T5.1 THE DYNAMICS OF NOVA SCOTIA'S CLIMATE

The main features of Nova Scotia's climate are ample and reliable precipitation, a fairly wide but not extreme temperature range, a late and short summer, skies that are often cloudy or overcast, frequent coastal fog and marked changeability of weather from day to day. These features can be related to four basic factors:

1. the prevailing westerly winds
2. the interactions between the three main air masses which converge on the east coast
3. Nova Scotia's position astride the routes of the major eastward-moving storms
4. the modifying influence of the sea

WIND SYSTEMS

The basic eastward movement of the wind systems (known as the westerlies) over North America is a result of the general circulation of warm air from the equator towards the pole being deflected to the right by the Coriolis effect, an inertial force caused by the rotation of the earth (see Winds in T6.1). The westerlies, though subject to much local disturbance, bring Nova Scotia a continental type of climate, albeit much modified by the waters that surround the province. As a result of air moving across a large land mass, which heats up and cools down more quickly than a body of water, a continental climate experiences larger daily and seasonal temperature changes than a maritime climate. Nova Scotia therefore experiences warmer summers, colder winters and higher snowfall than might otherwise be expected of an area of land which is almost an island.

MAJOR AIR MASSES

Satellite photography, computer modelling, a greater knowledge of the structure of weather systems and a better understanding of the physical processes that control our weather have all led to a much-reduced use of air-mass concepts. Air-mass theory is still used descriptively, however, and is very useful to introduce people to the disciplines of meteorology and climatology.

Much of the variability of the weather is caused by the shifting positions of the three main air masses that dominate the eastern seaboard. Continental arctic air from the northwest is very dry and cold in winter. Maritime polar air, moving in from the north or northeast, has been somewhat warmed by its passage over the ocean and is cool and moist. Maritime tropical air from the south or southwest is warm and moist.

Fronts

The boundary where two air masses meet is called a front. If the cold air is advancing, the front is a cold front. If the cold air is retreating, the front is referred to as a warm front. The clouds and precipitation that accompany the passing of a front are caused by the lifting of the warmer air mass over the wedge of cold air, causing the warm air to cool, which triggers condensation. Cold fronts are steeper than warm fronts and have relatively narrow bands of clouds and precipitation. Cold-frontal precipitation tends to be short lived and is frequently showery. On the other hand, warm fronts, with their low slopes, have much larger areas of clouds and precipitation, giving many hours of continuous precipitation.

Jet Streams

At high altitudes within the westerlies, 10 to 15 km above the surface, narrow bands of strong winds (referred to as jet streams) can occur over long distances. Television weather broadcasts often feature a map showing the location of the jet stream. Jet streams occur where the contrast between warm and cold air masses is the greatest. This contrast is greatest in winter, causing jet streams to be strongest and more continuous (i.e., longer) at that time of year. In the short term, the jet stream can give a good indication of where disturbances will track. The location and strength of the jet stream and its pattern are constantly changing, thus forecasting the tracks of storms for more than twelve hours to one day is not recommended.

Pressure Systems

Two semi-permanent pressure systems influence the circulation of air (Figure T5.1.1).[1] In the summer the Bermuda and Azores high, an area of persistent high pressure east of Bermuda, feeds hot and humid air into the southern United States, where it may be picked up or entrained by the prevailing westerlies.

The Icelandic low is situated near Iceland and southern Greenland in the winter, but tends to weaken and move westward toward Hudson Strait in summer. Most of the low-pressure systems, or cyclones, which sweep across North America eventually die out in the area of the Icelandic low.

STORM TRACKS

A prominent feature of Nova Scotia's weather is the fairly frequent movement of low-pressure systems over the region. Three storm tracks or streams of low-pressure systems converge:

1. one that moves into British Columbia and the Yukon from the Pacific Ocean and moves across the country, often reinforced by moist air from the Mississippi Valley
2. one that develops in the midwestern United States and moves across the Great Lakes
3. one that originates in hot, humid air over the tropical Atlantic Ocean, the Caribbean or the Gulf of Mexico and then sweeps around, first westward, then joining the westerlies to move up the east coast of the continent, bringing some of the most significant storms to the Atlantic provinces.

COASTAL INFLUENCES

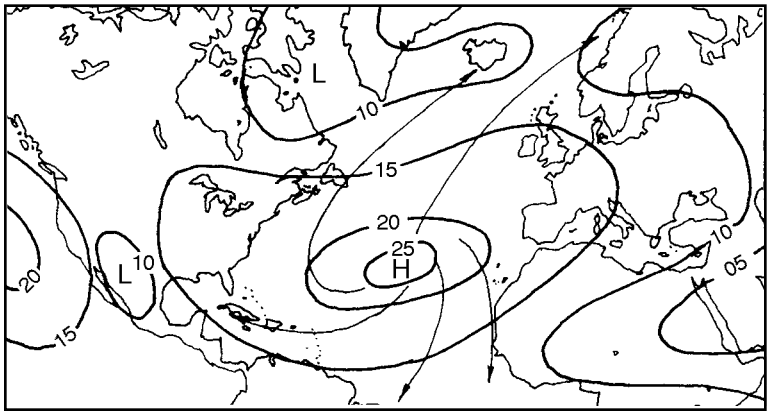
The weather that moves into the Atlantic region is modified in a number of ways by the seas that almost completely surround the province. The high heat capacity of water means that the sea is much slower to warm up and cool down than land. Cold winds from coastal waters therefore delay the arrival of spring. Similarly fall is extended, and the onset of winter is delayed. During hot weather, the influence of the cold Bay of Fundy (Unit 912) waters keeps the Fundy shore cool, while the Annapolis Valley (District 610), which is protected from the intrusion of the cool air by the North Mountain (District 720), is frequently as much as 15°C warmer.

Sea Breeze

Along the coast in late spring and summer, in the absence of strong pressure patterns, a local convection cell called a sea breeze frequently develops. During the day, the air over land warms and rises, causing a cool breeze to move in from the sea. Sea breezes are strongest when the difference between land and sea temperatures is the greatest: in late spring and early summer. The difference in temperature between the area under the influence of a sea breeze and further inland can be as high as 20°C. At night this air movement is reversed, as the land cools more quickly than the sea.

Sea Fog

Sea fog is another example of a coastal influence. When warm, moist air from the south or southwest moves over the colder waters of the Nova Scotia Current, condensation occurs and sea fog forms. Sea fog is blown by the wind across the coastline, moving inland during the night and retreating towards the sea during the day under the influence of the sun.



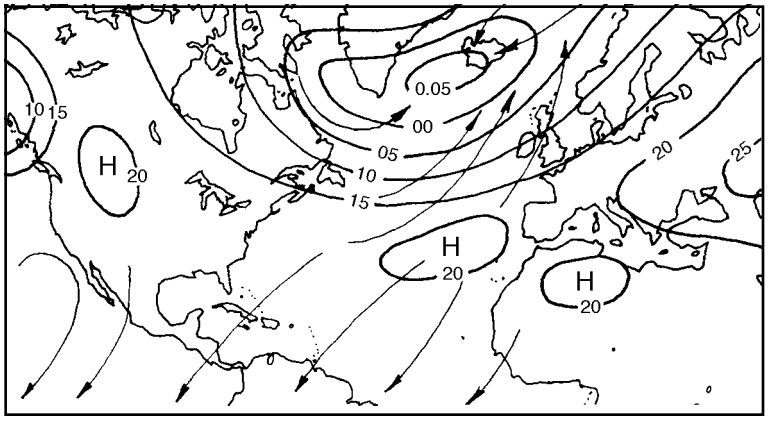


Figure T5.1.1: Semi-permanent Atmospheric Pressure Systems. (Above) – Summertime, Bermuda high. (Below) – Wintertime, Icelandic low. Units shown are millibars above 1000 millibars. (Modified after Hare and Thomas.[1])

Cold Inland Winds

In winter, another coastal influence is experienced in areas where cold winds blow inland off open water. Cold, dry arctic air masses pick up a lot of moisture and become very unstable in low levels when flowing over open water. These modified air masses rise when they hit the coastline, and the moisture precipitates out as heavy snow.

The areas most affected by the heavy snow are the Annapolis Valley, the Gulf coast of Cape Breton and northern Nova Scotia. For the latter two areas, the heavy snow in onshore flows ceases when the Gulf of St. Lawrence freezes over. The high tides in the Bay of Fundy, however, prevent the formation of an ice cover, and the Annapolis Valley is subject to this kind of weather for a larger part of the winter.

Pack Ice

Pack ice, which forms in the Gulf of St. Lawrence and moves downstream with the Nova Scotia Current in winter, is a further cooling influence in spring. Off southwest Nova Scotia, ocean surface temperatures are warmer in winter and cooler in summer than off the Eastern Shore. Consequently, the climate of southwest Nova Scotia is milder.

Freezing Spray

Freezing spray occurs when a strong flow of cold air streams out over coastal waters. The higher the wind speed, the greater the amount of freezing spray. The wind blows water droplets from the crests of the waves and cools these droplets to well below freezing. Upon contact with a solid object, such as the superstructure of a vessel, the cooled droplets freeze.

CLIMATIC VARIABILITY

The number of storms, their intensity and tracks vary considerably from year to year. Our weather in Nova Scotia can therefore vary considerably and still be considered within the normal range. There are some influences which are not considered normal, such as the eruption of volcanoes and the El Niño effect. Mount Pinatubo in the Philippines erupted in June 1991, spewing massive amounts of volcanic ash into the higher atmosphere. Winds distributed this fine ash throughout a large portion of the world's atmosphere. The ash reflected some of the sunlight back into space, reducing the amount of light that reached the earth's surface. At the peak of its influence, the average temperature of the earth was reduced by 0.5°C. The effect of such an eruption can last two to three years before all the volcanic ash has settled out.

From time to time, the normal pressure pattern in the equatorial Pacific Ocean reverses and the trade winds weaken. As a result, the upwelling of cold water along the west coast of South America ceases and a large pool of warm water forms in the eastern Pacific. This phenomenon is referred to as El Niño and, even though it seems remote, has a profound influence on Nova Scotia's weather as well as on many other areas in the world. The 1991–92 El Niño event gave Nova Scotia a very cold and snowy winter. The El Niño occurs in intervals from two to ten years, with varying degrees of intensity, and is a classic example of how our weather is influenced by phenomena in distant areas.

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Associated Topics

T4.1 Post-glacial Climatic Change, T5.2 Nova Scotia's Climate, T6.1 Ocean Currents, T6.2 Oceanic Environments, T9.1 Soil-forming Factors, T10.3 Vegetation and the Environment, T12.5 Climate and Resources

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T5.2 NOVA SCOTIA'S CLIMATE

Nova Scotia has a modified continental climate, with proximity to the coast and elevation determining local variation in climate. The coastal influence is the major one in Nova Scotia, since the relief is not extreme, and only the Cobequid Hills (Unit 311) and the Cape Breton Highlands (Region 200) have elevations over 350 m. Dzikowski divides Nova Scotia into nine broad climatic regions which provide an overview of the variety of climatic conditions found in the province.[1] (see Figure T5.2.1)

a. Northumberland Shore (District 530): Has a delayed spring, a warm summer and fall, but a cold winter and the lowest precipitation in the province, being sheltered from storm winds from the south and east. The Northumberland Strait (Unit 914) is a shallow, sheltered body of water that warms quickly in summer and freezes in the winter, providing less of a moderating effect than other coastal waters.

b. Northern Nova Scotia (Region 300 and much of Region 500): The highlands receive high snowfall and have the coldest winter temperatures, but quite warm summer temperatures.

c. Cape Breton Highlands (Regions 100, 200): Receive the highest total precipitation in the province and have cool temperatures summer and winter.

d. Eastern Nova Scotia (parts of Regions 400 and 500): A diverse geographic area with high rainfall and generally cool temperatures, due to the influence of the cool Nova Scotia Current.

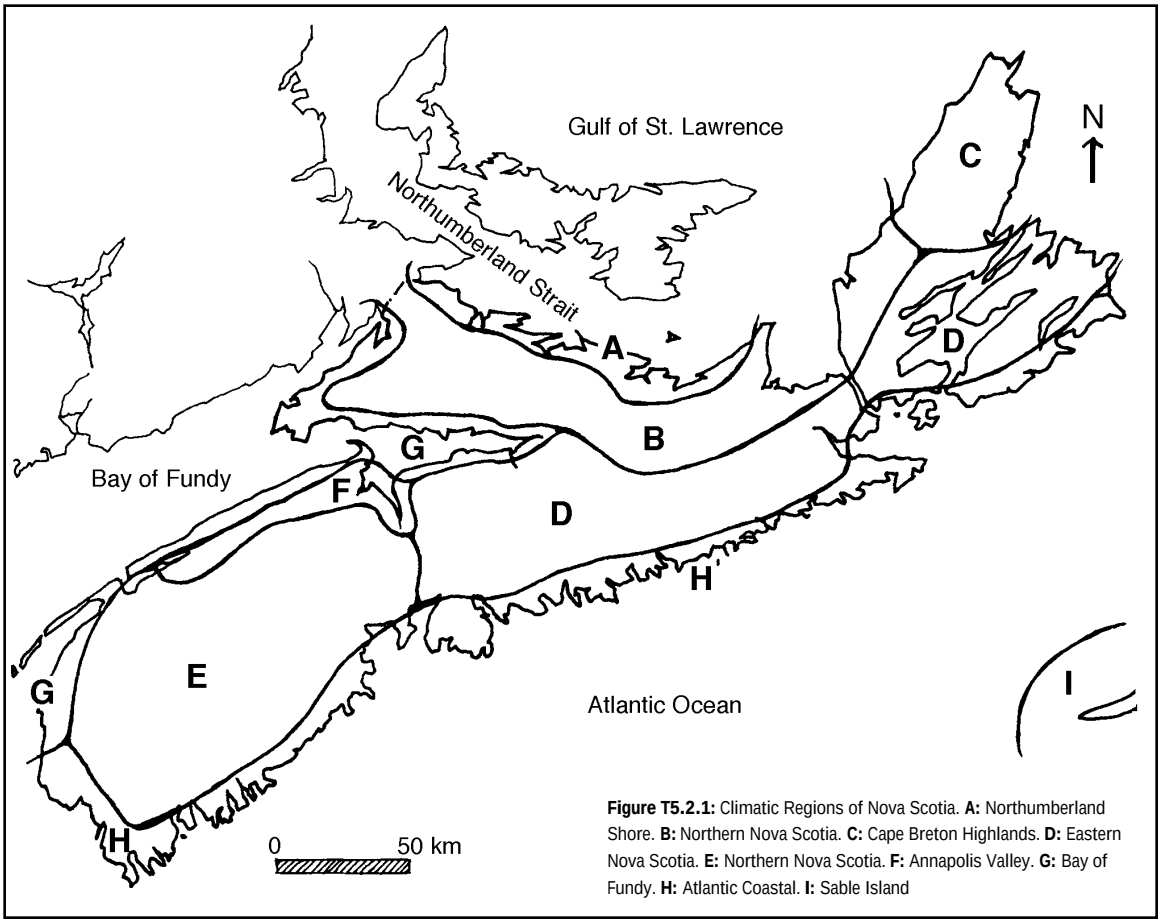


Figure T5.2.1: Climatic Regions of Nova Scotia. **A:** Northumberland Shore. **B:** Northern Nova Scotia. **C:** Cape Breton Highlands. **D:** Eastern Nova Scotia. **E:** Northern Nova Scotia. **F:** Annapolis Valley. **G:** Bay of Fundy. **H:** Atlantic Coastal. **I:** Sable Island

e. Western Nova Scotia (most of Region 400): A gradual slope upwards from the Atlantic Coast, with high rainfall and warmer temperatures than eastern Nova Scotia.

f. Annapolis Valley (District 610): A sheltered lowland, with the warmest temperatures and the lowest precipitation totals on the mainland.

g. Bay of Fundy (Region 700): A narrow strip along the coast from New Brunswick to Yarmouth. A strong coastal influence produces a long, cool summer and a mild winter. There is frequent fog and moderate precipitation.

h. Atlantic Coastal (Region 800): A strong coastal influence produces the coolest summer and the warmest winter temperatures in the province. However, this effect extends only a few kilometres inland. The moderating influence is strongest in the extreme southwest, where coastal waters are well mixed and unstratified. Rainfall amounts are high and there is frequent heavy sea fog.

i. Sable Island (District 890): Has a marine climate characterized by a narrow temperature range, little snowfall and frequent fog. It is unsheltered and exposed to high winds.

These areas do not take into account extensive local variations, particularly along the coast and in the drier southwest interior.

MICROCLIMATES

Many local influences can modify a climate of an area. For example, the southern slope of a hill can sometimes receive enough sunshine to grow grapes, whereas the adjacent level field would not be suitable. The southern slope of hill has a climate that is different than that of the surrounding area and is referred to as a microclimate. Many factors can create microclimates. Cities and towns introduce changes in the environment which create microclimates. Vegetation can cause minor changes in climate; for example, the climate in a stand of trees is different than that in the surrounding fields.

SEASONS

Winter

In winter, the air mass dominance is shared by cold continental arctic air and the moister maritime polar air, with the prevailing winds being west or northwest. But the weather is rarely settled, because a series of low-pressure systems move up from the southwest, bringing storms as the colder air is briefly replaced by the warmer maritime tropical air. Sometimes the path of a storm will take a more northerly route over New Brunswick, and warm southwest winds will bring thaws to Nova Scotia and southeastern Newfoundland. Cloud cover is persistent and wind speeds are at their highest in this season.

Spring

Spring comes slowly to Nova Scotia, especially in coastal areas. The passage of midwest or Atlantic coast storms often sweeps cold arctic air alongside the warmer maritime air. As warmer air moves northward over the cold waters of the Labrador Current, dense fogs are formed.

Summer

The frequent outflows of arctic air abate as the southern border of the arctic and polar air masses migrate northward, usually sometime in June. A rather brief summer begins, dominated by maritime tropical air. The heat and humidity experienced in Ontario and Quebec are modified by the coastal influence. Cyclones moving out of the midwest are usually not severe, but in late summer and early fall the province is, from time to time, affected by the remnants of tropical storms or hurricanes.

Fall

Fall is the season of the greatest cyclonic activity in the tropical western Atlantic, bringing heavy rains. In between storms, however, there is often clear, settled weather. Offshore waters are at their warmest and help to prolong the season.

GROWING SEASON

The start of the growing season is defined as the date when the average temperature reaches 5°C and the end of the growing season occurs when the average temperature drops to 5°C. The value of 5°C is used because at that average temperature the daily maximum is about 10°C and the minimum is about 0°C. Most plants do not grow when temperatures fall below freezing at some time during the course of day. The length of the growing season in Nova Scotia

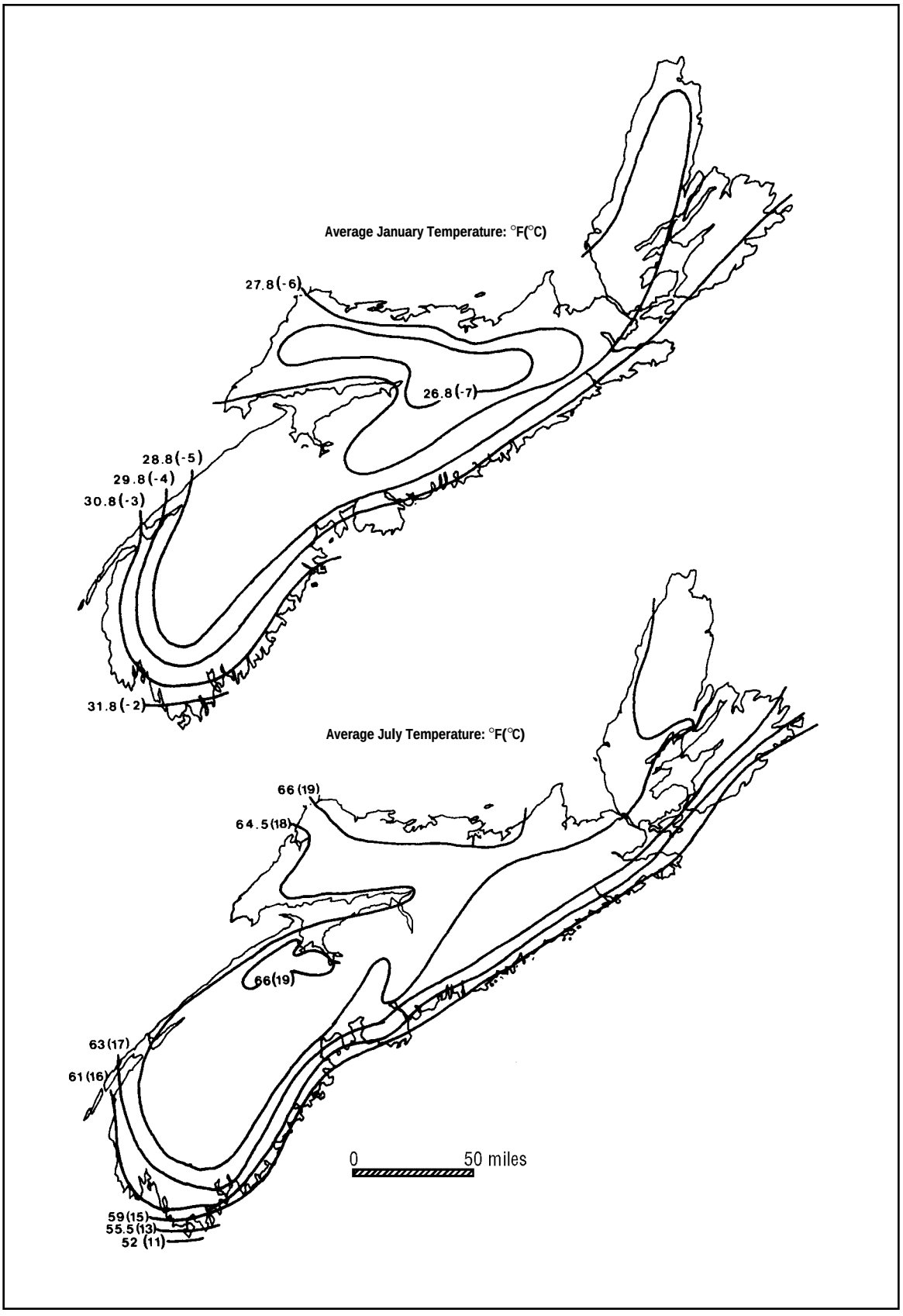


Figure T5.2.2: Average temperature for January and July in Nova Scotia.

ranges from somewhat in excess of 210 days in the west to less than 190 days in central and eastern portions of the province.

WEATHER

Climate is the long-term average describing the overall regime of an area, while weather is the immediate pattern of temperatures, precipitation, wind and humidity that occurs daily. Climatic normals are available from the Atmospheric Environment Service. Information is published on temperature, precipitation, wind, frost, solar radiation, bright sunshine and degree days. Normals are based on the latest three decades and are updated every ten years.

TEMPERATURE

The mean annual temperature ranges from 5 to 7°C for most of Nova Scotia, except the Cobequid Hills and Cape Breton Highlands, where it is cooler. The annual range of temperature is the greatest in the vicinity of Northumberland Strait, with over 25°C difference between the mean temperature of the warmest and coldest month. This decreases to a range of 10°C along the southwest coast (see Figure T5.2.2)[1].

January and February are the coldest months, whereas July and August are the warmest. In January, the coldest mean temperatures, below –7°C, are found in the Cobequid Hills and the Cape Breton Highlands, while the warmest, above –2°C, are found along the southern tip of the province. In July, the situation is reversed, with the southern coastal belt being cooler than inland areas. The shallow waters of the Northumberland Strait and the upper reaches of the Bay of Fundy exert a local warming influence, while the Gulf Stream moves further offshore during the summer months. Mean daily temperatures fall below freezing between late November and mid-December across most of the province. The period of freezing temperatures ends mid-March in southwestern Nova Scotia, but extends into April in the higher area in the northern part of the province. The winter period ranges from 80 days at the southwestern tip to over 120 days in the Cobequid Hills and is longest in the Cape Breton Highlands.

WINDS

Winds are strongest in the colder months and blow most frequently from the west of northwest as the cold arctic air moves in. In the summer, winds from the southeast or south predominate.

PRECIPITATION

The mean total annual precipitation—rainfall plus the snowfall converted to its equivalent in water (approximately one-tenth)—ranges from less than 1250 mm along the Northumberland Strait and in the central lowlands to over 1600 mm in the wettest area on the Cape Breton Highlands Plateau (Region 100) (see Figure T5.2.3)[2].

The seasonal distribution of precipitation is fairly even, with the cold half of the year receiving one-third more than the warm half. Measurements of precipitation at four stations in the province indicated that measurable precipitation occurred on the average 122 to 189 days in the year, while significant precipitation, 2.5 mm or more, occurred on about 60 to 65 per cent of those days. A dry month is usually considered to be one in which 25 mm or less of rain falls. Dry months are not common anywhere in the province but are somewhat more likely to occur in the Annapolis Valley, eastern Cape Breton and the North Shore.

SNOWFALL

The lowest snowfall is to be found in coastal areas where onshore winds blow in warmer maritime air, causing precipitation to fall in the form of rain. The greatest total snowfalls are found on the Cobequid Hills and the Cape Breton Plateau. Snowfall tends to vary more from year to year than the total annual precipitation, as much as 30 to 40 per cent from the annual mean (see Figure T5.2.4)[2].

In some areas, the variation from the mean exceeds 40 per cent. The median winter maximum snow depth ranges from less than 30 cm in coastal areas to more than 75 cm in upland and highland areas. At least one year in twenty, the median maximum snow depth over much of the province is near 20 cm or slightly more. The snow cover is usually not continuous because thaws often occur. During the snow season, snow cover usually occurs 75 per cent of the time away from the Atlantic coast, and especially over higher ground. Near the Atlantic and the mouth of the Bay of Fundy, snow cover can be expected 50 to 65 per cent of the time.

Figure T5.2.3

Average Total Annual Precipitation

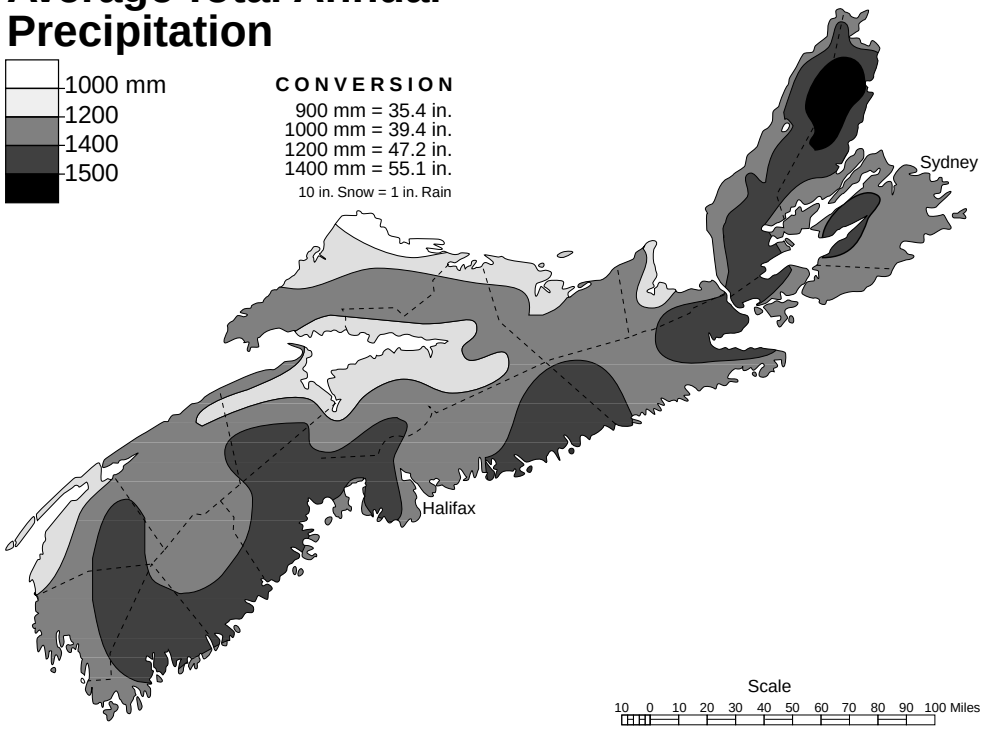
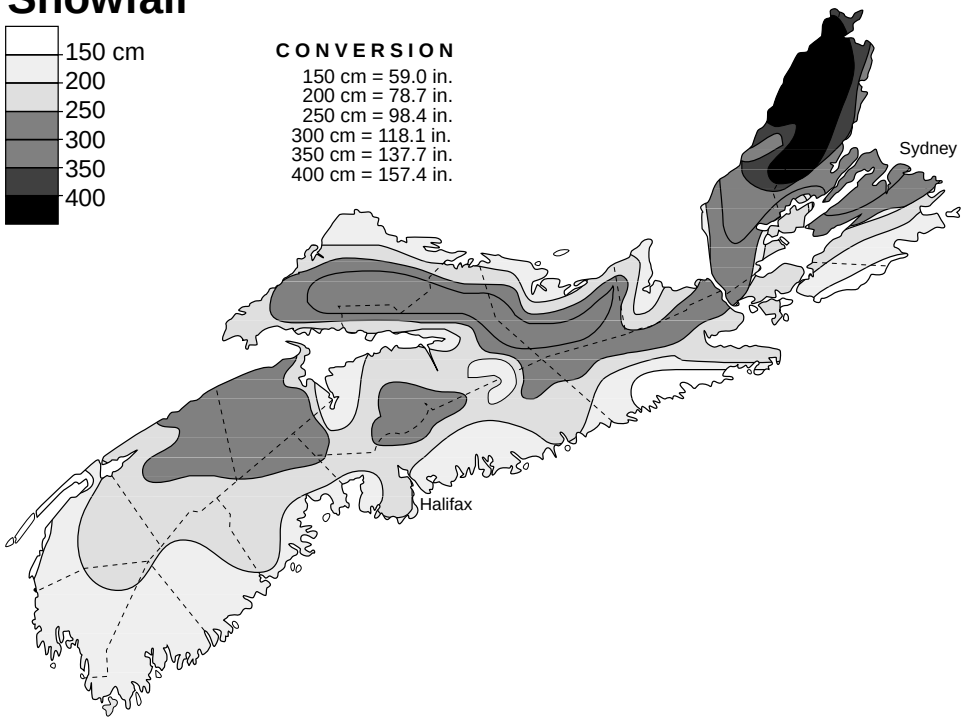


Figure T5.2.4

Average Total Annual Snowfall



FOG

The Fundy and Atlantic coasts are frequently affected by sea or advection fogs, formed as warm, moist air moves over cooler surfaces, such as the cold water of the Nova Scotia Current. On average, these coasts experience fog 15 to 25 per cent of the year. The peak month for sea fog is July. Sea fog tends to move inland at night as the surface cools rapidly, and then retreats to the coast by day. The southwestern tip of the province and Sable Island are most affected by fog. In Yarmouth, fog is recorded on average one out of every three days. The Northumberland Strait is relatively fog free in the spring, because of the predominance of cold winds off the ice in the Gulf of St. Lawrence, and in the summer, because of the warm temperatures of the shallow waters in the Strait.

In other parts of the province, radiation fog (caused by rapid nighttime cooling of the land under clear skies) plays a more important role, with average annual frequency of occurrence of only 10 to 15 per cent. This type of fog occurs most often in November.

HUMIDITY

Relative humidity tends to be high, because of the influence of the surrounding sea and because of frequent incursions of air of maritime tropical origin. In summer, even continental arctic air is moist, because of the vast number of lakes crossed before the air mass reaches Nova Scotia. The mean relative humidity tends to be highest along the Atlantic Coast.

SUNSHINE

Nova Scotia is often influenced by disturbances, local coastal effects and fog and does not receive as much bright sunshine as more continental areas further inland. The annual mean number of bright sunshine hours ranges from 1799 at Nappan to 1949 at Shearwater. Sable Island has a mean of only 1471 hours. These compare with 2054 hours for Ottawa and 2038 hours for Toronto.

The percentage of total possible sunshine ranges from 40 per cent at Sydney, Nappan, Truro and Kentville, 42 per cent at Yarmouth to 44 per cent at Shearwater. For inland locations less subject to coastal influences, this percentage may be higher. Sable Island receives only 33 per cent of possible sunshine, because its weather is dominated by the influence of the Atlantic Ocean.

OFFSHORE WEATHER

Depending on the track of a storm, mariners can face much the same weather that we do on land. The two factors that lead to most of the differences are reduced friction over water and water temperatures. The strength of the wind is considerably greater over open water than it is over land where topography and vegetation interfere with the flow. Water temperature also influences the type of weather experienced. For example, whereas it may be snowing over land, it could very well be raining over coastal waters simply because of the water temperature.

The presence of the Gulf Stream, a narrow ribbon of warm water that originates in the Gulf of Mexico and meanders northeastward to pass 200 to 250 nautical miles south of Nova Scotia, has the greatest influence on offshore weather. The Gulf Stream not only affects the track of storms but its warming influence can also intensify these storms, resulting in stronger winds.

The difference between air and water temperatures can also influence the weather. In winter, when very cold air from the north or northwest floods over the Atlantic Ocean, the cold air is warmed at the water surface and begins to rise. This convective circulation can give rise to snow squalls and very strong winds, which are not experienced over land or over waters adjacent to land. When these cold winds flow over ice, as occurs frequently over the Gulf of St. Lawrence, the snow squalls do not form.

In the summer, the sun can rapidly heat up the surface of the land, which results in thunderstorms when the conditions are favourable. The sea, however, is very slow to heat up, and the convection currents which produce thunderstorms over land do not develop over water. If a thunderstorm should drift over water in such a situation, the updraft of warm, moist air is replaced by a short-lived updraft of cold air from the water surface, which very rapidly causes the storm to dissipate.

Sea fog occurs frequently to the north of the Gulf Stream in spring and summer when the winds are from the south or southwest. The warmer waters beyond the continental shelf are less likely to produce fog. Radiation fog, which can occur over land in the morning and can persist a few hours past sunrise, is not experienced over water, because the water temperature does not vary much between night and day.

Freezing spray can occur from November to April in offshore areas. In the Scotia/Fundy region, the greatest risk of vessel icing occurs in February.[3] In the Northumberland Strait (Unit 914), freezing spray is usually worst in December, as the ice cover in the Strait in January and February can reduce wave height and lessen the occurrence of freezing spray.[4] Sea ice around the coast of Nova Scotia is described in T6.1.

Sea State

A feature that often varies with distance offshore is sea state, which is the combined effect of waves due to the wind blowing over the water surface (wind waves) and the remains of waves that were generated elsewhere (swell). The height of the waves depends on the wind speed, the length of time the wind persists without changing speed or direction (duration) and the distance the wind has been blowing from the same direction (fetch). Close to the coast, the sea state is not high, because the fetch of the offshore winds is limited. Further out to sea, the same wind gives much higher waves. Coastal effects, such as tidal interaction, shoaling and refraction, can result in exceptions to this rule.[5]

Environment Canada has identified Marine Weather Forecast Areas for the East Coast. For Nova Scotia, they extend south to the Scotian Slope and provide a framework for detailed forecasting in specific areas offshore.

Associated Topics

T4.1 Post-glacial Climatic Change, T5.1 The Dynamics of Nova Scotia's Climate, T6.1 Ocean Currents, T6.2 Oceanic Environments, T10.3 Vegetation and the Environment, T12.5 Climate and Resources

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