

Interactive
Comment

Interactive comment on “Characterization of trace gases measured over Alberta oil sands mining operations: 76 speciated C₂–C₁₀ volatile organic compounds (VOCs), CO₂, CH₄, CO, NO, NO₂, NO_y, O₃ and SO₂” by I. J. Simpson et al.

Anonymous Referee #3

Received and published: 29 September 2010

General comments:

This paper describes the measurements of a large suite of trace gases with the NASA DC-8 airborne laboratory above large surface mining operations of oil sands in north-east Alberta. According to the authors these are the first such detailed, peer-reviewed observations. The used analytical methods are well characterized in the manuscript with proper citations of previous publications. The presented data is valuable to the scientific community to gain a first insight into the atmospheric implications from oil sand mining operations, which are increasingly gaining importance.

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The paper can be published after minor revisions, most importantly the readability of the figures should be improved.

Specific comments:

Page 18511, line 8: Would it be worth pointing out that the used hot water process to extract bitumen from the oil sands is very water and energy intensive? There are other methods which use less water and energy by igniting some of the bitumen underground.

Page 18514, lines 24ff: Are tests performed on a regular basis to exclude “rogue” tanks which have been activated, e.g. due to corrosion?

Page 18518, lines 8-27: You present here a classification of all compounds into three groups. However, in Section 3.3 and in the Conclusion section you classify the compounds in different groups. Maybe one consistent classification could be used and added to Tables 1 and 3?

Page 18519, line 24: Could you please explain in short the chemistry involved in the processes you think are being performed at the site, e.g. as far as I know alkanes are typically produced by hydrocracking from unsaturated compounds via addition of hydrogen, while alkenes are typically produced by steam cracking of saturated compounds.

Page 18520, line 23ff: Could the presence of hydrocrackers, which typically generate ethane and heavier alkanes explain the good correlation among higher hydrocarbons and the bad correlation with methane? Similarly, the use of LPG could explain correlation among C3 and C4 alkanes (but not ethane).

Page 18521, first paragraph: Could the presence of hydrocrackers, the use or the production of LPG explain some of the observed correlations?

Page 18523, line 5: Suggest to add “e.g. from the used diluent Naphtha” after “Aberta” as most listed compounds are listed as constituents of Naphtha in Siddique et al., 2007.

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Page 18528, line 3: Is this consistent with observed isoprene levels?

Page 18534 lines 19ff: McTaggered-Cowan et al., 2010 and other sources detail that the composition of natural gas varies substantially with geographical origin, time of year, and treatment and that the content of ethane and propane can be close to zero. Do you have any information on the composition of the natural gas used at the site and whether a very low content of ethane and propane could explain the missing correlations with methane? Also, the operation of hydrocrackers could explain the emission of ethane and other alkanes without emissions of methane and thus explain the low correlations.

Page 18535, lines 25ff: This sentence seems somewhat strange to me. Please break it into two sentences.

Page 18536, lines 17: If natural gas with low ethane and propane content is used and/or other ethane propane sources such as hydrocrackers are operated, couldn't the increased methane content by itself - without any correlations of methane with ethane and/or propane - point to natural gas leaks? Do you have knowledge on the typical natural gas content at the site or in Canada in general?

Figure 2 A, B: The flight tracks are very hard to see. Could you use different colors, e.g. yellow? Could you add the trajectory or the prevailing wind direction somehow?

Figure 2 B: Why are not all sample locations shown?

Figure 2 lower part: The sample numbers are very hard to read.

Figure 3: It would improve readability of the figure to zoom in much more, focusing on the trajectories, and not wasting too much space on a mostly empty map.

Figure 4: It is literally impossible to access trace gas variability from most figures. The CFC-11 and 12 figure e.g. could be modified with a y-scale from 200 to 600 ppt. The C2Cl4 data e.g. could be plotted on the altitude scale. Some of the other plots could be improved e.g. by breaking the y-scale in two scales and thus having different resolution

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for low and high points and/or by plotting some of data on logarithmic scales.

Figures 5-9: Many of the figures should be improved e.g. by shrinking the scales, by braking the x-scales in two scales and thus having different resolution for low and high points and/or by plotting some of the data on logarithmic scales.

Technical corrections:

Page 18509, line 15, page 18510, line 2, line 7, etc.: Be consistent about the use of ‘commas’ in enumerations before “and”.

Page 18509, line 18: Remove “up to”.

Page 18510, line 4: Add “x” after “383”.

Page 18510, line 12: Add “ppt” after “217”.

Page 18510, line 13: Add “ppt” after “ 20 ± 7 ”.

Page 18511, lines 11-12: The link does not work.

Page 18512, line 28 and similar: Rather use “45 s long integrated”.

Page 18513, lines 21 and 24, etc.: Be consistent about “leg” or “Leg”.

Page 18514, line 6: Replace “2002; 2006” with “2002, 2006”.

Page 18514, line 19: “liquid nitrogen cleaned” is lab jargon.

Page 18515, line 5: Replace ‘1/4 in.’ with ‘1/4 “’.

Page 18515, line 20: “An instrument mass flow controller (Brooks, manufacturer place, 5850E model)”.

Page 18514, line 21: How has the water been purified?

Page 18515, lines 26: Specify manufacturer and model of each column, e.g. which PLOT column was used?

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Page 18516, line 7: "... and its integration is manually".

Page 18516, line 8: Why do the peaks need to be manually integrated? Is the chromatography changing so much that an automatic integrator does not work?

Page 18516, lines 10ff: Please specify how the standards were certified.

Page 18516, lines 15ff: Are there any compounds which have not been intercalibrated?

Page 18516, line 16: Replace "unknown" with "blindly selected".

Page 18516, line 23: Is it "onboard" or "aboard"?

Page 18518, line 5: "are available at".

Page 18518, line 16: Please list the HCFCs.

Page 18520, line 16: To increase readability, please use "4407 pptv ethane; 2713 pptv propane".

Page 18522, lines 20 and 21: Please add "maximum" in the brackets.

Page 18523, line 22: Please remove "," after "ethane" to improve readability.

Page 18523, line 27: "the summer of 2006".

Page 18527, lines 18 and 19: Please remove brackets.

Page 18531, line 29: "the first half of the".

Headers 2.2, 3.2.1, 3.2.2, 3.2.3, 3.5: Please add "and".

Page 18532, last sentence and page 18533, first sentence: Please remove brackets.

Page 18533, line 23: "... emissions lead to a titration of O₃, ...".

Page 18536, line 23: Add " α -pinene and β -pinene".

Table 3: Please do not use compound abbreviations such as "2+3-MePentane".

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Table 3: How were the compounds on the y-axis selected?

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10, C8115–C8120, 2010

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