# Detection and mitigation of RLAN interference in C-band weather radar

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## Motivation

Radio Local Area Network (RLAN) devices and C-band weather radars share the same radio frequency (RF) band $\Rightarrow$ presence of RF interference (RFI) that are not always avoided by Dynamical Frequency Selection (DFS).

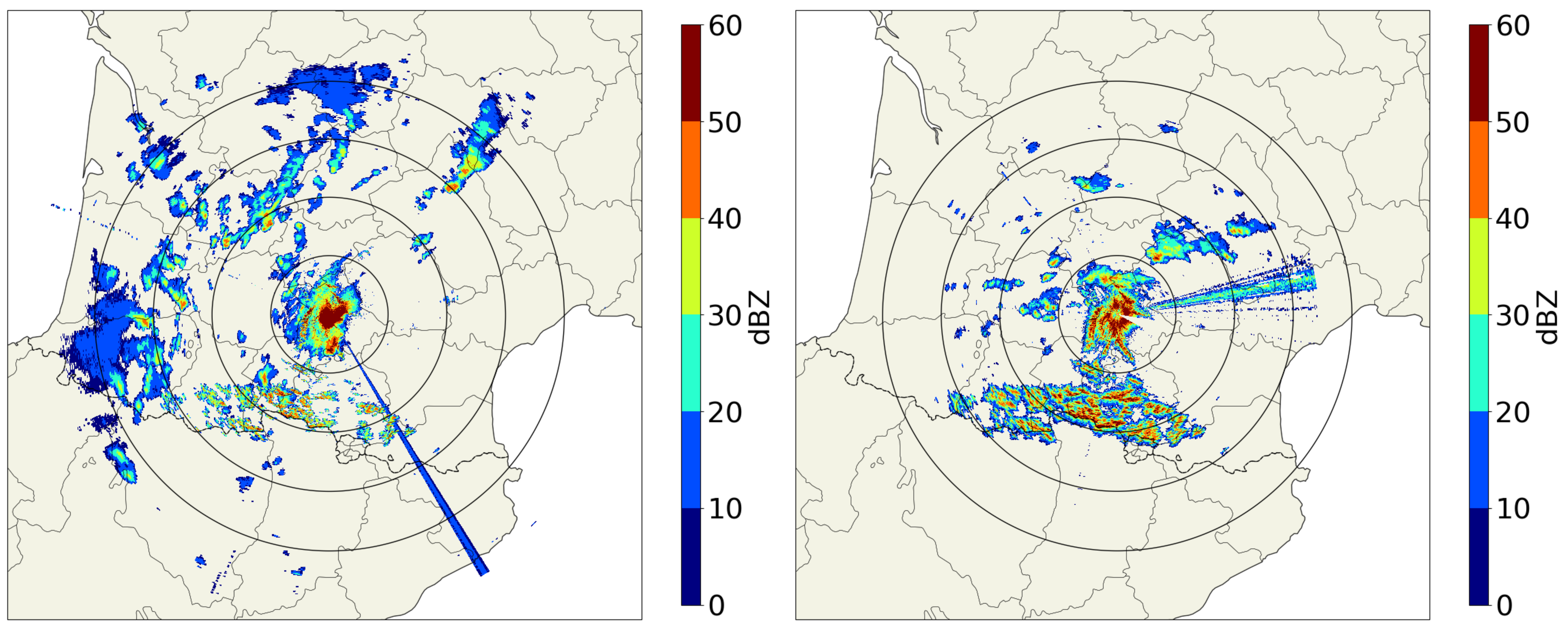


Figure 1: Reflectivity product with (**left**) Magnetron-based radar and (**right**) solid-state-based radar.

With the arrival of radars equipped with solid-state transmitters (large duty cycles up to 10%), DFS will not be sufficient as it is adapted to radars equipped with tube-based transmitter (small duty cycles $< 1$%). The problem of interference is meant to increase with this new technology.

## Signal fluctuation and RFI

In general, RFI is easily spotted as it often affects most of the range gates over an angular sector. At Météo-France, it is detected using the fluctuation of reflectivity, namely SIGMA, or $\Sigma$.

$$\Sigma = \frac{\sum_{k=1}^{n} 10 P_k \left| \log_{10}\left(\frac{P_k}{P_{k-\tau}}\right)\right|}{\sum_{k=1}^{n} P_k},$$

where $P_k$ is the power of the $k$-th sample, $n$ is the number of samples considered in a pixel (dwell) and $\tau$ is an index shift (equal to 3 at Météo-France).

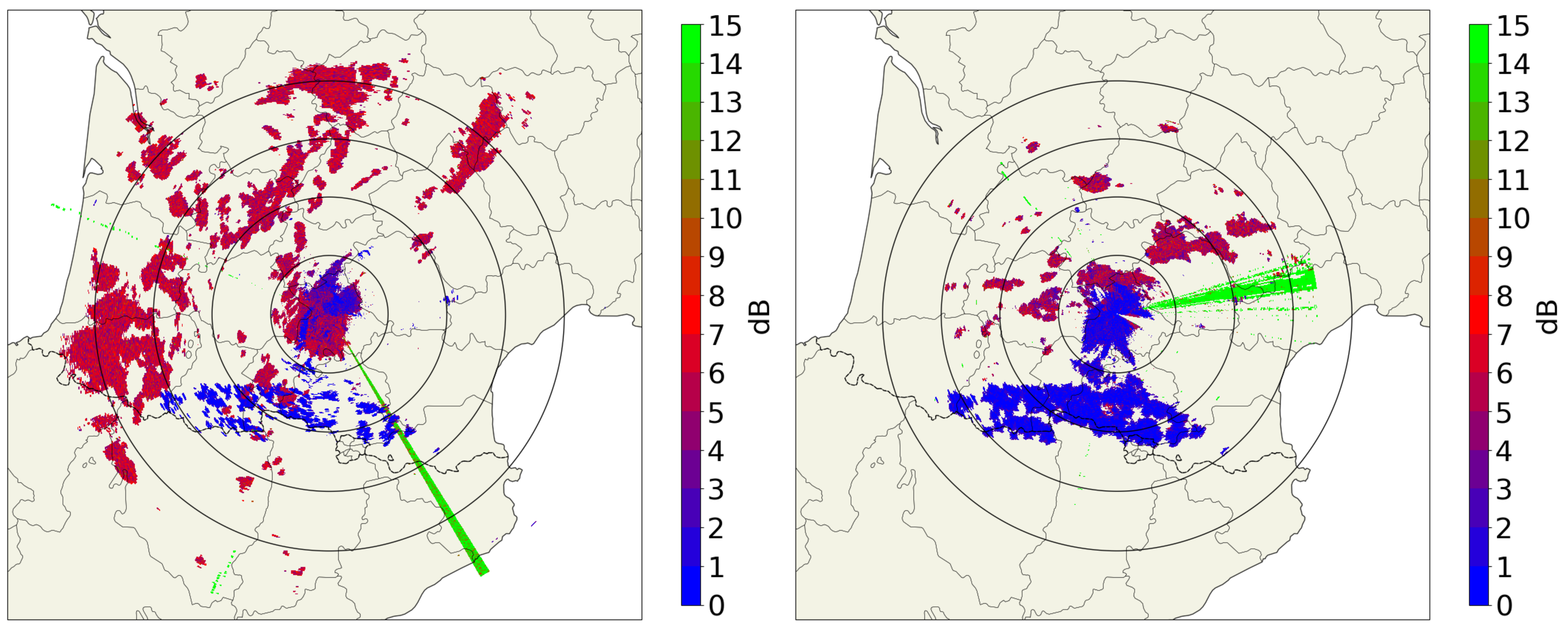


Figure 2: SIGMA product with (**left**) Magnetron-based radar, (**right**) solid-state-based radar.

Under certain hypotheses, the product $\Sigma$ can be seen as a Gaussian random variable with the following characteristics:

- For ground clutter: $\mathrm{E}\{\Sigma\} < 3$ dB,
- for meteorological echoes (Lubeigt 2025): $\mathrm{E}\{\Sigma\} = 6$ dB and $\mathrm{STD}\{\Sigma\} \approx 8.05/\sqrt{n}$,
- for RFI: it can be shown that $\Sigma$ is proportional to the interference-to-signal ratio (ISR): $\mathrm{E}\{\Sigma\} \approx 10/\ln(10) + \mathrm{ISR}_{\mathrm{dB}}$.

## Pixel detection test

Consider the following test:

- $H_0$: no RFI, $\mathrm{E}\{\Sigma\} = 6$ dB
- $H_1$: RFI, $\mathrm{E}\{\Sigma\} \gg 6$ dB.

$\Sigma$ is compared to a threshold, $t_1$, fixed by the prob. of false alarm ($P_{\mathrm{fa}}$):

$$t_1 = 6 + \frac{8.05}{\sqrt{n}}\Phi^{-1}(1 - P_{\mathrm{fa}})$$

where $\Phi(\cdot)$ is the normal cumulative density function. Then, the prob. of detection ($P_{\mathrm{d}}$) is driven by the ISR.

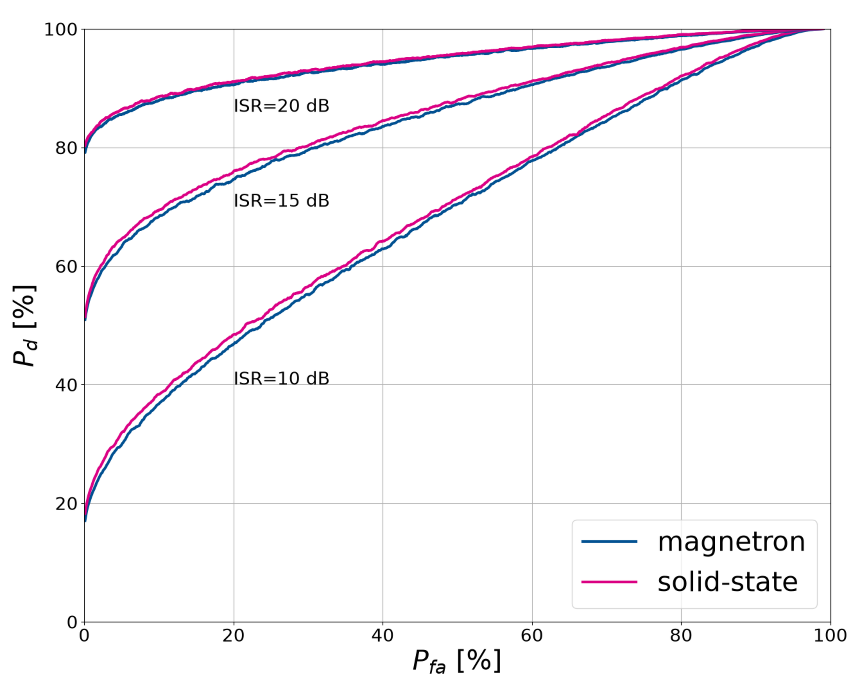


Figure 3: $P_{\mathrm{d}}$ as a function of $P_{\mathrm{fa}}$.

## RFI on IQ data: a sparse phenomenon

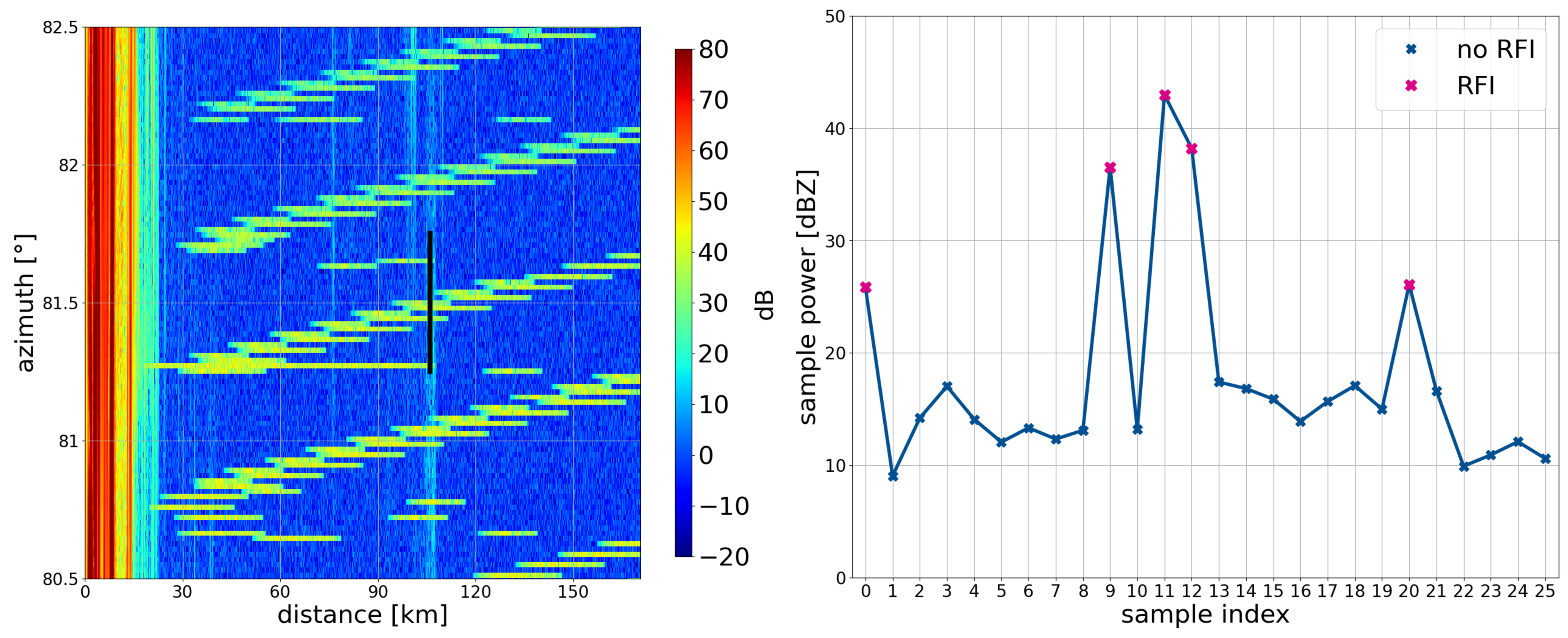


Figure 4: (**Left**) Solid-state-based radar sample power at the native angle resolution and (**right**) extracted data of the dwell represented by the black like.

## Sample detection test

Once the polluted dwell is determined, the goal is to remove the few samples affected by RFI. The general assumption is that the dwell power samples, $\mathbf{x} = [x_1, \ldots, x_n]^T$ are such that, $x_k \sim \mathrm{Exp}(\sigma_P^2)$ with $\sigma_P^2$ the mean power. A common approach (Cho 2017) is based on the dwell median $\widehat{m}_e$:

1. Extract the largest sample $x_{\max}$.
2. Compute the median $m_e$ of the remaining samples (without $x_{\max}$).
   - if $x_{\max} > t_2 \widehat{m}_e$, sample affected by RFI, $x_{\max}$ is removed. Repeat step 1.
   - else, $x_{\max}$ is not affected by RFI, this is the end of the procedure.

It can be shown that the relationship between $t_2$ and $P_{\mathrm{fa}}$ depends only on $n$ (and not on $\sigma_P^2$)! In this study, the threshold $t_2$ was obtained numerically.
The final radar product can be obtained based on the cleaned dataset where the removed samples are replaced with an interpolation of the neighboring samples.

## Results

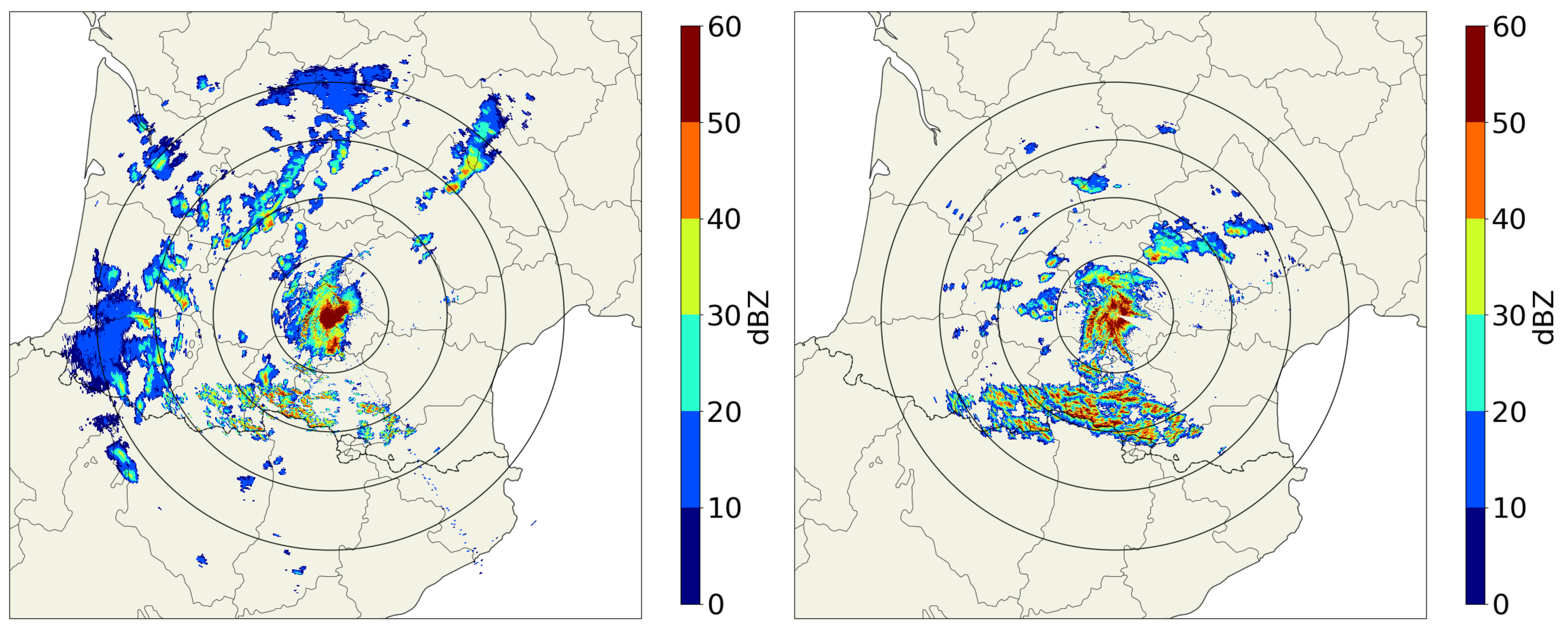


Figure 5: Cleaned radar data for (**left**) magnetron radar and (**right**) solid-state radar.

## Conclusions and perspectives

- Implementation of a two-step detection test based on $\Sigma$ and dwell median,
- Test on magnetron and solid-state radars.
- Perpectives: explore RFI radial coherence (e.g. spectral analysis).

## Acknowledgments

The authors would like to thank their colleagues at Météo-France in Toulouse who helped collecting the magnetron radar data. Solid-state radar data was collected thanks to a collaboration with Meteo France International and Meteopress.

## References

Cho, J. Y. N. (2017). "A new radio frequency interference filter for weather radars". In: *J. Atmos. Oceanic Technol.* 34.7, pp. 1393–1406.

Lubeigt, C. (2025). "SIGMA: A weather radar signal fluctuation descriptor for ground clutter identification". In: *IEEE Geoscience and Remote Sensing Letters* 23, pp. 1–5.