How Do We Define Salinity? Transcription

So let's talk about the idea of salinity for a moment. What do we mean by salinity? Again anybody who has ever taken a swim knows the ocean is salty. That salt that you taste is mostly sodium and chloride ions. In fact every one of the 92 naturally occurring elements are present in sea water to some extent, most of them in vanishingly small extents, but here in this table are the top ten or so ions that are present in sea water. You can see that the sodium and chloride together are something like 80% by weight of all the dissolved stuff in sea water. Then there's these other things there that exist as well.

Now when we're talking about salinity we're not just talking about sodium and chloride, we're talking about everything. The beauty of this whole idea is the concept of salinity involves all of these ions, and the salinity varies from place to place. The amazing thing is that these ions are in almost constant proportions in most of the world ocean, which means no matter what the actual concentration is if you just measure one of these ions, you can infer what all of the other ones are from that.

You can see here in this table that in a kilogram of water about 34 grams or so, in this case 34.482 of those grams is dissolved salt that we call salinity, and the rest of it is the other 965 or so grams is freshwater. So when we're talking about salinity, we're talking about this number here at the bottom 34.482. How many grams of stuff is dissolved in this kilogram of sea water, and this stuff is mostly sodium chloride but it's all these other things too that come into the ocean via runoff mostly. It could come in also just from the internal chemistry of the ocean, the dissolving of biological things, the sediments from the bottom, and of course runoff from the land. That's how these things get into the ocean.

The next one is just a similar version of the same thing. If we had a kilogram of sea water there on the left, the blue represents the water part which is most of it. But of that kilogram, a thousand grams, 34.4 grams in this case is the red slice there. You can see what's in that. Again most of that is sodium and chloride ions, but there are other things in there as well, the major constituents of sea water.

Now historically, if you look at observations of the ocean going back 100 years it's amazing how many observations temperature there are going back a century. In fact even Benjamin Franklin in the 18^{th} century made some observations of the ocean in the Gulf Stream and collected some temperature data. There was useful temperature [data] even going back that far occasionally. But salinity is much harder to measure; you can sort of see why, even though it's a very basic quantity. Temperature historically you could measure it with a thermometer. Now you can do it with a thermistor which is a fairly low-tech device.

But salinity you have to actually measure what's in this water, and traditionally that meant you had to do wet chemistry. So you actually had to titrate samples of sea water to figure out how much of this dissolved stuff there was, and if you can imagine on a rolling ship in bad weather how hard that must have been to do, then you can see why historically there was not nearly as much salinity measurements as there were temperature.

In recent years we learned that we don't have to do titrations no more, we can measure salinity just by measuring the electrical conductivity of sea water. As soon as people figured out how to do that the number of good salinity measurements went way up. And as soon as we started putting them on Argo floats, which we'll talk about here later, the amount of data increased by an order of magnitude again. We're finally in a position here to say something quantitative about salinity, and why it matters, and what it can tell us about the ocean circulation.

Again, here's another slice through the water cycle, just what you might expect various things to do to salinity and to the ocean. So if we look on the left side here, how could you increase the salinity of sea water? Well you could do it by evaporation of course. You're always going to be losing some moisture from the surface of the ocean to the atmosphere. That would decrease the amount of water in some samples near the surface, but leave the salt to be the same because that salt doesn't evaporate, so the effective salinity would go up. Or you could do it by freezing. When you freeze sea water the ice phase will mostly take up water and leaves the salt behind, so in the surface water under the ice the salinity can get much higher just due to the salt being left behind.

On the right side here, how would you decrease salinity in sea water? Well you can runoff some water off the land; that's purely fresh water of course, so you would increase the amount of fresh water without changing the salt. Precipitation, either rain or snow, will do the same thing. It will add freshwater to the system without changing the amount of salt. Or you could just have groundwater, or the melting of ice is an important one. That ice that freezes and increases the salinity sometimes if it is seasonalized it will thaw, and then it will put all of that freshwater right back into the ocean and it will decrease the salinity to what it was before it was frozen.