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Atmospheric Mercury Measurements and Networks in Canada

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Canadian Situation

- Mercury is an issue in Canada
- Certain Canadian populations are at higher risk of exposure
 - Non-aboriginal recreational fish consumers from Quebec
 - Inuit of northeast Canada, that eat marine mammals and fish as part of their traditional diet
 - Indigenous populations in several areas of the Arctic
 - Asian populations consuming high fish diets
 - Pregnant and breastfeeding woman and young children
- MeHg levels are high enough ($>0.3 \mu\text{g g}^{-1}$) to pose a risk to the reproductive health of fish and fish-eating wildlife
- ~ 90% of annual provincial/ territorial fish consumption advisories are from high Hg levels
- Hg levels exceed the Canadian limit for commercial sale of fish at many sites across Canada



Environment Canada's Hg science

- **Monitoring:** Hg levels in fish and aquatic systems, polar bears and sea bird eggs, atmospheric levels, transport and deposition
- **Research:** Ecotoxicological effects of Hg on fish and wildlife. Processes affecting the transport, transformation, deposition and pathways of mercury within ecosystems
- **Modelling:** Simulating transfer of Hg from emissions to biota. Determining source attribution, policy benefits, climate change impacts and future levels of Hg
- **Science Assessment:** A comprehensive description of Hg in Canadian environment to establish national baselines to inform policy
- **Risk Assessment:** Assessing toxicity of Hg containing substances and cooperating in developing and amending risk management regulations



Air Monitoring in Canada

- Atmospheric total gaseous Hg (TGM) / gaseous elemental Hg (GEM)
- Wet deposition
- Atmospheric speciation
 - Gaseous elemental Hg (GEM)
 - Reactive Gaseous Hg (RGM)
 - Particulate Hg (PHg)
- Initiated cohesive monitoring in 1997
 - Canadian Atmospheric Mercury Measurement Network (CAMNet)
 - Canadian Air and Precipitation Monitoring Network (CAPMoN)
 - Northern Contaminants Program (NCP)
 - Environment Canada – Clean Air Regulatory Agenda (CARA)

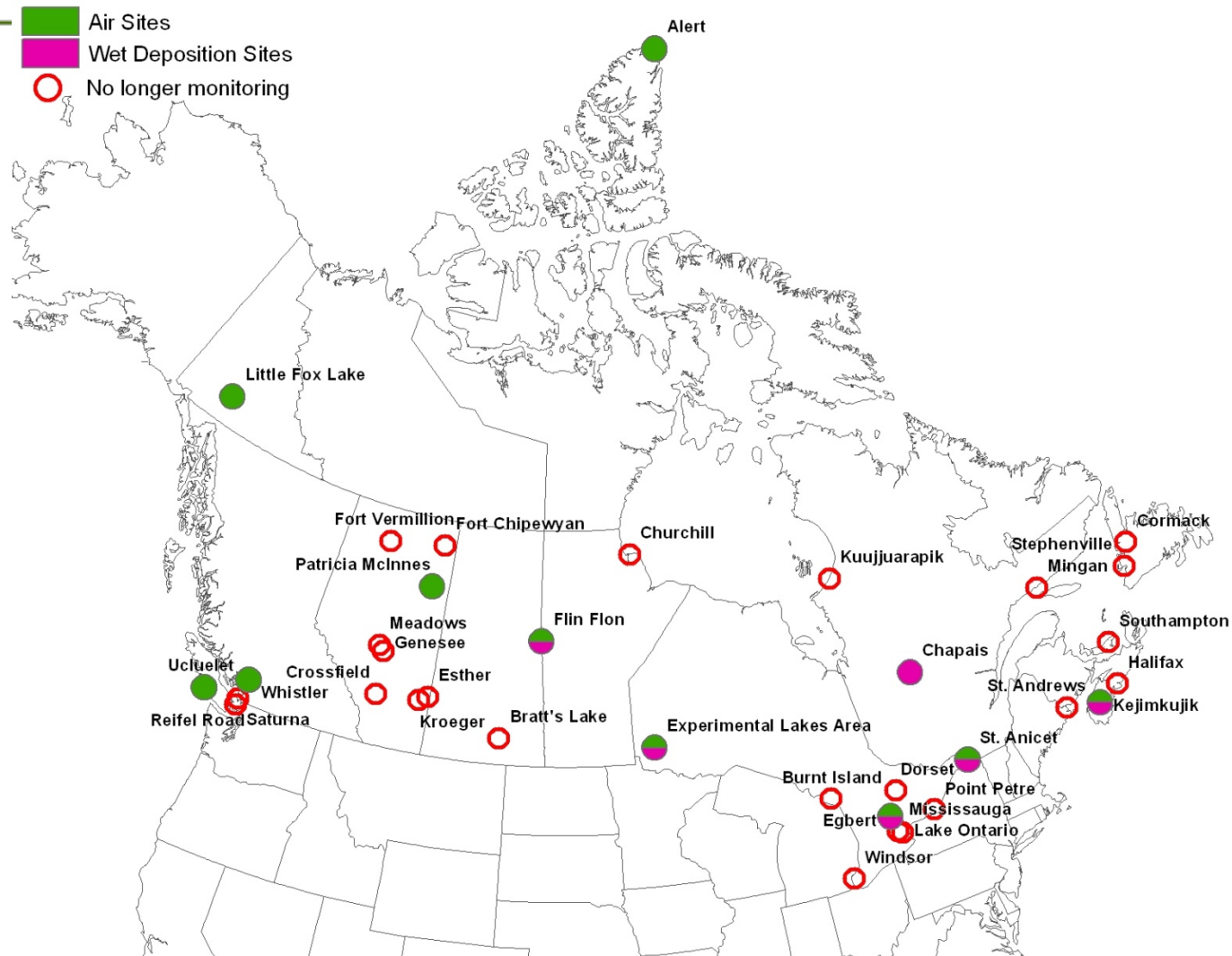


Environment Canada and others

Air Monitoring Networks in Canada

Air monitoring

1. **CAMNet**
(1996-2007) 9-13 sites
2. **CAPMoN**
(2007-present) 4 sites
3. **Wet deposition**
(1996-now) 5-6 sites
CAMNet/CAPMoN
4. **NCP** (1995-now)
5. **CARA** (2005-2012)
6. **IPY** (2008-2010)

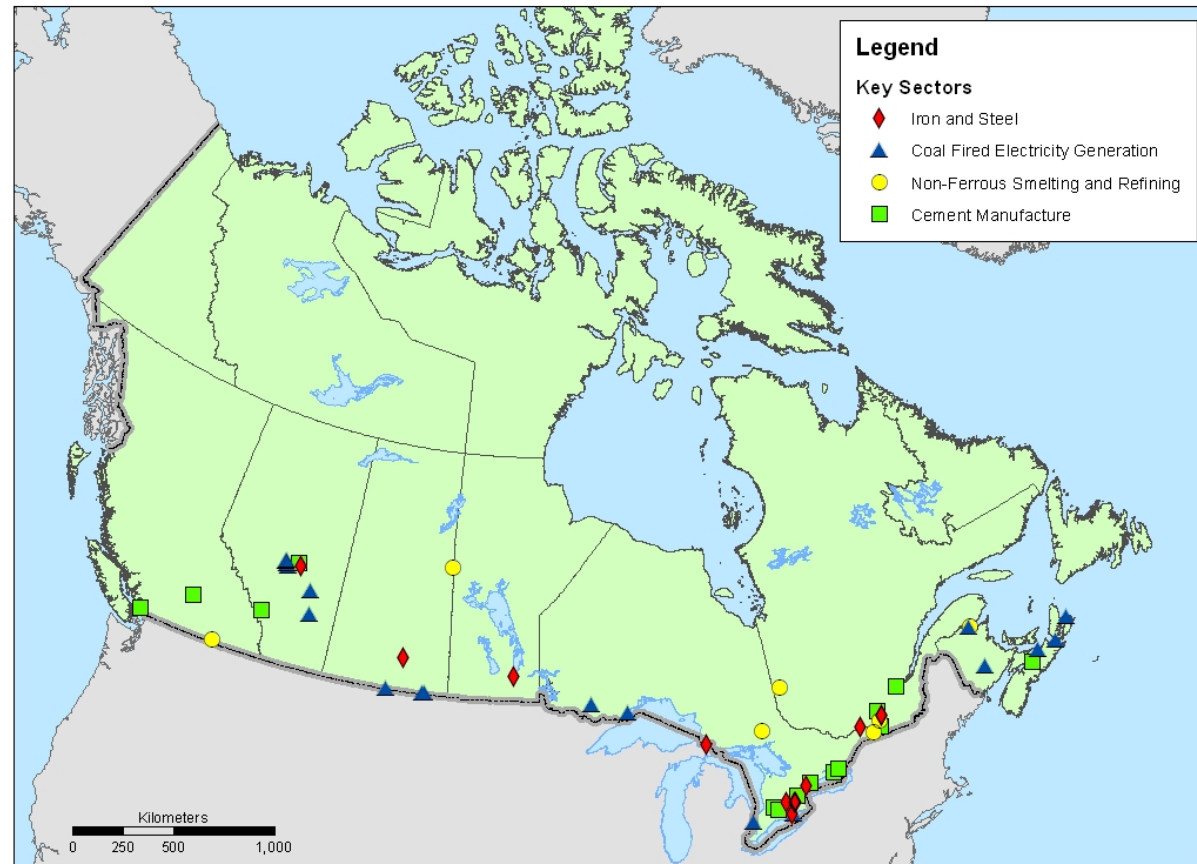


Canadian Anthropogenic Emissions

- Canadian emitters from the four most important industrial sectors
- Contribute > half of Canada's emissions.

Sectors

- Iron and steel production
- Coal-fired power plants
- Non-ferrous metals processing
- Cement production and processing



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National Pollutant Release Inventory, 2013



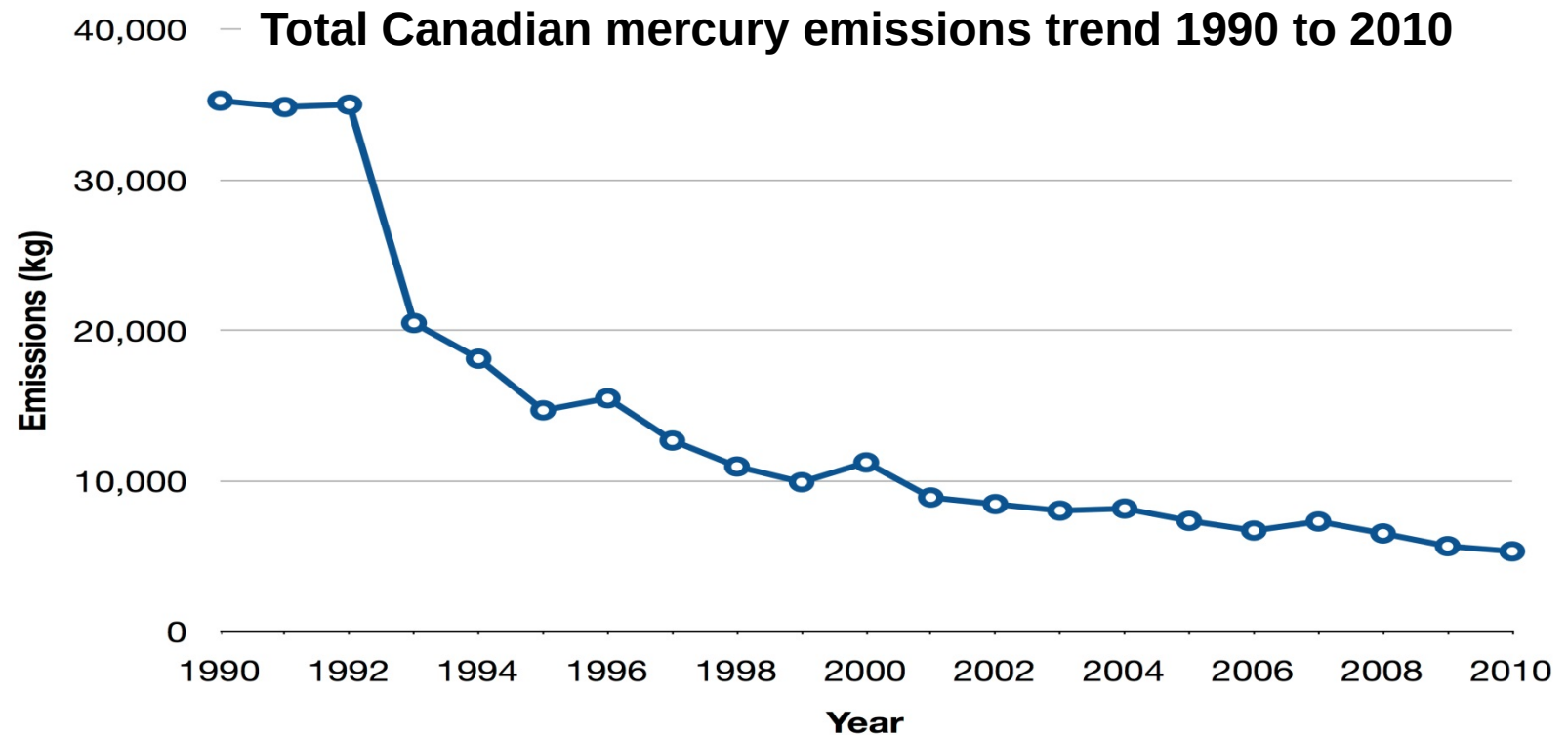


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Canadian Anthropogenic Emissions



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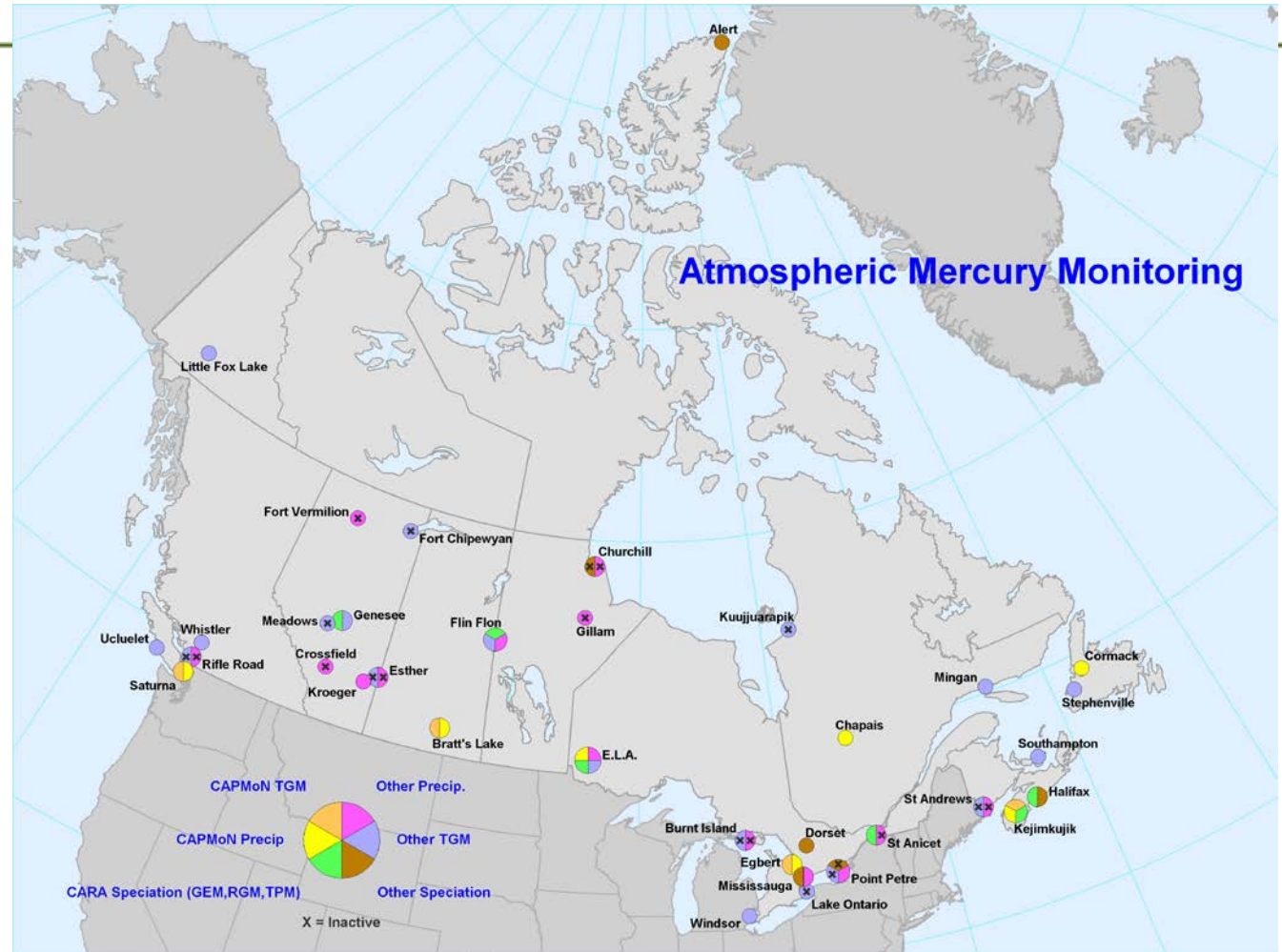
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Detailed Hg Monitoring in Canada

Currently operating

- TGM – 12 sites
- Wet dep – 9 sites
- Speciation – 5 sites



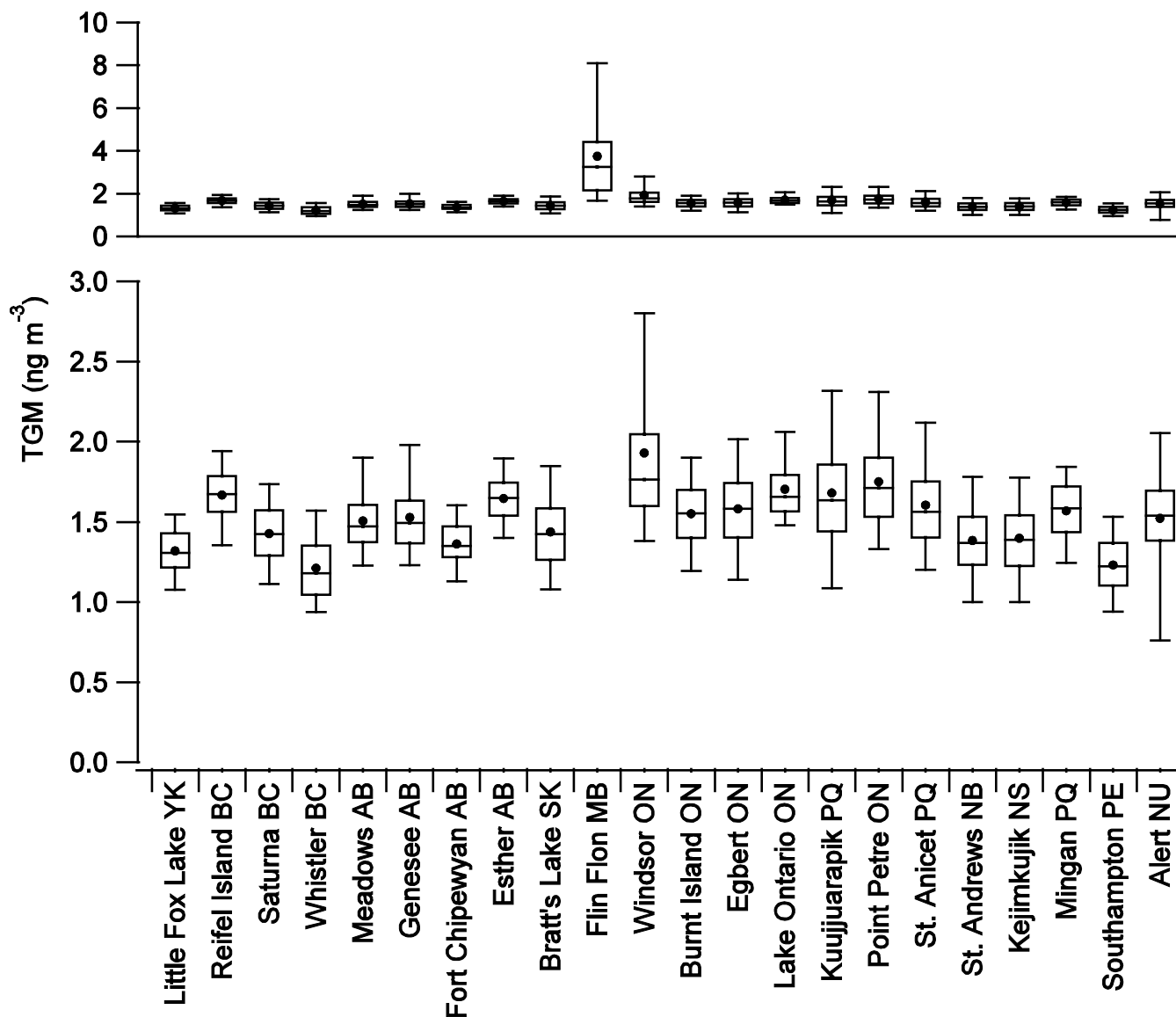
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Air monitoring – TGM over all years

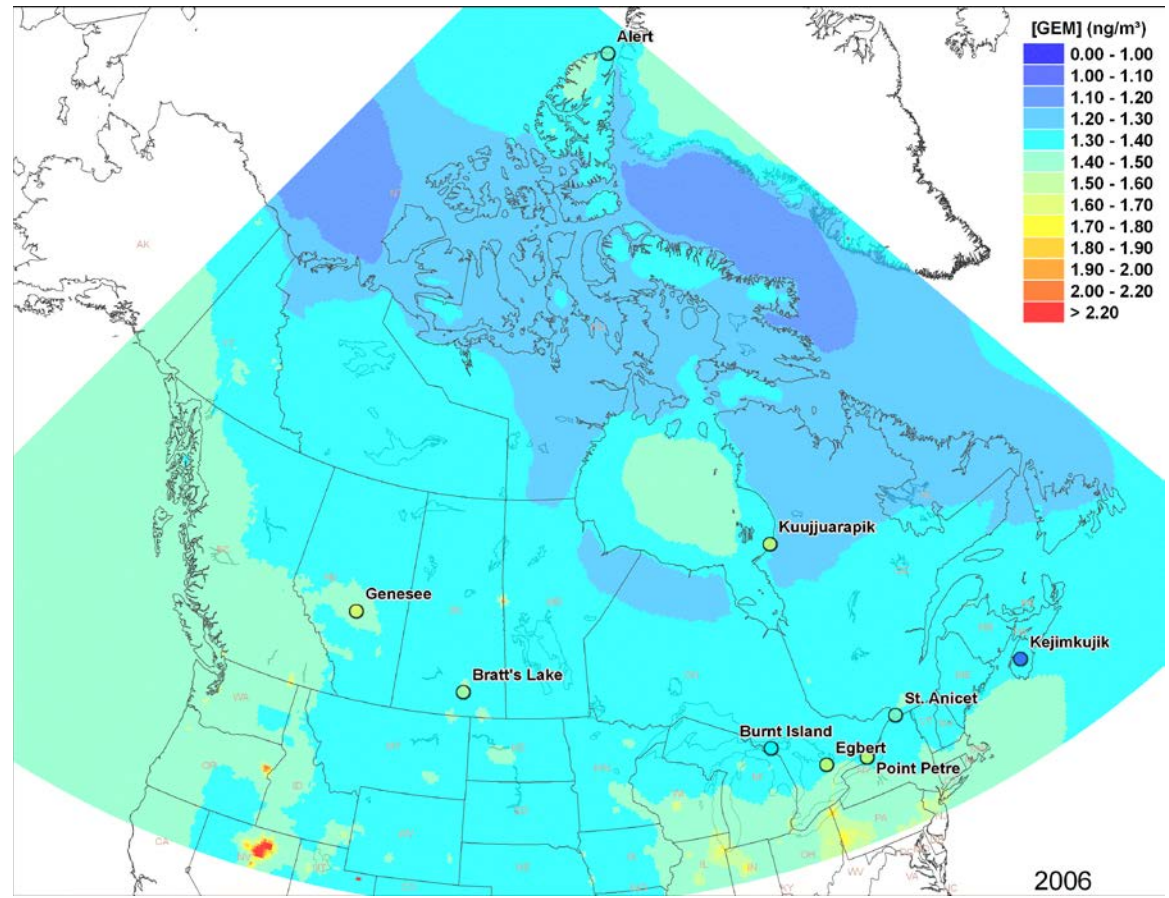
- Total gaseous mercury
- 23 sites
- Different time periods
- Inset Flin Flon



Model and measurement comparison

Global/Regional Atmospheric Heavy Metals Model

Modelled annual means of GEM and TGM measurements at Canadian sites active throughout 2006



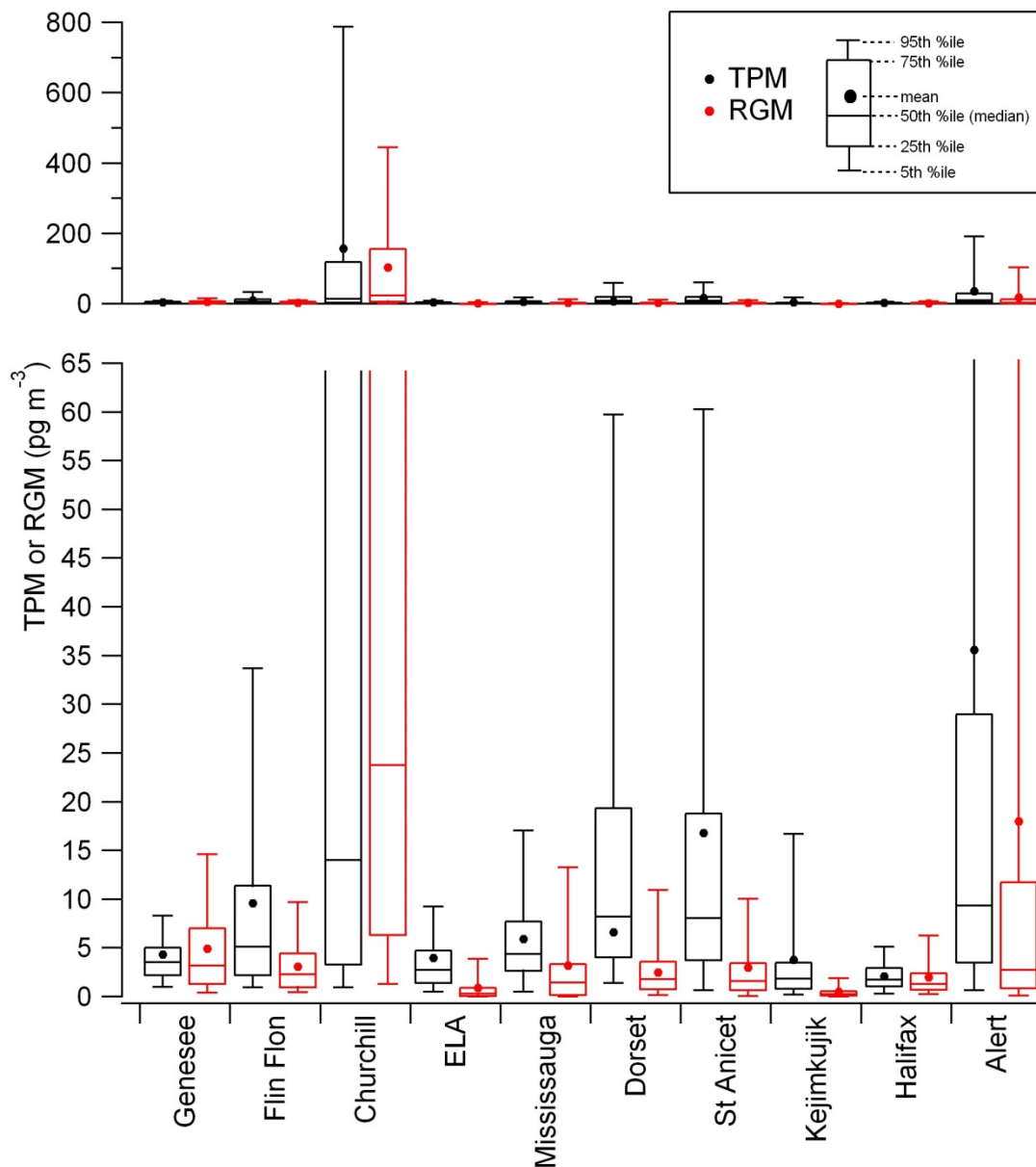
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Air monitoring – Speciation TPM, RGM

- 11 sites
- Reactive gaseous mercury (RGM)
- Total particulate mercury (TPM)
- Inset includes Churchill

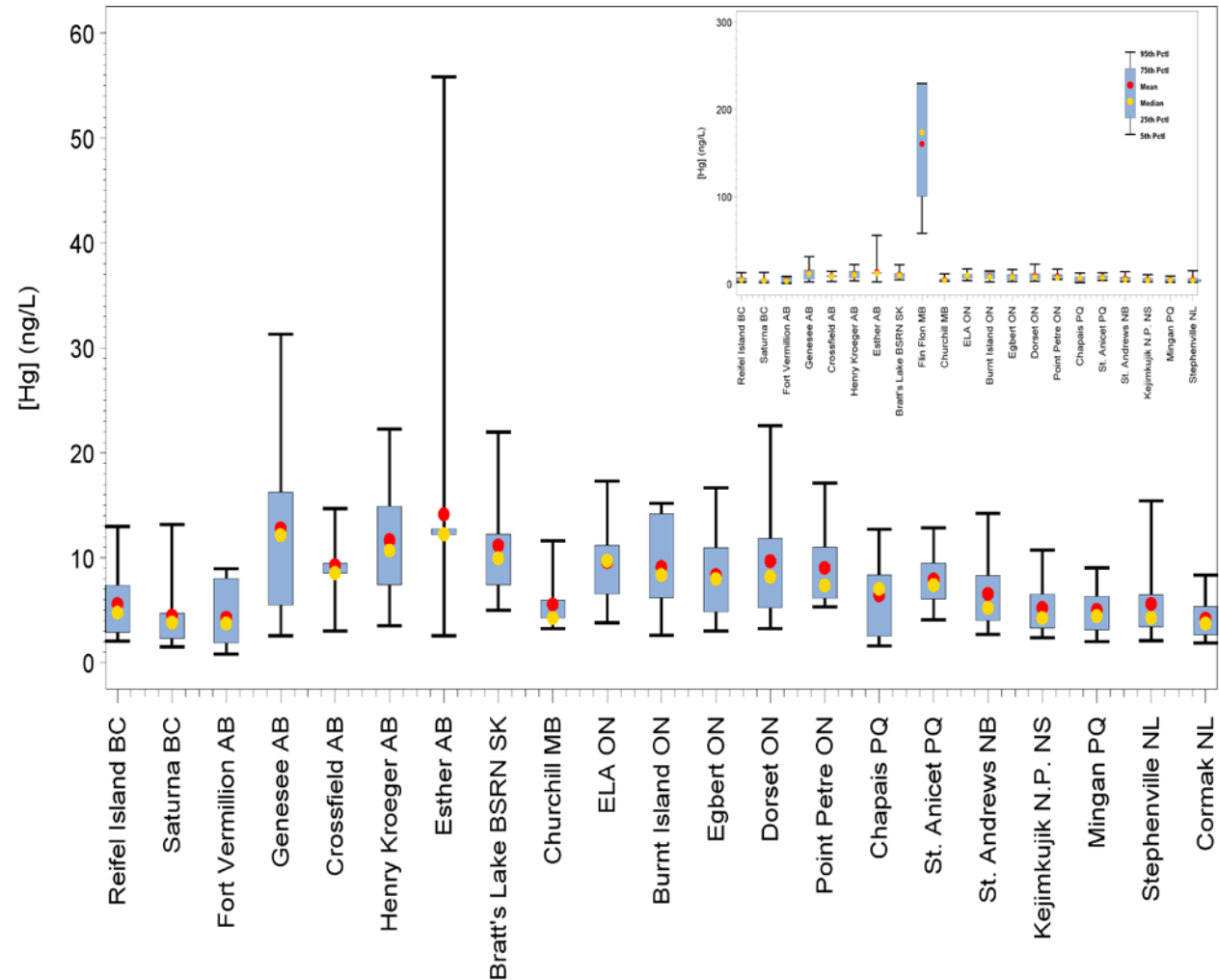


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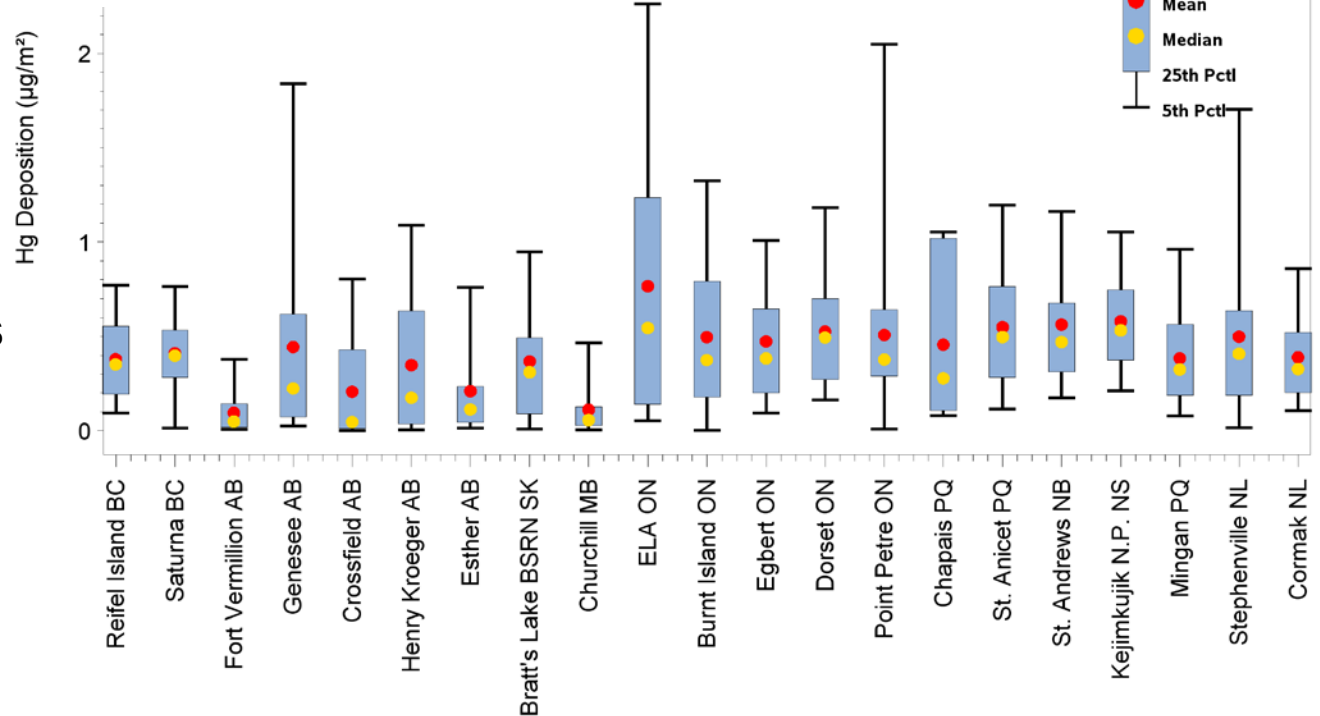
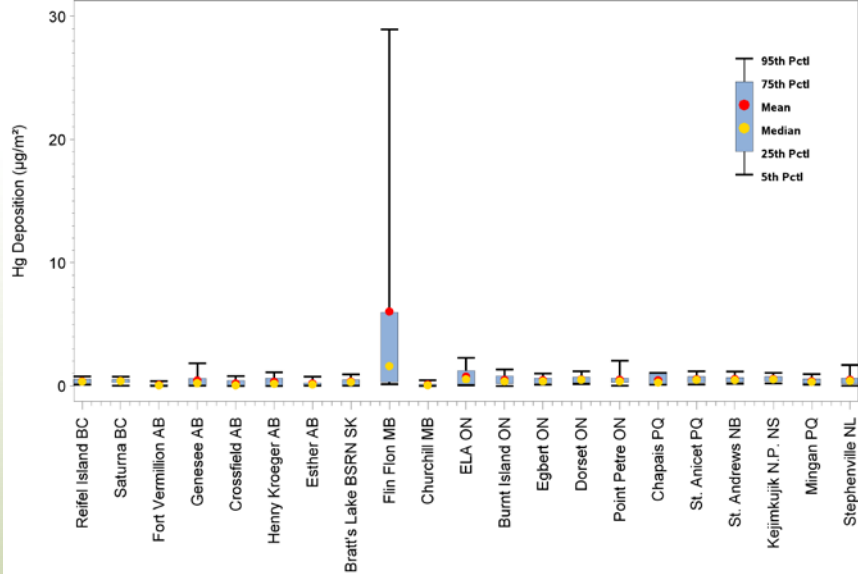
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Hg concentration in precipitation

- Total Hg concentrations
- Part of US MDN
- Insert Flin Flon
- 22 sites



Hg deposition from precipitation

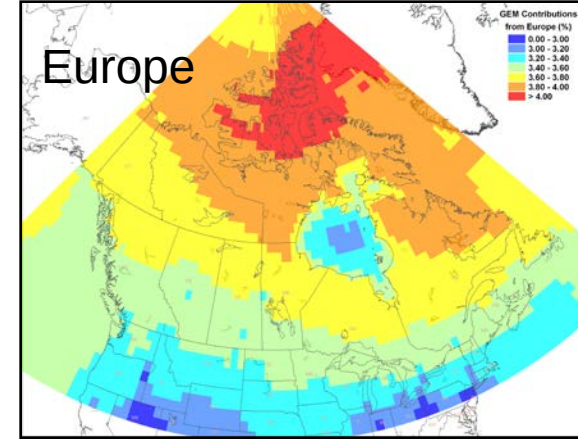
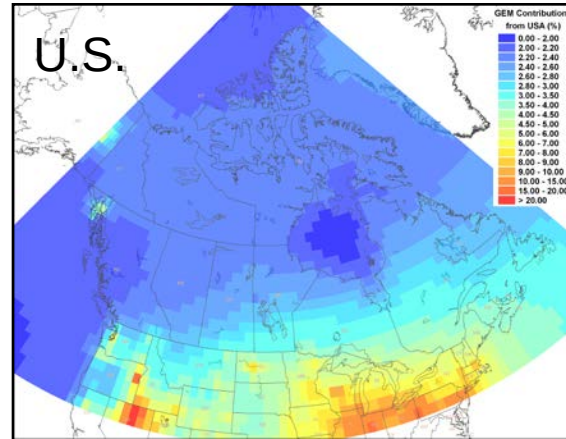
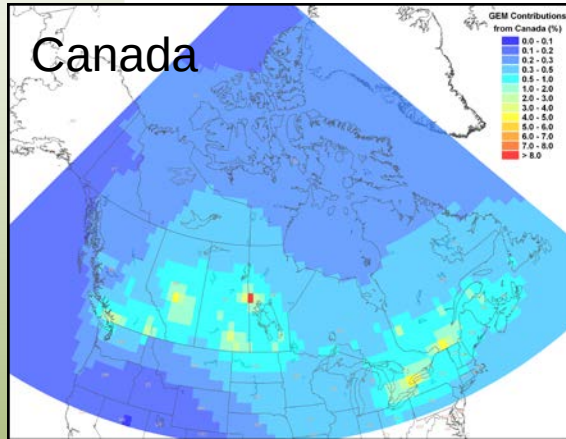


- Monthly Hg wet deposition
- 22 precipitation sites
- Insert Flin Flon

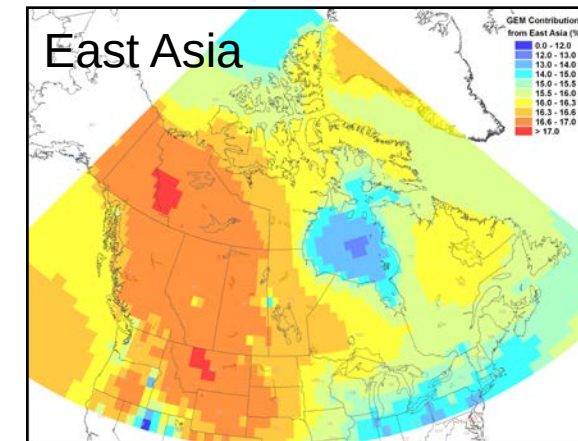


Air Modeling - Spatial distribution GEM

Global/Regional Atmospheric Heavy Metals Model for 2005



Relative contribution to the concentration of atmospheric surface-level GEM from Hg emitted during anthropogenic processes



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Temporal trends for TGM

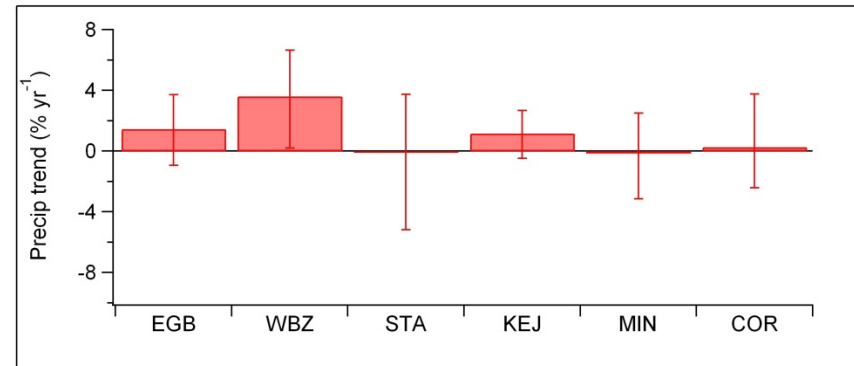
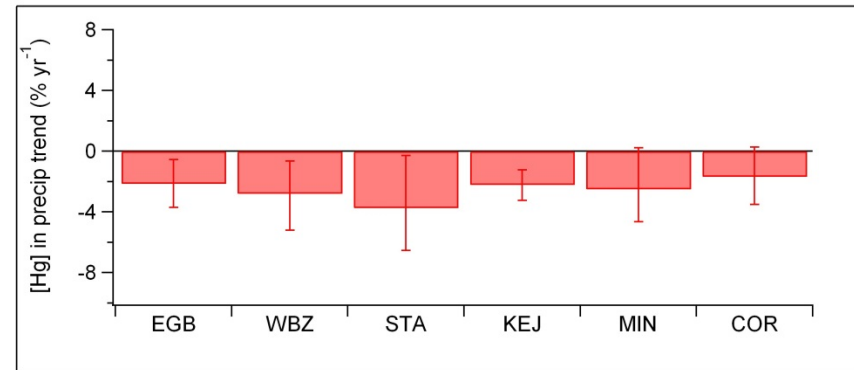
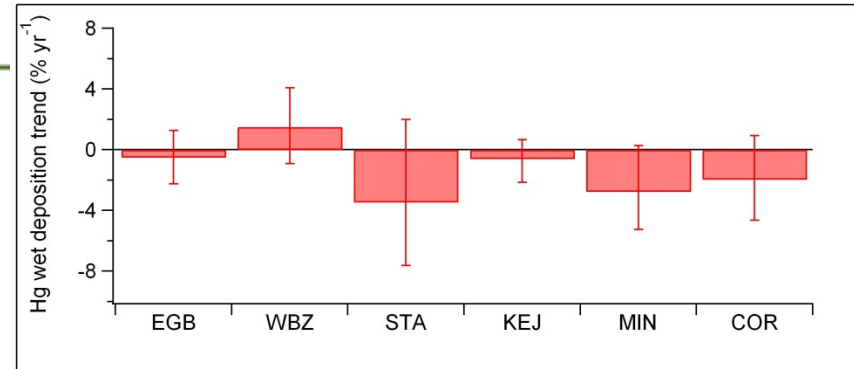
Site	Time period	TGM trend, pg m ⁻³ yr ⁻¹	TGM trend, % yr ⁻¹
Reifel Island	1999-2004	-55 (-70 to -40)	-3.3 (-4.2 to -2.4)
Genesee	2004-2010	-6 (-21 to +1) ^{ns}	-0.4 (-1.4 to +0.1) ^{ns}
Bratt's Lake	2001-2010	-37 (-48 to -23)	-2.5 (-3.4 to -1.6)
Burnt Island	1998-2007	-15 (-22 to -7)	-1.0 (-1.4 to -0.4)
Egbert	1996-2010	-20 (-27 to -16)	-1.3 (-1.7 to -1.0)
Kuujuarapik	1999-2009	-40 (-55 to -23)	-2.4 (-3.4 to -1.4)
Point Petre	1996-2007	-29 (-38 to -20)	-1.7 (-2.2 to -1.2)
St. Anicet	1995-2009	-24 (-29 to -19)	-1.5 (-1.8 to -1.2)
St. Andrews	1996-2007	-30 (-42 to -20)	-2.2 (-3.1 to -1.5)
Kejimikujik	1996-2010	-14 (-20 to -6)	-1.0 (-1.4 to -0.5)
Alert	1995-2009	-11 (-15 to -6)	-0.7 (-1.0 to -0.4)



Temporal trends of wet deposition

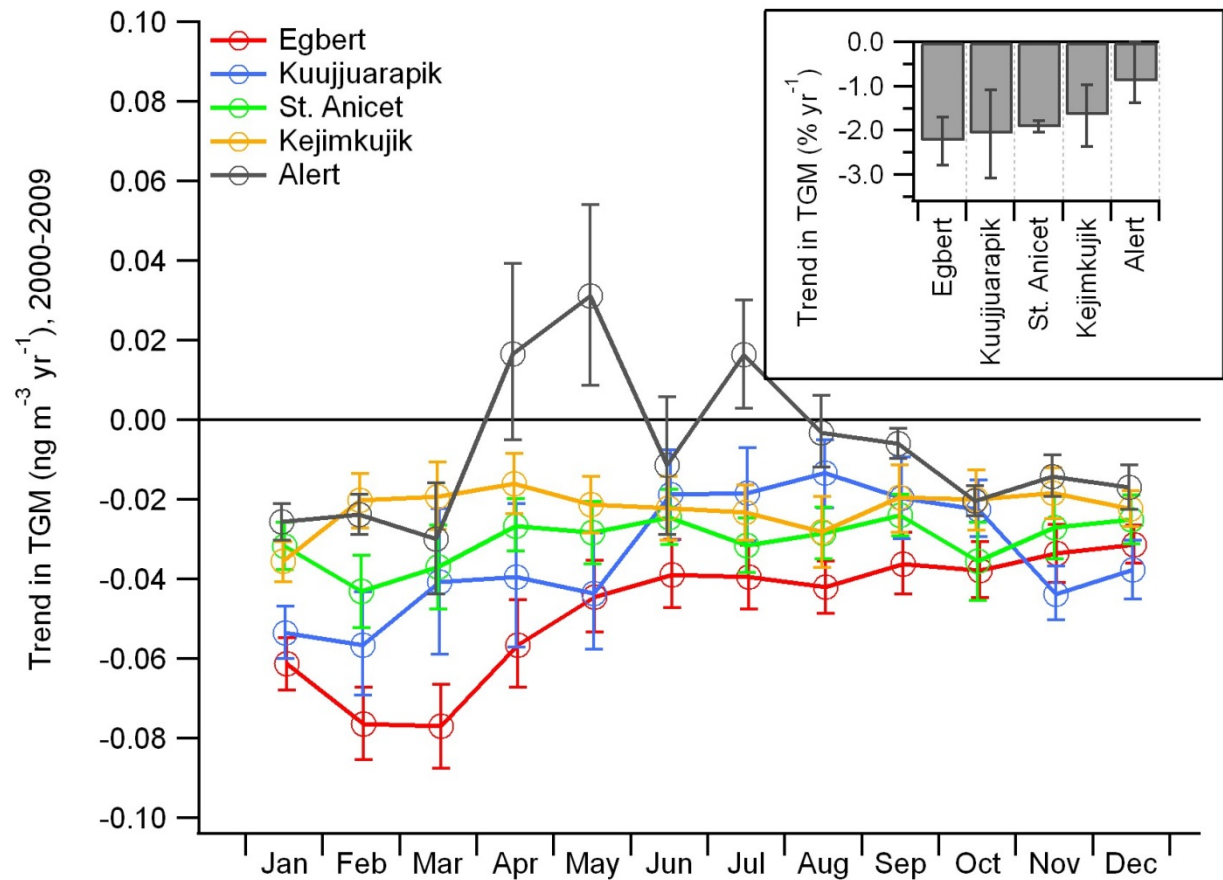
Overall trends:

- Wet deposition
- Mercury concentration
- Total precipitation
- % per year
- 6 sites with > 5 years



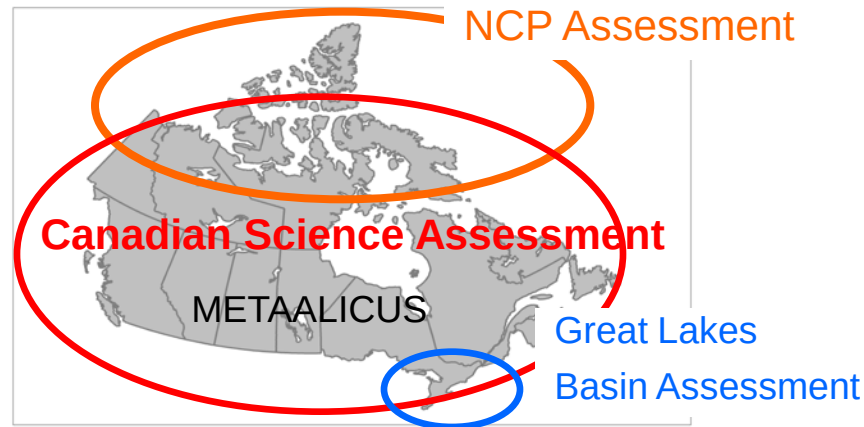
Total gaseous mercury trends 2000-2009

- Seasonal trends in TGM
- $\text{ng m}^{-3} \text{ year}^{-1}$
- Insert: overall annual trends % per year
- Median values



Canadian Mercury Science Assessment

- **First ever comprehensive national description of mercury in the Canadian environment**
- Establish a baseline to assess future changes in mercury emissions
- Identify priorities for future science activities
- Target date for delivery May 2014



The science assessment is expected to point to the need for:

- Increased monitoring coverage
- Integrated science plan
- Understanding impacts of climate change on Hg cycling



Overall conclusions of air monitoring in Canada for Hg

Models tell us

- 95% anthropogenic deposition from external sources – Canadian emissions affect deposition close to sources
- Modelled net deposition is decreasing in the mid-latitudes but increasing in Arctic/sub-Arctic
- Multi-media modelling shows emission control technology worldwide can stabilize or reduce the Hg concentrations in fish in Canada

Measurements tell us

- Hg in air is decreasing but decline is smaller in Arctic
- Changes in Hg species in air over time may result in changes in deposition
- Spatial differences in Hg in air across Canada



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