

Identification and characterization of submesoscale activity over the continental shelf in the Bay of Biscay



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Co-Badged Masters Degree
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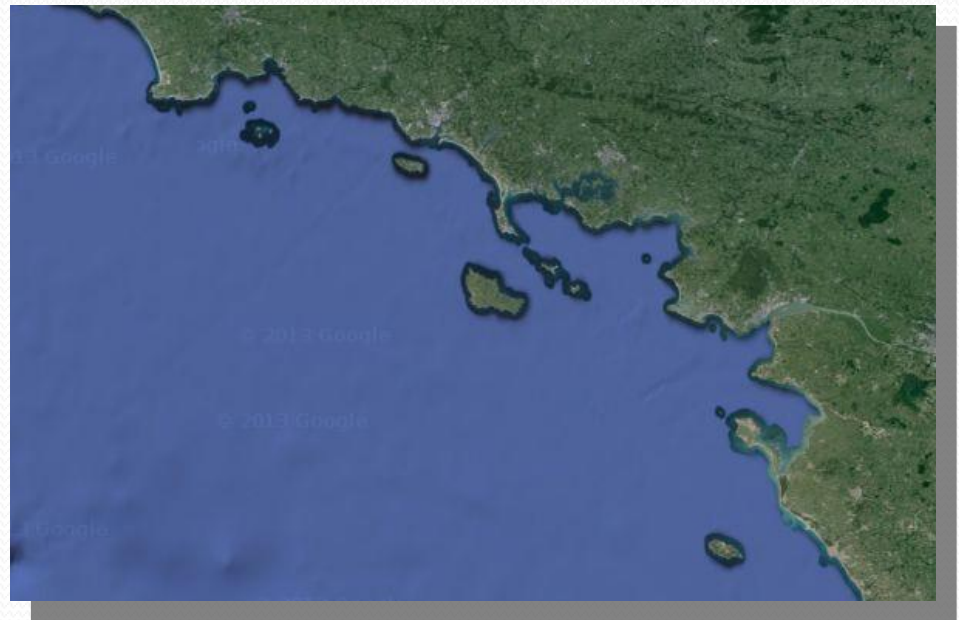
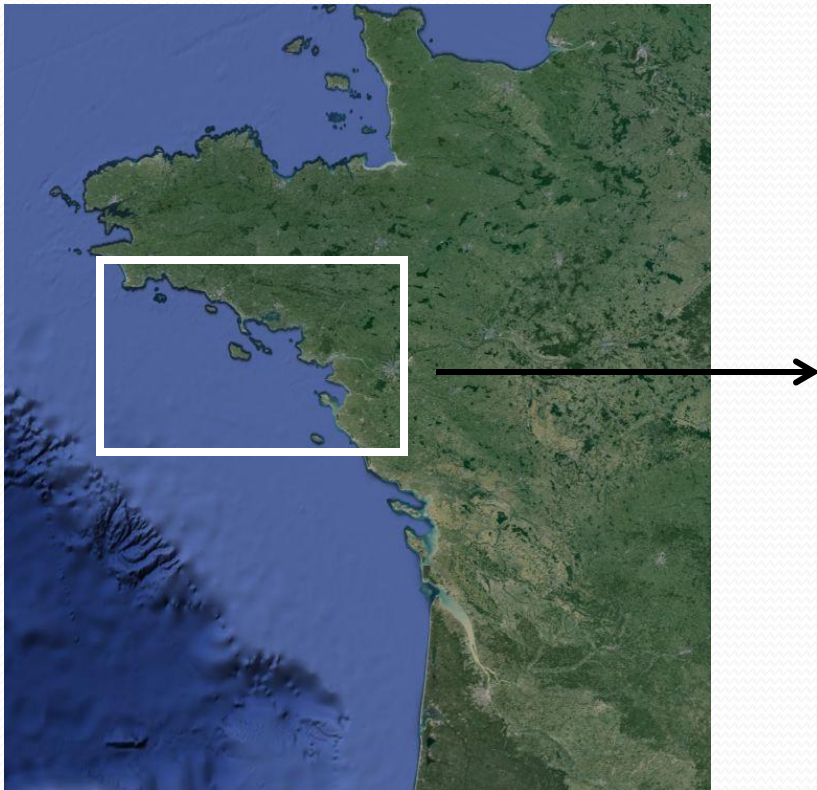
Laboratory DYNECO-PHYSED, IFREMER- Brest
Supervisor: Guillaume CHARRIA

AIM

Identify submesoscale structures by analysing **satellite images** of *Sea Surface Temperature (SST)*, *Chlorophyll-a concentration (CHL)* and *Suspended Particulate matters (SPM)*.

- Focus on main rivers -**Loire River**.
- Using **Methods to highlight** and **characterize** these **submesoscale structures**.
- Analysis of the **impact of winds** and **river runoffs** on the circulation of river plumes.

Study Area (Loire River)



Domain :

Latitudes : 46.5 deg N to 48 deg N

Longitudes : -2 deg W to -5 deg W

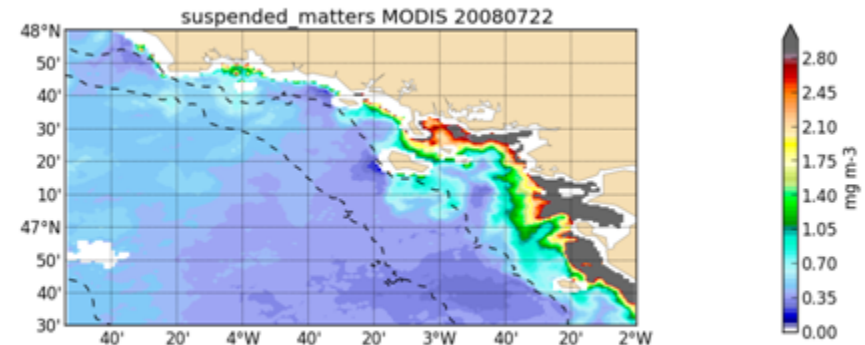
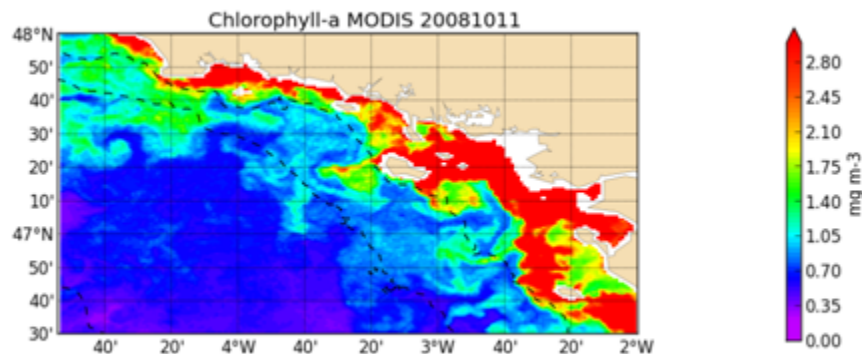
Overview

- Data and Methods
- Availability of Data
- Examples of some events
- Interannual variability
- Conclusions and Perspectives

DATA

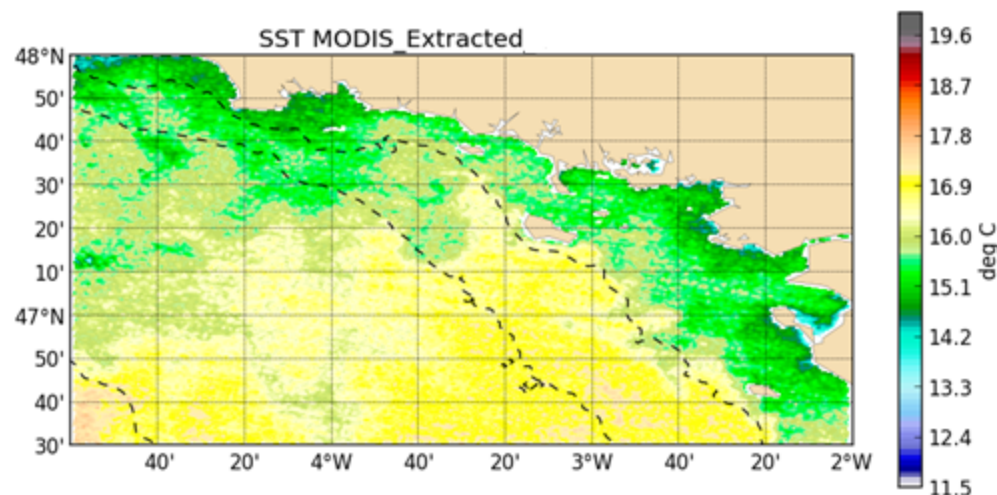
Chlorophyll-a Concentration and Suspended Particulate Matter

- Satellite imagery of **chlorophyll-a concentration (CHL)** and **suspended particulate matters (SPM)** were extracted from MODIS onboard Aqua and Terra instruments.
- Gohin et al. (2002) developed a **4-channel algorithm for MODIS** - gives results similar to Ocean Colour 4 in open waters but provides more realistic values over the continental shelf.
- Spatial Resolution : **800m**
- Time Resolution : **Daily over a period of 10 yrs (Jan 2003-June 2013)**



Sea-surface Temperature

- Satellite data of **Sea-surface temperature (SST)** MODIS-onboard Aqua and Tera instruments
- Extracted from NASA website: (<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl?sen=am>)
- Spatial Resolution : **800m**



River Discharge Data



- (CDOCO) provides a list of **rivers**, their **time series** and corresponding **distributors**.
- Loire River
 - River discharge data collected via **Banque Hydro** - measures effectively at each station the **instantaneous river runoffs** on a daily and monthly basis.



* (CDOCO) - *Centre de Données pour l'Océanographie Côtière Opérationnelle*

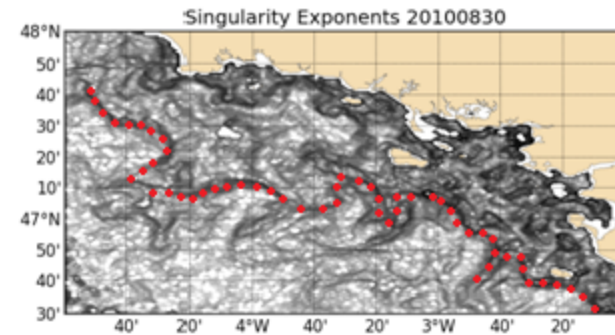
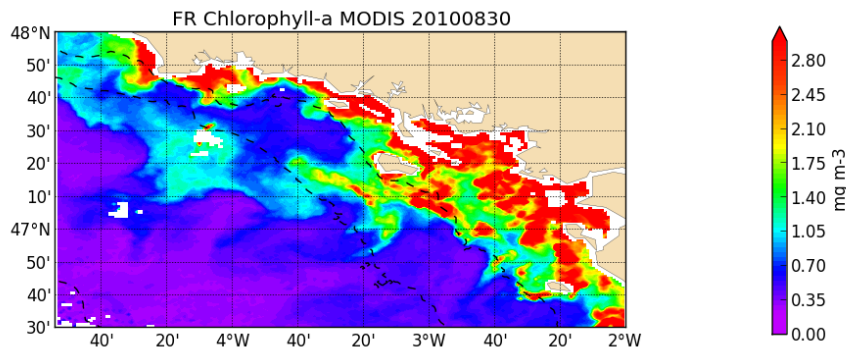
Winds

- Wind data provided by **Météo-France** - uses a numerical prediction **model** called **Arpège** (*Action de recherche Petite Echelle Grande Echelle*).
- Spatial resolution (High Resolution Arpège) : **10 km**
- Time resolution : **Daily**

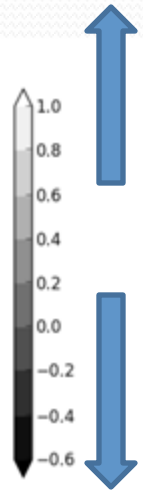
Methodology

(i) Singularity Exponents

- Based on Wavelets
- To **highlight** and **sort** frontal structures



Low
gradients

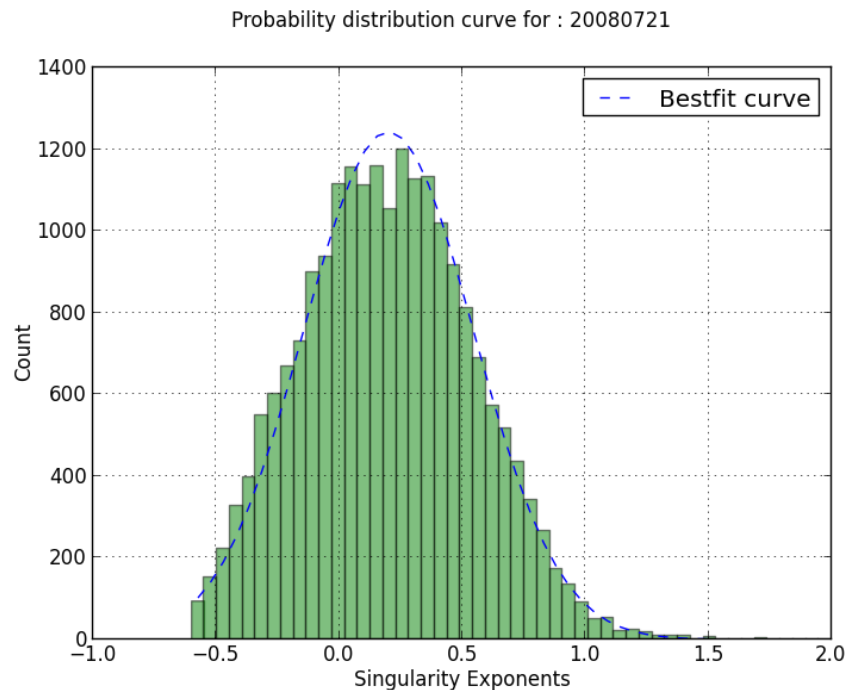


High
gradients

- In Collaboration with Yahia H. (INRIA, Bordeaux) and Sudre J. (LEGOS)

Yahia.H , Sudre.J et al ., 2010. Motion analysis in oceanographic satellite images using multiscale methods and the energy cascade. Pattern Recognition , 43(10), pp. 3591–3604, Elsevier, (2010).

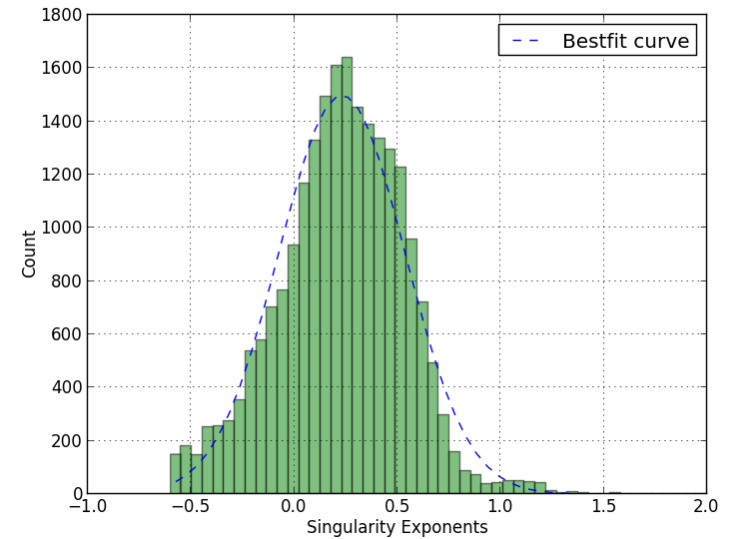
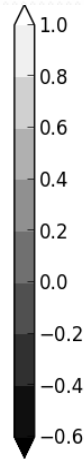
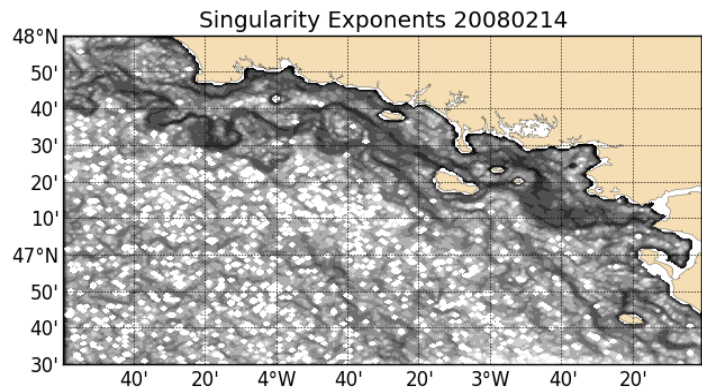
(ii) Probability Distribution Function



- Represented by plotting **Histogram** –values of singularity exponents v/s Number of occurrences/ Count
- Indicate whether graph is **skewed right or left**.

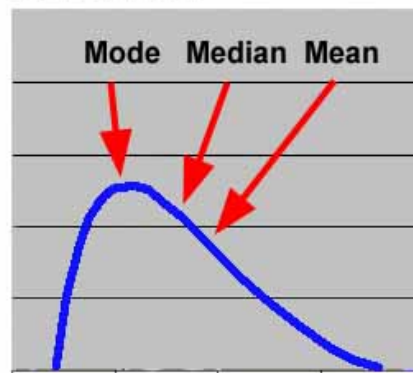
Reminder on Skewness

The measure of how asymmetric a distribution can be.

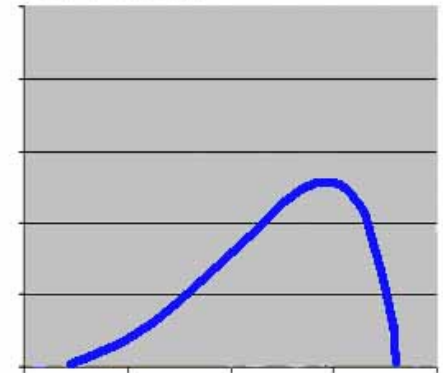


The more negative the value of singularity exponent is, the stronger will be the frontal activity.

RIGHT SKEW



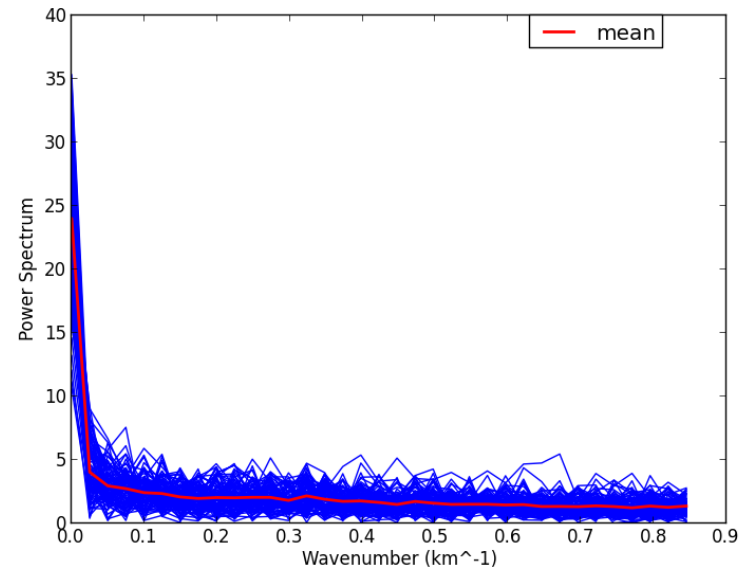
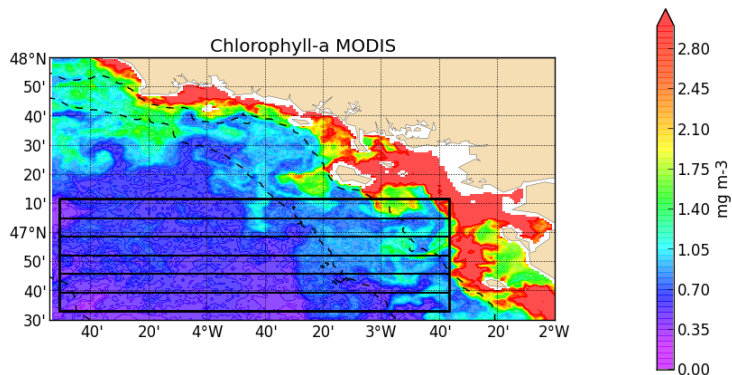
LEFT SKEW



(iii) Fourier Analysis

- Performed on (CHL-a and) Singularity exponents.

FFT LAT



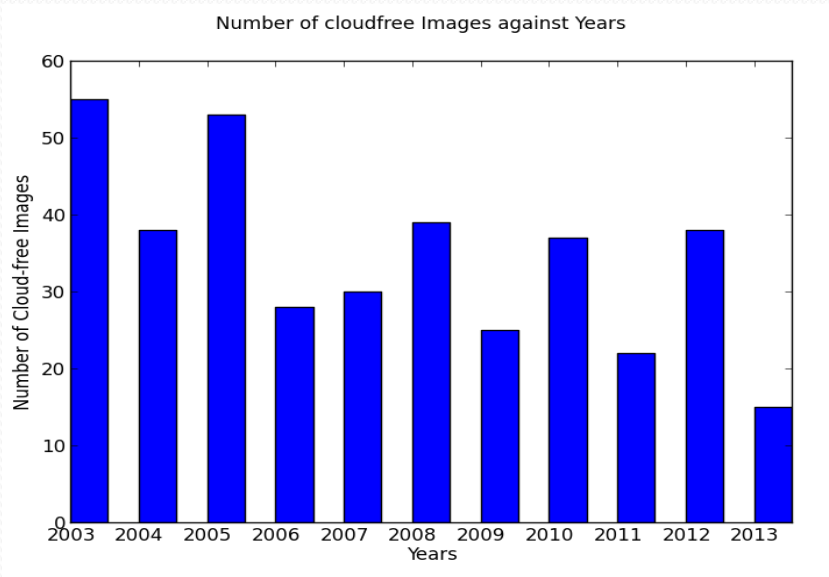
Domain

Latitudes : 46.3 N to 47.1 N

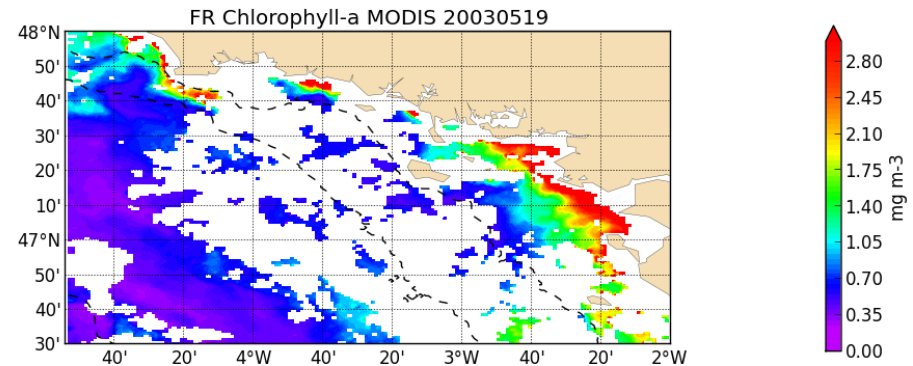
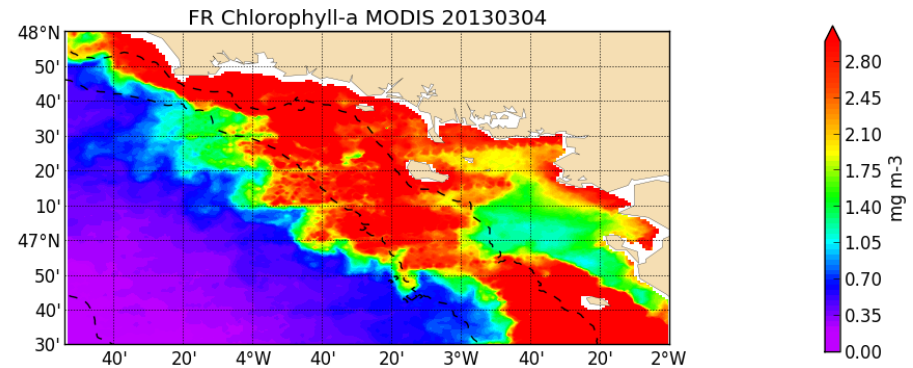
Longitudes : -2.3 W to -4.5 W

Data availability

Data Availability



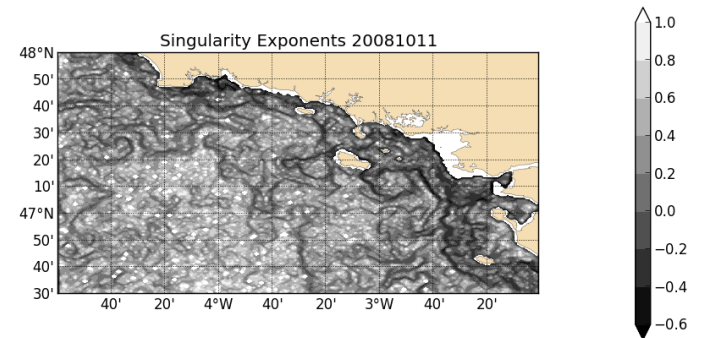
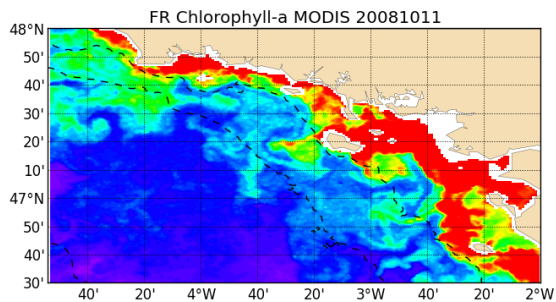
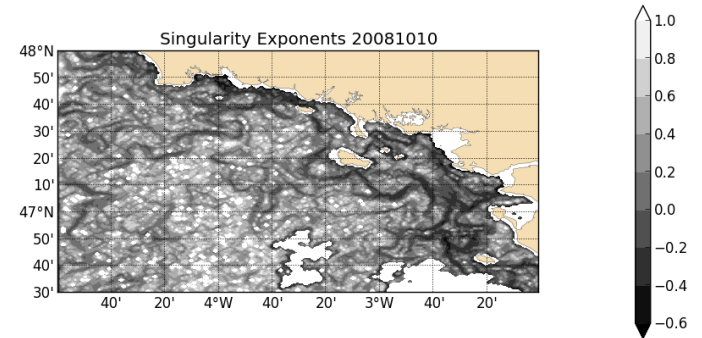
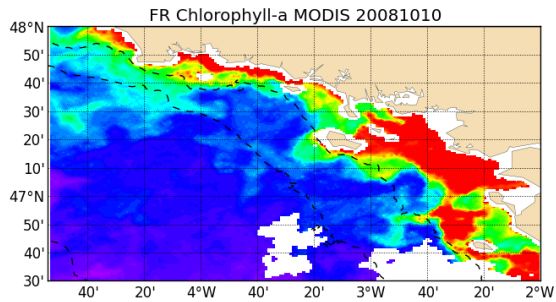
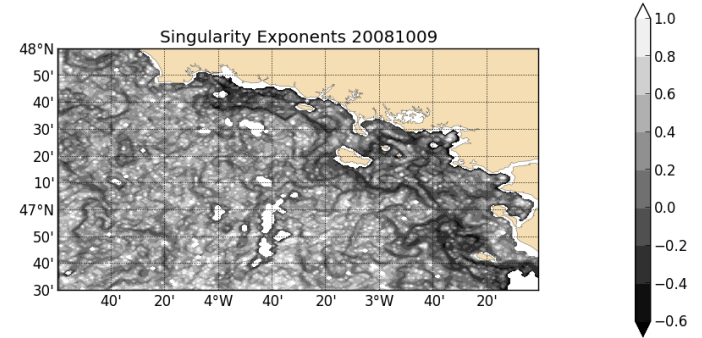
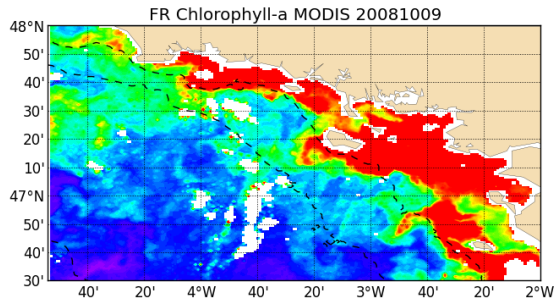
Cloud-free images were selected visually.



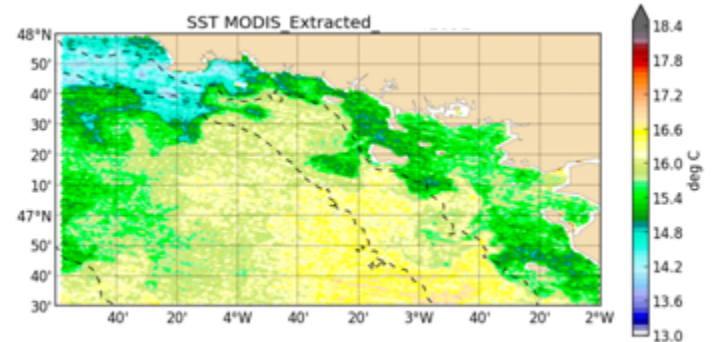
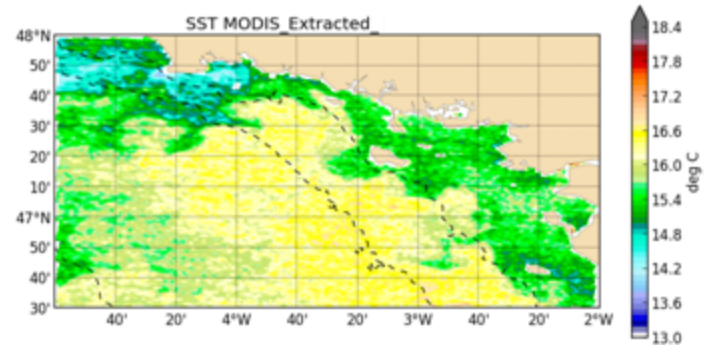
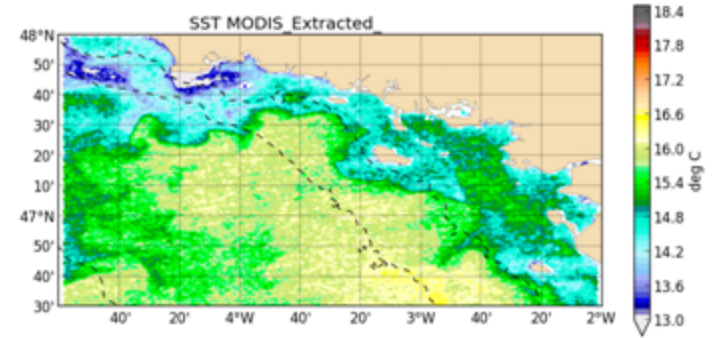
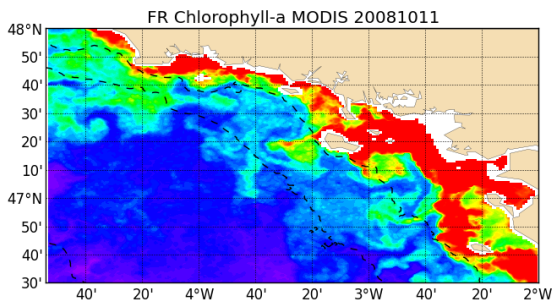
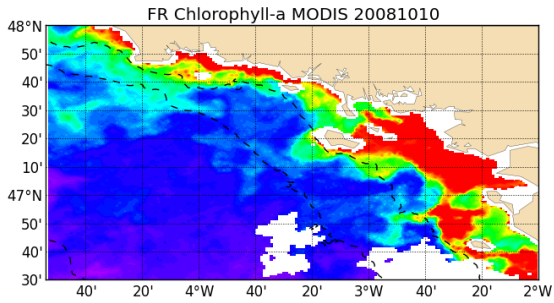
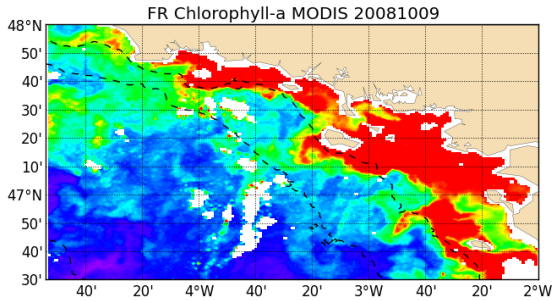
Examples of some events

- Consecutive images
- Spring and summer 2012
- Winter and Autumn 2008

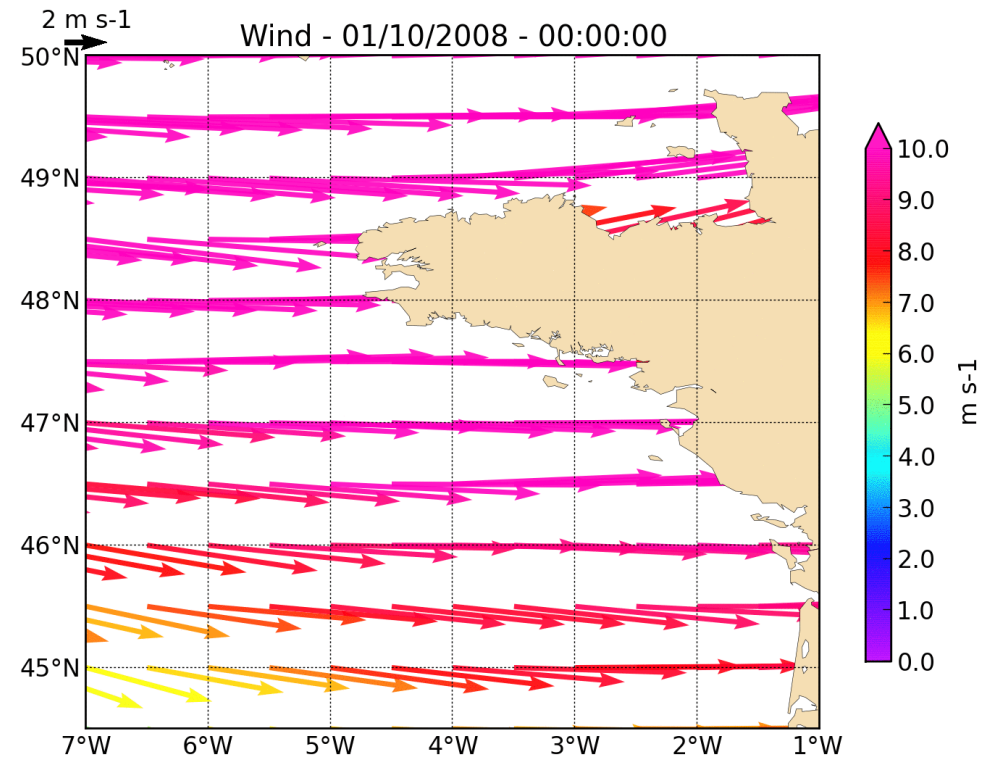
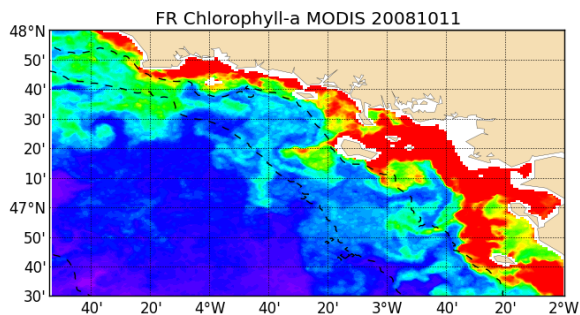
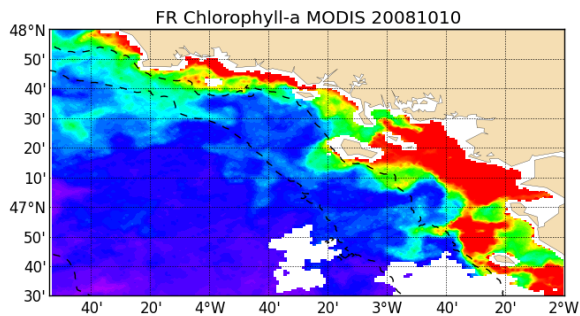
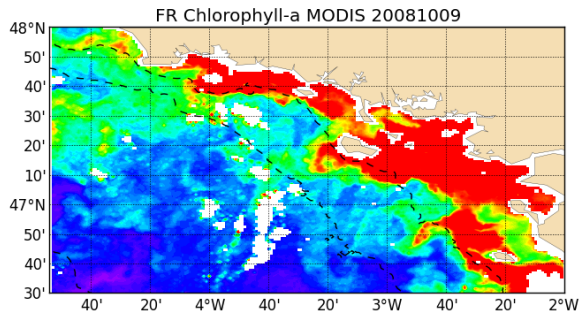
Chlorophyll-a concentration and Singularity exponents (Oct 2008)



Chlorophyll-a concentration and Sea-surface Temperature

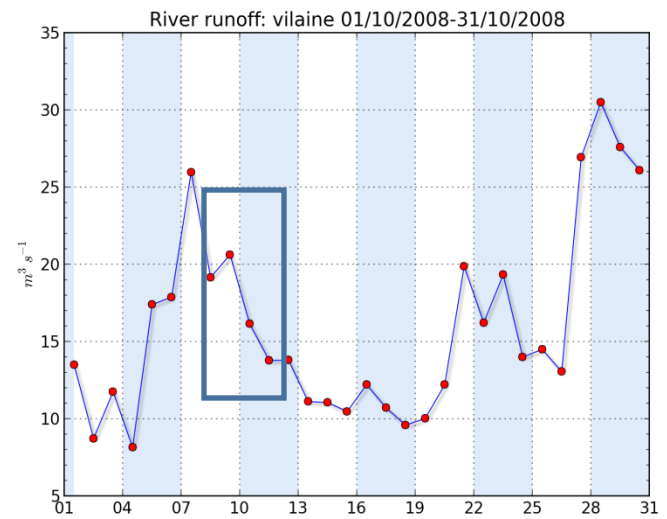
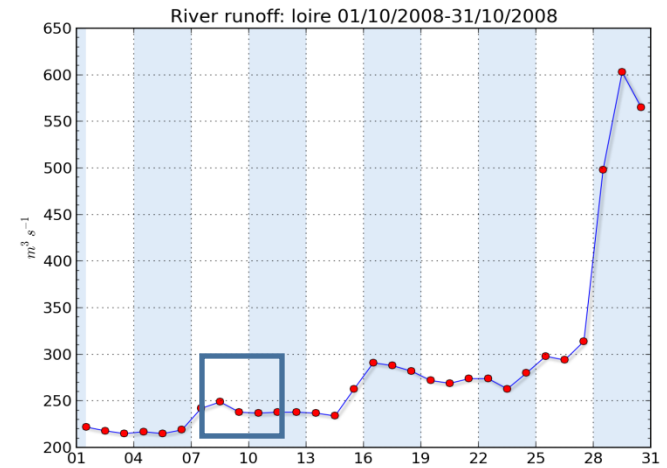
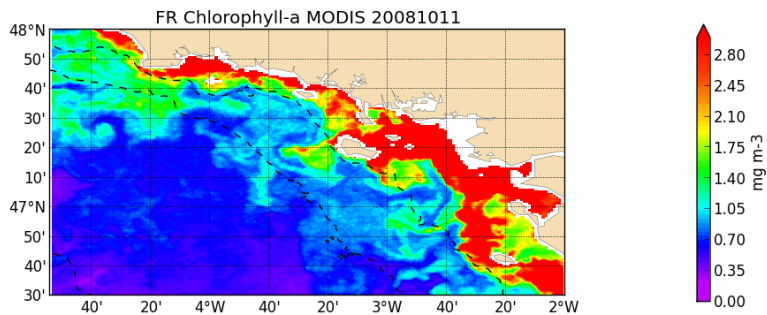
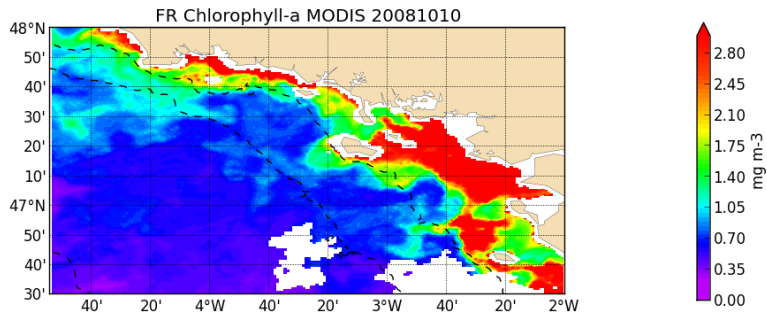
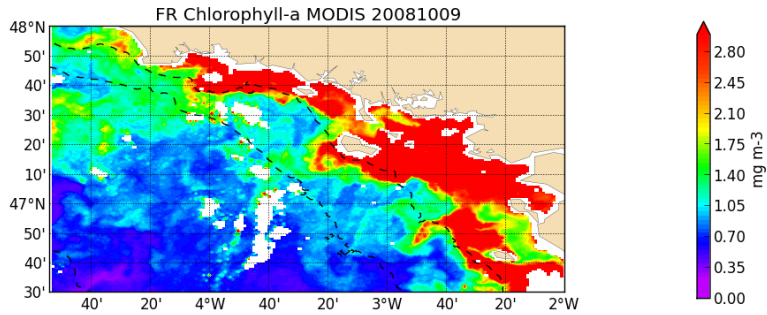


Winds

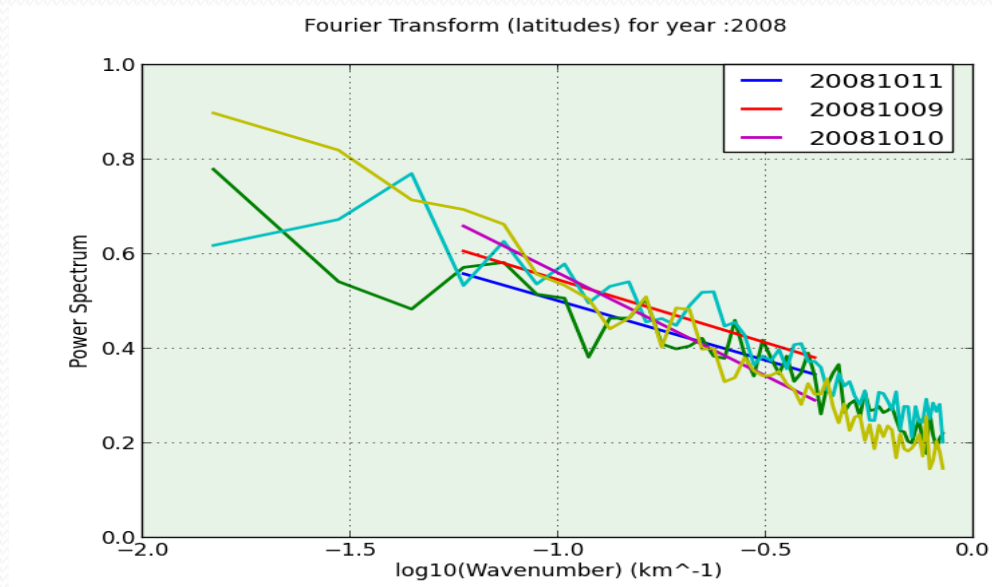


- Weaker and easterly winds on 9,10
- Wind intensifies on the 11

River runoffs

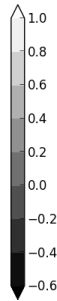
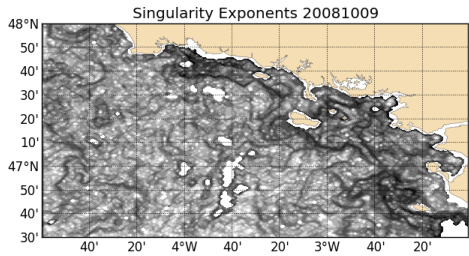


Fourier Transform



Wavelength :
2.5 km – 20 km

	Spectral slope
9/10/2008	-0.252
10/10/2008	-0.266
11/10/2008	-0.436

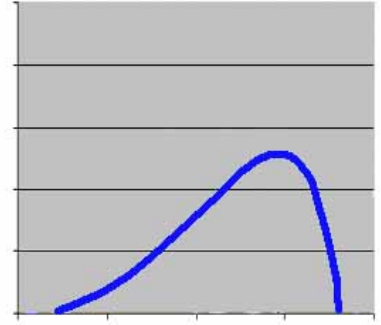


PDF

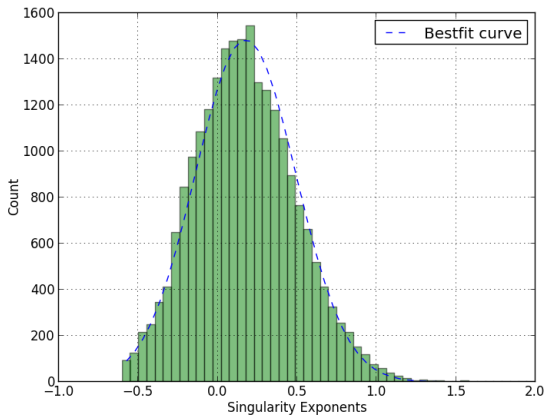
RIGHT SKEW



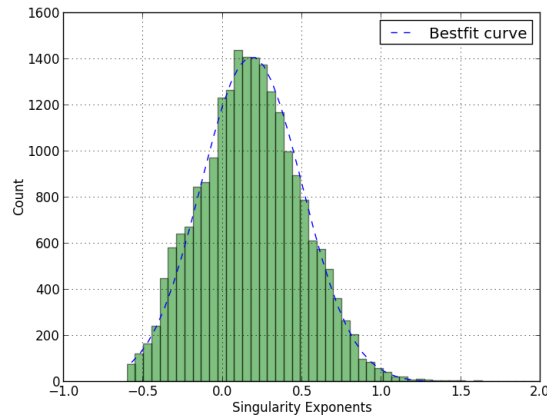
LEFT SKEW



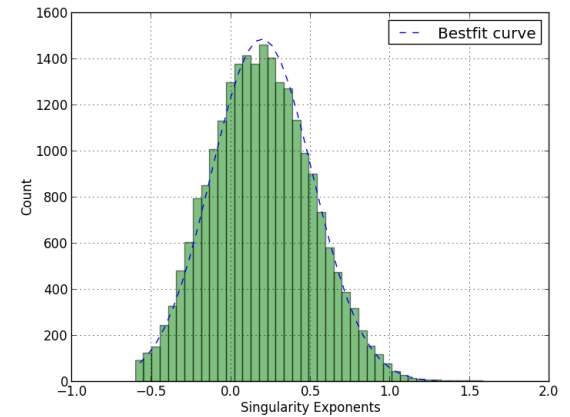
Probability distribution curve for : 20081009



Probability distribution curve for : 20081010



Probability distribution curve for : 20081011

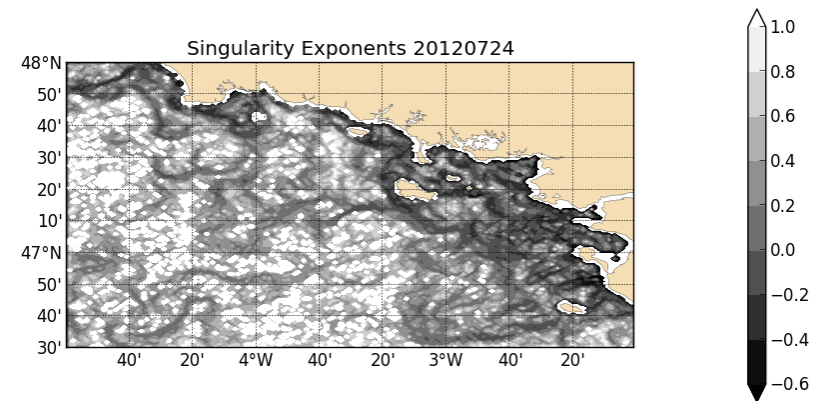
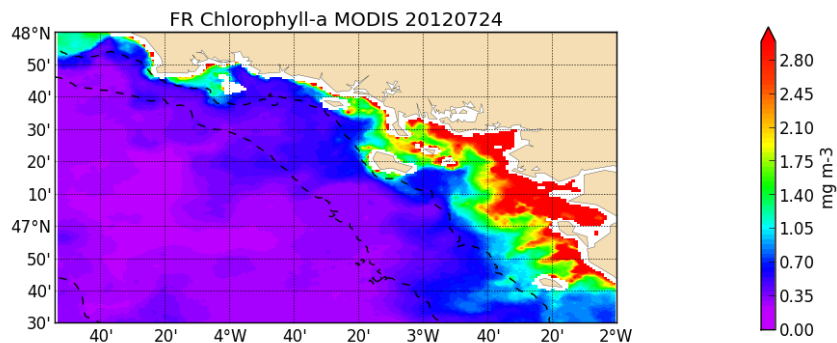
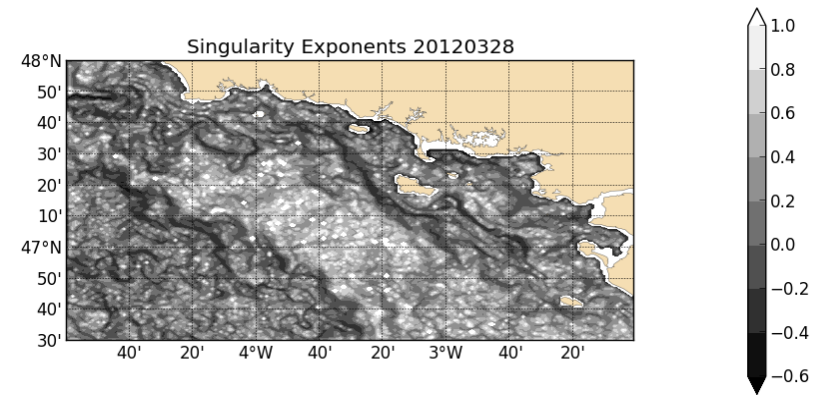
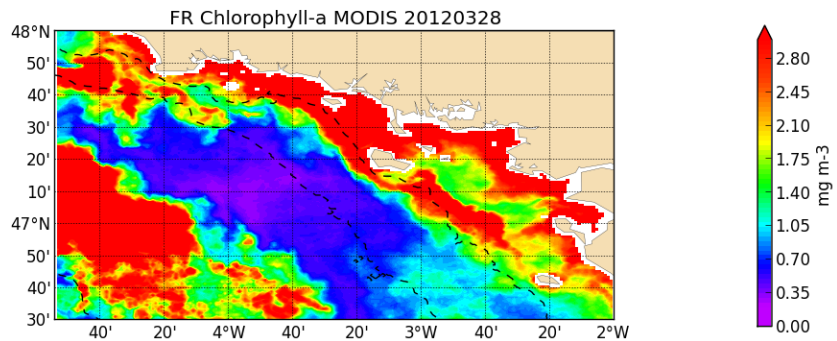


	Skewness
09/10/2008	0.264 (Right)
10/10/2008	0.160 (Right)
11/10/2008	0.177 (Right)

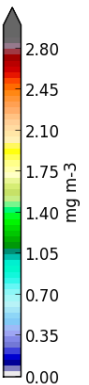
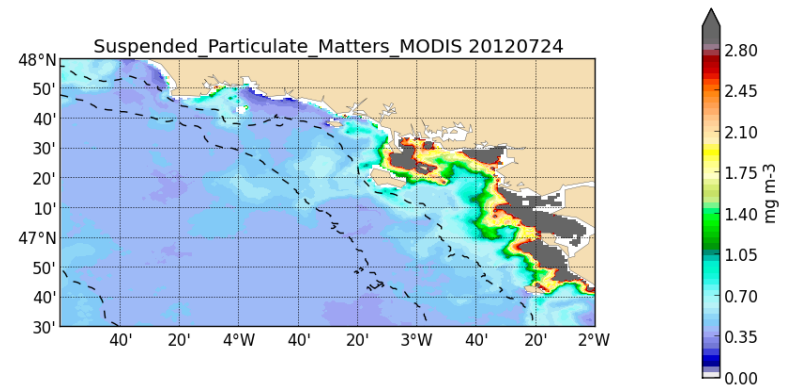
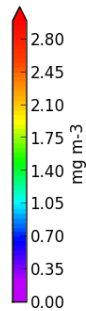
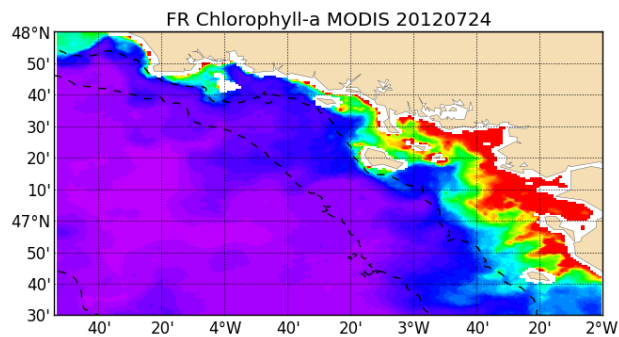
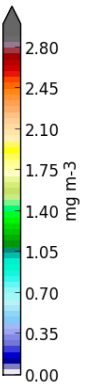
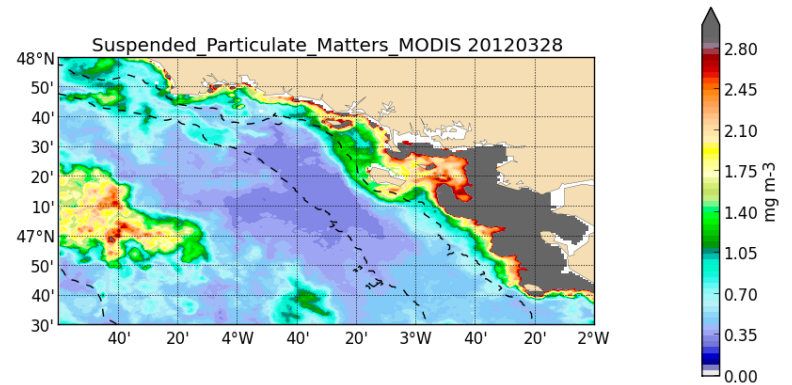
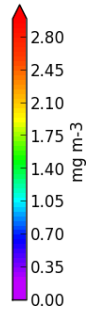
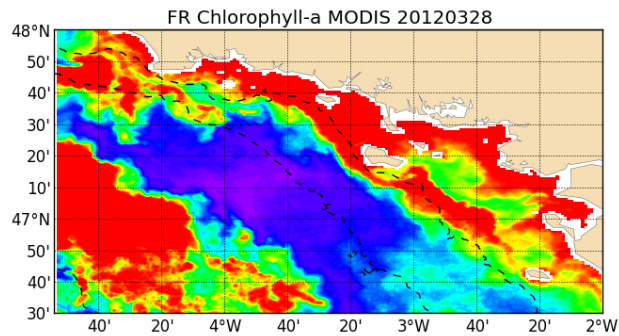
← Intensity of fronts is lower

Spring and Summer 2012

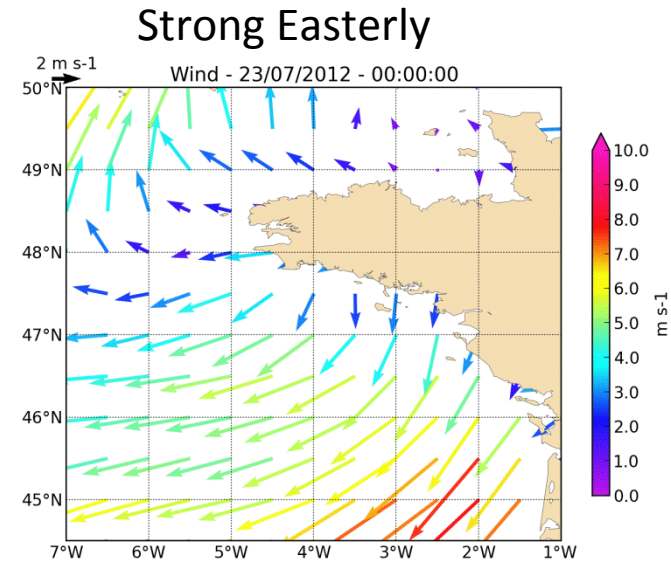
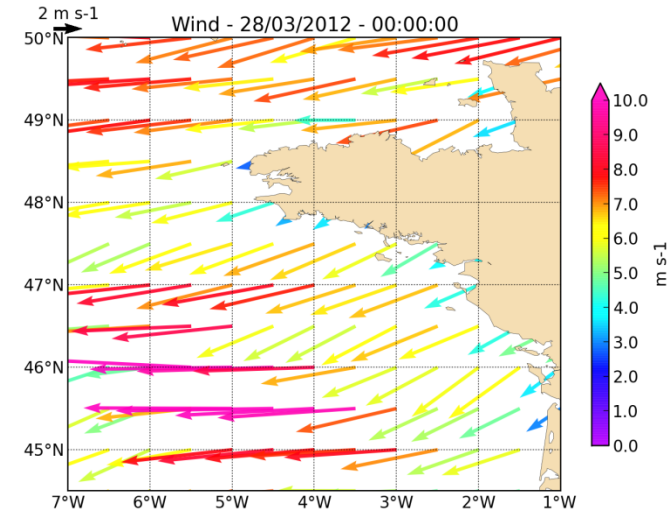
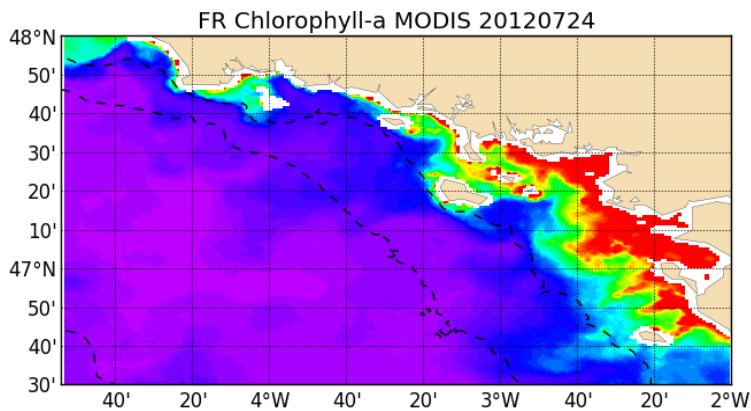
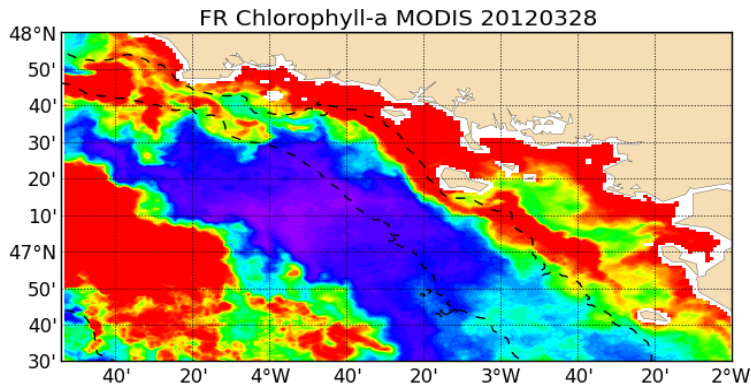
Chlorophyll-a and Singularity exponents 2012



Chlorophyll-a concentration and suspended particulate matters for spring and summer 2012

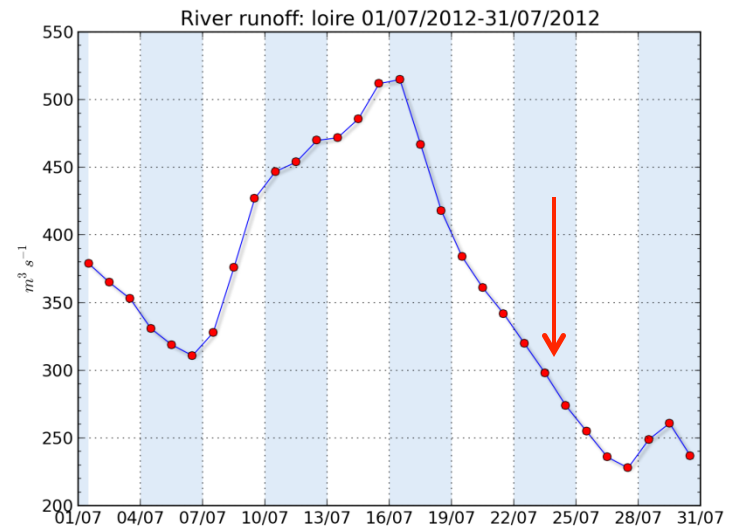
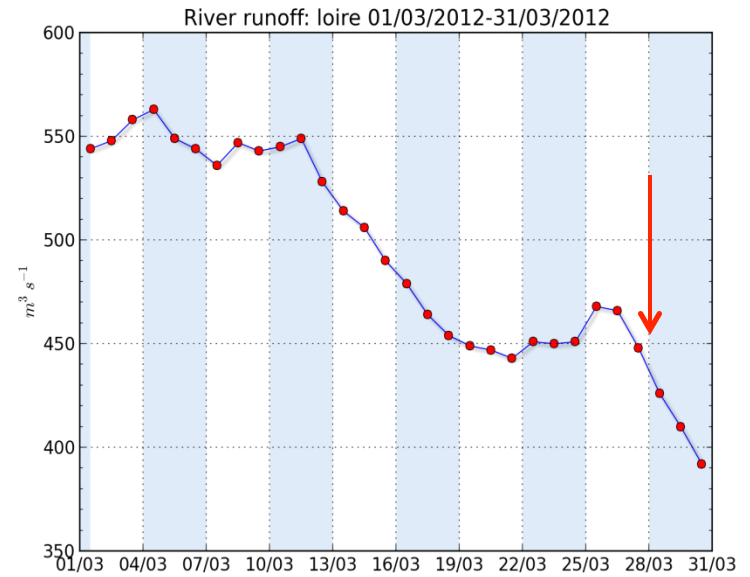
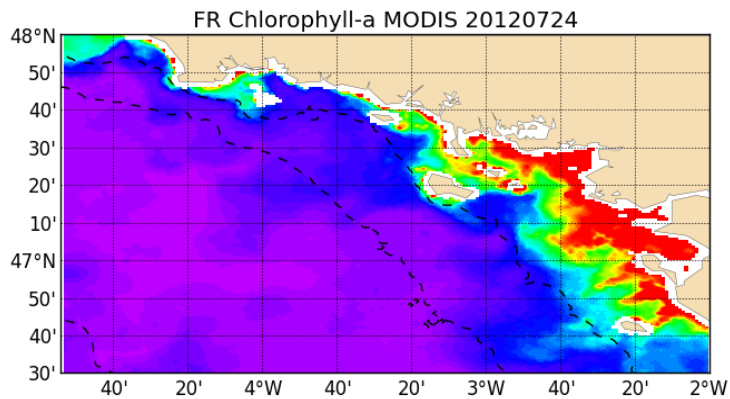
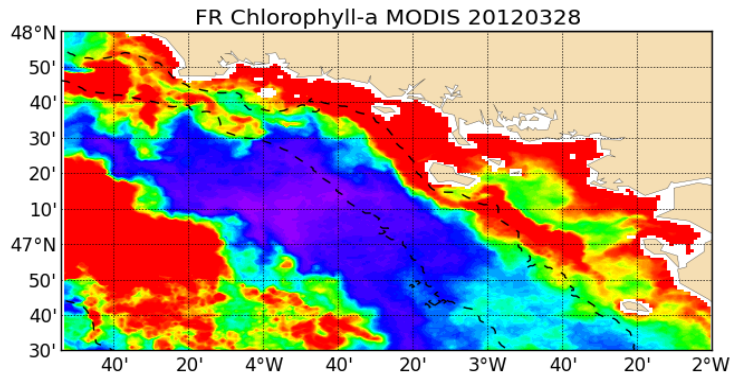


Winds

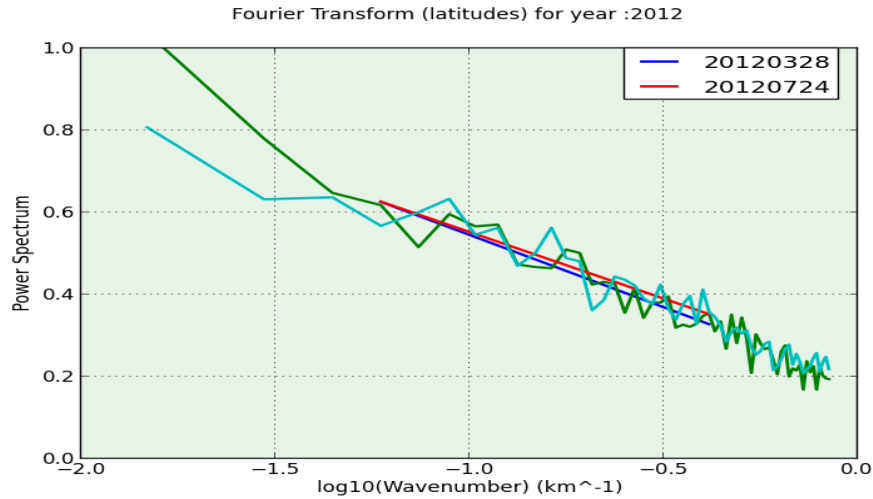


Weak north-Easterly

Runoffs



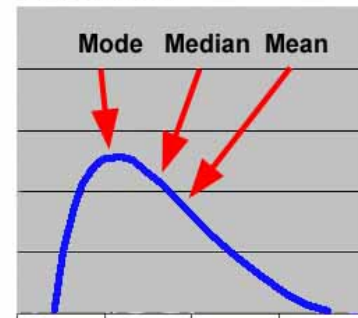
Fourier Transform



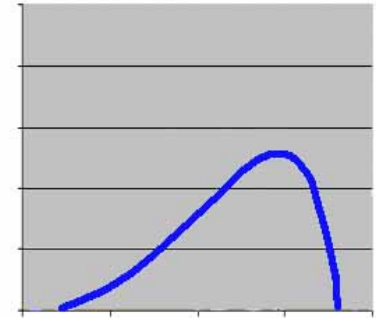
Date	Spectral Slope
28/03/2012	-0.353
24/07/2012	-0.325

PDF

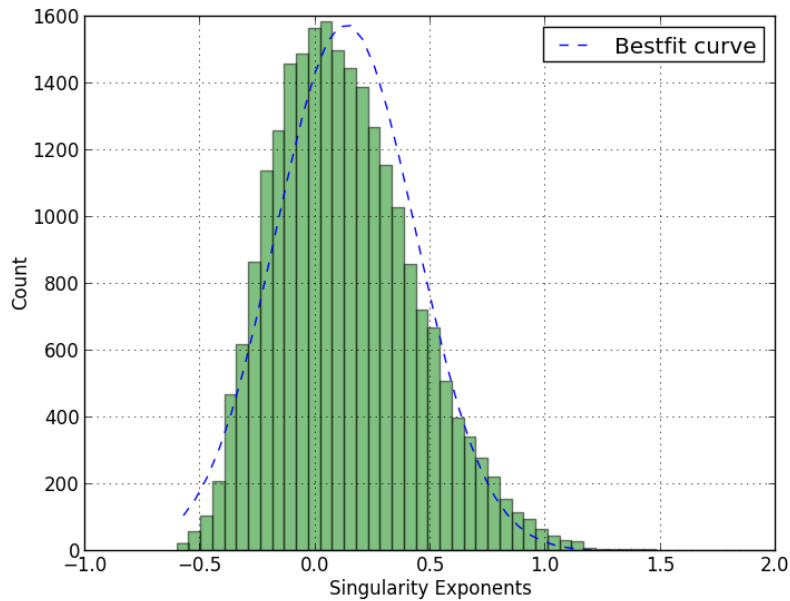
RIGHT SKEW



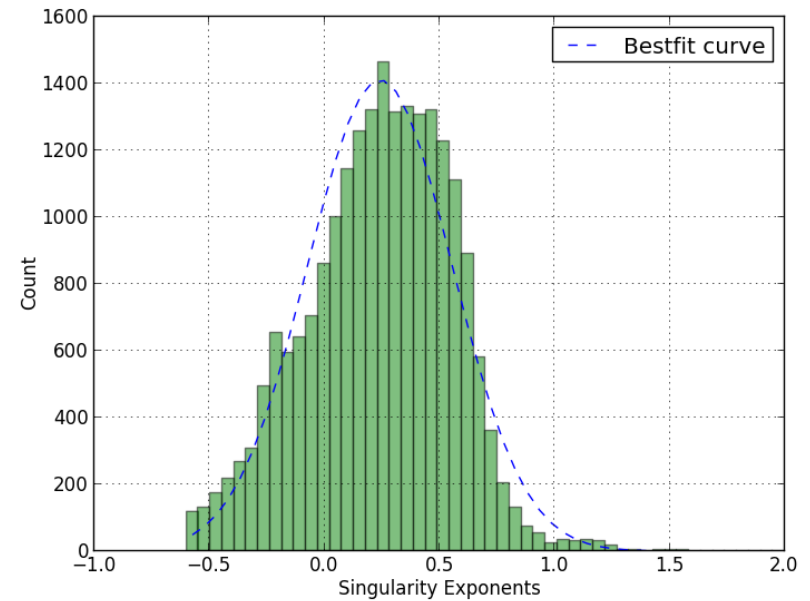
LEFT SKEW



Probability distribution curve for : 20120328



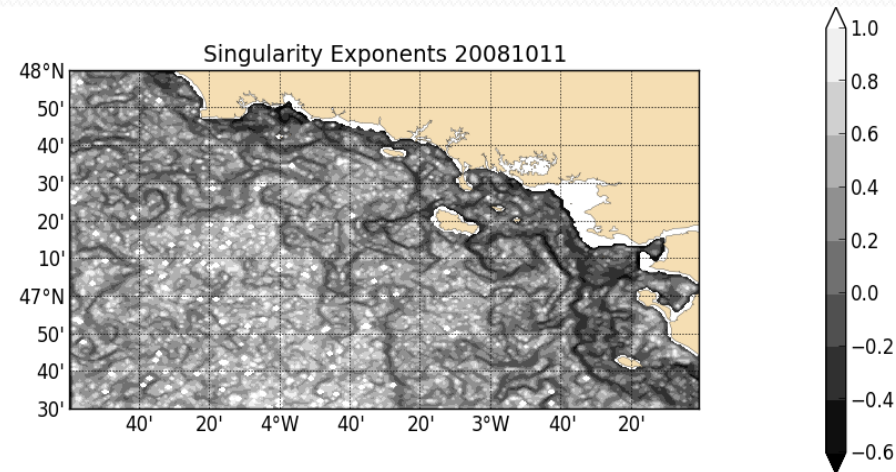
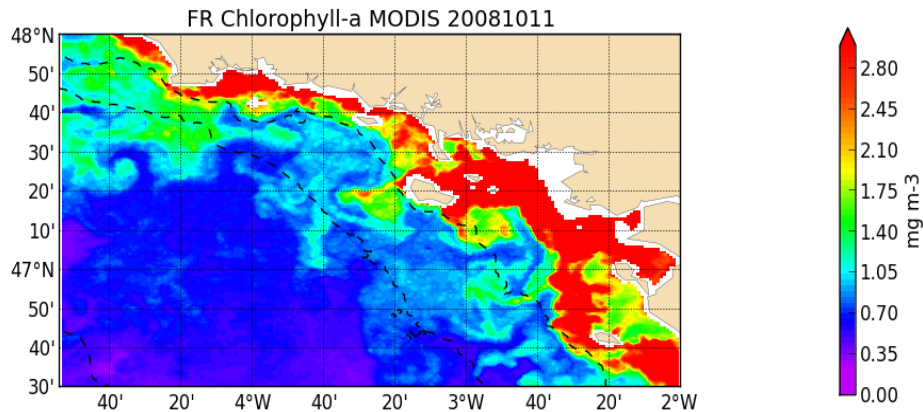
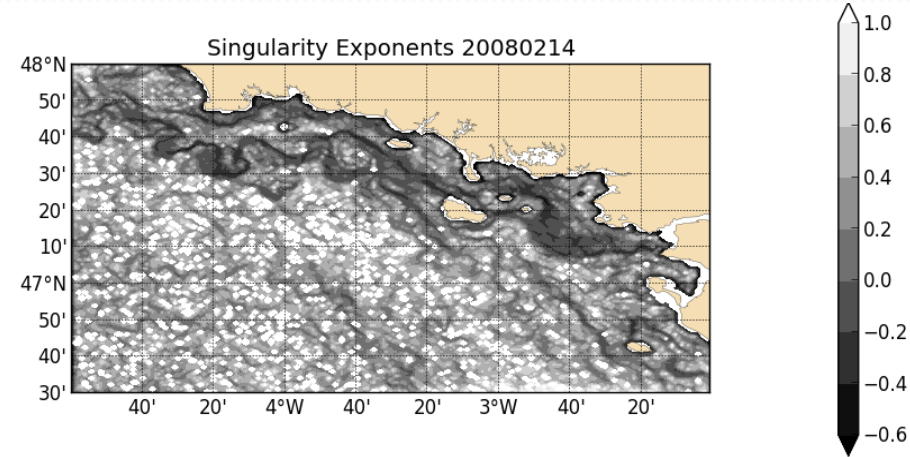
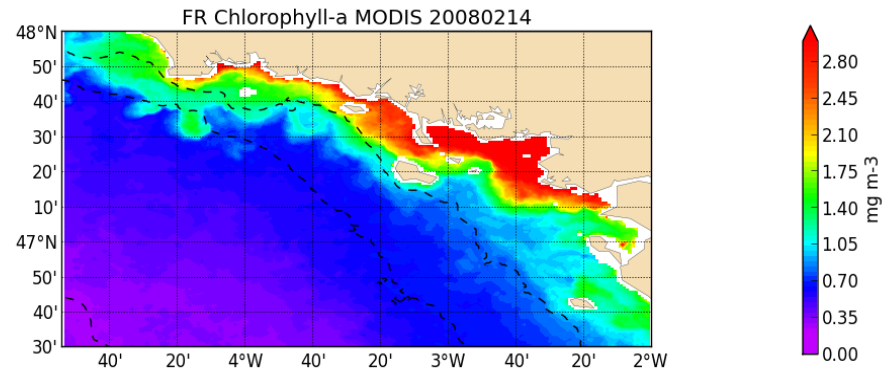
Probability distribution curve for : 20120724



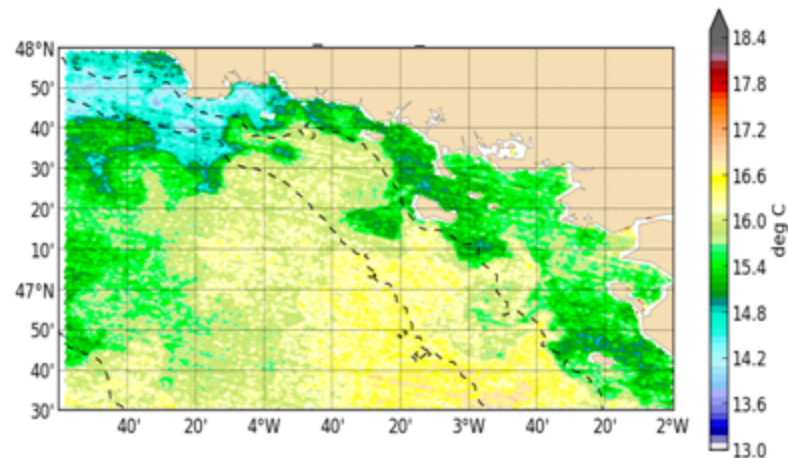
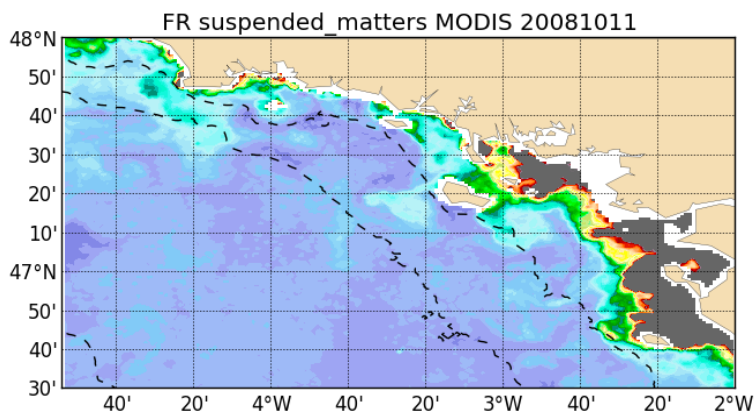
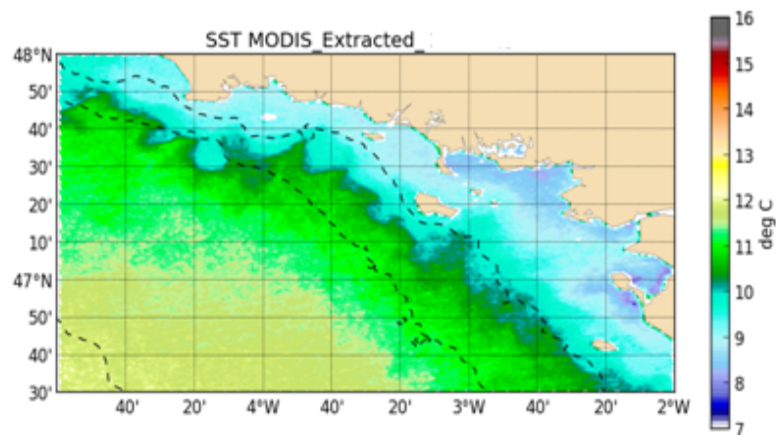
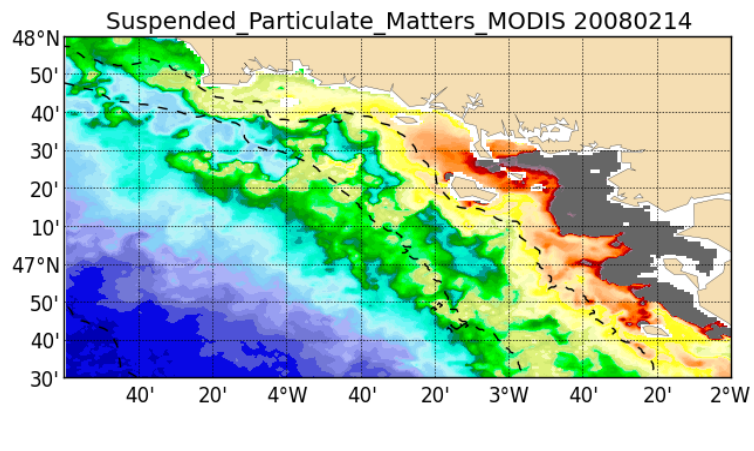
	skewness
28/03/2012	0.5137 (right)
24/07/2012	-0.184 (left)

Winter and Autumn 2008

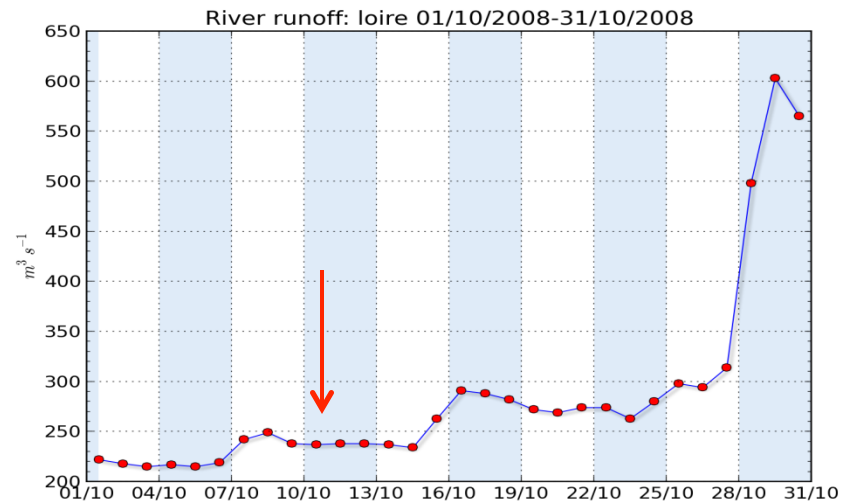
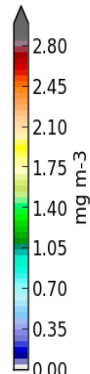
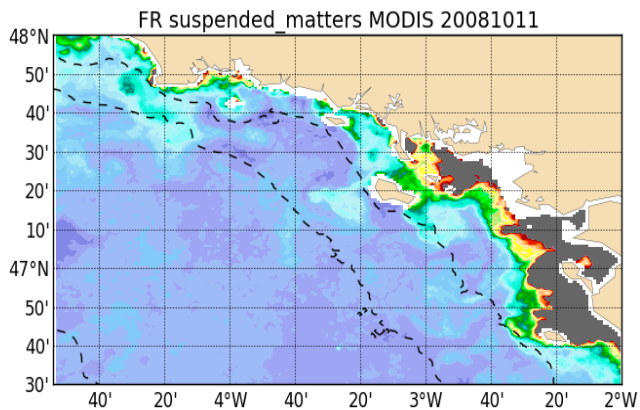
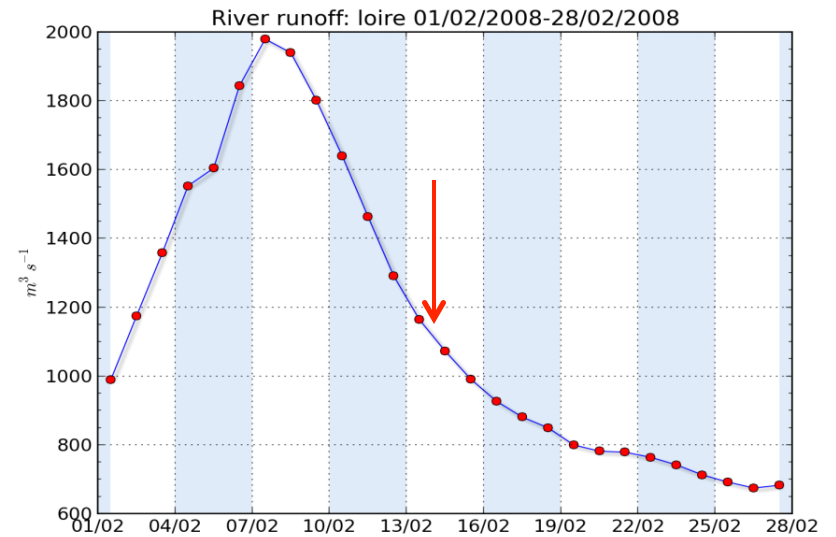
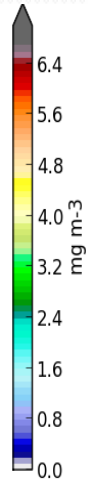
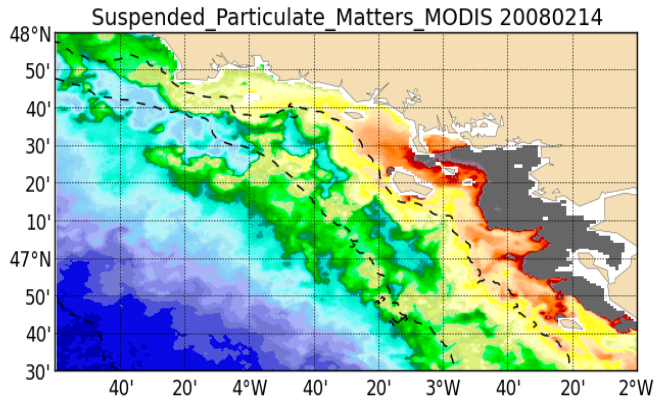
Chlorophyll and Singularity Exponents - Winter and Autumn 2008



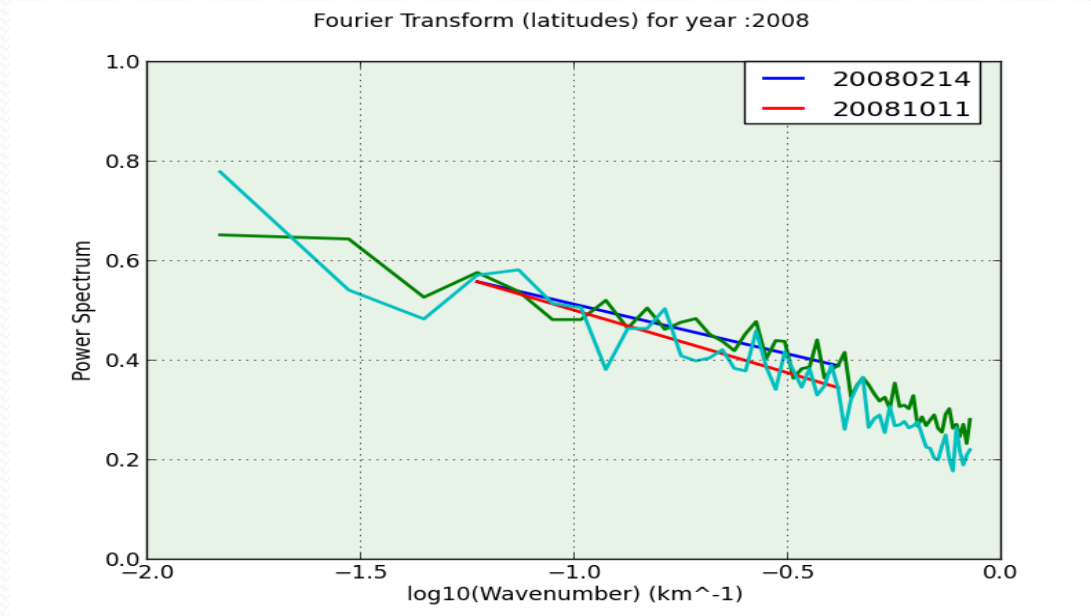
Suspended Particulate Matter (SPM) and Sea-surface Temperature



River runoffs



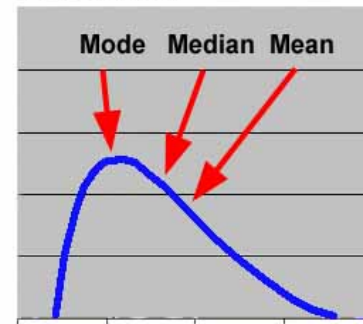
Fourier Transform



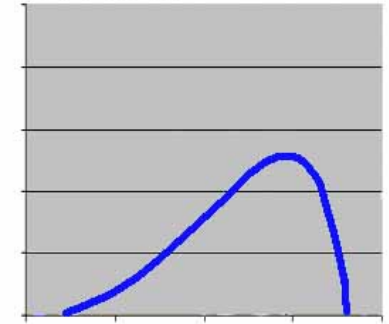
	Spectral Slope
14/02/2008	-0.200
11/10/2008	-0.252

PDF

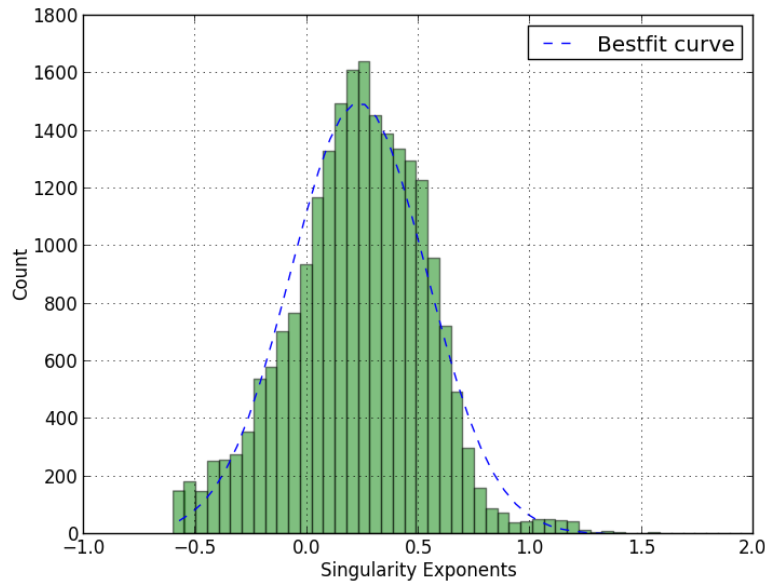
RIGHT SKEW



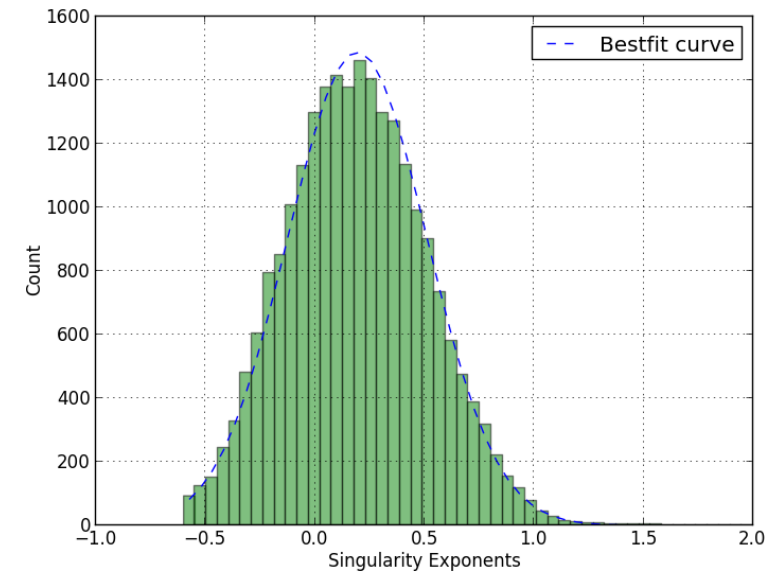
LEFT SKEW



Probability distribution curve for : 20080214



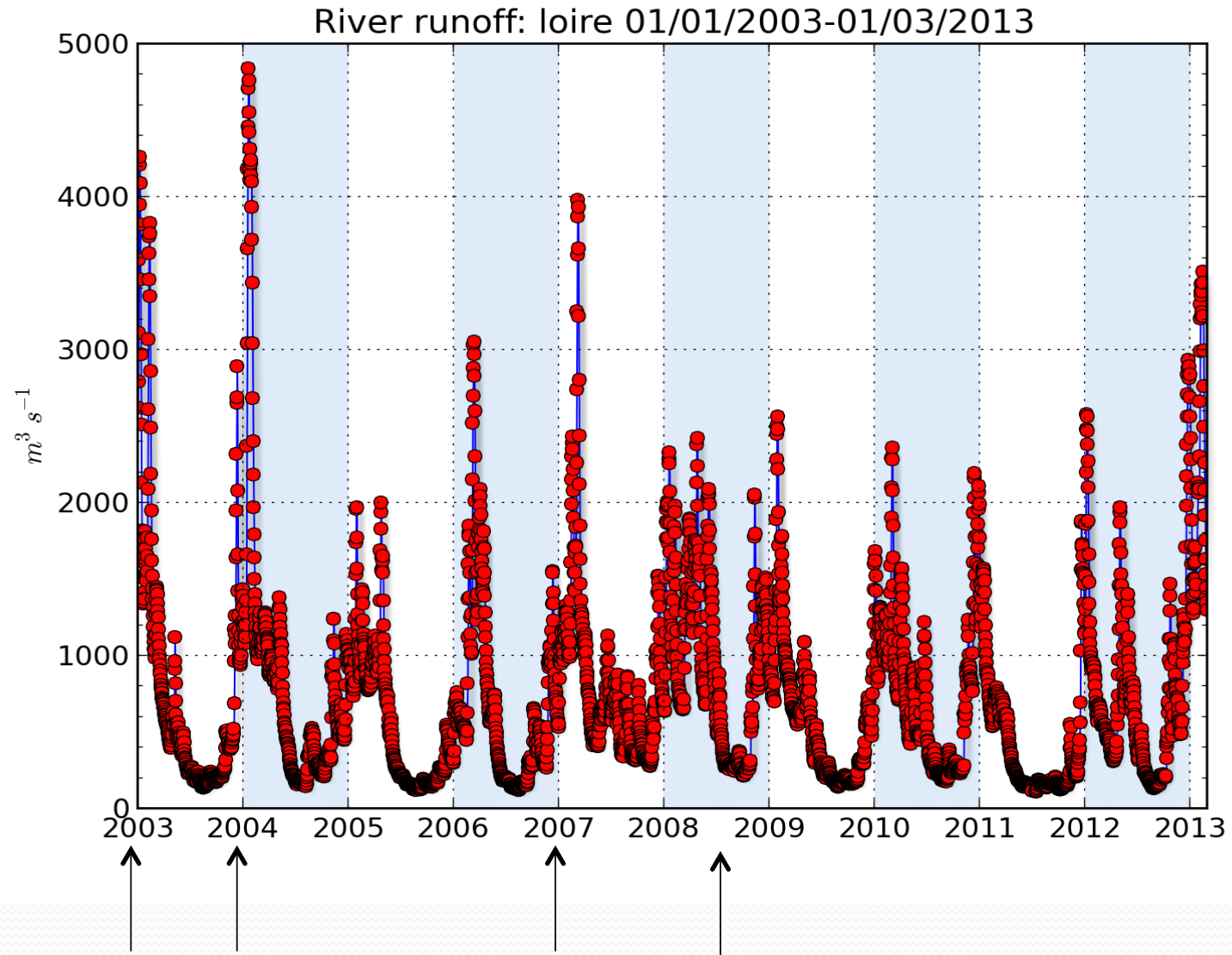
Probability distribution curve for : 20081011



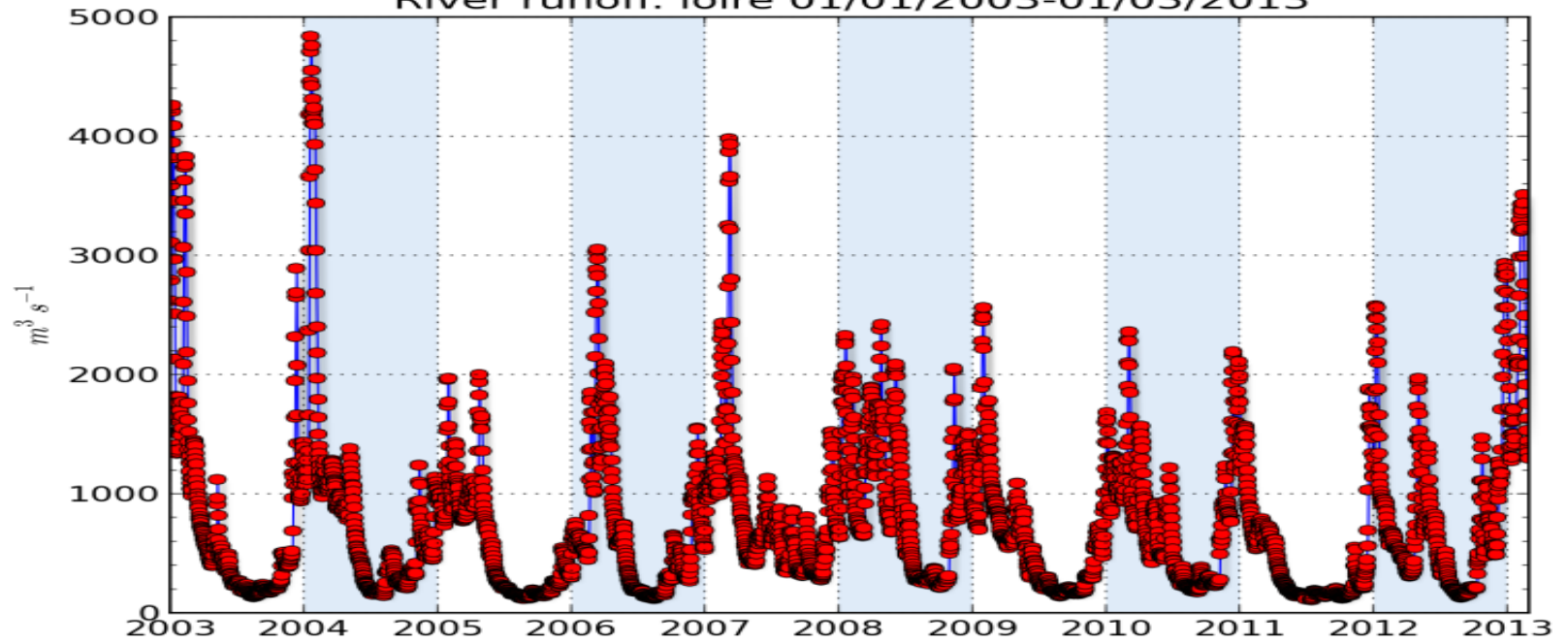
	Skewness
14/02/2008	-0.088 (Left)
11/10/2008	-0.177 (Left)

Interannual Variability

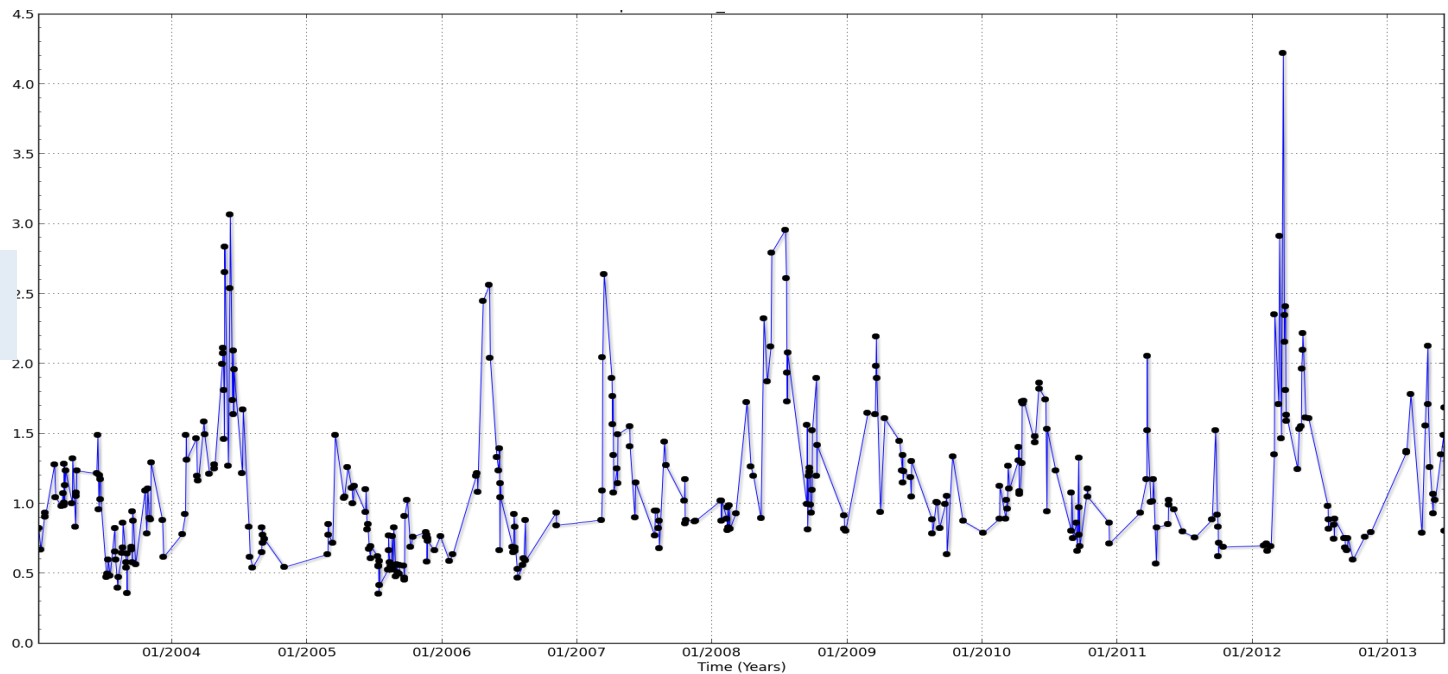
River Runoffs



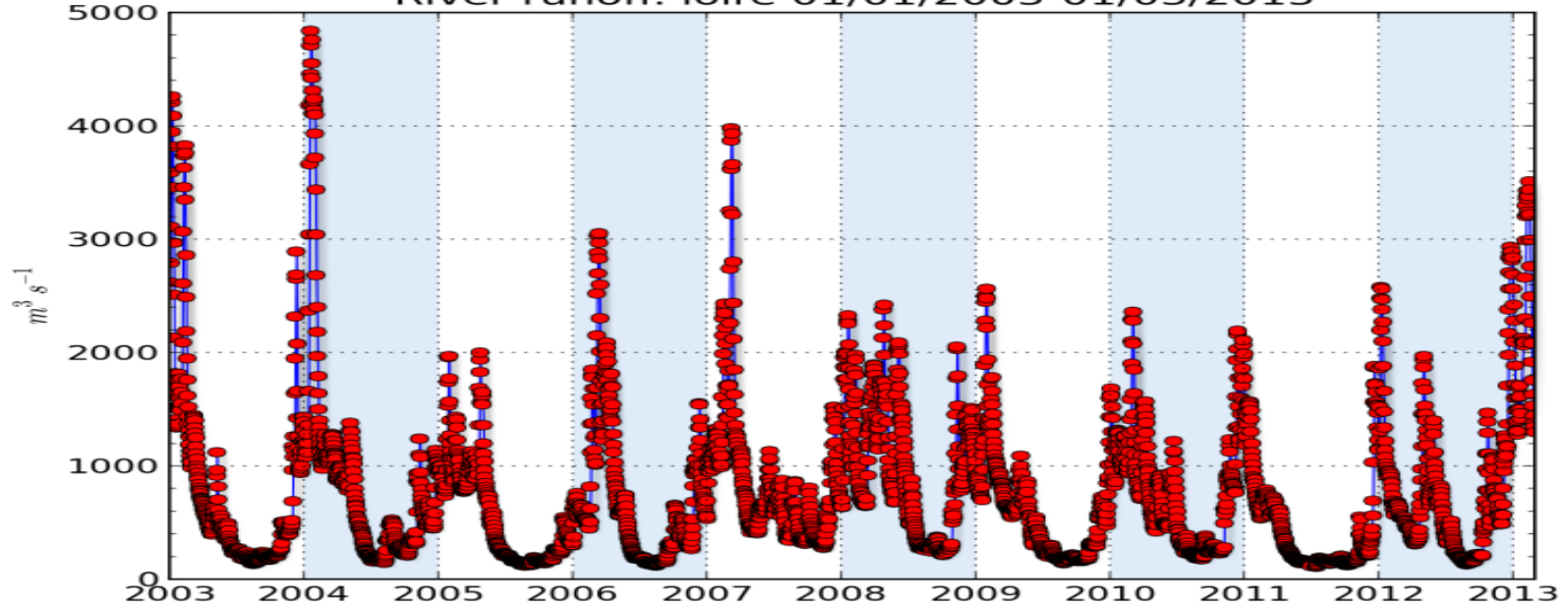
River runoff: loire 01/01/2003-01/03/2013



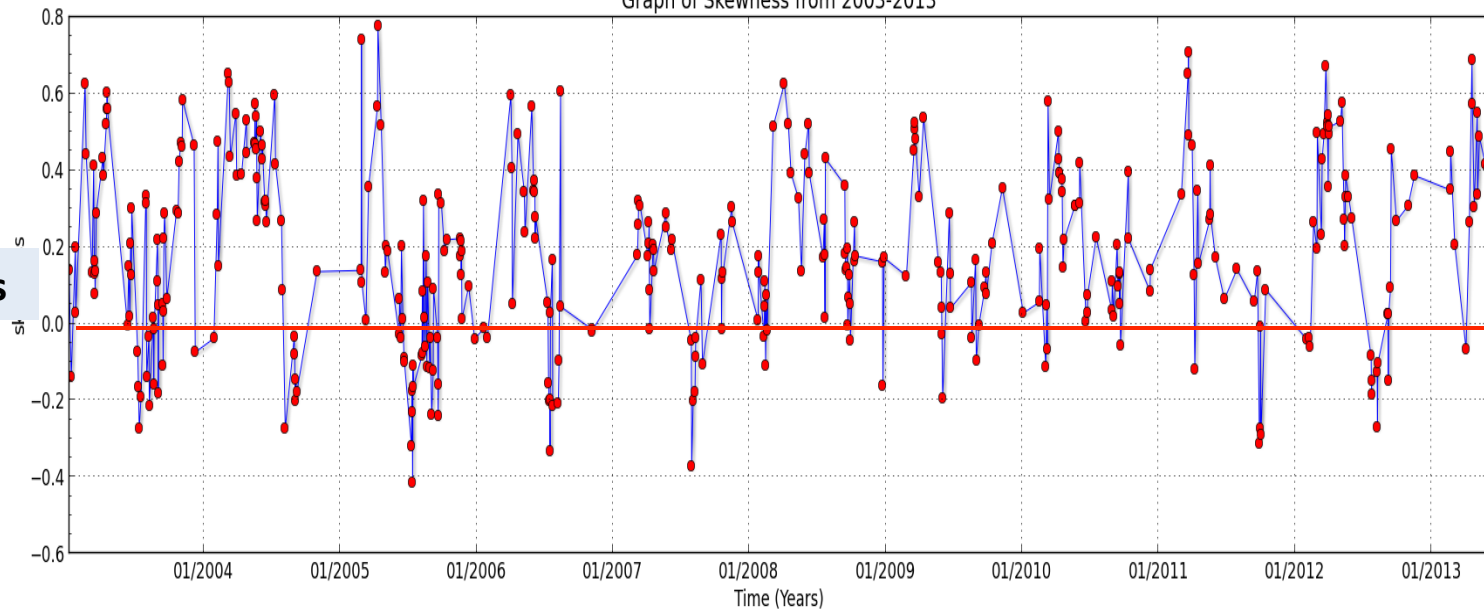
Mean chlorophyll-a



River runoff: loire 01/01/2003-01/03/2013

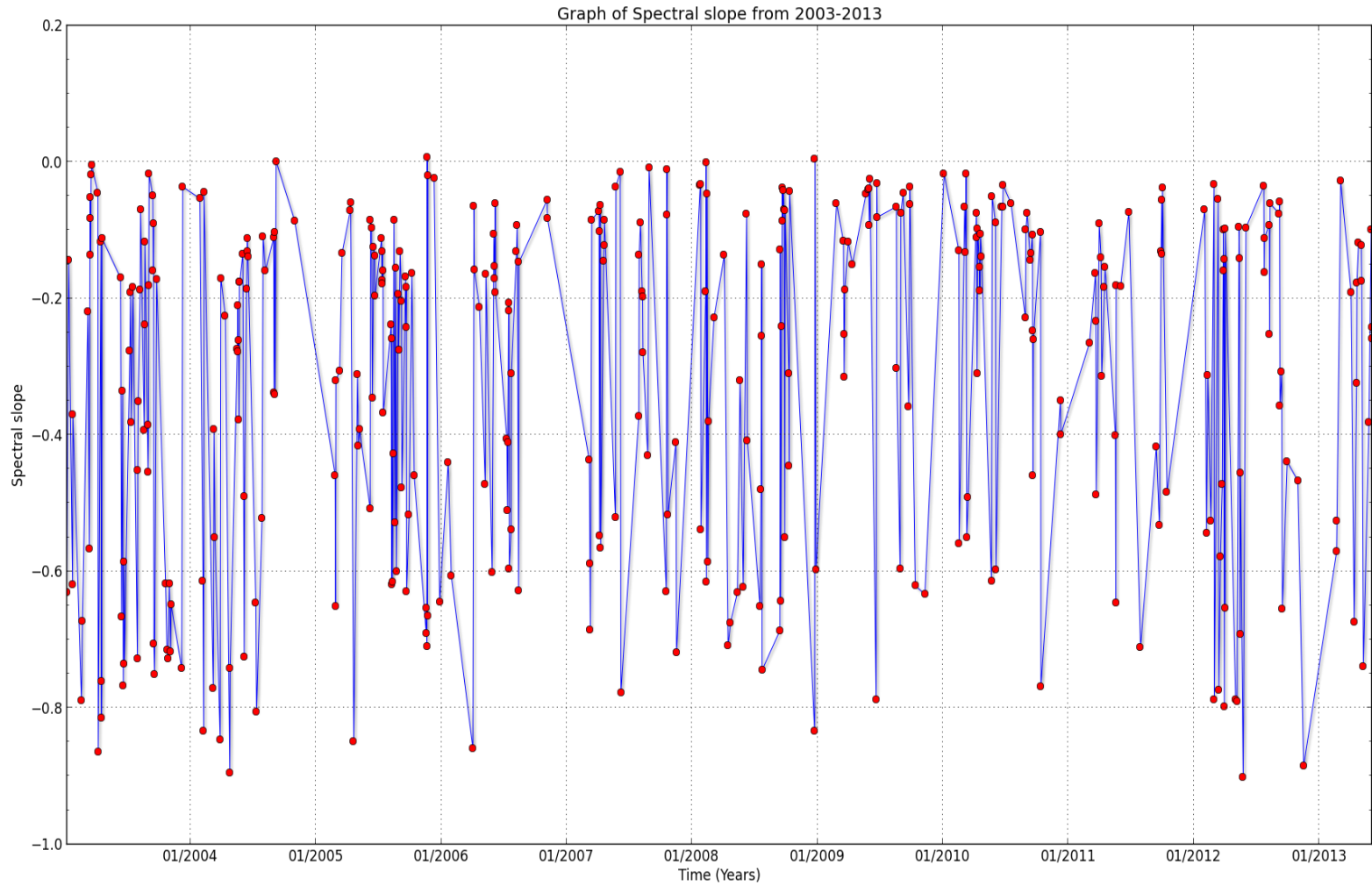


Graph of Skewness from 2003-2013



Skewness

Fourier Transform (Global)- Latitudes



Conclusions

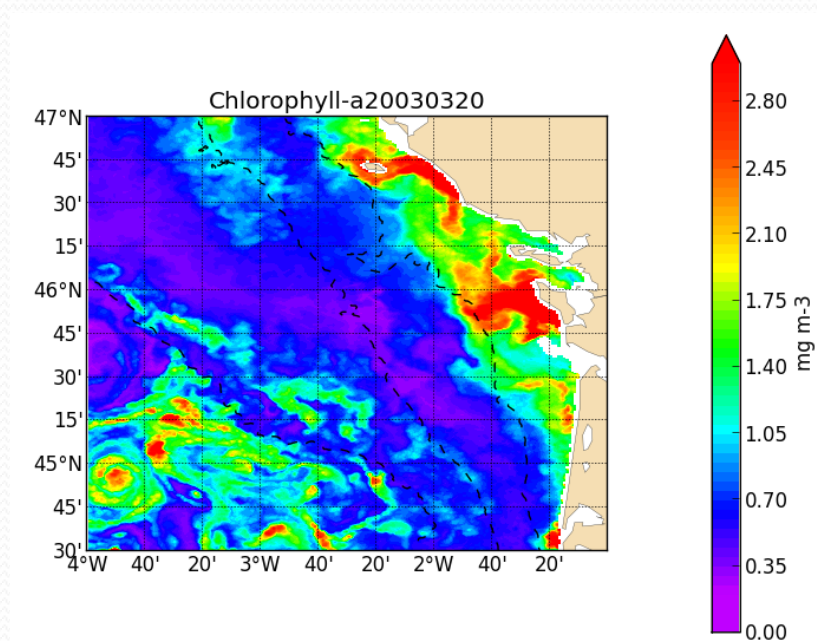
- Few CHL-a cloud-free images over the period 2003-2013
- Chlorophyll –a images allow us:
 - ✓ To identify frontal activity using **singularity exponents**
 - ✓ To characterize submesoscale activity using **PDF statistics (skewness on Singularity exponents)**
 - ✓ To confirm the **dominant Influence of winds** on biological production.
- Frontal activity:
 - ✓ No significant differences in **frontal spatial scales** with time.
 - ✓ **Stronger frontal gradients** in winter than in autumn and higher in spring than in summer.

Perspectives

- Developing new indicator using PDF : Threshold value

Perspectives

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- Analyzing other rivers like Gironde



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- Developing new indicator using PDF : Threshold value
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- Exploring available in situ data (island network, cruise sections, future experiments)

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- Developing new indicator using PDF : Threshold value
- Analyzing other rivers like Gironde
- Exploring available in situ data (island network, cruise sections, future experiments)
- Using model to explore processes (*PhD Thesis : Ozge Yelekci*)



Thank you!