- **RC3**: 'Comment on amt-2021-165', Anonymous Referee #3, 01 Aug 2021 reply

  The authors established a ground observation system to estimate the surface emissivities from brightness temperatures at four channels (18h, 18v, 36h, and 36v). The results are interesting. But the paper wasn't written clearly and the paper lack of some necessary information. The errors in the title of y-axis for figures 5,6,7,8 needs to be corrected. The authors provide the measurement accuracy of the brightness temperature (1K), which is the specification of the radiometer. But, the authors didn't give the accuracy of the derived surface emissivities.

  Reply: Thank you for your comments. We will try our best to modify the paper clearly and preciously.

  The errors in the title of figures 5,6,7,8 have been corrected, sorry for our mistakes.

  As to the accuracy of the derived surface emissivity, firstly it is obtained from the direct grounded observations, which help to reduce more uncertainties for estimated emissivity using model or satellite remote sensing data. Secondly, the microwave radiometer is the core device to obtain surface emissivity, and the measurement accuracy of observed brightness temperature from radiometer is basic and the most important guarantee for calculating surface emissivity. Third, to demonstrate the accuracy of derived surface emissivity better, we plan to do more comparisons between our results and emissivity model to check the consistency in theory although there are uncertainties in model.

  Specific comments:

1. "Xie et al. (2017) developed a parameterized soil surface emissivity model for bare soil surfaces and compared with Weng's model, results reflected the reduced overall errors, especially for horizontal polarization." is unclear, whether Xie's model is more accurate?

   Reply: Here we cited Xie et al. (2017) related work to show the development of emissivity model, and they mentioned that the improving results from the parameterized emissivity model were obtained on limited ground-based measurements and satellite data, and still need more validations and evaluations over larger areas and various surface conditions.

2. Define the emissivity polarization difference (vertically polarized – horizontally polarized?)

   Reply： Yes, it was added in line 377 as "the emissivity polarization difference (ε_v-ε_h) shown in Fig. 7b"

3. Change "angle" to "angles" in line 28.

   Reply: We did the change in line 28.

4. Explain why "but exhibit the opposite trend over water" in line 28.

   Reply: This sentence in line 28 is mainly coming from Fig.6(a,b). The different variations of surface emissivity over water and land with scan angle depend on the properties of surface reflectivity and dielectric constant, and the detailed and quantitative emissivity values over different surfaces are obtained from direct observation in this paper.

5. The soil emissivity depends on soil moisture and temperature. The authors mentioned the measurements in lines 231 and 232. The authors may provide the information in a table.

   Reply: Thanks for your concern. Yes, adding soil moisture observations is used to further study the relationship between emissivity and soil moisture. In this paper we focus on introducing the mobile observation system for surface emissivity, and we will do more analysis for soil moisture data in the later.

6. Water surface emissivity is a function of a surface wind. The surface wind is missed from the paper.

   Reply: Thank you for your suggestion. There is an automatic weather station nearby the observation site, wind data will be used to study the influence on water surface emissivity in the later.

7. (1) and (2) are good for a specular reflection. The authors may add sentences about why the surface reflection here is neither Lambertian nor BRDF.

   Reply: Thank you for your suggestion. Yes, Eq (1) and Eq (2) are good for specular reflection, and have been used in similar referenced work, so we used them to calculate

surface emissivity in this work. The results derived from this assumption will be investigate more in the later by combining more auxiliary observations over the actual surface of test plots. We added more sentences about this comment in line 293-300 as following "It is noted here that Eq.(1) is assumed for specular reflection, and was used in previous similar observation study (Lemmetyinen et al., 2015; Montpetit et al., 2018), so we used Eq.(1) and (2) to calculate surface emissivity in this work. The dual-polarized radiometer can provide both vertical and horizonal polarization information, then the idea and uniform Lambertian surface is too simple and the bidirectional reflectance (BRDF) surface seems more complex, and the specular reflection is a good option. The results derived from this assumption will be further investigated by combining more auxiliary observations in the actual surface of test plots."

8. The brightness temperature change for cement and sand in (a) of Fig. 5 follows the change of the surface temperature. But the brightness temperature for soil and grass between 8 and 12 looks strange. The authors can use the data in Fig. 5 to derive the surface emissivity.

   Reply: Thank you for your comment. Yes, the surface emissivity shown in this paper is calculated from the observed Tb used in Fig.5. As to brightness temperature change in Fig.5, it is a monthly averaged value in Oct.2018, so the observed Tb over soil and grass between 8-12hr look less smoothly change than that over cement and sand, and the change pattern within 24hr looks similar to the surface temperature.

9. The y-axis titles in (b) of Fig.(5), (c) of Fig.(6), (b) of Fig.(7), and (c) of Fig. (8) aren't right. The title should be "Brightness temperature difference" or "Emissivity difference".

   Reply: Thank you for your suggestion, the titles have been corrected.

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