Relations between mixing-layer height, low-level jets and cross-over heights – evaluations of SODAR and RASS measurements

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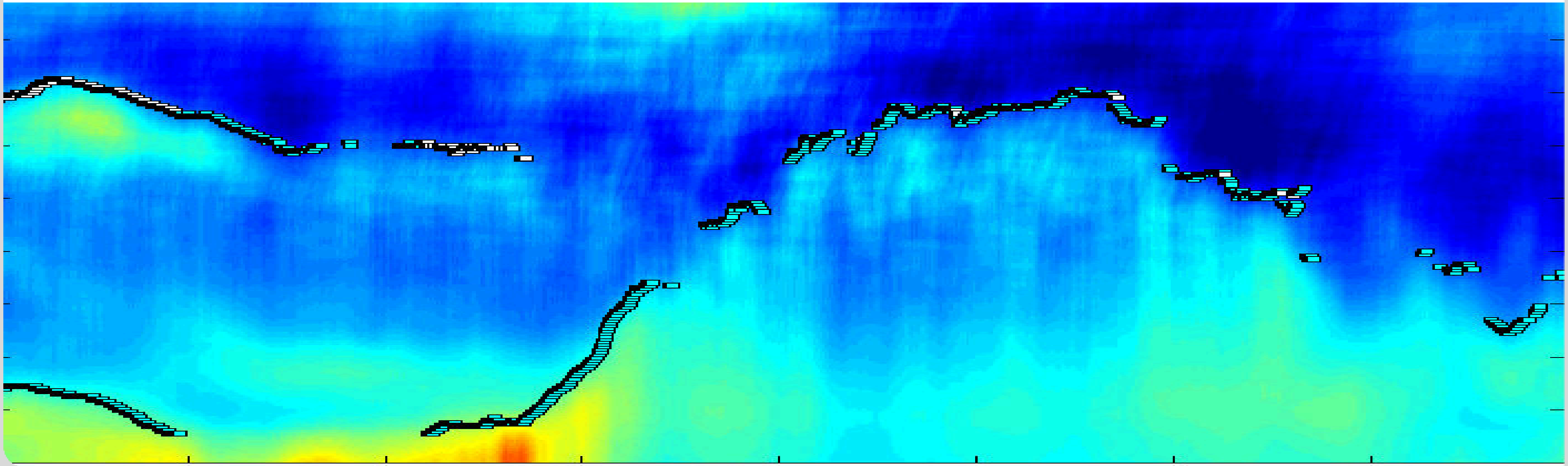

Mixing-layer height

low-level jet

cross-over height

are a few items which have become important issues in Energy Meteorology

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Wind conditions for pollutant dispersion and wind energy conversion are influenced by (among others):

- the height of the surface layer

influences the diurnal wind speed variation

- mixing-layer height

influences the wind profile shape above the surface layer

- low-level jets

shift peak wind harvests to night-time hours for larger wind converters,
lead to long-range nocturnal pollutant transports

- cross-over height

cross-over of mean daytime and night-time wind profiles (usually different from surface layer height)

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☺☺☺💣 **RASS** delivers temperature profiles, wind profiles are additionally available.
MLH directly from temperature profiles. LLJ from wind profiles.
Does not work properly under high wind speeds. Restricted range.

☺☺☺💣 **wind lidar** detects wind profiles, aerosol distribution and water droplets. It has to be assumed that the aerosol follows the thermal structure of the atmosphere and the wind.
MLH from aerosol backscatter, wind speed variance, LLJ from wind profiles.
Does not work properly in extreme clear (aerosol-free) air and during precipitation events and fog.

☺☺💣💣 **Ceilometer** detects aerosol distribution and water droplets. It has to be assumed that the aerosol follows the thermal structure of the atmosphere.
MLH indirectly from aerosol backscatter using a MLH algorithm.
Does not work properly in extreme clear (aerosol-free) air and during precipitation events and fog.

☺💣💣💣 **SODAR** detects wind profiles, temperature fluctuations and gradients, but no absolute temperature.
MLH indirectly from acoustic backscatter (MLH algorithm). LLJ from wind profiles.
Does not work properly under perfectly neutral stratification, with very high wind speeds, and during stronger precipitation events. Restricted range.

mixing layer height

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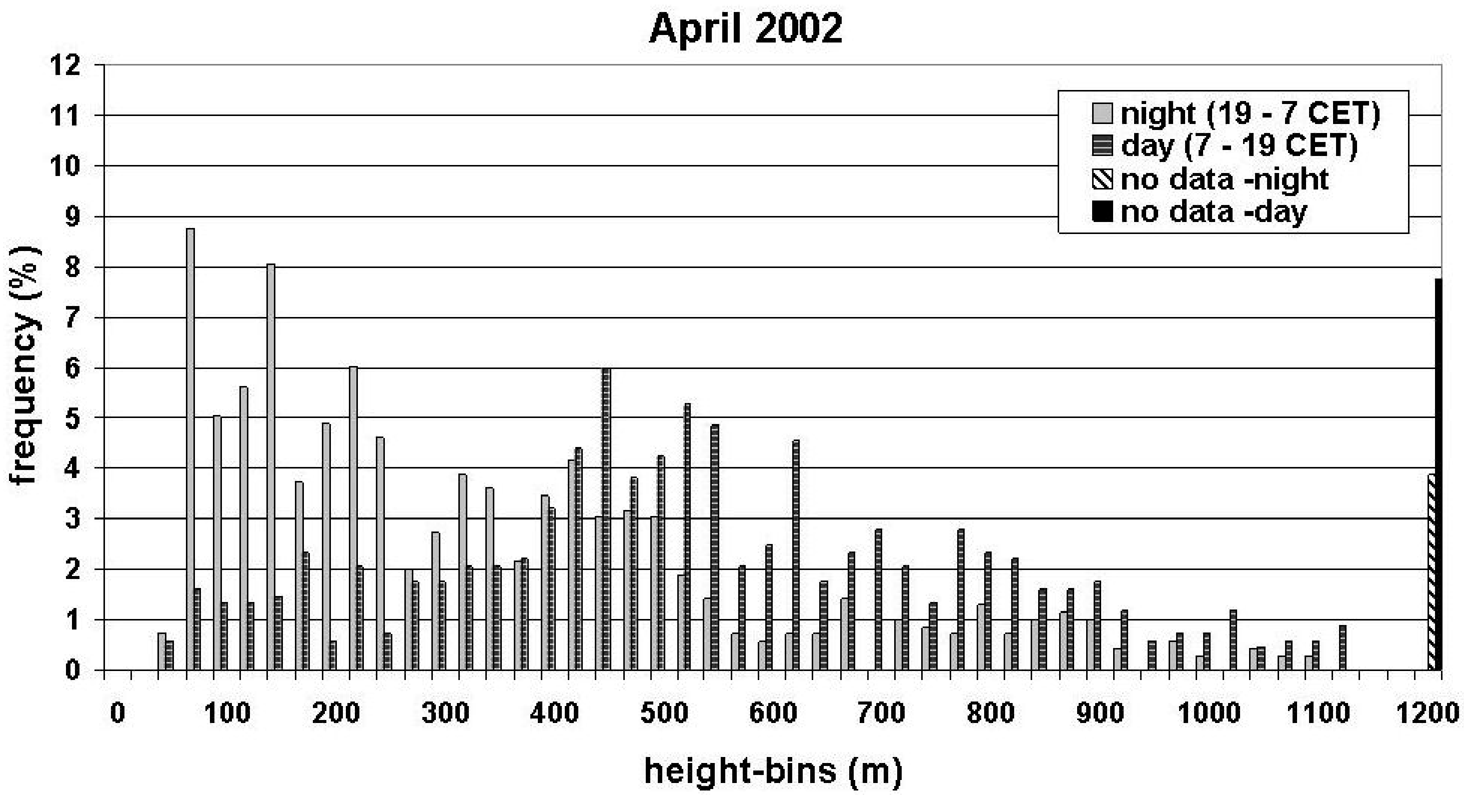
Mixing layer height statistics from sodar observation



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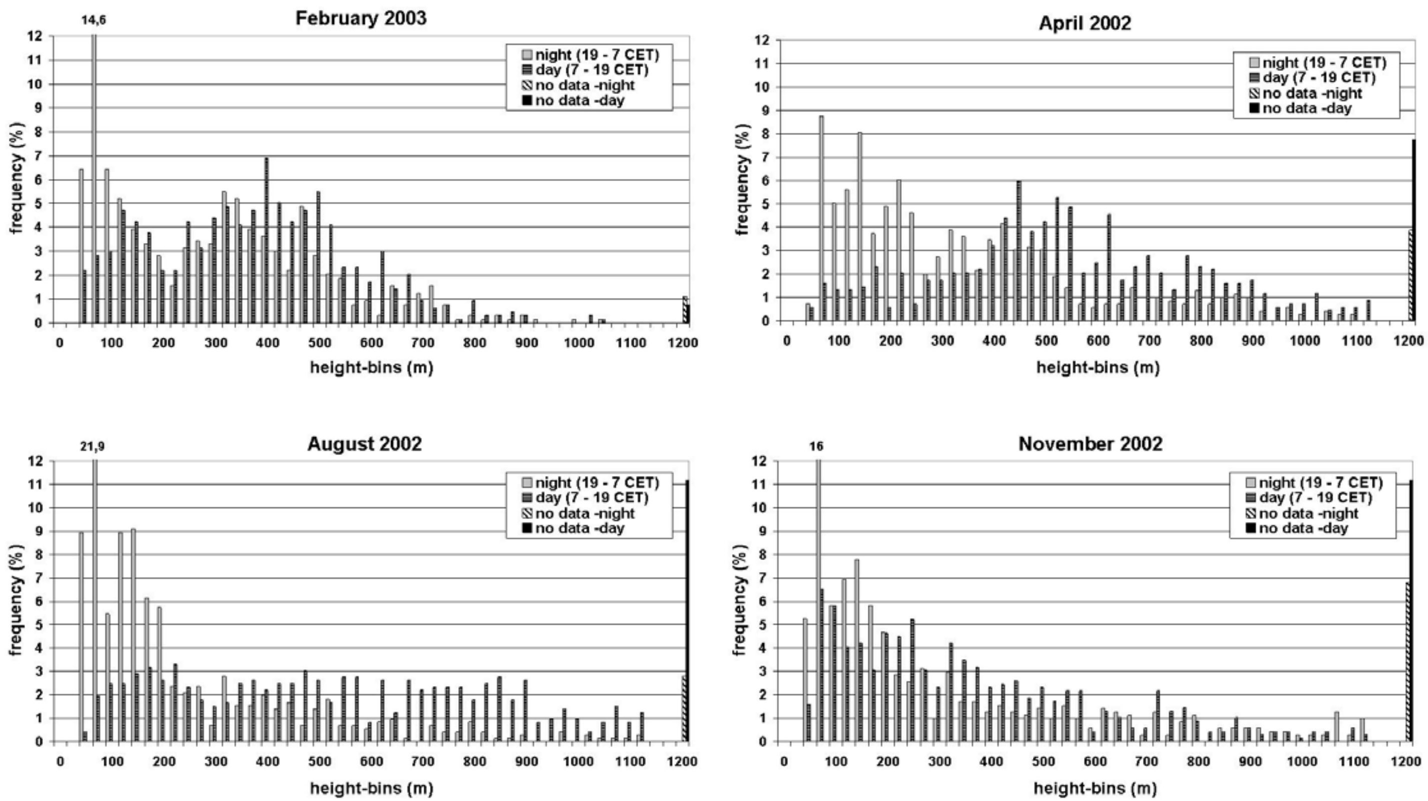
Mixing layer height statistics from sodar observation



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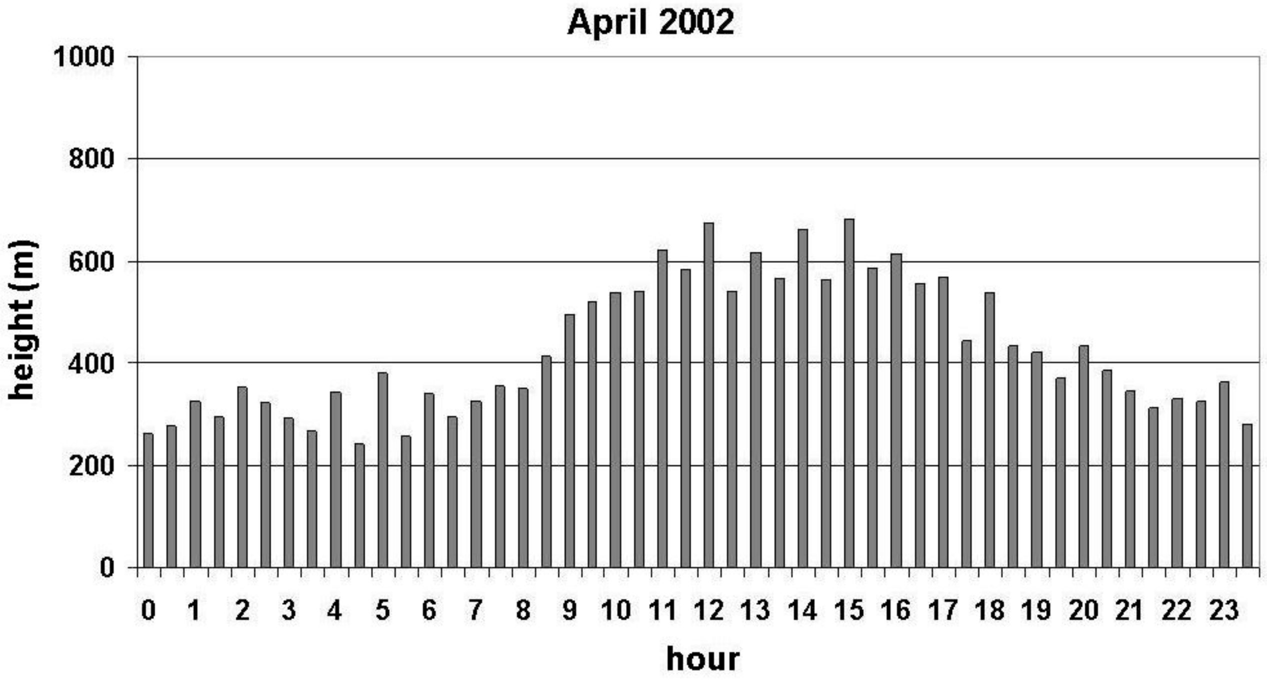
Diurnal variation of mixing layer height from sodar observation



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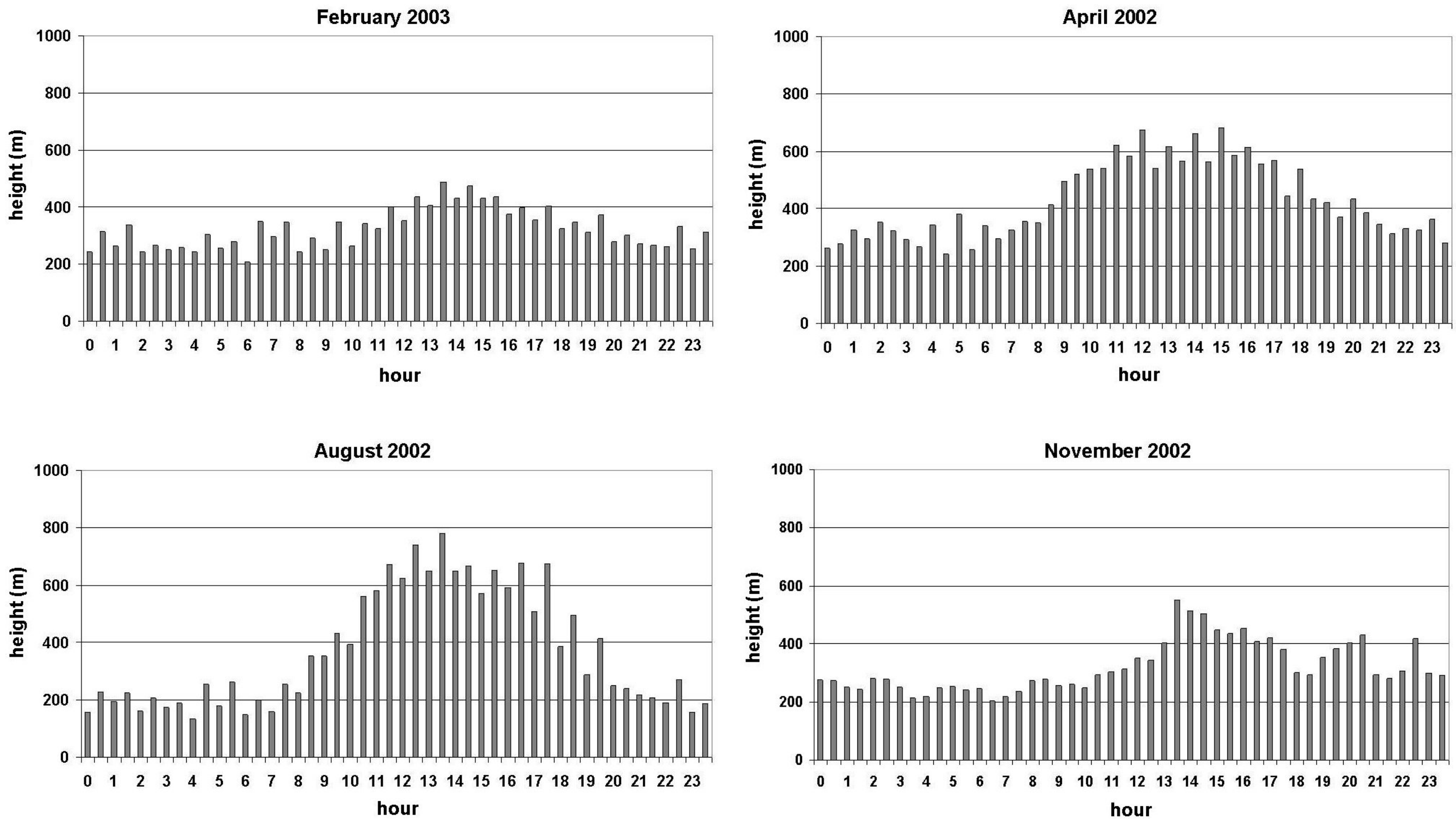
Diurnal variation of mixing layer height from sodar observation



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low-level jets

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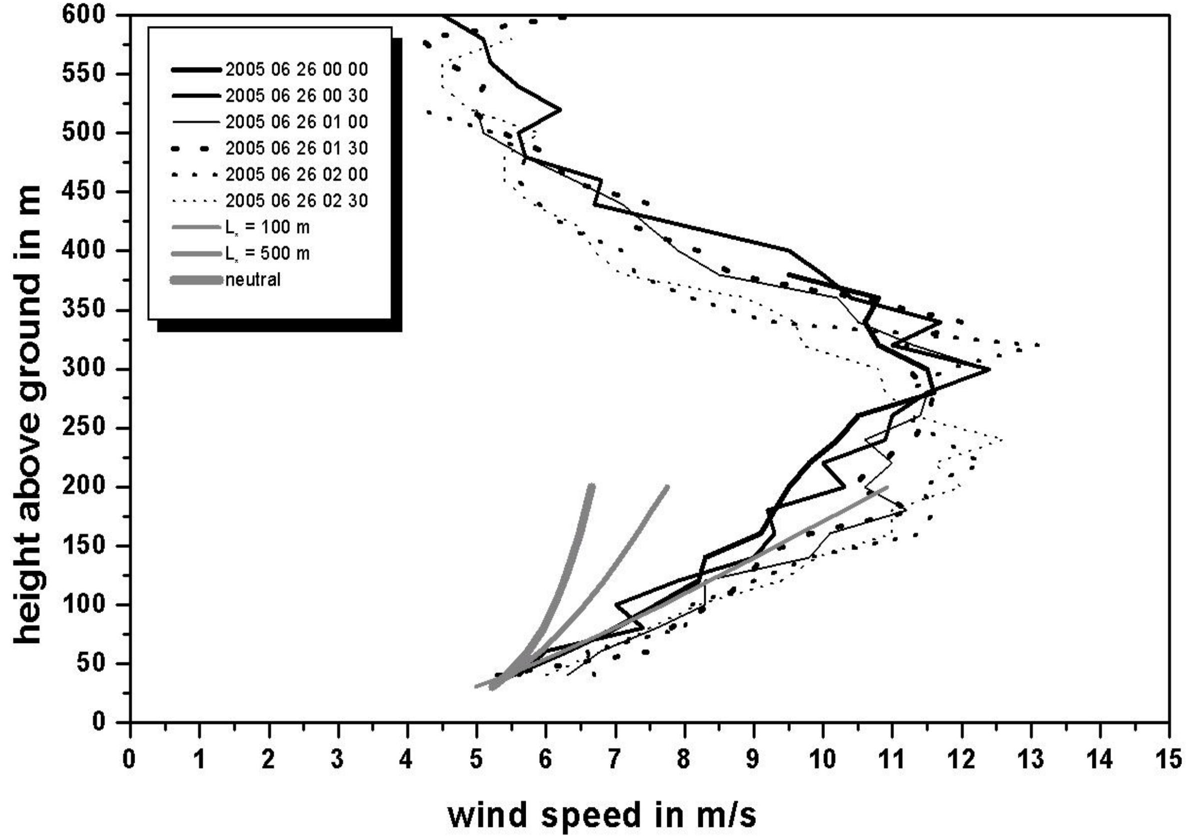
Sodar observation of a nocturnal low-level jet – six subsequent half-hour mean wind profiles over Paris airport on June 26, 2005



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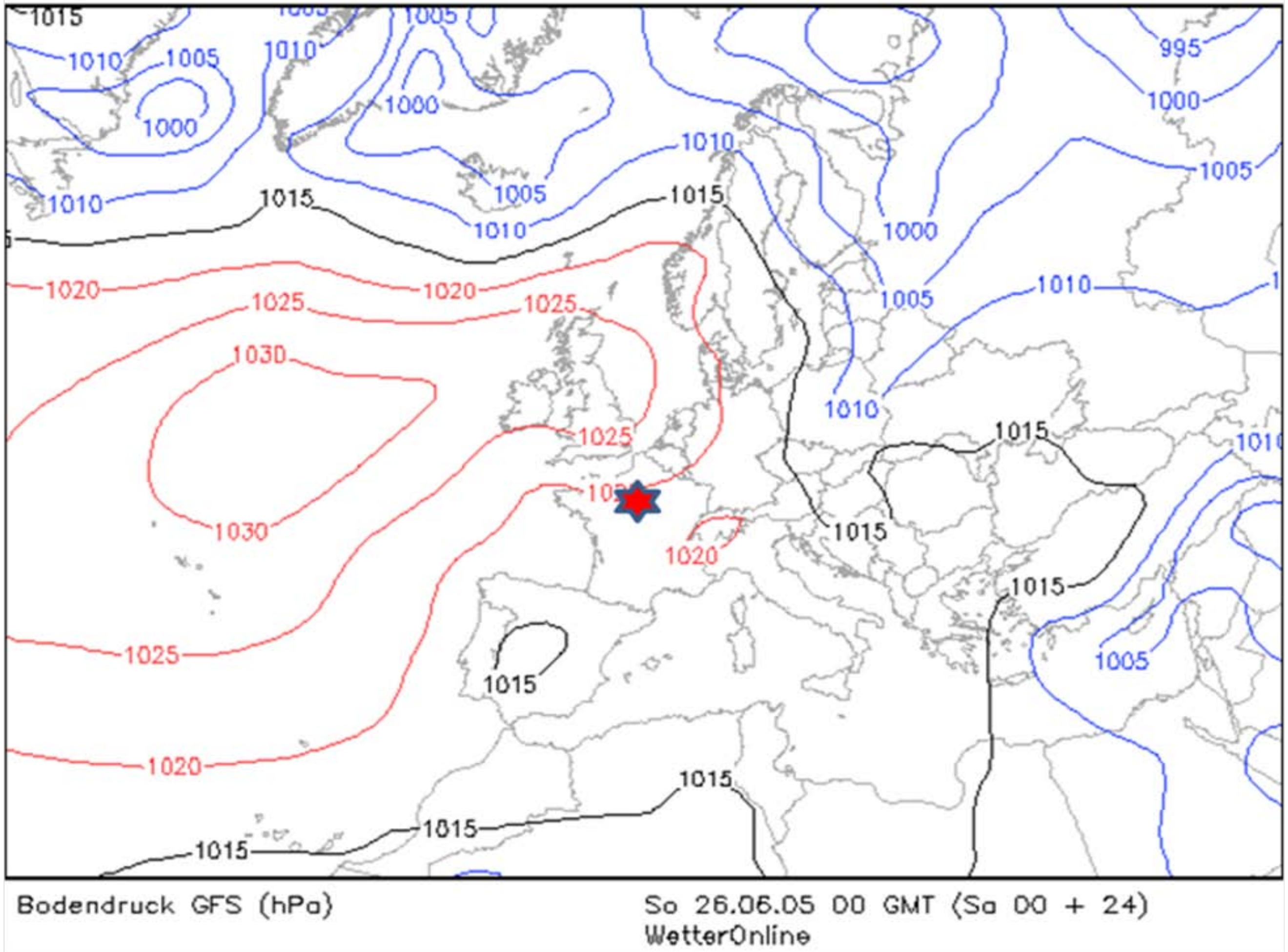
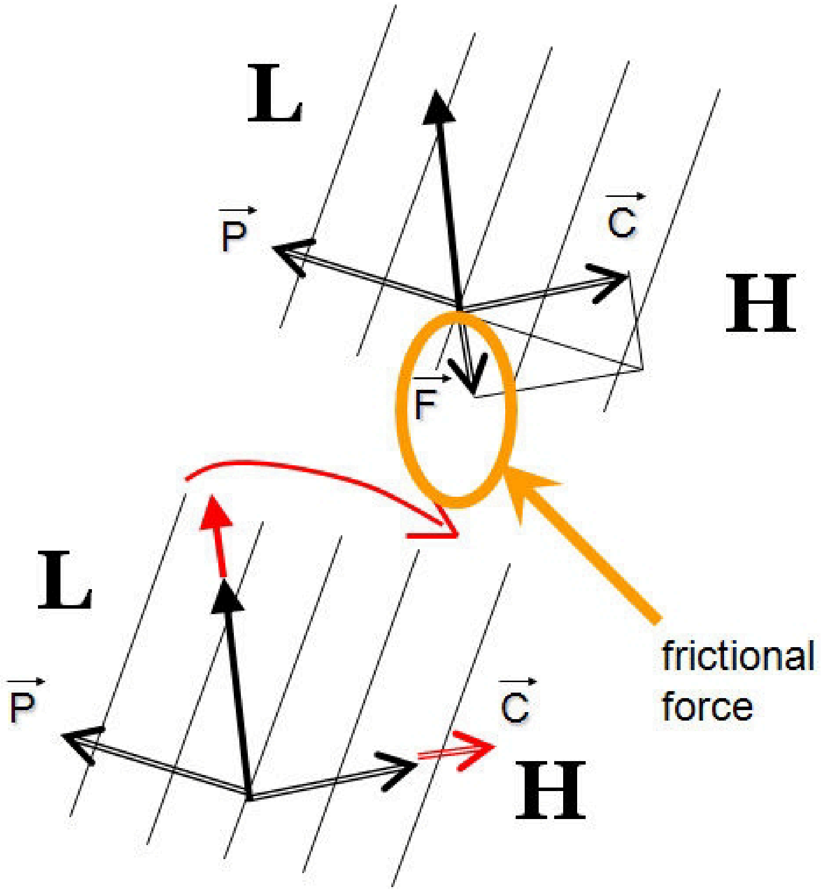
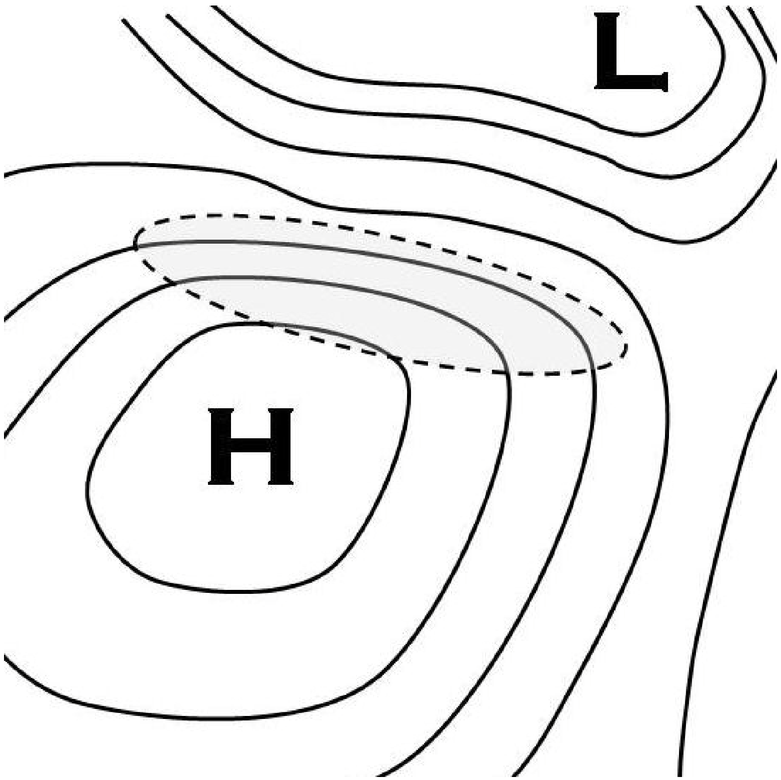
Weather conditions causing the low-level jet over Paris airport on June 26, 2005



Balance of forces causing a low-level jet and regions of highest occurrence





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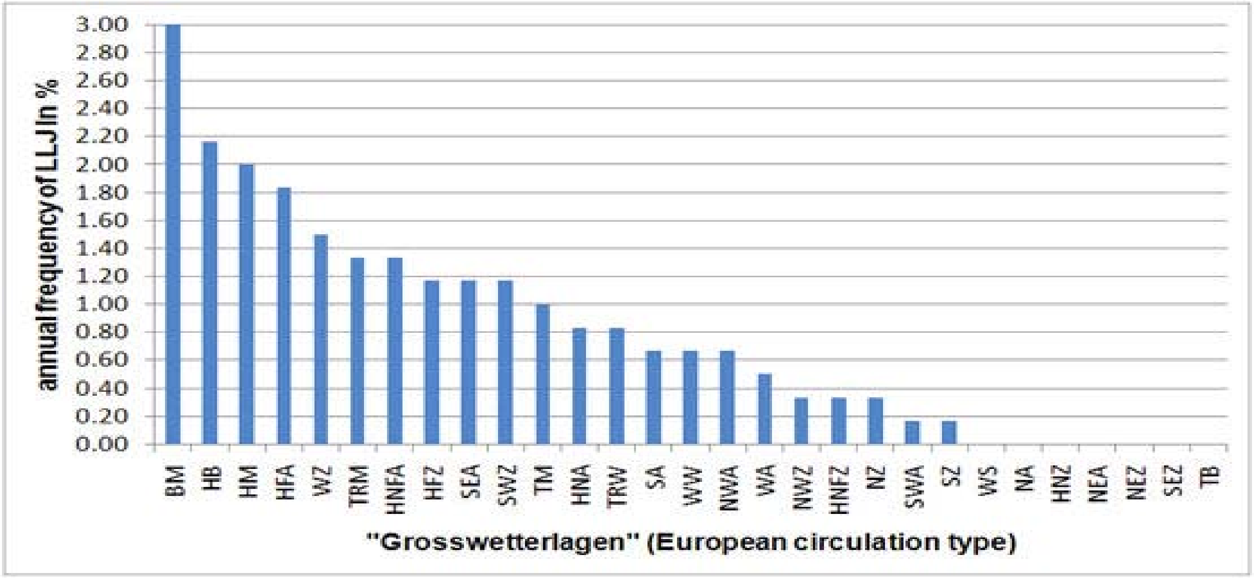
Circulation types leading to low-level jets over Hannover in 2002 and 2003



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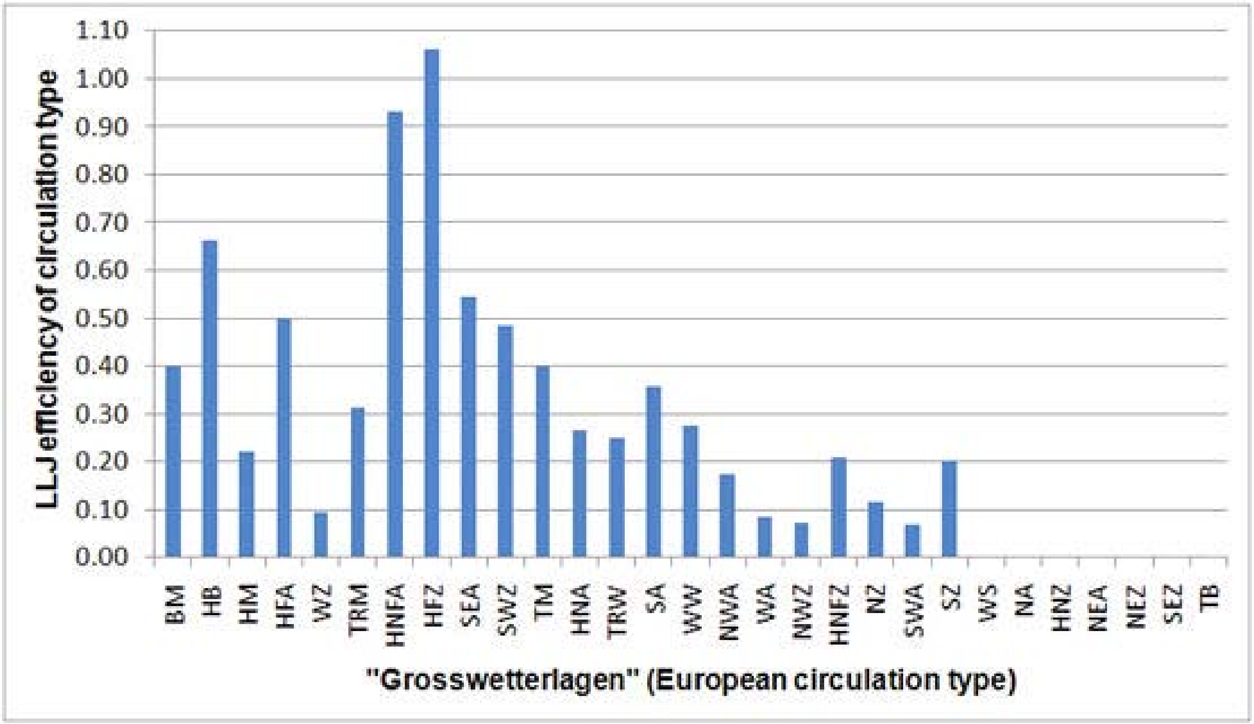
Efficiency of circulation types in producing low-level jets over Hannover in 2002 and 2003



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surface layer height

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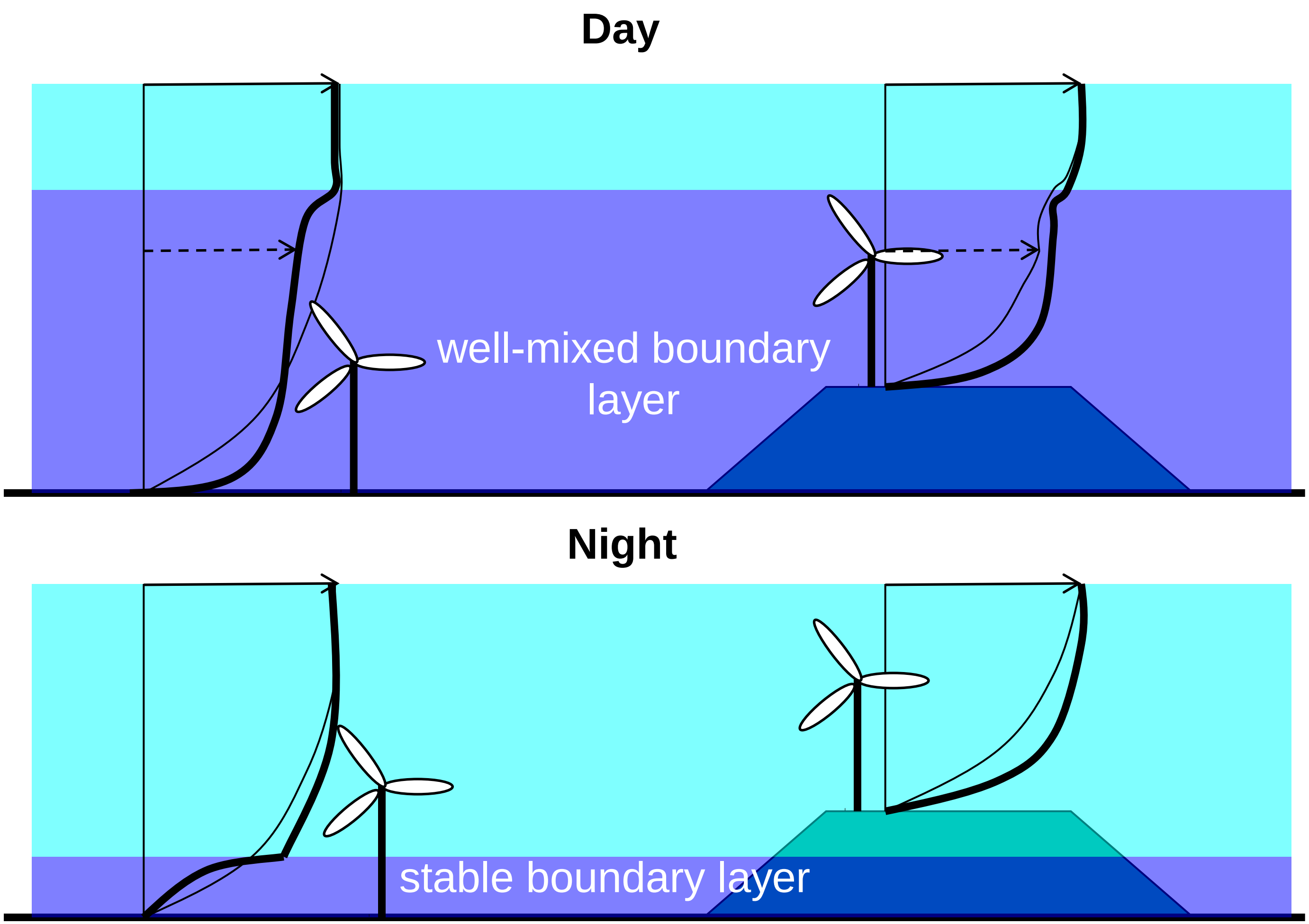
Mixing-layer height influences diurnal variation of vertical wind profiles



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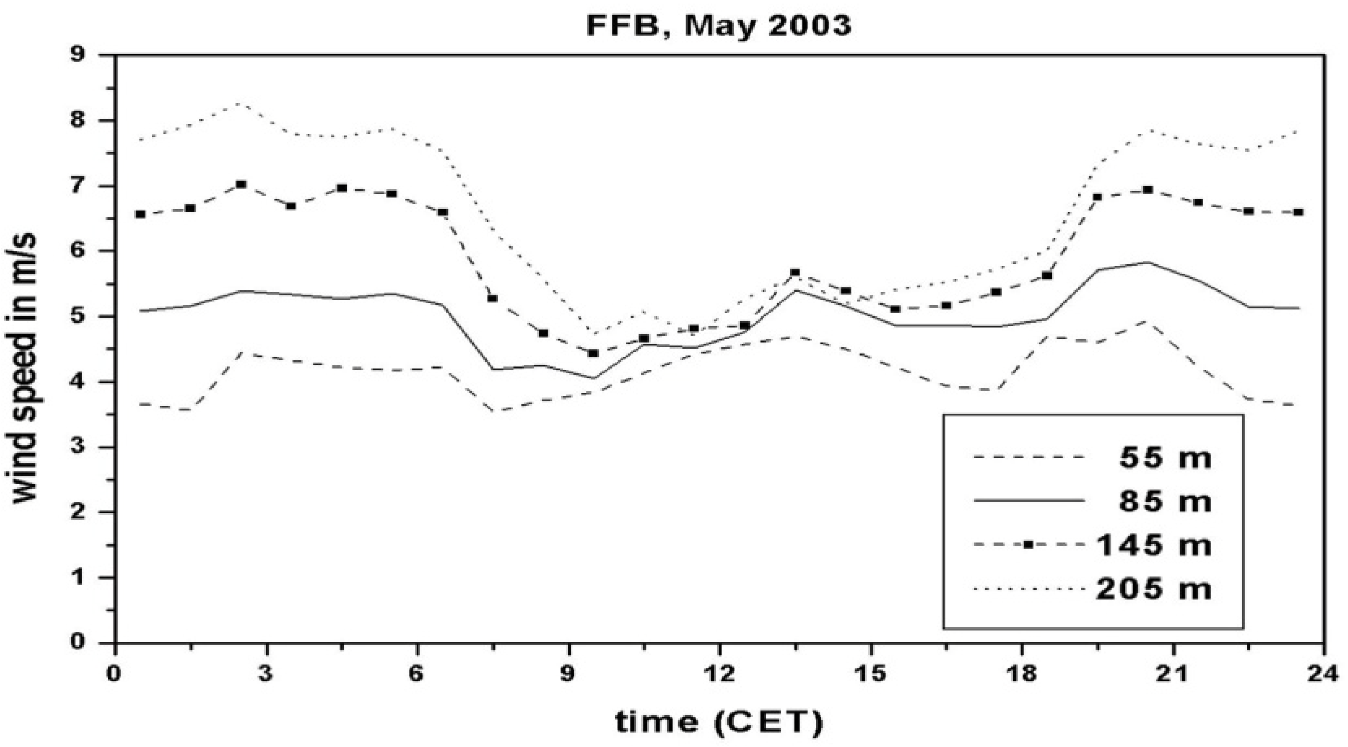
Sodar observation of diurnal wind speed variation



cross-over height

- above this height nocturnal wind harvest is larger than daytime harvest

- may be relevant for choosing the appropriate hub height

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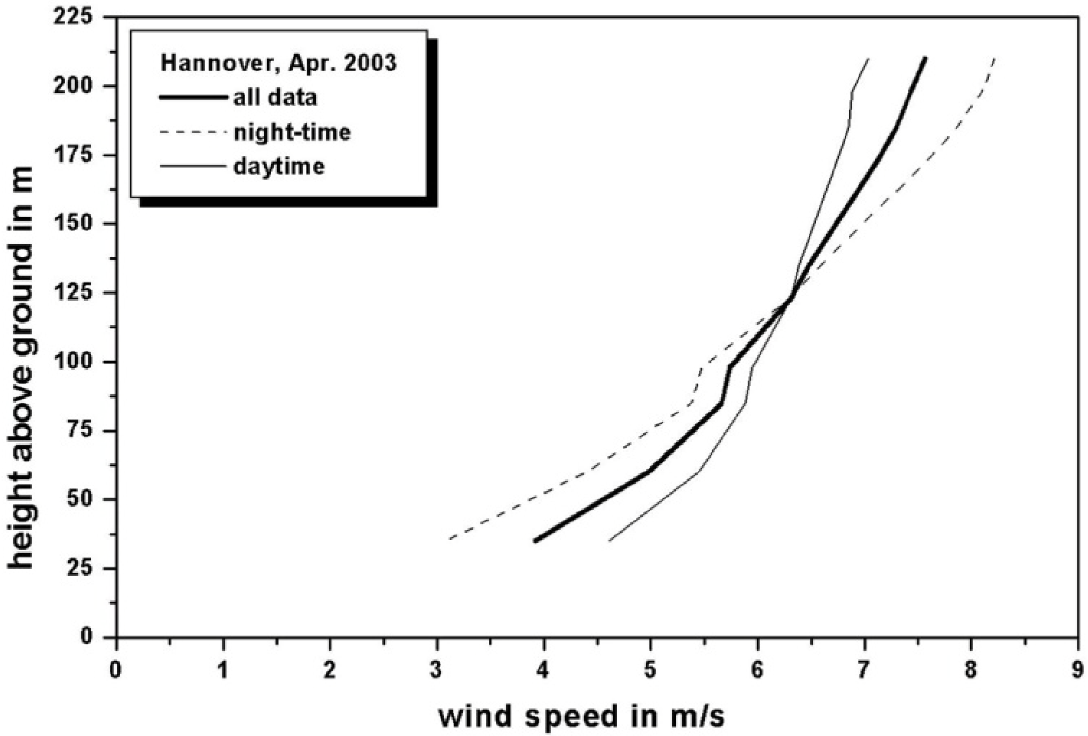
Cross-over height from sodar observation



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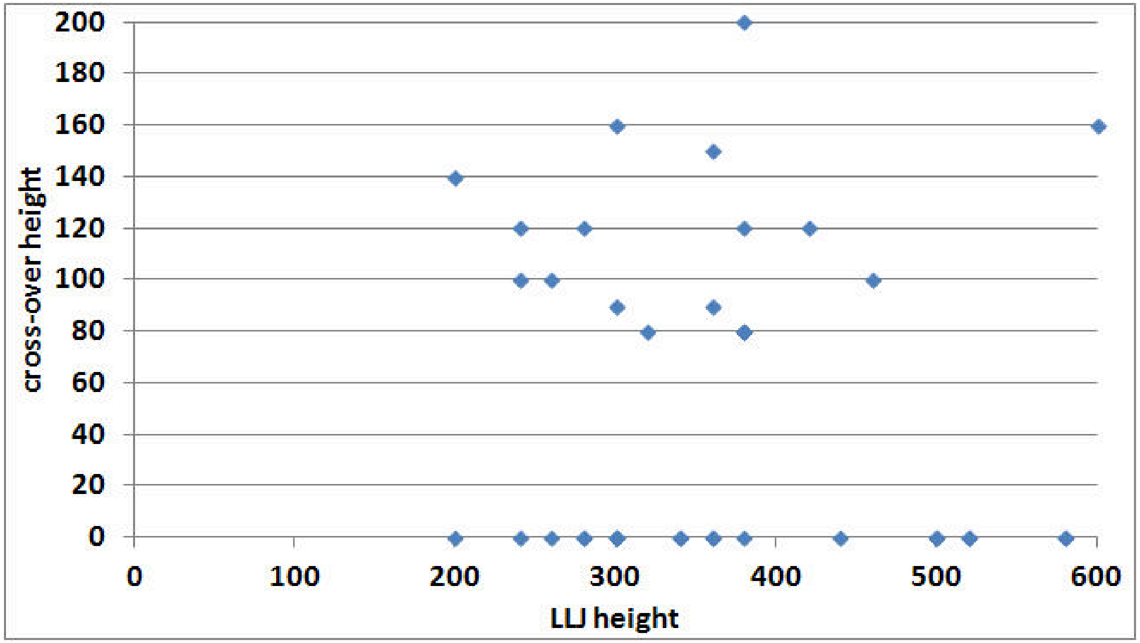
Correlation between cross-over heights and low-level jet core heights from RASS observations over Hamburg in spring 2011



Conclusions:

- energy meteorology has become a new and important branch of meteorology

- ground-based remote sensing is an important tool in energy meteorology

- mixing-layer height statistics can be obtained from all types of ground-based remote sensing
  (ceilometer and wind lidar is better than sodar and RASS)

- low-level jets occur in about 23% of all nights over the plains of Central Europe

- low-level jets are coupled to certain weather/circulation types ➔ predictability

- cross-over heights occur for major low-level jet events

- cross-over heights are typically 1/3 of low-level jet core heights

Thank you very much for your attention