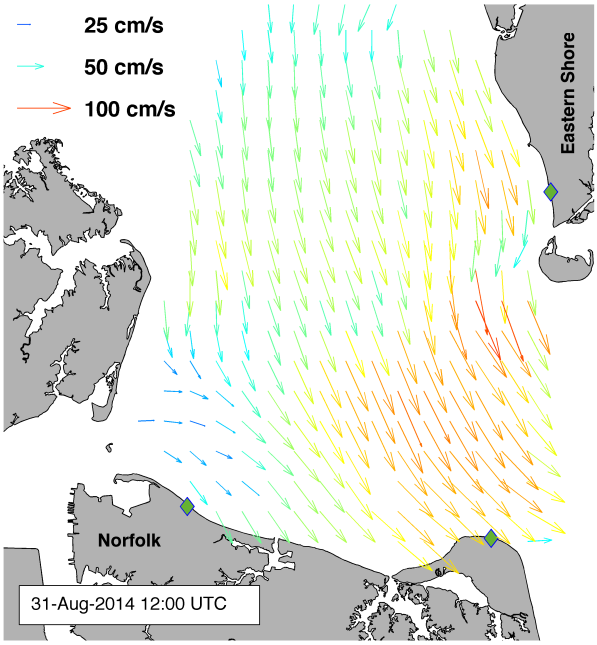
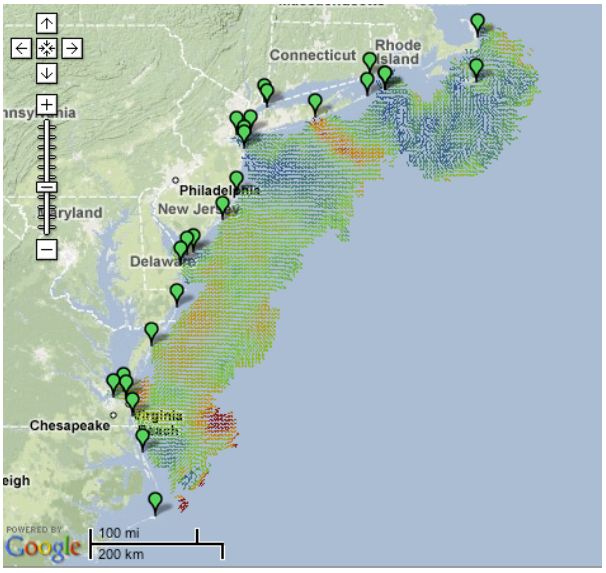
Measuring Ocean Surface Currents with High Frequency Radar

This radar antenna helps oceanographers monitor how surface water moves in the Chesapeake Bay. The Center for Coastal Physical Oceanography (CCPO) at Old Dominion University (ODU) operates three high resolution radar systems like this one in the lower Chesapeake Bay. Antennas are located at Ocean View Community Beach in Norfolk, Joint Expeditionary Base Little Creek-Fort Story in Virginia Beach and Sunset Beach Resort in Cape Charles. These stations are part of a nationwide network of high frequency radar systems that measure and map coastal currents.

An example of a current map for the Chesapeake Bay is pictured below (left side). Arrow length and color indicate how fast the surface water is moving and the arrows point in the direction the water is flowing. Longer/red arrows show faster currents and shorter/blue arrows show slower currents. New maps are created every hour and posted online. At the time of these measurements, water was leaving the Bay in an ebb tidal current. Tide and winds play a big role in how these surface waters move. The map on the right shows ocean currents for the Mid-Atlantic region. The radar measurements can extend 100+ miles offshore; green markers on the coast show radar locations.





HOW DO WE USE THIS DATA?

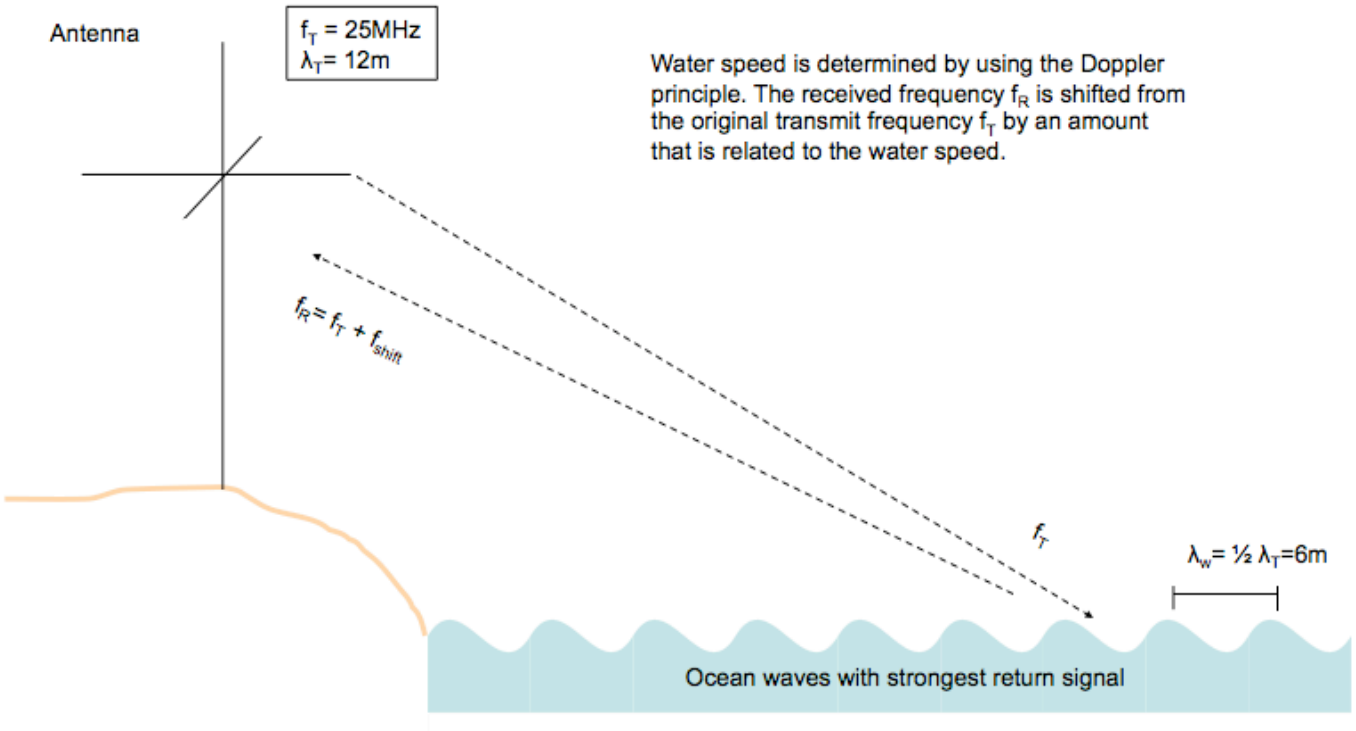
Radar data are entered into the U.S. Coast Guard's Search and Rescue Operations System to better define search areas for lost and drifting boats.

We can help predict where a floating object will go or investigate where it has been. We can also help determine where surface pollution may travel and what beaches it will affect (for example, if there is an oil spill).

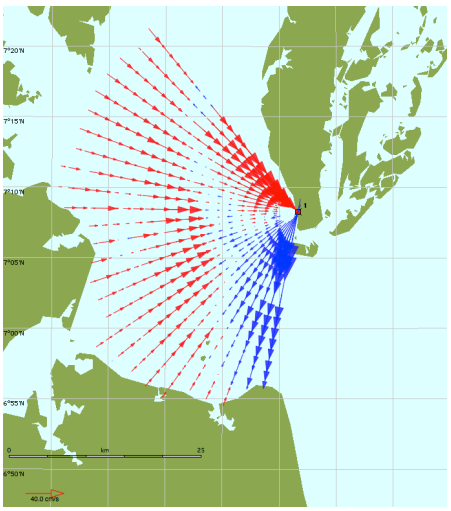
We make tidal current predictions as navigational aids for sailboats and other personal and commercial watercraft. These predictions are a type of ocean weather forecast for boaters.

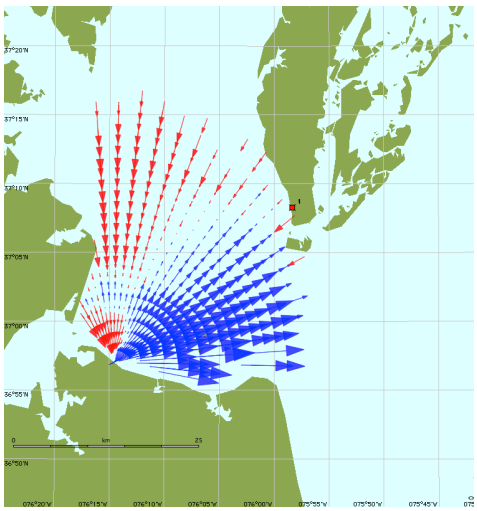
HOW DOES IT WORK?

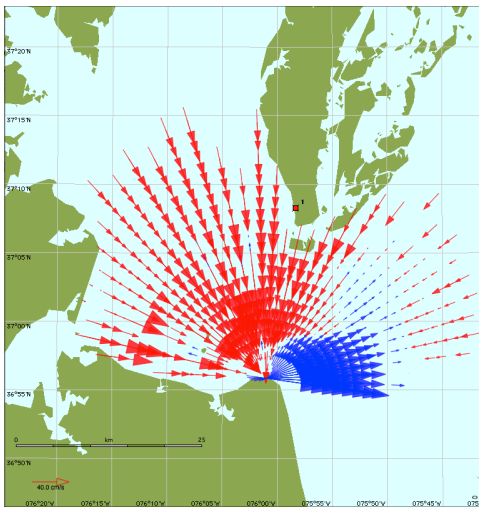
The antenna is a type of remote sensing instrument because it observes or "senses" the water speed from a distance. This is different from a current meter that is placed directly in the water. The antenna sends out a radio signal, which reflects off of ocean waves and returns to the antenna as a signal with slightly different properties.



The frequency changes in the signal let us calculate the water speed. The time it takes for the signal to return tells us the distance to the patch of water that we are measuring and the way the return signal hits the different horizontal and vertical pieces of the antenna tells us the direction the reflected signal came from. All of this information allows us to create station maps like the ones below.

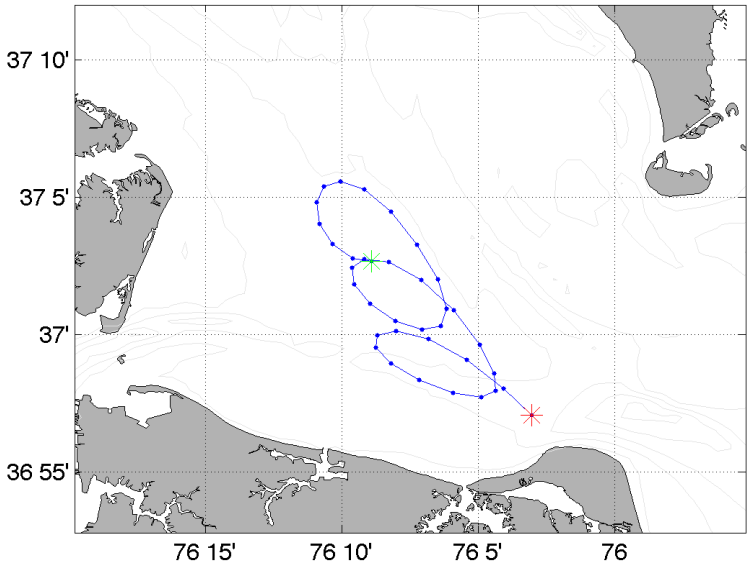

Sunset Beach Map


Ocean View Map


Cape Henry/Fort Story Map

Two or more stations are needed to calculate an accurate and complete map of the currents. The Sunset Beach radar data is combined with data from two other stations: one at Ocean View Community Beach and another at Fort Story.

Suppose an object fell into the water in the middle of the Bay. We can use the radar measurements to find out where the current carries it. The next figure shows an example of a floating object's path. The starting location is the green star and the blue dots indicate where the object has drifted as each hour passes. The red star is the location after 35 hours.



The circular motion is due to the tidal currents associated with the movement of water between high and low tides. The overall motion towards the mouth of the Bay is due to estuarine circulation. This example takes place during a time when there is not much wind. Strong or persistent winds can dramatically alter the currents and the course of an object floating in the water.

Project Website: http://www.ccpo.odu.edu/currentmapping
For more information, contact Teresa Updyke at Old Dominion University: garner@ccpo.odu.edu