CeiLinEx 2015

Comparison of cloud base heights

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Cloud base height and cloud cover are important for

- Weather reports on airports (METAR, SPECI, ..)
- Aviation forecast for aircrafts which needs visual flight conditions (rescue helicopters, …)
  required accuracy < 30 m

Big challenge for the future, because of the automation of weather stations

- Automation of all 183 weather stations of DWD until 2021
- Automatic generation of airport reports (METAR) until 2021

What do we want to know from such comparison?

For different clouds- and weather conditions, especially for very low clouds:

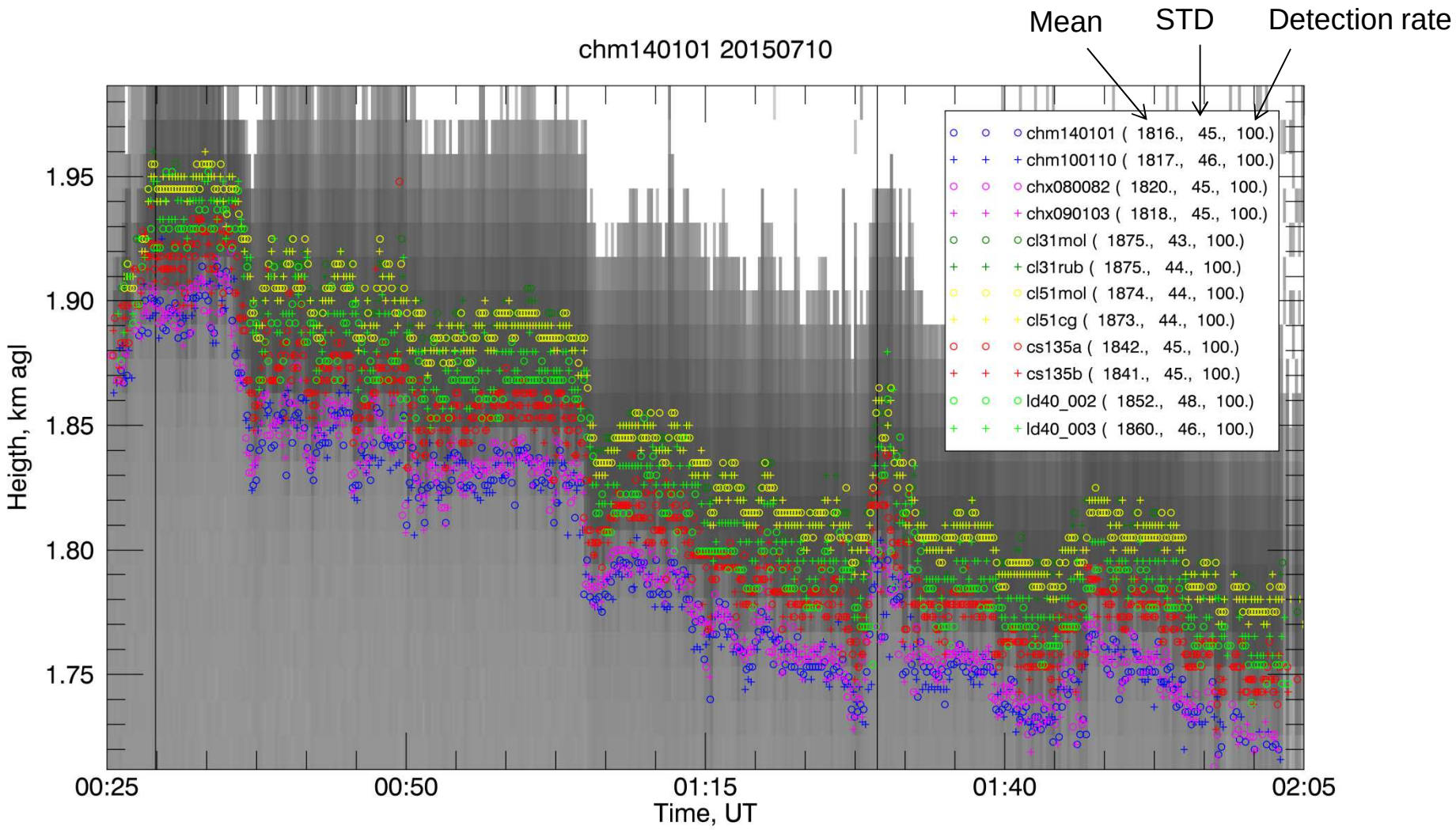
1. Detection rate, false alarm rate of different systems
2. Cloud base height differences
3. Repeatability (comparisons of the same instrument type)
4. Differences in backscatter profiles (especially at lowest heights)

Difficulties:

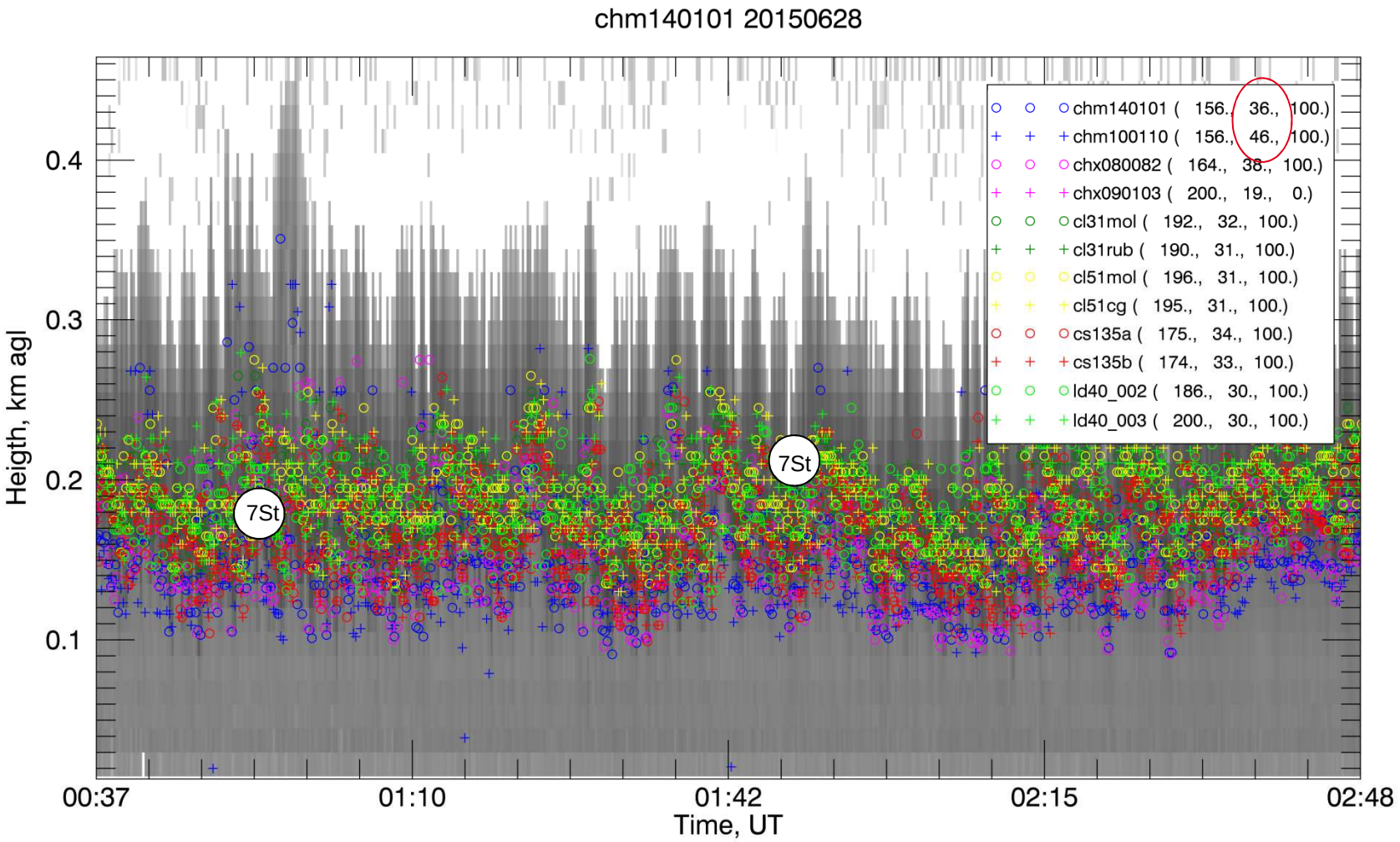
1. No independent reference providing information of cloud occurance and cloud base height
2. No general definition of cloud and cloud base height

Sc without drizzle/rain

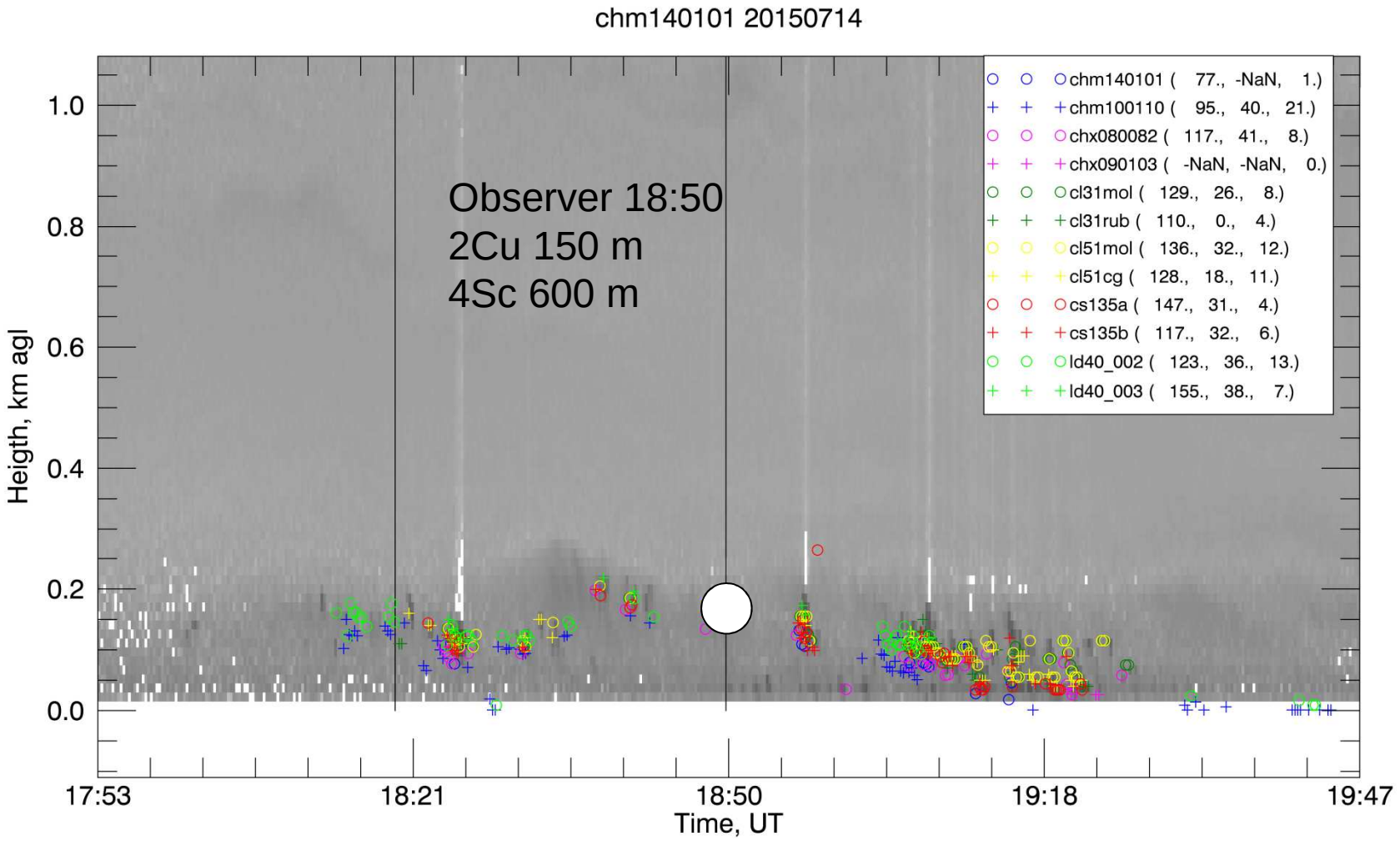
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



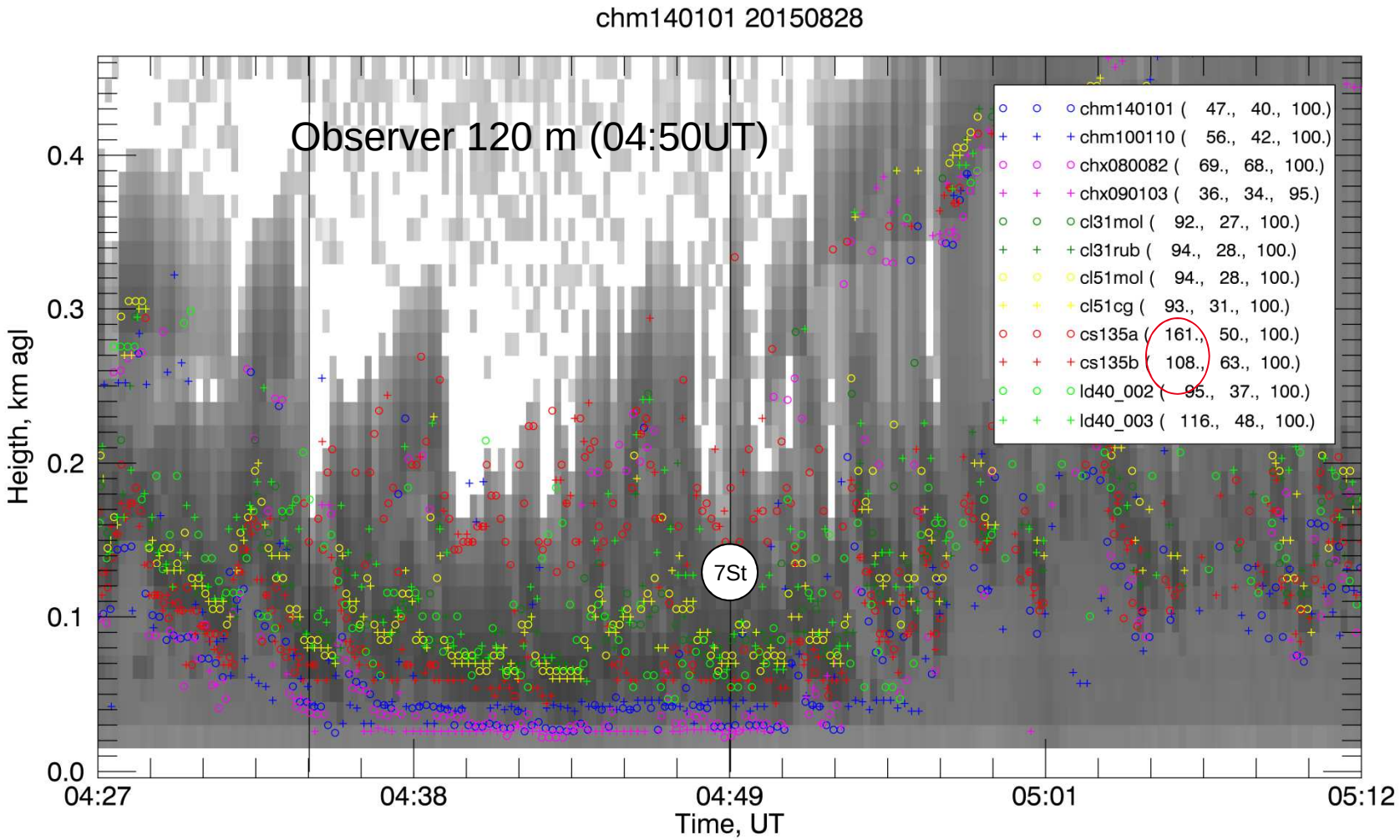
Low St without rain



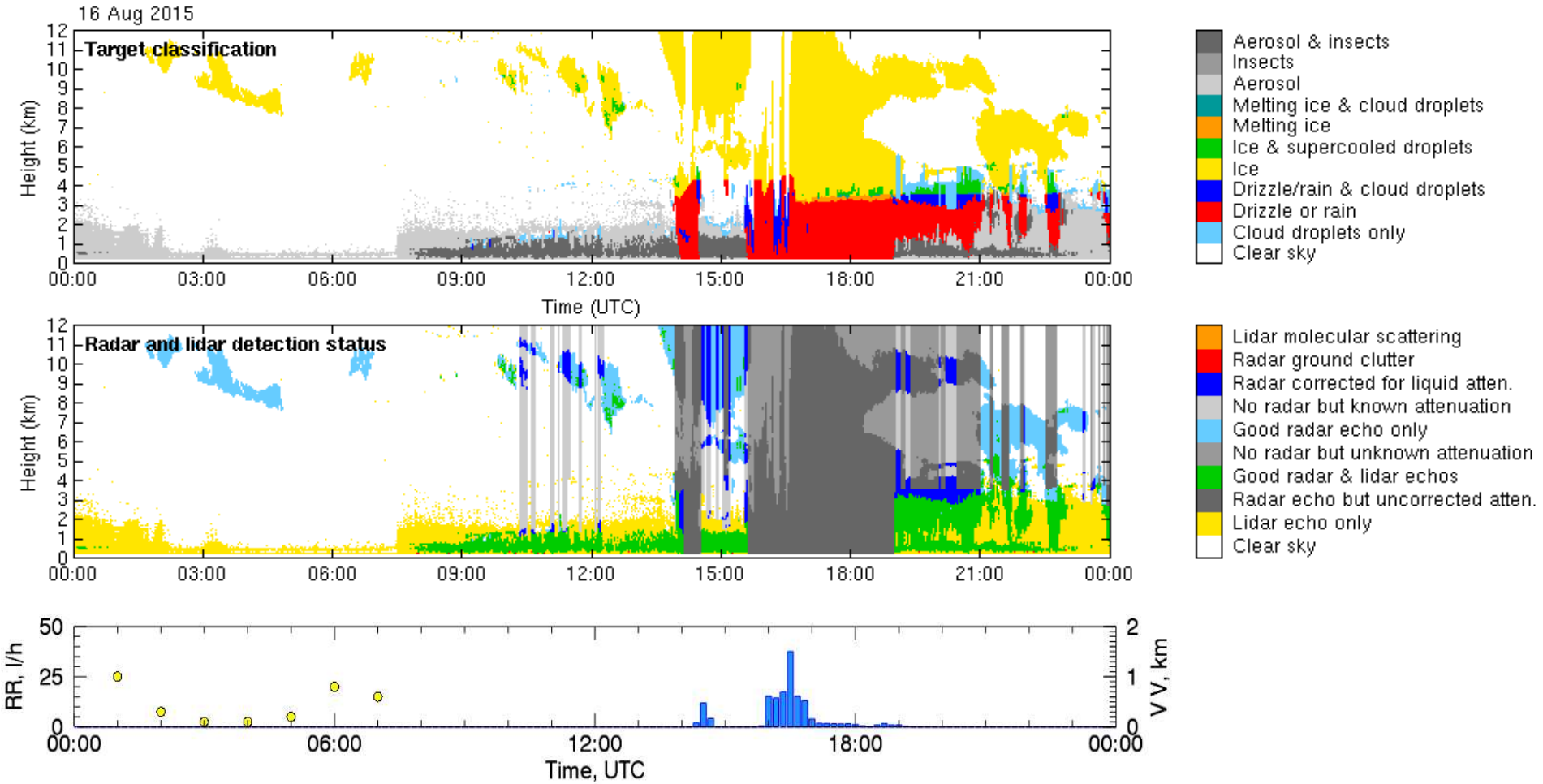
Low Cu without rain



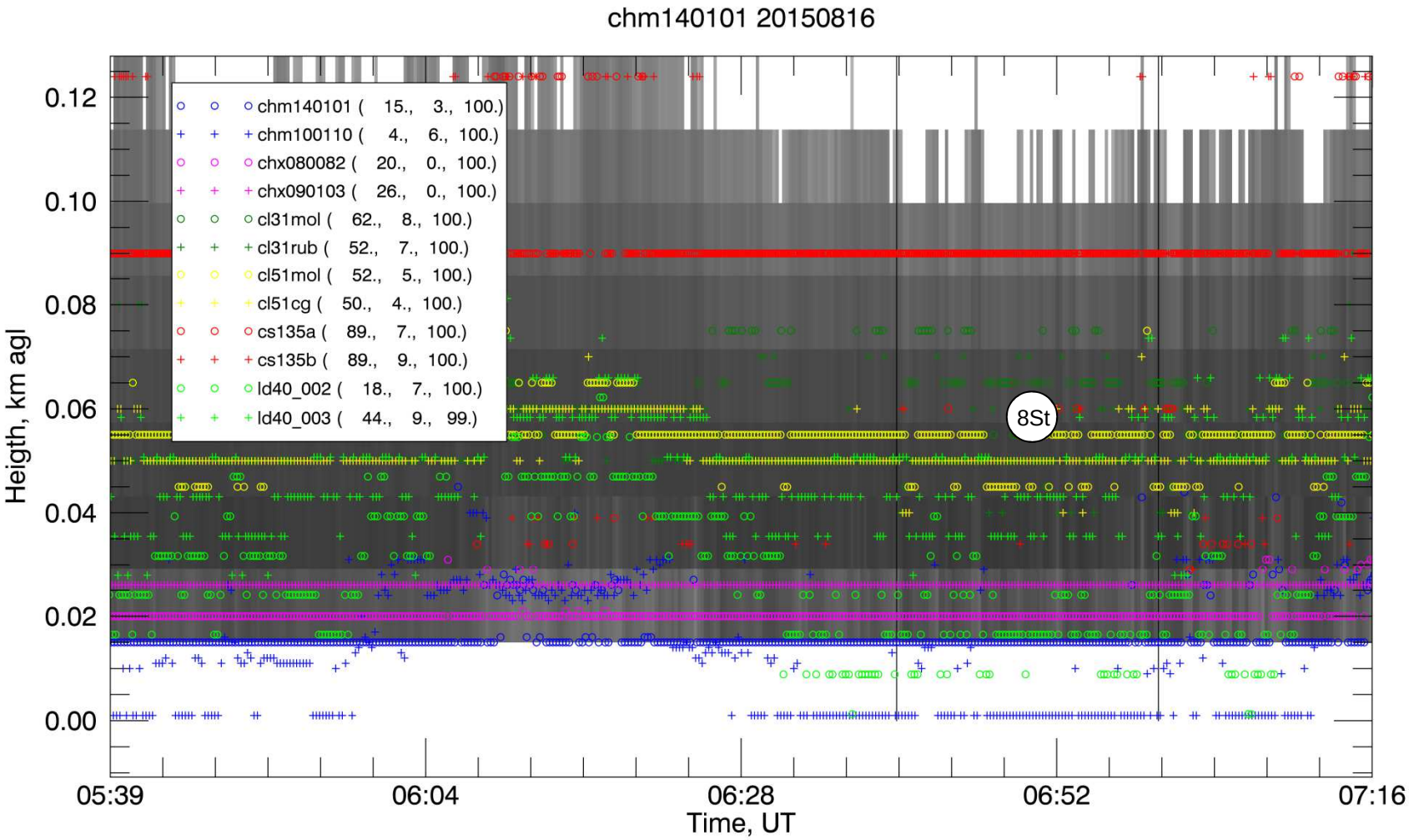
Low St with rain



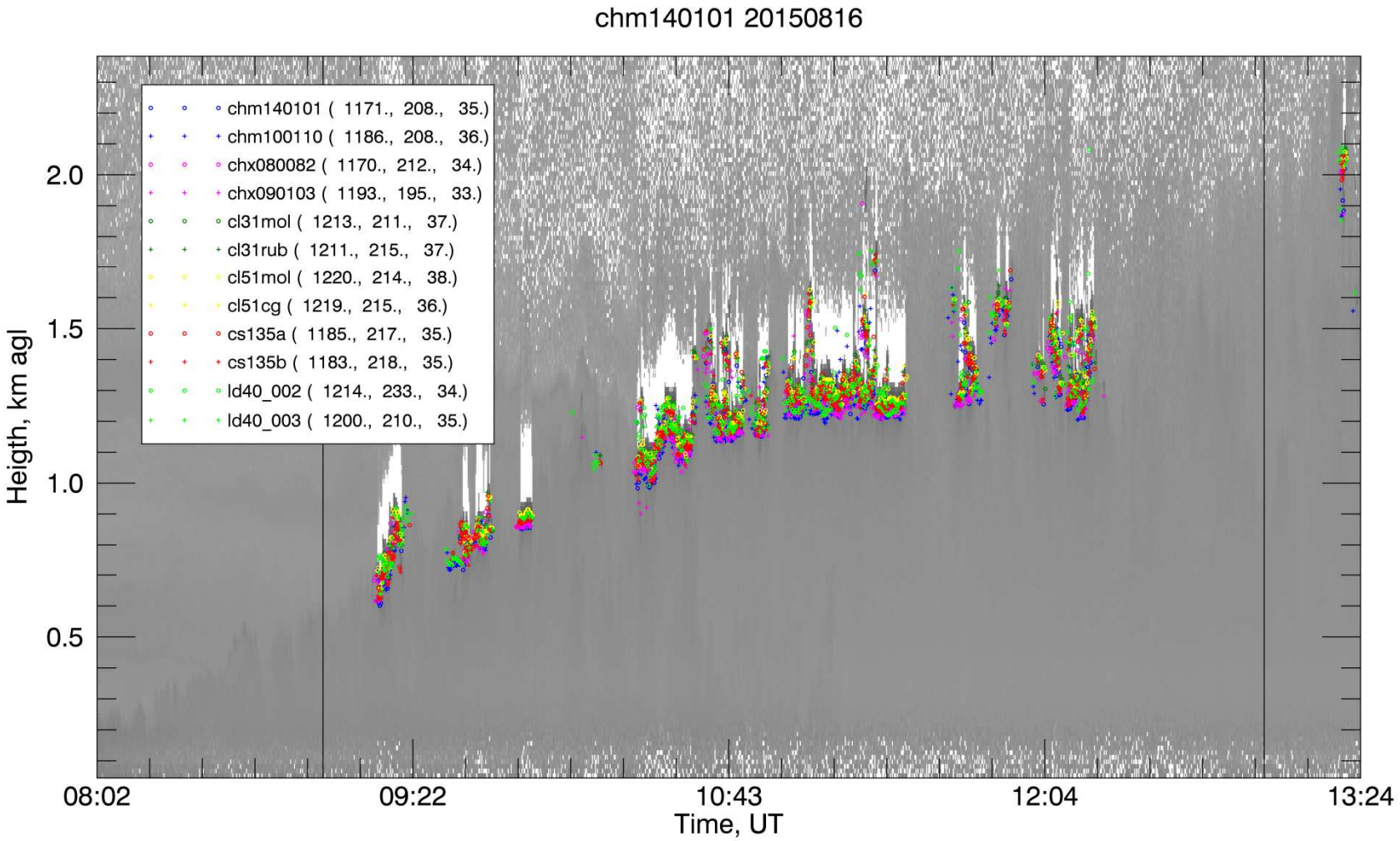
Fog dissipation, Cu hum, Cb heavy rain, moderate rain/virga



Fog dissipation



2-4 Cu hum/med


chm140101 20150816
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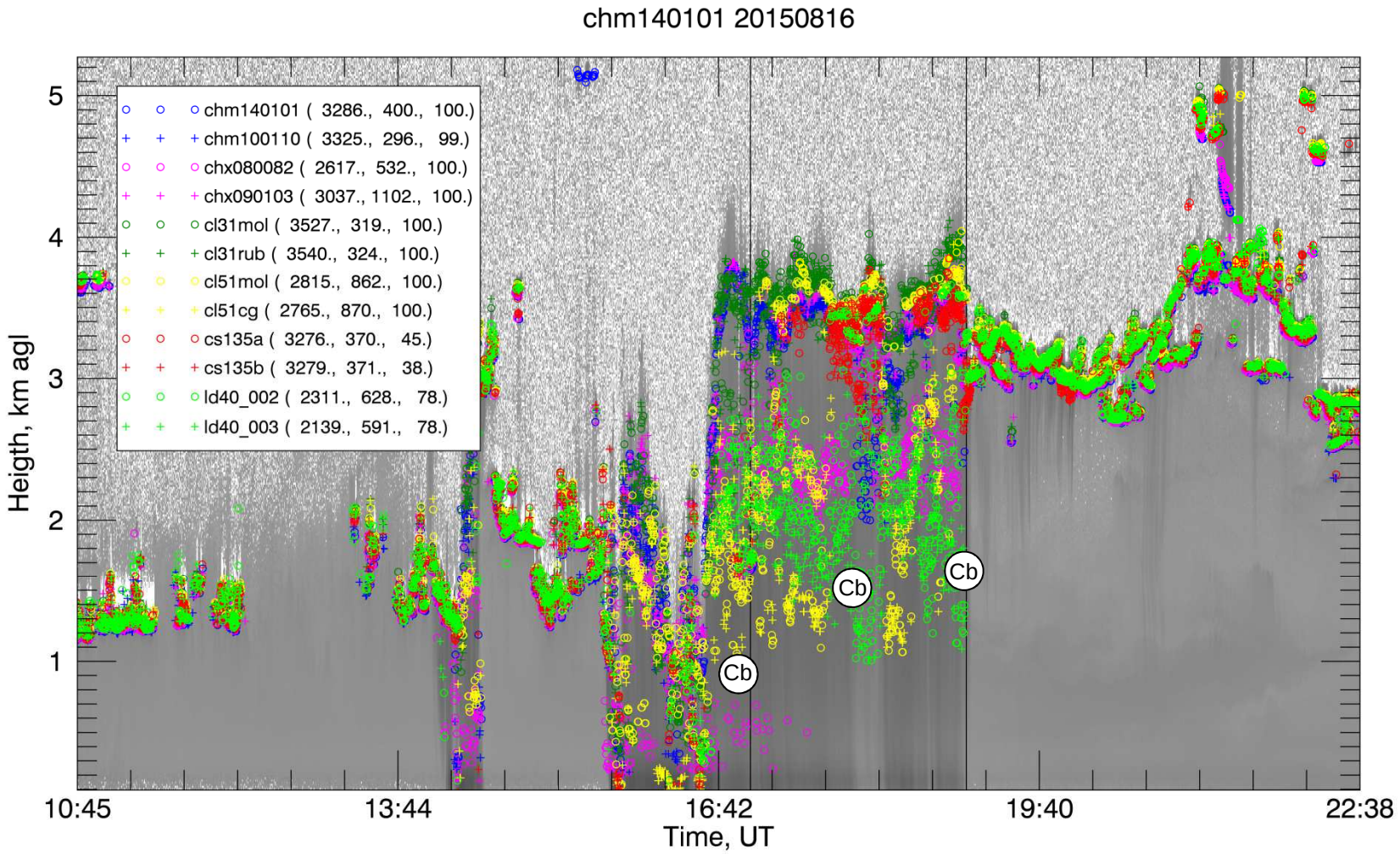
chm100110 (1186., 208., 36.)
chx080082 (1170., 212., 34.)
chx090103 (1193., 195., 33.)
cl31mol (1213., 211., 37.)
cl31rub (1211., 215., 37.)
cl51mol (1220., 214., 38.)
cl51cg (1219., 215., 36.)
cs135a (1185., 217., 35.)
cs135b (1183., 218., 35.)
ld40_002 (1214., 233., 34.)
ld40_003 (1200., 210., 35.)
Heigth, km agl
2.0
1.5
1.0
0.5
08:02
09:22
10:43
12:04
13:24
Time, UT

Cb with rain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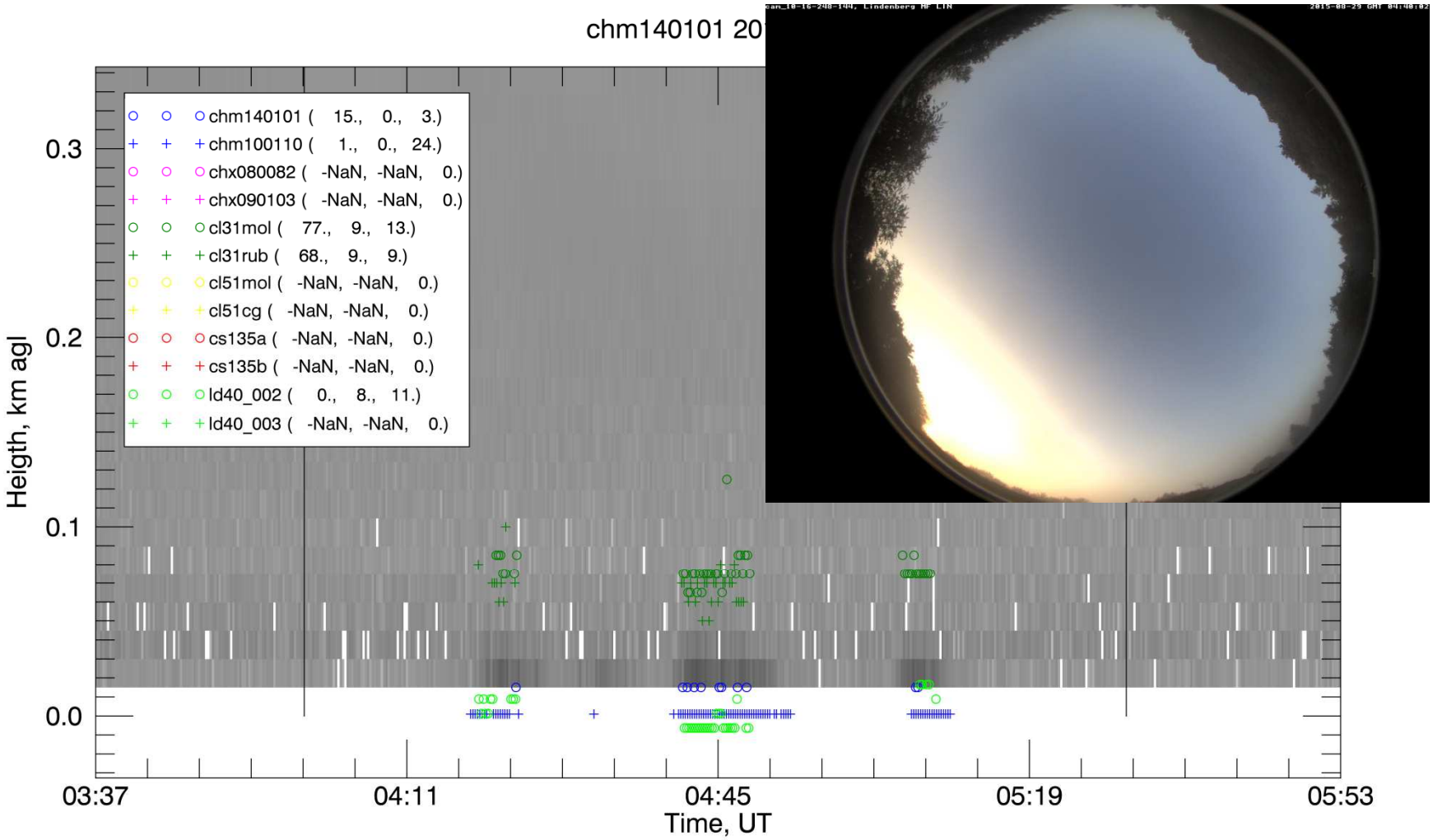
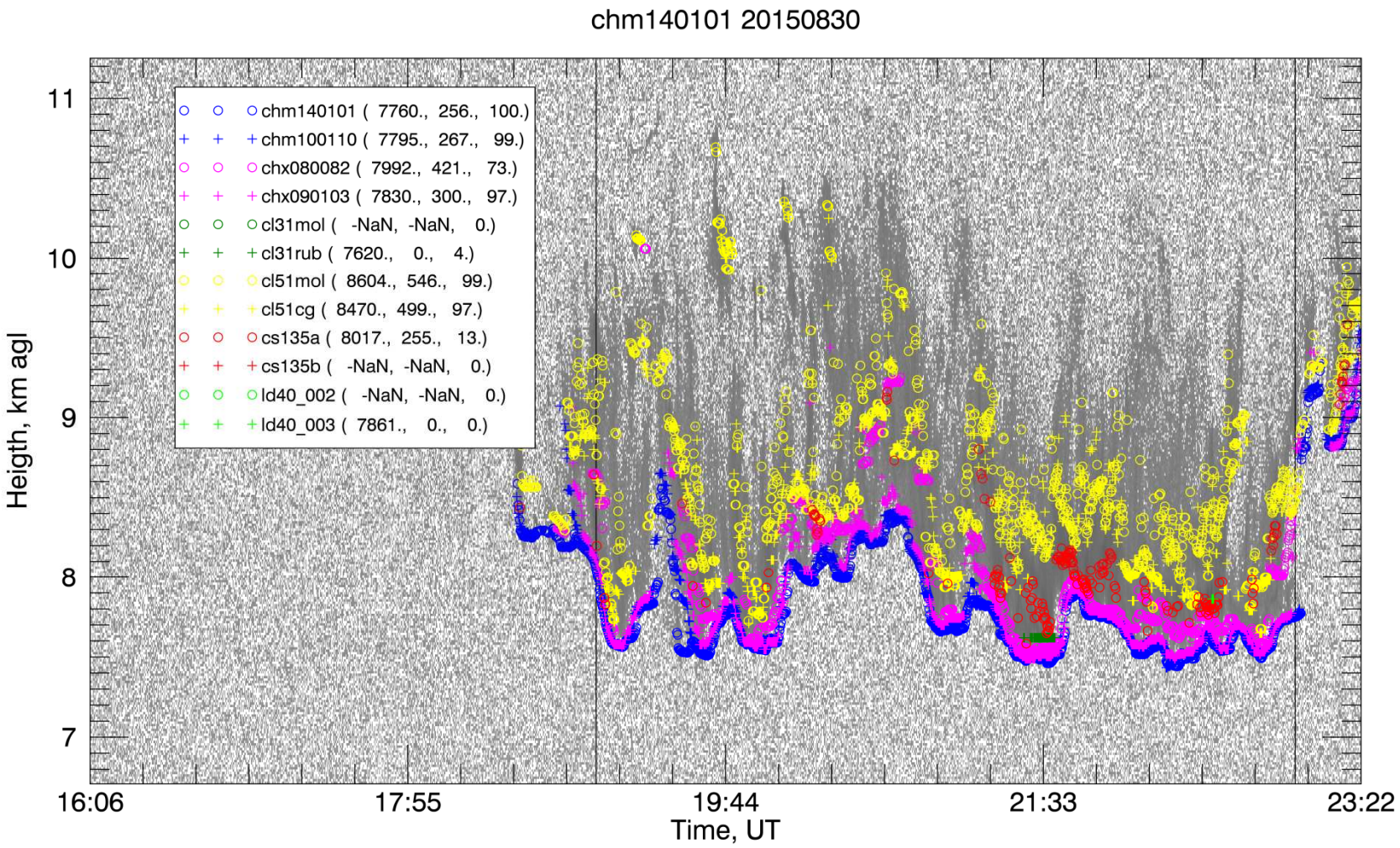
chm100110 (3325., 296., 99.)
chx080082 (2617., 532., 100.)
chx090103 (3037., 1102., 100.)
cl31mol (3527., 319., 100.)
cl31rub (3540., 324., 100.)
cl51mol (2815., 862., 100.)
cl51cg (2765., 870., 100.)
cs135a (3276., 370., 45.)
cs135b (3279., 371., 38.)
ld40_002 (2311., 628., 78.)
ld40_003 (2139., 591., 78.)
Heigth, km agl
5
4
3
2
1
Cb
Cb
Cb
10:45
13:44
16:42
19:40
22:38
Time, UT

Erroneous detection of low clouds

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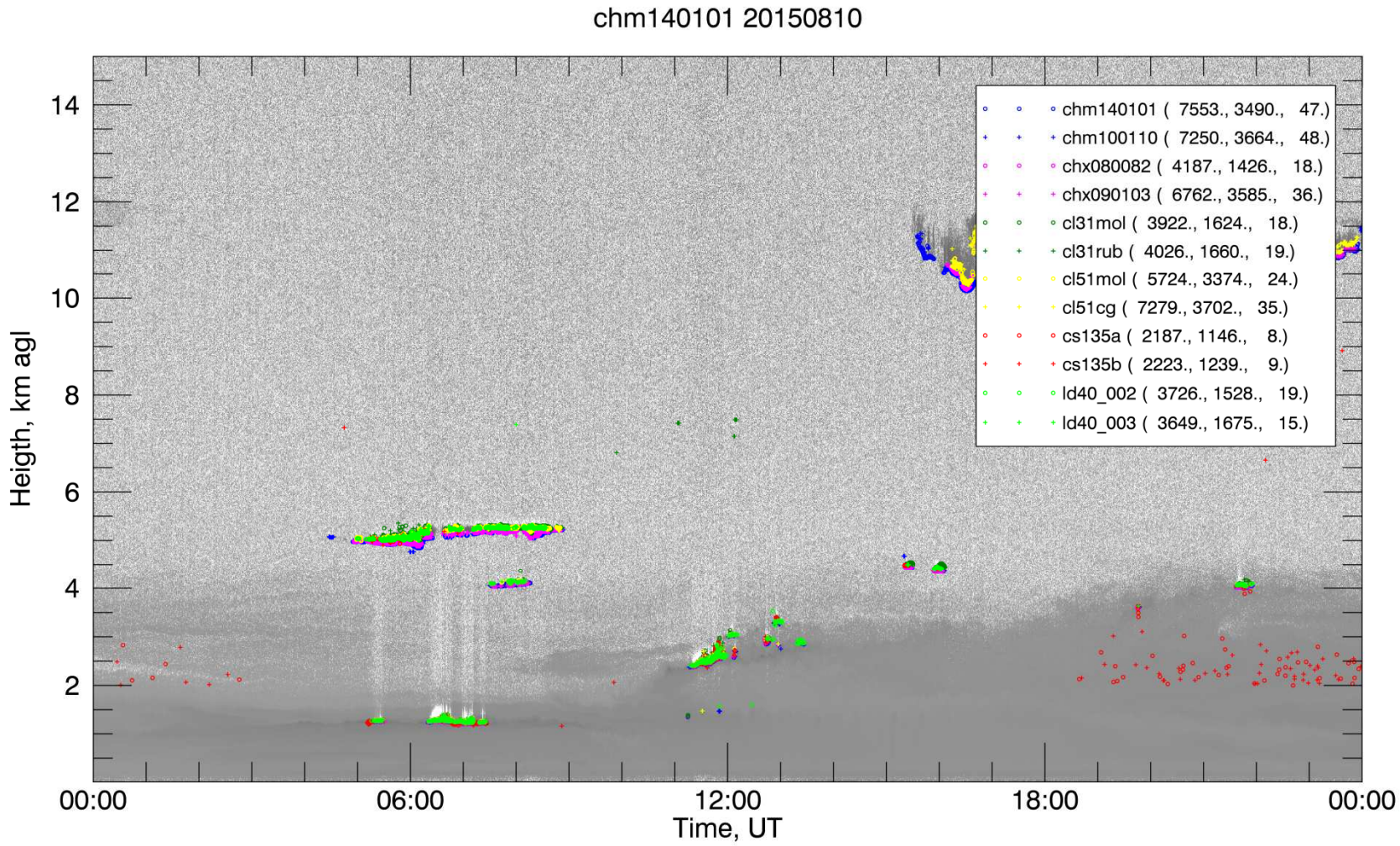
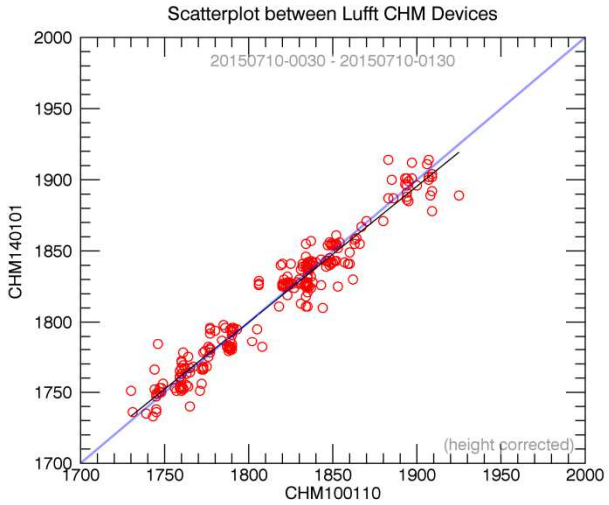
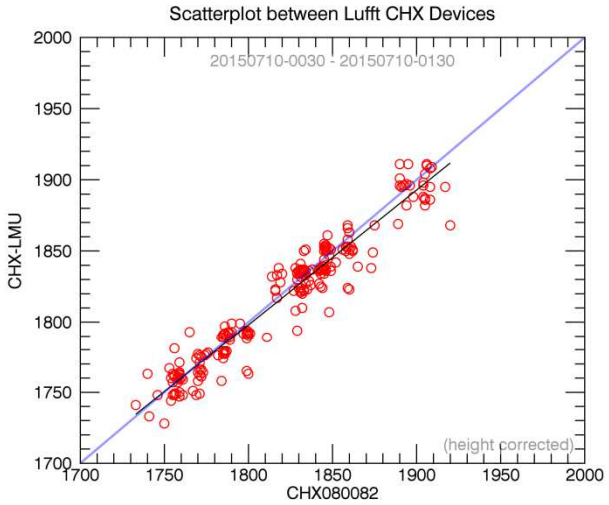
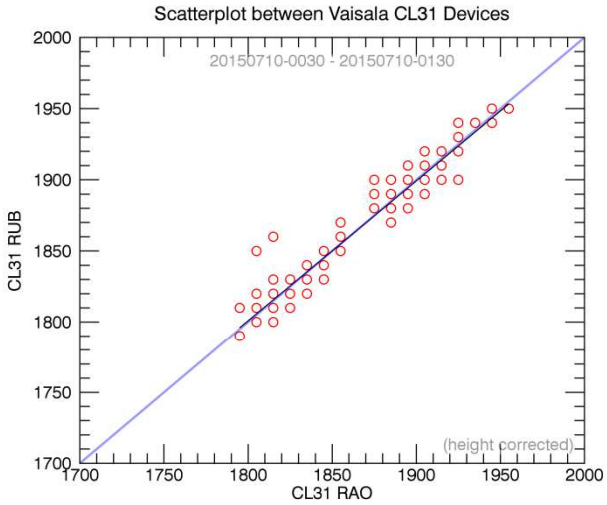
chm100110 (7795., 267., 99.)
chx080082 (7992., 421., 73.)
chx090103 (7830., 300., 97.)
cl31mol (-NaN, -NaN, 0.)
cl31rub (7620., 0., 4.)
cl51mol (8604., 546., 99.)
cl51cg (8470., 499., 97.)
cs135a (8017., 255., 13.)
cs135b (-NaN, -NaN, 0.)
ld40_002 (-NaN, -NaN, 0.)
ld40_003 (7861., 0., 0.)
Heigth, km agl
11
10
9
8
7
16:06
17:55
19:44
21:33
23:22
Time, UT

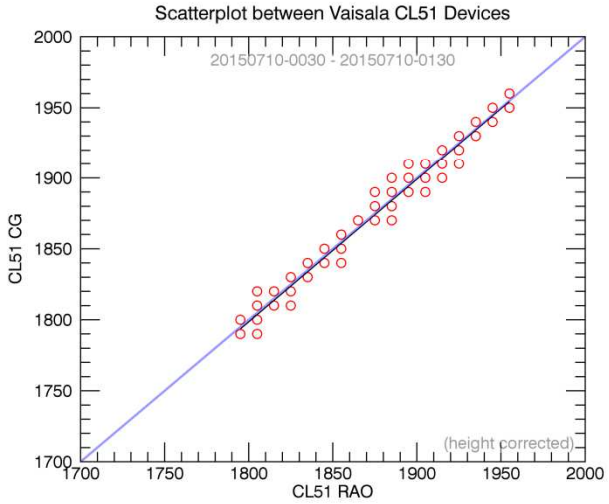
Erroneous cloud detection by CS135

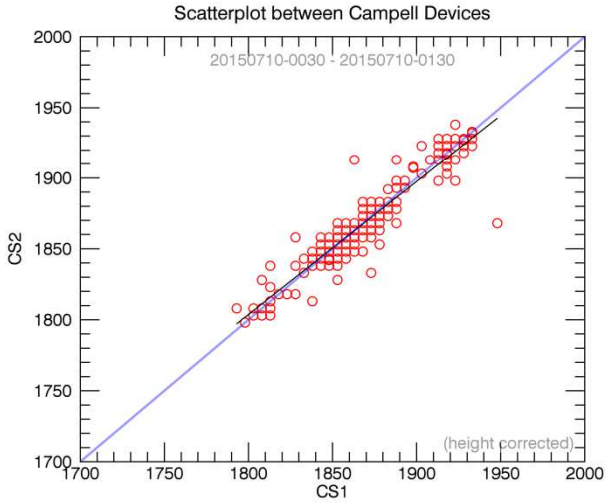


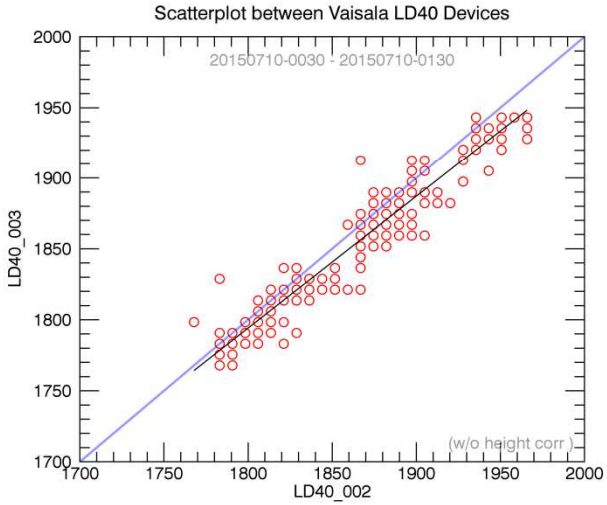

Scatterplot between Lufft CHM Devices
20150710-0030 - 20150710-0130
(height corrected)
CHM140101
CHM100110
2000
1950
1900
1850
1800
1750
1700


Scatterplot between Lufft CHX Devices
20150710-0030 - 20150710-0130
(height corrected)
CHX-LMU
CHX080082
2000
1950
1900
1850
1800
1750
1700


Scatterplot between Vaisala CL31 Devices
20150710-0030 - 20150710-0130
(height corrected)
CL31 RUB
CL31 RAO
2000
1950
1900
1850
1800
1750
1700


Scatterplot between Vaisala CL51 Devices
20150710-0030 - 20150710-0130
(height corrected)
CL51 CG
CL51 RAO
2000
1950
1900
1850
1800
1750
1700


Scatterplot between Campell Devices
20150710-0030 - 20150710-0130
(height corrected)
CS2
CS1
2000
1950
1900
1850
1800
1750
1700


Scatterplot between Vaisala LD40 Devices
20150710-0030 - 20150710-0130
(w/o height corr.)
LD40_003
LD40_002
2000
1950
1900
1850
1800
1750
1700

Summary (preliminary)

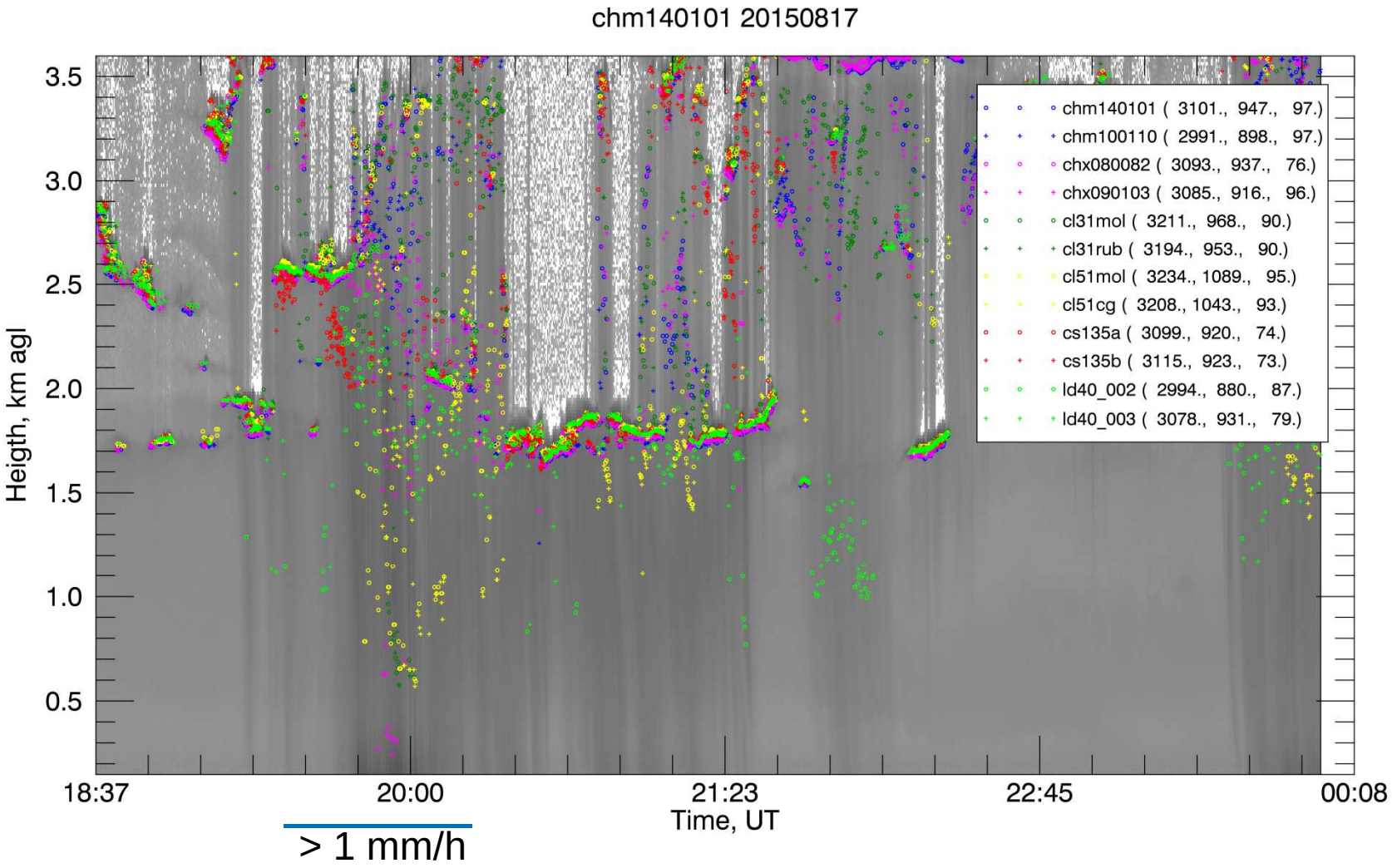
- For well defined water clouds
  - the detection rate of all systems is similar (except CHX-LMU)
  - there are systematic differences of cloud base heights, cloud base heights of LUFFT systems are about 30 .. 60 m lower than cloud base heights of Vaisala systems CL31, CL51; LD40 and Campbell systems represent the average
- Similar results for very low clouds (overcast), but differences in detection rate for scattered clouds
- In situations of very wet boundary layer CHM‘s and CL31‘s tend to detect erroneously clouds
- In rain very large cloud base differences between the system
- During fog dissipation cl31,51 show the most realistic values, Campbells cloud base heights look artificial
- Campbell ceilometers tend to analyse aerosol layers as clouds (during night)

Summary, cloud base differences

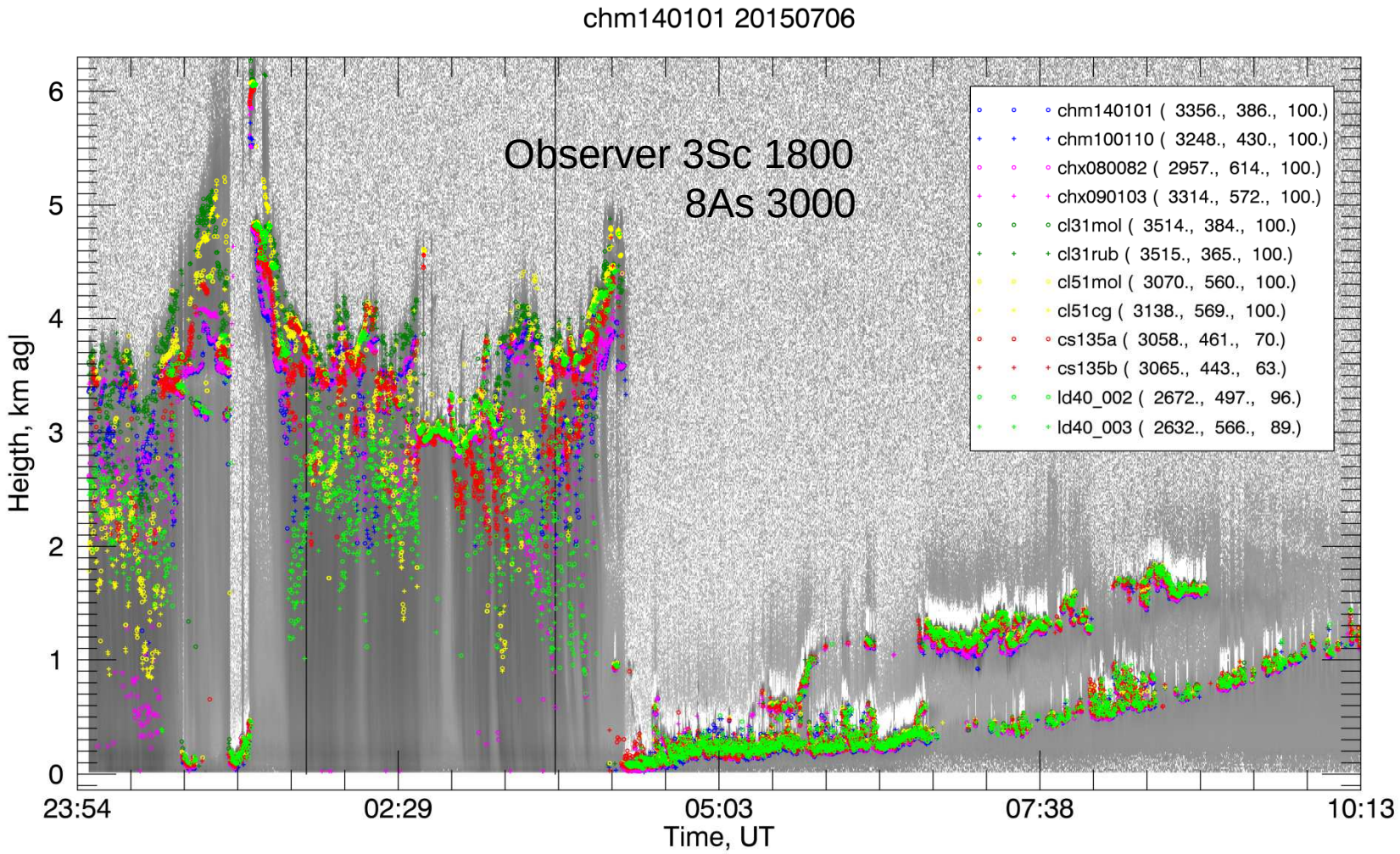
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

System	Sc without rain (1852)	Low St without rain	Fog dissipation	Cb with moderate rain
Mean	1852	178	48	2998
CHM140101	-36	-28	-33	288
CHM100110	-35	-28	-45	326
CHX080082	-31	-19	-28	-380
CHX090103	-33	-	-22	40
CL31MOL	24	7	14	530
CL31RUB	24	4	4	543
CL51MOL	23	10	4	-183
CL51CG	22	9	2	-233
CS135a	-10	-11	41	279
CS135b	-11	-13	41	281
LD40_002	0	3	-30	-687
LD40_003	8	15	-4	-859

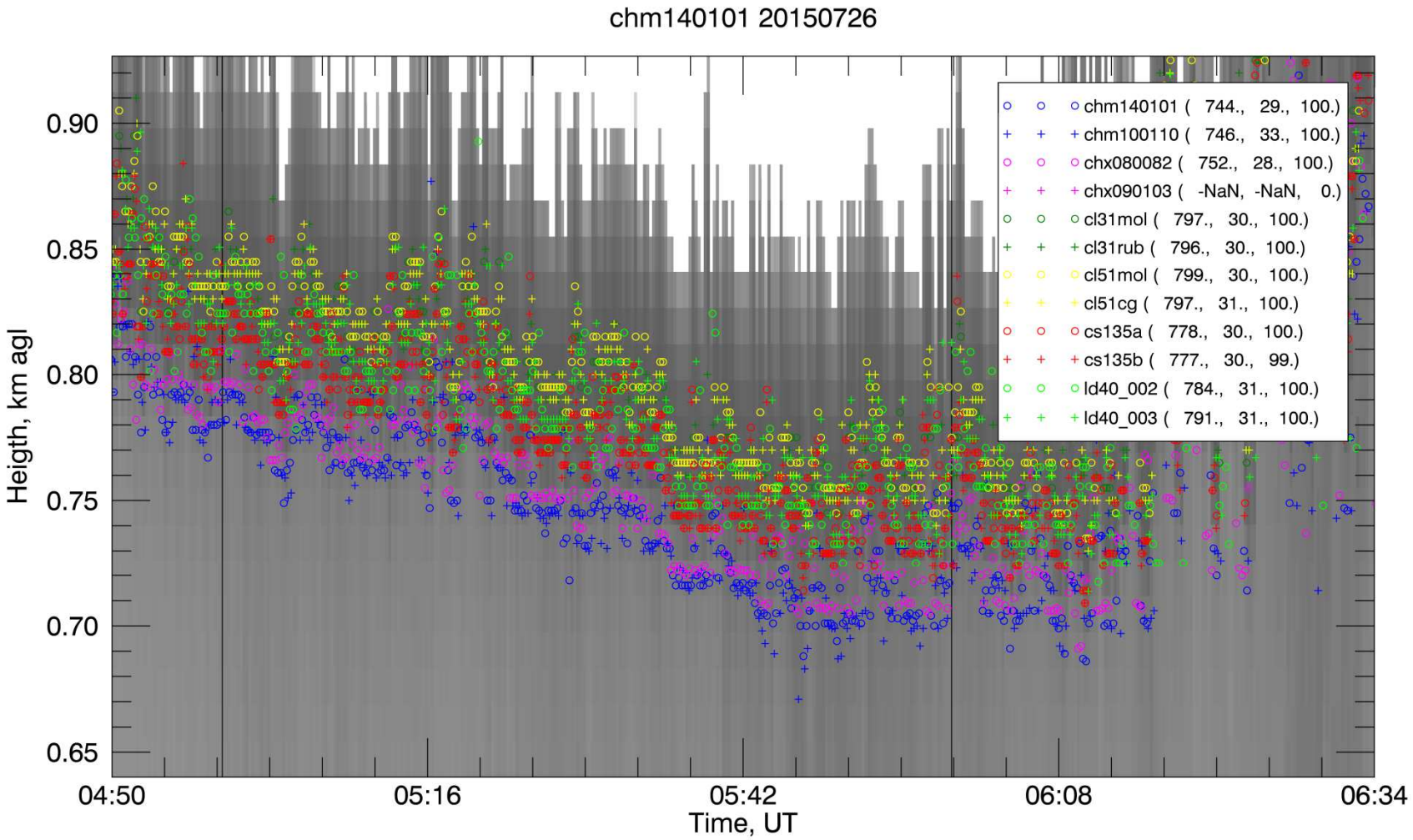
Ns with rain


chm140101 20150817
Heigth, km agl
3.5
3.0
2.5
2.0
1.5
1.0
0.5
18:37
20:00
21:23
22:45
00:08
Time, UT
> 1 mm/h
chm140101 (3101., 947., 97.)
chm100110 (2991., 898., 97.)
chx080082 (3093., 937., 76.)
chx090103 (3085., 916., 96.)
cl31mol (3211., 968., 90.)
cl31rub (3194., 953., 90.)
cl51mol (3234., 1089., 95.)
cl51cg (3208., 1043., 93.)
cs135a (3099., 920., 74.)
cs135b (3115., 923., 73.)
ld40_002 (2994., 880., 87.)
ld40_003 (3078., 931., 79.)

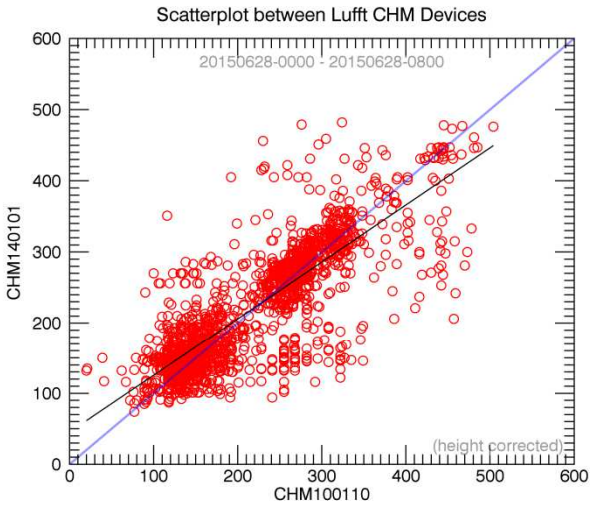
Sc/As with rain

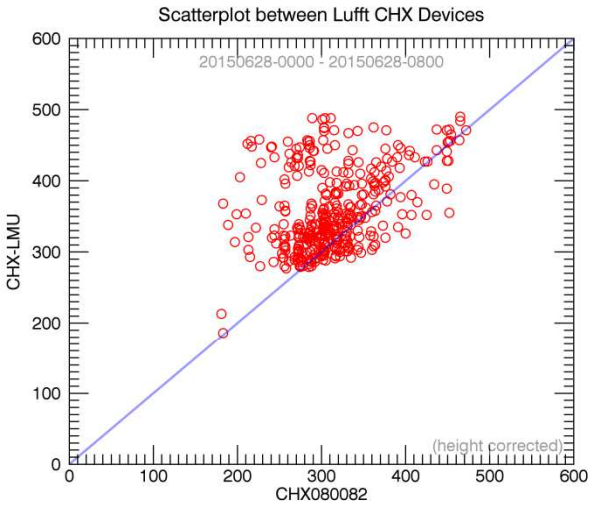


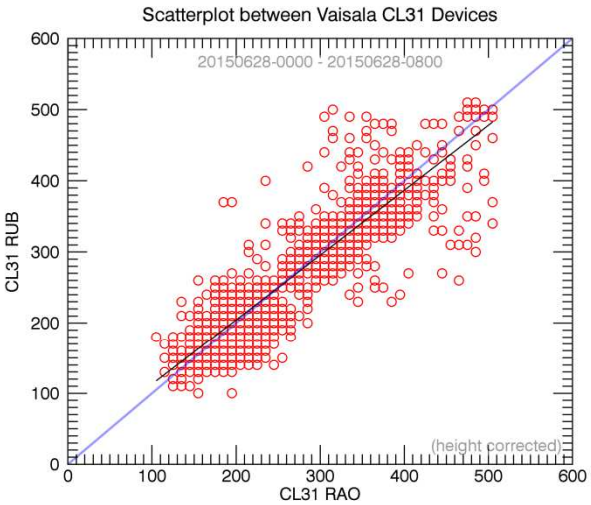
Sc with drizzle/rain

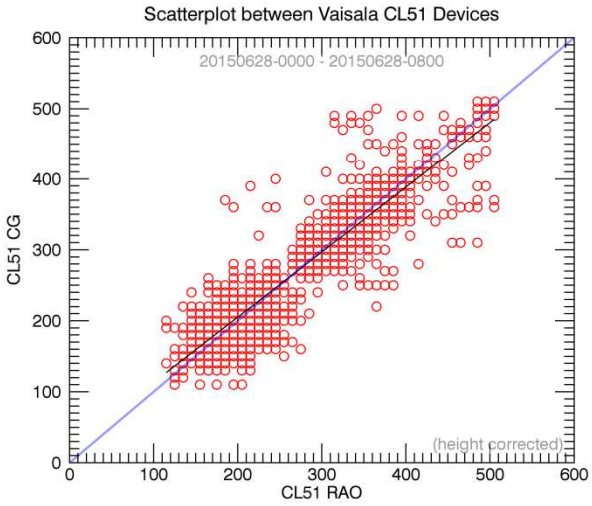


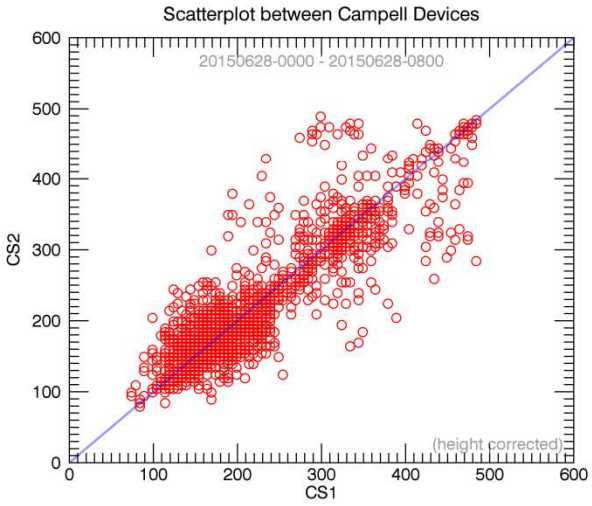
Low St without rain

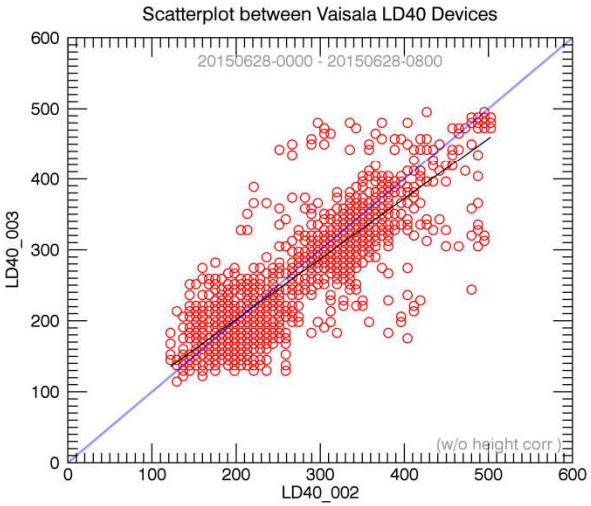


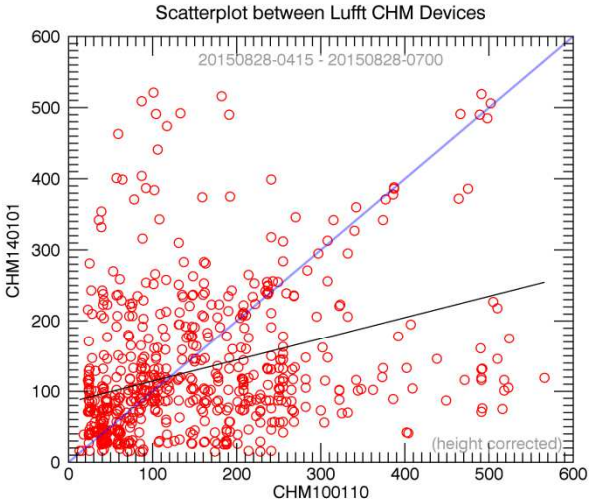


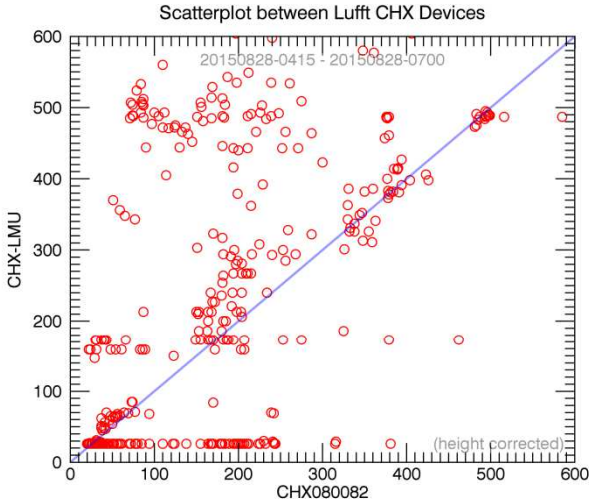


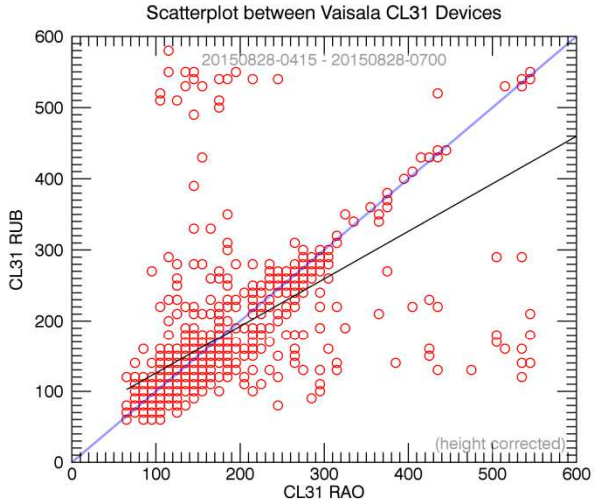


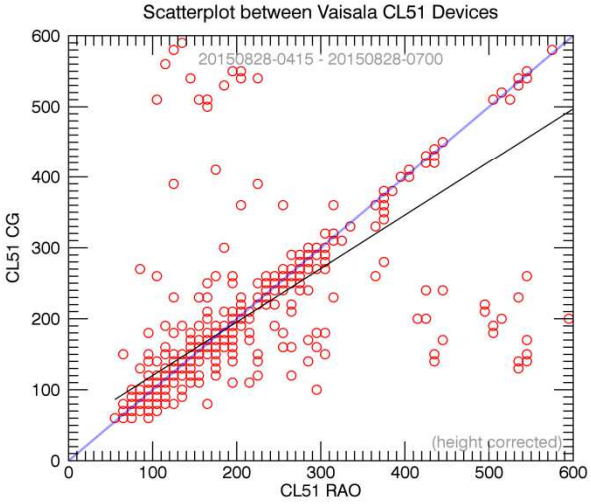


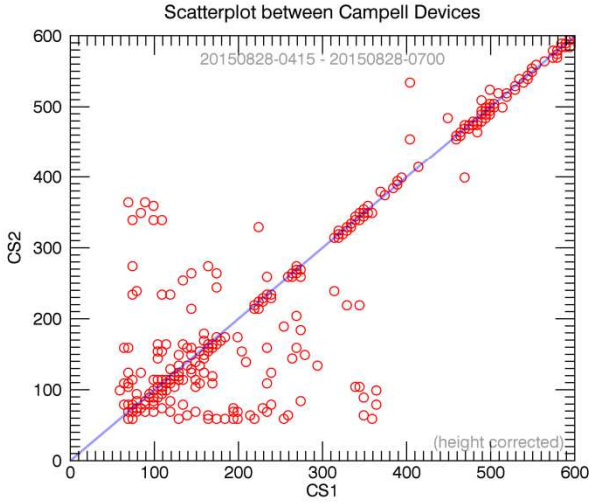


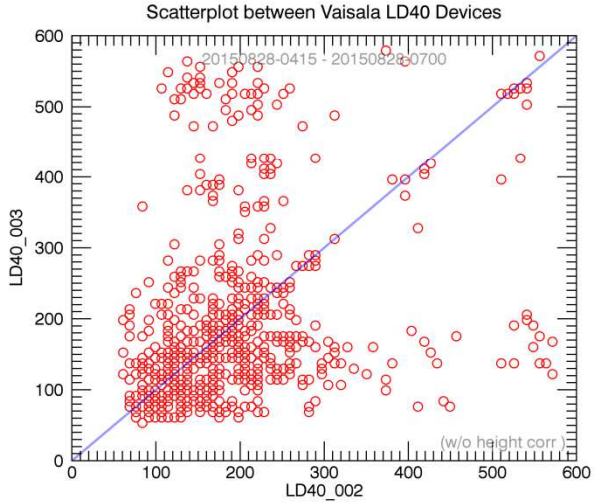

Scatterplot between Lufft CHM Devices
20150828-0415 - 20150828-0700
(height corrected)
CHM140101
CHM100110
0
100
200
300
400
500
600


Scatterplot between Lufft CHX Devices
20150828-0415 - 20150828-0700
(height corrected)
CHX-LMU
CHX080082
0
100
200
300
400
500
600


Scatterplot between Vaisala CL31 Devices
20150828-0415 - 20150828-0700
(height corrected)
CL31 RUB
CL31 RAO
0
100
200
300
400
500
600


Scatterplot between Vaisala CL51 Devices
20150828-0415 - 20150828-0700
(height corrected)
CL51 CG
CL51 RAO
0
100
200
300
400
500
600


Scatterplot between Campell Devices
20150828-0415 - 20150828-0700
(height corrected)
CS2
CS1
0
100
200
300
400
500
600


Scatterplot between Vaisala LD40 Devices
20150828-0415 - 20150828-0700
(w/o height corr.)
LD40_003
LD40_002
0
100
200
300
400
500
600

Example of erroneous cloud base heights (hft), Ninjo, 24.08.2015

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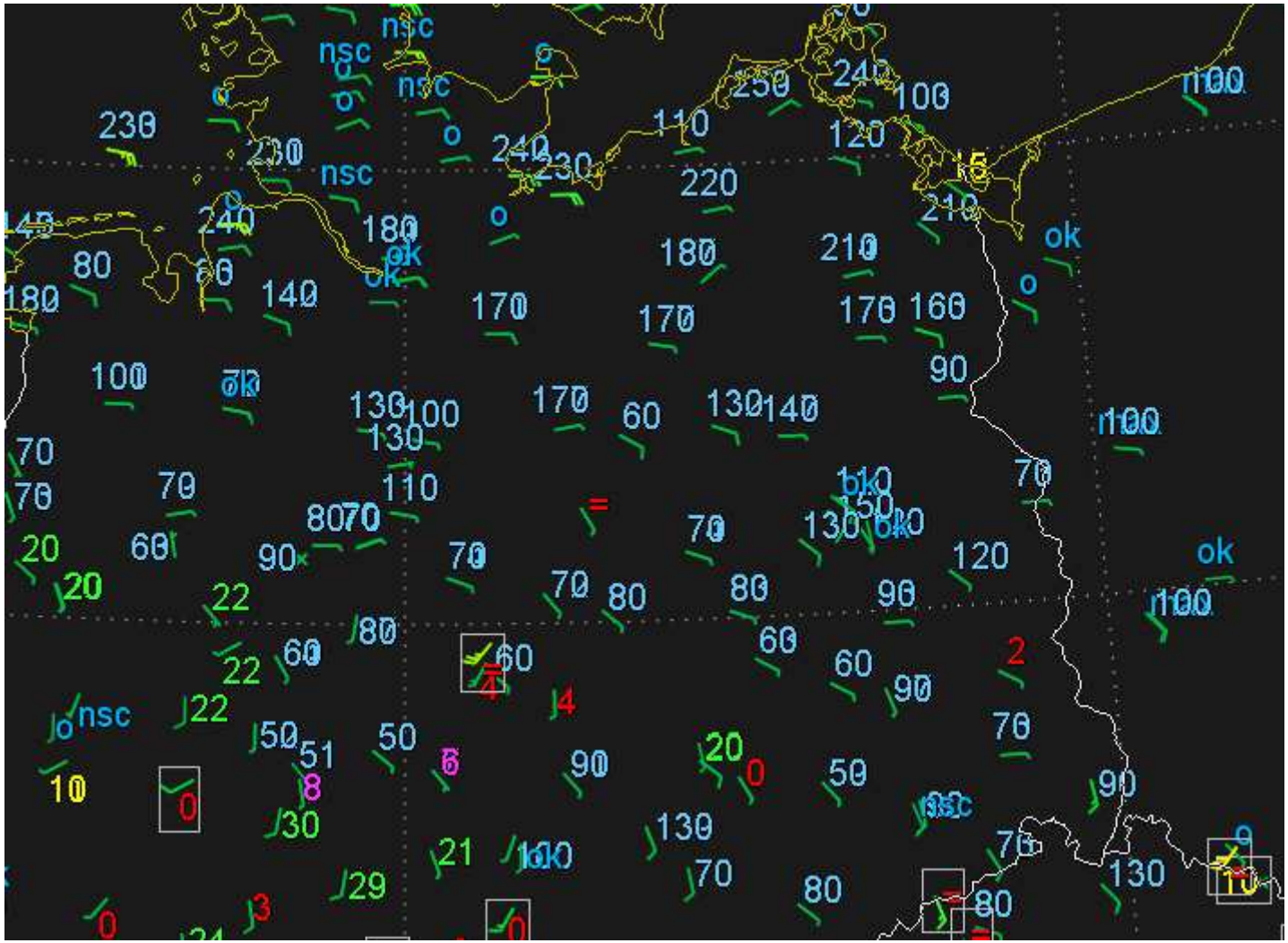
Wetter und Klima aus einer Hand



6 different ceilometer types

CS135
2xCampbell

Vaisala
CL51
1xMOL
1xCG

Vaisala
CL31
1xMOL
1xRUB

Vaisala
LD40, WHX
2xMOL/RAO

LUFFT
CHM15k
2xMOL

LUFFT
CHM15kx
1xLMU
1xMOL

Categorization of cloud and weather conditions

1. Stratocumulus without drizzle or rain, 7-8 Sc
2. Stratocumulus with drizzle (virga), 7-8 Sc virga
3. Stratocumulus with rain, 7-8 Sc rain
4. Cumulunimbus/Nimbostratus/Stratus with rain, 7-8Cb/Ns/St rain
5. Low Stratus without rain, vv > 1 km
6. Low Stratus with rain, vv < 1 km
7. Cumulus hum/med, 3-7 Cu
8. Fog, vv < 500 m, sky not visible, fog dissipation
9. Cirrus, 7-8Ci