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## Underwater Fluxes of biogenic constituents and their Ecological Implications

Jérémy Mayen, Pierre Polsenaere, Philippe Geairon, Jean-Michel Chabirand,  
Jonathan Deborde, James Grizon, Jean-Christophe Lemesle, Benoit Poitevin,  
Christine Dupuy, Marie Vagner

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# Spatial and temporal variations in water pCO<sub>2</sub> and atmospheric CO<sub>2</sub> exchanges over a temperate salt marsh system

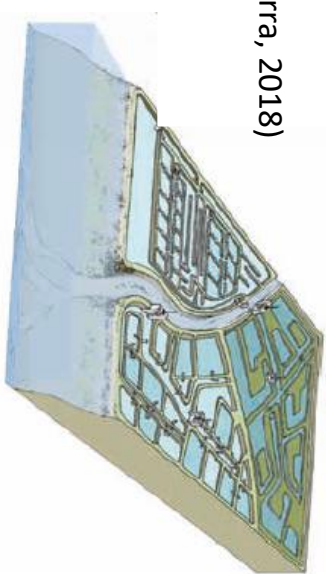
*J. Mayen<sup>a</sup>, P. Polsenaere<sup>a</sup>, P. Geairon<sup>a</sup>, J.-M. Chabirand<sup>b</sup>,  
J. Deborde<sup>a</sup>, J. Grizon<sup>a</sup>, J.-C. Lemesle<sup>b</sup>, B. Poitevin<sup>c</sup>,  
C. Dupuy<sup>d</sup>, M. Vagner<sup>e</sup>*

<sup>a</sup>IFREMER, LER-PC, <sup>b</sup>LPO, Réserve Naturelle de Lilleau des Niges, <sup>c</sup>Pôle-Nature de l'Ecomusée du Marais Salant, <sup>d</sup>LIENSS UMR7266 CNRS-Université La Rochelle, <sup>e</sup>LEMAR, UMR 6539 CNRS

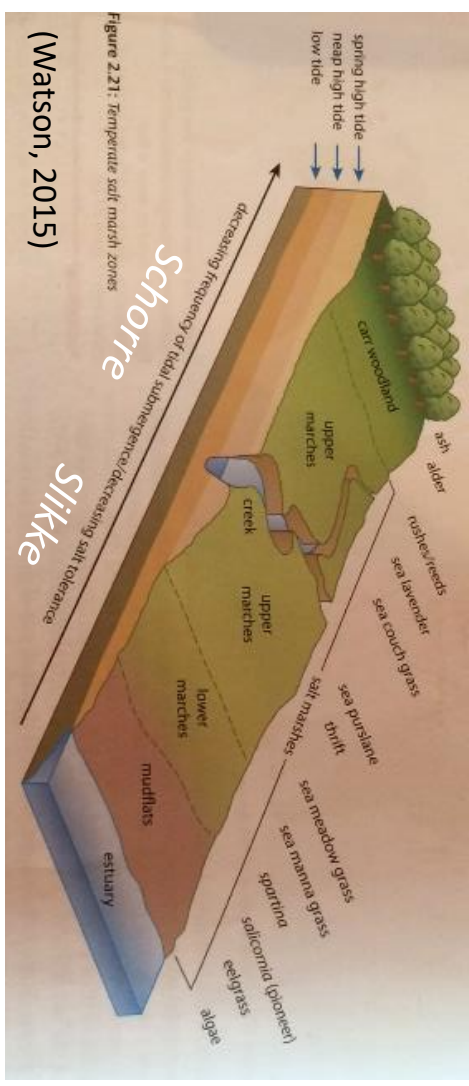
SS25 - Underwater Fluxes of biogenic constituents and their Ecological Implications – 6/27/2021

- « Salt marshes are coastal wetlands that are flooded and drained by salt water brought in by the tides. » (National Oceanic and Atmospheric Administration)

(Acclimattera, 2018)

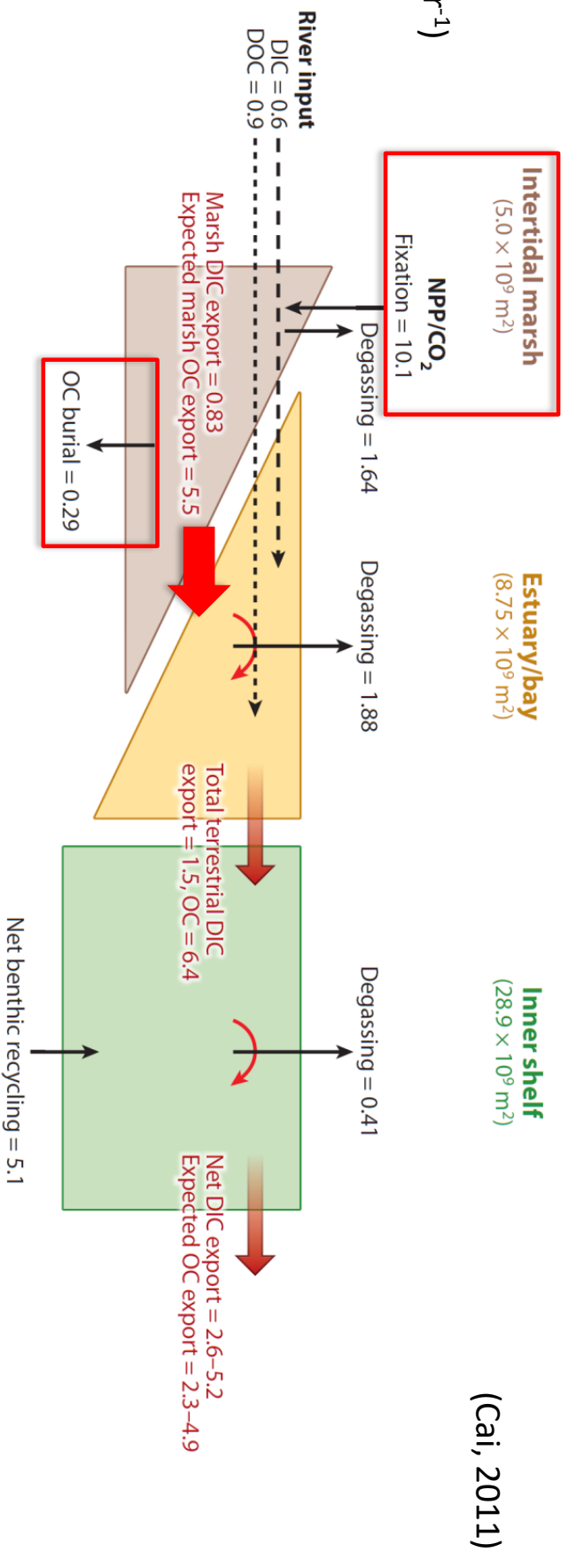


Dyked salt marshes

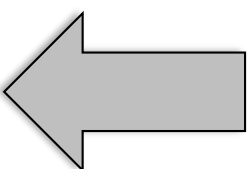


- CO<sub>2</sub> sink, organic carbon burial and C export by the tide :

Tg C yr<sup>-1</sup> (10<sup>12</sup> g C yr<sup>-1</sup>)



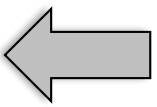
- Study the dynamics of (i) water pCO<sub>2</sub> and (ii) atmospheric CO<sub>2</sub> exchanges in relation to biotic and abiotic controlling factors along an intertidal bay – channel – salt marshes continuum at seasonal, diurnal and tidal scales



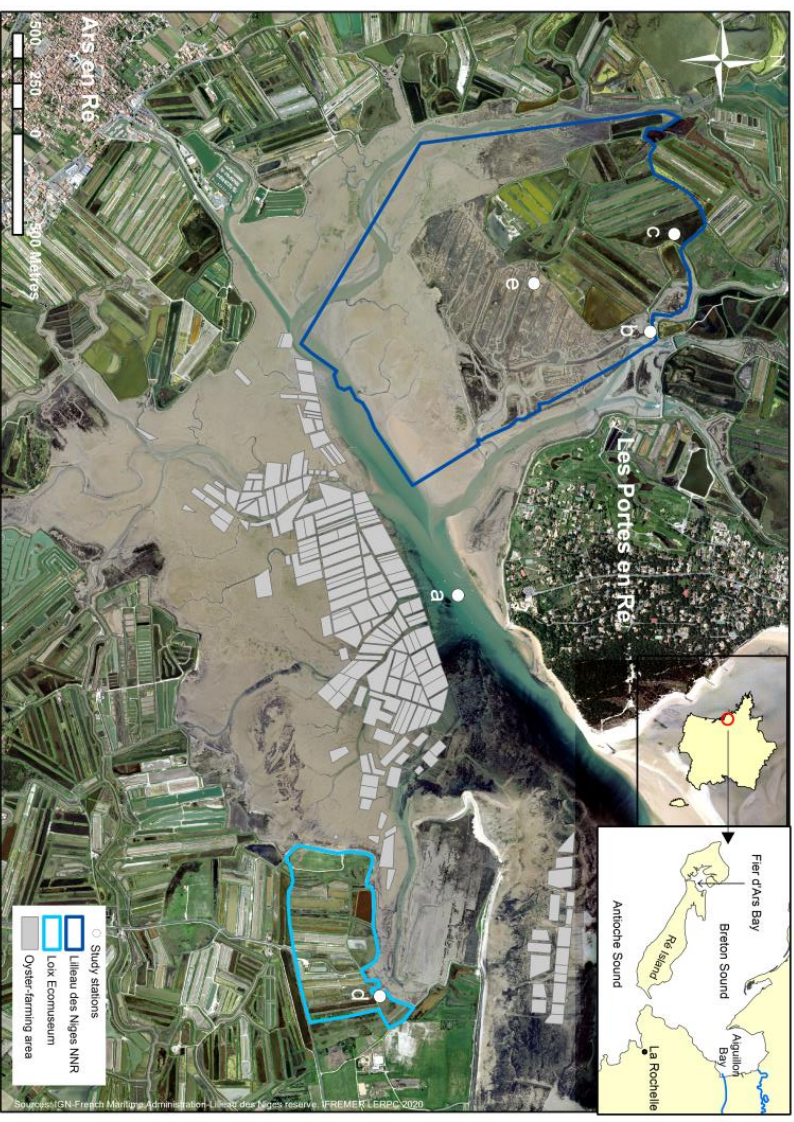
**Understanding the evolution of the ecological functions of coastal wetlands (CO<sub>2</sub> sinks, C sequestration in sediments) in the face of global change.**



- Intertidal bay on the Ré island – France
- Complex of salt marshes and anthropised mudflats (1,200 ha): **coastal wetland**
- Bay – channel – salt marshes continuum



**4 interconnected stations** with different management practices and configurations



*Station b: intertidal system*

01/05/2019



*Station c: nature reserve*

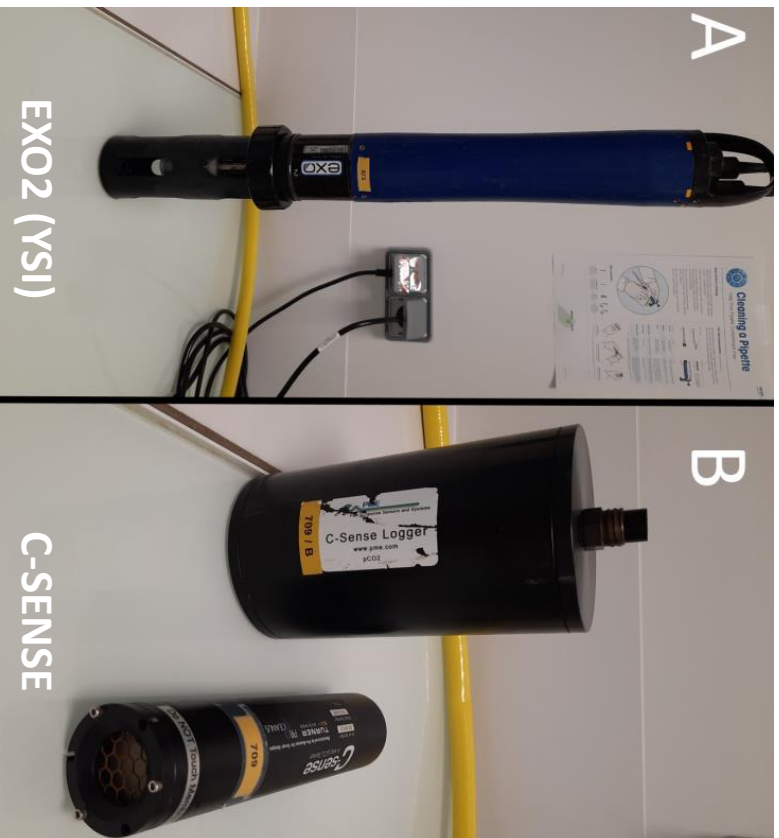
10/02/2020



*Station d: salt-farming activity*

11/02/2020

- *In situ* measurements of  $pCO_2$ , [Chl  $a$ ] and biogeochemical parameters (oxygen, salinity, temperature ...)
- 24-hour cycles of *in situ* measurements at the seasonal and spatial scales → high frequency (1 minute)
- 5 multiparameter and specific probes (autonomous) in sub-surface waters:
  - C-SENSE (X2):  $pCO_2$  measurements (0-2000 ppmv + 0-4000 ppmv, %Er = 3% of range)
  - EXO2 (YSI): biogeochemical parameter measurements (T, S, TU, pH,  $O_2$ )
  - Aquatic MinipAR (PME)
  - C3-fluorimeter: chlorophyll- $a$  concentration

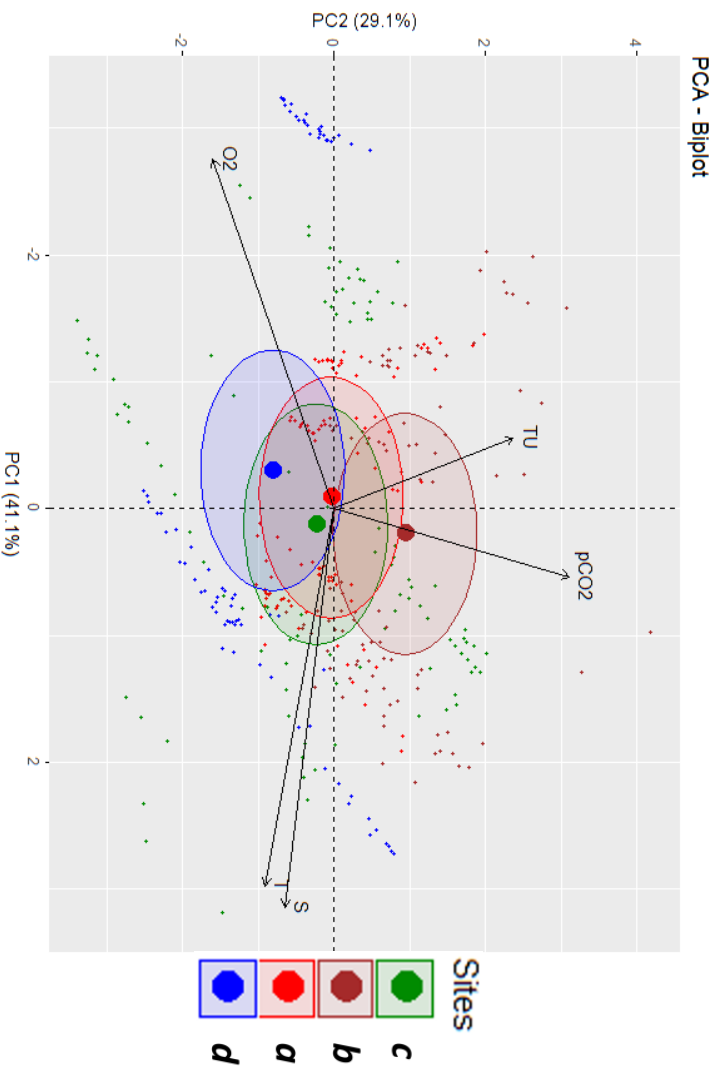


## 1. Major influence of station typologies on pCO<sub>2</sub>

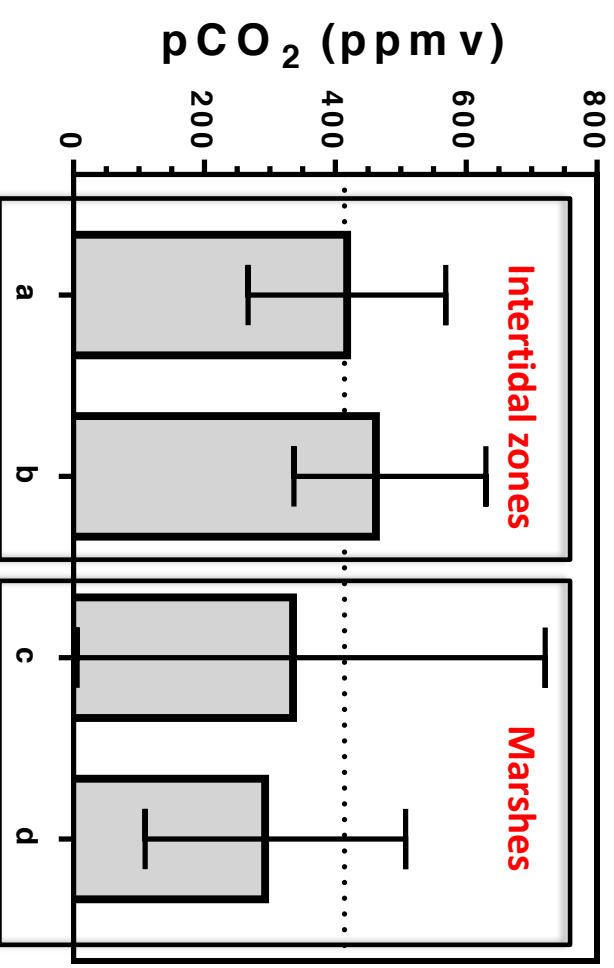
- a*: Fier d'Ars intertidal bay
- b*: Vieux port channel
- c*: A1 salt marsh (nature reserve)
- d*: Loix salt marsh (salt-farming activity)

- Intertidal bay and channel (*a* and *b*)**
  - Strong tidal influences → High turbidity → **limited phytoplankton activity**
  - Few aquatic vegetation

- Salt marshes (*c* and *d*)**
  - **Photosynthesis of primary producers** (macroalgae/ phytoplankton/*Ruppia maritima*)



Source: facadeira



Studied continuum

## 2. Major influence of management practices on pCO<sub>2</sub>

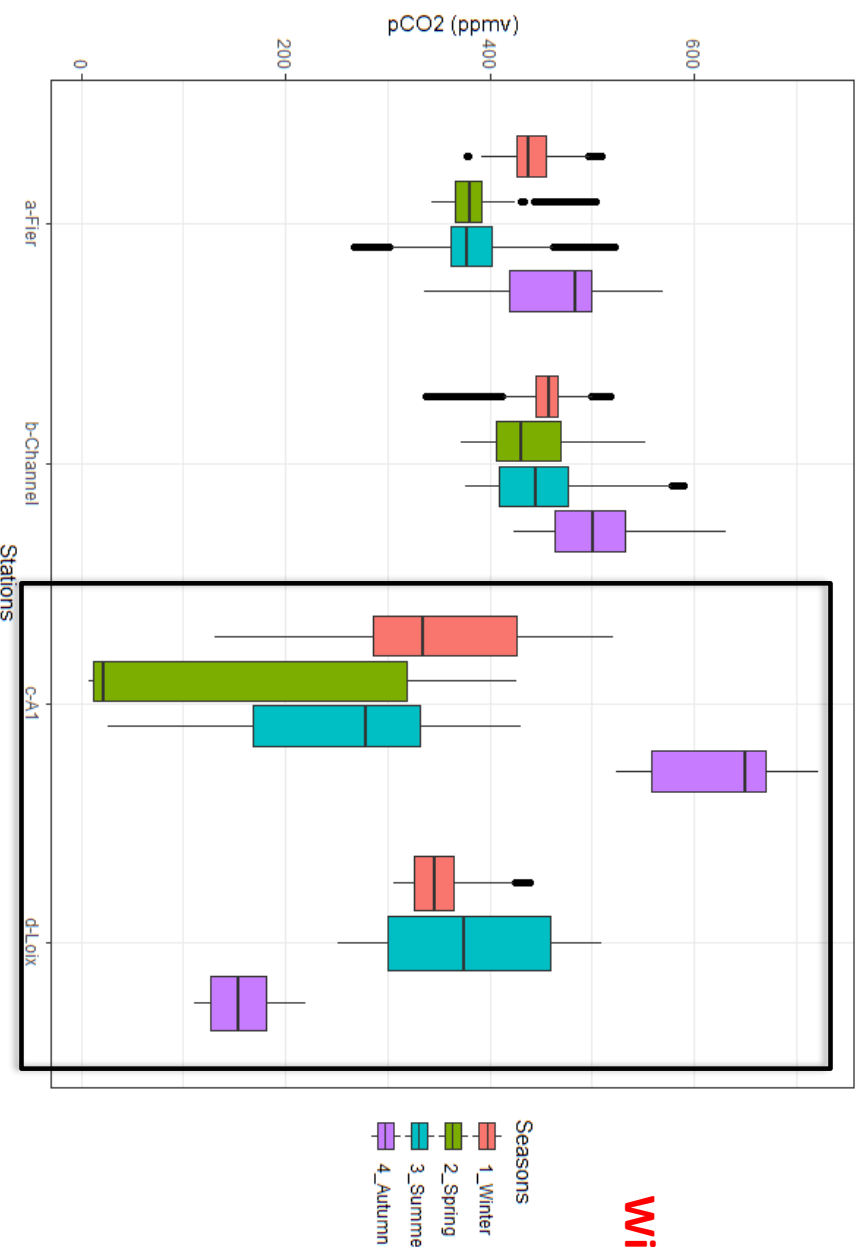
### Summer 2019:

- **c:** photosynthesis activity of aquatic macroalgae
- **d:** zooplankton bloom → phytoplankton cell degradation



### Autumn 2019:

- **c:** Macroalgae degradation → Organic matter mineralisation → high pCO<sub>2</sub>



**Winter 2020:** no significant difference on pCO<sub>2</sub>

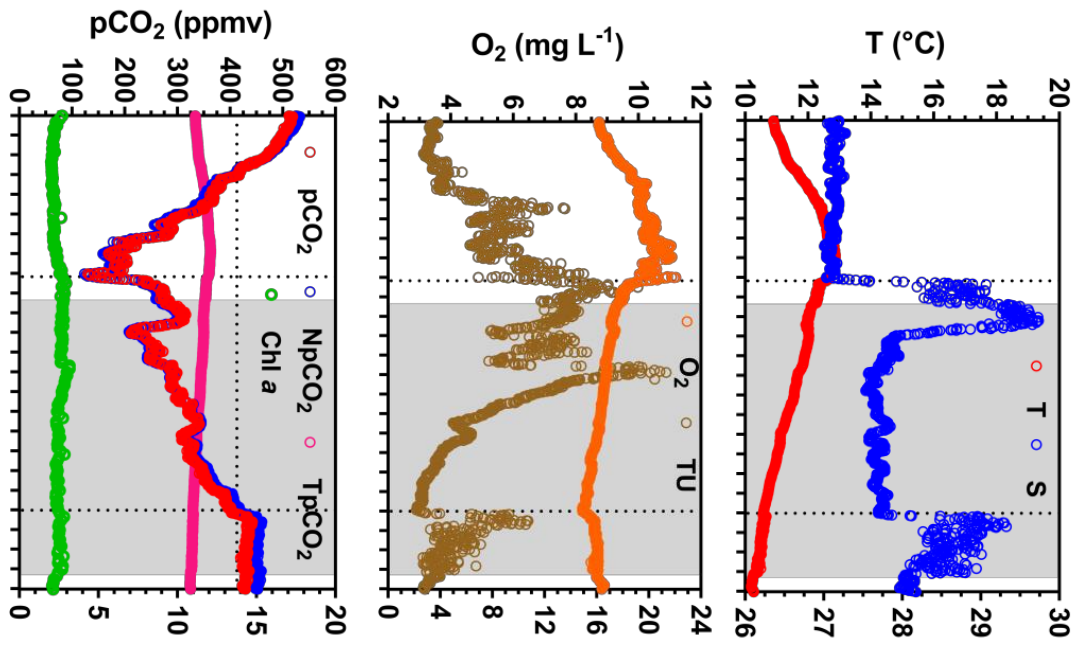
**pCO<sub>2</sub> (c) > pCO<sub>2</sub> (d)**

- a:** Fier d'Ars intertidal bay
- b:** Vieux port channel
- c:** A1 salt marsh (nature reserve)
- d:** Loix salt marsh (salt-farming activity)

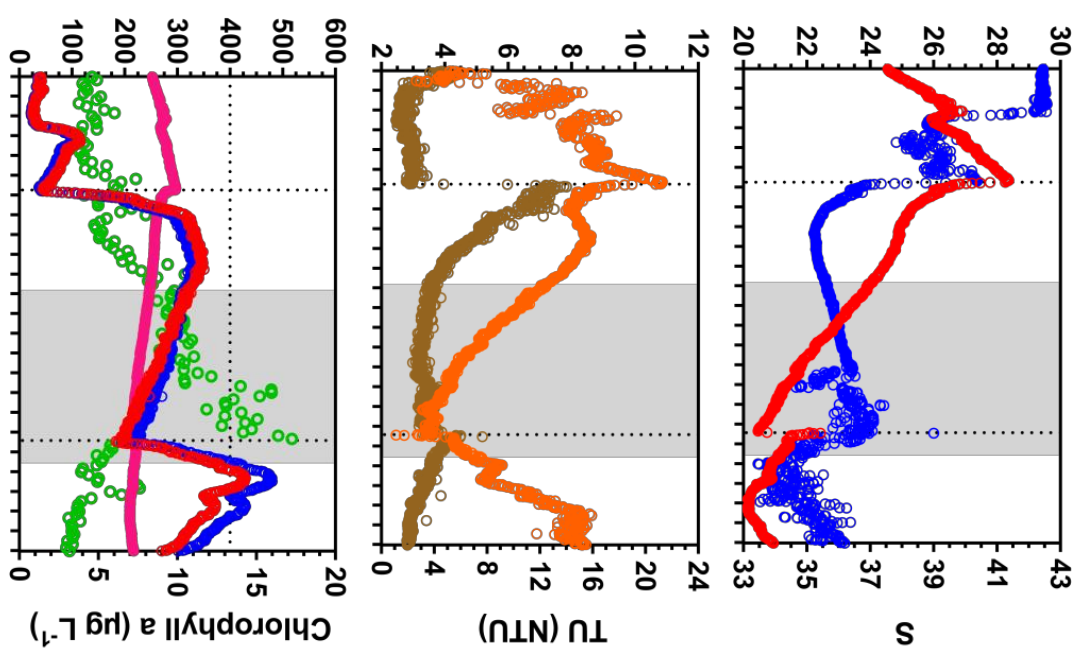


- Indigenous biological activity (primary production/respiration) at the diurnal scale
- Coastal water intrusions (tidal advection): increase pCO<sub>2</sub> in winter, spring and summer

Station c - Winter 2020



Station c - Summer 2019



pCO<sub>2</sub>/salinity = -0.93  
 pCO<sub>2</sub>/water level = 0.85

- Large diurnal and tidal variations on pCO<sub>2</sub>

Winter: 130 < pCO<sub>2</sub> < 519 ppmv

Summer: 25 < pCO<sub>2</sub> < 430 ppmv

- Estimated water-air CO<sub>2</sub> flux (mmol CO<sub>2</sub> m<sup>-2</sup> h<sup>-1</sup>): **FCO<sub>2</sub> = α k (pCO<sub>2</sub>eau – pCO<sub>2</sub>air)**

(Takahashi et al., 2002)

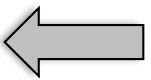
- Channel:** CO<sub>2</sub> source

→ **b:** +0.16 ± 0.24 mmol m<sup>2</sup> h<sup>-1</sup>

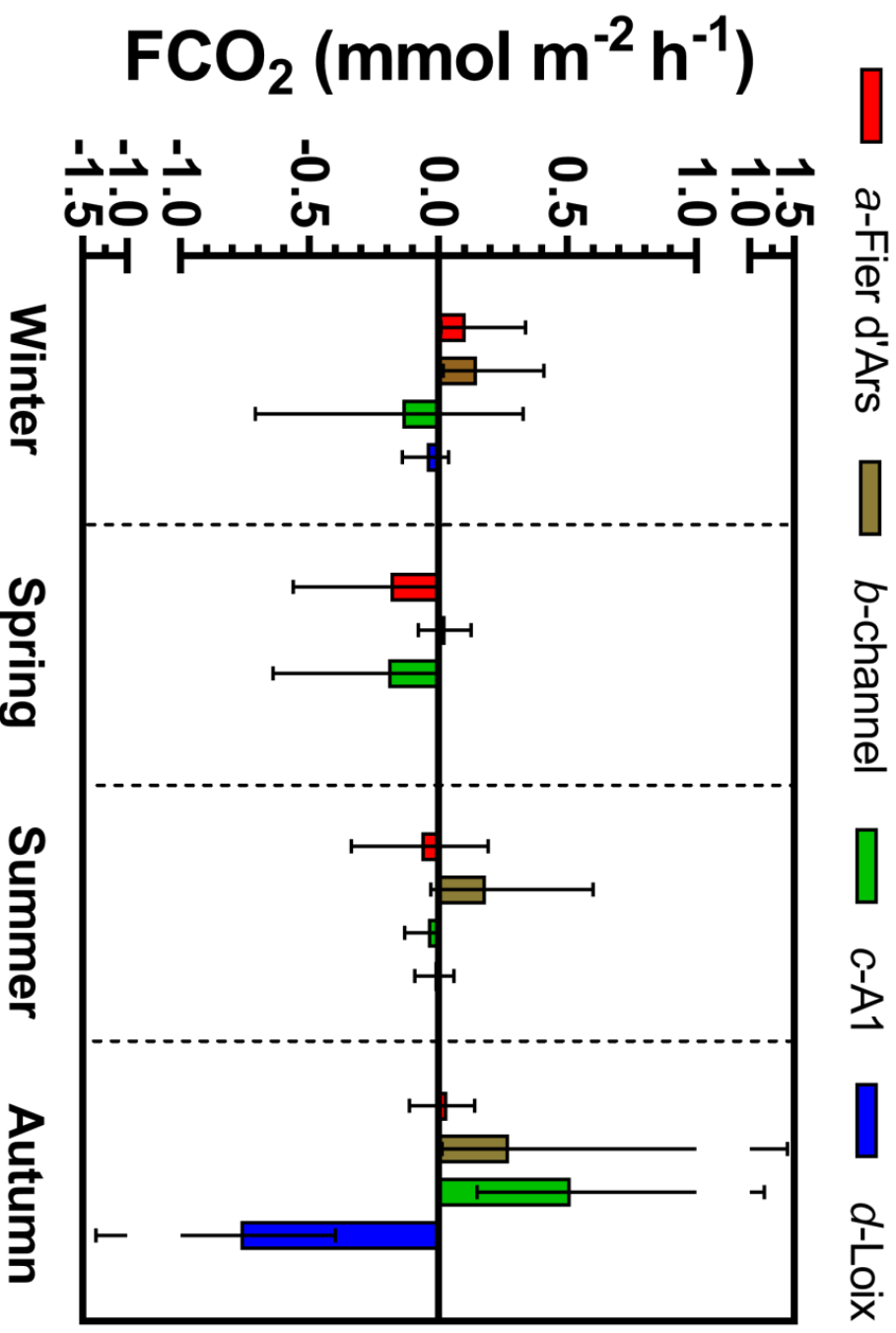
- Marshes:** CO<sub>2</sub> sink

→ **c:** +0.04 ± 0.36 mmol m<sup>2</sup> h<sup>-1</sup>

→ **d:** -0.28 ± 0.38 mmol m<sup>2</sup> h<sup>-1</sup>



Strong variations in autumn



**a:** Fier d'Ars intertidal bay

**b:** Vieux port channel

**c:** A1 salt marsh (nature reserve)

**d:** Loix salt marsh (salt-farming activity)



- **Significant influences of  $p\text{CO}_2$  dynamics:**
  - ✓ Station typologies within the coastal zone (Bay, channel, marsh)
  - ✓ Management practices: water turnover
- Diurnal and tidal scales: **non-temperature effects on  $p\text{CO}_2$  dynamics**
  - ✓ Biological activity (photosynthesis/respiration)
  - ✓ Different tidal effects according to water column  $\text{CO}_2$  saturation
- **Métabolism:**
  - ✓ **Channel:**  $\text{CO}_2$  source to atmosphere
  - ✓ **Salt marshes:**  $\text{CO}_2$  sink
- Study: (1) the atmospheric  $\text{CO}_2$  fluxes by Eddy Covariance (*in situ* measurements)  
(2) the salt marsh aquatic metabolism

Jérémy MAYEN, PhD student

Ifremer (French Research Institute for the Exploitation of the Sea)

E-mail : [jeremy.mayen@ifremer.fr](mailto:jeremy.mayen@ifremer.fr)

Lab page : <https://www.ifremer.fr/littoral/Laboratoires-Environnement-Ressources/LER-Pertuis-Charentais>



Thank you for your attention !

