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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Uncertainty of atmospheric microwave absorption model: impact on ground-based radiometer simulations and retrievals" *by* Domenico Cimini et al.

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This paper describes an approach for quantifying impacts of spectroscopic parameters on radiative transfer model simulations and on atmospheric retrievals that accounts for correlation between different parameters. This is an important consideration which is often ignored in other studies. The paper also an example of the application of the approach to downwelling microwave radiative transfer calculations and retrievals. The work is thorough and makes a useful contribution to the body of work on quantifying retrieval uncertainties associated with spectroscopy. The paper is generally well organized and well written. I recommend publication after addressing the comments below.

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Discussion paper

As the authors state in the conclusions, the approach is applied to one particular widely used microwave absorption model. This should also be stated clearly in the abstract and made clear at the beginning of Section 2. Section 2 would initially seem to imply that the "review of absorption model equations" is also general, but the descriptions of the parameterizations of resonant and non-resonant absorption are particular to the MPM-based family of models. Not all atmospheric absorption models use these same parameterizations. As the authors are aware (since on page 2, within the introduction, the authors cite Long and Hodges [2012], which describes impacts of different choices of line shape parameterization on calculations of absorption for the 0.76 micron O2 A-band utilized by the Orbiting Carbon Observatory and other remote sensing instruments), there are models out there for other wavelength regions that use non-Voigt line shapes for resonant absorption. Also, the description of non-resonant absorption does not apply, for example, to the widely used MT_CKD continuum model. It would seem to make sense to move the material in sub-section 2.4 up to the start of Section 2 in order to make it clear that this review of absorption model equations is not general.

Page 2, lines 50-54. The need to account for correlation between uncertainty estimates for different spectroscopic errors is general to all wavelength regions, and this is good to emphasize. The authors list a few examples of studies that discuss the impact of spectroscopic uncertainties on remotely-sensed profiles. There is one microwave example, one sub-mm example and one visible (0.76 micron) example. The authors might consider adding examples in other wavelengths. Possible examples for the thermal infrared region include Alvarado et al., [2013] and Alvarado et al [2015]. Possible examples for the near infrared region include Connor et al., [2016]. For disclosure: I happen to be a co-author on each of these particular suggested references... I am sure there are also others if you wanted to look for alternatives.

- Alvarado, M. et al., Performance of the line-by-line radiative transfer model (LBLRTM) for temperature and species retrievals: Recent updates evaluated with IASI case studies, Atmos. Chem. Phys., 13, 6687-1711 (2013)

- Alvarado, M. et al., Performance of the line-by-line radiative transfer model (LBLRTM) for temperature and species retrievals: Recent updates evaluated with IASI case studies, Atmos. Chem. Phys., 13, 6687-1711 (2013)

- Connor, B. et al., Quantification of uncertainties in OCO-2 measurements of XCO2: Simulations and linear error analysis, Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-128, 16th June 2016

Page 3, line 81: Please make it clear that “the absorption models” means a particular set of microwave absorption models.

Page 4, line 125: Hill (1980) is a pretty old reference. Does “analogous” mean alternative Voigt parameterizations? Do the authors know if anyone has re-visited fits of line shape parameterizations to microwave experiments since then?

Page 7, lines 220-223. Does water to air mixing ratio (r’w2a) here mean that in theory the mixing between oxygen lines would be altered by the presence of water vapor? Please consider some more words here for additional clarification. Are there any calculations out there to suggest that the line mixing for oxygen should look different in wet vs dry air?

Page 12, line 1: Have these line intensities and lower state energies changed between the HITRAN 2004 and HITRAN 2016 compilations?

Page 12, line 377: Later in the paper, there is a reference for the JPL catalogue. Please also add the reference here.

Page 14, line 438-439: please add citation/reference for the 22 GHz line intensity for clarity here.

Page 16, line 500: Please provide more information here on the indirect method used in R18.

Page 25: How does the uncertainty associated with spectroscopic parameters com-

pare to the uncertainty associated with instrument noise for these examples? Please comment.

Page 28, lines 873-874: “the laboratory and field measurements”. Although these are presumably referenced in Tretyakov et al. 2016, this is a very interesting point for many potential readers of this paper and therefore it would also be helpful to include the references for these laboratory and field measurements here directly also.

Typos/word choice

Page 9, line 259: “from the microwave to *the* far infrared range”

Page 10, line 303: Please consider replacing “retrieved” with “determined”, since “retrieved” has its own other meaning in this context.

Page 10, line 312: Please consider replacing “involved” with “associated”.

Page 10, line 313: Please consider replacing “retrieved” with “taken”.

Page 11, line 342: “of which 37 **are** within the 60 GHz band, one **is** at 118 GHz and the remaining 11 **are** in the sub-mm range”.

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