

How are Humans Affecting Ocean Salinity?

Transcription

We'll probably go through this one a little more quickly. This particular module asks the question; How does the understanding of salinity help us to understand climate change, both natural and human induced. First of all, our choices are, climate variability is caused by human activities, or climate variability is caused by natural phenomena. The scientific consensus is pretty broadly accepting of the idea that both of course are very important. Human induced changes are probably longer term, gradual changes natural variability occurs on all kinds of time scales.

Just going to the next piece of this here, human induced changes have a lot of effects on the land and the atmosphere, and potentially on changes to the water cycle. What I'd like to do is skip over this part here and just get to the ocean right away. Let me just open up this one here; there is something I wanted to show you. There are a number of things happening in the ocean related to climate change.

Just let me show you this one record here. This is one of the highlights of accomplishments that we made in our remote sensing program over the years is to measure the changes in sea level from satellites. This is only indirectly related to Aquarius, but it is an important aspect. This is a graph of sea level from the late 1800s all the way up to the present time. This black curve here is reconstructed from tide gauges and sea level measurements from coastal stations and islands and so forth from around the world. These records are not all continuous, and there's a lot of problems in trying to reconstruct the global sea level measurement from that. But this red line here that you see over the past 18 or 19 years or so is the record from satellite altimetry. You can see that the satellite altimetry itself is basically giving us the same slope that we recorded from sea level gauges in the past. It shows that the sea level is changing about 3 mm. a year. That's actually a pretty substantial rate of sea level change. It's about 30cm. per century. We expect that to start to accelerate over time.

The sea level is rising for two reasons. One is that the ocean is warming, and as it warms it expands. So you get some sea level rise just due to the expansion of sea water. But the other cause of sea level rise is that this fresh water from the ice sheets, from alpine glaciers, from the land, is now working its way back into the sea, and that's causing sea level to rise. The best estimates are that 50% of that is coming from melting ice, and 50% of it is coming from the thermal expansion of sea water.

The ice is an important factor, and I'm going to go to this other module here, because we detect over the last 15 or 20 years a shrinkage in the sea ice cover over the Arctic Ocean. There are a whole bunch of curves in this figure here; I'll just touch on them briefly. This is the summer season in the northern hemisphere, July through November. This curve is the average sea ice cover in terms of the area of the Arctic Ocean covered by sea ice. Starting in July you see that it decreases and reaches a minimum in September and then it increases again as it starts to freeze over for the following winter.

This gray area here is the average from 1979 to 2000. In the decade of the 2000s we see a drastic drop in the area of the Arctic Ocean that is covered by sea ice. That's shown in these curves. The minimum was observed in 2007 which is the lowest sea ice cover we have ever seen in the Arctic Ocean

in recorded history. You can see from the 1970s all the way through to the late 2000s there's been an enormous reduction of sea ice cover in the Arctic Ocean.

Well, the production of sea ice is an interesting process. When sea water freezes it squeezes salt molecules out of the sea water, so the frozen salt water is actually a lot less salty than the sea water it is frozen from. And that extra salt that is squeezed out just stays in solution in the water; it increases the salinity of the water underneath the ice, and causes it to sink to the bottom because it is more dense. When that sea ice melts it leaves a pool of fresh water on the surface, and the waves will blow that fresh water out of the Arctic Ocean towards the Atlantic Ocean, and it will begin to affect the salinity of the North Atlantic Ocean. So the sea ice processes that are going on in the Arctic will have an impact on ocean salinity, and it will have an impact on ocean circulation.

Let me see now, I want to close this one and go back to another figure. The other one I wanted to show you here is another factor about climate change in the ocean which is indirectly related to what we're measuring with Aquarius. This is a map of changes in the pH of the ocean. The pH—if you remember your chemistry—is the acidity of a solution, in this case sea water. What we're finding out is that the ocean is becoming more acidic. The pH is dropping. The reason it's dropping is because carbon dioxide that we are putting into the atmosphere because of the burning of fossil fuels, is being dissolved into the ocean.

Basically, when carbon dioxide is dissolved in sea water, it forms carbonic acid. It's an acid, and it's changing the pH of sea water, and making the ocean more acidic. As time goes on, as we burn more fossil fuels, we'll put more carbon dioxide into the atmosphere, about a 1/3 of that carbon dioxide that we produce by burning fossil fuels ends up back in the ocean. It's causing the ocean's chemistry to change. That's having an impact on sea life. It's causing shells of marine organisms to start to dissolve. It can interfere with the primary production of plankton that's growing at the surface of the ocean, which is the basis of the food chain.

What this has to do with Aquarius is that there is a secondary piece of science that we want to do with these salinity observations because the rate of flux of carbon dioxide from the atmosphere to the ocean depends on the chemistry of the sea water. And one element of the chemistry of the sea water is called the alkalinity of the sea water. The alkalinity of the sea water is proportional to salinity. Scientists will be able to take the salinity data that we measure from Aquarius, and get better and more accurate maps of the alkalinity, and use this information to predict more accurately the fluxes of carbon dioxide between the atmosphere and the ocean, and help us better understand how that impacts on climate change.