The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-211

Anonymous Referee #2

Referee comment on "Offset of MODIS land surface temperatures from in situ air temperatures in the Upper Kaskawulsh Glacier region (St. Elias mountains) indicates near-surface temperature inversions" by Ingalise Kindstedt et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-211-RC2, 2022

Overview

The manuscript describes a thorough comparison between in-situ 2m air temperature data and a MODIS LST product for two sites in the St Elias mountains. The authors use additional data from ASTER, Landsat, ERA-5 and AWSs to further support their conclusions.

The main aim of the study is to determine the cause of the difference between 2-m air temperature measurements and the MODIS LST. Three possible causes are explored: the large MODIS footprint, errors in the surface emissivity, and near-surface temperature inversion. The study finds that the latter is the most likely cause of the temperature offset. The manuscript gives insight into how well MODIS LST represents the actual surface conditions in the remote St Elias mountains, which is important for future monitoring.

The manuscript is generally well-written and the presented results are interesting. I have two areas of concern, but most of my comments are minor:

1. I think you should be a bit clearer about the fact that you can’t directly compare the 2m air temperature and the land surface temperature. In some sections, you talk about “correcting” the MODIS LST (e.g. Figure 10) – it is not necessarily that the MODIS data is biased, it is just because you are comparing two different things. For the same reason, I would also be careful calling it a “bias” in the title.

2. You mention that both AWS are situated on nunataks, but you don't really go into detail on the effect of this. If they are placed on nunataks, and not on glacier ice, could this not also be causing part of the bias? See also my specific comments for L 136-138 and L 270.

Specific comments

L 4-5: is this referring to previous work over St Elias? Or to the current study?

L 39: ""brightness temperature", an intermediate temperature product used to produce the final surface temperature." - I would explain what this is here, not just call it an intermediate product.

Table 1: can you add a bit more info about the different data sources here? Resolution (temporal and spatial) and maybe uncertainty.

L 109: What do you mean with "more influential"? In terms of current sea level rise?

L 111: you do not define "Divide Icefield" as "Divide" until later in the text

L 125-126: How do you know the datasets are consistent, when the time periods do not overlap? Please clarify.

Figure 2: Where is the location of the iButton?

Table 2: change "Ice core site – AWS site" to "MODIS Ice Core Site – MODIS AWS site", to clarify it is not in situ observations.

L136-138: I am not sure I follow this. You are comparing two MODIS pixels – one with only ice, and one with ice and a nunatak, to find out the difference in temperature between the nunatak surface and the ice surface? If so, this is interesting, but should be clarified and mentioned in the discussion. In addition, I would guess that the difference between the AWS and the ice covered ground is bigger than found in this comparison, since both MODIS pixels does contain some glaciated area.

L 144: why only between 11 and 1:30?

L 145-147: Do I understand correctly, that the 700+ images at Divide span 20 years, and the 100 images at Eclipse span ~2 years of data?

L 199: How do you get the downward radiation for Eclipse/iButton?

L 200: can you provide a bit more info about the ERA-5 product you use?

Page 10, 11 and others: consider your number of significant digits – are your results really that accurate? I would stick to 1-2 significant digits. Also in e.g. L 255: if it is a simple model, it probably does not have an accuracy of 3 significant digits.

Figure 6: this is at Divide?

L 270: Why do you compare MODIS, Landsat and Aster over the ice core location and not the AWS location (if I understand figure 2 correctly). If you are investigating the cause of the difference in AWS and measured LST, it would make more sense to look at the AWS location – especially since the AWS is on a nunatak, you would be able to better investigate the effect of this.

L 302: How is the DIVIDE snowfall record measured? Maybe give some information about this in the data section.

L 314-315: Why are you using different emissivities for the two sites?

Figure 10: What happened in 2020? The AWS temperature is much lower than the MODIS temperature.