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Observation minus Background Statistics for Humidity and Temperature from Raman lidar, microwave radiometer and COSMO-2

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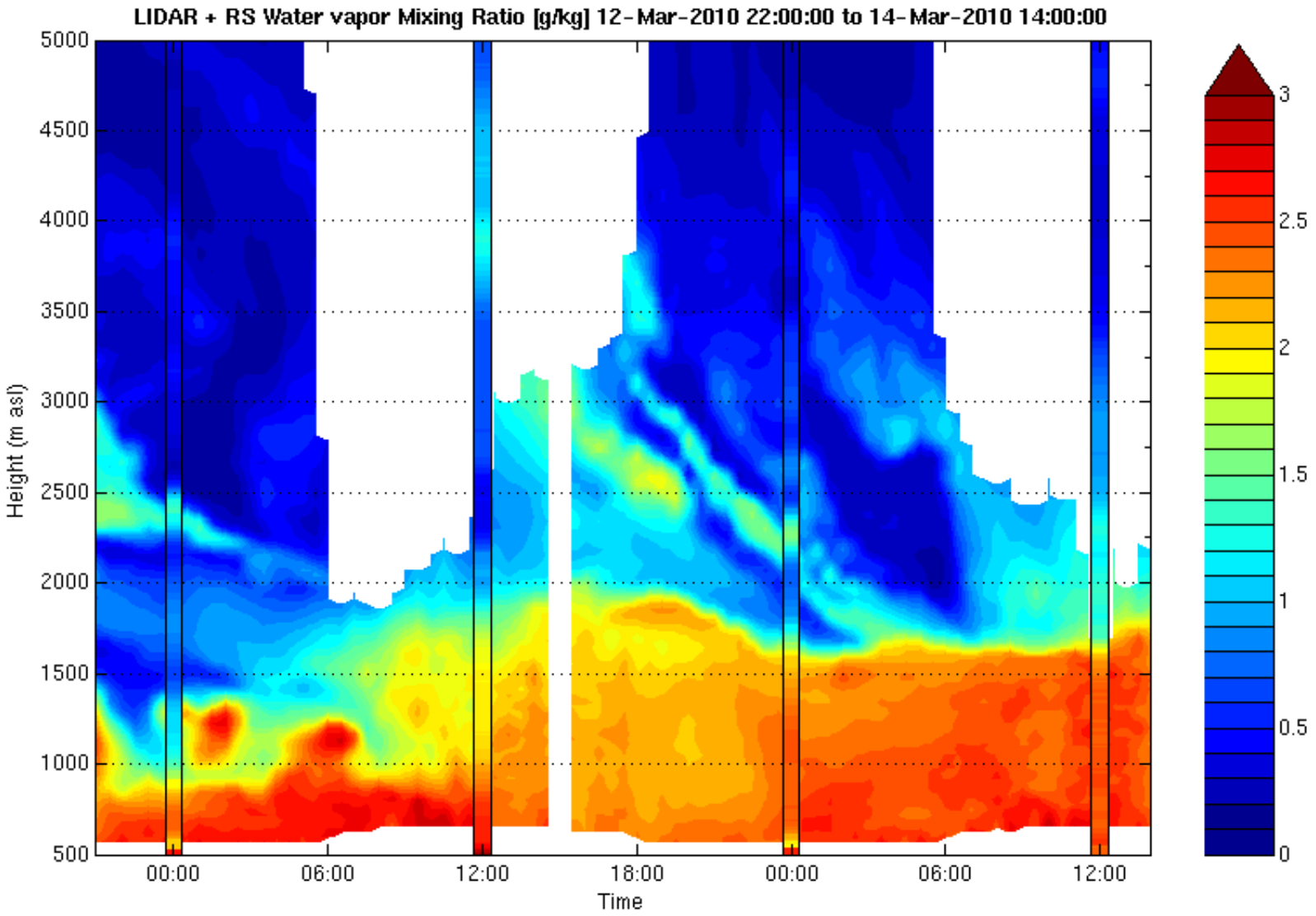
Introduction

- Need for additionals PBL observations, particularly Temperature and Humidity
- Water vapour Raman Lidar and Microwave Radiometer are candidates for high-frequency PBL observations
- Investigate potential for assimilation
- Examine obs – background statistics of one year of observations in Payerne

Water Vapour Raman Lidar

- Active instrument
- Emits pulses of light and measures backscattered light
- Backscattered signal is proportional to the number of scattering molecules
- Mixing ratio q=C*Swv/Sn
  - Swv: signal from water vapour
  - Sn: signal from nitrogen
- Constant C is determined by fit with Radiosonde data

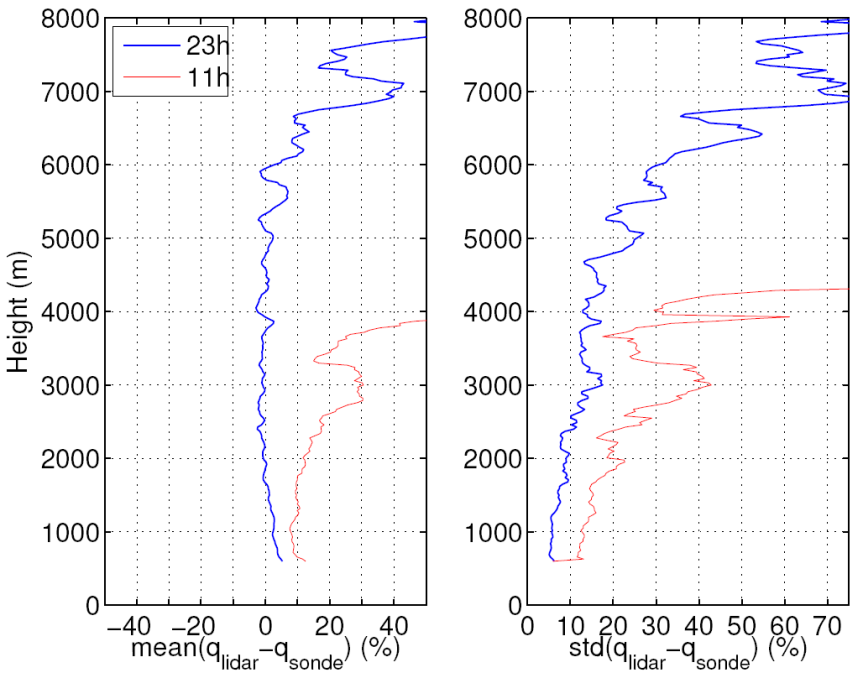
Continuous Observations

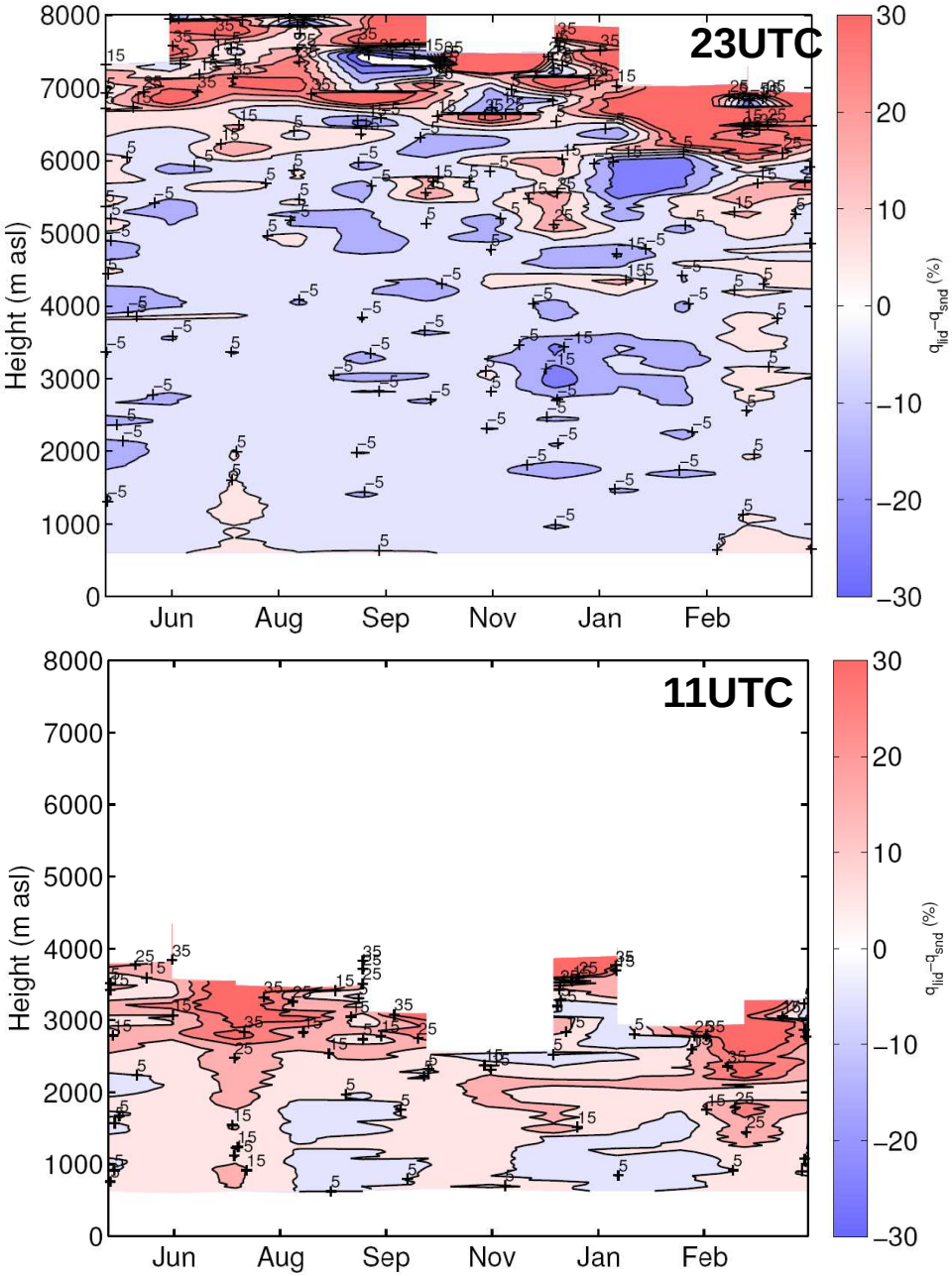


Water Vapor Raman Lidar Network

Non-exhaustive list!

Validation with Radiosonde

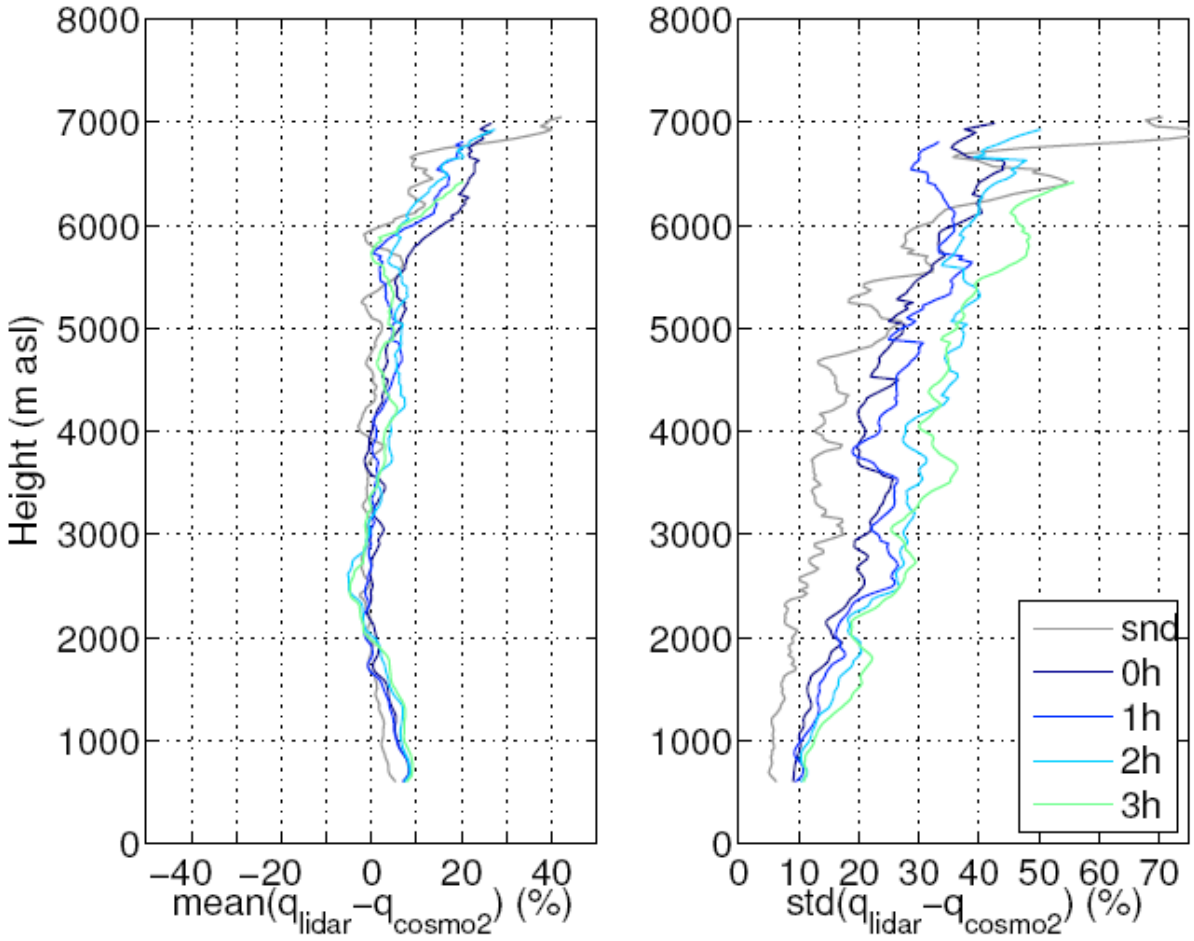




- Agreement with RS within 5% for nighttime
- Wet bias of 10-20% during daytime
- Daytime bias varying with season

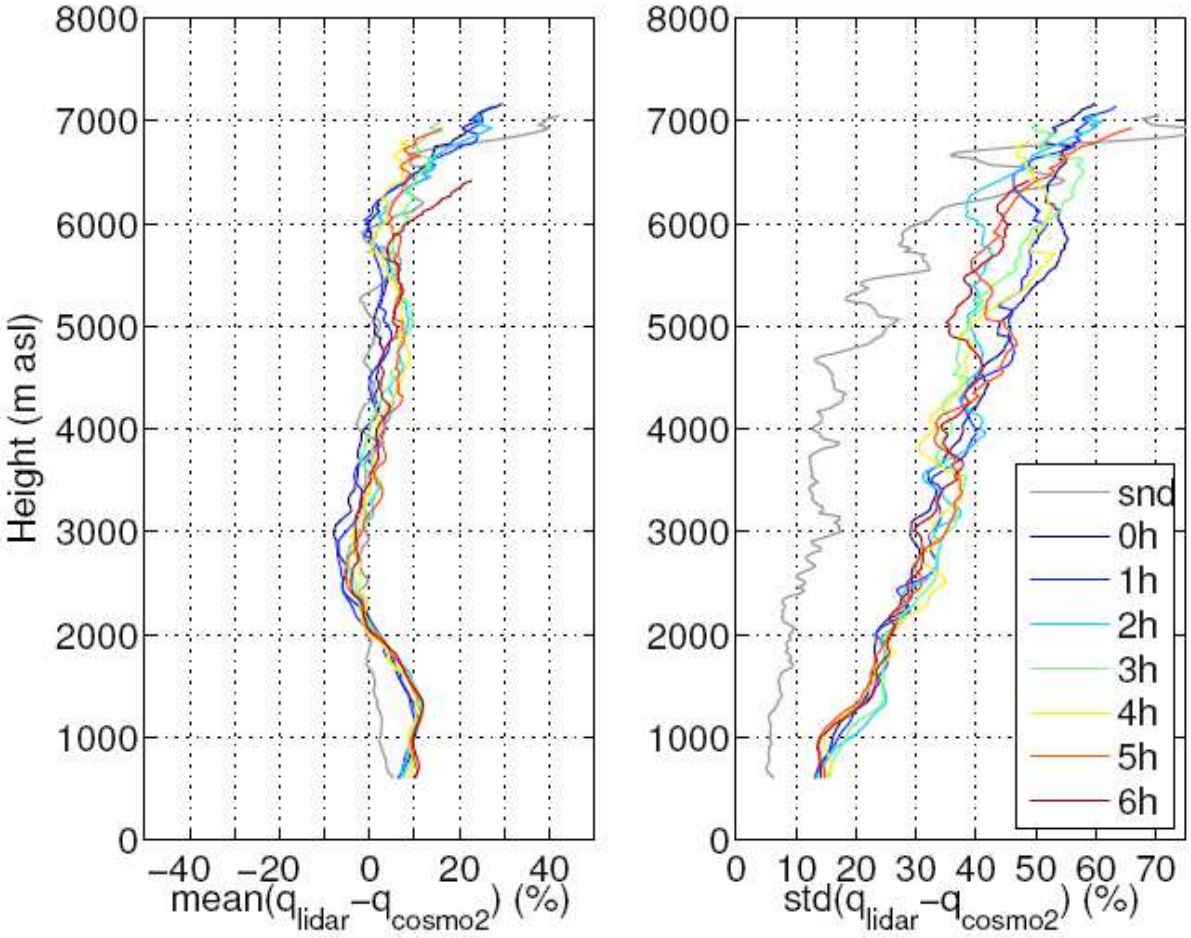
Comparison against 00UTC COSMO-2

- 00UTC Payerne Radiosonde assimilated
- Humidity obs information is 0-3h old



Comparison against 21UTC COSMO-2

- 12UTC Payerne Radiosonde assimilated
- Humidity obs information is 9-15h old



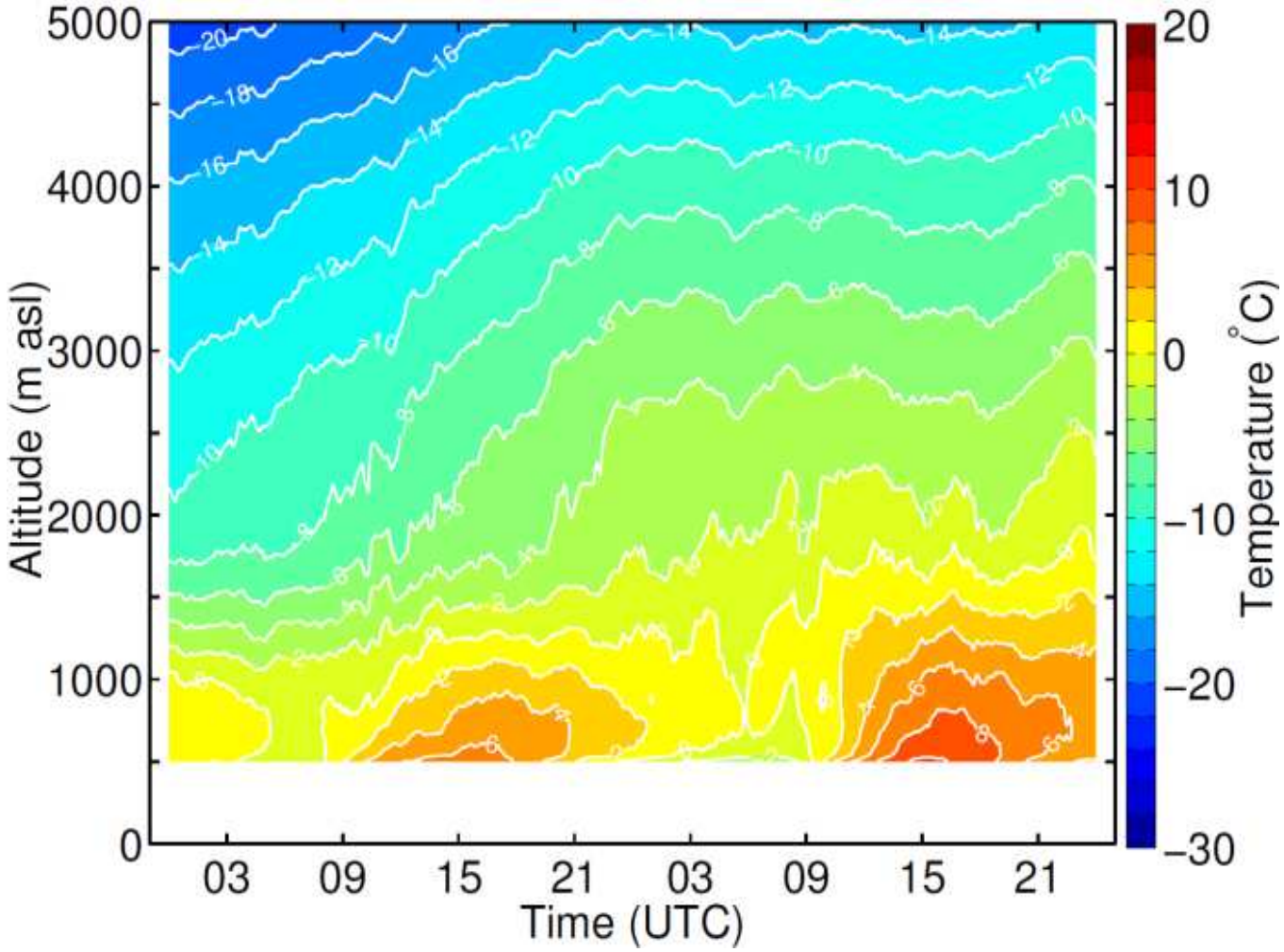
Summary: Humidity

- Nighttime lidar observations of comparable quality as radiosonde
- Daytime data excluded due to variable bias
- Bias of analysis and forecasts < 10% for z < 6km
- Std of analysis is 10% @ 1km and 30% @ 5km
- Std of forecasts increases to asymptotic value after 3 hours
- Std of forecasts is 20% @ 1km and 40% @ 5km
- No evidence of humidity information update for assimilation cycles different from 00/12UTC -> all information comes from radiosounding (at Pay!)

Microwave Radiometer

- Passive Instrument
- Measures the thermal radiation (or brightness temperature) of the atmosphere, similar to the microwave channel of a satellite sensor.
- Retrievals of temperature profiles are routinely done at Payerne using quadratic regression with radiosonde data
- We examine retrieved temperature profiles, but ultimately, a direct assimilation of brightness temperatures should be envisaged.
- Work on an observation operator using the RTTOV radiative transfer model is under way

Continuous Observations in the LT

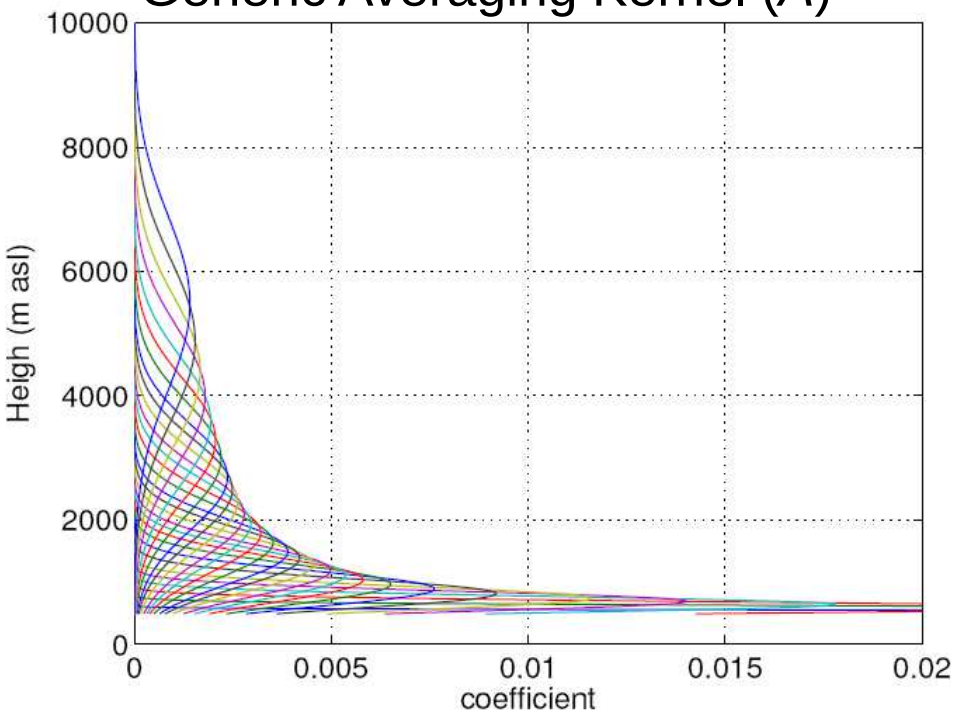


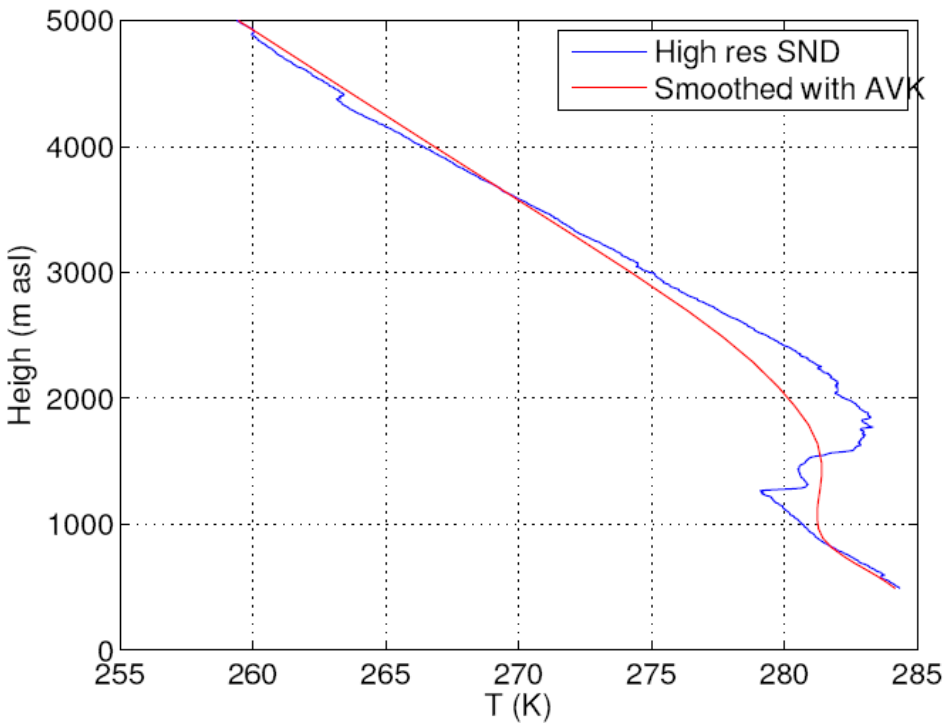
Microwave Radiometer Network

[MWRnet]

Observation Operator

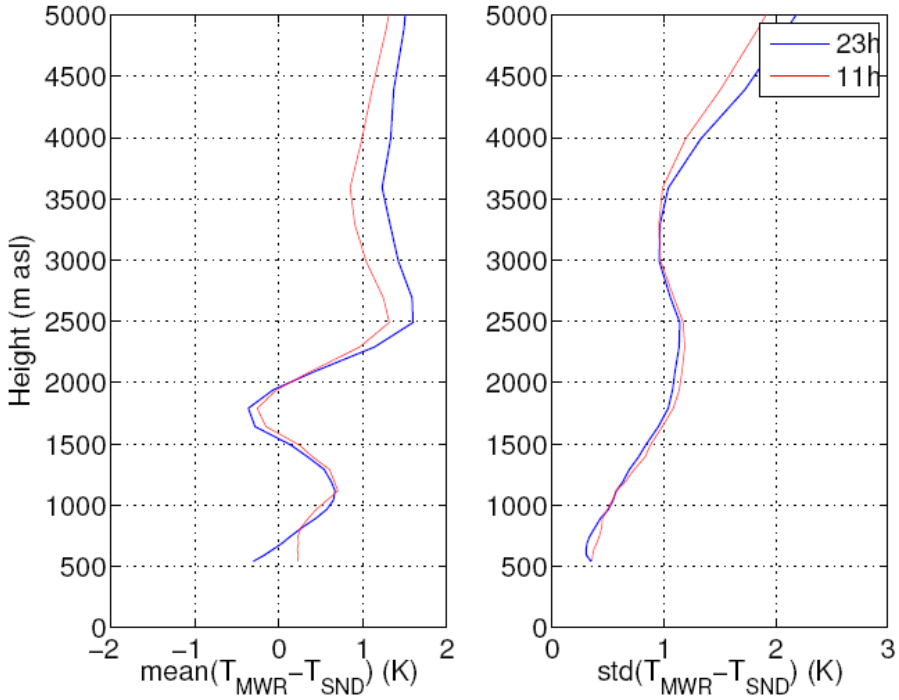
Generic Averaging Kernel (*A*)



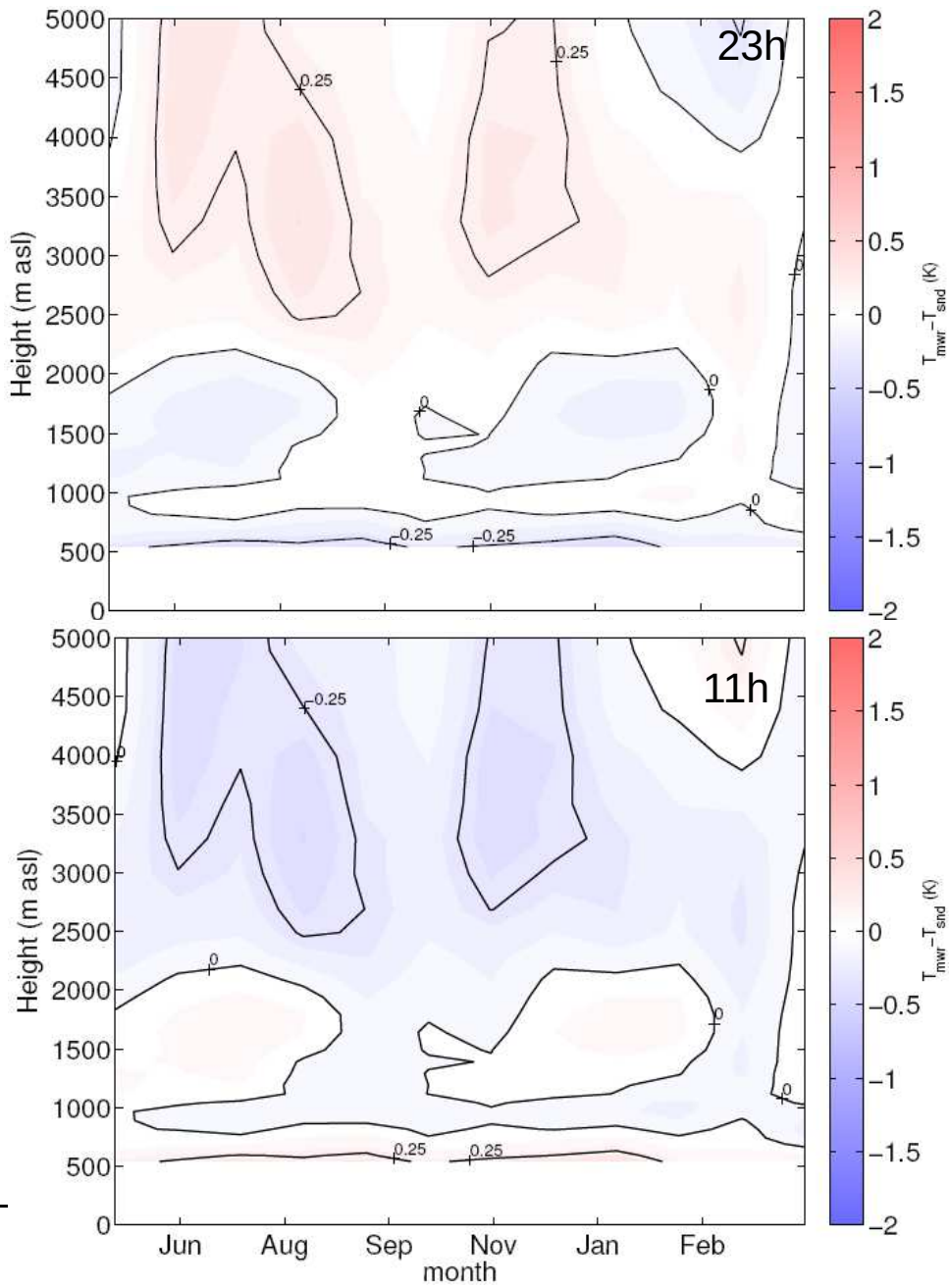


$$H(x) = A * x$$

Validation with Radiosonde

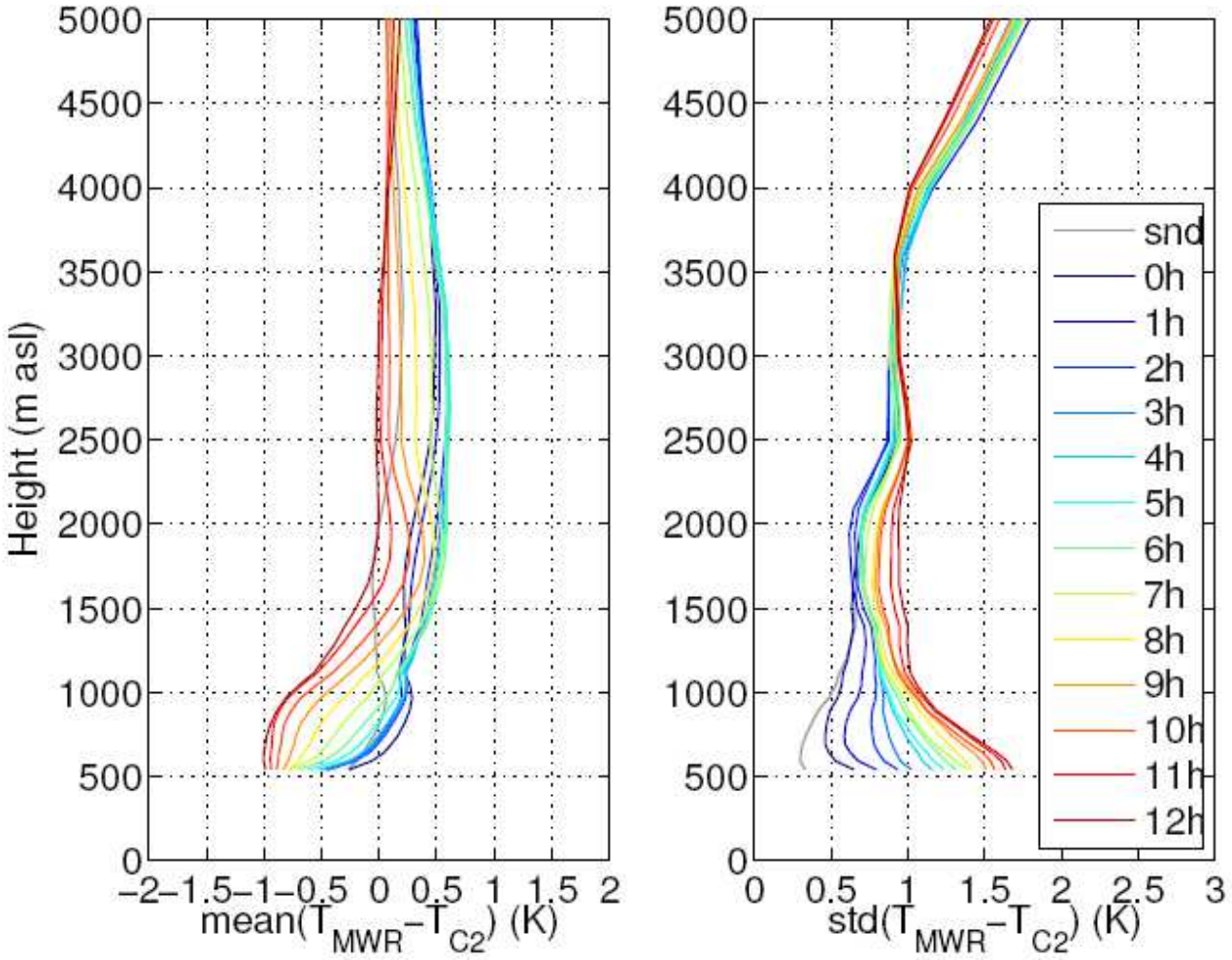


- One bias correcton has been applied for day and night
- Corrected MWR data: Bias < 0.25K for z < 2500 m asl



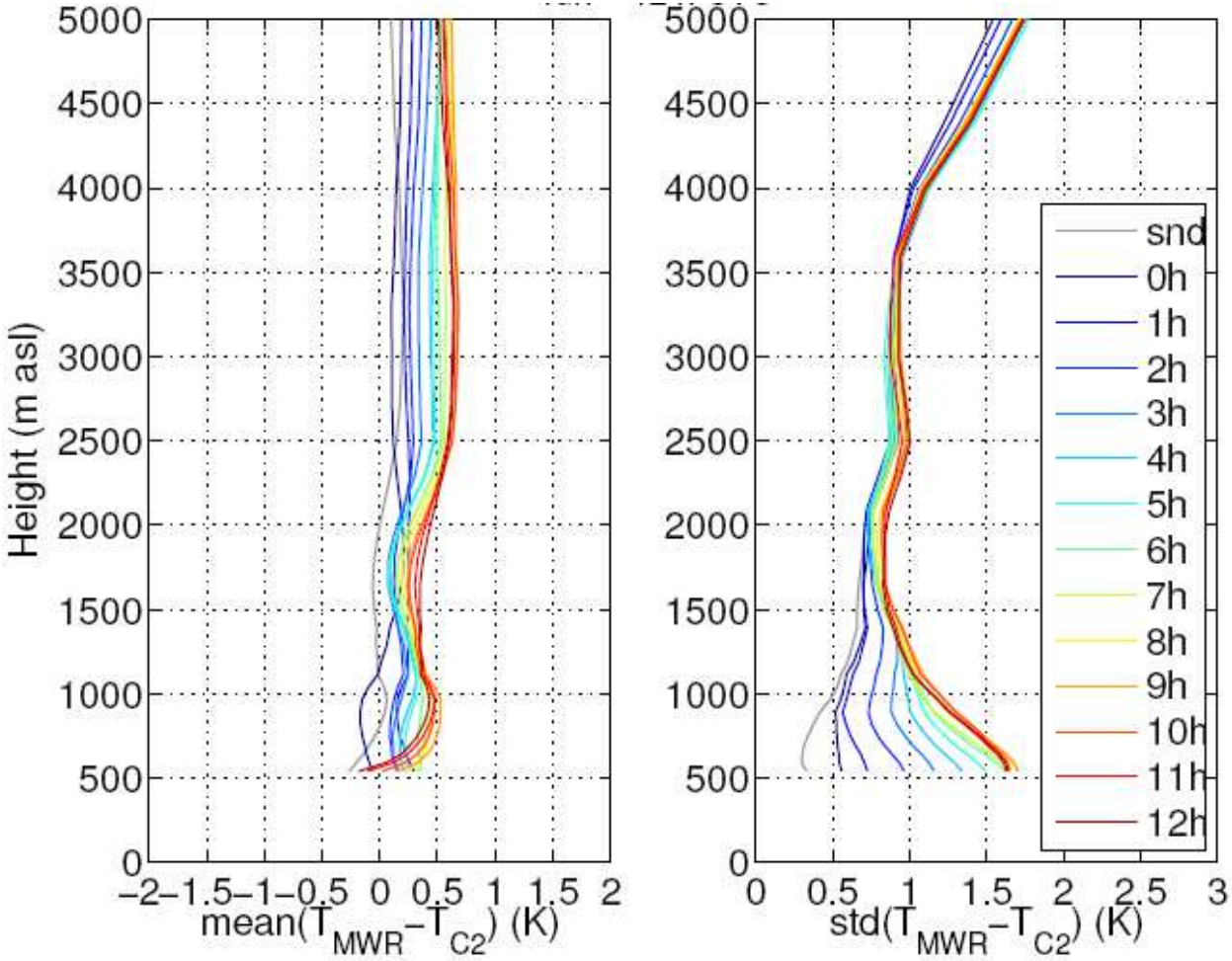
Bias and Std versus COSMO-2

- 00UTC Payerne Radiosonde assimilated
- Temperature obs information from TEMP is 0-12h old



Bias and Std versus COSMO-2

- 00UTC Payerne Radiosonde assimilated
- Temperature obs information from TEMP is 6-18h old



Summary: Temperature

- MWR data require observation operator and bias correction
- Corrected data is of good quality with std<0.75K for z<2000 m asl
- The MWR does not provide significant amount of information above 2500 m asl
- Analysis is of comparable quality as observation
- Analysis shows a cold bias of up to 0.5 K for z<5km
- There is evidence for updated temperature information for runs different from 00/12UTC -> not all information comes from radiosondes (at Pay!)

Conclusion and Outlook

- Raman lidar and MWR fill important gap in observing system
- Raman lidar and MWR have very clearly the potential to improve high resolution NWP
- MeteoSwiss is in a unique situation with Raman lidar and 3 MWR network (CN-MET) and should make use of existing data for NWP
- Next: Assimilation of temperature and humidity retrievals, eventually direct assimilation of brightness temperatures from MWR
- Collaboration with new Hans Ertel Zentrum for Boundary Layer Meteorology at University of Frankfurt and DWD (Jürg Schmidli and Annika Schomburg)

Thank you!