CeiLinEx2015

Ceilometer Performance Experiment at Lindenberg 2015

Fully automated algorithm for lidar PBL height detection at ICOS-atmospheric stations: STRAT+ improvements and application

Bravo-Aranda, J.A.; Haeffelin, M. and Pietras, C.

Institut Pierre-Simon Laplace, CNRS-Ecole Polytechnique, France

Outline

1. Introduction
2. STRAT+: fully automated algorithm for PBL height detection
3. STRAT+ performance analysis:
   1. radiosonde Vs ALC
   2. ALC Vs ALC
   3. Overlap influence
4. To-do list

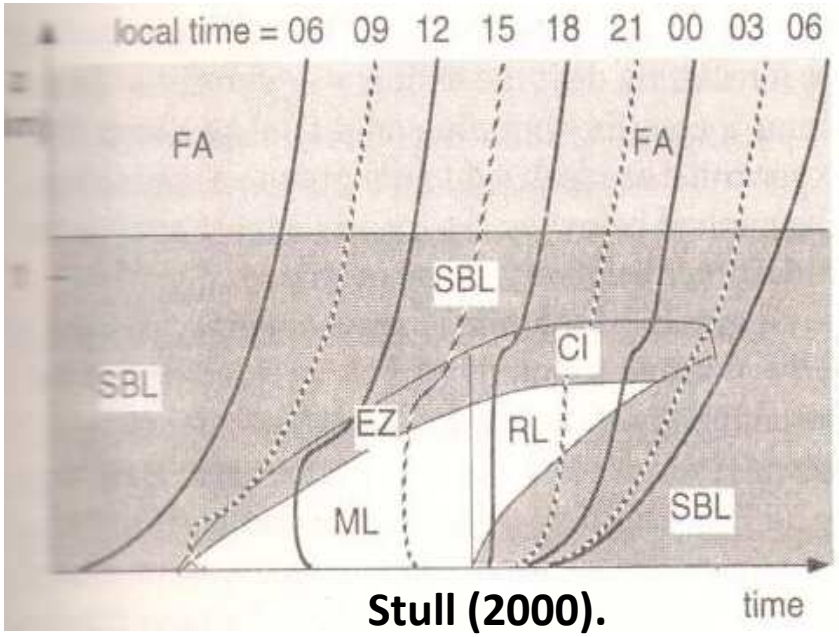
Introduction

- Boundary layer height (**BLH**) is the first-order control on the relationship between **surface-atmosphere trace gas fluxes**
- A correct representation of BLH in a tracer **transport model** is of key importance for interpreting ground-based mixing ratio measurements.
- To this aim, **lidar measurements** are part of the **ICOS** level-1 stations

ICOS-inwire

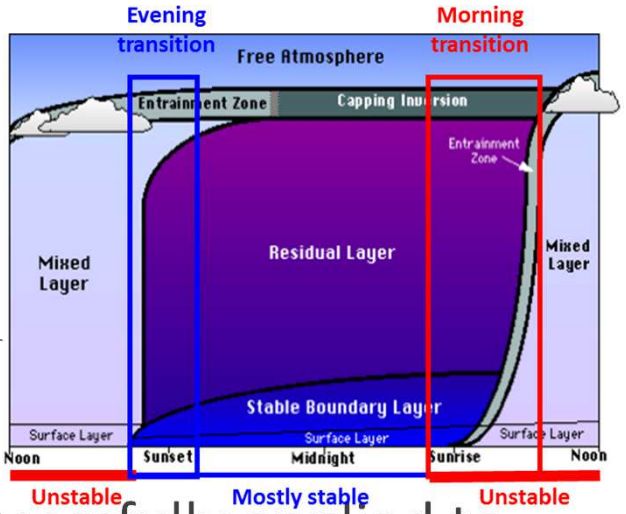
New standardized, fully automated algorithm for lidar characterization of PBL vertical structure at ICOS-atmospheric stations

As a step to the operational implementation of the PBL height retrieval, STRAT+ algorithm (already implemented on lidars, *Pal et al. 2013*) is been improved for ceilometers

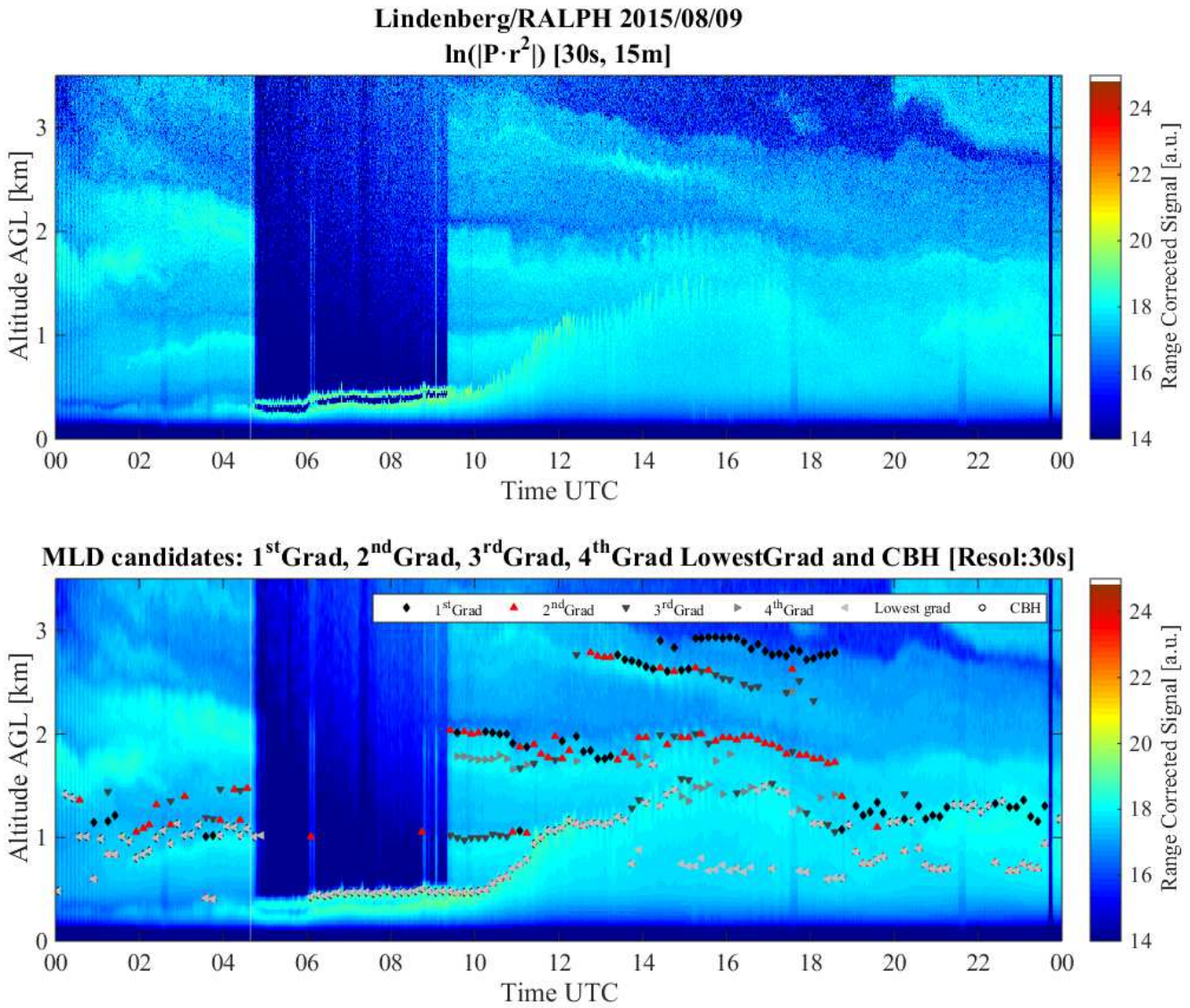


Stull (2000).

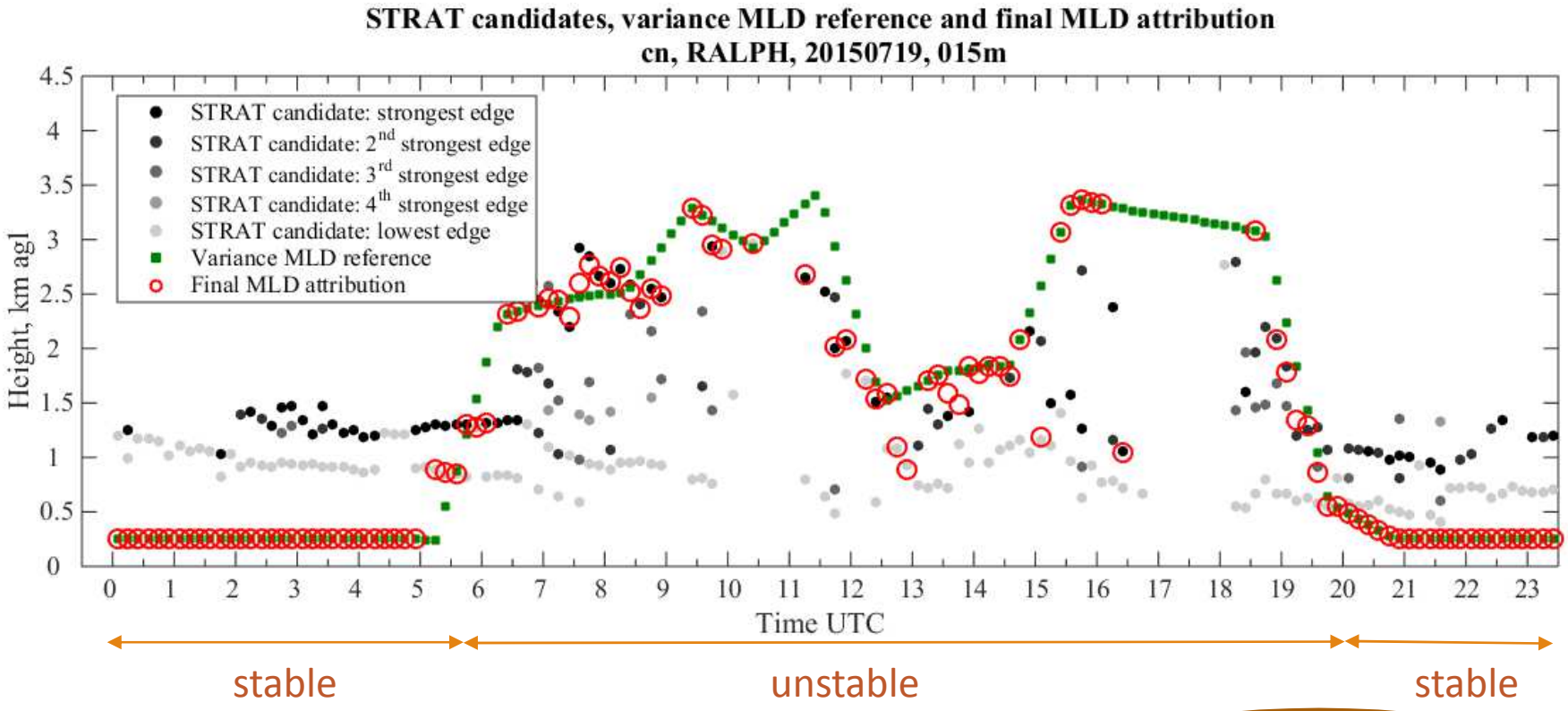
STRAT+ method



- STRAT+ based on two modules has been successfully applied to lidar systems by *Pal et al. 2013*:
  - Module 1 (**STRAT**; *Morille et al. 2007*; *Haeffelin et al. 2012*): 2D-edge detection. It provides up to five 10-min **MH candidates**
  - Module 2 (**Variance method**):
    - noise removing using an spectral filter. It provides 1-hour variance MH (**MH reference**)
    - **Anemometer data** is used to **determine** the 'day-' and 'night-time' in terms of **atmospheric stability**
  - **Final attribution**: comparison between the candidates and the MH reference



- Edge detection is mainly based on Gaussian smooth and Canny's method (gradient in several directions)
- From 3+1 to 5+1 PBL candidates (4 stronger and lowest edges and cloud base height)



No sonic data available: stability is set between sunrise+2 and sunset+1

- Step 1: 1-hour variance profile is used to determine the MLD
- Step 2: the 1-hour MLD is splined into 10-min resolution
- Step 3: Nearest 10-min PBL candidate to the 10-min variance MLD reference is choose as final MLD

STRAT+ performance analysis

- STRAT+ performance analysis:
  - PBL height **reference** (from radiosonde measurements)
  - Different **locations** and large period: Palaiseau (France), Granada (Spain), Payerne (Switzerland), Humain (Belgium), Brno (Czech Republic)
  - Different collocated **ceilometer types**: Jenoptiks, Vaisala and Campbell Scientific (and their different versions)

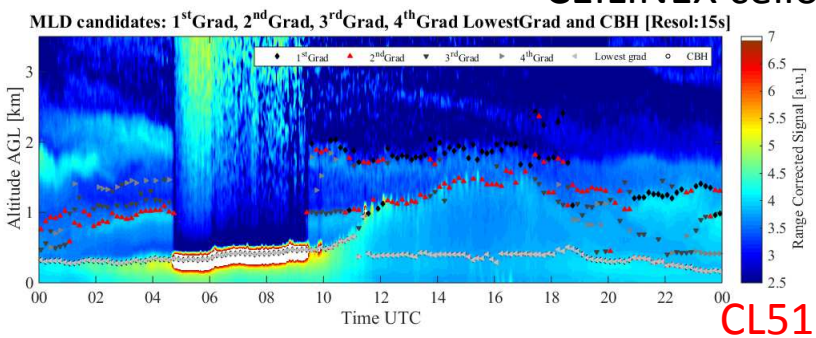
CEILINEX campaign allows the comparison of different collocated ceilometers with radiosondes (4/day)

CEILINEX ceilometers and lidar

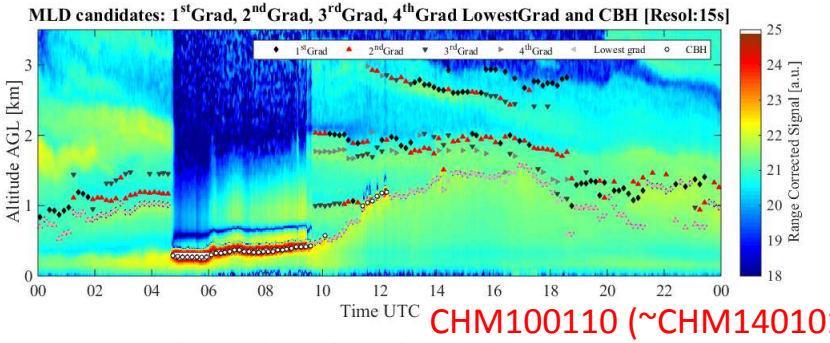
Instrument name	Instrument ID	Instrument type	Institution
CHM140101	140101	CHM 15k Nimbus	MOL-RAO
CHX080082	080082	CHX 15k Nimbus	MOL-RAO
CL51RAO	124350003	CL51	MOL-RAO
CL31RAO	124350004	CL31	MOL-RAO
LD40_002	002	LD40	MOL-RAO
CHXLMU	090103	CHX 15k Nimbus	LMU
CL51CG	141530001	CL51	CG
CS2	167484	CS135	CS
RALPH		PollyXT	MOHP
CS1	167483	CS135	CS
CL31RUB	134550001	CL31	RUB
CHM100110	100110	CHM 15k Nimbus	MOL-RAO
LD40_003	003	LD40	MOL-RAO

- ✓ Ceilometers: 12!!!
- ✓ 1 lidar
- ✓ Radiosondes: 4/day!!!
- ✓ Meteo and sonic data (coming soon)

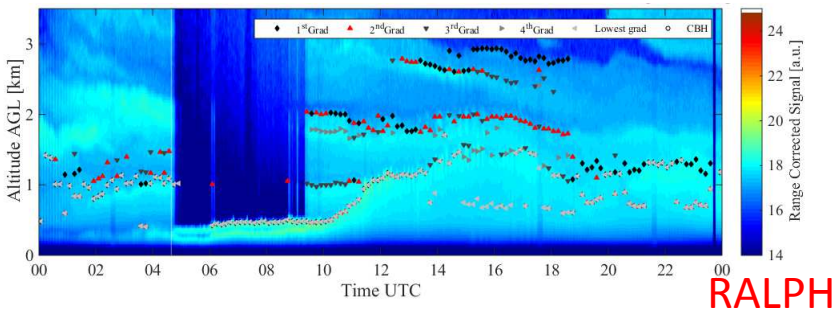
CEILINEX ceilometers and lidar



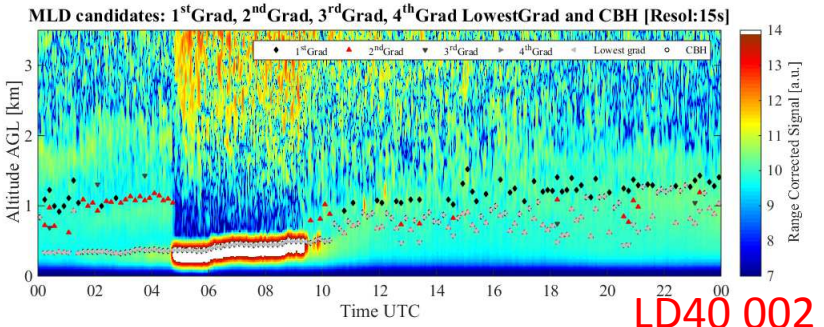
CL51CG



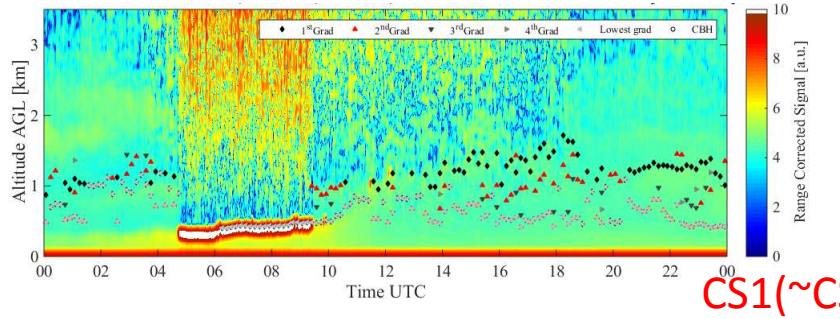
CHM100110 (~CHM140101)



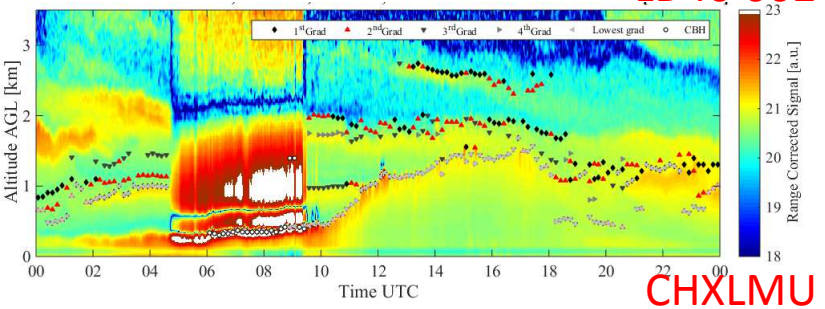
RALPH



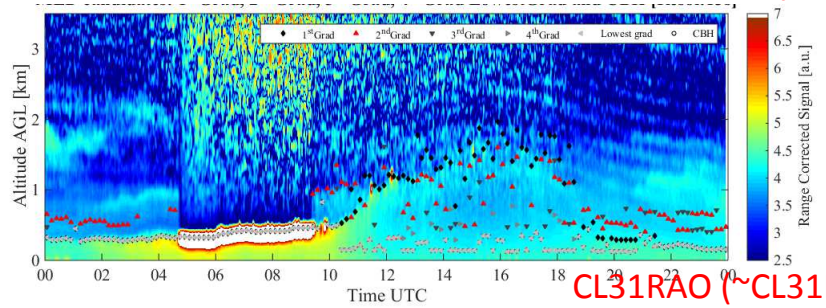
LD40 002



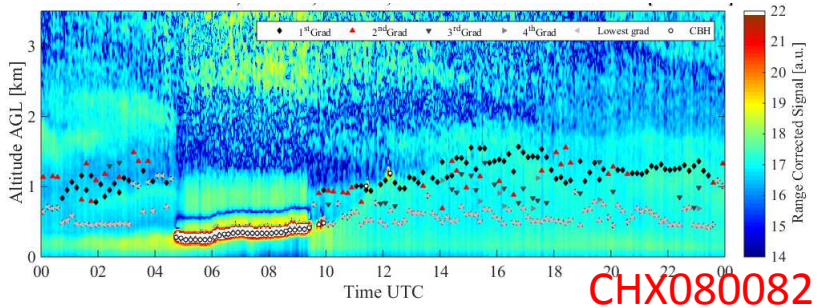
CS1(~CS2)



CHXLMU



CL31RAO (~CL31RUB)

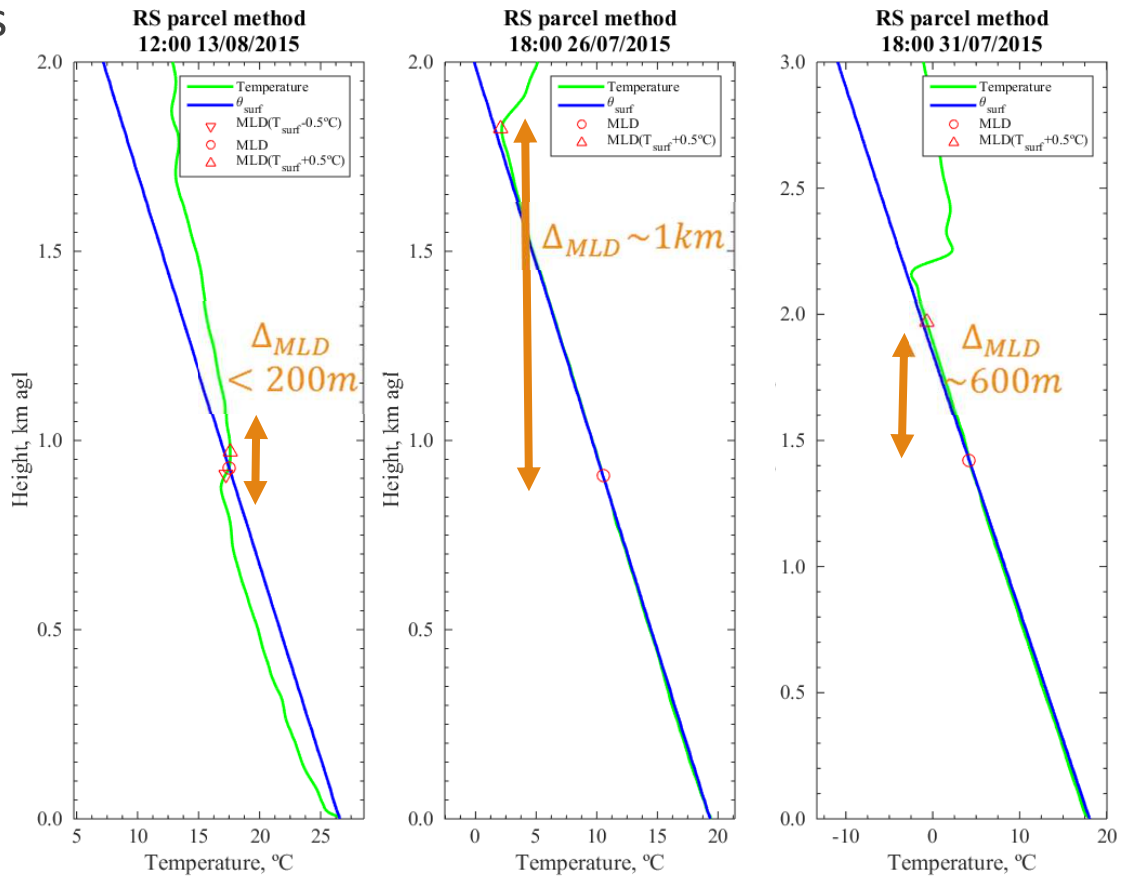


CHX080082

Module 1 (STRAT): 5 PBL candidates (4 stronger edges and cloud base height)

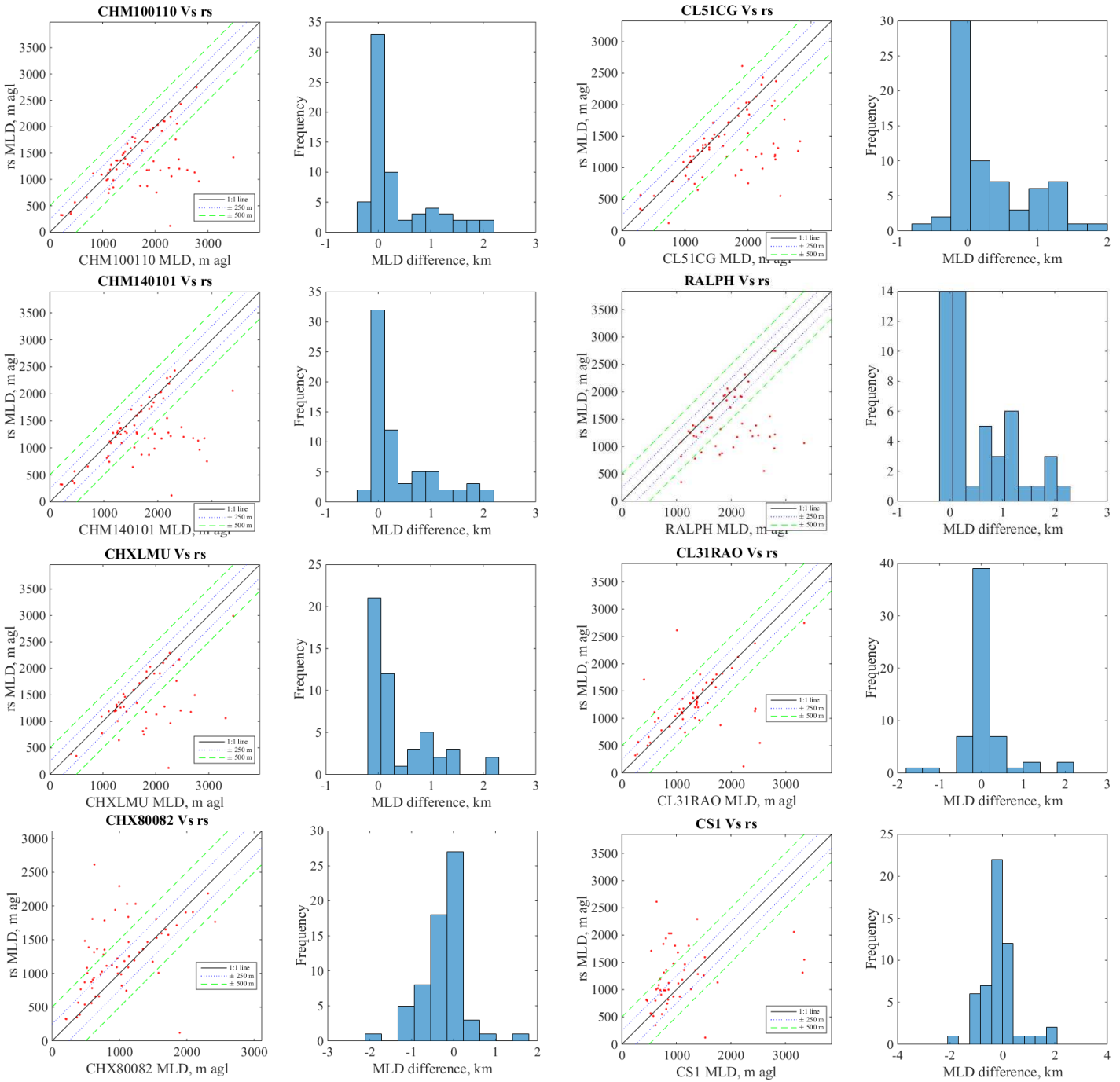
Radiosonde (parcel method)

- Parcel method strongly depends on the surface temperature
- Radiosonde MLD (rs-MLD) has been determined at surface temperature (Ts) and Ts$\pm$0.5ºC
- Richardson number will be used



Midday RS-ALC comparison

- ALC MLD height is compared with the nearest rs-MLD determined by Ts, Ts-0.5ºC and Ts+0.5ºC.
- rs-ALC MLD differences are lower than 500 m in more than 50%
- no-filtered CEILINEX database (e.g., rain, very low clouds, …)
- Despiking filters are under investigation for improving the variance method retrieval



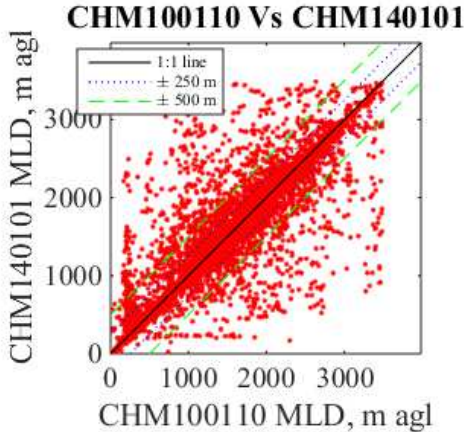
ALC-ALC analysis

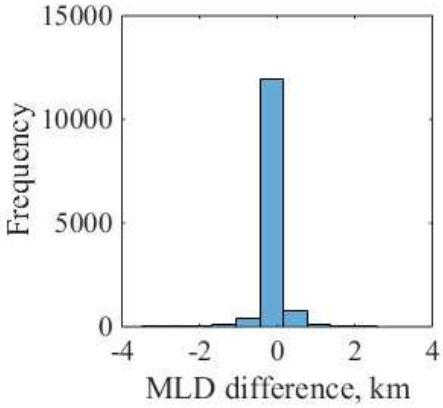
- CHM100110 and CHM140101 show similar results

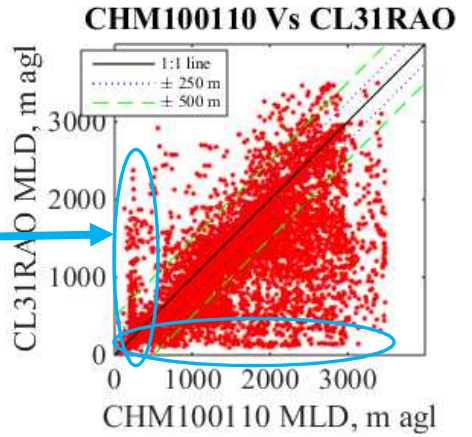
- Overlap-affected detection

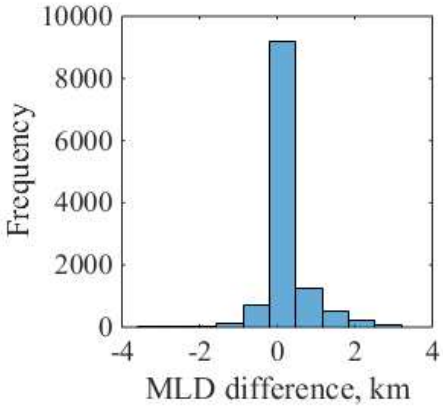
(Yan's method for overlap correction!)

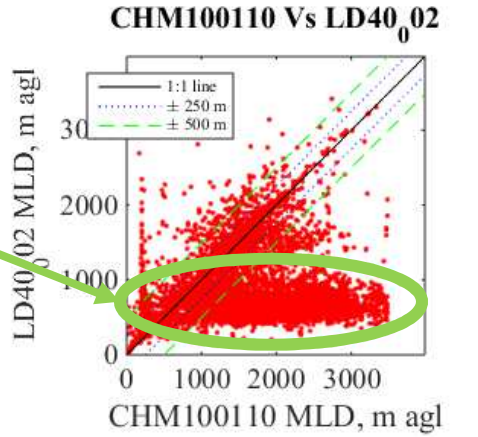
- LD40_002 and LD40_003 generally provide low PBL height

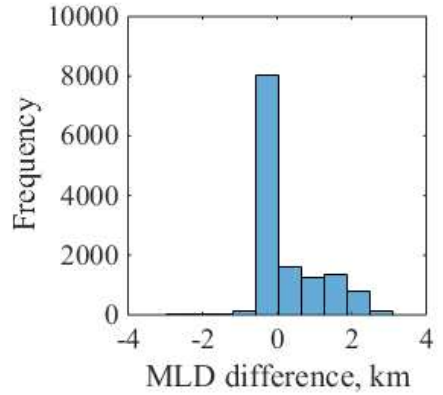




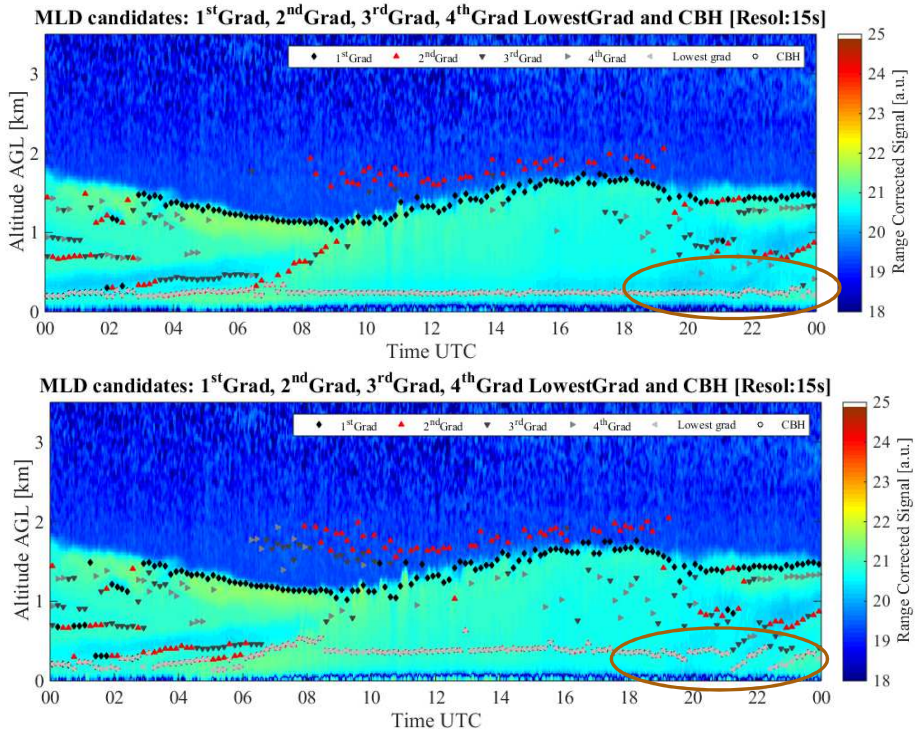




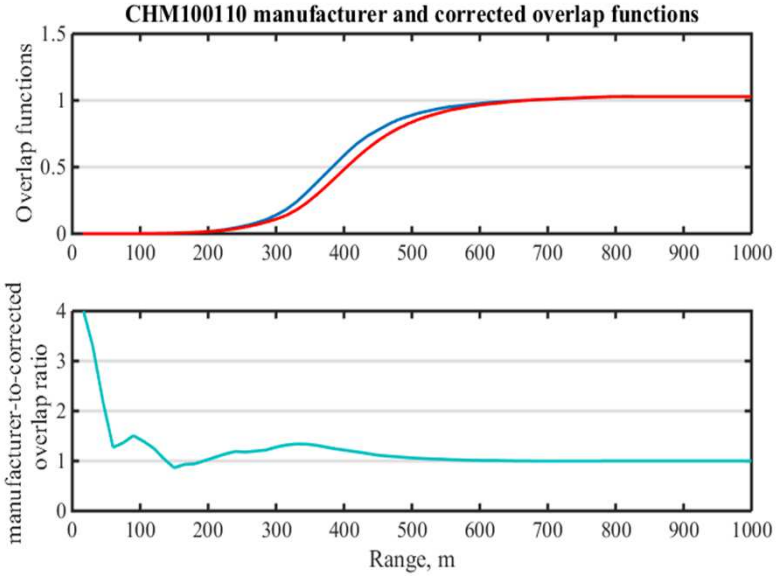




Overlap influence on Jenoptik ceilometers



Overlap retrieved by Payerne's colleagues (data provided by Yann Poltera)



- Improvement of the edge detection (PBL candidates) due to overlap correction (specially during night-time)

To-do list

- *Meteorological and anemometer sonic data*
- *Reprocess STRAT+*
- *Night- and day-time PBL height from radiosondes (Richardson number method)*
- *Despiking improvement*
- *Analyze the PBL detection after the overlap correction (application of Yan's method)*

***Manuscript title**: -*

***Author list** (to be discussed) : Bravo-Aranda J.A., Haeffelin M., Pietras C., Tarniewicz J., Pal S., 'long-term database station co-author list' and 'CEILINEX's co-author list'.*

***Topics**:*

- *STRAT+ improvements:*
- *RS Vs ALC: CEILINEX data*
- *Spatial intercomparison: Granada, Payerne, Lindenberg, Humain, Brno?*
- *STRAT+ on different ceilometer types and models: CEILINEX data*

Thank you for your attention!

See you in the CEILI**NEXT** meeting!