The field and laboratory intercomparison test between two different types of the sondes and the ground systems

A. Borštnik, D. Groselj, J. Knez, L. Ravnik, M. Rus
Environmental Agency of the Republic of Slovenia
Vojkova 1b, 1000 Ljubljana, Slovenia
ales.borstnik@gov.si

Introduction

At the Environmental Agency of the Republic of Slovenia (EARS) we decided to make the intercomparison test between two sounding systems of different manufacturers and two different types of radiosondes. At EARS we had used Vaisala RS90-AL radiosondes with DigiCORA II system, but we were forced to change the ground system for the upper-air measurements and we decided to test Modem SR2K2 ground system with GPSonde M2K2. Because of the historical compatibility of the measured data, we decided to borrow Modem system first and make the intercomparison between the measured data to see what the differences are. We made the field and lab tests. First the laboratory test of each pair of sondes was made in the climatic chamber of the calibration laboratory of the EARS, and after that the field test was made with the multiple radiosonding, a balloon and the parachute.

The main goal of the intercomparison was to test the accuracy of PTU sensors in calibration laboratory and to compare PTU and wind measurements of both types of sondes in real conditions.

Sounding equipment

In the intercomparison we used two different types of sondes with their receiver stations: VAISALA **RS90-AL** and MODEM **M2K2** GPSonde. In the table there are the technical specifications, as they are stated by the manufacturers.

Type	**Vaisala RS90-AL**	**Modem M2K2**
Manufacturer	Vaisala Oyj, Finland	Modem, France
Wind/ Position	Loran C	GPS
Temperature		
Type	capacitive wire	thermistor
Range	-90 to +60°C	-90 to +50°C
Resolution	0.1 °C	0.1 °C
Response time	0.4 – 2.5 s	< 2 s
Accuracy	0.5 °C	0.5 °C
Humidity		
Type	thin film capacitor, heated twin-sensor design	capacitive
Range	0 to 100 % rh	0 to 100 % rh
Resolution	1 % rh	0.1 % rh
Response time	<0.5 s (at 6 m/s, 1000 hPa, +20°C)	< 2 s
Accuracy	5 % rh	5 % rh
Pressure		
Type	BAROCAP silicon sensor	calculated from GPS altitude
Range	3 to 1080 hPa	3 to 1050 hPa
Accuracy (at 1050 hPa)	1.5 hPa	2 hPa

VAISALA receiver station:
- **DigiCORA** II MW15 with three modules (UPP20A, MPU13P and MWV201),
- MicroCORA Radiosonde Receiver UR12 with antenna system RB 15
- Ground check (thermometer, silicagel for humidity calibration).

MODEM receiver station:
- SR2K2 receiver rack
- GPS antenna and GPS repeater system
- Omnidirectional radio 400 MHz antenna
- Built-in barometer
- Ground check (ambient temperature and humidity, with reference sensor and fan)
- Desktop PC with Modem data acquisition software

Data acquisition

The data acquisition based on the hardware and software of the two tested systems. The data from both systems were stored on a PC. In laboratory tests also data from Vaisala PTU were collected. Computers clocks were synchronized to ensure the uniformity of measurements.

The frequencies of the two sondes that were measured simultaneously were kept apart to ensure the correct functioning of the two systems. The Vaisala system operated on 403 MHz and the Modem on 401 MHz radio frequency.

Laboratory test

For measurements of temperature, humidity and pressure in laboratory we used the following equipment:

- Climatic chamber: Heraus HPC/S 4026
- Reference sensor in climatic chamber: Vaisala PTU 200 (**PTU**)
- Humidity generator: Thunder Scientific Corporation 2500 Humidity Generator
- Pressure chamber: Theodor Friedrich 8700.0000 BK
- Reference pressure sensor: Setra 370
- Power supplies for PTU and both type of radiosondes in laboratory test
- Personal computers (**PC**)

Due to loss of the sondes signals in both chambers, the antennas had to be extended to receive the data. Because of the duration of the laboratory measurements (several days) power supply instead of batteries was used.

Vaisala
The DigiCORA unit was used for the collection of data coming from the RS90-AL sonde and transmission of gathered data to the PC through the RS232 ports. We used two outputs on DigiCORA system, one for raw and the other for filtered data. The sampling interval was one second. The start of data recording was set to manual (in operational mode is set to automatic).

The calibration of the RS90-AL sonde in ground check was not performed before laboratory tests.

Modem

Changes of software settings of the system compared to operational mode were necessary during the laboratory tests. The system was in *test mode* and the option *static recording* was used to enable manual start of the recording. The data were available in raw and filtered format.

The calibration of the M2K2 sonde in ground check was not performed before laboratory tests.

Measurements in Climatic chamber

The three sensor sets from Vaisala, Modem and PTU were kept in appropriate distance (5 cm apart) to ensure the homogeneity of the measured parameters.

Wind speed in climatic chamber was about 5m/s.

We selected 12 points with different temperature and humidity where the two sondes were tested.

-20°C, 10%	-20°C, 50%	-20°C, 80%
0°C, 10%	0°C, 50%	0°C, 95%
20°C, 10%	20°C, 50%	20°C, 98%
40°C, 10%	40°C, 50%	40°C, 98%

After the stabilization half hour interval for analysis was selected.

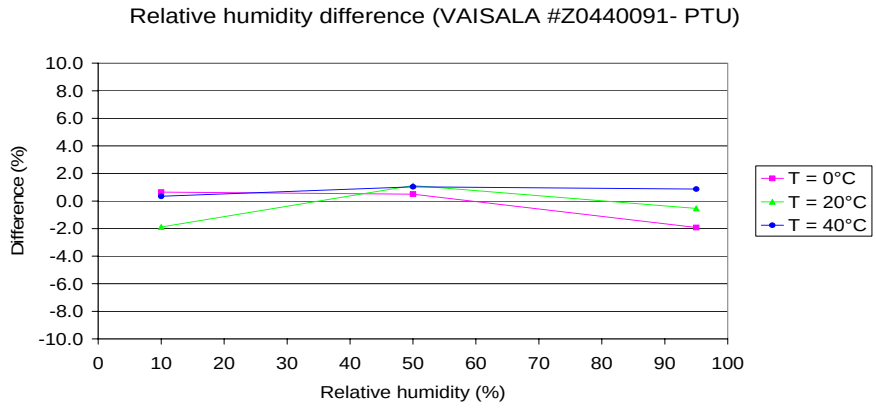
The measurements included individual disconnections of the sondes. Beside the frequency difference this procedure was necessary to avoid the possible disturbances between both sondes.

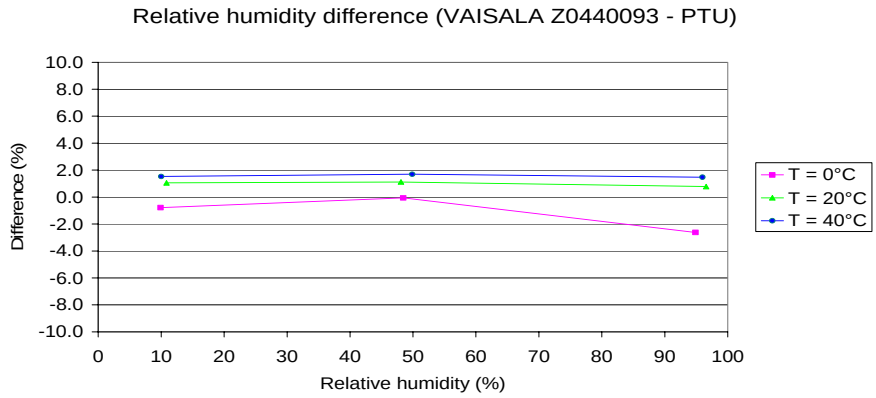
Measurements in Pressure chamber

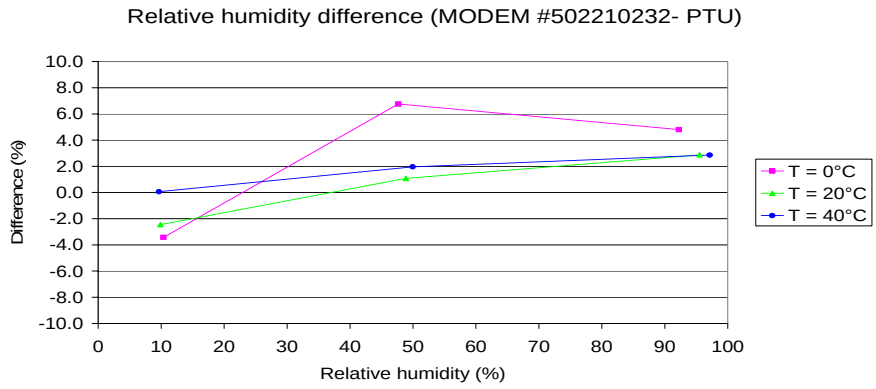
The chamber was used to test the RS90-AL pressure sensor. The pressure was changed in steps of 200 hPa in the range from 1100 hPa to 100 hPa. The measurements were taken during descent from 1100 hPa to 100 hPa and ascent from 100 hPa to 1100 hPa.

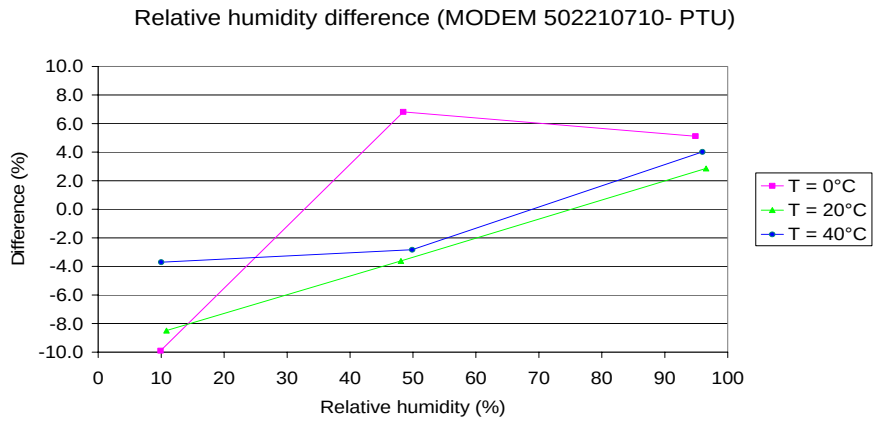
The data from the reference pressure sensor were collected on a PC using RS232 port.

Results of laboratory measurements of humidity







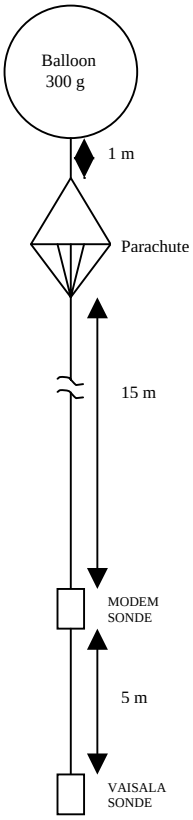


Launching

Flight configuration

300 g balloon was used, that carried the two sondes and a parachute.
The parachute was mounted 1m under the balloon to ensure a safe descent during which the data could also be collected.

The sondes were attached to the parachute on a 15 m rope. The upper sonde was M2K2. The RS90-AL was attached on a rope 5 m under the M2K2.

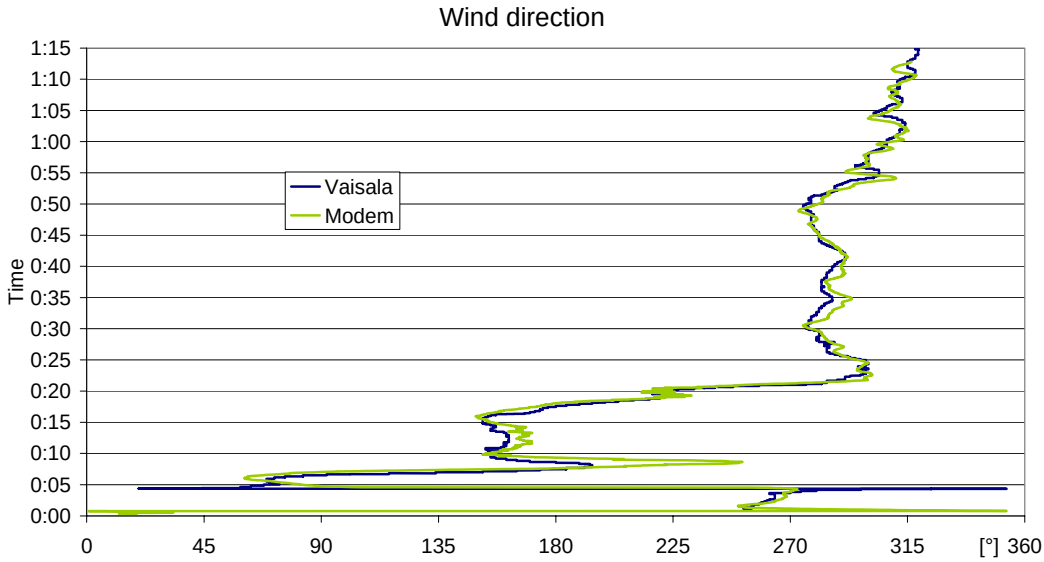


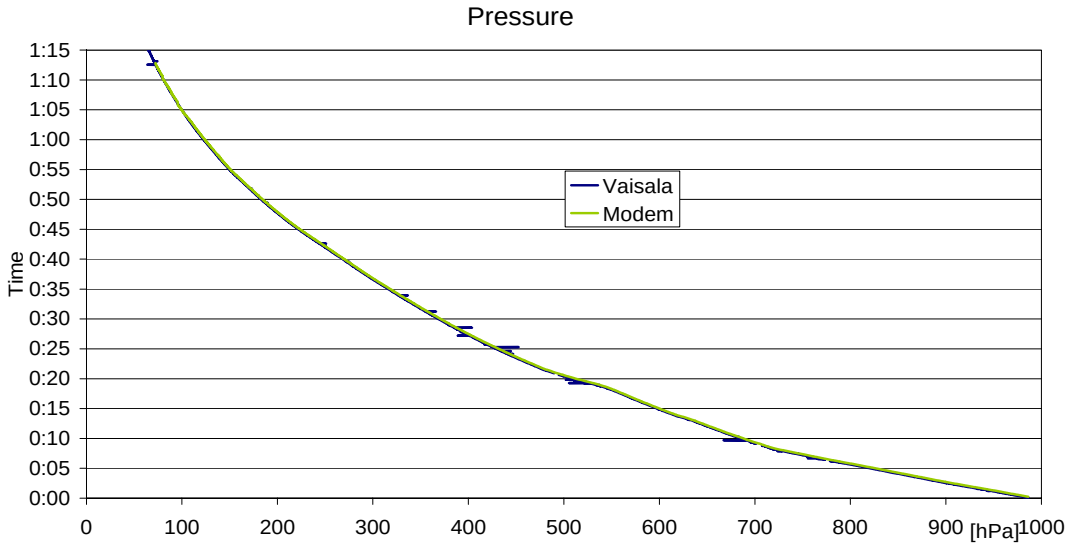
Vaisala
The same settings, apart from sonde calibration, remained valid during the common sounding. The sonde calibration was made in the ground check.

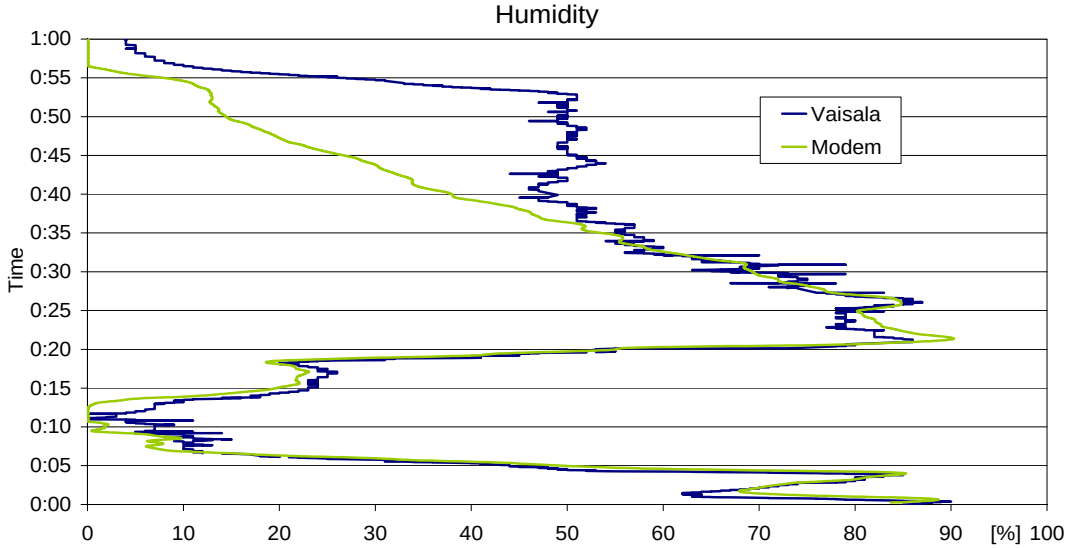
Modem
During the common sounding the system was in operational mode. This means that the *test mode* and *static recording*, which were used in laboratory tests, were turned off.

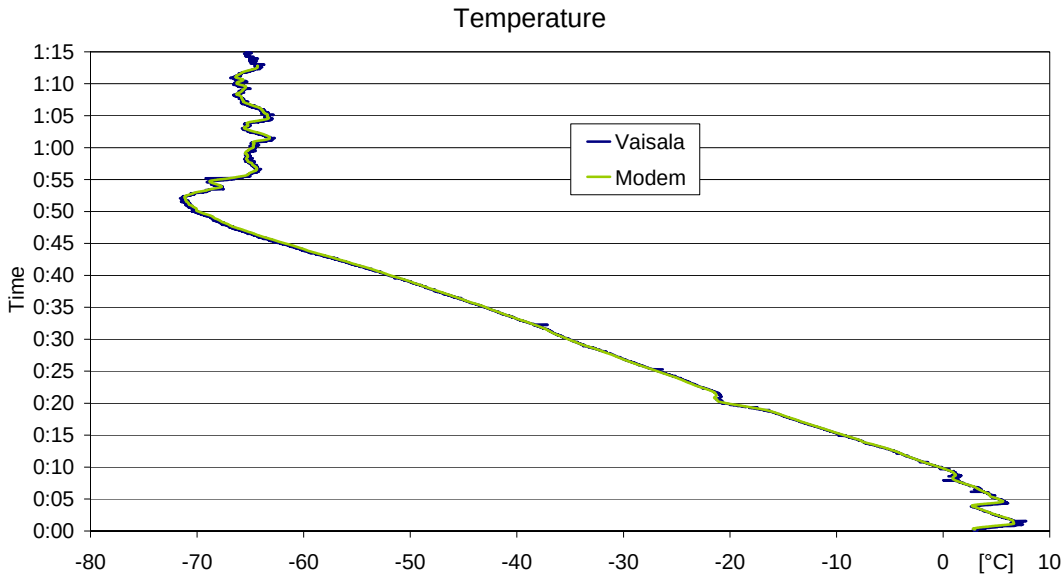
The sonde was calibrated in ground check. The protocol was the same as during regular operational soundings. It included the initialization of the Modem system, calibration of the sonde and automatic start of sounding.

Examples of sounding data:









Conclusions

Some conclusions of the intercomparison test are:

- There were small differences between measured temperatures in the climatic chamber;
- There was a difference between the measured relative humidity in the climatic chamber between Modem sondes and the reference.
- Both types of sondes have very similar pressure measurements (field test), although Modem doesn't have the pressure sensor, but it is calculated from GPS altitude.
- The differences between wind speed and direction measurements with both types of sondes in the field tests were very small.

The intercomparison test was made on a small sample of sondes, which is not enough to value the quality of the sondes. But the laboratory tests in the climatic chamber gave us very good view, how the sondes fulfill meteorological requirements.

References

- M2K2 GPSonde; User's notice, Document No. M2K2-MUUS031001

- Vaisala Radiosonde RS90-AL: Technical Information: Ref. B210310en-B