

Spatial and Seasonal Variability of Mixed Layer Depth in the Tropical Atlantic at 10 °W Using 40 Years of Observational Data

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I. INTRODUCTION:

The mixed layer is the oceanic surface layer in which the salinity, density, and temperature are almost uniform due to the high mixing initiated by the air-sea exchange such as heat flux and wind stress (Kantha and Clayson, 2000). It's essential for the coupled ocean and atmosphere system and its effect on biogeochemical cycles, biological production and ecosystems (Polovina et al., 1995; Kara et al., 2003a; McCreary et al., 2001; Morel and Andre, 1991; Longhurst, 1995). Studies involving mixed layer have been conducted over global ocean and in the Gulf of Guinea (de Boyer Montégut and al., 2004; Caniaux and Planton, 1998; Paci et al., 2005; Malick Wade et al., 2011; Peter, 2007). We study the temporal and spatial variability of the mixed layer depth in the Gulf of Guinea during cold and hot season.

II. STUDY AREA, DATA COLLECTION AND PROCESSING:

The conductivity, temperature and depth (CTD) data used were extracted from a box centered on 10°W ± 0.25 in the Gulf of Guinea (GG) between latitudes 2°N and 10°S (Figure 1). They come from two databases: Coriolis (<http://www.Coriolis.eu.org>) and the Scientific Information System for the Sea (<https://data.ifremer.fr/SISMER>) and cover the period of October 1973 to March 2017, i.e. 44 years of observation. The data collected were processed according to the method used by N'guessan et al. (2019): 382 CTD profiles including 240 in the hot season and 142 in the cold season.

III. METHODS:

a. Determination of the mixed layers depth (MLD)

The MLD was determined using Holte and Talley density threshold method with a criterion of 0.03 kg m⁻³ as in N'Guessan et al. (2019).

b. MLD spatial and seasonal variability study

The climatological mean MLDs were calculated on a one-degree resolution grid computed between 2°N and 10°S. The spatial variability is analyzed using a plotted 2-dimensional diagram (climatological mean MLD as a function of latitude). For each season, and for the different zones, the climatological monthly mean MLDs were calculated and plotted on the same graph. The evolution of the monthly and thus seasonal variability were analyzed for the hot (November to April) and the cold seasons (May to October) in the three different areas: the equatorial zone (2°N-2°S), the 6°S zone (5°S-7°S) and the 10°S zone (8°S-10°S).

IV. RESULTS:

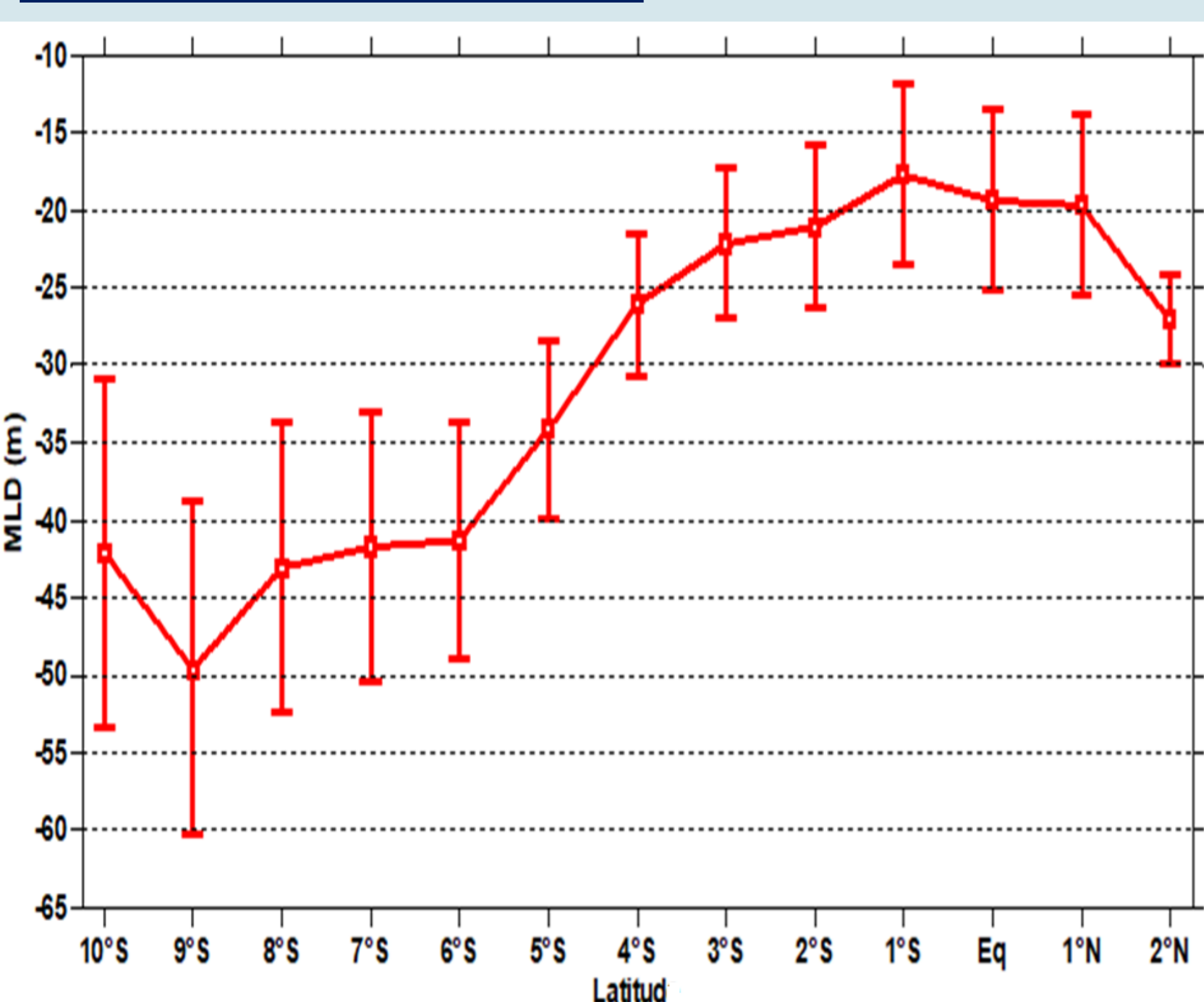


Fig. 2 MLD spatial variability between 2 °N and 10 °S along 10 °W from October 1973 to March 2017. The error bars on the graph represent the standard deviation values

The MLD varies between 18 and 50 m. From 2 °N up to 4.5 °S, the MLDs are less than 30 m. The MLD decreases from 27 m at 2 °N, to a minimum of 18 m at 1 °S before increasing to about 30 m at 4.5 °S. Between 4.5 °S and 9 °S the MLD increases greatly from 30 to 50 m and then decreases to 42.5 m at 10 °S.

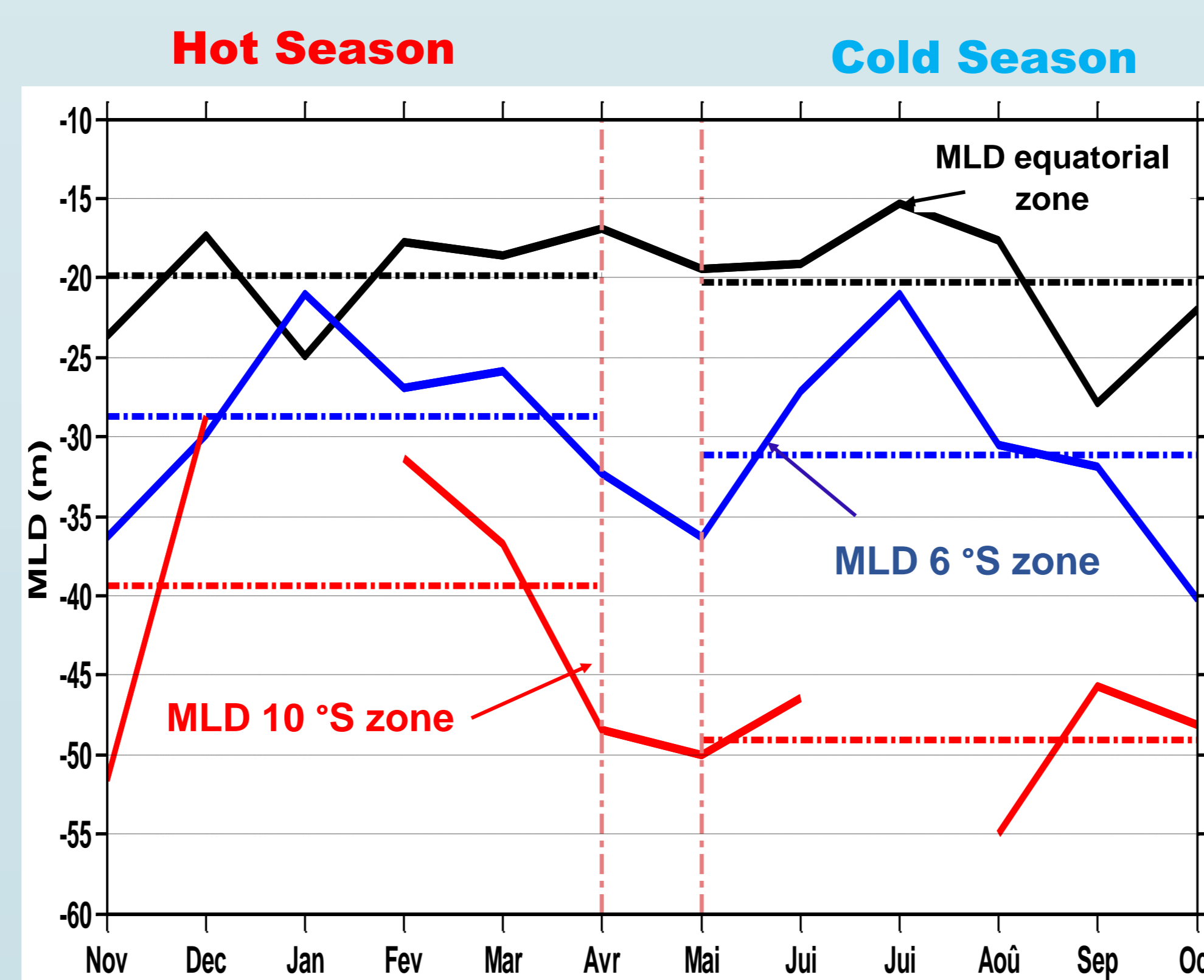


Fig. 3 Seasonal evolution of the MLD (m) at 10 °W from October 1973 to March 2017

- Equatorial band: the seasonal average MLD is 20 m whatever the season.
- At 6 °S and 10 °S: the MLD is relatively higher during the cold season.
- At 10 °S, during the hot season, the MLD varies between 28 and 52 m and the seasonal average is 39.5 m. During the cold season, the MLD varies between 45 and 55 m with a seasonal average of 49 m.

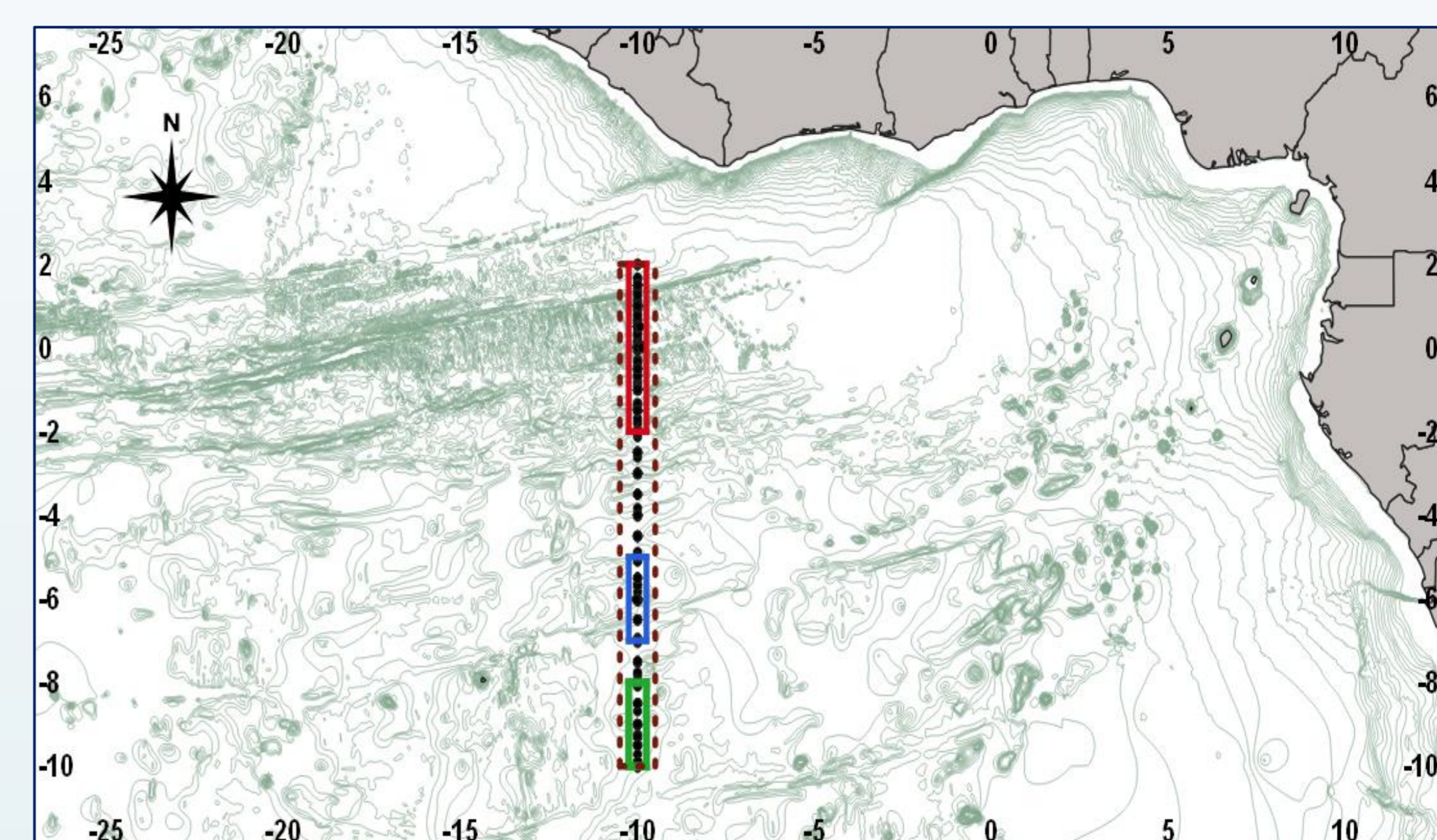


Fig. 1 Study area located in tropical Atlantic. CTD stations are indicated by black dots. The three boxes indicate from top to bottom, the equatorial zone in red (2 °N -2 °S), the 6 °S zone (5 °S -7 °S) in blue and the 10 °S zone (8 °S-10 °S) in green

V. CONCLUSION:

The spatial and seasonal variability of the mixed layer depth (MLD) were studied using hydrological data from several databases collected over the period October 1973 to March 2017 at 10 °W between latitudes 2 °N and 10 °S in the Gulf of Guinea. The density threshold method with 0.03 kg m⁻³ criterion was used to calculate the MLD. The MLD increases from 2 °N to 10 S. Seasonal variability of MLD at the equator averages 20 m over the 2 seasons, but deepens south of the equator in the cold season with more than 50 m depth.

REFERENCES

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