Update on assimilation of microwave-radiometer and Doppler-lidar observations at DWD

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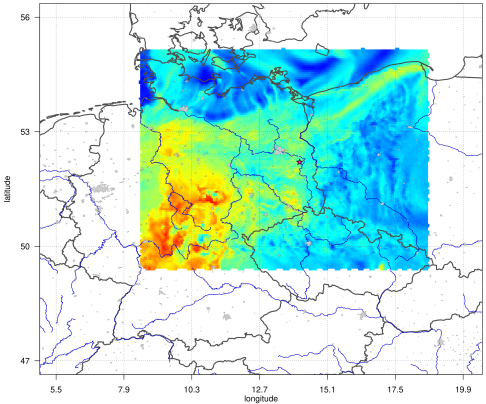
Ground-based remote sensing in Lindenberg (MOL-RAO)

Microwave radiometer

Doppler lidar

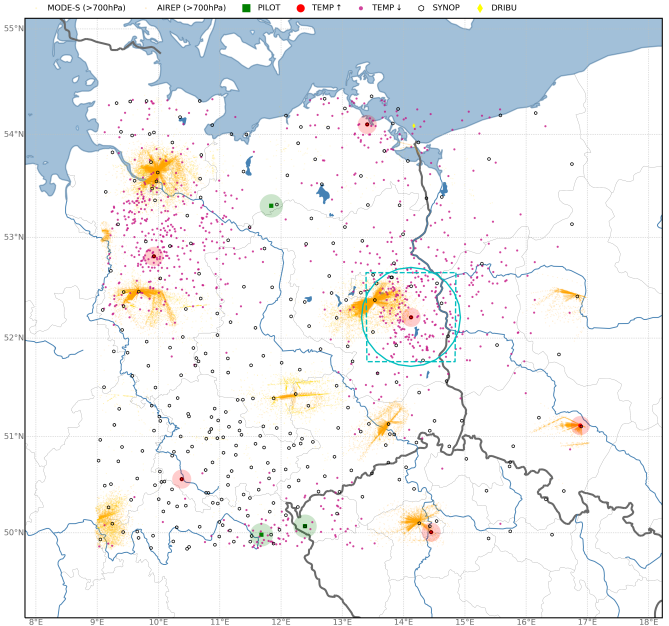
Setup of assimilation system

- assimilation: KENDA, LETKF with 40 members
- first guess & forecast: ICON-D2 ($\approx$ 2.1 km)
- subdomain of ICON-D2
- most experiments in June 2021
- selected experiments for longer (May-August 2021)
- no assimilation of radiosonde & radar-wind profiler in Lindenberg



Verification areas

- radius of 55 km around MOL-RAO for forecast verification
- rectangle of $\approx$ 50 km around MOL-RAO for departure statistics (*obs_err_stat*)



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- 7 K-band channels (water vapour, liquid cloud water)
- 7 V-band channels (temperature)
- assimilation of T_{b} with RTTOV-gb

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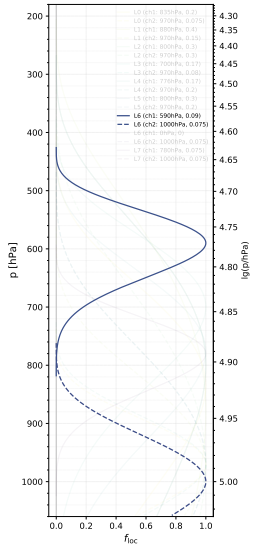
- assimilation of channel 2 & 13 only
- observation errors approximately 4:1 (Desroziers)
- vertical localisation functions must not overlap

  ← cross-validation diagnostic (Stiller, 2022)



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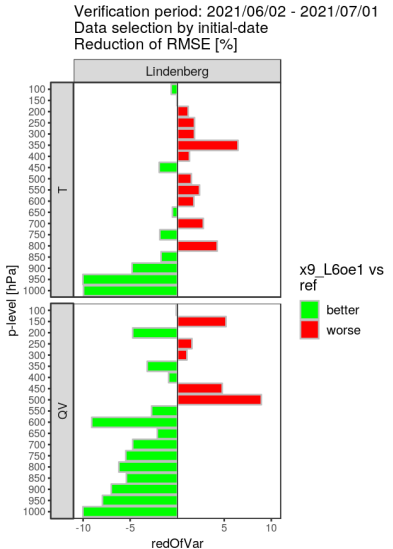
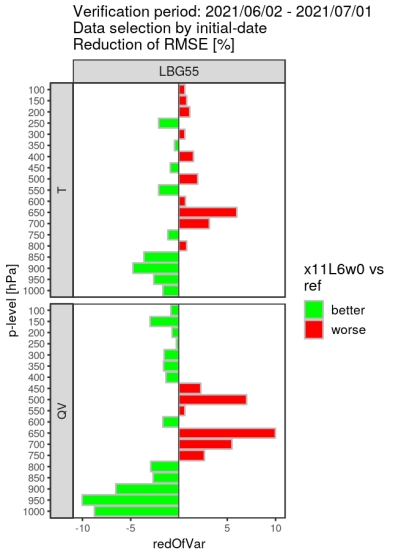


New verification strategy

- radiosonde & RWP both switched off

  1 month



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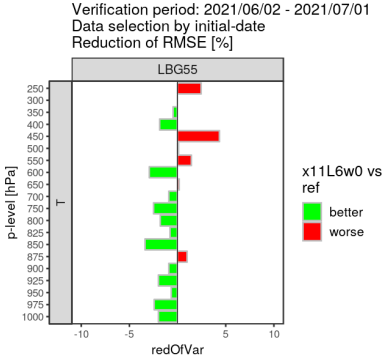

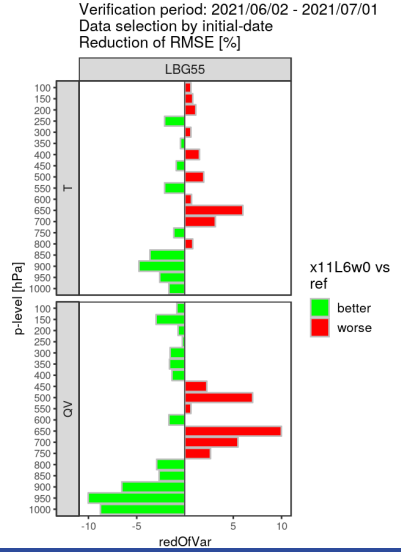

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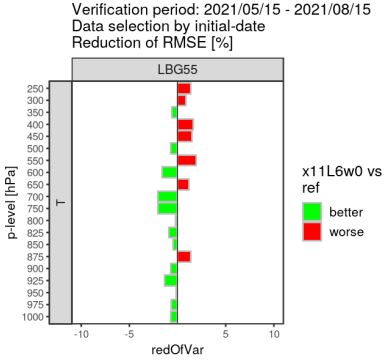

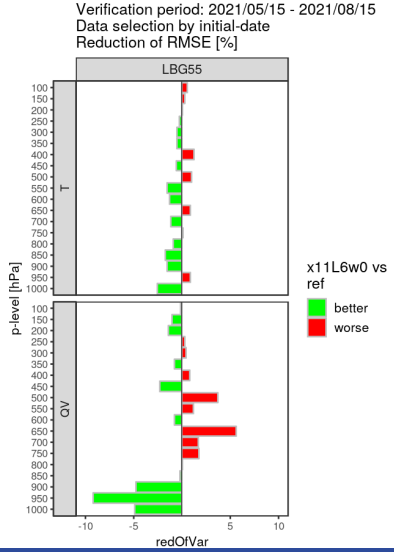

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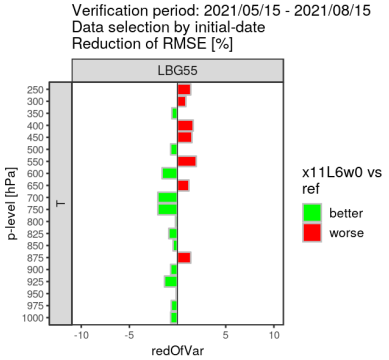
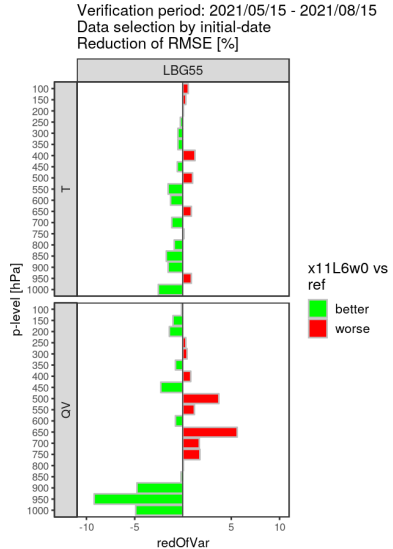
- gained more significance for single lead times
- loss of positive impact due to less clear-sky?





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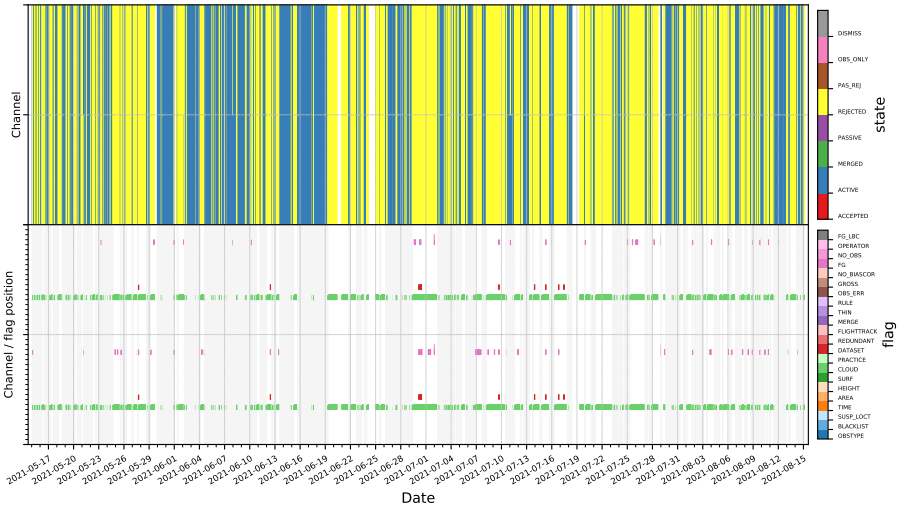

Height correction

- height of instrument (127 m) $\neq$ model (97 m)

$\Rightarrow$ apply height correction:

  - remove lowest level
  - p_{surf}: interpolate press to new h_{surf}
  - $T_{2\mathrm{m}}$: approximation for moist-adiabatic lapse rate (0.625K/100m)

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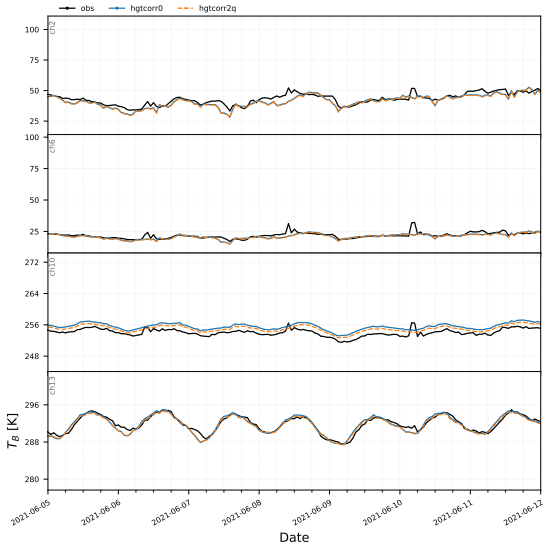
- positive impact on (unused) channel 8-10



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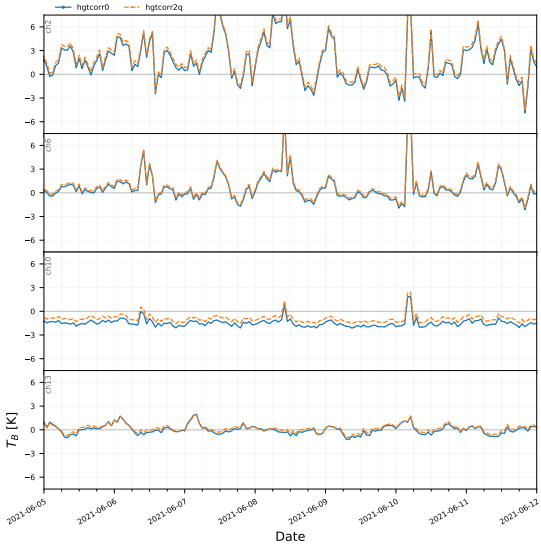

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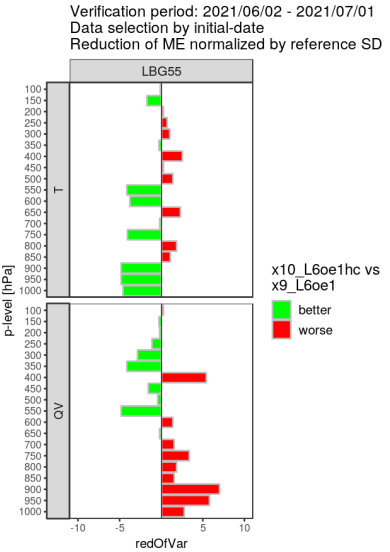

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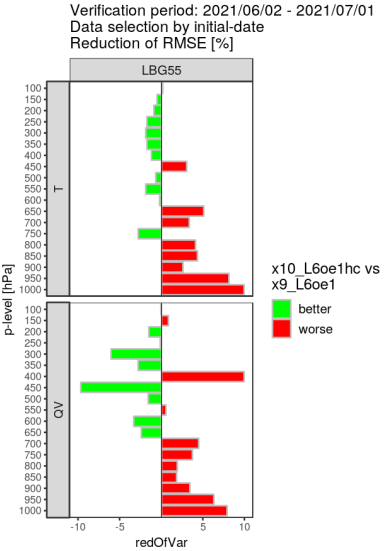
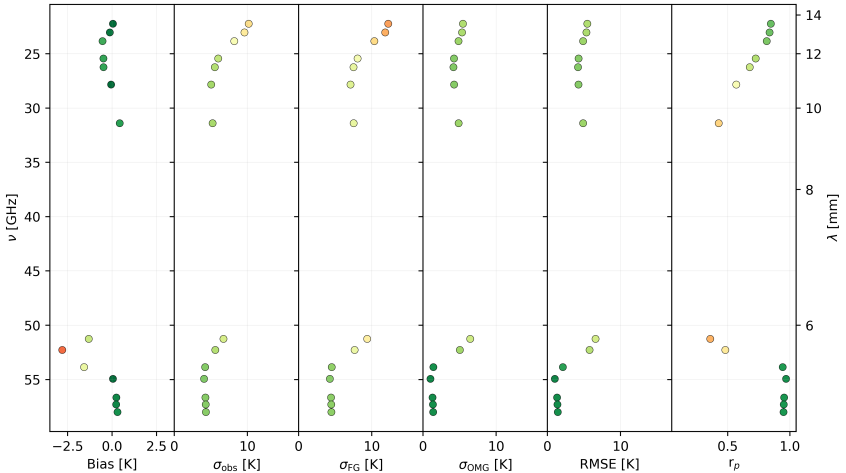


Clouds – observations

- channel 13 almost not sensitive to clouds ⇒ always active



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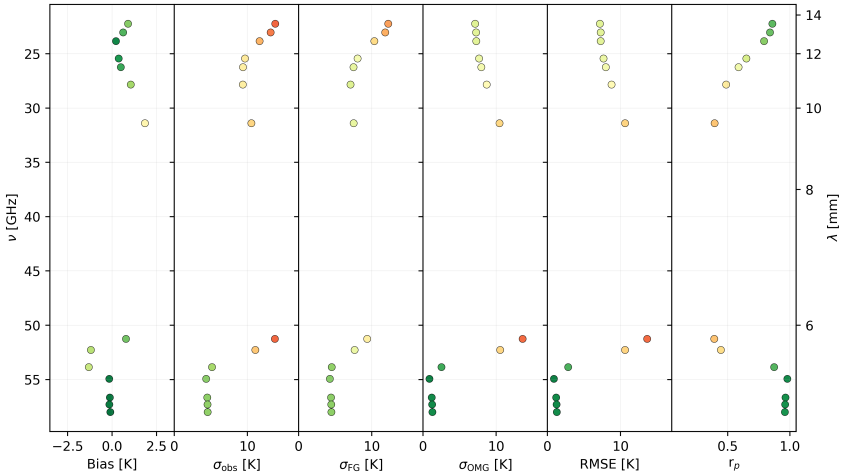
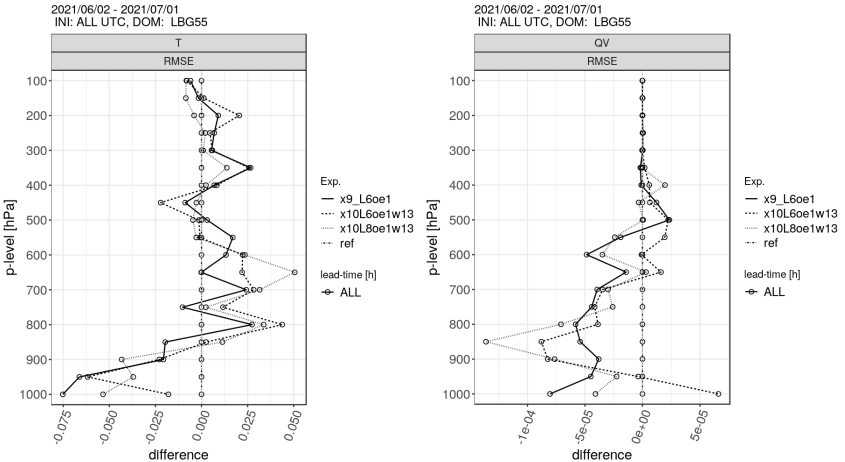


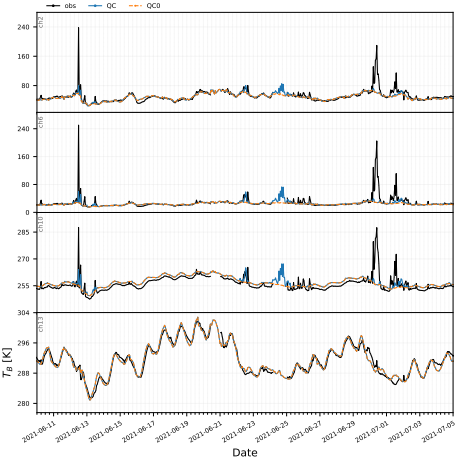
Clouds – observations

- channel 13 almost not sensitive to clouds ⇒ always active
- change vertical localisation again?



Clouds – model

- model clouds were neglected so far
- avoid losing even more data to cloud-flagging, set Qc=0



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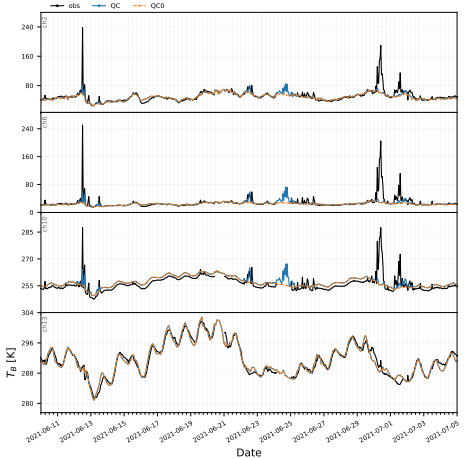

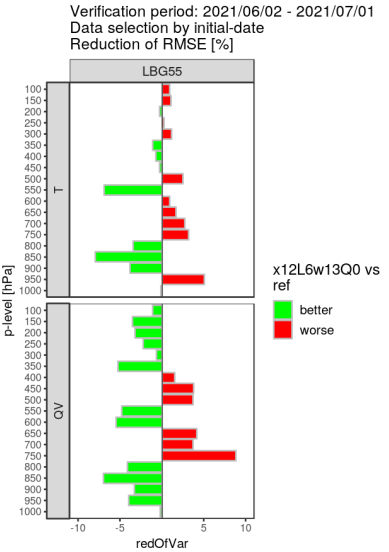

Do we need channel 2?

- unexpected vertical localisation
- not very useful when cloudy
- seems to interfere with channel 13
- omitting channel 2 doesn't look too bad...

$\rightarrow$

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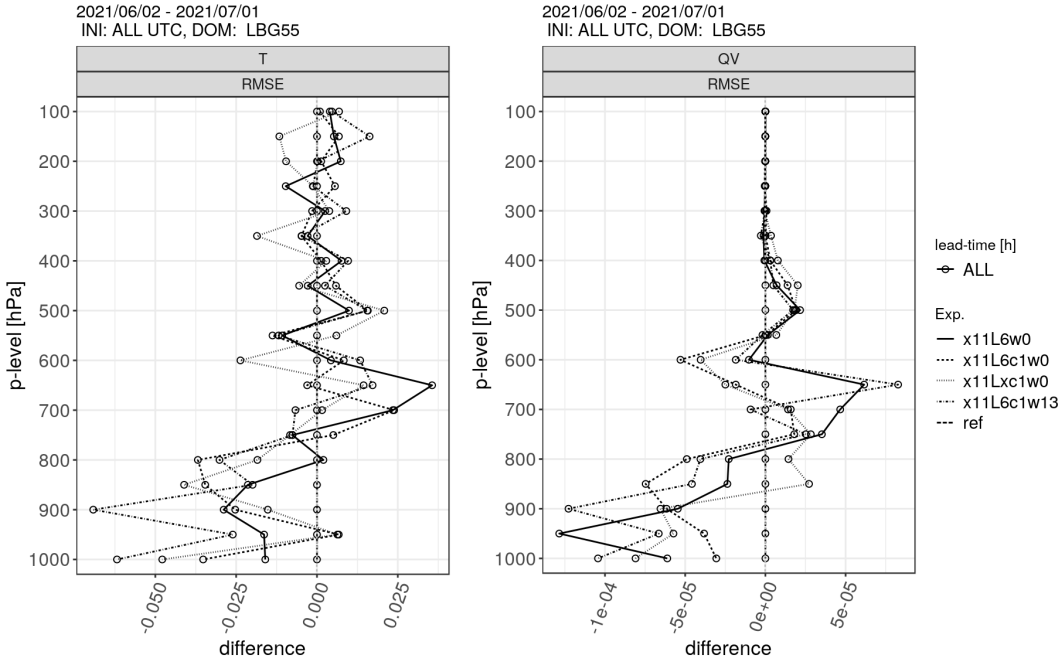
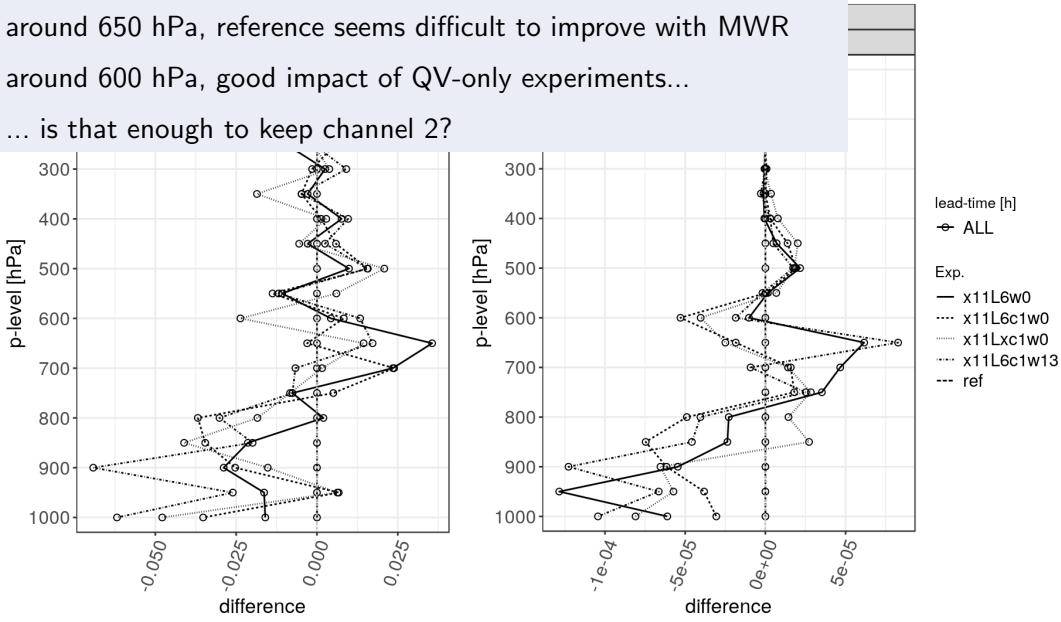
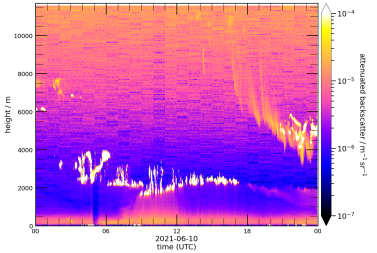

2021/06/02 - 2021/07/01
INI: ALL UTC, DOM: LBG55
T
RMSE
p-level [hPa]
100
200
300
400
500
600
700
800
900
1000
-0.050
-0.025
0.000
0.025
difference
2021/06/02 - 2021/07/01
INI: ALL UTC, DOM: LBG55
QV
RMSE
p-level [hPa]
-1e-04
-5e-05
0e+00
5e-05
difference
lead-time [h]
ALL
Exp.
x11L6w0
x11L6c1w0
x11Lxc1w0
x11L6c1w13
ref

- up to at least 800 hPa, good results without channel 2
- around 650 hPa, reference seems difficult to improve with MWR
- around 600 hPa, good impact of QV-only experiments...
- ... is that enough to keep channel 2?



Recap Doppler lidar (DL)

- Doppler velocities → u & v winds with VAD retrieval
- 250 height levels, 50 m sampling



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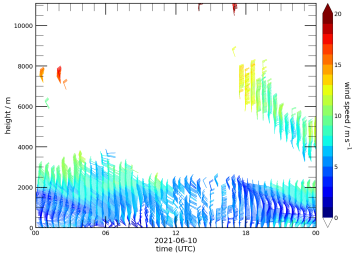

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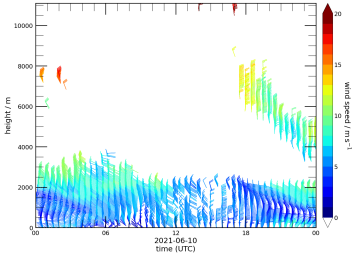
- inconsistent behaviour June vs. July 2021



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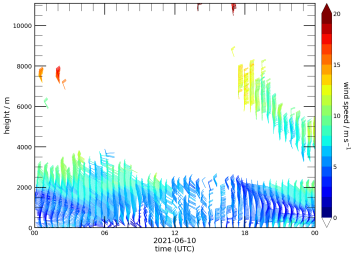
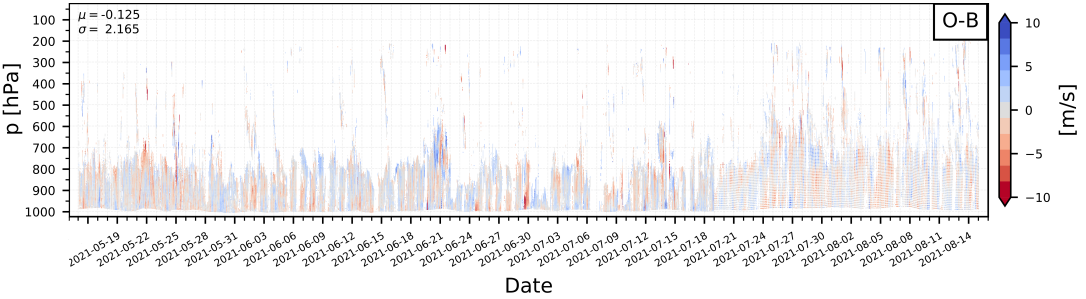
  ⇐ inconsistent instrument settings
  (coordinates, observing mode)



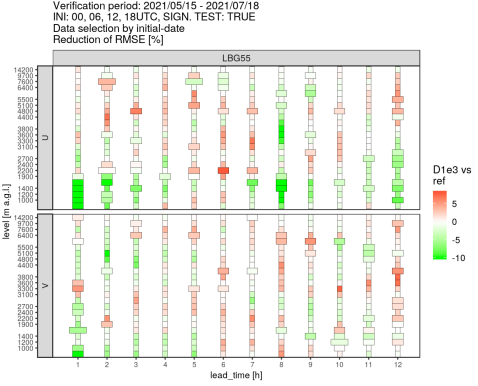


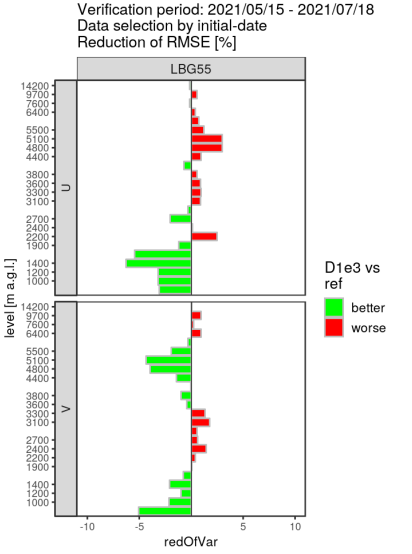
Forecast verification

- further tuned observation error

p [hPa]	1000	850	700	500	400	300	250	200
σ^2 [m/s]^2	1.3	0.9	1.9	2.1	2.5	2.7	2.9	3.0

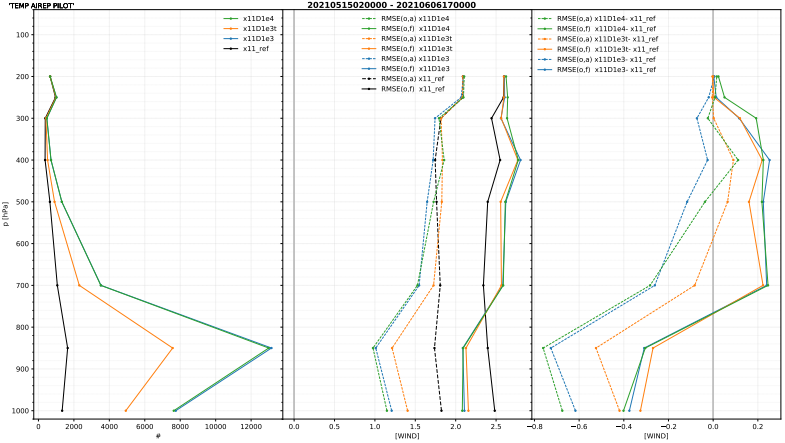
- verification against RWP only
- good impact for first few hours





More experiments

- no improvement with increasing observation error for > 500 hPa
- experiment with thinned observations still running



Conclusion

- longer experiments for both instruments
- more realistic verification

MWR
- height assignment
- observation & model clouds
- use of channel 2?

DL
- good impact for first few hours
- ongoing experiments with thinned observations