The

Oregon

Weather Book

A State of Extremes

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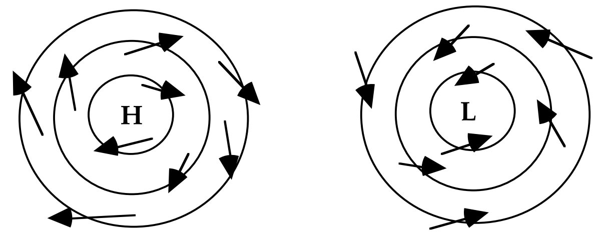
Local Winds

Winds at any given location are affected by a number of factors. In general, winds blow from high to low pressure, but rotation of the Earth changes this slightly. Rather than blowing directly away from high pressure or directly in toward low pressure, winds blow at an angle to isobars (lines of equal pressure). The diagram below illustrates typical wind direction in the vicinity of a high pressure area (H) and a low pressure area (L). The circular lines are isobars. Notice how winds blow outward from the high, but at an angle (roughly 60°, barring other influences such as terrain). They also blow in toward a low, at a similar angle. The greater the difference in pressure in a given area, the closer together are the isobars, and the stronger the winds.



Typical wind dirrection in the vicinity of areas of high (H) and low (L) pressure

Actual winds can be significantly different from the idealized diagram above. Winds at a given location can vary depending on terrain and other surface obstacles, the presence of s storm system, and temperature differences between nearby areas. Winds can change during the day, from day to day, and seasonally. Below are some of the factors which influence local winds.

Cyclonic Storms

Mid-latitude storms exert a strong influence on local wind speed and direction. Rising and descending air and horizontal pressure gradients play a key role in determining winds.

In the diagram below, isobars, frontal positions, and approximate wind vectors (assuming flat terrain) are shown for an idealized cyclonic storm. Locations 1, 2 and 3 show sites in three areas in the storm (or the relative location of one site at three different times, as the storm approaches, arrives, and leaves the area. The vertical cross-section just below is along the line connecting the three points.

The cross-sectional diagram shows the generally rising air at the two frontal locations, descending air in the higher pressure behind the cold front, and horizontal winds elsewhere. Notice also that there tends to be somewhat of a closed circulation: air rising at the frontal boundaries connects in a closed circulation with the descending air in higher pressure to the east and west of the storm.

Location 1. Winds are from the southeast. Pressure is falling. Warm front clouds (cirrus, altostratus, etc.) are observed. Precipitation is likely; generally light and steady.

Location 2. Winds are from the south; generally strong and gusty. Pressure is falling. Precipitation is possible, but less likely than at 1.

Location 3. Winds from the west or southwest. Pressure is rising rapidly. Precipitation is possible (convective, showery). Temperatures considerably colder than earlier.

Sea Breeze and Land Breeze

The diagrams on the following pages show wind and pressure patterns over Oregon for two idealized cases: high pressure offshore, and high pressure onshore.

High pressure offshore ("sea breeze"). High pressure is offshore, low pressure onshore. This occurs day or night during the summer; during the daytime in spring or fall; or the day after a cyclonic storm. This is a common summertime pattern, particularly in the daytime, when high temperatures inland cause lower surface pressure due to convection. Offshore air remains cool due to the rather cold ocean temperatures. General air flow is onshore, but local wind directions vary somewhat. At the coast, winds are from the north due to the orientation of the isobars. Onshore winds are from the west or northwest, but locally can be very different due to terrain influences. Strong winds tend to funnel eastward through the Columbia Gorge. (goes with a diagram)

High pressure onshore ("land breeze"). High pressure is onshore, low pressure offshore. This occurs in the nighttime during fair weather throughout the year; day or night during the cool season; or the day before a cyclonic storm. This is a common cool-season pattern, when colder air over inland areas causes higher surface pressures. The sea surface is now warmer than most inland areas (east of the Cascades). If the storm track is far to the north, cyclonic storms will not disrupt this pattern, and it can persist for many days. Winds are generally easterly over most of the inland areas, and can be locally strong, especially near canyons (the Gorge again serves to funnel air, this time toward the west. (goes with a diagram)

Lake Effects

Lakes and other large bodies of water can exert an influence on local winds. The diagrams below show cross-sections of wind movement during periods when the lake is warmer or cooler than surrounding air. (*needs a diagram*)

A. The lake is relatively warm compared with its surroundings. This is most common at night or during the cooler seasons. Warmer air over the lake tends to rise. Air from peripheral areas flows toward the lake to replace the rising air. Closed circulations, with descending air over areas adjacent to the lake, tend to occur, particularly during calm conditions.

B. The lake is relatively cool compared with nearby areas. This is most common during the warm season, especially in the daytime. Air rises over the warmer land areas adjacent to the lake, descends over the lake, and flows at the surface away from the lake.

(*needs a diagram*)

Urban "Heat Island"

The term "heat island" was coined several decades ago when researchers noticed that the atmosphere in and above urban areas was often significantly warmer than surrounding areas due to urban activities, including space heating, industrial activities, and transportation. Much of the early research was done in the St. Louis area, where temperature effects were measured, and where precipitation enhancement was shown to occur.

The diagram below shows idealized air flow patterns in and around an urban area. In general, urban areas tend to stay warmer than rural landscapes throughout the year, so this pattern is much more consistent than those described earlier. The warmer air over the urban sections cause rising air and lower surface pressure. This in turn results in air flow into the city from surrounding rural areas. Aloft, there is a closed circulation, which includes descending air over the rural areas.

Mountain-Valley Circulation

Mountain and valley circulations develop in complex topography along mountain slopes. During the daytime (illustration 1 below), sunlight warms the valley floor, which in turn warms the air near the ground. Due to lower density, this air rises as a gentle upward-moving wind known as an upslope or valley wind. At night (illustration 2), this trend reverses. Cooler air at high elevations flows downslope into the valley, resulting in a mountain or drainage wind. This cycle is most prevalent during clear, warm weather with light winds.

Katabatic Winds

The term “katabatic” refers to downslope winds which are much stronger than typical mountain breezes. Many parts of the world experience katabatic winds, and a number of different local names for thses winds exist. The strongest katabatic winds are those with a significant elevation change from high mountain or plateau to low valley or plain; if air is confined to narrow valleys or canyons, speeds can be especially strong.

A few examples of katabatic winds are:

Santa Ana—east winds in Southern California
Chinook—along eastern slopes of Rockies (westerly wind)
Bora—northeast wind along the northern Adriatic (Yugoslavia)
Mistral—east wind in the Rhone Valley of France
Sirocco—southerly wind along the North African coast
Brick fielder—westerly wind along the eastern Australian coast

The diagram below shows typical pressure patterns and wind vectors during a Santa Ana wind event. The "Coho" wind (see Wind Storm chapter) is a local example of katabatic winds.