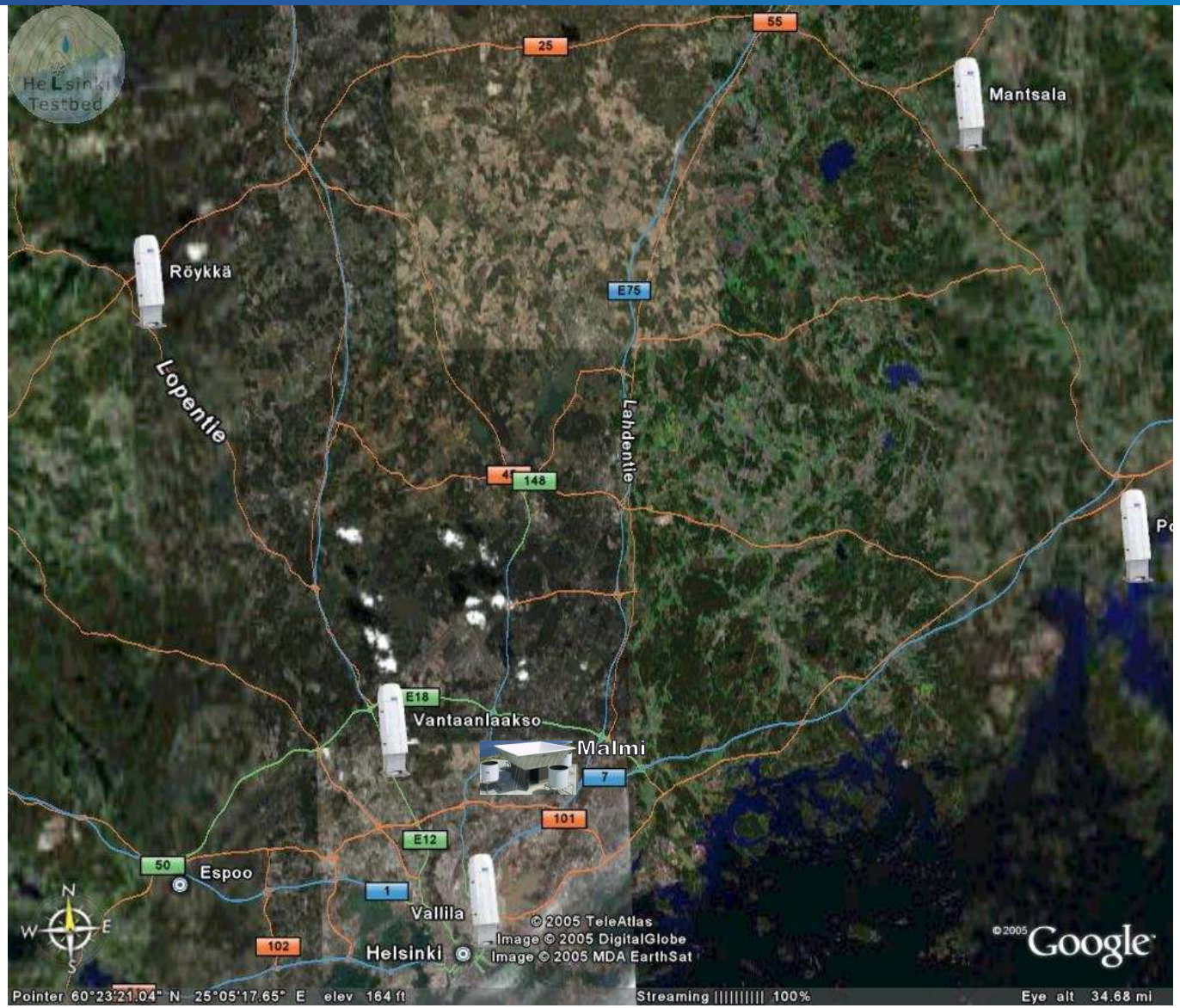
Wind profiler, RASS and ceilometers in Helsinki Testbed

HTB Seminar 6.4.2006

Hannu Talvitie

VAISALA

Profiling remote sensing instruments at Helsinki Testbed



Wind profiler LAP3000 with RASS

Ceilometer CL31

Wind profiler and RASS system at Malmi

Wind Profiler at Malmi Airport

- LAP-3000 wind profiler (8/2005 -)
- RASS for temperature profiling (10/2005 -)

- Remote access from Vaisala (Boulder and Vantaa) and FMI

Wind Profiler – LAP3000

Measurement signal

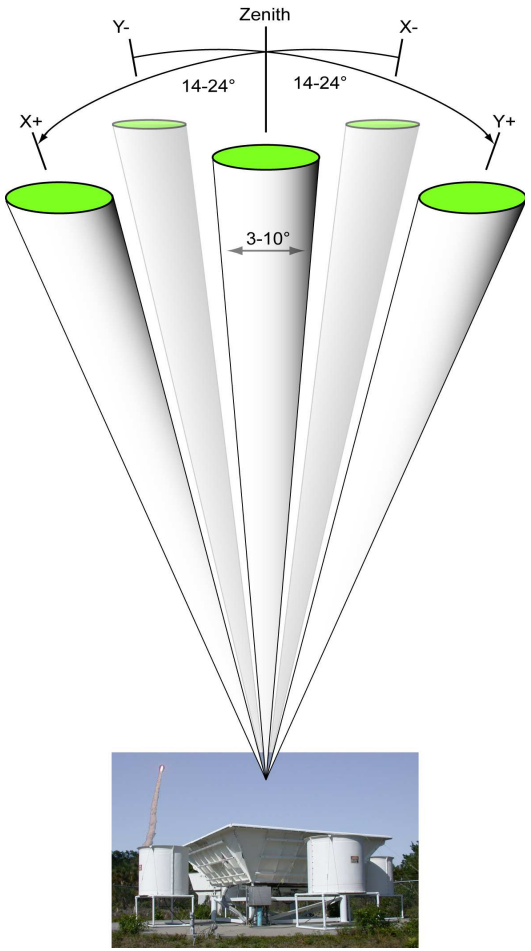
- RF signal at 1290 MHz
- Doppler Beam Swinging (DBS) method for wind vector calculations (u,v,w)
- Radial scattered velocities measured with one vertical and 2 (4) off-zenith beams
- Signal from RF scattering:
  - perturbance in refractive index
  - backscatter from hydrometeors
- beam-pointing sequence is repeated every 1-5 minutes
- electronic beam pointing with phase shifters using one antenna
- local horizontal uniformity of the wind field is assumed

Wind profile

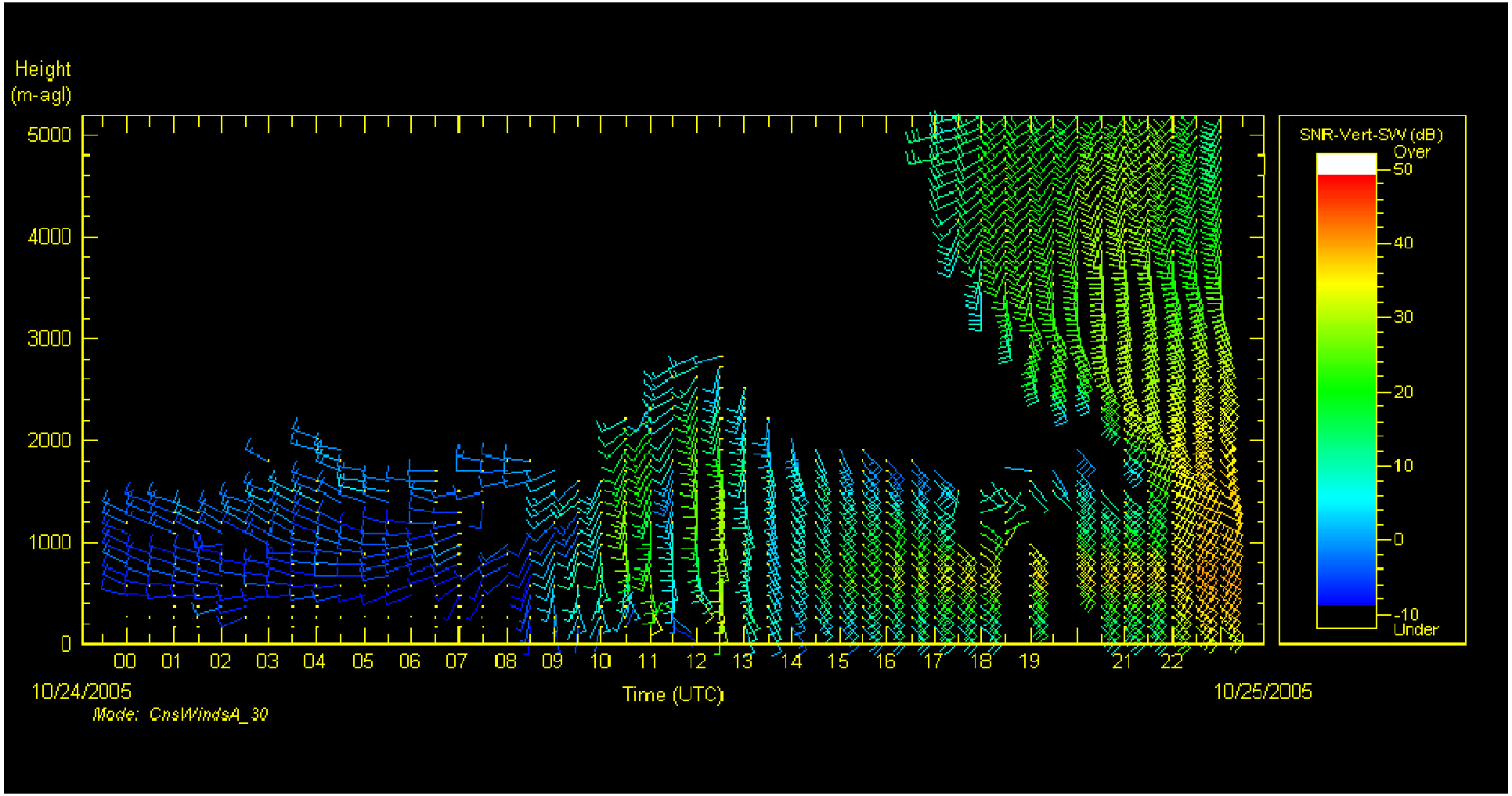
- lowest 70 m, up to 1000 .. 5000 m, 100 m steps
- averaged over 15 min, updated every 5 min

Interfering signals:

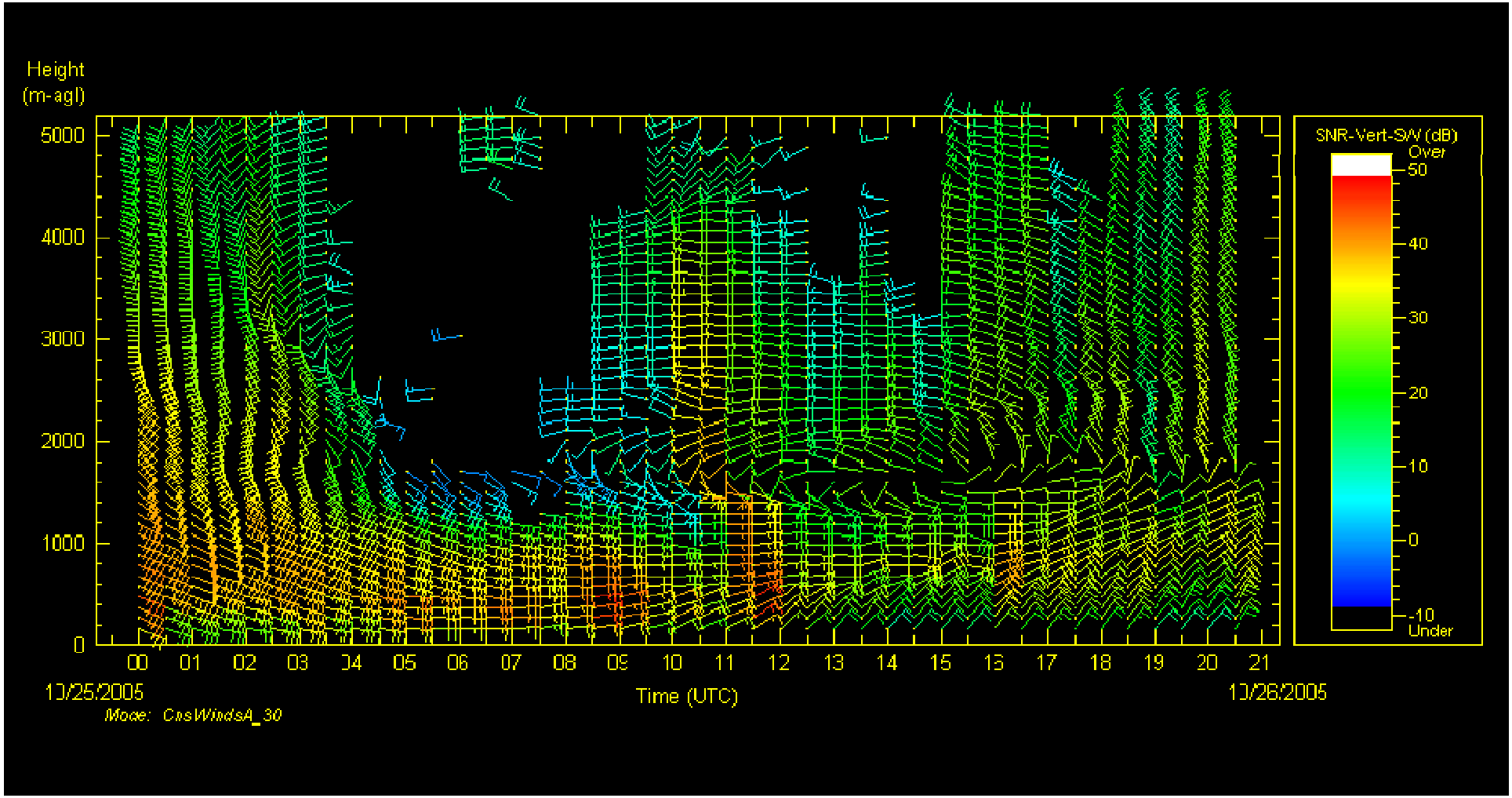
- ground and sea clutter
- aircraft and migrating birds
- RFI (depends on frequency band)



Wind profile on 25.10.2005 - Low pressure system

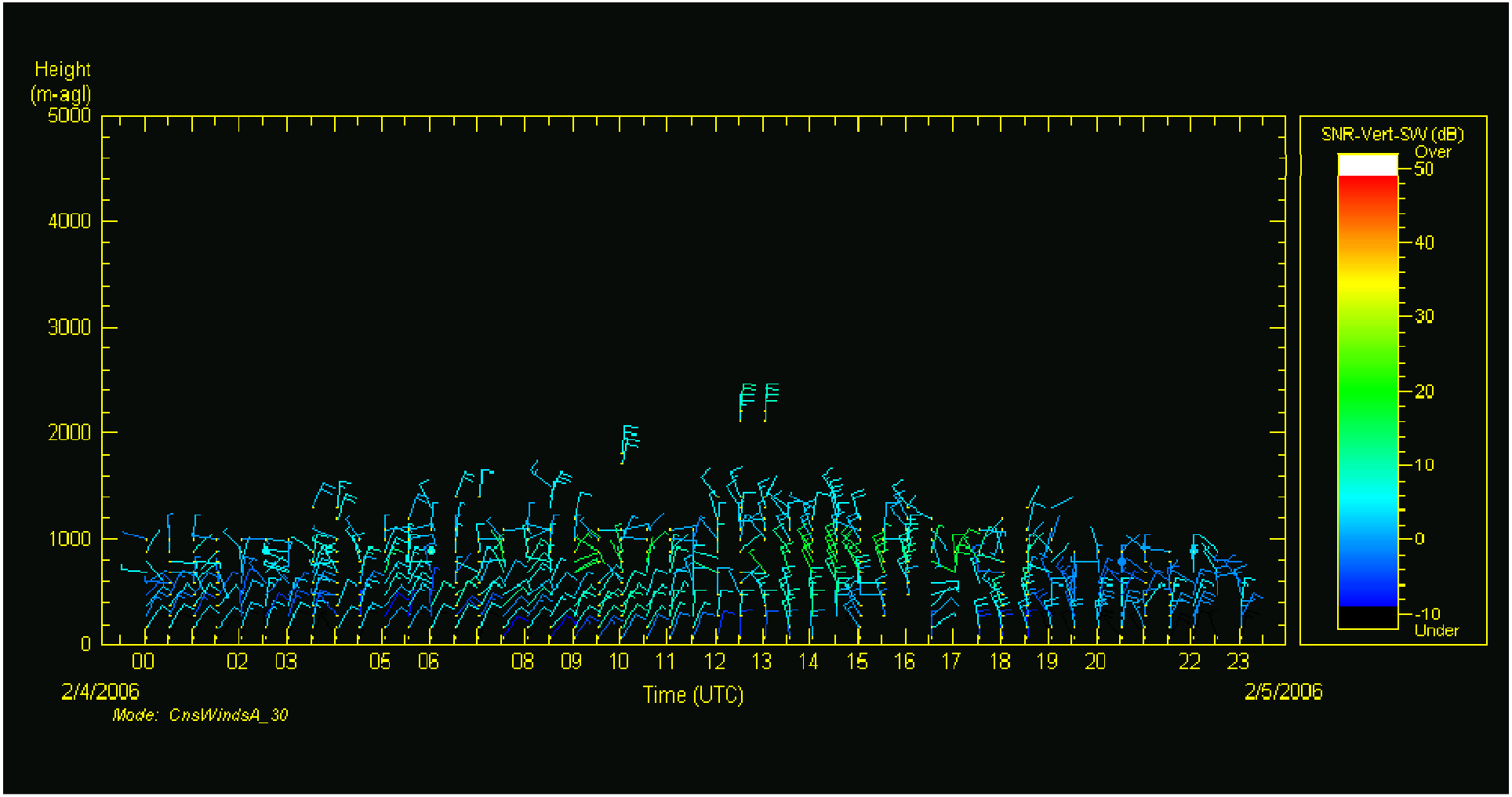


Wind profile on 26.10.2005 - Low pressure system



Dry, cold weather limits the profile range – 5.2.2006

T = -25...-16°C



Doppler peak display

N = Noise power

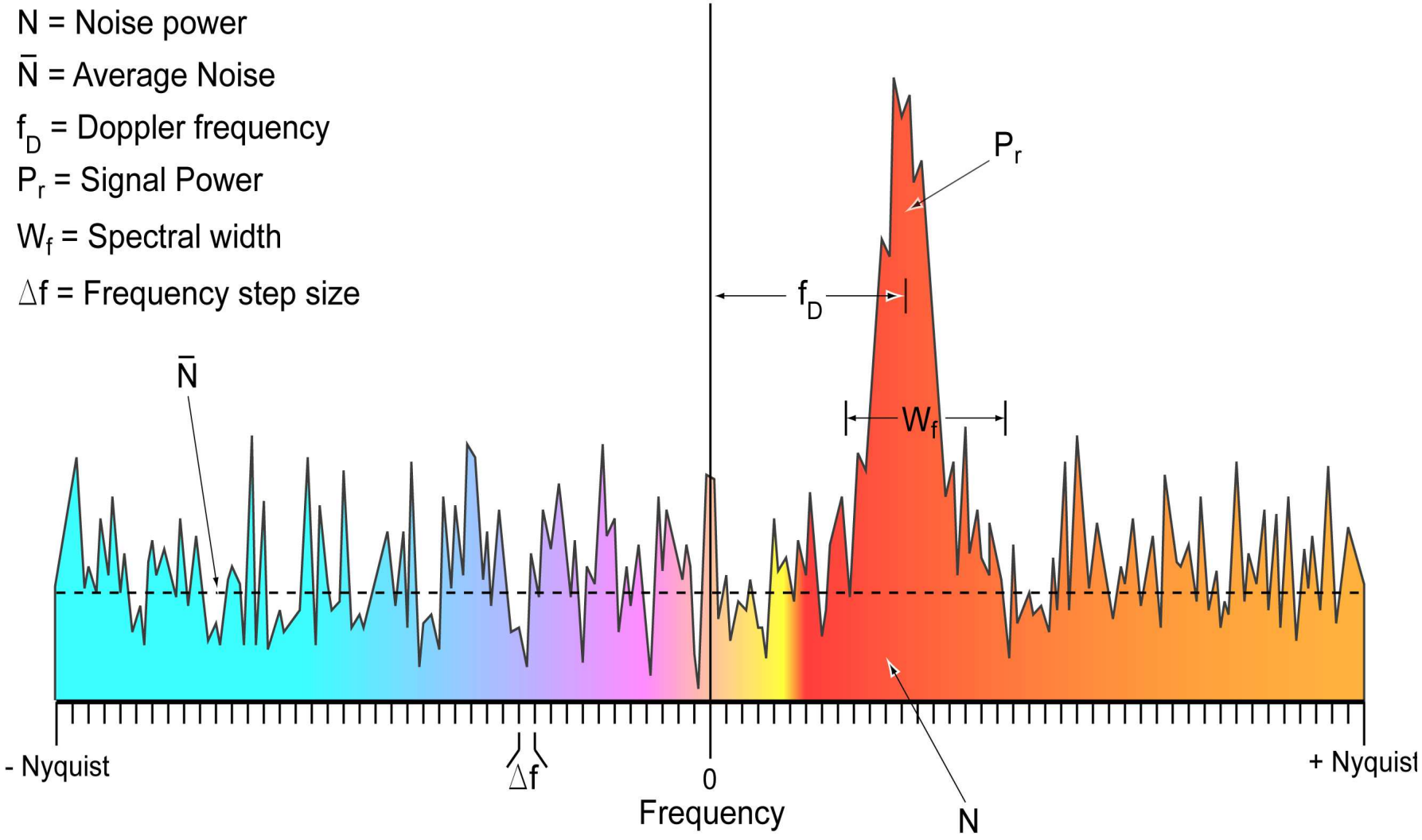
$\bar{N}$ = Average Noise

f_D = Doppler frequency

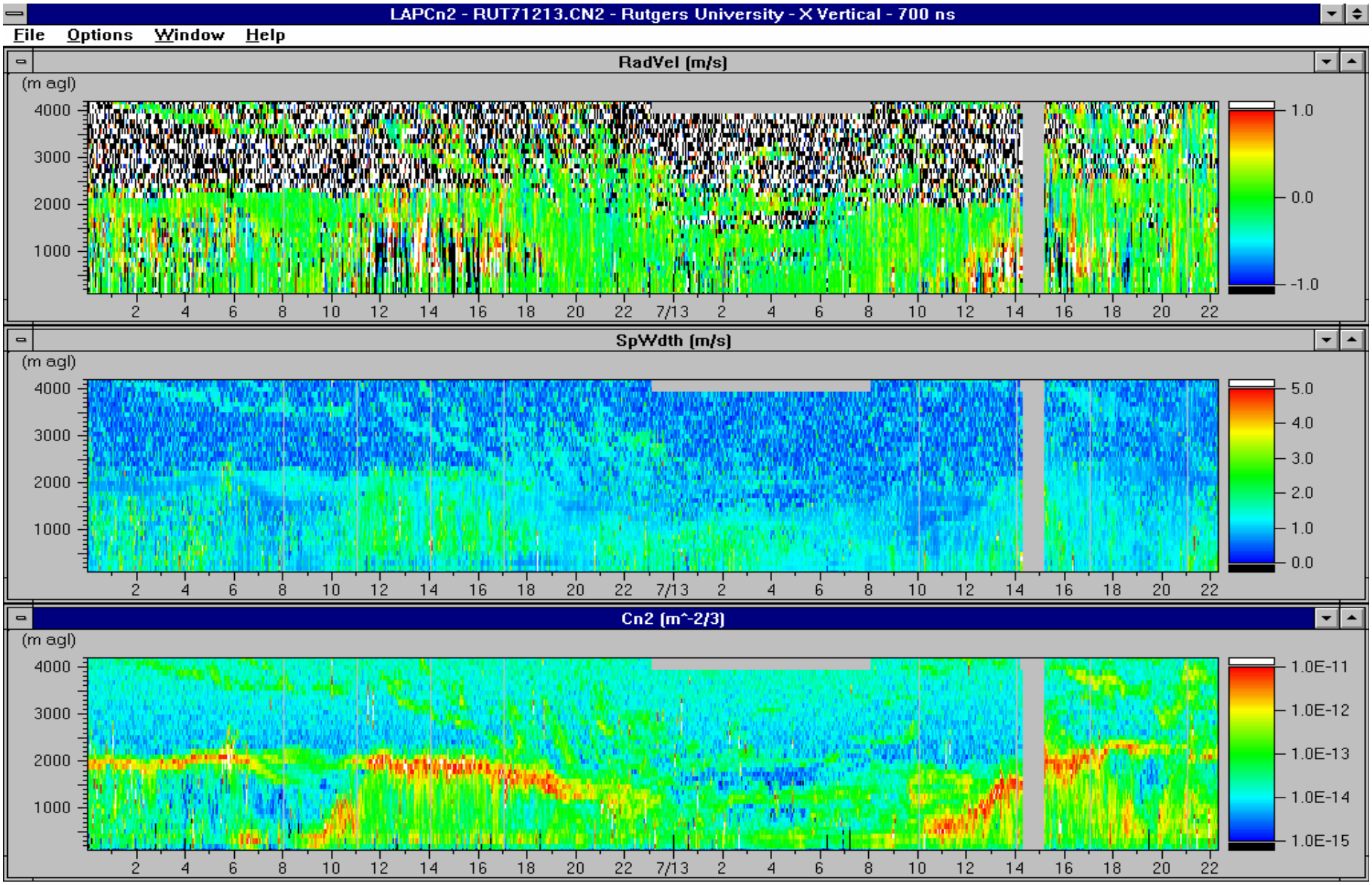
P_r = Signal Power

W_f = Spectral width

Δf = Frequency step size



Moments data



Radio Acoustic Sounding System (RASS)

RASS provides
virtual temperature profiles

- Emits a continuos acoustic sine wave synchronized to RADAR frequency, about 2.6 kHz (half wavelength)
- Wind Profiler measures the speed of propagation of the sound burst
- Speed of sound depends on the air temperature, virtual temperature can be computed from the received signal

Profiles (configuration in HTB)

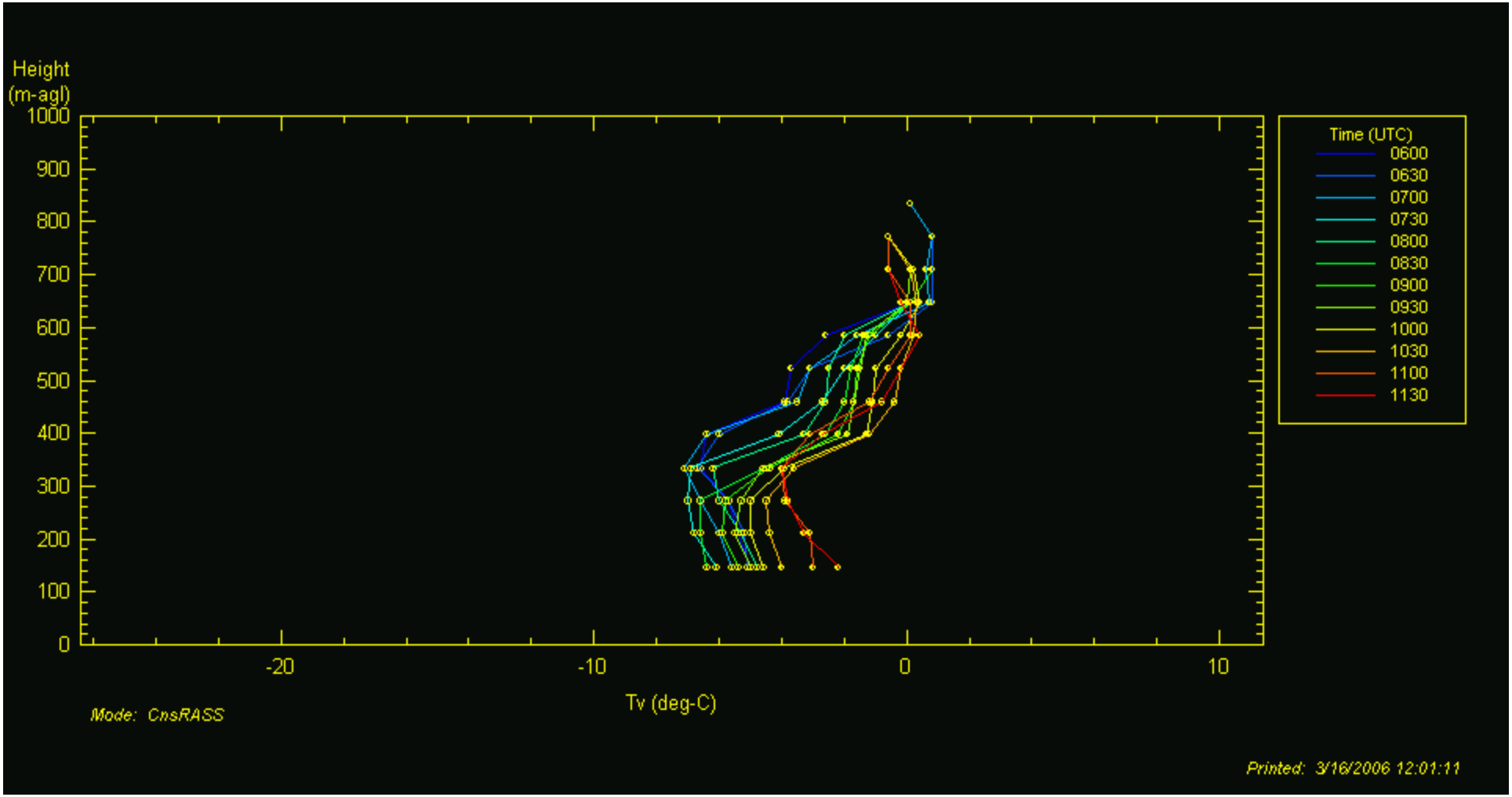
- lowest range 149 m, up to 400 ..1500 m, step 62 m
- average of 5 min,
  repeated every 30 min

Virtual temperature is the temperature that dry air would have if its pressure and specific volume were equal to those of a given sample of moist air.

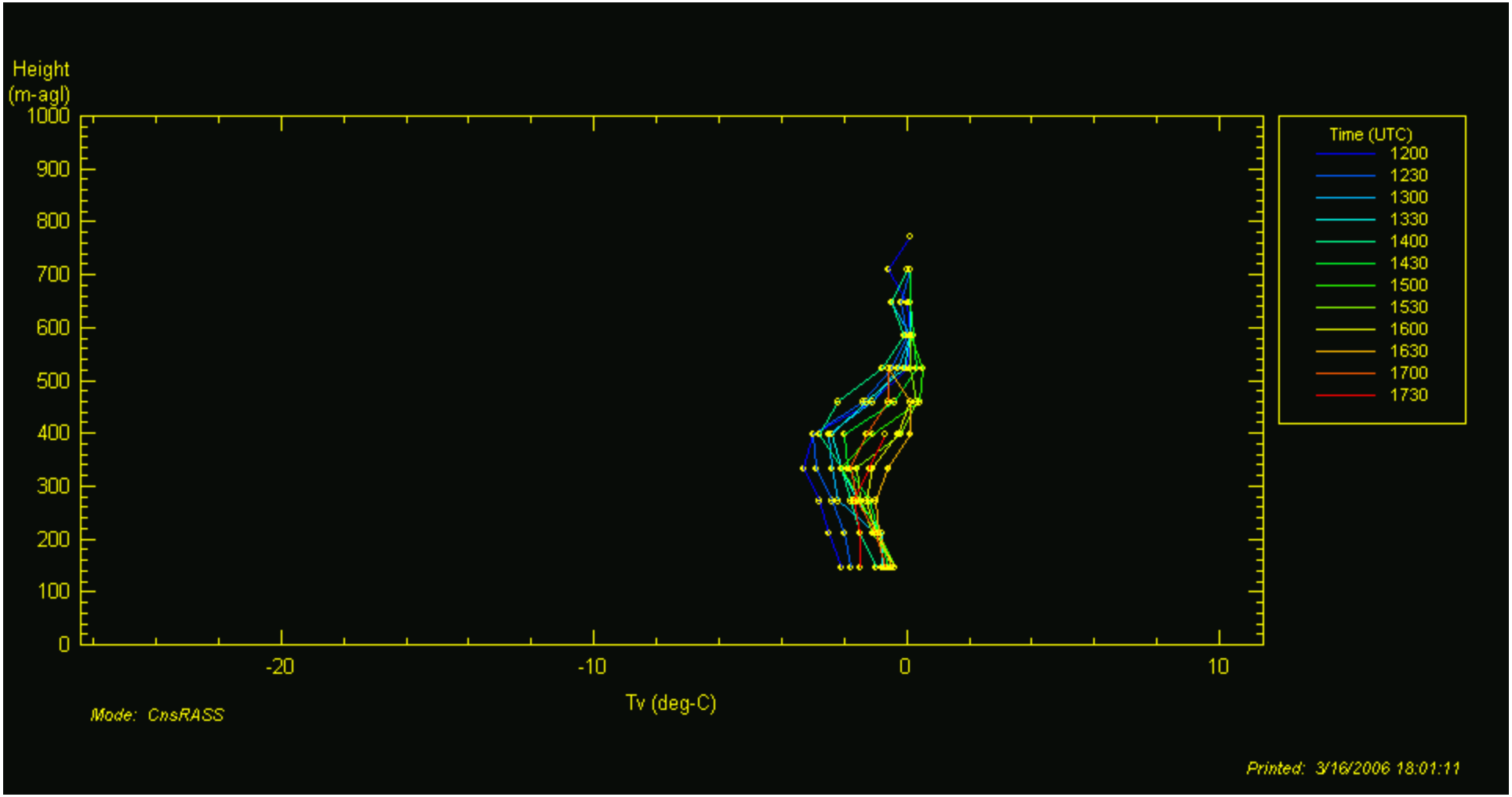
VAISALA

WP and RASS location at Malmi

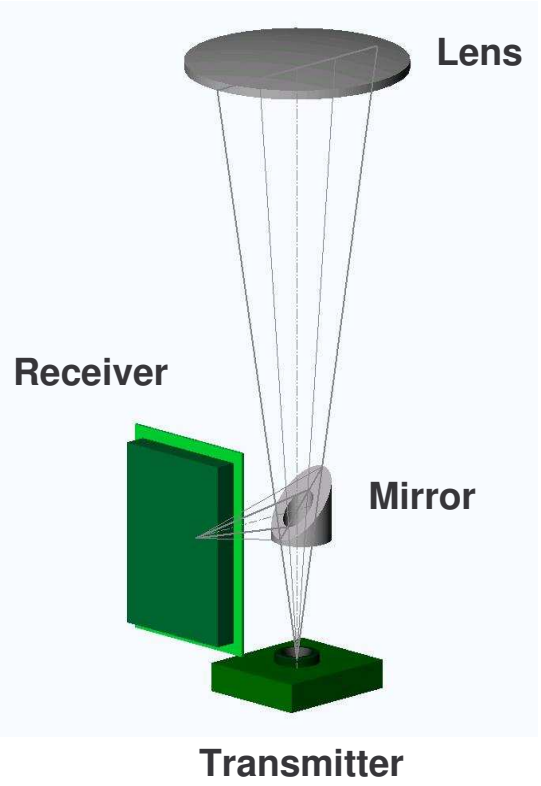
Inversion on 16.3.2006 – Temperature profile at 06..12



Inversion on 16.3.2006 – Temperature profile at 12..18



Enhanced single lens system Vaisala Ceilometer CL31

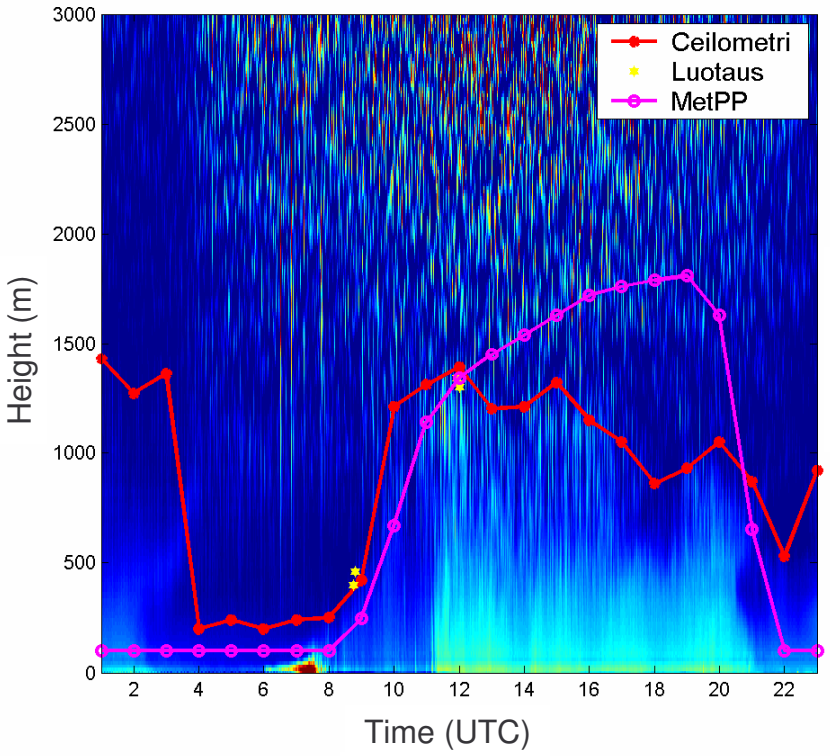


Ceilometers

- 8 pcs of CT25 (FMI)
- 5 pcs of new CL31
  - clouds
  - cloud cover
  - backscatter profile
  - new optics provides good signal already at 10 m

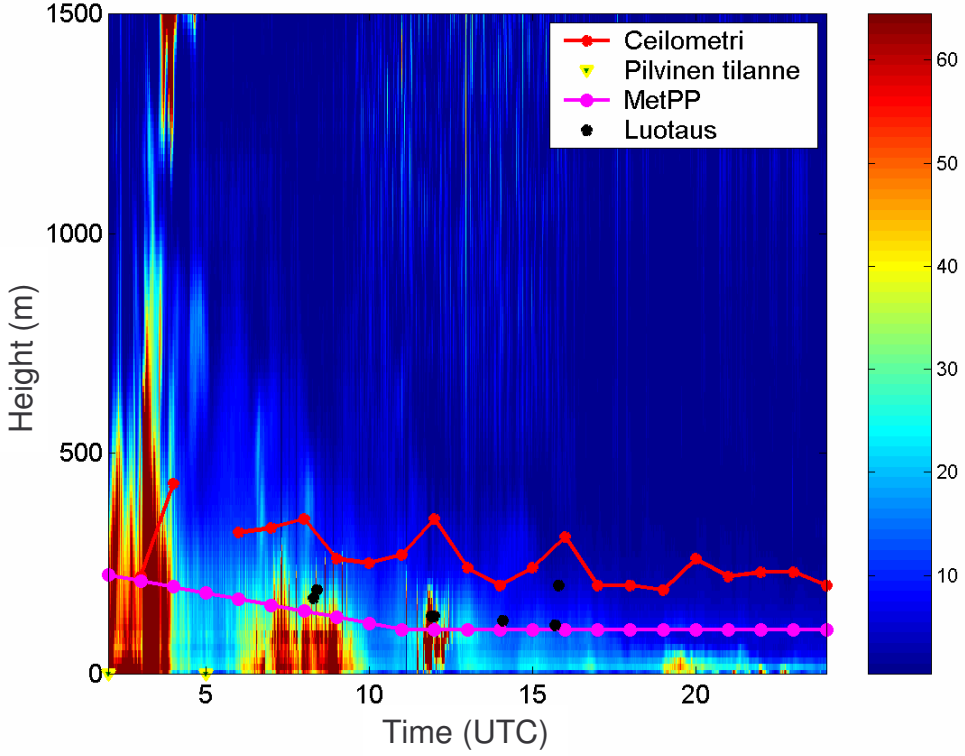
Aerosol profile measurements by CT25K

convective case



29.5.2002

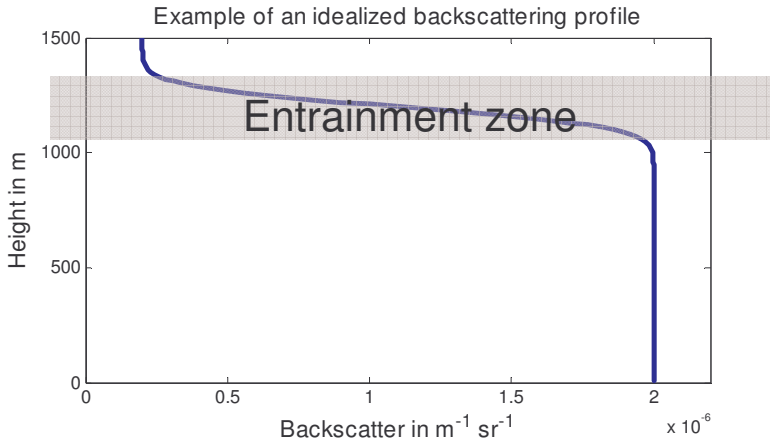
stable case

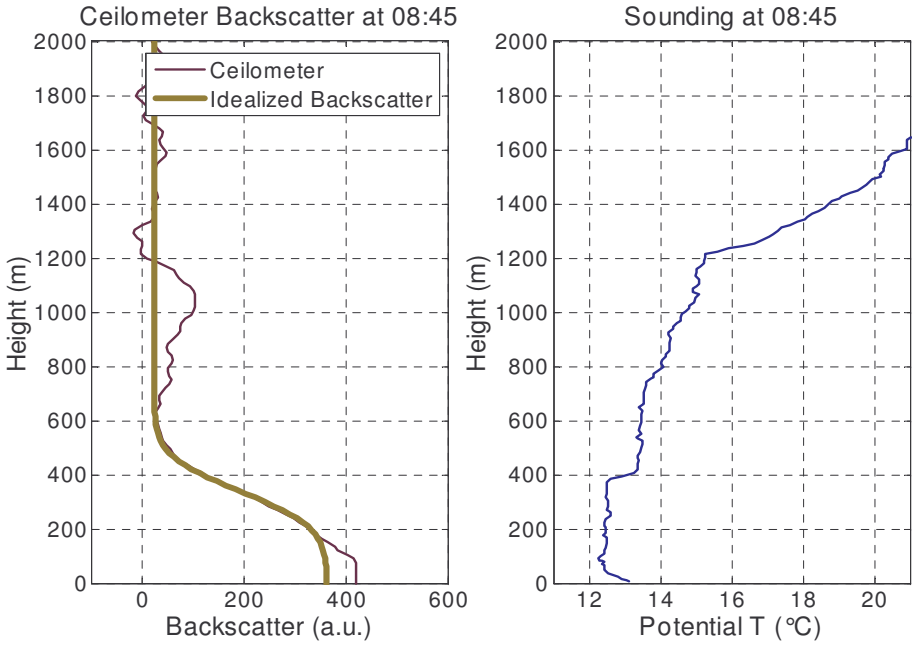


2.1.2002

Noora Eresmaa, Ari Karppinen, FMI

Mixing height retrieval - idealized backscatter method



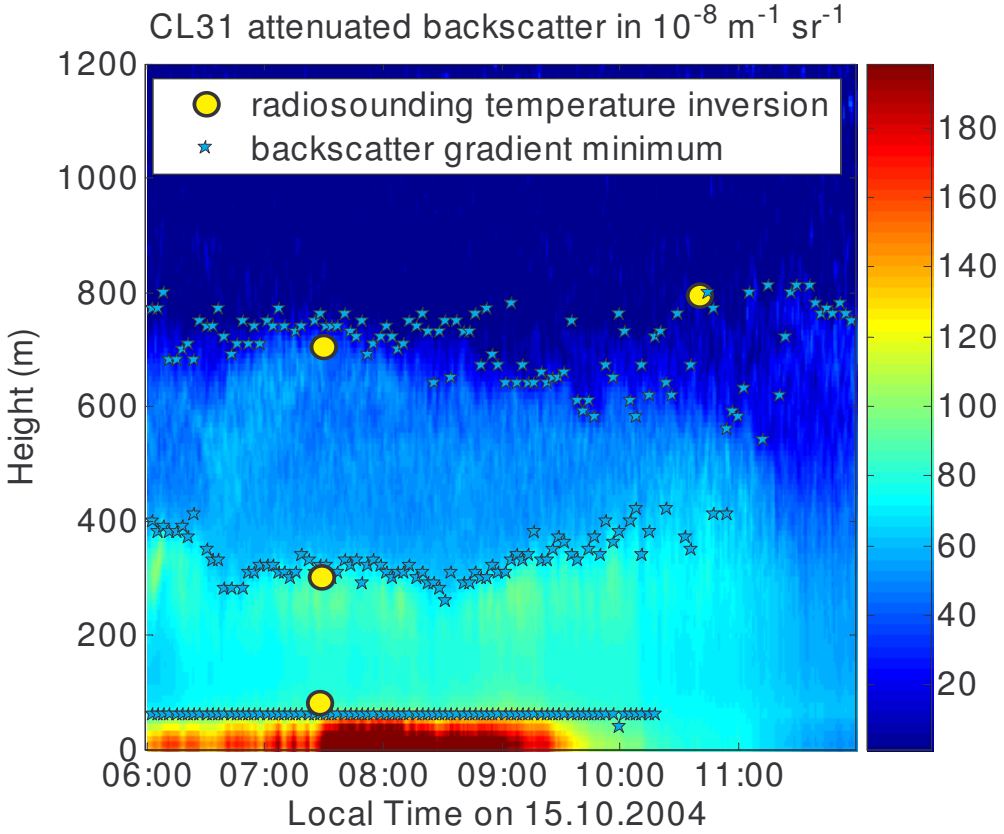


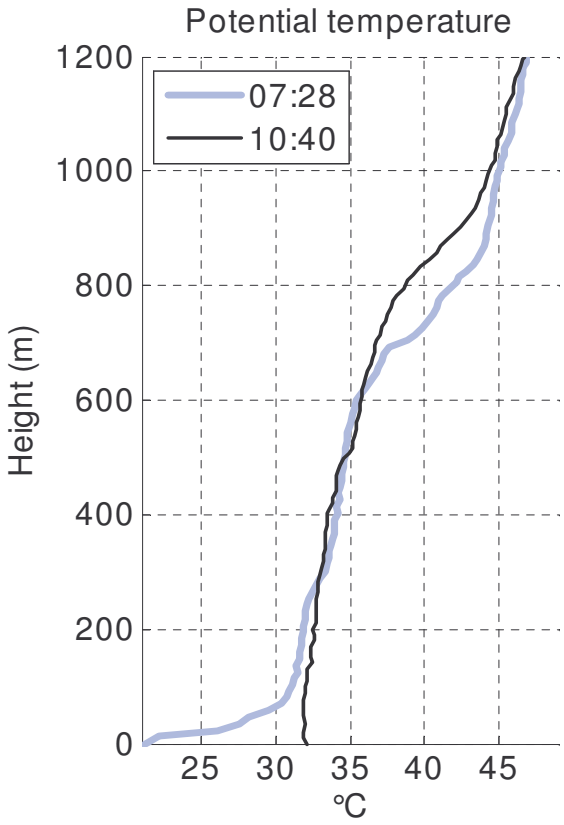
$$B(z) = \frac{B_m + B_u}{2} - \frac{B_m - B_u}{2} erf\left(\frac{z - MH}{s}\right)$$

- B_m mean mixed layer backscatter
- B_u mean backscatter in air above the mixed layer
- s is related to the thickness of the entrainment zone.

Noora Eresmaa, Ari Karppinen, FMI

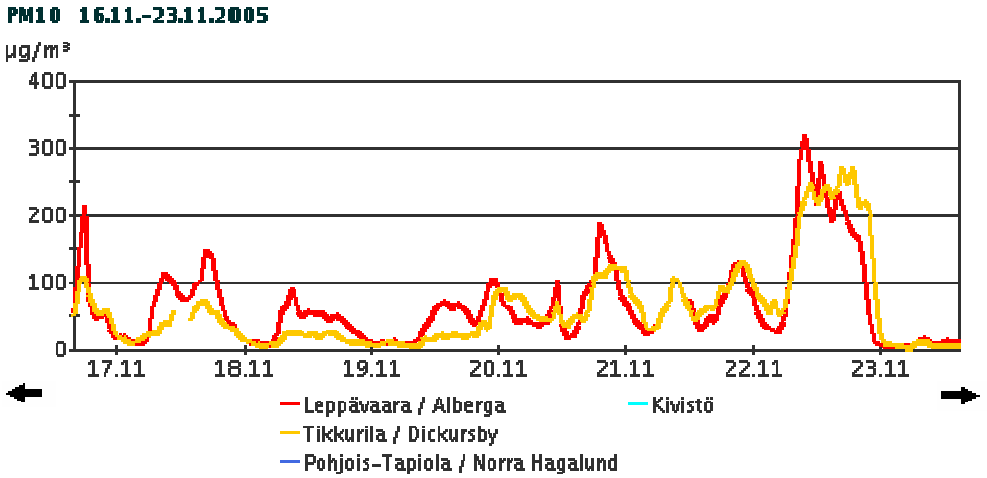
Gradient method - measurement example, local minima

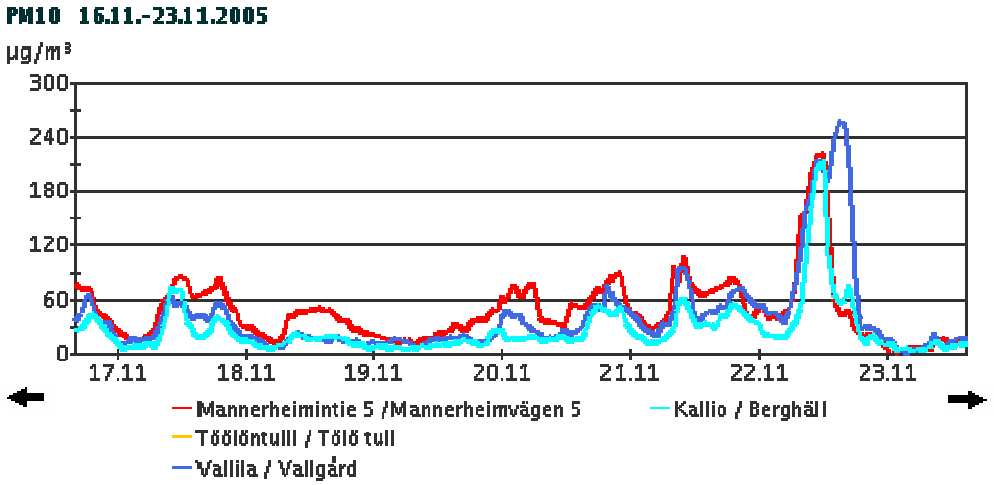




Christoph Münkel, Vaisala

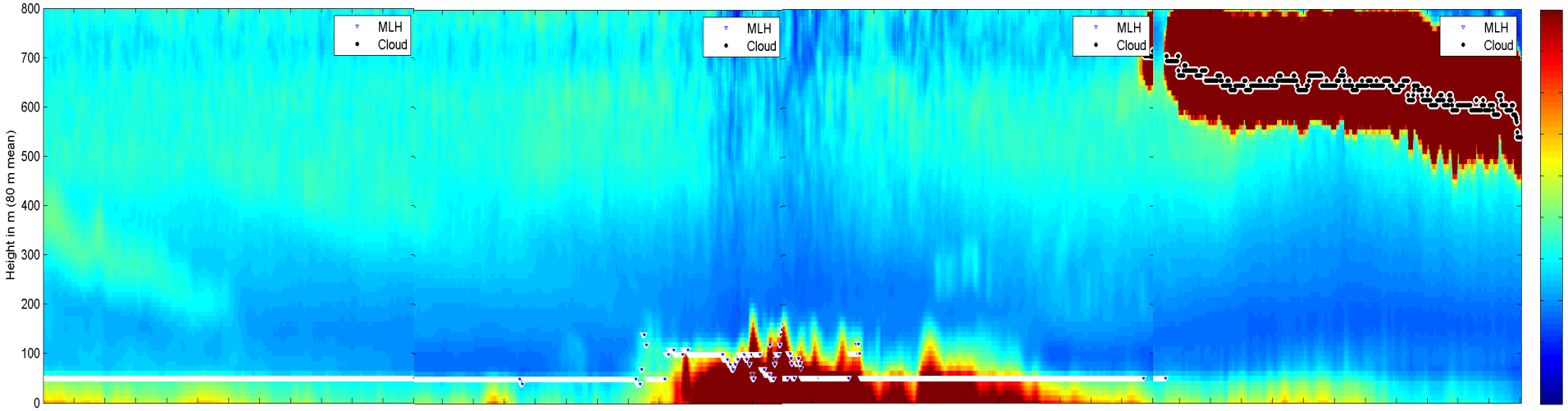
Bad air quality on 22.11.2005 – YTV particle measurements



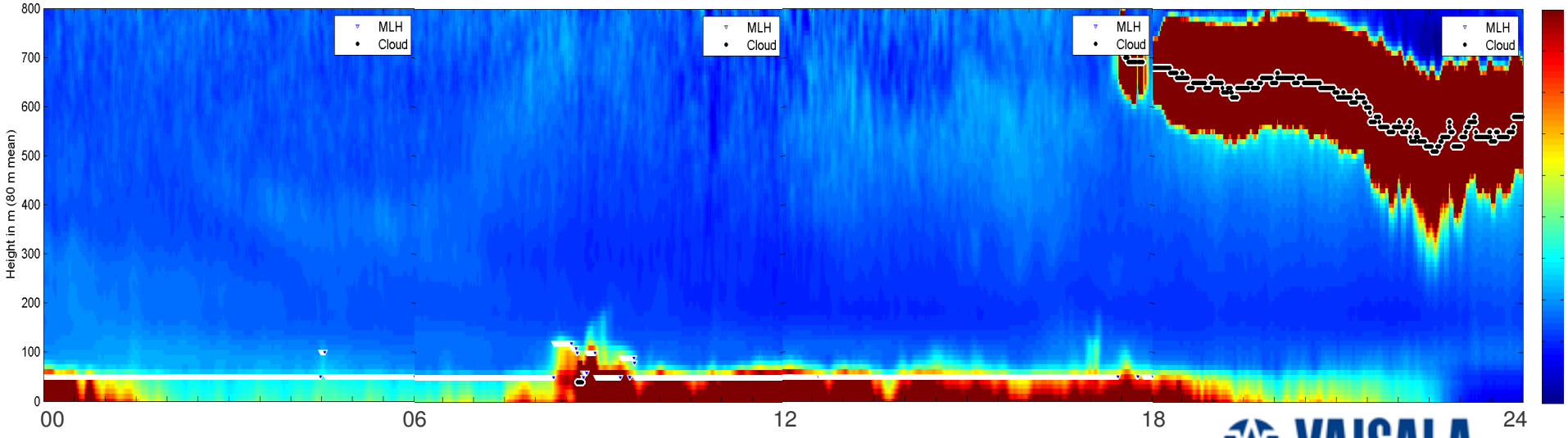


Bad air quality on 22.11.2005 - CL31 profiles

Vallila

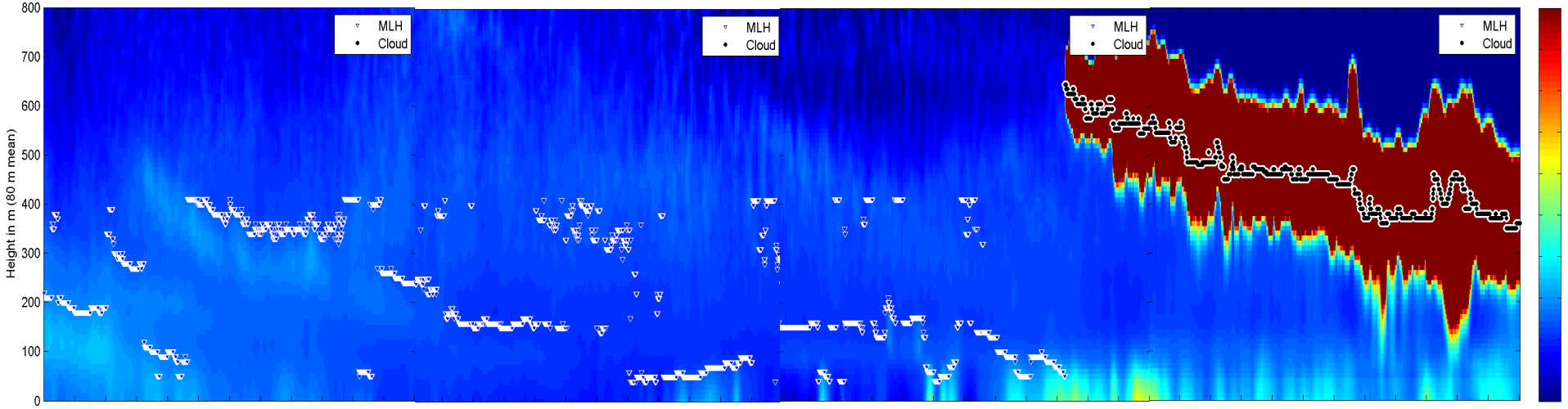


Vantaanlaakso

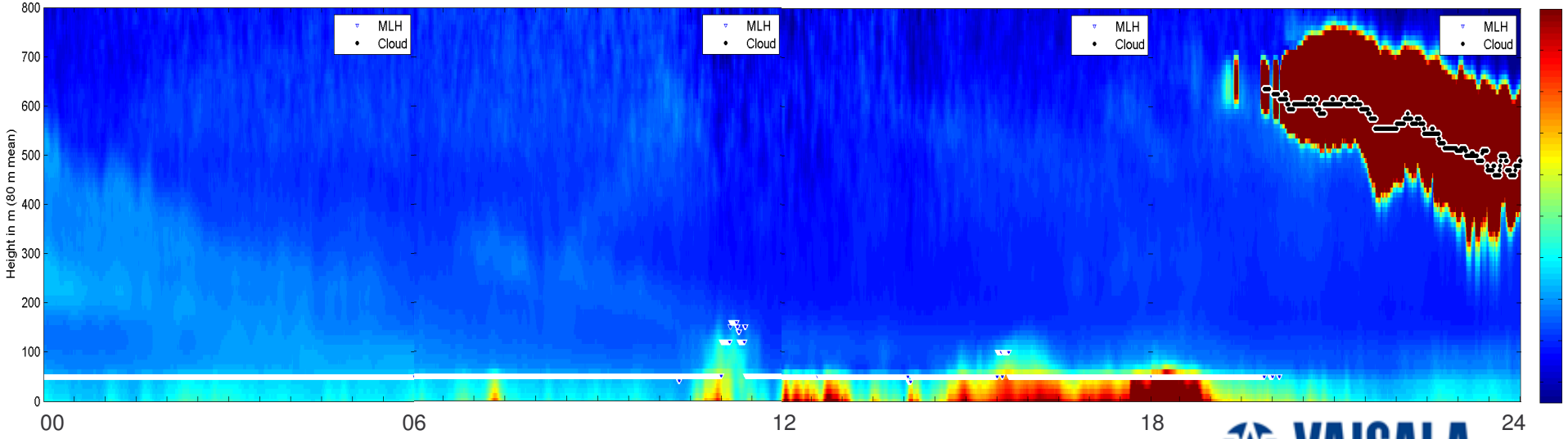


Bad air quality on 22.11.2005 - CL31 profiles

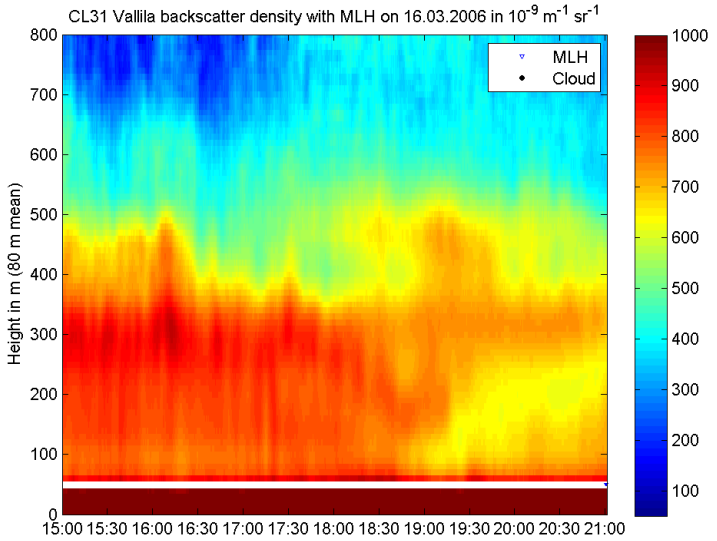
Röykkä

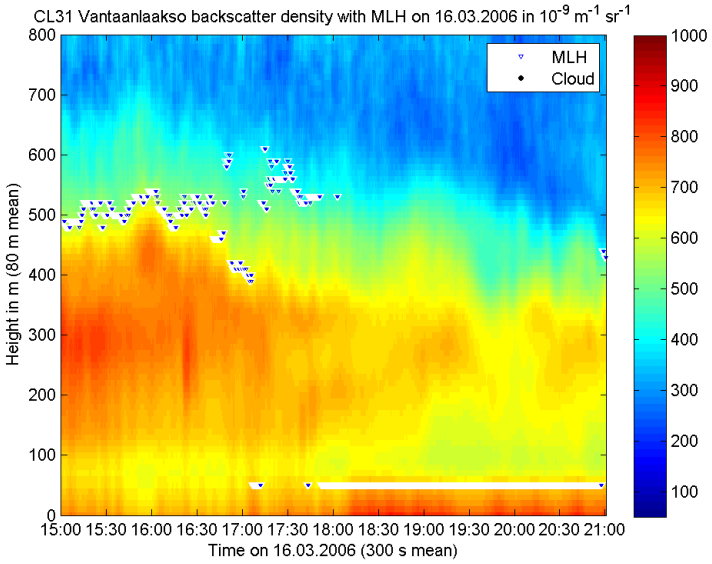


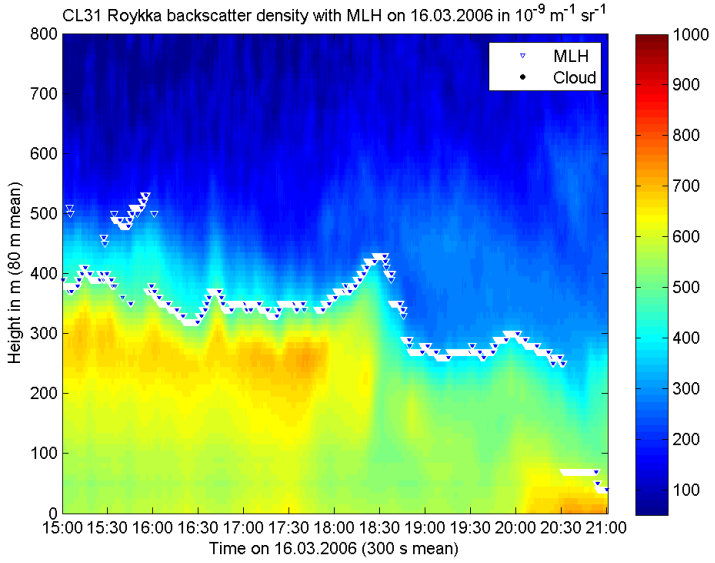
Porvoo



Multiple aerosol layers on 16.3.2006







Salford University Doppler Lidar in May campaign

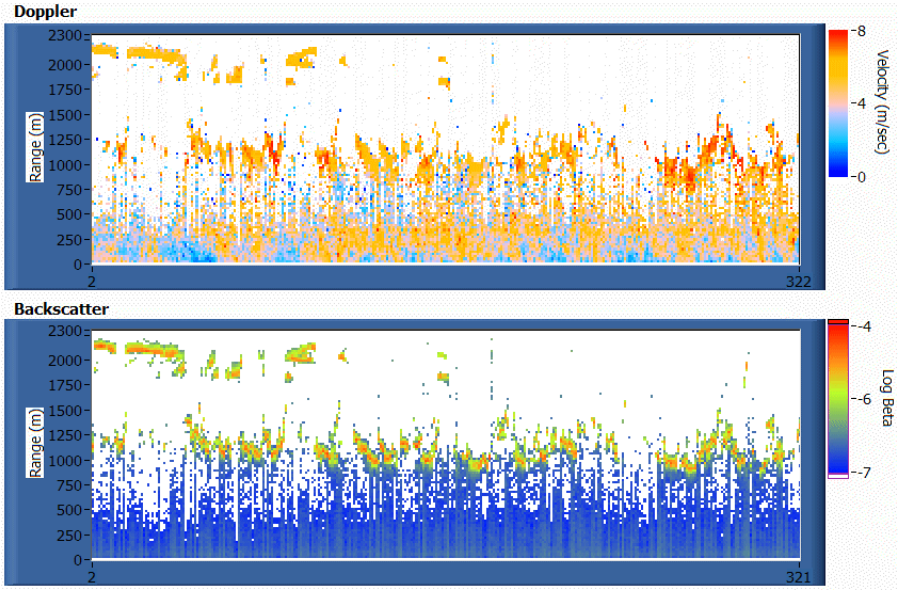
Prof. Chris Collier
Dr Karen Bozier
Dr Fay Davies

Doppler lidar from Halo Photonics

- vertically pointing to measure air velocity and turbulence

Research proposed

- Comparison with other remote sensing instrumentation.
- Investigation of the day-night boundary layer transition.
- Measurements of the eddy dissipation rate and the integral length scale of turbulent eddies.
- Comparison of model and lidar measured parameters.



Conclusions

In the Helsinki Testbed mesoscale network the remote instruments provide relevant continuous profile data from the boundary layer

Profiling instruments

- wind profiler LAP-3000 for wind
- RASS for virtual temperature profile
- ceilometer CL31 network for clouds and aerosol profile

Ceilometer profiles can be used to determine the mixing height or even more refined aerosol profile for the purpose of air quality measurements and forecasting.

Thank you!

Bad air quality on 22.11.2005 - CL31 profiles

Mäntsälä