Two simple methods to monitor the calibration of a 35 GHz cloud radar

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The derivation of microphysical parameters from radar requires an accurate measurement of radar reflectivity. The radar calibration, however, remains a major challenge for all radar operators. This applies particularly to vertically pointing radars without scanning capability, as some of the common methods, such as corner reflector calibration or the use of solar radiation, are not readily applicable to this type of radar.

The DWD operates a 35 GHz pulsed polarimetric Doppler radar MIRA36 at the Meteorological Observatory Lindenberg, which has been in continuous operation since April 2004. Before delivering the radar system the so-called budget calibration has been performed by the manufacturer. Here, the gain and the loss of all components were determined separately to estimate the radar constant. Varying parameters (e.g. transmit power) are measured during the operation. However, the aging of electronic components can lead to a drift in the radar constant, which reduces the accuracy of the derived reflectivity. This study presents two methods, which allow to monitor the radar calibration with simple means and little effort.

The first method is based on the calculation of monthly or annual means of reflectivity for all cases where clouds are present. Under the assumption that the variance of mean values is rather small, larger deviations from the long term mean can be associated with a possible radar calibration issue. It appears that the altitude of 5000 m is most appropriate for such an analysis, since the radar's altitude-dependent sensitivity is still sufficient to detect all clouds, and there is no saturation of the receiver by large particles (e.g. rain drops). The mean annual reflectivity varies between −10 dBZ and 5 dBZ in the period from 2004 to 2018. However, without additional information these variations cannot be clearly attributed to natural or device-specific causes.

The second method is based on comparisons between MIRA36 and a 24 GHz Micro Rain Radar (MRR). Such a radar is operated at the same location as the cloud radar since 2008. For rain events, the reflectivity of MIRA36 and the MRR was compared for altitudes of 500 m and a reflectivity range between about 0 dBZ and 20 dBZ. At this range the MRR has a sufficiently high sensitivity and MIRA36 is still below the saturation level. The mean differences vary between about −9 dBZ and 3 dBZ and are of the same order of magnitude as the variations of the annual mean values. Interestingly, the temporal evolution of the reflectivity differences (MIRA minus MRR) is very similar to those of the annual mean reflectivity, which confirms the applicability of each individual method.
In this way, a calibration problem was detected in 2016 and 2018 caused by system parameters that were not optimally adapted to aged hardware components. This especially affected the phase correction of the received signal. Despite the obvious uncertainties and assumptions the two methods presented here are a useful tool to monitor the radar calibration.

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