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Vaisala RS41 Trial in the Czech Republic

The newest generation of radiosondes developed by Vaisala, the RS41 type, has been introduced recently at the Meteorological Technology World Expo (MTWE) in Brussels. Before the release there have been trials completed in the Fall of 2013 at Czech Hydrometeorological Institute (CHMI) in order to evaluate functionality and precision of the new sounding system.

CHMI and Vaisala before 2013 trial

First contact of Czech aerology and Vaisala is dated back into early 50s of 20th century. Few years after the war Vaisala radiosondes were used in our institute. The modern Vaisala radiosondes have been used in CHMI since February 1992 until now.

In the period 1992-1998 CHMI used RS80 radiosondes, 1999-2003 the RS90 was used. During May and June 2003 there has been trial testing consisting of 33 dual soundings at our station in order to compare RS80, RS90 and RS92 radiosondes. In the last 10 year period RS92 has been in use.

Steps towards the August trial

We feel honored that we've been allowed to see development of the new system during last two years and that we could share our feelings, opinions and experience with MW41 and RS41 with developers. Our first contact with RS41 was in January 2011 when we were invited by Vaisala for a brief introduction of the planned new generation sounding system. In October 2011 the first presentation of RS41 at our station was done by Vaisala, which gave us the chance to discuss with Vaisala what we would like to see different in the new system. Since March 2012 we tested MW41 software with RS92 sondes at our station with the first data made from this software sent to GTS during autumn 2012. On 26th – 29th August 2013, shortly before official introduction of RS41 at MTWE, there was a trial made at our station in order to compare RS41 radiosondes with RS92.

System setup and testing process

During the trial, 22 soundings with same setup were made. To cover day and night behavior, soundings were spread almost equally during 4 days – from August 26 to August 29.

Martin Motl, Head of the Upper Air Department, with sounding operator Miroslav Klučina prepare wooden cross-rod.

Miroslav Klučina with Pavla Skřivánková, the Deputy-Director for Meteorology and Climatology, and Zdeněk Černoch (Chief Operator).

In each sounding there were used 4 radiosondes - two of RS41 and two of RS92. Sondes were hanging about 60 cm under wooden cross-rod, so they made corners of square with a side of about 1,5 m. The cross-rod itself with parachute was about 50 meters under the balloon. Data from both RS41 were processed with MW41 system while one of RS92 was processed with MW21 and the other one with new MW41. From previous tests when we processed simultaneously data from one RS92 sonde with two systems – MW21 and MW41 – we already knew that this won't affect results. During whole testing period we were lucky with the weather – almost no wind close to the ground, so it was easy to launch our setups.

The following metrics for the evaluation were used: direct differences between old and new sondes to discover possible systematic errors, standard deviations between two pairs of sondes of the same type to reveal accuracy of sensors, and comparison of geopotential heights on standard isobaric levels with the results from weather prediction model ALADIN used in CHMI on regular basis as a quality check.

Pressure level	Average difference [m]		Standard deviation [m]	
	RS92	RS41	RS92	RS41
100 hPa	2.3	1.8	4.0	4.3
30hPa	13.6	13.6	15.5	14.9
20hPa	18.7	18.7	20.1	19.9
10hPa	22.3	22.9	28.1	26.0

Height differences between radiosondes and ALADIN weather prediction model.
Sample of 22 sondes from each type.

Test results

We were probably most interested in results of pressure and height comparison. RS92 sonde computes height from measured pressure and temperature. This apporach was changed and RS41 computes pressure from temperature and height. This change was possible thanks to the improved accuracy of GPS height measuring.

One sounding with pressure sensor fault was excluded from the evaluation – one RS92 measured 1.2 hPa more than all other sondes even on 5 hPa level. Comparison didn't show any significant bias (lower than 10 m in all levels up to 32 km), but the standard deviation was much lower for the new type of sonde (Figure 1). RS41 standard deviation is between 2 and 3 meters for all levels, but RS92 standard deviation rises from similar values in lower levels up to 90 meters in 34 km. Comparison with WPM ALADIN in Table 1 doesn't show any important differences between sondes.

Because pressure is variable highly connected with height, there was no surprise that we observed very similar behavior. Maximum difference was some 0.3 hPa decreasing to zero when reaching higher levels, standard deviation (Figure 2) decreasing to 0.02 hPa for RS41 instead of 0.1 for RS92.

According to wind measurements, there were no significant differences between two types of sondes – wind velocity difference below 0.1 m/s for all levels, standard deviation lower than 0.1 m/s up to 24 km, raised to 0.5 m/s around 30 km for both systems.

Differences between day and night temperature measurements are illustrated in Figure 3 to 5. Differences in day (Figure 3) were higher than at night, but still lower than 0.2 °C. Temperature standard deviation in night (Figure 4) was from 0.02 to 0.09 °C for both types of sondes. Daily standard deviations progressed from 0.02 on surface up to 0.2 in 34 km for new type of sondes, from 0.08 to 0.4 for the old one (Figure 5). The performance of day soundings was better for RS41 than RS92, when RS41 standard deviation varies between 50-70% compared to standard deviation of RS92. In one sounding RS41 temperature deviated non-typically from the other RS41 and RS92s for unknown reason. This sounding was not included to the statistical analysis in order to get representative data set.

As RS92 sondes hadn't been reconditioned during testing, the humidity measurement of RS92 does not represent operational RS92 data. Regardless, RS41 measured correctly in this sample, so reproducibility of measurement represented by standard deviations could be used. On the Figure 6 we can see that they are lower than 1% in whole profile. In order to compare humidity sensors of RS92 and RS41, 10 more flight tests were conducted to get good RS92 reference set for this comparison. In this case dual soundings were with one RS92 and one RS41. Figure 7 shows the result of these soundings. The 1% difference is caused by higher sensitivity of the new sensor. It reacts faster, so on average it shows higher humidity in heights where sonde more often enters the cloud layer and less humidity in heights where it comes out.

Summary

Trial itself fulfilled our expectations. We found the new system quite easy to handle and we also had maximal weather support. Much less fragile temperature sensor worth noticing, which reduces danger of physical damaging while handling before the launch. There weren't found any significant biases between RS41 and RS92. It seems that new approach with measuring height from GPS and computing pressure is a step in the right direction. Results indicate higher precision of RS41 height and pressure data, also precision of other parameters seems to be increased due to the lower standard deviations of RS41. New humidity sensor apparently reacts faster on changes in atmosphere.

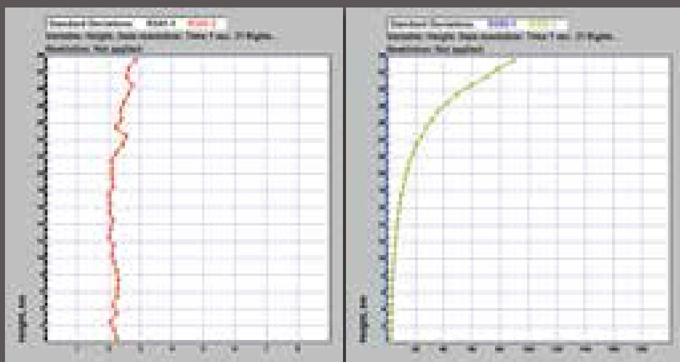

Figure 1: Standard deviations of geopotential height measurements for RS41 sondes (left) and RS92 sondes (right).

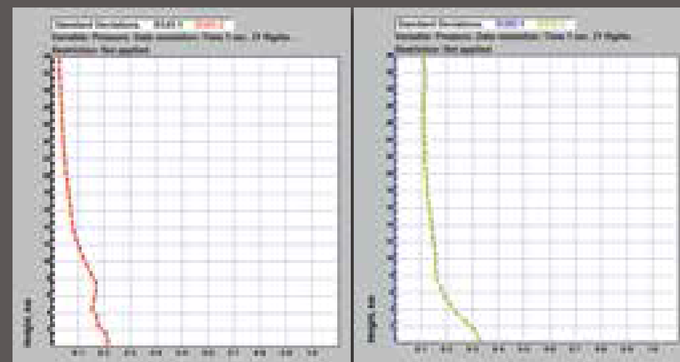

Figure 2: Standard deviations of pressure measurements for RS41 sondes (left) and RS92 sondes (right).

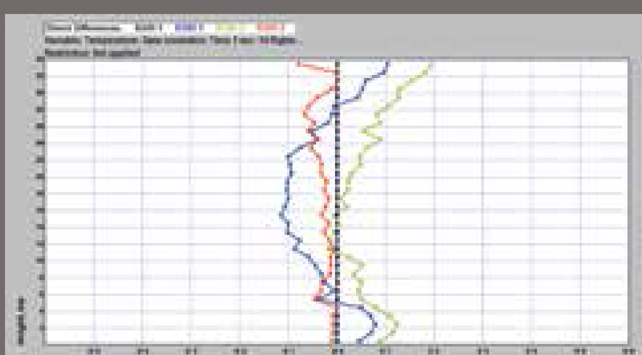

Figure 3: Temperature direct differences during day soundings. RS41_1 as a reference.

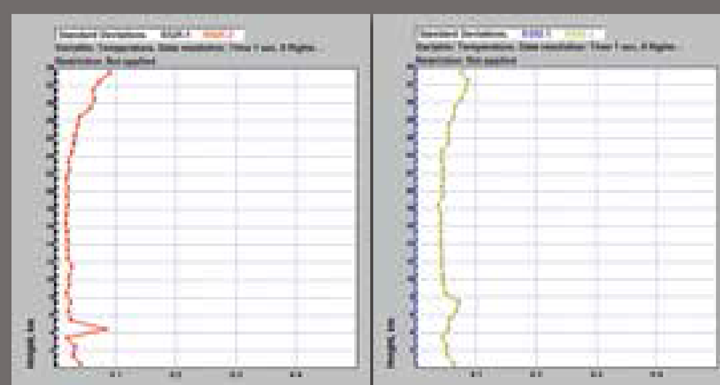

Figure 4: Temperature standard deviation during night soundings for RS41 sondes (left) and RS92 sondes (right).

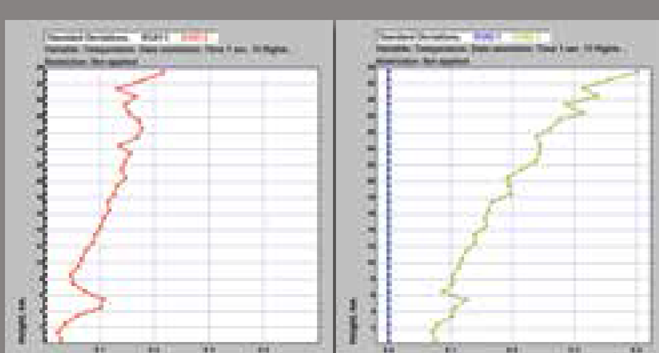

Figure 5: Temperature standard deviation during day soundings for RS41 sondes (left) and RS92 sondes (right).

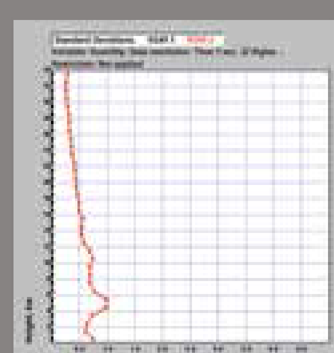

Figure 6: Standard deviation of RS41 humidity.

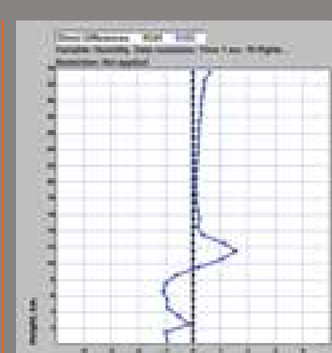

Figure 7: Humidity direct differences, RS41 as a reference.