Thermodynamic Profiling during the Winter Olympics

CMOS 2010 Congress

Scientific Session: Vancouver 2010 Olympic and Paralympic Winter Games

4 June 2010

R. Ware[1], N. Cimini[2], G. Giuliani[2], E. Westwater[3], J. Oreamuno[1], E. Campos[4], P. Joe[4], S. Cober[4], S. Albers[5], S. Koch[5]

[1]Radiometrics, [2]University of L'Aquila (Italy), [3]University of Colorado, [4]Environment Canada, [5]Earth Science Research Laboratory (NOAA)

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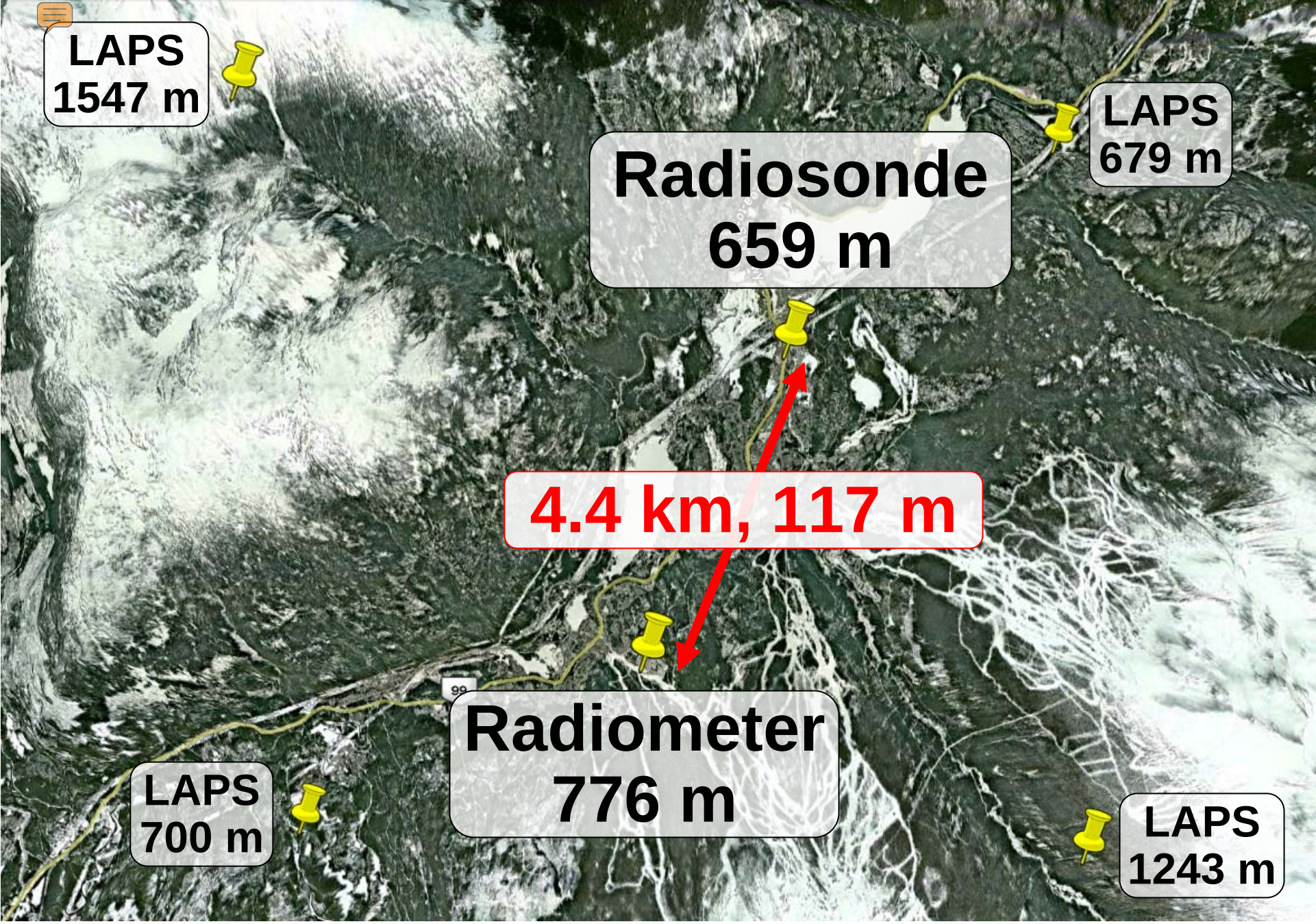
Presentation Summary

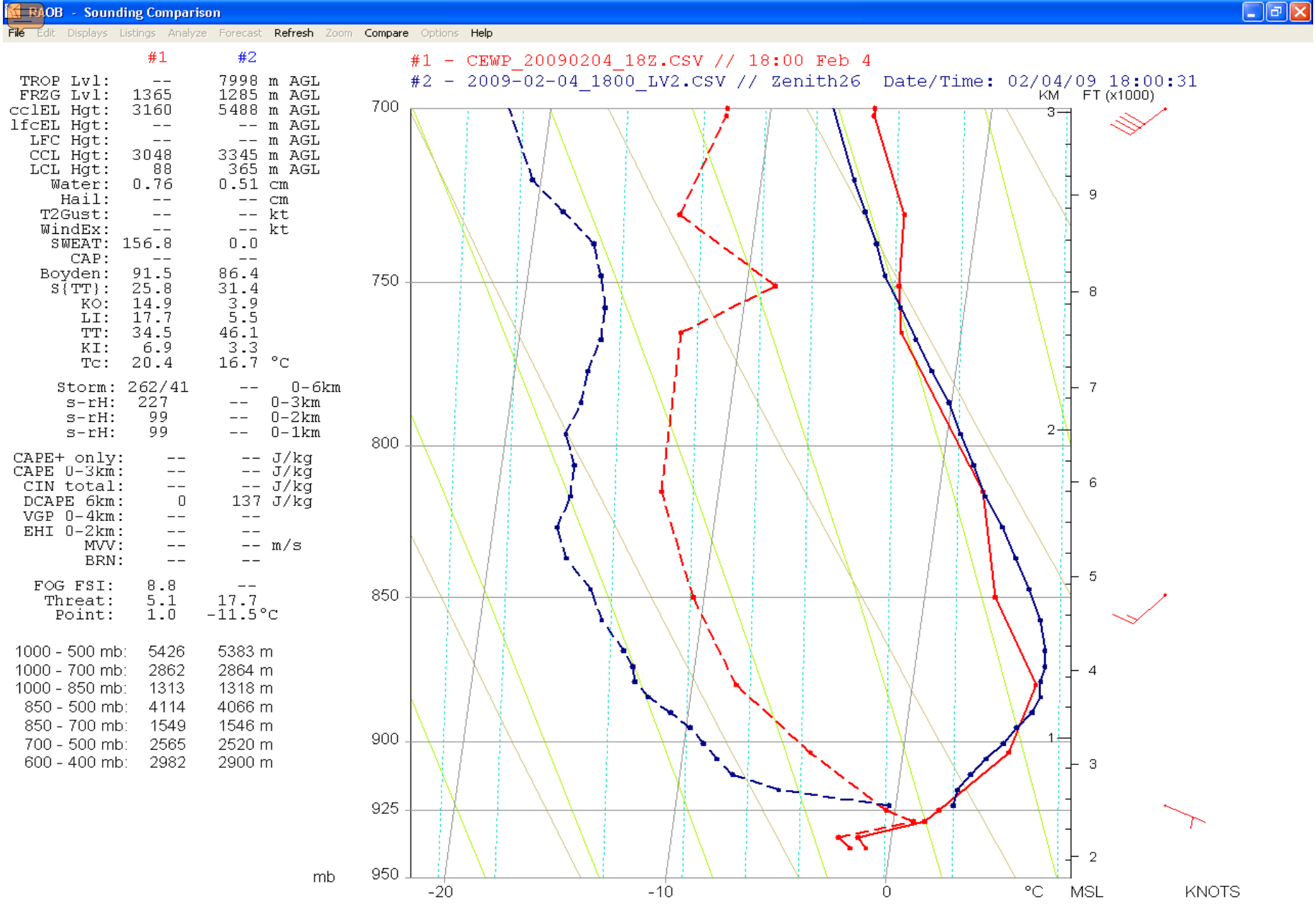
- EC operated a thermodynamic (temperature, humidity and liquid) profiler at gondola base during the 2010 Winter Olympics
- Off-zenith retrievals provided reliable performance during strong precipitation
- 1DVAR model analysis - radiometer retrievals are compared with radiosonde soundings and neural network retrievals
- Forecast indices generated from continuous thermodynamic profiles can improve local short term forecasting.
- Thermodynamic profiling is ready for operational use.



Radiometer, radiosonde and LAPS grid point locations and altitudes.

Radiometer, ceilometer, precipitation plate and radar, visibility, and surface met sensors near the Creekside gondola base.

Radiosonde launch site at the NavCan METAR met station
(659 m elevation) on Nesters Road at Whistler.



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

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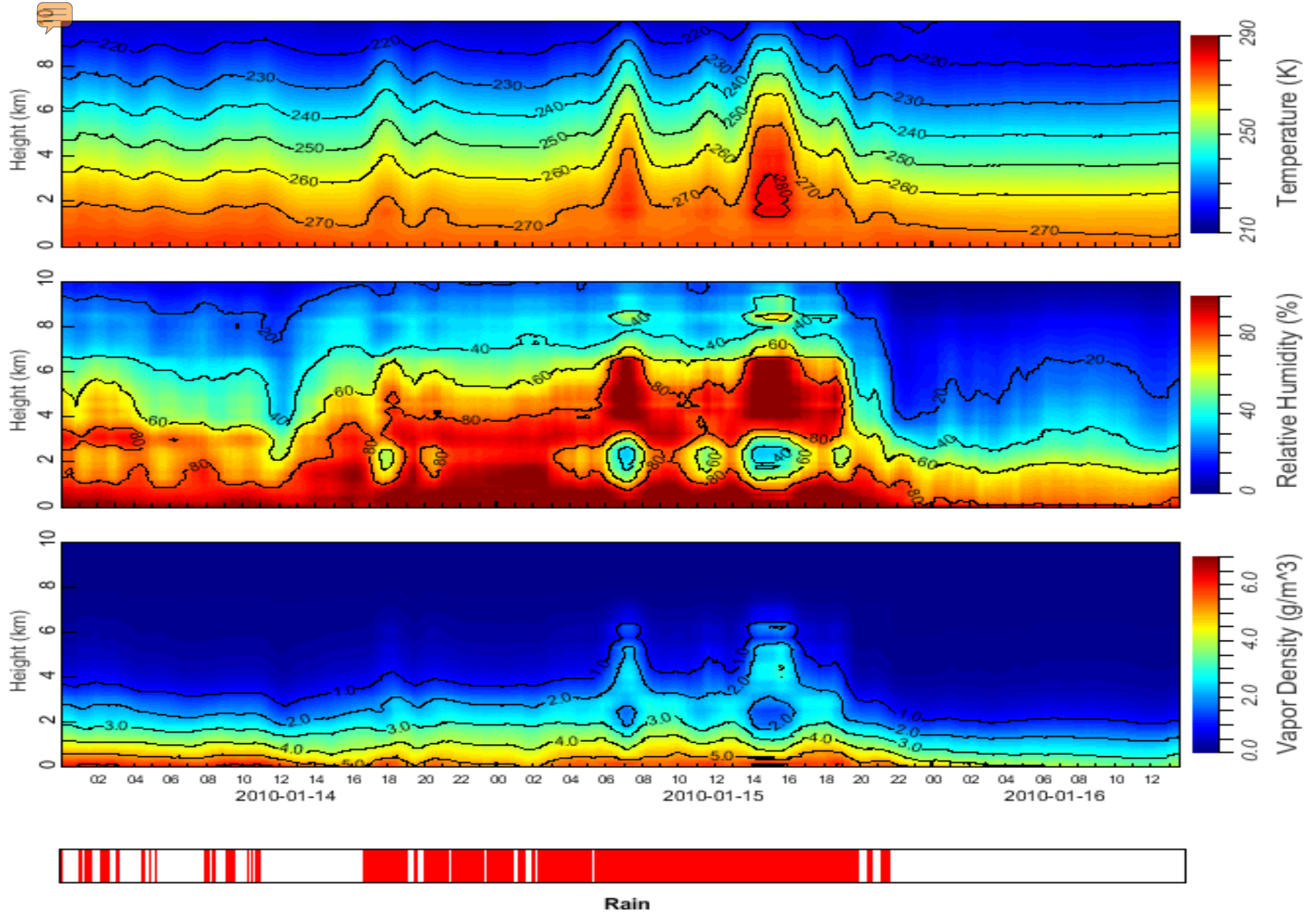
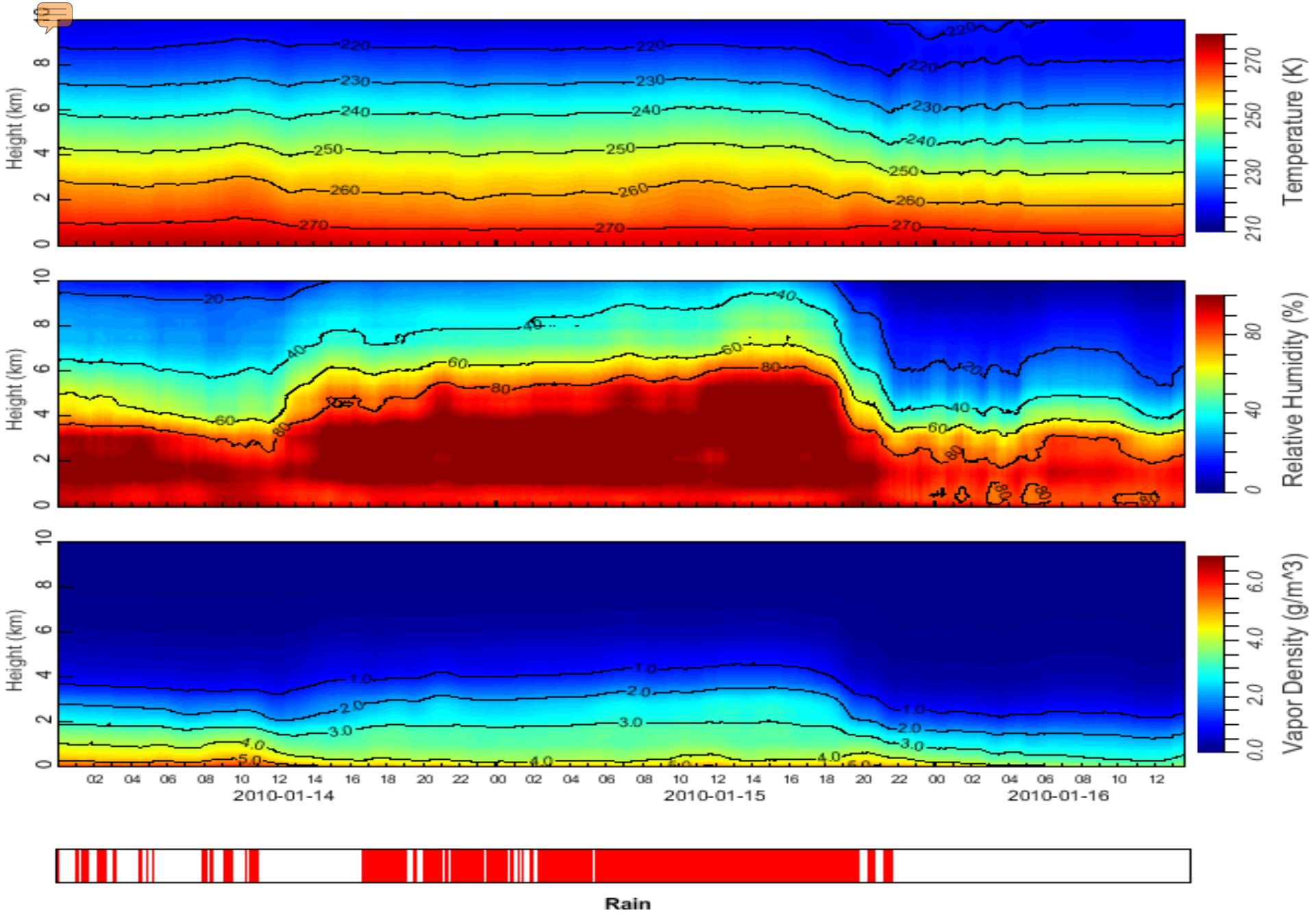
Accurate Retrievals during Strong Precipitation

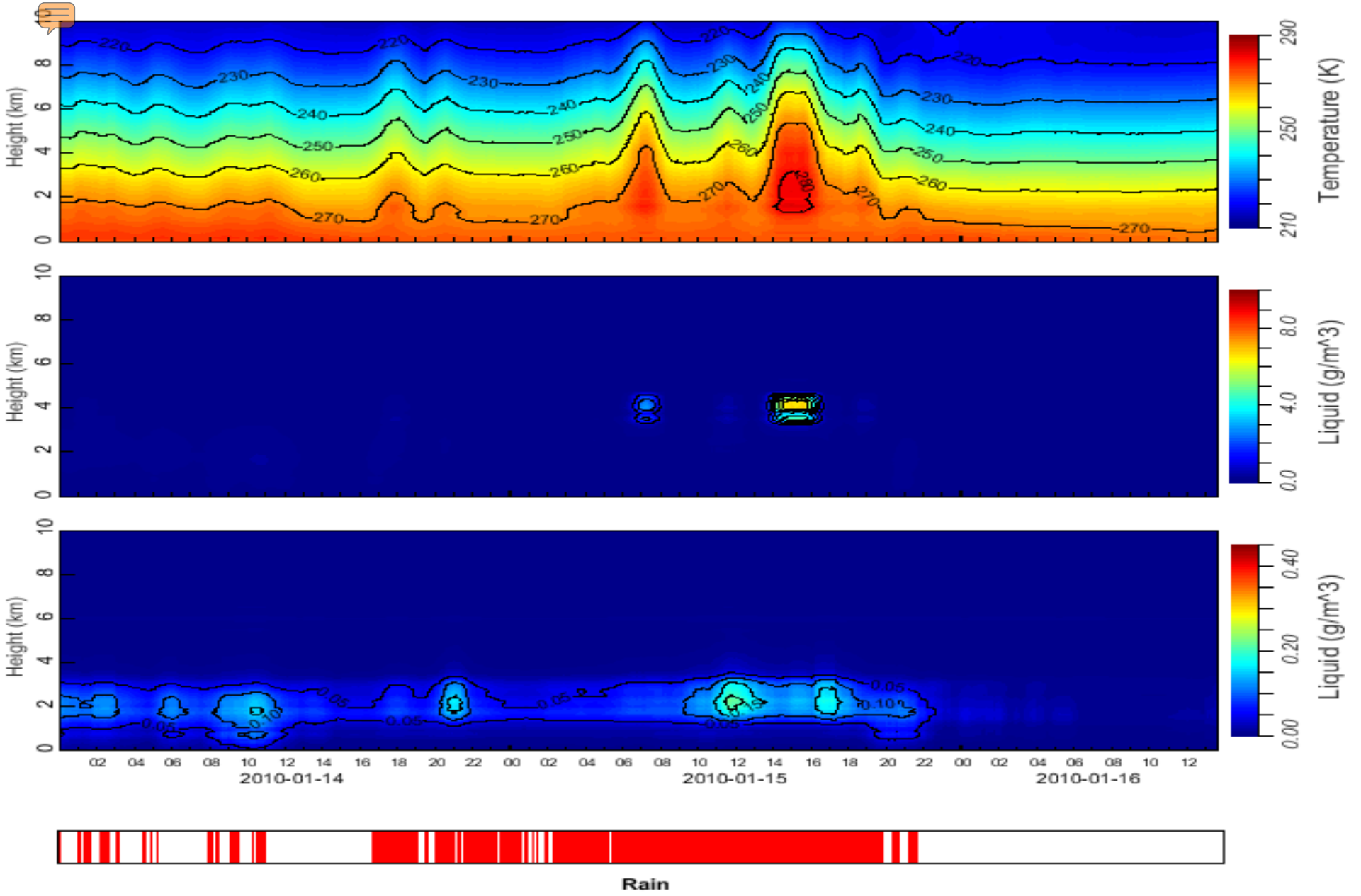
- Zenith and off-zenith observations and retrievals were obtained during strong precipitation including rain, snow and sleet.
- Zenith retrievals were badly degraded during strong precipitation, whereas off-zenith retrievals were well behaved.
- Off-zenith methods demonstrate optimum performance during all weather conditions.



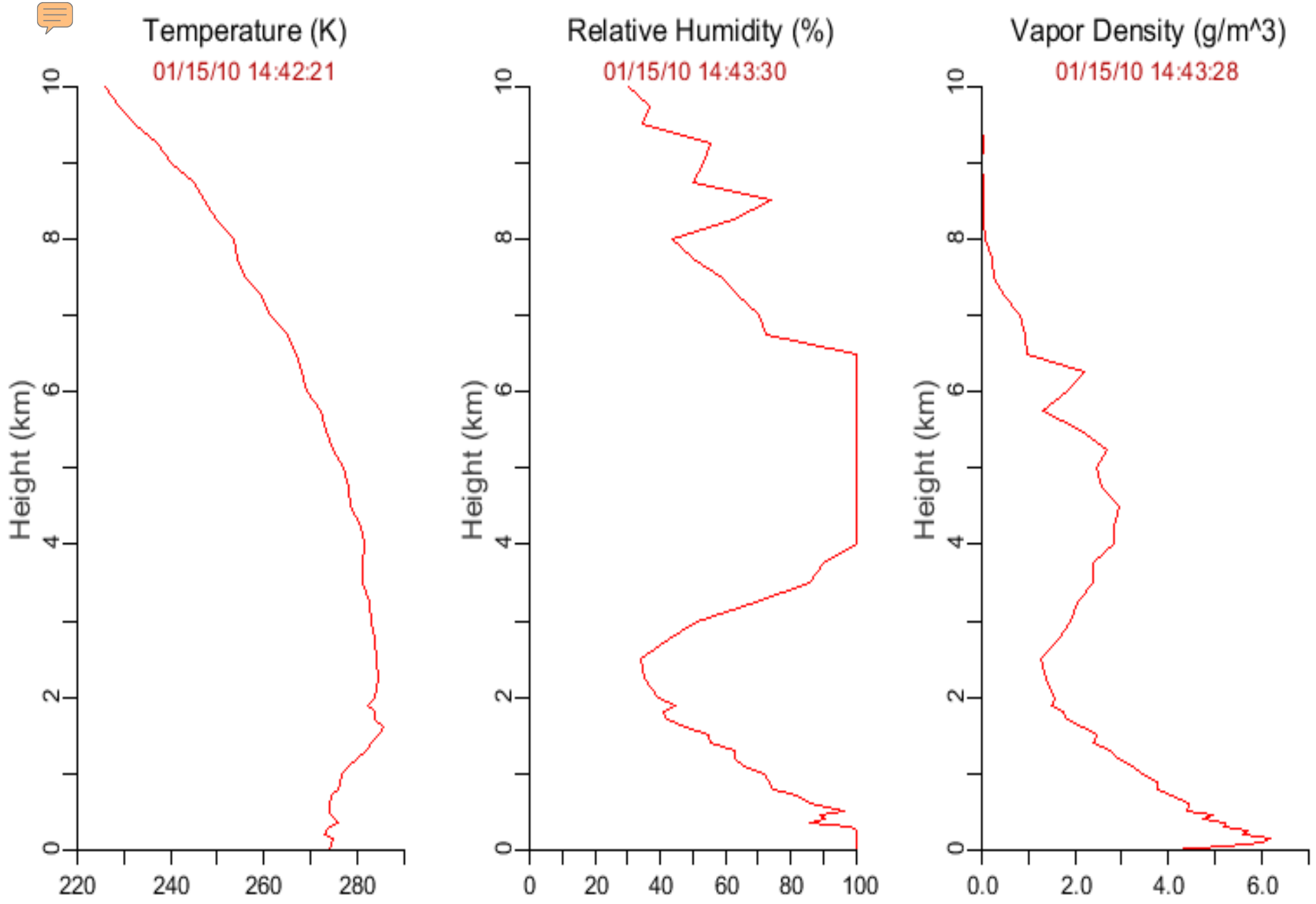
Retrievals from zenith observations are unstable during strong precipitation.



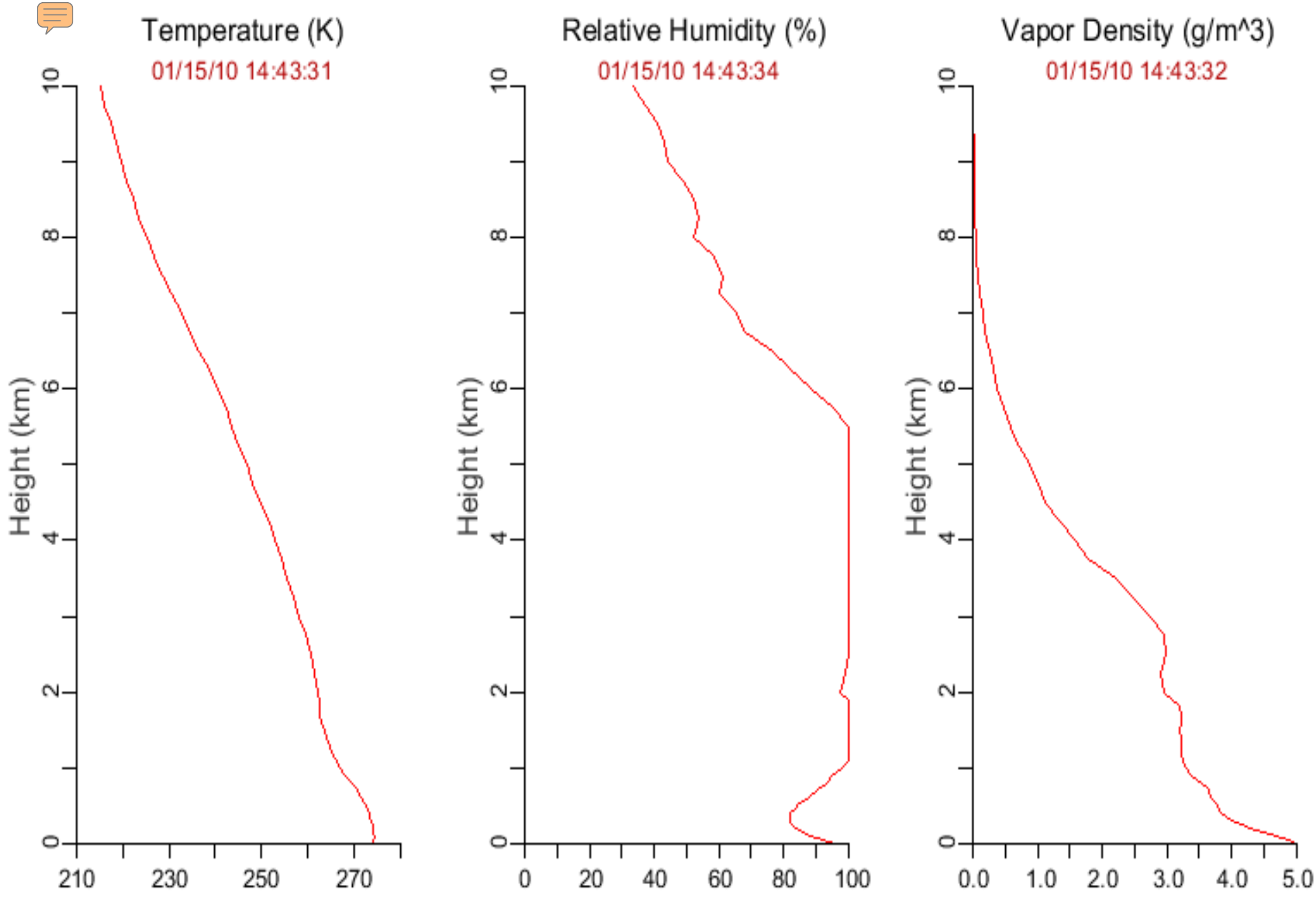
Retrievals from off-zenith observations are stable.



Zenith liquid during rain (center, >9 g/m^3) is unreasonable; off-zenith liquid is reasonable (bottom, <0.5 g/m^3).



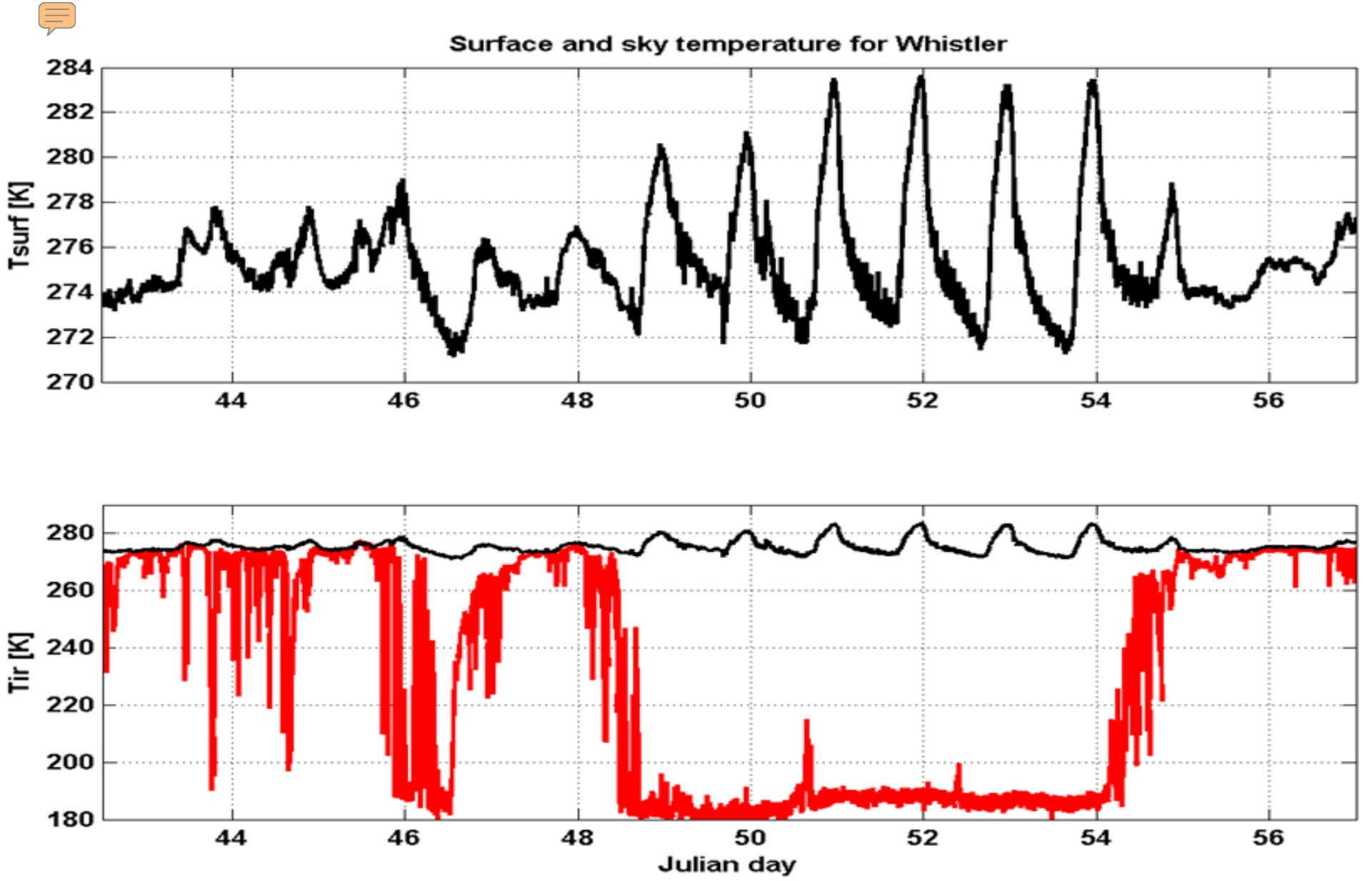
Zenith retrievals are degraded during heavy precipitation.



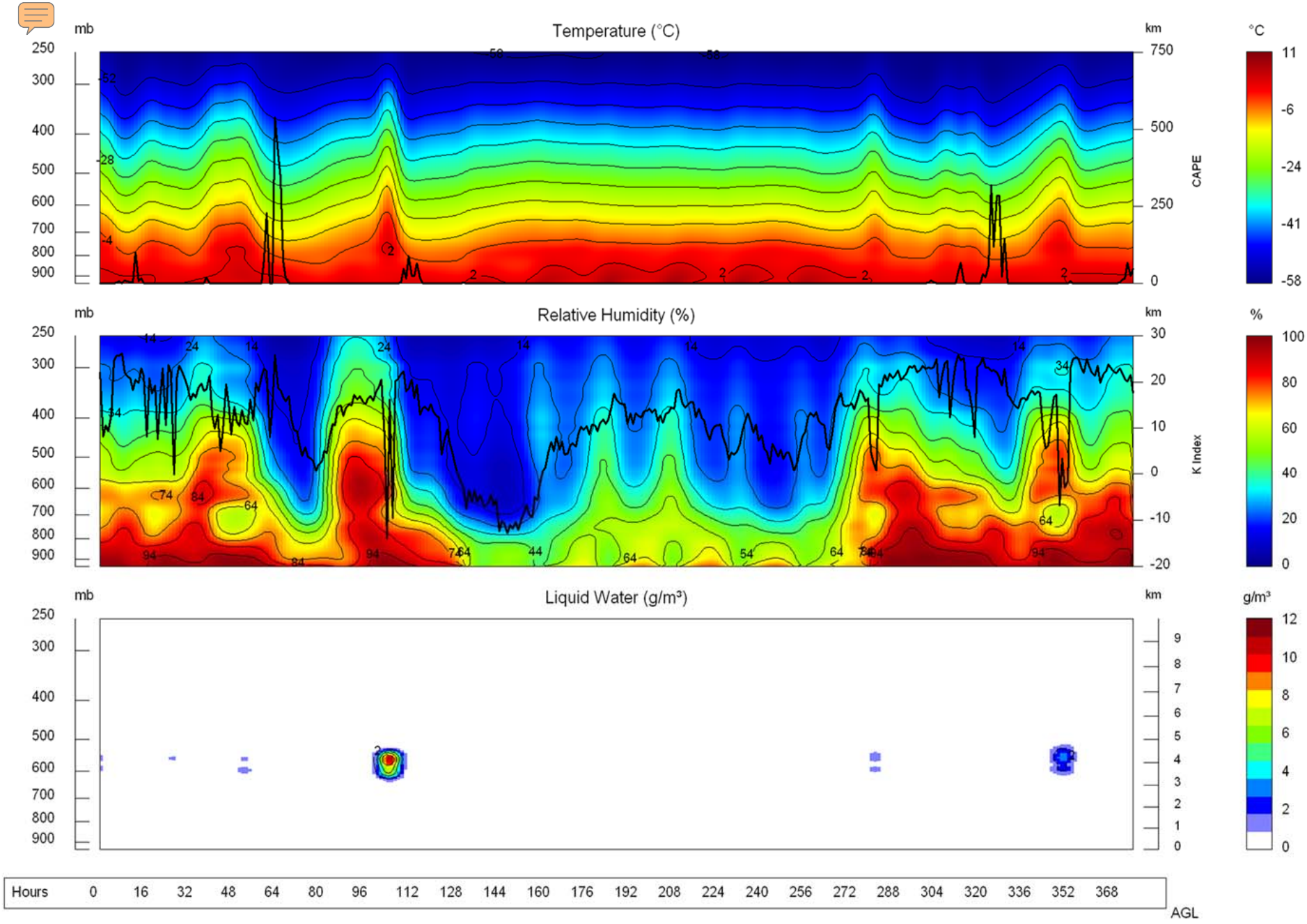
Retrievals from off-zenith observations during rain maximum.

Radiometer - Radiosonde Comparisons

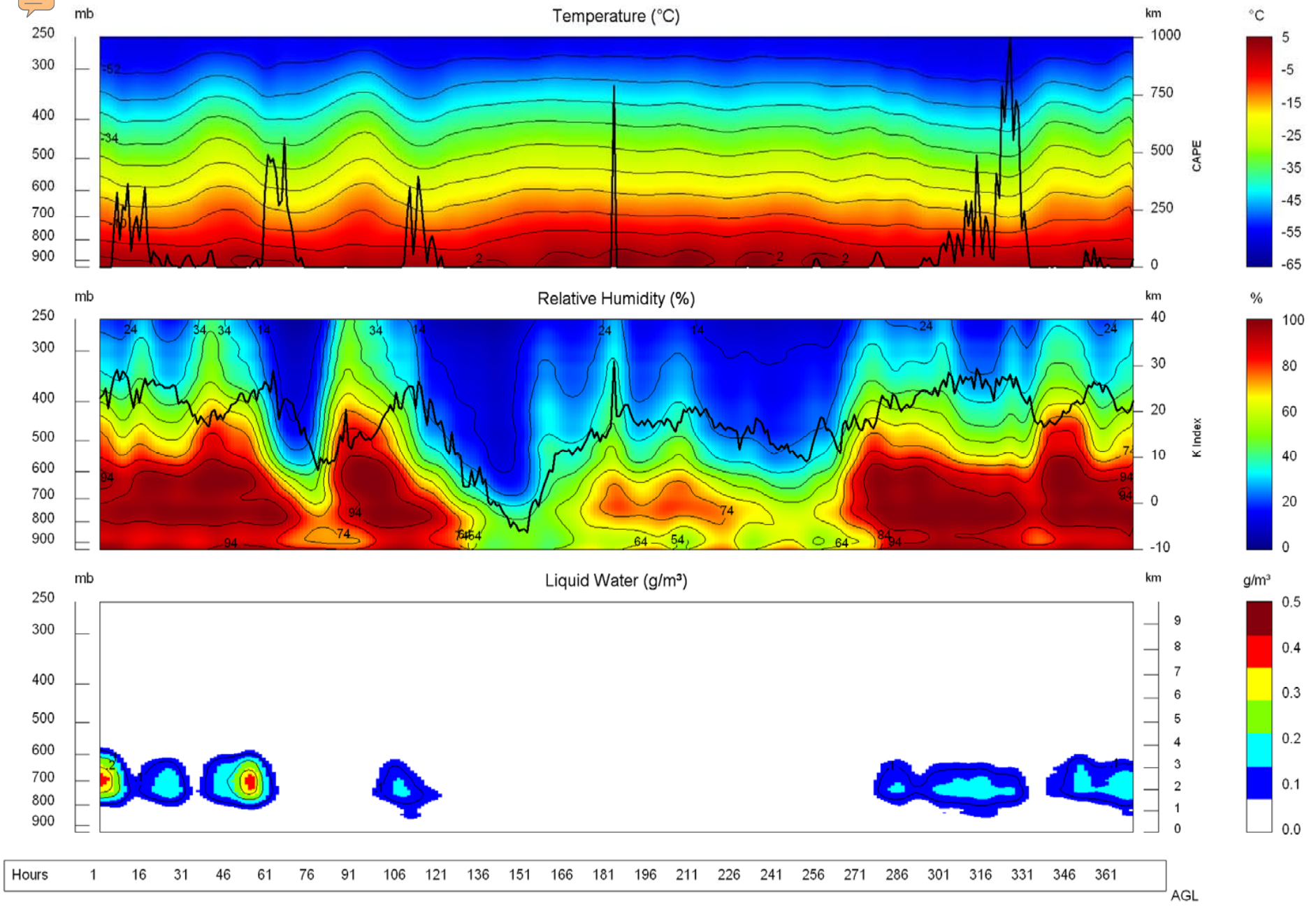
- 2 week, 1 week and 1 day radiometer and 6-hr radiosonde temperature, humidity and liquid profile comparisons.
- Comparison of WMO Bulletins and high resolution radiosonde soundings.
- Comparison of CAPE and K-indices generated from radiometer and radiosonde soundings.



Radiometer surface (black) and cloud base temperatures (red) measured by the thermodynamic profiler.



Zenith radiometric soundings, 12-28 Feb 2010 (2 weeks).



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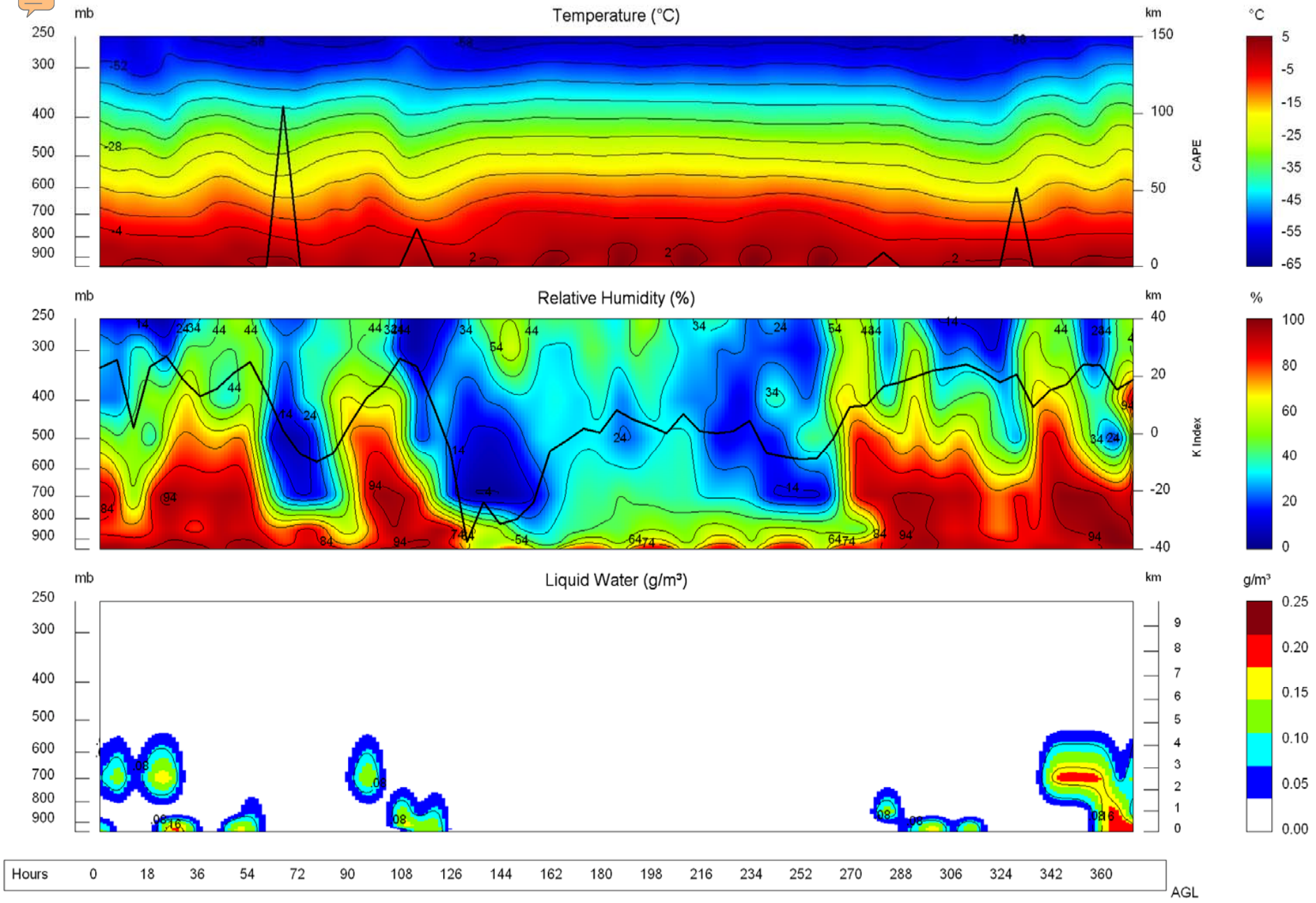
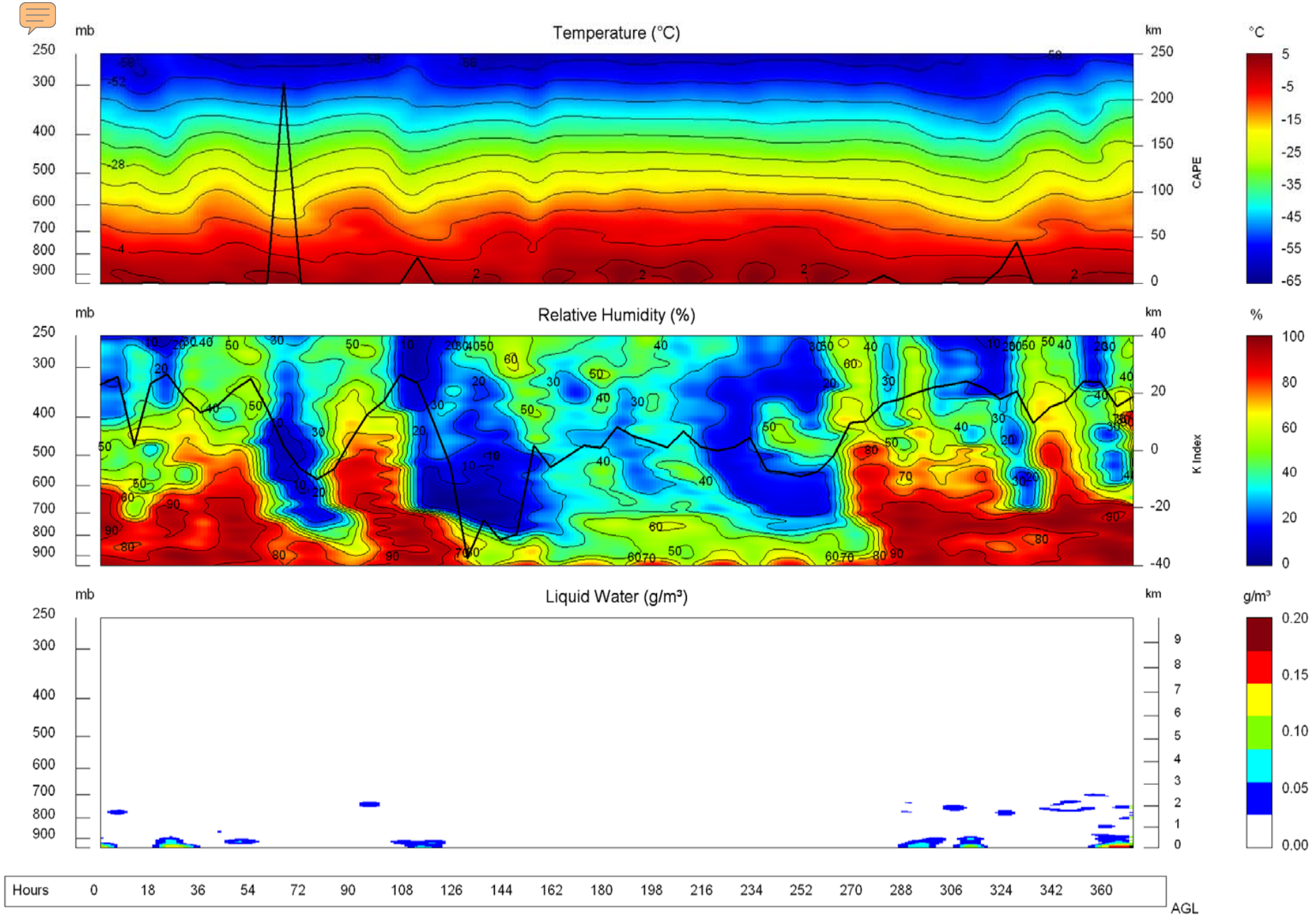
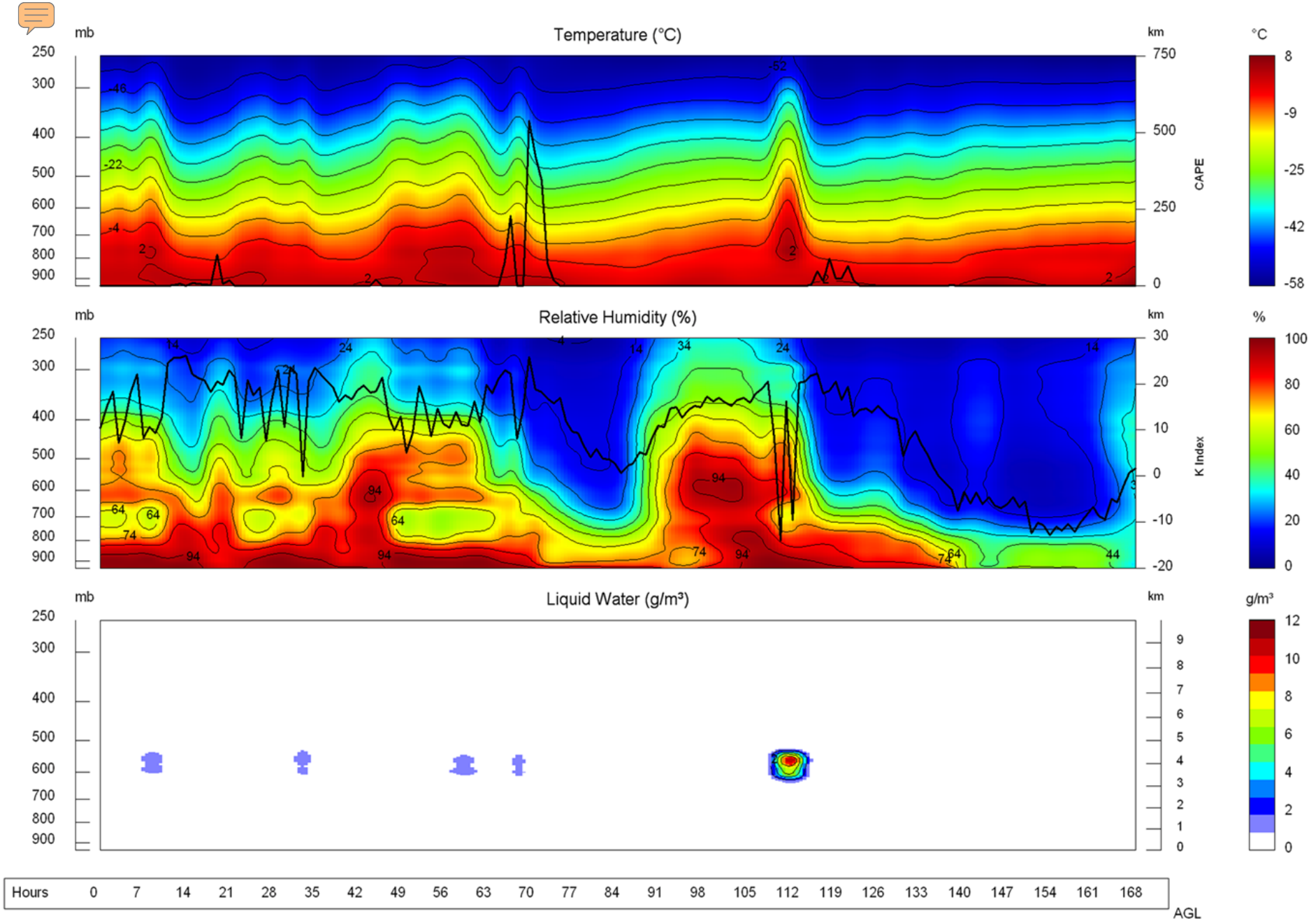


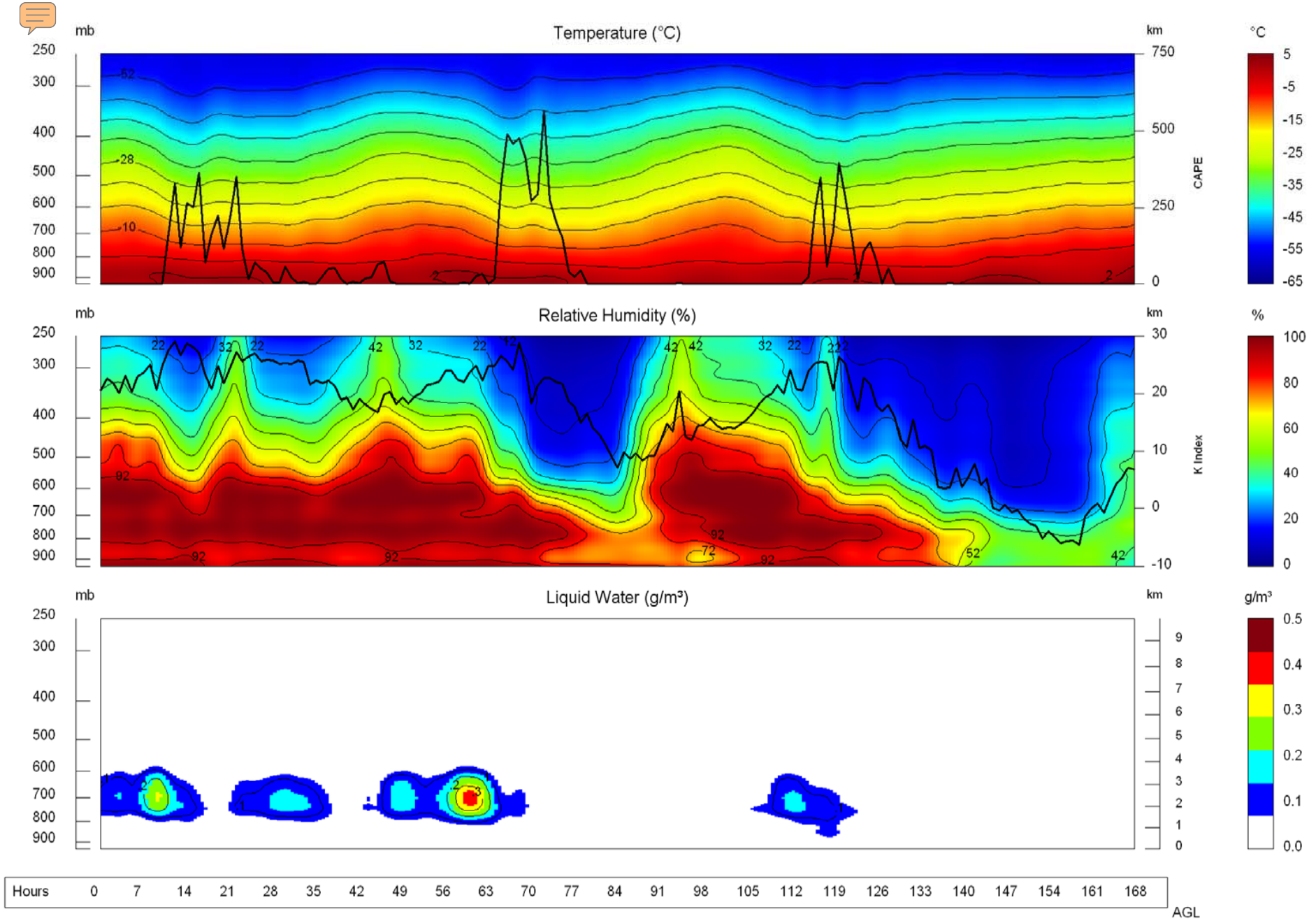
Radiosonde (WMO Bulletin) soundings, 12-28 Feb 2010 (2 weeks).



Radiosonde (high resolution) soundings, 12-28 Feb 2010 (2 weeks).



Zenith thermodynamic profiles, 12-19 Feb 2010 (one week).



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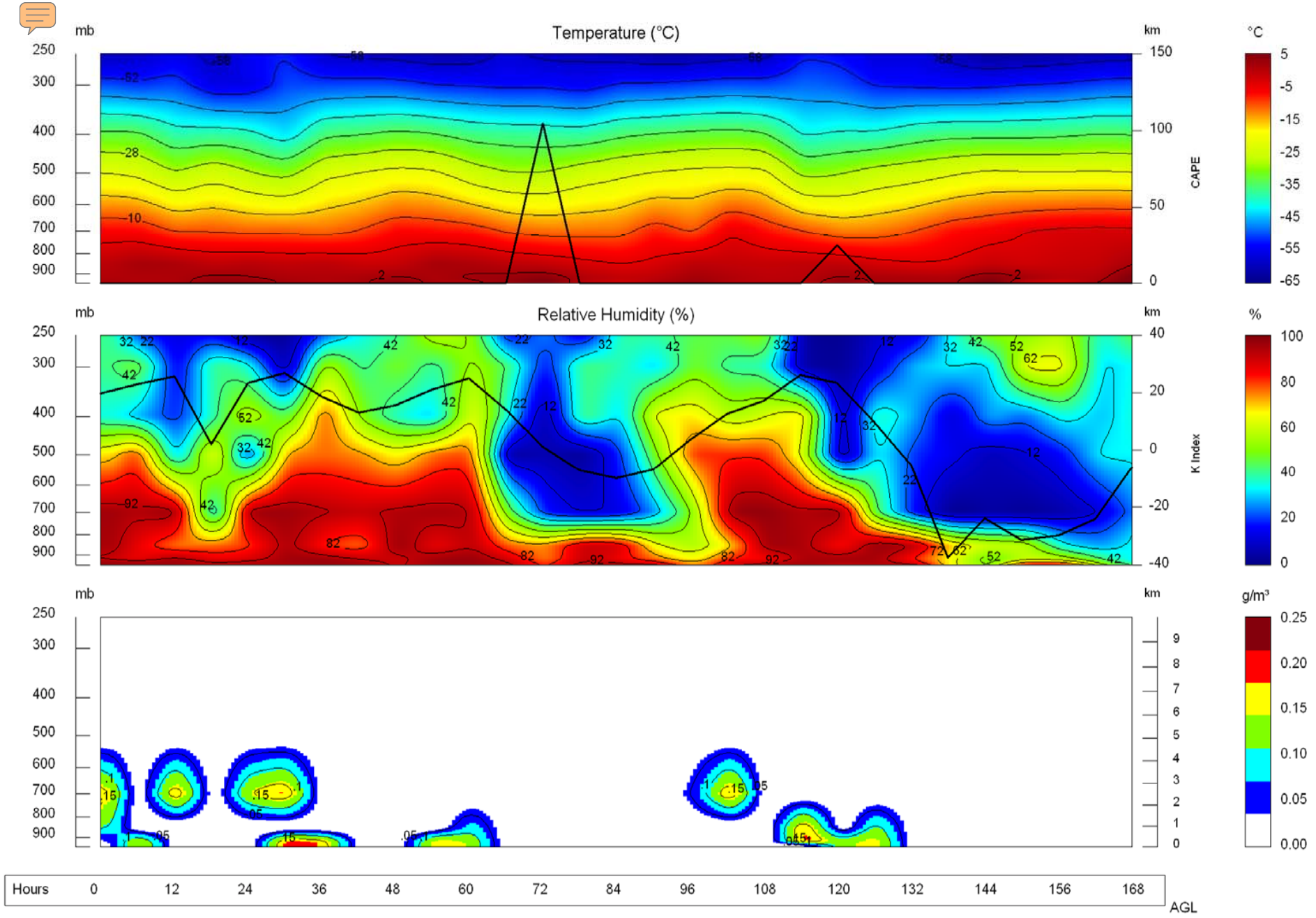
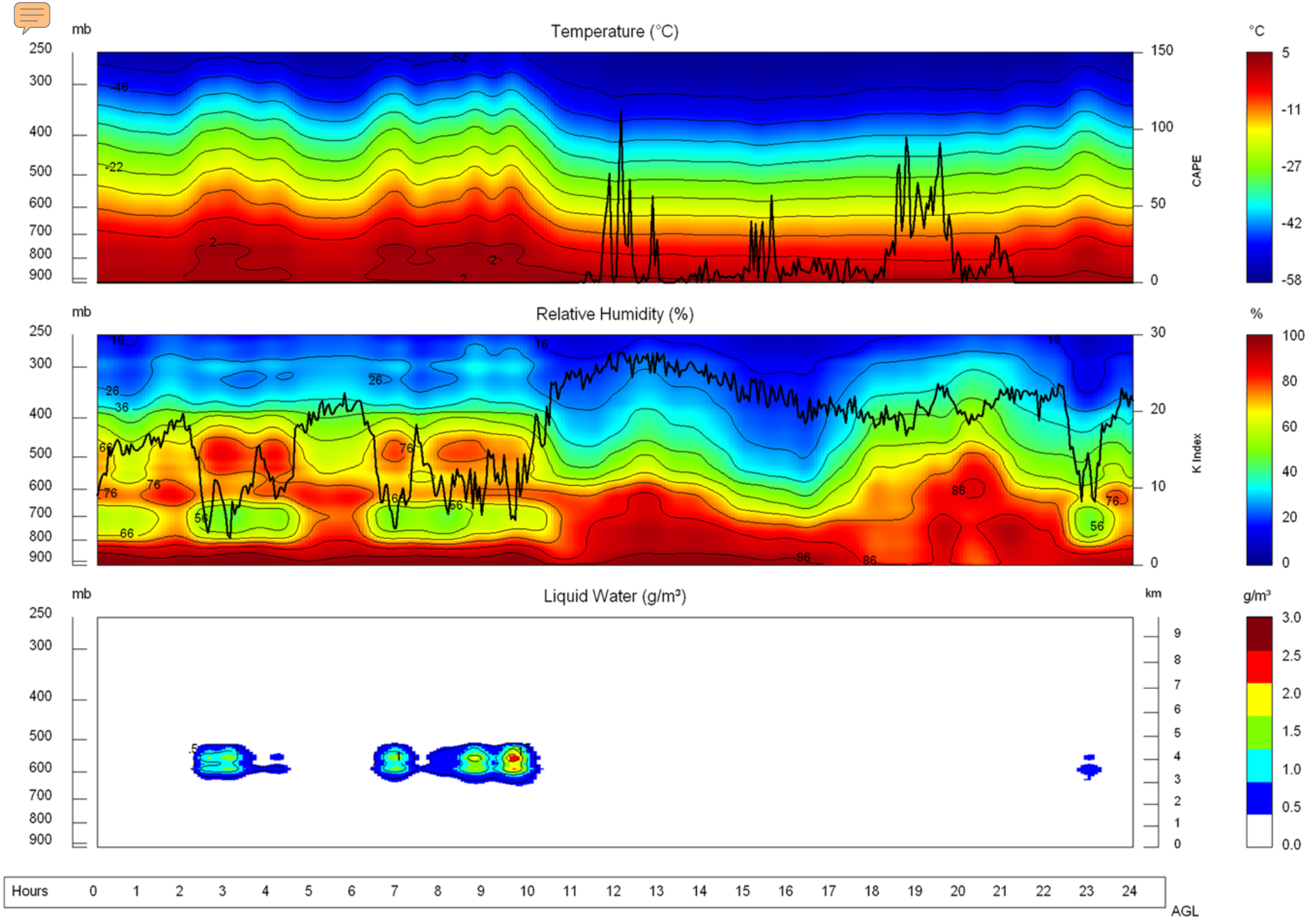
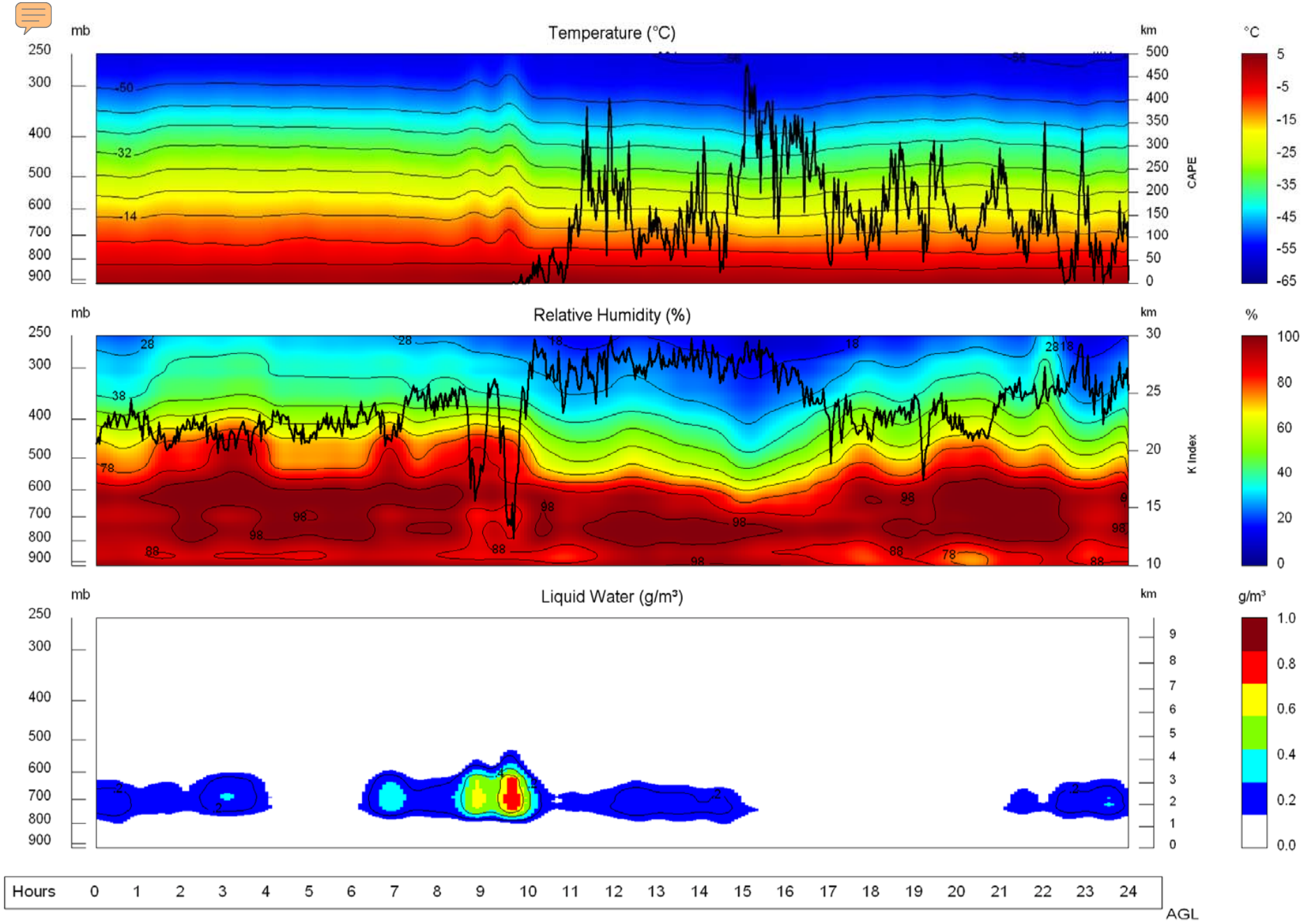


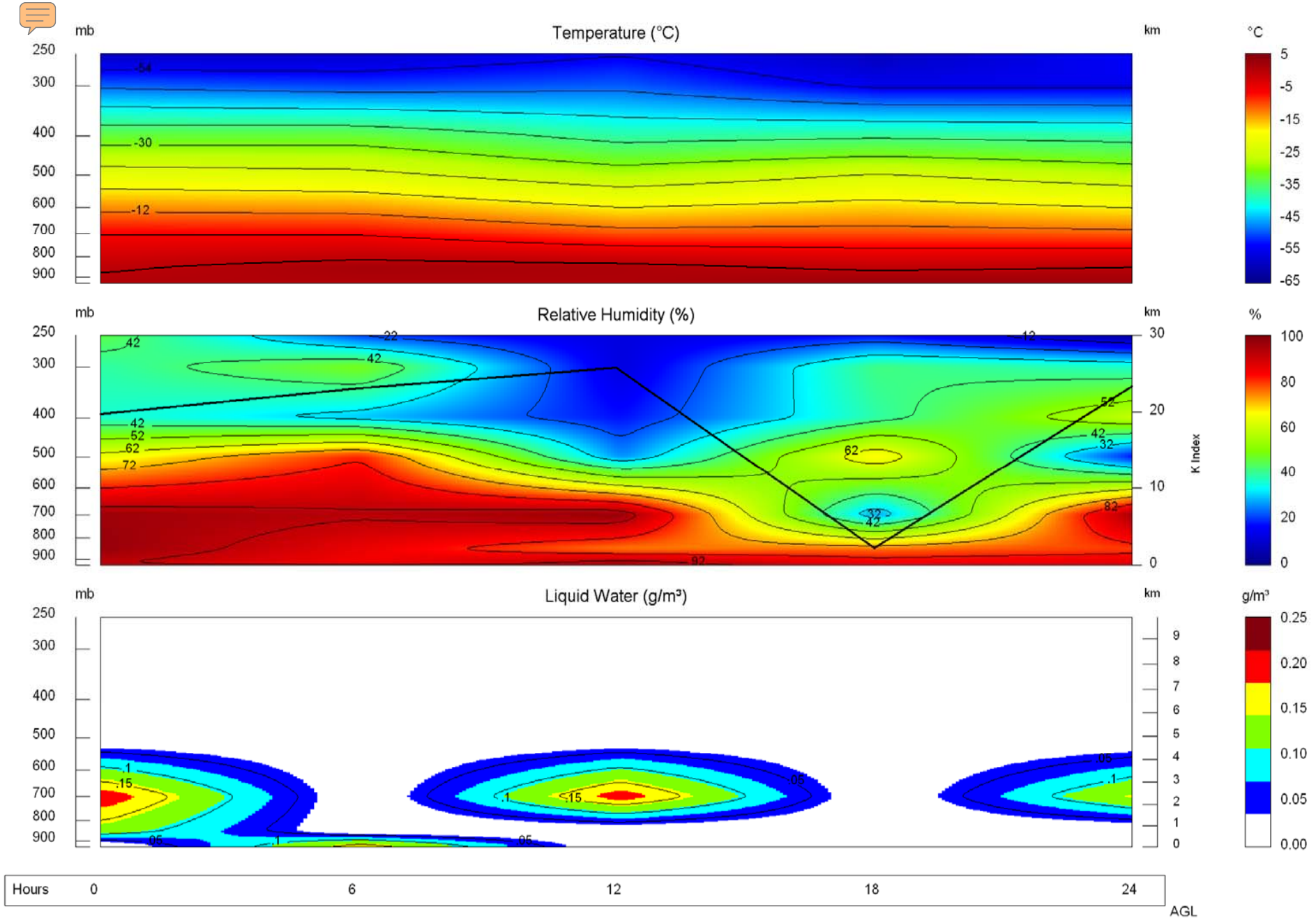
Radiosonde soundings, 12-19 Feb 2010 (one week).



Zenith thermodynamic profiles, 12 Feb 2010 (one day).



Off-zenith thermodynamic profiles, 12 Feb 2010 (one day).



Radiosonde soundings, 12 Feb 2010 (one day).

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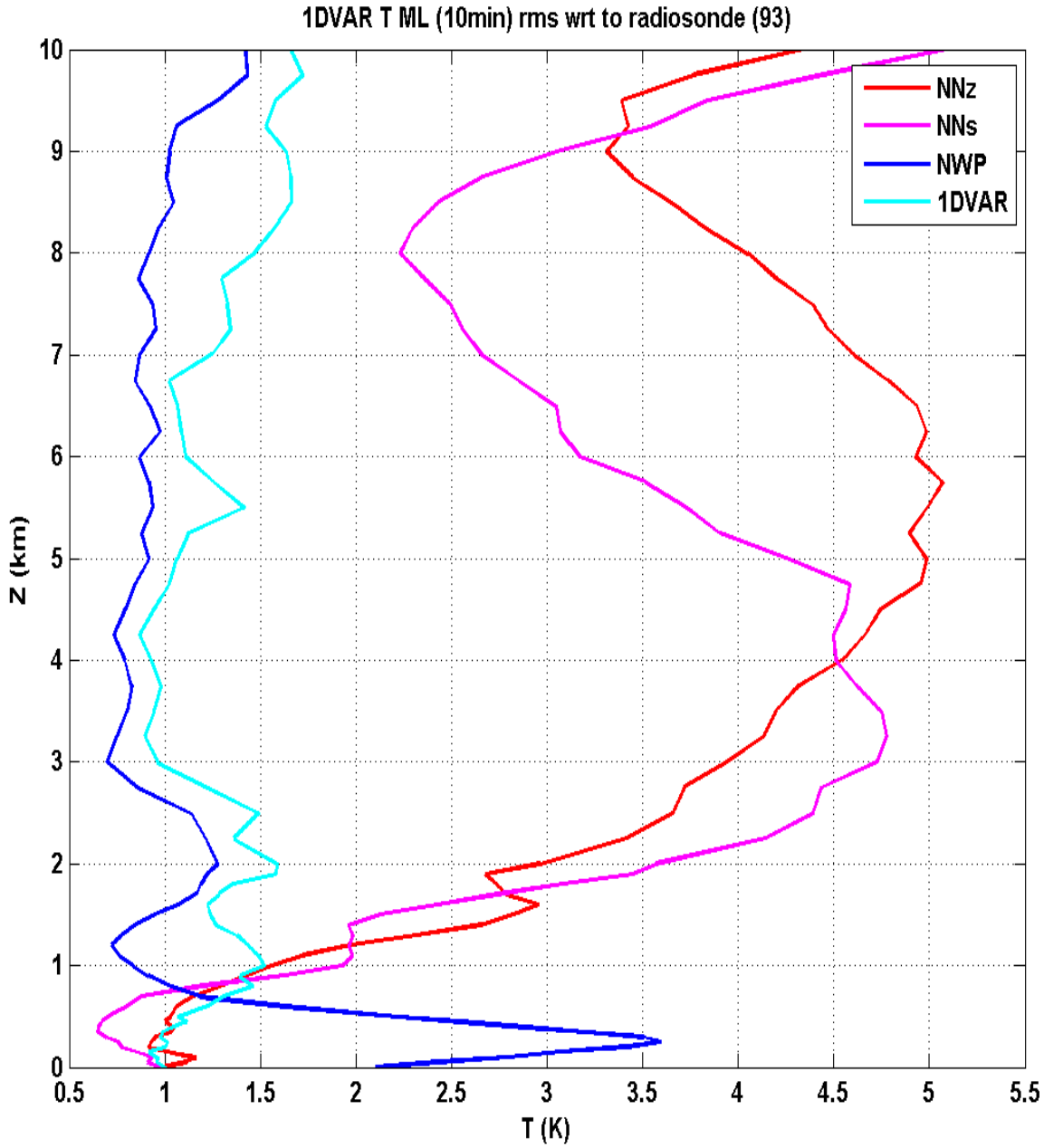
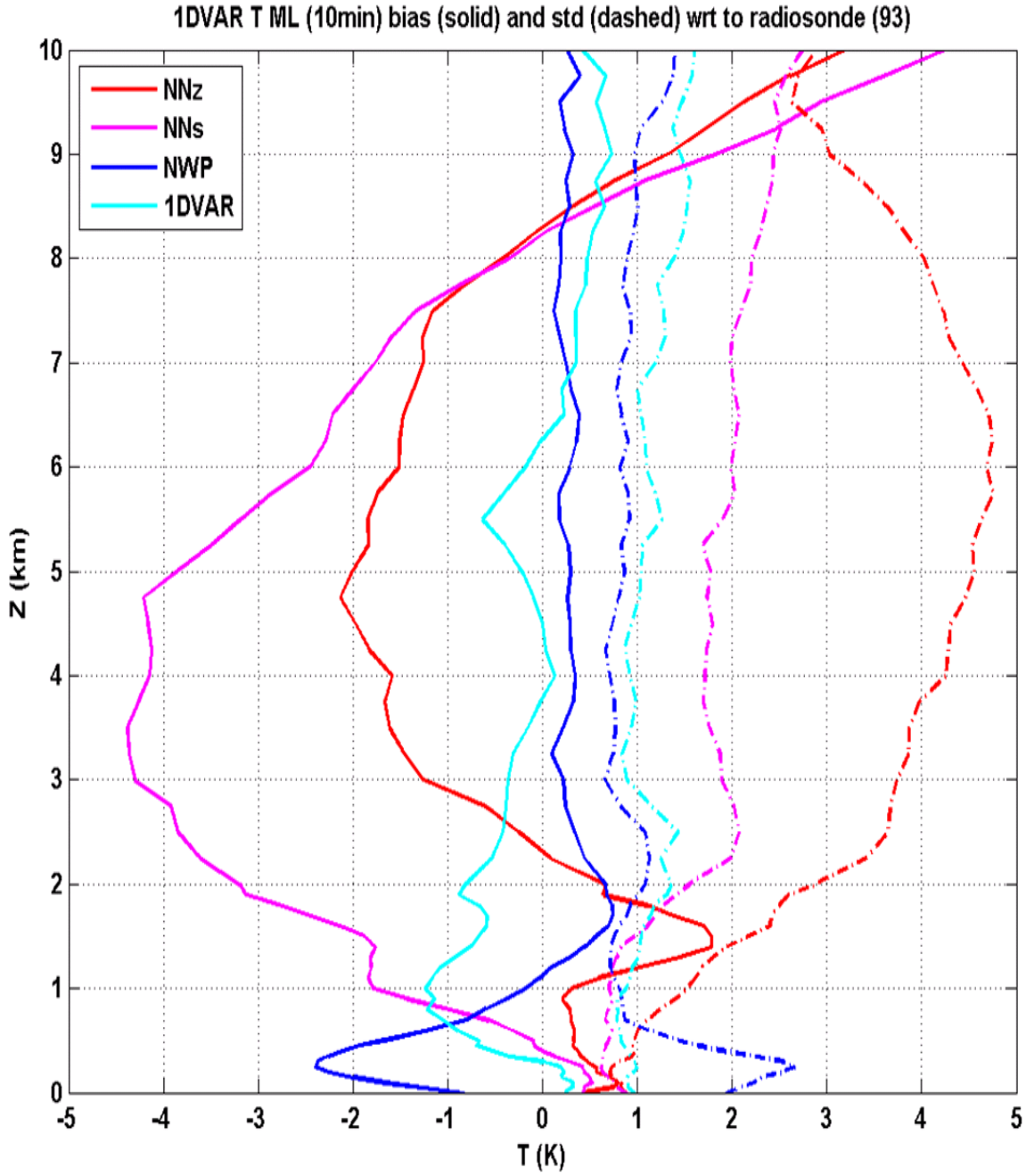
1DVAR, Radiosonde, Analysis and Neural Network Soundings

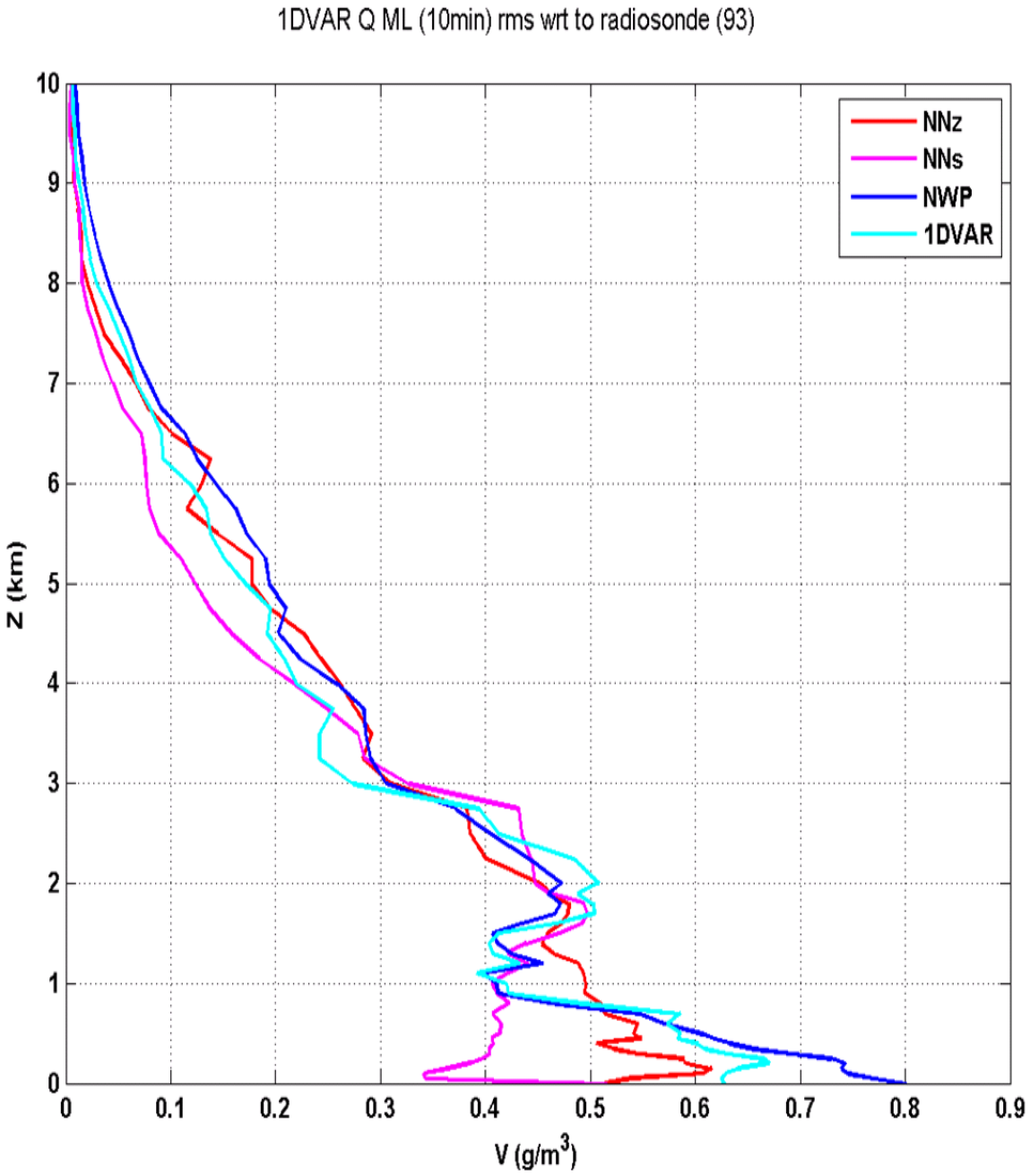
- 1DVAR temperature and vapor density statistical comparison with radiosondes.
- Example radiosonde, zenith and off-zenith radiometer, analysis and 1DVAR sounding comparisons.
- Clear, cloudy, upper level warm air, precipitation and nocturnal radiative inversion cases.



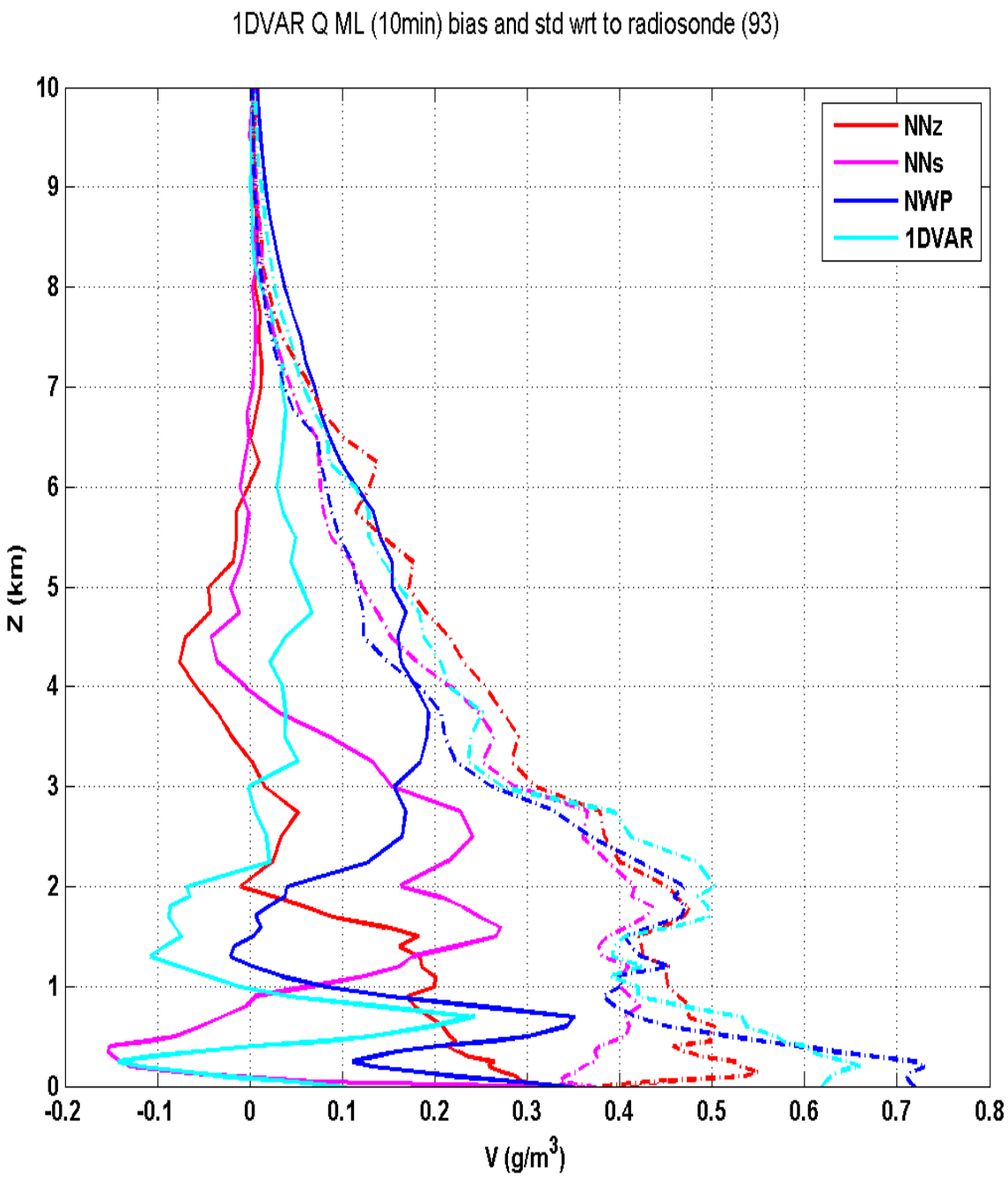
1DVAR, analysis (NWP) and neural net (NNz: zenith; NNs: 15 deg elevation down valley) temperature profile statistics (rms), vs. radiosondes.



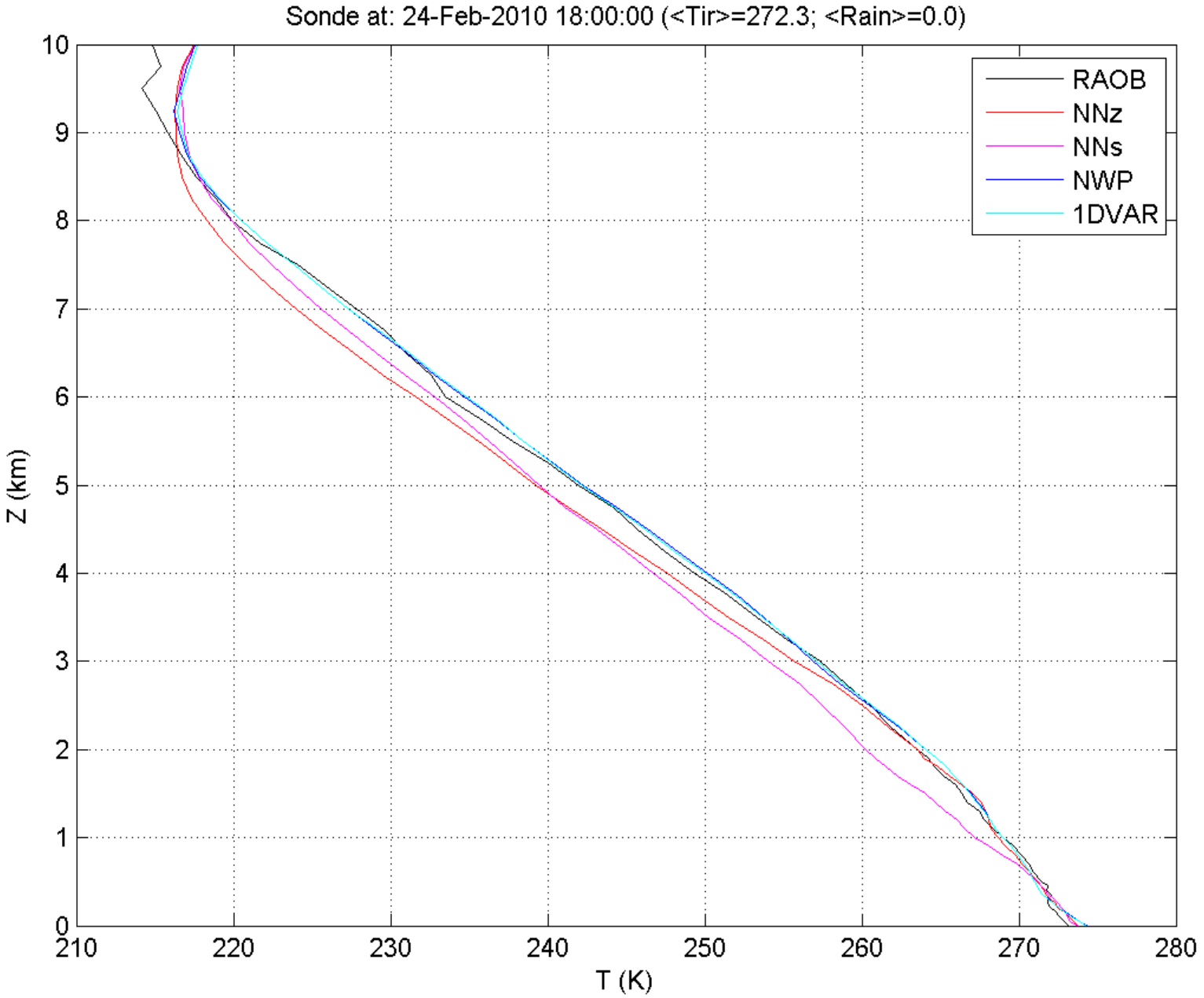
Bias and standard deviation, compared to radiosondes.



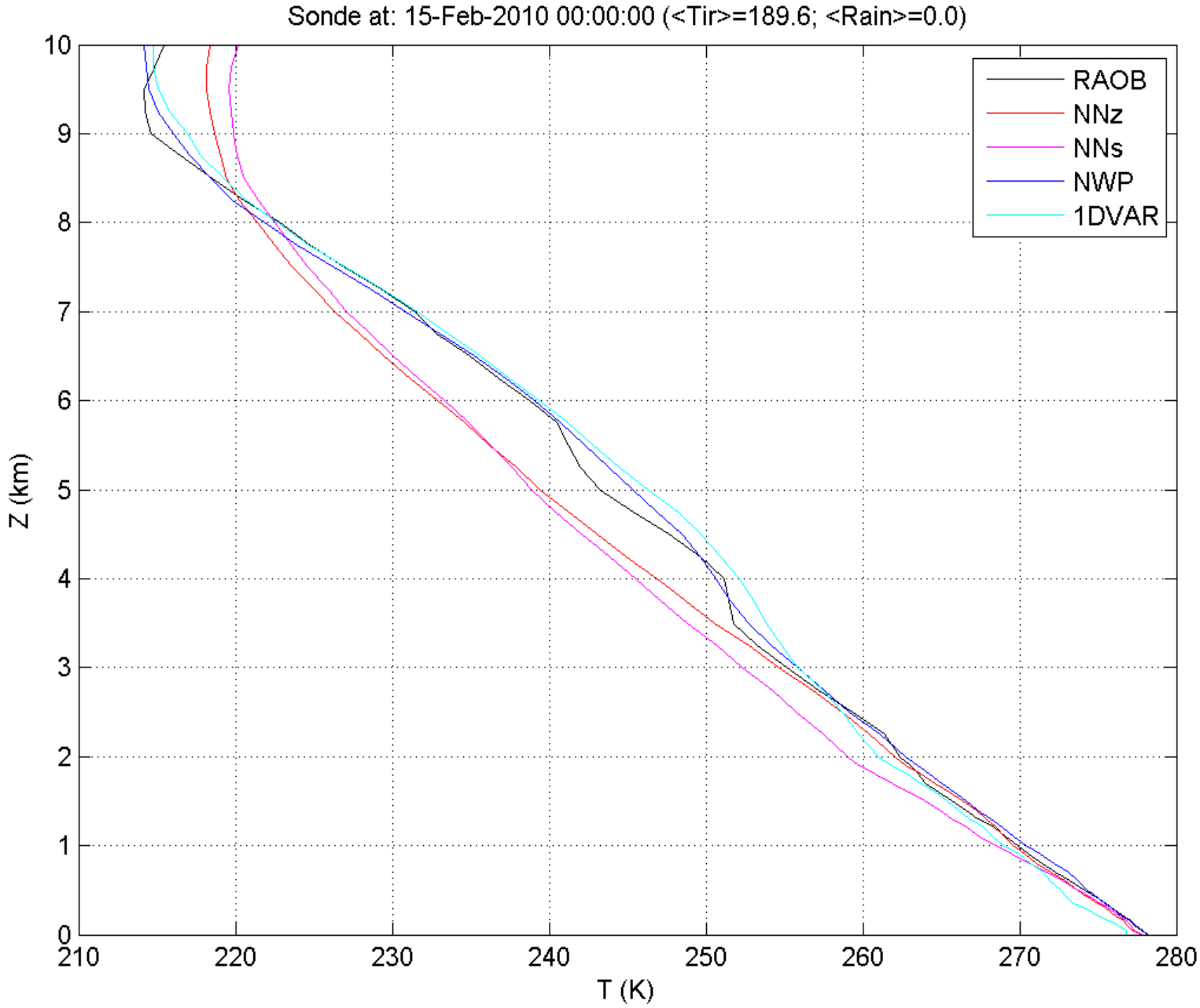
Vapor density profile statistics (rms), vs. radiosondes.



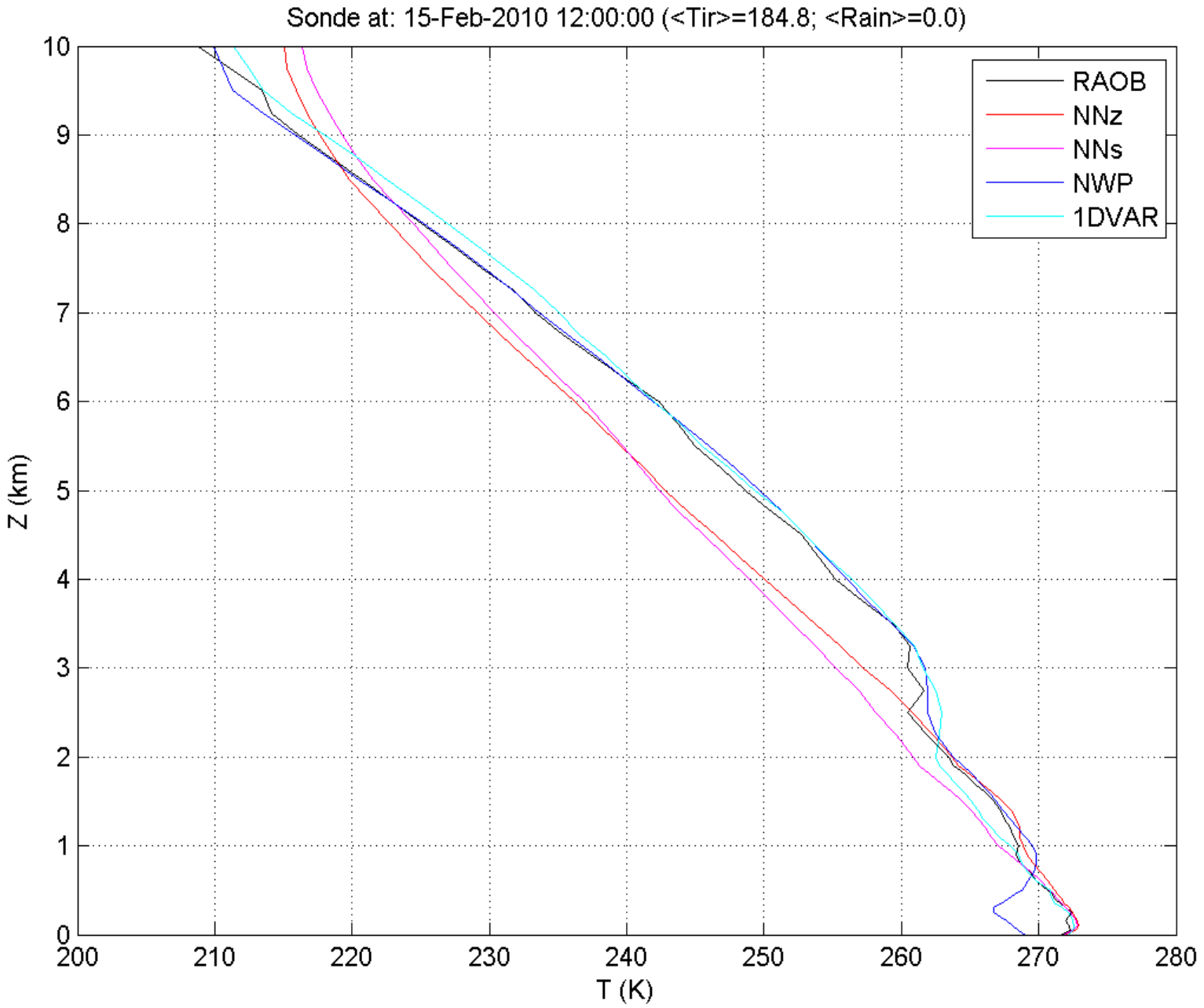
Vapor density profile statistics (bias and standard deviation), vs. radiosondes.



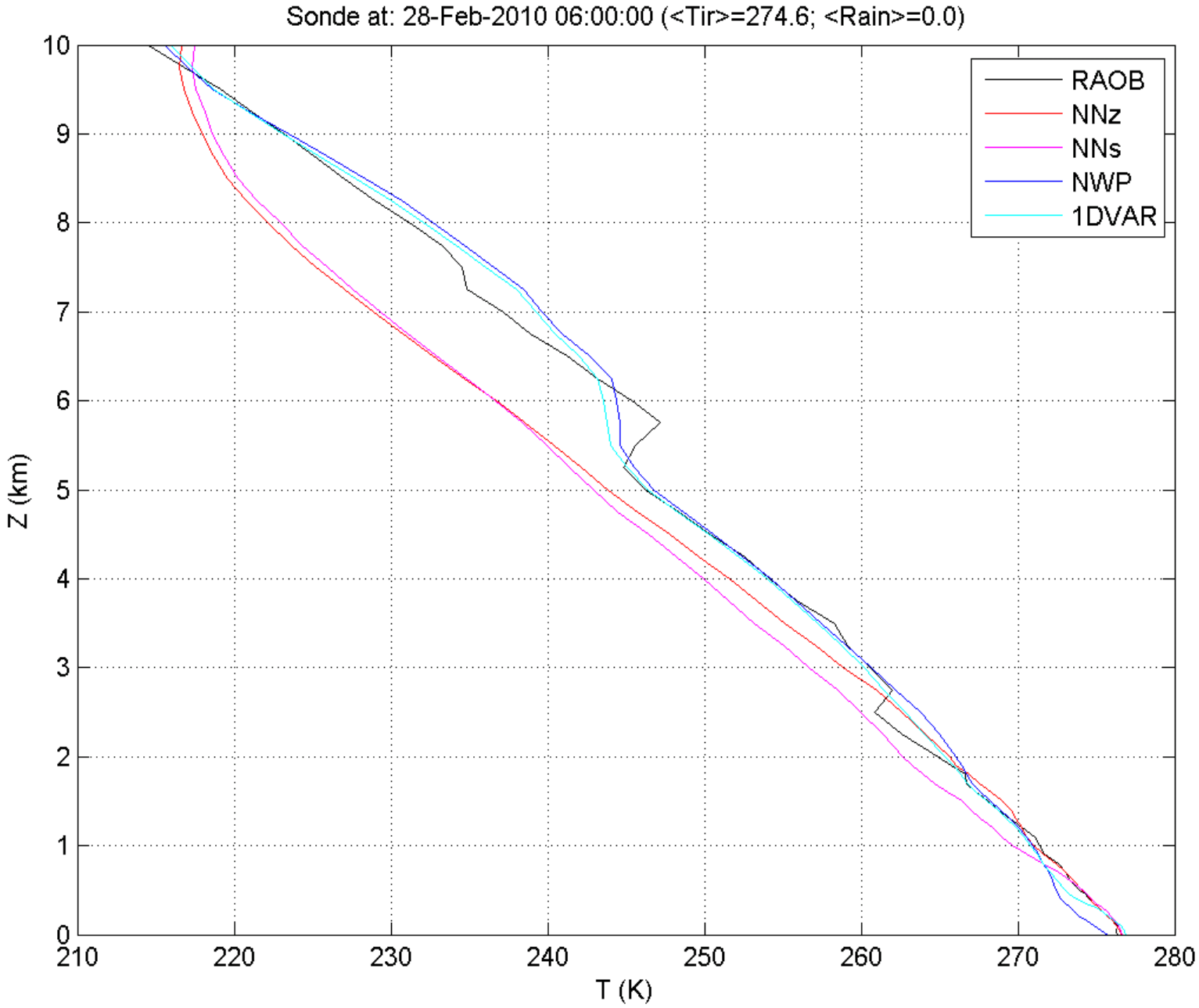
Radiosonde, neural net, analysis and 1DVAR temperature profiles during low cloud - no precipitation conditions.



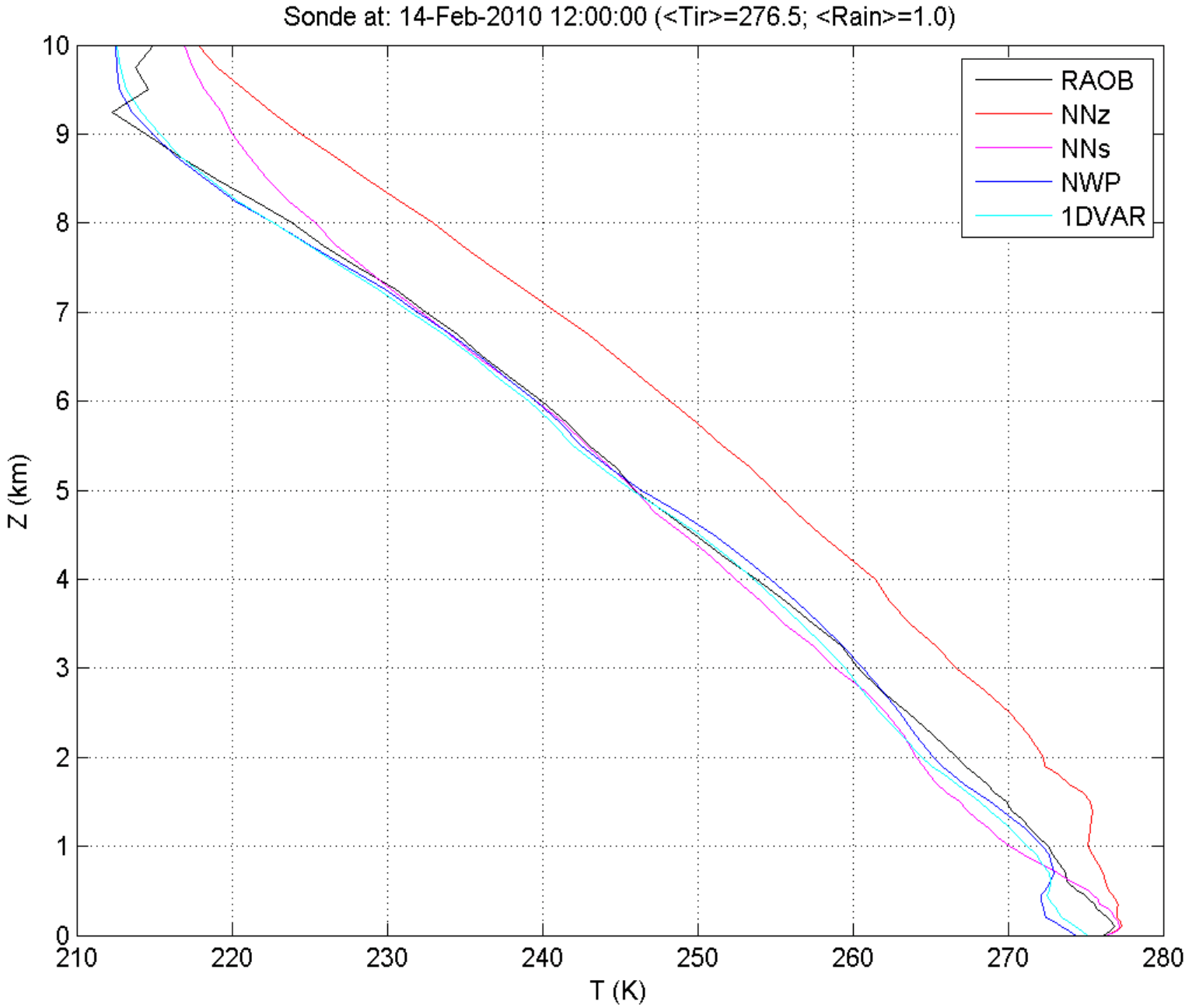
Temperature profiles during clear conditions with warm air above 3.5 km height.



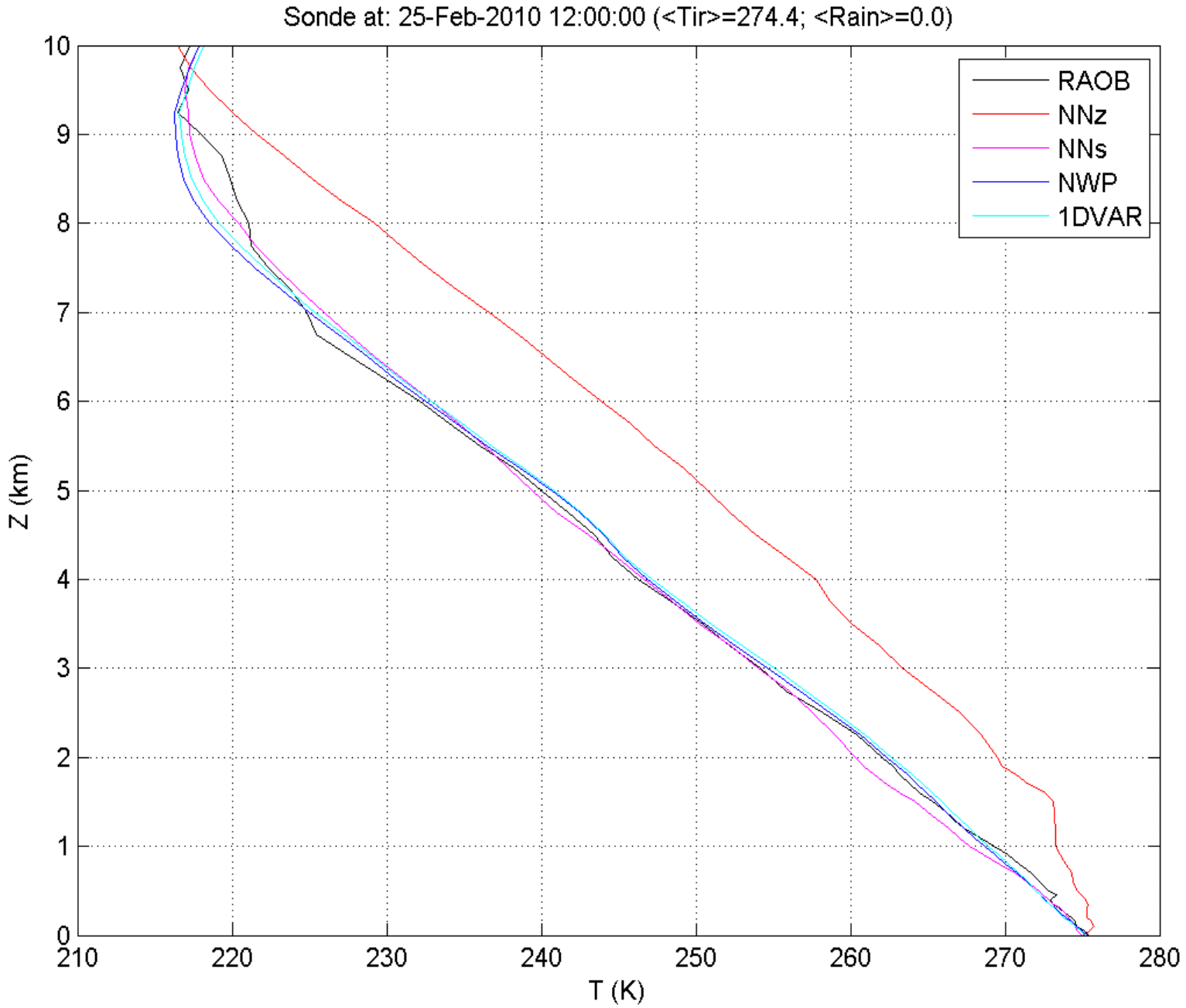
Temperature profiles during clear upper level warm air conditions.



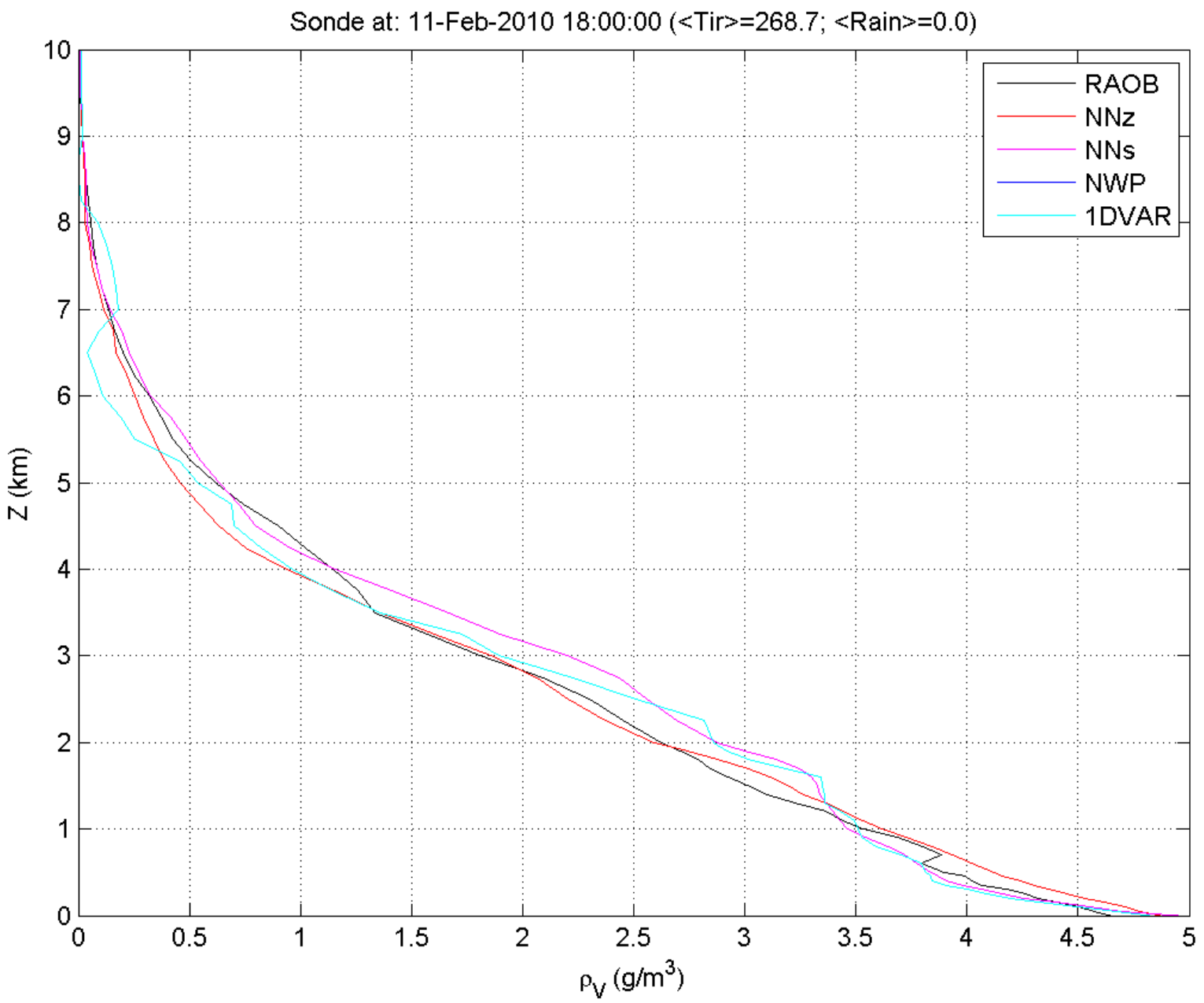
Temperature profiles during cloudy, no precipitation upper level warm air conditions.



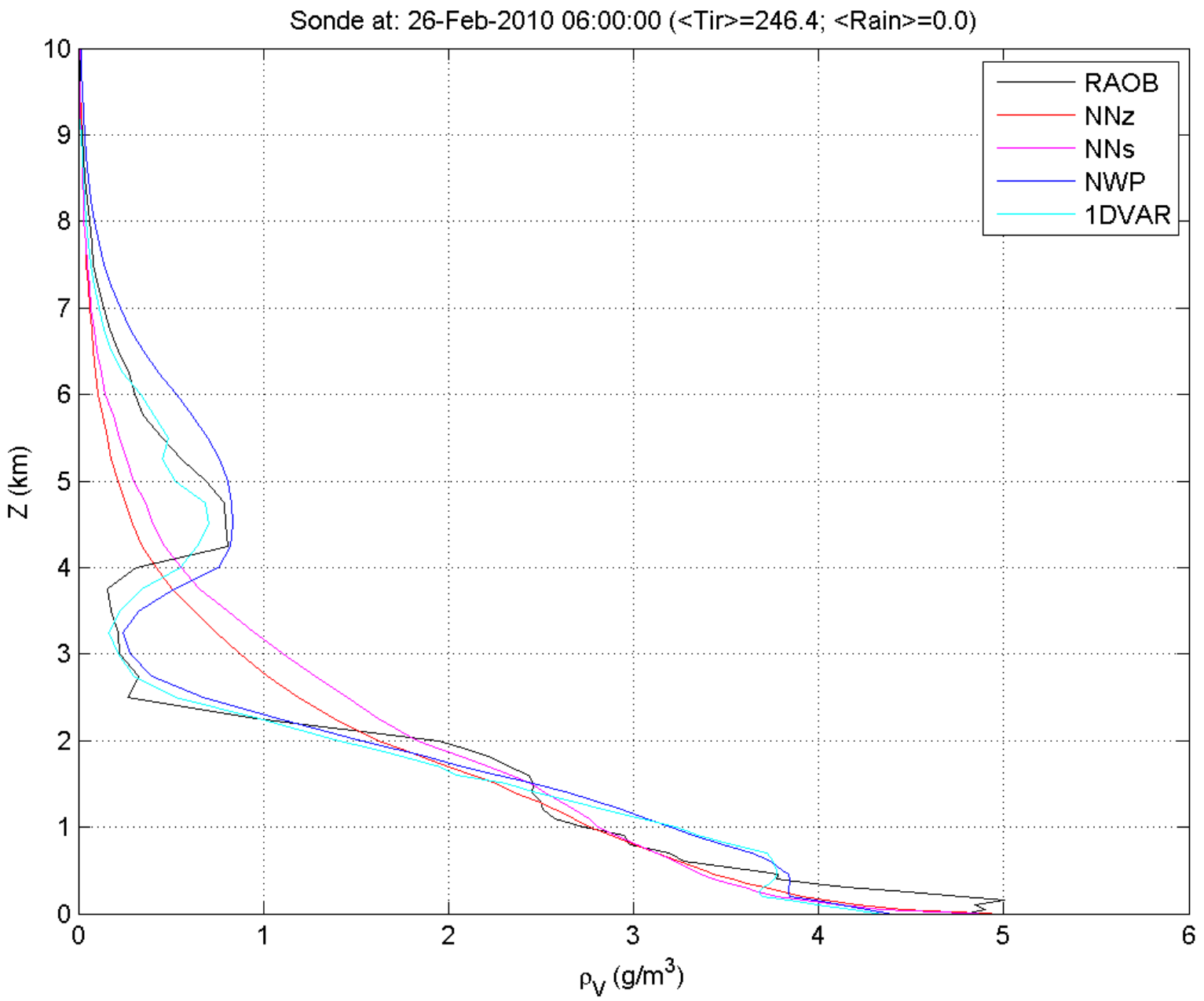
Temperature profiles during precipitation.



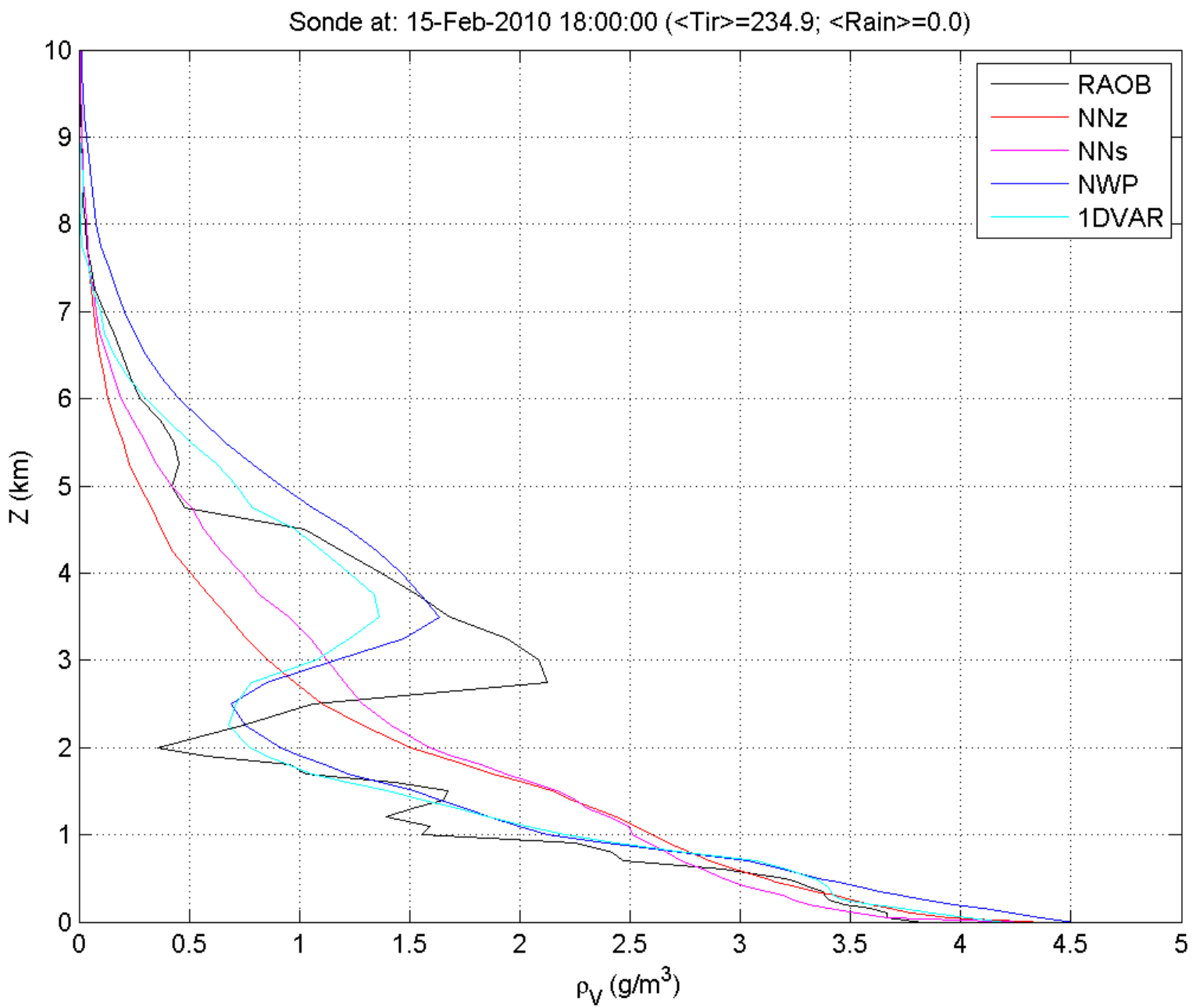
Temperature profiles with water and/or ice on top of the radiometer radome.



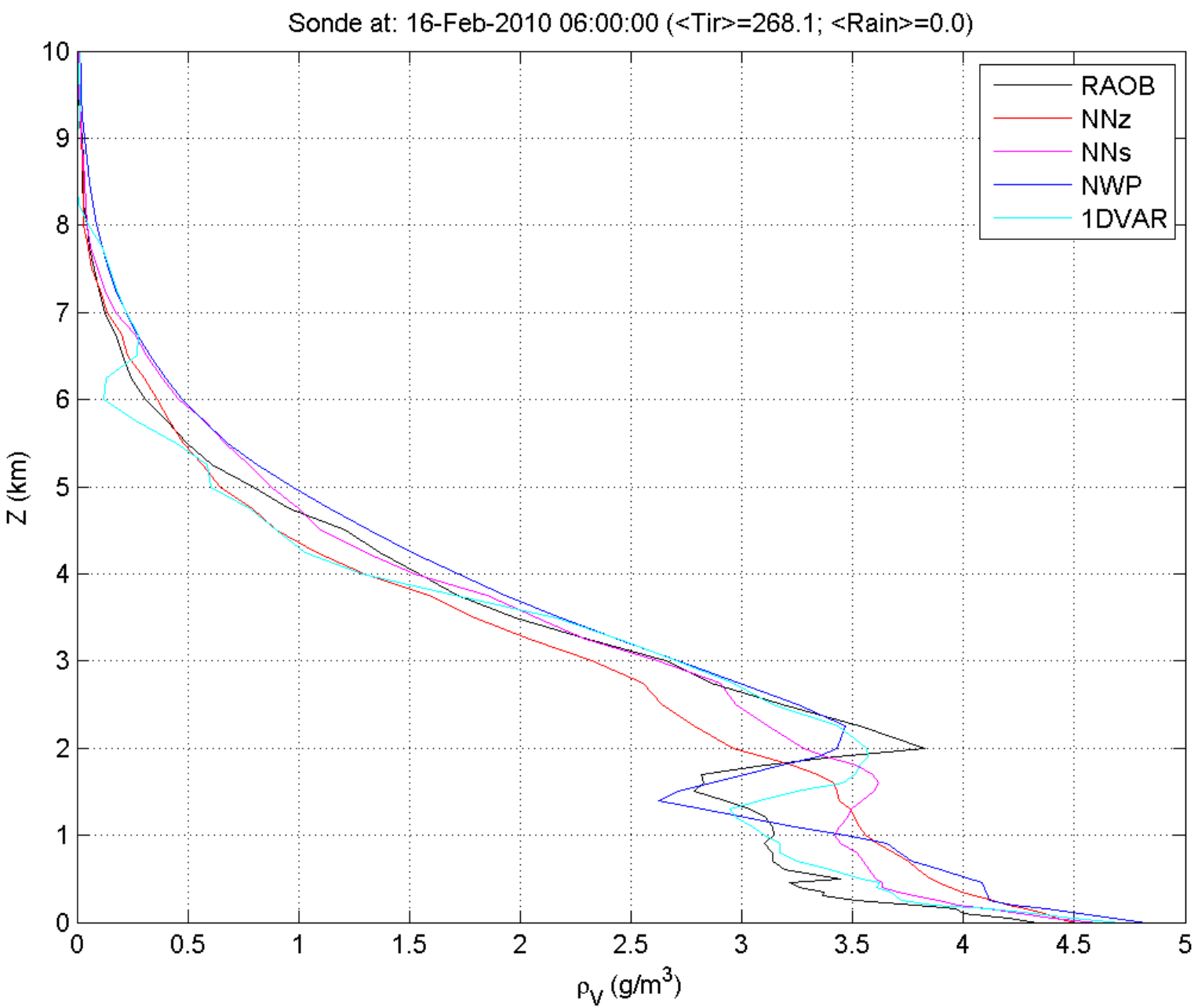
Radiosonde, neural net, analysis and 1DVAR water vapor profiles during low cloud, no rain conditions.



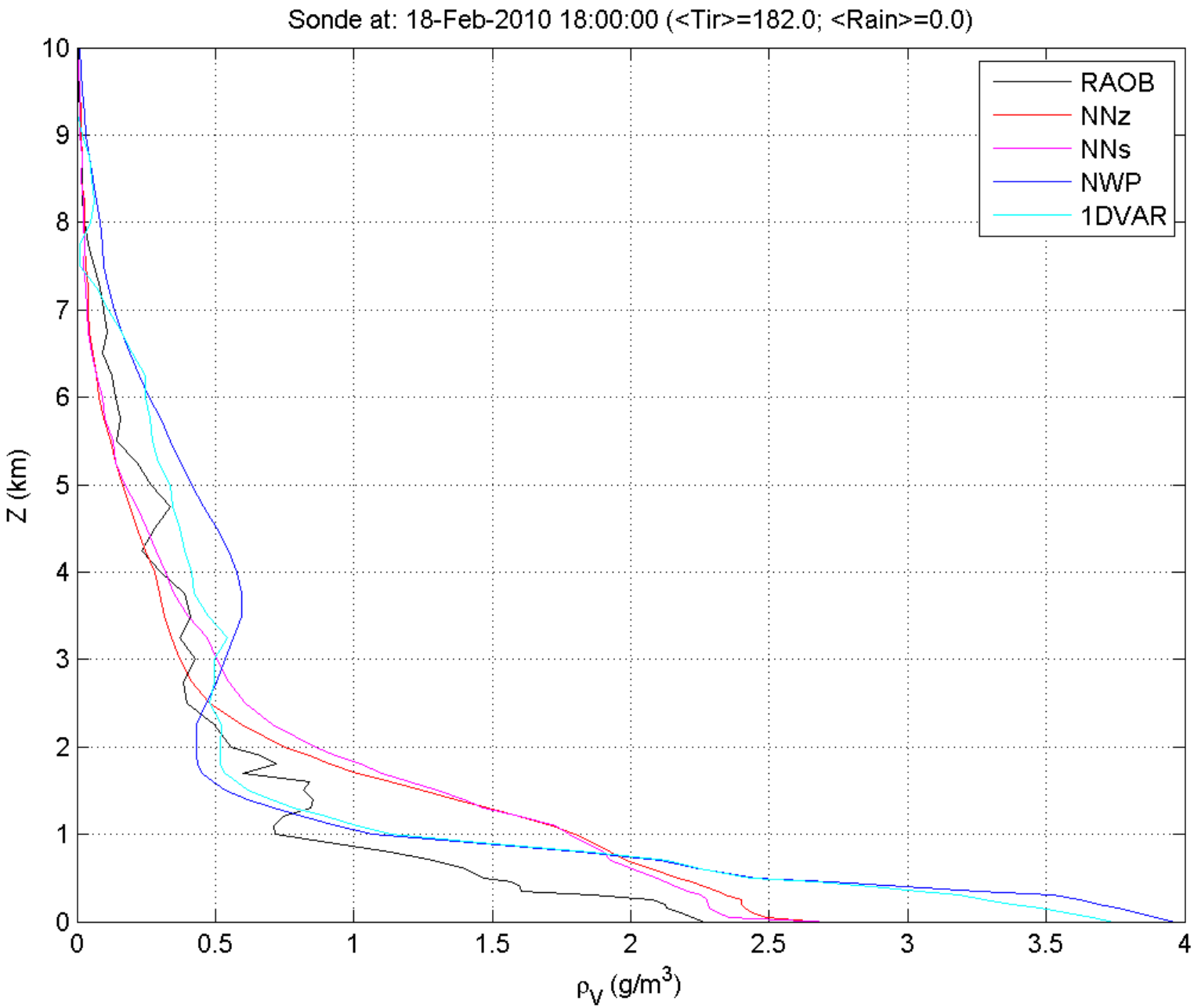
A vapor inversion in the radiosonde sounding near 4 km height is seen in 1DVAR and NWP but not in neural network retrievals.



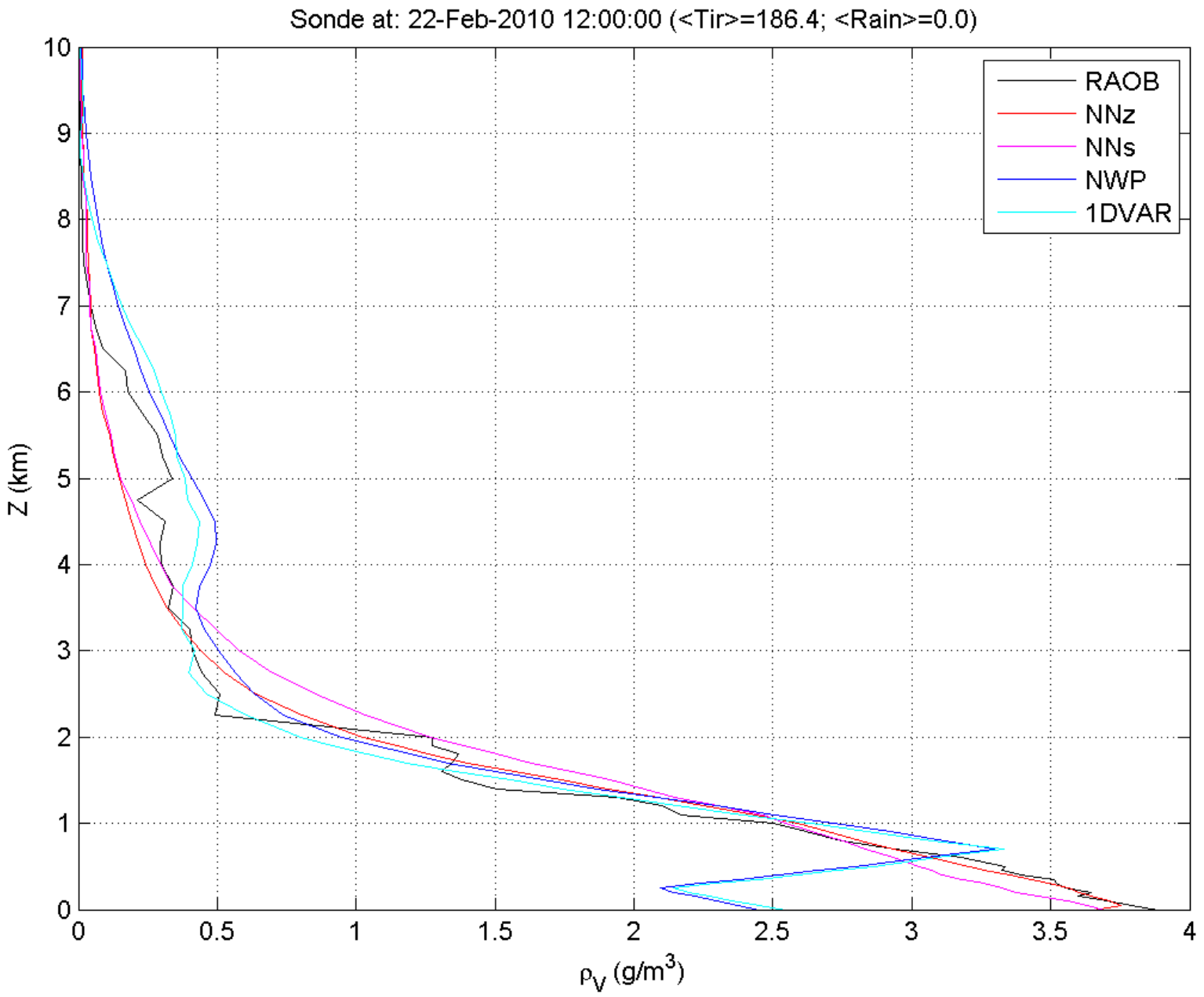
A vapor inversion in the radiosonde sounding near 2 km height is seen in 1DVAR but not in neural network retrievals.



A vapor inversion in the radiosonde sounding near 1.5 km height is seen in 1DVAR and 15 deg NN, but not in zenith NN.



Vapor profiles during clear, dry conditions. 1DVAR and NWP show much higher vapor density at the surface than the radiosonde or neural net retrievals.



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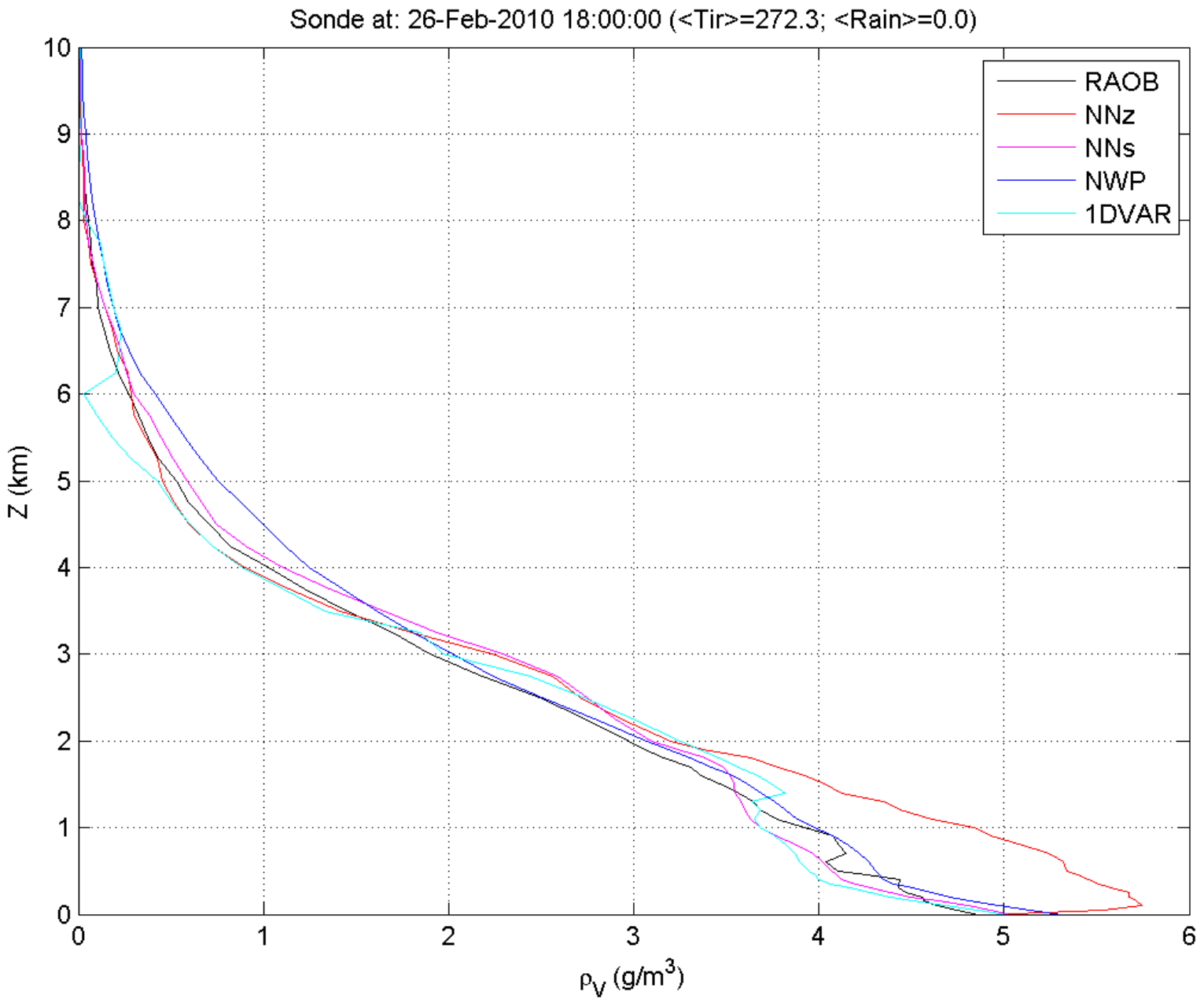
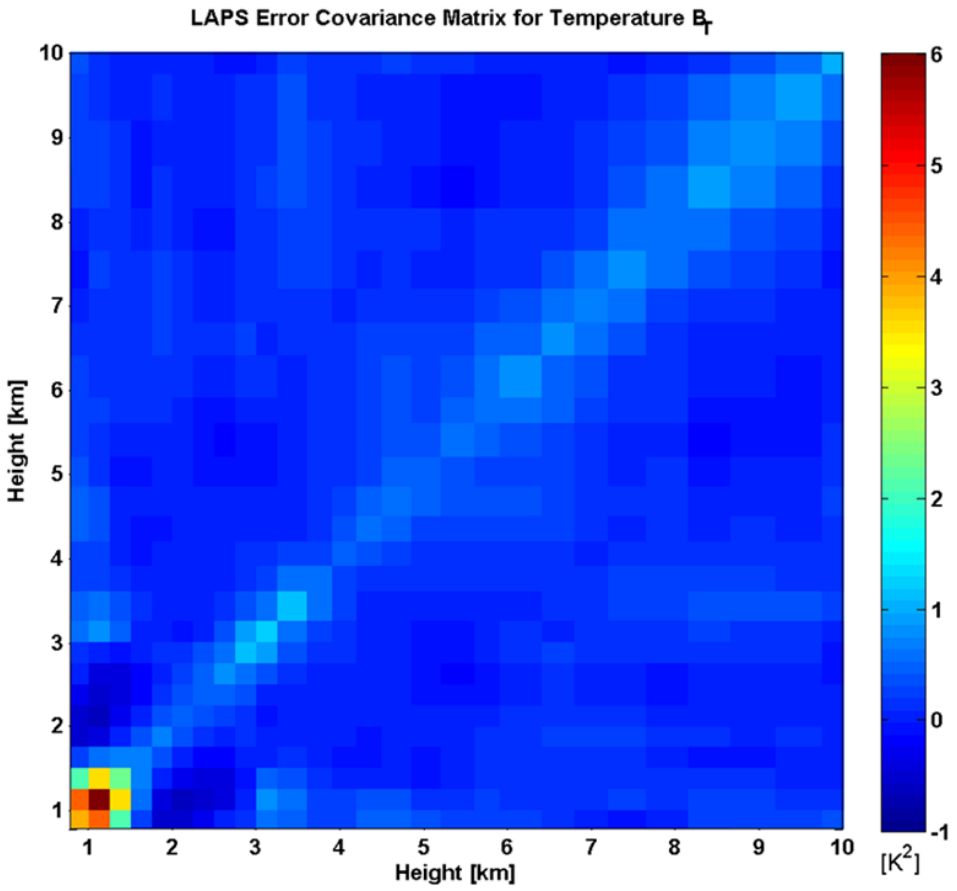
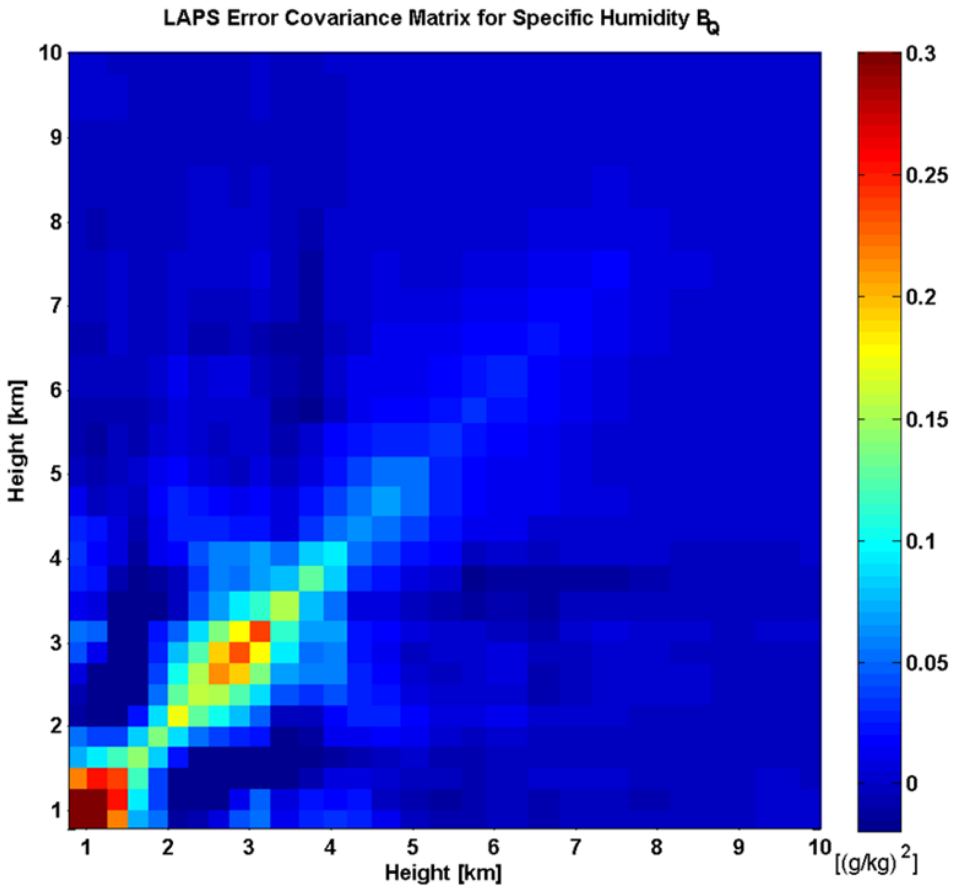


Vapor density profiles with possible water and/or ice on top of the radiometer radome.





Temperature and specific humidity background error covariance matrices calculated from 6-hr radiosondes (93) with 30 min LAPS analyses.

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Conclusions

- Accurate thermodynamic profiling during rain, sleet and snow was demonstrated and is ready for operational use
- 1DVAR retrievals provide continuous NWM constraints with equivalent accuracy to radiosondes
- Traditional forecast indices generated from continuous thermodynamic profiles are powerful local short term prediction tools