THE COST 720 TEMPERATURE, HUMIDITY, AND CLOUD PROFILING CAMPAIGN : TUC

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ABSTRACT

The international COST 720 Temperature, hUmidity, and Cloud (TUC) profiling experiment was organized during three months in Winter 2003/2004 at Payerne, Switzerland. Various in-situ and active/passive ground-based remote sensing systems, including three microwave radiometers, a cloud radar and a wind profiler, were operated in the same location. As example, temperature and humidity profiles from two microwave radiometers are compared with profiles obtained with a radiosounding system.

1. INTRODUCTION

Within the European COST 720 Action "Integrated Ground-based Remote-Sensing Stations For Atmospheric Profiling" and in connection with the COST 720 Swiss project "Integrated remote sensing system for physical and chemical atmospheric parameters", MeteoSwiss, in close collaboration with the UK-Met Office and several other institutes in Europe and in United States organized a comparison campaign in Payerne (Switzerland), from 15 November 2003 to 31 January, 2004: the Temperature, hUmidity, and Cloud (TUC) profiling experiment.

The main goals of this campaign were to:

- test ground-based temperature and humidity profiling systems,
- study in particular their ability to detect planetary boundary layer phenomena like temperature inversion, presence of fog, fog dissipation, low clouds formation and evolution,
- test cloud detection systems (passive and active ground-based systems),
- provide a dataset for studying the possibility of system integration for improving temperature and humidity profiling with ground-based remote sensing systems.

The aerological station of Payerne is located in the Swiss Mittelland at 491 m asl (46.813° N, 6.943° E). The region is characterized by rollings hills surrounded to the N-NW by the Jura mountains (1'000-1'500 m asl) and to the S-SE by the Alps (1'000-3'000 m asl). This particular topography tends to enhance the formation of wintertime thermal inversions within the first hundreds of meters above ground (Fig.1).

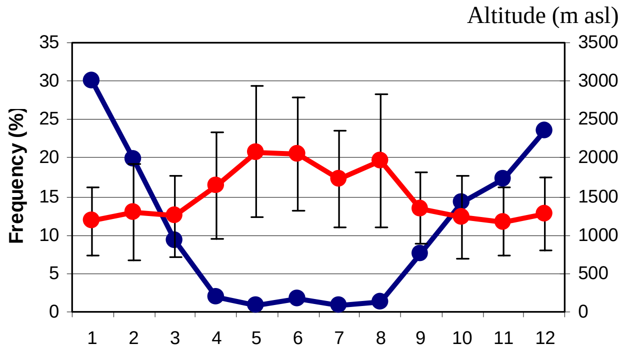

Fig. 1. Yearly cycle of elevated temperature inversions above Payerne at 11 UTC. Statistics based on inversions thicker than 250 m between 0.1 and 2.8 km agl and a time period of 10 years (1993-2002). The red curve (Y scale, altitudes, to the right) indicated the mean altitude and standard deviation of the basis (m asl), and the blue curve (Y scale to the left), the frequency.

2. SYSTEMS INVOLVED IN TUC

At the aerological station of Payerne, temperature, humidity and wind profiles from ground to up to 30 km asl are operationally performed twice a day (12 and 00 UTC) [1]. During the TUC experiment, many extra radiosondes were launched with various types [2] [3] of temperature and humidity sensors. If humidity can substantially vary from system to system, the temperature profiles fit very well each other all the time. During TUC, both active and passive ground-based remote sensing systems were deployed in Payerne. Table 1 describes the systems involved in the experiment and the main parameters measured.

3. EXAMPLE

A web page was created for the duration of the experiment. Daily time series of most parameters were made accessible to TUC participants as well as to any interested scientist. Data were made available through a ftp site. One example was selected to illustrate a typical thermal inversion situation with the presence of a thin fog layer next to the ground: 21 November 2003. The time series of temperature profiles measured with one microwave radiometer shows well the temporal evolution of the inversion layer with a stronger inversion during the night and the surface warming during the afternoon hours (Fig. 2). The corresponding humidity profile is shown in Fig. 3

The comparison of profiles estimated with two microwave radiometers with profiles of temperature and humidity measured with the radiosondes is shown in Fig. 4. One can observe the good agreement between the MP3000 radiometer and the radiosounding temperature profiles while ASMUWARA (which had some technical failures at that time) is not as good, compared to the radiosonde. The comparison of humidity profiles illustrates the difficulties for microwave radiometers to measure humidity profiles with very sharp discontinuities like it is in presence of fog (very moist below and very dry above). Further and more detailed studies of such phenomena are currently under way [4].

4. SUMMARY

During the Temperature, hUmidity, and Cloud profiling Experiment TUC, a huge amount of data was collected by various in-situ and ground-based remote sensing systems. Among others, three microwave radiometers, using three different technologies were operated. A first look in the dataset showed a great potential for both temperature and humidity profiles validation with radiosoundings as well as precious information for studies related to cloud detection and properties.

5. REFERENCES

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[4] T.J. Hewinson, C. Gaffard, D. Ruffieux, J. Nash, R. Nater, and B. Andrade, "Monitoring Inversions from Ground-based Remote Sensing instruments during Temperature, Humidity, and Cloud profiling campaign (TUC)", this issue.

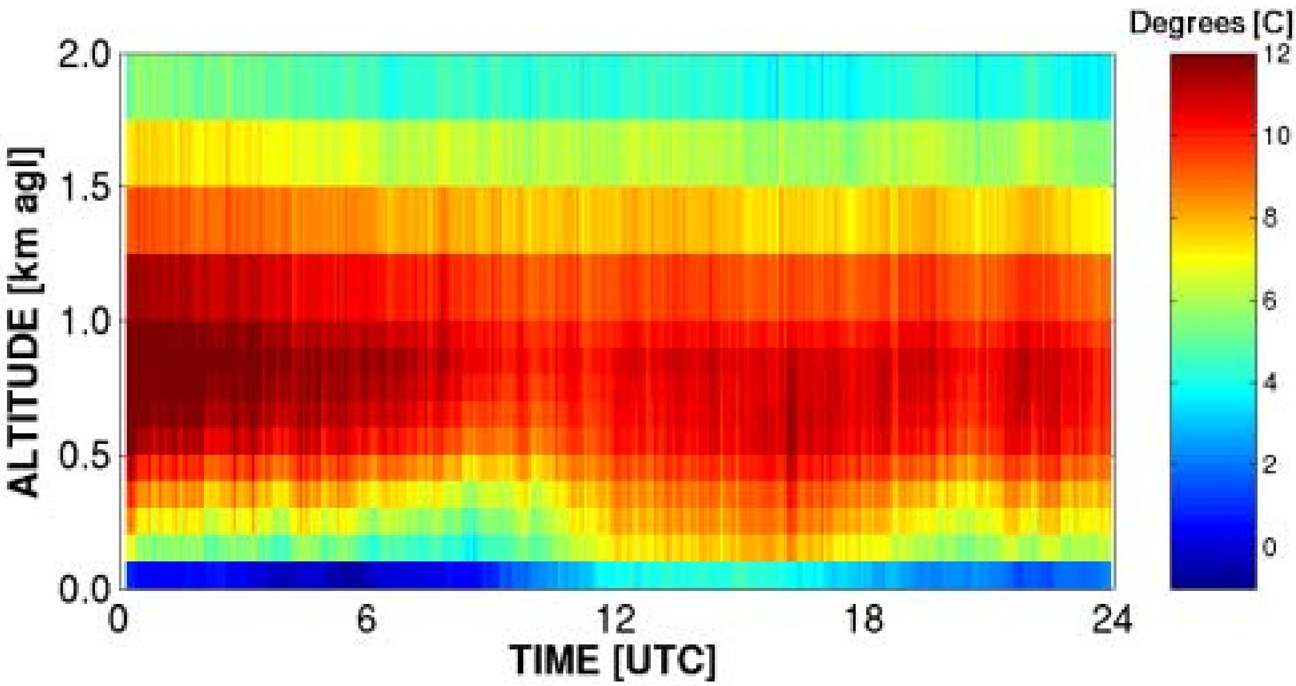

Fig. 2. Time series of temperature profiles retrieved from the microwave MP3000 radiometer, 21 November, 2003. The first 2 km agl only are displayed.

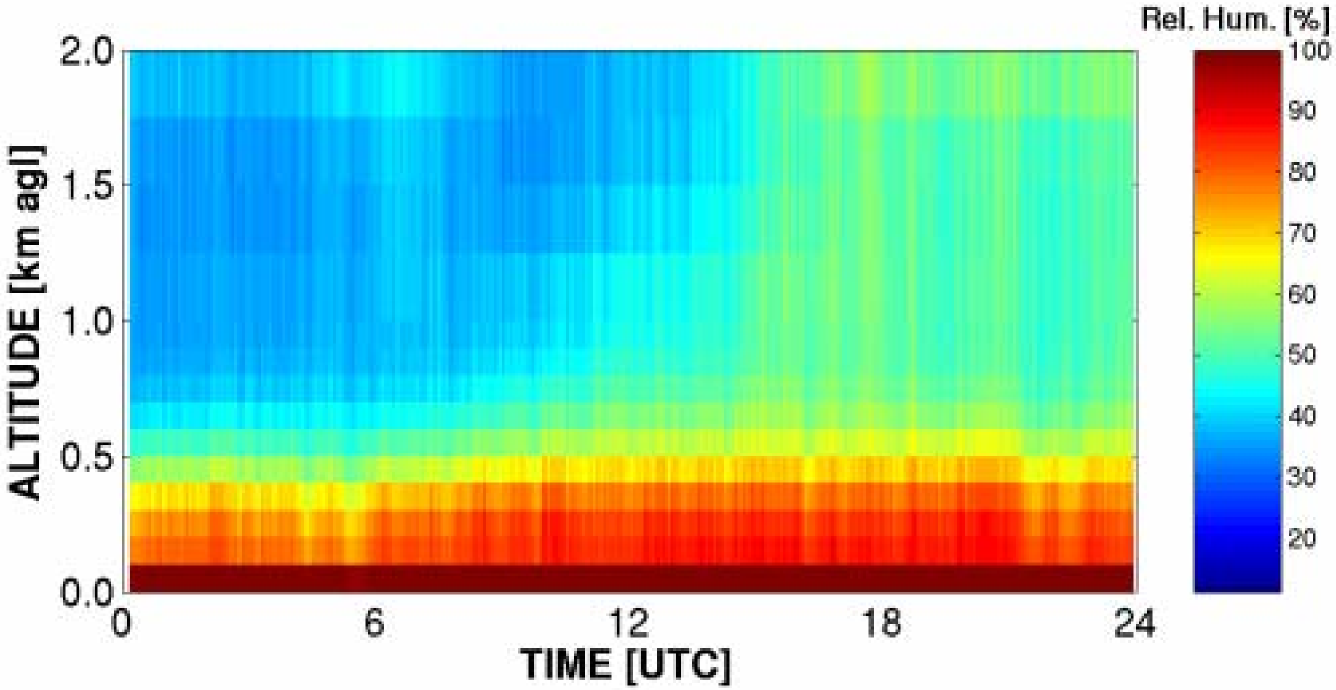

Fig. 3. Time series of relative humidity profiles retrieved from the microwave MP3000 radiometer, 21 November, 2003. The first 2 km agl only are displayed.

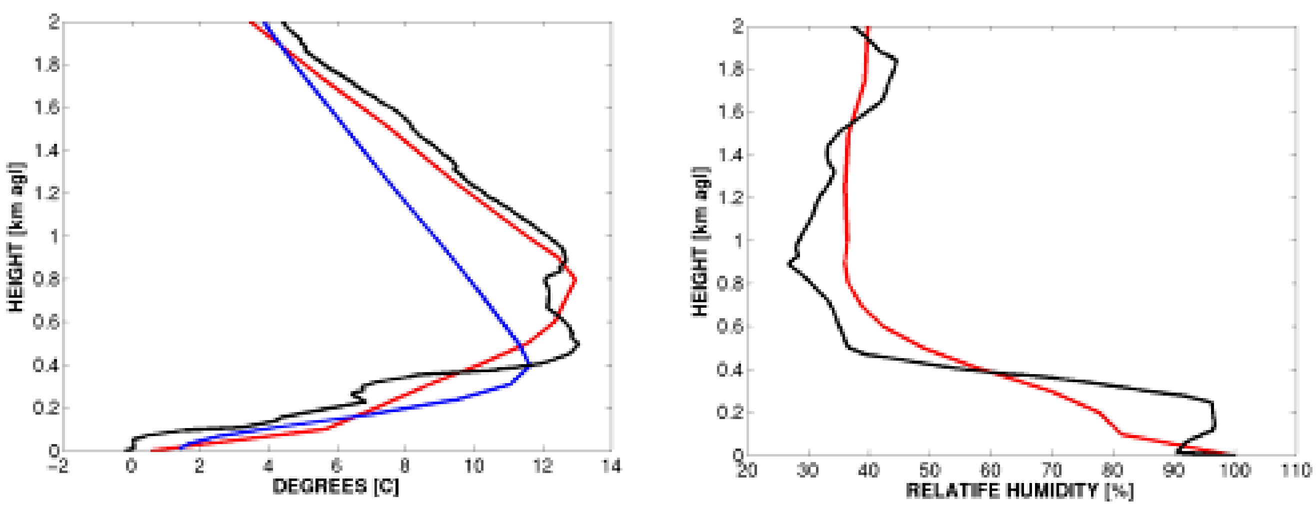

Fig. 4. Temperature (left panel) and humidity (right panel) profiles measured at 11 UTC, 21 November, 2003. The black line represents the operational radiosonde profile, the red line the MP3000 microwave radiometer profile, and the blue line, the ASMUWARA microwave radiometer. The first 2 km agl only are displayed.

Sytem	**Manufacturer**	**Measured parameters**	**Averaging interval**	**Max. Height**	**Owner**
Clouds and Radiation					
Cloud radar 78 GHz	Rutherford Appleton Laboratory RAL UK	• Cloud base • Cloud top	30 seconds	8 km	Rutherford Appleton Laboratory RAL (UK)
Ceilometer CT25K	Vaisala	• Cloud base	30 seconds	8 km	MeteoSwiss (CH)
Total sky imager TSI-880	Yankee Environmental Systems	• Sky cover (daytime)	30 seconds	No profiling	MeteoSwiss (CH)
Infrared Radiation Pyrometer	Pacific Northwest Laboratory (USA)	• Sky temperature • Cloud layers	5 seconds	No profiling	Pacific Northwest Laboratory (USA)
Scanning video camera		• Sky cover (daytime)		No profiling	MeteoSwiss (CH)
Automatic **P**artial **C**loud **A**mount **D**etection **A**lgorithm (APCADA)	World Radiatation Center (CH)	• Radiation (short and long, up and down) • T, RH • Sky cover percentage	10 minutes	No profiling	World Radiatation Center (CH)
Satellite maps	Meteosat Second Generation + MODIS	• Fog estimates • Cloud optical depth	Variable	No profiling	University of Marburg (GE)
Present weather FD12P	Vaisala	• Visibility • Precipitation type	60 seconds	No profiling	MeteoSwiss (CH)
Surface measurements	Swissmetnet +BSRN	• T, RH, P, Wind, precipitations • Radiation (short and long, up and down)	10 minutes	No profiling	MeteoSwiss (CH)
Temperature and Humidity					
Radiosounding system [1]	Meteolabor	• T, RH, P, wind	2/day (operational)	30 km	MeteoSwiss (CH)
Radiosounding system SnowWhite [2]	Meteolabor	• T, RH, P, wind	On request	30 km	MeteoSwiss (CH)
Radiosounding system	Vaisala	• T, RH,P,wind	On request	30 km	MeteoSwiss (CH)
Microwave radiometer MP3000	Radiometrics Inc. (USA)	• T, RH • IWV	6 minutes	3-5 km	Met Office (UK)
Microwave radiometer ASMUWARA	Institute for Applied Physics, Uni Bern (CH)	• T, RH • IWV	~20 minutes	5 km	Institute for Applied Physics, Uni Bern (CH)
Microwave radiometer MTP 5HE	Kipp and Zonen (NE)	• T	5 minutes	1 km	Kipp and Zonen (NE)
Global Positioning System antenna	Swisstopo (CH)	• IWV • Zenith total delay	60 minutes	Integrated value	Swisstopo (CH)
Others					
wind profiler 9panel 1290Mhz	Vaisala	• Wind, W • Signal to noise ratio • Spectra	30 minutes 30 seconds	2-4 km	MeteoSwiss (CH)

Table 1. Systems involved in TUC and measured parameters (T=temperature, RH=relative humidity, P=pressure, wind=wind speed and direction, W=vertical motions, IWV=Integrated water vapor).