Snapshot of transition monitoring Vaisala radiosonde RS92 to RS41 at GRUAN and DWD site Lindenberg

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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Introduction

The upper air sounding site at Lindenberg Meteorological Observatory is a certified GRUAN site since 2014 and supports the ongoing work of the GRUAN Lead Centre (GRUAN-LC) regarding the GRUAN change management (Dirksen et al., 2014, Immler et al., 2010) and transition of Vaisala radiosonde RS92 to RS41. Furthermore it supports the development of the RS41 GRUAN data product. Basic investigations take place to quantify differences between both radiosondes referring error sources, bias, uncertainties and noise to derive suited corrections. Concerning this matter essential experiments are dual-soundings, climate chamber measurements, radiation error measurements and humidity calibration checks with reference saline solutions at laboratory ambient temperature conditions. This publication has the objective to show the work status of some experiments, but primary try's to request experiences and new ideas about shown results.

Plots of sounding data are based on experiments done at Lindenberg Meteorological Observatory and during the StratoClim* balloon campaigns in India (2016), Nepal (2017) and on Palau island (2018). This dataset is used here as "all sites".

Pressure

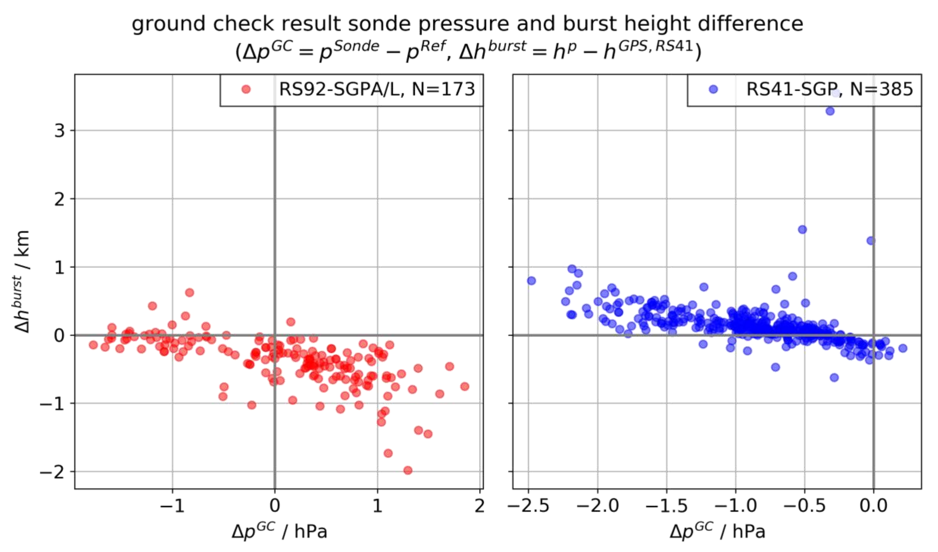

Figure 4: Ground check results versus burst height difference.

Weather services like the DWD or other institutes for atmospheric research prefer measuring air pressure than deriving from GNSS (global navigation satellite system) positioning. Vaisala provides the RS41-SGP type with a building silicone pressure sensor. That sensor is adjusted during the ground check procedure.

A connection between needed adjustment and differences of pressure measurements especially at usual burst heights (~30 km) is assumed from comparisons with pressure was derived from GPS (see Figures 4 und 5).

A balloon-borne pressure reference is needed and would make further comparisons more reliable.

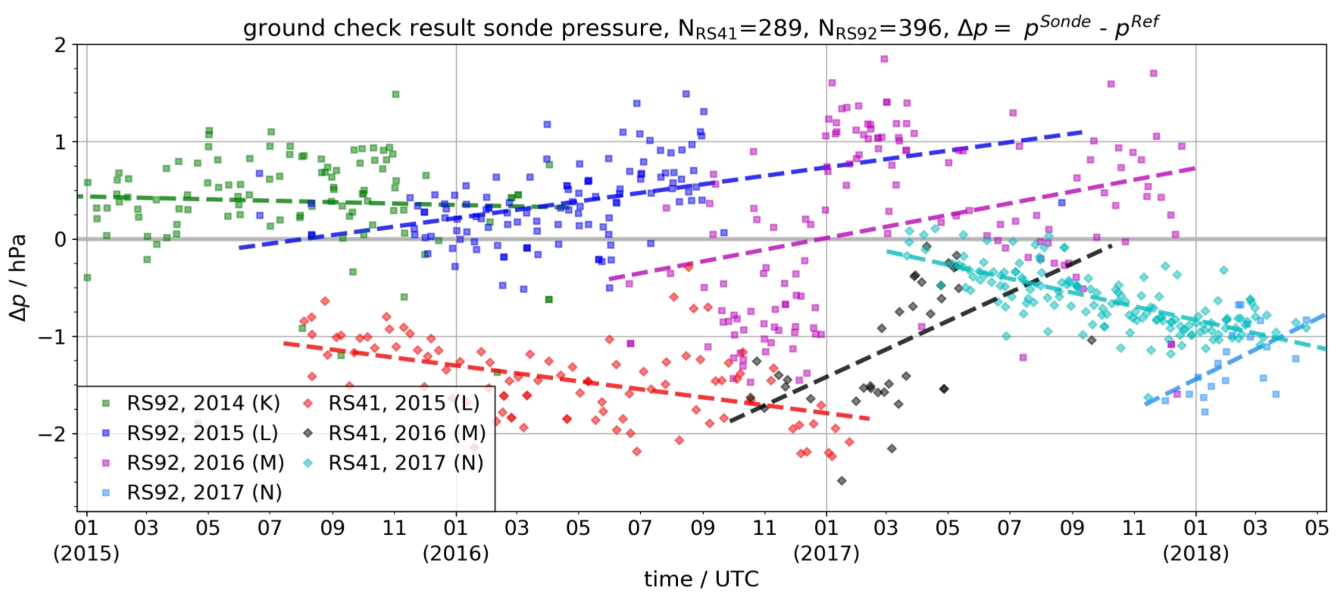

Figure 5: Comparison of RS41 and RS92 pressure adjustment from ground check by radiosonde batches. It is visible that the adjustments is sometimes more than 1.5 hPa.

Humidity

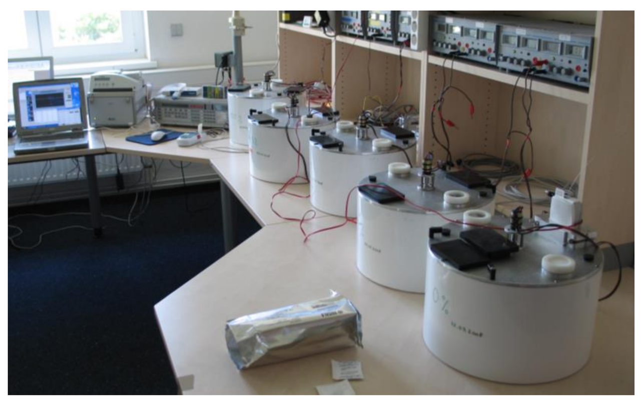

Figure 1: Radiosondes humidity cal. check in standard humidity chambers.

Humidity calibration of radiosonde batches is checked in laboratory experiments with conditions of well known humidity references. This conditions are generated in standard humidity chambers, short SHC (Figure 1), in respect to saline solution surfaces near 11, 33 and 75 %RH und chemically clean water surfaces at 100 %RH and room temperatures above 21 °C. The chambers are well ventilated (> 5 m/s at sonde sensor boom). Figure 2 shows normalized distributions of humidity differences (sonde - reference) and related statistics by median, interquartile range and 5% und 95% percentile. RS41 results in lower uncertainties of calibration and improved absolute calibration in contrast to RS92. More than 90% of the most common humidity differences are within ±1 %RH for RS41.

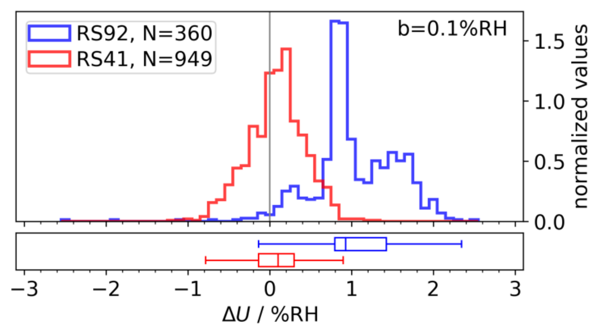

Figure 2: Results of humidity calibration checks of RS41 and RS92 from different batches (calculated sonde - reference).

Results from dual-soundings concerning humidity comparisons of RS41 and RS92 are shown in Figure 3. It is currently expected, that from an improved lower dry bias RS41 humidity measurements are more realistic than from RS92 especially in high humidity situations and low temperatures. A comparisons dataset with the CFH (cryogenic frost point hygrometer) reference is available and should state this in near future. The RS41 humidity sensor utilizes a continuous heated polymer at sensor temperatures of +5 K compared to the ambient temperature. At water saturated conditions the sensor therefore is measuring at approximate 75 %RH. The heating system provides not only reduced issues from contamination with liquid water, but also avoids sensor icing and improves the temperature depended the sensor time lag. While a temperature measurement at the polymer is needed for controlling the heating system, the sounding system is using this temperature information to reduce the radiative forced dry bias. RS92 has no such temperature monitoring possibility of the humidity sensor.

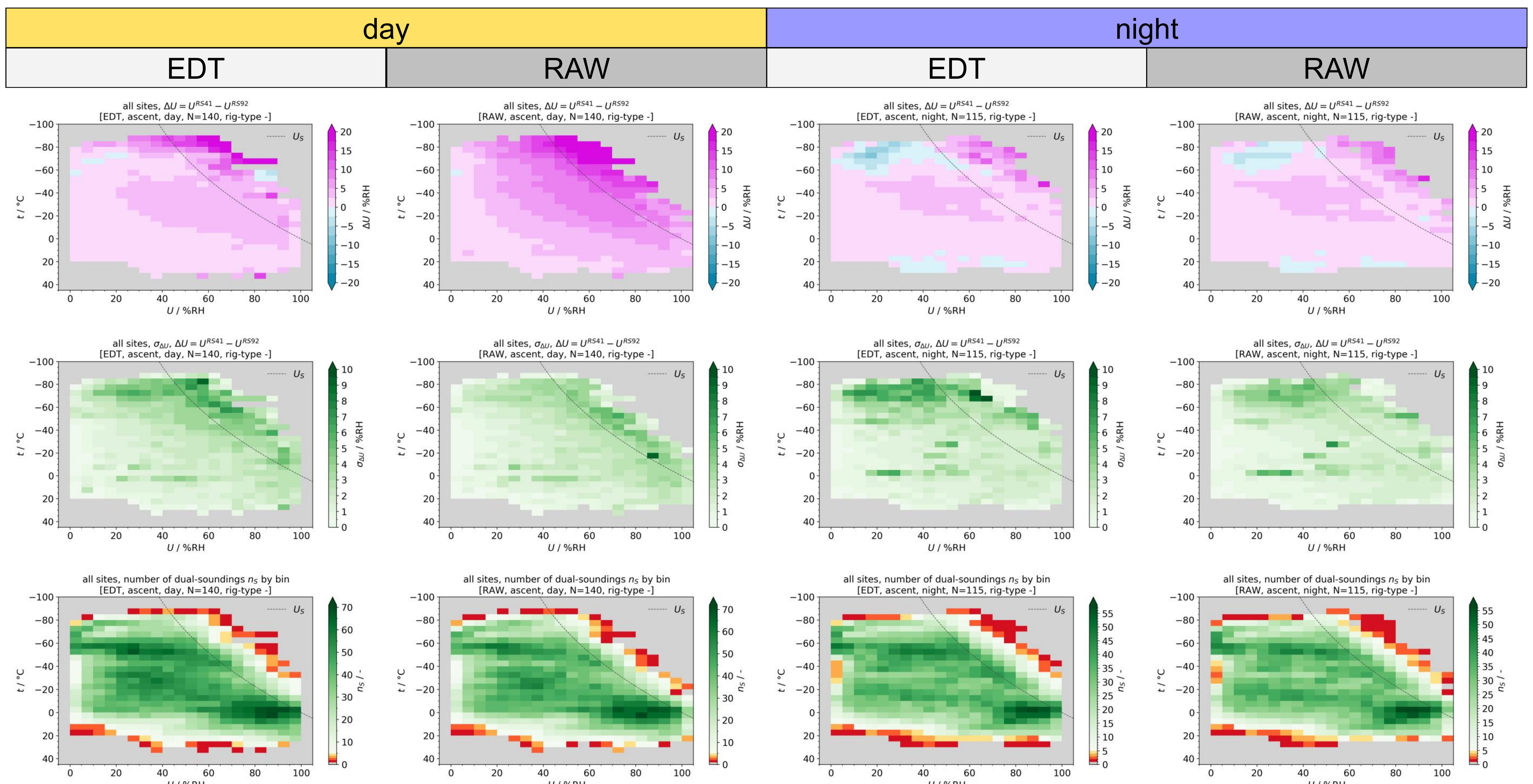

Figure 3: Humidity differences (RS41-RS92), standard deviation and number of soundings per temperature and humidity bin measured with RS41. *EDT* is edited data and *RAW* is raw data from Vaisala archive files. A significant day/night difference is clear visible from RAW data.

Temperature

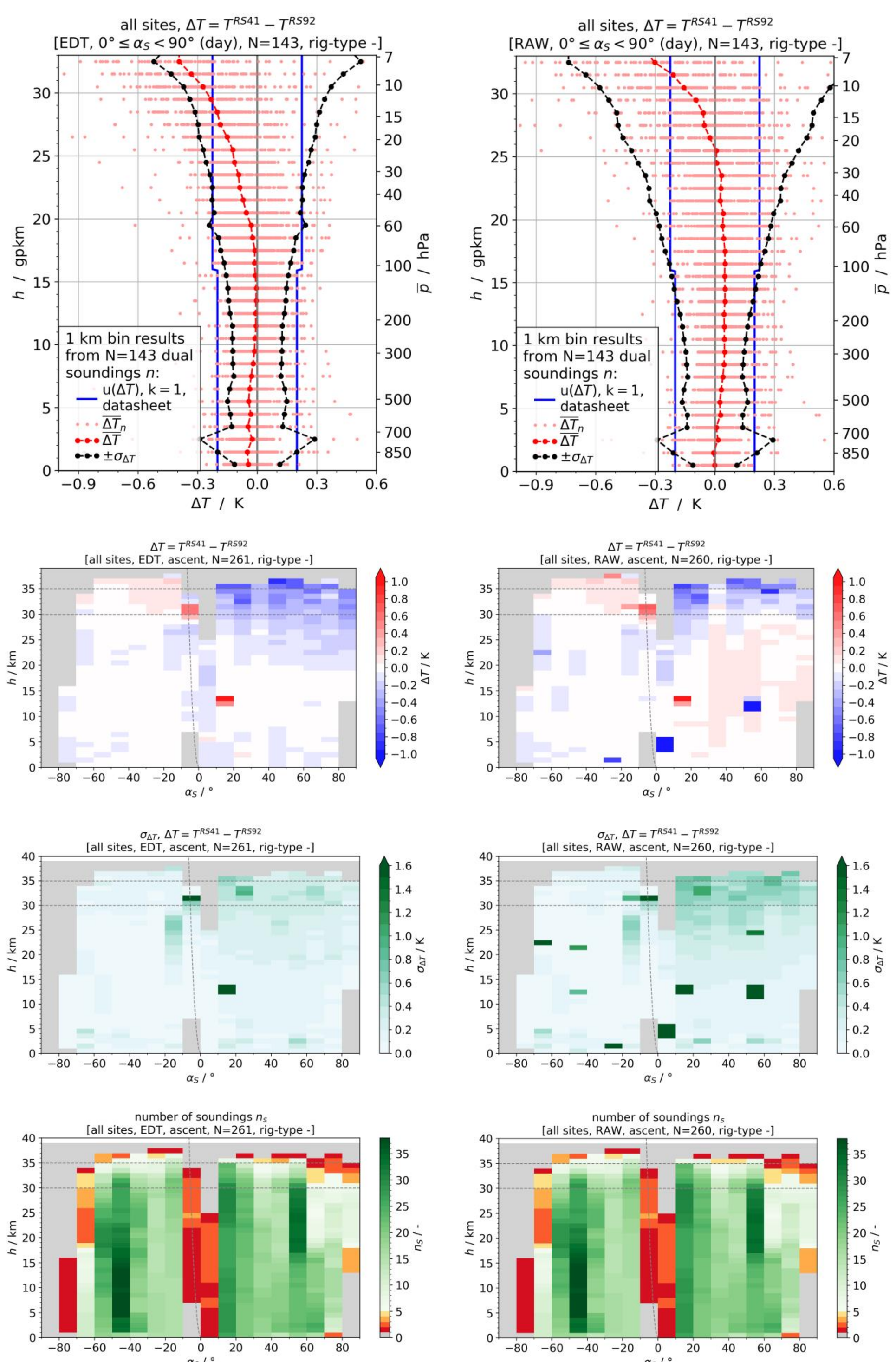

Figure 7: Overall result of temperature difference RS41-RS92, standard deviations and number of soundings per bin. α_S is the solar elevation angle. This summaries data shown byFigure 8.

The radiosonde temperature is measured together with a PT100 temperature reference during 100 %RH humidity checks with the standard humidity chamber (SHC). The setups are similar to those in Figure 1. In Figure 6 the comparison results by normalized distributions of humidity differences (sonde - reference) and related statistics by median, interquartile range and 5% und 95% percentile is visualized.

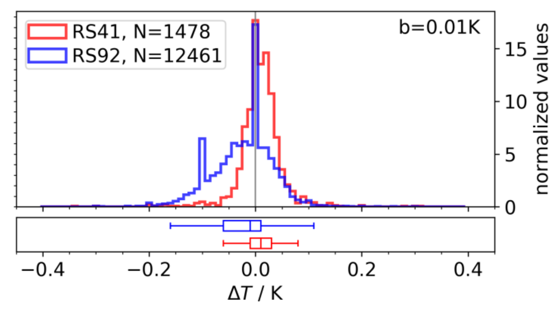

Figure 6: Temperature comparison in 100 %RH SHC.

From comparison flights with RS41 and RS92 temperature differences are getting analyzed in respect to height and solar elevation angle α_S (see Figure 7). Also the influence of the rig setup on temperature differences of vertical resolutions of 1 km height is tried to be focused on (see Figure. 8). As first coarse result, differencing rig-types this influence is lower than ±0.2 K at given vertical resolution of 1 km. The data coverage was extended to α_S > 60° by StratoClim*.

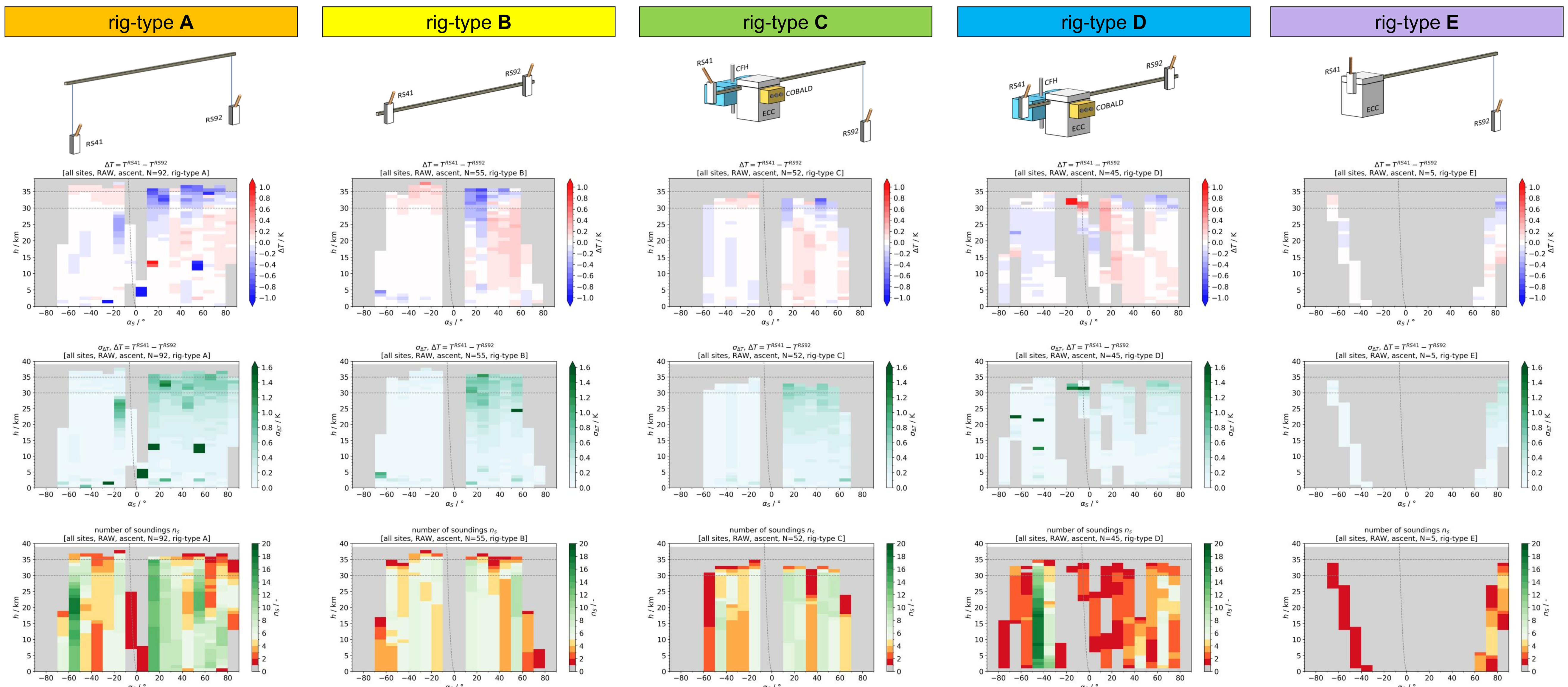

Figure 8: Results of RAW temperature difference RS41-RS92, standard deviation and number of soundings per bin and grouped by rig-type. Schematic drawings shows the differentiated rig types. Hanging sondes are about 80 cm below the rig mounting bar. In Lindenberg rig-types A, B and C were used for RS41/RS92 comparisons. At StratoClim* 2016 rig-types B and D, at StratoClim 2017 the rig-types A and D and at StratoClim 2018 the rig-types A and E were applied.

Acknowledgement

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