# Mercury in arctic tundra snowpack: temporal and spatial concentration patterns and trace-gas exchanges

Yannick Agnan[1,2], Thomas A. Douglas[3], Detlev Helmig[4], Jacques Hueber[4], Daniel Obrist[5,2]

[1]Milieux Environnementaux, Transferts et Interactions dans les hydrosystèmes et les Sols (METIS), UMR 7619, Sorbonne Universités UPMC–CNRS–EPHE, 4 place Jussieu, F-75252 Paris, France
[2]Division of Atmospheric Sciences, Desert Research Institute, Reno, Nevada 89523, USA
[3]US Army Cold Regions Research and Engineering Laboratory, PO Box 35170, Fort Wainwright, Alaska 99709, USA
[4]Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado 80309, USA
[5]Department of Environmental, Earth, and Atmospheric Sciences, University of Massachusetts, Lowell, MA 01854, USA

*Correspondence to*: Yannick Agnan (yannick.agnan@biogeochimie.fr) and Daniel Obrist (daniel_obrist@uml.edu)

## Supplementary material:

**Table S1: Geographical coordinates of transect sampling sites.**

| site | latitude | longitude | elevation (m) | distance to Dalton Highway (m) |
|---|---|---|---|---|
| transect 1 | 68.7605° N | 148.8659° W | 501 | 730 |
| transect 2 | 69.0350° N | 148.8258° W | 400 | 230 |
| transect 3 | 69.4212° N | 148.6691° W | 333 | 210 |
| transect 4 | 69.5692° N | 148.6049° W | 145 | 560 |
| transect 5 | 69.6741° N | 148.7003° W | 118 | 240 |
| transect 6 | 69.8324° N | 148.7555° W | 84 | 140 |
| transect 7 | 70.0031° N | 148.6804° W | 46 | 250 |
| transect 8 | 70.1323° N | 148.4896° W | 21 | 250 |

**Table S2: Summary total ($Hg_{tot}$) and dissolved Hg ($Hg_{diss}$) concentrations in snowpack and surface snow layers on the tundra and lake at Toolik Field Station.**

| date | location | height (cm) | $Hg_{tot}$ (ng $L^{-1}$) | | $Hg_{diss}$ (ng $L^{-1}$) | |
|---|---|---|---|---|---|---|
| | | | mean | SD[a] | mean | SD[a] |
| Oct. 14th 2014 | tundra | 36 | 0.22 | 0.04 | 0.18 | 0.00 |
| | | 25 | 0.24 | 0.04 | 0.14 | 0.08 |
| | | 13 | 0.17 | 0.18 | 0.09 | 0.08 |
| Dec. 7th 2014 | tundra | surface | 0.21 | 0.03 | <DL[b] | – |
| | | 21 | 0.43 | 0.55 | 0.12 | 0.03 |
| | | 11 | 1.06 | 1.30 | 0.16 | 0.06 |
| Dec. 31st 2014 | tundra | surface | 0.36 | 0.28 | 0.17 | 0.06 |
| Jan. 26th 2015 | tundra | surface | 0.27 | 0.16 | 0.12 | 0.05 |
| | | 50 | 0.36 | – | 0.26 | – |
| | | 37 | 6.23 | – | <DL[b] | – |
| | | 25 | 0.46 | 0.16 | 0.11 | 0.11 |
| | | 10 | 0.28 | 0.17 | 0.08 | 0.06 |
| | lake | 8 | 0.31 | 0.06 | 0.21 | 0.05 |
| Feb. 20th 2015 | tundra | surface | 0.18 | 0.03 | 0.13 | 0.02 |
| Mar. 8th 2015 | tundra | 48 | 0.66 | 0.10 | 0.15 | 0.02 |
| | | 37 | 0.59 | 0.36 | 0.11 | 0.10 |
| | | 25 | 0.19 | 0.03 | 0.08 | 0.05 |
| | | 13 | 0.29 | 0.05 | <DL[b] | – |
| | lake | 11 | 0.74 | 0.02 | <DL[b] | – |
| Apr. 3rd 2015 | tundra | surface | – | – | 0.24 | 0.06 |
| Apr. 17th 2015 | tundra | surface | 0.87 | 0.25 | 0.21 | 0.04 |
| | | 35 | 1.03 | 0.45 | 0.28 | 0.01 |
| | | 25 | 0.61 | 0.05 | 0.31 | 0.08 |
| | | 15 | 1.24 | 0.41 | 0.29 | 0.15 |
| | | 5 | 0.91 | 0.62 | 0.33 | 0.22 |
| | lake | 11 | 1.43 | 0.23 | 0.09 | 0.07 |

[a] standard deviation

[b] below detection limit

"–" no data

**Table S2: Continued.**

| date | location | height (cm) | $Hg_{tot}$ (ng $L^{-1}$) | | $Hg_{diss}$ (ng $L^{-1}$) | |
|---|---|---|---|---|---|---|
| | | | mean | SD[a] | mean | SD[a] |
| Oct. 19th 2015 | tundra | surface | 0.32 | 0.03 | 0.12 | 0.07 |
| Nov. 15th 2015 | tundra | surface | 0.46 | 0.17 | 0.26 | 0.13 |
| Dec. 5th 2015 | tundra | surface | 0.19 | 0.01 | 0.10 | 0.09 |
| | | 34 | 0.32 | – | 0.12 | – |
| | | 26 | 0.78 | – | 0.23 | – |
| | | 16 | 0.43 | 0.12 | 0.20 | 0.04 |
| | | 8 | 0.37 | 0.08 | 0.27 | 0.13 |
| Jan. 13th 2016 | tundra | surface | 0.82 | 0.54 | 0.13 | 0.08 |
| Jan. 29th 2016 | tundra | surface | 0.38 | 0.15 | 0.29 | 0.02 |
| | | 35 | 1.00 | – | 0.18 | – |
| | | 25 | 0.69 | 0.75 | 0.16 | 0.05 |
| | | 15 | 0.56 | 0.18 | 0.19 | 0.05 |
| | | 5 | 0.64 | – | 0.17 | – |
| | lake | 5 | 1.63 | 0.63 | 0.24 | 0.06 |
| Feb. 20th 2016 | tundra | surface | 0.60 | 0.15 | 0.24 | 0.08 |
| Mar. 3rd 2016 | tundra | surface | 0.41 | 0.04 | 0.33 | 0.05 |
| Mar. 25th 2016 | tundra | surface | 1.01 | 0.07 | 0.49 | 0.03 |
| | | 50 | 0.58 | – | 0.13 | – |
| | | 40 | 0.85 | – | 0.14 | – |
| | | 30 | 0.54 | – | 0.10 | – |
| | | 20 | 0.31 | 0.06 | <DL[b] | – |
| | | 10 | 0.46 | 0.13 | 0.19 | 0.09 |
| | lake | 13 | 0.41 | 0.16 | 0.17 | 0.02 |
| Apr. 2nd 2016 | tundra | surface | 1.46 | 0.16 | 1.15 | 0.15 |
| Apr. 13th 2016 | tundra | surface | 0.21 | 0.03 | 0.13 | 0.01 |
| May 1st 2016 | tundra | surface | 0.66 | 0.23 | 0.23 | 0.08 |
| | | 33 | 0.21 | 0.12 | 0.12 | 0.11 |
| | | 23 | 1.07 | 1.20 | 0.13 | 0.06 |
| | | 15 | 0.43 | – | 0.13 | – |
| | lake | 13 | 0.24 | 0.07 | 0.12 | 0.11 |

[a] standard deviation
[b] below detection limit
"–" no data

**Figure S1: Snow tower installation over the arctic tundra at Toolik Field Station.**

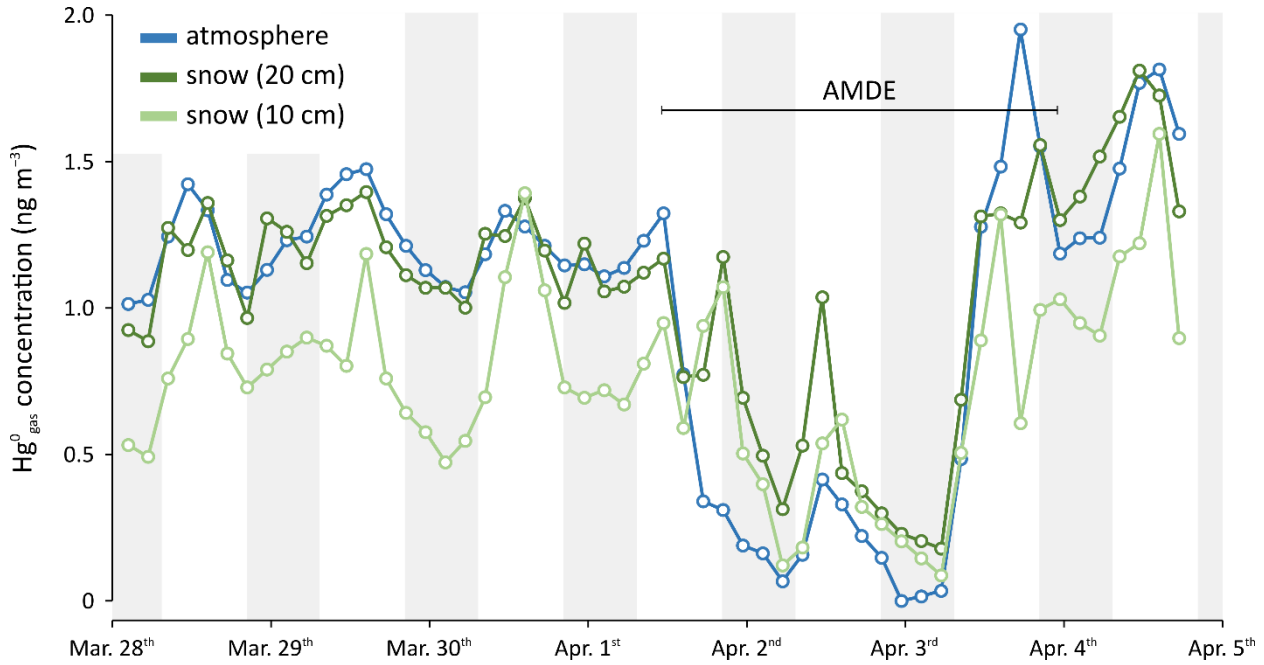


**Figure S2**: **$Hg^0_{gas}$ concentrations (3-hours averages) in the atmosphere and snowpack interstitial air (10 and 20 cm above the ground surface) during a week in spring 2016, including an AMDE, measured at Toolik Field Station. The gray bars indicate nighttime periods.**