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National Marine Weather Guide

British Columbia Regional Guide

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Wind, weather and wave symbols used in this guide.

BRITISH COLUMBIA REGIONAL GUIDE

1. Introduction

While they may appear chaotic, changes in the winds and weather off the coast of British Columbia are parts of patterns that can be recognized.

The pressure-slope concept is used in this chapter to categorize winds by the weather patterns that create them and to highlight variations that can take place within each category. It does not indicate when certain winds will occur; however, it is helpful in visualizing the changes that take place in different systems and identifying those that can cause serious wind conditions in a particular location and those that cannot.

While mariners experience increases and decreases in winds at a specific place and time, the variations discussed in this chapter look at the bigger picture and cover the entire coast over the course of the year. It should be noted that pressure slope is a simplification of reality and smooths out the small-scale variations in the pressure pattern that create many small-scale variations in the wind.

To make best use of the information provided, mariners must tailor these basic weather patterns to the local conditions described in the rest of this chapter.

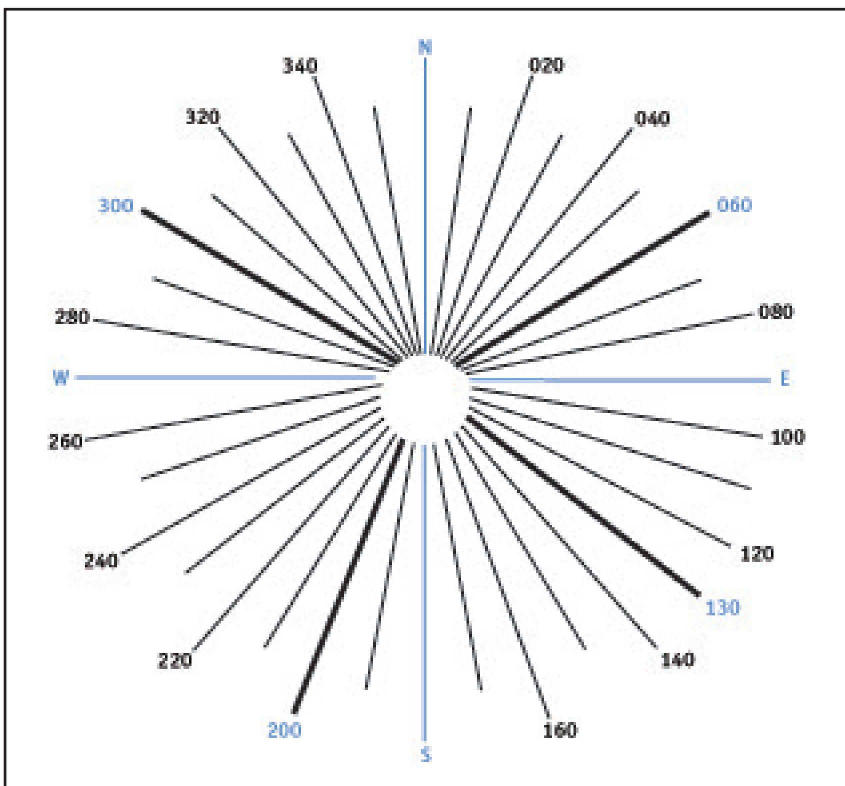
1.1 Determining Pressure Slope

There are two ways to determine pressure slope, both of which require the use of an analysis or forecast weather map—as can be obtained from a weather fax or the internet. It is always best to use the most recent map available.

The valid time of weather maps is often given in Universal Coordinated Time (UTC) and is sometimes abbreviated with the letter Z. Analyzed maps are generally issued every six hours, at 00, 06, 12, 18 UTC (1600, 2200, 0400,1000 PST). Forecast maps may list both the valid time of the map and the time it was created.

To use the first method, copy the compass provided in this section onto a clear-plastic overlay and place the centre of the overlay over the area of interest on the map. The overlay is a learning tool; after gaining some familiarity with it, users will be able to estimate the pressure slope without it.

Position a pen or pencil on the overlay such that it lies perpendicular to the isobars on the map and points toward the centre of the compass, from higher to lower pressure. The compass value nearest the line of the pen is the pressure slope. For example, if the pen runs along the compass radius labelled 060°, the pressure slope is 060° (i.e., northeast).



Compass for determining pressure slope using a weather map.

The second method is to look at a weather map as if it were a topographical map, with high pressure representing higher terrain and low pressure, lower terrain. Imagine placing a drop of water on the area of interest: the direction it would flow is the direction of the pressure slope (e.g., water flowing to the southwest is flowing from the northeast; hence, the pressure slope is northeast).

Once the direction of the pressure slope has been determined, the other important factor to consider is the pressure-slope gradient (the spacing of the isobars on the weather map), which indicates the steepness or intensity of a weather system. The higher the gradient, the higher the potential winds.

Coastal topography influences possible wind directions. In inlets, for example, the winds are light in certain pressure-slope directions no matter what the gradient is, because they blow aloft, above the local terrain. When the pressure-slope gradient is weak, as often occurs during the summer, daytime heating and cooling may also override pressure-slope considerations.

It should be noted that weather maps show the intensity of a weather system across a distance in space (e.g., a pressure-slope gradient of 12 mb over 100 km), while the intensity of a moving weather system is experienced by a stationary observer over time (e.g., a fall in pressure of 12 mb over a period of hours).

1.2 Categories of Weather Patterns

The pressure-slope concept can be used to group the many variations of weather patterns into five distinct categories: easterly, northerly, southerly, westerly, and coastal low (which, potentially, includes all of the others).

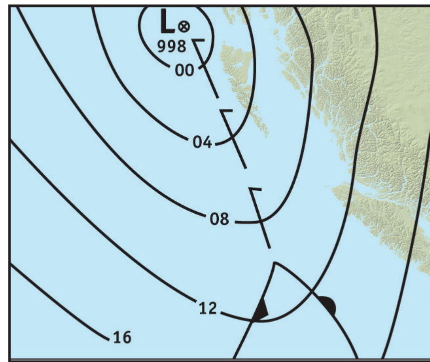
In autumn, the dominant wind is from the east; because of the orientation of the BC coastline, southeasterlies are frequent. During winter, easterly winds still prevail, but the season is distinguished from autumn by the occasional presence of northerly outflow winds. Within the months of spring, the winds gradually shift to the westerly winds of summer. During this transition period, southerly winds are common.

The examples of pressure-slope variations provided in this chapter are illustrated using three aids: regular surface-weather maps with isobars and fronts, satellite images, and radar wind-images.

Radar wind-images relate the surface roughness of the water to the wind speed and show the speeds of the winds across the region at the moment the images were taken. Areas with very light winds are black, with other levels of intensity indicated by gradients of colour ranging from blue to yellow to red (lightest to strongest winds). The arrows marked over the images indicate the general wind direction but should not be used to gauge actual local winds, which vary with the topography. While each weather system is unique, these radar wind-images show patterns that are repeated time and again.

1.3 Approaching Front: Easterly Pressure-Slope Winds

This pattern develops ahead of an approaching low or associated front with a ridge to the east, along the Coast Mountains. While southeast winds are the main wind over most coastal waters ahead of a front, the word "easterly" is used because the actual direction of the wind varies with the local topography. Channels that run from east to west, such as Dixon Entrance and Queen Charlotte Strait, have winds that are more easterly than southeasterly. The inlets of the mainland coast, because of their orientation, have northeast winds, while the inlets of Vancouver Island are more northerly.



A typical weather map for an easterly pressure-slope.

Easterly winds can occur year-round but are the dominant wind from late September through March. They often rise to gale, storm, or even hurricane force and are accompanied by large waves and heavy rain. As a result, they are a major concern for mariners. The lows and fronts that create these storms can be simplified into two patterns based on the orientation of the front and the direction from which it arrives.

The first pattern occurs when a front approaches from the northwest. The winds over the open waters back from west to south and then to southeast, and they gradually strengthen. These fronts are associated with lows that turn into the northern Gulf of Alaska well before they approach the coast. The front moves away from the low and crosses Haida Gwaii before moving down the coast. Since it weakens as it encounters land, the peak winds in the south are less than in the north.

The second pattern occurs when a front approaches from the southwest. The winds start out from the northeast but veer east and then southeast, and they gradually strengthen. Fronts that approach the coast from the southwest are associated with lows that move close to the coast before turning northward; in some cases, the low may actually cross the coast. The front, in this instance, will be oriented almost parallel to the coast, so Vancouver Island will be as strongly affected as Haida Gwaii, if not more.

Whether the front arrives from the northwest or the southwest, winds through the inlets remain from the northeast until near the passage of the front. The inlets will have stronger northerly winds ahead of a front coming from the southwest. The winds tend to shift more dramatically to the southwest after the frontal passage.

The strength of the winds depends on three factors: how close the low gets to the coast; the strength, orientation, and speed of the front; and the position and strength of the high over the interior. If the low is deep and the ridge ahead of it is strong, the pressure will drop and the winds will rise very rapidly with the approach of the front. A fast-moving system will also cause the pressure to fall more rapidly. When the pressure falls rapidly, it means the pressure slope is steep and the winds will be strong.

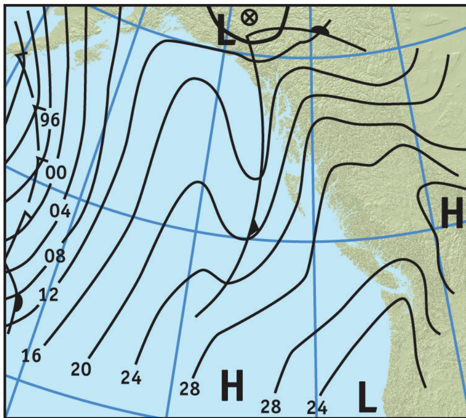
Did You Know?

The day before a major southeast storm is often deceptively calm; then the bad weather strikes with a vengeance. Veteran mariners call these glassy calm days "weather breeders."

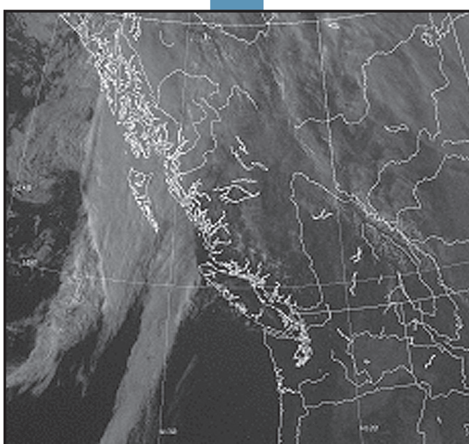
Stability also affects the winds associated with an approaching front. In general, stable air produces lighter winds than less-stable air. In coastal areas, however, the winds may be strengthened by cornering effects if the air is not able to flow up and over the islands and peninsulas.

Sea Conditions

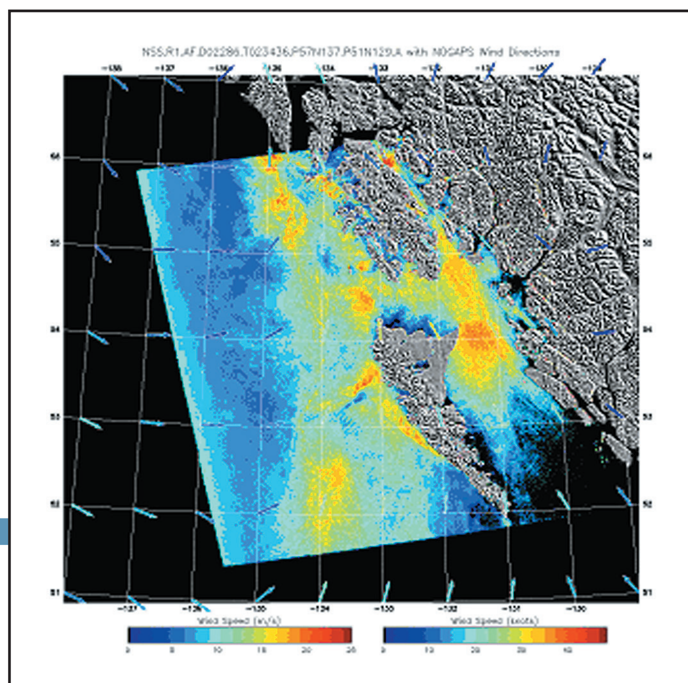
Gale- to storm-force southeast winds ahead of a front can build the seas to 8-9 m over the northern waters and west of Vancouver Island, with seas of 10-12 m possible in intense storms. Over the inner waters, the seas are much lower due to sheltering from coastal land masses, and the sea height is largely controlled by the fetch distance. Heavy swells of 4-6 m that form in the westerly winds behind the low typically arrive on the outer coast within 12 hours after the front has passed.



In an example from mid-October, a front approached Haida Gwaii from the west. Southeast winds rose to gale-force strength over northern Hecate Strait and in some areas west of Haida Gwaii and northwest of Langara Island but were lighter further southeast, away from the low. They were also lighter in the wind shadow near the top of Graham Island but increased again toward the Alaska Panhandle. Winds flowed almost parallel to the coast, so the coastal areas of east Hecate Strait were generally sheltered, although some winds blew out from Grenville Channel. The pressure slope was near 080°.



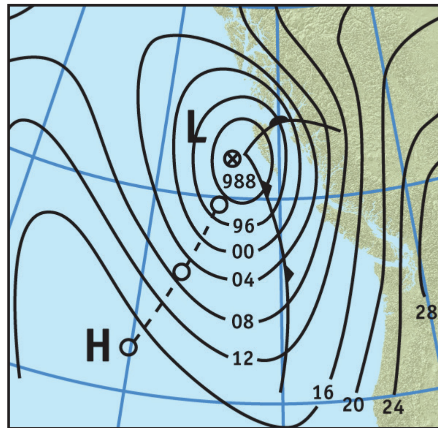
The main low lying well north of the region, with the front just west of Haida Gwaii and a wave on the front (or possibly a secondary low) west of Langara Island. The low band of cloud stretching south from Queen Charlotte Sound was present well before the arrival of the front

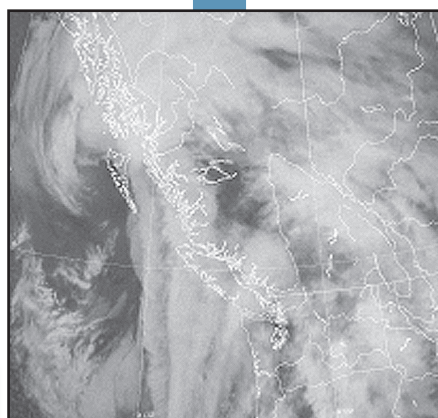


Radar wind-image showing the frontal boundary west of Haida Gwaii, with generally light westerlies behind it. Southeasterlies were gale-force in northern Hecate Strait, west of Haida Gwaii and near the Alaska Panhandle, but lighter in the wind shadow near the top of Graham Island.

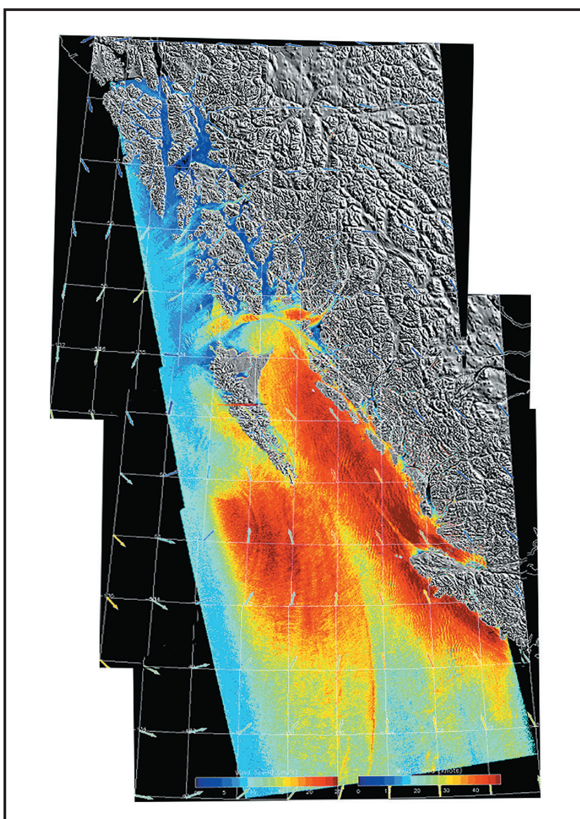
In a winter example from mid-January, a low approached from the southwest, with a large area of southeast winds rising to storm force across Hecate Strait. A band of strong east-to-northeast outflow winds out of the Portland Inlet were squeezed northward to lie beside the Alaska Panhandle. The pressure slope in this case ranged from 040° in the north to 100-120° in the south.

Weaker winds and waves occurred along the east side of Moresby Island due to lee shadowing by the island. These lighter winds were either an actual wind shadow, reduced water movement due to a limited fetch downwind of Moresby Island, or a bit of both. The lighter winds on the west side of Moresby Island were due to a relaxing of the pressure gradient just after the passage of the front. The stronger winds southwest of Cape St. James were caused by a strong gradient south of the low. Strong winds also poured through the





The low, just west of Langara Island, with the front stretching along the western edge of cloud extending to the south of Cape St. James. The low is near the hook of cloud that wraps around the clear area west of the front.



Strong east to northeast outflow winds leave Portland Inlet, along the Alaska Panhandle, while weaker winds occur along the east side of Moresby Island, due to lee shadowing. Strong winds southwest of Cape St. James are caused by a strong gradient south of the low. Strong winds can also be seen inside the channels along the mainland coast.

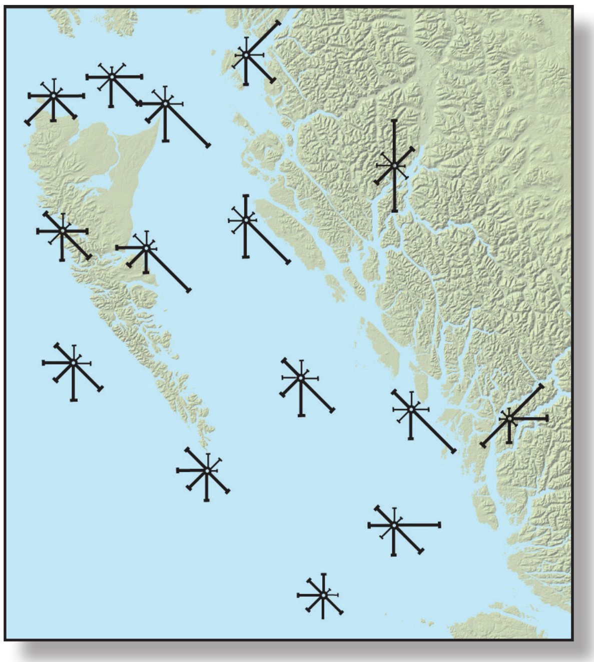
channels along the mainland coastal edge. When a low moves into the northern Gulf of Alaska and only the front passes over the coast, a band of strong winds does not follow so close behind.

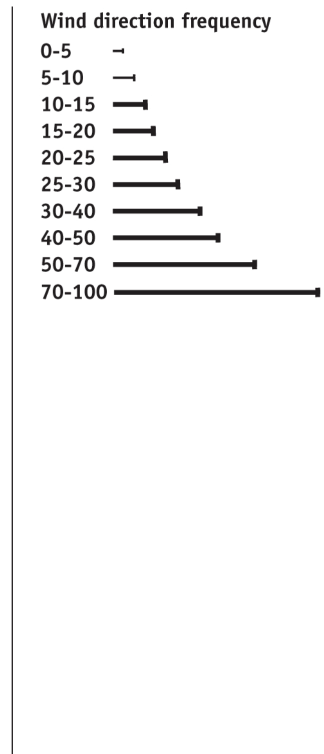
When the pressure slope is backed toward the northeast (about 060°), the winds in Hecate Strait are stronger on the west side and affect both Sandspit and Rose Spit equally. Winds also pour through Dixon Entrance and the inlets on Haida Gwaii as easterlies but are light northeasterlies along the mainland coast. When the pressure slope veers beyond 090°, the winds are stronger in the middle and eastern sections of Hecate Strait and start increasing through the channels of the coastal edge. There will also be some lee shadowing along Haida Gwaii. At some point, when the pressure-slope approaches 130°, the winds can be equally strong on both sides of Moresby Island. When the pressure-slope veers slightly more, the lee shadow spreads up Haida Gwaii to Sandspit, where the winds ease while they remain strong at Rose Spit. The difference in angle between the pressure slopes is small, but the potential difference in winds at a given location can be dramatic.

In general, the pressure slope is closer to the southeast when the front comes from the Gulf of Alaska, creating what could be called "true" southeast winds. When the front approaches from the southwest, the pressure slope is initially from the northeast, and more easterly winds result. As this front reaches the south coast, storm-force southeasterly winds develop in the warm sector over northern Vancouver Island, with brooks Peninsula and Cape Scott often affected by stronger winds than other coastal sites. Gale-force winds develop further south and along most of the inner south coast, as the front weakens by the time it reaches these areas.

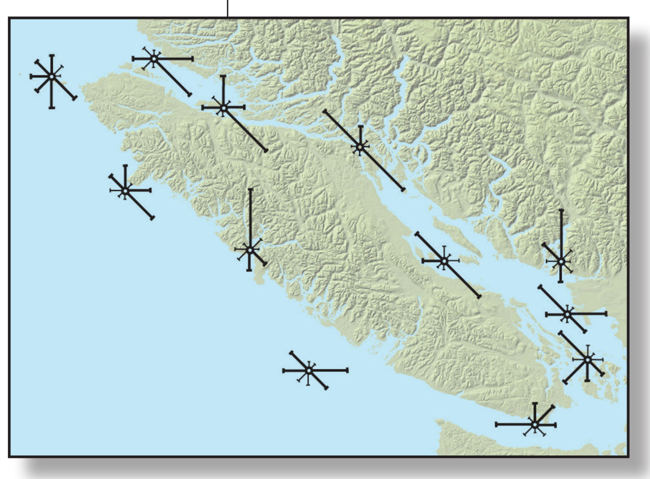
October Wind Roses

Wind roses show the relative frequency of wind from the eight cardinal directions. October is representative of autumn and its easterly winds. Southeast winds dominate the open waters at this time of year; however, other wind directions are also represented, especially west of Haida Gwaii. This is largely because, in autumn storms, the wind direction changes as a front approaches and then passes. As always, topography plays a major role in steering the wind, which, in coastal inlets, is limited to blowing along their axes.



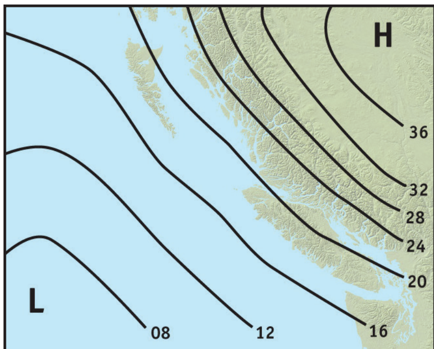


October wind-rose diagrams showing the relative frequency of eight cardinal wind directions.



1.4 Ridge Over the Interior: Northerly Pressure-Slope Winds

This pattern has a trough of low pressure offshore and a ridge over the interior; however, the ridge is dominant and lies parallel to the Coast Mountains. The air is pushed out through the mainland inlets. The actual wind direction depends on the orientation of the coastal topography.



A typical weather map for a northerly pressure-slope.

“Garden variety” northerlies occur when both the ridge of high pressure and the low or offshore front are weak. These winds rise to moderate-to-strong values but are rarely dangerous. The ridge of high pressure that creates them is often a northern extension of the high that sits over Idaho and Montana for much of the winter.

Another type of northerly wind is a drainage wind, created by cold air flowing down the mountains and into the inlets. Drainage winds are most prevalent in the spring and early summer when the snow persists on the mountain tops, but the valleys are warm.

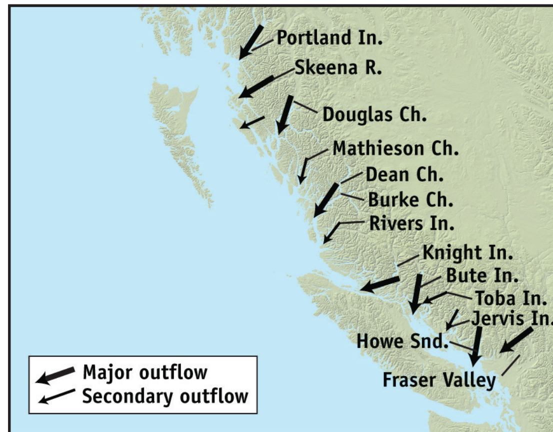
The most dangerous northerly winds—Arctic outflows—develop when an Arctic high moves into the Yukon and northern BC and builds southward into the central interior. The cold air associated with the Arctic high becomes dammed up on the interior side of the Coast Mountains and is forced through the valleys and inlets that pierce the mountain chain. The inlets that have the lowest connecting passes to the interior are the first to receive these winds; however, as the depth of the cold air continues to build, it pours across higher passes and into other coastal inlets. Temperatures in the interior can fall well below -20°C in such instances.

Strong winds funnel down mainland inlets, often reaching speeds of 60 kt. Side tributaries from the main inlets can also have strong winds; where a major side valley joins the main inlet, chaotic conditions are found. Outflow winds are strongest within the confines of the inlet but ease and fan out as they leave its mouth. In very cold outflows, a plume of wind extends beyond the opening of the inlet, and the areas outside the plume have little or no wind. Extreme caution is advised when crossing coastal inlets during an outflow event, as winds can increase from light to gale or storm force almost instantly.

Northerly outflow winds occur when the pressure slope is from about 300° to 130°, with the strongest occurring when the pressure slope is between 340° and 060°. The direction of the outflow wind is determined by the local topography. In most cases, the orientation of the mainland inlets is such that the winds are from the north or northeast, but in some cases east or even southeast winds can occur.

Because of the localized character of outflow winds, many weather-observing stations do not experience them. Coastal stations that do provide good indications of outflows are Grey Islet and Green Island for Portland Inlet, Holland Rock for the Skeena River, Nanakwa Shoal buoy for Douglas Channel, and Cathedral Point for Bute Inlet and Dean Channel. Pulteney Point gives only a hint of the outflow from Knight Inlet. There are no reporting sites that observe Bute or Jervis outflow winds. Pam Rocks is a good indicator for Howe Sound outflows.

The weather preceding an Arctic front may seem quite settled, and the barometer is often steady before it arrives. When it does, it is usually accompanied by snow flurries, and strong northerly outflow winds begin. As the front passes, the temperature can drop to -10°C in a few hours, and the barometric pressure rises rapidly.



The larger arrows mark the inlets that receive the first and strongest outflow winds; the smaller ones, the lesser and later outflows.

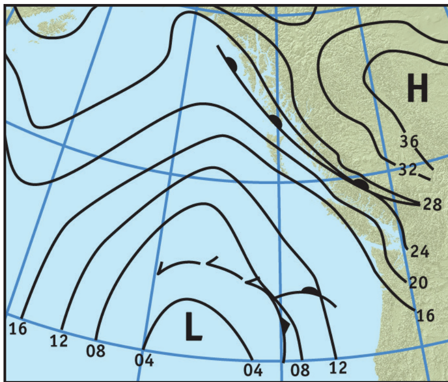
As a strong northerly Arctic outflow races through the inlets, it blows spray off the top of the waves. The air temperature is so cold, it chills the spray to below freezing; however, it does not solidify until it makes contact with a boat or some other surface. Freezing spray can be hazardous to both the safe operation and stability of a vessel.

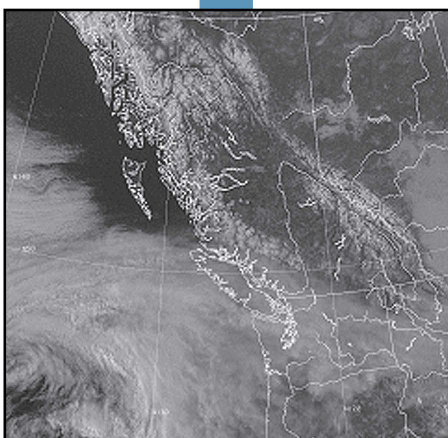
As the cold air moves over the warmer waters off the coast, snowsqualls can develop. When a Pacific weather system approaches the mainland coast, warm, moist air overrides the Arctic air, and precipitation passing through it falls in the form of snow. Often, the snow to changes to rain as warmer air arrives. Some of the heaviest snowfalls occur in this transition from cold to warmer air. During the transition, cold air may persist at the heads of inlets, resulting in freezing rain. Freezing rain or mixed rain and snow can significantly reduce a vessel's radar efficiency.

Climate records suggest that the first hint of cold northeasterly outflow winds occurs in mid-October, sometimes followed by a stronger event in mid-November. The main shift toward cold, northeasterly outflow winds begins in mid-to late December and continues into early spring. In some years, the worst Arctic outflows occur in February and March. Once such an event begins, it generally persists without respite for several days.

Sea Conditions

The fetch of northerly outflow winds is normally quite small and, since the winds decrease outside the inlets, the seas that develop are not normally very large. The winds exiting the inlets, however, fan out into plumes, creating bands of higher seas when they are strong.

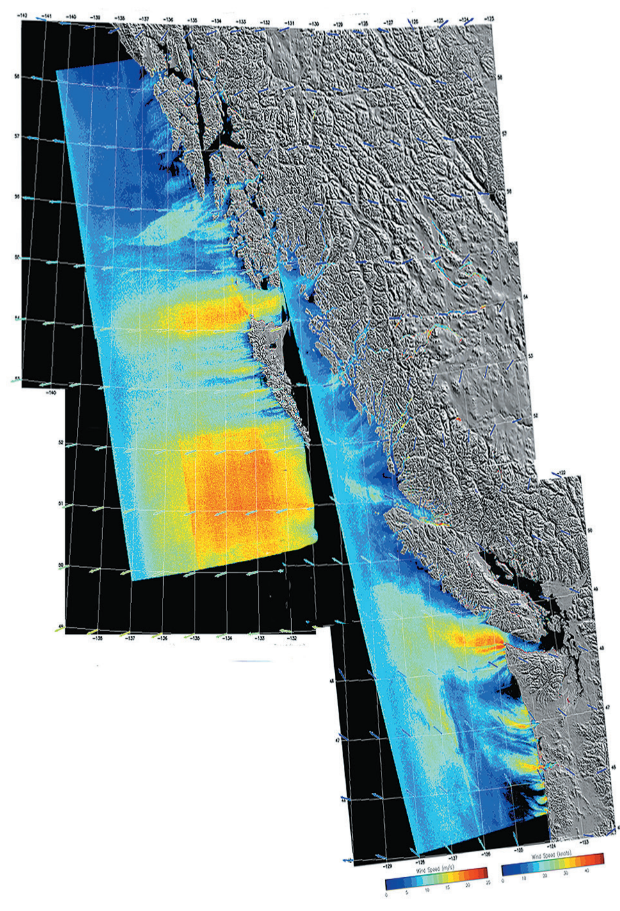




An Arctic ridge of high pressure in the BC interior, with a frontal boundary along the coast, indicating the extent of the Arctic air. A low to the southwest spreads cloud over the south coast.

An outflow event that wreaked havoc in the Victoria area in December 1996 also created problems along the central coast. The temperature at Cathedral Point dropped below freezing on December 20 and stayed there until the evening of January 1, 1997. The winds at the point rose to above gale force on the first day of the sub-zero temperatures and continued at that strength through the next eight days. A “mean” wind of 65 kt on December 22 was the highest ever recorded at Cathedral Point. By the ninth day, the wind equipment stopped recording. The dock at Shearwater was torn up by the blow, and some of the boats tied up there almost sank under a foot-thick coating of ice from freezing spray.

In an example from an Arctic outflow in March, a ridge of high pressure was located over the BC interior, with



Radar wind-image of the west coast, showing plumes of stronger winds flowing out of the inlets and lighter winds between them. Outflow from Knight Inlet extended into Queen Charlotte Strait. Winds exiting Juan de Fuca Strait had some outflow component from Fraser Valley and Howe Sound but were also drawn outward by the offshore low. Stronger winds occured closer to the low, to the southwest of Moresby Island.

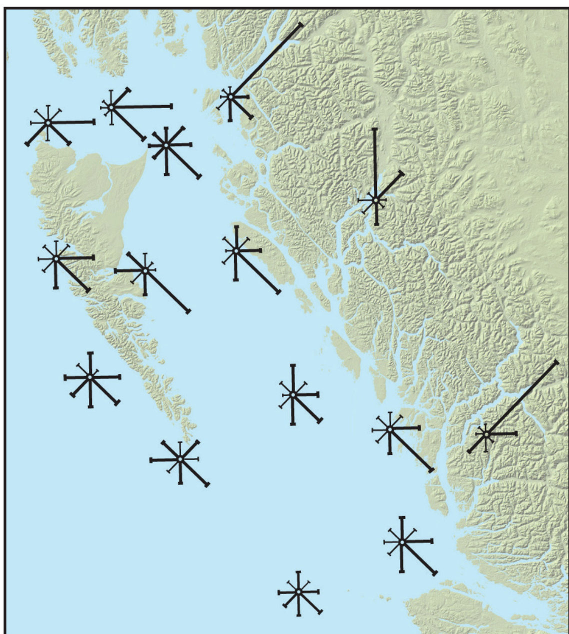
a low and front well to the southwest of Haida Gwaii. Cloud was associated with the front, while the north coast remained perfectly clear. The pressure slope was near 040°. Plumes of stronger winds flowed out of the inlets, with areas of lighter winds between. Lucy Island was generally in a wind shadow, but Holland Rock received some outflow from the Skeena River. Bonilla Island was in a wind shadow until the flow turned more northerly.

The easterly winds through Dixon Entrance appeared to increase toward the west, but the images are based on surface roughness, so it may be that the seas gradually built as the fetch increased. The winds may have actually decreased slightly over this distance, but their direction clearly remained due easterly. Easterly winds also passed out of the inlets on the west coasts of Haida Gwaii and Vancouver Island, with stronger winds and higher seas occurring closer to the low, to the southwest of Moresby Island.

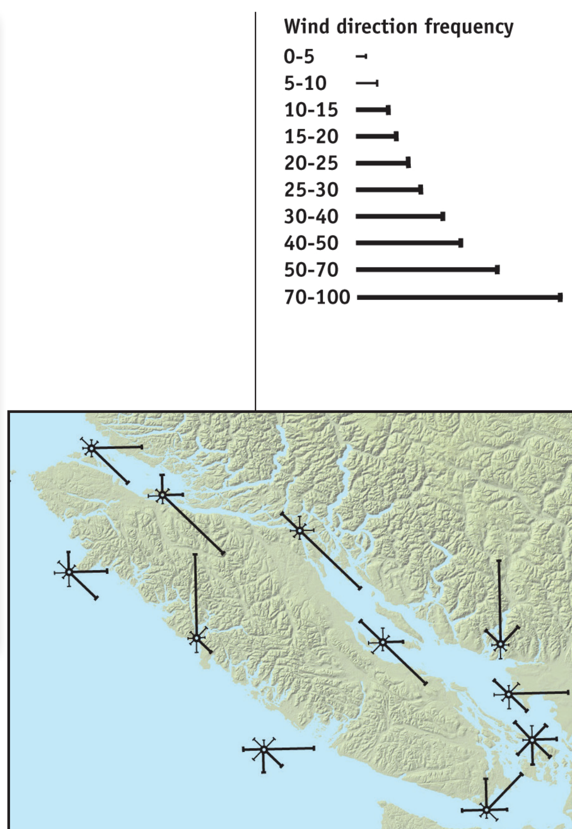
Outflow from Knight Inlet extended into Queen Charlotte Strait. A plume of winds exiting Juan de Fuca Strait still had some outflow component from Fraser Valley and Howe Sound but was also drawn outward by the low offshore.

January Wind Roses

Southeast winds remain the dominant direction through the open waters in January, although northerly winds are much stronger than they were in October. North to northeast winds are dominant through the inlets of the mainland coast and Vancouver Island. In Dixon Entrance, the dominant wind is easterly and ranges from northeast to southeast. West of Haida Gwaii, the dominant wind ranges from south to east. Through the inner waters, the winds are predominantly southeast, but significant northwesterlies also occur. In the Strait of Georgia and Juan de Fuca Strait, the winds are almost polarized between northwest and southeast or west and east. Further offshore they become more uniform, with little directional preference. This is clearly seen in the East Dellwood buoy west of the Scott Islands.



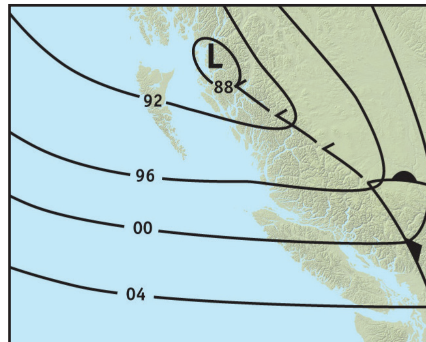
January wind-rose diagrams showing the relative frequency of eight cardinal wind directions.



1.5 Coastal Ridge: Southerly Pressure-Slope Winds

Southerly winds are transitional winds that usually occur near the spring and fall equinoxes. They develop in one of two ways: when pressures rise sharply after the passage of a front, and when a ridge of high pressure develops on an east-west line across the coast, south of a location. The typical pressure slopes for southerly winds are 130-200°.

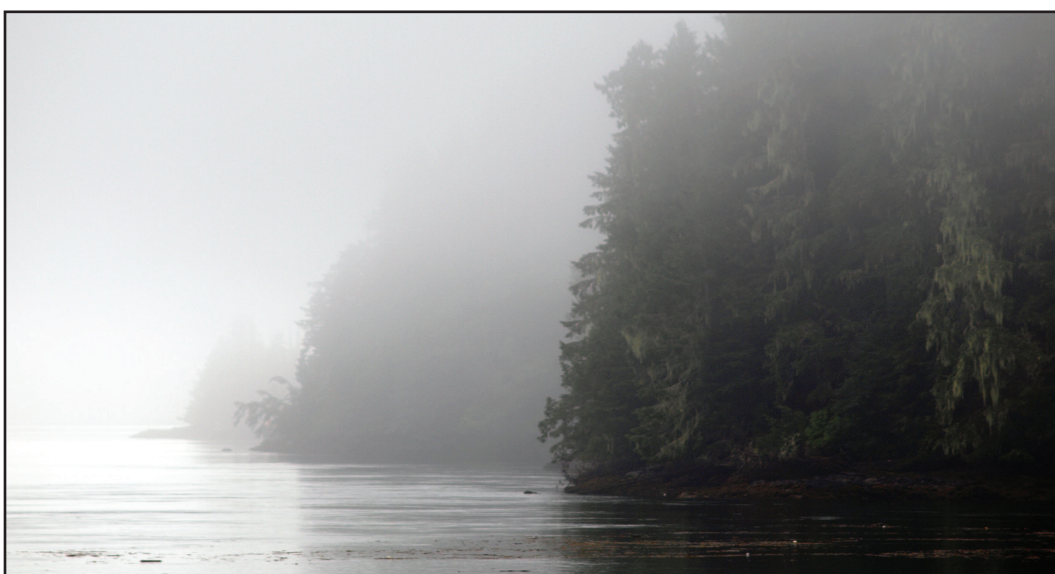
After the passage of a front, the winds normally decrease as they shift from southeast to west. In some situations, however, such as when a low crosses directly over the coast, the pressures may rise rapidly behind the front to produce very strong winds. These southerly winds are particularly dangerous because many docks, moorings, and structures are not built to withstand strong winds from this direction. Their intensity depends on the intensity of the front and the rate of the pressure increase: the stronger the front, the stronger the winds. Fortunately, they are usually very brief.

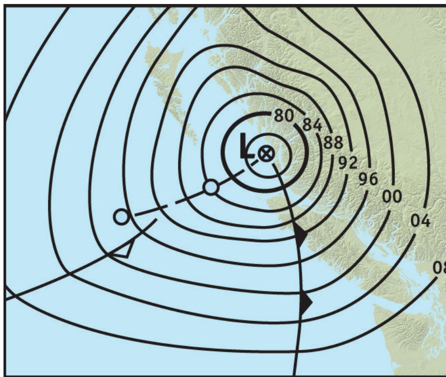


A typical weather map for a southerly pressure-slope.

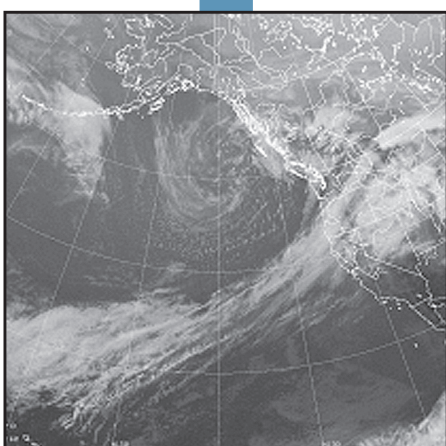
Sea Conditions

The seas also go through a change as the winds shift from one direction to another. Southeast seas may continue in the form of swell after the southeast winds end and south-to-southwest wind waves begin to develop. Southerly wind waves are only a problem if the winds are particularly strong. Southwest swells arrive after the passage of the front and affect areas that are open to the west.

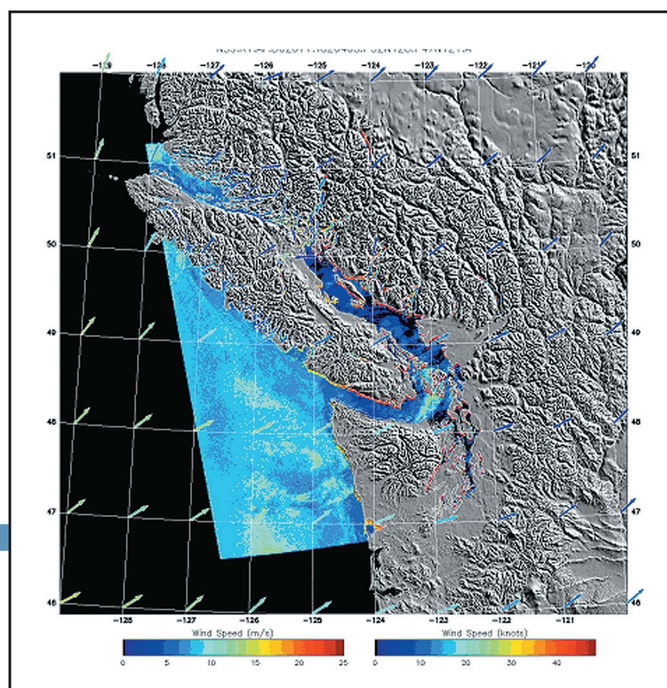




In a March example, the main low was moving toward Haida Gwaii, the associated front had just crossed the south coast, and the pressure slope was near 150° over Vancouver Island. Winds that were noticeably stronger than those through the Strait of Georgia spread directly onto the west coast of the island and entered all of the inlets. A band of strong winds moved northward from Juan de Fuca Strait across the San Juan Islands, and strong southerlies also spread through Queen Charlotte Strait, the strongest occurring along the northern shoreline.



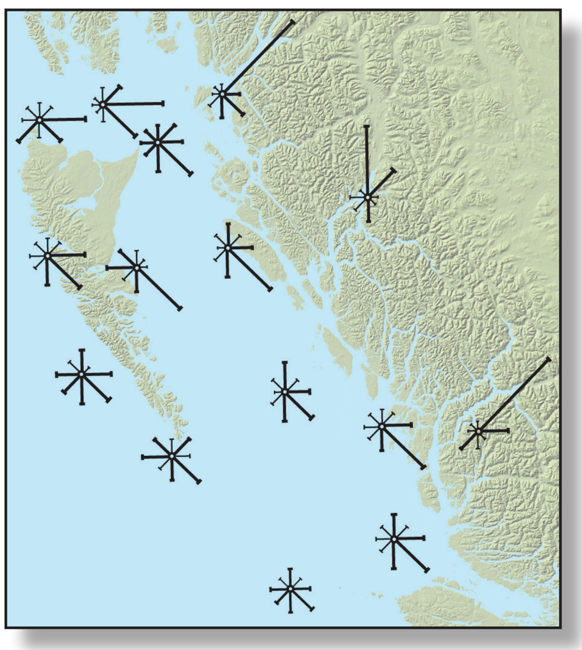
The low moves toward Haida Gwaii, while the associated front, marked by a long band of cloud stretching southwest from Oregon, crosses the south coast. Another trough rotating around the low lies over the north coast.

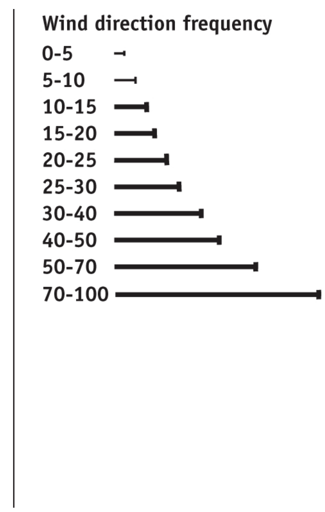


South-to-southwest winds on the west coast of Vancouver Island enter all of the inlets. A band of strong southerly winds from eastern Juan de Fuca Strait flows across the San Juan Islands. Strong southerlies flow through Queen Charlotte Strait, the strongest occurring along the northern shoreline.

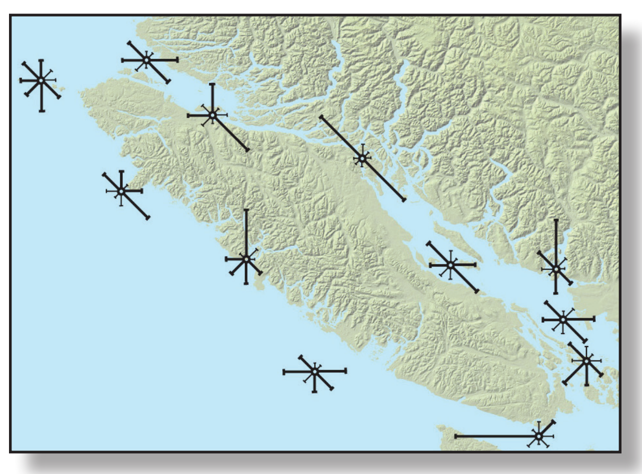
April Wind Roses

The dominant wind in Hecate Strait continues to be from the southeast, although winds from the northwest are becoming slightly more noticeable by this time. Winds in Dixon Entrance are still mainly from the east and southeast, but the frequency of westerly winds has increased since January. The major change is through the inlets, where the south and southwest winds are now almost as frequent as the northeasterlies: the shift in regimes from the winter outflow to the summer inflow has begun. The winds west of Haida Gwaii have an almost even spread in terms of direction, having little directional preference at this time of year. Most locations have more westerly winds than they did in January but still have dominant easterly winds. Outflow winds still prevail through the inlets of the mainland coast and Vancouver Island.





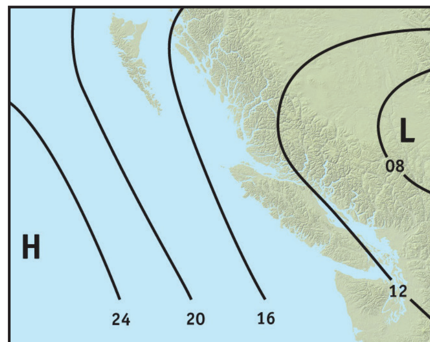
April wind-rose diagrams showing the relative frequency of eight cardinal wind directions.



1.6 Offshore Ridge: Westerly Pressure-Slope Winds

Westerly winds develop when a ridge of high pressure lies west of the coast and the pressure is lower along the Coast Mountains. This can happen in one of three ways. The first is when a ridge builds behind a passing front. The strongest westerly winds are post-frontal, meaning that they occur when the pressures rise very rapidly after the passage of a front. These winds typically rise rapidly but only last a matter of hours. One of the biggest concerns with post-frontal westerlies is the rapid change in wind direction: what was a safe anchorage in southeast winds may not provide any protection from westerly winds.

The second pattern for westerly winds develops when a ridge builds northward from the sub-tropical high and is most common from April through September. These offshore-ridge westerlies tend to last for days rather than hours, their duration and strength dependent on the orientation and position of the ridge. The north coast is near the most northerly end of the ridge, away from the sub-tropical high, so only a small change results when the ridge moves south of the area. As a consequence, frontal troughs from the Gulf of Alaska can affect the region.



Typical weather map for westerly pressure-slope.

A common scenario is for the ridge to build strongly northward for a few days, then to weaken and rotate over Queen Charlotte Sound. To the north of the ridge, the winds back into the south as frontal troughs approach, while the northwest winds continue over the waters further to the south. The ridge may later build northward again and repeat the pattern. The ridge is normally strongest and most northerly from mid-July to mid-August; however, it soon begins to weaken as the sub-tropical high starts moving southward. The increased chance of precipitation in the far north after late July and, more noticeably, mid-August is evidence of this.

The third type of westerly wind develops due to strong daytime heating and is called a diurnal westerly. The differential solar heating between the land and the water creates small-scale pressure differences. In areas with higher temperatures, the pressure falls a little more than it does in cooler areas. Like all winds, the diurnal westerlies blow from an area of higher to lower pressure. Most of the year, these subtle pressure differences are overshadowed by the large-scale dynamic pressure changes of weather systems. In the summer, with heating along the coast, there is a tendency for plumes of offshore winds to be drawn toward the coast in the afternoon and to retreat offshore again overnight. These diurnal changes are not always evident on weather maps.

Both post-frontal and offshore-ridge winds can be estimated by the gradient on weather maps, but diurnal winds are often so local in nature that they will not be seen on maps.

Diurnal westerly winds have a typical cycle of being light overnight, rising around 0010-0011 in the morning, reaching their peak in the late afternoon or evening, and then dropping quickly to light again just before sunset. In some areas, such as in the Strait of Georgia, the diurnal winds do not have the same timing because they are the result of a diurnal cycle from elsewhere—in this example, from farther upstream in Queen Charlotte Strait.

The general pressure-slope of westerlies is 210-300°. Within this range, winds vary between west and northwest, but the variations from west to northwest are more influenced by topography than they are by slight shifts in the pressure slope.

Fog is a summer phenomenon strongly connected with diurnal winds, as both are linked to daytime heating and will form earlier or later, depending on the strength of the heating. Fog forms only after the winds ease, because it cannot form when they are strong; winds develop after the fog dissipates because the air is not warm enough when the fog is present. Fog is most common in the southeast corner of Queen Charlotte Sound and off southwestern Vancouver Island in the late summer and early autumn, with August sometimes referred to as "Fogust" by local mariners.

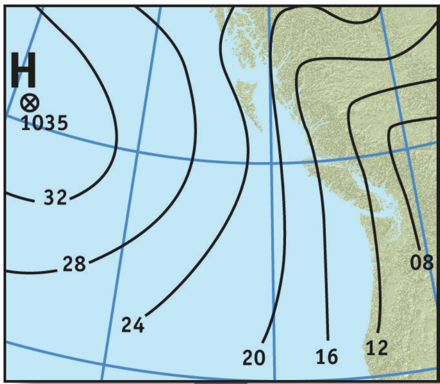
Sea Conditions

With westerly winds, the fetch over the unprotected western waters is virtually unlimited. As such, the seas can be considerably higher than they are in more sheltered inside waters, where fetch limits their height. The duration of the wind is also greater with ridges, which tend to be slower moving than fronts. The seas over the open western waters are, therefore, controlled almost entirely by the wind speed: higher winds create higher seas.

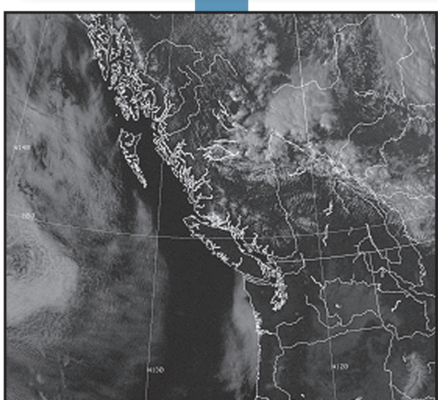
Swells that develop in westerly winds around a distant storm can move onto the coast regardless of the local wind direction. They generally arrive from the west at speeds of 20-30 kt, so can move from offshore buoys to the coast in a matter of several hours. Heights near 10 m are possible along the west side of Haida Gwaii, while swells reaching Vancouver Island are usually lower.

In an example from a mid-August afternoon, there was a ridge of high pressure offshore, while a trough of low pressure lay over the BC interior. Apart from some cirrus west of Haida Gwaii, the only cloud was a finger of fog and stratus along the Washington coast and off the mouth of Juan de Fuca Strait.

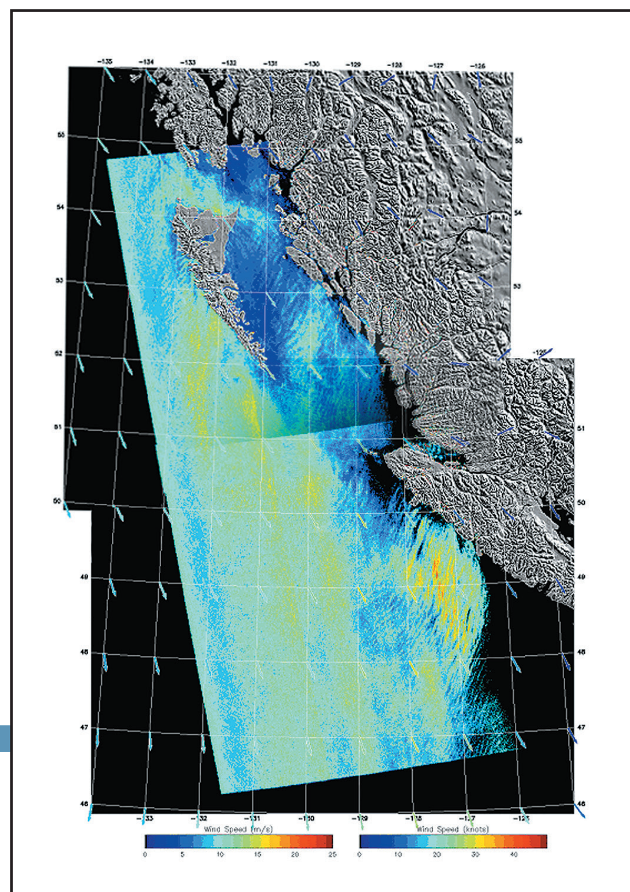
The pressure slope was near 260° and a plume of strong northwest winds extended south from northern Vancouver Island. The winds to the southeast of the plume were likely light easterlies or northeasterlies. Lee sheltering was evident downwind of various islands and peninsulas, including the area immediately southeast of Brooks Peninsula. Westerly winds were also seen developing in Queen Charlotte Strait.



Westerly winds spread through Dixon Entrance and across to the mainland coast south of Prince Rupert. Northwest winds ran down the west coast of Haida Gwaii and passed over western Queen Charlotte Sound, but they did not extend eastward into the sound. A wedge-shaped area of lighter winds lay in the lee of Haida Gwaii, but the northwest winds increased over the southeastern parts of Hecate Strait.



A ridge of high pressure occurs offshore and a trough of low pressure over the BC interior. There are generally clear skies along the coast, except for an area of fog and stratus extending southward from the mouth of Juan de Fuca Strait.

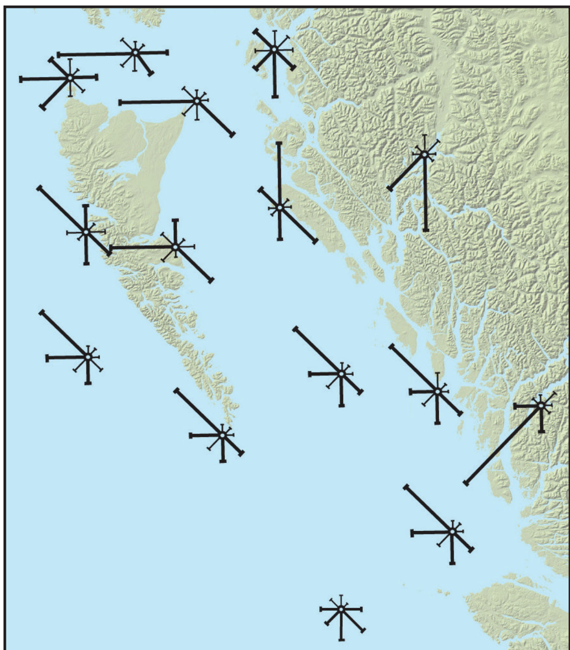


Northwest winds along the west coast of Haida Gwaii spread into western Queen Charlotte Sound and increase over the southeastern parts of Hecate Strait. A plume of stronger northwest winds extends south from northern Vancouver Island, with light easterlies likely to the southeast.

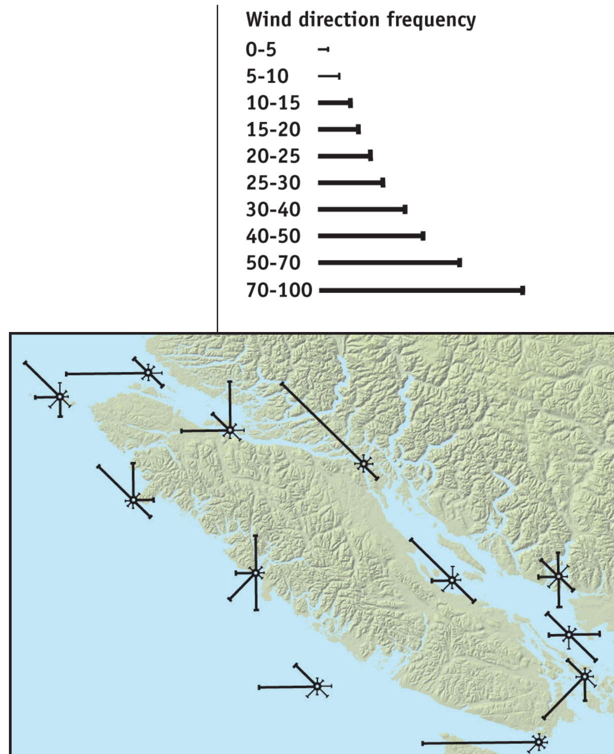
Lee sheltering is evident downwind of various islands and peninsulas, including east of Haida Gwaii and immediately southeast of Brooks Peninsula.

July Wind Roses

In July, west and northwest winds are dominant for almost all coastal areas. Some areas, such as Dixon Entrance, Queen Charlotte Strait, and Juan de Fuca Strait, have westerly winds due to their surrounding topography. Inflow winds through inlets flow parallel to the channels. The Nanakwa Shoal buoy in Douglas Channel is located near the junction of two channels and, as a result, has two main winds, one aligned with each channel.



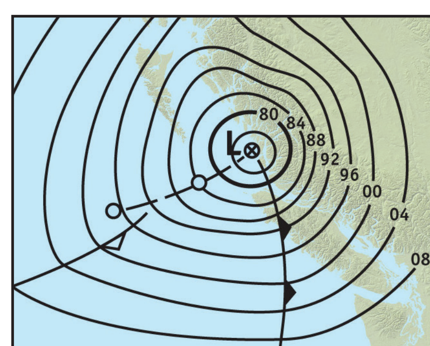
July wind-rose diagrams showing the relative frequency of eight cardinal wind directions.



1.7 Coastal Low: All Pressure-Slope Wind Directions

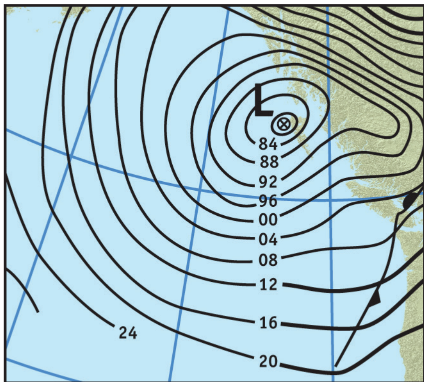
This pattern occurs when a low develops so close to the coast that it doesn't have room to turn northward into the Gulf of Alaska before passing over it.

Coastal lows are potentially dangerous for three reasons. The first is that winds may be extremely high near the centre of the low, which passes directly over the coast, while gale- to hurricane-force southeast winds precede it and lighter northerlies occur to its north. The second is that the exact track of the low is critical, as there are significant variations in the strength of the winds around it, yet it is difficult to predict accurately. Mariners south of the track of a coastal low would likely experience much worse conditions than they would north of it. The third is that the low may begin to form very

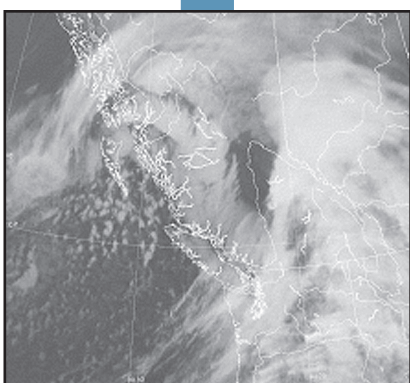


A typical weather map depicting a coastal low.

close to the coast, so the normal signs of development—such as thickening high clouds—might not appear until it is imminent.

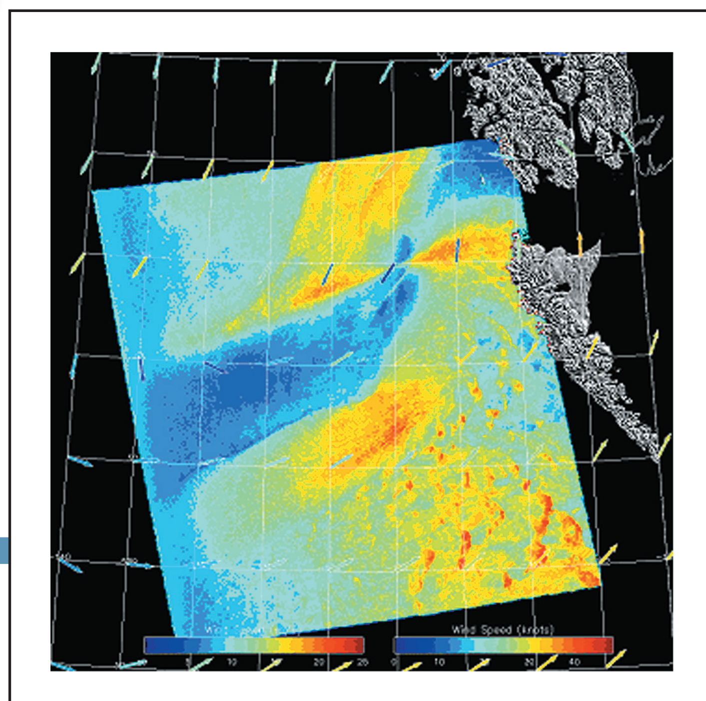


A low that develops very rapidly is referred to by meteorologists as a “bomb”. Even if the forecast gives ample warning of such an event, mariners may have no visual confirmation of what is happening until it is too late. This appears to have been the case in the storm of October 26, 2001, in which the Kella-Lee sank northwest of Cape Scott, claiming the lives of two fishermen. When a rapidly deepening low moves toward the coast, the pressure ahead of it falls quickly, and an almost equal rise in pressure occurs in its wake. Ahead of this fatal storm, at Kindakun Rocks, the pressure dropped 15 mb in just three hours; behind it, it rose 16 mb in the same amount of time.



A low passing northwest of Haida Gwaii, with an associated front near southern Vancouver Island.

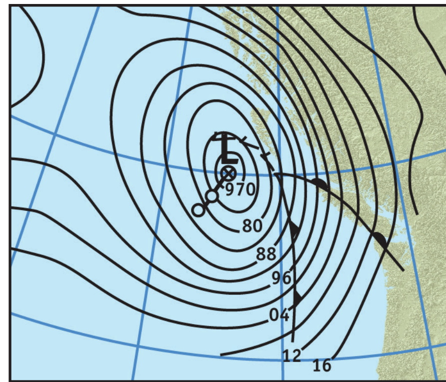
A preferred track for coastal lows is over Queen Charlotte Sound and into southern Hecate Strait. If the low turns northward soon enough, it may travel the full length of Hecate Strait, passing just north of Prince Rupert, before it crosses the mainland Coast Mountains. If it tracks farther south, the preference is usually to cross Barkley Sound or go through Juan de Fuca Strait. The pattern of clouds and weather is like that of an approaching front.



Bands of stronger winds occur around a low northwest of Haida Gwaii.

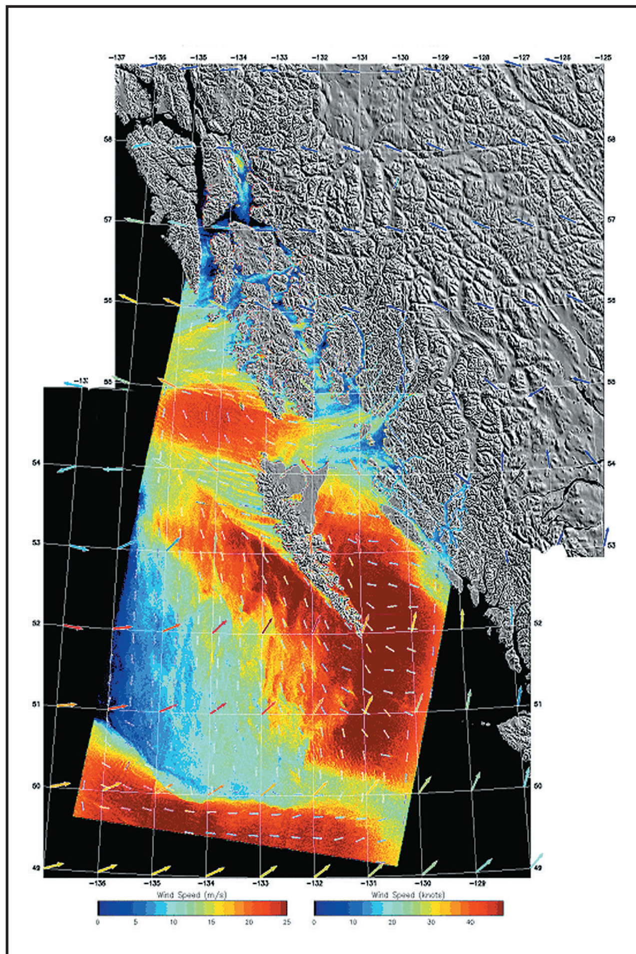
In a March example, a low passed just northwest of Haida Gwaii, circled by a pinwheel of bands of strong and weak winds.

Strong easterly winds extending from Langara Island into the low were mirrored by strong winds from the west-southwest. To the northeast were lighter northeast winds; to the southwest, lighter southwesterlies. Stronger winds also moved toward the low from the north and south. These bands did not rotate around it but translated northeastward with it. The patchy cells indicated that the southwest winds were gusty, due to unstable air.



A deep low moving towards Haida Gwaii.

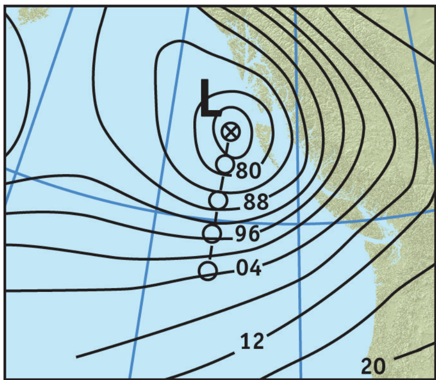
In this particular storm, the seas rose to just over 5 m; however, in the following example of a mid-November storm, they increased to nearly 10 m in the southeast winds ahead of the low and near 12 m in the southwest winds behind it. The lowest seas (build, perhaps, to 3 m) normally occur in the northeast quadrant ahead of the low. Mariners should keep in mind that weather buoys report only the significant wave height, and that extreme waves may be twice this value.

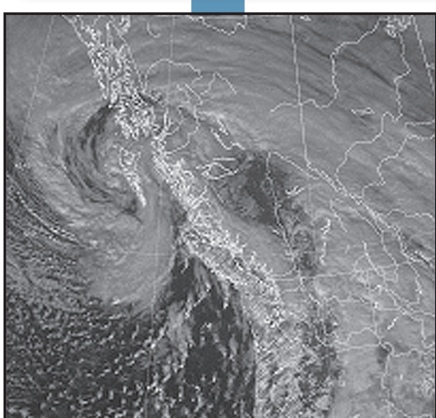


Northeast winds exit the mainland inlets and spread across Dixon Entrance. Southeasterlies in Hecate Strait are strongest close to Haida Gwaii and light in the mainland channels. The strong winds off Graham Island come primarily from the inlets.

This November low deepened as it moved from the southwest toward Vancouver Island, then tracked due north, passing just west of Haida Gwaii. Although it was not a true coastal low, since it did not cross the BC coast, it passed so close to Haida Gwaii that it exhibited the same features.

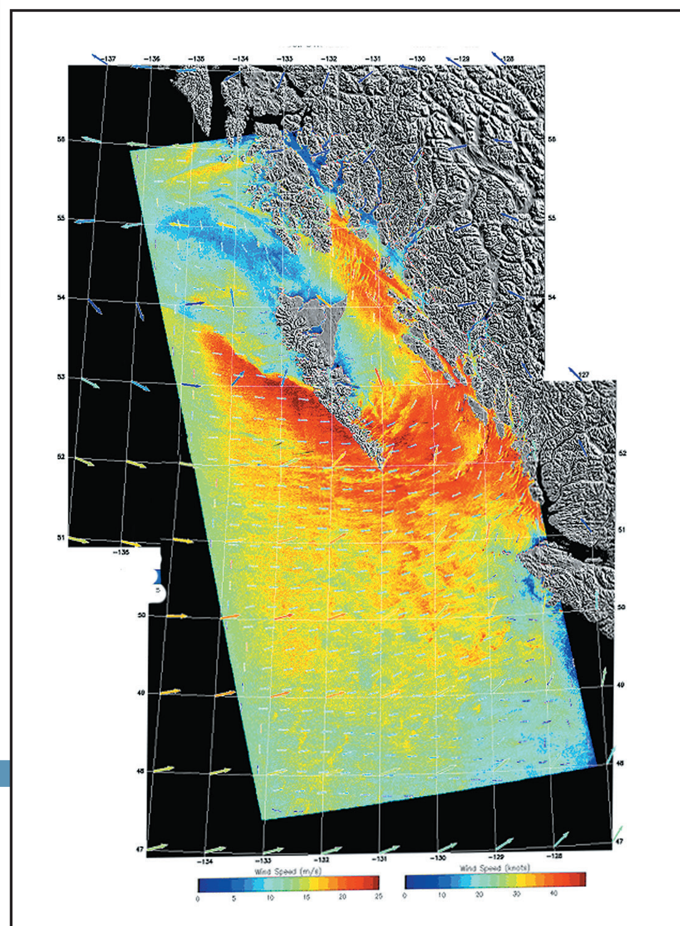
The pressure slope ahead of it was from the northeast: near 040° over Dixon Entrance and near 060° over Hecate Strait. Northeast winds poured out of the inlets of the mainland coast and spread across Dixon Entrance ahead of the front. The winds in Hecate Strait were from the southeast; however, since the pressure slope was from the northeast, the strongest winds were close to Haida Gwaii and did not move into the islands along the mainland coast. Although southeast winds moved up both sides of Haida Gwaii, the strong winds off Graham Island came primarily from the inlets, with much-reduced winds in between them.





As the low tracked farther north, the pressure slope rotated into the southeast. When this shift occurred, the northeast winds ended and the southeast winds spread across eastern Dixon Entrance. Strong winds also poured through the mainland channels of Hecate Strait. South of the low, the pressure-slope then shifted into the south, and west to southwest winds spread across southern Haida Gwaii and into southern Hecate Strait. Southeast winds rose to storm force at a number of locations further south and reached hurricane force off northwest Vancouver Island. Seas built to 10.3 m at the South Hecate buoy at 1600 hours. At Cape St. James, winds rose to southeast at 53 kt, with gusts of up to 65 kt ahead of the front, and veered to southwest at 46 kt, gusting to 54 kt west of the front.

Spiral arms of cloud are evident around the low, just west of Haida Gwaii. The cumulus and cumulonimbus clouds accompanying the strong, gusty southwest winds behind the front are moving onto Vancouver Island.



Northeast winds have stopped, but strong southeasterlies continue to pour through the mainland channels. West to southwest winds spread across southern Haida Gwaii and into southern Hecate Strait. Southeast winds rose to storm force at a number of locations further south and reached hurricane force off northwest Vancouver Islandsouthwest winds behind the front are moving onto Vancouver Island.

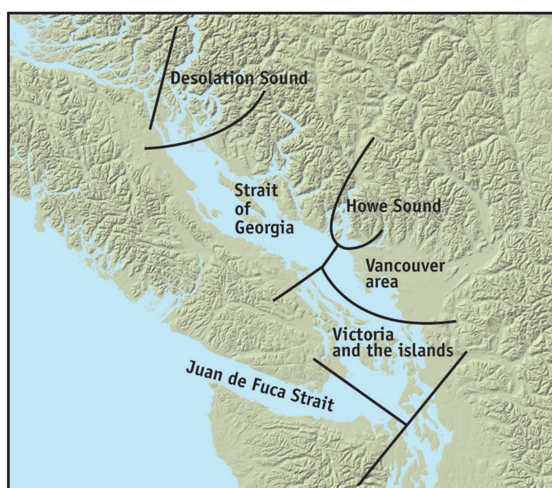
2. The South Coast

The four main regions of the South Coast of British Columbia—the Georgia Basin, Chatham Point to Port Hardy, North Vancouver Island, and West Vancouver Island—experience their own unique weather conditions due to differences in coastal topography, temperature, and other local factors. Information on winds, pressure patterns, waves, currents, and weather conditions affecting marine travel in these regions are covered in detail in this section.

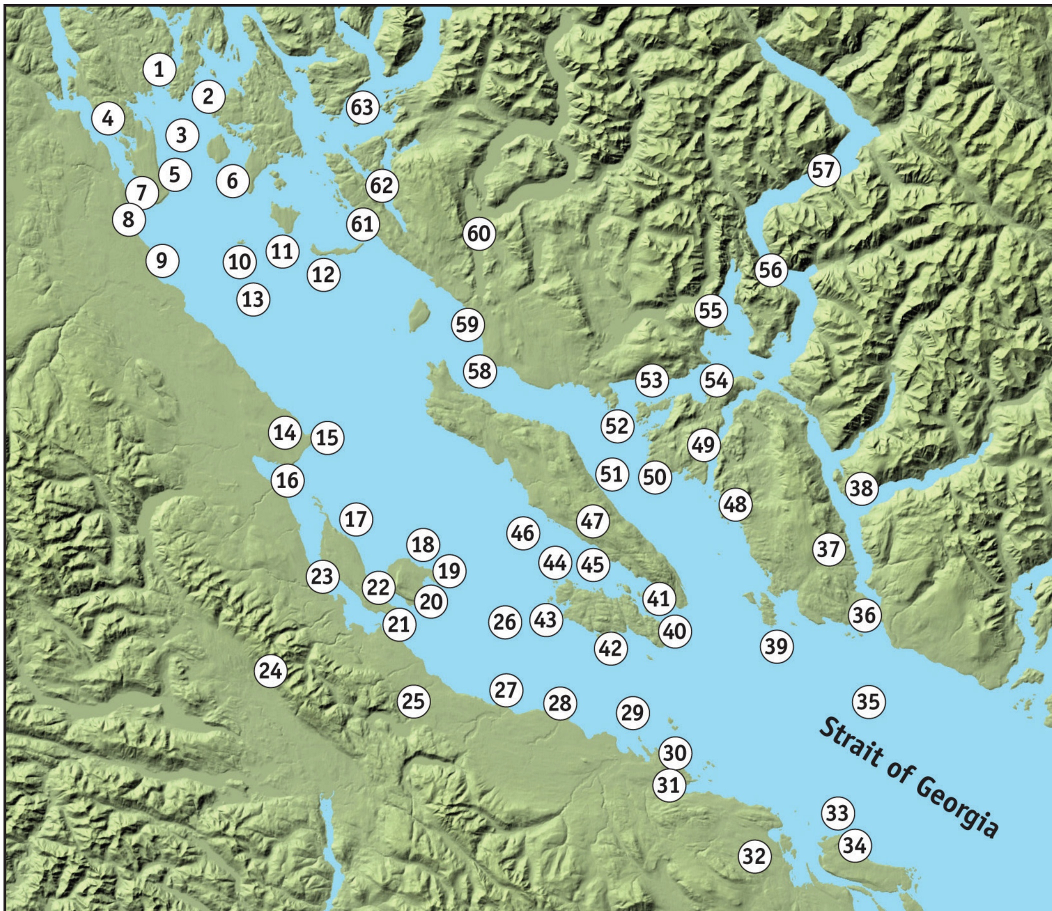
Coastal British Columbia (left) and the South Coast of the province (right), showing its four main regions.

2.1 The Georgia Basin

The winds in the Georgia Basin are both dynamic and complex and can vary dramatically in direction and strength from one area to another. The Basin itself is like a giant bathtub, in that the winds tend to slosh in one direction, then turn and shift back the other way. In light of these highly localized differences, separate treatment is given to marine weather conditions in each of the Basin's six sub-regions: the Strait of Georgia; Desolation Sound; Juan de Fuca Strait; Victoria and the Islands; Vancouver Area; and Howe Sound.



The six sub-regions of the Georgia Basin.



Strait of Georgia

1. Hoskyn Channel
2. Read I.
3. Sutil Channel
4. Discovery Passage
5. Quadra I.
6. Cortes I.
7. Cape Mudge
8. Campbell River
9. Oyster Bay
10. Mitlenatch I.
11. Hernando I.
12. Savary I.
13. Sentry Shoal
14. Comox Airport
15. Comox Bluff
16. Comox Harbour
17. Denman I.
18. Hornby I.
19. Helliwell Pk
20. Tribune Bay
21. Chrome I.
22. Lambert Channel
23. Baynes Sound
24. Beaufort Range
25. Horne Lake
26. Sisters I.
27. Qualicum Beach
28. French Creek
29. Ballenas I.
30. Schooner Cover
31. Nanoose Bay
32. Nanaimo
33. Entrance I.
34. Gariola I
35. Halibut Bank
36. Sechelt
37. Sechelt Inlet
38. Salmon Inlet
39. Merry.
40. Bull Passage
41. Jedediah I.
42. Lasqueti I.
43. False BAy
44. Scottie Bay
45. Sabine Channel
46. Texada I.
47. Mt. Davies
48. Pender Harbour
49. Agenemnon Channel
50. Nelson I.
51. Malaspina St.
52. Hardy I.
53. Saltery Bay
54. Jervis Inlet
55. Hotham Sound
56. Prince of Wales Reach
57. Princess Royal Reach
58. Grief Pt.
59. Powell River
60. Powell Lake
61. Lund
62. Okeover Inlet
63. Desolation Sound

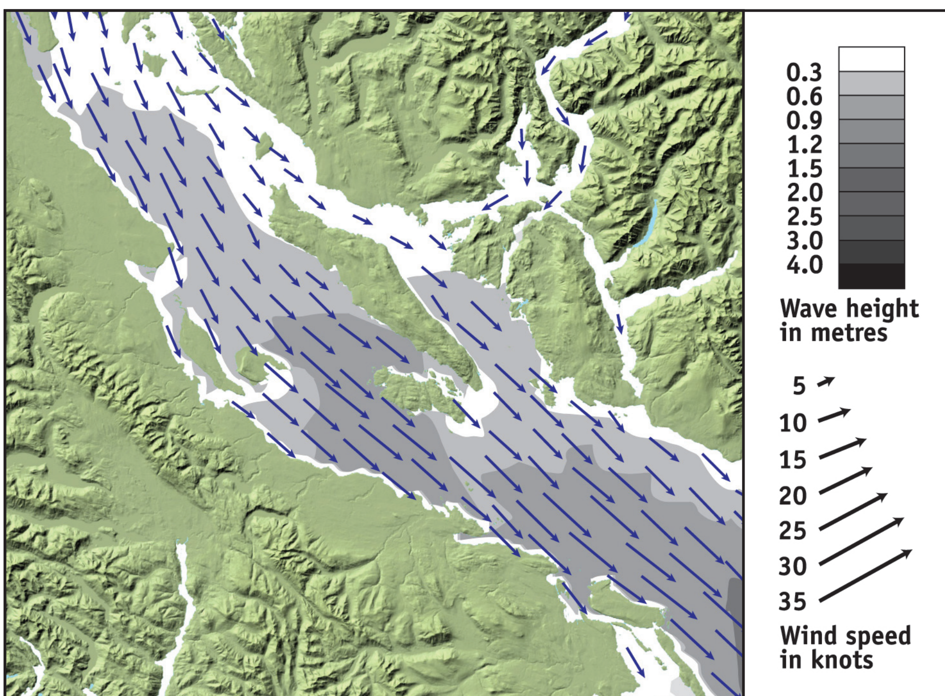
2.1.1 The Strait of Georgia

The Strait of Georgia is the largest of the sub-regions in the Georgia Basin and could, itself, be divided into three smaller areas. Conditions on the western (Vancouver Island) and eastern (Sunshine Coast) sides of the Strait can vary significantly, as can they in the northern and southern sections—the dividing line often being between Comox and Ballenas Island (most commonly, just north of Sisters Island). Generally speaking, the eastern side of the Strait has more southeasterly and less southwesterly winds than the west side, at any time of the year. The north has more northerly winds but less southwesterlies.

Northwest and southeast are the two main winds in the Strait. A third is called an "outflow" wind, although it is actually a combination of northwest and southeast winds. A fourth, and sometimes significant, wind can blow from the southwest; however, only in certain parts of the region.

2.1.1.1 Northwest Winds

Northwest winds begin to form over the northernmost sections of the Strait when the direction of the pressure slope moves to just west of south. They spread down the Strait as the direction veers toward the west and northwest. When the direction of the pressure slope becomes northeasterly, winds in the southernmost areas of the Strait shift to the east and away from the northwest. As such, northwest winds are present in at least some part of the Strait for all regional pressure-slope patterns, except easterly and southeasterly.



Northerly pressure-slope winds and waves using the example of 1100 hrs, 18 October 1997 with a pressure-slope direction of 360° and a slope steepness of 1.0 mb per 60 nm.

Northerly pressure-slope pattern

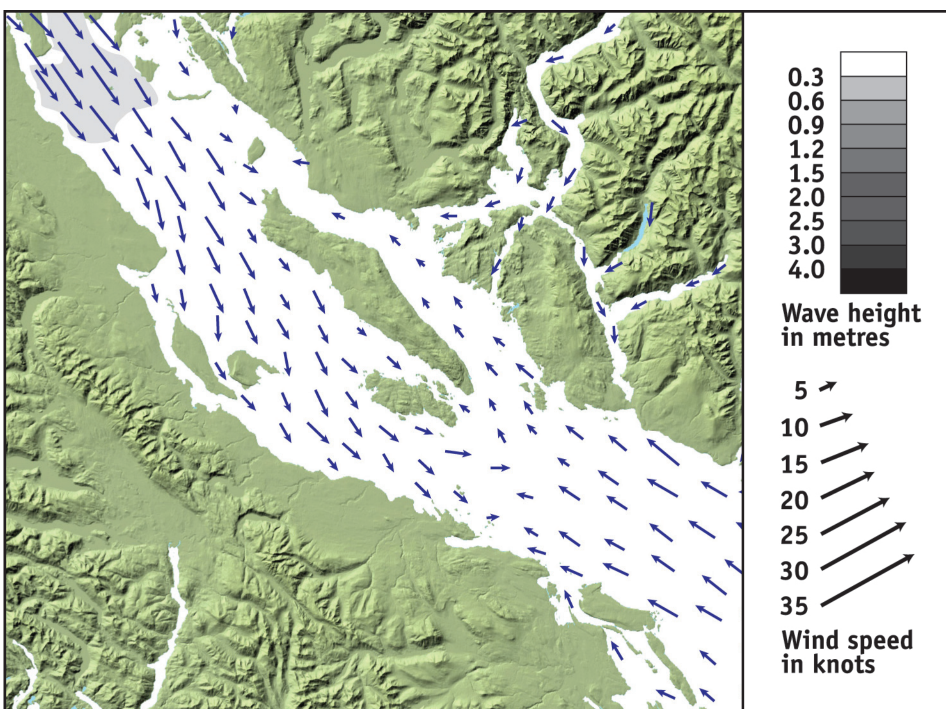
A northerly pressure-slope pattern of northwest winds develops when a ridge of high pressure builds over the central interior of British Columbia, north of the Strait. When this occurs, northerly winds pour out of Bute Inlet and blow southward the length of the Strait, creating wind speeds of between 15 and 25 kt. The winds in the northern part of the Strait, from Comox north, ease slightly in strength during the afternoon but not as much as they would in a "diurnal northwest" situation. Winds in the south continue unabated, day and night, at speeds of about 15 to 25 kt, although they are somewhat lighter along the Sunshine Coast. Because it can continue for several days once it is fully established, this pattern is often referred to as a "three-day northwesterly".

Mariners' Tips:

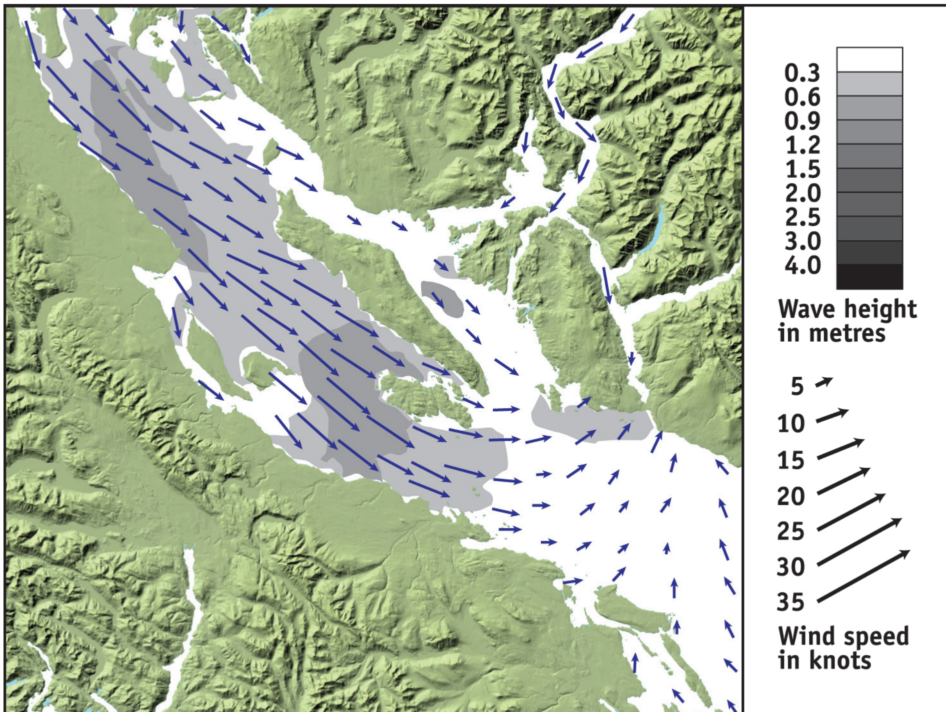
"When the winds don't go down with the sun, they will stay up all night."

Southerly, southwesterly, and westerly pressure-slope patterns

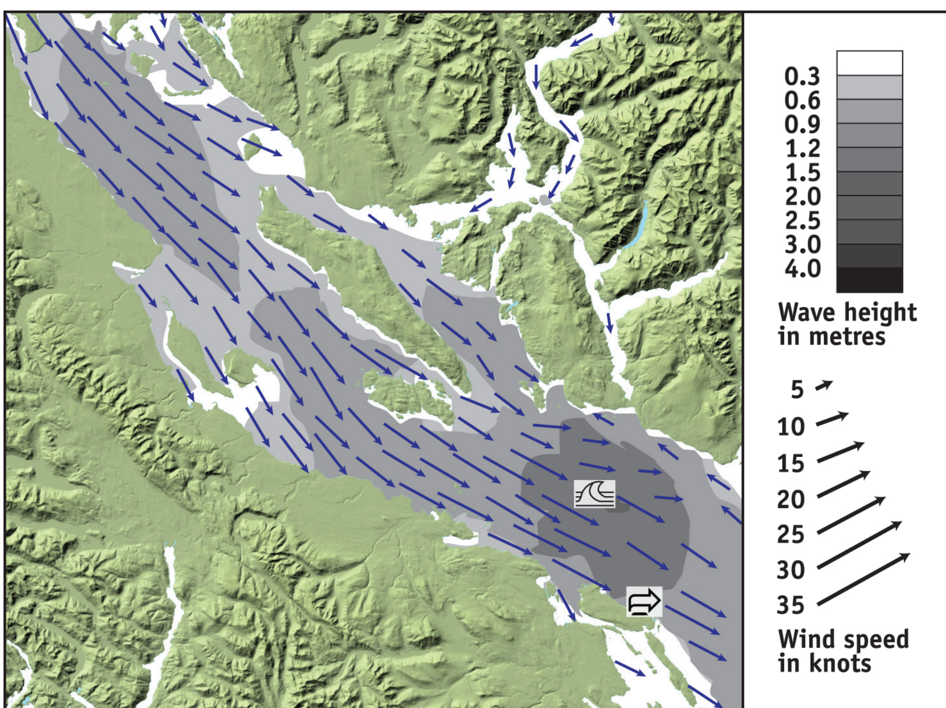
Southerly, southwesterly, and westerly pressure-slope patterns include typical summer diurnal northwest winds and those that develop after the passage of fronts. Diurnal patterns in the Strait move in the same way that water in a bathtub would shift if one end were raised and then the other: that is, it would slosh one direction to begin with and then back the opposite way.



The first appearance of northwest winds entering the strait using the example of 2300 hrs, 6 August 1997 with a pressure-slope direction of 230° and a slope steepness of 1.0 mb per 60 nm.



The second stage of northwest winds moving down the strait using the example of 0200 hrs, 7 August 1997 with a pressure-slope direction of 230° and a slope steepness of 0.9 mb per 60 nm.



The third stage of northwest winds moving down the strait using the example of 0800 hrs, 7 August 1997 with a pressure-slope direction of 250° and a slope steepness of 0.90 mb per 60 nm.

The northern end of the regional "tub" is raised when a ridge of high pressure lies to the west of Vancouver Island. When this occurs, winds begin flowing down Queen Charlotte Strait: initially at speeds of as little as 5 to 10 kt. If the skies are clear, sea-breeze effects will increase the flow to about 15 kt by the middle of the afternoon. The flow gradually increases in strength as it moves eastward and funnels through Johnstone Strait, often rising to 25 to 30 kt by the time it reaches Chatham Point in early evening—with gale-force winds of 35 kt not uncommon. From Chatham Point, the winds split into one of two paths. The main part of the flow moves down through Discovery Passage, reaching the northern end of the Strait of Georgia near midnight. Another part moves eastward through Nodales Channel, north of Sonora Island, and toward Bute Inlet. Part of this flow moves down the east side of Quadra Island and through the Okisollo and Hoskyn channels, arriving at the northern end of the Strait about an hour after the main flow blew through Discovery Passage.

This stream of winds then moves down the western side of the Strait, usually reaching Entrance Island before dawn. The typical wind speed is about 15 kt, but 20 kt is not uncommon, and speeds can sometimes get as high as 25 kt. The strongest northwest winds occur near the centre of the Strait, away from the frictional effects of the coast. South of Entrance Island, where the Strait widens, the funneling effect of the adjacent mountains is reduced, and the northwest winds often weaken and die out between there and Sand Heads.

When the northwest winds are light, they curl around Cape Lazo and enter the Comox Bay as a southeast wind. If, however, they are stronger, they move past the bluffs without changing direction and often pass through the gap between Hornby and Lasqueti islands. The winds in Baynes Sound are usually quite light, unless those in the middle of the Strait are more northerly, which allows them to curl around the Comox Bluffs. With strong northwest winds, a back eddy can form off Helliwell Park on Hornby Island and move into Tribune Bay as a strong southerly wind. This event usually occurs when the diurnal northwest winds first reach Hornby Island, around 0200 hours. Denman and Hornby islands provide shelter from the northwest winds, down the Vancouver Island coast to near French Creek—although some can blow through Lambert Channel. Winds can be strong again off Schooner Cove and Nanaimo and usually reach their peak within seven or eight kilometres of Entrance Island before easing farther south.

Mariners' Tips:

"A change in visibility is often a forerunner of northwest winds: when things stand up like a mirage, northwest winds are soon approaching."

"Westerlies are kind of predictable – more sun, more wind."

From the Sunshine Coast, the eastern edge of this plume of strong northwest winds appears like a black line on the horizon—the line being the edge of the higher seas caused by the winds. The northwest winds slowly approach the Sunshine Coast after daytime heating begins, the southern part of the plume usually arriving around 1000 or 1100, local time.

If the winds were 20 to 25 kt at Entrance Island, they slow to about 10 to 15 kt by the time they reach the mainland. The northern part of the plume funnels down Malaspina Strait but usually eases as it widens out just north of Nelson Island.

During the afternoon, as the land heats up, the pressure-slope direction slowly backs toward the south. This causes the northwest winds to ease throughout the Strait and, over the waters south of Entrance Island, to possibly turn into the southeast. This change frequently takes place around 1400 to 1500 hours. If the steepness of the pressure slope is very low, the winds caused by pressure differences will be light, and sea breezes will develop. These breezes will be from the west along the Sunshine Coast and may turn enough to become southwesterlies. Along the east side of Vancouver Island, the sea breezes will become easterly or even southeasterly near Campbell River. Over the central section of the Island, between Nanaimo and Comox, the winds maintain their northwest direction a little longer, although they gradually weaken and shift into light northeasterlies with speeds of 10 kt or less. Inflow winds will also develop in the various inlets during this period. Westerly inflow winds, which blow into the inlets on the Sunshine Coast during a sunny afternoon, die down at dusk—the strongest ones in Jervis Inlet usually occurring in Prince of Wales Reach. The winds tend to oscillate through the various reaches, being stronger on one side initially and then on the other. Through the evening the winds can shift to more of a land breeze from the southwest, but this is usually very short lived, as the northwest part of the cycle starts again in the late evening.

The last type of northwest wind in the Strait of Georgia develops after the passage of a front. Generally, fronts that approach from the southwest do not produce northwest winds in their wake, as they do not build a strong enough ridge behind them to shift the pressure-slope direction to the west and northwest. The winds frequently return to the southeast ahead of any subsequent front.

Fronts that approach from the northwest, however, develop a ridge strong enough to send northwest winds flowing all the way down the Strait. The pressure-slope direction rotates clockwise toward the south and southwest at around the same time the northwest winds begin. The wind shift to the northwest can occur quite suddenly, posing a potential danger to mariners who are not prepared for it. At other times, it is delayed until the winds higher in the atmosphere also turn into the northwest.

Although northwest winds are most frequent in the summer, they also peak in March. In any given year, the strongest northwesterlies normally occur in the winter after a front from the northwest.

Mariners' Tips:
In the Strait of Georgia, the strength of the surface northwesterly wind often depends on the strength of the winds at 500 mb (about 5000 m) aloft. If they are parallel to the Strait and of significant speed, the northwest winds may be quite strong—and could even reach gale force.

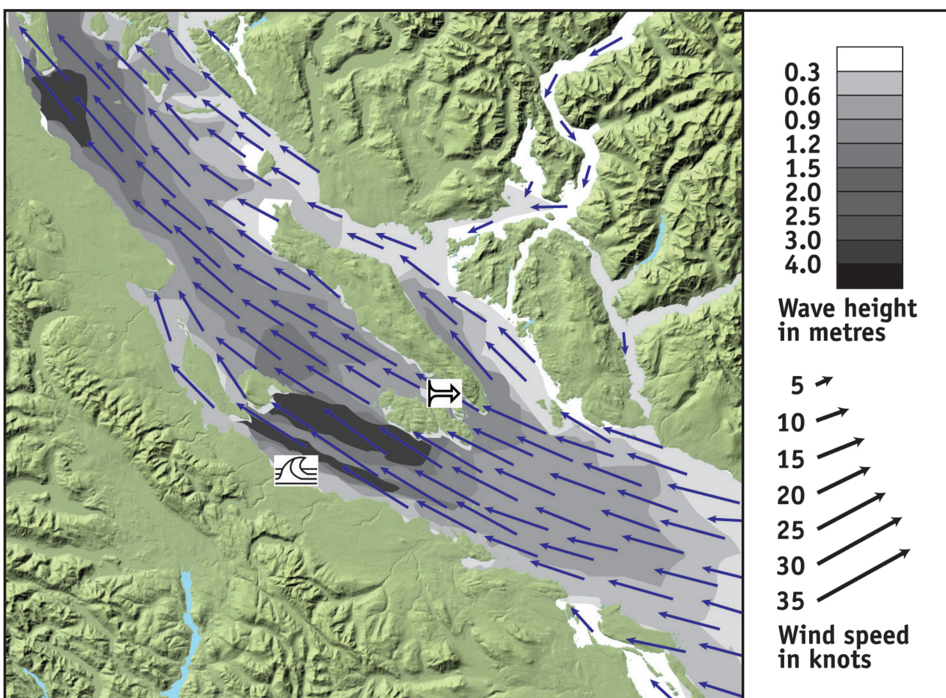
The strongest northwest winds—whether they occur with a northerly pressure-slope or after a frontal passage—will be similar on both sides of the Strait and will display the full range of topographical enhancements. Near headlands such as Grief Point, they can become fierce. Mariners may pass through a small, sheltered area at the bottom of Texada Island into a wall of winds funneling down between Texada and Lasqueti islands. Local topography also allows Selma Park to have fairly strong northwest winds—while just west of Sechelt, they are often much lighter. Some local bays, such as Gerrans Bay in Pender Harbour, are safe anchorages in summer but not after the stronger winds develop in late September. Sechelt Inlet and Porpoise Bay are not affected by strong northwesterlies unless the wind pattern becomes more of an outflow.

2.1.1.2 Southeast Winds

The strongest southeast winds in the region occur with east and southeast pressure-slope patterns; however, they can also develop with pressure slopes ranging from northeast to southwest. These slopes develop from a variety of weather patterns, which can be determined by the forecast synopsis or a recent weather map.

Northeasterly and easterly pressure-slope patterns

The southeast winds that form with a northeast pressure-slope pattern are basically "pushed" winds caused by the ridge of high pressure over the BC Interior. Pushed southeast winds will also develop and spread across the region when a ridge of high pressure builds



Winds and waves with a 'southwest' front using the example of 0900 hrs, 23 January 1998 with a pressure-slope direction of 080° and a slope steepness of 4.5 mb per 60 nm.

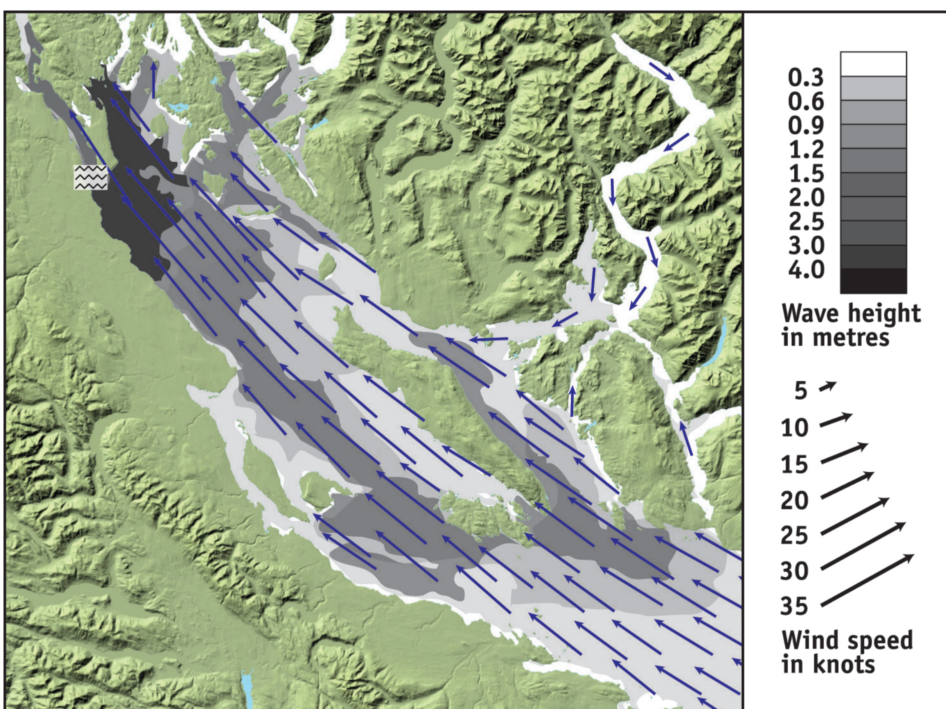
over eastern Washington State. Since the pressure-slope steepness is generally fairly low, the winds are only 10-15 kt over the southern part of the Strait and increase to 20-25 kt in the north after they have gathered momentum.

When fronts approach the region from the southwest, the pressure-slope direction backs to the east and is often north of east. As long as the pressure slope is coming from the northeast, the southeast winds usually remain below 25 kt and often drop to less than 20 kt. In general, they increase sharply if the pressure slope rotates and begin approaching from due east. In some cases, it shifts back and forth around this value, causing the winds to vary in strength.

In most cases, southeast winds are of similar strength on both sides of the Strait, with differences occurring only at opposite ends of the spectrum with regard to pressure-slope direction. Southeast winds associated with a northeasterly pressure-slope pattern are strongest on the Vancouver Island side of the Strait. As the direction of the pressure slope veers toward the south—as it does when a front approaches from the northwest—they become stronger on the Sunshine Coast. These winds are usually short lived, however, as the front moves quickly out of the region.

Southeasterly pressure-slope pattern

When a front approaches from the northwest, the pressure-slope direction backs only as far as to the southeast (perhaps almost to the east, ahead of the front) and shifts into the

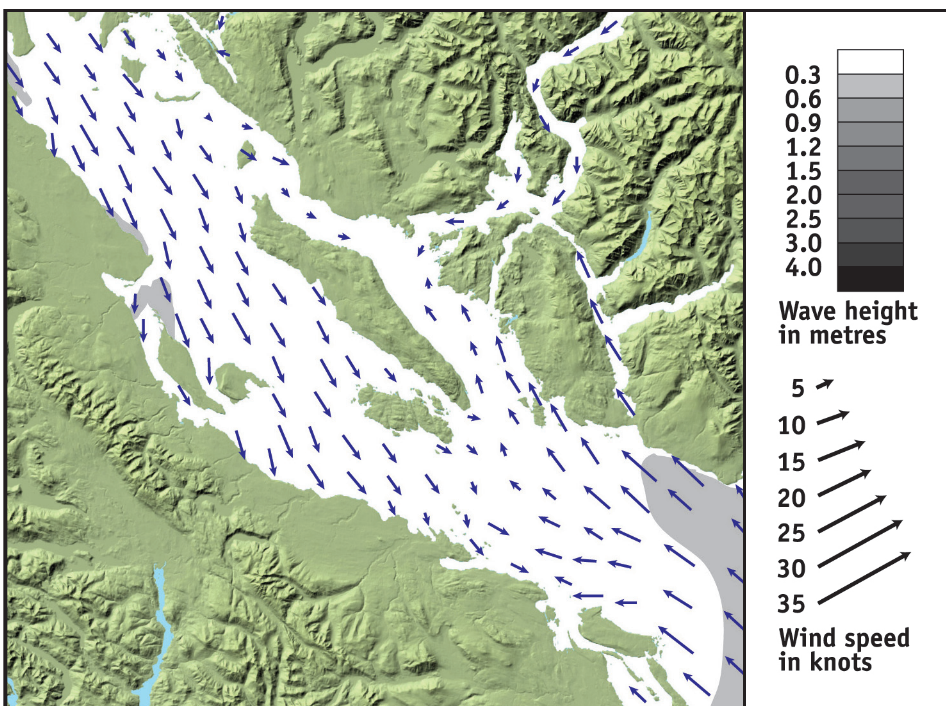


Winds and waves with a 'northwest' front using the example of 1400 hrs, 17 March 1997 with a pressure-slope direction of 100° and a slope steepness of 4.0 mb per 60 nm.

southwest or west after it has passed. As the front approaches, the pressure begins to drop across northern Vancouver Island and southeast winds begin to blow at the northern end of the Strait—gradually spreading southward as it draws closer. Southeast winds are usually stronger over the northern sections of the Strait: to reach gale force (35 kt) in the south, they are typically 45-50 kt in the north.

On occasion, a small ridge of high pressure will develop ahead of the front and move south over Vancouver Island, causing moderate northwest winds throughout much of the Strait. Even though the front is lurking just to the northwest, strong southeasterlies will not begin until the ridge moves south of the region. When it does, they can rise quickly—their onset often coinciding with the arrival of lower stratus clouds.

In all situations, winds are affected by topography. Southeast winds not only gain speed as they are funneled through Malaspina Strait but also are further enhanced off Grief Point, where they can be 10-15 kt stronger than they are in the middle of the Strait. In general, they don't funnel as much in Sabine Channel, except when they blow more from the south and are focused along the southern shore of Texada Island. In that case, they can be 20-25 kt when they are only 10-15 kt a bit farther away from the islands. At the southern end of Texada Island, conditions can be very difficult if southeast winds are blowing against an ebbing tide. Bull Passage, inside Jedediah Island, usually offers safe shelter. It is only when the strongest southeast winds occur on the Vancouver Island side of the Strait that strong



Juan de Fuca return flow winds and waves using the example of 0800 hrs, 16 July 1996 with a pressure-slope direction of 200° and a slope steepness of 2.4 mb epr 60 nm.

southeasterlies funnel into Baynes Sound and Lambert Channel. In such cases, the Comox-Powell River ferry sometimes heads south toward Lasqueti before cutting over to Comox.

Most of Jervis Inlet is protected from southeast winds, but stronger winter winds from the south can blow over Hardy Island and into Saltery Bay. Some also cross the southern end of the Malaspina Peninsula and blow over Okeover Inlet. In the north, Savary and Hernando islands provide some protection from southeast winds, so the south shore of Cortes Island usually has lighter winds than on the Vancouver Island side. A southeast wind of 30 kt or more has also been reported in Pender Harbour, apparently caused by winds banking up against the mountains and funneling down from Kleindale to shoot out through Gunboat Pass and into the harbour.

Southerly and southwesterly pressure-slope patterns

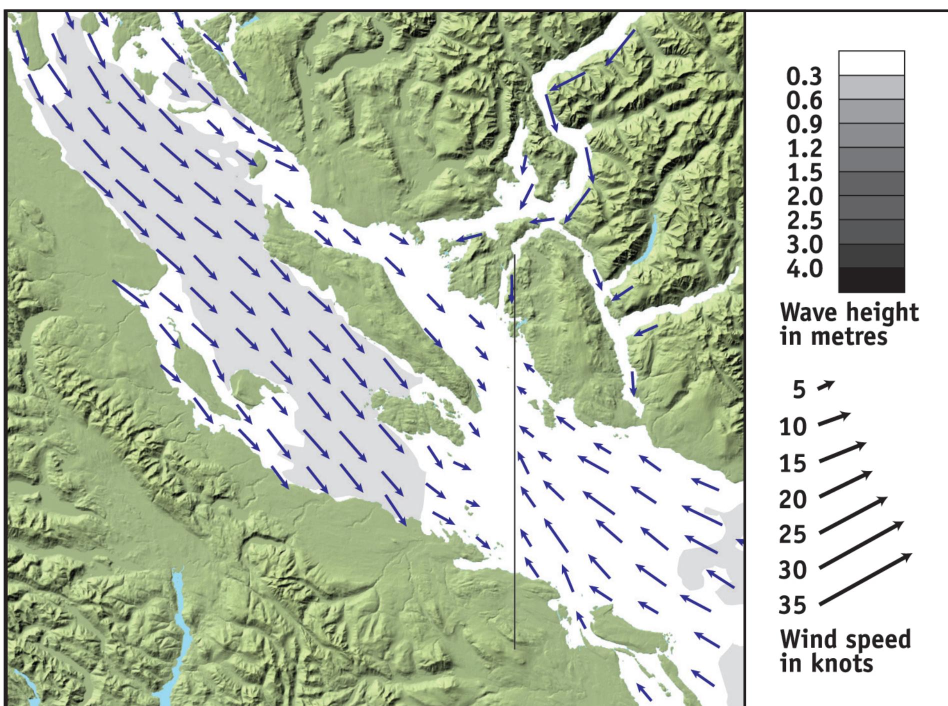
Another form of pushed southeast wind is caused by a pattern known as a "Juan de Fuca return flow", the early stages of which are described in section 2.1.4.3 of this chapter, on Victoria and the Islands. When the winds in Juan de Fuca rise to near 35 kt by late evening and the pressure-slope direction turns toward the south, a plume of strong winds is propelled northward. The winds usually spread northward across the San Juan Islands during the late evening hours, reaching the coastal mountains north of Vancouver and the southern Sunshine Coast before dawn. Point Atkinson often reports strong easterly winds about the same time or shortly before they show up at Merry Island. The plume then gradually builds backward toward Lasqueti Island and over to the Vancouver Island side. The winds appear first at Entrance Island, just off Nanaimo, during the early daylight hours,then spread northwest up the island—often as far north as Sisters Islands and Qualicum Beach. Their speed at this point is near 20-25 kt, or about 10 kt less than the maximum reported at Race Rocks the previous evening. The southeast winds usually ease in the mid- to late afternoon, shifting to northwest during the night and early morning hours, when the diurnal northwest winds strengthen again.

If an approaching front causes the pressure-slope direction to back into the south and maintains its strength as it crosses northern Vancouver Island, the southeast winds will spread north, all the way up the Strait. The winds will continue through the night, blowing their strongest at the northern end of the Strait. More often than not, however, the remains of diurnal northwesterly winds from Discovery Passage and Desolation Sound prevent them from reaching all the way up the Strait. A small lee low that usually forms between Comox and Sisters Island receives the two converging winds.

2.1.1.3 Outflow winds

When a ridge of high pressure builds over the Interior of the province, outflow winds blow out of Bute, Jervis, and Toba inlets and through Howe Sound. These winds can be very strong but usually end a short distance from the opening of the inlets. The wind patterns that occur in the main part of the Strait as the result of an outflow event follow a predictable cycle: a ridge builds over the northern part of the Interior and then slowly extends farther south. Parts of the cycle are sometimes compressed or skipped altogether.

The first inlet in the region to receive the outflow wind is Bute Inlet. Northerly winds move out of the inlet, past Maurelle and Read islands and over southern Quadra island, before spreading south along the east side of Vancouver Island. This produces the strong northwesterly winds previously described. As the ridge builds farther south, northerly outflow winds begin to move through the more southern inlets, such as Howe Sound and the passes leading into the Fraser Valley. At this stage, the pressure-slope direction rotates gradually from north to northeast, and the outflow crosses the southern part of the Fraser Valley and moves out into the Gulf and San Juan islands. Turned northward by Vancouver Island, it moves toward the middle of the Strait as a southeast wind, where it meets the winds from Bute Inlet. The convergence line between the two winds depends on the relative strength and temperature of their outflow streams. They are generally less than 15 kt but may briefly rise to 20-25 kt during the initial surge of Arctic air.



Outflow winds and waves using the example of 1600 hrs, 29 December 1996 with a pressure-slope direction of 040° and a slope steepness of 5.0 mb per 60 nm.

The outflow winds experienced in Jervis Inlet are generally weaker than those in Bute Inlet or Howe Sound because the cold air does not have a simple passageway from the Interior through the Coast Mountains. For Jervis to receive strong outflow winds, the depth of cold air in the Chilcotin region must be sufficiently high to allow the winds to pass into the valleys of the Elaho and Deserted rivers. Howe Sound, which has a lower pass from the Interior, may experience strong outflow winds when Jervis does not (although they may occur later). Although the zigzag nature of Jervis Inlet helps to reduce the strength of the outflow winds as they pass through, they often build again downstream. Marginal gale-force winds have also been known to occur in the inlet, which offers no safe shelter for anchoring. The strongest winds are found in Prince of Wales and Princess Royal reaches. Arctic outflow winds spreadinto Sechelt Inlet from Salmon Inlet; however, little comes out of Narrows Inlet, just to the north.

2.1.1.4 Southwest Winds

Two types of southwest winds occur over the Strait of Georgia. The best known are the “Qualicum” winds; however, southwest winds also form after a front passes and when strong southwesterlies aloft blow downward onto the sea. Many mariners call any southwest wind a Qualicum, regardless of the weather pattern that creates it.

Southerly and southwesterly pressure-slope patterns

During the summer, when a large ridge of high pressure lies to the west of Vancouver Island, the normal diurnal cycle of winds develops in the Strait. Northwest winds form overnight and spread southward during the early morning, easing again in the afternoon. This cycle occurs as the pressure-slope direction rotates from west or northwest to southwest. At times during the summer, a weak front will interrupt the cycle by moving down over Vancouver Island. The winds ahead of this system back to the southeast and are not typically very strong. After the front has passed, the ridge rebuilds west of Vancouver Island and the pressure-slope direction rotates from south to southwest, pushing winds into Barkley Sound and Alberni Inlet. If the skies are clear, these inflow winds will be enhanced by sea-breeze effects.

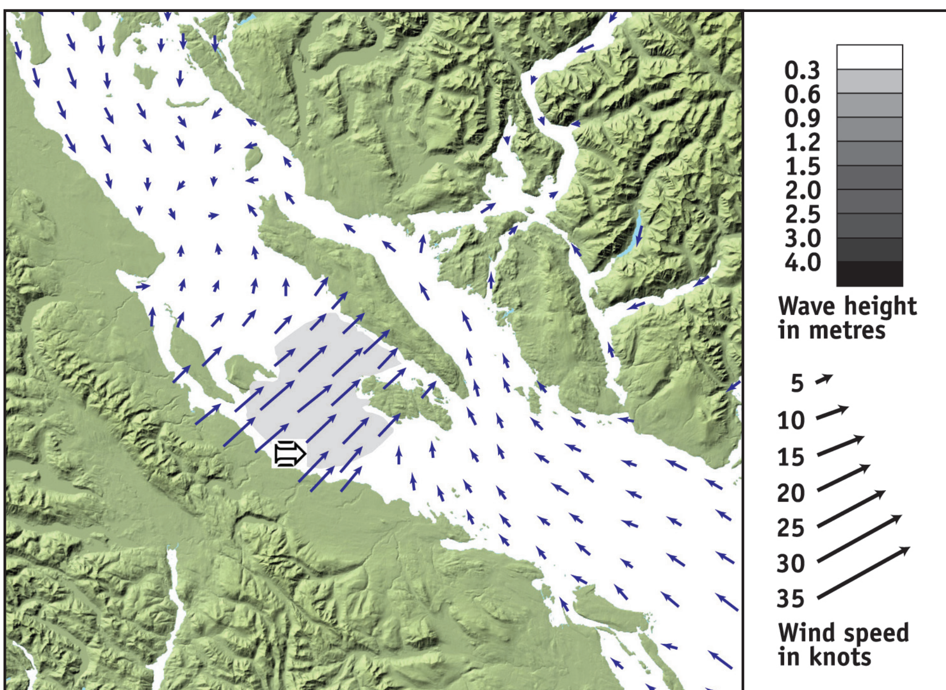
The strong southerlies move across the Island, passing over Horne Lake and out into the Strait, near Qualicum Beach—forming a plume of “Qualicum” winds from just south of Chrome Island to Qualicum Beach. The winds usually cross the Strait and blow into False Bay on Lasqueti Island, sometimes hopping over the northern part of the island and moving into Scottie Bay. The plume has a sharp edge that can be easily seen on the water, a sign that winds inside the plume are much stronger (25-30 kt) than those outside it.

In a typical Qualicum event, the winds begin in the late evening and sometimes last, in a weakened state, until early morning. Those in the southern part of the Strait are usually light southeasterlies, with light northerlies blowing to the north of Comox. If these southeasterlies are stronger than usual, the plume of southwest winds bends to the north, missing Sisters Island but being recorded at Chrome Island. Even more rarely, when the northwest winds over the northern end of the Strait are stronger than normal, the plume of southwest winds passes south of Sisters Islands and appears as a somewhat weaker westerly at Ballenas Islands.

A southwest Qualicum wind can also appear in Comox Harbour. This happens when some of the air flowing up the Alberni Inlet is blocked by the southern end of the Beaufort Range and steered northward over Comox Lake. From there, it flows down the Cumberland-Royston Road and out over the southern end of Comox Harbour as a southwest wind. The winds dissipate soon after they reach the water and may not be quite as strong as those reported at Sisters Islands.

The strong westerly winds that blow over Cowichan Lake may be yet another wind that results from the same pressure pattern. In this case, southerly winds blow up Nitinat Lake and are steered by the mountains to flow as a strong westerly wind over Cowichan in the late afternoon or early evening. A weakened remnant of this wind then flows out through Cowichan Bay or along the Chemainus River valley to Chemainus.

The second situation that produces southwest winds in the Strait of Georgia occurs after the passage of a front from the southwest. As the front moves across Vancouver Island, the pressure-slope direction veers from the southeast toward the south. Strong southwest winds flow into Juan de Fuca Strait behind the front and spread up over the Gulf and San Juan islands toward Vancouver. If the pressure builds strongly enough behind the front, light to moderate southwest winds will spread over Vancouver Island and out across the waters south of Sisters Island. The southwest winds are usually stronger offshore of Qualicum Beach than they are elsewhere to the south. Slightly enhanced winds will occur downwind

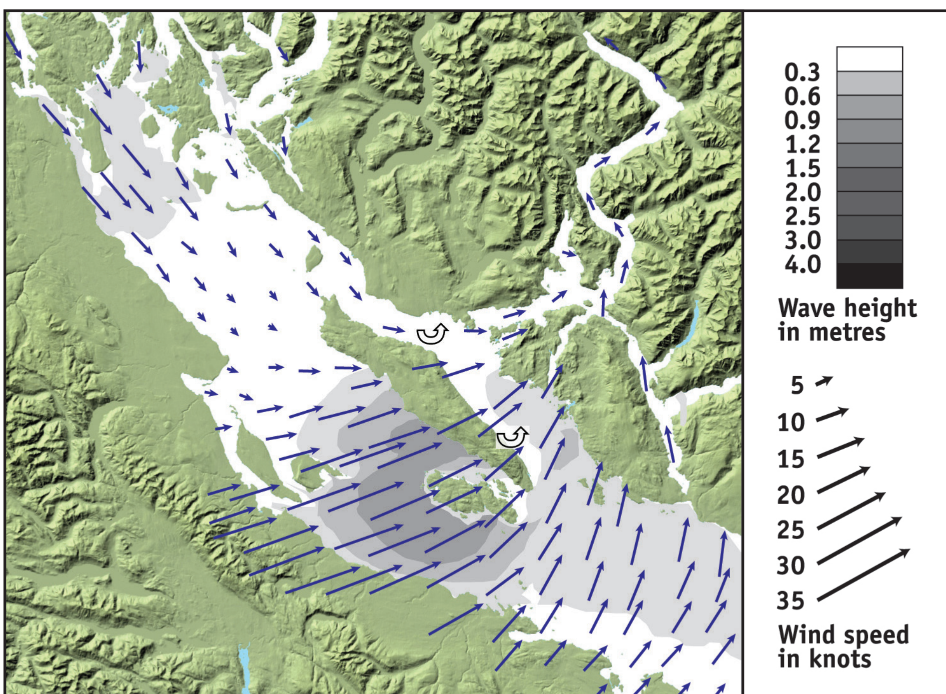


Qualicum winds and waves using the example of 2300 hrs,15 May 1997 with a pressure-slope direction of 210° and a slope steepness of 1.5 mb per 60 nm.

of other gaps through the Vancouver Island Ranges. To the north of Comox, the winds turn into the northwest, shifting weakly and only very briefly into the southwest. The southwest winds do not usually last very long, nor do they necessarily extend all the way across the Strait to the Sunshine Coast.

When there is a different structure of winds aloft, the southwest winds that develop behind a front—often referred to as “downslope winds”—can be much stronger and more dangerous than normal. The dynamics behind these winds are not fully understood; however, when a very deep, well-organized low moves rapidly toward Vancouver Island from the southwest, the associated front is very strong. Pressure falls quickly ahead of the low but rises even faster (by as much as 8-12 mb in three hours) after it has passed. The accompanying southwest winds aloft can reach up to 40-60 kt at the top of the Vancouver Island mountains. What makes this system particularly dangerous is the temperature inversion that occurs over the mountains, creating an invisible boundary over the area. This prevents the strong winds flowing over the Island from dissipating upward and forces them to interact with the mountain tops themselves.

As it passes over the mountains, the wind gains added rotation from frictional effects, which effectively thrust it downward onto the sea—in much the same way as a bow-shaped wave forms over a rock lying just below the surface of a stream. Winds can rise suddenly to speeds of 40-50 kt; however, they do not usually last more than an hour or two and do not always



Southwest winds and waves using the example of 1000hrs, 20 December 1997 with a pressure-slope direction of 190° and a slope steepness of 3.0 mb per 60 nm.

reach sea level. The rapid infilling of winds into the Strait quickly increases air pressure over the area and equalizes the pressure difference between the east and west sides of the Island. These powerful winds are not limited to mountain passes and can occur anywhere from around Qualicum Beach to Chemainus.

Mariners' Tips:
Strong southwest winds often develop just after the skies break, following the passage of the front. Very rapid pressure rises at locations on the west side of Vancouver Island—such as Tofino and Amphitrite Point—could provide very short advance warning of the onset of these winds.

Although most harbours on the Sunshine Coast are open to the southwest, winds seldom blow straight into their mouths. Qualicum winds do not generally extend east of Texada Island, and southerwesterlies on the Sunshine Coast are usually only light, transitional winds following the passage of a front. While downslope winds sometimes occur on the Sunshine Coast, they are formed by the mountains of Texada Island rather than Vancouver Island. Reports have also been made of strong southwest winds passing over Savary Island to Lund. These winds, which can occur once or twice a year, generally appear as noisy squalls that arrive with no advance warning and last only a few hours.

2.1.1.5 Local Waves and Currents

The most dangerous conditions for mariners are often due not only to strong winds but also to the rough seas created by these winds and the ways they are affected by opposing tidal currents. With strong southeast winds and opposing tides, conditions near Cape Mudge and at the south end of Texada Island, near Sabine Channel, can be extremely challenging. The seas off Jervis Inlet can reach 1.5 m when southeast winds blow against an ebb tide and as much as 2.5 m when strong outflow winds oppose a flood tide.

The development of wind waves is strongly restricted by fetch limitations. Texada and Lasqueti islands, for example, effectively divide the Strait in two because they limit the potential fetch to about half its total length. Wind waves from southeast winds will break over the shallower waters near the coast, such as the Comox bar and near Oyster Bay. Swells will move into some coastal areas where the full strength of the winds doesn't reach, as occurs with southeast winds in Nanoose Bay. Parts of the Malaspina Peninsula also get a certain amount of westerly swell even though most of the northwest winds pass offshore. Savary Island provides some lee shelter but very strong waves occur around it. Strong northwesterly winds do not produce as large a sea in Malaspina Strait as do winter southeasterlies. In general, the northwest wind produces only light chop.

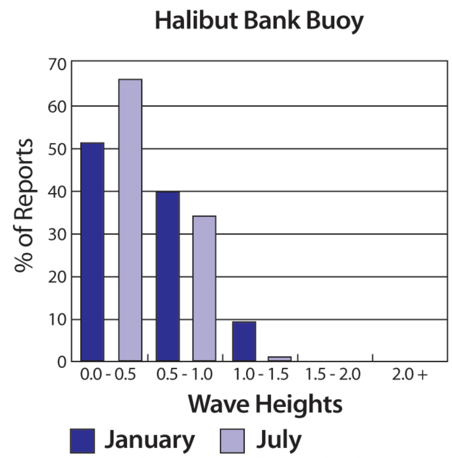
The water temperature in the Strait of Georgia warms noticeably over the summer months, unlike the cooler waters of the Juan de Fuca Strait. A marked reduction in the salinity of the Strait also occurs during the spring and summer months due to runoff from the Fraser River.

2.1.1.6 Local Weather

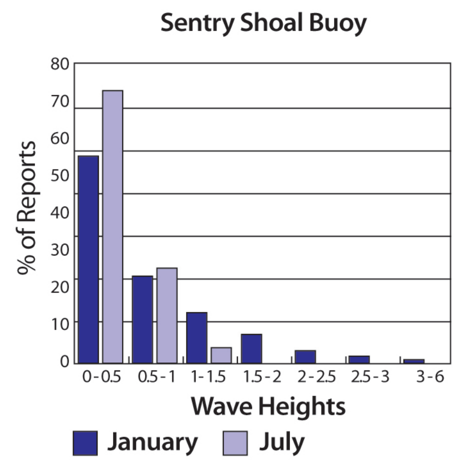
Most periods of rain occur with east or southeast winds. If the pressure-slope direction turns back toward an outflow pattern, the rain will end and, if the wind is strong enough, the sun will appear. Sunshine often follows the return of the northwest wind; if it doesn't, temperatures may remain fairly cold. The outflow pattern produces northwesterly winds over the northern parts of the Strait and southeasterlies in the south. The increased upward motion that develops along the line of converging winds may enhance the amount of cloud and precipitation. In other situations where there are converging winds, waterspouts will occasionally develop. The islands that lie within the rain shadow downwind of Vancouver Island receive enough sun and warmth to allow cactus to grow. It has been said that the temperature sometimes gets so warm near Jedediah Island that it has a hot smell similar to that of the Okanagan.

Fog is most common in late summer and early autumn. It usually burns off by 1000 or 1100 hours but can sometimes last all day. In winter, if fog rolls in overnight it may remain for much of the following day. Fog develops in some coastal inlets when cold air spills out over the warmer water or radiation fog formed over the land drifts down onto the sea. In general, it occurs only when the winds are light, although advection fog from the Gulf Islands may spread upward accompanied by stronger winds.

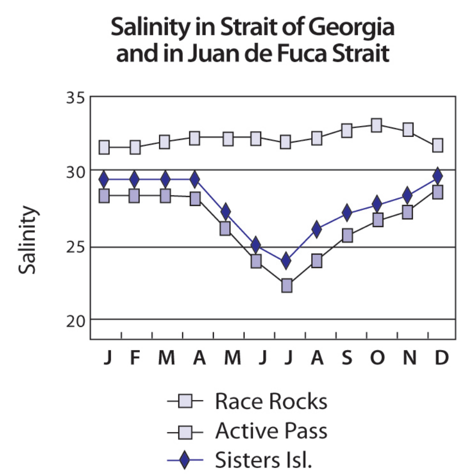
In one situation in September, there were strong northwest winds down the Vancouver Island side of the Strait and



Frequency of wave heights



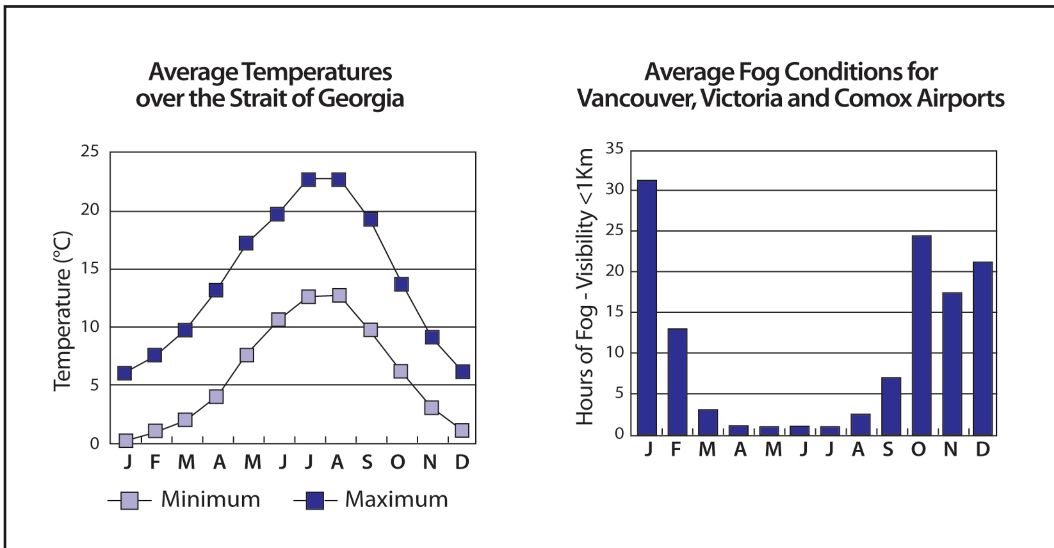
Frequency of wave heights

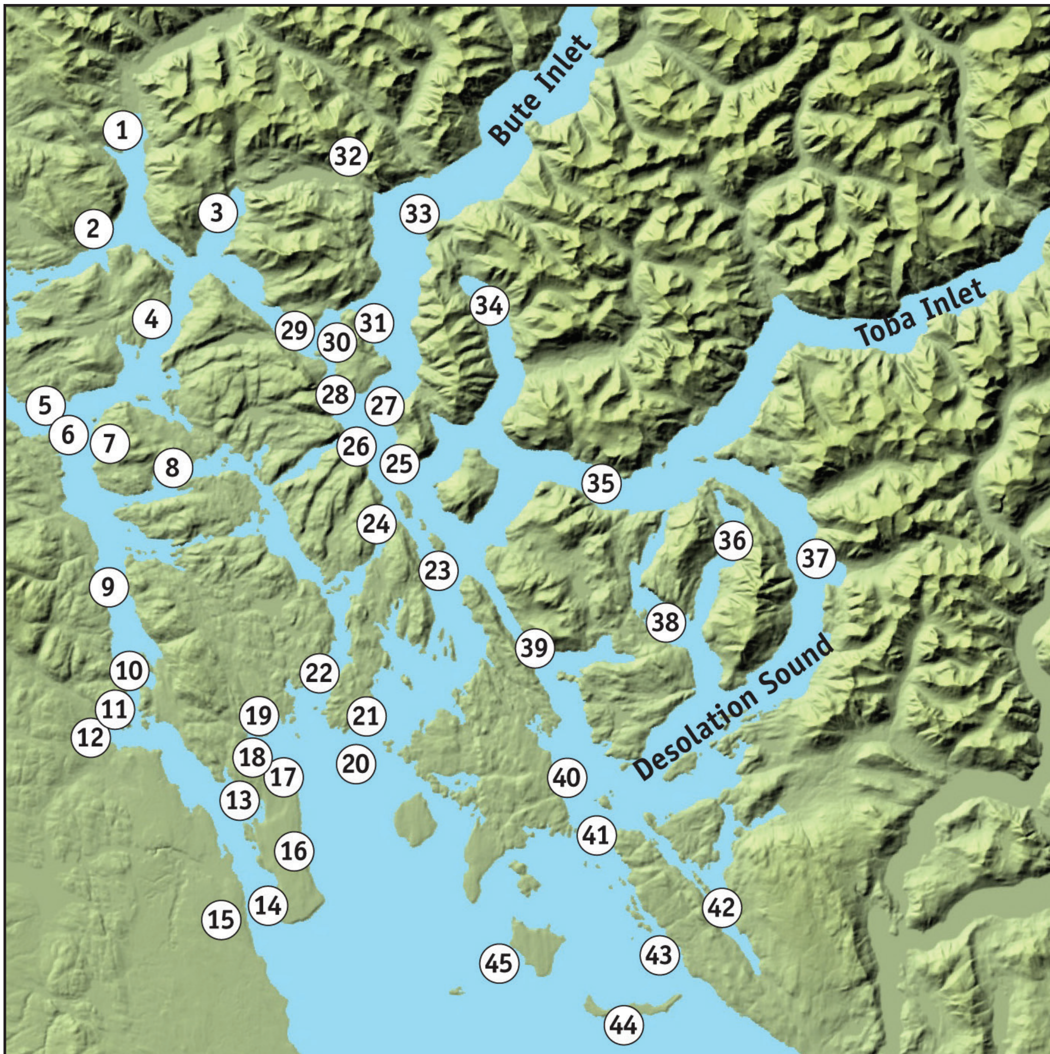


Salinity values in parts per thousand

light southeast winds along the Sunshine Coast. Fog developed in the light southeast winds and hugged the Sunshine Coast, while out near the border between the two winds, shear eddies could be seen in satellite images. These eddies often form in similar wind patterns during a winter outflow event; however, without any fog, they are invisible.

During a northerly Arctic outflow event, the amount of snow that falls is generally quite light, except when additional moisture is added to the air. This can occur when the air flows over water or a low approaches from offshore. The mountainous Malahat area, south of Nanaimo, can receive considerable snowfall when outflow winds move out of the Fraser Valley and cross the southern Strait of Georgia.





Desolation Sound

1. Phillips Arm
2. Cordero Channel
3. Frederick Arm
4. Nodales Channel
5. Johnstone Str.
6. Chatham Pt.
7. Discovery Mtn.
8. Okisollo Channel
9. Discovery Passage
10. Plumper Bay
11. Seymour Narrows
12. Menzies Bay
13. Gowlland Harbour
14. Cape Mudge
15. Campbell River
16. Quadra I.
17. Drew Hbr.
18. Heriot Bay
19. Hyacinthe Bay
20. Subtle I.
21. Sutil Channel
22. Hoskyn Channel
23. Read I.
24. Whiterock Passage
25. Calm Channel
26. Maurelle I.
27. Johnstone Bluff
28. Sonora I.
29. Yuculta Rapids
30. Big Bay
31. Stuart I.
32. Estero Basin
33. Fawn Bluff
34. Ramsay Arm
35. Pryce Channel
36. Pendrell Sound
37. Homfray Channel
38. Redonda I.
39. Lewis Channel
40. Cortes I.
41. Sarah Pt.
42. Okeover Inlet
43. Malaspina Pen.
44. Savary I.
45. Hernando I.
46. Mittlenatch I.

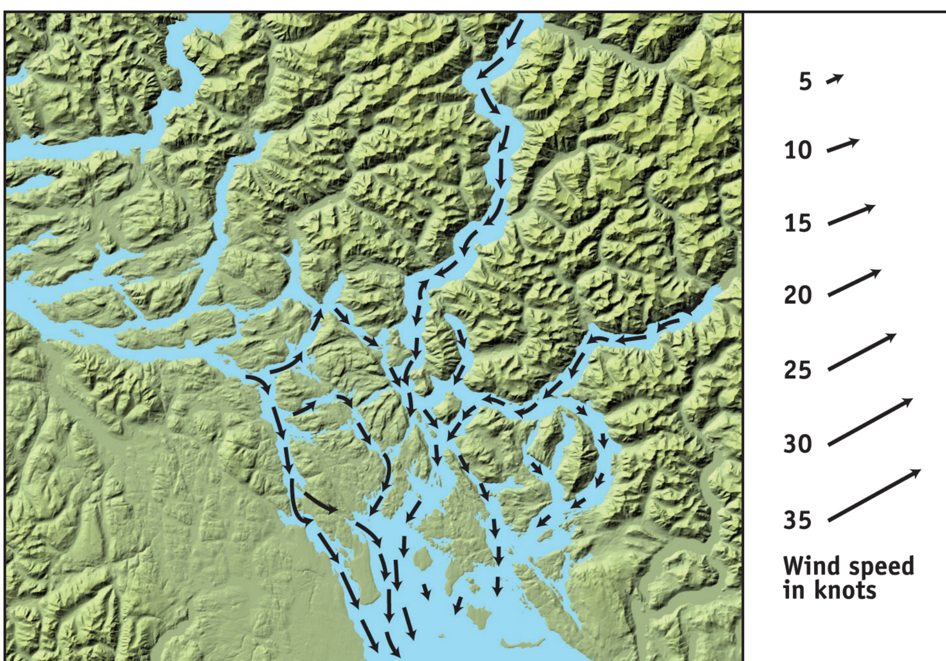
2.1.2 Desolation Sound

Desolation Sound encompasses the area from Bute and Toba inlets to Cape Mudge and the northern Malaspina Peninsula. Like the Gulf Islands, the complex topography of this island region makes it prone to a variety of local winds, not all of which can be described or are fully understood.

The winds in the Sound approach from four directions: the northwest, northeast, southeast, and southwest. Northwest winds occur with five of the seven regional wind patterns; however, in some areas, northeast winds are also frequent. Winds blowing from the southeast over the western portion of the region will back more to the east; over the eastern portion, more to the northeast. Southwest winds are primarily light and short lived, except for the afternoon sea breezes that blow up Bute and Toba inlets in summer. The eastern part of Desolation Sound experiences little or no wind, regardless of the wind pattern. Over the western parts of the region, the tides have sudden, severe, and often chaotic effects on conditions—and can vary greatly from day to day, regardless of the wind.

2.1.2.1 Northwest Winds

The diurnal northwesterly winds that occur during the summer in the Strait of Georgia begin as westerlies in the Queen Charlotte Strait. As the winds move down into Johnstone Strait, they increase in speed due to funneling, often reaching their peak just east of Kelsey Bay. Fanny Island usually reports winds 5-10 kt lower than this maximum value. The winds continue down Johnstone Strait, reaching Chatham Point during the evening, and then split into several possible channels. When there is lower pressure over the central BC Interior,



Overnight westerly pressure-slope with a slope steepness near 1.0 mb per 60 nm.

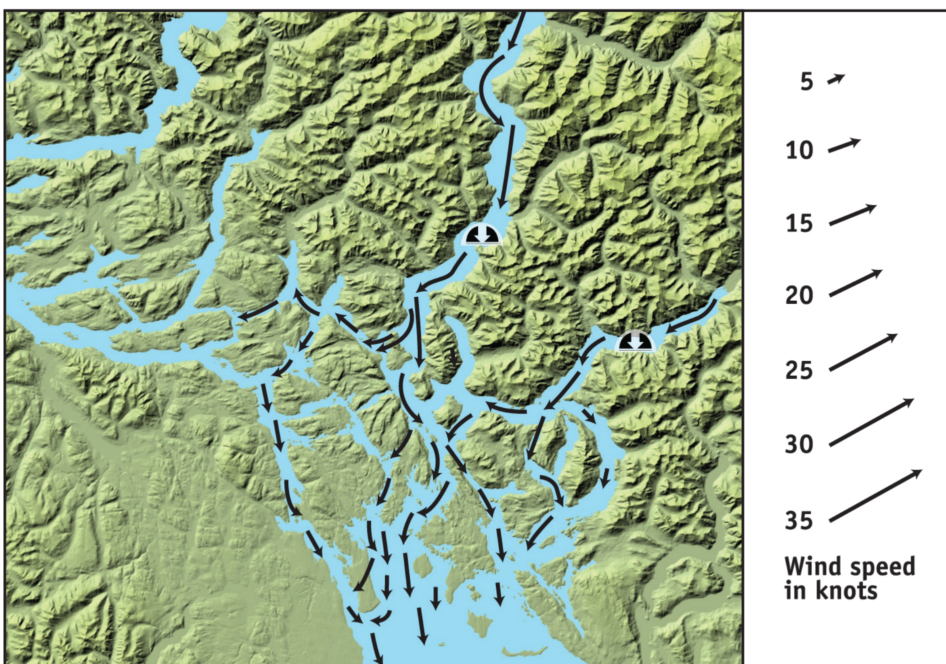
some are drawn up Nodales Channel. The westerlies that take this route are usually lighter than those at Chatham Point and are not typically threatening. Another part of the flow is deflected off Discovery Mountain and down Discovery Passage.

In Discovery Passage, the winds again have the potential to divide, which means the flow in any channel is usually less than it was in Johnstone Strait. At Plumper Bay, some winds head through Seymour Narrows and some cut across the low part of southern Quadra Island and over Hyacinthe Bay before entering the southern part of Sutil Channel. About an hour after the winds enter Discovery Passage, some lighter winds are drawn through Okisollo Channel and south, out Hoskyn Channel. These northwest winds frequently switch to a light southeast sea breeze between 1100 and 1300 hours.

Strong westerly winds rarely reach the eastern parts of the region around the Redonda Islands. Homfray Channel is usually quiet, with only light westerlies blowing. Some channels and inlets are more likely to draw inflow winds with a southwesterly pressure-slope pattern. Pryce Channel often sees inflows of 10-15 kt in the afternoon, and Bute Inlet often draws a strong inflow on summer afternoons that is so regular, one could set a watch by it. Outflow drainage winds also occur in most inlets on summer nights, especially those with glaciers or cold lakes at their head.

2.1.2.2 Outflow and Northeast Winds

The main thrust of the Arctic outflow winds in Desolation Sound comes out of Bute Inlet and, to a lesser extent, Toba Inlet. Bute winds are generally much stronger than outflows in



An outflow event with a pressure-slope between 020° and 050° and a slope steepness between 3 and 5 mb per 60 nm.

Howe Sound or Jervis Inlet and are, by far, the biggest influence on conditions in Desolation Sound during the winter. In Knight Inlet, a short distance north, the winds are almost as strong, but its turns break up the flow and create more places to hide. Bute winds begin in the Chilcotin region of the BC Interior and flow through the Homathko and Southgate river valleys, passing several glaciers before descending into the inlet—accelerating to speeds of 60-70 kt by the time they reach its mouth. Two places that offer some shelter from the winds are just south of Fawn Bluff and below Johnstone Bluffs, just south of Stuart Island.

Mariners' Tips:

"Bute winds are fierce, they come out like an air hose, with no gusts, just steady."

"If you hear a roar up in the mountains, you have four hours to get out of the inlet."

"The winds are so strong, you can't cross the mouth of Bute during an outflow."

"Bute winds are very vicious; you need to respect them."

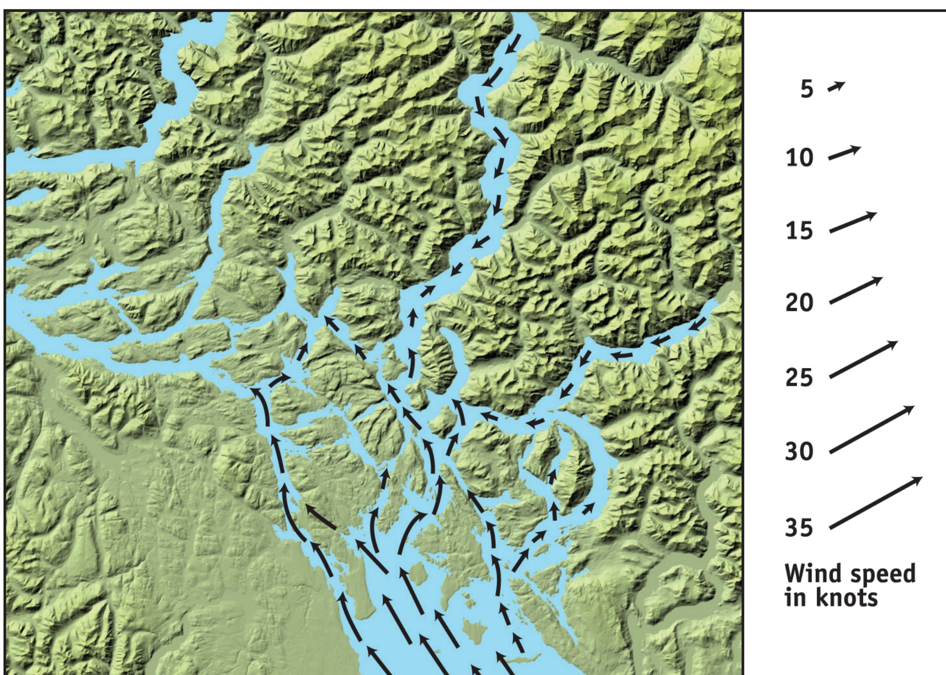
After northerly pressure-slope winds move down the inlet, they pass just south of Stuart Island and hammer hard on Maurelle Island. The main flow usually ends near the northern tip of Read Island. Downburst winds have been reported in Big Bay, on the southwest side of Stuart Island. Calm Channel can be anything but where the main plume of a strong outflow crosses from Bute Inlet to northern Read Island. Part of the flow will head down Whiterock Passage, through Hoskyn Channel, and into Sutil Channel; another part, into Sutil Channel east of Read Island. As they pass over the channel, the outflow winds cross low terrain on southern Quadra Island, sending northeast winds to the Cape Mudge lighthouse. Along the shore south of the lighthouse, however, conditions can remain calm. When eddies form with the outflow winds at the southern end of Quadra Island, the Cape also receives east to southeast winds. During one outflow event, this path of winds was clearly visible on a satellite image as it cut a narrow swath through a layer of fog over the northern Strait of Georgia, almost all the way down to Comox.

In some situations, the winds proceed down Calm Channel and into Lewis Channel; however, this is normally a much weaker branch than the winds on the other side of Cortes Island that blow through Sutil Channel. When outflow conditions are very strong and the winds have been blowing for several days, the depth of the cold air in the region becomes progressively higher. This causes strong winds to cross the low peninsula at the southern end of Bute Inlet and move across Estero Basin, down Frederick Arm, and into Nodales Channel. After the cold air has, once again, built up sufficiently, strong outflows may also occur in Ramsay Arm, Phillips Arm, and Loughborough Inlet. The outflow from Toba can be extreme in Pryce Channel yet light or even flat calm in Homfray and Lewis channels and Desolation Sound itself. Since they tend to follow the orientation of the channels, the Toba outflow winds are more easterly in comparison to the near northerly Bute winds.

2.1.2.3 Southeast Winds

The eastern side of the region receives only a fraction of the southeast winds that come up from the Strait of Georgia because their flow is disrupted by the Savary and Hernando islands. The winds in the eastern half of the region are backed into the east or northeast, as in an outflow pattern. Some southeast winds move into Lewis Channel, but they are not generally dangerous and only produce a little chop. It is said that if mariners can cross between Heriot Bay and the south end of Read Island during a southeast blow, they can go anywhere in Desolation Sound.

With an approaching front, most of the southeast winds move up into Discovery Passage and across the southern part of Sutil Channel. The ferry between Quadra Island and Cortes Island is occasionally cancelled during the winter due to strong winds and high seas. From Sutil Channel, the winds funnel up Hoskyn Channel but dissipate as it widens out just south of Surge Narrows. The main strength of the southeast winds does not reach much past the Subtle Islands. Some pass through Sutil Channel and into Ramsay Arm, but they don't usually enter Bute Inlet. In Discovery Passage, the winds are strongest on the western side, up to Menzies Bay and Seymour Narrows. Some of the winds crossing Menzies Bay likely also pass up Menzies Creek. According to some reports, the winds generally ease just north of Seymour Narrows but may strengthen again near Chatham Point as a result of corner effects and winds coming out of Nodales Channel. Gowlland Harbour is generally protected from southeast winds, while Cape Mudge receives some lee shelter when they are backed east of southeast.



An example of an easterly pressure-slope near 080° with a slope steepness between 3 and 4 mb per 60 nm.

2.1.2.4 Inflow and Southwest Winds

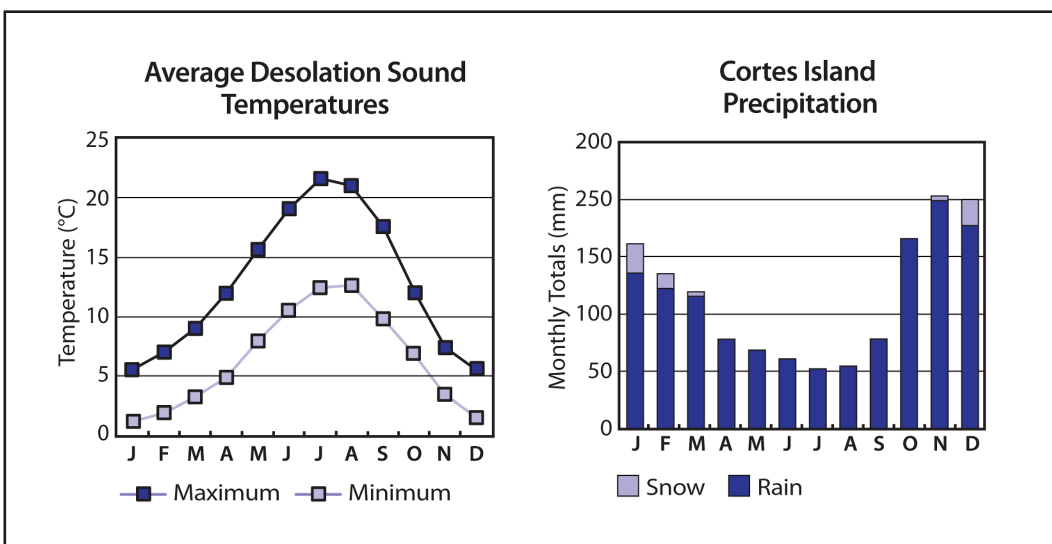
Southwest winds are not common in Desolation Sound but do occur with two certain types of weather. After the passage of a front, winds in the region shift from the southeast toward the northwest. For an hour or so during this shift, southwest winds can occur, generally at speeds of less than 15 kt. In the summer, Bute Inlet can draw up strong southerly winds, particularly near its head; however, these typically last for only an hour or two in the late afternoon. Summer westerly winds flow through Pryce Channel at speeds of about 10-15 kt before moving into Toba Inlet, where inflow winds tend to be weaker than those in Bute Inlet.

2.1.2.5 Local Waves and Currents

The build-up of seas through most of this region is severely limited by the fetch and will generally be highest at the downwind end of a channel. Due to its extreme outflow winds, the seas in the southern end of Bute Inlet can build up to nearly 4 m.

The main flood tide in this area comes down Discovery Passage and meets the tide coming up from Juan de Fuca Strait at a point just south of Mittlenatch Island. The eddies that form on the southwestern corner of Quadra Island during the flood tide create a northward current close to the shore. Part of the tide also turns around the bottom of the island and moves up its eastern side as far north as the Breton Islands. A back eddy often forms near the southeastern tip of Quadra as the tide turns northward, causing the current near the shore to move southward, as if it is an ebb. These tidal eddies—which sometimes number two or three—are strongly influenced by coastal topography, and can form, break down, and quickly reform, although not necessarily in the same location.

This region is known for having warm water temperatures. The fresh water that flows into Bute Inlet forms a layer on top of the salt water that heats up much faster than the underlying waters.

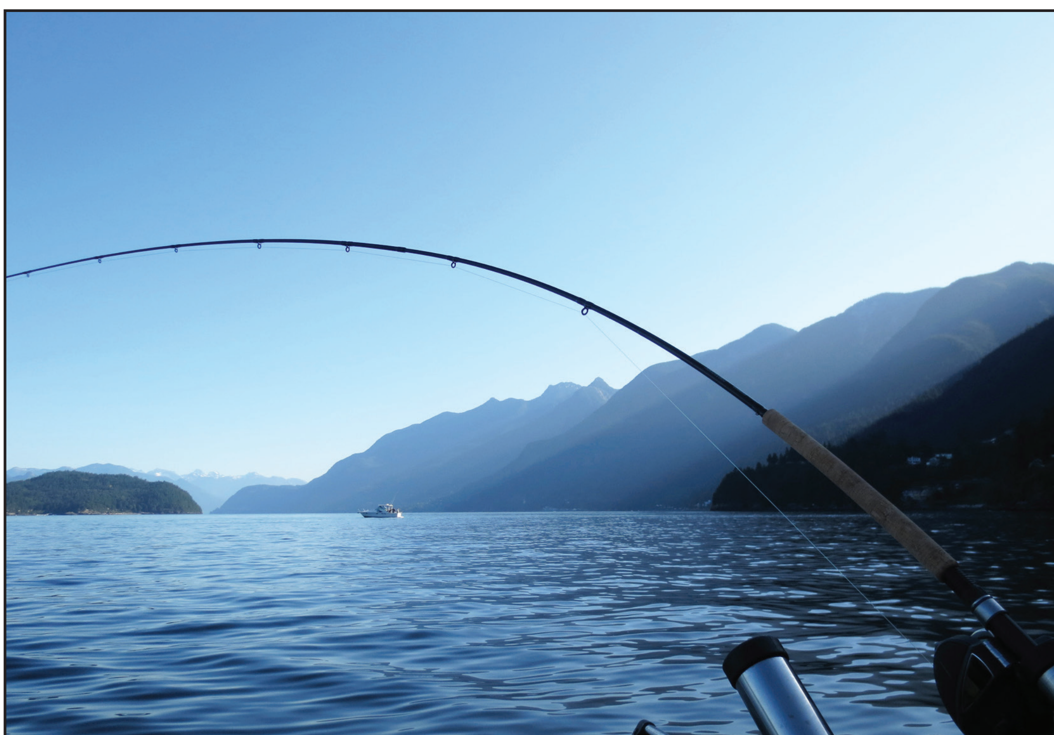


2.1.2.6 Local Weather

Precipitation can vary widely throughout this region, as it is strongly linked to regional wind patterns and interaction with the local topography. For example, while the amount of rainfall can be significant in the mountainous areas of northern Quadra Island, the total annual rainfall at Drew Harbour in southern Quadra Island is about the same as it is in Vancouver's Stanley Park. In the winter, snowfall is the heaviest on mountain sides facing strong outflow winds. The mountains on Stuart and Maurelle islands, in particular, receive large amounts of snow.

Several locations across the Georgia Basin appear to experience significant changes in their wind and weather patterns—Seymour Narrows, in Desolation Sound, being one of them. It is said that going north through Seymour Narrows and the Yuculta Rapids is like going through a door into another room, with both colder water and air. Precipitation amounts are also different on opposite side of the Narrows. Sarah Point is a similar transition point for clouds, with more to the north.

Sonora, Maurelle, Quadra, and other islands downwind of Bute Inlet can also experience heavy snowfall, which can extend to the area north of Campbell River. When rain falls through air that is below freezing, it can form super-cooled droplets that freeze immediately on contact with an object. This freezing rain occurs most frequently at the heads of inlets or valleys, when warm air associated with a warm front is forced over top of a cold outflow from the inlet.



Juan de Fuca Strait

1. Carmanah Pt.
2. Port San Juan
3. Sombrio Pt.
4. River Jordan
5. Sheringham Pt.
6. Otter Pt.
7. Sooke Bay
8. Beechey Head
9. Race Rocks
10. Pedder Bay
11. William Head
12. Albert Head
13. Trial I.
14. Gonzales Pt.
15. Discovery I.
16. Victoria
17. Sam Juan I.
18. Smith I.
19 Dungeness Spit
20. Port Angeles
21. Slip Pt.
22. Tatoosh I.

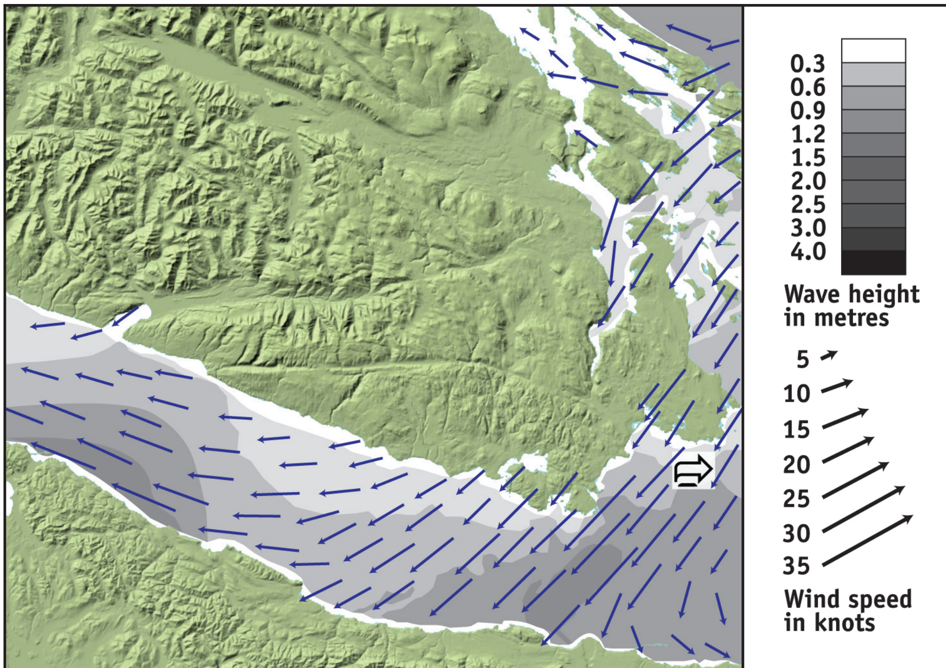
2.1.3 Juan de Fuca Strait

Juan de Fuca Strait experiences only two types of wind: easterly and westerly. These winds vary from northeast to southeast and northwest to southwest, respectively. In the winter, winds are mainly northeasterly on the eastern side of the Strait, but they turn to easterly over western sections. In the summer, westerly winds are far more common. Maximum winds at Race Rocks range from 55 kt in winter to 40 kt in summer.

2.1.3.1 Easterly Winds

Northerly pressure-slope pattern

When a ridge of high pressure lies to the northwest of the region, light westerly winds blow through Juan de Fuca Strait. As the pressure rises over the BC Interior, the pressure-slope direction rotates toward the north. Northwest winds in the Strait of Georgia turn to the north and northeast as they push south across the Gulf and San Juan islands, past Victoria and into the eastern end of Juan de Fuca Strait. Initially, the winds are very light, but as the pressure-slope direction rotates toward the northeast and the slope steepness increases, the winds off Victoria become northeasterly and increase to 10-15 kt. These winds move across the Strait and bank up against the Olympic Mountains, where they are steered westward along the Washington coast. The winds along the shore of Vancouver Island, west of Race Rocks, are quite light but continue as a weak northeast land breeze.



Winds and waves using the example of 2200 hrs, 28 December 1996 with a pressure-slope direction of 045° and a slope steepness of 7.0 mb per 60 nm.

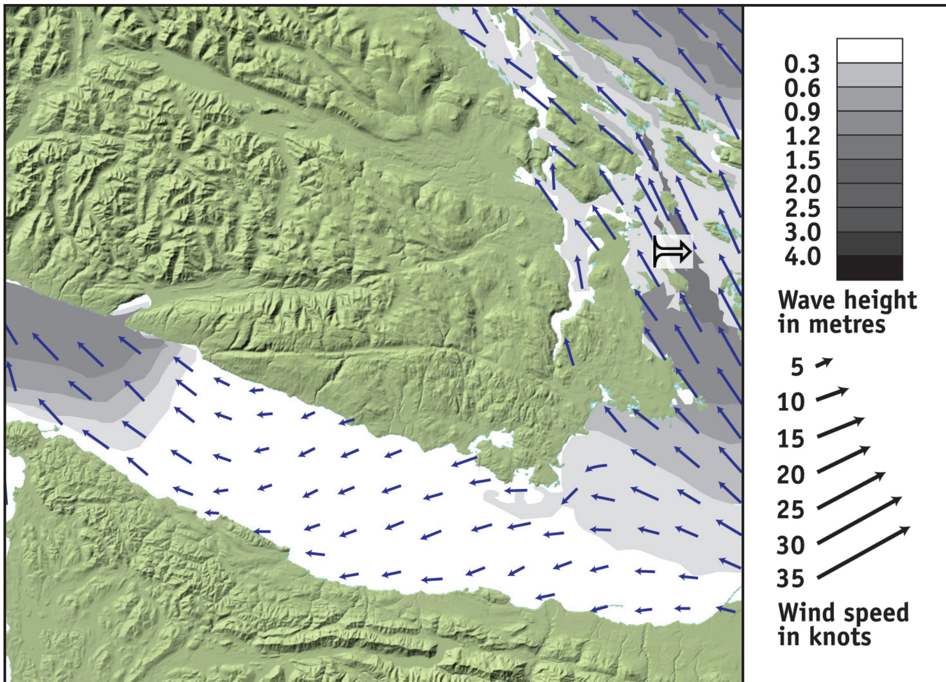
Northeasterly pressure-slope pattern

The strongest northeast winds occur with a northerly outflow from the Fraser Valley. During very strong outflow events, when the winds at Trial, Discovery, and Race Rocks rise to 30-40 kt, the winds west of Race Rocks, along the Vancouver Island coast, are typically east-northeast at less than 15-20 kt. A plume of strong northeast winds extends past Race Rocks to the Washington coast just west of Port Angeles, producing easterly winds of 30-40 kt along the shore from there to Tatoosh Island. A small portion of these winds is deflected eastward to form a weak counter-clockwise circulation just west of Dungeness Spit. In the middle of the Strait, easterly winds of 25-30 kt are possible.

With outflow winds during the summer, the winds at Tatoosh Island are usually strongest late at night and in the early morning. As the land begins to heat up on the Vancouver Island side after daybreak, this plume of winds is drawn toward Vancouver Island. Winds of 15-25 kt are reported at Pachena Point and Cape Beale from mid-morning until early afternoon; about 5-10 kt less than the maximum at Tatoosh Island. In a particularly strong easterly flow, east to southeast winds of 20 kt can occur as far east as Carmanah Point and even Port San Juan. This oscillation of winds—often referred to as the “Tatoosh-Carmanah wobble”—may also occur in winter when the winds are stronger and the skies are relatively clear; however, the timing of the shift does not appear to be as closely linked to a diurnal cycle.

Easterly pressure-slope pattern

In this region, the winds ahead of a front are generally called easterlies, although they can vary, both in time and space, from northeast to southeast. When a front approaches from the



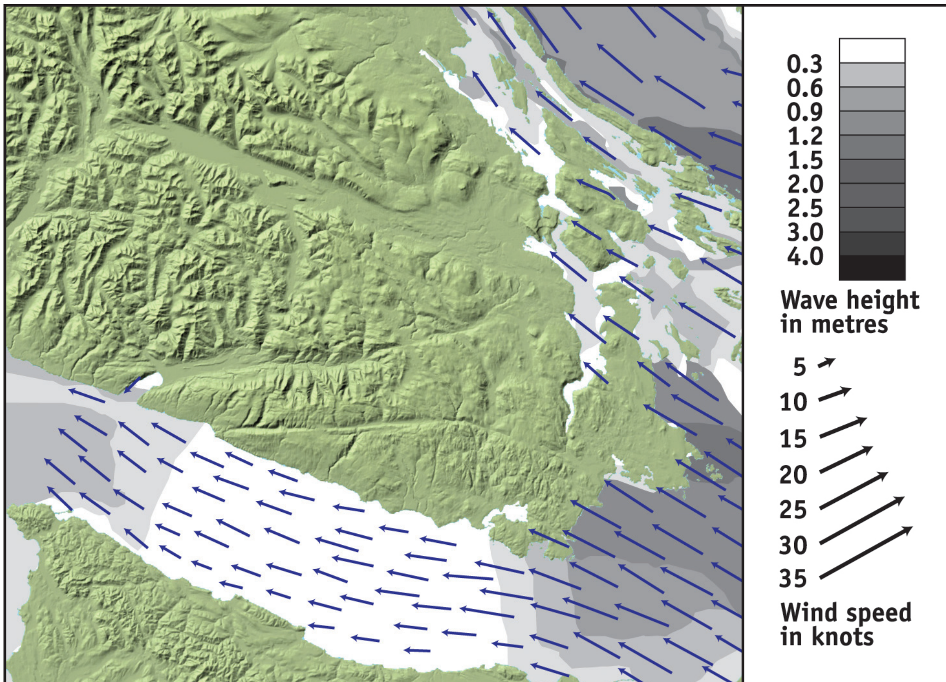
Winds and waves using the example of 1900 hrs, 18 March 1997 with a pressure-slope direction of 110° and a slope steepness of 3.5 mb per 60 nm.

southwest, the pressure-slope direction backs into the northeast, producing northeast winds across the Gulf and San Juan islands. When it approaches from the northwest, however, the pressure-slope direction backs to the east or southeast (100-130 °). In this situation, a plume of strong southeast winds moves out of Puget Sound and northward across the Gulf and San Juan islands. If the southeast winds are particularly strong, the plume may have a very sharp edge and present a formidable wall when approached from the west.

When Discovery Island has southeast winds of 30-35 kt, the winds through the western parts of the Strait do not usually rise much above 15 kt. In much stronger events, when Trial, Discovery, and Smith islands have southeast gale-force winds of 40-45 kt or storm-force winds of 50 kt, the western parts of the Strait still receive easterly winds of about 15-25 kt. Closer to Carmanah Point, the winds again increase to stronger southeast winds.

The border between the sub-regions of "Juan de Fuca Strait" and "Victoria and the Islands" lies along the line marking the normal western edge of the strong southeast winds. This line extends from just east of Dungeness Spit to Albert Head, just west of Victoria.

In the winter, most fronts approach the region from the northwest. On occasion, when one arrives from the west or southwest, stronger easterly winds will spread throughout the Strait. The strong southeast winds that move out of Puget Sound become more easterly and spread to Race Rocks, where they can increase to speeds as high as those at Trial and Discovery islands. They then spread into the Strait and, depending on their angle, may strike the shorenear Sheringham Point—at times, remaining there as light northeasterlies.



Winds and waves using the example of 1900 hrs, 25 January 1998 with a pressure-slope direction of 080° and a slope steepness of 4.5 mb per 60 nm.

The stronger easterlies reappear along the coast of Vancouver Island near River Jordan and Carmanah Point, reaching a gale force of 35-40 kt in extreme cases. The winds along the Washington coast are not as strong as they are in an outflow event.

In the Canadian marine forecast, the Canadian waters east of a line from Albert Head to Dungeness Spit are referred to as the "east entrance". In the American marine forecast, Juan de Fuca Strait is divided into three zones: East, West, and Central. The area east of the line between Albert Head and Dungeness Spit is the East zone and is numbered PZZ132. The West and Central zones are numbered PZZ130 and PZZ131, respectively, and divided by a north-south line through Slip Point.

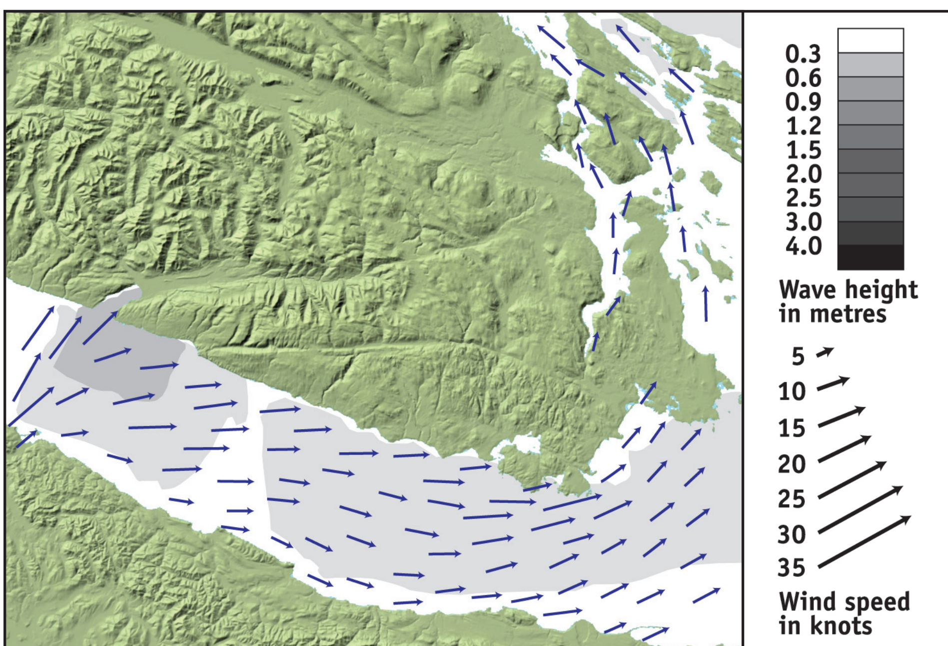
2.1.3.2 Westerly Winds

Southeasterly and southerly pressure-slope patterns

Westerly winds develop after the passage of a front. The direction of the wind flowing into the Strait depends on the direction from which the front approaches. A front from the northwest will produce northwest winds, and a front from the southwest will produce southwest winds. These variations from true west are most pronounced at the western end of the Strait, as the winds are steered somewhat toward due west by the time they reach the eastern end. A weather system that approaches the coast from the southwest will often have more than one frontal trough rotating around it before the ridge behind the system builds sufficiently to produce west or southwest winds. Behind each front, the winds may only make a half-hearted shift into the west before they turn back into the east, ahead of the next approaching front. The onset of strong westerly winds does not occur until a strong enough ridge builds behind the last front in the series.A strong front is usually associated with a deep, tightly wound Pacific low that moves toward northern Vancouver Island. Behind such a front, strong southwest winds will blow over the northwest corner of the Olympic Peninsula and move into the Strait, striking hard against southern Vancouver Island. Winds up to 50 kt are possible in such a situation; fortunately, they do not last too long.

Fronts that approach from the northwest slowly move away from the "parent low" that spawned them, gradually weakening as they drag their way across Haida Gwaii and the northern part of Vancouver Island. As a result, they are fairly weak by the time they reach the southern part of the Island. The southeast winds ahead of the front are an indication of the strength of the winds behind it: if they rise to only 25 kt over the eastern entrance to the Strait, the westerlies that follow will be of similar strength. Likewise, gale-force winds ahead of the front may be followed by gale-force westerlies behind it. Trial, Discovery, and Smith islands are appropriate sites for gauging the strength of the southeast winds.

Westerly winds that are associated with a front from the northwest may actually begin just before the front arrives. Light westerly winds are sometimes formed by a weak ridge that develops just ahead of a front, although the strongest westerlies arrive after it passes. If the upper front is well to the west of the surface front, the strongest westerly winds may not arrive until the upper front passes up to several hours later. This delay may be somewhat misleading, as it might seem to indicate that the winds have shifted into the west and are not very strong—when, in fact, the strongest winds may be still to come.



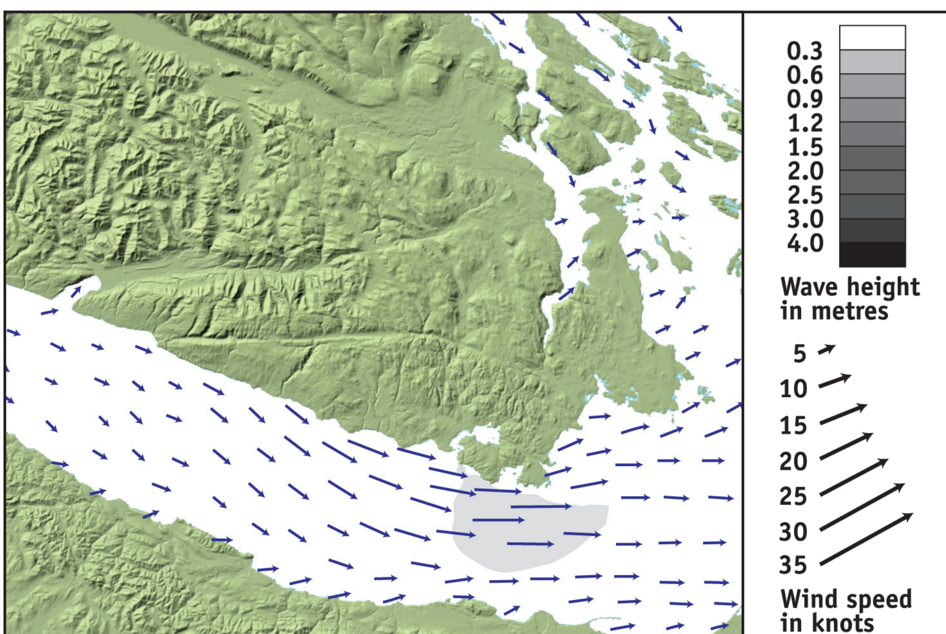
Winds and waves that develop briefly, as a front from the southwest moves across the region, using the example of 2000 hrs, 23 January 1998 with a pressure-slope direction of 135° and a slope steepness of 3.7 mb per 60 nm.

Mariners' Tips:
Westerlies can be extremely dangerous, not only because of their strength but also because of their sudden onset. A mariner should always listen to weather reports from stations upstream of a system's path for news of any significant changes.

Southwesterly, westerly, and northwesterly pressure-slope patterns

On a sunny day summer day, the air over the southwest shore of Vancouver Island and the northern shore of Washington State becomes much warmer than the air over Juan de Fuca Strait. Sea breezes develop along both shores and over the coastal mainland south of Vancouver, resulting in a westerly wind within Juan de Fuca. Known locally as a "heat westerly", the wind gradually increases during the late afternoon, reaching its maximum of about 20-25 kt near Race Rocks during the early evening and usually beginning to lighten up by around midnight. It could also be called a "diurnal westerly" because it goes through a set pattern of development and relaxation over the course of the day.

As a result of the gradual build-up of sea-breeze effects, summer westerlies are lightest at the western end of the Strait and strongest at the eastern end, near Race Rocks. They become lighter east of Race Rocks, where the widening of the Strait reduces both the topographic channeling of the winds and the strength of the sea breeze. The winds at Sheringham are usually 5-10 kt lower than those at Race Rocks, and the winds at River Jordan half as strong as those at Sheringham. Although the winds are westerly in the middle of the Strait, when combined with the local sea breeze, they turn to the southwest along the Vancouver Island coast and to the northwest on the Washington shore.



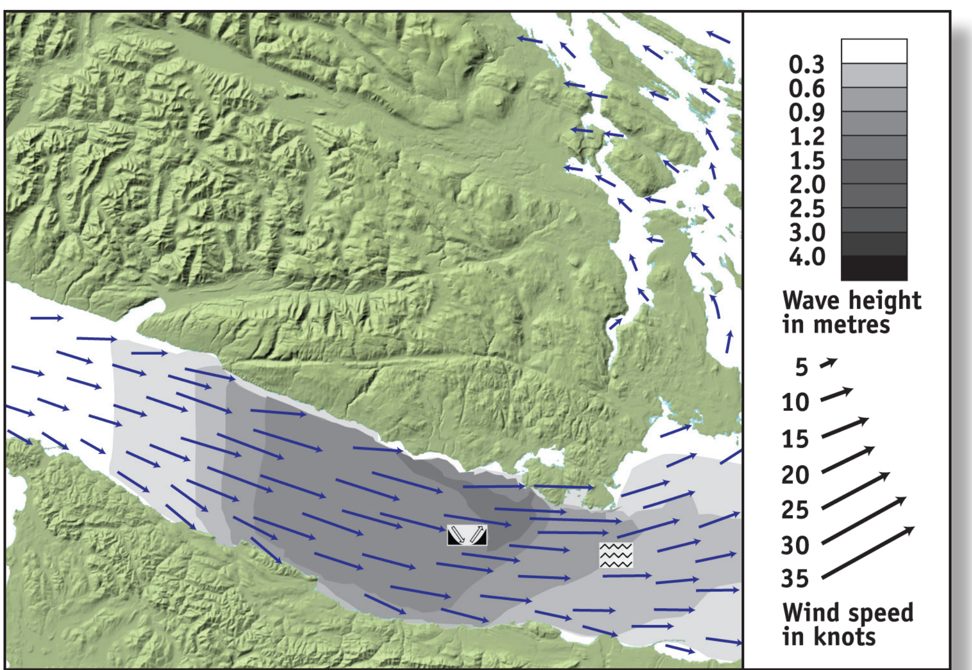
Winds and waves for the morning phase of the diurnal cycle using the example of 0600 hrs, 6 August 1997 with a pressure-slope direction of 300° and a slope steepness of 0.7 mb per 60 nm.

A "heat westerly" occurs in the summer when a surface ridge of high pressure orients itself on a north-south line west of northern Vancouver Island. The northerly flow aloft around this high creates a lee trough along the southwest corner of Vancouver Island. At locations within the trough, such as Cape Beale and Pachena Point, the winds are light and usually from the east. In Juan de Fuca Strait, westerly winds driven purely by the sea breeze will rise to near 25 kt at Race Rocks by early evening. If the ridge shifts to a northeast-southwest line, outflow winds will create northeasterlies in the eastern end of the Strait that will virtually extinguish the sea-breeze winds. If the ridge turns toward a northwest-southeast line, however, the combination of sea-breeze winds and northwesterlies blowing down the west side of Vancouver Island into the Strait could create winds of 35-40 kt at Race Rocks by early evening.

Due-westerly winds remain offshore as they pass Race Rocks. A lee shelter from the winds extends from inside Race Rocks and along the coast toward William Head. With a southwest wind, the flow bends around Race Rocks and spreads closer to the Victoria shore. On occasion, a southwest wind will be drawn into the Sooke Basin, pass over the peninsula, and emerge at Pedder Bay, but it is usually quite light.

Mariners' Tips:

The peak speed of a westerly wind in Juan de Fuca Strait can be estimated by multiplying the pressure difference between Quillayute, on the outer Washington coast, and Whidbey Island (or White Rock) by 10. For example, if the pressure at Quillayute is 3 mb higher than it is at Whidbey, a 30-kt wind can be expected.



Winds and waves for the afternoon phase of the diurnal cycle using the example of 2200 hrs, 6 August 1997 with a pressure-slope direction of 230° and a slope steepness of 1.1 mb per 60 nm.

In the summer, a phenomenon called a "stratus surge" sends a finger of cloud up the coast from northern California to southwestern Vancouver Island. This usually occurs at the end of a prolonged period of low-level offshore flow, which gives hot and sunny weather to most of the coast. Tofino, for example, may see temperatures in the mid- to high 20s on these days. A trough of low pressure or a low-pressure centre then forms just off the coast, sending a plume of cool moist air surging northward. Since the air inside the wave is colder than the water below it, it is accompanied by low stratus and fog. On occasion, a stratus surge will move past the mouth of Juan de Fuca Strait and northward along the west coast of Vancouver Island. At other times, it will stay over the southwestern part of the Island, build up pressure, and force a surge of westerly winds—also carrying low stratus and fog—into the Strait. This is referred to as a "marine push".

2.1.3.3 Local Waves and Currents

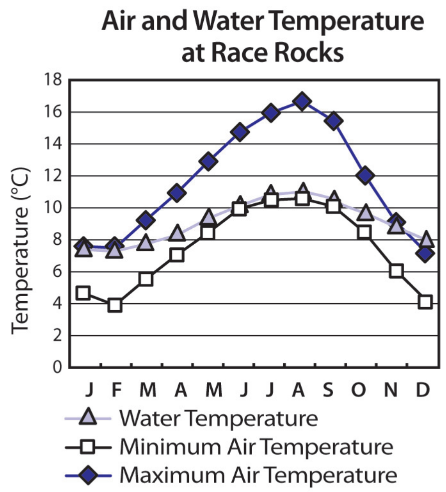
Juan de Fuca Strait is the only part of the Georgia Basin that receives swells from the Pacific Ocean. They can arrive at any time, as they are not connected with the weather systems that create the local winds. Swells are biggest at the western end of the Strait and are usually reduced to a low ground swell by the time they reach its eastern end. River Jordan and Sombrio Point are popular destinations for surfers because of the large swells that can occur in these locations with correspondingly high winds. Swells that can come in against an ebbing tide are shorter, higher, and steeper than they would be with a flooding tide.

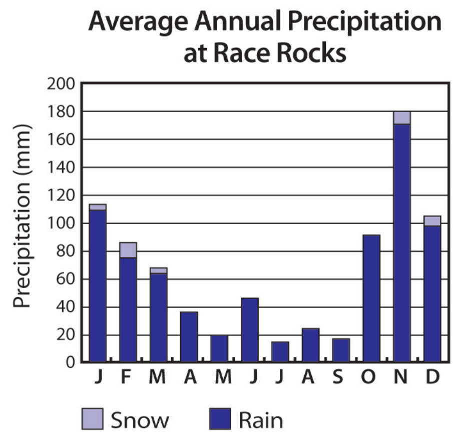
Seas that develop with heat westerlies (which occur, most typically, in summer) are highest in the east, since that is where the winds are strongest. When these westerlies are augmented by northwest winds coming up from Vancouver Island, the seas are higher on the Washington side of the Strait. Seas with frontal westerlies are uniformly strong throughout the Strait, as are the winds. Since most strong frontal westerlies occur in winter, when the air is colder, the same wind speed will produce higher seas than it would in summer.

The tides are most affected by the topographical features at the eastern end of the Strait, especially east of Otter Point. The bigger the tide, the bigger the back eddies that develop along the coast. When an ebb tide flows out of the Strait, a back eddy often forms so close to the shore near Beechey Head that it looks like an incoming flood. Wherever the tidal current opposes the wind waves, the seas will be much sharper and more difficult to handle with a small boat. The most dangerous areas in such cases are near prominent points and over banks.

2.1.3.4 Local Weather

August and September are the primary months for fog. While it usually remains at the entrance to the Strait, fog occasionally moves in as far as Race Rocks and only rarely into Albert Head. Fog tends to occur more frequently along the Washington coast, hinting at the northwest component of the winds that bring it. With a stratus surge, fog can move all the way into the Strait, but it generally lifts into a stratus cloud as it reaches the warmer waters at the eastern end. The air temperature is moderated toward the water temperature, so the stratus may evaporate gradually as it moves northward over the Gulf and San Juan islands, spreading only cooler, more humid air. The precipitation drops off noticeably in December, when the dominant flow pattern shifts toward the east and northeast.

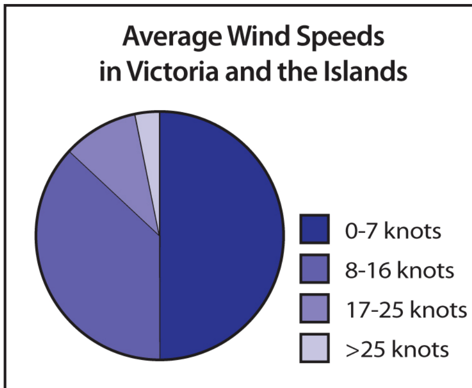




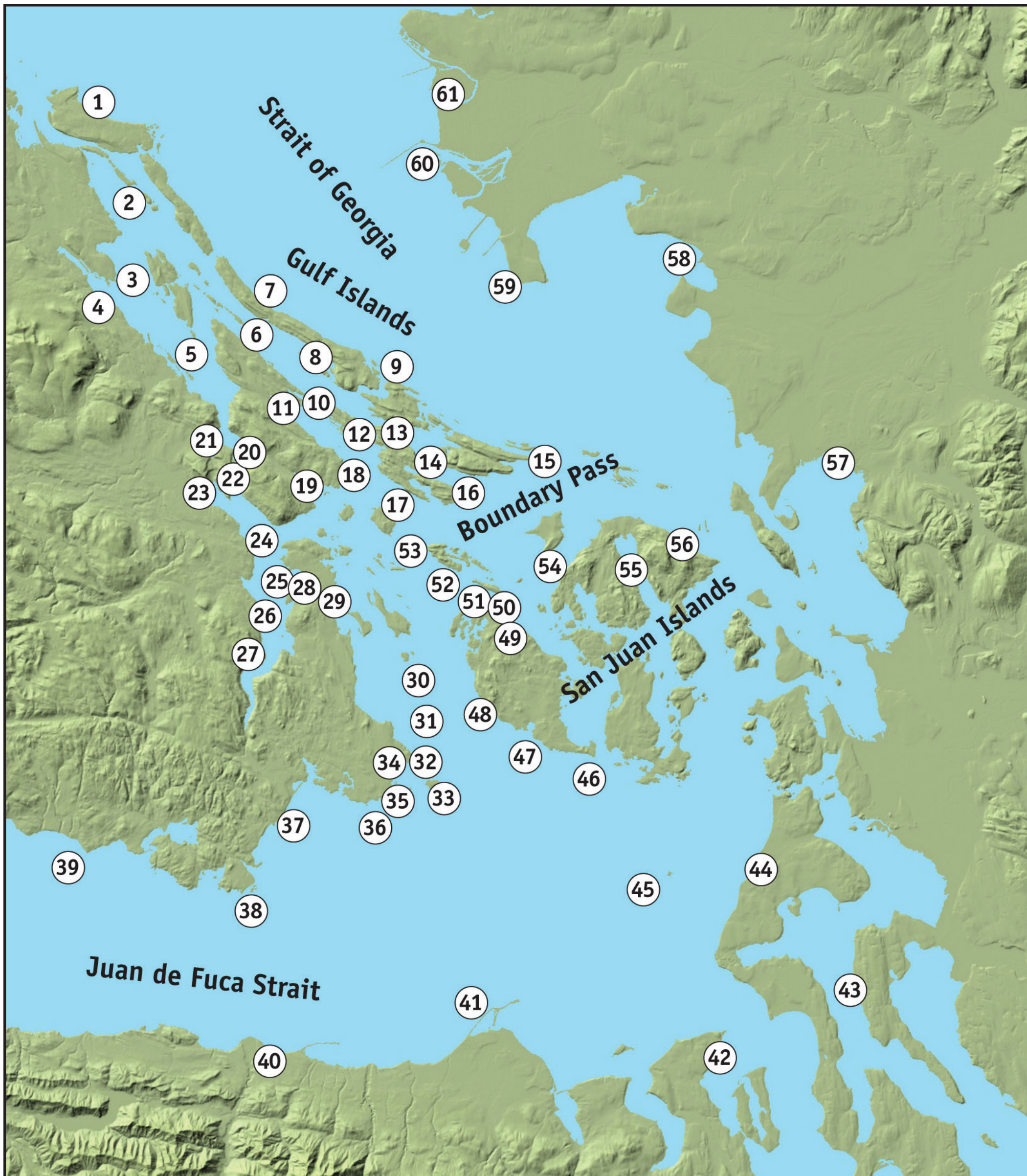
2.1.4 Victoria and the Islands

This region, while not located at the exact geographical centre of the Georgia Basin, is a pivotal point of balance for its wind flow. It changes little, even though conditions on either side of it can swing strongly one way or the other. Winds here are generally light; however, strong winds can sometimes flow in from elsewhere in the Basin. The local winds rotate around the compass, in lock-step with the rotation of the local pressure slope.

The Olympic Mountains of Washington State strongly influence the weather in the region, while the mountains of Vancouver Island and the Coast Mountain Range have a slightly smaller impact. Winds in the region generally originate from one of the five inlets that surround it: Juan de Fuca Strait, Puget Sound, the Fraser River Valley, Howe Sound, and the Strait of Georgia. The Cowichan Valley on Vancouver Island also has an effect on winds, although it is highly localized, as does the location of a lee low. A lee low develops east of Port Townsend when there is southwest flow over the surrounding mountains, and



Frequency of wind speeds in the Victoria and the Islands region, based on data from Victoria Gonzales Heights and East Point.



Victoria and the Islands

1. Entrance I.
2. Ruxton I.
3. Thetis I.
4. Ladysmith
5. Stuart Channel
6. Trincomali Channel
7. Galiano I.
8. Montague Harbour
9. Sturdies Bay
10. Captains Passage
11. Ganges Harbour
12. Prevost I.
13. Navy Channel
14. Plumper Sound
15. East Point
16. S. Pender I.
17. Swanson Channel
18. Beaver Pt.
19. Fulford Harbour
20. Burgoyne Bay
21. Maple Bay
22. Sansum Narrows
23. Cowichan Bay
24. Satellite Channel
25. Patricia Bay
26. Saanich Inlet
27. Malahat
28. Victoria Airport
29. Sidney
30. Kelp Reef
31. Haro Strait
32. Baynes Channel
33. Discovery I.
34. Cadboro Bay
35. Gonzales pt.
36. Trial I.
37. Albert Head
38. Race Rocks
39. Otter Point
40. Port Angeles
41. Dungeness Spit
42. Port Townsend
43. Camano I.
44. Whidbey I.
45. Smith I.
46. Cattle Pt.
47. San Juan I.
48. Lime Kiln Light
49. O Neil I.
50. Limestone Pt.
51. Spieden Channel
52. Stuart I.
53. Turn Pt.
54. President Ch.
55. East Sound
56. Orcas I.
57. Bellingham Airport
58. White Rocks
59. Point Roberts
60. Sand Head
61. Vancouver Airport

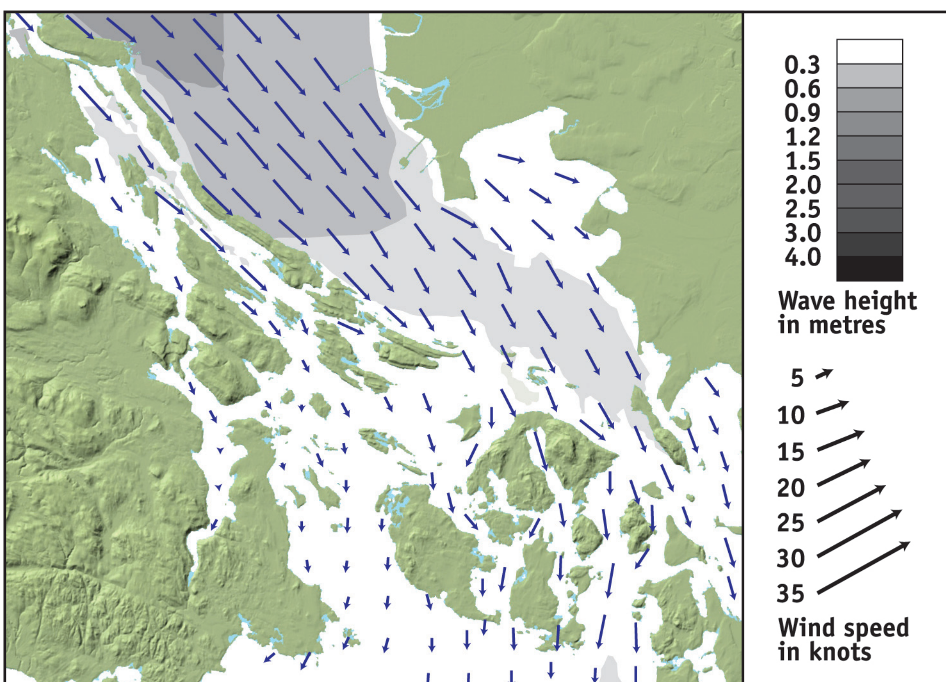
a weaker one sometimes forms farther east, along the base of the mountains, when strong northeast winds blow over the Cascades. The exact location of the lee low changes with shifts in the direction of the flow aloft.

Among the Gulf Islands, the winds are quite local in nature and vary considerably. An accurate description would require more detail than can be given in Canadian marine forecasts. The marine forecasts for the Strait of Georgia and Juan de Fuca Strait apply only to the main waterways, so they can only be used as general guidance for conditions within the Islands. The Haro Strait forecast region covers the waters from Discovery Island to Boundary Pass. In the American marine forecast, the waters to the east of Whidbey Island and through the San Juan Islands are referred to as “Northern Inland Waters including the San Juan Islands” and are numbered zone PZZ133.

2.1.4.1 Northerly Winds

Westerly, northwesterly and northerly pressure-slope patterns

When a ridge of high pressure lies to the north or northwest of the region, the northwest winds in the Strait of Georgia are stronger than the winds in Juan de Fuca Strait. Northwest winds of 5-15 kt spread across the Gulf and San Juan islands (often referred to in this section as “the islands”). The coastal topography turns the winds into northerlies just southeast of the San Juan Islands and northeasterlies as they round the corner past Victoria. These winds continue, easing a little in the afternoon, as long as this pattern persists.

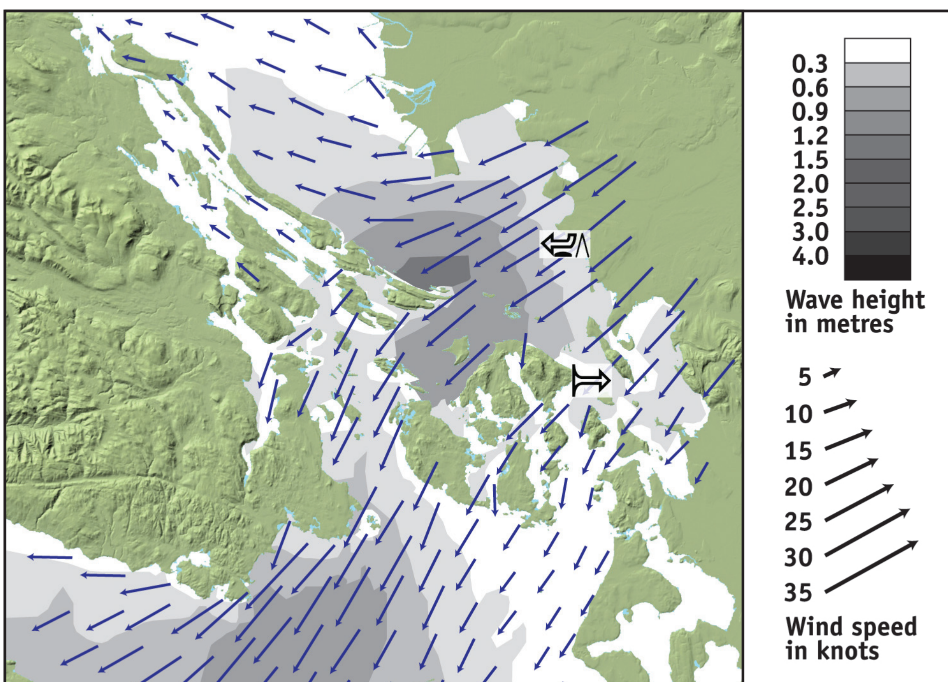


Light northerly winds and waves using the example of 1000 hrs, 19 October 1997 with a pressure-slope direction of 010° and a slope steepness of 1.1 mb per 60 nm.

Northwesterly winds generally blow only through Trincomali Channel, but when the flow is slightly more northerly, they can be directed by Vancouver Island through Stuart Channel instead. From there, they continue through Sansum Narrows and head south across Patricia Bay and the Saanich Peninsula. Strong northwest winds follow gaps in the topography, resulting in increased speeds from funneling effects. For example, winds often pass between the higher terrain near the University of Victoria and the hills on the east side of Cadboro Bay or out through the Cowichan Valley and into Cowichan Bay. Northwest winds flowing through Trincomali Channel tend to turn south past North Pender Island and into Swanson Channel, rather than pass through Navy Channel. West to northwest winds that funnel through passages between the San Juan Islands can be channeled out through East Sound as a strong northerly.

Northeasterly pressure-slope patterns

If the ridge rotates more to the northeast, northerly outflow winds strengthen through Howe Sound and the Fraser Valley—which, in turn, strengthens the winds across the region and veers them into the northeast. This outflow pattern can occur at any time of year but is strongest in winter, when the air is cold and heavy. The strong northeast winds flow out of the southern part of the Fraser Valley, cross over to near Saturna Island, and then split—most passing south over the San Juan Islands, through Haro Strait, and across southern Victoria. Another part of the plume moves northwestward across the Gulf Islands and up into the southern Strait of Georgia. The winds gradually decrease in strength and become more southeasterly as they move northward over the Gulf Islands. In a strong outflow event,



Northeasterly winds and waves using the example of 2400 hrs, 28 December 1996 with a pressure-slope direction of 045° and a slope steepness of 7.0 mb per 60 nm.

the northeast winds at East Point reach speeds of 35-40 kt, while those at Entrance Island are near southeast at 10-15 kt.

The northeast winds move through Boundary Pass and over the southern part of the Saanich Peninsula. Every other year or so, a plume of strong northeast winds crosses the Saanich Peninsula a little farther north than usual and enters Saanich Inlet. Sometimes, when the winds are very high, the ferry serving Galiano Island uses Montague Harbour instead of Sturdies Bay.

In some particularly strong outflow events, the winds enter President Channel and flow across the eastern end of Speiden Channel. The worst winds in the San Juan Islands often occur at Limestone Point but can also enter the bay near O'Neil Island. Further strengthening occurs if a low passes eastward over Washington, causing the pressure south of the region to drop. During a strong outflow event, cold, powerful northeast winds can last for days with only minor variations in speed and direction. The pattern ends when the ridge of high pressure east of the Coast Mountains weakens and moves east, the surface winds veer into the southeast, and warmer air spreads in from the Pacific. This transition can bring periods of snow that sometimes change to rain.

2.1.4.2 Easterly Winds

The strongest southeast winds in this region occur ahead of fronts, the strongest of which happen in winter. Wind patterns and pressure-slope directions are affected by the direction a front is moving—and even subtle differences in these values can cause markedly different winds. When a front approaches from the northwest, the winds and pressure slope across the region are from the southeast. When weather systems approach from the southwest, however, the pattern is often complicated by the passage of more than one front. Ahead of the first, the winds and pressure slope are from the northeast, but they veer south after it passes. Ahead of the second, the winds shift into the southeast and, after the last front in the series has passed, into the southwest or west.

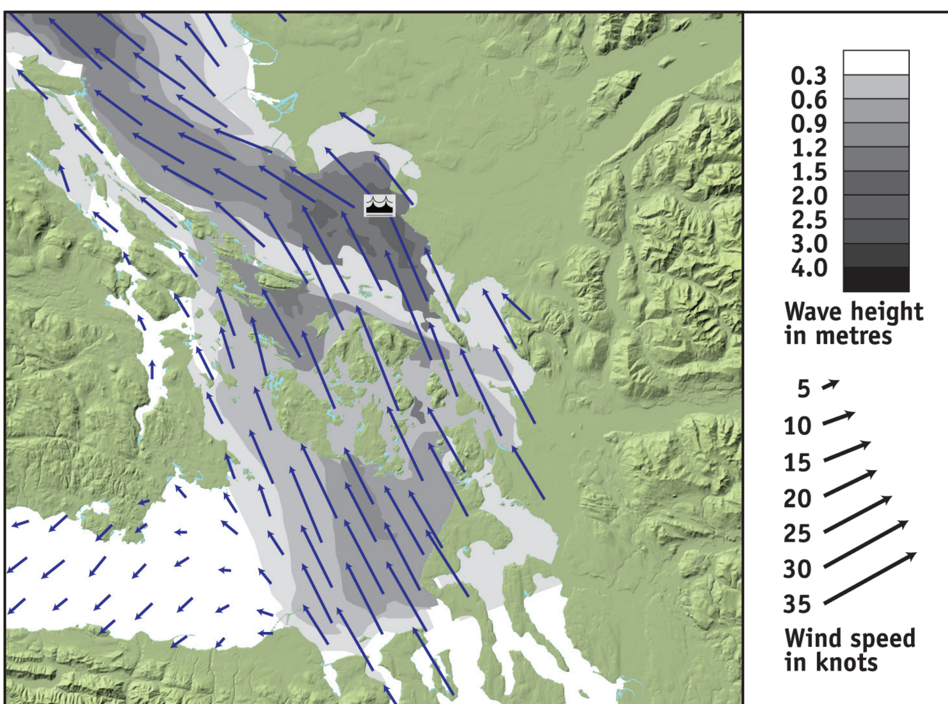
Easterly and southeasterly pressure-slope patterns

When a front approaches from the northwest, the pressure-slope direction is east or southeast at 100-130°. The strongest southeast winds begin over the northern Strait of Georgia and spread south as the front draws nearer—becoming lighter as they do, because the front weakens as it moves south, away from its parent low. In this situation, winds are southeast across the region, usually at less than 25 kt.

If the front comes from the southwest and the pressure slope is backed toward the northeast at 090-050°, the winds are northeasterly. Their strength depends on the strength of the approaching front, which determines the steepness of the pressure slope. In most cases, however, they will be around 15-20 kt. As the first front passes and the pressure-slope direction veers into the southeast, it causes a similar and sometimes sharp shift in the wind direction. A plume of strong southeast winds will move north out of Puget Sound and flow across the Islands—rising quickly to high speeds if they were building up prior to this shift. More frequently, however, this marks the beginning of a gradual increase in strength as the next front approaches.

Variations in wind direction and strength take place along the two sides of the plume, the western edge of which is usually quite sharp and lies from just east of Dungeness Spit to near Albert Head. The southern coast of Victoria, including Trial and Discovery islands, experience strong southeast winds, while a bit farther west, at Race Rocks, the winds are often much lighter northeasterlies. With only slight movements of this plume, perhaps caused by slight variations in the pressure slope, the western edge of the strong southeast winds will oscillate westward, causing the winds at Race Rocks to shift to the southeast and increase in strength.

On the eastern side of the plume, similar effects will take place. The Bellingham area will initially lie just outside of the plume and will experience light northeast winds. Sometimes the winds will remain like this for several hours after the onset of southeast winds across the San Juan Islands and may shift into the southeast only when the pressure slope turns a little further the same direction. At first, Smith Island and East Point may experience winds of 40-50 kt and Bellingham Bay only 15-20 kt; however, Bellingham's will rise to gale force as the plume moves eastward across the Islands.

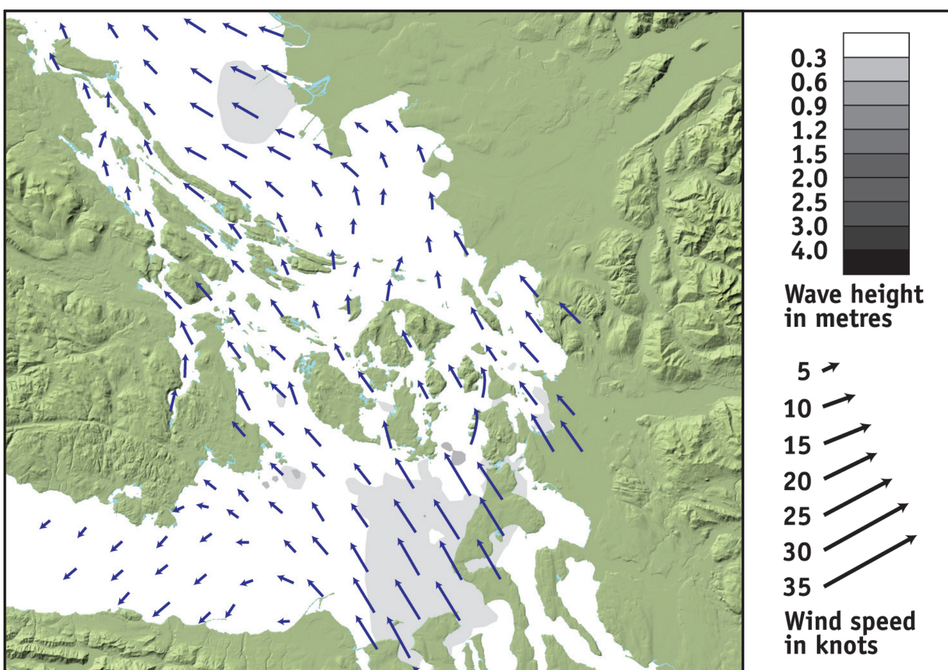


Southeast winds and waves using the example of 0400 hrs, 20 December 1997 with a pressure-slope direction of 115° and a slope steepness of 4.0 mb per 60 nm.

Mariners' Tips:
The report from Whidbey Island Airport may give the first indication of the winds moving out of Puget Sound. It has been said that when the sky is white over Port Townsend and black everywhere else, the southeasterlies are coming.

The southeast winds can be significant through Haro Strait. In general, however, they deflect off San Juan Island and funnel along the Saanich Peninsula, so are even stronger west of D'Arcy Island and in Sidney Channel. They generally cross the northern Saanich Peninsula near Patricia Bay and pass over Satellite Channel and into Sansum Narrows. While southerly winds are predominant through Saanich Inlet, they are rarely strong south of Patricia Bay. With a slightly more southerly flow, the winds pass east of Sidney and through Fulford Harbour to Burgoyne Bay, where they then howl through Sansum Narrows and into Stuart Channel.

Southeast winds pour through all of the northwest-southeast oriented channels, including San Juan and Swanson, and through Plumper Sound. In Swanson Channel, they veer and become southwesterly as they pass North Pender Island and join the strong stream flowing into Trincomali Channel from Plumper Sound. Strong southeast winds also enter Port Browning and cross North Pender Island to "rocket" out of Otter Bay. Southeast winds also flow through southern Rosario Strait and Lopez Sound and into East Sound, known locally as "Southeast Sound" for the strong southeast winds that pour into it. Southeast winds hit southern San Juan Island and move into the bays on the east side of the island.



Pushed southeast winds and waves using the example of 2300 hrs, 28 August 1997 with a pressure-slope direction of 145° and a slope steepness of 0.8 mb per 60 nm.

Anomalies, such as strong southeast winds in Trincomali Channel but not in the Strait of Georgia or vice versa, can occur when the direction of the winds varies by only a few degrees. For example, winds that approach the Gulf Islands from the southeast might blow in both areas, while those that are more easterly might flow only in the Strait and, more southerly, only in the Channel. This is a generalization, however, and should be verified through forecast information and experience.

In most cases, southeast winds arise with the approach of a front. This is known as a “pulled” wind. In more rare cases, they can also develop without the presence of a frontal trough when a ridge of high pressure moves to the southeast of the region; however, the pressure gradient for such “pushed” winds is not usually very strong. When this occurs, moderate southerly winds are pushed through Puget Sound and out across the eastern end of Juan de Fuca Strait. The strongest southeast winds are usually at Smith Island at 15-20 kt, with lighter ones spread up over the Gulf and San Juan islands.

During the night and morning hours (before a heat westerly develops in Juan de Fuca Strait) a weak lee low often forms between Smith Island and Victoria, causing the winds over the southern Islands to back into the northeast, off Victoria. This helps cut off the strength of the southeast flow moving northward into the Islands.

2.1.4.3 Southwesterly Winds

Southerly pressure-slope pattern

After the passage of a front, the winds shift into the west or southwest through Juan de Fuca Strait and, shortly after, flow across Victoria and the Islands. The strength of these winds depends on the magnitude of the pressure increase behind the front. Often, with fronts that approach from the west or southwest, a strong following ridge will not build west of the coast, so the southwest winds will be lighter than the southeast winds that preceded them. A strong ridge often builds after the passage of a front from the northwest or when a closed low and associated front moves directly over Vancouver Island. In both cases, the southwest winds can come in very quickly and reach speeds equal to or even greater than those of the southeast winds ahead of the front.

Strong southwest winds occasionally develop in very localized areas following the passage of a strong front from the southwest. They can come up very quickly and reach gale-force speeds in excess of 35-40 kt but are usually gone in two to three hours. These are a type of downslope wind that forms in very narrow plumes, with much lighter winds on either side. They have been reported blowing down from the Vancouver Island mountains, across the Chemainus-Ladysmith area, and onto Thetis and Ruxton islands. They have also occurred in Ganges Harbour and off Saturna Island.

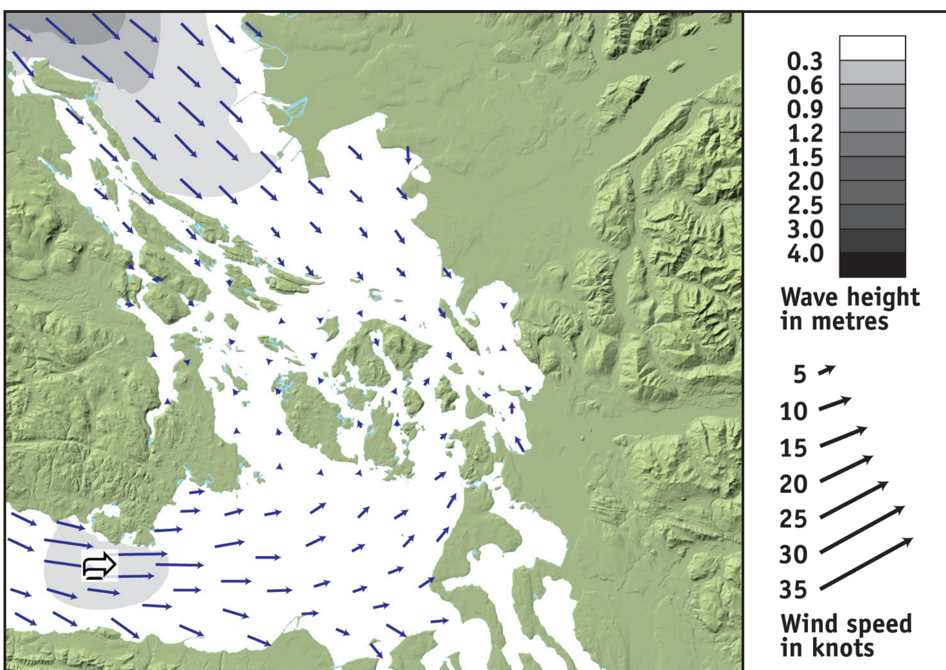
Southwesterly and westerly pressure-slope patterns

A ridge of high pressure to the west of Vancouver Island produces diurnal winds in both the Strait of Georgia and Juan de Fuca Strait. This pattern can occur at any time of the year but is dominant during summer. The wind changes direction based on the location and time of day, but it is usually not very strong.

In the morning, when the winds are at their strongest through the Strait of Georgia and their lightest in Juan de Fuca Strait, northwest winds move across the northern Gulf Islands shortly after dawn and spread into Trincomali Channel and Captain's Passage. They rarely extend into the inlets closer to Vancouver Island (such as Stuart Channel or Sansum Narrows) or south of Boundary Pass. At this time of day, the winds across the San Juan Islands are light and primarily southwesterlies that have come up the Juan de Fuca Strait. If the wind at Race Rocks is west at 20 kt, it will usually be less than 15 kt near Whidbey Island. The winds close to the Washington coast veer into the northwest.

During the afternoon, the winds in the Strait of Georgia ease, and the winds in Juan de Fuca Strait increase, reaching their peak at approximately 2000 hours. Part of this flow veers north as a southwesterly wind and crosses Haro Strait and the San Juan Islands. This wind is generally less than half the speed of that at Race Rocks—and may rise to 15 kt as the Juan de Fuca winds strengthen and possibly 20 kt in areas further south, near Victoria. If the winds at Race Rocks are 25-30 kt, the winds east of there—between coastal Victoria and Whidbey Island—will be around 20 kt.

Daytime heating in the summer creates light sea-breeze winds that are highly localized and usually peak at about 10-15 kt during the late afternoon. These winds tend to blow

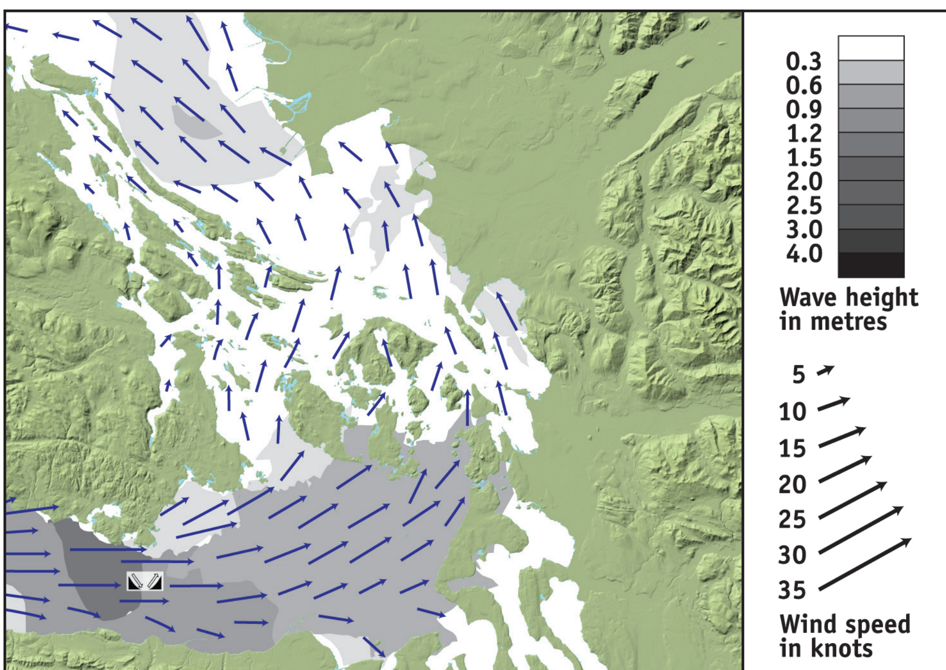


Morning phase of diurnal westerly winds and waves using the example of 0700 hrs, 6 August 1997 with a pressure-slope direction of 300° and a slope steepness of 0.6 mb per 60 nm.

perpendicular to the shore and are often funneled up narrow inlets and channels. Many locations with hills behind them, such as Maple Bay, receive some outflow drainage winds overnight, into the early morning, and sea breezes from the opposite direction in the afternoon. A fairly strong sea breeze wind draws up Satellite Channel toward Vancouver Island and moves into Cowichan Bay in the afternoon.

The diurnal change in the winds coincides with the rotation of the ridge shifting between counter-clockwise during the afternoon and clockwise overnight. This means that the pressure-slope direction oscillates between westerly in the morning and southwesterly in the afternoon. Occasionally, when it backs farther south in the afternoon than normal, the winds do not split near Whidbey Island and flow partly into Puget Sound, as they would normally. Instead, they turn northward and move across the Islands. If the westerly winds in Juan de Fuca Strait are near gale force (35 kt) at Race Rocks, as they round Victoria, they can reach 25-30 kt at Trial and Discovery Islands and hit hard on Cattle Point, on southern San Juan Island. They usually ease sharply north of the Lime Kiln light and blow about 5 kt lighter in Baynes Channel, inside Discovery Island.

As the winds flow farther northward, they build up against the mountains behind Bellingham and blow across the Fraser Valley to build up against the mountains north of Vancouver, reaching speeds of 20-25 kt at their approach. They gradually build back westward, away from the mountains and toward the straits: the strong flows over the eastern



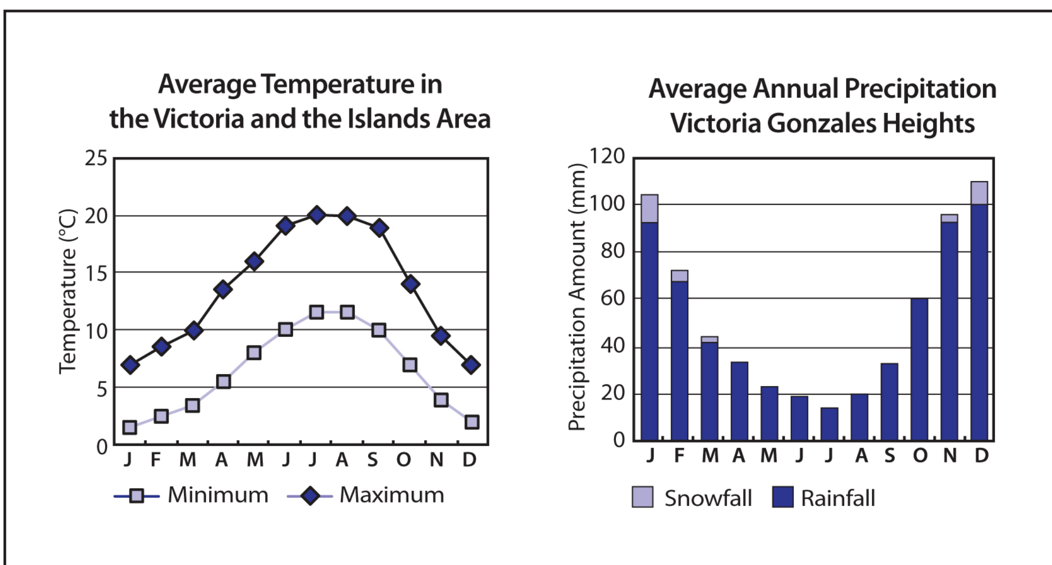
Afternoon phase of diurnal westerly winds and waves with Juan de Fuca return flow using the example of 2000 hrs, 16 July 1996 with a pressure-slope direction of 220° and a slope steepness of 1.8 mb per 60 nm.

parts of the San Juan Islands gradually spreading westward as southerly winds of 15-20 kt, and the winds farther north, over the Gulf Islands, backing into the southeast. They usually ease to 10 kt or less in the reverse order in which they formed: first, in the southwest, as the source winds in Juan de Fuca die away; and, second, close to the mountains. As this flow is like a sloshing of Juan de Fuca winds up into the Strait of Georgia, it is called a "Juan de Fuca return flow".

2.1.4.4 Local Waves and Currents

In this region, tides and currents are often a bigger issue than winds, and many eddies form near the coast and at the edges of stronger currents. The waters off Victoria go through a cycle that is likely similar to that of other coastal areas. When the tide begins to flood and the velocity of the tidal current is low, the bays begin to fill with water. As the water rises, it begins to pile up against the coastline, creating a noticeable current along the eastern shore of Trial Island to Gonzales Point. As the depth of water increases, the frictional effects of the land begin to slow the current. Since the flow of water farther offshore is not affected by friction, the current shifts to being stronger away from the coast than it is near it: a change that usually takes place about 15 minutes after the onset of the new tide.

After the tidal current moves out past the points of land, back eddies form between the strong current offshore and the coast. The currents in these back eddies move in the opposite direction of the main flow, so they appear like an ebb. They can break down as rapidly as they form but may quickly reform, often in a slightly different location. They may also drift away from the location where they were formed and into the surrounding waters. For more information on tidal phenomena, consult the local Sailing Directions publication.



2.1.4.5 Local Weather

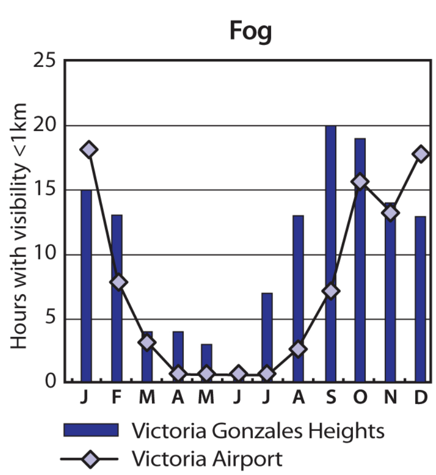
The weather in Victoria and the Islands is strongly influenced by the rain shadow created by the Olympic Mountains, which results in significantly less rainfall and more sunshine than anywhere else in the region. The rain-shadow effect of the mountains is greatest when the flow aloft is from the southwest, as occurs with easterly and southeasterly pressure-slope patterns. The area in the rain shadow has less cloud and appears brighter when viewed from the cloudier northern areas, which might be experiencing rain. The brightest spot is normally southwest of Smith Island toward Dungeness Spit.

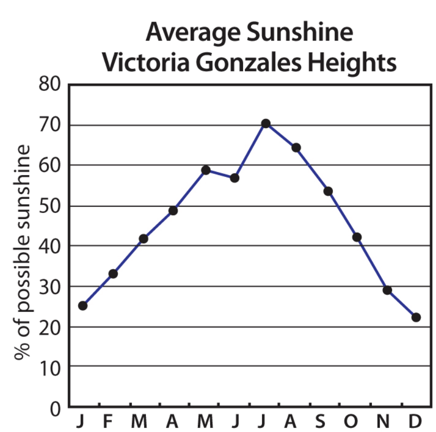
With strong westerly winds in Juan de Fuca Strait and northwesterlies in the Strait of Georgia, a convergence line sometimes develops over the Islands. This line moves either north or south, depending on the relative strengths and directions of the winds in the straits. If there is sufficient moisture in the air near the surface, enhanced cloud and precipitation may occur along the line.

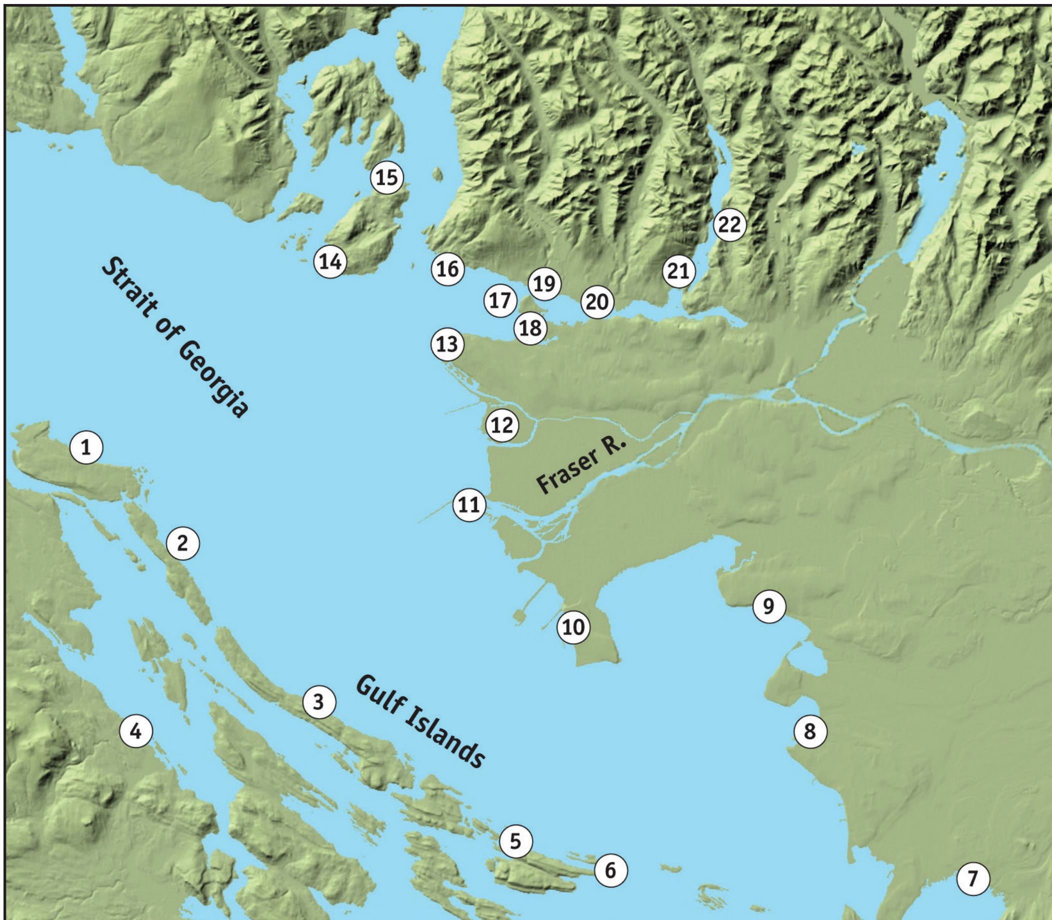
Fog moves up from Juan de Fuca Strait, through Haro Strait, and often ends near Turn Point on Stuart Island. It occasionally drifts as far as Prevost Island and into Ganges Harbour but does not usually extend much farther north than Beaver Point and the South Pender Island area.

Did You Know?

The sunniest Canadian location in the region is in the southern Victoria/ Gonzales area, which receives an average of over 2100 hours of sunshine a year.. Vancouver airport, by comparison, receives only about 1930 hours.







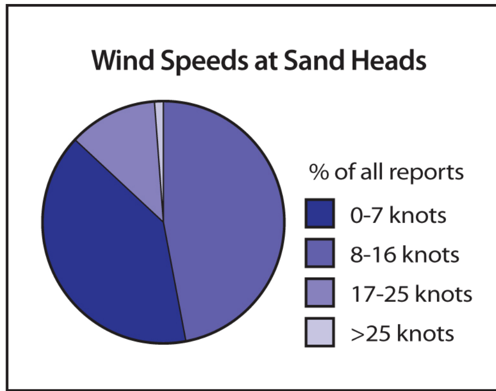
Vancouver Area

1. Entrance I.
2. Valdes I.
3. Galiano I.
4. Chemainus
5. Saturna I.
6. East Pt.
7. Bellingham Airport
8. Birch Bay
9. White Rocks
10. Tsawwassen Beach
11. Sand Head
12. Vancouver Airport
13. Point Grey
14. Cape Roger Curtis
15. Howe Sound
16. Pt. Atkinson
17. Burrard Inlet
18. English Bay
19 First Narrows
20. Vancouver Harbour
21. Deep Cove
22. Indian Arm

2.1.5 Vancouver Area

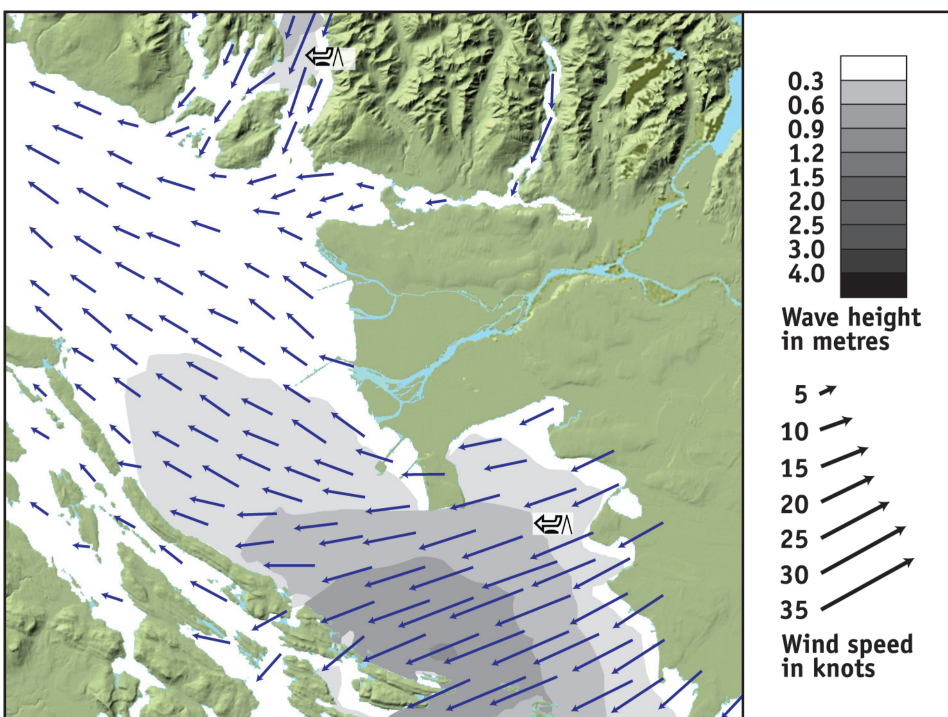
The Vancouver area receives westerly winds from the Strait of Georgia, outflow and easterly winds from Howe Sound and the Fraser Valley, and southerly winds from Juan de Fuca Strait and Puget Sound. Easterly winds occur most frequently, but some of the strongest and most dangerous winds are from the west. The former generally back into the east and northeast near the North Shore Mountains but are mostly from the southeast in southern parts of the region. Westerly winds occur much less frequently in Burrard Inlet than they do in more southern areas.

2.1.5.1 Outflow Winds



Northeasterly pressure-slope pattern

When a ridge of high pressure develops over the BC Interior, the pressure slope is northeasterly, and outflow conditions spread through Howe Sound, Fraser Canyon, and Harrison Lake. The Vancouver area is also affected by winds that flow out of the Fraser Valley. When a plume of strong winds extends from the narrow confines of the upper parts of the Valley across Sumas Prairie, south of the river near Matsqui, and is steered across Birch Bay and into the Strait by the mountains to the south, the more northerly areas of greater Vancouver experience light easterly winds. Even when outflow winds rise to gale force (35-45 kt) in Howe Sound and the upper reaches of the Valley, the easterlies that move into Vancouver Harbour are typically 5-10 kt or 15 kt, at most. With a strong outflow wind, easterly winds blowing at 20-25 kt from southern Vancouver to Bellingham, however, may reach gale force. The same pattern of wind can occur, with much reduced speeds, at any time of the year due to nighttime drainage from the mountains.

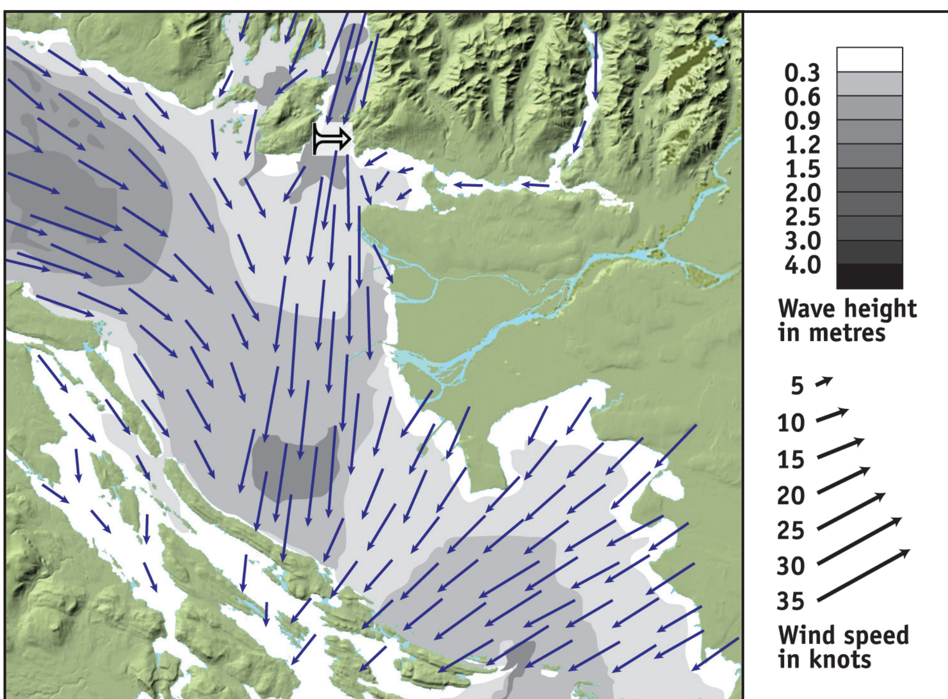


Outflow winds and waves using the example of 1600 hrs, 28 December 1996 with a pressure-slope direction of 040° and a slope steepness of 5.0 mb per 60 nm.

The winds from Howe Sound usually end within a kilometre or two south of its entrance, off Point Atkinson. If the ridge of high pressure rotates more toward the north, Squamish outflow winds can extend out to Point Grey and even move south of Tsawwassen Beach to the Gulf Islands. When this occurs, northwest winds move down the Strait of Georgia to just west of Vancouver, where they converge with the easterly winds from the Fraser Valley. The northerly winds in Howe Sound are drawn into this convergence zone and move southward out of the Sound, reaching speeds of up to 40 kt. Only the westernmost anchorages of English Bay receive any of this northerly wind. The northerly swells that bend into the Bay may be of more concern to mariners and can be held off or carried in by the tides.

Indian Arm also experiences outflow winds, although not with every Squamish outflow. When they do occur, they are not usually as strong as the peak winds in Howe Sound. In order for strong northerly winds to pour into Indian Arm, the cold air must be sufficiently deep—and the winds sufficiently “northerly”—that when they reach Squamish, they can flow southeastward through the Stawamus and Indian River valleys. Since the winds that blow into Indian Arm are affected by air temperature, they may decrease in the afternoon, when the air temperature in Squamish is higher. The winds in Howe Sound, which are not as restricted by such variations, see much less of a decrease. Another reason the winds are generally lighter in Indian Arm is that their path is less direct than it is in Howe Sound.

If the winds at Pam Rocks are near gale force at 35 kt, the peak winds in Indian Arm will be about 25 kt, the strongest occurring near the narrowest parts of the channel and major



Outflow winds and waves for Howe Sound using the example of 1000 hrs, 19 November 1996 with a pressure-slope direction of 025° and a slope steepness of 3.7 mb per 60 nm.

bends. In general, there are more places to find shelter along the west side of the Arm, but this changes as the flow meanders past the turns in the inlet. The winds that move into Deep Cove are lifted upward by the hills behind it, so the winds on the water are lighter as they approach the shore. The winds also become light near the opening of Burrard Inlet.

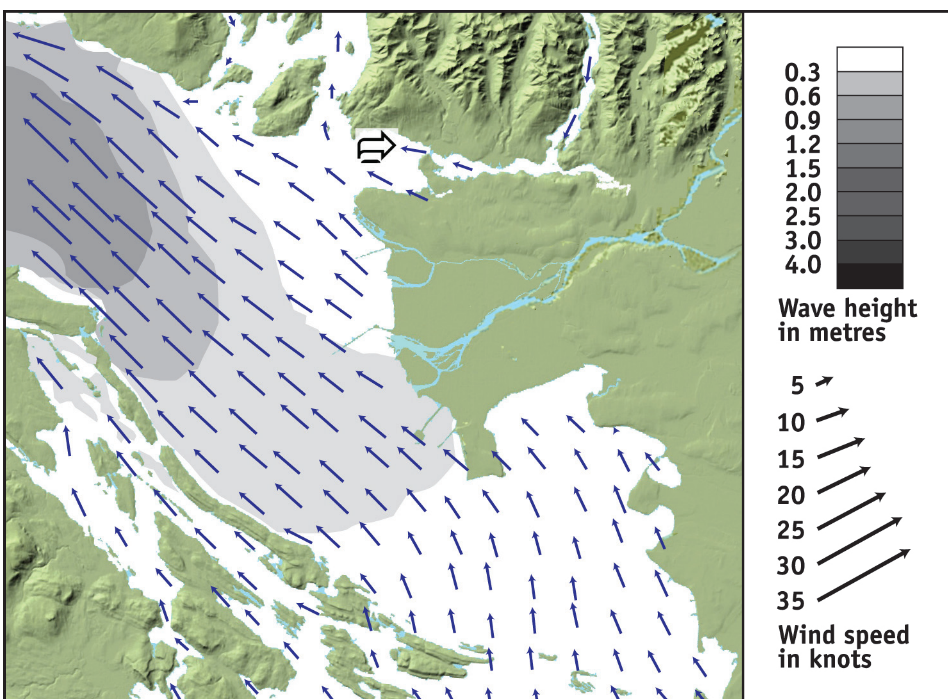
2.1.5.2 East to Southeast Winds

Easterly winds, ranging from just north of east to southeast, are the most common winds in the Vancouver area, occurring in various phases of five out of the seven regional patterns. Easterly winds do not create very high seas because they blow off the land and, as such, have a very short fetch. Those arising from a northeasterly pressure-slope pattern are discussed in section 2.1.5.1.

Easterly and southeasterly pressure-slope patterns

With the approach of a front, the pressure-slope direction backs into the east. The winds across the region vary considerably, depending on the direction from which the front approaches. Many of the variations described for Victoria and the Islands also apply to the Vancouver area.

When a front approaches from the west or northwest and the pressure-slope direction is south of east, southeast winds first appear in the northern part of the Strait of Georgia and gradually spread south toward the Vancouver area as the front draws closer. The strongest southeast winds cut a swath across the city, from the southwestern areas near White

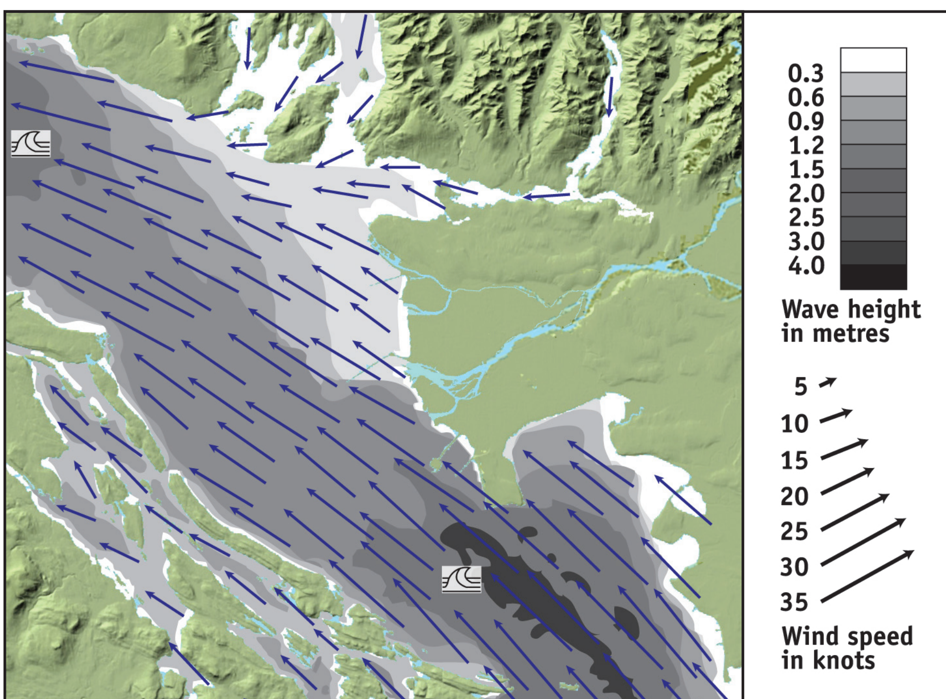


Southeast winds and waves with a 'northwest' front using the example of 2200 hrs, 27 August 1997 with a pressure-slope direction of 1400° and a slope steepness of 2.0 mb per 60 nm.

Rock and Tsawwassen to near Point Atkinson; however, they are usually much lighter in the Vancouver area than the peak winds in the Strait. To the northeast of this swath—in particular, closer to the Coast Mountains—the winds tend to back more into the east or even northeast and are much lighter.

When a front approaches from the southwest, the pressure-slope direction rotates, such that it backs to north of east. This causes the plume of strong southeast winds to move farther from Vancouver and closer to Vancouver Island. In places like East Point, on Saturna Island, the winds wobble from east to southeast. Most areas of the region northeast of Sand Heads experience east or northeast winds at generally less than 15 kt. This flow pattern is more like an outflow condition. The strongest winds do not begin in the northern part of the Strait of Georgia but arise, more or less equally, in the southwest area close to Vancouver Island. Once established, the plume of strong southeast winds extends north from the mouth of Puget Sound, hugging the shore of Vancouver Island and spreading out across the Strait farther to the north. As the pressure-slope direction veers more toward the southeast, the plume moves northward across most of greater Vancouver.

The channeling effect of the North Shore Mountains causes the winds at Point Atkinson to back into the east and strengthen to speeds of up to 5 kt higher than at Sand Heads. When the pressure-slope direction veers more toward the south, the winds at the Point ease



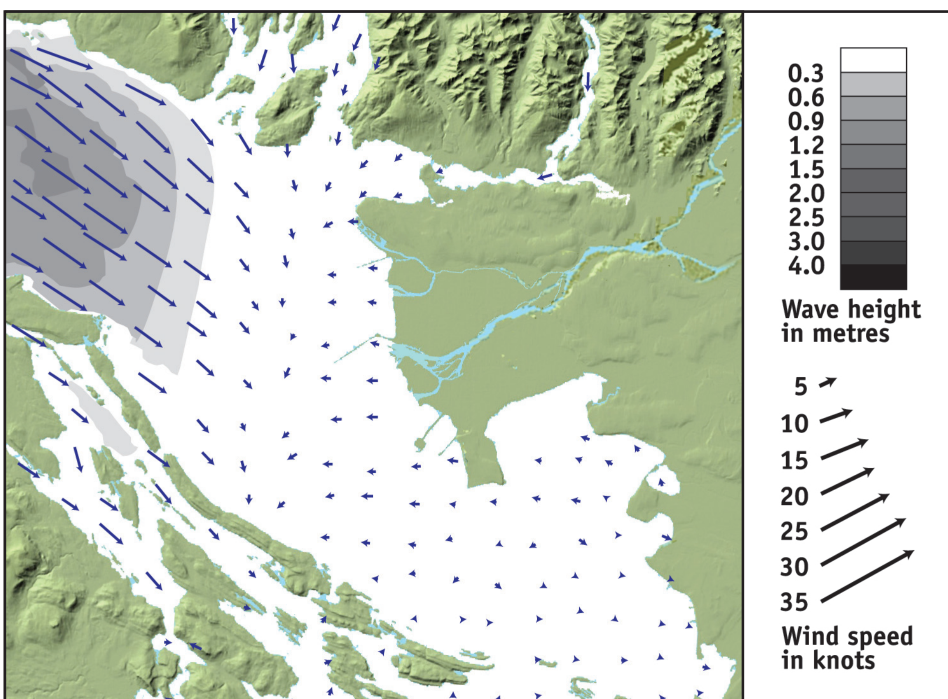
Southeast winds and waves with a 'southwest' front using the example of 1600 hrs, 25 January 1998 with a pressure-slope direction of 100° and a slope steepness of 4.4 mb per 60 nm.

considerably and become much lighter than at Sand Heads. In all of these frontal scenarios, the winds at Indian Arm remain northerly and are not normally very strong.When a ridge of high pressure develops to the south or southeast of the region, the wind blows from the east or southeast, even without an approaching front. Pushed southeast winds such as this can develop at any time of the year but are common during the summer when a ridge of high pressure lies west of Vancouver Island. If this ridge rotates even slightly, so the pressure-slope direction turns toward the south, Juan de Fuca return-flow winds move north across western Vancouver.

2.1.5.3 South to Southwest Winds

Southerly and southwesterly pressure-slope patterns

South or southwest winds are not common but occur during the transition from southeast to westerly winds. The strongest southwest winds usually accompany the passage of a front over the region. They are strongest closer to Vancouver Island and tend to weaken and back into the southeast near Vancouver. Along the North Shore Mountains, the winds remain from the east or southeast until they turn fully into the west. Southwest winds can also occur in different parts of the area with sea-breeze winds during the summer. Indian Arm experiences southerly winds during sunny summer afternoons when upslope winds develop through the inlet. The strongest southerlies develop when a deep low passes directly over the south coast and moves into the Interior, north of the region.



Winds and waves for morning phase of the diurnal westerly cycle using the example of 0400 hrs, 6 August 1997 with a pressure-slope direction of 230° and a slope steepness of 0.7 mb per 60 nm.

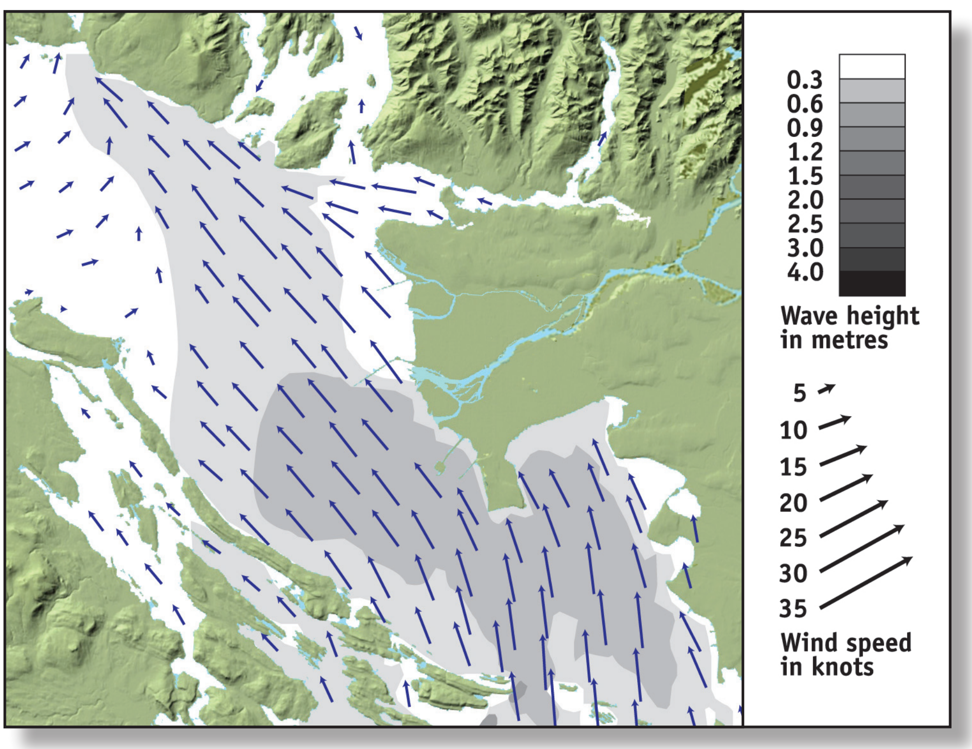
2.1.5.4 Westerly Winds

The Vancouver area experiences west-to-northwest winds when the pressure-slope direction ranges from southwest through west, to just east of north. In most cases, the winds resulting from these patterns are more likely to shift over the southern areas than into the west near the North Shore Mountains.

Southwesterly and westerly pressure-slope patterns

Southwesterly and westerly pressure-slopes patterns represent the morning and afternoon phases of the normal summer diurnal cycle. Many subtle variations of winds can develop with these patterns, depending largely on how much sunshine the region is receiving and the strength of the winds in Juan de Fuca Strait.

On a typical summer day, northwest winds spread down the Strait of Georgia during the night, reaching Entrance Island near dawn. They generally ease a short distance southeast of this area and die out before reaching Vancouver because the widening of the Strait reduces its channeling effects. Another factor is opposition from east-to-southeast winds over the Vancouver area, which occurs when the westerly winds in Juan de Fuca Strait turn northward overnight and back into the southeast due to topographical channeling. The convergence line between the northwest winds from the Strait of Georgia and the westerlies from Juan de Fuca Strait frequently lies in this area between Vancouver and Entrance Island.



Juan de Fuca return flow winds and waves using the example of 0800 hrs, 16 July 1996 with a pressure-slope direction of 200° and a slope steepness of 1.8 mb per 60 nm.

When the line is close to Vancouver, there may be light southeast winds near the coast but northwest winds a little farther offshore.

If the northwest winds do not move all the way down Sand Heads and Vancouver in the early morning, the presence of light southeast winds can make conditions in the area ripe for the development of a sea breeze. Heat from the sun is another key factor, so sea-breeze winds rarely form during the shortest days of winter and are strongest in late spring and early summer, when the temperature contrast between the land and water is greatest. Coastal sea breezes can also be enhanced if it is drawn into the upslope valley winds of the upper Fraser Valley.

The most common time for the onset of a sea breeze in English Bay is near 1000 hours, although it occasionally begins as early as three hours after sunrise. The strength of the breeze increases rapidly through the late morning and decreases almost as rapidly in the late afternoon. Usually, the westerly winds shift back into the east again shortly after sunset. If the east-to-southeast winds are near 10-15 kt in the early morning, the sea-breeze winds will be delayed until late afternoon and, if it is cloudy, will not develop at all. In light summer wind conditions, the winds at Indian Arm are usually northerly overnight and into the early morning because of nighttime drainage, but they become southerly in the afternoon when air is being drawn up the valley slopes. The strongest southerly winds occur near the northern end of the Arm.

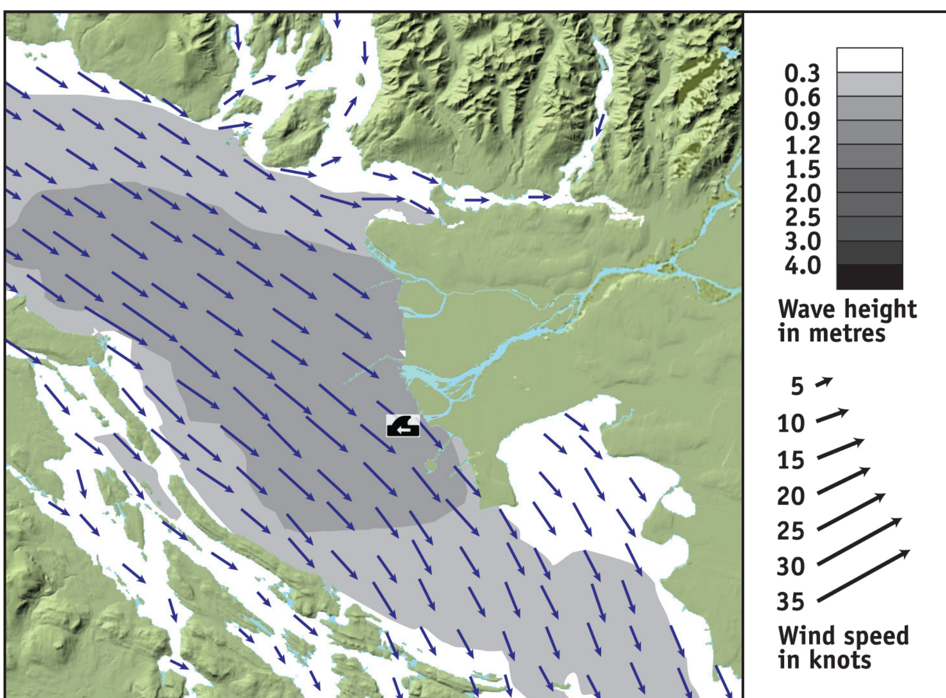
Southeast winds are usually stronger in the early morning if the winds through Juan de Fuca Strait were particularly strong westerlies during the previous afternoon and if the pressure-slope direction has backed far enough toward the south to propel the winds northward toward Vancouver. This pattern develops when the ridge of high pressure west of Vancouver Island rotates counter-clockwise enough for the lee trough off Barkley Sound to collapse. This allows strong northwest winds to pour into Juan de Fuca Strait, thereby increasing the westerly winds at Race Rocks to near gale force of 35 kt by early evening. If the ridge rotates a bit farther back, so the pressure slope becomes southerly, these winds spread over the Gulf and San Juan Islands during the late evening and reach the Vancouver area overnight. The southeast winds from this Juan de Fuca return flow reach the Coast Mountains and Sunshine Coast in the early morning and spread back across the Strait of Georgia toward Entrance Island an hour or two later. They usually ease in the afternoon but not soon enough for a sea breeze to develop.

Northwesterly and northerly pressure-slope patterns

If there are particularly strong diurnal northwest winds and the ridge of high pressure lies north of the region, the winds will continue past Entrance Island and spread directly across Vancouver and south toward Bellingham. If the northwest winds that reach Vancouver are part of the normal diurnal cycle, they will ease in the early afternoon. Locations close to the coast may develop westerly sea-breeze winds during the late afternoon.

If, however, the northwest winds are caused by a northerly pressure-slope pattern, the addition of a sea breeze will cause them to increase to 20-25 kt in the afternoon. Although the winds will ease slightly to 15-20 kt overnight, they will continue into the next day and can persist for several days if the pressure slope remains northerly. In such cases, the strong winds at Sand Heads can cause the seas to build sharply, especially against a strong river outflow, making it difficult for small boats to move out of the river and past the mouth of the jetty. The westerly winds that move into English Bay and Burrard Inlet are strongest on the southern side of the Bay. In an ebb tide, this can make wave conditions at First Narrows uncomfortable, if not dangerous. On windy days in the Vancouver area, the winds tend to be light farther up the Strait, north of Ballenas.

The northwest winds that develop after the passage of a front can be the strongest of all winds in the Vancouver region. Although they do not usually last as long as east or southeast winds, they often have a much greater impact. March is a prime month for the formation of strong northwesterlies, the strongest of which occur behind a front that has approached from the northwest or a deep low that has passed eastward over southern Vancouver Island. The latter scenario is usually the worst. In both cases, the winds can shift from east to southeast ahead of the front or low and quickly rise to strong northwest winds. In rare, extreme events, shifts from southeast at 30-35 kt to northwest at 45-50 kt can occur in a matter of minutes. Although similar shifts occur every winter at much lower wind speeds, northwest winds rising to even 25-30 kt can still be quite powerful, as cold air packs more of a punch than warm air. The northwesterlies that develop behind a front spread uniformly across the region.



Northwest winds and waves using the example of 1900 hrs, 19 October 1997 with a pressure-slope direction of 350° and a slope steepness of 1.0 mb per 60 nm.

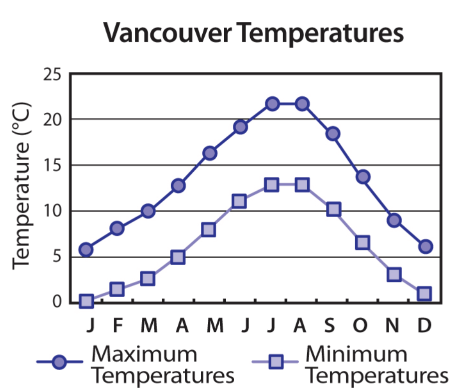
2.1.5.5 Local Waves and Currents

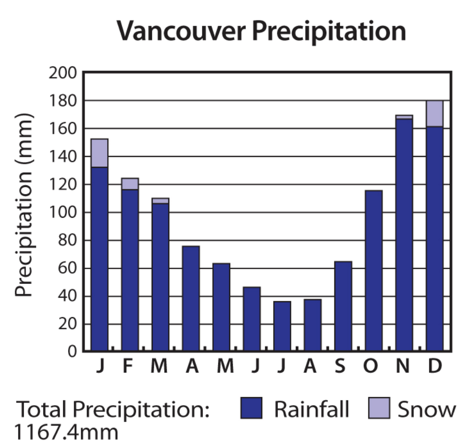
With southeast winds, the seas are low near the coast but build farther to the west, as the fetch increases. In Burrard Inlet, while there will be low seas on the south side, those on the north can build to nearly one metre. With west or northwest winds, conditions are vastly different, as the fetch can be as long as 50-60 NM in the southern part of the region. Northwest winds of 50 kt can build seas to 3 m if they blow for two hours and over 4 m if they blow for five. Conditions are even worse if the northwest winds blow against a strong Fraser River runoff. Westerly winds flowing out of the harbour against an ebb tide have created standing waves along the North Shore just west of Lions Gate Bridge. The currents are usually less on the south side of the harbour. The seas can build to 2-2.5 m in the southern parts of Indian Arm during a strong northerly outflow event.

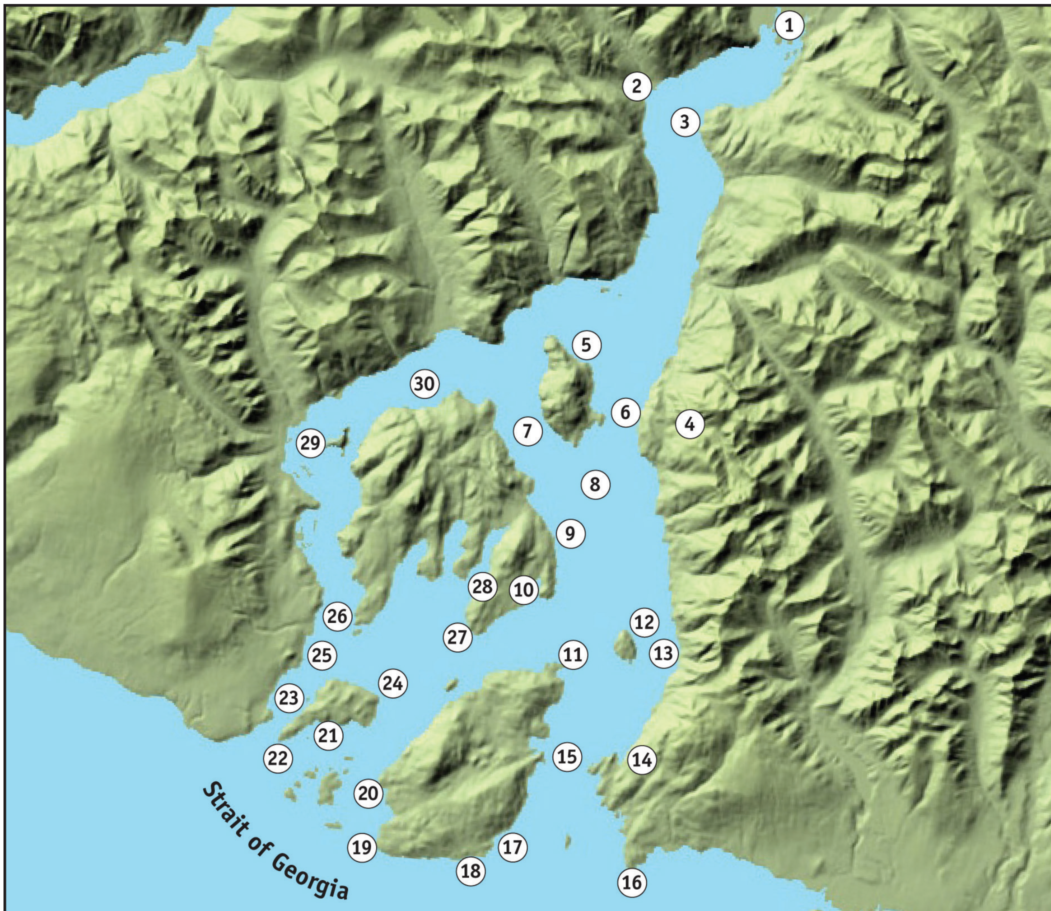
Both the Fraser River and local topography significantly affect the winds, waves, and weather in the region. The effects of the freshwater flow from the River extend all the way to Valdes Island and up to Cape Roger Curtis. Small changes in the wind may be noted crossing the freshwater-saltwater boundary, due mainly to differences in the current on either side. Heavily laden vessels should use caution in such areas, as buoyancy decreases when crossing from salt water to fresh water. The boundary between the freshwater plume from the Fraser River and the salt water is visible as a change in the colour of the water.

2.1.5.6 Local Weather

Topography plays a major role in the weather of the Vancouver area. Annual precipitation varies from almost 800 mm over the extreme southern part of the region to over 3000 mm near the northern end of Indian Arm. Generally speaking, most heavy rain occurs with southeasterly winds, while westerlies bring sun and possible showers. Temperatures vary significantly from coastal to inland locations, with the sea having a moderating influence—that is, keeping winter temperatures warmer and summer ones cooler—on the former. Freezing spray can develop in Indian Arm during a strong northerly outflow event.





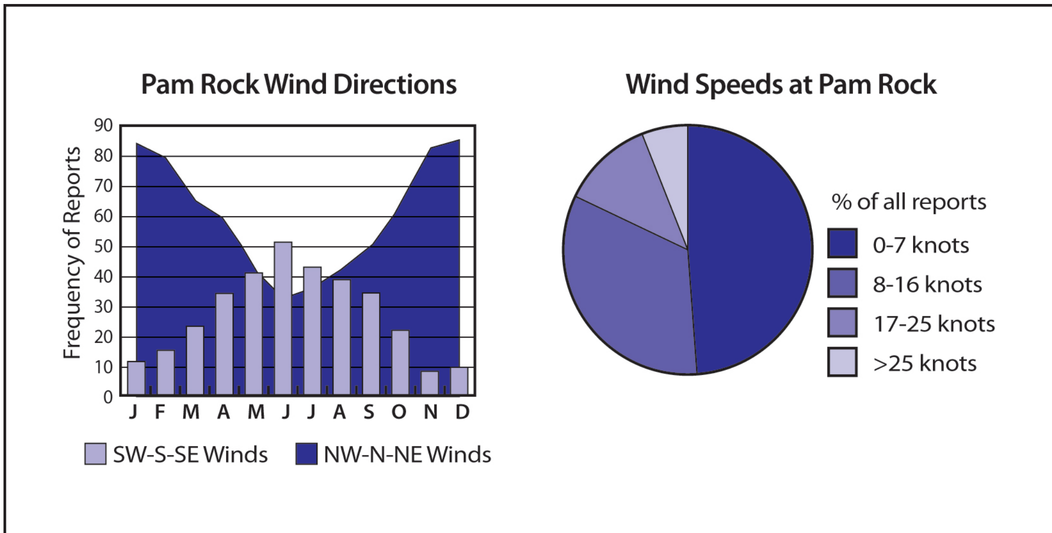


Howe Sound

1. Squamish Airport
2. Woodfibre
3. Watts Pt.
4. Defence I.
5. Anvil I.
6. Montagu Channel
7. Ramillies Channel
8. Pam Rock
9. Gambier I.
10. Halkett Bay
11. Hood Pt.
12. Bowyer I.
13. Sunset Beach
14. Horseshoe Bay
15. Queen Charlotte Channel
16. Pt. Atkinson
17. Seymour Landing
18. Bowen I.
19. Cape Roger Curtis
20. Collingwood Channel
21. Keats I.
22. Shoal Channel
23. Gibsons
24. Cotton Pt.
25. Hopkins Landing
26. Langdale
27. Hope Pt.
28. Port Graves
29. Port Mellon
30. Thornbrough Channel

2.1.6 Howe Sound

The winds through the main, easternmost channel of Howe Sound are primarily northerly or southerly. From November through February, almost 80 percent of all reported winds at Pam Rocks are from the northwest, north, or northeast. In the summer, the frequency of northerly winds drops to about 35 percent. Southerly winds also have a yearly cycle, ranging from a frequency of less than 10 percent in winter to about 50 percent in summer. Winds from the east and west are short-lived and usually light.



2.1.6.1 Northerly Winds

Northerly, northeasterly and easterly pressure-slope patterns

The strongest northerly winds occur with outflow events when there is a ridge of high pressure over the Interior. Northerly winds are often called "Squamish" winds or "Squamishes" after the community located at the head of Howe Sound. Similar winds that blow through other inlets, such as Indian Arm and Jervis Inlet, are also sometimes referred to by this name.

Outflow winds through Howe Sound begin when temperatures fall and pressures rise over the Chilcotin plateau. The cold air that builds to the east of the Coast Mountains pours out through the mountain passes and down the valley past Lillooet and Pemberton, then out across Squamish and into Howe Sound. The air oscillates through the confines of the valley like water flowing around the bends in a river. In a normal flow pattern, the plume of outflow winds races past Watts Point to the coast south of Woodfibre, where it veers southward, banking off Anvil Island before heading farther south to Queen Charlotte Channel. This is known locally as a "Northerly". With a slightly different orientation in their flow pattern, however, the winds can turn right at Anvil Island and pass north of Gambier Island through Thornbrough Channel. This less frequent pattern is known as a "Northeasterly".

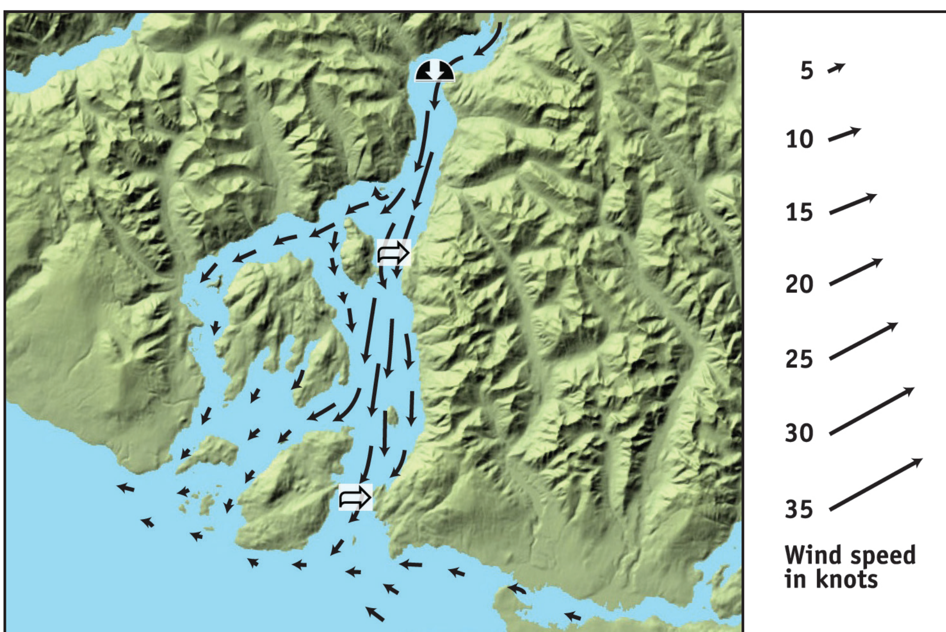
Mariners' Tips:

Surface-pressure values can vary dramatically even when the weather pattern remains the same. Between December 21, 1996, and January 2, 1997, during a significant Arctic outflow event in the Georgia Basin, the pressure at Pemberton rose and fell nine times from a high of 1035 mb to a low of 980 mb, yet the pattern of winds remained unchanged. This suggests that monitoring a single barometer may not always be sufficient, and that pressure-slope direction may be a better way of seeing the bigger picture.

The conditions required for the flow to shift from the main channel, east of Gambier Island, to a more northeasterly path through Thornbrough Channel are not well understood. The change may be caused by the pressure-slope direction veering south of due east or be part of the normal oscillations of fluid flow as it moves from one side of the main stream to the other. These hypotheses, however, remain to be confirmed. Regardless of which path the winds take, those at Pam Rocks tend to remain from the northeast, while those outside the area, at locations such as Sand Heads, may shift from northeast to southeast.

With a northerly outflow pattern, the main thrust of the outflow winds moves past Watts Point, through Montagu Channel, and west of Bowyer Island into Queen Charlotte Channel. The winds east of Bowyer Island are lower but can be gusty. If the outflow winds are particularly strong (i.e., greater than 40 kt) and have a slightly more northwesterly direction upstream, they can pass east of Bowyer Island, reflect off the mountains, and enter Sunset Beach as a "Northeaster". These subtle variations are likely explained through the normal oscillations of fluid flow.

The strongest winds are usually in Montagu Channel, just east of Anvil Island. Little northerly wind enters the channel to the northwest of Anvil Island, but back eddies will occur around the Defence Islands. Northerlies can bend around the bottom of Gambier Island but do not usually extend beyond Hope Point. Collingwood Channel generally experiences much less outflow than Queen Charlotte Channel. When the winds at Pam Rocks are more than 20 kt, some usually enter Horseshoe Bay. Once again, the explanation of when they blow into Horseshoe Bay and when they don't is perhaps best explained by the simple oscillations of the plume of winds.

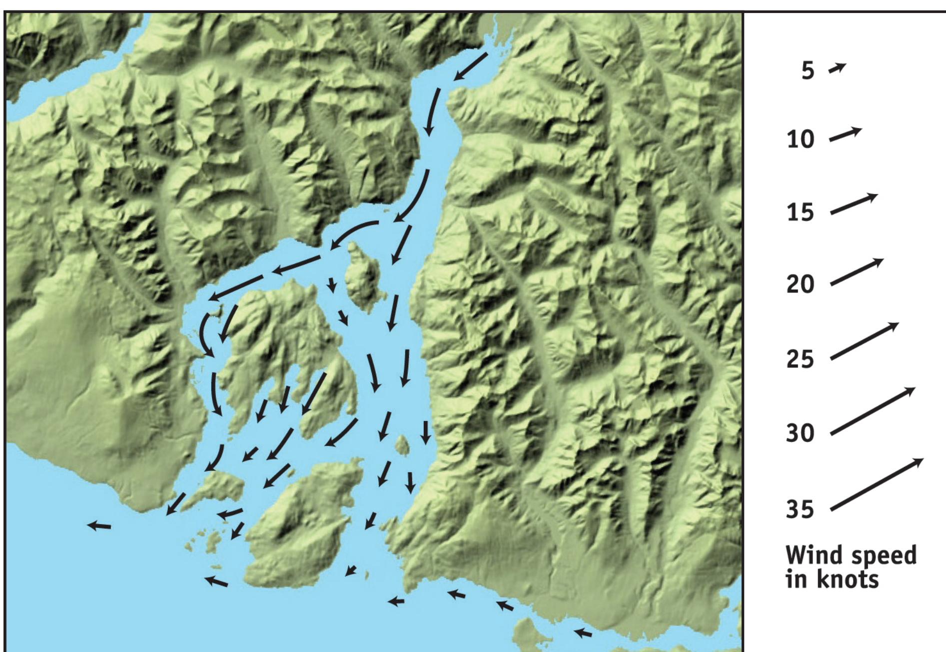


Northerly outflow winds using the example of 1800 hrs, 29 December 1996 with a pressure-slope direction of 040° and a slope steepness of 5.0 mb per 60 nm.

Squamish winds are usually lighter in Queen Charlotte Channel than they are farther north. The northerly winds generally end within a kilometre or two of the Channel, dissipating quickly as they move out over the open waters of the Strait of Georgia. Strong northerlies can extend farther south and, in one specific weather pattern, have been known to move past Vancouver.

Northeasterly Squamish winds that affect the western section of Howe Sound do not occur as frequently as northerlies and are typically weaker. They, move through the channel north of Anvil Island and into Thornbrough Channel. Winds can be very strong as they hit Port Mellon but lighten up farther south toward Hopkins Landing. They also flow between Bowen and Gambier islands and can cut across the peninsula at the south end of Gambier Island and pour into Port Graves. While winds at the mouths of all of the bays on Gambier Island can be rough, the strongest ones blow through Port Graves. When the outflow winds at Pam Rocks are more than 40 kt, the winds at Langdale and through Thornbrough Channel are roughly half as strong. In this pattern, the winds through Queen Charlotte Channel are light, even if Pam Rocks is reporting a strong northeast outflow. With both northerly and northeasterly Squamishes, there are generally no winds in Ramillies Channel between Anvil and Gambier islands.

Southwesterly, westerly and northwesterly pressure-slope patterns
Northerly winds can also occur when the pressure-slope direction is closer to the west but they are not usually strong. During the summer, when there is a ridge of high pressure to the west of the region, the winds are northerly overnight and in the early morning. Speeds are usually near 15-20 kt but can be as high as 25 kt. In the afternoon, the diurnal southerly inflow winds develop. This diurnal rhythm of breathing in and breathing out is usually



Winds with a 'northeasterly' outflow pattern.

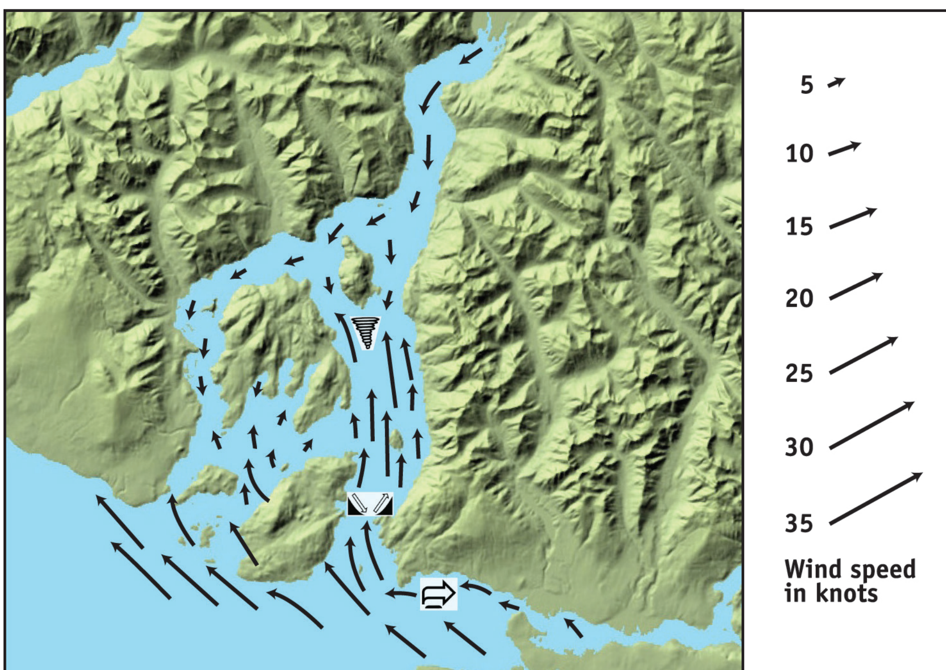
strongest during the summer. Downslope drainage winds can occur on quiet summer days and in some of the smaller bays and inlets of the islands in Howe Sound. Halkett Bay, on Gambier Island, receives drainage winds almost continuously from the cold lake at its head; however, they rarely extend very far into the Bay.

2.1.6.2 Southerly Winds

Southeasterly, southerly and southwesterly pressure-slope patterns

Southerly winds in Howe Sound occur whenever the pressure is higher on the coast than it is over the Interior and the pressure-slope direction ranges from southeast to southwest. This pattern develops after the passage of a front over the region or when a ridge of high pressure builds offshore.

When a front approaches from the southwest, a plume of strong southeast winds extends from Port Townsend to near Victoria. As the front draws closer, the plume moves over to Bellingham and spreads north, past Sand Heads to Point Atkinson. Just before the surface front enters Howe Sound, causing pressures to rise, strong southerly winds often spread into the Sound. The shift from northerly to southerly can be dramatic: in the case of an extremely strong front, winds can change from northerly at 20-30 kt to southerly at 40-45 kt in a matter of minutes. The winds are not generally this strong, although some approach these values almost every year. The initial, strong surge of southeast winds lasts only an hour or so, but the southerly winds can persist for many hours. Waterspouts sometimes develop during these sudden wind changes.

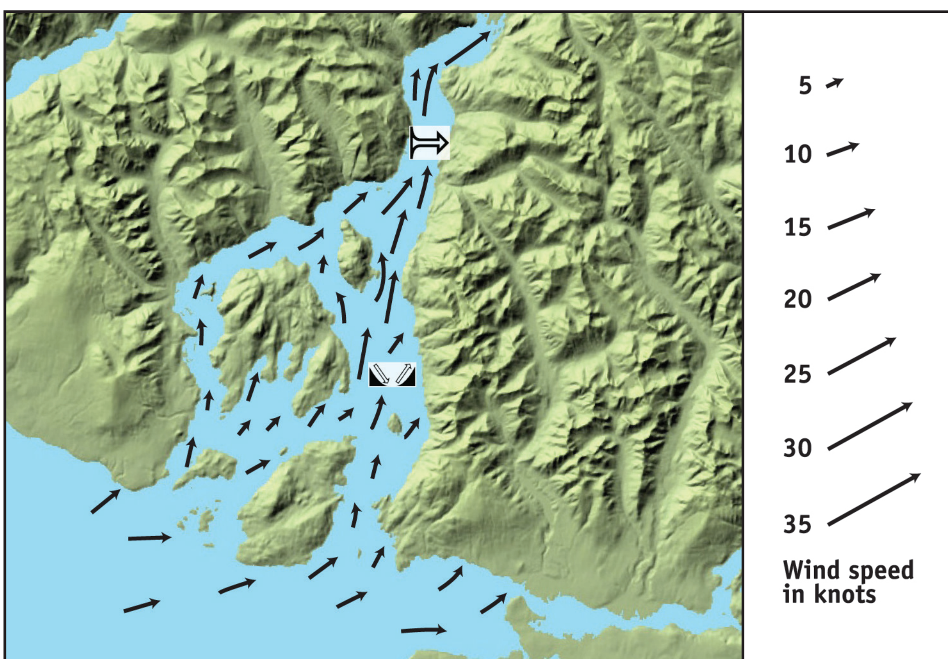


Southerly winds moving into Howe Sound ahead of a front, using the example of 2200 hrs, 23 January 1998 with a pressure-slope direction of 140° and a slope steepness of 4.0 mb per 60 nm.

Southeast winds run up against Bowen Island—in particular, near Seymour Landing. Most are deflected into Queen Charlotte Channel, where they can be quite strong, but some crossover Bowen Island, pass Cotton Point on Keats Island, and flow into Langdale. Hood Point reports strong southeast winds, but there is little wind north of Bowen Island and southeasterlies do not generally blow through Collingwood Channel. On occasion, strong southeast winds come down off the mountains north of Point Atkinson and spill onto the sea along the coast from near Horseshoe Bay to Sunset Beach. These winds, which can reach speeds of 40 kt, often occur later in the day during autumn. Since the fetch is very limited, however, no seas develop.

During a typical summer day, when there is a ridge of high pressure to the west of Vancouver Island, the pressure-slope direction varies from the northwest during the morning hours to the southwest or even south during the afternoon. As the daytime heating of the mountain slopes around Howe Sound draws air up the mountains, air is drawn into the Sound to replace it. The winds caused by this process gradually build speed as they approach the head of the Sound, accelerated by the funneling effect of the narrowing inlet. As a result, the lightest winds in Howe Sound are at the mouth and the strongest just south of Squamish.Pam Rocks reports winds of 10-15 kt on a typical summer afternoon, while Squamish sees speeds of about 5-10 kt higher. These winds usually ease after the peak heating period of the day, switching back to northerly as the mountain slopes cool overnight and the drainage winds begin.

Westerly, northwesterly and northerly pressure-slope patterns
Southwesterly winds in Howe Sound are usually the result of northwest winds in the Strait of Georgia. If the northwest winds in the Strait are less than 20 kt, they usually cut across



Winds with a diurnal southerly inflow.

southern Bowen Island and blow over to Point Atkinson without turning north into the Sound. If they are stronger than 20 kt and there is enough blue sky to allow an inflow wind to develop, westerly winds of up to 15-20 kt will move up both Collingwood and Shoal channels. When a northerly pressure-slope pattern is in effect, the northwest winds in the Strait can last for days, and the westerlies in the channel, just as long.

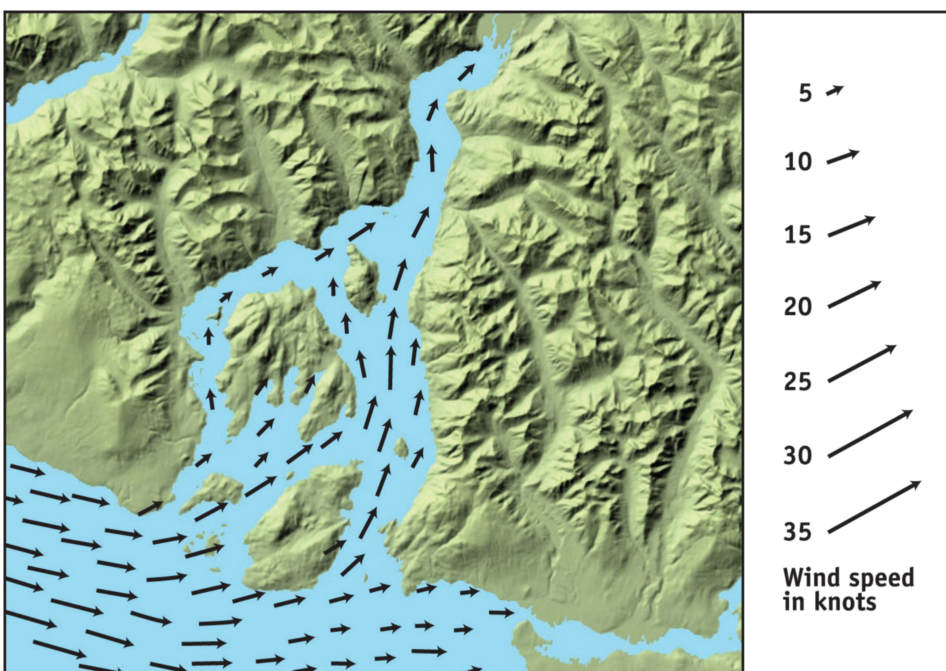
2.1.6.3 Local Waves and Currents

The highest seas possible in Howe Sound with a northerly wind of 50-60 kt would be 3-4 m. In most parts of the Sound, fetch limitations mean they are much lower. Swell waves can move into the southern waters of the region when the winds in the southern Strait of Georgia are west or southwest. These swells can spread farther north when strong southerly winds are blowing west of Vancouver; however, they are not usually very high, as winds from this direction do not last very long.

2.1.6.4 Local Weather

In a winter Arctic outflow event, cloud and snow may accompany the passage of a front as it moves out to the coast. Behind the front, snow flurries may develop over the north-facing slopes of the mountains on Anvil, Gambier, and Bowen islands, but Howe Sound is generally free of low cloud and extensive precipitation when there are strong northerly winds.

Fog forms over the water during the morning hours when cold air first reaches the coast. Usually, the air dries out sufficiently during subsequent cold days that fog does not form

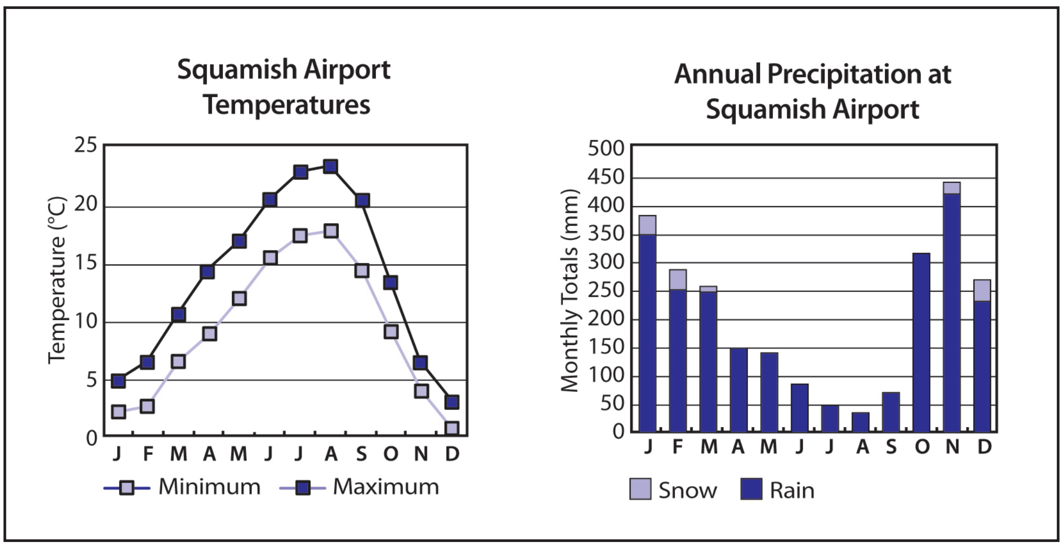


Southerly inflow winds based on 0700 hrs, 16 July 1996 with a pressure-slope direction of 240° and a slope steepness of 2.2 mb per 60 nm.

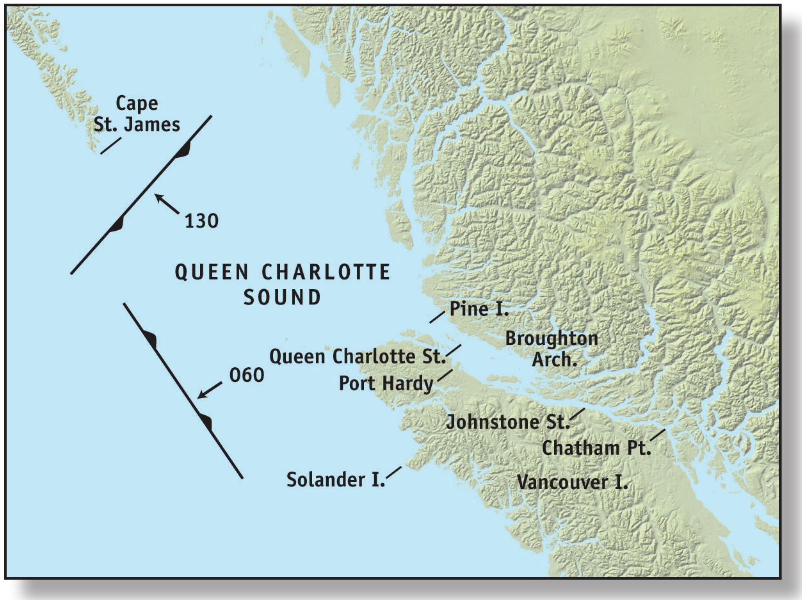
or is patchy. Freezing spray can develop in parts of Howe Sound with very strong northerly Arctic winds. It was so severe one year that the weight of the accumulated ice almost sank a weather buoy anchored near Pam Rocks.

Rains usually begin during the easterly pressure-slope pattern, when there are still light to moderate northerly winds in the area. The heaviest precipitation develops as the pressure-slope direction veers into the southeast, and the winds aloft turn into the south and southwest. This is usually marked by the surface winds shifting into the south. With upper winds from the southwest, clouds fill the inlet and are enhanced by lift up the mountains, so that heavy rains occur. November can be a particularly wet month, with the weather pattern bringing storm after storm from the southwest. These warm, moisture-laden systems are something referred to as a “pineapple express” because the moisture source usually originates near Hawaii. Brighter but occasionally showery weather develops when the pressure-slope direction turns into the southwest and west.

Waterspouts are frequently reported in Howe Sound, where they may be encouraged to form by the strong shift in winds from north to south. The rotational effects of this shift may be enhanced by the confining nature of the surrounding mountains. While there have been no reports of navigational difficulties arising from an encounter with a waterspout, safety suggests they be avoided.



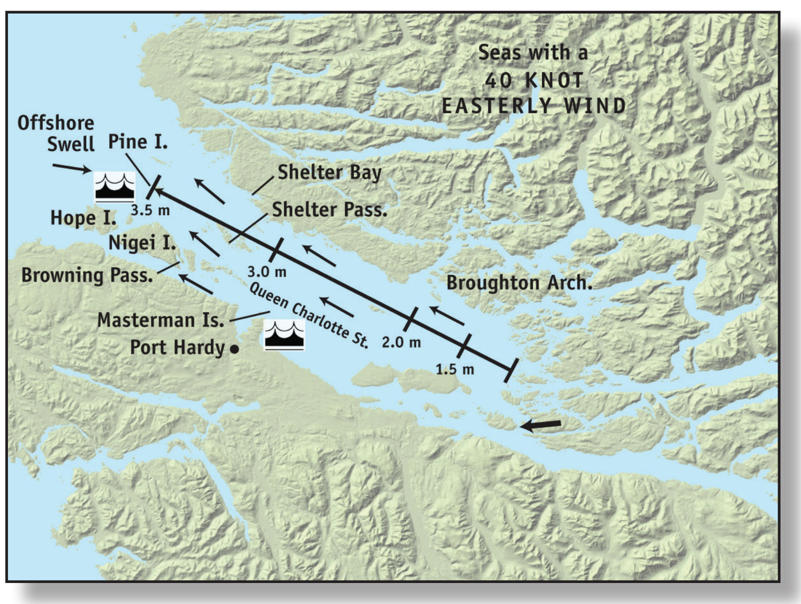
2.2 Chatham Point to Port Hardy



2.2.1 Easterly Pressure-Slope Winds

2.2.1.1 Queen Charlotte Strait

When a front approaches this region, the winds shift to an easterly direction and the angle of the pressure slope is 60-130°. The degree of tilt determines where and how strongly the winds blow. When a front approaches from the northwest, the pressure slope is closer to 130°, and the winds are strongest through the central and northern parts of Queen Charlotte Strait and enter the southern sections of the Broughton Archipelago. When a front approaches from the southwest, it is closer to 60°, and the winds are strongest on the Vancouver Island side of the Strait and light through most of Johnstone Strait. The winds in Johnstone increase as the front draws nearer, and the pressure slope turns more toward 130°.



When a front approaches from the northwest, the winds in Queen Charlotte Strait shift from southeast to west, six or seven hours after they do at

Cape St. James. When it approaches from the southwest, the wind shift that occurs at Cape St. James or Solander Island takes place near Port Hardy only an hour later. If a front stalls over Queen Charlotte Sound, as sometimes happens, it may never cross the Strait or take many days to do so.

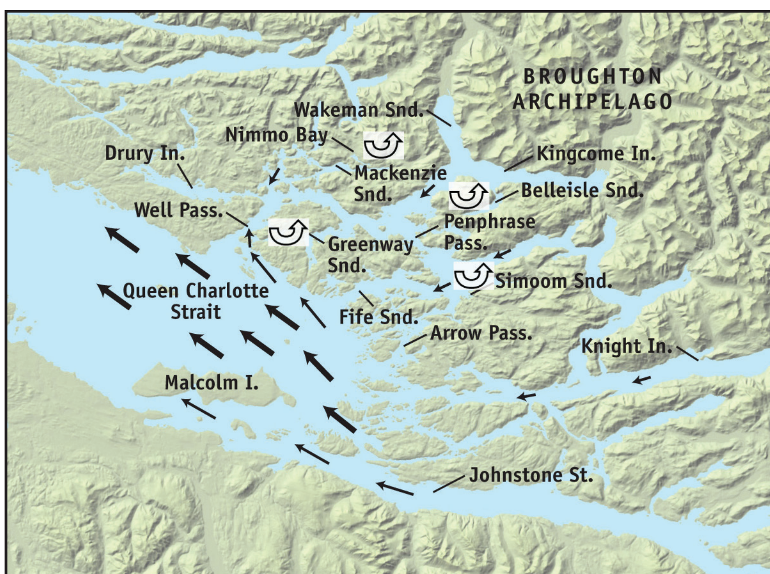
Sea conditions in the Strait arise primarily from wind-generated waves and their interaction with tidal currents, which play a significant role. When these currents run against the winds, the seas become shorter and sharper and can build up to a metre higher than what they would otherwise. Wind waves, on the other hand, are largely limited by fetch. If the winds were steady at 40 kt over the 45 NM from the eastern end of Queen Charlotte Strait to Pine Island, the seas would vary from less than 1 m in the east to about 3.5 m at Pine Island.

Western Queen Charlotte Strait offers no shelter from a storm between Shelter Bay, on the north shore, and Hope and Nigei islands, on the south, although the islands may provide shelter in some situations, depending on the direction of the wind. In the passages between the islands, such as Shelter Passage and Browning Passage, southerly winds may become even stronger due to funneling effects.

Sea conditions near the Masterman Islands, off Port Hardy, are notoriously rough due to strong easterly winds. Tides between Masterman Islands and Pulteney Point are also strong. Swells from distant storms bend around the top of Vancouver Island and enter Queen Charlotte Strait; however, their impact is confined to the northern shore and the southern area of Broughton Archipelago.

2.2.1.2 Broughton Archipelago

Strong southeast winds in Queen Charlotte Strait strike the edge of the Broughton Archipelago when the pressure slope is east or southeast but do not spread with the same strength through the waters within the Archipelago. As such, the winds may be strong at the mouths of Arrow Passage, Fife Sound, and Wells Passage but less so farther up in the waterways. Drury Inlet, Sutlej Channel, and Penphrase Passage, which are oriented toward the southeast, get stronger winds. Since the fetch is limited, however, the seas are choppy but not rough.



Locally gusty winds occur in various inlets, such as Simoom

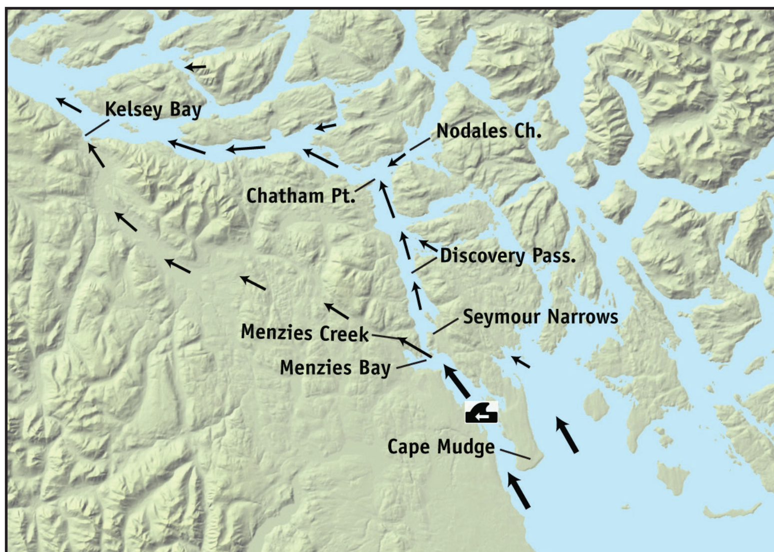
Sound, Belleisle Sound, Nimmo Bay off Mackenzie Sound, and Greenway Sound, where southeast winds aloft flow down the mountain sides. Less mountainous areas do not have problems with gusty, downslope winds.

Mariners' Tips:
Sailors refer to steady winds as "clean" winds because they are smoother and pull their sails better than gusty winds do.

When the pressure slope is from the northeast, light outflow winds blow through some passages, although the winds in Queen Charlotte Strait may be strong and from the southeast. When the pressure slope turns more northerly and the air becomes colder, as it does from December through March, most waters within the Broughton Archipelago are glassy calm. Only those with connections to the northerly outflow experience much wind.

2.2.1.3 Johnstone Strait

After the passage of a front, the winds in Johnstone Strait ease and attempt to shift into the southwest. Unable to do so because they are confined by the channels of the Strait, they lighten further. The winds aloft, however, are able to make the shift and, in some locations, interact with the mountaintops to produce downdrafts. This can cause strong, gusty winds at the surface.

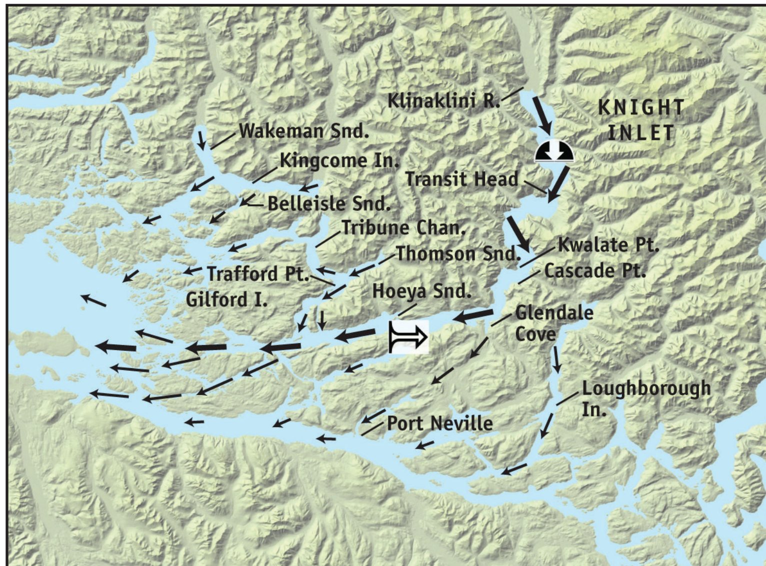


In Discovery Passage, the southeast winds are strongest on the western side of the passage up to Menzies Bay and Seymour Narrows. In a flood tide, the west side of the Passage should be avoided. The winds tend to ease just north of the Narrows, some crossing Menzies Bay and flowing up Menzies Creek. They may strengthen again near Chatham Point due to corner effects and additional wind coming out of Nodales Channel.

Strong southeast winds that flow against a flood tide in Johnstone Strait produce seas over a metre higher than they would with an ebb or slack tide. The waves in the Strait subside quickly after the winds drop or the tide runs against them.

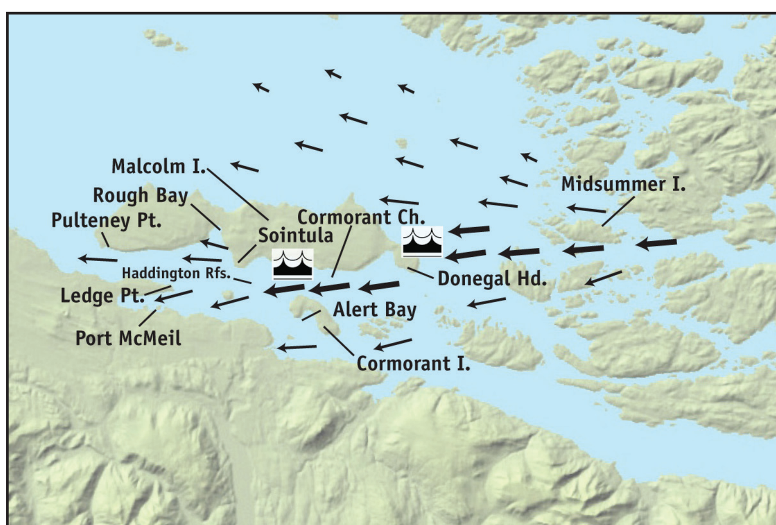
2.2.2 Northerly Pressure-Slope Winds

2.2.2.1 Knight Inlet

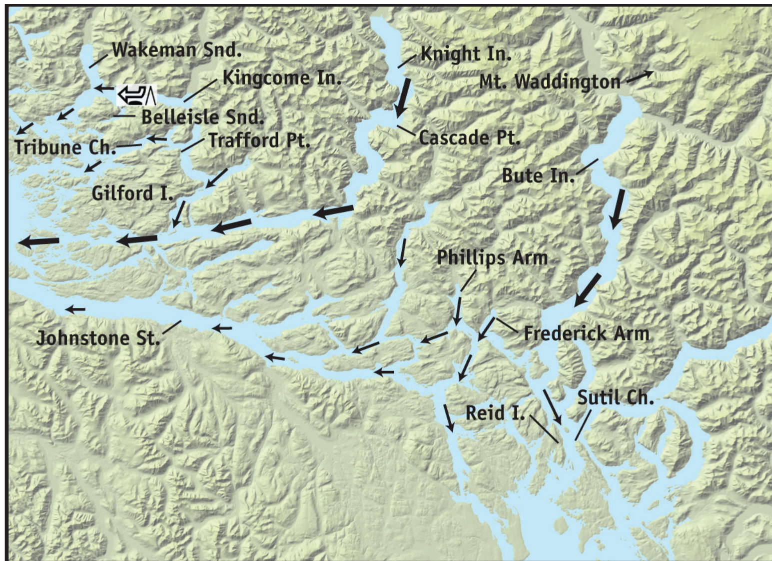


Knight Inlet, like the other coastal inlets that experience outflow winds, has its own unique traits. Arctic air spreads from the Chilcotin region of the Interior down the Klinaklini River valley, forming a wall of northerlies as it enters Knight Inlet. This causes "wild winds" at corners such as Cascade Point. The winds that pass through Bute Inlet also originate in the Chilcotin Plateau but exit through the Hamathko River valley. Both the Klinaklini and Hamathko rivers pass through glacier fields, which add cold drainage winds to the strength of the outflow.

The northeast outflow winds flow like a river through Knight Inlet, deflecting off one side of the shoreline and then the other. Some relief from moderate northerly winds may be found in the bays just south of Transit Head, south of Kwalate Point, and in Hoeya Sound. In the strongest outflow events, however, the winds fan out into most bays, so there is no safe shelter. In these events, the winds are non-stop, creating a steady roar from the head of the Inlet to Glendale Cove. Passage up the Inlet during a strong outflow is said to be impossible, and there are few places to anchor. In some cases, the outflow has been known to ease between Hoeya Sound and the mouth of the Inlet. Although there are no reporting sites to indicate the strength of the winds in Knight Inlet, they appear to be similar to those at Cathedral Point, in Burke Channel, which is included in regular marine broadcasts.



The outflow winds from Knight Inlet fan out, at slightly reduced speeds, into the channels at the mouth of the Inlet. The main thrust passes south of Midsummer Island and moves out toward Malcolm Island, hitting hard at Donegal Head. Large seas are created with outflow winds south of Malcolm Island, but the winds are hardly noticeable north of the Island. They funnel into Cormorant Channel, just north of Cormorant Island, and can be especially intense near the Haddington Reefs. The winds south of Ledge Point may be 5-10 kt stronger than those near Rough Bay, on Malcolm Island. Easterly winds pass south of Cormorant Island, but Alert Bay has lee protection. In the strongest outflow events, the winds extend all the way west along Vancouver Island to Port Hardy and are recorded at Scarlett Point.



After several days of outflow, during which time the depth of the cold air has increased, the outflow begins taking other paths to the coast. The cold air moves into Loughborough Inlet and flows out into Johnstone Strait. It also passes from Knight Inlet, over Glendale Cove, and into Port Neville. Northeast winds also blow over the mountains and into Thompson Sound, with speeds of 60 kt experienced at its mouth near Trafford Point. These winds are reportedly strongest in January but are still much lighter than in Knight Inlet.

Mariners' Tips:
Weather reports in Alberta and northeastern BC may provide some forewarning of northeast outflow winds. If the temperature there drops to well below zero, an outflow may be coming.

Lesser northerly outflow winds travel down along the back side of Gilford Island, some spreading west from Trafford Point into Tribune Channel. Kingcome Inlet receives outflow winds that are partially drainage winds from the Mt. Waddington glacier. They are not extreme, however, because the Inlet does not have an open passageway to the Interior. Some of the Kingcome outflow passes through Belleisle Sound. Wakeman Sound also likely receives some outflow winds, which merge with those in Kingcome Inlet. Wells Passage and Drury Inlet see some as well, but they merely hint at the strength that occurs through Knight Inlet.

Bute outflow winds are fierce and warrant full respect. The main thrust of the Bute winds passes over the top of Reid Island and flows out into Sutil Channel. During the most severe Arctic outbreaks, when the depth of cold air increases sufficiently to move over higher passes, these winds begin flowing through nearby passageways, such as Frederick Arm and Phillips Arm, and out various channels into Johnstone Strait. By the time they reach the channels, however, their full ferocity has been greatly reduced. Both Bute and Knight inlets can develop a coating of surface ice, which helps to reduce wave development.

Mariners' Tips:
Strong outflow winds create dangerous conditions near the mouths of inlets when they run against an incoming tide.

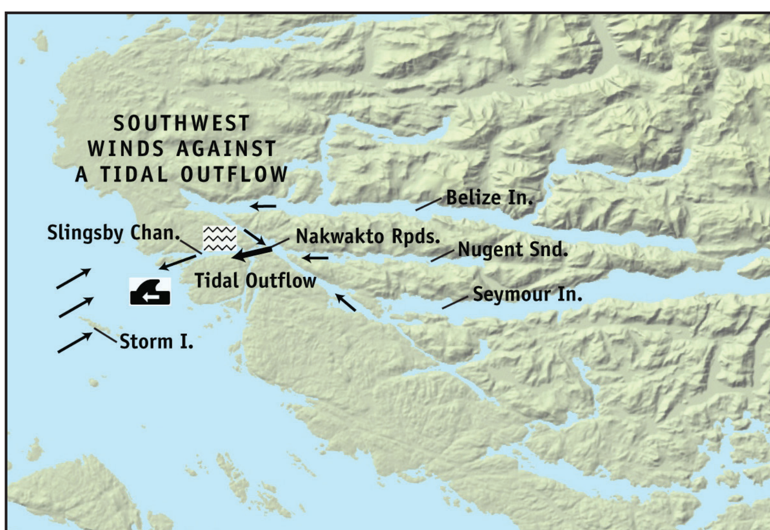
During the initial outbreak of the cold Arctic winds, there may still be enough cloud present for snow to fall. Once the ridge has built over the area and the cold air is fully established, however, it becomes sunny. Additional snowfall may occur when a weather system moves off the Pacific, bringing sufficient moisture for clouds to form. During the transition from Arctic cold to normal mild Pacific weather, periods of localized freezing rain may occur at the heads of inlets where cold air is trapped.

Mariners' Tips:
"All kinds of weather are possible during the winter in the Broughton Archipelago. The weather can be beautiful with a flat, glassy calm, but there can also be strong winds, turbulence, rain, and snow. The snow line can drop down to the water."

Wakeman Sound and the upper parts of Kingcome Inlet can freeze over in winter, as can the waterfalls along the Inlet down to Cascade Point (known locally as Twin Falls). For mariners, freezing spray is more of a hazard than the freezing of surface water.

2.2.3 Southerly Pressure-Slope Winds

Southwest winds are generally only experienced in the more open, western parts of Queen Charlotte Strait and in some channels in the Broughton Archipelago that are open to the south. The only place they occur in the Johnstone Strait area is through Discovery Passage and, locally, in smaller inlets such as those near Kelsey Bay. Strong southwest winds aloft at mountaintop height and capped by an



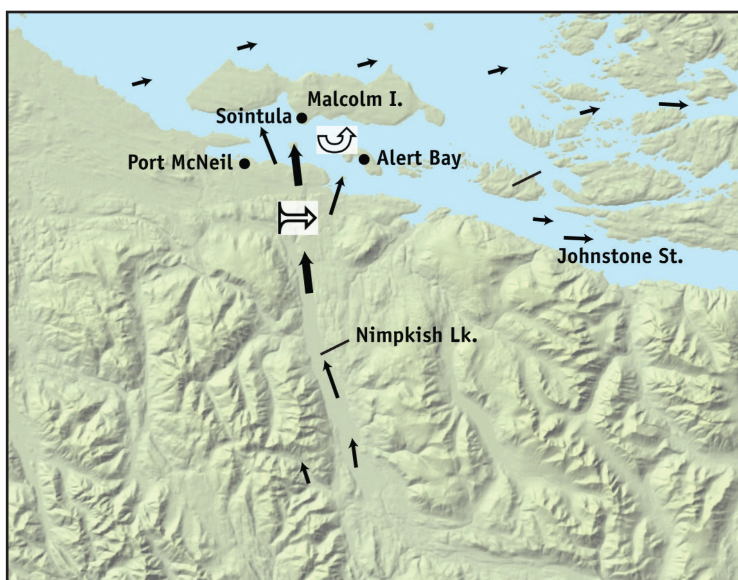
inversion sometimes flow downward, onto the water. These winds occur in a number of places throughout the Broughton Archipelago.

Seymour Channel, Nugent Sound, and Belize Inlet all empty their tidal waters through narrow Slingsby Channel. As a result, the outgoing tide is very strong. When it moves against a west or southwest wind, conditions on the water can be very rough. The plume fans out and eases slightly after leaving the Inlet, creating an even larger area of rough water that can extend all the way out to the Storm Islands.

Mariners' Tips:
The Nakwakto Rapids, which lie between Seymour Inlet and Slingsby Channel, reach speeds of 16 kt during an ebb tide, making it one of the strongest tidal streams in the world. Safe navigation is only possible during slack water, which lasts just six minutes.

South or southwest winds in Queen Charlotte Strait are often called Nimpkish winds, even if not all southerly winds pass through the Nimpkish Valley. The classic Nimpkish winds are caused by daytime heating in the valley, from spring to early autumn. As the air is heated along the valley sides, it rises upward and is replaced by winds travelling from the south along the lake. The surface winds reach 30 kt, at times. Some of the wind spills out of the valley, hitting Alert Bay and Sointula at speeds of 10-20 kt. When there is a ridge west of Vancouver Island and lower pressure in Queen Charlotte Strait, they get an added boost from the pressure difference.

The strongest south-to-southwest winds, however, are not due to daytime heating but to a strong increase in pressure behind a front. The Nimpkish Valley funnels these winds to much greater speeds, with southerlies of 50 kt occurring downwind of the valley and, in extreme cases, being reported at 85 kt. Nimpkish winds are most common from April to June but can occur at other times of the year, as well. Typically brief, they have been known on rare occasions to last for several hours.



In an inlet that is not aligned to the southwest, the southerly winds behind a front are not usually a concern, as they tend to flow up and over the inlet. Local turbulence and even whirlwinds and waterspouts have been reported off the south side of Hanson Island, where winds are deflected and spun by the steep shoreline. Similar conditions likely occur elsewhere in the region. In some cases, the topography confines the winds to a narrow plume, visible from a distance as a black streak with glassy calm waters on either side.

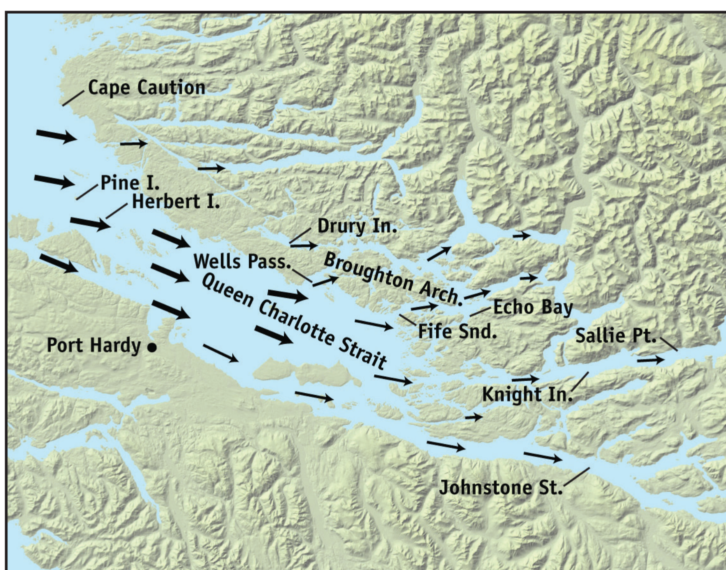
2.2.4 Westerly Pressure-Slope Winds

2.2.4.1 Post-Frontal Westerlies

Summer westerly winds are primarily associated with a weak ridge of high pressure offshore and sea-breeze effects. Stronger westerly winds can also occur during the summer months, either associated with a strong ridge of high pressure offshore or the passage of a front. Winds can rise rapidly behind a front if the pressure does so as well, but their strength is usually short-lived because the pressure difference equalizes quickly. Winds up to 45 kt have been recorded at Echo Bay in the Broughton Archipelago.

Westerly winds that develop after the passage of a front are not linked with diurnal heating because the fronts can pass at any time of day. Many storms follow a front that is crossing the region when a low is moving northward into the Gulf of Alaska; however, before the southeast winds ahead of the front shift all the way into the northwest, a secondary trough, extending southwest from the low, has to pass. The interval between the passage of the first front and the arrival of the trough is often a full day. This provides a period of relative calm, although clouds may lift but not necessarily clear until the trough has passed.

Westerly winds spread fairly evenly throughout the region and are much the same strength on both sides of the Strait. They spread into all inlets that open toward the west or southwest, including Wells Passage, Drury Inlet, and Fife Sound. The speed of the winds in these inlets can be increased through funneling or slowed by blockages in the terrain. When strong westerlies arrive at the mouth of an inlet while diurnal outflow winds are occurring, the seas become steeper and more dangerous. Those caused by a combination of sea-breeze effects and a strong ridge of high pressure offshore usually move up Knight Inlet as far as Sallie Point.



2.2.4.2 Diurnal Winds

A ridge of high pressure west of Vancouver Island creates generally westerly winds, the strength of which depends on the exact position and strength of the ridge.

They do not blow continuously but have a daily "breathing" rhythm similar to that of a sea breeze: increasing as the adjacent land heats up during the day, and decreasing as it cools after the sun goes down. In the peak of the summer, the most significant variations in the wind often occur due to highly localized differences in the heating effects of the sun at one site compared to another—sometimes even when they are in close proximity.

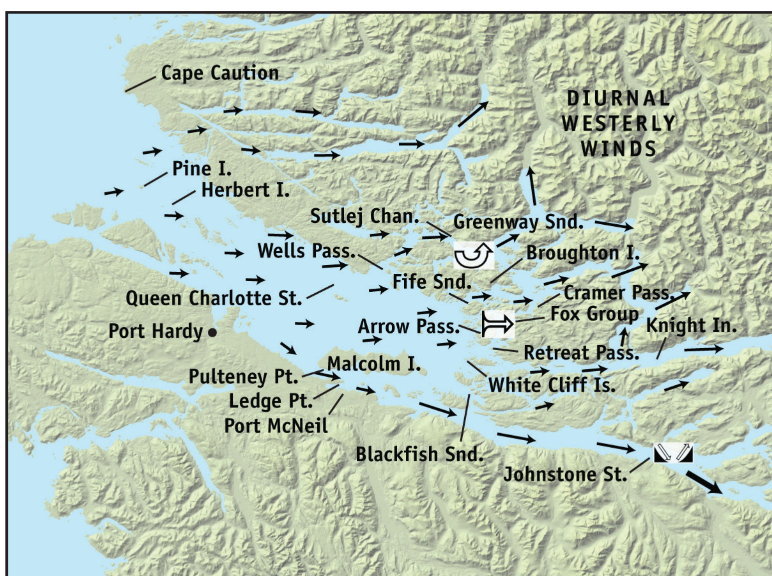
Westerly winds begin around 1000 hours if there is no fog overnight but are delayed until 1200 or 1300 if the fog is slow to burn off. The winds usually rise to about 15 kt in Queen Charlotte Strait during the afternoon and ease near sunset. As fog reforms overnight, light westerlies may shift to light easterlies. It is generally said that the warmer the day, the stronger the winds: a cloudy day may see little, if any at all.

Did You Know?

Blackfish Sound, just east of Malcolm Island, had nine straight days with westerly winds over 35 kt in August 1974. Although westerlies are common at that time of year, these were stronger than normal and never let up.

Summer westerlies at the western end of Queen Charlotte Strait are never very strong and are usually not much more than a light sea breeze of 10-15 kt. The westerlies moving into Wells Passage can reach 20 kt near the junction with Sutlej Channel. Inflow, sea-breeze-type winds occur through the rest of the channels on the northern side of Queen Charlotte Strait but are very local in nature and not generally strong. Westerly winds funnel around Broughton Island, creating gusty, turbulent air on the north side, in Greenway Sound.

Summer westerlies are a little stronger on the north side of Malcolm Island than to the south. Sailors report the cleanest winds near Pulteney Point, where there are few gusts and eddies. Westerlies cross over the isthmus near Port McNeil, so the best place to anchor is just south of Ledge Point. They bunch up over the eastern areas northeast of Malcolm Island and toward the opening of Johnstone Strait and are noticeably stronger at White Cliff Islets. West winds also funnel into Arrow Passage and Cramer Passage, but there is some shelter in the Fox Group of islands, and little westerly wind moves into Retreat Passage.

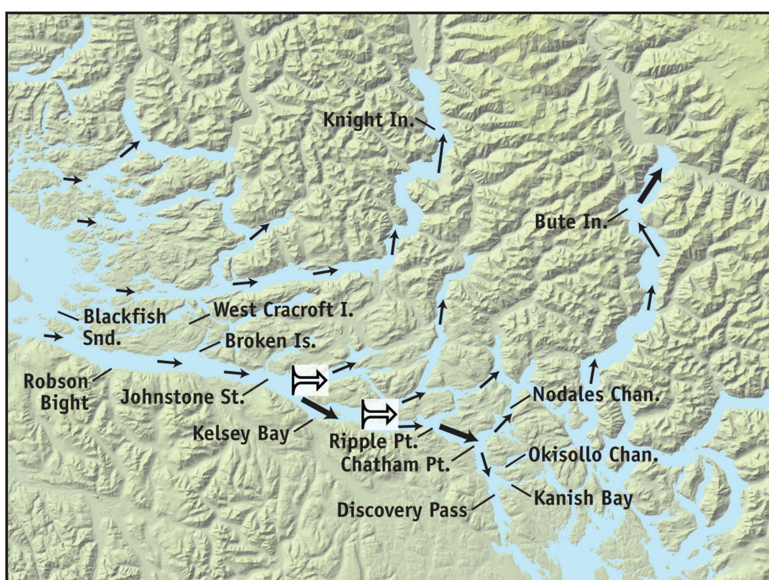


The westerly winds begin to pick up in western Johnstone Strait, off West Cracroft Island, and strengthen as they are funneled eastward into the narrower passageway of the Strait. They are worst at Kelsey Bay. Both onset and ending times are later heading east: at Chatham Point, for instance, the winds do not usually start until around 1500 hours and peak in the evening, sometimes close to midnight. If the sun is shining, they can be expected to rise to 25-30 kt at Chatham Point with a westerly pressure-slope pattern. Winds of gale force at 35-40 kt are not uncommon. Occasionally, the winds last through the night and die down in the early morning.

After the flow of westerly winds passes Kelsey Bay, it eases, then increases again, reaching its peak near Ripple Point, a little west of Chatham Point. The winds at Ripple Point often appear to be about 10 kt stronger that they are just off Chatham Point. Winds of 15-20 kt at Herbert Island in western Queen Charlotte Strait result in winds of 25-30 kt near Chatham Point, where they occasionally reach gale force of 35-40 kt. They ease after passing Chatham Point, once the Strait splits into several channels. Little of the westerly wind moves into Nodales Channel, except after a three-day blow, when it spreads virtually everywhere—except, usually, beyond Brougham Point. Most of the wind turns down into Discovery Passage, with Kanish Bay receiving some of the flow but little going into Okisollo Channel.

2.2.4.3 Inlet winds

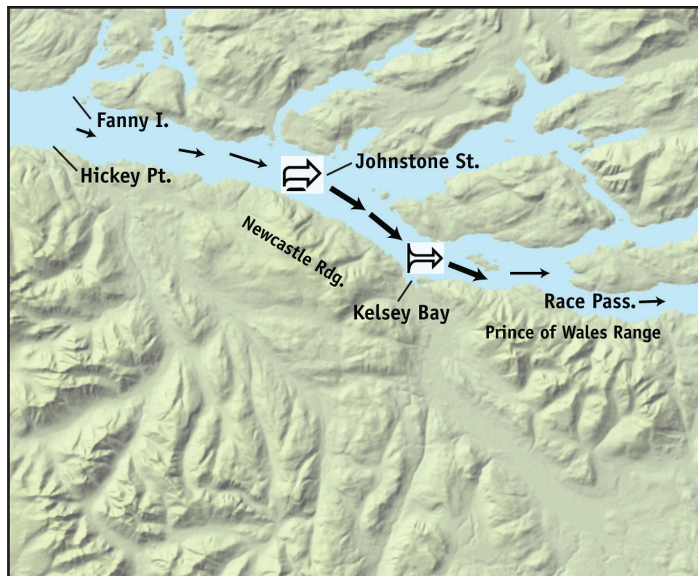
During the summer, the winds generally blow up the coastal inlets during the late morning and afternoon. The strength of these inflow winds is greater in the inlets that have more gentle slopes, because they are more directly exposed to the heat from the sun. These winds switch to a light outflow during the night. In the early days of summer, before much snow melts off the mountains, the outflow winds are strong because there is a sharp temperature contrast between the snow-capped mountains and the lower parts of the inlets. These winds can rise abruptly in the evening. The seas rise over the shallow bars at the mouth of the inlets, which should only be crossed when running with the tide. Summer outflow winds die away in the morning, as the temperature rises. Near the head of Knight Inlet, cold winds coming down from the glaciers persist while the southerly inflow winds strengthen in the afternoon. Where the two winds meet, some impressive waterspouts can form.



2.2.4.4 Kelsey Bay Winds

In summer, the westerly winds that run through Johnstone Strait strengthen as they pass Hickey Point, reaching their peak off Kelsey Bay before easing again just west of Race Passage. The explanation for these winds is somewhat uncertain, but they appear to be caused by interaction with Newcastle Ridge. There is a slight bend in Johnstone Strait near Hickey Point, so the westerlies likely increase through corner effects as they pass the Ridge. There may be additional downslope effects from upper-level winds coming down off the Ridge, just east of Hickey Point. The winds are cold after passing over the snow-covered mountain, so they bend and flow down toward the sea.

At Hickey Point, the winds may be only 15-20 kt, but they could reach gale force or higher at Kelsey Bay. Fanny Island, the nearest recording site, would likely report winds of 20-25 kt if this were the case. Normally, the peak winds off Kelsey Bay are less than 40 kt, but seasoned mariners have reported westerly squalls of up to 100 kt. When winds even close to this magnitude flow against the tide, massive seas develop, creating a veritable wall of water. Twenty-foot seas have been observed off the government dock at Kelsey Bay. The prime time for these winds to form is from May to early July, when there is a significant amount of snow on the peaks.



Mariners' Tips:

Strong Kelsey Bay winds occur when it is clear and there is a cap of cloud over the Prince of Wales Range. If the clouds drift over the mountain, all is likely well; but if they remain stationary, strong winds are almost guaranteed.

It is possible to avoid travelling past Kelsey Bay by taking a route through the many passages north of Johnstone Strait, from Sutil Channel to Sunderland Channel.

2.2.5 Fog

In late summer and early autumn, a large bank of advection fog forms to the north of Vancouver Island, near the central coast, and extends south into Queen Charlotte Strait. Its initial approach can be very sudden, so mariners must keep a sharp eye out for it. The fog spreads through the Strait and into most inlets but generally does not extend much farther east than Robson Bight, in Johnstone Strait. It does not move inland, as the air over the land is hotter and drier than it is over the water.

The fog goes through a daily cycle of burning off during the day and reforming overnight. The clearing begins near the coast, where the air warms up fastest, and spreads toward the centre of the Strait. On its first day, the fog usually burns off before 1000 hours; however, because it gets thicker each day, it takes progressively longer to clear, and can sometimes persist until 1200 or 1300 hours. In the centre of the Strait, some patches can remain throughout the day. The fog penetrates farther into Johnstone Strait and its inlets with each passing day. Clearing begins at the inlets' heads around 1000 hours and reaches their openings an hour or two later. It usually takes three days before fog becomes a major problem for mariners.

If fog is covered by cloud, daytime heating will be weaker, and it may not burn off for days. Blackfish Sound once had fog for 16 days in a row. The winds in fog are generally light but increase as it lifts. Fog reforms soon after the winds ease during the evening; if they blow until midnight, it reappears around 0400 hours. If they continue through the night but die in the early morning, it reforms instantly around 0700 or 0800 hours. Local coastal phenomena may also cause some areas to have more persistent fog, while some others tend to avoid it altogether. For example, when fog spreads toward the end of Malcolm Island it usually turns back out, leaving a hole in the fog bank just off Sointula.

Mariners' Tips:
When fog doesn't dissipate but lifts into stratocumulus clouds in the morning, there may be rain by afternoon.

2.3 North Vancouver Island

2.3.1 Easterly Pressure-Slope Winds

2.3.1.1 Port Hardy to Winter Harbour

Leaving Port Hardy for the west side of Vancouver Island requires some planning, as there are few places to hide from the potentially strong southeast winds off the end of the island before reaching Quatsino Sound. When the tides are against the wind, the seas can build to amazing heights in the shallow waters of Nahwitti Bar, although they are generally fine beyond it. To avoid crossing it, take the route through Gordon Channel and head well past Hope Island before turning west.

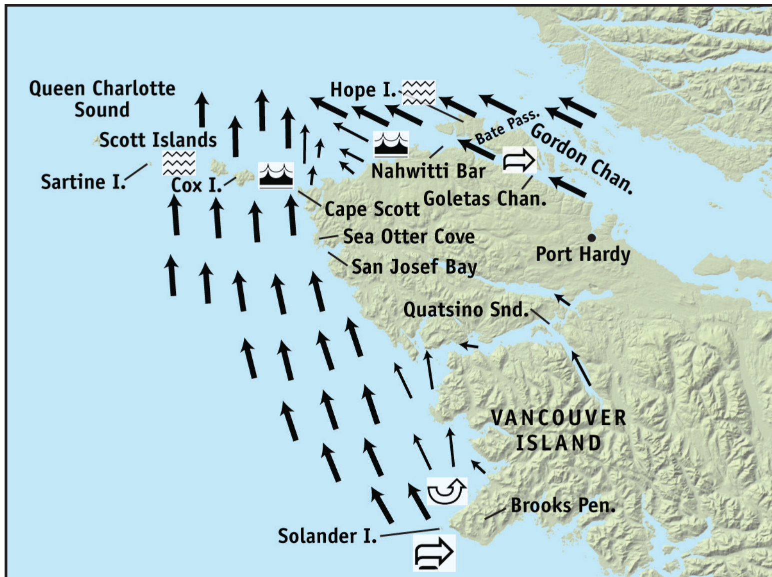
Mariners' Tips:
Crossing Nahwitti Bar, like Cape Caution to the north, takes careful timing. What is an easy passage when the weather and tides are just right can be a frightening ordeal when they are not.

Dangerous rips and overfalls—turbulent stretches of water caused by the currents over a marine ridge—occur when the tides flow against currents of 1.5-3 kt off Cape Scott. The best way to avoid them is to head out to near Cox Island before turning south. The tidal currents on the west side of Vancouver Island are generally less than those on the inside, and peak around 1.5 kt. They can be strong, however, in areas such as the outer Scott Islands, where they have been described as "running like a river."

Mariners' Tips:
While the winds in Goletas Channel and Nahwitti Bar are sometimes very calm, they can also blow hard from the southeast. In October 2001, when they were reported as hurricane force at Solander and Sartine islands and in Queen Charlotte Sound, they were over 80 kt in Goletas Channel. Bate Passage offers some shelter under certain directional conditions; in others, it experiences winds that are as strong or stronger than they are elsewhere.

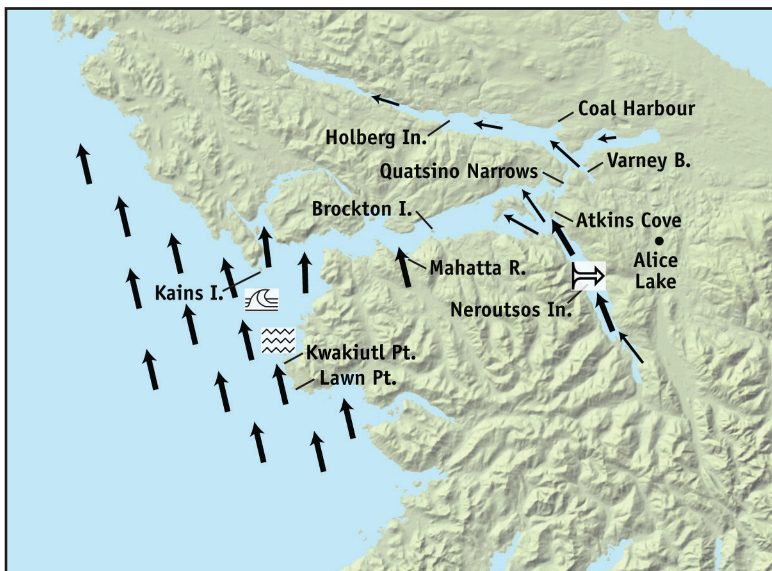
Southeast winds blow on both sides of northern Vancouver Island, creating an area of lighter winds off Cape Scott and a line of stronger winds that extends further out where the two streams converge. With very slight variations in wind direction, this line moves from one side of Cape Scott to the other. While the winds can be very strong, they are generally lower than those at Solander, which are strengthened by corner effects from Brooks Peninsula.

Conditions can change over very short distances as a result of coastal effects. Southeast winds are usually much lighter inside bays than they are a short distance outside of them. For example, when it is calm in San Josef Bay, Sea Otter Cove—which is right beside it—may be experiencing strong winds.



2.3.1.2 Quatsino Sound

With the approach of most lows and fronts, the winds in Quatsino Sound begin as light northeasterlies. At the Quatsino light station, on Kains Island, they remain light northeast long after those as little as a mile offshore have risen to strong or gale-force southeasterlies. It is said that the full strength of the wind blows over the top of the community of Quatsino, as winds inside the Sound do not generally exceed 30 kt when they are reported at 50 kt in Queen Charlotte Strait and 60 kt at Solander Island. Because of this sheltering effect, the Sound is often like a "pond", protected from the wild winds offshore.



When the pressure-slope is close to southeast, the southeast winds accelerate around Lawn Point and move into the entrance to the Sound. They do not spread with the same strength, however, and usually do so only when the air is stable—producing steady rather than gusty winds. If southeast winds occur during an outgoing tide (which can be as high as 4 m), huge seas will develop at the mouth of Quatsino Inlet. Conditions are particularly rough from Kwakiutl Point to Kains Island.

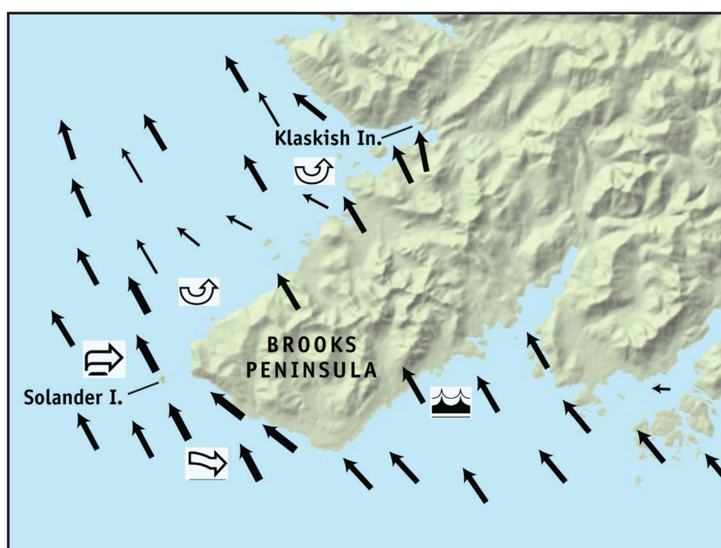
The strongest southeast winds occur near the mouth of the Sound, off the Mahatta River, and in Neroutsos Inlet. Off the Mahatta, the winds spill out in a narrow plume just over a kilometre and a half wide—and are light on either side of it. In Neroutsos Inlet, the southeast winds are generally stronger, hitting particularly hard near Atkins Cove. Some weaker ones turn up through Quatsino Narrows and into Holberg Inlet. Holberg gets most of its southeast wind from Varney Bay, which is open to the shallow land near Alice Lake. Although its gentle slopes don't funnel the winds like the steep-sided walls of Neroutsos Inlet do, it can be gusty if they approach at a certain angle.

At the end of Neroutsos Inlet, gusts have reportedly reached 100 kt and, on one occasion, were so strong they blew the windows out of a tug boat that was bucking into the wind. Such extreme winds are said to occur only when the pressure slope is southeast and the flow is drawn all the way from Kyuquot Sound, passing through various valleys before it reaches the Inlet. Although the winds shift regularly into the south after a front passes, their strength is greatly reduced by that time. What is likely needed for strong winds to develop is the passage of a low near Cape Scott, with strong pressure rises behind it and a strong southerly gradient on its southern flank.

Swells from the ocean can move into Quatsino Sound, especially if they come from the west and the seas offshore are very large. They gradually weaken and generally end just past Brockton Island, so little swell passes through Quatsino Narrows into Holberg Inlet.

2.3.1.3 Brooks Peninsula

Brooks Peninsula has earned the respect of mariners and aviators alike. Said to create its own weather, this massive peninsula juts out more than 30 km from the main part of Vancouver Island and rises to 800 m above sea level. The interruption it causes to the flow of both air and water results in various significant coastal effects. A windward or front-face effect develops when winds blow directly against the peninsula and back into the east or southeast as they run along its edge. This causes turbulent air with marked swirls to develop where the easterly winds mix with the more southerly winds further offshore. The seas, as a result, are very chaotic.



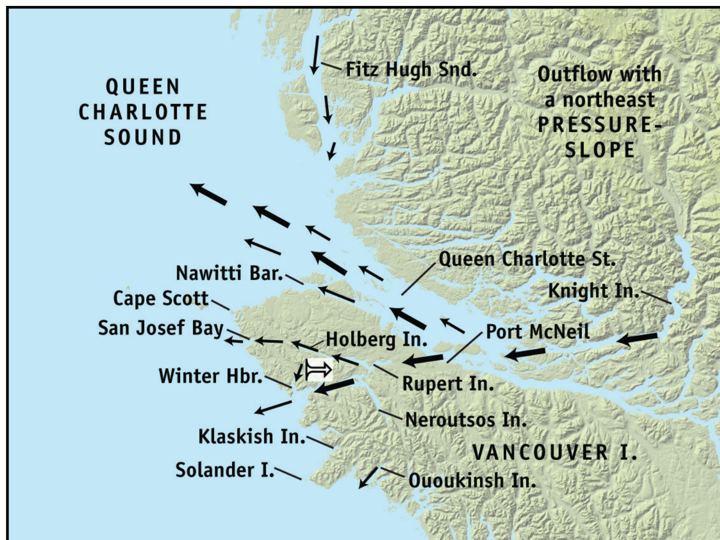
Corner effects make Solander Island the windiest place on the coast. As the wind passes around the end of the Peninsula, leeside eddies form that can sometimes pose a hazard to boats.

When the air is stable, most of the southeast winds flowing up against Brooks Peninsula are steered around it. Since the north side is somewhat sheltered from this flow, an area of lower pressure forms that acts as a miniature vacuum—sucking the air travelling over the Peninsula into strong, downward winds. Klaskish Inlet is notorious for such winds, described by one mariner as “plunging into the sea with such explosive force they send the water nearly 100 m into the air before it falls back into the hole it came from”. Skiffs have been overturned, planes have crashed, and ships have been pushed down nearly 30 cm by these forceful winds, which have left the head of the Inlet devoid of trees. Although they don’t happen all the time, they occur often enough that the north side of Brooks Peninsula and Klaskish Inlet, in particular, should be approached with extreme caution.

2.3.2 Northerly Pressure-Slope Winds

2.3.2.1 Quatsino Sound

Easterly outflow winds from Knight Inlet, when combined with the easterly winds in Queen Charlotte Strait, extend well past Nahwitti Bar. Part of the flow passes over the low land west of Port McNeil and into Rupert Inlet, moving from there into Quatsino Sound and out past the Quatsino Lighthouse. Some blows into Holberg Inlet and out through San Josef Bay. The coastal winds between these two outflows are light. Winter Harbour does not normally receive strong outflow winds, except during cold Arctic outflow events that have been blowing for several days. The plume of wind leaving Quatsino Sound turns northward if the pressure slope is more easterly and southward if it is more northerly—and normally dies out within 40-50 km. When the pressure slope turns more to the north, the northerly winds from Fitz Hugh Sound extend southward, past Cape Scott.



This sign on the road to Winter Harbour, while intended to warn off logging trucks, could also be used as advice for mariners who ply the waters of the BC coast.

2.3.2.2 Brooks Peninsula

The strength of the winds at Solander Island, off Brooks Peninsula, depends largely on the direction they are coming from. They blow from the northwest with full fury but drop off if they shift toward the north. Likewise, a northerly wind of 15-20 kt can rise to 30 kt in minutes if the wind direction backs by 10-20° toward the northwest. The pressure-slope transition point between these two winds is nearly 300°. During a strong northerly outflow event, the winds off Brooks Peninsula remain light, with stronger winds coming out of Quatsino Sound to the north and Kyuquot Sound to the south. Ououkinsh Inlet, just east of Brooks Peninsula, gets some turbulent outflow winds.

2.3.3 Southerly Pressure-Slope Winds

Southwest winds hit hard on the west coast, especially at the heads of inlets that are open to the southwest. Sea Otter Cove and San Josef Bay are particularly susceptible. Although they don't last long, these winds can be destructive. The strongest occur after coastal lows track over northern Vancouver Island, when southerlies of 50-60 kt develop in their wake.

2.3.3.1 Quatsino Sound

Quatsino Sound is open to the southwest, so it receives both winds and swell from the same direction. Coal Harbour, near the head of the Sound, is particularly vulnerable to southwest winds, which can be quite powerful but don't last long. Southerly winds can also bring fog.

Mariners' Tips:

"Southwest winds come at the tail end of a good southeaster and give one hell of a beating. It is short but strong. Boats slam on the docks. It is almost impossible, then calms down in a half hour. If it happens at a certain point of the tide you will get more than four feet of water over the fingers of the dock—it comes up instantly."

Did You Know?

The Royal Canadian Air Force set up a seaplane base in Coal Harbour during the Second World War because it was believed to be protected from the effects of a tsunami by Quatsino Narrows. Their theory proved right: when one hit in 1964, it caused damage at the head of Alberni Inlet but nothing more than an increase in sea level in Coal Harbour.

2.3.4 Westerly Pressure-Slope Winds

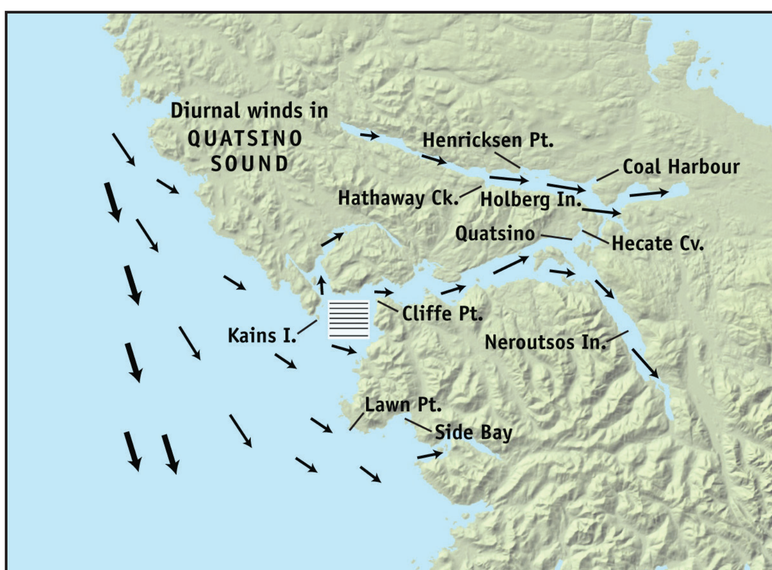
2.3.4.1 Port Hardy to Winter Harbour

The best time to navigate around the northern end of Vancouver Island in the summer is in the early morning, as northwest winds pick up in the afternoon. The westerlies in Goletas Channel can be fierce when they blow against an ebbing tide but flatten out once they cross Nahwitti Bar. Heavy showers and, sometimes, thunder and hail can develop with westerlies behind a front. Waterspouts have also been spotted between Topknot Point and and Cape Scott during such conditions.

Sea Otter Cove receives only a quarter of the strength of the northwesterlies that blow offshore; however, even when these offshore winds are light, westerlies aloft can reflect off Mount St. Patrick, causing gusty conditions in the Cove. When the pressure slope is more southwest than northwest, the winds blowing down the valley from San Josef Bay strengthen the flow inside Winter Harbour to almost the same level it is outside it.

2.3.4.2 Quatsino Sound

When the pressure slope is westerly, the offshore winds do not enter Quatsino Sound. When it is southwesterly, the northwest winds affect the outer areas of the Sound and extend down the coast, striking Brooks Peninsula. When the pressure slope is at a particular angle, northwest winds pour into Holberg Inlet, creating somewhat choppy seas near Henricksen Point. On occasion, some this wind passes over the Peninsula and descends into Hecate Cove,



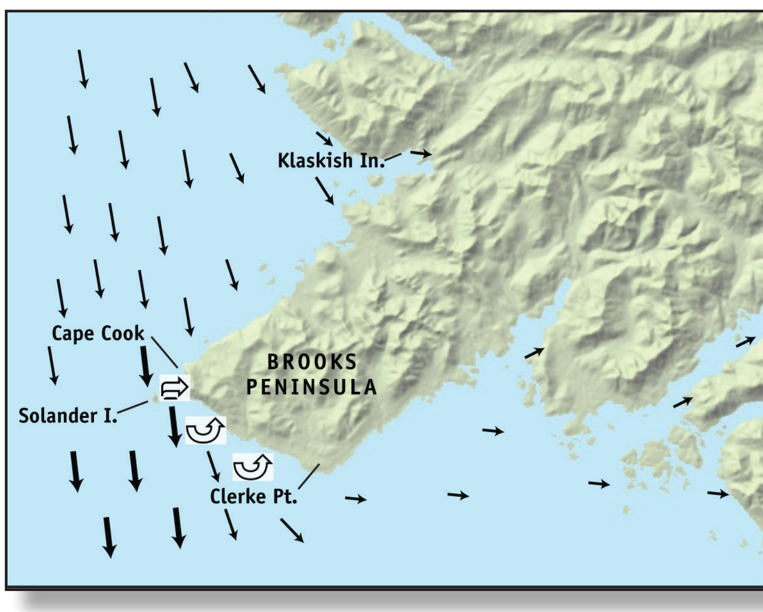
just west of Quatsino. Side Bay, just east of Lawn Point, may appear to provide some shelter, but when northwest winds strike the coast they flow over the Peninsula and into the Bay. Tree coverage on the hilltops influences the route the winds take down to the water.

Westerly winds can also carry fog into Quatsino Sound. If it clears with daytime heating, diurnal inflow winds soon follow: starting near Cliffe Point and gathering speed as they flow into the Sound. Even on hot sunny days, when conditions outside the Sound are calm, these winds can howl. Sometimes, they turn into Neroutsos Inlet; however, even when they are strong, conditions in Holberg Inlet are calm. On occasion, when Holberg develops a westerly sea breeze, winds will blow from Hathaway Creek toward Coal Harbour. Outflow northeasterlies develop overnight after the inflow has stopped and continue into the morning hours.

2.3.4.3 Brooks Peninsula

The orientation of westerly winds around Brooks Peninsula changes with the pressure slope. The winds strike along the coast when the pressure slope is southwesterly but tend to head almost due south as it turns west. As such, the centre of the plume moves further from the coast as the pressure slope moves more to the northwest. Corner effects cause the winds striking Brooks Peninsula to double or triple in speed: a 10-15 kt northwesterly north of the Peninsula becomes 30-35 kt near Solander Island. As little as halfway across Brooks Bay, toward Klaskish Inlet, the winds are much reduced.

The plume extends south from Cape Cook, leaving the area inside Clerke Point with light winds. Under certain conditions, when the Peninsula is capped by an atmospheric inversion, the northwest winds pass over it and plunge down to the water on its south side. If the inversion is quite high, the winds remain aloft, so the air at the surface of the water is still. Since there is no easy way to determine the height of an inversion, caution should be exercised when seeking shelter on the south side of the Peninsula. On occasion, small waterspouts form in this area, but they are not as much of a hazard as those caused by southeast winds on the north side.



2.4 West Vancouver Island

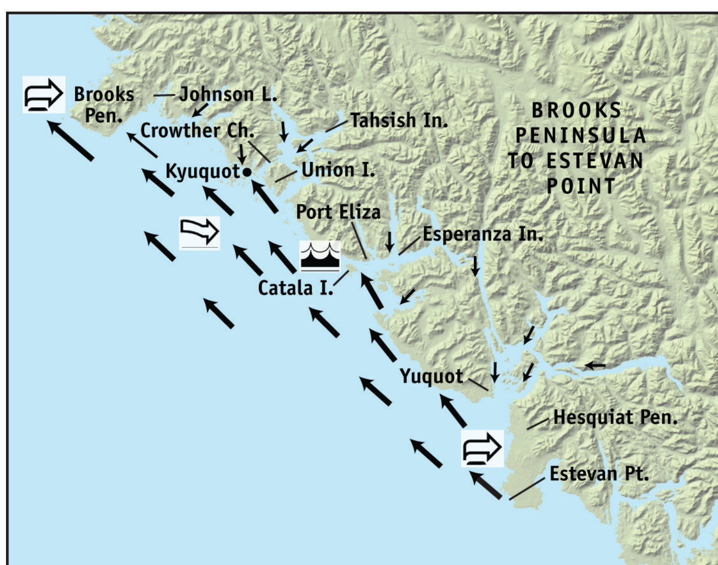
2.4.1 Easterly Pressure-Slope Winds

During the fall and winter, the southeast winds that affect western Vancouver Island occur ahead of an approaching front. Depending on the orientation of the front, the winds affect some areas more than others. When a front approaches from the west or northwest, the winds are usually strongest at the northern end of Vancouver Island and weaker farther south—in particular, south of Estevan Point (often a dividing point for weather). When one approaches from the southwest, the strongest winds are found offshore and near the headlands of the Hesquiat and Brooks peninsulas. Southeast winds do not enter any of the inlets, which experience only light northeasterlies.

2.4.1.1 Brooks Peninsula to Estevan Point

In the local indigenous language, both Kyuquot and Yuquot mean "winds that come from all directions". In coastal inlets, channels, and other "inside" waters, the wind changes significantly with even a slight change in the orientation of the pressure slope. For example, when the pressure slope is east or northeast, there may be storm-force southeast winds outside but little wind inside these areas. If, however, the pressure slope shifts to southeast, which tends to happen with the passage of a front, the winds flow into them, causing conditions to change suddenly.

When the pressure slope is northeasterly, the winds come out of Tahsish Inlet as an outflow. When the pressure slope is easterly, they flow parallel to the coast and pass the southern end of Crowther Channel. The easterly winds pass over Union Island, reflect off the mountains behind Kyuquot, and flow into the harbour. Winds also move into channels, such as Port Eliza, and pile up against the mountains just west of the mouth of Esperanza Inlet. They create rough conditions as they funnel through the channel just north of Catala Island, which is aptly named Rolling Roadstead.

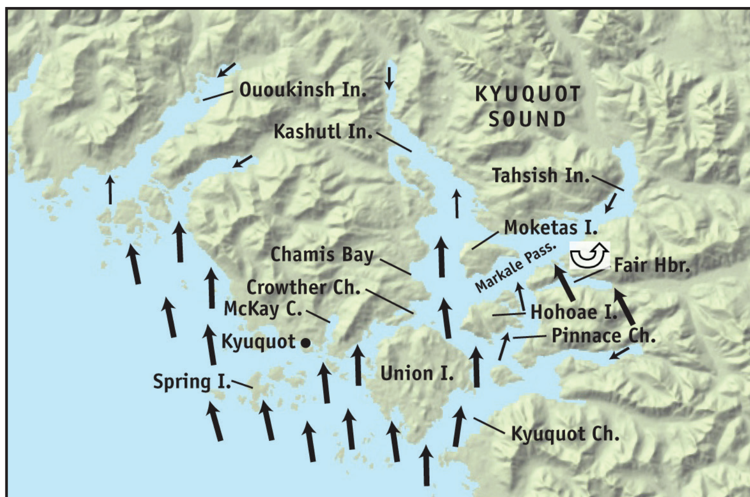


Southeast winds increase in speed as they round Estevan Point; however, since the outer area of Hesquiat Peninsula is not mountainous, this enhancement is not as strong as it is at Brooks Peninsula. By the same token, the downwind and lee effects are less pronounced, although there is some lee sheltering on the north side in most southeast wind events. Since the Estevan Point light station is located on land and not within the band of stronger winds that occur off the Point, it does not report the same strength of winds as those offshore.

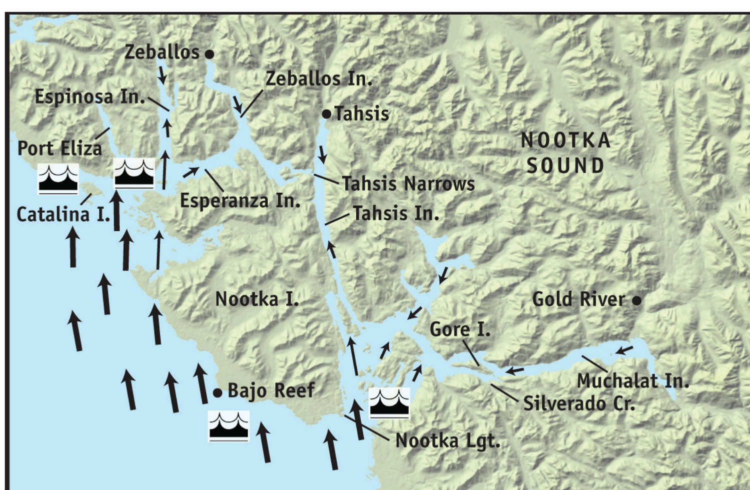
When the pressure slope is southeast, which occurs close to the passage of the front, the winds blow into Kyuquot Channel, pass between Union and Hohoae islands, and flow over to Chamiss Bay and Kashutl Inlet. They generally don't extend much farther eastward than the western tip of Hohoae Island and western Moketas Island. As a result, they are often calm through Markale Passage—except at the eastern end, which receives winds from Pinnace Channel.

Fair Harbour is quiet in most southeast-wind events, but when the winds offshore approach hurricane force, it is anything but fair. In such situations, the winds flow down from the mountains south of the Harbour and hit hard onto the water. With wind speeds of up to 100 kt observed on occasion, little wonder locals don't leave their boats moored over the winter. Cars parked at the head of the inlet have had windows blown out or damaged by flying debris.

With a southeasterly pressure slope, the winds move into Esperanza Inlet, over the flats of Hesquiat Peninsula, and into Nootka Sound. Although they flow all the way up Tahsis Inlet, by the time the pressure slope has turned south enough for them to enter the inlets, the front has usually passed and the wind gradient has dropped considerably. Tahsis does see strong southerlies, however, when the pressure slope is near 120° and the air is stable, as occurs between warm and cold fronts.



Sea conditions can be poor locally when southeast winds entering Nootka Sound meet the remnants of outgoing northeast winds, but it is only when rapid pressure rises occur behind a front that very strong winds move into the inlets. Muchalat Inlet remains calm even with very strong



southeasterlies offshore, except at its western end, near Gore Island, where some wind blows across Silverado Creek.

Zeballos Inlet is aligned northwest to southeast, so it should be vulnerable to strong southeast winds, but the presence of high mountains at both ends of the Inlet blocks them from funnelling in from outside. The only winds are created locally by the pressure difference across the Inlet, so they rarely rise to extreme values.

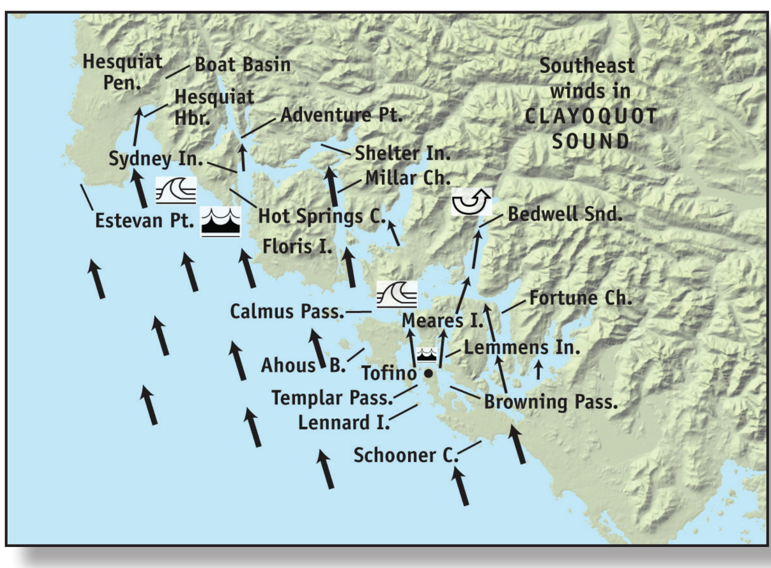
Seas and tidal currents are also enhanced by the shallow waters near Estevan Point— and can be dangerous. Tides are not very strong in most parts of the inlets, except narrow openings such as Tahsi Narrows. Huge swells can move across the shallow waters of Hesquiat Bar, creating breaking waves that have been known to damage fishing boats. Swells that move into Nootka Sound usually dissipate before reaching Strange Island.

Swells also enter Esperanza Inlet, mostly from the west or northwest, but they weaken as they move up Zeballos Inlet. Tides are not generally a problem in Kyuquot and Nootka sounds except in narrow openings, such as those leading into McKay Cove, Johnson Lagoon (south of Brooks Peninsula), and Tahsis Narrows. The reefs just outside Esperanza Inlet are very rough when southeast winds flow against the tides—as is Bajo Reef.

2.4.1.2 Clayoquot and Barkley Sounds

Clayoquot and Barkley sounds respond to southeast winds in a similar way to Nootka Sound in that the inner waters don't get the full force of the winds until the pressure slope turns more to the southeast. Fronts and associated winds tend to weaken somewhat south of Estevan Point. Southeast winds hitting the outer edge of the coast blow straight into Schooner Cove, one area of which has had logs thrown more than 20 m above the normal high-water line in winter. When the southeast winds are howling outside Ahous Bay near Foam Reefs, some shelter can be found near the beach.

Southeast winds move up Millar Channel and turn squally over the top of Flores Island, in the western part of Shelter Inlet. They blow up Fortune Channel and into Lemmens Inlet and, after crossing the top of Meares Island, become gusty in Bedwell Sound. Browning Pass and Templar Channel experience southeast winds of similar strengths.



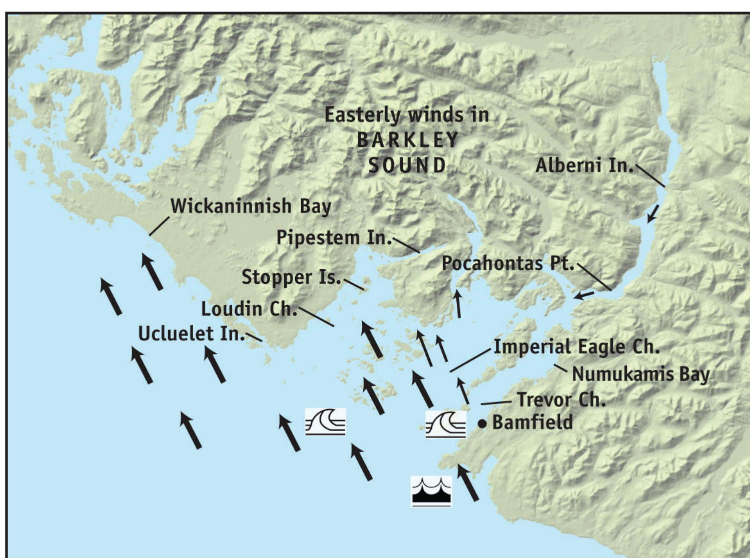
Southeast winds against an ebbing tide create steep, dangerous waves over Coomes Bank in Calmus Passage, near the mouths of Hot Springs Cove and Lemmens Inlet. Giant swells move across Hesquiat Bar and into Hesquiat Harbour, where they have been known to damage fishing boats. Boat Basin, at the head of the Harbour, is a safe anchorage. Seas also spread up along Flores Island and into Sydney Inlet but usually end before Adventure Point.

Barkley Sound is the most open of the sounds on the west side of Vancouver Island. While all of the others have a few large islands with only narrow channels between them, Barkley has many small islands that lie in nearly straight lines parallel to its northwest and southeast edges. The waterways between these island chains are much wider and more open, so the Sound experiences different wind and sea effects.

When the pressure slope is easterly, the southeast winds flow parallel to Vancouver Island, across the mouth of Barkley Sound. When it tilts a little toward the southeast, they sweep across the southwest corner of the Sound. Loudoun Channel is hit harder than Imperial Eagle Channel, which is protected by the mountains behind Cape Beale and Bamfield. When the pressure slope nears southeast, the winds spread up Trevor Channel to just beyond Bamfield, where they join up with flows coming down the mountains and move across Numukamis Bay.

As a result of these variations, there are times when southeast winds are very strong outside the Sound but light inside it and others when they are strong in both. The fact that not all inside sections of Barkley Sound get strong southeast winds, however, does not prevent them from getting their full share of rain.

Swells can roll into Barkley Sound at any time, irrespective of the speed and direction of the winds. The swells shorten and increase in height as they cross the shallow waters near the outer islands and at the heads of the various channels. They also change direction as they interact with the bottom topography: breaking right across the mouth of Ucluelet Inlet. Imperial Eagle Channel has been described as a bowling alley, with swells rolling from the front, where they are long and rounded, to the back, where they are compressed into short, steep waves with breaking tops. Swells of 1.5-2 m are not uncommon. The waves cross behind single islands, but larger ones and those in groups offer shelter from the incoming swells.



2.4.2 Northerly Pressure-Slope Winds

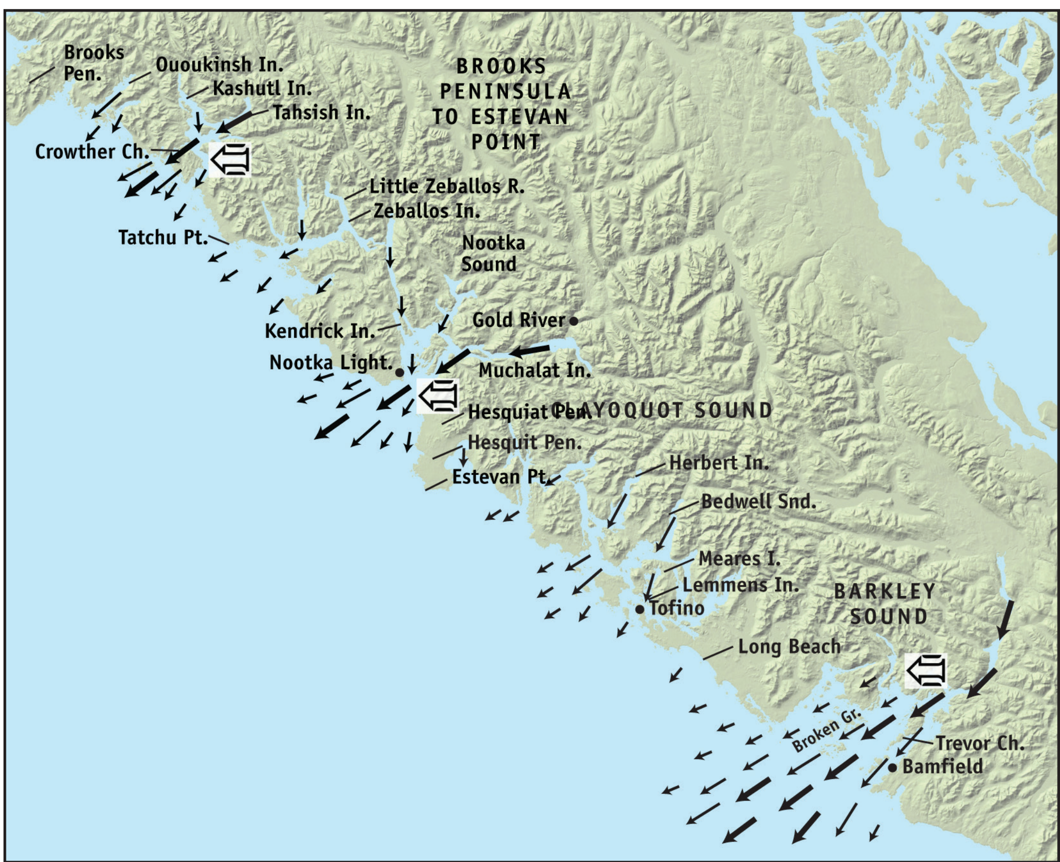
2.4.2.1 Brooks Peninsula to Estevan Point

In winter, when there is a strong outflow in mainland inlets, the winds pass over Vancouver Island and funnel through its inlets at speeds of up to 30-35 kt (but usually lower). While Kashutl Inlet and the community of Gold River do not receive strong, turbulent outflow winds, the opposite is true for Ououkinsh Inlet. Outflows have reached speeds of up to 30 kt in Muchalat Inlet and extended some 16 km beyond the mouth of Nootka Sound, while the Nootka lighthouse reported wind speeds of only 14 kt.

If an Arctic outflow continues for several days with temperatures well below freezing, the fresh water at the heads of the inlets will freeze. The top of Zeballos Inlet, for instance, sees a centimetre of ice, and the freezing spreads all the way down to the twin islands at the bend opposite the mouth of Little Zeballos River. Water near the outlets of other rivers, even when it is not at the head of an inlet, also freezes over in colder years.

2.4.2.2 Clayoquot and Barkley Sounds

Bedwell Sound and Herbert Inlet receive most of the northerly outflow winds that occur in Clayoquot Sound, although they are usually lighter than those coming out of Barkley



Sound. The outflow from Bedwell Sound crosses the top of Meares Island and flows through Lemmens Inlet before hitting Tofino, which it usually does once or twice a year. Northerly winds are most common in December and January but also occur in mid-November. The calmest conditions at Long Beach occur during outflow conditions when there are no lows offshore.

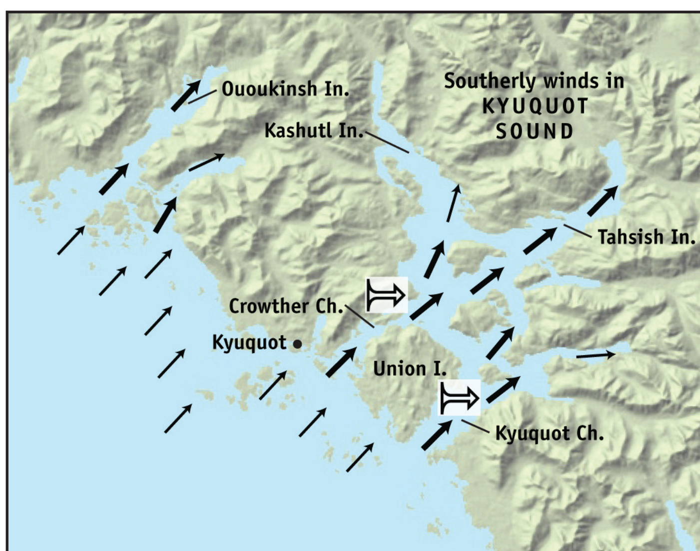
Barkley Sound experiences the strongest outflow winds on southern Vancouver Island. They pass out through Alberni Inlet and, when the pressure slope is northeasterly, flow through Imperial Eagle Channel and over the Broken Group Islands near the mouth of Barkley Sound. Coaster Channel often gets a large part of this wind. When the pressure slope is more northerly, the winds flow through Trevor Channel before exiting the Sound, some of them hitting Bamfield. In either case, almost all of Barkley Sound is affected, except the northwest corner beyond Peacock Channel.

In a typical winter, wet snow begins when there are still light northeast winds in the inlets, but southeast winds are blowing offshore. As much as 2-3 cm can fall in half an hour and disappear an hour later, as temperatures warm up. Larger, longer-lasting snowfalls occur with northerly outflow winds, usually several times a year—although snowstorms lasting through the night happen only once every five years or so. It hails in the Tofino area more often than it snows—with both lightning and hail more frequent from November to March than in the summer. Effects tend to be localized and minimal.

2.4.3 Southerly Pressure-Slope Winds

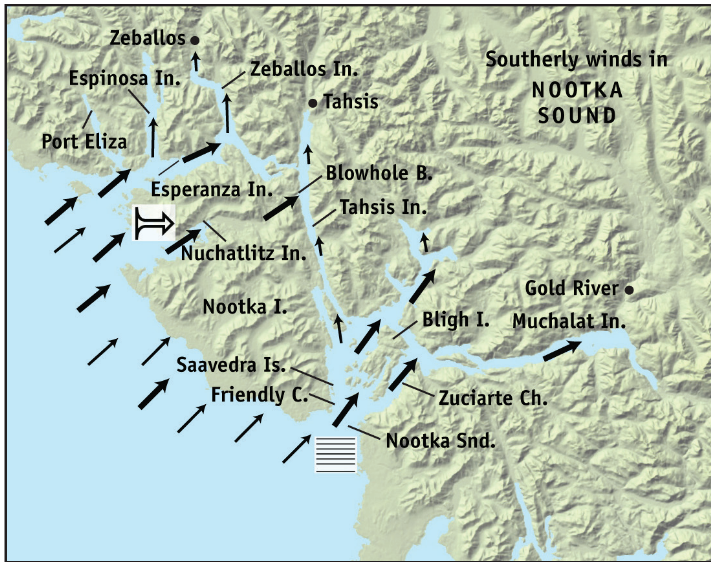
2.4.3.1 Kyuquot Sound

Many of the channels of Kyuquot Sound—and Kyuquot itself—are open to the southwest, so they experience the full thrust of winds coming from this direction. The southwest winds increase in speed as they funnel through Crowther and Kyuquot channels and move into Tahsish Inlet, sometimes accompanied by waves of thunder and heavy hail.



2.4.3.2 Nootka Sound

In Nootka Sound, southwest winds blow through Nuchatlitz Inlet, across the peninsula on Nootka Island, and out Blowhole Bay into Tahsis Inlet. They also pass through Zuciarte Channel and into Muchalat Inlet. Winds in the inlets that run toward the north or northeast, such as Port Eliza, Espinosa, and Tahsis, remain light. Some southwesterlies move a short way up Zeballos Inlet but don't normally make it all the way to Zeballos itself.



Fog often spreads into Nootka Sound with southerly winds, filling almost all the waterways around Bligh Island. It does not usually spread far up Tahsis Inlet, however, and although the orientation of the flow often causes it to pass over Friendly Cove at the Nootka light station, it leaves the area west of the Saavedra Islands clear.

Did You Know?

The sequence of weather systems referred to as the "pineapple express" (also known as an "atmospheric river") causes a period of nearly non-stop rain on the south coast of Vancouver Island. This pattern develops when a front extends to the southwest of the Island and a series of frontal waves and lows develop along it, repeatedly crossing the coast.

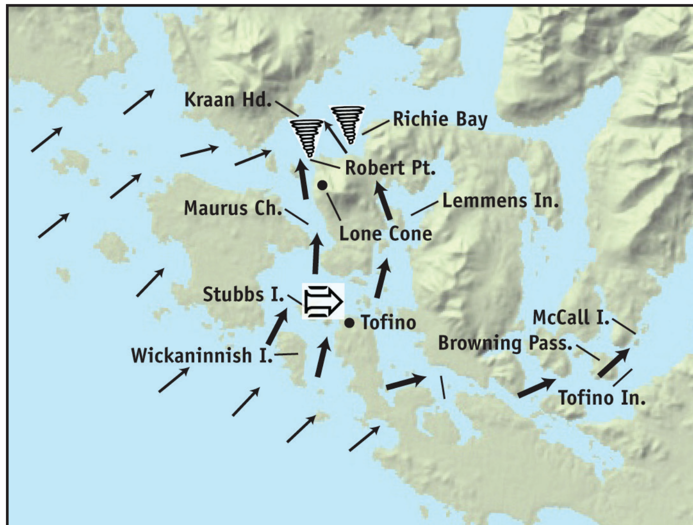
2.4.3.3 Clayoquot and Barkley Sounds

A typical frontal passage sees strong southeast winds ahead of the front and much lighter south to southwest winds behind it. South winds are very strong only when the pressure rises sharply behind the front—usually with a strong front or when a coastal low passes over Vancouver Island.

The worst winter conditions do not usually occur with south or southeast winds but with the strong southwesterlies that follow a front. On one notable occasion, the southeast winds ahead of a front registered 54 kt at Estevan Point, while the southwest winds behind it gusted to nearly 110 kt in Tofino Harbour—overturning a dry-docked houseboat and causing a house near McCall Island to collapse. Southwest winds funnelling through Browning Passage have risen from 30-35 kt at its entrance to 50-60 kt at its exit and gusted to nearly 80 kt off Indian Island.

Did You Know?

When a flooding tide moves around both sides of Wickaninnish Island, it sometimes causes a 30-m stretch of standing waves to form over the sandbar between there and Stubbs Island. This strange phenomenon, known locally as a “zipper”, happens most often in spring.



When the pressure slope is from the south or southeast, southerly winds flow up through Maurus Channel. After striking Lone Cone Mountain, they hit hard onto the water near Robert Point, where they often cause eddies and waterspouts to form. On several occasions—when the winds blowing up the channel were at least 40 kt—a string of 15 to 20 waterspouts up to 20 m high, 15 m wide, and 25 m apart has been spotted between Robert Point and Kraan Head. Waterspouts have also formed in Ritchie Bay, likely because that is where the winds from Maurus Channel and Lemmens Inlet, east of Lone Cone Mountain, converge.

Southwest winds move into Barkley Sound and extend at least part way up Alberni Inlet, causing brief winds—sometimes accompanied by thunder and lightning—in the area off Bamfield. Waterspouts are not uncommon in the unstable air that often accompanies southerly winds.

Debris tends to accumulate in Deadman Cove, a small bay just east of Cape Beale named for the fact that the bodies of many drowning victims have washed in there over the years. The waters between Pachena Point and Cape Beale are generally rough, especially near Seabird Rocks and just off the Cape when the winds are from the southwest. An outgoing tide through Trevor Channel breaks just west of the Cape when it encounters strong westerly swell. South to southwest winds also push fog into Barkley Sound.

Did You Know?

The mouth of Juan de Fuca Strait has been called the “Graveyard of the Pacific” because of the number of vessels that sank in the area during the days of sail. The nearly 140 shipping tragedies that took place in the area between 1830 and 1927 spurred the creation of the West Coast Trail along the 70 km of coastline between Port Renfrew and Bamfield to assist shipwrecked survivors.

2.4.4 Westerly Pressure-Slope Winds

On quiet days between April and mid-September, when there are no major systems approaching the coast, all inlets receive light outflow winds at night and in the early morning, and inflow winds during the afternoon. The diurnal inflows start around 1000 hours, increase until about 1700 hours, and fade away with the setting sun. If fog is present, however, they won’t start until after it has cleared. The winds tend to be lighter near the mouths of the inlets and increase to 20-25 kt near their heads. The hotter it gets, the stronger they blow, as their intensity is directly affected by the contrast in temperature between the land and sea. As such, the northerly outflow at night is strongest in spring and early summer, when there is still snow on the mountaintops. When the winds rise quickly, they will drop equally quickly.

2.4.4.1 Fog

Fog is a frequent problem west of Vancouver Island. It occurs most frequently south of Estevan Point and is worst close to the mouth of Juan de Fuca Strait. The cold waters in this area maintain an almost constant fog through July and August and into early September.

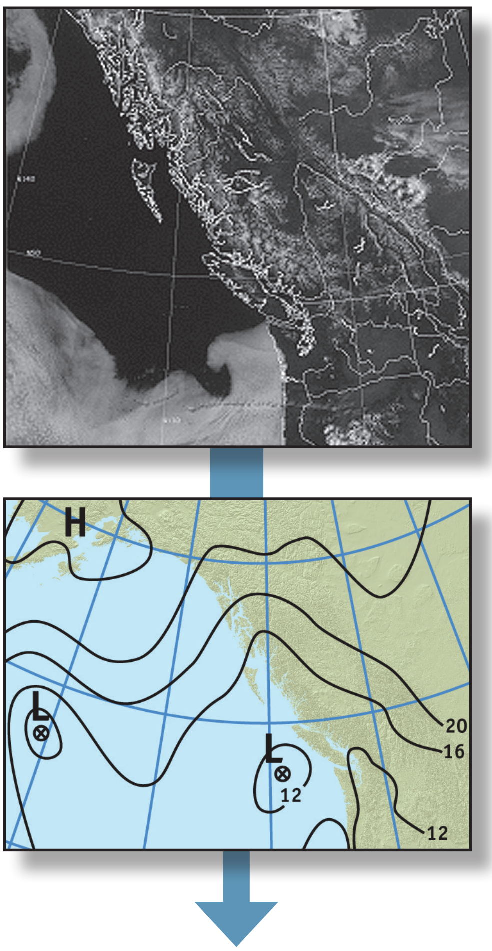
Diurnal fog is a type of advection fog that is caused by the temperature difference between the air and water and that thins and thickens according to daytime heating and cooling. Winds are generally light if there is diurnal fog, although sun-induced inflow winds strengthen once it lifts.

Diurnal fog has a diurnal cycle. When the pressure slope is northwesterly, the strong northwest winds remain offshore and do not collapse onto the coast in the afternoon. Light winds remain along the southwestern coast, and a bank of fog lies 8 km or so offshore. Often, this pattern will continue for two or three days: sunny skies prevail and the temperature rises slowly each day until it reaches about 24°C or more over the land. With this heating, the pressure slope backs a bit and the northwest winds move toward the coast. The fog follows, normally staying for several days once it reaches the coast but still undergoing its daily cycle of change.

Typically, fog moves onto the coast overnight, near dawn. It begins to burn off near the land around 1000 to 1100 hours and may clear completely by early afternoon, retreating a few kilometres offshore. It remains clear on the coast until evening, when the cycle begins again.

If the fog does not arrive by dawn, it rolls in from about 0630 to 0700 hours and begins to clear around 1300 hours. If high cloud is moving across the region, it will slow the rate of daytime heating and delay the lifting of the fog; if thicker cloud moves in, it may not burn off at all. If the fog does not clear by midday, it will return again earlier in the evening.

Fog generally spreads up the inlets with a wedge-like front, but it sometimes appears gently as the temperatures fall in the evening. Clearing begins near the heads of the inlets or near open fields and recently logged areas, because the open land heats up faster. Fog moving toward the coast may burn off as it moves inland. The temperature difference between foggy areas and the warmer land creates strong sea-breeze effects and strengthens the inflow winds in the inlets. If there is fog offshore in the morning, stronger inflow winds develop in the afternoon.



Satellite picture for 2300 hours 13 June 2002, and a weather map for one hour later showing a typical stratus surge pattern.

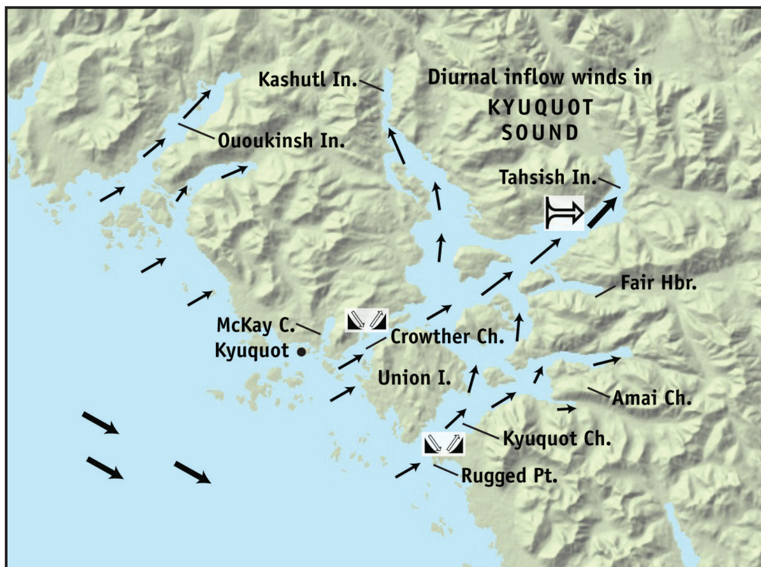
Another type of advection fog is related to the movement of an atmospheric wave—known as a stratus surge—that develops along the California coast and moves northward up the coasts of Oregon and Washington to the west coast of Vancouver Island. This wave is named for the fog and low stratus clouds that accompany it, which move at speeds of 15-30 kt. With the onset of fog, wind speeds can increase suddenly from light to southeast at 25-30 kt—often rising to gale force as they round Brooks Peninsula. The northwest winds remain well offshore as these southeast winds pour up the coast. A stratus surge normally occurs after a period of hot, sunny weather and is usually accompanied by an onshore push of winds into Juan de Fuca Strait. It often arrives on the west coast of Vancouver Island overnight or in the early morning hours.

2.4.4.2 Kyuquot Sound

In the summer, when an offshore ridge of high pressure creates a pressure slope that is westerly or northwesterly, the northwest winds remain off the coast during the overnight and morning hours and move toward it during the afternoon. Recognizing this pattern, many mariners attempt to travel around Estevan Point in the morning before the winds increase.

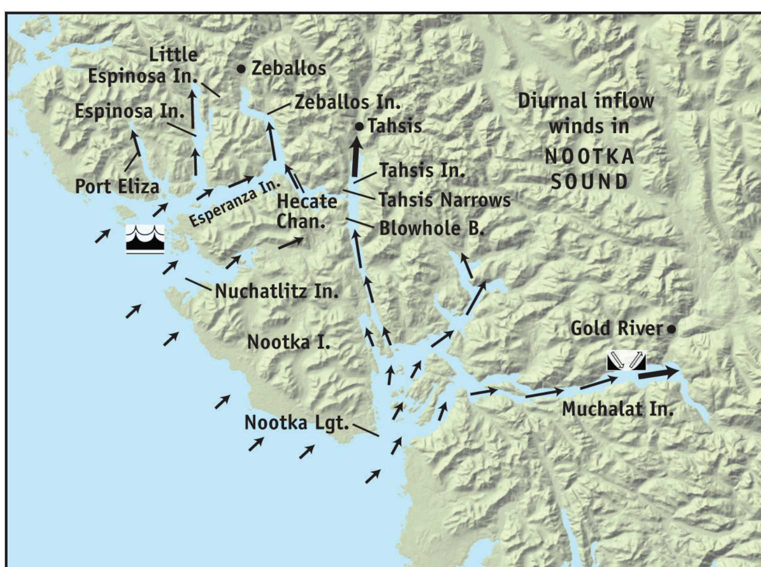
When strong northwest winds are offshore, the inlets have light outflow winds, which remain light all the way out to Rugged Point. It is only when the pressure slope becomes more southwesterly that the westerly winds enter the inlets—blowing through Crowther Channel into Tahsish Inlet and through Kyuquot Channel into Amai Inlet.

Kyuquot Sound has diurnal inflow and outflow winds on a sunny summer day. The inflow winds develop in all the inlets but are strongest in Kashutl and Tahsish. The outflow comes primarily down Tahsish Inlet. During periods of hot weather, Kyuquot gets outflow winds in the early morning that come down through McKay Cove. Fair Harbour remains calm.



2.4.4.3 Nootka Sound

In Nootka Sound, the offshore-ridge westerly winds blow into Nuchatlitz Inlet, over the peninsula, and out Blowhole Bay. Vessels passing the Blowhole often slow down in anticipation of these strong and sudden side winds. Rough seas develop over the reefs just outside Esperanza Inlet when westerly winds blow against an outgoing tide. The Nootka lighthouse, which is just inside the Sound, tends to receive much less wind than there is blowing outside of it.



The diurnal westerly winds howl up Muchalat Inlet (known locally as “Miserable Inlet”), creating short, sharp chop. They reach their peak around 1730 hours and drop off quickly with the setting sun. Inflow winds flow up the valley from the harbour at Gold River but only extend as far as the golf course, just south of the community itself. Gold River gets a northerly wind on hot summer days. Esperanza has a strong afternoon inflow, which is worst near the junction at Hecate Channel, where it combines with the inflow up Zeballos Inlet. Tahsis also draws a strong inflow wind, but Tahsis Narrows gets very little. Port Eliza and Espinosa Inlet draw enough inflow to create choppy seas, the latter being the stronger of the two. Nuchatlitz Inlet doesn’t have a strong inflow.

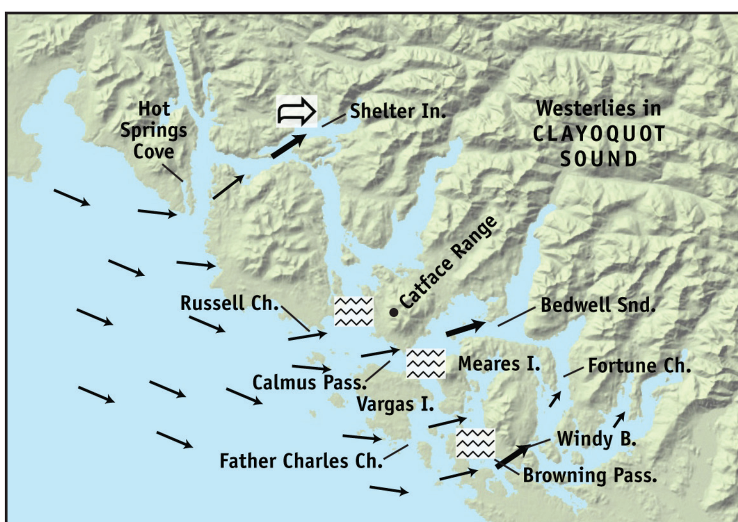
Did You Know?
Zeballos, which gets about 4000 mm of rain a year, celebrates its rainfall during an Umbrella Festival in August. The terms “horizontal rain” and “frog stranglers” are sometimes used by the locals to describe the heavy rain and strong winds.

Zeballos gets some fog that crosses over the peninsula between it and Little Espinosa Inlet. It tends to get more than Tahsis Inlet, which gets more than Muchalat Inlet. Nootka Sound often gets more periods of lowered visibility from fog and rain during the winter months, between November and January, than it does in the summer.

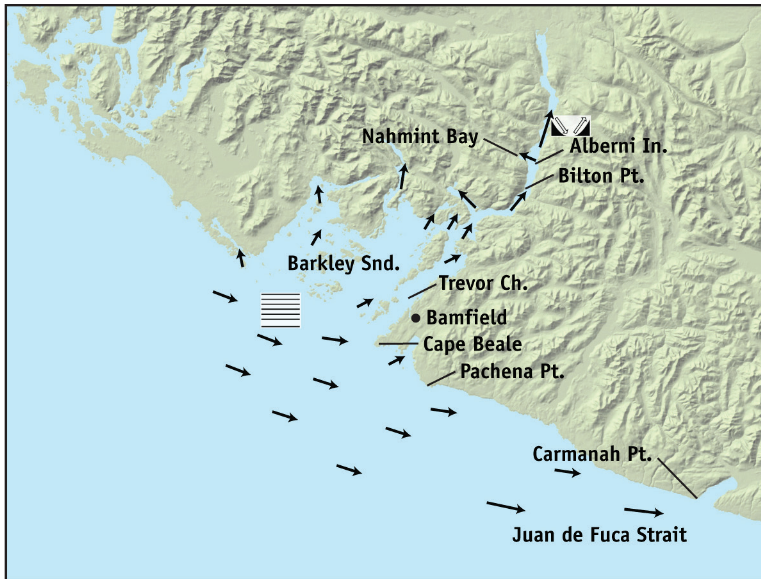
2.4.4.4 Clayoquot Sound

The outer coastline is fully exposed to the northwest winds, which flow into all channels open to the west. Westerly winds blow solidly into Shelter Inlet, passing above Meares Island and flowing into Bedwell Sound, where they were once so strong they destroyed a fish farm. A 20-kt westerly wind offshore increases as it passes through Browning Passage and rises to 40 kt after crossing the peninsula into Windy Bay. The winds are calm just to the north, in Fortune Channel. The channel between Vargas and Meares islands is also protected from westerly winds.

Tidal currents in Clayoquot Sound are slightly stronger than they are in Barkley Sound. As a result, westerly winds blowing against an outflowing ebb tide can create dangerous seas. Areas of particular concern are localized and include just outside Hot Springs Cove, Russell Channel, off Catface Range in Calmus Passage, Father Charles Channel, and Browning Passage.



2.4.4.5 Barkley Sound



Alberni Inlet goes through the typical cycle of light winds in the morning with increasing southerly winds from late morning through the afternoon. The seas don't get too high because of the bends of the Inlet, and the Inlet gets little northerly wind overnight. Nahmint Bay draws inflow winds during a hot summer day and has colder outflows in winter and early spring. Trevor Channel is fairly calm in summer. Barkley Sound is more affected by swells than Clayoquot Sound is because it is more open and has fewer islands to break them up. There are few places to hide, as the swells move all the way to the back of the Sound.

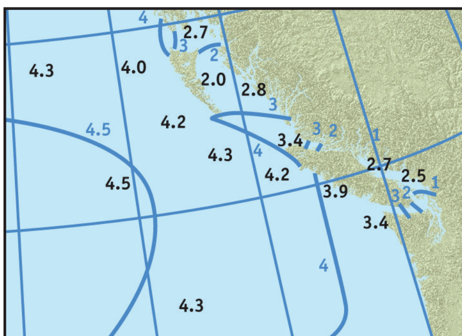
When fog moves into Barkley Sound, it spreads almost everywhere but is especially thick in Trevor Channel and off Bamfield. It moves up Alberni Inlet but usually stops near Bilton Point, some 24 km south of Port Alberni. Barkley Sound, being closer to the cold waters off the mouth of Juan de Fuca Strait, tends to get more fog than the other sounds farther north. Locations near the mouth of the Strait, such as Cape Beale, Pachena Point, and Carmanah Point, all get extensive fog during the summer.

3. The North Coast

This section provides information on waves and offshore winds along the rugged North Coast of British Columbia, as well as details on localized wind, fog, and sea state conditions in three main regions: Dixon Entrance, Hecate Strait, and Queen Charlotte Sound; Haida Gwaii; and the North Mainland Coast.

3.1 Waves

Average wave heights are lower close to the mainland coast and lowest in the shadow of the outer islands. The highest significant wave height ever recorded by Environment Canada on the West Coast was 14.9 m at the South Hecate buoy, which is located between the southern tip of the outer islands and the mainland. The highest extreme waves were over 30 m high, recorded at both the South Hecate and East Dellwood buoys. What is most dangerous about these giant waves is how quickly they can build from very little. In October 1968, when a drilling rig encountered a 30-m wave while working in Queen Charlotte Sound, south of Cape St. James, the seas rose from 3 m to 18 m in just eight hours.



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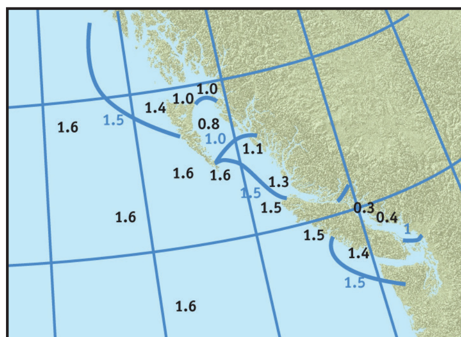
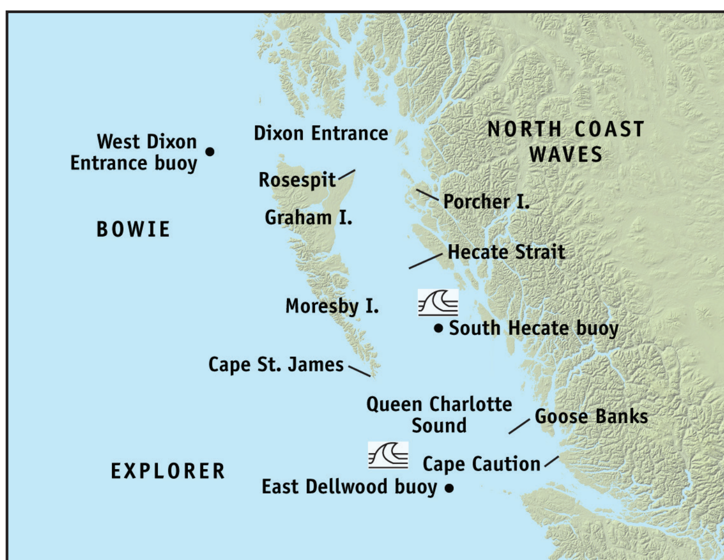


JULY

Average values of wave heights from the buoy network for December and July, with estimated values for locations between the buoys.

Northwesterly swell from offshore storms spreads into Queen Charlotte Sound and Dixon Entrance, but not into Hecate Strait. Westerly swells refract slightly into the southern parts of the Strait, while swells from the south or southwest leave only its northwestern areas unaffected.

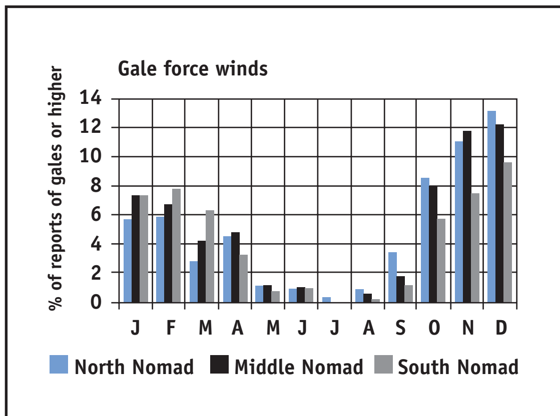


Overall, the northern section of Hecate Strait has much lower seas than the southern section. Westerly swell passing into Dixon Entrance fans out as it passes Rose Spit and moves as far south as Porcher Island. The height of the waves along the mainland coast is much lower than at Dixon Entrance. On average, the highest wave heights occur in December, while the lowest are recorded in July and August.

3.2 Offshore Winds

Winds in the open, offshore waters of the North Coast can come from any direction, as they are not constrained by topography. What determines their direction is the position of any nearby high- or low-pressure areas. In the coastal inlets, on the other hand, the winds are strongly directed by topography to blow along the channels as either inflows or outflows. Most of the North Coast lies somewhere between these two extremes, with a number of preferred wind directions apparent.

Gales are most frequent from October to December and least common from May through September, with the transition to higher winds normally happening in late September. From January through March, the frequency of gales is higher at the South Nomad buoy than at the Middle and North Nomad buoys; from September through December, it is lower. This is because the track of the lows is typically farther north in autumn and farther south in winter.



The frequency of gales at offshore buoys throughout the year.

Did You Know?

The offshore marine forecast areas are named after the Bowie and Explorer seamounts. The Bowie seamount, 180 km west of Haida Gwaii, is one of the shallowest in the northeast Pacific Ocean, its peak lying just 25 m below the surface of the water. Seamounts create an oasis of life in the mid-ocean desert, serving as refuges for certain species of fish and a variety of unique plant and animal communities.

3.3 Dixon Entrance, Hecate Strait, and Queen Charlotte Sound

3.3.1 Easterly Pressure-Slope Winds

3.3.1.1 Dixon Entrance

When the pressure slope is at the northeast end of the easterly range, the winds through Dixon Entrance are easterly. As it turns toward the southeast, however, the southeast winds from Hecate Strait flow across low-lying Rose Spit and affect the eastern end of the Entrance. Although the southeast winds also move up the west side of Graham Island, the middle section of the Entrance receives lighter winds, especially toward the south, close to the Island. The winds ease throughout Dixon Entrance if the pressure slope rotates south of 130°.

Did You Know?

Because buoys are tilted and partially sheltered by waves and their anemometers are lower than those used on landstations, they don't necessarily record the full strength of the winds at ship-level. For example, the Central Dixon buoy might report winds near 20 kt when those at nearby Rose Spit are close to 25 kt.

3.3.1.2 Hecate Strait

Hecate Strait is a dangerous body of water—not only because of the severity of the winds but also because of how quickly and drastically they can change. On some occasions, they have been known to rise from almost nothing to 60 kt in just half an hour.

In most winter storms, there are roughly three categories of sea height. The weakest occurs when a front passes quickly and the seas rise to just 2-3 m. The second and most common occurs when the winds are from gale to marginal storm force (40-50 kt) and the seas rise to 5 m, at least over southern sections of Hecate Strait and in Queen Charlotte Sound. The third happens during the strongest storms, when the waves can reach more than 8 m in height due to either particularly strong southeast winds or a very long fetch.

3.3.1.3 Queen Charlotte Sound

Queen Charlotte Sound is a large, open body of water that experiences winds and waves affected by three topographical features. The two most obvious are northern Vancouver Island and southern Moresby Island, both of which can either steer bands of strong winds part way across the Sound or provide some degree of shelter, depending on the wind direction. The tidal currents at the southern end of Haida Gwaii, near Cape St. James, are particularly strong and complex and have a significant effect when they are flowing against the winds, especially winds coming from the south and southwest.

The third, less obvious feature is the depth or bathymetry of the ocean floor. Three long troughs separated by two ridges influence the height of some of the longer swells moving across the Sound, causing higher seas near the ridges, where the waves converge. Some of the highest seas reported on the BC coast have occurred over Queen Charlotte Sound, likely due, to some degree, to the unique shape of its seabed.

Mariners' Tips:
With a 7-m tidal range, Queen Charlotte Sound experiences some very strong currents. When the winds flow against these currents, conditions can be particularly dangerous.

Queen Charlotte Sound is often a preferred location for the passage of coastal lows. When lows develop near the coast, they often move from the southwest across Queen Charlotte Sound before weakening over the Coast Mountains. As a result, the winds can be extremely strong over southern sections of the Sound while those in the north receive much lighter, northerly winds.

Over the open waters of the central coast, it takes two or three days for the swell to subside after a big storm. Goose Banks can be quite hazardous, because its shallow waters allow the seas to peak. The dominant wind north of Cape Caution is northeast; south, it is southeast. As its name aptly suggests, caution should be exercised when passing the Cape, as winds from the southeast and northwest can be particularly strong.

3.3.2 Northerly Pressure-Slope Winds

When the pressure slope is northerly, the winds flow mainly out of the coastal inlets. Dixon Entrance can receive plumes of strong winds from Portland Inlet, creating an area of generally choppy seas along the east coast of Haida Gwaii. As the pressure slope becomes more northerly, bands of stronger winds exit from the inlets of the Alaska Panhandle. If it shifts into the easterly range (060-130°), the outflow winds through the inlets ease and the southeast winds in Hecate Strait increase. If it backs to the north into the westerly range, the northwest winds begin to strengthen along the mainland coast. In general, northerly pressure-slope winds produce fair conditions in Hecate Strait.

Winds from Queen Charlotte Strait and the Central Coast inlets can also raise the seas in Queen Charlotte Sound, but not usually to heights of major concern. The southern part of the Sound receives strong Arctic outflow winds from the inlets on the mainland coast; however, in most such events, it is more affected by the proximity of lows or fronts lurking just outside the area.

West of Haida Gwaii, outflow winds from the inlets are typically jets of air punctuated by periods of calm. Like Queen Charlotte Sound, the area is affected by weather systems west of the coast, which give it stronger easterly winds and more cloud.

3.3.3 Southerly Pressure-Slope Winds

Southerly winds are transition winds. As a result, they are normally short-lived and can shift to easterly or westerly with only a slight change in the pressure slope. As the pressure slope veers toward the west, the winds in Dixon Entrance become westerly and flow directly across to Dundas Island and the mainland coast. When it backs into the east, southeast winds spread up Hecate Strait and across Rose Spit into Dixon Entrance. Out in the open waters of Queen Charlotte Sound, the winds blow from the southwest and are not turned to the southeast or northwest by the topography.

Mariners' Tips:
The shift of the winds from the southeast to the southwest is a major concern to mariners and is related to the timing of the frontal passage. Mariners in Hecate Strait listen for wind shifts at Kindakun Rock and Langara Island to determine when they will change in Hecate Strait. Cape St. James is used to predict wind shifts for the Central Coast.

3.3.4 Easterly Pressure-Slope Winds

Offshore-ridge westerly winds passing over the open waters of Dixon Entrance, Hecate Strait, and Queen Charlotte Sound are influenced mainly by the orientation of the pressure slope. Diurnal effects are experienced to a much lesser extent—most noticeably near the edge of the coast, as the land warms up faster than the ocean waters do during the day. Daytime heating draws the winds toward the land and into the channels near the edge of the open water. This landward bending of the wind takes place on both sides of the waterway: the wind in the middle, farther away from the land, continues to flow in the direction determined by the pressure slope.

If the ridge causing the westerly winds is weak, the diurnal heating effects are more noticeable and will cause strength and directional changes that extend farther out from the coast. If the ridge is strong, the westerlies will blow steadily for days without weakening overnight, strengthening during the day, or bending toward the land. If it is cloudy, diurnal effects also will not occur.

Mariners' Tips:
Fog is a problem across Queen Charlotte Sound in August and continues to be so, on and off, into October. The worst areas lie over the western sections of the Sound, near the edge of the continental shelf, and from northern Vancouver Island toward the mainland coast.

Diurnal heating effects are stronger in the narrow channels of the Alaska Panhandle than they are in more open Dixon Entrance. On hot summer days, the Panhandle's inflow winds counteract the northwesterlies in Dixon Entrance, causing them to lighten. At night, however, its outflow winds tend to strengthen the northwest winds. Plumes of wind from the Alaska Panhandle also create bands of higher seas.

When the pressure slope is between southwest and west, winds from the west-northwest flow through Dixon Entrance. They have a strong impact on the north shore of Graham Island and are particularly intense as they funnel south of Langara Island. Conditions are treacherous when the winds meet the strong tidal current flowing out of Masset Sound.

Both the seas and westerly swell sharpen up when they flow against an ebbing tide. Westerly swells moving into Dixon Entrance peak over the Learmonth Bank, where they create overfalls and rips. In most cases, however, they are reduced by half by the time they reach Dundas Island and are barely noticeable with a flooding tide unless the winds have been blowing for several days. The westerly seas must be over 4 m at the West Dixon Entrance buoy before much swell is noticed at Prince Rupert. The swells steepen when they meet ebbing tides from coastal inlets.

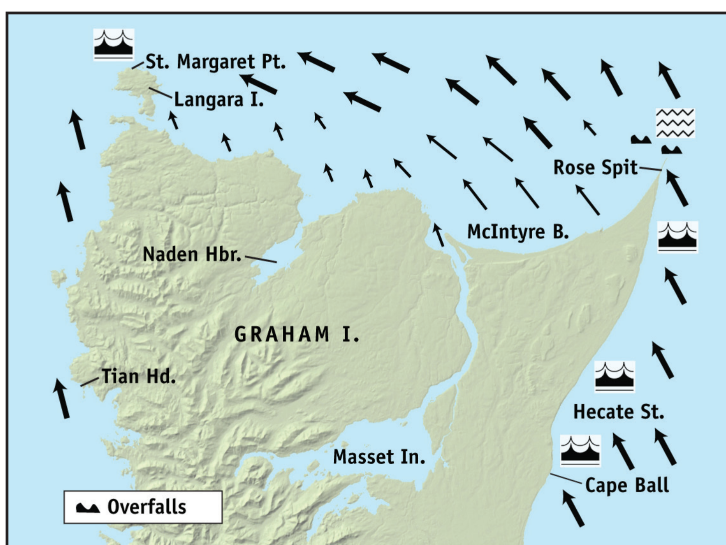
3.4 Haida Gwaii

Haida Gwaii consists of more than 150 islands, with a total area of over a million hectares and a population of approximately 5,000. The fascinating history and culture of the Haida people and the rugged beauty of the land lure more and more visitors to this remote area each year.

3.4.1 Easterly Pressure-Slope Winds

Some say the winds at Rose Spit are worse than reported at the observation site and can be as fierce as those near Cape St. James.

Southeast winds spread across the peninsula but are generally weaker and backed more into the east on the northern end, in McIntyre Bay. Winds are often backed into the east across Dixon Entrance because northeasterly outflow from Portland Inlet continues until the front is almost past. Since southeast winds come off the peninsula itself, the fetch is short and the seas manageable. Naden Harbour and Masset Inlet receive southeast winds when the



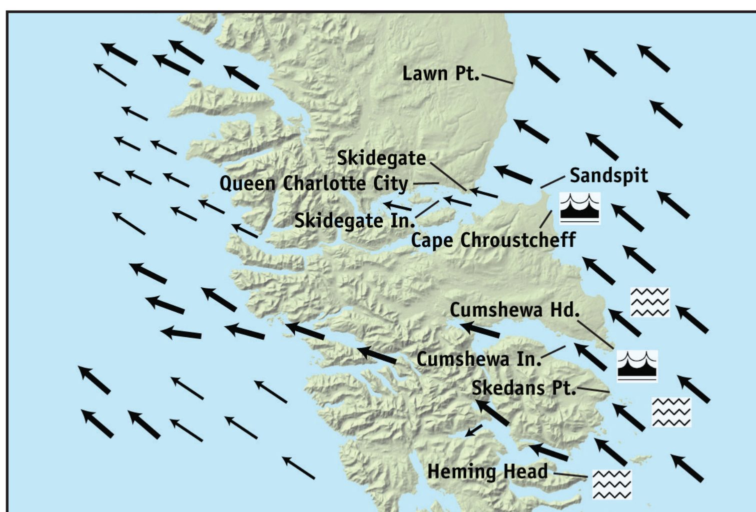
southeasterlies in Hecate Strait are very strong; however, they are much lighter than those at Rose Spit.

Mariners' Tips:
The Langara Island reporting site is sheltered from southeast winds, so it does not record the strength of those blowing a short distance offshore. As such, the site may report winds of 10-15 kt when they are southeast at 40-50 kt just west of the Island. The site does, however, provide an indication of northwest and northeast winds.

The shallowness of Hecate Strait near Graham Island causes the waves to steepen so much that they break, creating "holes" in the sea. This results in hazardous conditions—in particular, from Cape Ball to Rose Spit—that move with the shifting sandbars. It is best to stay in deeper water when rounding the Spit, as strong overfalls occur just off the end. The conditions are even worse when the southeast winds blow against a flooding tide, which can be as strong as 3.5 kt. Rounding the spit, the transition from shallow to deeper water also affects the sea conditions.

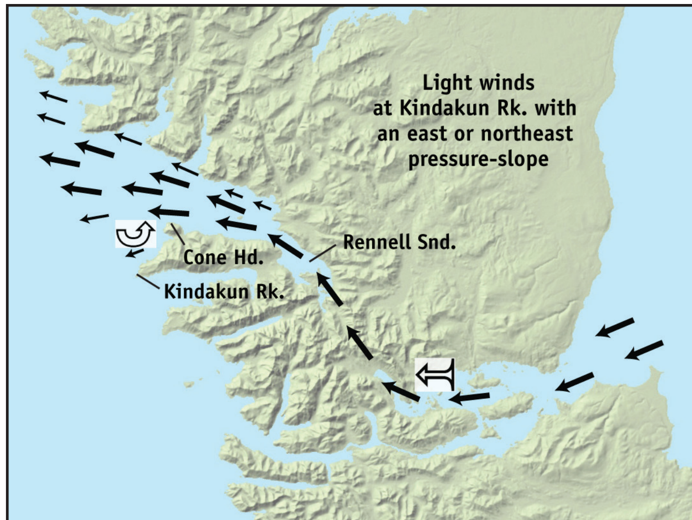
When the pressure slope is east or northeast, strong southeast winds strike the headlands on the east coast of Haida Gwaii and flow into Skidegate Inlet, although Queen Charlotte City is not usually hit very hard. When the pressure slope turns more to the southeast, a wind shadow spreads up the east coast, and the winds in the Inlet are light.

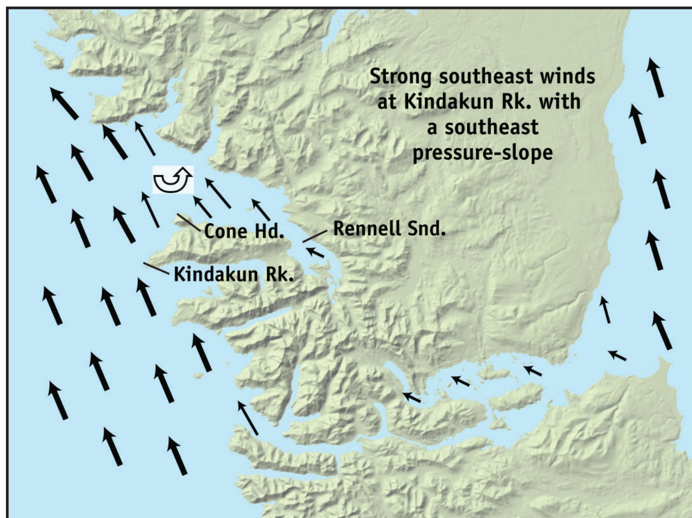
The waves break around 1.5-5 km off Cape Chroustcheff, just south of Sandspit, and steepen as they cross the bar at the mouth of Skidegate Inlet. They also steepen when they encounter tides exiting Cumshewa Inlet. Currents near Cumshewa Head, Skedans Point, Heming Head, and Benjamin Point can be challenging when the tide is changing.



Mariners' Tips:
Beware of all headlands and points, as winds and tidal currents are often stronger around them. With extreme tidal ranges, winds against tides are especially dangerous. It is best to pass the headlands at slack tide or give them a wide berth.

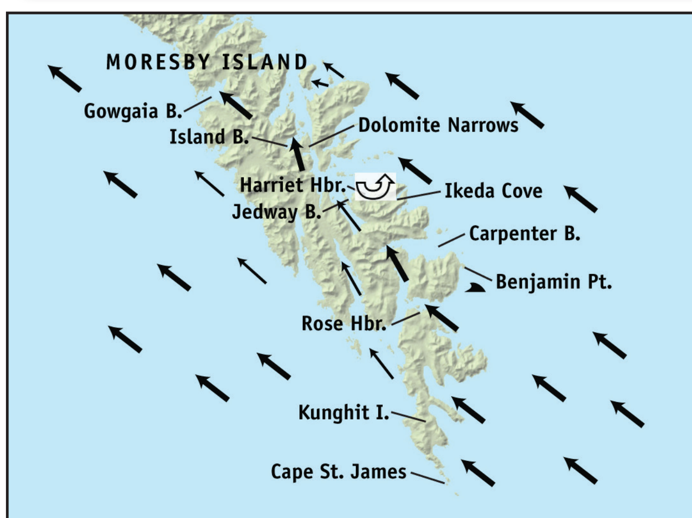
The winds at Kindakun Rock are sensitive to the orientation of the pressure slope. When it is southeast, they will also be southeast and can rise to gale or storm force with a strengthening gradient. In such cases, Rennell Sound receives some sheltering and lighter winds. The opposite occurs as the pressure slope backs toward the northeast: strong winds flow through Rennell Sound, often creating eddies or "spin drifts" near Cone Head, while Kindakun Rock gets more sheltering from Moresby Island and its winds shift from southeasterlies to light easterlies. When the pressure slope causes easterly winds to pass through the inlets on Graham Island, most of the coast north of Tian Head has light winds.





3.4.1.1 Moresby Island

The narrowness of Moresby Island allows southeast winds along the east side of the island to flow over top and hit hard onto the waters of the inlets on the west side. In strong wind conditions, this makes it difficult to anchor or find shelter. The southernmost part of Haida Gwaii is particularly difficult in this regard, with Gowgaia Bay and Tasu Sound two examples of places where gusty winds come down off the mountains.



Harriet Harbour, the native name for which means "place of strong winds", also receives southeast winds that have passed over the mountains. When the pressure slope is close to southeast, strong southeast winds also blow into Rose

Harbour and, from there, across the narrow neck of land and the head of the inlet to cause gusty winds in Carpenter Bay. It is important to note that areas that are safe in southeast winds ahead of the front may not be safe with the westerly winds that follow its passage.

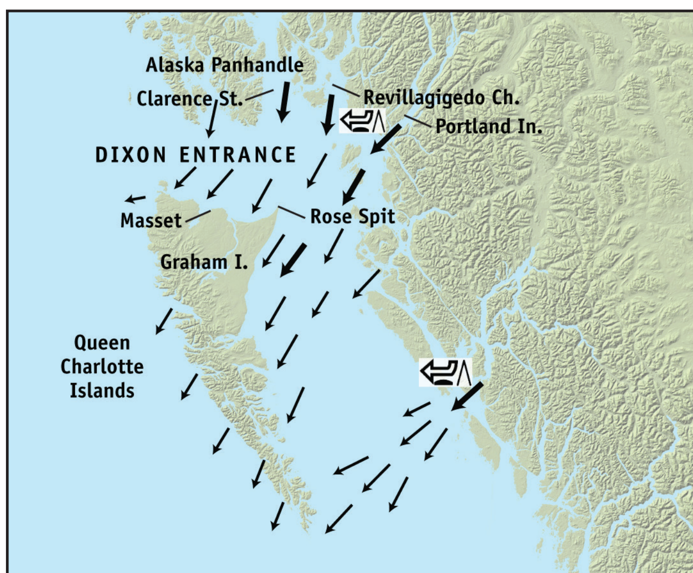
Downslope winds develop in various inlets when there are strong winds at mountaintop level, perpendicular to the mountain range. The winds, trapped between the mountaintop and an inversion aloft, are forced down the lee side of the mountain and into the adjacent inlets. Ikeda Cove and Jedway Bay are among the worst inlets for such winds, which can reach 60 kt even if the southeast winds outside them are much weaker. The winds take mariners by surprise because they flow at an angle perpendicular to the inlets' orientation rather than parallel to it.

Did You Know?
The high level of magnetite near Ikeda Cove affects compass readings.

When the air is very stable and the winds are not too strong, the southeast winds blowing into the inlets on Moresby Island bounce off the mountains at the heads of the inlets and return the direction they came from as westerlies. This can create gusty, confusing, and potentially dangerous wind conditions.

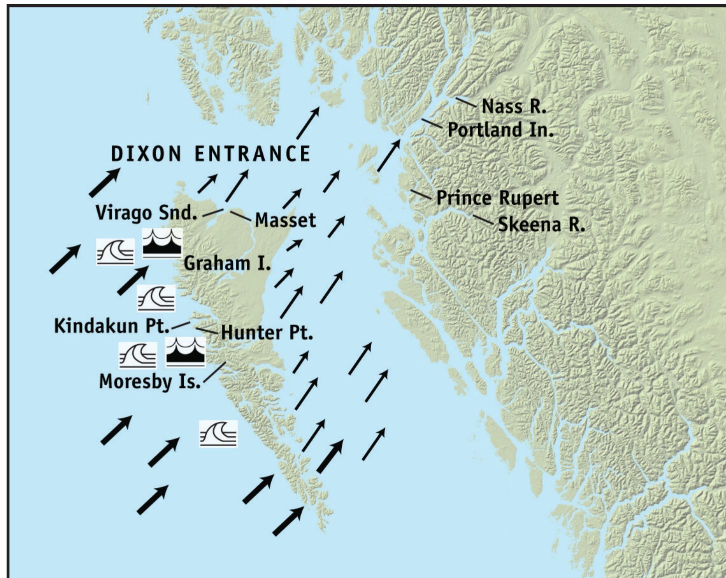
3.4.2 Northerly Pressure-Slope Winds

When the pressure slope is closer to northeast, the outflow that affects Haida Gwaii comes primarily from Portland Inlet. Although the outflow from mainland inlets normally eases over such a long distance, when a strong northeast gradient extends beyond the Coast Mountains, across Haida Gwaii, strong winds flowing out of the inlets strike the east side of Haida Gwaii and pass through the gaps that cross the islands. Winds on the west side are varied, being very strong east to northeast near the mouths of the inlets but relatively calm away from them.



When the pressure slope is closer to due north, the outflow winds also flow from the inlets of the Alaska Panhandle. These winds primarily affect just the north coast of Graham Island and eastern Dixon Entrance. In this situation, the plume of winds exiting Portland Inlet moves more toward the south and, instead of flowing out of Dixon Entrance, spreads down the full length of Haida Gwaii. The winds still pass through the gaps that cross the islands and exit out the west side: this time, with a more southerly slant.

3.4.3 Southerly Pressure-Slope Winds



When southeast winds shift to southwest, they ease but become more turbulent. In winter, southwest winds bring poor visibility all along the west coast. Their strength depends largely on the strength of the front and the rate at which the pressure behind it is rising. The southwest winds are not as turbulent in summer as they are in winter, but they still cause low visibility.

South to southwest winds and seas that encounter opposing currents around headlands—such as Kindakun Point and Hunter Point—create rough conditions. Southwest winds flow through all of the inlets across Moresby Island and funnel out those along the coast.

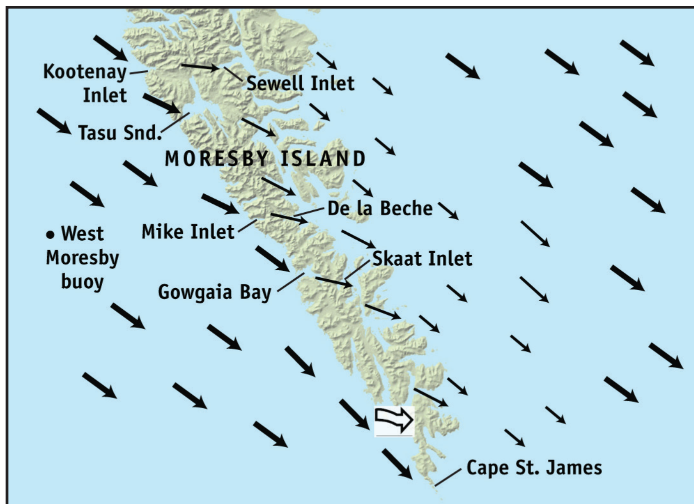
Fog can form in the light southwest-to-west winds that follow the passage of a front. A wall of fog sometimes occurs on the north coast of Graham Island. Foggy conditions are usually worst west of Virago Sound; although Masset also sees some, it is not as dense or as frequent as it is near Prince Rupert and the Skeena and Nass rivers. Often, the fog along the west coast of Haida Gwaii lifts into low stratus clouds.

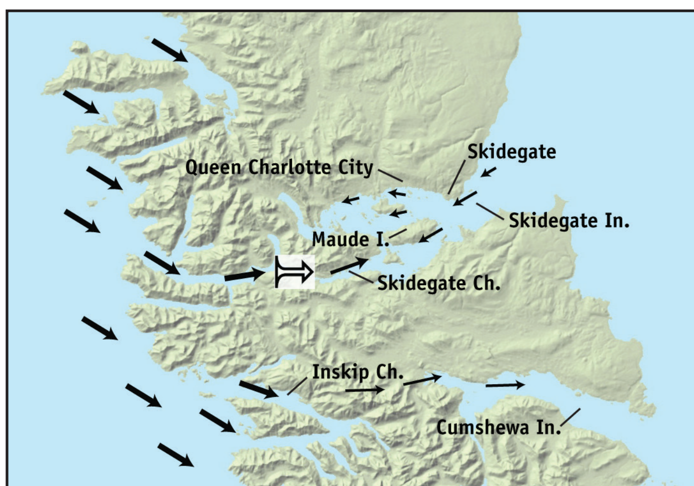
3.4.4 Westerly Pressure-Slope Winds

Northwest winds can strike hard all the way down the west coast of Haida Gwaii when the pressure slope is westerly near 220°. The winds turn into the inlets during the afternoon and often increase to gale force where they are funnelled by the higher mountains. This is quite common near Cape St. James, where tidal rips make conditions especially dangerous, even when there are almost no winds. Rips can be a problem the entire length of west Moresby Island, from Gowgaia Bay southward, as northwest winds against the flooding tides produce sizeable breakers.

3.4.4.1 Diurnal Winds

Moresby Island heats up during the daytime, creating inflow winds through almost all of its inlets that increase during the afternoon and drop off in the evening. On some days, these winds howl even when it is calm outside the inlets: but there is something about the inflows on Moresby Island that is unlike those on the mainland coast. Because the Island is narrow and has many inlets on both sides, inflow winds that develop through the inlets on one side can flow over the island and out through the inlets on the other side. These winds are comparable to the Qualicum and Nimpkish winds of Vancouver Island; however, because southern Haida Gwaii is much narrower than Vancouver Island, there are more locations where these "crossover winds" occur. Three examples are between Gowgaia Bay and Skaat Inlet, Kootenay Inlet and Sewell Inlet, and Mike Inlet and De la Beche Inlet.





The winds begin crossing the island in the late afternoon, once they have gained sufficient strength and only if the air is stable enough for them to rise up and over the mountains. An inversion above the mountaintop is also needed to cap the flow's upward motion and deflect it back down to water level—as could be created by a nearby ridge of high pressure, with its subsiding air. Downslope winds have similar requirements. The winds may be strengthened if the flow comes from just the right direction: for example, in certain conditions, northwest winds channelled along southern Moresby Island can create very strong winds off Cape St. James.

Easterly inflow winds can also form through channels on the east coast and pass out through inlets on the west coast. This does not occur under the same pressure-slope orientation that produces northwest winds along the west side of Haida Gwaii and a west-to-east crossover flow; however, it would occur once the pressure slope has turned far enough to the northwest that the winds are slack on the west side of the islands. For example, afternoon inflows (which are southeasterlies) in Cumshewa exit through Inskip Channel on the west coast.

Westerly winds that blow into Skidegate Channel get as far as Maude Island, where they are met by easterly inflow winds developing along the east side of Haida Gwaii in Skidegate Inlet. The easterly inflow winds are strongest on the south side of the Channel. During a summer afternoon, these two flows can oscillate back and forth, depending on their individual strengths, such that Queen Charlotte City may receive alternating westerly and easterly winds.

3.5 The North Mainland Coast

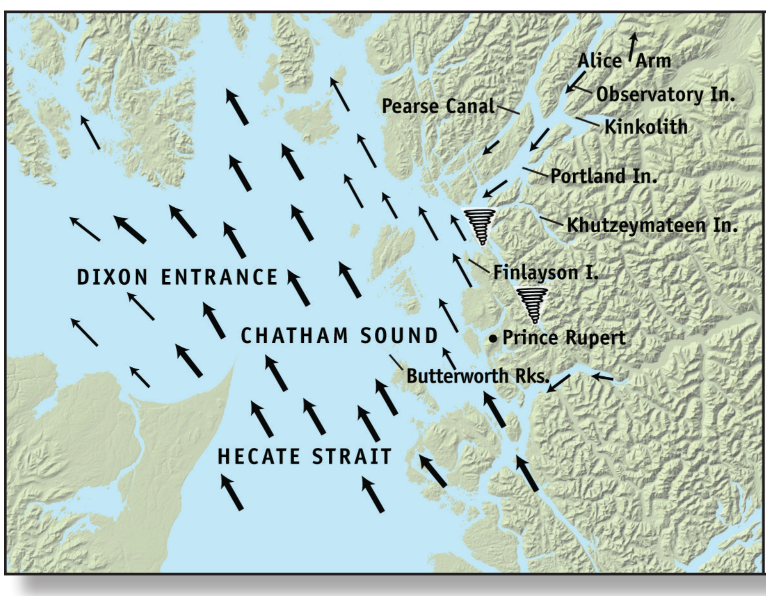
The north mainland coast, while blessed with an abundance of places to see and explore, is affected by its proximity to the Gulf of Alaska—a frequent home to low-pressure systems that cause wind, clouds, and rain. Fortunately, rainbows are common, and nowhere are they are more brilliant. The Inside Passage is the main route taken between Port Hardy and Prince Rupert and follows a variety of channels and passageways that are usually sheltered from the wind and waves experienced on the open waters of Queen Charlotte Sound and Hecate Strait. In certain weather patterns, however, some of these channels experience strong winds that pose a potential hazard to mariners.

3.5.1 Easterly Pressure-Slope Winds

A wide range of easterly pressure-slope winds affect the north coast. Their impact on Haida Gwaii is usually greatest when the pressure slope is closer to the northeast; on the mainland coast, when it is closer to the southeast. Mainland inlets generally receive light northeast winds throughout the range of easterly winds.

3.5.1.1 Chatham Sound

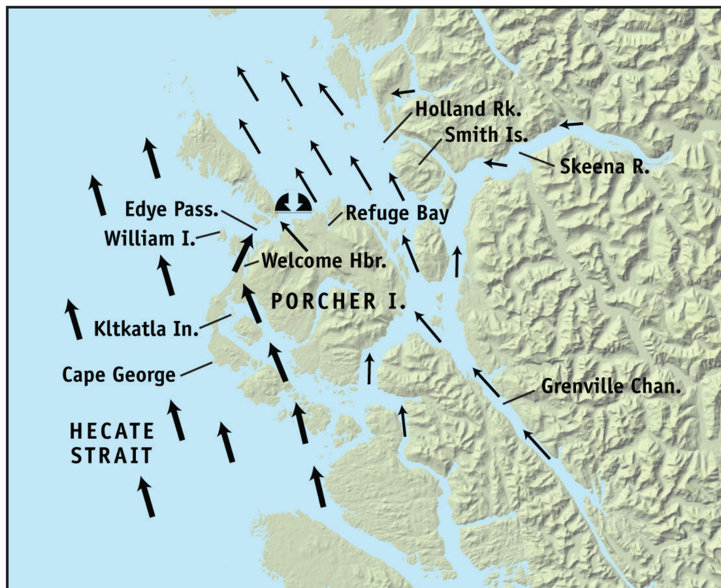
Chatham Sound lies on the dividing line between the southeast winds of Hecate Strait and the northeast winds of the coastal inlets. The mouth of Portland Inlet is potentially dangerous when northeast winds persist in the canal and southeast winds are strengthening in Chatham Sound. When tides are added to this mix, the seas can build to 4-5 m, with crests only 3 m apart. Butterworth Rocks is a dangerous area when the tides and southeast winds meet.



Southeast winds build steep waves near Finlayson Island and produce gusty conditions inside Prince Rupert Harbour. In most situations, even when the winds are nearly southerly as the front passes, they do not blow with any strength up Pearse Canal.

Edye Passage, at the top end of Porcher Island, is an area to cross with caution. Southeast winds blow across the peninsula from Kitkatla Inlet into Welcome Harbour and flow into the passage to meet the downslope winds coming off the mountains on Porcher Island, which also affect the waters of Refuge Bay. Bands of very strong winds are created in the area: if Holland Rock is receiving 20-kt winds, Edye Passage (just 16 km southwest) could be getting winds of 30-35 kt. Similarly, if winds of 40 kt are being reported in Hecate Strait, the winds in Edye Passage could be gusting as high as 80 kt.

Winds are stronger over the deeper waters west of Porcher Island than they are near the Island. Heading out into Hecate Strait, the swell becomes noticeable near William Island; the full force of the wind, outside Cape George. Southeast winds passing around the back side of Porcher Island create steep standing waves as they meet the outflow from the Skeena River, just off Smith Island. The area at the mouth of the Skeena River also sees standing waves during a flooding tide.



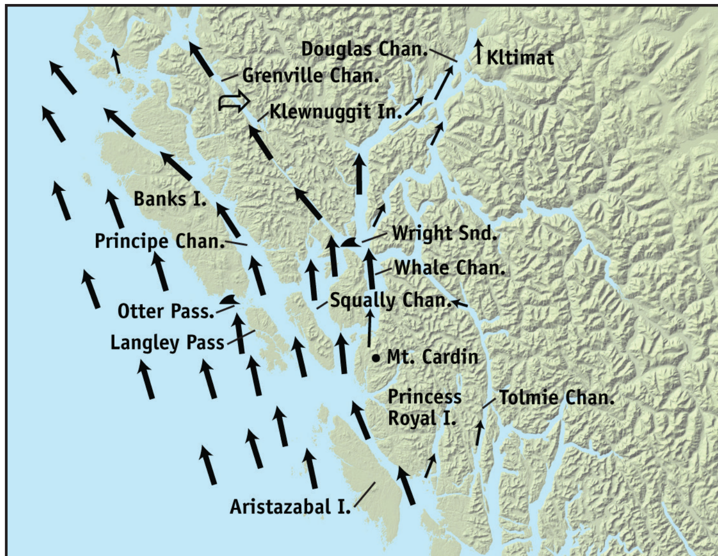
3.5.1.2 Grenville Channel Area

When strong southeast winds hit the mainland coast, sizeable seas develop along the eastern side of Hecate Strait from Aristazabal Island to Banks Island. Steep waves build against the ebb tides coming out of Otter and Langley Passages.

The winds in Grenville Channel are highly dependent on the direction of the pressure slope. If it is northeast, the Channel is calm; however, if it veers toward the southeast, the southeast winds funnel through it, producing winds that are potentially higher than those in Hecate Strait. Klewnuggit Inlet is aligned such that it receives all of the southeast winds in Grenville Channel.

The seas that develop in Grenville Channel are not normally as high as those in Hecate Strait, as they are limited by a maximum 80-km fetch, which is the approximate length of the Channel. At its western end, the seas can build to 2.6 m with a 30-kt wind and to 4.8 m with 50 kt.

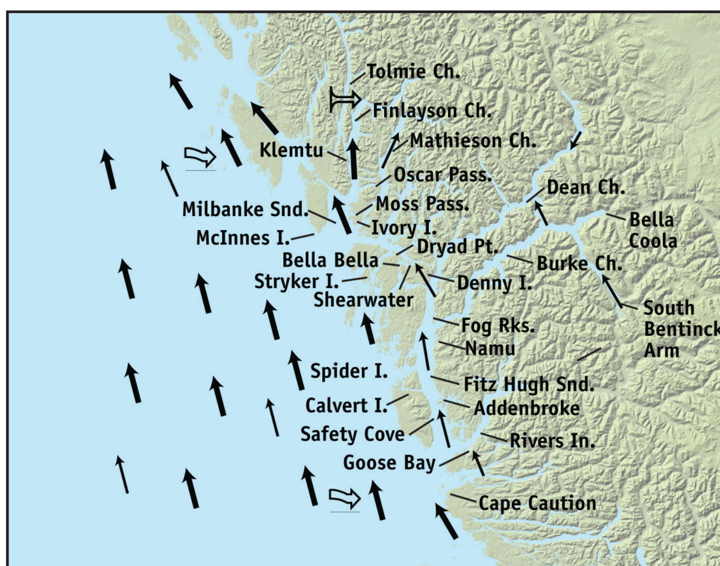
Principe Channel can receive the same strength of winds as Hecate Strait when the pressure slope is from the southeast; like Grenville Channel, however, only wind waves are created and no swell is present. When the pressure slope is from the east or northeast, both Grenville and Principe channels receive lighter winds than the Strait, so they are popular refuges.



Wright Sound, Whale Channel, and Squally Channel can experience wild southeast winds. Wright Sound is particularly prone, as no matter which direction the pressure slope is oriented, at least one of its five channels will likely experience strong winds. When northerly winds continue to flow out of Douglas Channel into Wright Sound as the southeasterlies approach, the seas steepen and become chaotic. The western part of Wright Sound gets some protection from northerlies coming out of Douglas Channel. Gusty, southeast downslope winds come off Mt. Cardin on Princess Royal Island and cross the harbour into Whale Channel. Both Tolmie Channel and Princess Royal Channel get southeast winds, but they are not as strong as in Douglas Channel.

3.5.1.3 Milbanke Sound

Milbanke Sound gets hit hard with both southeast and southwest winds. Oscar and Moss passages are generally fine in true southeast winds, but when they shift to the south, they turn into the passages—creating rough conditions, especially against the tide. During most autumn and winter seasons, it is normal for the Sound to see roughly half a dozen storms with winds of 40-50 kt, some of them reaching 60-80 kt. Southeast winds also funnel up Finlayson Channel fairly regularly and are stronger than those in Tolmie Channel. During



severe storms, Mathieson Channel also gets strong southeasterlies if the pressure slope is near southeast. The Shearwater area generally get stronger southeast winds than Bella Bella does, as storm-force winds flow down off Denny Island and onto its waters.

Mariners' Tips:
The winds on McInnes and Ivory islands are a fair representation of those experienced in Milbanke Sound and the area off Shearwater and Bella Bella. Dryad Point, on the other hand, represents little more than itself.

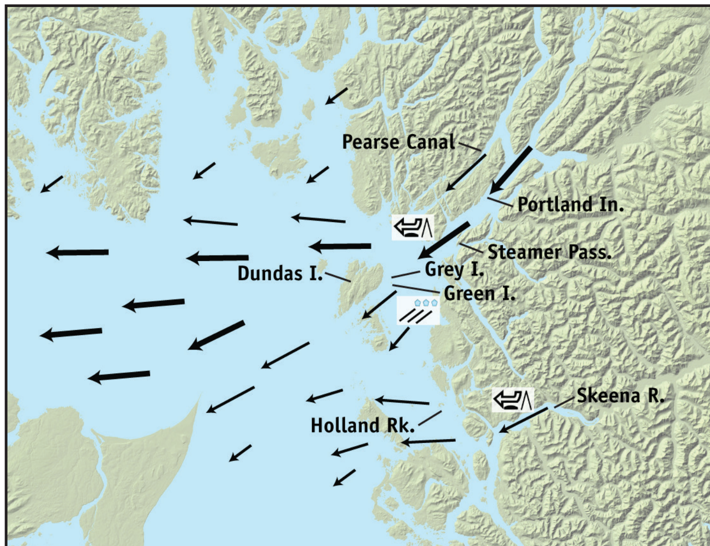
While winds in Dean and Burke channels remain light with southeast winds offshore, southeasterlies affect South Bentinck Arm. Southeast winds that flow up Fitz Hugh Sound are worse at its northern end, near Namu, than in the south, off Addenbroke. Namu, the place of many winds, occasionally gets strong easterly winds that come down off the lake behind it at speeds up to 90 kt, creating downbursts and waterspouts in aptly named Whirlwind Bay. The light station at Addenbroke is sheltered from most southeast winds by the hills to the south. Southeast winds and the southerly swell tend to be stronger on the west side of Fitz Hugh Sound, while the tidal currents are stronger on the east side and particularly sloppy near Fog Rocks. As its name suggests, Safety Cove, on Calvert Island, offers a place to hide from southeast winds. Spider and Stryker islands, near the edge of Hecate Strait, get strong southeasterlies, even if there is little wind at Shearwater. Goose Bay, at the mouth of Rivers Inlet, is challenging when southeast winds are blowing, as air cascading down the mountains produces strong, gusty conditions. Since the winds blow off the land, however, the water is calm.

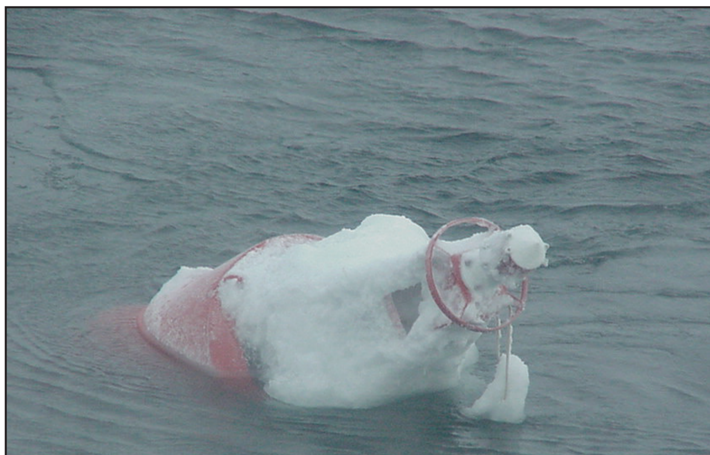
3.5.1.4 Coastal Inlets

The winds through the coastal inlets remain northeast across the range of pressure slopes that create easterly winds over open waters. They turn south only if the pressure slope veers beyond 130°. In most cases, as a front passes and the pressure slope shifts toward the southeast, the winds ease. As such, by the time the pressure slope has tilted far enough around to send wind up the inlets, the pressure gradient has weakened so much the winds are not of any note. Strong winds do occasionally move up the inlets, however, when the pressure slope is southerly.

3.5.2 Northerly Pressure-Slope Winds

The coastal inlets are the main arteries for northerly winds flowing from the BC interior to the coast. The other channels are affected to various degrees, depending on their orientation. Portland Inlet, Douglas Channel, and Dean and Burke channels have all experienced high storm-force winds, several of which have touched hurricane force. The Skeena Valley also experiences strong outflow winds. Pearse Canal, just west of Portland Inlet, generally receives less wind and noticeably lower seas, and Steamer Passage to the east provides some protection from outflow winds. In classic Arctic outflow events, the temperature drops enough for freezing spray to become a significant problem. Cold air at the heads of the inlets can create sea ice, especially at freshwater entry points.





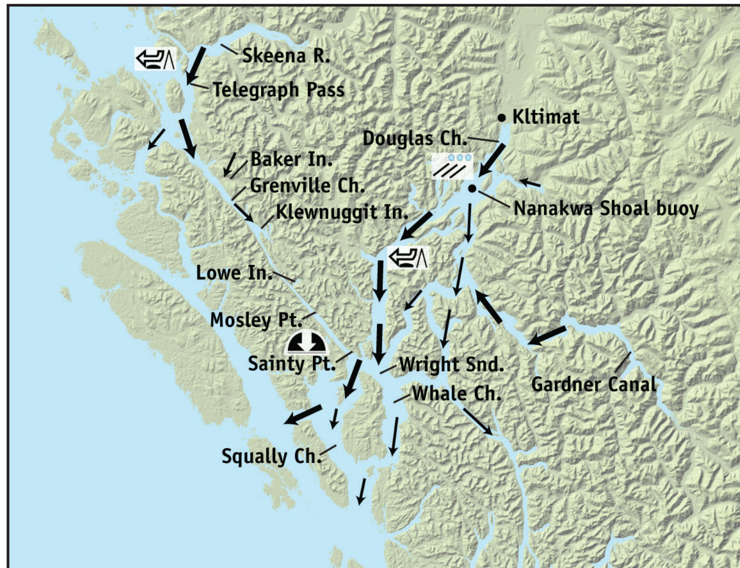
A typical buoy iced up by outflow winds.

Mariners' Tips:

Grey Islet and Green Island are indicators of outflow from Portland Inlet, while Holland Rock represents the outflow from the Skeena River. The Douglas Channel buoy reports outflow winds, but they are generally 20 or 30 percent lower than in other parts of the Inlet. Cathedral Point is representative of the winds in Dean and Burke channels.

3.5.2.1 Grenville and Douglas Channel

The outflow from Douglas Channel spreads throughout Whale Channel and, to a lesser extent, Squally Channel. The small channels that run at right angles between the main outflow inlets generally have light winds. Grenville Channel has reputedly been known to blow with a northerly outflow even though it runs perpendicular to Douglas Channel. If may be that, if the pressure slope is far enough north, the flow from the Skeena River turns down Telegraph Passage and moves into the top of the Channel. The bottom could be affected by winds coming out of Douglas Channel. Northeasterly winds that blow over the tops of the Coast Mountains occasionally descend on the north side of Grenville Channel, striking the waters between Mosley and Sainty points. Similar downslope winds of 30 kt have also been reported in Baker Inlet.



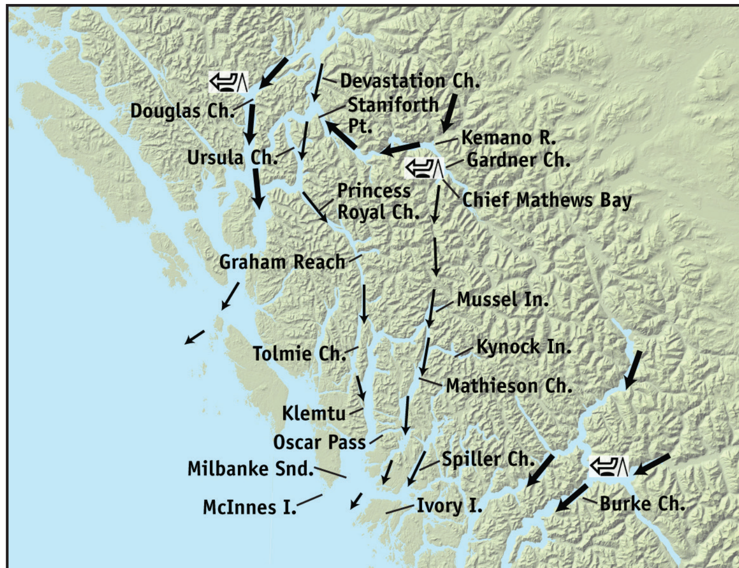
The tides enter Grenville Channel from both ends and meet near Klewnuggit Inlet, where conditions can be chaotic. While the ebb tide separates about 1.5 km to the northwest, the exact meeting and separation points change with the winds outside the Channel. Eddies develop with the ebbing stream off Lowe Inlet.

The wave conditions through the inlets are limited by their available fetch. Since some of the longest (without a 30° change in direction) are less than 50 km, even a 65-kt wind would create no more than a 4-m sea. In shorter, secondary inlets where the fetch is more limited, the seas are, at worst, choppy. Since strong outflows and waves bounce off the steep sides of Douglas Channel, the worst wave conditions are found near its edges, where the rougher waters meet the main flow.

3.5.2.2 Douglas Channel to Milbanke Sound

Graham Reach, off Princess Royal Channel, and Tolmie Channel receive strong northerly winds after they have passed down Devastation Channel and across the peninsula into Ursula Channel. They weaken considerably by the time they reach Klemtu: dropping, for example, from 30-40 kt in Tolmie Channel to just 10-15 kt.

Gardner Canal gets strong outflow winds that some say can be 10-15 kt stronger that the winds in Burke Channel and that have been recorded at up to 100 kt. They come from the interior and along the Kemano River, entering as northerlies but turning into easterlies as they pass Staniforth Point, at the south end of Devastation Channel. Corkscrew eddies, which push the water downward, are created as the winds round the dogleg turn in the Canal.



After several days of cold outflow conditions, the depth of the Arctic air increases, and outflow winds develop in other channels, such as Spiller and Mathieson. The outflow winds from Mathieson Channel and Gardner Canal are connected by way of a pass between Chief Mathews Bay and Mussel Inlet. The winds through Mathieson remain strong at the eastern end of Oscar Passage, begin to ease as they pass Ivory Island, and are further weakened by the time they reach McInnes Island. Strong eddies or "williwaws" form off the steep sides of Kynoch Inlet.

Northeast winds moving down Dean Channel pass over northern Denny Island and flow into Shearwater Harbour, McLoughlin Bay, and the western entrance of Lama Pass. Bella Bella lies just north of the main plume, so it misses the worst of it. The winds can be very intense at the bottom of King Island, where the flow from Dean and Fisher channels meets the outflow from Burke Channel. Except in extreme cold outflow events, the winds generally ease soon after they leave Fitz Hugh Sound. Icing conditions in all of these channels can be severe as far south as Hakai Passage. Cousins Inlet freezes over from near Ocean Falls to Wearing Point.

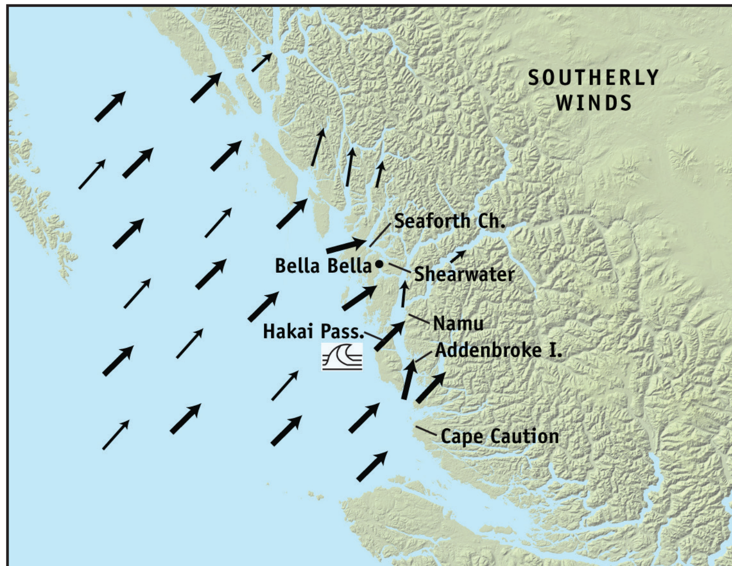
Outflows are the only winds of concern in Bella Coola, which sometimes receives storm-force blows passing from the interior across the Bella Coola River. Passes give Dean and Burke channels easy access to the interior, so both experience strong winds during outflow conditions. Although some say Burke's is stronger, Dean's powerful tidal currents likely make their conditions about equal. Crossing Burke Channel in a strong outflow is extremely difficult, if not impossible.

Mariners' Tips:
Local knowledge says northeast winds at Cathedral Point must be above 30 kt for Shearwater to get any wind, and that the two rise at roughly the same pace. An even bigger difference exists between Bella Coola and Bella Bella, with the former seeing outflow winds of 70 kt when the latter is receiving just 25-30 kt. In most winters, the Shearwater area receives two or three weeks of outflow.

It is important to note that, as the pressure gradient changes, the winds in some inlets become stronger and in others, weaker. In one real-life example, severe icing was experienced in Hakai Passage from cold outflow winds, yet Fitz Hugh Sound was calm. The winds remained light until near Egg Island, where there was a strong outflow from Rivers Inlet. It may be that with a more easterly pressure slope, the outflow winds coming down Fisher Channel join up with those from Burke Channel and turn into Hakai Passage rather than flow further down Fitz Hugh Sound. The next area that would receive these more easterly winds would be near the mouth of Rivers Inlet. When the pressure slope is more northerly, the outflow winds pass all the way down Fitz Hugh Sound and do not turn into Hakai Passage.

Rivers Inlet gets a strong outflow only after a high over the interior has been well established and the winds have been blowing for two or three days. It gets gale-force winds when those in Burke Channel are of storm force. In Goose Bay, at the mouth of Rivers Inlet, the outflow winds come around the corner and swirl downward, depressing the water.

3.5.3 Southerly Pressure-Slope Winds



Coastal inlets blow mainly northerly outflows or southerly inflows, regardless of the time of year. Southerly inflows arise from either the strong southerly winds that develop behind a front with a southerly pressure slope or the heating of the walls of the inlets in summertime. Southwest winds come up fast and can be dangerous, but they generally die away quickly. They are most common in the transition periods of spring and early autumn. The summer inflow is discussed more in Section 3.5.4, as they are primarily caused by daytime heating.

Southwest winds can be strong in places such as east of Dundas Island, where funnelling effects and a long fetch can build fairly high seas. Inlets that are open to the southwest, such as Seaforth Channel and Hakai Passage, can be rough, as southwest wind waves and swell can flow directly into them and may increase in height through funnelling. Namu Harbour and Addenbroke both receive southwest winds that pass through these inlets. The waters off Cape Caution receive the full thrust of southwest winds.

Mariners' Tips:

"Southwest winds are readily made and quickly even."

"Southwest winds are usually very short and rare: a passing disaster."

3.5.4 Westerly Pressure-Slope Winds

Westerly winds are affected primarily by the strength and orientation of the ridge of high pressure that typically lies off the coast during the summer. These winds, which are created through pressure differences, are known as “offshore-ridge winds”. During the summer, the heat from the sun modifies the winds such that they follow a diurnal cycle of strengthening and weakening. These are called “diurnal winds”. The overall pattern is set by the ridge’s strength and orientation, both of which affect the pressure slope, but modified by heating effects over the land. Pressure-slope winds mainly affect the open waters and adjacent areas, while diurnal effects are strongest further inland, especially near inlets. Inlets that have strong northerly outflows in winter have strong southerly inflows in summer, as the strength of these flows is connected to the temperatures over the interior plateau. If the interior heats up significantly during the afternoon, the cool coastal air will be sucked up into the inlets: the warmer the interior, the stronger the inflow. The reverse happens with a winter outflow, which is dependent on significant cooling over the interior. Inflows happen every day in the summer, unless there is a weak low and cloudy skies over the coast.

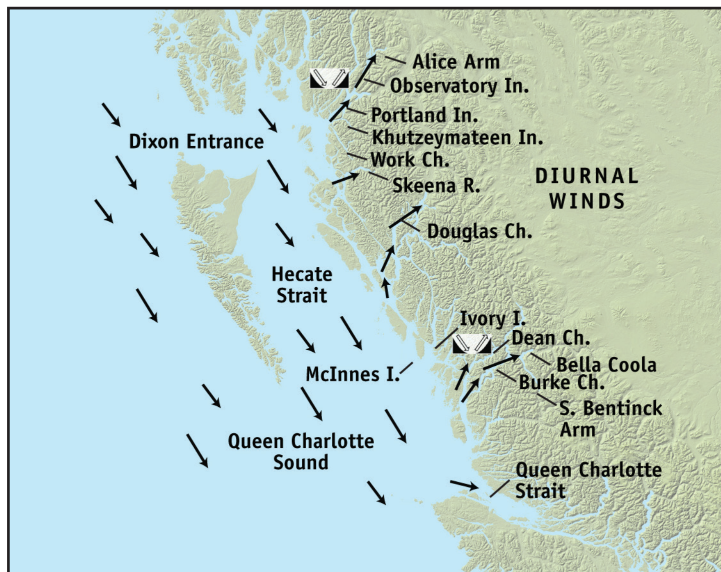
3.5.4.1 Offshore-Ridge Westerly Winds

Northwest winds that spread through Dixon Entrance don’t strike the shore along Chatham Sound until they have overcome the nightly outflow winds. Once they do reach the coast, they tend to wrap around the islands and are notoriously hard to escape. Called “the worst winds in Chatham Sound” by some, they can create a heavy buildup of seas at the mouth of Portland Inlet and the entrance to Prince Rupert Harbour. In a worst-case scenario, a 30-kt wind blowing up into Portland Inlet at the same time as a 7-m ebb tide flows out can produce 3-4 m seas roughly 3 m apart, the impact of which should not be underestimated.

As the pressure slope turns from southwest to west, the winds blow down the length of Hecate Strait, hitting the islands on the outer mainland coast first. While Laredo Channel and Milbanke Sound are affected by northwest winds, many channels further inland are not and see only light winds except those caused by local heating. Northwest winds spread into Principe Channel, Grenville Channel, and Estevan Sound and may even be stronger than they are outside them, due to funnelling. Locations directly downwind of islands have much lighter winds.

The Bella Bella and Shearwater areas are not strongly affected by northwest winds. Bays on the east side of islands, such as Calvert Island, are safe for anchorage with westerly winds, while locations open to the west, such as Namu, are not. Even if the upper winds are strong northwesterlies, they remain aloft and do not come down to the surface. Each channel steers the winds according to its own orientation, hence they may be westerly in Seaforth Channel but almost northerly in Fitz Hugh Sound.

3.5.4.2 Diurnal Winds



Since the diurnal winds along the northern mainland coast are a form of westerly, they are enhanced by the prevailing westerlies, which blow more or less the same direction. On the east side of Haida Gwaii, however, the sea breeze winds are easterly, which may weaken or totally overcome the prevailing westerly winds, depending on their relative strengths. The inlets generally receive northerly outflow winds in the morning that persist until heating starts to draw the winds up the inlets. With strong diurnal heating, the northwest winds over Hecate Strait are drawn closer to the mainland coast and add to the afternoon inflow through the inside channels.

The winds normally begin around 1000 hours, gradually increase in strength until late afternoon, and ease fairly quickly around 1800 or 1900 hours. All of the mainland inlets experience inflow winds that typically peak near 20-25 kt in the afternoon. In extreme events, winds at the heads of the inlets may rise to gale force. The larger channels, such as Portland Inlet, Skeena River, and Douglas, Dean, and Burke channels, all have connections to the interior and experience stronger inflow winds than the smaller inlets. These winds, like northerly outflows, take on the direction of the channel. The afternoon inflow gradually increases up the inlets, peaking near their heads. In Burke Channel, for example, the winds are funnelled up toward Bella Coola, where they are at their worst. Inflow winds also develop in South Bentinck Arm.

These channels also all have straight stretches where the fetch is long enough to build significant seas. Inflow winds through Work Channel increase during the afternoon but are rarely dangerous. It has been said that 1 m of sea in Work Channel means 2 m in Portland Inlet.

Clouds that limit daytime heating can change these patterns, as diurnal winds do not develop without heat from the sun. Fog, which often extends from southern Hecate Strait along the central coast and into Queen Charlotte Strait, slows heating over areas close to the open water but increases the temperature contrast between the coast and the inlets further inland. Fog also goes through a diurnal cycle, as described in Section 2.2.5.

Drainage outflow winds are also part of the diurnal wind. While southerly inflow winds develop during the late morning and afternoon, northerly outflow winds develop overnight. The strength of the outflow depends on the strength of the westerly pressure-slope gradient and the amount of snow on the mountaintops. When the gradient is strong, the southerly inflow winds last longer. They weaken through the evening and night but, since they do not completely disappear until quite late, there is little time for the northerly winds to strengthen. When the mountains are covered with snow, as they are in spring and early summer, there is a constant push of cold wind down into the inlets that is only overcome by a strong inflow gradient. The northerly part of the cycle is thus strengthened, and it remains so until the snow melts. The higher coastal mountains that have year-round snow continue to create drainage winds throughout the summer, but these tend to affect only the upper reaches of the larger inlets.