

Application and Benchmark testing of Vertical Profiles at Lindenberg Observatory

Dirk A.M. Engelbart

- **Vertical Profiling @ MOL/RAO**
 - **Goals and quality**
- **Ground-based remote sensing**
 - **Aerological Hardware**
 - WPR
 - Lidar
 - Ceilometer
 - EISAR (FTIR)
 - MW profiling
 - Integrated profiling
 - NWP validation (assimil.)
- **International Projekts & Activities**
 - Reference station (GRUAN, GVaP, etc.)



The **Winch house** at Lindenberg observatory:
Technical monument for the operational start
of meteorol. **kites** in the last century

Vertical Profiling @ MOL/RAO

GOAL:

- Short- & long-term detection, monitoring and assessment of meteorolog. structure, atmospheric composition & processes

Objectives:

- (1) Continuation of the measuring programmes for „**climate monitoring**“ (e.g. for *WMO programmes*)
- (2) Acting as a **reference** for aerological in-situ systems & for new measuring techniques
- (3) **Improvement & Testing** of ground-based **active / passive** remote-sensing techniques + assessment of their **synergic potential**
- (4) Participation in **operation. networks** (*DWD, EUMETNET*) & **internat. projects** (*WMO, EUMETSAT + EU*)

Vertical Profiling @ MOL/RAO

Reference Qualities:

Variable	WS	WD	T	u	Cloud-Base	Cloud-Top	Cloud-OD
max. Range	12 - 16 km	12 - 16 km	3 - 4 km	10 - 12 km	Troposphere	Tropopause	Troposphere
z-Resol.	60 - 500m	60 - 500m	45 - 130m	7.5m	7.5m	30m (Ci = 7.5m)	7.5m (Lidar)
t-Resol.	30min	30min	30min	30s	30s	30s	30s
Accuracy	0.1 m/s	2 deg	0.1 K	2 - 5 %	7.5m	30m (Ci = 7.5m)	0.01 (Ci)
System / Availab.	WPR / always	WPR / always	RASS / always	Lidar / weather-restrict.	Ceilo + Ka-Band / always	cloud radar / always	Lidar / thin clouds

Aerolog. Hardware

Active remote sensing

- 2 wind profiler/RASS (+ MN-2000)
- Sodar/RASS
- LIDAR
- Ka-Band cloud radar
- Micro-rain radar
- 3 Laser Ceilometer



Passive remote sensing

- Microwave systems
- FTIR spectrometer
- GPS receiver (cooperat. BKG + GFZ)



Validation systems

- 4 - rawinsondes / day (8 profiles)
- 6-sonde-tethered balloon system (ff,dd,T,q, p, z)
- Sun- and star photometer
- [99m tower (dx = 5km)]





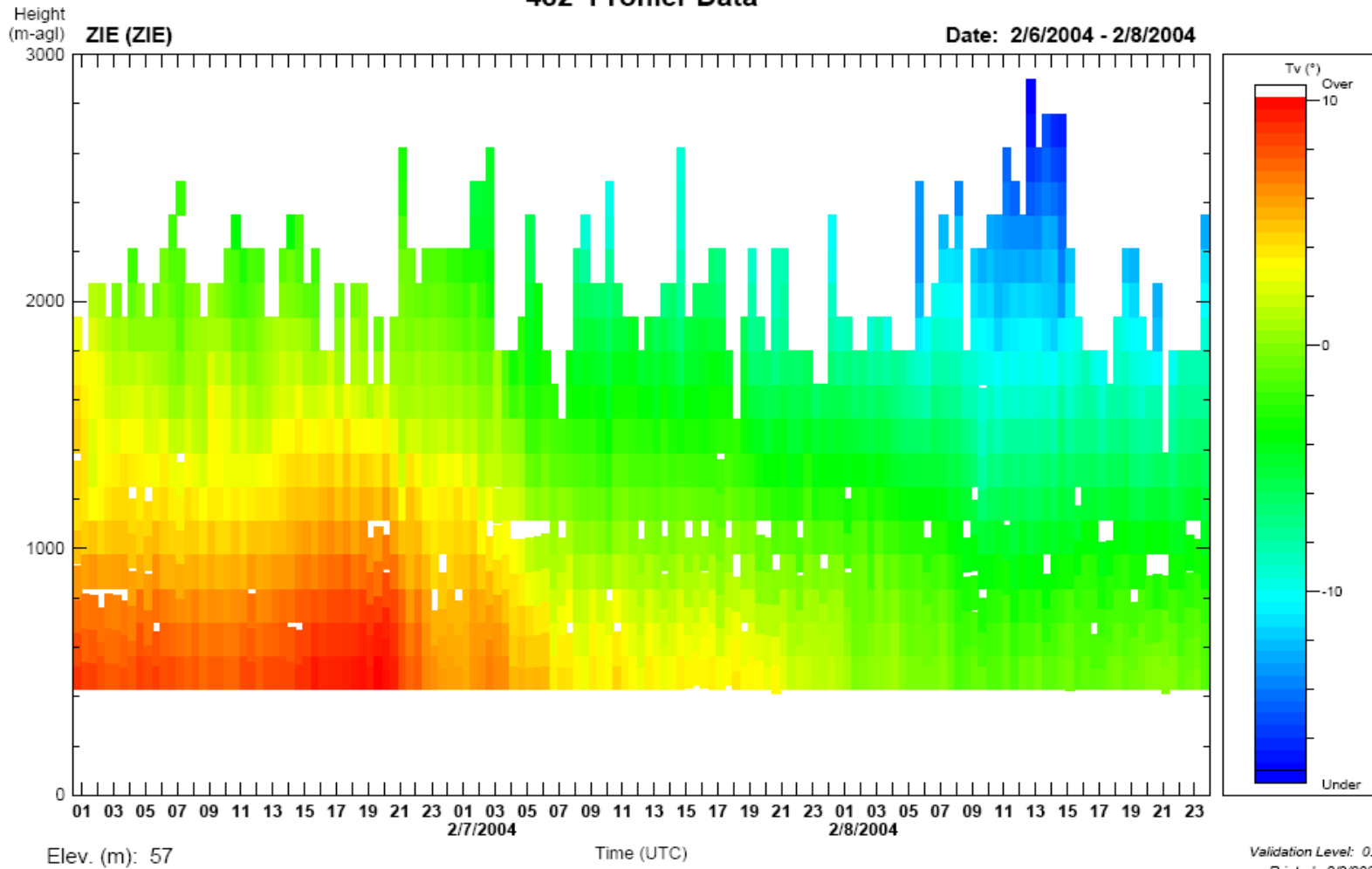
WPR / RASS

Rawin

WPR

RASS

482 Profiler Data



Validation Level: 0.0



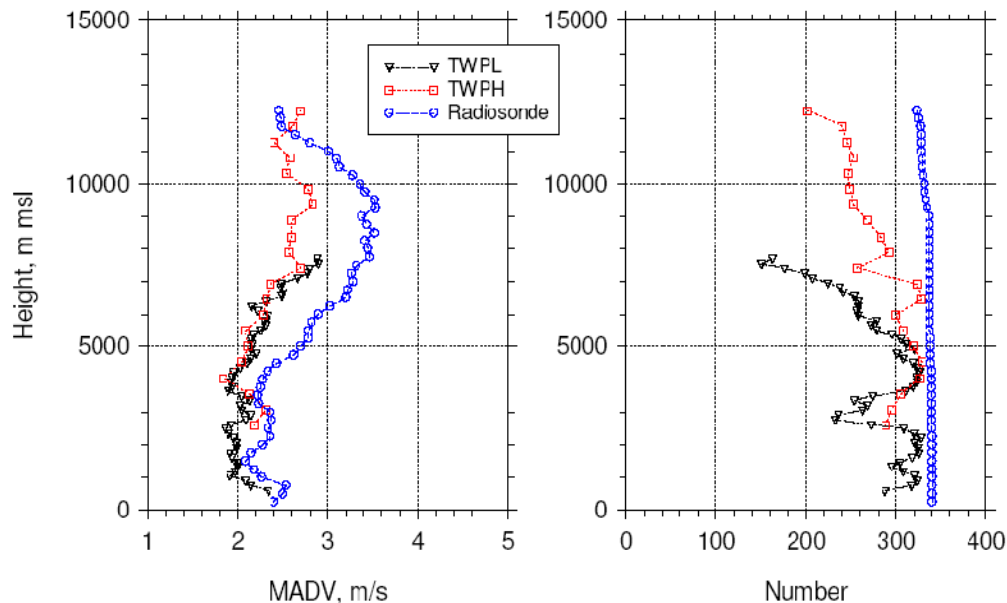
WPR / RASS - II

Concept

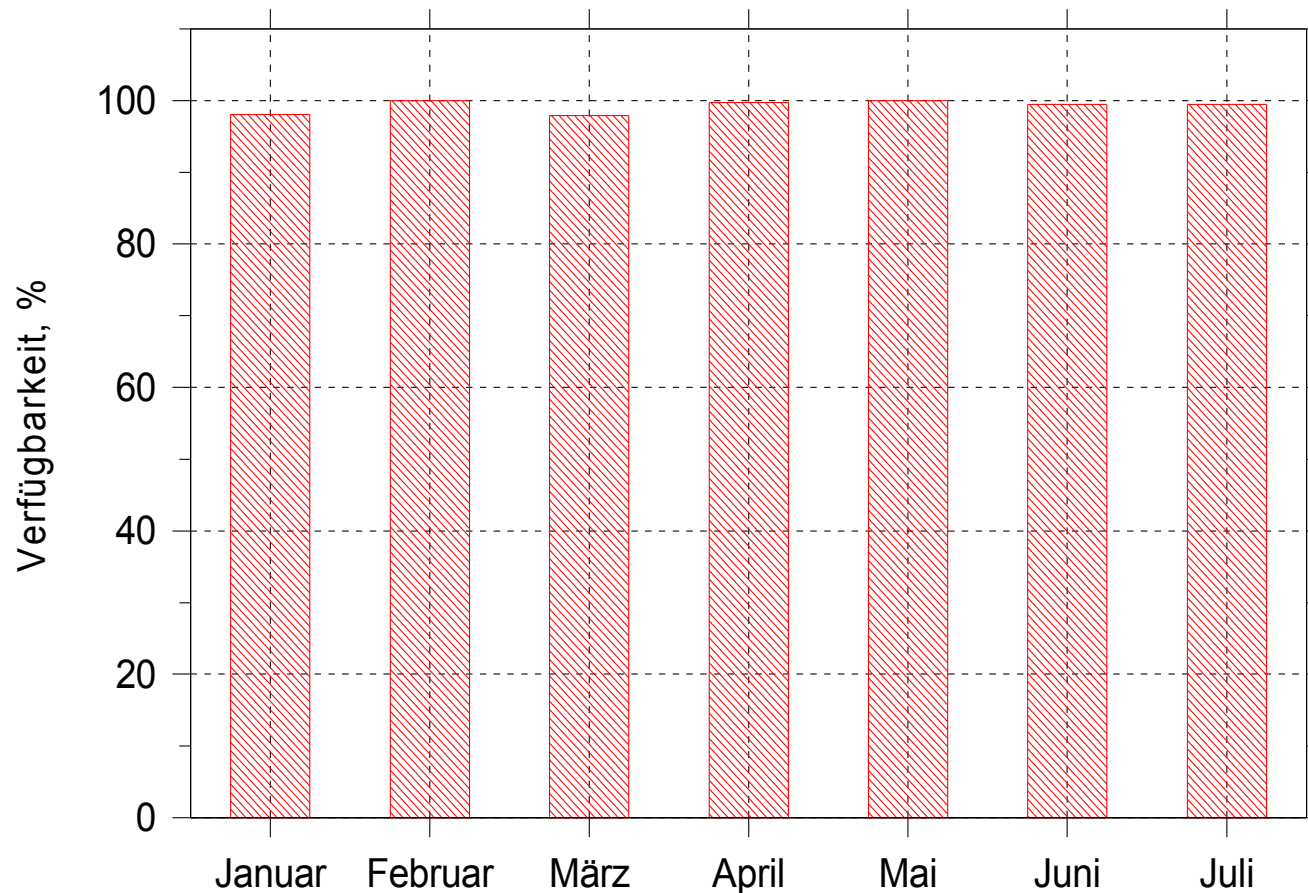
- Monitoring von Wind / Temperatur mit hoher zeitl. und vertikaler Auflösung (300 - 16000m)
- Weiterentwicklung der Messmethodik im Hinblick auf operationelle Anwendung (Datenassimilat.)
- Validierung geplanter Satellitensysteme (LIDAR)

Vergleich mit Modell- Betrag des Differenzvektors

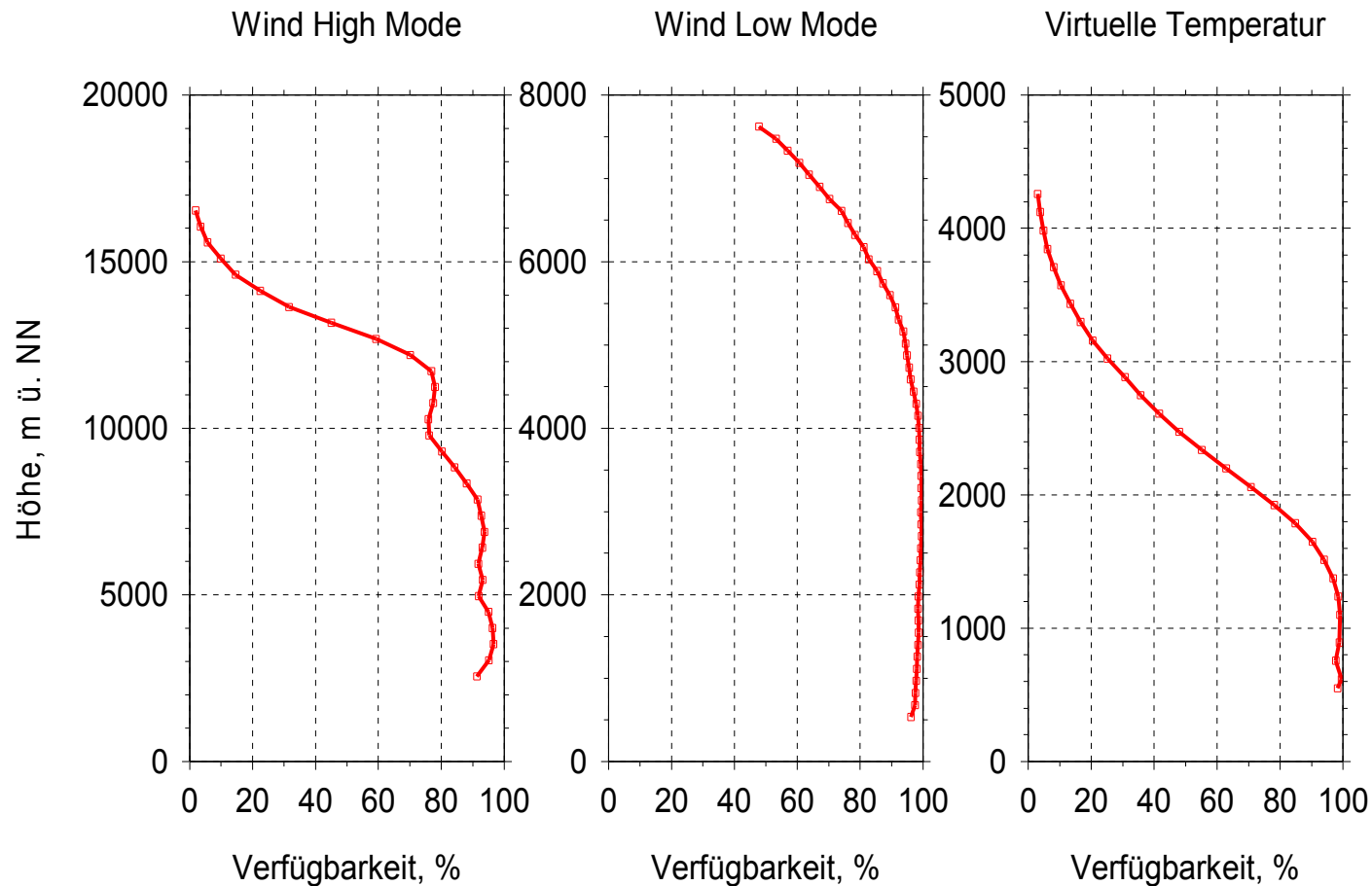
Dez. 2003 - Mai 2004



WPR - System Availability

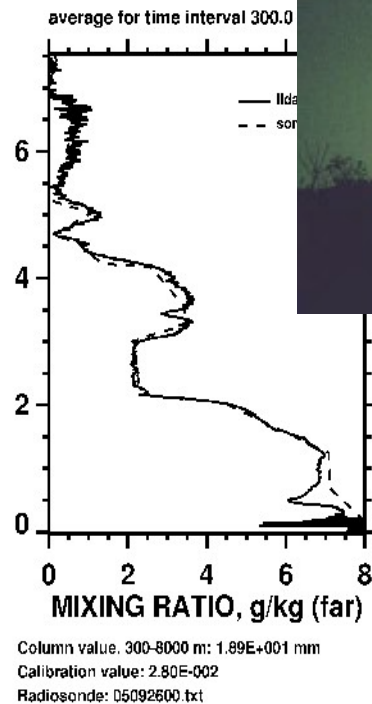
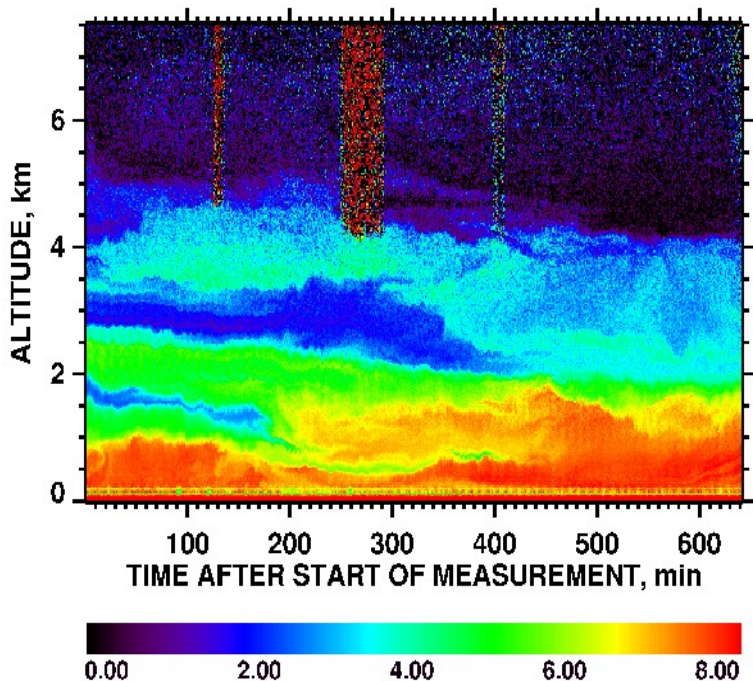


WPR / RASS: Vertical Measuring Range



Development / Test of new techniques → Lidar (GVaP)

WATER-VAPOR MIXING RATIO (far), res. 7.5 m, 30 s
DWD Raman Lidar, Lindenberg (52.21 N, 14.12 E), 25 Sep 2005, 17.54 UTC

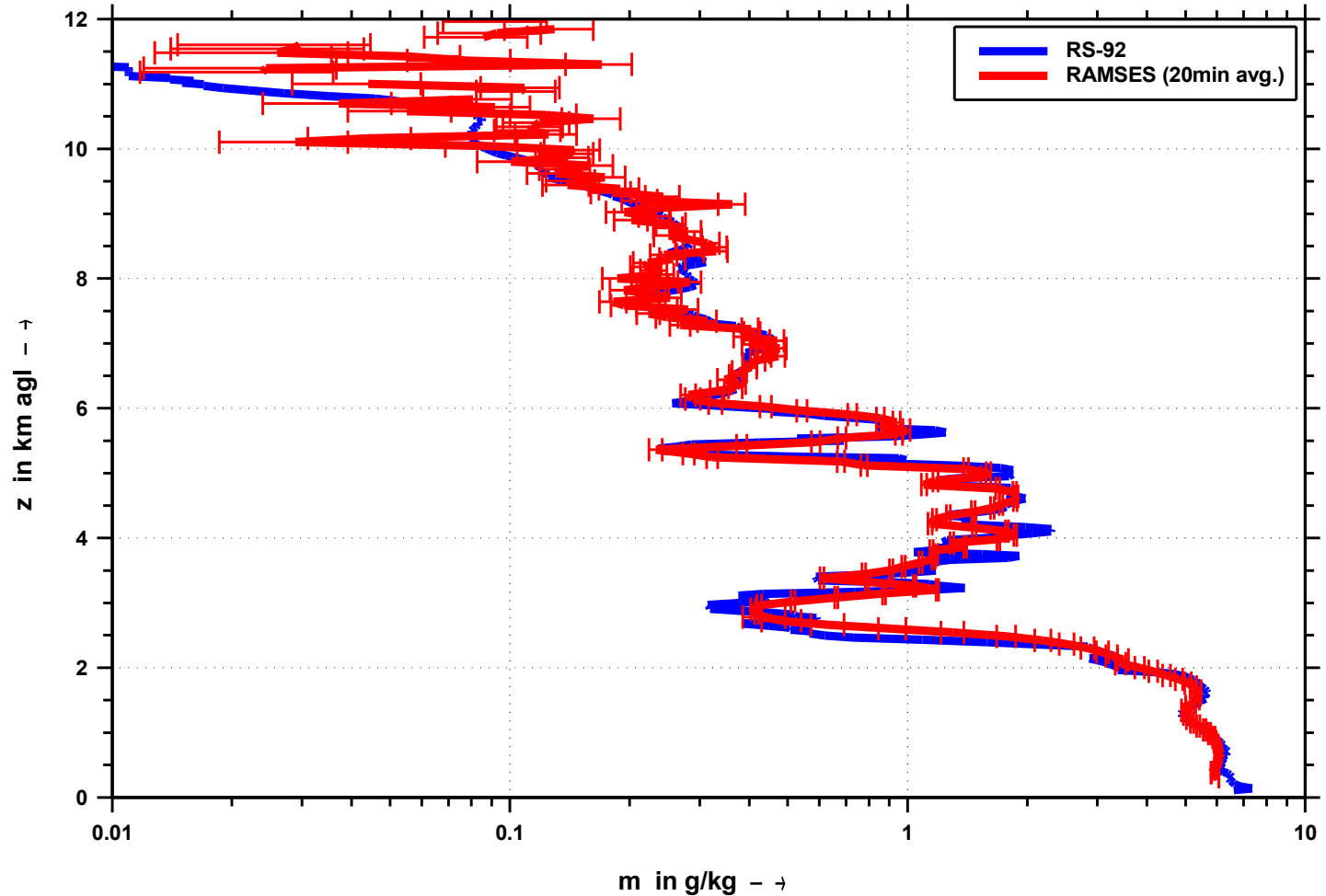


LUAMI (WMO)
internat. campg. at RAO in Nov/Dec '08

- Remote sensing
- Radiosondes

LIDAR - II

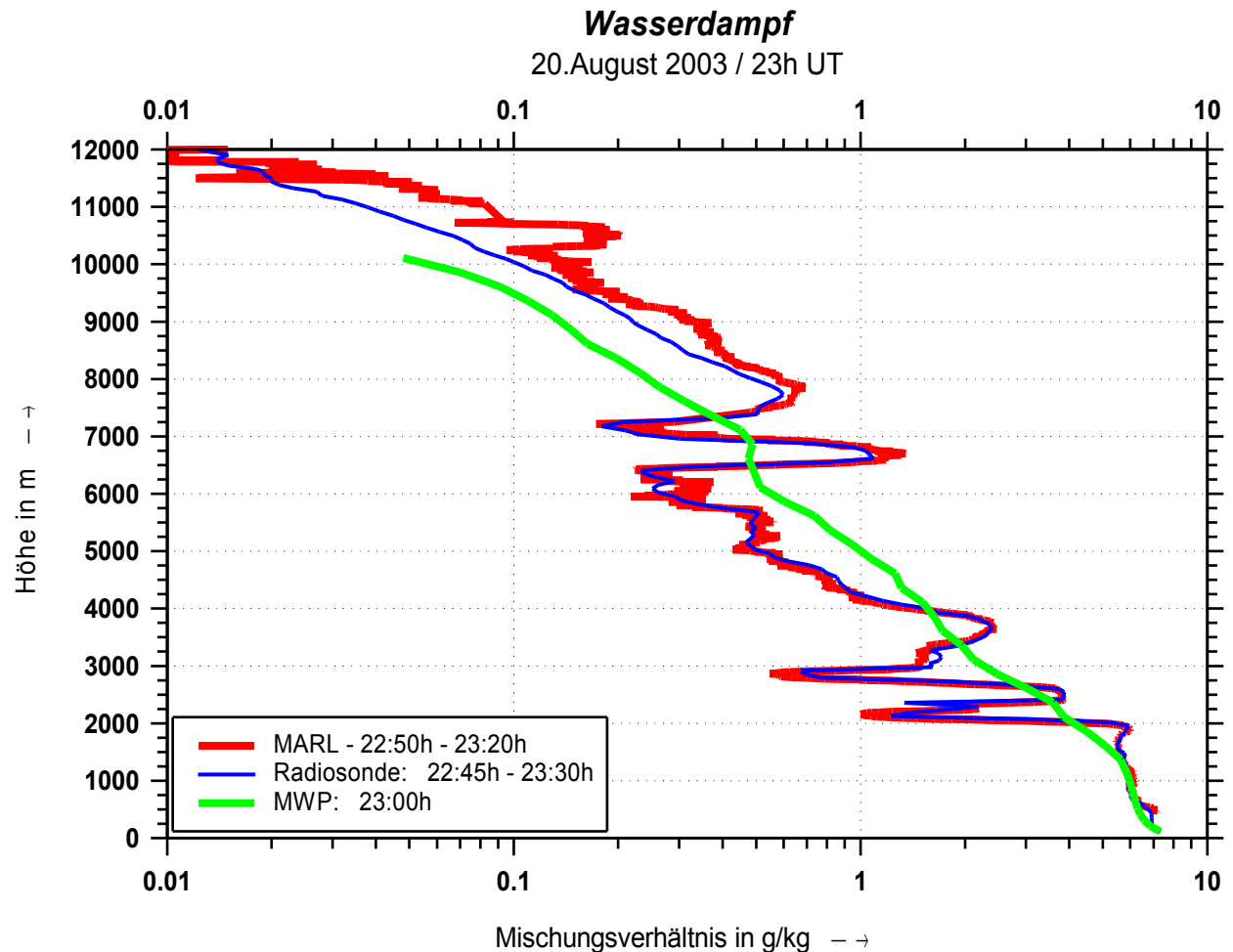
08 July 2007 / 23:00 UT



LIDAR - II

MARL@MOL-2003

Intercomp. of calibrated
MARL-measurements
with Radiosonde + MWP



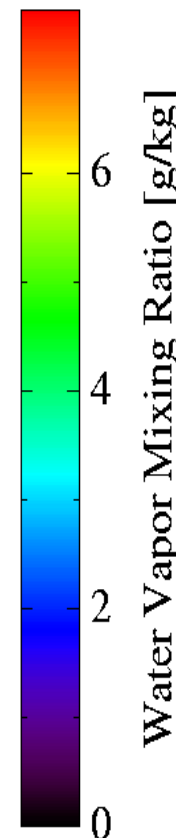


Observation

ECMWF i.s.

4D-Var i.s.

WV mixing ratio
Oct. 26/27, 2005



Height asl / km

23:00 00:00 Time UTC 01:00 02:00

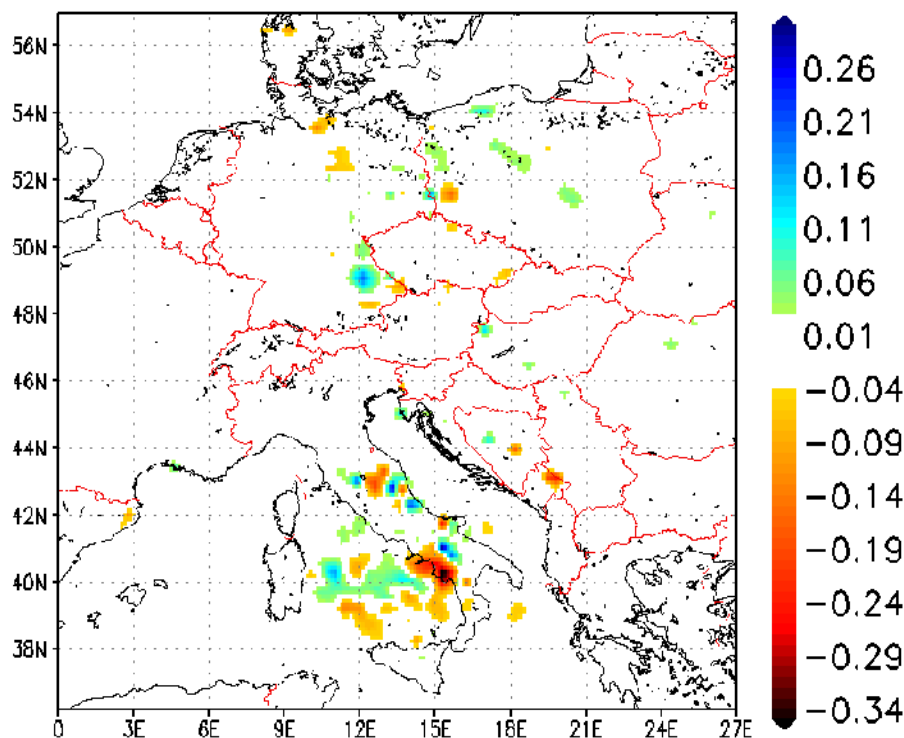
i.s. = initial state



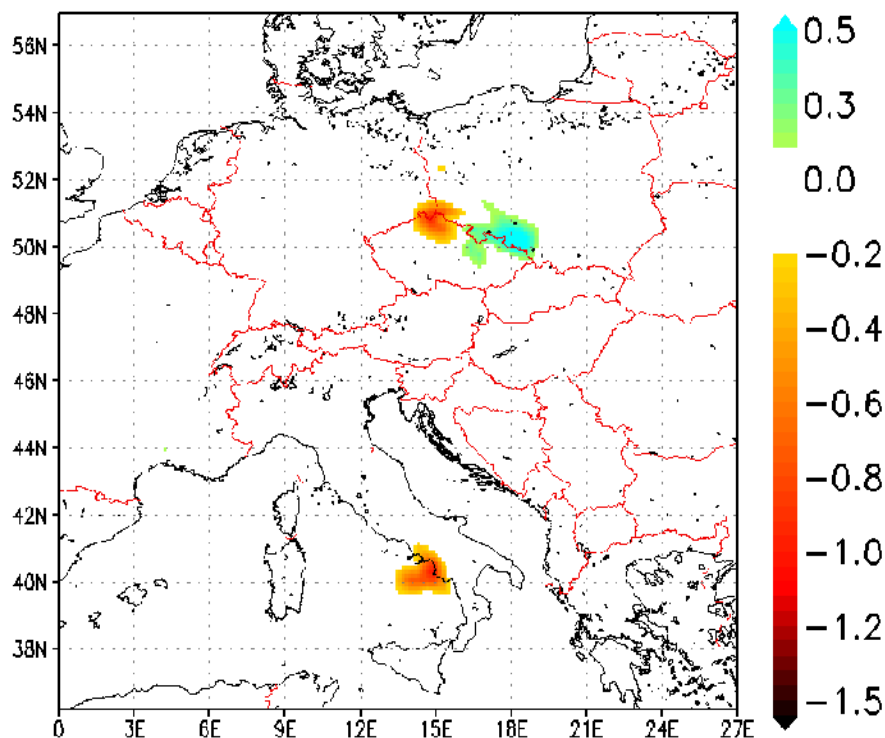
4D-VAR

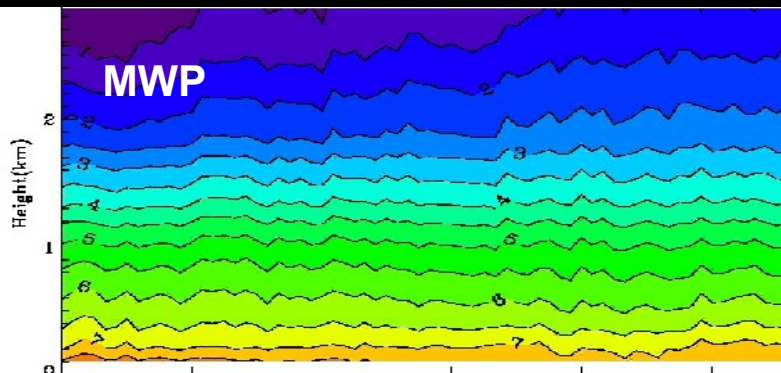
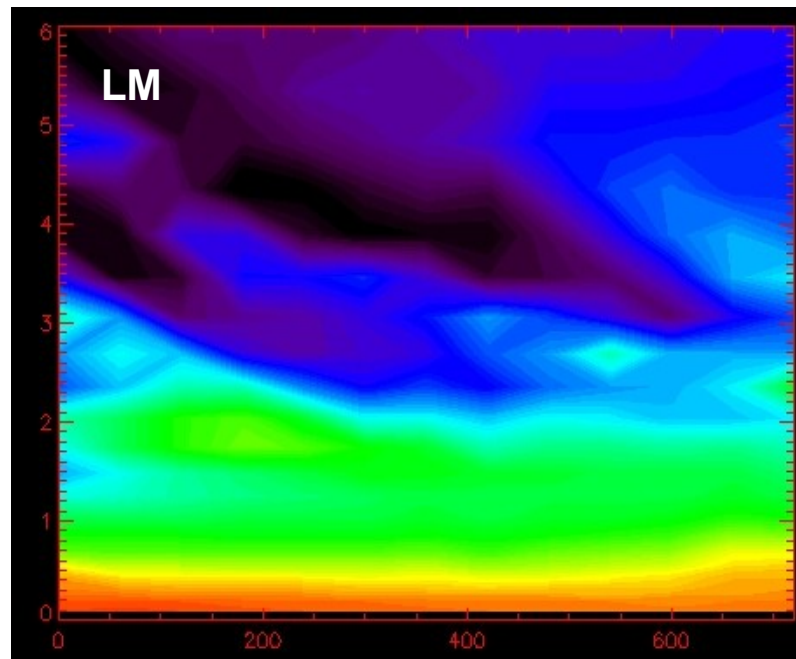
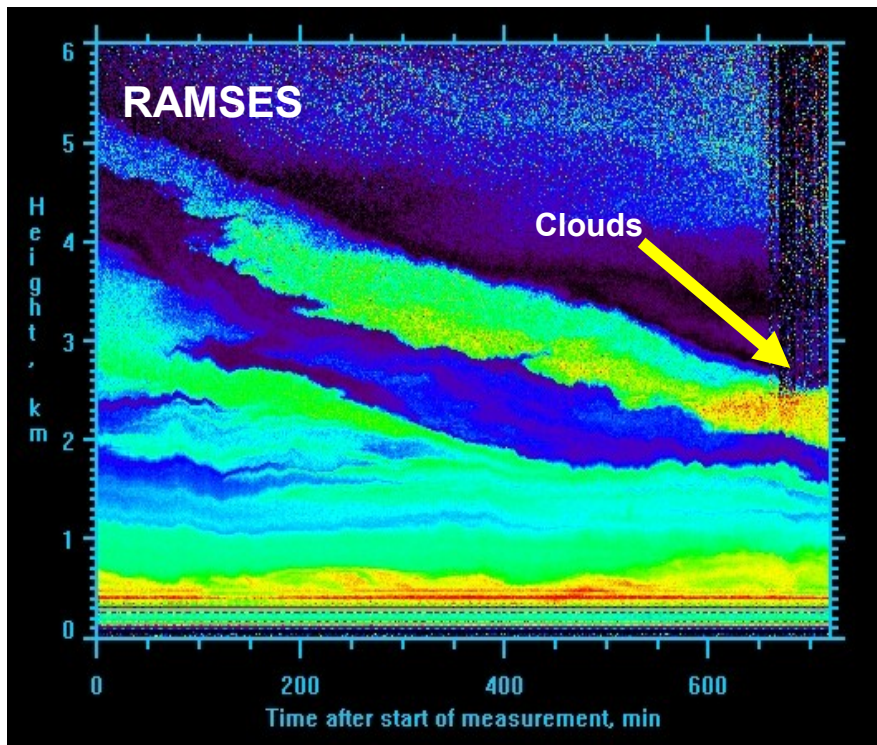
Water vapor mixing ratio [g/kg] (4D-Var - Control)
at 08:00Z27OCT2005

2m wv mixing ratio



850hPa wv mixing ratio



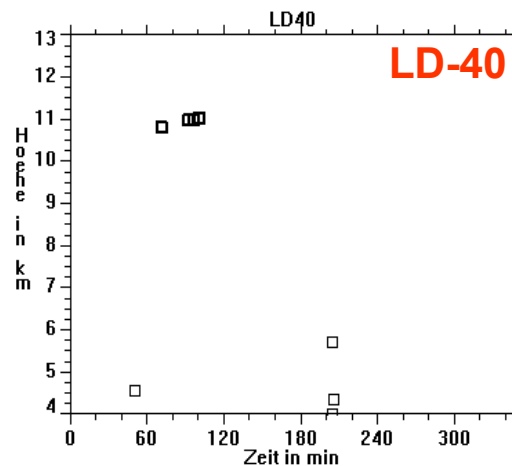
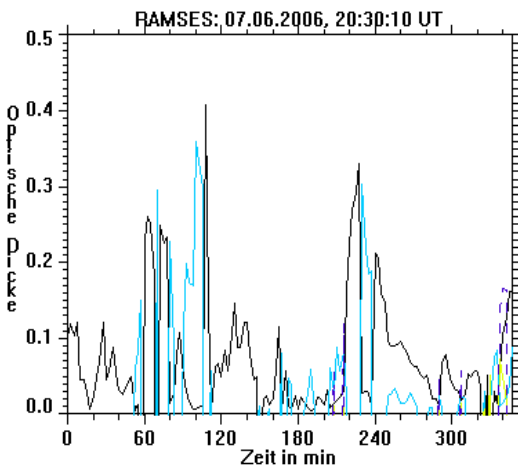
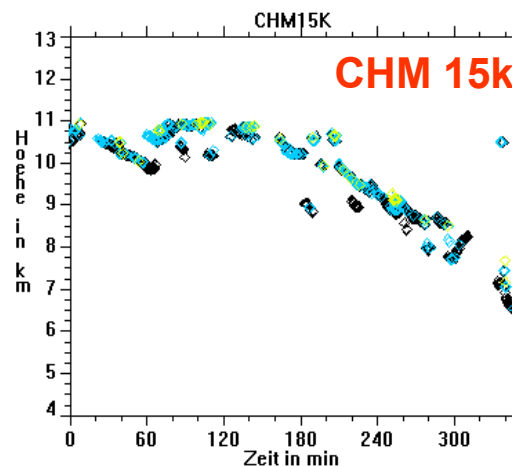
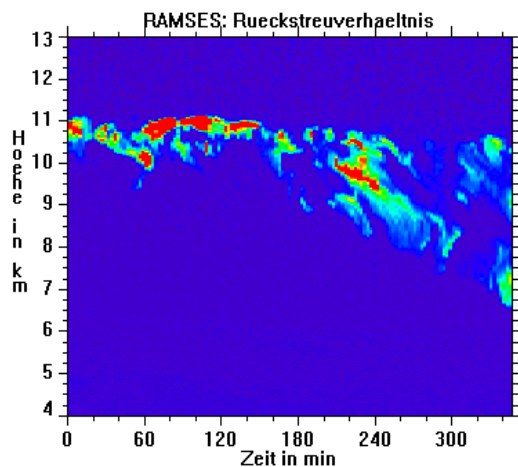


Water-vapour mixing ratio
14.10., 1712 UTC - 15.10., 0511 UTC



Ceilometer

→ example for assessment of new techniques



Vaisala LD-40



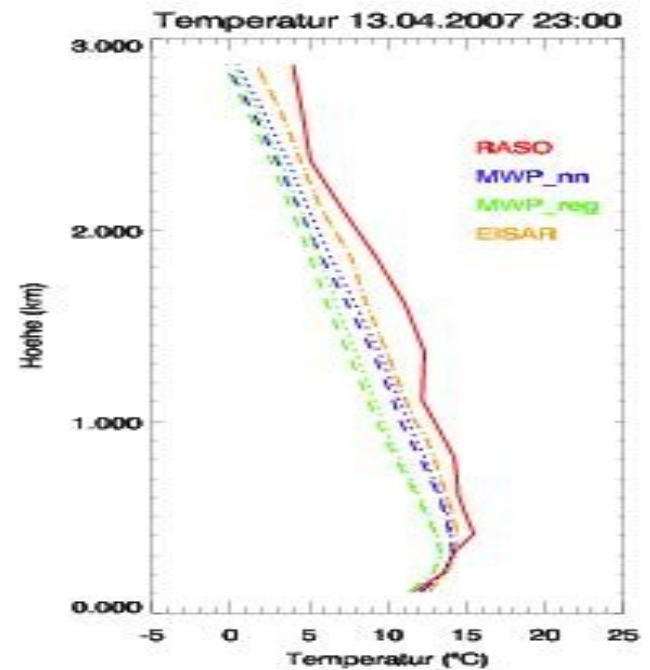
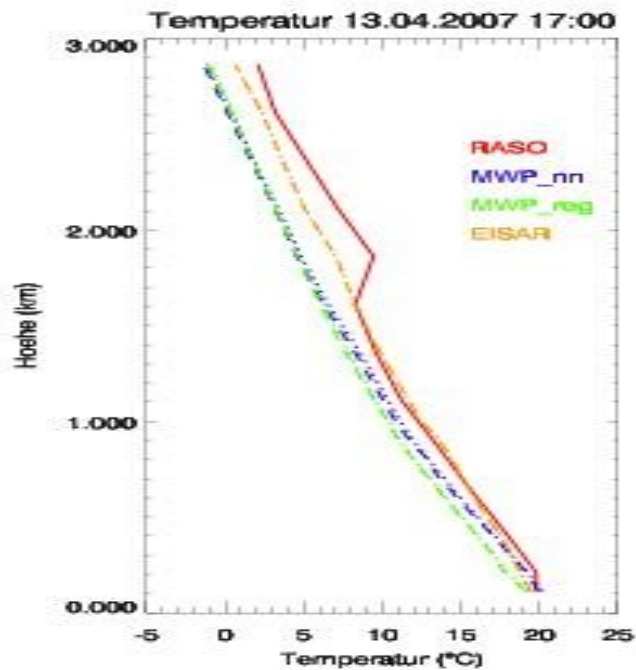
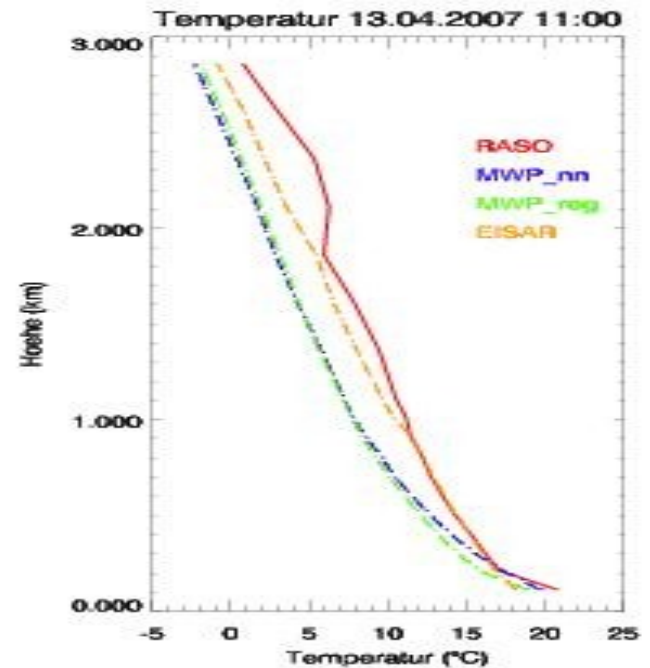
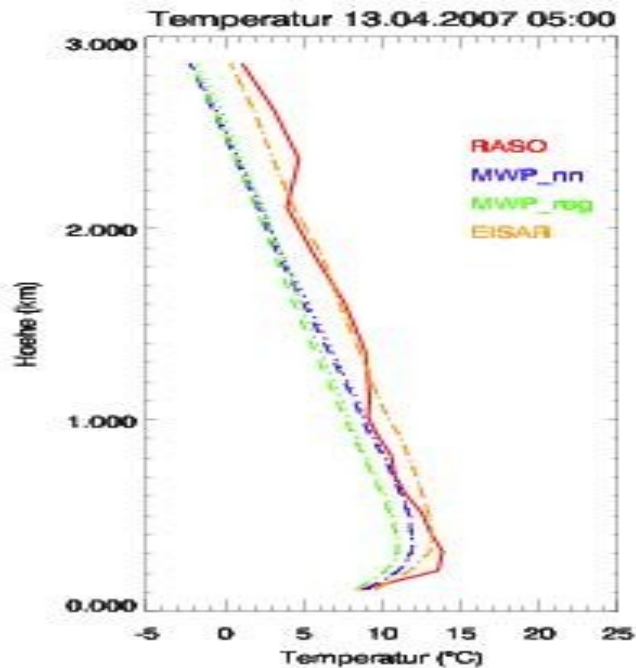
Jenoptik CHM-15k

FTIR & MWP

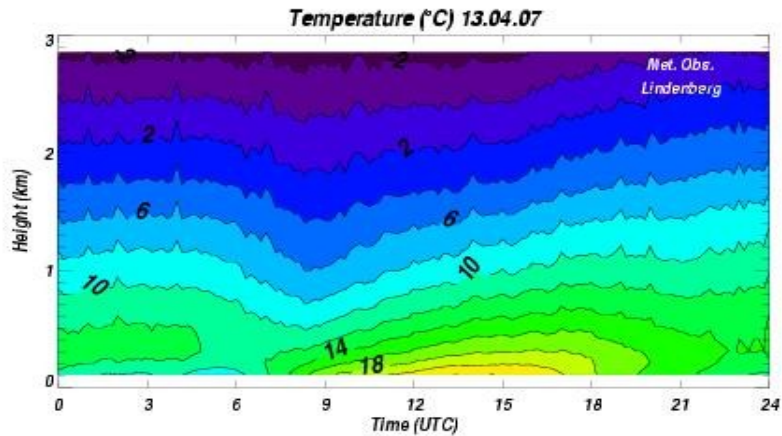
Intercomp. von Rasos vs.

EISAR (FTIR) & MWP
temperatures

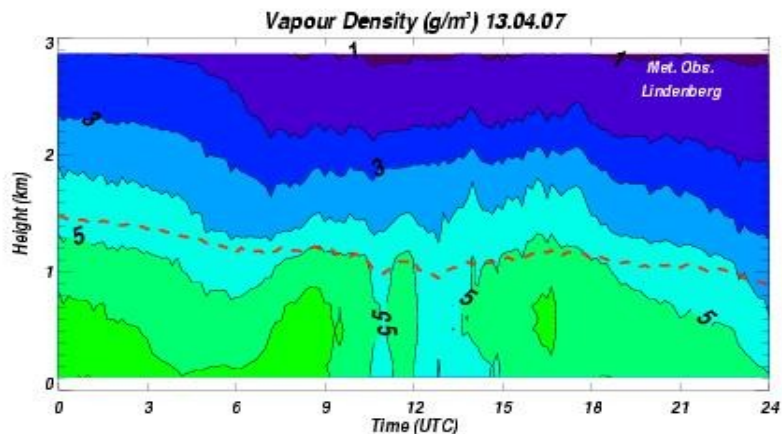
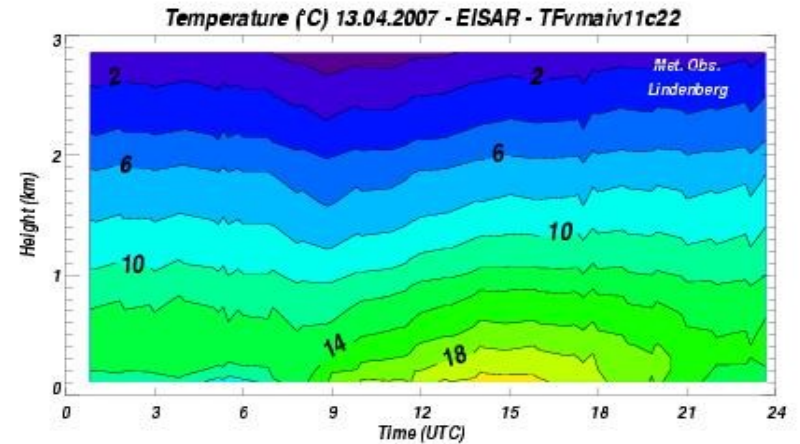
→ 13th April 2007
(all rasos)



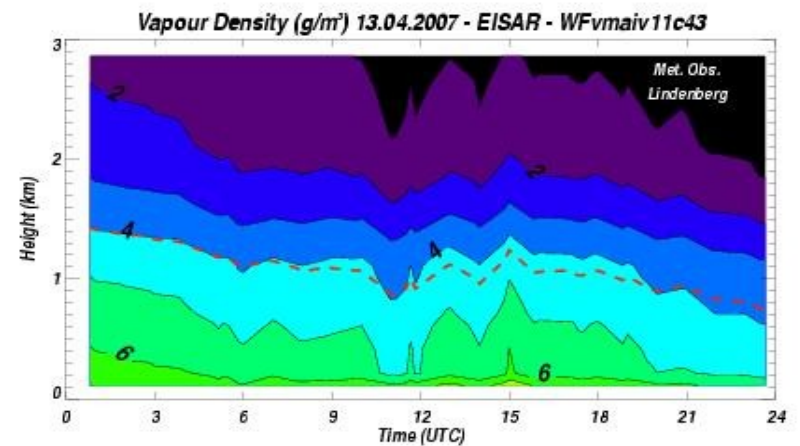
MWP



EISAR



--- IWV - Integrated Water Vapour (cm)



--- IWV - Integrated Water Vapour (cm)

Improvement of operational techniques → MWP

Validation → Dec. 2004 – Nov. 2005:

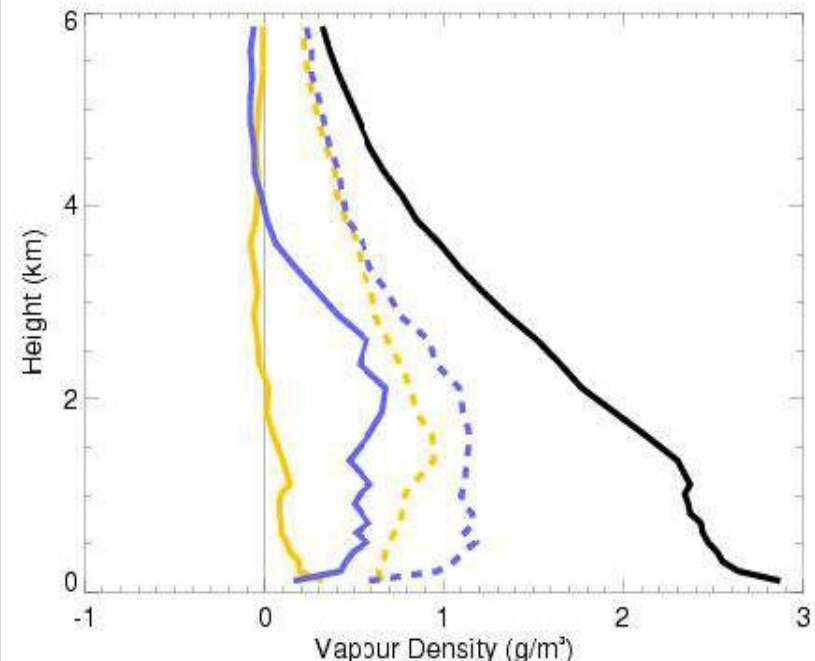
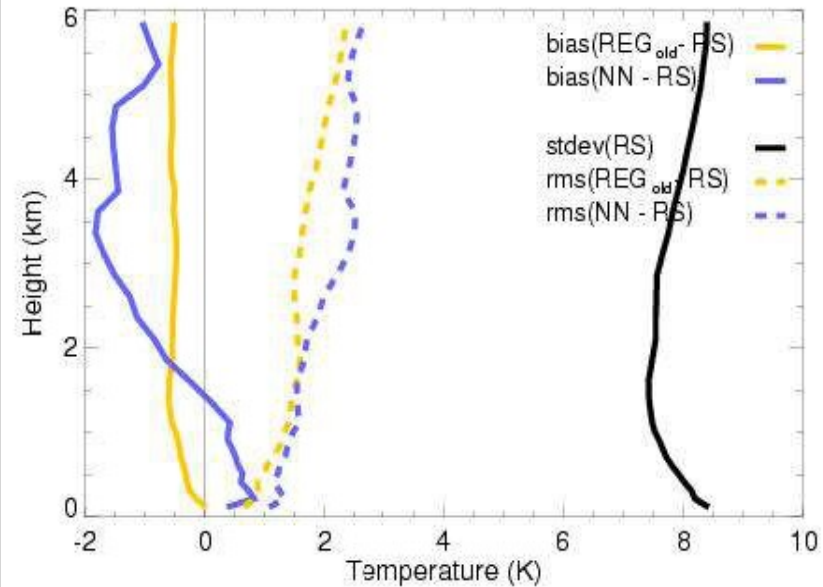
Bias & rms error of **T-** & **U-** profiles (vs. Raso):

- neuron. net
- data-based regression (operational)

Model-based regression (training):

- for reduced systemat. errors
- allows easy use of MWP everywhere

01.12.2004-30.11.2005 (cases: 520)



Deutscher Wetterdienst

Meteorological Observatory Lindenberg
Richard Aßmann Observatory



Cloud Radar

Availability

2004: 83 %

2005: 95 %

2006: 98 %

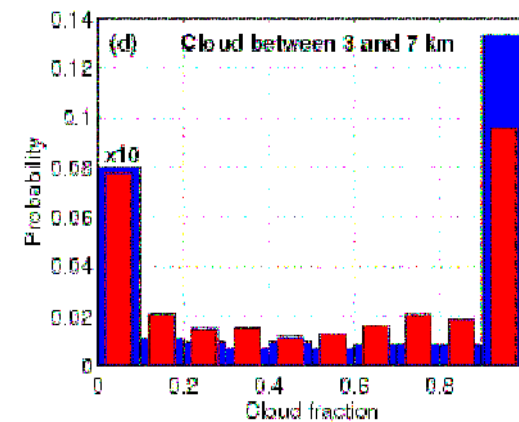
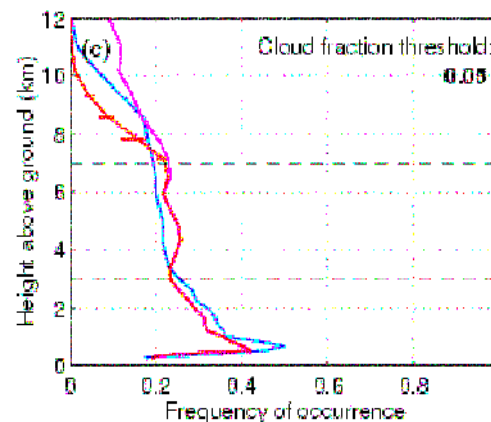
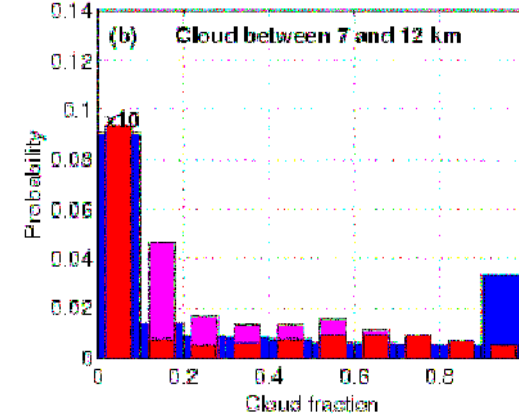
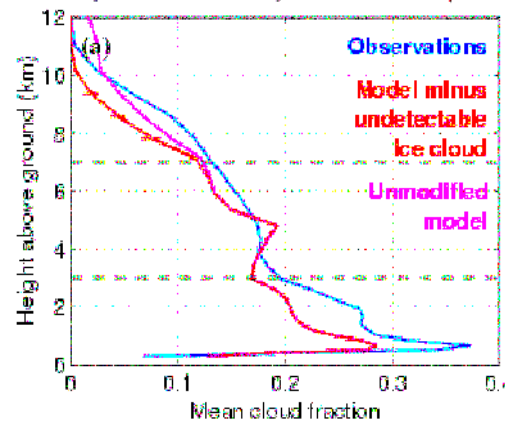
2007: 92 %

2004	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
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2006	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
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Cloud Radar: internat. projects & networks

Evaluation of DWD Lokal Modell cloud fraction at Lindenberg during Dec 2004
Equivalent of 29.4 days of data (6-17 hour forecasts)



CLOUDNET:

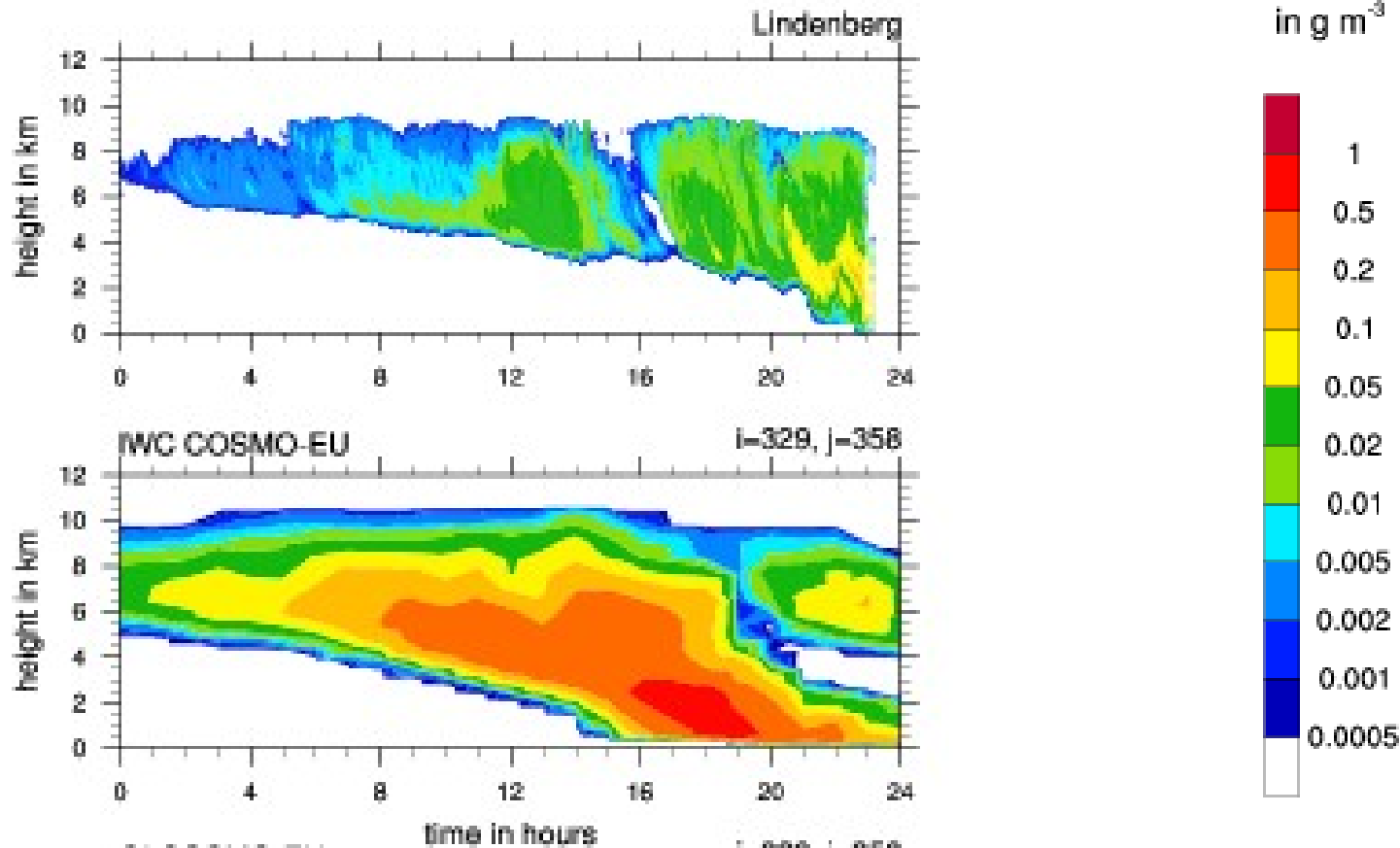
Intercomp. measur. - model:

e.g. Lindenberg vs. DWD-LM Dec. 2004:

- Frequency of cloudiness rates
- shows positive aspects of **sensor synergy** by **combination** of methods

Cloud Radar: NWV validation (MOL/RAO - FE1)

Ice water content of 20070320



“large“ droplet mode (6h data)

Synergetic effects

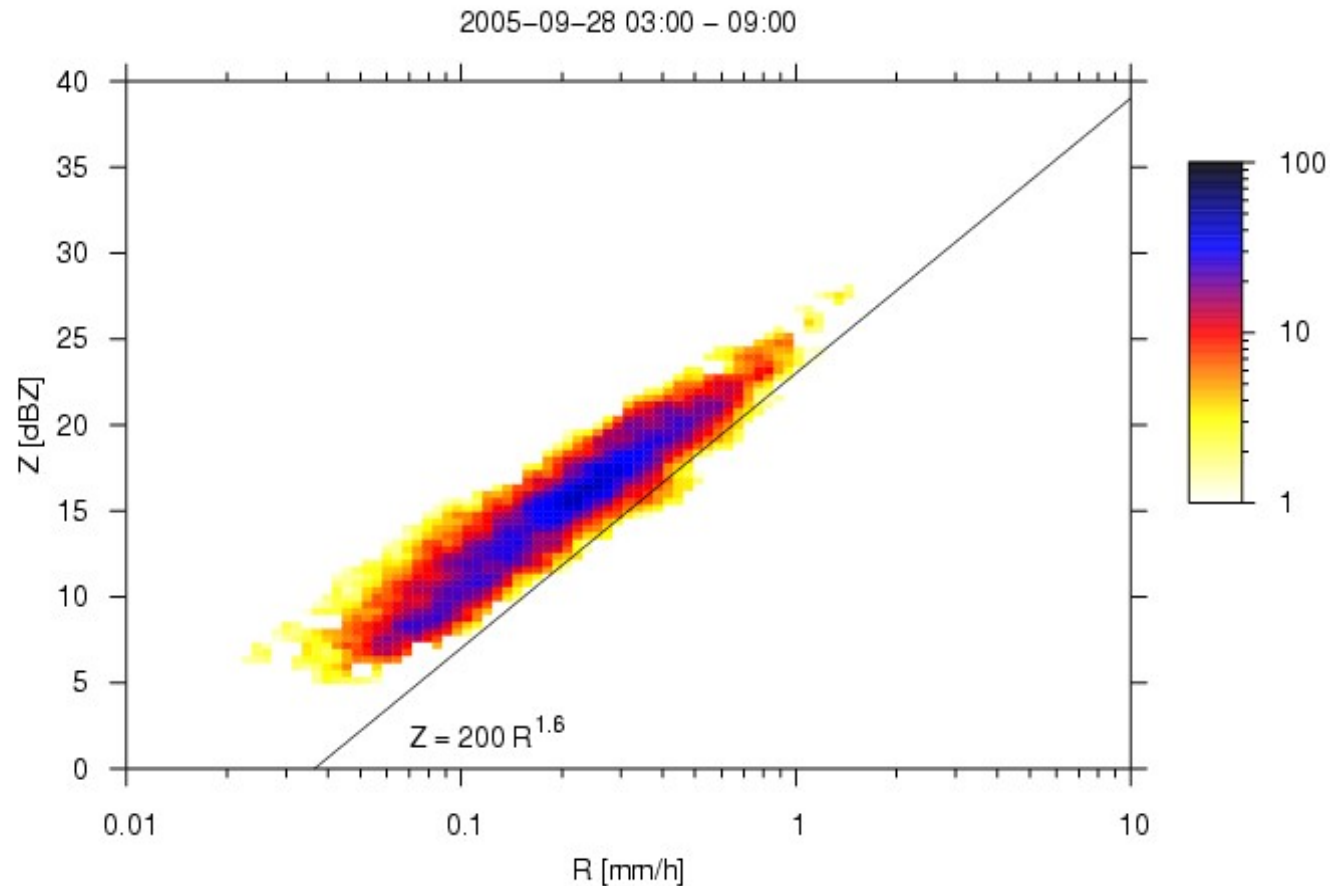
Rain rates

from
Weather radar
+
Micro-Rain Radar

→ Z/R relation
via x-Band-Rad. & real DSD

DSD:

- classif. in modes
- meas. by MRR



Internat. Projects and Activities

- **GRUAN** (GUAN, GSN) → **WMO GCOS**
- **COST-720** / -WaVaCS & -CLIMET
- ADM/Aeolus validation (**ESA**)
- EUMETSAT → project to METOP-IASI (validation)
- **WMO – CIMO** → **LUAMI-2008**
 - OPAG UA (ET RSUT&T, ET-RSUASI)
- **GVaP**
- **WINPROF** (**EUMETNET**)
Interface to WMO-CIMO, OPERA, EUMETFREQ

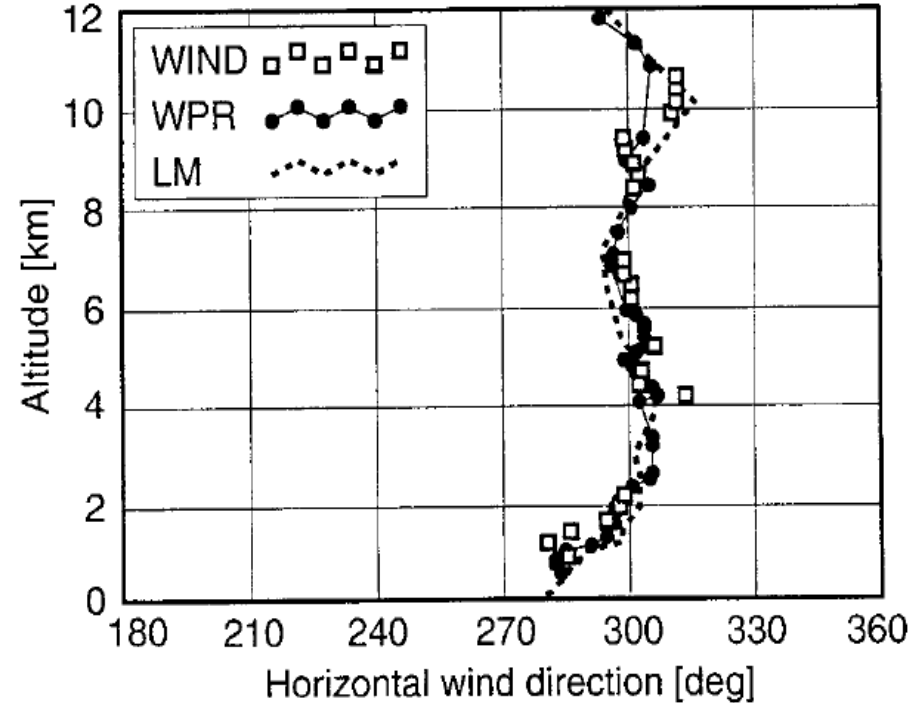
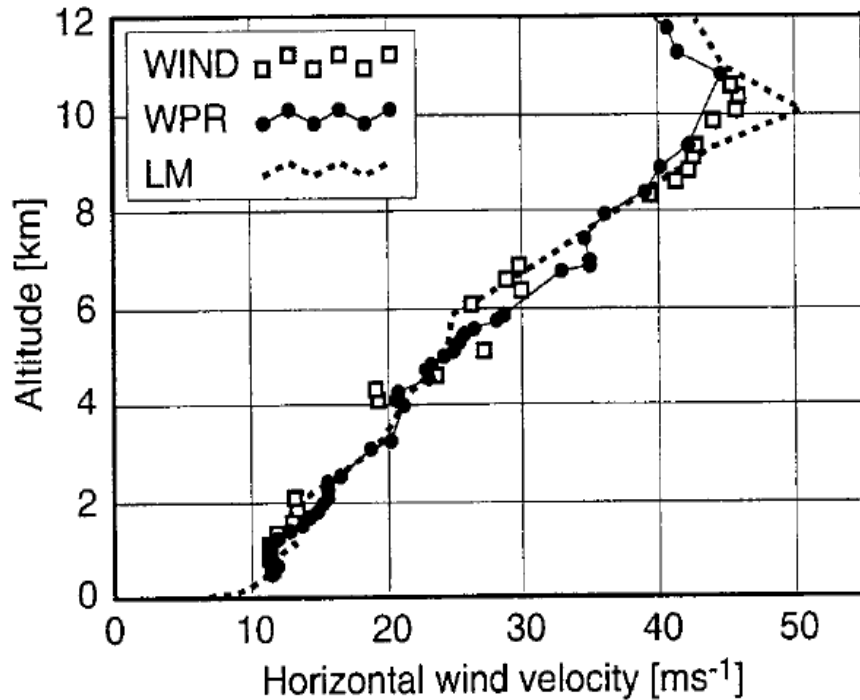


National / internat. Projects

➔ ADM/Aeolus = 1st wind LIDAR in space

Preinvestigation-2001 (E-W flight track):

WIND → 1335 UTC (dt=100 s), WPR → 1335 to 1400 UTC, LM → 1330 UTC

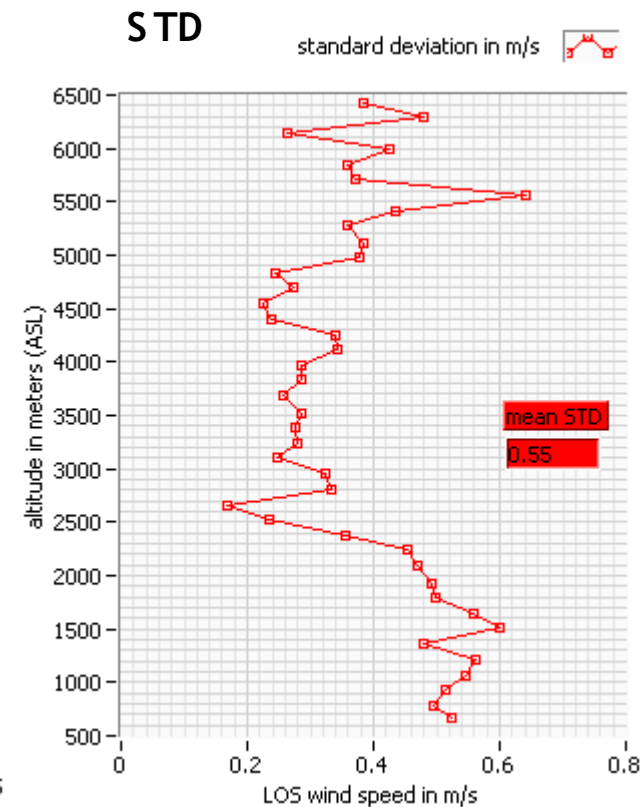
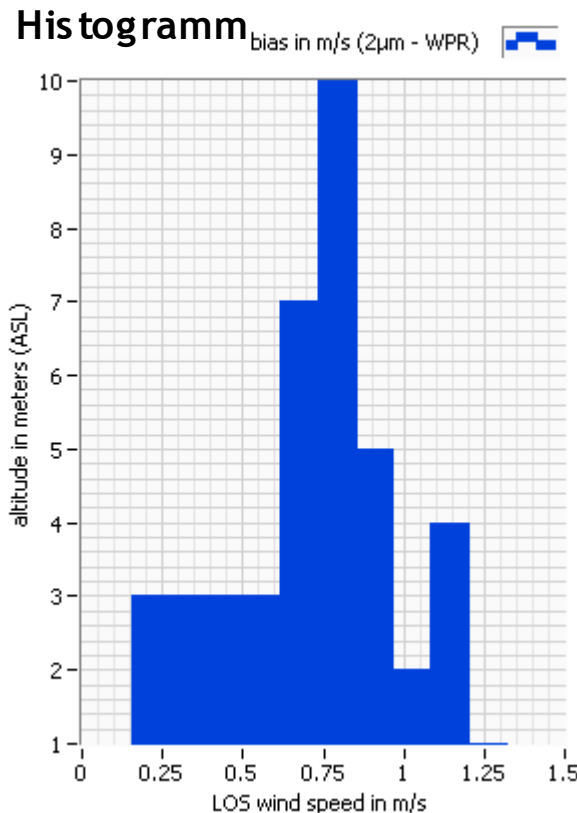
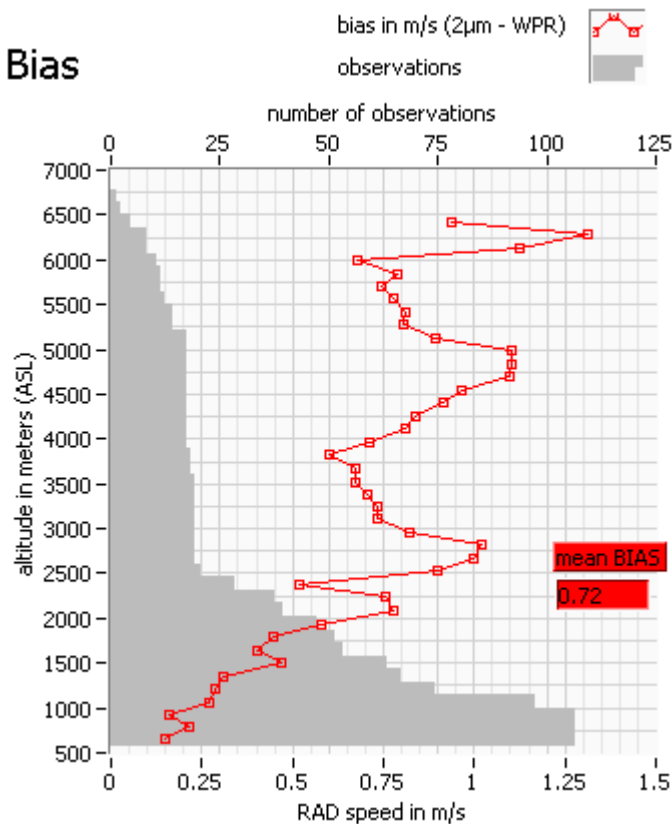


MOL-RAO:

- Ground-based campaign in **Okt. 2006 + Juli 2007**
- Airborne campaign in **November 2007**

Launch: **Oct. 2008**

ADM/Aeolus: Results of Validations at MOL/RAO in 2007

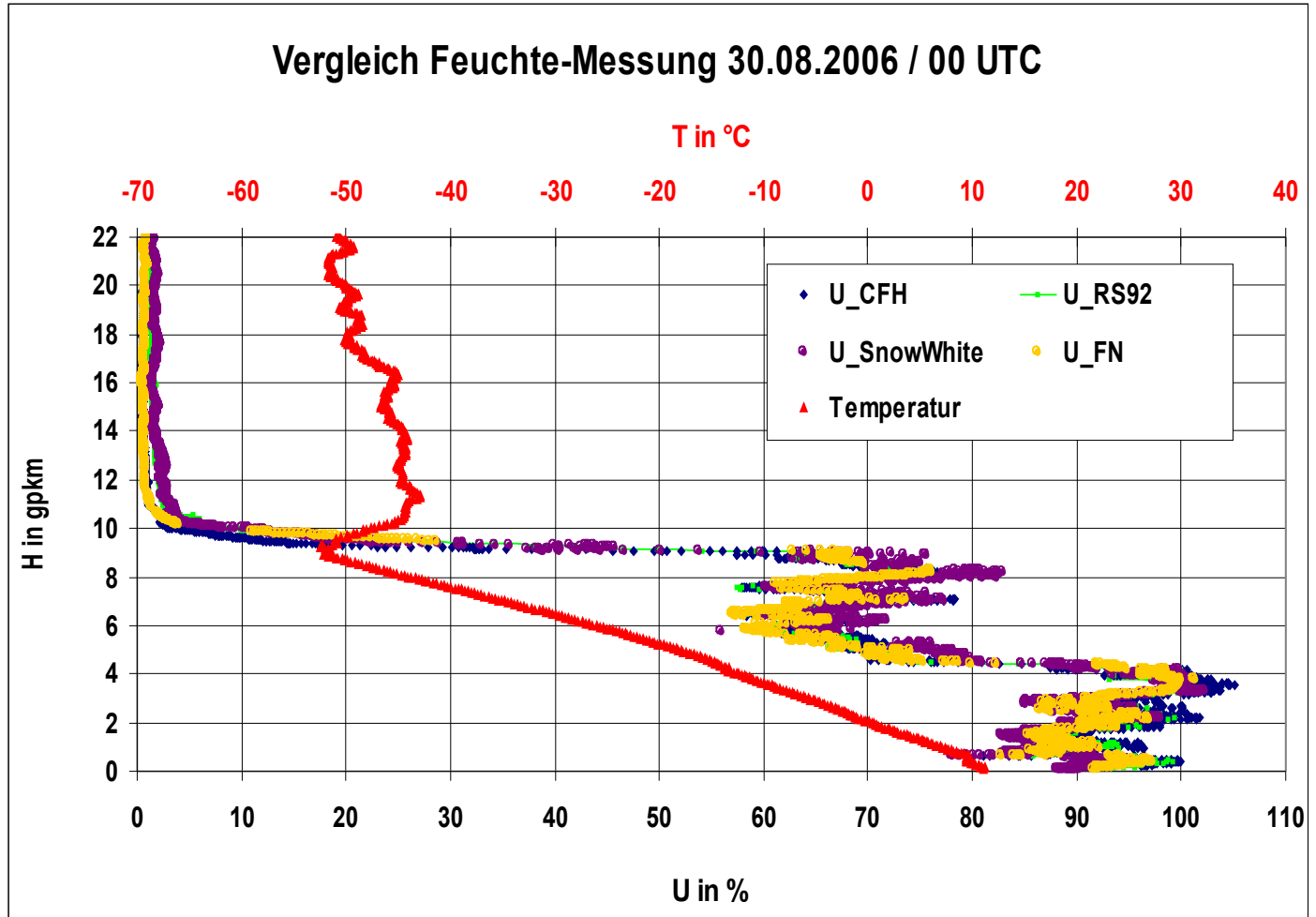


PROJECTS

Remote-sensing &
Radiosondes with
High-precision
humidity sensors

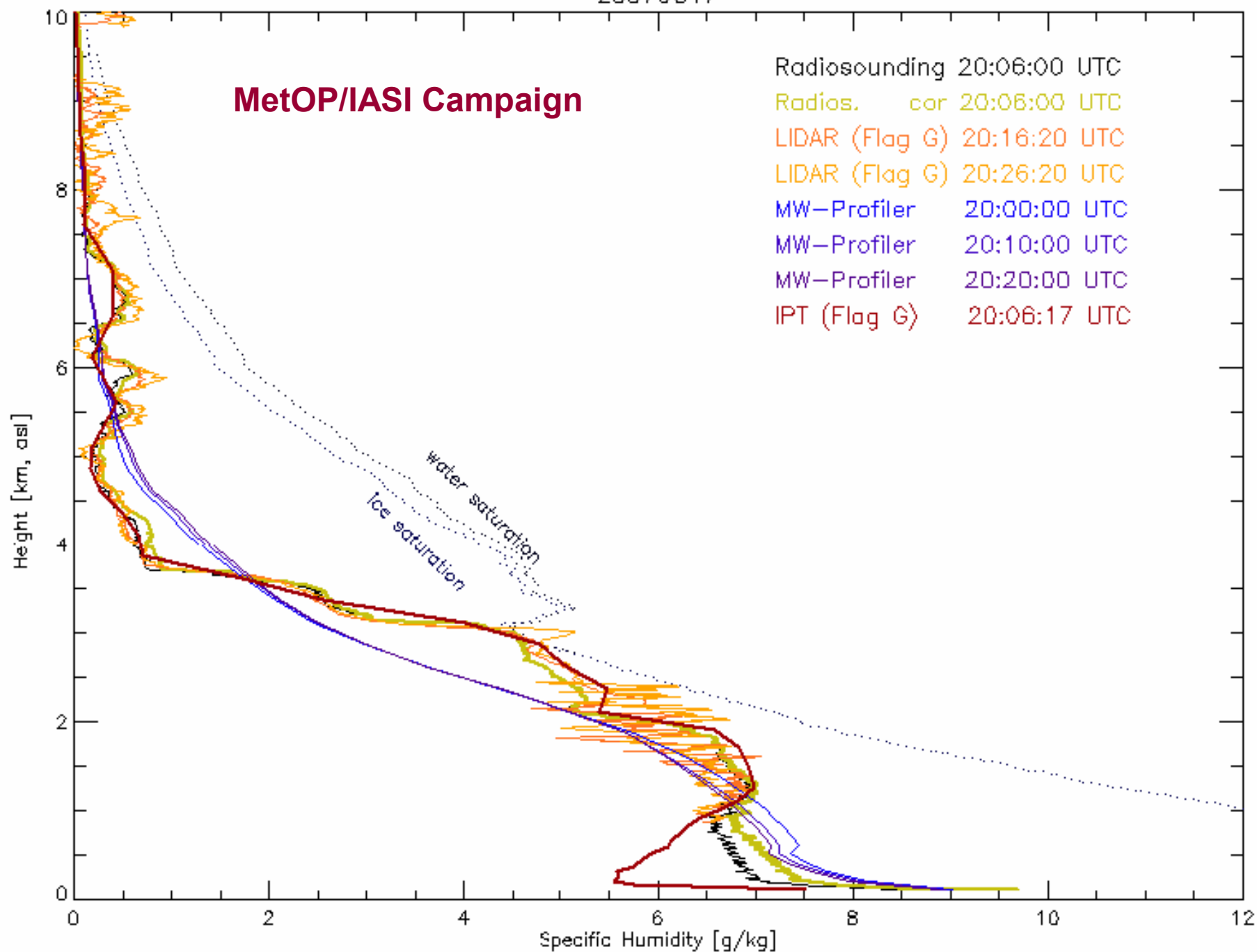
→ **LUAMI-2008**

CIMO & COST:
Nov. / Dec. 2008

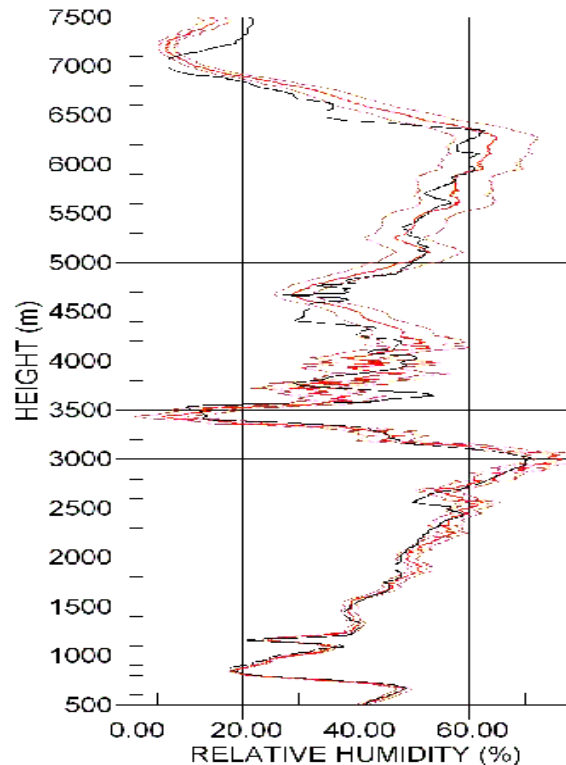
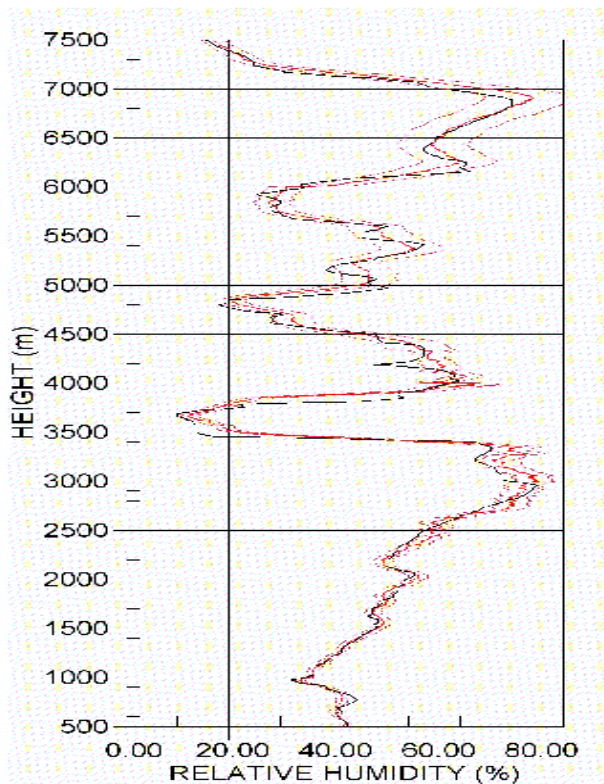


Intercomparis. of humidity sounding @ RAO using different reference sondes (FN, CFH, SnowWhite) & routine sondes (RS92) at 30 Aug.2006 / 00UT

MetOP/IASI Campaign



Absolute quality of radiosonde profiles: Oct 30 – 31, 2005



RH profiles for the period 23:13–23:23 UTC on 2005-10-30(left) & for the period 05:03–05:13 UTC on 2005-10-31(right)

- Bold (red) lines correspond to the **lidar** profiles, thin (red) lines indicate the measurement **uncertainties**
- **Black** lines show the profile of the 00 UT **radiosonde** (left) and of the 06 UTC radiosonde (right)