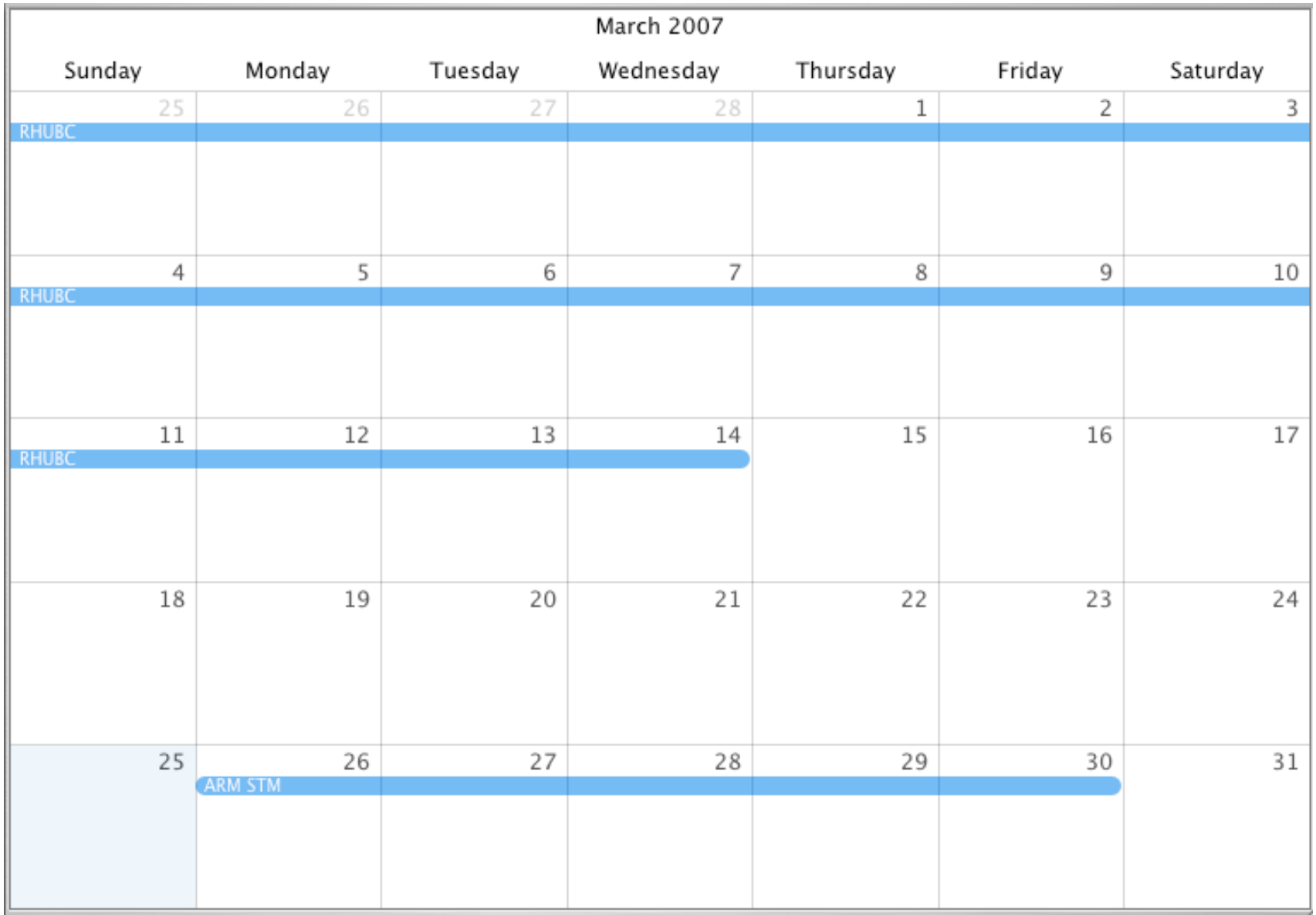
Radiative Heating in Underexplored Bands Campaign (RHUBC)

Feb 22 - Mar 14, 2007

Dave Turner, Eli Mlawer

RHUBC Breakout Session
ARM Science Team Meeting
Monterey, California
27 March 2007

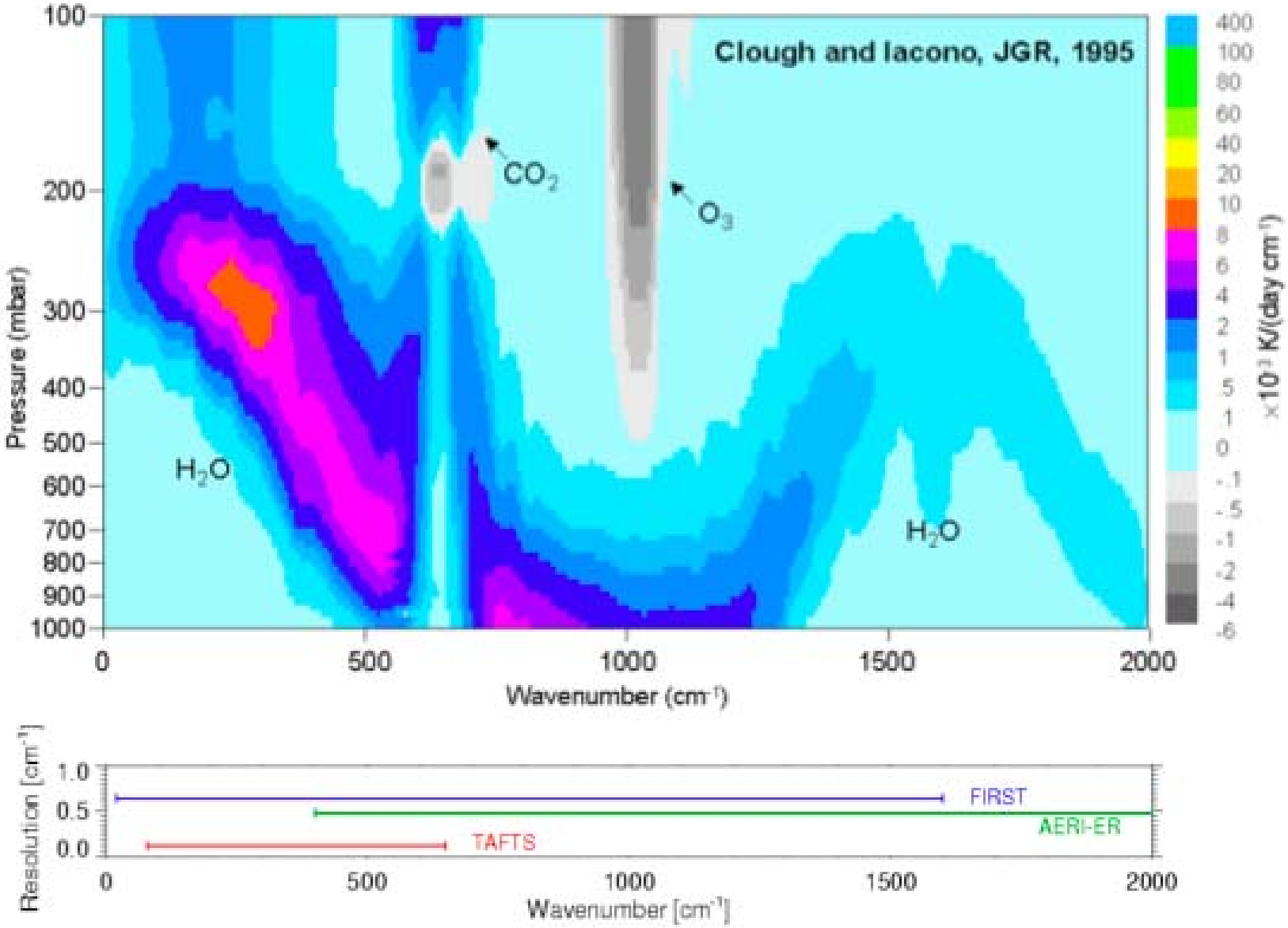
Not a Lot of Time Between IOP and STM!



RHUBC Motivation

- Radiative cooling due to water vapor in mid-to-upper trop contribute significantly to the dynamical processes and radiative balance the regulate Earth's climate
- ~40% of the OLR comes from far-IR (wavelengths > 15 μm)
- Far-IR has not been well studied because:
  - Far-IR is opaque from the surface at most locations because of "large" PWV amounts
  - Lack of spectrally resolved far-IR instruments

Importance of the Far-IR



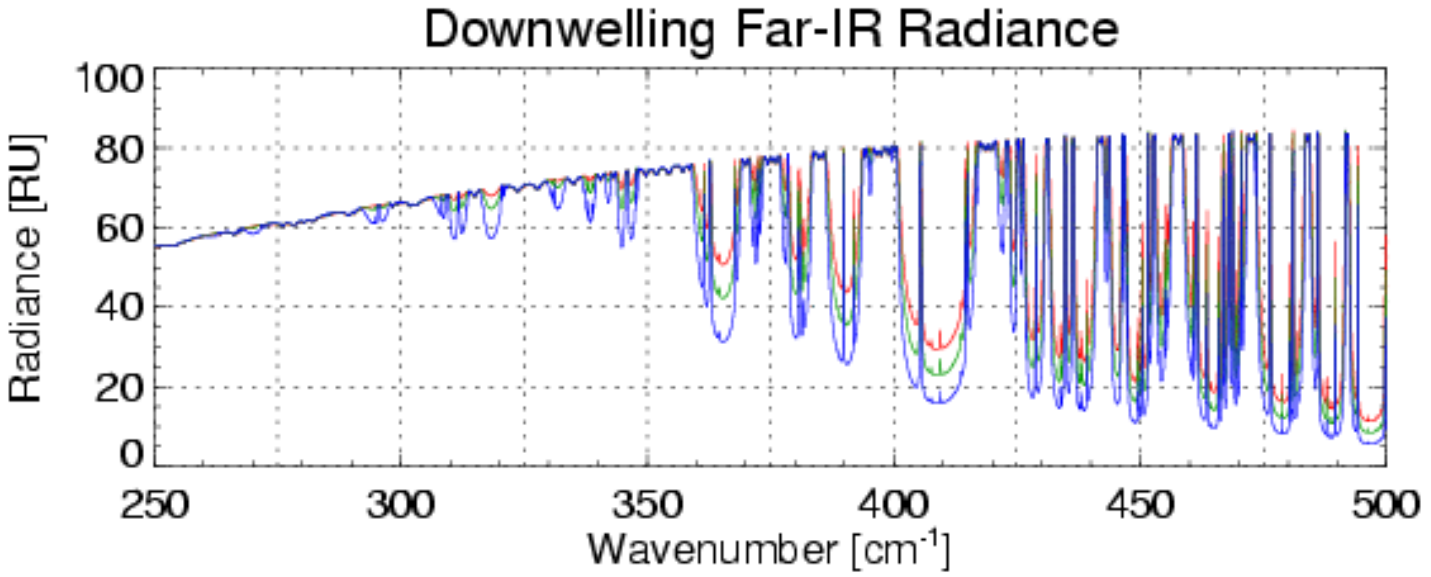
RHUBC Objectives

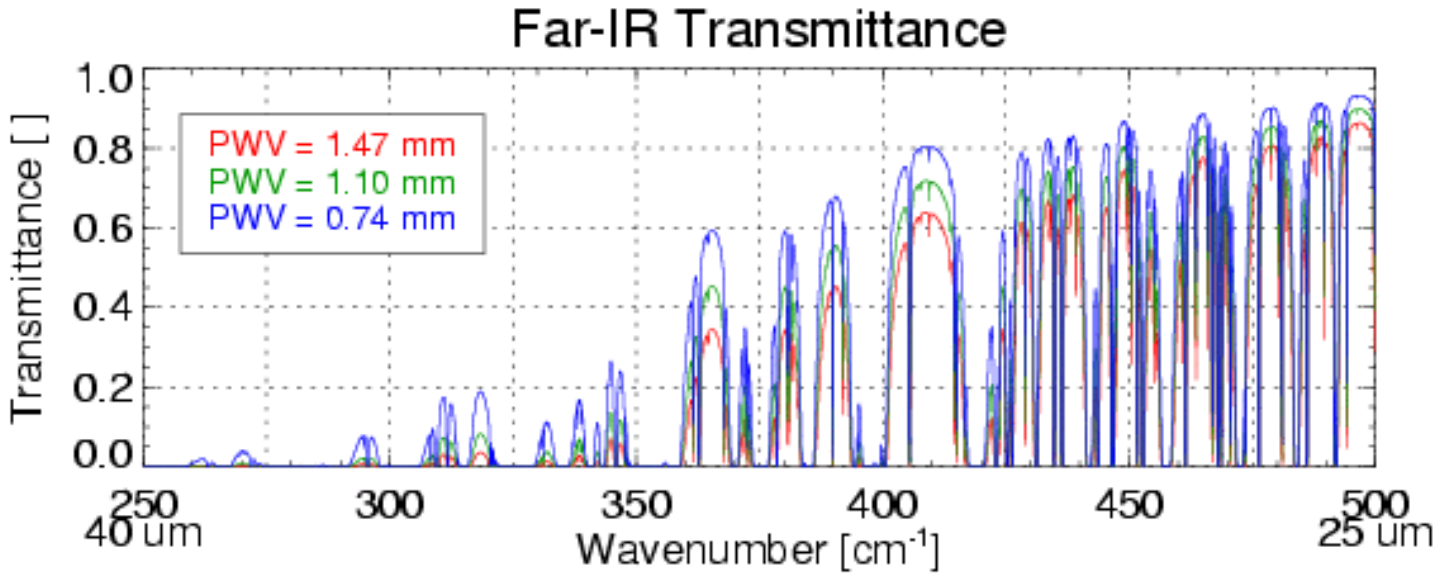
- Conduct a clear sky radiative closure exercise in the far-IR, to reduce uncertainties in water vapor continuum and absorption line parameters
- Investigate the radiative properties of cirrus in the far-IR
- Instrument cross-comparison and validation
  - Far-IR instruments (AERI-ER, FIRST, TAFTS)
 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

RHUBC Approach

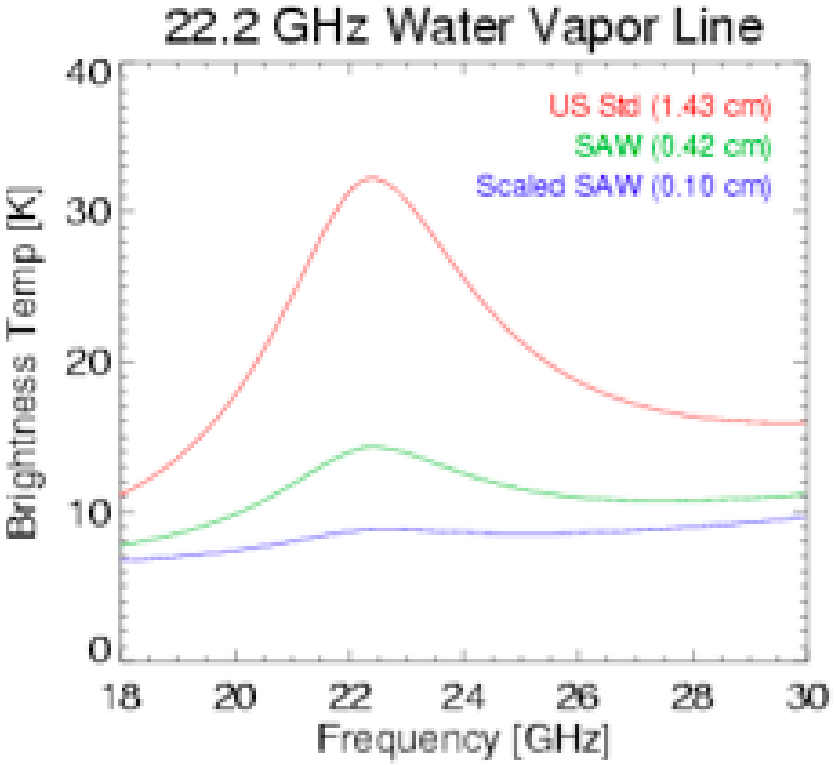
- Conduct experiment at NSA ACFR in Feb - Mar, when climatology favors clear skies and PWV is the low (~ 2 mm)
- Bring in TAFTS, FIRST, second AERI-ER
- Bring in GSR
- Have extra radiosondes available for investigators to launch when conditions are ‘good’
- Daily planning meeting to discuss operations,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

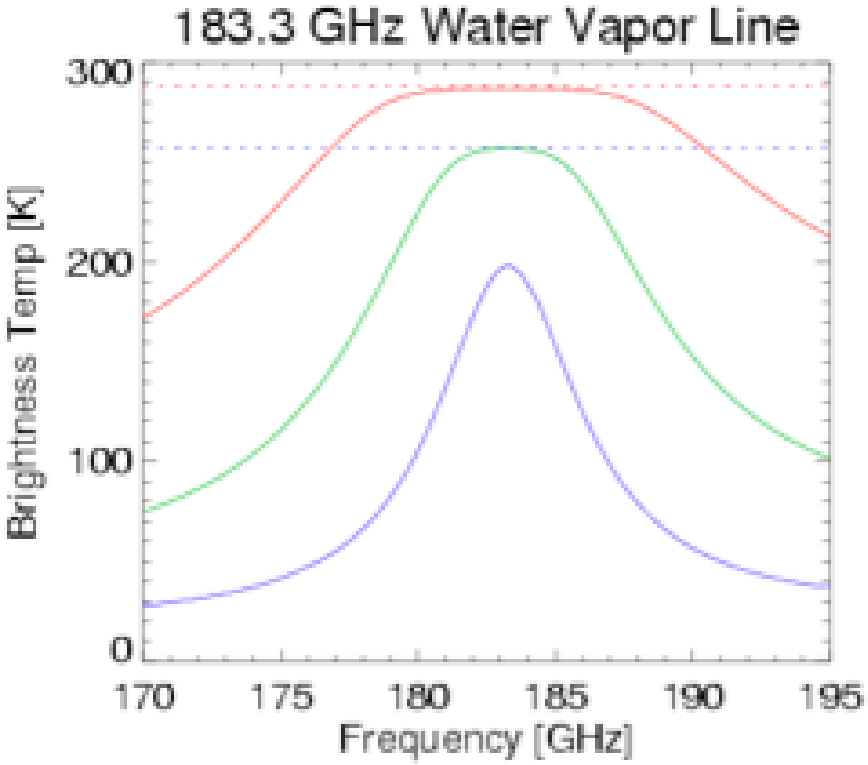
Microwindows in Far-IR





Why 183 GHz Radiometers are Critical for RHUBC





No sensitivity at 22.2 GHz for these low PWV amounts, but good sensitivity at 183 GHz

RHUBC Participants

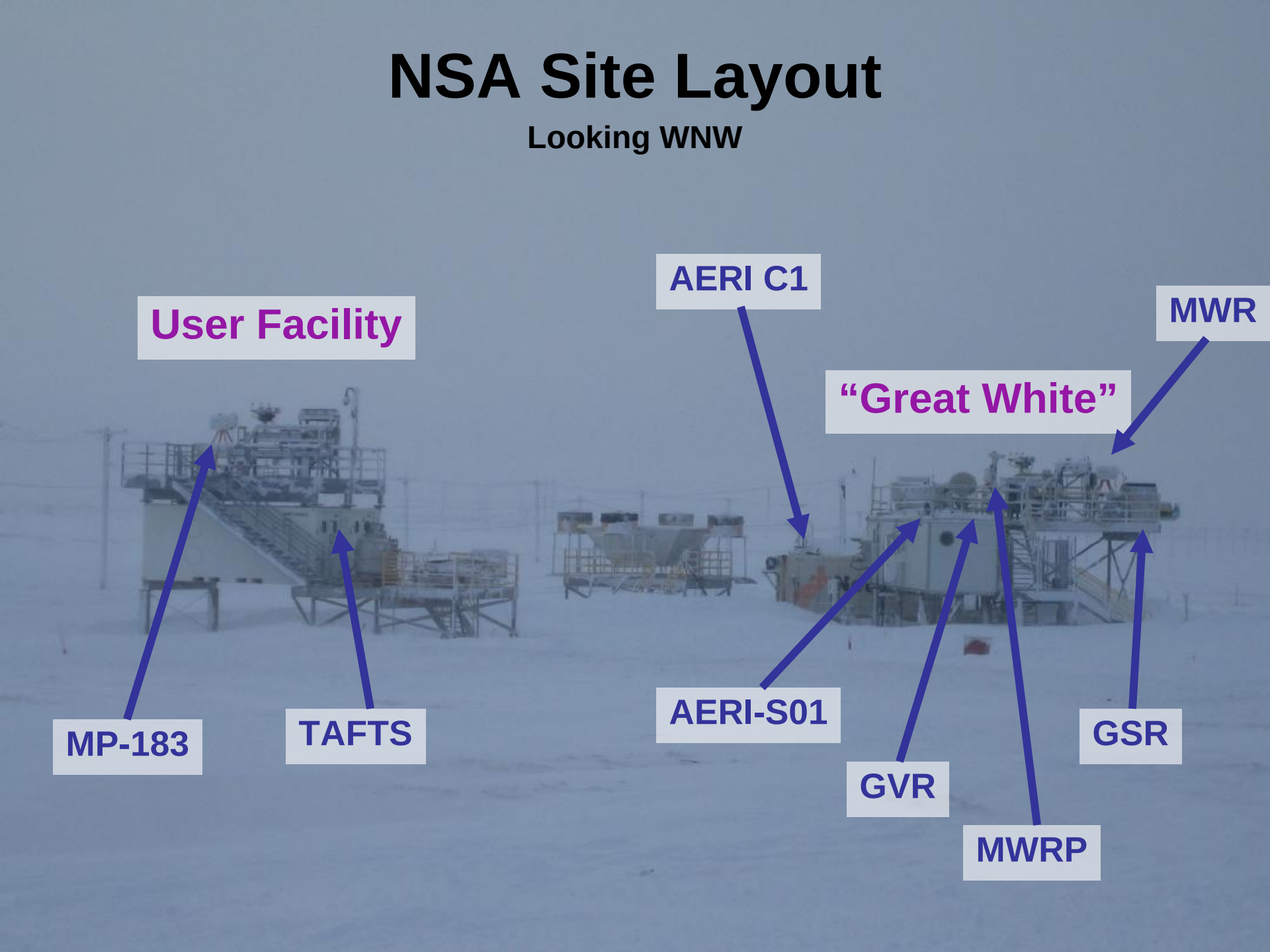
- PIs: Dave Turner and Eli Mlawer
- Co-Is:
  - Paul Green, Neil Humpage (Imperial College)
  - Ed Westwater, Nico Cimini, Marian Klein (CET)
  - Marty Mlynczak (NASA/LaRC)
  - Maria Cadeddu (ANL)
- Site preparation and organization
  - Mark Ivey, Jeff Zirzow (SNL)
  - Walter Brower, Jimmy Ivanoff (NSA site ops)
  - Hans Verlinde, Chad Bahrmann (NSA site sci. team)
- Other important participants
  - Mike Exner (Radiometrics)
  - Bob Aune (NOAA/NESDIS)

Participants

Not shown:
Mark, Marian, Jeff

NSA Site Layout

Looking WNW



GVR

- Developed by ProSensing under DOE SBIR grant
- 4 double-sideband channels at +/- 1, 3, 7, 16 GHz away from 183.31 GHz
- Uses hot (~330 K) and ambient calibration targets
- Operational at NSA for over 1 year

GSR

- Developed at NOAA Earth System Research Lab
- Multi-wavelength radiometer from 50 - 380 GHz
- Rotating drum head
- Double-sideband radiometer, with channels at +/- 0.55, 1, 3, 4.7, 7, 12, and 16 GHz from 183.31 GHz

- Periodic views of two internal and two external targets, and uses TIP curves

MP-183

- Developed at Radiometrics under DOE SBIR
- Uses synthesizer, so number of channels on 183.31 GHz line is programmable (single-sideband)
- Used 14 channels from 170 to 183.31 GHz
- Scanned continuously during IOP
- Found out about instrument 2 weeks before IOP started!

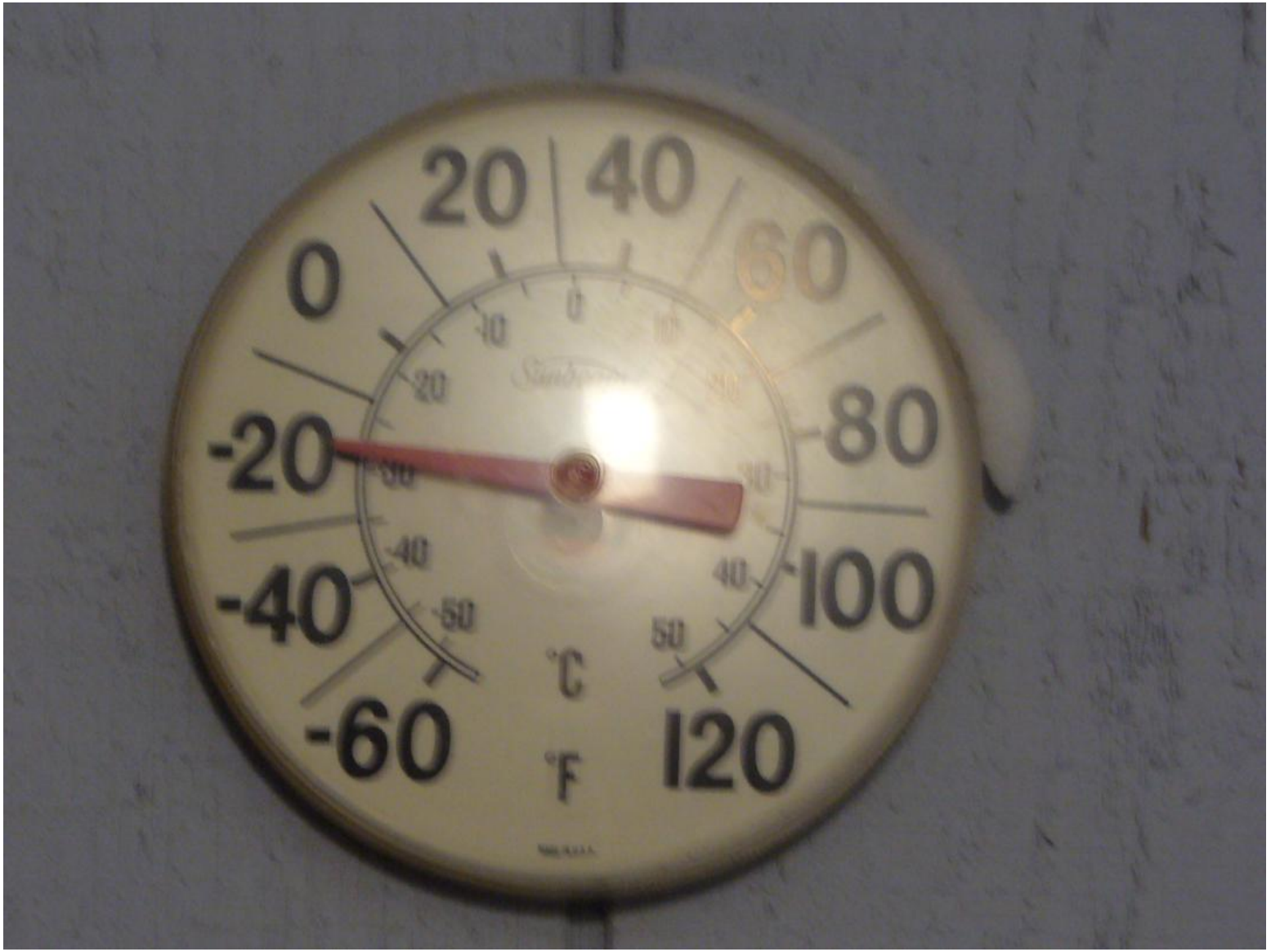
AERI

- Hardened automated interferometer
- Range 3.3 - 25 μm with 0.5 cm^{-1} resolution
- 3-min (normal) or 20-s sky (rapid-sample) averages
- Accuracy better than 1% ambient radiance

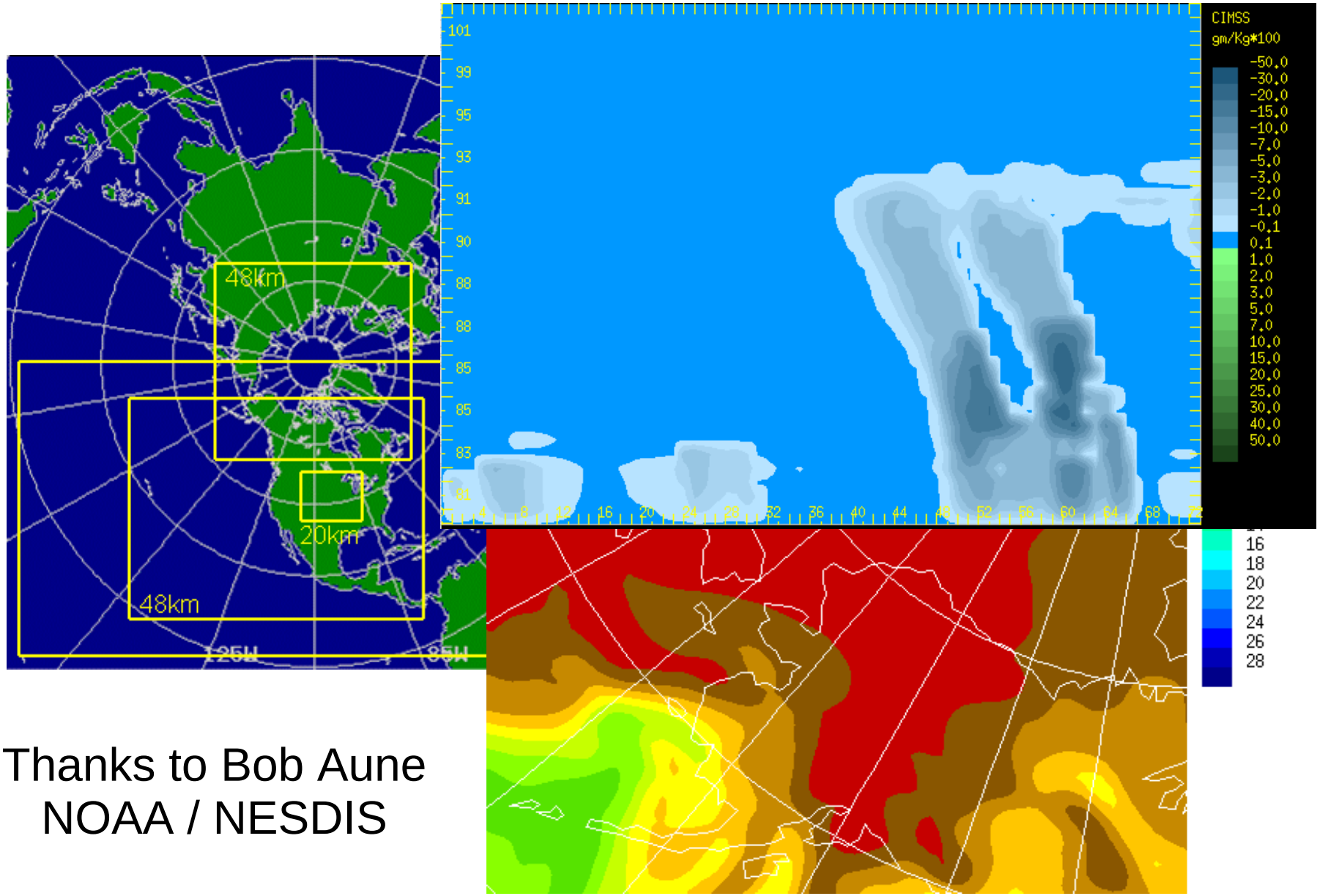
TAFTS

- Aircraft instrument, developed in late 1990s
  - Flown on UK Met Office C-130, ARA Egrett, FAAM BAe-146
- Two detectors: 80-300 and 300 - 650 cm^{-1}
- Spectral resolution: 0.12 cm^{-1}
- Utilizes 4 blackbodies
- Detectors require liquid helium and liquid nitrogren
- Last mission: January 2007 over the UK !

Forecasting 101



CRAS Model

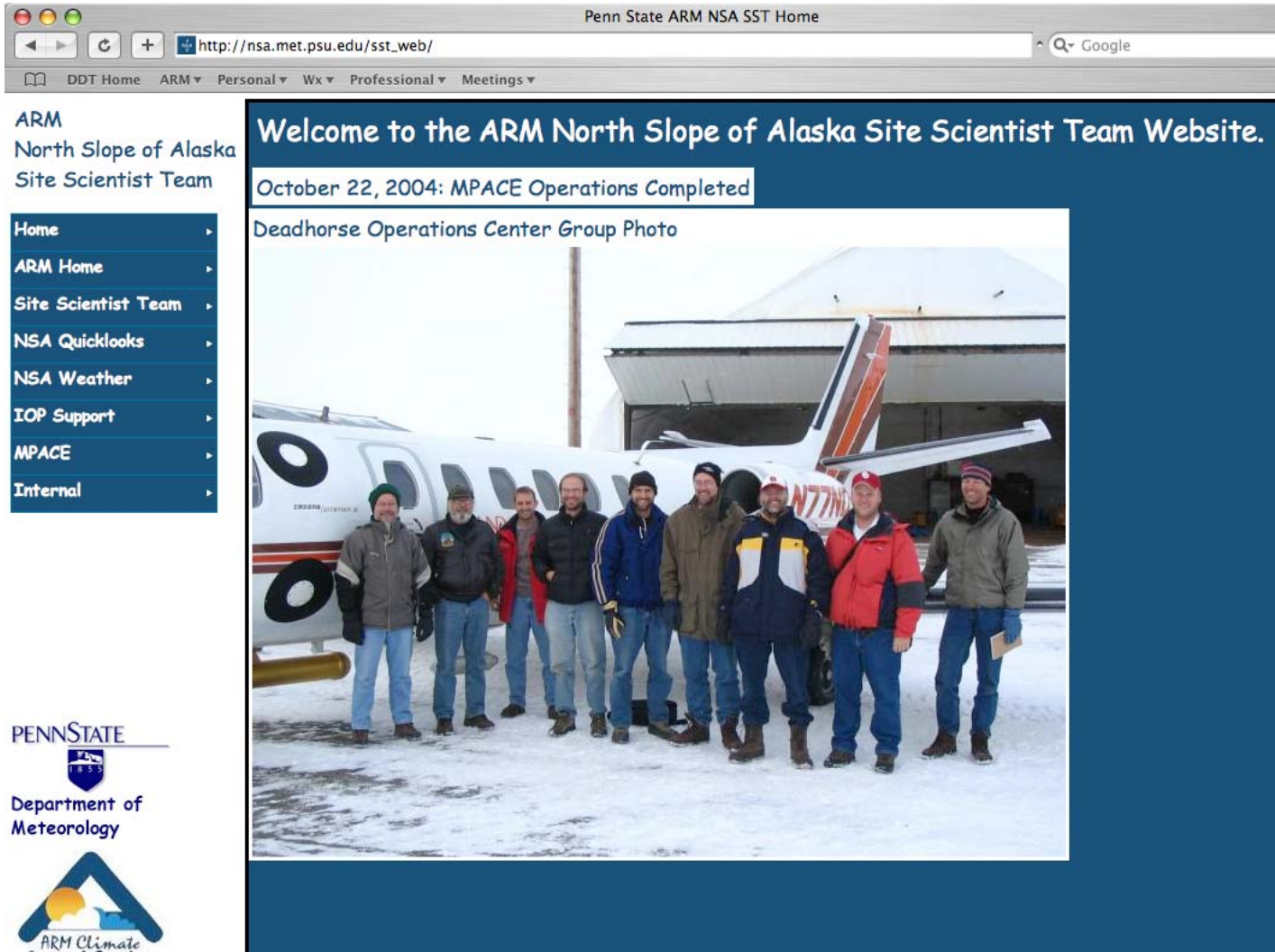


Thanks to Bob Aune
NOAA / NESDIS

PSU NSA SST

Hans Verlinde and Chad Bahrmann provided invaluable help

- Quicklooks
- Forecasts
- Conferencing in daily

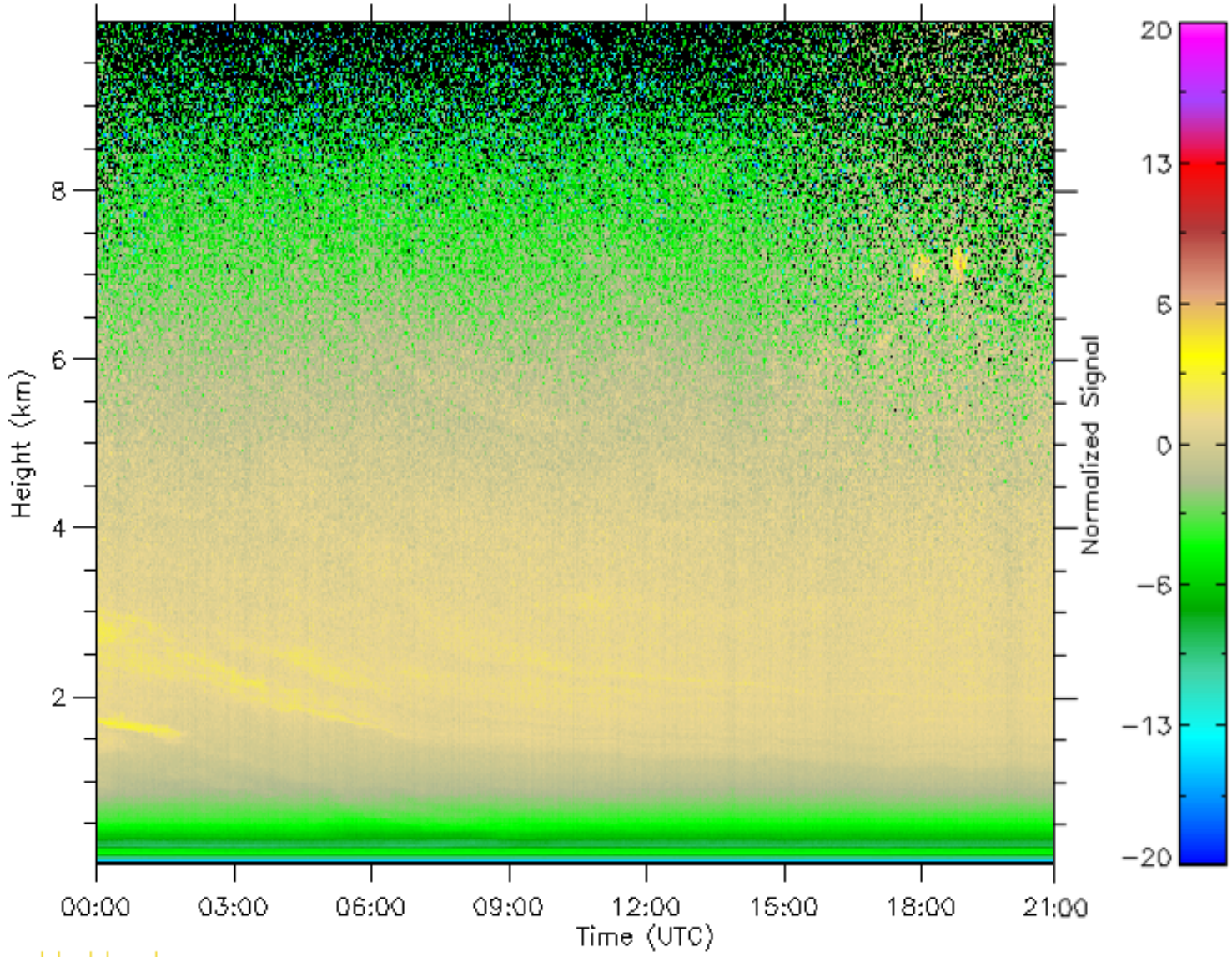


Weather Conditions

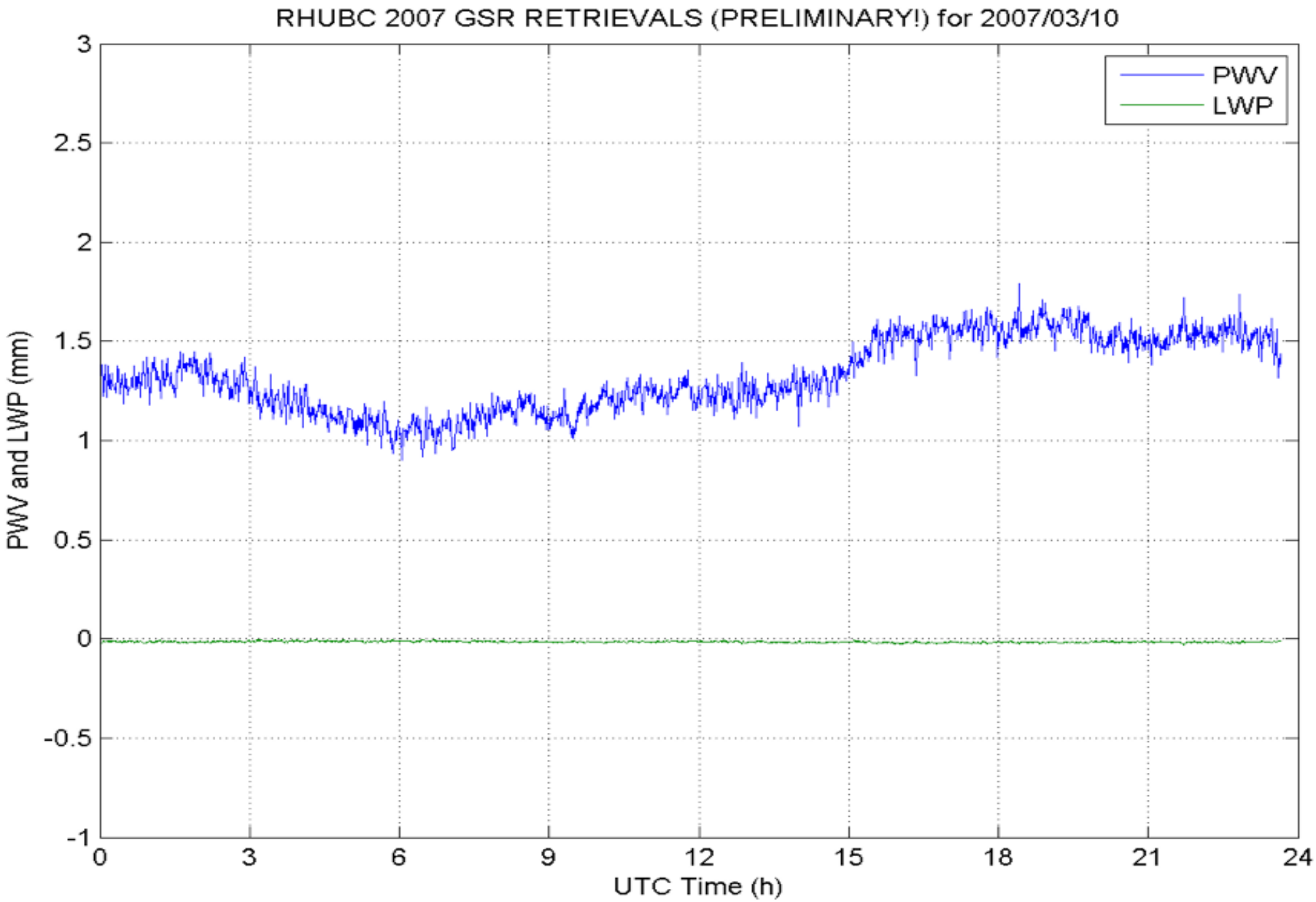
Reported in the NWS forecast discussion on 14 Mar:
"…the temperature, which has been well below normal the last two weeks, will be returning to normal…"

We Saw Some Clear Skies

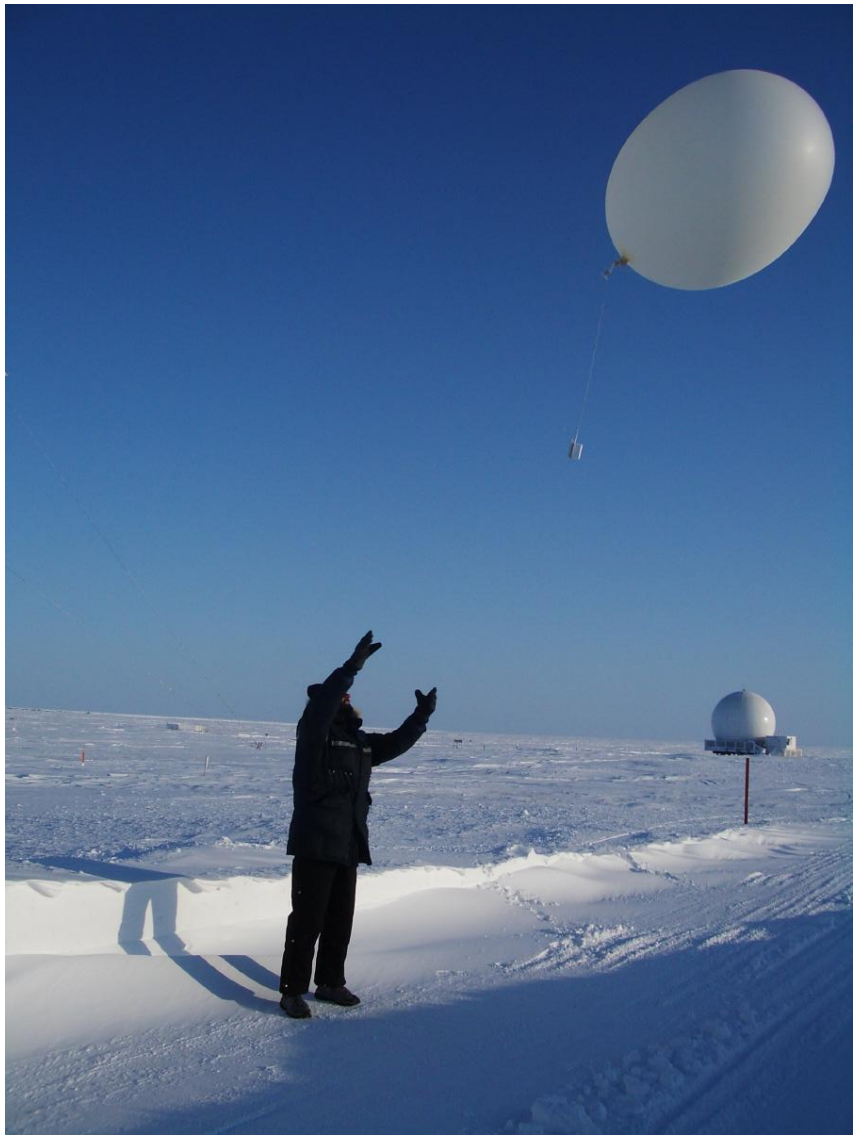
10 March 2007 at NSA ACRF



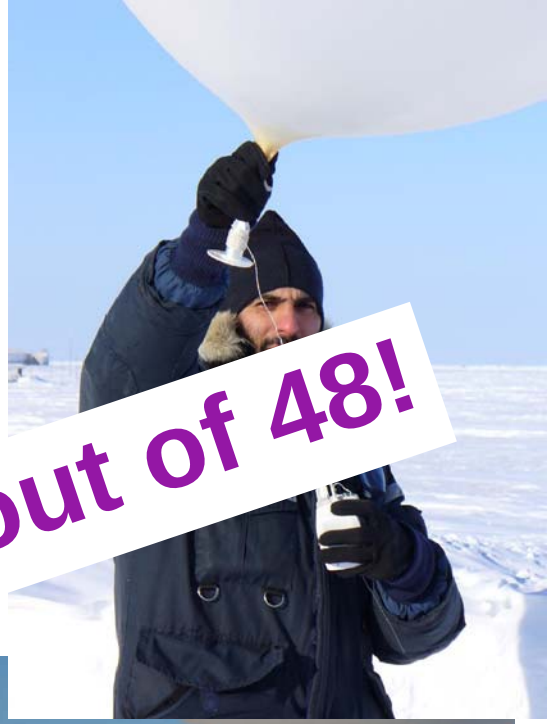
We Saw Some Low PWV Periods



We Launched Some Sondes

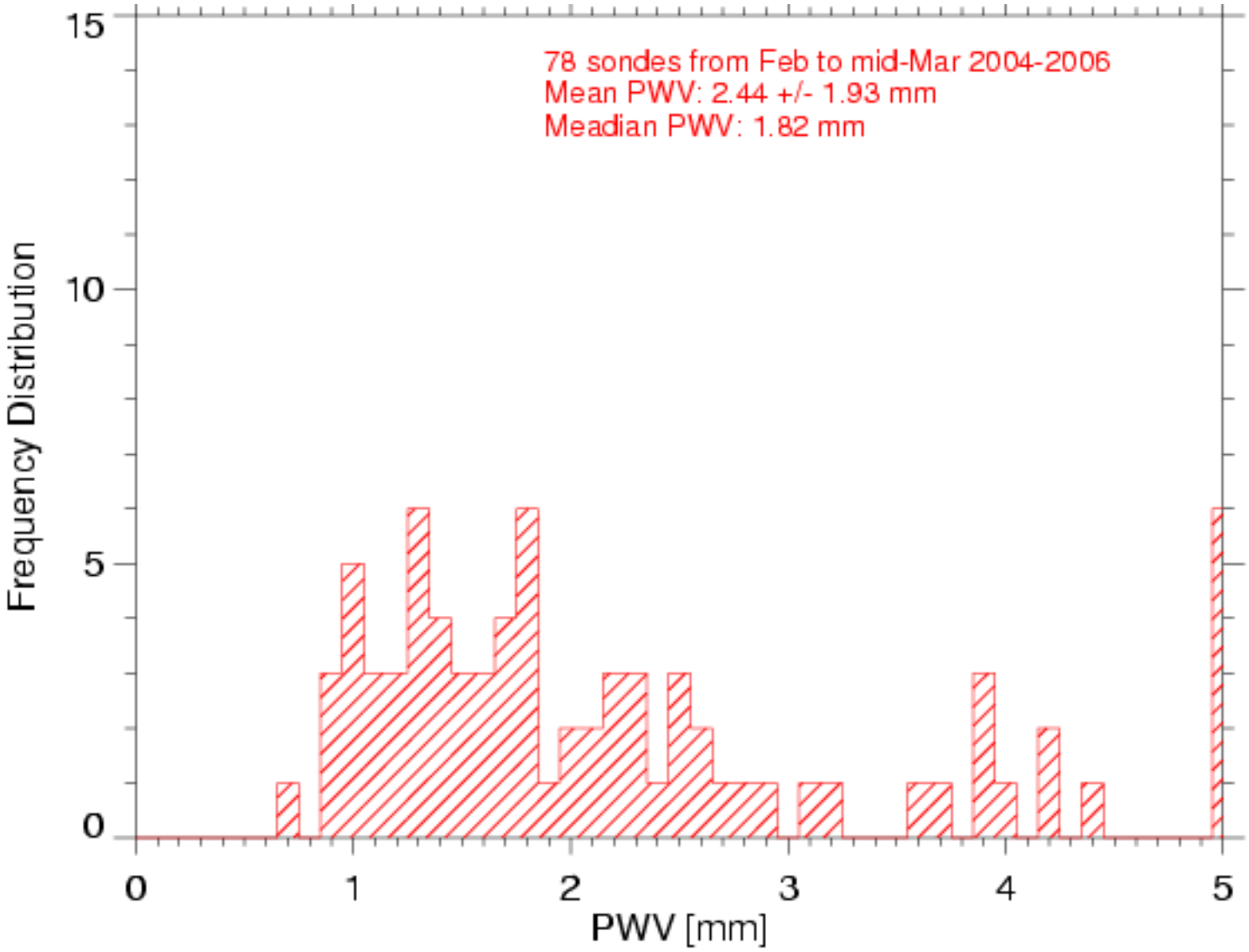


All of Us

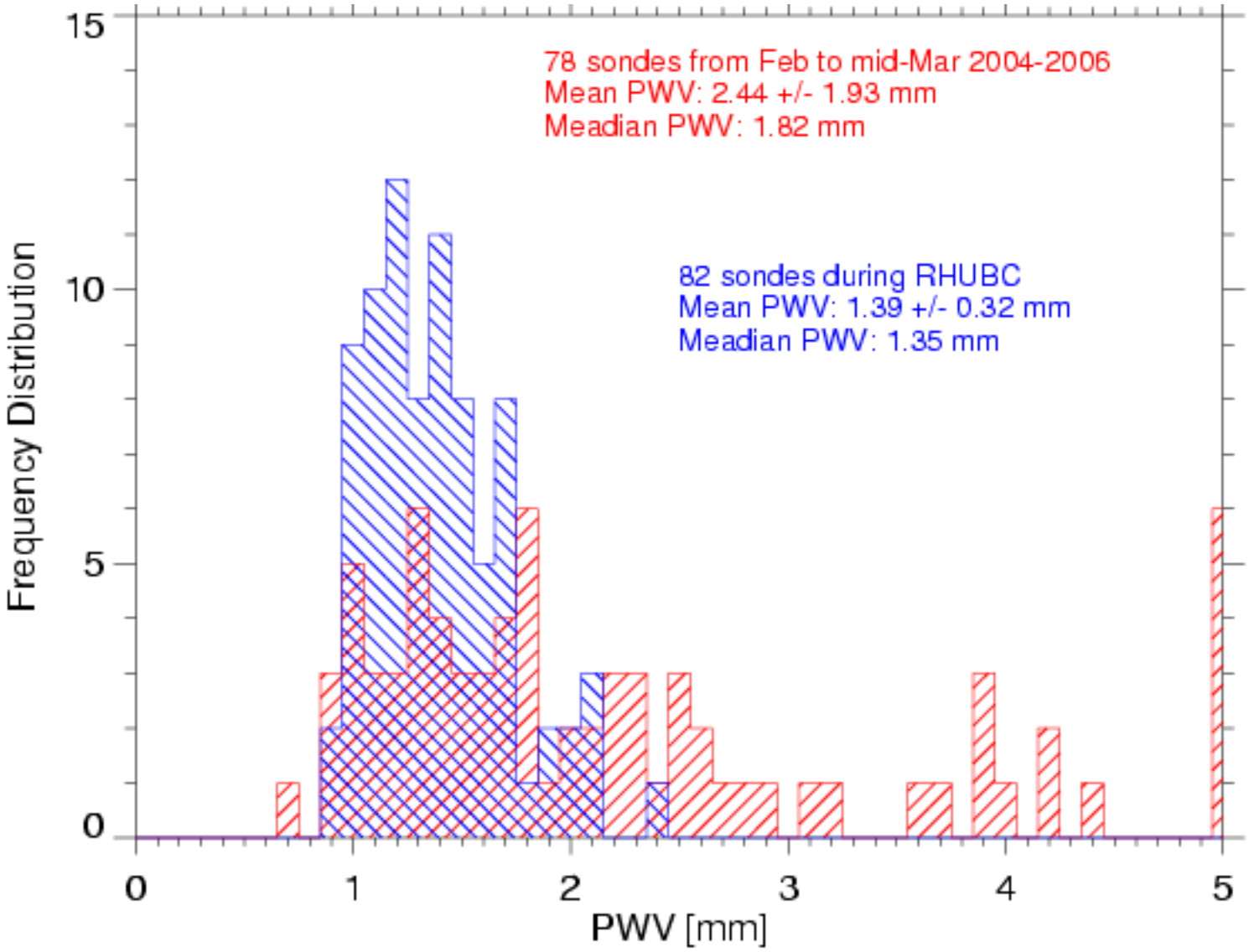


47 successful launches out of 48!

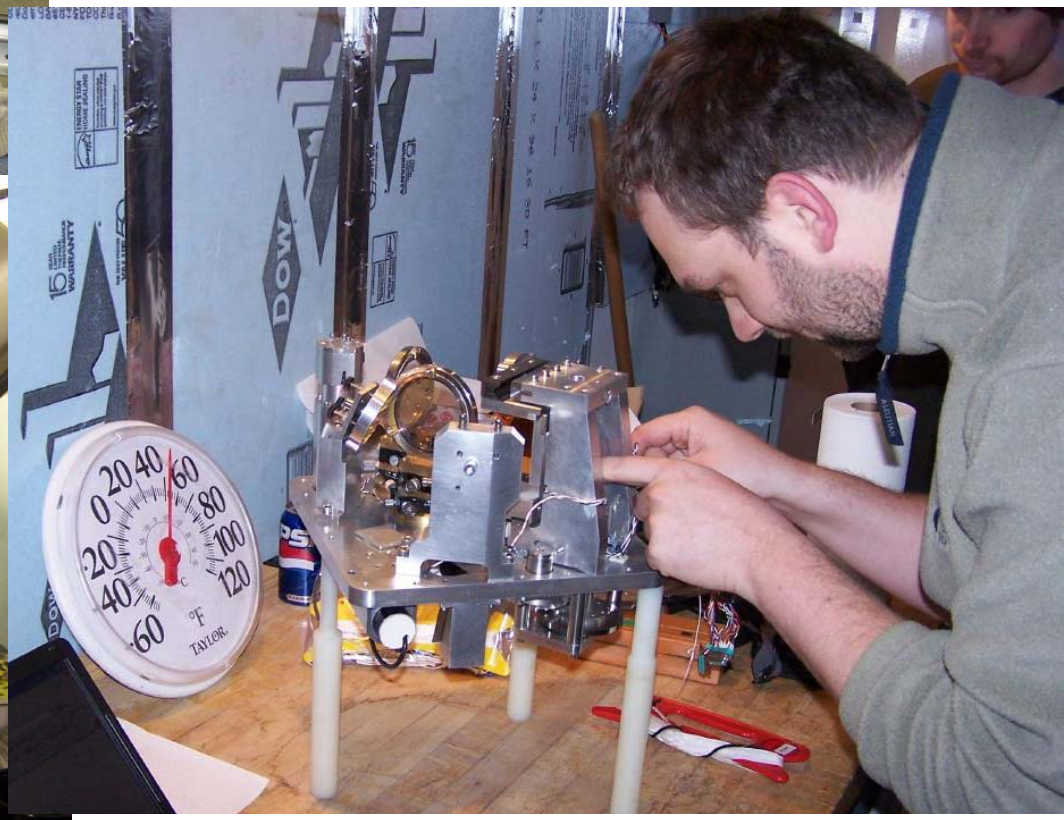
PWV Distribution from Sondes



PWV Distribution from Sondes



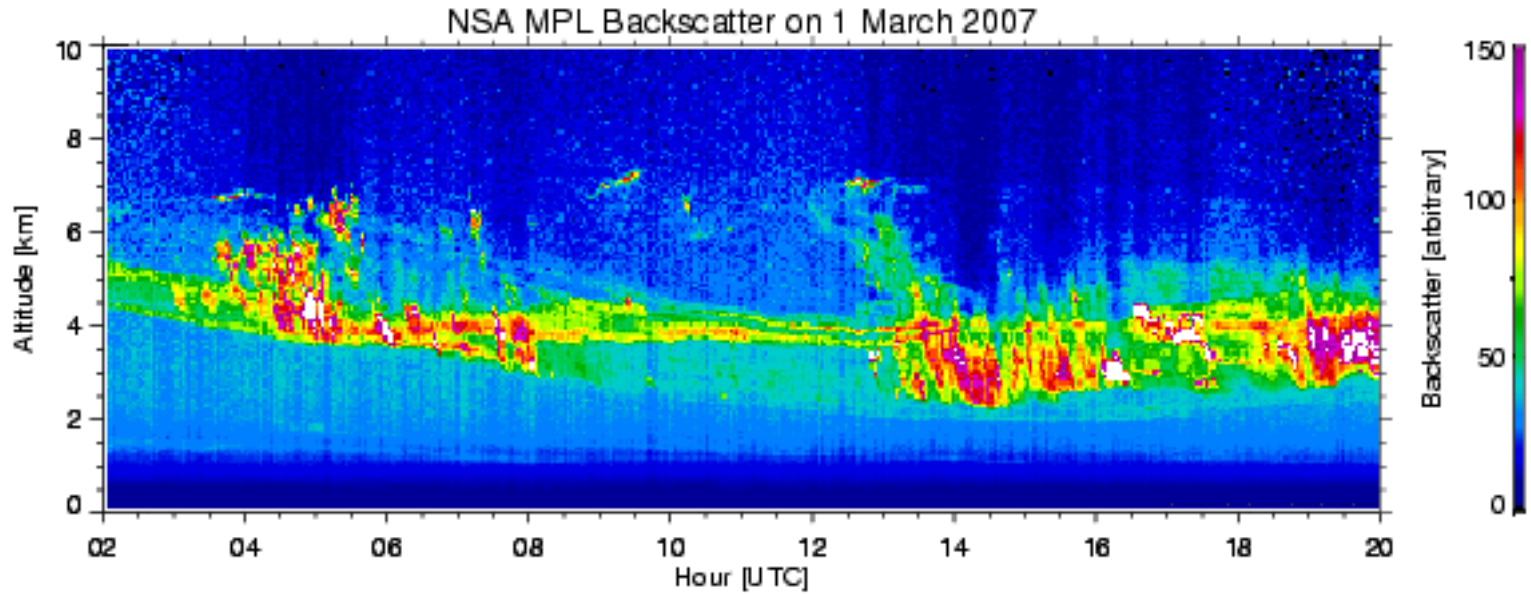
We Had to Work on the Instruments

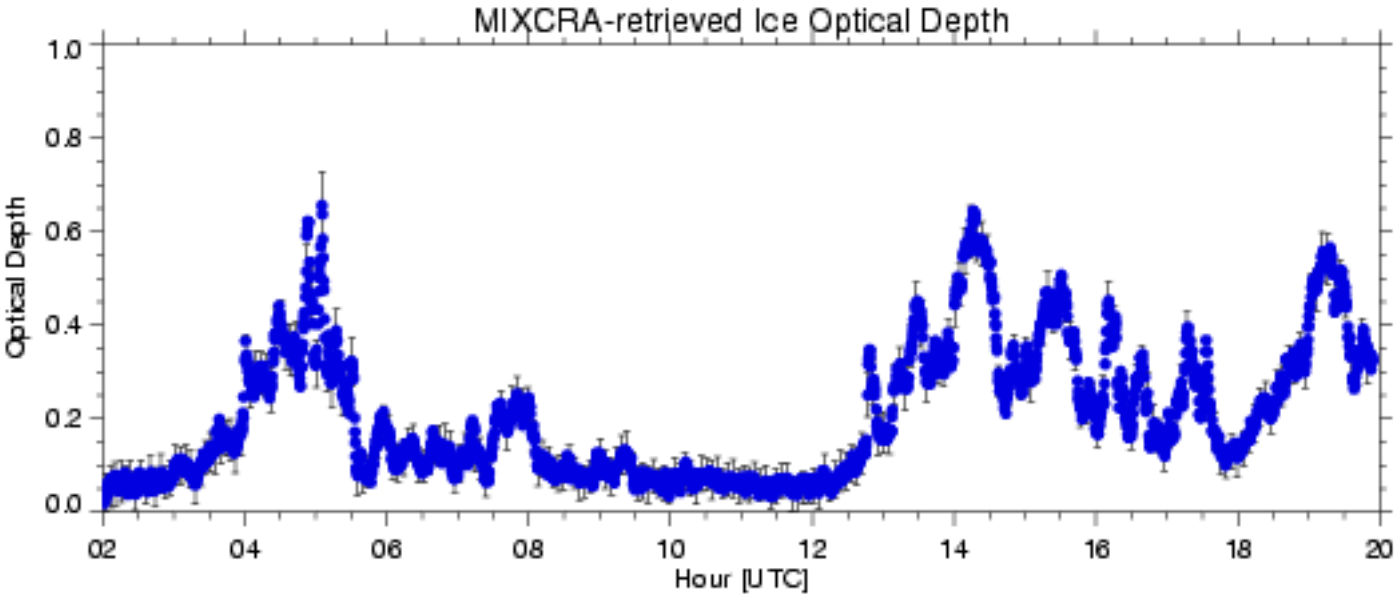


We Saw Some Cirrus

Including Some Sundogs

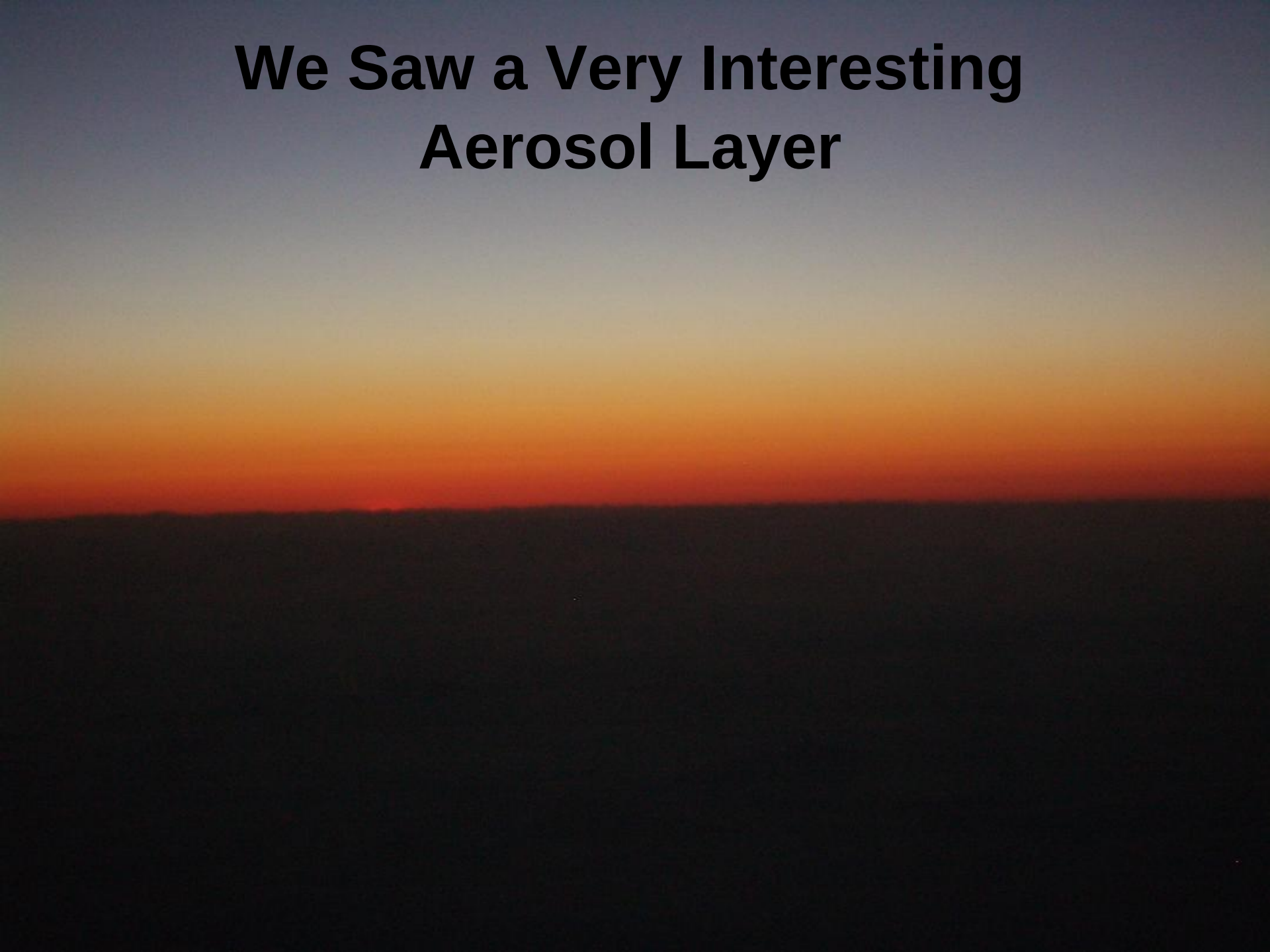
First Retrievals of Cirrus OD





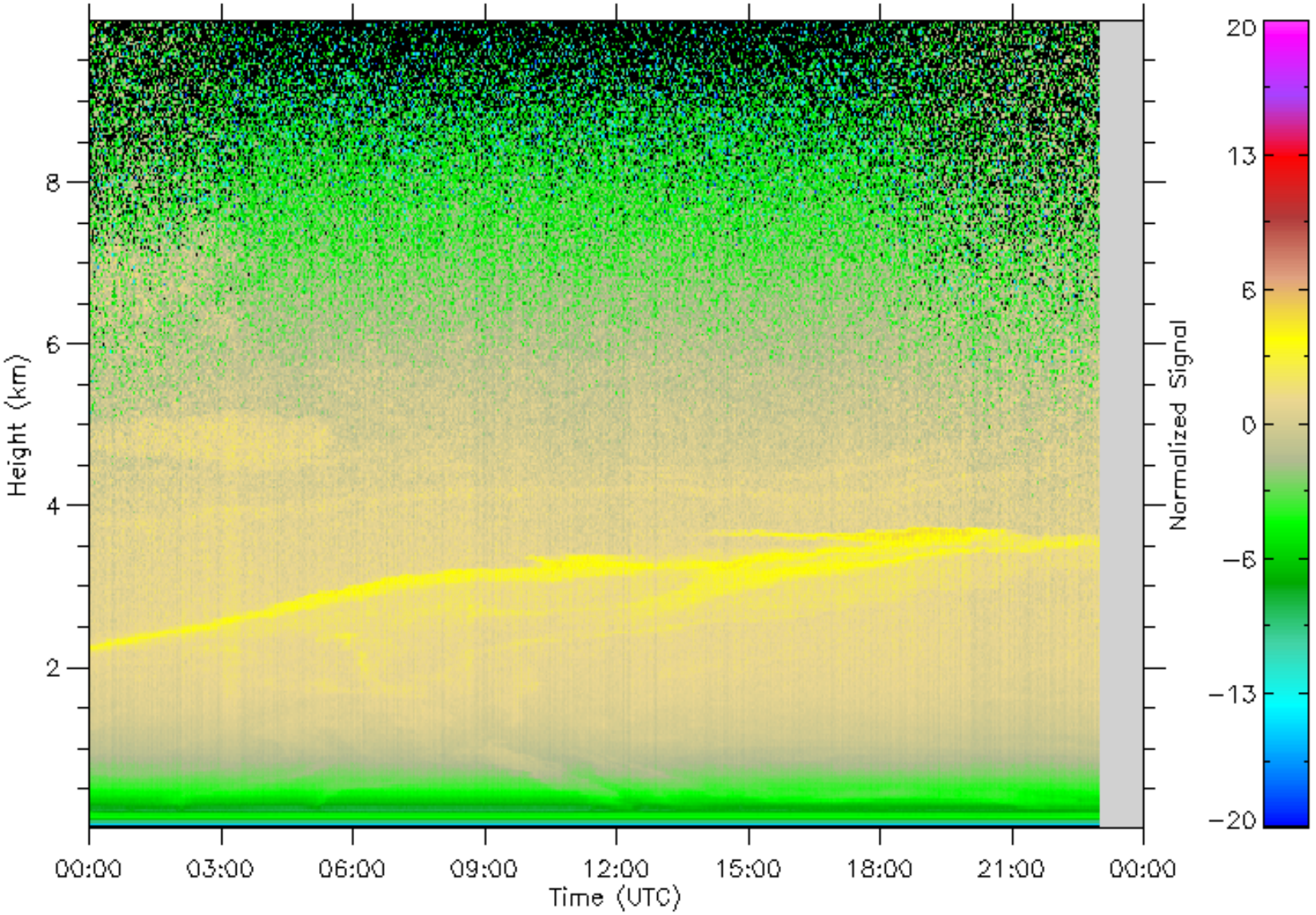
We Saw Sites on the Way to the Site

We Saw a Very Interesting Aerosol Layer

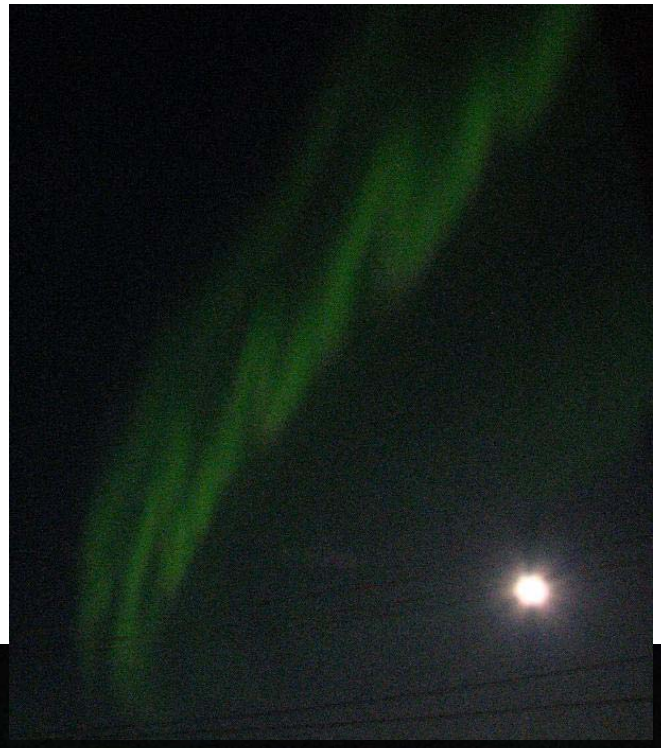


MPL's View of Aerosol Layer

4 March 2007 at NSA ACRF

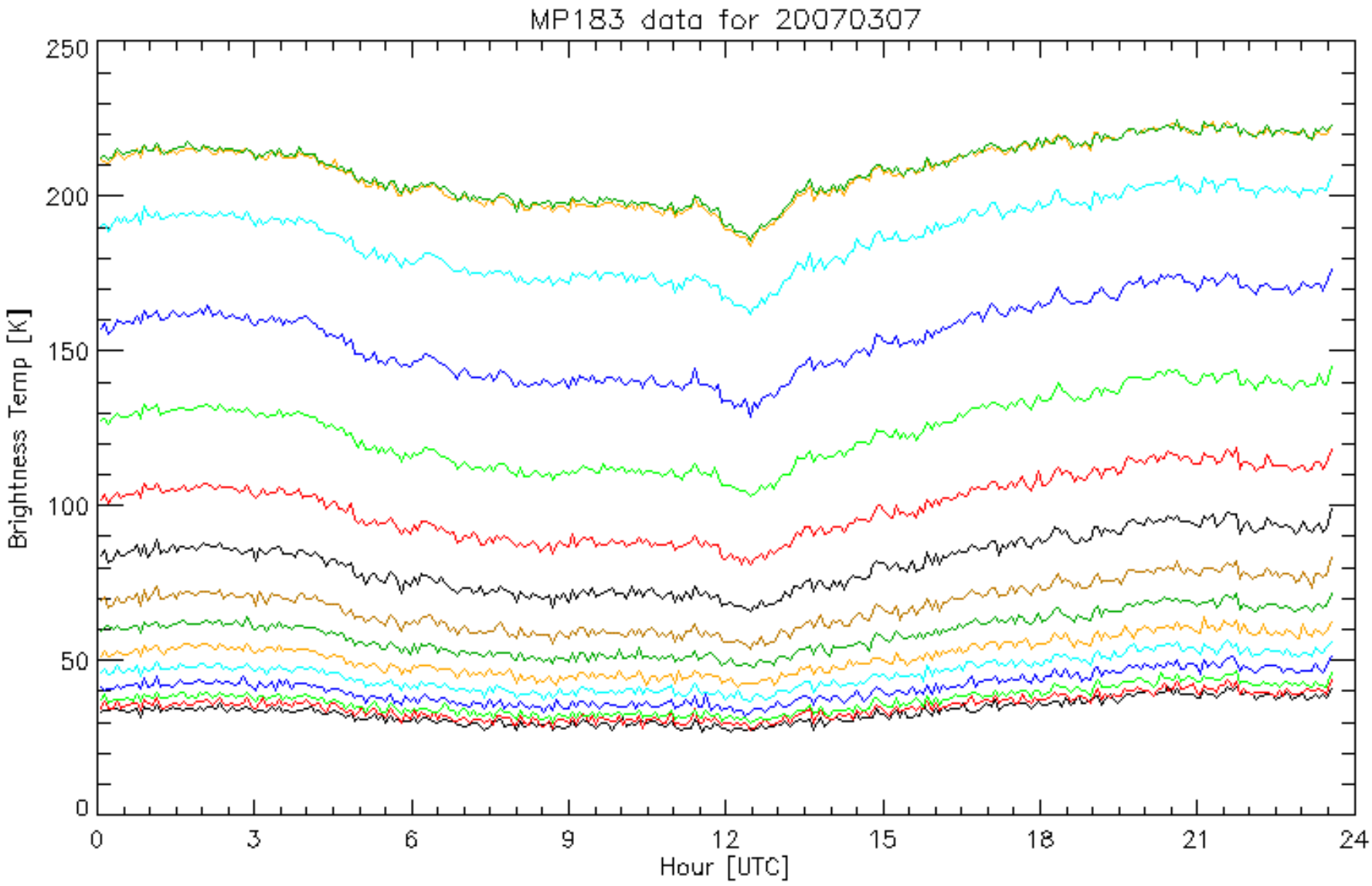


We Saw Some Aurora

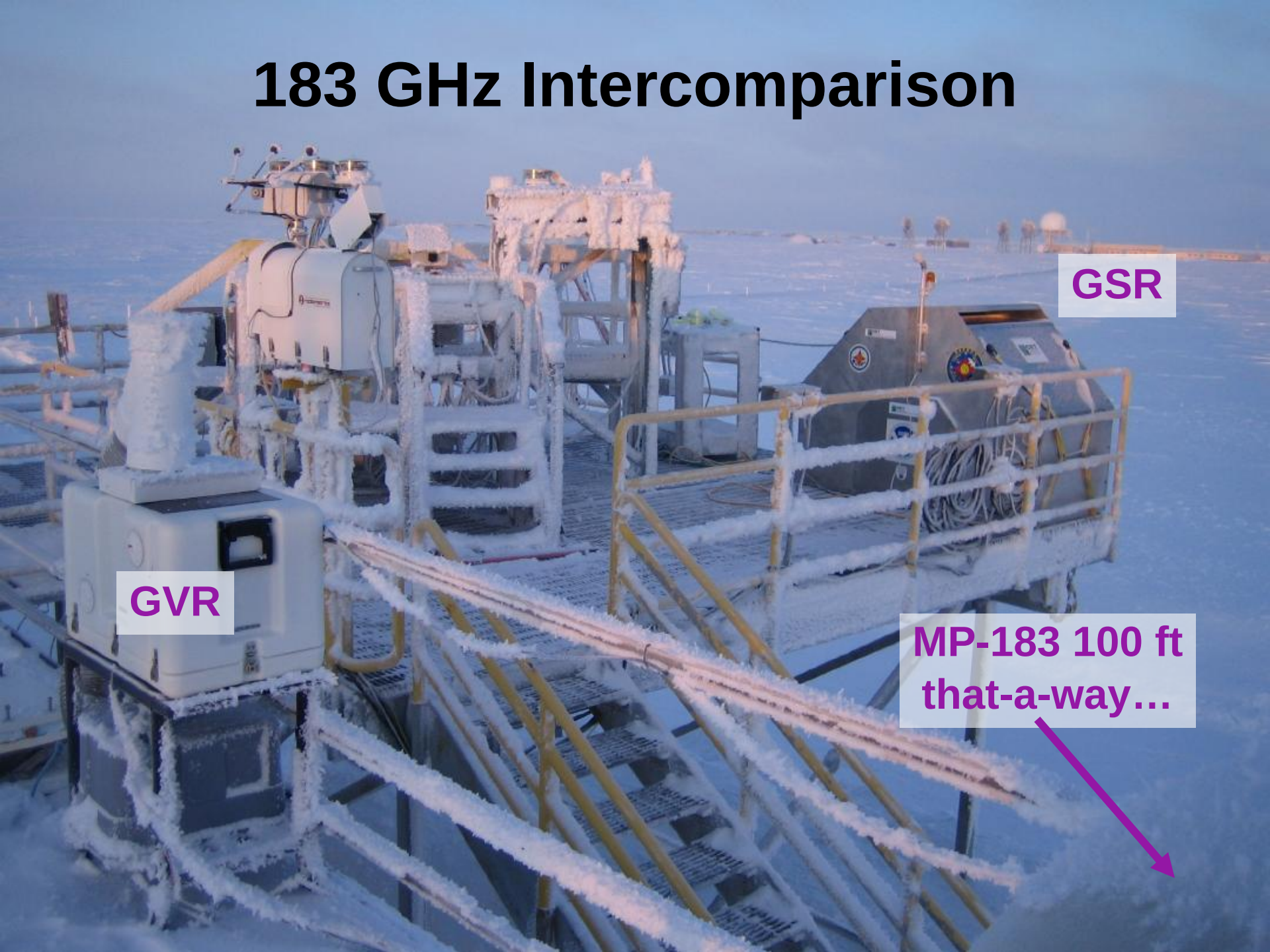


Radiometrics MP-183

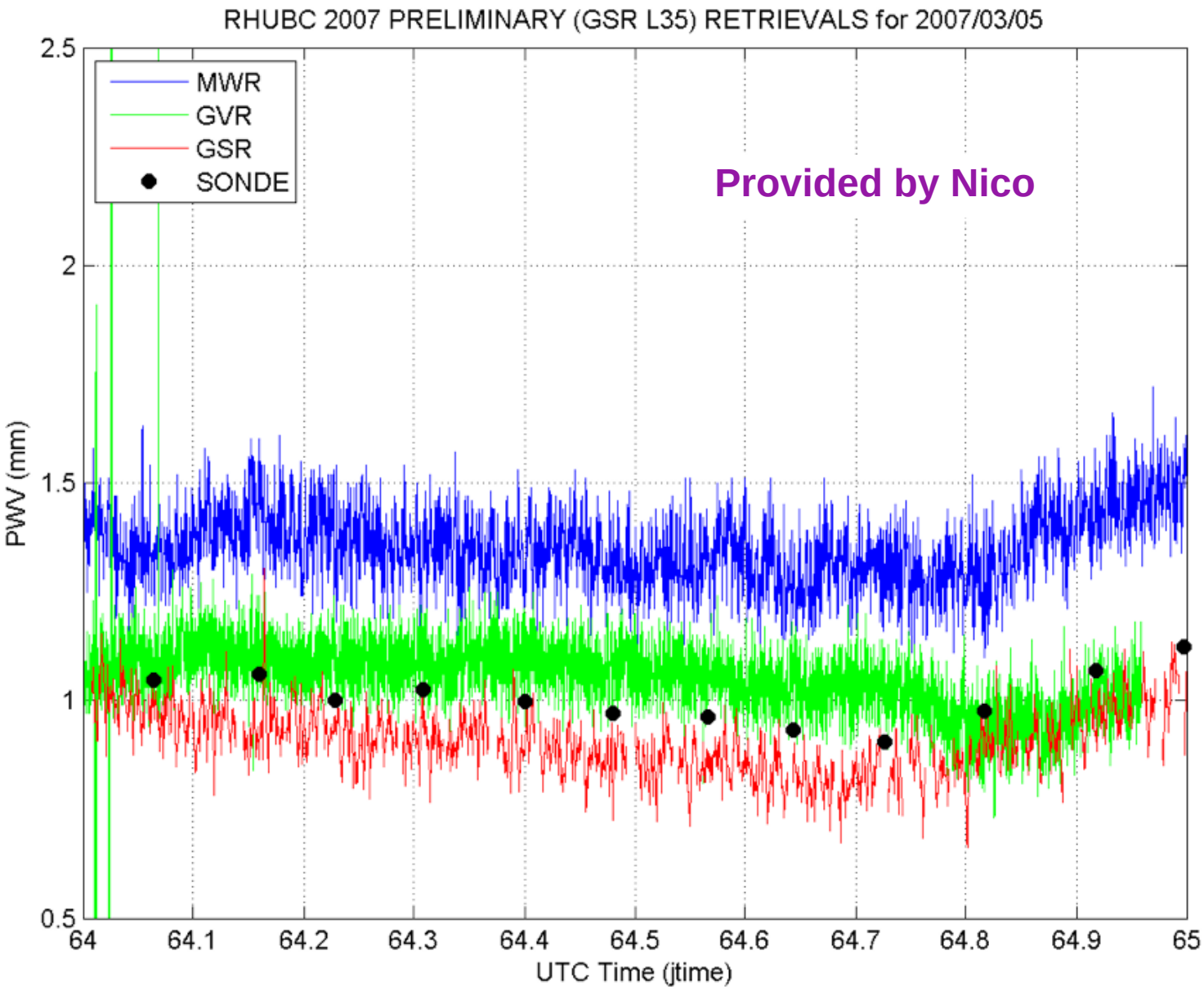
MP-183 Data


MP183 data for 20070307
Brightness Temp [K]
250
200
150
100
50
0
0
3
6
9
12
15
18
21
24
Hour [UTC]

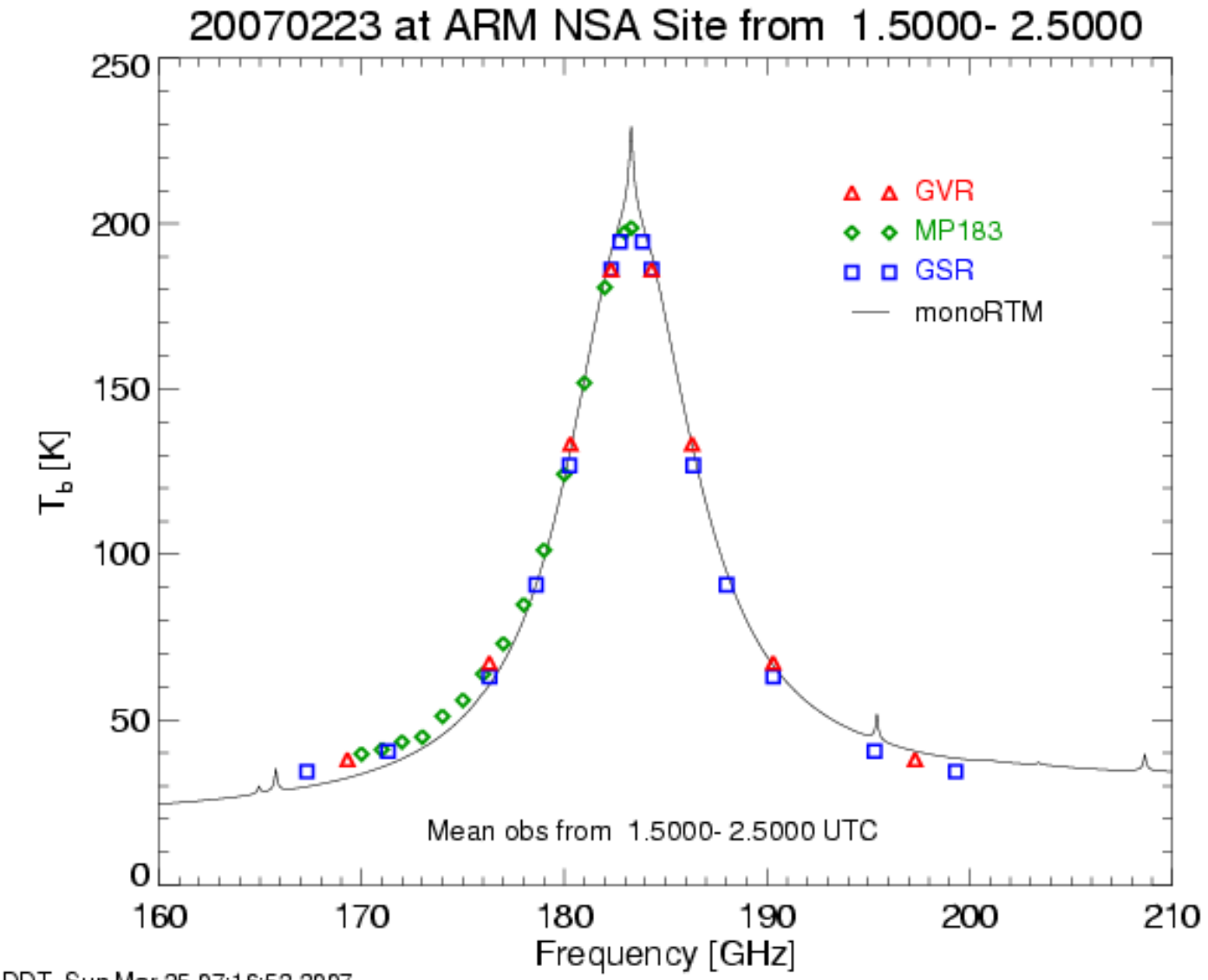
183 GHz Intercomparison



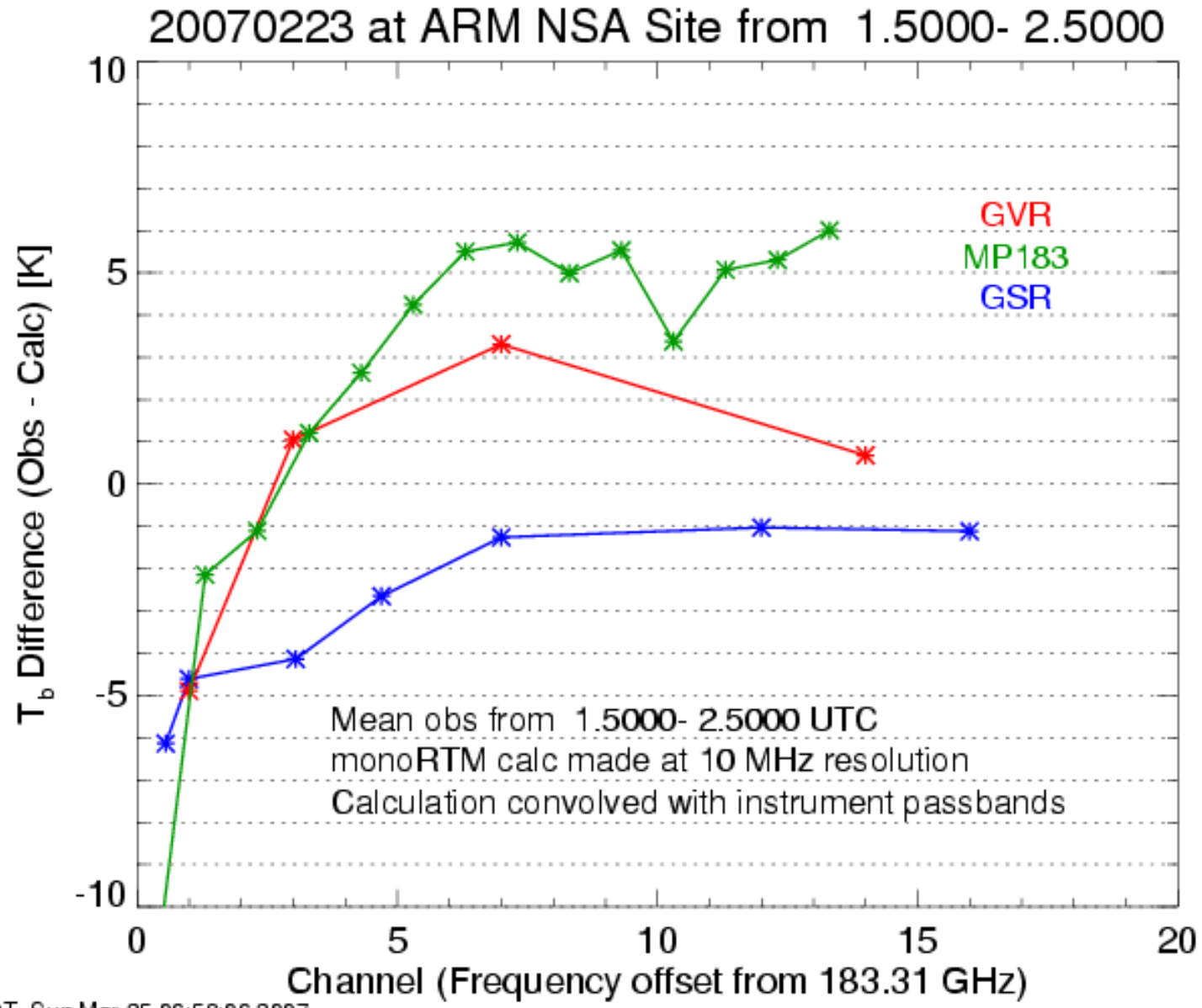
Comparison of PWV



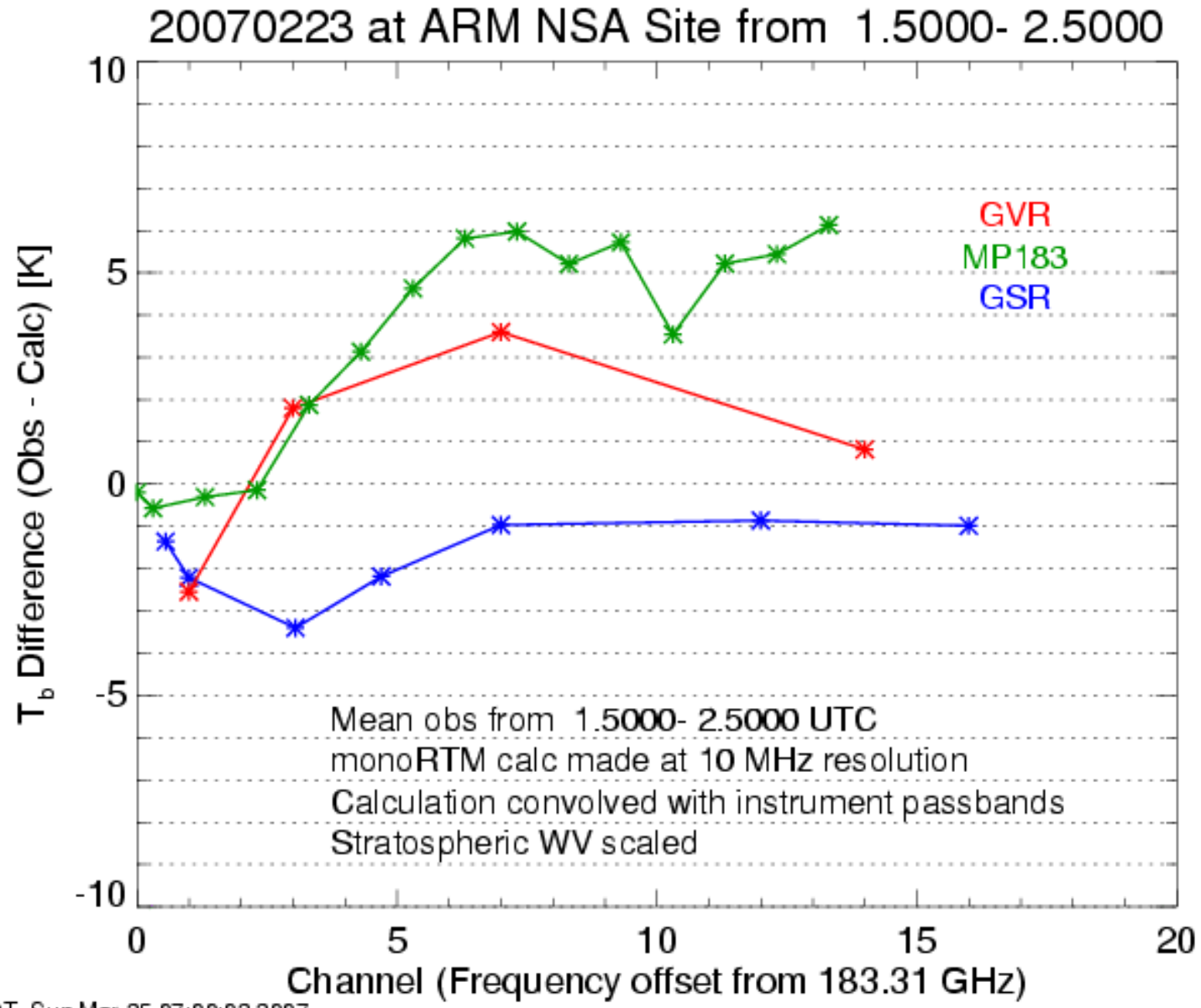
183 GHz Intercomparison



183 GHz Intercomparison

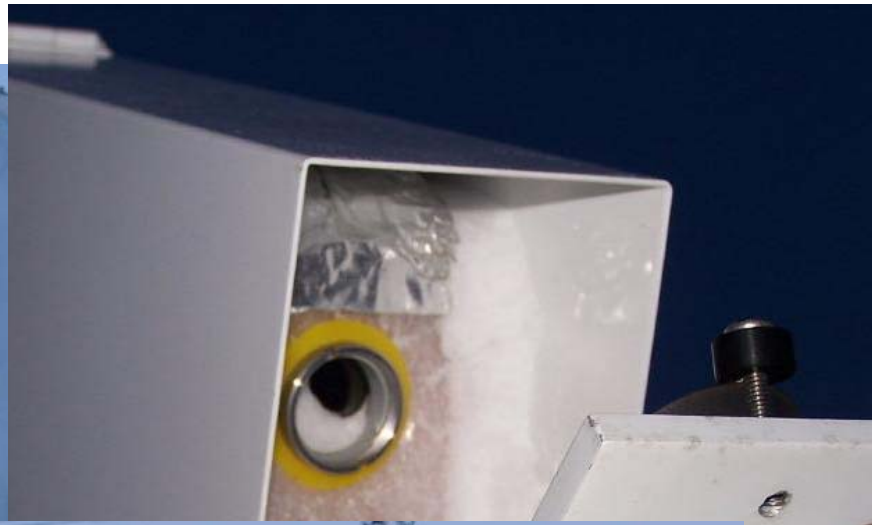


183 GHz Intercomparison



We Saw a Snowblower Attack

The Instruments Didn’t Like That

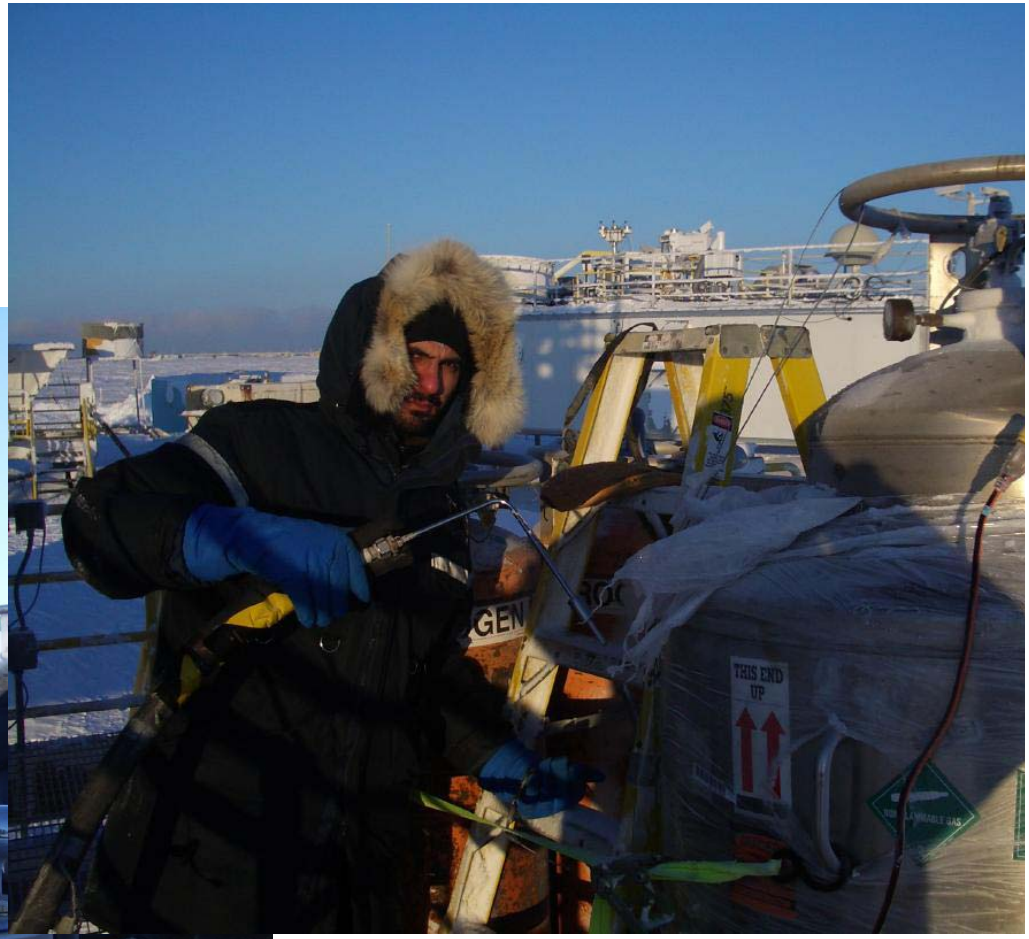


We Saw Some Wildlife

We Saw Jeff Create the "8th Wonder of the World"

We Were Happy to See This

And Immediately Got Busy Hooking It Up



We Saw the TAFTS Collecting Data

We Saw a Masked Man Watch the GSR

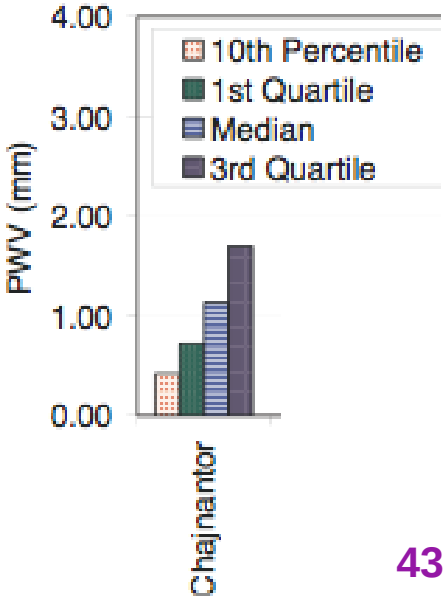
We Saw Lead “Smoke” and Ice Fog

Best Dining? At the Duplex

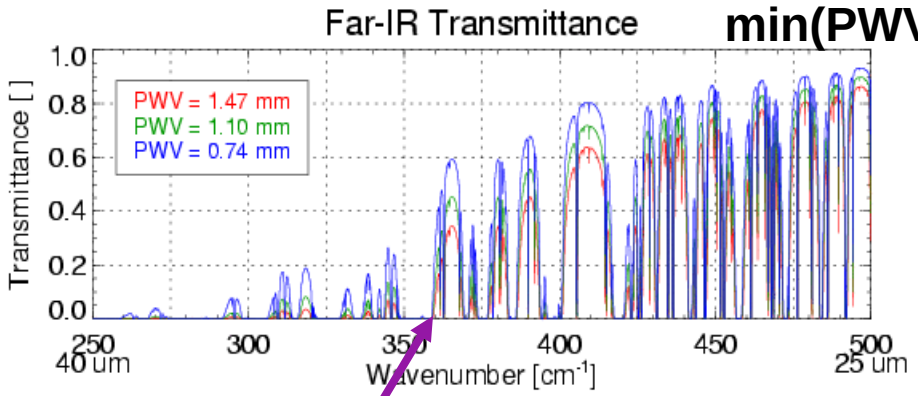
Undoubtedly

It’s Been a Busy Month

Shameless Plug for RHUBC-II



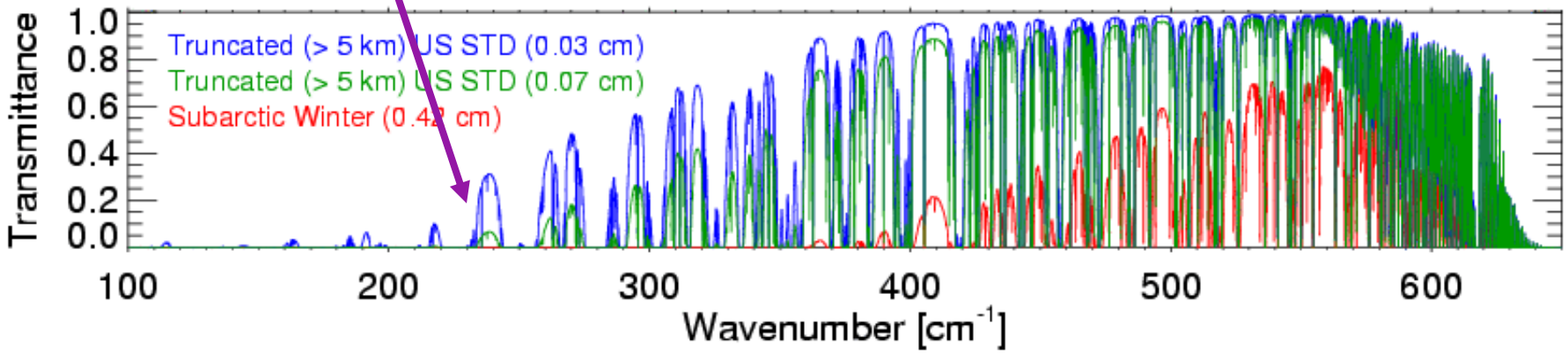
RHUBC-I
min(PWV) = 0.96 mm



28 µm

43 µm

RHUBC-II
Anticipated min(PWV) ~ 0.3 mm



Any Questions?

Thank you for your attention.