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INTEGRATED A/C NOISE & FLIGHT TRACKS MONITORING SYSTEM AT PARIS CDG

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ABSTRACT

Noise impact monitoring requires permanent systems. It is especially the case to withstand aircraft noise since such a particular source has a variable impact. Aéroports de Paris has been operating an integrated -with SSR information- noise monitoring system around Orly and CDG for the last few years. Such a system needs a periodical upgrading in order to comply with new requests [new terminals, metrics] and new technology [e.g. PC]. Main outcomes are presented in this paper: changeableness of noise impact, influence factors, comparisons between actual and certification noise levels, and evenmore with noise levels assessed through noise contours.

1 - NOISE MONITORING TERMINALS AROUND AIRPORTS

ADP has been operating for long Noise Monitoring Terminals around main Paris airports (fig. 1). Aircraft noise is discriminated according to its emergence from the ambient noise level. An aircraft noise level is recognised when exceeding a given level during a given time. This criteria has two consequences upon NMT's location (fig. 2). First a NMT should be located in a rather quiet area, far away from any other noise source, especially road traffic. Furthermore, aircraft noise level should be high enough. Noise monitoring makes sense only in the vicinity of the airport, where it is possible to detect every noise events.
So far the ADP System, certificated ISO9002, is made of:

- at CDG, fourteen NMT's, three of them are dedicated to run-up tests monitoring and eleven to the noise impact upon the community.
- at Orly, six NMT's, two of them for run-up tests.
- at some general aviation aerodromes, a few terminals -for instance at Toussus le Noble-.

Noise impact assessment at a given location does not require a permanent terminal. A special request, from a local government for instance, generally leads to a temporary setup -four months-. Aircraft Noise impact is then known with a sufficient accuracy to be correlated to results from permanent NMT's and/or to the noise modelling around the airport (mapping) (fig. 3).

2 - DATA COLLECTION AND TELETRANSMISSION

Measurements have been so far carried out in dB(A) and expressed in LAeq(1s). Therefore Leq over various periods can be calculated. Noise events are stored aside and weighted with a factor 10 during nighttime, from 22:00 till 7:00, to give Ldn [Day-Night Level]. These simple metrics have the advantage to allow for comparisons between impacts from various noise sources, especially road traffic.
However usual units are different in aeronautics. Instead of A weighting, PNdB [Perceived Noise Decibel] is used, because it fits better with hearing performance. For each third of octavum, the correcting factor depends of noise intensity. In practice, in order to use a filter, the D-weighting used to replace PNdB. Nowadays, present PC technology allows to carry out on site these precise corrections real time.

Figure 1: Noise monitoring terminal around CDG.

For Aircraft Noise Certification purpose a tone correction is added to the previous weighting factor. Data that are acquired each half-second and treated this way give for each Noise Event an EPNdB value.
Since it is interesting to compare certificated aircraft noise levels [expressed in EPNdB] with actual operational noise levels, ADP has started to upgrade NMT's with analysers giving the whole spectrum in third of octavum. Each half-second, a local operation gives PNLT. These data are stored and retransmitted either real-time or during nighttime to the master PC.
This upgrading operation is just starting and therefore results presented afterwards are expressed only in LAeq.

3 - AIRCRAFT NOISE IMPACT TIME-DEPENDENCE

First, time dependence is linked with operations discontinuity, the opposite of road traffic noise on a motorway. A given sequence of operations is neither even nor repeatable. E.g. take-off or landing should be performed against the wind direction; therefore, according to meteorological conditions, airport operations are at Paris airports either eastwards or westwards, and the same NMT may be flied over by either take-off or approaches.
Furthermore noise levels from a given aircraft-type during take-off (and it is the same thing for landing) are quite changeable. At a NMT located at 6 km from the runway (fig. 4 B737-200), these levels may vary within a range of up to 20 dB(A). Operational conditions are actually changeable; for instance, meteorological conditions have an influence on aircraft climbing performance, much better when temperature is low and front wind high. For modern aircraft (fig. 5 A320), the range of variation is quite the same, but shifted of a dozen of decibels towards the left.
Meteorological conditions determine operations direction -westwards or eastwards- and have an influence on aircraft climb performance. They have also an influence on noise propagation: winds gradients for

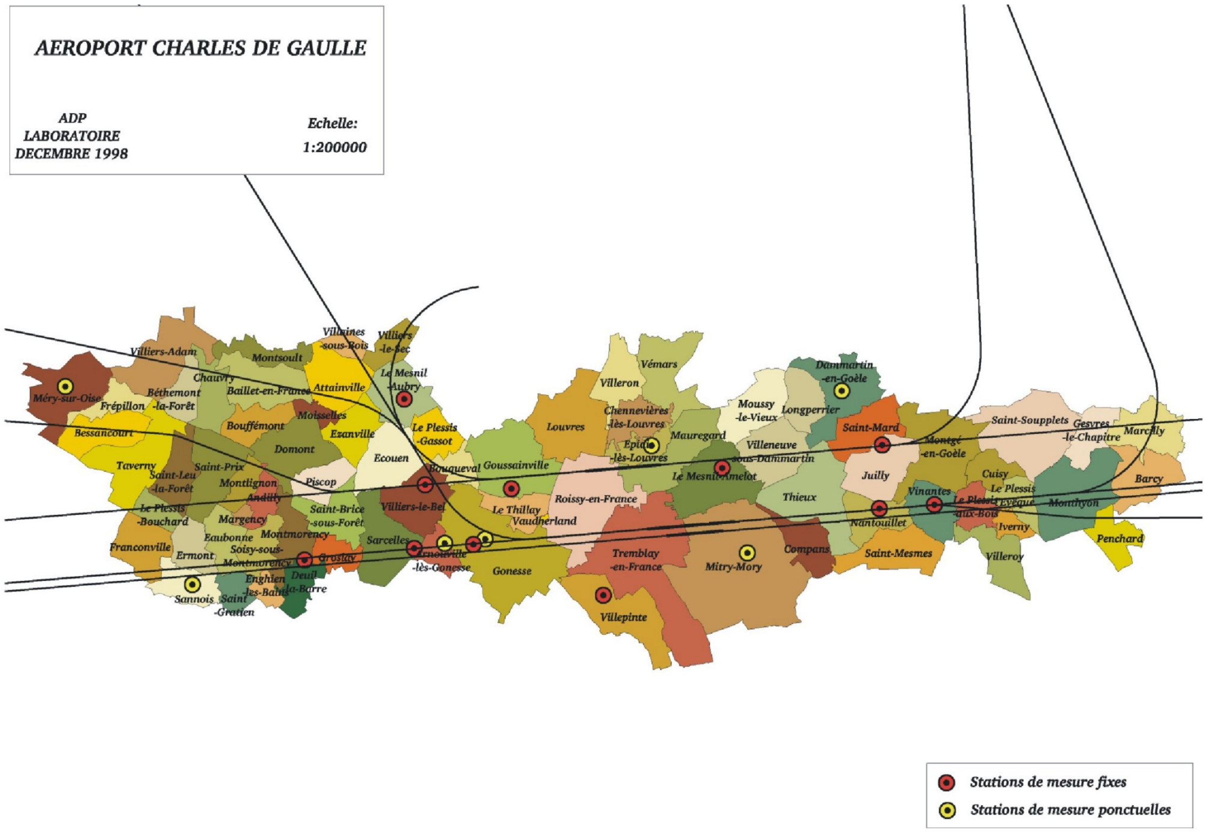

Figure 2: NMT's location around CDG.

instance may contribute to *noise shadow*. All these factors explain changeability of actual noise levels. Therefore permanent monitoring system is necessary in order to assess aircraft noise impact.
Considering this noise levels deviation, it is possible to consider the question of the abnormally high noise levels in a different way. This question that is frequently raised makes sense for a given aircraft-type. In the above example, a noise level of 87 dB is abnormal for a A320, but normal for a B737-200. The noise monitoring system operated at CDG and Orly and correlation between noise events and noise source identification leads to a better analysis of these so-called abnormal noise levels.
Air traffic determines the frequency of noise events. Changes in traffic according to day, week, season, etc. results in a changeable impact that can be expressed by noise levels expressed for instance in Ldn. On the opposite, concentration of operations during certain periods of the day may disrupt the link between noise levels measured (in Leq or Ldn) and nuisances. Moreover, the community is more sensitive to noise during certain periods, as it is the case during nighttime.

4 - NOISE SOURCE (INDIVIDUAL AIRCRAFT) IDENTIFICATION

For each noise event, the system provides the source id. Data from the secondary radar (SSR) are received real time, which means flight number and airplane location. From these data, airport databases give airplane tail number, airline identity (owner and operator) and, as a matter of fact, airplane characteristics: aircraft-type, engines, take-off weight, etc.
For each aircraft-type, the average LAmax is determined and the flyover altitude as well (fig. 6). The less noisy Chapter 3 aircraft are those having engines with a high by-pass ratio, since the noise level emitted is lower, but also because having excellent climbing performance, they are higher than aircraft-types having the same take-off weight but less powerful engines.
B777 operated at CDG are fitted with the engine GE90, which has by-pass ratio of 9, a record so far. The B777 is a quiet aircraft because this engine is both quiet and powerful, since the important factor is the ratio thrust/weight. An aircraft must be able to take-off with an engine out of order, which means, for a 2-engine, a take-off with only one engine. A two-engine aircraft is therefore over-engined of 100%, and is for this reason much less noisy than a four-engine of the same weight.
The influence of take-off weight upon noise energy emitted by an aeroplane is roughly linear with a log-log scale (fig. 7). When doubling the weight, noise levels should be expected to increase of about three

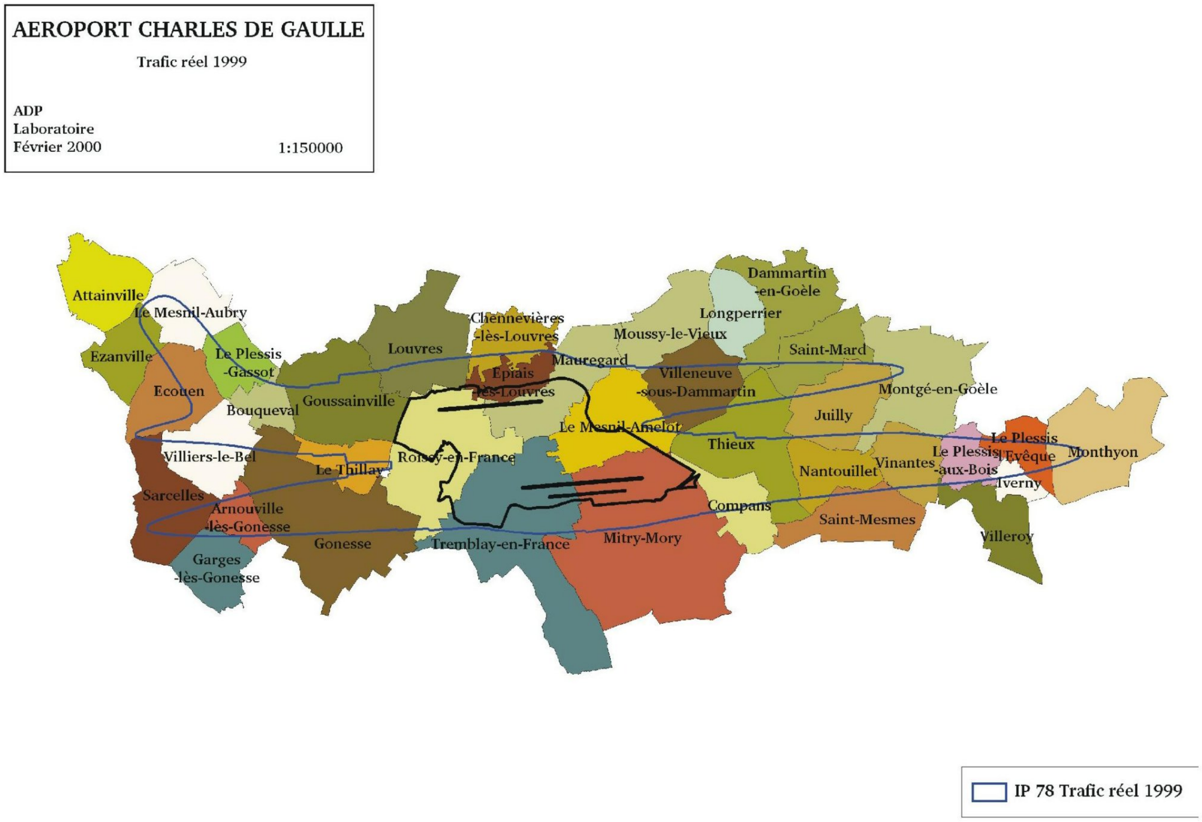

Figure 3: Aircraft noise impact at CDG.

decibels. For instance, noise certification limits are linear with an increase of four EPNdB for the flyover and 2.3 EPNdB for approach when doubling the weight. Correlations $L = f(\log \text{MMD})$ can therefore be setup at least for each aircraft technology, say Chapter 2 on one hand and Chapter 3 on the other.
At take-off, when doubling aircraft weight, actual noise level increases of three dB for a chapter 3 and two dB for a Chapter 2. Which means that the difference between Chapter 3 and Chapter 2 is still better for narrow-body aircraft than for large body (or four-engine) aircraft.

5 - CONCLUSION

At both CDG and Orly, the Noise monitoring system is in a permanent evolution. New terminals should be located at CDG because of the development of this airport. And with new technology already available, it is possible to get much more information from this system, including real-time. Major outcomes from this system can provide a support for the whole legal and regulatory scheme aiming at protecting the community from aircraft noise impact.

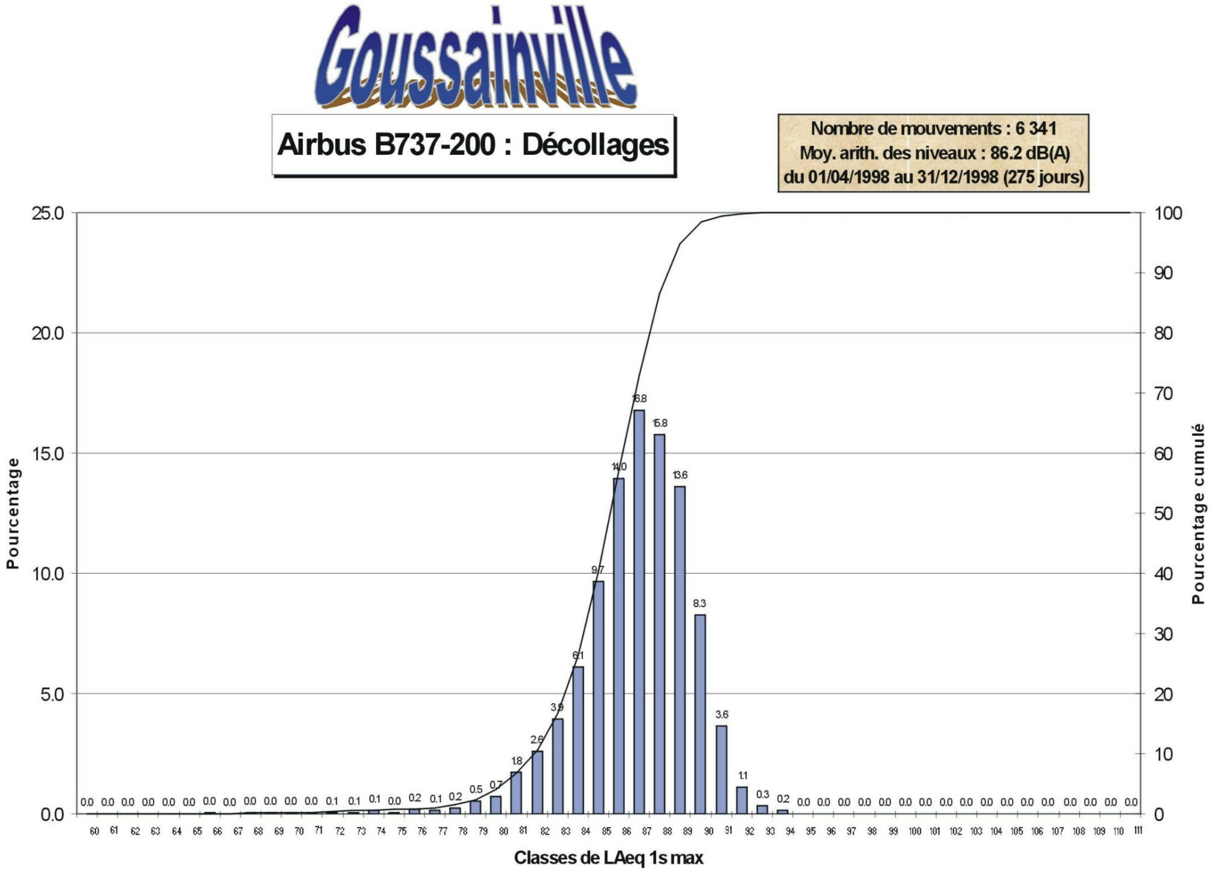

Figure 4: B737-200 noise levels at take-off.

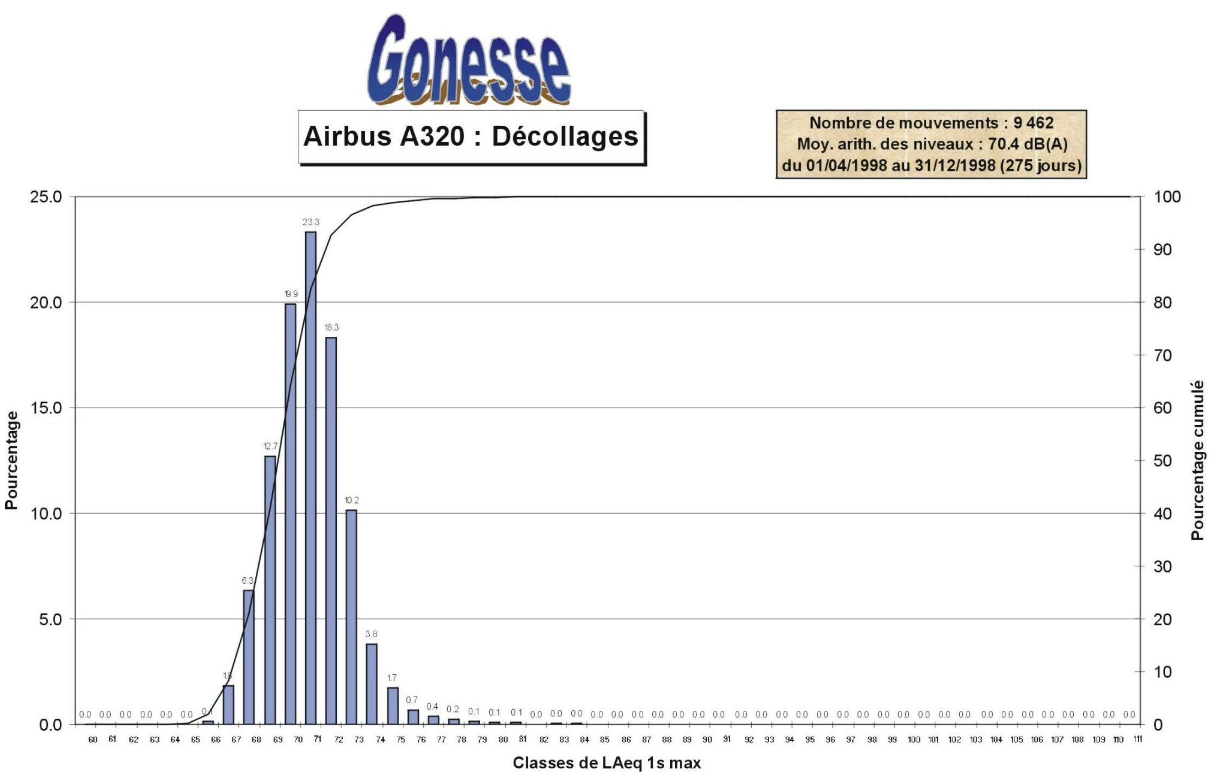

Figure 5: A320 noise levels at take-off.

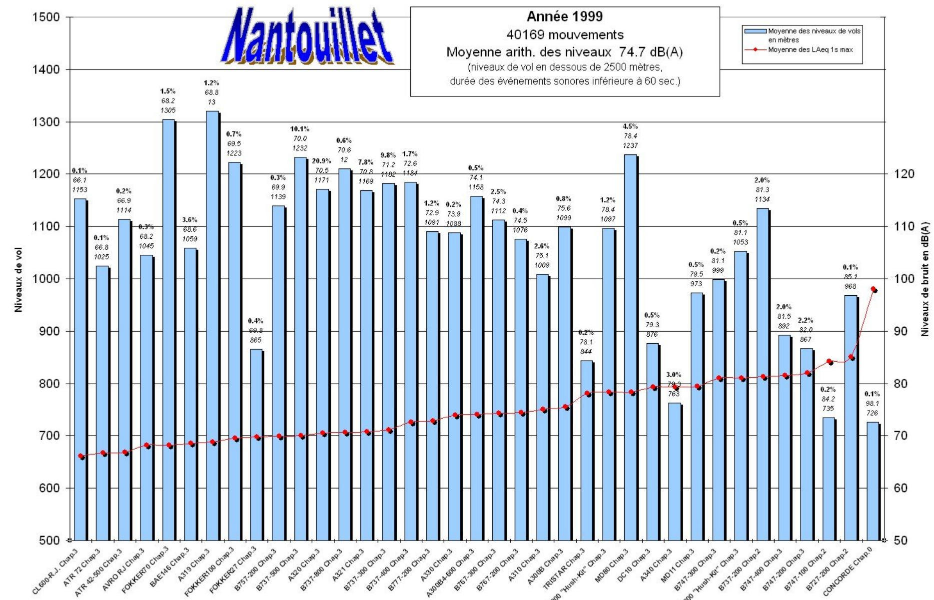

Figure 6: Flyover altitude and average Lmax for various aircraft-types.

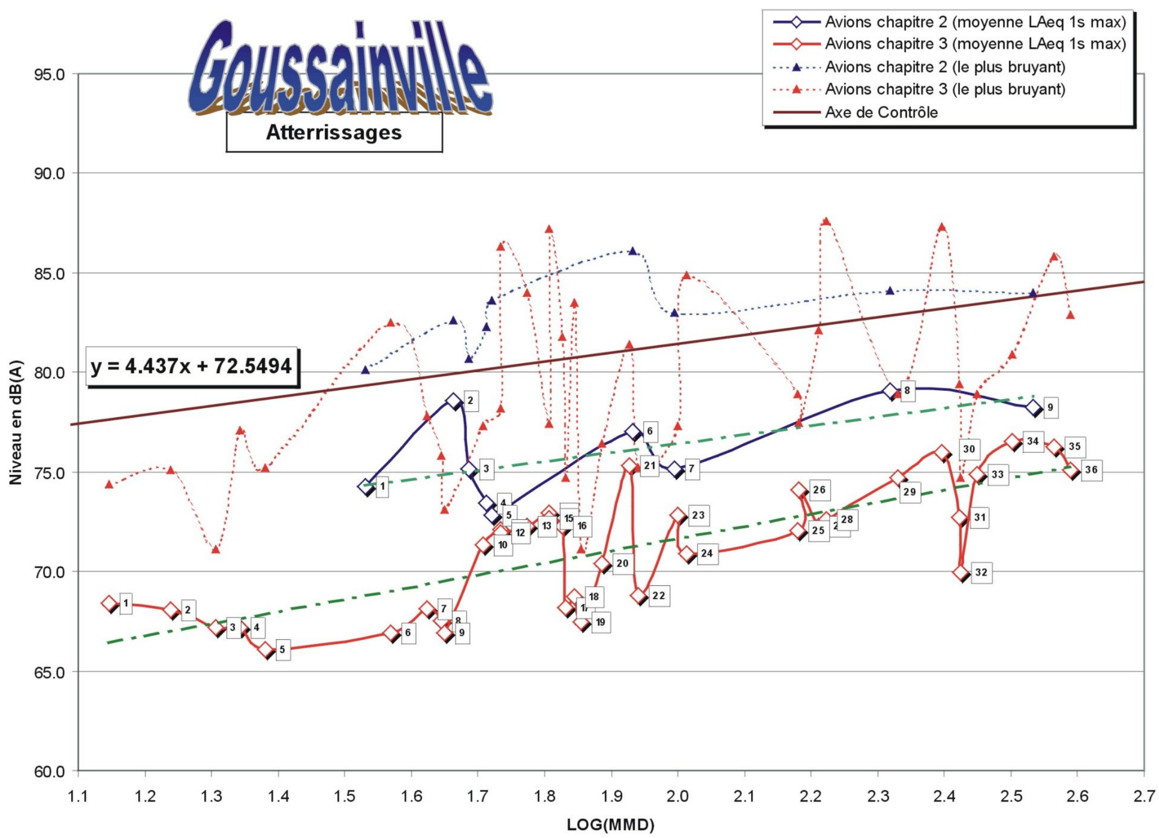

Figure 7: Correlation L = $f(\log \text{MMD})$.