Sea Surface Salinity and the Freshwater Cycle Transcription

We have the precipitation, and we have the evaporation, mainly contributing to the fresh water cycle. What I want to give you an idea of is that these precipitation and evaporation are happening on very fast time scales compared to the salt cycle. So the salts are put in on geologic time scale, whereas if we think about precipitation events we know that precipitation events are happening on hourly, daily, weekly, monthly time scales, and the same thing with evaporation. Together between the salt cycle and the fresh water cycle is those two combined are responsible for the sea surface salinity. But the salt cycle is very slow, and the fresh water cycle is very fast.

When we think about sea surface salinity, and sea surface salinity is measured as the parts of salt per thousand parts of sea water, any change to that is really because of the fresh water cycling through the system, not because of the change in the salt. So what I want you to think of is that the salts that are distributed throughout the global ocean are changing the amount of salts on geologic time scales; we have a very rapid turnover of the fresh water. It's raining over the ocean, it's evaporating, clouds are carrying it back to the land where it's raining, and then that's carried to the rivers. I'm going to be talking about the Aquarius data and the measurement of sea surface salinity, and just keep in mind that sea surface salinity is really changing because of the evaporation and precipitation.

Really to make that clear, here is the talking about the water cycle and its impact on increasing and decreasing surface salinity. You'll notice that none of these involve anything about the salts. The salinity changes are just due to the changes in fresh water cycling. So if there is precipitation, or river runoff, or groundwater inflow to the ocean, or the melting of ice, all of those are fresh water inputs; so there is a decrease in salinity. But then if we have a fresh water deficit by the evaporation of sea water or the freezing sea water, that increases the salinity.

I mentioned earlier that primarily we are interested in evaporation and precipitation. If we look at a map of the total of evaporation and precipitation over the globe, and this is averaged over the course of a year—let me just see if I can bring the map up (maybe not, but here's the scale over here). So what we're looking at here, this is a map of evaporation minus precipitation. So wherever you see positive values, that's where evaporation exceeds precipitation, and wherever you see negative values, that's where precipitation exceeds evaporation. What I mentioned earlier, when you look at that global map and you saw the precipitation, you saw the strong precipitation around the equatorial belt, and then you saw that there was strong evaporation in these subtropical belts.

That map of evaporation minus precipitation largely creates this map of sea surface salinity. This global map is largely dictated by those two processes. The sea surface salinity then comes about primarily because of the fresh water cycle. The questions that we are primarily interested in sea surface salinity currently, unlike the questions [?] asked because we got those answered 900 years later. I'm just calling out these three questions about what we are interested in now about sea surface salinity and its role in climate. We are particularly interested in understanding how the ocean surface salinity is changing in response to climate variability and climate change. We're interested in whether the area of

ocean desert, and that's where there is really strong evaporation and not much precipitation, if those ocean deserts are expanding or contracting in time. We're also interested in understanding the spatial extent of seasonal variability and salinity due to ice melt.

These are just some of the questions, but I do want to point out that there was a very interesting article that just appeared in Science last Friday. You'll see the title that's here, *Ocean Salinities Reveal Strong Global Water Cycle Intensification During 1950 to 2000.* This paper, you can look at it later, talks about the intensification such that over the past 50 years drier areas have become drier, and wetter areas have become wetter. And so they are looking at how this information over the past 50 years will project on into the future as we expect more climate change. If you are interested, you may want to go back and look at that paper, but I wanted to highlight that, because it is really showing how the fresh water cycle is very important. The analysis that was done for that paper was done using sea surface salinity.