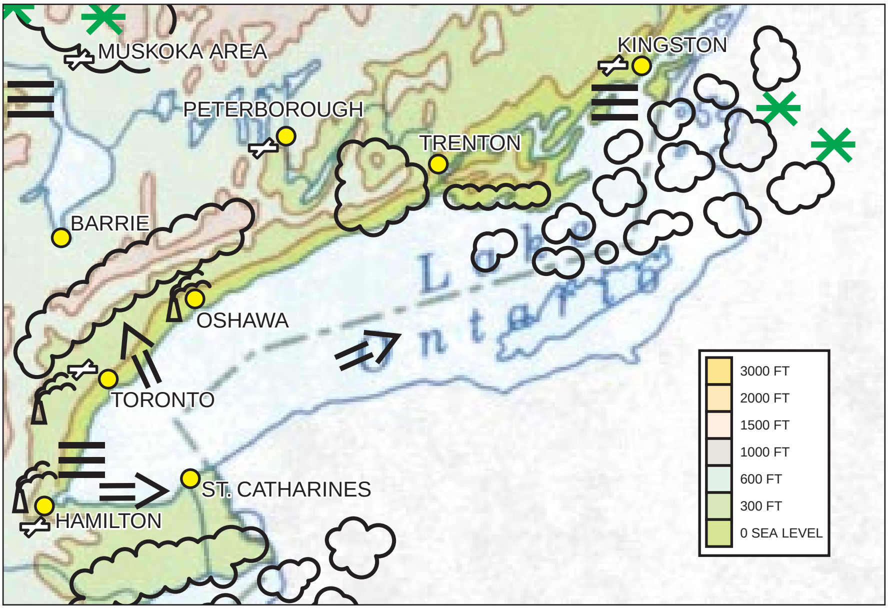


Map 4-17 - Lake Erie

Lake Erie is slightly larger than Lake Ontario but it is much shallower and far warmer. Water temperatures near the western end of Lake Erie can exceed 24 degrees C. The gently rising terrain on either side of the lake tends to channel winds along its length from west-southwest to east-northeast. As a result, prevailing winds are out of the southwest. The prevailing year round wind speed is 10 to 15 knots, however, funnelling causes winds to be stronger at the eastern end of the lake. Lakeshore convergence also causes the easterly wind along the north shore and the westerly wind along the south shore to be stronger than the prevailing wind.

Severe weather is more common across Lake Erie than on any of the other Great Lakes. Severe thunderstorms occur on 8 to 10 days each summer and waterspouts 4 to 6 days per year from late July through October, most toward the southwest end of the lake. On the positive side, because it warms quickly, Lake Erie has less fog than the other lakes and little of that occurs throughout the summer after June. The area around Long Point and the Inner Bay is subject to frequent summer thunderstorms and is a common location for waterspouts.

Lake Ontario



Map 4-18 - Lake Ontario

With a surface area of almost 19,000 square kilometres, Lake Ontario is the smallest of the Great Lakes. It does not freeze over completely in winter and its long fetches of open water often result in heavy lake effect snowfalls to the lee of the lake in Syracuse and Watertown, during the winter. Pronounced lake breezes tend to develop along Lake Ontario's shoreline, especially in the Toronto area, where strong temperature differences develop between the heat island of the city and cool lake waters.

Under stable conditions, such as beneath a strong ridge of high pressure or with the influx of tropical air moving up from the Gulf of Mexico, pollutants and humidity will build up in the cool stagnant air over the lake, reducing visibility. On clear calm nights, cold air drainage will set up a light northerly flow to the east of the Niagra Escarpment.

The western end of Lake Ontario includes the population and industrial centres of Hamilton, Burlington and St. Catharines. Westerly winds tend to be channelled along the southern shore of the lake and upslope along the rising terrain and steep bluffs of the Niagara Escarpment, from Burlington to Beamsville. Thunderstorms often develop in this area during the summer and drift out over the lake.

In the Dundas Valley near Hamilton, prevailing fall westerlies and the easterly winds prevailing in spring are commonly funnelled through the valley, increasing wind speeds near Hamilton by roughly 50 percent over those in surrounding areas.

Visibility in the region is frequently reduced by haze, often to less than 5 miles in the vicinity of Hamilton.

During the winter, an easterly wind off Lake Ontario can give significant snowfalls to areas downstream of the lake. In the spring, these same easterly winds can cause poor visibility in fog to persist over the western end of the lake for extended periods.

The eastern end of Lake Ontario, near the mouth of the St. Lawrence River, is dotted with islands. The most prominent local effect is the channelling of winds to the southwest and northeast along the St. Lawrence Valley. Fog is common throughout the spring and often reduces visibility. Lake breezes occur frequently throughout the summer, often initiating the upslope flow that in combination with daytime heating leads to afternoon thunderstorms over the heated slopes around the lake. Cornering winds and gusty lee eddies are common within the Thousand Islands between Brockville and Kingston.

Quebec

Nunavik

Map 4-19 - Nunavik

Weather conditions across Nunavik are strongly influenced by the large saltwater bodies of Ungava Bay, Hudson Bay and Hudson Strait, as well as mountains and river gorges. Ungava Bay usually freezes over in late October or early November and remains covered until the pack ice goes in late July. From 1997 to 2000, however, the bay froze later and never froze completely during the winter of 2001. During the same four years, the pack ice was gone at the beginning of July and the remainder (small floes; grounded ice chunks) by mid-July, one month early. Hudson Bay freezes much later, usually by the end of December, but never does so completely as the ice shifts continuously under the influence of the wind. Near the coastline, however, the ice usually melts in late June or early July with the rest of the ice not breaking up until much later in the summer. As for the Hudson Strait, the water usually freezes by the end of November and remains so until the pack ice goes away in mid-July, leaving floes and small bergs that finally clear out of the strait by the end of July.

(a) Ice-covered season

So far north, traditional seasons are less relevant to flying conditions than ice-free, ice-covered or transition periods. Once the ice pack is well established, flying conditions tend to become more favourable, both in terms of ceiling and visibility. This is especially true for the months of February, March and April. Typically, during this time of year, a localized high pressure system establishes itself over Ungava Bay giving clear skies and good visibilities. This did not happen in 2001, however. The area is still exposed to synoptic-scale weather systems that move generally from west to east or from southwest to northeast. In such a case, weather conditions that hit the eastern shore of Hudson Bay usually reach Ungava Bay 24 hours later.

Whiteout conditions can develop without warning and last for several days. Whiteouts are frequent north of the tree line, since there are few visual markers and the horizon is easily lost. Whiteout conditions become generalized as soon as the land is covered by low stratus cloud. Nowhere is it as frequent as the Raglan Plateau, which is at 1,900 feet ASL.

Due to usually stronger winds at this time of the year, turbulence becomes more frequent both over and in the lee of mountainous terrain. On the Raglan Plateau, lenticular clouds (SCSL or ACSL) are frequently observed at altitudes of 6000 to 7,000 feet ASL, indicating the presence of severe lee wave turbulence. Moderate to severe mechanical turbulence is common with northwesterly winds of 30 knots or more developing after the passage of a cold front. It is also frequent throughout the Ungava Peninsula when the upper winds at 3,000 feet are 30 knots or more. Severe mechanical turbulence reported further south that is associated with a 40 to 45 knot low-level jet stream often extends to 58°N, and sometimes to 60°N.

Icing may become an issue as most flights are short “hops” between neighbouring villages and tend to be conducted at altitudes of less than 3,000 feet ASL. Significant amounts of ice can then accumulate over aircraft surfaces over long periods of time. Fog, producing significant icing and zero ceilings and visibilities, forms over any open water and drifts inland, pushed by the wind during colder months. Ice fog also tends to form over villages as soon as there is a little wind mixing the air, due to the humidity contained in the smoke from house and building chimneys.

On very cold and clear days, drifting snow or blowing snow is common. The weather can rapidly change to whiteout conditions as visibilities fall drastically in ice crystals in the lowest thousand feet of the atmosphere. The Inuit call this phenomenon “natarluk” (the “r” is pronounced like a “k”).

(b) Late spring and early summer

The arrival of warmer air over ice- or snow-covered surfaces generally results in the formation of thick fog or low stratus cloud. As a result, low ceilings, low visibilities, and light to moderate rime or mixed icing are common. Conditions improve once the snow melts and the pack ice moves away. The top of the fog layer may reach 500 feet AGL. It generally stays over water during the day but it can move inland as the ground, and air, temperature warms up. For example, it is common to see the fog moving inland along the southern shore of Ungava Bay around 5 pm in early May and around 7 pm by early June.

(c) Ice-free season

Fog is the dominant weather maker once the ice is completely gone and the water starts to warm up. This is advection fog, giving either zero or near zero ceilings and visibilities. It is generally so thick; that pilots may not see their own aircraft propeller. The months of July and August are generally the worst. Advection fog is usually observed along the entire coast line, from Killinek to Kuujjuaq, to Ivujivik, then to Kuujjuarapik.

Rain is generally observed with the passage of a weather system. Thunderstorms, on the other hand, are rarely observed over northern Nunavik. When observed, they are usually associated with a trowel crossing Hudson Bay from the west and are found at higher altitudes, embedded in nimbostratus clouds.

Strong southerly winds (20-30 knots) are often observed during the summer months, bringing in warmer air masses. Lee wave turbulence and lenticular clouds are frequently observed over the Ungava Peninsula, especially over the Raglan Plateau, during the time.

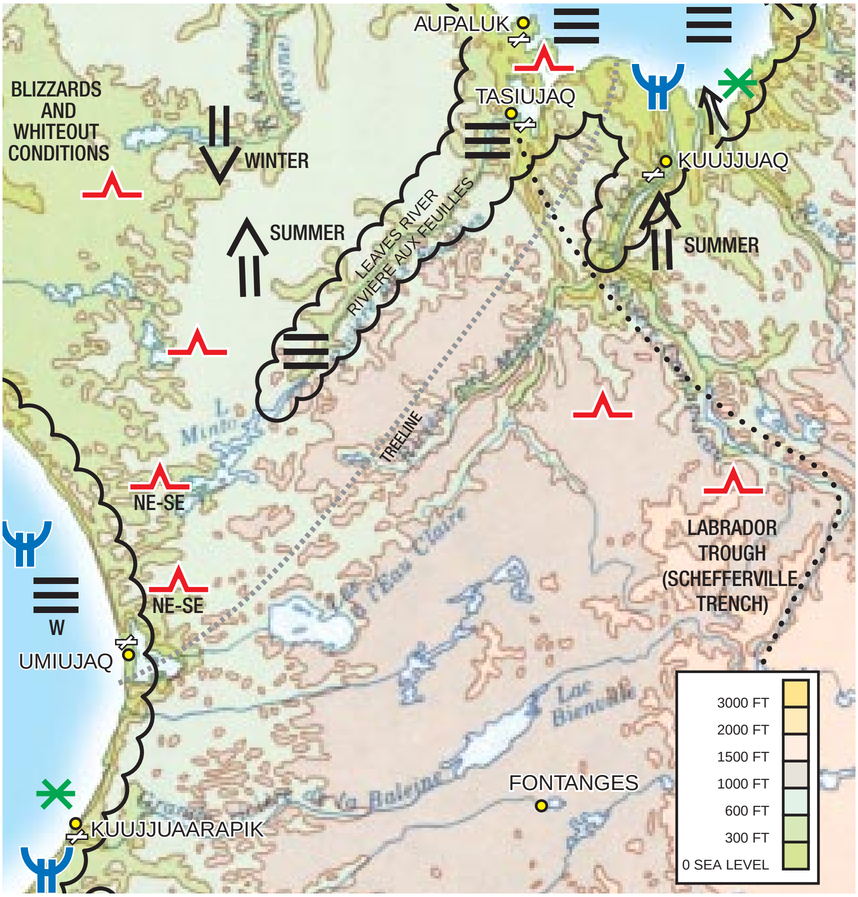
(d) Fall transition from mid-September to mid-November

Fog becomes less dominant as the land cools down. On the other hand, cooling lands favour the production of freezing drizzle, depending on weather systems. Freezing drizzle then tends to form in onshore / upslope flow off the sea. Icing is common over water and along the coast line. Conditions get better further inland.

Photo 4-1 - Advection fog and 500-foot stratus ceiling near Leaves Passage

copyright: Peter Duncan, Nunavik Rotors Inc.

Kangiqsualujjuaq to Kuujjuaq

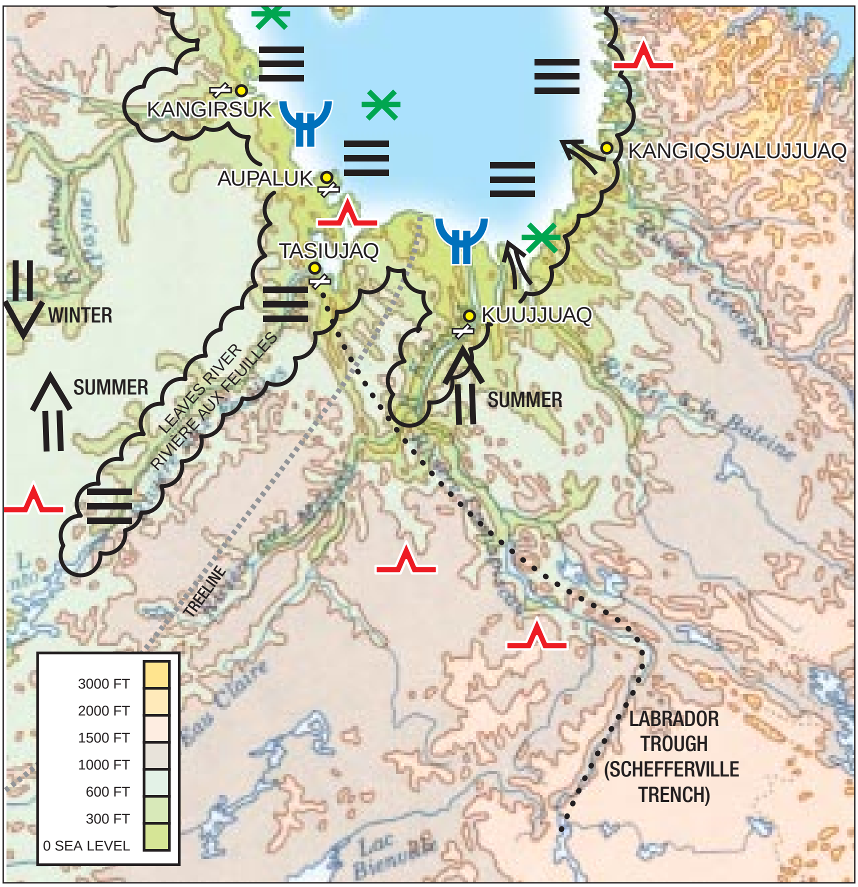


Map 4-20 - Kangiqsualujjuaq to Kuujjuaq

During the warmer months, onshore circulation results in persistent zero ceilings and visibilities in advection fog. Trapped under an inversion, this fog will not lift, regardless of how strong the sun. The worst conditions are generally encountered between the coast and the bank of the George River.

During cooler months, icing can also be expected in the fog. During the coldest months, numerous snow squalls will develop over the bay and move onshore, pushed by dominant northwesterly winds. Severe turbulence and icing, along with whiteout conditions, are usually encountered in these squalls. Strong turbulence can be expected when the wind runs crosswise to the fjord. It will be smoother when a strong, but steady and stable, wind is coming down the fjord. Additionally, strong katabatic winds, which have reached 80 knots on occasions, sometimes developed in various fjords at night.

Labrador Trough (also called Schefferville Trench)



Map 4-21 - Labrador Trough (also called Schefferville Trench)

The Labrador Trough starts at Tasiujuaq, goes to the Koksoak River, then follows the Caniapiscau River and continues on toward Schefferville. The trough is approximately 45 nautical miles wide. Moderate mechanical turbulence occurs frequently over this mountainous area throughout the year.

Riviere aux Feuilles (Leaves River)

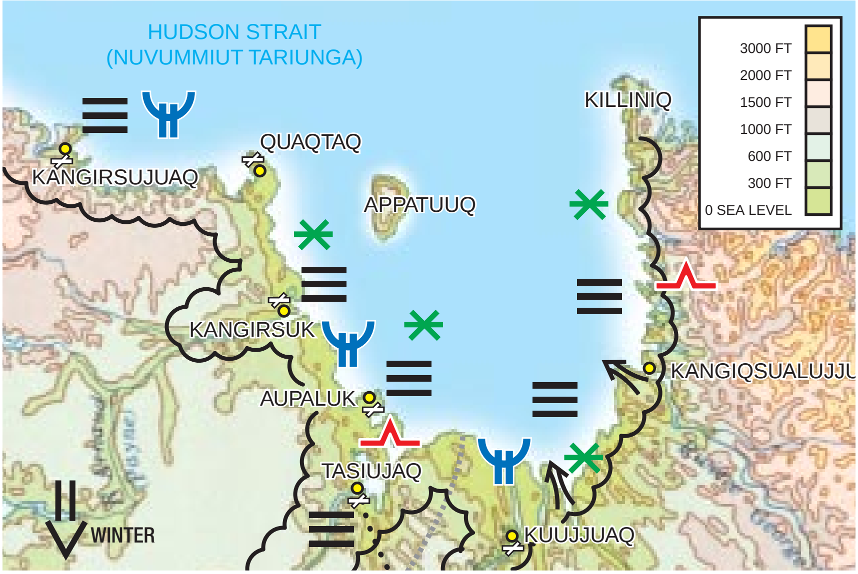
Leaves River, that is the area within 20 to 30 nautical miles either side of the river, is usually wrapped in fog or very low-level stratus cloud. The cloud cover occurs occasionally in summer but it is more generalized and persistent in the spring and the fall.

Tasiujuaq Area

Tasiujuaq is at the end of a very large bay, surrounded by mountains. Due to the geography, this area is subjected to some of the highest tides in Canada. At low tide, the water withdraws almost completely from Dry Bay and Whales Bay. While the bays do freeze up, Leaves Passage never freezes in winter. As a result northeast winds result in extensive advection fog, giving near zero ceilings and visibilities, or very low level stratiform clouds.

In winter, the passage of a cold front brings arctic sea smoke and ice fog. Additionally, strong northwesterly winds may result in moderate mechanical turbulence near the surface.

Aupaluk Area



Map 4-22 - Aupaluk Area

Aupaluk is well exposed to the waters of Ungava Bay. The land surrounding the aerodrome is composed of low lying marshes and, as a result, any wind coming from the northwest, the north or the northeast will bring in advection fog or very low stratus clouds. The fog and stratus clouds are usually extensive and tend to persist, especially in late spring or fall. Even southeasterly winds will push fog and stratus over the low-lying area toward the aerodrome.

This area of the bay usually freezes late in January, although freezing occurred later over the last few years. Light to moderate rime or mixed icing is frequent in the fog and stratiform clouds in cooler months, especially during the two transition periods. The cooler months will see more snow, which will give low visibilities when the circulation comes from the bay. Like Tasiujuaq, the passage of a cold front often brings northwesterly winds of 20 to 30 knots. These winds are perpendicular to the runway axis, making landing and take off problematic.

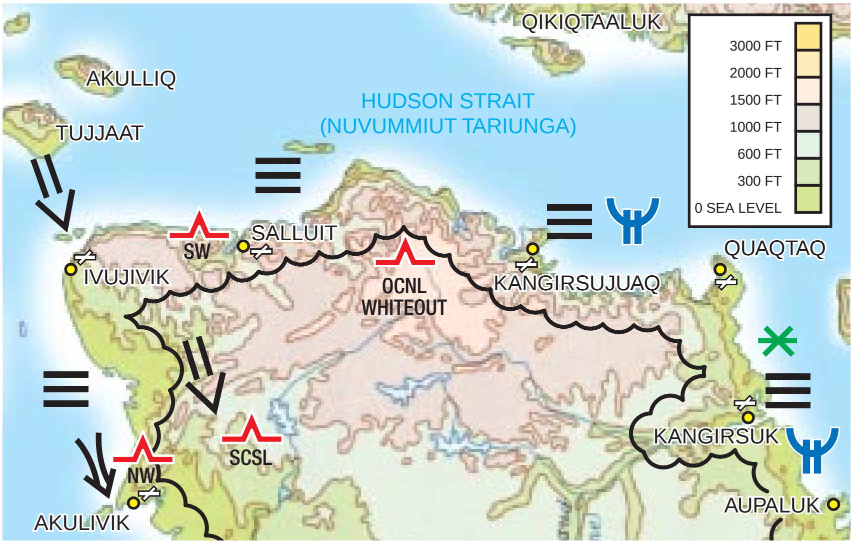
Kangirsuk

Kangirsuk is situated near the mouth of the Payne River, on its northern shore. The runway is located at an altitude of 383 feet ASL.

While the river eventually freezes in winter, Payne Bay does not and the limit of the ice usually ends only a few miles from the aerodrome. East or northeast winds continuously bring moisture and very low stratiform clouds with bases between 200 and 300 feet AGL. This results in the runway being in the cloud itself due to the runway elevation, with zero visibilities.

In late spring, the arrival of warm air while the ice has not yet cleared the coastal area of Ungava Bay, results in local cooling and poor ceilings and visibilities.

Area from Quaqtaq to Salluit to Ivujivik



Map 4-23 -Area from Quaqtaq to Salluit to Ivujivik

There are four aerodromes which are found along the Hudson Strait coast line. They are Quaqtaq (elevation 95 feet ASL), Kangiqsujuak (elevation 511 feet ASL), Salluit (elevation 742 feet ASL), and Ivujivik (elevation 137 feet ASL).

North of 60°N, strong coastal winds are common. In the depth of winter, violent winds from the southeast, in excess of 50 knots, are observed when an intense low pressure system moves from Hudson Bay to northern Baffin Island. After the passage of a cold front, northwesterly winds of 50 to 60 knots are often observed, mostly at night. Such winds usually generate significant mechanical turbulence along the coast, especially in Kangiqsujuak and Salluit, due to the high elevation of their respective runways.

Quaqtaq is situated on the north-western tip of Cape Hopes Point. It is surrounded from most directions by the waters of Hudson Strait. As a result, Quaqtaq experiences extensive fog or low stratus (ceilings 400 to 500 feet AGL) during the ice-free season, with a temperature-dew point spread of only one degree for long periods of time. An inversion tend to persist over the area due to the cold temperatures of the land and water so that Quaqtaq tends to remain shrouded in fog banks even with high winds.

Spring arrives very late, usually in the latter half of June, several weeks after surrounding localities. Icebergs can sometimes be found stuck between Quaqtaq and Hearn Island, or in Diana Bay. On the other hand, turbulence occurs very rarely in Quaqtaq.

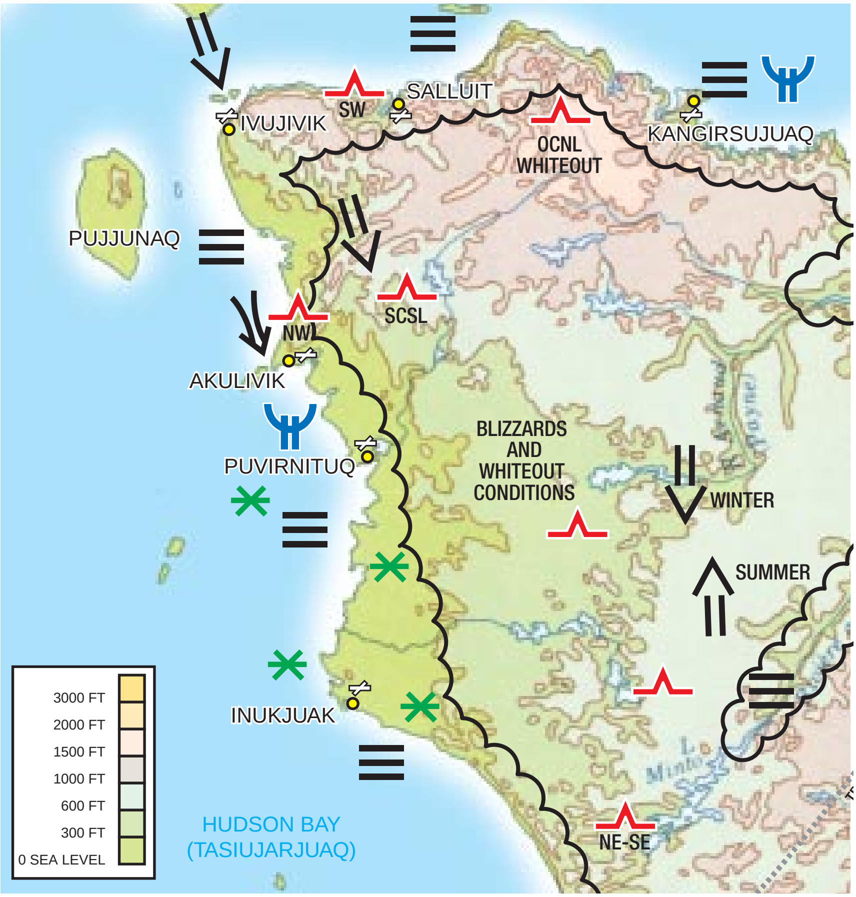
Salluit aerodrome is located on top a cliff, approximately 740 feet above the actual village, on the east side of Sugluk Inlet. Dominant winds are from the northwest, perpendicular to the inlet and to the runway. For their part, northeasterly winds are rare and usually occur with speed of 2 knots or less. In Salluit, the turbulence generated in summer or fall by winds of 20 knots or more, from a direction varying from southwest to west, is often too strong to allow for passenger flights.

With northwest winds, the village often experiences a 500-foot stratus ceiling while the runway is shrouded in thick fog. Such a situation can last for three to four days, until the wind direction changes. This occurs throughout the year.

In Ivujivik, the aerodrome is surrounded by flat land to the south and the east, and with water to the north and west. Fog is frequent during the ice-free months.

The waters along the coast line freeze solid by end-January. For the following months (February through May), flying conditions are excellent with the best conditions in April, and the air temperature is in the -30°C to -35°C range. Ivujivik is subjected to very strong northwesterly winds, especially behind a cold front. It is worth noting that it usually takes about three hours for the weather conditions at Ivujivik to move to Salluit (with a front moving at 20 knots).

Akulivik and Puvirnituq
(northern section of the east shore of Hudson Bay)



Map 4-24 - Akulivik and Puvirnituq

Akulivik and Puvirnituq are separated by approximately 54 nautical miles and, as such, their weather tends to be quite similar. Akulivik is situated on Chanjon Point, on the western tip of the d'Youville Mountain Range. Puvirnituq, on the other hand, is surrounded by flat lands to the east and the Povungnituk Bay to the west. In this area the waters of Hudson Bay freeze for a good distance to the west.

The predominant winds are from the northwest and low stratus cloud (ceilings 500 to 600 feet) is common. Additionally, north or northwest winds usually cause moderate mechanical turbulence in Akulivik, due to a mountain to the north and the runway axis (NE - SW) respectively.

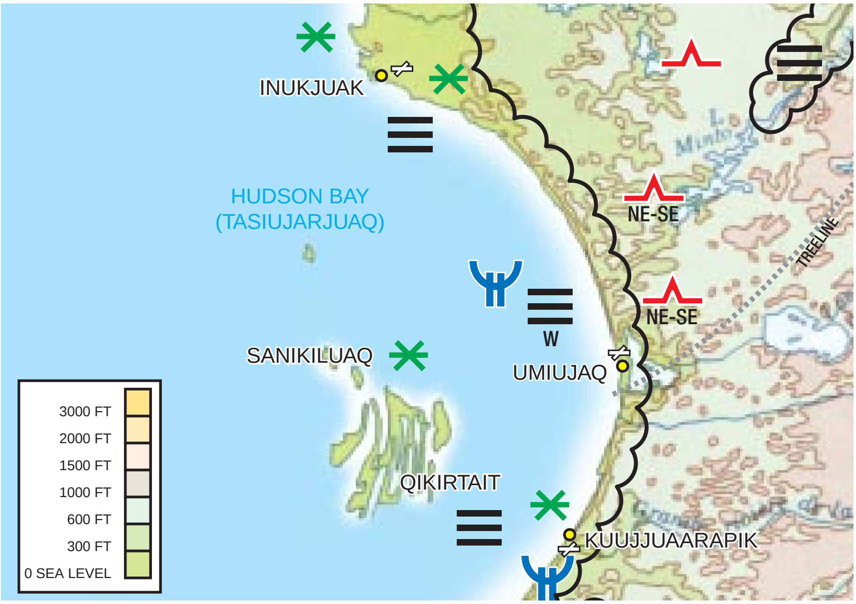
Inukjuak

During the ice-free season, fog banks and stratus are common, whenever the wind comes from any direction between south and west. When this happens, near zero ceilings and visibilities are frequently encountered.

During the fall, when arctic air (air temperature of -8°C or less) invades over still warm waters, snow squall activity becomes prevalent giving near zero ceilings and visibilities, along with moderate turbulence and icing.

Once the eastern section of Hudson Bay freezes over, flying conditions become favourable when the wind dies down, especially in January and February. As soon as the wind picks up, blizzard conditions and whiteout can be expected. The ice is usually present on the eastern Hudson Bay until mid-July. As long as the ice lasts, the fog that does advect in off Hudson Bay usually only moves inland about 10 miles.

Umiujaq



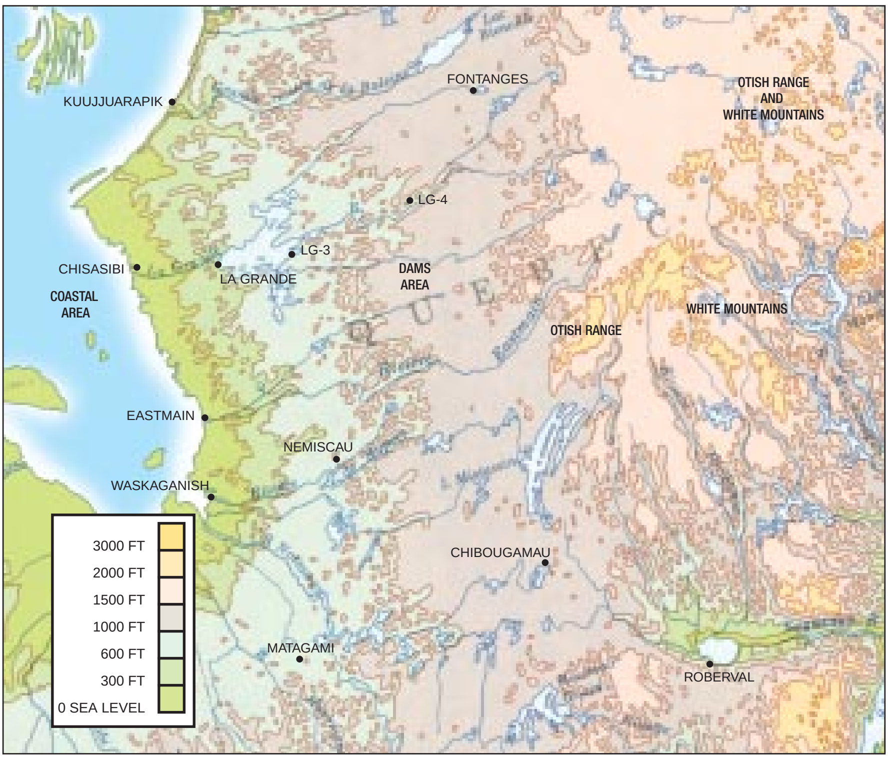
Map 4-25 - Umiujaq

Umiujaq is situated on the coast of Hudson Bay and abutted against a narrow north to south hill range to the east of the aerodrome, culminating at 1,415 feet ASL in its immediate vicinity. A chain of flat islands, the Nastapoka Islands, runs parallel to the coast, separated from it by a narrow sound.

Orographic effects create particular weather-related problems for flight operations. Winds coming from any direction between northeast and southeast, over the hills, generate significant mechanical turbulence over the runway. During the ice-free season and the fall transition period, westerly winds generate combined onshore and upslope flows, which produce very low stratus clouds, with ceilings of 200 to 300 feet, and visibilities of less than one mile in drizzle and mist (or fog). When the air temperature hovers just below freezing, the precipitation may be freezing drizzle and significant icing should be expected.

Once the ice sets on the Bay, the stratus ceiling tends to rise to 500 feet and the visibility improves. Being north of the tree line, there are no easy visibility markers beyond the runway for a plane on final approach, during the winter and early spring season. As with aerodromes further north, Umiujaq can be subjected to snow squall activity in the fall.

James Bay Region



Map 4-26 - James Bay region

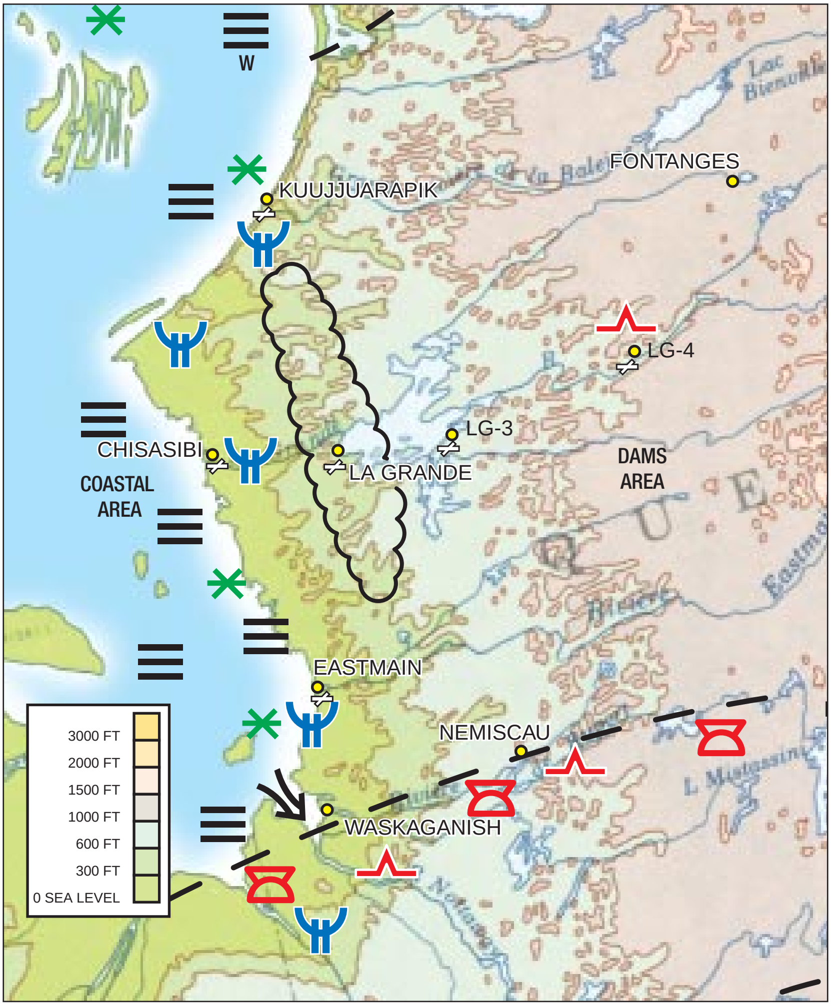
James Bay, its seawater either frozen or open, is the major controlling element of weather in this area. When open, between June and December, James Bay is a major source of low cloud, fog and icing. Frozen over the rest of the year, the area resembles a frozen desert. To further complicate this area, the large reservoirs of Hydro-Quebec dams, rivers, and a multitude of lakes all add their own effects to the local weather.

The winter weather in this area is typical of this latitude. Long periods of cold and clear weather occur when the frigid air covers the region. The most active weather tends to occur in the transition seasons, spring and fall, when larger weather systems move across the area.

Summer is a time of convection. Turbulence, sufficient to affect passenger flights, remains a rare occurrence and, when it happens, it is usually associated with thunderstorm activity. Most of the larger convection occurs south of a line from Moosonee to Waskaganish to Nemiscau, although individual cells are sometimes observed north of that boundary. South of the boundary, thunderstorms usually travel in bands from west to east. Hydro-Quebec flights, returning from any airports in the James Bay Area to Montreal, Quebec City, or Bagotville, usually encounter thunderstorm activity along a specific line around 3 to 4 p.m. during the summer. These cumulonimbus clouds travel along the same trajectory day in and day out. This trajectory, a general east to west line, passes approximately 7 nautical miles south of Matagami, to approximately 13 nautical miles south of the Chibougamau NDB, to approximately 23 nautical miles south of the Chute-des-Passes NDB, then continuing on eastward.

Local effects

Coastal Area



Map 4-27 - Coastal Area

(a) Winter and spring

Flying conditions are usually good along the coast in winter and early spring. On very cold winter days (and nights), the visibility can rapidly be reduced to 1/2 to 3/4 statute miles by ice crystals. Chisasibi, like Kuujjuarapik, are particularly prone to this phenomenon.

Turbulence is seldom encountered at this time of the year and when it does occur it tends to be localized, generally associated with surrounding topography. As for icing, it is very rare once James Bay is frozen. It does occur, however, over a two-week period when the air starts to warm up and before the ice goes, usually in May. Freezing drizzle and SLD icing, due to liquid phase low stratus clouds, are sometimes observed along the coast in late spring. It is a lesser problem in the fall since the air temperature near the surface is usually above freezing. In late spring, fog starts to form offshore over the ice. It is inclined to remain there but Eastmain Airport, being situated on a piece of land protruding farther into the bay, is more often affected by the fog, with visibilities around 1/2 to 1 statute mile.

(b) Summer

Flying conditions are generally favourable. Light westerly and northwesterly winds may bring in fog from the bay, but it does not stay long during the daytime. The fog moves in at sunrise and it usually lifts between 9 and 10 a.m. It also comes ashore during the late afternoon, usually between 5 and 6 p.m., and stays throughout the evening, before lifting after midnight. Visibilities are sometimes restricted in smoke from forest fires. Along the coast, Waskaganish is the airport most affected by smoke.

(c) Fall

Like Nunavik, flying conditions are more challenging during the fall transition period. The most dangerous icing conditions are associated with low-level stratiform cloud forming in the onshore and slightly upslope flow. These clouds consist mainly of large cloud drops, producing freezing drizzle and significant icing. These clouds usually top between 4,000 and 5,000 feet, where the icing is the most severe. The problem is further accentuated when the air temperature at the surface is between 0°C and -5°C. Several of the local carriers provide special training to their pilots, who will be operating into the coastal sites, on how to handle these conditions.

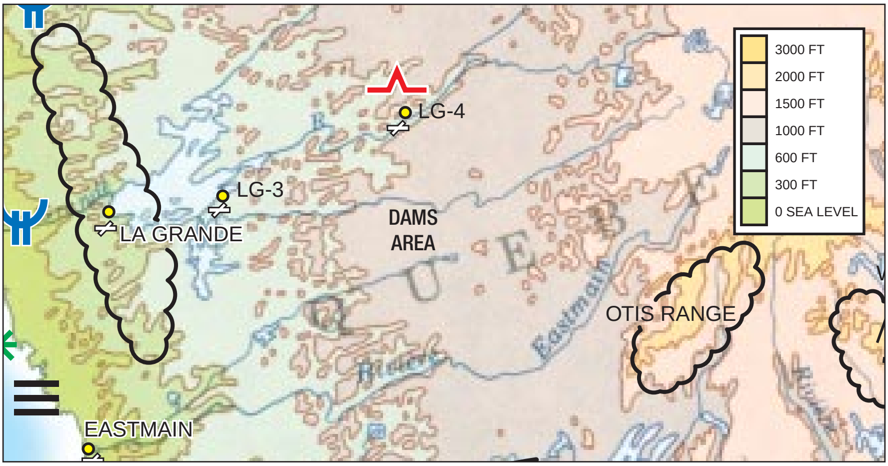
Although significant turbulence remains a rare occurrence in the fall, this is the season when it is the most frequent. Even scheduled flights are cancelled 3 or 4 times in the fall, usually in October or November, due to the dangerous turbulence associated with strong winds along the coast.

Low level clouds usually occur throughout the year. The associated ceilings are usually above 1,000 feet. Precipitation is more common in the afternoon than at any other time. Visibilities of 1/2 statute miles are frequent in precipitation, regardless if it is rain or snow. These lower visibilities are usually associated with westerly to northwesterly winds. Southerly winds in the summer generally result in higher values.

Wind shear layers are very rarely observed in the James Bay Area, regardless of the time of year. One problem area is Waskaganish, where northwesterly winds tend to be faster than anywhere else. Typically, Waskaganish may experience 30 knot winds while they may be 20 knots elsewhere. This is likely due to the localization of the airport deep in Rupert Bay, the latter acting like a funnel, accelerating the wind.

This phenomenon is less common in summer, due to the higher frequency of southerly winds. Speeds up to 50 knots have, however, been observed with northwesterlies in summer, when the air temperature reaches 28 to 30°C. This is likely due to a combination of funnelling and the stark temperature contrast between hot land and cold water temperature in the Bay.

Dams Area



Map 4-28 - Dams Area

A series of airports have been built to service Hydro-Quebec dams. The better known are those along the river called "La Grande Riviere": La Grande 2, La Grande 3, and La Grande 4. Other northern dams being regularly serviced are Nemiscau, Fontanges and Chute-des-Passes. Hydro Quebec has contracted out daily scheduled flights to and from these dams and the southern cities of Montreal, Quebec City, and Bagotville.

In normal years, the seasonal changes, from winter to summer conditions and vice versa, usually occur over a short two-week period. For example, the fall transition generally occurs around Halloween, October 31st. This is due to the fast freezing of rivers and lakes during very cold nights.

Throughout the year, turbulence and low level wind shears are very rare due to the general flatness of the landscape. They can, however, be encountered at some airports due to local rugged terrain. For example, southerly or southwesterly winds will produce crosswind turbulence at La Grande 4, due to the rugged terrain to the south of the airport and the east west orientation of the runway. Another case is with northerly winds at Nemiscau (elevation 800 feet), due to the presence of an 1,800-foot hill just to the north of the airport with a very steep southern face, causing strong downdrafts and moderate or stronger mechanical turbulence. Fortunately, these occurrences at Nemiscau are very rare as predominant winds are from the south or the southwest.

(a) Winter and Spring

Once the ice has set on the lakes, reservoirs, and rivers, visibility becomes bound only by the horizon, and the sky is generally cloudless. These excellent flying conditions are only interrupted when a large-scale weather system passes through the area. As a result, only 30 percent of Hydro-Quebec flights require an instrument approach. On extremely cold days (e.g. -45°C at night and -35°C during sunny days), ice fog may occur but it is rare and seldom affects flights. Similarly, engine-exhaust contrails, produced by the aircraft turboprop engines on take off, usually dissipate 200 to 300 feet behind the aircraft. These clear conditions usually last until the end of May. During the spring transition period, instrument approaches become more frequent and mud becomes an issue at some airports. Low pressure systems are moving through the area, at that time, with their clouds and precipitation. Easterly winds are then observed, announcing warm frontal weather conditions: nimbostratus and low level stratus, rain, drizzle and mist reducing ceilings and visibilities. These reductions are usually less severe than those observed in the fall.

(b) Summer

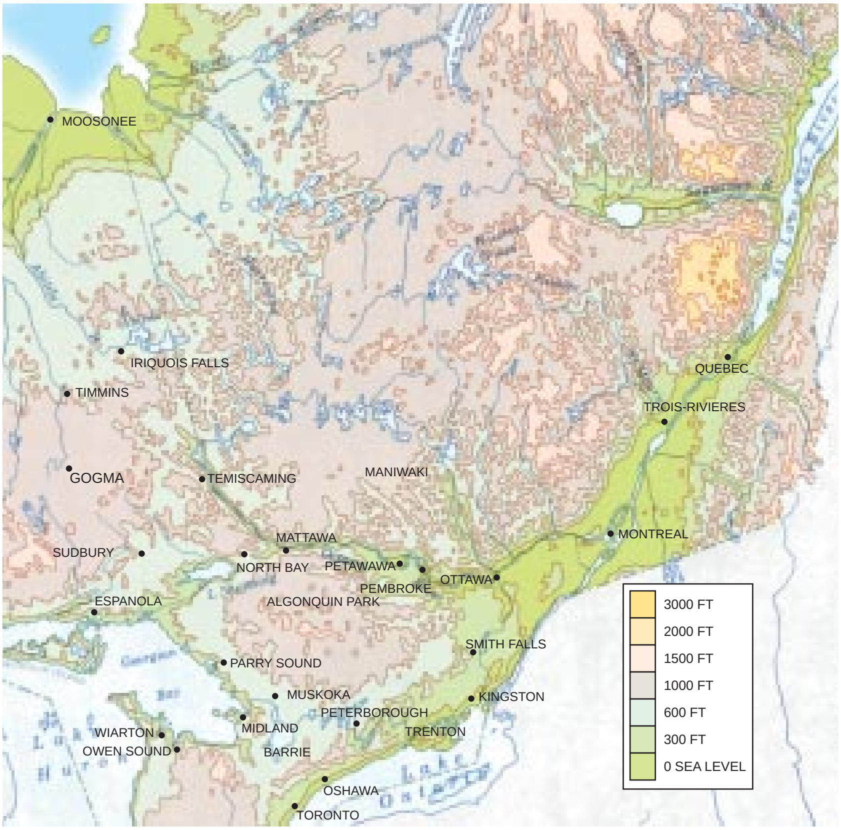
Summer flying conditions are usually not much of a challenge. Scattered or broken cumulus or stratocumulus cloud based at 3,000 feet AGL are generally encountered over the area. Lower conditions may occur when a warm front or a cold front goes through the area. Isolated thunderstorms can develop on moist and unstable days. Turbulence is rare, except for the convective turbulence associated with the cumulonimbus and towering cumulus (cumulus congestus). La Grande 3 Airport is subjected to localized turbulence close to the airfield on hot and sunny summer days. There is a sandpit 1/4 statute miles to the east end of the runway, immediately followed by a small land depression. On these days, fixed wing aircraft are subjected to a sudden loss of altitude, approximately 50 feet, as the aircraft moves over the ground depression after passing over the sandpit. This is caused by differential heating of the two ground surfaces by the sun.

(c) Fall

During the fall transition period, up to 70 percent of flights require an instrument approach. Easterly winds become more frequent as low pressure systems move through the area in an incessant ballet, bringing with them their warm frontal weather conditions. The cooling ground and shortening days contribute to the formation of mist and fog in the rain, thus reducing visibilities further. A change from rain to snow, or vice versa can also occur. Freezing precipitation can sometimes be observed as well.

Westerly winds from James Bay can carry very low stratus cloud, mist, fog and sometimes freezing drizzle in upslope circulation along the largest rivers up to 60 nautical miles inland. La Grande 3, not far away, is immune to these westerly low ceilings and visibilities. Light rime or trace icing is usually encountered in low pressure system cloud between 10,000 and 18,000 feet ASL. A quick transition through liquid-phase, low-level stratus coming from Hudson Bay (on approach or takeoff) does not seem to cause much of a problem for larger aircraft (Bombardier Dash-8 or Convair 580). However, the SLD icing and freezing drizzle generated by these low-level clouds may endanger small aircraft, which usually fly at these altitudes.

Northwestern Quebec

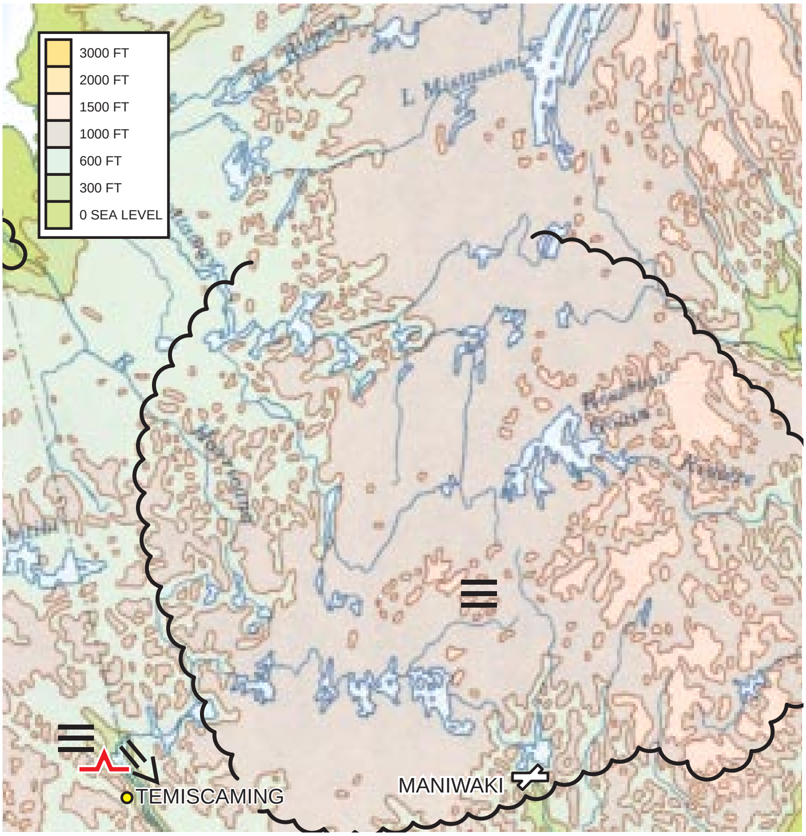


Map 4-29 - Northwestern Quebec

Northwestern Quebec, the area southeast of James Bay, essentially has two season of the year. In the dead of winter, a continental regime of cold arctic air prevails, giving excellent flying conditions along with frigid air temperatures that have their own adverse effects on ground operations and piston engines. Furthermore, jet engine exhausts being rich in moisture tend to generate ice fog.

Summer is the convective season. With the warmer temperatures thunderstorm activity is the main weather maker.

Chibougamau Mistassini Area



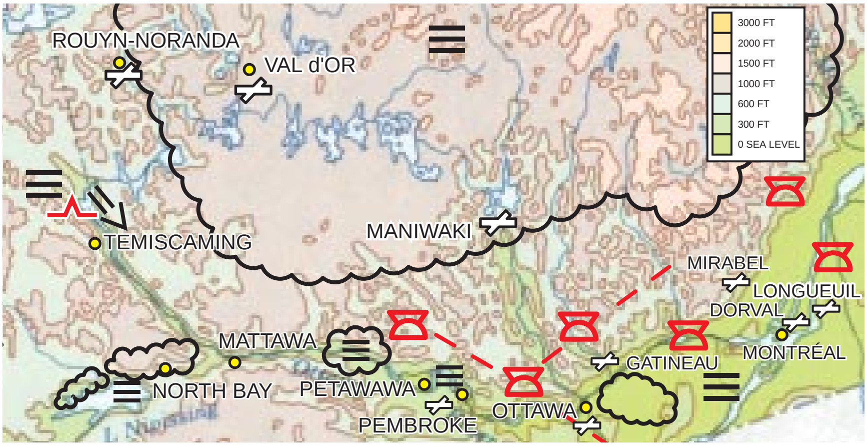
Map 4-30 - Chibougamau Mistassini Area

The terrain around Matagami is relatively flat with marshlands to the northwest and a large lake to the northeast. There is a hill to the east-northeast of the airport, which can generate significant turbulence when the wind comes from that direction. Northeasterly winds can bring fog over the airport in the fall. At any other times, flying conditions are usually good in Matagami.

Chibougamau is a different matter altogether. The land is much higher in Chibougamau than in Matagami. There are lakes in every direction from the airport with a very large one, Lake Mistassini, further to the northeast. There are also higher mountains to the north-northeast and to the east. As a result, winds coming from any of these directions can produce moderate or greater turbulence. Pilots report that clouds tend to close in faster than elsewhere while ceilings and visibilities lower very rapidly. As a result, flying conditions deteriorate much faster and much sooner in the Chibougamau area than anywhere else when a large-scale low pressure system moves in from the west or the southwest. Low stratus clouds, with bases around 400 or 500 feet AGL, are frequent and sometimes are even lower. Flights must frequently be redirected to a nearby airport where conditions are much better.

During the summer months, usually July and August, a quasi-permanent line of cumulonimbus clouds, producing thunderstorms, can be observed in a line passing to the south of Matagami and Chibougamau, and extending to the west and to the east of these two land marks. These thunderstorms usually reach their full development between 3 and 4 pm.

Abitibi Area



Map 4-31 - Abitibi Area

Most of the weather problems in this area occur during the summer or the fall. During the winter the continental regime which predominates generally results in excellent flying conditions. Strong southwesterlies can sometimes push lake-effect streamers generated over Lake Huron and Georgian Bay all the way to Val d'Or. Freezing precipitation is a very rare occurrence in this area. Local weather specialists could only recall two cases of freezing rain in early winter over a nine-year period.

The weather conditions in the western portion of the area seem to be somewhat poorer than further east. This might is likely due to the presence of Lake Abitibi to the northwest and a better alignment with James Bay with the onset of northerly winds, generating upslope flow over rising elevations.

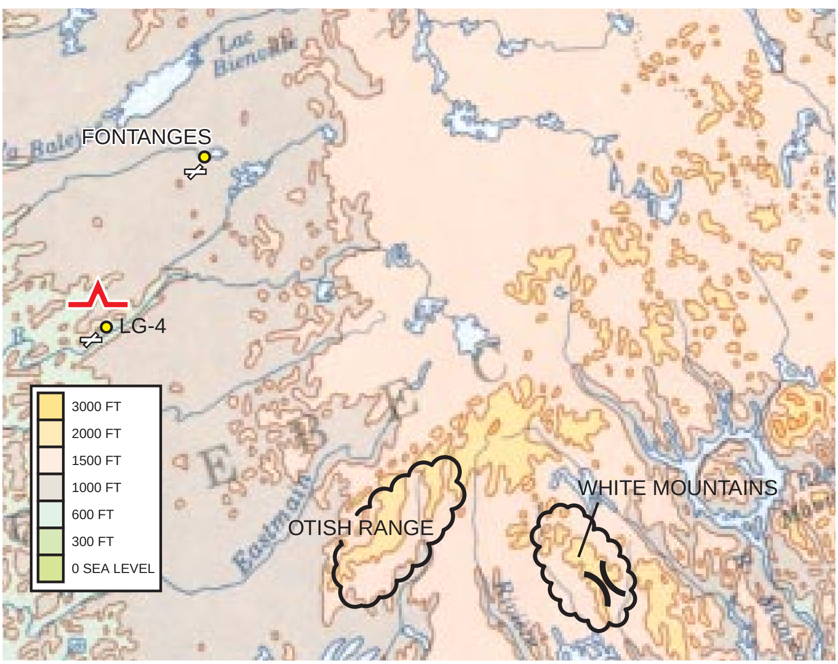
Summer convection tends to create challenging flying conditions. The nature of the terrain and the vegetation combines with favourable weather conditions to give frequent, strong and violent thunderstorms with hail, weak tornadoes (F0) and "Chablis", especially in the La Verendrye Park, situated to the southeast of Val d'Or. Some of the affected areas are well travelled due to fish being abundant in many lakes.

A "Chablis" is a localized-forested area where all or most trees have been felled in either in a line or a star or spiral pattern. The line is usually indicative of a very strong gust front. The star pattern is usually indicative of a downburst or a microburst while the spiral is usually produced by a weak tornado. At other times, high-based (often 10,000 feet) towering cumulus clouds are frequent in the summer. It is prudent to watch for telltale signs of strong descending winds, causing downbursts or microbursts and severe turbulence. These signs can be a swirl of dust at the surface underneath the cloud or the presence of virga. The complete evaporation of the rain aloft results in adiabatic cooling which generally results in a significant acceleration of downward winds and an increase of the associated turbulence.

Cold fronts tend to be very strong and to accelerate as they move across the Abitibi area in August, fall and winter. Large and rapid temperature drops are often noticed with the passage of the front. Behind the front the northwesterlies often generate 1,000-foot thick stratocumulus clouds based around 3,000 feet AGL until the lakes freeze over in the fall.

Throughout the Abitibi area there seems to be some delay in clearing lower clouds after the onset of a northwesterly circulation in the fall and in the spring with regard to other times of the year.

Otish Range and White Mountains Areas



Map 4-32 - Otish Range and White Mountains Areas

The Otish Range is oriented along a southwest-northeast axis with peaks up to 3,725 feet ASL. Low-level clouds tend to hang on along the Otish Range with very low ceilings and very poor visibilities and no holes in the clouds to pass through. Ceilings and visibilities improve somewhat when there are very strong winds. However, aircraft have to handle moderate to severe lee wave turbulence.

The White Mountains, with peaks up to 3,400 feet ASL, are surrounded by the Riviere-des-Montagnes-Blanches to the west, the Manouanis River to the south, the Outardes River to the East, Pletipi Lake to the northeast, and the Lac-aux-Deux Decharges to the north. The area is rugged with very narrow river valleys. When weather conditions go bad, pilots have nowhere to go.

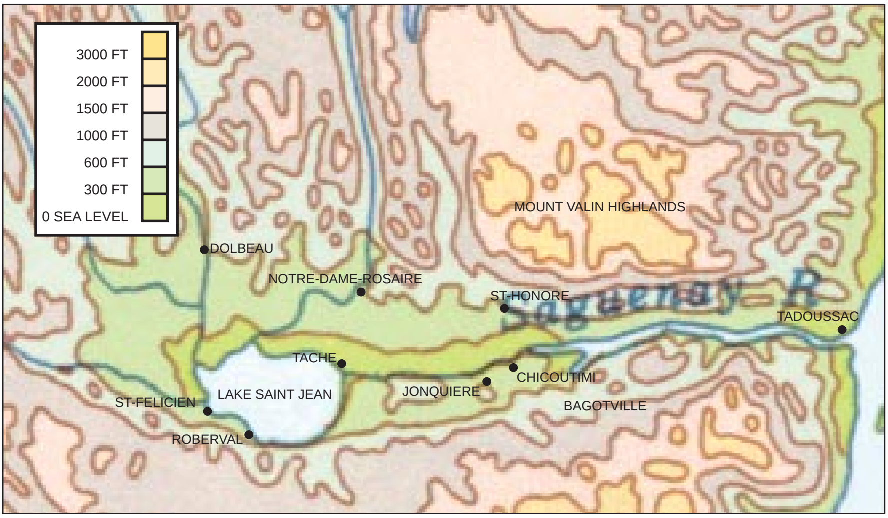
Saguenay, Lake Saint-Jean, and surrounding mountainous terrain

The weather conditions in the Saguenay River Valley and surrounding area are strongly influenced by Lake Saint-Jean itself and the mountains surrounding the valley. As a moisture source, Lake Saint-Jean usually freezes in early December and its ice melts in early May.

When the trajectory of large-scale, low-pressure systems is to the north of the Saguenay River Valley, this induces a southwesterly flow over the area (except in the valley itself). Most of the precipitation falls over the Laurentides Wildlife Reserve and little falls in the valley. On the other hand, if the trajectory is south of the valley, predominant winds are from the east and most of the region can expect generous precipitation and low ceilings and visibility. The general circulation is from the northeast, the Mount Valin Highlands act as a barrier, offering good protection and resulting in minimal precipitation amounts.

Local effects

Saguenay River Valley



Map 4-33 - Saguenay River Valley

Throughout the year, predominant winds tend to be aligned with the valley. Easterly winds are generally associated with deteriorating weather conditions while westerlies are a precursor of fair weather or clearing. Poor weather conditions associated with an approaching large scale low pressure system usually reach the airport of St-Honore three to four hours after reaching Roberval.

Winds aloft, however, are frequently from the southwest. Low-level wind shear near the ground is a rare occurrence in the upper Saguenay River Valley. When present, the wind shear is usually encountered between 1,500 and 3,000 feet ASL in the St-Honore area. The altitude and strength of the wind shear usually depends on the intensity and height of the temperature inversion.

Pilots usually avoid flights in the lower Saguenay River Valley (also know locally as the Saguenay Fjord) due to its narrowness, its deep canyon-like topography and the presence of high power electric transmission lines crossing the river. As a result, little information is available for the Fjord. Experienced pilots, who have occasionally used that route, have indicated the occasional onset of moderate to severe mechanical turbulence from L'Anse-St-Jean to Tadoussac, then along the north shore of the St. Lawrence toward Charlevoix.

Low-level moderate mechanical turbulence is often encountered over an area extending from the western half of Lake Kenogami, up to and including the northern bank of the Saguenay River.

Due to the shape of the valley, there is a sharp funnelling of northwesterly winds, resulting in frequent westerly winds of 40 knots, or above, over the river. Wind speeds of 70 knots have been reported on occasion by Coast Guard ships in the Fjord.

(a) Spring

Flying conditions are usually fair in the valley. When clouds are observed, pilots in the area report cloud bases are typically between 3,000 and 4,000 feet ASL. North of the Saguenay River, just to the east of Lake Saint-Jean, when the wind is from the south or the southwest, fog is sometimes observed in April and May. This fog often lasts all day. Light rime icing in cloud is encountered at altitudes of 5,000 to 10,000 feet ASL, in early spring.

(b) Summer

Flying conditions are generally favourable in the valley. Thunderstorm activity tends to remain over mountainous terrain during the day, drifting toward the valley in late afternoon. Most thunderstorms tend to follow one of two tracks situated on either side of the valley. The southern track starts south of Lake Saint-Jean and continues eastward, passing to the south of Canadian Forces Base (CFB) Bagotville. The northern track begins at Dolbeau and follows the southern edge of the Mount Valin Highlands.Some of the strongest thunderstorms, producing hail, are often found along this northern track, between Lake Labrecque and Lake Sebastien. The visibility easily lowers to 5 statute miles in the rain and sometimes as low as 3 miles. Pilots report that convective clouds usually tend to develop from Alma to Bagotville with a base between 3,000 and 4,000 feet ASL. On these days, light to moderate convective turbulence can be expected over most of the valley flat lands. This is common in June, July and August.

(c) Fall

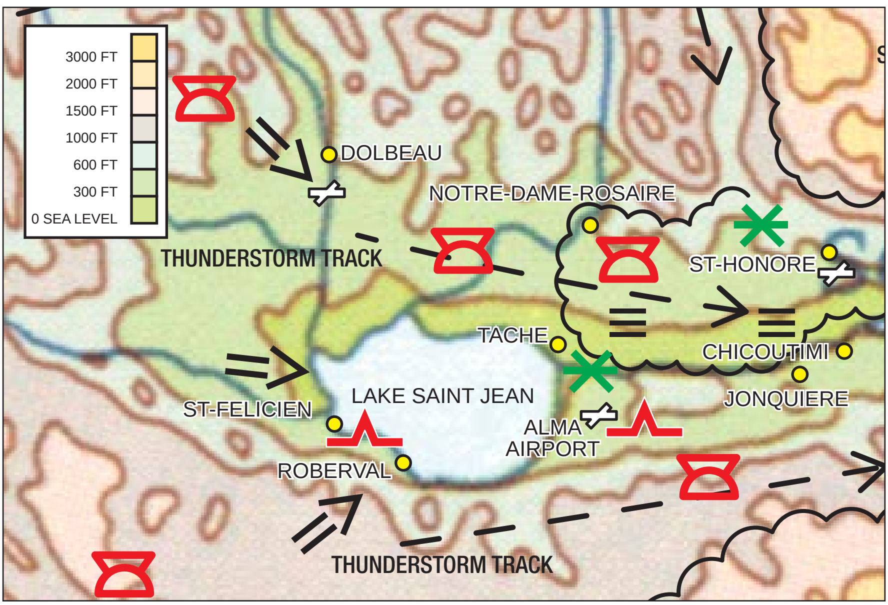
In October, fog is often observed just to the north of Lake Kenogami. In the same month, fog often forms over the Saguenay River just after sunrise, extending to just south of the St-Honore Airport with light southwesterly winds, lasting all morning and dissipating around noon. When the wind increases, the fog bank can extend to the southern half of this airport. From mid-November to late-December, low stratus clouds (with ceilings around 1,500 feet above ground), virga and snow (with visibilities as low as 1-1/2 statute miles) are frequently encountered in an area extending northward from the Saguenay River to the hills, and bound by Tache, Notre-Dame-du-Rosaire, St-David-de-Falardeau and St-Honore. Further to the east up to the foothills, cloud ceilings lower to 1,000 feet above sea level. From late-October to mid-December, clouds are ever present with a cloud base varying between 1,500 and 2,000 feet. Snowfalls come in waves, usually caused by arctic air moving over the still-warm waters of Lake Saint-Jean, amassing moisture and energy, and producing strong convection. Vsibilities can lower to 1/8 statute mile in these heavy snowshowers.

Freezing precipitation is a rare occurrence in the valley. On these occasions, this is freezing drizzle which is generally being reported. It happens when the air temperature in the valley remains around zero to -2°C, although the warm air and the associated rain may reach the terrain north of the valley. The wind in the valley is then predominantly from the east.

(d) Winter

Flying conditions are usually excellent in the valley once Lake Saint-Jean freezes over, save for the occasional snowfalls usually due to large-scale low pressure systems. The weather regime becomes continental with very cold temperatures. Flying then becomes mostly limited by these frigid temperatures, although the sky is usually clear and the visibility unrestricted. When the wind blows from the west-northwest in late fall and winter, there is an area between Larouche and Jonquiere where snowshowers tend to last longer than elsewhere. A visibility of 3 statute miles is common in snowy precipitation. On very cold days, mist or ice fog is often observed in the Chicoutimi area due to the presence of open waters in the Saguenay River, up to the Shipshaw hydroelectric dam and moisture laden smoke coming from the various aluminium- and paper-making plants.

Lake St. Jean Area



Map 4-34 - Lake St. Jean Area

Throughout the year, weather conditions are generally favourable to low-level flights. The predominant winds are usually from the southwest to the northwest. Most of the thunderstorms form over the hills surrounding the lake in the summer and remain there. Others that are north and south of the lake move east toward the Saguenay River Valley.

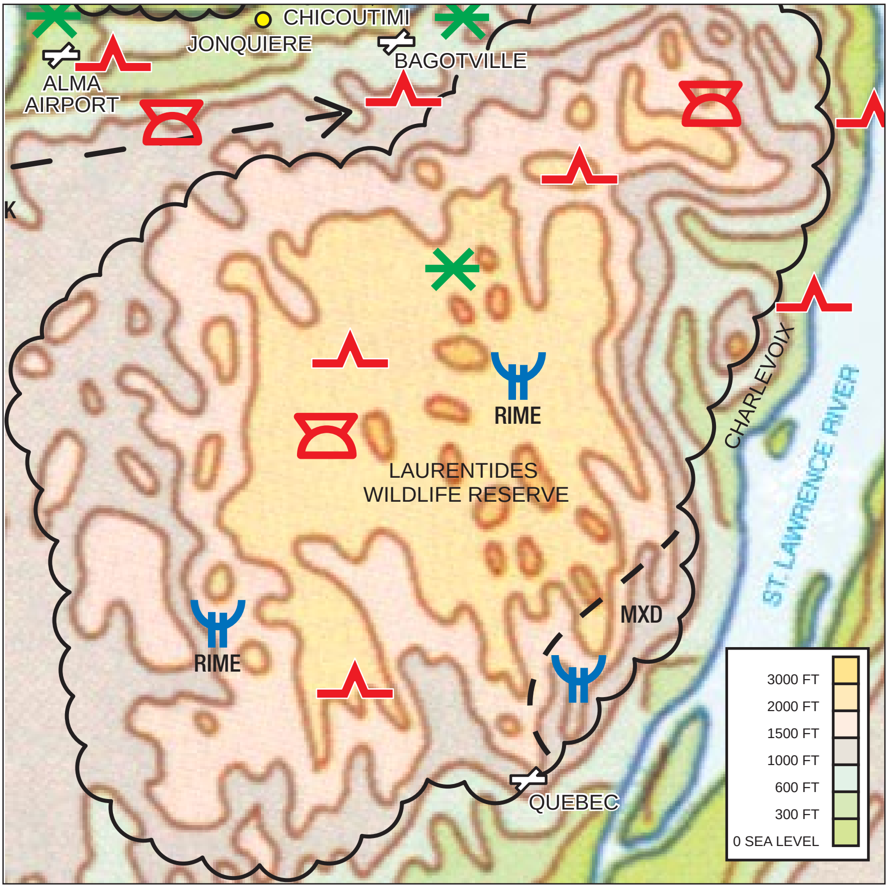
Fog tends to form over the lake in May with the arrival of warmer airmasses and their passage over the near-freezing waters and remaining ice floes. The fog is then transported inland by the generally associated southwesterly flow.

There are three airports around the lake (Alma to the east, Roberval to the southwest, and Dolbeau to the northwest) and three hydrobases (St-Felicien to the west, Roberval so the southwest and Alma to the east). These airports and hydrobases are well situated since predominant winds are coming from the land instead of the lake. This is especiallt true for Alma, where the airfield is sufficiently to the south to be out of the main track followed by the fall lake-effect snow. The runway in Dolbeau is well aligned with the predominant winds, thus reducing the occurrence of mechanical turbulence. In Alma, crosswinds are frequent but the forest nearby acts as a screen and the wind dies down on the runway. There can be some mechanical turbulence on approach, however. There may also be some convective turbulence over the lake in the fall but pilots seldom fly over the lake, usually electing to follow the shoreline.

Pilots are reporting that cloud ceilings are generally above 3,000 feet ASL and visibility above 6 statute miles around the lake. They also report the presence of a very localized high-pressure system around the lake in the summer, likely due to the cold water.

Mechanical turbulence and wind shear are rare occurrences around the lake. There is, however, a small section of the shore to the southwest of the lake where mountainous terrain approaches the shoreline. This closeness generates low-level moderate mechanical turbulence over a distance of approximately 10 nautical miles, with occasional low-level wind shear. This turbulence is more prominent in the summer than in winter.

Laurentides Wildlife Reserve



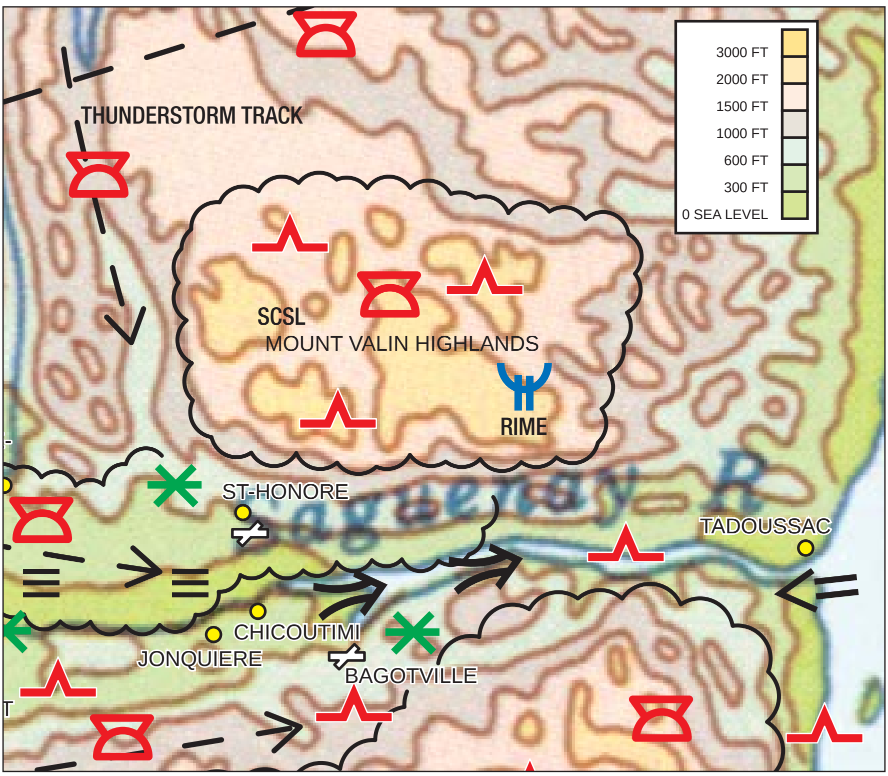
Map 4-35 - Laurentides Wildlife Reserve

Low-level clouds are predominant over the Laurentides Wildlife Reserve, formerly known as the Laurentides Park. This is a vast area of rolling highlands, part of the Canadian Shield, which culminates at 3,825 feet ASL. There is an upslope circulation from every wind direction. Additionally, the nature of the terrain favours the convective activity. As a result, the Laurentides Wildlife Reserve is cloudy most of the year. Pilots report that clear skies may be encountered in this area only 6 or 7 days per year. Cloud bases are usually above 1,000 feet, which means that these clouds frequently obscure the mountaintops. The base can be less than 1,000 feet if the airmass is very unstable. Beneath the clouds, low visibility is frequent in mist or in precipitation. The lowest ceilings and visibility are generally in the fall and in winter. Local pilots have noted that the top of the clouds over the wildlife reserve is usually found between 6,000 and 8,000 feet ASL. The first snowfall in the Laurentides Wildlife Reserve usually occurs in mid-September.

Pilots also report the presence of a permanent area of moderate mechanical turbulence and wind shear below 6,000 feet ASL along the foothills, extending east-south-eastward from the eastern tip of Lake Kenogami for at least 20 nautical miles. This is usually observed when the wind is from the south or the southwest. Pilots of smaller planes flying at 3,000 feet ASL, on approach to the Bagotville Airport, sometimes report moderate to severe mechanical turbulence when crossing this narrow area. A seasoned flight instructor has reported that a safety belt left inadvertently unbuckled has resulted in his head hitting the cabin roof. Even when buckled in, pilots and passengers can feel themselves lifting off their seats for a few seconds. This occurs only when there is no snow on the ground. Elsewhere in the wildlife reserve, light to moderate mechanical or convective turbulence is common with the type of turbulence depending on the weather situation.

Light to moderate rime icing can be expected near the cloud tops, usually around 7,000 feet above sea level. Pilots report a change to moderate mixed icing near the cloud top when they reach the mountains at the southern edge of the Laurentides Wildlife Reserve.

Mount Valin Highlands



Map 4-36 - Mount Valin Highlands

Weather conditions over the Mount Valin Highlands are very similar to those found over the Laurentides Wildlife Reserve. If anything, some situations can produce even more dangerous flight conditions. For example, moderate to severe lee wave turbulence, producing stratocumulus standing lenticularis (SCSL) are a frequent occurrence over the Mount Valin Highlands and can extend further east or southeast depending on the winds aloft. These clouds and the lee wave turbulence are commonly found at altitudes up to 6,000 feet ASL, but may sometimes reach higher altitudes. These wave-like bands of lenticular clouds can often be observed on visual pictures taken from weather satellites, when there are no other cloud layers above.

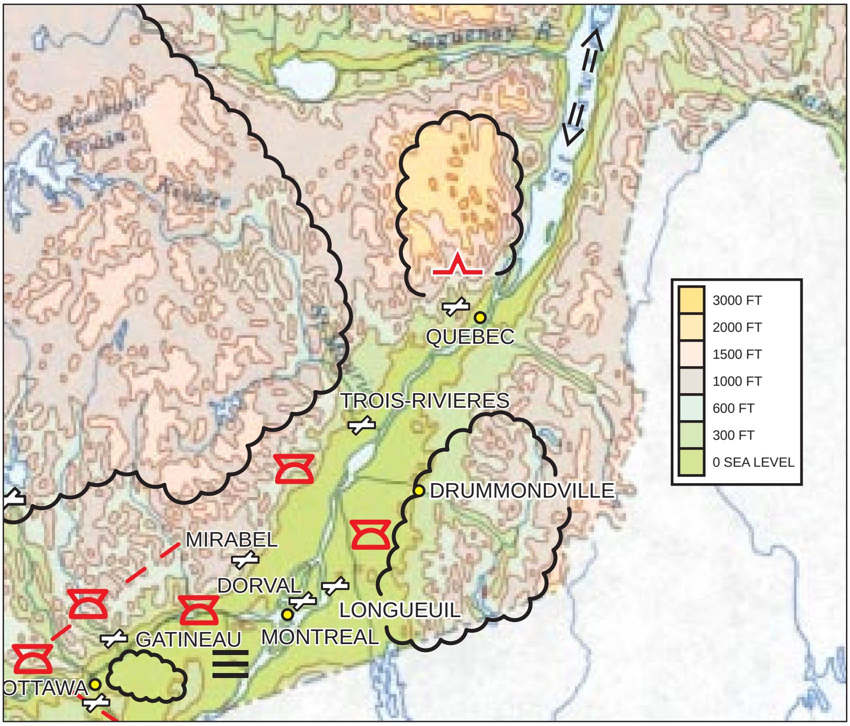
(a) Summer

Thunderstorms are frequently observed over the area in the summer. Isolated cumulonimbus clouds sometimes form over the Highlands moving southward along the Shipshaw River, in late morning or in the afternoon.

(b) Fall and winter

Light to moderate rime icing is often encountered over the Mount Valin Highlands between 5,000 and 6,000 feet ASL, in the fall or in winter. Pilots also report the frequent occurrence of 500-foot obscured ceilings and visibility of 1/2 statute miles in fog or precipitation over the area.

Saint Lawrence river valley and surrounding terrain



Map 4-37 - Saint Lawrence river valley and surrounding terrain

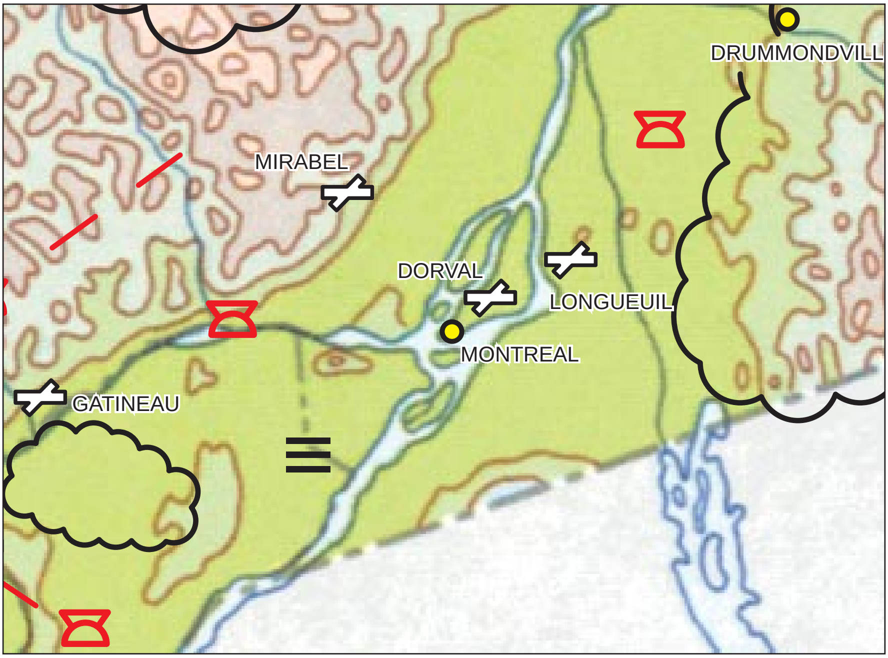
The southwest to northeast orientation of the Saint Lawrence River has an important influence on the weather. At the same time, the difference in latitude throughout the valley results in climatological variations such as seasonal regimes and the onset of thaw and freeze-up.

Most of the time the large-scale weather systems originate from the west (Alberta Clippers or Great Lakes Lows) or the southwest (Colorado Lows). In some instances, however, as is the case with Hatteras Bombs or cold lows, clouds and precipitation may arrive from the south, east or the north.

One of the great forecast challenges in this area is associated with system re-developments on the eastern side of the Appalachian Range. A Great Lake Low which moves straight east often weakens as it hits the western edge of the Appalachians. A new low develops on the eastern side and moves off to the north, or northeast, shifting the precipitation pattern with it. In situations like these, the western section of the valley is hit by precipitation from the west that tapers off as the initial low dissipates. As the redeveloped low forms, and if its trajectory is sufficiently northerly, the precipitation will then spread into the remainder of the valley and could even wrap around the low, hitting the western section once again but from a different direction.

Local effects

Greater Montreal and Monteregie



Map 4-38 - Greater Montreal and Monteregie

Throughout the year, the land south of Montreal, commonly known as Monteregie, is mostly devoted to agriculture. The terrain is flat with a few hills scattered throughout the area. These hills are not that large but still pilots report the occasional occurrence of lee turbulence near Mount Rougemont, Mount Yamaska, Mount St-Hilaire, and Mount Shefford.

When bad weather occurs, the lowest ceilings tend to occur north of Montreal, rather than south. It usually takes approximately two hours for poor weather to move from Montreal-Mirabel International Airport to the Montreal / St-Hubert Airport on the south shore. Low stratus clouds are rather rare over the Montreal / St-Hubert Airport, unless there is nimbostratus producing continuous precipitation. In this case the combination of the precipitation and mist or smog tends to lower the visibility to near 3 miles.

In the presence of generally southerly circulation, either at the surface or aloft, precipitation associated with large-scale low pressure systems approaching from the west often reaches the Montreal-Mirabel International Airport, but dissipates before reaching Montreal-Dorval International Airport.

Depending on the direction, the winds often vary between Montreal-Dorval International Airport and Montreal-Mirabel International Airport. Southwesterly winds tend to be stronger at Montreal-Dorval than at Montreal-Mirabel. Montreal-Dorval typically will report winds 15 gusting to 25 knots while Montreal-Mirabel will be reporting only 5 knots. In a light southerly circulation ahead of a large-scale low pressure system, Montreal-Dorval International Airport often registers a south-easterly wind of 5 to 10 knots while Montreal-Mirabel International Airport will report a northeasterly wind of 5 to 10 knots. Northwesterlies tend to be slightly weaker at Montreal-Mirabel International Airport than at Montreal-Dorval International Airport.

Fog is another phenomenon which occurs throughout the year. Fog, with visibilities of 5/8 statute miles or less, is much more frequent over and in the vicinity of the Montreal-Mirabel International Airport, than in Montreal-Dorval International Airport. It is also more frequent at the Montreal/St-Hubert Airport than at the Montreal-Dorval International Airport. In the first case, this is likely due to cold air draining from the mountains to the north of the Montreal-Mirabel International Airport. For the same reason, the fog tends to persist longer, not dissipating until the late morning. In the Montreal / St-Hubert Airport, the fog tends to be localized over the northeast section of the runway complex. The fog layer tends to be shallow, typically 15 to 30 feet thick. It tends to form in the evening and lasts most of the night. On occasion, a quick reformation of the fog can be observed early in the morning but it does not persist for long. The most likely cause of this fog is a light drainage wind from the surrounding built-up area stirring the air laden with moisture from the city and local soils. Montreal-Dorval is sheltered from this development, however, the ceiling and visibility tends to lower with an easterly wind due to the moisture and drainage coming from downttown Montreal Downtown and oil refineries further east.

The lowland area north of the Saint Lawrence River, between Mascouche and Lake St-Pierre, is drier with widespread low ceilings and visibilities being rare occurrences. Elsewhere, the geographical environment often combines with winds to generate low level wind shear and/or turbulence. Pilots landing at the Sorel airfield often encounter moderate turbulence on final approach when the wind exceeds 15 knots. This wind and turbulence will cease abruptly as the plane lands, likely due to the forest that surrounds the runway. In St-Mathieu-de-Beloeil, moderate turbulence is common on take off and landing when westerly winds of 15 knots or greater are present, likely due to eddy effects from several buildings built along the runway.

(a) Spring

Low level stratus ceilings, around 1,200 feet, tend to be common in the Monteregie with northwesterlies. Over the Montreal archipelago and north, up to Montreal-Mirabel International Airport, clouds tend to scatter out with cloud bases around 2,000 feet. Further to the north, cloud bases tend to be lower.

(b) Summer

Thunderstorm activity is the main problem in the summer. Depending on the degree of instability of the atmosphere, scattered thunderstorms (cumulonimbus) and shower-producing towering cumulus (TCU) can develop rapidly. Typically, showers develop in the early afternoon with the thunderstorms holding off until the late afternoon, around 4 p.m. These thunderstorms can also form into an organized line. These thunderstorms are stronger in intensity and generally follow one of three tracks, depending on wind direction aloft. One of the tracks, the northern track, follows the Lower Laurentian foothills, passing over Montreal-Mirabel International Airport in a northeasterly direction. Another extends from Alexandria in Eastern Ontario, passes near Valleyfield, and then moves toward Lake Champlain. The third track lies mostly over the South Shore, just south of the Montreal Island toward Victoriaville and then continuing northeastward.

Pilots report that thunderstorms tend to be the most severe along the northern track, especially in the St-Jerome and Joliette areas. There is a high occurrence of localized cumulonimbus, based around 1,500 feet, producing funnel clouds over the St. Lawrence River, especially near Valleyfield, when the air is humid and unstable. Thunderstorms tend to dissipate over Montreal Island and redevelop over the south shore.

There is little occurrence of fog at Montreal-Dorval International Airport during the summer. There is, however, an area south of the Saint Lawrence River, bordered by Montreal / St-Hubert Airport, Iberville, Farnham, Bromont, Gramby, and St-Mathias, where mist (visibilities greater than 5/8 statute miles but less than 6 statute miles) tends to linger on.

Haze can be a problem in the greater Montreal area, more so than elsewhere in southwestern Quebec. Haze is caused by high levels of pollutants and humidity in the lower strata of the atmosphere. Although not an immediate hazard, the haze tends to reduce the visibility, blur details, and make navigation more challenging when facing into a setting or rising sun.

Moderate wind shear and turbulence are sometimes encountered by pilots south of Montreal, during flights at night. These usually occur at 2,000 to 3,000 feet above ground, in the presence of a warm front and a low-level jet stream. This may cause a 45° drift during a flight.

(c) Fall

Over the Monteregie, northwesterlies often result in a low level cloud deck, with ceilings of 1,100 to 1,200 feet above ground. North of the Saint Lawrence River, however, these winds generally result in much better conditions, such as in Mascouche or Joliette.

One of the great forecasting challenges in the fall is that of precipitation type. It is common to observe rain in the valley and snow in the mountains. Sometimes, Montreal-Dorval International Airport will report light rain while ice pellet or freezing rain is falling at Montreal-Mirabel International Airport. On occasion, Montreal / St-Hubert Airport will stay in the warm sector, south of the warm front (eg. +10°C), while the air temperature at Montreal-Dorval International Airport remains below freezing. Similarly, when the air temperature rises above freezing at Montreal-Dorval International Airport, it tends to remain below freezing for a longer period of time at Montreal-Mirabel International Airport.

(d) Winter

As in the fall, warm fronts tend to linger on between Montreal-Dorval International Airport and Montreal / St-Hubert Airport, along the Saint Lawrence River. Ice fog is also a common winter occurrence at Montreal / St-Hubert Airport, while it tends to be rarer at Montreal / Dorval Airport.

Southerly winds tend to become a problem in winter at Montreal / St-Hubert Airport, since runway 28 is not maintained in winter, thus creating crosswinds on the remaining runways.

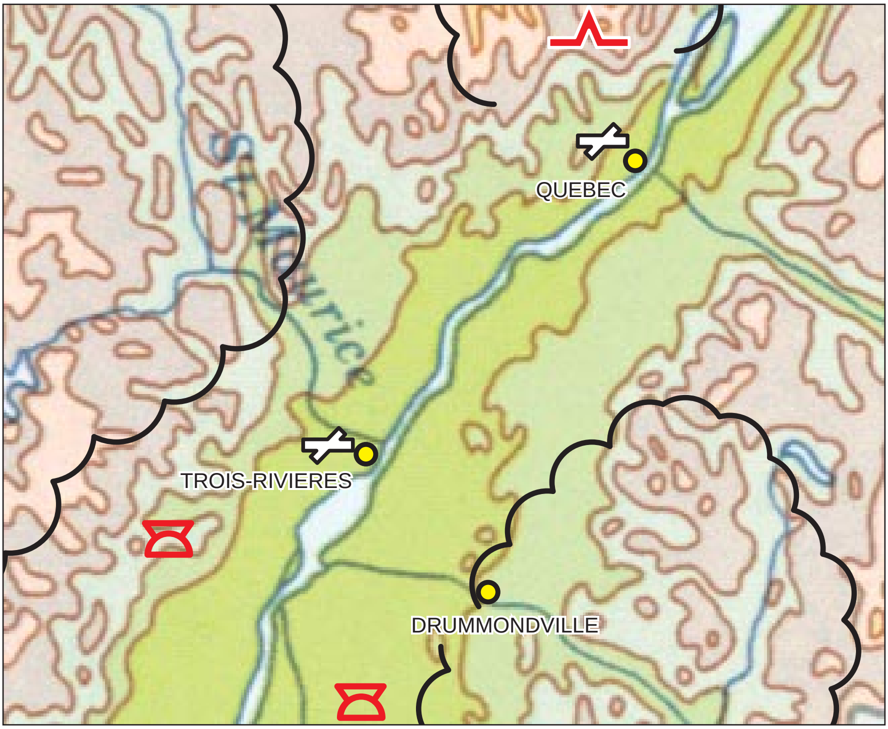
Lower Laurentians

Map 4-39 - Lower Laurentians

Over the mountainous terrain of the Lower Laurentians, stratus clouds with a base around 3,000 feet above sea level are often observed by pilots, resulting in some mountain tops being hidden by clouds. Fog and mist are frequently associated with this cloud. The cloud tends to become patchy in the afternoon and sometimes will dissipate entirely in late afternoon. Further to the north, cloud bases tend to be lower, especially when the wind blows from the northwest. Clouds and fog tend to be particularly extensive during the summer months.

Thunderstorm activity is a common summer occurrence over the Lower Laurentians, especially south of a line extending from Fort Coulonge on the Quebec Ontario border, to St-Jovite to St-Gabriel, near Lake St-Pierre.

Quebec City - Trois-Rivieres - Drummondville Area



Map 4-40 - Quebec City - Trois-Rivieres - Drummondville Area

Greater Quebec City Area

South of the Saint Lawrence River, but north of the Appalachian foothills, offers the best conditions for flying. The area situated to the east of the Chaudiere River usually has good visibility and, when clouds are present, their base tends to vary between 4,000 and 5,000 feet ASL. West of the Chaudiere River, the base of the cloud tends to be slightly lower, usually around 3,000 feet ASL.

During the summer months, convective clouds are common and cumulus clouds are often based around 2,000 feet along the south shore of the Saint Lawrence River. On hot and humid days, when the air temperature reaches or exceeds 28°C, haze becomes widespread, lowering the visibility as low as 5 statute miles. When there is rain, the visibility tends to be 5 statute miles or greater, while cloud bases vary between 1,500 and 2,000 feet above sea level. If mist forms in the rain, then the cloud base lowers further, to below 1,000 feet above sea level.

Clouds tend to be predominant in the area between the Saint Lawrence River and the Laurentians foothills, especially north of Quebec City. It is in this area that Canadian Forces Base Valcartier is situated, with its heliport at an elevation of 550 feet.

During the summer months, thunderstorms form over the Laurentians Foothills and Mount Belair, moving in a southeasterly direction toward the town late in the day. During the rest of the year, from the time the snow melts in the spring until lakes and rivers freeze up in the fall, fog is a concern.

Drummondville

Pilots report an interesting microclimate effect around Drummondville. It seems to delineate poor weather. When lower ceilings and visibility is reported, such as in snow, to the east of Drummondville, conditions tend to be much better west of Drummondville. When the lower ceilings and visibilities are reported west of Drummondville, conditions are much better east of the city.

Drummondville frequently tends to have better weather than both Montreal and Quebec City. For example, clouds could be based at 3,000 feet above sea level within a radius of 20 nautical miles of Drummondville, while much lower ceilings and visibilities prevent flights for fixed wing aircraft in both Quebec City and Greater Montreal areas.

Trois-Rivieres

When a large-scale low pressure system approaches Montreal, the Trois-Rivieres Airport tends to be much slower to see lower ceilings and visibility than both Montreal and Quebec City.

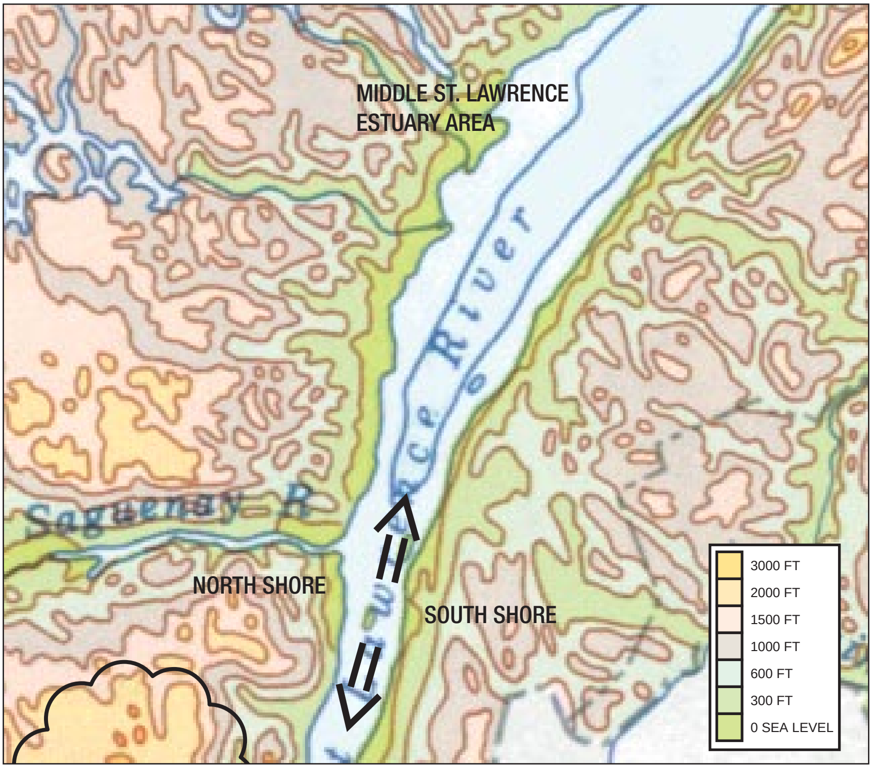
The Trois-Rivieres Airport is seldom affected by lake breezes coming from Lake St-Pierre. On the other hand, crosswinds and the associated low level turbulence are common when the wind blows from the southeast or the northwest. Wind shear, however, is a rare occurrence in Trois-Rivieres.

In the fall, the general cloud base is around 5,000 to 6,000 feet above ground over the Trois-Rivieres area, with a lower broken cloud layer based at 400 or 500 feet above ground over the actual airport. The lower cloud layer tends to dissipate around 11 am. East of the airport, toward Quebec City, a cloud layer based at 1,500 feet above ground is often observed.

The behaviour of fog at the Trois-Rivieres Airport is similar to Montreal / St-Hubert Airport, especially in summer and fall. The fog tends to be localized and shallow, often forming in the evening and persisting through much of the night. At times, fog may form in the early morning but soon dissipates.

Middle Saint Lawrence Estuary Area

South Shore Area



Map 4-41 - South Shore Area

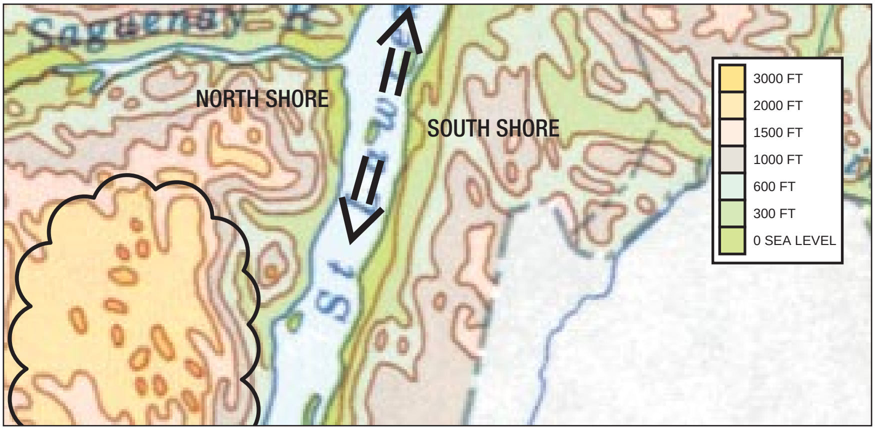
The poorest weather is usually associated with northeasterly winds, especially ahead of approaching low pressure systems. Due to the funnelling effect of the valley between the mouth of the Saguenay River and Orleans Island, the northeast winds tend to be very strong, with gusts sometimes exceeding 50 knots. The cold waters of the St. Lawrence River keep the air cool and favour the formation of fog. In late fall and early winter, the northeasterlies, combined with open waters, produce very low visibilities and ceilings in moderate to heavy snowfalls. Pilots frequently report moderate icing in cloud below 6,000 feet, over the river and along the south shore, often extending to the hill range. Throughout the winter, the area surrendering Montmagny generally gets twice the snowfall amounts that Quebec City gets.

Further inland, over the mountains and toward the border with Maine, cloud bases are usually between 3,000 and 5,000 feet above sea level.

West to southwest winds usually bring better flying conditions, with scattered to broken clouds. There is one exception, however. The onset of very cold arctic air after the passage of a particularly intense cold front can generate intense frontal snow squalls, with visibilities of 1/4 statute miles or less, and obscured ceilings near or below 200 feet. This phenomenon is usually short lived, typically one to two hours, over a specific location but it stays with the front as it swipes across the province. An abrupt reduction in ceiling and visibility, very strong and gusty northwest winds, moderate or greater turbulence, and a rapid drop in air temperature usually accompany these frontal squalls. The improvement behind the front can be equally as abrupt.

The best weather comes with south to southwest winds that generally result in warming air temperature and mostly sunny days.

North Shore Area



Map 4-42 - North Shore Area

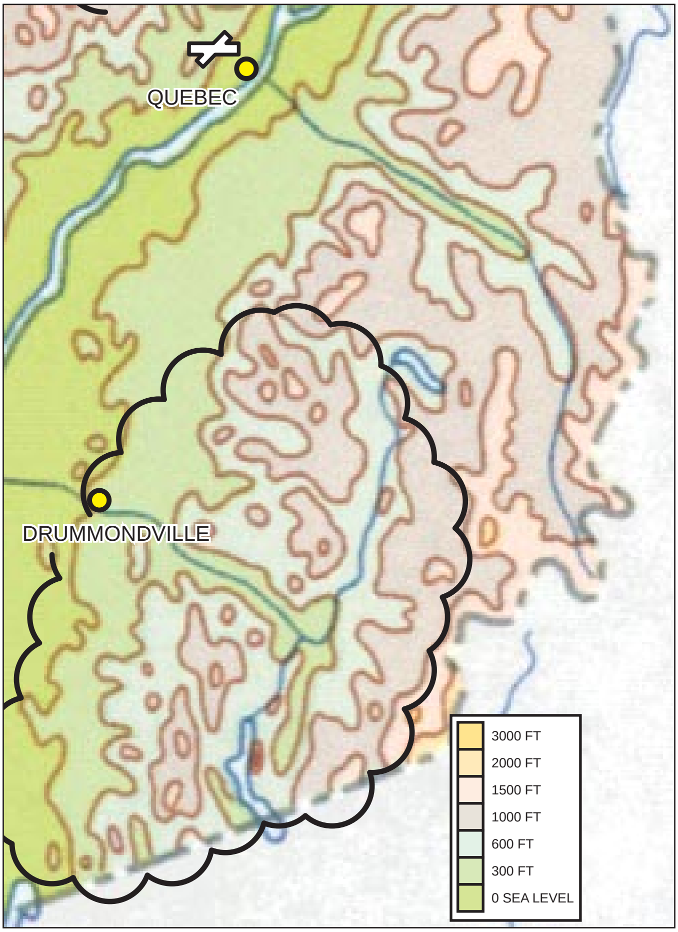
Along the north shore, northeasterlies and southwesterlies are the prevalent winds. The northeasterlies usually announce the arrival of poor flying conditions, with very low cloud bases, thick cloud layers and low visibilities in precipitation. This is especially true when there are strong south to southwest winds aloft pushing warmer and moist air over the area, while the surface air remains much cooler due to the influence of cool St. Lawrence river waters.

Northerlies and northwesterlies usually result in excellent ceilings and visibilities as the air subsides along the southern mountain slopes. These strong katabatic winds do, however, generally result in moderate to severe turbulence, especially in the area between Baie-St-Paul and the mouth of the Saguenay River.

Eastern Townships and Beauce

The mountainous nature of the terrain creates its own set of meteorological challenges to flying operations. The poorest conditions are often associated with a northerly to northwesterly circulation as the air is forced upslope, due to the rising terrain. Low conditions can also be found with an approaching and intense low pressure system. At any other time, cloud base is usually between 3,000 and 5,000 feet above sea level with visibilities excellent to the north of the foothills.

Eastern Townships Area



Map 4-43 - Eastern Townships Area

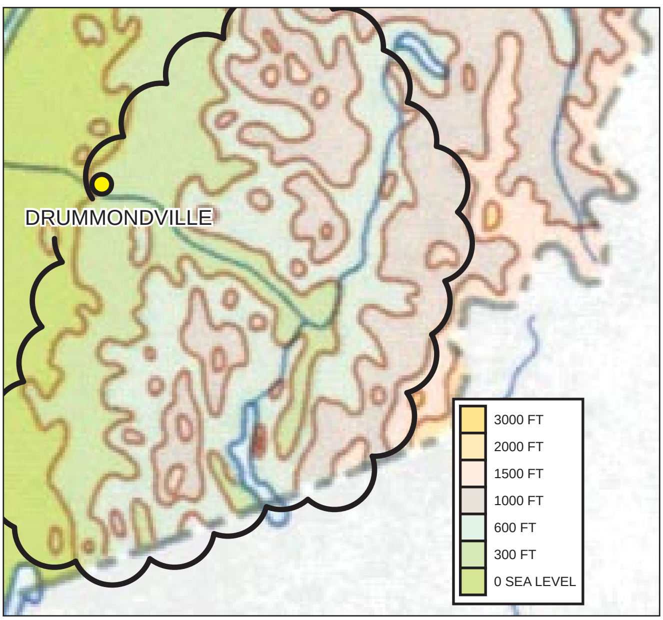
Low clouds and poorer visibilities, along with obscured mountaintops, can be expected at any time of the year. Also, because of the higher elevations, snow shows up earlier and stays longer than anywhere else in the area. Narrow valleys and deeply set lakes also affect clouds and precipitation types. Fall, early winter, and spring are times of the year when precipitation types can change rapidly from snow to freezing rain to rain or vice versa over short distances or with slight changes in elevation.

Mountainous terrain is conducive to the pooling of cooler air in narrow river valleys and deeply set lakes, during the night, with the onset of the nightly katabatic circulation. Fog often forms in these areas either in the evening or early morning. This fog may slowly lift in a thin stratus cloud hugging the valley summits.

Wind shear is common as the surface winds tend to follow river valleys and long lakes, while the upper winds remain better aligned with the general atmospheric circulation. As a result, the winds reported at some Eastern Townships airports may be weaker than actually occurring winds in the surrounding area.

The greatest concern expressed by several pilots travelling southward from St-Hubert into the New England states in the U.S., at low altitude, is the frequent occurrence of moderate or greater turbulence over Eastern Townships Mountains. Stratocumulus Standing Lenticularis (SCSL) clouds are frequent whenever there is a strong circulation from the northwest, as well as the occasional rotor cloud. The intensity of the turbulence tends to increase toward the American border and further south. Satellite pictures can be a great help in identifying these areas.

Beauce Area



Map 4-44 - Beauce Area

Similar to the Eastern Townships, the mountains in this area also exert a strong influence on the local weather. Upslope flow produces low cloud especially over the Beauce Highlands, during the winter months.

Pilots have also identified an area over the foothills, limited to the east by the

Chaudiere River and to the west by Coleraine and Inverness, where lower cloud bases tend to be more common. On the other hand, the area closer to the American border, from St-Georges on east, tends to have cloud bases around 6,000 feet ASL and excellent visibilities.

There is a higher hill range, which peaks at 3,040 feet ASL, that lies to the south of St-Philemon and Buckland. Lower clouds are a common occurrence over this range.

Notes: