Weather Phenomena – Video Tutorial

Now that we have an understanding of overall climate, let's look closer at specific weather phenomena, starting with fronts: warm fronts and cold fronts. When warm air moves into an area already occupied by cold air, the warmer, less dense air gradually rises up and over the cold air. During this gradual ascent, the air cools and loses it moisture over a wide swath of ground. A good indication that a warm front is coming is when you see high clouds coming, with progressively lower and lower clouds behind them.

When cold air is the one advancing; and warm air is already in the area, the cold air will shove its way under the warmer air. The warmer air gets pushed upwards rapidly. That makes the air cool and lose its moisture in a very narrow belt of intense rains. The rapid upward movement of the air can also rip electrons off the gas molecules in the air and generate lightning.

A **sea breeze** is wind that originates from the sea and moves onto the land. Why? Higher pressure over the ocean than on the land. This is typical when the sun heats up the land and ocean simultaneously, but the low heat capacity of the land allows it to raise in temperature much faster and higher. The air above heats up from conduction and radiation, and it rises, sucking in the air that was colder and denser and higher in pressure over the ocean. Note: we also call a sea breeze an **onshore wind**. A **land breeze**, or **offshore** wind, is one that moves from the land towards the ocean. It is caused usually at night, when the low heat capacity of land causes it to drop its temperature quickly, meaning the air over the oceans is warmer, lower in pressure, and rising, while that over the land is sinking.

In California and other Mediterranean climates worldwide, prevalent westerly winds bring in cool, high-relative-humidity air masses that collide with and are pushed up inland mountains. Our mountains, the Sierra Nevada, act as a barrier, forcing the air to climb to areas of lower pressure, where the air expands and cools and loses its moisture. The western side of the mountains receive a lot of rain. And when the now-mostly-dry air crosses over the crest of the mountains, it then sinks down the opposite side, where it contracts and warm under higher pressures. Its relative humidity is close to zero. Its capacity for water is high because it's so hot. Evaporation reigns supreme, and we get what's called a **rainshadow desert**. Those of you who have traveled to Hawaii have seen similar climate zones associated with the windward (northeastern) side of the islands that are directly hit by the northeast trade winds as they move equatorward. These are the wet sides of the island. The opposite sides, the leeward sides, are much drier.

The proximity of the ocean to the land on the coast of California helps moderate its temperature by acting like air conditioning. The breezes that come across the ocean evaporate water and cool off. They then collide with the coast and cool the coastal land. In the winter, they do the reverse. They warm the land and keep it from getting too cold. That's thanks to the high heat capacity of the oceans, which keeps its temperature about the same year round. The land nearby benefits from this high heat capacity. Without the nearby water, like in Death Valley, the low heat capacity of the land causes huge, unmoderated fluctuations in temperature, from warm summer with temperatures as high as 120 °F to cold winters where it gets below freezing and snow falls.

What about hurricanes? What are they? By definition, a hurricane is a low-pressure tropical storm system in which the winds surpass speeds of 112 kilometers per hour. You'll remember that to get wind speeds this high, we need to have a really large pressure difference. That means we need a REALLY low pressure system to develop, which means REALLY low density, which means HOT AND WET air – and that's why hurricanes form in the tropical oceans.

Hurricanes can extend over 600 km wide with a center, or eye, about 50 km wide. Because they are low-pressure systems, they exhibit the counter-clockwise (or cyclonic flow) in the northern hemisphere. The motion is clockwise in the southern hemisphere, because the leftward deflection causes winds to be deflected to the left of the low pressure as they are sucked in. What happens if these storm systems head toward the equator? The coriolis effect weakens, and the storm peters out. Hurricanes can NOT cross the equator. Instead they usually get pushed by the trade winds until they collide with land. Once they do, their primary energy source (the latent heat of evaporation of water) disappears, and they also peter out. But not before flooding the land with a massive **storm surge** – a dome of water that the low pressure system has sucked up and carried along with it.

This picture shows the path of a hurricane that moves north along the eastern US coastline. You'll notice that the air is moving in a counter-clockwise motion around the center, where mostly air is rising. However, you should also notice a small eye in the center, where air is sinking. The rising air brings rain, of course. The sinking air should be cloudless. Why both? With all the rising air in the center of this massive low pressure system, there will be a huge pileup at the tropopause. Some of it will migrate ouwards along the tropopause, but some also gets shoved down in the center.

Here is an image of hurricane Katrina on August 27, 2005 as it heads toward Louisiana. Notice the extremely warm sea-surface temperatures that are fueling this storm. Imagine what the residents of the gulf coasts would have experienced when this hurricane hit land – first the winds stronger as the center of the storm approached and accompanied by more and more rain. The storm surge is carried onto the land, and the coastal regions are flooding. Then, when the winds and rain are at their worst, the eye hits, and there's a short moment of calm. However, you are also now under the extreme height of the storm surge, and coastal flooding is happening. Then from calm to chaos, as the winds and rain come back fiercer than ever but in the opposite direction. Then gradual diminishing of rain, wind, and coastal flooding until the hurricane has dissipated. If you live in a coastal area with regions that are normally below sealevel, like parts of New Orleans, it can be weeks before the storm surge waters can be pumped out.

This picture shows the common paths of hurricanes, as they are pushed by the Trade Winds. Hurricanes are also called cyclones in the Indian Ocean, and Typhoons in the southwestern Pacific.

Pause now.

[End credits]

Air-Sea Interactions Series:
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Part IV: Atmospheric Circulation
Part V: Weather Phenomena

Weather Phenomena
Geoscience Video Tutorial
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