Pioneer-adjacent CPIESs: Characterizing Variability at High Temporal Resolution for Long Duration on the Continental Slope of the Southern Mid-Atlantic Bight

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Northeast of Cape Hatteras, the Gulf Stream separates from the continental margin and flows into the open ocean (**Figure 1**). The separating Gulf Stream can impact exchange processes between the Middle Atlantic Bight (MAB) shelf and open ocean (e.g., Savidge and Bane, 2001; Han et al., 2022). Two current- and pressure-sensor-equipped inverted echo sounders (CPIESs) were deployed on the 1000 m isobath in June 2024 (Perez et al., 2024) at sites near the offshore edge of the relocated Ocean Observatories Initiative (OOI) Coastal Pioneer Array (**Figure 2**). The CPIESs will be deployed for 4-year duration and are equipped with Popup Data Shuttles (PDSs) that send data batches to shore via satellite link (**Figure 3**). We aim to share these observations broadly with the research community, as soon as they are available, to provide complementary observations for the Pioneer Array. The first two PDSs surfaced on September 1, 2024.

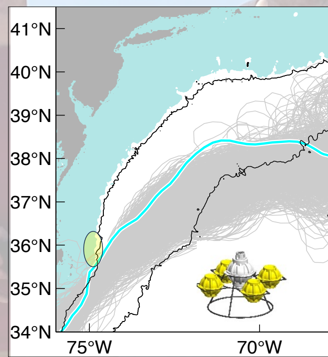


Figure 1. Location of the PDS-CPIESs (yellow oval) with paths of the Gulf Stream based on the 25 cm SSH contour (grey), and the path on one day (August 22, 2022) highlighted. Shelf (<100 m) is shaded (blue).

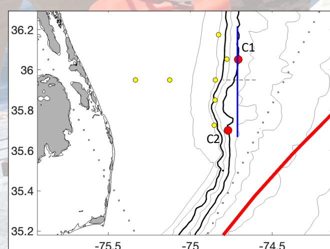


Figure 2. Map of PDS-PIESs (red dots, C1: 36° 3.125' N; 74° 42.365' W and C2: 35° 42.005' N; 74° 46.209' W), Pioneer moorings (yellow dots), and nominal offshore Pioneer glider line (blue). Red curve is time-averaged position of the Gulf Stream core and dotted lines are Jason altimeter tracks. Heavy contours are the 200 and 1000 m isobaths.

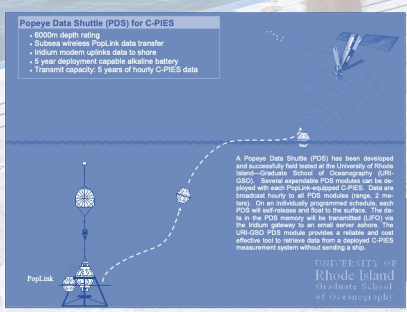


Figure 3. PDS operations. Image credit: URI/GSO Dynamics Group, headed by Randy Watts (web.uri.edu/gso/research/dynamics/).

The CPIESs measure round trip vertical acoustic travel time with bursts of 16 12-kHz pings every 10 minutes (96 pings per hour) and measure near-bottom pressure and current measurements every 30 minutes. The PDSs record processed data records to give hourly acoustic travel times and twice-hourly pressures and currents. The PDSs are programmed to rise to the sea surface at preset times. Two more data batches from each PDS-CPIESs are scheduled and the CPIESs, with the full datasets, will be recovered in 2028.

The scientific motivation for the Pioneer-adjacent PDS-CPIESs deployments is to:

(1) measure mesoscale variability on the continental slope offshore of the Pioneer Array,
(2) capture western excursions of the Gulf Stream North Wall that may influence ocean-shelf exchange, and
(3) observe the upper portion of the equatorward-flowing Deep Western Boundary Current where it squeezes under the poleward flowing Gulf Stream.

The PDS-PIESs were deployed on the 1000 m isobath 40-km apart to extend the Pioneer Array mooring footprint offshore and to allow comparison with a Pioneer glider which is running a line (nominally) along the 1000 m isobath (**Figure 2**, blue line).

To interpret CPIES measurements regional look-up tables are constructed from hydrography (e.g., Watts et al., 2001) and are used to convert from measured acoustic travel time to water column properties such as temperature, salinity or density profiles (e.g., **Figure 4**), or derived properties like thermocline depth (**Figure 5**). The lookup tables capture the the Gravest Empirical Mode (GEM) and to first order, shorter travel times correspond with a deeper thermocline and an onshore-shifted Gulf Stream, while longer travel times correspond with a shallower thermocline and an off-shore shifted Gulf Stream (Andres, 2021).

Figure 4. Temperature and salinity lookup tables from 2,672 Spray glider dives (e.g., Todd 2020) off Cape Hatteras.

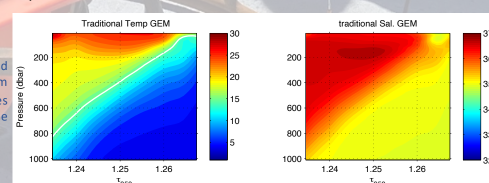
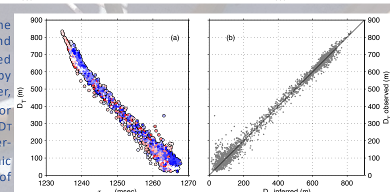


Figure 5. (a): Relationship between the depth of the 15°C isotherm (measured) and τ_{950} (calculated), with both determined from Spray glider dives, color- coded by yearday (red is summer, blue is winter, white is spring or fall). (b): Comparison for each glider dive of the glider-inferred D_T (using a lookup table) with the glider-observed D_T (from the dive's hydrographic profile). Reproduced from figure 5 of Andres (2021).



The first data batches have arrived and document the variability for the first ~3 months of the 4-year deployments at sites C1 and C2 (e.g., **Figure 6**).

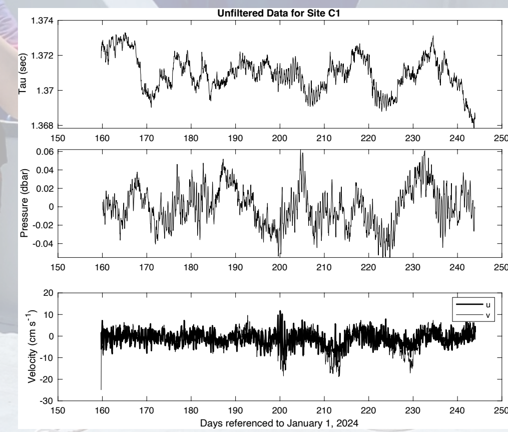


Figure 6. (a): First three months of data from C1 showing hourly (top) acoustic travel time, (middle) detided bottom pressure anomaly, and (bottom) horizontal currents 50-m off the seabed.

The PDS-CPIESs data batches will be processed and hourly and 2-day low pass filtered records (.mat and netcdf) will made publicly available shortly after download. The first data batches from the CPIESs at sites C1 and C2 will be available soon at the following website (presently under construction and expected to be completed by the end of September):

https://hdl.handle.net/1912/70492

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