

# **The Ground-Based Scanning Radiometer: Observations during RHUBC**

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# The Arctic Winter Radiometric Experiments WVIOP2004 and RHUBC (2007)

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**Co-PIs:** A.J. Gasiewski, M. Klein, V. Leuski  
D. Cimini

**Periods:** March-April 2004 (WVIOP2004)  
and February-March 2007 (RHUBC)

**Location:** ARM NSA, Barrow, Alaska

## Radiometers

1) **Dual channel Microwave Radiometer (MWR):**  
23.8; 31.4 GHz

2) 4-channel GVR 183.31  $\pm$ 1;  $\pm$ 3;  $\pm$ 7;  $\pm$ 16  
GHz

3) 12-channel Microwave Radiometer Profiler (MWRP):  
22.235; 23.035; 23.835; 26.235; 30.0 GHz  
51.25; 52.28; 53.85; 54.94; 56.66; 57.29; 58.8 GHz

4) 27-channel Ground-based Scanning Radiometer (GSR)  
50.2; 50.3; 51.76; 52.625; 53.29; 53.845; 54.4; 54.95; 56.215; 56.325 GHz  
89 V; 89 H GHz

183.31 $\pm$ 0.55;  $\pm$ 1;  $\pm$ 3.05;  $\pm$ 4.7;  $\pm$ 7;  $\pm$ 12;  $\pm$ 16 GHz

340 V; 340 H GHz 380.197  $\pm$  0.4,  $\pm$  1.5;  $\pm$ 4;  $\pm$ 9;  $\pm$ 17 GHz



## Radiometer Calibration

Internal Loads (10 ms)

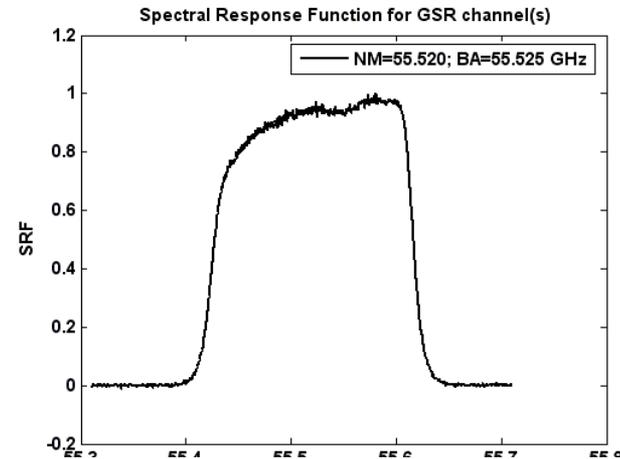
External Blackbody Targets (2 min)

Tip Calibration (Window Channels)

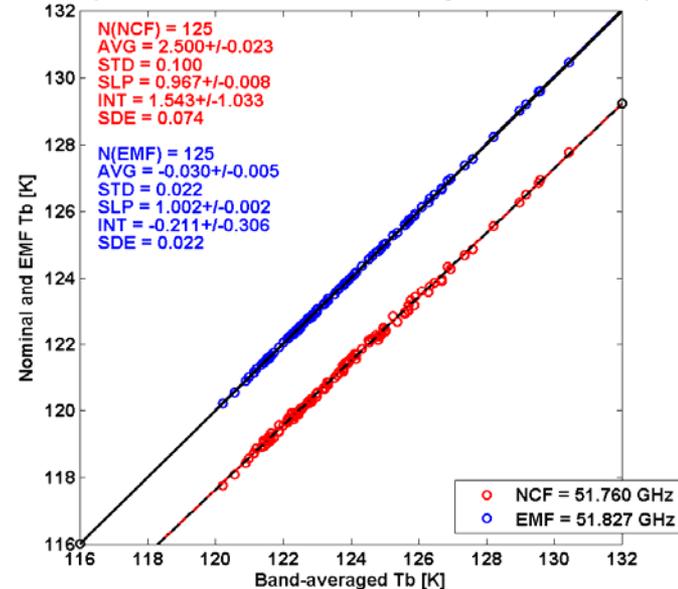
## Calculations from Radiosondes

Compute band-averaged Tb

Relative to Monochromatic, band calculations provide corrections up to 2.5 K !



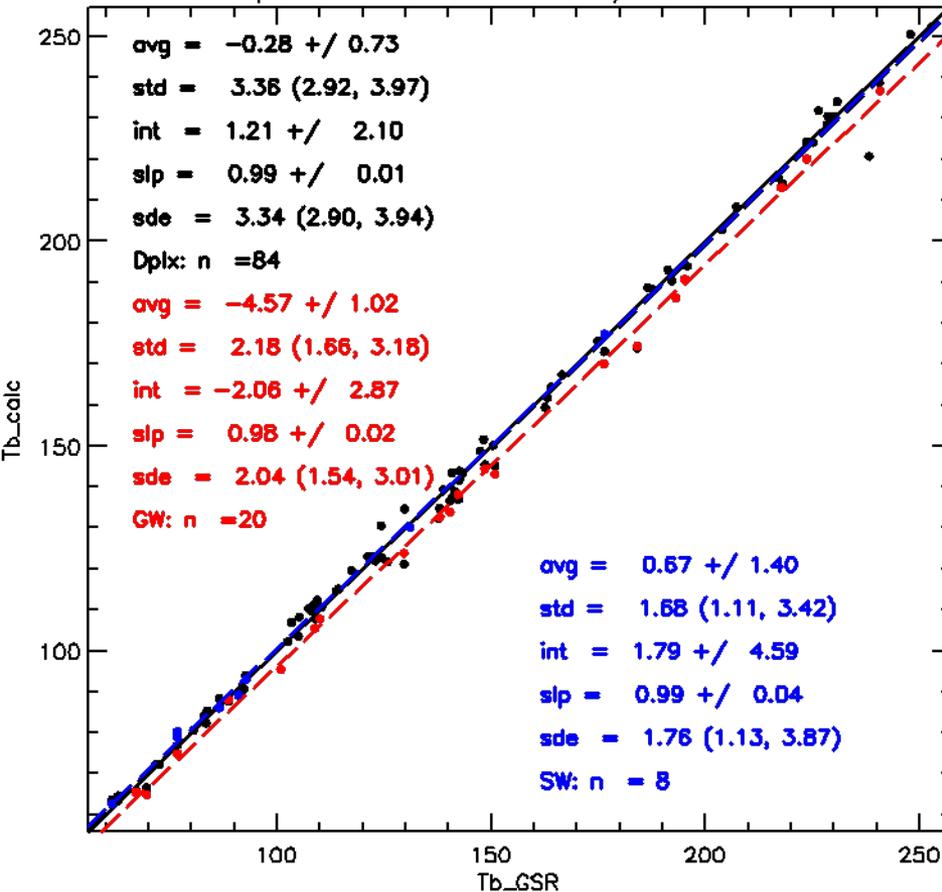
Nominal and Equivalent Monochromatic vs Band-averaged Tb for 51.760 GHz (LIL model)



# Typical results of Forward Model Analysis Near 183.31 GHz for WVIOP2004

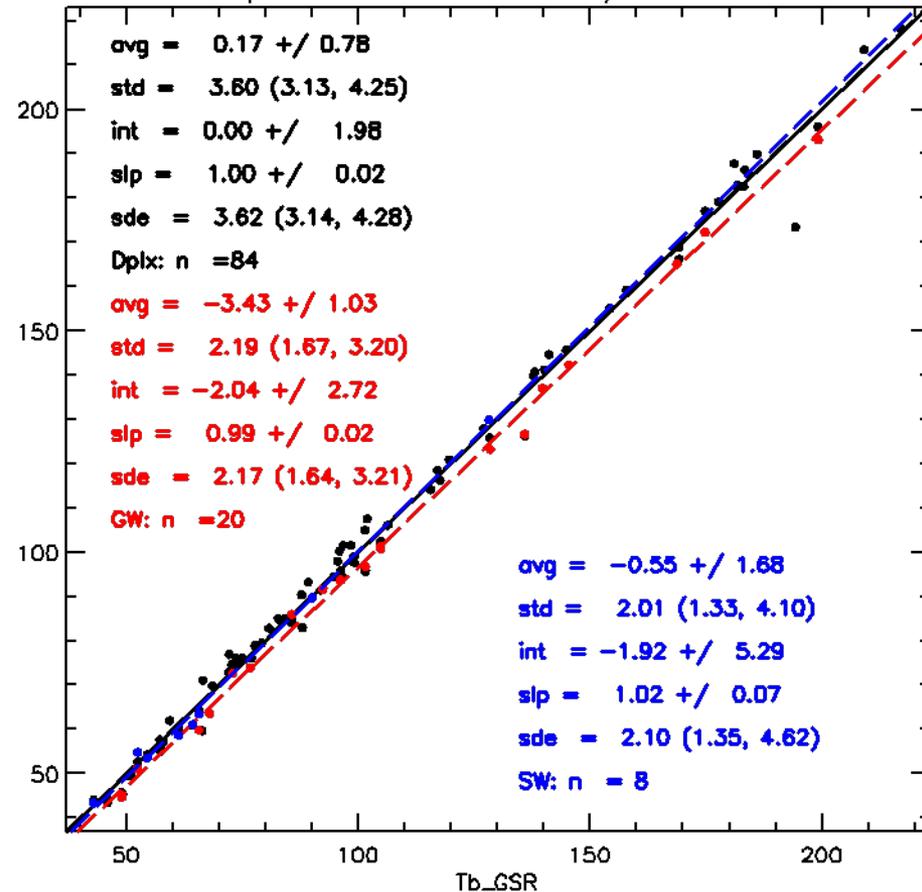
183.31 +/- 4.7 GHz

Dplx + GW +SW 183.31+/-4.7 LIL05



183.31 +/- 7 GHz

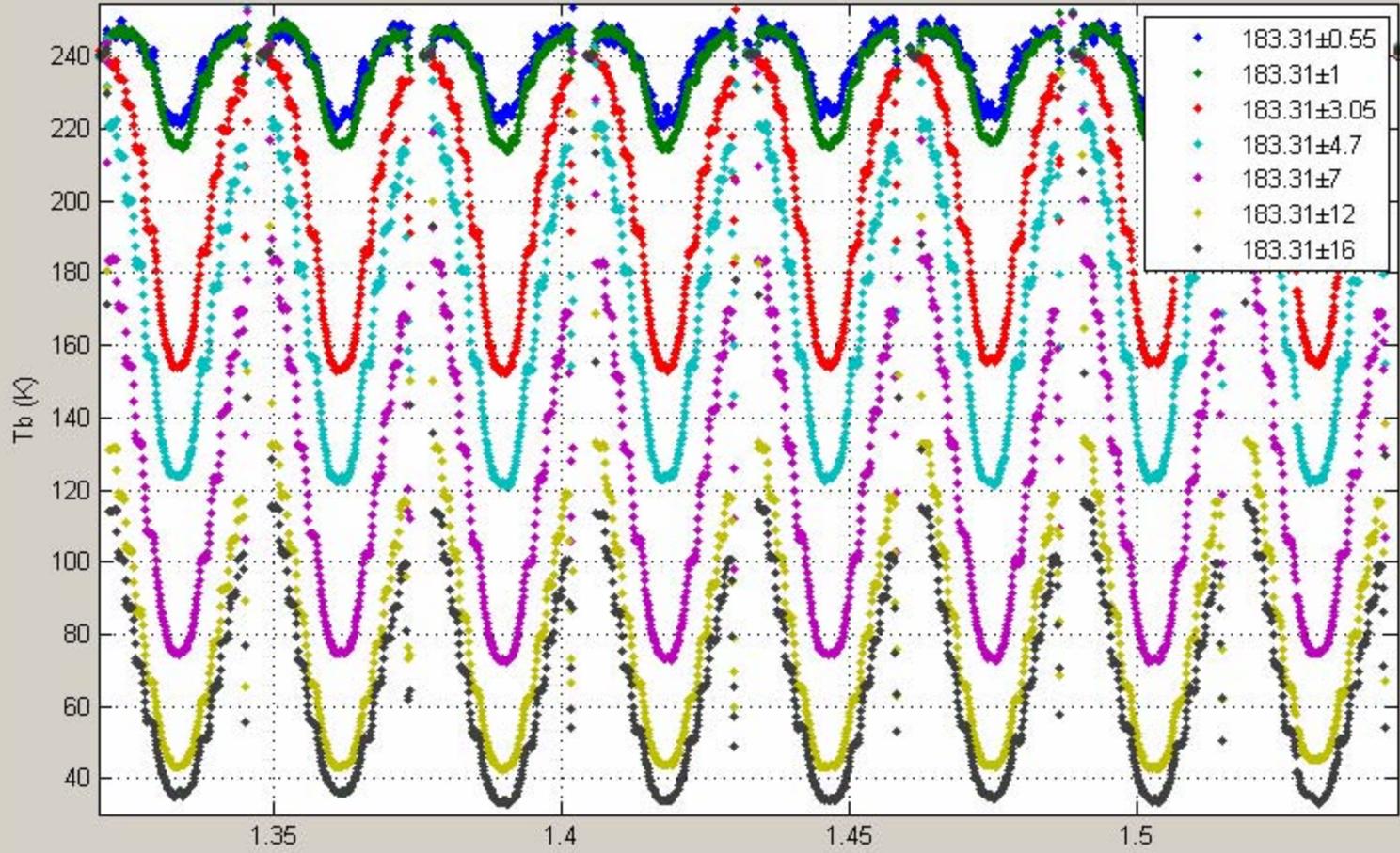
Dplx + GW +SW 183.31+/-7 LIL05



- RHUBC focused on  $PWV < 2$  mm (usually associated with  $T_S < -30$  C)
- Promising conditions for PWV/cirrus cloud provided by Penn State University forecast
- Decision to launch radiosondes used quasi real time GSR data.

# GSR Quasi Real Time Display

GSR (all) from 08-Mar-2007 01:09:28 to 08-Mar-2007 02:09:28



- CHANNELS
- 50.300 GHz
  - 51.76 GHz
  - 52.825 GHz
  - 53.290 GHz
  - 53.845 GHz
  - 54.400 GHz
  - 54.950 GHz
  - 55.520 GHz
  - 56.025 GHz
  - 56.215 GHz
  - 56.325 GHz
  - 89v GHz
  - 89h GHz
  - 183.31±0.55 GHz
  - 183.31±1.0 GHz
  - 183.31±3.05 GHz
  - 183.31±4.7 GHz
  - 183.31±7 GHz
  - 183.31±12 GHz
  - 183.31±16 GHz
  - 340v GHz
  - 340h GHz
  - 380.1974±0.4 GHz
  - 380.1974±1.5 GHz
  - 380.1974±4 GHz
  - 380.1974±9 GHz
  - 380.1974±17 GHz
  - PWV (mm)
  - LWP (mm)

CALIBRATION

- Internal Loads
- External Targets
- Tipping Curve

LEVEL

- Raw Data
- Trimmed Data
- Calibrated Data

PLOT

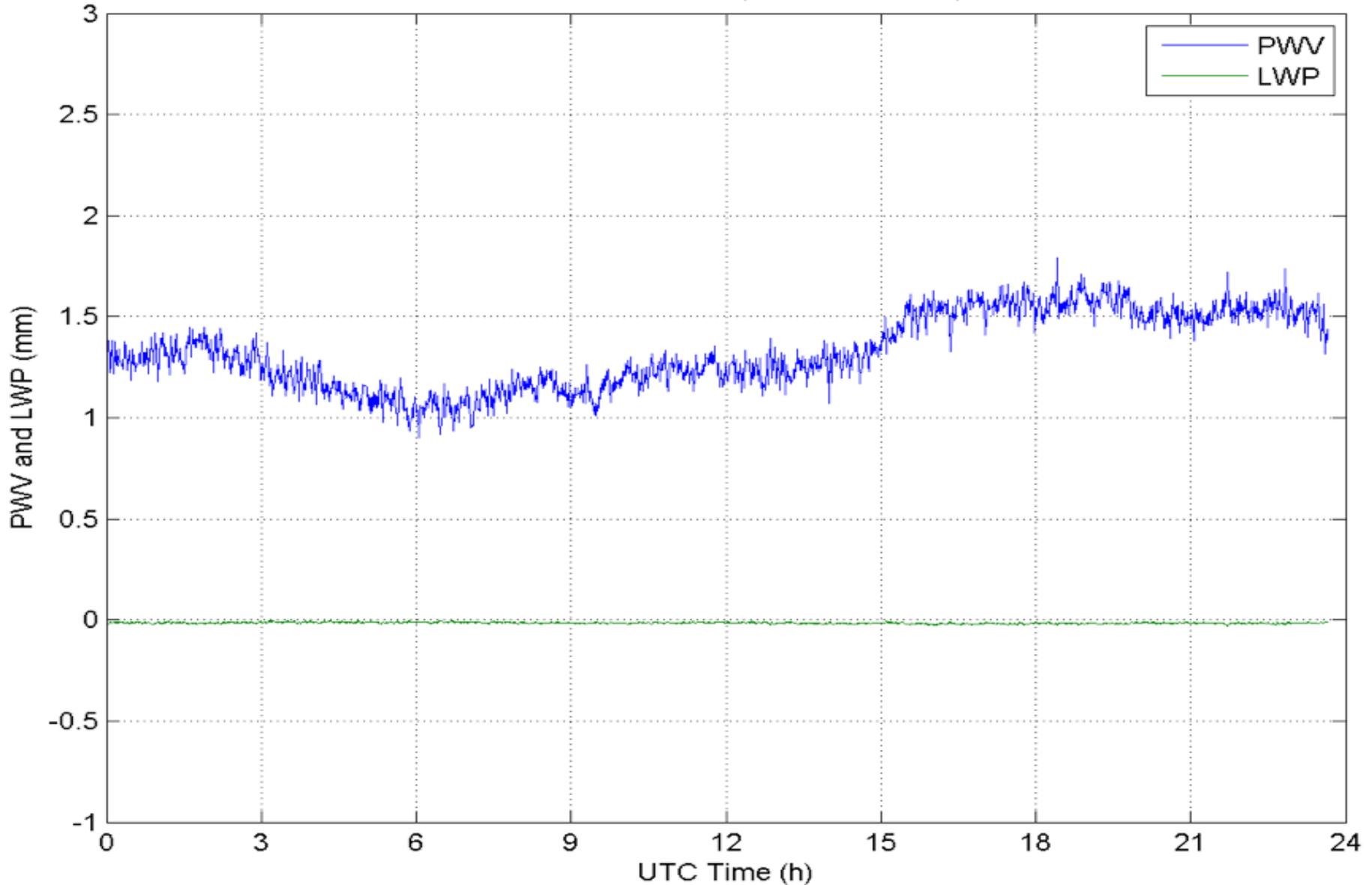
- All Data
- Scene Only
- Zenith Only

ACTION:

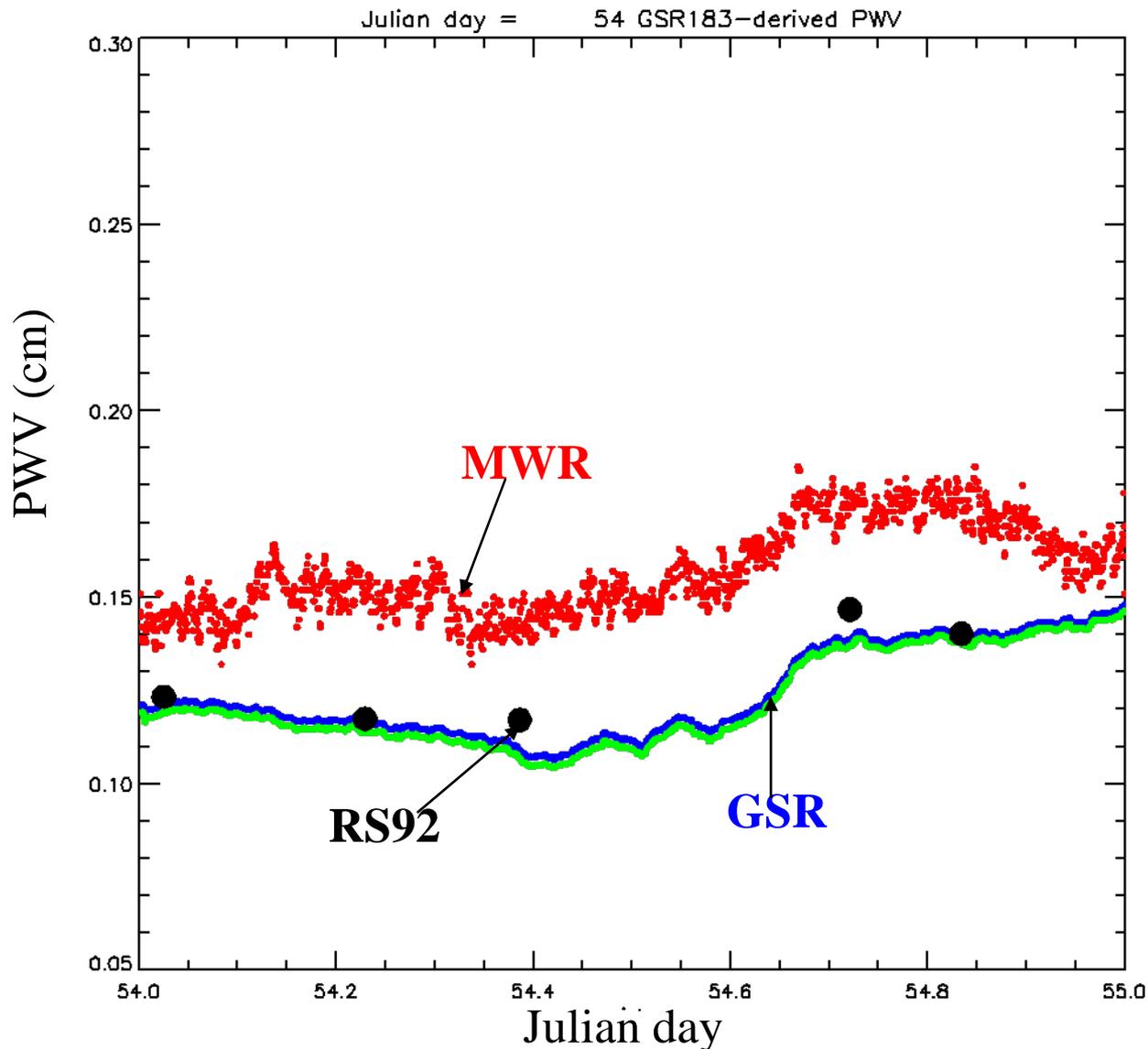
**Display latest 1-hour data...**  
**Next update at 07-Mar-2007 17:34:28**  
**AKT**

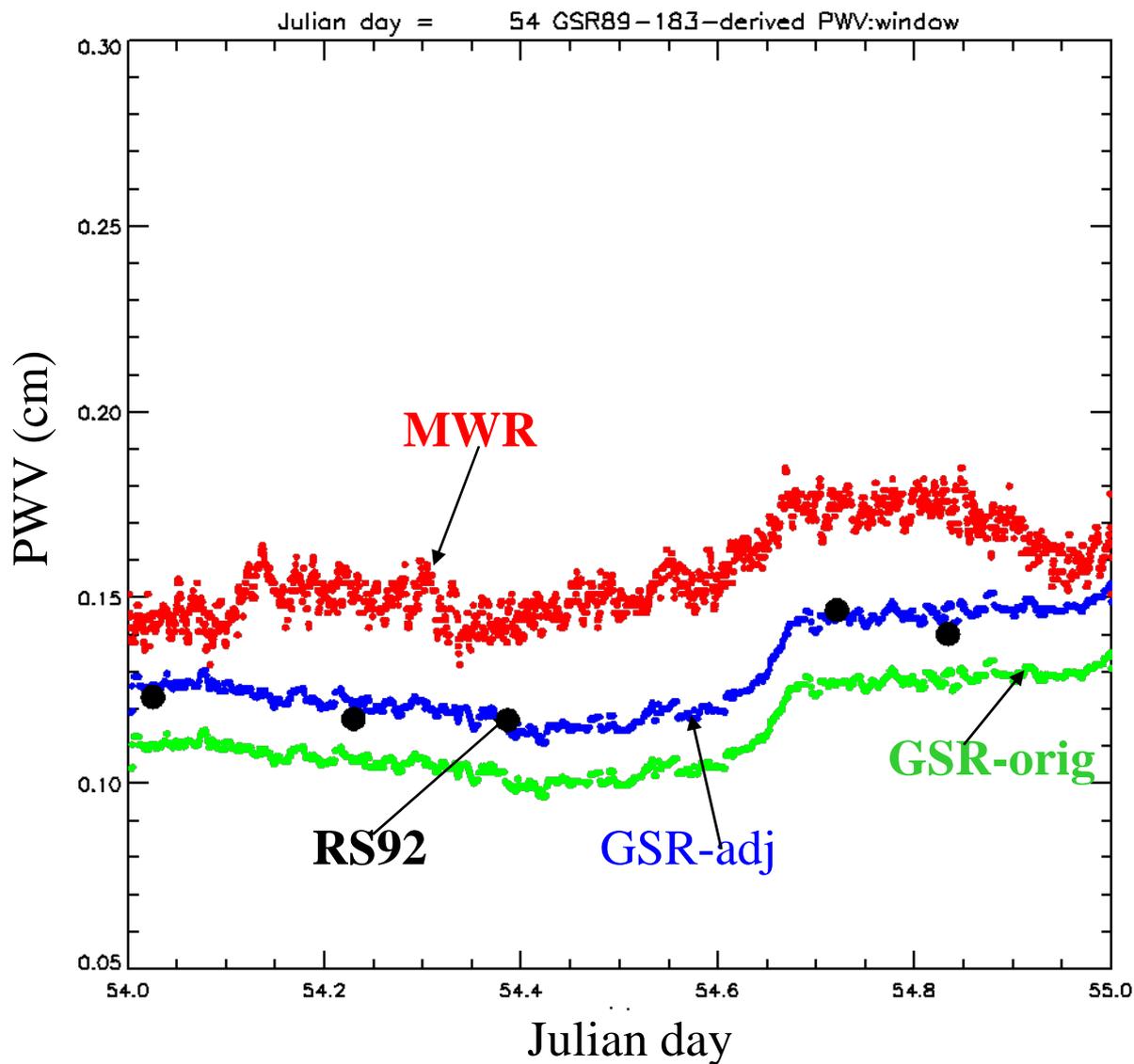
STOP

RHUBC 2007 GSR RETRIEVALS (PRELIMINARY!) for 2007/03/10

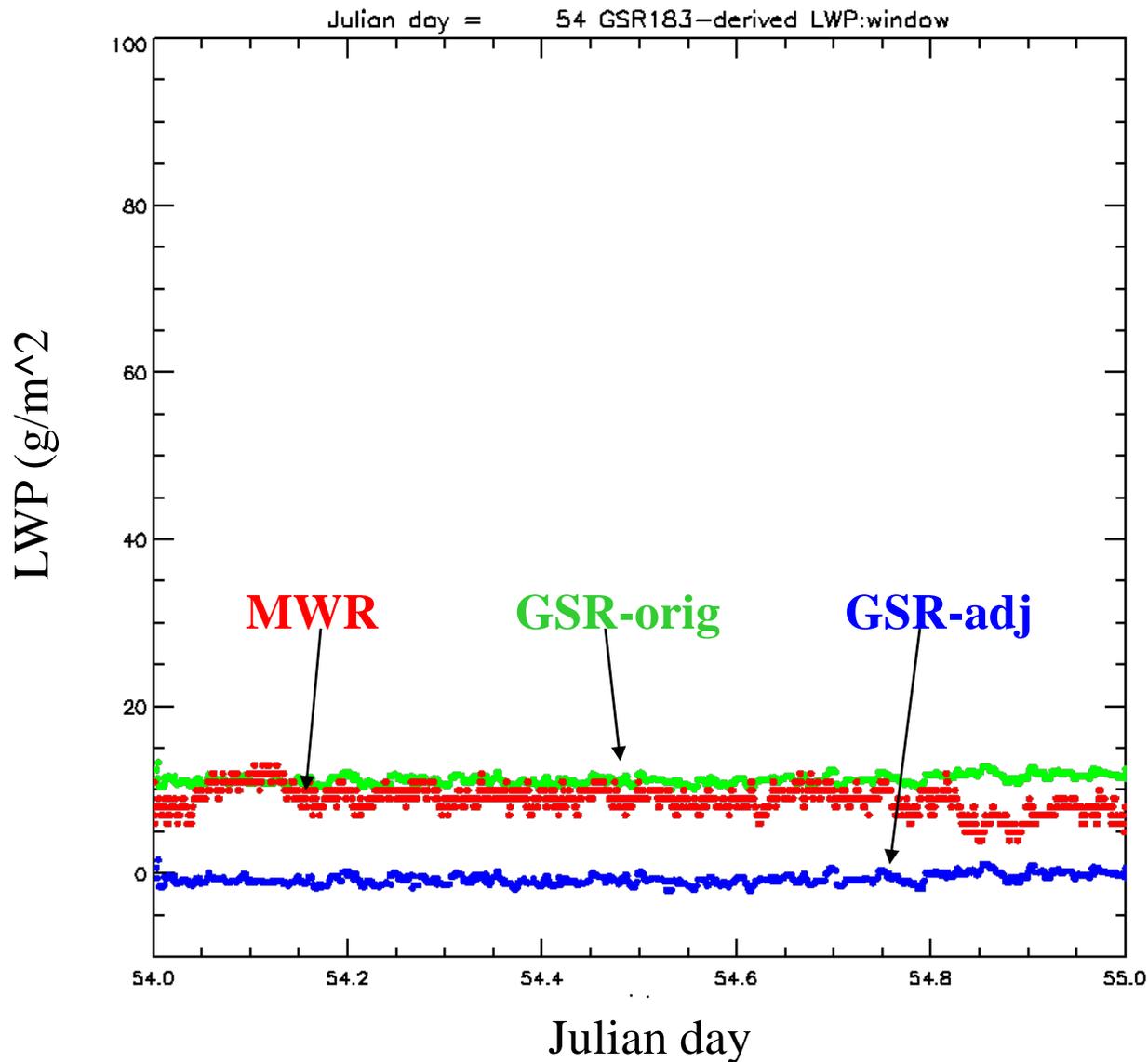


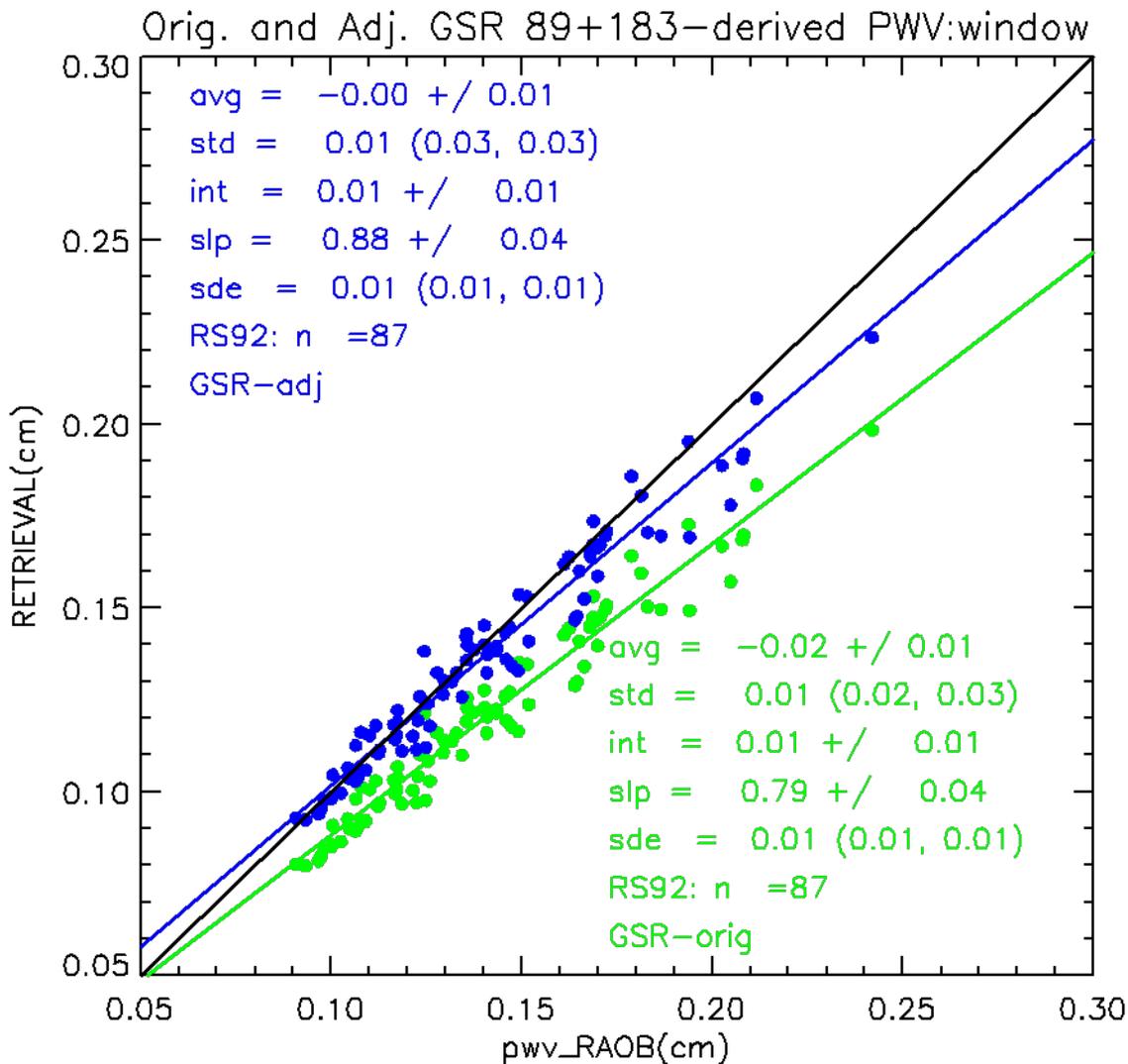
- A Priori Linear Statistical Retrieval
- Historical data set of Vaisala RS90/RS92 taken at NSA (Substantial QC was necessary)
- RTE model based on Liljegren et al. (2005)
- Two sets of PWV retrievals: (A) Using original Tb calibration; (B) using Tb's adjusted to Liljegren et al. 2005 model based on WVIOP\_2004
- Covariance matrix of experimental errors determined from WVIOP\_2004 data
- Ground truth from Vaisala RS92 Radiosondes launched at the Great White

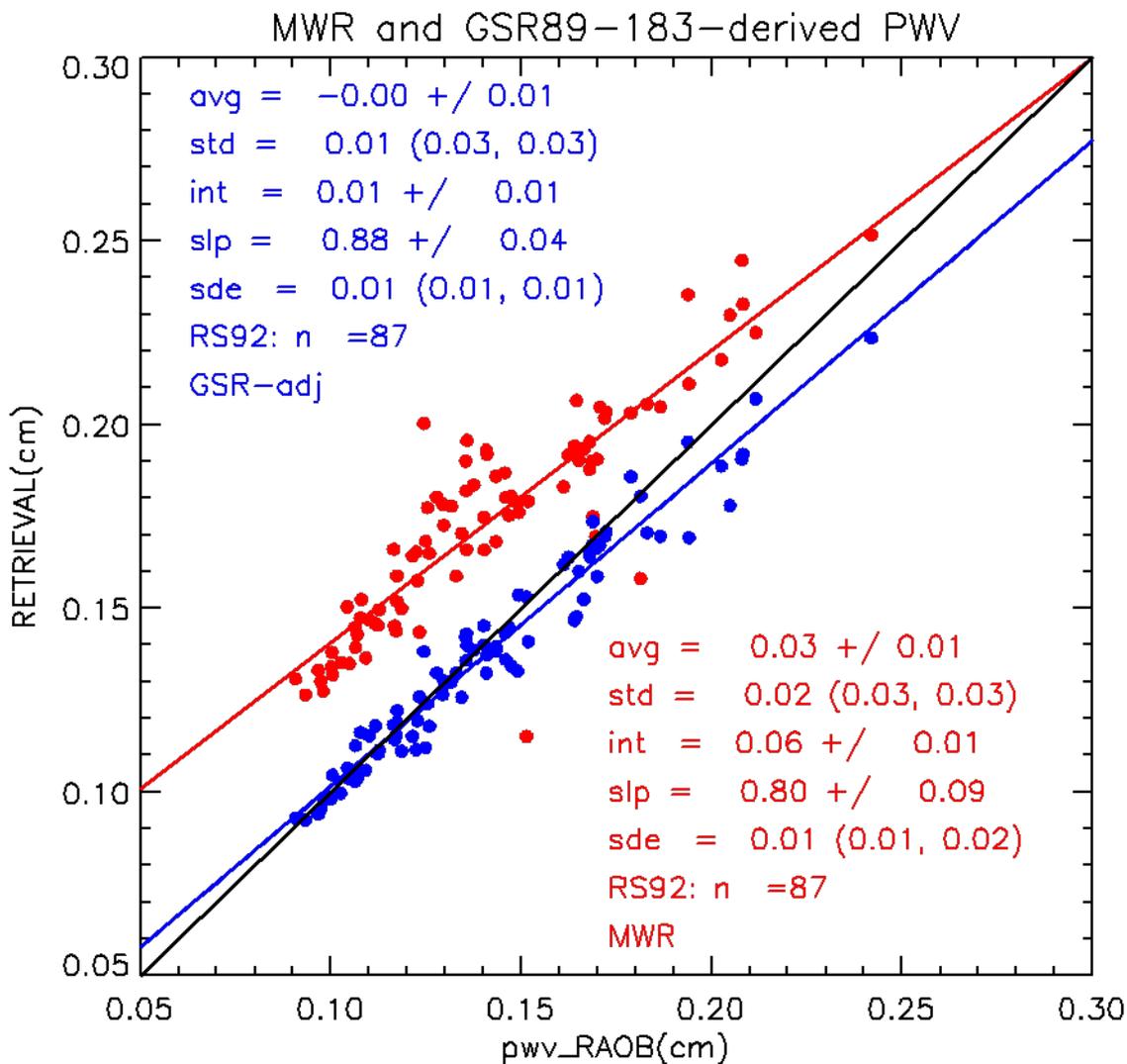




# Window channel LWP retrievals for Julian Day 54, 2007







- Quasi Real-time PWV retrievals (without tip cal) were used successfully for radiosonde launch decisions
- GSR linear 7-channel and 89- window PWV Retrievals compared well with Vaisala RS92/LIL05 calculations (0.1 mm rms: 6%)
- GSR linear 89- window LWP Retrievals are promising, but need independent verification

### Work in Progress

- Profile Retrievals from GSR using Optimal Estimation

Thank you very much for your attention

D. Cimini, E. R. Westwater, A. J. Gasiewski, M. Klein, V. Leusky, and J. C. Liljegren, „The Ground-based Scanning Radiometer (GSR): a powerful tool for the study of the Arctic Atmosphere”, *IEEE Transactions on Geosciences and Remote Sensing*, **Vol. 45, No. 9**, September 2007, pp. 2759-2777..

D. Cimini, E. R. Westwater, A. Gasiewski, M. Klein, V. Leuski, J. Liljegren, Ground-based millimeter- and submillimeter-wave observations of low vapor and liquid water contents, *IEEE Transactions on Geosciences and Remote Sensing*, **Vol. 45, No. 7**, Part II. July 2007, pp.2169-2180.

V. Mattioli, E. R. Westwater, D. Cimini, J. S. Liljegren, B. M. Lesht, S. I. Gutman, and F. J. Schmidlin “Analysis of Radiosonde and ground-based remotely sensed PWV data from the 2004 North Slope of Alaska Arctic Winter Radiometric Experiment” *Journal of Atmospheric and Oceanic Technology*, **Vol. 24, March 2007**, 415-431

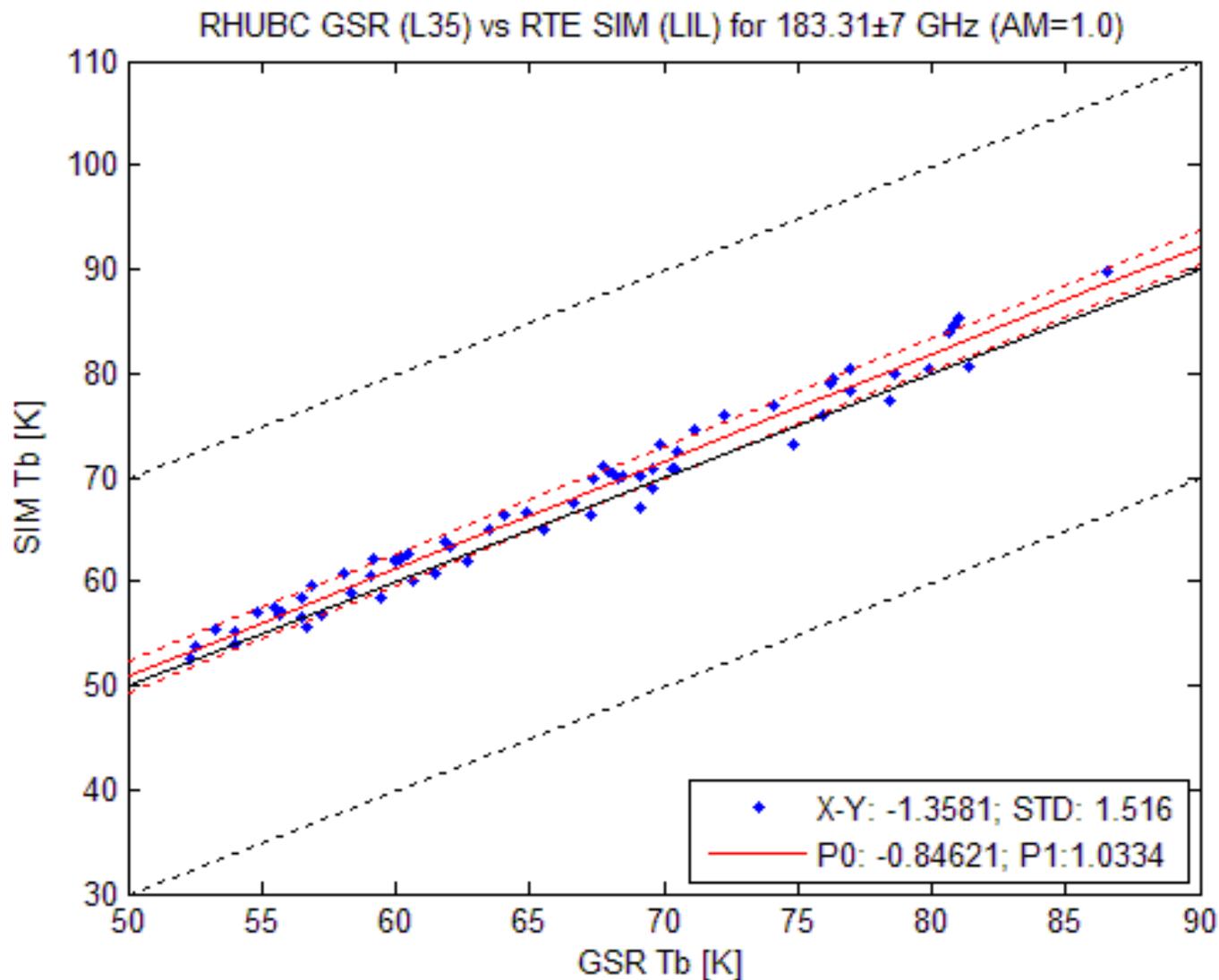
Liljegren, Cadeddu, and Pazmany papers in

Special Issue on the 9th Specialist Meeting on Microwave Radiometry and Remote Sensing Applications (MicroRad’06), *IEEE Transaction on Geosciences and Remote Sensing*, **Vol. 45, No. 7**, Part I. July 2007

Back up Slides

# RHUBC: GSR 183.31 +/- 7 GHz

## meas. vs. LIL05 calc.

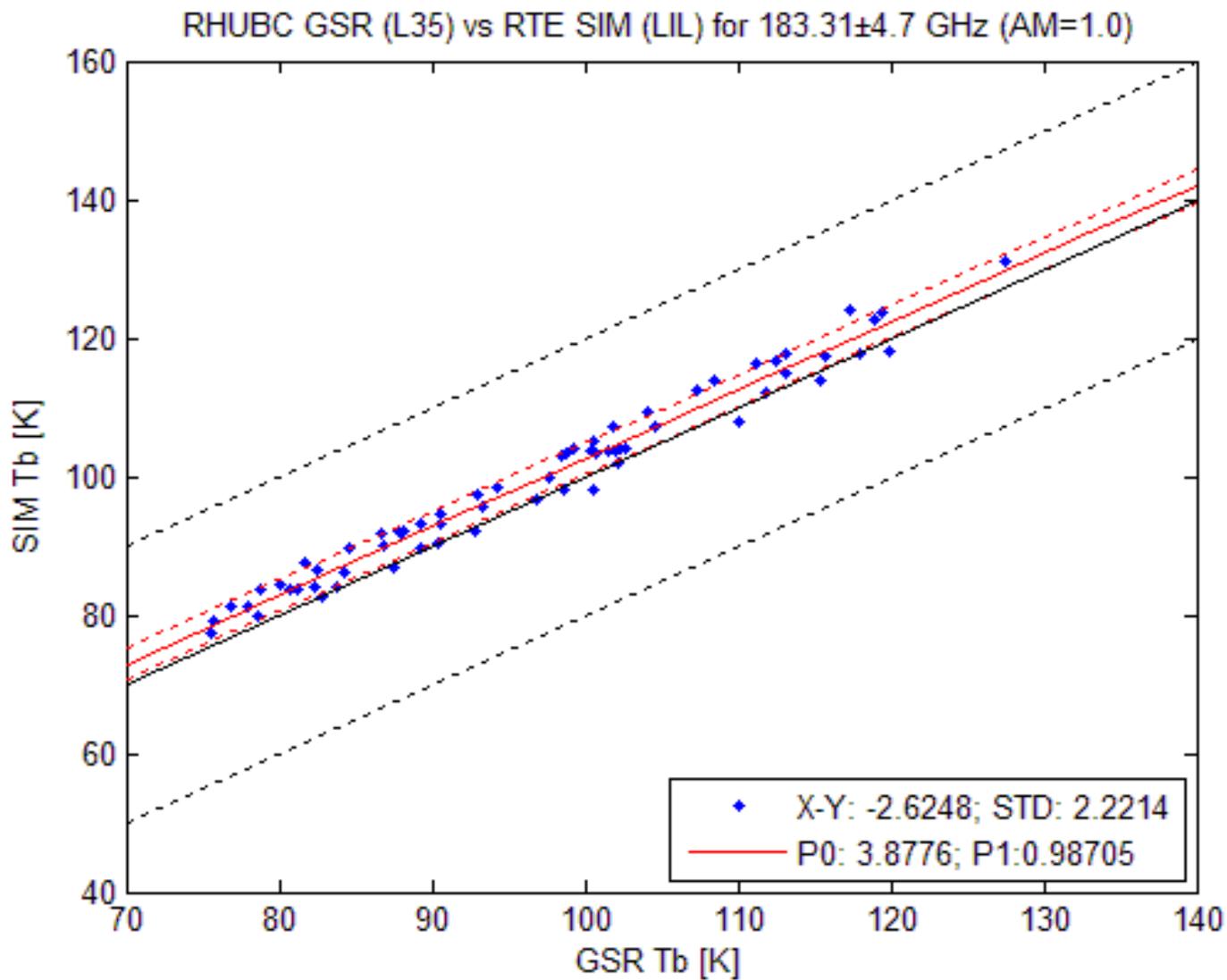


# RHUBC Objectives

## Pi's: Dave Turner (UW) and Eli Mlawer

- Conduct a clear sky radiative closure exercise in the far-IR, to reduce uncertainties in water vapor continuum and absorption line parameters
- Investigate the radiative properties of cirrus in the far-IR
- Instrument cross-comparison and validation
  - Far-IR instruments (AERI-ER, FIRST, TAFTS)
  - 183 GHz microwave radiometers (GSR, GVR, later MP-183)

# RHUBC: GSR 183.31 +/- 4.7 GHz meas. vs. LIL05 calc.



# RHUBC Approach

- Conduct experiment at NSA ACFR in Feb - Mar, when climatology favors clear skies and PWV is the low ( $\sim 2$  mm)
- Bring in TAFTS, FIRST, second AERI-ER
- Bring in GSR
- Have extra radiosondes available for investigators to launch when conditions are 'good'
- Daily planning meeting to discuss operations, as we were targeting clear + dry and cirrus + dry conditions

