Specific Comments

Lines 473-475. Section 4.2. Figure 5. Yes, for the 183 GHz water vapor absorption band, the three curves in Fig. 5 appear flipped with respect to those in Fig. 4. However, for the 50-70 and 118 GHz O_2 absorption bands, only the red curve (surface emissivity = 0.9) in Fig. 5 appears flipped; the green and blue curves (surface emissivity = 0.45) in Fig. 5 do not. It would be helpful if the authors provide an explanation of this feature. Another interesting feature shown in Fig. 5 is that in the 50-70, 118, and 183 GHz gas absorption spectral regions, all the three curves in Fig. 5 are close to each other. It would be wonderful if the authors can also provide an explanation of the insensitivity of simulated upwelling T_B to surface emissivity and sensor viewing angle in these spectral regions.

We thank the reviewer for this comment. Indeed, a deeper explanation was needed for Figure 5. Following the reviewer's comment, we modified the text as follows:

"The graphic output is reported in Figure 5, where the impact of pointing angle and surface emissivity is shown by varying their values. In particular, 90° pointing angle indicates nadir observations, while 37° indicates typical observing angle of MW imagers (53° from nadir), while 0.9 and 0.45 represent typical high and low emissivity values in the MW spectral region. Figure 5 shows that if the emissivity is relatively high (e.g., 0.9), the spectrum resembles that of a warm black-body emission at ~270 K (except where strong atmospheric absorption occurs, e.g., 60, 118, and 183 GHz). Conversely, if the emissivity is relatively low (e.g., 0.45), the background is relatively cold and the atmospheric emission features stick out, similarly to Figure 4. However, near the center of strong emission features (e.g., 60, 118, and 183 GHz) T_B appears flipped with respect to Figure 4, indicating gas absorption that removes radiation from the emission coming from the relatively warm background. It is notable that in those regions T_B nearly overlap for the three emissivity and angle conditions; this is because the atmospheric opacity is so high to make T_B saturate within a short distance, thus becoming insensitive to surface emission and observing angle (i.e., path length)."

Lines 497-498. Section 4.3. Figure 6. The legend of Fig. 6b is not very clear. What does "τ (wet+dry)" stand for? It would be better to introduce this notation in the figure caption. In addition, the authors present the gases that account for the absorption bands in the spectral range between 20 and 201 GHz shown in Figs. 4 and 5. The readers may also be interested in the gases that cause the absorption bands between 118 and 874 GHz shown in Fig. 6.

With "τ (wet+dry)" we intend the total opacity (τ) arising from water vapour (wet) and the "dry" air (i.e., the two highest-concentration gases N_2 and O_2). But we agree this is unclear. So, we modified the figure legend and caption as follows:

Legend:
– Atmospheric opacity due to H_2O, O_2, and N_2 above aircraft altitude (5 km)
– Atmospheric opacity due to H_2O, O_2, and N_2 below aircraft altitude (5 km)

Figure 6. Top: downwelling and upwelling T_B simulating aircraft observations at respectively zenith and nadir from 5 km altitude (gas absorption model: R22; surface emissivity equal to 1). Bottom: Atmospheric opacity (τ) corresponding to dominant gases (H_2O, O_2, and N_2) computed for the uplooking and downlooking views. All the features correspond to H_2O absorption but the following, due to O_2: 118, 368, 424, 487, 715, 773, 834 GHz. Input profile from the radiosonde launched from Camborne (UK) on 22 July 2021 at

12:00 UTC and retrieved from the Wyoming Upper Air Archive. Vertical black lines indicate the ISMAR channel frequencies.

Lines 597-604. Figure 11 is a good example, but does it have something to do with the uncertainty covariance matrix estimation approach said to be incorporated into the PyRTLib?

Correct. The grey shadings correspond to (respectively darker to lighter) 3-sigma, 2-sigma, 1-sigma uncertainty obtained by propagating the spectroscopic parameter uncertainty covariance matrix through the radiative transfer Jacobians (i.e., sensitivity of T_B to spectroscopic parameter). We modified the text as follows to make it clearer:

"One example is shown in Figure 11. It shows ground-based zenith radiometric measurements from the MWRP with its typical calibration uncertainty (Cadeddu & Liljegren, 2018) compared with zenith downwelling T_B computed processing one radiosonde from the TCAP dataset, together with the associated uncertainty estimate $\sigma(T_B)$. $\sigma(T_B)$ is computed within PyRTLib by propagating the spectroscopic parameter uncertainty through the radiative transfer. Calling $\boldsymbol{Cov}(p)$ the parameter uncertainty covariance matrix (as in Cimini et al., 2018), $\boldsymbol{K_p}$ the sensitivity of T_B to spectroscopic parameter (Jacobian), $\sigma(T_B)$ is computed as

$$\sigma(T_B) = diag\left(\boldsymbol{Cov}(T_B)\right) = diag(\boldsymbol{K_p} \cdot \boldsymbol{Cov}(p) \cdot \boldsymbol{K_p^{\mathrm{T}}})$$

where $^{\mathrm{T}}$ indicates the matrix transpose."

Technical Corrections

Line 252. The integral in Eq. (5) is from s_{i-1} to s_i, not from s_i to s_{i+1}. The RHS should be…

Correct. Eq. (5) has been modified accordingly. Thanks for spotting the typo.

Line 359. Change "Ccenter" to "Center".
Line 466. "elevation angle" or "elevation angles"?
Line 482. "emissivity at" or "emissivity values of"?
Line 485. "elevation angle" or "elevation angles"? "emissivity at" or "emissivity values of"?
Line 544. "Figure" of "Figures"?

Agreed. Thanks for spotting the typos.

Line 519. What are "wave" water vapor lines?

The hyphen was missing, sorry. Corrected with "submillimeter-wave". Thanks for spotting the typo.

Lines 541 and 548 and 552. Line 541 says 149 match-ups while lines 548 and 552 both say 153 match-ups.

After both screenings, 149 matchups are left. Thanks for spotting the inconsistency.

Not sure if other users also meet the problem, but I could not succeed in running the RT package the authors developed on my machine. After the package was installed, I failed in executing the examples provided by the authors with the same following error message:

```
ModuleNotFoundError: No module named 'pyrtlib'
```

Under the virtual environment where the package was installed, I tried installing the package again using the command: *pip install pyrtlib* but did not change anything. The following message helped me gain some confidence that the package was successfully installed:

```
Requirement already satisfied: pyrtlib in xxx
```

Thanks for spotting this issue. The "ModuleNotFoundError" could be due to different python installation on the machine. Maybe multiple python versions coexist on the same machine? PyRTlib must be ran through the same python version it was used for its installation. Also, Python v3.7 or higher is required to work with PyRTlib.

Nonetheless, we have now released an upgrade (PyRTlib v1.0.3) which may be installed via the *pip install pyrtlib -U* command. Please have a look.