Western ocean climate in the eastern mountains?

Appalachian mountain-induced weather patterns are not as dramatic as in higher ranges such as the Rockies, but location in relation to the Atlantic Ocean and the Gulf of Mexico creates unique effects that give southern Appalachian weather an identity all its own.

by R. Kelly Coffey

A major characteristic of southern Appalachian weather is the large amount of precipitation we receive. Certain locations record the second highest annual rainfall in North America (after the Pacific Northwest), and even fit the definition of a temperate rainforest.

Rain is created as a result of the cooling of an air mass. For illustration, consider a glass of iced tea. The chilly glass cools a thin layer of air immediately around it, resulting in the condensation of moisture onto the glass itself because cool air cannot hold as much water vapor as warm air. In almost all situations, rain forms as a result of being cooled, i.e. whenever a relatively warm air mass is forced into the upper, cooler levels of the atmosphere. Thunderstorms form when hot, humid air near the earth's surface rises to much cooler levels of the upper atmosphere. As that mass of air cools, the moisture in the air condenses (like droplets on the iced tea glass), forming rain. Another example is the passage of a cold front. As a relatively cold, dry air mass plows its way across the continent, it forces warm, moist (& lighter) air to rise over the top of it at its "front." As the warm, moist air rises, it cools, moisture condenses, and torrential rain can result.

The western slopes

Mountain topography often enhances these processes. The basic way mountains affect weather is that they force air to rise higher and quicker than it would over a level area of land. More air is cooled to the point where moisture is condensed, and consequently, more rain is produced. Since overall wind patterns and the movement of fronts in North America are almost always from west to east, air masses rise on the western slopes of mountains, and western sides generally receive more rainfall than the eastern slopes. The air crests the mountain peaks from the west and descends the eastern slopes, warming as it descends. In the West, this process creates warm currents, called "chinook winds," on the eastern side of the Rockies. Although not as pronounced, this phenomenon can be felt in the eastern foothills of the Blue Ridge as well. Locations along the base of the escarpment (i.e. Wilkesboro, Lenoir and Morganton, in North Carolina) are notorious for oppressive heat in the summer. Although their lower elevation and latitude are major reasons for higher temperatures, the chinook effect is a significant factor as well; many days in the foothills see temperatures several degrees higher than towns at the same elevation and latitude farther east.

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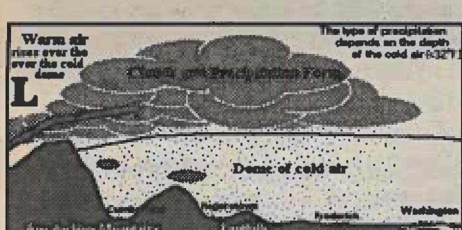
The eastern slopes

Given the west-to-east wind patterns in North America, the eastern side of mountain ranges are typically dry (the Nevada desert, for example, lies on the eastern side of the Sierra Nevada range). The proximity of the Atlantic Ocean and the Gulf of Mexico, however, moderate this effect on the eastern slopes of the Appalachians. The east-facing Blue Ridge escarpment, in fact, generally receives more precipitation than the western slopes. As low pressure systems move across the continent, the center of the low occasionally travels far enough south to be directly over the southern Appalachians. A low pressure center acts somewhat like the nozzle of a vacuum cleaner, drawing air into it from all directions. If a low pressure center is situated just west of the Blue Ridge, air is being pulled out of the south from the Gulf of Mexico, and out of the east from the Atlantic. When these moisture-laden currents hit the Blue Ridge escarpment, the air is forced up, resulting in heavier rain along the *eastern* slopes. (An interesting side note is that Asheville, being situated in a basin, is shielded from mountain-induced rainfall from both the east and the west, making it the driest city in North Carolina.)

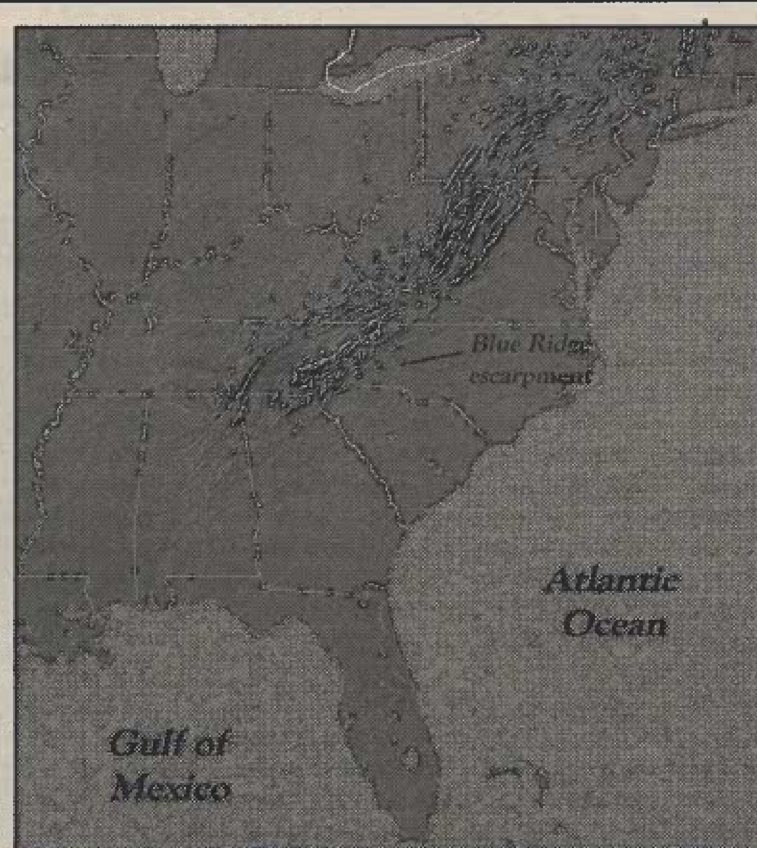
Another topographical feature makes this phenomenon even more dramatic. A relief map shows that the Blue Ridge in North Carolina is not uniform. The escarpment is somewhat wavy or scalloped, with extensions jutting out from the main ridge, creating bowl-like features (these features can be seen at several overlooks along the Blue Ridge Parkway, including Grandview near Boone). These bowls enhance the flow of moist air from the south and east, funneling it even higher, resulting in even heavier precipitation. I can personally attest to this weather pattern, as I live on the Blue Ridge and consistently measure more rainfall than locations just a few miles west (and occasionally receive rain when more westerly locations receive none). Precipitation from dying hurricanes (hurricanes are actually intense forms of low pressure) that cross the Blue Ridge is enhanced by the escarpment as well. In July 1916, remnants of two hurricanes — one from the Gulf and one from the Atlantic — merged over western North Carolina. The community of Altapass on the Blue Ridge recorded the highest 24-hour rainfall ever measured in the United States at that time (22 inches). Runoff from the Blue Ridge slopes in the Catawba River basin resulted in massive flooding, both in the mountains and in the Piedmont.

Dammed cold air

Listen closely to weather reports and you will often hear meteorologists refer to "cold air damming." The "dam" in this situation is the Appalachian Mountain range. At various times throughout the year, high pressure over eastern Canada pushes cool air out of the northeast and toward the west. The air encounters the Appalachians and, since the currents are generally weak, the air is unable to crest the Blue Ridge (although it occasionally spills over to some degree). The fact that the air is cool also means that it is dense (heavy) and thus tends to hug the ground. As a result, a relatively shallow layer of cold air spreads across the Piedmont while the mountain heights are actually above the layer, and record higher temperatures. If weather patterns are such that warm, moisture-laden air moves in over the cold layer and rain begins to fall, the mountains (located above the cold air) experience a normal rainfall, while in the Piedmont and along the eastern slopes of the Appalachians, the rain falls through the cold layer of air, freezes, and the result is a coating of ice at elevations below about 3,000 feet. The mountains can experience freezing rain as well, when cold currents are strong enough to push over the higher elevations, or if the cold layer deepens. But usually at least once a winter, the Piedmont experiences severe icy weather while the mountains remain untouched by freezing temperatures.



Mountain cold air trapped under clouds. Graphic courtesy NOAA/ Department of Commerce.



The east-facing Blue Ridge escarpment generally receives more precipitation than the western slopes. If a low pressure center is situated just west of the Blue Ridge, air is being pulled out of the Gulf of Mexico, and out of the Atlantic, resulting in heavier rain along the eastern slopes.

Blue Ridge fog

The Appalachian Mountains rank with two coastal locations — the Pacific Northwest and Canada's maritime provinces — as having the most days per year with fog. Although fog occurs throughout the mountains, it is notorious along the Blue Ridge front. Drive along a highway that climbs the Blue Ridge and you will see signs warning motorists of the likelihood of fog. Why is fog more prevalent along the escarpment? Upslope fog is a result of the temperature difference between the foothills of the Blue Ridge and the crest. Under certain atmospheric conditions, air in the foothills- being warmer and therefore more buoyant- will rise up the slope of the Blue Ridge. As it rises, it cools. When the air was at the base of the Ridge, it was holding a large amount of moisture, due to the fact that warm air can absorb much more water vapor than cool air. By the time the air mass reaches the crest of the Ridge, it has cooled to the point that it can no longer hold all the moisture it held at the base. This moisture is released in the form of fog. By this point, the air mass has lost its buoyancy and is unable to move farther west. The fog clings to the Blue Ridge until another weather system moves in.

Warm peaks, cool valleys

A familiar characteristic of mountain climate is that temperature decreases as the elevation increases. During the spring and fall, however, this situation often reverses. On clear spring and fall days, the sun quickly warms the earth to summer-like temperatures. Nevertheless, this heat quickly dissipates at sundown. Due to the thinner atmosphere, mountain locations tend to have a large diurnal range in temperature (the range between a daily high and a daily low), a characteristic more common in desert areas. As the land surface cools, the heavier cold air descends and collects in the mountain valleys, while the air that remains warm rises and forms a distinct layer at the higher elevations (bikers ascending or descending can easily detect the often sharp boundary between the two layers). As a result, hilltops and mountain peaks generally have a longer frost-free growing season than valleys just a few hundred feet below. This phenomenon has not been lost on mountain fruit growers, who long ago discovered that they could protect apple blossoms from late spring frosts by simply planting the orchards at higher elevations.

Dynamic and diverse

The overall climatic pattern in the Appalachians is similar to certain coastal locations. The standard, worldwide Koppen climatic classification system, in fact, classifies the southern Appalachian climate as "marine west coast" (the same as western Oregon, Washington, and British Columbia), even though the mountains are obviously miles from large water bodies. Southern Appalachian weather is dynamic and diverse, often surprising, but never dull.