- **RC2**: 'Comment on amt-2021-165', Anonymous Referee #2, 28 Jul 2021 reply

  This work presents a well-designed emissivity observation experiment, including a dual-frequency, polarized microwave radiometer on a mobile platform as well as *in situ* measurements of coincident environmental parameters. Five different surface types are created and observed over a one month time period. The work is well performed and described. Some questions and comments amounting to minor revisions are given below.

  -In the "real world" of satellite footprints, a homogeneous surface is rare. What are the authors' thoughts about what this experiment can tell us about emissivity variability in a heterogeneous field of view? Are there any plans to create something like this?
  Reply: Yes, the “real world” of satellite footprint usually is a heterogeneous field, including many types of surface, such as soil, sand, and grass. Using this experiment can help us better know the temporal evolution of emissivity over certain typical surface. To obtain the emissivity over a heterogenous field of view, microwave radiometer can be installed at higher position, or mounted on a moving crane to observe the real and heterogenous field on the ground. We will try the plan later.

  -Is this an ongoing experiment? It would be interesting to see data over a longer time period. Similarly, vegetation emissivty (higher than grass) is a key missing component here and vegetation life cycle would be a really interesting case to explore with this setup (though not necessary for this paper - something for future study).
  Reply: Yes, it is ongoing experiment. It has been stably running since Sep. 2018, and we had obtained almost 2 years observations until now. In this paper we focus on introduce the mobile observation system, and will do more and detailed analysis using longer time observation in the later.

  Thank you for your suggestion on the vegetation emissivity (higher than grass), such as wheat or other crops, we are more interested in that too. We did a couple of months observations for the wheat field on the other side of moving track in the last year, watching the grow of wheat from begin to end. We will do more data analysis for

those observations, and will plan to grow different crop in next year to see the different of vegetation emissivity. Thanks for your interesting, we will work on that in the future.

Abstract line 11: I realize this is the abstract, but a couple of words at the end of the first sentence as to why would be helpful here (e.g. due to the relatively small hydrometeor signal as compared to the land surface emission)

Reply: Thanks for your supplement, I did the change in the first sentence of abstract (line 9-10) as following "Large microwave surface emissivities with a highly heterogeneous distribution and the relatively small hydrometeor signal over land make it challenging to use satellite microwave data to retrieve precipitation and to be assimilated into numerical models."

Line 20-21: this occurs frequently in the paper that "sensitve to land surfaces" is used. I suggest changing these instances to "sensitive to surface type" or "sensitive to land surface variability" or similar.

Reply: Thank you for the comments. I did the modifications using the words you provided, such as line 21-22, line 337-338, and so on.

Line 35: "obscures radiance from the atmosphere and hydrometeors"

Reply: Thank you, it was modified into "this strong surface radiance obscures radiance from the atmosphere and hydrometeors" in line 35.

Line 45: Remove "Furthermore"

Reply: Yes, it was removed.

Lines 90-92: Another important limitation is availibility and accuracy of necessary input parameters on a global scale.

Reply: Yes, it was added in lines 92-93 as following "At present, the accuracy of surface emissivity estimates calculated from either emissivity models or satellite observations is limited by the complexity of the land surface and the variability of

vegetation types and soil moisture. Another important limitation is availability and accuracy of necessary input parameters on a global scale. Hence, surface emissivity calculations need to be verified and improved with more in situ observation data."

Lines 137-138: Add frequencies to this sentence.

Reply：It was changed in lines 138-139 into "a dual-frequency (18.7 and 36.5 GHz)，dual-polarized ground-based microwave radiometer"

Line 164: Could also add another GMI here - the NASA GPM Microwave Imager also has these frequencies.

Reply: Thank you. It was modified as "such as the SSM/I, AMSR-E (Advanced Microwave Scanning Radiometer for EOS) and GMI (GPM Microwave Imager) sensors." In line 165-166.

Line 197: How many fixed times per day?

Reply: The fixed times are introduced more detail in "2.4 Scanning mode". Using 45min to scan 5 test plots in each hour, that is the 0thmin,9^{th} min, 18^{th} min, 27^{th} min, and 36^{th} min of each hour are the fixed times for each test plot. If so 5 fixed times per hour, and 24*5=120 fixed times per day within 24hr.

Lines 200-207: This might be a good place to say something about penetration depth at these frequencies for each surface type.

Reply: Thanks for your suggestions. Penetration depth is a complex variable, hope to get more good ideas for that in the later.

Line 232: replace humidity with moisture

Reply: It was replaced.

Figure 4: Some Chinese characters on lower left

Reply: Thank you. It was modified in Fig.4.

Line 310: refer to Figure 5 here.

Reply: It was modified in Line 310 as "As Fig.5a shown, the changes in the observed Tb at 36.5 GHz".

Line 336: "more sensitive to the land surface type"

Reply: We did the change.

Line 342: Remove "In addition"

Reply: We removed it.

Line 353: Remove "Furthermore"

Reply: We removed it.

Figure 6: It might be interesting to add a line on these plots identifying the 36 degree (53-degree incidence) angle for reference

Reply: A good suggestion, we added a dotted line to identify the 36°in Fig.6.

Figure 7: Expand the caption with more information and label panels a) and b). Add information about time period of averaging and identify the b) panel as polarization difference

Reply: Thank you for your comment. We did the modifications in Fig.7 as "Fig. 7 Variations in the surface emissivity(a) and emissivity polarization differences (v-h) (b) over different land surfaces at 02:00 (BJT) in Oct. 2018"

Line 416: Remove "Hence"

Reply: It was removed.

Line 419: "the observed polarization difference"

Reply: It was modified.

Line 422: Remove "Moreover"

Reply: It was modified.

Line 403: Please include some discussion of differences between the Tb and emissivity plots, and why they occur

Reply: Thank you for your comment. We added some discussions in line 388-395 as following "Emissivity polarization differences is more significant over water than over land due to different surface reflectivity and dielectric constant property. Among four land surfaces ε_v-ε_h over cement is most obvious and over grass is slight, which is closely related to land surface roughness. Both Tb and emissivity polarized difference demonstrated that surface roughness over grass is obviously larger than that over other three land surfaces, especially smooth cement surface, thus scatters more surface radiance and weakens the polarization difference over grass."

Line 414: "more sensitive to land surface type"

Reply: It was modified.

Variability with weather conditions is never really discussed - one would expect an emissivity decrease after precipitation due to water on the surface for example. Was this observed?

Reply: Thanks for your suggestion. Yes, we did observe the emissivity variability with weather conditions, such as obvious emissivity decrease in rainy case. In this paper we mainly introduce the mobile observation system and only show some results under clear-sky. We will do more comparisons for emissivity variability with weather conditions later.

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