« BIO CHEMICAL COLLECTORS »

BCC PROJECT

FUNDED BY R&D CEA/DAM (CBRN-E)

ONE YEAR OF BIOAEROSOLS MEASUREMENTS WITH A WIDEBAND INTEGRATED BIOAEROSOL SENSOR (WIBS-4A/WIBS-3M) AT CEA ATMOSPHERIC SUPER SITE

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BIO CHEMICAL COLLECTOR (CBRN-E PROJECT)

Main Scientific Objectives:

- Atmospheric background of Bioaerosols (Pollen, Fungal Spores, Bacteria, Virus)
- Spatial distribution of Bioaerosols
- Ice Nuclei studies in the region of Paris

Technical Objectives :

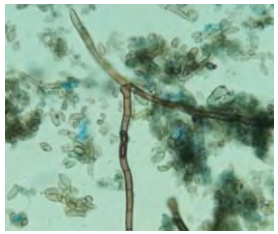
- Optimization of the real-time measurements of Bioaerosols with the Wideband Integrated Bioaerosols Sensor (WIBS)
- On line measurement of Bioaerosols Chemical Tracers with collector/concentrator & Liquid Chromatography

BIOAEROSOLS WHO ARE THEY & WHAT THEY CAN DO?

Pollen

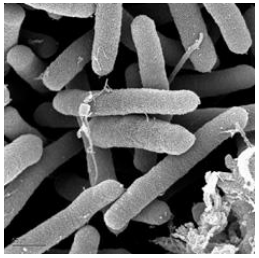
20µm-100µm

Fungal spores



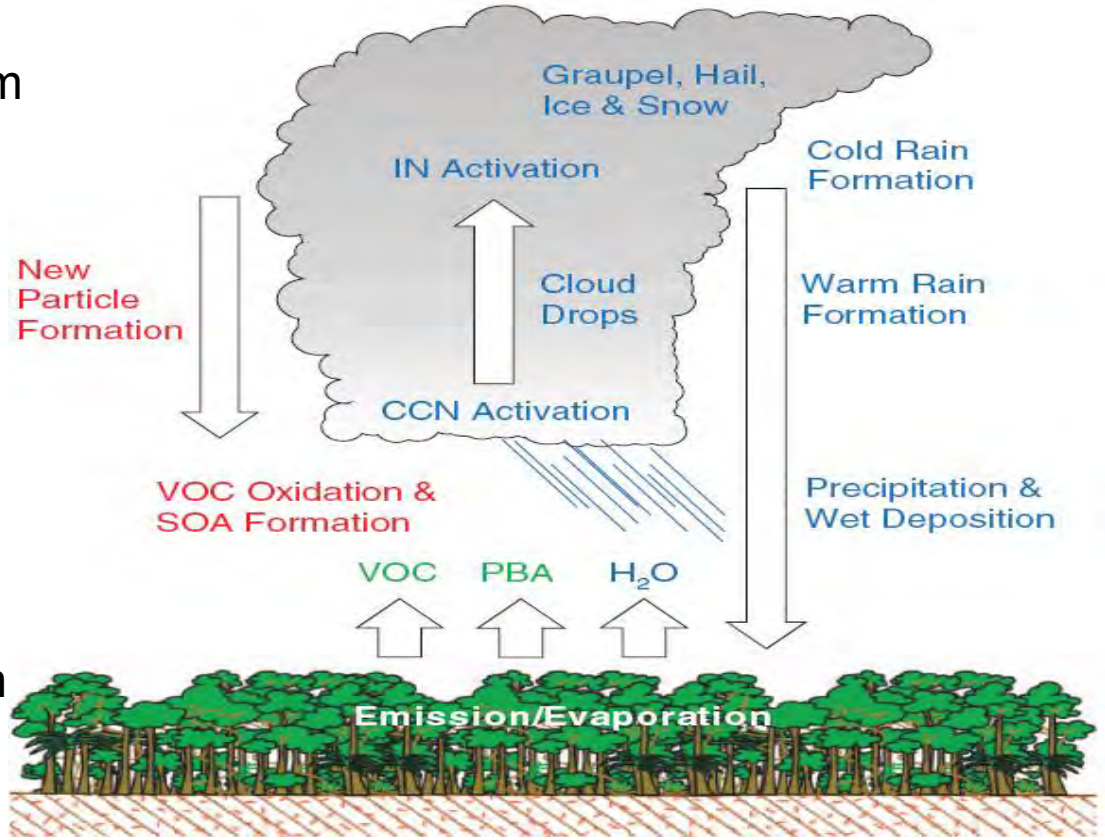
2µm-40µm

Bacteria



0.5µm-1.5µm

Bioaerosols: Precipitation Initiators & Biological Ice Nucleators

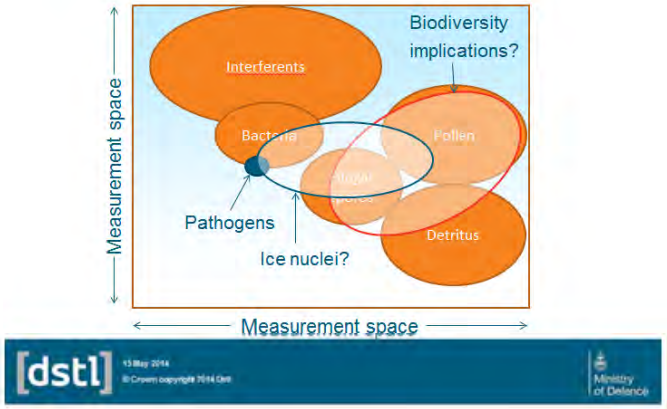


Pöschl et al., Science, 2010

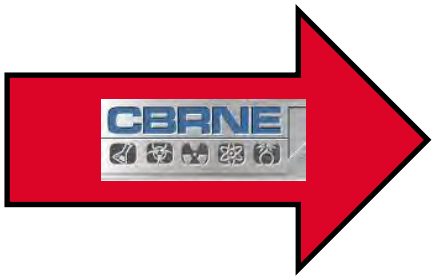
Climate Sciences - Global change - Keys in the global warming - Health effects

GLOBAL SECURITY AND CBRN-E STUDIES

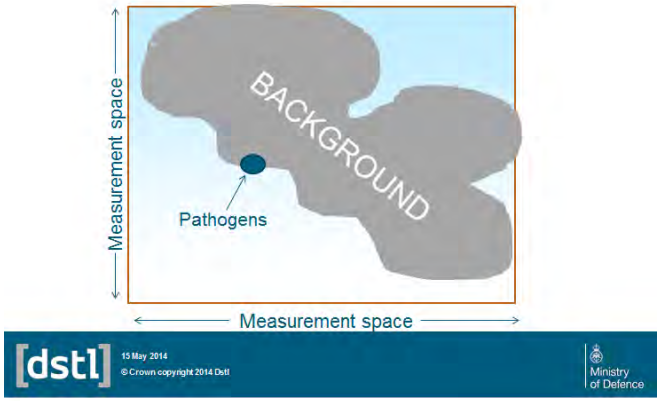
The atmospheric science perspective (simplified)

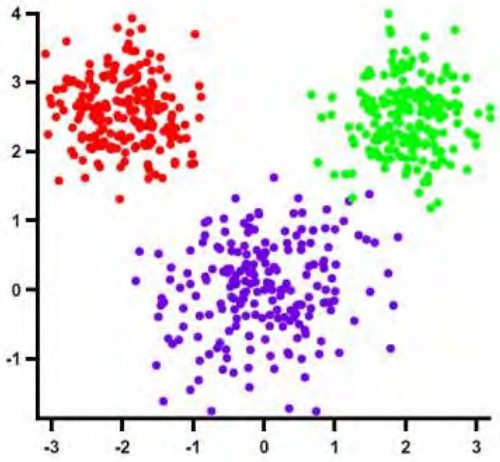


Courtesy of A.M Gabey



The defence perspective (simplified)

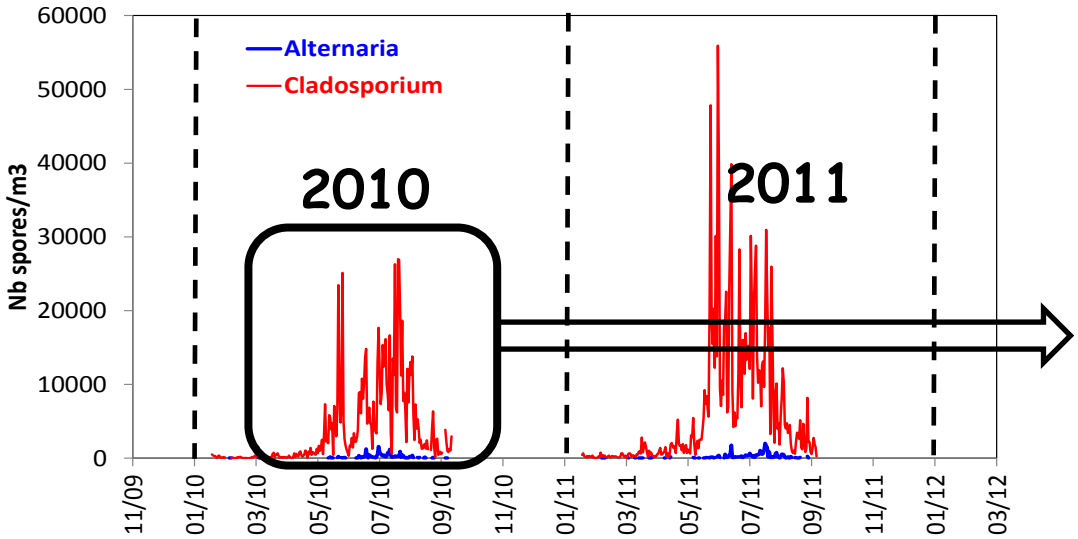


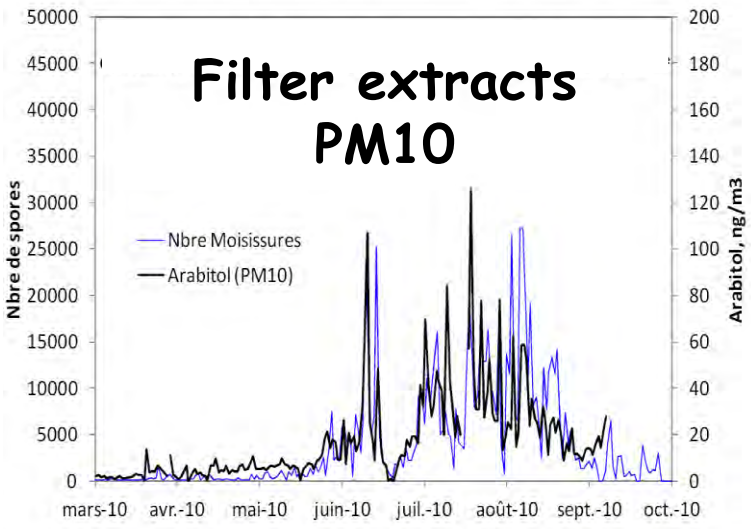


Cluster analysis of WIBS single particle bioaerosol data. Robinson et al. Atmos. Meas. Tech., 5, 6387–6422, 2012

Statistic data treatment - New prototypes - New tracers (dry or wet)
On line validation - Scientific and Technical Collaboration

BEGINNING OF THE STORY (BIODETECT 2013)





Bauer et al., 2008

Particle Into Liquid Sampler
coupled to
Liquid Chromatography
Mass Spectrometry
(PILS LC-MS)

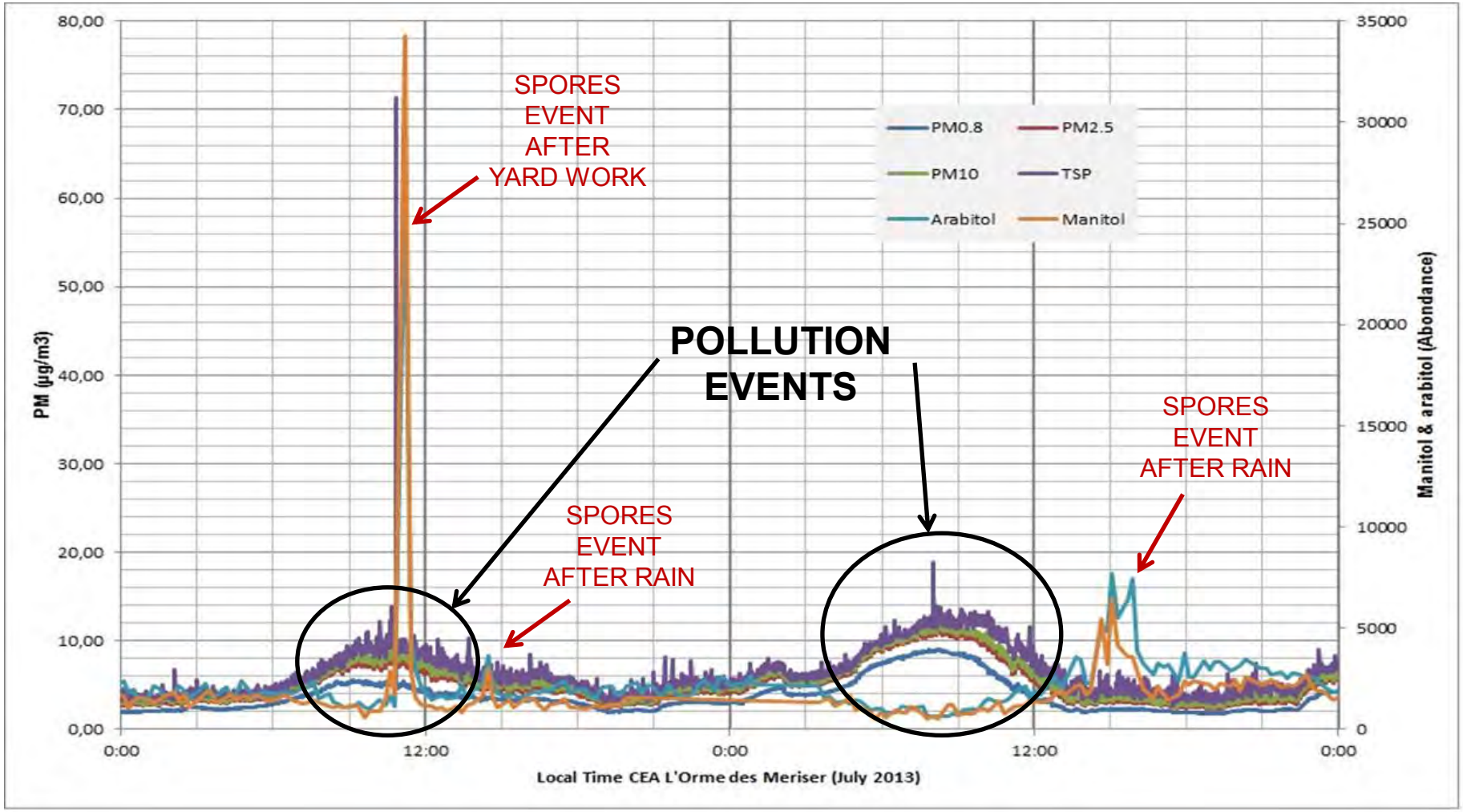
First Real-time Measurements Of Airborne Fungal Spores Biomarkers

(Arabitol & Mannitol)

Sarda Esteve et al, AAAR 2103

BEGINNING OF THE STORY (BIODETECT 2013)

Particulate Matter & PILS-LC-MS/MS



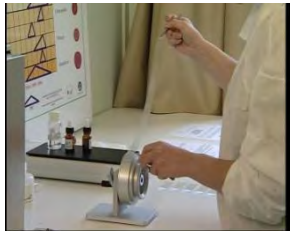
Sarda Esteve et al., *IOP 2013*

CEA ATMOSPHERIC SUPER SITE

MICROSCOPY VALIDATION WITH A SPORE TRAP

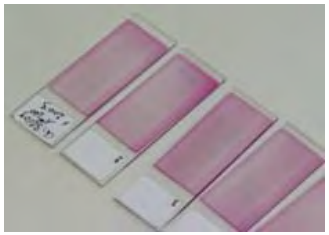
Lanzoni
Spore Trap

Bioaerosol Impaction
on a drum band



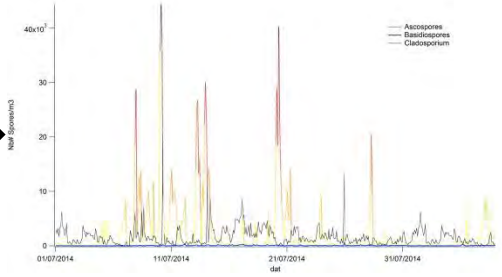
Removing the band
from the drum

Dividing the band
into daily sections



Coloration for microscopy
experiments

Counting with a
vocal recognition system

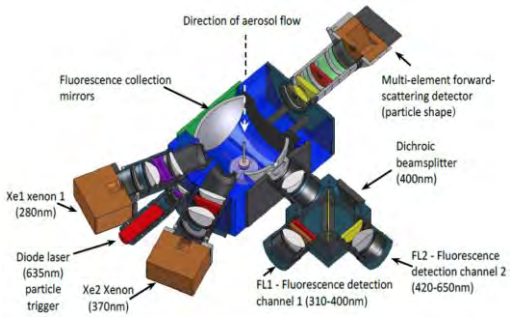


Variability and Speciation
of species

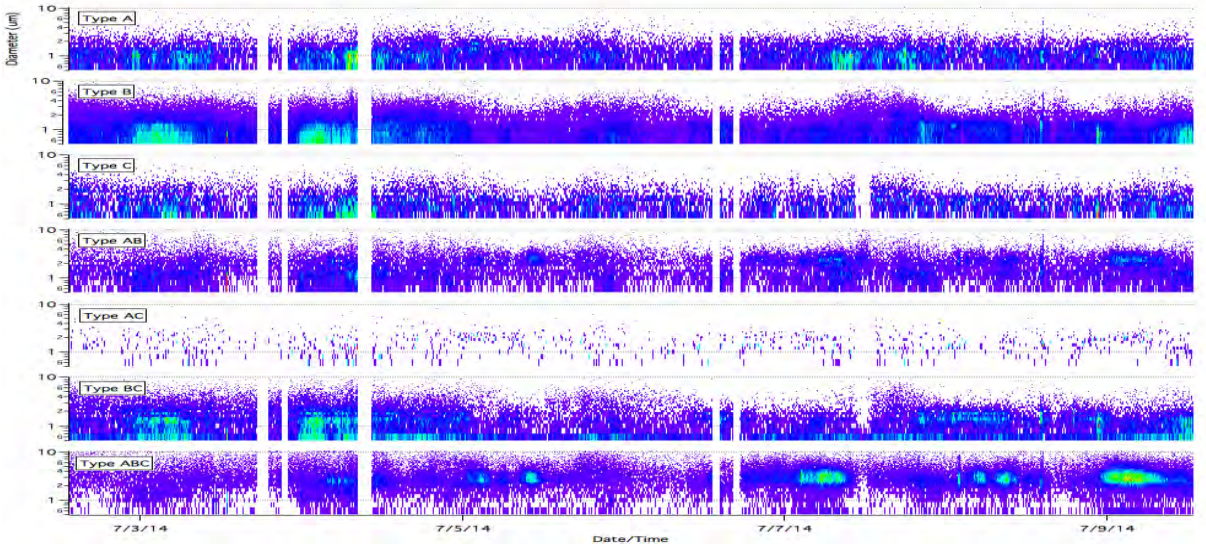
The Pumping flow rate of the Lanzoni trap is 10 L/min. The internal geometry provide an cut of PM1.
Pollen are "impacted" on a transparent tape coated "sticky" in front of the suction nozzle. The recording mode allows analysis by daily tranches and/or hourly tranches. Analyses of the strips are made by optical microscopy according to determination keys.

Baisnee et al., AAAR, 2014

ON LINE MEASUREMENTS OF FLUORESCENT PARTICLES



Compounds	WIBS-4A			WIBS-3M		
	λ Excitation	λ Emission	Chanel	λ Excitation	λ Emission	Chanel
Tryptophan	280 nm	310 à 400 nm	A	280 nm	320 à 600 nm	FL1
HAP + Bioparticles	280 nm	420 à 650 nm	B	280 nm	410 à 600 nm	FL2
NADPH	370 nm	420 à 650 nm	C	370 nm	410 à 600 nm	FL3
Optical Size	scattering signal from 635 nm laser: related to particle physical size					
Asymmetry factor	root-mean-square variation across a quadrant PMT: related to particle shape					



CHANELS

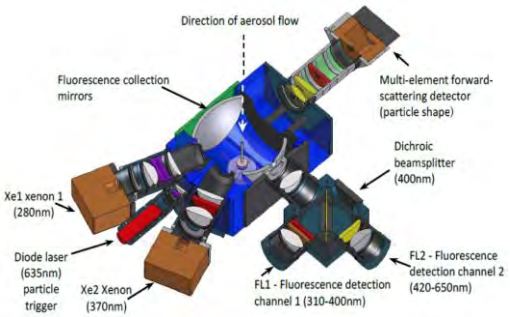
A B C

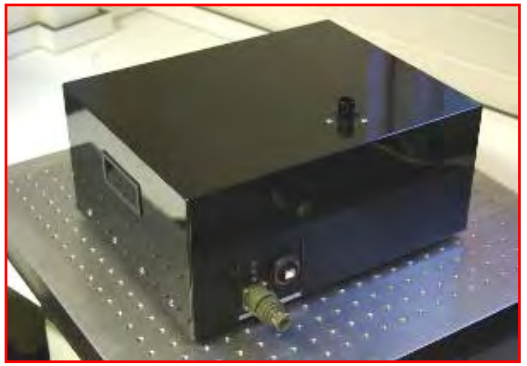
AB AC BC

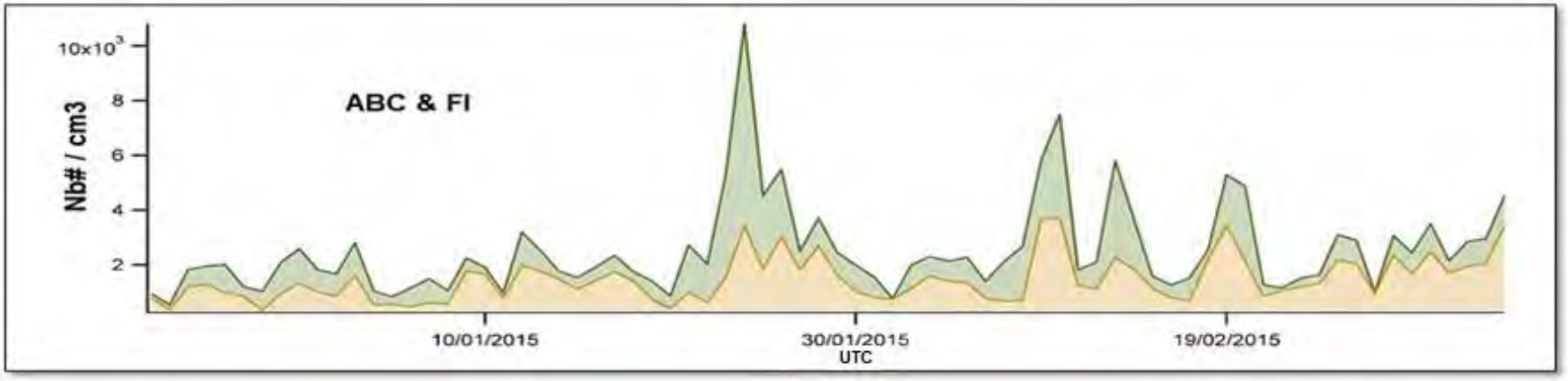
ABC

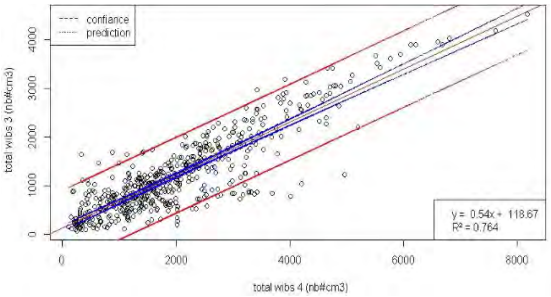
NOT THE SAME INFORMATION

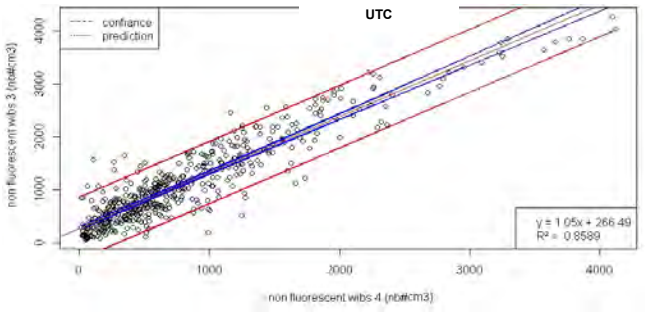
COMPARISON OF FLUORESCENT SENSORS WIBS4&3

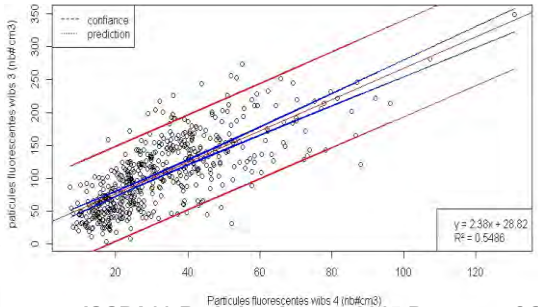




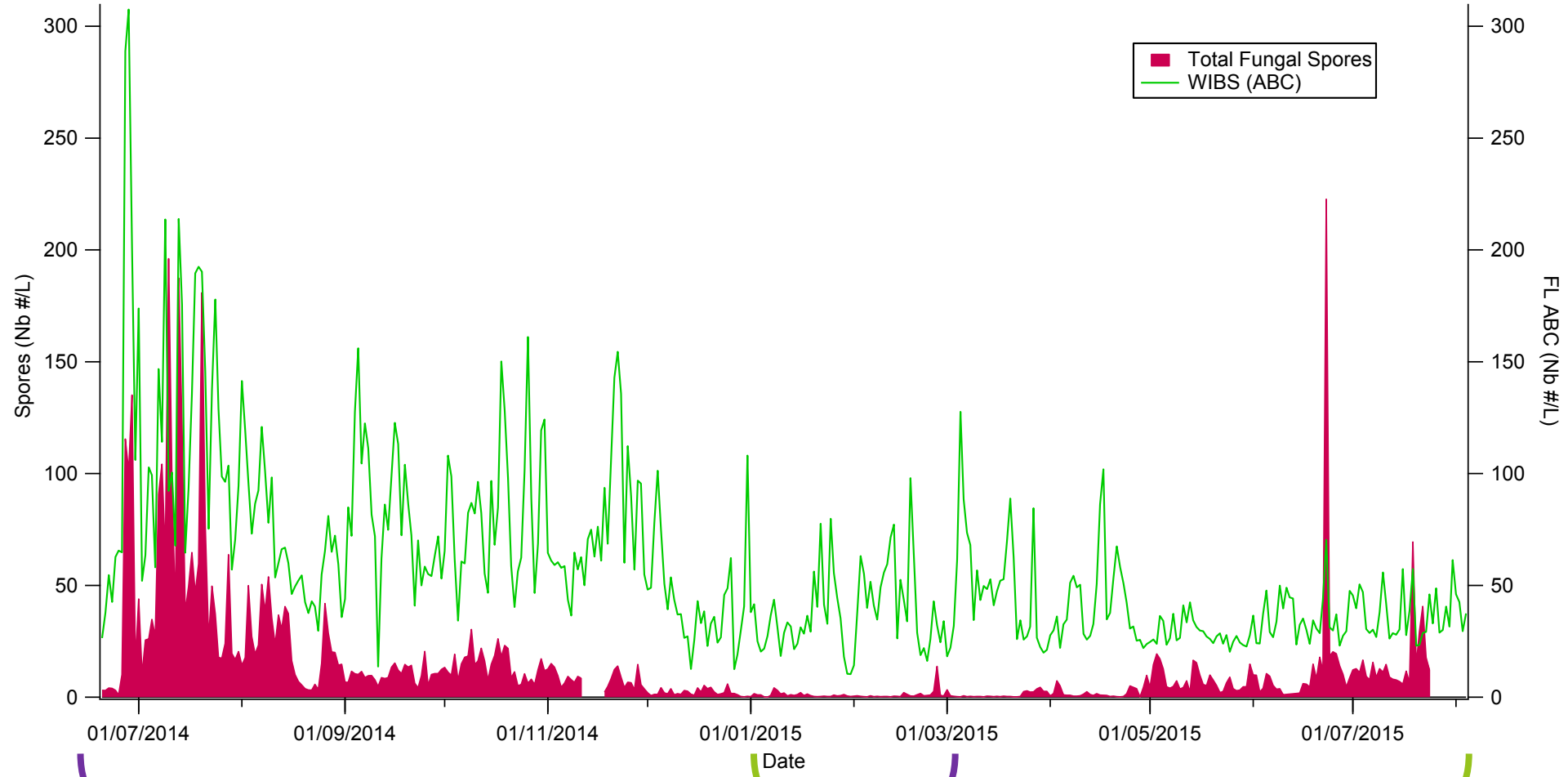








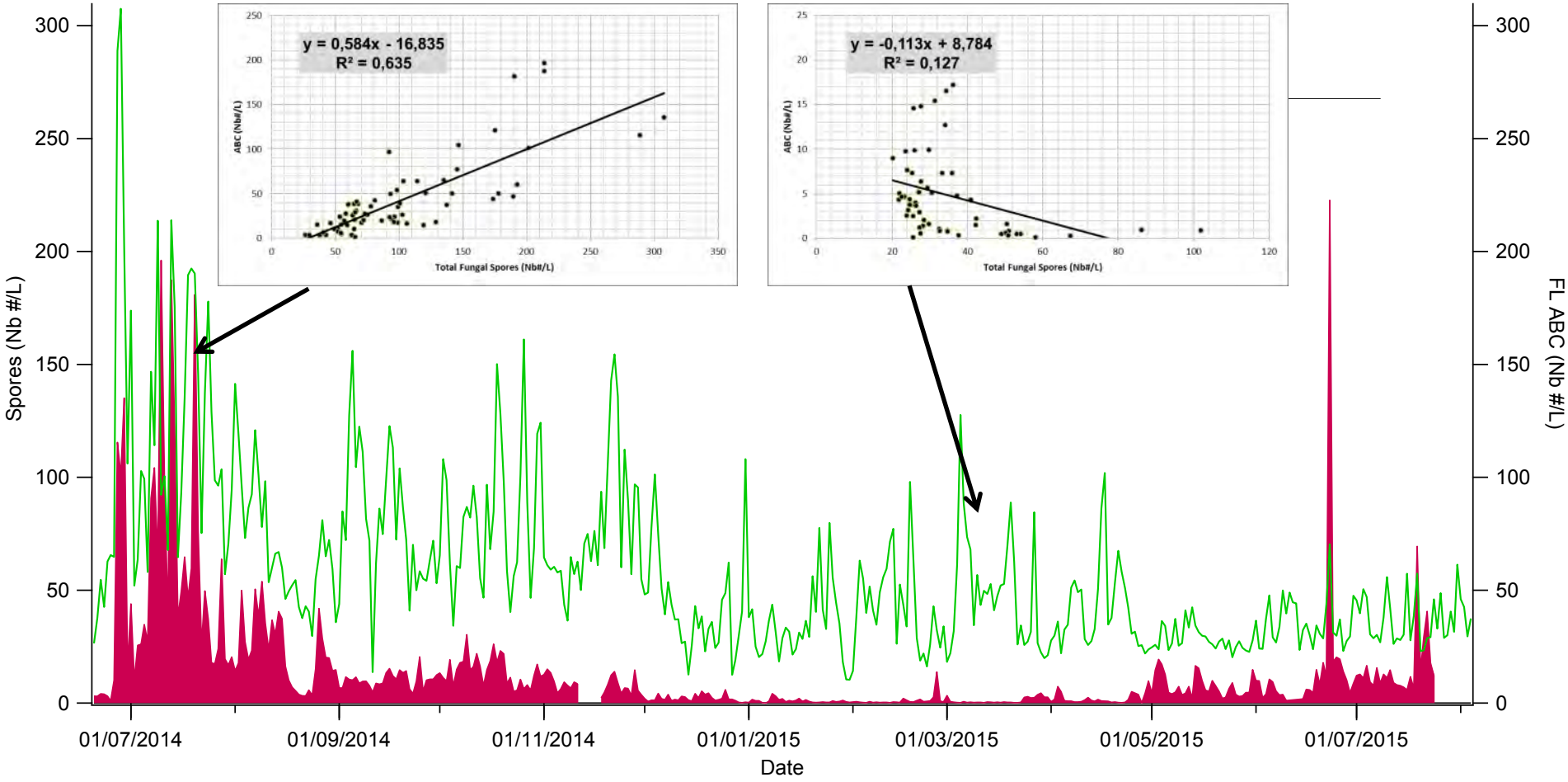
VARIABILITY OF FLUORESCENT PARTICLES 2014-2015



WIBS 4A

WIBS 3M

WHAT IS THE FLUORESCENCE ORIGIN ?



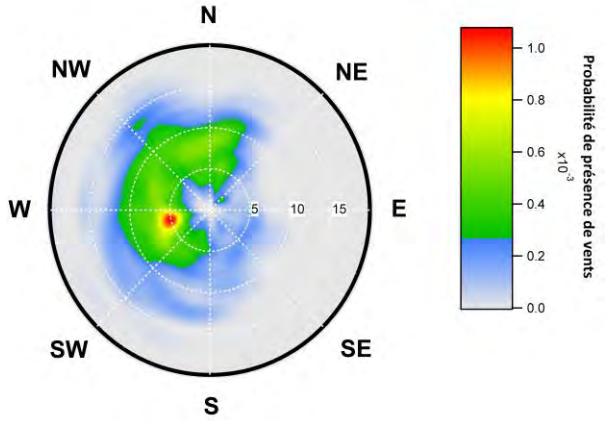
MEASURING BIOAEROSOLS ONLY WITH WIBS IN A COMPLEX ENVIRONMENT IS DIFFICULT AND REQUIRES FURTHER STUDIES TO BE BETTER UNDERSTOOD

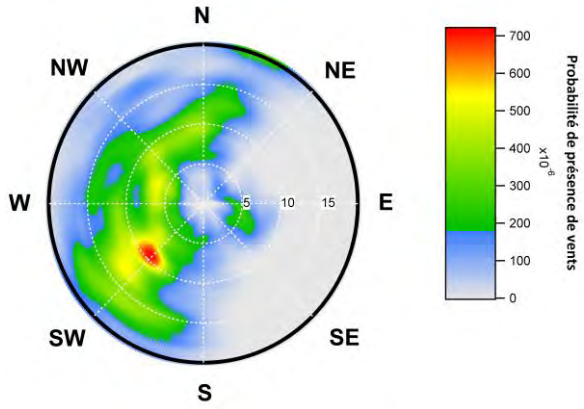
SOURCE OF BIOAEROSOLS IN THE REGION OF SACLAY

Summer 2014

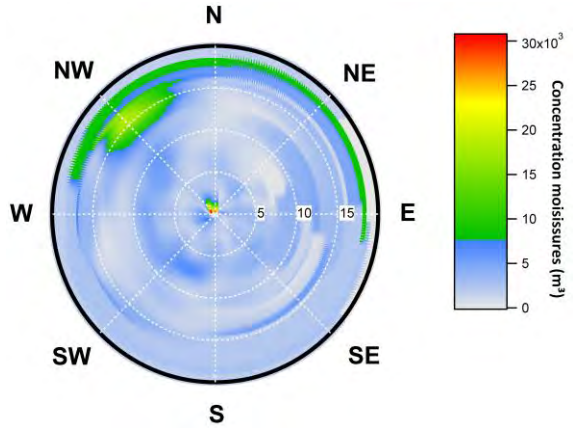
Winter 2014

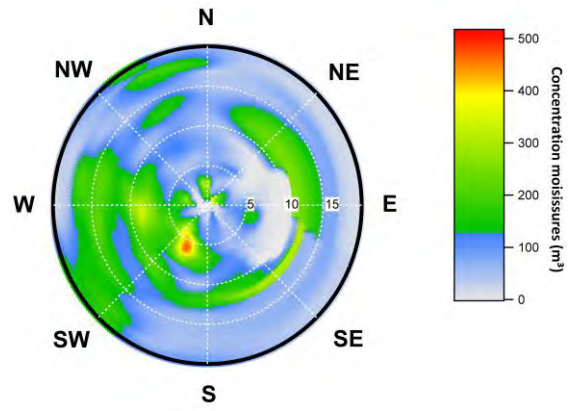
Wind Direction
&
Wind Speed





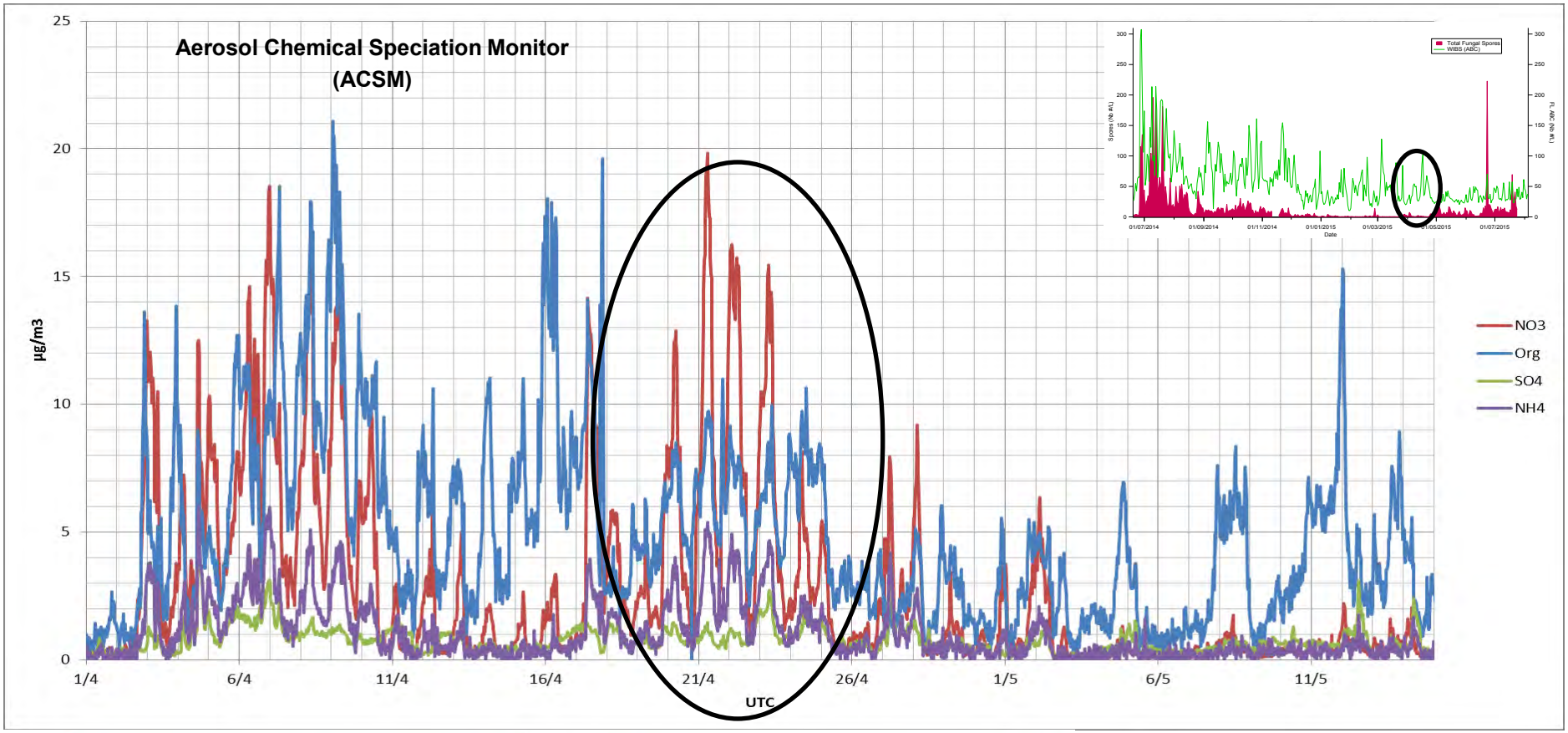
Bioaerosols
Concentrations

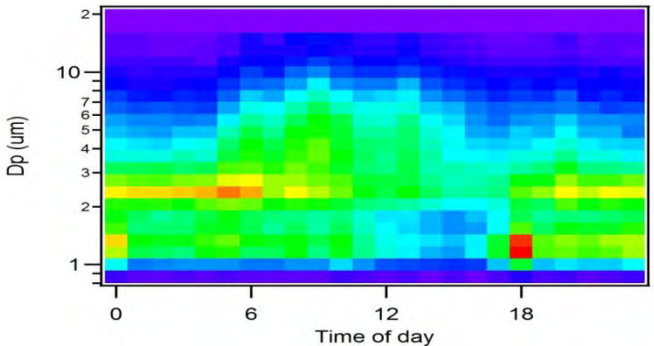


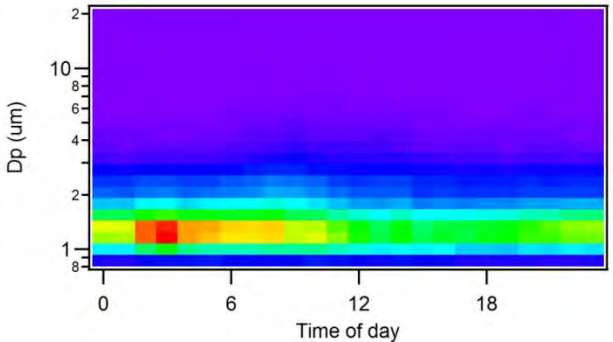


NonParametric Regression (NPR)
Courtesy of J.E Petit

CASE OF STUDY: POLLUTION EVENTS IN APRIL 2015





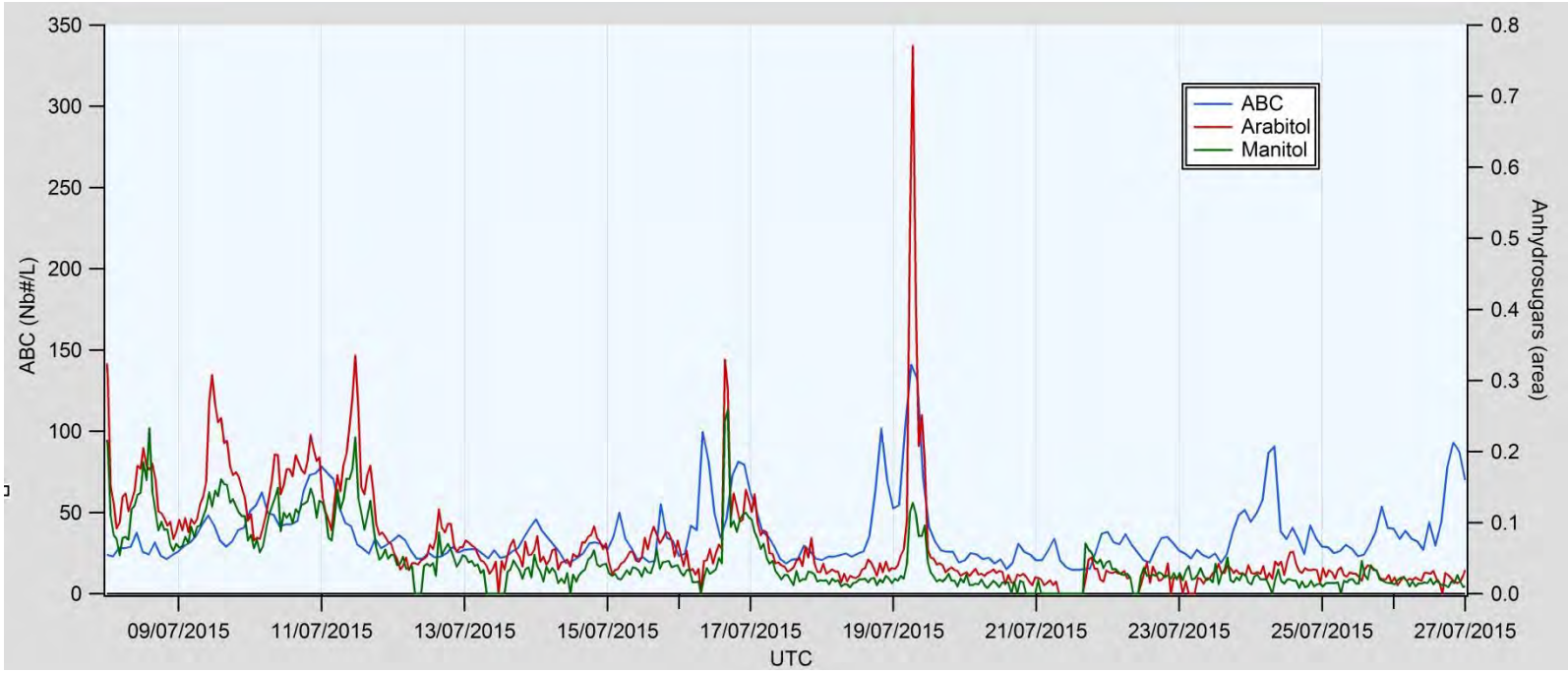


The observed fluorescence is probably due to pollution and not to the presence of bioaerosols

ALTERNATIVE METHODE: ON-LINE CHEMISTRY

MEASUREMENTS OF CHEMICAL TRACERS WITH AEROSOL CONCENTRATOR COUPLED TO LIQUID CHROMATOGRAPHY

(Poster 27)



CONCLUSIONS

Main Scientific Objectives:

- Atmospheric background of Bioaerosols:

On line fluorescence measurements can be used to detect Bioaerosols events between PM2.5 and PM10 like fungal spores but more work is needed to constrain the measurements in the range of PM1 for bacteria detection

- Spatial distribution of Bioaerosols:

Most of the Bioaerosols events are coming from local sources during the summer and they are not correlated with wind Speed and Direction.

- Ice Nuclei studies in the region of Paris: *Mason et al., ACPD, 2015*

Technical Objectives :

- Development and optimization the real-time measurements of Bioaerosols with the Wideband Integrated Bioaerosols Sensor (WIBS):

refinements in the clustering approach: *Crawford et al., AMT,2015 and relation ship between the* A,B,C channels size distribution and fluorescence for the on line bacteria detection

- On line measurement of Bioaerosols Chemical Tracers with collector/concentrator & Liquid Chromatography:

the method is robust for the detection of fugal spores but needs to be optimize and simplify for bacteria and fungal spore detection

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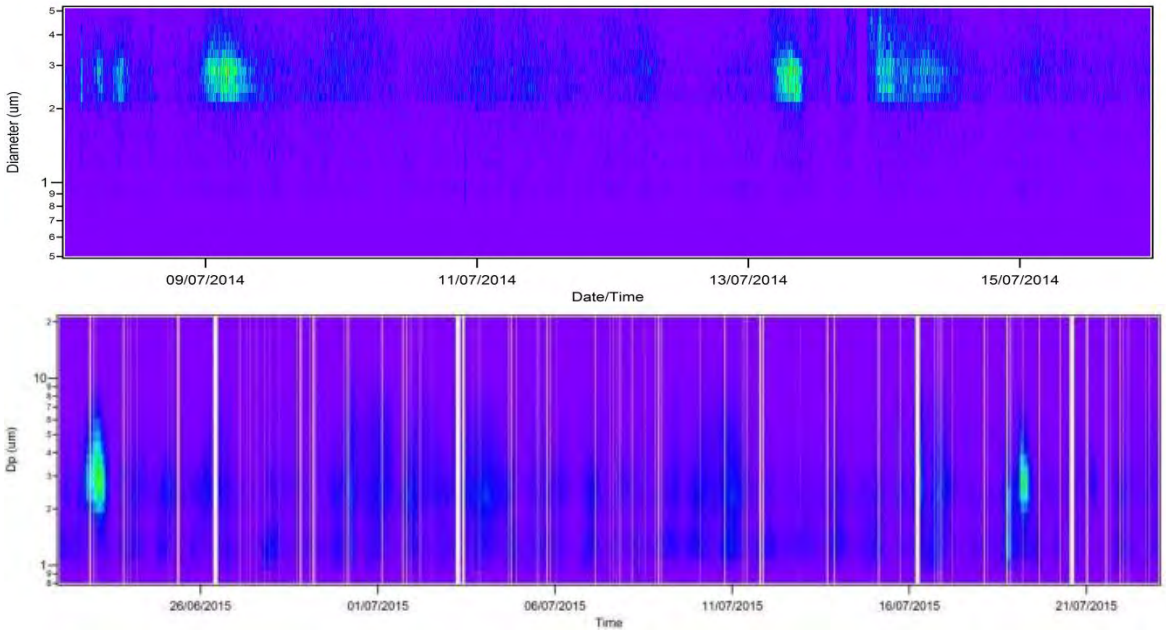

THANKS