Earth's Rotation Influences Ocean Currents Transcription

I'm going to talk about a little bit more on how the wind-driven circulation works, and how the rotation of the earth influences ocean currents. That is a very important thing. This is a similar schematic. Just to remind people it shows the surface pattern of the general average schematic pattern of surface winds, and the associated vertical circulation. Generally winds on the earth follow these patterns.

The trade winds generally blow from the northeast to the southwest. In the mid-latitudes you get mainly westerlies which generally blow from the southwest to the northeast. Then you get a polar vortex that goes the other way around again. Between those [you have vertical exchanges. Especially this one here, the Hadley cell, which I mentioned before has a rising wind right near the equator, where you get a lot of precipitation which is a rising mass of moist air. You lose all that moisture when you bring very dry air over here.

The wind has an influence on the ocean. As you can imagine there is a [?], and that transfers energy from the wind field to the ocean. This is just another representation. You can see here that the left one is a more schematic representation. The right one is getting a little bit more realistic in terms of we see these weather systems. Or weather system. These are rather stationary high and low pressure systems that are then as you know overlay actual weather systems. I'm going to talk about that a little later.

OK. Let's take a little time to explain this. Basically the wind blows over the ocean surface. Many people would think that the water would actually be blowing in front of the wind, but it actually doesn't. Due to the rotation of the earth, the current vector rotates more [like a step?], and forms this Ekman spiral until the influence of the wind decays at a certain depth depending on the wind stress. The really exciting part about this is if you integrate the transport throughout this Ekman layer you will always get a transport which is 90 degrees to the right of the wind stress in the northern hemisphere. In the southern hemisphere it goes to the other side because you basically turn the other way around if you were standing on the surface.

I'm going to go back to that last frame. As you can see here in the subtropical high the westerlies generally push water to the southeast, and the trade winds push water to the northwest, which leads to an accumulation of water right in the middle of the subtropical high, as you can see here.

This is a really important concept. By piling up all that water you create a pressure gradient. The water wants to flow out of the middle of the Atlantic gradient to lower pressures and lower sea surface heights. Due to the rotation of the earth the current will do this twice. We're talking about the northern hemisphere. This won't be displaced until we reach an equilibrium at least for large-scale flows. I'm talking about features that are way larger than 100 kilometers, so basin scale features. This relieves the equilibrium as the pressure gradient forces bows to the Coriolis force. Wind and ocean currents both obey the same laws here, will follow the lines of constant pressure. If you see a high pressure system on a weather map, the wind we'll always run parallel to the isobars, the lines of constant pressure, and it will circle clockwise around the high pressure system, and anticlockwise around a low pressure system.

If you look at the circulation up in the North Atlantic, this basically creates the large-scale gyre-scale circulation in the North Atlantic. You have a high pressure system over here, as I showed before. This is a little more realistically shown. Generally the currents follow the same pattern.

You can measure the pressure gradient at the surface. It's determined by the sea surface height. What this means is you measure the height of the sea surface and you compare it to the height that the water would have if there would be no motion in the ocean. As you can see here you have this bump or mountain. This is highly exaggerated of course. This is on the order of meters over the whole Atlantic Ocean, but you can see here that you have the mountain underwater, and it generally flows around like this.