Extreme coastal events linked with climate variation

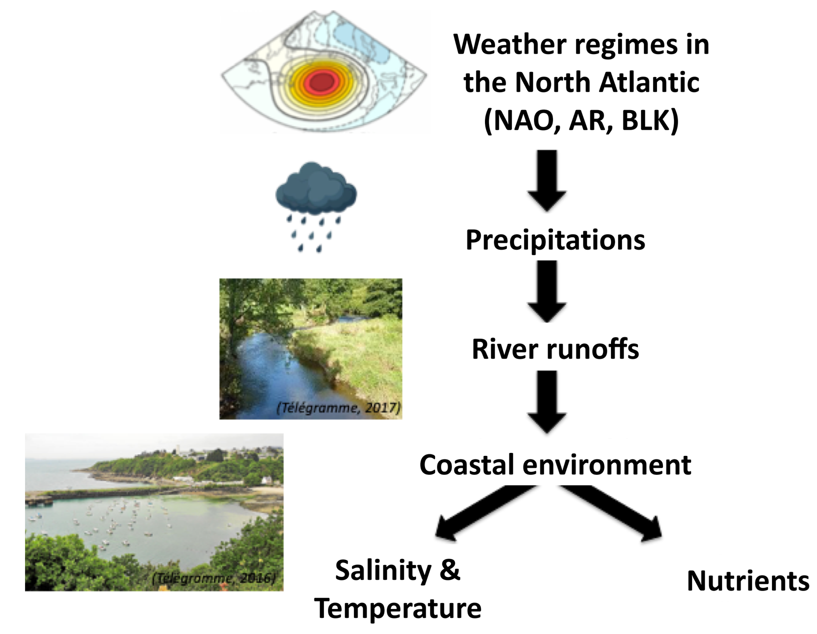
Understanding low salinity episodes in the Bay of Brest, north-eastern Atlantic

Coline Poppeschi[1](*coline.poppeschi@ifremer.fr*), Guillaume Charria[1], Maximilian Unterberger[1], Peggy Rimmelin-Maury[2], Eric Goberville[3], Nicolas Barrier[5], Sébastien Petton[6], Emilie Grossteffan[2], Michel Repecaud[7], Loïc Quemener[7], Sébastien Theetten[1], Jean-François Le Roux[1], Paul Tréguer[4]

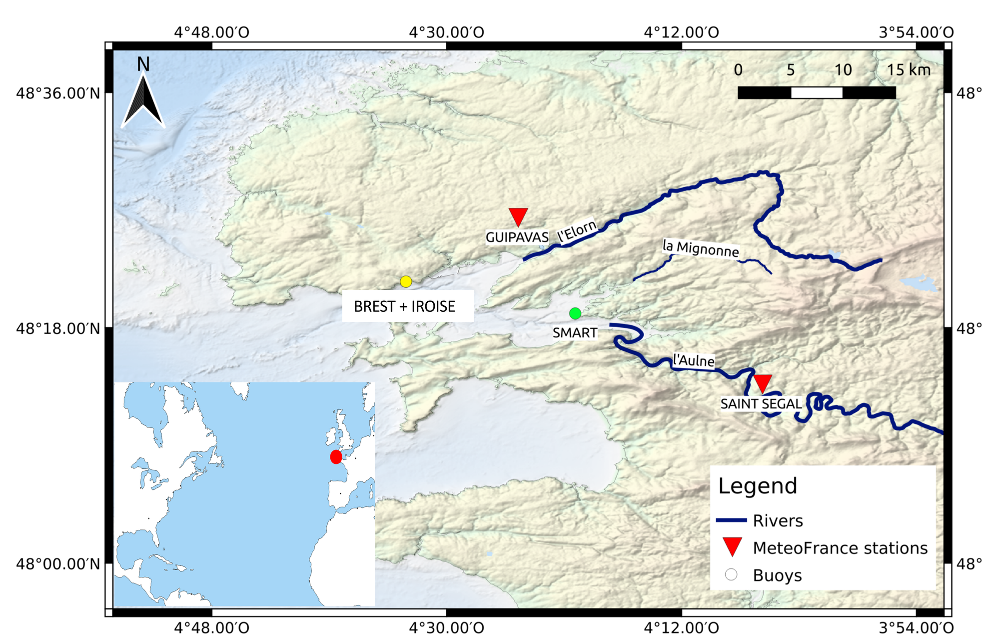
[1] *Ifremer, Univ. Brest, CNRS, IRD, Laboratoire d'Océanographie Physique et Spatiale (LOPS), IUEM, Brest, France.*
[2] *OSU-Institut Universitaire Européen de la Mer (IUEM), UMS3113, Plouzané, France.*
[3] *Muséum National d'Histoire Naturelle, UMR 7208 BOREA, Sorbonne Université, CNRS, UCN, UA, IRD, Paris, France.*
[4] *Univ. Brest, CNRS, IRD, Ifremer, Institut Universitaire Européen de la mer, LEMAR, Rue Dumont d'Urville,, Plouzané, France.*
[5] *MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Sète, France.*
[6] *Ifremer, Univ Brest, CNRS, IRD, LEMAR, Argenton, France.*
[7] *Ifremer, Centre de Brest, REM/RDT/DCM,, Plouzané, France.*

Aims

- ❑ To detect and characterize extreme events in a coastal ecosystem by combining ***in situ* high-frequency observations** and **high-resolution numerical simulations**
- ❑ To describe the **interannual variability** of extreme events in a **context of climate change**
- ❑ To quantify the links between extreme low salinity episodes and both large and local scale processes, using **weather regimes, precipitations and river runoffs as proxies of hydro-climate forcing**



1. Time series in the Bay of Brest



1.1. Locations of the sampling sites considered in our study

- **Ocean *in situ* observations**

COAST-HF- Iroise: high-frequency measurements (20min sampling of physical and biogeochemical parameters)
SOMLIT-Brest: low-frequency measurements (weekly sampling of physical, biogeochemical and biological parameters)

- **Rivers *in situ* observations**

Average discharge of the Aulne, Elorn and Mignonne rivers (HydroFrance)

- **Meteorological *in situ* observations**

Mean daily precipitation: Guipavas station (Météo-France)

- **3D Numerical model simulations (MARS3D)**

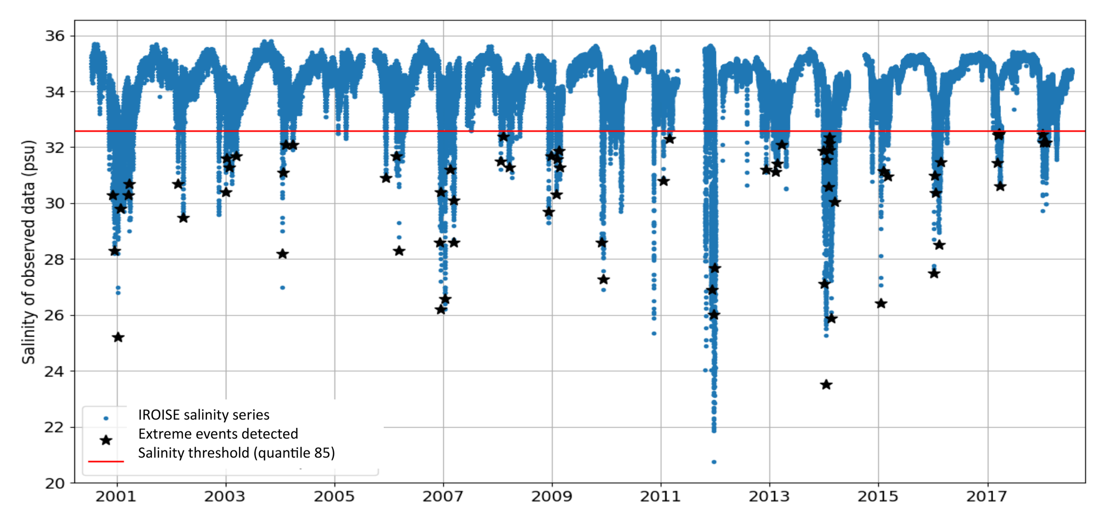
BACH configuration – 1km-resolution **[1]**
MARC configuration – 50m-resolution **[2]**

- **Weather regimes [3],[4]**

Positive and negative phases of the North Atlantic Oscillation (**NAOp, NAOn**), the Atlantic Ridge (**AR**) and the Scandinavian Blocking Regime (**BLK**)

2. Methodology

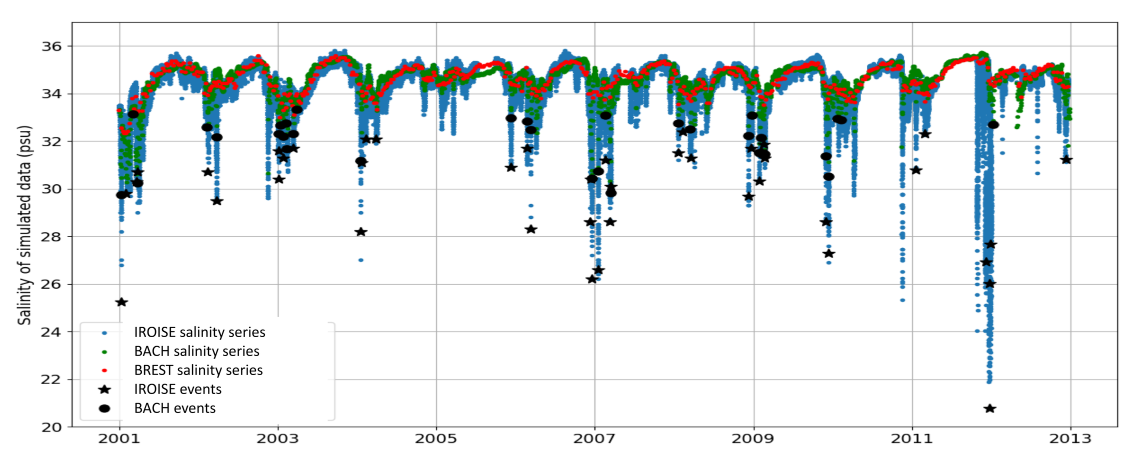
- A seasonal focus: **winter months** (December, January, February, March)
- Tides filtering for event identification: **only low tides considered**
- Extreme salinity threshold defined by **quantile 85**
- Pre-event precipitations and river runoffs considered over **~ 14 days before the events**



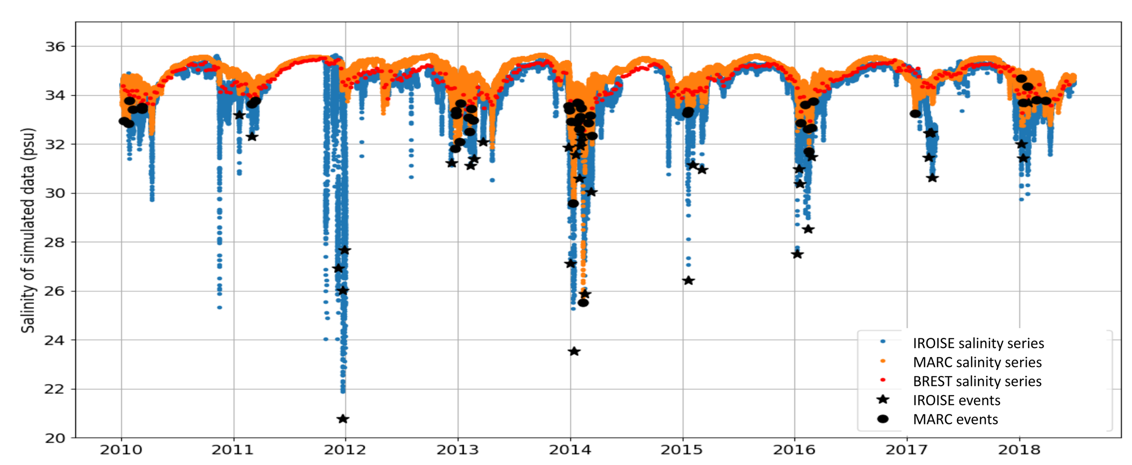
2.1. Extreme low salinity events detected under threshold on *in situ* data

3. Identification and characterization of extreme low salinity events

a)



b)



3.1 Detection of low salinity extreme events of the observed and simulated salinity data divided in two time periods corresponding to numerical simulations: (a) BACH simulation and (b) MARC simulation

The detection and characterization of the low salinity events for observed and simulated data present similar results in terms of occurrence, duration and intensity.

	Time series data		
	Observed data COAST-HF	Simulated data MARS3D	
	Iroise	BACH	MARC
Studied period	2000-2018	2000-2012	2010-2018
Mean duration (days)	3	5	2,6
Minimum salinity intensity (psu)	23,5	29,7	25,5
Number of events	72	32	46
% of observed events in simulations	X	78%	100%

3.2 Global characteristics of detected observed and simulated data

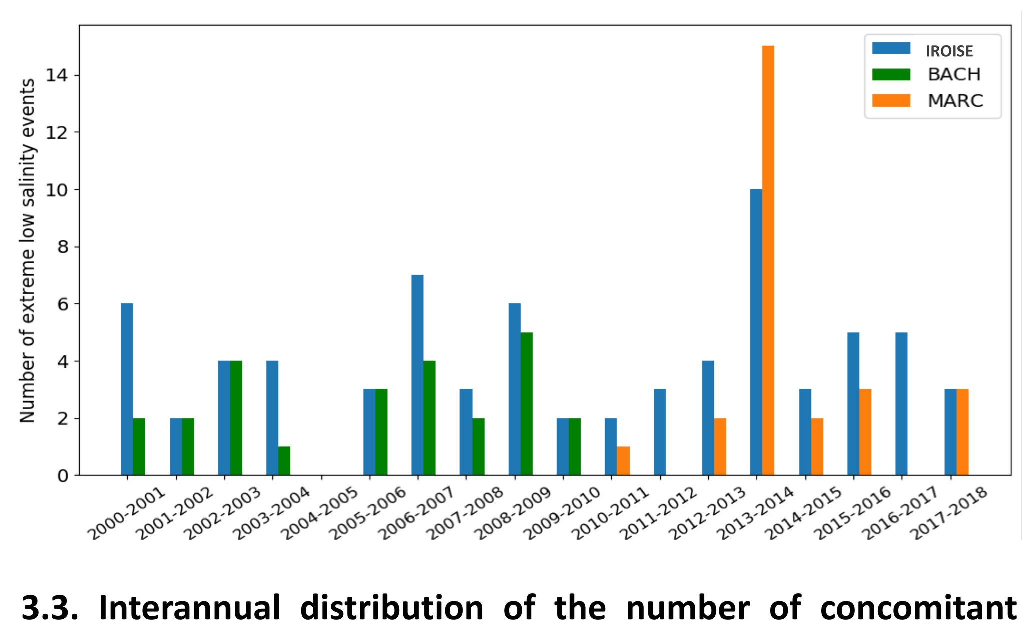
Extreme - observed and modeled - events show a strong interannual variability

No event was detected during winter 2004-2005 but a large number of events was identified during winter 2013-2014

Interannual variability can be explained by extreme weather conditions

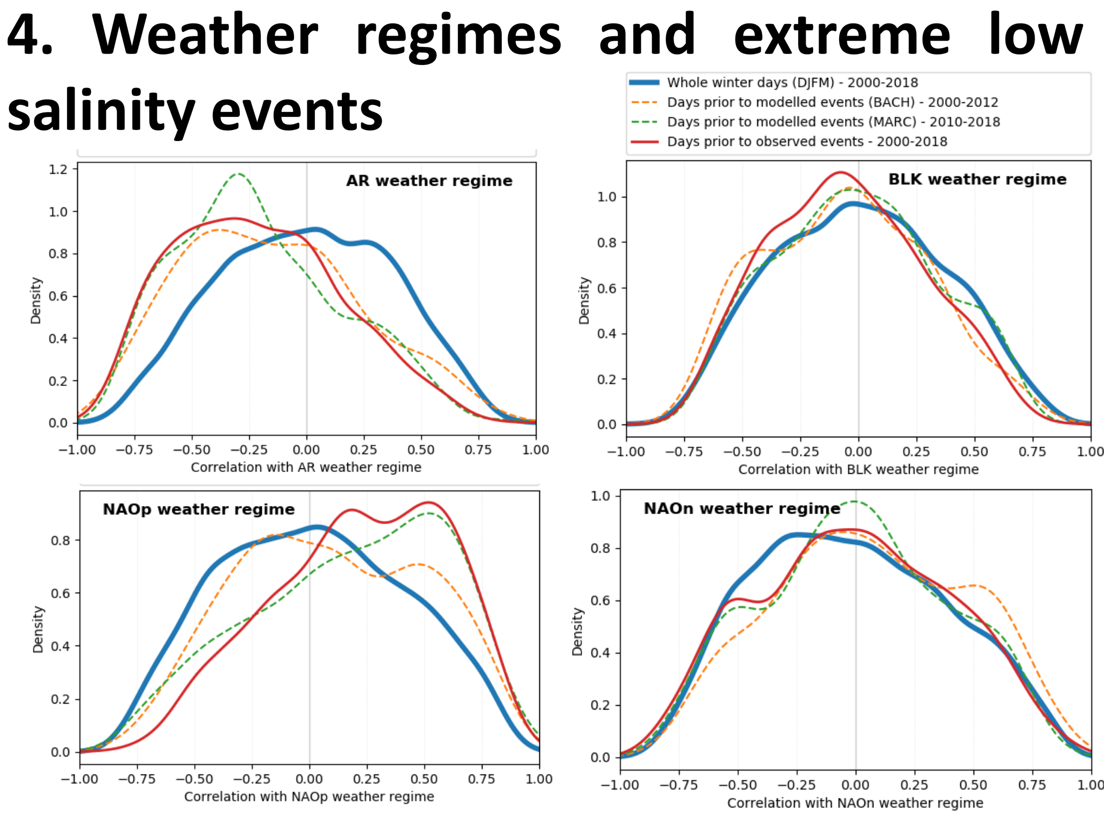
Winter 2004-2005 was characterized as an exceptional cold and dry winter **[5]**

Winter 2013-2014 was marked by 12 storm events **[6]**



3.3. Interannual distribution of the number of concomitant extreme low salinity events between simulated and observed data (COAST-HF-Iroise buoy)

4. Weather regimes and extreme low salinity events



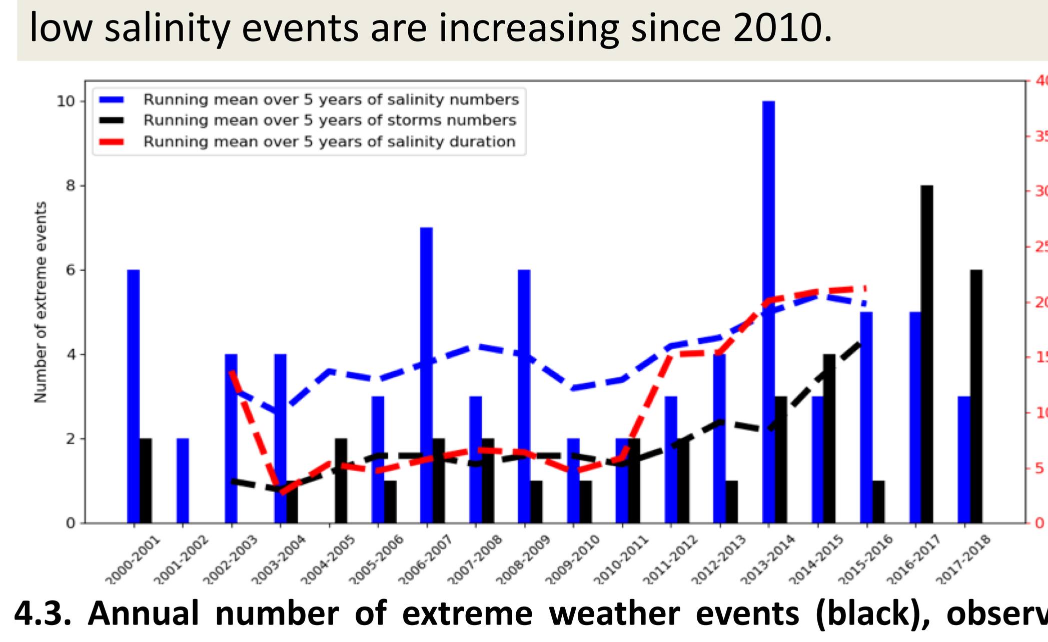
4.1. Kernel density estimation of the correlations of atmospheric sea level pressure with weather regimes (NAOp, NAOn, AR, and BLK) for winter periods and during 14 days before extreme events for *in situ* observations and numerical simulations

The NAOp and the negative phase of the AR are the most frequent weather regimes over the 14-days period before extreme low salinity events. These two winter weather regimes induce more precipitations in the north-eastern Atlantic.

	Weather regimes							
	AR		BLK		NAOp		NAOn	
	r	P	r	P	r	P	r	P
Winter precipitations	-0.296	<0.001	-0.185	<0.001	0.262	<0.001	0.077	<0.001

4.2. Pearson's correlations between winter precipitations and the four weather regimes

Linked with large scale weather regimes and the extreme weather episodes (storms), the duration and occurrence of low salinity events are increasing since 2010.



4.3. Annual number of extreme weather events (black), observed extreme low salinity events (blue) and cumulative duration of low salinity events (red) at COAST-HF-Iroise buoy

4. Conclusion

- ❑ ***In situ* high frequency observation combined with high resolution models have a great potential to investigate the long term effects of extreme events on the coastal marine ecosystems**
- ❑ At a **local scale** this variability is driven by **river unoffs** and **precipitations** (not shown)
- ❑ At a **larger scale** this variability can be related with **the North Atlantic Oscillation** (NAOp) and **the negative phase of the Atlantic Ridge** (AR), i.e. processes that are related to changes in the atmospheric circulation
- ❑ A relation between **extreme weather episodes** and **low salinity events occurrence** in the region is observed and highlight a **slight increase since 2010**

Acknowledgments and References:
This study is part of the Contrat Plan Etat-Région ROEC partly supported by the European Regional Development Funds. *In situ* observations were provided by the COAST-HF (http://www.coast-hf.fr) and the SOMLIT (http://somlit.epoc.u-bordeaux1.fr) national observation network from the ILICO research infrastructure. Model experiments (BACH configuration) have been performed with one of the GENCI (French Big National Equipment Intensive Computing) computational resources administered at CINES (National Computing Center for Higher Education). Data processing and figures have been partly performed using the open-source Python library VACUMM (http://www.ifremer.fr/vacumm/) and the Geographical Information System (QGIS - http://www.qgis.org). We also thank Michel Aïdonidis from Météo-France for the insightful discussions as well as the SHOM for provided tides data.

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