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Original

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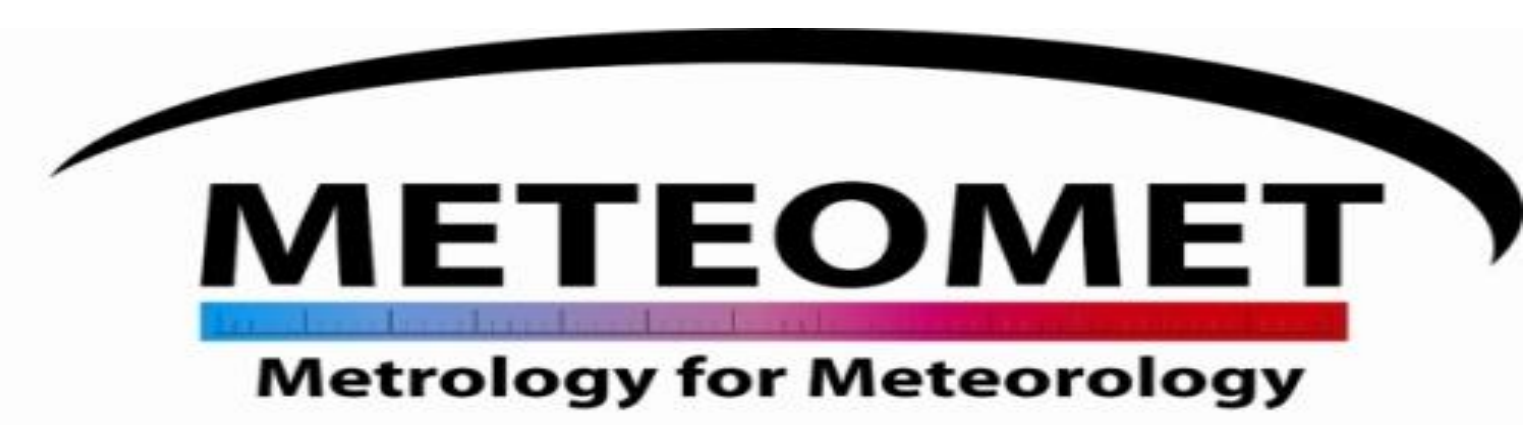
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Intercomparison of Vaisala RS92 and RS41 radiosonde temperature sensors under controlled laboratory conditions



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Abstract

Radiosoundings are essential for weather and climate applications, as well as for calibration and validation of remote sensing observations. In the fall of 2013, Vaisala introduced the **RS41 model to progressively replace the RS92**. To ensure the highest quality of measurements following the transition from RS92 to RS41, a methodology was introduced to **simultaneously test and compare the two radiosonde models inside climatic chambers, in terms of noise, calibration accuracy, and bias in temperature measurements**. A pair of RS41 and RS92 radiosondes has been **tested at ambient pressure under very different temperature and humidity conditions**, reproducing the atmospheric conditions that a radiosonde can meet at the ground before launch. The radiosondes have also been **tested before and after fast temperature changes of about ±20 °C**, simulating a scenario similar to steep thermal changes that radiosondes can meet when passing from indoor to outdoor environment during the pre-launch phase. The results show that the **temperature sensor of RS41 is less affected by noise** and more accurate than that of RS92, with noise values less than 0.06 °C for RS41 and less than 0.1 °C for RS92. The deviation from the reference value, referred to as **calibration error**, is **within ±0.1 °C for RS41** and the related uncertainty is less than 0.06 °C, while **RS92 is affected by a cold bias in the calibration**, which ranges up to a few 0.1 °C, with a calibration uncertainty less than 0.1 °C. The temperature bias between RS41 and RS92 is within ±0.1 °C, while its uncertainty is less than 0.1 °C. **The thermal changes that radiosondes can meet during the pre-launch phase might lead to a noise increase in temperature sensors during radiosoundings**, up to 0.1 °C for RS41 and up to 0.3 °C for RS92, with a similar increase in their calibration uncertainty, as well as an increase in the uncertainty of their bias up to 0.3 °C.

Climatic chambers for the RS41-RS92 comparison



Climatic chamber Kambic MeteoCal KK-105 in operation at INRiM.

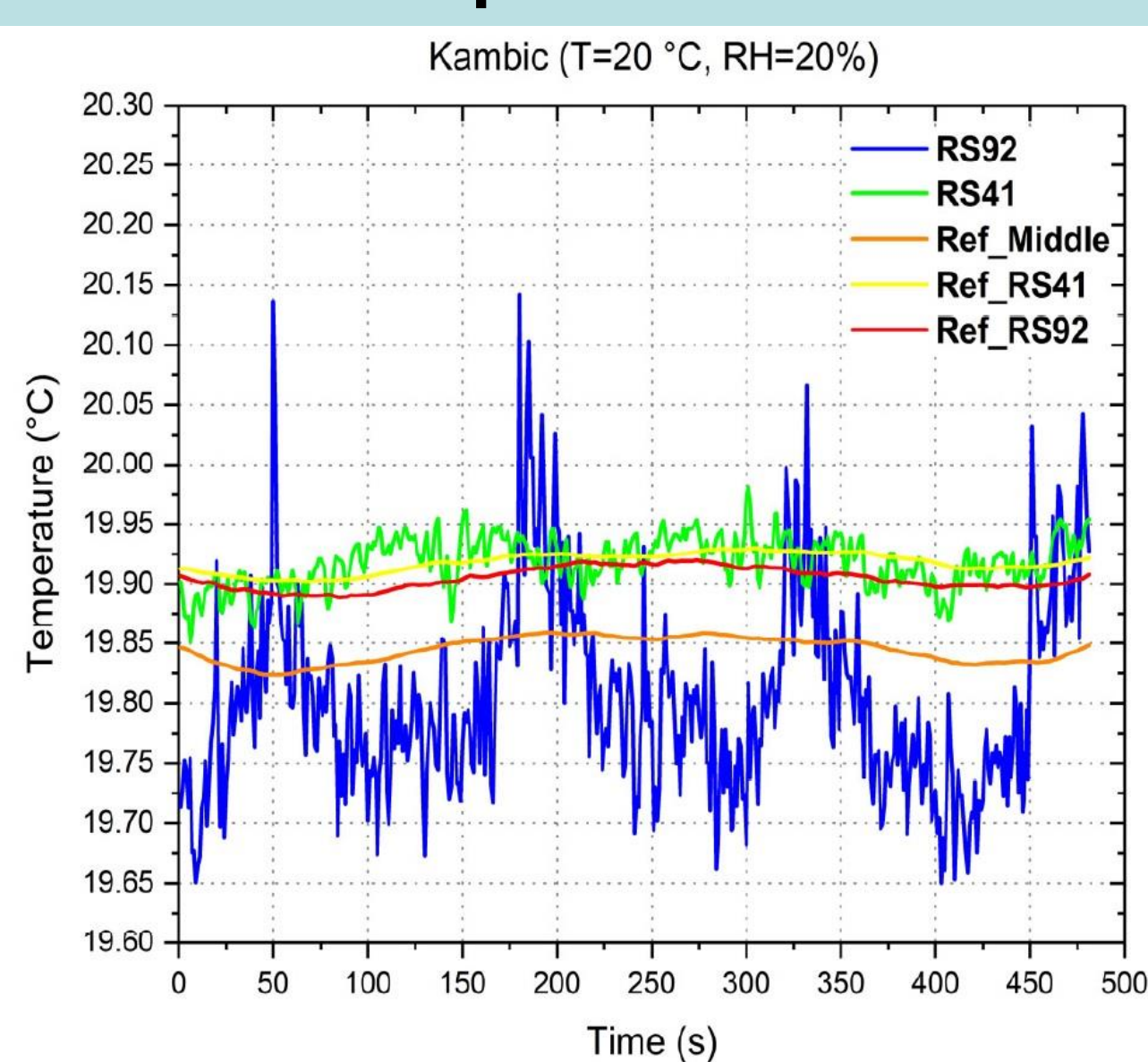


Photo of the measurement layout inside the Kambic chamber.

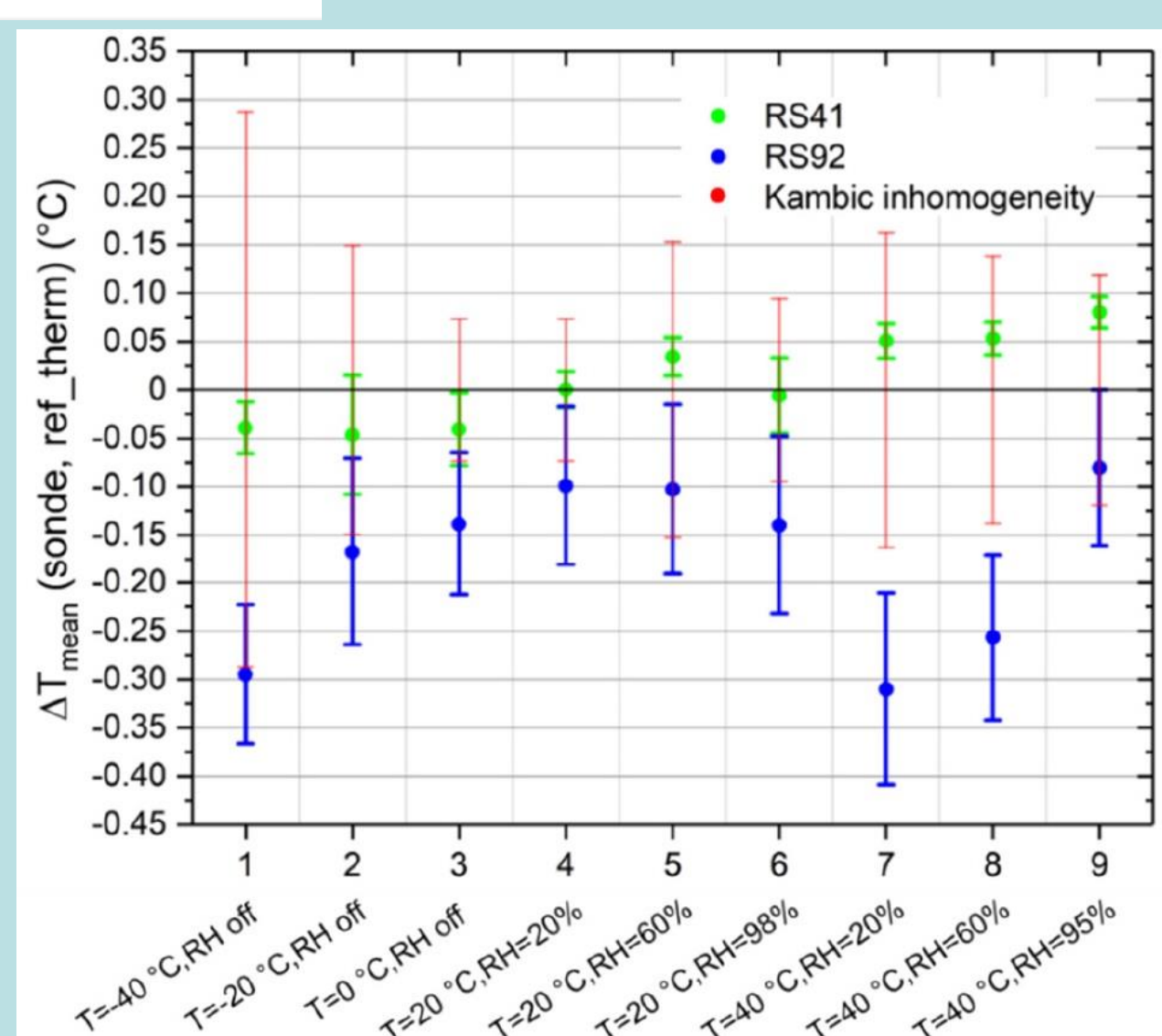


Climatic chamber Weiss Technik in operation at INRiM and used, coupled with the Kambic chamber, to test RS92 and RS41 before and after fast temperature changes.

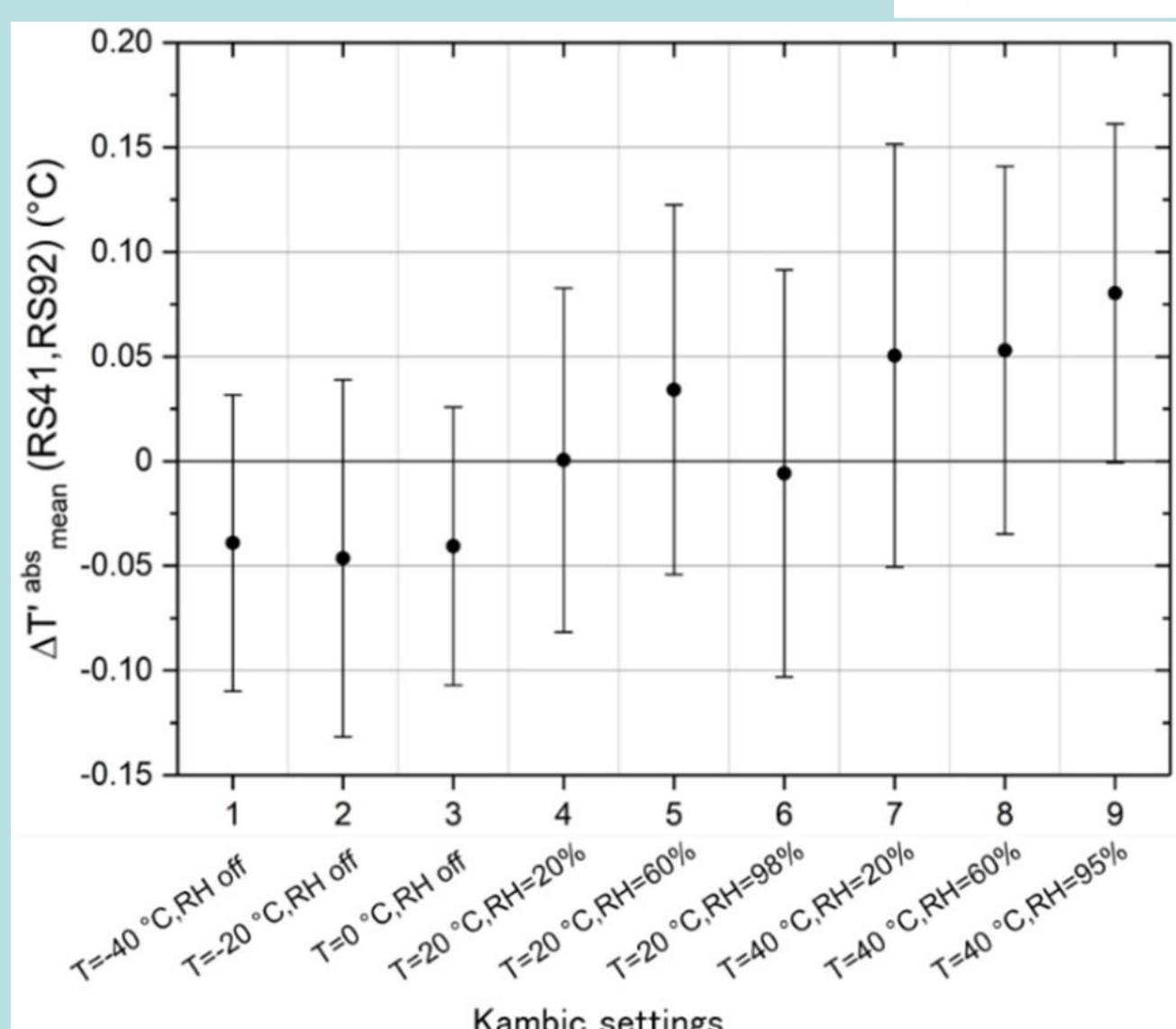
Comparison in climatic chamber



Example of temperature read by the two sondes, in comparison with reference temperature sensors

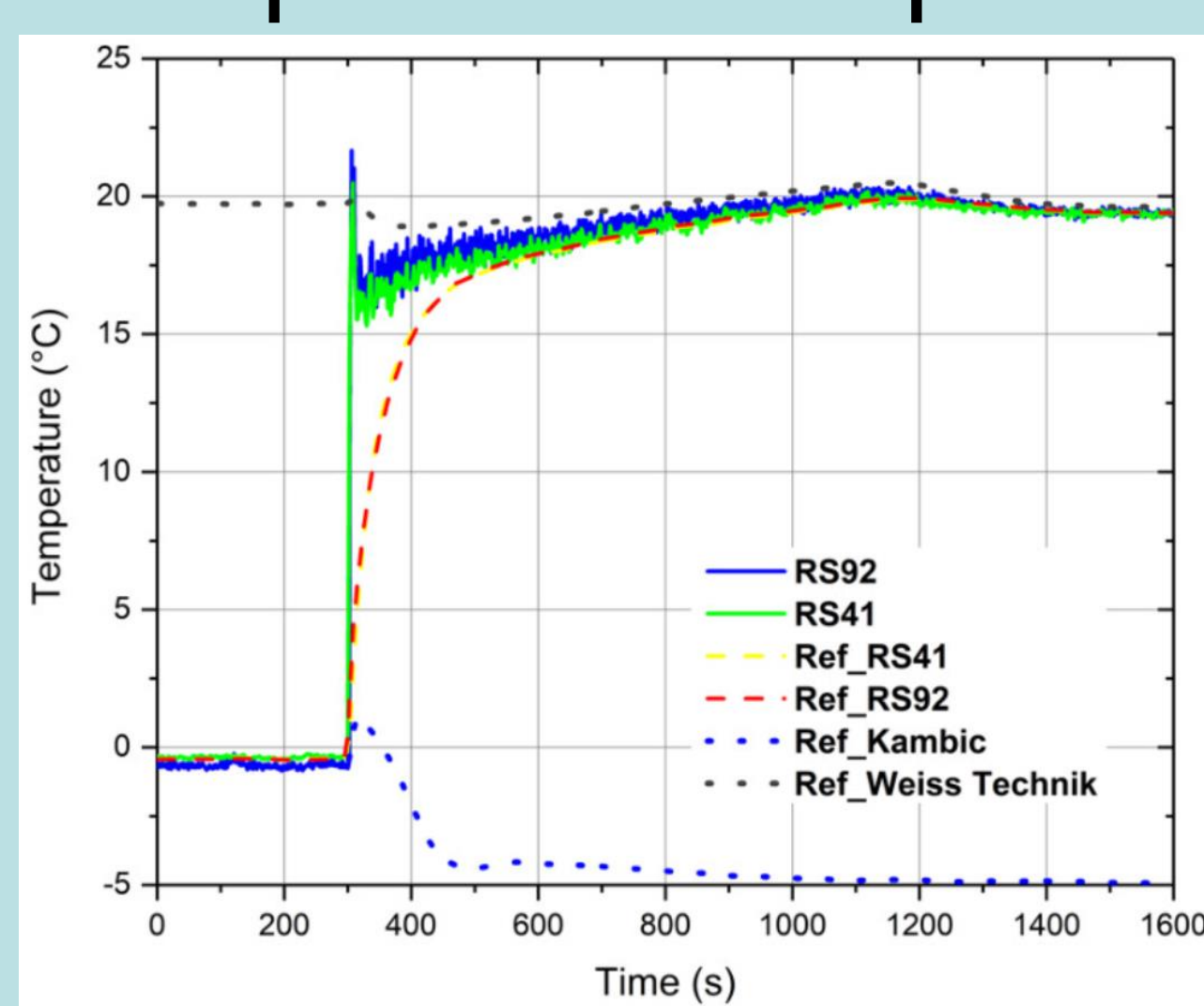


Temperature differences between the sondes at different temperature and humidities



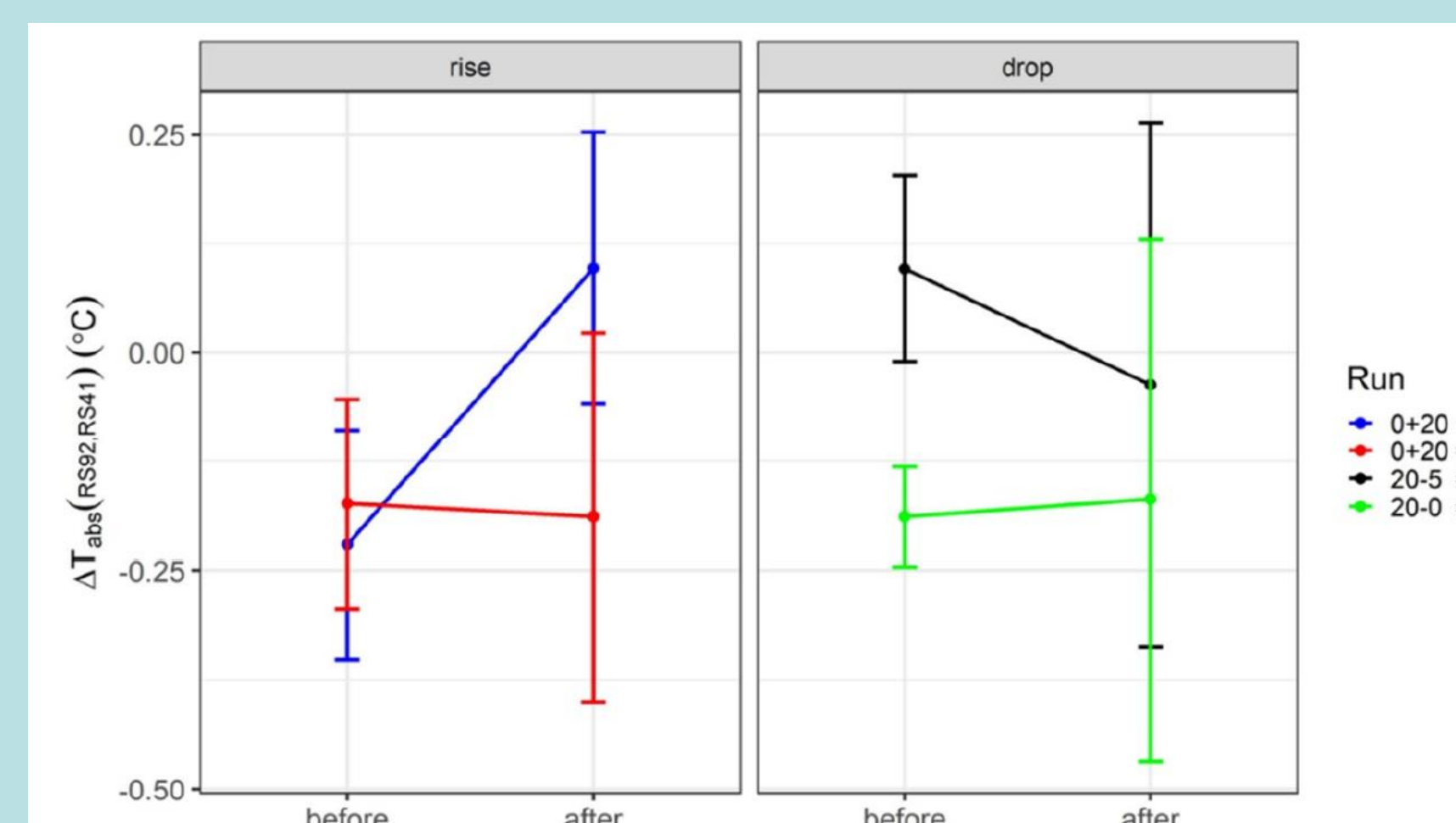
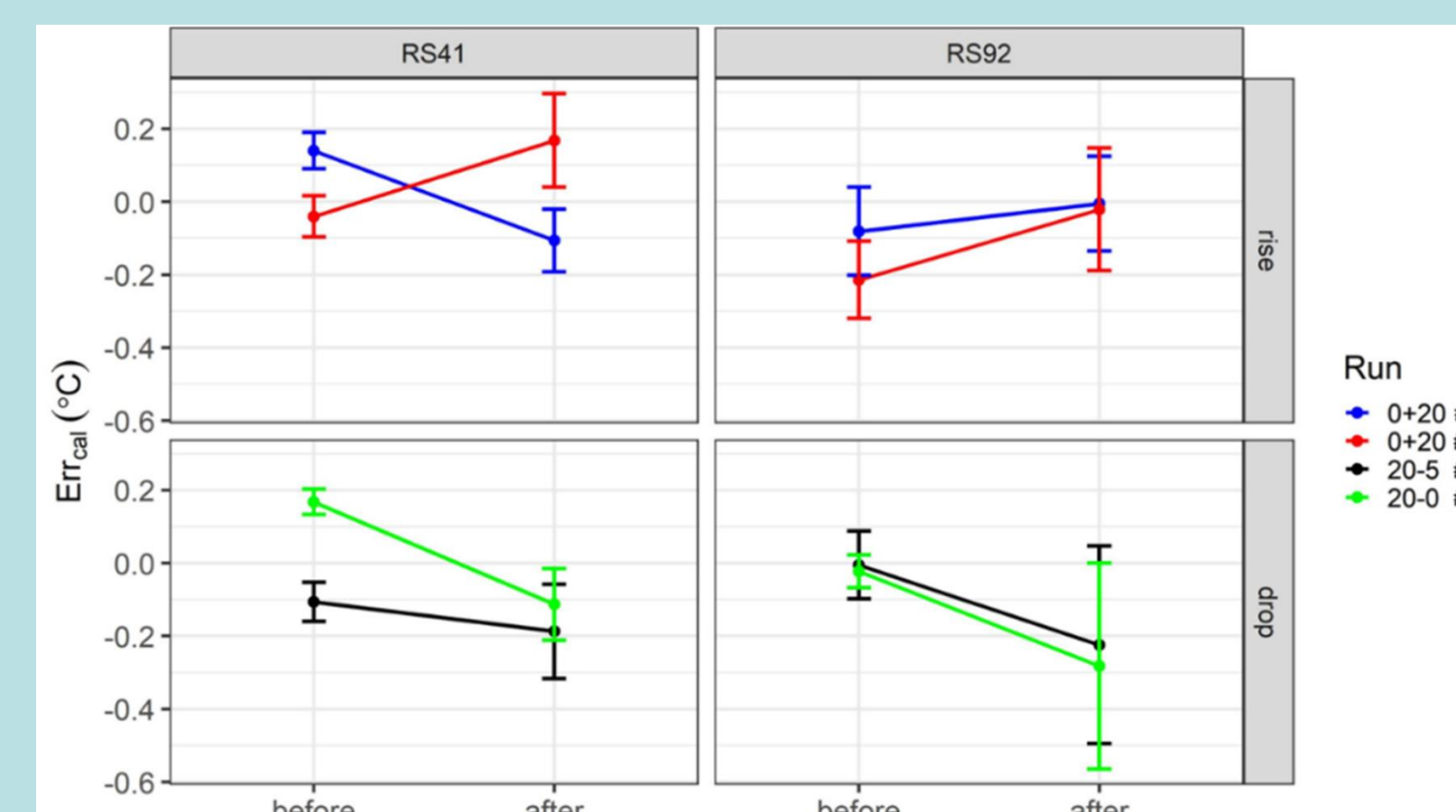
Mean corrected temperature bias between RS41 and RS92. The vertical bars represent the repeatability calculated as the standard deviation.

Temperature step-change comparison



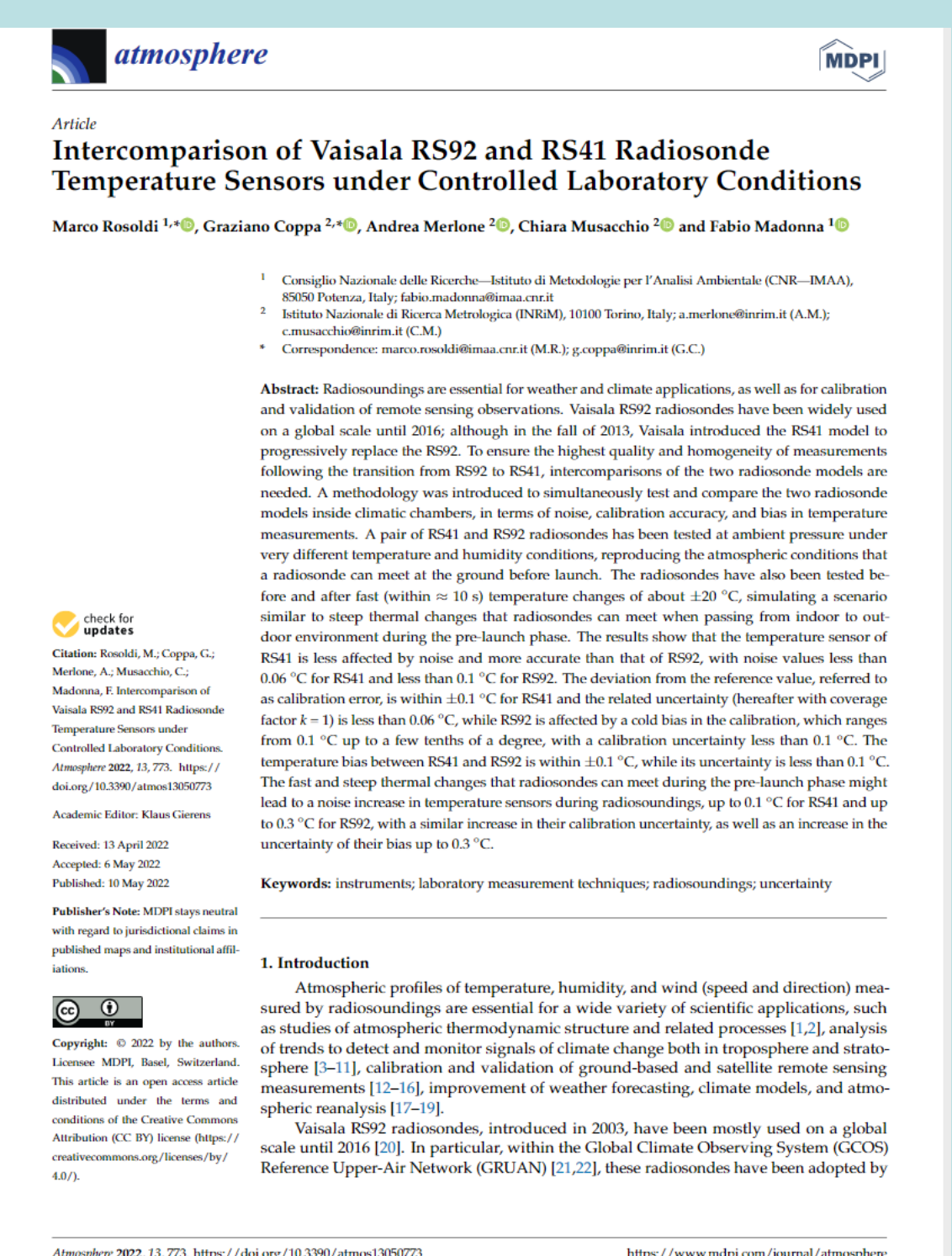
Plots of calibration errors and related uncertainties (vertical bars) for RS41 and RS92 temperature sensors before and after the temperature changes (vertical axis). Top panels refer to rising changes, bottom panels to dropping changes, left panels to RS41 and right panels to RS92

Example step-change in temperature, from 0 °C to 20 °C, performed by moving the sensors' frame from one chamber to the other. Solid lines refer to the radiosondes, dashed lines refer to the reference thermometers, dotted lines refer to the chambers' thermometers.



Temperature absolute bias before and after the temperature change

Paper with details



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