Vaisala Lower Troposphere Wind Profiler LAP®-3000

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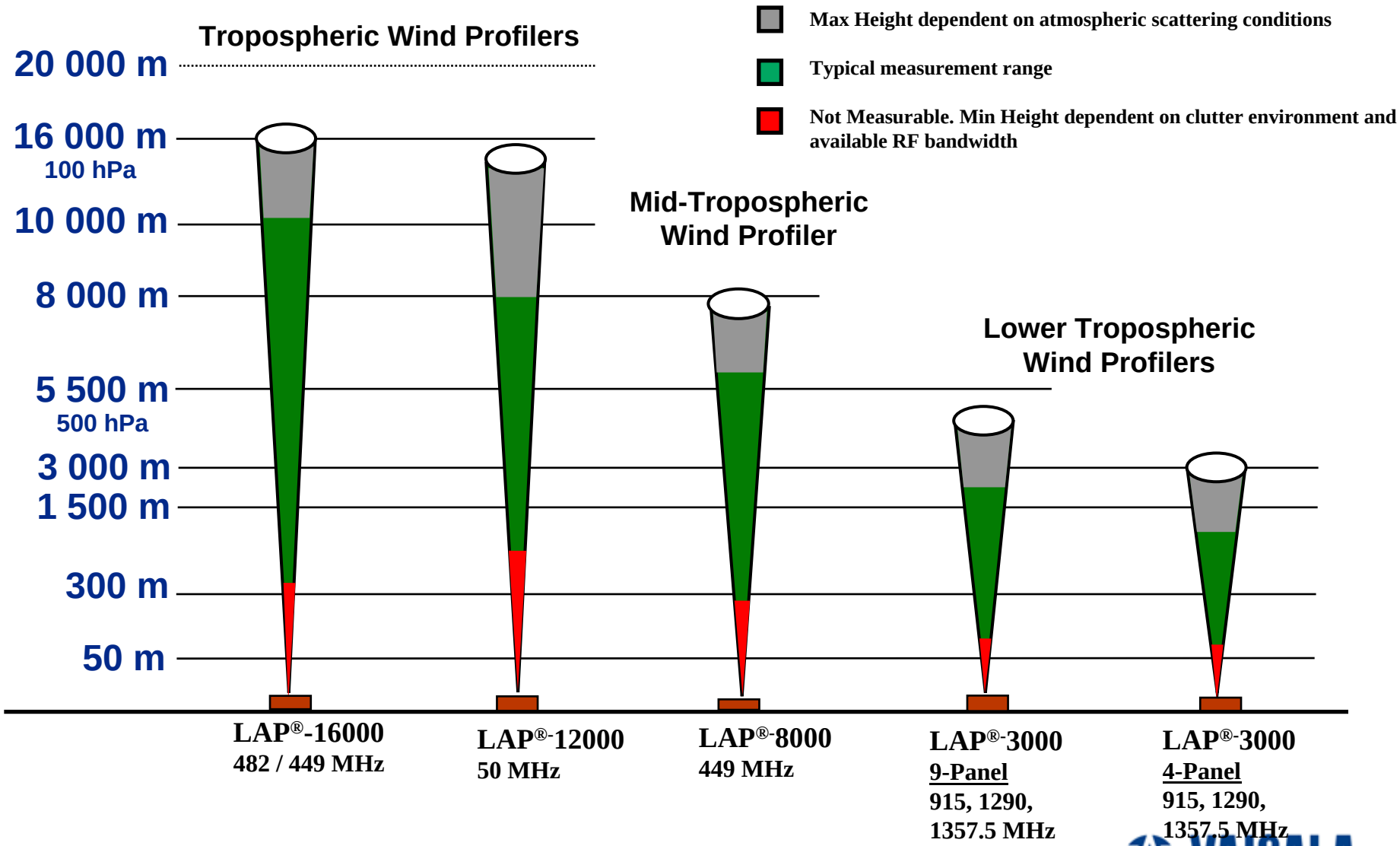
Vaisala Wind Profiler Portfolio



Cooperative Research & Development Agreement (CRADA)

Vaisala is Commercial Provider of U.S. Government (National Oceanic and Atmospheric Administration = NOAA)

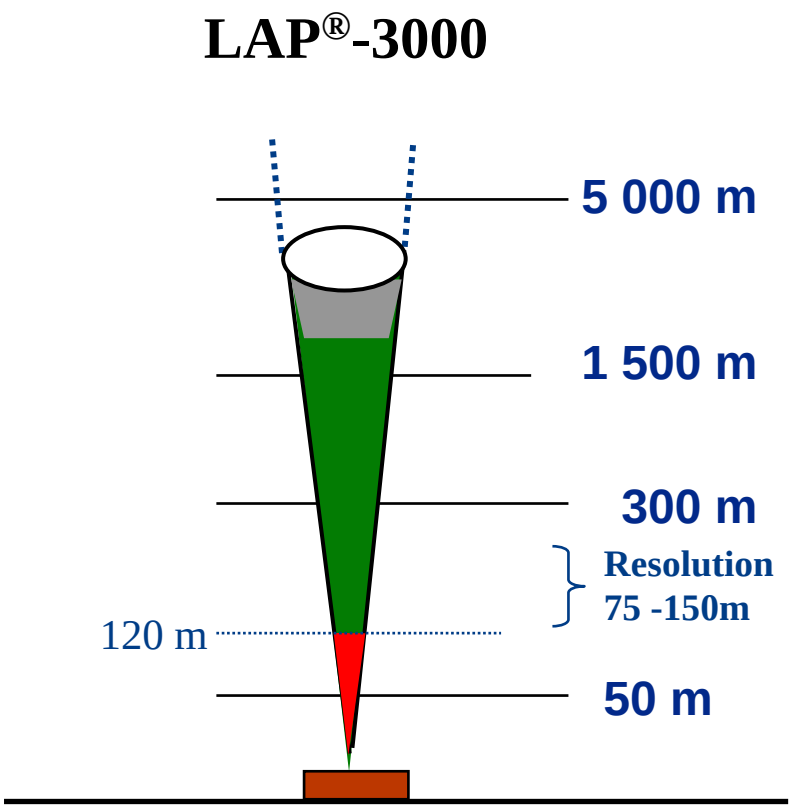
- NOAA is the world's leading Institute in Radar technology

Advancements in Wind Profiler Technology

- Use of the latest Technology (hardware and signal processing) and transfer is possible in Wind Profiler Applications
- By this agreement the latest algorithms developed by NOAA will be available for Vaisala and Vaisala's customers
  - Such as Wavelets, Multiple peak picking, Running Consensus, Weber-Wuertz Wind and Temperature QC, Cn2, Snow Level Detection, Boundary Layer Detection etc
- All product enhancements are reviewed and validated by NOAA

Vaisala has benefited from CRADA with NOAA since 1991

LAP®-3000 Altitude Coverage



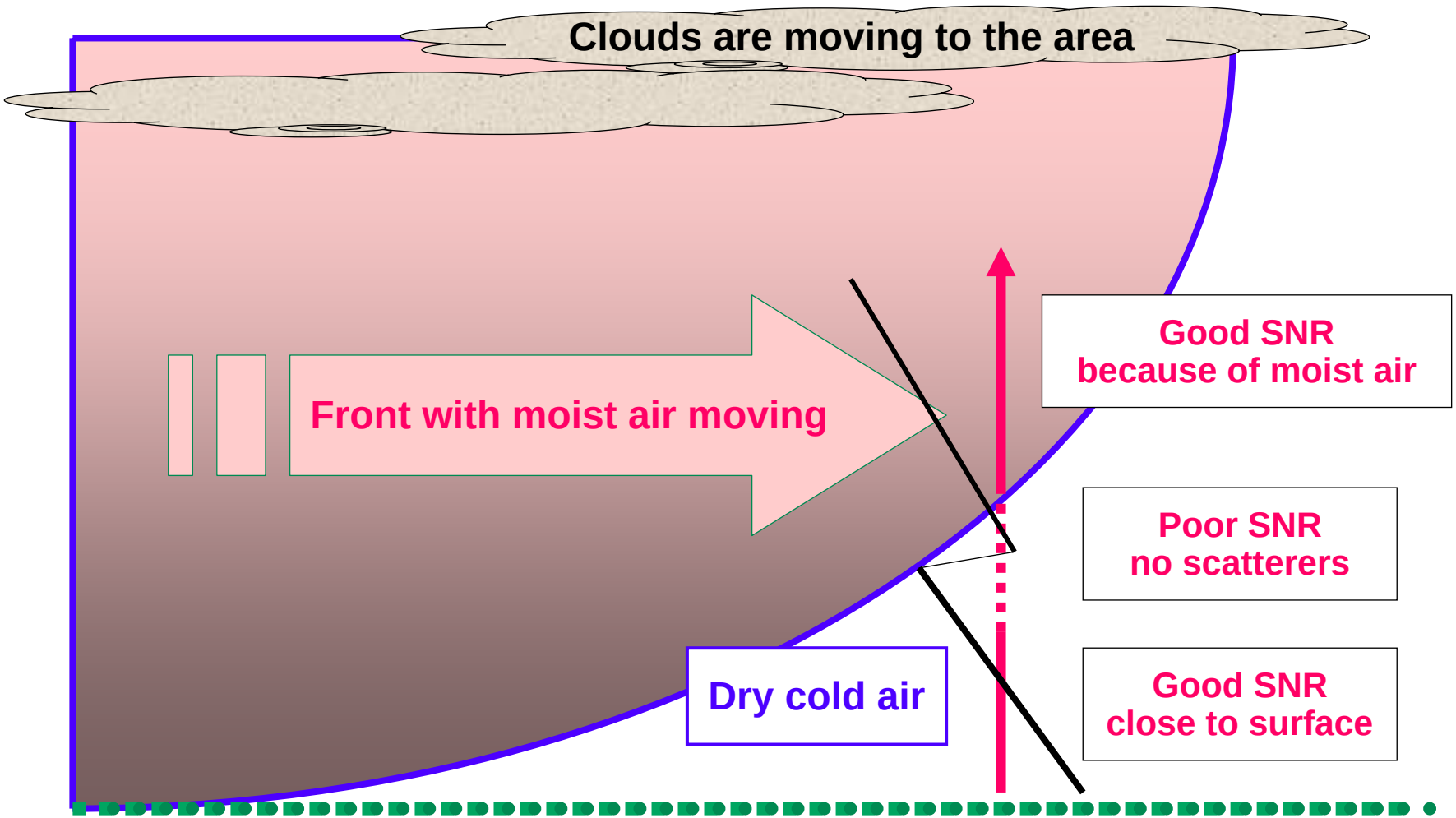
Elements affecting altitude coverage

- Operating mode (Low-mode, High-mode)
  - LAP-XM configuration files
- Scattering from turbulence
  - Weather conditions
- Refractivity
  - Humidity

The maximum altitude reached depends on weather conditions

Adverse weather good for profilers (turbulence, high humidity)

The effect of refractivity



LAP-3000 specifications

- Operating frequency
  - 915 MHz South and North America
  - 1290 MHz Europe and Asia
  - 1357.5 MHz Japan
- Minimum measurement height: **75-150 m** depending on clutter environment and available RF bandwidth
- Maximum measurement height: **2-5 km** depending on atmospheric scattering conditions
- Range resolution: 60, 100, 200, 400 m
- Wind speed accuracy: **<1 m/s**
- Wind direction accuracy: **<10°**
- Transmitter average/peak power: 100/600 W
- Maximum measurement height for RASS: **1-1.5 km**, depending on atmospheric scattering conditions
- Virtual temperature accuracy: **1°C**

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LAP®-3000 Applications

- Applications
  - Air Quality
  - Defense
  - Mesoscale Networks
  - Atmospheric Research
  - Tactical Artillery/Ballistics
  - Test Range Support
  - Space Vehicle Launch/Landing
  - Aviation - Terminal Airport Weather
- ~135 installations worldwide

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LAP®-3000 Installations

USAF,
White Sands Missile Range

MMS, Off-Shore Oil Platform,
Gulf of Mexico

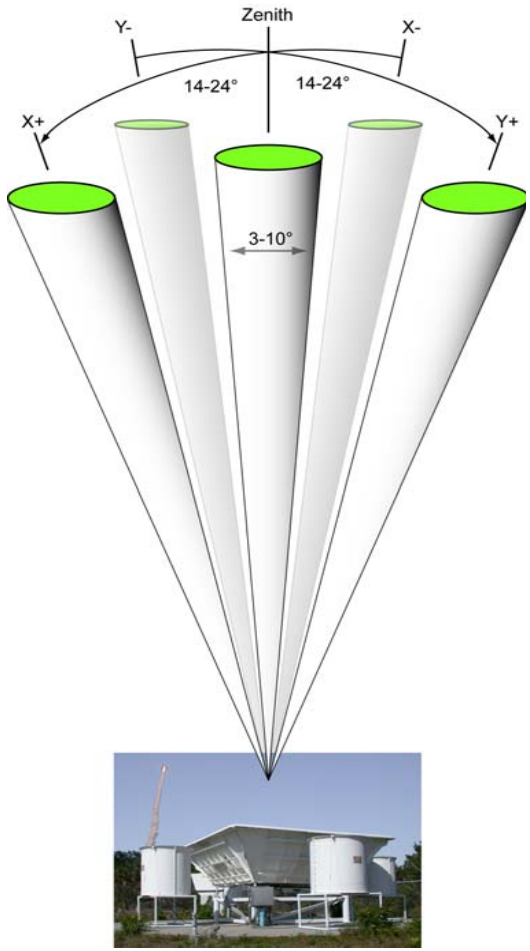
LAP®-3000 Wind Profiler Installations

1299 MHz Hong Kong Observatory, Sham Shui Po, Hong Kong

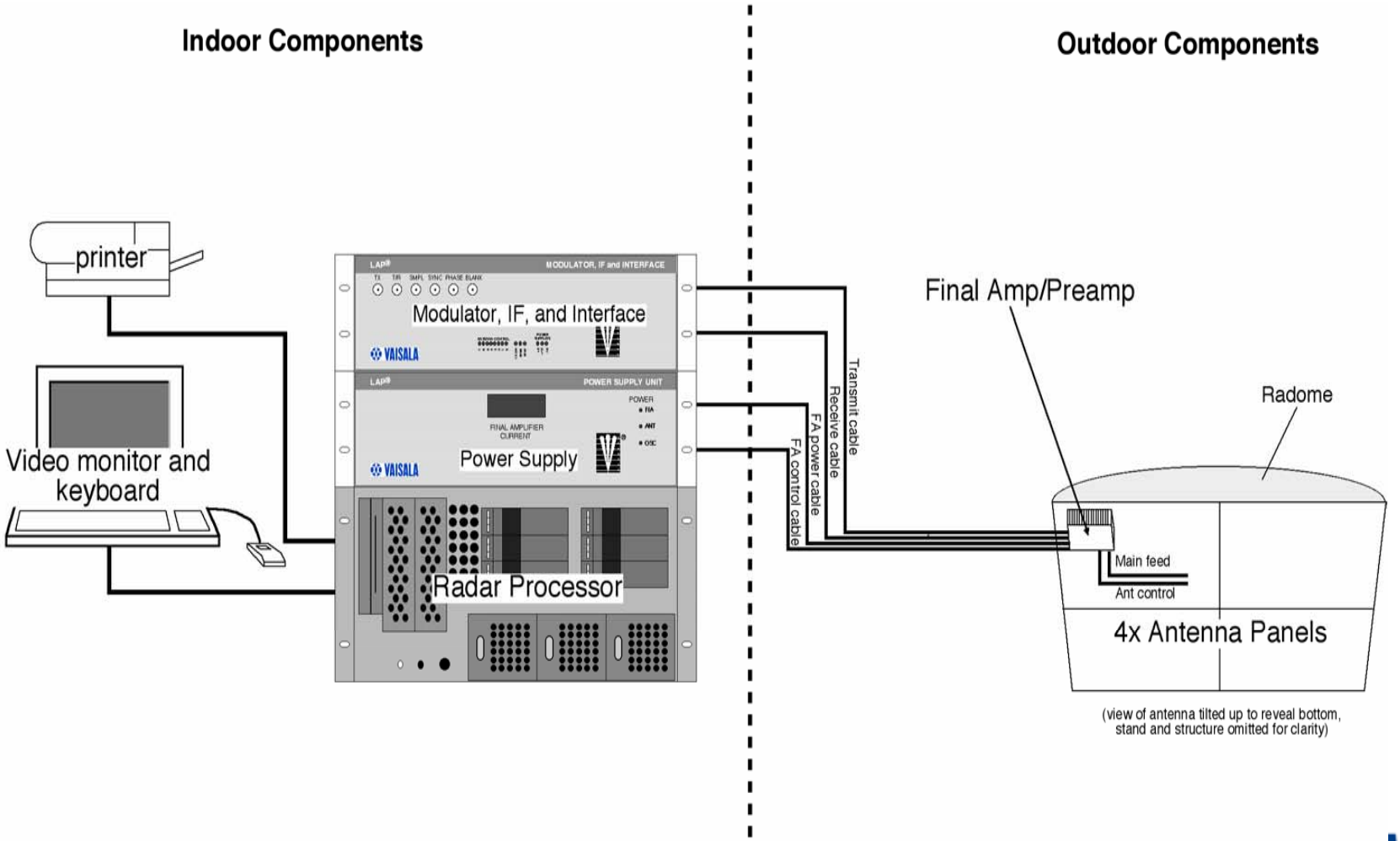
Thai Pollution Control Department, Mah Moe, Thailand

LAP-3000 technology: Doppler Beam Swinging (DBS)

- DBS method for wind vector calculations (u,v,w)
- Radial scattered velocities measured with one vertical and 2 (4) off-zenith beams
- 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

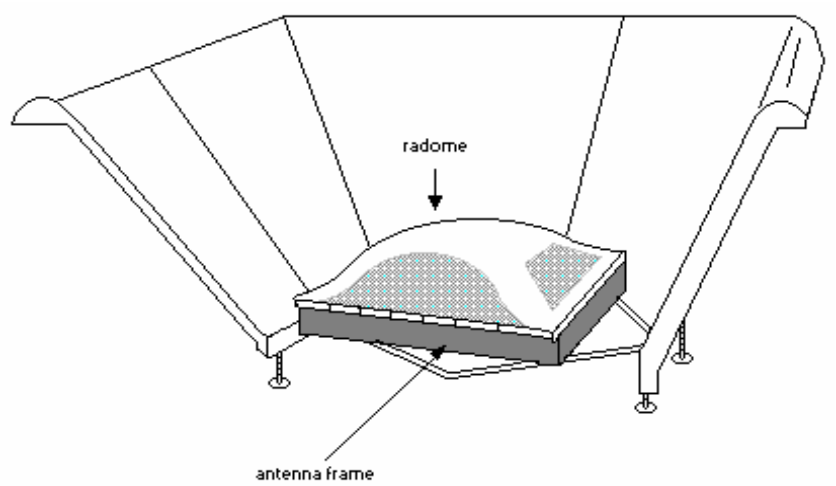


Components of the LAP®-3000



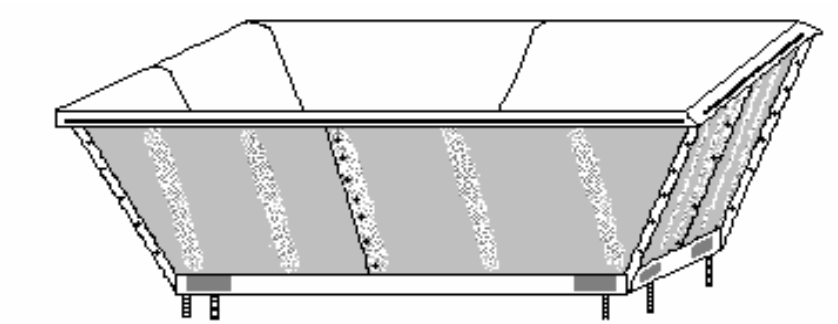
Antenna System

- The antenna system consists of four 0.87 m x 0.87 m planar micro-patch array panels with a clutter reduction screen
- Antenna panels oriented horizontally
  - Beams point to four orthogonal oblique directions and to zenith
- Micro-patch antenna elements
  - Electrically switched phase delays
  - Change the pointing direction
- Each planar panel protected by integral radome

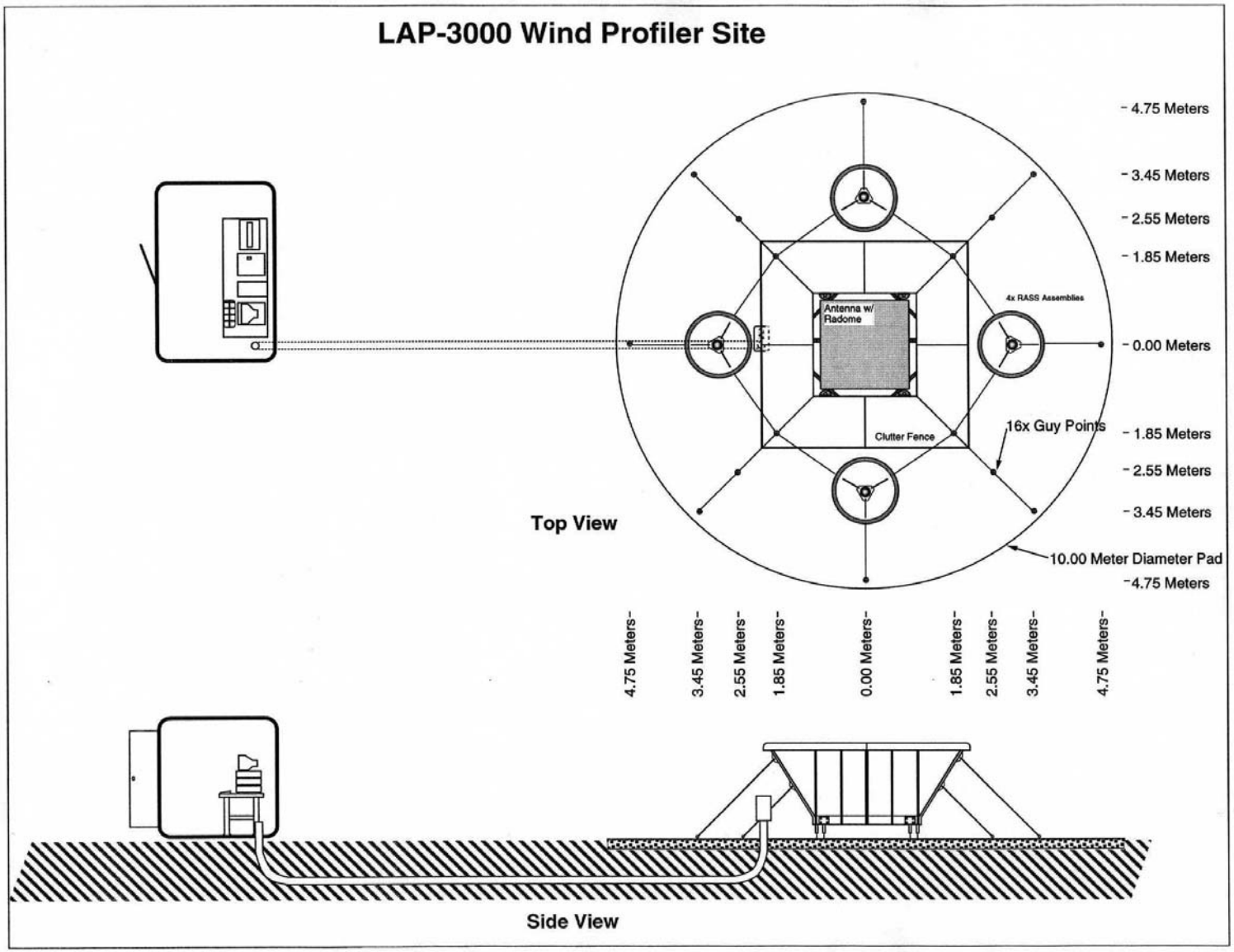


The Clutter Reduction Screen

- Reduces system susceptibility to signal contamination from ground clutter
- Includes the adjustable support structure for the antenna system
- Modular and transportable
- Provides significant improvement in clutter rejection up to 20º elevation above the horizon



Typical system configuration



Digital IF receiver

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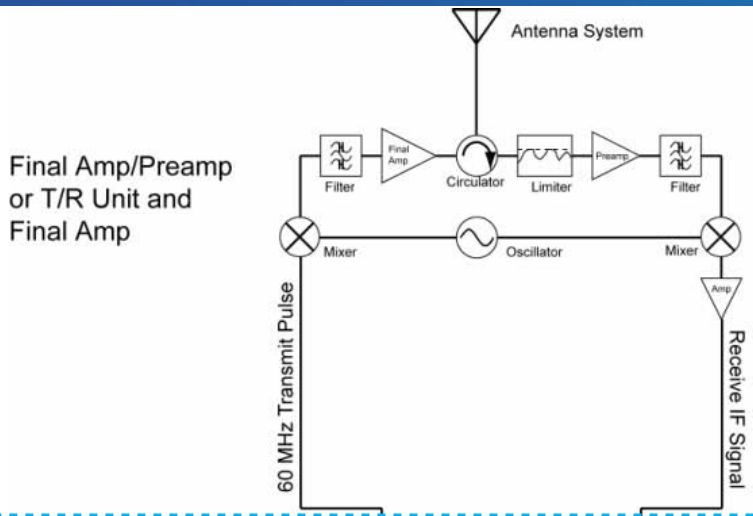
Exclusively-Licensed Digital IF Technology

Profiler RF infrastructure

New Digital IF hardware

Modulator, IF, and Interface unit



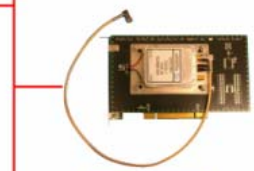
Modulator, IF, and Interface Unit

Power Supply Unit

Radar Processor Unit

Digital IF

Radar Controller

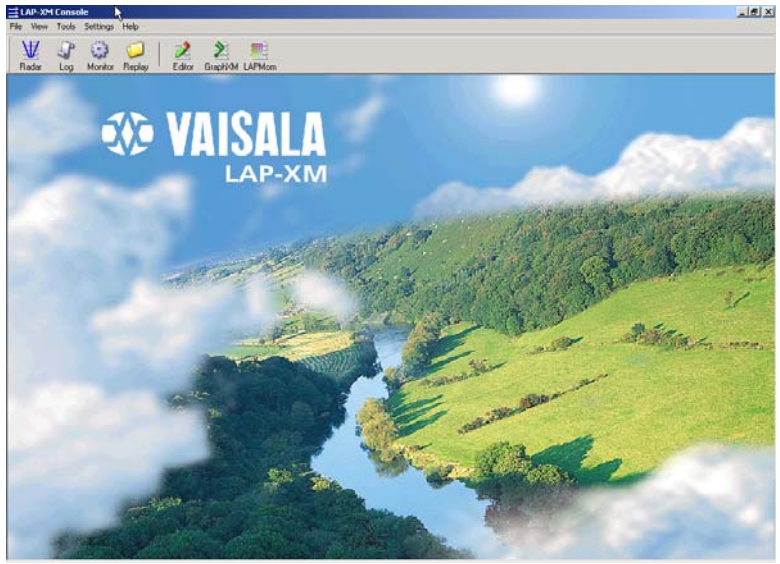


Reference Oscillator

RASS Source (optional)

LAP-XM application software

- Acquiring and processing new signal data
- Computing, displaying and saving meteorological data products
- Converting data products to new formats
- Monitoring data products
- Controlling operation of the profiler from remote locations
- Generates wind and temperature outputs
  - Text and BUFR formats



Digital Receiver

- Employs state-of-the art digital signal processing hardware
- Provides enhanced system performance
  - improved dynamic range
  - high signal sensitivity
  - improved data quality
- Supports an expanded software set
  - Wavelets - eliminate clutter effects caused by Aircraft, Birds, Ground Clutter
  - WMO BUFR messaging - New data transfer standards
  - Multiple Peak Picking (MPP) - selection of atmospheric signals
  - Running consensus - for more frequent data updates
  - Weber-Wuertz – QC for error-free data
  - C_n^{2} - for air quality and dispersion applications
- Provides upgrades to current LAP® installed base

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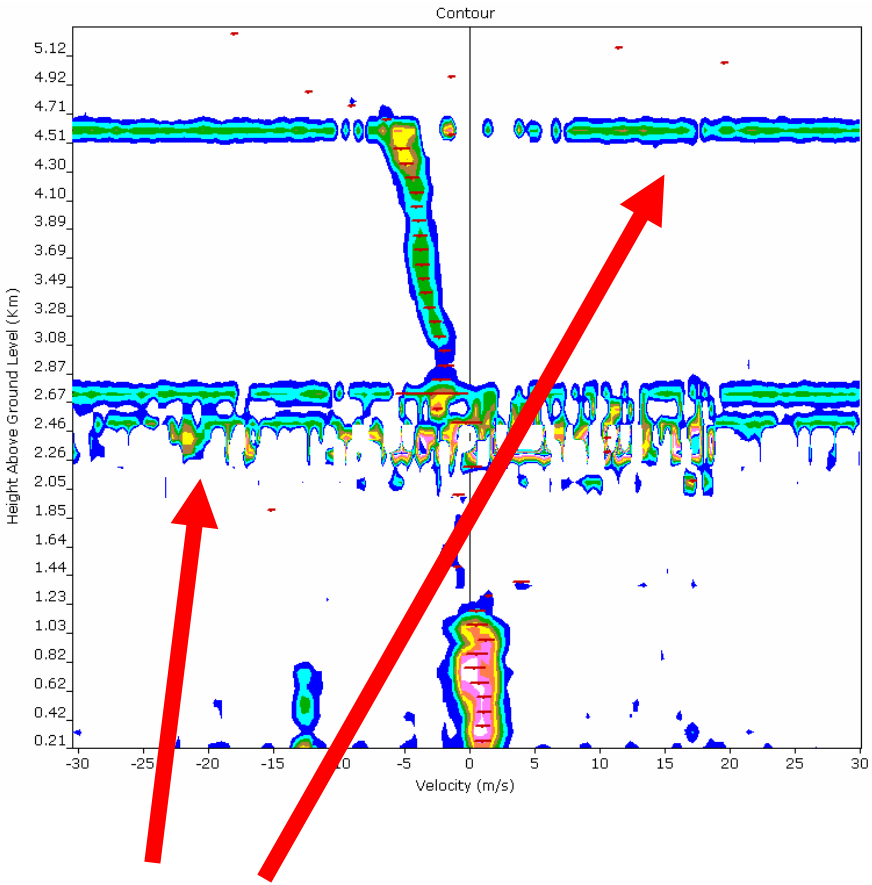
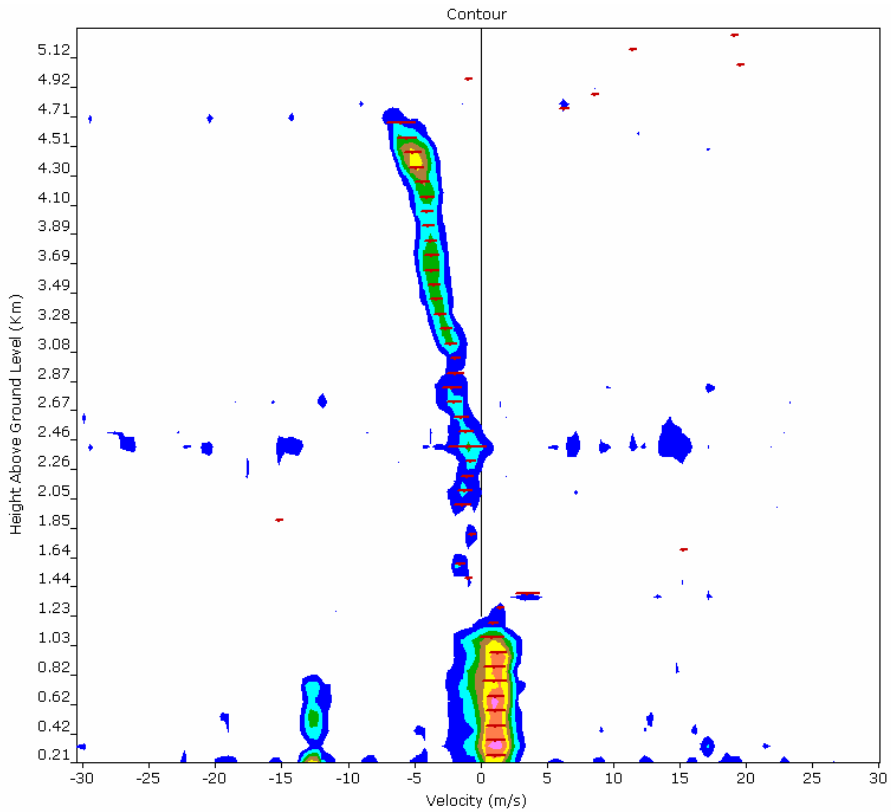
Example of Wavelet Clutter Rejection

Before Wavelet:



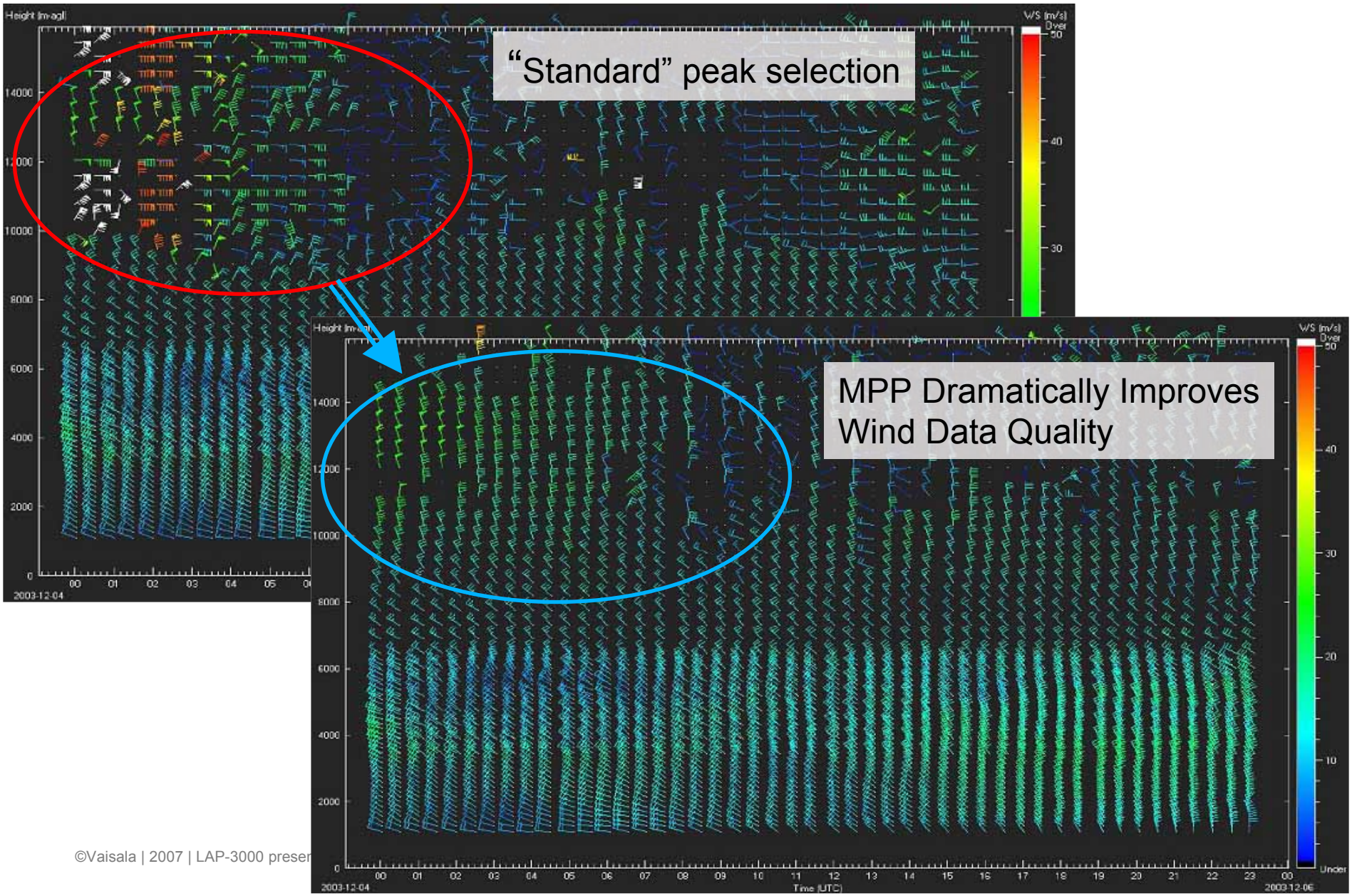
Bird interference

After Wavelet:



Wavelet eliminates much of the clutter due to birds

Example of Winds With Multiple Peak Picking Algorithm



Wind profiler options

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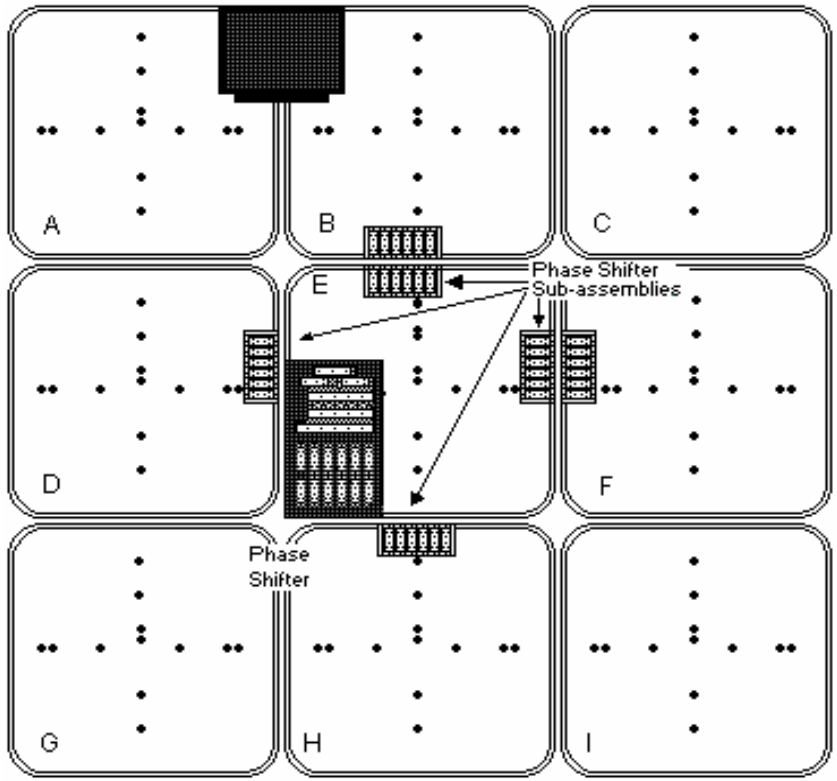
Wind profiler options

- RASS
  - For virtual temperature measurements
- Graph-XM™ display software
  - For graphical data representation
- LapMOM™ moments display software
  - For graphical moments data representation
- GPS timing
  - For autonomous, precise timekeeping
- Hardware Monitor
  - To monitor the condition of the hardware
- Services

LAP®-3000 Extended Antenna Aperture Option

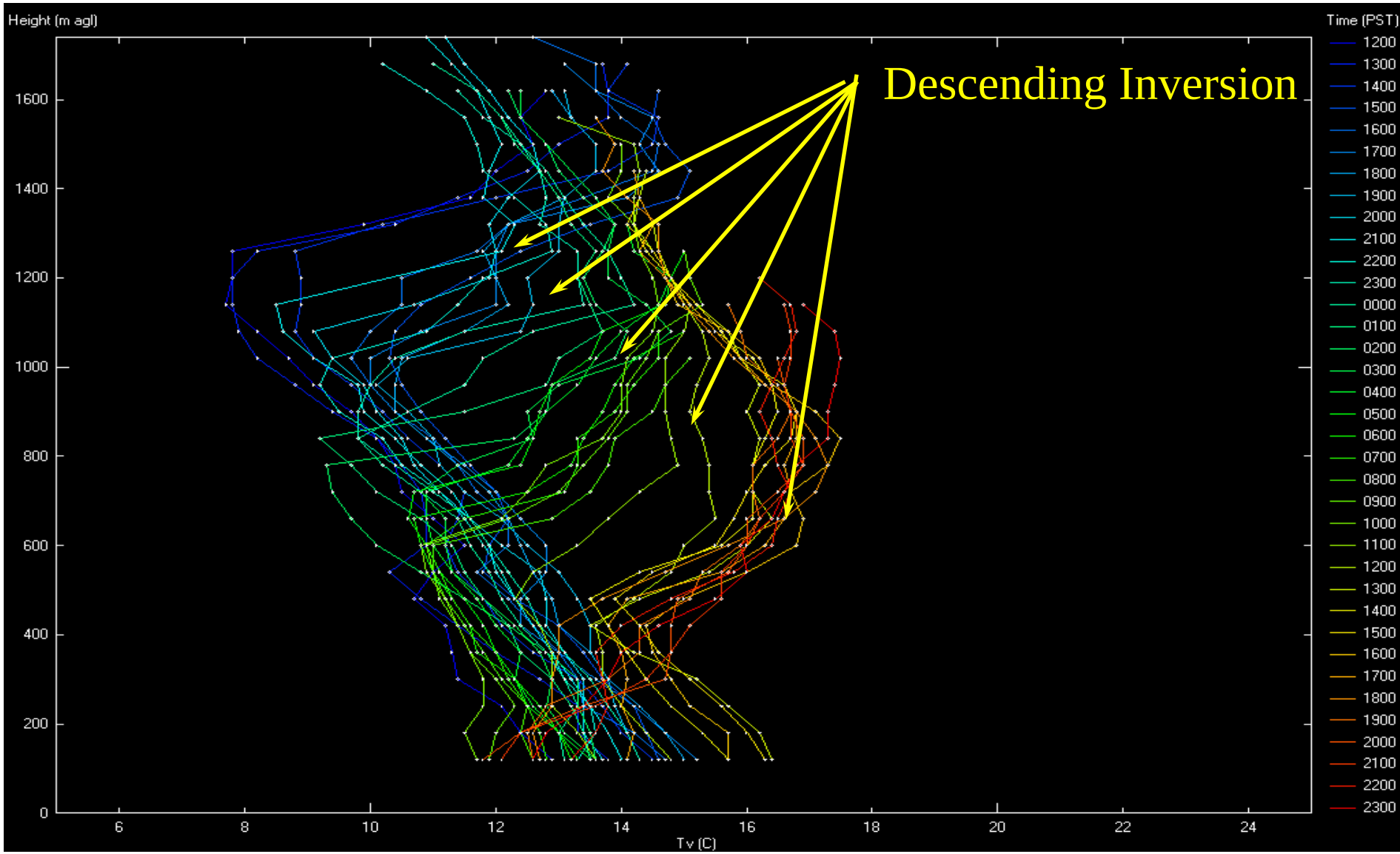
- Extended antenna aperture option
  - Uses nine planar antenna panels (instead of four)
  - Larger clutter screen
- Larger antenna aperture
  - Increases the antenna array gain
  - Improves data quality, performance and height coverage



Optional RASS

- Radio Acoustic Sounding System (RASS)
  - Provides profiles of virtual temperature
  - Achieved by transmitting a short acoustic energy pulse vertically
  - Tone burst propagates as a compression wave with the speed of sound upwards in the atmosphere
  - Wind profiler measures the speed of propagation of the sound burst
  - Since the speed of sound depends mostly on the air temperature, virtual temperature can be computed from the received signal

Descending Inversion measured with RASS



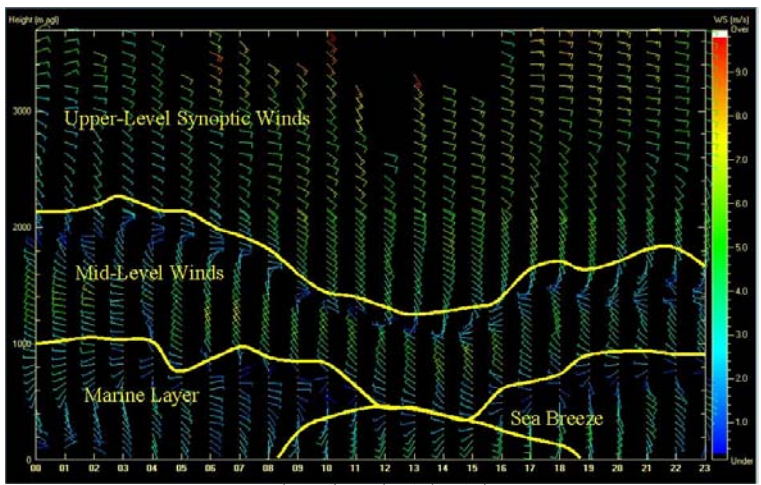
Optional Graph-XM™ Display Software

Graph-XM™ provides graphical displays of wind and temperature data

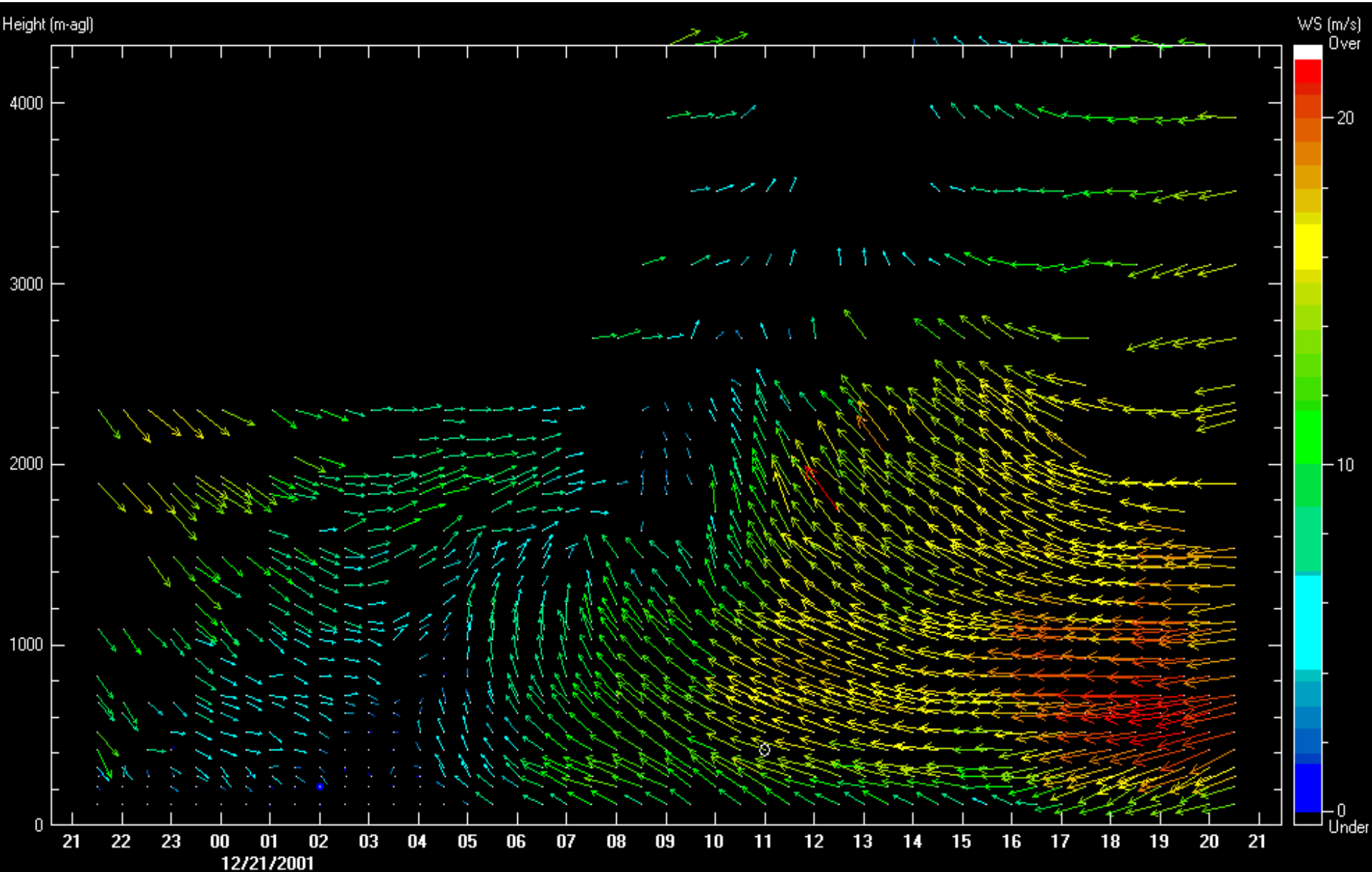
- Provides visualization displays of:
  - wind barb, wind vectors and temperature
  - vertical profile data spectral width
  - SNR (Signal to Noise)
  - radial velocity

Many presentation choices for the data

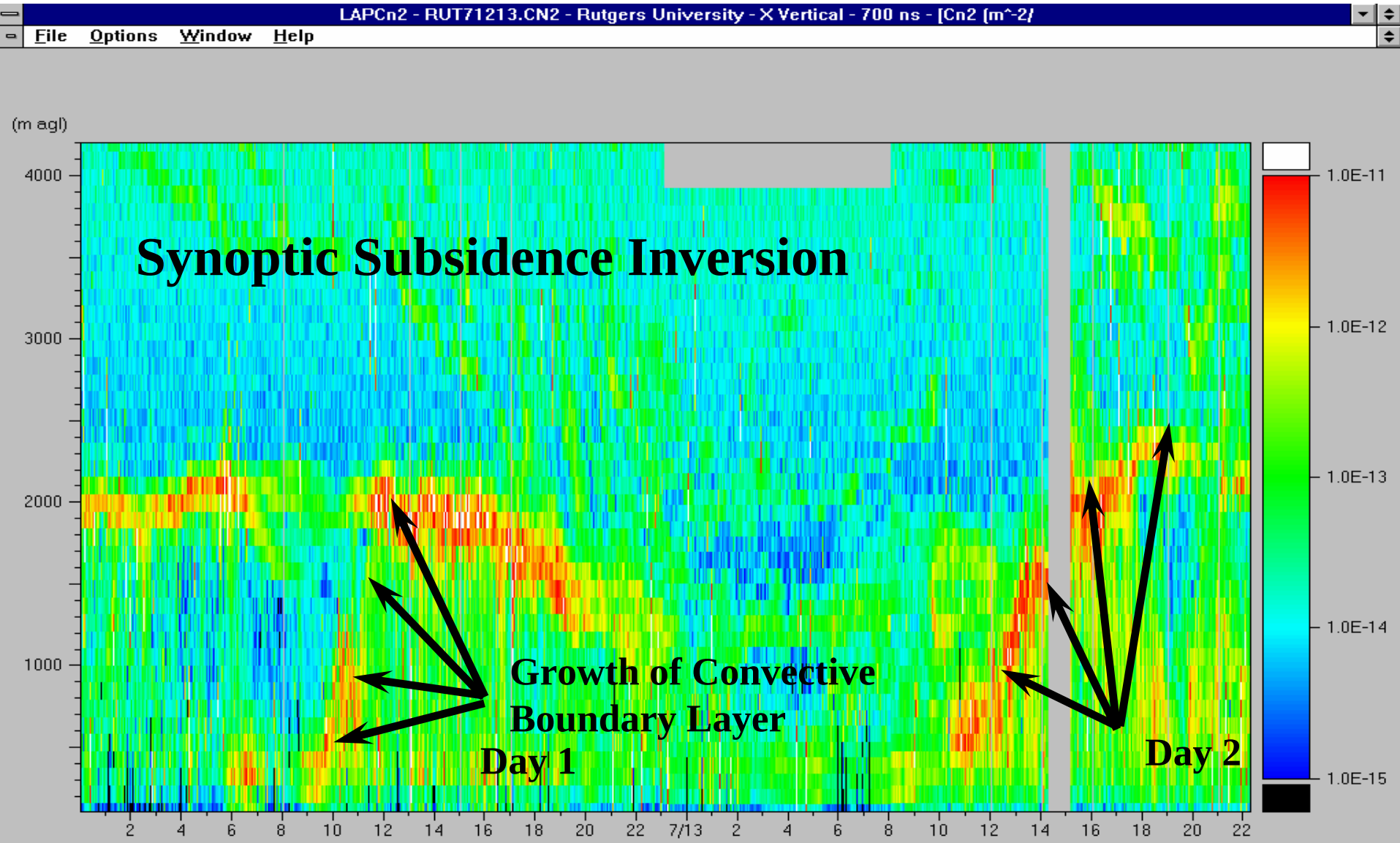
- The operator can scale the display of data or zoom in on a particular area
- Batch files can be printed
- Custom configurations can be saved and edited



Graph-XM: Sample Vector Display



Graph-XM: Boundary Layer Evolution (C_n^2 data)



Optional LapMOM™ Display Software

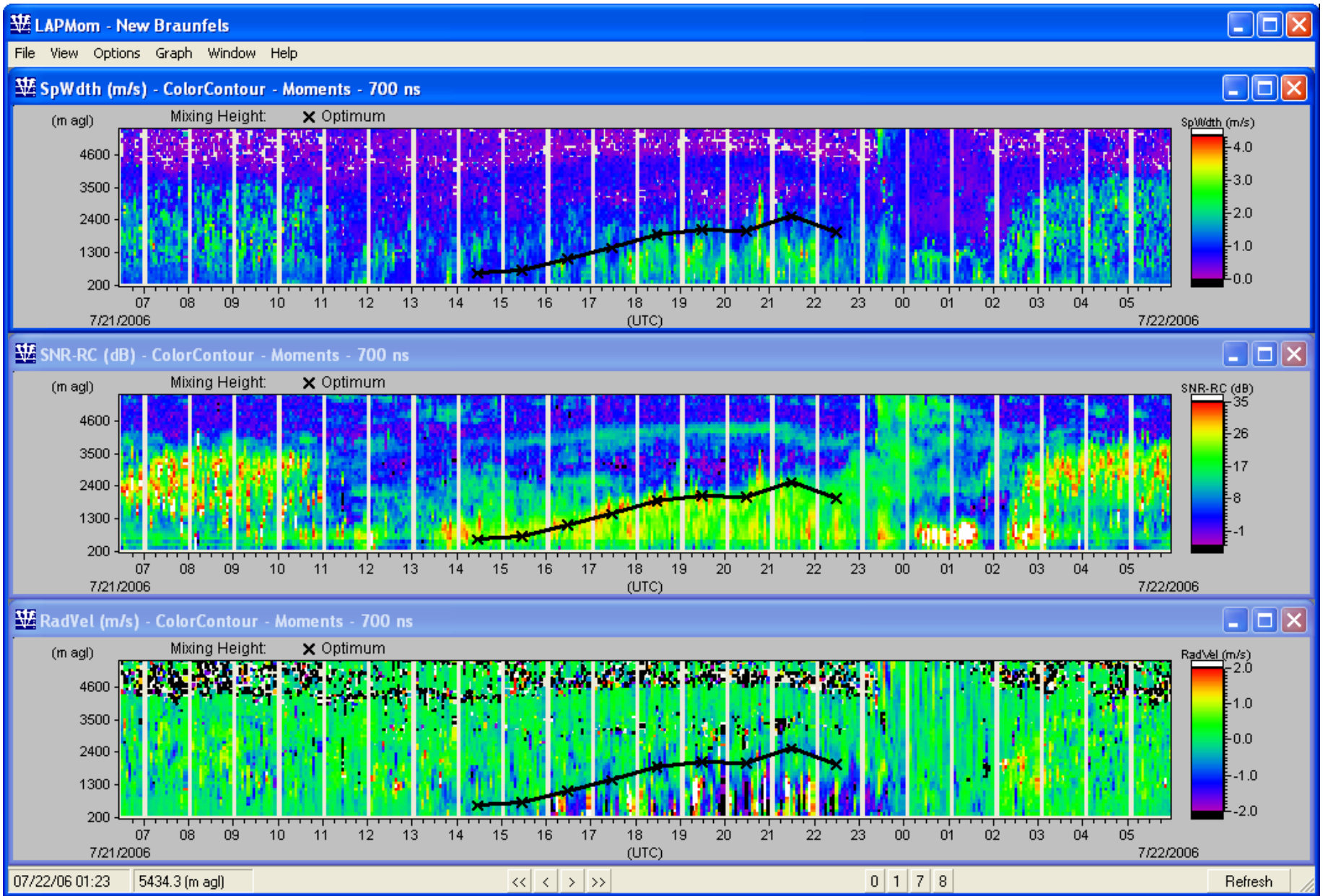
Graph-XM™ provides graphical displays of moments, mixing layer and melting layer data

- Provides visualization displays of:
  - Reflectivity
    - SNR (Signal to Noise)
    - Spectral width
    - Vertical velocity
  - Mixing layer
    - Planetary boundary layer
  - Melting layer
    - From reflectivity and vertical velocity
    - With optional software package

Many presentation choices for the data

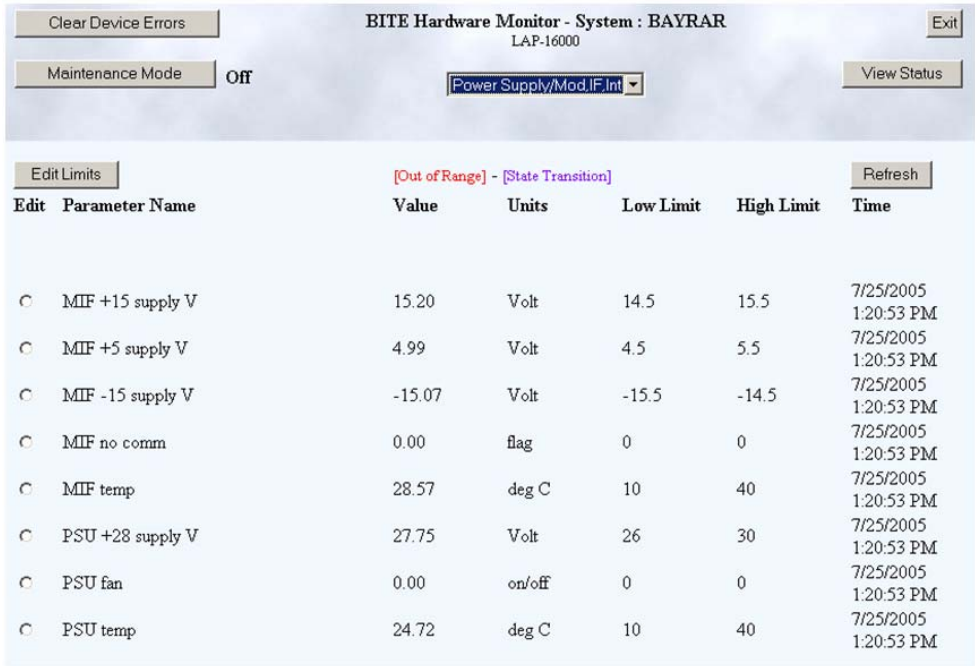
- The operator can scale the display of data or zoom in on a particular area
- Batch files can be printed
- Custom configurations can be saved and edited

LapMOM: Displaying reflectivity data



Optional LAP® Monitor

- Data acquisition subsystem
  - To monitor the health of the LAP®-3000 hardware components
  - Assist maintenance personnel with fault diagnosis
  - Even shut down the system should certain critical conditions exceed predetermined limits.
- Communicates directly with the radar computer
  - Remote fault diagnosis
  - Log file of operational performance and out-of-limit measurements
- The profiler monitor resides within the system electronics (BITE)
- Measured parameters
  - Multiple voltage levels, currents, temperatures, forward and reflected RF power, processor test output, minutes left on UPS etc



Edit	Parameter Name	Value	Units	Low Limit	High Limit	Time
○	MIF +15 supply V	15.20	Volt	14.5	15.5	7/25/2005 1:20:53 PM
○	MIF +5 supply V	4.99	Volt	4.5	5.5	7/25/2005 1:20:53 PM
○	MIF -15 supply V	-15.07	Volt	-15.5	-14.5	7/25/2005 1:20:53 PM
○	MIF no comm	0.00	flag	0	0	7/25/2005 1:20:53 PM
○	MIF temp	28.57	deg C	10	40	7/25/2005 1:20:53 PM
○	PSU +28 supply V	27.75	Volt	26	30	7/25/2005 1:20:53 PM
○	PSU fan	0.00	on/off	0	0	7/25/2005 1:20:53 PM
○	PSU temp	24.72	deg C	10	40	7/25/2005 1:20:53 PM

WP Services

- Site survey
- Installation
- FAT (Factory Acceptance Test)
- SAT (Site Acceptance Test)
- Training (at Vaisala or at site)
  - Operator’s training
  - Maintenance training
  - Application training
- Extended warranty
- Service Contract