2016

# Adiabatic Cooling and Warming

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In order to understand how deserts form one needs to understand two processes called **adiabatic cooling** and **warming**. In order to perceive adiabatic cooling, consider a highland ridge oriented transverse to the prevailing moisture-bearing wind, the **windward** side of the ridge. Picture a volume of air at the base of the windward side of the highland. It is affected by two sources of energy, heat and pressure with "H" being the amount of heat contained within the air as measured by the temperature, "T". The pressure, "P", is the atmospheric pressure which at the base of the highland is at a max. In order for the mass of air to cross the highland, it must rise. As it rises, it expands as because it is being affected by a constantly decreasing atmospheric pressure. The first question to arise is "where does the heat come from to cause the expansion? The answer is that the energy used to cause the expansion comes from the heat contained within the expanding volume of air. As the heat is removed to cause the expansion, the rising volume of air undergoes what is called **adiabatic cooling**. Consider that the mass of air rises, the temperature drops below the dew point, the temperature at which moisture within the air reaches a concentation of 100% and must undergo precipitation, as rain if the dew point is above $32^{O}F$ or $O^{O}C$ and as snow or ice if the temperature is below $32^{O}F$ or $O^{O}C$. You may have experienced the effects of adiabatic cooling during a hike where you begin your trek in a warm, moist valley and note the decrease in temperature as you begin to climb the ridge. As you climb high, the air continuously cools. Depending on the elevation at the summit of the ridge, by the time you reach the crest, you may have had to don various combinations of sweaters and coats.

When the volume of air reaches the elevation at which it will cross the highland, the volume of the air mass is as large as it will get, the atmospheric pressure, moisture, and temperature of the air are all as is as low as they it will get. The cool, dry air then crosses the highland and begins to descend on the leeward side of the highland. As the volume of air descends, the air encounters increasing atmospheric pressure that causes the volume of air to decrease. As the mass of air deceases, the heat originally used to cause the expansion of the air on the windward side of the highland is returned, warming the descending air on the leeward side. This process is called **adiabatic warming**. When the air finally reaches the base of the highland on the leeward side, it is warm and dry. The land

on the leeward side of the ridge is said to be in the rainshadow of the ridge. Note as a result of the process, most of the moisture, be it rain or snow, falls on the windward sides of ridges while the dryer air bathes the leeward side. If the air is warm and dry enough, it will form what is known as a rainshadow desert. Adiabatic warming and cooling need not result in the formation of a desert. If the remaining amount of moisture upon reaching the leeward side of the highland is sufficient, it may simply result in a change in precipitation and subsequent vegetation between the windward and leeward sides of the highland.