1DVAR Microwave Radiometer and LAPS Thermodynamic Retrievals

LAPS Workshop

27 Oct 2010

Boulder, Colorado

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radiometrics

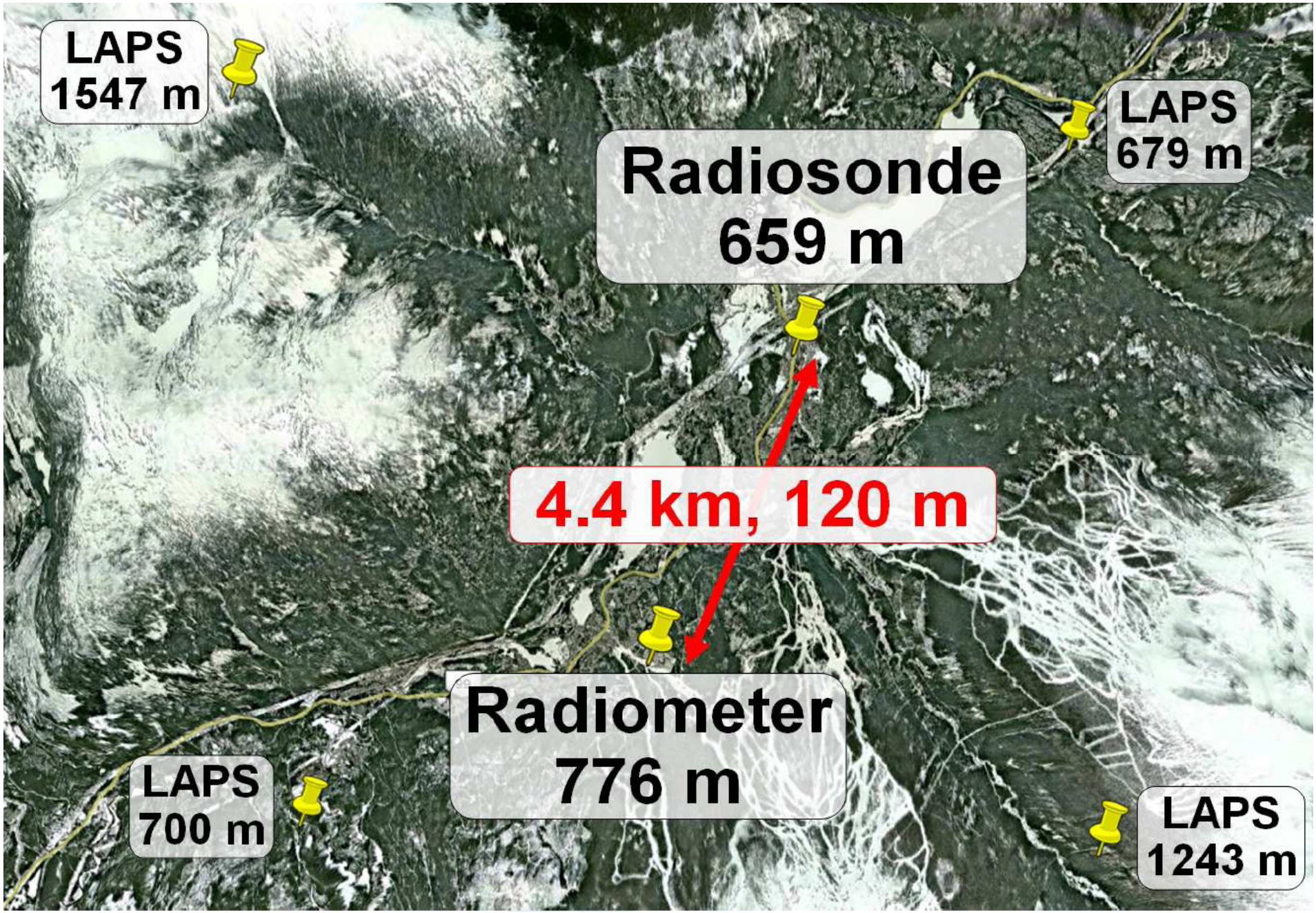
Presentation Summary

- Winter Olympics
  - Zenith and Off-Zenith NN retrieval – radiosonde comparisons
  - Radiometer - LAPS brightness temperatures
  - 1DVAR Statistics and radiosonde observation error
- Windsor Tornado
  - Skew-T evolution
  - Radiometer - LAPS brightness temperatures
  - Next Step (LAPS-STMAS-radiometer analysis?)

radiometrics

2010 Winter Olympics

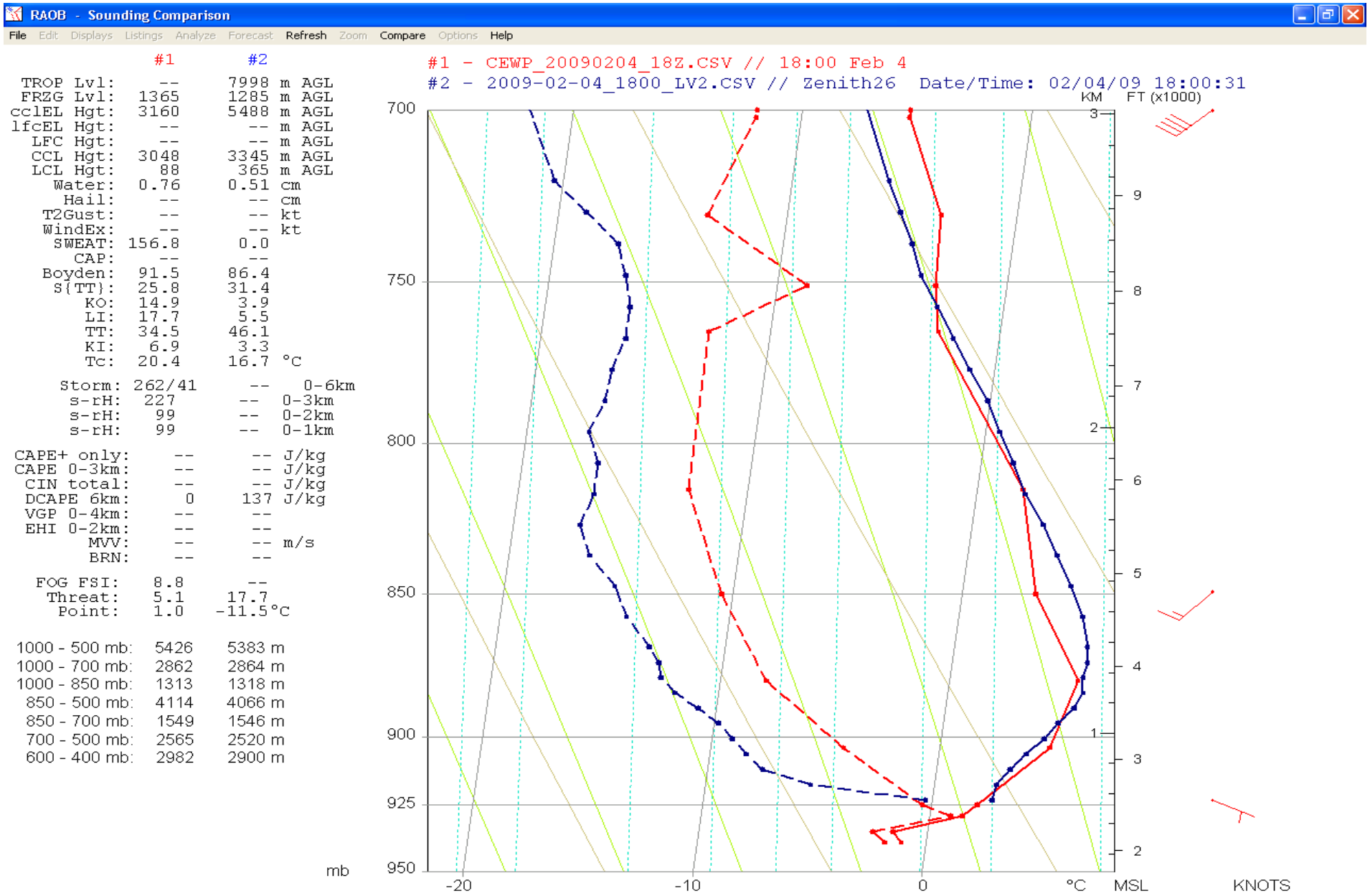
- Whistler, BC, Canada
- 14-28 February 2010
- 6-hr radiosondes
- Microwave Thermodynamic Profiler
- High Resolution LAPS analysis



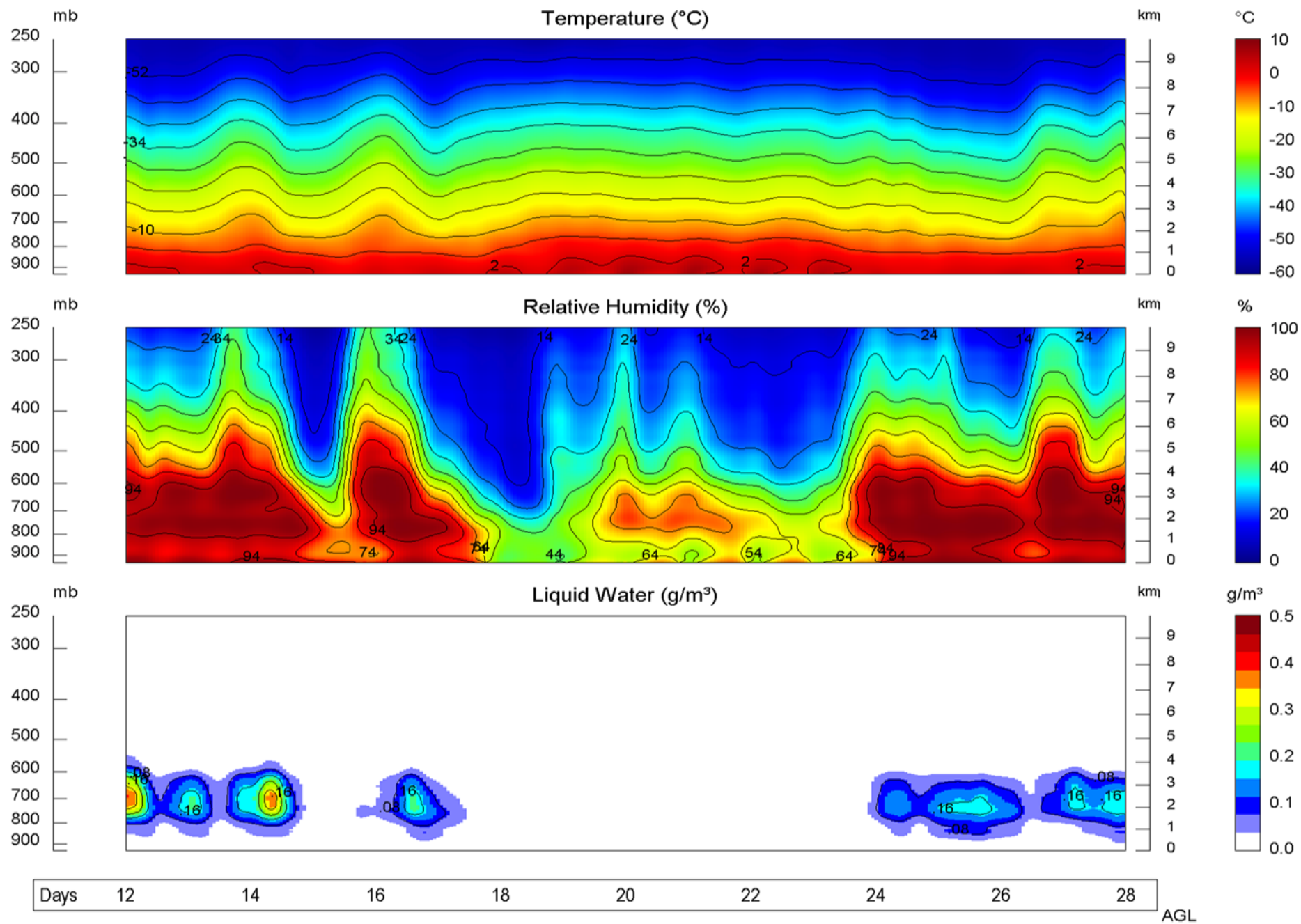
Radiometer, radiosonde and LAPS grid points at Whistler

Ceilometers, radar and surface met sensors at the base of Creekside Gondola, Whistler Mountain (776 m altitude).

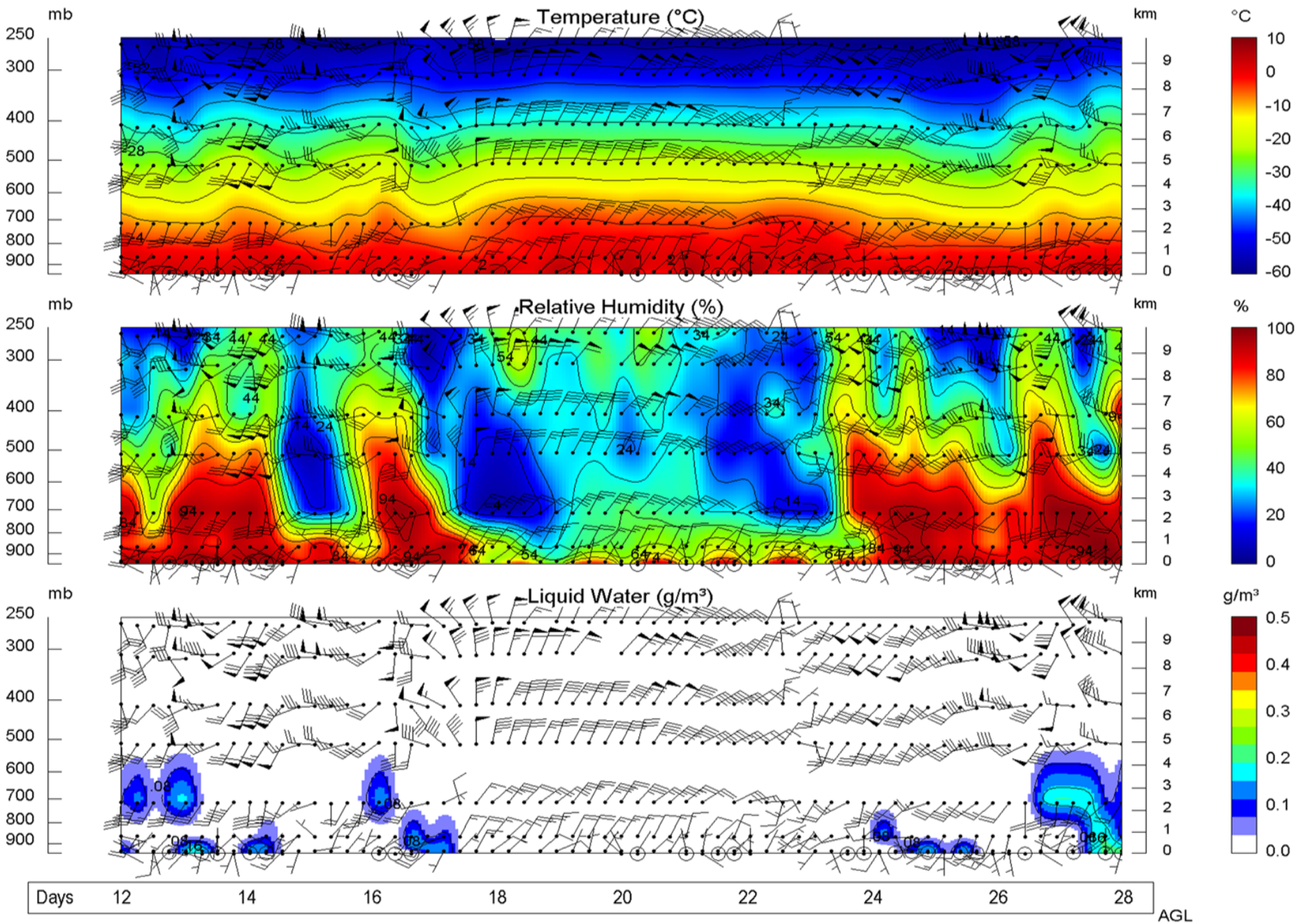
Radiosonde launch site on Nesters Road at Whistler (659 m altitude)



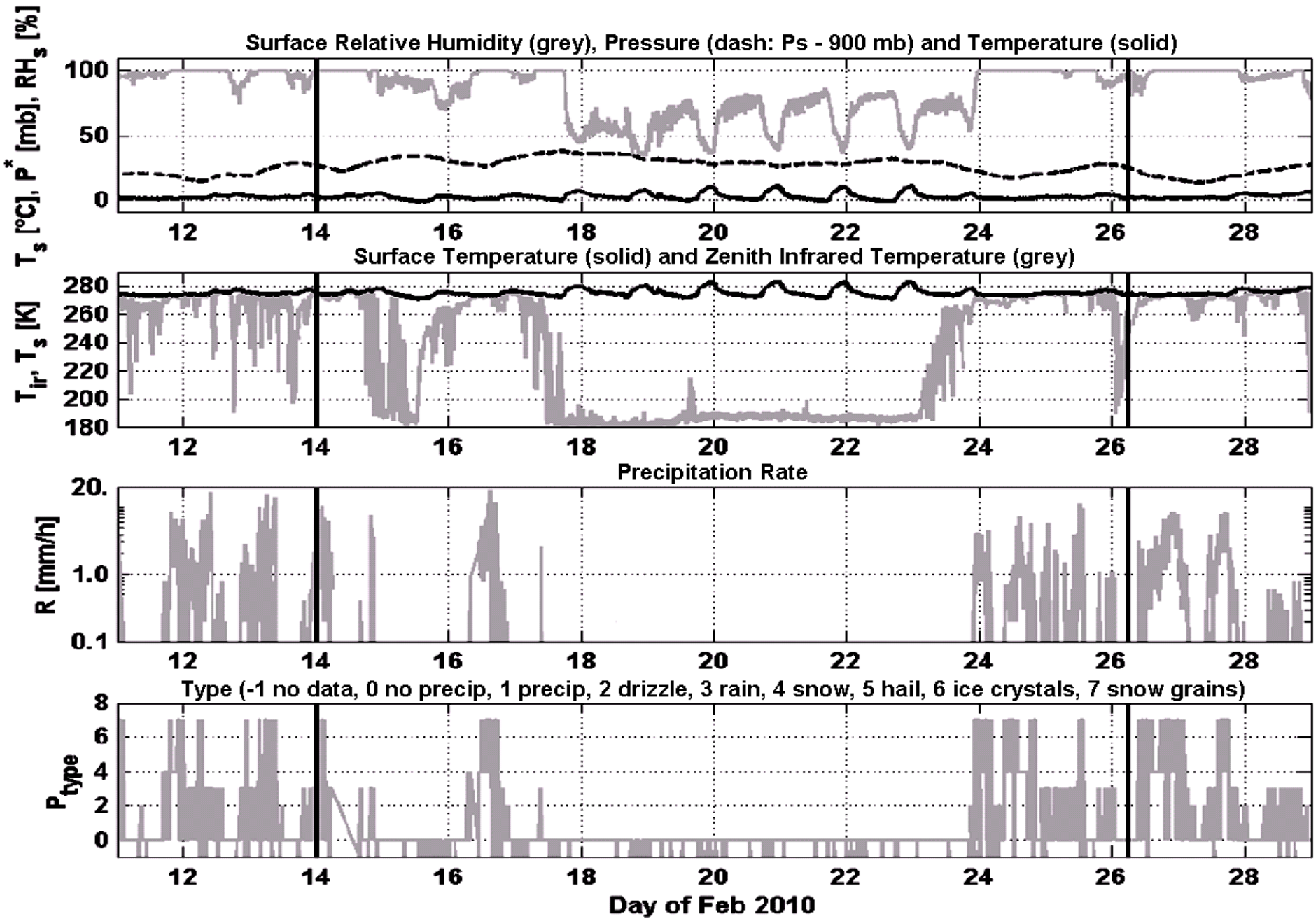
Nesters radiosonde (red) and Timing Flat radiometer (blue) T (solid) and Td (dash) soundings (1800 UT 4 Feb 09) and forecast indices.



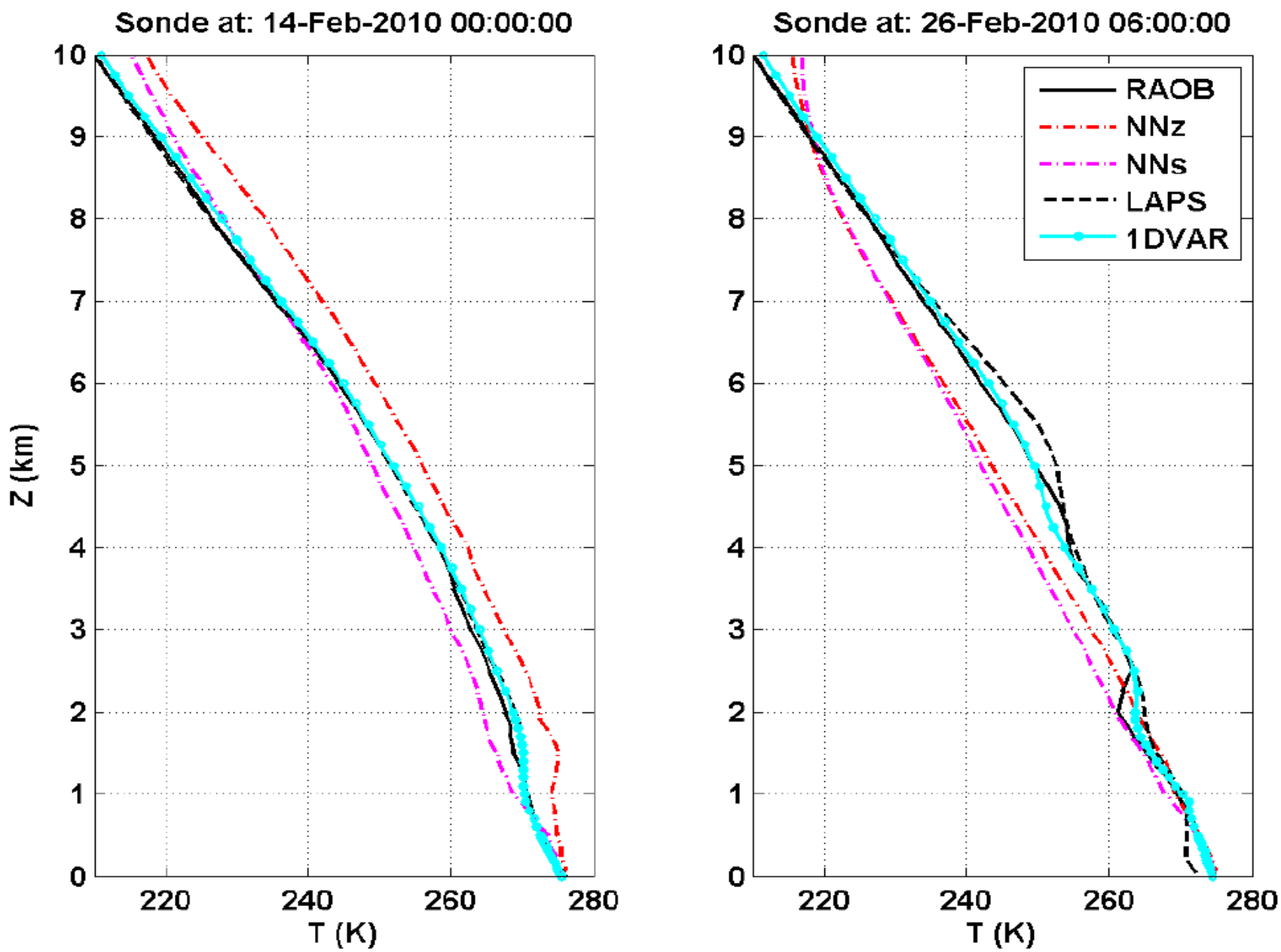
Radiometer (2-min) temperature, humidity and liquid profiles (14 days).



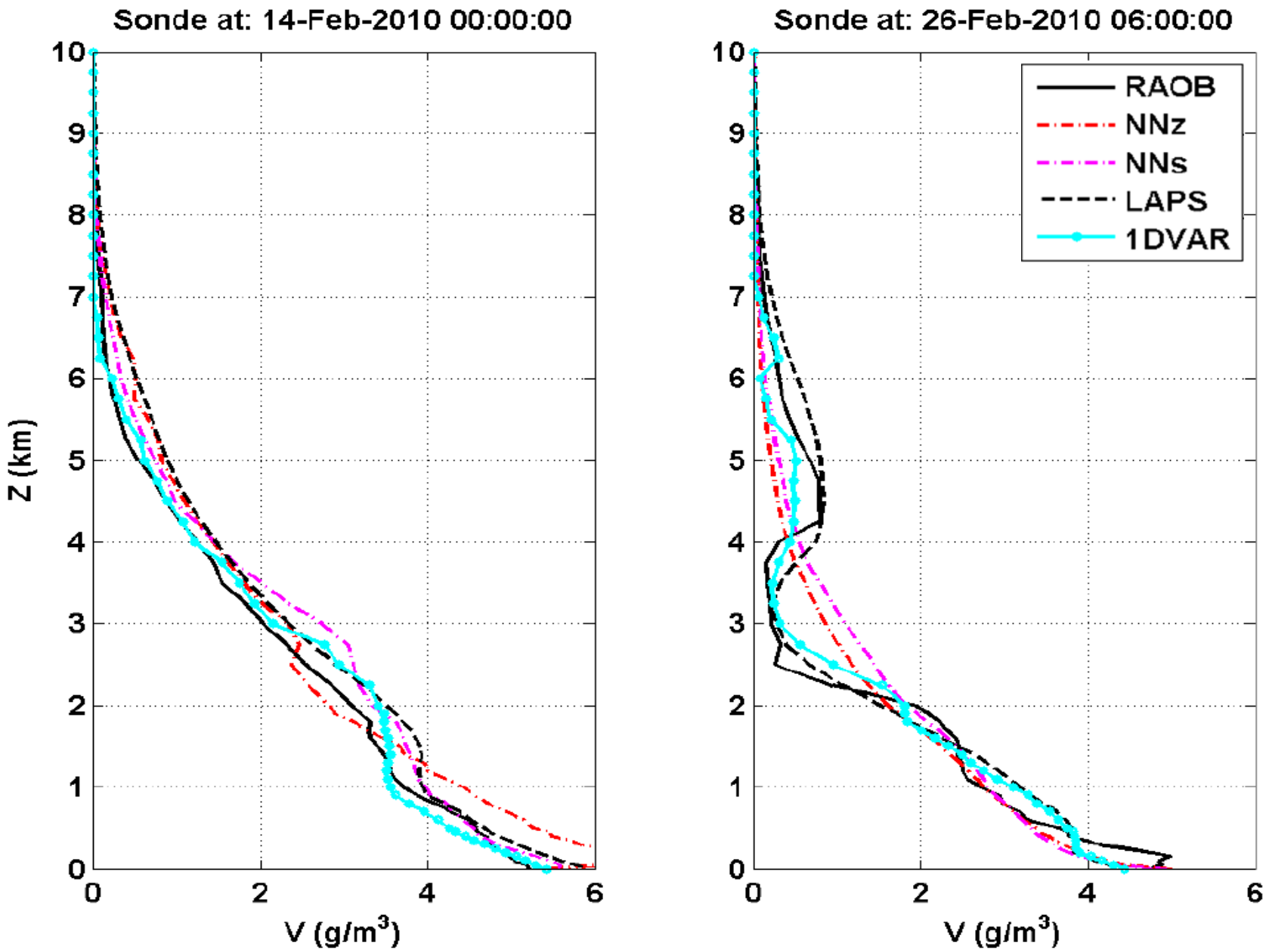
Radiosonde (6-hr) temperature, humidity, wind and estimated liquid (14 days).



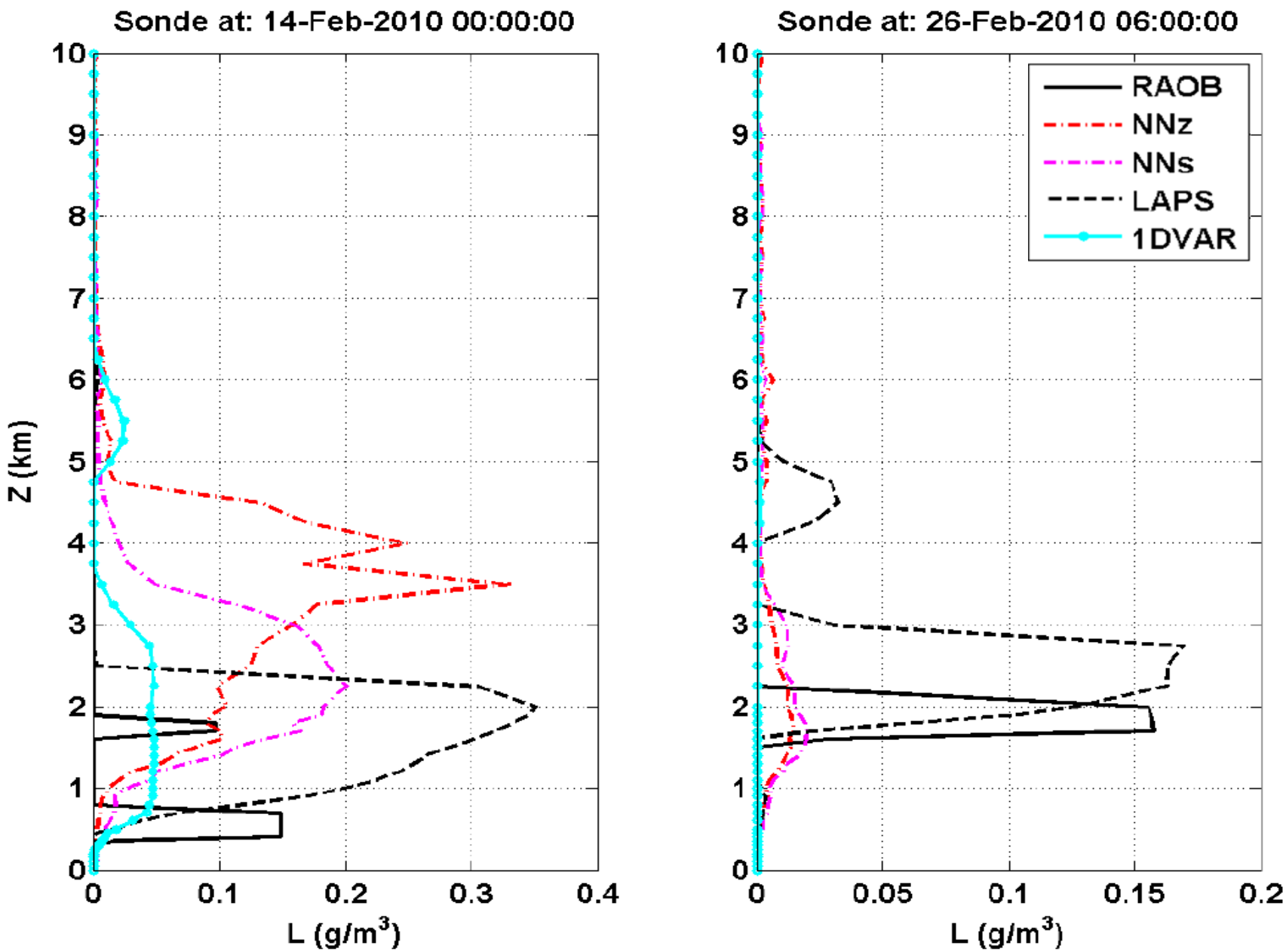
Surface meteorology and precipitation measurements at the radiometer site.



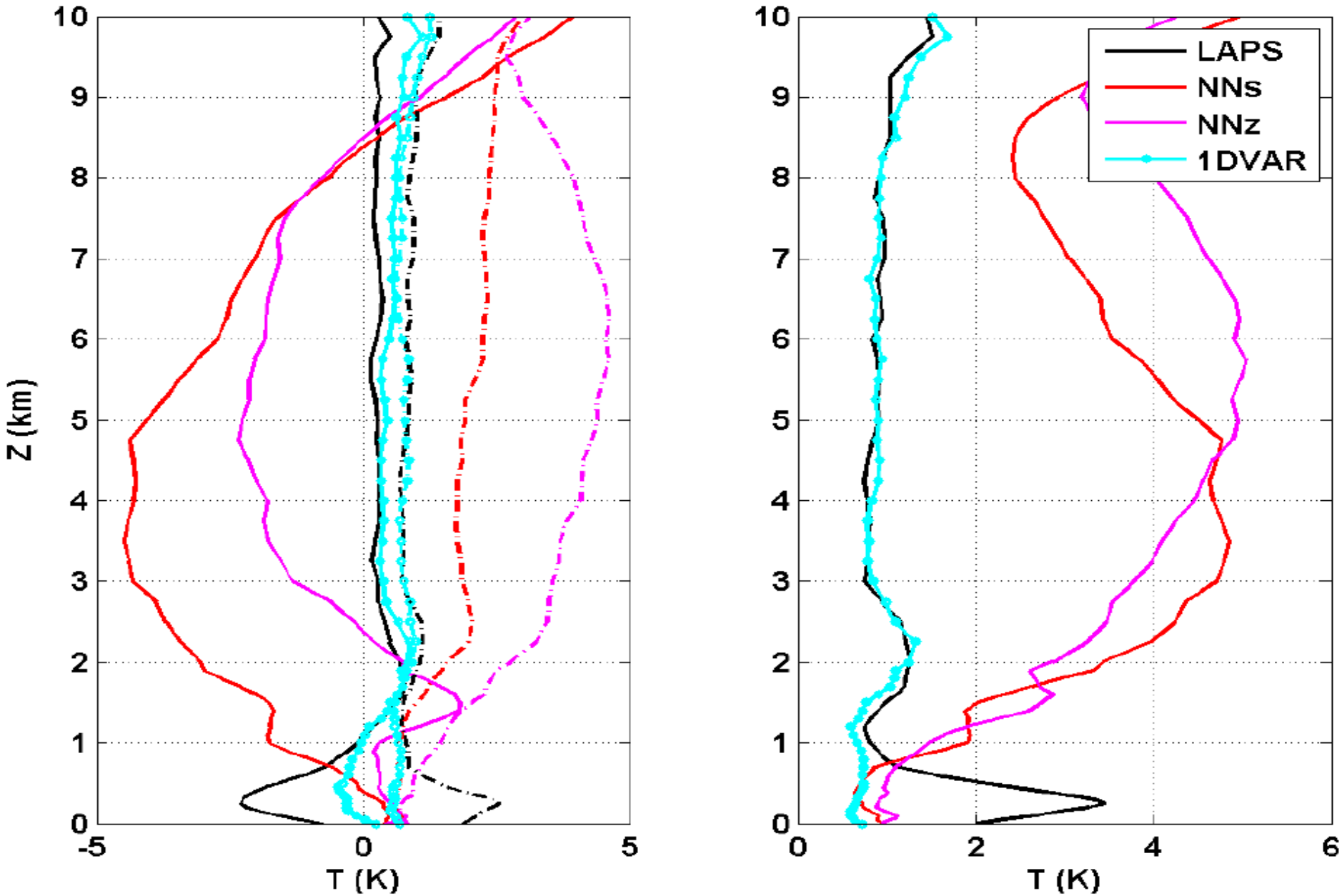
Radiosonde (RAOB), radiometer neural network (NNz=zenith and NNs=off-zenith), LAPS and 1DVAR temperature profiles during heavy (left) and no (right) precipitation.



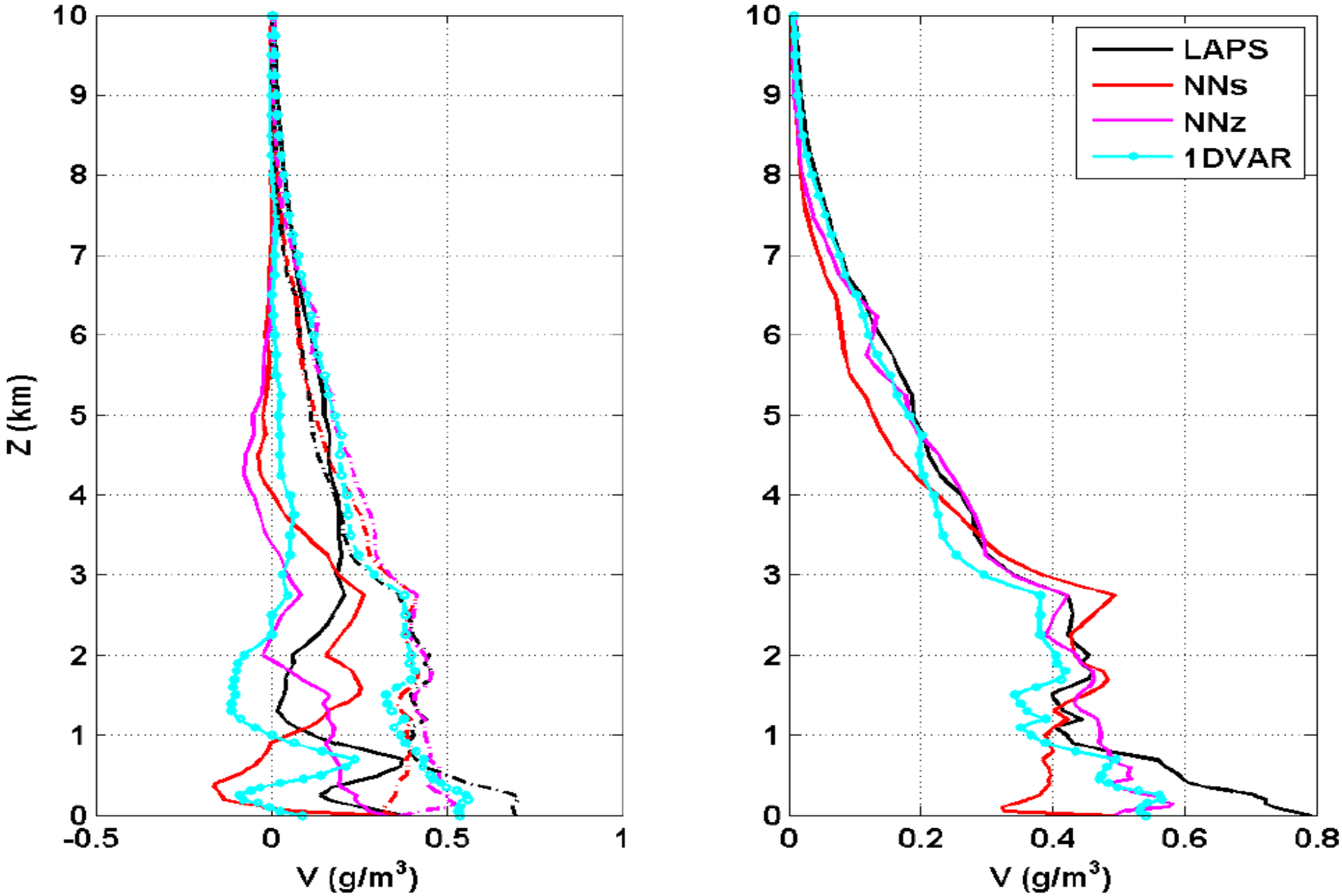
Radiosonde (RAOB), radiometer neural network (NNz=zenith and NNs=off-zenith), LAPS and 1DVAR vapor density profiles during heavy (left) and no (right) precipitation.



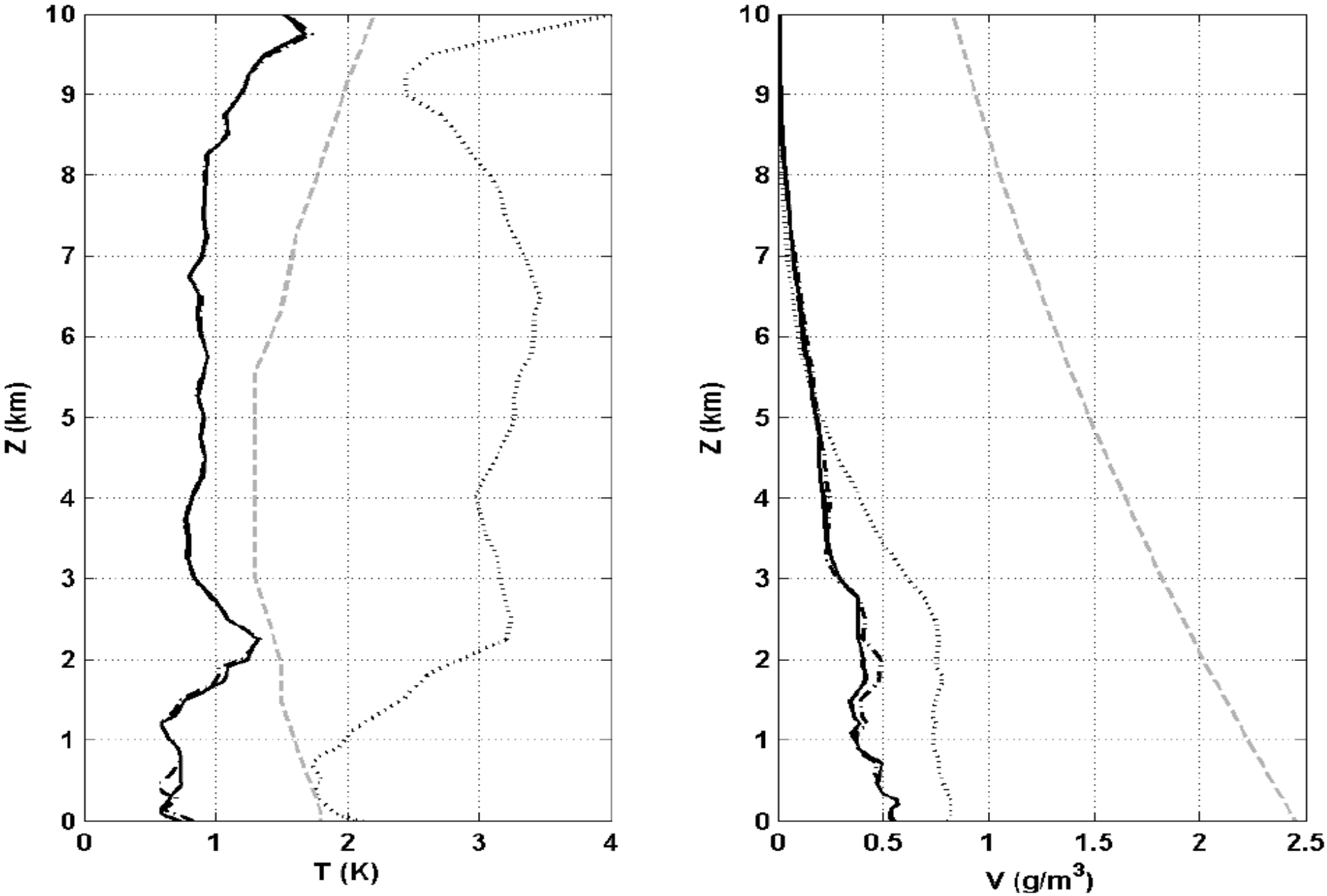
Radiosonde (RAOB), radiometer neural network (NNz=zenith and NNs=off-zenith), LAPS and 1DVAR liquid density profiles during heavy (left) and no (right) precipitation.



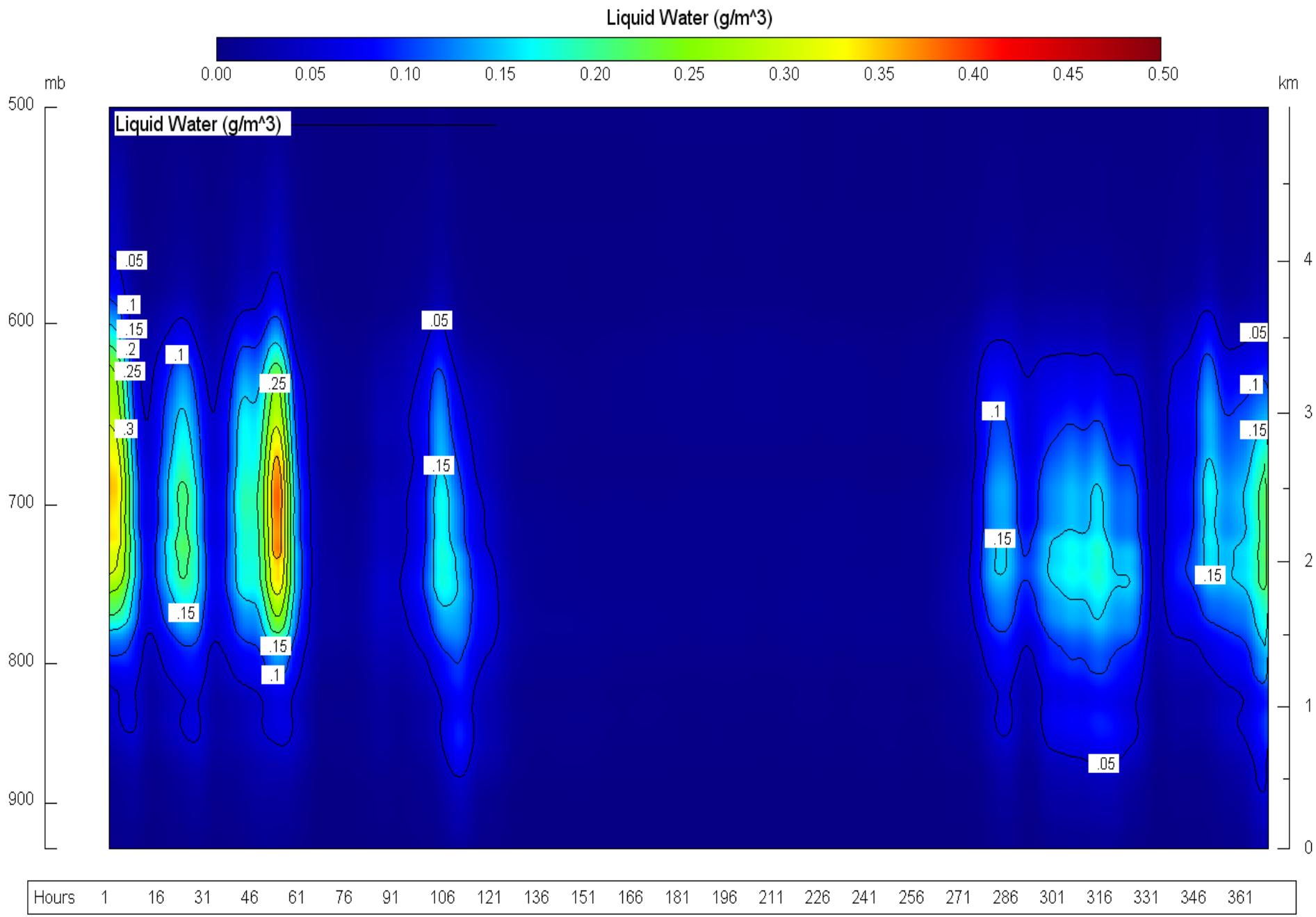
LAPS radiometer neural network (NNz=zenith and NNs=off-zenith), and 1DVAR temperature profile bias (left) and rms (right).



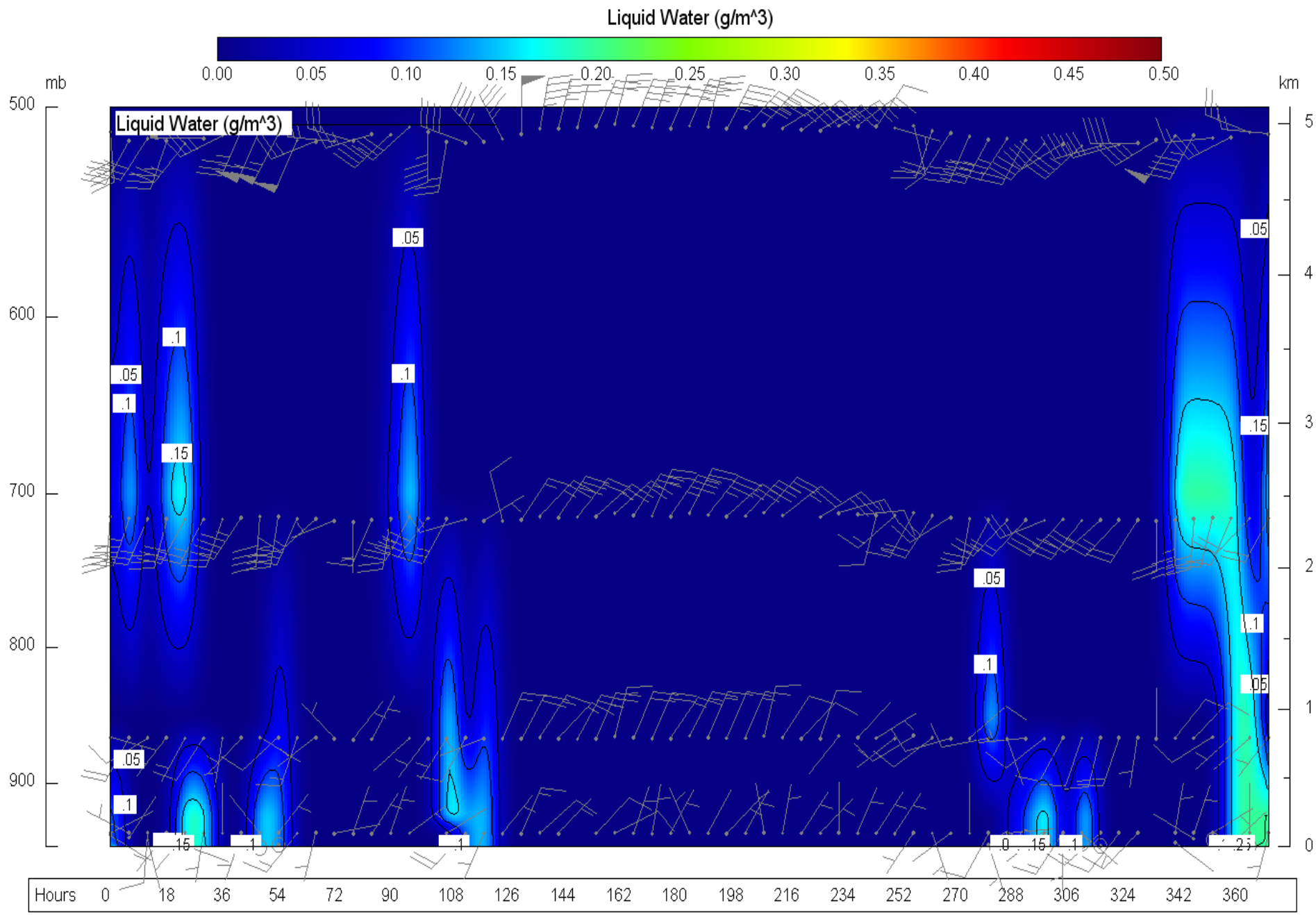
LAPS radiometer neural network (NNz=zenith and NNs=off-zenith), and 1DVAR vapor density profile bias (left) and rms (right).



1DVAR - radiosonde STD with (solid) and without (dot-dash) bias, observation error assigned to radiosonde by NCEP (grey dash), radiosonde dataset STD (grey dot).



Radiometer liquid profile retrievals.



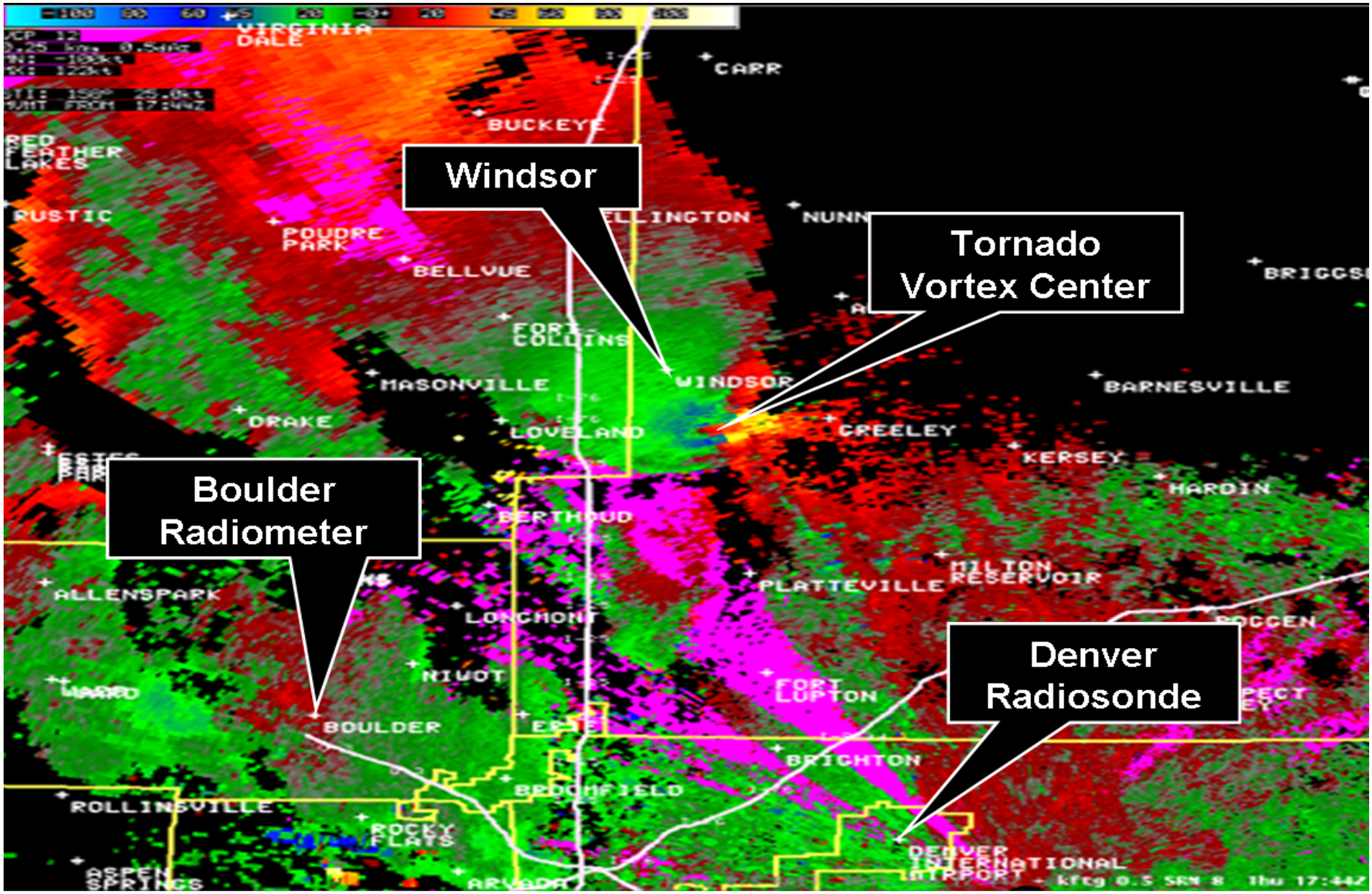
Radiosonde liquid profiles (estimated).

radiometrics

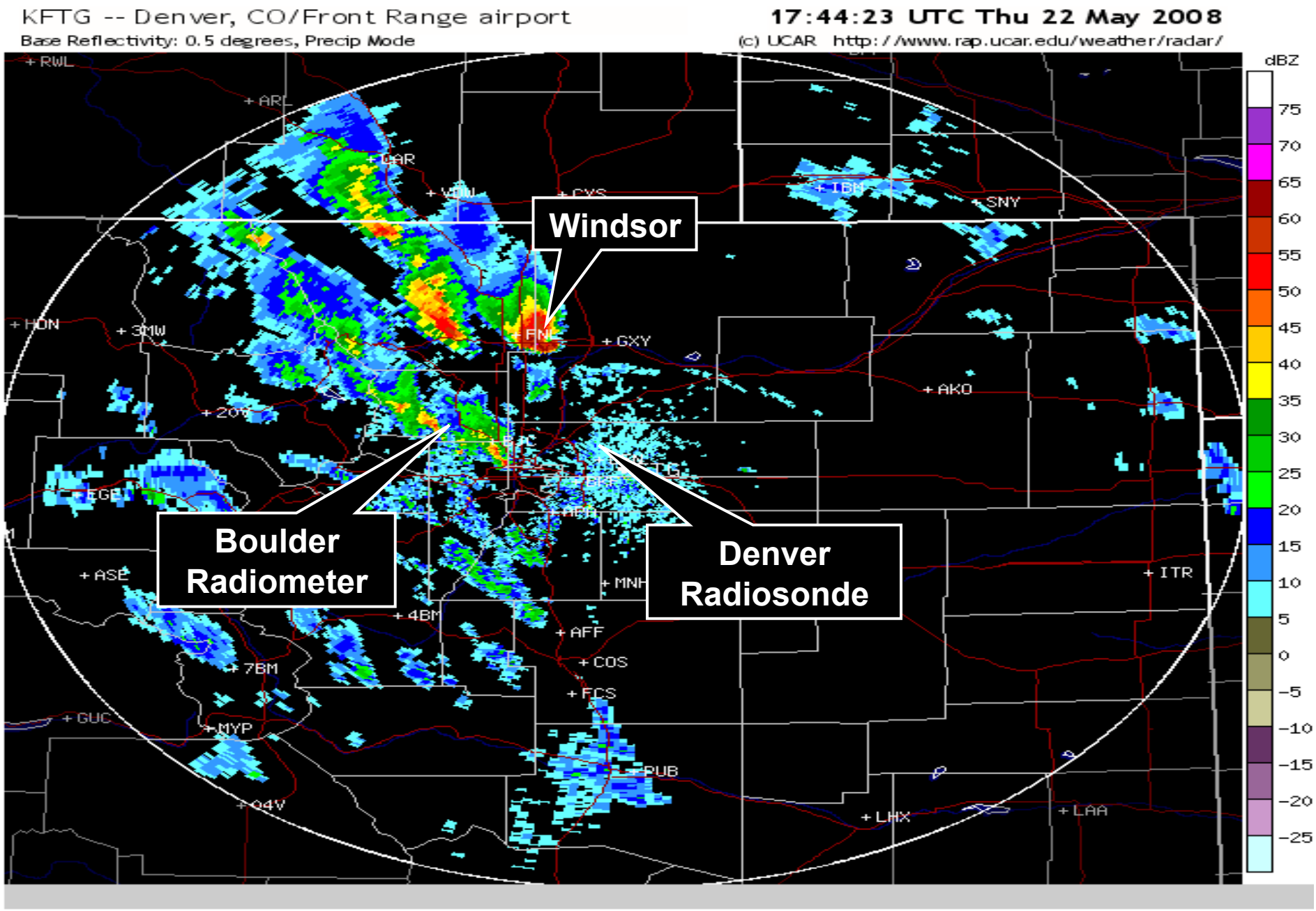
Windsor Tornado

- 22 May 2008: Mile-wide tornado on ground from Platteville to Windsor CO (~45 min)
- Thermodynamic Profiler data at Boulder (50-km southwest of tornado touchdown at Platteville)
- NWS Wind Profile data at Platteville
- High Resolution LAPS analysis

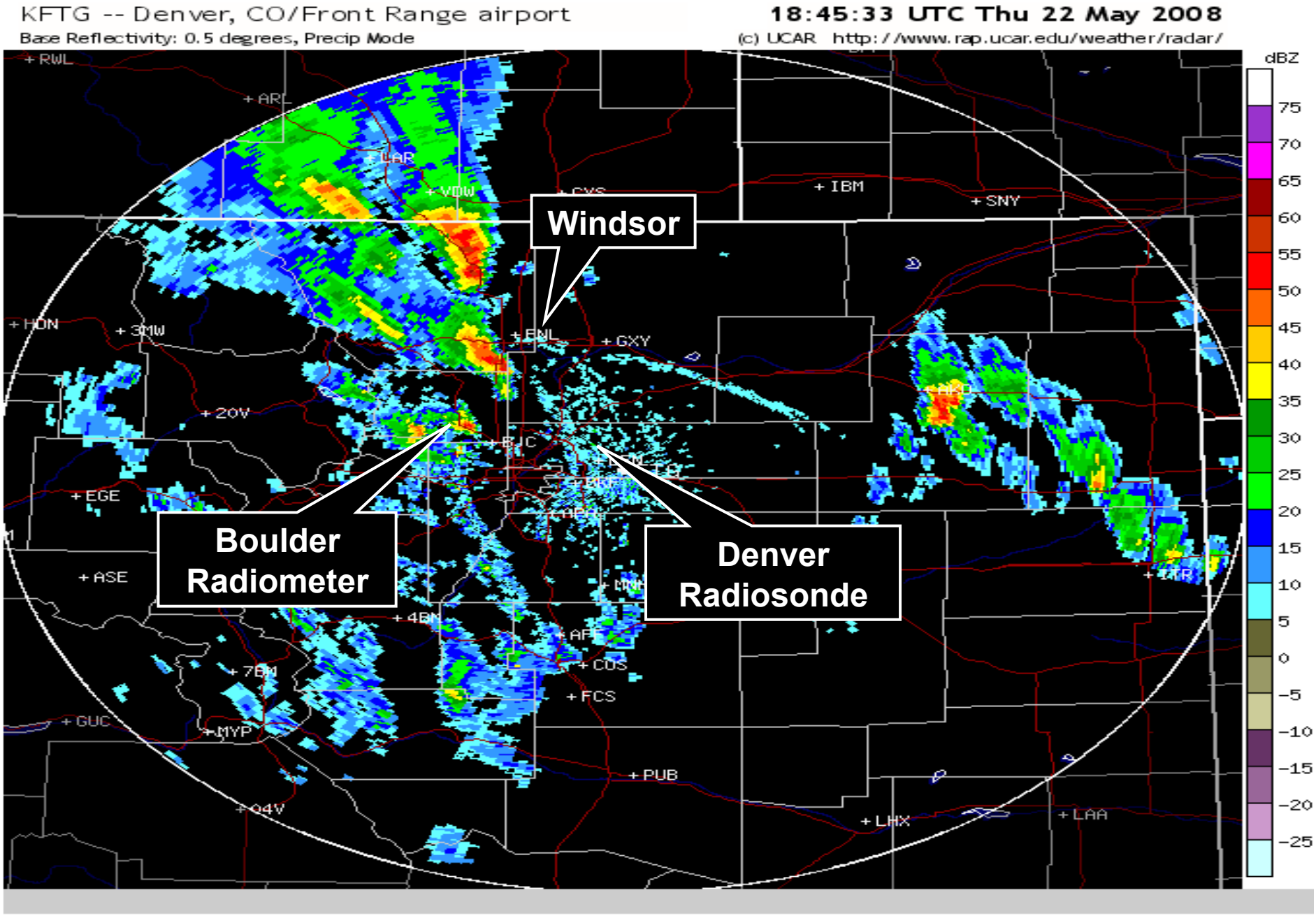
“Windsor, Colorado, was hit by a mile-wide tornado around lunch time, and at least one person died as a cluster of twisters carved a swath of destruction through Northern Colorado. The tornadoes badly damaged dozens of houses, semis and cars.”
(Denver Post, 5-22-08)



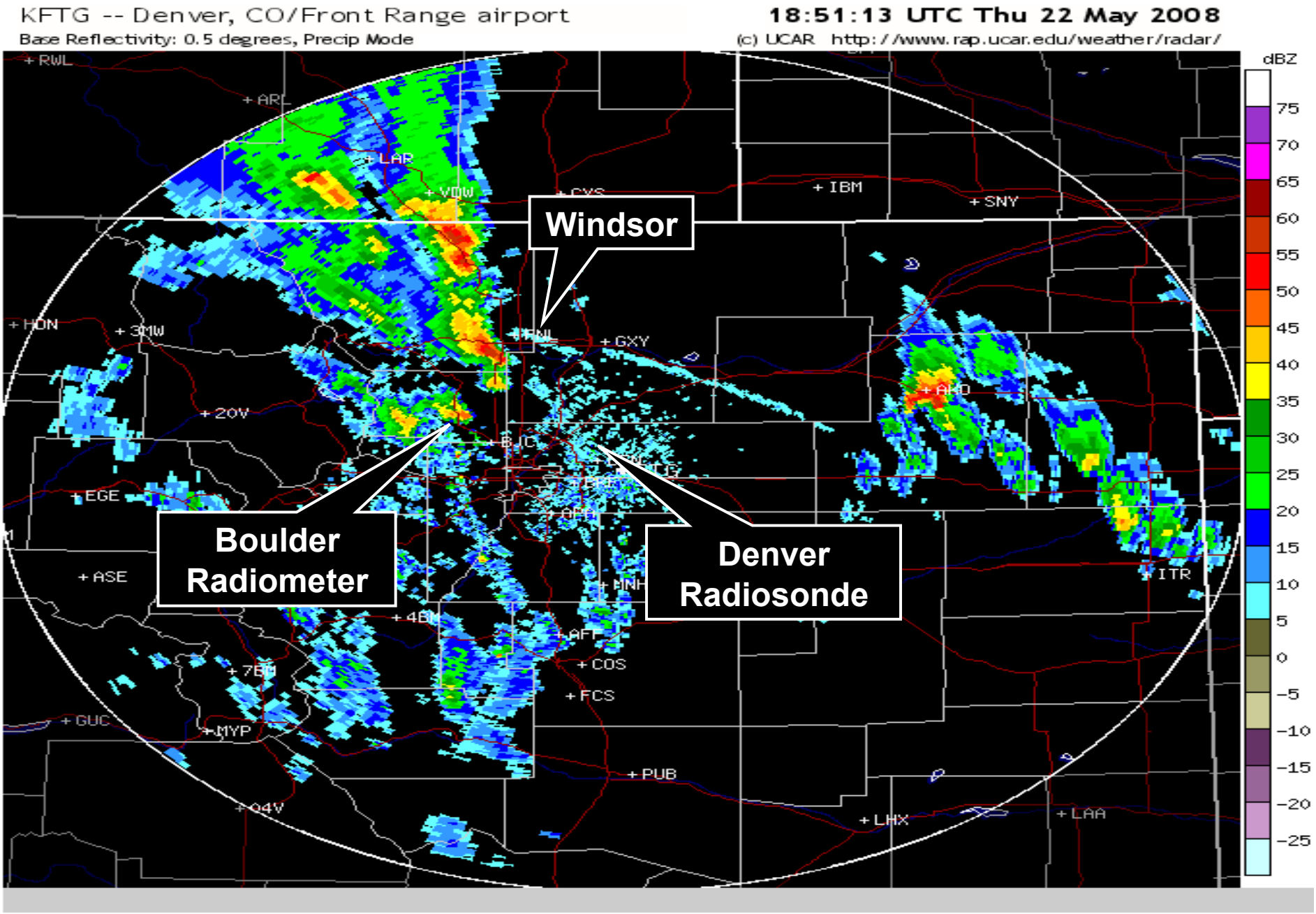
Denver (Doppler) radar showed 180 mph winds near Windsor at 11:44 am (local time) 22 May 2008.



Strong reflectivity near Windsor at 11:44 am (local time).



Strong reflectivity south of Boulder at 12:45 pm (local time).

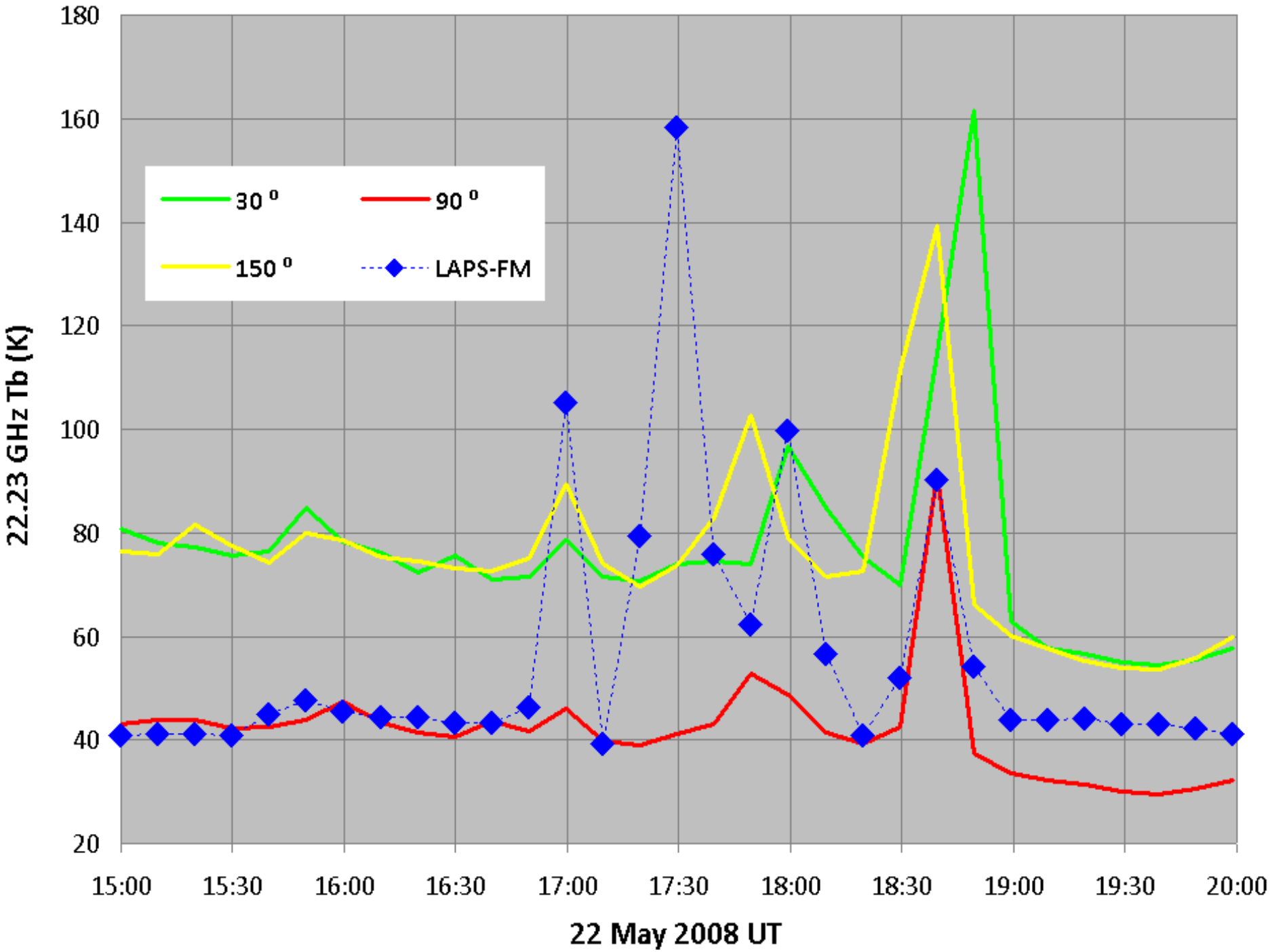


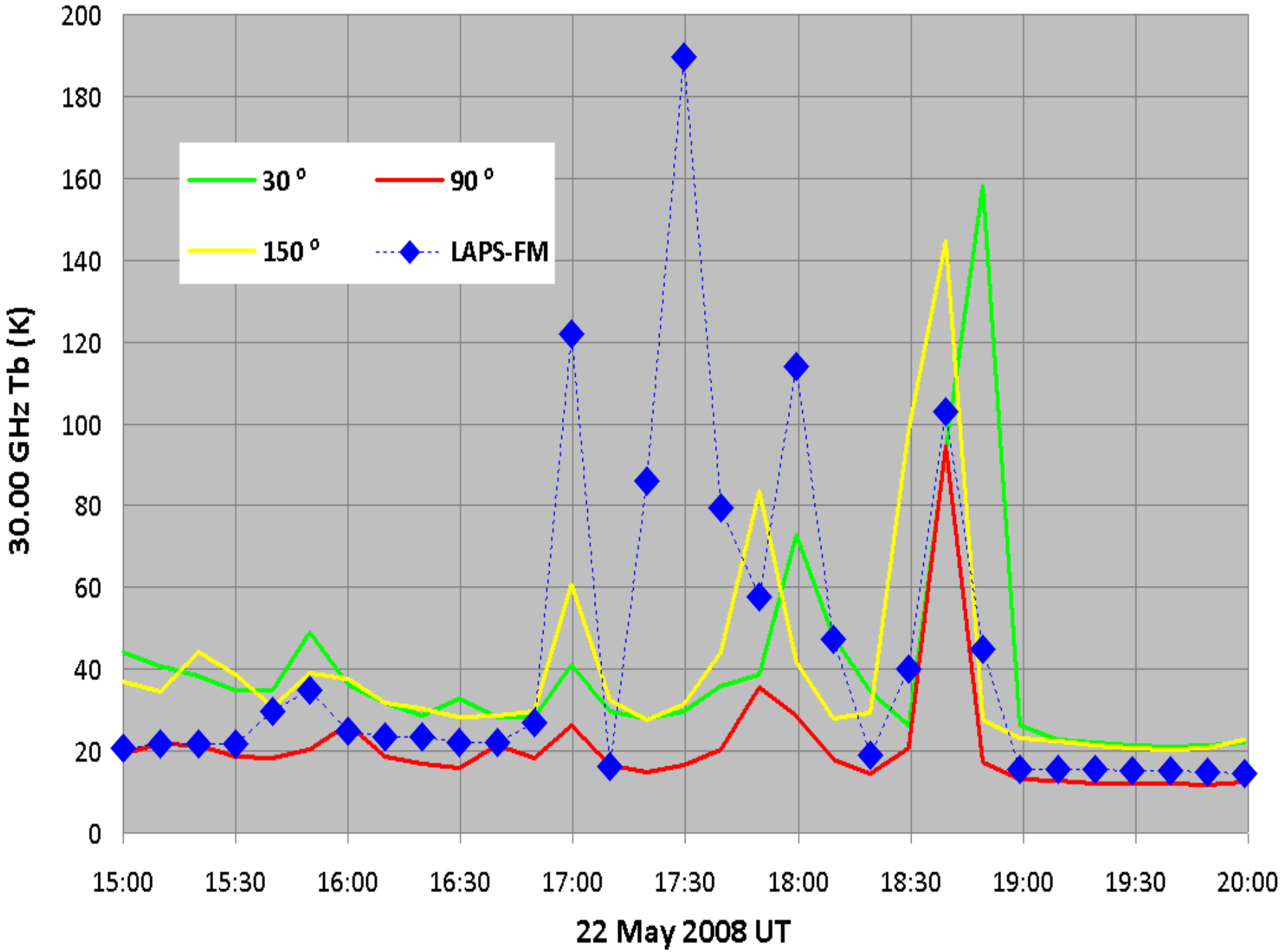
Strong reflectivity north of Boulder at 12:51 pm (local time).

radiometrics

Brightness Temperature Observation & Analysis

- Forward-modeled LAPS grid point analysis brightness temperatures (Tb)
- Zenith and off-zenith radiometer Tb observations
- Comparison on the day of the Windsor Tornado (22 May 2008).


180
160
140
120
100
80
60
40
20
22.23 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
22 May 2008 UT


30 °
90 °
150 °
LAPS-FM
30.00 GHz Tb (K)
200
180
160
140
120
100
80
60
40
20
0
15:00
15:30
16:00
16:30
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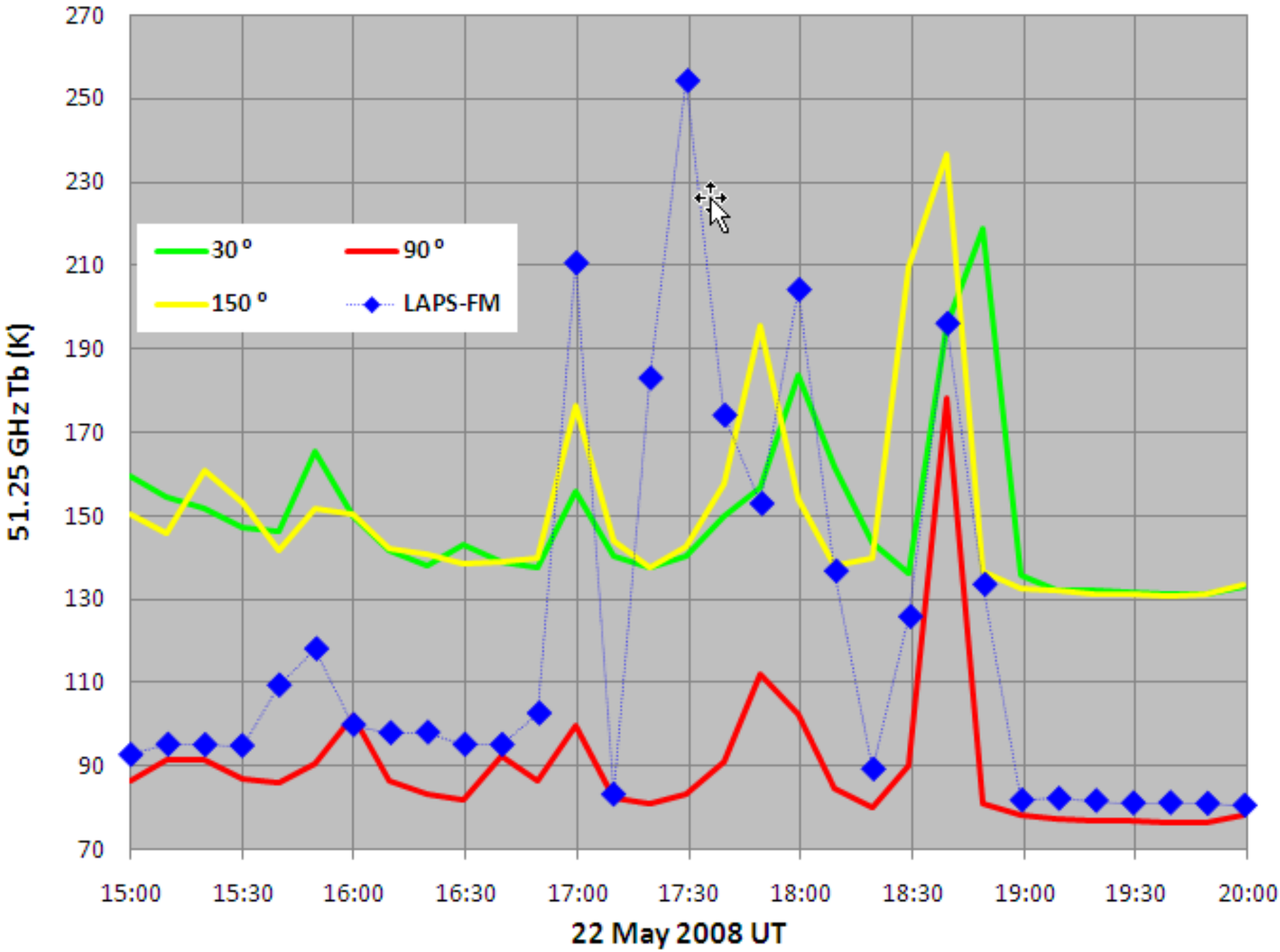
17:30
18:00
18:30
19:00
19:30
20:00
22 May 2008 UT


270
250
230
210
190
170
150
130
110
90
70
51.25 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
15:00
15:30
16:00
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18:00
18:30
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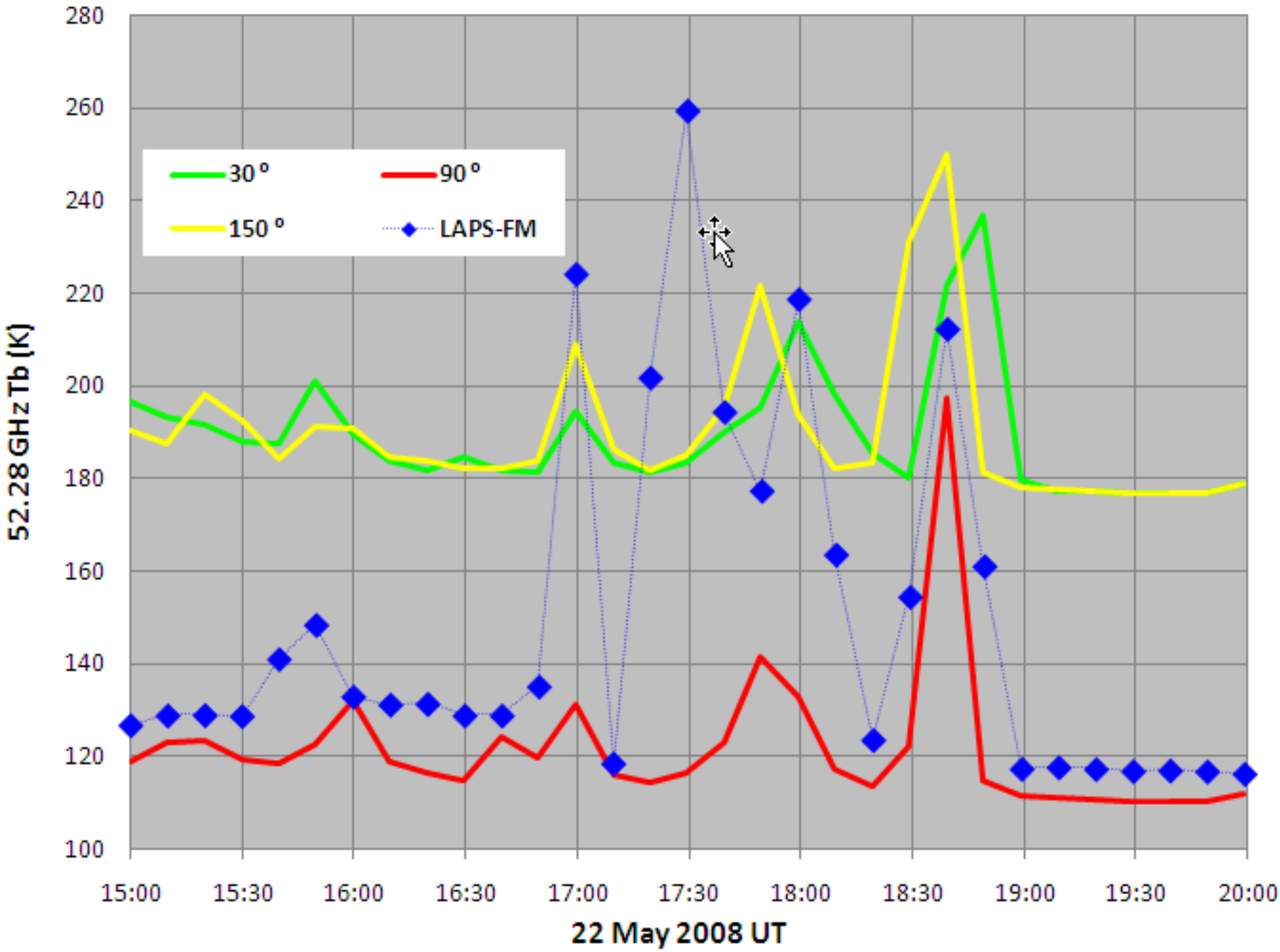
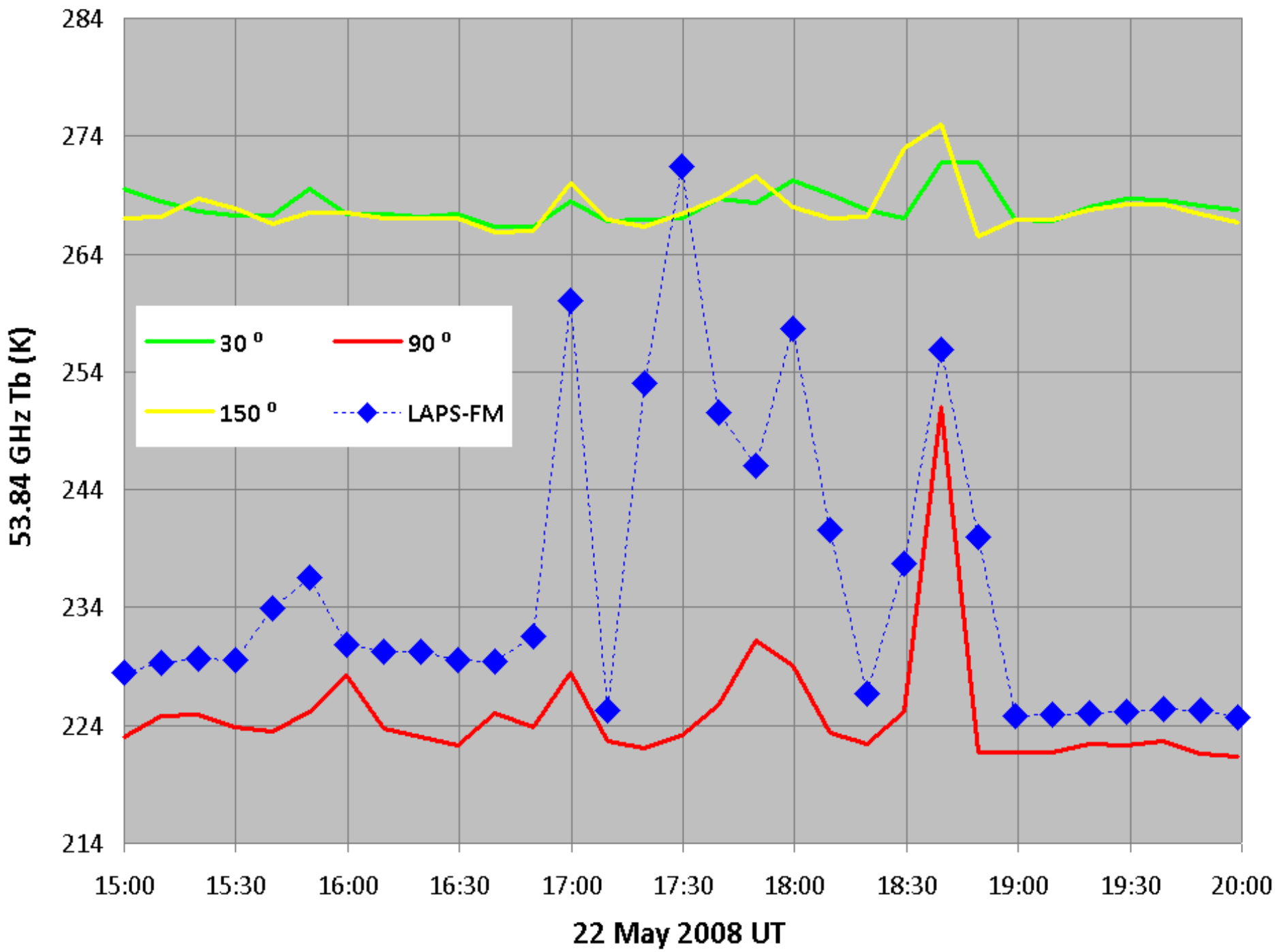
19:30
20:00
22 May 2008 UT


280
260
240
220
200
180
160
140
120
100
52.28 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
22 May 2008 UT


284
274
264
254
244
234
224
214
53.84 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
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18:00
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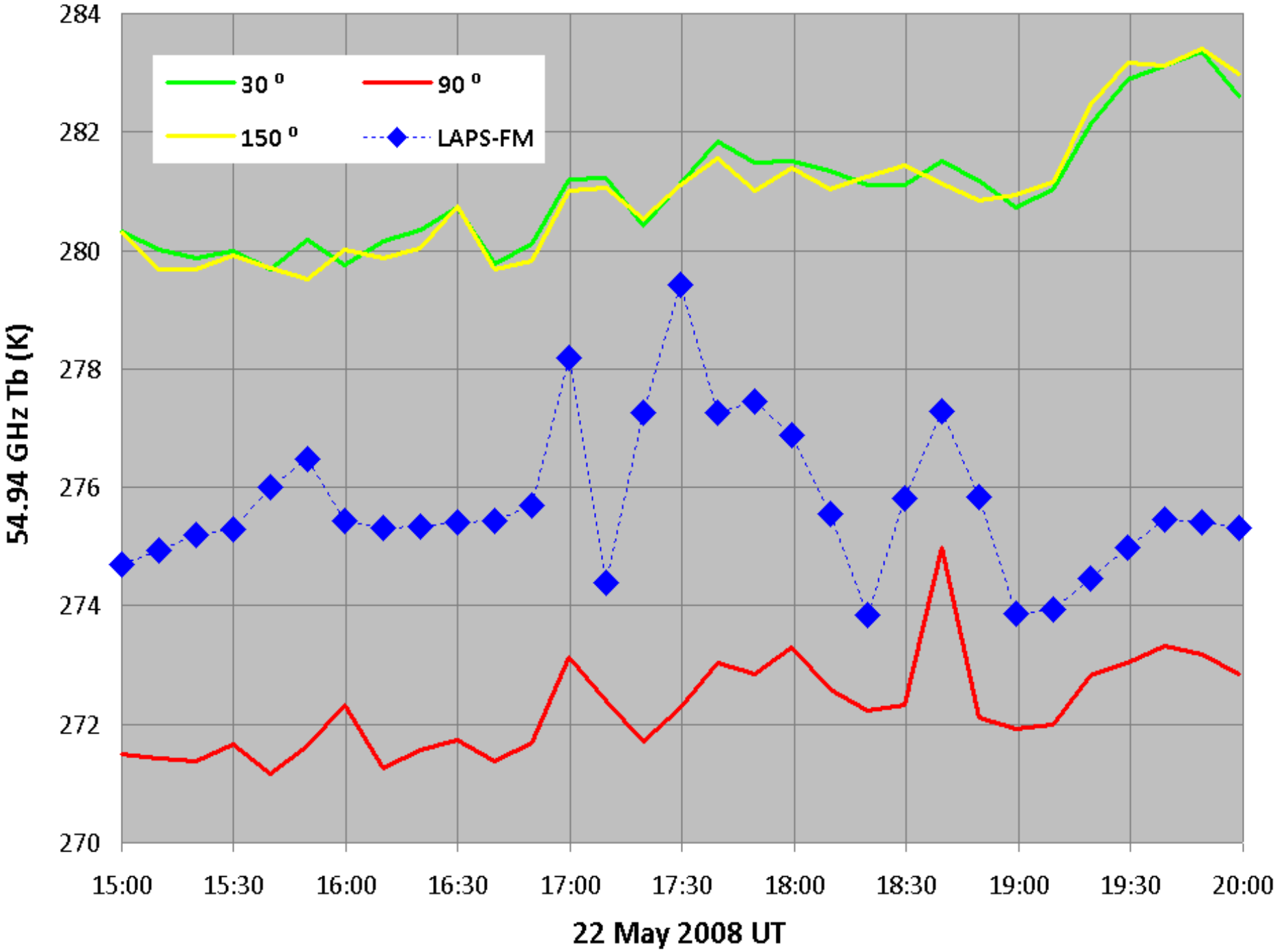
19:00
19:30
20:00
22 May 2008 UT


30 °
90 °
150 °
LAPS-FM
284
282
280
278
276
274
272
270
54.94 GHz Tb (K)
15:00
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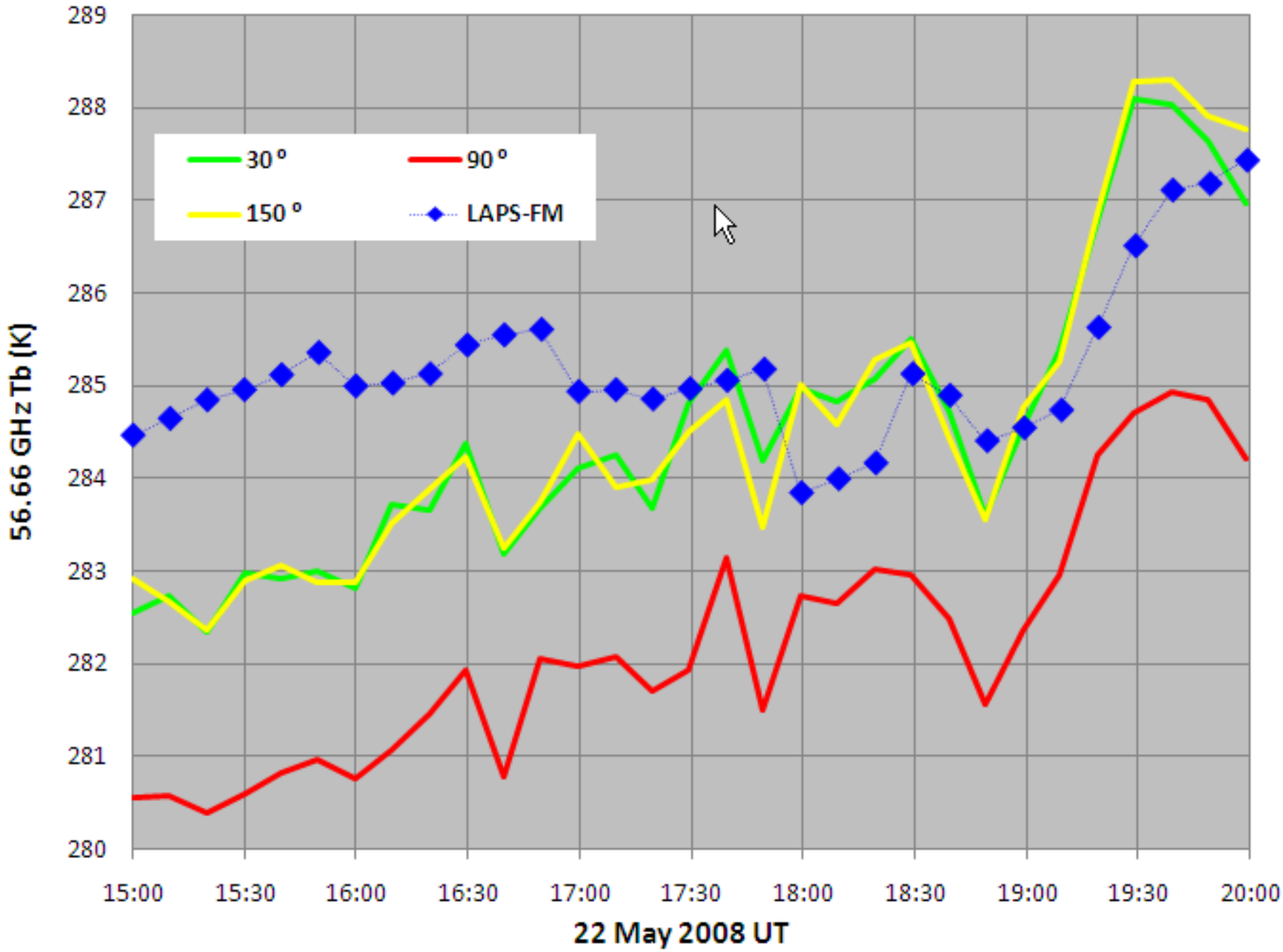
19:30
20:00
22 May 2008 UT


289
288
287
286
285
284
283
282
281
280
56.66 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
15:00
15:30
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17:30
18:00
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19:00
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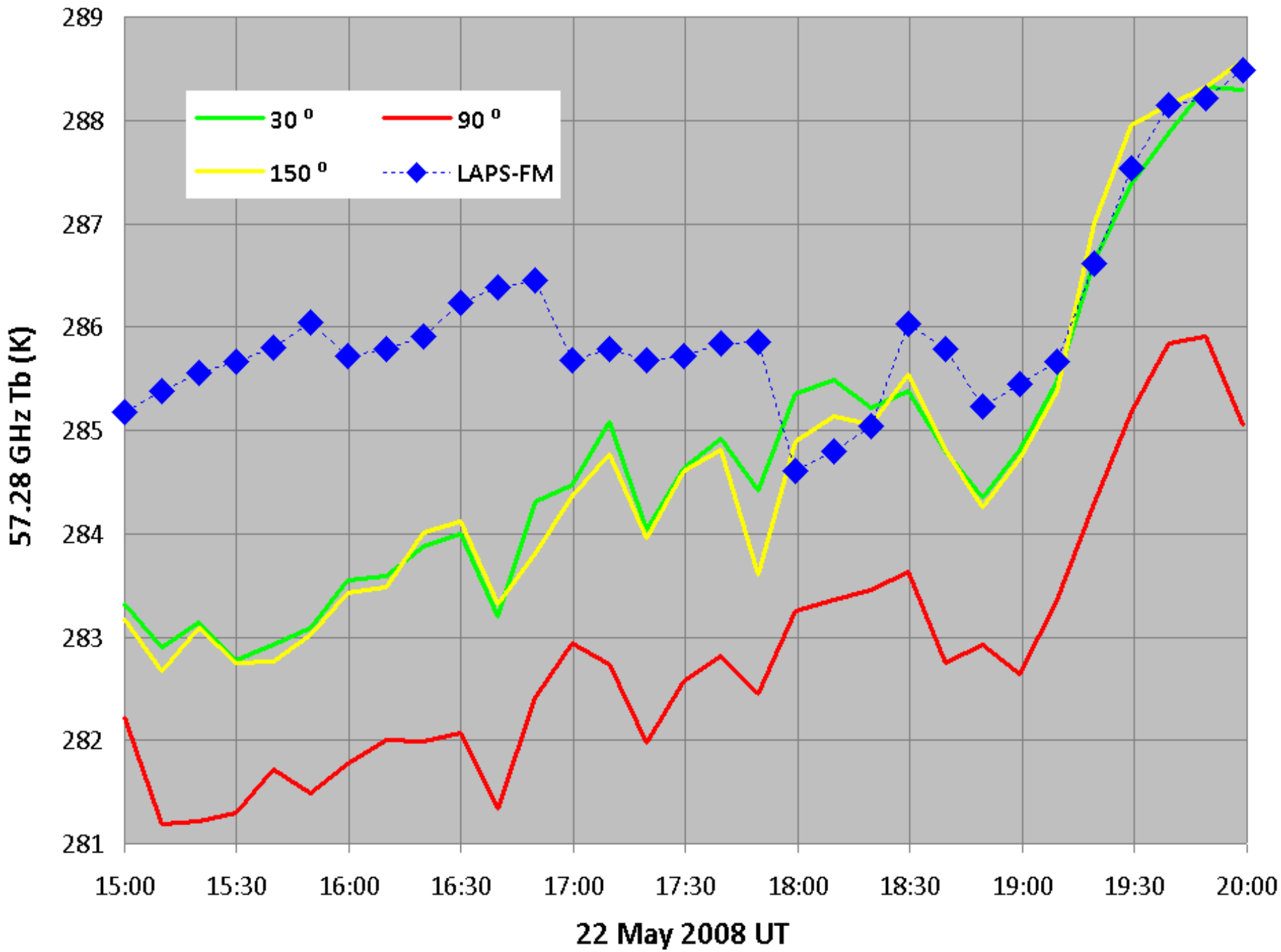
20:00
22 May 2008 UT


289
288
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286
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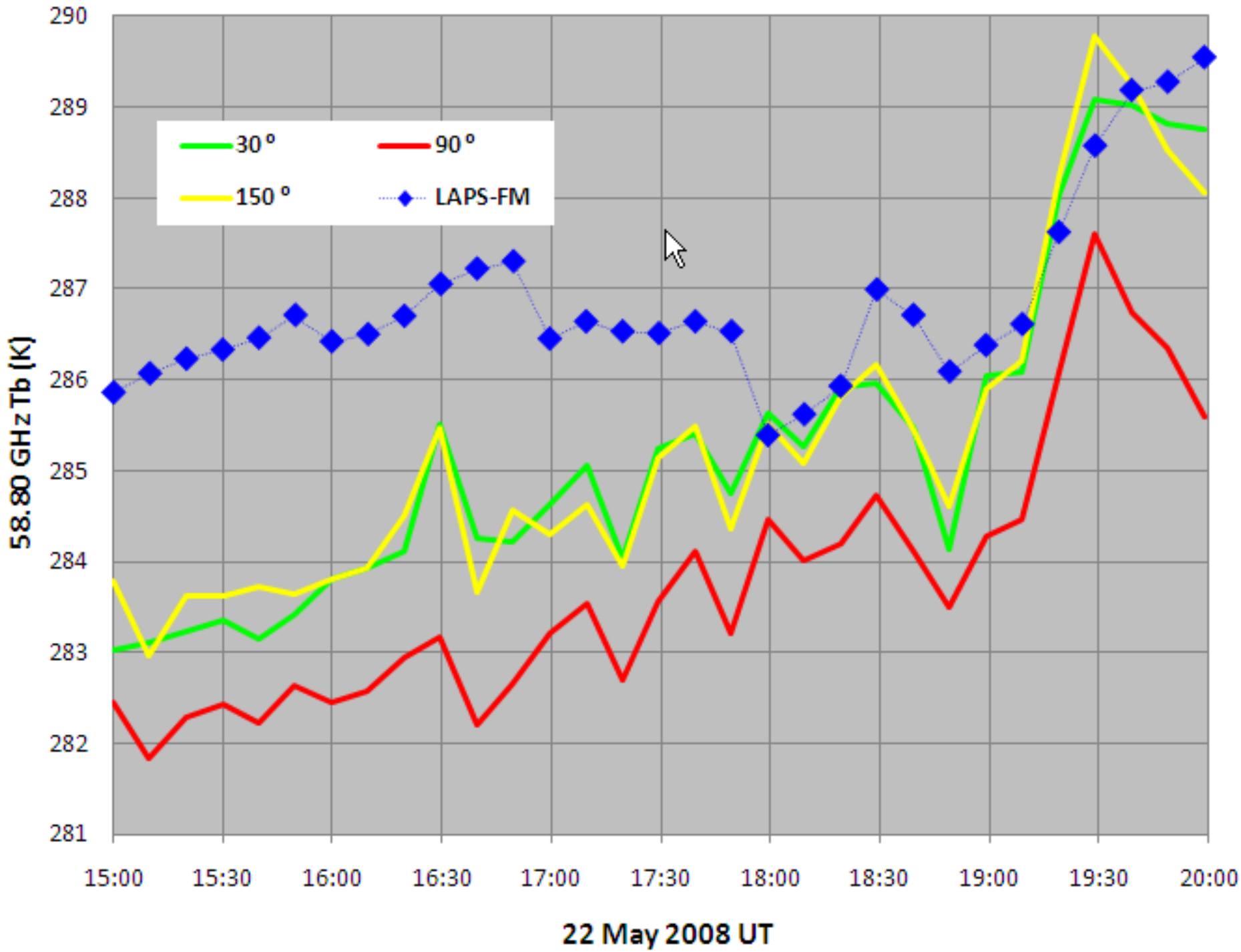
284
283
282
281
57.28 GHz Tb (K)
30 °
90 °
150 °
LAPS-FM
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
22 May 2008 UT


290
289
288
287
286
285
284
283
282
281
58.80 GHz Tb (K)
30°
90°
150°
LAPS-FM
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
22 May 2008 UT

radiometrics

Continuous Forecast Tools and Indices

- Thermodynamic and liquid profiles from a radiometer at Boulder
- Wind profiles from the Platteville radar (until 1700 UT)
- Continuous forecast tools and indices generated from thermodynamic and wind profiles are presented

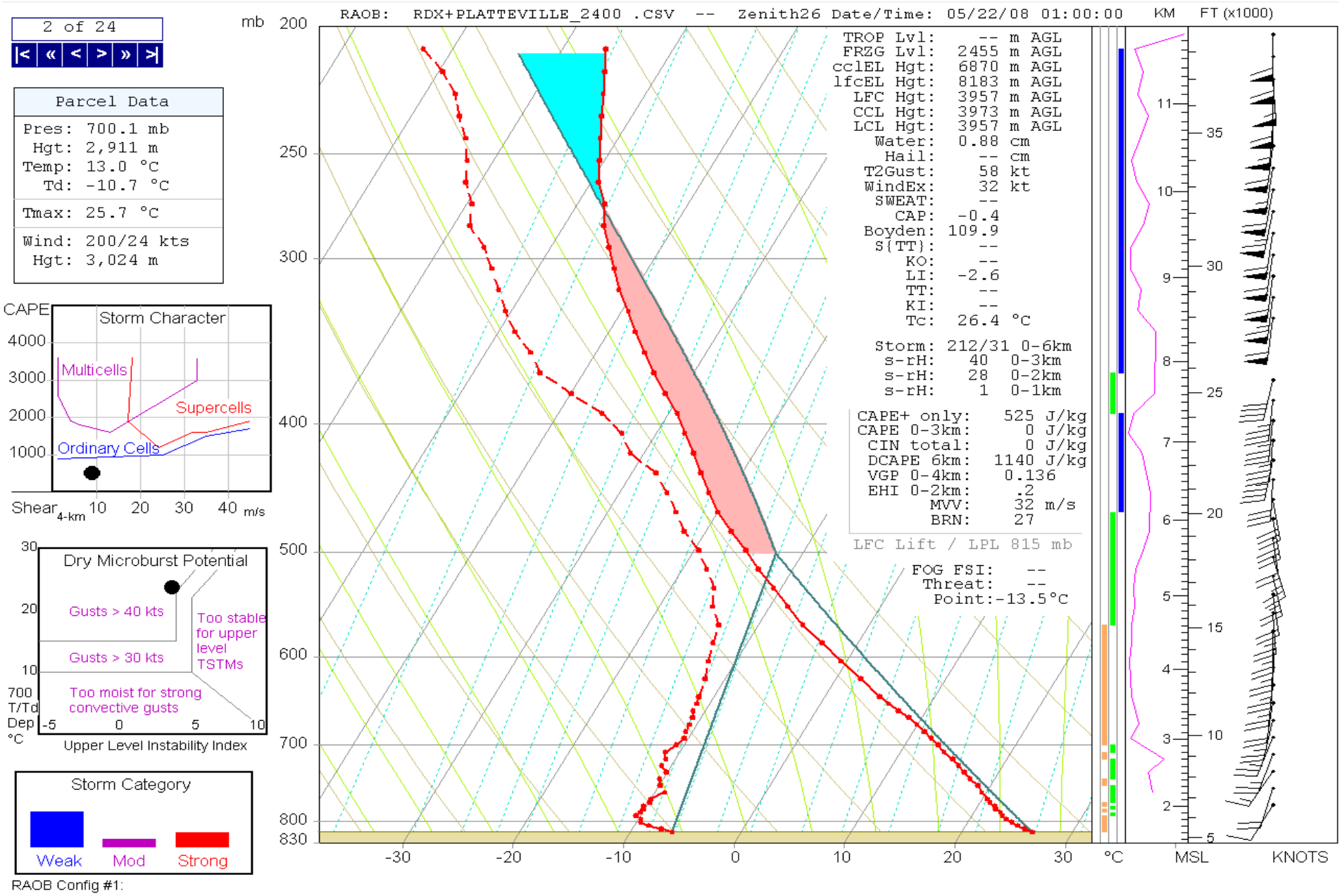
Scott McLaughlin photos

RASS DATA INTERMITTENT

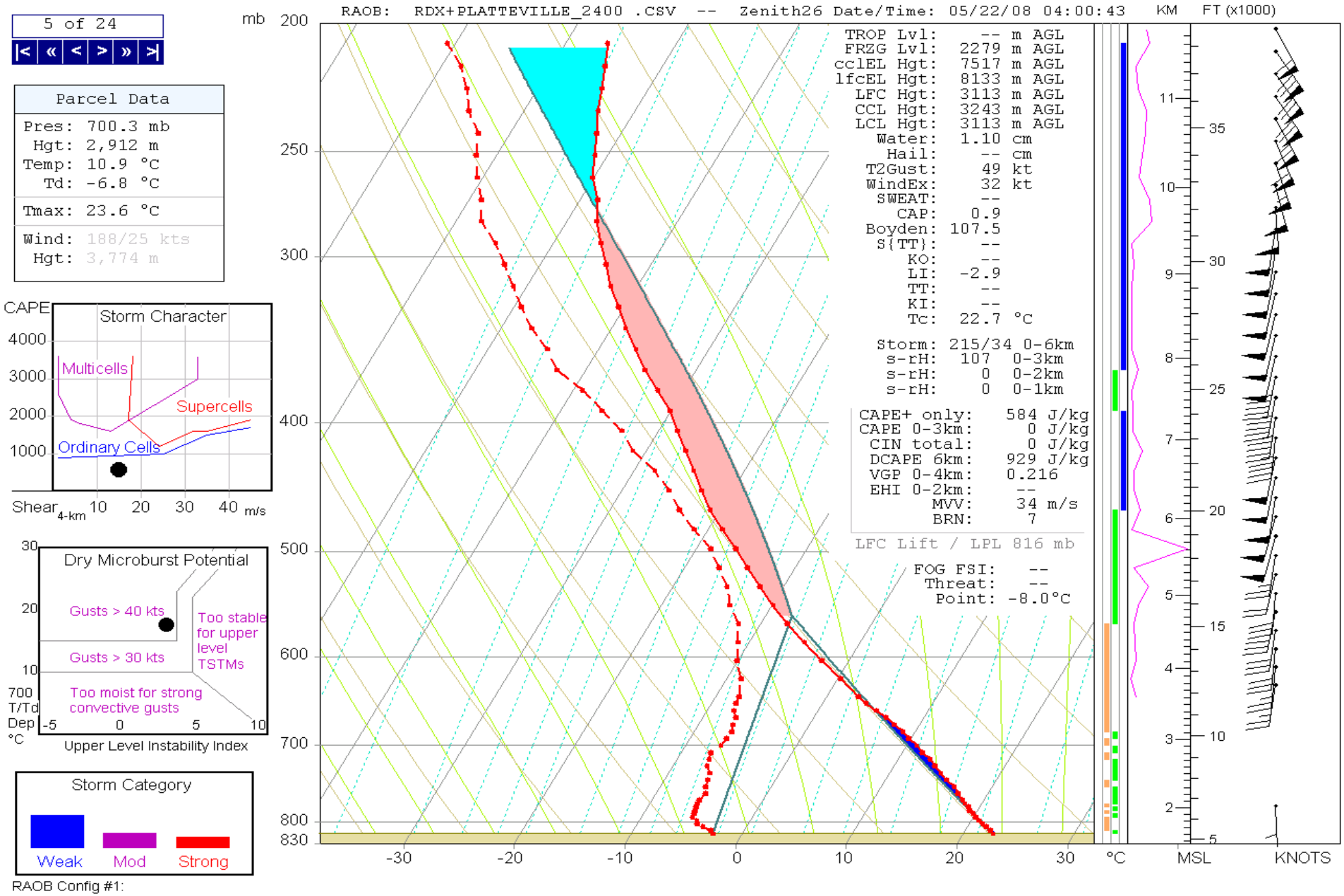
RASS cuff over 8’ tall

Winds est. 70+ MPH
In the news, a tornado touched down to the north, maybe 5 miles or so. (We didn’t see the tornado, just lots of cloud rotation.)

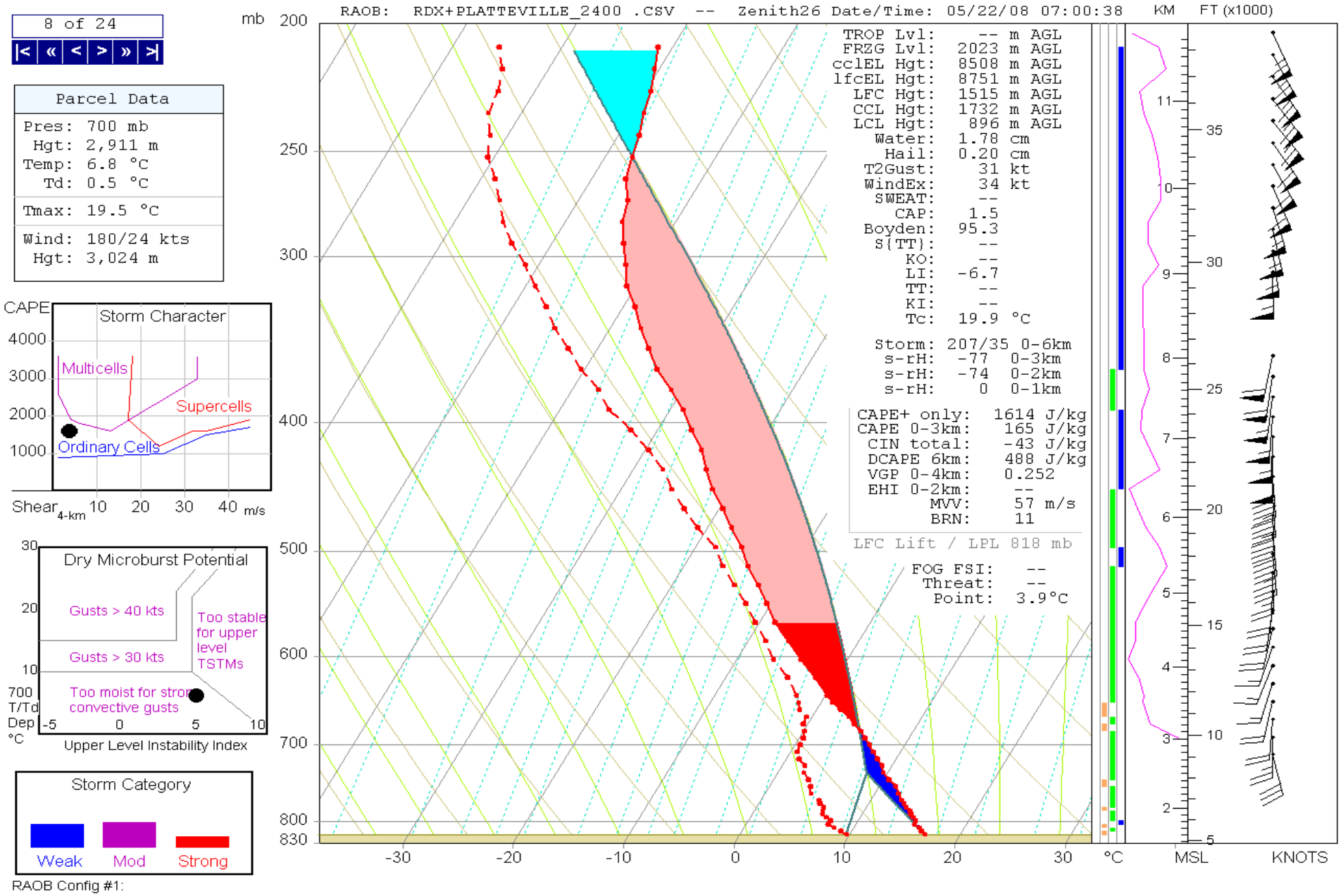
Platteville, CO
11:20 AM, May 22, 2008
NOAA Radar Wind Profiler Site



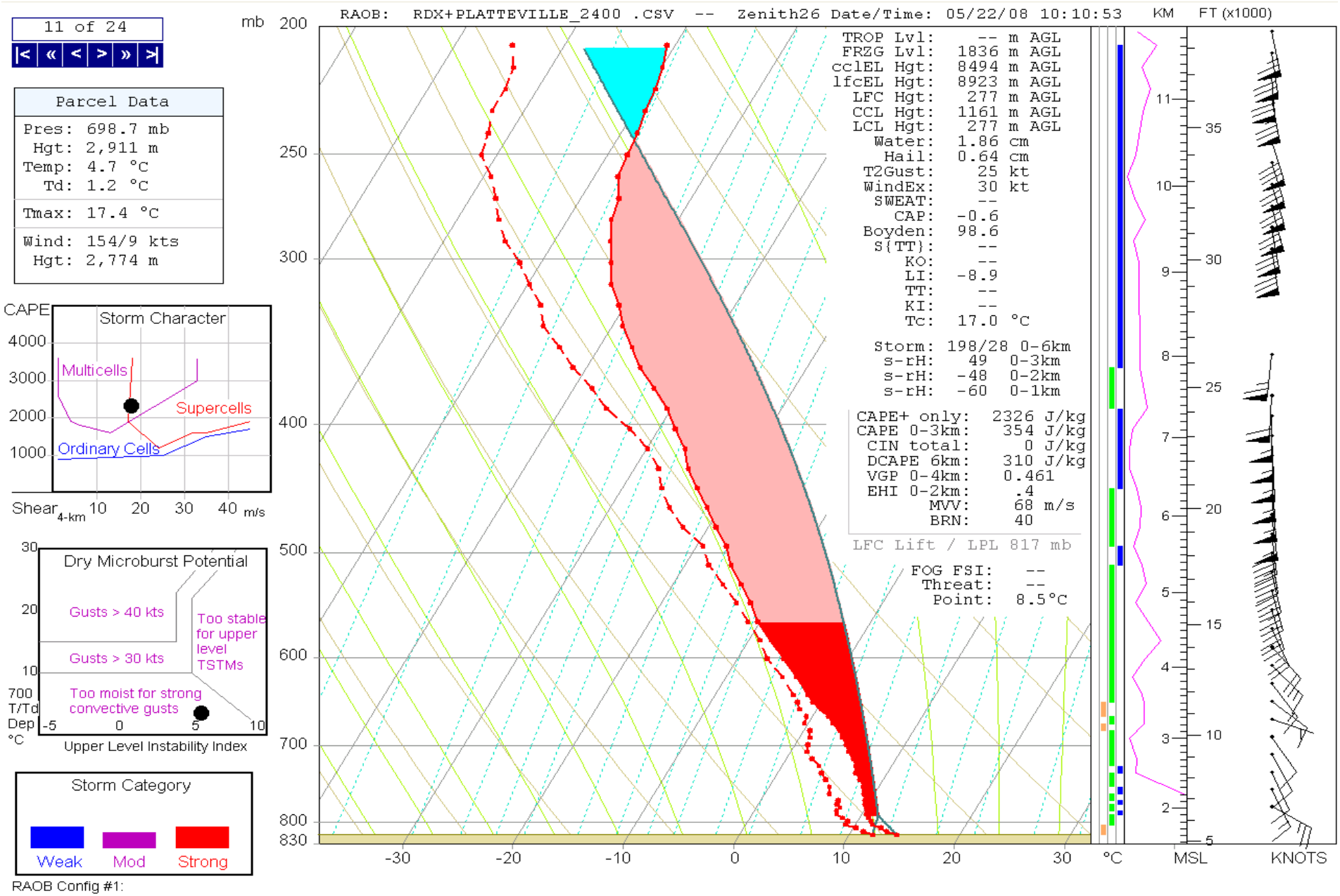
<u>0200 UT</u> (22 May 2008): Forecast Tools and Indices from Boulder thermodynamics and Platteville wind profiles; Gusts >40 kt, Storm Category = Weak (lower left panels)



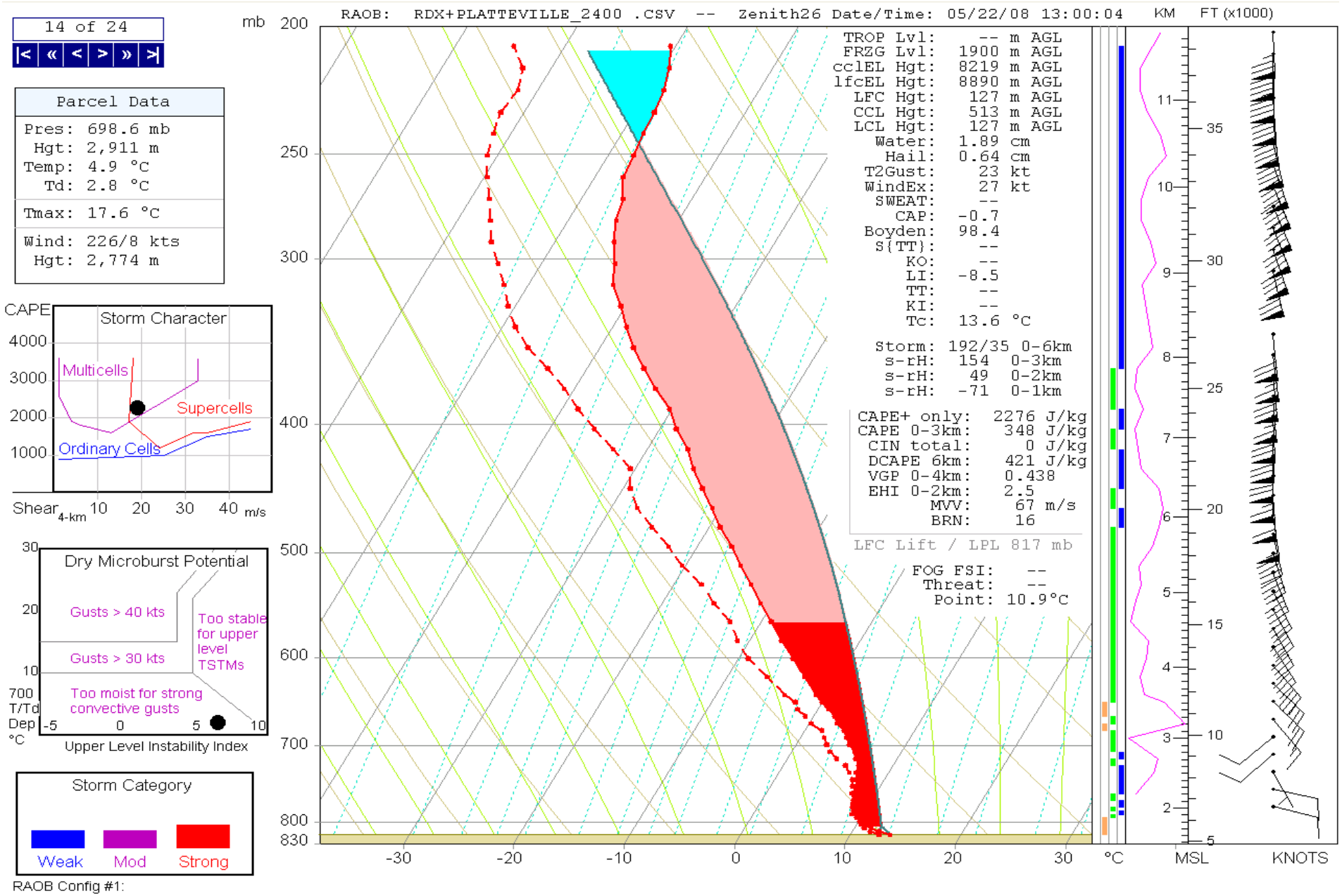
<u>0500 UT</u>: Gusts >40 kts, Storm Category = Weak (lower panels at left); CAPE = 584 J/kg, MVV = 34 m/s (right center)



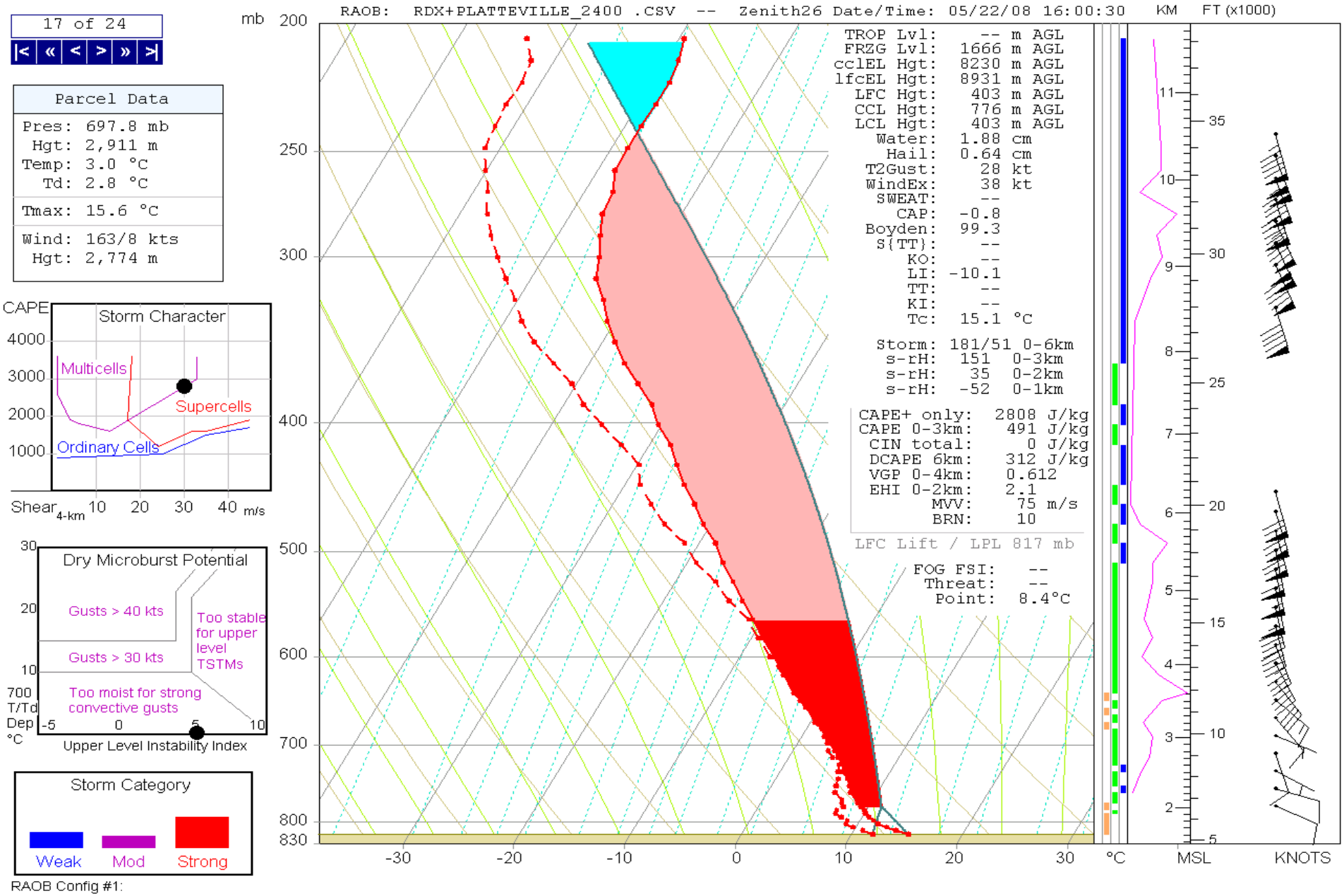
<u>0800 UT</u>: Storm Character = Ordinary Cells, Gusts <30 kts, Storm Category = Mod; Hail = 0.2 cm, CAPE = 1614 (J/kg), MVV = 57 m/s



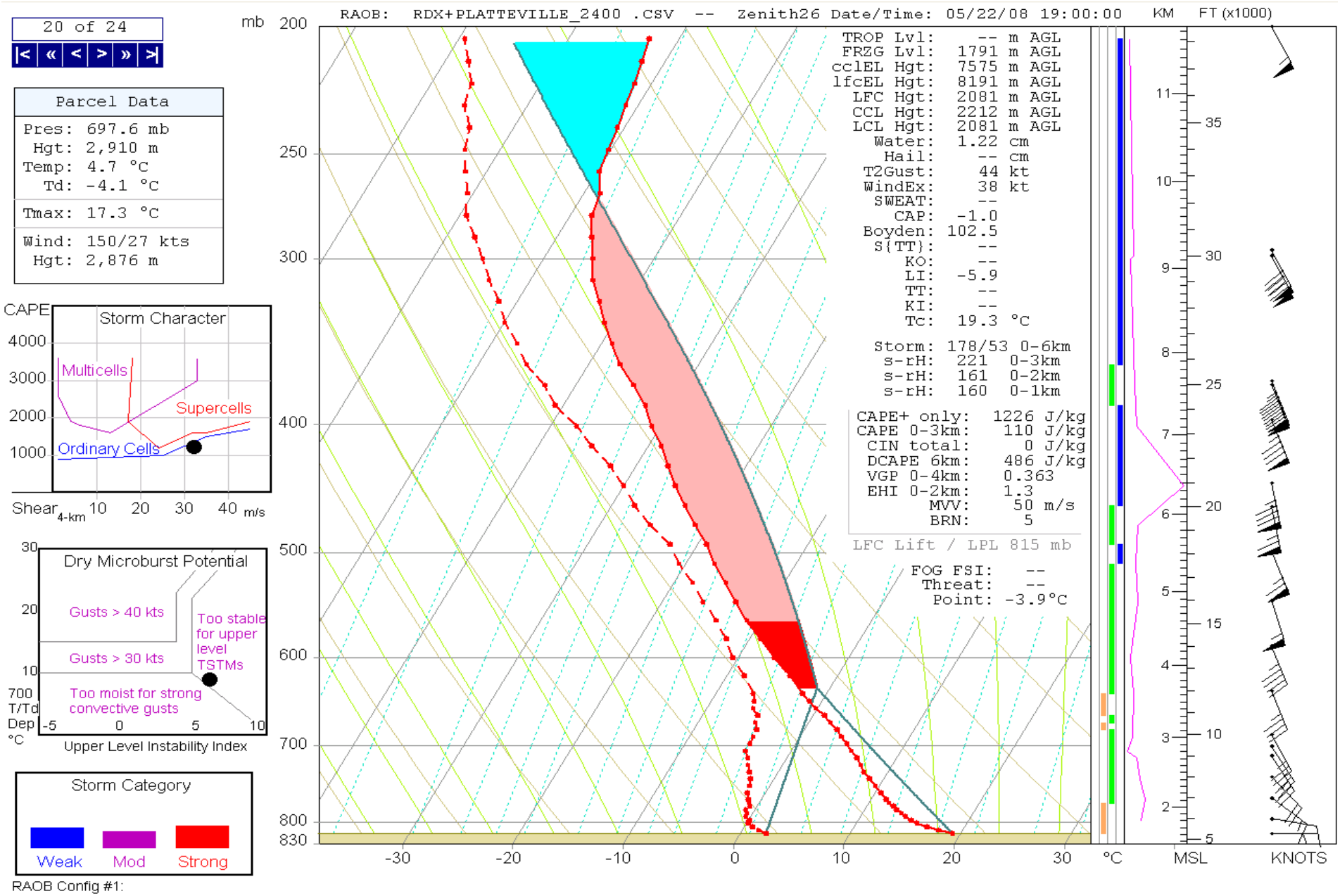
<u>1100 UT</u>: Storm Character = Multicell-Supercell, Gusts <30 kts, Storm Category = Strong; Hail = 0.64 cm, CAPE = 2326 J/kg, MVV = 68 m/s



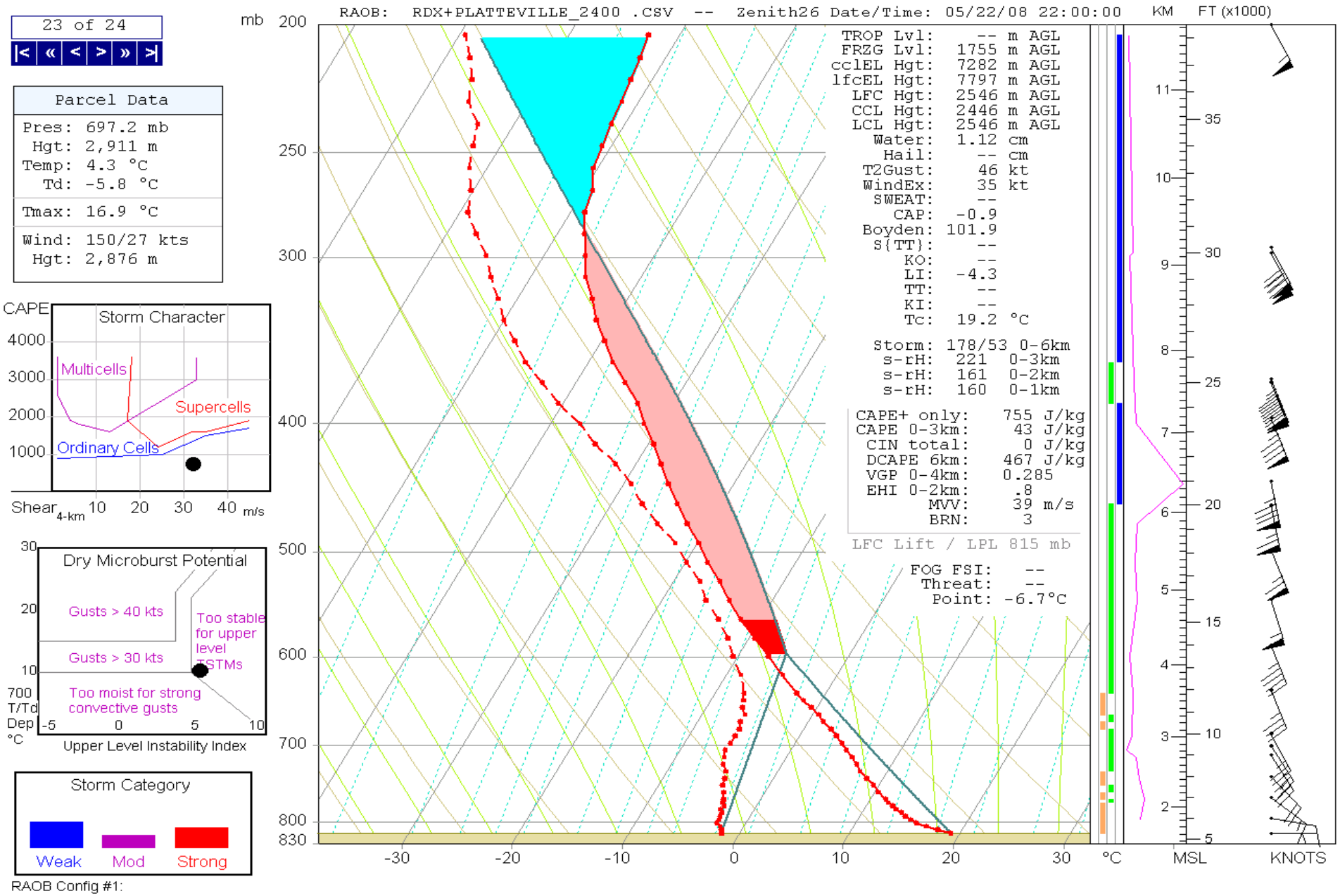
<u>1400 UT</u>: Storm Character = Multicell-Supercell, Gusts <30 kts, Storm Category = Strong; Hail = 0.64 cm, CAPE = 2276 J/kg, MVV = 67 m/s



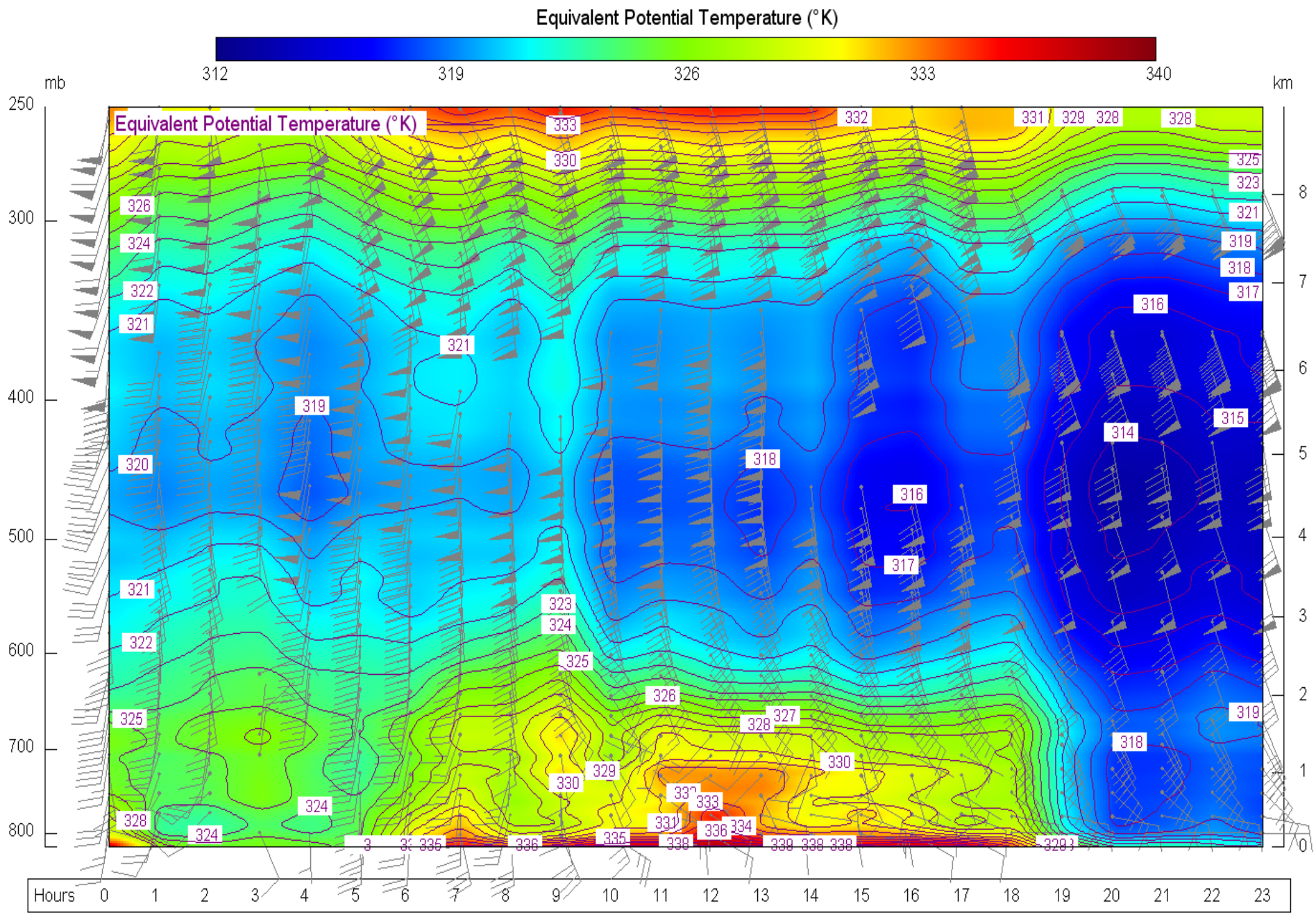
1700 UT: Storm Character = Supercell, Gusts <30 kts (too moist for strong convective gusts), Storm Category = Strong; Hail = 0.64 cm, CAPE = 2808 J/kg, MVV = 75 m/s



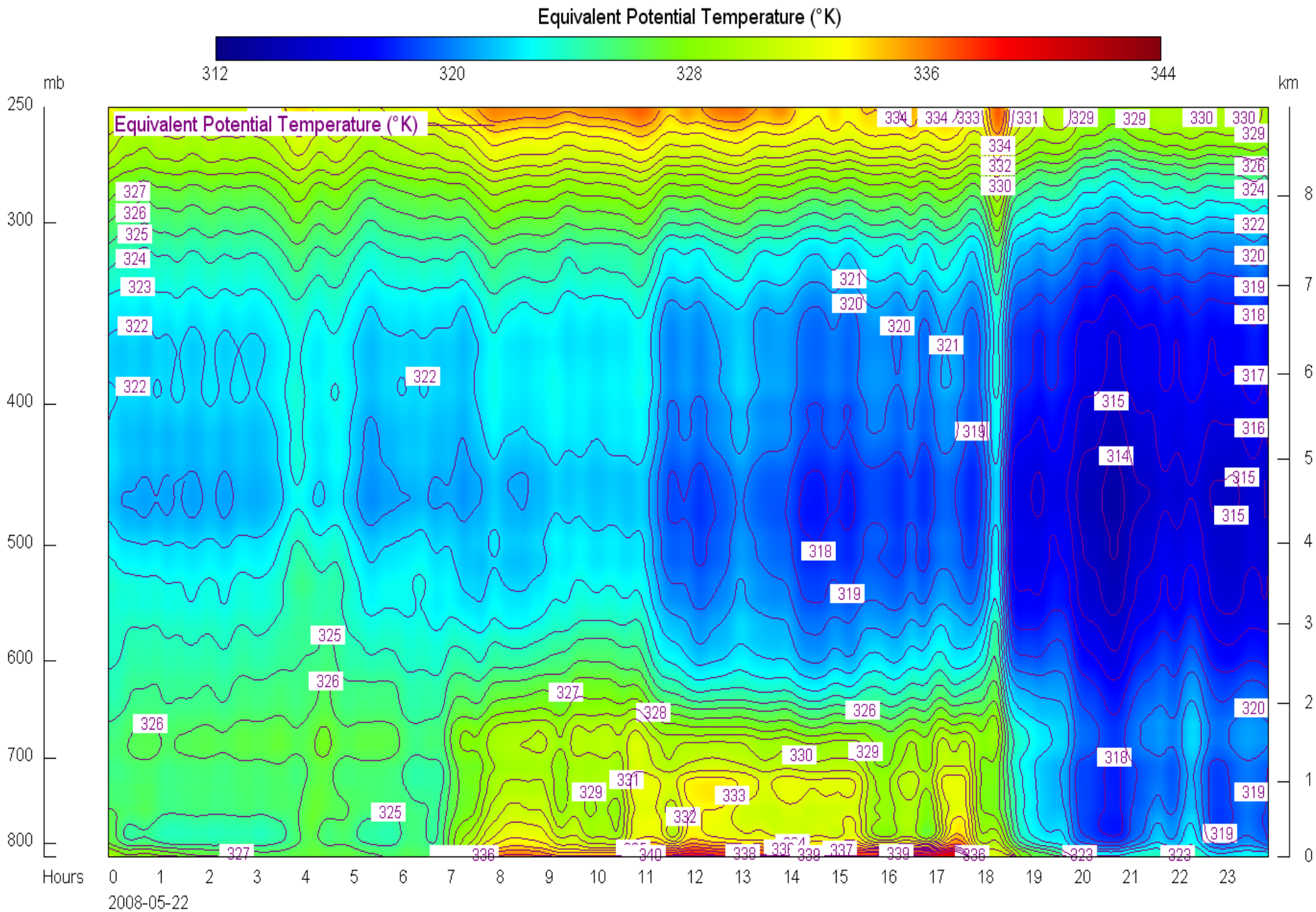
<u>2000 UT</u>: Storm Character = Ordinary Cells; Gusts <30 kts;
Storm Category = Strong; CAPE = 1226 J/kg, MVV = 50 m/s



2300 UT: Gusts <30 kts; Storm Category = Weak;
CAPE = 755 J/kg, DCAPE = 467 J/kg, MVV = 50 m/s



1-hr radiometer Theta-e with Platteville WPR (Denver sonde after 1800 UT) winds.



3-min radiometer Theta-e

radiometrics

Next Steps

- Assimilate radiometer temperature and humidity profiles to 1 km height, and liquid profiles in LAPS analysis.
- Include STMAS in LAPS analysis
- Generate continuous forecast tools and indices from radar + surface met + radiometer LAPS-STMAS analysis?