Change in hailstone size distributions in relation with a rise in the freezing level

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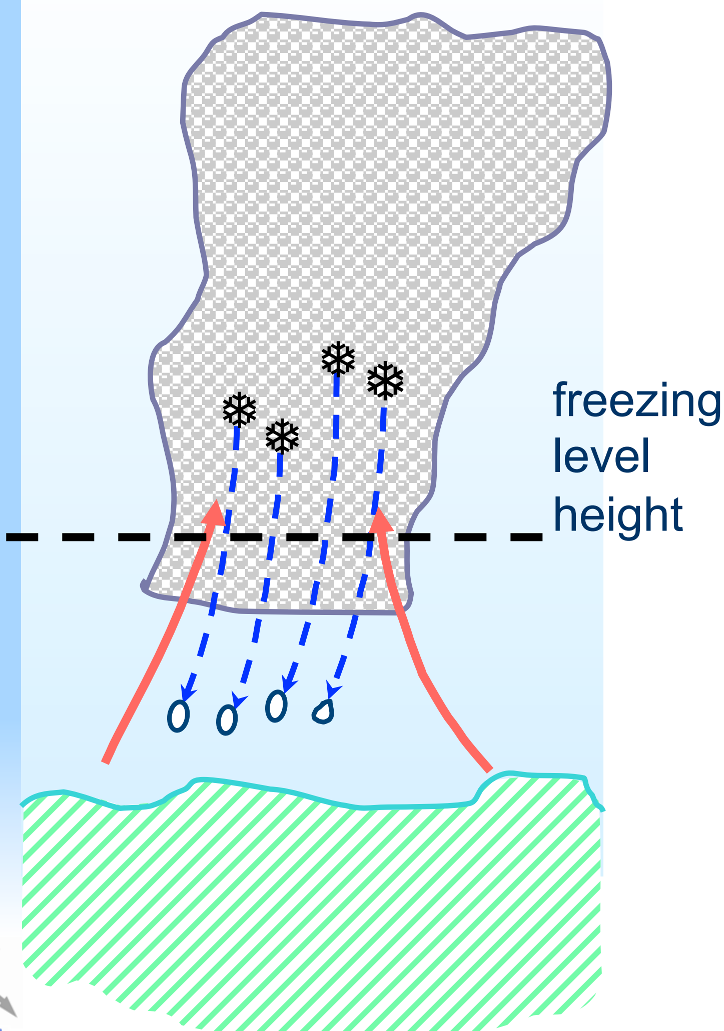
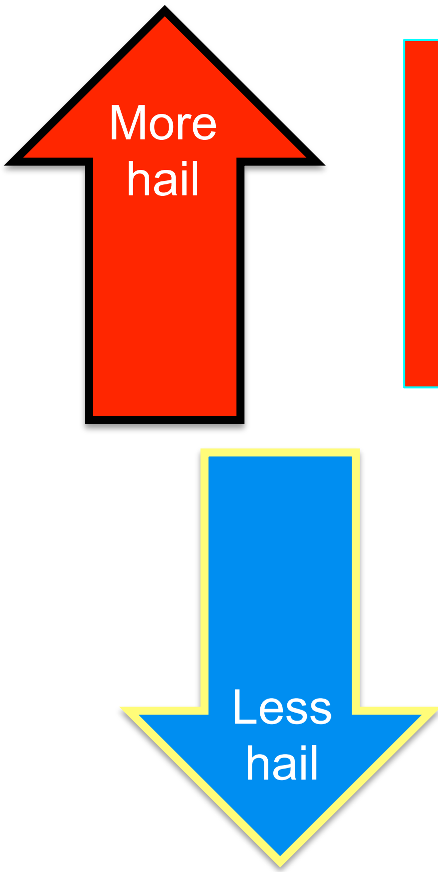
HAIL PRECIPITATION AT THE BACK OF A TORNADO
SEYSSES (31-France) April 2012, 29th
Photo courtesy of Jérôme SALORT ©.

Effect of surface temperature increase





Convective processes are enhanced

Hailstone melting is reinforced

Global warming and hail: Trends and forecast

Country	Type of observations	Hail trend	Authors
France	Insurance data	40% crop damage increase for a 1°C nighttime warming	Dessens 1995
Australia, Sydney Basin	High-resolution numerical model	Greater intensity hailstorms (largest hailstones)	Leslie et al. 2008
Canada, Ontario	Meteorological data and models	More frequent severe events	Cao 2008
China	Climatological data	Decrease in frequency	Xie et al. 2008
Germany	Meteorological and Insurance data	Increase in damage to buildings	Kunz et al. 2009
Netherlands	Insurance data	Up to 200% damage increase for +2°C	Botzen et al. 2010
France	Hailpad data	Increase in intensity, not in frequency	Berthet et al. 2011
Italia	Hailpad data	More extreme events	Eccel et al. 2012
US, Colorado	Numerical model	Near-elimination of hail at the ground	Mahoney et al. 2012
US	Climate model simulations	Little change (more CAPE, less windshear)	Brooks 2013

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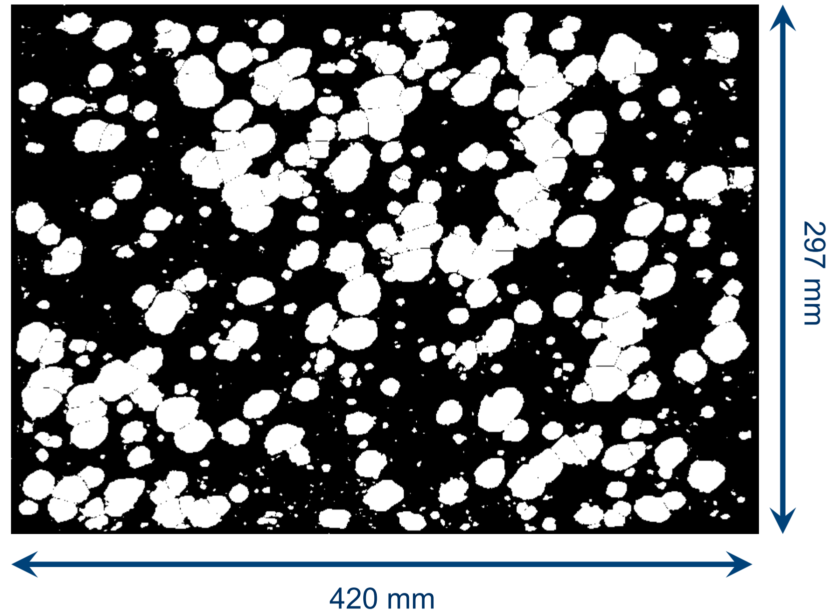
Physical hailfall parameters

HAILPAD STATION



Madiran (Long: 0°5'45"W Lat: 43°32'48")
Date : 24/05/08 Hour : 19h15
Maximum hailstone diameter : 21 mm
Number of hailstones : 3713 /m²
Kinetic energy : 460 Joules/m²

Size distribution									
Hailstone diameter (mm)	**5-7**	**7-9**	**9-11**	**11-13**	**13-15**	**15-17**	**17-21**	**21-25**	**25-29**
Hailstone number (per m²)	**1106**	**567**	**356**	**548**	**375**	**433**	**318**	**10**	**0**

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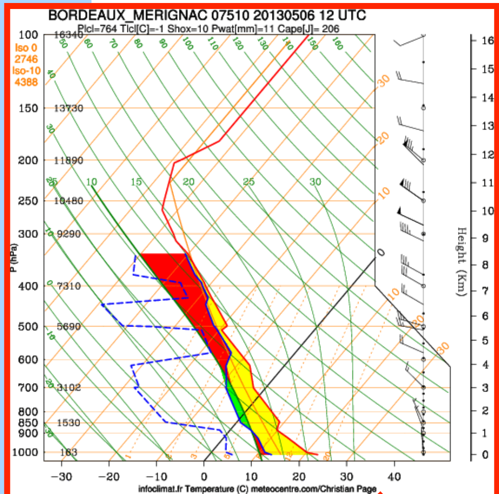
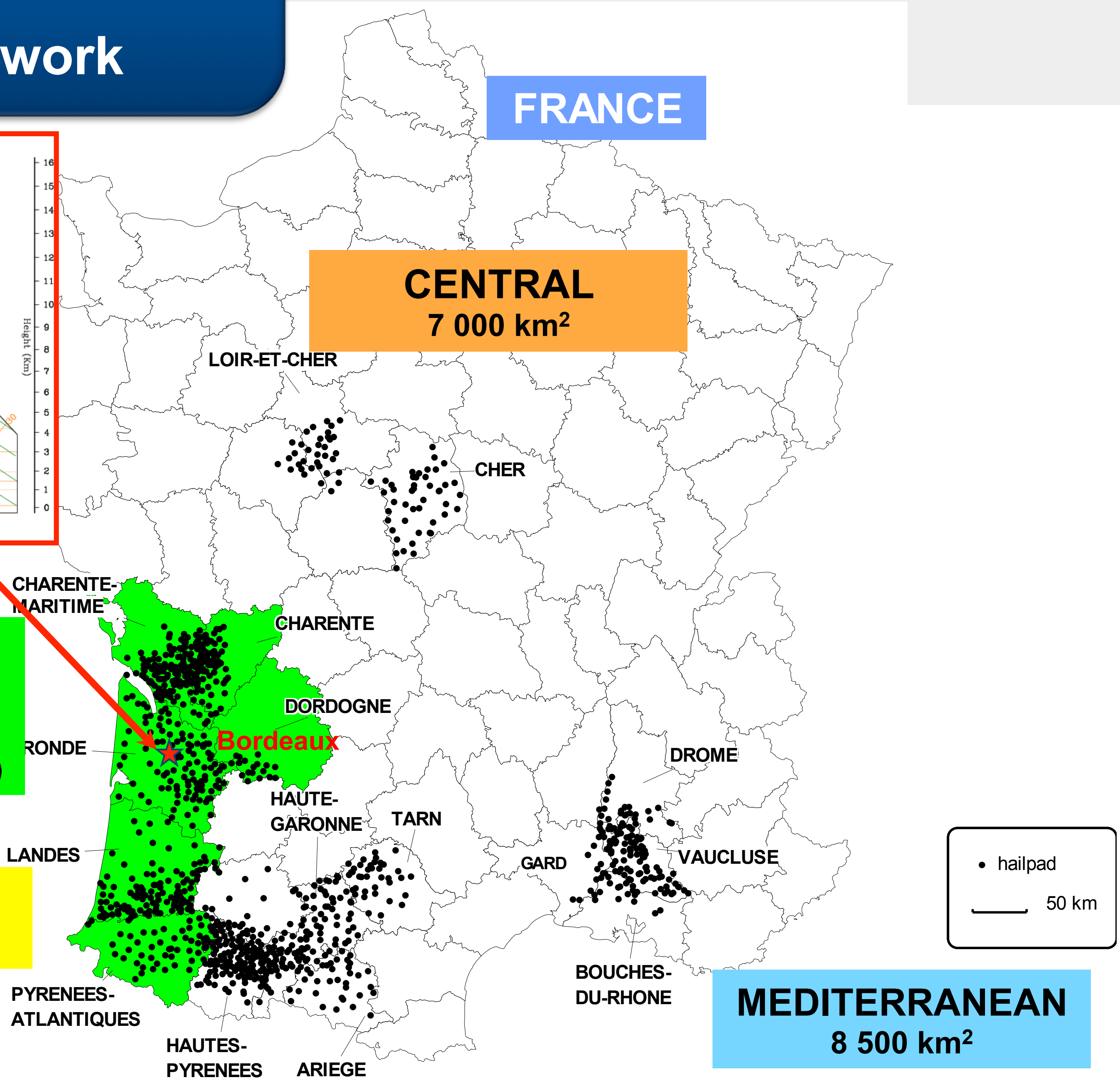
Hailpad Network





CENTRAL
7 000 km^2

ATLANTIC
31 000 km^2
474 hailpad stations
(mean annual number)

PYRENEAN
20 000 km^2

MEDITERRANEAN
8 500 km^2

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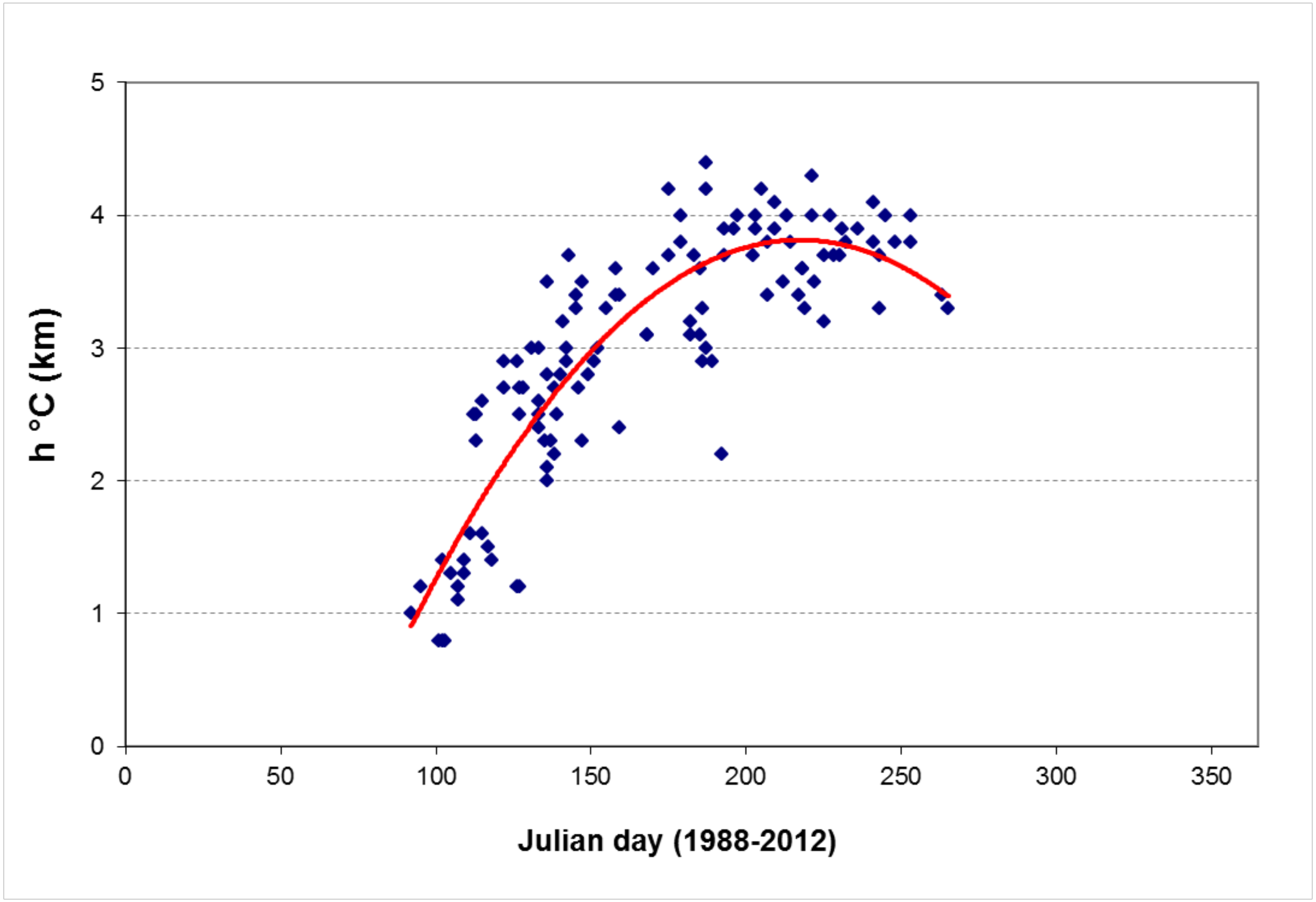
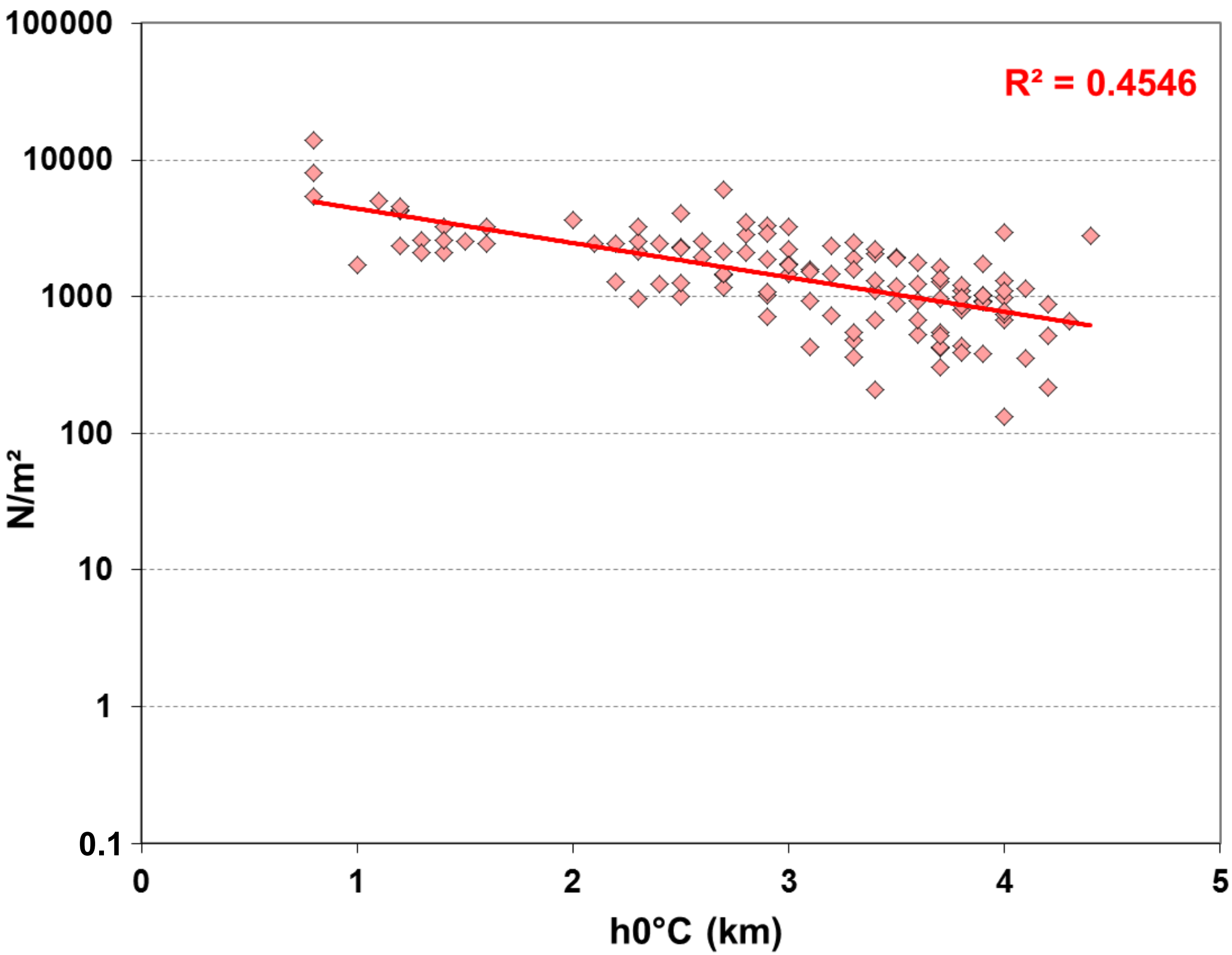
Evolution of the freezing level during a hail season



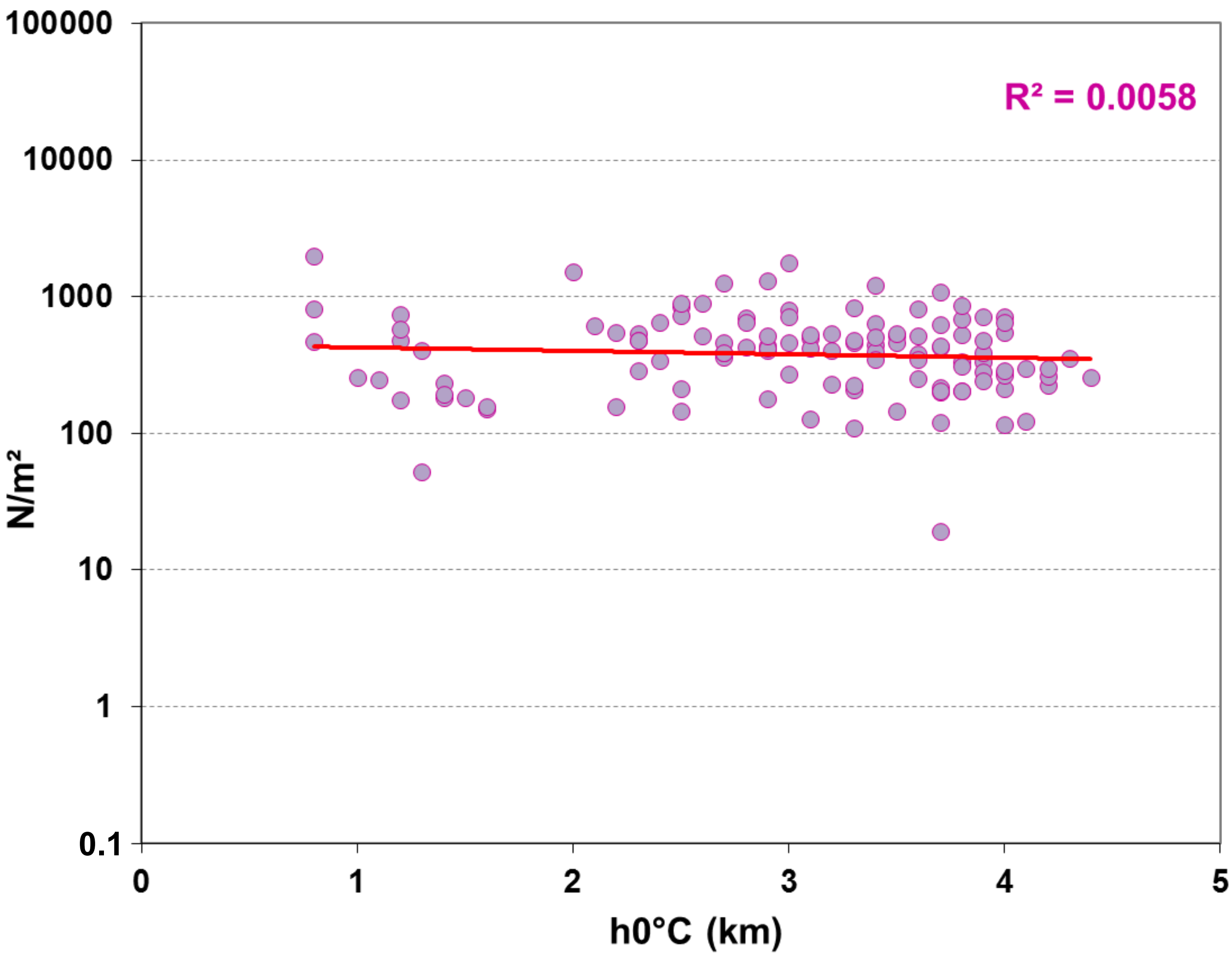
Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec

Mean distribution as a function of the freezing level



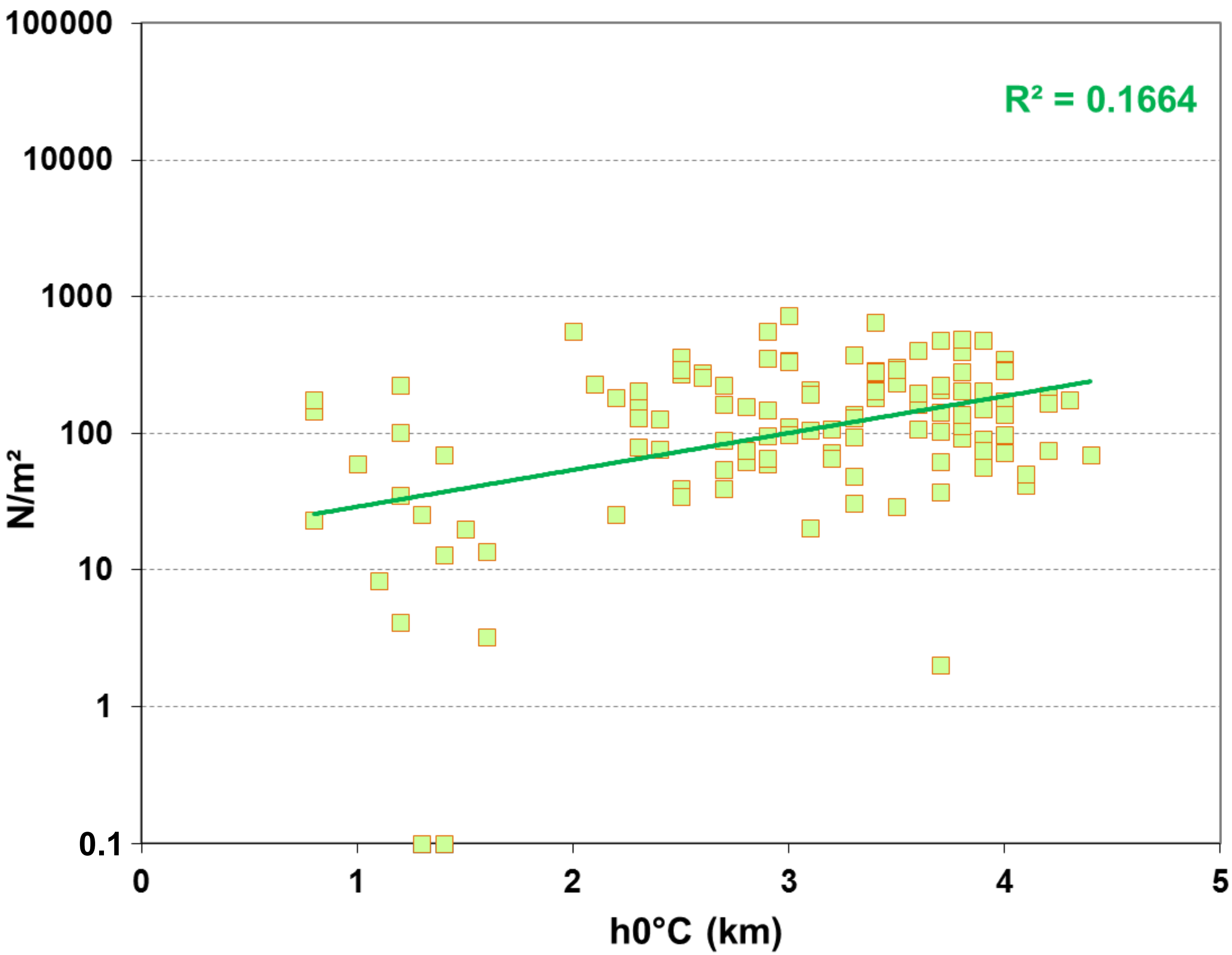
0.5 - 0.7 cm
hailstone number

Mean distribution as a function of the freezing level



0.7 - 0.9 cm
hailstone number

Mean distribution as a function of the freezing level



0.9 - 1.1 cm
hailstone number

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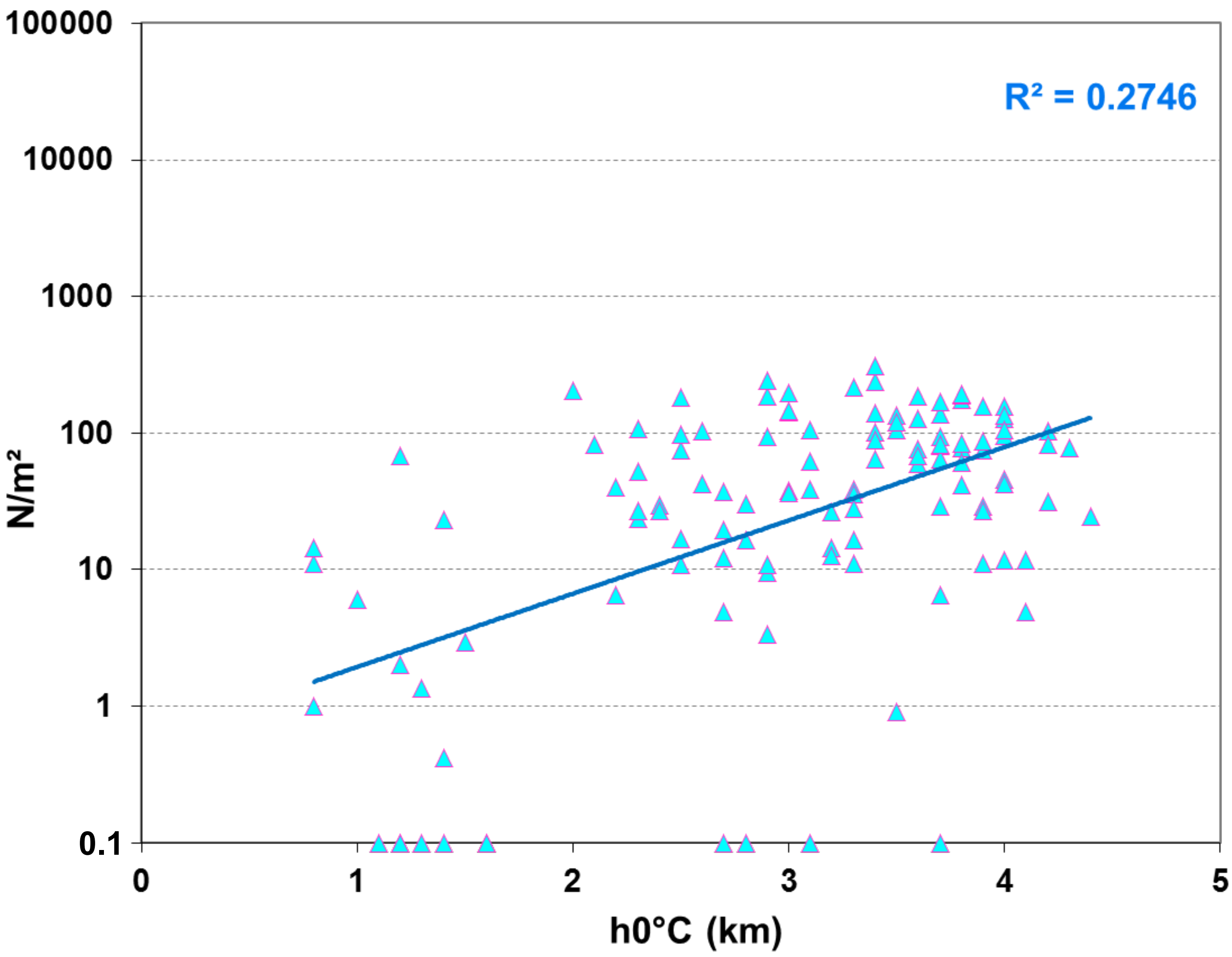
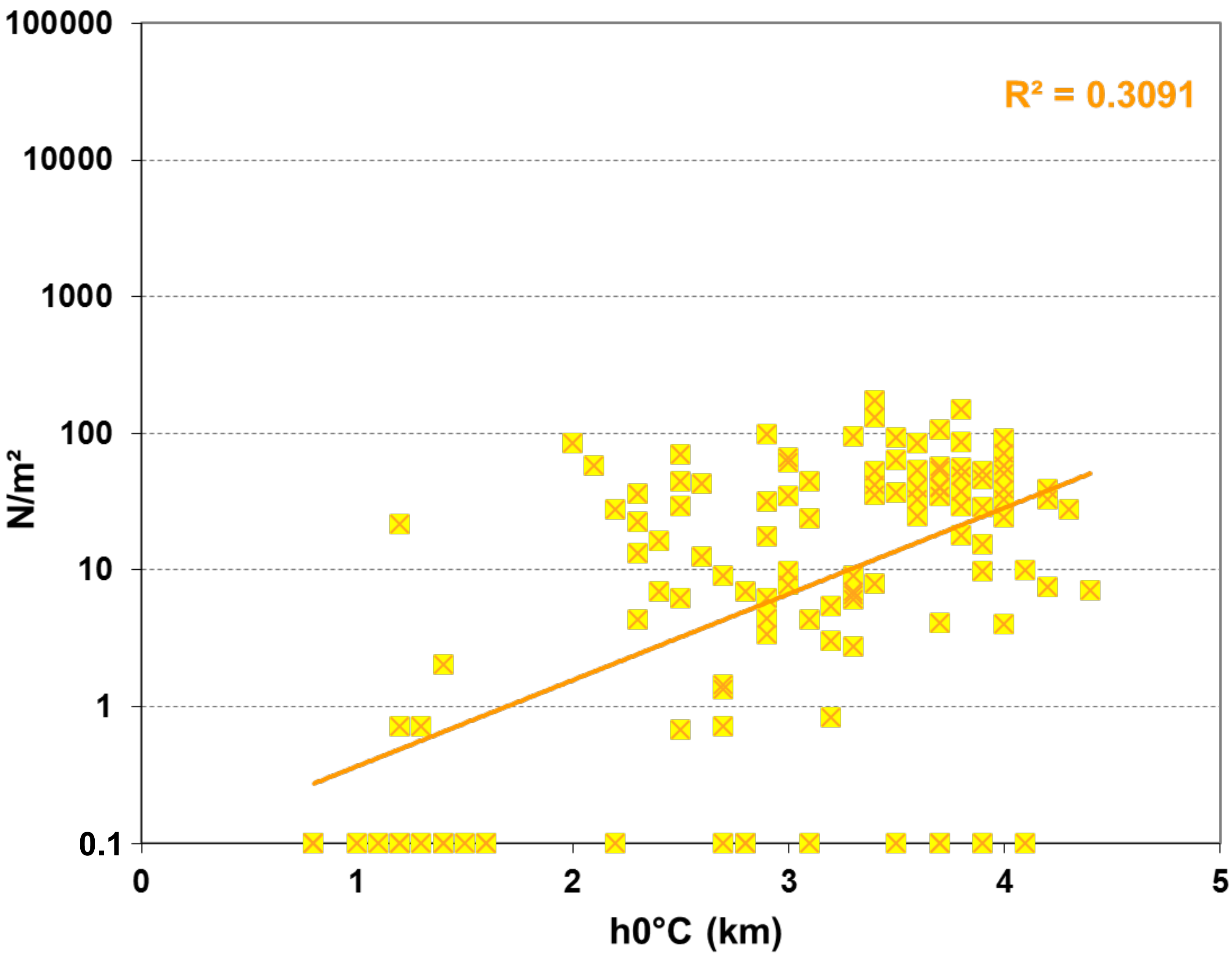
Mean distribution as a function of the freezing level



1.1 - 1.3 cm
hailstone number

Mean distribution as a function of the freezing level



1.3 - 1.5 cm
hailstone number

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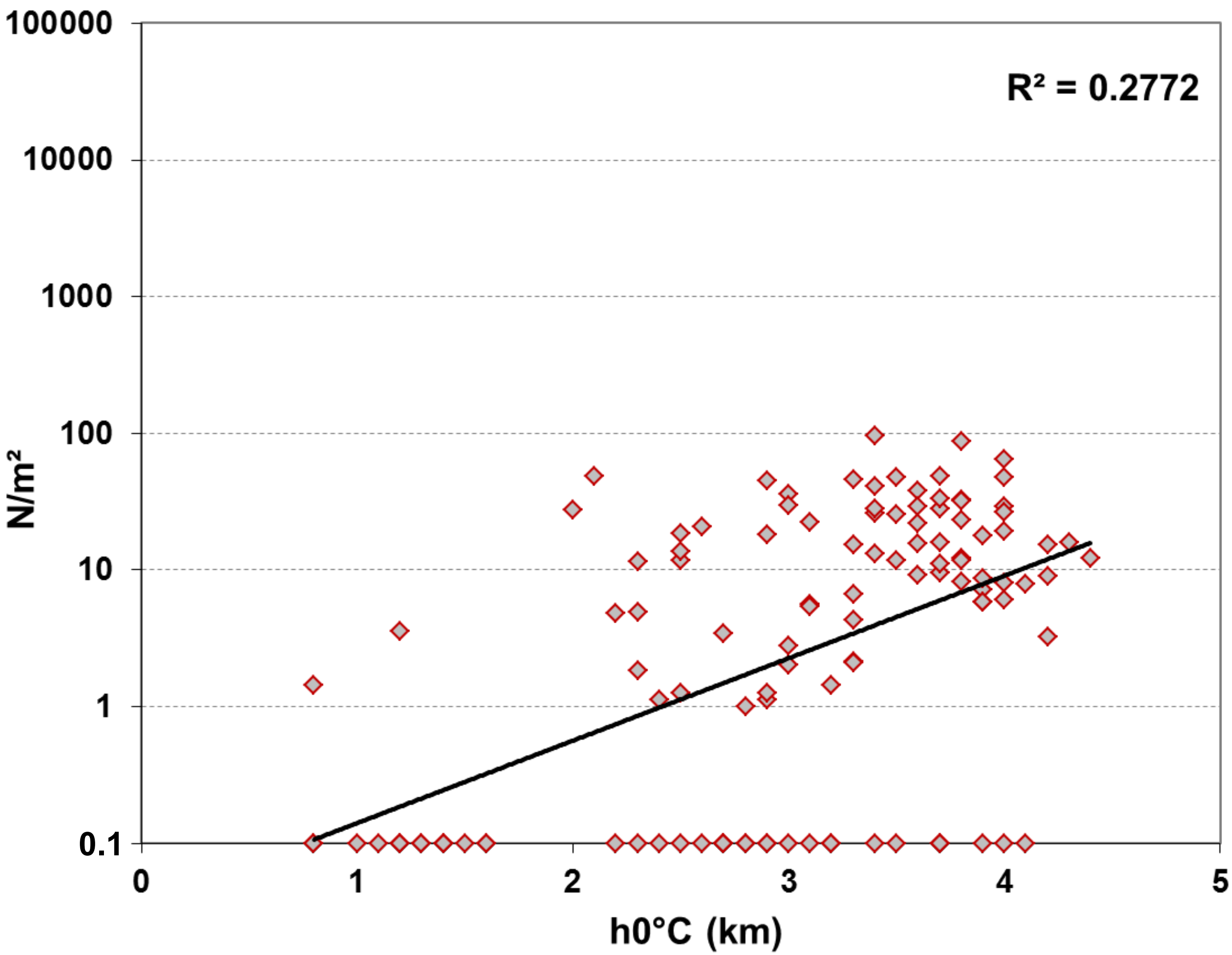
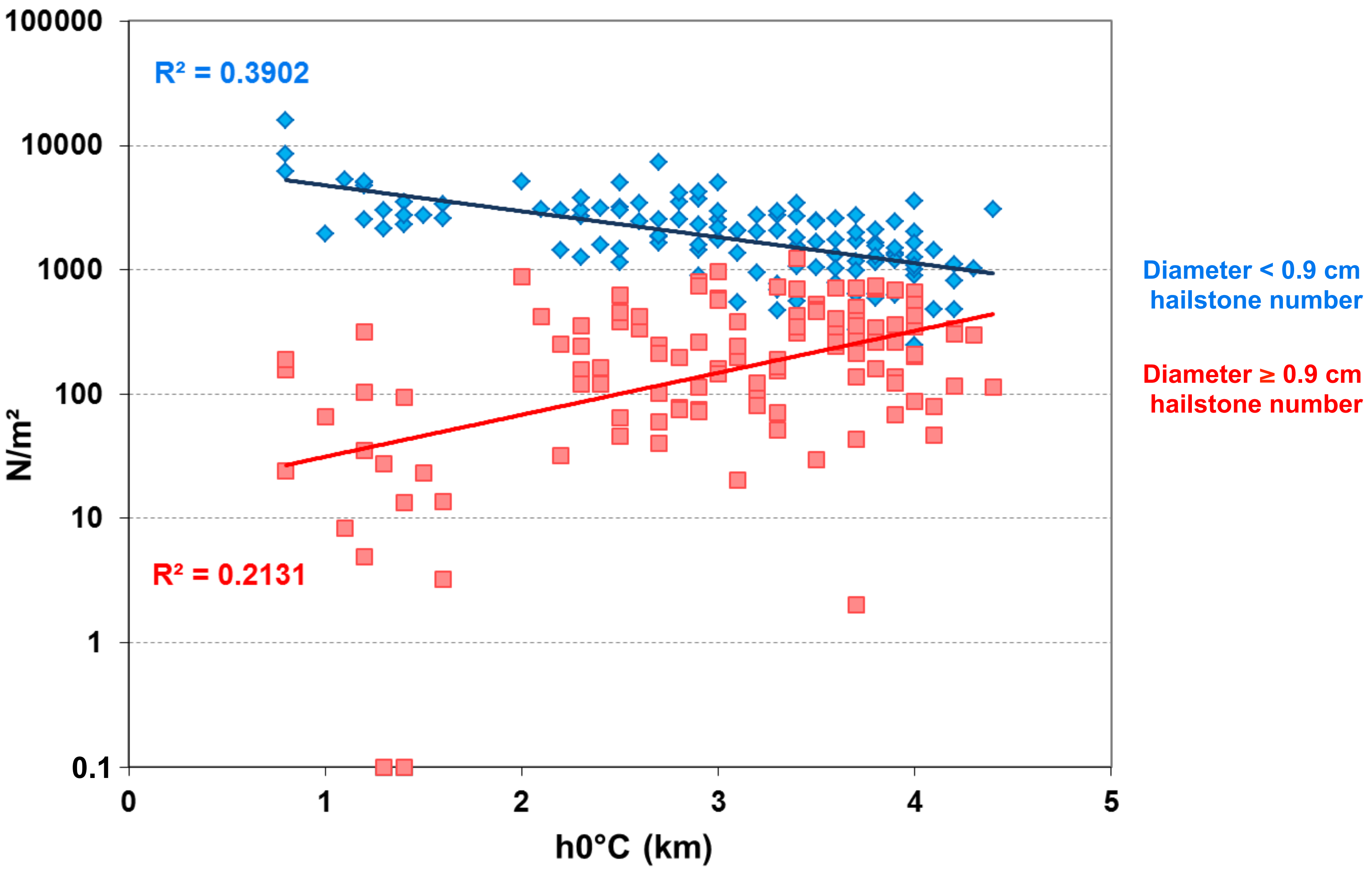
Mean distribution as a function of the freezing level



1.5 - 1.7 cm
hailstone number

Distribution as a function of the freezing level



Monthly rise in the freezing level

h0°C trend values, 1988-2012.

Month	Number of days	h0°C 1988 (km)	h0°C 2012 (km)	Difference (km)	Significance level
April	106	1.45	1.92	+0.47	5%
May	117	2.62	2.69	+0.07	
June	71	3.04	3.70	+0.66	1%
July	75	3.59	3.72	+0.13	
August	68	3.36	3.87	+0.51	1%
September	23	2.91	3.50	+0.59	

h0°C rise in June

Number of small hailstones (5-7 mm) **decreases by 16%,**

Number of larger hailstones (13-15 mm) **increases by 54%.**

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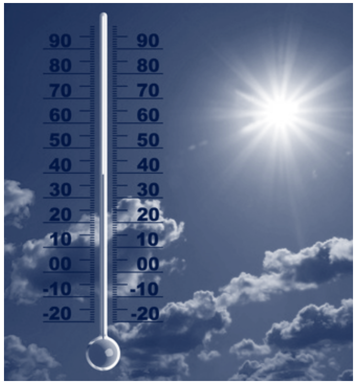
Conclusion



This presentation introduces a method to forecast the global warming effect on hail in a given country equipped with a hailpad network by examining the response of an increase in the thickness of the warm atmospheric layer (at positive temperatures) on hailstone distributions.

In the present study, it is shown that, in Southwestern France, a rise in the freezing level produces hailfalls with less small hailstones, but more larger ones. Similar studies of the effect of CAPE, windshear… on the hailstone distributions are possible, and they may give useful data to complete numerical model studies in order to forecast the effect of global warming on hailfalls.

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