

## Chapter 4

### Seasonal Weather and Local Effects

#### Introduction



Map 4-1 - GFACN 32 Domain

This chapter is devoted to local weather hazards and effects observed in the GFACN32 area of responsibility. After extensive discussions with weather forecasters, FSS personnel, pilots and dispatchers, the most common and verifiable hazards are listed.

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

Weather of Alberta



Map 4-2 - Topographical overview of Alberta

The climatic regimes of the Prairie province are classified as either cold-temperate or sub-arctic and range from dry continental type conditions, in the southwest, to sub-arctic conditions in the northeast along the Hudson Bay coastline. The western mountain ranges have a pronounced effect on the precipitation patterns across the region and on winter temperatures. This is one reason why most areas of the Prairie provinces receive their heaviest precipitation from storms that are fed by moisture flowing northward from the US mid-west. With no east-west mountain range to act as a barrier for air masses, such as the Alps do in Europe, cold dry Arctic air and warm moist air from the American southwest collide here on a regular basis.

The Rocky Mountains, however, are an effective barrier to the maritime influences of the Pacific Ocean and the air is greatly modified by the time it makes its way into Alberta. Cool, north pacific air loses considerable moisture coming over the mountains and is then warmed as it descends the eastern slopes of the Rockies before arriving on the “rain-shaded” Prairies. However, this air is still associated with rather cloudy, mild and windy weather for Alberta. Precipitation can be relatively heavy in the foothills and in the Peace District, where the altitude decreases and precipitation-bearing air masses enter the province more freely from the west. Nowhere, however, is the yearly total precipitation excessive. In fact, Montreal’s annual average total of 1,070 mm exceeds that of any Alberta station.

### (a) Summer

Summers in Alberta are fairly short, warm and usually quite dry. There are some main precipitation producing patterns. Cold lows bring prolonged precipitation and poor flying conditions and extensive thunderstorm activity on hot unstable days make severe weather a concern. Summer in Alberta is generally considered to be from late April, or early May, to late August and perhaps into September. During this time the weather is normally pleasant as it requires a well-developed weather system with plenty of moisture and significant upper dynamics to generate widespread low ceilings and visibility.

The principal situation that will produce a prolonged period of low flying weather (two or more days) is the passage of a cold low. These systems usher in very moist unstable air and are typically slow moving, if not stationary. Poor weather conditions are usually found north of the low’s center where a persistent east to northeasterly flow, which is upslope in Alberta, has plenty of time to build up a large area of low level moisture. The lowest ceilings and visibilities generally occur within 60 to 100 nautical miles north of the center. Cold low scenarios are most prevalent in June and July, during which two or three such passages typically occur each month.

Similar conditions can develop in an easterly flow to the west of a high pressure system over the central prairies. If the flow persists long enough, stratus, drizzle and fog will eventually develop in the upslope areas and over the foothills.

Throughout the warm summer days, thunderstorms are common. While air mass thunderstorms occur most frequently, the passage of a cold front can also initiate the development of a thunderstorm. In fact, the most severe thunderstorms are those associated with cold fronts. This is exemplified by the Edmonton tornado in 1987 and again by the Holden tornado in 1993, both of which were the result of a cold frontal passage. Typically, in the summer, convective activity commences during the morning in the foothills and moves off to the east (includes northeast, east and southeast directions) during the remainder of the day. Most of these convective clouds dissipate as they move away from the foothills. However, if a source of low-level moisture is located further east or a means of initiating or maintaining convection is present, then the activity will persist late into the afternoon or evening. Nocturnal thunderstorms can also occur during Alberta summers but are much rarer than over the rest of the prairies. The normal thunderstorm season coincides with the summer period with the maximum activity occurring in July.

Another phenomenon typical to Alberta is the low-level nocturnal jet, most common during the spring and summer months. This feature forms on clear nights after there have been strong, gusty winds in the late afternoon. As the sun sets, a low-level temperature inversion (created by radiation cooling) develops near the ground causing the surface wind to diminish. The area of stronger winds has not disappeared. Rather, it has been effectively decoupled from the surface by the inversion and remains in the warmer layer aloft. In some cases, the winds at the top of the inversion can be stronger than the gusts observed the previous afternoon. The depth of the cold layer increases to as much as 1,000 feet during the night before it is destroyed by daytime heating the following morning.

Low level turbulence is a common occurrence during Alberta summers. Thermal updrafts are always present on sunny days and can become quite noticeable near lakes, where they are contrasted with downdrafts over the cooler water. These paired updrafts and downdrafts can even create a lake breeze circulation over larger bodies of water. In southwest flows of 30 knots or greater over the mountains, severe turbulence will occur in any of the valleys located on the east side of the Rockies. Grande Cache is a prime location for such turbulence events.

## **(b) Winter**

Winter in Alberta is generally considered to be from late November to late March, or early April. During this period, good flying weather is common but it is possible to identify two patterns that produce generally poor conditions. The first of these is a cold trough scenario. These troughs are not as frequent in the winter as they are during the summer months and tend to be drier but, when associated with a frontal area or jet stream, can still bring prolonged periods of very low flying conditions and significant snowfalls when they pass.

The other situation producing poor weather is the phenomenon referred to as a “dirty ridge.” It occurs when a north to south upper ridge builds over BC, an Arctic surface front lies along the foothills, and a maritime frontal wave has developed along the BC coast. Since the cold air is dammed up against the mountains with no where to go, the warmer, moister air associated with the maritime system overruns the cold as it moves into Alberta. Depending on the temperatures aloft and the depth of the cold air, this pattern can result in large amounts of snow for Alberta and extended periods of poor flying conditions. Freezing rain can occur if the temperatures in the maritime air are conducive to producing liquid precipitation.

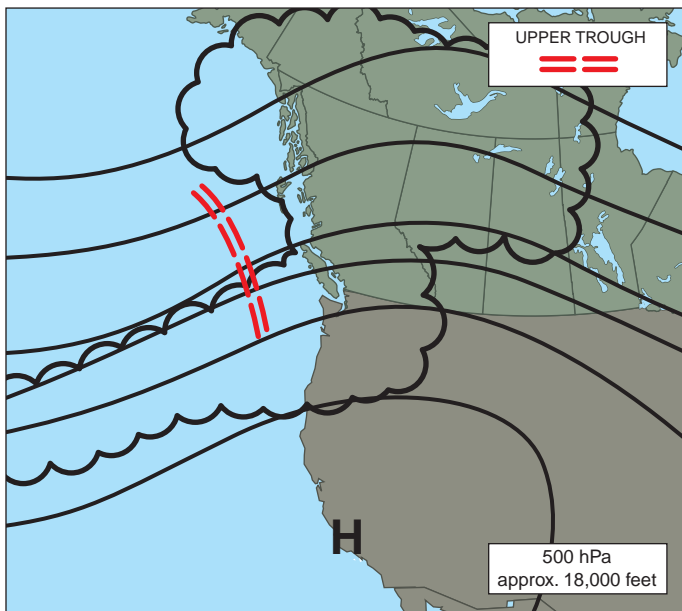


Fig. 4-1 - Upper pattern showing a typical “Dirty Ridge”

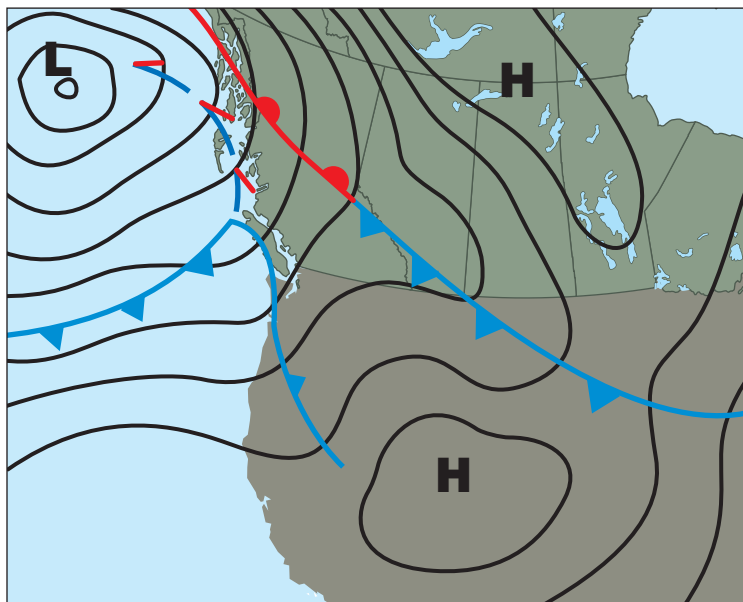


Fig. 4-2 - Surface analysis under a "Dirty Ridge"

During the winter, a strong area of high pressure can form in the very cold air found over Alaska and the Yukon. This frigid air mass will often spread southeastwards onto the Prairies with an Arctic front marking its leading edge. Depending on the strength of this front, winds can shift abruptly into the northwest with its passage and be gusty for several hours. Coupled with local snowfalls ahead of the front, these winds can produce short lived blizzard-like conditions. Once the ridge of high pressure is established over the area, widespread clear, cold weather dominates.

As mentioned in Chapter 3, Southern Alberta is noted for its winter Chinooks. Chinooks occur most often from November to January, and have been known to persist for up to 10 days. The position of the lee trough at any given time determines the weather at a specific site. To the east of the trough, a light southeast flow pushing up continually rising terrain will result in cool temperatures and generally low ceilings and visibilities, whereas to the west of the trough, the moderate to strong westerly Chinook flow quickly clears the skies and significantly warms the temperatures. This strong westerly flow is, however, notorious for producing significant turbulence.

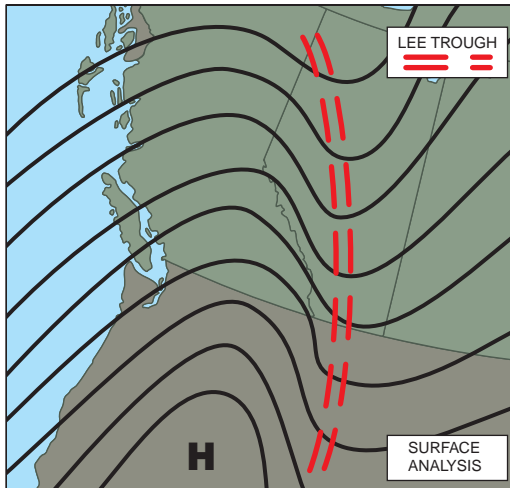


Fig. 4-3 - Basin high surface chinook flow

Within about 50 miles east of the Continental Divide, moderate to severe lee waves are common below 18,000 feet when there is a strong flow from the southwest (i.e. nearly perpendicular to the Rocky Mountain range). The favoured levels for waves to develop are between 8,000 and 15,000 feet. In strong westerly flows (greater than 60 knots above 25,000 feet), clear air turbulence will form near the mountains followed downwind by a relative lull and a secondary turbulence area. Sometimes these areas are marked by the presence of lenticular clouds forming on the upslope side of the wave but, when the air is very dry, there can be little or no indication of their presence. A westerly flow of 20 knots or greater at 9,000 feet can produce a similar effect in the lower levels. Lee waves are most common in the winter when the upper flow is strongest, but can also occur in the summer.

## Transition Periods

Occurrences of stratus and fog constitute the primary aviation hazard during the transition seasons of spring and fall, when poor flying weather is fairly common. Spring across the prairies is generally short and includes the period from when the snow begins to melt in earnest to when it has completely disappeared, and the lakes have thawed. During this time, good flying conditions occur more often as the days get longer and warmer, allowing the moisture from the melting snow to dissipate easily into the air. However, on nights relatively free of cloud, nocturnal inversions develop and effectively trap the moisture near the surface, often resulting in early morning fog and stratus which lingers until insolation is strong enough to break down the inversion.

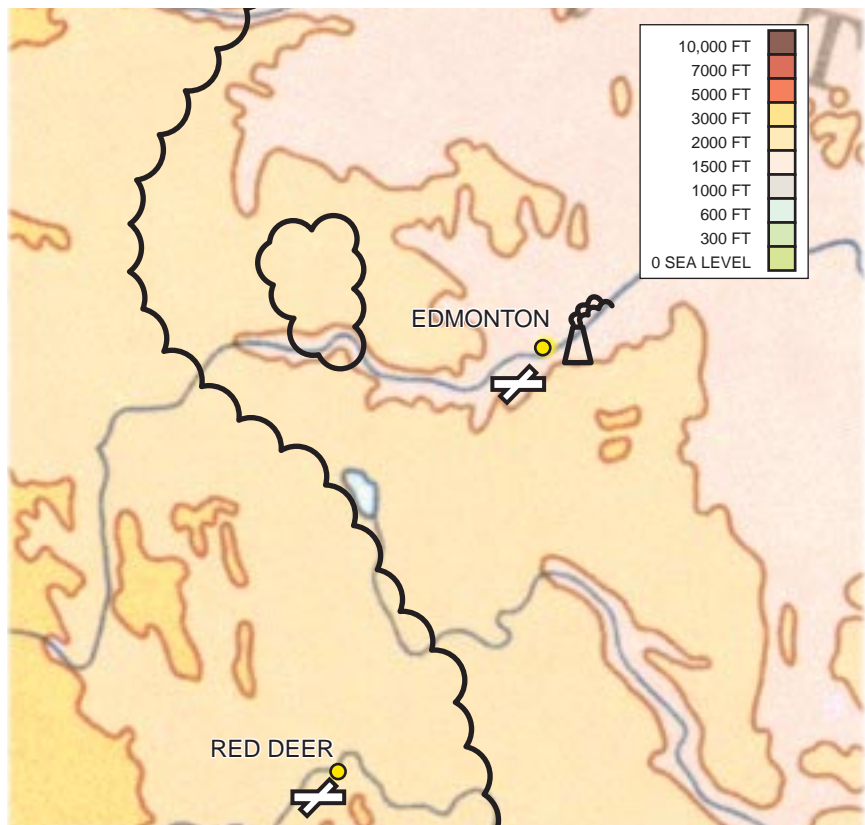
The springtime “cold lows” can often be a problem. Moving normally across the northern U.S., the easterly upslope flow to the north of the low can produce heavy, wet snow across southern Alberta.



The fall, on the other hand, is a time of lengthening nights, falling temperatures, and plentiful moisture supplied by the still-open lakes. The passage of cold air over the relatively warm water frequently produces low level cloud and instability downwind that can continue for as long as the cold flow persists. Conditions begin to improve as lakes freeze up, generally by mid to late November, for most prairie sloughs. Cold lows also make an appearance during this time of year producing heavy showers.

**Local Effects**

**Edmonton and Area**



Map 4-3 - Edmonton and area

The area around Edmonton is generally flat with a gradual slope upwards towards the southwest. The local weather is affected by the North Saskatchewan River, flowing through Edmonton from the southwest to the northeast, and by a number of small lakes in the vicinity. The West Practice Area, 30 miles west of Edmonton just to the southeast of Lac St. Anne, is a student pilot training area and its weather is very similar to that of Edmonton.



In an upslope east to northeasterly flow, fog and stratus can form in the area at any time of the year, although it is much more likely in the fall months due to the plentiful moisture supplied by open water. After freeze-up, fog and stratus become much less common.

Lake Wabamun lies about 40 miles west of Edmonton and has three large power plants situated around it. These plants release heated water back into the lake throughout the year, keeping it open during much of the winter. This leads to frequent and localized stratus development in the area, especially when the temperatures are cold and the surface flow is light, as is common in the winter.

In a northeasterly flow, fog and stratus can form and linger in the North Saskatchewan River Valley. Normally in this flow, conditions will be slightly lower and winds somewhat stronger at Namao than at the City Centre Airport, likely due to urban effects.

A light northerly flow in the spring typically yields a band of stratus and low ceilings south of the Edmonton, between Wetaskawin and Ponoka. Observations from Red Deer and Edmonton International will not provide any hint of this cloud.

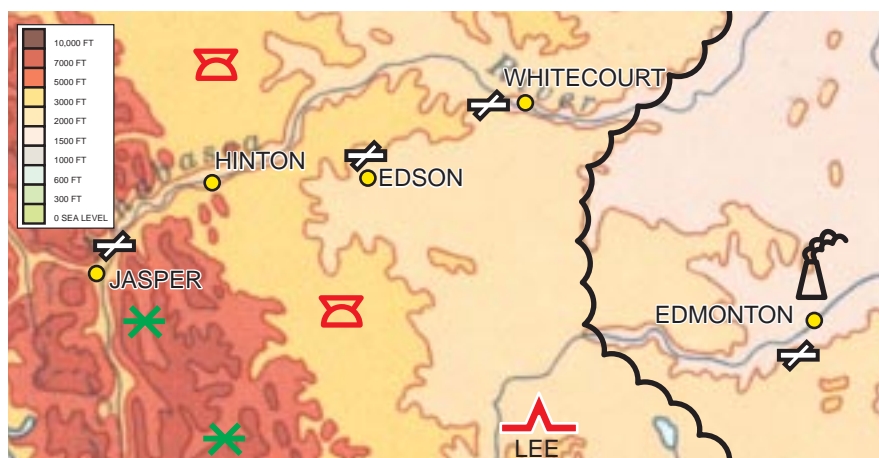
A depression in the land, extending southeast of Edmonton to Lake Miquelon, forms a shallow valley. In a northwesterly flow, stratus can form in this valley and linger well into the afternoon.

In a moderate to strong surface flow, independent of direction, there will be significant mechanical turbulence over the city of Edmonton. A 30-knot wind will produce severe turbulence for aircraft flying into the City Centre Airport. An updraft over the adjacent Kingsway Garden Mall, just to the south of the airport, frequently extends the turbulence up to 4,000 feet.

In a moderate or stronger west to northwesterly flow, low level turbulence occurs over the long narrow lakes to the southeast of Edmonton (e.g. Driedmeat Lake and Coal Lake). Similarly, the northwest flow off Big Lake, northwest of the city, can be quite turbulent.

In temperatures colder than  $-30^{\circ}\text{C}$ , ice fog develops over eastern sections of the city due to the warm output from the refineries situated there. With a very light easterly flow, the City Centre Airport will be engulfed by this fog. When the flow is slightly stronger and more northeasterly, all of Edmonton, as well as the International Airport to the south, can be affected. These reduced visibilities can be very persistent, often taking until mid afternoon to clear.

## Edmonton to Jasper



Map 4-4 - Edmonton to Jasper

From Edmonton heading westward to Jasper, the terrain rises gradually to about 3,000 feet above sea level in the vicinity of Edson. To the west of this line, there is a more abrupt increase in elevation due to an escarpment that exists west of a line from Edson to Drayton Valley and southeastwards along the Battle River towards the Ponoka area (note: the location of the 3,000 foot mean sea level contour is an important marker for low cloud development). In an east to southeasterly flow over Alberta, a band of stratus forms along and west of this escarpment and will persist for some length of time. This stratus thickens westward and typically extends in this direction as far as the Continental Divide. Weather observations taken at Edson, located in a small valley, and Drayton Valley, just to the east of this escarpment, are not representative of the weather in this area, and if marginal conditions are occurring at these two towns, worse weather can be expected further west. These low conditions are rare in the summer, but in the fall this stratus can persist all day. Some diurnal improvement will occur during the afternoon but conditions will lower once again in the evening. Any PIREP from the Rocky Mountain House area is usually quite indicative of the weather. The Obed Hills to the west of Edson will have cloud right down to the ground in such a situation, and Jasper's weather cannot be used as a reliable planning tool since it also is located in a valley where conditions can be quite different.

In the summertime, convective cells form in the foothills west of Edson due to enhanced warming by the sun along the slopes. These clouds build during the day to a height of about 18,000 feet and then begin to move eastward. Unless there is some other factor to support their development, they will usually dissipate before reaching Edmonton. If the mean flow is northwesterly, thunderstorms can also form on the windward side of the Swan Hills and move towards Edmonton. Again, these cells usually dissipate before reaching the city due to subsidence on the lee side of the hills.



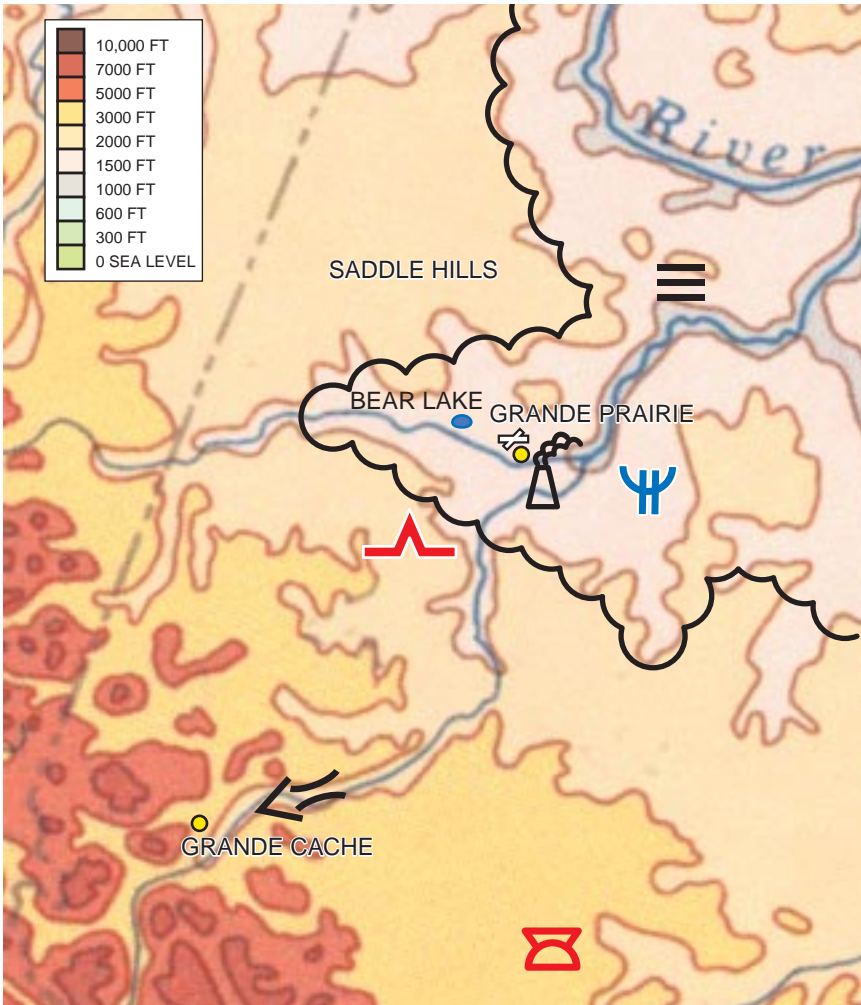
the pattern is reversed. The stratus and fog associated with the front will be thick to the northwest of the hills, but will scatter out on the southeast side.

About 40 miles northwest of Whitecourt lies Fox Creek, which is situated in a sheltered depression in the land. This is an area where stratus can easily form in an east to northeasterly flow and be very slow to leave, since it is protected from light flows from most directions. A strong flow from some direction, usually from the northwest, is required to clear it out.

In the summertime, the ridge of the Swan Hills supplies enough orographic lift to produce a great number of thunderstorms. Their development is further enhanced by the sun's heating action on the higher terrain on top of the hills but these cells are frequently dissipated by subsidence as they move away from their source. In a northwesterly flow, the convection tends to originate in the Chetwynd area, build to approximately 18,000 feet, and then dissipate due to subsidence as it moves away from the hills. These cells will quickly redevelop if there are any other factors present to support convection. The ridge of the Swan Hills also supplies enough lift to produce moderate turbulence up to about 7,000 feet.

The route from Whitecourt to Grande Prairie is, for the most part, over a basin formed by the Smoky and Little Smoky drainage systems. It has a tendency to fill with low cloud in moist northeasterly flows, especially those associated with low pressure systems moving eastward south of the area. The terrain rises between Fox Creek and Whitecourt due to a ridge of hills connecting the foothills near Obed, with the Swan Hills to the northeast. This ridge is usually shrouded in cloud whenever Grande Prairie and Whitecourt report ceilings less than 1,600 feet above ground level. It can also be an area of enhanced convection on unstable days and mechanical turbulence on windy days.

## Grande Prairie and Southward



Map 4-6 - Grande Prairie and southward

The Grande Prairie airport is in natural bowl with the foothills of the Rocky Mountains to the south and west, the Saddle and Birch Hills to the north, and minor rises to the east. The fairly deep valleys of the Wapiti and Smoky Rivers lie south and east of the airport. Upslope flows from the north and east tend to fill the area south of the Saddle Hills, up to the foothills west and south of Grande Prairie, with stratus. This cloud will often remain until it is cleared by a change in the wind. It can be enhanced, especially in winter, by exhaust emissions from the city, which lies just east of the airport, and from a plywood plant and pulp mill to the southeast.

The surrounding soils tend to be quite moist due to a high water table, with a fairly large body of water, Bear Lake, just northwest of the site. Shallow inversions, bolstered by light easterly surface winds, are frequent year round and trap moisture in the low levels. As a result, overnight fog tends to persist here longer than other sites in the region, especially from late fall to early spring.

Freezing rain is fairly common in the Grande Prairie area because of frequent shallow inversions during the winter which are intensified by the passage of low pressure systems just to the south. When an inversion is in place, even strong southwest to west winds aloft do not erode it quickly and significant wind shears and associated turbulence tend to occur within a few hundred feet above ground level.

Lenticular cloud is common with strong southwest to west wind flows aloft and can be a good indication of the existence of hazardous low level wind shears when the station is reporting variable, or light easterly winds, at the surface. These winds have likely surfaced over higher terrain, especially to the south and west, and mechanical turbulence also can be a problem for low flying aircraft over these areas. Furthermore, during strong southwest to west wind events, subsiding air off the Rocky Mountains can make it difficult for helicopters and small fixed wing aircraft operating in the area to maintain altitude. The turbulence associated with these winds tends to be worse over the eastern slopes and the foothills area but is generally not as severe among the mountain ranges themselves.

Convective cells that develop in the foothills to the west and southwest of Grande Prairie and approach the town are usually dissipated by subsidence as they approach. They will often show some redevelopment in the vicinity or east of Grand Prairie as the land begins to level.

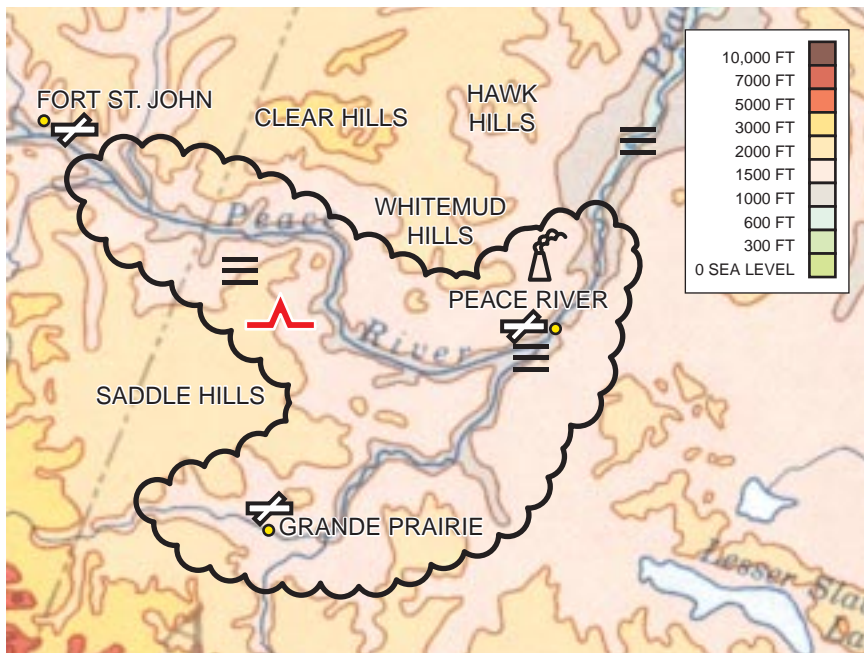
Birds in flight have been noted as a problem near the airport, especially during migratory seasons.

Routes southward from Grande Prairie encounter rising terrain and mountain weather. Mechanical turbulence can be expected within 5,000 feet or more of the surface with gusty winds from any direction over this area. However, winds flowing perpendicular to mountain ridges tend to be somewhat broken up and are not as strong in the low levels as winds which flow parallel to the openings in mountain barriers. In a typical southwest to westerly flow, funneling in southwest to northeast valleys increases the wind speed which can result in locally severe mechanical turbulence. The valleys of the Kakwa, Smoky, Athabasca, Brazeau and North Saskatchewan Rivers are prime locations for this phenomena, and it has also been noted in lesser valleys like that of the Embarras River. Light fixed wing aircraft can expect difficulties at aerodromes situated in such valleys (e.g. Grande Cache), especially with winds 20 knots or greater from the southwest.



Orographic mechanisms causing enhanced convergence and lift make the foothills a prime area for the onset of convective activity in unstable airmass situations. Cells tend to form along ridges and then move downwind. Heading south from Grande Prairie, the forest changes from a largely mixed deciduous canopy to a predominantly coniferous one, roughly along  $54.5^{\circ}$  N latitude. Differences in albedo and evapotranspiration can account for enhanced convection south of this line. This is particularly true in spring and fall when snow is covering the ground and deciduous trees are without leaves. The lower albedos of the coniferous forest can create pockets of enhanced daytime heating, which in turn can create convective currents and heightened snow flurry activity in unstable situations. Visibility can fluctuate greatly when these snow flurries occur.

### Grande Prairie - Peace River and Area Westward



Map 4-7 - Grande Prairie - Peace River and area westward

The elevation of the land gradually decreases heading north from Grande Prairie, and the Smoky and Peace River Valleys are the dominant topographic features. These valleys are quite sharp and the terrain tends to fall off with sudden drops up to 1,000 feet from the top of the valley to the level of the river. In strong wind situations, turbulent eddies and funneled currents are common along these trenches, which can cause problems for low flying aircraft.

Flows of moist air from the north through to the east are responsible for widespread upslope stratus which is bounded by the Clear Hills to the northwest of Peace River.

The Saddle and Birch Hills form a minor east to west barrier north of Grande Prairie but are high enough to create local effects of their own. Ceilings are usually lower on the windward (upslope) side, and markedly better on the lee (downslope) side, with winds out of the north or south.

It has been noted that the Peace River Valley, west of the town of Peace River, is where many cold fronts advancing from the north, behind an eastward moving low pressure system, tend to slow or stall. When this happens, poorer weather conditions can be anticipated at the north end of the route between Grande Prairie and Peace River, especially in winter.

The Peace River Airport is located about 5 miles west of the town, which is situated in the Peace River Valley. The immediate valley is deep, and a climb of roughly 800 feet is necessary when traveling from the town to the airport, most of which is in the first mile and a half. Because of this, striking differences in weather conditions can be expected between the two places. For example, a cloud ceiling of 1,500 feet above ground in town would constitute a ceiling of 700 feet at the airport, everything else considered equal. As well, the deep part of the valley near the river is often completely filled in with stratus and fog, while the airport is clear. Due to cold air drainage into the valley, the temperature at the town is usually lower than that at the airport and, of course, winds in the town would be biased to the north and south by the orientation of the river, whereas the airport is more exposed to other directions.

The Peace River and its valley and, to a lesser extent its tributaries the Smoky and Heart Rivers, are responsible for most of the local effects peculiar to the airport at Peace River. When stratus or fog (typically formed by radiational cooling overnight, especially in the fall) has filled the valley, it can “spill out” and spread across the aerodrome, especially when winds are light and variable, or light southeasterly. This condition can be fairly persistent but, since the terrain is well sloped overall, daytime heating will usually dissipate the moisture, even if it lingers for longer periods in the valley. A good rule of thumb is to expect improvement to begin at the airport roughly two hours after sunrise, maybe a little longer in winter.

The Peace River is wide and fairly fast moving in the vicinity of the town of Peace River. As a consequence, stretches of water can remain unfrozen well into the winter, and sometimes they don’t freeze at all. If conditions are clear and cold, stratus and fog can be expected along and downwind of these stretches. A large pulp mill near the river, and about 8 miles north-northeast of town, can further enhance the low cloud and lower the visibility if winds are from that direction.

Another local source of low level moisture is Lake Cardinal, about 12 miles west of the airport. Cool flows out of the west to north in the fall can create low cloud and fog, over and downwind of the lake. West winds can occasionally advect this moisture as far as the airport, but this is rare.

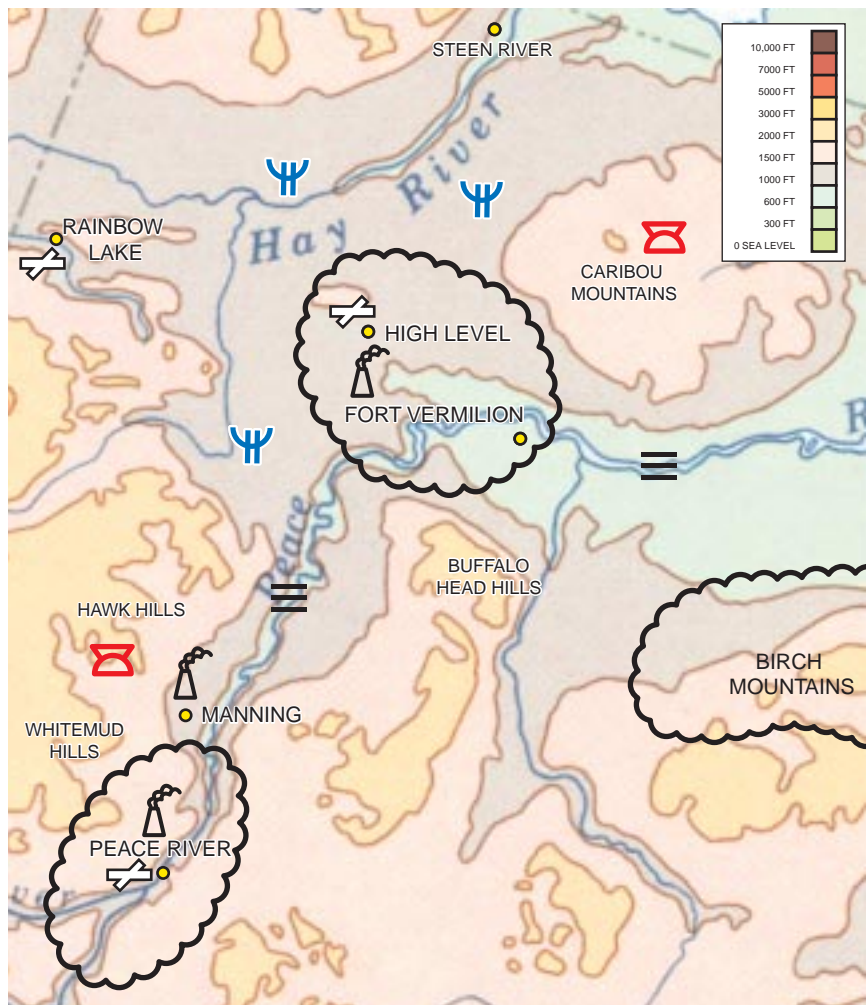
On the larger scale, the Peace River area is susceptible to widespread poor weather conditions in easterly (upslope) flows of moist air associated with organized low pressure systems passing to the south. However, conditions tend to be slightly better here than at other centers in northwestern Alberta under such a situation, and this is due to the slope of the land. A study of the terrain within a 60 mile radius of the airport shows the only true upslope direction into the airport is from the north, heading upstream along the Peace River. The Buffalo Head Hills and Utikima Uplands to the east of the airport would introduce a slight downslope component to winds from that direction, thus allowing some measure of drying in the low levels. That said, northerly winds tend to bring the worst weather into Peace River. This is especially true in the fall, when the cool northerly flow passes over still open water, and in the winter, when a northerly flow often brings cloud and snow from arctic outbreaks. Flows with a westerly component subside off the Rocky Mountains and, more locally, the Clear, Whitemud, Saddle and Birch Hills provide drier conditions and typically good flying weather. Although lenticular cloud and short-lived “Chinook” conditions are common, severe turbulence in these flows is a rarity.

Birds can be a problem near the airport during migratory seasons. Also, local agricultural practices such as tilling can attract large numbers of seagulls to the airport area.

The route between Peace River and Fort St. John is along the Alaska Highway and is dominated by the Peace River Valley. There is a gradual rise in the elevation of the valley westbound, with higher terrain on either side; to the south, the Birch and Saddle Hills and, to the north, the Whitemud and Clear Hills. This area tends to fill with low cloud and fog when there is a moist, upslope easterly flow, while subsident west winds are dry and give typically good conditions. Moist air moving from the north or south can give variable conditions due to the alternating upslope and downslope circulations produced by the terrain. There can be marked differences in weather from one side of the valley to the other in such situations. Winter cold fronts moving southward behind an eastward moving low pressure system often slow or stall through this valley, with poorer conditions in low cloud and snow to the north of the front.

Deep trenches formed by the Peace and its main tributaries, the Montagneuse, Eureka, Clear and Pouce Coupe Rivers, can produce local turbulence and wind changes in the low levels. Mechanical turbulence can be a problem within a few thousand feet of the ground over more rugged sections of the Clear Hills, especially with strong northwest to northerly winds.

Peace River - High Level and Area



Map 4-8 - Peace River - High Level

The Peace River Valley connects these two towns and is the main navigational landmark. The valley is flanked by the Clear, Whitemud, Hawk and Naylor Hills on the west side and by the Buffalo Head Hills on the East. A gradual decrease in elevation is encountered in the northbound direction. The valley broadens northeast of Manning, where the surface cover is predominantly muskeg, and, on a synoptic scale, north to northeast circulations of moist air can create widespread low cloud and fog over the gradually rising terrain. In recent years, beavers have dammed many of the minor tributaries flowing into the Peace River in this area, creating much standing water. This provides plenty of low level moisture to aid the formation of radiation fog in the summer and advection fog with cool northerly flows in the fall.

There can be stretches of open water on the Peace River well into the winter, allowing stratus to form. Exhaust from a lumber mill north of Hotchkiss can enhance fog formation in that area. The Peace River “trench” decreases in depth as the river flows northward, but can still cause turbulent eddies resulting in variations in wind direction and speed horizontally and vertically at low levels.

As with many of the ranges of hills in northern Alberta, those flanking the valley tend to develop “weather of their own.” In situations where ceilings are 1,000 to 1,500 feet in Peace River and/or High Level, the cloud can be “down to the trees” over these hills. One particularly hazardous location is where Highway 35 crosses the eastern reaches of the Hawk Hills. The highway is used by many pilots, especially novices, as a landmark to follow between Peace River and High Level. Unfortunately, the highway rises over 500 feet within a distance of about 20 miles north of the Meikle River, with even higher terrain (and communication towers) to the east and west. These hills, like others in the area, can be shrouded by cloud when conditions at Peace River and High Level are marginal or better. They are also susceptible to local obscuration on the upslope side under moist flows from practically any direction. Seasoned pilots usually opt for a route following the Peace River itself to avoid sharp changes in elevation.

Easterly winds are not necessarily “upslope” winds everywhere in northwestern Alberta. Local topography must be taken into account when resolving areas of upslope from downslope areas. Dramatic changes in weather conditions can occur across a river valley, on opposite sides of a range of hills, or from one valley to the next. One particularly good example occurs to the northwest and southeast of the Halverson Ridge, a rise of land extending northeast of the Clear Hills. When the winds are from the east or southeast, conditions can be poor over the rising terrain of the Notikewin River valley west of Manning, but can be wide open to the northwest of the ridge into the valley of the Chinchaga River. Conversely, the weather is typically, but less dramatically, better to the southeast of the ridge, especially in the fall and winter when the winds are north or northwesterly. These same phenomena can occur, to a lesser degree, over the smaller Milligan Hills to the northwest of the Chinchaga Valley, so conditions can change across the valley itself, as the general flow changes from subsident to ascending.

When the air mass over the region is unstable, the hills are a favoured region for convective initiation. There are three main mechanisms responsible for this: orographic lift, stronger sensible (daytime) heating of sunward slopes, and earlier realization of convective temperatures at higher elevations (especially when inversions are present at lower elevations early in the day). If winds are relatively strong, then orographic ascent is the main mechanism for cell formation, with convective currents being initiated on the windward side of the hill. In a weaker flow, local heating is the dominant trigger.

Finally, the hills can be expected to produce, or intensify, mechanical turbulence when winds are strong in the low levels. Some ridge lines can even generate local lee wave activity when the flow across their tops is close to perpendicular.

High Level is situated in a wide, shallow depression within an area of fairly flat terrain, with the Hay River drainage system to the west and north, the Peace River valley to the south and east, the Caribou Mountains to the northeast, and a gradual slope up into the Hawk, Naylor and eastern Milligan Hills to the southwest. This “bowl” has a tendency to trap cold air beneath shallow inversions and to hold it there for prolonged periods, earning High Level a reputation for low cloud, fog and freezing precipitation.

When cold arctic air floods the area behind one of a family of easterly migrating low pressure systems, it has a tendency to pool into the low lying land. When a warmer east to southeasterly flow develops ahead of the next low in the series, it does not clear out this cold air but instead rides over it. If the air temperature below is subzero, and rain is falling from the overrunning warm air, then freezing rain and severe clear icing are the result. This is most common in the spring and fall when it is likely that the overrunning warm air is supporting liquid precipitation. During the winter, these same cold fronts push well south of High Level during an arctic outbreak, and then they stall or begin a slow retreat. As a result, the town endures more frontal weather with low cloud, snow and gusty northerly winds than do places further south.

Mount Watt is a dominant topographic feature disrupting the otherwise smooth terrain near High Level. It is seven miles west of the airport, rising more than 1,000 feet above it, and has several communication towers situated on top. Mount Watt is blamed for many local effects, including the generation of upslope cloud from winds out of the northwest or southeast, and turbulent eddies downwind, especially when the flow is from the northwest.

Most of the poor weather in High Level occurs when the synoptic flow is out of the northeast quadrant. However, these winds are effectively blocked by the Caribou Mountains and are forced to stream in from the north up the Hay River Valley, or from the east up the Peace River Valley. In both cases, persistent upslope conditions usually result. The best weather can be expected with winds from the south through to west, and even from the southeast, with the Buffalo Head Hills providing some protection.

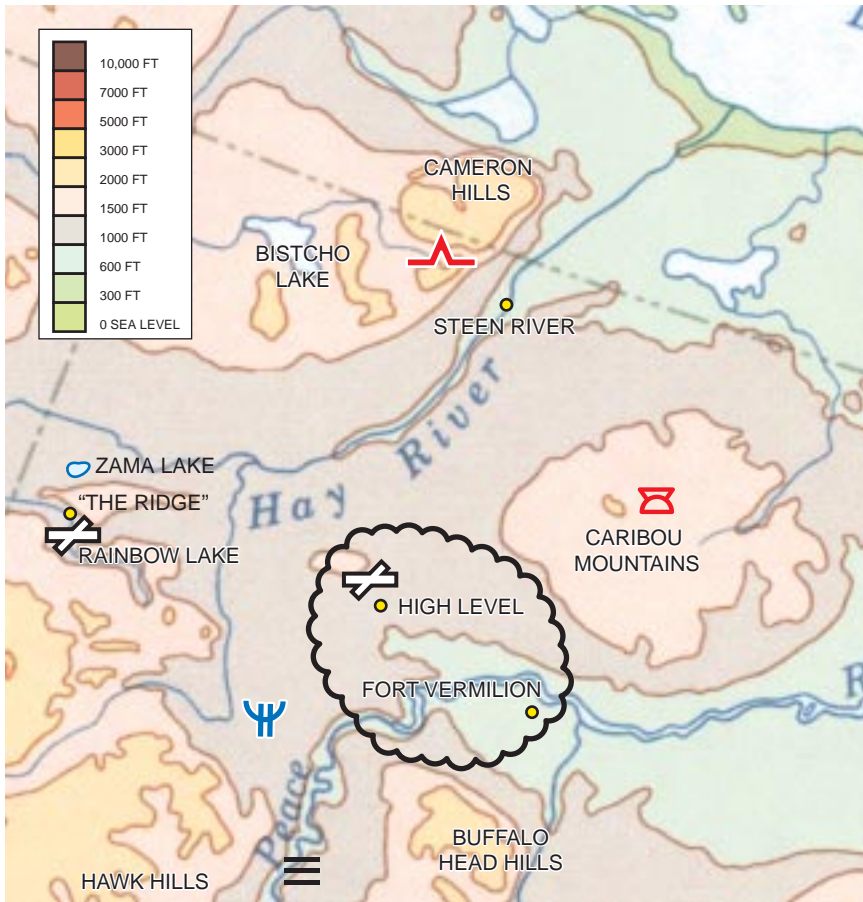
There are two local mill operations, a saw mill in town and a plywood plant just to the south. Both can accentuate fog conditions, especially under an inversion, with their addition of moisture and particulate into the lower atmosphere.

There are two small lakes near the airport. Hutch Lake lies about 6 miles north and Footner Lake, the local water aerodrome, is just to the west. Both act as moisture



sources and can generate fog, especially in the fall. As well, much of the surrounding terrain is muskeg and beaver ponds. After major rainfall events, the water table can remain quite high for several weeks, leading to an increase in standing water and a similar increase in the chance of low ceilings and poor visibilities.

## Northwestern Alberta including Rainbow Lake, Fort Vermilion and Steen River



Map 4-9 - The main routes northwestward from High Level

This route follows the Hay River Valley and gradually increases in elevation westbound. The valley is flanked to the south by the Naylor and eastern Milligan Hills, and to the north by the Cameron Hills, and easily fills with stratus and fog under moist easterly flows. The surface is typically quite wet when not frozen, as it is dominated by muskeg and beaver ponds. Because of the fluctuations in the water table depth, Zama Lake varies greatly in size and, when the table is high, it can rival Bistcho Lake in the Cameron Hills for surface area. All of these moisture sources

contribute to the formation of widespread radiation and advection fogs, especially in fall and late spring.

A landform, known locally as “The Ridge”, rises over 1,000 feet from the valley floor and separates Rainbow Lake from Zama Lake. It is over 40 miles long and oriented east to west, similar to Mount Watt near High Level. It is also a generator of turbulence and upslope cloud and is a prime location for the early onset of convective activity on sunny, unstable summer days.

Weather from northeastern British Columbia moves fairly easily through this corridor when the controlling flow is westerly. When this is the case, the rule of thumb is “Fort Nelson today, High Level tomorrow.”

The Cameron Hills are situated in extreme northwestern Alberta and stretch into the North West Territories. They are similar in many respects to the Caribou Mountains but on a smaller scale. Elevations rise abruptly about 800 to 1,000 feet into a ridge on the southeast side and then gradually diminish northwestward with the terrain wrapping around Bistcho Lake. The wind direction that produces the most upslope stratus in this area is from the northwest, simply because of the broader, more gentle incline from that direction, and the moisture that is added from Bistcho Lake. The lake is also a frequent generator of fog and stratus in the fall when the air is generally cooler than the water. Upslope stratus can occur from the southeast as well but is usually confined to a narrower area between the Hay River and the summit of the southeast ridge. There can be significant turbulence to the lee of the southeastern ridge, especially with strong northwest winds.

The Peace River turns eastward to the southeast of High Level and flows past Fort Vermilion. The river’s “trench” is basically nonexistent east of Fort Vermilion as the drainage basin becomes broad and uniformly flat. It is bounded on the north by the Caribou Mountains and to the south by the Buffalo Head Hills, as far as the Wabasca River Valley, and then the Birch Mountains further east. The surface is again dominated by muskeg and is ordinarily moist when not frozen. Rainfall does not run off quickly. Shallow radiation fog can form over these moisture sources on clear nights and advection fog is common in the fall when cool west to northwesterly winds are present (north winds are typically weak and not very common in this area as they are effectively blocked by the Caribou Mountains). Effluent from a sawmill plant near La Crete can add to the problem locally. Moist east and southeasterly winds tend to funnel up the slope through this area and pick up additional moisture from the surface, thus generating widespread stratus and fog. Flows from the west, however, usually have the opposite effect and are associated with good flying weather.

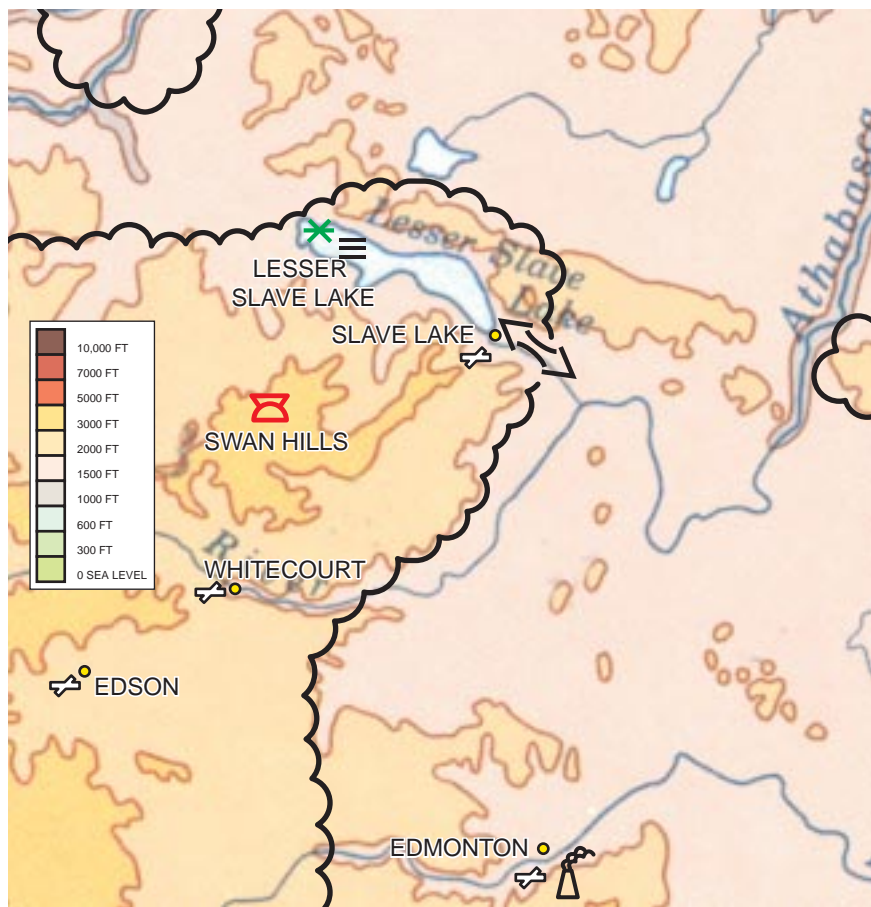
The Caribou Mountains make up one of the largest upland regions in Alberta away from the Rocky Mountains. The “mountains” are actually a nearly circular plateau that rises more than 2,000 feet above the surrounding terrain. There is a ring of

higher, terraced hills in the center of the plateau that form a bowl containing several lakes, the largest of which is Margaret Lake. The rest of the plateau is mostly muskeg, described by some to be “the wettest place in Alberta.” Strong inversions, and thus radiation fog, are a rarity over the plateau and are quite short lived when they do occur, due to cold air drainage katabatic down the slopes into the surrounding valleys. Because the crest of the plateau is usually situated well above the top of any inversion, below (nocturnal, arctic), temperatures can be considerably warmer there, sometimes as much as 25 to 30 Celsius degrees in the winter. This is one of the reasons that convection commences much earlier over the Caribou Mountains on unstable summer days; less heating is required to reach the temperature where upward convective currents are generated. Slope heating and orographic lift around the perimeter can also speed up this process.

The worst weather over the Caribou Mountains occurs when the entire plateau is obscured by widespread low cloud, usually associated with the passage of an organized low pressure system. Local upslope and downslope flows around the perimeter can further augment or dissipate this cloud. Turbulence can be a problem when strong winds from any direction encounter the steep perimeter. Winds can swirl over the edge in both ascending and descending currents, generating rolling circulations and violent eddies that can be very dangerous to low flying aircraft. Wind directions can fluctuate radically over short distances.

The route northward from High Level follows the Hay River downstream, flanked on the east by the Caribou Mountains and on the west by the Cameron Hills. The valley is broad and flat with few obstructions; very similar to the Peace River Valley east of Fort Vermilion. It is the preferred northern route in and out of Alberta as it has good visual references, including Highway 35. Moist north to northeasterly winds are upslope and can produce lower conditions. In the winter, outbreaks of arctic air can progress rapidly southward, unimpeded by any terrain barriers, bringing an onrush of cloud, snow and wind to points south. Widespread low cloud associated with passing low pressure systems can shroud the higher terrain to the east and west.

Edmonton - Slave Lake and Area

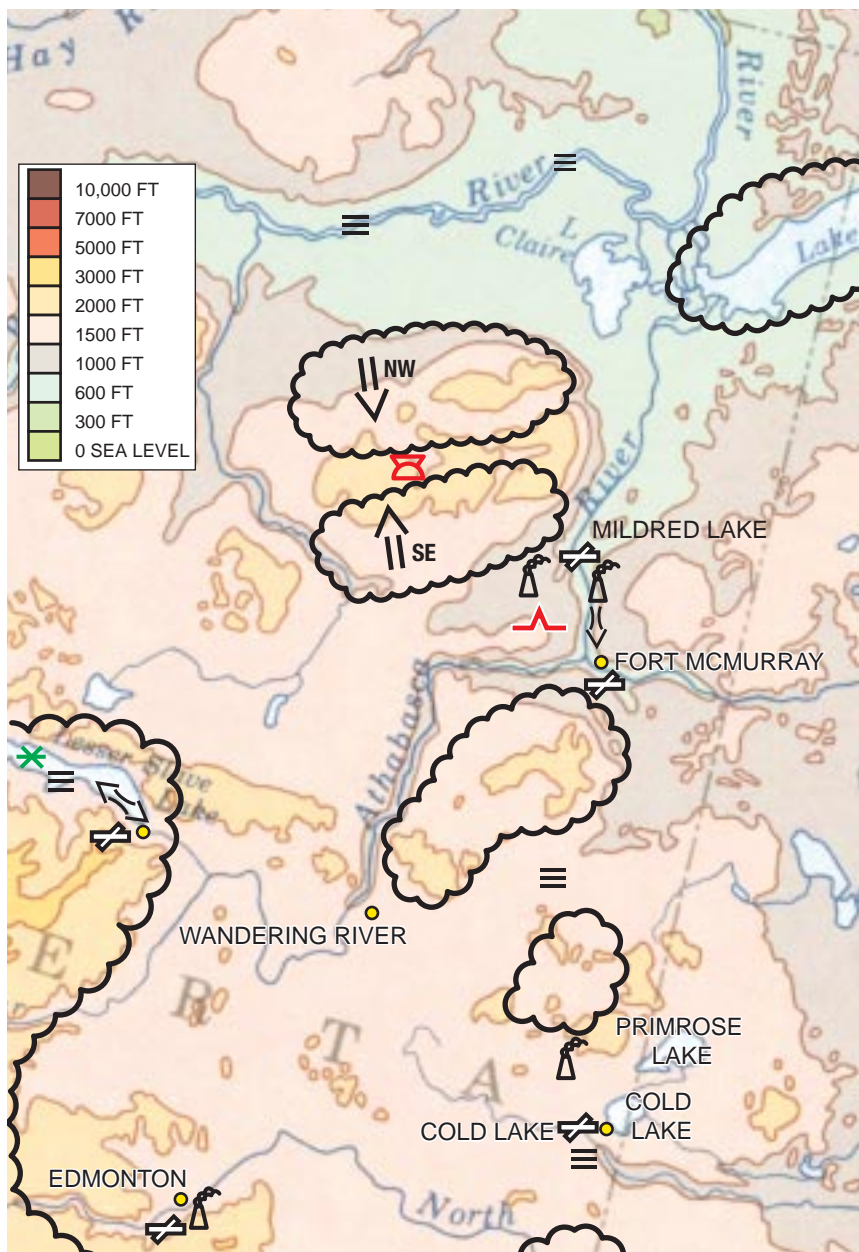


Map 4-10 - Slave Lake and area

Flying from Edmonton to Slave Lake, the terrain is relatively flat until it begins to rise over the Swan Hills to the southwest of Lesser Slave Lake. These hills, combined with the Pelican Hills to the northeast, act to funnel the winds through the eastern end of Lesser Slave Lake in either a west/northwest, or east/southeast direction. The town and airport of Slave Lake are situated between these hills and are the recipient of these strong funneled flows. This creates significant mechanical turbulence near the end of the lake, often reaching to approximately 5,000 feet above sea level.

In the spring and fall, a west or northwesterly onshore flow over the east end of Lesser Slave Lake will produce a layer of stratus up to 1,000 feet thick. This will typically extend down the valley of the Lesser Slave River, almost as far as Smith, and frequently engulfs the town of Slave Lake.

## Edmonton to Ft. McMurray and Northward



Map 4-11 - Edmonton to Fort McMurray and northward

The region between Edmonton and Fort McMurray is known for its high frequency of poor flying conditions. This is because a ridge of slightly higher terrain existing between the two points provides uplope conditions for almost all wind



directions. Also present is an abundant moisture supply in the form of swamps and small lakes throughout the area. The region between the Marianna Lakes and the Wandering River is most notorious for low conditions. Ceilings are often down to the trees and precipitation is enhanced in this area, particularly in a northwesterly flow. The highway between Edmonton and Fort McMurray runs along this ridge, but because of its generally poor conditions, pilots often choose the Athabasca River to the west, or the railway clearing to the east, for visual navigation. As a general rule of thumb, when Fort McMurray is reporting a ceiling in the 1,000 to 1,500 range, expect low ceilings from Fort McMurray to the Lac la Biche area.

Another point of danger is Stony Mountain. It is 18 miles to the south of Fort McMurray and rises abruptly some 1,350 feet above the surrounding terrain. Pilots flying under low ceilings will generally avoid this area completely as the top of the hill is frequently obscured.

The town of Fort McMurray is situated at the junction of two rivers, the Clearwater and the Athabasca. The Athabasca River pours in from the west-southwest and turns north at the point it meets the Clearwater, flowing from the east. The Fort McMurray airport is situated on the south side of the Clearwater River, and its weather is influenced by the Clearwater Valley. The surrounding land is generally flat muskeg except for Stony Mountain, which lies to the south.

The two rivers can create localized fog and stratus between the months of May through October when the water is open. During the overnight period, cooler air tends to pool in the valley which can lead to fog and stratus formation, especially in the fall. These conditions usually improve during the day but will often spill over the sides of the valley into the airport, especially in the morning hours. However, in the absence of this localized phenomena, the river valleys are preferred routes.

Within the airport boundaries there are a few local effects created by specific conditions. The first is the frequent occurrence of turbulence during a strong westerly flow of 20 knots or greater, causing higher than normal sink rates on a final approach. It is speculated that this is created by the difference in albedo between the surrounding forest and the cleared area of the airport, combined with the influence of the westerly flow making a transition from the treetops down to the aerodrome.

Another local phenomena is restricted to winter months only and is the result of snowmaking at a ski hill 3 miles east-northeast of the airport. If the surface flow is towards the airport, visibility is often reduced to half a mile or less by ice crystals. This persists until the snow making is ended.

The airport can also experience locally reduced conditions in a northerly flow. Such a flow, coming along the Athabasca River Valley, is funneled as the valley becomes progressively more narrow. When this strengthened flow meets the southern slope of



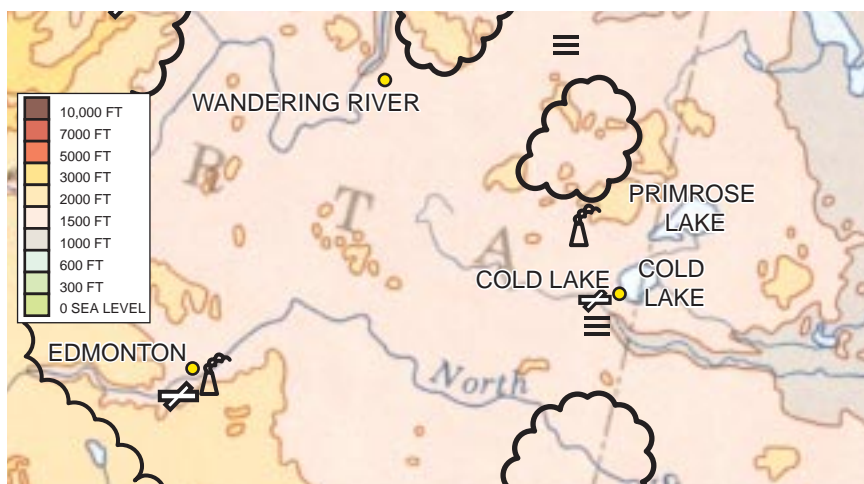
the Clearwater Valley, it is forced abruptly upslope and can give low conditions at the airport sitting at the top of the valley. This situation can also produce significant low level turbulence.

There is a landing strip at Mildred Lake, about 28 miles to the north of the Fort McMurray Airport, that is used to service the oilsands activity in the area. Because of the emissions from local plants, as well as the warmer effluent emitted into the tailing ponds, this strip will often be fogged in when conditions elsewhere are fine. Although this localized fog never reaches as far as the Fort McMurray Airport, it is often possible to see distant plumes of steam to the north.

There is a great deal of flight activity to points north of Fort McMurray due to the oilsands activity and the abundance of fishing and hunting lodges in the area. The local topography is the result of ancient glacial activity and consists of relatively flat land dotted by numerous small lakes, many low-lying hills and acres of swampland and muskeg. This area, with its abundant low level moisture, can often be blanketed in stratus and stratocumulus, regardless of wind direction and especially in the transition seasons of spring and fall. There is a definite lack of weather reports to aid flight planning. Experienced local pilots use their familiarity with the terrain to avoid higher ground that most likely will be obscured by low cloud.

Other features that stand out from the surrounding level terrain are the Birch Mountains, 50 miles to the northwest of Fort McMurray, and Trout Mountain, 80 miles to the west. Together these two form a physical barrier, with just a narrow pass in between, that effectively blocks flows from both the east to southeast and from the north to northwest. The terrain in this area also has sufficient elevation to initiate convective cloud on warm summer days.

## Edmonton to Cold Lake



Map 4-12 - Edmonton to Cold Lake

The flight path from Edmonton to Cold Lake takes a pilot over mainly agricultural lands with many small shallow lakes and gently rolling hills. Otherwise, there are no significant geographical features. The land slopes gradually downhill from west to east, losing about 500 feet of elevation between the two, and in the absence of any major synoptic weather feature there is very little to affect the enroute weather until Cold Lake. The Cold Lake region is a continuation of the gently rolling topography that extends off the north-northwest and sits on the dividing line between mainly farm and grasslands to the south and Boreal Forest to the north. The major influences on the weather in the Cold Lake region are two large lakes to the northeast (Cold Lake and Primrose Lake) and the Beaver River Valley running through the town.

The Beaver River is a fairly small waterway with an east-west orientation that flows just south of the military base and airport. It has carved out a very broad and shallow valley in which the airport is situated. This valley, despite its shallowness, has a significant influence on the weather. Winds are frequently channelled by the valley into either an easterly or westerly flow. Indeed, a wind rose of the area shows these two directions to be predominant, with westerly having a slighter greater frequency than easterly. Winds channelled from the west are almost invariably associated with good flying weather as they have been dried in the lower levels by the continual down-slope progression from the mountains. The one exception to this is when the westerly wind is due to the wrap-around flow from a cold low to the east or northeast of Cold Lake. In this case, there is an abundant supply of moisture and instability. A persistent easterly flow is gradually forced upslope and is more likely to give lower stratus or fog, but even this is mitigated to a great extent by the presence of a small sharp ridge rising 200 feet just to the east of the military base. This ridge acts as a

block and can often keep the stratus scattered at the airport, or at least raise it up a bit, before reaching the observing site. So, in essence, the Beaver River Valley helps to keep the weather at Cold Lake suitable for low-level operations in the absence of other weather influences.

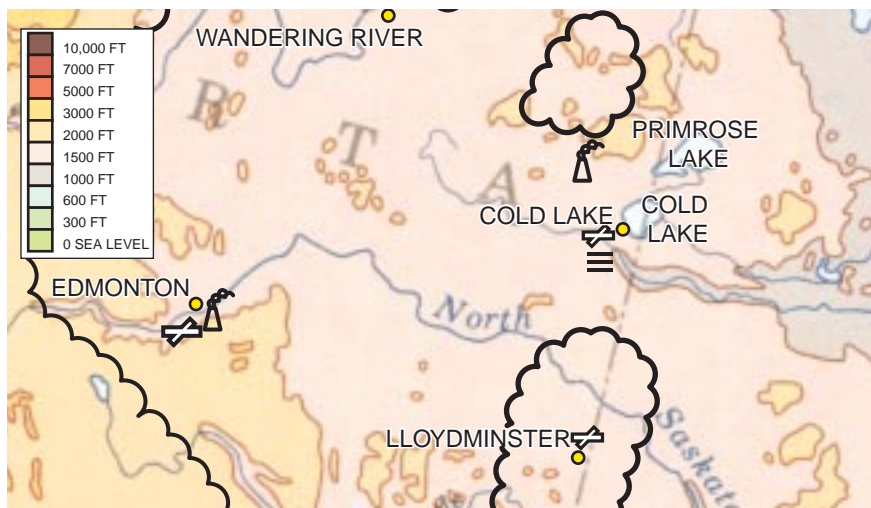
Cold Lake, the nearer of the two lakes, is about 5 miles northeast of the airport site. It acquired its name because an unusual depth, nearly 300 feet at maximum, keeps the water temperature much colder than that of surrounding lakes. Primrose Lake is a further 20 miles to the northeast and is much shallower. These lakes create an abundant moisture supply for stratus and fog formation, especially when the wind flow is from the northeast quadrant and, conversely, the lowest occurrence is when the wind flow is from the southeast. Fortunately, a northeasterly flow is one of the least common wind directions for this site.

The greatest influence from Cold Lake, and to a much lesser extent Primrose Lake, is felt in the fall and early winter. At this time, the lake water is still retaining a great deal of warmth from summer heating while the air above it is becoming progressively cooler. Any northeasterly flow will become saturated in the low levels bringing stratus, fog, drizzle, freezing drizzle, or even snow to the airport. This is further enhanced by the slight upslope component of this flow. If the northeasterly flow is particularly cold, the relatively warm water can create low level instability leading to the formation of cumulus and towering cumulus that can give localized heavy snow squalls over the airport. Poor flying conditions tend to peak in November and then come to a halt in December, when Cold Lake completely freezes over. Primrose Lake freezes over much earlier.

The area around Cold Lake, being part of a Prairie climatic regime, is susceptible to summertime convection, but there are two effects that tend to lessen the number of storms that pass over the airport itself. First, there is a preference for convection to be initiated over the higher and warmer terrain on either side of the valley, where there also tends to be abundant moisture from small lakes and evapotranspiration from vegetation. However, once the cells start to move over the river valley, they are often weakened, or dissipated, by the downslope flow and the relatively cooler air that is pooled in the valley. Second, the waters of Cold Lake also act as a dampening force on local convection. The cooling effect of the water on the lowest level of the atmosphere almost completely inhibits convective processes on warm summer days and a clear hole can be seen over, and downwind, of the lake. The Mostoos Hills, just northeast of the lake, form another preferred region of convective development due to their elevation and many small moisture sources. However, the dampening effects of Cold Lake stand as a barrier between this convection and the town, proving to be particularly beneficial for the town and airport. Note that this effect is reversed in the cooler fall months when the open lake acts to heat the air above it.

There are a couple of man-made weather influences that can affect Cold Lake and its surroundings under the right conditions. A large oil refinery is situated 13 miles to the north-northwest of the airport and injects a great quantity of heated water vapour into the air. In the winter months, this is favourable for the formation of stratus and ice fog. However, this phenomena does not often reach the airport as a northeasterly flow is rare. More common at the airport on extremely cold winter days is the formation of ice fog, due to water vapour emissions that result from frequent jet activity, and a steam plant situated on the Canadian Forces Base.

### Edmonton to Lloydminster



Map 4-13 - Edmonton to Lloydminster

The terrain from Edmonton to Lloydminster slopes gradually downwards which means that, as with many areas in Alberta, the lowest flying conditions are often produced with a persistent upslope easterly flow. This will occur when a low passes though the southern portion of the province, or when there is a well developed and stationary ridge over the eastern Prairies. These conditions can occur at any time of the year but are most frequent in the fall, with the greatest amount of fog occurring in October, November and early December, when lakes are generally open. When the prevailing winds are west to northwesterly, which is the most frequently occurring wind direction for this area, flying conditions are generally good.

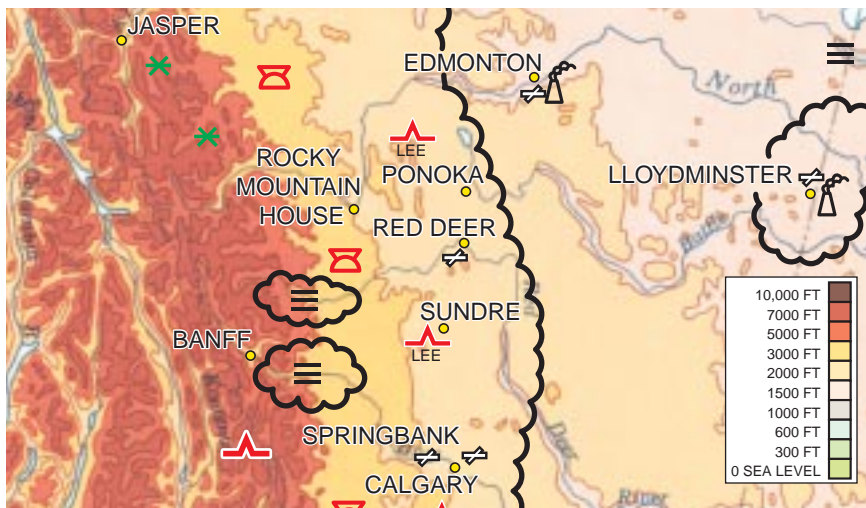
The town and airport of Lloydminster are situated on relatively high ground between the North Saskatchewan River, to the north, and the Battle River, to the south. These rivers can supply sufficient moisture for fog and stratus to form in their valleys, especially in the spring and fall, but this tends to stay confined within the valleys and does not often reach as far as Lloydminster. Most of the lakes in the vicinity are too small to have an effect but the Big Gully Lakes, 10 miles east of Lloydminster,

provide an extra boost of moisture to stratus that is heading towards the airport in an already upslope easterly flow. Some purification ponds are situated two to three miles to the northeast of the airport, and these can create fog and stratus over the runway in a northeasterly flow.

There is a north-south ridgeline through Kitscoty, about 16 miles west of Lloydminster. In a westerly flow, fog and stratus will stay to the west of this ridge allowing Lloydminster to be clear while Vermilion, 35 miles west of Lloydminster, is immersed in fog. The reverse is true in an easterly flow where Lloydminster will be in fog, while Vermilion is clear. This effect is most apparent during the fall.

There are three industrial plants in and around Lloydminster: an oil refinery, a heavy oil upgrader and a canola oil refinery. All three of these contribute condensation nuclei to the atmosphere and enhance the development of low cloud, especially in the fall and winter.

### Edmonton to Calgary via Red Deer



Map 4-14 - Edmonton to Calgary via Red Deer

Flying southward from Edmonton to Calgary, there is a continual increase in elevation from 2,300 feet ASL in Edmonton to 3,700 feet ASL in Calgary. There is also higher land on the west side of this flight path as the elevation increases towards the foothills, so any flow from the north through to the east has an upslope component. Synoptic features such as cold lows or lee troughs, which usually produce an easterly surface flow across this route, can result in poor conditions at any time of the year, particularly during the fall and winter. Also, a flow from the north to northeast produces a band of stratus that will typically extend from the foothills to the Ponoka area and southeastward. November is the worst month for flying between Edmonton

and Calgary, as there is a high frequency of events of fog, snow flurries and icing from freezing rain. The output from automatic weather stations at Rocky Mountain House and Sundre can be used to fill in extra information for conditions along this route, but since Rocky Mountain House is situated up against the foothills, it is not always a good indicator of what is happening further east. The observation from Sundre, however, can be quite indicative of the weather conditions along the southern portion of this route.

The city of Red Deer and the Penhold Airport are in the valley formed by the Red Deer River and are further situated in a bowl-like depression within this valley. Because of this, the airport is sheltered from most wind directions and often reports much lighter winds than would otherwise be expected. It also means that low cloud will tend to linger at the airport, sitting in the sheltered depression, long after the rest of the area has cleared. The Red Deer River flows from south to north, just to the west of the airport. Both the river and the small Dickson Reservoir to the southwest are open (at least partially) throughout the year. Cool weather in the fall and early spring, combined with moisture from these two sources, can produce fog which then drifts across the field to the runways. This phenomena is often associated with a northwesterly flow which gains an extra dose of moisture from Sylvan Lake. The fog starts overnight and generally persist till mid-morning.

If conditions are poor in Red Deer, then they generally worsen southwards towards the Olds-Didsbury area due to the increase in elevation. This area is also quite open and prone to drifting and blowing snow in the winter. Because of Red Deer's sheltered position in a valley, it is advisable to use all other sources of information, such as the Sundre auto weather station, when flying southward to Calgary.

Chinooks are common in the Red Deer/Calgary region. Thorough discussions of this phenomenon can be found in Chapter 3 and at the beginning of this chapter.

The foothills, stretching along the west side of the flight path between Edmonton and Calgary, are a favoured region for convective initiation on summer mornings. These cells move away from the foothills during the afternoon and affect points along the flight path. The region between Red Deer and Edmonton generates a great deal of activity, particularly in the Lacombe/Ponoka area and the Innisfail/Crossfield area. Because of its closer proximity to the foothills, Red Deer is more likely to experience thunderstorms than Edmonton. In a northwesterly flow, the cells moving towards Red Deer will often stick to the higher ground to the west and head south towards Innisfail. However, the cells that do track across Red Deer eventually move over the higher terrain of the Wild Rose Ridge, southeast of the town, which provides a further impetus for their development. Sometimes in a northwesterly flow, thunderstorms that move into the Alder Flats/Rimbey area, to the northwest of Red Deer, are slow to leave and produce low ceilings and heavy rainfalls over the area.

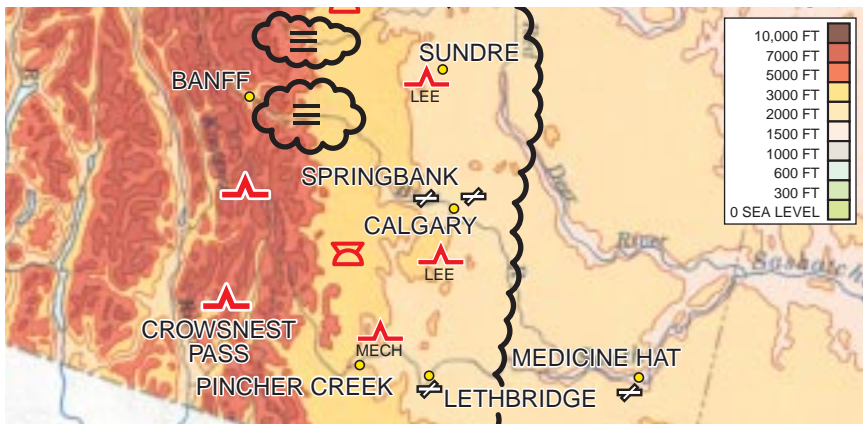


Foothills thunderstorms are frequent producers of hail, squall lines and, occasionally, tornadoes. Altocumulus Castellanus (ACC) observed early in the morning is a good indication that convection will develop later in the day. Two weather radars, one at Strathmore and the other at Carvel, are used to monitor this development. Red Deer is situated at the halfway point between the two installations but, unfortunately, near the limit of coverage of both. Because of this, the information over the Red Deer area is less detailed.

Lee wave turbulence is frequent in this region up to 8,000 to 10,000 feet when a moderate or stronger westerly flow exists across the mountains. Occasionally, this turbulence can be identified by the presence of lenticular clouds, but this is not a necessary condition for its existence.

From Didsbury southward, the climate becomes drier and the amount of agricultural land increases. Dust storms are possible, especially in the spring and fall when the winds are stronger and crops do not protect the land. These storms can begin anywhere beyond 30 miles east of the mountains.

### Calgary, Springbank Area and Westward



Map 4-15 - Calgary, Springbank and westward

This is yet another area in Alberta where any flow with an easterly component has the potential to produce fog, stratus, and drizzle, especially in the spring and fall. This easterly flow, common when there is a low pressure area sitting near the US/Alberta border, will create a region of stratus extending 50 to 110 miles east of the Continental Divide, sometimes as far east as Beiseker, 30 miles east of Calgary. A few occasions have been noted when the stratus edge will sit between Calgary and Springbank but, as a rule of thumb, whenever there are low ceilings in Calgary, even lower conditions will exist in Springbank, due to the rise in elevation to the west. The higher terrain of Scottlake Hill, located about 10 miles west of Calgary, opens up first in these stratus situations.

Sometimes the Calgary Airport will report stratus when Springbank and other surrounding areas have none. This is most likely due to the moisture and large quantities of particulate matter released into the atmosphere by the industry in and around the city. Conversely, unexpected stratus sometimes occurs at Springbank when there is a northerly flow coming off Cochrane Hill.

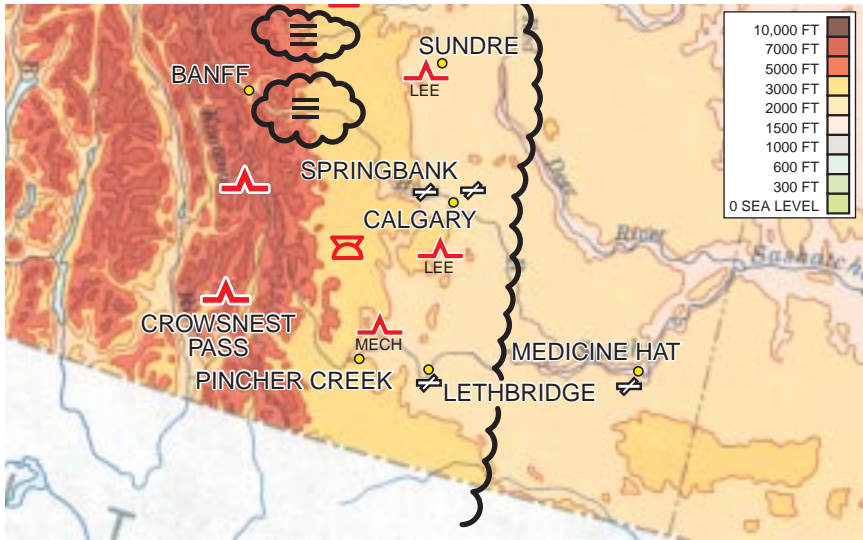
The “Okotoks Hole”, an anomalous and puzzling area of clearing within 10 to 15 miles of the town of Okotoks, just south of Calgary, is often observed when Calgary and Springbank are both immersed in stratus. Since this normally happens with an easterly flow, there may be a local subsidence circulation off a small range of hills that is responsible for this phenomenon.

In the summertime, convection can be initiated anywhere in the foothills to the west of Calgary. One common source region is the Cochrane/Ghost Lake/Water Valley area. Cells that form here move southeastward in the Bow River Valley and from there will move either along the Cochrane Ridge into northwest Calgary, or along the Elbow River into southwest Calgary. Other source areas can be the Lake Minnewanka Valley or the Banff/Canmore region, and thunderstorm cells that form as far south as the Livingstone Range can still move northeastward towards Calgary. Convection that forms in the foothills 50 to 60 miles to the southwest of Calgary will frequently dissipate before reaching the city unless some upper support is present and, even in this case, it will generally remain south of Calgary, moving into the Bow River valley and following it eastward.

A strong west or southwesterly flow aloft brings the likelihood of lee or mountain waves over this region. Downdrafts of up to 3,000 feet /minute through Kootenay, Jasper, Bow Valley and Banff park areas are common, producing moderate or severe turbulence up to 14,000 feet in a zone which can extend 60 to 110 miles east of the Continental Divide. This flow is also associated with strong wind shears at the Calgary and Springbank airports. Mountain waves can often be identified by the presence of Altocumulus Standing Lenticular clouds (ACSL), cap clouds, rotor clouds or the “arch” phenomena generated by the common Chinook winds. The strong winds associated with the Chinook first appear in the Bow Valley and then generally take two to three hours to reach Springbank. About an hour later, they reach Calgary. Although the Chinook will improve ceilings and visibilities, severe wind shear and turbulence are always a hazard.

Flying westward into the Bow Valley, Mount Yamnoska is the first mountain encountered where moderate to severe turbulence is frequently reported. Significant turbulence reports are also common flying at 9,500 feet near Rundle Mountain. At low levels, the ride can be equally dramatic with strong surface winds giving low-level turbulence that is often moderate or greater. This turbulence tends to begin just to the east of Canmore between Morley and Exshaw.

## South of Calgary



Map 4-16 - South of Calgary

The weather along the flight path from Calgary to Lethbridge is susceptible to many of the same influences as Calgary and areas north. Again, any prolonged easterly flow will eventually blanket the entire area in stratus due to the westward increase in elevation. This flow is most frequently created by a low over the northwestern US. It can happen at any time of the year but is less common in the summer. In the winter, this pattern will often bring snow which appears first in an east to west line over the Milk River Ridge and then progresses northward into Lethbridge.

The airport in Lethbridge is located south of the city to the southeast of the Oldman River, which is fed by a number of tributaries in the area. By far, the most frequent wind directions at this location are west and southwest. These are downslope winds and, when they are blowing, Lethbridge generally enjoys fine weather with clear skies. However, mechanical turbulence is a genuine concern for pilots flying in this area. The predominantly westerly flow is usually quite brisk and, if it attains speeds of 25 to 30 knots, moderate to severe mechanical turbulence can occur up to 4,000 feet above ground level. Even with a westerly flow of less than 20 knots, moderate turbulence can also be experienced directly at the edge of the Oldman River Valley and over the coulees to the west, although these effects will only be felt in the lowest levels.

Chinooks are very common between Lethbridge and Calgary. The weather at any location will change abruptly as the Chinook passes eastward, going from cold temperatures and low overcast skies to warm, sunny and windy conditions. As always, severe turbulence is cause for concern with a Chinook.

In the summer, most convective cells in the Lethbridge area form in the foothills to the west or southwest and move northeastward during the day. Because this region is generally very dry, thunderstorms will often generate microbursts which produce strong surface gusts. Indeed, the entire southern section of Alberta is a favoured region for microburst activity.

Strong northerly winds will usually only occur in Lethbridge in association with a cold frontal passage. In these cases, there is little to no weather, and the passage is mostly marked by a few hours of very gusty north to northwest winds.

Ice fog occurs several times during the winter in Lethbridge. It requires light winds or calm conditions, a stable atmosphere and temperatures colder than  $-25^{\circ}\text{C}$ . Events have been known to last for two to three days. During these episodes, diurnal improvements are minimal and a pronounced reduction in visibility is usually experienced during the evening hours.

Although Pincher Creek is known for its high frequency of good flying weather, wind is often a big concern. As with Lethbridge, the most frequent wind direction is from the west, and this direction also brings the highest wind speeds. Pincher Creek is situated at the east end of the Crowsnest Pass, which is famous for strong flows that channel through it. For a pilot looking to fly this route, there are a few observations that can help determine the strength of the flow at any time. Pincher Creek, at the east end of the pass, can be quite indicative of the pass winds, as well as the Crowsnest auto station half way through, and Sparwood, British Columbia at the west end of the pass. Winds are frequently very strong all the way through the Crowsnest Pass and into Pincher Creek, weakening somewhat by the time they reach Claresholm, Fort McLeod and Lethbridge. With these strong west winds, turbulence is often experienced in the pass up to 10,000 feet.

The severity of turbulence at Pincher Creek is not always directly correlated to the wind speed. Because the terrain is so irregular, there have been occasions of little turbulence with very high wind speeds and excessive turbulence with relatively weak winds. One phenomena that Pincher Creek is susceptible to, and one that increases the likelihood of turbulence, is the formation of a “rotor” circulation at the base of the hills. This type of flow occurs when the wind coming down off the mountains is strong enough that a portion of it bounces off the land and returns back up the lower part of the hill. This intense rotation of air is occasionally made evident by the existence of a rotor cloud at the base of the hill but, since the air in the Pincher Creek area is often extremely dry, it is rare that such a cloud will form.

Thunderstorms tend to form from enhanced heating along the slopes of the ridges to the west of Pincher Creek, but they frequently dissipate as they move eastward. Because of this, Pincher Creek and Lethbridge have a relatively low number of thunderstorm occurrences annually when compared to many other Alberta stations. Due

to the dryness of the region, whenever thunderstorms do occur, they are typically high-based and precipitation often evaporates before it reaches the ground (virga). This is the primary mechanism that produces dry microbursts and their associated strong winds.

There have been occasions where the stations at Sparwood and Pincher Creek, on either side of the Crowsnest Pass, are reporting clear skies whereas, in the pass itself, severe thunderstorms will force pilots to turn back.

The area from Lethbridge to Medicine Hat does not differ much from the rest of southern Alberta. The land slopes upwards to the west, so any feature producing an easterly flow has the potential to generate low ceilings over the upward sloping terrain. Such a flow usually comes from low pressure systems moving northeastward over the northwestern US or stay just to the south of the US/Alberta border. The resulting stratus band will often begin just to the east of Medicine Hat. Here, the nature of the flow changes from downslope (off the Cypress Hills) to upslope. The climate in this area, much like the rest of southern Alberta, is extremely dry, so it is only during the fall or spring that such a flow can create widespread low ceilings.

All of southern Alberta is susceptible to the effects of the Chinook, but its potency diminishes as the winds spread further east. Usually, the lee trough that forms in advance of the Chinook will be somewhere near Lethbridge, leaving areas to the east in a cool, moist, southeasterly flow. The Chinook and lee trough almost always progress eastward but only rarely reach Medicine Hat, and even then they are generally quite weak, having been displaced that far from the mountains.

The Medicine Hat Airport is situated southwest of the town, just south of the valley formed by the South Saskatchewan River. The predominant wind direction for this site is from the southwest with many flows deflected around the Cypress Hills and down the valley formed by Seven Persons Creek. The area is relatively sheltered and winds are rarely as strong as at Lethbridge. Often, though, when winds are reported from the southwest at about 10 knots at the airport, they can quickly increase to westerly 25 knots, or more, just a short distance above the surface. It is also possible to have lee wave turbulence as far eastward as Medicine Hat.

When a migratory low passes eastward through the Medicine Hat area, the winds will shift to northwest as the associated cold front sweeps southward in its wake. A northwesterly wind is a cross wind at the airport, and any northwest flow 30 knots or greater makes it difficult to use the main runway.

The South Saskatchewan River, as well as Murray and Rattlesnake Lakes, are local sources of moisture for the formation of stratus and fog. In general, however, it is just too dry in this part of Alberta to see these conditions at any time other than during the fall season and occasionally in the spring. There are also two local industrial

concerns, a rubber plant and a fertilizer plant, that produce particulate matter and heat which affect conditions in the winter. They can, under a cold winter inversion, produce ceilings of 500 to 1,000 feet, but the visibility is generally good. This cloud is highly localized and may only cover one to two square miles and be 200 to 300 feet thick. When ceilings are below 2,500 feet, the Cypress Hills to the southeast are not visible.

Medicine Hat does not have a great frequency of thunderstorms, but some can be generated on the flat terrain to the west on hot unstable days. Sometimes thunderstorms will cross the border from Montana, and these are usually quite intense. Large and slow moving thunderstorm cells are one of the few phenomena that will generate conditions with low ceilings and poor visibility in the area around Lethbridge and Medicine Hat during the summer, and even this situation tends to be short lived. The typical summertime air mass is just so dry that copious amounts of moisture are necessary to saturate the lower levels.



## Weather of Saskatchewan



Map 4-17 - Topographical overview of Saskatchewan

Saskatchewan's distinction as the sunniest and driest of all the Canadian provinces makes it the most truly continental as well. There are no mountains, large bodies of water or climatic irregularities to moderate the extremes allowing for hot summers, cold winters and large diurnal temperature differentials. The land is one vast, glacially carved plain sloping gently to higher elevations in the west. The most southern third of the province is classified as true prairies with open grassy plains, rolling hills and broad river valleys. It is a highly agriculturalized region owing its productivity to the deep layer of glacially deposited fertile soil. This gives way to the mixed forest of the boreal plain of central Saskatchewan, where substantial deposits of sandy soil over top of the Precambrian Shield support vigorous forest growth. The forest becomes mainly coniferous further north, as the soil cover becomes progressively thinner and coarser and barely covers the rock below. Eventually the boreal plain transforms to boreal forest, which is characterized by sparser and more stunted coniferous growth, muskeg, frequent bare rock outcroppings and numerous shallow lakes and streams.

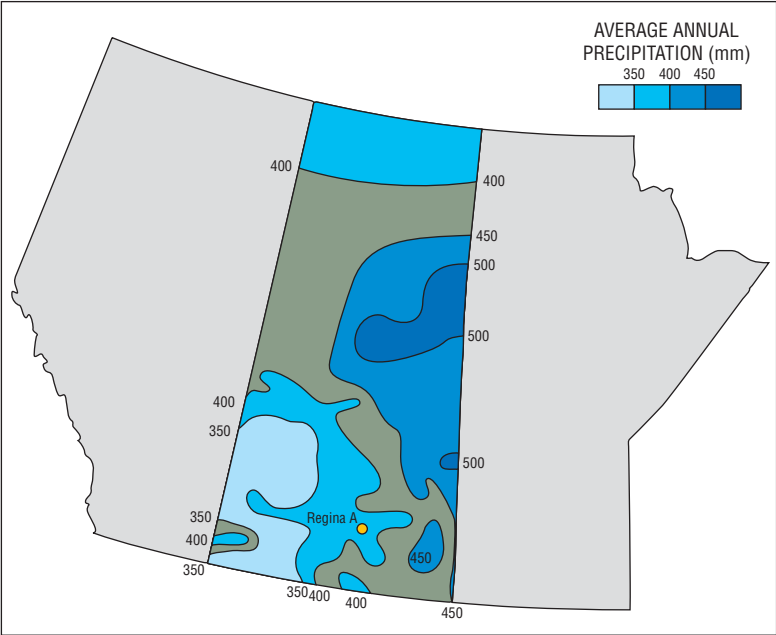


Fig. 4-4 - Annual Precipitation (mm)

The climate across Saskatchewan does not vary greatly. The south is classified as cold temperate meaning it has cold winters and short warm summers, while the northern section is sub-arctic, with the main difference being slightly longer winters and even shorter summers. Annual precipitation is not great in any area and varies from a low of just over 300 mm in the southwest to a high of just over 500 mm in the east/central portion. Most remaining locations receive around 400 to 450 mm per year. Again, this unvaried moisture regime is explained by Saskatchewan's land locked position in the middle of the continent and its relatively uniform topography.

It is the Cypress Hills in the extreme southwest that boast the highest elevations in Saskatchewan at near 4,600 feet, but this is just a rather modest 2,000 feet above the surrounding terrain.

Saskatchewan, as with the rest of the prairies, lies under the zone of mean westerly winds, and weather disturbances generally move from west to east. However, because it is physically open in all directions, it can be the recipient of any number of air masses; cold dry Arctic air from the north, cool and modified Pacific air from the west and southwest, and warm, somewhat moist air from the American south. These air masses will meet and clash over the province frequently generating storms along their frontal boundaries, especially in the spring. This provides a benefit to Saskatchewan agriculture as the maximum precipitation generally falls in the month of June giving a boost to crops during the early part of the growing season. But these storms are not frequent enough to rescue Saskatchewan from being the driest of all the provinces, and even when a moister flow makes its way eastward from the Pacific it has dried considerably by the time it arrives in Saskatchewan.

The heart of the dry country is found over the southwest in the South Saskatchewan River basin, an area sometimes referred to as “Palliser’s Triangle” after the man who first settled and explored the region. A climatological study of the area reveals that its dryness can be explained by a combination of characteristics of the mean upper atmospheric and surface circulations that all work together to limit the available moisture. This region is frequented by fewer low pressure systems and more highs than areas to the north and south. In the summer, a time when the rest of Saskatchewan reliably receives the bulk of its annual precipitation, the mean upper flow over the dry belt of Palliser’s Triangle acts to deflect the pacific storms well to the north.

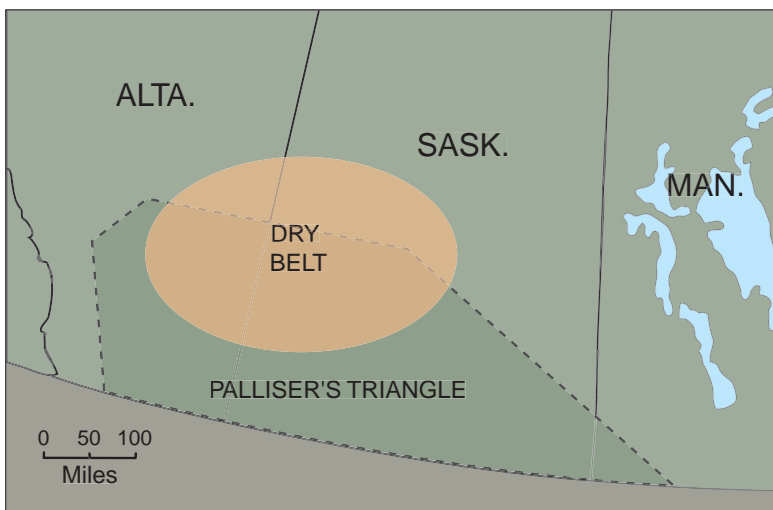


Fig. 4-5 - Palliser's Triangle

### (a) Summer

Saskatchewan summers have several characteristics to distinguish them from those of the other Canadian provinces; they are the sunniest; they are the hottest and driest; and they have the greatest diurnal temperature variation, averaging 14 degrees a day. The records for the highest temperature, 45°C, and the most hours of bright sunshine, 2,537 annually, both belong to southern Saskatchewan. Although there is on average little precipitation, the bulk of it is received during the period from May to August, with the wettest month generally being June. This is useful for southern agricultural areas, especially since the harvest months of September and October are noticeably drier.

The generally sunny conditions are occasionally disrupted by the presence of a cold low, the only significant pattern producing large scale, long lived poor flying weather in the summer months. The frequency of these cold lows peaks during the summer, contributing to the monthly precipitation maximum in June. Also, as with Alberta, the worst flying conditions are found over the north quadrant of the low where north to northeasterly winds are forced upslope, producing lower ceilings and visibilities.

Saskatchewan is also noted for violent summer thunderstorms, with the month of July being the most convectively active of the season. There is seldom a summer day without a thundershower somewhere over the province, especially in the southeast where there is an average of 25 thunderstorm days a year. The rain accompanying these storms is usually intense and brief. One particularly violent storm dumped 250 mm of rain in one hour over Buffalo Gap in southern Saskatchewan setting a new Canadian record. Small hail is frequent, and each summer there are about 10 to 15 severe hailstorms that inflict considerable damage. They can occur anywhere but are most frequent over the southwestern dry belt.

Convection in Saskatchewan is most frequently of the airmass variety which is initiated by daytime heating. In this wide-open area, visibility is excellent and convective buildups can be seen at great distances. It is possible to get nocturnal thunderstorms throughout the province, but they generally require some large-scale upper atmospheric support to keep them alive. Sometimes, the early morning period can produce a “surprise storm” over areas that were convectively active the previous day. This happens when residual mid level moisture from a previous thunderstorm lingers overnight and becomes destabilized by morning by radiation cooling at the cloud top. The presence of *Alto cumulus Castellanus* (ACC) cloud is a definite indication of this process.

Convective currents provide an environment for significant turbulence, up to 9 to 10 thousand feet on warm sunny summer days, even when the air is clear. These currents are accentuated along the preferentially heated slopes of hills and valleys and over freshly tilled and summer-fallow fields.

Evapotranspiration from crops is a significant source of low level moisture to feed cell development during the convective season. It peaks during the growing season of June and July and then diminishes as the crops mature in August. The amount and severity of convective activity correlates well with this trend.

Aside from the obvious risks of lightning and hail, violent and damaging winds are a constant concern for aviation interests during the convective season. Tornadoes are, of course, the most violent of these wind events with an average of seven confirmed sightings in the province each year, but these episodes are usually localized and generally last less than an hour. Full-fledged tornadoes are associated with large violent thunderstorms, or supercells, and because of their many hazards are completely avoided by pilots. However, a much more common occurrence, and one that is harder to avoid, is the “cold core funnel” which comes with its own set of dangers. These funnels are usually associated with the cold lows when the cold air moves over the warm land. These funnels rarely touch ground, and are certainly less dangerous than a full tornado, but they do indicate the existence of considerable turbulence. They are often associated with large areas of broken to overcast cumulus and stratocumulus clouds with ragged bases and producing scattered showers. Within this area, a particularly strong updraft can produce a small vortex that appears as a funnel. Cold core funnels are most common in spring and fall.

It must be noted that strong gusty winds and severe turbulence can be associated with any convective cell, even the seemingly innocuous. Downdrafts from cells supporting precipitation also produce a great deal of surface gustiness as they spread out upon impact with the ground and, if cells are large enough or organized into an area, gusts fronts can result. Microbursts are of special concern in Saskatchewan because of the unusual dryness of the atmosphere. In a dry environment, cell bases are invariably quite high. Precipitation from these cells usually evaporates before it reaches the surface but still entrains air, drawing it downwards. Evaporative cooling accelerates this downward motion until the air impacts with the earth, forcing it to spread out horizontally.

Although the Canadian coastlines are certainly windier than Saskatchewan, this province is still famous for its “Prairie Blows.” The lack of any topographic features to impede the flow and create sheltered areas in part explains this reputation. In the winter, the mean flow is northwesterly, but this changes to southeasterly in the spring with April and May usually recorded as the windiest months. During the spring and summer period, it is not uncommon to get a very hot and dry southerly flow from the American southwest. These winds dry up the surface moisture over southern agricultural lands and produce reduced visibility in blowing sand and dust an average of 15 hours a year, but these events diminish after May when the planted crops act to stabilize the soil.

## **(b) Winter**

Winter in Saskatchewan is bitterly cold and long with less than half of the year being free from freezing temperatures. Snowfall amounts are not great, varying from an annual average of 100 cm in the south to 175 cm in the north, but it is an important moisture source for groundwater reserves. Good flying conditions are the standard with periods of clear, cold and very dry weather often lasting for days on end. The prevalent wind direction, both at the surface and aloft, is from the northwest and is associated with frigid continental arctic air that supports little moisture making low ceilings and visibility unlikely. These northwesterlies are, however, generally stronger in the south than the north, and this coupled with the wide-open terrain can produce locally reduced visibility in blowing snow.

The transition period when cold arctic air moves in from the north to replace a more temperate airmass over the Prairies is known as an “arctic outbreak.” Generally, along the leading edge of this cold air, flurries will occur and flying conditions will be marginal for a short time. Of equal concern to aviation are the gusty northwest winds on the cold side of the outbreak which will likely produce significant mechanical turbulence in the low levels, as well as giving blowing snow, especially in areas where there has been recent snowfall.

Blizzards are the most perilous of all winter storms in Saskatchewan. Snowfall is not necessarily great, but visibility is reduced to near zero due to a combination of snow and blowing snow. To qualify as a Saskatchewan blizzard, the visibility must be reduced to less than 5/8 of a mile for at least four hours. January is the most likely month for these storms to occur, and they occur most frequently over the southwest where there is an average of two full-fledged blizzards a year.

## **(c) Transition Periods**

Early springtime brings an increase in the frequency of poor flying conditions to many areas of Saskatchewan. This is a period when the mean surface flow starts to turn towards the southeast, and any flow with an easterly component is upslope over large parts of the province. Stratus formation is aided by abundant low level moisture supplied by melting snow and lakes that are just starting to open. Once the long warm days of summer set in, poor flying conditions are quite rare as all levels of the atmosphere become progressively drier. The main exception to this is the occasional passage of a cold low which can give low flying weather in the easterly flow to the north of its centre.

Spring is quite a windy season and mechanical turbulence is usually present in the lower two to three hundred feet of the atmosphere if winds attain speeds of more than 15 knots. This turbulence is seldom severe but is often enough to make flight rough for smaller aircraft.



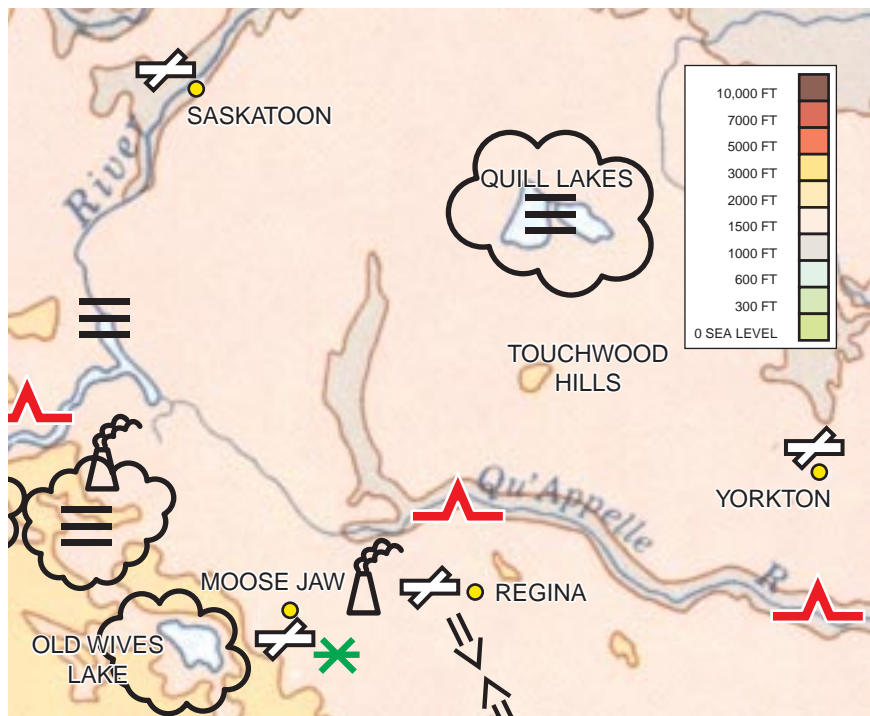
Fall, at least in the southern part of the province, is quite dry and pleasant especially in the first half. In the north, there is an increased likelihood of stratus as there are numerous glacially formed lakes to provide low level moisture. A few of the larger lakes in the northern half of Saskatchewan have enough surface area to generate snow streamers if the air flowing across their open waters is cold enough. This usually requires winds from the north or northwest.

## **Local Effects for Southern Saskatchewan**

This area of the province is, for the most part, a large expanse of gently rolling agricultural land interrupted by a few ranges of larger hills, and by sharp river valleys, sometimes falling several hundred feet below the surrounding terrain, such as with the Qu'Appelle Valley. The main exception to this is the more rugged terrain over the southwestern corner of the province, south of the Trans-Canada Highway. This area's principal features include the Missouri Coteau south of the South Saskatchewan River, the Wood Mountain Hills shared with the U.S., and the eastern Cypress Hills. However, it must be noted that Saskatchewan's topographic features, that at first seem insignificant, can be quite influential when considering weather in the very low levels. They induce small changes in the surface airflow that can create areas of turbulence and wind shear or create regions of frequent inversions, such as with the Souris Basin. Most ranges are high enough to give local very low flying conditions when ceiling heights in the area are marginal. They are also favoured sites for early day convective initiation as updrafts can be induced or enhanced by differential heating, orographic lift, and surface convergence.

The motion of synoptic scale systems, such as cold fronts, tend to be fairly predictable as they approach and cross the area, as there are no large topographical features acting on them. Simple airmass convection can also be fairly predictable. A visual assessment of the strength of early morning cumulus and towering cumulus development will often speak for the rest of the day.

Regina to Saskatoon



Map 4-18 - Regina to Saskatoon

A broad, level basin formed by the Souris and Moose Jaw Rivers and Wascana Creek, is the primary topographic feature influencing the weather in Regina; more accurately for the entire corridor from Minot through Estevan, Weyburn, Regina, Lumsden and, at times, areas further northwest. Southeasterly flows channelling through this valley frequently advect areas of stratus and fog, which have developed upstream, into the Regina area. Although this phenomena can occur at any time of the year, it is most common from late fall to early spring. It is normally associated with the eastward advance of a low pressure system over Montana and the Dakotas or southern or central Saskatchewan, or with a building ridge of high pressure over Manitoba. Either of these synoptic set-ups provides the persistent upslope southeasterly flow needed to generate stratus.

Weather in Regina is estimated to be good about 90 to 95 percent of the time. The most common time of year for extended periods of poor flying conditions is during the late fall transition period (mid October to early November) when lakes are still open. During this time, cold air advancing from the north or northwest picks up moisture as it crosses open lakes. Much of the area can be covered with low cloud. Even if the flow changes to the southeast, the Souris/Wascana effect mentioned above can prolong the problem.

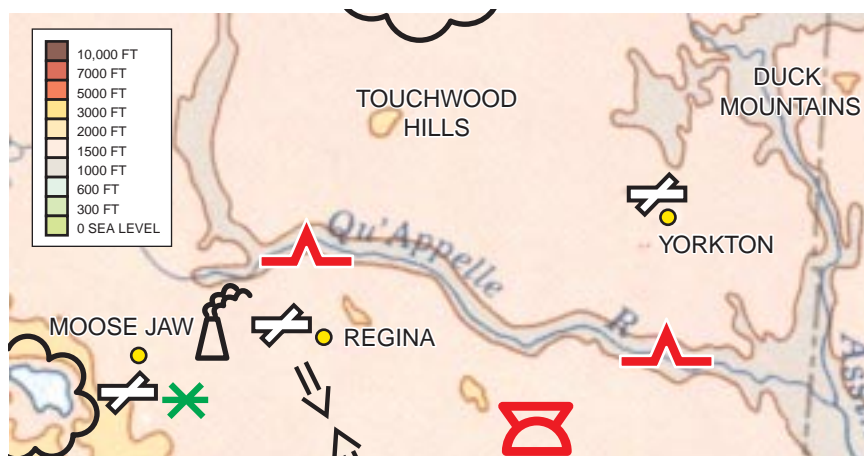
Thunderstorms are common in the area, but those moving toward Regina from the west or southwest have a tendency to split upstream from the city, “following” or developing along the Qu’Appelle Valley to the north and along the western side of the basin southeast of Moose Jaw.

Regina is considered a very windy place by local pilots and is viewed by many to have the most problematic weather, particularly in summer. There are seldom days when winds are calm and most days have gusty winds predominantly from the southeast or northwest. Mechanical turbulence is common up to about 5,000 feet ASL but is seldom severe.

When cold fronts advance from the northwest, Saskatoon and Elbow are good upstream sites to look for signals (changes in pressure, temperature and wind) of a frontal passage. These two sites can be used to anticipate the arrival and severity of the front in Regina.

The path between Regina and Saskatoon covers the open flat agricultural territory of the Souris Basin and the West Central Plains, with Regina situated a mere 240 feet higher in elevation than Saskatoon. Between the two, and closer to Saskatoon than Regina, are the Allan Hills. They are gently sloped and average only 300 to 500 feet above the surrounding terrain, but with an east to northeasterly upslope flow and sufficient low level moisture, stratus can blanket the area with ceilings being lower over the hills than at either the Regina or Saskatoon airport. The fall and early winter months are the periods when this most frequently occurs. When flying between the two points, if conditions are good in Saskatoon but poor in Regina, then the beginning of the stratus is often in the region of the Allan Hills. In fact, weather systems that are passing over the southern prairies will often spread low cloud to the north as far as a line running from around Rosetown to Hanley at the edge of the Allan Hills. Beyond this line, the upslope component of the terrain becomes barely perceptible.

## Regina to Yorkton and Eastward



Map 4-19 - Regina to Yorkton

Overall, the terrain is fairly smooth along this route, with a rise in elevation between the Souris/Wascana Basin and the Qu'Appelle River Valley. Once north of the Qu'Appelle, there are regions of higher terrain both to the northwest (the Beaver Hills) and to the southeast (the Pheasant Hills). Ceilings over these hills can be very low when marginal conditions are reported at either Regina or Yorkton, but it is easy to avoid the higher terrain by sticking close to Highway 10, situated in a slight valley between the two ranges. The Qu'Appelle River provides the only distinct relief along the flight path, as it flows in a sharp trench that is roughly 400 feet below the surrounding land surface. Like those formed by most rivers and creeks in the area, the Qu'Appelle Valley trench is contained within a broader drainage system, and turbulence can be present in the low levels when not a problem elsewhere. Winds can shift direction across the valley, forcing pilots to adjust aircraft attitude to stay on course. Convective cloud can be accentuated along the valley as well, and cells tend to follow the lower terrain eastward south of Yorkton.

Yorkton lies in an area of flat land between the Beaver Hills to the west and the Duck and Riding Mountains to the east, near the Manitoba border. Pilots consider the locale to be one of few surprises, topographically and meteorologically.

Yorkton is less windy than Regina, and mechanical turbulence is seldom a significant problem in the area. The flow is predominantly from either the northwest or south-southeast. Flows from the northeast quadrant are quite rare. In the fall months, north to northwesterly winds frequently bring low cloud and fog which is accentuated by the moisture input from Good Spirit Lake to the northwest of the town. Precipitation amounts are also higher on average over southeastern Saskatchewan, as this area is closer to the path of moisture laden synoptic systems moving northeastward

from the central and southern U.S. As a consequence, the period when large amounts of low-level moisture are made available due to snowmelt is extended in the spring.

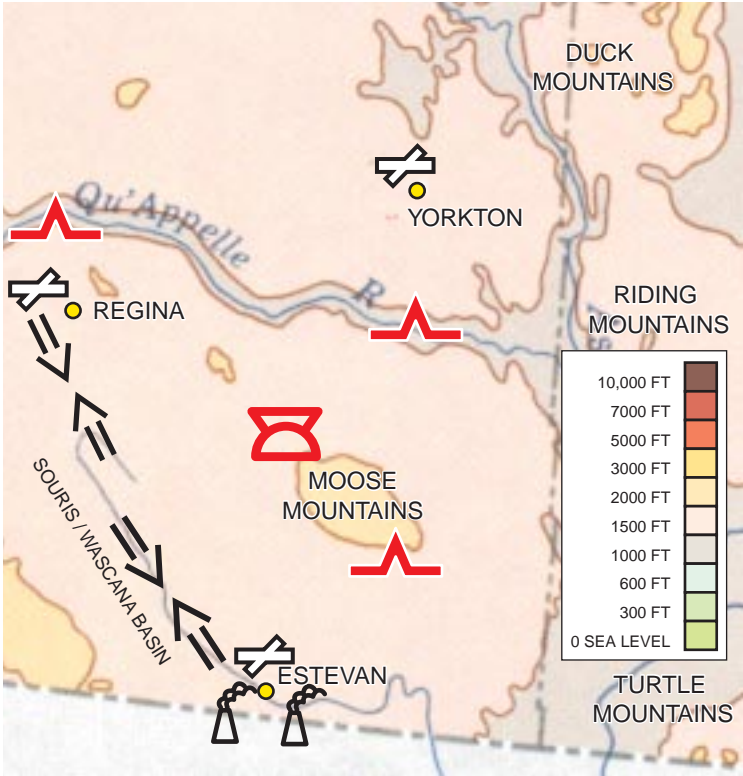
Convective currents are present in clear air on sunny days in the spring, summer and fall, especially over tilled fields, and this causes rough flying conditions in the low levels. In the spring, the snow melts off plowed fields first and the differences in surface heating, due to abrupt variations of albedo, accentuate the updrafts and down-drafts.

## **Yorkton Eastward**

The roughly north-south valley of the Assiniboine River lies just east of Yorkton. Low cloud can pool in the valley especially around the Lake of the Prairies, a long man-made lake that extends north of a dam near Shellmouth. This area is also a common site for enhanced convection in summer.

East of the Assiniboine River, the terrain rises over a series of hills and ranges. Well north of Yorkton, straddling the Manitoba/Saskatchewan border, are the Porcupine Hills, and further south and mostly contained within Manitoba, are the Duck and Riding Mountains. There are several lakes in the area and the surface tends to be moist. Flows from the west are pushed upslope so there can be some deterioration in ceiling and visibility, even if conditions at Yorkton are good. The higher terrain is often shrouded in cloud if marginal values are reported at Yorkton or Dauphin, Manitoba.

Yorkton to Estevan



Map 4-20 - Yorkton to Estevan

As with the path between Yorkton and Regina, the Qu'Appelle River Valley is the main topographical feature enroute. The valley trench is still quite deep at this point, as is that of Pipestone Creek, which joins with the Qu'Appelle north of Broadview. The terrain in this area is fairly complex and susceptible to low level turbulent eddies in gusty wind situations. About 40 miles south of Broadview, the land rises abruptly, about 700 feet, over Moose Mountain and then falls off again into the Souris Basin on the other side. The tops of Moose Mountain are often obscured when low cloud is in the area and there are plenty of small lakes in the region to support and maintain its longevity. Mechanical turbulence is often encountered below 5,000 feet ASL over this higher terrain in strong wind situations, especially those from the northeast.

Annual precipitation amounts are higher over this region than any other area of southern Saskatchewan, the bulk of which arrives in summer when low pressure systems move up from the south carrying warm moist air from the Gulf of Mexico. Higher levels of low level moisture lead to a greater chance of severe convective weather and, indeed, the highest number of thunderstorm days, occur over this corner of the province.



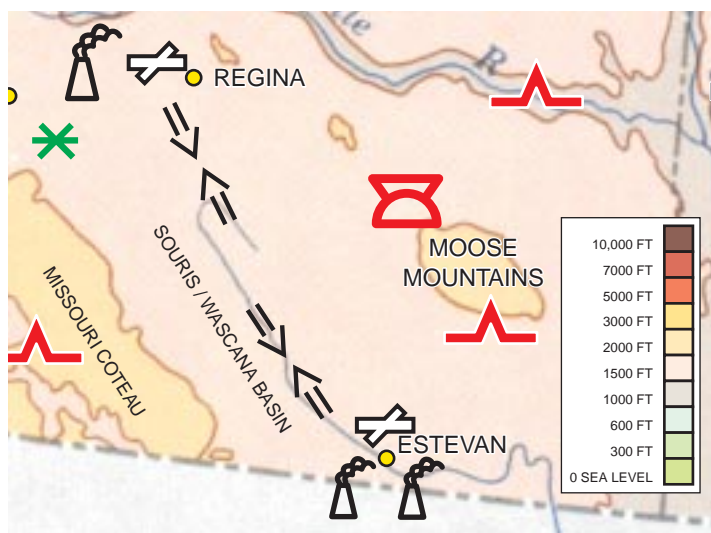
The Estevan Airport is situated about 4 miles north of the town of Estevan which, in turn, lies in an active coal mining area. The provincial electrical utility uses the coal to fuel two large power generating plants in the area. The more modern "Shand" plant lies approximately 8 miles southeast of the airport. The older, larger "Boundary" plant lies about the same distance to the southwest. Both plants are fitted with precipitators which reduce the amount of pollution resulting from coal combustion. However, a huge quantity of water vapour is injected into the atmosphere by these installations each day.

Depending on local atmospheric conditions, this added moisture can cause marked changes in weather conditions across the area surrounding the town and airport. Inversions at any time of the year, but particularly in winter, can trap the moisture near the surface causing local marginal or even lower flying conditions. Reduced visibility in ice crystals is common downwind from the plants on cold winter days and nights, but can also occur when temperatures are higher than those normally associated with the phenomena (usually below  $-16^{\circ}\text{C}$ ). Southeasterly flows, often already laden with moisture and associated with the poorest weather in the area, are further saturated by the plant discharge, accentuating low cloud and fog conditions.

The most common wind direction is from the northwest, and cross winds often occur over the main runway which is oriented west to east. These flows are also known to bring low cloud and fog to Estevan, particularly in the spring and fall, with a ridge of high pressure building from the north or northwest.

Otherwise, Estevan enjoys a high percentage of good flying days. Winds are the most prevalent concern to aviators, and mechanical turbulence, rarely severe, is common up to about 4,000 feet ASL. Standing lenticular cloud is often present, sometimes at fairly low levels, with strong southwesterly flows aloft over the Missouri Coteau. Convective cloud tends to form upstream in unstable southwesterly flows. Large cells are visible at great distances so severe weather "surprises" are unusual. Convective currents are also responsible for bumpy low level flying conditions in summer, especially over tilled fields.

## Estevan - Regina (Souris/Wascana Basin)



Map 4-21 - Estevan - Regina (Souris/Wascana Basin)

The Souris/Wascana Basin is one of the more subtle surface features in southern Saskatchewan but, no doubt because of its overall size, is one of the most important topographical influences on weather conditions in the area. As mentioned earlier, the basin extends from the southeast through Estevan to the Lumsden/Elbow area. It is wider in the south than it is to the north, so southeasterly flows are channelled and accelerated.

The basin is quite shallow, with depths averaging 300 feet below the terrain to the southwest (Missouri Coteau) and northeast (Touchwood Hills - Indian Head - Moose Mountain areas). However, persistent inversions, up to 800 feet deep, are common over the area, especially from late fall to early spring. When an inversion is present, the cold layer is usually moist and stagnant or is being fed by a moist southeasterly low level flow. This causes, sustains, or advects stratus and fog into the area. As a general rule, locations on the southwestern side of the basin enjoy better weather conditions than those sites in central and northeastern areas. When this is the case, winds above the inversion are usually stronger, warmer, drier and from the southwest or west. The inversion is eroded or broken down earlier and rather easily along the southwestern side of the basin by the warm winds subsiding off the Missouri Coteau, thus improving conditions there. However, the shallow cold layer, with its inherent poorer weather, can be quite stubborn over central and eastern sections. Significant directional wind shear is possible near the top of the inversion in this situation, especially when there are reasonably strong southeasterly winds in the cold layer.

With the passage of a synoptic scale low pressure system, there can be locally enhanced precipitation along the “sides” of the basin where winds have an upslope trajectory. This is especially true when systems pass to the south, producing an easterly flow across the basin that is forced to rise up the eastern slopes of the Missouri Coteau. In winter, this can lead to significant snowfalls that, when combined with gusty winds, can produce local blizzard conditions with visibility near zero in snow and blowing snow.

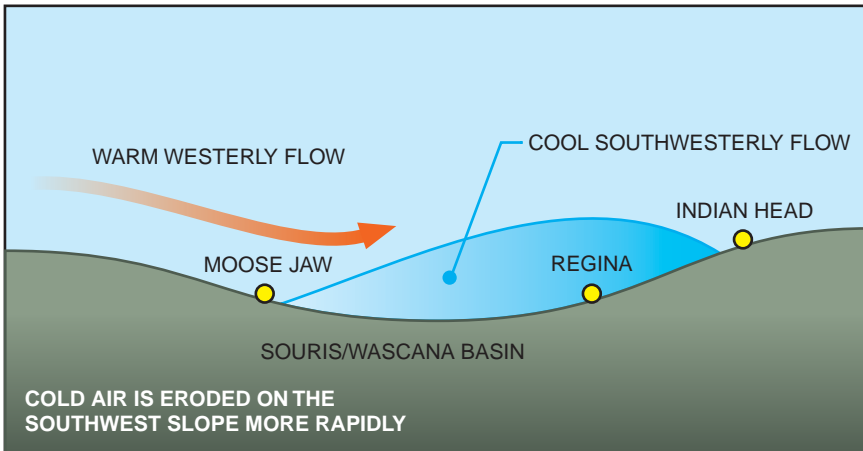
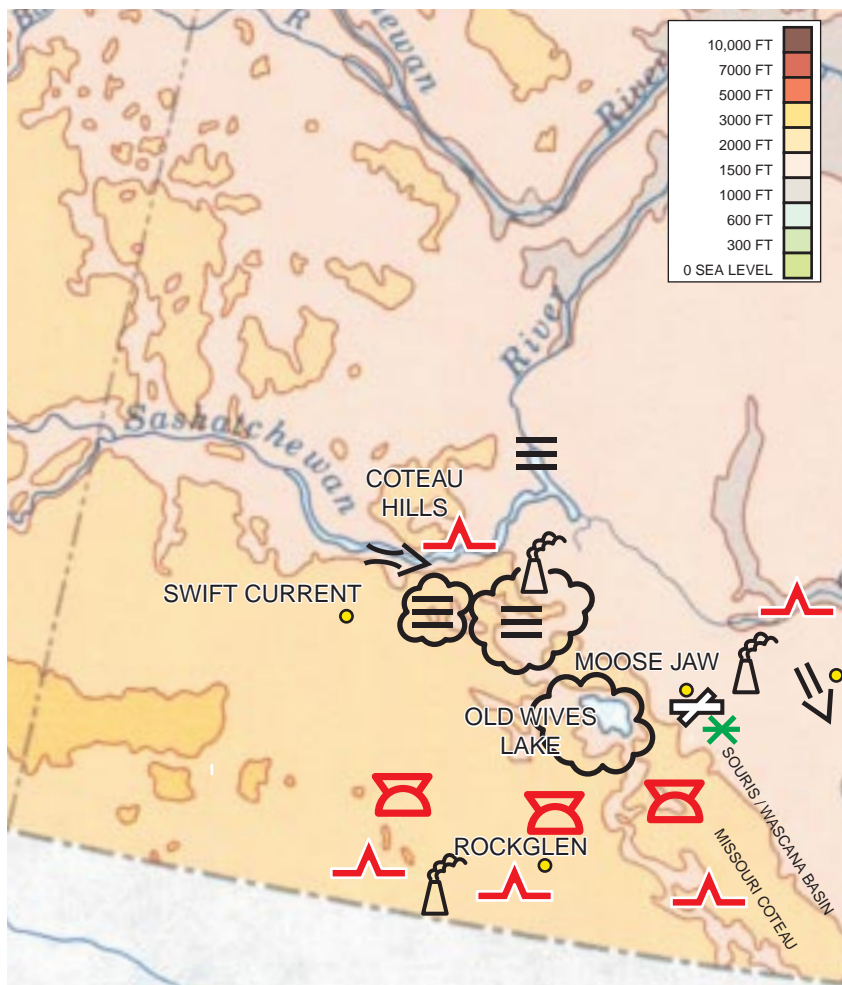


Fig. 4-6 - Pooling cold air in Souris/Wascana Basin

The Missouri Coteau



Map 4-22 - The Missouri Coteau

The Missouri Coteau is a large region of relatively rugged terrain made up of several ridges of hills, criss-crossed by deep valleys and coulees. Geologically, it extends west from the Souris/Wascana Basin to the Cypress Hills and northwestward into Alberta east of Edmonton, but is most prominent south of Lake Diefenbaker. The myriad of landforms are a result of glacial movements during several ice ages and the subsequent melt and runoff. This is especially evident over extreme southern sections (Big Muddy Lake, Rockglen and Wood Mountain areas) and the Cactus Hills south of Moose Jaw.

Convective activity in the area tends to initiate earliest along ridges of the Missouri Coteau and drift eastward across the Souris/Wascana basin as it continues to develop.

The Coteau itself is typically an area of enhanced convection when the airmass is unstable. Severe weather is most likely in June and July when daytime heating is most intense, and low level moisture is at its peak. Because of the complex nature of the terrain of the Coteau, winds can be funnelled in an almost random way. Mechanical turbulence below 6,000 feet ASL is common over the area.

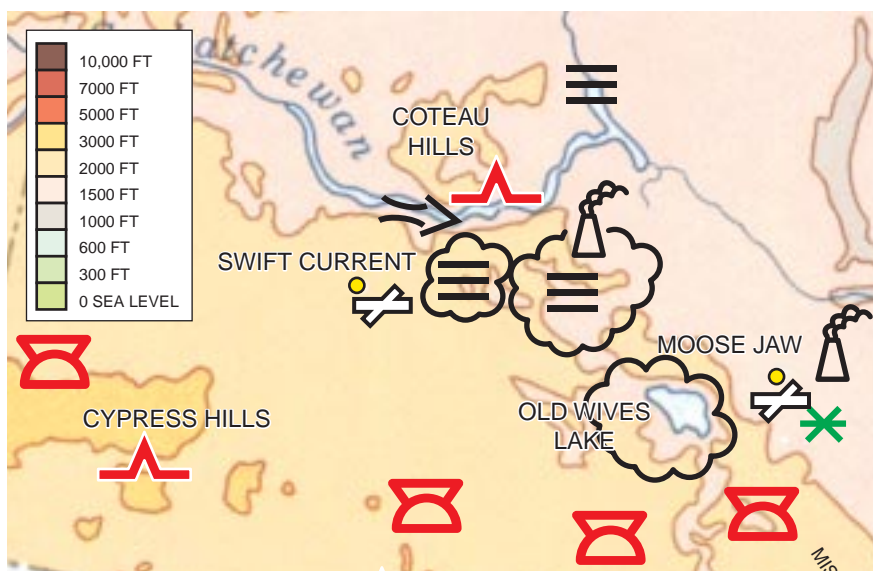
Strong southwesterly flows can produce widespread standing wave activity and mechanical turbulence over and to the lee of the Coteau. Lenticular cloud is often present at low and mid levels and indicates the presence of lee waves.

The land can be described as semi-arid so widespread radiation fog in summer is not very common. It can happen where cool air pools in the lower valleys and near lakes. There is a coal-fired power plant, similar to the Shand Plant near Estevan, located on the Poplar River east of Rockglen. This generator can be responsible for locally poor conditions, as its emissions also include a large amount of water vapour.

The Cypress Hills rise, on average, about 1,400 feet above the surrounding territory and include one of the few forested areas in southern Saskatchewan. The highest elevations in the province are here, exceeding 4,500 feet ASL near the Alberta border. As one would expect, the area is susceptible to mechanical turbulence up to several thousand feet above the terrain in windy conditions, and in enhanced convective weather when the airmass is sufficiently unstable. Small-scale upslope and downslope effects can produce varying deterioration and improvement in weather conditions over short distances, depending on the amount of low level moisture and wind direction. The northern slopes of the Cypress Hills are particularly vulnerable to upslope stratus when cool moist air is invading from a northwest, north or northeasterly direction. When surrounding stations are reporting marginal ceilings, the higher terrain is likely enshrouded or, at least, the ceilings are considerably lower there.

Precipitation amounts tend to be greater over the Cypress Hills than the surrounding area and snowfall accumulation can be significant over the higher elevations in winter. In fall, when freezing levels are dropping, precipitation phase can often change from liquid to solid, and back again, as one traverses the Cypress Hills. This phase transition can result in serious icing conditions when temperatures are sufficiently cold.

## Swift Current to Moose Jaw



Map 4-23 - Swift Current - Moose Jaw

Swift Current is situated north of the more rugged sections of the Missouri Coteau and Cypress Hills, but much of the local weather is still caused by the influence of that terrain. Southwest to westerly flows are forced over and around the Cypress Hills resulting in occasional “Chinook-like” conditions in the winter, as well as some acceleration in winds from those directions at any time of the year. Lee wave and/or mechanical turbulence up to 6,000 feet ASL can be expected with these winds. The local land surface is somewhat smoother, but there are several ranges of hills in the area, as well as rivers that have carved deep trenches. The South Saskatchewan River and Lake Diefenbaker, just north of Swift Current, twist through a trench that falls as much as 500 feet below the surrounding area. Terrain around these features is ideal for enhanced mechanical turbulence and erratic wind shifts.

Low cloud events at Swift Current are usually the result of one of two situations. During the fall months, cool, moist northwest or northerly flows are forced up the slope out of the South Saskatchewan River Valley and encounter the rising terrain to the south of the town. Sometimes stratus invades from the west, but this is usually cloud that has been formed in the northerly upslope flow and deflected eastward by the Cypress Hills. In the second case, low cloud can also advect from the southeast with a flow from that direction. This is common in the fall but can happen in the winter and spring as well, especially during or after a period of snow melt.

Several sewage lagoons lie just to the northwest of the Swift Current airport. In an effort to reduce the water volume in the lagoons in winter, local authorities use what



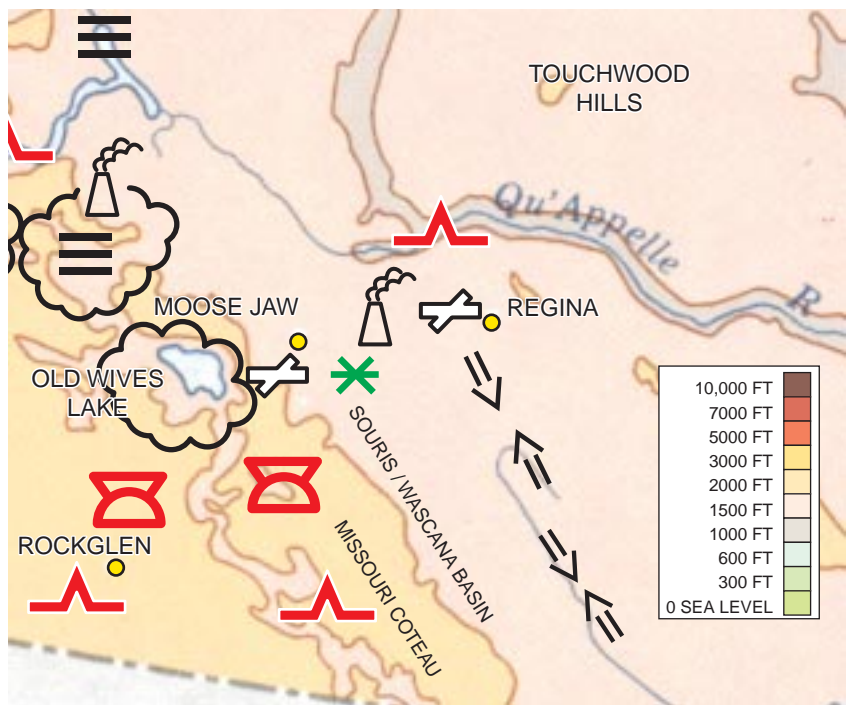
is best described as a type of snow making machine. When temperatures are below  $-10^{\circ}\text{C}$ , the machines are turned on and inject the fluid into the air, with the hope that it will be evaporated or sublimated and carried away by the wind. This process has a tendency to create local stratus and fog that can directly affect the airport when the winds are northwesterly.

The route from Swift Current to Moose Jaw follows the Trans-Canada highway, which crosses several shallow valleys separated by ridges or lines of hills, most of which are aligned roughly northwest to southeast. Although these features are not as prominent as those further south, they can produce some mechanical turbulence in the low levels when winds blow across them.

There are several shallow alkaline lakes in the area. The largest of them are Reed Lake and Chaplin Lake, near the highway, and Old Wives Lake, southwest of Moose Jaw. The size of these lakes can vary greatly depending on the amount of precipitation or evaporation that takes place in a given year. These lakes can be responsible for several local effects: local fog on cool, clear summer nights; enhanced convection due to the extra availability of low level moisture; fog and stratus with cold west to northwesterly flows in the fall; and, occasionally, some enhanced early winter snowfalls. Also, like other alkaline lakes, these do not always freeze completely and can continue to inject a small amount of heat and moisture into the lower atmosphere throughout the winter and early spring.

There is a sodium sulphate processing plant near the highway at the north end of Chaplin Lake. When the plant is operating, its discharge can enhance (or locally cause) low flying conditions in fog and low cloud. The combined effects of the sodium sulphate plant and the lake could be the reason for a local rule of thumb: when ceilings are poor or marginal in Swift Current and Moose Jaw, they can be as much as 400 feet lower near Chaplin Lake.

Moose Jaw to Regina



Map 4-24 - Moose Jaw and area

Moose Jaw lies on the western side of the Souris/Wascana Basin on the eastern slopes of some high terrain that is part of the Missouri Coteau. This location is beneficial, especially in winter, because subsiding westerly winds (Moose Jaw “Chinooks”) erode the shallow inversions that frequently form in the basin, much earlier here than at points further east. Since the winds at Moose Jaw are predominantly westerly, temperatures are usually several degrees warmer and the weather is typically better, or at least, isn’t poor for as long, in Moose Jaw than in Regina.

Easterly flows are upslope here and are responsible for the majority of cases of poor weather, especially from fall to spring. The synoptic pattern is usually that of a high pressure area to the north and lower pressure to the south. In the winter, strong east to southeasterly upslope winds will accentuate snowfalls and in turn combine with the fresh precipitation to produce poor conditions in blowing snow. Westerly winds will also bring blowing snow to Moose Jaw. However, this condition gradually makes its way into the aerodrome area only after it has already obscured the higher terrain to the west, so there is some advance notice of impending deterioration.

As mentioned, the Missouri Coteau is noted for enhanced convection during the summer. Old Wives Lake, southwest of Moose Jaw, is another feature in the area that

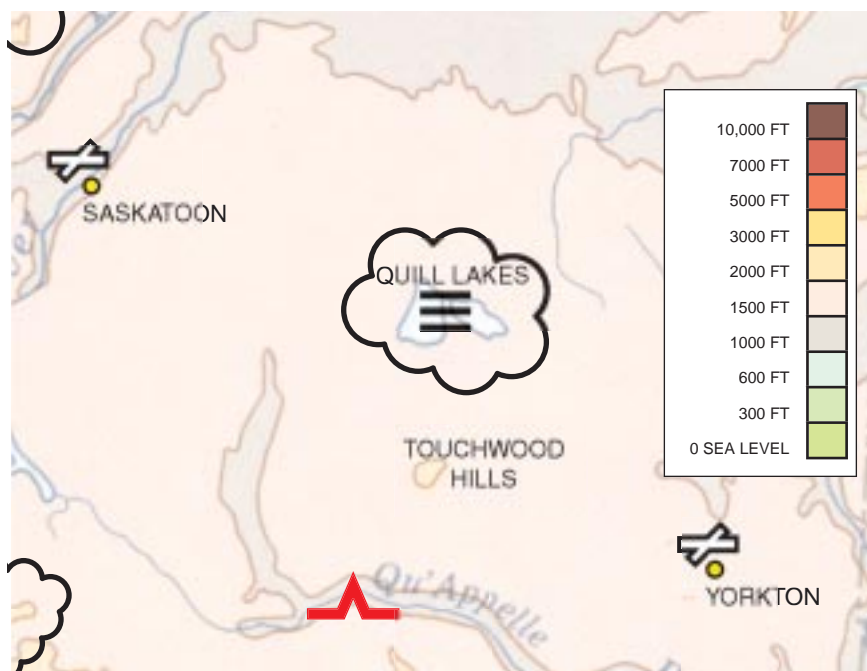
can intensify convective activity by providing extra low level moisture. As a result, thunderstorms are common at Moose Jaw during the summer season.

Strong southwesterly winds traversing the Coteau can cause significant mechanical and/or low-level lee wave turbulence over Moose Jaw.

Railway lines run through the area and there are several sidings west of Moose Jaw where locomotives will sit and idle. In the winter, when winds are light and temperatures cold, the exhaust from these engines can promote the formation of ice fog that tends to pool in the Thunder Creek valley, which joins the Moose Jaw River in the town.

There is a noticeable “transition zone” in weather conditions between Regina and Moose Jaw, which tend to be quite different between the two places. This is particularly evident in winter when an inversion is present in the Souris/Wascana Basin (Regina) and drier, warmer westerly winds have scoured out the cold air to the west (Moose Jaw). Belle Plaine, a town on the highway between the two cities and site of a large potash plant, commonly marks the boundary between good conditions to the west and poor conditions to the east. The potash plant probably has something to do with the predictability of the boundary. If this boundary is farther west, there can be marked differences from the weather reporting site at the military base south of Moose Jaw and the Moose Jaw Municipal Airport, 6 to 7 miles northeast of the town.

## Yorkton to Saskatoon



Map 4-25 - Yorkton to Saskatoon

This path also takes a pilot along fairly flat terrain; there is less than a 20-foot difference in elevation between the two airports. Major topographic features include the Beaver and Touchwood Hills to the south on the first half of the route, and the Allan Hills just southeast of the Blackstrap Reservoir, near Saskatoon. These hills can be dangerous obstructions when marginal flying conditions exist at reporting sites, and they are often locations of enhanced convective activity in the summer.

The Quill Lakes are large, shallow alkaline bodies of water located roughly halfway between Saskatoon and Yorkton, just north of the Touchwood Hills. In fact, Big Quill Lake is the largest saline lake in Canada. These lakes are responsible for several marked changes in the weather along the route. If the airmass is sufficiently unstable, the lakes can provide enough low level moisture to initiate and accentuate convective activity in the area. In the summer, stratus and fog commonly forms on cool, clear nights over and around the lakes and is then advected downwind, creating a problem for flight operations until late in the morning. In the fall and early winter, cold west to northwesterly flows passing over the warmer water generate large areas of low cloud that can extend downwind as far as Yorkton. This low cloud is usually embedded with streamers of convective cells that produce locally enhanced precipitation. When air temperatures are low enough, poor visibilities in snow showers can be expected. Since the lakes are high in mineral content, they typically do not freeze readily and

can have “soft spots” in the ice cover. These spots continue to inject heat and moisture into the lower atmosphere throughout the winter and early spring, although on a much smaller scale. Finally, the lakes are a breeding area for vast numbers of shore birds during warm months and bird populations swell further during migratory season. Pilots should be concerned with bird impacts in the region.

When this area is under the influence of flows with a westerly component, pilots in Yorkton prefer to use Saskatoon, rather than Regina, as the best upstream indicator of weather they can expect. The limited information provided by the automatic reporting site at Wynyard can give some indication of the weather around the Quill Lakes, but it may not be representative of the general conditions along the route.

Saskatoon is situated in a broad area of open and flat terrain, in central Saskatchewan. The airport is on the north side of the city and has a relatively uncomplicated climatology, with close to the lowest frequency of low flying conditions in Saskatchewan. The months of November through February bring the greatest likelihood of poor weather. The South Saskatchewan River flows through the center of town in a south-southwest to north-northeast, but the valley is quite wide and has gently sloped sides. There is some higher terrain, the Allan Hills, about 25 miles to the south-southeast of the town, but they rise only 400 to 500 feet above the surrounding area. Because of the openness of the land, there is no strongly preferred wind direction in Saskatoon, although there is a slight partiality for winds from the northwest or the southwest. The strongest winds are almost always from the northwest.

Saskatoon is frequently cold and clear in the winter, as dry continental arctic air enters from the north. This allows for frequent low level inversions which does lead to the occasional period of ice fog fed by condensation nuclei from local industry. A power plant on the south side of town will sometimes spread smoke as far as the airport under inversion conditions if there is a light southerly flow, but it will not usually significantly reduce the visibility.

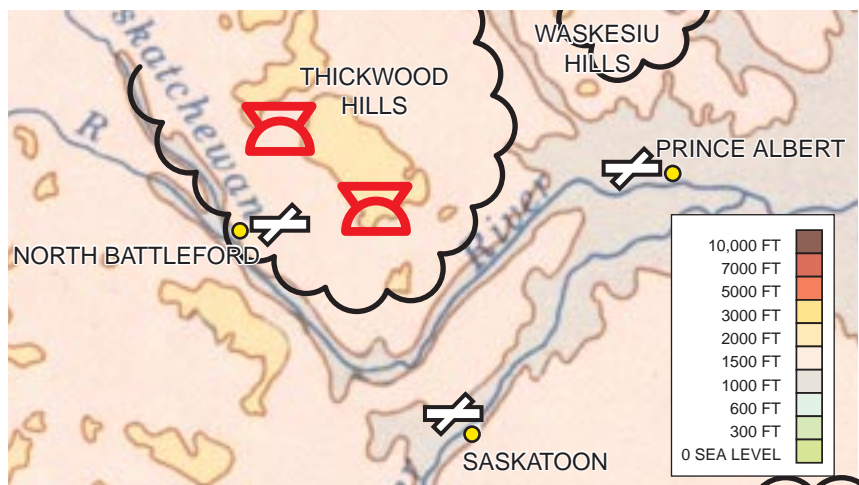
Local Effects for Northern Saskatchewan

For the purposes of describing aviation weather, northern Saskatchewan will be defined as Prince Albert and all areas to the north. At this point, the land makes a transition from being mainly agricultural to the much more sparsely populated areas of the boreal plains and forest of the north. The land between the Saskatchewan River and the Churchill River (between Prince Albert and La Ronge) is characterized by small rolling hills, several larger lakes and the vigorous mixed forest. The most significant topographical feature is the Mostoos Hills, to the north of Meadow Lake.

North of the Churchill River, the land becomes flatter with the lakes becoming much more numerous and smaller in size. The rock of the Precambrian Shield is very near the surface in this region and only a scrubby coniferous growth is supported. Lake Athabasca and its drainage system dominate the farthest northern reach of the province. Here, outcroppings of bare rock are not infrequent.

In general, convective activity decreases as one progresses northward due to the mitigating influences of forest cover and numerous lakes. Compared to the south, thunderstorms are less frequent in northern Saskatchewan, and more importantly, less severe, with large hail and tornadoes being extremely rare. The north is prone to more stratus, especially in the transition seasons, as there is abundant low level moisture supplied by the lakes. As well, the larger lakes in the central region, and Lake Athabasca in the north, can be prone to streamers in the early spring and the late fall, especially in a cold north to northwest flow.

Saskatoon - Prince Albert - North Battleford



Map 4-26 - Saskatoon to Prince Albert



The path between Saskatoon and Prince Albert mainly follows the broad valley of the South Saskatchewan River. The terrain around Saskatoon is flat prairie but heading towards Prince Albert, land cover shifts to predominantly boreal forest. Prince Albert is situated on the North Saskatchewan River, just west of the junction where the two branches of the River meet to form the Saskatchewan River. At this point, the valley is very wide and gently sloped. Along this route, the terrain slopes gradually downwards to the northeast, with Prince Albert 250 feet lower than Saskatoon. Stratus tends to form along this route in the fall and early winter whenever there is a moist flow coming from the northeast quadrant.

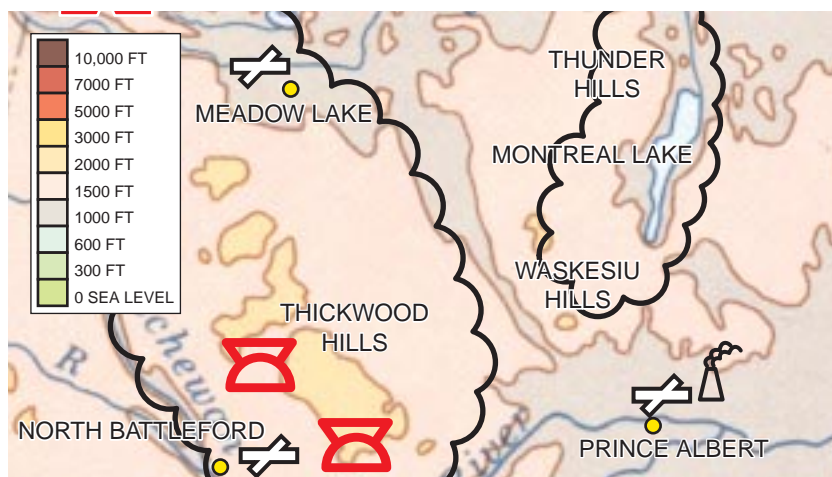
The main topographical feature between Prince Albert and North Battleford is the southern end of the Thickwood Hills, which are encountered about half way to North Battleford and rise about 1,000 feet above the surrounding area. If conditions are marginal at either North Battleford or Prince Albert, then they will certainly be lower over the Thickwood hills where ceilings are often down to the ground. A moist east to southeasterly flow will give the lowest conditions over the hills with the stratus piling up on the east side. Although a westerly flow will still be upslope on the western half of the hills, it is usually too dry to induce any cloud formation.

North Battleford Airport is situated on the east side of the town. Both are just north of the North Saskatchewan River. Because of the influence of the northwest to southeast valley, the winds are almost always oriented along this axis with winds from any other sector being infrequent and generally light. With the prominent hills situated on either side of the valley, the Thickwood Hills to the northeast and the Eagle Hills to the southwest, the only upslope flow comes from the southeast up the river valley. If a moist southeast flow blankets southern Saskatchewan in stratus, then there is almost always a progressive deterioration in ceilings with the highest values occurring in Moose Jaw and Saskatoon, and lower values in North Battleford. Ceiling heights then continue to deteriorate towards Lloydminster.

In spring and summer, if there is little spread between the temperature and dew point in the overnight period, a broad band of fog and stratus will often form over the North Saskatchewan River Valley and spread into the North Battleford Airport. It will usually start to break up by 8:00 AM local time.

The path between Saskatoon and North Battleford stretches over the much flatter terrain of the North Saskatchewan River Valley, with the Thickwood Hills on the north side and the Eagle Hills on the south. If the region is blanketed in stratus due to an easterly flow, then ceilings will often gradually lower towards North Battleford due to the slight increase in elevation, but with no significantly lower ceilings enroute. The southern slopes of the Thickwood Hills are known to generate convective buildup in the summertime. Cells formed in this area will generally track southeastward along the North Saskatchewan River Valley.

## Prince Albert to Meadow Lake



Map 4-27 - Prince Albert and area

Prince Albert airport is located in the east to west valley of the North Saskatchewan river, nestled into a U-shaped deviation of the river so that it is surrounded on three sides by water. This means that flows from every direction, except the north, could potentially advect stratus and fog into the airport from the river valley. However, an easterly flow is the most likely to do this as it is pushed upslope. As well, it can acquire significant moisture in the low levels from its long trajectory within the confines of the east-west valley of the South Saskatchewan and North Saskatchewan Rivers.

There are two local anomalies in the topography that need to be considered when low cloud is in the area. About 15 miles southwest of the airport, Red Deer Hill rises nearly 300 feet above the surrounding terrain, and 16 miles to the north-northwest, Handson's Hill rises slightly over 300 feet.

Prince Albert is a prime location for morning radiation fog due to its proximity to the river. These events are most frequent from April through October, with the peak being in August and September, when the night becomes longer and radiational cooling is greater. Radiation fog tapers off greatly in the winter months when the river freezes over, but there are still some occurrences of ice fog due to rapids on the river just to the north of the airport that are slow to freeze. Occasionally, there is ice fog or thin stratus coming from the emissions of the local pulp mill if the flow is light north-easterly, and there is a low level inversion. Another wintertime consideration for the Prince Albert Airport is the making of snow at a ski hill situated one mile to the west. If the flow is light westerly, then this will advect some of the low level moisture and subsequent ice fog over the airport, usually creating low ceiling and low visibility.

The orientation of the river valley in Prince Albert is from east to west and this strongly influences the wind, which predominantly blows within the confines of the valley. However, the strongest winds are generally northwesterlies which develop in the wake of the passage of a low over the area.

Heading northwestward from Prince Albert towards Meadow Lake, one follows a path that is in a natural depression in the land with ranges of hills on either side. The Thickwood Hills stretch most of the distance along the southwestern side, and the much smaller Waskesiu Hills are on the northeast side on the first part of the flight. Closer to Meadow Lake the prominent Mostoos Hills rise to the north, but they are not encountered on either a path from Prince Albert or La Ronge. This course also tends to delineate agricultural lands to the south from the forests of the boreal plain to the north. Not surprisingly, flows from the east to southeast are upslope over this area and are most likely to bring the lowest conditions. However, Meadow Lake is only 170 feet higher in elevation than Prince Albert, so there is generally not a notable difference in weather reported at either of the two sites. There are usually no significantly lower conditions between the two airports if the hills on either side are avoided.

Meadow Lake, both the airport and the town, are situated in an east-west valley created by the Beaver River flowing eastward from Cold Lake. The river itself is more than 10 miles north of the airport so it does not have a great influence on conditions there, but it does mean that a north wind is upslope for the airport as it makes its way up the side of the valley. However, winds from either the north or the south are uncommon in Meadow Lake, and are usually quite light. Meadow Lake is sheltered from strong wind flows from most directions; southwesterlies are the most common direction, but it is rare that speeds attain more than 10 knots.

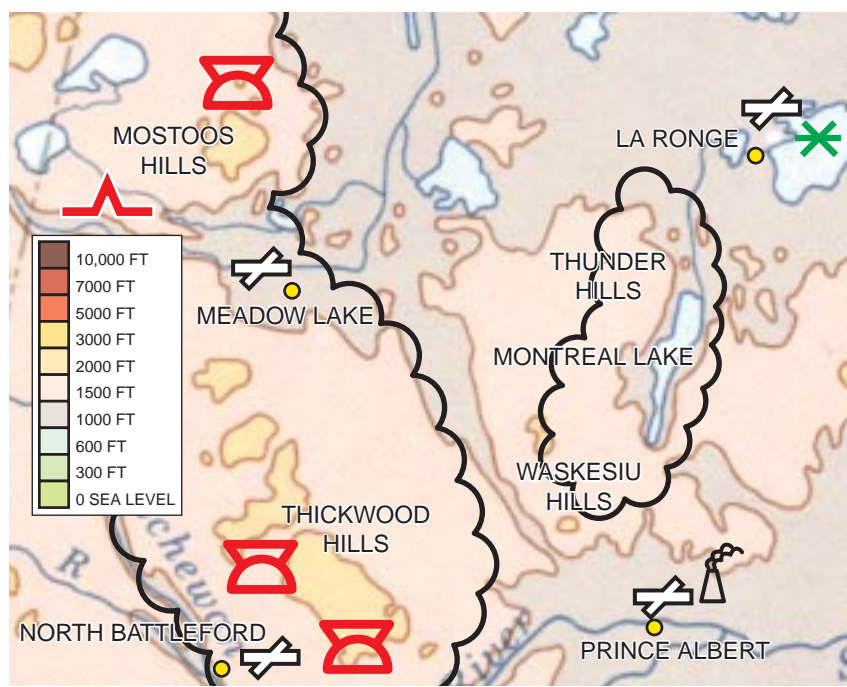
Meadow Lake does not have a high incidence of reduced visibility in fog, but there is a peak season for morning radiation fog that runs from June through September. August is the month most likely for this to occur with about 8 percent of the days seeing some period of fog in the morning hours. The lake that the town is named after is about 4 miles to the west and no doubt plays a role in supplying low level moisture for fog formation.

Flying the lower terrain between Cold Lake, Meadow Lake, Prince Albert, and even northeastward to La Ronge, provides fairly safe and reliable weather conditions. The most hazardous regions are directly to the north or south of Meadow Lake. Heading south towards North Battleford takes a pilot directly over the Thickwood Hills that rise 1,000 feet between the two airports. When conditions are even close to marginal at either of these two airports, there is likely to be very low conditions, even down to the treetops, somewhere over these hills. It is often necessary to divert around the the eastern side of the Thickwood Hills. Almost every wind direction will

provide upslope conditions at some point over the hills, but winds from the northwest through to southwest are generally the safest as they are typically dry in the low levels, due to the predominantly downslope conditions to the west in Alberta.

To the north, the Mostoos Hills rise quite sharply, more than 1,500 feet above the valley of the Beaver River, and are the most prominent geographical feature in the northern half of Saskatchewan. They are infamous for very low to obscured conditions especially in a moist south to southeasterly flow. The northeastern portion of the Mostoos Hills is situated inside the boundaries of the Primrose Lake Weapons Range, which is restricted airspace under the control of the Cold Lake military base. For this reason, as well as the likelihood of weather hazards over the hills, pilots heading north from Meadow Lake towards Buffalo Narrows will often stick to the lower ground on the eastern side of the hills. In the summer, the southern slopes of the Mostoos Hills are also an area of frequent convective buildups and thunderstorm generation.

Prince Albert to La Ronge



Map 4-28 - Prince Albert to La Ronge

Flying directly between Prince Albert and La Ronge, the territory is quite flat and swampy with small ranges of hills on either side. Montreal Lake, a long thin body of water stretching on the west side of the flight path about half way between the two sites, is notorious for producing a great deal of stratus, especially in a moist flow from the east. On the west side of the path there are also two ranges of hills, the Waskesiu

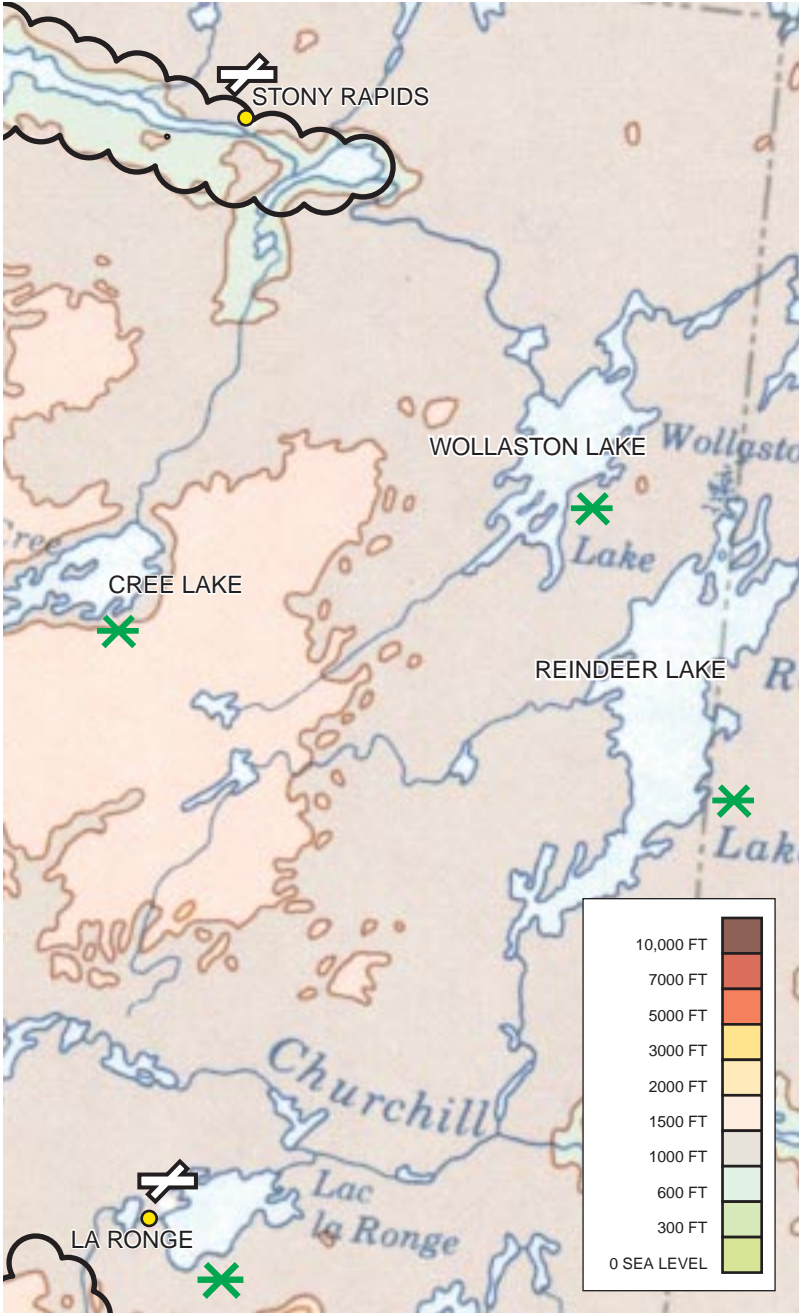
Hills, just southwest of Montreal Lake and the Thunder Hills, just west of the lake at its northern end. Naturally, these two areas of higher land, 600 to 800 feet above the terrain to the east, experience very low ceilings in east to southeasterly flows. The Thunder Hills can be particularly treacherous, as any flows from the eastern quadrant will receive an extra injection of low level moisture from Montreal Lake before ascending to higher elevations. Staying on the east side of Montreal Lake will generally ensure the best ceilings and visibilities as this keeps a pilot to the lowest elevations in the area. There is also the additional benefit of a slight downslope off the small ranges of the Cub and Wapawekka Hills to the east. In general, any flow from the west is quite favourable in this region. However, in the fall and the spring, a cold northwesterly flow can become unstable as it crosses the warmer waters of Montreal Lake. This can produce an area of cumulus and stratocumulus with the potential for embedded snow streamers.

La Ronge sits on a small peninsula of land, at the border of the Precambrian Shield, which is surrounded by lakes on most sides. The largest of these is Lac La Ronge, to the east of the airport, which is quite shallow and dotted with numerous islands. Any prolonged east to northerly flow can advect quite low conditions into the airport area due to the long fetch over the lake, but this is most prevalent in the spring and fall; the late fall shows the greatest likelihood of poor flying conditions. Lac La Ronge tends to freeze and thaw somewhat later than other lakes in the area, and this does affect the periods of maximum stratus formation.

La Ronge has the reputation of being a windy airport. It is exposed to winds from most directions with west to northwesterly flows being the most frequent, followed closely by east to northeasterlies. Flows with a northerly component must be regarded with caution when flying in areas to the south of La Ronge, as the Thunder and Wapawekka Hills do provide enough upslope terrain to generate stratus.

The winds at La Ronge Airport can be influenced by lake breezes during the summer months causing changes that are completely opposite to the expected flow. One way of anticipating the onset of the lake breeze is to watch for the signature of these lake effect winds; ripples in the water close to the shore while the center of the lake remains mirror-like and smooth.

La Ronge and points north



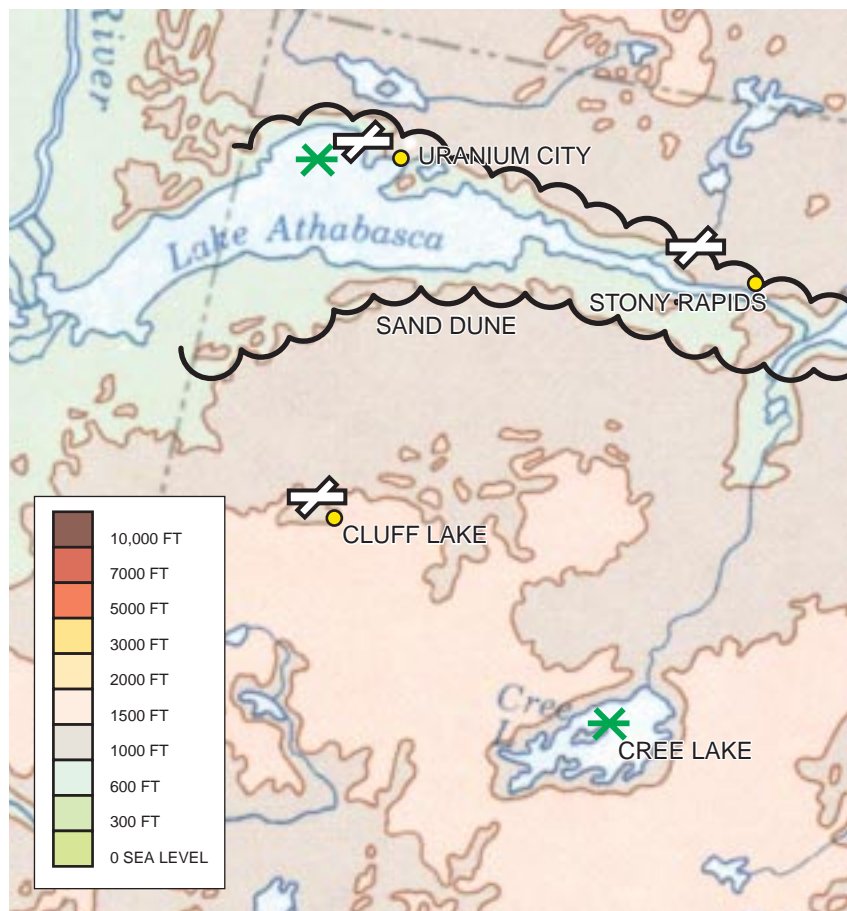
Map 4-29 - La Ronge and points north



Regions to the north of La Ronge are within the Precambrian Shield and this greatly effects the topography as well as human activity; settlements are infrequent and landing strips are widely spaced. At this point, the lakes and rivers become countless and most of the land cover is scrubby forest growth and muskeg. The lakes are generally small and shallow with the exceptions of Cree Lake, Wollaston Lake, and Reindeer Lake. The hills in this area are few and very small, so upslope conditions are present only for flows from the northeast to east. Obviously, with these wind directions, there is copious low level moisture available, outside of the winter season, so stratus can blanket the entire region if the flow persists long enough. In the fall, before the lakes freeze, cold northwest or northerly flows are quickly saturated and destabilized in the low levels as well, causing widespread low cloud and precipitation. Regardless of the situation, the worst conditions tend to exist to the lee of the larger lakes mentioned above.

The Churchill River runs roughly west to east, about 40 miles to the north of La Ronge, joining numerous lakes through the north-central section of the province. It is frequently observed that the river itself forms a natural weather divide over northern Saskatchewan, with low cloud staying confined to one side or the other. Differences in land elevation and topography no doubt play a role in this, but it is not impossible for well-developed areas of low stratus or stratocumulus to cross the river and fill the valley completely.

**Stony Rapids and the Lake Athabasca Drainage Area**



Map 4-30 - Stony Rapids and the Lake Athabasca drainage area

The Lake Athabasca drainage area comprises the extreme northern part of the province and shapes the local weather conditions in a number of ways. Lake Athabasca is situated in a broad east-west basin with numerous small lakes and rivers and with elevations a mere 600 to 800 feet above sea level. The southern shore of the quite large Lake Athabasca is a long stretch of sand dunes, and the northern side is a sharp escarpment rising 1,200 feet above the level of the lake. The eastern end of the lake constricts into a long channel, the Pine Channel, that joins Fond Du Lac and Stony Rapids. The Western end of the lake extends southwestwards into Alberta ending at Fort Chipewyan.

Stratus frequently invades from the north into this area, and often has its southern edge within the confines of the basin lowlands. Ceilings can be very low, or down to the surface, over the escarpment on the north shore of the lake. This is a consideration

when flying to, or near, Uranium City which is on the southern edge of this escarpment.

The weather conditions at Stony Rapids are strongly influenced by the Pine channel. Winds are frequently funnelled through this passage and show a strong preference for either east or west directions. Winds coming from the west have a long fetch over open water and can advect stratus down the Pine Channel and into Stony Rapids. Winds coming from the north or south quadrants occur less than ten percent of the time and are invariably quite weak.

Lake Athabasca produces snow streamers in the spring and fall when cold flows develop from the west to northwest. Often these will reach as far as Stony Rapids, plaguing the airport with low visibilities in flurries. Lake Athabasca is quite shallow and will usually freeze over by late November or early December, with the spring thaw happening in late May or the first week of June. However, the Pine Channel has some relatively fast flowing waters and often stays open most of the winter between Fond Du Lac and Stony Rapids. This leads to frequent occurrences of ice fog at the Stony Rapids airport.

Morning radiation fog becomes a problem at Stony Rapids after the spring thaw, peaking during the months of July, August and September. In fact, Stony Rapids has the greatest frequency of summer radiation fog in Saskatchewan, with occurrences on 16 percent of the days during the month of August.

Adding all of these factors together, Stony Rapids, as with many sites in the Athabasca Basin, has a rather high likelihood of poor weather compared with other spots in Saskatchewan. Low flying conditions peak in the late fall and early winter when the area is prone to snow streamers, morning fog events, and frequent invasions of stratus from the north. Around January, conditions start to improve as very cold and dry arctic air masses frequent the area.

Weather of Manitoba



Map 4-31 - Topographical overview of Manitoba

Manitoba's climate is purely continental; its location in the centre of Canada puts it a vast distance from any truly moderating coastal influence. It is certainly not a surprise that it possesses the distinction of being the province with the greatest range between summer and winter temperature averages. Winters are long and hard, while summers are warm and short. The transition seasons are short and unreliable; there is a greater than 50 percent chance of having a frost after May 25, and before September 20, in any given year. A persistent snow cover can usually be expected after mid November but with sporadic events occurring much earlier.

Manitoba is quite dry as would be expected of a continental climate, but it does receive a bit more precipitation than the other two Prairie provinces. Totals range from a low of 400 mm annually in the north, to near 600 mm in the southeast. The foothills of Alberta are the only other location on the Prairies to exceed 600 mm in a year. The reason for Manitoba's higher, and somewhat more reliable, precipitation amounts has to do with its greater exposure to southerly flows of warm moist air from the central United States and the Gulf of Mexico. Fortunately, 60 percent of the annual precipitation falls during the growing season from May to August, with June being the wettest month.

Even though one sixth of Manitoba's surface is water, the lakes and rivers do not exert a major influence on the province's climate. In actuality, the much more distant Pacific Ocean and Gulf of Mexico have a much stronger influence than the local bodies of water. The only exception is the Interlake region, between Lake Winnipeg to the east and Lakes Winnipegosis and Manitoba in the west. Even the influence of Hudson Bay is minimal and usually confined within a short distance of its coast. Churchill's temperatures are somewhat cooler in the summer, but by mid winter the bay is completely frozen and becomes almost indistinguishable from the frozen tundra around it.

Manitoba is at the eastern edge of the vast sloping plain that comprises all of the Prairie provinces, and it has the lowest and most uniform elevations of the three. For this reason, terrain does not exert a significant control on the province's climate, with the local exception of the Manitoba Escarpment. This topographic feature, shared along the southwestern boundary with Saskatchewan and the U.S., is the most recognizable in the province, and is made up of at least four separate sets of hills or mountains: the Porcupine Hills, Duck Mountain, Riding Mountain and Turtle Mountain. The Escarpment extends from west central Manitoba, south-southeastward, to the international border and beyond. Together, these hills present a fairly uniform north-south barrier and have a significant influence on the local climate.

Manitoba, as with the rest of the Prairies, lies under the zone of mean westerly, with weather disturbances generally moving from west to east. There are, however, a great variety of synoptic situations that have the potential to affect this province.

Colorado Lows are more likely to bring moisture to southern parts of Manitoba than elsewhere in the Prairies. When they reach Manitoba, they have generally developed into full-fledged frontal systems with a plentiful supply of moisture. The Colorado Low can occur at any time of the year, but peaks during the spring. Cold lows formed over Alberta also frequent the province, but by the time they make it to Manitoba they have usually lost their closed circulation in the upper levels, and this gives them a faster more predictable movement. As is typical with all lows in the Prairies, the worst flying conditions are found in the moist upslope easterly flow on the north side of the low's centre.

In summer, southern portions of Manitoba can be the recipient of sweeps of warm humid air from the Gulf of Mexico. There is usually a great deal of thunderstorm activity embedded in these air masses which gives this part of Manitoba an extra dose of rainfall, making the local agriculture less dependent on irrigation. In the northern reaches of the province, there are often prolonged periods of low cloud and poor weather. This is due to the tendency for lows to move into the region of Hudson Bay, or northwestern Ontario, and then remain nearly stationary for some time, flooding the region with cool, moist air from the north.

Another synoptic situation that is worthy of mention, although not associated with precipitation, is the winter phenomenon known as the "Arctic Outbreak". Strong high pressure cells, that have developed in extremely cold air masses over the western Arctic, invade the Prairie provinces, usually in the wake of a migratory low pressure system. These domes of frigid air spread southeastward, almost unimpeded, and typically herald long periods of clear, dry, and bitterly cold weather.

### (a) Summer

Summers in Manitoba are short and hot by Canadian standards; they begin in late April or early May and last until the beginning of September. While Saskatchewan holds the record for the hottest recorded temperature, Manitoba has slightly warmer summers on average. Both are known for the large summer diurnal temperature range, averaging 14° Celsius degrees per day. Summers are fairly dry, but 60 percent of the annual precipitation falls within the growing season of May to August.

During the summer, the typical storm track is pushed northward. Cold lows formed in Alberta often end up near Hudson Bay and affect northern parts of the province, whereas Colorado Lows typically follow a path close to the Manitoba/U.S. border, influencing the weather over southern regions. Regardless of where the low originates, the lowest flying conditions are generally found within 60 to 100 miles north of its center where a persistent east to northeast flow, forced to rise up the sloping terrain, becomes increasingly saturated. However, by the time these storms have reached Manitoba, they have usually gained some momentum and move through this province at a faster pace than those to the west. Thunderstorms are



common over Manitoba throughout the summer and most prevalent over the south. Typically, Brandon and Winnipeg report thunder 25 to 30 days a year. Air mass thunderstorms are the most common, although they do not have a strongly favoured region of development, due to Manitoba's flat terrain. Two slightly preferred areas are the slopes of the Manitoba Escarpment and the Interlake region, but often storms are initiated elsewhere and enter the province freely from any direction. Manitoba is the Prairie province that is most susceptible to nocturnal thunderstorms, mainly because it is the most eastern of the three. Thunderstorms that are formed far to the west and southwest begin tracking in an easterly direction once they have reached a certain stage. Most of these will weaken and die after moving away from their source region, but if they are strong and there are sufficient dynamics to support them, they can travel a considerable distance. The storms that are able to reach as far as Manitoba will generally arrive late in the day or overnight. They often seem to dissipate during the evening hours, but then have a period of regeneration during the overnight hours when cloud top cooling gives them an extra dose of instability. It is this modified life cycle that accounts for the higher frequency of overnight and early morning thunderstorms.

When discussing thunderstorms in Manitoba, it is necessary to consider those that sometimes invade from the south, embedded in very warm, humid and unstable streams of air that originate over the Gulf of Mexico. This is a pattern usually only seen in the summer, as it requires a southerly upper circulation to transport air from the Gulf all the way to Canada. When such a pattern occurs, southern Manitoba often receives a significant infusion of rainfall. These air masses can support thunderstorm complexes that are large and long-lived. The typical path they follow often just clips southeastern Manitoba as it turns into Ontario.

Low-level turbulence is a frequent concern during summer, most notably on warm sunny days. Thermal updrafts are common over the land due to surface heating, and their effects can be particularly turbulent along boundaries where they are juxtaposed with downdrafts generated over large bodies of cool water. These paired updrafts and downdrafts can be strong enough to initiate lake-breeze circulations which are common in the Interlake region.

## **(b) Winter**

Winter in Manitoba is generally considered to be from mid-November through to early April. During this period, good flying weather is common, but the migratory lows that affect the other Prairie provinces also plague Manitoba. These can originate in Colorado, the western Prairies or Northern Canada, and often bring prolonged periods of very low flying conditions and significant snowfalls when they visit.

Lows that form in the Colorado or Wyoming region can be particularly messy for southern Manitoba. The typical trajectory for the center of such a low will keep it

south of the province, but there is often a warm front extending from the low that reaches into southern sections. Precipitation can change from snow through freezing rain to rain, depending on one's location with respect to the front. Low ceilings and visibility, as well as significant icing, are common with this pattern. Ceiling heights can vary greatly, especially in the southwest where the terrain is irregular. Once the system has passed, a strong northwesterly flow invariably develops in its wake. The resulting cold winds cause blowing snow over regions of fresh snow cover and can quickly freeze warmer surfaces where rain has fallen.

Lake effect snowfalls, such as the “Elie Blizzard” scenario (see Winnipeg to Portage La Prairie to Brandon section), are most common over southern Manitoba during the late fall, but can still develop in mid winter. This is usually a small-scale phenomenon that happens when a northwesterly flow over the large lakes is strong enough to create large openings (leads) in the ice cover. The resultant injection of heat and moisture produces snow streamers downwind. Because of the large amount of snow generated along a narrow swath, localized blizzard conditions are easily achieved when the wind further lowers the visibility with blowing snow.

Arctic outbreaks plague Manitoba throughout the winter. Generally, along the cold front which normally marks the leading edge of this cold air, flurries will occur and flying conditions will be, at best, marginal for a short time. Of equal concern to aviation are the gusty northwest winds that develop north of the front which often produce significant mechanical turbulence in the low levels and cause blowing snow, especially in areas where there is fresh snow cover.

## **Transitional Seasons**

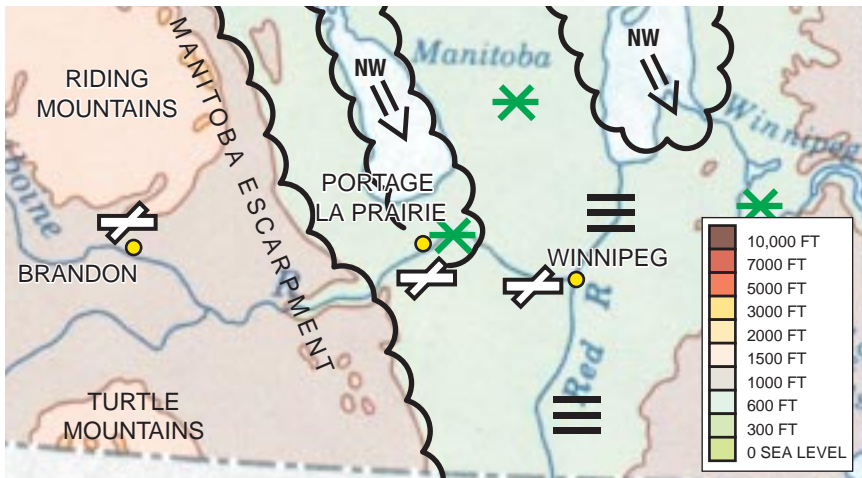
Spring and fall are both short and provide unreliable flying weather in Manitoba. Often the south is beset by late spring snow storms, and the Red River Valley occasionally floods. Both seasons bring an increased occurrence of fog and stratus, especially in the north where the abundance of trees and lakes can trap and hold the low-level moisture for extended periods. In general, there is a more plentiful supply of low level moisture in the transitional seasons. In the spring, evaporation from snow melt and a greater frequency of upslope northeasterly winds provides the moisture. In the fall, it is supplied by Manitoba's numerous lakes.

Manitoba is a windy province, and spring and fall are its windiest seasons. The strongest winds are unvaryingly northwesterly, but this is not the most prevalent direction. In the spring, it is north to northeasterly, and in the fall, westerly winds are most common. Mechanical turbulence is usually present in the lower two to three thousand feet of the atmosphere on windy days but is seldom severe. However, it is often enough to shake smaller aircraft, particularly in the southwest where rough terrain enhances and deepens the turbulent layer.

The “Land of 100,000 Lakes” is, of course, susceptible to the development of snow streamers in the fall. This is mitigated somewhat in the north as most of the lakes are quite small and stretched in a southwest to northeast direction. This orientation limits the distance, or “fetch”, that cold northwesterly winds span over the water surface. However, there are several larger lakes in the north and, of course, Lakes Winnipeg, Manitoba, and Winnipegosis in the south, that are particularly well known for streamer development.

## Local Area Weather

### Winnipeg and Area



Map 4-32 - Winnipeg and area

Winnipeg is located in the middle of the wide, shallow, north to south valley of the Red River. The smaller Assiniboine River also flows into the city from the west, meeting the Red River in the centre of the downtown area. The combined flow of the two rivers then heads north-northeastward to Lake Winnipeg. The city of Winnipeg is about 45 miles southeast of Lake Manitoba and 40 miles south-southwest of Lake Winnipeg. The area has a decided preference for southerly winds; not surprising, as any winds from the south tend to be channeled along the Red River Valley. The valley carved by the Assiniboine River is slight and does not influence the local flow. Northwest is the second most frequently occurring wind direction for Winnipeg, most notably in the winter. North to northeasterly winds are also common as some channeling will occur in the valley north of the city. Winds from other directions are quite rare and usually light.

Radiation fog is extremely rare in Winnipeg and its few appearances are usually in the spring, when the snow is melting and there is plentiful low level moisture. There are more occurrences of ice fog in winter because of the prolonged periods of very

cold temperatures, not to mention the usual particulate matter common in large urban centres. Winnipeg frequently sees large deposits of hoarfrost during these ice fog events. If this is the case, the fog can be slow to lift as the sublimation of the hoarfrost feeds moisture back into the atmosphere. Cold air entrenched in the Red River Valley is difficult to remove. Warmer flows from any direction tend to overrun the cold pool, and the process of eroding the inversion can be markedly slow.

While radiation fog is uncommon, advection fog is not. It is usually associated with low stratus and almost invariably invades from the south, travelling within the confines of the Red River Valley. Its passage down the valley can happen quite quickly, but it is possible to get advance warning by watching for the development of low conditions at Grand Forks and Emerson. If the southerly flow is strong enough, it will diminish the likelihood of fog, but may still advect in a deck of low stratus. Less frequently, fog can also move into Winnipeg with a northeasterly flow off Lake Winnipeg.

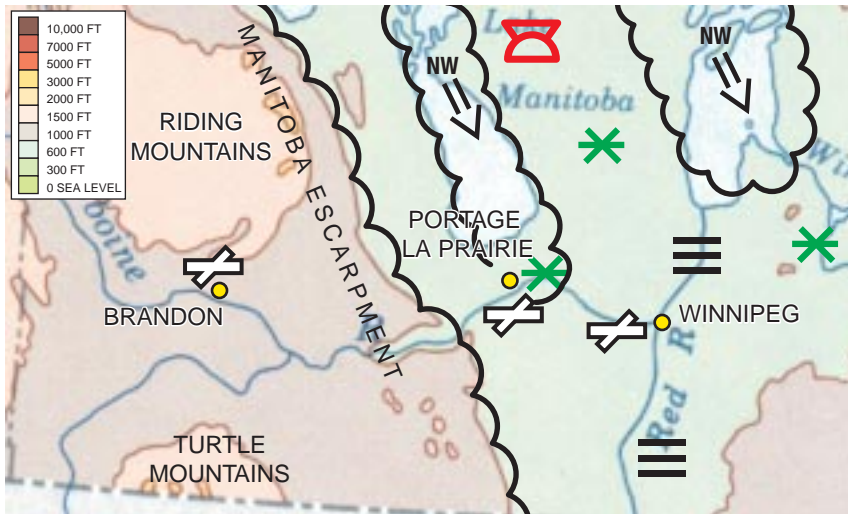
Even though the Red River Valley is very shallow, it does have a marked effect on the weather. Winds with a north or south component are channelled and strengthened within the confines of the valley. This increases both mechanical turbulence in the low levels and the frequency of reduced visibility in blowing snow in the winter months. Southerly flows are likely to be much stronger than the synoptic situation would indicate, especially if the flow in the lower portions of the atmosphere is also brisk and aligned from the south. Also, because of the valley sides, winds from the west and the east are downslope and are less likely to produce low flying conditions. Westerly winds give the best flying weather over the Winnipeg area. Easterly flows are trickier for two reasons; both because they are often associated with the moist flow on the north side of a low pressure system, and because they are generally upslope over southern Manitoba. If a moist east to northeast flow does bring stratus into Winnipeg, then it can be expected to persist until there is a change in the wind direction.

A large portion of the precipitation that falls in Winnipeg is attributable to the passage of Colorado Lows that are described in the climate portion. Rainfall from thunderstorms is also a major contributor in the summer, and Winnipeg is especially known for the nocturnal variety. Snow squalls from Lake Manitoba and Lake Winnipeg can dump copious quantities of snow over areas around Winnipeg, but they usually miss the airport and city itself. The required condition for their initiation is a cold north to northwesterly flow, and this will give the streamers a trajectory that will take them east of Winnipeg if they form off Lake Winnipeg, and west of the city if they form off Lake Manitoba.

In the fall months, a pilot flying around Winnipeg must be on the lookout for areas of reduced visibility due to smoke from stubble burning. This is a frequent practice of

local farmers that usually starts in late August and continues to the end of October. If there is low level moisture in the vicinity of the burning, particulate matter provided by the smoke can aid or initiate the formation of stratus.

### Winnipeg to Portage La Prairie to Brandon



Map 4-33 - Winnipeg to Portage La Prairie to Brandon

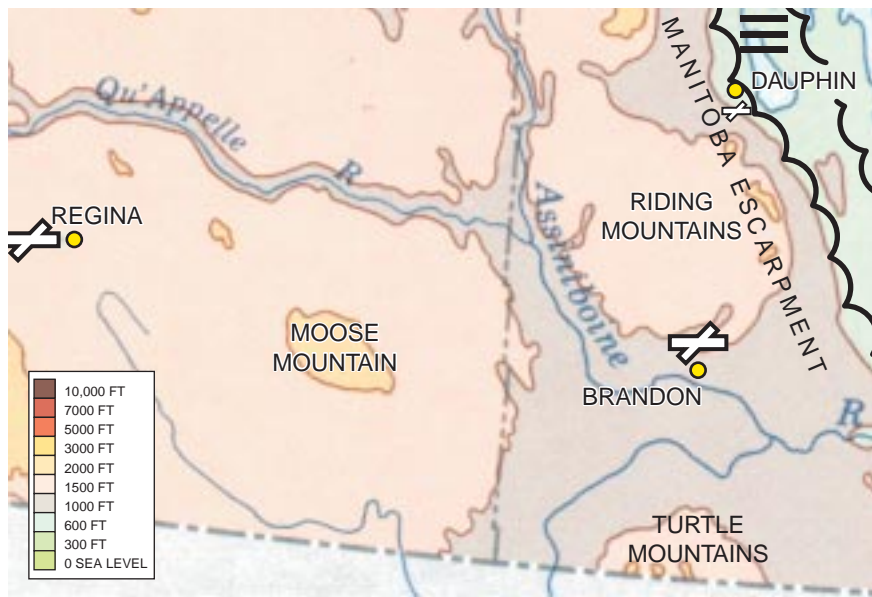
The land between Winnipeg and Brandon slopes gradually upwards towards the west with a gain in elevation of over 560 feet by the time Brandon is reached. Naturally, an east to northeast flow is the most likely to give prolonged stratus due to the upslope component. It is quite normal to see deterioration in ceiling heights from east to west under such conditions. To the west of Portage La Prairie, ceilings and visibilities tend to deteriorate markedly near Austin because of terrain height increases and can become quite low further west over the Carberry Hills. These hills are quite distinctive as they are comprised of sand and gravel, and their gently rolling slopes can trap stratus in an easterly flow and hold it in the area. Flying further west towards Brandon, terrain rises become quite significant on the north and south sides, but a safe and reliable route is found along the lower terrain of the Assiniboine Valley.

Encountering snow streamers or snowsqualls, on a flight from Winnipeg to Brandon, is a distinct possibility, from fall to spring, when the flow is northwesterly. The locally heavy snowfalls are the result of cumulus and towering cumulus embedded within a larger area of stratocumulus cloud, so the hazards to aviation are threefold; pockets of very low visibility in snow flurries, significant turbulence, and mixed icing throughout the entire region of cloud.

Streamers off the Lakes Winnipeg and Manitoba follow a fairly predictable path. Those from Lake Manitoba tend to give the highest snowfalls to the area between

Winnipeg and Portage La Prairie, and those from Lake Winnipeg to areas east of the city of Winnipeg. It is rare that the cells will persist beyond about 20 miles south of the Trans Canada highway. In either case, Winnipeg is generally safe from this effect. The worst hit area is often centered around the tiny town of Elie, located halfway between Portage La Prairie and Winnipeg. This small area not only receives the greatest amount of lake effect snowfall, it is also a very open region where winds can blow unimpeded. Visibilities near zero in blowing snow are common, even after the snow has ceased to fall. Pilots should watch for the presence of this phenomenon, known locally as the “Elie Blizzard”, particularly when the wind direction is anywhere between 320 and 350 degrees true and the temperatures are cold.

**Brandon and Westward**



Map 4-34 - Brandon and westward

The city of Brandon is nestled in the west to east valley of the Assiniboine River on the river’s south side, and the airport is about 3 miles north of it. From the Assiniboine River valley northward, the terrain slopes gradually upward, reaching the tops of the Riding Mountains at 2,200 to 2,300 feet, some 50 miles north of Brandon. The Minnedosa River Valley interrupts this rise in the terrain, about 20 miles north of the airport. From the Assiniboine River valley southward, the land is fairly flat for about 10 miles and then rises into the Brandon Hills about 20 miles south of the airport. Farther south, near the American border, is the much more significant rise of Turtle Mountain.

A northwest flow is very favourable for Brandon as any weather associated with it is weakened by subsidence off of the Riding Mountains. The second most favoured



wind direction in Brandon is northeasterly, important because it is an upslope flow that is quite capable of producing stratus. The majority of stratus events for Brandon are confined to the fall and are associated with this northeast to east flow. If the airport is reporting marginal to good ceilings in stratocumulus, it must be kept in mind that conditions could be much lower over the higher terrain on virtually all sides.

Because the city of Brandon is in a river valley, it does get radiation fog, but it is not overly common at the airport. In the spring-time, with an east or southeasterly flow, melting snow in North Dakota can supply enough low level moisture to give widespread stratus across North Dakota and southern Manitoba. This low cloud can last 5 to 6 days and be the cause of significant accumulations of rime ice.

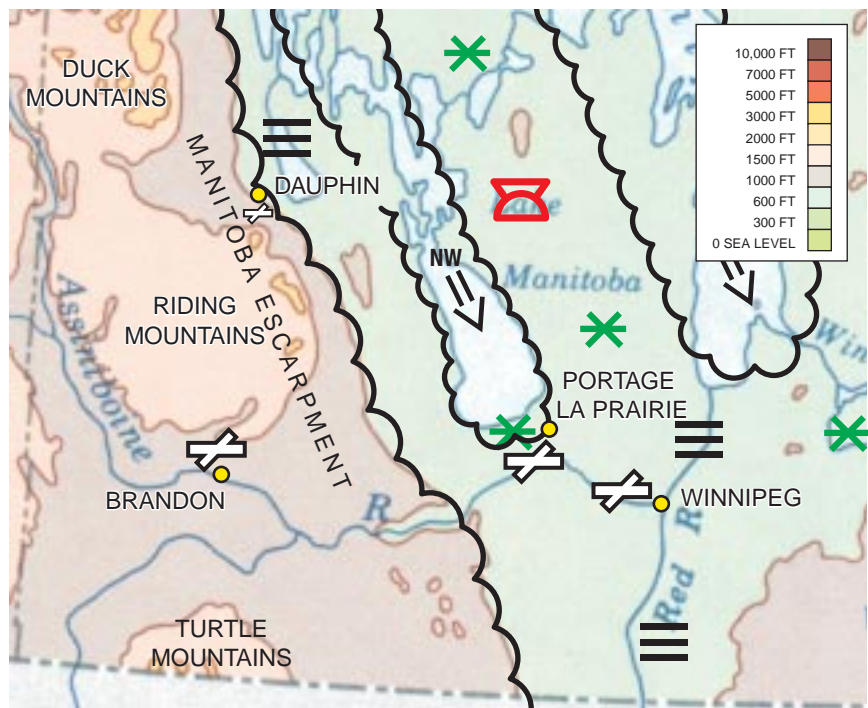
The summertime brings frequent convective activity in the region around Brandon. The convective cells have a tendency to form in areas to the south and southwest but, due to the prevailing west to northwesterly flow, they will frequently miss the airport and stay south of Highway 2.

While there is not much pollution or industry in the area, Manitoba Hydro and a fertilizer plant have smoke stacks on the southeast side of the city. The condensation nuclei from these can contribute to stratus development and lower ceilings if the flow is from the southeast.

Flying west from Brandon, it is usually advisable to stick to the lower terrain of the Assiniboine River Valley which takes a turn to the northwest about 50 miles west of the city. Right at the Manitoba/Saskatchewan border, the Qu'Appelle River joins the Assiniboine River, making the valley of the Qu'Appelle an easy visual landmark to follow on a westbound route.

South of the valley of the Assiniboine and Qu'Appelle Rivers, and about 60 miles to the west of Brandon, the Moose Mountains rise some 400 to 500 feet above the surrounding terrain. These mountains start near Virden and carry on as far west as Fort Qu'Appelle. If the Brandon, Yorkton, Estevan and Regina observations are showing a lower deck of stratocumulus in the region, then conditions can be very low over the Moose Mountains. If the flow is from the east or northeast, ceilings could even be close to the ground over the highest points of land.

Brandon to Dauphin



Map 4-35 - Brandon to Dauphin

Brandon’s elevation at 1,341 feet above sea level is actually higher than that of Dauphin at 1,000 feet, due to Dauphin’s location within the lower terrain of the basin formed by Lake Manitoba. However, the Riding Mountains stand as a barrier between the two and rise a considerable 1,200 feet above the elevation of Brandon. Whatever ceilings are reported in Brandon, it is necessary to subtract at least 1,000 feet to get representative ceilings over the Riding Mountains.

The Minnedosa River runs from the town of Rivers northeastward through Minnedosa, 30 miles north of Brandon. The associated valley has fairly steep sides and tends to trap stratus for extended periods of time. The absence of stratus in Brandon is no guarantee that it won’t be encountered in the Minnedosa Valley. The valley can also be an area of frequent low level turbulence, especially with a north-westerly flow and on convectively unstable days.



cooled by relatively cold waters causing it to subside. This produces a low level circulation pattern as the denser, cooler lake air will move westward into the region where the warm slope air is rising. This can produce an easterly wind of up to 15 knots.

The worst weather conditions, at least in terms of flying, will generally occur when there is a low pressure system situated over Hudson Bay. This gives a north to northeasterly flow of moist air from Hudson Bay over western parts of Manitoba, which provides a good deal of upslope terrain, especially in the Dauphin area. To add to this, there is a further injection of low level moisture from Lakes Winnipeg, Manitoba, and Winnipegosis, and the marshy terrain that surrounds them. Very low conditions can also occur when a low passes to the south of the area. The moist easterly flow to the north of the low is further saturated by upslope terrain and by moisture from Lake Manitoba.

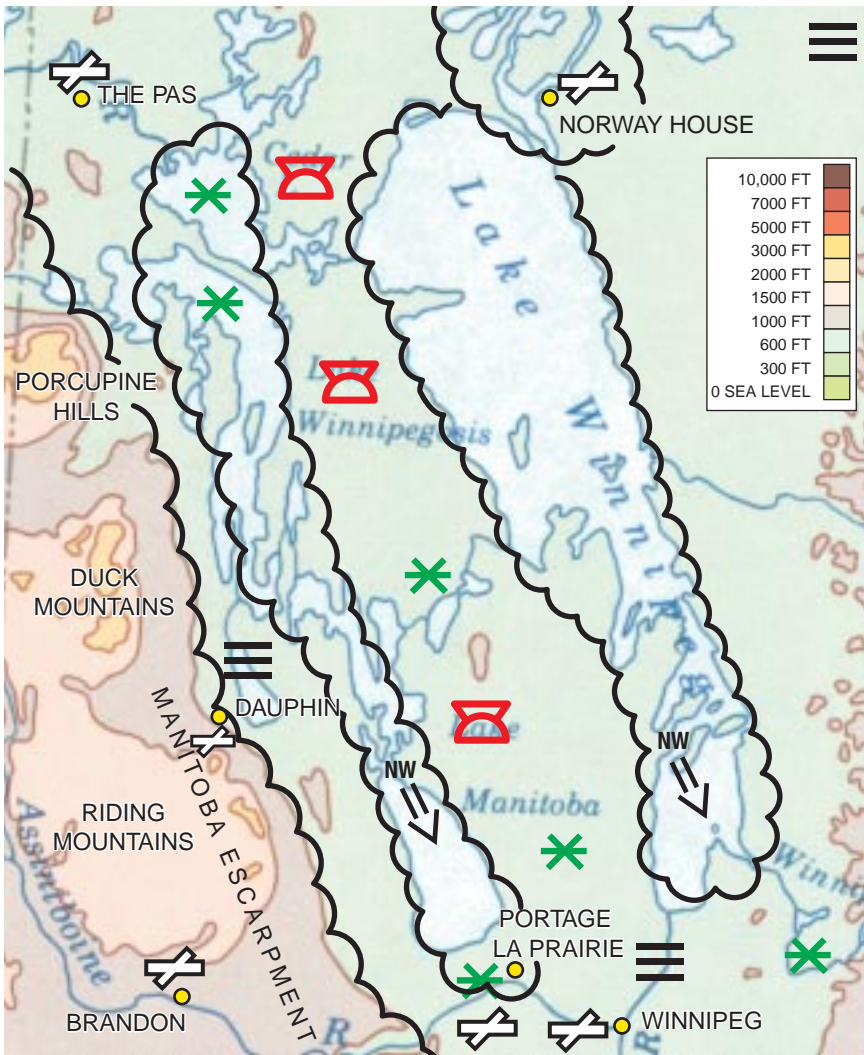
The eastern slope of the Riding Mountains is quite steep, so with a fairly strong west to southwesterly flow it is possible to have Chinook effects. This flow actually produces a small lee trough east of the hills with southeasterly winds on the east side of the trough and westerlies to the west. It is difficult to detect the presence of this phenomenon, as the only observation site in the area is the auto station at Dauphin; too far north to be in the lee trough. Often, however, low level standing lenticular cloud forms about 10 miles east of the mountains, and significant subsidence warming occurs. Both are a sure indications of the presence of the downslope flow. Regardless, a strong west to southwesterly flow should always be regarded with caution as it can generate, or add significantly to, turbulence on the lee side of the hills, up to about 5,000 feet ASL. As one would expect, the same effect can be felt on the eastern slopes of the Duck Mountains. The most common area for the "Dauphin Chinook" to be felt is from Cowan in the north to McCreary in the south.

Radiation fog does not occur very often at Dauphin. On clear nights with light winds, a drainage wind tends to develop off the escarpment to the south that will prevent fog from forming. There is, however, some possibility of fog being advected into the airport area by an upslope northeasterly flow off of Dauphin Lake. This is most likely to occur in the late summer and early fall.

It is possible, with a persistent northeast flow off the lakes to the east of Dauphin, to generate a continuous band of very low stratus that begins near Sifton, about 15 miles north of Dauphin, and extends southward. To the north of Sifton, ceilings are generally much better. This pattern is much more likely in the spring and fall when the lakes are open and the lower atmosphere is not as dry.

Thunderstorms typically form in the regions to the west of Dauphin, under a southwest or northwest flow. They frequently diminish in intensity before reaching the town and airport due to the effects of subsidence.

## The Interlakes Region



Map 4-37 - The Interlakes region

The Interlake refers to the area between Lakes Manitoba and Winnipegosis on the west and Lake Winnipeg to the east. Carved by the last glacial passage over Manitoba, the lakes are long, shallow, and irregularly shaped, stretching from the north-northwest to the south-southeast. The large basin-like depression around the lakes is mostly marsh and bog lands, interspersed with many smaller lakes, and is virtually uninhabited except for the extreme southern end.

The three larger lakes are big enough to set up sea breeze circulations producing quite variable winds throughout the area. This has a significant effect upon convective

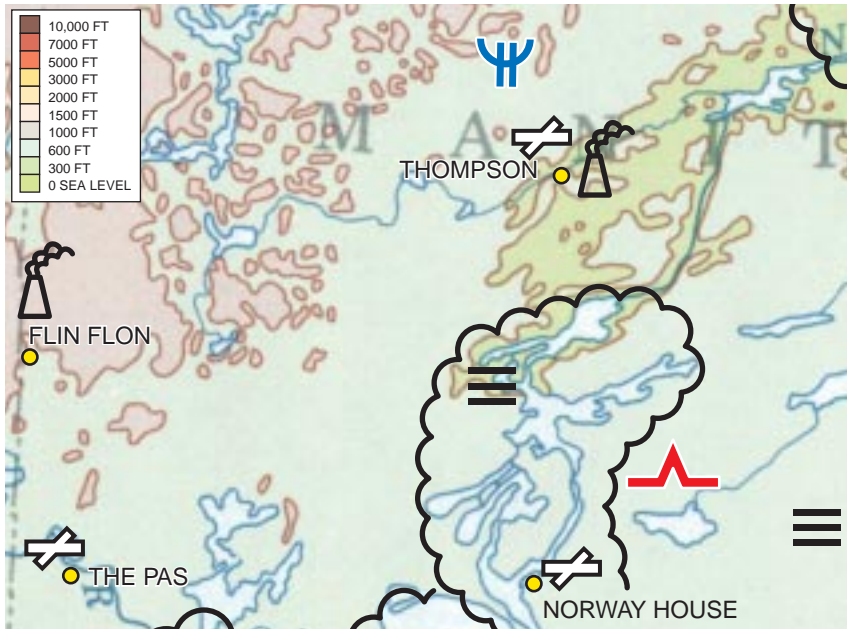
patterns on warm summer days. The air over the water is cooled in the low levels, producing subsidence that keeps the skies over the lakes completely clear. On the east and west sides of the large lakes, however, there is enhanced development of convective cells where lake breezes have established a line of convergence with the environmental flow. This is especially magnified in the Interlake region as the lake breeze from Lake Winnipeg impacts with the lake breeze from Lake Manitoba. Small cumulus or towering cumuli are the norm, but large thunderstorms are quite possible if there is enough instability. The cells will usually dissipate if they move away from their source area.

In the spring and fall months, snow squalls are also a distinct possibility over and to the lee of the lakes. The ideal synoptic set-up requires a predominantly ice free water surface and a cool north to northwesterly flow, with the air temperature at least 10 degrees Celsius colder than that of the water. If the air is very stable, a widespread area of cumulus and stratocumulus cloud will be formed giving snow flurry activity. However, more often, towering cumulus cells will develop producing localized areas of moderate to heavy snow, or ice pellets and mixed rain and snow. In a few cases, the air will be unstable enough to form small cumulonimbus cells up to about 20,000 feet. Low visibility is not the only concern within a band of snow streamers; this is the perfect environment for convective turbulence and moderate to severe mixed icing.

With any synoptic scale low pressure system passing south of the region, the already moist easterly flow to the north of such a feature can be further saturated by passage over the Interlake area. This is only true as long as the lakes are open, which in general tends to be from early May to the first week of November. Expect ceilings to be considerably lower to the west of the larger bodies of water.



## North of the Lakes - The Pas - Flin Flon - Thompson



Map 4-38 - North of the Lakes - The Pas - Flin Flon - Thompson

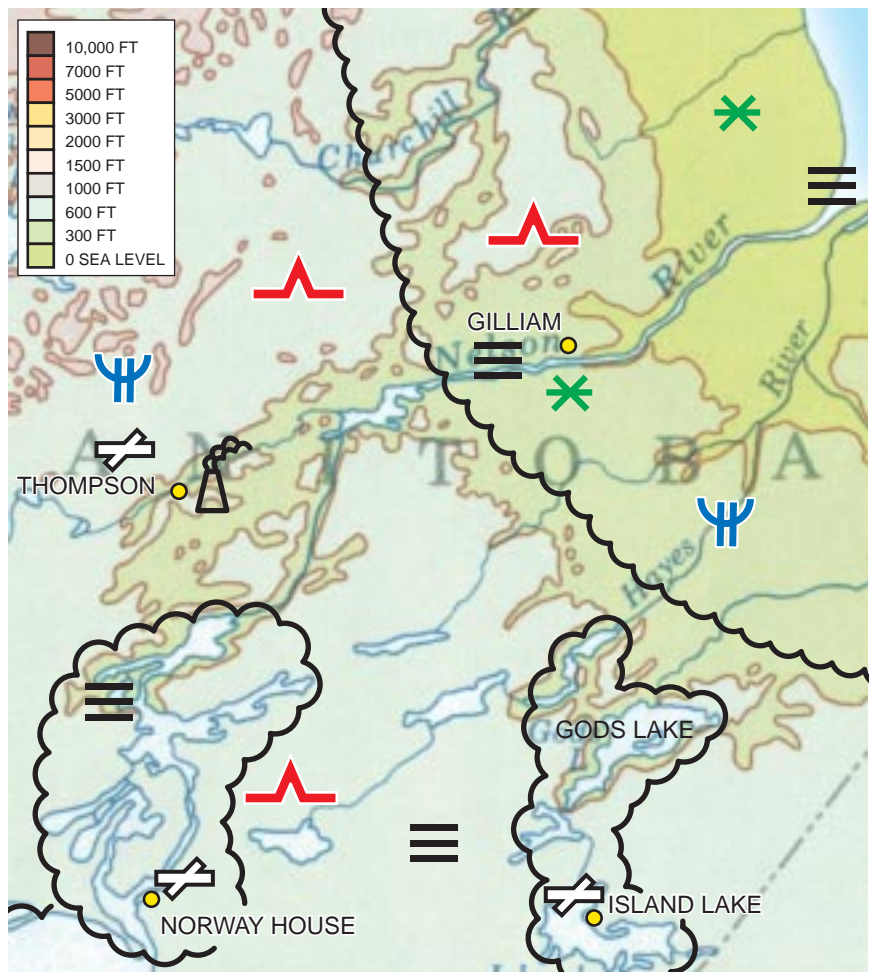
Elevations fluctuate only slightly over this area, averaging about 850 feet ASL, and ranging from about 1,200 feet northeast of Flin Flon to about 600 feet near the lakes south of Thompson. From spring through late fall, moist east to southeasterly upslope flows can cause deteriorating conditions, especially for points northwest of Snow Lake, and moisture picked up off Lake Winnipeg can further aggravate the situation.

Vegetation is predominantly mixed boreal forest that provides some shelter from strong winds. Winter “white-outs” are rare, but low level wind shear and/or mechanical turbulence below 4,000 feet ASL are quite common during strong wind events.

There are several large lakes in the Flin Flon - The Pas area. The largest, including the huge Cedar Lake Reservoir and Lake Winnipegosis, are southeast of The Pas. The Pas Airport is located just south of Clearwater Lake, which is roughly 12 miles across. The area is susceptible to local fog and stratus, especially in the spring and fall. Extensive streamer activity can occur over and southeast of these lakes in the fall, when the winds are cold and from the northwest.

Flin Flon is one of several mining towns in northern Manitoba and is the site of a large copper/zinc smelter, located on the western outskirts. The stack discharge adds particulates to the atmosphere which, at times, can contribute to fog formation, especially when a strong low level inversion exists.

Norway House - Island Lake - Thompson



Map 4-39 - Norway House - Island Lake - Thompson

This region exhibits one of the smoothest topographies in Manitoba, with elevations staying uniformly near 750 feet ASL. There are a few widely scattered hills reaching as much as 200 feet above the surrounding terrain and a few water surfaces dipping 100 feet or so below. The area, covered by mostly coniferous boreal forest that thins only over the northeast, is peppered with lakes and muskeg. The region, much like the rest of northern Manitoba, is plagued by ample surface moisture and poor drainage. Fog and stratus are most common during the transitional seasons, especially when there are moist flows from the northwest through north to southeast. The Norway House and Cross Lake districts are particularly vulnerable, due to large expanses of water and muskeg near the upper reaches of the Nelson River, as are the areas adjacent to the two largest lakes in the area, Gods Lake and Island Lake.

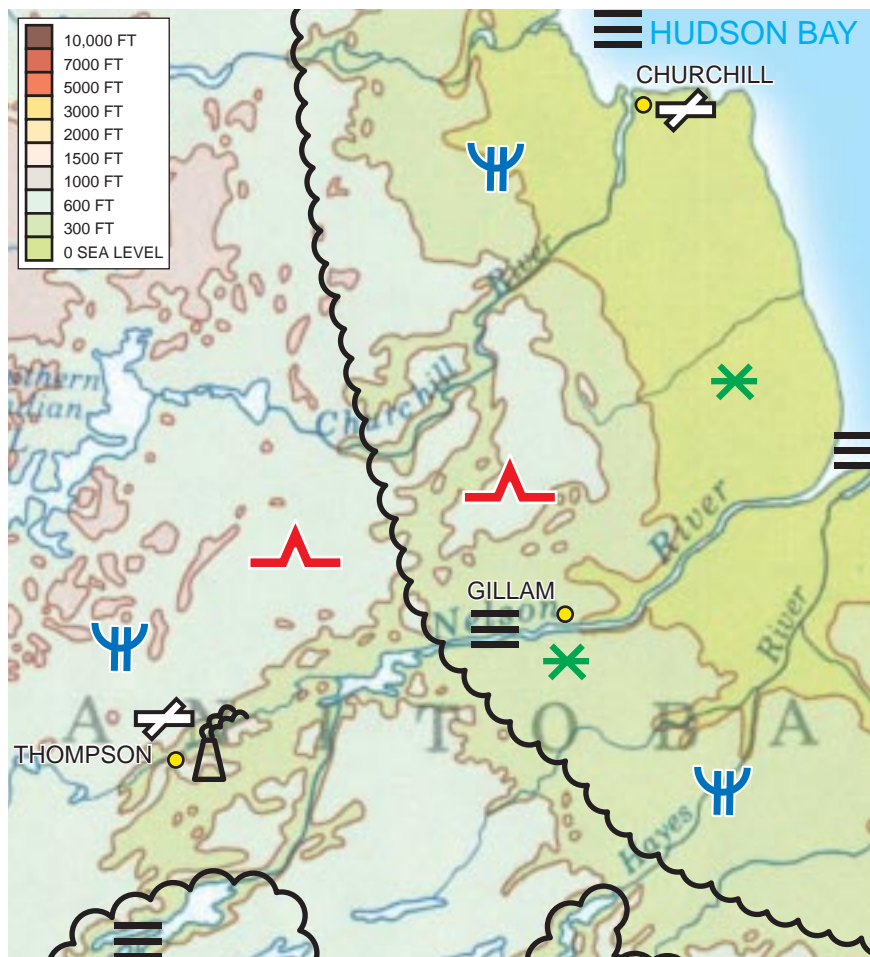
Primary aerodromes in this sector are all very close to (or surrounded by) water, so freeze up (early to mid November for smaller lakes, December for Lake Winnipeg) and break up (mid to late April) are significant controls for the weather.

Even though Hudson Bay is at a considerable distance, it still has an influence on the weather in this region. Thick blankets of stratus and fog can develop over the bay at any time of the year, but most notably from June to December. Northeasterly onshore flows advect this "blanket" inland, usually about 150 miles, affecting the lower Gods River valley and Shamattawa areas. It can, however, under a persistent northeasterly flow, reach Gods Lake and Thompson. Often these regions of stratus present an icing problem; if temperatures within the cloud fall in the range of zero to -15 °C, then moderate mixed icing is common, and severe mixed or clear icing is possible.

There are no preferred areas of summertime convective development. Thunderstorms, usually moving from west to east, tend to live out their life cycle in a reasonably predictable fashion. Fair weather currents of buoyant and subsiding air along forest/lake boundaries can interact with the environmental wind and sometimes cause significant turbulence up to 4,000 feet ASL.

Even though drainage in the region is poor, there is so much water to move that several of the rivers have sections of rapid flow that often do not freeze over in winter. The presence of open water at this time of year can create local pools of evaporative fog or ice fog, especially when temperatures are very cold and winds are light. Two notable places where this phenomenon commonly occurs is around the strip and float plane facilities at Gods Lake Narrows and near the village of Gods River.

Thompson and Area



Map 4-40 - Thompson and area

Thompson is the transportation hub of northern Manitoba. The city’s airport is the second busiest in the province with several companies providing scheduled and charter service to and from Winnipeg, and to many other communities in northern Manitoba and southern Nunavut. Thompson also boasts an active float plane and helicopter base on the Burntwood River and is a principal railway depot on the line serving Churchill. A huge nickel mine and smelting operation, located on the southern outskirts of the city, is a major supporting industry.

The Thompson Airport, located about 4 miles north of the city, is built on what is locally described as “a swamp.” As with much of the terrain in northern Manitoba, the ground does not drain well naturally, although recent ditching around the runways has improved the situation. Nonetheless, local ponds and muskeg, the northern

reaches of Birch Tree Lake just to the west, and a generally high level of soil humidity, give a ready supply of low level moisture outside of the winter months. Frequently, during shallow fog events, the worst conditions tend to occur within the local control zone. In fact, it is often noted that the lowest conditions are encountered on final approach to the main runway from the west. This is most likely due to the proximity of Birch Tree Lake as well as particulate discharge from the nearby gravel pit and asphalt plant. The fog can sometimes extend outward along the Burntwood River valley nearby. However, fairly often, the float plane base on the river near the town is not affected. Another problem attributed to ground moisture is the tendency for the paved surface of the main runway to be somewhat unstable. Freeze and thaw cycles create dips and heaves that require constant repair by maintenance crews.

Seasonal weather conditions are generally fairly predictable. Since much of the system weather affecting Thompson approaches from the west, observations from Lynn Lake and The Pas make good upstream indicators. Lynn Lake is especially useful for timing cold frontal passages behind low pressure systems. Gillam provides advanced notice of weather approaching from the northeast or east, but since a flow from Gillam is upslope, there could be some further deterioration by the time it reaches Thompson.

Summer is short, but it tends to be pleasant and possesses the greatest percentage of good flying weather of all the seasons. Cumuliform cloud is very common and convective currents cause some turbulence up to about 4,000 feet ASL. Combined with gusty surface winds, this turbulence can be significant below 1,000 feet above the ground, especially along lake/forest boundaries. Severe convective weather can be expected once or twice each year, especially in June and July when evapotranspiration from the surrounding vegetation is at its peak. Locally, there are no preferred areas for convective development.

Winter is the time when strong, arctic high pressure systems move or build across this area from the north or northwest. They bring gusty west to northwesterly winds, very cold temperatures, and very pronounced surface based inversions. These inversions can act to trap exhaust moisture and particulate matter from aircraft and auto engines, from the local smelter, and from wood burning heaters used in many of the local households, resulting in locally reduced visibilities in ice fog. Ice crystals are usually present and can be large and heavy enough to cause a significant reduction in visibility, as well as accumulate to measurable amounts. To complicate matters, Manitoba's most northern ski resort is located about 4 miles north of the airport. When snow making operations are underway and the winds are from the north, visibility can be reduced by crystals carried downwind.

Typical winter storm tracks tend to carry eastward-moving low pressure systems south of Thompson. This is significant as snowfalls are frequently at their heaviest

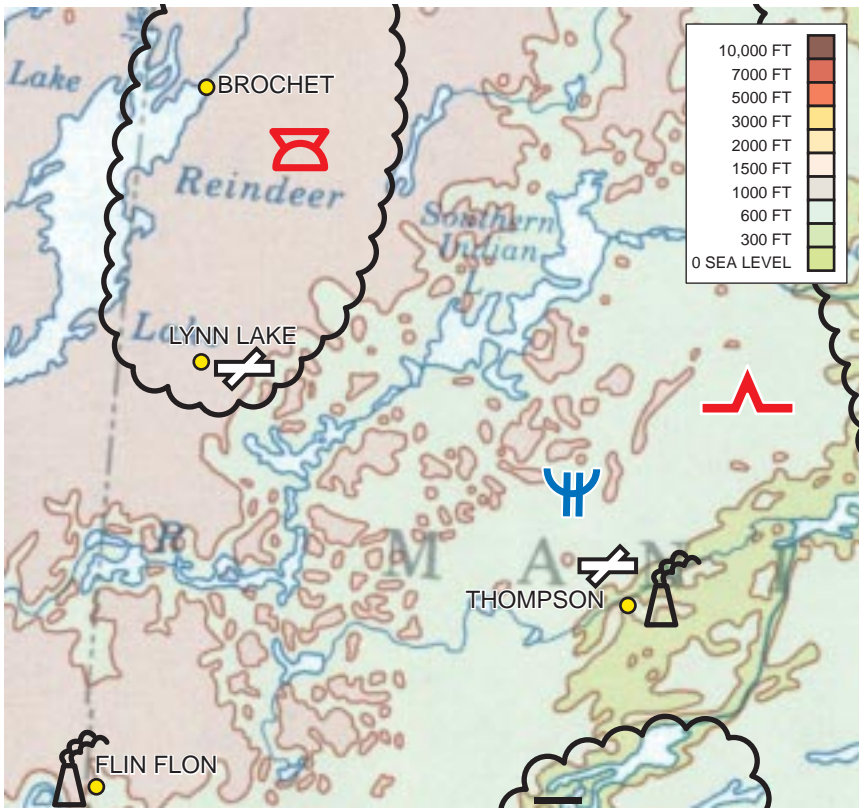


north of these lows, not to mention the enhancement of low level moisture created by the east to northeasterly flow. The strongest winds will generally occur in the northwesterlies that develop after the centre of the system has passed eastward, but luckily for Thompson, the surrounding forest provides enough shelter to diminish the winds and minimize the occurrences of blowing snow. Freezing precipitation is not uncommon, with an average of roughly two events per month during the winter. These events are not triggered by classic surface warm front situations as these tend to pass well to the south of Thompson. What happens, instead, is an upper warm front develops well north of the surface front, as the warm air in the south overruns the firmly entrenched arctic air at the surface. The rising warm air can generate liquid precipitation that falls through the much colder layer below. The icing created by such an event can be extremely tenacious as there is rarely any subsequent surface warming to cause melting.

As with most communities across the northern Prairie provinces, the trickiest weather occurs during the transitional seasons of spring (late March to mid May) and fall (late September to early November). During these periods, a greater number of storms move across the area. Cold northwesterly flows inevitably develop behind these systems and are quickly saturated in the lowest levels by moisture from melting snow in the spring, and from the warmer water of the many lakes and muskegs in the fall. Poor flying conditions usually persist until the flow pattern changes to a warmer southerly direction. Fog is most common during the transition seasons, and is considered the biggest obstacle to aviation activities in the Thompson area. A local rule of thumb for classic radiation fog (usually occurring with a ridge of high pressure, giving clear skies and light winds) puts the time of dissipation at around 10:00 a.m. The last traces of fog are usually gone by 11:00 a.m. However, if other processes, such as evaporation or advection, formed the fog and stratus, it can be much more persistent and sometimes requires a complete change in air mass to dissipate, showing only marginal diurnal improvement. The addition or removal of local moisture sources is important to consider when assessing the threat of fog. Lakes and muskeg in the area are usually frozen over by mid-November. The snowmelt begins in April, and ice on the lakes starts to break up during the latter half of that month. Large diurnal temperature swings in early fall and late spring are common in the area and can cause additional difficulties; rainfall during the day often falls on ground that has not yet warmed to above freezing temperatures after a cold night. The result is hazardous and widespread ice formation on roads, runways and other surfaces. Finally, the worst airframe icing conditions usually occur during spring and fall, when thick low cloud is present at temperatures in the zero to  $-15^{\circ}\text{C}$  range. Mixed and rime icing are common but significant clear icing is relatively rare.



## Thompson - Lynn Lake - Northwards



Map 4-41 - Thompson - Lynn Lake - Northwards

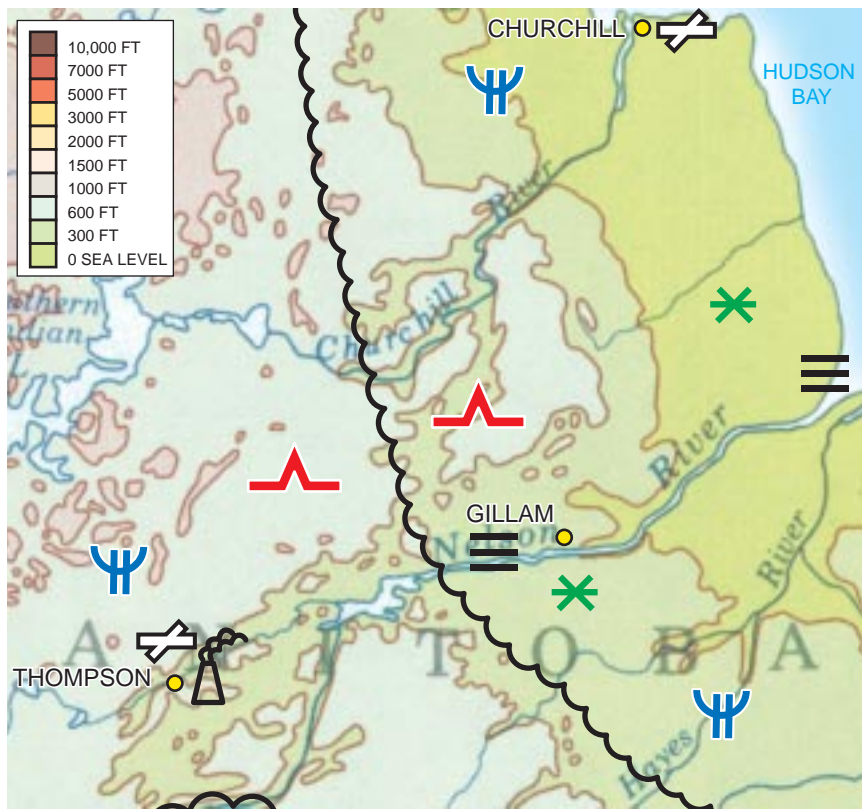
This route follows highway 391 along a gradual incline from the Burntwood and Nelson River Valleys across the Churchill River Valley, to the higher elevations of northwestern Manitoba. Surface characteristics in the area are, for the most part, similar to those around Thompson; a profusion of lakes and muskeg with ample surface moisture. However, there is some ruggedness north of Lynn Lake due to a multitude of eskers and other glacial leavings. Easterly winds are effectively upslope with elevations increasing roughly 600 feet between Thompson and Lynn Lake. Under the influence of such a flow, lower ceilings can be expected in the Lynn Lake area and to the north, but these differences are usually not very great.

Trees become more spotty and stunted as one progresses further north to places like Brochet and Tadoule Lake. Because of this, surface winds tend to be stronger in these areas and there is a greater susceptibility in winter to periods of reduced visibility in blowing snow. Moderate mechanical turbulence below 3,000 feet above ground is a common occurrence, especially if the winds are from the north or northwest.

The high land near the Saskatchewan border, northeast of Reindeer and Wollaston Lakes, tends to be a preferred place for development or intensification of convective cloud when the area is under the influence of a southwesterly flow of unstable air. Topographical effects and added moisture from these large lakes are probably responsible for this phenomenon.

In the fall, northwesterly flows of cold air across the warmer water of Reindeer and Wollaston Lakes can generate “streamers” of convective cloud that bring bands of rain or snow showers to the area around Lynn Lake and southward toward Pukatawagan. Extreme and rapid fluctuations in ceiling and visibility can be expected in such conditions. Other lakes in the area, which are generally elongated in a southwest to northeast direction, do not have a similar potential for streamers when the flow is northwest, as the distance or “fetch” across each lake is relatively short.

**Thompson - Gillam**



Map 4-42 - Thompson - Gillam

The Thompson to Gillam route follows the Nelson River downstream toward Hudson Bay. Elevation decreases roughly 250 feet between the two communities and

there are no surprises topographically. Northeast of Gillam, the land follows a similar, but slightly steeper slope to the Hudson Bay Lowlands, which contain the lower reaches of the Churchill and Seal Rivers. The local features of this area are glacially created and include several eskers and some fairly rough debris deposits (one just north of Stephens Lake near Gillam) but, overall, the terrain is fairly smooth.

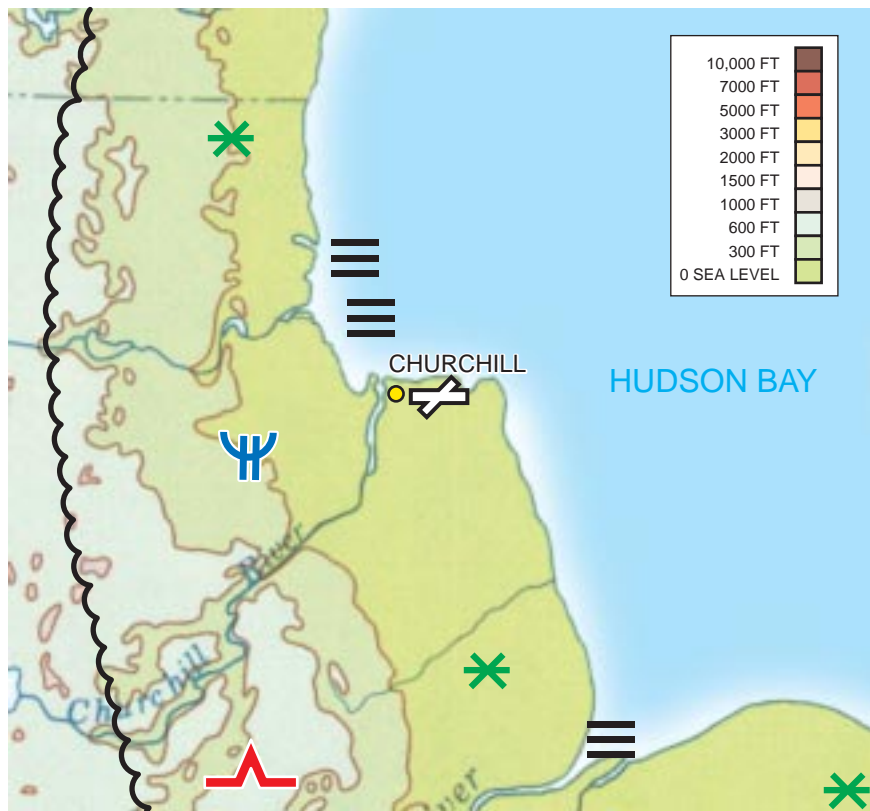
Any winds with an easterly component are upslope over this area, and those from the northeast statistically give the lowest ceilings and visibilities. This is, of course, due to the vast open body of water provided by the Hudson Bay from late spring to early winter.

The Nelson River current is quite strong along this stretch, bolstered by water diverted from the Churchill River system. Hydroelectric installations, two of which are just downstream from Gillam, tap this flow. Many stretches of the river are slow to freeze in the winter and break up early in the spring, especially where rapids exist and in discharges from dams. These stretches, when they are open, are particularly vulnerable to evaporation fog on cold winter days.

Stephens Lake, extending approximately 27 miles west-northwest of Gillam, is a sizable body of water. In the fall, this lake can produce streamers around the Gillam airport during west to northwesterly cold air outbreaks.

Because the forest canopy gradually thins out over the lowlands towards Hudson Bay, that area is more prone to winter blizzard conditions when strong northwest to northerly flows develop behind the deep low pressure systems that frequently traverse the area.

Churchill - Hudson Bay Coast



Map 4-43 - Churchill - Hudson Bay

Churchill has the distinction of being the site of the only major aerodrome in the Prairie provinces that is situated along a coastline. It is also Canada’s only arctic seaport. The airport itself sits on a bluff a little over 90 feet above Hudson Bay and is roughly one mile south of the water’s edge. The coastline runs about 27 miles due east to Cape Churchill, then south-southeastward toward the mouth of the Nelson River. Just to the west of the airport, the northward flowing Churchill River spills into the bay. It is about 3 miles wide at this point, although it narrows to a channel just over 1/2-mile wide at the mouth itself. A few miles further west is Button Bay, an inlet about 6 miles across. From there, the coastline begins to turn northward toward Arviat.

Topography in the area plays a relatively minor role. The Hudson Bay Lowlands could easily be described as one of the smoothest tracts of land on the Prairies, broken only by the lower valleys of the major rivers that drain into the bay. Muskeg, small lakes, patches of stunted trees and sedge grass cover the landscape. Mechanical

turbulence is seldom severe, but can be moderate up to 3,000 feet ASL during episodes of strong winds. Needless to say, the local weather in Churchill (and anywhere else along the coast for that matter) is largely dictated by Hudson Bay itself.

As is the case with any coastal environment, it is critical to have a good idea what constitutes an “onshore” wind and one that flows “offshore”. In this region, a general rule of thumb concludes that the weather usually is poorest when winds blow from the water to the land, and is usually better when the opposite transpires. This, of course, depends on many other things, including qualities of the air (moisture content, temperature and stability), temperature of the water, amount and extent of ice cover, but the rule of thumb is a good one. Even though the coastline in the immediate area of Churchill lies roughly west to east, an examination of the larger scale shows it runs, overall, from north-northwest to southeast. Although Cape Churchill protrudes to the east of the town, it is too low and flat to alter the moisture content in east to southeasterly flows. If atmospheric conditions are prone to change, any wind from about 310° through 360° and 90° through 140° traverses enough of Hudson Bay to pick up sufficient additional moisture to cause some deterioration in the weather in Churchill.

Hudson Bay is largely free of ice from the end of July to early November, but open water can be present near the coast at any other time of the year as well. Knowing the location and extent of open water at these “other times of the year” is fundamentally important when trying to understand why certain weather conditions occur under different wind regimes during that time. It is also important to note that water surface temperatures can differ greatly, particularly in summer, between the colder open sea and warmer shallow coastal areas. The surface water is even warmer near the mouths of the major rivers, as it takes some time for the heated, fresh water from the river to mix into that of the bay. As a result, the river outlets are preferred locations for advective and evaporative fog formation when conditions are ripe. This is especially true at the mouth of the Nelson River.

Ice formation and break up cycles on Hudson Bay are quite complex, especially near the outlets of major rivers such as the Churchill River. This is, in part, due to the layering effect of fresh over saline water in these areas. The fresh water is less dense than salt water and freezes sooner. In October, fresh water from the rivers “flooding” the salt water begins to freeze, creating a slushy suspension called “grease ice.” Onshore winds cause the grease ice to accumulate along the coast where it freezes into a hard sheet. This event marks the beginning of the formation of stationary “shore-fast” ice that typically extends about 3 to 4 miles out from the coast. Waves, tidal actions and storm surges break this ice up into blocks and slabs, which refreeze into a thicker, rougher surface. Ice does not start to form in earnest over the open sea until the latter half of November. It is hardly a continuous sheet, but rather a jumble of pans or floes that are blown about by the winds and otherwise drift with the counter-clockwise

current that is present in the bay. They collide with each other and with the shore fast ice, creating ridges along impact zones that can be 60 feet high. By mid winter, Hudson Bay is basically ice covered, but prolonged winds from a given direction can open up leads that are several miles wide, often along the edge of the shore-fast ice. These leads can persist as long as the winds continue and take many hours, even days, to close or freeze over once the winds abate or change direction. In early June, the break-up of the rivers marks the beginning of the end of the winter's ice over Hudson Bay. The fresh water rushing out floods the ice and eventually cuts a channel through it. Through June and July, the ice gradually recedes, fractures and thaws until it eventually disappears. The area of the bay north of Churchill can be completely cleared of ice fairly early in this period if there is a prolonged southwesterly wind event (4 to 5 days on average) followed by a shift in the winds to the northwest or north. The southwesterly winds push the ice out past Cape Churchill where the current begins to carry it southeastward. If the winds then shift to the northwest or north, the ice is literally driven toward the mouth of the Nelson River and areas to the east, where it tends to remain until it melts.

Summer along the Hudson Bay coast is fairly short. The bay is open and generally covered, at least partially, with low cloud (marine stratum). Northeast to easterly winds will eventually advect this cloud over the lowlands and cause a general deterioration in ceiling. Moderate rime or mixed icing often occurs in this cloud where it extends above the freezing level. On warm sunny days with light winds, a sea breeze circulation can set up and this, too, can cause or advect low cloud several miles inland along the shore. Fog can accompany this low cloud, but normally does not extend too far inland. At the Churchill airport, the northern end of the runway can be completely enshrouded while the visibility at the southern end is unrestricted. Southwesterly to west flows are associated with good flying weather and usually push the marine stratum offshore. Flows that follow the coastline bring variable weather conditions to the area. Summer convection is normally associated with unstable west to southwest upper flows. Cells that affect the area usually form upstream (inland) and move downwind. A few thunderstorms reach the Churchill region each summer. Once the cells move out over the colder surface of Hudson Bay, much of their thermal support is lost and they tend to weaken rapidly if not supported by other dynamic or thermodynamic mechanisms.

During the fall, the local moisture sources are gradually cut off as the rivers freeze over and the shore-fast ice develops. However, easterly winds continue to advect stratus and fog into the area from further out on the bay. Early in the season, strong northwest to northerly flows of cold arctic air (generated by building high pressure areas to the west and/or deep low pressure systems moving across Hudson Bay) become unstable over the warmer water. Widespread low cloud formed in these flows is embedded with bands of convective cells that bring a mixture of precipitation types to the area, resulting in wildly variable ceilings and visibilities at times. Even cool



westerly flows can be tricky in Churchill at this time of year, as Button Bay and the Churchill River can provide sufficient fetch for the formation of low cloud and fog around the town. Freezing drizzle is most common at this time of year since the bay is largely open and temperatures are dropping. As the season progresses, substantial snowfalls can occur along the coast, which combine with the strong winds to cause periods of white out conditions. Low level icing associated with the embedded convective cloud or freezing precipitation can be problematic for approaching and departing aircraft. A combination of mechanical and convective turbulence can also cause difficulties. Conditions improve when the winds shift to an offshore direction, cutting off the low-level supply of moisture and heat.

As winter sets in and ice cover extends well out over the bay, the polar bears leave the land to gorge on seals during their annual hunt and overall weather conditions tend to improve. However, winter storms that affect the area usually follow a track that carries them from the south or southeast toward Hudson Bay, where they can remain for several days. These storms are usually accompanied by ridges of high pressure over western Canada. The strong pressure gradient in between the two features generates a long ribbon of strong northwesterly winds along “blizzard alley”, which extends from the central High Arctic across northeastern Manitoba into northern Ontario. Since the lowlands are basically devoid of a continuous forest canopy, the area is susceptible to prolonged blizzard conditions. These winds also open huge leads in the pack ice, often just beyond the shore-fast ice, and streamers of low level convection develop downwind. If the winds increase from the east after the northwesterlies subside, these streamers turn with the wind and affect the coastal areas with widespread snowshower activity, especially if the lead is along the edge of the shore-fast ice (i.e. close to shore). If this is the case, a rule of thumb in Churchill states that the lead will close in 8 hours or less if the ice on the other side is visible on the horizon. If it is not, expect the flurries to last until the lead finally closes or the winds shift direction again. Arctic high pressure areas that establish themselves over northeastern Manitoba bring clear skies, very cold temperatures and light winds to the area under a strong inversion. Periods of reduced visibility in arctic sea smoke, ice crystals and ice fog are common during these events. Smoke from refuse burning at Churchill’s famous dump, just east of the airport, can aggravate this problem locally.

Spring along the coast arrives with snow melt and the opening of the rivers, in late May and early June. There is a rapid increase in local surface moisture sources as the rivers flood the ice on the bay. Fog is common over and downwind from the rivers and over pools of meltwater on the ice. The Churchill airport is often affected by fog off the Churchill River when winds are light westerly, during the spring. As the sea ice retreats, larger and larger expanses of open water gradually return the general weather trend to an oscillating marine stratum scenario, as winds shift from onshore to offshore and back. The polar bears come back, too.