**Atmospheric
Measurement
Techniques**
Discussions

# Interactive comment on "Real-time remote detection and measurement for airborne imaging spectroscopy: a case study with methane" *by* D. R. Thompson et al.

**Anonymous Referee #1**

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The paper by Thompson et al. reports on the deployment of an airborne imager operating at low spectral resolution. The instrument is capable of providing information on methane concentration enhancements below the aircraft e.g. caused by localized sources such as drilling wells. Deployments in the frame of a measurement campaign in California demonstrate the concept and suggest using such imaging spectrometers for detecting fugitive emissions and for coordinating monitoring measures in real-time.

The study is a valuable contribution to the atmospheric sciences since it demonstrates the added-value of real-time observation capabilities for methane despite the mostly qualitative information on detected enhancements and emission patterns. The paper

is well written and methods appear robust. I recommend publication in AMT after considering some recommendations and mostly minor comments below.

1. The study could benefit from being a bit more quantitative. It would be interesting to see whether the detected enhancements could actually be used for quantitative interpretation e.g. concerning emission strengths.

(a) There is an attempt (P6294,l19) to compare the detected enhancements to MAMAP measurements. The comparison, however, remains qualitative since ground-pixels do not match. Would it be possible to average AVIRIS NG such that the average is representative of the MAMAP measurements and that the comparison would work?

(b)The IMAP algorithm is mentioned repeatedly in the manuscript but not used. Although the algorithm is too slow for real-time processing, it could be used to (once) validate the real-time processor in an offline validation study. Maybe one could even derive a quantitative calibration of the real-time retrievals.

2. A retrieval from the 2.37 micron $CH_4$ bands can only provide column enhancements (eg. units $molec/cm2$). How are mixing ratios (units: ppm) calculated? Are the structures in the background image (Figure 8) related to unknown air column? Could air column be derived from the AVIRIS NG measurements?

3. Technical comments

In many places: In-line citation should not be in parentheses.

P6284,l3+: Consider citing Vogel et al., AMT, 2011 (http://www.atmos-meas-tech.net/4/1785/2011/amt-4-1785-2011.html), Lübcke et al., AMT, 2013 (http://www.atmos-meas-tech.net/6/677/2013/amt-6-677-2013.html), Stremme et al, AMT, 2012 (http://www.atmos-meas-tech.net/5/275/2012/amt-5-275-2012.html), Krueger et al, AMT, 2013 (http://www.atmos-meas-tech.net/6/47/2013/amt-6-47-2013.html), if you find these studies applicable.

P6288,l17+: The discussion of the matched filter reads confusing:

*What does column-wise mean?

*It is not entirely clear to me what dimensions the variables "mu" and "t" have. Are they scalars or vectors of dimension number of spectral or spatial points? Vectors should be boldface in AMT.

*Why is "sigma" boldface in the text, but regular font in equation (5), (6), (8)?

*What are the "hat"-ed variables in equation (5) (Does it indicate eigenvalue truncation?)?

*Right-hand-side equation (6) is a scalar, left-hand-side is said to be a matrix (but has scalar font).

*Equation (7): scalar quantity is subtracted from identity matrix. Please rework this paragraph for the general reader.

P6289,l12: q eigenvectors and eigenvalues phi -> p eigenvectors q and p eigenvalues phi

P6290,l14: The use of "l" for length could be confusing since it looks like a division in equation (10).

P6290,section 2.4: I do understand that real-time processing needs a fast (and therefore approximate) retrieval. However, I have some questions concerning section 2.4:

*Is the approximation log(x) = x -1 really carried out at zero absorption path? The real absorption would be clearly outside the validity range of the approximation. CH4 and H2O absorption at 2.37 micron is optically thick. p6291,l5+: As far as I understand, what you actually do is that you calculate the Jacobian at absorption path l=0 and then, you assume that the zero-path Jacobian is also applicable to the case with realistic absorption path. I.e. while using the zero-path Jacobian, your final retrieval step linearizes at a "typical transmission signature" and performs one step in the direction of the zero-path Jacobian. Is that correct? It might be worthwhile clarifying this.

*Are the derivations carried out for the (infinitely resolved) atmospheric spectrum or is the convolution by the instrument response function already taken into account? Convolution and exponential do not commute unless the approximation of small optical thicknesses really holds.

*"The target signature t1 is the vector of negative absorption coefficients ... multiplied by the background mean radiance." Isn't t1 the slant column ie. the absorption coefficient times the path length (which might be 1m a priori, but still it has units meters)?

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 6279, 2015.