Southern Mid-Atlantic Bight conditions observed with shelf gliders during the PEACH project 2017-2018

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The NSF-funded PEACH project studied shelf-open ocean exchange near Cape Hatteras, where the Gulf Stream separates from the continental shelf to become a free jet, and where shelf flows from the Mid-Atlantic (MAB) and South Atlantic Bights (SAB) converge. Over 2017-2018 nine shelf glider missions lasting more than 20 days were conducted, measuring temperature, salinity and pressure on all missions, and chlorophyll-a (chla) florescence, optical backscatter, colored dissolved organic matter (CDOM) florescence on all but two missions. Eight missions sampled in the southern MAB, operating in the region of the OOI Pioneer Array between the 20-60m isobaths, allowing examination of water mass properties, their variability, and their association with measured optical properties. All missions observed waters of MAB and SAB or Gulf Stream origin (difficult to distinguish based solely on temperature and salinity) on the southern MAB shelf. Gulf Stream or SAB waters were often intrusions within MAB waters, but the nature of these intrusions varied widely. Both MAB and SAB waters seasonal variability was reasonably well captured by the climatology of Savidge et al. (2013) though a fresher water mass was seen in several of the missions that likely reflects either the 'Virginia coastal waters' of Flagg et al. (2002) or outflow from the Albemarle/Pamlico Estuarine System through Oregon Inlet. Strong southward wind events led to gliders deployed in the MAB being advected into the SAB, along with MAB waters, on several occasions. High CDOM was typically associated with low salinity, implying a nearshore source, whereas high chla was associated with either MAB waters or waters along a mixing line between MAB and SAB waters. On several missions chla was 'spikey', suggestive of colonial forms, and maximum concentrations were observed near the seafloor. Backscatter was prone to saturation, presumably due to sediment resuspension associated with strong wind/wave forcing.

Example deployments – observations from two deployments are shown in detail.

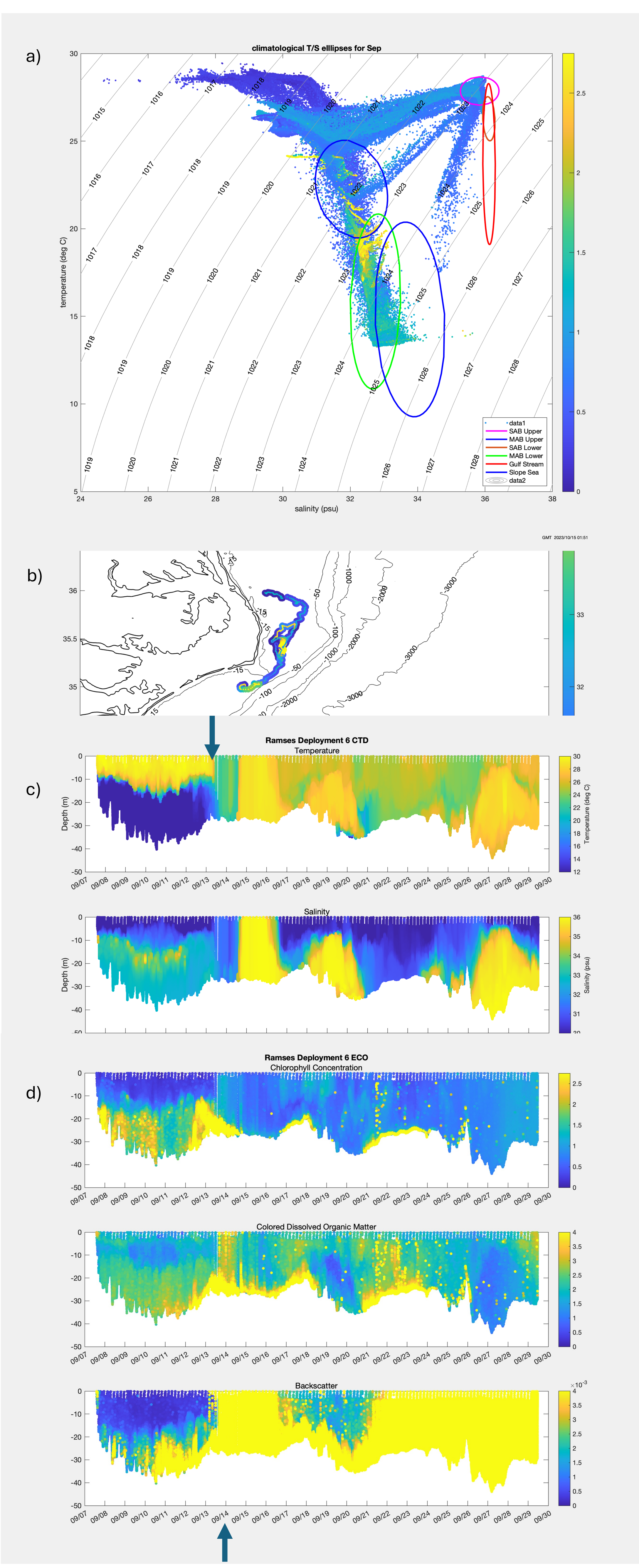

Figure 2 – late December 2017-early January 2018 deployment. (a) T/s plot, color-coded by measured chlorophyll a. Ellipses denote climatological expectations for water masses listed in the legend; (b) map view of glider path during deployment; colors show salinity averaged over the upper third (larger symbol) and lower third (smaller symbol) of the water column; (c) temperature and salinity as a function of time-depth; (d) chlorophyll a, colored dissolved organic matter concentration and backscatter intensity as a function of time-depth. Note 'spikey' character to optical data, and occurrence of bottom maxima in chla that correspond to lower bottom temperature/salinity. Arrow marks passage of Hurricane Florence over the glider, which led to rapid homogenization of most measured variables. Saturated backscatter likely reflects sediment resuspension.

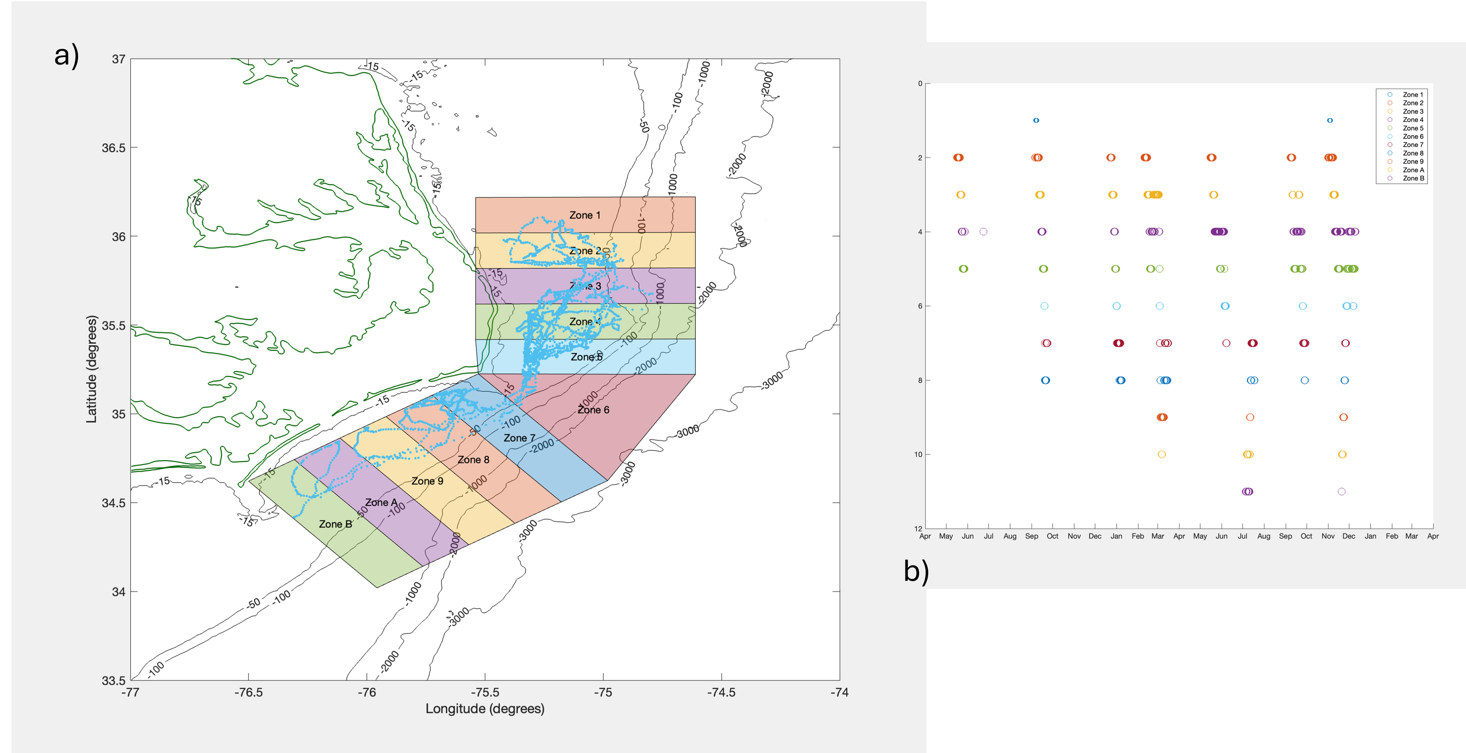

Figure 1 - (a) map of study site overlain with glider tracks (blue) and zone definitions (color shading); (b) – time coverage of glider deployments (x-axis) by zone (y-axis)

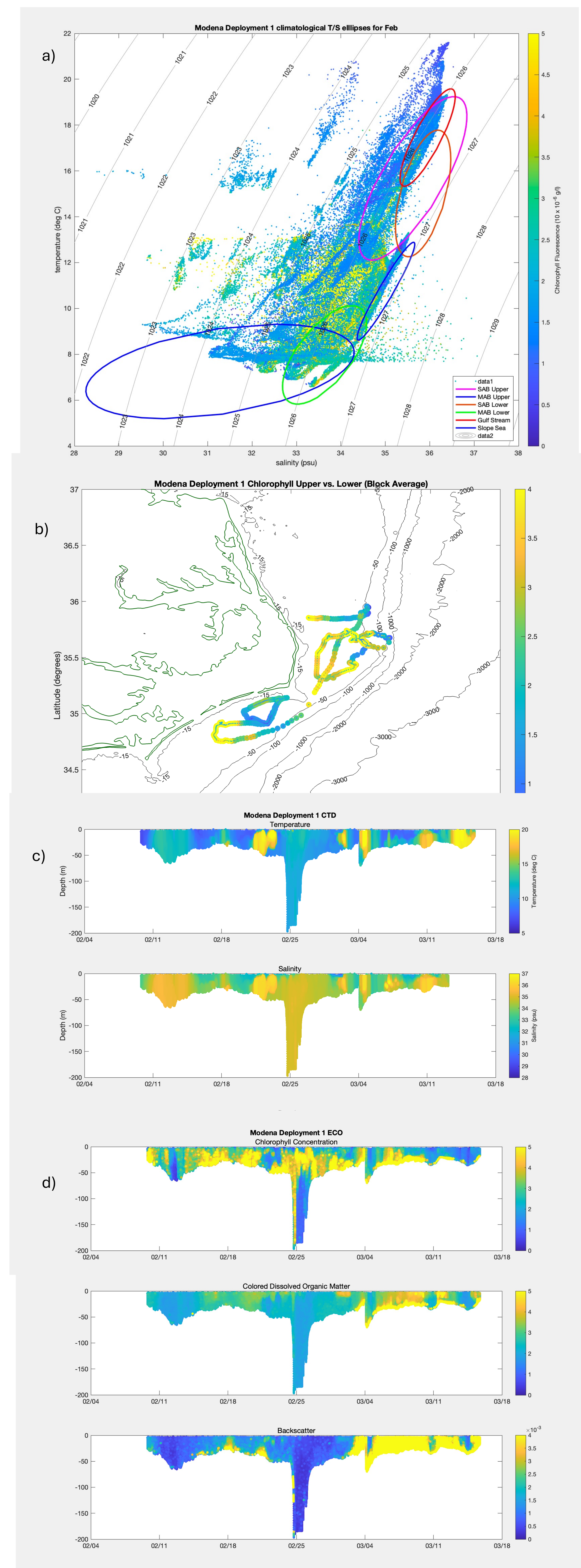

Figure 3 – February 2018-mid March 2018 deployment. (a) T/s plot, color-coded by measured chlorophyll a. Ellipses denote climatological expectations for water masses listed in the legend; (b) map view of glider path during deployment; colors show Chl a averaged over the upper third (larger symbol) and lower third (smaller symbol) of the water column; (c) temperature and salinity as a function of time-depth; (d) chlorophyll a, colored dissolved organic matter concentration and backscatter intensity as a function of time-depth. Note occurrence of bottom maxima in chla that correspond to lower bottom salinity. Backscatter saturates in March, possibly due to biofouling.

References:

Flagg, C., L. Pietrafesa and G. Weatherly, 2002. Springtime hydrography of the southern Mid-Atlantic Bight and the onset of seasonal stratification, Deep-Sea Research II, 49, 4297-4329.

Savidge, D., J. Austin and B. Blanton, 2013. Variation of the Hatteras Front density and velocity structure Part 2: historical setting, Cont. Shelf Res., 54, 106-116.

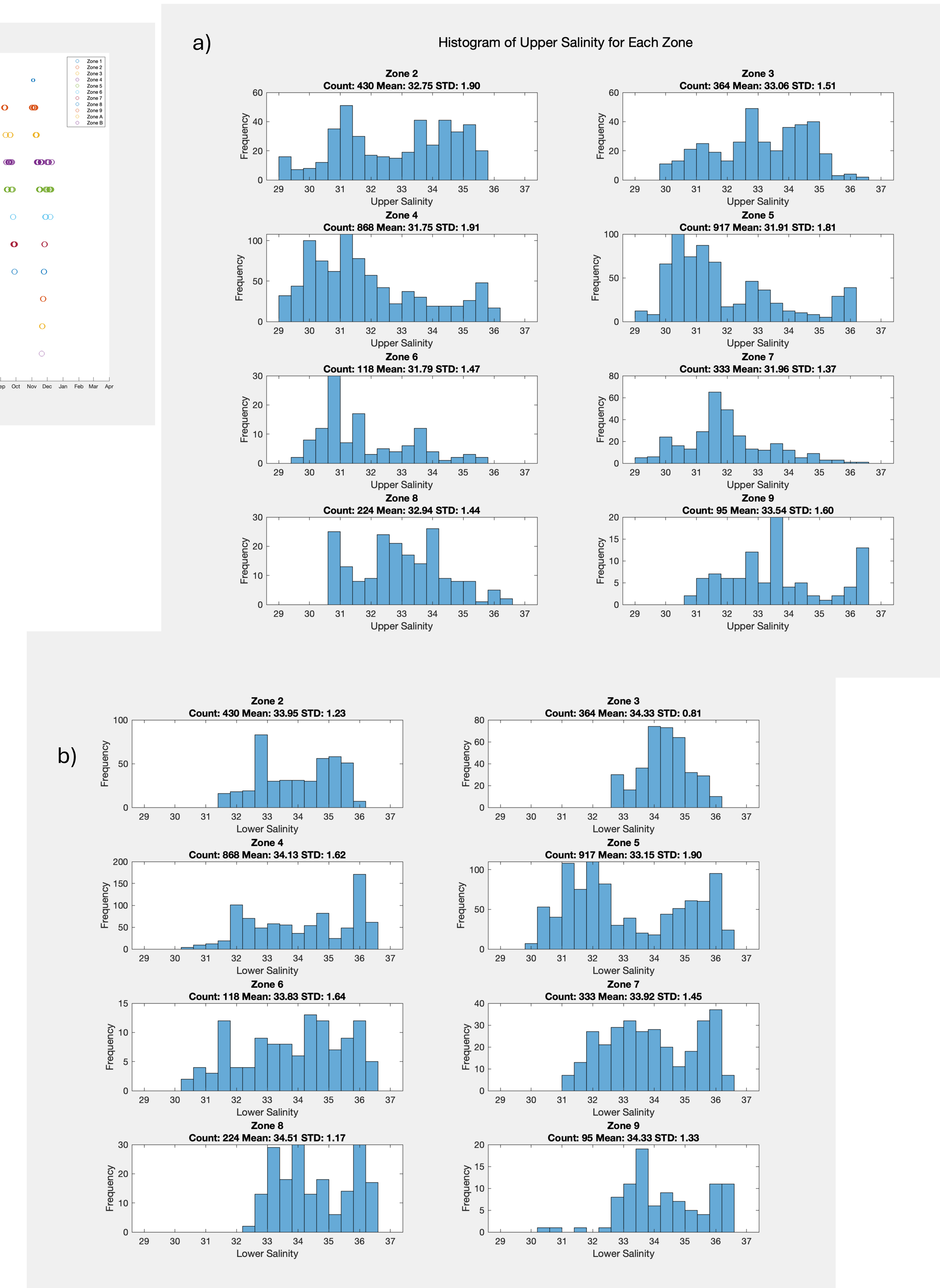

Figure 4 - probability distributions of salinity in (a) upper third and (b) lower third of the water column across all deployments as a function of zone (shown in Figure 1). Of note is the broad range of salinities, indicating intrusions and interleaving of MAB and SAB/GS waters across the entire region.

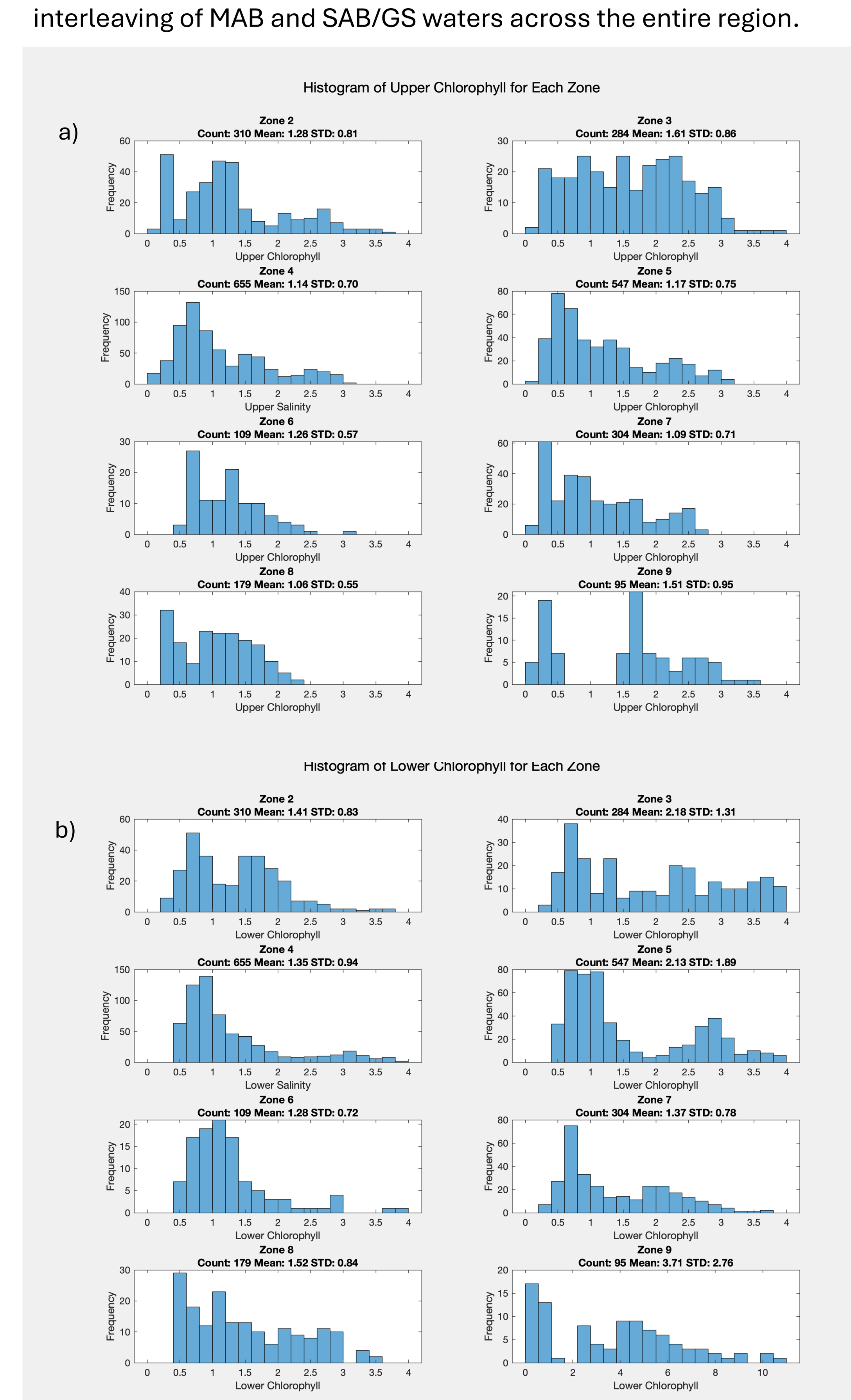

Figure 5 - probability distributions of chlorophyll a in (a) upper third and (b) lower third of the water column across all deployments as a function of zone (shown in Figure 1). Higher chla can occur anywhere in the region; T/s plots in Figs. 2 & 3 suggest high values are most prevalent where MAB and SAB waters mix.

Conclusions – the PEACH project collected spatially-dense observations over more than a year, allowing more detailed characterization of the hydrography and optical properties of southern MAB (sMAB). Key findings are: 1) both MAB and SAB/GS waters are typically present in the sMAB; intrusions and interleaving are common; 2) strong southward wind events drive MAB waters around Cape Hatteras into Raleigh Bay; 3) elevated chla is associated with mixed MAB/SAB waters, and near-bottom maxima were seen on several occasions; 4) the broad distributions of salinity and chla across zones surrounding Cape Hatteras indicate the sMAB is an extended along-shore mixing zone. Note: this is a tough place to pilot gliders!

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