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# Development and application of an X-band radar target simulator for calibration purposes

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MeteoSwiss operates a polarimetric Doppler X-band weather radar in the Swiss plateau. Its main purpose is to assess the influence of rain on the detection performance of aviation radars. The focus of our application is on low to medium rain rates. Rain rate measurements need to be performed with the highest possible precision and therefore the radar constant needs to be accurately estimated in a continuous manner. Considerable fluctuations of the radar constant are mainly expected during wet radome conditions. It is therefore the goal of this experiment to develop a tool that allows to calibrate the radar without interrupting its operation and to continuously assess variations of the radar constant under all weather conditions.

A radar target simulator (RTS) is an external transponder system that is set-up within the coverage of the radar. It receives the radar pulses, applies a predefined Doppler shift and a time delay and sends them back to the radar with a fraction of the received signal power, where this fraction corresponds to a specific radar cross section (RCS). If the fraction of the re-emitted power is sufficiently accurate, the virtual target that appears in the radar display at the distance that corresponds to the applied time delay has a known RCS and can therefore be used to estimate the radar constant.

A low-cost RTS has been developed at MeteoSwiss. Pulses are received via a standard gain horn and a receiver, which consists of an RF amplifier, three down-conversion stages and an A/D conversion. The digital data stream is sent over a high-speed connection to a host computer, where the signal processing, i.e., the application of the time delay and the Doppler shift, is performed. The data is then converted to analog pulses, up-converted to the target frequency over three stages, amplified and sent back to the radar via the same horn antenna.

First laboratory tests with a pulse generator showed that the time, frequency and amplitude stability of the re-emitted pulses is sufficiently high for the foreseen application. For further tests, an old X-band marine radar has been employed. With this test it was confirmed that the RTS can cope with the varying carrier frequency of a magnetron based system. Right know, the system is tested and tuned with two different magnetron based X-band weather radars. We will show the results of these tests together with an assessment on how accurate the radar constant can be determined with this system. In addition, it will also be shown how the radar constant of the two X-band radars varies in time under wet radome conditions.