

# Historical Challenges of Measuring Salinity From Space Transcription

I want to introduce you to the concept of remote sensing, which should not be new to you all. If you go to Wikipedia and you type remote sensing, the definition of remote sensing is to obtain information of an object without physically touching the object. So that sounds pretty simple. If you go to your doctor's office, and the doctor tests your body temperature without touching your body with the little remote sensing device which was not available even a few years ago. A sidetrack as a matter of fact the founder of that company that produced that device was a former employee of the Jet Propulsion Lab. So they applied the remote sensing technique to practical applications.

Another good example of the remote sensing in your daily life is you see on the TV, the weather maps, and the clouds, and the weather systems passing through. It's a very powerful concept to allow you to see the entire weather system from space, getting a global view of the weather coming through your neighborhood. Let me go start with my concept.

Ocean observing started in the early 70s, shortly after we launched the satellite in the 60s. JPL has been a leading center developing ocean satellites. What I show you here is a picture of the first such satellite JPL launched in the earth science called the SEASAT. The satellite monitors the ocean. Although the Seasat lasted only 3 months it provided a really solid demonstration of the many technologies available at that time. They enabled many satellite launchings in the next two decades. Some of you are familiar with the TOPEX/Poseidon which was tested on SEASAT for the first time in 78. And also the scatterometer sensor on the SEASAT leading to the QuikSCAT satellite launch in the 90s.

Today NASA satellite has been measuring a variety of different ocean variables such as temperature, measure the rainfall from space, ocean vector wind from space. We measure the sea level, the waves, and also we're able to measure ocean color which is a measure of the productivity of the ocean. So as I go through this list many of you can guess there's one parameter missing. I know if you don't have the mute button right here so in other words it is salinity I assume.

We are launching the salinity satellite in two weeks. I will take you on a journey basically almost 3 decades ago. Hopefully we'll go through the process so you can see how this simple idea to measure salinity from space takes this long to get developed.

So I should start with the first concept here. The concept of measuring salinity from space actually is pretty simple. If I put in a schematic diagram here, the theoretical foundation of measuring salinity from space is to figure out the right frequency in the microwave band. We know what we call a radiometer is to measure the emission from the ocean surface which will give you the so-called brightness temperature of the ocean which is labeled in the y axis. If you know brightness temperature, and you know the temperature on the x axis you can look at this graph—it is almost like a lookup table—and determine the ocean salinity, so the salt concentration in the sea water. That sounds pretty simple then done, isn't it?

Going back from that 70s theoretical framework, it has been two parallel activities. I call it the yellow track and green track. The yellow track has been the scientific community being developed. Gary has been playing a major role in the 80s and the 90s. To articulate the science questions and how we use the salinity data, and also define the requirements for such a mission. What kind of accuracy? What kind of spatial and temporal resolution? What kind of orbit for the satellite and so on? So Gary has been organizing the meetings on a yearly basis, building the communities. There's a lot of hard work to define such a mission.

The green track on the same time engineers have been developing radiometers, the instruments, the first generation radiometers which I'll click on momentarily. The picture on the top is David LeVine from Goddard Space Flight Center, the deputy PI for the Aquarius mission. He built one of the first generation radiometer instruments to measure the brightness temperature, the emission from the surface. His team flew across the Gulf Stream because it was near the East Coast, and it also had the largest signals across the Gulf Stream. So the graph you are seeing here shows you the first evidence of salinity remote sensing from an aircraft crossing the Gulf Stream. It basically shows you about 5 units of the salinity we call parts per thousand. It's a fairly large signal. So this is the first aircraft experiment to lay down a foundation to demonstrate the feasibility of the salinity remote sensing from space.

Since then we have been developing the instruments like Aquarius. The first time we flew the instrument like Aquarius was in 2000 on an aircraft on the west coast. We moved the experiment from the east coast to the west coast because we wanted to demonstrate an accurate radiometer that we can measure salinity from space. The Gulf Stream on the east coast has about 5 units of salinity. Off the west coast we flew over Monterey for example, we have a signal of less than one salinity unit, less than one part per thousand.

As you can see from all these bubbles I don't really have any results to show because the 2000 experiment really didn't detect any ocean signal. We see a lot of noise in the measurements. I can make a long list ranging from the stability of the instrument and different environmental contaminations from a variety of different sources. It just demonstrated how challenging it was to make a very accurate salinity measurement from space. So actually this was a good lesson for us, this failed experiment in 2000 kind of forced us to return to the drawing board, and try to understand all the processes affecting the salinity, so that we can develop a more accurate measurement, and then measure salinity everywhere in the global ocean.