Characterization of the Hatteras Front using Shelf Glider Deployments during PEACH Project

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Abstract

The Processes driving Exchange At Cape Hatteras (PEACH) Project sought to explore seawater exchanges between the continental shelf and open ocean near Cape Hatteras, North Carolina. This region contains cool, fresh water from the Mid-Atlantic Bight (MAB) north of Cape Hatteras, and warm, salty South-Atlantic Bight (SAB) waters that both converge towards each other. Additionally, the region is influenced by the Gulf Stream and Slope Sea Gyre (Figure 1). From 2017 to 2018, Ramses, a Slocum G1 Glider developed by Teledyne Webb Research, was deployed as a component of the PEACH project a total of seven times north and south of Diamond Shoals before it became lost at sea on its seventh deployment. The methods and results collected from Deployment 6 are observed and described, with a focus on analyzing water mixing between SAB and MAB waters in the Cape Hatteras region.

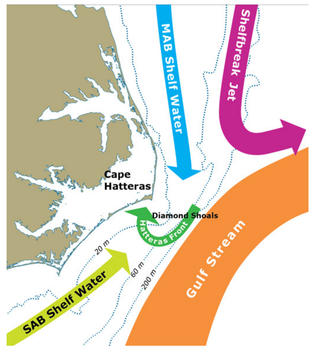

Figure 1. Coastal schematic depicting ocean circulation in the Cape Hatteras Region. Gulf Stream is indicated in orange. MAB = Mid-Atlantic Bight. SAB = South-Atlantic Bight. Sourced from Seim et al. 2022 in the academic journal *Oceanography, Volume 35, No. 2.*

Ramses 6 Flight

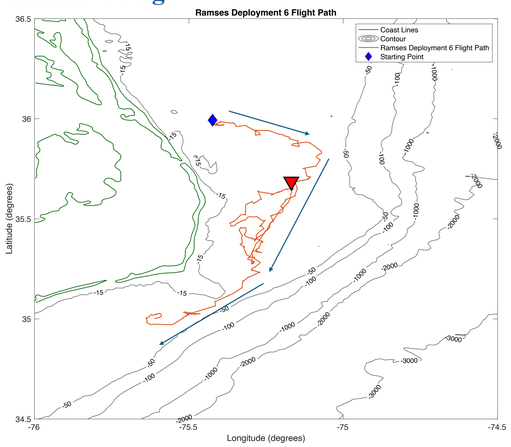

Figure 2. Two-dimensional bathymetry map of Ramses Deployment 6 throughout the month of September 2018. The green section of the map indicates the coastlines of North Carolina. The blue diamond shows the starting point from where Ramses was deployed from, and the orange line indicates the southward path the glider traversed throughout the course of its deployment. Red marker shows where Hurricane Florence started. Blue arrows show the general direction the glider is going. Strong currents and its variability over the continental shelf made it difficult for the glider to conduct its routine, preplanned transects.

Temperature vs. Salinity

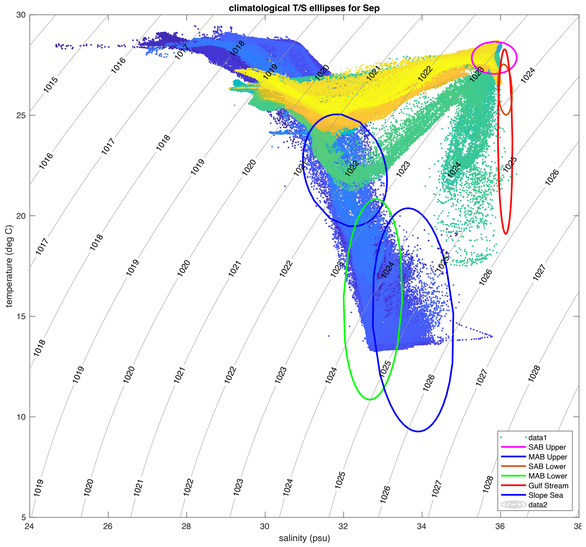

Figure 3. Temperature vs salinity plots of Ramses Deployment 6. Temperature, salinity, and depth plotted in respect to time. Darker, bluer coloration signifies the beginning of the time series data, while a lighter, more yellow coloration indicates towards the end of the time series data for Deployment 6. Ellipses shown represent characteristics of the upper and lower portions of MAB/SAB waters, the Gulf Stream, and Slope Sea. Ellipse data sourced from *Savidge et al., 2012.*

Water Column Profiles

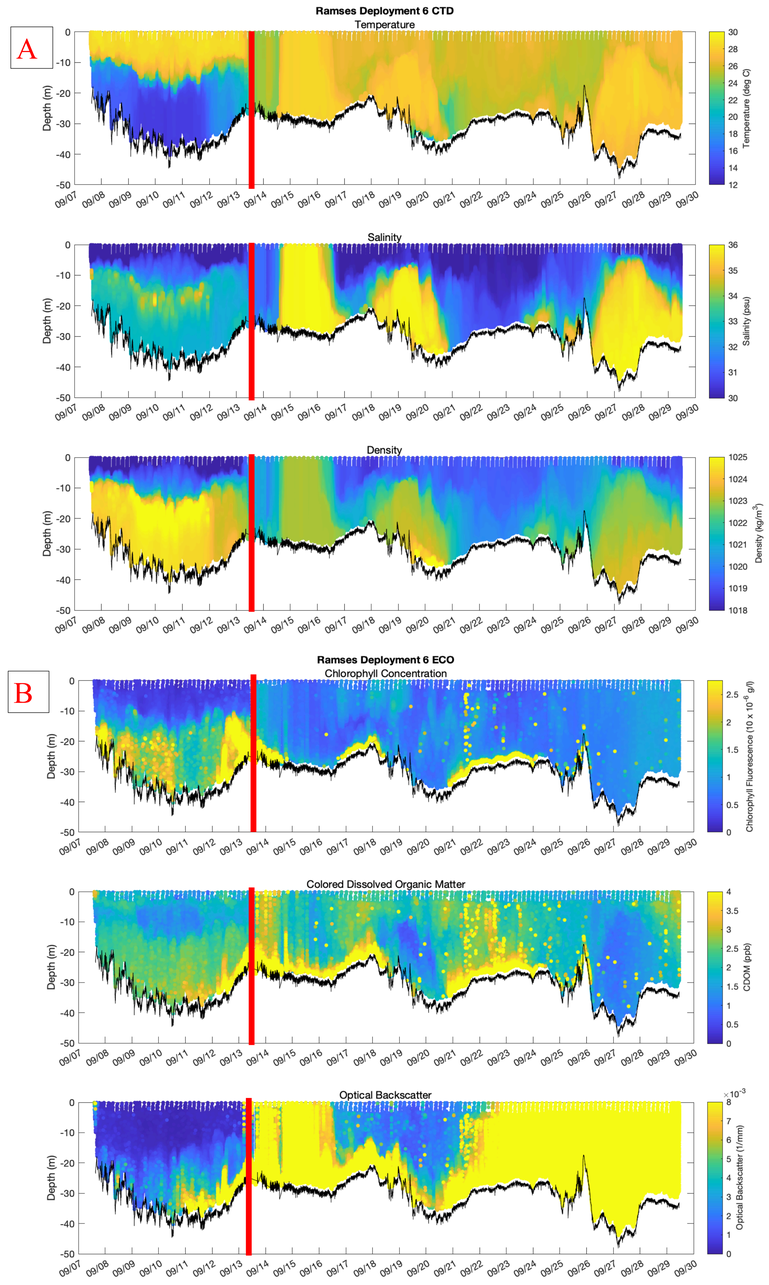

Figure 4. Conditionally Colored Plots (CCPLOT) of water column profiles from Ramses 6. All figures have time as the x-axis, depth as the y-axis, and specified data collected from sensors plotted by color. The black line represents the water depth, calculated by adding the measured depth and altitude values from the flight computer. Red vertical line indicates the beginning of Hurricane Florence that affected the region. **Set A** contains the Conductivity, Temperature, Depth (CTD) data collected from <INSERT NAME> sensor installed onto Ramses. Temperature (degrees C), Salinity (psu), and Density (kg/m^3) data are plotted onto their respective graphs. **Set B** contains Environmental Characterization Optics data collected from the Sea-Bird Scientific ECO Puck installed onto Ramses. Chlorophyll fluorescence (µg) colored dissolved organic matter (ppb) and optical backscatter (1/mm) are plotted in these figures.

Upper vs. Lower

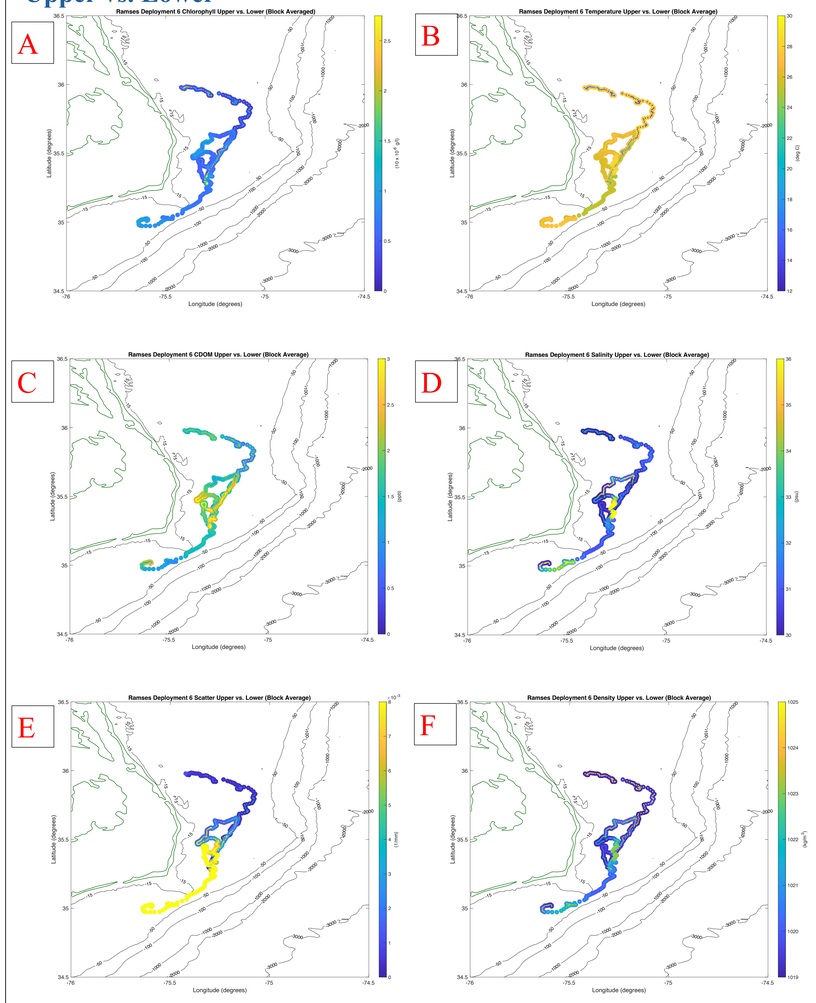

Figure 5 A-F. 2D Bathymetry of the Cape Hatteras Region; upper third of water column plotted as the exterior line, while the lower third of the water column plotted as interior line. Green line portrays North Carolina coastline. A, C, and E show ECO data; B, D, and F show CTD data. A 20-point block average is applied to each value before being plotted.

Summary

- Hurricane Florence contributed to upwelling and resuspension of nutrients from the bottom of the continental shelf, as shown in Figure 4.
- Large pockets of salty, warm water were measured while the glider traversed in the MAB part of the continental shelf; intrusions likely to originate from SAB or Gulf Stream.
- Observed mixing between the SAB and MAB waters (Figures 3 and 5); additional influence of the Gulf Stream and Slope Sea.

Acknowledgements

Glider data collection from 2017-2018 done in collaboration with scientists from the PEACH project onboard the R/V *Armstrong*.

References

Savidge, D., J. Austin, and B. Blanton, 2012. Variation in the Hatteras Front density and velocity structure Part 2: Historical setting, *Continental Shelf Research*, doi.org/10.1016/j.csr.2012.11.006.

Seim, H., D. Savidge, M. Andres, J. Bane, C. Edwards, G. Gawarkiewicz, R. He, R. Todd, M. Muglia, J. Zambon, L. Han and S. Mao, 2022. An Overview of the Processes driving exchange at Cape Hatteras (PEACH) Program, *Oceanography*, doi.org/10.5670/oceanog.2022.205.