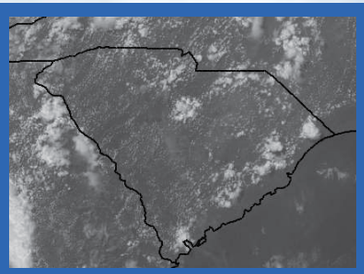
SEA BREEZE: SCIENCE AT THE BEACH

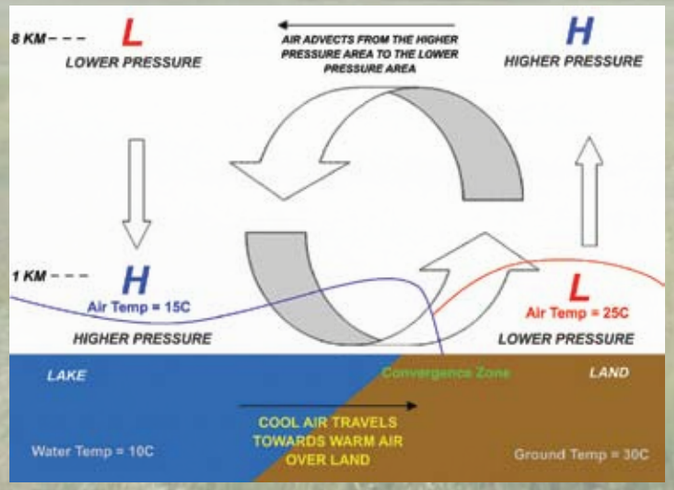
You are enjoying a warm, sunny day at the beach. By mid-afternoon a wind whips up off the water, the air becomes cooler, and large, towering cumulus clouds menace the skies inland from the beach. These clouds darken, then the crack and rumble of thunder soon send you and other beach visitors scurrying for shelter. Your day at the beach quickly comes to an end. Why? Atmospheric thermodynamics has the answer which is not very complicated and requires no math.

All materials, liquid, solid or gas, have a unique physical property called specific heat capacity. Specific heat capacity is nothing more than the amount of heat required to raise the temperature of a fixed mass of the material one degree Celsius. Land (dirt, rocks, sand, and soil) has a significantly lower specific heat capacity than water, thus it heats up more rapidly than nearby bodies of water when the same amount of sunlight is applied.

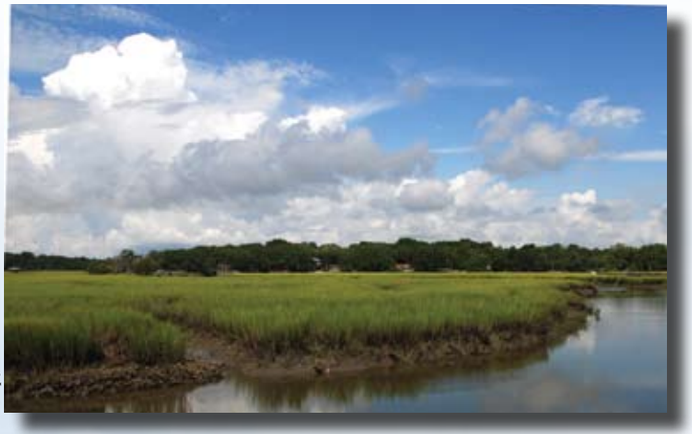
Back at the beach, in the morning, when temperatures are at their minimum, air pressures over water and the adjacent land are equal. When the day's heating by the sun reaches a maximum late in the afternoon, the air heats up over warmed earth and expands, causing the surface air pressure to decrease. Over water, the surface air pressure did not change because the high specific heat capacity of the water prevented heating of the air over water. The air pressure over water would then be greater than the air pressure over land. This difference in pressure forces air to flow from high to low pressure on a circulating path that has cool, moist air flowing off the water onto the beach, rising over the heated land behind the beach, forming clouds and thunderstorms. At the top of the clouds, the rising air has released its water vapor and cooled. Cooler and unable to continue higher, the air finds itself at a higher pressure than air back out at sea at the same altitude. This elevated, reversed pressure gradient forces the air back out over water, where gravity helps complete the circuit back to the surface where it repeats the circulation.



Coastal clouds form by afternoon sea breeze.



The sea breeze is the surface part of this circulation–the cool, moist winds off the water late in the afternoon, or the on-shore breeze. The sea breeze is most common in the tropics and lower latitudes where the sun's heating is greatest. Sea breeze winds are usually 5-15 miles per hour, but some hilly coastlines have 25 mile per hour sea breezes. The average sea breeze penetrates inland only 10-20 miles. Florida has the most dramatic sea breeze in the United States, firing off like clock work in the afternoon during the summer. The summer Florida sea breeze is notorious for causing very strong thunderstorms that produce dangerous lightning and large hail. Along the California coast, the sea breeze arrives on shore bringing a thick layer of fog. Sea breeze and its inland cousin, the lake breeze, are generally weaker at higher latitudes. The afternoon sea breeze, particularly in the tropics, is an important forcing mechanism for producing rain over what would otherwise be rocky, arid tropical islands. Topography can enhance the sea breeze, forcing the moist winds upslope and increasing the amount of rain that falls.



Phillip Jones

As night falls, land cools faster than offshore waters. This cooling increases the surface air pressure overland making it higher than the surface air pressure over offshore waters. This reversed pressure gradient forces the surface wind to flow from land out over coastal waters in a reversed sea breeze circulation commonly called a land breeze. The land breeze circulation is generally weaker and more diffuse than the sea breeze. Little or no rainfall is associated with the weaker land breeze as the atmosphere is more stable at night and the surface air over land is dryer.

Phillip Jones

South Carolina has a variable sea breeze that is highly dependent upon daily heating and the strength of the prevailing winds. Eight to ten mile per hour southwest winds will cancel out the afternoon sea breeze along the coast. The sea breeze in South Carolina frequently produces afternoon showers and thunderstorms. The South Carolina sea breeze also interacts with other weather features to create severe weather. On July 6, 2001, the afternoon sea breeze collided with a strong cold front, triggering at least one, possibly two, tornadoes that touched down in Myrtle Beach.

—Source: Wikipedia