

## ***Interactive comment on “The municipal solid waste landfill as a source of ozone-depleting substances in the United States and United Kingdom” by E. L. Hodson et al.***

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Thank you for the thoughtful input. We will address the comments in sequential order as listed by Anonymous Referee #1

Response to specific comments:

1. You only look at MSW landfills. Somewhere, please discuss to what extent non-MSW landfills are likely to have different ODS emissions. And if this has any potential to affect your conclusions. Perhaps using LandGEM?

This would certainly be a great further research project. For most ODSs, it seems

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unlikely that non-MSW landfills would be a much bigger source of ODS with two notable exceptions. The Toxics Release Inventory (TRI) provides information submitted by US facilities processing toxic chemicals, which include a lump sum number of various ODSs disposed in all landfills in the US over the last 20 years. The numbers for total landfill disposal over the years 2001–2008 (chosen for being the longest set of years that TRI lumps together) are less than 1% of total gas released to the atmosphere during this 7 year period for almost all ODSs. This matches what was found in our study. The stand-out exceptions in the TRI inventory are methyl chloroform and HCFC-123, where TRI estimates that about 20% and 100% of the total compound released to the environment is disposed in landfills over the 2001–2008 time period. Other TRI inventory years tell the same story. For these two compounds, a further analysis of other types of landfill emissions is likely warranted.

A second point is that the term "municipal solid waste landfill" is deceiving. Almost all MSW landfills accept commercial and industrial waste, which can comprise up to 50% of their total solid waste input. For example, in the US state of Massachusetts, there are no landfills which only take industrial and construction waste. However, New York state sends about 10% of their waste stream to special industrial/commercial waste landfills. These landfills could potentially have higher relative emissions of ODSs, but comprise a smaller fraction of the total waste stream. Yet, unpublished data from seven UK landfills with industrial waste fractions greater than 50%, which we collected during this study, had indistinguishable ODS/CH<sub>4</sub> ratios compared to the UK "MSW" landfills. In the end, we did not include the UK industrial landfills in the regressions to keep the extrapolation consistent, since the national methane statistics are based on data from MSW landfills.

2. What about other ODSs? Are landfills likely to be more important for those or not?

Again, the TRI data is the best for answering this question. The only ODSs with landfill disposal rates during 2001–2008 above 1% are methyl chloroform and HCFC-123 as indicated in the previous question. Other ODSs, with high total disposal rates (over

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one thousand pounds per year), but low disposal fractions (less than 1%) relative to total annual release of the chemical to the atmosphere, are HCFC-22, HCFC-141b and HCFC-142b.

3. According to Fig. 1, the closed landfills generally have lower ODS emissions. You exclude them in the regression. Doesn't this mean that the resulting emission numbers are high estimates for landfill ODS emissions? This would bolster your overall argument that landfills are not an important ODS source for the US or UK. Some brief discussion seems needed.

Agreed. Previous versions of the manuscript included a discussion of this topic, but we ultimately decided to exclude closed landfills because there are only two for each country, with one of those two emitting very little gas. It seemed hard to tell whether our two points were reliable indicators of all closed landfills, but the data does not at least contradict the main argument that landfills are not an important source of ODSs.

4. 22807, L16 how large a majority? 51%? 99%?

The US Environmental Protection Agency estimates that around 93% of US methane emissions are from municipal solid waste. Correspondingly, methane and carbon dioxide together are the main components of landfill gas (over 95% usually). See EPA [1994, 2009a,d] for a discussion of their methodology.

5. 22808, L19-21..... Any ideas about why CFC-11 is so variable? Related possibly to the high rates of degradation you mention later?

In this case, we meant different years at the same landfill (Table 1). From unpublished data that we collected at one landfill over 1.5 years, CFC-11, CFC-113 and methyl chloroform can vary by as much as 50% of their mean value over one year. This variability increases when new gas collection technology is installed at the site. We could not pin the variability to ambient temperature or pressure changes. Moreover, the systems we were investigating are highly engineered, so human influences on the

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pipe pressure, pipe flow, pipe temperature, etc. will have a great effect on mole fraction variability of the landfill gas. On top of this, CFC-11 degrades in anaerobic conditions as discussed in the Scheutz papers, which likely adds to the annual variability. In this context, it was remarkable how stable CFC-12 mole fractions were over the 1.5 year study (see Table 1 of original submission).

The other comments seemed to be mostly technical clarifications, which we will incorporate into the final draft. Thank you for your comments!

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 22803, 2009.

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