Dear Dr. Ran,

Thank you for your revised manuscript entitles "Climate warming has led to the degradation of permafrost stability in the past half century over the Qinghai-Tibet Plateau" (tc-2017-120). I have read the revised paper and see that it addresses the reviewer's concerns. I have several minor changes and one major concern that you will need to attend to before publication.

Major comment:
The manuscript uses Cheng's (1984) proposed classification system on the grounds that it describes permafrost from an engineering perspective, which many readers would take to mean that there is a relation to load-bearing capacity. Consequently, the thermal stability of permafrost is a function of surficial materials and ground-ice content as much as temperature. Arguably, seasonally frozen ground could be the most stable because there is no ice-rich permafrost to thaw. However, the paper takes a MAAT modelling approach and does not incorporate ground materials. Permafrost borehole data are rare in the study area, and this also impacts appropriateness of the classification system used as it is additionally based on permafrost depths that are also not examined in the paper. From a strictly thermal perspective, the notion that cold permafrost is more "thermally stable" than warm permafrost typically does not hold true. For a given increase in MAAT, MAGT in cold permafrost often responds more quickly than warm permafrost because of relatively low latent heat effects in the former versus the latter. In the extreme case, thawing permafrost appears thermally stable, because heat is used for phase change rather than temperature change and MAGTs appear stable despite being nearly 0 °C. One wonders how much the statistical relations established by Cheng between MAAT and MAGT have changed since 1984 in this transient environment. Ultimately, the results from the current approach suggest that permafrost everywhere is changing, which implies that all of the permafrost is thermally unstable. Finally, *The Cryosphere* is an international journal, but those seeking more information on the classification system must be fluent in Chinese (Cheng, 1984), which is somewhat problematic. Given that the modelling approach taken actually focuses on estimating MAAT, and no data on MAGT permafrost depth change, surficial materials, or ground ice are provided, I find it difficult to justify the use of the "permafrost thermal stability" classification scheme. I strongly suggest that the classification system used should be modified to something like "permafrost thermal condition", rather than "permafrost thermal stability". The class types will necessarily change. I suggest something like "Extremely stable" becomes "Very cold", "Stable" becomes "Cold", "Sub-stable" becomes "Cool", "Transitional" becomes "Warm", "Unstable" becomes "Very warm", and "Extremely unstable" becomes "Likely thawing". This change will not affect your results, but will subtly, yet substantially, affect your interpretation and discussion.

Specific comments:
Title: Becomes something like: Climate warming over the past half century has led to thermal degradation of permafrost in the Qinghai-Tibet Plateau"

P1 L10-13: Becomes "Air temperatures increases thermally degrade permafrost, which is important for engineering design…"

P1 L13: "This study evaluates the degradation of permafrost stability over the…" becomes "This study evaluates the potential thermal degradation of permafrost over the…"

P1 L15: "MAATs taken at 152 weather stations using geographically" becomes "MAAT date from 152 weather stations with a geographically"

P1 L17: The abstract needs a sentence about using a classification matrix to convert modelled MAATs to permafrost thermal conditions.

P1 L18: "The total degraded area of stability" becomes "The total area of thermally degraded permafrost"

P1 L18-21: I suggest rounding all reported percentages to 1 decimal place. Also important to note the area of permafrost that likely has not changed.

P1 L24: Oxford comma after "161 m"

P1 L25: "degradation has led" becomes "degradation may lead"

P1 L29: "materials that include ice or organic material and remains at or below" becomes "materials, including ice or organic material, that remain at or below"

P1 L30 to P2 L2: "Temperature rise … often expressed as the degradation of permafrost thermal stability, which" becomes "An increase in air temperatures often thermally degrades permafrost, which"

P2 L13-22: Change to " At Xidatan, near the city of Golmud (Figure 1) at the northern boundary of permafrost adjacent to the Qinghai-Tibet Railway (QTR), the lower elevation limit of permafrost moved upward ~ 25 m from 1975 to 2002 (Nan et al., 2003). On northern and southern slopes of the Bayan Har Mountains (Figure 1), the lower elevation limits of discontinuous permafrost have moved upward ~ 90 m and ~ 100 m, respectively, from 1991 to 2010 (Lou et al., 2012). On the southern side of the Tanggula Mountains (Figure 1), climate change and infrastructure development have resulted in permafrost degradation; from 2006 to 2012, permafrost temperatures at 10 m depth have increased by 0.03 °C in undisturbed areas and 0.06 °C beneath an embankment, and respective active layers have deepened by 0.29 m and 0.41 m. (Sun et al., 2014)."

P2 L25 to P3 L27: These paragraphs are difficult to follow, in comparison with much of the text in the rest of the document that reads easily and in a logical order. This section is the cornerstone of your research justification/ gap analysis, needs to be re-written so that it is concise and clear. For example, P3 L19-25 seems out of place and vague, and the line about MAAT as an index should be included somewhere in the text near to where it is first used (P2 L10). Currently, this section (P2 L25 to P3 L27) makes it clear to the reader that the point of the research exercise is to model changes to MAAT over time, but the revised version should emphasize that the objective of the study is to use these estimates to evaluate potential for thermal degradation of permafrost. One piece of the puzzle that also needs to beadded is the relation of LST to MAST to

MAAT. The acronym for mean annual land surface temperature (MAST) is defined in the abstract, but must also be defined in the body of the manuscript. MAST pops up on P5 L10, but has not been discussed in the background section. Please carefully revise this section and include phrases that link the ideas together for the reader. E.g., "Naturally, these boundaries are continuous, inexact representations of the permafrost distribution and permafrost degradation (Yang et al., 2010). Ran and Li (2016) assessed the degradation of permafrost stability in China over the past 30 years; however, this study used a near-surface air temperatures reanalysis data set with low resolution and large uncertainties." could be re-written as "However, such boundaries are continuous, inexact representations of the permafrost distribution and permafrost degradation (Yang et al., 2010). As an alternative modelling approach, Ran and Li (2016) used spatially distributed near-surface air temperature reanalysis data to assess spatial variation in the degradation of permafrost stability in China over a 30-year period, but the data set has a low resolution and large uncertainties."

P3 L11: As defined in the current text, "permafrost stability" types are based on MAGT and permafrost thickness as much as air temperature, but because long-term measurements of MAGT and permafrost thickness are not available to test your predictions on changes over the study period, any discussion of changes to permafrost stability are purely speculative. This highlights why the idea of "permafrost thermal stability" should be modified to something like "permafrost thermal condition".

P3 L 29: "the degradation of permafrost stability" becomes " the potential thermal degradation of permafrost"

P4 Section 2.1: This section needs careful revision based upon the major comment. Invoking the term "engineering perspective" is actually not helpful because it is not clear what that perspective is. The way the manuscript reads, permafrost change is described by a spatially distributed perspective, rather than a boundary perspective, evaluating the change in area of the different permafrost classes and the spatial heterogeneity of the changes.

P4-5 Sections 2.2:and 2.3 Everywhere that mathematical notation occurs within the text it is raised. It should be in line. E.g., "$y_i$" should be "$y_i$". Equation numbers should be in line with the equation. Variables that are in-line with text should also be *Italicized*. E.g., "$y_i$". should be "$y_i$". See other *TC* articles for presentation examples.

P5 L10: First use of MAST in text, but variable not defined and acronym not explained
P5 L24-25. This sentence does not make sense, and has phrases that seem repetitive. Please re-write for clarity.

P5 L27: Section title becomes "Evaluation of the rate of permafrost thermal degradation".

P5 Section 2.3: Please separate the any text regarding "warming rate" and text regarding "degradation rate". These two calculations are mixed together and should be divided for clarity. I am not sure that you even need to write out the numerical model for a linear regression, but if you do, you need to repeat it for calculations regarding the degradation rate as the model

variables are different. Currently the text only defines variables related to calculating warming rates.

P5 L28:"The following linear regression model…50 years:" becomes "A linear regression model was used to evaluate rates of MAAT change in the QTP over the past 50 years:"

P6 L3: Do not assign the variable $Y$ to two factors. Refer to MAAT here and then edit text near L 11 to indicate linear regression model is used again, but to look at permafrost area changes.

P5 L6-7: insert a space between $<$ or $>$ and the number.

P5 L10: "calculate" becomes "determined" and "decades and the rate of change" becomes "decades and calculated the rate of change"

P7 L10: "Data Center in Lanzhou" becomes "Data Center, Lanzhou"

P8 L13: "Landsat TM/ETM+" becomes " Landsat Thematic Mapper (TM) or ETM+"\

P9 L3: Change subtitle to something like "Potential thermal degradation"

P9 L4-5: This line clearly states the objective of the analysis, and should be modified and worked into the final statements within the Introduction, somewhere near P1 L26.

P9 L6: Change subtitle to something like "Temporal dynamics of thermal degradation"

P9 L7: "The permafrost thermal stability has degraded" becomes Permafrost has thermally degraded"

P9 L20: subtitle becomes something like "Spatial variation of thermal degradation"
P10 L7-9: "The area of permafrost … $12 \times 10^4$ km$^2$ (12.02%)." Becomes "Permafrost stability did not change over a $12 \times 10^4$ km$^2$ (12.02%) located primarily east of Lhasa in the southeastern part of QTP where there are numerous marine glaciers and substantial snow cover (Figure 4j)."

P10 L10 "stability of approximately $1.63 \times 10^4$ km$^2$ of permafrost increased" becomes "stability of a permafrost area of has increased"

P10 L12: "may have large uncertainties; the uncertain MAAT" changes to "may relate to large uncertainties as the MAAT"

P10 L13: "low-elevation areas, due to the lack of" becomes "low-elevation areas. This is because of the lack of"

P10 L15: "than those of the MAAT" becomes "than those of actual MAAT". You do mean real measurements here, correct?

P10 L22: Subtitle becomes something like "Relation of variation of thermal degradation to elevation"

P10 L24: "the elevation" becomes "the mean elevation"

P11 L13: "The permafrost distribution is also very similar to that presented by Zou et al., (2016) … approximately 0.82." becomes "The permafrost distribution is also very similar (consistency is 92%; kappa coefficient is 0.82) to Zou et al. (2016) (Figure 5b). Note: There are numerous places in the text that can be shortened in such a manner. Please try to shorten the amount of text in the revised manuscript.

P11 L26: "the degradation" becomes "permafrost thermal degradation"

P12 L9: "approximately a hundred metres" becomes "~ 100 m".

P12 L24-26: This sentence hints at the type of class that should be used in the manuscript.

P14 L4: As this … deep layers of soils" becomes "In order to reduce the uncertainties, more field data are required, especially from boreholes."

P14 L 4-5: This doesn't make any sense. How will inexpensive sensor and machine learning methods help obtain data from deep layers of soil? Boreholes are needed.

P14 L5-7: Comment: if you want to estimate permafrost stability/sensitivity to thermal disturbance in the future, you will need to think about incorporating data on surficial geology and ground ice.

Universal comments:
Change symbology for denominators. E.g., /x becomes $x^{-1}$, or /a becomes $a^{-1}$. This affects text in the main body, tables, figures, and captions.

Comments on tables:
From our Manuscript preparation guidelines for authors (https://www.the-cryosphere.net/for_authors/manuscript_preparation.html): Horizontal lines should normally only appear above and below the table, and as a separator between the head and the main body of the table. Vertical lines must be avoided.

Table 1: as the focus of the paper is on MAAT, move the MAAT column in front of the MAGT column. Types should reflect the classes that you actually model.

Table 2: Text in table head does not need to be bolded.

Table 3: The type will likely change, but as it stands, "remely stable" becomes "Extremely stable". Text in table head does not need to be bolded.

Table 5: Text in table head does not need to be bolded.
Comments on figures:

In all maps: please move text away from other objects so that the words are clearly legible. Nearly all city and town names are affected.

Figure 1. Scale bar should span 1000 km as in other figures. Evergreen broadleaf forest, deciduous broadleaf forest, and grasslands are too similar in color to differentiate on the map.

Figure 2. Change warming rates in map legend from, e.g., "-0.43 - -0.15" to "-0.43 to -0.15"

Figure 3. "<3600 m" becomes "< 3600" and ">5800 m" becomes "> 5800". "Elevation intervals" becomes "Elevation intervals (m)".

Figure 4. Non-permafrost and Unchanged stability are the same color and can be confused. Please indicate  areas by a different color such as grey in all panels. Also, if non-permafrost includes seasonally frozen ground and lakes, map out lakes in a different color and add to the legend, and re-name "non-permafrost" to "seasonally frozen"

Figure 5. There a lot of white on the maps. Please indicate what it represents, i.e. seasonally frozen? The color of the lakes is hard to distinguish from the blue permafrost. Consider different colours, or higher contrast between colors.