JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, D13314, doi:10.1029/2006JD008069, 2007

Reply to comment by Ted Michaels on "Recent trends in anthropogenic mercury emission in the northeast United States": Waste-to-energy's low mercury emissions

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Received 25 September 2006; accepted 12 February 2007; published 13 July 2007.

Citation: Sigler, J. M., and X. Lee (2007), Reply to comment by Ted Michaels on ''Recent trends in anthropogenic mercury emission in the northeast United States'': Waste-to-energy's low mercury emissions, *J. Geophys. Res.*, *112*, D13314, doi:10.1029/2006JD008069.

[1] *Sigler and Lee* [2006] (hereinafter referred to as SL06) combined measurements of mercury (Hg) and a combustion tracer at a background site to estimate regional Hg emission rates in the northeast United States from 1999/2000 to 2003/2004. Significant interannual variation in regional Hg emission was observed. Inventory calculations of Hg flux from the regional electric power sector suggested that the power sector strongly influences annual variation in Hg emission in the northeast but may not account for as large of a percentage of the total atmospheric Hg flux as expected given previous inventory estimates.

[2] We thank *Michaels* [2007] (hereinafter referred to as M07) for comments on SL06. M07 cited substantial reductions in Hg emissions from municipal waste combustors (MWC) nationwide since 1990 and a clear ability of MWC to achieve federal emissions standards and suggested improper speculation by SL06 as to the role of MWC in Hg emissions in the northeast. Here we briefly address several of the important issues raised by M07.

[3] We stress that SL06 did not claim that MWC cannot or do not test significantly lower than U.S. emission standards as defined by the Clean Air Act. More importantly, SL06 did not speculate that "high mercury emission levels in the northeast might be attributable" to MWC and failure to achieve standards, as suggested by M07, or to the performance of any other source category. SL06 cited multiple sources which indicate significant reductions in Hg emissions from MWC in several northeastern states since the late 1990s and were led to specifically investigate inventory Hg flux from the electric power sector because the substantial decline in MWC emissions due to legislative impact would leave power plants as by far the most important Hg emission category in the northeast [*U.S. Environmental Protection Agency* (*EPA*), 1997]. Rather than qualifying or searching for reasons behind high emission rates, SL06 sought to understand the observed interannual variation in Hg emissions determined from atmospheric measurements and gain insight into the relative contributions of different sources to total emissions in the northeast.

[4] SL06 posited several potential contributing factors for the observation that power sector emissions were unable to account for as high a percentage of total Hg emissions in the northeast as expected. Among them (SL06, paragraph 38) was the possibility that "emissions from municipal and medical waste combustion emissions have not been reduced to the level targeted by EPA in 1997 and still contribute significantly to the regional Hg emission rate." While not intended to suggest that MWC are responsible for "high mercury emission levels" in the northeast or are unable to test below federal standards, this contention could be misleading and deserves clarification.

[5] As M07 noted, U.S. Hg emissions from large MWC declined significantly (95%) between 1990 and 2000 because of Maximum Achievable Control Technologies (MACT) compliance [*EPA*, 2002]. According to *EPA* [1997], New Source Performance Standards (NSPS) adopted in 1995 sought to reduce U.S. Hg emissions from municipal and medical waste combustion by at least an additional 90% over 1995 levels by 2000. Using inventory estimates presented by *EPA* [1997] as a baseline, we therefore expected MWC emissions to have declined from roughly one third of total Hg emission (1995 inventory) in the source region considered by SL06 (New England, Mid-Atlantic, Maryland, and Delaware) to on the order of 5% during the observation period (1999/2000–2003/2004), assuming no changes in emission among other major sources. This is clearly not the case, despite the dramatic reductions in bulk Hg emissions from MWC that have been achieved during the past decade. For example, recent inventory data suggest that MWC may have contributed approximately 21% of total Hg emissions in the northeast (not including Pennsylvania, Maryland, and Delaware) as recently as 2002, roughly the midpoint of the observation period of SL06, despite an 86% reduction in total MWC emissions in the same region since 1998 [*Northeast States for Coordinated Air Use Management* (*NESCAUM*), 2005]. We also note that total Hg emissions from MWC in New England, New York, and New Jersey were approximately 8.5 Mg in 1995 [*EPA*, 1997]. If a 90% reduction were

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0148-0227/07/2006JD008069$09.00

achieved under the NSPS, then Hg emissions from this category should have been no more than ~850 kg by 2000. Inventory Hg emissions from MWC in this region were estimated at 1012 kg as late as 2002 [*NESCAUM*, 2005]. Although the difference is small, this does suggest that the bulk reduction in Hg emissions from MWC since 1995, though significant and dramatic, may have fallen slightly short of the targeted level of 90%. However, we acknowledge that the targeted 90% reduction was for national emissions, and extrapolating this reduction to a plant-by-plant or regional basis, as was done by SL06, may be problematic. An important consideration here is that many MWC facilities in the northeast were already achieving significant reductions in Hg emissions in 1995 by using technologies such as scrubbers, baghouses, and electrostatic precipitators. Therefore a total reduction in emissions of 85–90% over 1995 levels might have been impractical given previous reductions. In any case, MWC were in compliance with applicable regulations (T. Michaels, personal communication, 2006).

[6] In summary, recent inventory data suggest that MWC play a significant role in regional Hg emissions in the northeast, despite the large reductions in MWC emission that have taken place in response to EPA legislation during the past decade. When juxtaposed with inventory data, the emissions estimates derived from atmospheric measurements presented by SL06 support the finding that sources other than the electric power sector, such as MWC, still account for a significant percentage of total Hg emission in the northeast.

[7] SL06 speculated that MWC could be contributing more to regional Hg emissions than expected because some facilities lacked Hg control during the observation period. The phrasing used by SL06 in this instance should have been clearer. This was in reference to small MWC (<227 Mg d^{-1} capacity) which though in compliance with applicable federal and state regulations, were not required to achieve MACT standards until December 2005. However, emissions from these facilities were included in inventories (W. Stevenson, personal communication, 2006; J. Graham, personal communication, 2006), and pre-MACT emissions have been largely offset by the significant reductions in emissions from large MWC.

[8] M07 notes that the "waste-to-energy industry... should be given due credit." While our role is not to give credit or assign blame, SL06 intended no implication that large MWC facilities were not in compliance with applicable standards and did not dispute the significant progress that has been made toward reducing Hg emissions from MWC. This is a critical achievement toward reducing overall Hg emission in New England, New York, and New Jersey by approximately 70% between 1998 and 2002, according to inventory estimates [*NESCAUM*, 2005]. Hg emissions from this source category should continue to decline (as noted by M07) as small MWC came into MACT compliance recently and additional efforts are made to remove Hg from waste. Still, MWC and other sources outside of the power sector are significant contributors to regional Hg emission in the northeast. Combining both inventory data and atmospheric measurements is a useful approach toward not only tracking overall Hg emissions but gaining confidence in our understanding of the relative contributions of different sources to total emission.

[9] **Acknowledgments.** We thank Ted Michaels (Integrated Waste Services Association), Walt Stevenson (Office of Air Quality Planning and Standards, EPA), and John Graham (NESCAUM) for providing information related to recent trends in Hg emission from municipal waste combustion in the United States.

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