

## Review of AMT-2024-52 “Remote sensing of lower-middle thermosphere temperatures using the N<sub>2</sub> Lyman-Birge-Hopfield (LBH) bands”

by Easter, Evans, Gan, McClintock, and Lumpe

### Summary Comments

This paper summarizes the GOLD multi-band LBH temperature retrieval approach described in a recent paper, briefly discusses recent version 5 improvements of the TDISK product, and compares results to two other approaches for retrieving thermospheric from FUV observations. The paper argues that the absence of artifacts in new GOLD temperatures, the physical behavior of retrieved temperatures, and the low uncertainties from high signal-to-noise from multi-band retrievals make the GOLD thermospheric temperatures reliable. The paper provides an overview of retrieved GOLD temperatures and uncertainties during the mission. Moreover, examples of challenges in an alternate single-band rotational temperature retrieval method and a vibrational band ratio temperature retrieval method indicate that these methods are not yet mature and require further analysis to resolve issues regarding biases and uncertainties compared to GOLD temperature retrievals.

The paper is well-organized and supports the major conclusions with examples, particularly as the intent appears to be to more widely disseminate GOLD temperature products to the community and provide a basic understanding of GOLD temperature behavior and limitations. This paper is not an exhaustive modeling or statistical study of the GOLD temperature product versus other approaches. The wording is not as economical as possible and the figures would benefit from minor tweaks. An attachment details minor suggestions.

Line 9: “advance our understanding” Reword?

Line 9: Suggest joining these two sentences: “in the lower-middle thermosphere, particularly in light of the rapid increase...”

Line 11: “almost equivalently”. Remove.

Line 12: “However, specification...satellites is large”. Not clear why number of satellites affects the importance of quiet-time temperature specification.

Line 16. Missing period after “gap”

Line 17, “neutral temperature, which is a key...”. Change to “neutral temperature, a key...”

Line 19. Instead of putting emphasis on researchers who are unfamiliar with GOLD, consider “...launch of GOLD, its current observational capability relevant to data interpretation may not be widely known.”

Line 28. A reference for forcings as a significant source of variability in the T-I system might be useful versus the assertion here.

Line 35. Change to “Temperature is a fundamental state variable and key to understanding...”

Line 38. “some informative analyses” seems ambiguous. Be more specific about what is relevant to this paper.

Line 42. Delete “some” “that is”: “...summarize additional information relevant to...”

Line 59: Consider “Consequently, observed FUV emissions must...”

Line 64: Consider citing a reference for the peak of LBH emission trending higher as SZA increases.

Line 67: The McClintock et al (2020) paper still exists. Use present tense to refer to Figure 4.

Line 77: Join the sentences that refer to the limb scale height temperature technique.

Line 79: Change to "This paper focuses on..."

Line 86: Consider "...LBH excitation occurs by cascade..."

Line 94: Importantly, the peaks of the atomic 1356 and 1493 multiples do not shift with temperature as molecular bands might. GOLD also has the resolution to resolve components of the multiplets, at least in the case of 1356.

Line 97: Remove comma: "small-scale wavelength errors"

Line 129: This approach is related to the vibrational, not rotational, temperature. "...to deduce temperature from relative vibrational populations."

Line 131: Add comma for independent clauses: "... technique is uncertain, because..."

Line 131: "because the vibrational populations are affected by..."

Line 136: Differences in rotational emission is more accurately specified as the distribution about the peak, not just the amount of long wavelength emission.

Line 140: Comment: Also, to determine the total amount of emission in two different upper state progression bands depends upon spectrally resolving the bands to measure them.

Figure 4: Please clearly label the differing dates for the two observations.

Figure 4: The color scale is non-intuitive: cooler values are plotted as yellow, while hotter temperatures are plotted in progressively more intense values of blue, which is a "cool" color. Consider using a different color scale where higher temperatures are plotted as a "warmer" color.

Line 196: "Results and analyses" is a very non-specific term. Much better to summarize in this sentence the particular results (SNR? Uncertainties? Viewing-geometry related behavior? Comparisons with model? Reduction of bias? Elimination of artifacts?) that demonstrate the robustness of the GOLD approach, or perhaps some rewording of this concluding paragraph.