

# LAP<sup>®</sup>-3000 Wind profiler

## Optimizing the wind measurement

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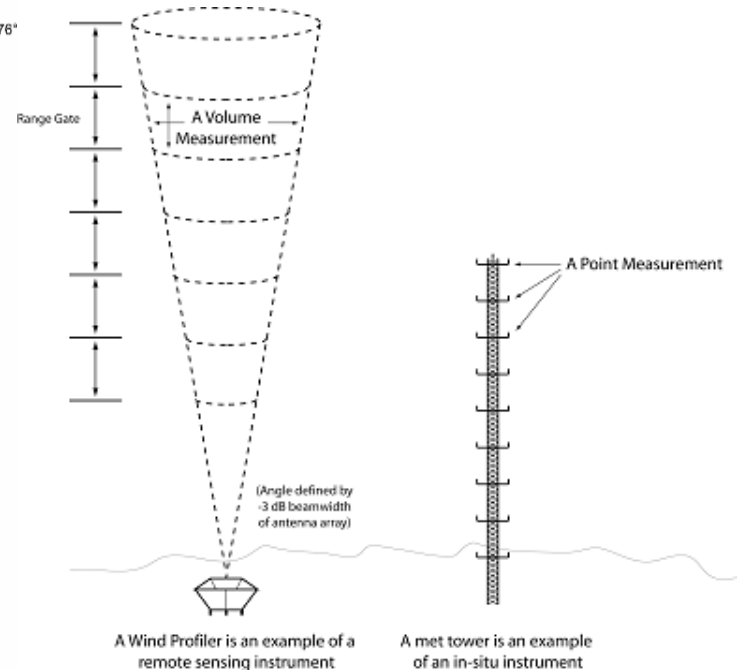
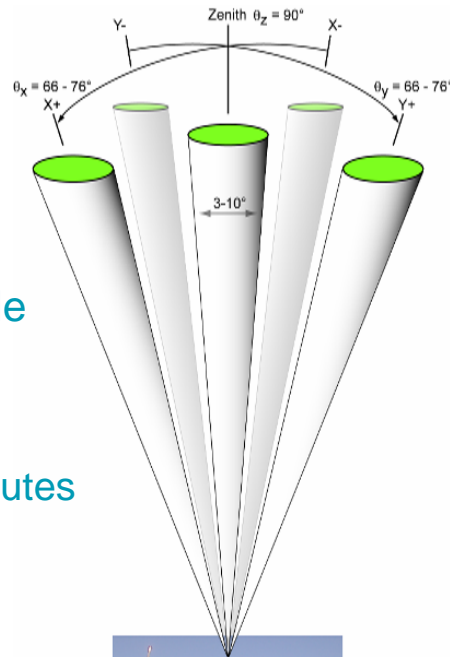
**VAISALA**

# Agenda

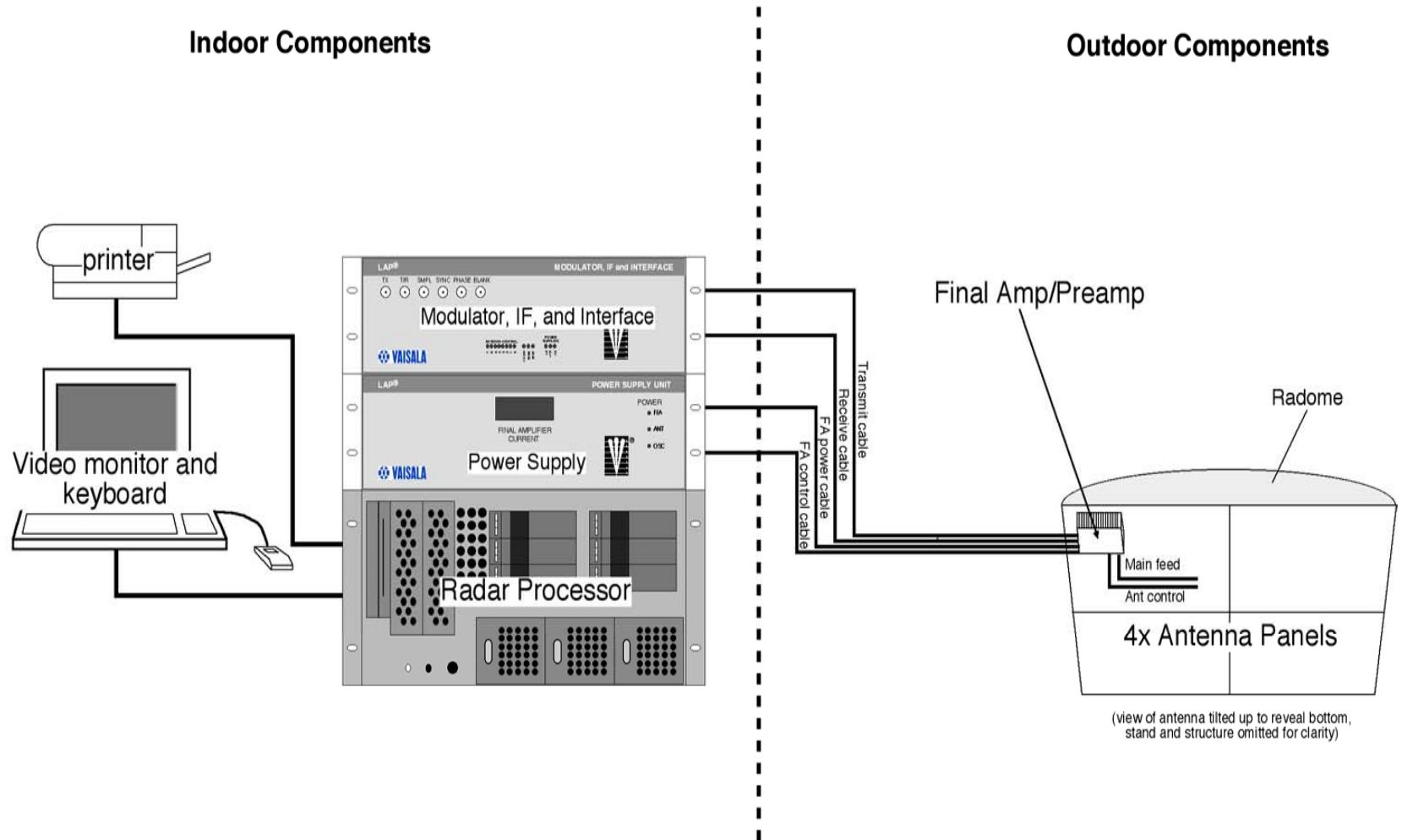
- LAP<sup>®</sup>-3000 Wind profiler
- Wind profiler measurement set-up
- Quality control of wind profiler data
- Quality control of meteorological information

# LAP<sup>®</sup>-3000 Wind profiler

- Radio frequency remote sensing instrument
- Provides
  - wind profile
  - turbulence profile
  - virtual temperature profile (with RASS)
- Typical
  - Averaging period ~10 minutes
  - Sampling every 30 m
  - Vertical resolution 60 m
- Volumetric measurement
  - Directly above the site
- Doppler beam swinging (DBS)
  - 3-5 beams

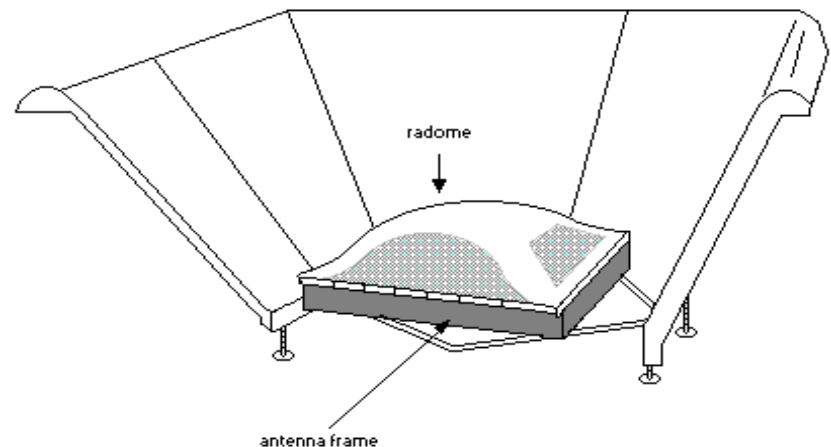


# LAP®-3000 Components



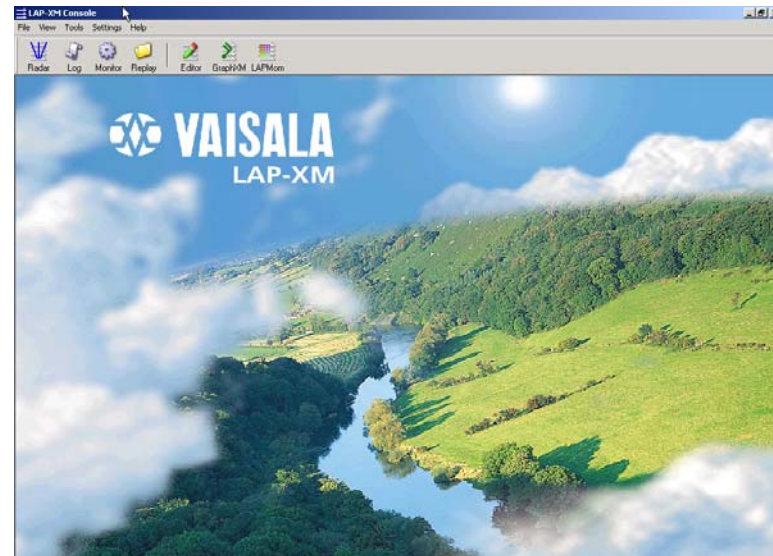
# LAP®-3000 Antenna System

- The antenna system consists of four or nine planar 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



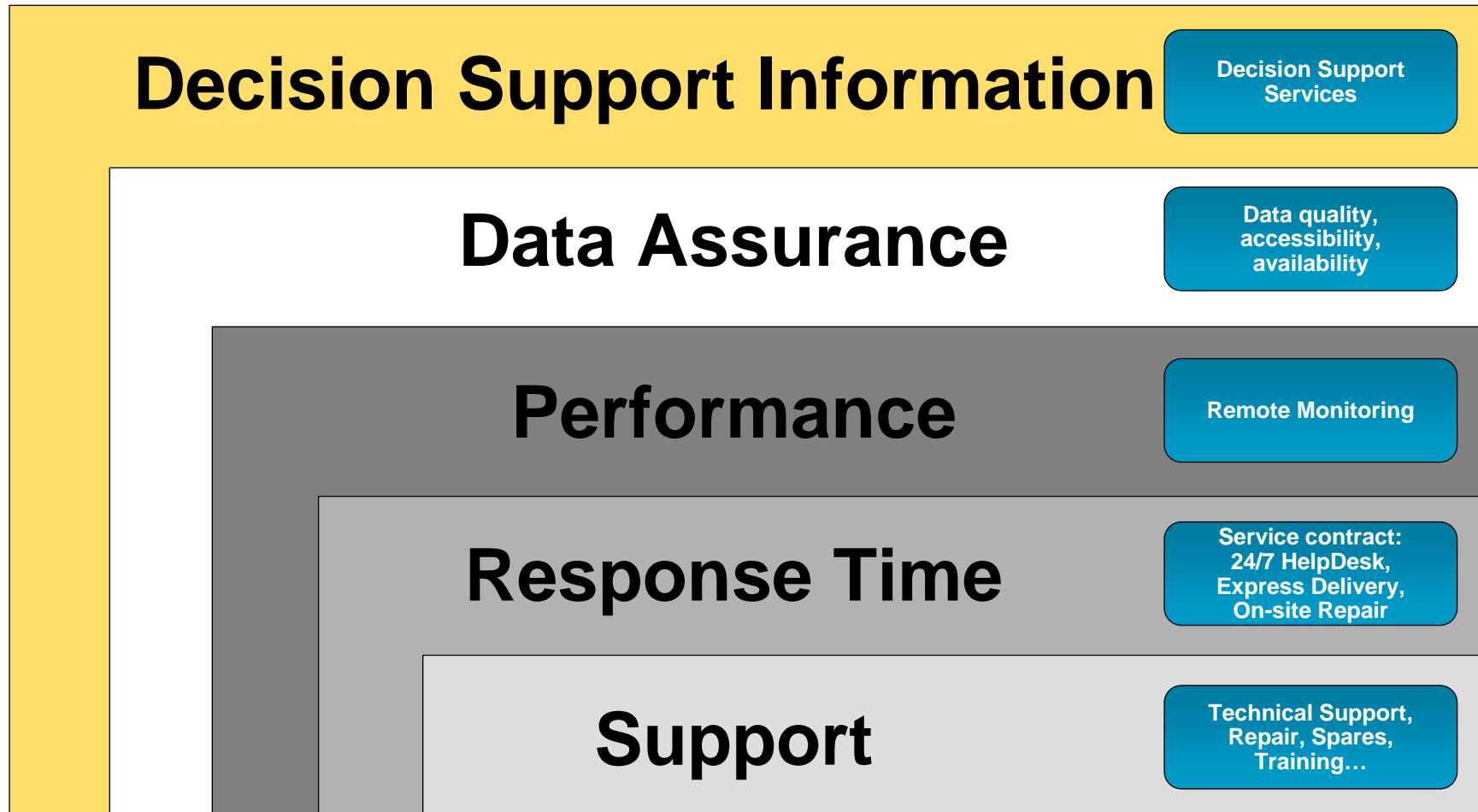
# LAP-XM application software

- Acquires and processes signal data
- Computes, displays and saves meteorological data products
- Converts data products to new formats
- Monitors data product quality
- Controls operation of the profiler from remote locations
- Generates wind and temperature outputs



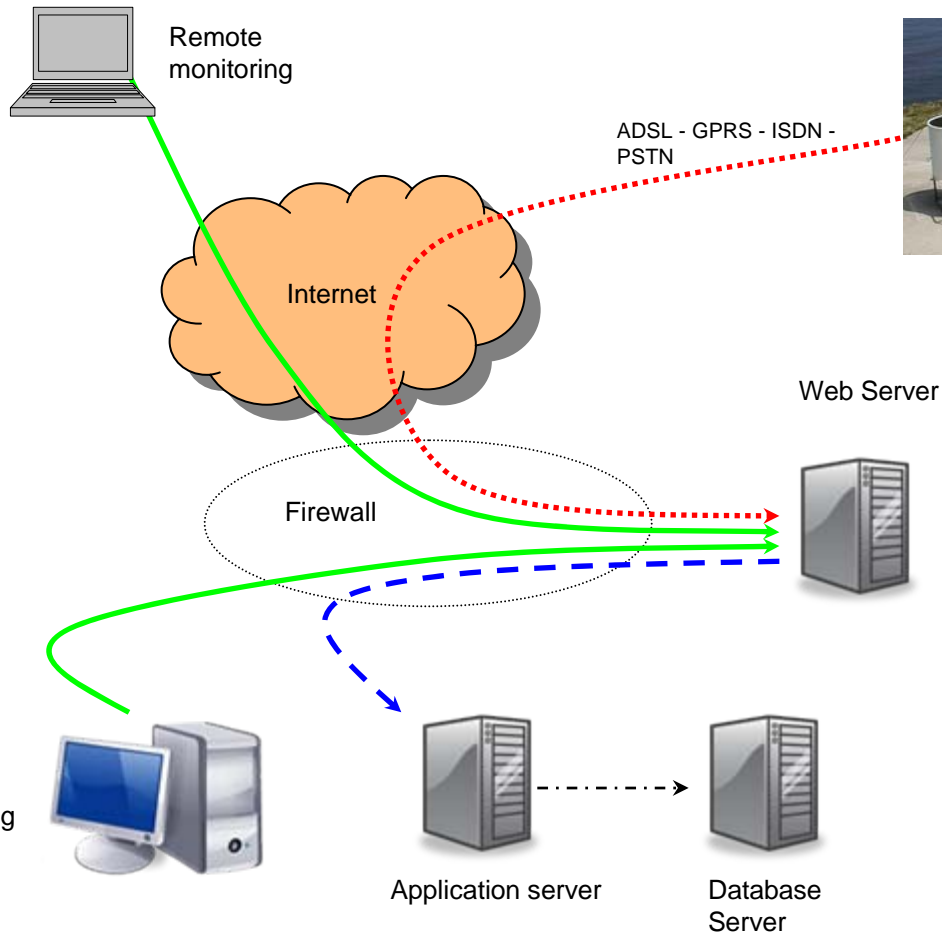
# How to ensure information availability?

## Supporting elements



# How to ensure information availability?

## Vaisala SiteConnect



- Diagnosis and Repair
- Patch Management
- Remote Access
- Preventive Maintenance
- Usage Monitoring
- Reporting

# Wind profiler measurement optimization

- Wind profilers offer a range of alternative measurement configurations
- User's application requirements
  - time resolution and update interval of wind observations
  - vertical resolution
  - the altitude range of interest
  - lowest measurement altitude
- Optimal profiler set-up often requires adjustments and test iterations
  - specific requirements of the user's application
  - local radio interference and clutter environment
  - climate and seasonal effects

# Wind profiler measurement optimization

- The optimal choice is a balance between
  - frequent observations of the lower boundary layer, or alternating lower and upper boundary layer winds?
  - maximize detection sensitivity or height resolution?
  - maximize shear detection or outlier rejection?
  - short averaging time, or more stable and higher reliability estimates?

# LAP<sup>®</sup>-3000

## Installation at Barajas Airport



# Operational parameters for Barajas airport LAP-3000

- Parameters were adjusted in 3-4 iterations during a 1 month evaluation period
  - Quality control using 30 min of history data
  - Winds are averaged for 10 minutes
  - RASS virtual temperature is averaged for 3 minute every 30 min
  - The lower boundary layer is observed 50% of time with 60m height resolution
  - The full boundary layer (<3.2km) is observed 50% of time in 100m height intervals and 200m height resolution

# Wind profiler signal processing steps

Time series

Quality control

Time-frequency filtering

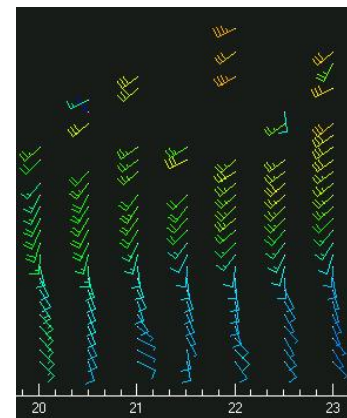
Spectra

- Multiple peak picking
- Feature identification

Moments

Time/height  
continuity  
analysis

Met. products

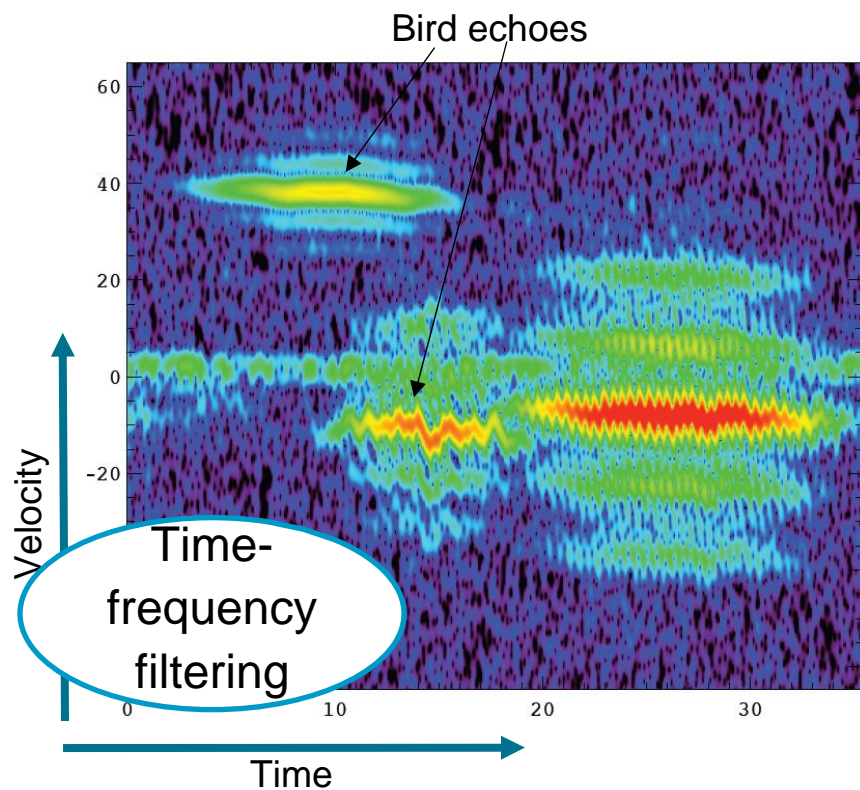


# Advanced methods for interference removal

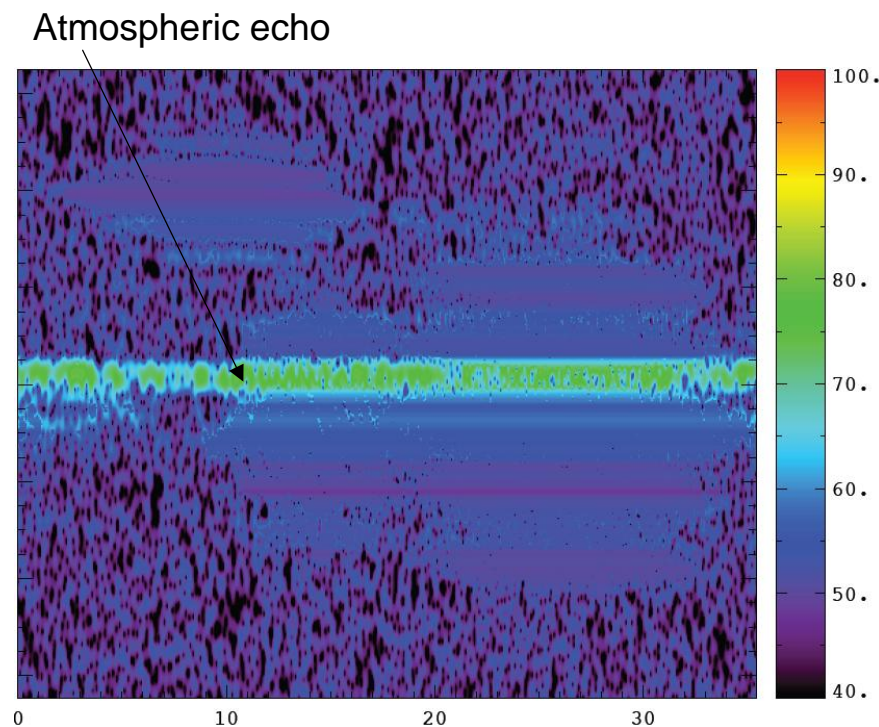
- Intermittent clutter filtering
  - intermittent clutter sources: birds, airplanes
  - analyze raw radar time series data using a time-frequency presentation (Gabor frame expansion)
  - intermittent clutter signals are separated and removed using a statistical threshold
  - implemented in cooperation with DWD (Gerhard Teschke and Volker Lehmann)
- Power spectrum analysis
  - Multiple peak picking
  - Radio frequency interference rejection

# Time-velocity analysis of raw radar signal to remove interference sources

- 1) Radar power intensity from one measurement height (Velocity versus Time)

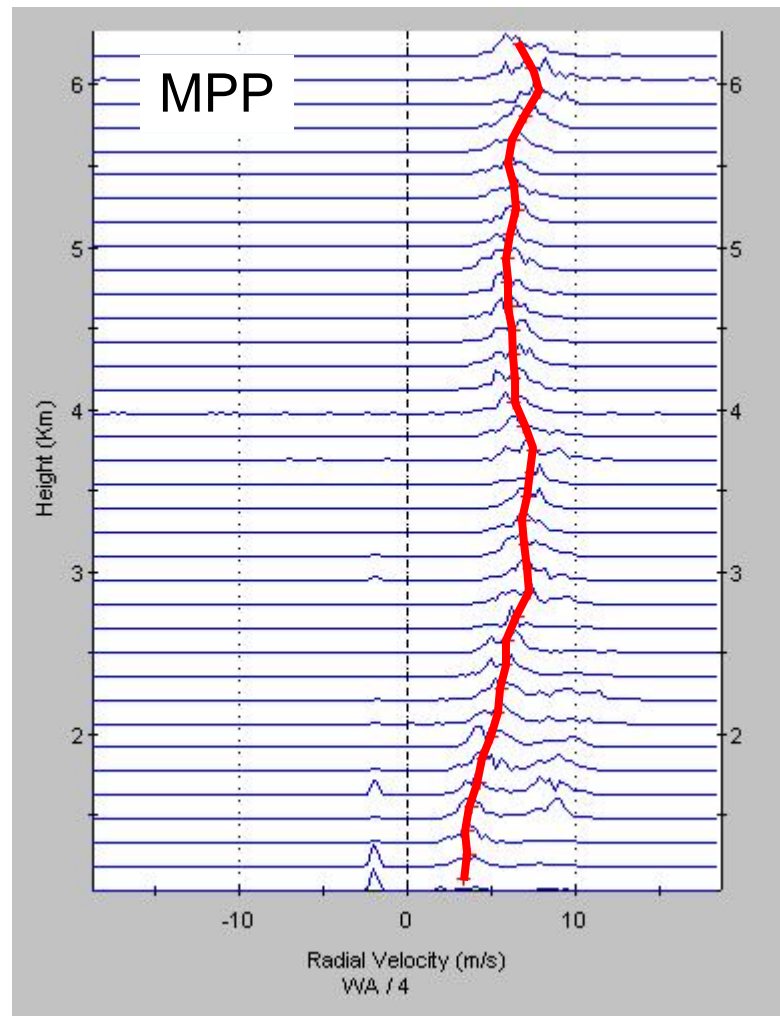
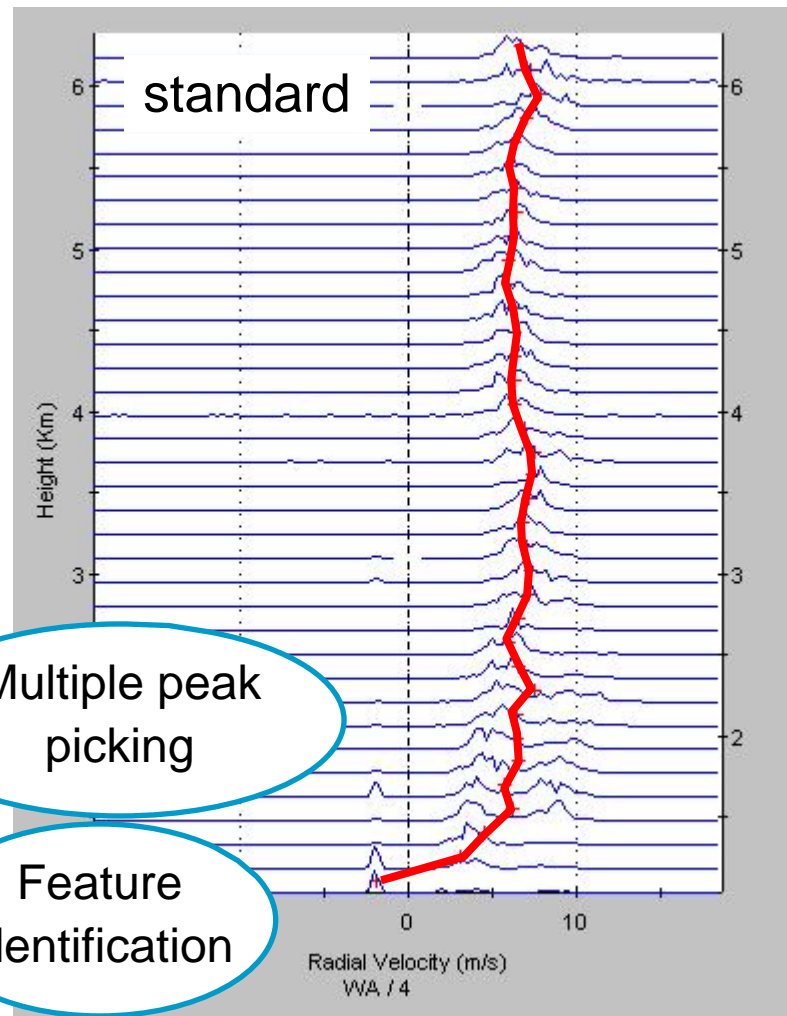


- 2) Statistical filter removes intermittent features



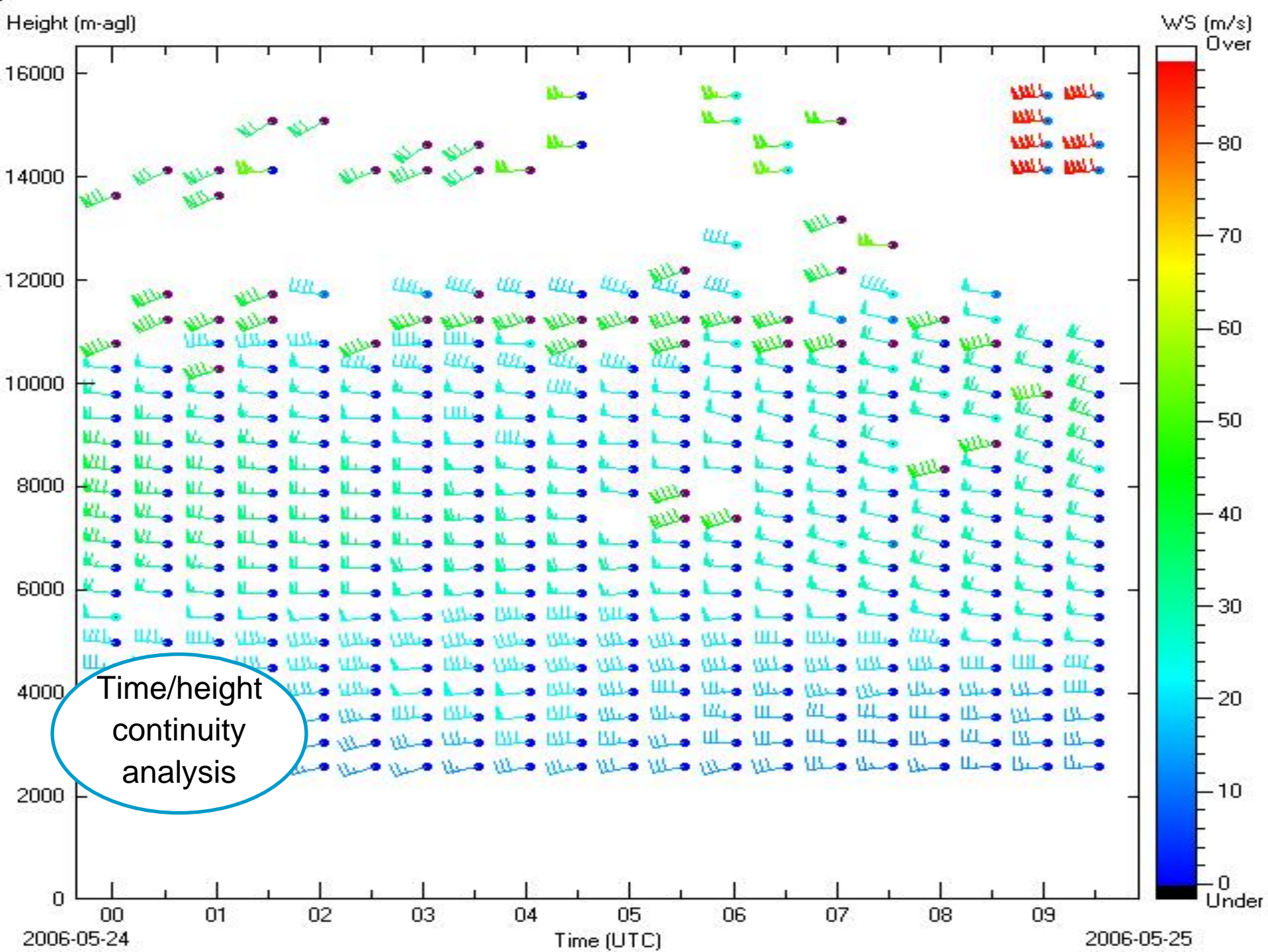
Volker Lehmann / DWD

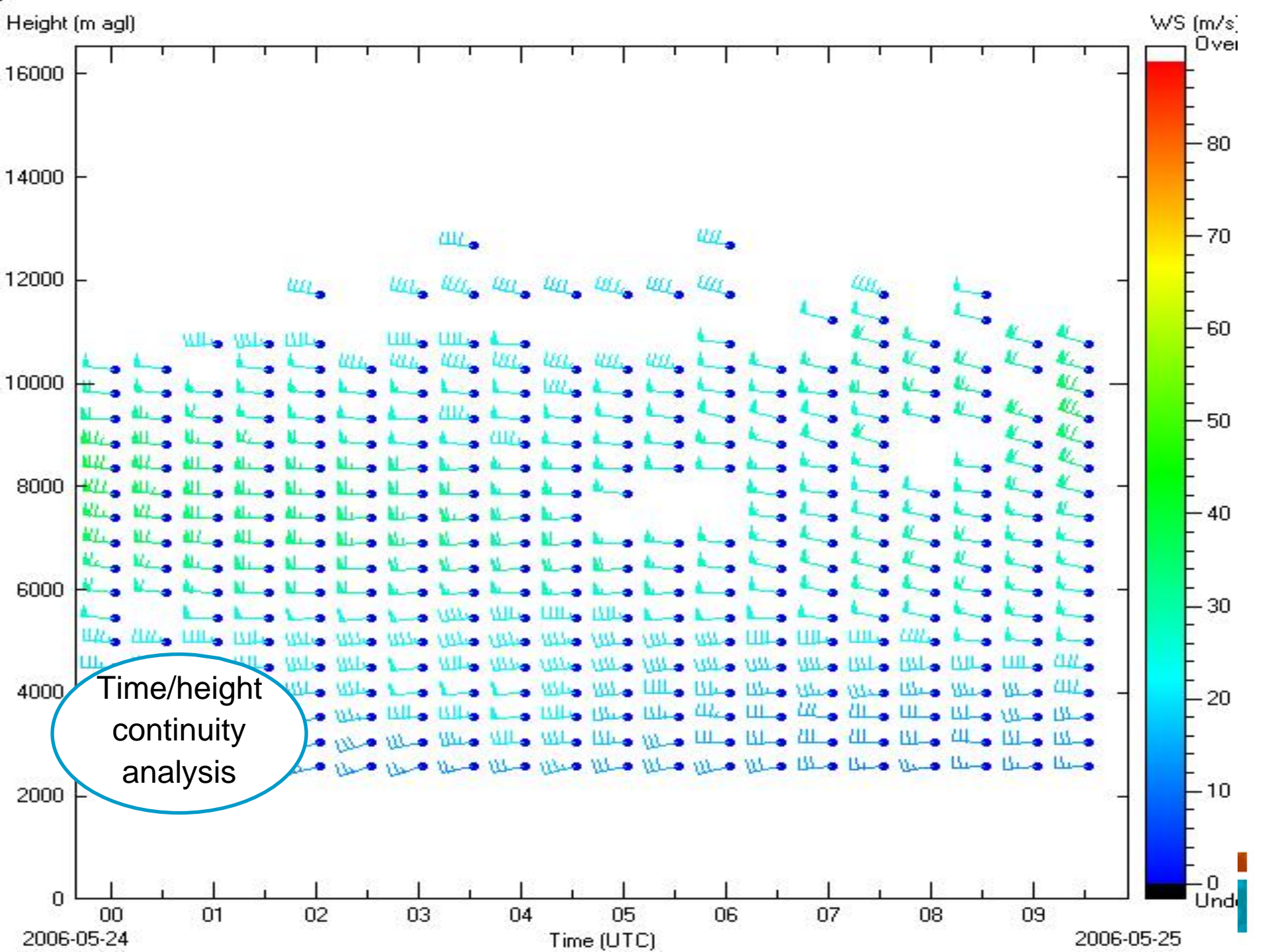
# Multiple peak picking method finds the wind velocity from other echoes



# Quality control of meteorological information

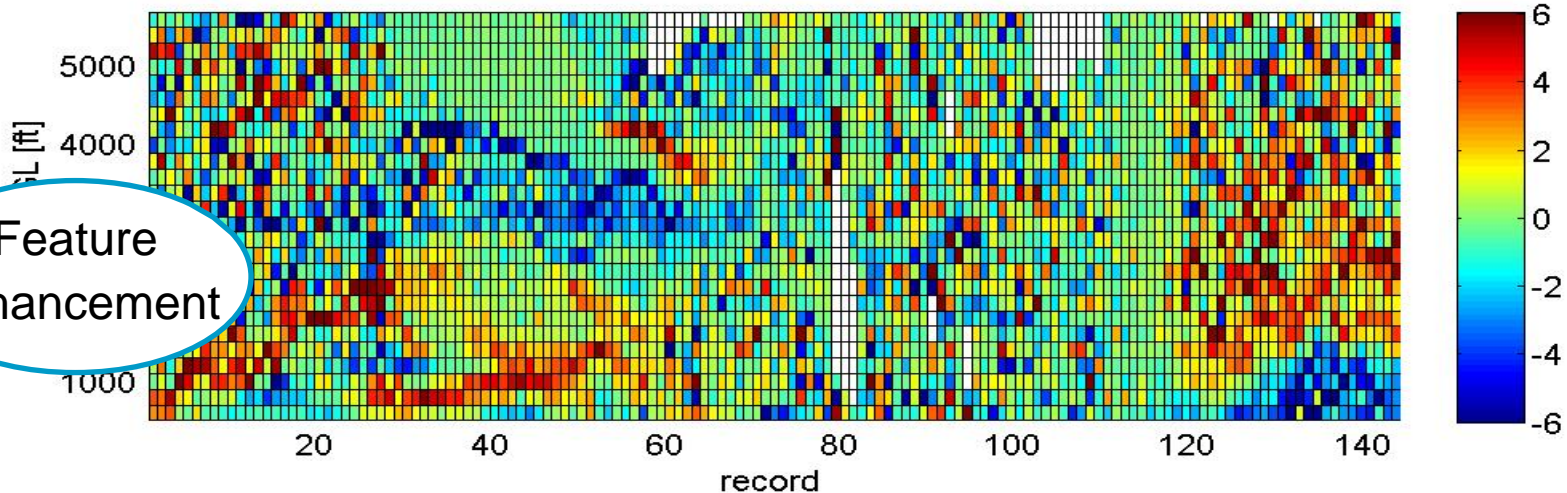
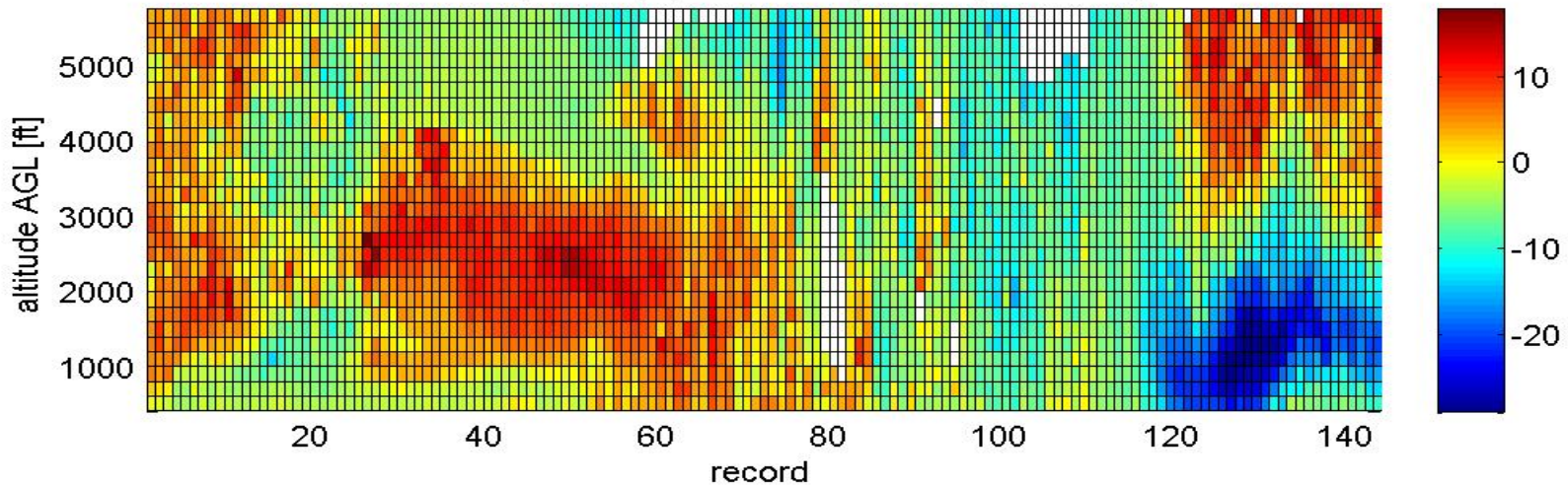
- Wind field
  - Time-height continuity analysis and radar beam consistency check
  - flag suspect results in severe RFI environment
- Wind shear
  - Feature enhancement through noise reduction
- Other phenomena



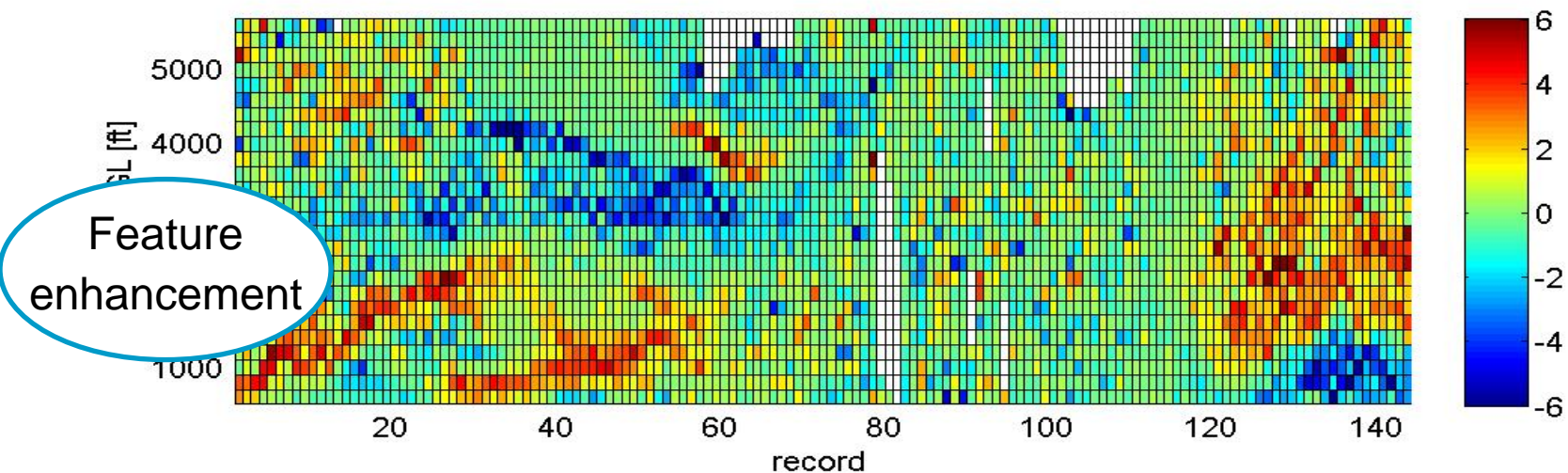
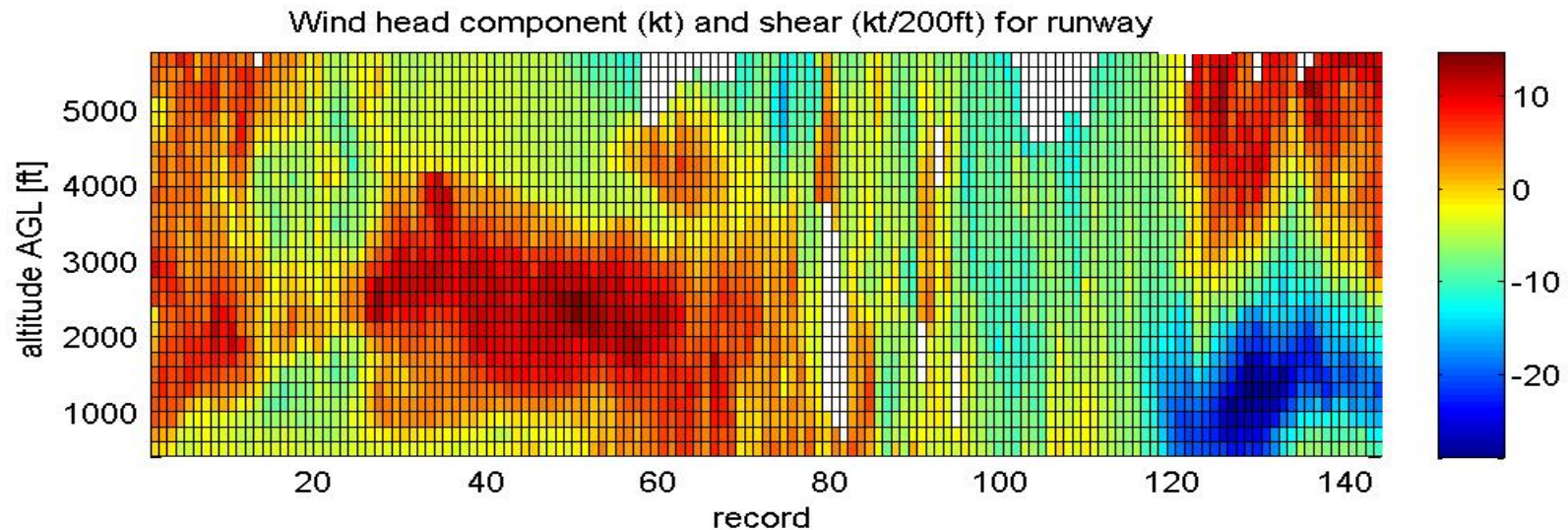


# Application specific end product: wind field and vertical windshear above airport runway

Wind head component (kt) and shear (kt/200ft) for runway



# Wind field and vertical windshear above airport runway: filtered data for feature extraction



# Thank You

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