Large-, local-scale influences and impacts of extreme events on the characteristics of coastal waters of Western Europe (1998-2016)

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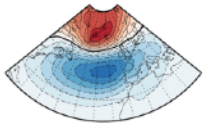
Charruyer, C. David-Beausire, T. Cariou, P. Tréguer

Objectives



Large-scale influence ?

Extreme events influence ?

Local-scale influence ?

North Atlantic atmospheric modes of variability (*e.g.* NAO, EAP)

Precipitations

River discharge

Coastal environment

Temperature & Salinity

Nutrients

Adapted from Tréguer *et al.*, JMS, 2014; Goberville *et al.*, pers. comm., 2015

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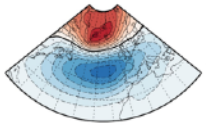

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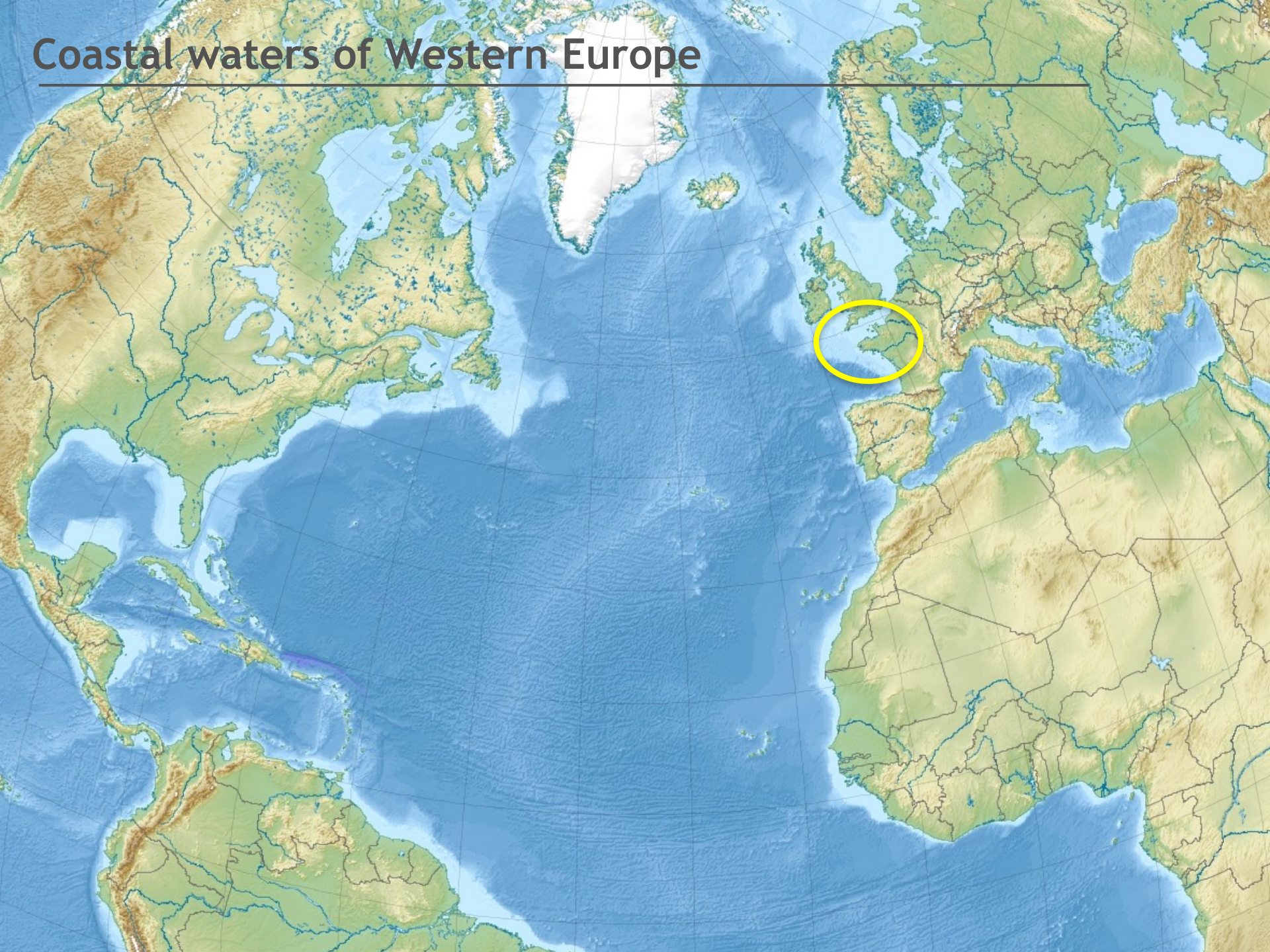
Coastal waters of Western Europe



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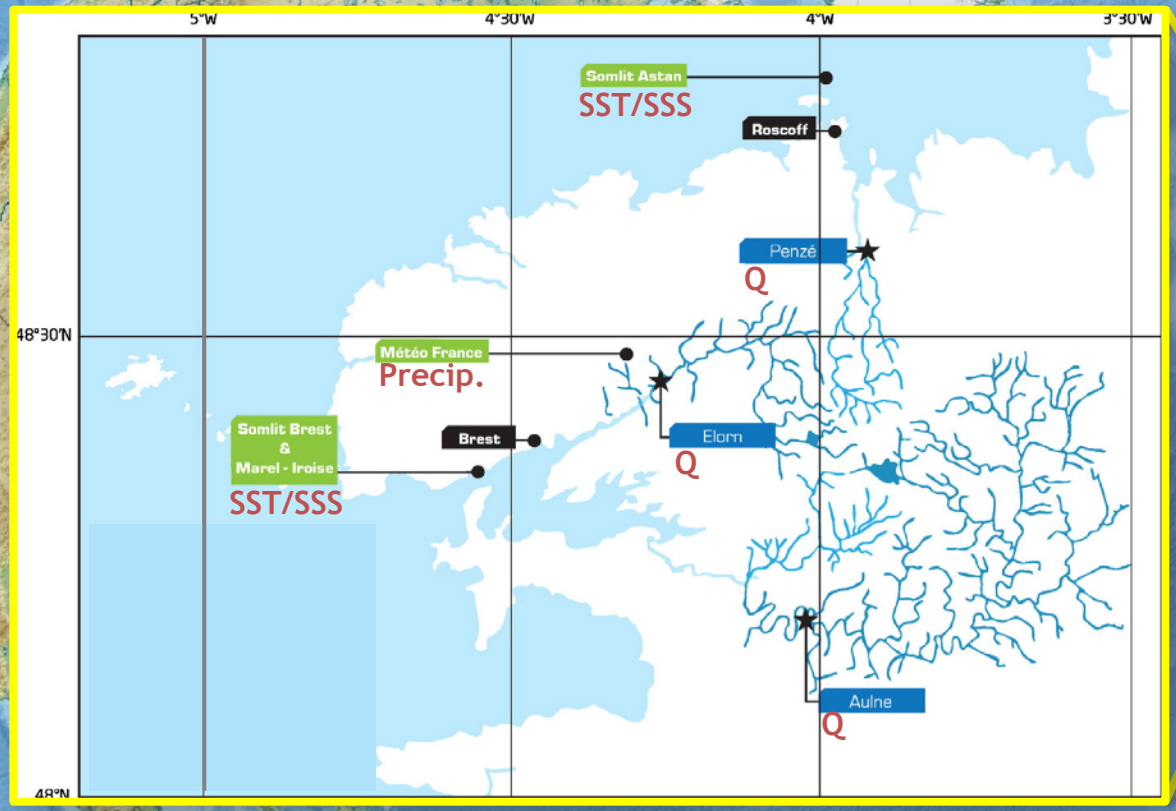
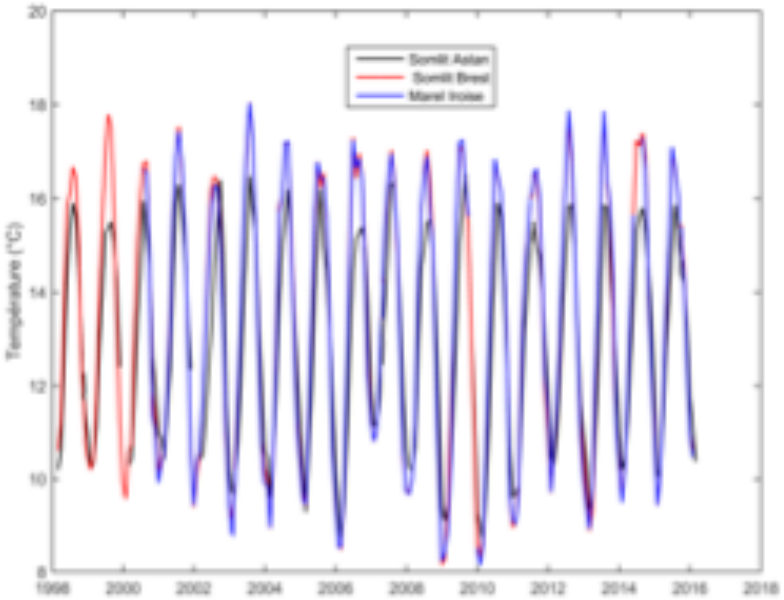


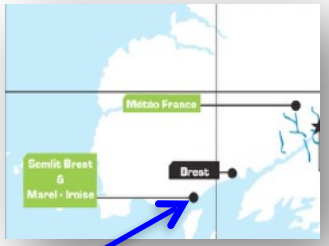
Tréguer *et al.*, JMS, 2014

Low-frequency measurements (LF): weekly 1998-2017

High-frequency measurements (HF): 10 min 2000-2017

Trends from observations (1998-2016)

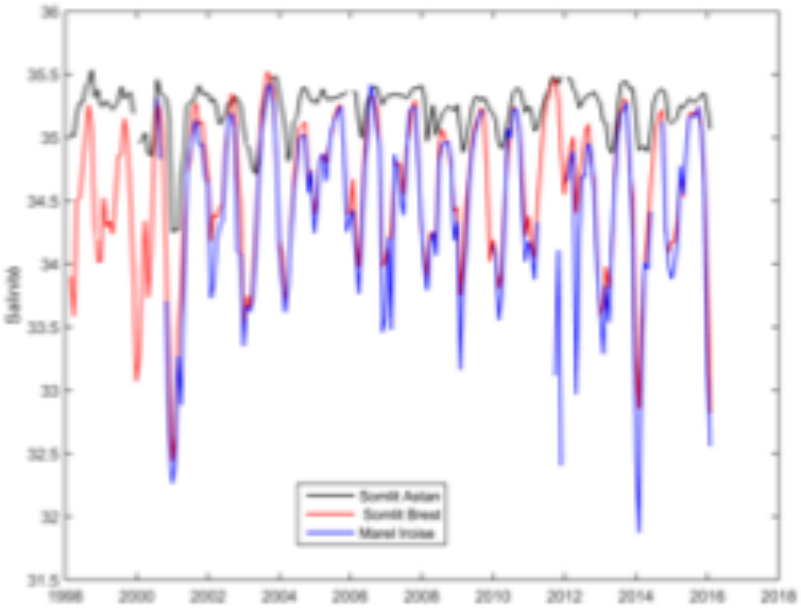


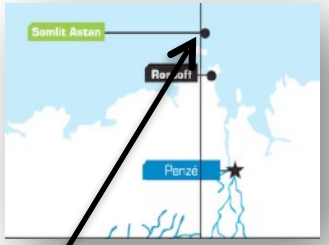


SST Brest +0.04 °C (10 yr)$^{-1}$

SSS Brest +0.11 (10 yr)$^{-1}$

Q (Aul+Elo) -0.99 m^3 s^{-1} (10 yr)$^{-1}$





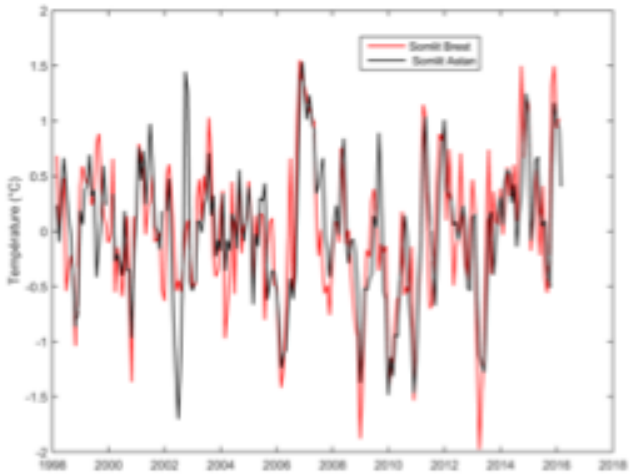
SST Astan +0.03 °C (10 yr)$^{-1}$

SSS Astan +0.04 (10 yr)$^{-1}$

Q Penzé -0.1 m^3 s^{-1} (10 yr)$^{-1}$

In winter … local-scale influence (1998-2016)

Temperature anomalies



	r	p-value
SST Brest *vs* SST Astan	**0.76**	<0.05
SSS Brest *vs* SSS Astan	**0.69**	<0.05
Aulne+Elorn *vs* Penzé river	**0.96**	<0.05

A significant correlation between Brest (West) and Roscoff (North) areas …

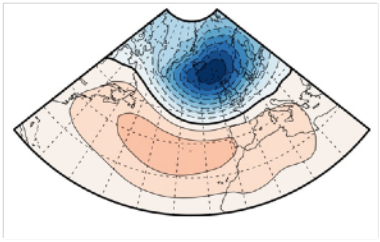
	r	p-value	%
Precipitations *vs* Aulne+Elorn runoffs	**0.82**	<0.05	67.2
Precipitations *vs* Penzé runoffs	**0.72**	<0.05	52.1
Aulne+Elorn runoff *vs* SSS Brest	**-0.73**	<0.05	52.7
Penzé runoff *vs* SSS Astan	-0.46	<0.05	21

… related with local precipitations

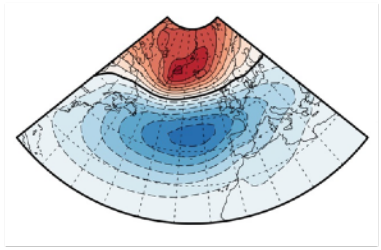
Winter ⇔ December - January - February
r ⇔ Pearson correlation coefficient

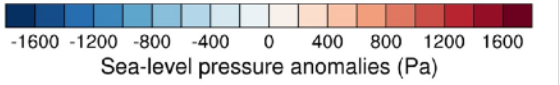
In winter … large-scale influence (1998-2016)

NAO+



NAO-



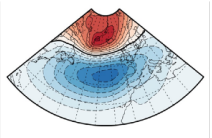


NAO index *vs*	r	p-value	%
SST Brest	0.55	<0.05	29.9
SST Astan	0.61	<0.05	36.9
SSS Brest	-0.05	0.78	0.2
SSS Astan	-0.02	0.91	0
Precipitations	0.06	0.64	0.4
Aulne+Elorn runoffs	0.06	0.86	0.1
Penzé runoff	0.03	0.86	0.1

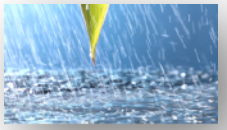
Sea Surface Temperature related with NAO index

Explained by wind changes (NAO+ - stronger warmer westerly winds / NAO- weak wind then cold air from Siberia)

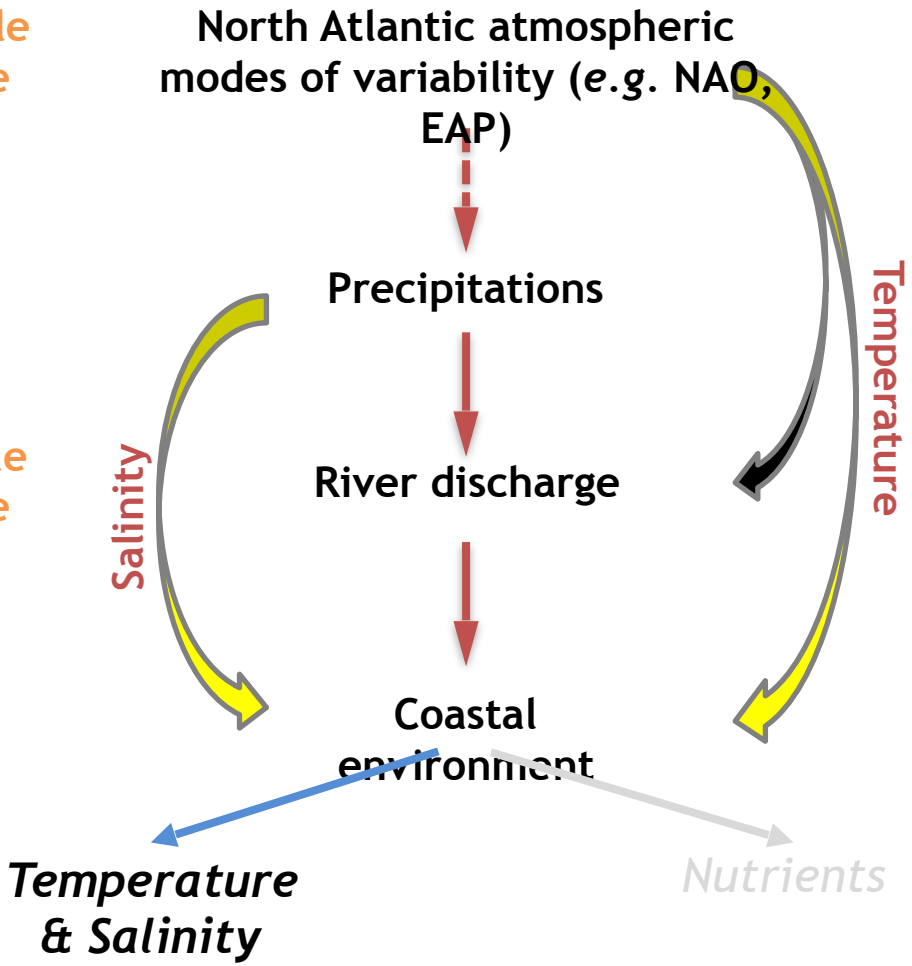
Large- and local-scale influence (in winter)



Large-scale influence

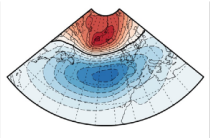


Local-scale influence



Adapted from Tréguer *et al.*, JMS, 2014; Goberville *et al.*, pers. comm., 2015

… and extreme events ?



Large-scale influence

North Atlantic atmospheric modes of variability (*e.g.* NAO, EAP)

Precipitations

River discharge

Coastal environment

Salinity

Temperature

Extreme events influence ?

Local-scale influence

Temperature & Salinity

Nutrients

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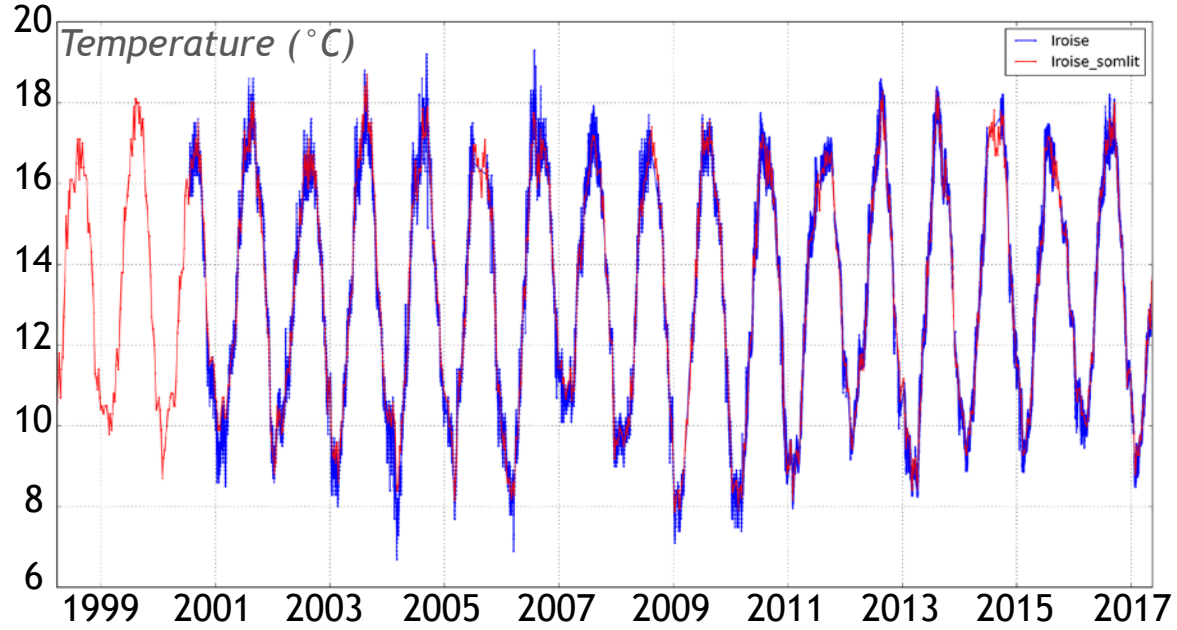
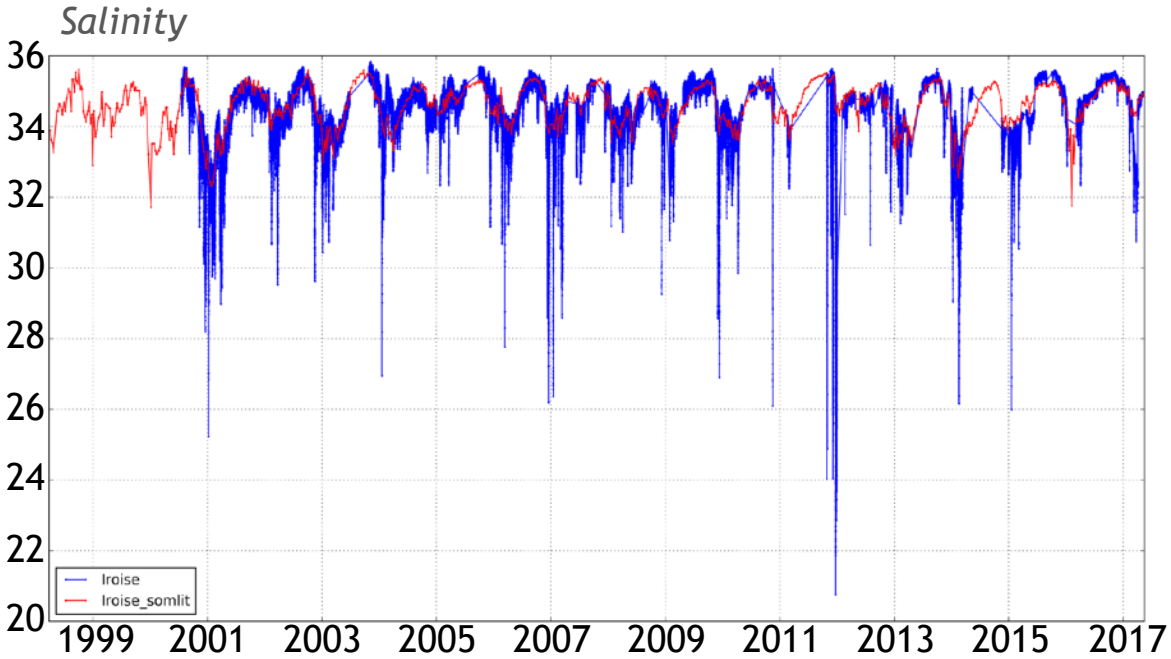
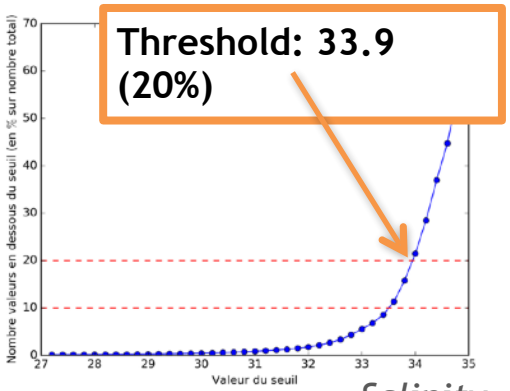
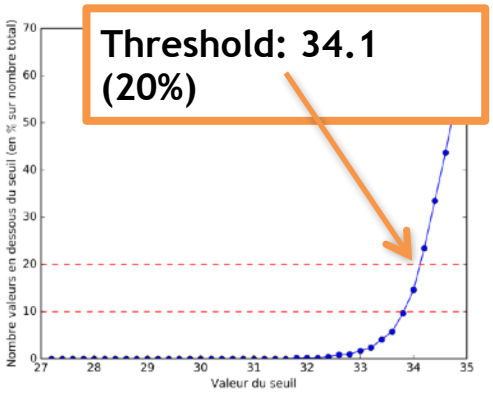
Tracking the signature of extreme events

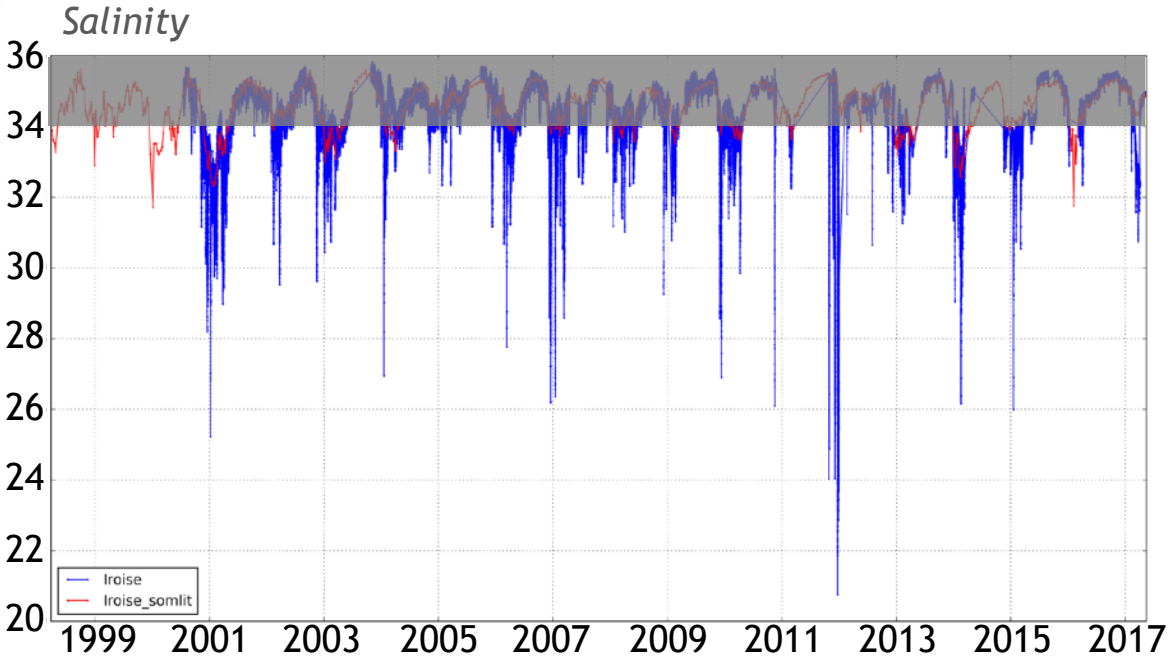




Occurrence of extreme events







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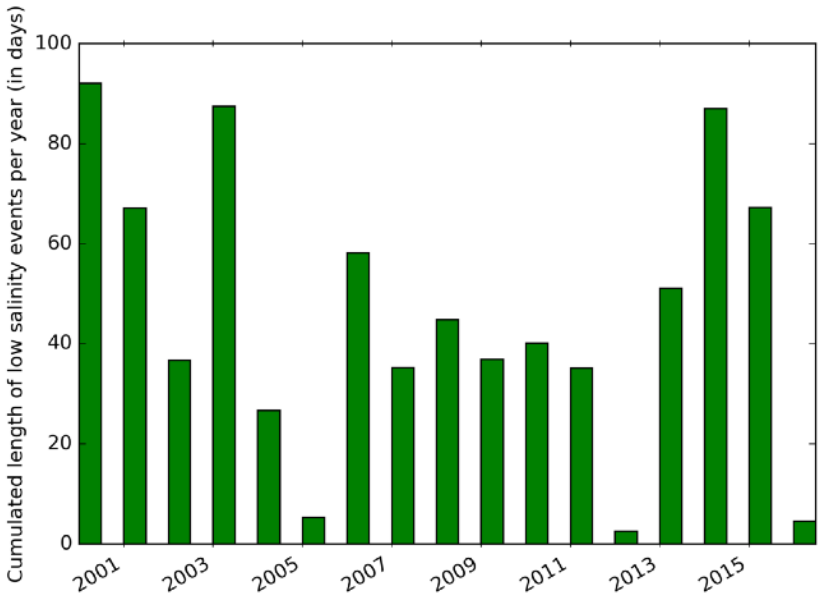
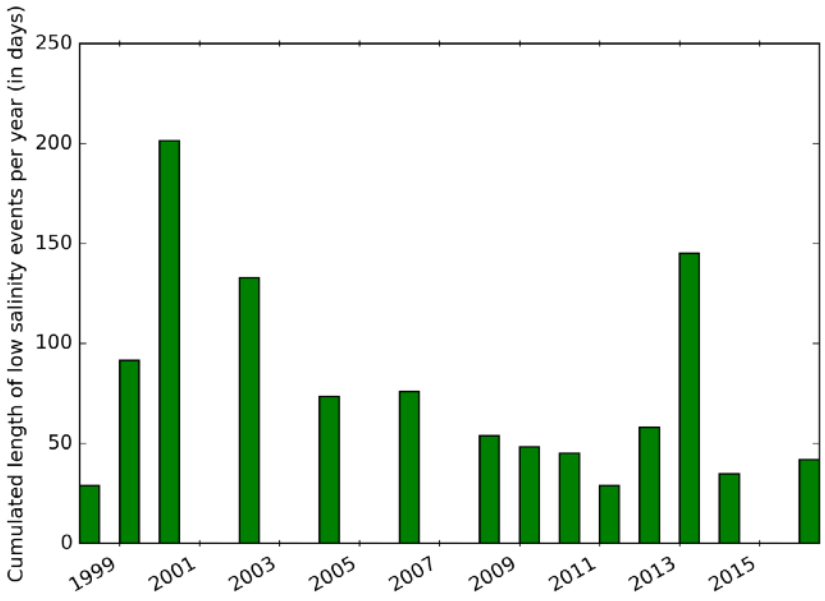
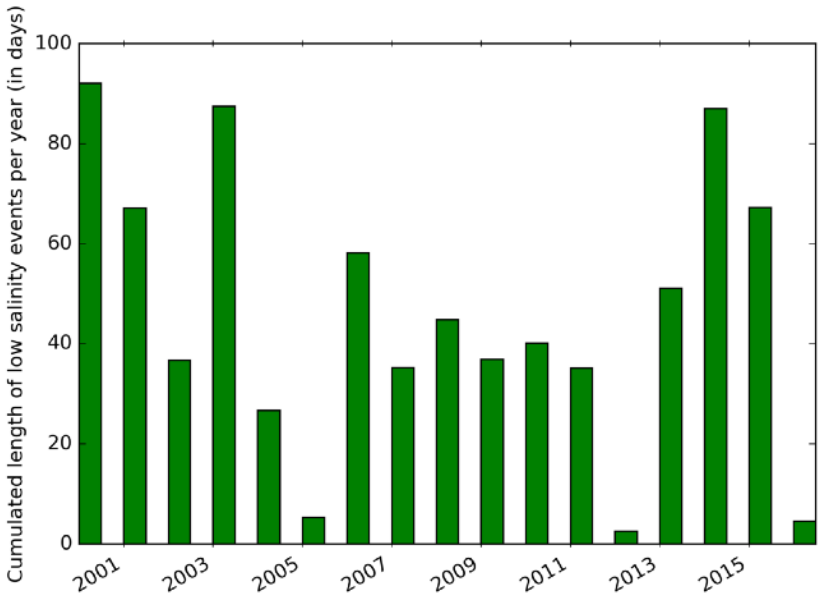
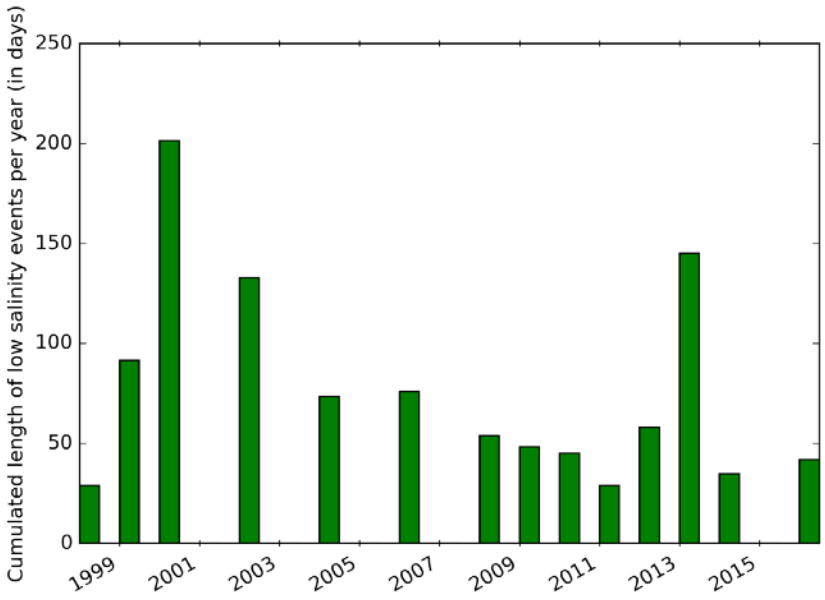




Occurrence of extreme events

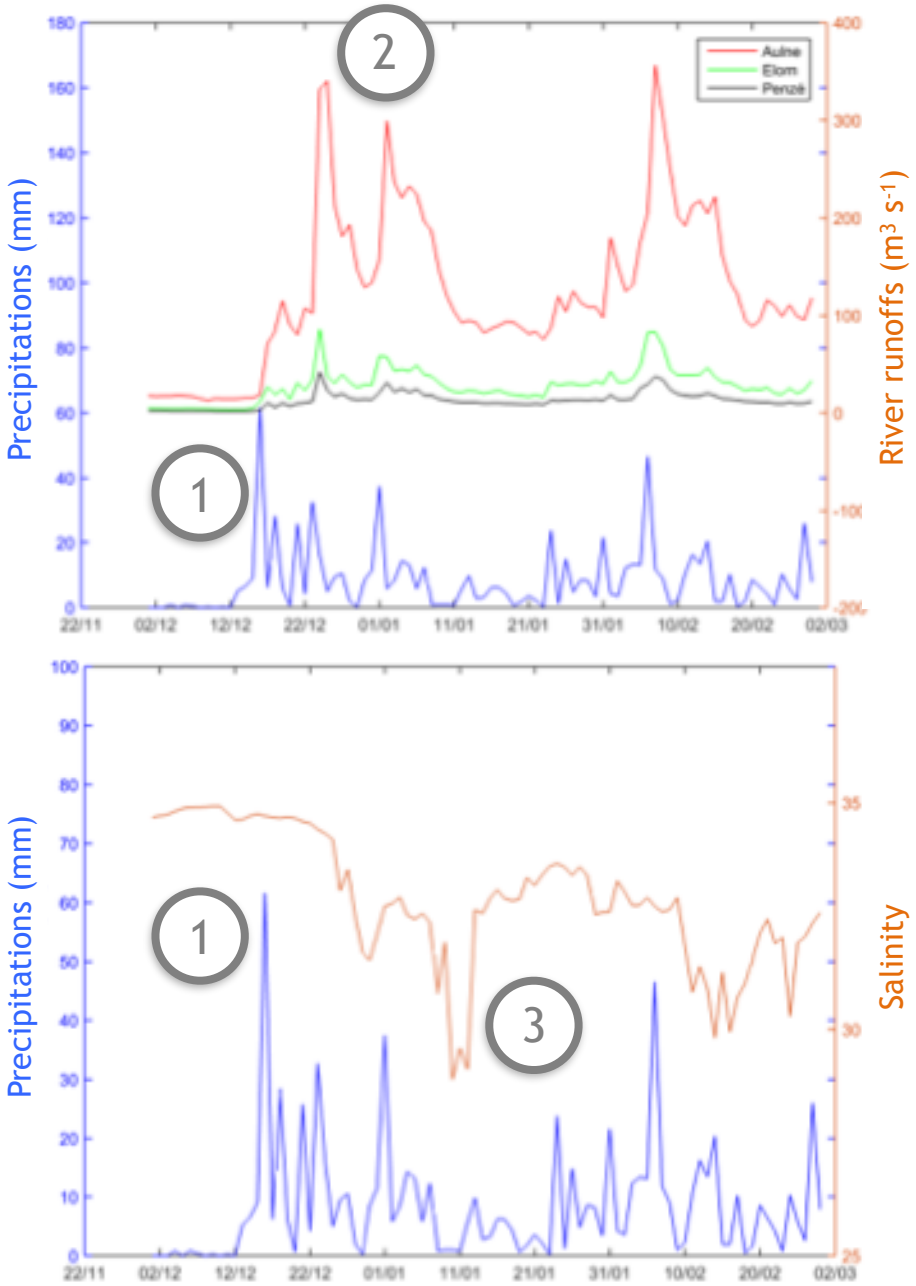
Need of HF to detect extreme events however …
Gaps in HF observations





What is the influence of those events on coastal waters ?

An example during winter 2013-2014 (December-January-February)



1. Observed strong precipitation event

8 days

2. Impacts on river runoffs (in 3 rivers)

5 days

3. Decrease in salinity

The influence of an intense atmospheric event will impact salt content in coastal waters after **10 to 15 days** in the region.

Conclusions

18 years of observations

Large- and local-scale influences on coastal water features

(Tréguer *et al.*, JMS, 2014 – extended to 2016)

Variability in coastal waters of Western Europe connected to

- the large-scale **North Atlantic atmospheric circulation** *(mainly temperature)*
- **local river** influences related with local precipitations *(salinity)*

Extreme event influences on coastal water features

Salinity minima related with precipitation intense events

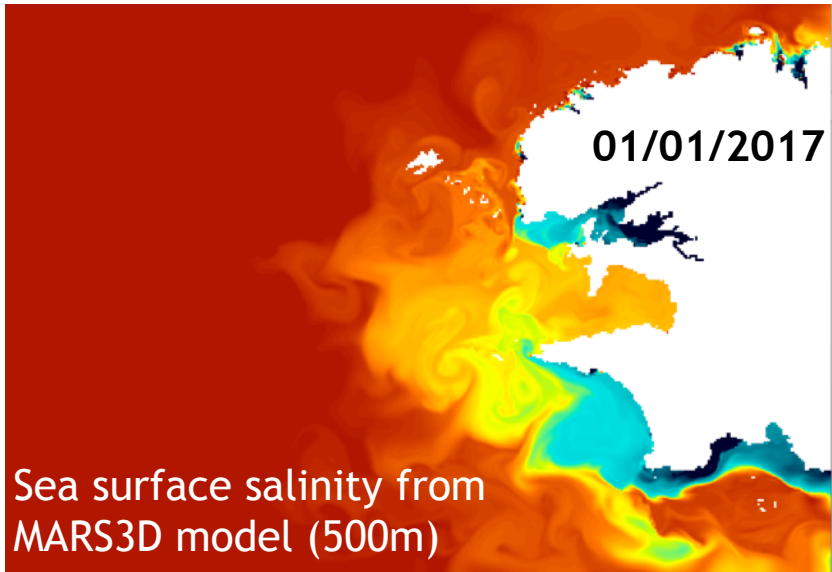
- **continuous high-frequency sampling** needed to detail variability in occurrences
- strong **interannual variability**
- impact on ocean observed **within few days** (10-15 days)

Next steps

To evaluate the impacts on the ecosystem (*e.g.* nutrients)

To connect weather regimes and ocean circulation regimes

To quantify the influences of climate change on coastal waters
(*e.g.* heat, salt, nutrients contents)

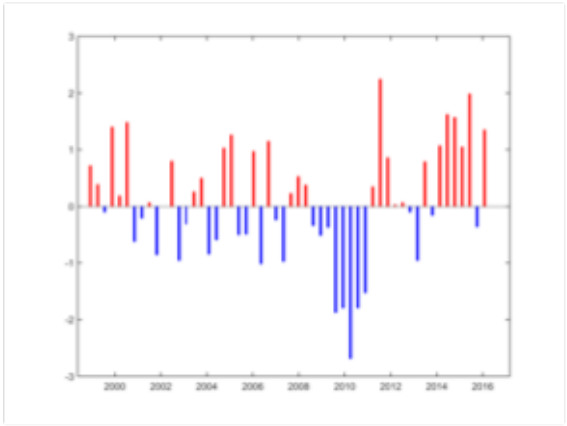


Sea surface salinity from MARS3D model (500m)

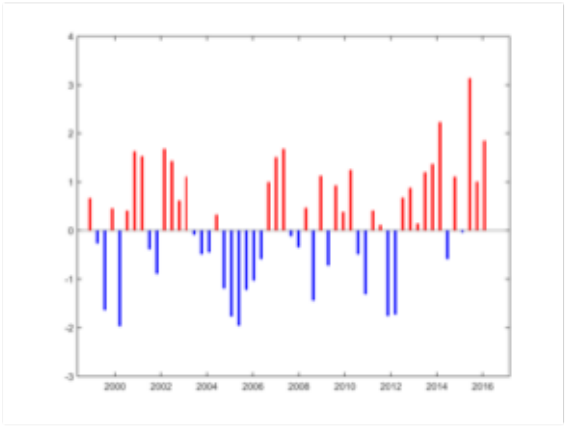
Thank you for your attentio

In winter … large-scale influence (1998-2016)

EAP index *vs*	r	p-value	%
SST Brest	0.24	0.14	5.7
SST Astan	0.20	0.24	4.2
SSS Brest	-0.37	<0.05	14
SSS Astan	-0.18	0.29	3.1
Precipitations	0.65	<0.05	41.7
Aulne+Elorn runoffs	0.58	<0.05	34.2
Penzé runoff	0.51	<0.05	26.2



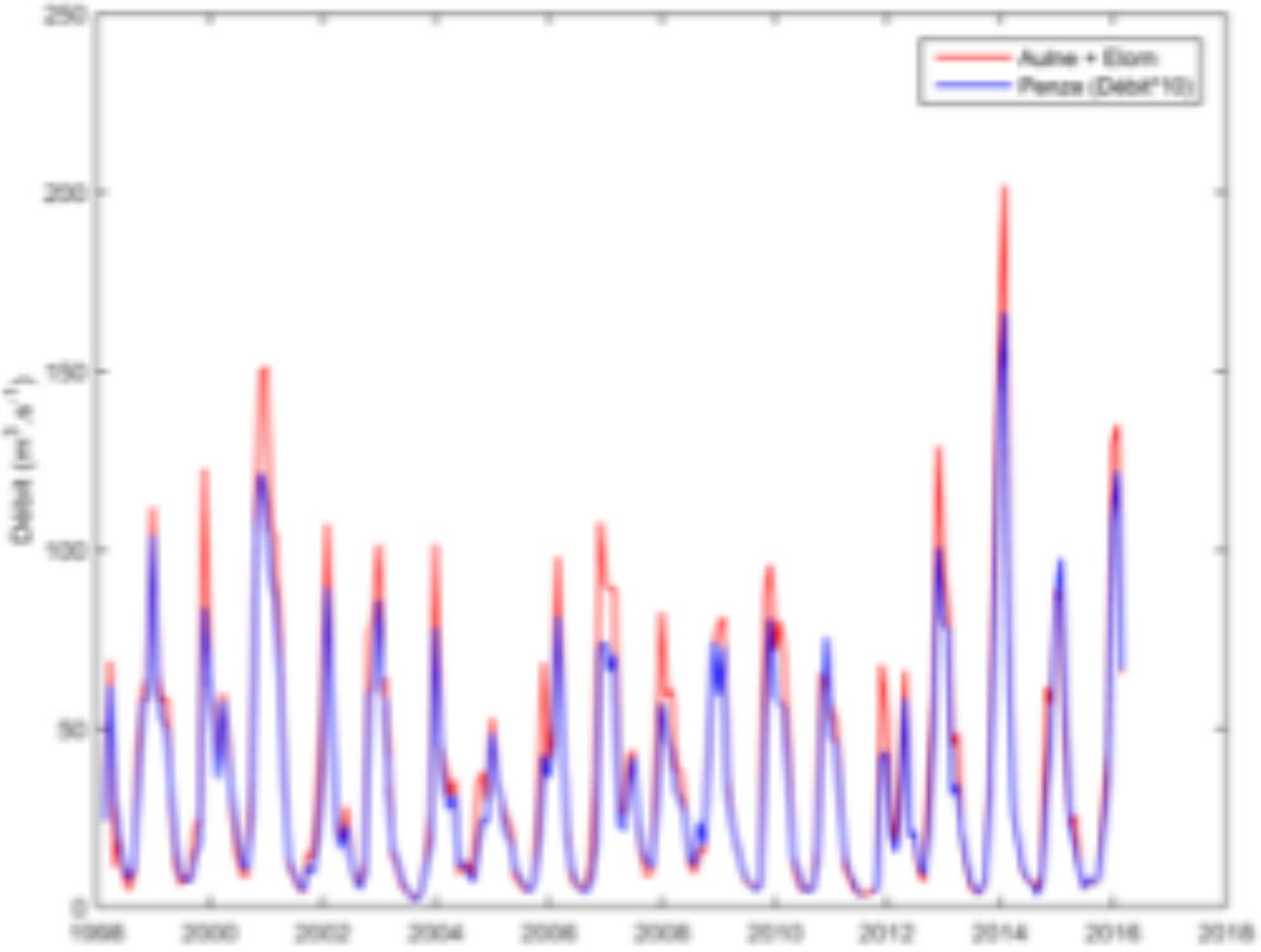
(a) NAO



(b) EAP

FIGURE 3 – Indices des téléconnections climatiques à grande échelle calculés pour les mois d'hiver (décembre, janvier, février) sur la période 1998-2016. Les anomalies positives sont en rouge et les négatives en bleu. (a) NAO : Oscillation Nord-Atlantique et (b) EAP : Pattern Est Atlantique.

River runoffs



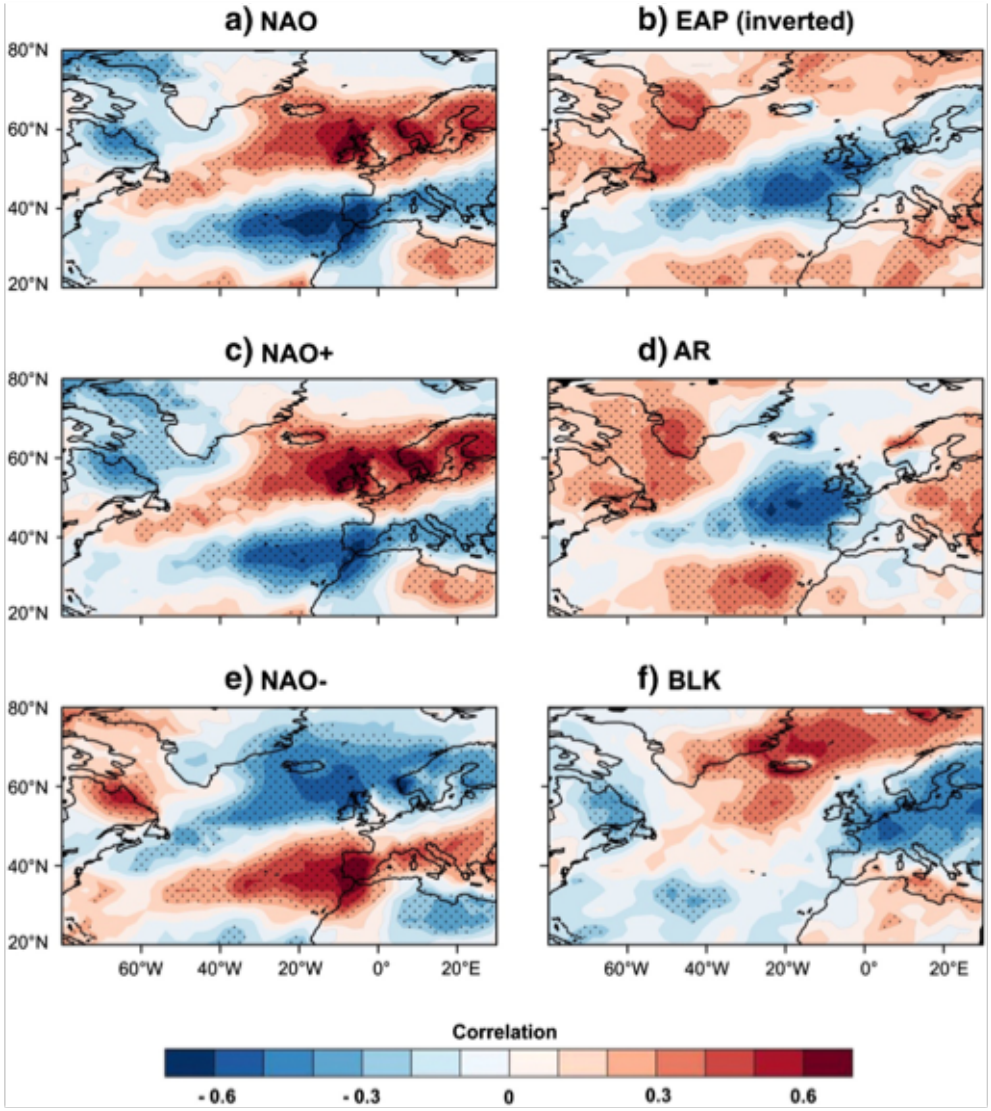


Fig. 7. Correlation maps between DJF (December–January–February) monthly mean precipitation anomalies and DJF monthly mean large-scale indices. (a) NAO: the North Atlantic Oscillation; (b) EAP: the East Atlantic Pattern; (c) NAO+: positive phase of the NAO; (d) AR: the Atlantic Ridge; (e) NAO−: negative phase of the NAO; (f) BLK: the Scandinavian Blocking regime. The East Atlantic Pattern was inverted (multiplied by −1) for comparison with the Atlantic Ridge. The color shading shows the correlation values. Black dots indicate the areas where correlations are significant after correction to account for temporal autocorrelation. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)