Evaluation of the interpretation of ceilometer data with RASS and radiosonde data

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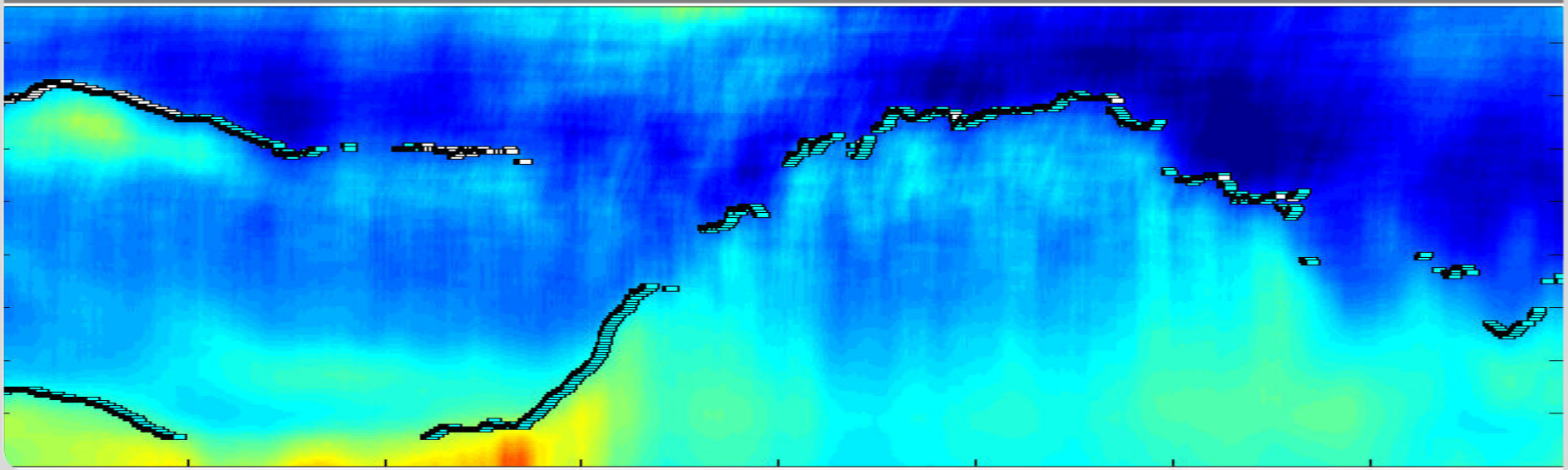


Ceilometers deliver optical backscatter intensities

Optical backscatter intensities are:

- **primarily determined by**

  size and density of aerosol particles

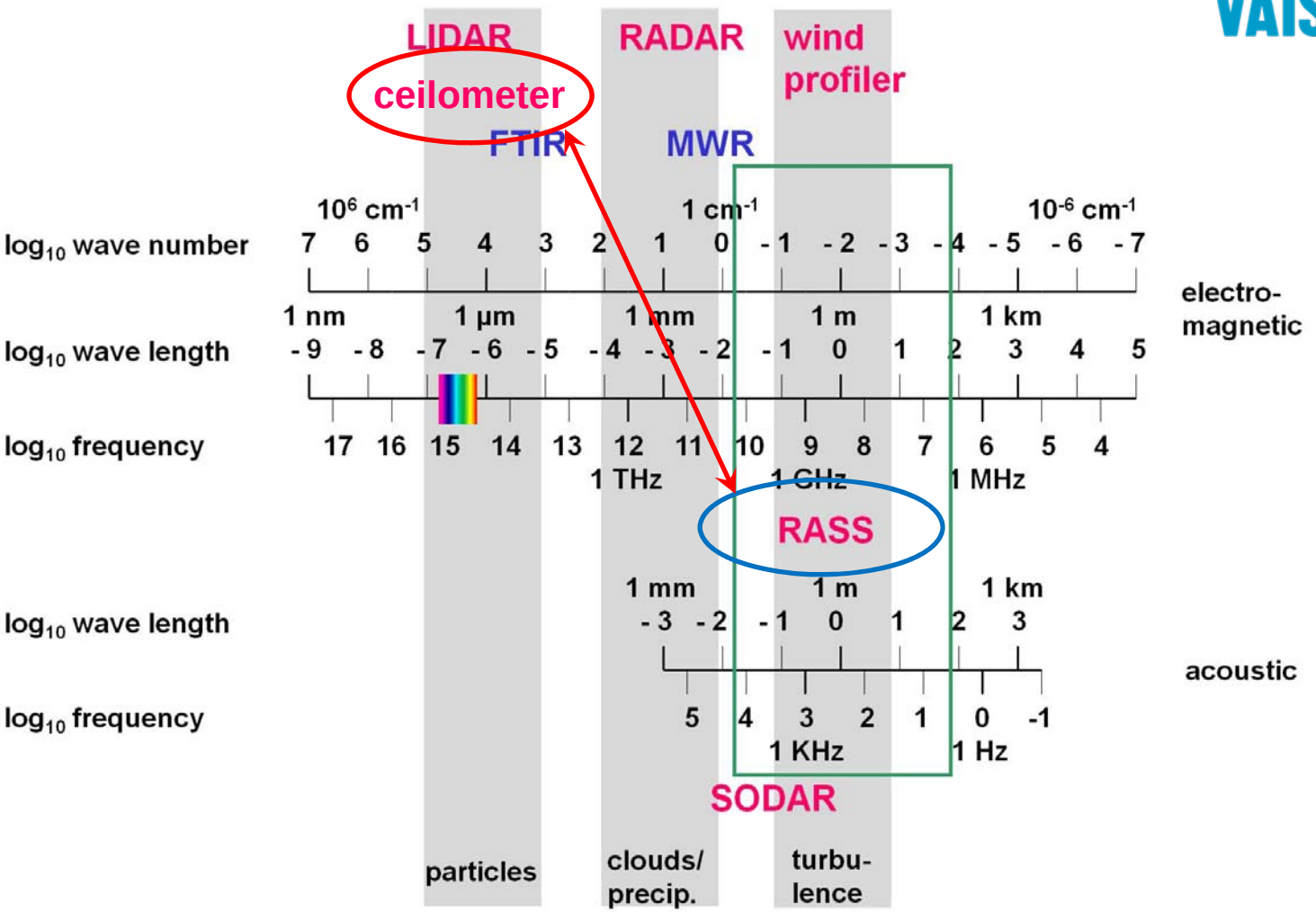
  affected by advection
  formation and dissolution

- **secondarily determined by**

  atmospheric humidity

➔ **evaluation from independent information desirable**

Frequencies for atmospheric remote sensing



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.

Wanted:

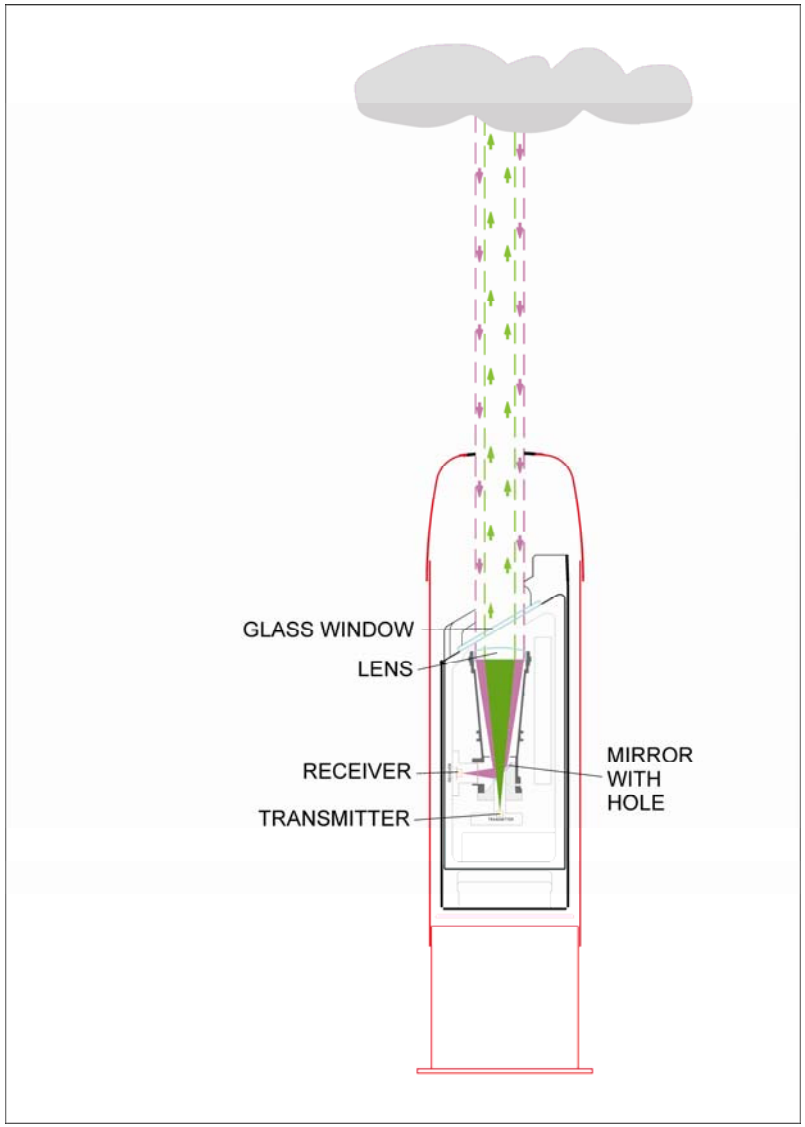
independent temperature, wind, and humidity information

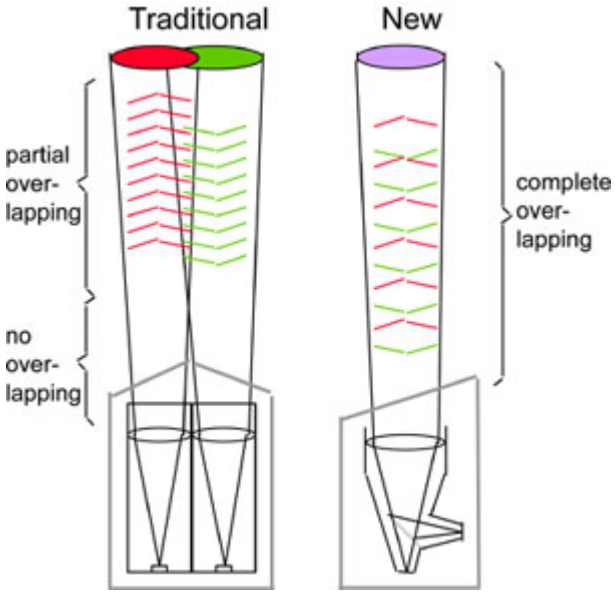
temperature	**➔ RASS, radiometer, Raman lidar, interferometer, radiosonde**
wind	**➔ SODAR, windprofiler, RASS, wind lidar, radiosonde**
humidity	**➔ radiometer, Raman lidar, interferometer, DIAL, radiosonde**

Available:

temperature, wind (up to 540 m)	**➔ RASS, at the same site as the ceilometer**
humidity, temperature, wind (higher layers)	**➔ radiosonde, about 60 km away**

CL 31 ceilometer (Vaisala)





LD 40 CL 31

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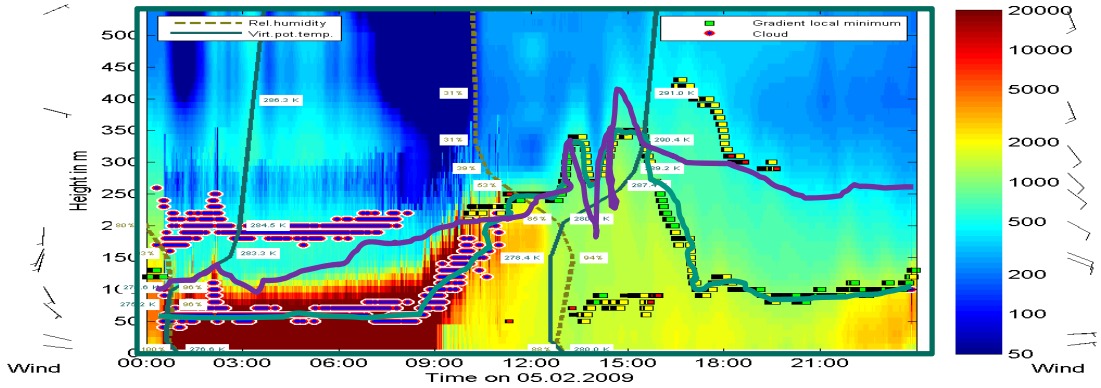
SODAR-RASS (Doppler-RASS) (METEK)

acoustic frequ.: 1500 – 2200 Hz
radio frequ.: 474 MHz
resolution: 20 m
lowest range gate: ca. 40 m

vertical range: 540 m

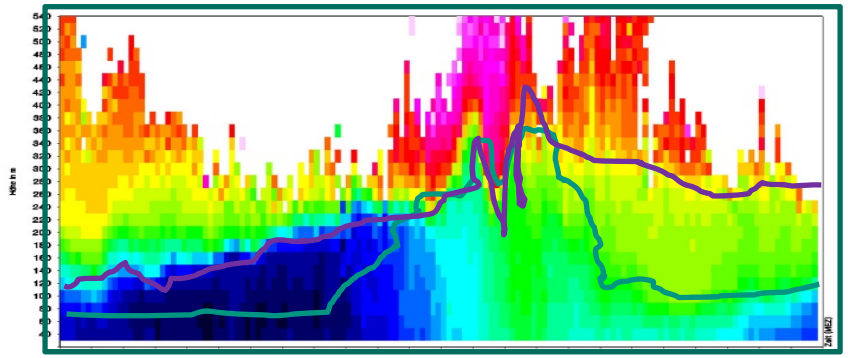
comparison to temperature information



ceilometer

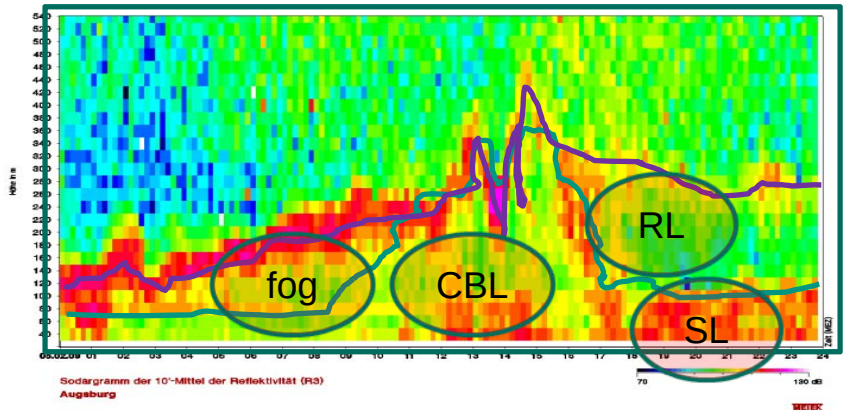
optical backscatter intensity

radiosonde profiles



RASS

potential temperature



SODAR (RASS)

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

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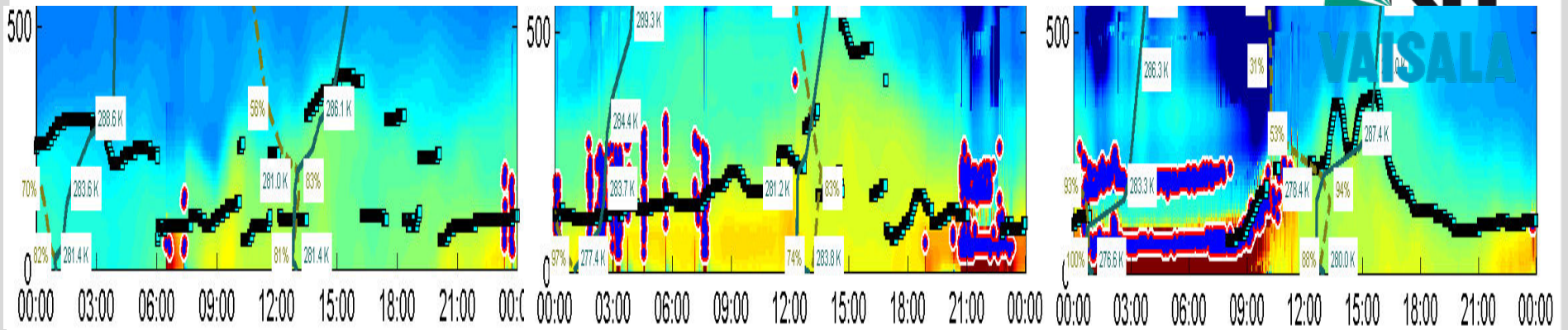
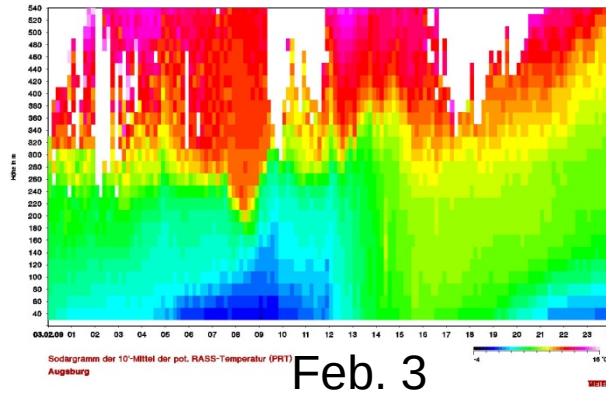
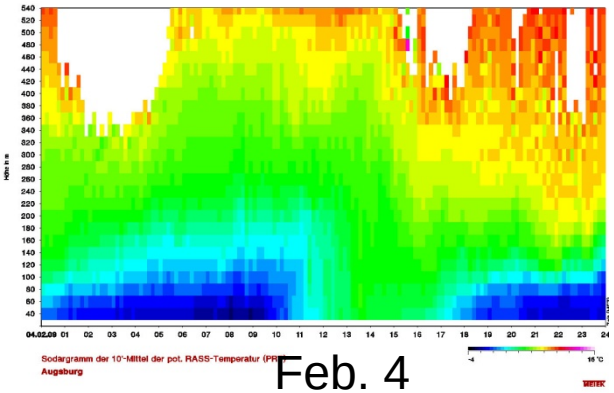
ceilometer (top), pot. temp. RASS (middle), acoust. backsc. SODAR (bottom)

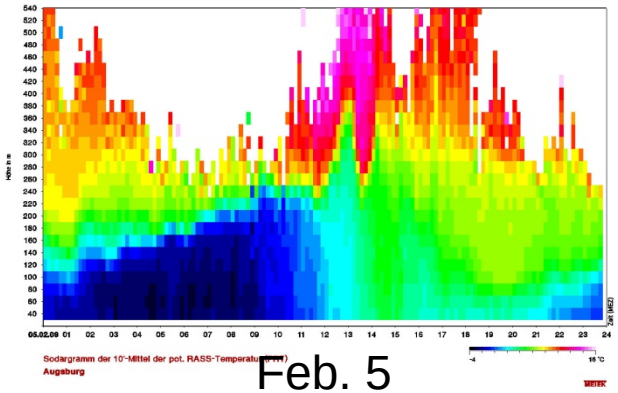




Feb. 3



Feb. 4



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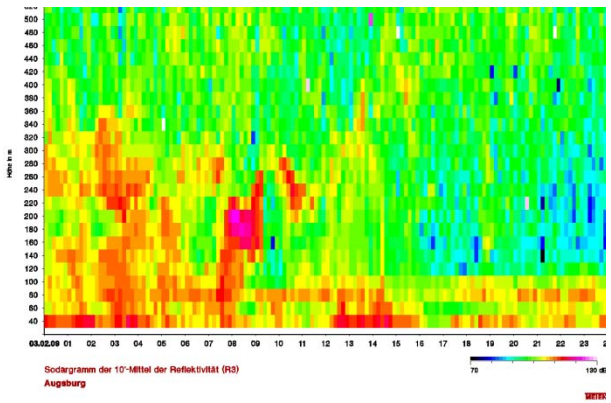
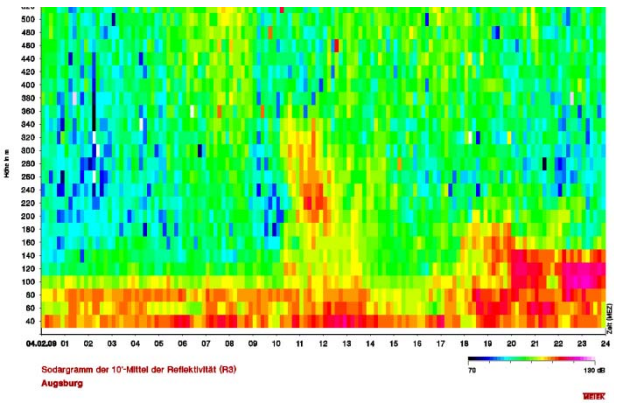
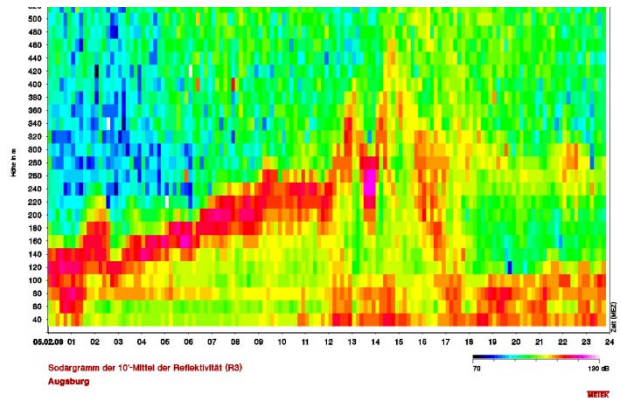
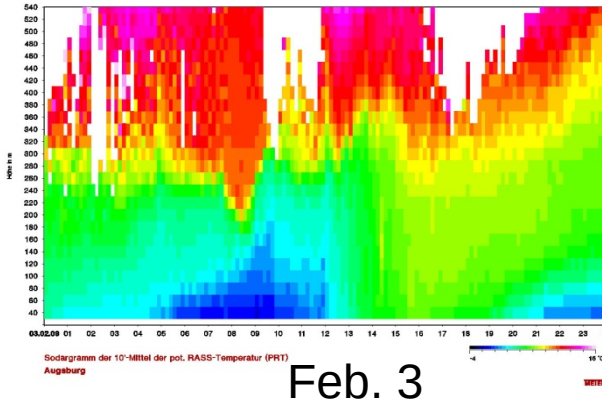






RASS data Augsburg February 2009

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



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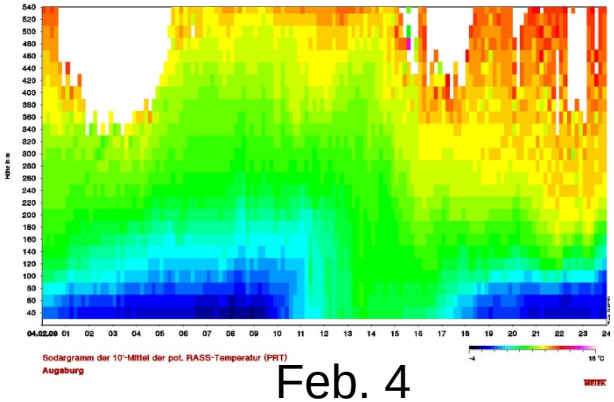

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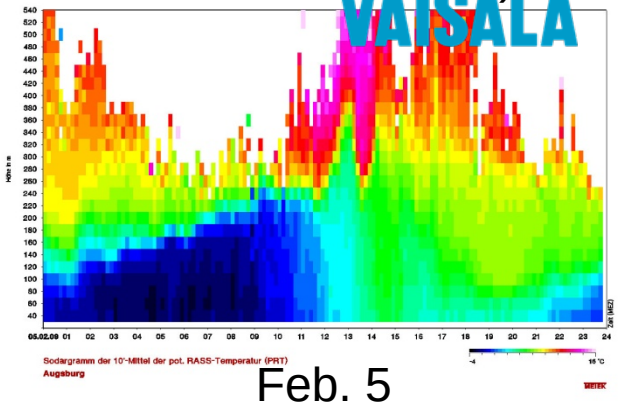

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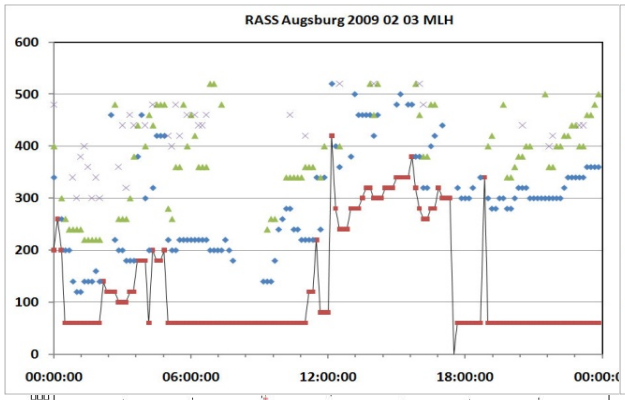

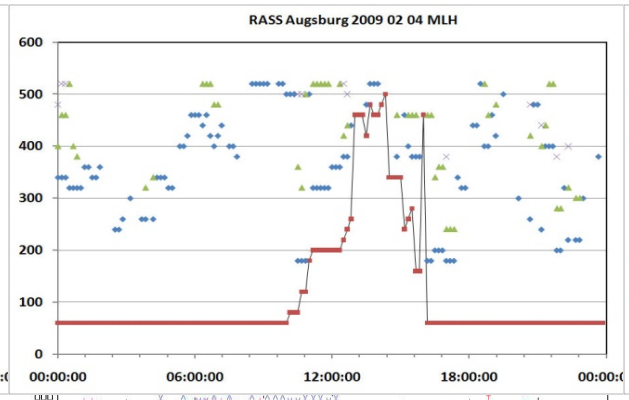

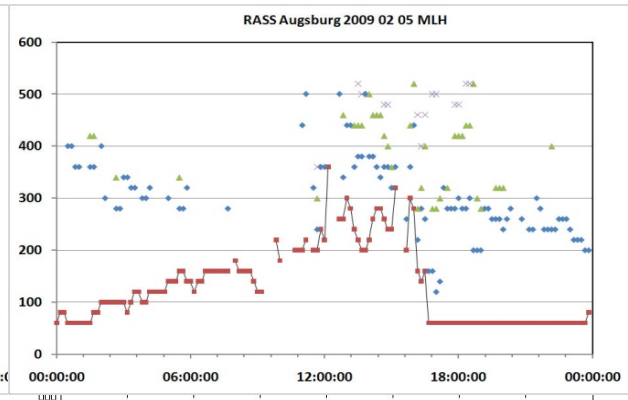

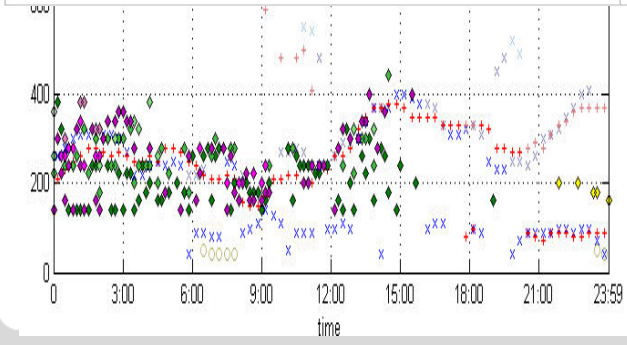

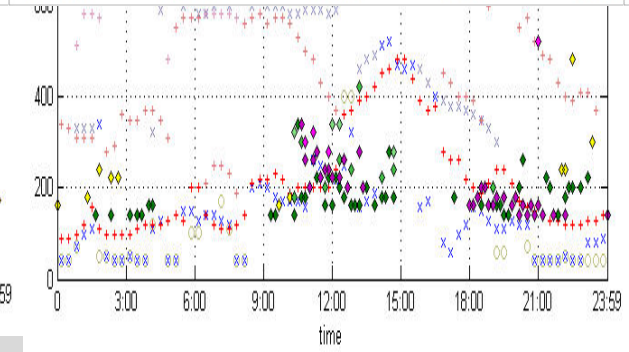

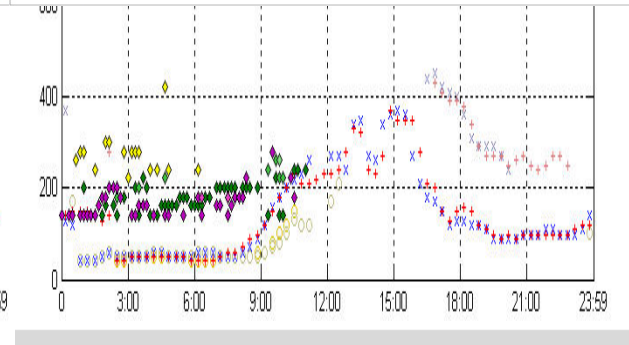

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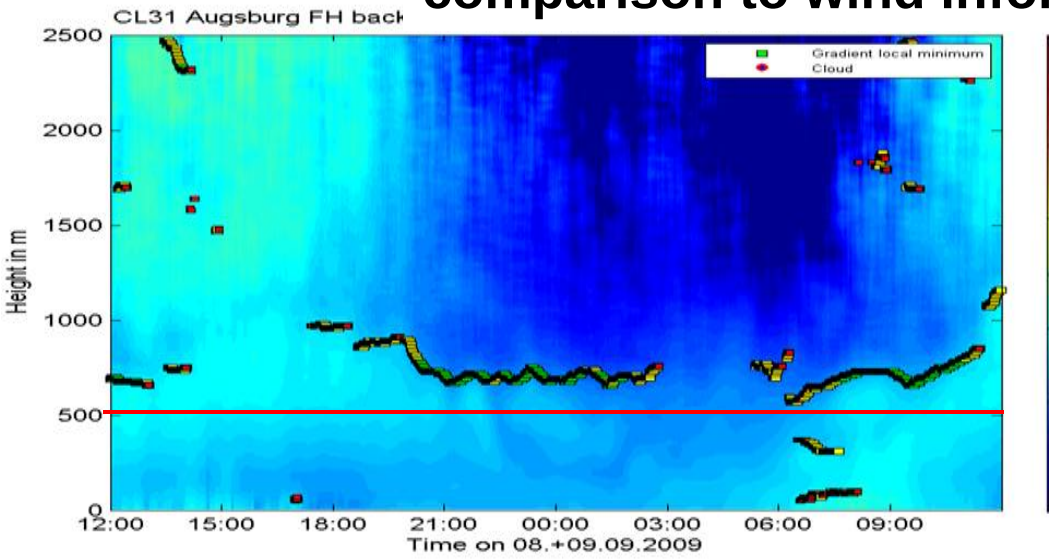
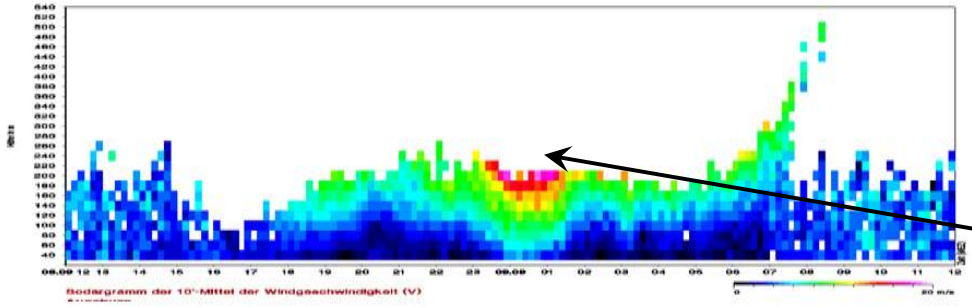
comparison to wind information



ceilometer

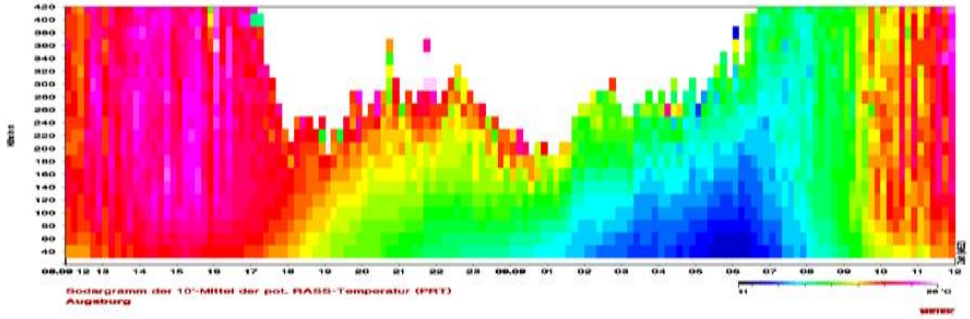
optical backscatter intensity



SODAR (RASS)

horizontal wind speed

LLJ > 19 m/s



RASS

potential temperature

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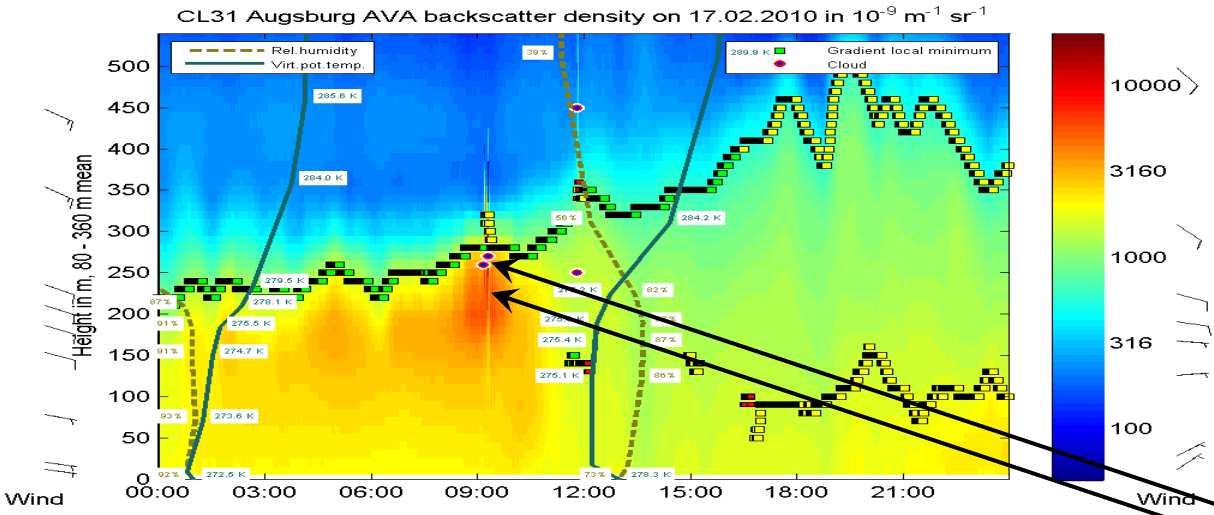
comparison to moisture information



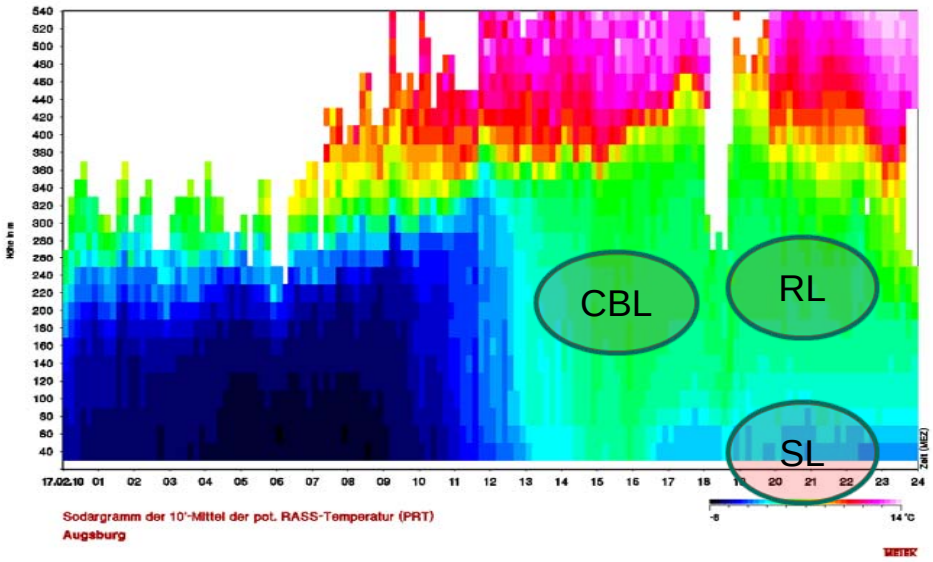
ceilometer

optical backscatter intensity

radiosonde profiles

first clouds

near saturation



RASS

potential temperature

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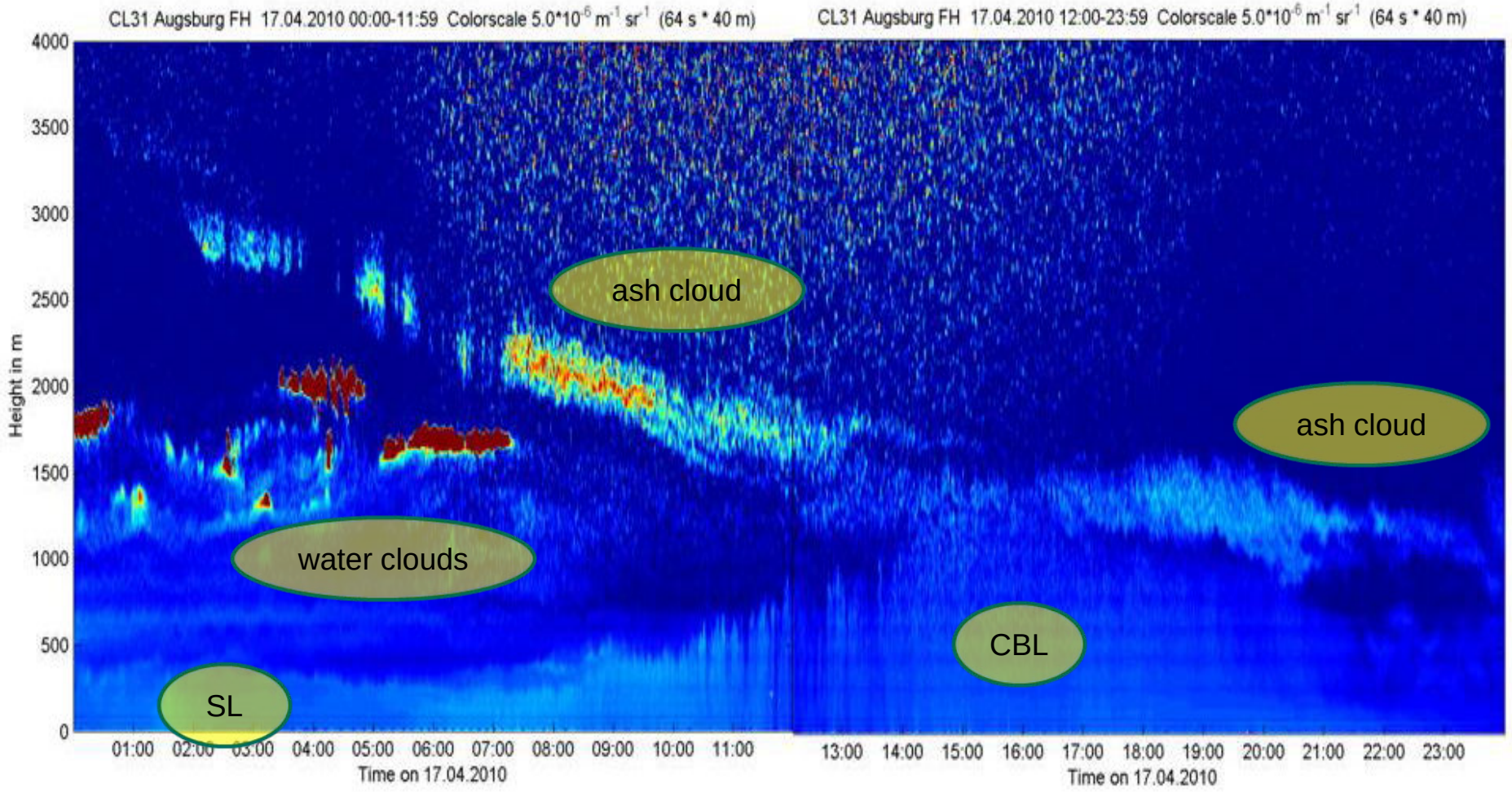
influence due to advected particles

Eyjafjallajökull ash cloud over Southern Germany



Conclusions

- Ceilometers have become a frequent (and rather cheap) tool to monitor cloud heights, mixing-layer heights and boundary-layer structure

- if aerosol particle distribution adapts rapidly to the thermal structure of the PBL, ceilometers are a good tool to observe this structure

- advection of aerosols may play a decisive role, it is dangerous to interpret ceilometer measurements just locally

- particle size spectrum influences ceilometer data in a non-quantifiable way

- atmospheric humidity influences ceilometer data in a non-quantifiable way

➔ automated evaluation algorithms for ceilometer data have to be developed with great care

➔ the combined operation of a ceilometer with a RASS is an option for PBL research

Thank you very much for your attention

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