# Rain At Sea Has Consequences for Global Salinity Transcription

So the next one is just kind of the anatomy of one of these events as we're coming to the end here. The upper panel is temperature in the upper 15 meters as a function of time. This is just over the course of about half a day or so. You can see one event here maybe half a day long. The upper panel here, the top one, was rainfall measured from the TRMM satellite. Let's follow along the rainfall. You can see here around 2 o'clock, 0200, it starts to rain. The rain gets a lot bigger around 10 o'clock GMT, and peaks at about 12 o'clock GMT, and then decreases.

If we look at the temperature of the ocean, that's the middle panel here. You can see just around 10 o'clock GMT that day when the rain really got big the ocean turns yellow there. Yellow, from red to yellow, means that the temperature is going down. So that rainfall was cold, and it cooled the ocean. As the rain continues there through noon you can see now the ocean gets a lot colder. It's actually a couple of tenths of a degree colder.

Moreover you can also see that that rain signal is penetrating down from the surface, down as far as 10 meters into the ocean. That rain signal continues up to around 1900 GMT, and then it kind of goes away. You can see that there is a little bit of penetration of that rain signal all the way down to about 15 meters where it gets slightly colder, but mostly by 2200 GMT it's all gone.

What we're interested in is the bottom panel here which is salinity. You can see very much the same thing. When the rain gets started around 900, 1000 GMT, you can see the salinity decreases, and then it continues to decrease as the rain continues. We're talking a change here of .1 or so salinity units, and you can see eventually that penetrates all the way down to 5 or 10 meters. By 1500 or so GMT the rain has stopped, but the salinity is still low around 10 meters. If you go out to 2200 GMT you can see a hint there that that fresh signal has penetrated all the way down to 15 meters before it goes away completely.

The rain squall came through. The whole thing took less than 12 hours to evolve to the point where you can't even see it in the ocean anymore. Yet, well you may say that's nice, what do we care about events like that? That's the whole picture of how ocean salinity gets set. Remember I said that somehow all of these things have to come to equilibrium; this is one of the ways this happens. We're putting fresh water in. How do we keep the ocean from getting fresher? How does it stop getting fresher here? That fresh water has to go somewhere, and it probably diffuses via turbulent diffusion down deeper and then perhaps evaporation will cancel it out.

We've never been able to see things like this before, but these floats and all of the other things in SPURS are allowing us to do this. Now we have maybe 50 instruments like I said over the world ocean. So we got lots of events like this. We have a whole catalog of things like this. This figure was put together by a graduate student, Jesse Anderson, who I'm working with. Jesse has cataloged many many events like this over the world ocean.

Now that we have so many we can begin to look at detail at them. What is the real mechanism whereby these surface properties penetrate into the deep sea and help maintain this large scale equilibrium? We've gone from skin to deep. Here's the skin, but the skin is what determines the deep. We just don't quite know how it does it yet. One of these days with enough data like this we'll be able to do that.

Just as a final thing here, we're talking here kind of a simple one-dimensional model for our concept here. Things come to the surface; they diffuse down and get into the deep sea. But if you looked at the motion you'll find that the ocean is a lot more complicated than that. It's really three-dimensional. This is a plot of many of the floats that we put out in the SPURS area over the course of a half a year or so. You can see that these red circles here are where these floats began. It's kind of on a grid, almost a grid. The red stars show where they were 6 months later.

You can see here the motion is rather complicated. This is horizontal motion, but you can see here these floats are moving in some complicated way indicative of just how turbulent this whole fluid is. So these simple ideas that I've been foisting on you on here is a good way to be thinking about this. The real ocean is three-dimensional, it's turbulent, and it's more complicated than these simple ideas probably are. This is the flow at 1000 meters where these flows spend most of their time, but if we were to look near the sea surface which is where the rain events are, we would find this is even more complicated than it appears here.

The final picture here is one some of you may have seen before. It is kind of a movie of what this might look like in the horizontal. It is called *The Perpetual Ocean*. This is a movie of ocean circulation made from a computer model, the sea surface. You can see just how turbulent the ocean is here. In this case you can see the Gulf Stream going up the coast of Florida. It goes out to sea, it sheds eddies. Up near the Gulf Stream the flow is highly energetic and eddified, but if you look out even in the SPURS region you can see that everywhere there are eddies near the sea surface; it's turbulent, and it's this turbulence in the horizontal coupled with this stirring in the vertical, and these squalls, these rain events and evaporation that really we have to study to look at the world ocean and salinity.

Salinity is important because it tells us something about the hydrological cycle, the water cycle. It's also important because it determines the density of sea water along with temperature. If we really want to understand ocean circulation we need to understand salinity. Now for the first time they're really getting a good view of it with using modern technology.