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MP-3000A and HATPRO Calibration Comparison

Top and Side-Mount Cryogenic Targets

Accuracy, Safety, Portability

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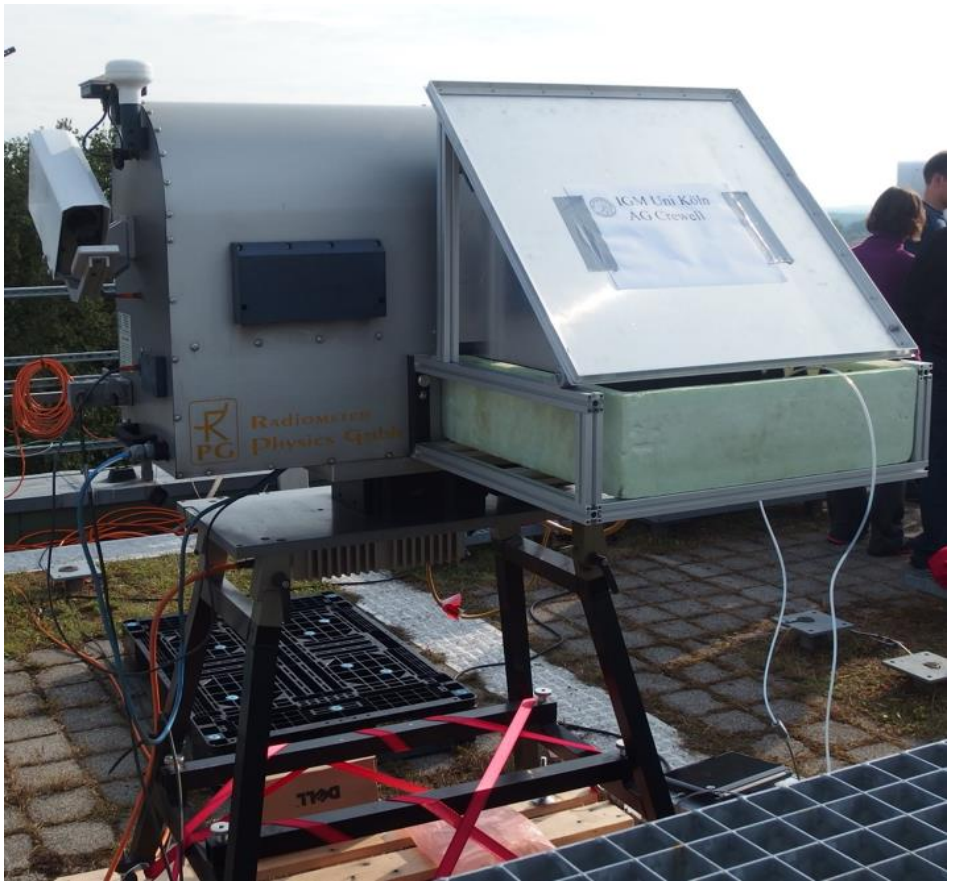
Cryogenic Calibration Targets

Top-Mount



Side-Mount

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MP-3000A Calibration

- Patented, closed, top-mount liquid nitrogen target
- User-demonstrated 0.5 K accuracy
- Safe (spill-proof), portable
- Radiosonde-equivalent observation accuracy[1]

[1] Güldner and Spänkuch, JAOT, 2001; WMO Guide to Meteorological Observations, 2010; Cimini et al, TGRS, 2011; Ware et al, Atm. Res., 2013.


Marta Nelson (Radiometrics Staff Meteorologist) prepares calibration target


Pouring liquid nitrogen into target

Enclosed spill-proof target placement on calibration saddle

Top-mount enclosed target ensures safe, accurate calibration

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MP-3000A Cryogenic Calibration

From: Güldner Jürgen [mailto:Juergen.Gueldner@dwd.de]
Sent: Tuesday, January 20, 2015 4:40 AM
To: Stick Ware
Subject: AW: WG: J-CAL Lindenberg experiment

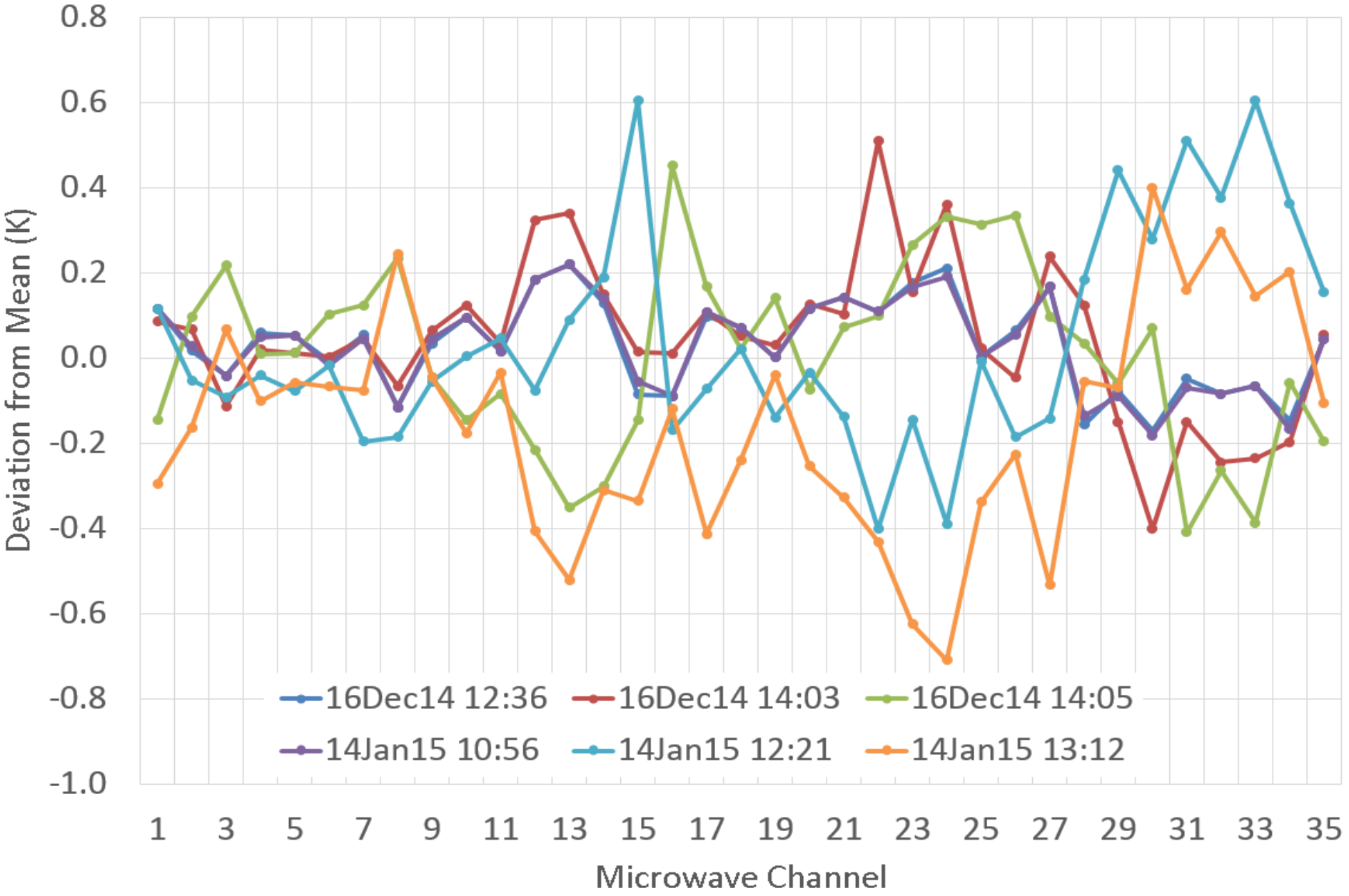
Hello Stick:

We performed indoor calibrations on two different days with three calibration cycles each. Thereby two different liquid nitrogen targets were used. The results look quite similar, especially the first calibration on both days match perfectly.

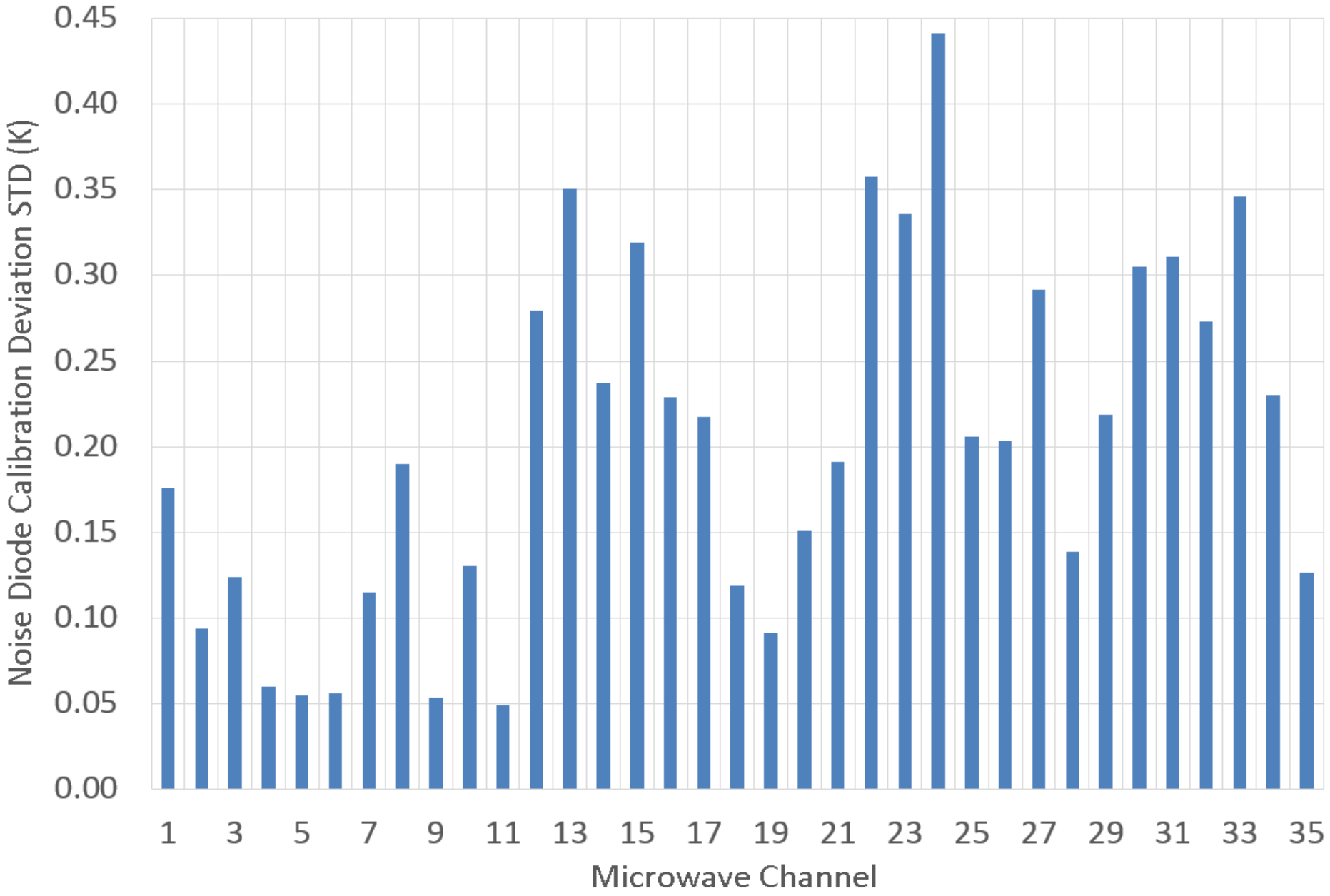
I attached a figure illustrating the results. Deviations of ND temperature versus mean value of all 6 calibrations carried out in Lindenberg are displayed.

Best regards,

Jürgen



Six consecutive MP-3039A German Weather Service calibrations using two different targets. Accuracies of all 35 channels are within specification (<0.5K).



Standard deviation of six separate MP-3039A calibrations using two different targets -- all 35 channels are within specification (<0.5 K)

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MP-3000A Summary

- Multiple MP-3000A calibrations with different cryogenic targets were conducted by the German Weather Service
- All 35 microwave channels including 21 K-band (22-30 GHz) and 14 V-band (51-59 GHz) channels calibrated and compared
- All six consecutive calibrations agree with 0.5 K accuracy specification for all 35 channels

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HATPRO Calibration

- Open side-mount system
- 7 K inaccuracy reported by users[1-4]
- Cryogenic spill hazard, limited portability

[1] Löhnert, U., and O. Maier, Operational profiling of temperature using ground-based microwave radiometry at Payerne: prospects and challenges, AMT, 2012.

[2] Paine, S., D. Turner and N. Küchler, Understanding thermal drift in liquid nitrogen loads used for radiometric calibration in the field, JAOT, 2014.

[3] Pospichal, B., G. Maschwitz, N. Küchler and T. Rose, Standing Wave Patterns at Liquid Nitrogen Calibration of Microwave Radiometers, 9th International Symposium on Tropospheric Profiling, 2012.

[4] Pospichal, B., COST-TOPROF Joint Calibration Experiment (J-CAL), Lindenberg, Germany, 2014.

HATPRO open side-mount calibration

Side-mount open calibration target

Open side-mount target

Open target cryogenic spill hazard

Calibration error from oxygen and humidity condensation inside target

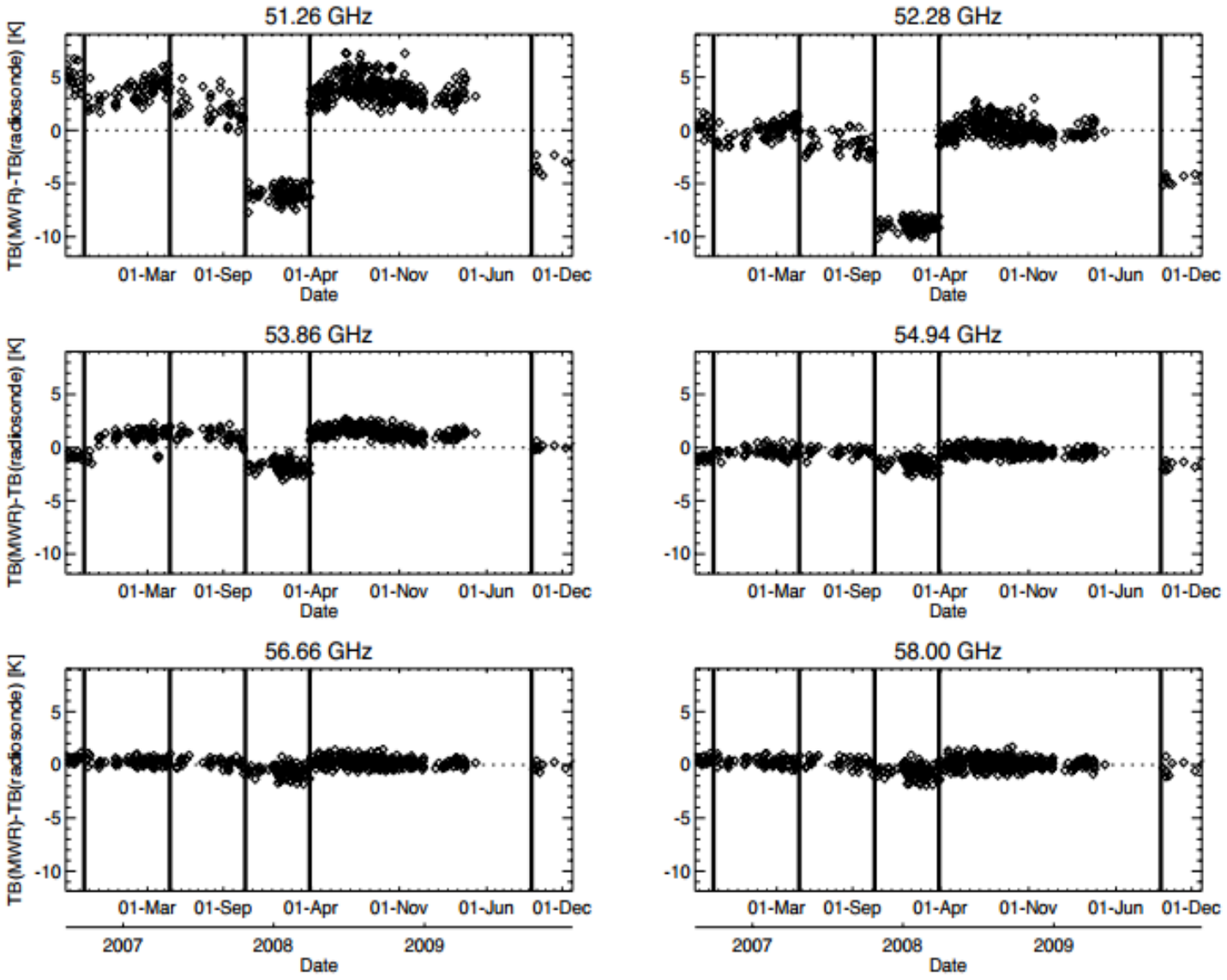
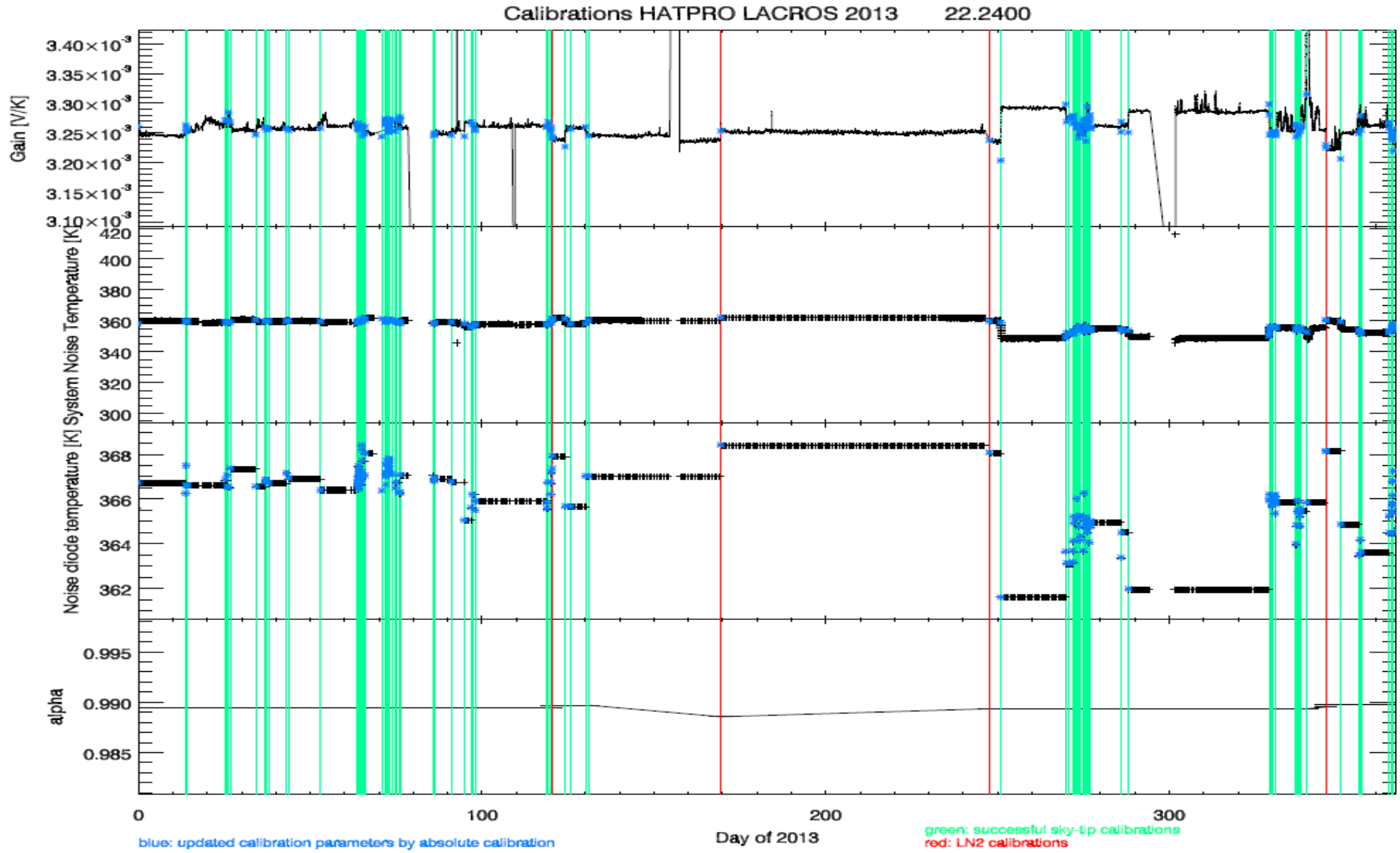
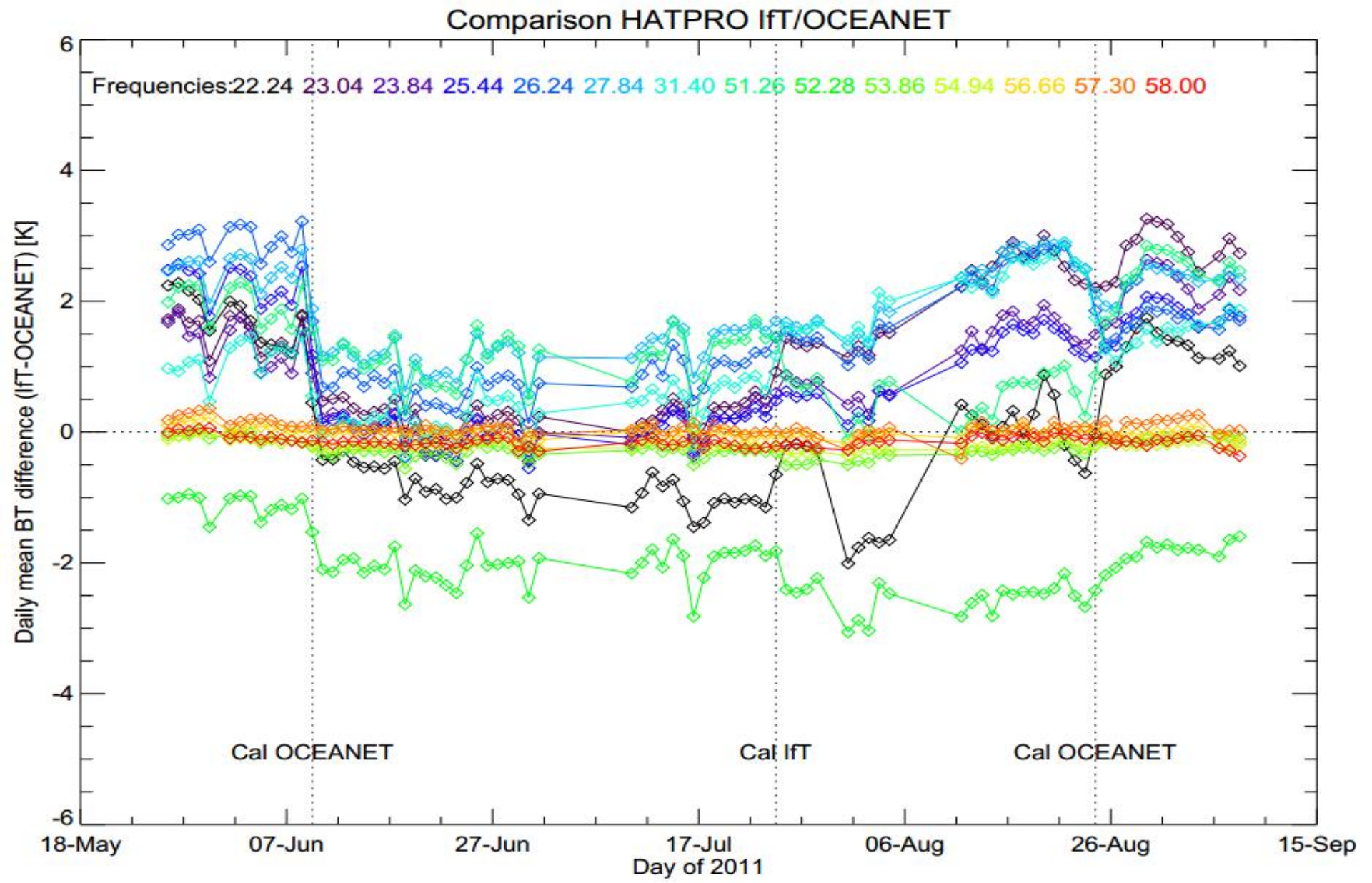


Fig. 3. TB offset time series at 90° elevation for 6 HATPRO V-band channels: TB(measured by MWR)-TB(simulated from sonde). The thick vertical lines indicate the absolute calibration times with liquid nitrogen.

Up to 7 K HATPRO calibration error (Löhnert and Maier, 2012)

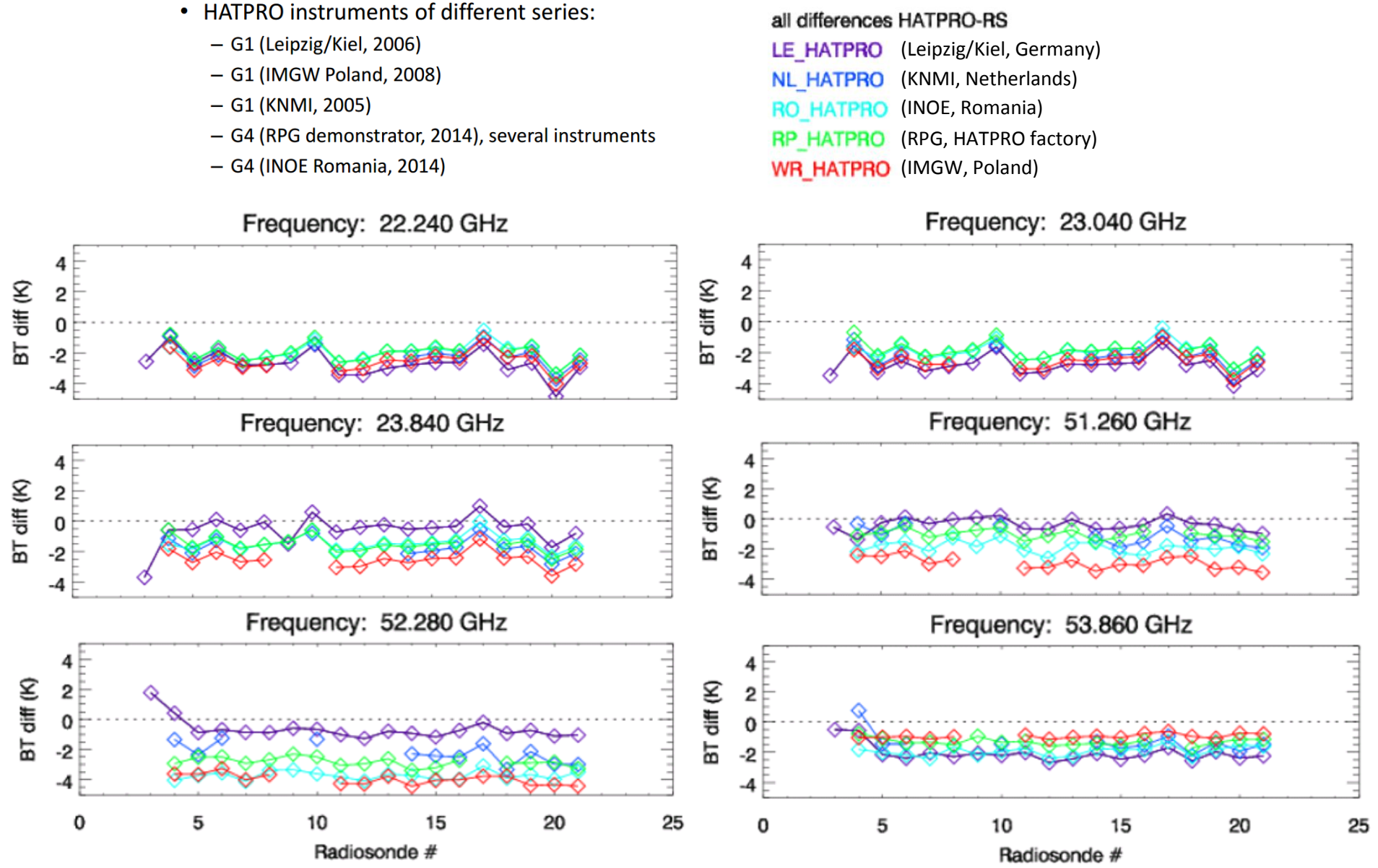


Up to 7 K HATPRO noise diode steps in liquid nitrogen (red) and tipping (green) calibrations and radiosonde comparisons (blue) reported by users (Pospichal, TOPROF J-CAL, 2014)



Up to ±3 K differences in side-by-side HATPRO brightness temperature observations (Pospichal, COST TPROF J-CAL, 2014).

- HATPRO instruments of different series:
  - G1 (Leipzig/Kiel, 2006)
  - G1 (IMGW Poland, 2008)
  - G1 (KNMI, 2005)
  - G4 (RPG demonstrator, 2014), several instruments
  - G4 (INOE Romania, 2014)



HATPRO vs. radiosonde brightness temperatures (Pospichal et al, COST TOPROF J-CAL2, 2015).
Up to 4-5 K inaccuracy for G1 and G4 models -- an order of magnitude larger than the 0.5 K RPG-HATPRO accuracy specification.

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Conclusions

- Closed Top-Mount Target (MP-3000)
  - Safe -- no cryogenic spillage hazard
  - Accurate -- 0.5 K (user confirmed)
- Open Side-Mount Target (HATPRO)
  - Safety Risk -- cryogenic spillage hazard
  - Inaccurate >4-5 K (user reported)