Review of “Improved analysis of solar signals…” by A. Huuskonen et al. 2016.

The authors describe procedures for obtaining the system ZDR bias and quint angle using solar radiation. The paper contains valuable data and its results can be used for the monitoring of ZDR calibration in operational weather radars. To make the authors’ findings clearer, I’d recommend considering the following issues.

1. It was not clear to me how ZDR of the solar flux has been obtained in the Finnish radars. In the calculations of ZDR, the IRIS subtracts the system ZDR from ZDR measured in all range gates (see also page 15 lines 6, 7) including the gates with solar hits. Let denote the ZDR biases introduced by the three major radar components, i.e., the transmitter, receiver and antenna, as B_T, B_R, and B_A correspondingly. The authors consider the antenna bias as a component of the receive bias, i.e., $\Delta R_{dr} = B_R + B_A$ in eq. (17). It is not clear from the manuscript whether the authors consider the antenna bias as a part of transmitter bias as well, i.e., $\Delta T_{dr} = B_T + B_A$. I assume this here. The system ZDR (ZDR_{sys}) is

$$ZDR_{sys} = \Delta R_{dr} + \Delta T_{dr} = B_R + B_A + B_T + B_A = B_R + 2B_A + B_T. \qquad (A)$$

This is eq. (17) rewritten in more detail. Now consider the measurements in the solar flux. The radar processor subtracts the system ZDR from measured ZDR values. ZDR from the sun is B_R + B_A before subtracting ZDR_{sys}. So the reported ZDR from the sun (ZDR_{sun}) is:

$$ZDR_{sun} = B_R + B_A - ZDR_{sys} = -B_A - B_T = -\Delta T_{dr} \qquad (B)$$

Eq. (B) shows that the reported ZDR depends on the bias in transmit. ZDR_{sun} depends on the bias in receive as well. Thus the reported solar ZDR depends not only on the bias in receive as the authors stated throughout the text but on the transmit bias as well. If B_R changes and ZDR_{sys} have not been yet adjusted by rain measurements, then ZDR_{sun} changes as well. So the reported ZDR_{sun} depends on the receiver and transmitter biases. Please clarify if this is correct.

2. The ZDR scatterplot from the solar spikes shown in Fig 2 (the right panel) exhibits quite strong diagonal disturbances. Such a feature has not been observed in French, German, and US radars. To make this feature more pronounced, a scatterplot from a distinct solar scan is desirable. Could you please show data from a box solar scan when the antenna scans the solar disk. Such data can be obtained with the IRIS routines by setting up a sector scan with an angular step of 0.2 deg . Such data could already exist in the radar data archive.

   A “saddle” ZDR scatterplot makes it difficult to match it with a parabolic surface eq. (8). The ZDR surface is a difference of two parabolic surfaces eq.(2), i.e., it should be a parabolic surface as well. The observed ZDR saddle surface raises a question of its origin. I wonder if this is a feature of the antenna. Please compare the ZDR diagonal disturbances with the placement of the antenna struts that support the feedhorn. Are there 4 antenna struts placed about 45 deg to the horizon?

3. It is recommended in the manuscript to obtain the system ZDR by subtracting the fitted powers from the sun in H and V channels. The radar reports Z_H and ZDR from which Z_V is obtained as $Z_V = Z_H – ZDR$ (eq. (12) and also p.7 line 8). It is stated (p.7 line 8) that this implies $C_H = C_V$. The latter means that the system ZDR is zero dB, which can be not the case for radar. A nonzero system ZDR implies that C_H differs from C_V because amplifications and losses in the polarization channels are different. So it is not clear from the manuscript how the system ZDR bias affects the calculation of Z_V.
   It is being recommended obtaining the ZDR bias by subtracting the fitted solar powers in the channels (page 12). Then what is the purpose of section 3.3 where the modeled ZDR signature is considered?

4. Measurements in rain with a vertically pointed antenna could be affected by a water film on the radome. A rain film on a radome is not ideally uniform that leads to different attenuation of H and V waves. For low antenna elevations, ZDR can be distorted by more than 1 dB at a wet radome (e.g., https://ams.confex.com/ams/96Annual/webprogram/Paper288057.html) Similar effect could be expected at vertical incidence. So I wonder if ZDR from rain at vertical incidence is so perfect.

Some other comments.

It follows from Fig. 3 that rain has been observed at altitudes as high as 8 km. These are very high altitudes for Finland. The radar volumes at such heights are above the melting layer, most likely. Radar UTA in the figure is absent in Table 1.

After transmitting a radar pulse, radar receivers can be out of their normal stage during a time interval equivalent a range of 8 km (page 8 line 10). Most likely, no rain can be present at this height. How do you calibrate ZDR in such situations?

Signals with SNR > 5 dB have been used in the analysis (page 8 line 13). Has noise been subtracted from the measured powers? What is SNR of the sun flux and how noise is processed in the solar hits?