Decadal changes in carbon budget of a SW Atlantic estuary: Coupling between a drop in plankton biomass and the erosion of salt marshes

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Coastal ocean processes are characterized by the **exchange of energy and material** across landforms and the water column.
The Bahía Blanca Estuary
Eastern South America
A coastal landscape modeled by the Holocene marine transgression

6k yr BP

Mid-Holocene highstand

present

Present rate of relative SLR is about 1.6 mm yr⁻¹
A coastal landscape modeled by the Holocene marine transgression

Pratolongo et al. 2017
How is landscape responding to SLR?

1967  2005

Pratolongo et al. 2013
Loss of marshes, steppes, and shrubs

- **Sarcocornia perennis marshes**: 21.5 km²
- **halophytic steppes**: 11.7 km²
- **halophytic shrubs**: 2 km²
- **mudflats**: 11.7 km²

Pratolongo et al. 2013
12 mg of TSS l⁻¹ day⁻¹

What does this value mean?
TSS interferes with light penetration

How has the water turbidity evolved in the last decades?

Recent positive trend on water turbidity
Drifting into the Anthropocene: Multiscale factors interact to drive long-term water turbidity

**Global**
- **SLR**
  - Present rate of relative SLR is about 1.6 mm yr\(^{-1}\)

**Regional**
- **Wind**
  - Higher persistence of winds toward of NW quadrant since the 1978

**Local**
- **Dredging**
  - The dredged volume increased 11-fold after 1999
- **Bioturbation**
  - Crabs excavate large burrows and remove up to 5 kg m\(^{-2}\) d\(^{-1}\) of sediments
- **Precipitations**
  - Modulates turbidity at the annual scale

Water turbidity
Long-term wind pattern modifications

shift towards low intensity NW winds

López Abbate et al. in prep.
Long-term wind pattern modifications

Local wind is modulated by the displacement of the South Atlantic High Pressure System…

…which revealed southward movement in the last decades and promoted changes in regional wind patterns.
Intense dredging operations to allow maritime trade
Interactive effect between wind direction and dredging on water turbidity

Long-fetch NW winds

Dredging

\[ R^2 = 0.283 \]
\[ p = 0.012 \]

NW quadrant

SE quadrant

threshold

López Abbate et al. in prep.
Ecosystem state change: Long-term decline on chlorophyll-a and phenological shift

Three regimes of variability

ARD 1%

López Abbate et al. 2017
Ecosystem state change: Phytoplankton structural change

From winter blooming to summer blooming and non-blooming

López Abbate et al. 2017
Ecosystem state change: Long-term decline on planktonic ciliates

ARD 2.8%

ARD 1.6%

López Abbate et al. in prep.
Ecosystem state change: Long-term decline on planktonic ciliates

Particle size distribution in the surface of the water column during the post-bloom period (September-November)

MOD=40 µm

Optimal size spectrum of prey below 10-15 µm

Guinder et al. 2015, López Abbate et al. in prep.
Ecosystem state change: Loss of covariation between chlorophyll-a and tintinnids during 1986-2011

Limitation by encounter and handling

The PSM to phytoplankton biomass ratio in recent years, denotes that ciliates must sort 25% more inedible suspensoids to meet with their carbon requirement.
Ecosystem state change: The emergence of turbidity as the dominant driver of chlorophyll-a and a higher interaction among drivers

Time-varying hierarchical relationships of drivers
This is what we learned from the Bahía Blanca Estuary:

• Low lying coastal landforms are undergoing fast erosion in response to the present rate of SLR.

• Soft sediments provided by marsh erosion, and other regional and local factors such as wind shifts and intense dredging, interferes with the pelagic ecosystem by reducing light penetration and limiting the encounter rate between consumers and their prey.

• In coastal areas subject to rapid environmental change, hierarchical relationships may predict biotic responses more precisely than generalizable linear models.
Thank you!

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