Atmospheric pollen survey: a metrological study between Hirst and Cour sampling methods

Farrera I.[1], M. Calleja [1], J. Belmonte [2], T. Almeras [1] & I. Plaisant [3]

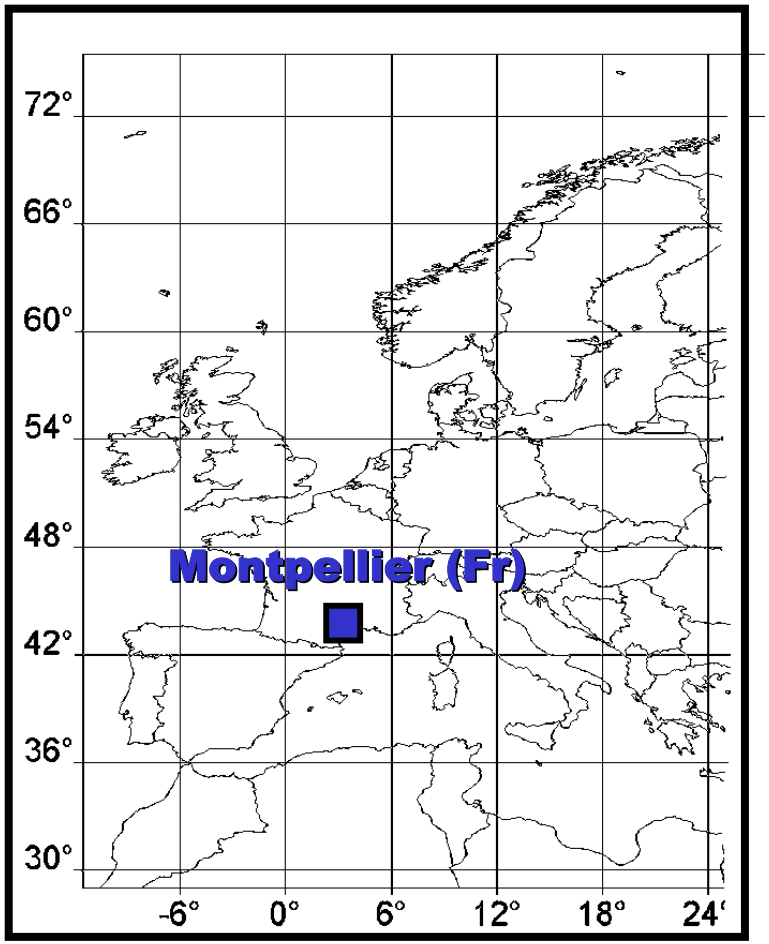
[1] Unité de Palynologie. École Nationale Supérieure Agronomique Montpellier (ENSAM). France
[2] Botany Unit. Autonomous University of Barcelona. Cerdanyola del Vallès. Spain
[3] DRASS Languedoc Roussillon. France

Objectives

To compare the Cour and Hirst aerobiological sampling methods from the point of view of the:

- **advantages and disadvantages of each method**
- **evaluation of the repeatability of the measurements of each method**
- **analysis of the differences between results of the two methods**

Study design



Comparison Cour-Hirst

From 31/12/01 to 05/08/02

31 weeks

Repeatability Cour and Hirst

From 24/06/02 to 05/08/02

6 weeks

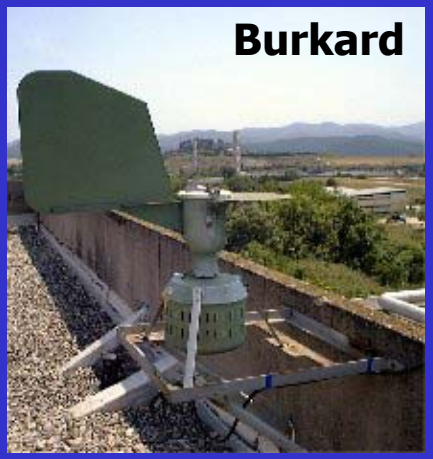
H_1 H_2

C_1 C_2

H Hirst sampler **C** Cour sampler

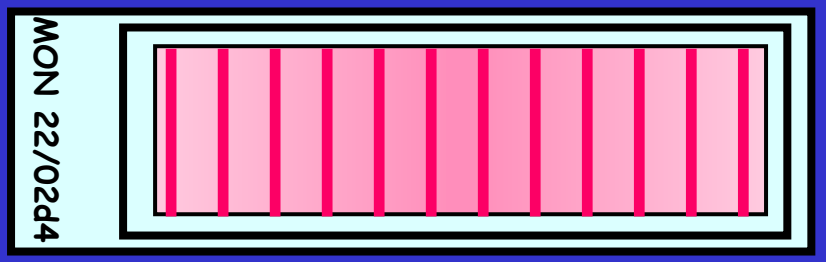
Same experimental conditions

HIRST sampler



RNSA counting methodology

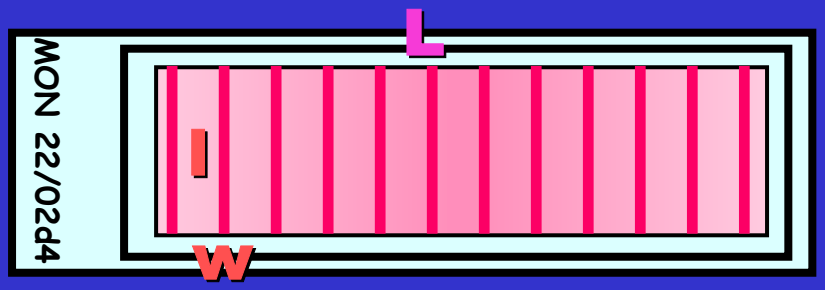
Light microscopic analysis of 12 transversal lines



N Number of pollen grains

HIRST methodology calculations

Light microscopic analysis of
12 transversal lines



Sa Slide area = l L = 14 mm x 48 mm = 672 mm^2 = 0.000672 m^2

Aa Analyzed area = 12 (l w) = 12 (14 w) =168w = 0.168w m^2

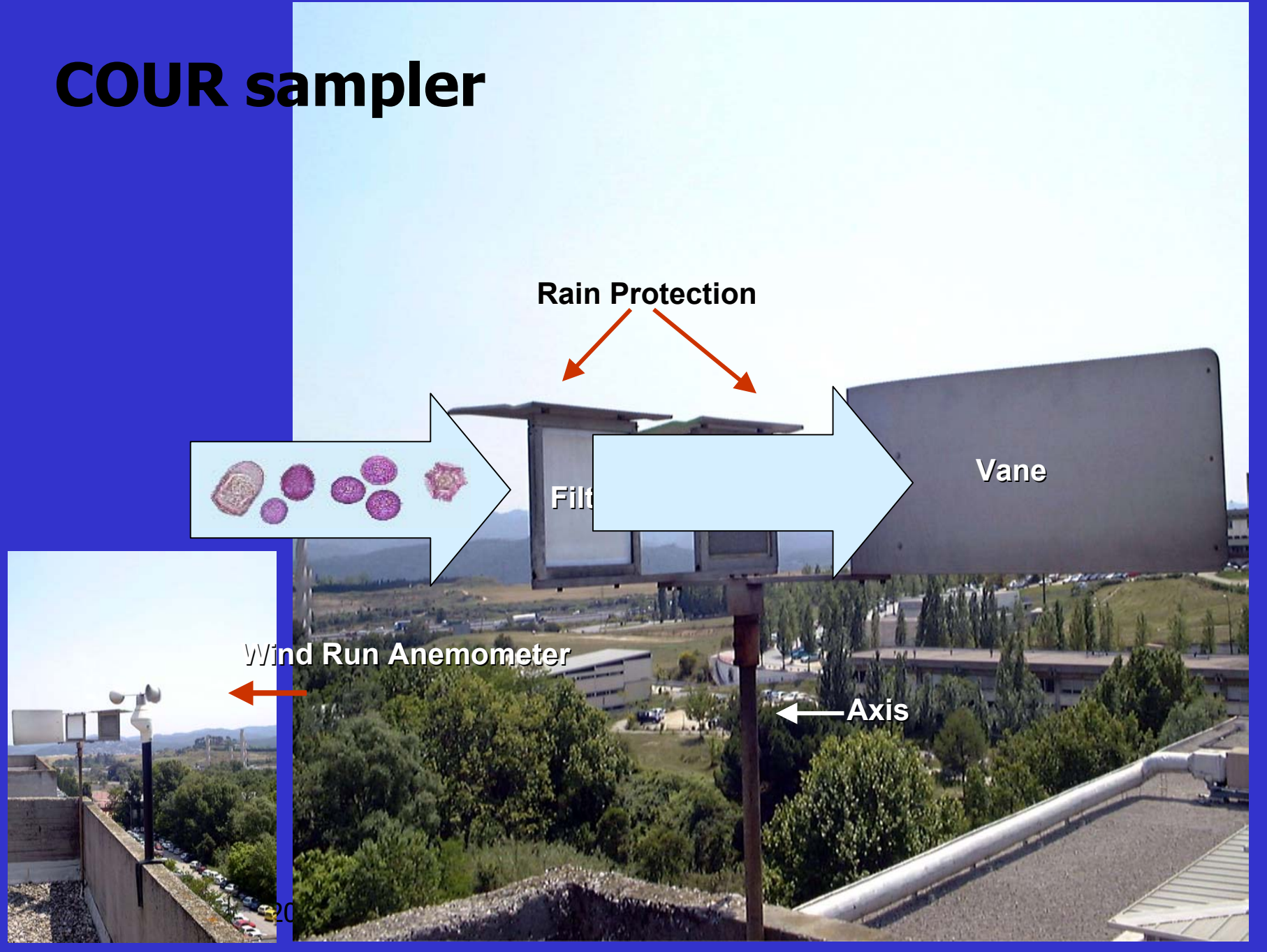
N Number of pollen grains per analyzed area

V Air volume analyzed per day = 14.4 m^3
10 l/min x (24h/day x 60min/h) x 1/1000 m^3/l

Mean dayly pollen concentration
N x (Sa/Aa) / 14.4 m^3

Pollen grains per volume unit

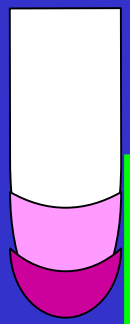
COUR sampler



COUR methodology

Gauze Filter

Laboratory protocol:
H_2SO_4, HCl, HF, KOH…
Acetolysis (Erdtman 1960)

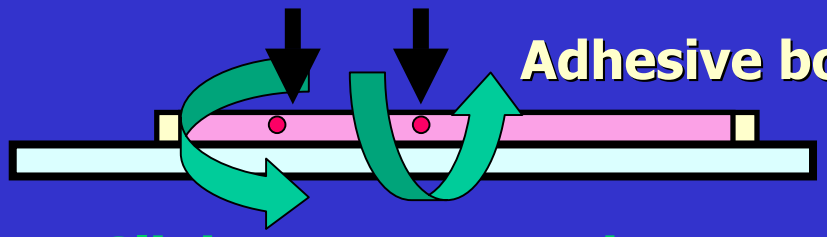


Known volumes:

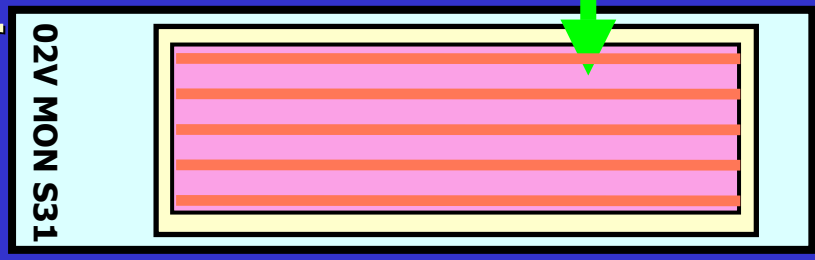
Glycerogelatin

Pollen and spore sediment V_t V_0

50 ul



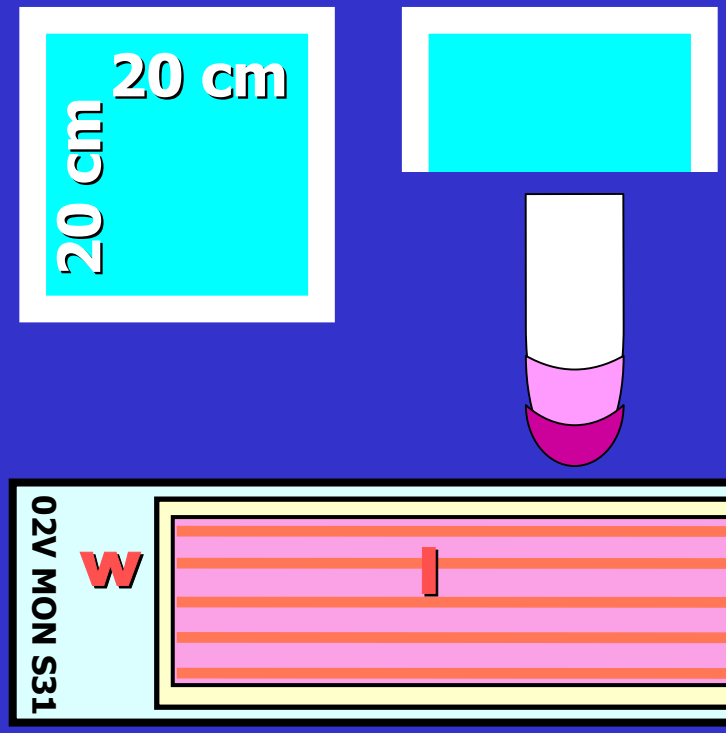
Slight pressure makes pollen turn over itself



Light microscopic analysis of 5 longitudinal lines

N Number of pollen grains

COUR methodology calculations (1)



S Filter Surface = 0.02 m²

V_t Total sediment volume

v Slide volume = 50 ul

Aa Analyzed area = 5 (l w)

Sa Slide area = l L

Number of pollen grains per analyzed area = N

Number of pollen grains per filter (week)

$$N \times (V_t / v) \times (Sa/Aa) / S$$

Pollen grains per surface unit

COUR methodology calculations (2)

Wind Run Anemometer

Longitude of the air column (Wr) passing across the 20cmx20cm gauze filter during the exposition period

Efficiency (filter resistance) 1/5 of wind run

Mean weekly pollen concentration

$$N \times (V_t / v) \times (Sa/Aa) \ / \ S \times (Wr/5)$$

Pollen grains per volume unit

Objective 1

Advantages and disadvantages of the Hirst and Cour methods

Comparison Cour/Hirst (operational point of view)

		Hirst method		Cour method	
Need of electricity	!!!	Yes (Battery)		No	★
Dimension of the sampling surface		14mm x 2 mm		20 cm x 20 cm	★
Facility to remove and install periodical samples		Attention needed		Easy	★
Protocol previous to microscopic analysis		Easy	★	Laboratory protocol needed	
Pollen grain observation	!!!	Good		Very good	★
Fungal spore observation	!!!	Good	★	Some of them lost	
Lost of slide sample		Irreparable		Reparable	
Frequency of sampling		Daily (Hourly)	★	Weekly ((Daily))	
Economy					
Cost of the sampler		Expensive		Cheap	★
Cost of functioning		Cheap	★	Expensive	

!!! **Key aspects** ★ **Better option**

Objective 2

Repeatability of the measurements

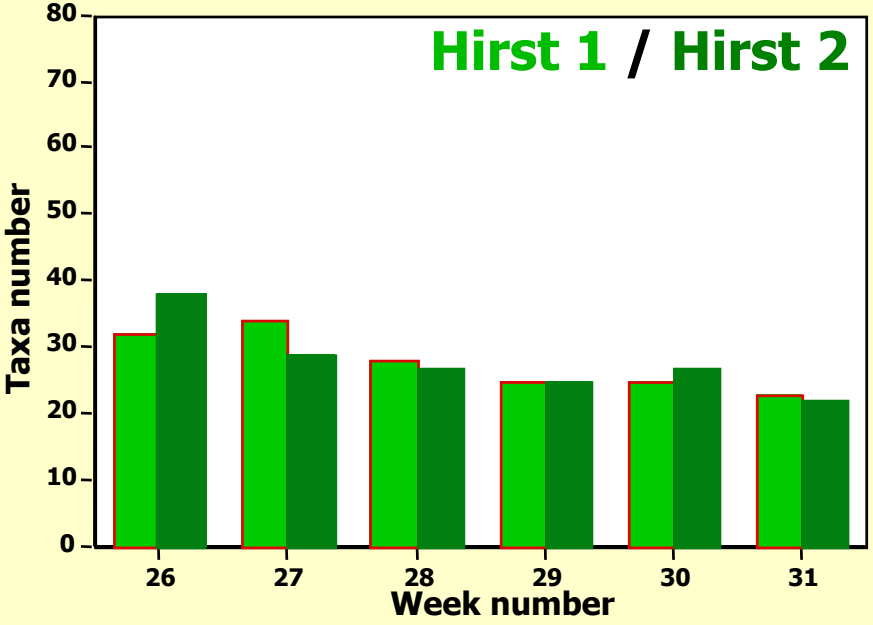
Comparison Hirst 1 - Hirst 2
Cour 1 - Cour 2

Items Taxonomic richness
Daily / Weekly concentrations
Daily / Weekly abundance classes

Observation period of 6 weeks

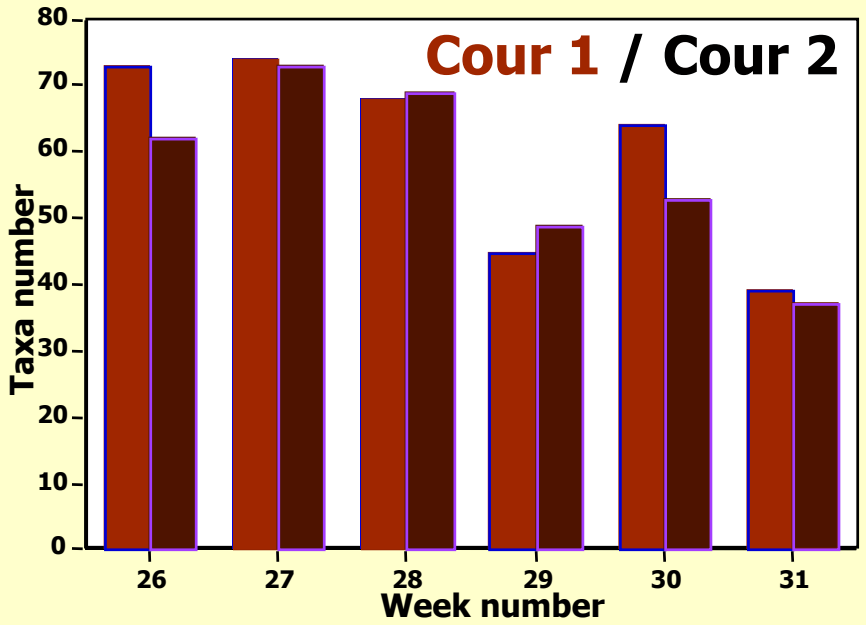
Comparison of the taxonomic richness

Hirst method



Mean = 27
Mean of the weekly differences = 8%

Cour method



Mean = 58
Mean of the weekly differences = 8%

Hirst and Cour methods are equally repeatable

Comparison of the pollen concentrations

Statistical approach:
1-WAY ANOVA or KRUSKAL-WALLIS (NPAR1 WAY)
H_0 There is not a method effect

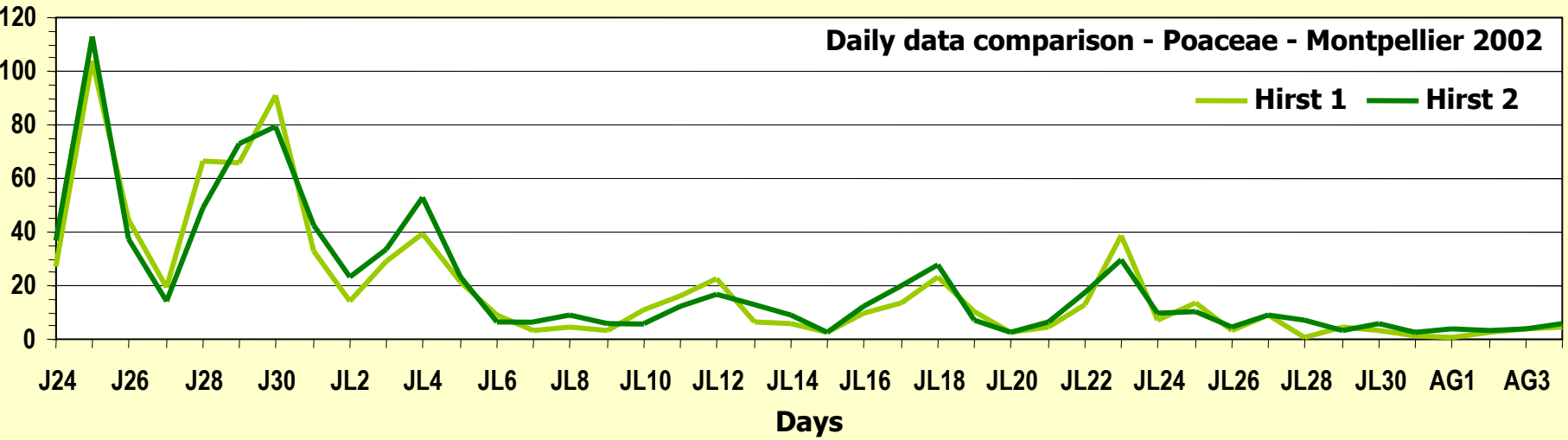
Applied to **Hirst 1 / Hirst 2** 2*342 observations **and to** **Cour 1 / Cour 2** 2*666 observations

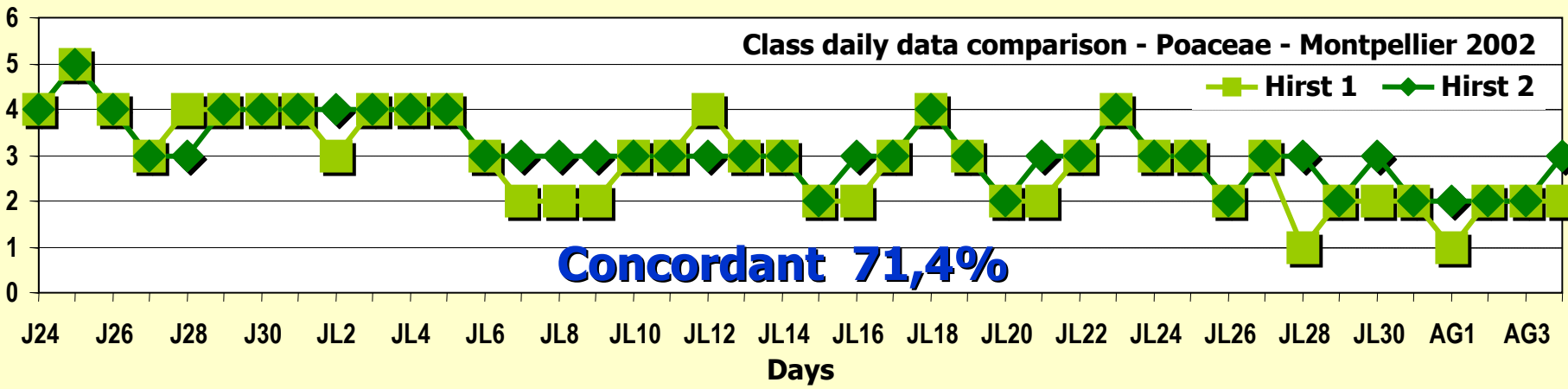
Pvalue > 0,05 **Pvalue > 0,05**

H_0 is accepted, the global variability observed in the data series is not explained by the method effect

Hirst/Hirst and Cour/Cour show not significant differences

Comparison of the pollen concentrations Hirst daily data series – an example





Comparison of the abundance classes Hirst daily and weekly data series - statistics

- **49 pollen taxa** (present at least once in both methods in the 6 weeks)
- **Relative mean of the differences (Rel mean dif) of repeatability per abundance classes with 5% confidence interval**

Hirst method - Daily data		
Abundance class		Rel mean dif
1	<1	250%
2	1-5	139%
3	5-20	73%
4	20-100	32%
5	>100	19%

Hirst method - Weekly data		
Abundance class		Rel mean dif
1	<1	183%
2	1-5	74%
3	5-20	21%
4	20-100	13%

Smaller differences when higher concentrations

Comparison of the abundance classes
Cour weekly data series - statistics

Cour method - Weekly data		
Abundance class		Rel mean dif
1	<1	110%
2	1-5	27%
3	5-20	13%
4	20-100	8%

Cour method - Weekly data		
Abundance class		Rel mean dif
1'''	<0.05	211%
1''	0.05-0.25	108%
1'	0.25-1	39%

Smaller differences when higher concentrations

Objective 3

Analysis of the differences

Comparison Hirst 1 - Cour 1

Items Taxonomic richness
Weekly concentrations
Weekly abundance classes

Observation period of 31 weeks

Taxon	Percentage period w1 - w31 HIRST	COUR
ABIES		0,000
ACACIA	0,004	**0,049**
ACER	**1,159**	0,796
AESCULUS	**0,048**	0,036
AILANTHUS	0,002	**0,008**
ALNUS	**0,394**	0,239
AMBROSIA	**0,002**	0,001
ARTEMISIA	0,004	**0,006**
BETULA	**0,989**	0,521
BORAGINACEAE	**0,020**	0,006
BUDLEJA	Not det.	0,002
BUXUS	0,400	**0,456**
CANNABACEAE	0,009	0,011
CARPINUS	0,077	**0,193**
CARYOPHYLLACEAE	0,000	0,001
CASTANEA	**2,224**	2,062
CEDRUS	0,003	0,002
CELTIS	0,217	**0,296**
CENTAUREA	0,001	0,001
CHENOPODIACEAE/AMARANT.	**0,160**	0,107
CISTACEAE	**0,005**	0,001
CONVOLVULUS		0,000
ASTERACEAE ECHINATE	**0,023**	0,015
ASTERACEAE FENESTRATE	0,017	**0,029**
CORIARIA	0,006	0,005
CORYLUS	**0,625**	0,307
CRASSULACEAE	**0,004**	0,000
BRASSICACEAE	0,027	**0,037**
CUCURBITACEAE		0,001
CUPRESSACEAE	38,468	**44,956**
CYPERACEAE	0,053	0,056
DIOSPYROS	Not det.	0,003
DIPSACACEAE	0,001	0,001
ELAEAGNUS	**0,002**	0,001
EPHEDRA		0,001
ERICACEAE TOTAL	**0,113**	0,080
EUCALYPTUS (MYRTACEAE)	0,009	0,010
EUPHORBIA	0,002	0,002
FAGUS	**0,152**	0,126
FRAXINUS	**6,166**	4,541
GINKGO	Not det.	0,036
POACEAE CEREAL	0,008	**0,022**
POACEAE WILD	**2,355**	1,672
HEDERA	0,002	0,001
HELIANTHUS	0,000	**0,002**
HYPERICUM		0,002
ILEX	**0,007**	0,001
JUGLANS	**0,027**	0,018
JUNCUS	**0,016**	**Acetolysis!!!**
LAMIACEAE	0,007	0,003
LAGERSTROMIA		0,000
LARIX	Non det.	0,004
LIGUSTRUM	0,029	**0,085**

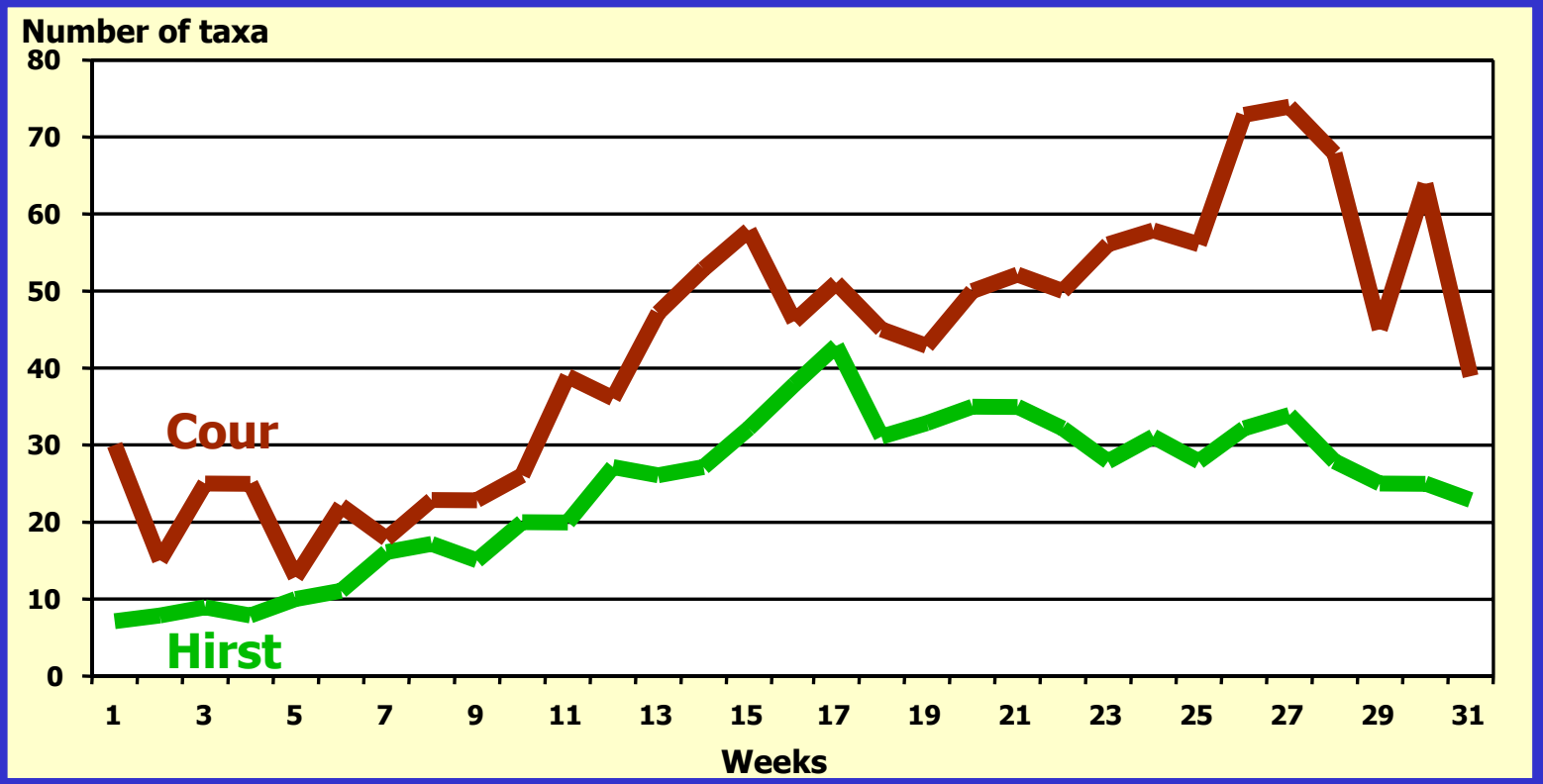
Taxon	Percentage period w1 - w31 HIRST	COUR
LIPPIA		0,000
LIQUIDAMBAR	0,010	0,009
MELIA		0,001
MERCURIALIS	**0,049**	0,024
MONOCOTYLEDONEAE HERBS	0,005	**0,024**
MORACEAE	**3,968**	2,479
OLEA	0,633	0,608
APIACEAE	0,016	**0,036**
OSTRYA	0,001	To be revised
OXALIS		0,000
PALM TREES	**0,017**	0,000
PAPAVERACEAE	0,040	0,036
PAPILIONACEAE	0,004	**0,119**
PARTHENIUM	Not det.	0,007
PHILLYREA	0,024	**0,081**
PICEA	0,016	0,060
PINUS	9,748	**11,111**
PISTACIA	0,187	0,190
PLANTAGO	**0,681**	0,558
PLATANUS	**7,187**	6,726
POLYGONUM		0,002
POPULUS	2,004	**2,698**
PRIMULACEAE	Not det.	0,001
POTERIUM	0,006	0,006
PUNICA		0,002
QUERCUS TOTAL	**18,045**	15,081
RANUNCULACEAE	0,016	**0,037**
RESEDA	0,002	0,001
RHAMNUS	0,016	0,015
RHEUM	Not det.	0,001
RHUS	Schinus?	0,005
RICINUS		0,000
ROSACEAE lign.	0,002	**0,209**
RUBIACEAE	0,005	**0,019**
RUMEX	**0,178**	0,145
SALIX	0,279	**0,348**
SAMBUCUS	0,010	**0,050**
SCHINUS	0,001	Rhus?
SCROFULARIACEAE	0,000	**0,016**
SOLANACEAE	0,000	0,001
TAMARIX	0,064	**0,114**
TAXODIUM	Cupressaceae	0,003
TAXUS	Cupressaceae	0,514
TILIA	0,018	**0,038**
THIMELACEAE	0,000	0,000
TSUGA	Not det.	0,001
TYPHA	0,017	0,018
ULMUS	0,225	0,238
URTICACEAE	**2,450**	1,321
VIBURNUM	0,002	**0,037**
VITIS	0,136	0,155
XANTHIUM	0,000	0,000
ZIZIPHUS	Non det.	0,001
BROKEN -UNKNOWN	**0,095**	0,046

Pollen Taxa numbe

Hirst 84

Cour 112

Comparison of the taxonomic richness



Cour method shows higher taxonomic richness

Comparison of the pollen concentrations

Statistical approach:

Wilcoxon signed rank text (non parametric) with paired data

H_0 There are no differences between the mean results from Hirst and Cour methods

Applied to **Hirst 1 / Cour 1**
2*1984 observations

↓

Pvalue < 0,05

↓

H_0 is rejected, the two methods give mean different results

Hirst and Cour methods give different mean results

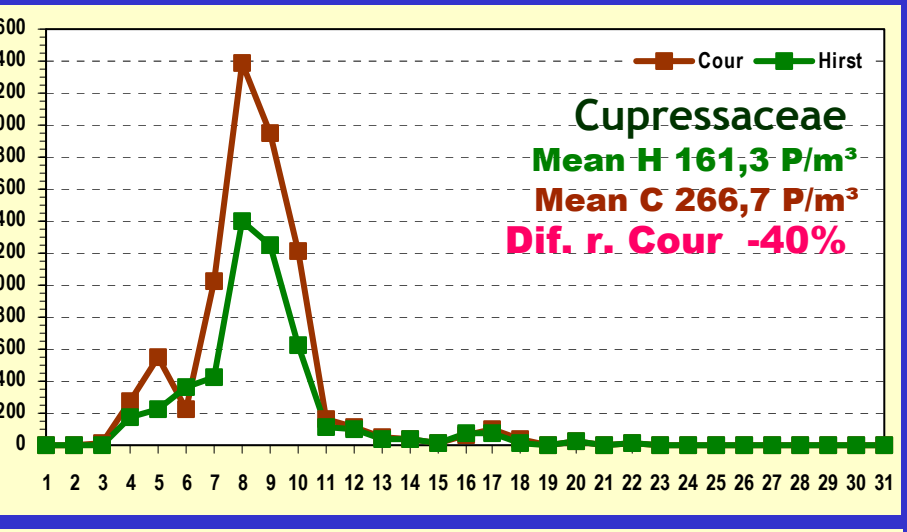
Comparison of the abundance classes Hirst - Cour weekly data series - statistics

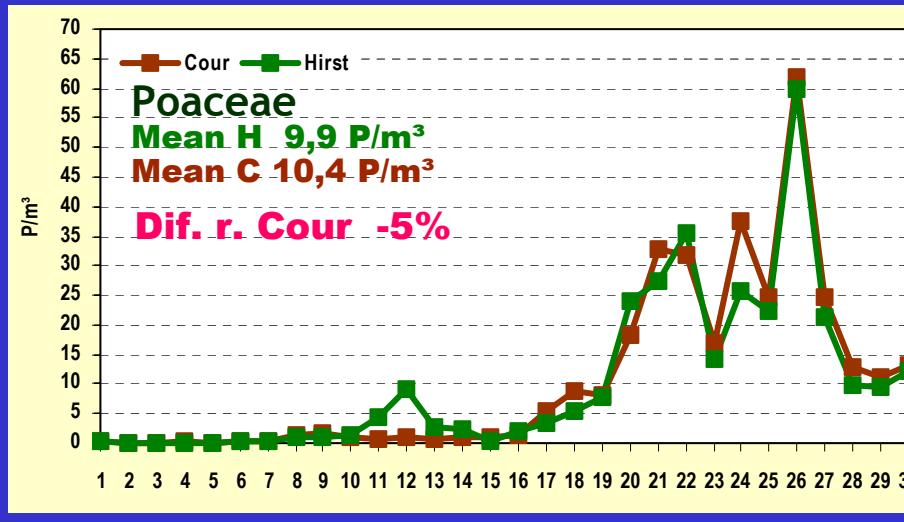
Hirst and Cour methods - Weekly data				
Abundance class		Mean concentration		Differences
Mean values		Hirst	Cour	respect Cour
1	<1	0,147	0,299	- 51%
2	1-5	1,961	2,892	- 32%
3	5-20	9,423	10,213	- 8%
4	20-100	30,977	52,540	- 41%
5	>100	352,219	524,467	- 33%

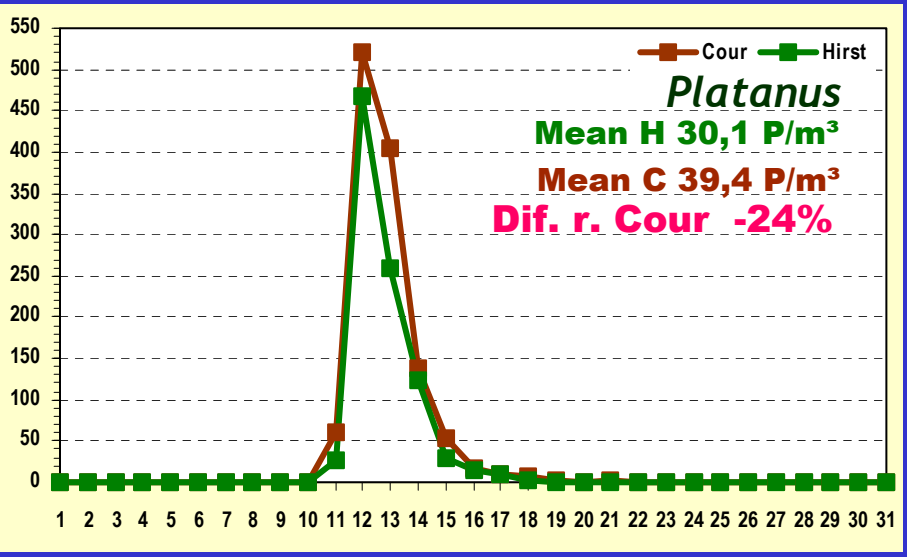
Cour method shows higher mean concentrations

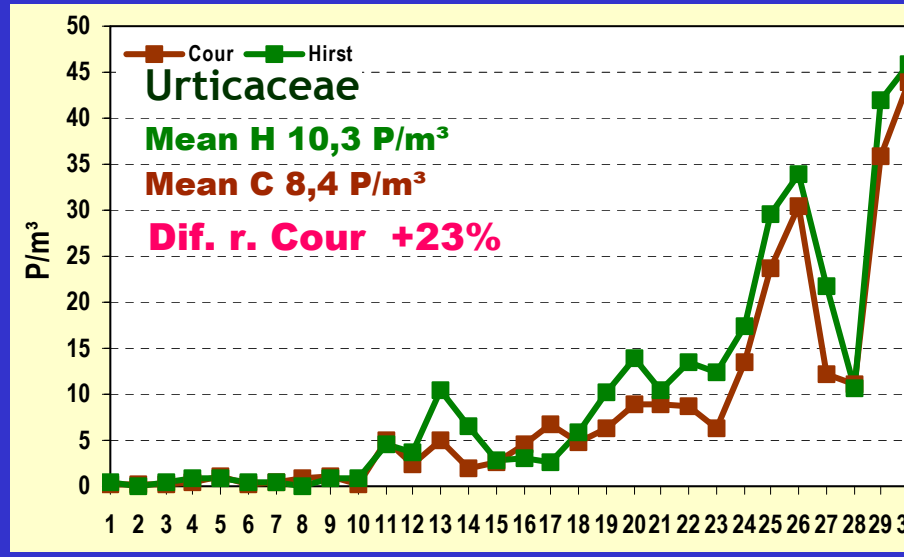
Smaller differences in the abundance class 3 (5-20 P/m³)

Comparison of the pollen concentrations Hirst/Cour data series – examples



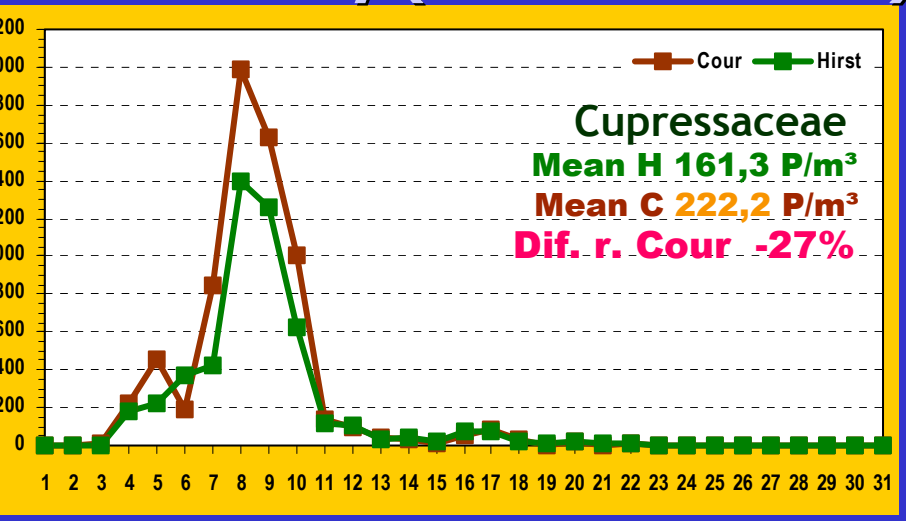


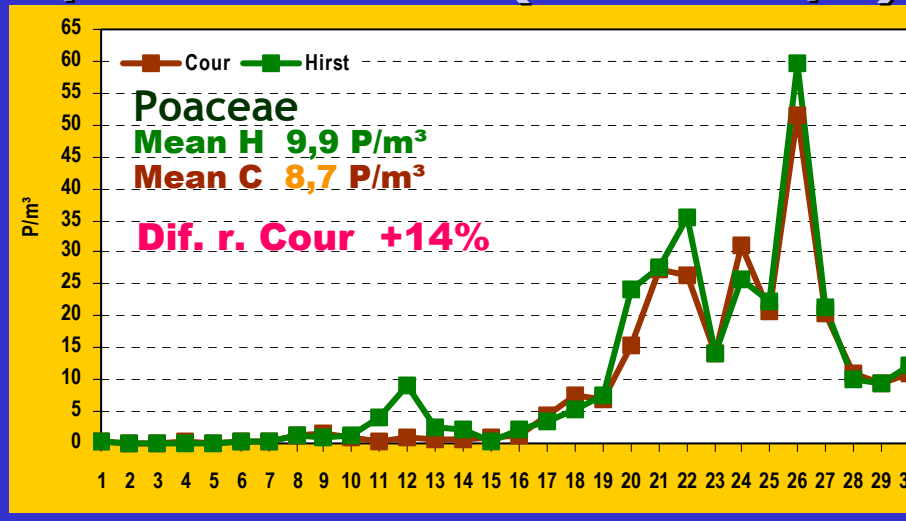


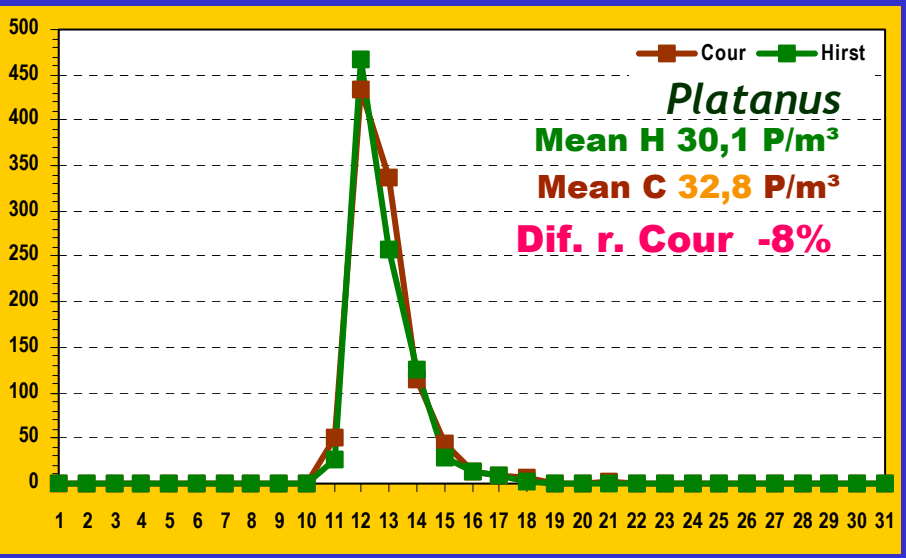


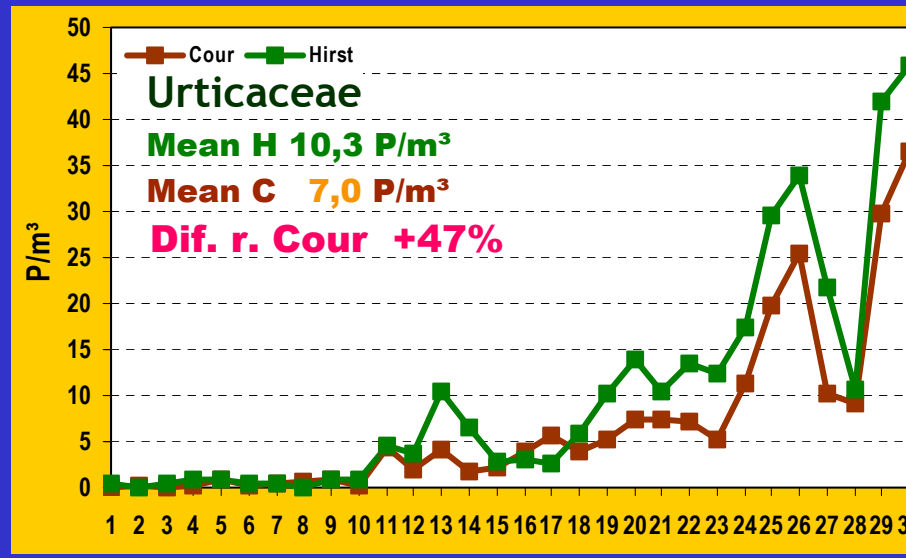
Comparison of the pollen concentrations Hirst/Cour data series – a proposal

Efficiency (filter resistance) 1/6 of wind run (instead 1/5)

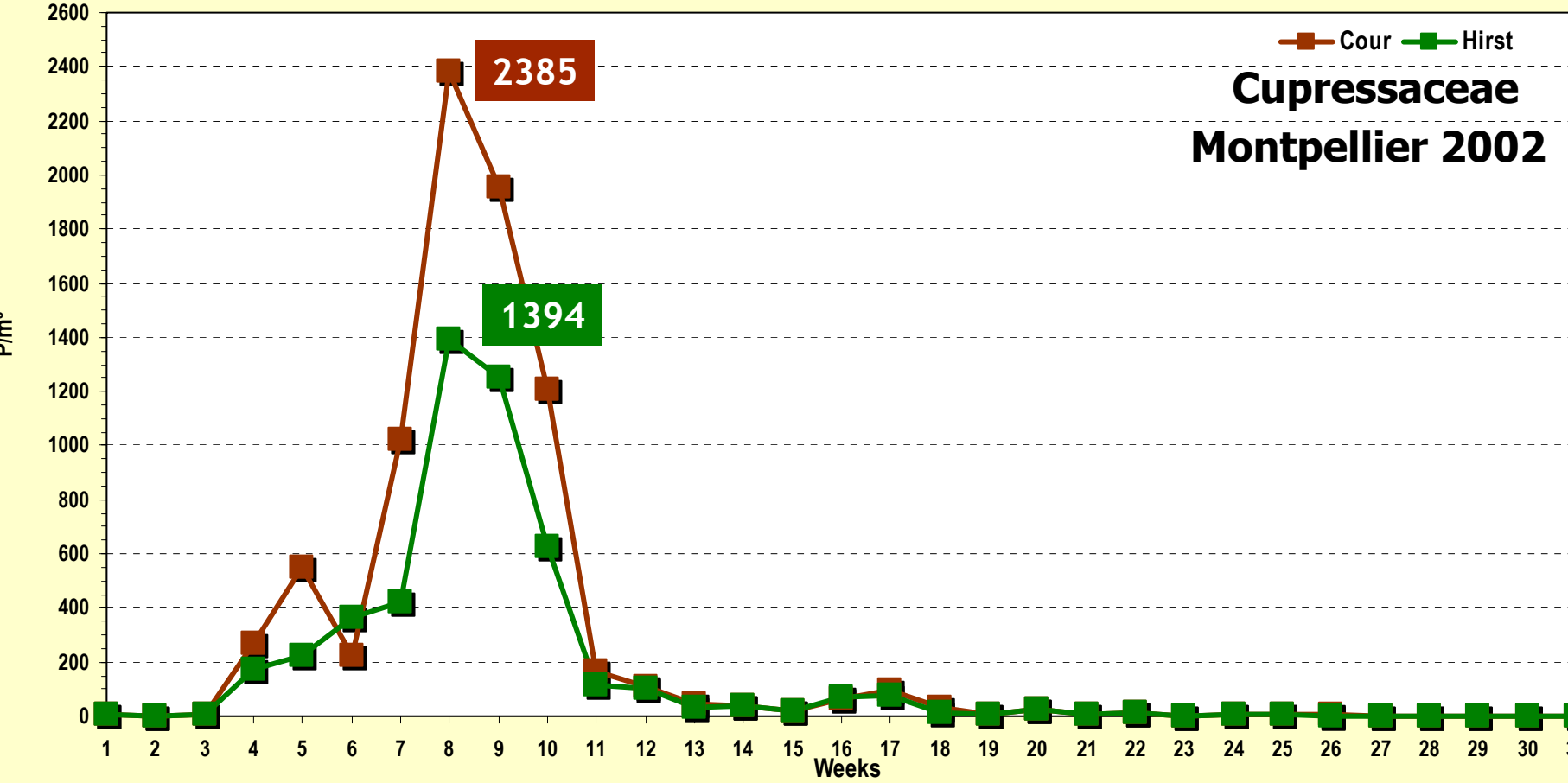




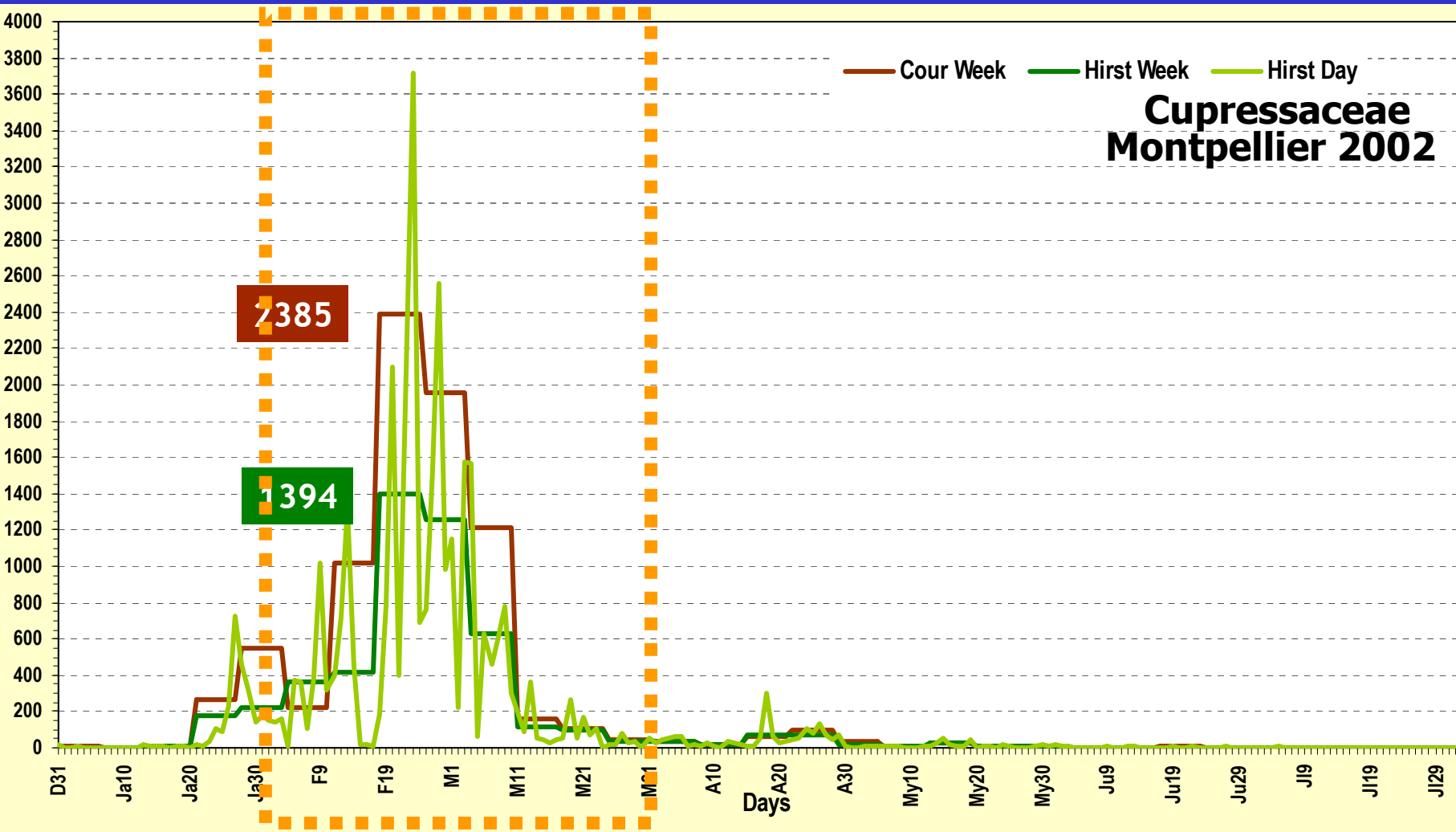




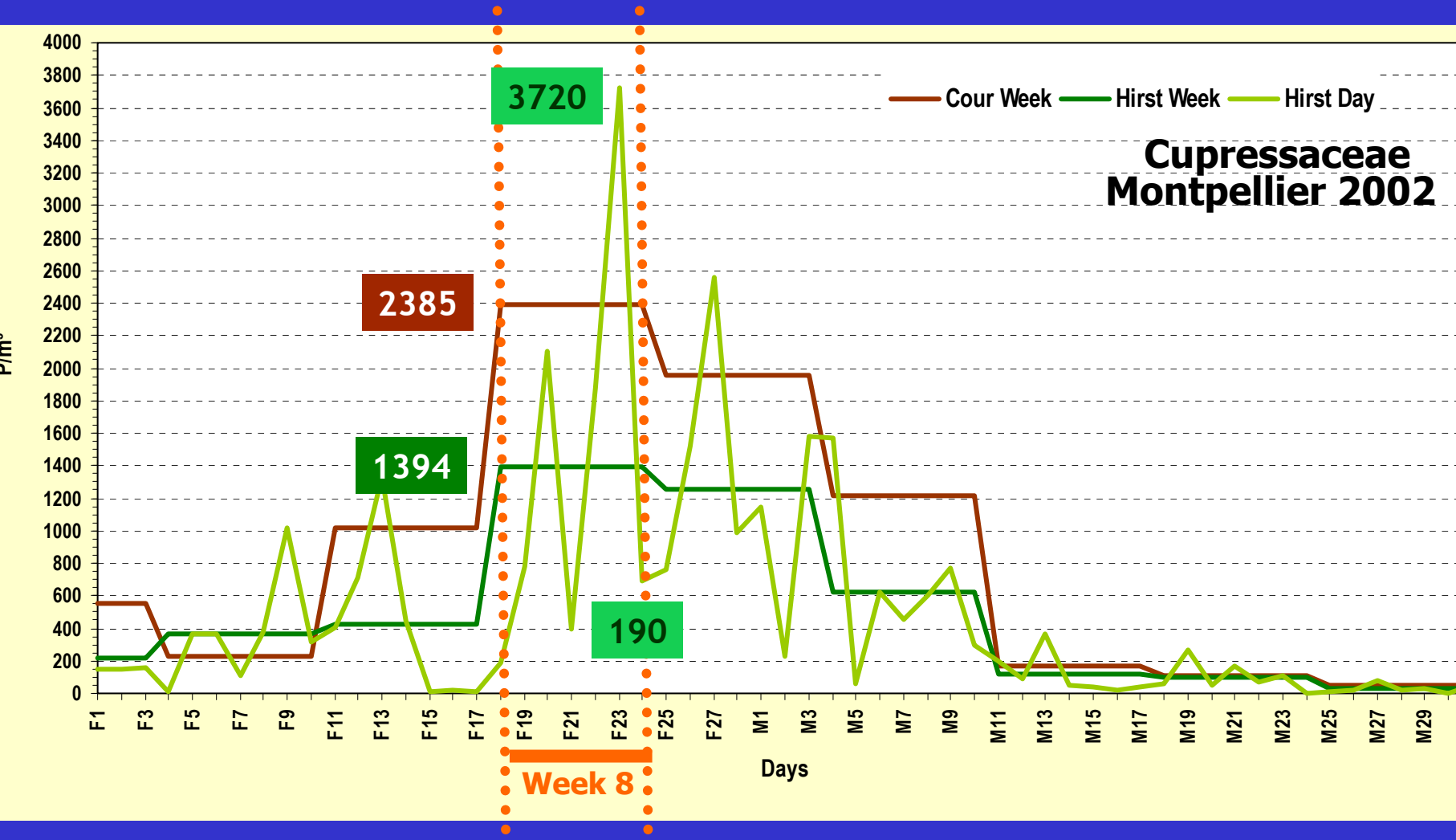
Hirst/Cour data series – other considerations



Hirst/Cour data series – other considerations



Hirst/Cour data series – other considerations



Conclusions

More investigation is needed on metrological aspects (i.e. per pollen type)

Hirst and Cour methods showed:
- to be metrologically acceptable
- to estimate atmospheric pollen content quite similarly

The election of the method to be used should be based on the objectives of the study