Anomalies in frequency / intensity correlations in hail climatology

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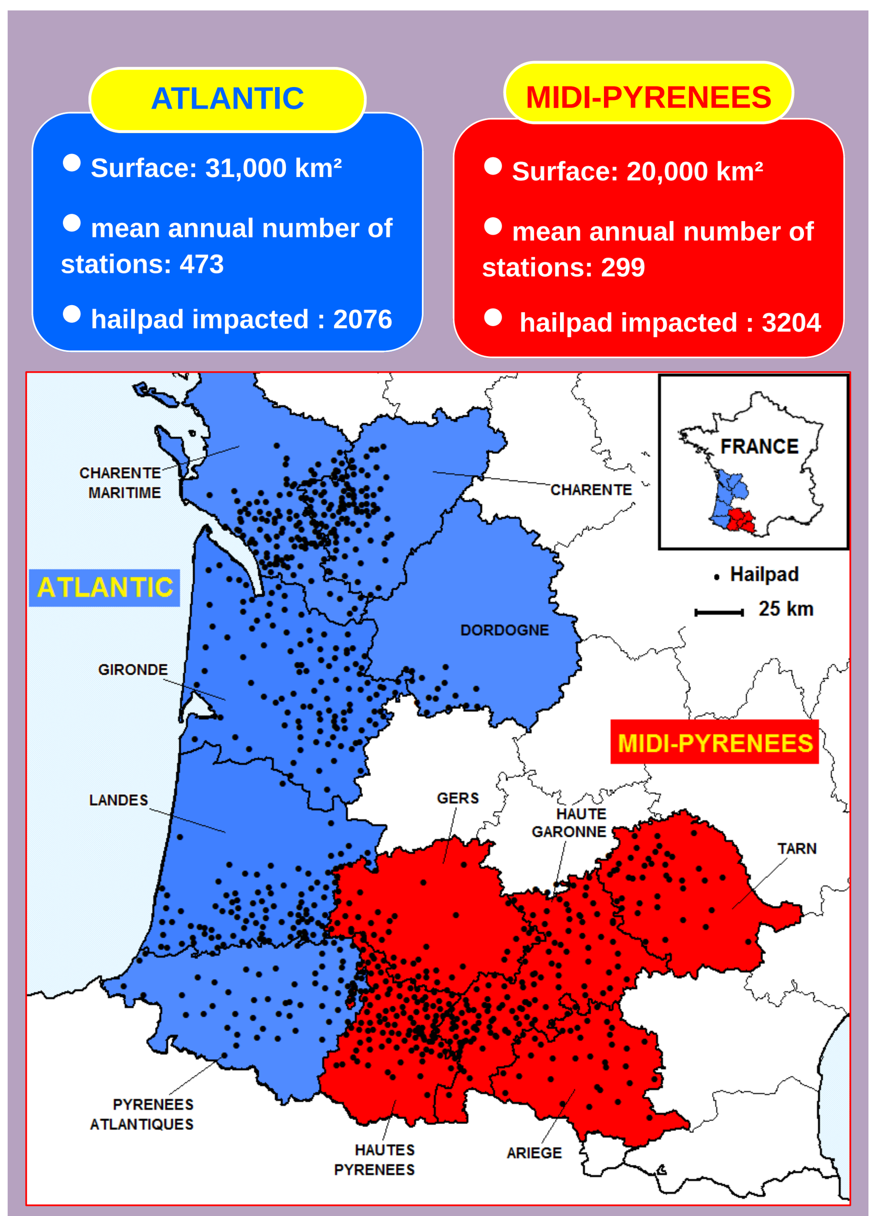
Introduction

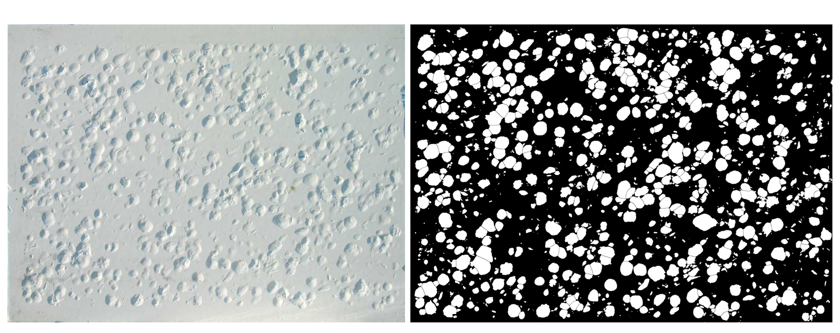
One of the main characteristics of hail in a country is its high variability in space and time. Some information about this is given by insurance data, but only a long-running hailpad network can contribute to an accurate knowledge of hail variability. This paper deals with the time variability at scales from the year to the hour in Southwestern France where hailpads have been operated continuously since 1988 by the Association Nationale d'Etude et de Lutte contre les Fléaux Atmosphériques (ANELFA).

The point parameters considered are the frequency F, %, (sum of 100/ number of stations) and the intensity Eh, J/m² (mean value of the total hailstone kinetic energy per hailfall). The poster is based on the examination of diagrams where x and y ordinates give the F and Eh values relative to the same periods of time: year, month of the year, day of the week, hour of the day.

Two areas are considered separately, because they have different meteorological regimes (Berthet et al 2011): The Atlantic area, AT, with a maritime climate, and the Midi-Pyrenees, MP, area, with a semi-continental climate (Fig. 1). The numbers of recorded hailfalls during the 25-year period (1988-2012) are respectively 2076 and 3204 in AT and MP.



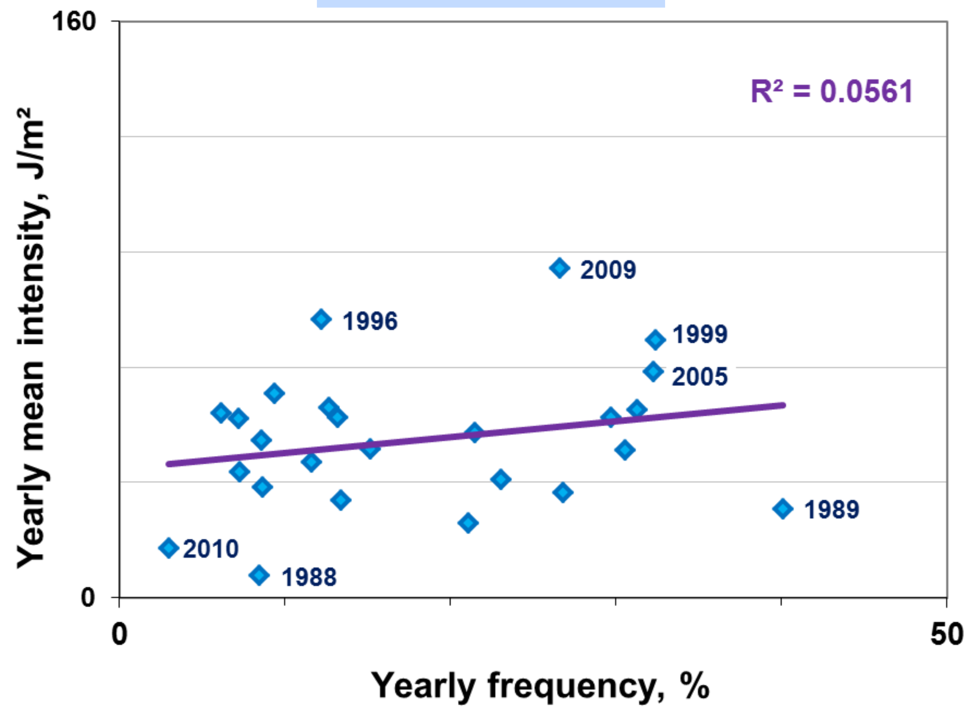
⇧ Fig 1 : Map of the hailpad network ⇧

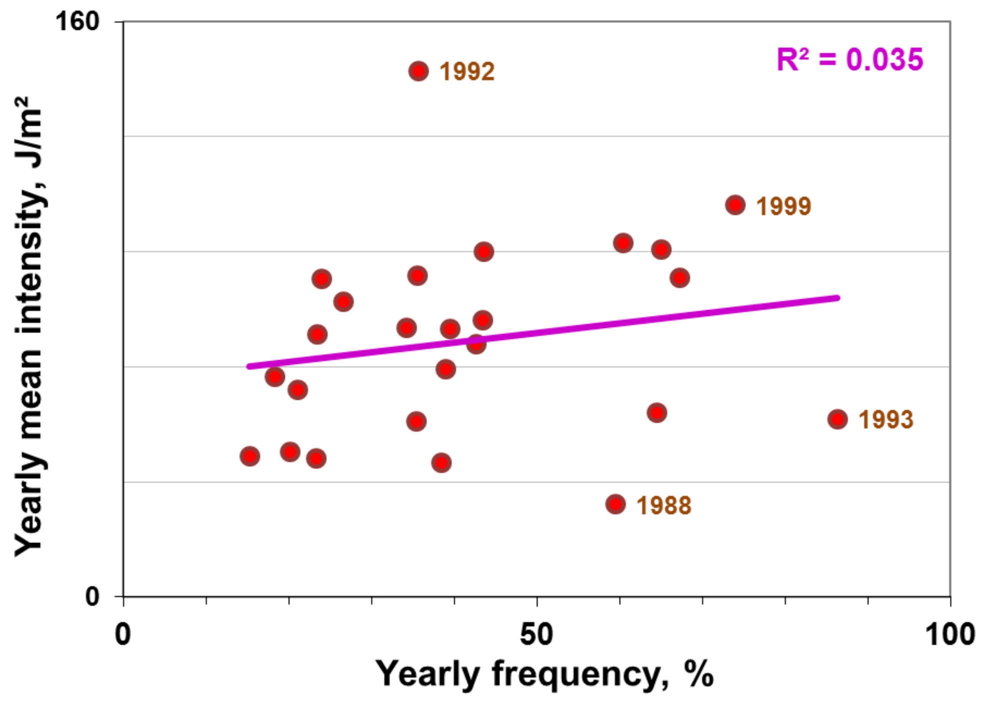


Hailpad impacted before (left) and after (right) inking

a. Yearly variations

ATLANTIC (AT) — MIDI-PYRENEES (MP)

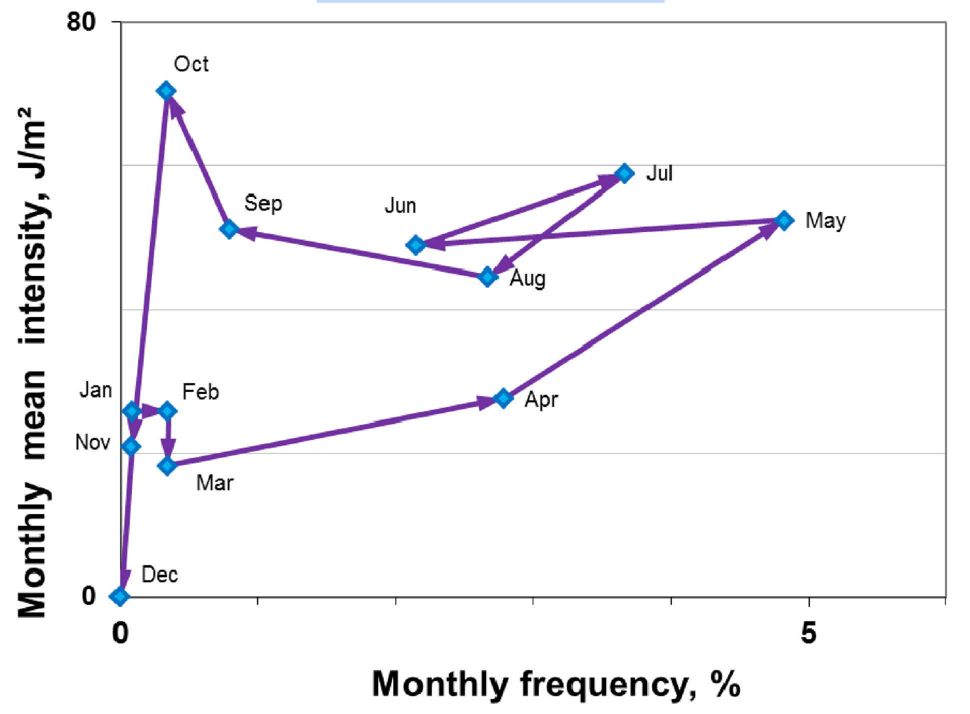


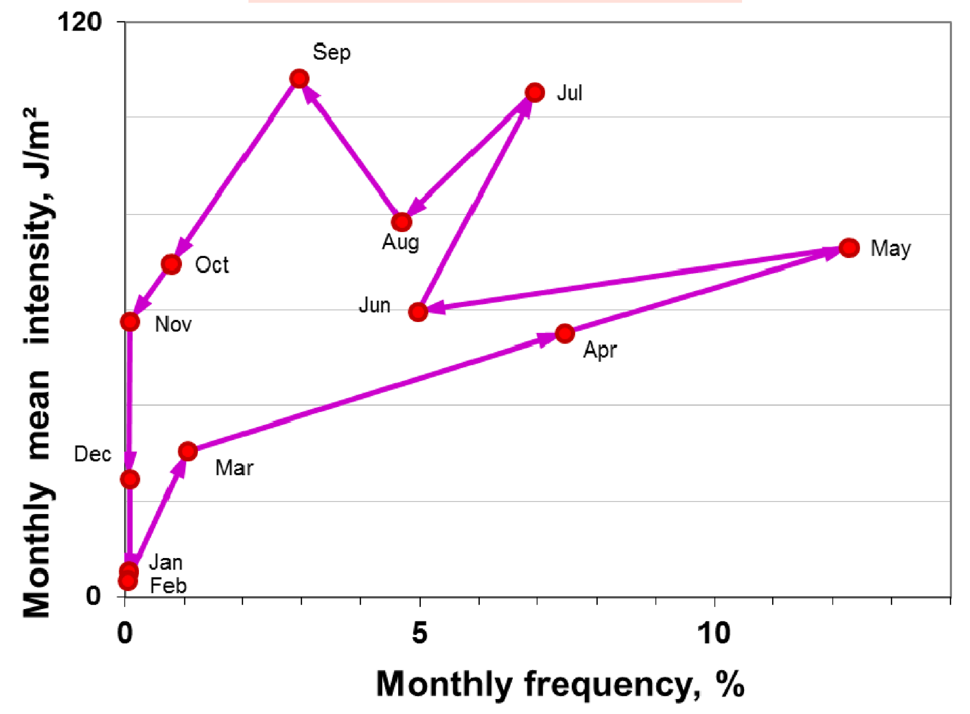


On the two diagrams, each point represents one year with its F and Eh values. The years (not all specified on the figures) are scattered without apparent order (no evident cyclic variations), and just some exceptional years can be highlighted by these figures. The correlation between F and Eh indicates a positive but not significant correlation between the parameters. Some similar low correlations are observed on the other subsequent diagrams, and they confirm that F and Eh are rather independent parameters which should be examined separately (hail in the region finally being the product of the two parameters).

b. Month-of-the-year variability (seasonal cycle)

ATLANTIC (AT) — MIDI-PYRENEES (MP)



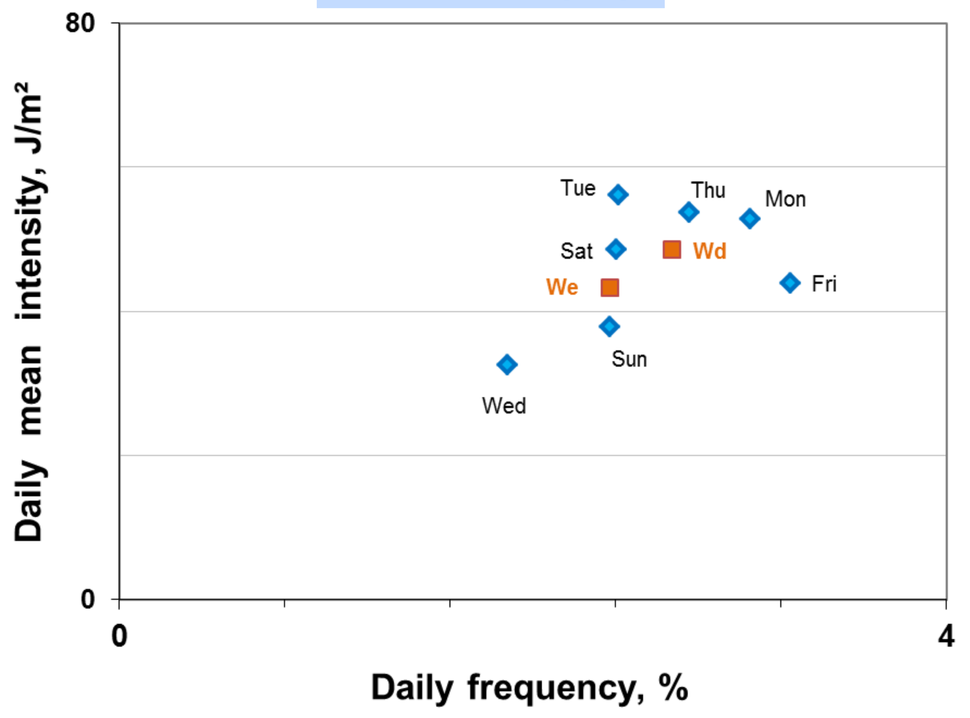


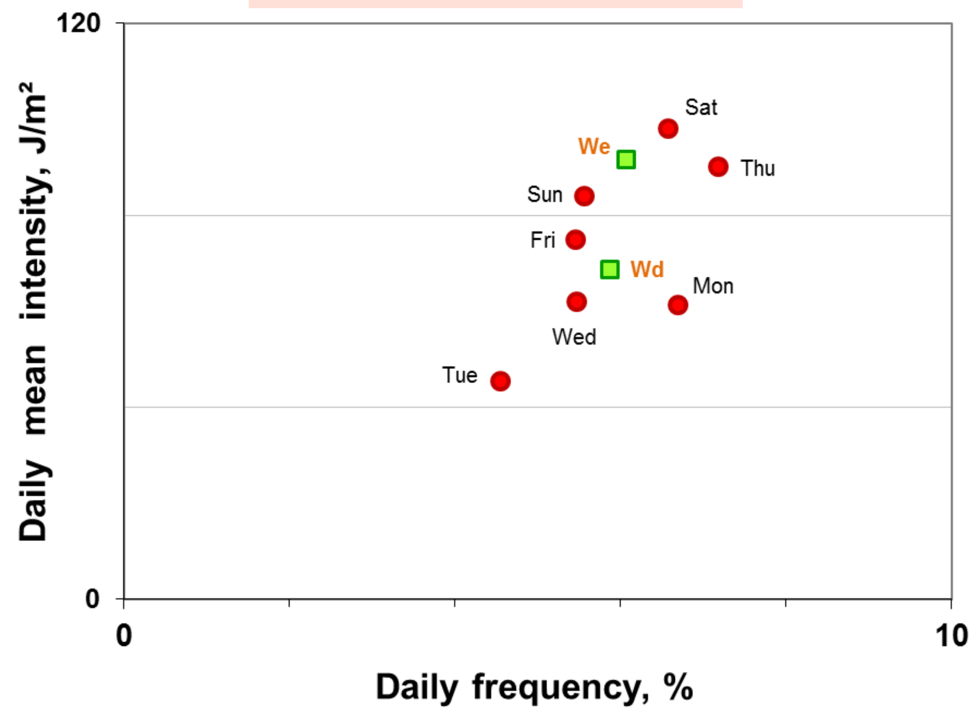
Each of the points gives F and Eh for all the hailfalls recorded by month from January to December. The monthly evolution is similar in the two regions. In the first part of the hail season, F peaks in May, then divides by two in June, and increases again in July. The June F regression, already suggested from the insurance data, is probably related to the general circulation. In the second part of the season, Eh does not decrease before October, so that the diagrams recall hysteresis curves, with the Eh evolution following the F evolution.

c. Day-of-the-week variability

ATLANTIC (AT) — MIDI-PYRENEES (MP)

Wd: week days
We: Saturday and Sunday



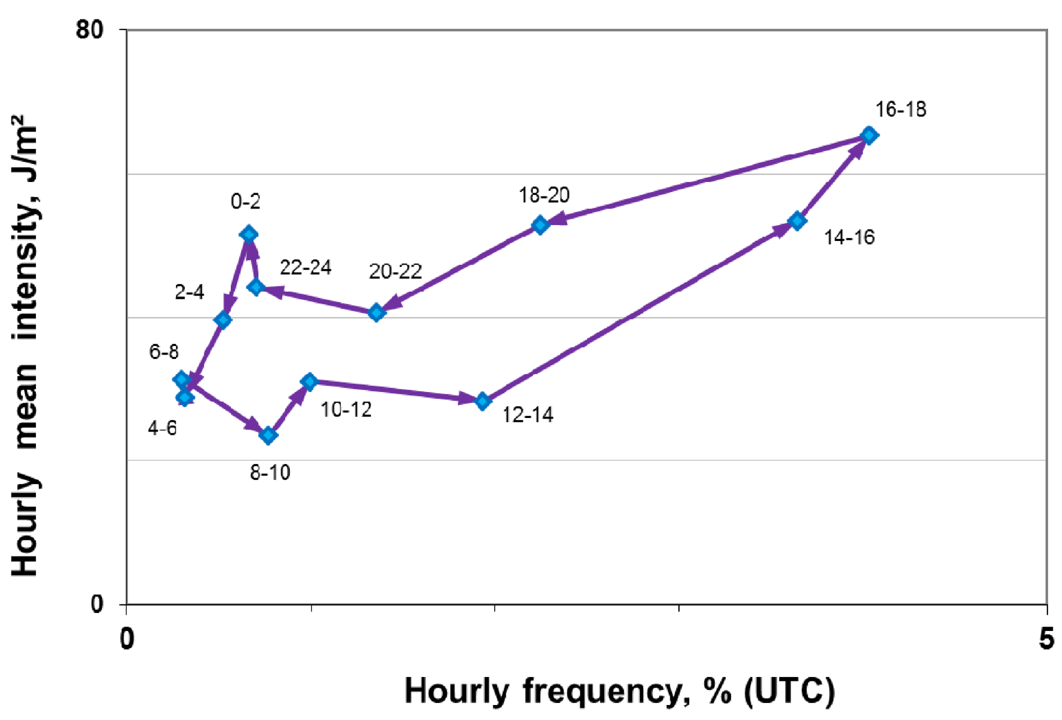


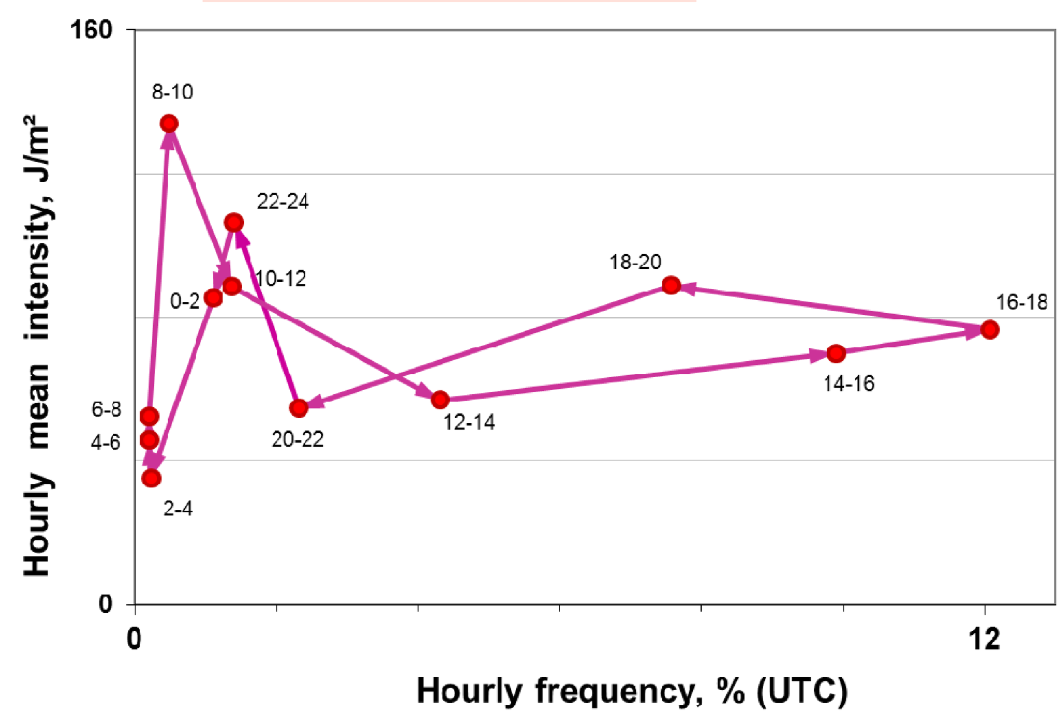
A former study made with hailpad measurements of the 1989-1999 years has shown an organized day-of-the-week variability of hail in MP (but not in AT), with hailfalls of lesser intensity on week days, and this was explained by an atmospheric pollution effect (Dessens et al. 2001). With the much larger sample now available, the day distribution remains disorganized in AT. In MP, week day hailfalls are still less intense than weekend ones (-25%). However, in the decreasing order of intensity, Saturdays and Sundays are now numbers 1 and 3 instead of 1 and 2 before. The week-end effect is weaker, a possible consequence of recent laws relative to atmospheric pollution.

It is noteworthy that, even with mean values of respectively 297 and 458 hailfalls per week day in AT and MP, the scattering remains important on the two diagrams.

d. Hour-of-the-day variability (diurnal cycle)

ATLANTIC (AT) — MIDI-PYRENEES (MP)





The hailfall times are documented for 2011 occurrences in AT, and 3178 in MP. In order to have enough data in each hour range, the data have been grouped by 2 hour intervals. In AT, the hourly diagram is a nearly perfect hysteresis curve, which means that there is a delay in the evolution of Eh by comparison with F. The relative Eh maximum in the middle of the night, which is observed in the two areas, should be related to sea breezes (AT) or mountain breezes (MP), which both enhance the convergence over the plains during the night. The diurnal cycle is more disturbed in MP than in AT, a possible consequence of the mountain thunderstorms which flow over the plains during summer evenings.

Conclusion

To our knowledge, it is the first time a 25-year climatology of hail based on physical measurements is presented. While this time duration is generally considered as sufficient for rain, the scattered diagrams presented above clearly show that it is not the case for hail. However, these first 25 years of measurements in one of the most hailed regions of the world show three interesting results, even if they are difficult to interpret:

- June is definitely a special month with a significant relative minimum for hail frequency, between the maximums of May and July. This observation is certainly related to the general atmospheric circulation above France.
- The hail frequency decreases in the second part of the hail season, while the intensity remains at its summer level until October. The ground temperature mean variability may explain this observation.
- The frequency/intensity diurnal cycle of hail is a perfect example of a hysteresis curve, the evolution of the intensity following that of the frequency. The delay in the intensity evolution is probably related to the surface temperature cycle. It explains why hailfall frequency and intensity are not strongly correlated.

These preliminary results are open to discussion. In the meanwhile, the ANELFA will use them to improve hail forecast and, consequently, the hail prevention project by silver iodide ground seeding.

References:

- **ANELFA,** annual reports from 1952 (N°1) to 2012 (N° 61)
- **Dessens**, J., R. Fraile, V. Pont, J.L. Sanchez, 2001. Day-of-the-week variability of hail in southwestern France. Atmos. Res., 59-60, 63-76.
- **Dessens J.,** Berthet C., Sanchez J.L., 2011: Regional and yearly variations of hail frequency and intensity in France. Atmos. Res., 100, 391-400.

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