Review AMT-2020-397
The De-Icing Comparison Experiment (D-ICE): A study of broadband radiometric measurements under icing conditions in the Arctic

General comments:

The manuscript presents results from "The De-Icing Comparison Experiment" (D-ICE) which was conducted from August 2017 to July 2018 at the NOAA Atmospheric Baseline Observatory in Utqiaġvik, Alaska (71.3°N). In addition, data from the DoE ARM NSA (also Utqiaġvik) and Oliktok Point (250 km east of Utqiaġvik) sites were used. Main objective was to study existing ventilation and heating technologies developed to mitigate radiometer icing. D-ICE comprised 20 pyranometers and 5 pyrgeometers operating in ventilator housings from various vendors alongside operational systems such as BSRN and ARM. Ventilator/heater performance was high with an average ice mitigation at 77% and many being 90 % effective or even better. In addition, a record of ice-free radiative fluxes was compiled. This data set was used to quantify short- and long-term biases in iced sensors. While biases in instantaneous 1-minute records can be up to +60 and -211 to +188 Wm^{-2} for long-wave and shortwave fluxes, respectively, the corresponding biases in the monthly means were substantially smaller at less than approximately 2 Wm^{-2} except for some few systems with insufficient ice mitigation. Finally, observed ice mitigation processes were verified in the laboratory: ventilators without heaters were postulated to be effective by providing heat through waste energy from the fan and adiabatic heating.

The Earth's radiation fluxes play a fundamental role in the climate system, thus accurate ground based observations of shortwave and longwave radiative fluxes are essential for long term monitoring and validation of corresponding satellite products and climate model outputs. Therefore, such experiments are of great importance. D-ICE is an impressive and comprehensive experiment, conducted and documented very carefully. It is unique with respect to its extent providing very useful and novel results.

The manuscript is very well structured and clearly written. The literature has been selected and cited carefully. Graphics and tables are clear and the captions self-explanatory. This work is a very interesting and a valuable contribution to the atmospheric science community and is in my opinion absolutely suited for publication in AMT. I recommend publishing with minor revisions and/or technical corrections.

Specific comments:

- The heater in the 480 unit from Eigenbrodt is operated at 25 W. I expect a substantial warming of the radiometer's body as shown in Fig.1a (on the next page). While the long-wave irradiance is interestingly not necessarily affected (Fig. 1b), the overheating reduces the stability of the pyranometer measurements considerably (see Fig.2). Thus, a high power heating system may boosts ice mitigation but it can affect the observations negatively. Did you also observe higher case temperatures of systems operated at 15 W or higher with respect to heaters running at 10 W?

Some technical corrections:

- Line 310: add 'with respect to windowless long-wave radiometers'
- Line 320: SWD on 13-14 April (but the x-axis of the figure is labelled as 14-15 April)
- Line 383: aggregate means → mean of all sensors? BE product?
- Line 459: Another reasonable explanation would be a different fan speed. However, fan speed was apparently monitored at D-ICE as pointed out later in line 542. You may place this statement already here.
- Line 898 (Caption of Fig. 6): Panel a, c represent LWD (not SWD) and panel b, d SWD (not LWD). Even though the dots in panels c, d may be inferred intuitively from the respective panels a, b, a legend in panels c, d might be helpful to identify the sensors with higher biases highlighted in panels a, b.

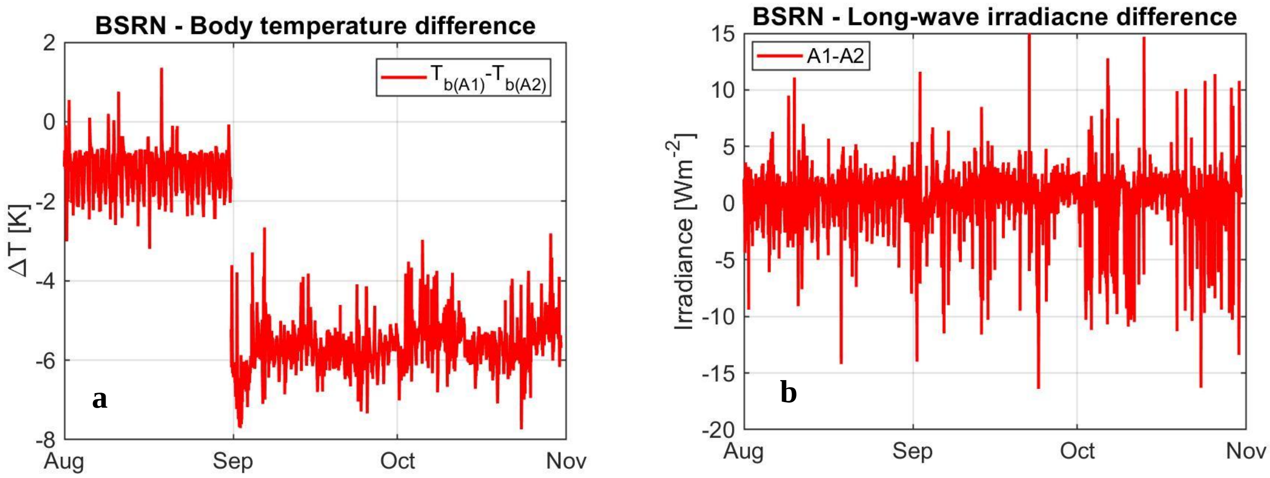

Fig.1: Differences in body temperature (a) and irradiance (b) between two pyrgeometers operated in Eigenbr. 480 ventilation housings. While the heater of the pyrgeometer A1 was continuously run at 10 W, the power of the heater of A2 was increased from 10 to 25 W by end of August.

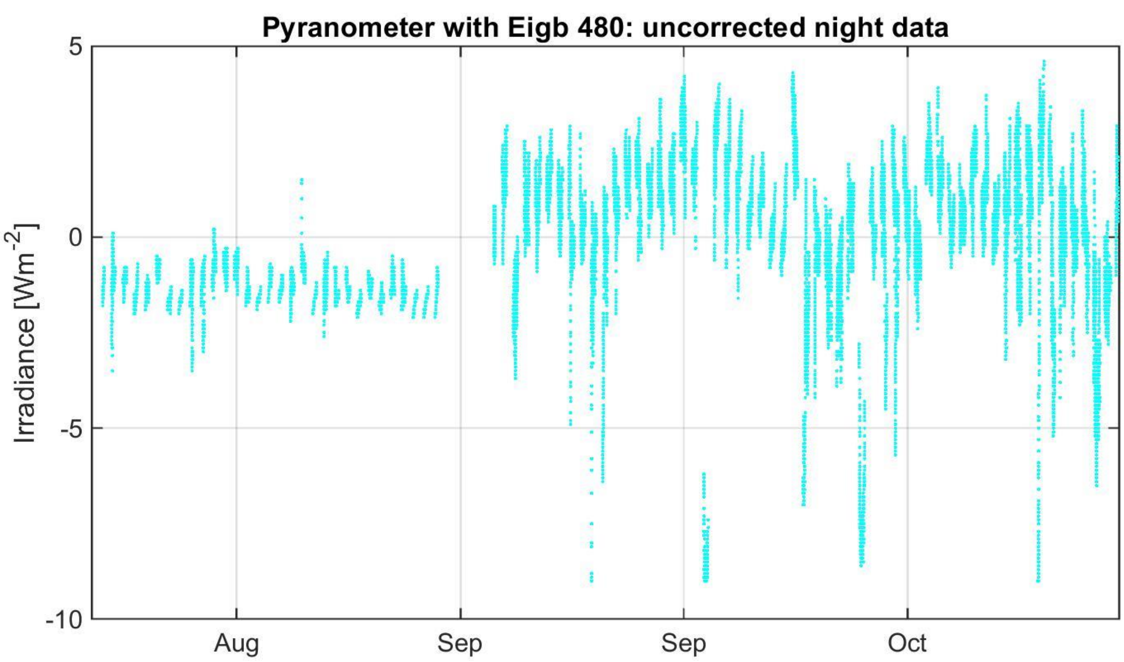

Figure 2: Night data of a pyranometer operated in an Eigenbr. 480 housing. The power of the heater was increased from 10 to 25 W by end of August.