4th Weather Radar Calibration & Monitoring workshop, 8-10 November 2023

Unwanted Effects in Operational Data from the SHMU Weather Radar Network

Ľuboslav Okon, Marián Jurašek, Ladislav Méri , Ján Kaňák, Jozef Uličný, Mikuláš Lenďák
Slovak Hydrometeorological Institute (SHMU), Jeséniova 17, 833 15 Bratislava, Slovakia
e-mails: firstname.lastname@shmu.sk

Introduction

Since 2015-16, SHMU has been operating four identical dual-polar C-band radars METEOR 735 CDP10 by Leonardo. Detailed description of the radars parameters and settings and the data processing chain can be found here: Data from these radars are crucial for the detection and nowcasting of hazardous weather phenomena and are used in many fields, including civil protection, hydrology, aviation, etc. Despite state-of-the-art technology and advanced signal processing, the operational data from these radars are affected by several problems that result in either false echo detection or total or partial loss of useful information. These problems can have a significant impact on the quantitative application of the data as well as on the automatic detection of various weather phenomena.

RLAN interference

One of the biggest problems the weather radars face today, is interference from RLAN devices operating on close frequency channels. The worst situation in Slovakia is at radar Malý Javorník (Fig. 1a left) which is rel. low elevated (60[illegible] located close to densely populated regions. The best situation is on the other hand at higher elevated radar Kubínska hoľa (1425 m) whose operating frequency (5630 MHz) lies directly between two Wi-Fi channels.

At SHMU, the RLAN interference is filtered out in several steps. First, in the signal processor, by the built-in Interference filter (in Safe mode) and by the SQI filter with threshold 0.3 (applied also to the reflectivity data) and finally, by th[illegible] meteo filter based on the dual-polar measurements. In result, we obtain relatively clear images without interference (Fig. 1a right). On the other hand, the filters (mainly the SQI) remove sometimes also part of precipitation echoes (Fi[illegible]). Due to the rel. high SQI threshold, unfortunately, also cores of severe thunderstorms are sometimes removed (Fig. 1c).

Another unwanted effect of the RLAN interference is a short-term overestimation of reflectivity in rays with the RF signal superimposed on precipitation echo (Fig. 1d). The overestimation is probably caused by a faulty rain attenuation correction (bad PhiDP values due to the interference). This effect is most noticeable in the widespread precipitation echoes.

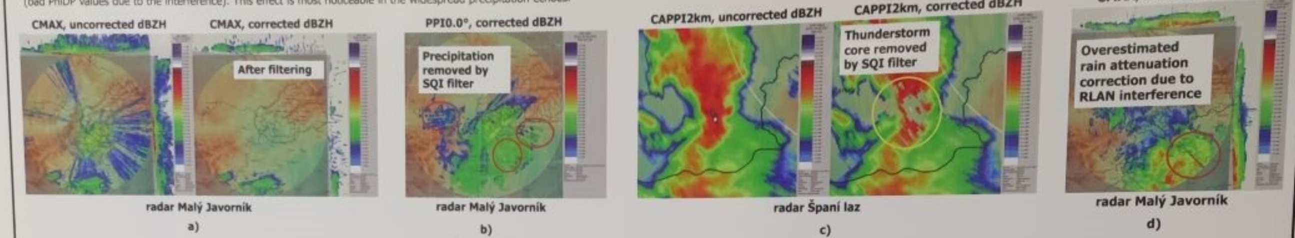

Fig. 1 Effects of RLAN interference in the SHMU radar data

Wind-farm clutter

At the time of writing, the wind-farm clutter does not pose a severe problem to the SHMU radars as there are currently only a few small wind-parks in Slovakia. However, there are plans to build many new wind-farms in Slovakia in the near future. SHMU is now involved in process of all environmental impact assessment studies for the all new wind-farms. Fortunately all planned wind-farms are further than minimal 20 km distance and almost all except one are under level of lowest beam. Currently, the only visible clutter in the SHMU data is from the wind-park in Lower Austria near Slovak border. This clutter is detected by the more distant radar Španí laz (Fig. 2) during suitable wind and radar beam propagation conditions (the much closer radar Malý Javorník usually overshoots the wind-park). The visibility of the clutter by Španí laz can be enhanced by the overlaying RLAN interference (not shown here).

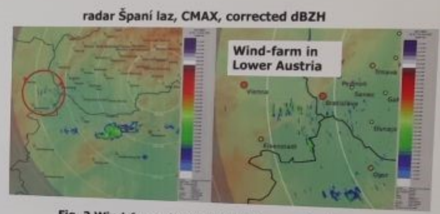

Fig. 2 Wind-farm clutter in data from radar Španí laz

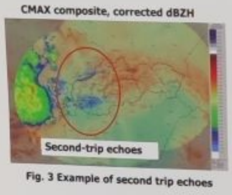

Fig. 3 Example of second trip echoes

Second (multi) trip echoes

Second, or generally, multi trip echo is a well known false echo of a high reflectivity target (usually intense thunderstorm) located beyond the maximum range of the radar. It is in fact an echo from the previous transmitted pulse detected by the receiver and incorrectly placed within the range. Fig. 3 shows an example of the second trip echoes in the Slovak national composite. Actually, there are second trip echoes from two radars captured in this image, from radar Španí laz on the south and Kubínska hoľa on the north of Slovakia.

T/R-limiters degradation

After 7-8 years of operation, some T/R-limiters in the SHMU radars (gaseous type) have been exhibiting signs of degradation. The worst situation is at radar Kojšovská hoľa where both limiters exhibit excessive insertion loss and transient attenuation (or recovery time) of the horizontal channel limiter significantly increased over the past three years. The T/R-limiters degradation has had several impacts on the radar measurement. Progress of the degradation over the past 2,5 years is shown in Fig. 4.

The first observable effect of the degradation was the well known "hole" around the radar in the horizontal channel products (Fig. 4a). The increasing attenuation in the first range bins due to degradation can be observed also in the output (daily averaged dBuZ) of the T/R-limiter monitoring (Fig. 4b). The fastest drops in the close-range ground clutter reflectivity were observed in May 2020 and in the beginning of 2023. In some range bins, the average uncorrected reflectivity dropped to the undetected level.

The degradation affected also the bird-bath scan data (Fig. 4c, d). First effect of the degradation was a negative bias of the ZDR offset due to higher attenuation in the H-channel. The second effect was an extension of the NOECHO region to higher levels, making the valid measurements sparser and less reliable (smaller dataset). Since September 2022, there are no new valid bird-bath scan data on this radar due to the limiter degradation.

In November 2022, we started to observe also occasional overestimation of the corrected reflectivity by this radar (see a secondary maximum in the scatterplot in Fig. 4e). The overestimation started at the moments when precipitation reached the radar site and occurred only in certain azimuth sectors. The effect was therefore most noticeable during widespread precipitation around the radar. The overestimation was caused by the faulty dual-pol attenuation correction which is based on PhiDP. The Rainbow software utilizes for this purpose the corrected PhiDP which is derived from raw uPhiDP data by smoothing (averaging) and removing PhiDP bias. The average is calculated from uPhiDP values in the first few range bins and these are affected by the unevenly degraded T/R-limiters. To avoid the overestimation, we decided to temporarily disable the dual-pol attenuation correction on this radar.

Note: At the time of writing, the SHMU is preparing a procurement for the new T/R-limiters.

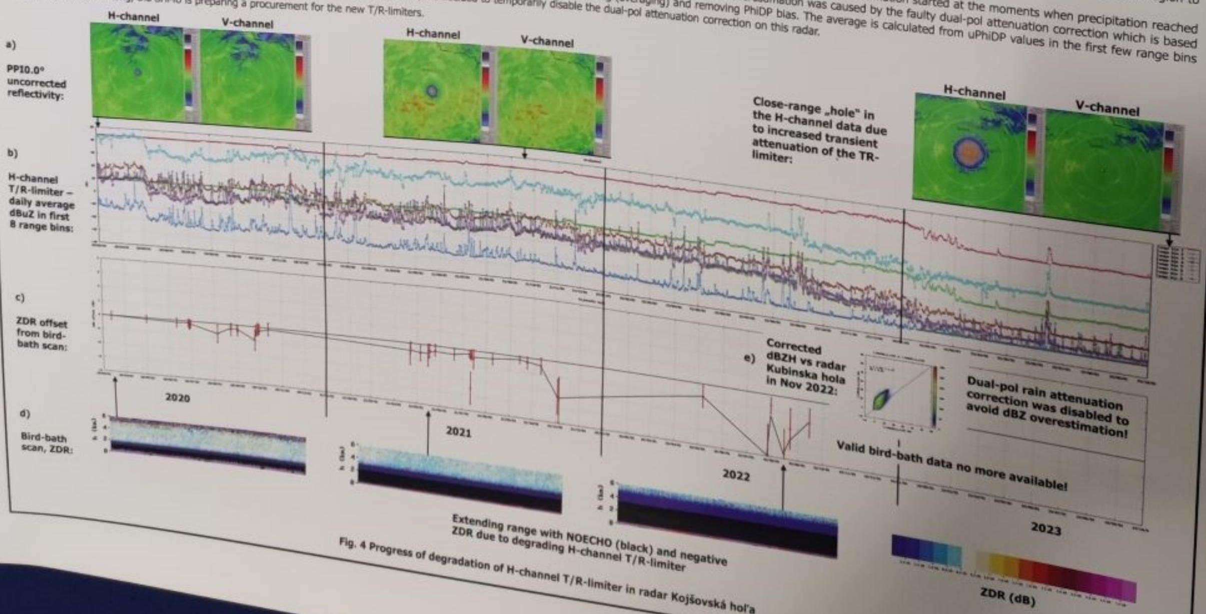

Fig. 4 Progress of degradation of H-channel T/R-limiter in radar Kojšovská hoľa