Response to Short Comment

General comments:

It is very difficult to disentangle the contribution to the spectral residuals due to spectroscopy and errors in the atmospheric state. We know that the ECMWF model can have large systematic biases in the stratospheric/mesospheric temperature profiles and that there are still issues with the performance of the ozone assimilation system. These points have been addressed in the paper. In addition, there is some more recent evidence that points to a dry bias in the ECMWF humidity fields that could explain the offset observed in spectral residuals in the tropics although the effect of spectroscopic errors cannot, again, be ruled out. This aspect has not been mentioned in the paper and I will introduce it in the revised version. The reviewer should also be aware of the fact that the RTTOV model does not offer much latitude in terms of changing the set up of the underlying LBL model. This would require the re-training of RTTOV and the consequent generation of a new transmittance database. This is a quite involving effort that is not performed routinely. The water vapour continuum model is an exception since we can change the continuum model without the need to generate a new LBL database.

Through the paper I have always tried to be very specific regarding the attribution of differences in residuals due to different aspects of the line-by-line models. The CO_2 line shape and the water vapour continuum are an obvious example of that. However, apart for these examples, is very difficult to control any aspect of the various LBL models. Differences can be very subtle and disentangling all various contributions is a very daunting task. I think I have done my best but I will see if any improvement can be made.

Specific comments:

1) I am not fully convinced by the argument brought up by the reviewer. Strictly, one can speak of profile lapse rate for a single, isolated profile. In our case we are speaking of residuals obtained averaging many thousand cases. In addition, the various LBL models behave differently and I do not see a clear cut pattern in the spectral residuals. For some models and in some latitude bands, the residuals do not tend to increase with wave number. In my view, errors in the CO2 line shape (and possibly water vapour continuum) are playing a more important role. In addition, I should stress that in the paper I refer to *systematic* biases in the ECMWF temperature profiles that we know are present at stratospheric and mesospheric altitudes. We do not have any evidence of any systematic effect at tropospheric altitudes.

2) (i) The same temperature profiles are used for all cases. What I meant is that different LBL models can responds differently to errors in the input state vector.

(ii) I am fully aware the most of the residuals are to be attributed to CO_2 and that water vapour lines are responsible for a few isolated residuals. I agree that is not spelled clearly in the text and will change it accordingly.

3) I agree with the comment made by the reviewer. For these high peaking channels the line shape is still dominated by pressure broadening and a first order treatment of CO_2 line mixing should be adequate. Other explanations must be sought and I will try to address this point in the revised manuscript.

4) I agree with the referee that the statement regarding ozone spectroscopic errors is not corroborated by facts. There are issues with the ECMWF ozone assimilation system that are the most likely clue to the larger residuals observed in this spectral region.

6) The comment made by the reviewer does not contradict my statement that the larger biases in the northern hemisphere cannot be attributed to SST alone.

7) See response to comment 1)

8) I agree with the comment made by the reviewer. I will make this clear in the text. I will also rewrite the second paragraph of section 5.3.1 by making a clear distinction between the spectral regions that see the presence of tropospheric and stratospheric channels.

9) I agree that in view of recent developments, the Masiello at al. reference might not be appropriate. I will change the text accordingly.

10) I am well aware of the fact the UMBC modifications to the MT_CKD continuum are not endorsed universally and in fact I may agree with the comments made by the reviewer. However, as a matter of fact, the kCARTA spectra seem to be in better agreement with observations. Whether or not this result is based on a physically sound ground, it is an issue that should be addressed by the LBL model developers.

11) I will change the text.

Minor edits and comments:

1) I will change the text.

2) I included a reference to Coudert et al. in the original version of the manuscript (in the conclusions section). This is missing in the discussion paper since the *Conclusions* section has been shortened. I will reconsider the introduction of this reference.

2) I will change the reference to MT_CKD and LBLRTM and will consider rephrasing the sentences quoted by the reviewer.

3) I will change the text.

4) It is clearly stated in the text that kCARTA is a fast LBL algorithm based on look-up tables. Based on the reviewer's comment, I will consider changing *fast LBL* to *pseudo LBL*.

5) I will change the text.

6) The differences between the MT_CKD and MT_CKD_UMBC are illustrated in figures 1 and 2.

7) I will make the use of the nu symbols more consistent.

8) I agree with the reviewer. I will add a new section.

9) The basic spectral database used with LBLRTM is indeed the AER line file. In the text I refer to HITRAN_2005 because the AER file is in fact based on HITRAN_2004. I will make this clear in the text.

10) I will consider introducing the reference to Shepard et al.

11) I will look into the issue of SST biases.

12) I will change the text.

13) I will change *spectrum* to spectral *residuals*.

14) I will change the text.

15) I will change the text.

16) I will change the text.

17) It means there are more spectra features. I will reword this sentence.

18) I will change the text.

19) I will change the text.

20) I agree with the referee that LBLRTM should be replaced by kCARTA_LBL

21) I agree with the referee. I will make all the appropriate modifications.