



COST-TOPROF

WG 3 (Microwave Radiometers)

**Report of
J-CAL (Joint Calibration Experiment)
Lindenberg
25–29 August 2014**

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1 Joint calibration experiment

Ground-based passive microwave radiometers (MWR) (Westwater et al., 2004) are becoming widely used in atmospheric remote sensing and start to be routinely operated by national weather services and other institutions. However, common standards for calibration of these radiometers and a detailed knowledge about the error characteristics is needed, in order to assimilate the data into models.

In the frame of TOPROF (COST action ES 1303), the joint calibration experiment (J-CAL) will make an effort towards establishing protocols for providing quality controlled (QC) MWR data and their uncertainties. To this end, standardized calibration routines for MWR will be developed, by jointly performing calibration experiments and establishing standards for error characterization.

The focus of J-CAL lies on the performance of the two main instrument types which are currently used operationally. These are the MP-Profiler series by Radiometrics Corporation (Ware et al., 2003) as well as the HATPRO series by Radiometer Physics GmbH (Rose et al., 2005).

The overall goals of J-CAL can be summarized as follows:

- Calibration and Operation of MWR
 - Review protocols for calibration, scanning and maintenance.
 - Develop standards for optimum absolute liquid nitrogen (LN2) calibrations for MWR
 - Recommendations for automatic calibrations of MWR

- Error characteristics of MWR
 - Maschwitz et al. (2013) already assessed calibration uncertainties for a HATPRO instrument, however several open questions remained:
 - Error characterization of LN2 calibrations
 - Repeatability of LN2 calibrations
 - Stability of calibration parameters (drift)
 - Estimation of random error (covariances)

2 Field experiment in Lindenberg

Intercomparisons of calibrations performed by different MWRs have rarely been performed. Therefore, a calibration experiment was planned in order to assess the above mentioned topics under standardized conditions.

The experiment took place at the Richard-Assmann-Observatory of the German Weather Service (DWD) in Lindenberg. The location was chosen because of the availability of regular quality-controlled radiosondes and the good working conditions there. During the week 25-29 August 2014, five microwave radiometers were operated at Lindenberg. These microwave radiometers were all operated on a rooftop terrace within less than 10 meters distance which ensured homogeneous environmental conditions.



Figure 1: View over the roof platform with all participating instruments

2.1 Instruments

Instrument type	Name	Institution
Radiometrics 12-channel (TP/WVP 3000)	MWP1	DWD Lindenberg
Radiometrics 22-channel (MP-3000A)	MWP2	Radiometrics Corporation
RPG-HATPRO G1	G1	Schneefernerhaus/Uni Köln (Germany)
RPG-HATPRO G2	G2	IMGW Wroclaw (Poland)
RPG-HATPRO G4	G4	RPG Radiometer Physics GmbH

Lindenberg is the GCOS Reference Upper Air Network (GRUAN) lead center. In this context, radiosoundings with improved ground check (Immler et al., 2010) are performed every 6 hours (at 00, 06, 12, 18 UTC). For the J-CAL campaign, two additional radiosondes were launched on 26 August, 15 UTC and 27 August, 09 UTC.

For comparison of water vapour retrieved from microwave radiometer measurements, the Raman lidar RAMSES (Reichardt et al., 2012) were performed.

2.2 List of participants

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2.3 Time line of J-CAL experiment

The experiment took place between Monday, 25 and Thursday, 28 August 2014. The weather conditions were in general quite favorable except for some drizzle on 26 in the morning, as well as short rain showers on 27 in the afternoon. The nights 26/27 and 27/28 had mostly clear skies, which was very valuable for comparing observations. Around the radiosonde launch times, all MWR were performing zenith observations.

2.3.1 Monday 25 August

LN2 calibration of HATPRO G1 instrument which served as reference during all further calibrations and has not been re-calibrated later during the experiment.

2.3.2 Monday night 25/26 August

Parallel operation of instruments during night also in case they are not re-calibrated yet. Only Vertical sky observation, standard calibration routines (gain calibration, no sky tipping). G4 performed azimuth scans at zenith

2.3.3 Tuesday 26 August

LN2 calibration repeatability

- Manufacturers performed one LN2 calibration cycle according to their usual practice (HATPRO G1 serves as reference)
- Users performed calibration experiments with their instruments, Radiometrics and HATPRO sequentially (turn off other instruments to avoid interferences)
- Each calibration cycle consists of hot-load and LN2 observations prior and after standard calibration routine
- 4 cycles with HATPRO G2 were performed on Tuesday
- 2 cycles with MWP2 were performed on Tuesday, one on Wednesday
- 2 cycles with MWP1 were performed on Tuesday, two on Wednesday
- 4 cycles with HATPRO G4 were performed on Wednesday (including new covered calibration target from RPG which minimizes evaporation of nitrogen)
- For all LN2 calibrations the physical bath temperature was measured with a Pt100 in order to estimate the amount of oxygen that was mixed into the nitrogen.



Figure 2: Preparations for calibration

2.3.4 Tuesday night 26/27 August

Determination of error covariances by several hours of hot-load observations for all instruments. Rest of night: Zenith observations.

2.3.5 Wednesday 27 August

- Continuation of LN2 calibrations for G4 and MWP1/2 (see Tuesday)
- Long-term stability of calibration parameters in K-band : hot-load observations with/without noise (HATPRO G2)

2.3.6 Wednesday night 27/28 August

Parallel multi angular observations ("manual" sky-tipping calibration) and zenith observations.

2.3.7 Thursday 28 August

Unmounting of HATPRO instruments.

3 Summary, Planned analysis

During the J-CAL experiment, all the planned questions could be addressed and the experiments were done very satisfyingly. The instruments were working perfectly fine, a preliminary view over the data shows promising results.

The data will be analyzed regarding the two main points: **repeatability of LN2 calibrations** and **covariance analyses**. A first report with recommendations for MWR calibration will be presented at the next COST-TOPROF meeting in Roskilde (18-20 November 2014).

4 Acknowledgements

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