What Is a Coupling Process and How Is It Related to Climate? Transcription

The other element that is important to understanding the relationship between ocean salinity and ocean circulation is the coupling between ocean salinity and the water cycle. What the water cycle is here is basically the balance between rainfall and evaporation over the ocean. What I'd like to do is open up this one here. No this is not the one I wanted to open up, let me go back. Take this one here. We're going to look at the video clips.

I am just going to play a little bit an animation of rainfall data from satellite measurements here, just to give you an idea of what rainfall over the ocean looks like. These green and yellow areas here that you see over Central America are rain showers. The rest of the ocean is colored blue here is basically clear atmosphere, so there's not that much rain going on.

So as I play this video you see the rainfall is very dynamic, and it's moving, and it's actually concentrated in smaller rain cells. The rainfall doesn't really fall in broad swaths; it's isolated in storms. You can see a hurricane here off of Baja California in this particular video. The point of this is that precipitation over the ocean is very uneven. It doesn't just rain generally over the ocean, but there are isolated storms and squalls that move around all the time. So it maybe raining somewhere for 5 or 10 minutes, or maybe an hour, a half hour, and then the rain will move on and it will clear up and there won't be any rainfall.

So it makes it very difficult to actually secure actual measurements or estimates of rainfall because the rainfall is always forming and dissipating and moving around. What the ocean does is act like a rain gage. It collects all of the rainfall that falls onto the surface. Over time, if you have an excess of rainfall or evaporation, you'll see the salinity change over time. It will begin to grow less and less if it is raining more than it is evaporating because the rainfall dilutes the salinity at the surface.

By measuring the ocean salinity, and taking into account the effects of ocean currents moving saltier and fresher water around, we can actually come up with a balance of what the rainfall is over the ocean. We can use that to check the rainfall measurements that we get from satellites and from numerical weather models and other sources of information of rainfall over the ocean, and really do a better job of understanding the amount of rain that goes into the ocean and how much is changing, how much is going out by evaporation. It's an important process because the surface salinity of the ocean is really determined by the difference between rainfall and evaporation.

The areas that are experiencing the most evaporation are the areas that have the highest salinity. The reason why the Atlantic Ocean is saltier than the Pacific Ocean, like I explained earlier, is that there is much more water being lost from the surface of the ocean to the atmosphere than returns either in the form of rainfall or river runoff. Even though most of the largest rivers in the world run into the Atlantic, the Atlantic still has a freshwater deficit, and that's why the surface salinity is higher there than in the Pacific.

So again, there is a very strong coupling between rainfall and evaporation, the global water cycle, and the ocean's surface salinity. And these in turn are then coupled to the ocean circulation as I described earlier. So if you can imagine a scenario where there are some changes in the atmosphere where rainfall patterns are changing, let's say in parts of the Atlantic Ocean we're getting less rainfall in this subtropical Atlantic Ocean which is something that we've observed over the last twenty or thirty years.

That's going to change the salinity of the surface waters. The salinities are actually increasing in the central North Atlantic Ocean. That's going to affect the density of sea water. That's going to affect the ocean's circulation. That's going to affect how the ocean moves heat from the equatorial regions to the poles. That's going to affect how the heat is delivered to the atmosphere. That's going to cause the atmosphere to change, and that's going to change the rainfall patterns, and that in turn will affect the ocean circulation. So we're looking at a very complicated coupled system between the ocean and the atmosphere.

The importance of measuring the salinity from the satellite is that we will be able to study these processes for the first time. All the historical data that we have collected from ships and buoys over the years has given us a general idea of what the average salinity of the ocean looks like, but it doesn't tell us anything about how it varies from month to month, or from season to season, or from year to year, or as we see changes in rainfall patterns or hurricane storm tracks from one year to the next, and other things.

So the importance of the Aquarius measurement is really to understand these coupling processes between the ocean and the atmosphere so that we can get a better handle on the linkage, the coupling, or the interaction between the water cycle, the ocean circulation, and climate variability. That's one of the core science objectives of making the Aquarius measurement.