Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2022-259-RC2, 2023

Comment on amt-2022-259

Anonymous Referee #2

Referee comment on "A new airborne broadband radiometer system and an efficient method to correct dynamic thermal offsets" by André Ehrlich et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-259-RC2, 2023

This paper describes the physical set up and processing methodology for a broadband radiometer measurement system on the HALO research aircraft. Both the engineering design and the processing are carefully done, tested, and documented. In particular, a derivation of the theory behind thermal offset corrections in quickly varying temperature conditions such as ascent and descent is given and applied to the data. Downwelling shortwave data is also corrected for attitude in flight using methods documented in the literature. The manuscript is well written, the methods are scientifically sound, and the work describes a high-quality radiation measurement system for a specific aircraft. This paper documents measurements that will be of great value to the scientific community for measuring radiative heating rates. I recommend this manuscript for publication after the authors respond to the minor points below:

- The abstract states that the correction function "depends on the mounting position of the radiometer on HALO." Please clarify what is meant by mounting position, and how conclusive this statement should be as several statements were made in the paper related to the impacts of mounting position, some of which seemed fairly conclusive and others more as hypotheses. In section 3.3 (Figure 3), the larger differences in sensor temperatures between the pyranometers than pyrgeometers rather than the upwelling or downwelling instruments is explained as being a matter of "the internal sensor housing" which I took to mean inherent to the differences in the instrument construction rather than how they were mounted on the plane. In section 5, the coefficients of the upper and lower pyranometer are described to differ by a factor of 2, and this is attributed to differing airflow between the two systems given the slight tilt of the plane. Then later in section 5, the up and downlooking pyrgeometers had much similar beta values which was hypothesized to be because "the CGR4 sensors are placed in front of the CMP22s". While there is a difference between sensor temperature agreement and agreement in coefficients for the corrections for dynamic offsets, they are related. I am curious whether the explanations that the authors give for these factors that cause differences in CMP22's and CGR4's thermal responses (position relative to airflow in section 5, and internal sensor differences in section 3.3) are perhaps related and how important the relative ventilation of the radiometers is

thought to be in comparison to sensor differences.

- I had a couple of questions about the practicality of the attitude correction method used. It seems to be sufficiently accurate, and the HALO aircraft remarkably level in most flights, so these are minor concerns that the authors shouldn't need to address for the publication of this paper. But I still found myself curious about a few practical details. The authors state that only the direct beam should be corrected for, so this correction should only be applied to clear sky conditions. I agree with that, however, I didn't understand how the data was determined to be clear or cloudy. In the test case, the profiles could be determined to be clear fairly easily by visual inspection, though I would imagine this would be a harder job for a full field campaign. Was this correction run at all times and it left to users to determine whether to use the corrected or uncorrected data or is some kind of determination made for a best estimate value? Also, as the correction was based on radiative transfer calculations using atmospheric profiles from drop sondes or radiosonde launches—I was curious whether these will always be available for all campaigns where the HALO flies?
- My primary concern with the methodology is that it wasn't clear to me in the text which thermal offset corrections are applied to the data (that derived in section 2.3 only, or also a correction derived in section 2.2). In Figure 6, after the dynamic linear-fit correction has been applied, there are still negative biases in the downwelling solar irradiance of 5-10 W/m^2 at night. I don't see an adequate explanation for what this bias is. The reason given in lines 348-349, "caused by different uncertainties such as the radiometric calibration of the pyranometer", seem quite hand-wavey and not satisfying to me compared to the careful work done elsewhere in deriving the corrections. A calibration error is multiplicative so shouldn't give a bias at night. It seems more likely to me from the shape of that bias (larger with higher altitudes) that it is in fact related to a thermal offset (like that derived in section 2.2) that isn't corrected for using the "beta" linear fit. The author's state in lines 325-326 that a more complex multi-variate fit including Tref doesn't improve the correction, and conclude that therefore the dynamic dome effect can't be discriminated from the thermal offset. But they don't show those results, and I still can't help but think that the post-correction results in Figure 6 look like they are still impacted by an equilibrium thermal offset. Also, Figure 4 shows downwelling SW offset corrections even in level flights when the temperature doesn't appear to be changing significantly, which implies that the static offset is taken into account in some way. So it was unclear to me whether the dynamic offset (beta) correction was applied to this data or a static offset as derived in section 2.2.

Minor comments:

- Line 6: it would read better as "an efficient new method".
- Line 30: should it be "which can be measured directly"
- Line 55: should be "Actively stabilized pyranometers"
- Line 80: Section 6 is not specifically referenced in the paragraph about the structure of the paper. Did you wish to add that?
- Line 92: should be "In the case of the pyrgeometer"
- Line 108: I think rho_p should be rho_d in the rho_s*rho_p << 1 assumption.
- Line 157: two the's at end of the line

- Line 244: should be “To enable maintenance”
- Line 265: What does “one magnitude lower” mean? Does this mean one order of magnitude lower?
- Line 313: should be “depends”
- Line 416: The wording at the beginning of this line is unclear.
- Line 508: should be “The data are used by Luebke et al (2022)”