Physical mechanisms and processes during the 2017 coastal El Niño and its influence on the vertical thermohaline structure applying the principles of the GFD: Case study of the North Coast of Peru.

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INTRODUCTION

The occurrence of the El Niño event brings with it serious implications on a global scale, generating changes in the coastal-oceanic, terrestrial and atmospheric systems; such as the rise in sea temperature, heavy rains, droughts, among others [1]; which cause serious socio-economic problems in countries linked to the equatorial zone.

In Peru, these problems were evident during the 2017 coastal El Niño (2017-CEN) [2]; in this context, it is necessary to carry out studies that help to expand the knowledge of the scenarios, mechanisms, physical processes and the evolution of the event in order to obtain prevention measures.

DATA AND METHODS

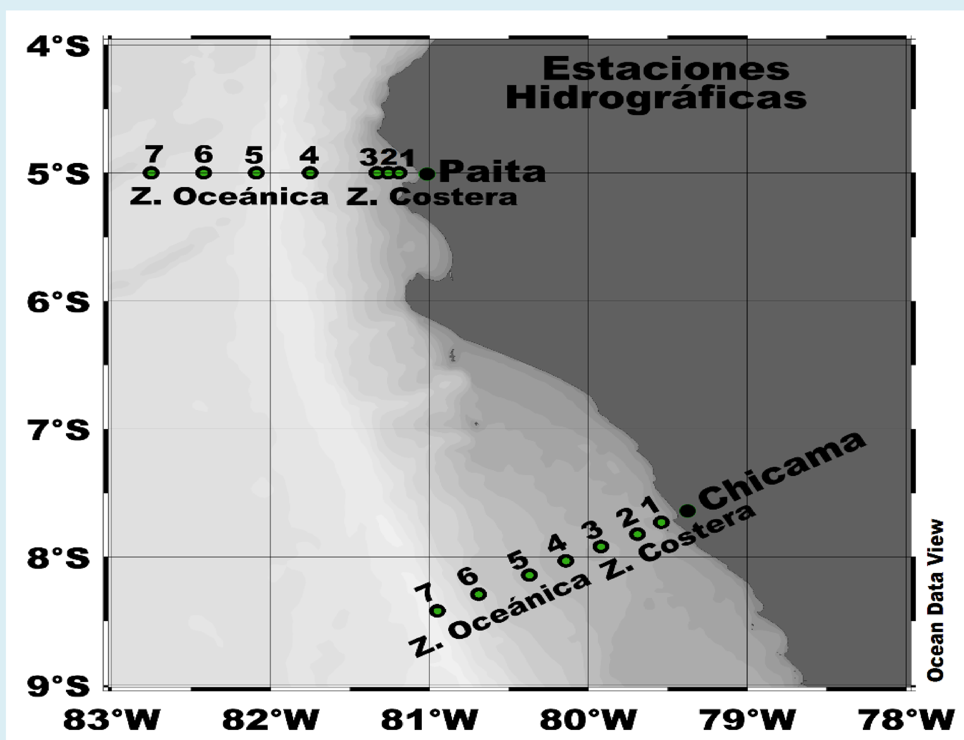

Figure 1: Map of the study region. The points represent the hydrographic stations, the labels on the stations indicate the line and station number during bio-oceanographic monitoring carried out monthly for the coastal and oceanic zone.

- To study the mechanisms and physical processes during the 2017-CEN, the equations of Geophysical Fluid Dynamics (GFD) were applied, related to the geostrophic balance, Ekman dynamics and vertical thermohaline structure (VTHS).
- To describe the influence during the coastal child on the EVTH, dynamic approximations were carried out in the equation of motion (Eq. 1), hydrostatic approximation (Eq. 2), continuity equation (Eq. 3), scalar transport equations (temperature T and salinity S) (Eqs. 4 and 5), equation of states (Eq. 6) and geostrophic balance equation (Eq. 7) [3].

$$\frac{D\vec{V}}{Dt} = -\frac{1}{\rho}\vec{\nabla}p - 2\vec{\Omega}x\vec{V} + \vec{F_r} + \vec{g} \quad ...(1)$$

$$-\frac{1}{\rho}\vec{\nabla}p + \vec{g} = 0 \quad ...(2)$$

$$\vec{\nabla}\cdot\vec{V} = 0 \quad ...(3)$$

$$\frac{\partial T}{\partial t} + \vec{V}\cdot(\vec{\nabla}T) = \frac{\partial}{\partial x}\left[K_x\frac{\partial T}{\partial x}\right] + \frac{\partial}{\partial y}\left[K_y\frac{\partial T}{\partial y}\right] + \frac{\partial}{\partial z}\left[K_z\frac{\partial T}{\partial z}\right] \quad ...(4)$$

$$\frac{\partial S}{\partial t} + \vec{V}\cdot(\vec{\nabla}S) = \frac{\partial}{\partial x}\left[K_x\frac{\partial S}{\partial x}\right] + \frac{\partial}{\partial y}\left[K_y\frac{\partial S}{\partial y}\right] + \frac{\partial}{\partial z}\left[K_z\frac{\partial S}{\partial z}\right] \quad ...(5)$$

$$\rho = \rho[S,T,p] \quad ...(6)$$

$$-\frac{1}{\rho}\vec{\nabla}p - 2\vec{\Omega}x\vec{V} = \vec{0} \quad ...(7)$$

- These equations were solved analytically, using the cross derivative method and integrating in the water column between 0 and 500 m depth, to estimate the variations in the vertical offshore structure of the physical properties: temperature, salinity and geostrophic flow.

RESULTS

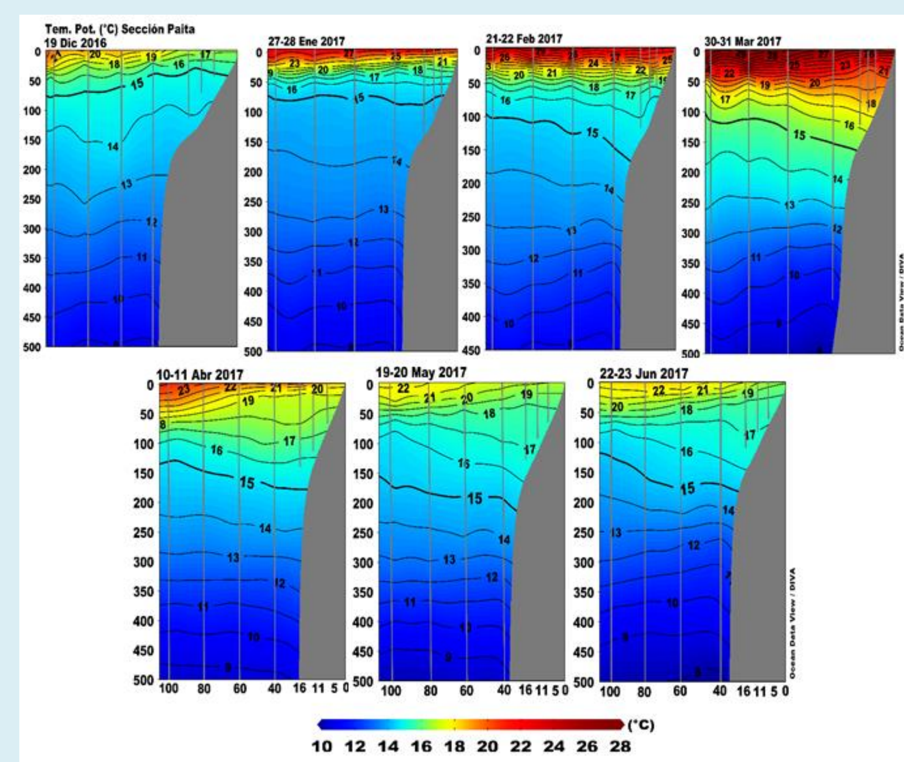

Figure 2: Vertical distribution of potential temperature (°C) in the Paita section in relation to the distance from the coast (n.m.). Period since December 2016 to June 2017. The distribution of the isotherms indicates the rise and deepening of the ISO of 15 °C, during the study period.

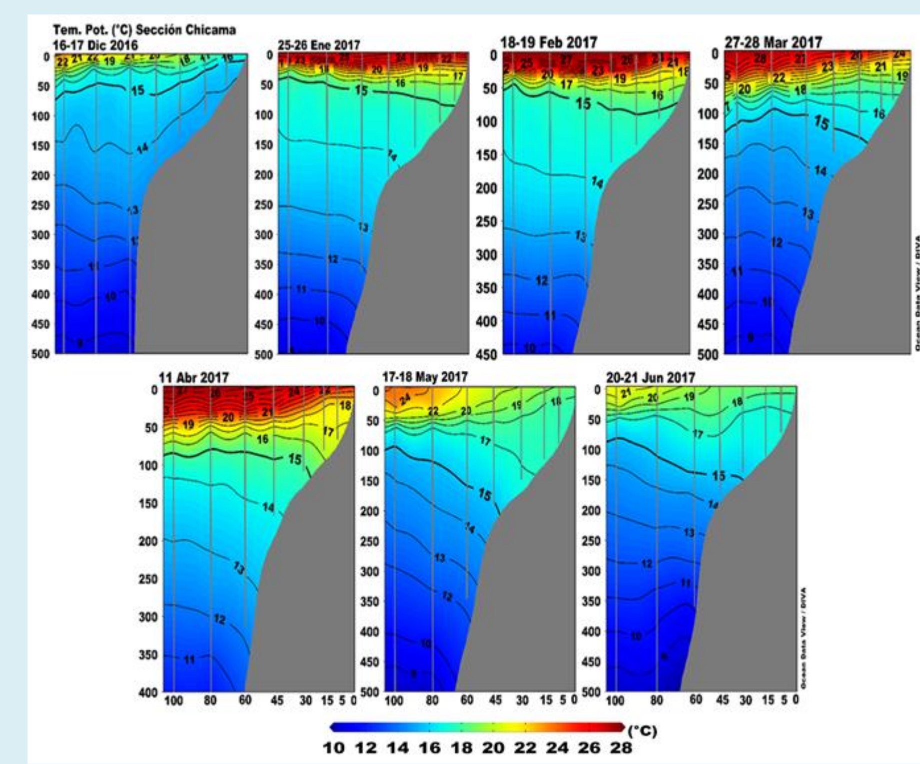

Figure 3: Vertical distribution of potential temperature (°C) in the Paita section in relation to the distance from the coast (n. m.). Period since December 2016 to June 2017. The distribution of the isotherms indicates the rise and deepening of the ISO of 15 °C, during the study period..

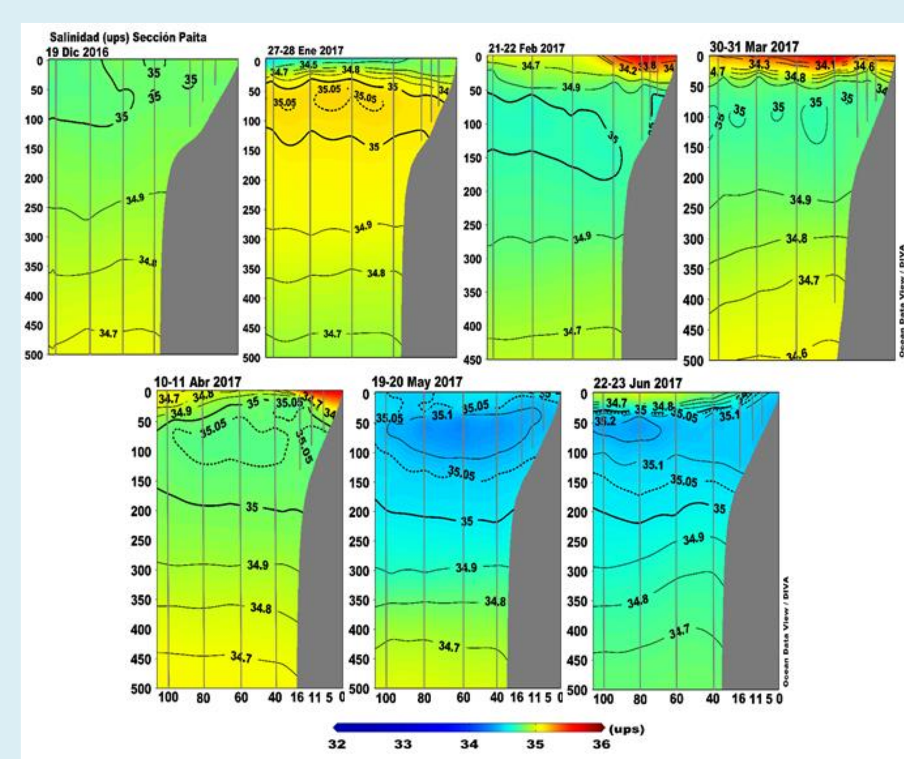

Figure 4: Vertical distribution of salinity (ups) in the Paita section in relation to the distance from the coast (n. m.). Period since December 2016 to June 2017. The salinity ranges indicate the presence of different bodies of water during the study period.

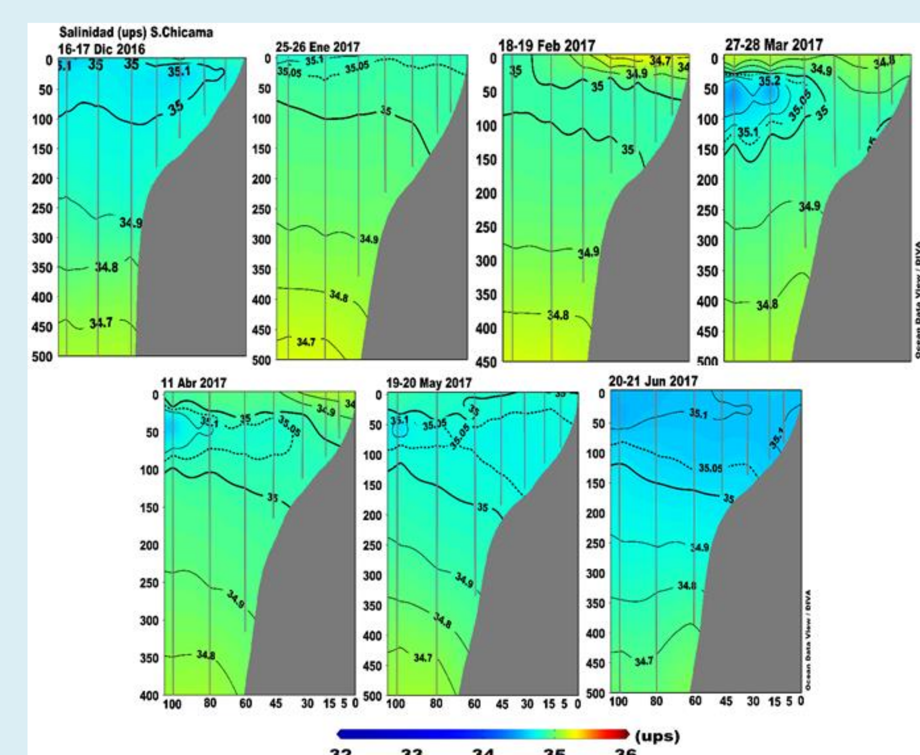

Figure 5: Vertical distribution of salinity (ups) in the Chicama section in relation to the distance from the coast (n. m.). Period since December 2016 to June 2017. The salinity ranges indicate the presence of different bodies of water during the study period.

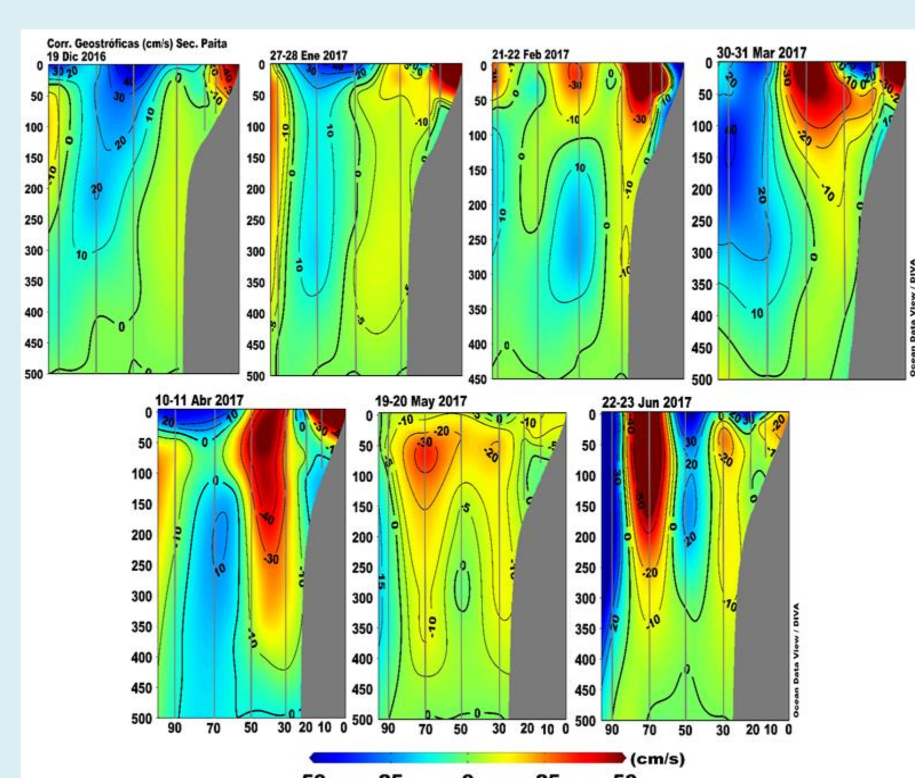

Figure 6: Vertical distribution of the geostrophic flow (cm/s) in the Paita section in relation to the distance from the coast (n.m.). Period since December 2016 to June 2017. Positive values indicate northward flows, while negative values southward flows.

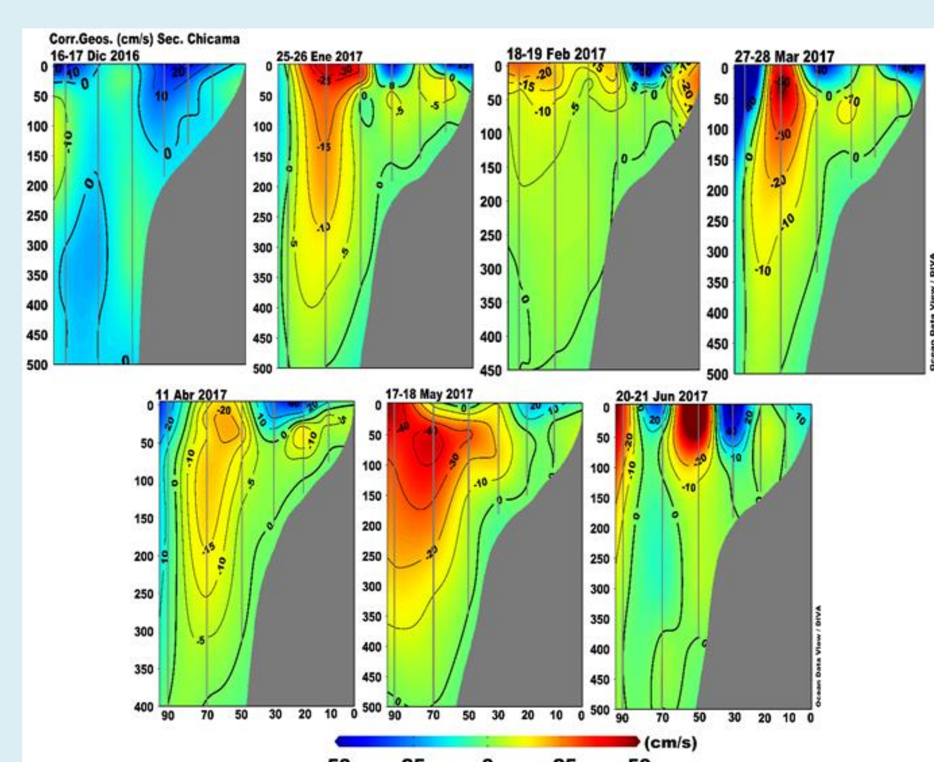

Figure 7: Figure 6: Vertical distribution of the geostrophic flow (cm/s) in the Chicama section in relation to the distance from the coast (n.m.). Period since December 2016 to June 2017. Positive values indicate northward flows, while negative values southward flows.

CONCLUSIONS

During the 2017-CEN, between January and March, the following were observed:

- Differentiated thermal gradients in the layer from 0 to 50 m, which indicated the presence of 2017-CEN, due to the deepening of the 15 °C isotherm.
- The saline gradients indicated the presence of tropical surface waters (TSW) and equatorial subsurface waters (ESSW), which expanded to the Chicama station.
- Predominant geostrophic flows in a southerly direction, which contributed to the warming of the subsurface of the vertical structure.

References:

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