

Response to Reviewer #2 (RC2)

Comment:

5 “One major concern is that the SISTER setup operates only at room temperature. As
previously reported, the radiation correction of the RS41 temperature sensor presented a
temperature dependency (Lee et al. Meteorol. Appl. 27, e1855, 2020). In the paper, the
radiation correction value (ΔT) of the RS41 is increased by 18% as the temperature is
decreased from 20 °C to -70 °C at a constant $p = 7$ hPa and $v = 5$ m/s. In this regard, the low
10 temperature effect cannot be ignored by the sentence “However, it is not expected ... and
the convective cooling.” in lines 665-668 in Summary and conclusions.”

Reply:

15 We are aware of the measurements presented in Lee (2020). Indeed, the
measurement points in Fig. 9 of that paper suggest an increase of ΔT at the lowest
temperatures at least for pressures below 30 hPa. However, as noted in the
conclusions of Lee 2020, no uncertainties were evaluated for the ΔT -measurements,
so that we think a reliable assessment of the results is not (yet) possible at this stage.
We think that more information is required, e.g. experimental data or quantitative
20 model calculations, to evaluate if and to what extent the dependence on the ambient
temperature is significant, and to clarify whether the observations can be explained
primarily by long-wave radiation. We are looking forward to learning more in the
upcoming study amt-2021-246 (see reply to next comment below).

25 The sensitivity of convective cooling to decreasing absolute temperature is not
directly obvious, since both thermal conductivity and viscosity decrease, whereas
density increases. As Lee et al. state, the absolute values for ΔT will be lower at a
more realistic incoming flow with inclined sensor boom (because of higher flow
resistance and more efficient heat loss), but the sensitivity to absolute temperature
may be different as well. It is not straightforward to evaluate whether the convective
cooling at low pressure loses significance such that longwave cooling dominates
when temperature decreases.

30 There are significant differences between the long wave radiation environment in the
laboratory setup and in the free atmosphere. In the laboratory setup there is a uniform
background emitted by the walls of the measurement chamber, with only a small
temperature difference with respect to the temperature sensor. In the free
atmosphere the long wave radiation background is composed of, amongst others,
35 contributions from the air masses and surface below and from the cold cosmic
background. Therefore, it cannot be excluded that the observed low-temperature
effect is to some extent specific for the conditions inside the measurement chamber.

Comment:

40 “Recently, Lee et al. submitted a new paper to the Atmospheric Measurement Techniques
(amt-2021-246) which deals with a potential solution for this issue by providing a formula to
estimate ΔT at low temperatures by only using measurements at room temperature. In
the paper, ΔT of the RS41 is increased by 20% as the temperature is decreased from
20 °C to -67 °C at a constant $p = 5$ hPa and $v = 5$ m/s. Therefore, it is more desirable for the

GRUAN to include the low temperature effect for the radiation correction for the GRUAN data processing. I would suggest the authors to comment on this point in their Conclusions.”

Reply:

5 We are very much looking forward to reading the results presented in amt-2021-246 once it is published. As the paper in question was not available when we prepared our manuscript (and at this moment still is not available), it is not possible to include a discussion of it in our manuscript.

10 **Specific comments:**

1) Line 665-668: The sentence “However, it is not expected ... and the convective cooling.” should be revised because the low temperature effect on the RS41 temperature sensor was observed previously and again recently (amt-2021-246). The same phenomenon was also observed for thermistor-type T-sensors even though there is no apparent air ventilation (Lee et al. Meteorol. Appl. 25, 283, 2018). Based on the fact that the low temperature effect
15 appeared when the convective cooling was limited (no apparent ventilation), it is likely due to the T4 dependent long-wave radiation from the sensor.

Reply:

20 We will revise the relevant paragraph and add a reference to Lee (2018).

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