

VAISALA RADIOSONDE RS41 COVER IMPROVEMENT

White Paper



PUBLISHED BY

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CHAPTER 1

INTRODUCTION

The first part of this document describes how radiosonde RS41 evolves from a hard plastic covered version to an improved cover version with EPS covers. Furthermore, as will be shown in the second part, the measurement accuracy of the radiosonde is not affected at all by the change of the cover material. Thus all specifications and previously published performance white papers apply.

Cover Improvement

This change is only about covers – the radiosonde covers have been replaced, but otherwise RS41 is still the same well-known RS41 radiosonde. The hard plastic covers have been changed to EPS (expanded polystyrene) covers with plastic fasteners to ensure the robustness of RS41 and to have a firm fastening for the unwinder pin. The proven, high quality sensors ensure that the performance is at the consistent RS41 level.

From the operator's point of view, the change is visible, but the operation remains simple and user-friendly.

RS41 design and infrastructure set the style and dimensions for the cover improvement. The dimensions of the radiosonde body are almost the same as in the current RS41. This is to ensure compatibility with the current AUTOSONDE AS15 without any modifications. Due to the characteristics of expanded polystyrene (EPS) and the constraints in the molding technique, some minor modifications have been made. However, when set side by side, the hard plastic cover version and the EPS version do not differ from each other, see Figure 1.

The new dimensions will not require any changes to the sounding equipment, only Ground Check Device RI41 needs an optional plastic sheet to the radiosonde pit to have a good mechanical fit for RS41 when placed onto the RI41, see Figure 2.



Figure 1. Improved cover version of RS41 (on the left) and hard plastic cover version of RS41 (on the right).

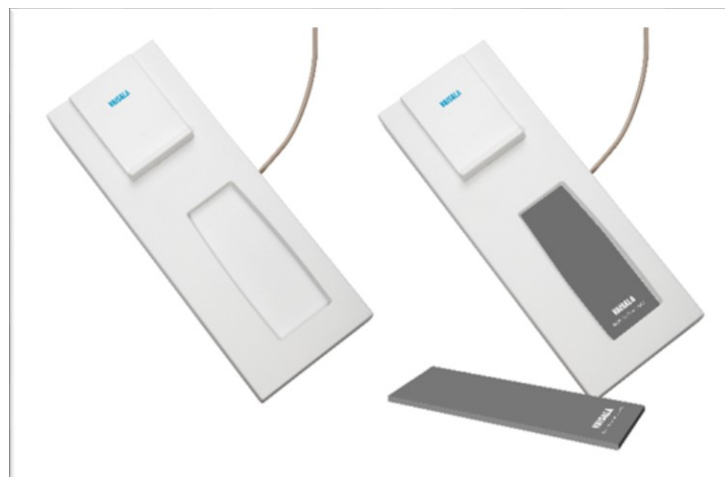


Figure 2. Additional plastic sheet for radiosonde pit at RI41 to have a good mechanical fit for RS41 when installed onto RI41.

Reduced Environmental Impact and Other Benefits

The reduction in environmental impact is mostly due to the reduced use of plastics, the amount of which is reduced by 47% when compared to the hard plastic cover version of RS41.

When the green house gas emissions and energy consumption are calculated (LCA), a reduction of 4% is achieved when the improved cover version is compared to the hard plastic cover version of RS41. With the cover improvement, the total greenhouse gas emissions of RS41 with EPS covers is equal to driving 36 km in an average medium sized car.

Furthermore, when compared to RS92 radiosonde, the reduction of the radiosonde weight is 71% (80 g vs. 280 g). When compared to RS41 with hard plastic covers, the reduction of weight is 27% (80 g vs. 109 g).

Due to the lower weight, the gas volume needed to lift the radiosonde will reduce. The benefit of this is dependent on the balloon size. In synoptical soundings with big balloons (>500g), the weight reduction decreases the gas usage by 1 to 3%. In applications using small balloons, the effect is more remarkable.

For maximum safety, Vaisala always recommends the use of a parachute when performing soundings, especially in densely populated areas. However, with the decreased weight and softer outfit of the improved RS41, the use of a parachute may be re-evaluated.

The change of covers does not influence the manufacturing flow, and the calibration of the sensors remains the same with the SI traceable references.

CHAPTER 2

COMPARISON DATA

In the following, the comparison data for plastic cover RS41 vs. RS41 with cover improvement is presented. To include different site environments and satellite geometries, sounding campaigns were carried out in two locations: in Malaysia (tropical latitude 5° N) and in Finland (high latitude 60° N). In each sounding, a total of four radiosondes were attached to a rig, that is, 2 x RS41 with hard plastic covers and 2 x RS41 with improved covers. Each radiosonde was tied to the radiosonde mounting points using the string normally used to attach it to its unwinder.

Temperature

The reproducibility of the Vaisala Radiosonde RS41 temperature measurement has been analyzed in Helsinki (high latitude), shown in Figures 3 and 4, and in Malaysia (tropical latitude), shown in Figures 5 and 6. The data in the figures is from daytime and night time soundings in various weather conditions. In the figures, the average difference between the four RS41 radiosondes is indicated in the left pane and the standard deviation of difference in the right pane. RS41_1 and _2 indicate radiosondes with hard plastic covers, and RS41_3 and _4 indicate radiosondes with improved covers.

The results show that the cover type does not influence the temperature measurement performance. The averaged differences between the different cover versions are small and of the same magnitude as between radiosondes having similar covers. The standard deviation of the measured temperature differences in a sounding increases gradually with altitude, starting at the level of 0.05 °C on the ground and ending at the level well below 0.2 °C at 34 km.

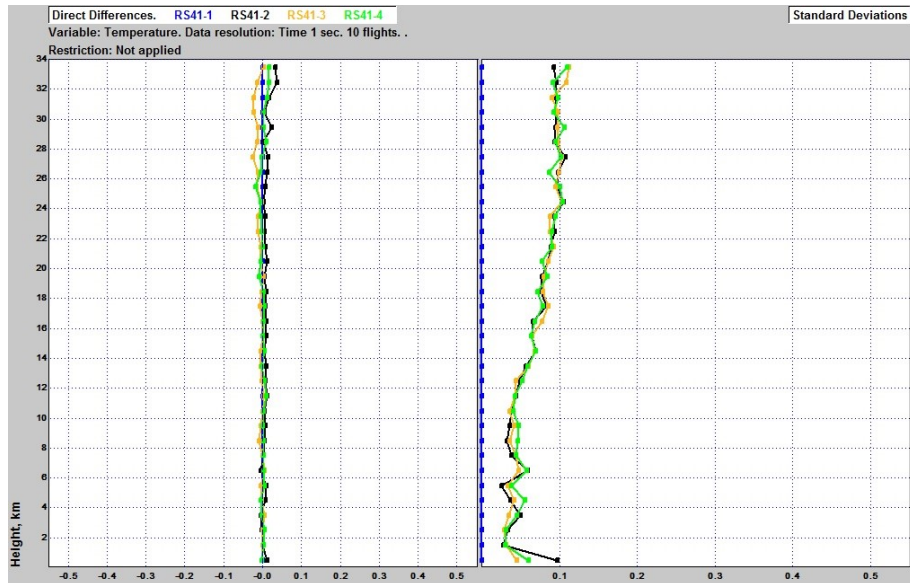


Figure 3. The direct differences and reproducibility of temperature measurement in ten daytime comparison soundings in high latitude.

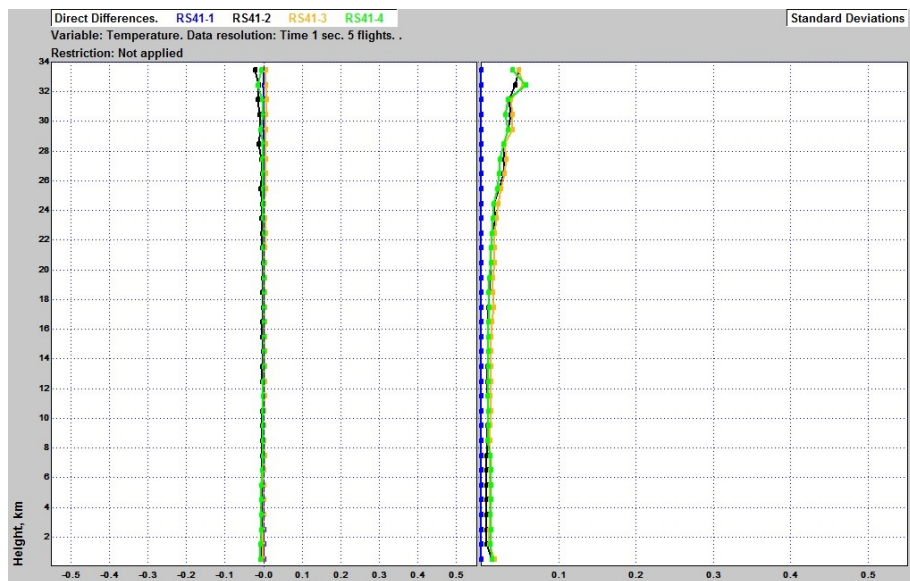


Figure 4. The direct differences and reproducibility of temperature measurement in five night time comparison soundings in high latitude.

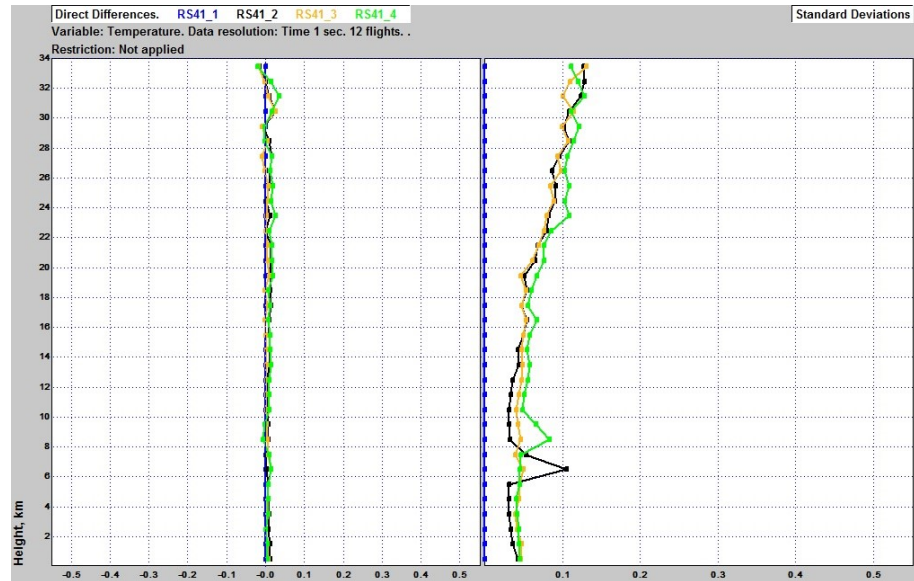


Figure 5. The direct differences and reproducibility of temperature measurement in twelve daytime comparison soundings in tropical latitude.

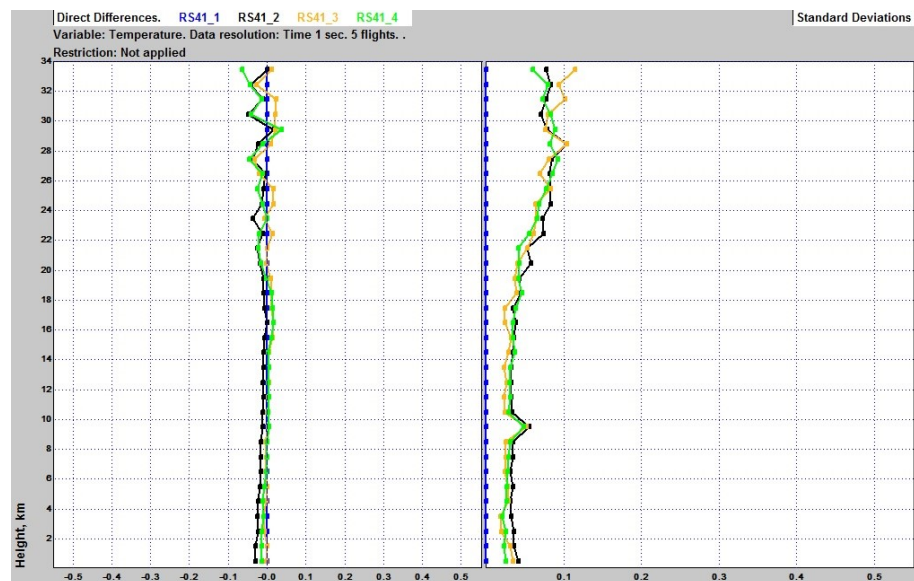


Figure 6. The direct differences and reproducibility of temperature measurement in five night time comparison soundings in tropical latitude.

Humidity

The reproducibility of the Vaisala Radiosonde RS41 humidity measurement has been analyzed in Helsinki (high latitude), shown in Figures 7 and 8, and in Malaysia (tropical latitude), shown in Figures 9 and 10. The data in the figures is from daytime and night time soundings in various weather conditions. In the figures, the average difference between the four RS41 radiosondes is indicated in the left pane and the standard deviation of difference in the right pane. RS41_1 and _2 indicate radiosondes with plastic covers and RS41_3 and _4 indicate radiosondes with improved covers.

The results show that the cover type does not influence the humidity measurement performance. The averaged differences between the different cover versions are small and of the same magnitude as between radiosondes having similar covers. Even in the most demanding cold and humid conditions of the tropical tropopause, the humidity differences in a sounding are typically less than 1% RH and the reproducibility is on the level of 2% RH.

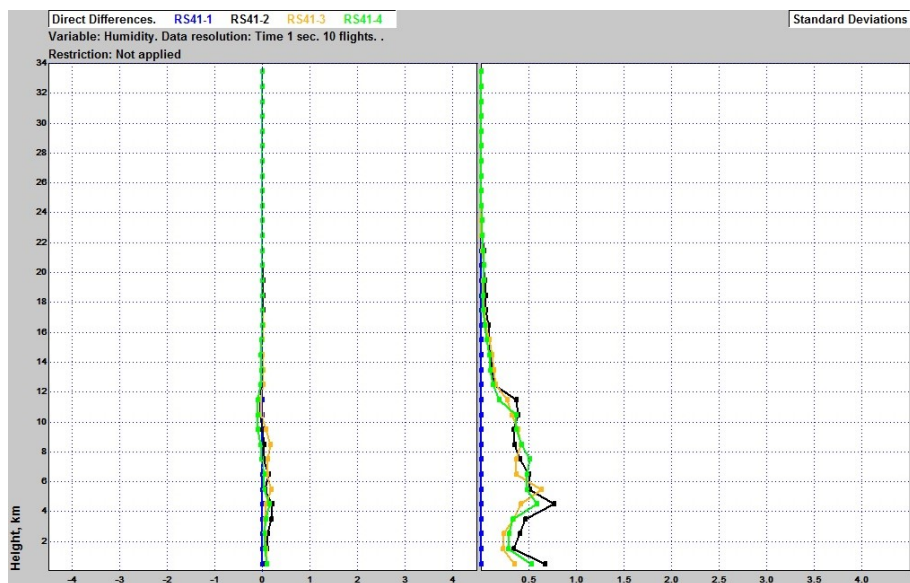


Figure 7. The direct differences and reproducibility of humidity measurement in ten daytime comparison soundings in high latitude.

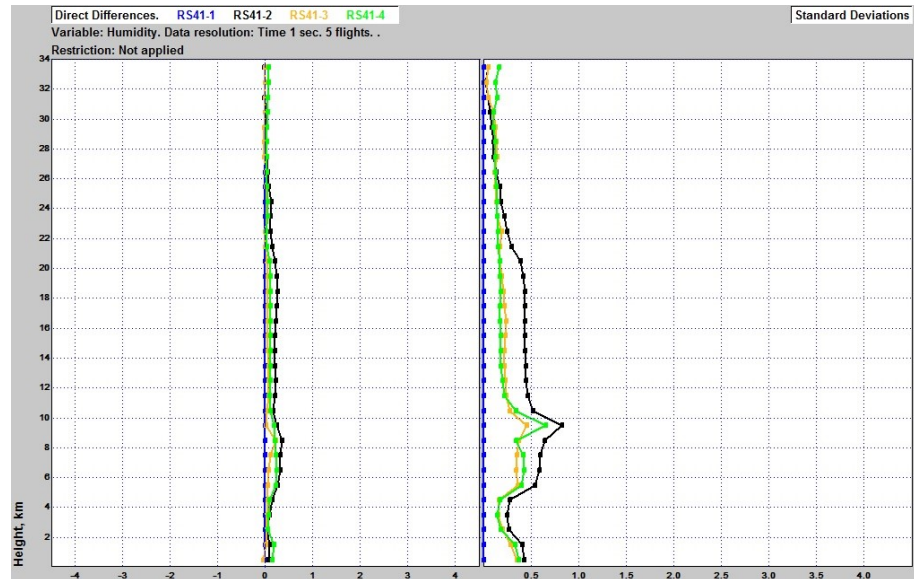


Figure 8. The direct differences and reproducibility of humidity measurement in five night time comparison soundings in high latitude.

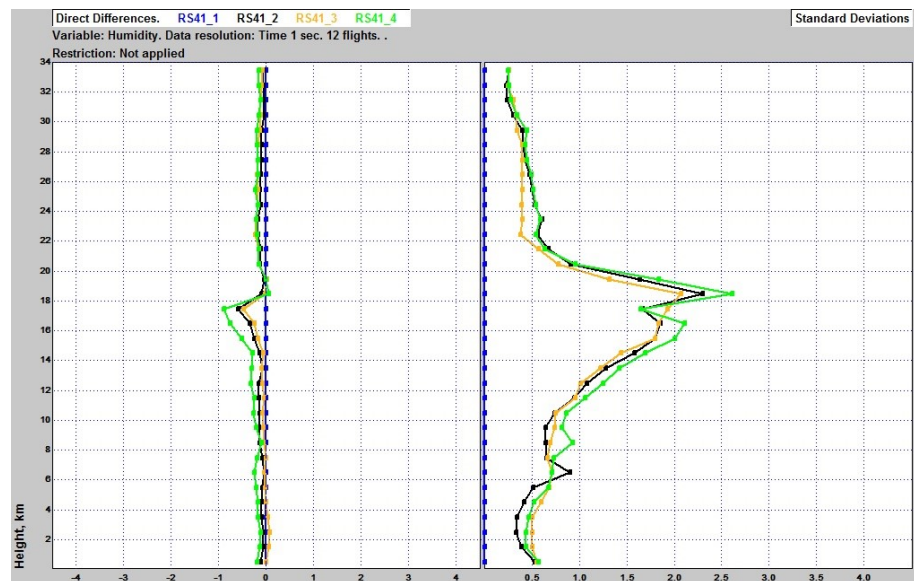


Figure 9. The direct differences and reproducibility of humidity measurement in twelve daytime comparison soundings in tropical latitude.

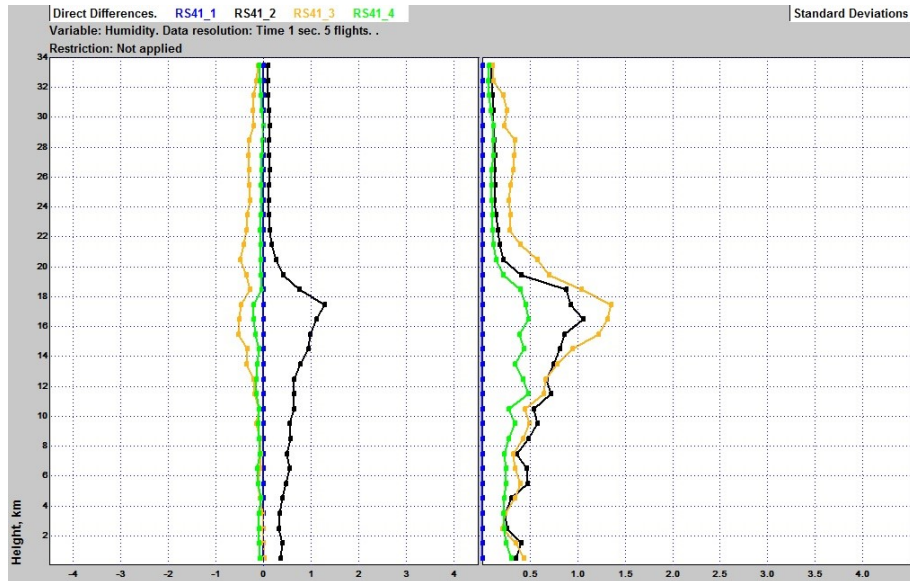


Figure 10. The direct differences and reproducibility of humidity measurement in five night time comparison soundings in tropical latitude.

Geopotential Height

The reproducibility of the Vaisala Radiosonde RS41 geopotential height measurement has been analyzed in Helsinki (high latitude), shown in Figure 11, and in Malaysia (tropical latitude), shown in Figure 12. The data in the figures is from daytime and night time soundings in various weather conditions. In the figures, the average difference between the four RS41 radiosondes is indicated in the left pane and the standard deviation of difference in the right pane. RS41_1 and _2 indicate radiosondes with plastic covers and RS41_3 and _4 indicate radiosondes with improved covers.

The results show that the cover type does not influence the geopotential height measurement performance. The averaged differences between the different cover versions are small and of the same magnitude as between radiosondes having similar covers. The performance is uniformly good at all heights, with average differences of 0–1 gpm and standard deviations of less than 6 gpm.

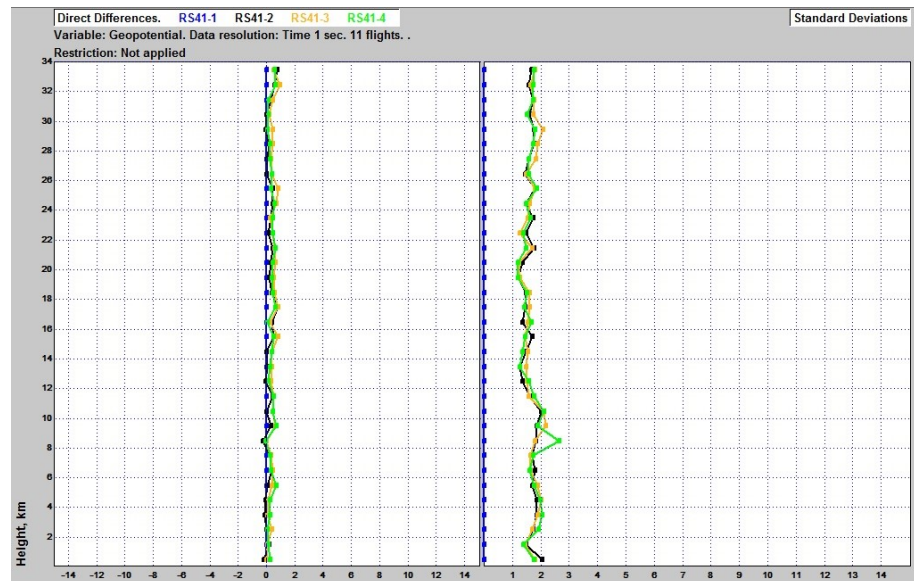


Figure 11. The direct differences and reproducibility of geopotential height measurements in eleven comparison soundings in high latitude.

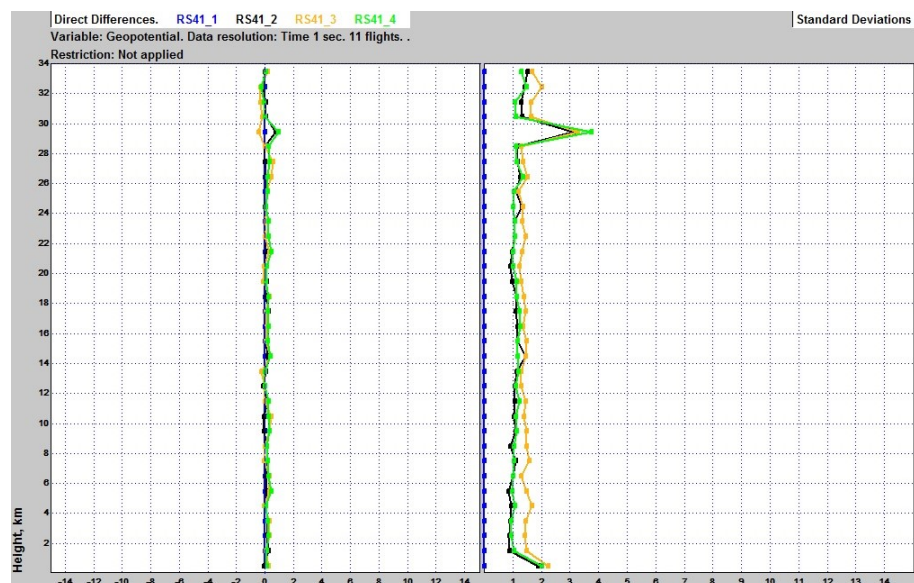


Figure 12. The direct differences and reproducibility of geopotential height measurements in eleven comparison soundings in tropical latitude.

Pressure

The reproducibility of the Vaisala Radiosonde RS41 GPS-based pressure measurements has been analyzed in Helsinki (high latitude), shown in Figure 13, and in Malaysia (tropical latitude), shown in Figure 14. The data in the figures is from daytime and night time soundings in various weather conditions. In the figures, the average difference between the four RS41 radiosondes is indicated in the left pane and the standard deviation of difference in the right pane. RS41_1 and _2 indicate radiosondes with plastic covers and RS41_3 and _4 indicate radiosondes with improved covers.

The results show that the cover type does not influence the GPS-based pressure measurement performance. The averaged differences between the different cover versions are small and of the same magnitude as between radiosondes having similar covers. The random differences in pressure decrease rapidly as a function of altitude, following the exponential decrease in atmospheric pressure. The observed standard deviations are below 0.4 hPa near the ground and <0.04 hPa at altitudes above 30 km.

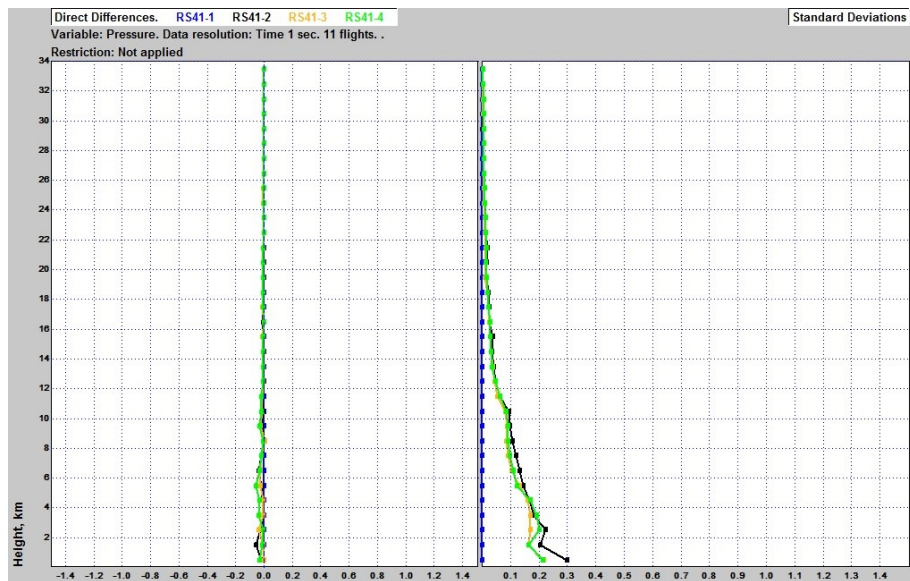


Figure 13. The direct differences and reproducibility of pressure measurements in eleven comparison soundings in high latitude.

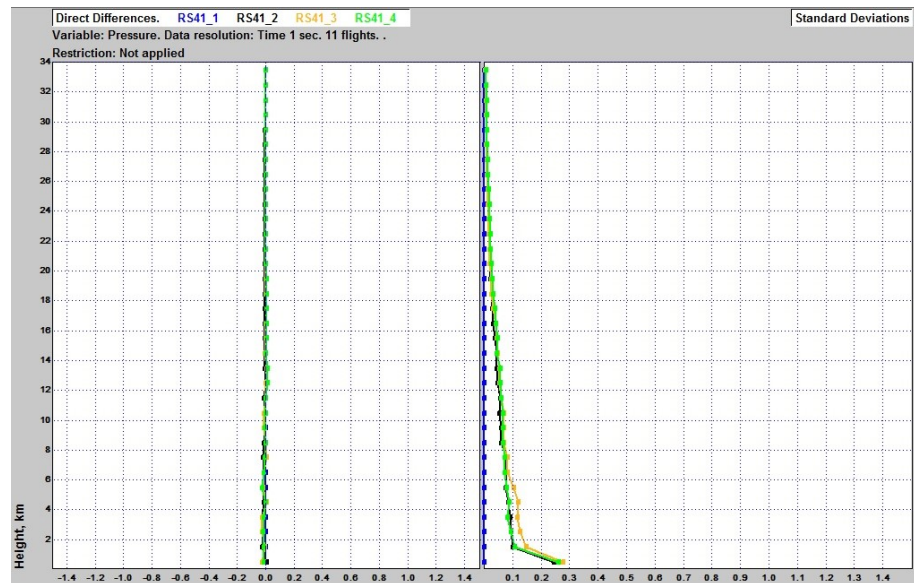


Figure 14. The direct differences and reproducibility of pressure measurements in eleven comparison soundings in tropical latitude.

Wind Measurement

The reproducibility of the Vaisala Radiosonde RS41 wind velocity measurements has been analyzed in Helsinki (high latitude), shown in Figure 15, and in Malaysia (tropical latitude), shown in Figure 16. The data in the figures is from daytime and night time soundings in various weather conditions. In the figures, the average difference between the four RS41 radiosondes is indicated in the left pane and the standard deviation of difference in the right pane. RS41_1 and _2 indicate radiosondes with plastic covers as RS41_3 and _4 indicate radiosondes with improved covers.

The results show that the cover type does not influence the GPS-based pressure measurement performance. The averaged differences between the different cover versions are small and of the same magnitude as between radiosondes having similar covers. The reproducibility for wind speed is on the level of 0.15 m/s.

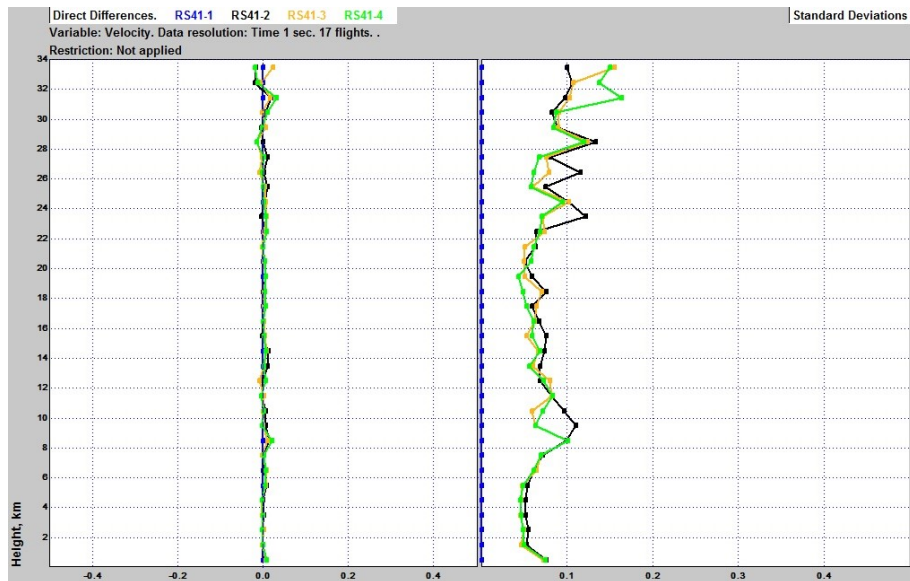


Figure 15. The direct differences and reproducibility of wind measurements in seventeen comparison soundings in high latitude.

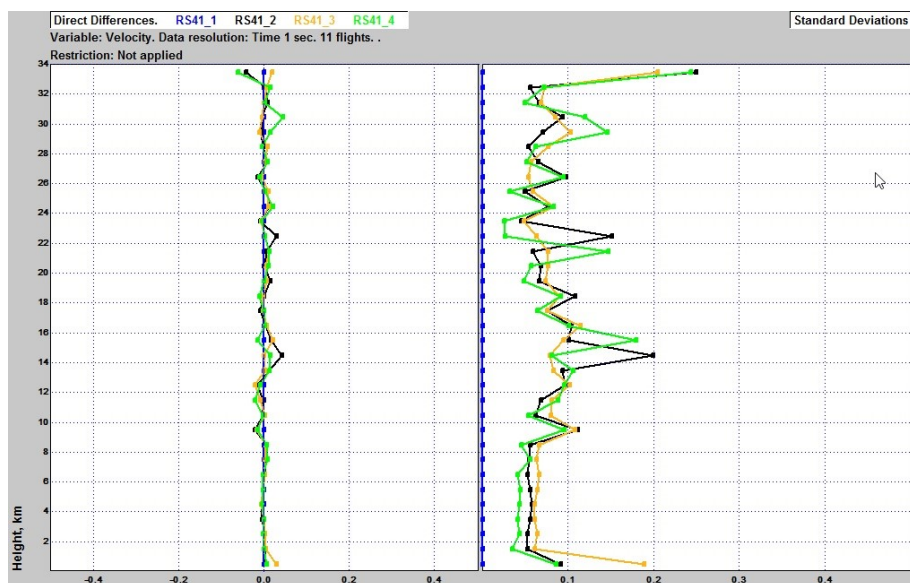


Figure 16. The direct differences and reproducibility of wind measurements in seventeen comparison soundings in tropical latitude.

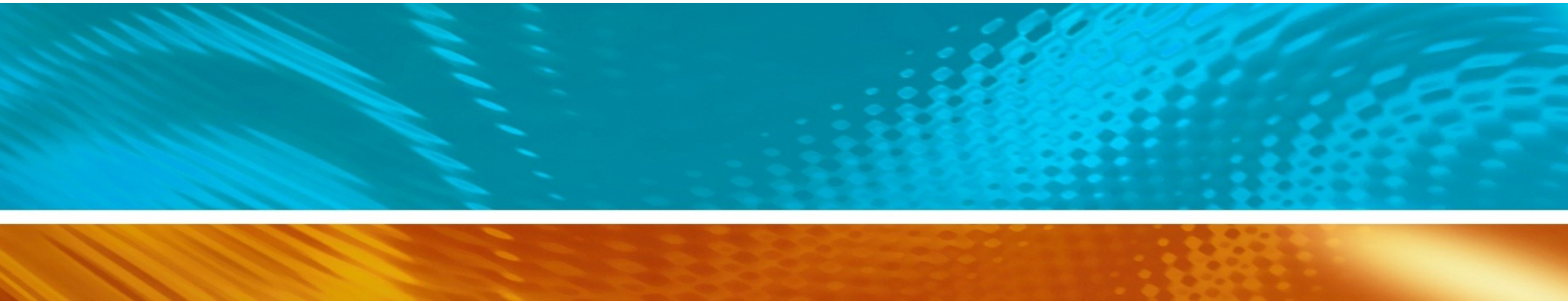
CHAPTER 3

SUMMARY

Regarding sounding operations and radiosonde measurement performance, the cover improvement applied to RS41 radiosonde does not involve any changes, but this is a significant change from the environmental point of view. With the improved covers, the plastic content of RS41 is decreased by 47% and the weight by 27% when compared to the hard plastic cover version.

As shown by the comparison flight data in Chapter 2, the change does not have any impact on the measurement performance of RS41. All specifications and previously published performance white papers fully apply. In addition, sounding operations remain the same, extremely simple and user-friendly.

The change is communicated also in www.vaisala.com, having no effect on the RS41 data continuity.



www.vaisala.com