MEASUREMENTS AND VALIDATION OF PARAMETRIC SCHEMES. RECENT RESULTS, CRACOW EXPERIMENT IN THE FRAMEWORK OF COST – ACTION 715

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The Cracow experiment

- 2 extensive measurement periods
  (20-25 08.2002 and 10-18 06.2003).
- AIMS:The investigation of the city influence on the ABL, especially on its MH.
- Domain : 200 x 100 km, Cities Cracow and Katowice with surrondings

The domain of the experiment

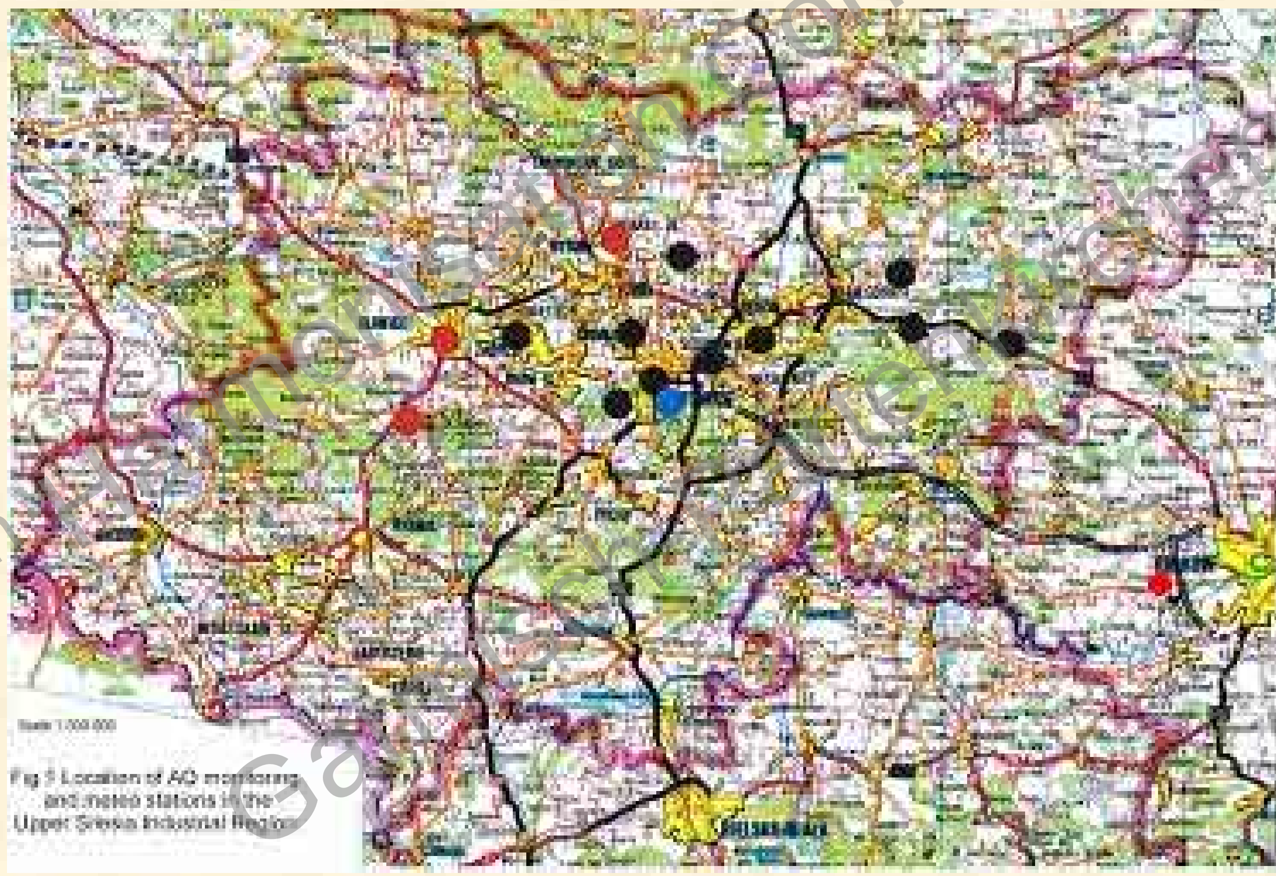
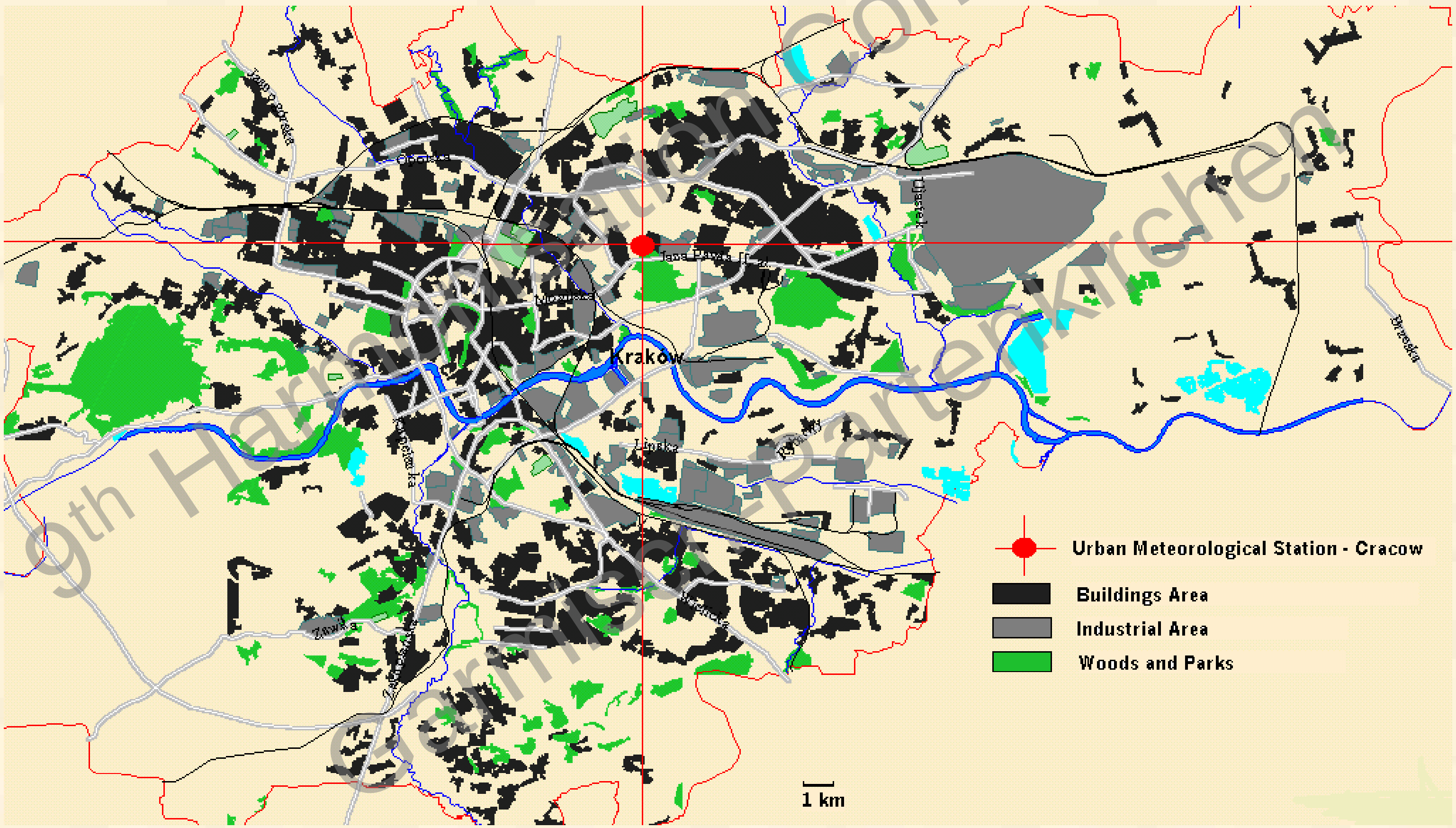
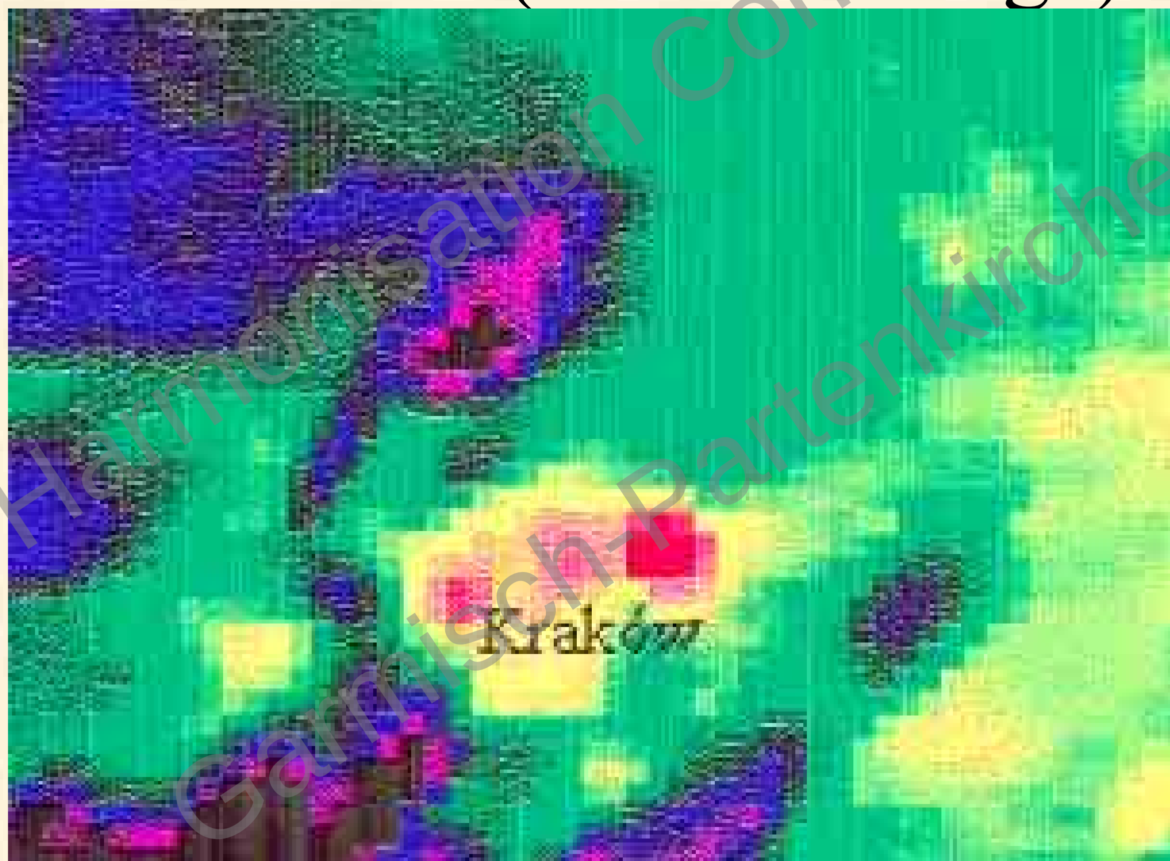


Fig 1 Location of AQ monitoring and meteo stations in the Upper Silesia Industrial Region

The localization of the urban meteorological station UMS in Cracow



The localization of the urban meteorological station UMS in Cracow – heat island (satellite image)



The view of the site of the urban meteorological station UMS in Cracow

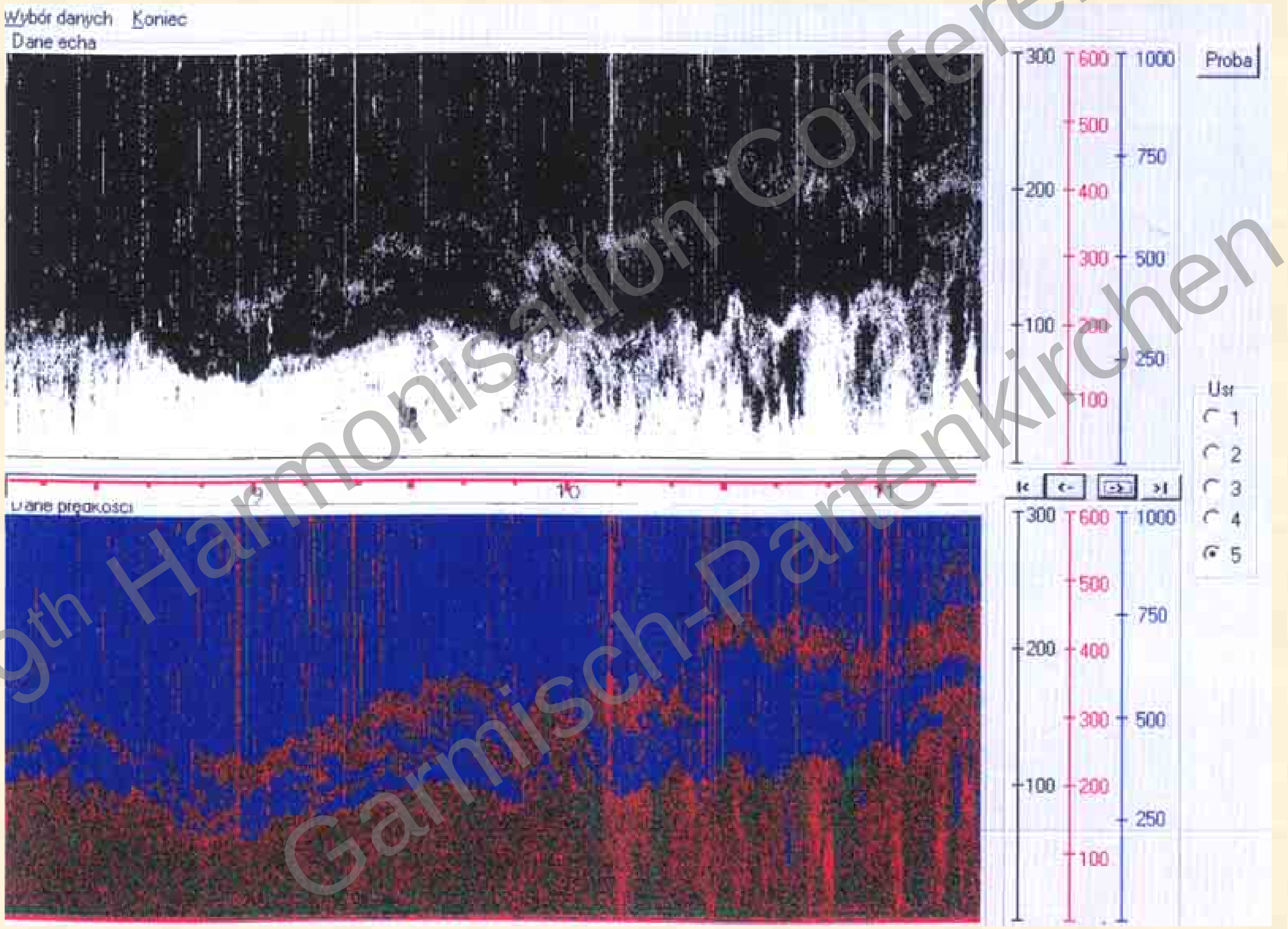
The measurement devices installed in UMS Cracow Czyżyny

- Monostatic sodar (30 – 1000 m) in operational way, vertical component of the wind speed Doppler analyses
- Doppler (3 antennas) sodar (30 – 600 m) in operational way
- Dust lidar
- Tethered balloon (wind speed, humidity, pressure, temperature) (0 – 1000 m)

The measurement devices installed in UMS Cracow Czyżyny cont.

- Sonic anemometer R. M. Young 81000 (2m)
- System of three pyrranometers and a semiconductor sensor to determine the heat flux
- Automatic meteorological station for the standard meteorological measurement, PGT clasification (measurement 2, 10 m)
- Meteorological tower (25 m)

Monostatic sodar with vertical wind component Doppler analyses



THE RESULTS OF THE THREE SCHEMES OF DAYTIME ESTIMATES FOR THE SENSIBLE HEAT FLUX CALCULATION IN COMPARISON WITH MEASUREMENT RESULTS OF THE SONIC ANEMOMETER

- The calculations of the sensible heat flux H schemes for given location : based on the Penman-Monteith resistance method with 3 different theoretical approaches (Smith, Holtslag and Van Ulden, Berkowicz and Prahm).
- The results were compared with the results of measurements made with use of a ultrasonic anemometer (30 minutes moving data for every 1 minute). $Q_H = \overline{w'\theta'}$ (K*m/s)*1216 (W/m2)/(K*m/s)

The Smith Heat Flux Scheme

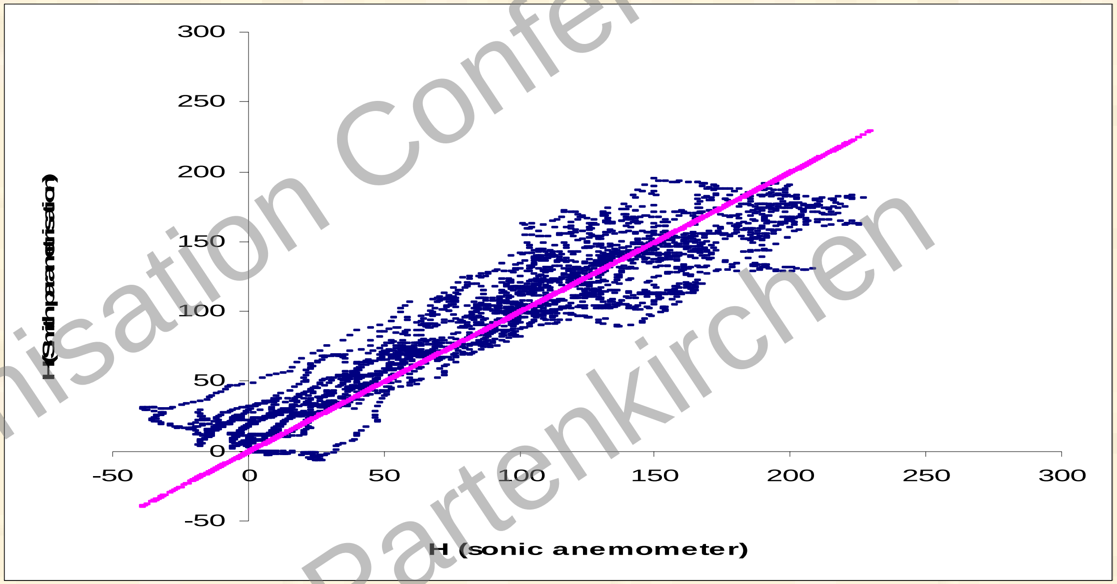
- The distribution of energy between sensible heat flux and latent heat flux is proportional to the total net radiation with additional dependence on the Sun elevation φ. The sensible heat flux is calculated by the Penman –Monteith resistance method (*Monteith, J. L. and Unsworth, M. H.*, 1990) with aerodynamic resistance reverse proportional to the wind speed. The surface resistance depends on the temperature and Sun elevation (*Galinski, A. E. and Thomson*, D. J. 1995, *Smith F. B.* , 1990).

The Smith Heat Flux Scheme

- The calculations were made for the Smith's height z=3m with constant c_z=188.9, u_z values were taken as 5 minutes mean values of the wind speed from the sonic anemometer. The values u_z equal to 0.01m/s were used in the calm wind condition to eliminate infinite values of aerodynamic resistance r_a.

The Smith Heat Flux Scheme

n	3340
$\bar{x}$	87.34
$\bar{y}$	91.23
S_x	64.41
S_y	54.50
$\bar{y}-\bar{x}$	3.88
rms	23.41
r	0.94



- *the calculated and observed values of daytime (φ >10°) sensible heat flux*

The Holtslag and Van Ulden Heat Flux Scheme

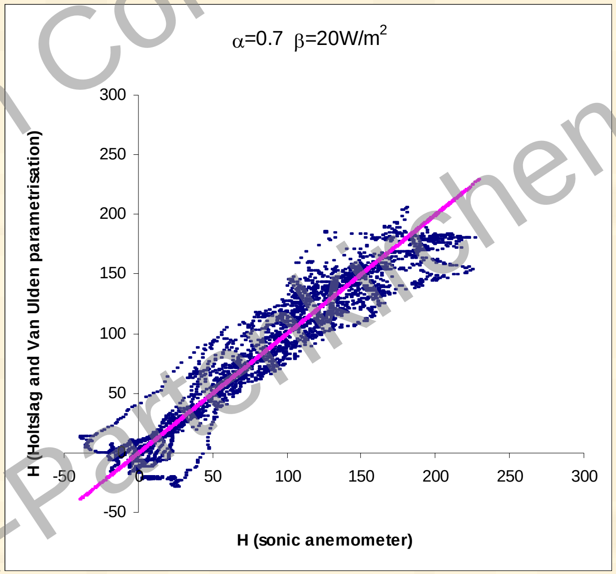
- The distribution of energy between sensible heat flux and latent heat flux is made with assumption of the available energy equal to 0.9 total net radiation Rn. Sensible heat flux is taken from the Penman –Monteith resistance method with empirical parameters α and β depending on the soil moisture conditions

The Holtslag and Van Ulden Heat Flux Scheme

- For the moist covered surfaces $\alpha \approx 1$ and $\beta \approx 20 W/m^2$ were found to be good estimates by Holtslag and Van Ulden. The best fit between the calculated and measured values was found with $\alpha \approx 0.7$ probably because of the drought condition in Cracow in June.

The Holtslag and Van Ulden Heat Flux Scheme

n	3340
$\bar{x}$	87.34
$\bar{y}$	85.55
S_x	64.41
S_y	61.61
$\bar{y}-\bar{x}$	-1.80
Rms	19.95
r	0.95



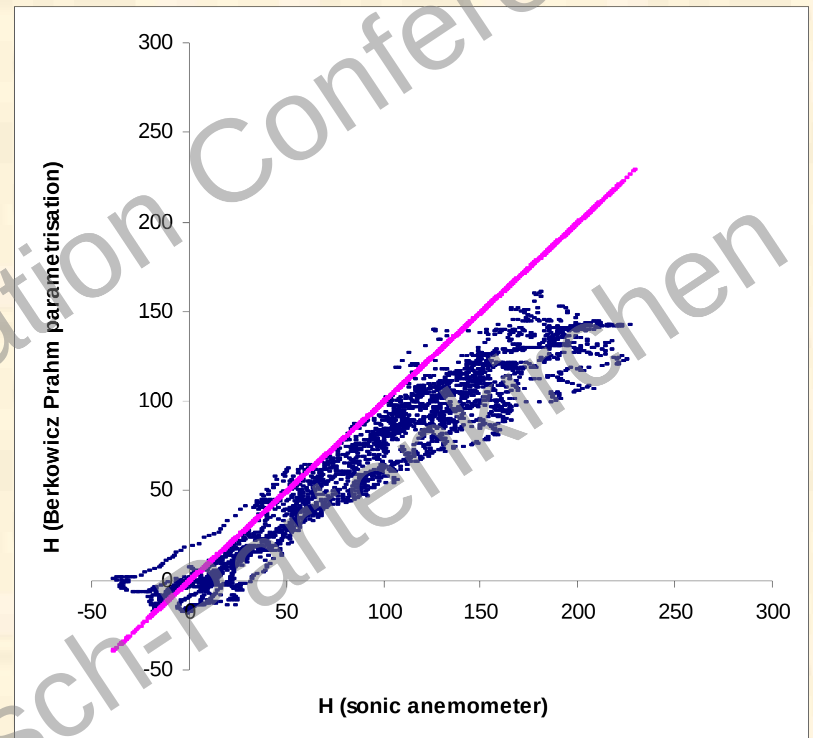
- *. The scatter plot of the calculated and observed values of daytime ($\varphi > 10^o$) sensible heat flux for α=0.7.*

The Berkowicz and Prahm Heat Flux Scheme

- The ground heat flux G is parameterized by H/3. The aerodynamic resistance used by Berkowicz and Prahm, which is based on the Monin - Obukhov similarity theory is determined by means of iteration (*Berkowicz, R. And Prahm, L. P.* 1982) Berkowicz and Prahm suggest to take the surface resistance reverse proportional to function F.

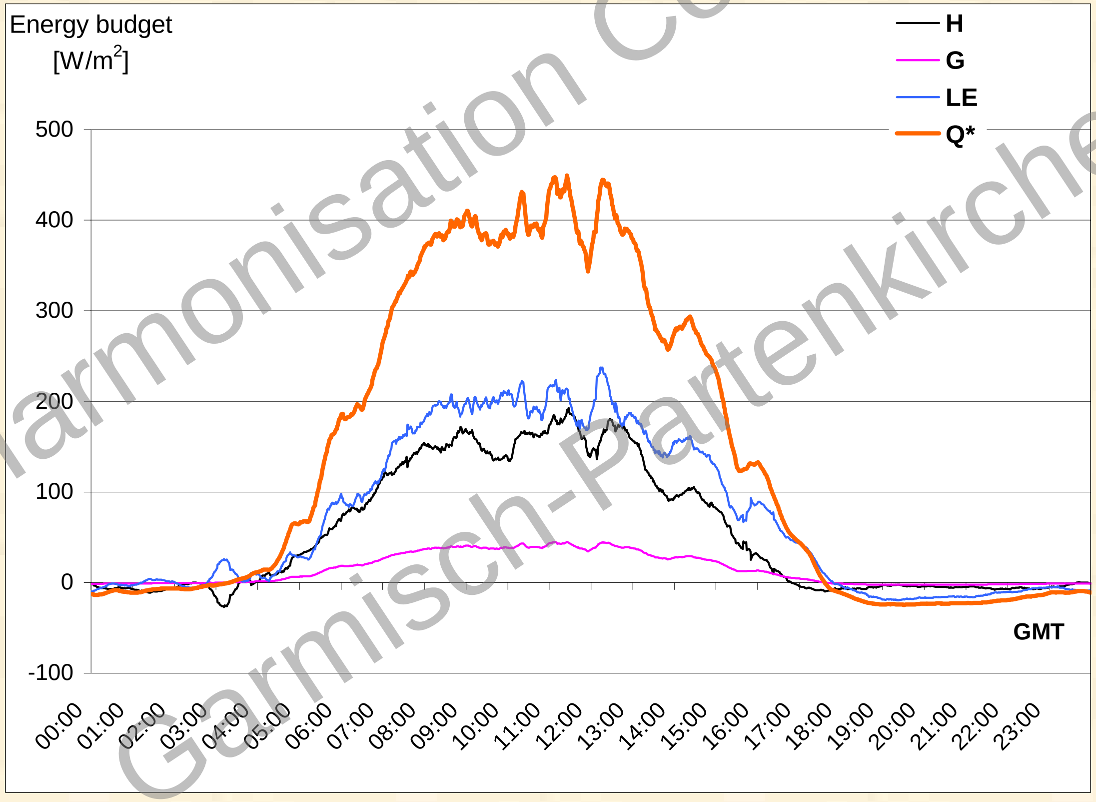
The Berkowicz and Prahm Heat Flux Scheme

N	3340
$\bar{x}$	87.34
$\bar{y}$	62.92
S_x	64.41
S_y	48.41
$\bar{y}-\bar{x}$	-24.43
Rms	33.05
r	0.96

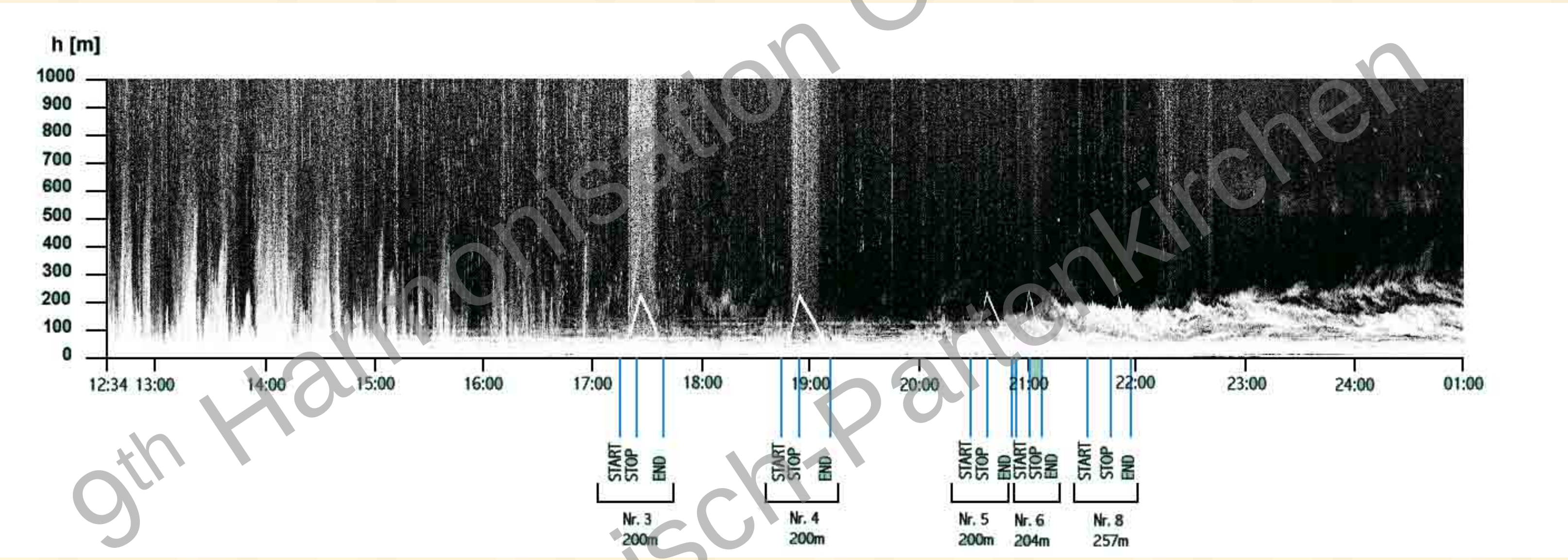


- *The scatter plot of the calculated and observed values of daytime ($\varphi > 10^o$) sensible heat flux.*

Energy Budget



COMPARISON OF THE MIXING LAYER HEIGHTS DETERMINED BY SODAR ECHOES AND BY THE VERTICAL PROFILES OF THE POTENTIAL TEMPERATURE



Sodar record for one of the experiment days, hrs 12.34 – 01.00, with marked times of the tethered ballon ascents. Convective echos visible up to 17.00 hr, ground-bases inversion since 19.00 hr.

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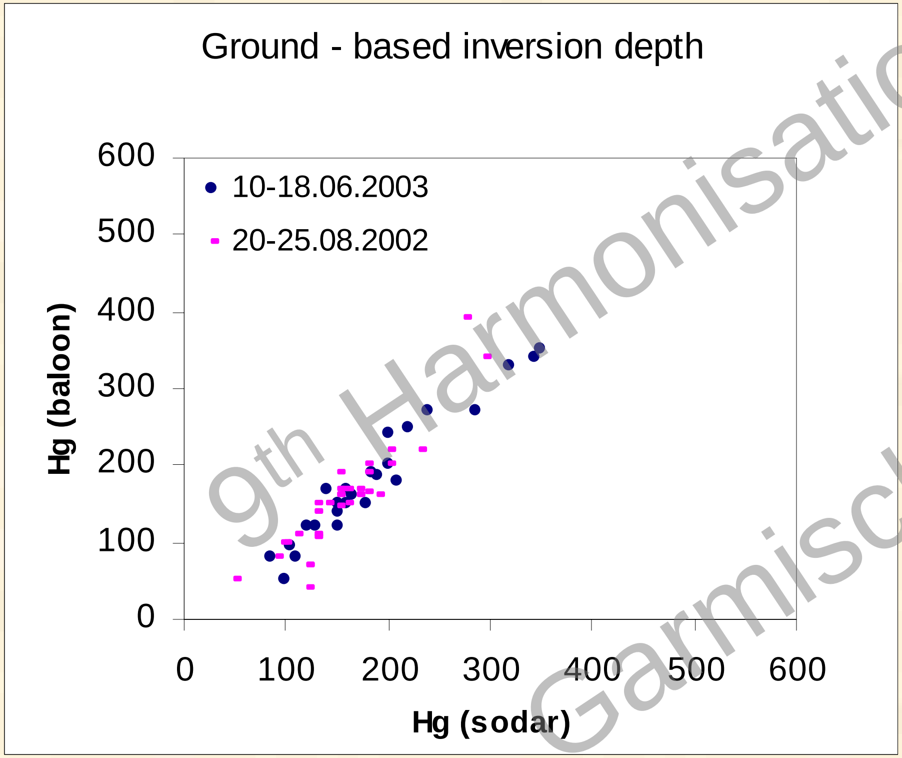

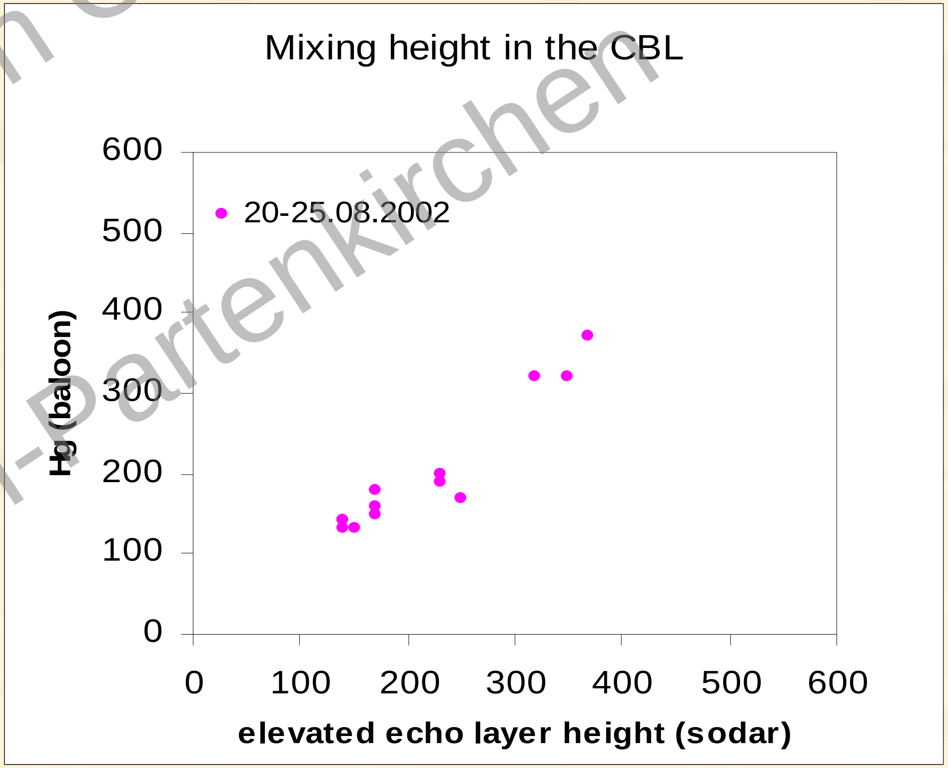

COMPARISON OF THE MIXING LAYER HEIGHTS DETERMINED BY SODAR ECHOES AND BY THE VERTICAL PROFILES OF THE POTENTIAL TEMPERATURE

- Conclusinons: in our opinion sodar with manually not automatic procedures for mixing height determination is convennient and realible tool for mixing height determination in a lot of cases excluded well developed CBL