

Evolution of Physical and Biological Patterns Along the Tropical and South Atlantic Western Boundary

A Satellite Perspective

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Key Points:

- Large-scale interannual temperature signals consistently propagate northward along the whole western boundary
- The Amazon region shows a local maxima in intra-annual chlorophyll signals
- Salinity has no dominant seasonal cycle away from major rivers

Supporting Information:

Supporting Information may be found in the online version of this article.

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Evolution of Physical and Biological Patterns Along the Tropical and South Atlantic Western Boundary: A Satellite Perspective

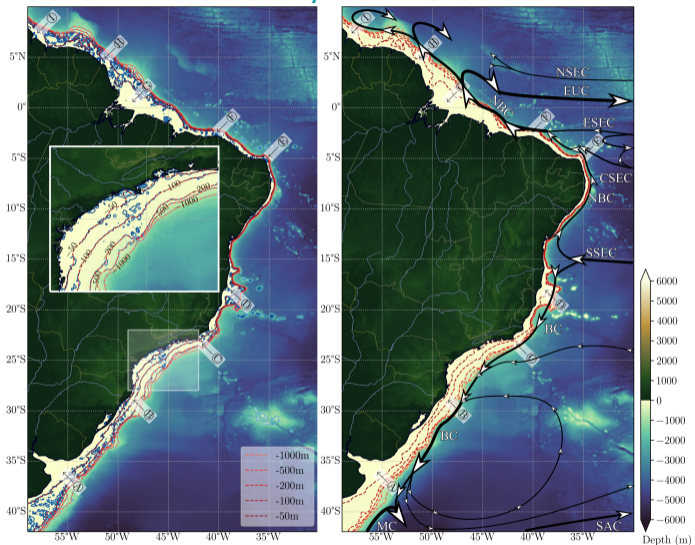
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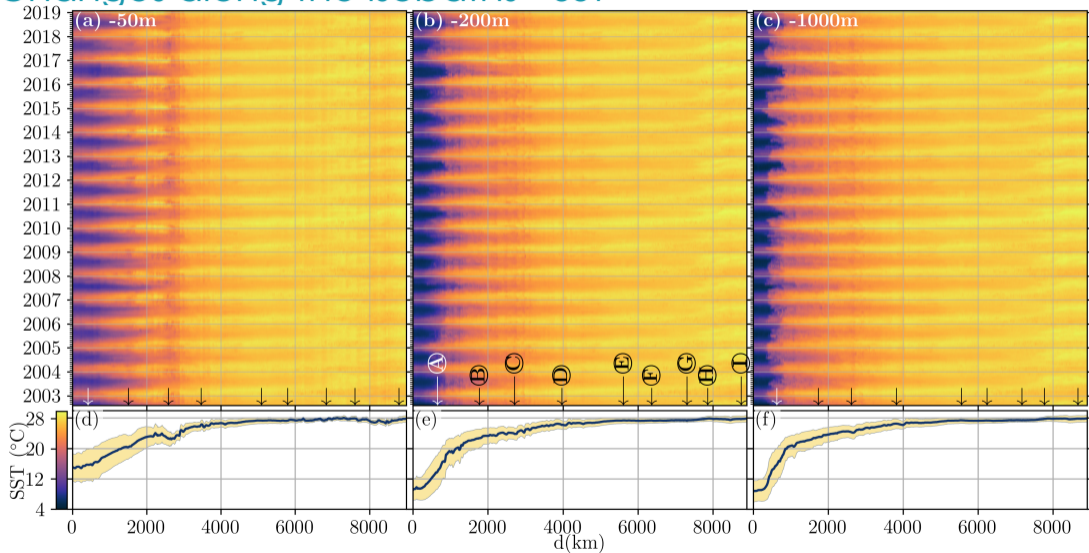
Abstract We investigate the spatial and temporal patterns of satellite-derived sea surface temperature, salinity and chlorophyll-a concentration along the eastern South American coast. Two decade-long time series (2002–2019; except for the salinity) allowed us to investigate changes from seasonal to interannual time scales on an array that stretches from the south (42°S) to the north (10°N) of the continent and from isobaths ranging from –50 to –1000 m away from the coast. The novelty of our approach is to assess comparatively the magnitude, variability, and spectrum of these variables following the same isobaths and using the same methodology. This allowed us to examine the influence of large scale ocean circulation patterns entangled with the local forcing systems such as river discharge and coastal currents, and to quantify to what extent these patterns are spatially and temporally consistent. The seasonal cycle of the temperature explains more variance than that of salinity and chlorophyll on average. Comparatively, salinity has a weak seasonal signal, except near major rivers. Significant long-term trends were observed in specific regions in the salinity time series. Our study revealed distinct interannual changes at 2- and 4-year period in the whole array with the largest spectral peaks near the La Plata and the Amazon Rivers. Within this period band, thermal signals propagate northward along the whole array. Statistical correlations between satellite-derived variables and several climate indices suggest remote forcing.

Plain Language Summary Studies based on satellite data are useful to assess surface ocean properties on a continuous and regular basis, with global coverage and consistent methodology. In this article

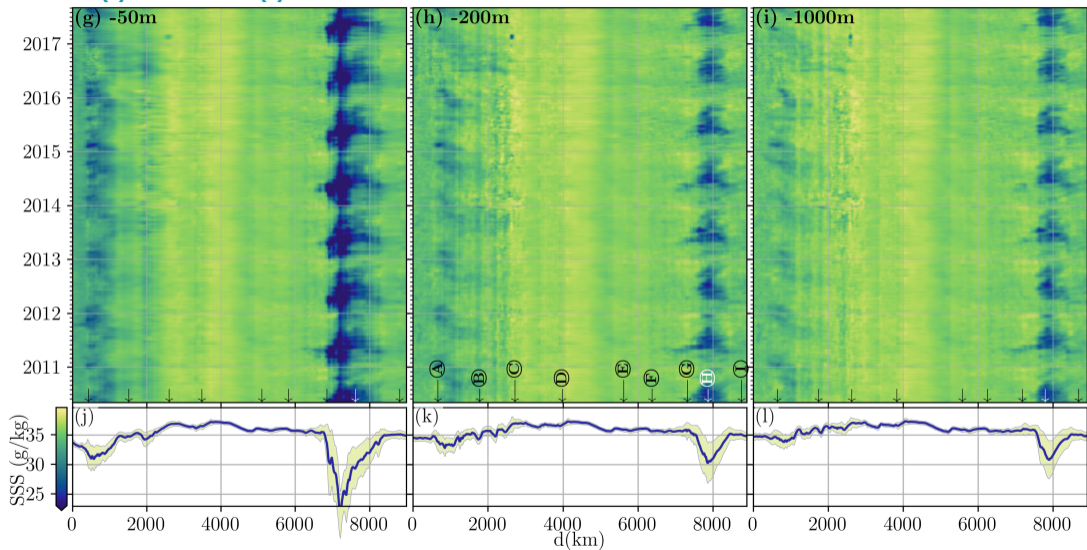
Along the Western Boundary of the South Atlantic



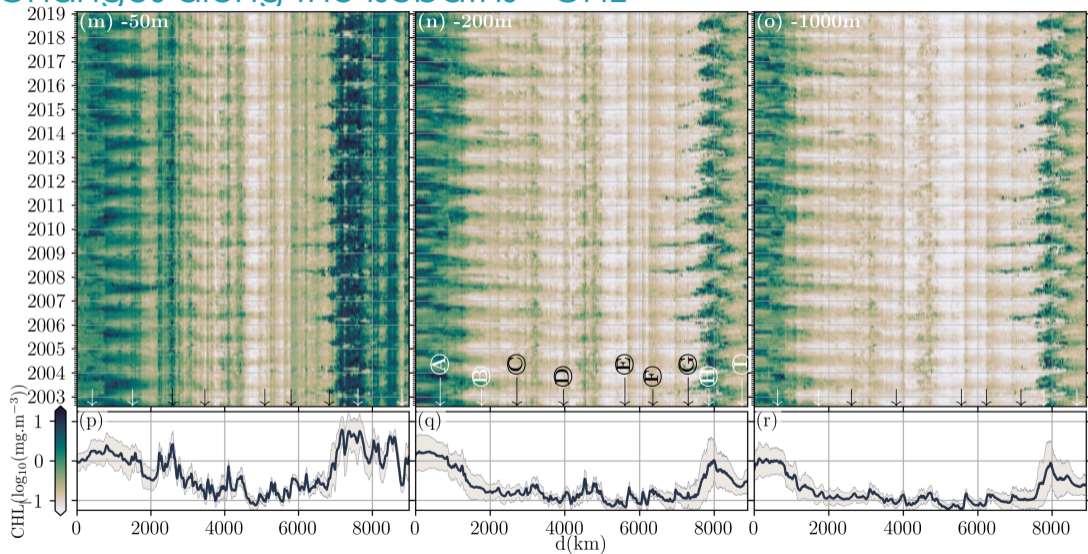
Changes along the isobaths - SST



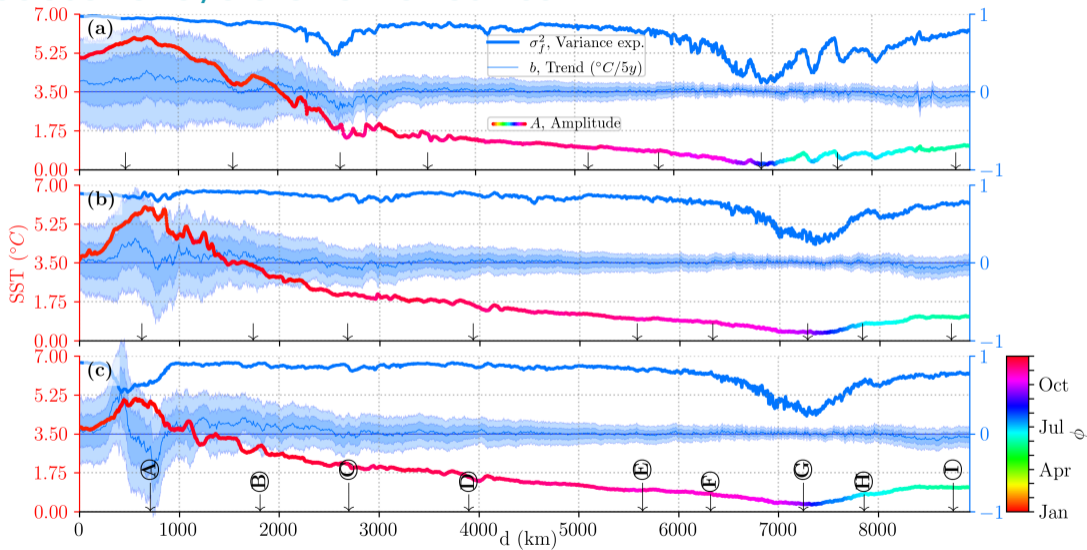
Changes along the isobaths - SSS



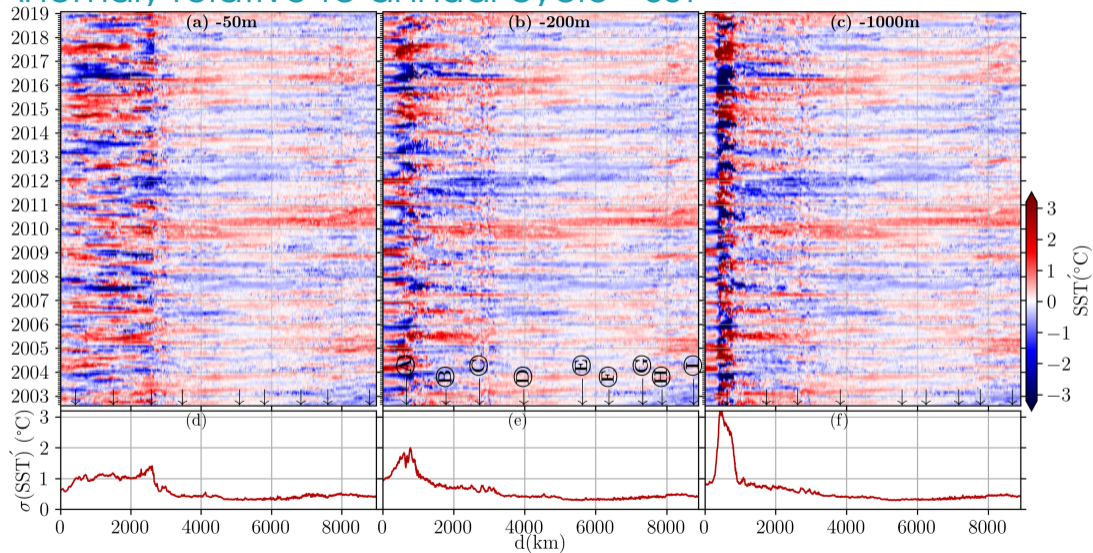
Changes along the isobaths - CHL



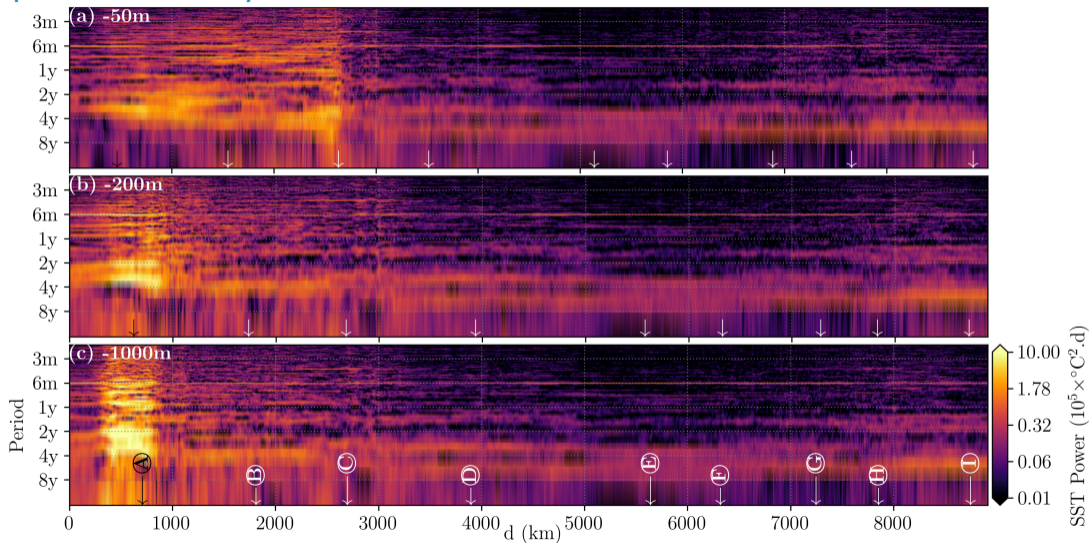
Seasonal cycle and trends - SST



Anomaly relative to annual cycle - SST



Spectral analysis - SST



Correlation with Climate Indices

Table 1
Zero-Lag Correlations Between the Climate Indices and Variables SST, SSS, and CHL (the Three Values Shown in Each Cell) at Each Selected Position (A to I) of the -200 m Isobath

Index	A	B	C	D	E	F	G	H	I
El Niño 3.4	-	-0.53	-0.57	-0.76	-0.37	-	-	-	-
	-	-0.32/0.44	-0.51	-0.31/0.41	-	-	-	-	-
	-0.56	-	-	-	-	-	-/-0.33	-/-0.40	-
PDO	-	-0.52	-0.34/ 0.58	-0.37/0.60	-	-	-	-	-
	-	-	-	-0.32/0.47	-	-	-	-	-
	-0.74	-	-	-	-	-	-	-	-
AO	-	-	-/-0.37	-/-0.45	-/-0.62	-/-0.56	-/-0.51	-/-0.57	-/-0.43
	-	-	-	-	-	-/-0.42	-	-	-
	-	-	-/-0.45	-	-	-	-	-	-
NAO	-	-	-0.32/-	-	-/-0.42	-/-0.39	-/-0.42	-/-0.53	-/-0.47
	-	-	-	-	-	-	-	-	-
	-	-	-/-0.54	-	-/-0.33	-	-	-/-0.45	-
AMO	-	-	-	-	-	-0.39	-0.72	-0.72	-0.72
	-0.63	-	-	-	-/-0.44	-	-	-	-
	-0.34	-	-0.46	-0.33/ 0.75	-	-0.38	-	-0.47	-0.31/-
TNA	-	-	-	-	-0.44	-0.49	-0.82	-0.86	-0.79
	-	-	-	-	-/-0.47	-	-	-	-
	-	-	-0.52	-0.50	-0.37	-	-	-0.42	-
TSA	-	-	-0.43	-0.53	-0.77	-0.77	-0.42	-0.36	-
	-	-	-	-0.37/0.63	-	-	-	-	-
	-	-0.38	-0.32	-	-	-0.38/0.55	-0.58	-0.32	-
SAODI	-	-/-0.33	-	-	-0.37	-0.45	-	-0.30	-0.37
	-	-	-	-	-/-0.72	-	-	-	-
	-	-0.30	-0.31	-	-0.40	-0.38/0.51	-0.74	-0.44	-/-0.30
AAO	-	-	-	-0.33/-	-	-	-	-	-0.31
	-	-0.52	-0.40/ 0.63	-0.47/0.85	-	-	-	-	-
	-	-	-	-	-	-0.32/-	-	-	-

Note. The time series were low-pass filtered for 2-year (left)/4-year (right) window. Only correlations above 0.30 were included with bold faces expressing values above 95% of confidence level, and normal face, above 68%.

Concluding Remarks

- SST shows strong seasonal cycle and it decreases northward. The largest SSS seasonal amplitudes are observed in regions affected by major river, La Plata and the Amazon. The CHL is also driven by the seasonal cycle.
- The SST and CHL show no trend over regions longer than 1000 km; the SSS has a positive trend from the Abrolhos Archipelago (D) up to 1100 km to the north.

Concluding Remarks II

- A series of continent-wise propagating interannual SST' signals (2- to 8-year range) can be seen consistently emanating northward from Cabo Frio (C), covering the whole extension in 1-2 years.
- The climate indices analysis intends to quantify the covariance of the examined times series at interannual scales due to external influence. SST' was the most influenced variable, followed by the CHL'. SSS' did not show significant results possibly due to the shorter time series.