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Atmospheric mercury monitoring in Canada



Alexandra Steffen

**Geoff Stupple, Ashu Dastoor, Andrei Ryjkov,
Andrea Darlington and Deyong Wen**

**Air Quality Research Division
Science and Technology Branch**

Mercury (Hg) in Canada

- Hg remains a risk to Canadian ecosystems and human health
- Certain Canadian populations are at higher risk of exposure
- Methyl Hg levels can be high enough to pose a risk to the reproductive health of fish and fish-eating wildlife
- Most annual provincial/territorial fish consumption advisories are for Hg (~90%)
- Canada is a net recipient of mercury
 - 95% of anthropogenic Hg deposited in Canada comes from external source regions
- List of Toxic Substances in CEPA – mercury and its compounds
- Contaminant of Mutual Concern (GLWQA)
- Current Hg issues in Canada
 - Wabigoon-English River (Grassy Narrows and Whitedog First Nations)
 - Muskrat Falls, Labrador



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What are the major emission source regions contributing to Canada's burden?

Long range transport
ECCC Global Hg Model

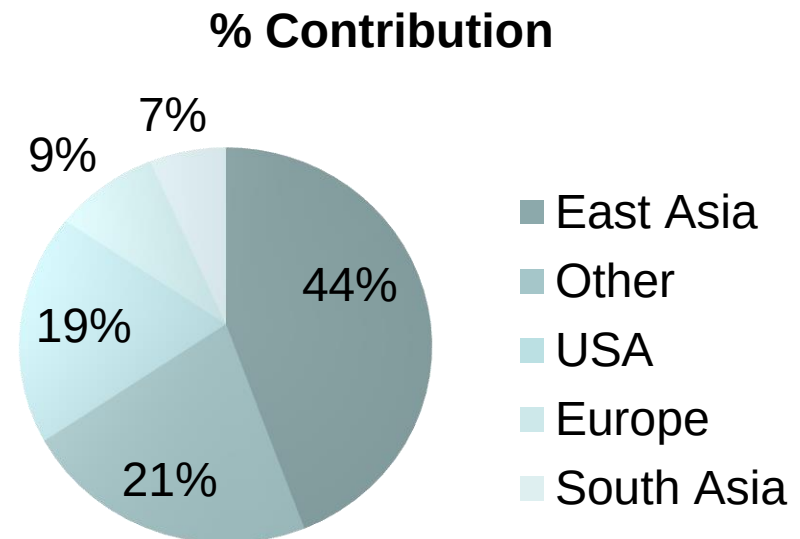
Total deposition in Canada
results from:

35% global terrestrial
25% oceanic
40% anthropogenic



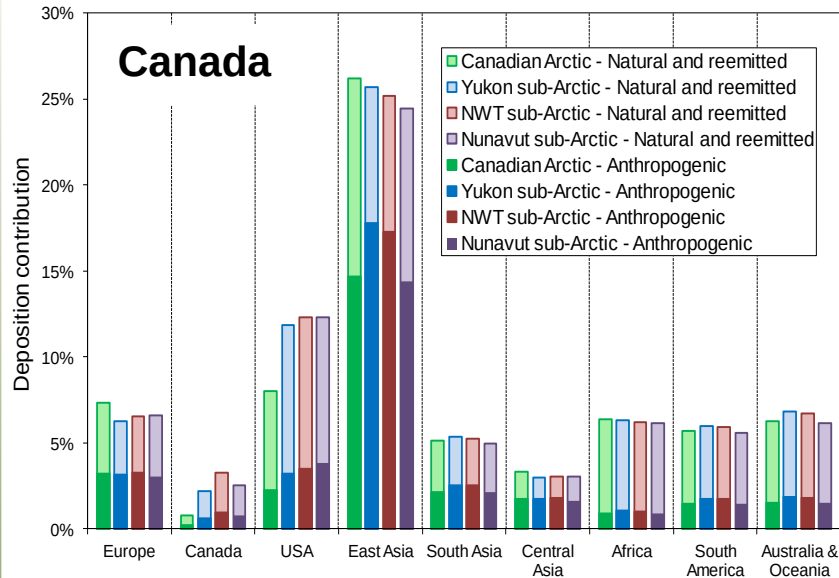
**95% anthropogenic Hg
deposited in Canada is from
outside of Canada**

Relative contributions from
individual source regions to
net Hg deposition

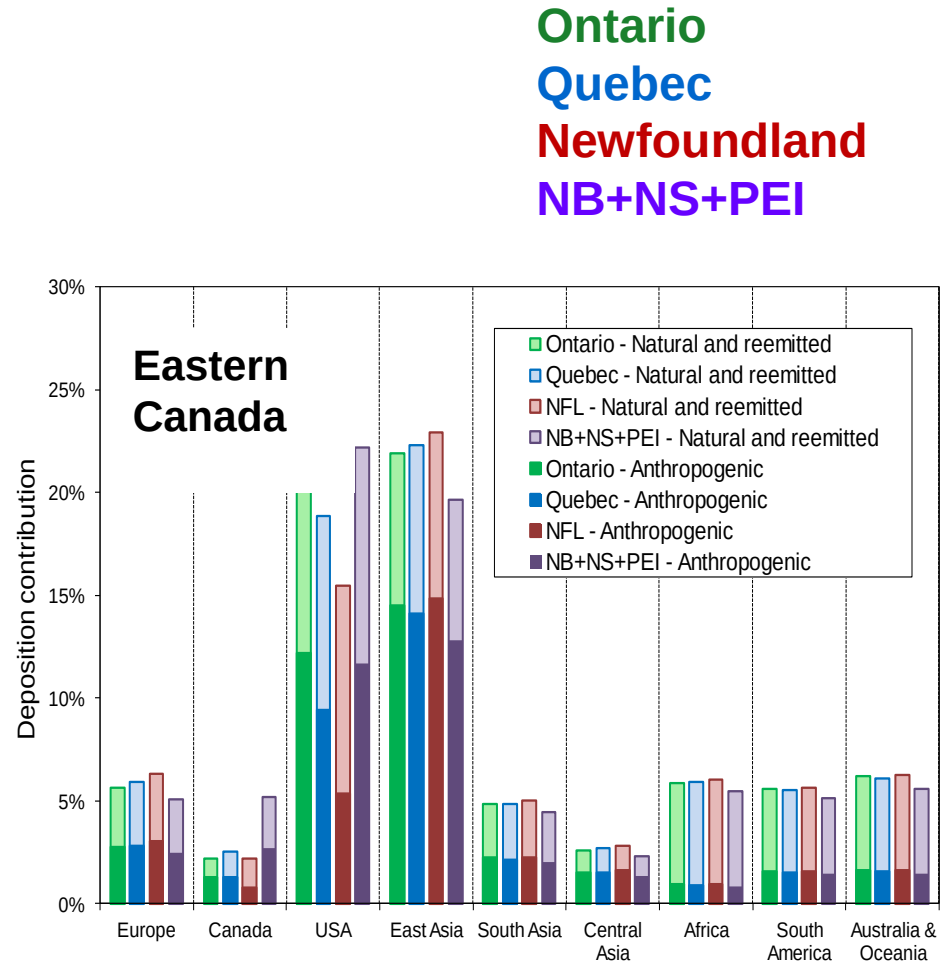


Hg deposition regional contribution

Global/Regional Atmospheric Heavy Metals Model for 2005



Canadian Arctic
Yukon sub-Arctic
NWT sub-Arctic
Nunavut sub-Arctic



Ontario
Quebec
Newfoundland
NB+NS+PEI



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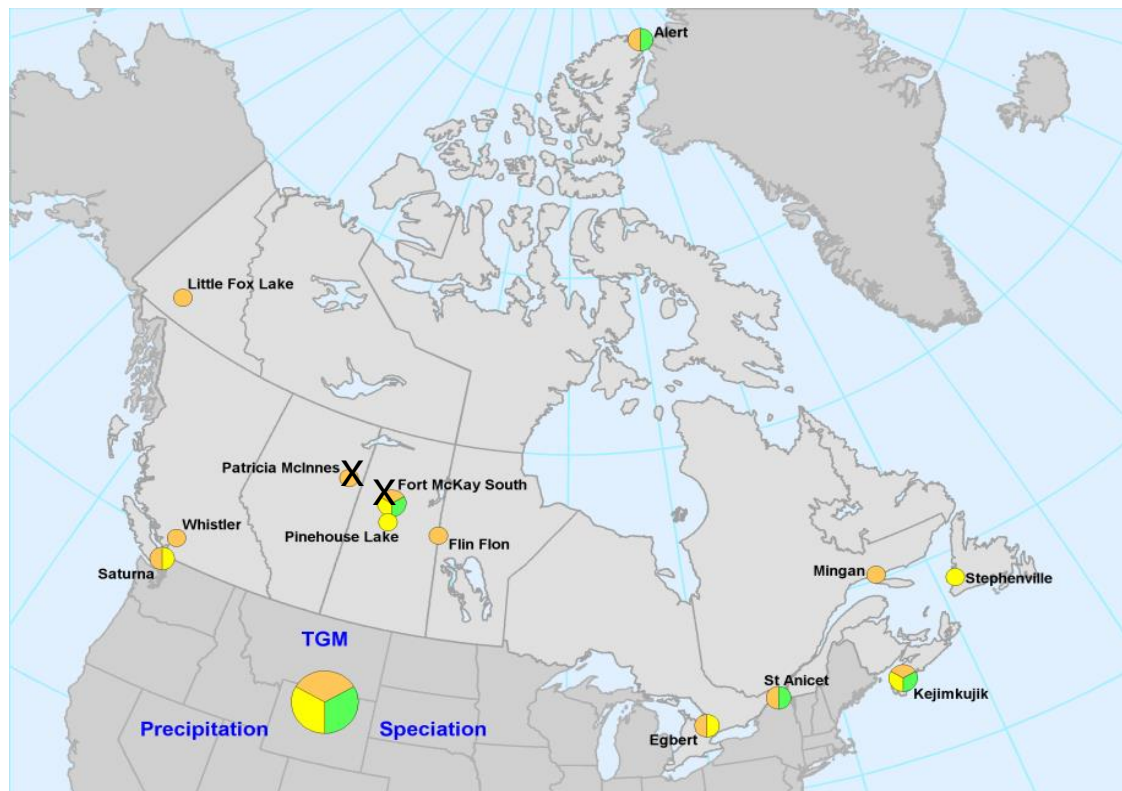
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What factors have we considered for Hg monitoring in Canada?



Air monitoring

- 1) input levels of Hg to ecosystems
- 2) ambient levels from domestic and regional emission sources
- 3) transboundary transport of Hg into Canada



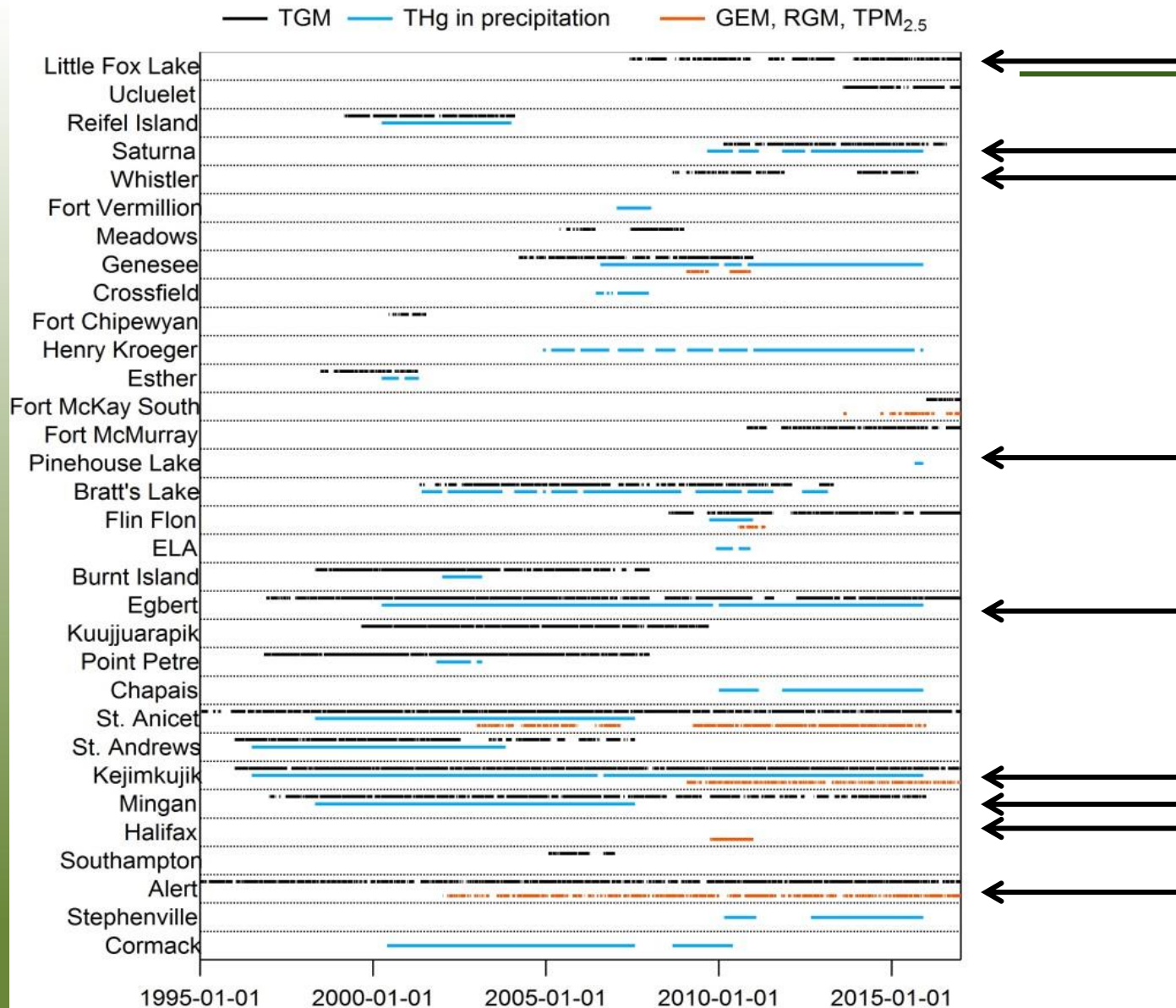
1. Ecosystems
2. Regional emissions
3. Long range transport



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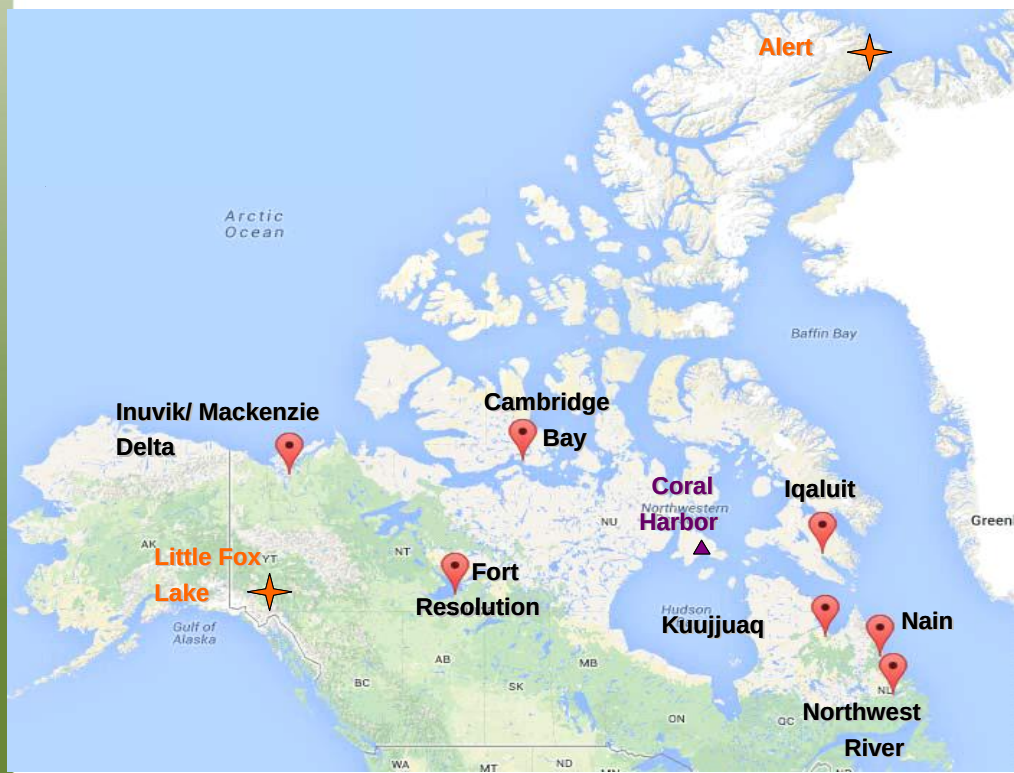
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Data coverage in Canada



How do we fill the gaps?

- Passive mercury sampling
- New method developed at University of Toronto, Canada in collaboration with Environment Canada



- New Project in Canadas Arctic
- Address large spatial gaps
- 9 sites
- 2 locations active and passive monitoring

Pilot project – global Hg passives

Global Atmospheric Passive Sampling (GAPS) Network



- 1 year of sampling
- Samples collected every 3 months
- Sent to Environment Canada for analysis
- Demonstrate feasibility, show ease of use
- Identify gaps, hot spots etc.
- Use POPs GAPS network as a start
- Want to initiate with governments/collaborate with researchers
- Use current infrastructure



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What are the Hg levels in Canada?



Total gaseous mercury and mercury in precipitation

Station	Measurement period TGM	Mean TGM (ng m ⁻³)	Measurement period in rain	Mean Total Hg (ng L ⁻¹)
Little Fox Lake YK	Jun 2007 – Dec 2016	1.39 ± 0.15	-	-
Saturna BC	Feb 2010 – Aug 2016	1.31 ± 0.16	Sep 2009 – Dec 2015	5.2
Whistler BC	Aug 2008 – Dec 2015	1.26 ± 0.20	-	-
Fort McKay South AB	Jan 2016 – Dec 2016	1.24 ± 0.38	-	-
Patricia McInnis AB	Oct 2010 – Dec 2016	1.32 ± 0.22	-	-
Pinehouse Lake SK			May 2015 – Dec 2015	8.4
Flin Flon MB	Jul 2008 – Dec 2016	3.23 ± 1.87	Sep 2009 – Dec 2010	59.9
Egbert ON	Dec 1996 – Dec 2016	1.51 ± 0.31	Mar 2000 – Dec 2015	8.1
St. Anicet QC	Aug 1994 – Dec 2016	1.53 ± 0.35	Apr 1998 – Aug 2007	8.0
Kejimikujik NS	Jan 1996 – Dec 2016	1.36 ± 0.28	Jul 1996 – Dec 2015	5.1
Mingan QC	Jan 1997 – Dec 2015	1.42 ± 0.23	Apr 1998 – Aug 2007	5.1
Alert NU	Jan 1995 – Dec 2016	1.47 ± 0.38	-	-
Stephenville NL	-	-	Feb 2010 – Dec 2015	5.2

Speciated Mercury

Station	Measurement period	Mean GEM (ng m ⁻³)	Mean RGM (pg m ⁻³)	Mean PHg (pg m ⁻³)
Fort McKay South AB	Aug 2013 – Dec 2016	1.18 ± 0.19	0.7 ± 1.5	4.4 ± 8.7
Flin Flon MB	Jul 2010 – Mar 2011	2.04 ± 0.58	3.9 ± 8.4	11 ± 16
St. Anicet QC	Jan 2003 – Dec 2015	1.43 ± 0.30	2.7 ± 4.1	17.2 ± 25.8
Kejimikujik NS	Jan 2009 – Dec 2016	1.31 ± 0.20	0.6 ± 1.3	5.4 ± 8.8
Alert NU	Jan 2002 – Dec 2016	1.25 ± 0.40	25 ± 54	42 ± 77



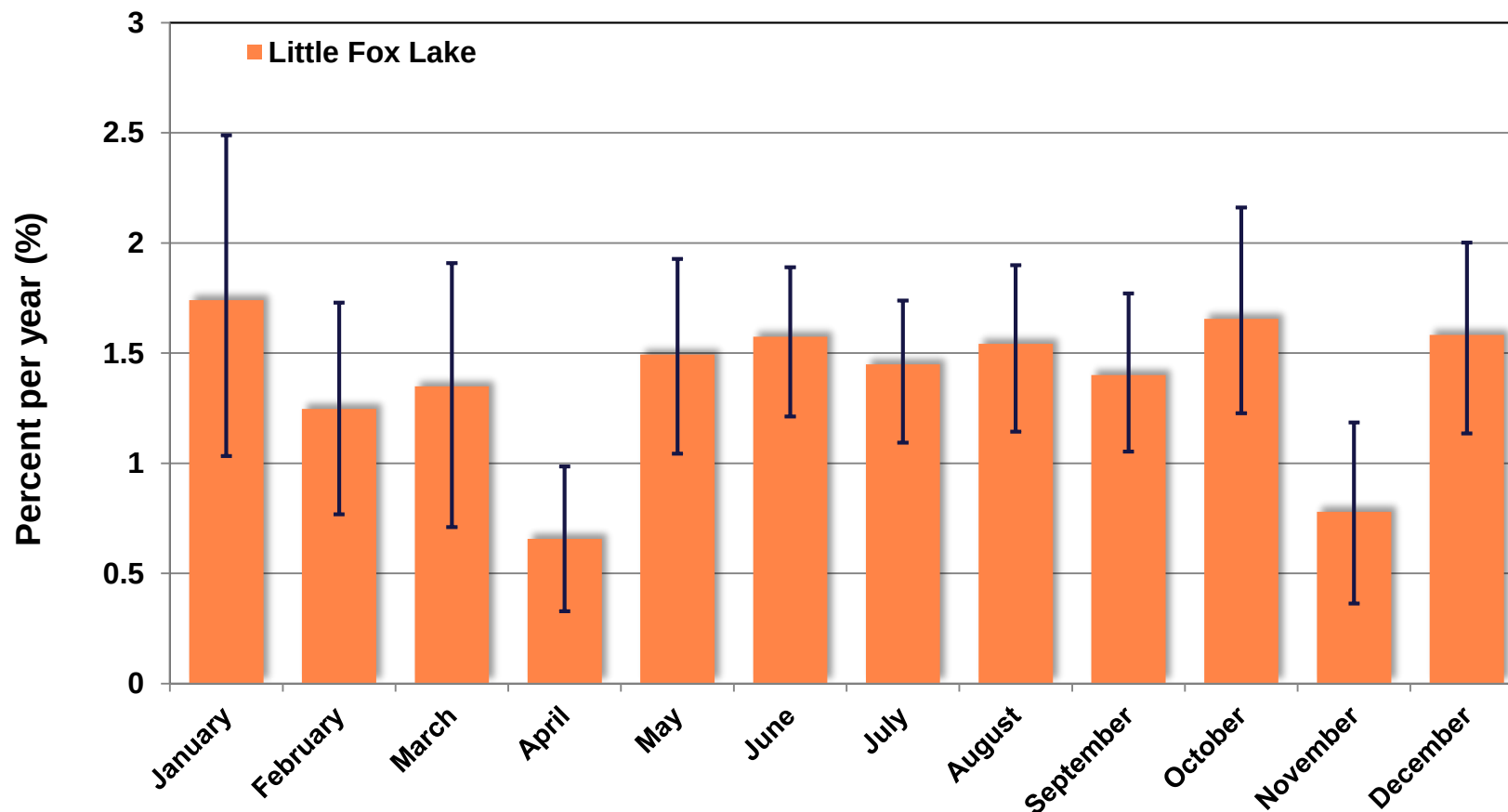
Trends (annual)

Station	Measurement period TGM	Trend TGM (% yr ⁻¹)	Measurement period wet deposition	Trend Total Hg (THg) in precip
Little Fox Lake YK	Jun 2007 – Dec 2016	+1.3 (+0.7 to +1.9)	-	-
Saturna BC	Feb 2010 – Aug 2016	-4.1 (-5.1 to -2.2)	Sep 2009 – Dec 2015	NS (-2.5 to +6.7)
Whistler BC	Jan 2008– Dec 2015	+1.29 (-2.1 to + 6.4)		
Genesee AB	Mar 2004 – Dec 2010	0.4 (ns) (-1.4 to +0.1)	Jul 2006 – Dec 2015	Ns (-6.6 to +0.3)
Patricia McInnis AB	Oct 2010 – Dec 2016	-3.6 (-5.4 to -2.1)	-	-
Flin Flon MB	Jul 2008 – Dec 2016	-4.2 (-6.5 to -2.4)	-	-
Egbert ON	Dec 1996 – Dec 2016	-1.7 (-1.9 to -1.5)	Apr 2000 – Dec 2015	NS (-1.2 to +0.6)
Chapais QC	-	-	Dec 2009 – Dec 2015	-6.4 (-10.8 to -1.8)
Mingan QC	Jan 1997 – Dec 2015	-1.1 (-1.4 to -0.9)	Apr 1998 – Aug 2007	NS (-5.1 to +0.5)
St. Anicet QC	Jan 1995 – Dec 2016	-1.5 (-1.6 to -1.3)	May 1998 – Aug 2007	-3.0 (-5.3 to -1.0)
Kejimikujik NS	Jan 1996 – Dec 2016	-0.9 (-1.1 to -0.7)	Jul 1996 – Dec 2015	-1.5 (-2.3 to -0.8)
Alert NU	Apr 1995 – Dec 2016	-0.9 (-1.1 to -0.7)		



Overall Trend

Overall trend (2007-2016): $+1.37 \pm 0.33$ %



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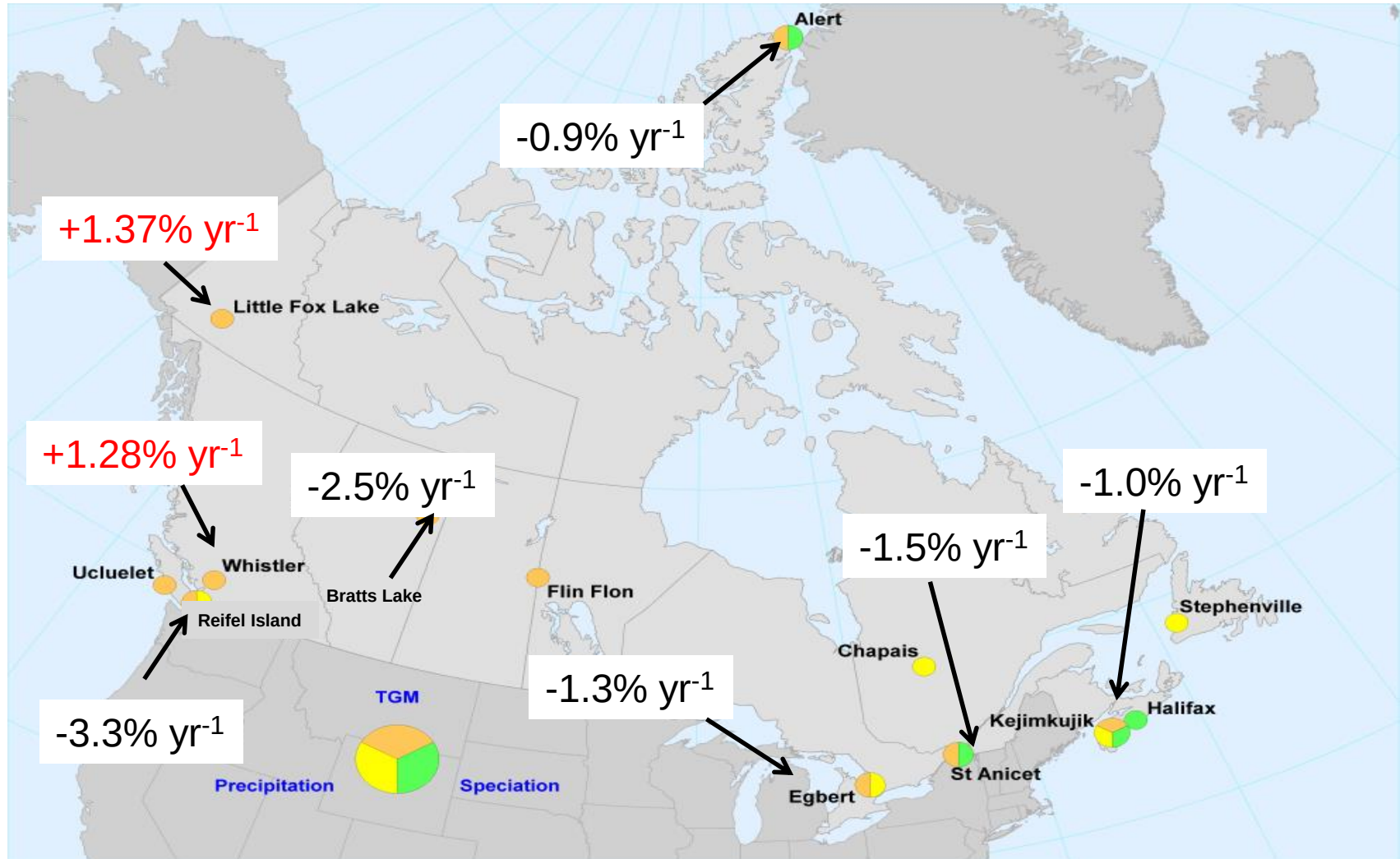
A photograph of a meteorological instrument, likely a weather station, mounted on a metal frame. The structure is topped with a large white dome-shaped sensor, possibly a radiation shield or a specialized weather instrument. Various other sensors, including anemometers and wind vanes, are attached to the frame. The entire structure is enclosed by a chain-link fence in the foreground. The background shows a clear blue sky.

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Overall trends of atmospheric Hg in Canada

Are Canadian ecosystems responding to recent reductions in domestic atmospheric emissions of Hg?



Why are we seeing this trend?

It is the only region in Canada with an increasing trend in Hg concentration

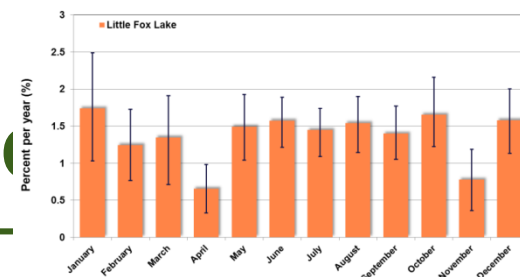
Little Fox Lake

What can affect the concentration of Hg at this site?

- Increase in Hg in the area
- Changes in meteorology
- Increase in Hg transported in



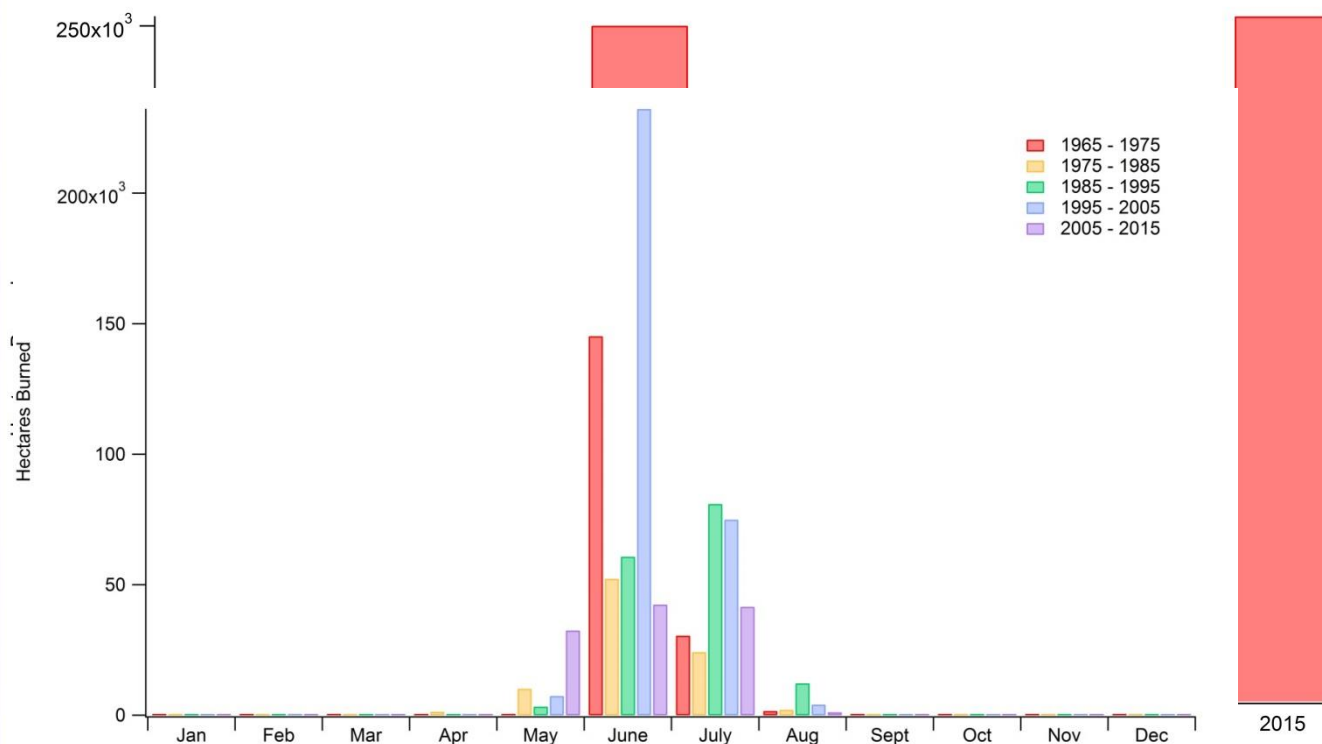
Forest Fires around Little Fox Lake



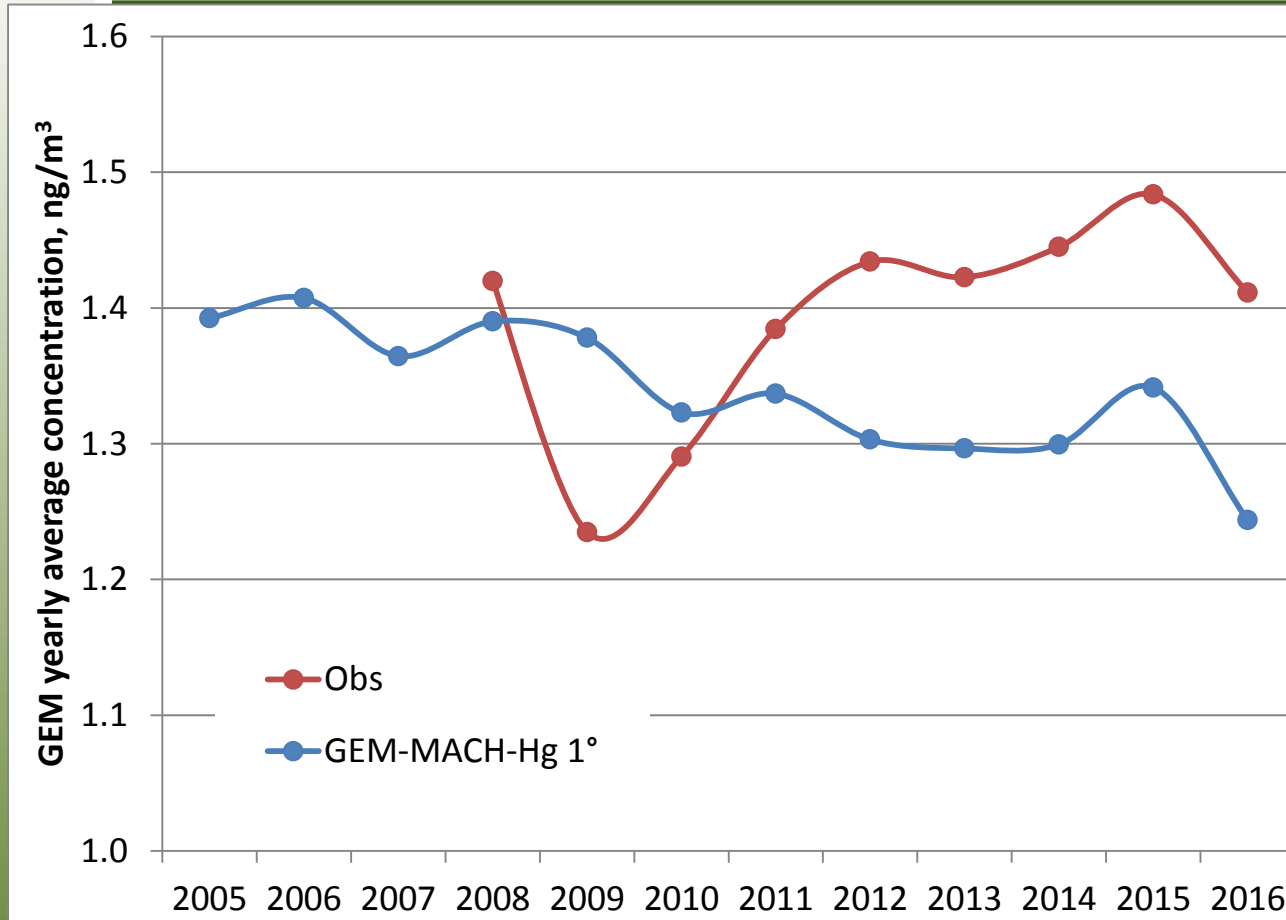
Biomass burning is a source of Hg to the atmosphere

Forest fires emitted 6-14 tonnes of Hg in Canada between 2010 and 2015* (May-Sep)

1. Hectares burned within 500 km around the site in the last 10 years
2. Monthly distribution of hectares burned around the site



Measurement/Model comparison of meteorology and Hg trends



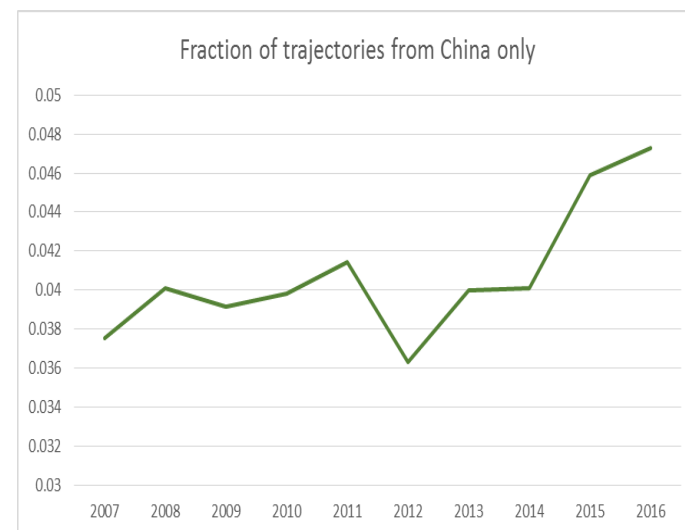
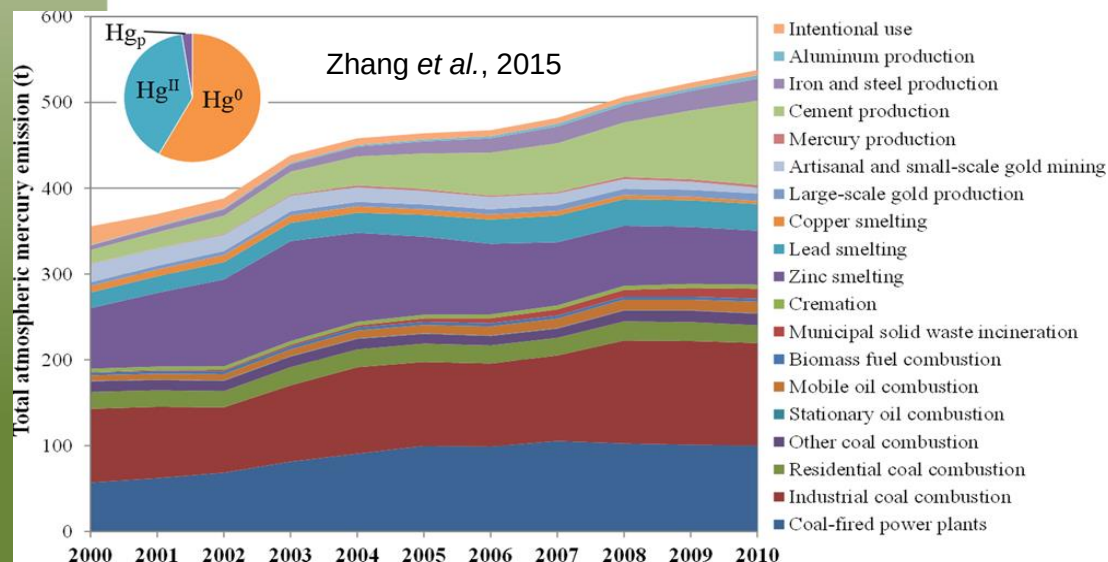
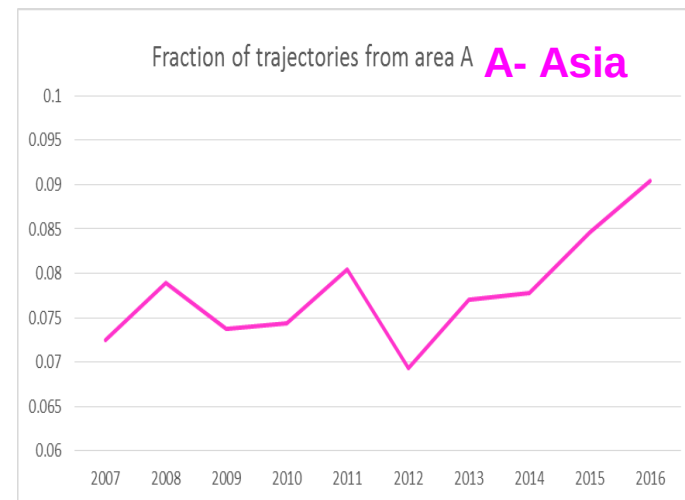
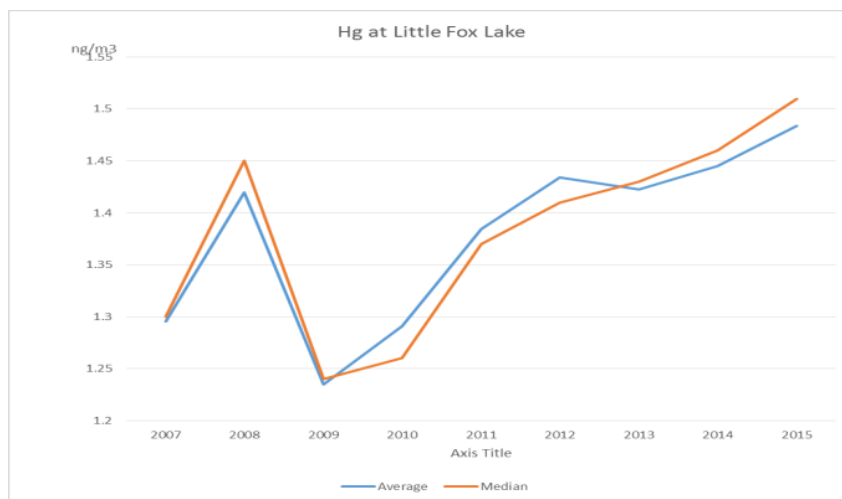
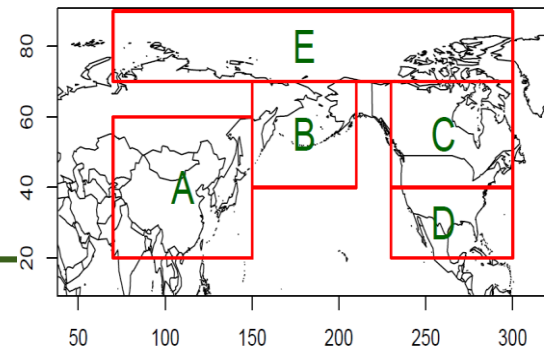
GEM-MACH-Global-Hg model configuration:

- Horizontal resolution – 1° latitude/longitude
- Meteorological fields – ECMWF ERA-Interim for 2005 – 2015
- Emissions – AMAP 2010, constant for all years

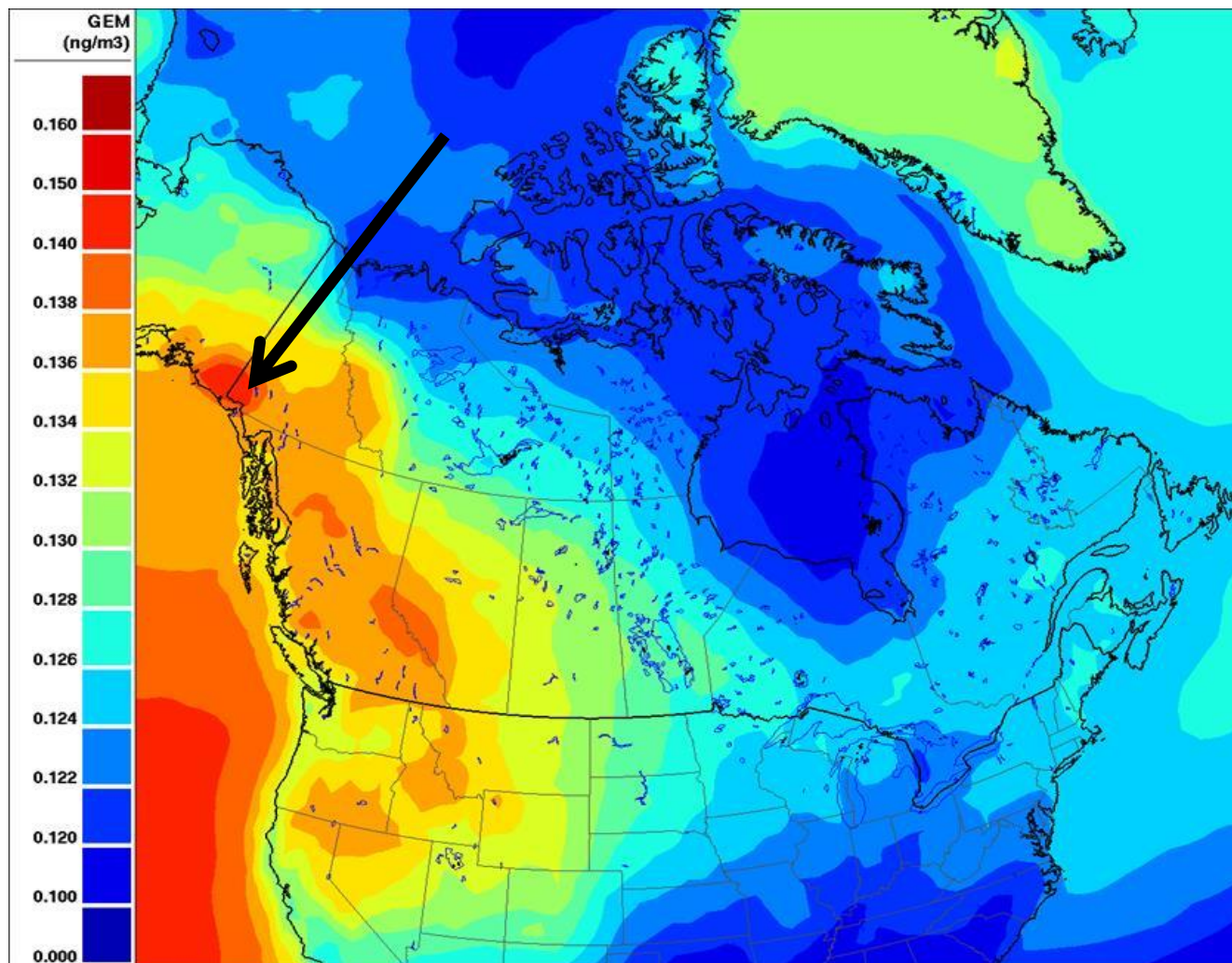
Conclusions:

Appears to be impacted in more recent years by inter-annual variability of meteorology

Is there a dominant area?



East Asian Contribution to Hg concentrations in Canada



East Asian emission impacts only on Hg levels using GEM-MACH- Hg



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Summary

- Canada continues to monitor atmospheric Hg
- Some locations have closed but working on filling gaps with passive samplers
- New project with passive samplers to get global snapshot of Hg levels
- TGM levels are going down in Canada except in the west
- Attributed primarily to emissions from China
- Keep going and monitor Hg and perform research studies to better refine our understanding of transport, transformation and deposition



Thank you!!!



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