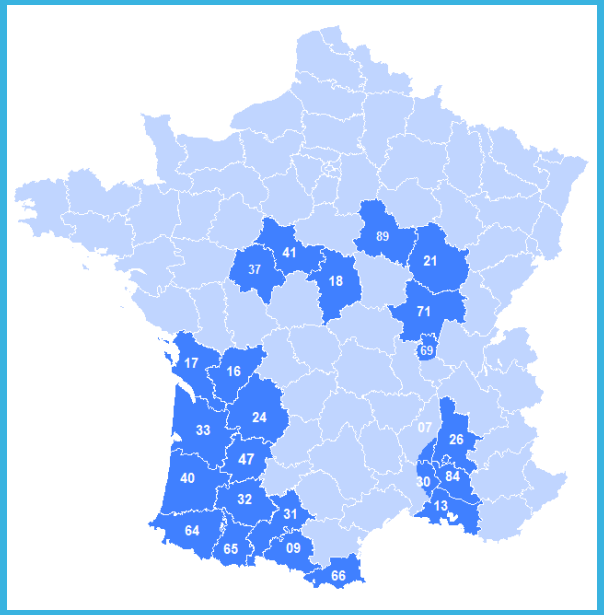
Moderate and severe hailfalls in France: Average Recurrence Intervals and recent evolution.

Claude BERTHET,
Director of Anelfa

Jean DESSENS
Scientific adviser



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2nd EUROPEAN HAIL WORKSHOP
19 – 21 April 2017, University of Bern, Switzerland

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Etudes et Prévention Grêle

Hail damage in France

2/08/2013: Damage on Bordeaux vineyards : 156 M€

8-10/06/2014: Damage on buildings and cars in France : 850 M€

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Average Recurrence Intervals (ARIs) of hail

1. Definition of different intensity (or severity) levels : Anelfa scale
2. Hailfall intensity distribution using hailpad data (1988-2015)
3. Correspondence measure on a pad / real occurrence
4. Average Recurrence Intervals of ordinary, severe and extreme hailfalls

Anelfa Scale

CLASS	A0	A1	A2	A3	A4	A5
Maximum hailstone diameter	<1	1-1.9	2-2.9	3-3.9	4-4.9	>=5
Common term	Graupel, pea	Marble, grape, cherry	Pigeon's egg, 2 euro coin	Walnut, ping-pong ball	Hen's egg, Golf ball	Peach, apple, orange, tennis ball
Mean kinetic energy and typical damage	10 $J.m^{-2}$ road accidents, tree flowers cut	50 $J.m^{-2}$ damage to vineyards, orchards, tobacco	200 $J.m^{-2}$ serious damage to cereals, vegetable, trees	500 $J.m^{-2}$ complete damage to all crops, windows cut, cars damaged	800 $J.m^{-2}$ winter landscape, animals killed, people injured, grounded aircraft damaged	Extreme dangerous event, unprotected persons killed
Mean ground coverage	10%	15%	25%	35%	35%	

Simplified ANELFA classification for the public.
A correcting + or - sign should be used for hailstone ground coverage more or less than average

Dessens, J., C. Berthet, J.L. Sanchez, 2007. A point hailfall classification based on hailpad measurements: The ANELFA scale. Atmos. Res., 83, 132-139.

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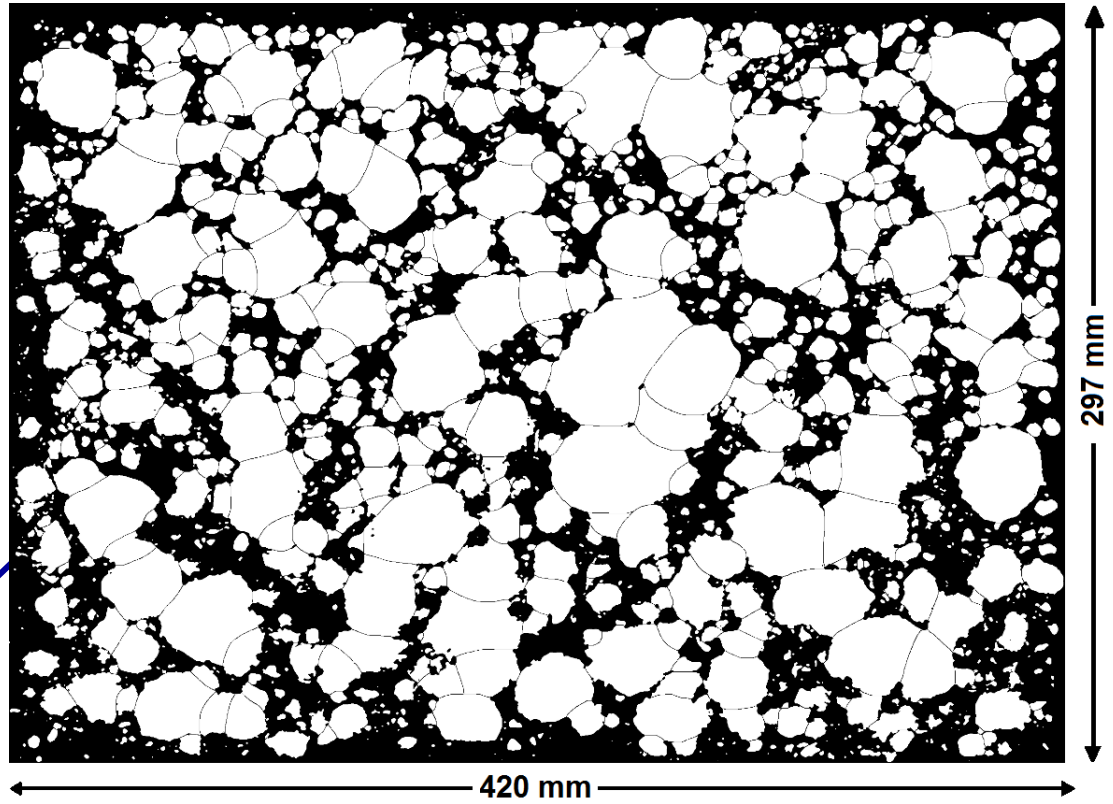
PHYSICAL MEASURE OF HAIL

A HAILPAD STATION



IMPACTED PAD (0.1 m$^{2)}$

16/04/07 22:55TU
09194 Mirepoix
Dmaxp: 3.8 cm
E = 1 912 J.m^{-2}

A3

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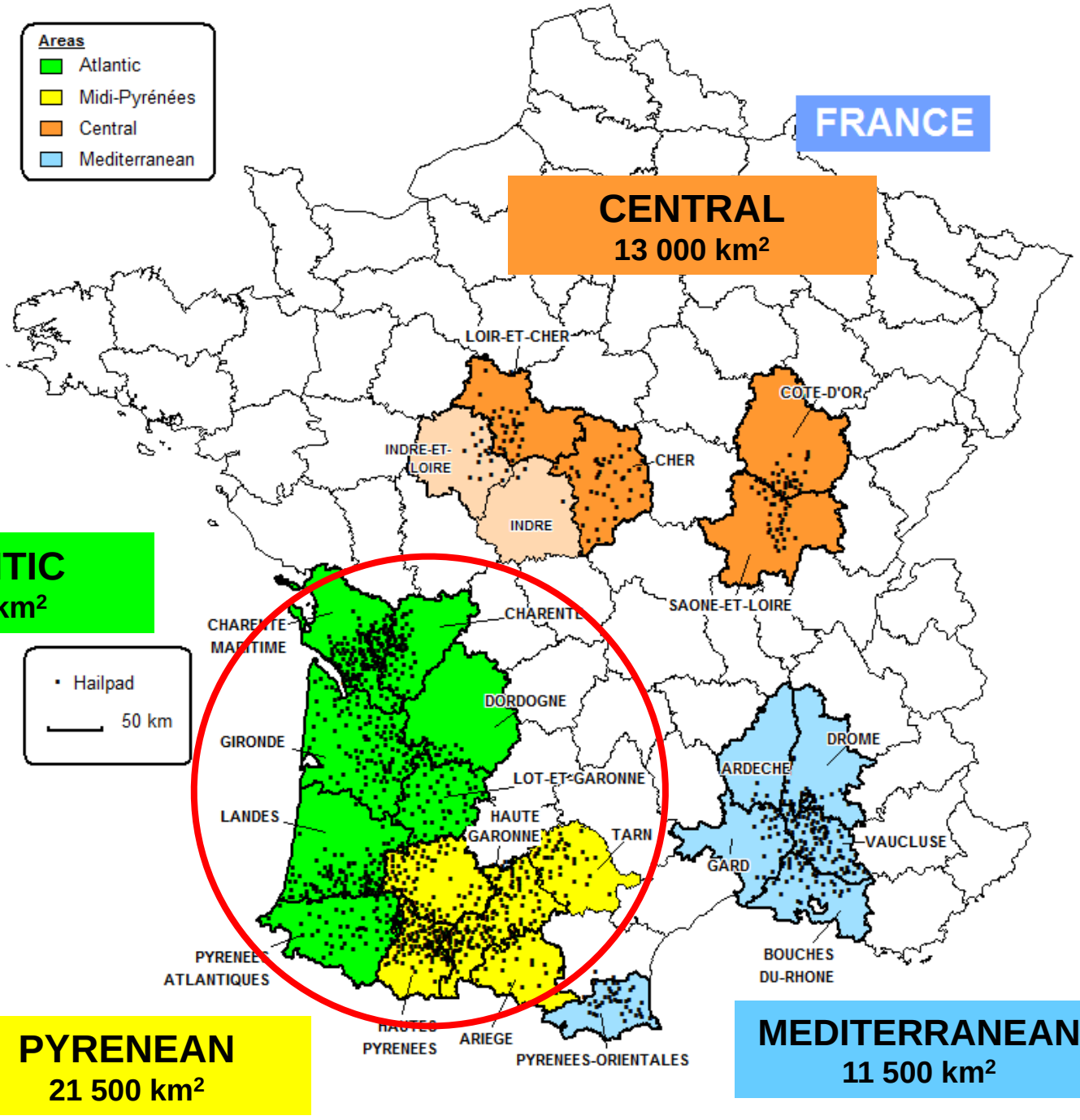
Hailpad Network (2016)

80 000 km²
1 320 Hailpad stations



Mean Frequency (1988-2015)

ANELFA class	Dmaxp *(cm)*	N *1988-2015*	%	Eh *(J/m²)*
A0	0.5 - 0.9	2 046	35.1	9.3
A1	1.0 - 1.9	3 095	53.1	53.3
A2	2.0 - 2.9	538	9.2	211.8
A3	3.0 - 3.9	121	2.1	496.3
A4	4.0 - 4.9	20	0.3	683.9
A5	5.0 - .	4	0.1	1583.5
All classes		*5 824*	*100*	

Dmaxp = diameter of the largest hailstone measured on the impacted pad
N = Number of impacted pads
Eh = mean kinetic energy in each class of the ANELFA scale during the 1988-2015 period

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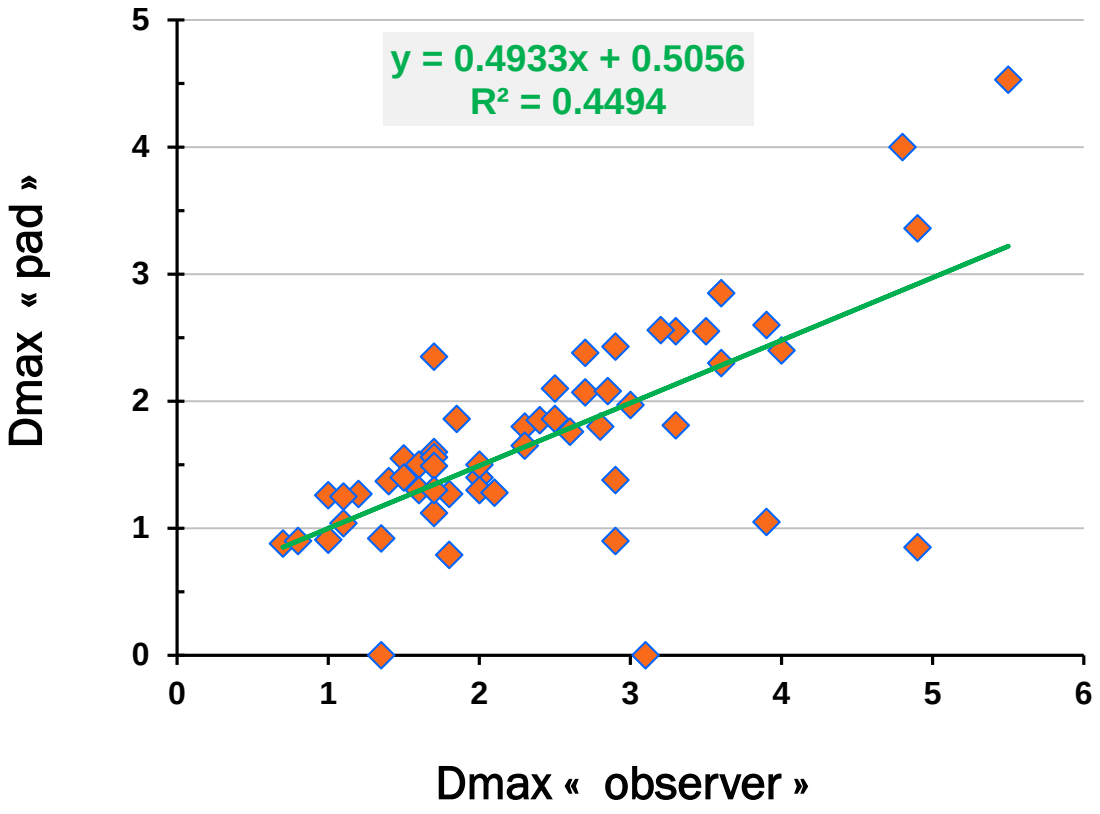
Comparison
1988-2001 and 2002-2015

ANELFA class	Dmaxp *(cm)*	Change *(%)*
A0	0.5 - 0.9	- 11
A1	1.0 - 1.9	- 20
A2	2.0 - 2.9	- 3
A3	3.0 - 3.9	+ 35
A4	4.0 - 4.9	+ 22
A5	5.0 -	+ . . .
All classes		***-14.4***

Evolution in the hailfall number by class from **1988-2001** to **2002-2015**

Dessens, J., Berthet, C., Sanchez, J.L., 2015 : Change in hailstone size distributions with an increase in the melting level height. Atmos. Res., 158-159, 245-253, doi:10.1016/j.atmosres.2014.07.004

Measurements and observations in Switzerland



Smith and Waldvogel (1989)

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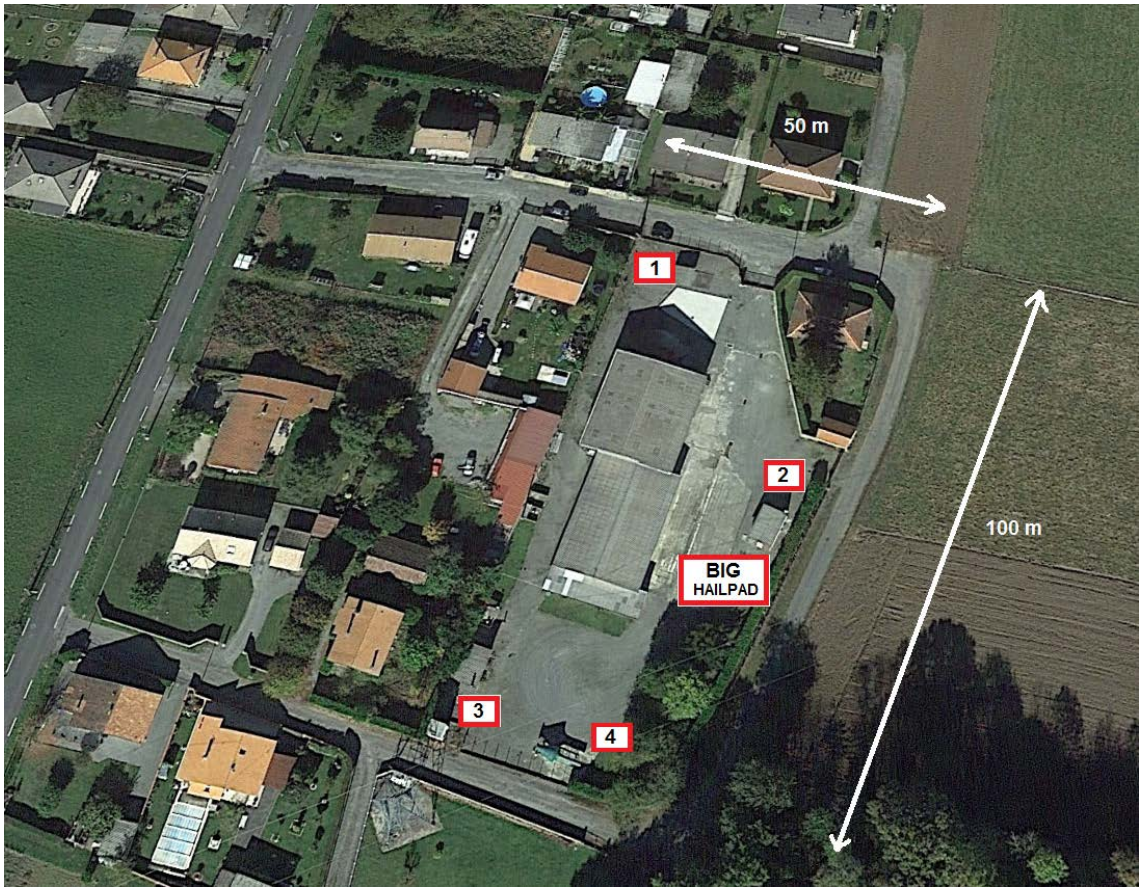
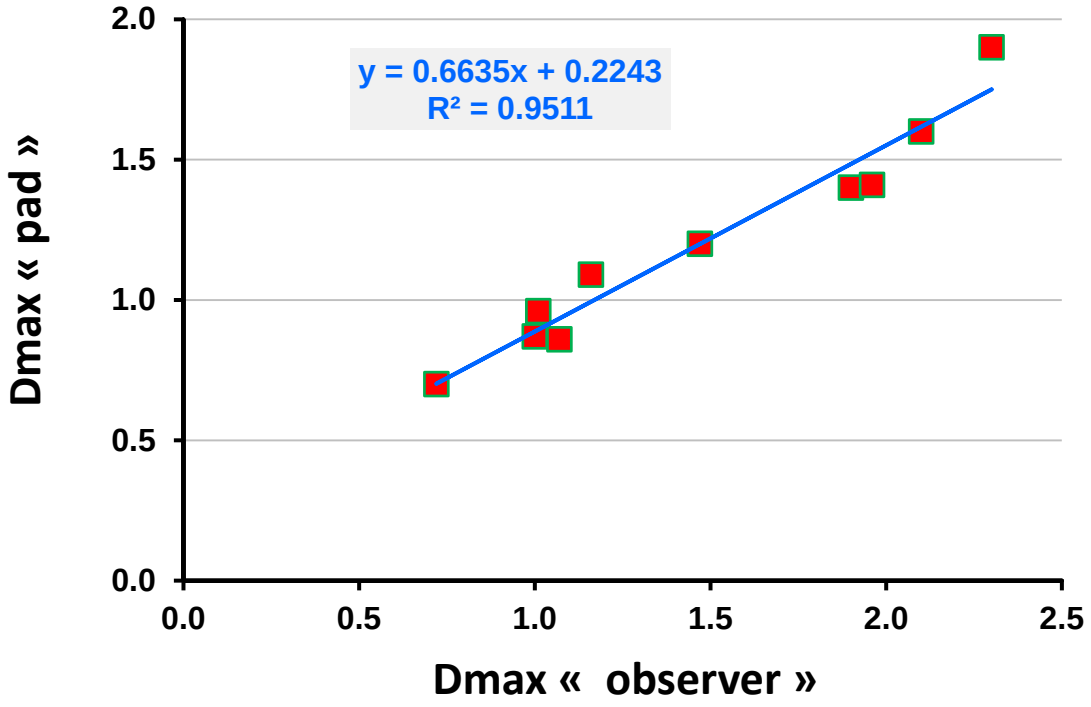
Map of the Lannemezan hailpad micro-network



4 Hailpads in a 5000 m^2 area

Measurements in the micro-network in France



Correlation between:
Dmax observer = largest Dmax measured on one of the 4 pads
Dmax pad = smallest Dmax measured on one of the 4 pads.

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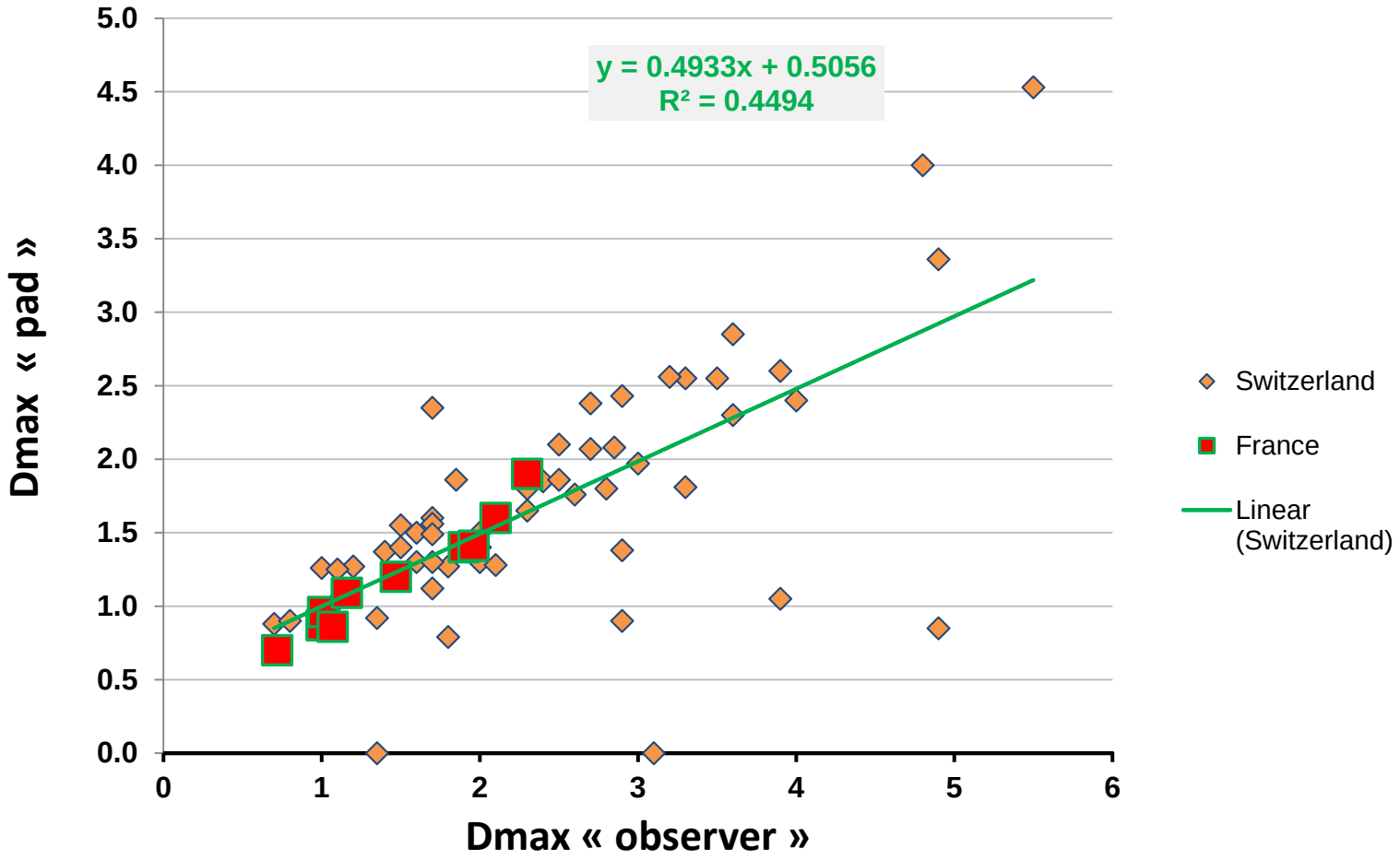
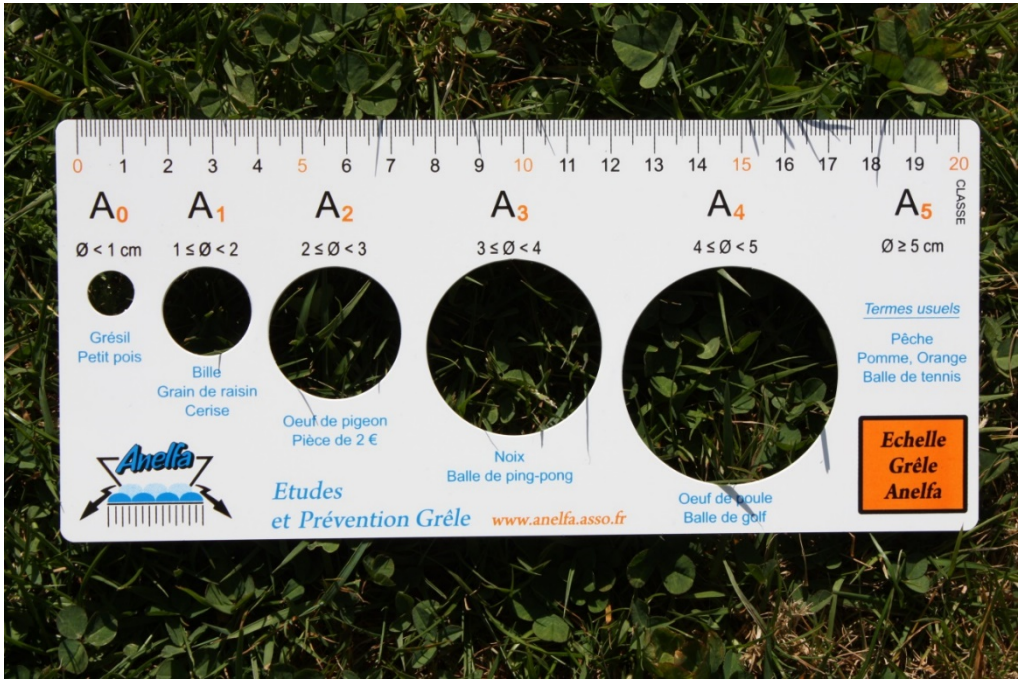
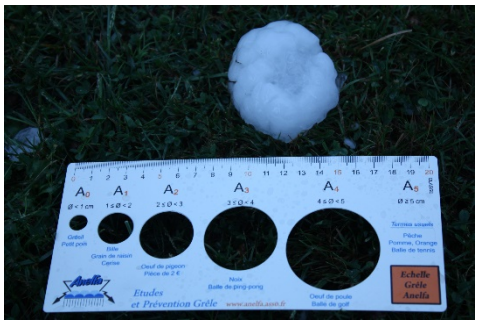
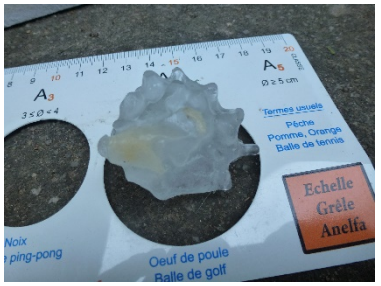
Comparison France / Switzerland

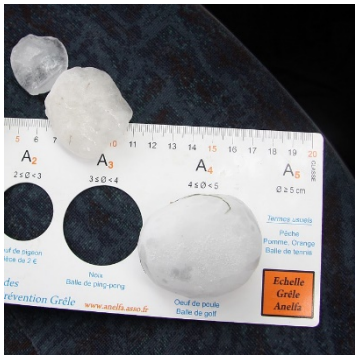


ANELFA GAUGE









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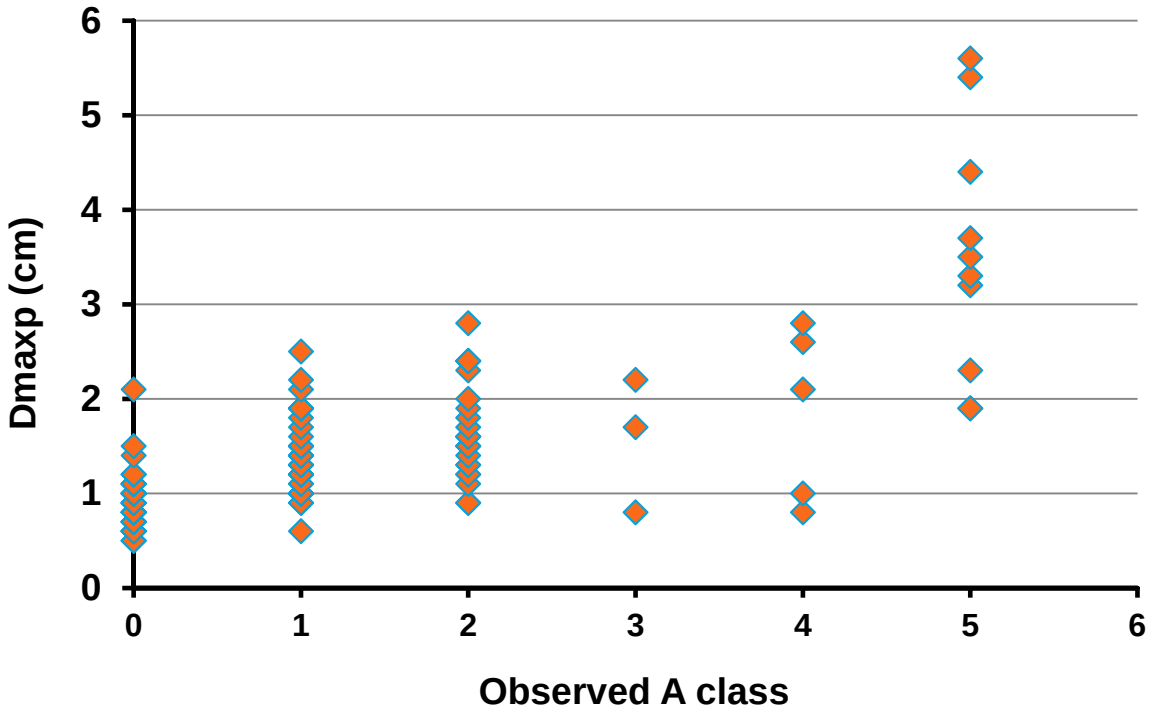
Measurements in the general network in France



Maximum diameter measured on the pad as a function of the hailfall class observed around the hailpad for 133 hailfalls.

Correspondence between measurements and observations

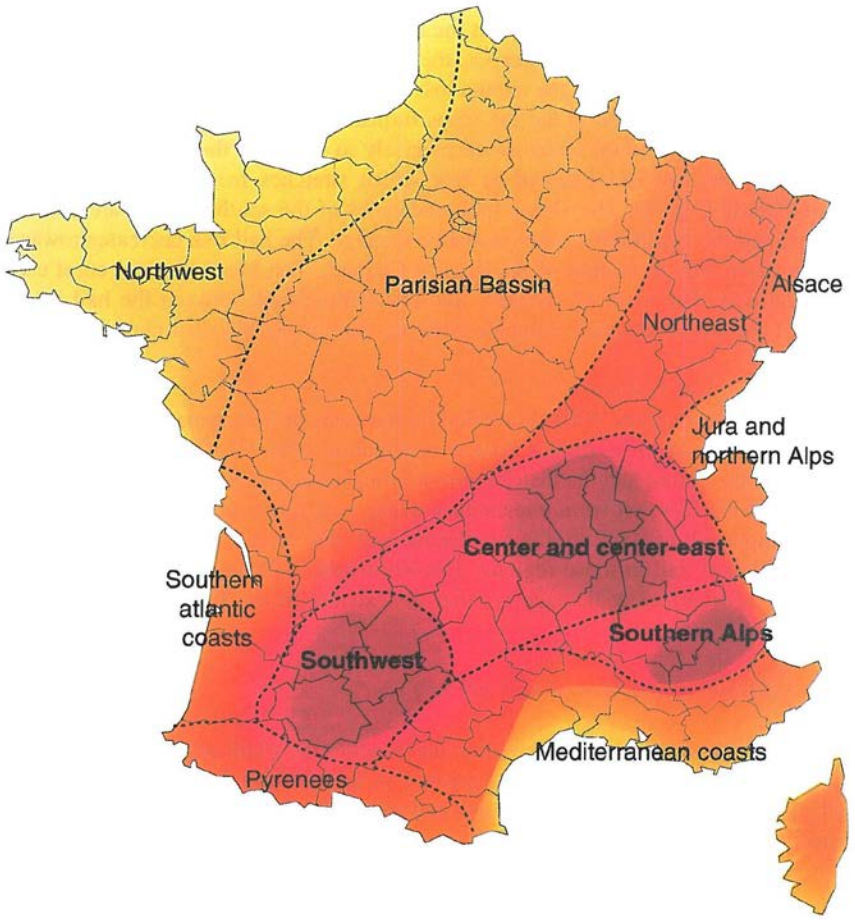
CLASS OBSERVATION MEASURE

ANELFA class	Dmaxo	Dmaxp
A0	>= 0.5	>= 0.5
A1	>= 1.0	>= 0.9
A2	>= 2.0	>= 1.5
A3	>= 3.0	>= 2.0
A4	>= 4.0	>= 2.5
A5	>= 5.0	>= 3.0

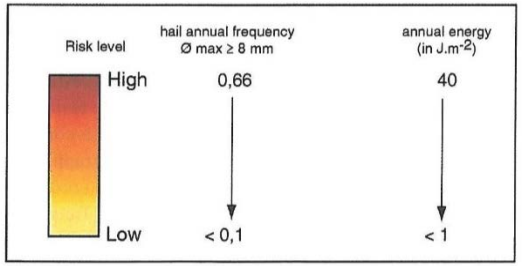
Average Recurrence Intervals

ANELFA class	Dmaxo *(cm)*	N. events	ARI *(years)*
A0 – A5	≥ 0.5	5824	4
A1 – A5	≥ 1.0	4314	5
A2 – A5	≥ 2.0	1600	14
A3 – A5	≥ 3.0	683	32
A4 – A5	≥ 4.0	454	71

Map of hail in France



Spatial distribution of hail in France
VINET F., 2001



Vinet, F., 2001. Climatology of hail in France. Atmos. Res., 56, 309-323.