

Replies to referee Report 2

We thank the reviewer for the analysis of our manuscript, its positive estimations and interesting comments. Here we reproduce these comments in full and give our replies in blue font. In the manuscript we use bold font to clearly denote the changed text.

The authors should include in the paper the non-LTE rotational temperature and kinetic temperature at the tangent heights of the synthetic LOS radiation calculations.

Generally, if the rotational LTE is broken, as is the case for levels 10011 and 10012 in this study, then one can not introduce the rotational temperature as a single parameter, which enters the Boltzmann formula for population probabilities of the entire set of rotational sub-levels. Each of these rotational sub-levels has instead its own rotational temperature, which may be close to, or strongly differ from the local kinetic temperature. Therefore, we do not think it will be informative to compare these rotational temperatures with the kinetic temperature, instead we think it is much more informative to show the rotational distributions (Fig. 2) discussed in the manuscript.

We suppose that the suggestion of referee to show/evaluate the rot. temperature was motivated by the idea to promote the rotational analysis of these, and similar spectra. We would like to refer here to our previous work (Kutepov et al, 1997), where the problems with the rotational LTE analysis of the non-LTE spectra are discussed in detail.

To better illustrate the problem let us present an example: the second maxima of the rotational non-LTE distributions discussed in the paper (Fig. 2) are positioned at $j = 30-45$. The rotational LTE distribution for CO₂ is maximized at these j for temperatures higher than 1000K. Therefore, any attempt to estimate the kinetic temperature from wings of spectra, which are affected by these secondary maxima, can lead to errors of several hundreds of K.

LOS radiance simulations were conducted with and without line overlap. Does the ALI-ARMS code include line overlap (within the bands and between lines of different bands) in computing the ro-vibrational level populations? If not, how might line overlap in computing the ro-vibrational levels alter the simulated LOS radiance?

Yes, the ALI-ARMS code allows complete accounting for the line overlapping when calculating the radiative terms of the steady-state equations (SSE) for populations, however this approach requires significantly longer (about a factor of 10) time. In the Martian atmosphere the line overlapping is important only for the lower 40 km. It may modify the SSE radiative terms by up to 10%. This effect should be mainly taken into account for populations of the CO₂ 15 μ m vibrational levels, and also for the 4.3 μ m vibrational levels at night. However, for the day time conditions, which were considered in this study, the excitation of latter levels is determined mostly by the absorption of solar radiation. Our tests showed that in this situation neglecting the overlapping for the the SSE radiative terms has a negligible effect on the populations of vibrational levels involved in the formation of studied spectra.

The written quality of the paper is not bad, but the grammar could be improved.

We hope we have improved the text.