Assessing the antenna characteristics and pointing accuracy of a polarimetric weather radar

*Michael Frech[1], Theodor Mammen[1], Bertram Lange[1]

1. Deutscher Wetterdienst

The exact navigation of detected radar signals is crucial for usage of radar data in meteorological application, in particular in radar networks, where radar data from multiple radars may be used to characterize the precipitation process in a given observation volume. Based on the pioneering work of Huuskonen and Holleman (2007), the method to monitor and quantify the pointing error from operational radar data has essentially become a standard in weather radar networks worldwide. We extend this methodology and assess the antenna pointing accuracy in azimuth and elevation of a polarimetric weather research radar depending on position of the sun using dedicated solar boxscans in a sequence of 10 min (Frech et al, 2019). In doing so, we assess the quality of the mechanical design to steer the antenna in azimuth and elevation. Furthermore we assess the design to encode the pointing angles and determine characteristics of the antenna main. The research radar of the German Meteorological Service (DeutscherWetterdienst, DWD) is located at the meteorological observatory Hohenpeissenberg. It is identical to the 17 weather radars of the German weather radar network. During the summer time, an azimuth range from 50-300° is covered and over 90 boxscans are available per day for analysis. A non-linear azimuthal variation of azimuthal pointing bias of up to 0.1°
is found, which is significant as this is commonly viewed as the target pointing accuracy. We can attribute this azimuthal variation to the mechanical design of the drive train with the angle encoder. This includes the inherent backlash of the gear-drive assembly. The pointing bias estimates based on over 1000 boxscans from 26 days show a small case by case variability, which indicates that dedicated solar boxscans from one day are sufficient to characterize the pointing performance of a particular system. We show that the pointing biases based on solar boxscan data are consistent with results from the operational assessment of pointing bias using solar hits from operational scanning. Furthermore the pedestal levelling can be assessed with the proposed methodology. A trend in elevation bias as function solar azimuth is indicative of a pedestal tilt. Examples are shown for the Hohenpeißenberg radar and from four operational radar systems of the German weather radar network. The analysis of a full diurnal cycle of boxscans from four operational radar systems shows that the azimuthal dependence of azimuth bias needs to be evaluated individually for each system. For one of the systems, the azimuthal variation of the pointing bias of about 0.2° is related to the bull gear. This analysis from four operational radar systems also reveals the need to optimize the built-in angle encoder.

A comparison of main beam characteristics (including patterns of differential power between H & V) from dedicated antenna pattern measurements with and without a radome in place, and beam pattern determined from solar box scans show a very good agreement. The differential power pattern also agrees very well with the differential power power pattern based on solar boxscans.

With the proposed end-to-end method (because it also includes the antenna and the microwave pointing of the antenna), the quality of the antenna assembly and the gear-drive system can easily be monitored during the life-time of a weather radar.

Literature:

Frech, Michael, Theodor Mammen, Bertram Lange: and Mammen, 2019: Pointing Accuracy of an Operational Polarimetric Weather Radar, Remote Sensing, **11(9)**,p18

Keywords: antenna pointing accuracy, beam squint, beam pattern