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Supplementary Materials for

Coastal trapped waves and tidal mixing control primary production in the tropical Angolan upwelling system

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Overview of observation

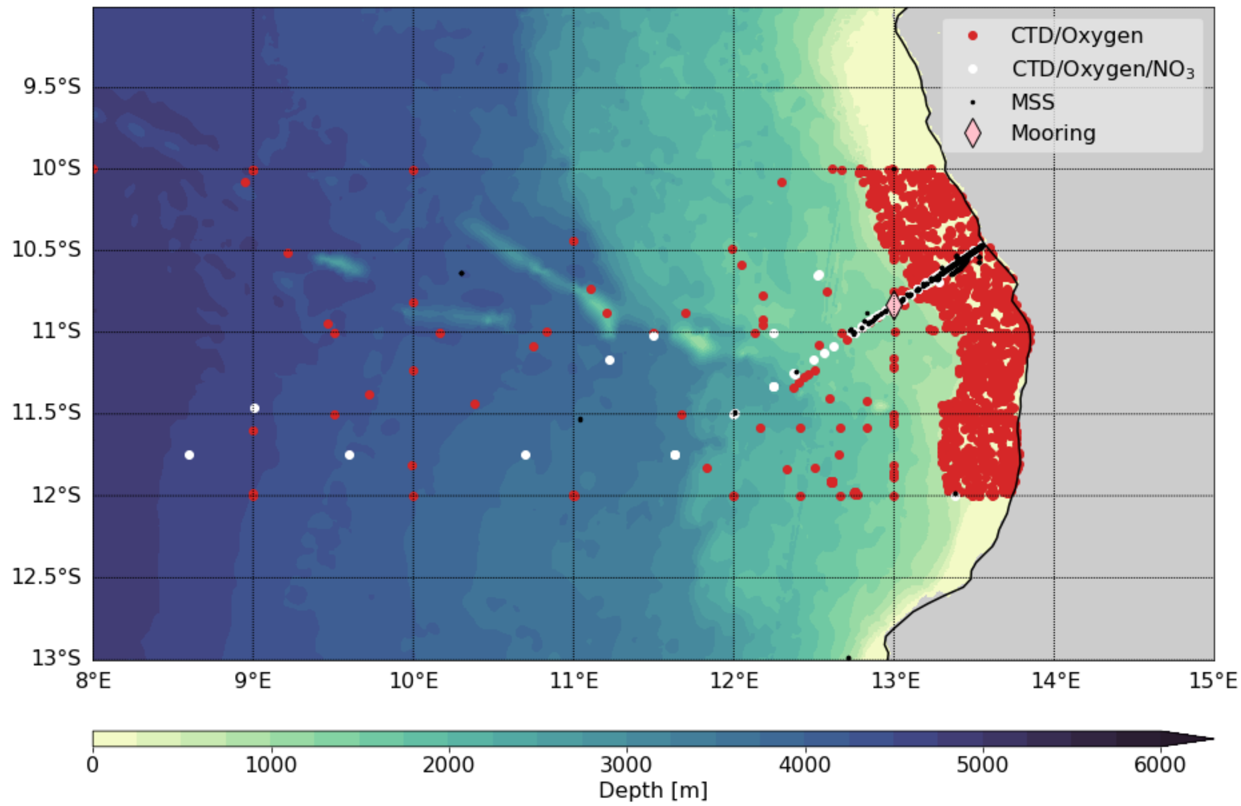

Figure S1: Overview of observational data used in this study. Red points display conductivity-temperature-depth (CTD) and oxygen profiles. White points show CTD profiles where oxygen and nitrate were measured as well. Black points show the location of microstructure measurements. The pink diamond indicates the mooring position.

Cruise	**Time**	**CTD/Oxygen profiles**	**Discrete NO_3 samples**	**Microstructure profiles**
M98	June 2013	21	0	212
M120	Oct/Nov 2015	23	83	62
M121	Nov/Dec 2015	11	36	0
M131	Oct/Nov 2016	19	11	44
M148	June 2018	29	192	135
M158	Sep 2019	21	15	41
M181	Apr 2022	20	45	207

Table S1: Overview of observational data collected during *R/V Meteor* cruises used in this study. The number of CTD/Oxygen profiles refers to the number of profiles taken between 8°S and 15°S east of 11°E. The number of discrete NO_3 samples refers to the number of samples used for the fit between NO_3 and AOU (samples taken between 8°S and 15°S east of 11°E in the upper 400 m). The number of microstructure profiles refers to the number of profiles taken between 8°S and 15°S, east of 11°E.

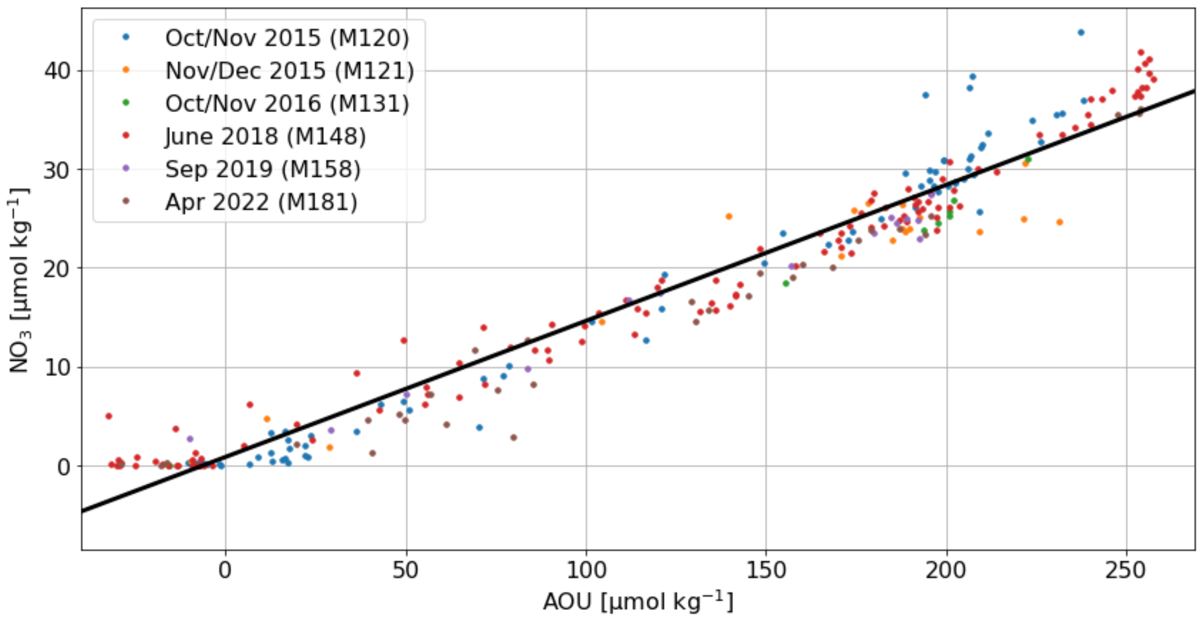

Figure S2: Relationship between Apparent Oxygen Utilization (AOU) and Nitrate (NO_3). Dots show the bottle data of CTD casts taken in the upper 400 m. CTD casts were taken during different cruises (colors, see legend). The black line shows the linear fit of the sample data.

Theoretically derived CTW modes

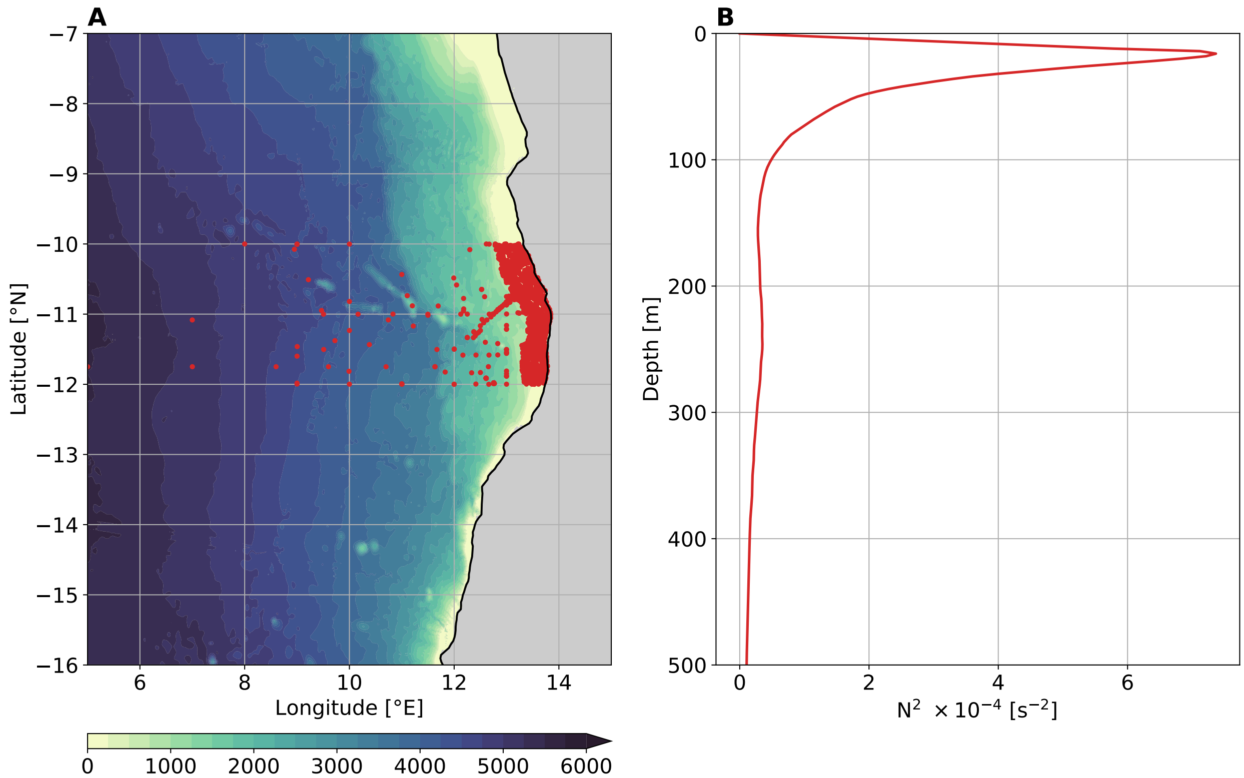

Figure S3: Stratification used to calculate CTW modes. (a) shows the positions of the used CTD profiles (red dots) and the bathymetry (shading). (b) shows the mean profile of the squared Brunt-Väisäla frequency in the upper 500 m.

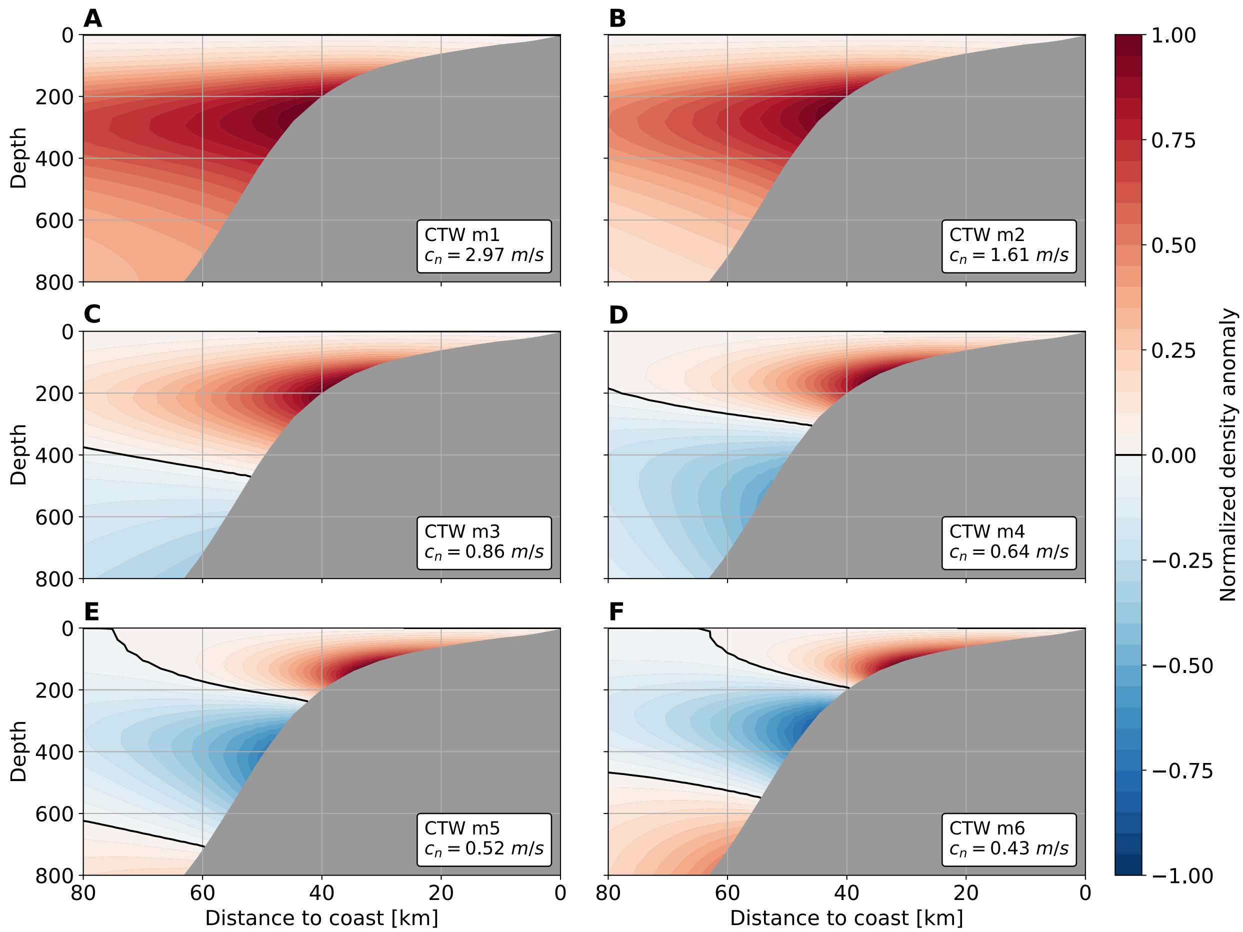

Figure S4: Cross-shelf – depth structure of density anomaly of the first six theoretical CTW modes at 11°S based on stratification and cross-shelf topography. The black line marks the zero line. The distributions are normalized to the maximum density anomaly of each mode. The associated phase speed of each mode is given in the lower right corner.

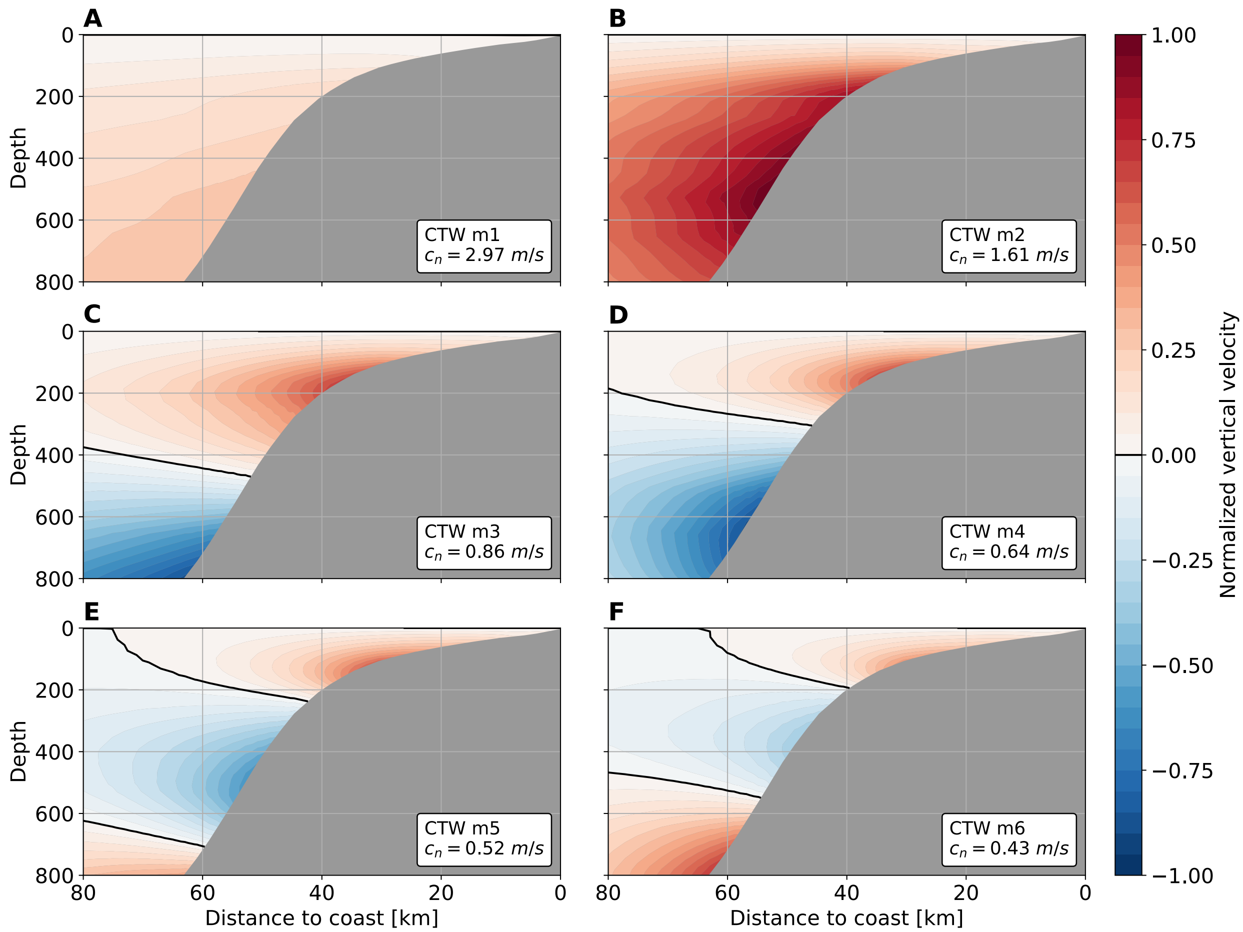

Figure S5: Cross-shelf – depth structure of velocity structure functions of the first six theoretical CTW modes at 11°S based on stratification and cross-shelf topography. The black line marks the zero line. The fields are normalized to the maximum velocity of each mode. The associated phase speed of each mode is given in the lower right corner.

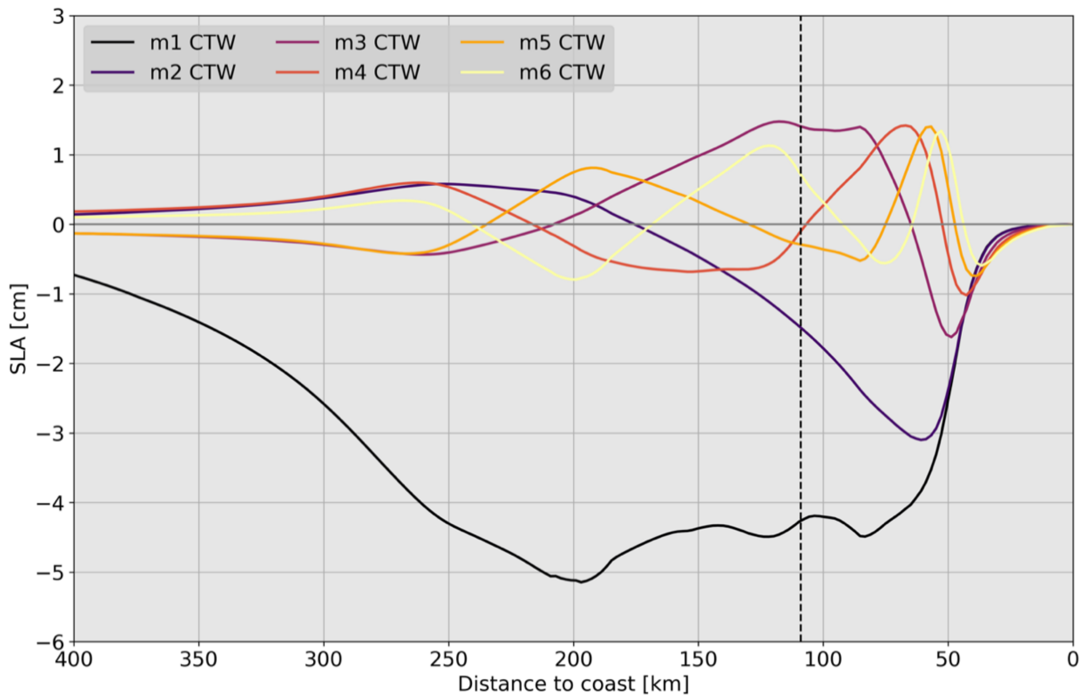

Fig S6: SLA signal of the first six CTW modes as a function of the distance to the coast. The SLA is calculated by vertically integrating the normalized density structures and by multiplying by a typical density variation divided by the mean density ($^{\Delta\rho}/_{\rho_0} = 1 \times 10^{-4}$). The dashed vertical line marks the distance of 1° in longitude.

CTW signal in moored velocity observations

We utilize moored velocity data to analyze the signal from CTWs on the Angolan shelf. The mooring is located at 10°50'S; 13°00'E at a water depth of approximately 1200 m (Fig. S1). The mooring measures velocity in the upper 500 m up to 45 m below the sea surface. We use geostrophic velocities from satellite observations to obtain information about the surface currents.

We analyze the alongshore velocities. Note that the mooring location is not ideal for separating the contribution of different CTW modes, as the velocity variability of the different modes is generally weak at this location (Fig. S7).

To extract the signal of the seasonal CTWs in the moored velocity data, we first filter out the variability on intraseasonal time scales. We do this by applying a low-pass filter to the mooring time series with a cut-off period of 135 days (Fig. S8). We also subtract the mean velocity at each depth respectively to remove the influence of the Angola Current. We then average the velocity data with respect to the annual minimum in SLA (Fig. S9). The derived mean alongshore velocity component reveals a signal indicative of a high-mode upwelling CTW that arrives about 25 days after the SLA minimum. In addition, the velocity field shows upward propagating wave phases after the arrival of the SLA minimum, indicating downward energy propagation.

Note that Fig. S9 shows a mismatch between the geostrophic surface velocities and the moored velocities prior to the annual minimum in SLA. This mismatch could arise from low effective horizontal resolution of the gridded altimetric SLA data (i.e., 100-200 km effective spatial resolution).

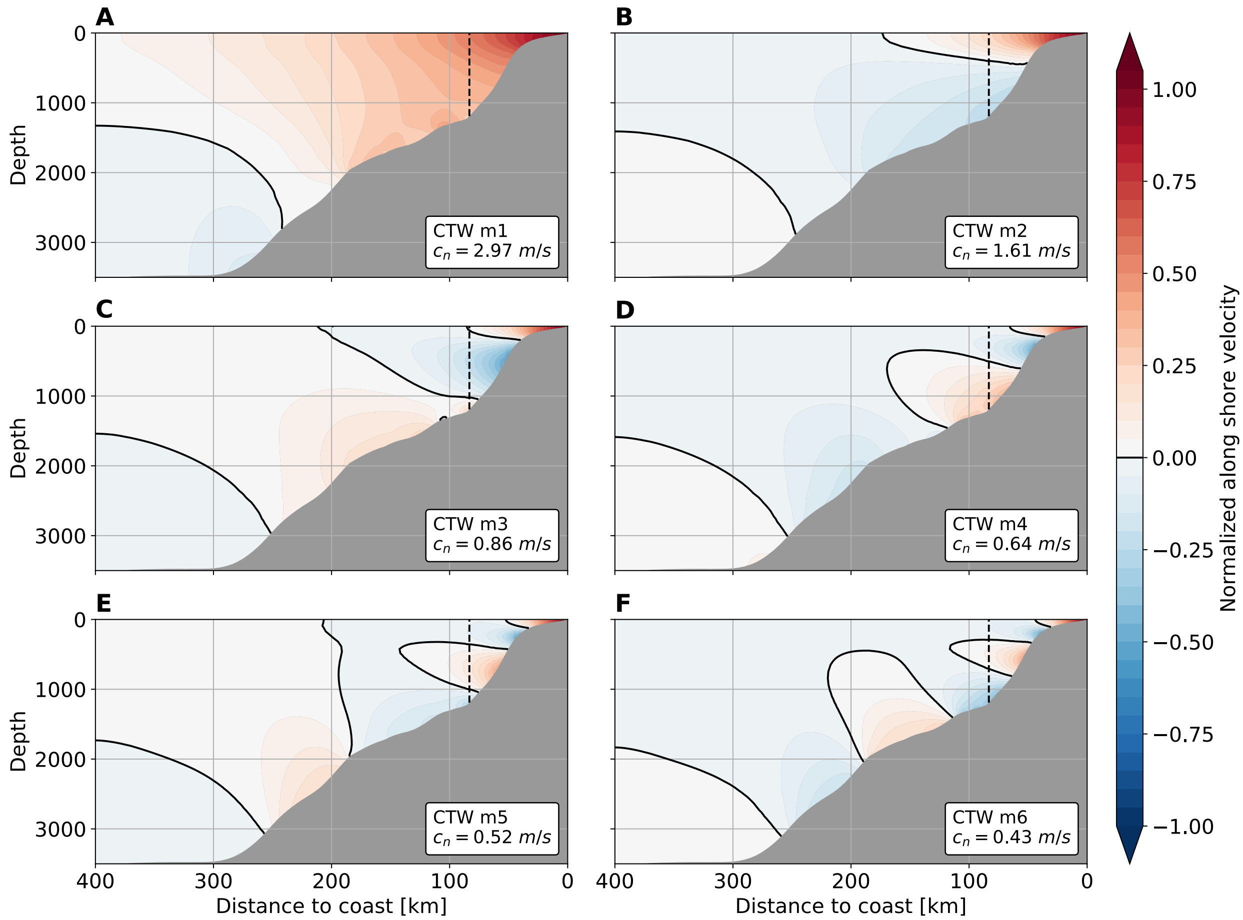

Figure S7: Alongshore velocity structure functions of the first six theoretical CTW modes at 11°S. The fields are normalized to the maximum velocity of each mode. The structures correspond to upwelling CTWs. The associated phase speed of each mode is given in the lower right corner. The black line marks the zero line of the alongshore velocity. Black dashed lines give the position of the mooring.

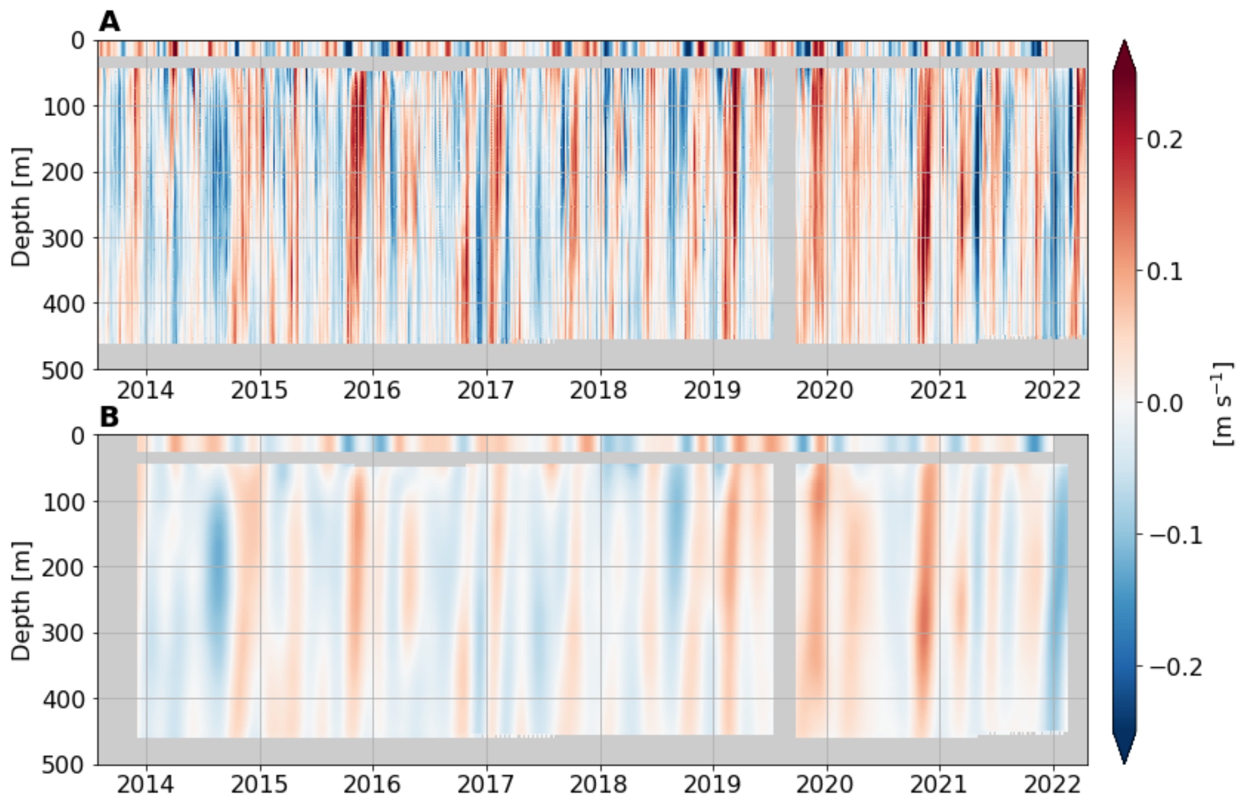

Figure S8: (a) Observed alongshore velocity (rotated by -34°) of a mooring installed at 13°00′E; 10°50′S (1200 m depth). Positive values represent northward flow and negative velocities southward flow. (b) shows the same as (a), but intraseasonal variability is removed by applying a low-pass filter (cutoff period = 130 days). At the surface, the corresponding geostrophic alongshore velocities from SLA are plotted. The mean velocity profile has been subtracted. The geostrophic velocities are taken from the SLA DUCAS satellite data product (https://doi.org/10.48670/moi-00148).

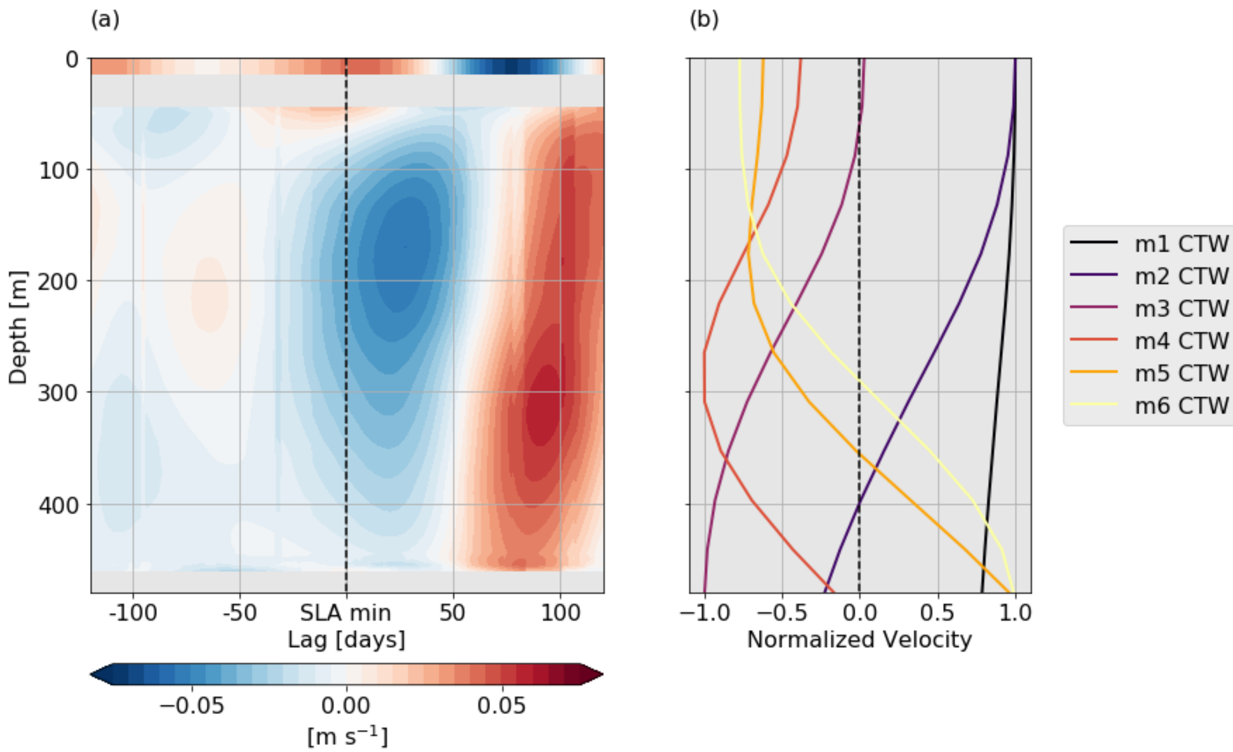

Figure S9: (a) Mean alongshore velocities averaged with respect to the annual SLA minimum. The mean velocity profile has been subtracted. (b) Vertical structures of alongshore velocity of the first six CTW modes at the mooring locations (see Fig. S6). The velocity structures are normalized with respect to the maximum in the profiles shown here.

Zonal velocity associated with the passage of CTWs in a regional ocean model

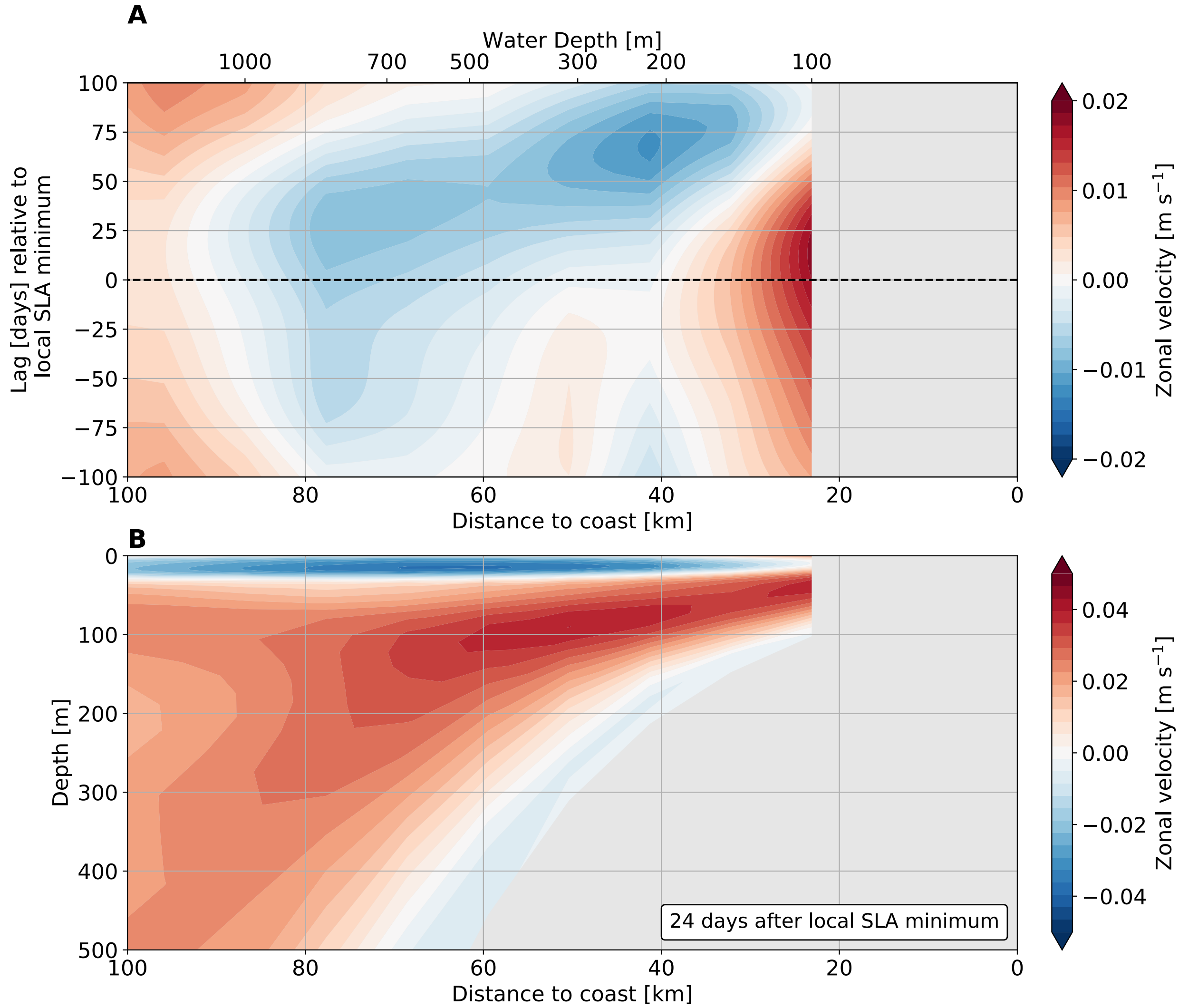

Figure S10: Zonal velocity at 11°S in a regional ocean model. (a) Zonal velocity from the CROCO simulation averaged within 10 – 50 m above the topography as a function of distance to the coast and lag [days] relative to the local SLA minimum. (b) Cross-shelf section of CROCO zonal velocity 24 days after the local SLA minimum. Fields presented here are composite of 58 upwelling seasons.

Lead lag correlation between SLA and NPP

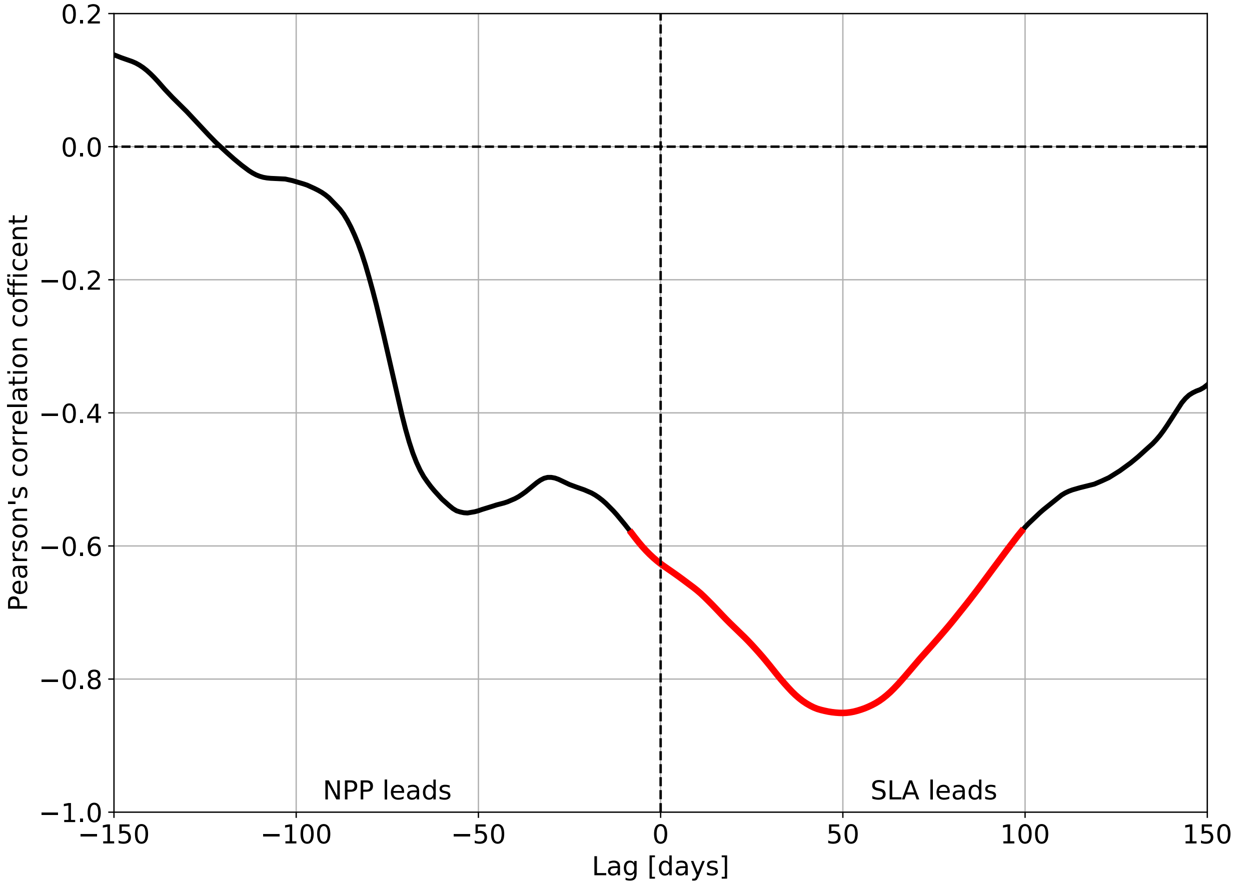

Figure S11: Pearson's correlation coefficient derived by correlating the interannual time series of the three-month mean SLA around the annual SLA minimum in the austral winter with the corresponding three-month mean NPP time series at different lags. The timing of the annual minimum SLA is determined using the SLA time series treated with a low-pass filter (cut-off period of 130 days). Red line shows significant correlation at the 99% confidence level. Both NPP and SLA data is averaged between 8°S and 15°S within 1° distance to the coast. Data from 2003 – 2021 was used.