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

**D. R. Thompson et al.**

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**1. Tactical remote measurement has been conducted already for radar and Lidar. It would be good to mention this context and to work out more clearly that the true novelty of the present study is not tactical remote sensing itself but rather its application to remote trace gas imaging spectroscopy.**

We agree, and have made the novel contribution clear in the introduction: “We believe the COMEX campaign to be the first *real-time* tactical deployment for remote trace gas imaging.” We also added new text to the introduction review that recognizes the historical use of radar and lidar: “Aircraft use radar to hunt extreme weather, and lidar to find cirrus, thunderstorms or biomass burning (Rolph, 2003). In each case, tactical remote measurement can identify desired features (and equally importantly, their absence) during flight, permitting flight plan adjustments to improve coverage (Davis et al., 2010).”

**2. The matched filter approach should not be called “current” if it was not used in June or September. It seems that the measurement campaign was actually a major driver for developing the real-time algorithms and if that was the case, this should be mentioned in the introduction. It should also be mentioned already in the introduction that during the COMEX campaign only a simple algorithm was available and that a more sensitive and quantitative real-time processing system was developed and tested post-campaign as described in detail in this manuscript. This scheme will be available for future missions.**

We have added new text as suggested: “COMEX exploited tactical remote measurements from multiple platforms. We focus on one participating instrument, the Next

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Generation Airborne Visible Infrared Spectrometer (AVIRIS-NG) (Hamlin et al., 2010; Green et al., 1998), which mapped CH<sub>4</sub> enhancements in real time. A simple detection method based on a band ratio was sufficient to detect several sources and enhance the COMEX campaign. These initial results motivated the development of a more sophisticated matched filter detection approach, described in this paper, which was developed after COMEX and has been adopted by subsequent CH<sub>4</sub> monitoring campaigns. Although prior studies have quantified CH<sub>4</sub> anomalies using Visible Shortwave Infrared (VSWIR) imaging spectrometers (Roberts et al., 2010; Bradley et al., 2011), we believe the COMEX campaign to be the first *real-time* tactical deployment for remote trace gas imaging.”

**3. The manuscript contains a large number of figures but not all of them are very informative. It would be more useful to show a schematic of the platforms... and communication links between them. Such a schematic could potentially integrate the photographs in Figures 1a and 6 and could thus replace Figures 1 and 6 entirely. Figure 7 seems unnecessary in any case.**

We have implemented these recommendations, removing Figure 7 and coalescing the three platforms into a single image with the communications topology (attached). We believe these changes strengthen the presentation.

### Minor Comments

**P6288 L14 and P6292 L21: Change citation from parenthetical to direct.** Fixed.

**P6290 L10: “Mixing ratio length” is more accurate than “concentration length”**  
We have changed all instances throughout the manuscript. We have also adopted

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“Noise Equivalent Mixing Ratio Length (NEMRL)” in lieu of “Noise Equivalent Concentration Length (NECL)”

**P6290, L16-17: I didn't quite understand why the approximation  $\log(x) \approx x-1$  is introduced. Wouldn't it be much more straightforward to introduce the approximation  $\exp(x) \approx 1+x$  for  $x \ll 1$  which results from the Taylor expansion of  $\exp(x)$ ? We agree, and substituted the new justification: “For  $x$  near zero, the first-order Taylor expansion  $\exp(x) \approx 1 + x$  permits...”**

**P6291, L5: Why “As before”?** Removed.

**P6291, L19-21: The IMAP-DOAS method was mentioned earlier in Section 2.3. The last two sentences in Section 2.4 could be deleted** Deleted.

**Section 2.5.: The operator display doesn't seem to display any coordinates. Isn't this a major weakness?** Yes! After COMEX we added real-time geolocalization displaying the coordinates of detected plumes. Following this reviewer's comment, we changed the figure to the new display while intentionally redacting some lat/lon precision for public distribution (attached). The conclusion states: “COMEX revealed a need for a real-time geolocalization capability to display accurate plume locations. This capability has since been implemented using a geometric camera model, geometric ray-tracing, and an onboard Digital Elevation Model (DEM).”

**Section 3.2 analyzes CH<sub>4</sub> detection sensitivity and finds a NECL of 140 ppm for the most sensitive method. Why isn't this value mentioned also in the conclusions? Why is a detection sensitivity of 500 ppm suggested in the conclusions (as well as on P6294, L13).** We felt a single significant digit was best because of the variability across different atmospheric and imaging conditions. We estimated the noise-equivalent mixing ratio length to be 140 ppm m. For conservatism, we used a  $3\sigma$  detection limit and rounded up. The text now states: “The matched filter resolves the plume at concentrations as low as 500 ppm m, approximately 3 standard deviations above the background noise.” In the conclusion: “The latest iteration of the system

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provides  $\sigma$  detection sensitivity of 500 ppm m.”

**P6297, L10: I don't think that “airborne in situ measurements” were mentioned before. What kind of measurements? On which platform?** We clarified this: “Along with AVIRIS-NG, the COMEX campaign deployed a second aircraft: the CIRPAS Twin Otter, which carried the Methane Airborne MAPper (MAMAP) (Gerilowski et al., 2011; Krings et al., 2011), a non-imaging spectrometer, and an in-situ Picarro CH<sub>4</sub> sensor sponsored by NASA, Ames.”

**P6298, L13: “increases, becomes” -> “increases, it becomes”** Fixed.

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

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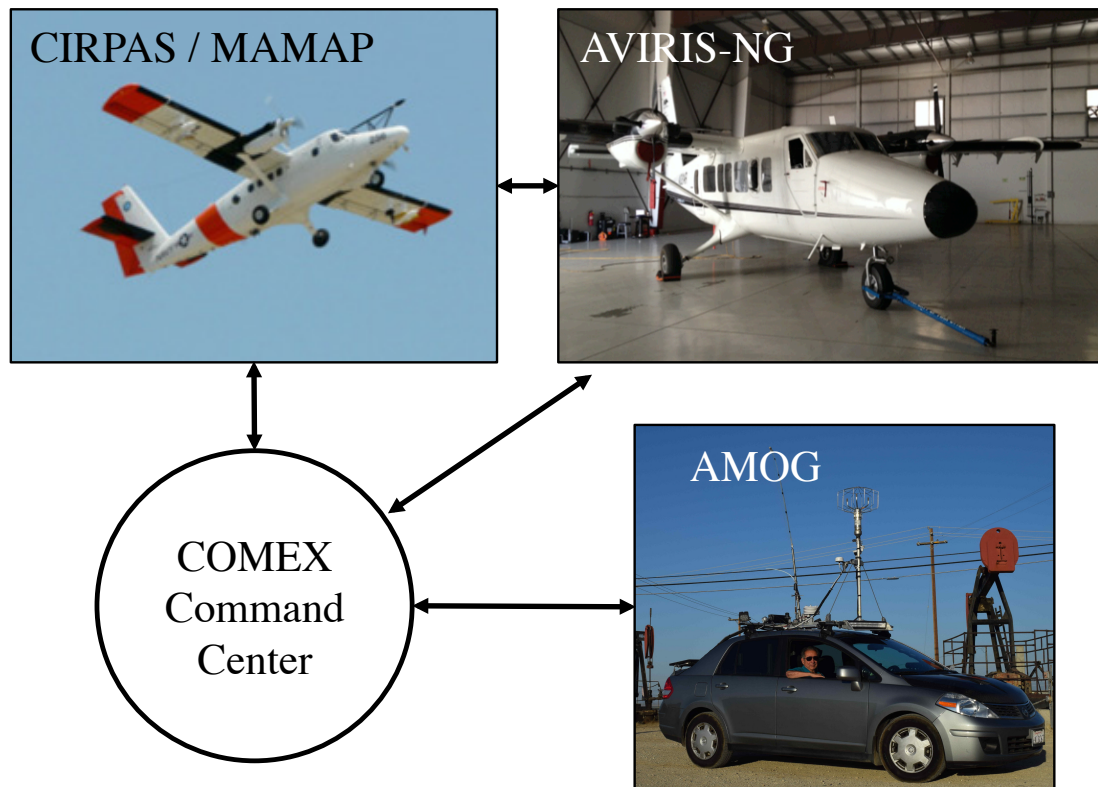
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**Fig. 1.** Communications topology during COMEX.

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**Fig. 2.** Upgraded display showing lat/lon coordinates (precise location has been redacted).

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