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Atmospheric Measurement Techniques Discussions

Interactive comment on "Vertical wind profiling from troposphere to the lower mesosphere based on high resolution heterodyne near-infrared spectroradiometry" *by* Alexander V. Rodin et al.

Anonymous Referee #2

Received and published: 6 February 2020

The paper "Vertical wind profiling from troposphere to the lower mesosphere based on high resolution heterodyne near-infrared spectroradiometry" by A. V. Rodin et al. makes, as far as I can judge, a compelling case for Doppler-shift based velocimetry. Putting a few minor language issues aside, the paper is well written and well organized. The logical structure of the paper is good. Numerous citations suggest that the work is adequately put in the context of existing work; however, I am not a specialist in this field and thus I cannot judge if any relevant literature is missing.

Many technical aspects of the paper are outside my scope of expertise, thus I may have missed some flaws. Hopefully the other reviewer is closer to this research field.

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Discussion paper

Fields where I lack expertise are heterodyne spectroscopy and maximum entropy regularization methods.

Scientific issues:

In various places of the text it is not clear that only along line-of-sight velocities are measured. E.g., add in line 95 "with along line-of-sight velocities"; line 180: the along-line-of-sight component of the wind...; since the method provides slant wind velocities, the calculation of the vertical wind speed requires knowledge of the horizontal components. Where are these taken from? This should be discussed latest in Section 3.3. (This is my most serious scientific concern).

l 146-147: Not sure if this statement belongs here. I think it would fit in much better with the Conclusion section.

l 167: The Boone reference seems to refer to a specific method to calculate line mixing. What about also including references on the discovery and measurement of the physical effect (e.g., Armstrong (1982), Bulanin et al. (1984), Strow et al. (1986) or Hartmann (1989)? It will certainly not be necessary to include all of these, but I suggest to include at least one historically relevant paper.

@article{ARMSTRONG82,

author = "R. L. Armstrong",

title = "Line mixing in the ν_2 band of {CO$_2$}",

journal= "Appl. Opt.",

volume = "21",

number = "12",

pages = "2141-2145",

year = "1982" }

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@article{BULANIN84,
author = "M. O. Bulanin and A. B. Dokuchaev and M. V. Tonkov and N. N. Filippov",
title = "Influence of Line Interference on the Vibration–Rotation Band Shapes",
journal= "J. Quant. Spectrosc. Radiat. Transfer",
volume = "31",
number = "6",
pages = "521-543",
year = "1984" }
@article{STROW86,
author = "L. L. Strow and B. M. Gentry",
title = "Rotational collisional narrowing in an infrared {CO}$_2$ {{\it Q}} branch studied with a tunable-diode laser",
journal= "J. Chem. Phys.",
volume = "84",
number = "3",
pages = "1149-1156",
year = "1986" }
@article{HARTMANN89,
author = "J. M. Hartmann",
title = "Measurements and calculations of {CO$_2$} room–temperature high-pressure spectra in the 4.3∼μm region",

journal= "J. Chem. Phys.",

volume = "90",

number = "6",

pages = "2944-2950",

year = "1989" }

l171-179: The radiative transfer model seems not to consider refraction. Is this important? How large is the related error?

same place: Is the numerical accuracy obtained from 100 uniform layers good enough? Is the integration of the radiative transfer equation based on arithmetic mean values of pressure and temperature of the upper and lower boundaries, or is a more sophisticated numerical integration scheme used, relying on mass-weighted mean values or any other integration scheme which takes into account that there are systematically more CO2 molecules in the path segment in the lower half of the layer than in that above? I think that this numerical integration issue deserves some discussion.

l. 189: I think that the adequate reference for ill-posedness is Jacques Hadamard: Sur les problèmes aux dérivées partielles et leur signification physique. In: Princeton University Bulletin. Bd. 13, Nr. 4, 1902, ZDB-ID 1282693-5, S. 49–52. Reference to the Rodgers book can be made, e.g., in the context of Eq. (12).

Technical and Language issues: Caveat: I am not a native English speaker. Thus my language-related recommendations should be taken with care.

l. 1: ... from THE troposphere...

l. 11: CO2: use subscript "2"

l. 14: ... provides AN unambiguous ...

l. 15: between THE offset ... and THE altitude ... where THE respective ...

l. 16: ...retrieve THE vertical ... with the vertical resolution of the retrievals...

l. 18: ... retrieved wind profileS ...

l. 30: Not only provide heterodyne ...

l. 35: ... have been ...

l. 39: Radiometric Doppler [remove "As"]... AN extraordinary...

l. 46: The heterodyne method...

l. 63: I am not sure if the term "experiment" is appropriate here. An experiment is often understood to be an observation under controlled conditions, and this is not typically the case for atmospheric observations. Perhaps better "instrument", "instrumental setup", or "measurement principle" or something similar.

l. 82: The power spectrum

l. 88: ..., the heterodyne signal...

l. 94: ... that the LO linewidth...

l. 108: ...with A 5:95 ... According to THE antenna...

l. 115: both THE heterodyne and THE reference...

l. 118: ... with A pulse length ... A dead time ... and A stepwise...

l. 119: ...at A pressure ...

l. 127: ... through A consecutive ...

l. 128: ... The preamplifier circuit ... to A Rohde...

l. 130: THE LO pumping ...

l. 131: THE oscilloscope (or AN oscilloscope)...

l. 139: ... by THE Fabry...

l. 141: have shown an root mean squares deviation ...

l. 151: Once THE heterodyne signal...

l. 152: ... eliminate THE baseline slope... Since THE heterodyne...

l. 155: of THE heterodyne ... and THE baseline...

l. 155/156: I would suggest to turn around: The final transmission ... is the ratio ...". Or if you do not want to turn the sentence around, you might with to replace "is" with "renders"

l. 157: notice A baseline...

l. 161: ... LHS THE scattered ... (???) ...the simulation of atmospheric spectra is...

l. 163: in THE calculations.

l. 165: ... A model of ... (???)

l. 166: In THE calculations, we used the Voigt line shape

l. 172: THE upper boundary ... uppermost layer ....

l. 173: AN example of THE line shape fit...

l. 174: ... that THE line shape...

l. 175: The atmospheric line...

l. 177: collisional Lorentz broadening ... whereas A narrow...

l. 178: that PROVIDES information {???}

l. 180: ... with OTS line shape and...

l. 190: introduces A certain ... forces THE instability ...

l. 191: consider THE generalized...

l. 206: implies THE introduction

l. 217: THE vertical wind ...

l. 236: Here a reference seems not to be resolved.

l. 238: THE averaging kernel...

In general the notation seems not to comply with AMT format guidelines. E.g. Matrices and vectors should be bold face. etc.

l. 241: ...to THAT particular altitude where THE ... so that one may consider it as a point ...

l. 243: Therefore, the characteristic width of the main peak of the averaging kernel is a measure of the effective...

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