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Better Understanding of the Biogeochemical Buffering Capacity of Ria Formosa, Portugal to Future Scenarios of Global Changes

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Background:

Estuaries and Coastal Lagoons: Most productive ecosystems on Earth, providing multiple goods and ecosystem services. ➡ **Protection and conservation are vital**.

Accurate modeling and prediction of the effects of climate change and variability, and the monitoring of their impacts, require sustained and extended observations of these ecosystems.

UBEST Project Goals

- Improve global understanding of the biogeochemical functioning and buffering capacity of 2 distinct Portuguese estuaries (Tagus estuary, and Ria Formosa lagoon - Fig. 1).
- Susceptibility to future scenarios of anthropogenic inputs and climate change.

RESULTS:

A Real Time Observation (RTO) station – Innovative approach

Continuously record every 15 min (Fig. 2), from May 17-Jan 18 (8 months):
Temperature, salinity, pH, Dissolved oxygen (Fig. 3), and chlorophyll *a* and turbidity (not shown)

What can we learn from it?

- Capture of seasonal signatures
- Capture of episodic events and marine processes
  - Upwelling events by ↓ in temperature
- Salinity ↑ in Summer
- pH ↓ in Summer, accompanying DO
- DO, lowest in Summer at night, with values < Minimum Allowable Value (**MAV** in Fig. 3)
- Chl-*a* (not shown) globally < 5 µg/L, max in Summer followed by Autumn, by satellite images (Fig. 3)
- Turbidity (not shown), some outliers data to ignore, globally < 15 NTU

Fig. 2. RTO location, multiparametric probe with sensors and datalogger

B SEASONAL SEMI-DIURNAL TIDAL CYCLES

Sampling: Spring: 5/30/2017; Summer: 9/14/2017; Autumn: 10/25/2017

- 7 sites (Fig. 1), complete semi-diurnal tidal cycles (~13 h), every 2 h: T, S, DO, Chl-*a*, NO_3 (Fig. 4), NH_4, PO_4, SiO_4, SS, pH (not shown)

Study area:

Ria Formosa productive coastal lagoon on the south coast of Portugal (Fig. 1).

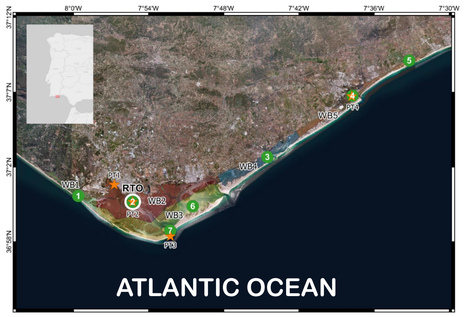

Fig. 1. Location of Ria Formosa, on south coast of Portugal, sampling stations ●, deployment of Pressure Transducers (PT) ✶ and real time observation station (RTO), and the limits of the water bodies (WB) identified by different colors.

Vision: Advancing the prediction of global changes in the Ria Formosa ecosystem

Implementation of an integrative "observatory":

- Data from continuous real time observations;
- Discrete *in-situ* field campaigns, at sites representative of the water bodies under Water Framework Directive;
- Hydrodynamic-biogeochemical mechanistic models (ongoing calibration and validation):
  - **System of numerical models SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model), to simulate the hydrodynamics and biogeochemical processes;**

- Development: **customizable and integrative WebSIG platform** (access to observations, real-time forecasts and future scenarios to stakeholders/end-users).

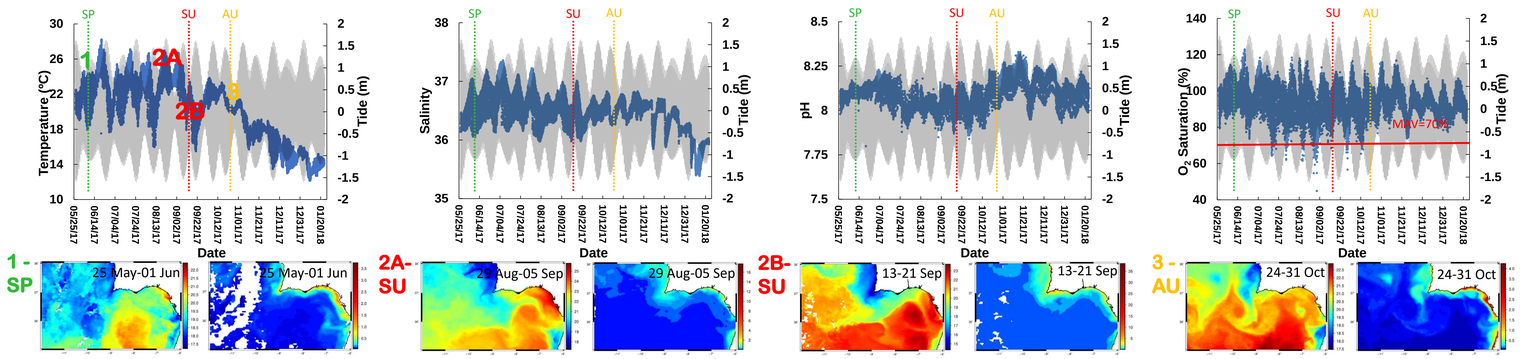

Fig. 3. TOP: Temperature, salinity, pH and % saturation of dissolved oxygen data acquired by RTO, from May to Jan 2018 with indication of the sampling date of the seasonal semi-diurnal tidal cycles (indicated in B) for Spring (SP), Summer (SU) and Autumn (AU). MAV=Minimum Allowable Value.
BOTTOM: 8-day composite SST (left) and Chl-*a* (right) satellite images from OceanColor (https://oceancolor.gsfc.nasa.gov/) at periods typical of the sampled seasons (indicated by 1 to 3).

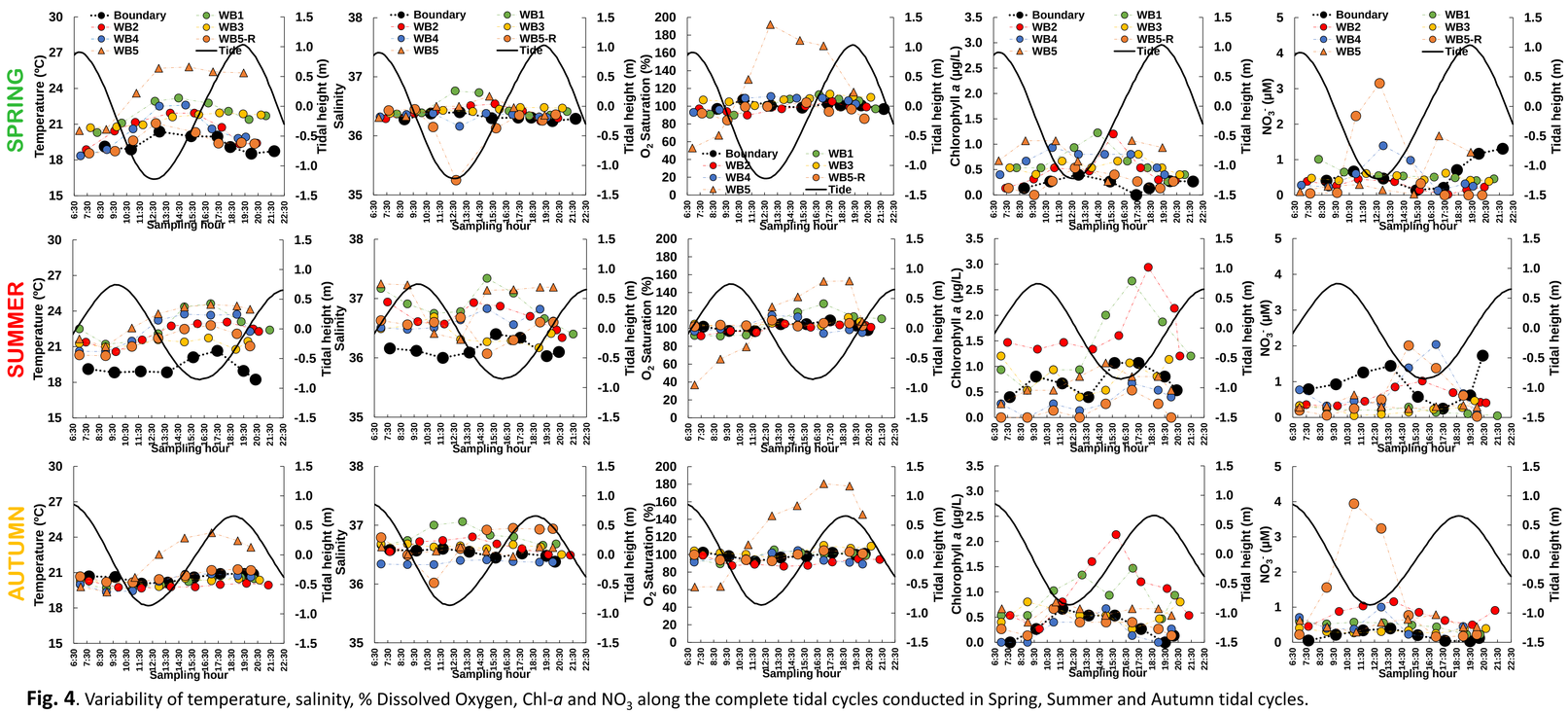

Fig. 4. Variability of temperature, salinity, % Dissolved Oxygen, Chl-*a* and NO_3 along the complete tidal cycles conducted in Spring, Summer and Autumn tidal cycles.

What do these tell about ?

- **Differences between seasons are not strictly marked**
  - Temperature in Summer reflects upwelling events shown in Fig. 3.
  - Extreme DO values at WB5 - the shallowest place at the **eastern edge** of Ria Formosa, low values during early morning (< 60%).
  - Chl-*a* max in Summer, after upwelling confirmed by satellite images (Fig.3).
  - NO_3 max at WB5-R, in antiphase with tide and salinity, associated with the highest freshwater input, ↑ in Summer by upwelling and globally lower in Autumn, by consumption.

- **Provide observations to support the numerical model calibration and continuous validation.**

Final Remarks

- Important observational data coupled with modeling can be translated into information useful for end-users and decision makers.

➡ Facilitate the better understanding of the functioning of this ecosystem, and contribute to its short and long-term management and protection, imperative to building knowledge-based societies.

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