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METEOSSWISS RAMAN LIDAR PRESENT AND FUTURE ACTIVITIES

10th GRUAN Implementation and Coordination Meeting

G. Martucci¹, V. Simeonov², L. Renaud¹, , Fran Navas-Guzman¹, Jordan Voirin¹, Shannon Hicks³, Sham Gamage³, Bob Sica³, Bertrand Calpini¹ and A. Haefele^{1,3}

¹ Office Fédérale de Météorologie et Climatologie, MeteoSuisse, Payerne, Suisse

² EPFL, École Polytechnique Fédérale de Lausanne, Suisse

³ Department of Physics and Astronomy, The University of Western Ontario, London, Canada

10th Implementation and Coordination Meeting in Potsdam, DE, 23 to 27 April 2018

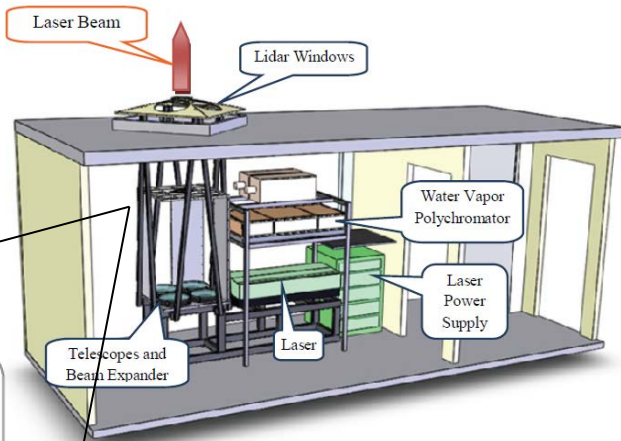
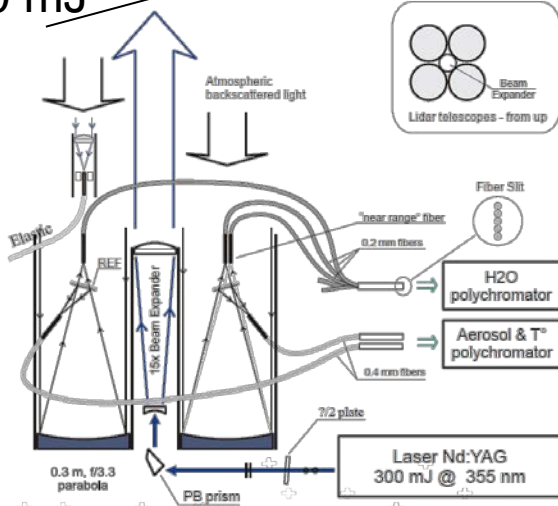
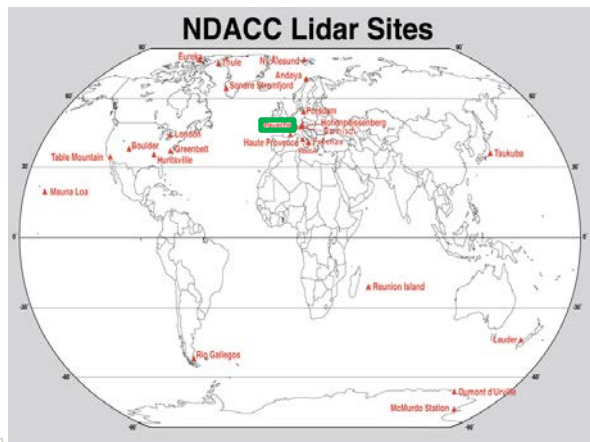
G. Martucci

Outline

- Automatic operations and availability
- LIDAR operational calibrated measurements
 - Tropospheric PRR temperature
 - Tropospheric Raman Water Vapour
- Aerosol hygroscopicity
- PRR temperature climatology in the UTLS
- Raman Water Vapour climatology in the UTLS
- Future activities: OEM retrieval

The Raman Lidar for Meteorological Observations - RALMO

- Operated in Payerne, Switzerland
- Since 2008
- Fully automatic Raman lidar
- Day and nighttime operation
- Narrow FOV and bandwidth
- High laser-pulse energy, 450 mJ



Automatic Operations 24/7

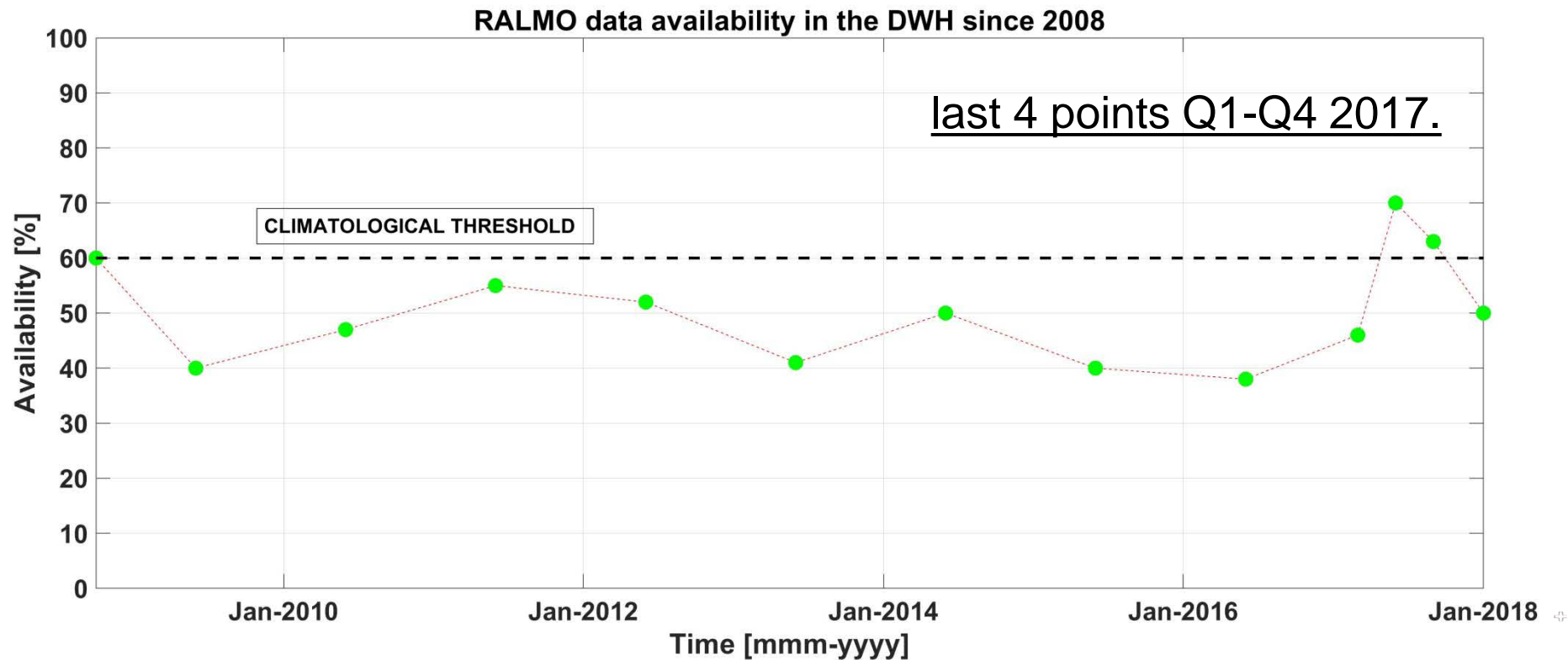
Weekly	Monthly	6 Monthly	Yearly
Cleaning	Flash lamp exchange after 40 M shots	Litron maintenance	Air conditioning
Raw data archiving	telescopes alignment		Cooling system
Energy measurement (before beam expander)	Energy measurement (after beam expander)		Cleaning of telescopes

Change in 2018: Litron LPY7000 Nd:YAG laser systems



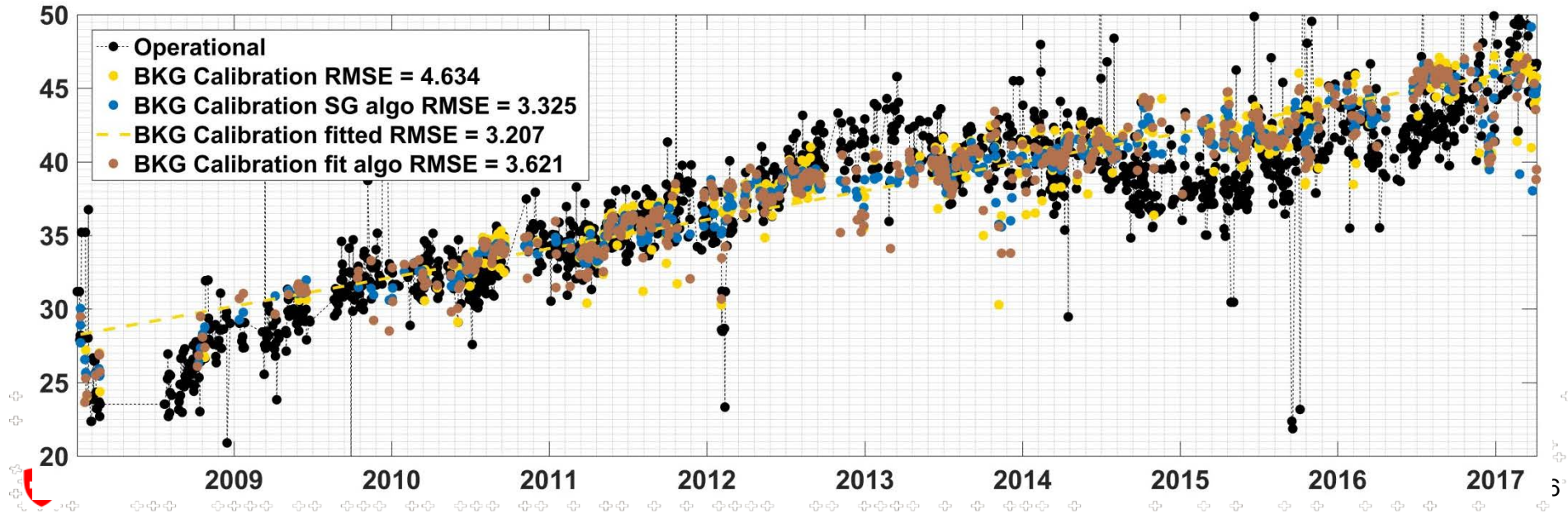
Wavelength	355 nm
Rep. Frequency	30 Hz
Energy @355 nm	450 mJ
Pumping	flashlamps
Operational	yes

RALMO data availability



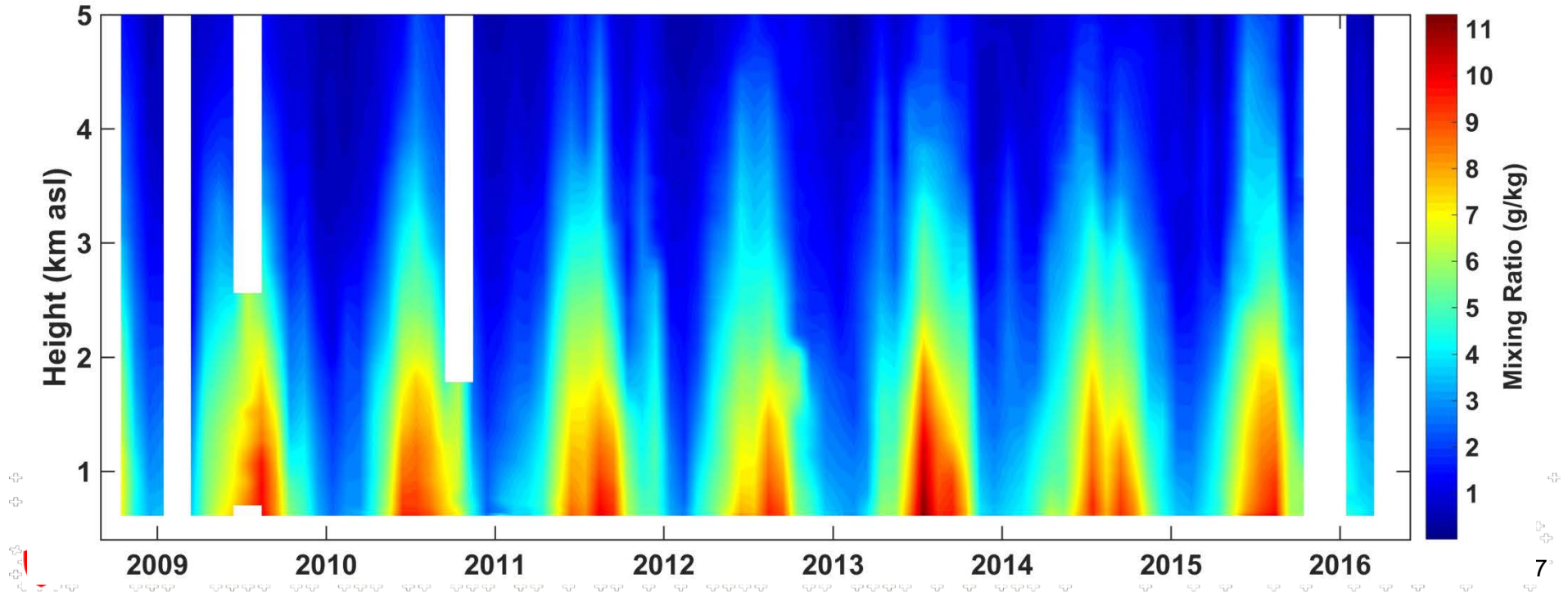
Solar background calibration

- The procedure to calibrate the RALMO water vapor mixing ratio (ω) consists of the daily automatic correction of the calibration factor C obtained by radiosounding at time t_0 .
- The correction of C is based on an automatic monitoring of the differential aging of the N_2 and H_2O PMTs using the solar background.
- **The $C(t)$ factors obtained using the BKG show an excellent agreement with the $C(t_0)$ factors within 10% and provide the possibility to characterize RALMO along the entire dataset (9 years) with only one radiosounding calibration (initialization).**

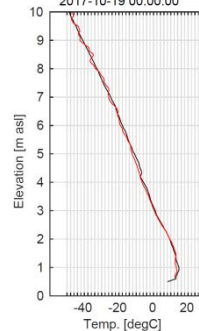
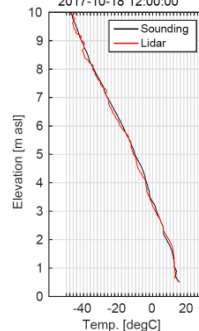
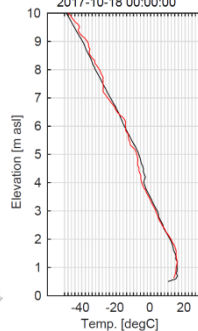
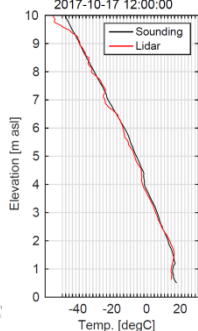
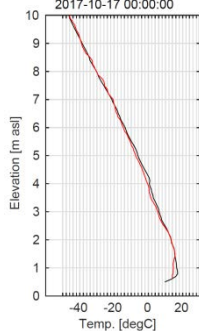
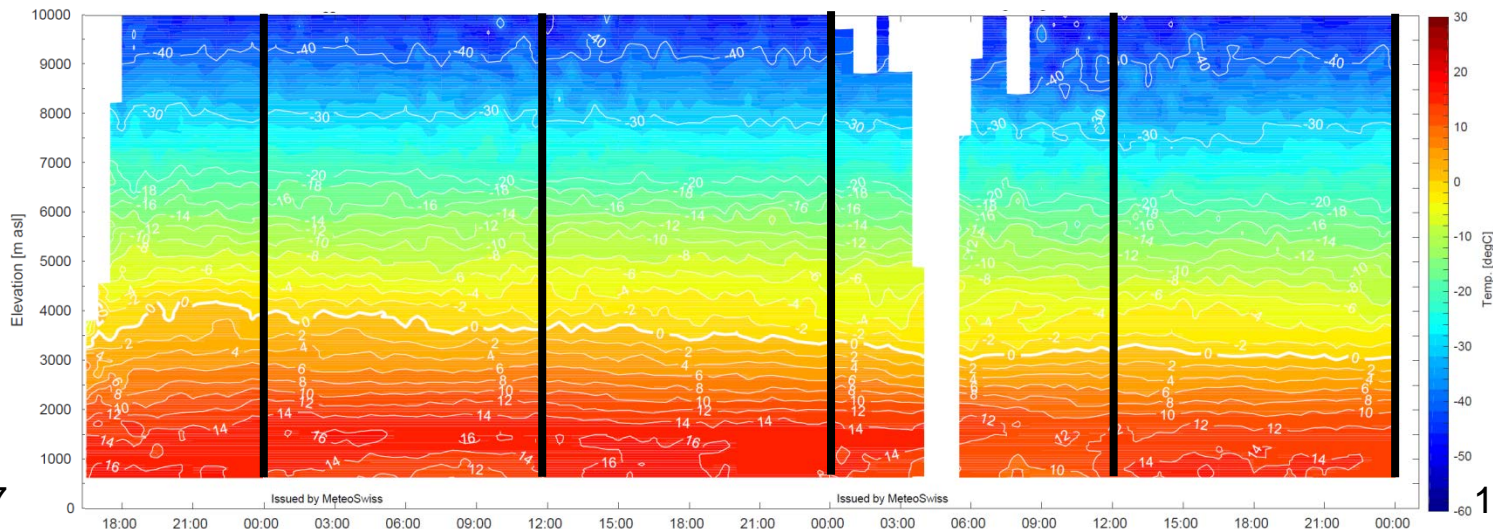


Tropospheric Water Vapour climatology

Since **2008** RALMO has produced on average 1 profile every hour, i.e. **50%** availability of tropospheric profiles.

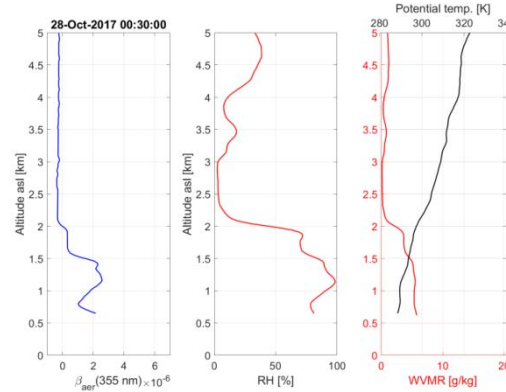
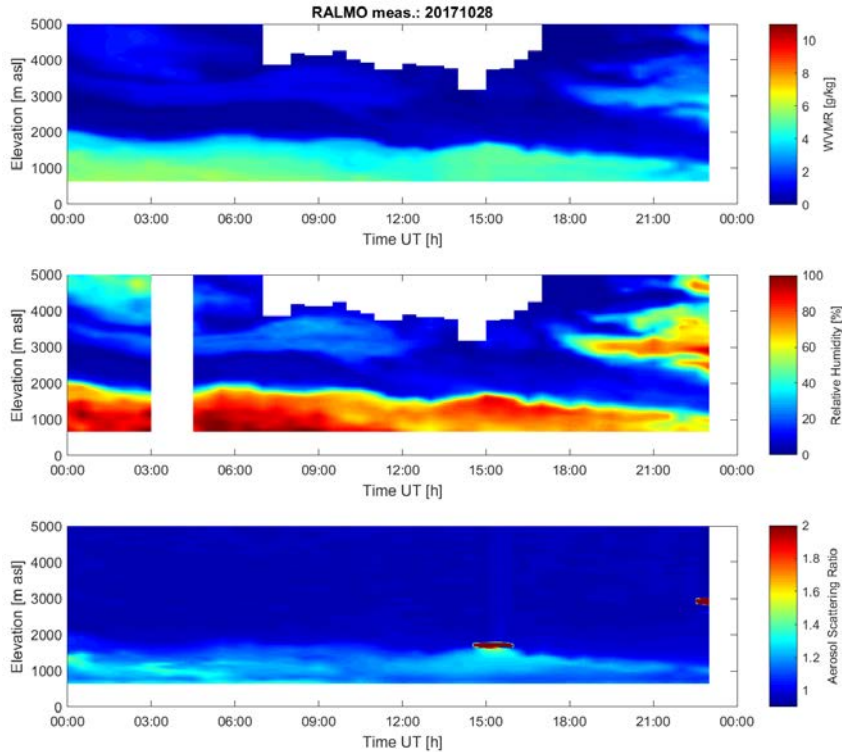


Tropospheric PRR-Temperature

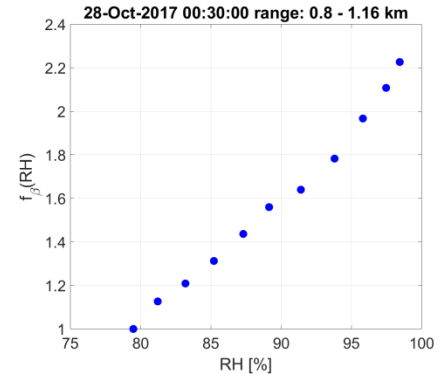


Aerosol hygroscopicity

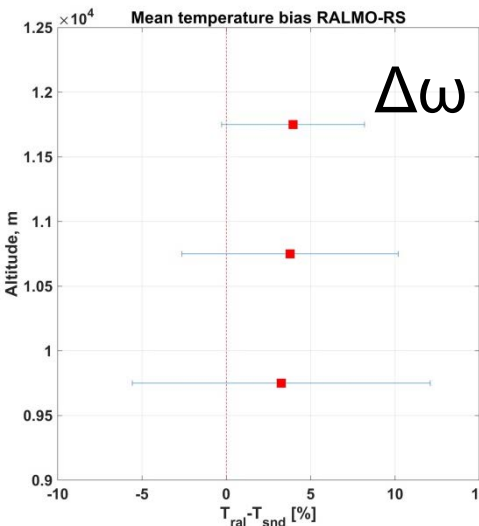
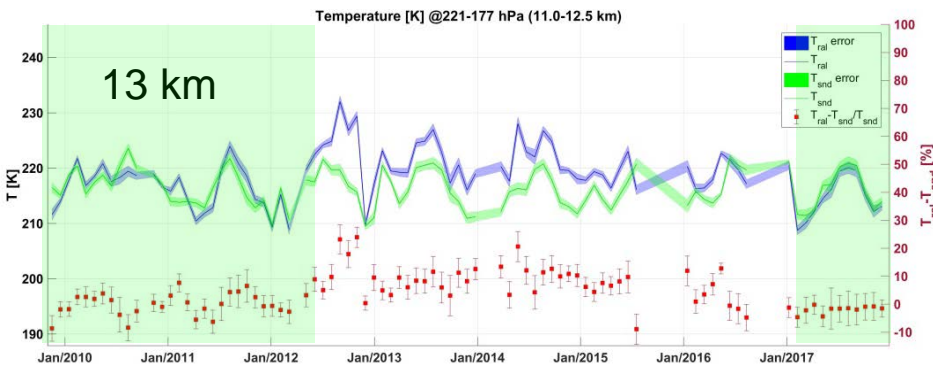
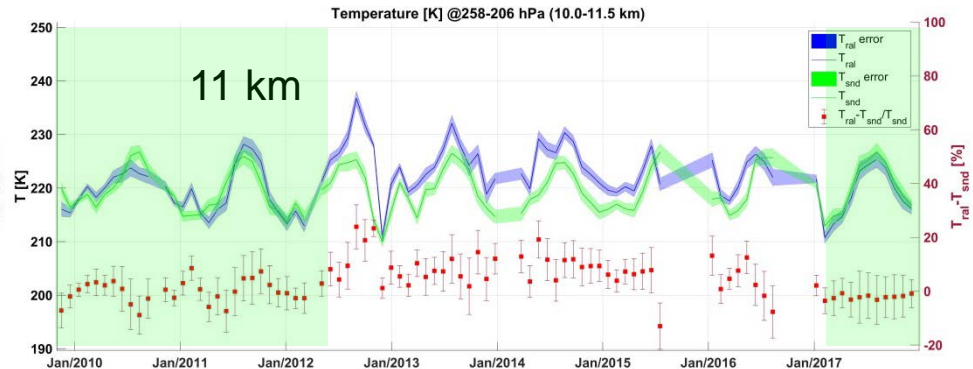
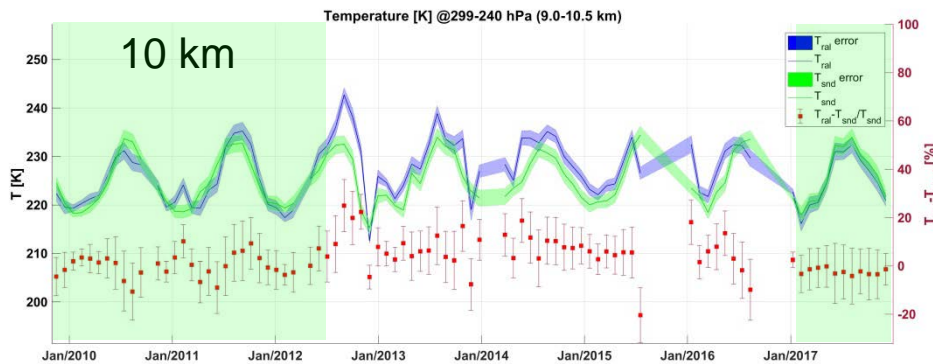
A three-way coupled system: humidity-temperature-backscatter



Requirements:
Same air mass
Well-mixed PBL
Correlation RH- β



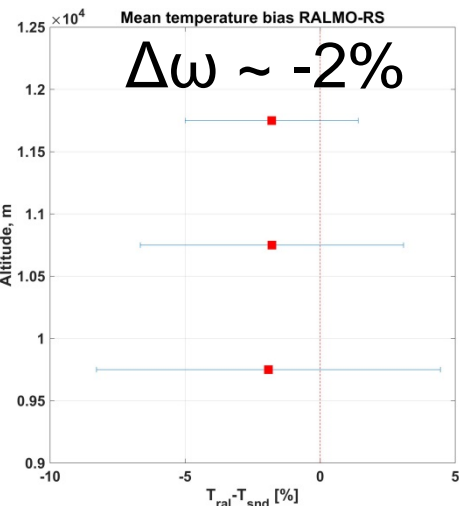
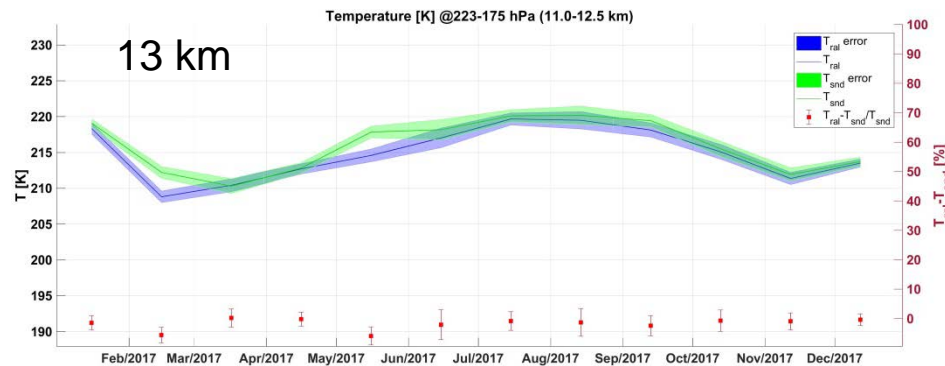
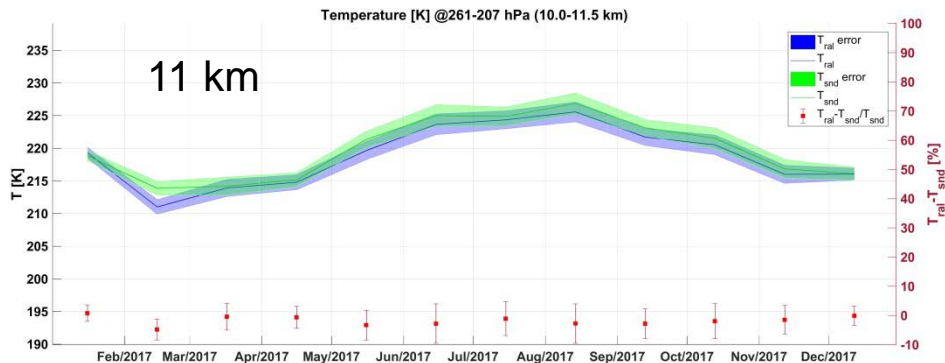
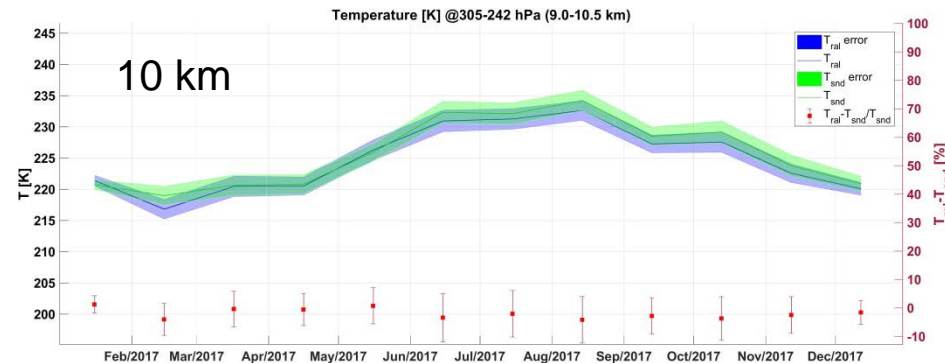
PRR temperature climatology in the UTLs



$$\Delta\omega = \text{RAL} - \text{C34}$$

$\Delta\omega$ in the 3-4% compared with the operational SRS-C34

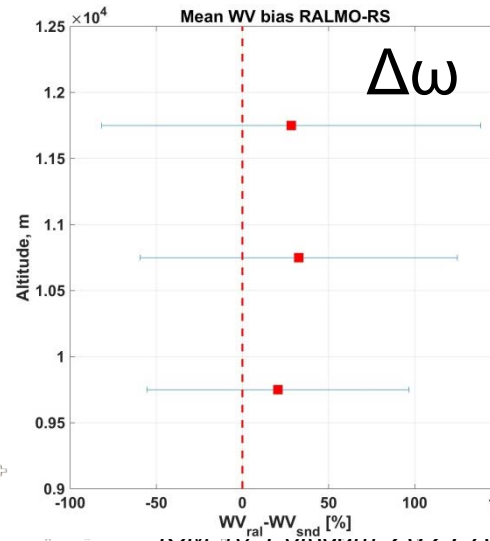
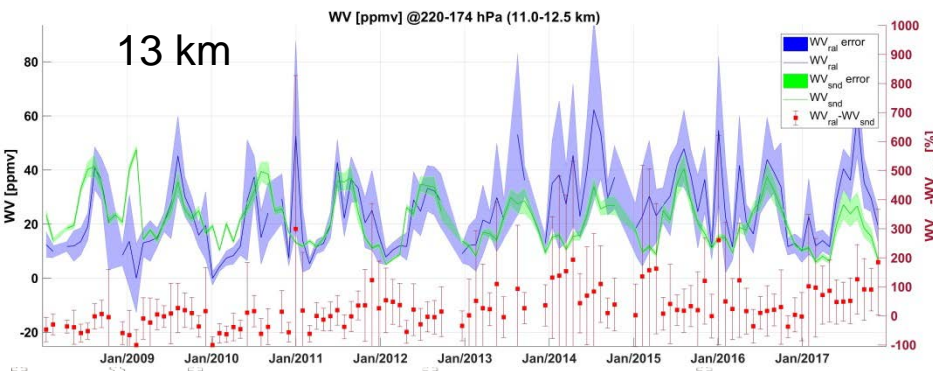
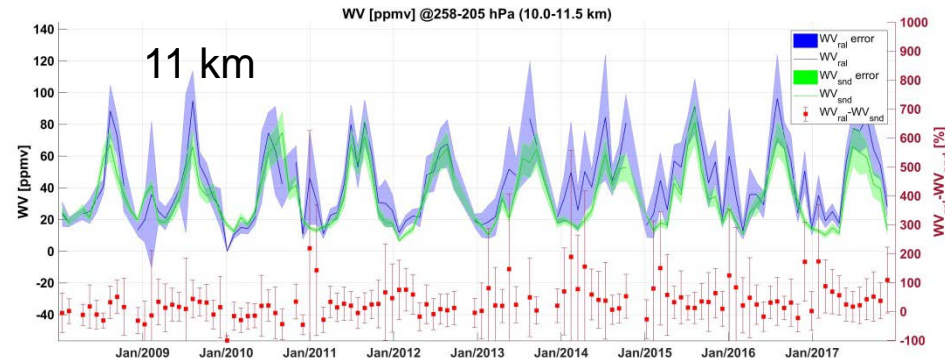
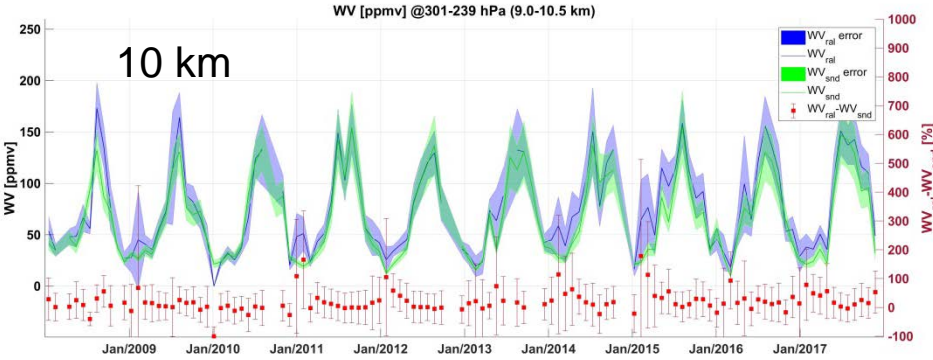
PRR temperature climatology in the UTLs



$$\Delta\omega = \text{RAL} - \text{C34}$$

improvement of
PRR temperature
in 2017

Raman Water Vapour climatology in the UTLS



$\Delta\omega$

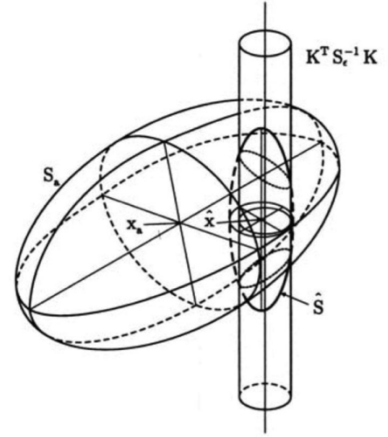
$$\Delta\omega = \text{RAL} - \text{C34}$$

$\Delta\omega$ in the 20-30% compared with the operational SRS-C34

Optimal Estimation Method

Bayes' Theorem:

$$P(\mathbf{x}|\mathbf{y}) = \frac{P(\mathbf{y}|\mathbf{x})P(\mathbf{x})}{P(\mathbf{y})}$$



The measurement: **y**

Measurement noise: **e**

The state vector: **x**

Auxiliary parameters: **b**

The forward model: **F**

The measurement **y** can be expressed through a forward model:

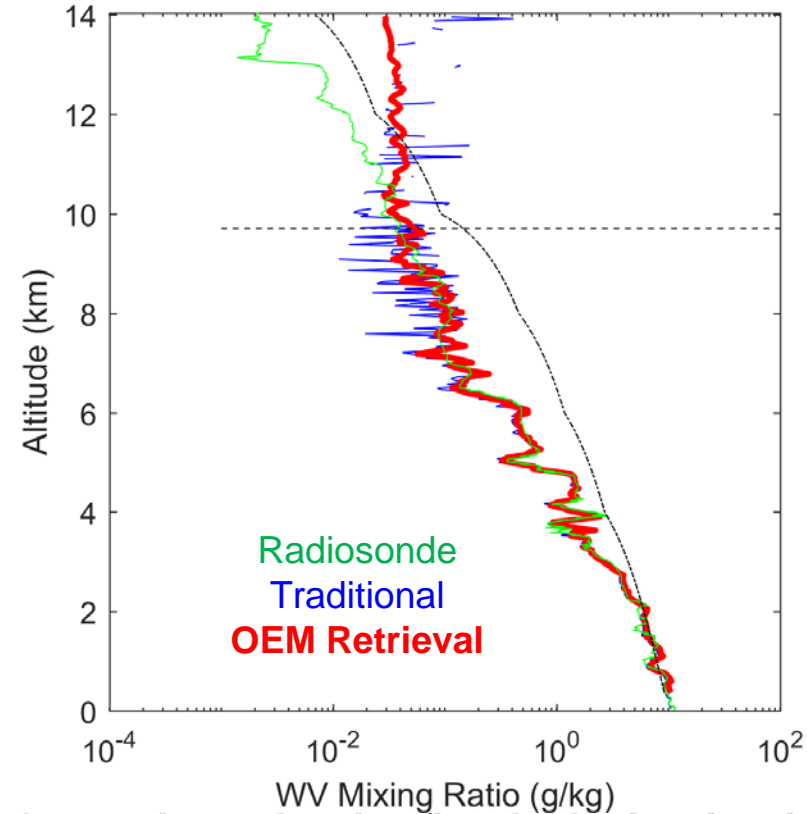
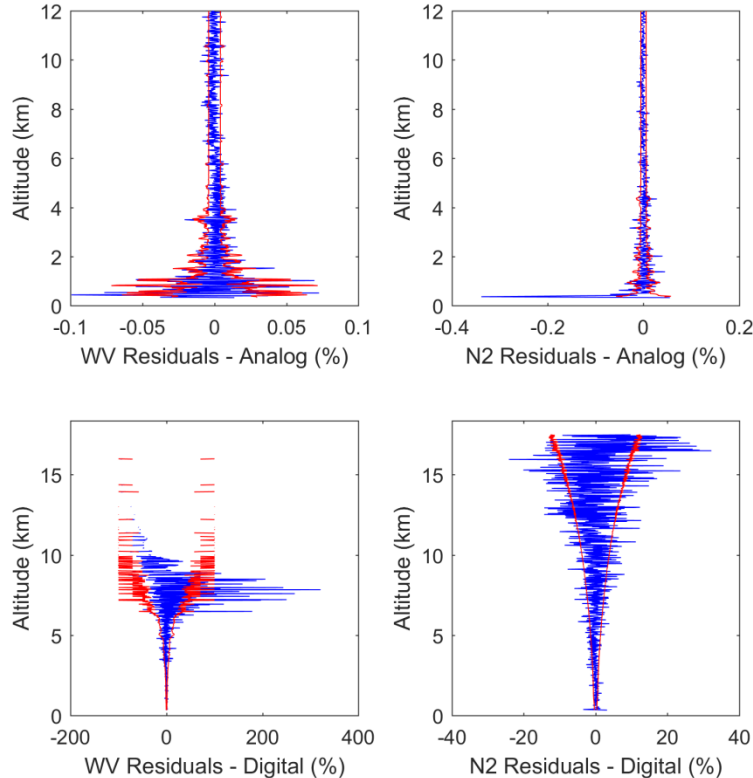
$$\mathbf{y} = \mathbf{F}(\mathbf{x}, \mathbf{b}) + \epsilon$$

Goal: solve the equation for **x**

Future activities: Water Vapour operational OEM Retrieval

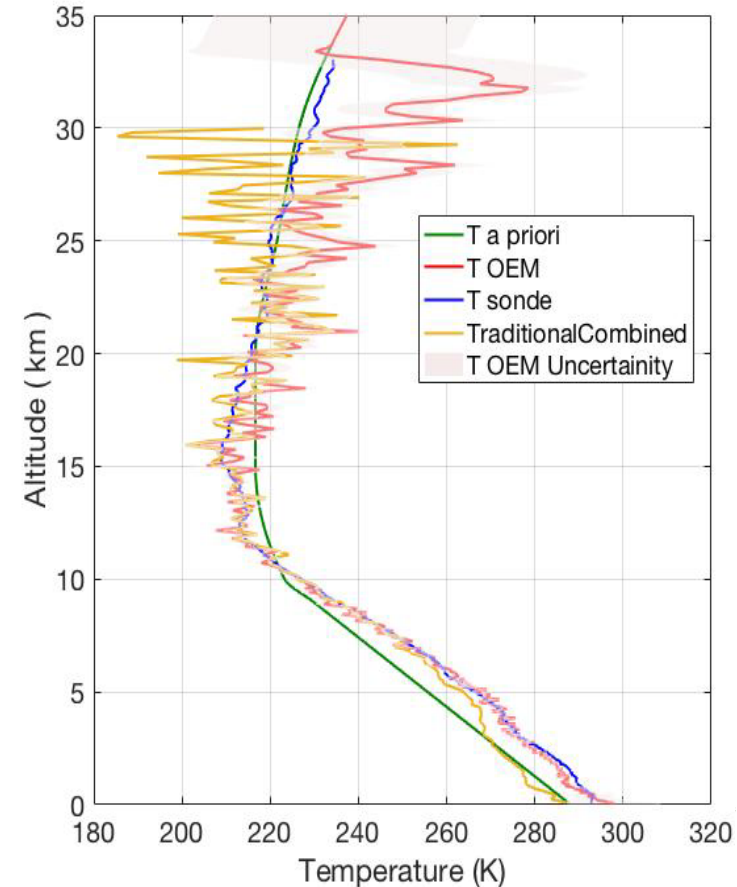
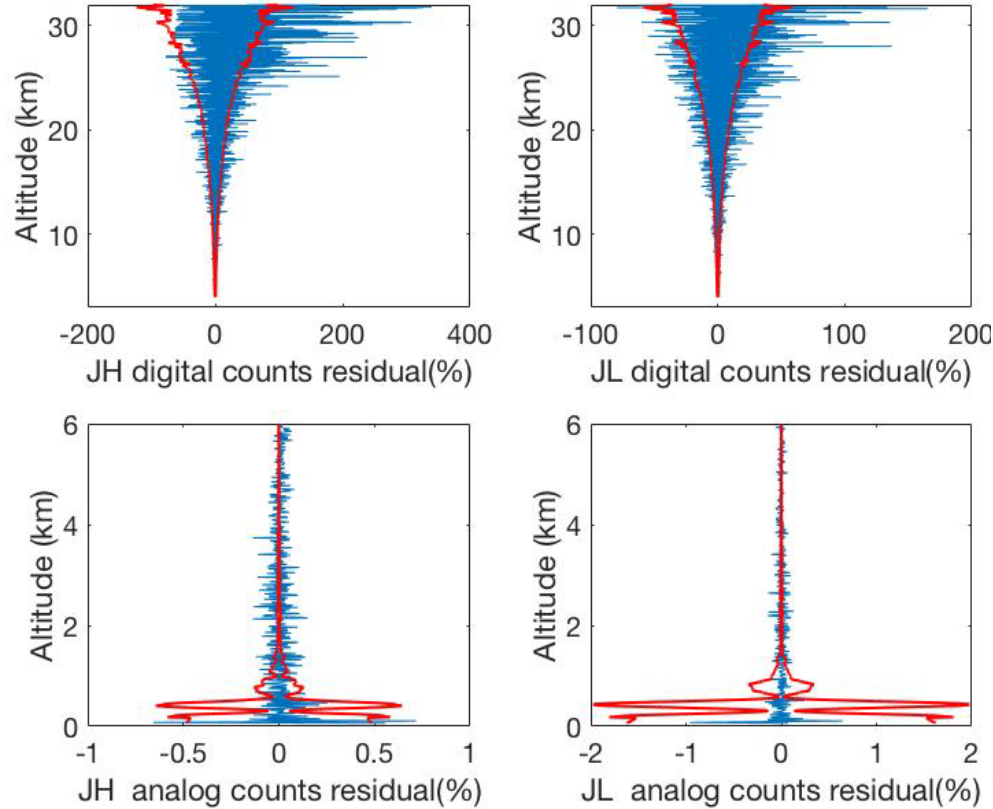
Residuals Forward model counts – Measurements
Statistical Uncertainty

2012 – 07 – 26 Night Retrieval



Future activities: PRR temperature operational OEM retrieval

20110909 – Clear Night



Summary

- RALMO operates 24/7 with average 50% availability since 2008, i.e. 1 profile every hour.
- The water vapour mixing ratio is calibrated automatically using the solar background since a year now.
- PRR temperature has been affectedly improved since beginning 2017 thanks to software and hardware upgrades.
- The continuous measurements of aerosol, temperature and humidity allows to study aerosol hygroscopicity. Relative humidity has also been tested for assimilation into COSMO KENDA (Kilometre-scale Ensemble Data Assimilation) with very positive impacts on forecasts.
- RALMO T and WV climatological timeseries well agree with the operational SRS-C34 radiosounding in the UTLS.
- In 2018/19 the automatic retrieval of T and WV by OEM will be put in place along with the traditional retrievals.



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Federal Office of Meteorology and Climatology **MeteoSwiss**

MeteoSwiss

Operation Center 1
CH-8058 Zurich-Airport
T +41 58 460 91 11
www.meteoswiss.ch

MeteoSvizzera

Via ai Monti 146
CH-6605 Locarno-Monti
T +41 58 460 92 22
www.meteosvizzera.ch

MétéoSuisse

7bis, av. de la Paix
CH-1211 Genève 2
T +41 58 460 98 88
www.meteosuisse.ch

MétéoSuisse

Chemin de l'Aérologie
CH-1530 Payerne
T +41 58 460 94 44
www.meteosuisse.ch