Dr. Thomas Rossby interview on Discovery of Sound in the Sea

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Interview Transcript

Q1
How did you first become interested in science?

"I grew up in a science environment. My dad was a well-known meteorologist and there were a number of people who came through our home over the years when they visited us, when we were growing up in Sweden. And so science wasn't something that I might look into from the outside, it was something that just surrounded me. Not so much my daily life as much as just the word science and what scientists do, with a limited picture I had or understanding I had, that was just going on all the time. So, being curious about nature, being curious about how the atmosphere works, was part of the conversation that went on. I also went to summer camp where the people were studying cloud convection, and so I saw the scientists work and I even got to take part in some of the measurement programs: writing down numbers and plotting them up and so forth. So, all of that was kind of part of my world. It didn't mean that I was going to be a scientist, by any means. In fact, I was much more interested in engineering kinds of questions, how things worked and so forth. But, I certainly was exposed to that kind of world when I was young."

Q2
What is the focus of your research and why did you choose this field of study?

"The focus of my research is very much the Gulf Stream and surrounging waters, no question about that. I have worked with other systems like the Agulhas current, which is a Gulf Stream-like system around South Africa, and so forth; but the Gulf Stream as it flows from the U.S. East coast all the way up to the Nordic Seas is what we have focused on mostly over the years. Why we have focused on that is, well, it's interesting. The technologies that we have developed to study ocean currents using drifters seem quite apropos, in other words, a good technique to apply to the Gulf Stream. We have indeed; we've learned an awful lot using the float technology in the Gulf Stream. We have learned how in shallow depths, for example, the Gulf Stream can act as a barrier between waters around it, so waters will go along the Gulf Stream. Where as in depth, the Gulf Stream, thanks to it's meandering, will actually act to stir up the waters on each side. And these are things that might have been rather difficult to understand with other techniques. But with the floats streaming through the Gulf Stream on different density surfaces or depths we can see the Gulf Stream is, I shouldn't use the word river, but acting like a river at shallow depths, separating the two sides, and as a mixer or blender at depth. There are many more aspects to that but maybe in a nutshell."

Q3
What have been some recent discoveries in the study of ocean currents?

"There are many angles to that; one of the earlier ones that was particularly exciting was the discovery of the 'Meddy' or Mediterranean Eddy. These are circular discs of water that spin around in the horizontal. They tend to be quite thin, not much more than a sheet of paper, that is, if they're one kilometer this way (vertical) and more than a hundred kilometers in diameter. These lens are very long lived and the one that we first found, the original discovery was the one off the Bahamas in 1976, and that was so warm and salty, that 'Meddy', that we were convinced it came from the Mediterranean outflow. And indeed, when people started looking in the East Atlantic they found these things, so that seemed like a wonderful confirmation. Twenty years later we are convinced that that was not actually from the Mediterranean but came from much farther North in the North Atlantic by a different pathway, but much more rapidly. And it is one of the stronger tales that we have, how you can be quite convinced of a certain answer to begin with and than many years later, or later on, discover that what you were so convinced of, we (now) think turns out to be wrong. So, science is very much an evolving process."

Q4
How do you use acoustics to study ocean currents?

"Many ways. We use acoustics, actually in a number of ways. But the principle application clearly has been to use what's called a deep sound channel in the ocean to hear and use acoustic signals over great distances in the ocean. And so the first application of that was the development of what's called the SOFAR float, in the late 1960's, where we use stationary hydrophones to track these drifting sound sources as they wandered over hundreds to thousands of kilometers. And then, in the early 80's, we developed what is called the RAFOS float, and it's the same system except the sound goes in the opposite direction. So, we have moored sound sources providing an acoustic navigation system. Just like in the LORAN-C system, the floats drift around, listening to those signals and can navigate or get their position. It's been a very very powerful, and when all is said and done, a pretty straightforward technique, all though there are lots of details to it."

Q5
What challenges have you faced in studying ocean currents?

"Clearly the development of the technology to such as these floats has been a major challenge. Not using them, but to getting them to work or to exist in the first place. But, when you say it like that, it sounds like that's a, not so much a necessary evil, but a necessary you have to go through in order to use them. But, for someone who grew up with a strong engineering interest, such as myself, that was actually to a large extent what motivated us. It was the development of the instrumentation; it was a lot of fun. We had some major headaches to deal with, failures in the beginning and we continue to have headaches. So, that makes it a real challenge, but a challenge in a fun sense. I sometimes worry that when we pursue our science we have a tendency to think of the instrumentation as a little necessity that has to be dealt with but it's the big science that is the one and only thing, but in fact, the methodology and the research that you do with it are extremely tightly interwoven. The methodology that we use or have is what defines our science. We tend to forget that sometimes. The shape of our science is really shaped by the tools that we have available."

Q6
What has most surprised you about studying ocean currents?

"What has been most surprising maybe, or at least a striking aspect to what we have learned in our work is related to what I said earlier about the 'Meddy', and that is how structured the ocean can be at times. The 'Meddies' (i.e. the think lenses-See Question 3), that I mentioned already are very discrete features; we now know that they exist perhaps in all oceans. We have seen them in the Sargasso Sea. We know people who have seen them in the Pacific. We see them in large numbers in the Northern North Atlantic say, in the Iceland Basin or South of Greenland. So, these are highly structured features that sit within the general, within the ocean. So, its not just some kind of a turbulent system, they are highly, very modified systems. The Gulf Stream clearly is another system, which is highly structured and coherent. It is quite astonishing to find out how stiff the Gulf Stream is in width as it meanders going down stream from Cape Hatteras, its width is extremely inelastic. There may be water going in and out to the sides but it is extraordinarily stiff to the side. That's another example. A third example might be the rolling, bathymetry or shape of the ocean bottom in shaping where the waters are allowed to go. That might seem kind of obvious in terms of a sloping continental boundary. You don't go in and out so easily as you do along the boundary, but even the Mid-Atlantic Ridge has a very noticeable influence on how waters cross the ocean."

Q7
What skills are important in your area of research?

"The skills that are needed in our work are varied. They, clearly in my case, I have an engineering background, and I find engineering a lot of fun. So, developing these instruments, the floats for example and other instruments that we have worked with, has been a fun thing to do. Fun in the sense of the engineering but it also feels motivating because you know in the end that these tools are going to be quite helpful in understanding various processes or phenomena in the ocean. But you don't do these things in isolation. You work together with people around you and the engineers that I have worked with over the years are really the people who have made all this possible. Doug Webb at Woods Hole, was key to the SOFAR float development that was really his doing. Jim Fontaine, here at GSO has been absolutely key to the development of the RAFOS float. And these people are just incredibly clever and with out them we just wouldn't be doing what we're doing today."

Q8
What are the opportunities in the study of ocean currents? Can people with out PhDs participate in some way in this type of research?

"No question about it. There's no need for a PhD for much of the things we do. Yes, I have a PhD, but the PhD that I have is of little use in the context of what I do today. The engineers don't have PhDs , they have a very varied background. What is critical is that they have a genuine interest in their work and stay on top of their field so that they know what kinds of tools, semi-conductors, materials are available to help us realize the types of instruments we have in mind. So, dedication and interest is crucial, more than a high form of education, to much of what we do. That's on the instrument development side, but there's much more to that in the scientific endeavor. There's data analysis, or rather, I should say the data reduction first in preparation and then we have the data analysis. There we have had a number of good people, John Lillibridge in the past and Sandy Fontana in our group today. She's absolutely fantastic. Without her we - I'm not sure what we would do. She has a masters degree, she's extremely talented and has a higher, more formal training. The education that you get is of course very very important, but its not long after you've gotten whatever degree you might have gotten that that becomes relatively unimportant compared to the continued learning that you are prepared to go through and grow with the project that you have. So, it's an evolving process."

Q9
What is the greatest impact/relevance of your research?

"I would think most people would feel very uncomfortable trying to reduce your work to questions like that. Again, primarily I guess because its such an evolving process, what I might think of as important today may not be at all important a few years from now. In a general sense, of course, I certainly hope that what we are doing will help us to understand better how the ocean works. At a more particular level, or local level, taking the "Meddies" or these lenses in speeding water as an example. We now know they're quite ubiquitous in the ocean. But, I don't know if we really have a good sense of how important they are or in what way they are important. Clearly if they are long lived and can travel great distances or long lived even as they interact with others, can actually coalesce or break up -they're providing some form of mixing in the ocean. That is a pretty difficult thing to quantify and I know there are a lot of smart people working on this, but I don't know how far they have gotten in translating these kinds of observations into some kind of numerical representation of them that you could use for example in numerical models where your trying to accurately recreate what the ocean circulation looks like. I have a funny feeling that most people would agree that these are important, but how far we have gotten in parameterizing, which is a word that people often use to represent these processes in ocean models, I don't know. That would be one example of potential importance but not necessarily important and the answer may evolve over time."

Q10
What continues to inspire you about your work?

"I mean the quick answer is very simple, its fun. I love working with the people around me. Everybody in the lab has pretty fantastic skills of different kinds. Jim Fontaine, George Schwartze. Sandy Fontana, Mark Prater, Davey Hebert- all great, unique talents and skills to the things we're involved with. The students are equally crucial. I haven't said anything about the students, but we are after all an academic institution and working with the students. Ok, once in a while that can be a bit frustrating, but most of the time it's actually quite a lot of fun. Especially those who are keen on the give and take of the science and most of them really are. That helps motivate. You don't think about it as motivation, you just realize that's part of the total package of enjoying what your doing. It's an enormous privilege to be in this kind of position, working with people like this."

Q11
What advice would you give a high school student who expressed an interst in pursuing a career in your field?

"It turns out - the quick answer to this question is, as far as I'm concerned, and probably only a high school student will understand the answer, is don't miss shop. But, I have the pleasure of working with a high school teacher in Narragansett, Sarah Quan, in physics and we have discussed this and she and I know many colleagues around here are very concerned with the fact that many students who come along have precious little experience with tinkering - with building things and taking things apart. Ok, now-a-days we sit in front of television screens rather than take apart cars, but maybe all the more reason then to encourage young people to get into the shop and build things. Learn how to use tools. Be curious about how things work. Have you taken your moms alarm clock apart and tried to put it together again? Unless the next generation knows how to talk a little bit in practical terms, there's reason to be worried because the next generation is going to try and articulate the new types of instrumentation that we're going to need. And unless they are in some sense fluent in that language, they don't have to necessarily have to build an instrument, but they have to be comfortable talking with engineers about the kinds of measurements they're going to need. They have to be able to conceptualize these things but unless they have at some point started to play around with things, build things, take them apart, break them, how are they going to be able to express themselves when they grow up?"