Karlsruhe Institute of Technology

Better understanding of the dynamics of the lower atmospheric boundary layer - technical meteorology and full-scale boundary layer measurements

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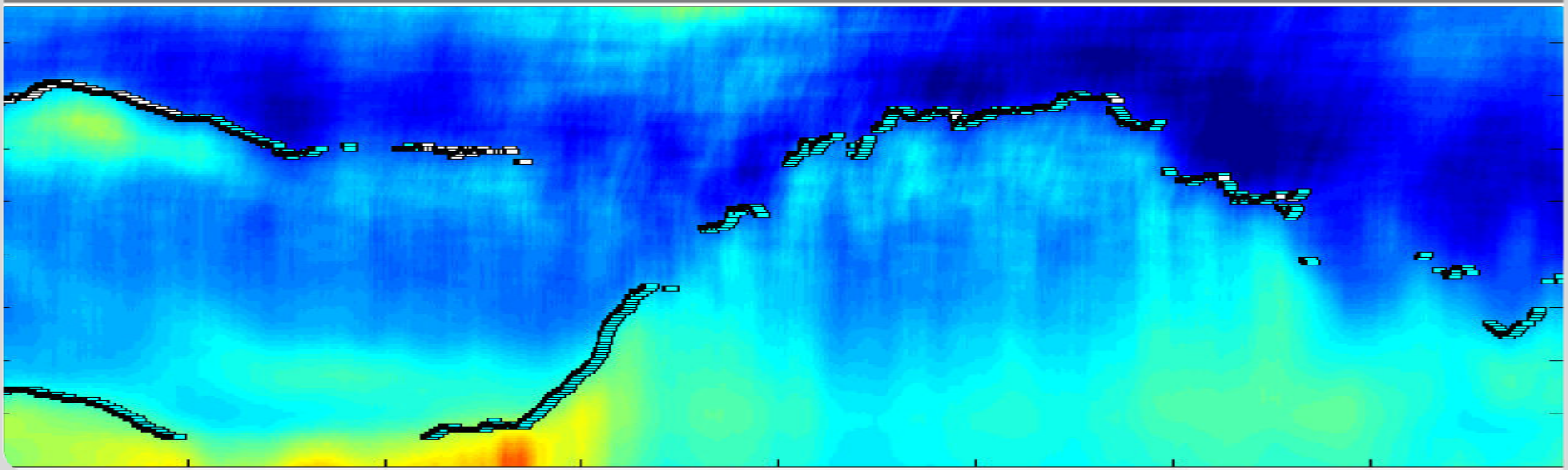


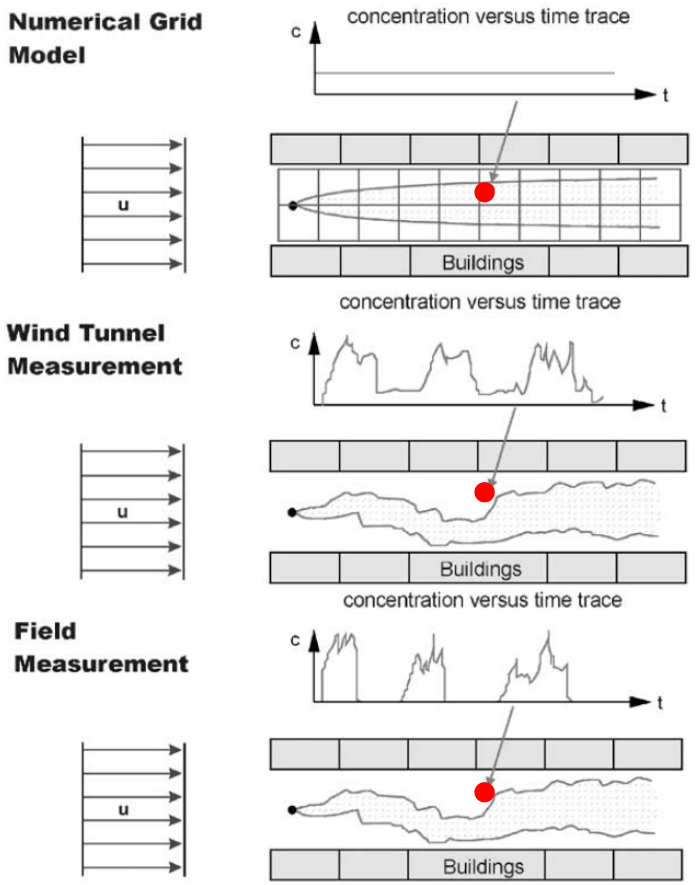
Better understanding of the dynamics of the lower atmospheric boundary layer

by

❶ **numerical experimentation: simulation models**

❷ **physical (laboratory) experimentation: wind tunnels**

❸ **full-scale (field) experimentation: outdoor measurements**



Universität (TH) Karlsruhe

❶ numerical experimentation: simulation models

1970-1982 SFB 80 „Ausbreitungs- und Transportvorgänge in Strömungen“
Coordinator: M. Schatzmann, Speaker: E.J. Plate

Report SFB80/T/86: Schatzmann, M.: „Auftriebsstrahlen in natürlichen Strömungen – Entwicklung eines mathematischen Modells“ (Juli 1976)

Report SFB80/T/90: Schatzmann, M., W. Flick: „ATMOSPHÄRE – fluiddynamisches Simulationsmodell zur Vorhersage von Ausbreitungsvorgängen in der atmosphärischen Grenzschicht“ (März 1977)

❶ simulation models / ❷ physical (laboratory) experimentation: wind tunnels

1983-1994 SFB 210 „Strömungsmechanische Bemessungsgrundlagen für Bauwerke“, Secretary: R. Friedrich, Speaker: E.J. Plate

German Atmospheric Research Programme (BMBF)

AFO 2000

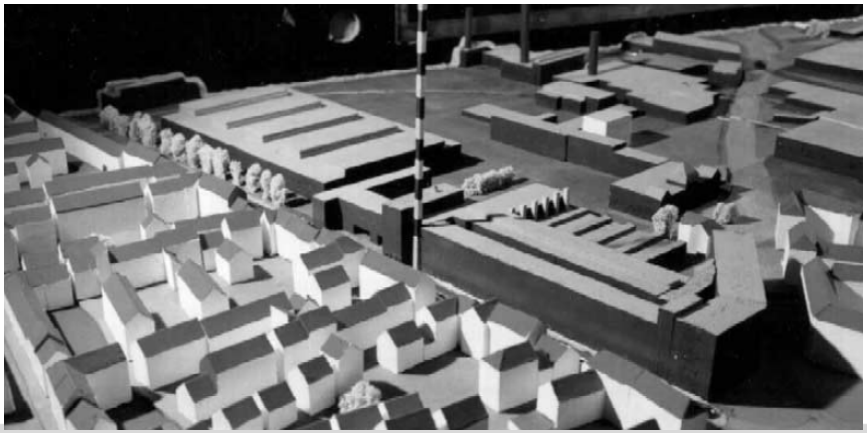
❷ physical (laboratory) experimentation: wind tunnels

VALIUM
2000 - 2004

Development and validation of tools for the implementation of European air quality policy in Germany
Coordinator: M. Schatzmann

Schatzmann, M., and Leitl, B., 2002: Validation and application of obstacle resolving urban dispersion models. Atmos. Environ., Vol.36, 4811-4821.

Schatzmann, M., Bächlin, W., Emeis, S., Kühlwein, J., Leitl, B., Müller, W.J., Schäfer, K., Schlünzen, H.: Development and Validation of Tools for the Implementation of European Air Quality Policy in Germany (Project VALIUM). ACP, **6**, 3077–3083, 2006.

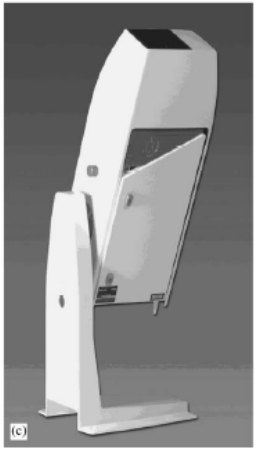


German Atmospheric Research Programme (BMBF)

AFO 2000 VALIUM

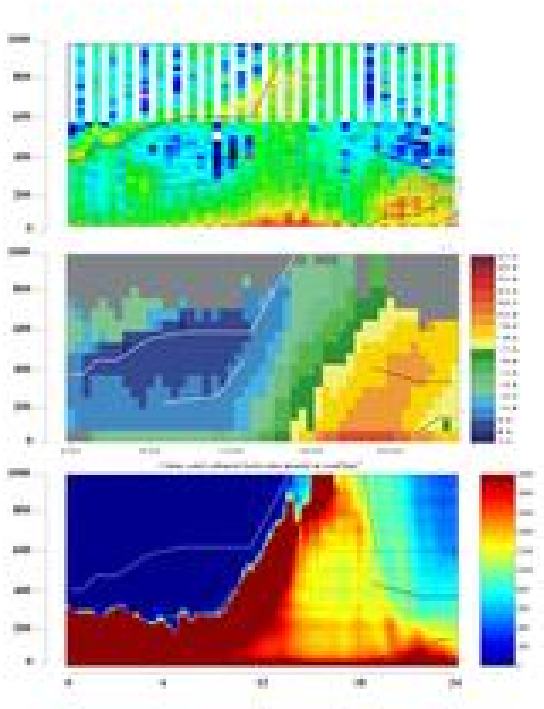
❸ full-scale (field) experimentation: outdoor measurements

Sodar

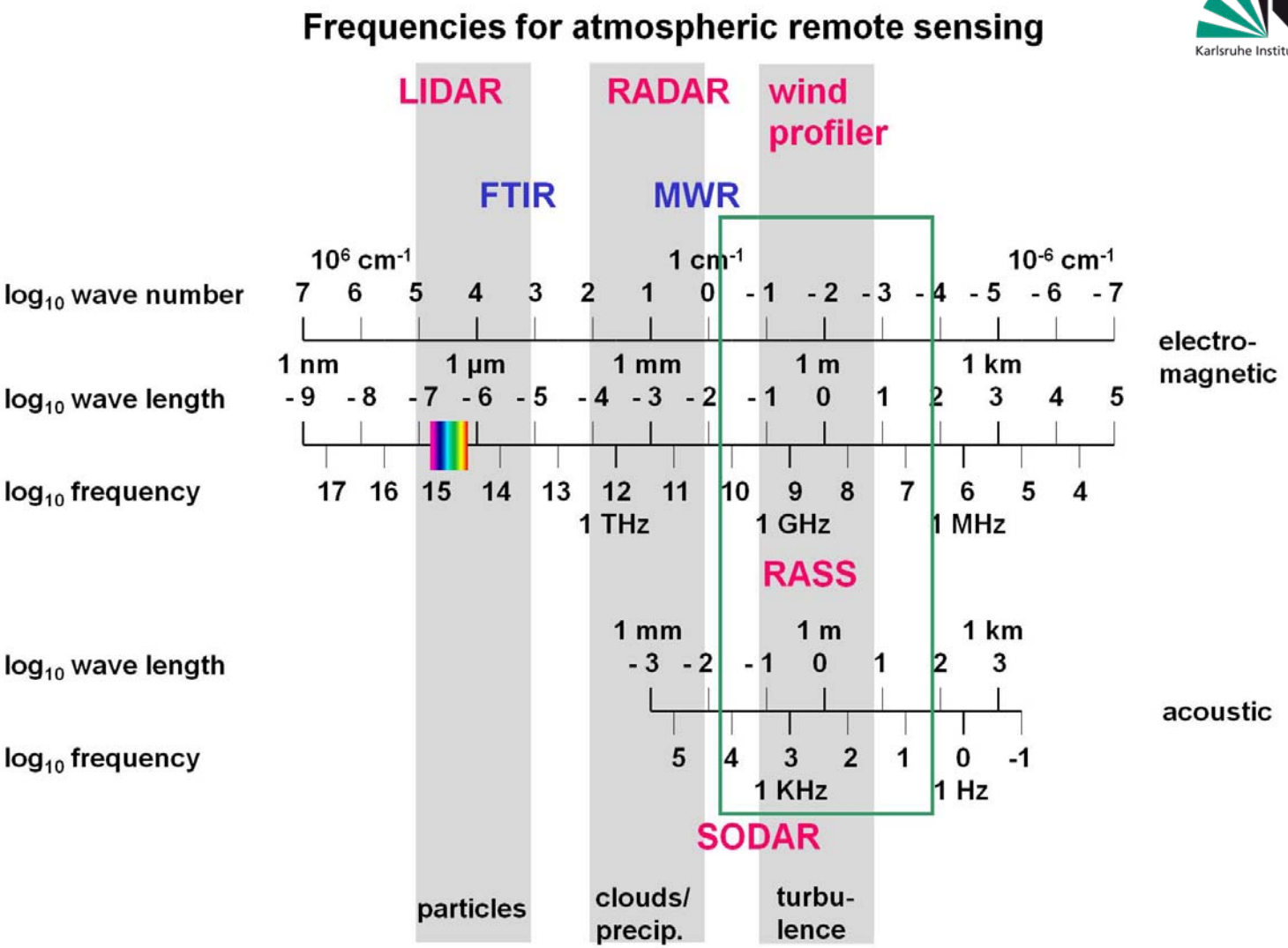


RASS

Ceilometer



Emeis, S., Chr. Münkel, S. Vogt, W.J. Müller, K. Schäfer, 2004: Atmospheric boundary-layer structure from simultaneous SODAR, RASS, and ceilometer measurements. Atmos. Environ., **38**, 273-286.



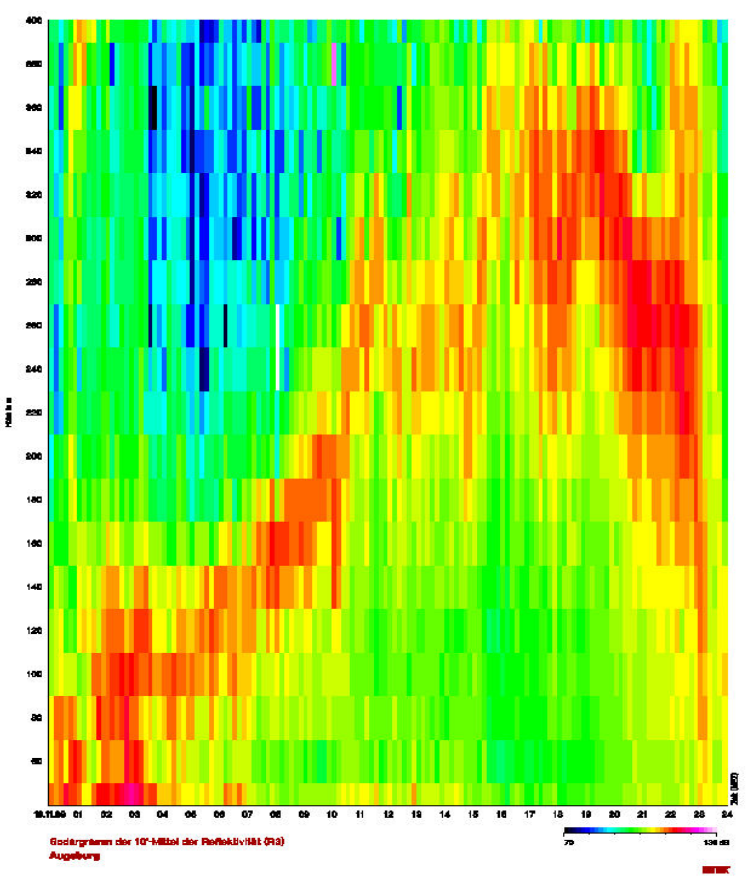
Emeis, S., 2010: Measurement Methods in Atmospheric Sciences - In situ and remote. Borntraeger, Stuttgart, 272 pp., 103 figs., 28 tables, ISBN 978-3-443-01066-9.

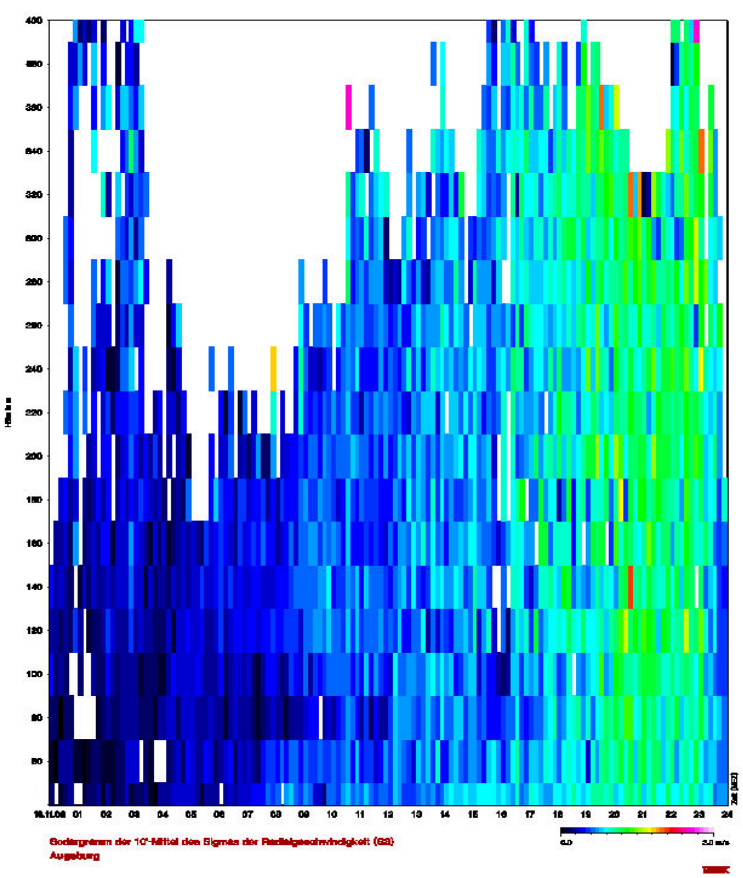
SODAR sample plot (lifted inversion)

acoustic backscatter intensity

sigma w

40 – 400 m





1 day, midnight to midnight

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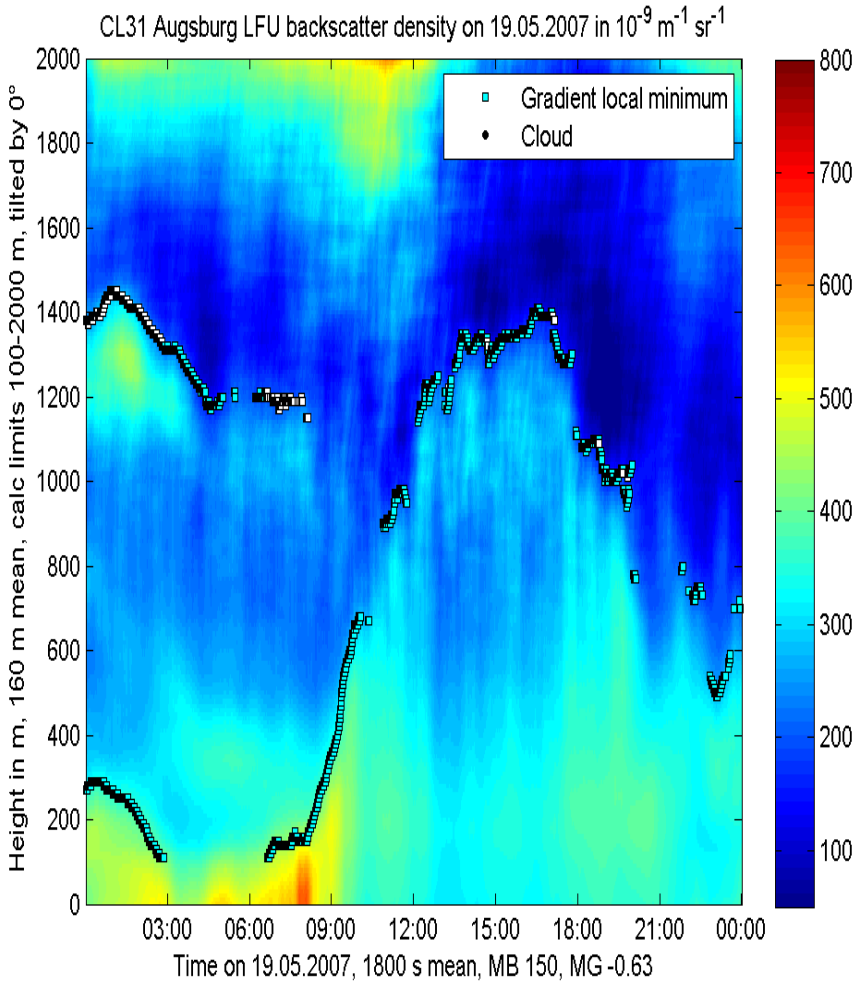
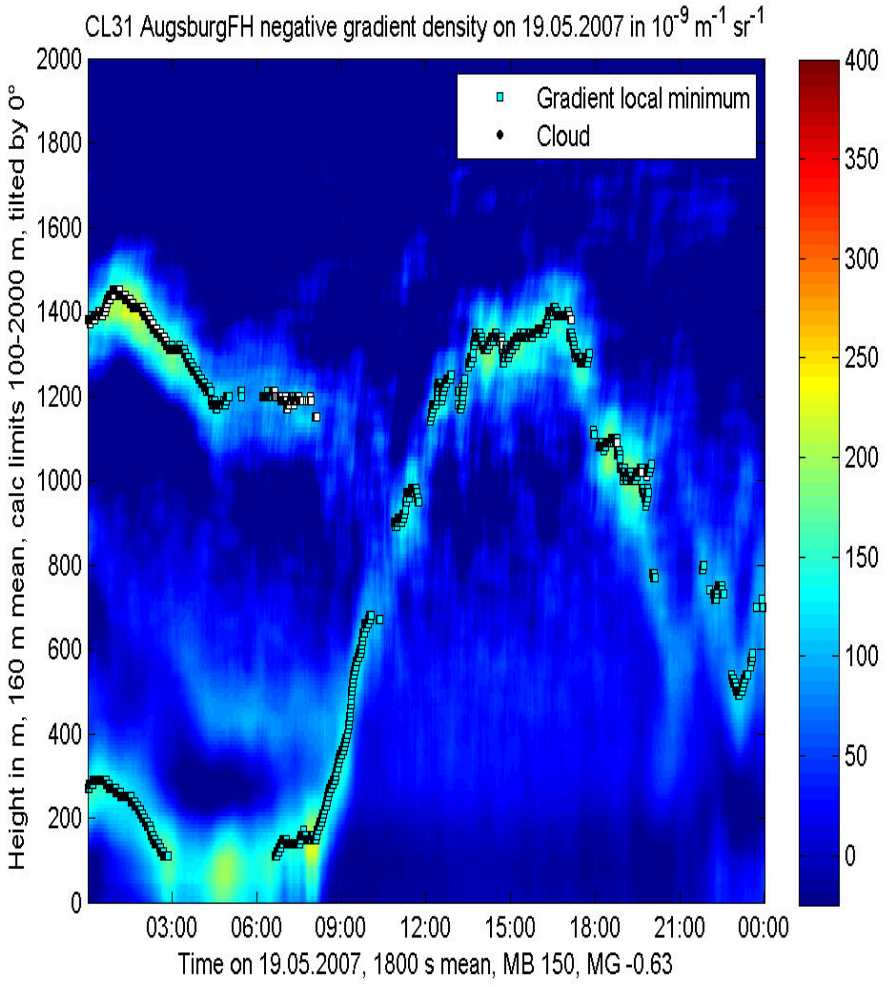
ceilometer sample plot (daytime convective BL)

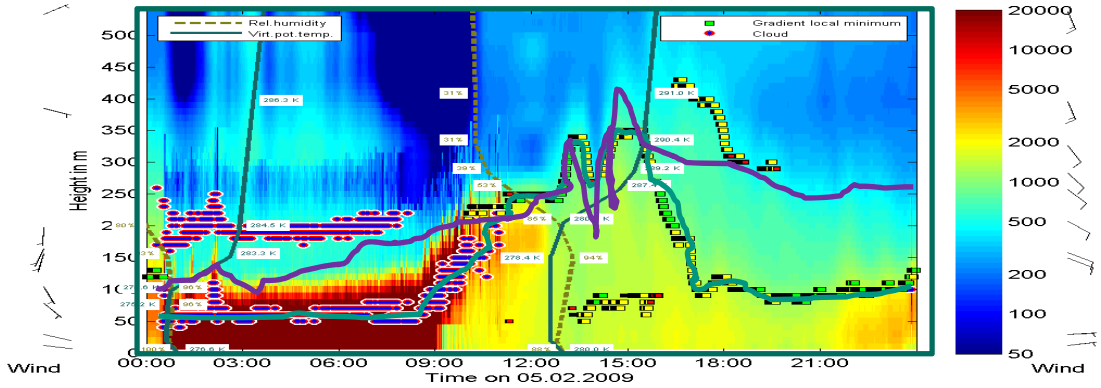
optical backscatter intensity



negative vertical gradient of optical backscatter intensity



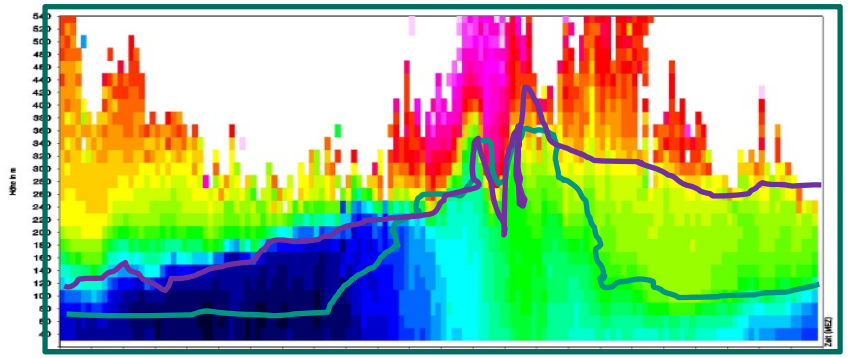
comparison to temperature information



ceilometer

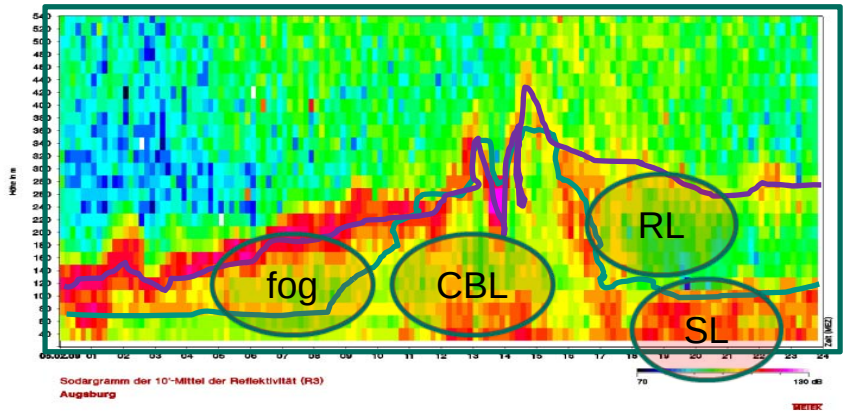
optical backscatter intensity

radiosonde profiles



RASS

potential temperature



SODAR (RASS)

acoustic backscatter intensity
(temp. fluct./vert. temp. grad.)

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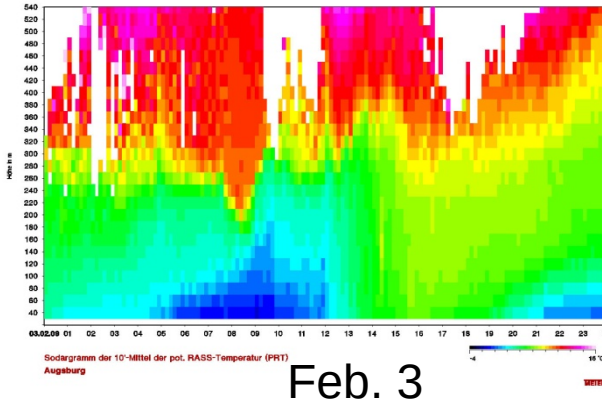
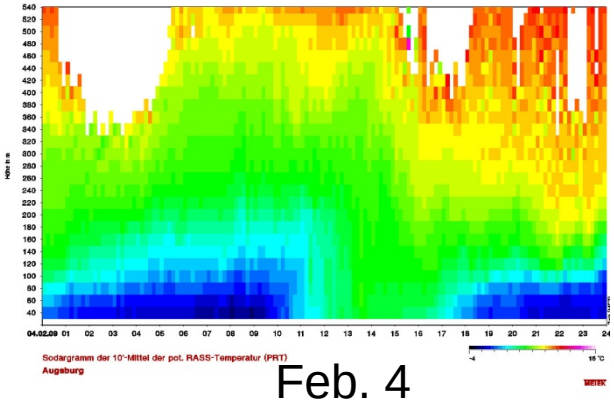
RASS data Augsburg February 2009

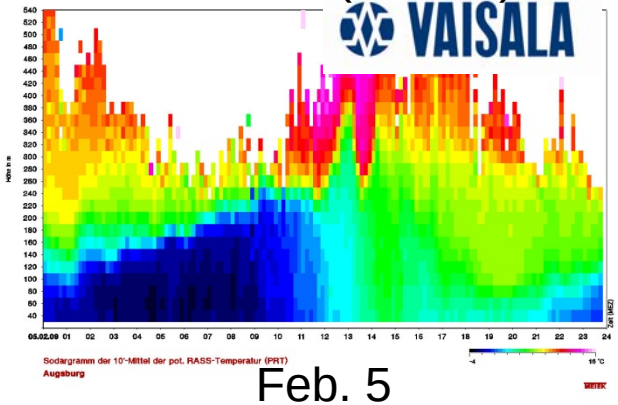
potential temperature (top), MLH RASS (middle), MLH SODAR/Ceilo (bottom)



Feb. 3



Feb. 4



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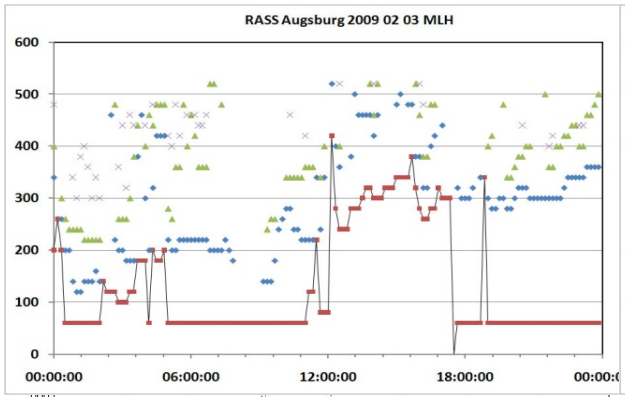

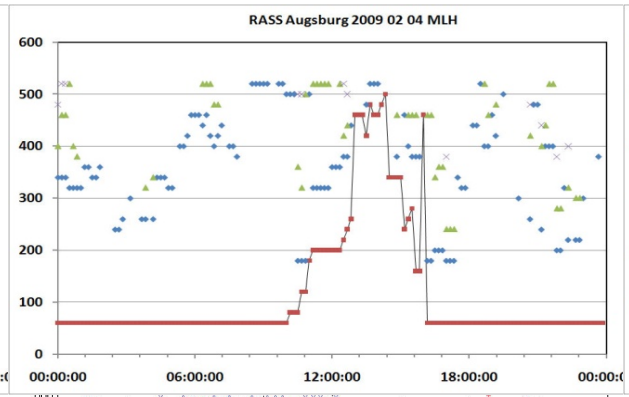

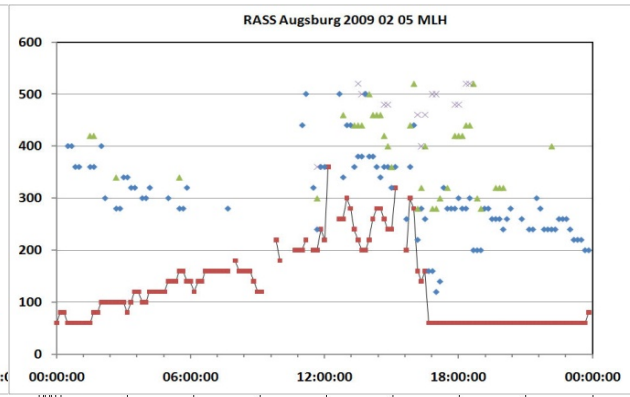

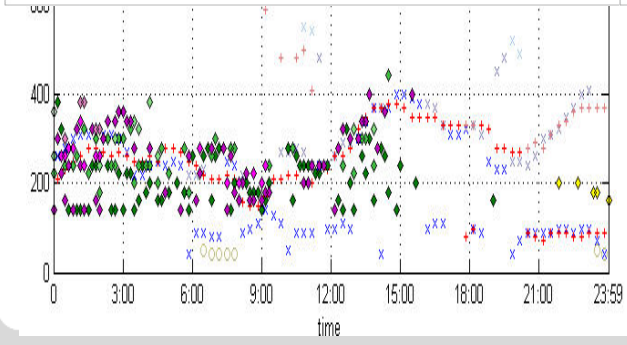

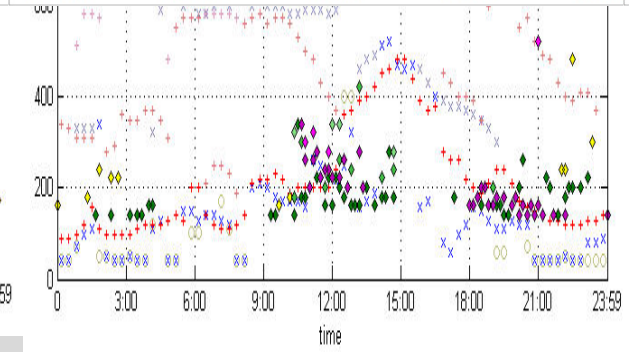

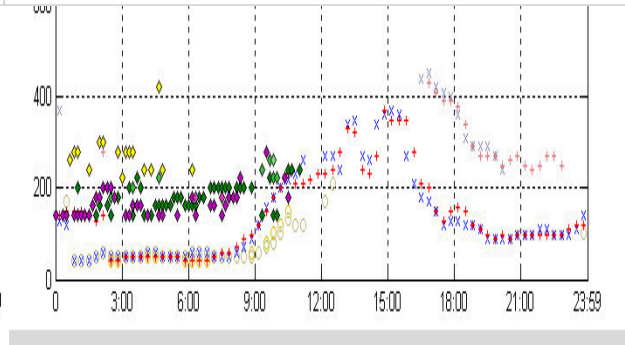

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❸ full-scale (field) experimentation: outdoor measurements

planned for 2011: tower, aerosol lidar, ceilometer and RASS measurements to detect the spatial and temporal structure of the mixing-layer height (MLH) over Hamburg

MLH is necessary to develop a unified description of wind profiles for the Prandtl layer and the lower Ekman layer

MLH is necessary to assess urban air quality and the dynamics of the urban heat island

Gryning, S.-E., E. Batchvarova, B. Brümmer, H. Jørgensen, S. Larsen, 2007: On the extension of the wind profile over homogeneous terrain beyond the surface boundary layer. Bound.-Lay. Meteorol., **124**, 251–268.

❸ full-scale (field) experimentation: outdoor measurements

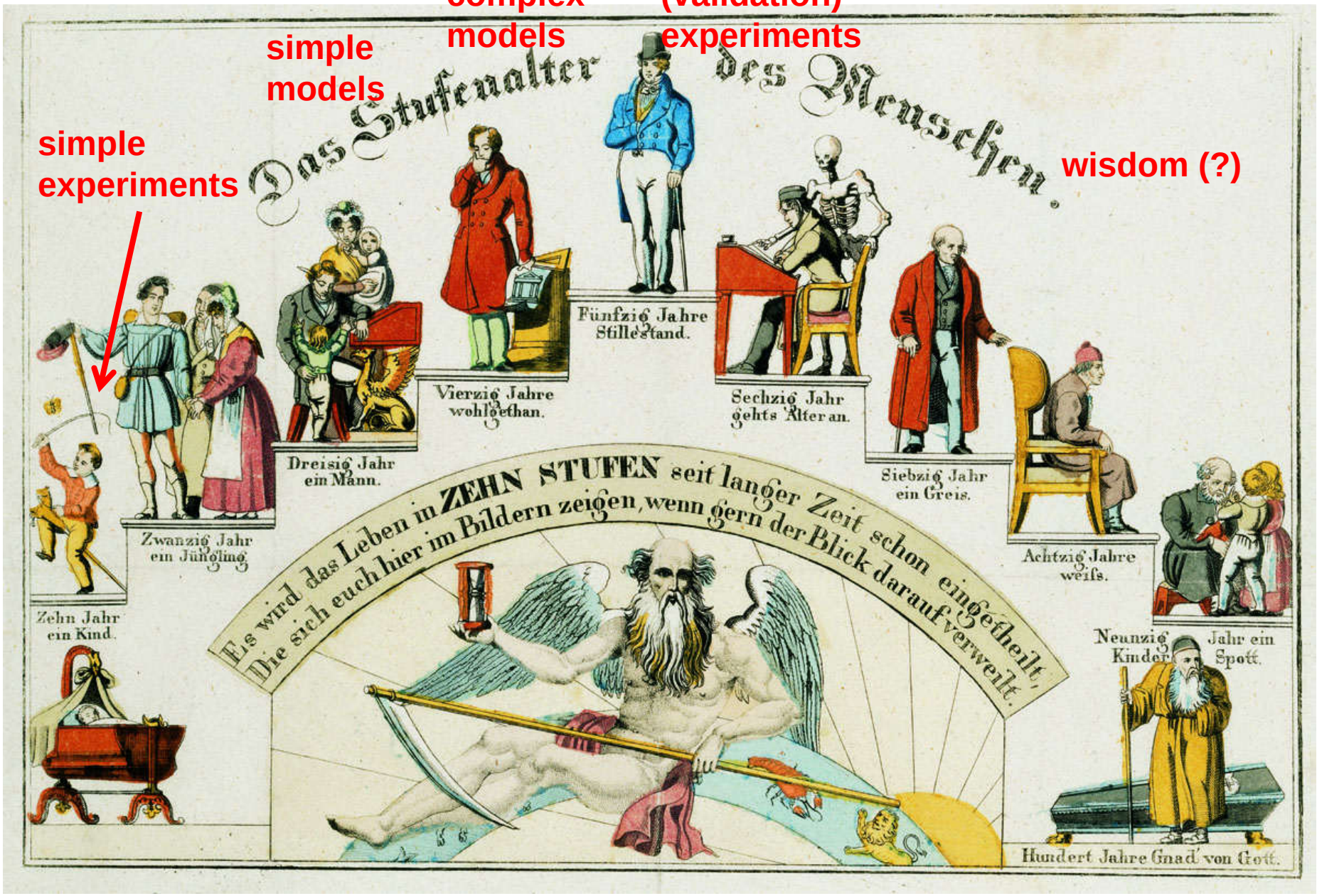
Outlook:

ground-based remote sensing techniques are developed further (examples):

- wind lidars
- aerosol lidars
- RASS for temperature profiles
- passive radiometers for temperature and humidity profiles
- precipitation rates and areal distribution from the attenuation of radio waves in a wireless cellular telecommunication network

applications (examples):

- urban planning (adaptation and mitigation strategies for urban heat islands)
- wind energy (large turbines, profiles up to about 200 m)
- solar energy (power plants with large chimneys, profiles up to about 1500 m)


simple models
complex models
(validation) experiments
simple experiments
wisdom (?)
Das Stufenalter des Menschen.
Zehn Jahr ein Kind.
Zwanzig Jahr ein Jüngling.
Dreisig Jahr ein Mann.
Vierzig Jahre wohlgethan.
Fünfzig Jahre Stillestand.
Sechzig Jahr gehts Alter an.
Siebzig Jahr ein Greis.
Achtzig Jahre weifs.
Neunzig Jahr ein Kinder Spott.
Hundert Jahre Gnad von Gott.
Es wird das Leben in ZEHN STUFEN seit langer Zeit schon eingetheilt,
Die sich euch hier im Bildern zeigen, wenn gern der Blick darauf verweilt.

I'd like to wish all the best for the upcoming years!