The Role of Summer Surface Thermal Structure in Modulating Baroclinic Velocities over the Continental Shelf of Concepción, Chile.

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The presented manuscript is part of the author's graduate education in the Graduate Program in Oceanography at the University of Concepción, Chile. Initially, the data analysis was conducted using Matlab; however, the second version of the manuscript data analysis was entirely re-written using Python and Julia.

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Abstract

Coastal cooling, driven by upwelling, coastal mixing, and the advection of nearby cold upwelled fronts, significantly influences the stratification of the upper ocean over the continental shelf of Concepción. This stratification modulates baroclinic velocities mostly dominated by Near-Inertial Oscillations. Wind-induced circulation plays a crucial role in modifying sea surface temperatures (SST) and the vertical thermal structure of the coastal ocean, with important implications for both physical and ecological processes in the region.

Introduction

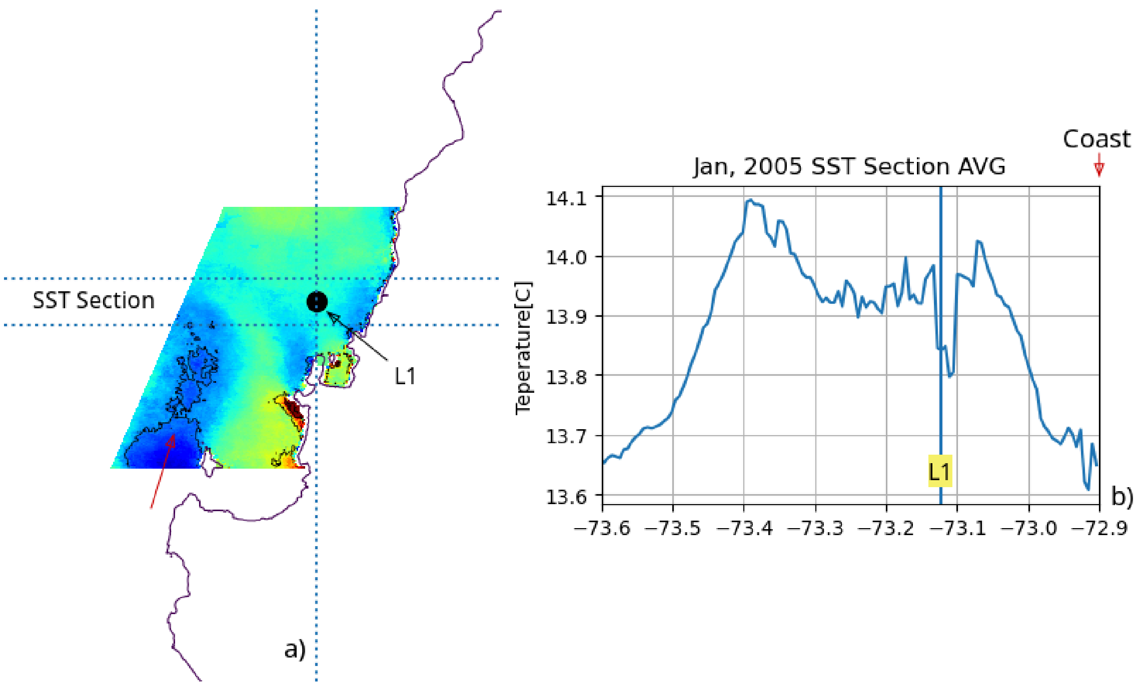

Figure 01:

Methods and data analysis

Data Collection and Instrumentation: Horizontal current velocities were measured using a bottom-mounted Acoustic Doppler Current Profiler (ADCP) deployed at a depth of 100 meters over the continental shelf of Concepción, Chile. The ADCP recorded velocity profiles at 30-minute intervals, covering a vertical range from approximately 8-10 meters to 90 meters depth, with a vertical resolution of 4 meters. Measurements were conducted over a 25-day period, from January 1 to January 25, 2005. **Baroclinic Velocity Extraction:** Baroclinic velocities were derived by subtracting the barotropic component from the raw current velocities (u and v). The barotropic velocities were estimated using the tidal analysis software UTIDE (Codiga 2011), which was applied to the alongshore and cross-shore velocity components to isolate the depth-independent tidal signals. **Spectral and Wavelet Analysis:** To identify dominant frequencies and temporal variability in the baroclinic velocities, rotary spectral analysis was performed. This method decomposes the velocity field into clockwise and counterclockwise rotating components, providing insights into the energy distribution across different frequencies. A Morlet wavelet-based rotary analysis was additionally applied to examine the time-frequency characteristics of the baroclinic velocities. This approach allowed for the identification of non-stationary signals and the temporal evolution of dominant frequencies. **Quality Control and Data Processing:** Raw ADCP data were pre-processed to remove outliers and correct for instrument errors. Gaps in the data were interpolated using linear methods to ensure continuity for spectral and wavelet analyses. All analyses were conducted using Python, with custom scripts developed for tidal analysis, spectral decomposition, and wavelet transformation.

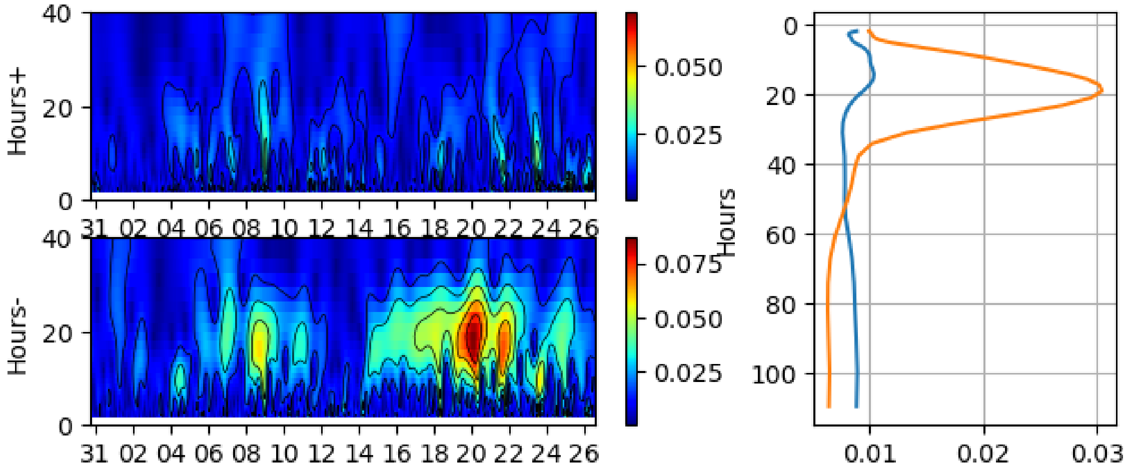

Figure 01: Panels (a) and (b) depict the positive and negative rotary wavelet spectra, respectively. Panel (c) shows the time-averaged wavelet spectrum, highlighting the dominance of anticlockwise rotary frequencies centered around the near-inertial frequency. These spectra are derived from the baroclinic velocities of the first mode of the upper ocean current velocities.

Codiga, Daniel L. 2011. “Unified Tidal Analysis and Prediction Using the UTide Matlab Functions.” Graduate School of Oceanography, University of Rhode Island. https://doi.org/10.13140/RG.2.1.3761.2008.