

WINPROF

The Optional Wind Profiler Programme of EUMETNET

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March 2, 2005



Outline of talk

1. EUMETNET and the WINPROF project
2. Wind profiler radars - a few basics
3. Existing profiler networks
4. The European network CWINDE
5. Discussion

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EUMETNET

Conference of the National Meteorological Services in Europe

- A network grouping 18 European National Meteorological Services
- A framework to organise co-operative programmes (both core and optional) in the various fields of basic meteorological activities, such as observing systems
- Develop collective capability to bring European users the best available quality of meteorological information
- More efficient use of collective resources

The WINPROF Programme

- bundles collective resources in the field of the operational use of Wind Profiler Radar / RASS systems
- optional programme for a duration of 2 years
- Participating countries:
 - Austria
 - Belgium
 - Finland
 - France
 - Germany
 - Ireland
 - Netherlands
 - Portugal
 - Switzerland
 - United Kingdom

COST-76 - Predecessor for WINPROF

- *Development of VHF/UHF wind profilers and vertical sounders for use in European observing systems*
- March 1994 to March 2000
- Some important achievements:
 - Wind profiler (WPR) frequency allocations: Acceptance by WRC-97 of Resolution COM5-5, and Footnotes S5.162A and S5.291A.
 - Development of BUFR code for data exchange, accepted by WMO early 2001
 - The semi-operational CWINDE¹ network was established
Network Hub + Website at UK MetO
(<http://www.metoffice.com/research/interproj/cwinde/profiler>).
 - UK MetO and Météo France started monitoring using global NWPM's.
 - WPR data evaluation: Quality can be comparable to radiosonde wind data.

¹COST Wind Initiative for a Network Demonstration in Europe.

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 - $w(z)$ for clear air situations
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Weather radar: SHF (3-30 GHz)
- Backscattering:
 - at (natural) refractive index irregularities (c_n^2 - clear-air radar)
 - at precipitation particles (similar to the weather radar)
 - at artificially generated refractive index irregularities (RASS)
 - sometimes unwanted scattering - clutter (birds, surroundings,...

Basic wind profiler types

	VHF	UHF-Low	UHF-High
Frequency (MHz)	40-80	300-500	900-1400
Frequency (D)	53.5	482	1290
Antenna area (m^2)	10.000	100	10
Peak Envelope Power (kW) (typical)	5 - 1000 50	1 - 30 15	0.3 - 10 1
vert. coverage (km)	1.5 -30	0.5 - 16	0.1 - 3
vert. resolution (m)	150 - 500	150 - 500	50 - 100

Doppler Beam Swinging

For a locally linear wind field, i.e.

$$\vec{v}(\vec{r}) = \vec{v}(\vec{r}_0) + \nabla \vec{v}|_{\vec{r}_0} \cdot \Delta \vec{r}$$

one gets for the radial winds

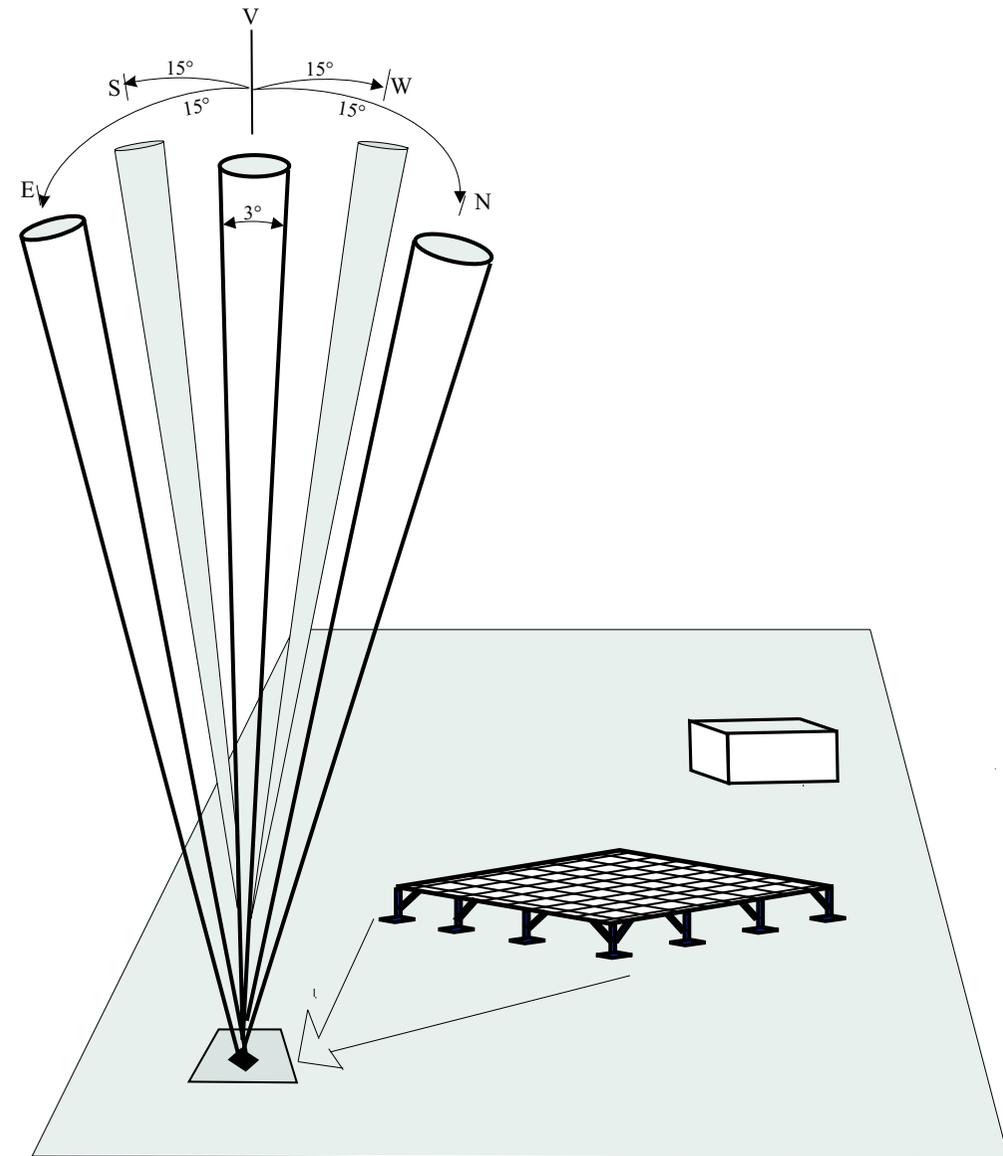
$v_r = \vec{v} \cdot \vec{n}$ at height z :

$$v_{rE} - v_{rW} = 2u_0 \sin(\alpha) + 2 \frac{\partial w}{\partial x} \delta x$$

$$v_{rN} - v_{rS} = 2v_0 \sin(\alpha) + 2 \frac{\partial w}{\partial y} \delta y$$

mit $\delta x = \delta y = z \tan(\alpha) \cos(\alpha)$

DBS assumption: $\frac{\partial w}{\partial x} = \frac{\partial w}{\partial y} = 0$



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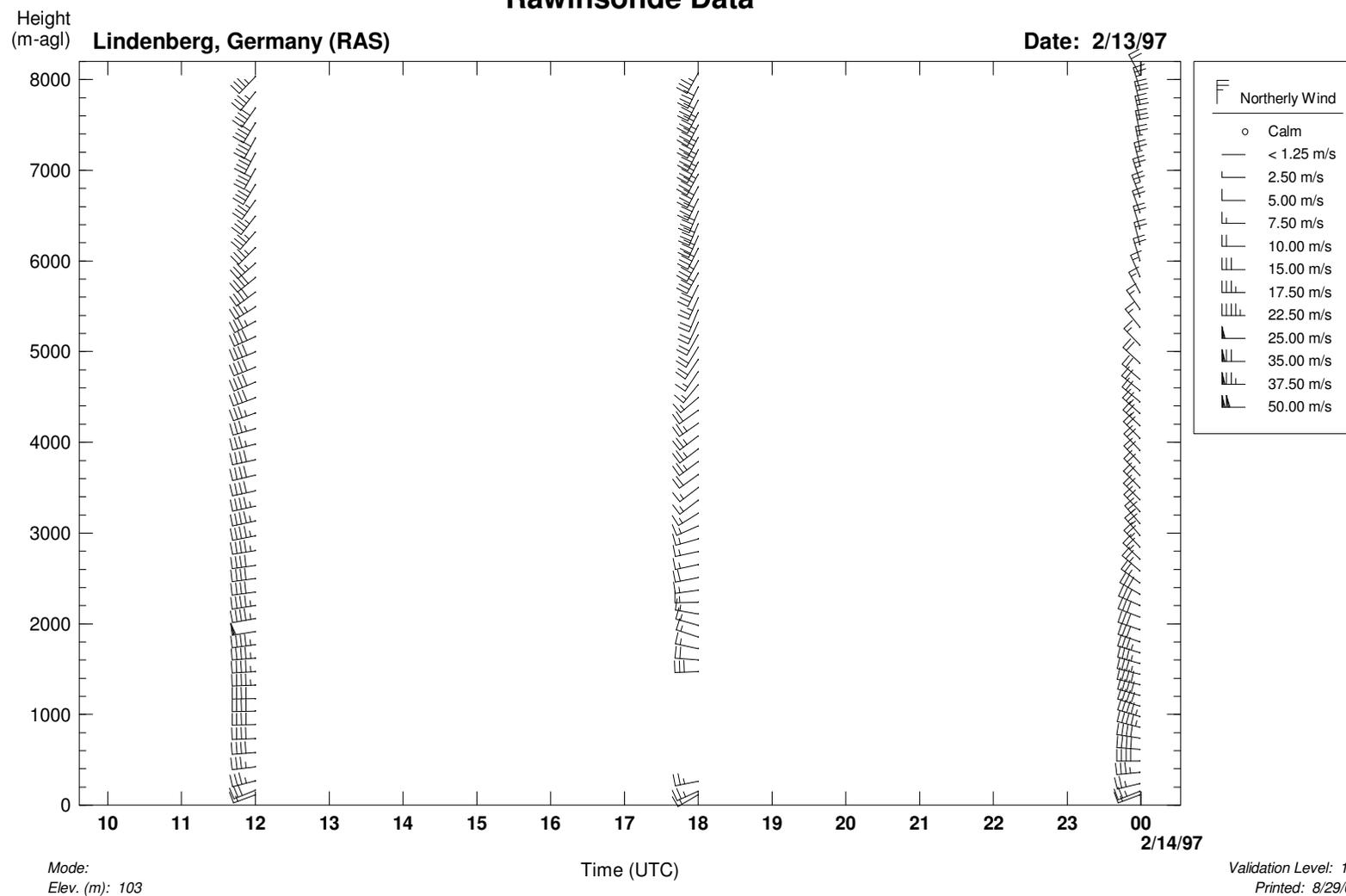
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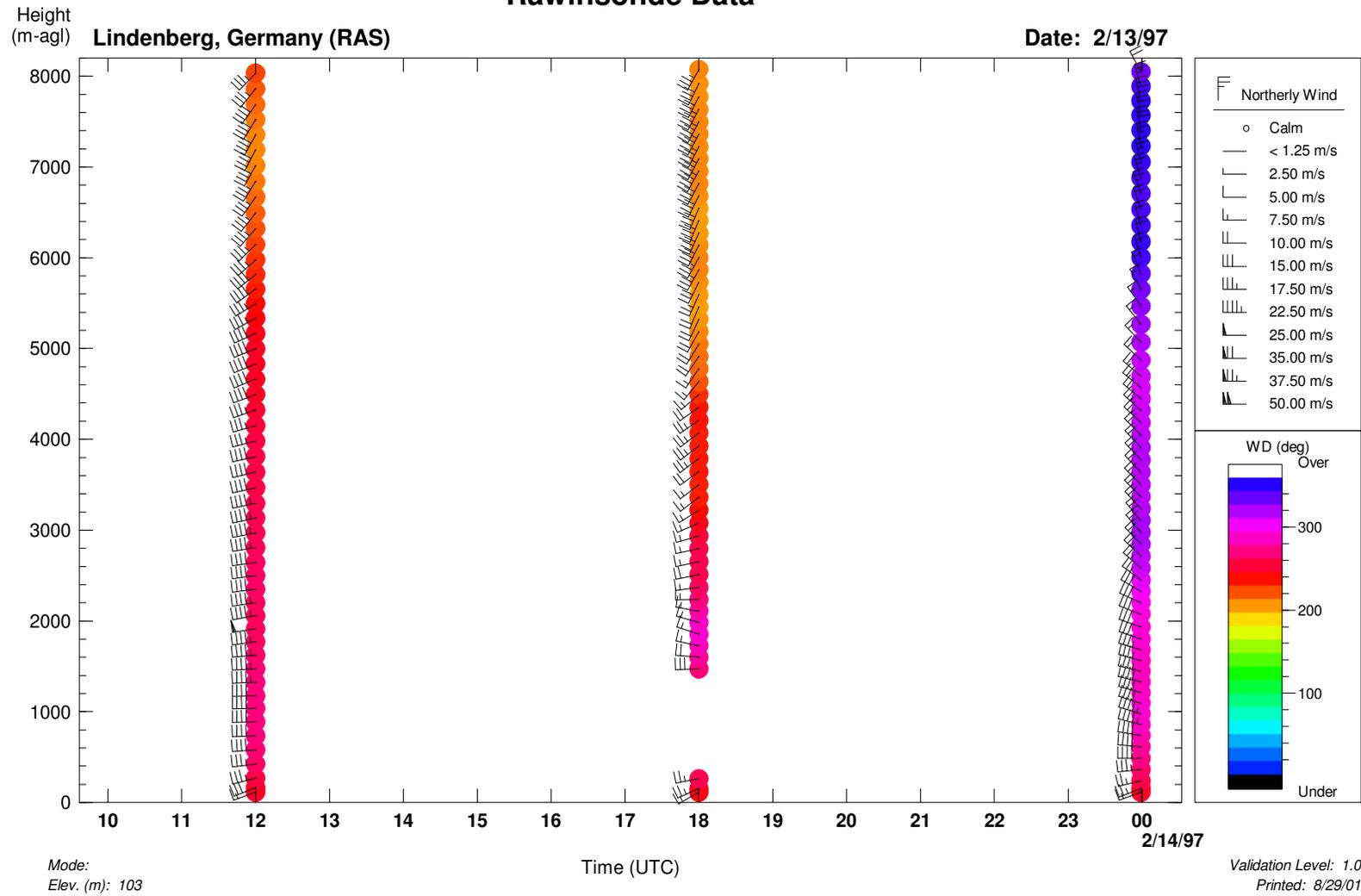
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- Unambiguous profiles, independent of the assimilation system.
- Almost all weather (exception: strong convective precipitation).
- Existing and proven (in contrast to proposed space-based systems).

Rawinsonde Data



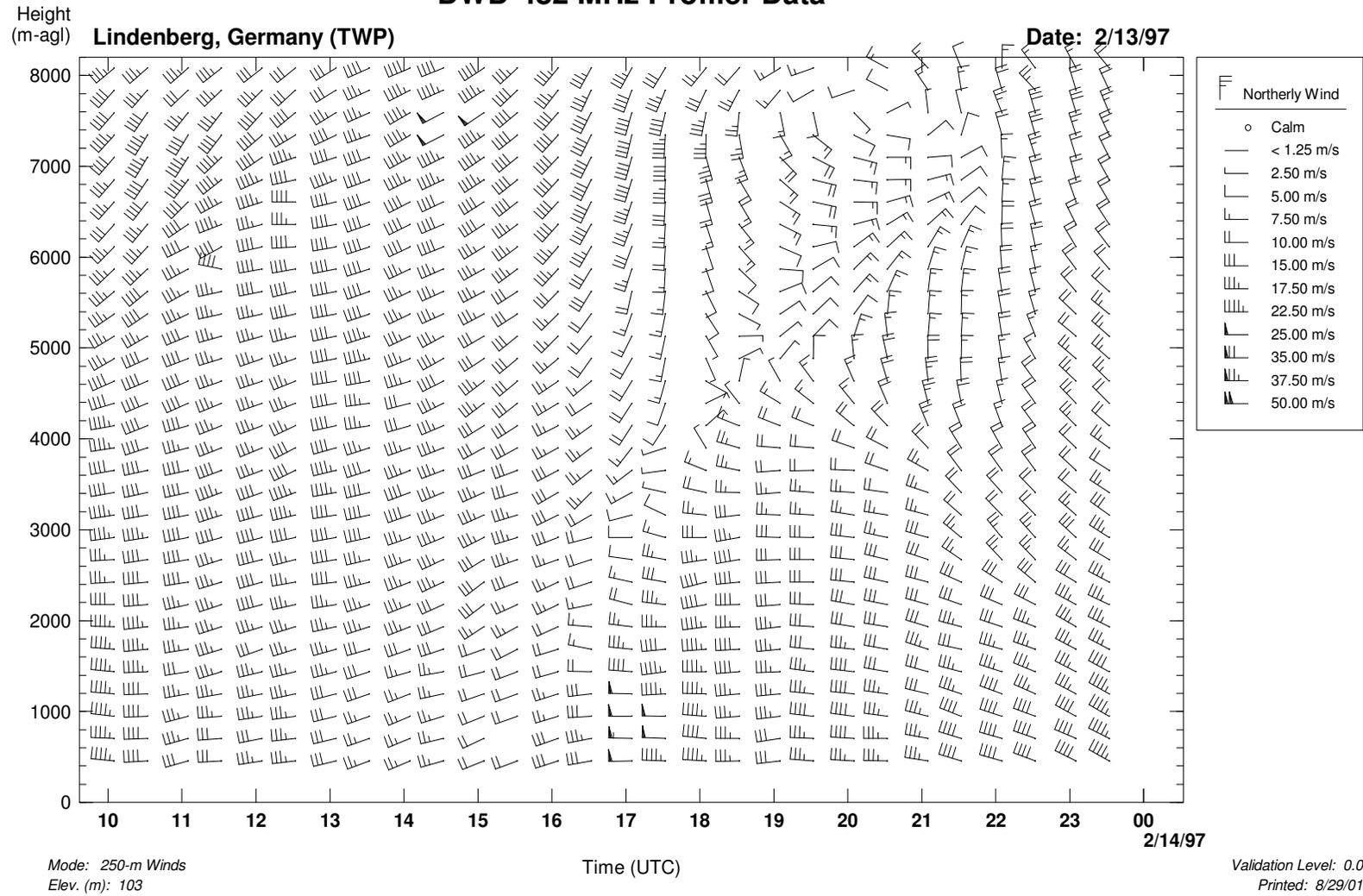
Upper air winds at Lindenberg (Rawinsonde) February, 13 1997

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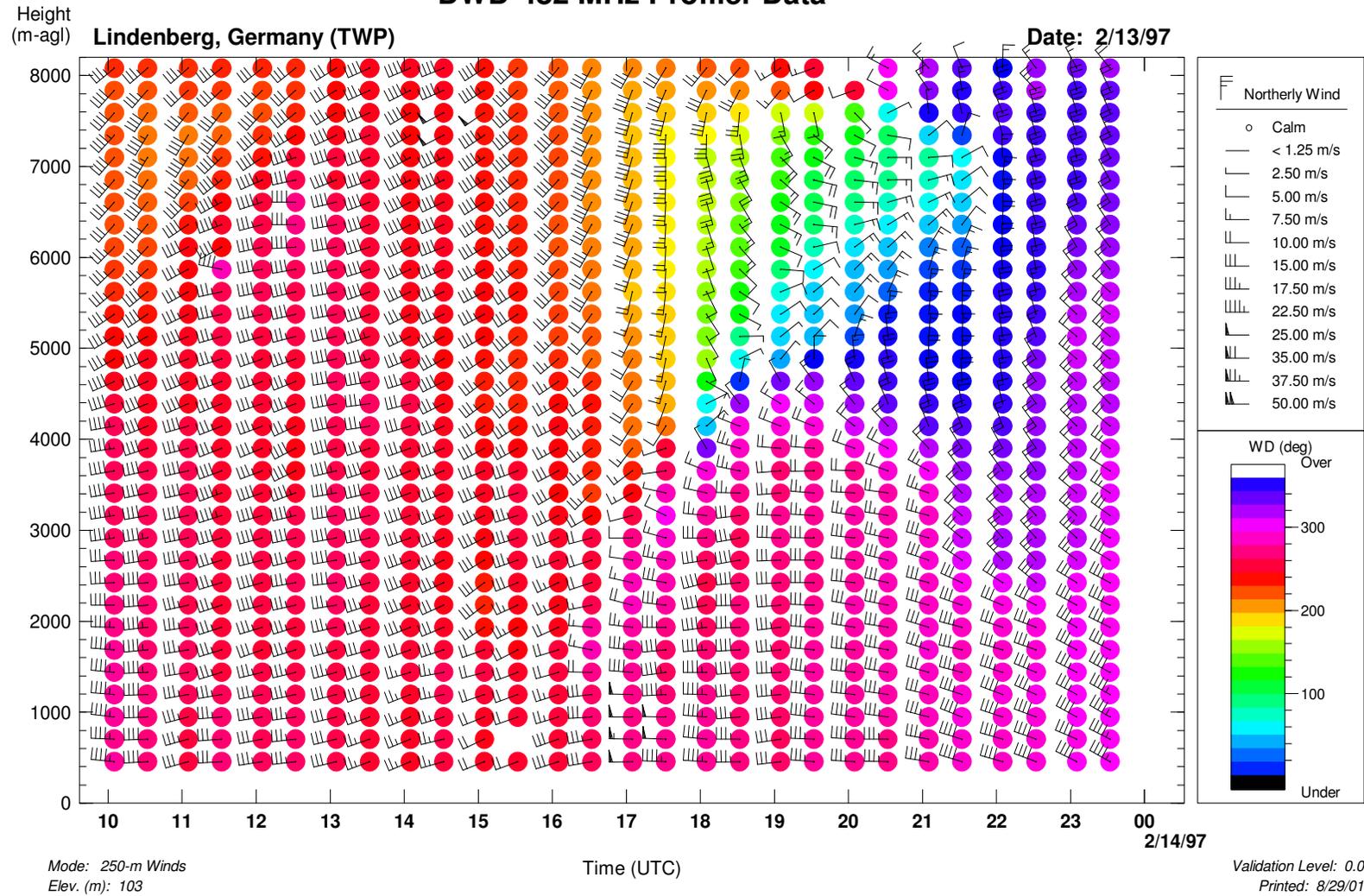
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DWD-482 MHz Profiler Data

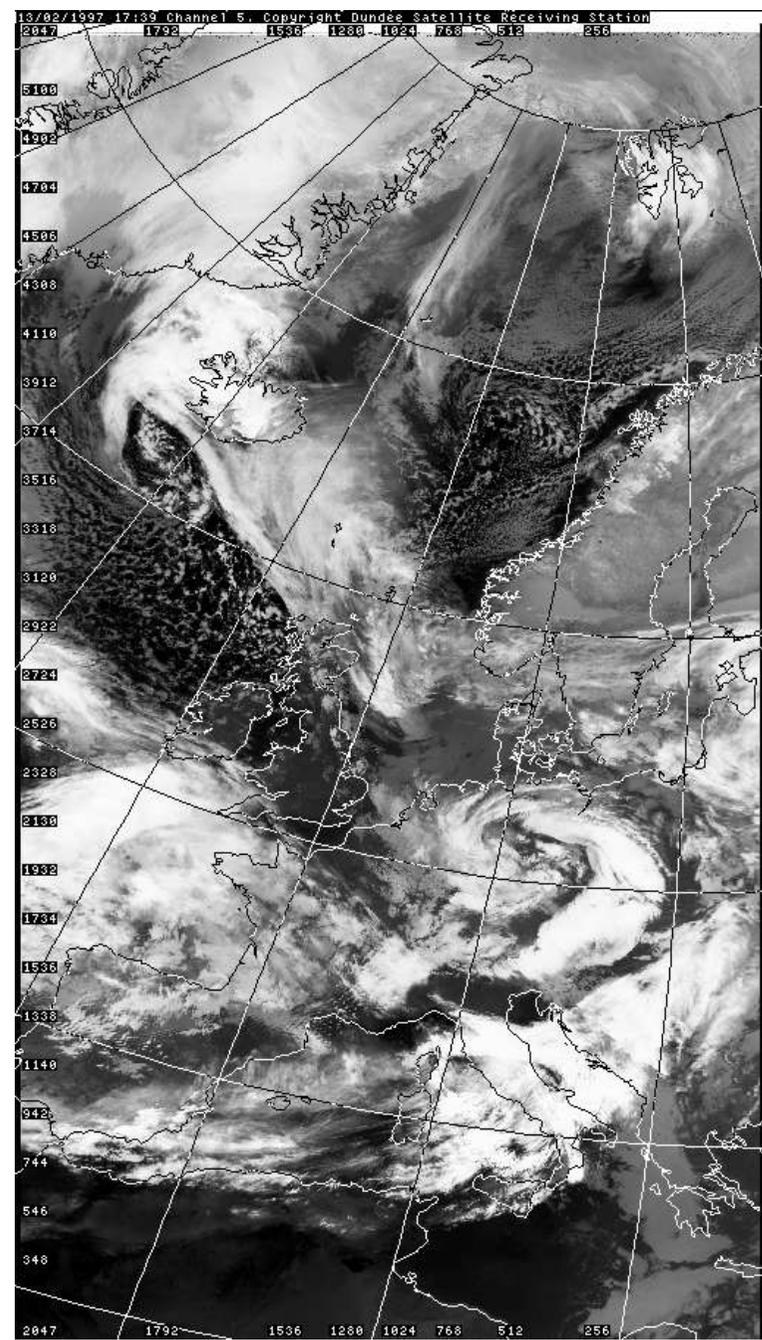
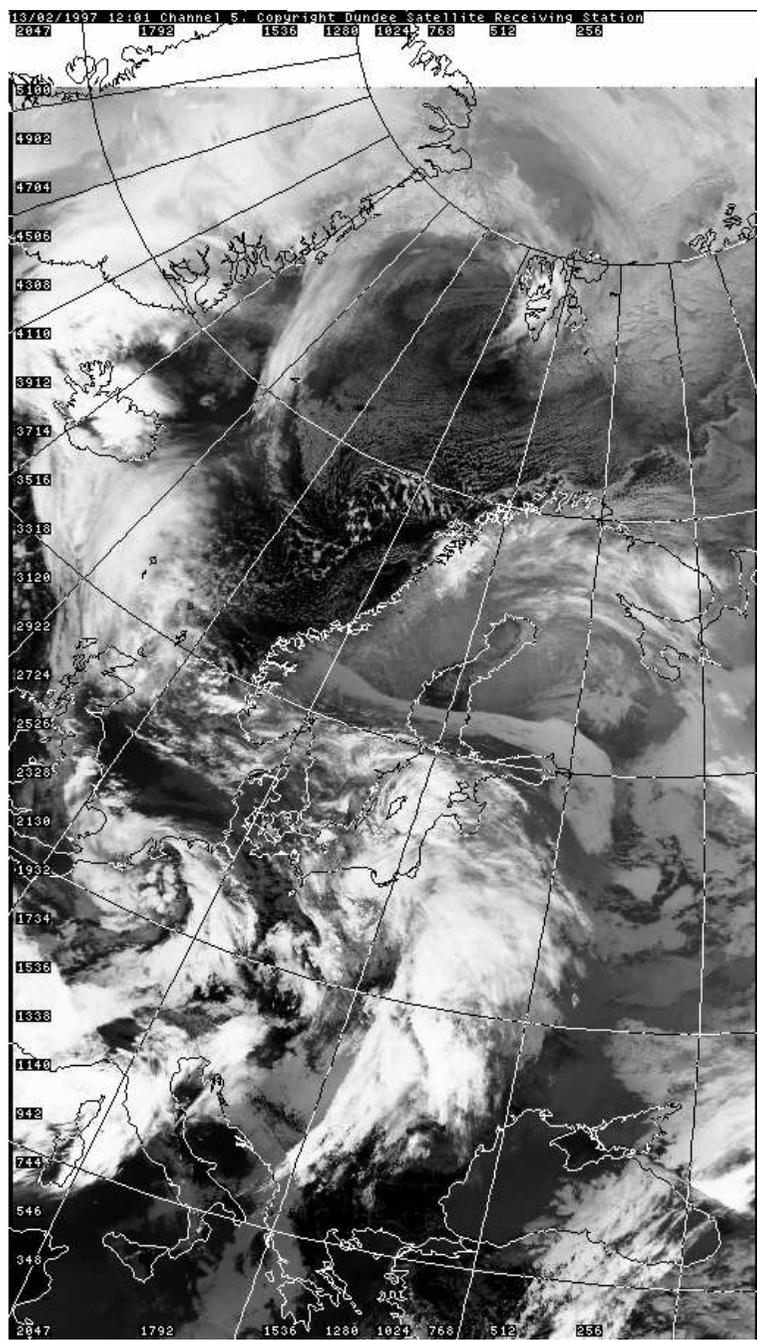


Upper air winds at Lindenberg (482 MHz wind profiler) February, 13 1997

DWD-482 MHz Profiler Data



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Satellite imagery Feb 13, 1997 (NOAA channel 5, 12:01 and 17:39)

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- Systems have potential for improvements - but research is needed !

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 - Modern mathematical techniques available (for example for instationary signals)

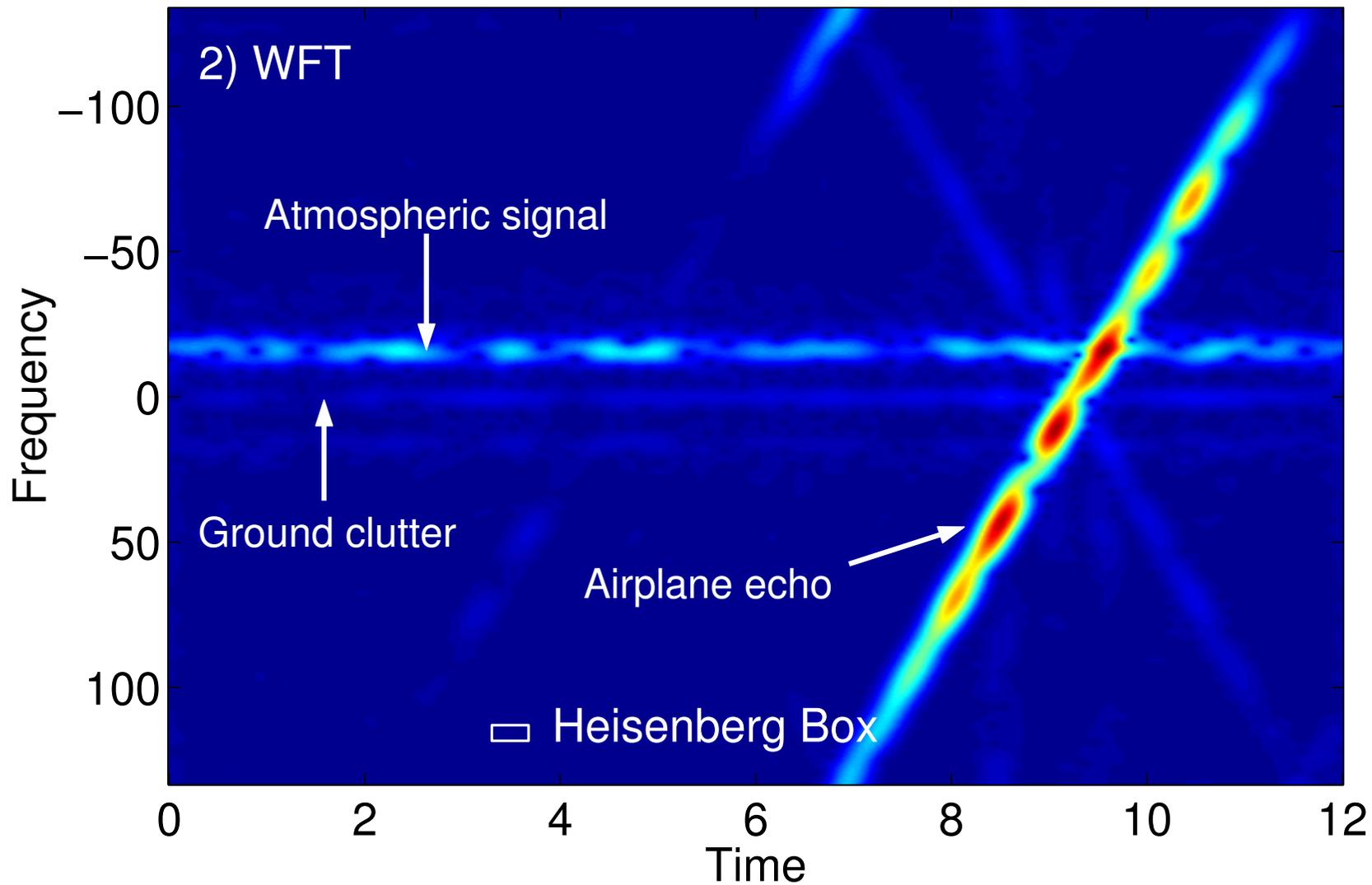
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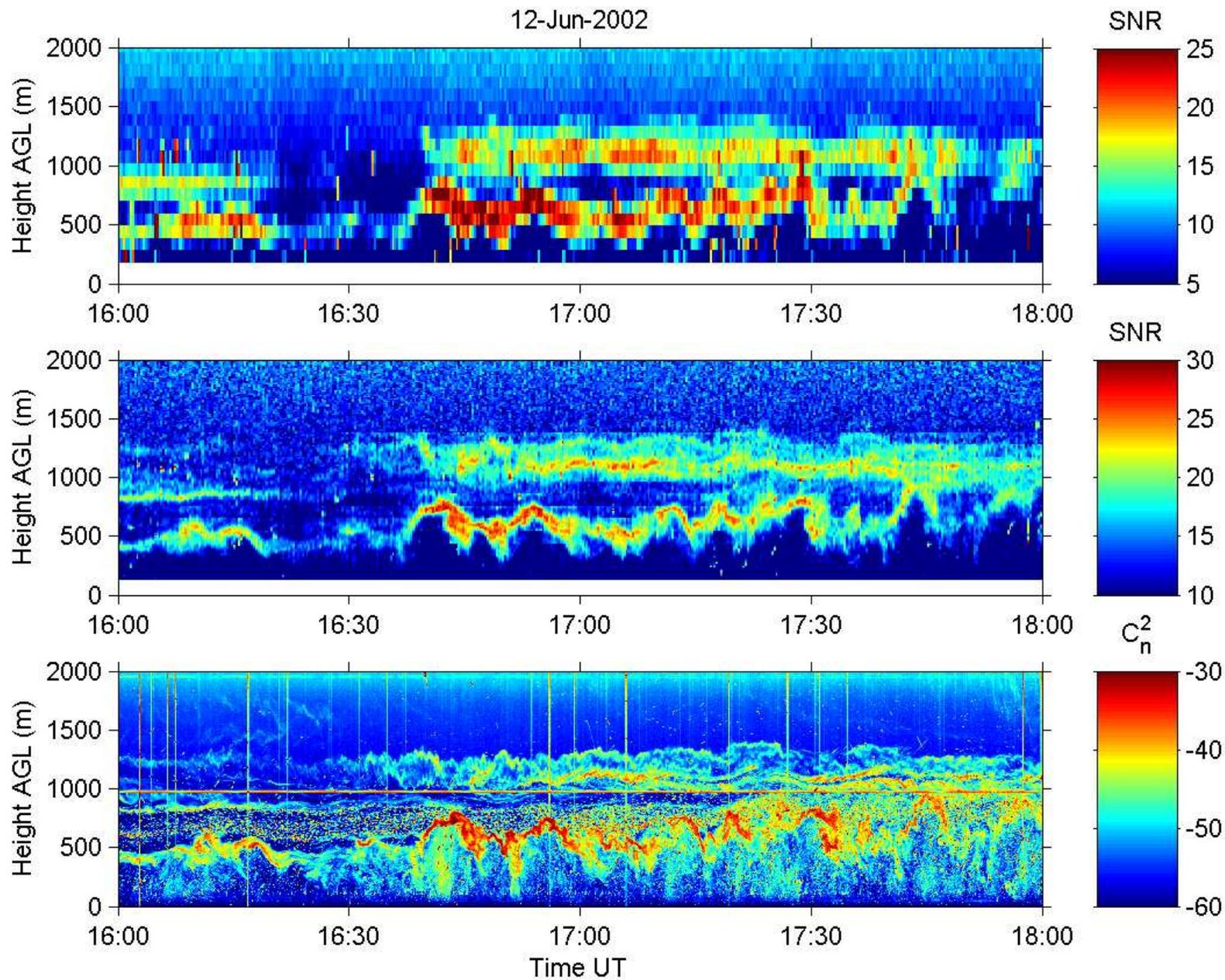
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- Hardware reliability needs to be improved with current technology:
 - State-of-the art amplifiers (LDMOS)
 - Digital IF receivers

Time-Frequency characteristics of the WPR RX signal



Spectrogram of the complex envelope of a RWP signal.

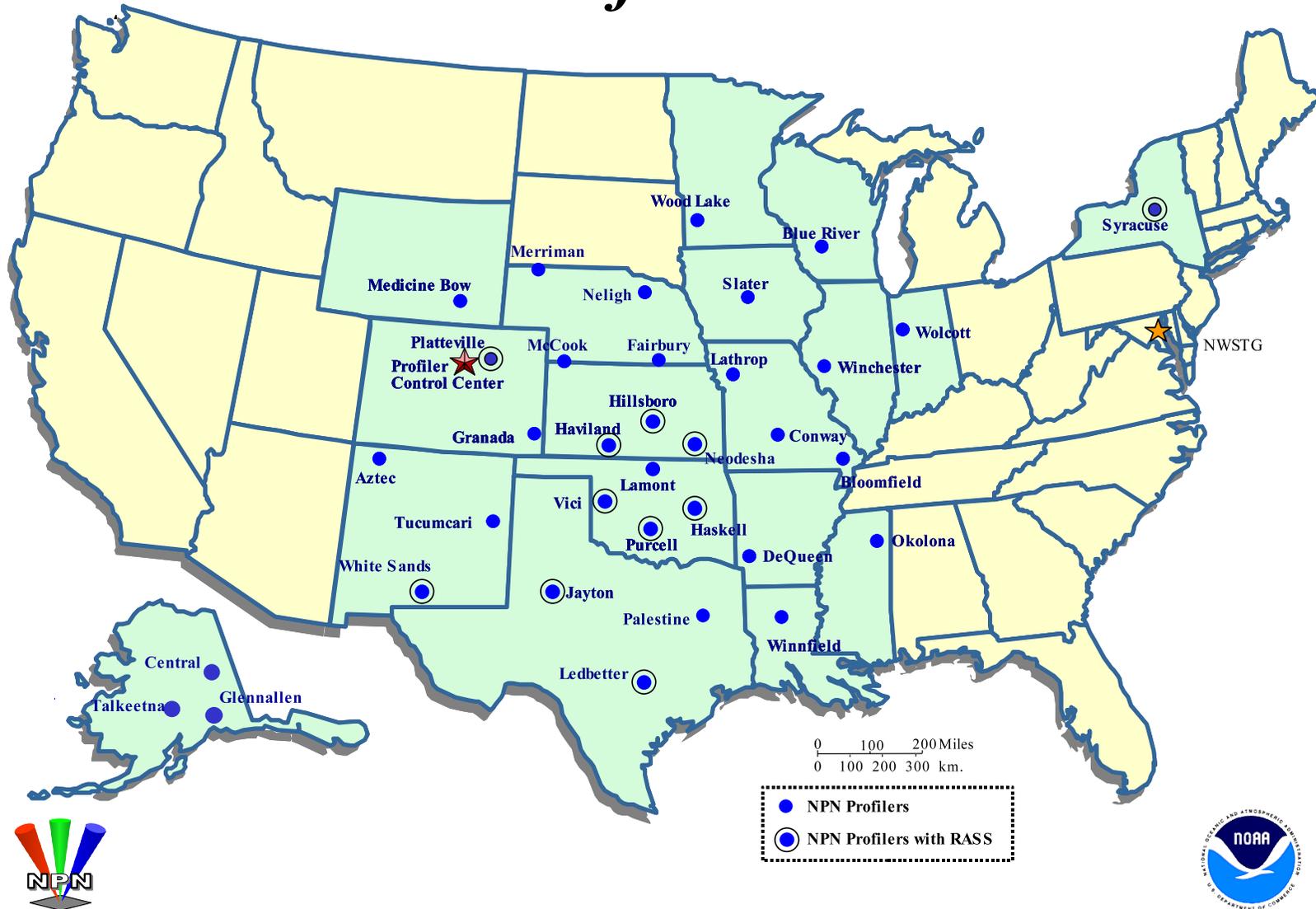


Range Imaging at 915 MHz, compared w/ FM-CW radar system, from Chilson et.al. (2003)

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NOAA Profiler Network



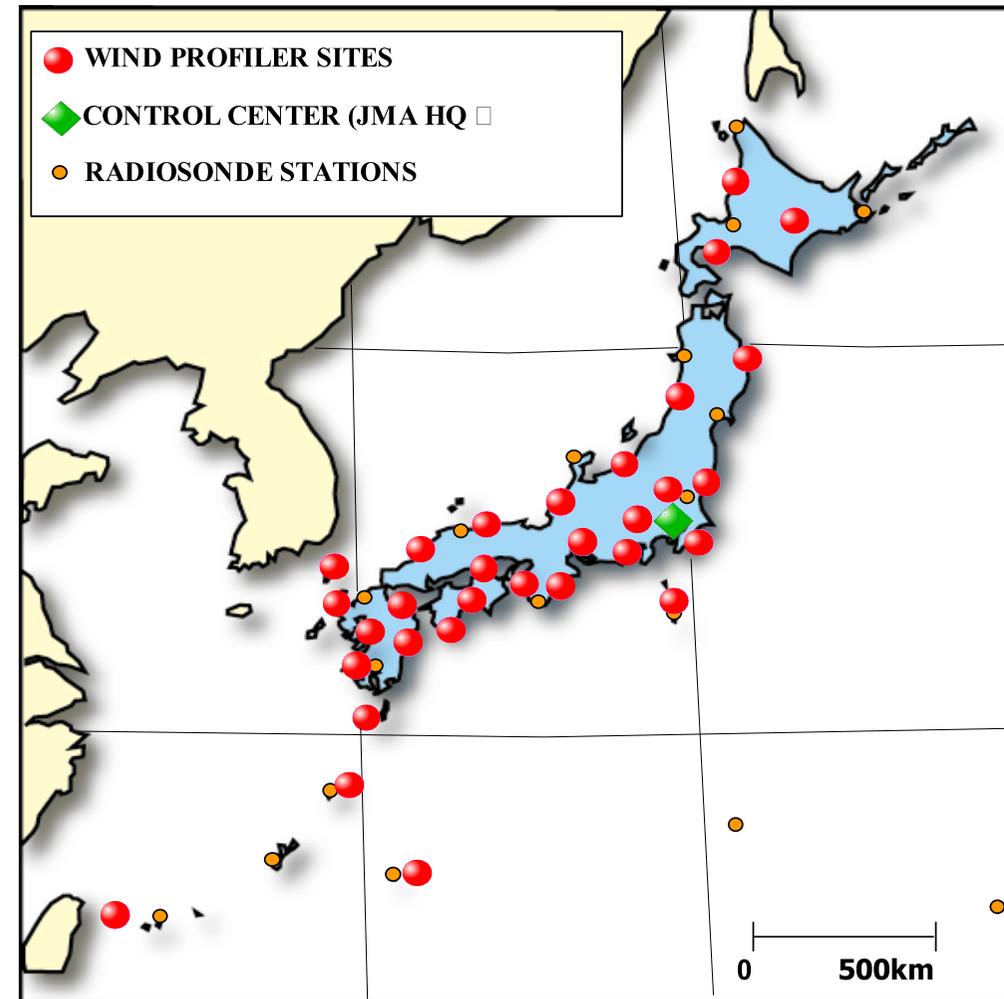
NPN: 35 UHF profiler (32 @ 404 MHz, 3 @ 449 MHz)



404 MHz NOAA Network Profiler at Ledbetter, Texas

Wind profiler network of JMA

- 31 profilers @ 1357 MHz
- Peak Power 1.8 kW
- Vertical resolution 100, 200, 300, 600 m
- Time resolution 10 min

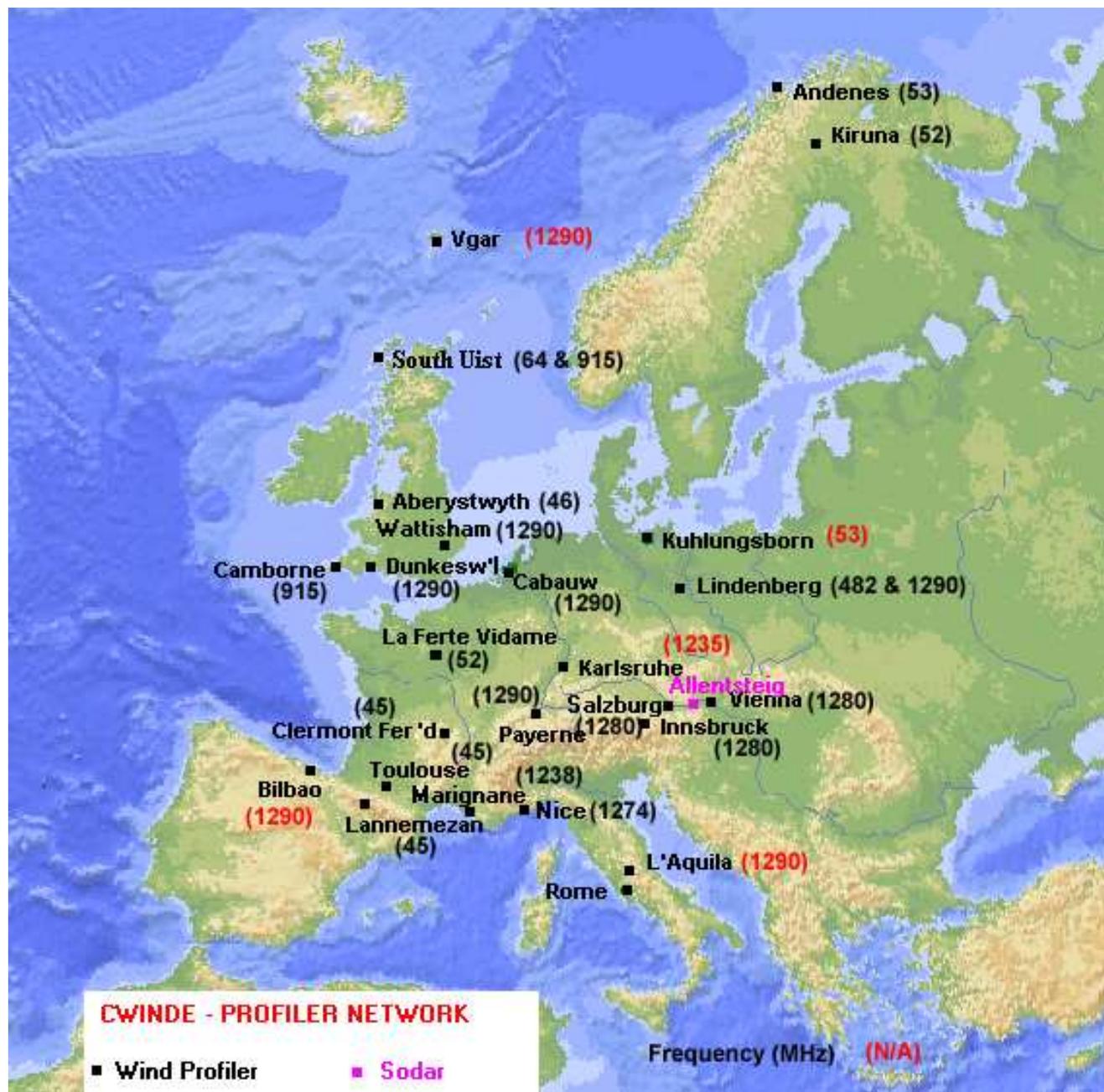




JMA Network Profiler

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Common WIND profiler network in Europe (CWINDE)



46.5 MHz MST Radar Aberystwyth, UK - Research system



482 MHz Wind profiler Lindenberg, Germany - Prototype system (quasi-operational)



915 MHz Wind Profiler South Uist (Hebrides), UK - Quasi operational system



1274 MHz Wind Profiler Nice, France - Quasi operational system



64 MHz Wind Profiler South Uist (Hebrides, UK) - operational system installed 2003



Aerial view of first 482 MHz network profiler of DWD, September 2003

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- Only quasi-operational WPR systems have availabilities near or above 90%

Main objectives of WINPROF Programme

1. Continued operation of CWINDE Hub at UK MetO (joint funding)
 - Routine collection and archiving of WPR and weather radar wind data
 - Quality evaluation and availability statistics

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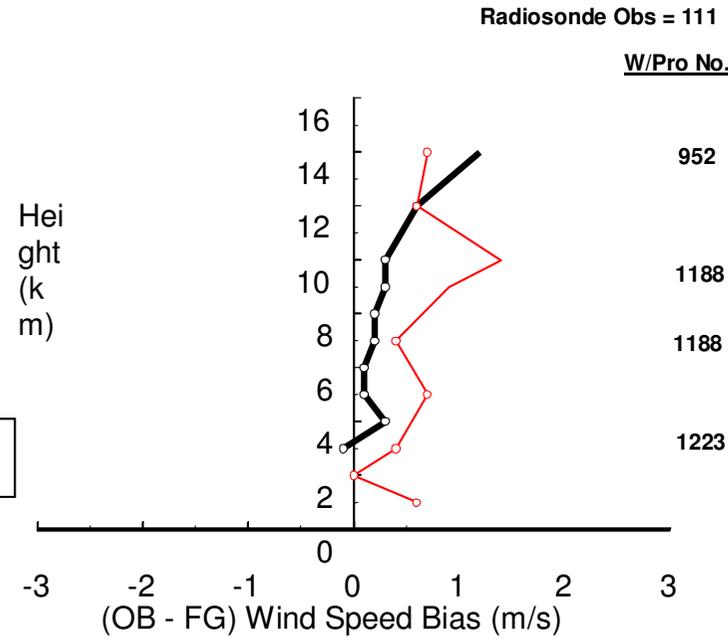
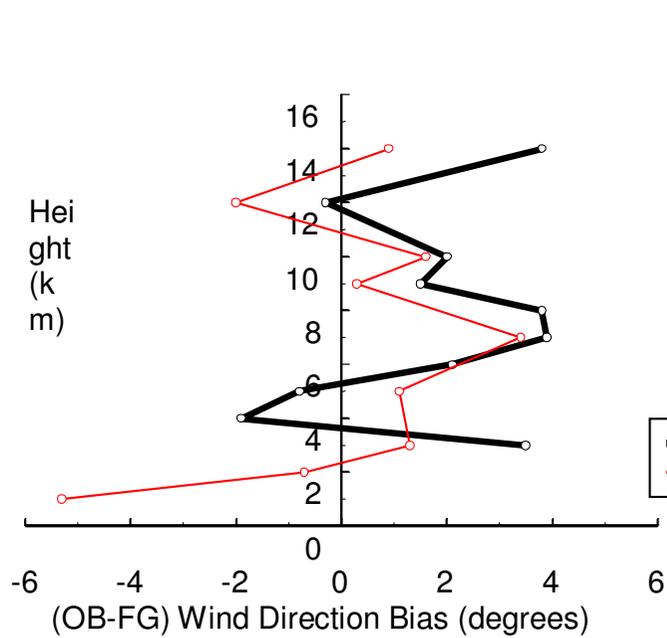
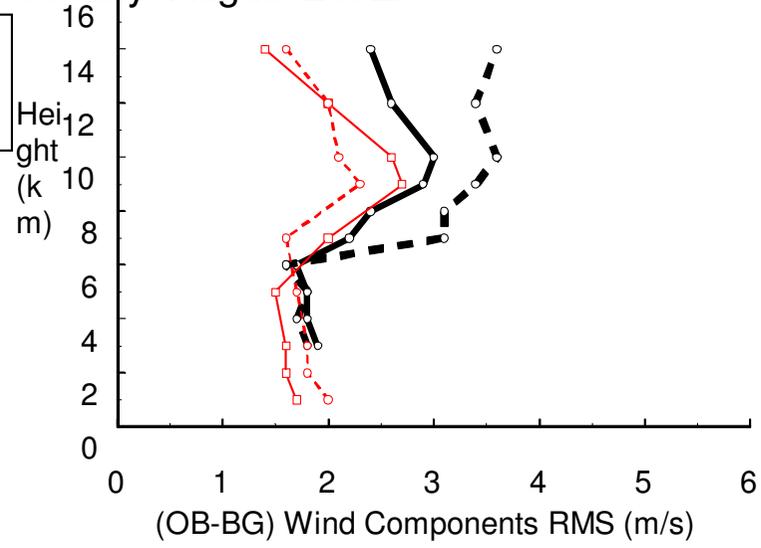
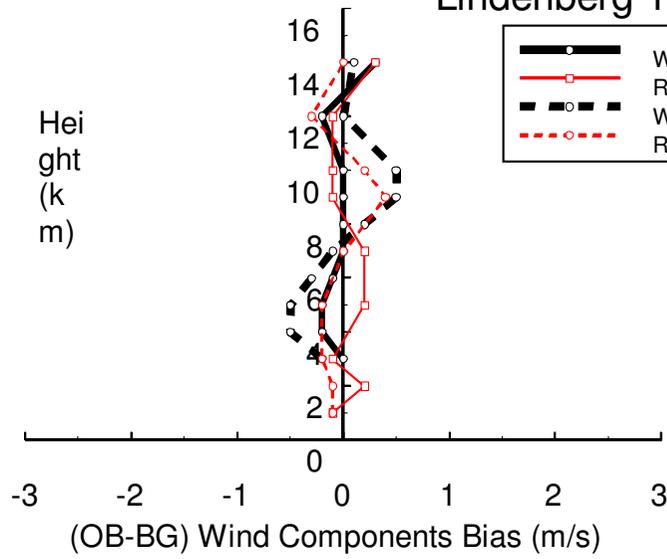
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 - Recommendations for WPR operation (maintenance, sampling, processing)
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3. Other operational aspects
 - Protection of frequencies: European Satellite Navigation system GALILEO may threaten 1290 MHz (E6: 1278.750 MHz)
 - User education and support

Comparison of Wind-Profiler/Radiosonde v UK Model Wind Measurements.

Lindenberg 10394, Germany. August 2002.



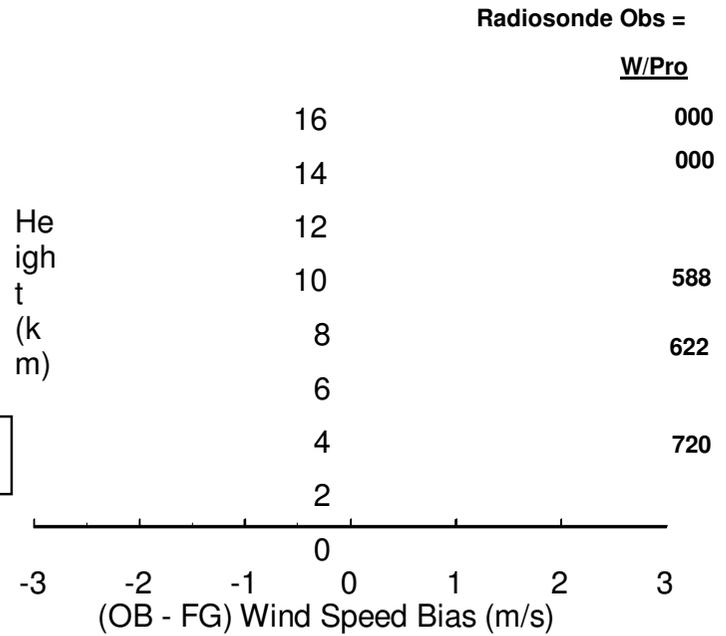
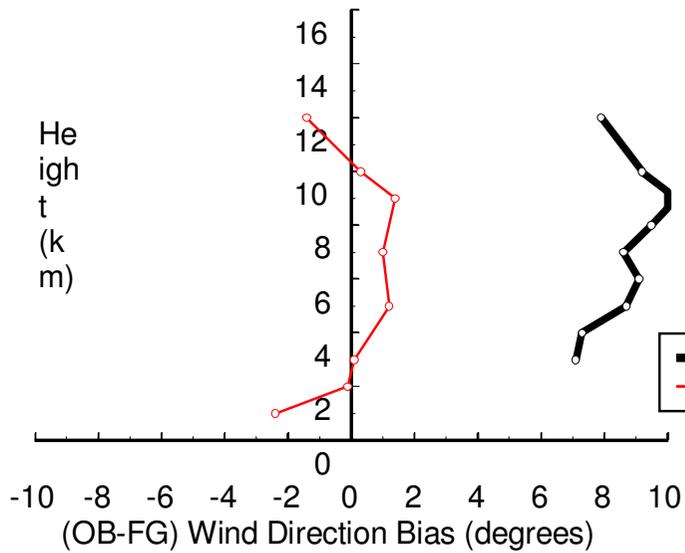
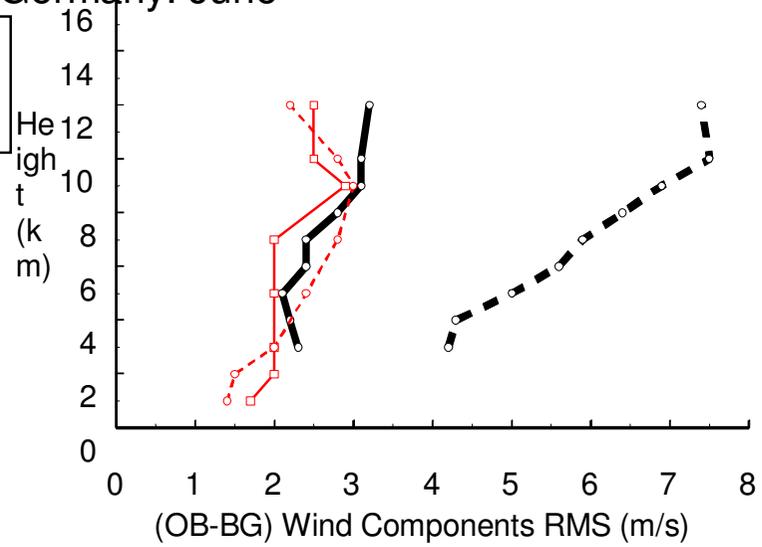
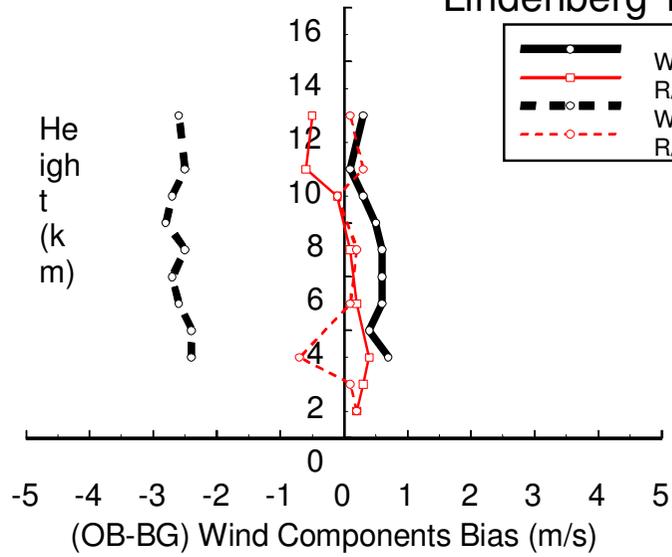
Radiosonde Obs = 111
W/Pro No.

- 952
- 1188
- 1188
- 1223

Radiosonde results are from the nearest Upper-Air site and statistics are converted to approximate heights from standard pressure levels.

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Lindenberg 10394, Germany. June



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- Clutter contamination
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2. WG2: "Problem fixing":

- User training
- Testing of *advanced* signal processing
- Recommendations for radar hardware improvements

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- Programme ends June 2004: Possible extension to be decided.