Physical and biogeochemical controls on pH dynamics in the northern Gulf of Mexico during hypoxia season

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High precision and accuracy pH measurements by electrode method (NBS scale) and spectrophotometry (total scale) were taken during a cruise in summer 2017 to study the pH dynamics and its controlling mechanisms in the northern Gulf of Mexico (nGOM) during hypoxia season. The measurement results from both methods agree well with the pH values calculated from dissolved inorganic carbon (DIC) and total alkalinity (TA) with an average difference of 0.050 ± 0.021 (n=550) for electrode method and 0.004±0.035 (n=550) for spectrophotometry respectively. In the surface water, the spatial pH variability in the nGOM is associated with the trajectory of the Mississippi and Atchafalaya river plumes and the biological processes therein. In both plume regions, the highest pH values (up to 9.3) were observed, together with pCO_2 minimum and oxygen maxima, at intermediate salinities where light and nutrient were both favorable for phytoplankton production. The surface pH variability is also related to the difference in buffering capacity of the fresh waters from the two rivers. In the subsurface layer, low pH values (down to 7.6) were observed in hypoxic waters mainly distributed in the bottom layer. The subsurface pH shows correlations with DIC and apparent oxygen utilization (AOU) suggesting that decomposition of organic matter was the dominant factor regulating the pH variability. In addition to the low pH in the hypoxic bottom water, this study highlights the occurrence of a pH minimum and hypoxia (even anoxia) at mid-water depth (5-10m) observed in several transects. T-S diagrams and numerical model suggest that this mid-water acidification and hypoxia is not caused by local surface production but as a result of the intrusion of low-pH and low-oxygen water sourced from nearshore bottom layer. This extension of hypoxia and acidification from nearshore bottom might be a threat to marine organisms in the offshore mid-water depth once thought to be not affected by the bottom hypoxia.