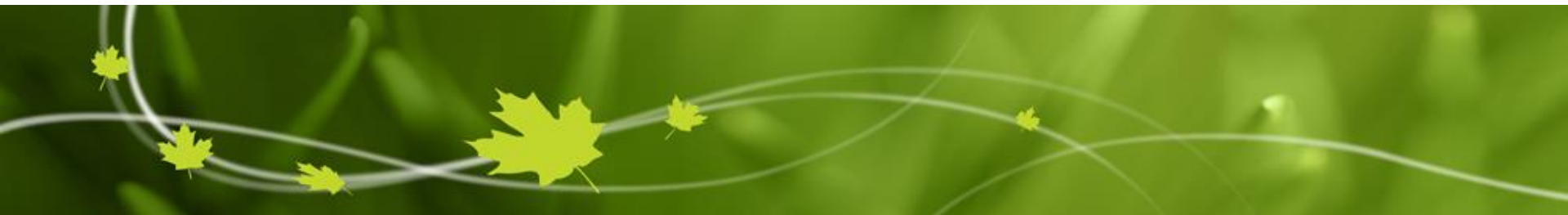




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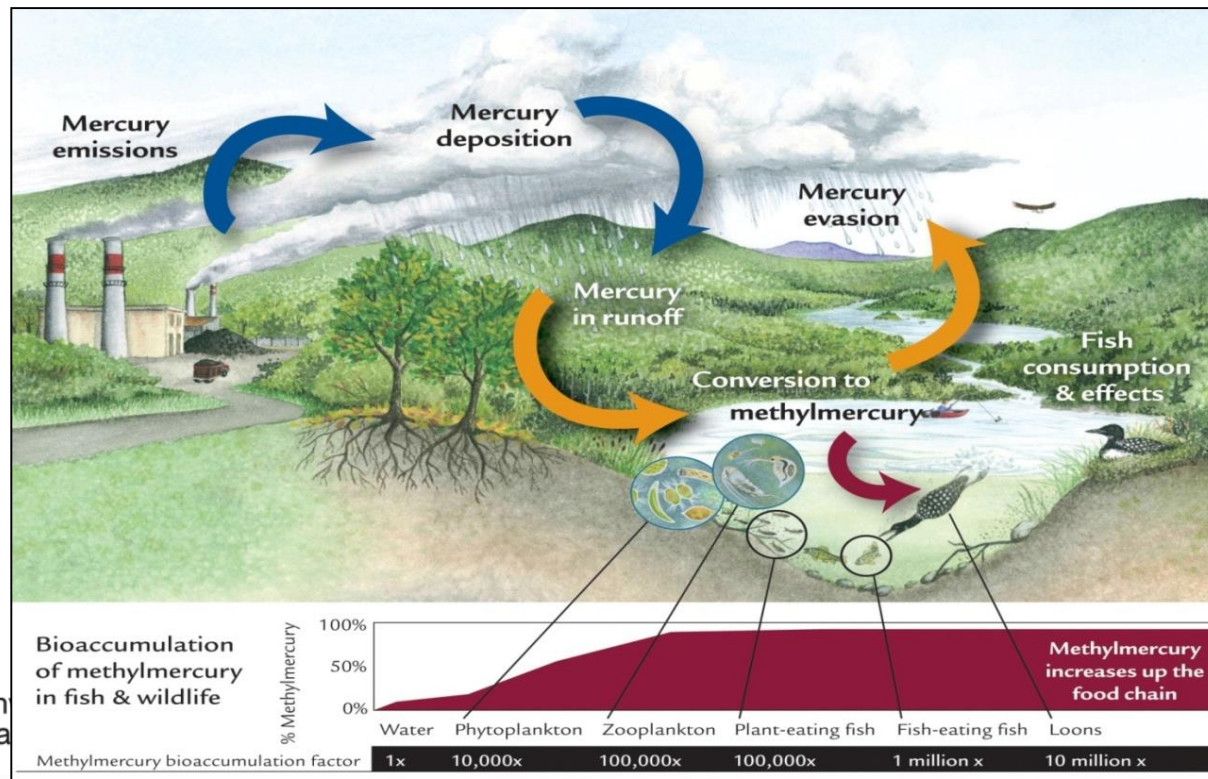


Atmospheric Mercury Monitoring in Canada

Dr. Pierrette Blanchard
Air Quality Research Division
Environment Canada

Mercury in the Environment

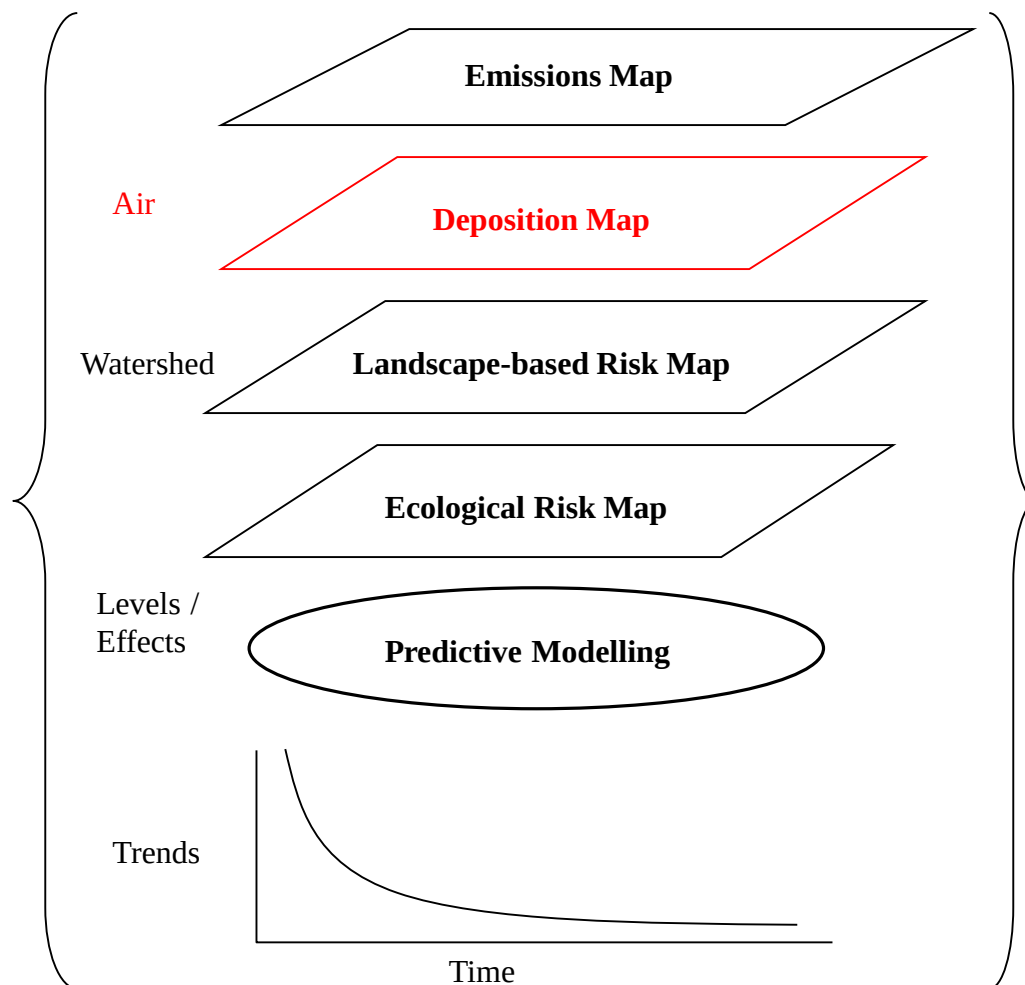
- Mercury (Hg) is a potent neurotoxin and is reported at levels in the Canadian environment that can be toxic to human and ecological health
- Methylmercury (MeHg), the most toxic form, bioaccumulates and biomagnifies through food web
- ~ 90% of annual fish consumption advisories posted by provinces/territories are a result of high mercury levels



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Environment Canada's Program: Enhance and advance on-going and past research and monitoring efforts to develop a cohesive national description of mercury pollution in Canada.



Environment Canada's Air Monitoring

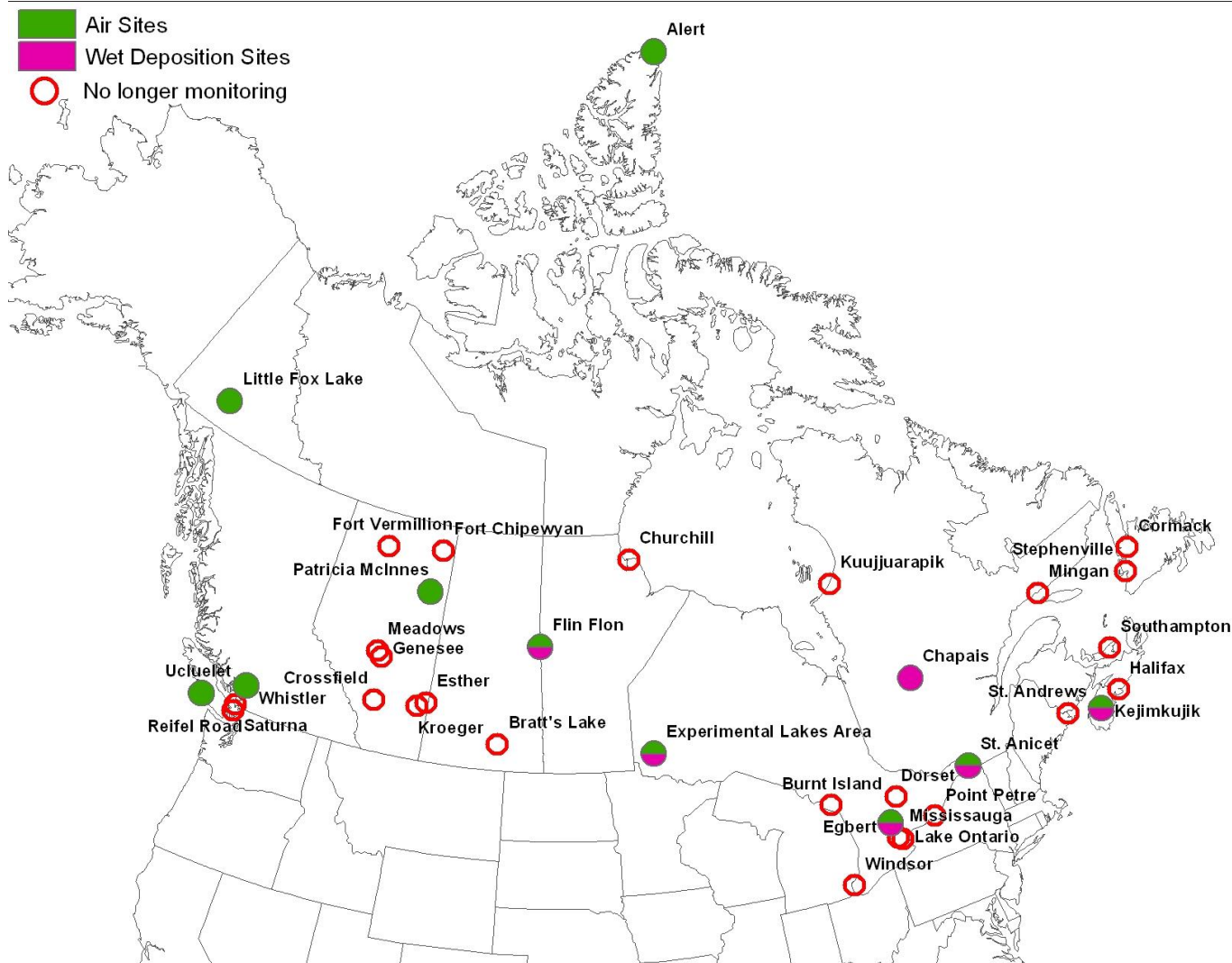
Air monitoring

1. Canadian Atmospheric Monitoring Network
(1996-2007) 9-13 sites

2. Canadian Air and Precipitation Monitoring Network
(2007-present) 4 sites

3. Wet deposition
(1996-now) 5-6 sites
CAMNet/CAPMoN/
MDN

4. Arctic (1995-now)



Atmospheric Mercury Measurements: What?

- Total Gaseous Mercury (TGM) or Gaseous Elemental Mercury (GEM):
 - In-situ continuous monitor, 5 min., $\sim 1.5 \text{ ng/m}^3$
- Mercury in precipitation:
 - precipitation collector, weekly sample, 5-15 ng/L.
 - US Mercury Deposition Network or sent to Canadian laboratory.
 - Methyl Mercury analyses at some sites.
- Mercury Speciation:
 - In-situ, 2-3 hours.
 - Gaseous Elemental Mercury
 - Particulate Mercury, pg/m^3
 - Reactive Gaseous Mercury (RGM) or Gaseous Oxidized Mercury (GOM), pg/m^3



Mercury Measurements Standard Operating Procedures (SOP)



**Standard Operating
Procedures Manual
for
Total Gaseous Mercury
Measurements**

**CANADIAN ATMOSPHERIC MERCURY
MEASUREMENT NETWORK
(CAMNet)**

VERSION 4.0 (MARCH 1999)

Journal of Environmental Monitoring

Cutting-Edge Research on Environmental Processes & Impacts

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RSC Publishing

PAPER
Steffen et al.
A comparison of data quality control protocols for atmospheric mercury
speciation measurements

- CAMNet TGM SOP (1999)
 - Set up of instrument, trouble shooting, calibrations, check sheets and minor repairs
 - Widely distributed
- Speciation Instrument SOP
 - Developed for Alert in 2002
 - Changing glassware, shipping samples, troubleshoot problems, look at data, check sheets
 - Can be applied to any station
- QA/QC SOP
 - Steffen, A., Scherz, T., Olson, M.L., Gay, D.A. and Blanchard, P., 2012, A comparison of data quality control protocols for atmospheric mercury speciation measurements

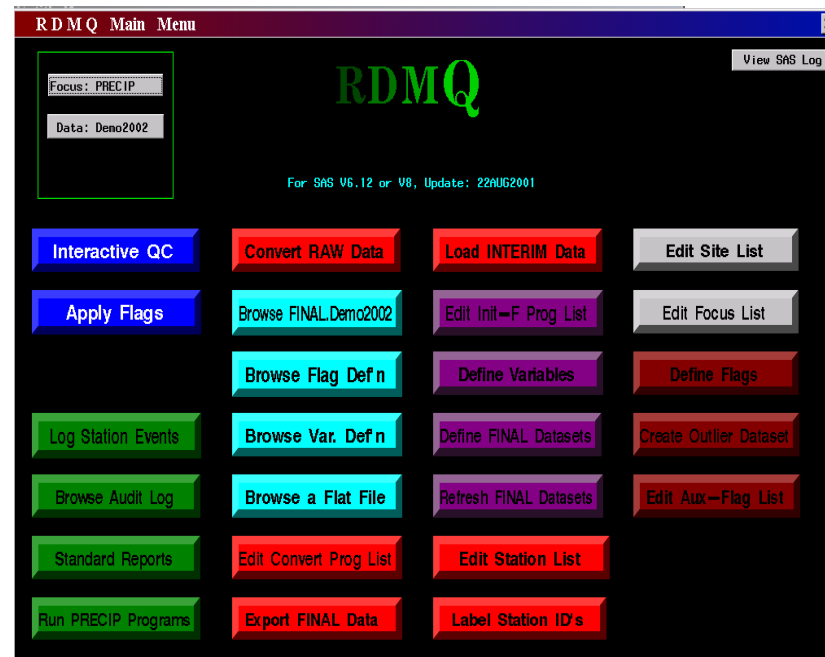


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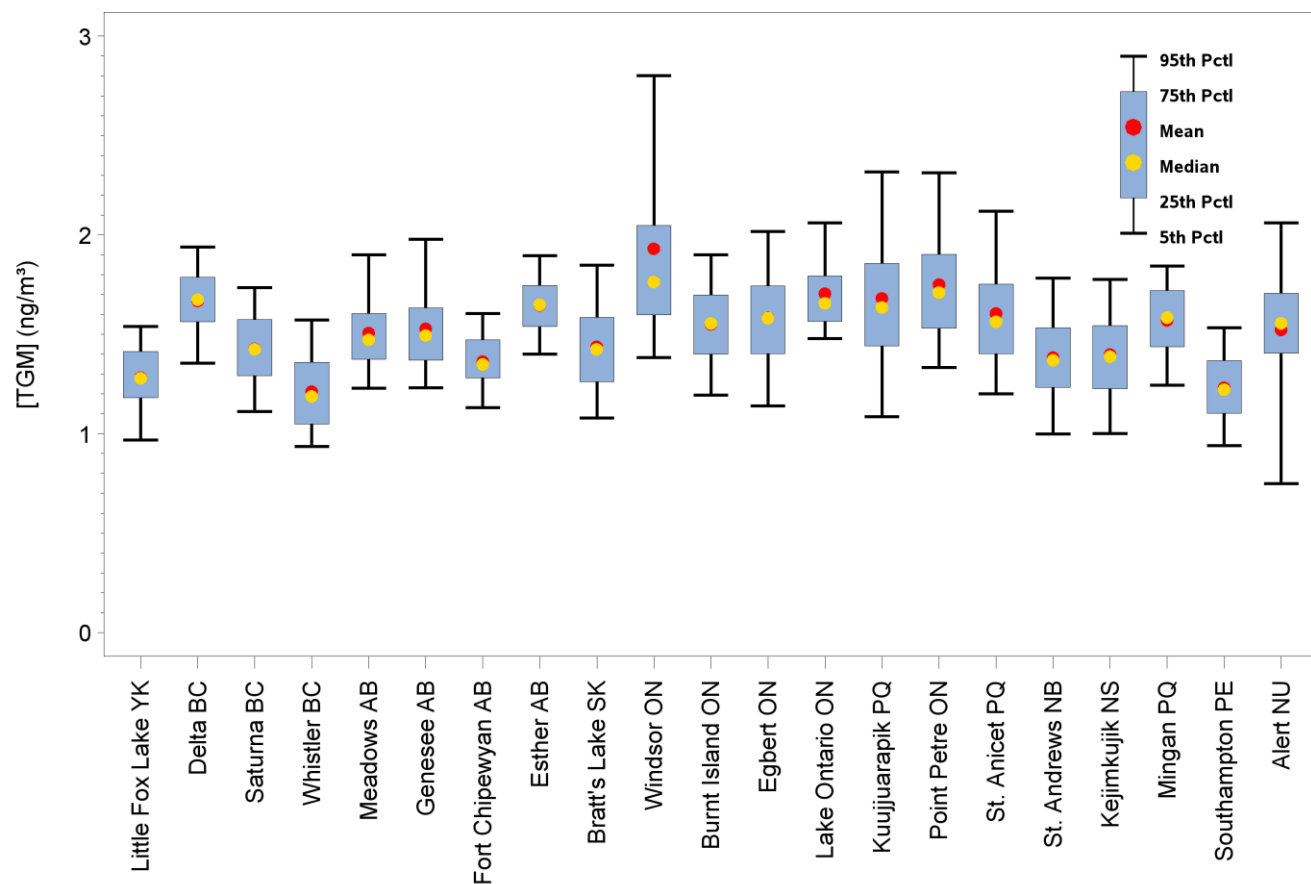
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QA/QC of TGM and Speciation data

- Program for QC of data
- SAS based system
- Started using in 1997 (TGM)
- Defined set of criteria, flagging system.
- Variable programming for site specific needs
- Data archived in Canadian National Chemistry Database (NATChem)
- Module added to QC PHg and RGM data 2007
- Collaborate with AMNet on QC



Atmospheric Mercury Measurements



Updated TGM trends in Canada

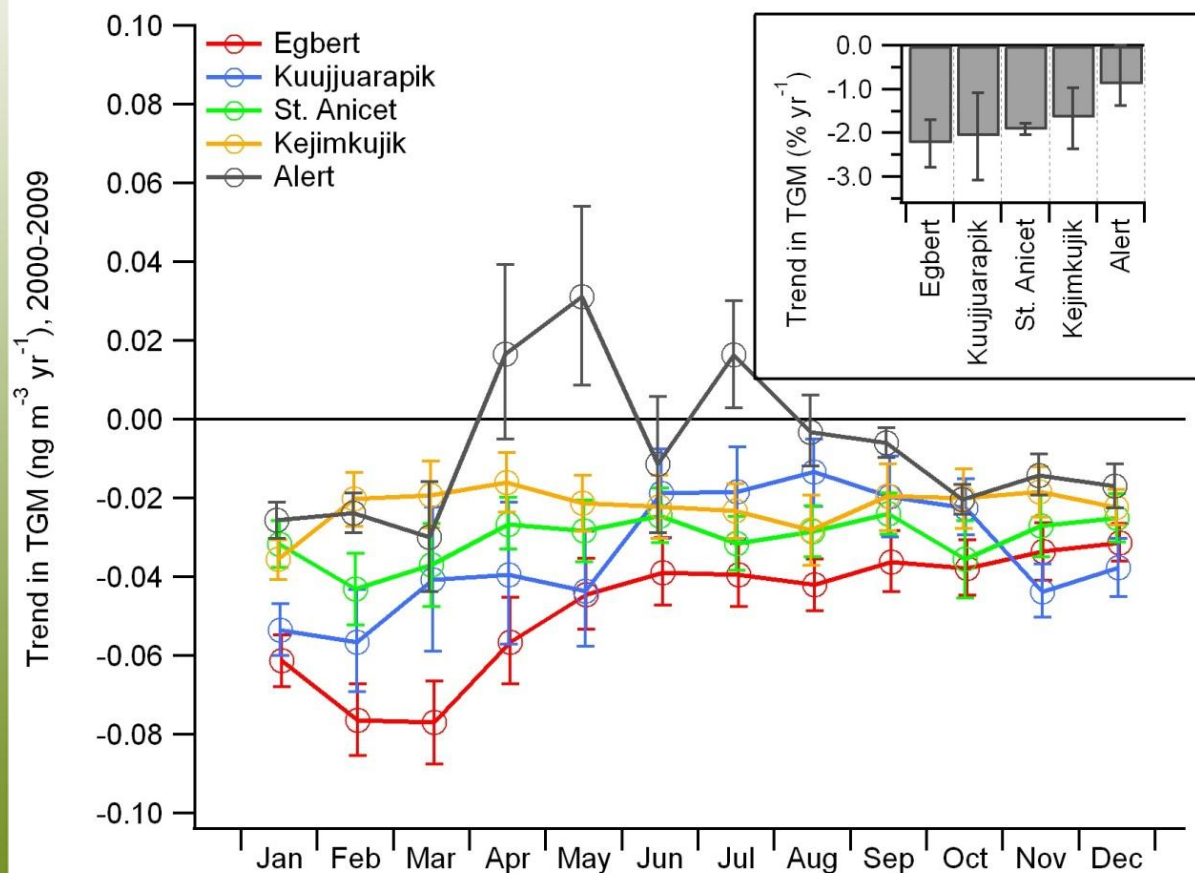
TGM trends at sites with >5 years of measurements compared with Temme et al., 2007

Site	Time period	Present TGM trend, pg m ⁻³ yr ⁻¹	Present TGM trend, % yr ⁻¹	Time period (Temme 2007)	TGM trend (Temme 2007), pg m ⁻³ yr ⁻¹	TGM trend (Temme 2007) % yr ⁻¹
Reifel Island	1999-2004	-55 (-70 to -40)	-3.3 (-4.2 to -2.4)	1999-2004	-37 (ns)	-2.03 (ns)
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)	2001-2005	+6 (ns)	+0.43 (ns)
Burnt Island	1998-2007	-15 (-22 to -7)	-1.0 (-1.4 to -0.4)	1998-2005	-11	-0.67
Egbert	1996-2010	-20 (-27 to -16)	-1.3 (-1.7 to -1.0)	1996-2005	-4	-0.24
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)	1996-2005	-37	-1.81
St. Anicet	1995-2009	-24 (-29 to -19)	-1.5 (-1.8 to -1.2)	1997-2005	-26	-1.46
St. Andrews	1996-2007	-30 (-42 to -20)	-2.2 (-3.1 to -1.5)	1996-2004	-12	-0.82
Kejimikujik	1996-2010	-14 (-20 to -6)	-1.0 (-1.4 to -0.5)	1996-2004	+5	+0.37
Alert	1995-2009	-11 (-15 to -6)	-0.7 (-1.0 to -0.4)	1995-2005	-5 (ns)	-0.31 (ns)

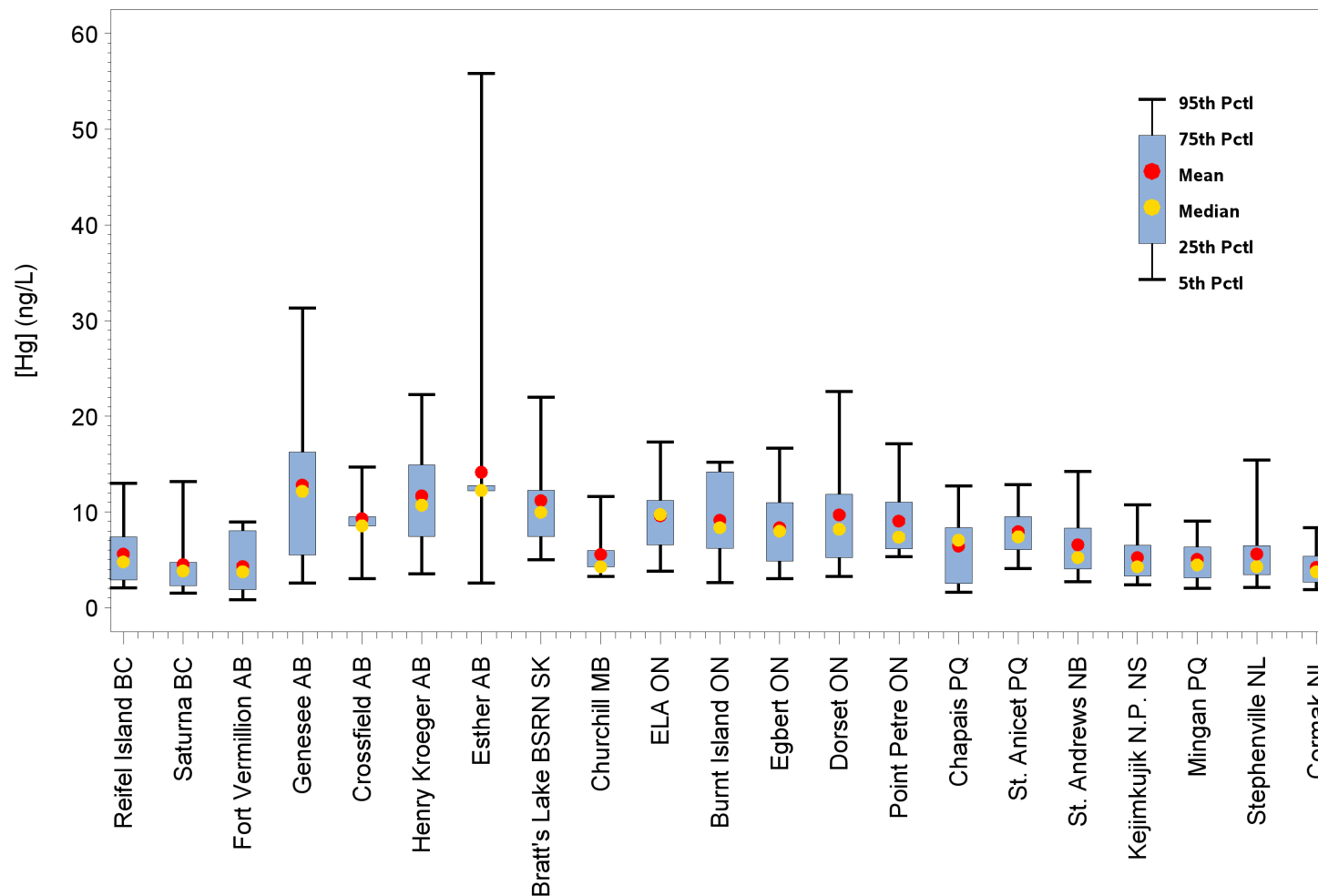


Hg in Air trends

Total gaseous Hg trends 2000-2009



Mercury in Precipitation



Hg in precipitation trends in Canada

[Hg] in precipitation trends at sites with >5 years of measurements

Site	Time period	[Hg] VWM trend ng l ⁻¹ yr ⁻¹	[Hg] VWM trend % yr ⁻¹	Time period (PG 2009)	[Hg] VWM trend (PG 2009), % yr ⁻¹
Egbert	2000-2010	-0.18 (-0.31 to -0.05)	-2.1 (-3.7 to -0.6)	2000-2005	ns
St. Anicet	1998-2007	-0.22 (-0.41 to -0.05)	-2.8 (-5.2 to -0.6)	1998-2005	-1.5
St. Andrews	1996-2003	-0.25 (-0.43 to -0.02)	-3.7 (-6.5 to -0.3)	1997-2003	-1.9*
Kejimikujik	1996-2010	-0.12 (-0.17 to -0.06)	-2.2 (-3.3 to -1.2)	1997-2005	-2.0
Mingan	1998-2007	-0.13 (-0.23 to +0.01) (ns)	-2.5 (-4.6 to +0.2) (ns)	1998-2005	ns
Cormak	2000-2010	-0.07 (-0.15 to +0.01) (ns)	-1.7 (-3.5 to +0.3) (ns)	2000-2005	-4.4

PG – Prestbo, E.M. and Gay, D.A., 2009, Wet deposition of mercury in the U.S. and Canada, 1996-2005: Results and analysis of the NADP mercury deposition network (MDN). Atmospheric Environment, 43: 4223-4233.

*may have error in data set



Mercury in the atmosphere

Atmosphere is the major pathway for Hg to enter ecosystems

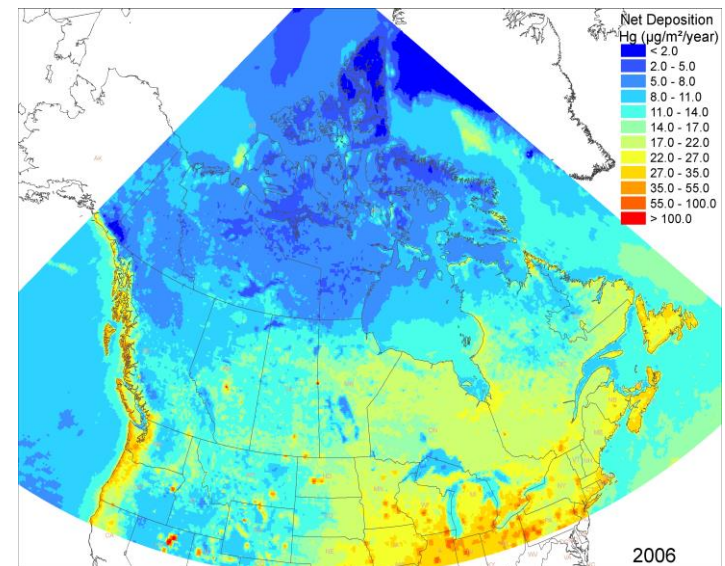
Measurements tell us

- 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

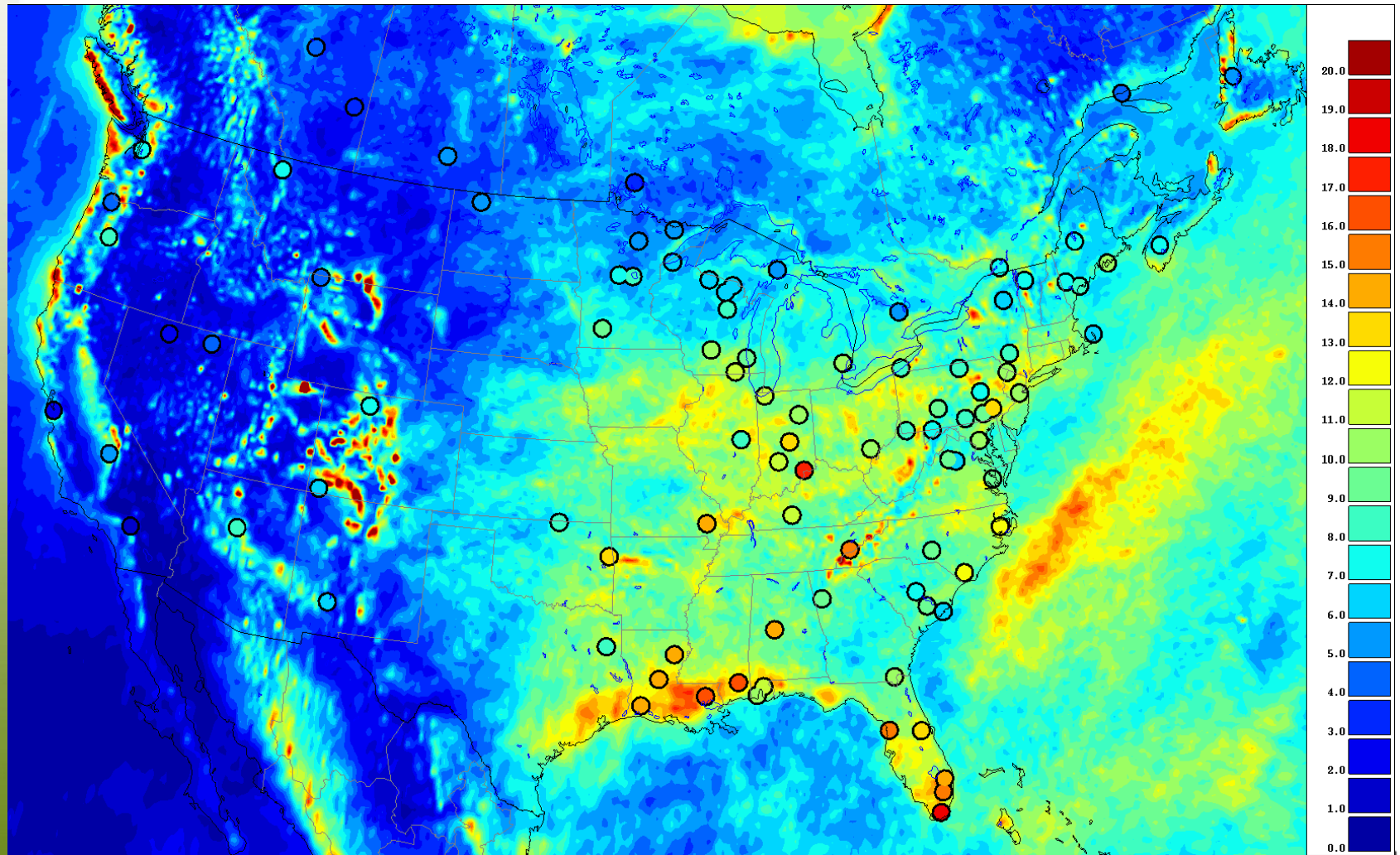
Models tell us

- 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

Model simulation of Hg deposition in Canada



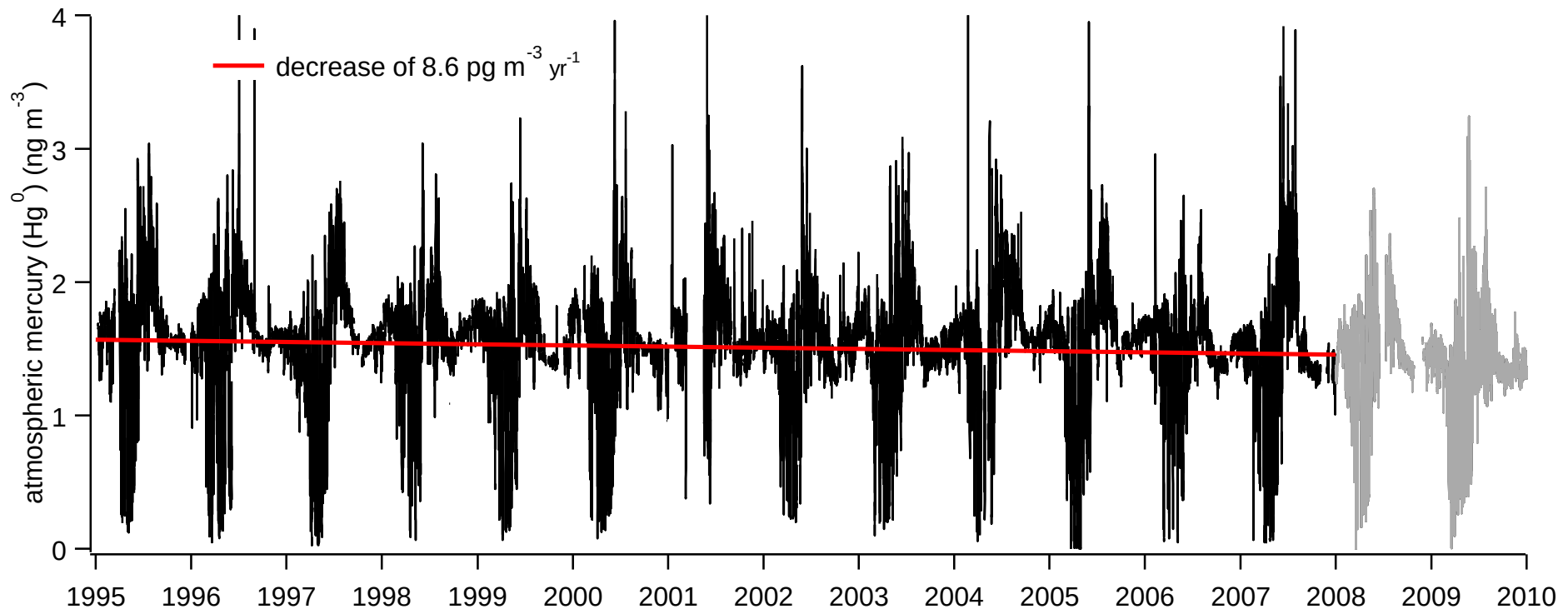
Hg Deposition in rain simulated by model and measurements ($\mu\text{g}/\text{m}^2/\text{yr}$); measured values are shown in the circles



Mercury monitoring at Alert

The longest GEM time series

Trend with time for GEM
 $-0.0086 \pm 0.0014 \text{ ng m}^{-3} \text{ yr}^{-1}$



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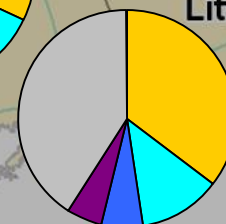
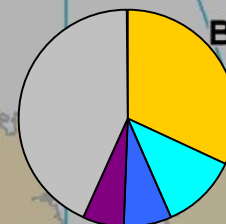
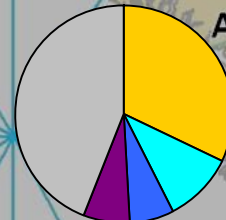
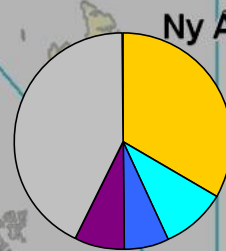
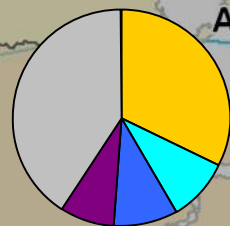
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Modeling mercury source regions to the Arctic



Waliguan

Mt Changbai

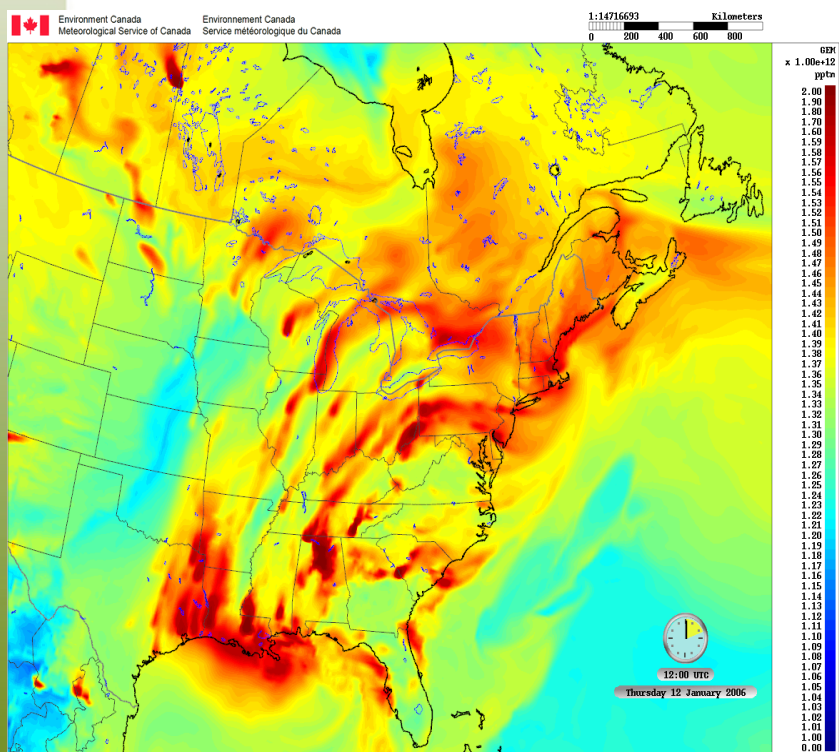
Zhushang

Whistler

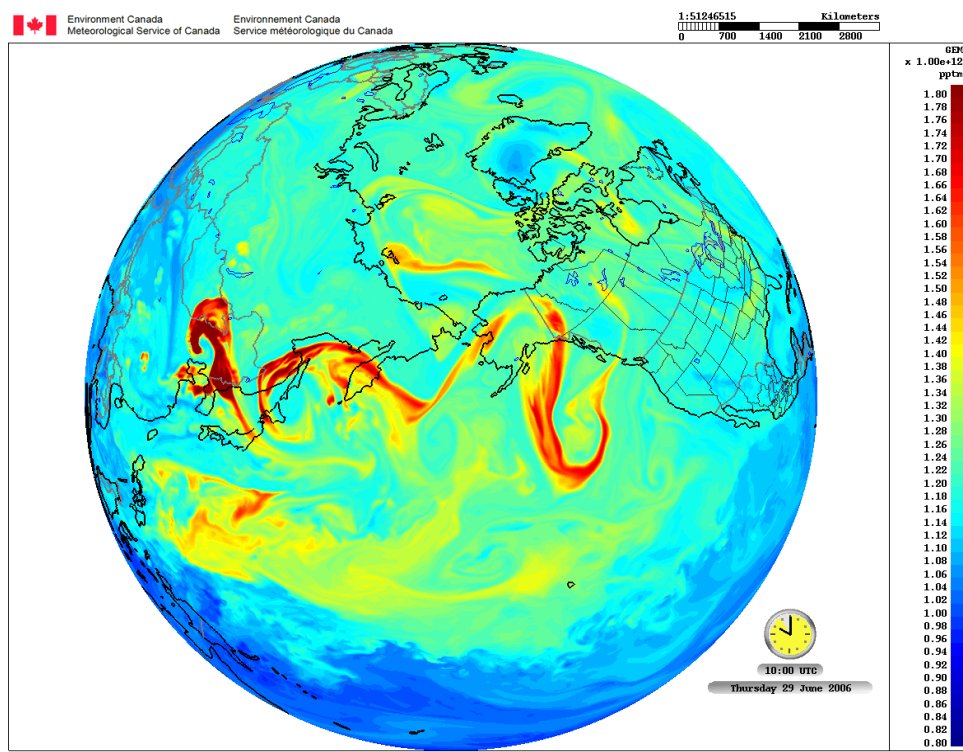
Data courtesy of D. Durnford
Ref. Durnford et al., ACP 20

Regional and Long Range transport of Hg

Surface air Hg flow (9 am, Jan 12, 2006)



Upper air Hg flow (5 am, June 29, 2006)



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Conclusions

- Canada continues to monitor mercury, utilizes CAPMoN infrastructure.
- Publication of Canadian mercury science assessment planned for 2013.
- Model development continues with bi-directional module.

