COASTAL-TRAPPED WAVES ALONG THE EAST-SOUTHEASTERN BRAZILIAN CONTINENTAL MARGIN: PROPAGATION AND MODAL STRUCTURES

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1. INTRODUCTION

The propagation of Coastal Trapped Waves (CTW) can be an important mechanism for the variability of currents along the continental shelf and slope regions. The present work aims to characterize the propagation of CTWs along the East/Southeastern Brazilian continental margin, and its effect on sea level and currents.

The data set used consists of coastal sea level time series measured at 11 coastal stations between 48°S to 12°S and continental shelf-break velocity time series measured at 5 stations between 31.5°S and 16°S. In addition, a high-resolution ocean model (HYCOM 1/24°) configuration from the UFRJ/COPPE Physical Oceanography Laboratory was used.

2. DATA SET AND METHODS

The data were filtered by a 4th order bandpass with cutoff frequencies of 0.025 and 0.43 cycles per day (cpd), which cover typical periods (3 - 30 days) of propagation of synoptic atmospheric systems in the region.

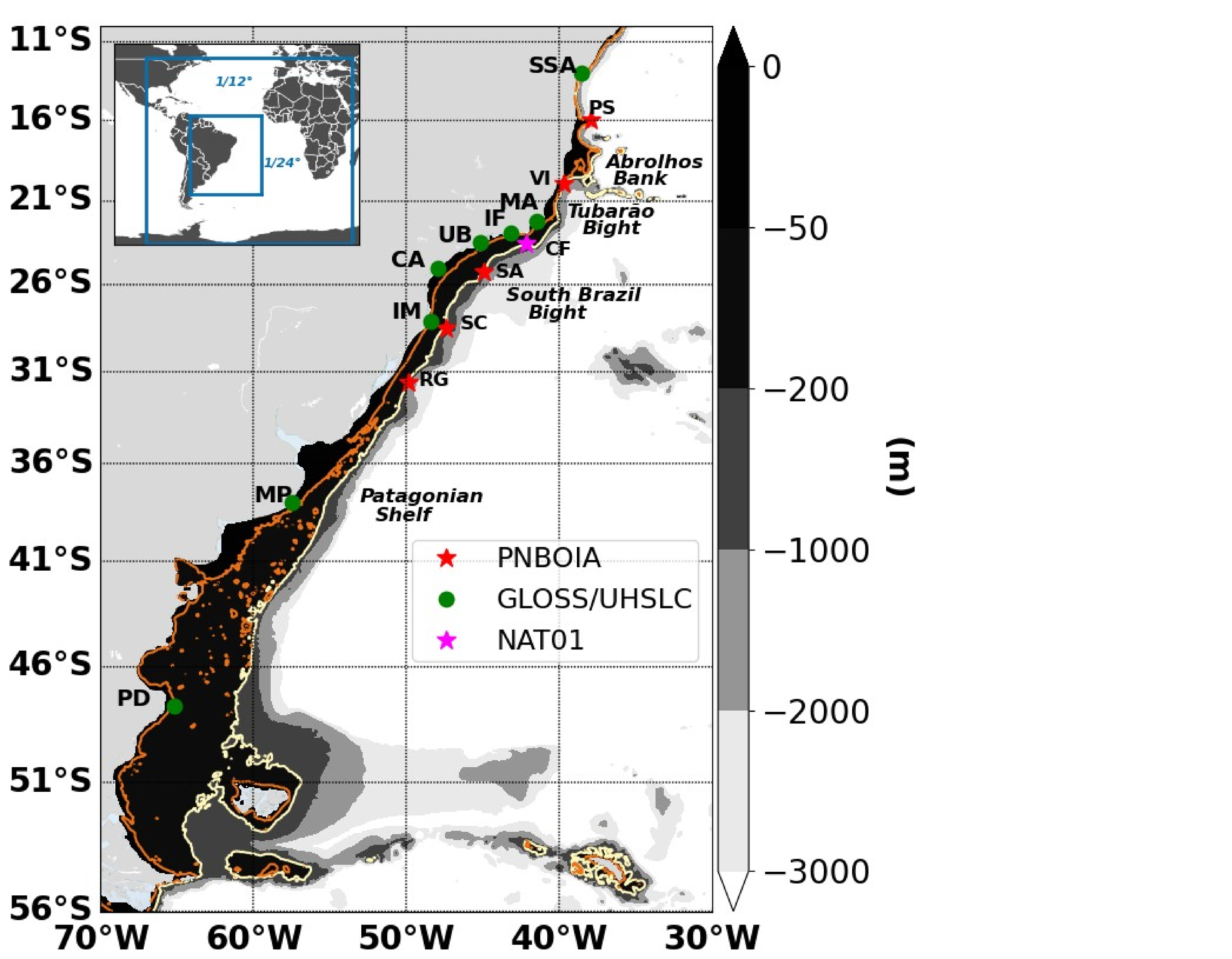

Figure 1. Bathymetry of the Southwestern Atlantic continental shelf (shaded), indicating the coastal sea level stations (GLOSS/UHSLC - green circles) and mooring positions (PNBOIA and NAT01 - red and magenta stars, respectively).The 50 m isobath is highlighted (orange), indicating the approximate inner portion of the continental shelf. The 200 m isobath is highlighted (yellow), indicating the approximate position of the shelf break. The inset indicates the model domains for the 1/12◦ and 1/24◦ horizontal resolution simulations.

3 RESULTS AND DISCUSSION

The in situ data indicates that the CTW coastal sea level propagates equatorward between 28°S and 22°S at a speed of 11 m/s and then decreases to speeds of 3 m/s, which is followed by a decrease in amplitude and correlation when compared to the signal further south, at the generation region. The latitudinal variations of the phase velocity of the CTWs indicate a close relation with the width of the Brazilian East/Southeast continental shelf.

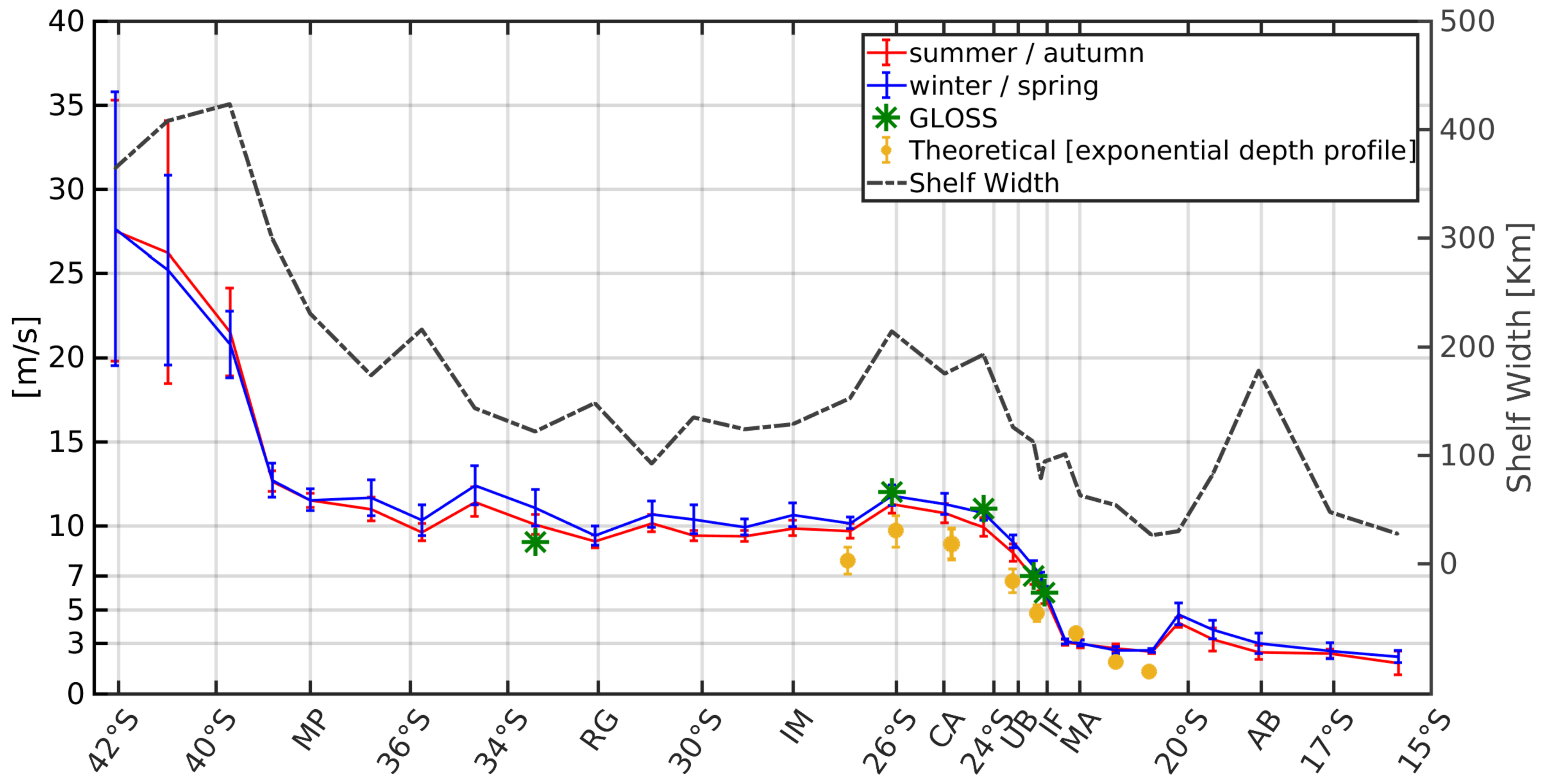

Figure 2. Phase speed (in m s⁻¹) of CTWs evaluated from SSH at the 50 m isobath and based on an 11-year (2006–2016) HYCOM 1/24 ◦ simulation considering periods of larger(red line) and smaller (blue line) stratification. The green dots represent the same property calculated using SSH from the sea level stations presented in Fig. 1. The yellow dots represent the theoretical values based on free CSWs theory using an exponential depth profile of the continental shelf with a deviation bar associated with a variation of 10% of the width of the continental shelf. The black dotted line represents the shelf width (in km).

The coastal sea level is highly correlated with variations in the intensity and direction of the alongshore currents at the continental shelf-break between 31.5°S and 16°S, indicating that the CTW propagation can be perceived near the shelf-slope region and therefore can also interact with the adjacent Brazil Current.

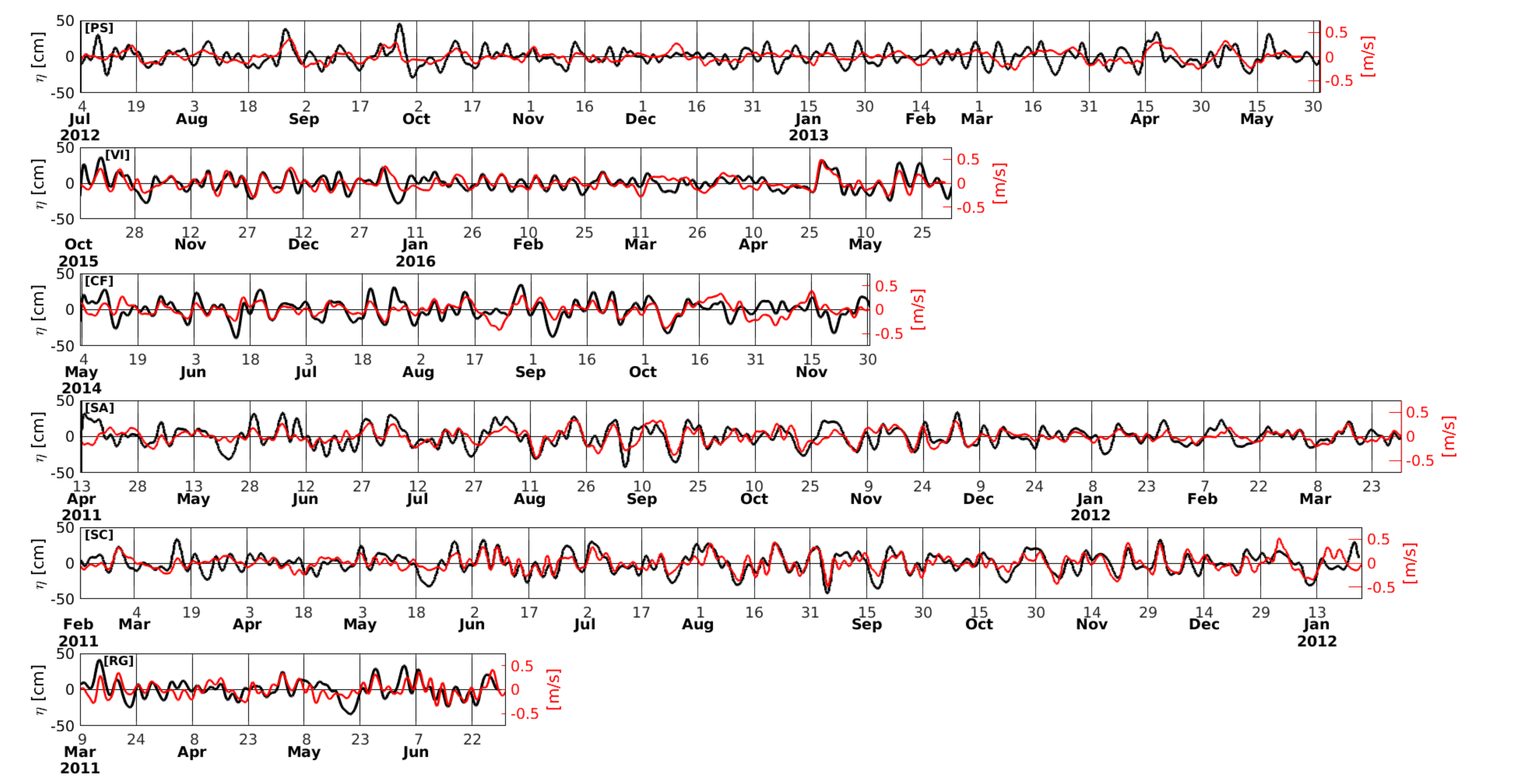

Figure 3. Comparison between sea level at IF coastal station (black line) and the top 50 m depth-averaged alongshore velocity component at the continental shelf-break moorings (red lines). The correlation coefficients between sea level at IF and velocity at the moorings are 0.4 (RG), 0.7 (SC), 0.6 (SA), 0.6 (CF), 0.6 (VI) and 0.4 (PS) (from bottom to top). The time series are plotted with maximum correlation lag (in hours) correction of 45 (RG), 27 (SC), 10 (SA), 8 (CF), − 42 (VI) and − 126 (PS). The geographical locations of the stations and their names are illustrated in Fig. 1.

Spectral analysis of the coastal sea level time series between 44°S and 11°S extracted from the HYCOM model show that the energy in the 3 and 30-day band is higher in the Argentine shelf region (41°S) and significantly decreases between 22°S and 18°S.

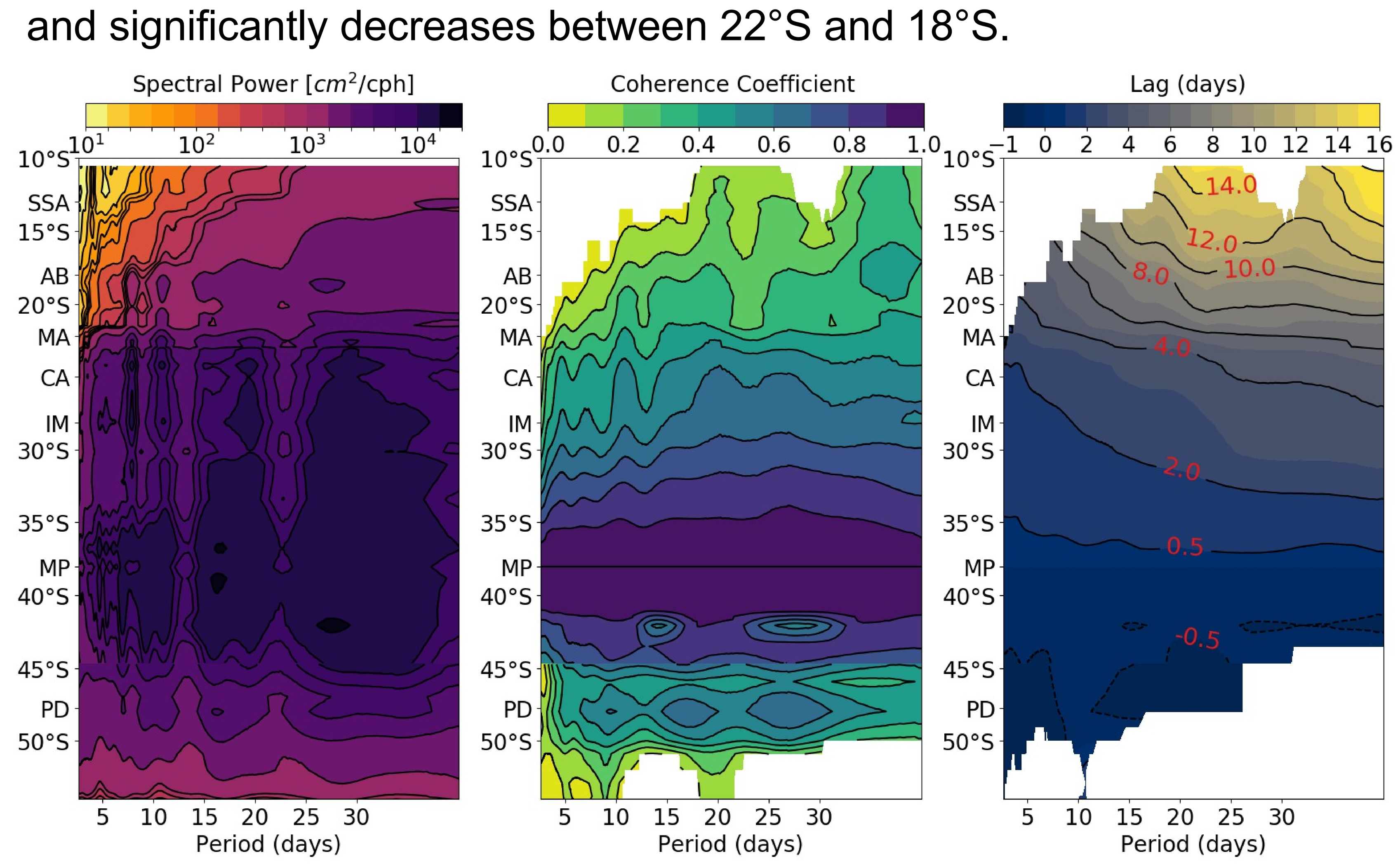

Figure 4. (Left panel) Spectral analysis (FFT) of the SSH at the 50 m isobath based on 11-year (2006–2016) HYCOM 1/12◦ (south of 45.18◦ S) and 1/24◦ (north of 45.18◦ S) simulations; (central panel) associated cross-spectrum coherence coefficients; and (right panel) cross-spectrum lag between station MP and the other stations with a 99% confidence interval. The red labels are lag values.

EOF analyses of 3 and 30-day band filtered velocity along selected cross-shore sections show that the first statistical mode is dominant (>75%) along the coast.However, between 23.7°S and 20.7°S, a region that encompasses the Cabo Frio coastal upwelling, the second statistical mode shows an increase in percentage importance (~19%).Using the linear model of Brink and Chapman (1987), it was possible to identify that the structure of the second statistical mode in this region is similar to that of the first CTW baroclinic mode.

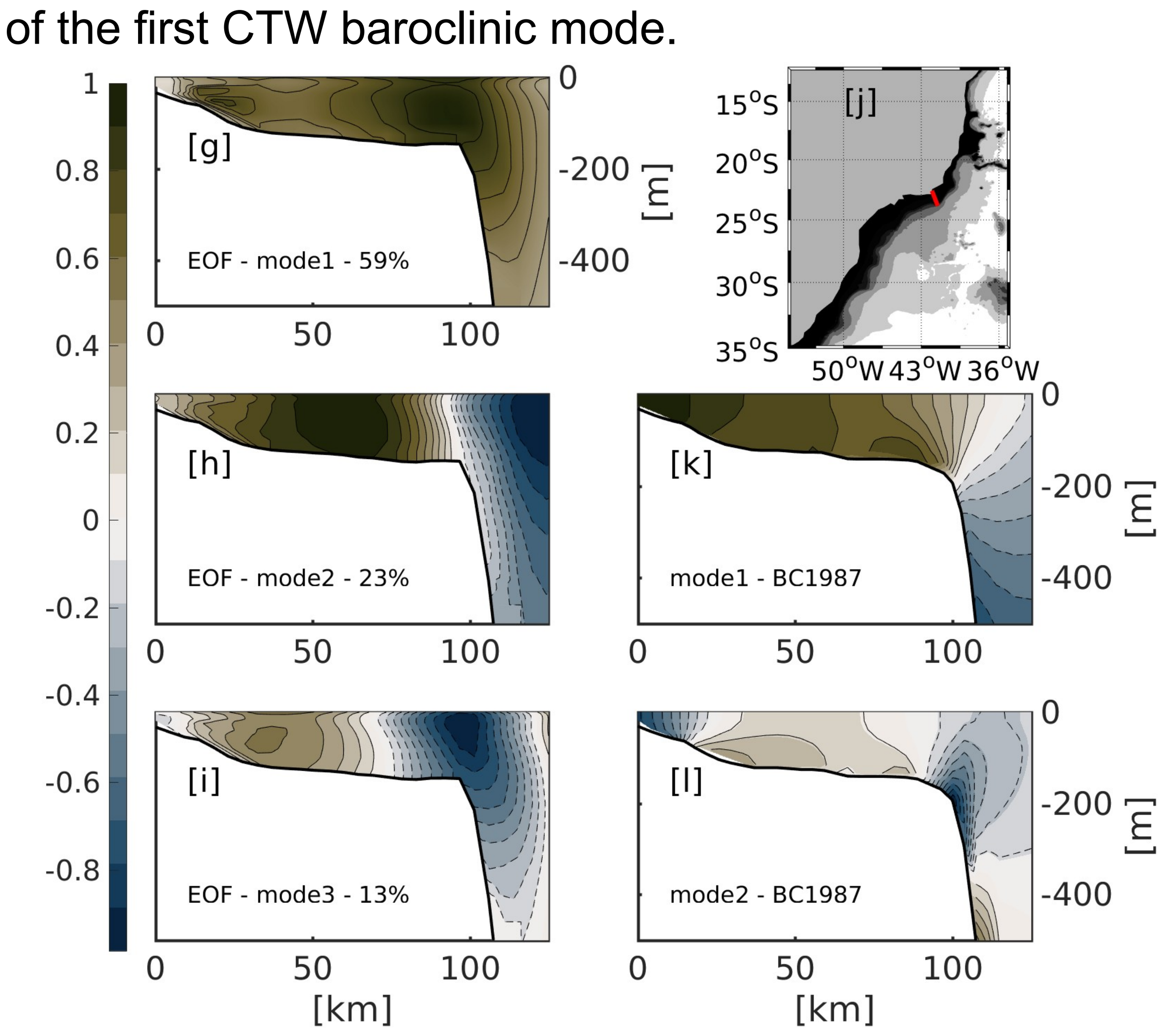

Figure 5.(Left panels) The first (g), second (h), and third (i) EOF modes based on the analysis of the alongshore velocity at two selected cross-shore sections located at the SBB shelf and based on the outputs of an 11-year (2006–2016) HYCOM 1/24◦ simulation. (Right panels). The first (k) and second (l) baroclinic modes from Brink and Chapman (1987) linear model for the same two cross-shore sections. The locations of the two cross-shore sections are indicated in panels j.

References
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