First informal JOYCE meeting

Forschungszentrum Jülich

Date: 23.03.2011
Time: 13:00 – 15:00
Location: Seminar room 3010 or 3012, building 05.2, entrance E4

Preliminary schedule

13:00 – 13:05	Welcome and Introduction	
13:05 – 13:15	FZJ meteorological station	Axel Knaps
13:15 – 13:25	Solar actinic and SW radiation	Birger Bohn
13:25 – 13:35	MAX-DOAS measurements	Li Xin
13:35 – 13:45	Pulsed Doppler-LIDAR	Theo Brauers
13:45 – 13:55	Aerosol backscatter LIDAR	Cornelius Schiller
13:55 – 14:10	Site seeing of roof installations	
14:10 – 14:20	MIRA-36 cloud-radar	Kerstin Ebell
14:20 – 14:30	HATPRO	Gerrit Maschwitz
14:30 – 14:35	Ceilometer/Microradar/Cloud camera	Ulrich Löhnert
14:35 – 14:40	Infrared-spectrometer & synergetic products	Ulrich Löhnert
14:40 – 14:50	TR32 & JOYCE: proposed science objectives	Susanne Crewell
14:50 – 15:00	Discussion	

Mitglied der Helmholtz-Gemeinschaft

JÜLICH
FORSCHUNGSZENTRUM

Meteorological Station of the FZ Jülich

- Observation Site ⇨
- Meteorological Tower ⇨
- Platforms ⇨
- Data Acquisition and Handling ⇨
- Meteorological Parameters ⇨

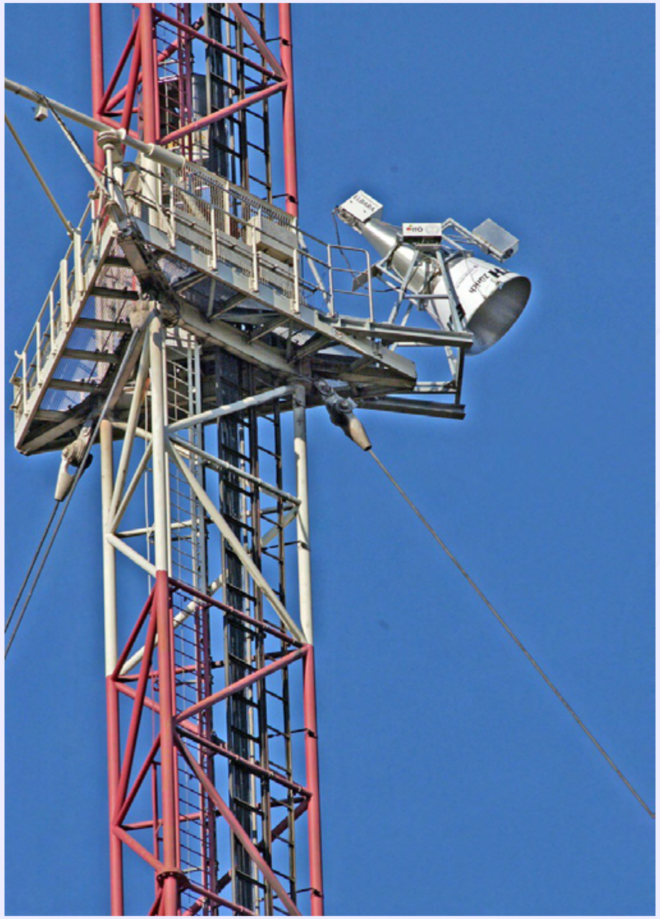
Observation Site

- built in 1963-1964
- on a glade in the Stetternicher Forst

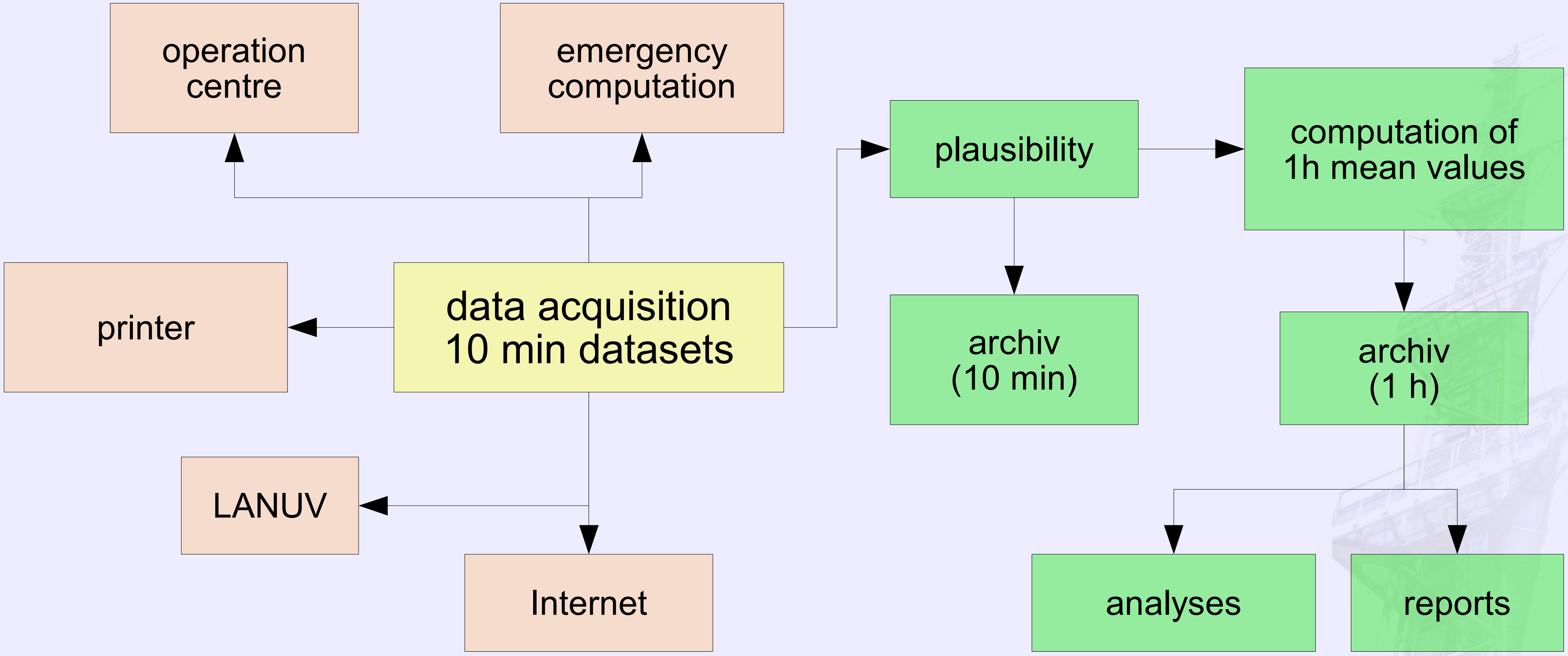
Tower

- height: 124 m
- 7 platforms
- electrically driven elevator
- -
- meteorolog. measurments
- dispersion experiments in 70th und 80th (TA-Luft)
- also used for atmospheric research by other institutes of the FZ Jülich

Platforms



Data Acquisition and Handling



operation centre

emergency computation

printer

data acquisition
10 min datasets

LANUV

Internet

plausibility

computation of
1h mean values

archiv
(10 min)

archiv
(1 h)

analyses

reports

Meteorological Parameters

heigth	tempe-ratur	direction	wind velocity	rel. humidity	radiation budget	precipi-tation	sunshine duration	pressure
🟩 120	🟩 1	2	1	1	1			
100	1		1	1				
80	1		1	1				
50	1	2	1	1				
🟩 30	1	🟩 2	🟩 2	1	1		1	
🟩 20	🟩 1		1	1			1	
10	1		1	1				
🟩 2	1		1	1		🟩 1		1

🟩 measurements according to KTA 1508

Pyrradiometer

- Ph. Schenk Typ 8111
- range: 0–1500 Wm^{-2}
- spectral sensitivity: 0.3 - > 30 µm
- response time: 25 s (95 %)
- response time: 45 s (99 %)
- housing temperature: PT100

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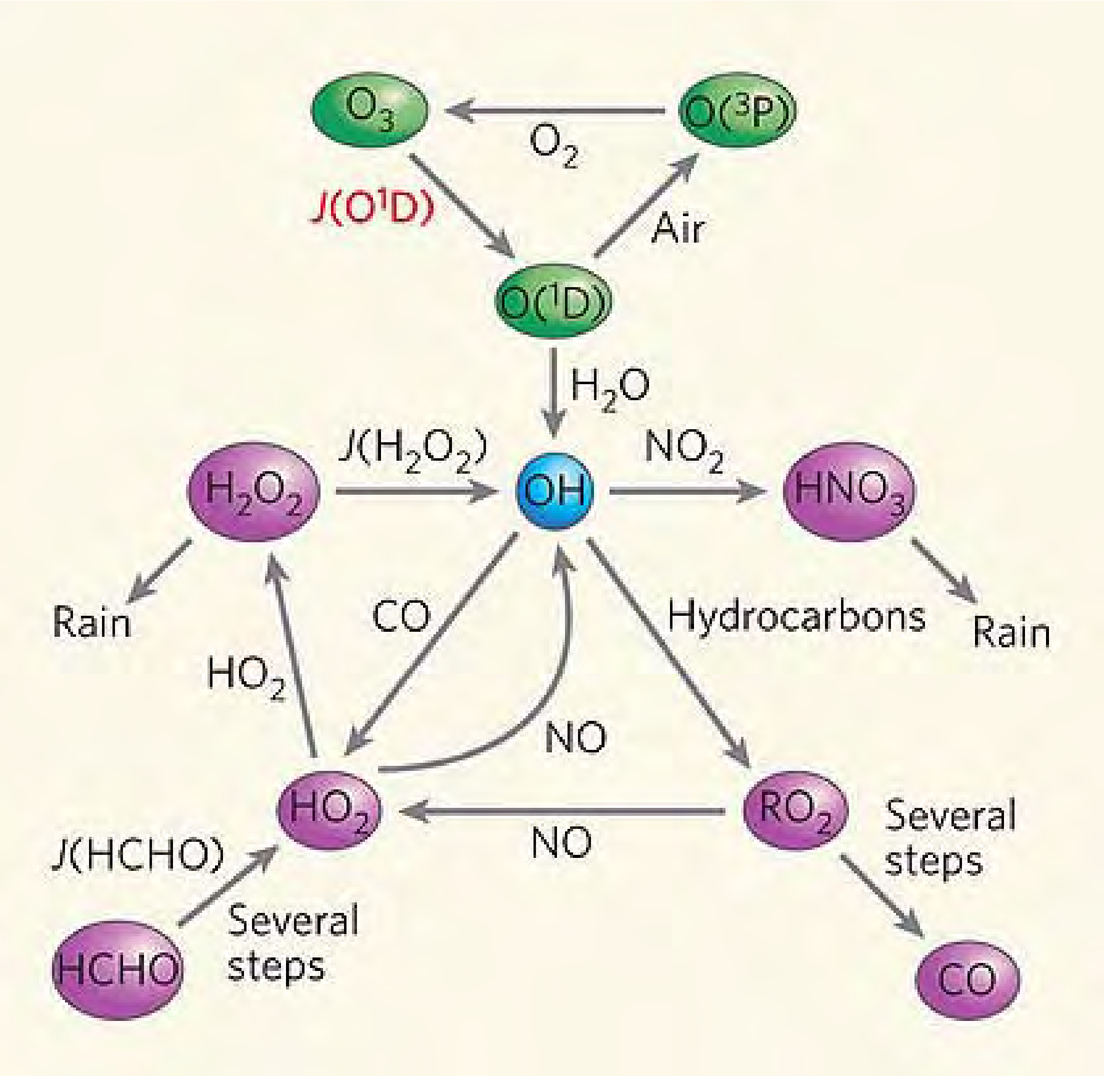
Solar actinic radiation measurements

Birger Bohn (Forschungszentrum Jülich)

Background: Atmospheric photochemistry



P. O. Wennberg, Nature 442, 2006

Photolysis frequencies

First-order rate constant:

$$O_3 + h\nu\ (\lambda \leq 340\ \mathrm{nm}) \rightarrow O(^1D) + O_2$$

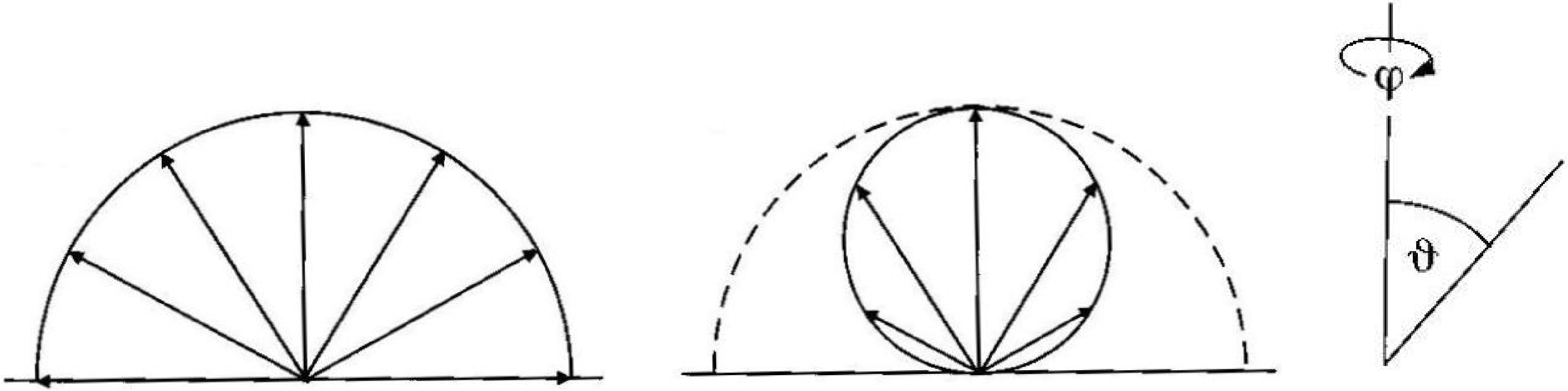
$$j(O^1D) = 1/[O_3] \times d[O^1D]/dt$$

Radiometric approach:

$$j(O^1D) = \int F_\lambda\ (\lambda)\ \sigma(O_3)\ \phi(O^1D)\ d\lambda$$

F_λ = spectral actinic (photon) flux density

Spectral actinic flux density / irradiance



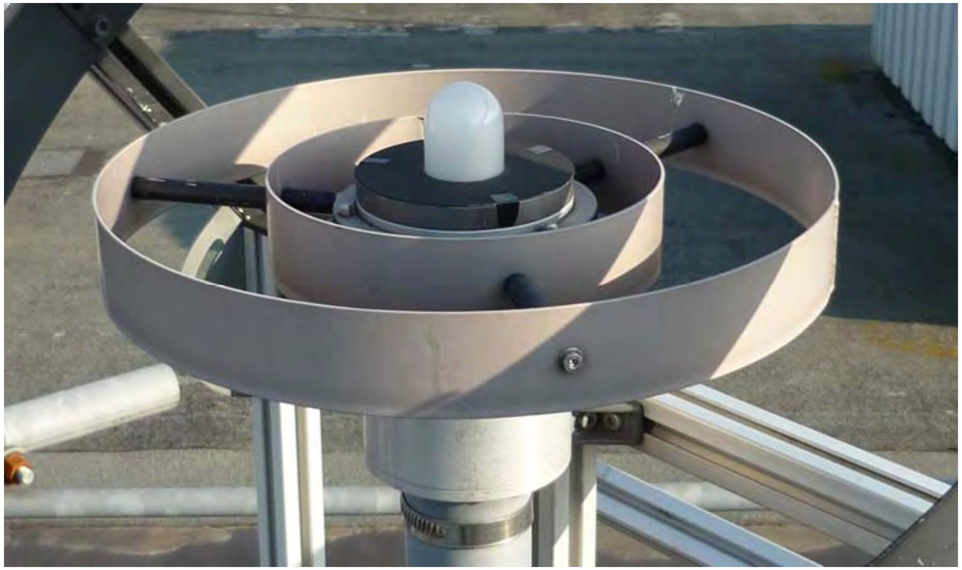
Actinic flux:
unweighted

ideal: spherical
receiver

Irradiance:
cos(ϑ) weighting

ideal: flat receiver

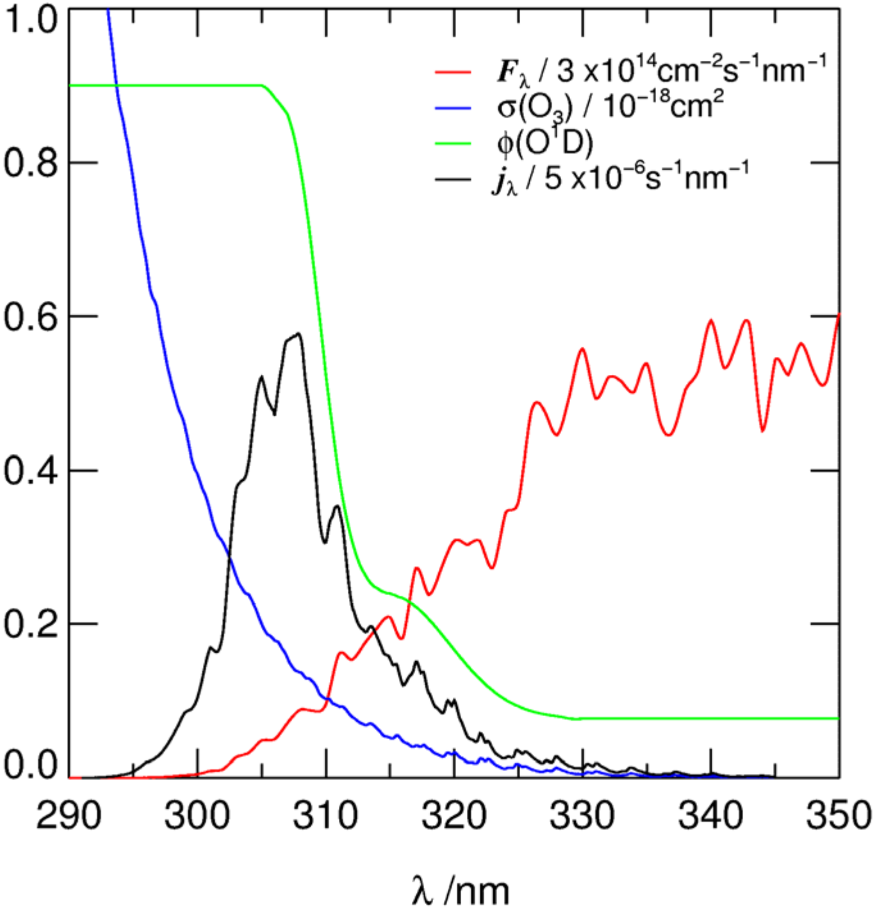
Spectral actinic flux density: receivers

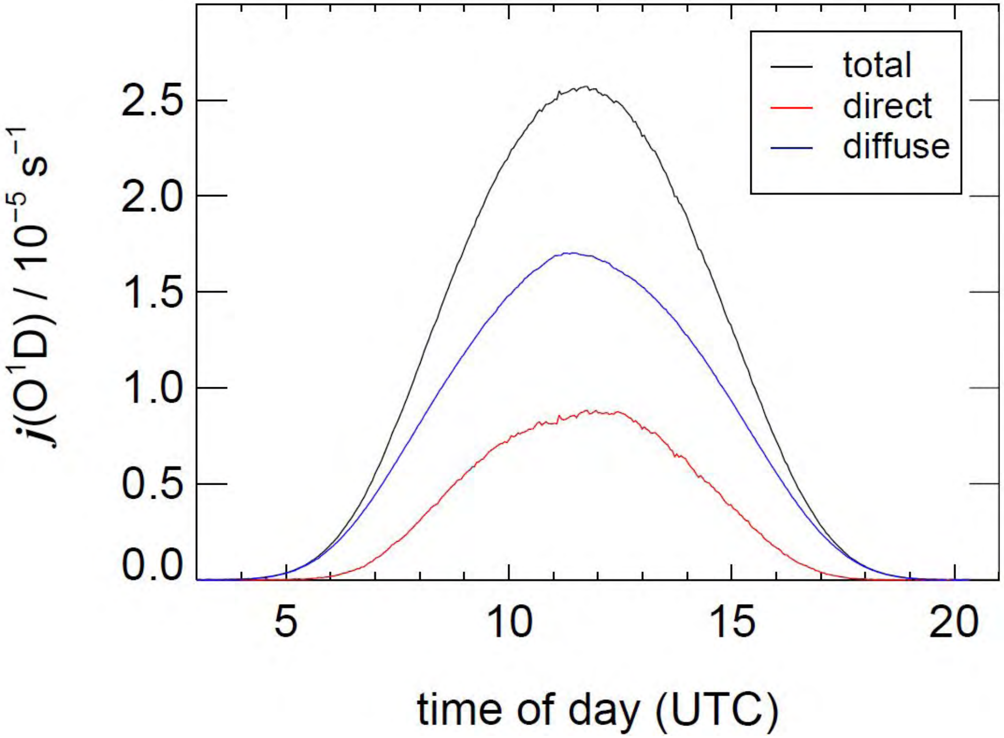


Calibration: Irradiance standards and mercury lamps

quartz fibre → Single or double monochromator based spectroradiometers

Example: O_3 photolysis





Applications (so far)

- Ground based field campaigns (e.g. ECHO, PRD)
- SAPHIR (direct + diffuse + model)
- Instrument comparisons/calibrations (quality assurance)
- Zeppelin/HALO (fast, both hemispheres)
- Laboratory reactors (small sized, artificial lamps)

JOYCE options

- Continuous long-term measurements
- Irradiance measurements (UV-VIS) (new receiver)
- Radiation transfer calculations including cloud/aerosol
- Zenith spectral radiance measurements (LIM co-operation)
- Spectral radiance measurements with sky-scanner (new setup)

Solar shortwave radiation

Birger Bohn (Forschungszentrum Jülich)

Pyranometer CM6/CM7

- Solar irradiance ↓
- Continuous measurements since 2005
- Cross calibrated with CM11 reference instrument (yearly)
- CM11 calibrated by DWD (Lindenberg) 2005

SCAPP-Sensor Pyranometer/Pyrheliometer

- Solar irradiance ↓
- Diffuse and direct
- Sunshine duration
- Calibrated by DWD (Lindenberg) 2010
- Continuous measurements start 2011

Mitglied der Helmholtz-Gemeinschaft

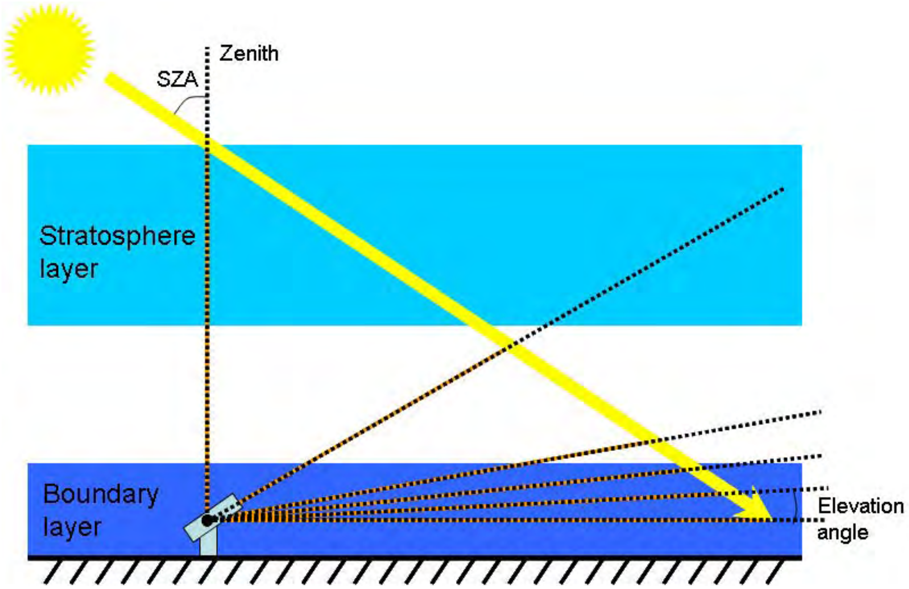
MAX-DOAS aerosol and trace gases measurements

Xin Li, Theo Brauers

Institut für Energie- und Klimaforschung: Toposphäre (IEK-8)
Forschungszentrum Jülich, Germany

Multi-axis differential optical absorption spectroscopy, MAX-DOAS

- Record scattered sunlight spectra at different elevation angles α
- Differential slant column density (DSCD) can be retrieved by **DOAS fit** using spectrum recorded at zenith as reference spectrum
- As DSCD at different α is sensitive to the concentration at certain altitude, the vertical concentration profile can be retrieved



$$SCD_\alpha = \int_L c(s) \cdot ds == \frac{1}{\sigma} \ln\left(\frac{I_0}{I_\alpha}\right)$$

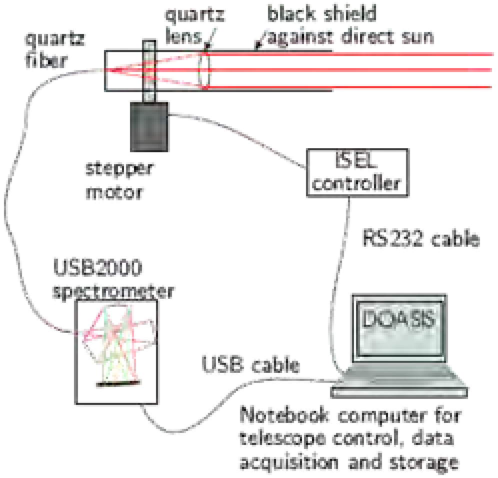
$$DSCD_\alpha = SCD_{\alpha \neq 90^\circ} - SCD_{\alpha = 90^\circ}$$

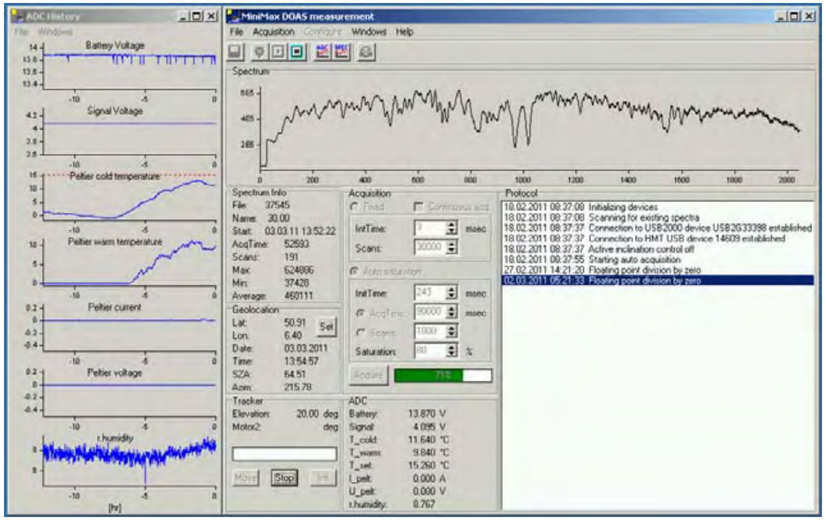
$$= \frac{1}{\sigma} \ln\left(\frac{I_{\alpha = 90^\circ}}{I_{\alpha \neq 90^\circ}}\right)$$

α: elevation angle; σ: absorption cross section; c(s): concentration; I: light intensity

Mini-MAX-DOAS instrument

- Commercial instrument by Hoffmann Messtechnik GmbH
- Czerny-Turner spectrometer (Ocean Optics USB 2000) with spectral resolution of ≈0.7 nm FWHM and spectral range of 318 – 458 nm
- Automated measurement program which adapt the integration time of the measurements to the light conditions, store the spectra and control the movements of the telescope (provided by Udo Frieß, IUP, Heidelberg)





File: 37545
Name: 30.00
Start: 03.03.11 13:52:22
AcqTime: 52593
Scans: 191
Max: 624886
Min: 37428
Average: 460111

Lat: 50.91
Lon: 6.40
Date: 03.03.2011
Time: 13:54:57
SZA: 64.51
Azm: 215.78

Elevation: 20.00 deg
Motor2: deg

○ Fixed ☐ Continuous acq
IntTime: 7 msec
Scans: 30000
● Auto saturation
InitTime: 243 msec
● AcqTime: 90000 msec
○ Scans: 1000
Saturation: 80 %

Battery: 13.870 V
Signal: 4.095 V
T_cold: 11.640 °C
T_warm: 9.840 °C
T_set: 15.260 °C
I_pelt: 0.000 A
U_pelt: 0.000 V
r.humidity: 0.767

```
18.02.2011 08:37:08  Initializing devices
18.02.2011 08:37:08  Scanning for existing spectra
18.02.2011 08:37:37  Connection to USB2000 device USB2G33398 established
18.02.2011 08:37:37  Connection to HMT USB device 14609 established
18.02.2011 08:37:37  Active inclination control off
18.02.2011 08:37:55  Starting auto acquisition
27.02.2011 14:21:20  Floating point division by zero
02.03.2011 05:21:33  Floating point division by zero
```

Methodology of vertical profile retrieval

- Profile parameterization

$$C(z) = \begin{cases} \tau \times F / H & z \leq H \\ \beta \times \exp(-z/5) & z > H \end{cases}$$

C(z): aerosol extinction / trace gas concentration at height z; **τ**: aerosol optical depth (AOD) / trace gas vertical column density (VCD); **F**: percentage of τ in the homogeneous mixed layer; **H**: height of the homogeneous mixed layer.

- Radiative transfer model (**RTM**) – McArtim: backward Monte-Carlo approach with the treatment of multiple scattering in a fully spherical geometry (Deutschmann, 2010)
- Levenberg-Marquardt algorithm (**LMA**): best fit between **RTM** calculated and measured DSCDs at all elevation angles

$$\chi^2(\tau, F, H) = \sum_{\alpha=3^\circ}^{30^\circ} \left(\frac{M_\alpha - R_\alpha(\tau, F, H)}{\sigma(M_\alpha)} \right)^2$$

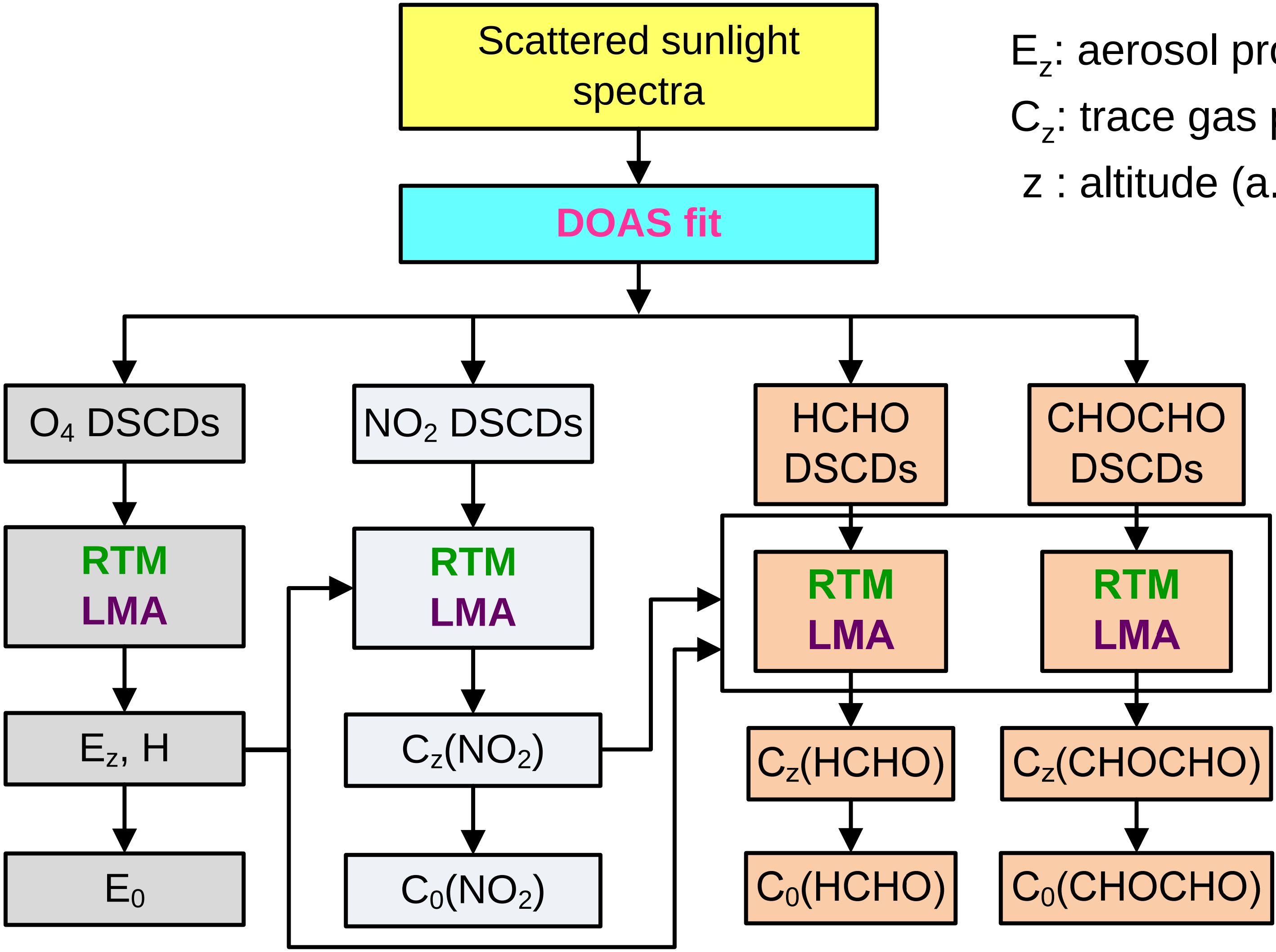
M_α: Measured DSCD; R_α: **RTM** calculated DSCD; $\sigma(M_\alpha)$: measurement error

Methodology of vertical profile retrieval

E_z: aerosol profile

C_z: trace gas profile

z : altitude (a.g.l.)



Scattered sunlight spectra

DOAS fit

O_4 DSCDs

NO_2 DSCDs

HCHO DSCDs

CHOCHO DSCDs

RTM
LMA

RTM
LMA

RTM
LMA

RTM
LMA

E_z, H

$C_z(NO_2)$

$C_z(HCHO)$

$C_z(CHOCHO)$

E_0

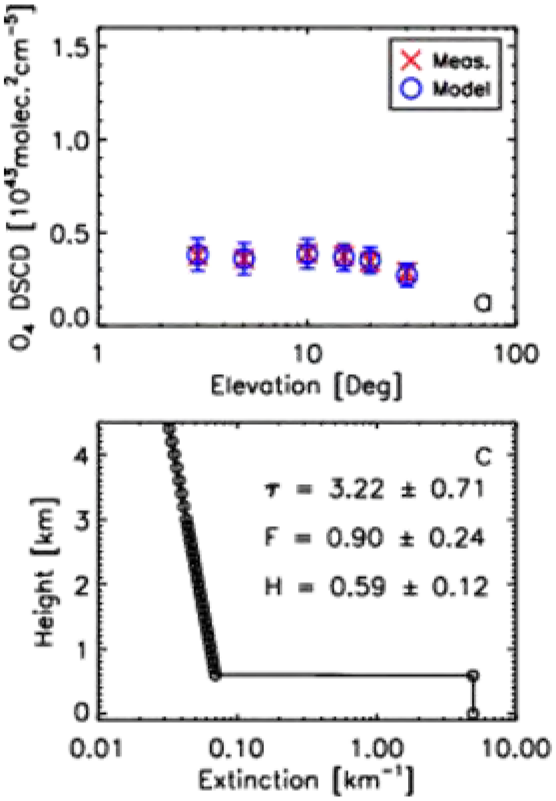
$C_0(NO_2)$

$C_0(HCHO)$

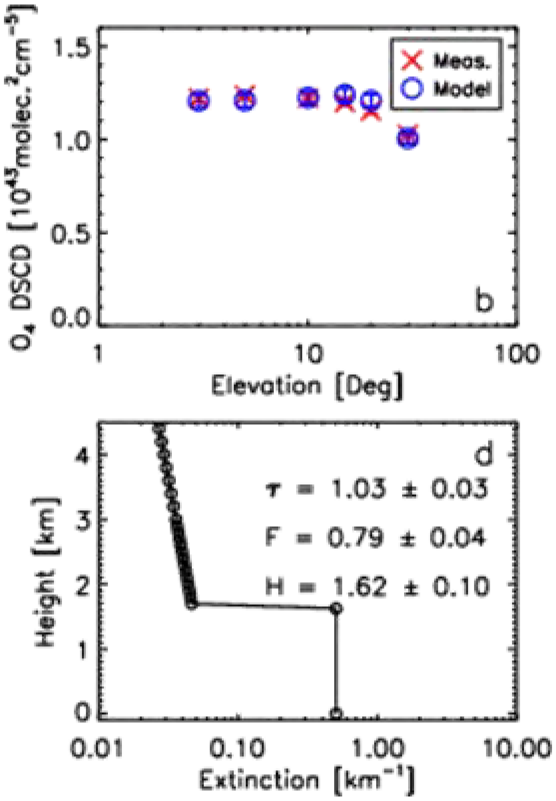
$C_0(CHOCHO)$

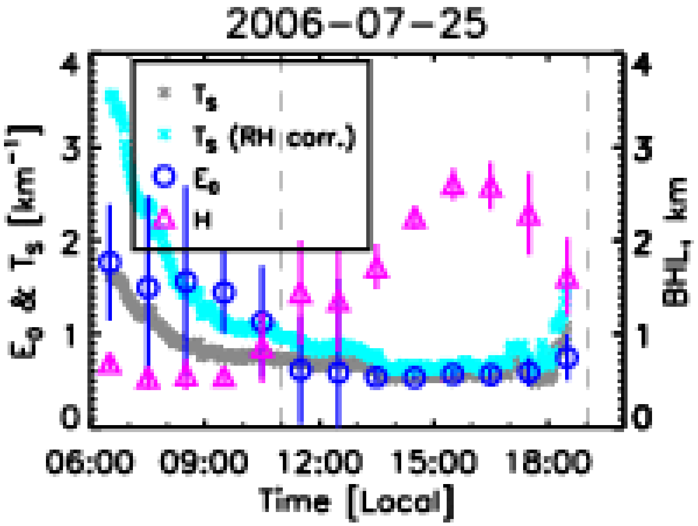
Example of aerosol profile retrieval

24-JUL 2006, 07:00–08:00,
SZA=70°



24-JUL 2006, 15:00–16:00,
SZA=41°



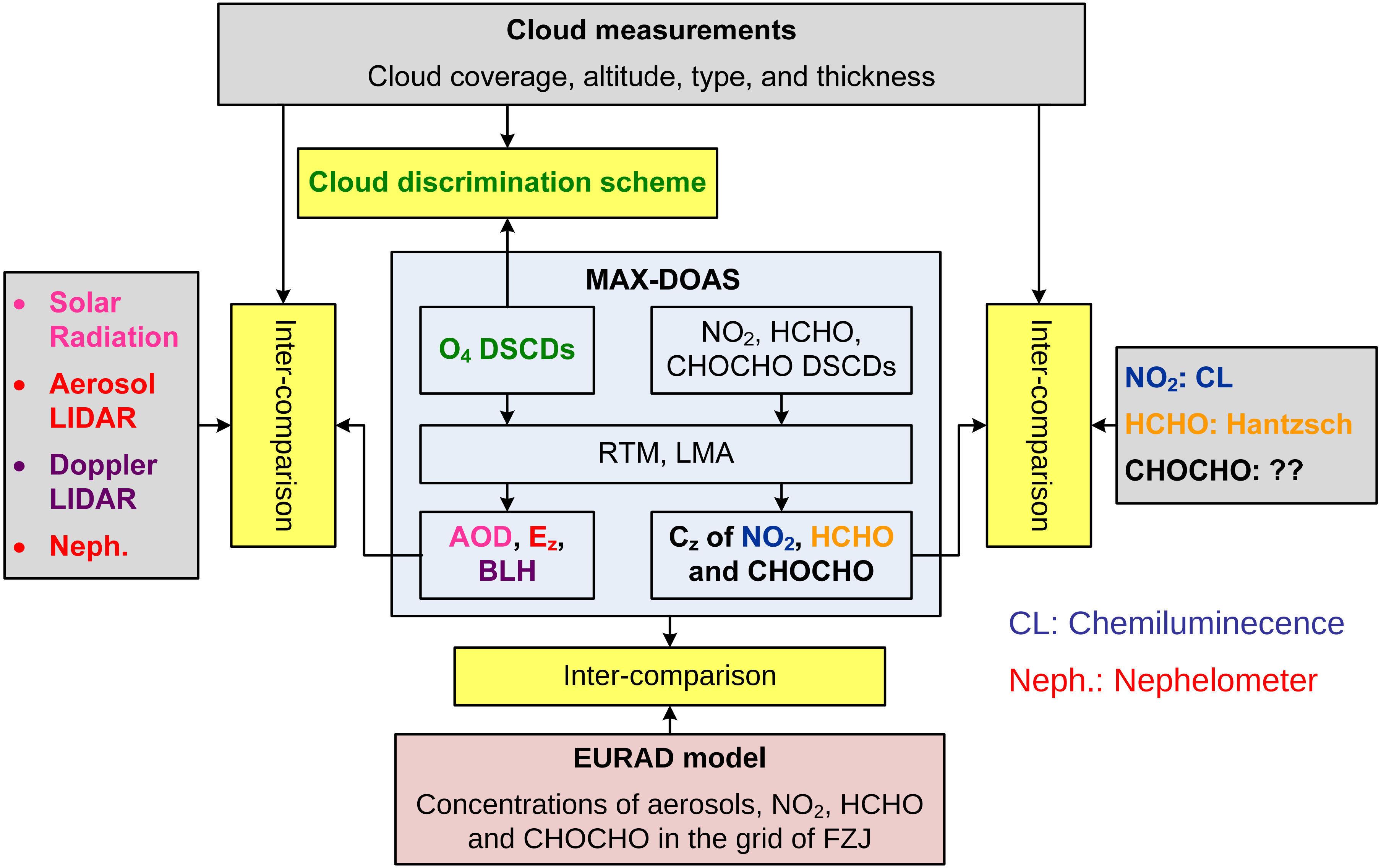


Results during the PRD2006 campaign in PRD, China

Questions to be addressed

- Influence of clouds
    - The existence of clouds will influence the RTM calculation
    - Under-estimation of AOD; under- or over-estimation of trace gases concentrations
    - Cloud discrimination by MAX-DOAS radiation and O_4 absorption measurements
- Inter-comparison with different techniques
    - Performance of the MAX-DOAS aerosol and trace gases measurements
- Inter-comparison with EURAD model calculation
    - Aerosols, NO_2, HCHO and CHOCHO at the grid of FZJ
    - Performance of the model calculation

Schematic setup



Cloud measurements

Cloud coverage, altitude, type, and thickness

Cloud discrimination scheme

- **Solar Radiation**
- **Aerosol LIDAR**
- **Doppler LIDAR**
- **Neph.**

Inter-comparison

MAX-DOAS

O_4 DSCDs

NO_2, HCHO, CHOCHO DSCDs

RTM, LMA

AOD, E_z, BLH

C_z of NO_2, HCHO and CHOCHO

Inter-comparison

NO_2: CL

HCHO: Hantzsch

CHOCHO: ??

Inter-comparison

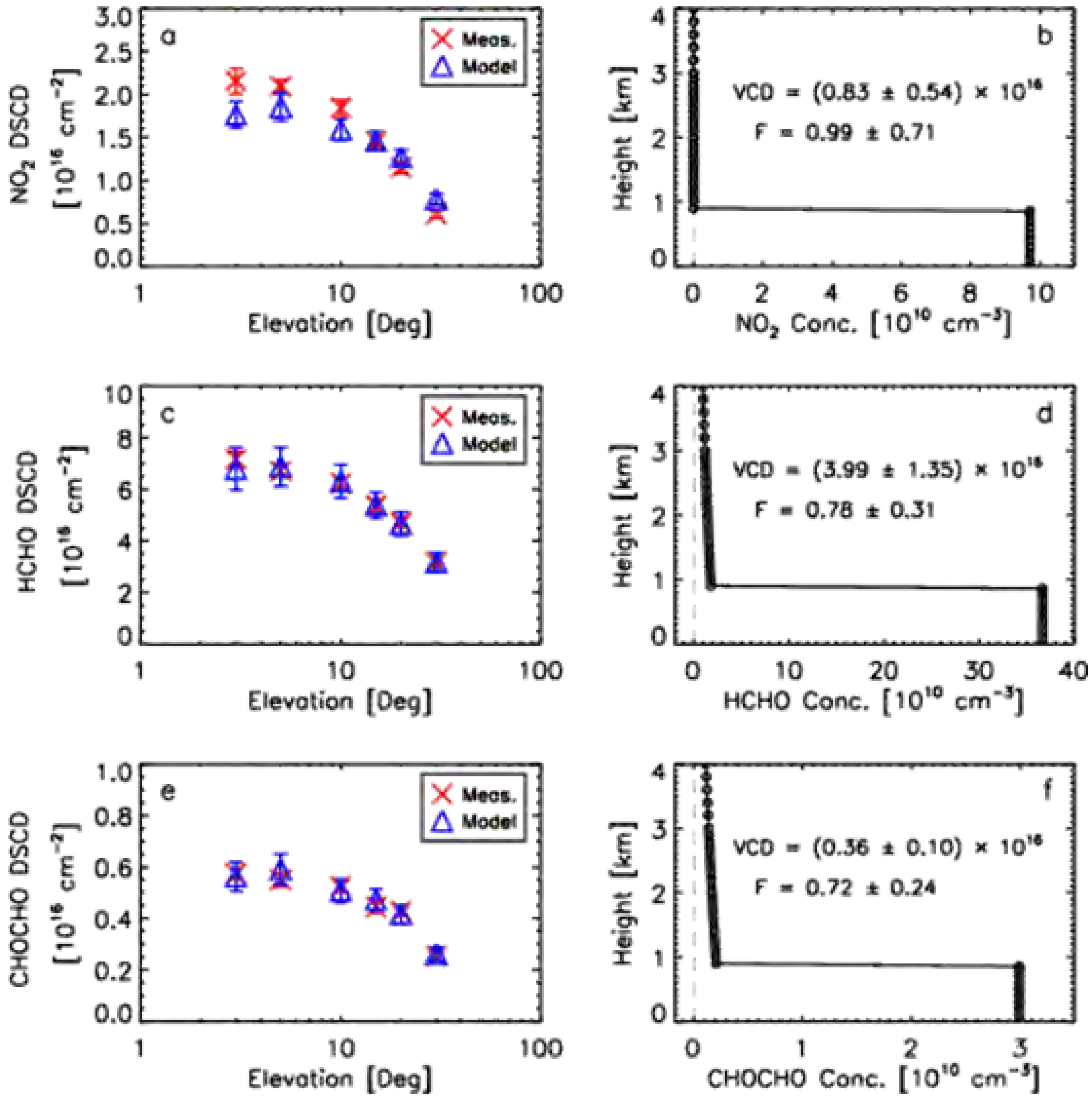
EURAD model

Concentrations of aerosols, NO_2, HCHO and CHOCHO in the grid of FZJ

CL: Chemiluminecence

Neph.: Nephelometer

Trace gases profile retrieval



Example of MAX-DOAS trace gases retrieval for 2006.07.25 10:00 – 11:00 at SZA=29°.

Left: comparison between RTM modeled and measured DSCDs.

Right: vertical distribution.

Error of the parameter refers to the 1-sigma fitting error.

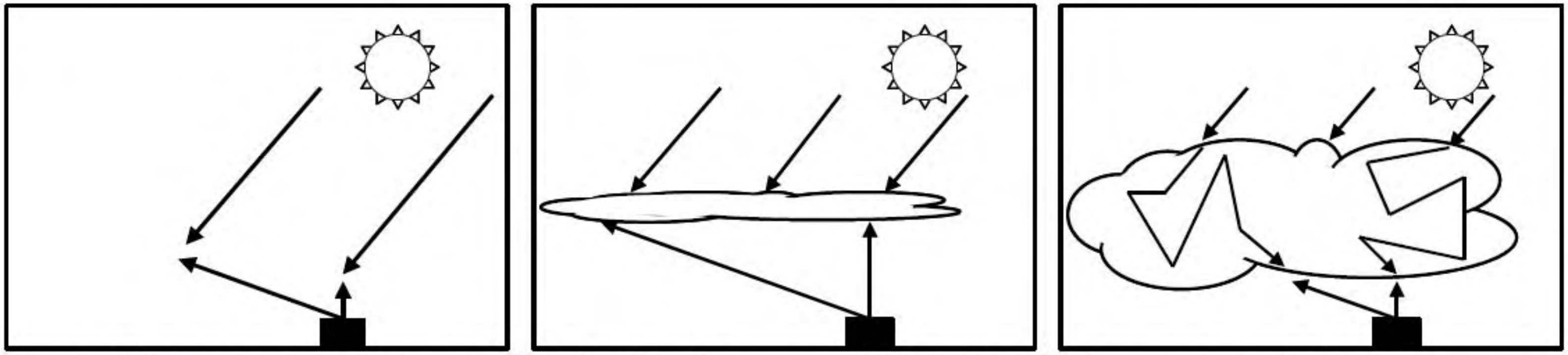


Fig. 9 Schematic description of the cloud influence on MAX-DOAS observations. Left: For clear sky, sun light is scattered by air molecules and aerosol particles towards the instrument. Center: Diffusing screen effect: in the presence of thin clouds, a substantial fraction of the observed photons is scattered by the cloud; especially for the smaller elevation angles, this effect leads to an increase of the absorption path. Right: For optically thick and vertically extended clouds, multiple scattering can lead to very large increase of the photon paths inside the clouds.

Wagner et al., *to be submitted to AMT*, 2011

Wagner et al., *to be submitted to AMT*, 2011

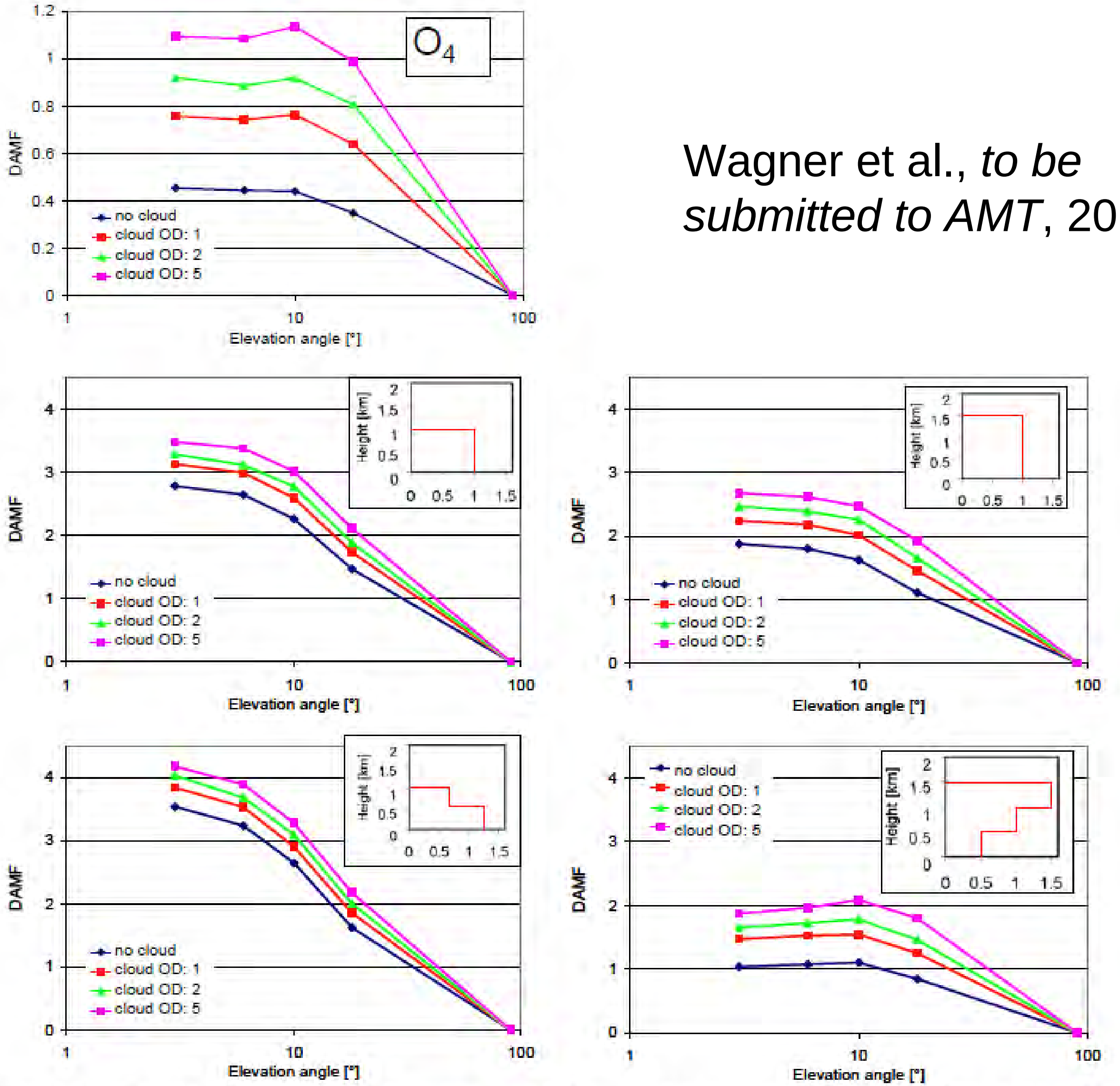


Fig. 12 Influence of a thin cloud between 4 and 5km on the measured DAMFs of O_4 (top) and trace gases with other vertical profiles on the DAMFs for different vertical profiles. Due to the ‘diffusing screen’ effect (see sections 4.1.1 and 4.3) the measured DAMFs are enhanced compared to clear sky conditions. With increasing profile height, the relative increase caused by the diffusing screen effect increases (simulations for an aerosol layer between 0 and 1km with AOD of 0.5, SZA = 45° and relative azimuth angle= 30°).

Mitglied der Helmholtz-Gemeinschaft

Introduction to Pulsed Doppler Lidar

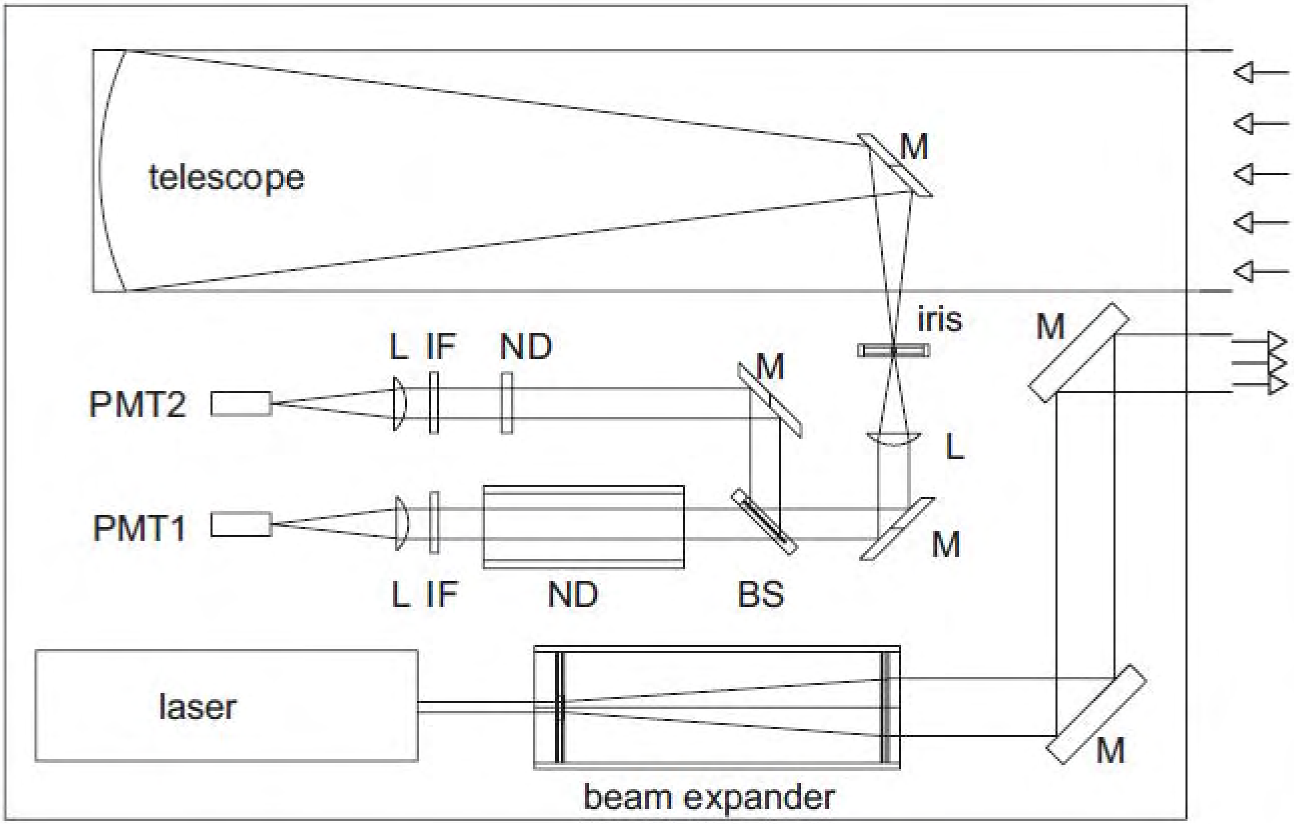
Theo Brauers, Institut für Energie- und Klimaforschung
IEK-8: Troposphäre

JOYCE meeting Jülich 2011

What is a Pulsed Doppler Lidar ?

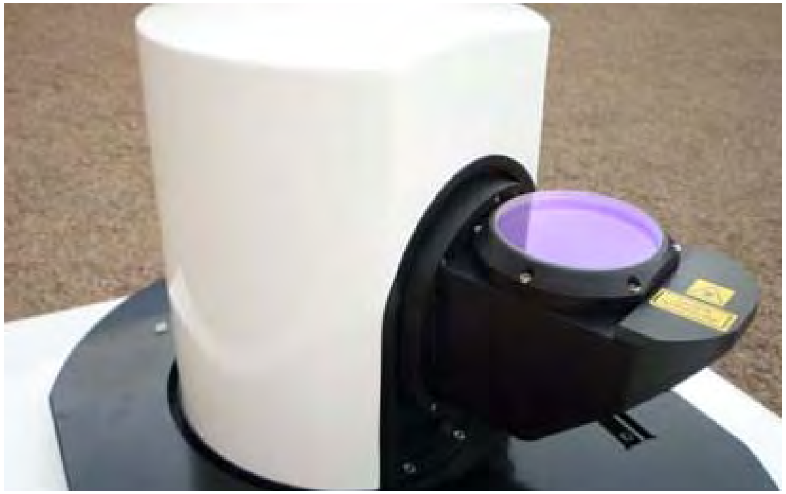
- The Doppler Lidar measures the **backscatter** (at $\lambda = 1.5\ \mu m$) from aerosols and provides range gated Doppler and return power measurements.
- From primary data the following product are derived
  - wind profiles, turbulence parameters, boundary layer height
  - backscatter coefficients
  - cloud base measurements
- Technical description of the system is given by
  - Pearson et al. (J. Atmos. Ocean Tech., 26, 240–250, 2009).
- Commercial device manufactured by Halo Photonics Ltd.
- Minimum range of 75m and maximum range of up to 7.5 km (dependent on atmospheric aerosol concentrations)
- Typical spatial resolution: 30 m
- Typical temporal resolution: 2 s (0.1 s – 30 s)
- Presision: 10 cm s^{-1} or less in the boundary layer
- Instrument is equipped with an all-sky scanner

Doppler Lidar layout



Hennemuth et al, 2008, Atmos. Chem. Phys., 8, 287-308, doi:10.5194/acp-8-287-2008

HALO Lidar pictures



Scanner ↑

← Instrument

Mass:	85Kg
Dimensions:	800 x 530 x 400 mm
Power:	24 V DC, 150 W

Example measurements using the HALO Doppler Lidar

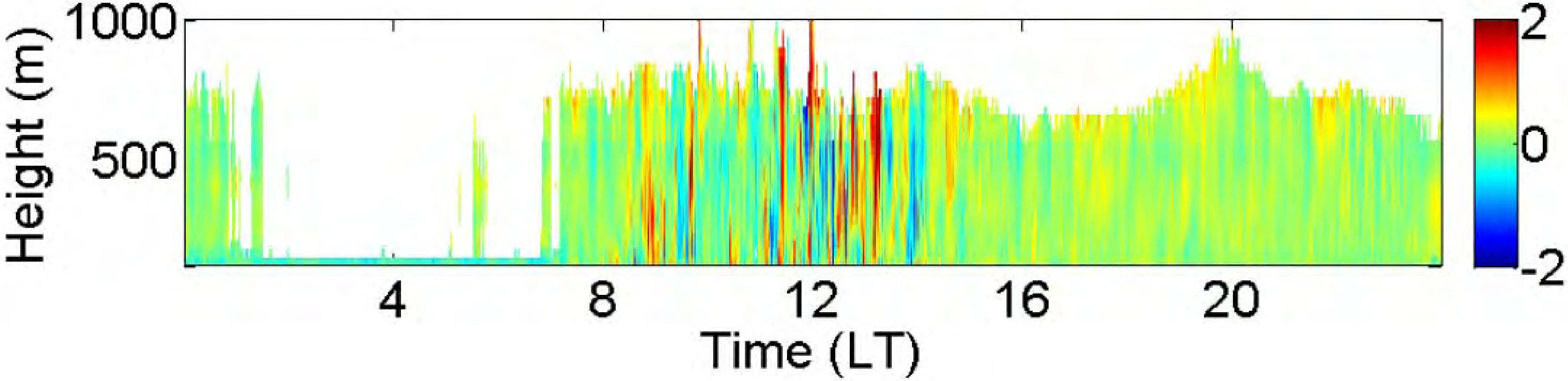
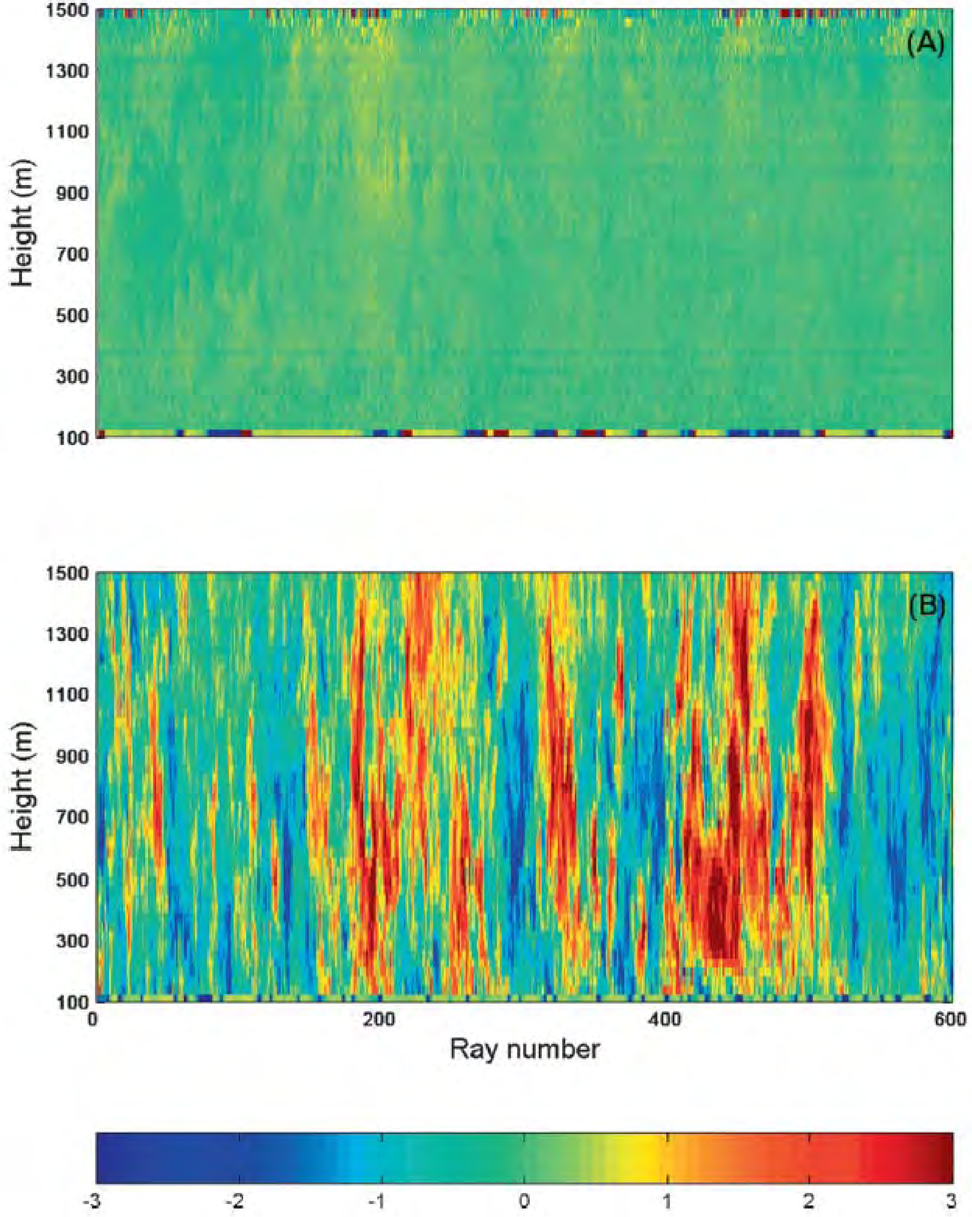


Fig. 4. An example of the daily vertical velocity field as recorded on 15 April 2008. The colour scale is ms^{-1}, the horizontal axis is LT and the temporal resolution is 13 s (observation time of 2 s and 11 s of processing time). The vertical axis is height (a.g.l.) in meters.

Pearson et al., Remote sensing of the tropical rain forest boundary layer using pulsed Doppler lidar
Atmos. Chem. Phys., 10, 5891–5901, 2010
doi:10.5194/acp-10-5891-2010

Example measurements using the HALO Doppler Lidar (2)

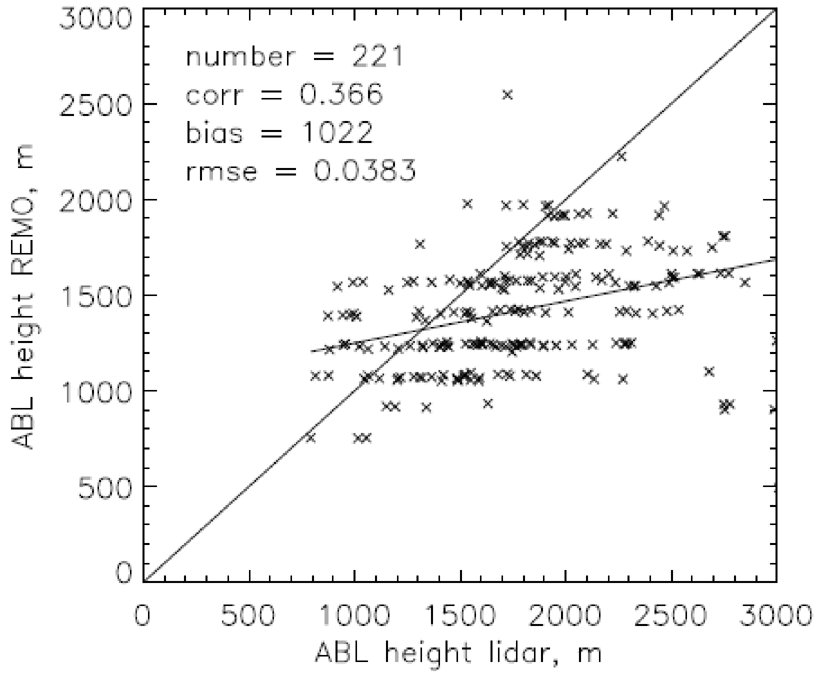


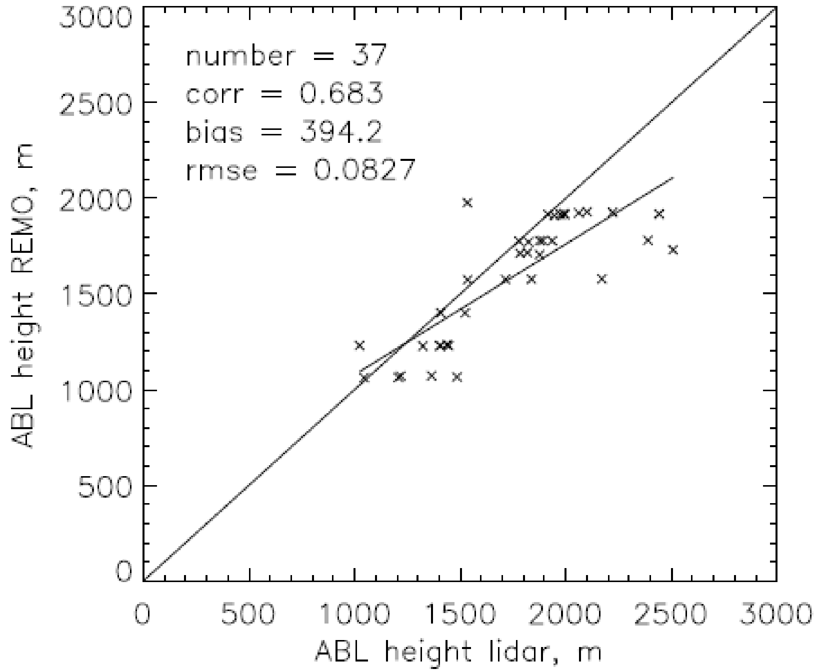
Time vs height representation of the vertical velocity data from (a) stable evening (1900 UTC 11 Sep 2007) and (b) early fternoon convective periods (1300 UTC 10 Sep 2007) as observed at the Cardington site. For (a) and (b) the total observation time was 55 min and the vertical resolution was 30 m. Blue colors indicate downward motion.

Pearson et al., An Analysis of the Performance of the UFAM Pulsed Doppler Lidar for Observing the Boundary Layer, J. Atmos. Ocean Techn. 26, 240, 2009

Example measurements of a HALO Doppler Lidar (3)

Comparison with regional model
Top: all data
Bottom: after rain events





From: Hennemuth et al, 2008, Atmos. Chem. Phys., 8, 287-308, doi:10.5194/acp-8-287-2008

Status of the instrument and outlook

- Project HOBIT approval 21-Dec-2011
  - Doppler Lidar £ 149310 = € 177750
  - Thanks to **Ministerium für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen**,
  - Grant No. B0975.01.10
- Instrument was ordered mid Jan 2011
- 20 weeks delivery (June 2011)
- First setup on the roof of the building
- Measurements in parallel with MAX-DOAS and Raman Lidar
- Possible employment during field campaigns:
  - e.g. Pegasos Zeppelin ground based support

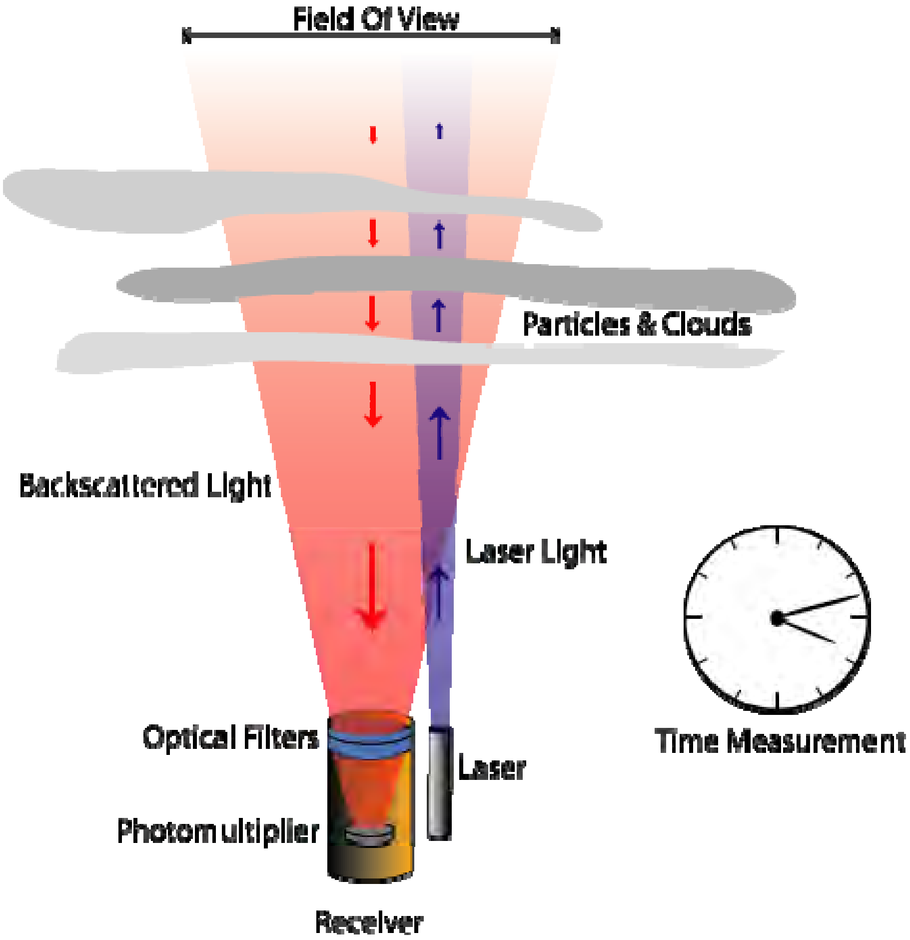
Mitglied der Helmholtz-Gemeinschaft

Lidar CORAL

Christian Rolf, Martina Krämer, Cornelius Schiller

Lidar principal

- Lidar (**Li**ght **d**etection **a**nd **r**anging)
- Time measurement gives the altitude of the backward scattered light
- Altitude and time evolution
- Optical properties of particles
  - Backscatter coef.
  - Extinction coef.
  - Depolarization



CORAL (Cloud ObseRvation with Atmospheric Lidar)

- Groundbased Mobile backscatter Lidar (Leosphere ALS 450)
- Laser @ 355 nm (UV)
- 20 pulses per second
- Laser energy / duration per pulse: 16 mJ / 4 ns
- Altitude: 0.5 - 15 km
- Resolution: 1 min in time (typically), 15 m (night), 60 m (day) in altitude

Depolarization

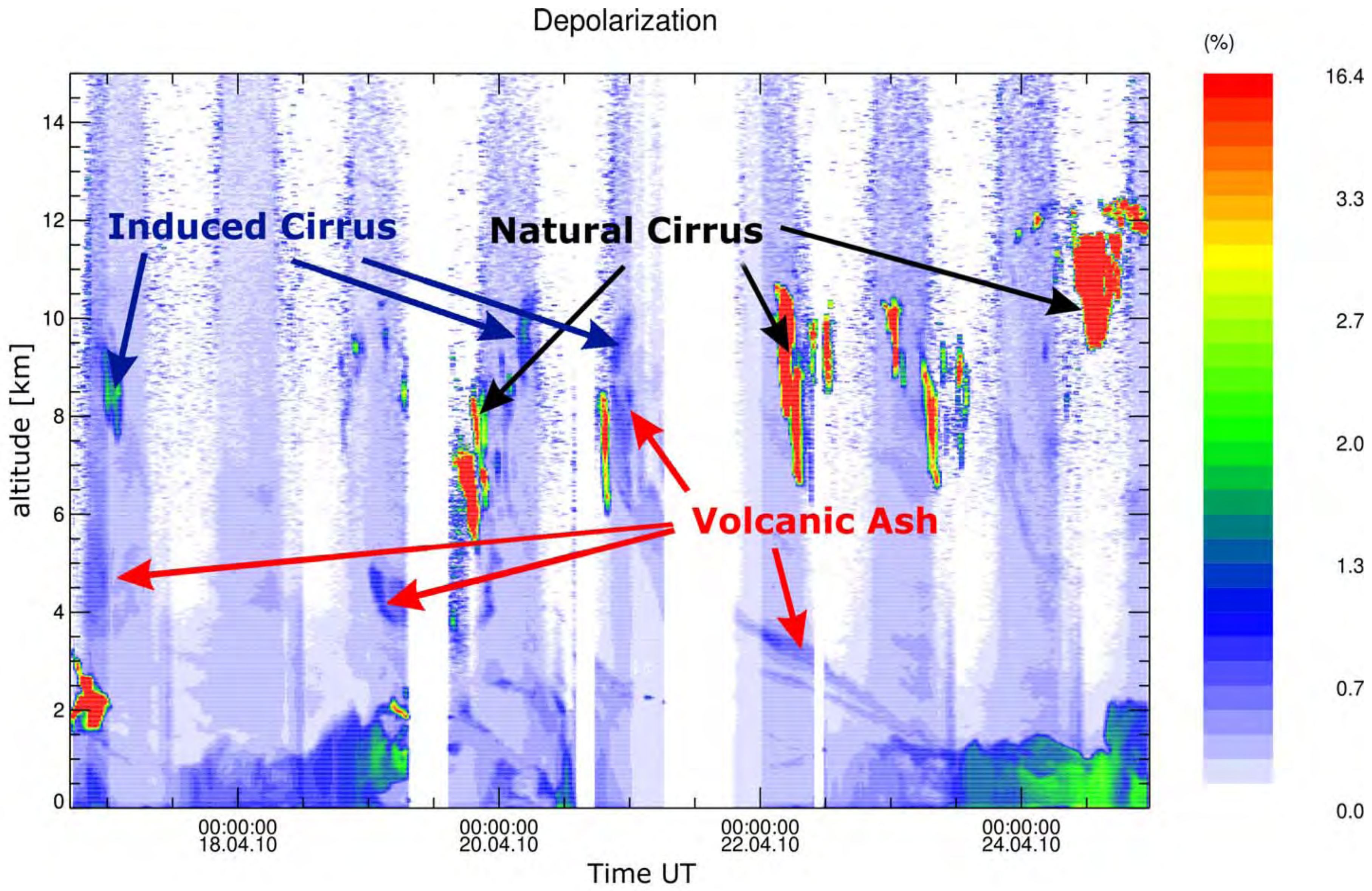
- 2 polarization channels: parallel and perpendicular
- Determination of depolarization possible

Depolarization shows the derivation from a sphere

$$\boxed{\delta_{vol}(r) = C \cdot \frac{I_{perpendicular}(r)}{I_{parallel}(r)}}$$

- Spherical particles / drops → depolarization = 0
- Aspherical particles / ice crystals → depolarization > 0

Characterisation of particles



tools: trajectory and microphysical calculations

JOYCE: Jülich ObservatorY for Cloud Evolution

Arbeitsgruppe „Integrierte Fernerkundung “
Universität zu Köln
Institut für Geophysik und Meteorologie

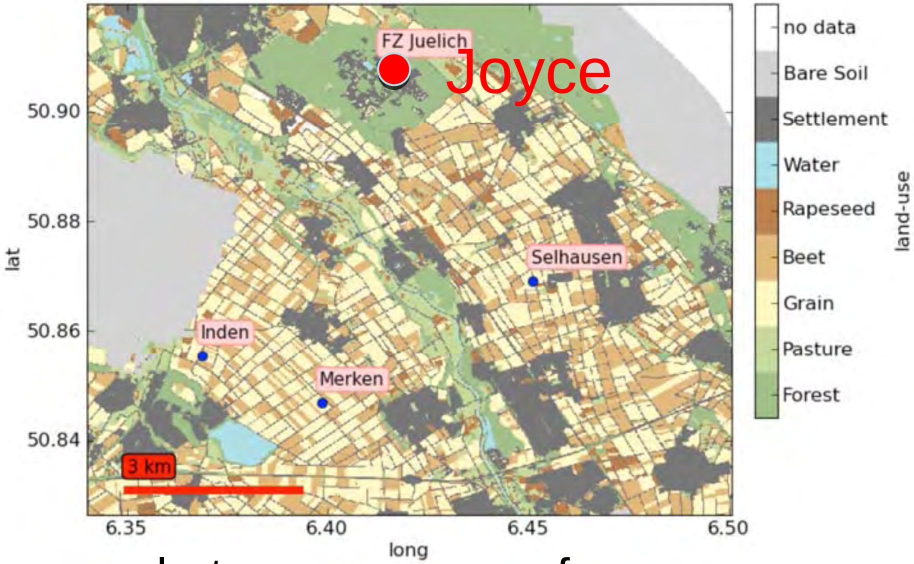
Jülich, 23.3.2011

JOYCE

Jülich ObservatorY for Cloud Evolution

Goals

- to disentangle water vapor variations due to advection and to local surface influence
  ➔ validate coupled models
- to better understand the development of boundary layer clouds
- to analyse cloud radiation interaction
- to observe precipitation formation (polarimetric weather radar)



heterogeneous surface

JOYCE: Jülich ObservatorY for Cloud Evolution

Sodar
Profiles of wind velocity and Direction
(operated in Selhausen)

Infrared-spectrometer (AERI)
Profiles of temperature & humidity, liquid and ice cloud properties

Cloud radar (scanning**)**
Vertical (along path) structure of ice & liquid clouds

Rain radar
Rain rate, Doppler winds, drop sizes

Lidar ceilometer
Backscatter profile, cloud base height, boundary layer height

Microwave-radiometer
Water vapour, cloud liquid water, temperature profile

Micro rain radar
Profiles of drop sizes distribution

GPS: Wet delay slant paths (GFZ Potsdam)

Total sky imager
Hemispheric sky image, cloud cover

120 m meteorological tower

- **red**: Instruments currently operating in Jülich area
- **green**: Ordered instruments
- **grey**: Instruments from external projects

Overview of quicklooks currently at:
http://tr32.uni-koeln.de/index.php

Doppler cloud radar MIRA-36s

Principle:

- sends out pulses of microwave radiation
- measures backscattered radiation
- time between emitted and received pulse → information on the distance to backscatterer

Specifications:

- frequency of 35.5 GHz → sensitive towards cloud droplets
- height range 150 – 15000 m
- range resolution 30 m, temporal resolution 10 s
- Doppler radar → radial velocity component can be measured
- transmits a linear polarized signal and receives co- and cross-polarized signals → information on target type
- scanning capability: combined azimuth and elevation scans → information on 3-dimensional cloud structure

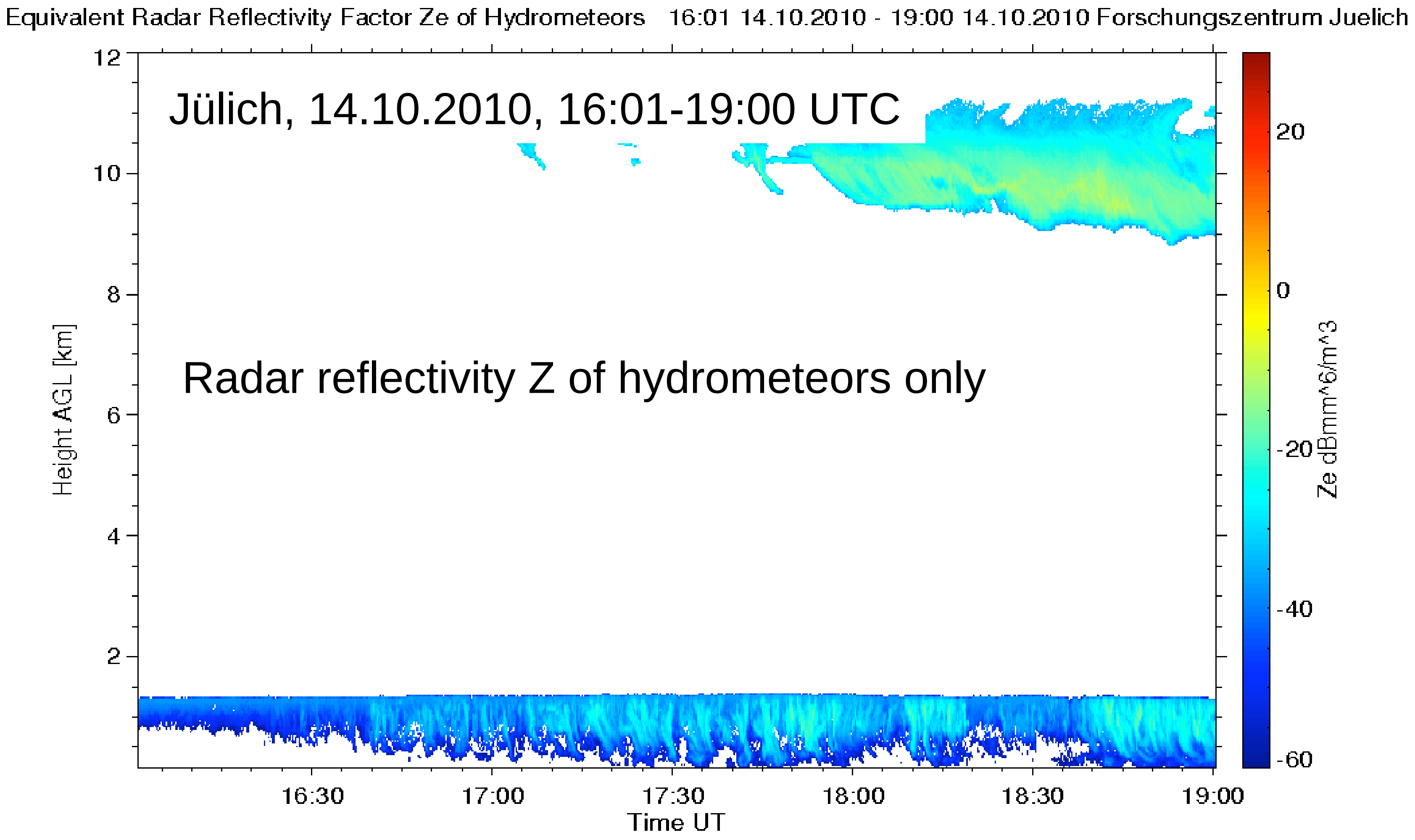
Doppler cloud radar MIRA-36s

Measurements / Products:

Profiles of

- radar reflectivity Z in dBZ
- mean Doppler velocity v in m/s
- variance of Doppler velocity σ_v^2 with Doppler spectral width σ_v in m/s
  → information on turbulence
- linear depolarization ratio LDR (ratio of cross- to co-polar reflectivity) in dB
  → information on target type
- hydrometeor / non-hydrometeor (plankton) classification with LDR as a primary distinctive feature

Doppler cloud radar MIRA-36s

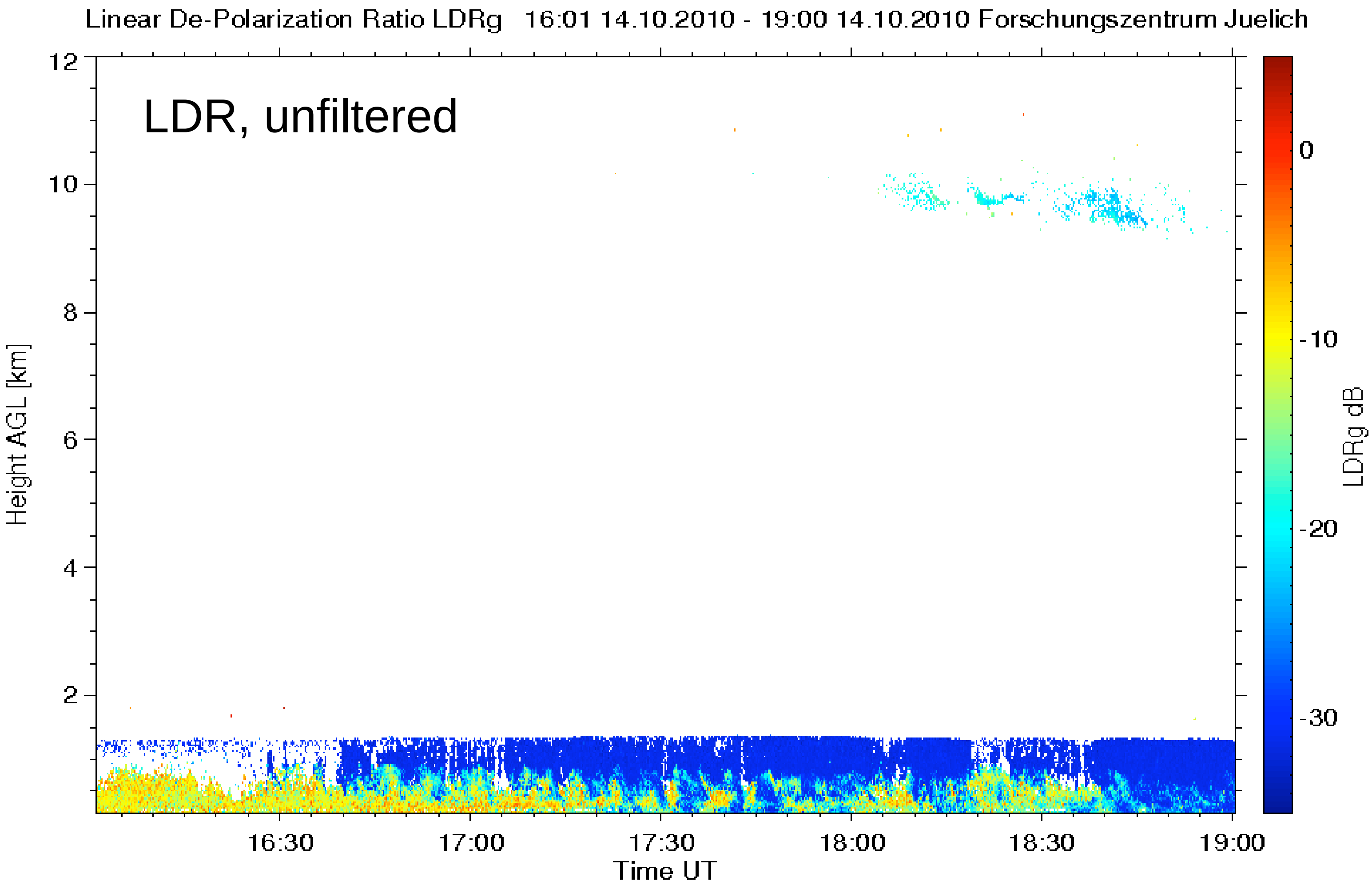


Jülich, 14.10.2010, 16:01-19:00 UTC

Radar reflectivity Z of hydrometeors only

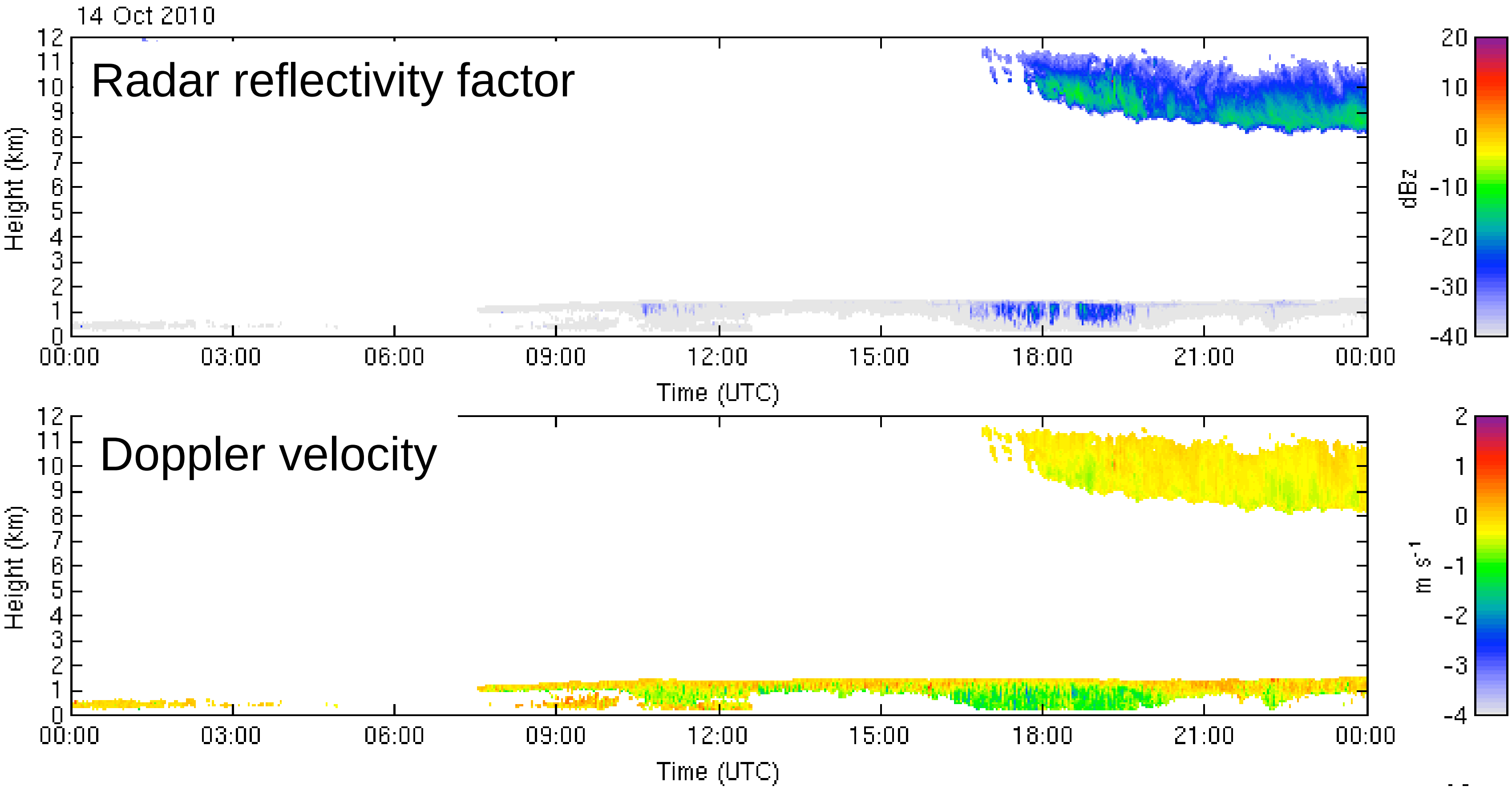
Doppler cloud radar MIRA-36s

Jülich, 14.10.2010, 16:01-19:00 UTC



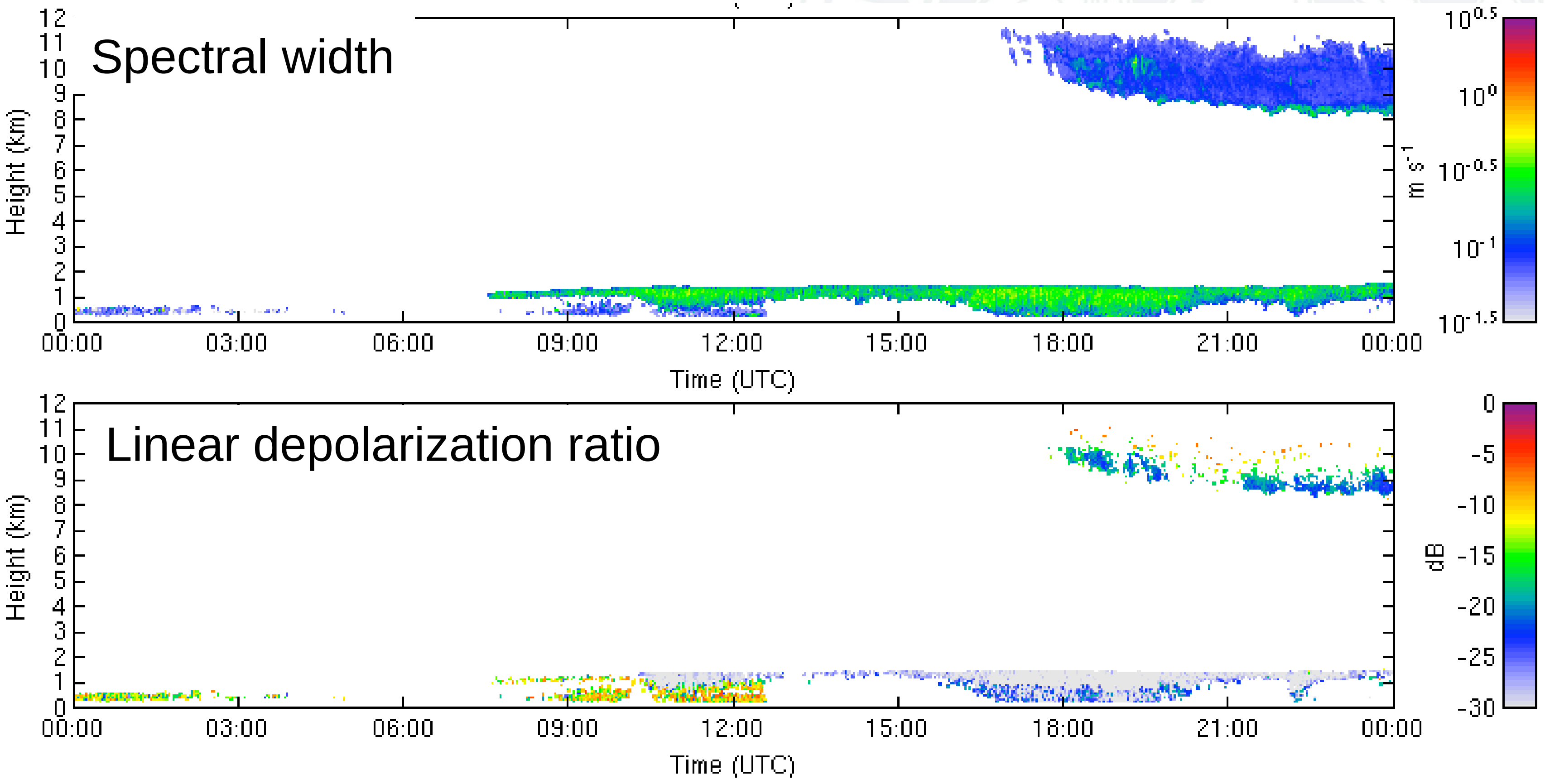
Doppler cloud radar MIRA-36s

Jülich, 14.10.2010



Doppler cloud radar MIRA-36s

Jülich, 14.10.2010



www.cloud-net.org/quicklooks/juelich_all.html

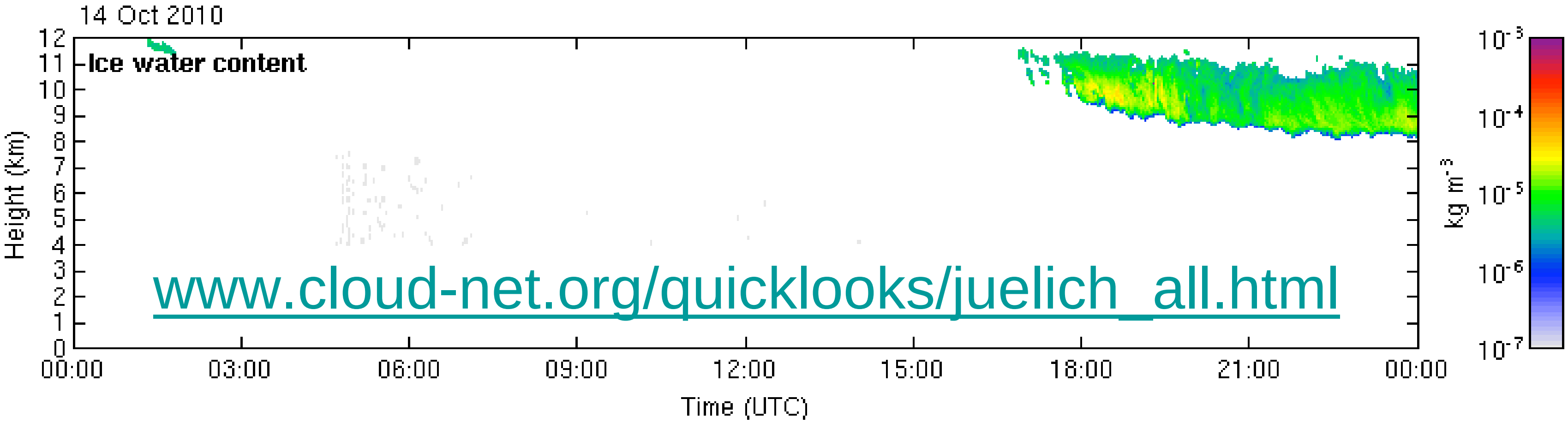
Doppler cloud radar MIRA-36s

Radar reflectivity and cloud microphysical properties:

- cloud water content and Z depend on the drop size distribution

→ many approaches to relate the liquid (ice) water content to the radar reflectivity Z via empirical relationships

Example for IWC (kg/m^3) using a Z-IWC-T relationship (Hogan et al., 2006):

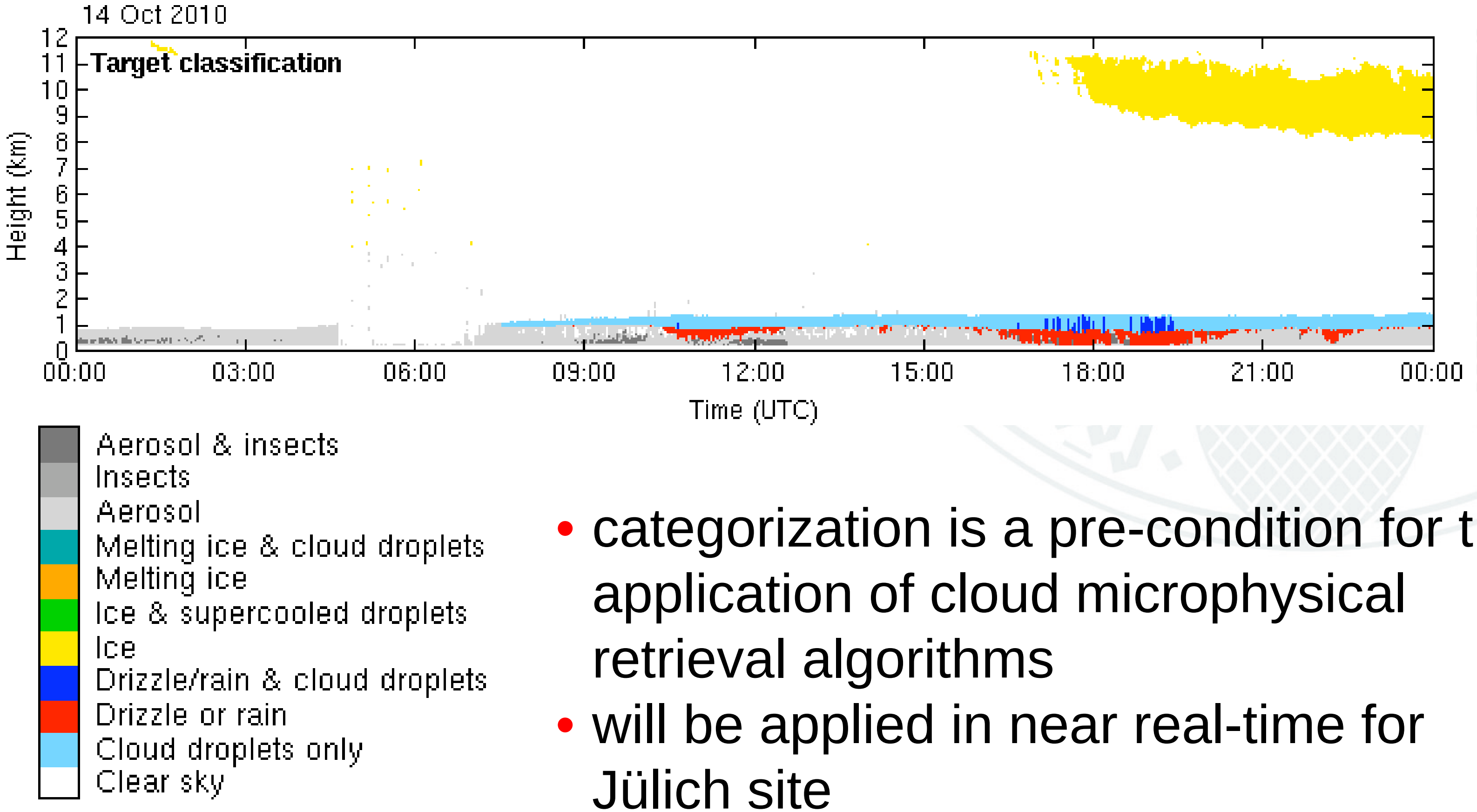


www.cloud-net.org/quicklooks/juelich_all.html

- more accurate retrieval techniques combine information from different active and passive remote sensing instruments!

Doppler cloud radar MIRA-36s

- Combination of cloud radar, microwave radiometer, ceilometer and NWP model data allows for a sophisticated target categorization (Hogan and O‘Connor, 2004)



- categorization is a pre-condition for the application of cloud microphysical retrieval algorithms
- will be applied in near real-time for Jülich site

www.cloud-net.org/quicklooks/juelich_all.html

TOPHAT microwave profiler

- 14 channel total-power microwave profiler
- High accuracy brightness temperature measurements (0.5 K < 1s int. time)
- Azimuth and elevation scanning (0.1°/0.6° resolution)
- Complete hemispheric volume scans during 7 min

Additional sensors

- 2 IR-thermometers (11.1, 12.0 µm) for cloud base height and opacity
- Surface sensors for T, p, RH, GPS clock, rain sensor

TOPHAT microwave profiler

Spectrum:

- 6 channels along the water vapor abs line (22GHz) + 1 window channel at 31.4GHz (most sensitive to cloud liquid water) provide humidity & cloud information
- 7 channels along oxygen abs. complex at 60GHz provide vertical temperature information

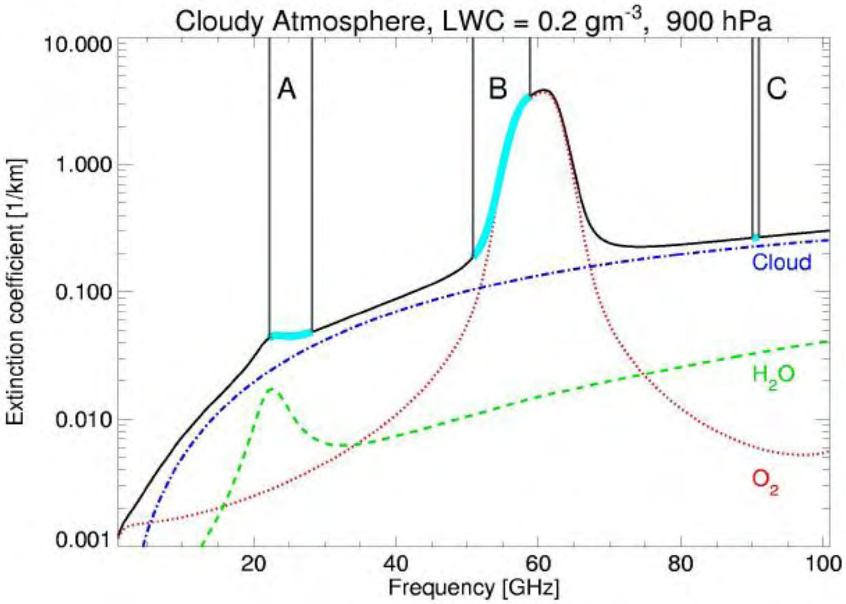
Products & accuracies

→ Integrated Water Vapor (IWV): 0.6 kg/m^2

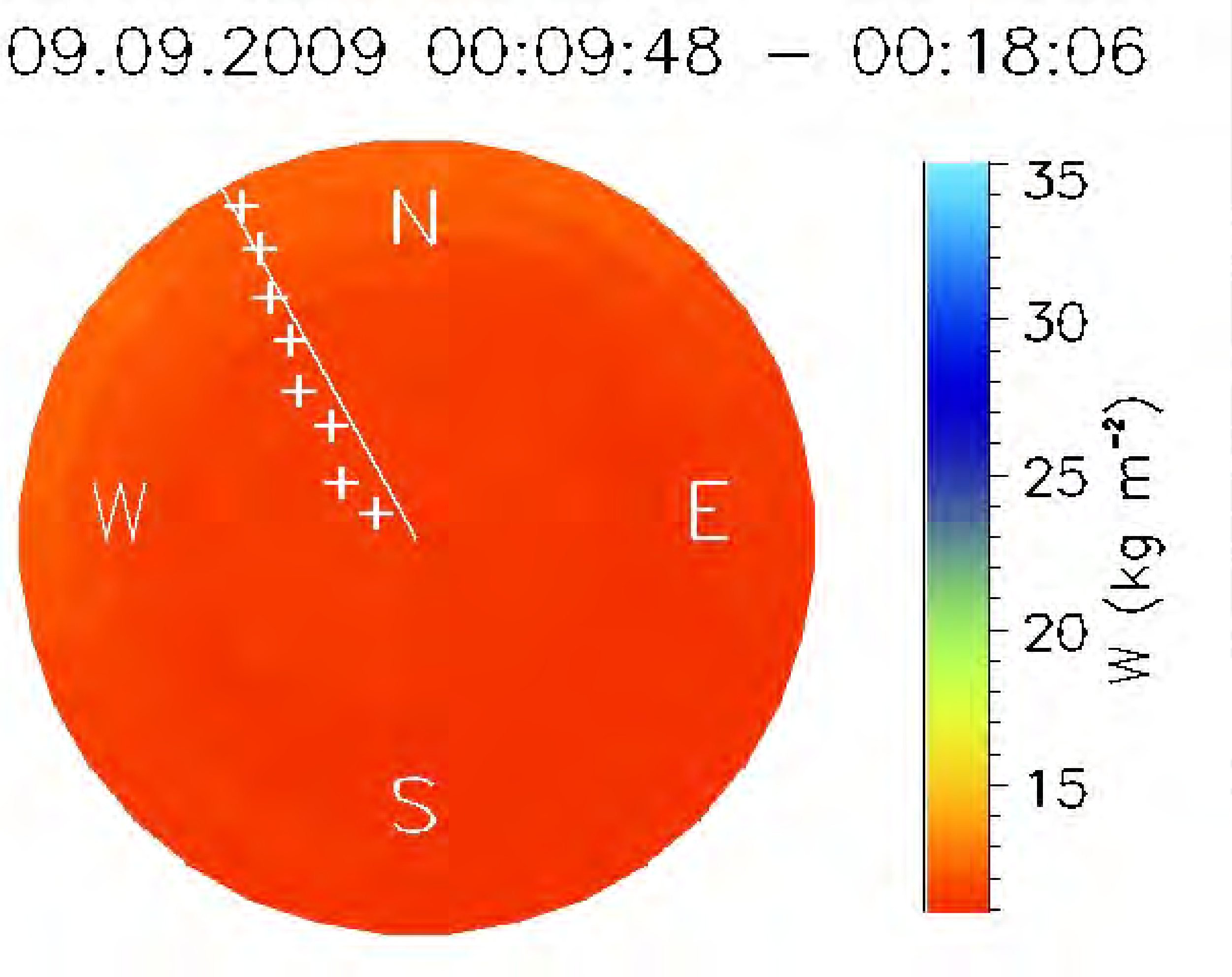
→ Liquid Water Path (LWP): 20 g/m^2

→ Hum. Profiles: 0.4-0.8 g/m^3 (2 degrees of freedom)

→ Temp. profiles 0.5-1.0 K (4 degrees of freedom)



TOPHAT IWV volume scans



- Estimation of Water vapor gradient (strength & direction)
- Crosses show gradient direction derived for individual elevation angles.

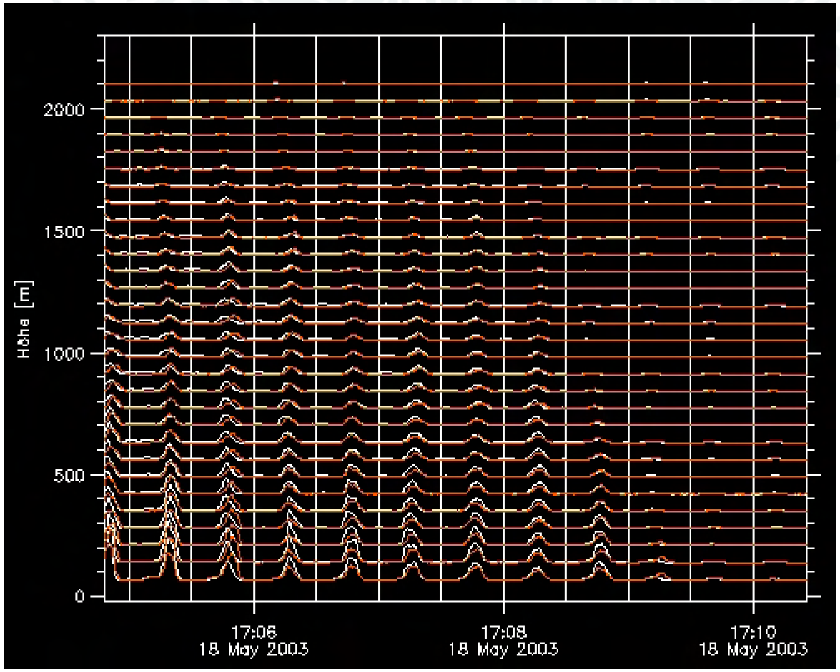
Schween, J.H., S. Crewell, and U. Löhnert, 2011: Horizontal-humidity gradient from one single-scanning microwave radiometer, *IEEE Geosci. Remote Sens. Lett.* 8(2), 336-340.

Micro Rain Radar (MRR)

Micro rain radar MRR (24 GHz)

- vertical pointing radar
- measurements of precipitation
  - ✓ Backscatter profile
  - ✓ Droplet size spectra
  - ✓ Rain rate
- To be moved from Selhausen to FZJ this year

Combination with Cloud Radar and X-Band Radar Sophienhöhe



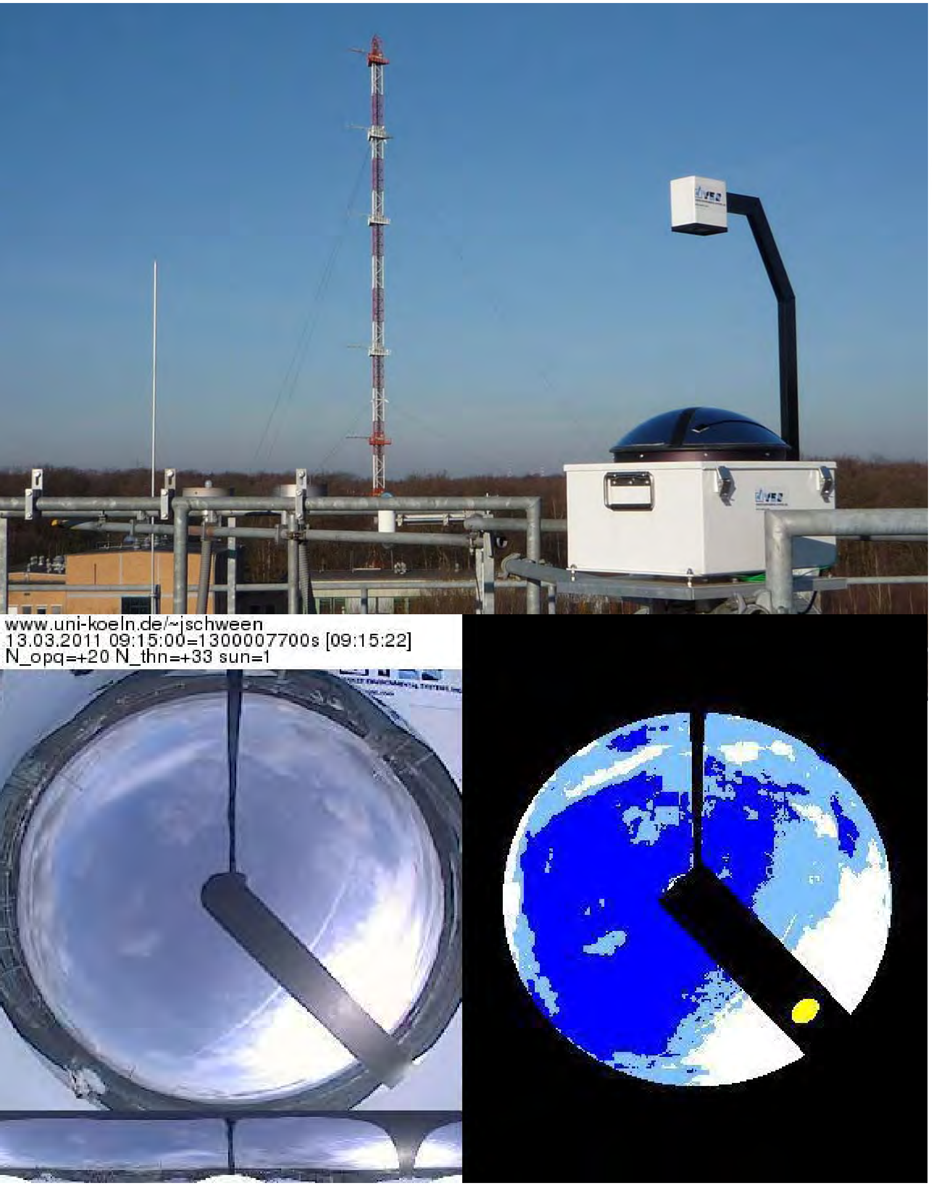
Atmospheric Emitted Radiance Interferometer (AERI)

- automated instrument measuring downwelling IR radiation from 3.3-19 µm at 0.5 cm^{-1} resolution
- measures absorption characteristics of well mixed gas CO_2 for temperature profile information
- multiple water vapor absorption features
- clouds and aerosol can lead to significant increase in IR-emission, as well as scattering

Retrieve:
Water content & effective radius of **thin clouds**
Profiles of temperature, water vapor, CO_2

Coming in April 2011!

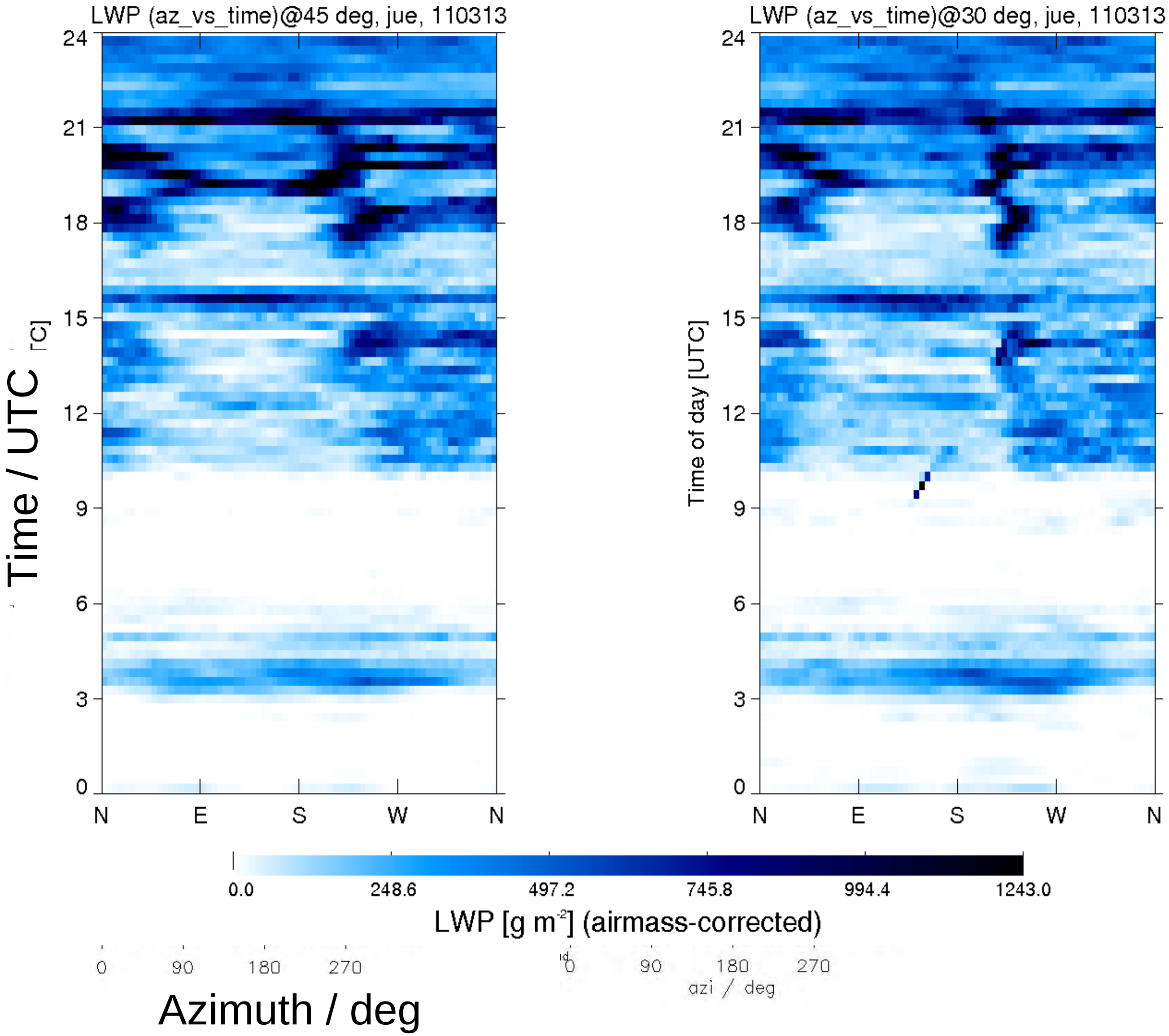
Total sky imager (TSI)



Hemispheric cloud observations

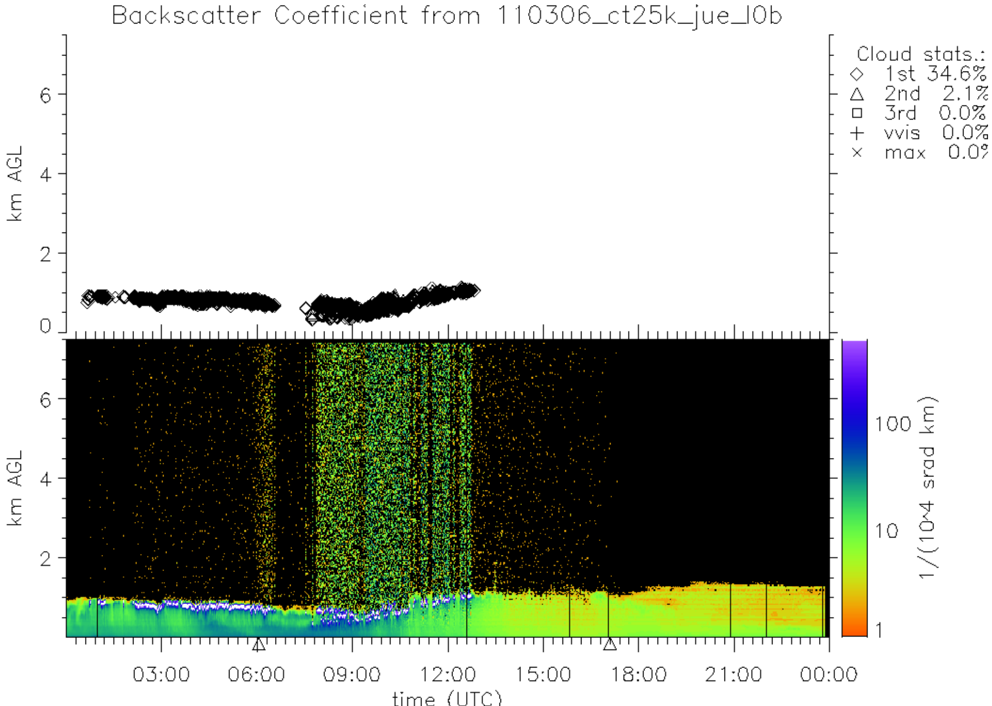
- Camera looks from above on spherical mirror
- Sun is blocked by black tape on mirror
- Every 20sec an image
- Cloud classification based on RGB values:
  → sky, thin- and opaque clouds (blue, light blue and white)

TSI & HATPRO scans



- Images give information about cloud type, distribution in the sky and temporal evolution
- Geometry of the imager allows pixel to coordinate transformation x,y → azimuth, elevation
- Comparison with punctual liquid water path (LWP) from microwave radiometer is possible

Ceilometer



- Determines cloud base height = ceiling *(aviat.)*
- Based on LIDAR principle: sends laser pulses and measures backscattered light
- Delivers profiles of backscatter coefficient
- Sensitivity allows detection of significant aerosol
  → atmospheric boundary layer height

Ultimately merge measurements: Integrated Profiling

Measurements = INPUT

passive RS – measurem.
+ error

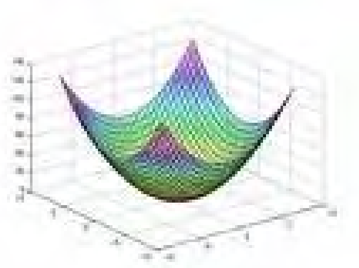
active RS – measurem.
+ error

in-situ measurem.
+ error

a priori information
+ error

Integration

Gauß-Newton
OPTIMAL
ESTIMATION



OUTPUT

atmospheric composition:
temperature, humidity, hydrometeors

+ errors

To be applied operationally within the next year

JOYCE & SFB/TR32

- Observations of temperature, humidity, clouds and precipitation for process studies and model validation in **SFB/TR32** „Patterns in Soil-Vegetation-Atmosphere Systems - Monitoring, modelling and data assimilation“

- Interaction processes between surface, vegetation and atmosphere via spatially and temporally highly resolved observations of the atmospheric branch of the hydrological cycle (Project **D2** – Crewell, Wahner, Rascher)

  - long-term monitoring (statistical analysis)
  - process studies (field campaigns with water vapour DIAL, RS..) and support of Large Eddy Simulations (Project **D6** Shao, Kollet)
  - “routine validation” of COSMO-NRW (Project **C4** Simmer, Bott)

- Relation between cloud formation and precipitation production
  Quantitative precipitation estimation
  → polarimetric rain radar at „Sophienhöhe“ & MicroRainRadar (MRR) at FZJ
  Integration in project **D6** (Simmer, Friedrichs)

JOYCE Goals

Long-term obseravtions of atmospheric state

- Application of Cloudnet/IPT in near real-time mode
  → consistent thermodynamic and microphysical profiles
- Retrieval “testbed” → „new“ synergies
- Satellite validation – pre-studies (Earthcare, GPM..)
- Investigation of Cloud-aerosol-radiation interaction
  → statistical assessment – filtering / classification of suitable cases
  → potentially running single column models (SCM) operationally
  (co-operation Pier Siebesma, GEWEX)

Example

Kerstin Ebell Susanne Crewell, Ulrich Löhnert, David D. Turner, Ewan J. O’Connor: Cloud statistics and cloud radiative effect for a low-mountain site, Quarterly Journal of the Royal Meteorological Society, March 2011

JOYCE Goals

Scanning observation

- Spatial representativeness of supersites – precondition for model validation and satellite validation
- Integration of ground-based and satellite borne observations
  → DFG project ICOS together with IfT and FU Berlin
- Derivation of 3D cloud fields
  → investigation of parametrizations (sub-grid cloudiness, cloud overlap)
  → parametrization of 3D radiation effects
- Characterizing 3D cloud structure in conjunction with the hemispheric scans of the atmospheric water vapour variability + rain radar
  → gain insight into cloud / drizzle / precipitation formation processes