Response to reviewer 1:

Thank you for taking the time to read and comment on our manuscript, we appreciate your insights and feedback. We have made changes to the text where you have noted typos or suggested more appropriate wording or description, which has improved the flow of the manuscript and better explains each point.

Line 20: suggest “various” in place of “varying”; Done

Line 23: suggest replacing “profiles” with “column or profile concentrations”; Done

Line 24: should read “15 µm” instead of “15 mm” (typo); Corrected

Line 27: suggest making clear that these are absorption micro-windows; Done

Line 28: suggest replacing “in some cases” with “under certain conditions”; Done

Line 35: suggest including a reference to the airborne Far-InfraRed Radiometer (Libois et al, 2016) in addition to the TICFIRE reference when citing the planned NASA mission; Done

Line 43: remove the “0” between “as” and “required” (typo); Done

Line 200: in Figure 3 and all Figures containing data plots thereafter, it would be clearer to include a legend on the plot themselves so that the reader does not have to refer to the caption to understand what is being shown; Done

Line 278: the expression for the PRT100 sensor uncertainty is a bit unclear, I assume T is in °C in the expression given? I think it should read something like “±0.15 (1 + 0.002|T|) where T is in °C”; Done

Line 489: suggest referring to the specific Section when referring to “… self-compensation effects discussed earlier” to help the reader understand the explanation for the lower sensitivity to offsets in the hot target; Done

Line 497: is the observation altitude 30 m above sea level, or above the ground? Above sea level, clarification now included

Line 500: did the authors consider using a representative CO2 profile in the LBLRTM simulation? It’s possible that it doesn’t make a significant difference given the strength of the absorption around 15 µm, but it would be useful to clarify this;

No, we did not consider using a representative profile for CO_2. Previous work has identified very limited sensitivity to the detail of the CO_2 profile as opposed to the surface concentration (as measured here by the Vaisala sensor) and uncertainties in the temperature profile but it is possible that we could see some differences outside the saturated features in the 15 µm band wings. We think this is best suited for detailed analysis when we attempt full radiative closure, which is not feasible for the measurements highlighted in this section given the lack of co-located profile information.

Lines 509-10: replace "mm" with "µm" (typos); Done

Line 522: suggest also commenting on the potential contribution of the uncertainty in the water vapour continuum absorption model assumed in the LBLRTM simulation here.

FINESSE radiance comparisons with simulations will be sensitive to the representation of the continuum in the line-by-line radiative transfer model. We used MT_CKD 3.5. Mlawer et al 2019

(**https://doi.org/10.1029/2018JD029508**) gives a comprehensive description of the evolution of the continuum model up to MT_CKD 3.0 estimating the uncertainties in the foreign component from 400 -600 cm^{-1} as of the order 7%. Since then, MT_CKD 3.5 was implemented before recently being superseded by MT_CKD 4.1.1 (Mlawer et al 2023, https://doi.org/10.1016/j.jqsrt.2023.108645)

Between v3.5 and v4.1.1 there is no difference in the self-continuum while the foreign-continuum is increased by about 5% in v4.1.1 relative to v3.5 between 400 – 600 cm^{-1}.

As suggested in our manuscript the radiance difference in the absorption micro-windows between the simulation and observation could be due to an overestimation of the water vapour concentration in the atmospheric layers just above FINESSE in ERA-5. Reducing the humidity in the layers below 1 km by 10% significantly reduces the difference. Alternatively, it may be that the continuum representation we are using is wrong. However, we would need to reduce both the foreign and self-continuum strengths by about 10% to get agreement. As noted above, these changes are inconsistent with the alterations made in MT_CKD 4.1,1.

Our comparison of instrument observations against simulation is to demonstrate FINESSE's capability and current uncertainties. Similar to future work on evaluating radiative closure, evaluation of the current continuum models are better suited to dedicated studies that include sufficient ancillary information.

Response to reviewer 2:

Thank you for taking the time to read and comment on our manuscript, we appreciate your insights and feedback. We have made changes to the text where you have noted typos or have suggested more appropriate wording or descriptive revision. We feel that these changes have improved the flow and clarity of the manuscript.

Title: "Part 1" here the Arabic numeral is used, while throughout the paper Part is always followed by Roman numerals "I", "II", please make a consistent choice; Have chosen and used "I"

line 24: "15 mm" -> "15 µm"; Done

line 30: add a comma between "that do" and "tend"; Done

line 43: "as0 required" -> "as required"; Done

line 59 add a comma between "Far-IR" and "FINESSE"; Done

line 66: "repeat" -> "repeated"; Done

line 120 delete "of the order"; Done

line 141: can you quote the uncertainty of CO2 probe?; This uncertainty is now included

line 163: I suggest to add the resolution used; Done

Fig. 3A: in the Y-axis label: 'Codes' is this a typo?(see also Figs. 4A, 6A); No this is not a typo, the use of codes is heritage from working with voltage read-outs for satellite detectors. It's an arbitrary detector signal response to incident radiance and we have now given an explanation of this in the

text.

line 220: add a comma after cavity; Done

Eq. 5: this is not consistent with Eq.4 (and Eq. 8), e_eff -> ε_{eff} ; L(σ,T) -> B(σ,T)

This is a good catch, equation 5 used L (scene radiance terminology) instead of B (Planckian radiance). There were omissions in the dependencies for some terms. All these have been corrected or expanded to provide consistency between the equations.

Fig. 4(E) the curve and the legend color for emissivity @150 C don't match; This has been changed to match.

line 450: clarify how L^{ext}_{hot} (L^{ext}_{hot}) is determined/modelled when calculating L_{scene}; This is now explained where we have equation 8.

line 468: a "signal-to-noise" of NESR sounds odd perhaps -> "assessment"?; Done

line 470: "we take the square root of the spectrally resolved NESR described above as the resultant single scan NESR", please clarify this part. I have two issues here:
1 - the square root of the rms of the radiance differences would have a measurement units of sqrt(RU)

2 - if I followed your line of reasoning, the NESR on a single scan should be the NESR estimate divided by the square root of 2

1) This was nonsensical and has been corrected. 2) Your reasoning was correct, we do divide by root(2) as the difference combines the noise from 2 measurements. We have now changed the text to reflect this.

line 506: I suggest to change "surface emission temperature" to "blackbody surface emission temperature", since at the end of the next line surface temperature, humidity ... are mentioned the latter being ground surface; Done

line 509 and 510: "15 mm" -> "15 µm"; Done