Ocean Thinking: Balanced Budget? Oh, Buoy! _ Q & A Transcription

Note: Bold text in the transcript indicates questions from the audience. Non-bold text is a response from Tom or the moderators.

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Question: How hard is it to figure out a salt budget for an area? Is it harder or easier than figuring out where all the heat goes?

Tom: It's harder. There are a couple of aspects to that. First of all, it's much easier to measure temperature than it is to measure salinity. We've gotten a lot better at measuring salinity. You can use a thermometer or a thermistor, both of which are very cheap things. A thermistor is basically a resistor whose resistance varies as a function of temperature. It's very cheap, robust. So we've had a lot more knowledge of temperature in the ocean than of salinity in the past, and it's much cheaper. In those drawings that I showed are the different instruments, and the ones that measure temperature only are about 5 times more cheaper than the ones that measure temperature and conductivity. We really have kind of a shortage of information on salinity.

Then there are other things that make the budget harder to understand. It has to do with the fact that temperature is easily damped by the atmosphere. So if you have some spot in the ocean that is unusually warm, the atmosphere will absorb that heat, because you got this hot spot, and it's giving up heat to the atmosphere. The atmosphere doesn't care how salty the ocean is. There's no kind of natural tendency of the atmosphere to damp salinity variations. So you get these very strong gradients that can be supported in the surface ocean in salinity, but not really in temperature.

Another factor here related to the measurements is that NASA and other space agencies have been measuring temperature from space for decades. They've been doing it pretty well since the early 1980s. We're only now developing this capability for salinity measurements from space.

Question: Are there more cruises like SPURS planned in the future?

Tom: Yes. There are lots of oceanographic cruises going on; they're going on all the time. I'm involved in other field campaigns. We're going to the Bay of Bengal this fall in the northern Indian Ocean to study other phenomenon in the ocean. I can't put a number on it, but there are cruises going on all the time to understand the ocean, and different aspects of ocean physics and ocean chemistry and ocean biology.

Question: Could you just go over what the red and the blue mean here for these different boxes?

Tom: Sure. I kind of glossed over this. This is from a report led by Lisan Yu who works here at the Woods Hole Oceanographic Institution. She has been working on this product called OAFlux which stands for Ocean Atmosphere Flux. It largely relies on satellite measurements to make global estimates of the air-sea fluxes. Here she's showing the difference between this product that's derived partly from satellite measurements and partly from weather models and other information. The difference between that product and the buoy measurements for the evaporative heat flux is in watts per meter squared. Values kind of between plus and minus 4 watts per meter squared are in excellent agreement.

Our ability to measure air to sea heat fluxes is kind of no better than that. If we can measure it to a few watts per meter squared, than we're pretty happy about it. Disagreements of 20 watts per meter squared, that's not so good. If you wanted to think of that in turns of SPURS, I gave this number 1.5 meters a year evaporation. Well 20 watts per meter squared of evaporative heat loss is about 25 centimeters per year of evaporation. We're talking about a 20% error in the fluxes there. That's something you'd like to improve upon.

Question: Why are there so many of them in the equatorial Pacific area?

Tom: Sure. The short answer is because of El Nino. The scientific community and the public at large were heavily affected by the 1983 El Nino event. There have been a few big El Nino events; 1997-1998 had big impacts on the weather in the U.S. Those El Nino events and the global impact on the weather pattern stimulated monitoring efforts so we that can better predict El Nino. These moorings were originally put out by NOAA in the eastern Pacific. International partners joined the effort. Japan has played a big role in these western Pacific moorings. They have been there since the late 80s; this monitoring effort started up there. It has been really important to our ability to understand El Nino, and to make forecasts of whether an El Nino or La Nina event is occurring.

Question: Have you heard any news about how the buoy recovery is going on the current cruise?

Tom: Yes. It's a very big job. It's a big job putting them out. It's an even bigger messier job getting them back, because everything is coming back covered with barnacles. Some of the people in my research group have let me know that things have gone well. They haven't given me a lot of details, but I know why that is. It's because they got a huge mess on the deck of the ship. They've pulled in over a 100 instruments, and more than 3 miles of wire and rope. They're working hard to clean it up and start taking the data off of the instruments.

Question: How has the ocean salinity content been affected by freshwater from the melting of glaciers?

Carla: We had a similar question asked last week, but we're just kind of curious if you've run into any of that in your research into the flux that you are looking at.

Tom: It's a very complicated situation. The glaciers are melting and that contributes to freshening. But on an even larger global scale there's some evidence that the global water cycle—this is just the evaporation of water from the oceans and from land and lakes and rivers (this water evaporates)—really drives the global scale weather patterns; it's really water vapor in the atmosphere that's driving the global atmosphere circulation. The tropics get heated up and water vapor gets evaporated. That causes rising motion near the equator and lots of clouds and storms like tropical storms. The air rises and then it descends here, and then a lot of precipitation occurs in mid-latitudes with water that's been evaporated in other places.

It's a subject of active research. People have different opinions. There's a lot of evidence to suggest that the water cycle is actually intensifying. The places where there is a lot of evaporation like the SPURS region are getting saltier, and the places where there's a lot of precipitation like the high latitudes are getting fresher. It's a big challenge to untangle the contribution of melting glaciers from changes in the precipitation and snowfall and rainfall at higher latitudes.

There are a lot of different scientists working on small parts of this, trying to put it altogether into a consistent story. So the answer is not simple. I don't really have the answer.

Question: Could you just quickly go over the difference of what the sensible heat was and what the latent heat was?

Tom: Sure. This is probably the simplest way to look at it. Latent heat is this heat flux due to evaporation. It's called latent because it is a heat loss from the ocean because we're converting liquid water into water vapor. That takes heat. That heat is lost from the ocean. It's called latent heating because it's not immediately given to the atmosphere, because it's tied up in keeping that water as a vapor. That water ultimately condenses somewhere in the atmosphere, say to form clouds. When it condenses it's converted from water vapor back to liquid water, and that heat that was used to turn it into vapor is given up and it's released into the atmosphere. So that's the latent heating.

The sensible heat transfer is quite a bit simpler. A good example of sensible heat transfer is if you grab a cold glass of water and your hand gets cold; that is sensible heat transfer. It's essentially conduction of heat. If you touch something cold, your hand gets colder, and you're giving heat to the cold thing. Or if you touch something hot and your hand gets burnt, that is a sensible heat transfer.

Question: How does a person who grew up in Indiana decide to become an oceanographer?

Tom: Well, there are different ways to answer that question. I actually didn't know that you can study ocean physics. I was about to receive my bachelor's degree in experimental physics, and didn't realize that there was even a field studying ocean physics until someone from here at the Woods Hole Oceanographic Institution gave a presentation at the physics department where I was going to school. That just happened to be at the time I was filling out graduate school applications and I thought, Wow, ocean physics. That sounds pretty cool. I'll apply there too.

But on a more philosophical level there are actually a lot of oceanographers from the Midwest. I mean it's really uncanny. I grew up in southern Indiana, and I've met 3 kind of well-known oceanographers who grew up within an hour of where I grew up right there in the middle of America on the border of Indiana and Kentucky. I think part of it is that if you grow up almost never seeing the ocean, it just has a real draw when you are choosing a career. You think, jeez, I can go out on boats and study the ocean. That has a lot to do with it I think.