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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Ground-based Multichannel Microwave Radiometer Antenna Pattern Measurement using Solar Observations" *by* Lianfa Lei et al.

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Thank you very much for your letter and suggestion.

The comments are all valuable and very helpful for revising and improving our paper. We have studied comments carefully, and have made corrections and modification which we hope meet with approval. We have been trying our best to improve the manuscript. Please see the revised version of the manuscript for detail. The following is the correspondence to the comments.

1. Comment: Lack of novelty. The presented method has been known for long time.

Antenna pattern measurements with the sun as a signal source are widely used for active and passive microwave instruments in meteorology.

Response: Thanks for your suggestion, may be the former version didn't describe the innovative points prominently. We have noticed that several researchers in literature used the sun to measure weather radar antenna pattern. In this paper, our study is to accurately measure the antenna pattern of MWR with a simplified solar method. We apply this method to measure the MWR pattern and this method can be used to improve the Tipping curve calibration accuracy, automatically check and calibrate the pointing accuracy. Therefore, this method can be used for MWR antenna measurements and hopefully to monitor the antenna pattern and pointing of a radiometer in operational, field applications after installation. The description above has been added to the manuscript. Please see Lines 39 - 57 on Pages 1 - 2 of the revised version.

2. Comment: A large part of the manuscript shows radiometry and antenna basics, which can be found in every handbook on the microwave radiometers.

Response: Thank you for your suggestions. We have simplified the part about radiometry and antenna. Furthermore, we have added the antenna design description and the schematic antenna structure to the manuscript. Please see Pages 2 - 4 of the revised version.

3. Comment: The authors do not mention design and dimensions of the antennas. Typically, mirrors with no subreflectors are used. In this case the antenna properties can be relatively accurately approximated following known relations between the gain and beamwidth and the antenna aperture size. It is also not clear why uncertainties of the beamwidth are so large (given are 3.8+/-0.8 deg and 1.9+/-0.8 deg). If the design of the antenna system is known, it should be possible to calculate the beam width with an accuracy of 15 %. Response: Thank you for your suggestions, I am very sorry for our negligence of the design and dimensions of the antennas and we have added the antenna design description and the schematic antenna structure. The antenna system

contains parabolic reflector (Size:320.5×186.3mm, focal length:180mm), beam splitter and compactness a corrugated feedhorn. Parabolic reflector can focus the beam and be used to scan the beams in elevation. Corrugated feedhorn offers a wide bandwidth, low cross polarization level, low sidelobe level and a rotationally symmetric beam. The MWR have many channels to observe atmospheric radiation intensity in K-band (22-30GHz) and V-band (51-59GHz). The designed beamwidth is less than 5° in K-band and 3° in V-band.

The description above the antenna of MWR has been added to the manuscript. Please see Pages 2 - 4 of the revised version.

4. Comment: Lack of motivation for meteorological applications of MWR. For main applications of radiometers in meteorology, which are temperature and humidity profiling and integrated water vapor, the atmosphere is often assumed to be uniform, i.e. the radiation is constant within the antenna beam. Taking into account that beamwidths of MWR are in the order of 1-4 deg, in the case of clear sky this assumption is fully justified. In such cases only the antenna loss, which is included in the total loss during the hot-cold calibration, matters. Gain and beamwidth have no impact. In presence of liquid clouds, the radiation within the beam is not homogeneous. But it is not clear how more precise knowledge of the beamwidth and gain can help to take this effect into account.

Response: Special thanks for this comment. The manuscript has been revised based on the following description:

As most observations for meteorology are done in the zenith direction, relatively large beamwidths are acceptable. However, this becomes important when viewing at low elevation angles during the period for Tipping curve calibrations. The antenna pattern and pointing error are important influential factors for Tipping curve calibration uncertainties (Han and Westwater, 2000 "Analysis and improvement of tipping calibration for ground-based microwave radiometers"). When Tipping curve calibration is enabled,

the radiometer performs a scan from zenith to 20° elevation, the calibration uncertainties increase by increasing beamwidth. If not corrected, this can introduce a bias to the Tipping curve calibrations (Radiometrics MP3000 Microwave Radiometer Performance Assessment. Technical Report –TR29. Version 1.0). In order to improve the observation and Tipping method calibration accuracy of MWR, the antenna pattern of MWR must be accurately measured on site any time necessary. The purpose of this study is to present a simplified solar method so that the method can be applied operationally in the future. On the other hand, we need to check whether the performance of an antenna in field operation complies with the design specification. Furthermore, in case the antenna is very large or the final assembly occurs at the installation site, the traditional method is extremely difficult. Especially the chamber method cannot be used to measure the antenna pattern of a radiometer in field operation. Therefore, we suggest to use the solar method in our study in order to improve the accuracy of a ground-based MWR observation by automatically checking the pointing accuracy together with alignment correction. And this paper presents the solar method to determine the MWR antenna pattern and to calibrate antenna pointing of MWR networks operating in the field.

The description above about the motivation for applications of MWR has been added to the manuscript. Please see the Lines 39 to 57 on Pages 1 - 2 of the revised version.

Thanks again for your kindly comments and suggestions.

All the best,

LEI Lianfa

On behalf of all the authors

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