

Chapter 3

Weather Patterns of Ontario and Quebec

Introduction

“Weather is what you get; climate is what you expect.”

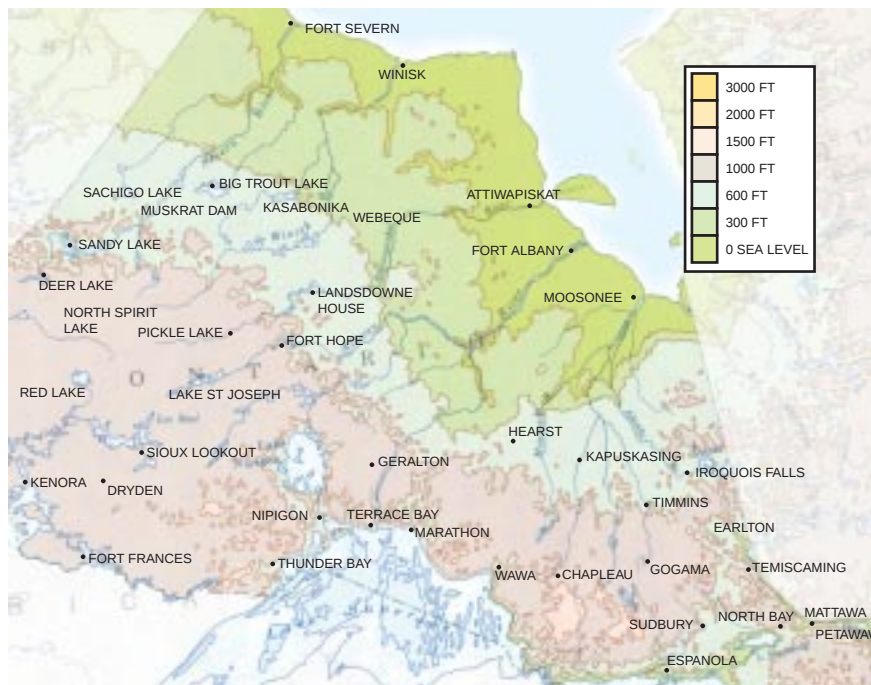
Most of us if asked to describe a particular location would include a comment about it being warm or cold, cloudy and wet or dry and sunny and maybe, windy or calm. We tend to think in terms of the north as cold, the south as warm, coastal areas as wet and cloudy and interior plains as dry and sunny. Viewed in this way, we are in a sense talking about climatology, taking an historic look at values of temperature, rainfall and cloud cover and recognizing that these values differ due to factors associated with geographic location.

Climatology can't tell us if it is currently raining in Toronto, snowing in Timmins or foggy in Montreal. Weather is dynamic, and its patterns transient. Meteorologists must combine knowledge of climate with an understanding of weather to forecast tomorrow's conditions. Add to this the effects of large bodies of water and elevated terrain and the task can be daunting.



Map 3-1 - Topography of the GFACN33 Domain

Geography
Northern Ontario



Map 3-2 - Northern Ontario

Northern Ontario borders the southern shores of Hudson Bay in the west and James Bay in the east. These are vast areas of relatively shallow inland sea, more than three times the combined area of the Great Lakes. James Bay contains many islands; Akimiski, the largest, has a length of 53 nautical miles. The bays remain largely free of ice from mid July through mid October, after which ice begins to form around the shores. The ice builds outward from the shore, frequently shifting and moving with changes in wind direction, until there is little or no open water remaining after mid December. These waters have a strong influence on flying conditions in this region, due to their comparatively cold temperature in summer and warm temperature in winter.

Rising gently from Hudson Bay and James Bay, the lands of northern Ontario form a broad drainage basin known as the Hudson Bay Lowlands. The Severn and Winisk Rivers flow northeastward across the lowlands into Hudson Bay, while the Ekwan, Attawapiskat, Albany, Missinaibi, and Abatibi flow into James Bay. Almost flat, there is little variation in elevation to the terrain across this region. A narrow band of flat treeless tundra rims the lowlands northern boundary with Hudson Bay, blending into boggy low terrain, or muskeg dotted with short sparse conifers that become progres-

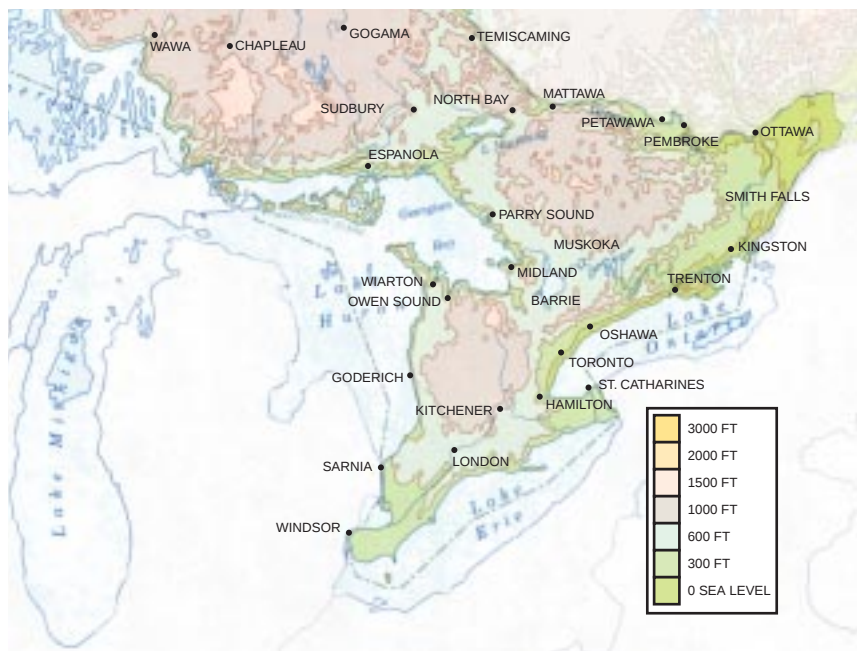
sively taller and more widespread to the south. The lowlands extend roughly 100 to 200 miles inland, gradually transitioning into the more rugged elevated terrain of the Canadian Shield.

The Canadian Shield, an enormous exposed outcropping of Precambrian rock, arcs across the bulk of northern Ontario, sweeping from the northwest south of the Hudson Bay lowlands, around the Great Lakes, and eastward to form the Laurentian Mountains of southern Quebec. This upland region is pitted with a maze of innumerable lakes and covered in needle leaf forest that gradually gives way to taller trees and more broadleaf species across the south.

While relatively low in elevation over northwestern Ontario near the Manitoba border, the Canadian Shield rises to the southeast, reaching heights just over 2,200 feet ASL near the Wisconsin border, west of Thunder Bay. This rugged higher terrain divide undulates as it arches eastward around the north of Lake Superior, Lake Huron, and Georgian Bay. Approximately 50 nautical miles north of the city of Sudbury, in Lady Evelyn-Smoothwater Provincial Park, it reaches its highest point, and also the highest elevation in Ontario, at 2,275 feet ASL, then falls away to the east and the Ottawa River Valley.

The Ottawa River Valley, oriented northwest to southeast from Lake Timiskaming through to the city of Ottawa, cuts deeply into the Canadian Shield and marks a political boundary between Ontario and Quebec. To the west of the Ottawa River Valley, the higher terrain of the Shield falls slowly southeastward to the Mattawa River, then rises again forming a broad roughly triangular outcropping of ridges and lakes set to the east of Georgian Bay and north of Lake Ontario. Geologists refer to this section of the Canadian Shields as the Frontenac Axis. It divides the Saint Lawrence lowlands to the southeast of the Ottawa River, from the Great Lakes lowlands to the southwest. Within the northern half of this region lies Algonquin Park.

Southern Ontario



Map 3-3 - Southern Ontario

South of Ottawa, the Ottawa River Valley fans out in low rolling hills that ease into the still broader, more gently sloping lowlands of the upper St. Lawrence River Valley of southeastern Ontario. The state of New York borders the southern shore of the St. Lawrence and, still farther south across the river valley, the terrain rises to meet the Appalachian Mountains. Near Kingston, at the eastern end of Lake Ontario, the river channel broadens, cutting through a low section of the Canadian Shield, leaving a collection of outcroppings known as the Thousand Islands. An irregular series of low prominences, bays and channels mark the northern shoreline of Lake Ontario, between Kingston and Trenton. The shoreline then becomes more regular, with inland terrain rising gently across rolling hills of glacial moraine. The most prominent of these, known as the Oak Ridges Moraine, extends roughly from a point just northwest of Trenton to the city of Caledon, just northwest of Toronto. Beyond the crest of the western end of the Oak Ridges Moraine, the lands slopes more gently downward toward Lake Simcoe, then across a rolling plain north of Barrie, to the southern shores of Georgian Bay.

A most prominent feature of the Great Lakes Lowlands is the Niagara Escarpment. A line of limestone cliffs rimming the edge of the Escarpment extend from Niagara Falls, just south of St. Catharines and Hamilton, northward across the Bruce Peninsula to the Manitoulin Islands in Lake Huron. The southern third of the

escarpment area forms a gently rolling plain, sloping south and southwest toward Lake Erie and Lake St. Clair. The bulk of the northern part of the escarpment slopes westward toward Lake Huron.

Quebec

Nunavik



Map 3-4 - Nunavik

The vast territory of northern Quebec is now known as Nunavik. It covers an area of more than 217,000 square miles, which extends from the eastern shore of Hudson Bay, to the Quebec/Labrador border in the east, and from approximately 55°N in the south to the Hudson Strait in the north. Lake-studded plains share the territory with mountainous terrain. The latter is mostly concentrated on the Ungava Peninsula, along large rivers, along Ungava Bay, and in the Torngat Mountain Range. Villages are dispersed along the coastline, separated by distances averaging 60 nautical miles. Another geographical feature of note is the tree line, which extends from Flat Point

(approx 50°N 69°W), to the northern shore of Lac À L'Eau Claire, then to the southern shore of Guillaume-Delisle Lake.

James Bay and Matagami - Mistassini Area



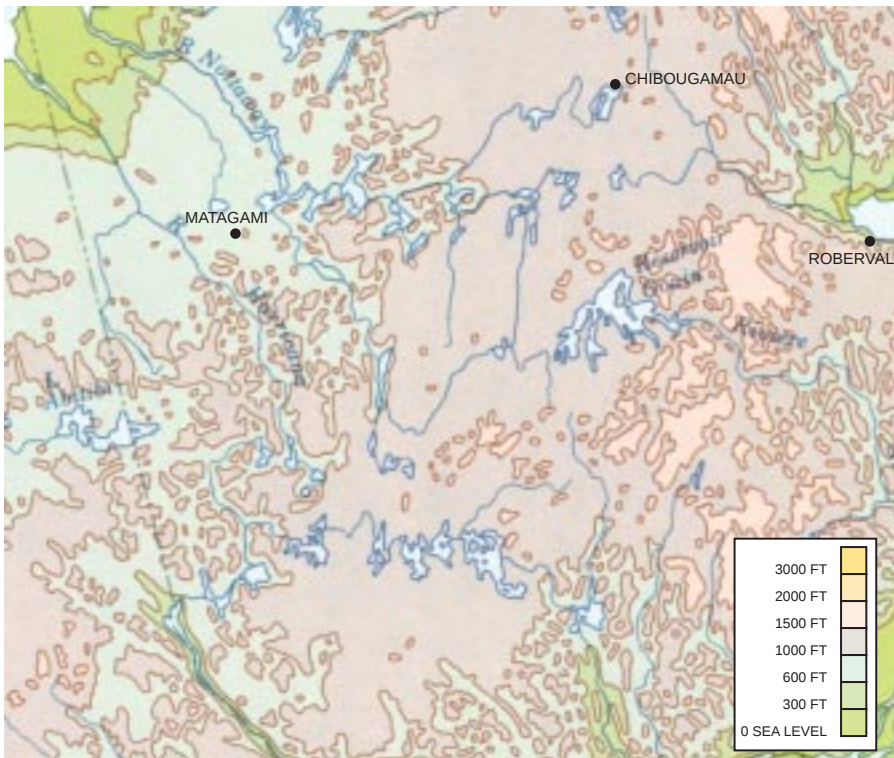
Map 3-5 - James Bay and Matagami - Mistassini Area

The James Bay region includes, on one hand, the eastern shoreline of James Bay, and, on the other hand, the flat landscape to the east, where vast hydroelectric reservoirs and large dams can be found along two of the largest rivers: the “La Grande” River and the Eastmain River. Just to the west of La Grande Airport, there is a sharp drop in topography, which varies between 500 and 1,000 feet ASL. East of La Grande Airport, the land rises slowly and gradually. To the south of Eastmain River, toward its head, there is a small mountain range called the Otis Range. This mountain range is oriented in a southwest to northeast line, with its highest peak culminating at 3,725 feet ASL.

Marshland can be found to the south of James Bay. The land rises slowly toward

the south and the east. At the head of the Nottaway River, Lake Matagami can be found, with the Matagami village and airport just to the southwest of the lake. Farther to the east, there is a series of lakes, in the midst of which lies the Chibougamau airport. To the northeast of Chibougamau, is one of the largest lakes in the province of Quebec, Lake Mistassini. Around Chibougamau, the land is relatively flat with scattered hills but the airport is surrounded by several hills, the highest being 1,950 feet. The terrain becomes rugged and desolate to the east of Lakes Mistassini and Chibougamau, carved by rivers flowing in canyons toward Lake Saint-Jean. There is one hydroelectric dam set at the mouth of Lake Peribonca, with a private airfield named Chute-des-Passes. To the northeast, the White Mountain Range peaks at 3,400 feet ASL. The White Mountains 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.

Northwestern Quebec



Map 3-6 - Northwestern Quebec

This vast area starts at the Ontario border and goes to the west of Lake St-Jean basin. It includes the Abitibi, Temiskaming, Upper Laurentians, Mauricie and the

Gouin Reservoir areas. Most of the region is part of the Canadian Shield and resembles a ridge. Elsewhere, the terrain is mountainous, extending to the city of Gatineau, and almost reaching Montreal. It is covered with lakes and rivers, with narrow valleys. Terrain elevations generally vary between 1,000 to 2,000 feet, with the highest elevation, 3,175 feet, in the St-Jovite area.

Saguenay River Valley, Lake Saint-Jean, Laurentides Wildlife Reserve, and Mount Valin Highlands



Map 3-7 - Saguenay River Valley, Lake Saint-Jean, Laurentides Wildlife Reserve, and Mount Valin Highlands

Lake Saint-Jean and the upper half of the Saguenay River are surrounded by farmlands in a valley, nestled in the Canadian Shield. There are approximately 300,000 inhabitants living in this region. Lake Saint-Jean is a large lake (26 nautical miles long and 17 nautical miles wide) with many tributaries coming from the surrounding mountains. The lake is shallow, however, and usually freezes in early December. The valley forms an asymmetrical funnel, oriented in a west-southwest to east-southeast direction. To the east of Chicoutimi, the river widens and deepens, while the valley narrows rapidly. The lower third of the Saguenay River is nested in a steep-sided canyon carved into the Canadian Shield. The geography of this portion of the river is very similar to Scandinavian fjords and, for this reason, the lower tier of the Saguenay River is usually called “Saguenay Fjord.”

The section of the Canadian Shield, which lies between the Saguenay River and

Quebec City, is now known as the “Laurentides Wildlife Reserve.” It also used to be called the “Laurentides Park”. The area is rugged with peaks up to 3,825 feet ASL, rivers, and a multitude of lakes. The tops of the mountains have been rounded by erosion and, in many sections of the Reserve, the forests have been harvested, exposing the granite rock underneath. The section of the Shield, which forms the north shore of the Saint Lawrence River between Beaufort and the mouth of the Saguenay River, is known as “Charlevoix.”

The section of the Canadian Shield lying to the north of the Saguenay River is known as the Mount Valin Highlands. Mount Valin, which gives its name to the area, is the highest peak at 3,548 feet ASL and lies close to the Saint-Honore Airport, along the southwestern edge of this mountainous terrain. The topography of the Mount Valin Highlands is similar to the Laurentides Wildlife Reserve. The most rugged terrain continues toward the northwest, up to the Nestaocano River, although the average elevation diminishes.

St. Lawrence River Valley



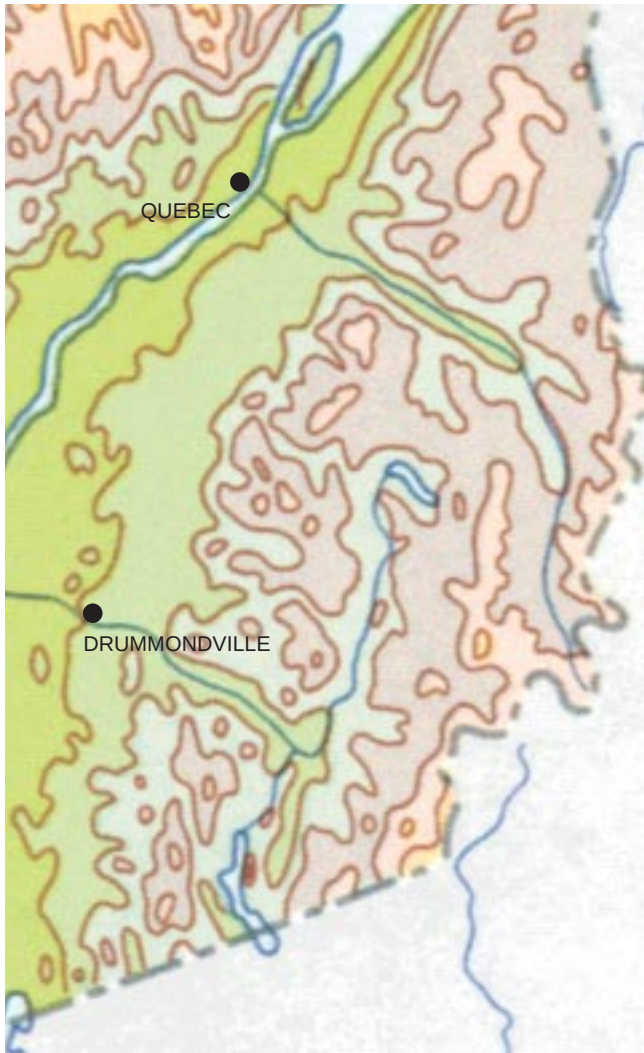
Map 3-8 - St. Lawrence River Valley

The St. Lawrence River has a southwest to northeast orientation from Lake Ontario to where it originates in the Gulf of St. Lawrence. The valley is wide near the Ontario-Quebec border and narrows toward Quebec City. Further east, the width of the valley remains almost constant, although the river itself widens gradually as it

flows downstream. The section of the Saint Lawrence River between the Isle of Orleans and Tadoussac is often called the “middle estuary”, while the section between Tadoussac and Pointe-des-Monts is usually called the “maritime estuary.” Both sections combine to form the “Saint Lawrence Estuary”, one of the longest (215 nautical miles) and one of the deepest (from approximately 160 feet near the Isle of Orleans to 300 feet just west of the Saguenay River, and 1,150 feet from then on) in the world. Its width goes from one nautical mile, in the west, to 27 miles by the time it reaches the Gulf. Exposed to northeasterlies, amongst the predominant winds, the Estuary acts as a funnel and, under the right conditions, wind speeds in excess of 60 knots have been reported. Due to its depth, high salt content, and frequent occurrences of high winds, the Estuary takes a long time to freeze over. It usually takes an outbreak of very cold arctic air for at least a week. Any onset of mild temperatures and strong southwesterlies often results in the ice breaking up.

The Canadian Shield bounds the St. Lawrence River Valley to the north. In the Montreal area, the land rises rapidly, but gradually, toward the Shield. This area is generally called the Lower Laurentian Highlands. By the time the river reaches Quebec City, the Canadian Shield gets very close to the river's northern shore, then it hugs the shore further to the east. South of the river, however, the land remains flat for a good distance, and then the ground rises gradually until the Appalachian Mountains foothills are reached, where the land rises sharply and where the valley ends. Although the slope is gentler to the south, some rivers, like Chaudière, flow in deep and narrow gorges. The St. Lawrence River dominates the valley and some of its tributaries, like the north - south Richelieu River, the Yamaska, the Saint-Maurice, and the Chaudière River.

Eastern Townships and Beauce



Map 3-9 - Eastern Townships and Beauce

The Eastern Townships and the Beauce regions are located to the south of the Saint Lawrence River Valley, along the Canada-United States border. Both of these contiguous regions straddle the Appalachian Mountains foothills. The highest hill, Mount Megantic, peaks at 3,640 feet ASL. The largest lakes and most important rivers are deeply encased by mountains. Furthermore, rivers in these two regions flow to the north and are prone to ice jams and flooding in the spring.

Mean Atmospheric Circulation

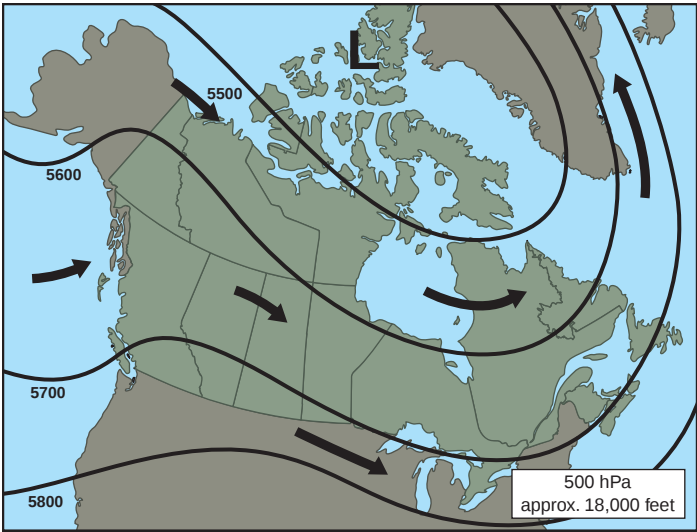


Fig. 3-1- Mean Summer Upper Winds

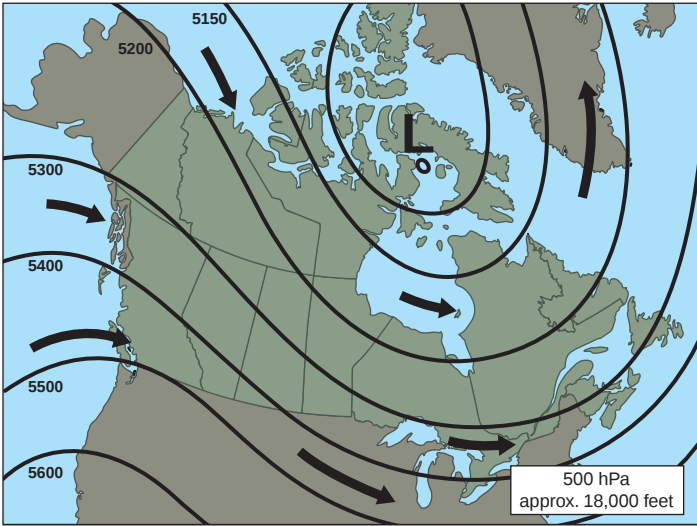


Fig. 3-2 - Mean Winter Upper Winds

The mean atmospheric circulation over Ontario and Quebec is from west to east, but shows a distinct seasonal shift. A good indicator of this shift can be seen in the jet stream, a relatively rapid flowing ribbon of air embedded in the general circulation, generated by temperature differences along the boundary between polar and tropical air masses. During the summer months, as polar air begins to retreat, the jet stream

weakens and migrates northward, oscillating between 45 and 60 degrees north latitude. The mean position of the jet stream parallels the mean summer circulation pattern of the upper atmosphere, as it arcs gently northward from the Pacific to the central Prairies, then southward across Ontario and Quebec.

In winter, the polar air mass deepens, the temperature gradient between polar and tropical air increases, and the jet stream migrates southward and strengthens. Upper level winds in winter can be as much as 60 percent stronger than in summer months. The jet stream arcs sharply northward over the west coast, southward across the Prairies and eastern Canada, sometimes dipping as far south as Florida. The large-scale trough created in the mean flow over eastern Canada during the winter months contributes to the development of surface pressure systems that move across Ontario and Quebec.

Upper Troughs and Upper Ridges

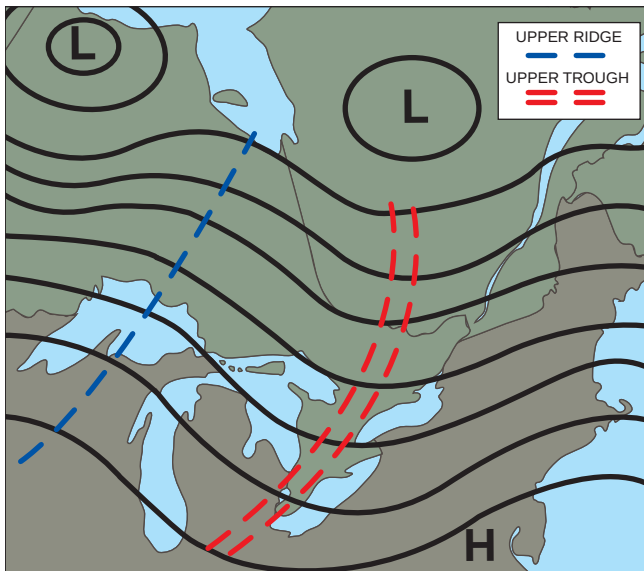


Fig.3-3 - Typical winter pattern with upper troughs and ridges added

The most common features moving in the upper flow are upper ridges and upper troughs. Upper ridges are usually associated with good or improving weather conditions, while upper troughs are usually associated with weather that is poor or deteriorating.

That being said, the position of the upper ridge plays a significant role on the impact it has on weather. When an upper ridge lies in the path of a low, it may force the approaching system to be deflected to the north or south. The air mass beneath the ridge may become stagnant, with light winds at all levels causing air pollutants to

linger, producing haze. Upper ridges often bring periods of dry weather, leading the way for sunny skies and hot temperatures in summer or sunny days, and clear cold nights in winter.

Semi-Permanent Surface Features

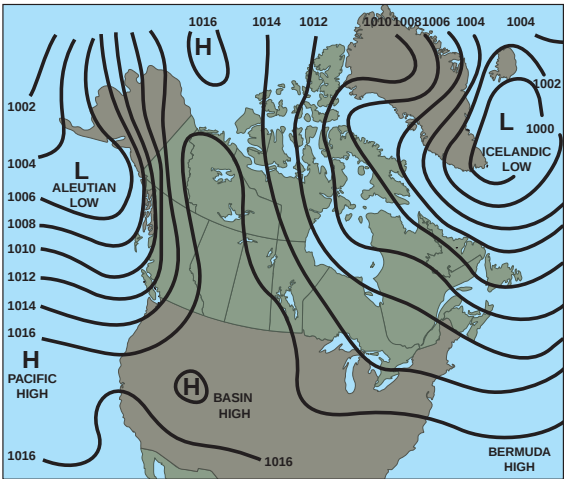


Fig. 3-4 - January mean sea level pressure

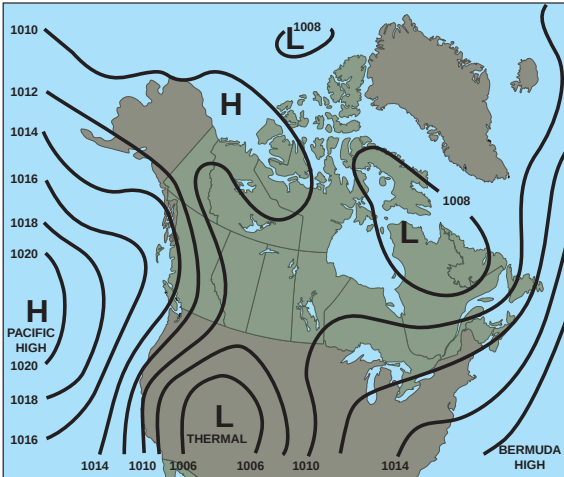


Fig. 3-5 - July mean sea level pressure

An examination of the average sea level pressure distribution over a number of years reveals the presence of relatively fixed features in the winter and summer pressure patterns. One of these is the Icelandic low located near or just west of Iceland. It is commonly associated with a trough of low pressure extending from Scandinavia southwestward to the Davis Strait. Migratory low-pressure systems, deepening and moving northeastward in the north Atlantic, eventually occlude, decelerate significantly,

and may become almost stationary for extended periods of time. They account for the presence of the Icelandic Low, a semi-permanent area of low pressure, much deeper and more extensive in the winter than the summer.

The Bermuda High, or Azores High, on the other hand, is a semi-permanent area of high pressure elongated along an east-west axis near 35°N. During the winter, it weakens and shifts eastward to lie near the Azores. Drifting westward and becoming more prominent in its summer position near the Bahamas, this feature plays a significant roll in directing occasional surges of humid tropical air northeastward, across the eastern seaboard into southern Ontario and Quebec.

Migratory Systems

The semi-permanent features seen in the mean surface patterns discussed above are in essence composites arising from the common and frequent motion of individual low and high pressure systems. Low-pressure systems can be classified as extra-tropical (systems originating over the mid-latitudes) and tropical (those that develop near the tropics). Of these, it is the extra-tropical lows that most frequently and significantly impact the GFACN33 region. The majority of these lows develop in areas well to the west or southwest and, steered by the upper flow pattern, track east or northeastward into Ontario and Quebec. Less common, and usually less severe, are storms arriving from the southeast that began over the Atlantic Ocean and moved inland losing much of their moisture and energy.

Passage over the Great Lakes or Hudson Bay can re-energize migratory systems, but eventually they slow and continue to occlude. Infrequently, they may even “retrogress” (move slowly westward).

Winter Storms

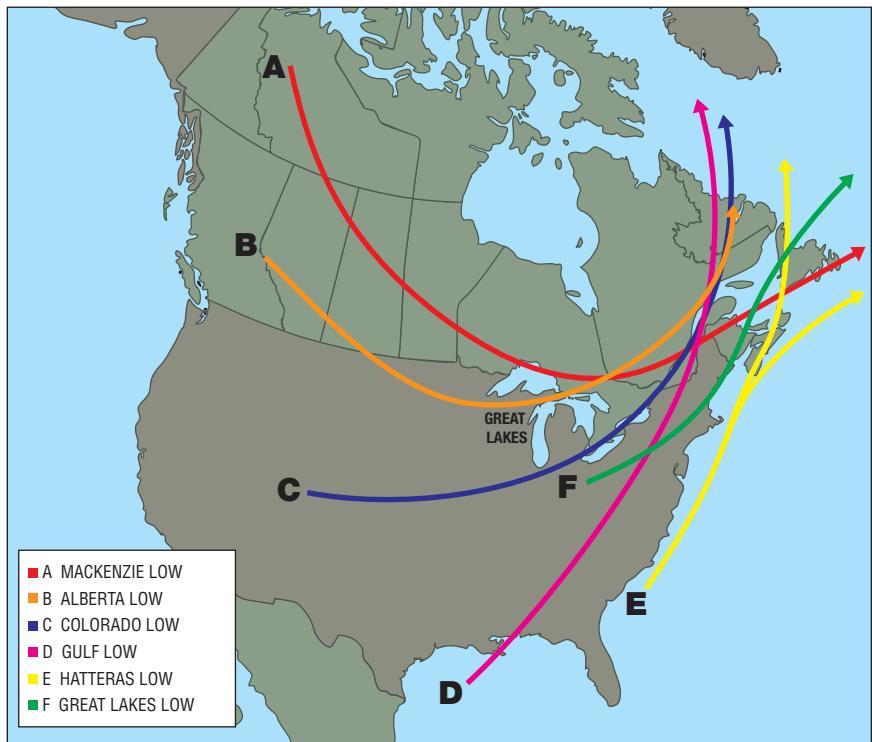


Fig. 3-6 - Winter storm tracks

More frequent and usually more intense than their summer counterparts, due to the strong winter temperature gradient between northern and southern latitudes, winter storms favor some locations for their formation and development. Moving along one of several common storm tracks, these systems frequently generate broad areas of cloud, snowfall, rain, high winds and, at times, freezing precipitation. Winter storms produce some of the worst flying conditions across the GFACN33 region.

Summer Storms

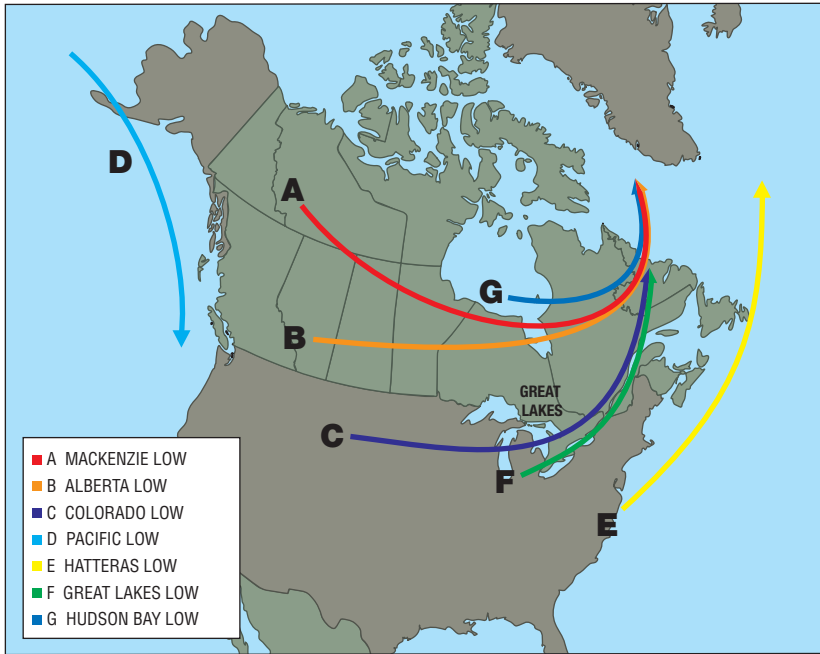


Fig. 3-7 - Summer storm tracks

With the approach of summer, the polar air mass becomes shallow and begins to retreat northward and, correspondingly, the severity and frequency of extra-tropical storms declines.

Alberta Lows (Alberta Clipper)

The Alberta Low forms to the lee of the Rocky Mountains in Alberta. Moving along a southeasterly track, this low often dips into the Plains of the northern US during the winter months, eastward across the Great Lakes, southern Ontario, Quebec and on to the north Atlantic. During the summer months the storm track shifts northward. The point of origin remains to the lee of the Rocky Mountains in Alberta, however, the lows tend to move eastward across the Canadian Prairies, northern Ontario and northern Quebec.

Alberta Lows, while not generally associated with heavy precipitation, are sometimes invigorated by an inflow of relatively warm moist air moving up the Atlantic seaboard. Under such conditions, these storms can then rapidly intensify, bringing heavy winter snowfall to southern Ontario and Quebec.

Colorado Lows

These lows develop to the lee of the Rocky Mountains, frequently forming over southern Colorado, during the winter, and somewhat farther north during the summer. They tend to track northeastward, intensify over the Great Lakes, and can bring heavy snowfalls and strong winds as they continue eastward across southern Ontario and Quebec. Colorado lows may also track eastward across the US, diminishing in strength then re-develop over the warm waters of the Gulf Stream, becoming Hatteras Lows that then track northeastward into the Maritimes.

Great Lakes Lows

The Great Lakes are yet another area of development for low-pressure systems. Acting as a reservoir, the lakes transfer stored heat and moisture into the lower atmosphere. Under favorable conditions, a thermal trough or thermal low will form and last for days, due to the effect of cold air over warm water. This may be enough to initiate the formation of a new low or serve to intensify a passing system. Lows forming over the Great Lakes tend to be less vigorous than their Atlantic counterparts but can still generate a significant amount of cloud, precipitation and strong gusty winds. Upon development, Great Lakes lows most frequently follow one of two routes, either wrapping northeastward across eastern Ontario, Quebec and Labrador, or a more easterly course to the Atlantic, where they may re-intensify off the east coast of the United States.

Hudson Bay Lows

Lows developing or re-forming over Hudson Bay frequently migrate eastward across Quebec and Labrador. They tend to be less intense than Great Lakes lows, affect mainly the northern areas and can occur in both summer and winter. In winter, the air mass associated with these systems is usually very cold and dry, allowing areas of low ceiling and visibility to improve rapidly in their wake. Much more moisture is available to the lower atmosphere during the summer, allowing areas of low cloud and showers to become more widespread and linger well after the low has left the region.

Polar Lows

By definition, the Polar Low is a small scale, but often intense, maritime cyclone ranging in size from 60 to 600 nautical miles across, carrying surface winds in excess of 30 knots. These lows form over coastal waters during outbreaks of very cold arctic air, where the air-sea temperature difference exceeds 20 degrees Celsius. Found most frequently over the Labrador Sea, but also forming over Hudson Bay, mature Polar Lows can give poor visibility in heavy snow showers, strong shifts in wind direction, occasional lightning and severe aircraft icing. They are difficult to forecast, since they mature rapidly over open water then quickly dissipate upon moving over ice or land, and frequently last less than 24 hours.

Hatteras Lows (or Eastern Seaboard Bombs)

Hatteras Lows develop just off the coast of Cape Hatteras, North Carolina. Here, the Gulf Stream, a warm water current, hugging the coastline up to that point starts moving off toward the northeast, eventually reaching the Shetland Islands, off Scotland. In winter, when very cold arctic air pushes south into the Southeastern American states, a strong temperature gradient develops off the Carolina coast, thus generating fast moving and fast developing weather systems. These Hatteras Lows move very rapidly north along the American seaboard and, as they deepen so quickly, they are generally referred to as “bombs”. These lows can follow either one of two typical trajectories: they either move over Nova Scotia and Newfoundland or they can move across New England, Quebec Eastern Townships, toward Ungava Bay. Like the Polar Lows, these storms are difficult to forecast.

Highs

During the winter months, cold domes of polar air form areas of high pressure, or anti-cyclones, over the northern continental regions. From time to time, this very cold arctic air mass will flow southeastward across Ontario and Quebec, clearing skies and bringing chilling temperatures in the wake of transient low-pressure systems. Gradually shifting southward, these cold highs tend to persist with greater frequency over the Quebec region during the mid-winter months, a time when the semi-permanent Bermuda High, so dominant throughout the summer, has shifted southeastward to lie near the Equator. In the summer months, the Bermuda High migrates northwestward to lie over the island for which it is named, and builds toward North Carolina. The polar air masses gradually retreat from Ontario and Quebec, replaced by warmer air out of the southwest and, at times, hot humid tropical air masses with origins in the Mexican Gulf. The path of highs, or anti-cyclones, across Ontario and Quebec shows a corresponding northward shift during the summer months.

Tropical Depressions, Tropical Storms and Hurricanes

From late summer to early fall, tropical cyclones, named after their place of origin in the tropical latitudes, migrate westward with the trade winds, accelerate in a northward arc off the east coast of North America and weaken as they begin to encounter the cooler waters of the North Atlantic. These Atlantic Ocean systems, broadly termed tropical cyclones, are referred to as “tropical depressions” when sustained winds achieve 20 to 33 knots, “tropical storms” when sustained winds reach 34 to 63 knots, and “hurricanes” when sustained winds attain or exceed 64 knots. Having reached hurricane strength, a storm is classified according to the Saffir-Simpson scale (see Glossary).

Statistics tell us that, on average, one tropical storm can be expected to reach Quebec every 6.6 years and Ontario every 11.1 years. These low numbers reflect the

fact that most tropical cyclones gradually enter the decaying stage of their life cycle as they move northward, leaving the warm (at least 26° C) tropical waters of their origin. Having made landfall and begun to move inland, the cyclone's source of energy is removed and further decay of the system is accelerated due to frictional drag with the earth's surface. Often no longer visible as a feature on the weather map, the dissipated energy of these storms may continue to move through the atmosphere, with very moist tropical air generating heavy rainfall on the surface and strong winds persisting aloft.

Tropical storms and hurricanes present a subject of continuing scientific interest and research. To this end, regular data reconnaissance flights are fully planned and carefully executed. However, with practically every known aviation weather hazard present within these storms, they are clearly not the place for general or commercial aviation. In addition, precautions for strong winds and heavy precipitation are advisable for aircraft on the ground.

Cold Lows

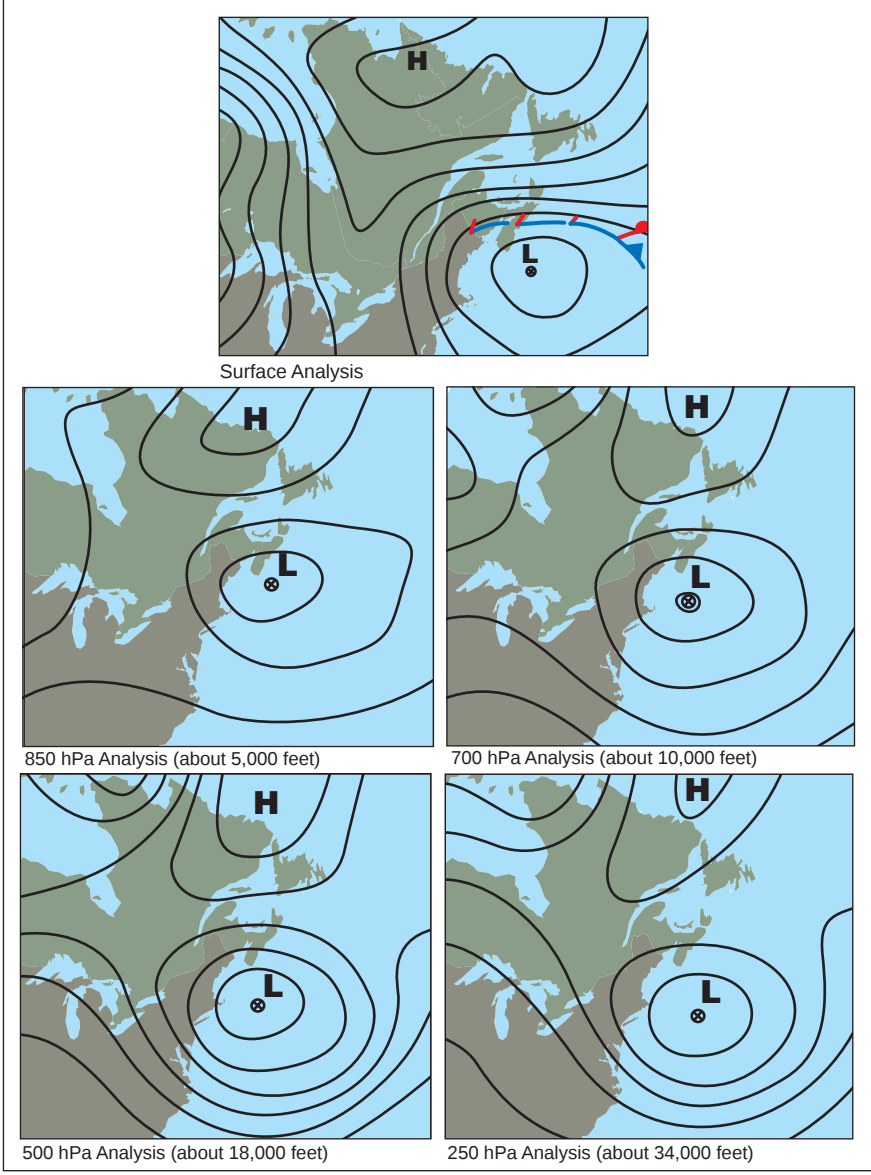


Fig. 3-8 - Typical MSL surface and upper cold low pattern.

The term cold low or “cut-off low” refers to a final stage of development in the lifecycle of a low-pressure system, but this stage is not reached by all storms. Occurring at any time of the year, they tend to develop more frequently over the northern latitudes in summer and southern latitudes in spring. They are often difficult to forecast, typically approaching along the common storm tracks out of the south-

west, and look much like any other low, until becoming “cut-off” from the prevailing upper circulation.

Cold lows may or may not produce recognizable centres of low pressure at the surface; therefore they are more easily identified on upper charts where they take on a circular appearance, forming a column through the atmosphere in which temperatures become colder toward a central core. Once formed, cold lows tend to be persistent, moving slowly or lingering in one location for prolonged periods of time. The cool and unstable air mass with which they are associated often generates broad bands of cloud, embedded convection, and precipitation, culminating at times in thunder-showers. For this reason, cold lows are favored locations for the development of aircraft icing, particularly throughout the northeast quadrant of the low, where enhanced lift usually produces thicker cloud and more widespread steady precipitation.

Seasonal Migratory Birds

Indirectly associated with seasonal changes in weather, large flocks of migratory birds fly across the GFACN33 region. Impact with birds can present a serious hazard to aviation. A four-pound bird striking an aircraft traveling at 130 knots exerts a localized force of more than 2 tons. An aircraft traveling at 260 knots and hitting a bird of the same size would receive a localized force of 9 tons.

Spring

Normally, migratory birds leave their staging areas between dusk and midnight, and during the first three hours after dawn: however, they may leave at any hour of the day or night, particularly after long periods of poor weather. They will not leave a staging area against surface winds in excess of 10 knots. Major movements, involving hundreds of thousands of birds, often follow the passage of a ridge of high pressure.

Autumn

Geese, swans and cranes normally move south with favourable winds. They depart from staging areas 12 to 24 hours after the passage of a cold front, especially if there is rapid clearing and there are strong northerly winds behind the front. The birds take off from the staging areas in the late afternoon for night flights. Occasionally, however, they may fly by day as well.

Notes

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Table 3: Symbols Used in this Manual

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