

GULF STREAM MARINE HYDROKINETIC ENERGY

OFF CAPE HATTERAS, NORTH CAROLINA

¹Mike Muglia, ¹Patterson Taylor, ²John Bane, ²Harvey Seim, ²Sara Haines
³Ruoying He, ³Andre Mazzoleni, ⁴Chris Vermillion

¹UNC Coastal Studies Institute, ²UNC Chapel Hill, ³NC State University, ⁴UNC Charlotte

The Gulf Stream (GS) off North Carolina has current velocities that approach 3 m/s and an average volume transport between 65 [1] and 90 Sv (1 Sv = 1×10^6 m³/s) [2] off of Cape Hatteras, making it the most abundant MHK (Marine Hydrokinetic Energy) resource for the state. Resource availability at a specific location depends primarily on the variability in GS position, which is least offshore of Cape Hatteras after the stream exits the Florida Straits [3]. Proximity to land, high current velocities, and relatively shallow waters abutting a steep shelf slope that places vorticity constraints on GS position variability make this an optimal location to identify the MHK energy resource for NC. The NC Ocean Energy Program has been quantifying the available energy resource here since 2013 using a Mid Atlantic Bight/South Atlantic Bight Regional Ocean Model (MAB/SAB ROM) and three different types of observations to qualify the model's skill. A 150 kHz ADCP (Acoustic Doppler Current Profiler) located on the 230m isobath since August of 2013 off the coast of Cape Hatteras continues to provide current measurements over nearly the entire water column. Several ADCP cross-stream current measurements have been made from different vessels that quantify the variability in the current resource at different water depths and provide a cross-stream velocity profile within the focus region (Figure 1). A land-based HF radar network measures ocean surface currents every hour providing consistent high-frequency GS position estimates. More recently, the model and observed currents have been used to design a prototype Autonomous Underwater Vehicle (AUV) (Figure 2) to that optimizes its position in the stream to harvest GS energy efficiently.

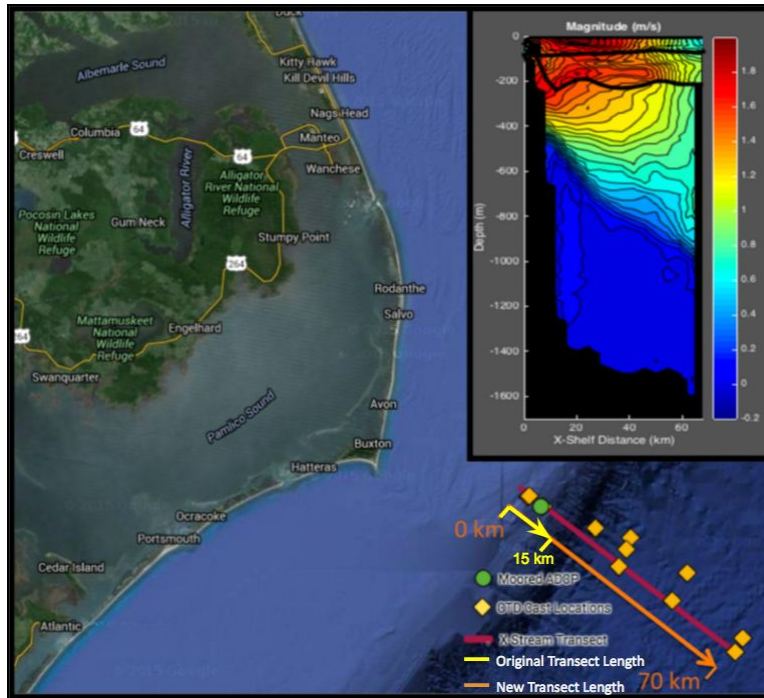


FIGURE 1. RV ARMSTRONG CROSS-STREAM TRANSECT IN RED STARTING FROM THE 100 METER ISOBATH, PROCEEDING 70 KM ACROSS THE STREAM. THE YELLOW DIAMONDS ARE CTD CAST LOCATIONS. THE GREEN DOT IS THE LOCATION OF THE MOORED ADCP AT A DEPTH OF ~230 METERS. THE CONTOUR PLOT SHOWS THE CURRENT SPEED MEASURED FROM 300 KHZ, 150 KHZ, AND 38 KHZ ADCPs SIMULTANEOUSLY. THEY MEASURE CURRENTS TO DEPTHS OF 100, 200, AND 1600 METERS RESPECTIVELY. EACH INSTRUMENT MEASUREMENT IS SEPARATED FOR VISIBILITY BY A BLACK CURVE ALONG THE DEEPEST RELIABLE CURRENT MEASUREMENTS FOR A GIVEN FREQUENCY.

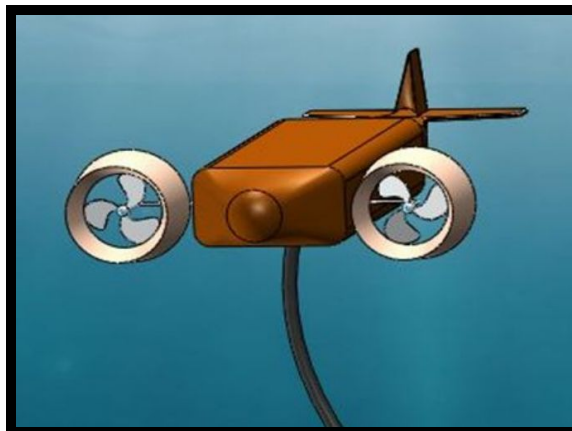


FIGURE 2. ARTIST'S RENDERING OF PROTOTYPE AUV

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- [2] Hogg, Nelson G. "On the transport of the Gulf Stream between Cape Hatteras and the Grand Banks." *Deep Sea Research Part A. Oceanographic Research Papers* 39.7 (1992): 1231-1246.
- [3] Miller, Jerry L. "Fluctuations of Gulf Stream frontal position between Cape Hatteras and the Straits of Florida." *Journal of Geophysical Research: Oceans (1978–2012)* 99.C3 (1994): 5057-5064.