

## *Weather and Climate of the Columbia Gorge*

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THE COLUMBIA Gorge is a remarkable landform, a low-elevation gateway from west to east through the Cascade Mountain Range of Washington and Oregon. From the standpoint of climate, the gorge provides an unusual transition from a marine-type climate to a continental-type climate. The area on the west side of the Cascades is near the Pacific Ocean, and dominated by maritime air masses. The land area on the east side of the Cascades is sheltered from the oceanic influence by the barrier to the prevailing wind from the west.

Climate is defined as a statistical summary of weather conditions over a fairly long period of time. It is the practice of the U.S. Weather Bureau to establish the so-called normal values of climate, for any given location, upon the averages of 30 years of record.

The word "climate" is derived from the Greek *klima*, meaning inclination, because of the importance attributed to the sun's influence. The angle of the sun, or in other words, the latitude of a given location, is partly responsible for the climate of that location. We speak of tropical climate, or an arctic climate. But many other factors are also important, such as elevation, and the character of the earth's surface, such as water, forest, grass, or desert. With respect to the Columbia Gorge, we are primarily concerned with two basic types of climate, marine and continental.

A marine climate prevails where the atmosphere is under the predominant influence of the sea, that is, high moisture content in at least its lower levels. Such a climate is found where the prevailing winds blow onshore, such as the western coasts of continents in middle latitudes. It extends inland either until it meets a climatic divide, or in level country, until it becomes modified and gradually attains greater continentality. Large bodies of water change temperature very slowly, mainly because of the high specific heat of water. Also, any change of temperature at the surface is spread downward by mixing. Hence, a marine climate is characterized by small daily range of temperature, and a small annual range of temperature. There is a lag in the seasons of about one month in comparison with a continental climate.

A continental climate is characteristic of the interior of a land mass of

continental size. Land surfaces often change temperature rapidly. Changes usually affect only a shallow layer of soil or rock near the surface. The air above is often dry, which favors rapid radiation at night. Hence, a continental climate is marked by a large daily range of temperature, a large annual range of temperature, low relative humidity, and by rainfall that is irregular. The hottest period of the year is soon after the time of highest sun, and the coldest period is soon after the time of lowest sun. In its extreme form, a continental climate produces a desert. Where a mountain barrier lies across the prevailing westerly winds, as in America, the greatest continentality occurs in the lee of the mountains.

Weather, as distinguished from climate, consists of the short-term variations in the atmosphere. We speak of today's weather. Everyone wants to know "what's the weather for tomorrow?"

It is incorrect to visualize the Cascade Mountains merely as a barrier between two relatively stagnant and passive air masses, one described as marine and the other as continental. Air masses are nearly always on the move, assuming one set of characteristics in one area, then moving to another region, and taking on another set of characteristics. Because of hemispheric circulation patterns, the prevailing wind across the Cascades is from the west. Marine air can, and does, move up, over, and across the mountains. In so doing, it expands, cools, and precipitation is encouraged. On the eastern side, the atmosphere blows downhill, is compressed, warmed, and precipitation is inhibited. As a result, annual rainfall statistics show greater differences between the west and east portions of the Columbia Gorge than would obtain if the mountains were not there.

#### Annual Rainfall at Selected Stations

Vancouver	37.95 inches
Portland, airport	35.23
Cascade Locks	75.60
Headworks, Bull Run	86.41
Hood River Exp. Sta.	30.10
The Dalles	13.80
Arlington	9.07
Umatilla	7.83

It is interesting to note that Cascade Locks has more rain than Vancouver or Portland, and nearly as much as the Bull Run Headworks. The streamlines of westerly winds converge as they blow through the gorge, and much of the air is lifted, with a result similar to that air which blows up the slopes of the Cascades. Cascade Locks has two and one half times as much rain each year as Hood River, which is only 18 miles farther east.

Although the majority of wind movement through the gorge is from west to east, there are many periods when pressure is higher on the east side, and east winds blow through the gorge. Also, there are many times when easterly winds from a depth of a few hundred feet up to a depth of 1000 or 2000 feet have westerly winds above the layer of easterly winds. This is especially frequent in the winter. Such a situation can cause serious weather problems, such as heavy snow, or sleet, or freezing rain.

Freezing rain, or "silver thaw" as it is often called, occurs when ordinary rain falls into a shallow layer of air which is below freezing, and the rain turns to ice after it falls on the ground, or on wires, or on vegetation. If the layer of cold air is somewhat thicker, say 500 to 1000 feet, the raindrops will freeze before impact, and this is called sleet. The Columbia Gorge is famous for its sleet storms, and periods of freezing rain. Such a storm occurred in November, 1921. At The Dalles the accumulation of sleet and snow was to a depth of 54 inches. In the narrow parts of the gorge the heavy accumulations of sleet on the steep slopes resulted in avalanches of sleet which completely covered the highway and railroad to a depth of many feet.

The Columbia Gorge has been described as a giant wind funnel. Although westerly winds can become quite strong, and they are often observed as far east as Pendleton, it is the east winds which are most violent. During the 1930's and early 1940's there was a weather station at Crown Point. The anemometer was of the type that recorded total air movement, and most of the statistics which were compiled were for average hourly wind movement. However, if an observer were present, he could measure the windspeed for periods as short as one minute. During the afternoon of November 23, 1930, Donald C. Cameron observed a peak velocity of 120 mph, and he reported the wind was even stronger during the forenoon before he arrived at the station. On December 20, 1935, all of the wind equipment was blown away, and also part of the roof of the weather station. Peak winds were estimated at 120 mph.

It is true that Crown Point is an exposed promontory, and the wind may be somewhat exaggerated due to a convergence of streamlines, but there is no doubt that many violent winds have been observed in the gorge. When strong winds occur at the time of icy roads, cars and trucks are often blown off the highway. Strong east winds can occur when other weather conditions can be described as "fair," with clear skies and rather mild temperatures. I made a visit to Crown Point during one of those occasions—it was during the fall of 1956, I believe. The wind was blowing about 70 or 80 mph. During a partial lull in the wind I wandered some distance away from my parked car,

then found that I could not stand up and walk back against the wind toward the car; I had to get down on my hands and knees and crawl!

On January 13, 1950, there was a remarkable example of a shallow outpouring of very cold air from the Columbia Gorge into the Portland area, with an over-running of moist marine air from the southwest. The cold air engulfed the weather station at the airport, but the line of demarcation moved very slowly, and for several hours most of the city of Portland was dominated by the warmer air from the Pacific. Here is a quotation from the Oregonian the next morning, after the storm:

The weather went crazy in Portland Friday. At the airport, the snow kept coming all day, with 8 or 9 inches of white stuff on the ground and drifts to 2½ ft piled up by gusts as high as 45 mph, with the thermometer at 21 degrees. Downtown, pedestrians slopped through rain soaked streets in a temperature of 35 degrees.

I saved a page of airway weather reports from the teletype for that day. At 2:30 p.m. on Friday, January 13, 1950, the following contrasts in weather were reported:

Salem: Rain, 36 degrees, wind southwest 28 mph

Portland airport: Snowing, 20 degrees, wind east 26 mph

Stevenson, Wash.: (in the gorge) Heavy snow, 9 degrees, wind east 49 mph with gusts to 60.