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Assimilation of Temperature and Humidity Profiles from a Raman Lidar

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thanks to Christoph Schraff (DWD) for support

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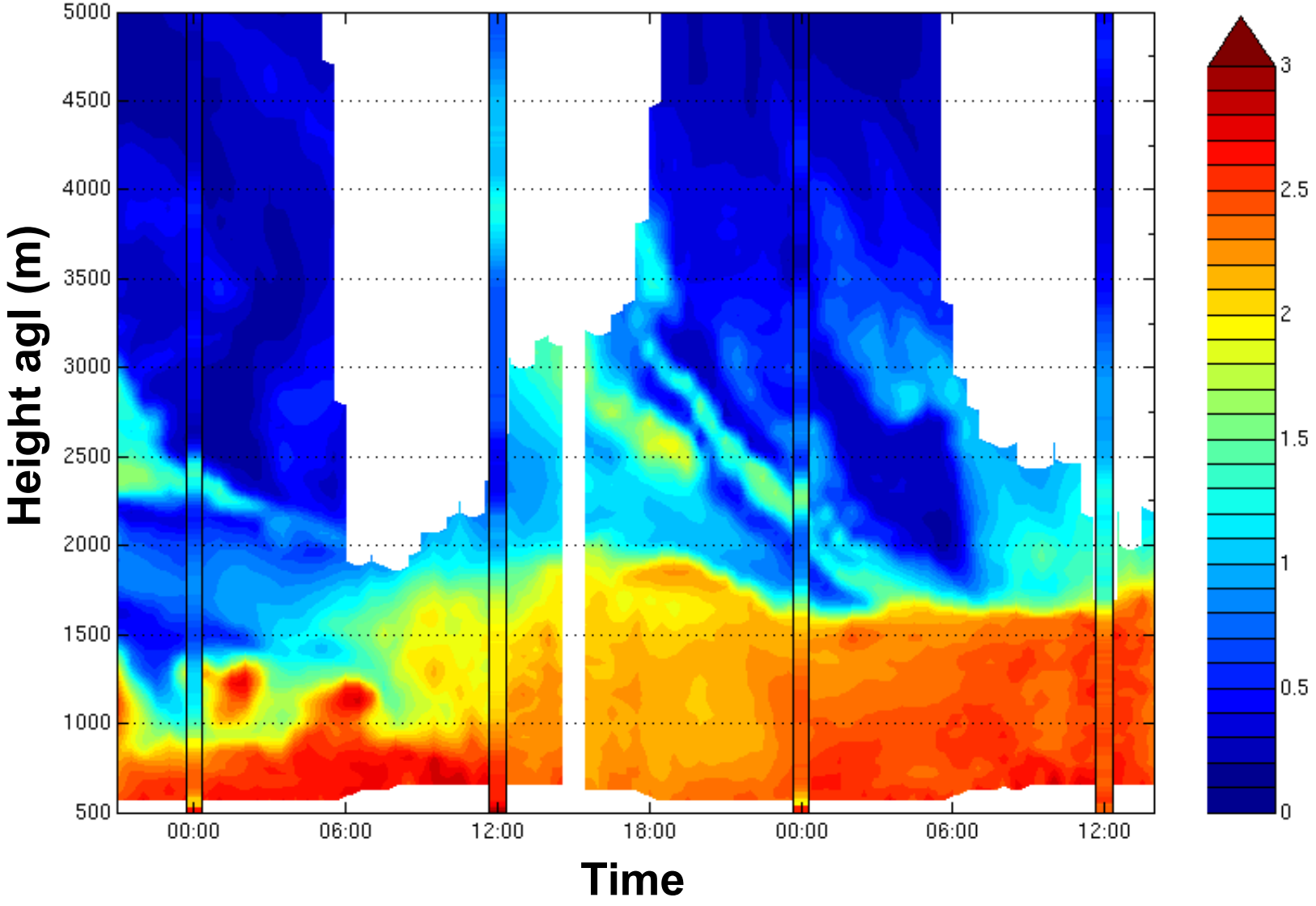
LMU Munich

Raman Lidar Humidity Profiles



Introduction

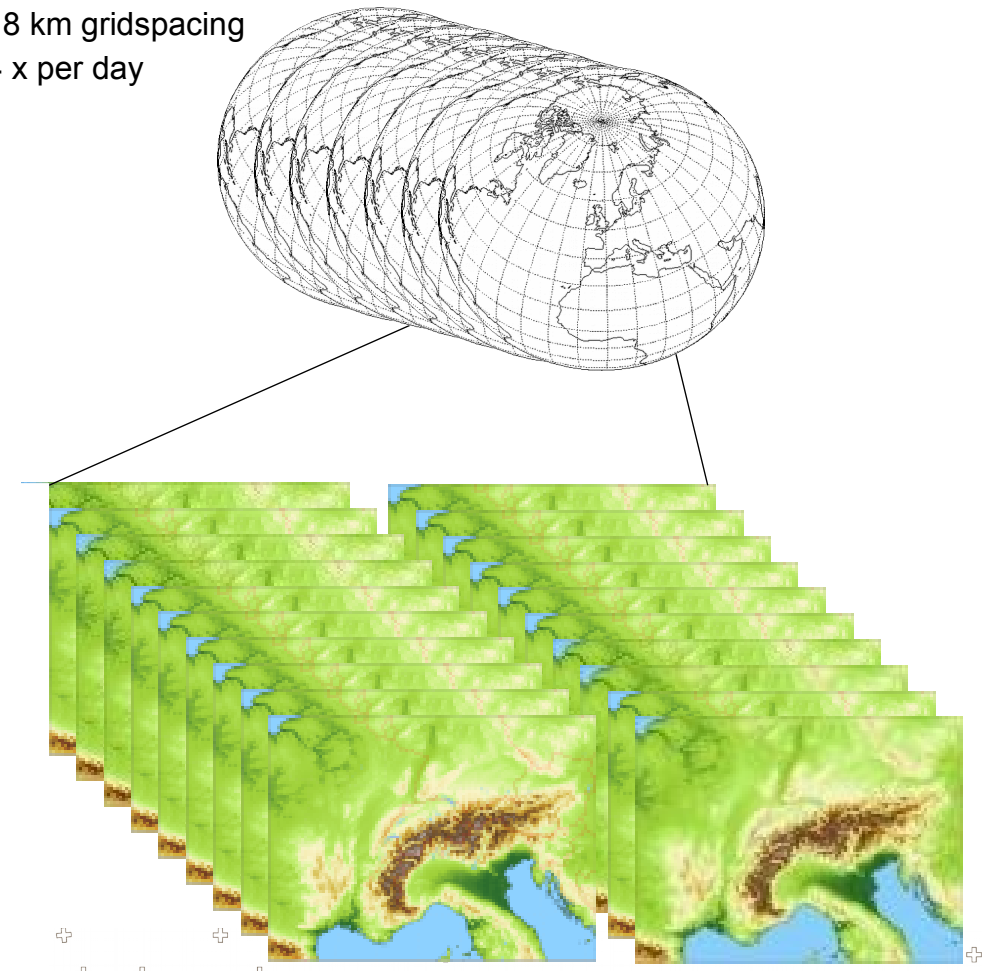
- Lack of temperature and humidity obs in PBL
- Raman Lidar can provide temperature and humidity profiles with high temporal and vertical resolution
- Investigate impact of Lidar profiles in the operational, convective-scale ensemble DA and NWP system of MeteoSwiss
- Two case studies: a convection and a low stratus case

The MeteoSwiss NWP and DA System

The NWP System

- COSMO Model
- 2.2km grid spacing
- explicit deep convection
- 21 member
- 2 forecasts per day to +120h

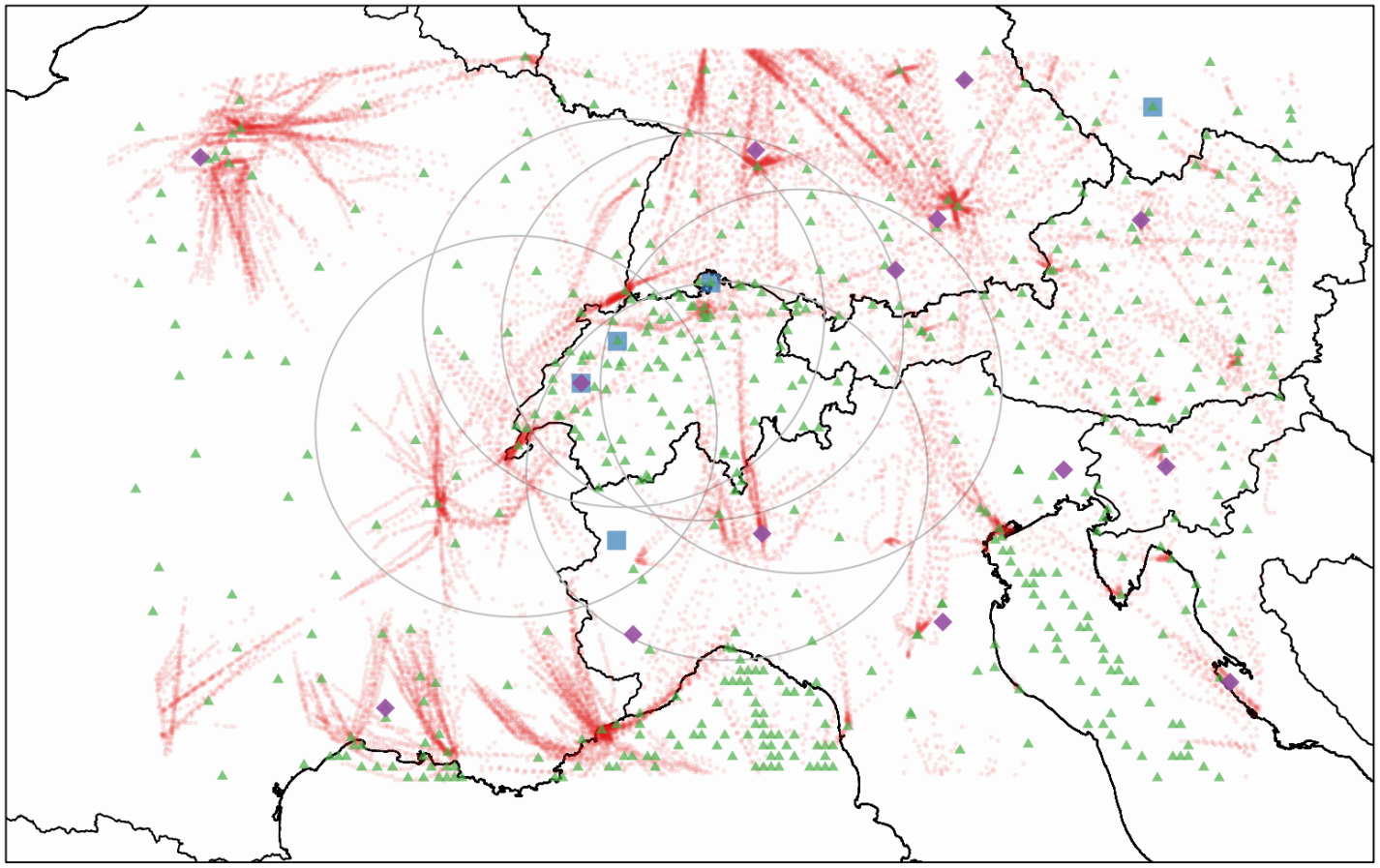
ECMWF-Model
18 km gridspacing
4 x per day



The DA System

- COSMO KENDA (Schraff et al., 2016)
- Based on LETKF (Hunt et al., 2004)
- 40 member
- Multiplicative and additive covariance inflation, RTPP

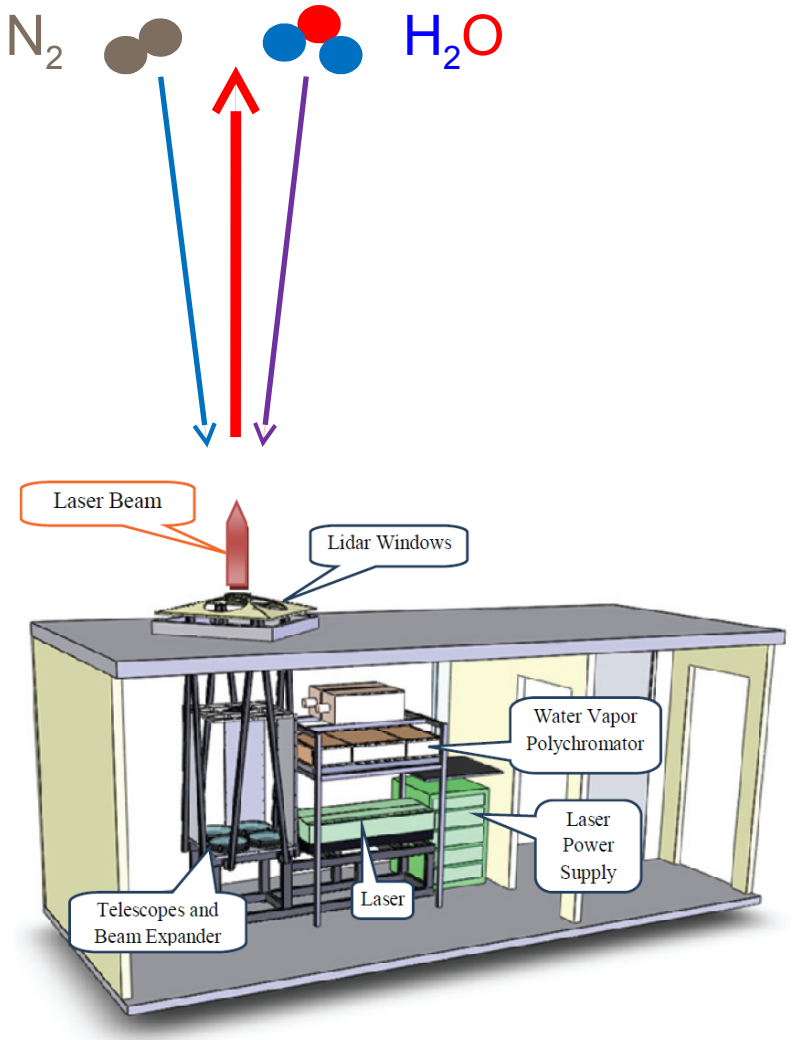
Assimilated Observations



Raman Lidar for Opr Meteorology: RALMO

Observation specifications

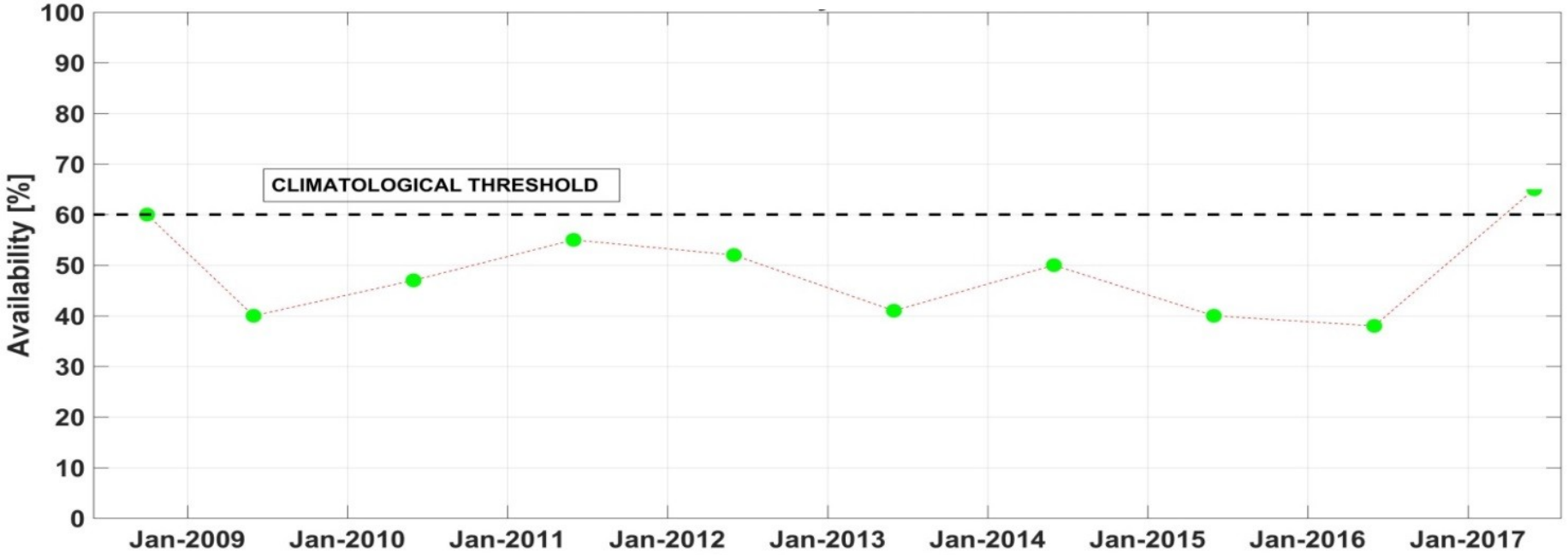
- Water vapor mass mixing ratio
- Temperature
- Time resolution: 30 min
- Vertical range (day / night): 60 – 5000 m / 10’000 m
- Vertical height bins of 30-300m
- Error: 10% WV MMR / 0.5 K
- 7/24 automatic operation



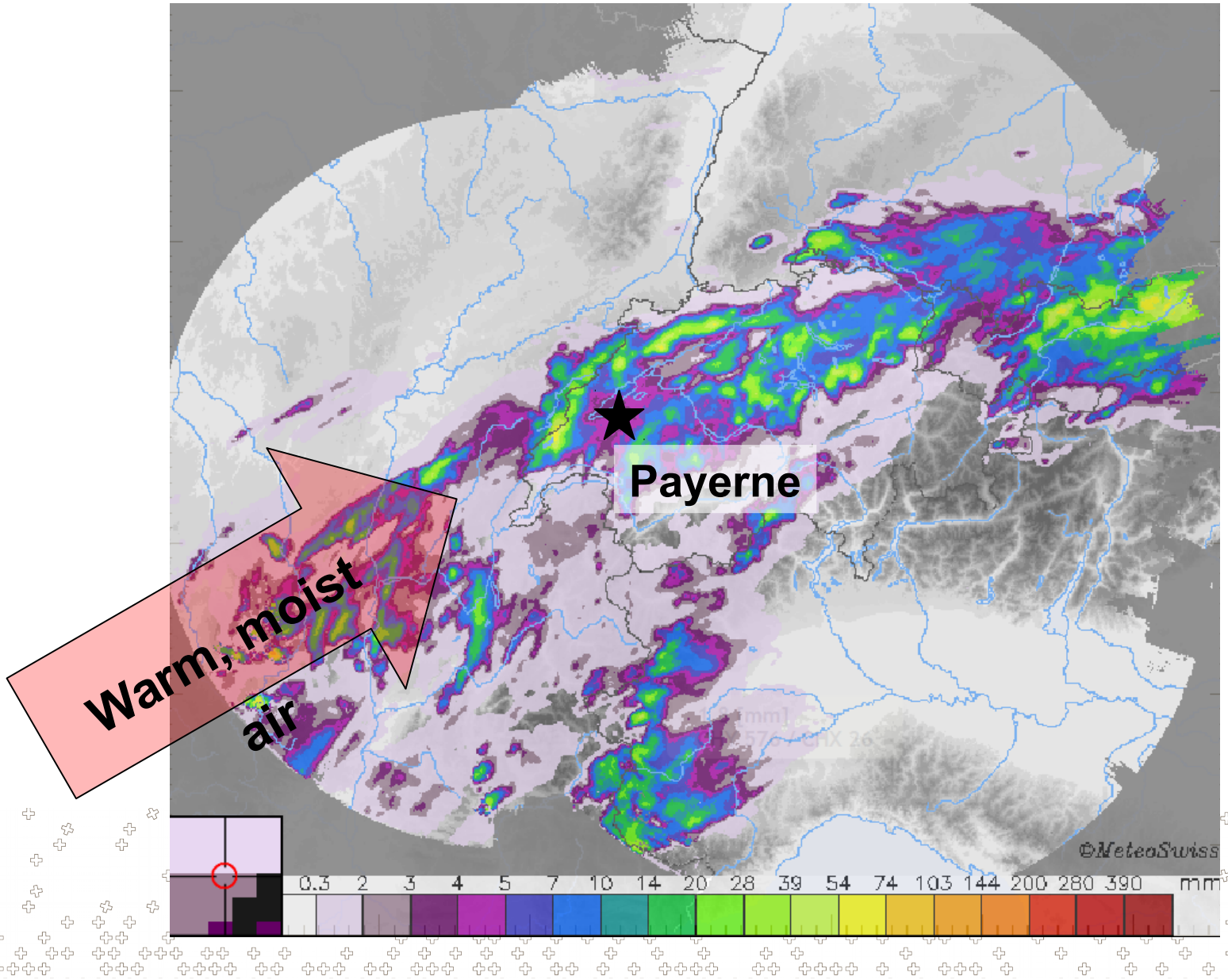
Availability of the Payerne Lidar Obs

Does not work in rain and low clouds

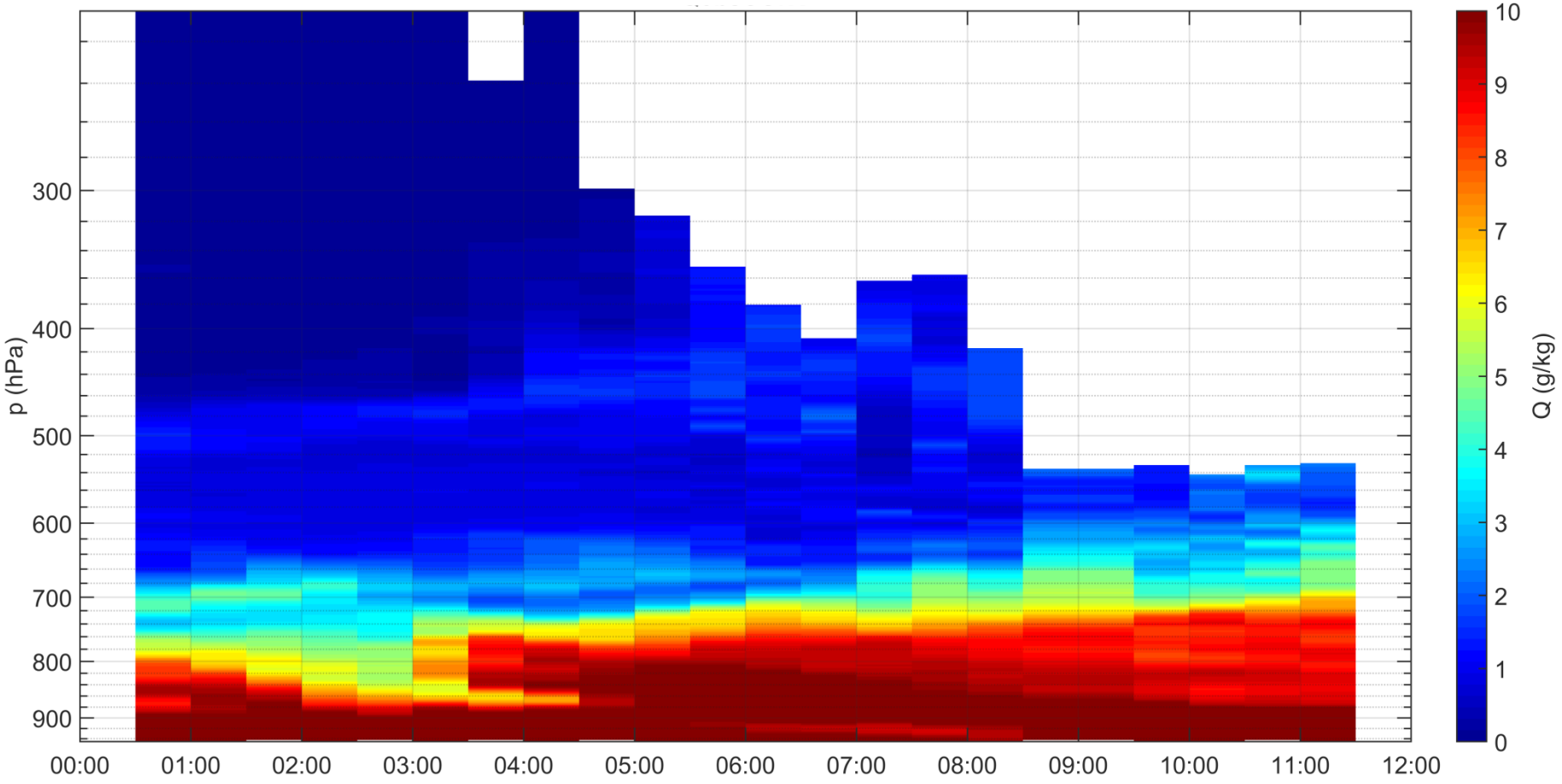
Climatological availability: 60%



Case study of 24.08.2017



Mixing Ratio observed by Lidar



Experimental Setup

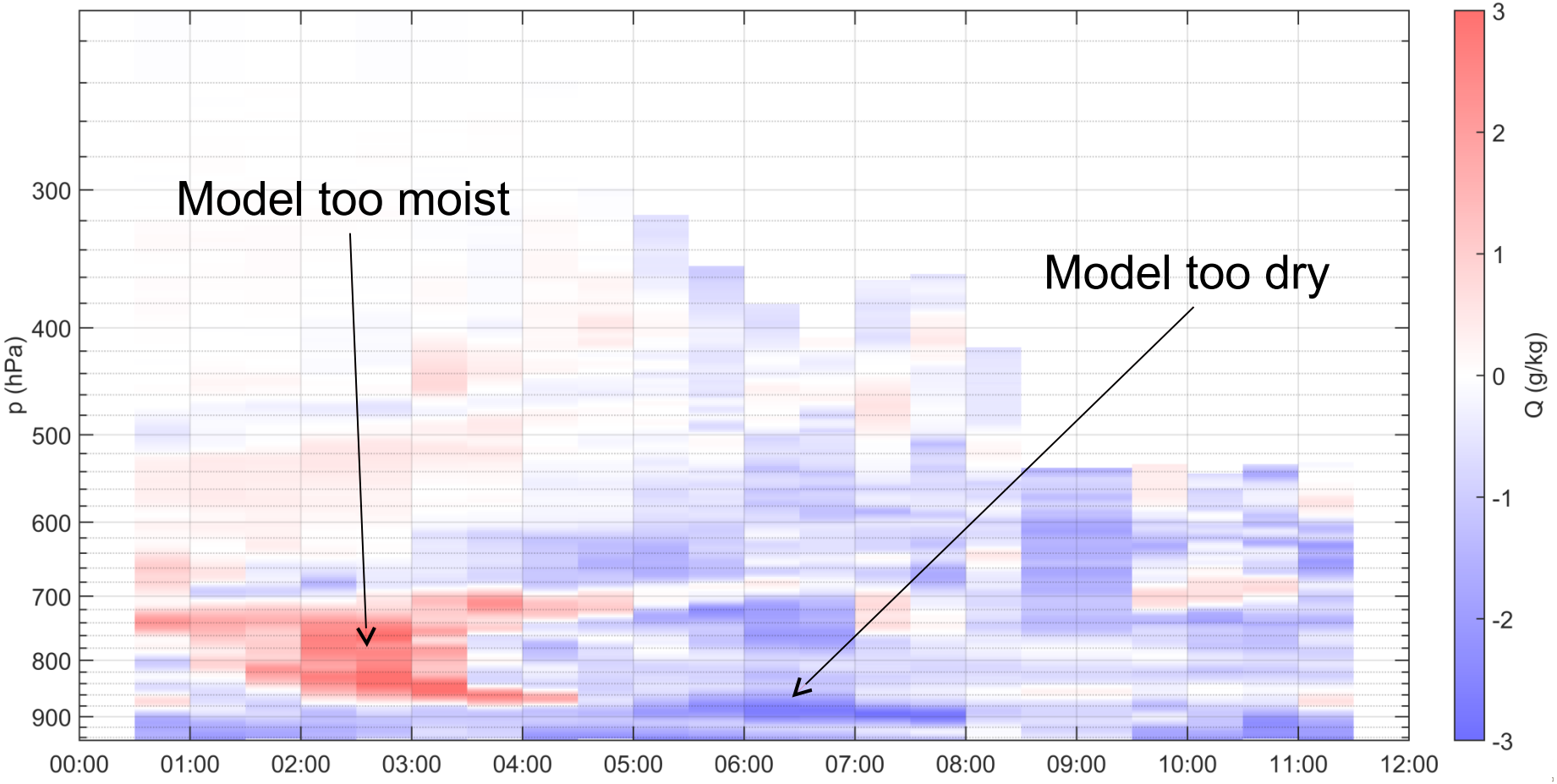
- KENDA assimilation from 00UTC to 12UTC
  - CONV (assimilation of conventional and Radar obs)
  - LIDAR (additional assimilation of Lidar T and RH profiles)

- COSMO-E forecasts (CTRL and ensemble) started at 12UTC from CONV and LIDAR analyses

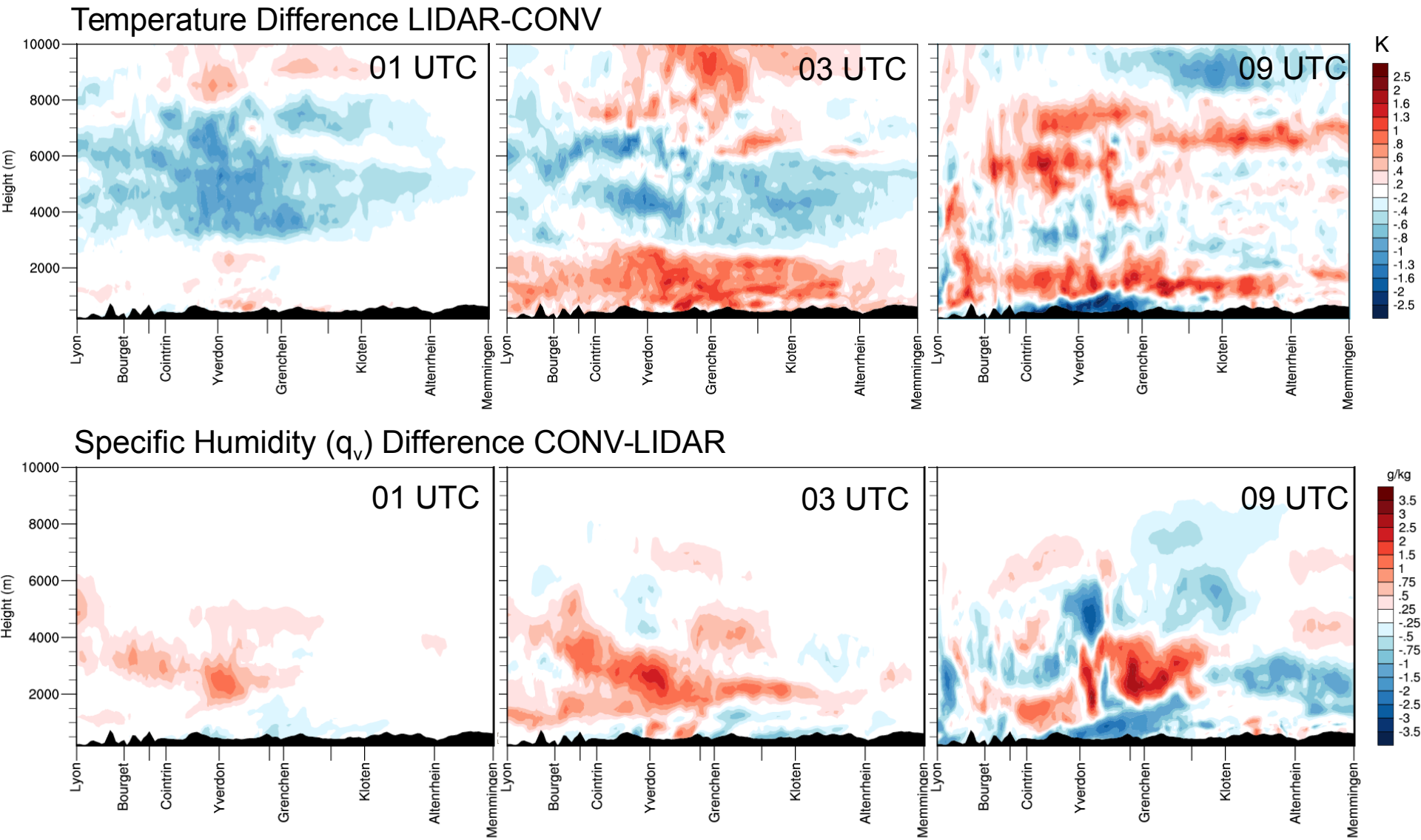
- CTRL forecast initialized by KENDA ensemble mean

CONV Analysis Mean vs Lidar Obs

Water vapour mixing ratio difference

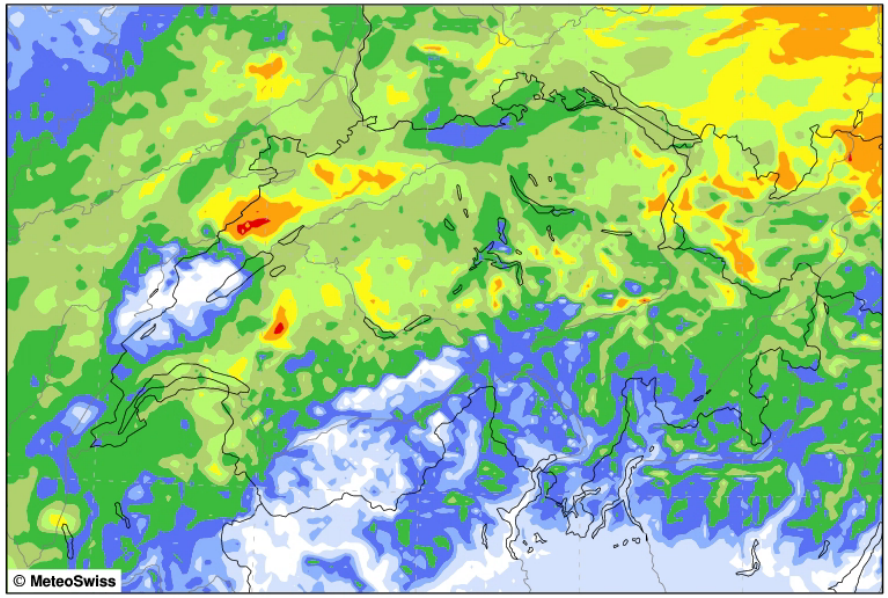


Effect of Lidar Obs on Analysis Means

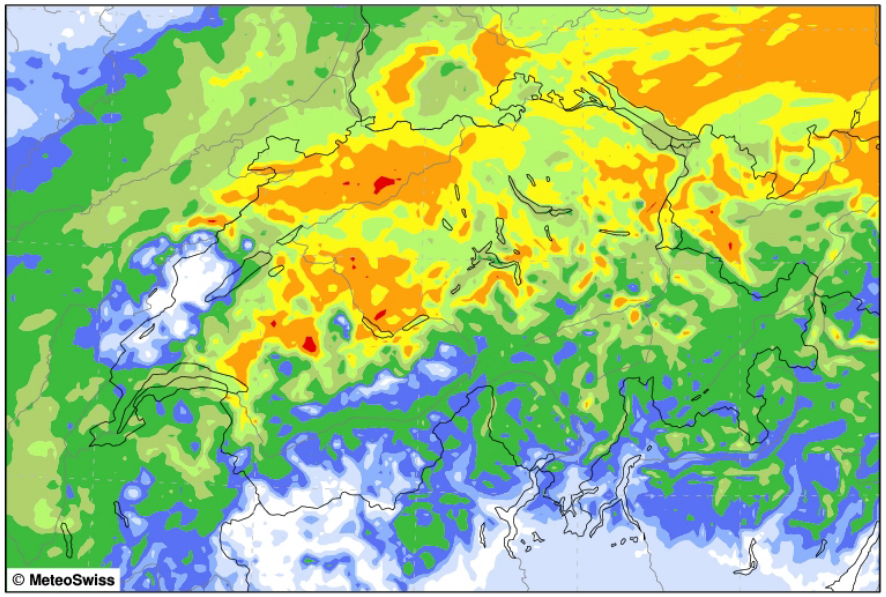


Pre-convective Environment

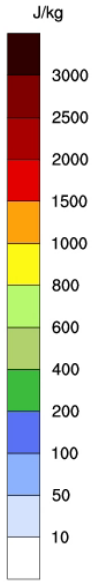
CAPE of Analysis Means valid at 12UTC (IC of forecasts)



CONV



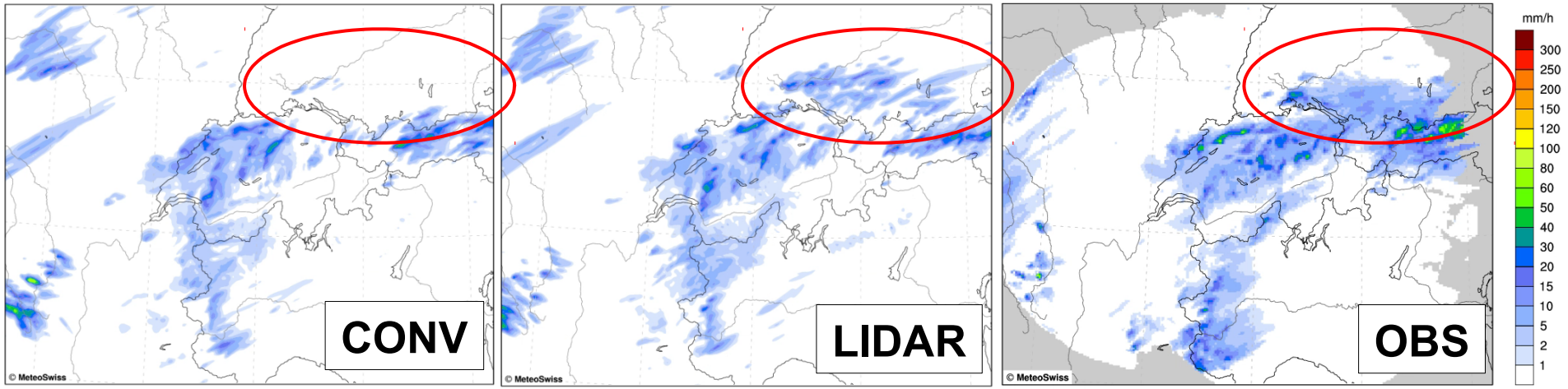
LIDAR



Precipitation Forecasts

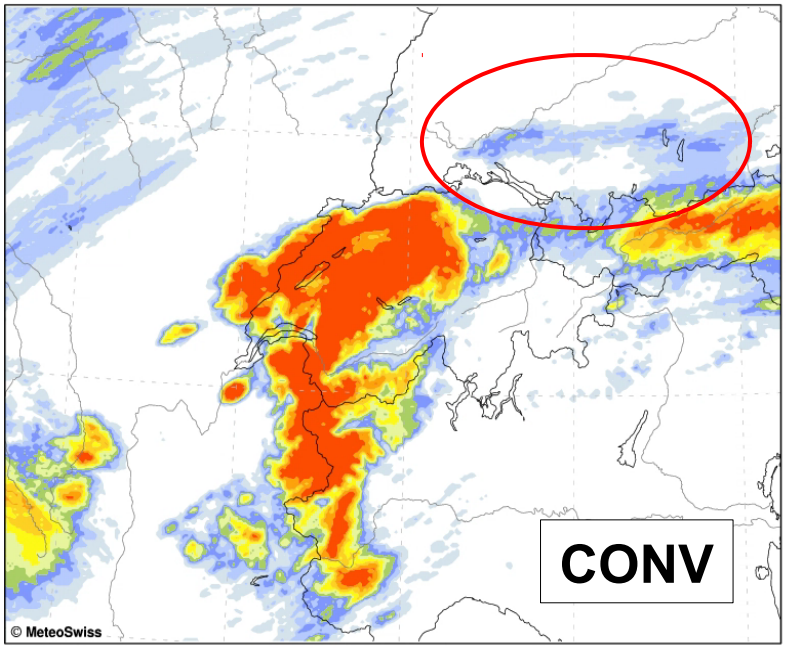
Deterministic CTRL Forecasts initialized at 12UTC

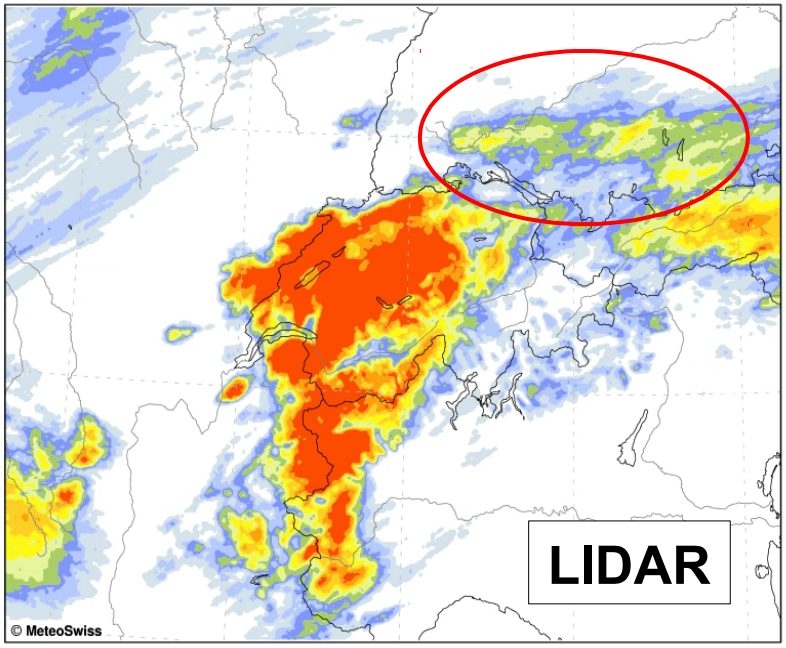
24h Precipitation sums ending at 25.08.2018 12UTC

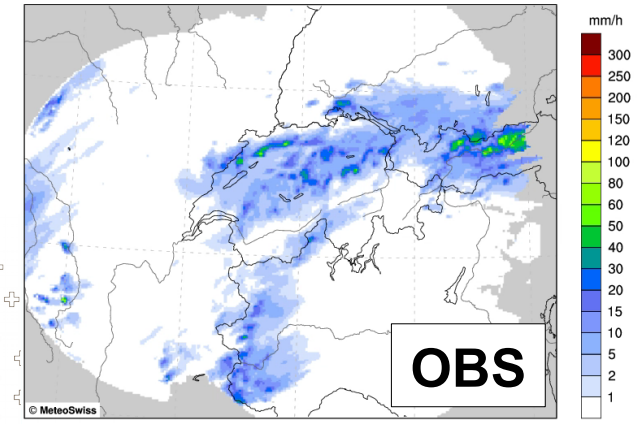


Precipitation Forecasts

Probability that 24h precipitation sum exceeds 1mm

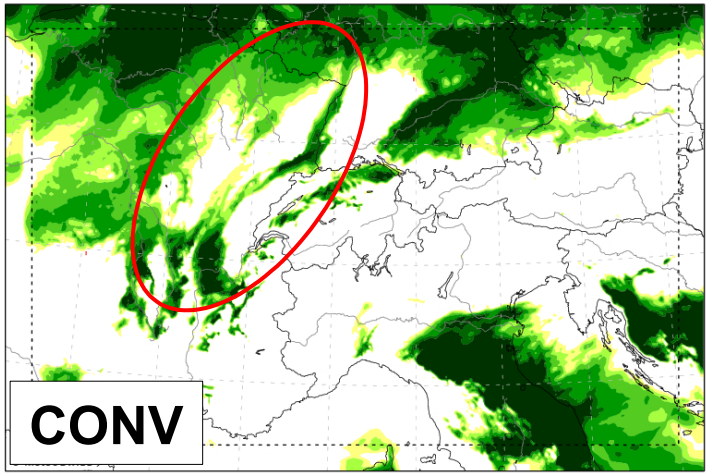


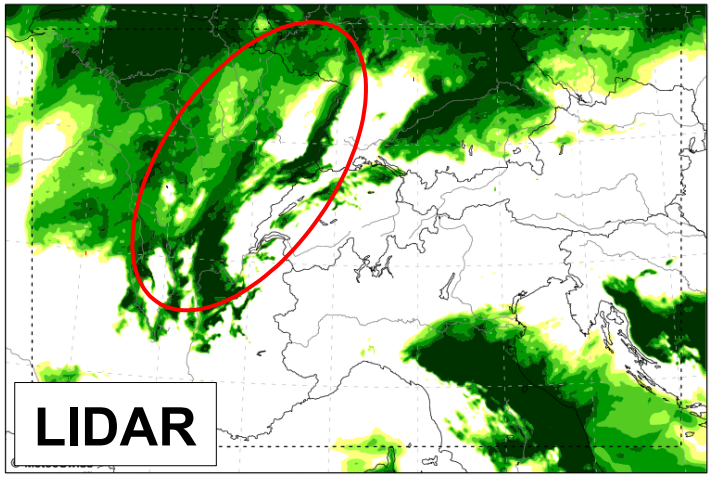


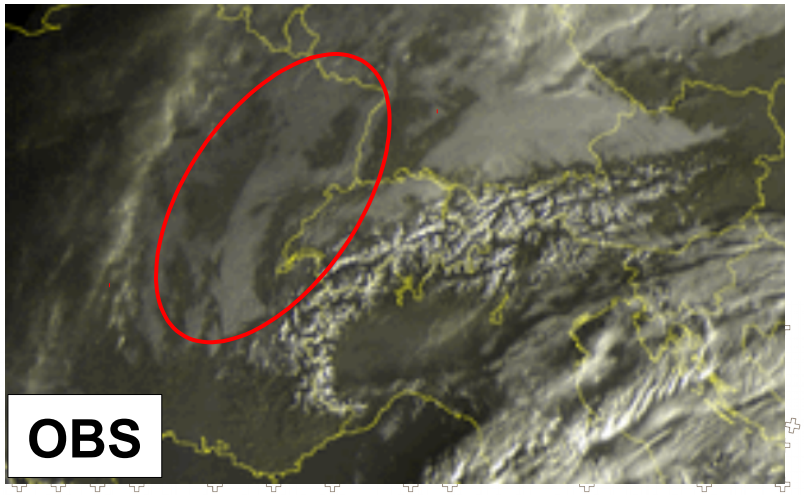


Effect of Lidar Obs on Low Clouds

Analysis means of low clouds versus SEVIRI VIS
15.11.2017, 07UTC







Summary

- Raman Lidar observations close a gap in PBL observation system
- Continuous temperature and humidity profiles from Lidar in Payerne (avg availability of 60%)
- Quality approaching that of radiosonde observations
- Successful assimilation with COSMO KENDA for a convection and low stratus case
- Lidar obs successfully adjusted the pre-convective environment, allowing for a more skillful precipitation forecast
- Impact smaller for the low stratus case

Outlook

- Extend assimilation experiments to longer periods
- Introduce new observation type in COSMO KENDA
- Adjust horizontal localization (smaller radius?)
- Adjust observation error