

## ***Interactive comment on “Simulation of sub-millimetre atmospheric spectra for characterizing potential ground-based remote sensing observations” by Emma C. Turner et al.***

**Anonymous Referee #2**

Received and published: 18 July 2016

### General comments

This paper presents a framework for determining the feasibility of ground-based sub-millimetre measurements of atmospheric trace gases at a particular site, and deciding which spectral lines are good choices for observation. The method uses estimates of instrumental parameters representative of current technology that is mainly used for astronomical purposes, and examples are given for six observation locations. The writing of high quality and the figures are clear and well created. I believe this work is suitable for AMT and will be of interest to many. I would recommend this work for publication if the following points can be addressed. The two biggest concerns are listed as the first comments.

C1

### Specific Comments

Page 10, line 24-25 A zenith angle of zero is not typical of a ground-based measurement. Usually measurements are performed at angles above 60 degrees or so. Viewing angle can have a significant effect on the signal-to-noise of a measurement, and depends on the relative strengths of the background atmosphere (i.e., absorption in the troposphere) and the signal. How will the presented results, for individual lines and continua, change when using a viewing angle that is more representative of a ground-based measurement?

Section 4.2 When calculating signal strengths in the enhanced resolution, and using this to estimate measurement times, etc., it matters whether the spectral lines of the gas of interest lie “on top” of (or overlap with) other spectral lines. This is particularly true if a small signal, like examples used here, overlaps with a strong signal, like that from ozone. If “strongest signal”, as calculated here for a gas, is meant to indicate a good choice for an observation window if one wants to retrieve that gas, then it is quite important to screen for so-called interfering species. They can cause both random and systematic effects that can lead to poor choices of measurement windows. Has this been considered when choosing the best window for observation of a gas?

Page 4, line 10-22 This section of the introduction is focused on using the sub-millimetre part of the spectrum for remote sensing of clouds. That subject is not addressed in the paper at all and so its introduction seems of little relevance or to serve no purpose. If this is the case, it should be removed.

Page 5, line 4-18 This section of the introduction focuses on the planetary energy balance. Similar to the last point, that is not addressed in the paper and does not directly relate to the work presented. Without justification, this should also be removed.

Page 7, line 9 What happens in the event that the edge of a 0.5 GHz frequency bin lands within a spectral line signal, splitting it?

C2

Section 3 Could you also specify the calculation grid that was used for the forward modelling?

Page 8, Line 32 “. . .10% of the year. . .” Where does this number come from?

Page 12, line 6-7 What is meant exactly by “the range of behaviour”? Shown are the driest and annual mean scenarios, which isn't representative of a full range. Please be specific here.

Page 13, line 14-15 Could you briefly elaborate on the origin of this effect?

Page 14, lin26-28 “As the simulations use averaged profiles, however, this does not rule out the possibility of detecting these species when they are present at higher abundances, as will occur in the real atmosphere.” While “not rule out” may technically be true, it is possibly misleading. What kind of higher abundances do you mean? Would detection require a ten-fold, or hundred-fold, etc., increase in gas concentration? And is it reasonable to assume that this required concentration will occur in the atmosphere?

Page 14, line 34 By “Uniquely”, do you refer to within this work, or in general?

Page 15, line 9-12 “The optimal frequencies for measuring HBr, HOBr, HO<sub>2</sub> and N<sub>2</sub>O from the ground have been determined and preliminary receiver characteristics calculated and tabulated for all considered locations and scenarios.” Related to the two main (first) comments: - Is this sentence valid if one were to make a measurement using a viewing angle that is more representative of a ground-based instrument? - If no account was made for the interference from spectral lines from other gases, then this sentence may not be true. Please consider and comment.

Figure 10 “The enhanced HBr signal”. Do you mean an enhanced resolution simulation, or an enhanced HBr signal from higher gas concentrations? Please clarify.

Technical comments

C3

Figure 6, lower panel The tick marks at label locations are missing (I don't know if this is intentional).

Figure 6 Please clarify what is meant by “bandwidth”. It is ambiguous without clarification or reference to the section of main text.

Figure 6, 7, 8, 9, and 10 Particularly (or at least) for Figure 6 and 7, which relate to the discussion of windows “opening”, the zenith angle for the simulation should be mentioned.

Table 2 For the description of Day and Night scenarios, could you please specify that it is the sun elevation angle? It can be slightly confusing as elevation angle is also used to refer to instrument pointing.

Page 3, line 6 I believe “catalyse” should be in plural form here as it refers to “family”?

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-173, 2016.

C4