Overview of Spatial and Temporal Distributions of Speciated Mercury

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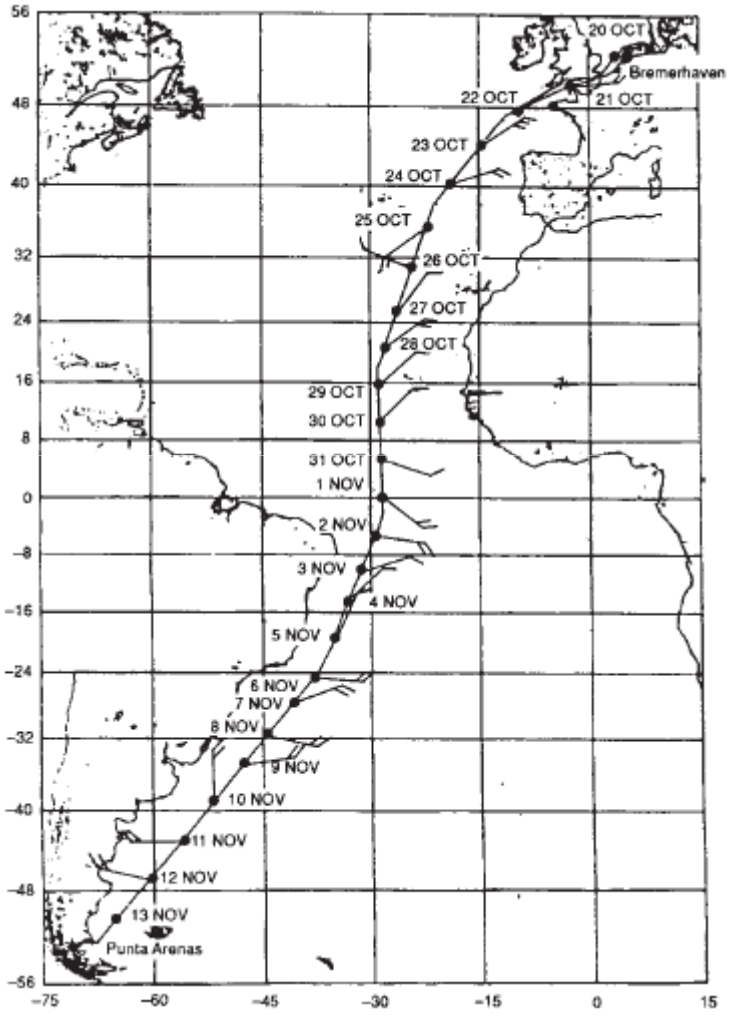
Great temporal variabilityies & Large heterogeneous spatial distributions of sources & sinks



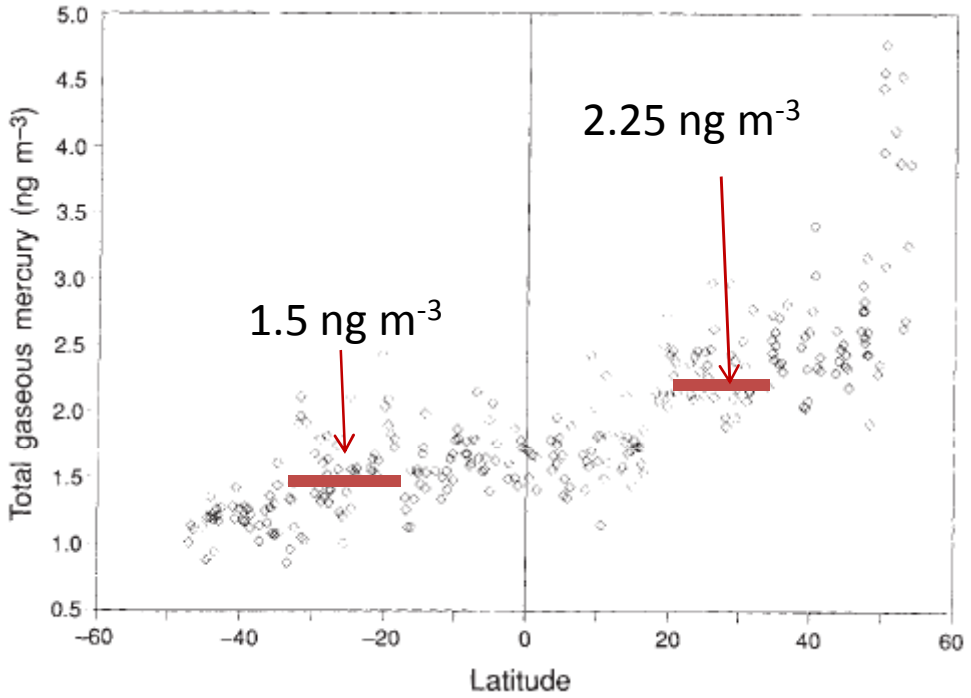
Distinctly different spatiotemporal variations of Hg^0, RGM, and Hg^p in various environments:

- Marine boundary layer
- Land: urban, suburban, rural, remote
- High elevation, high altitudes
- Latitudinal variation

Marine Boundary Layer



Oct – Nov 1990



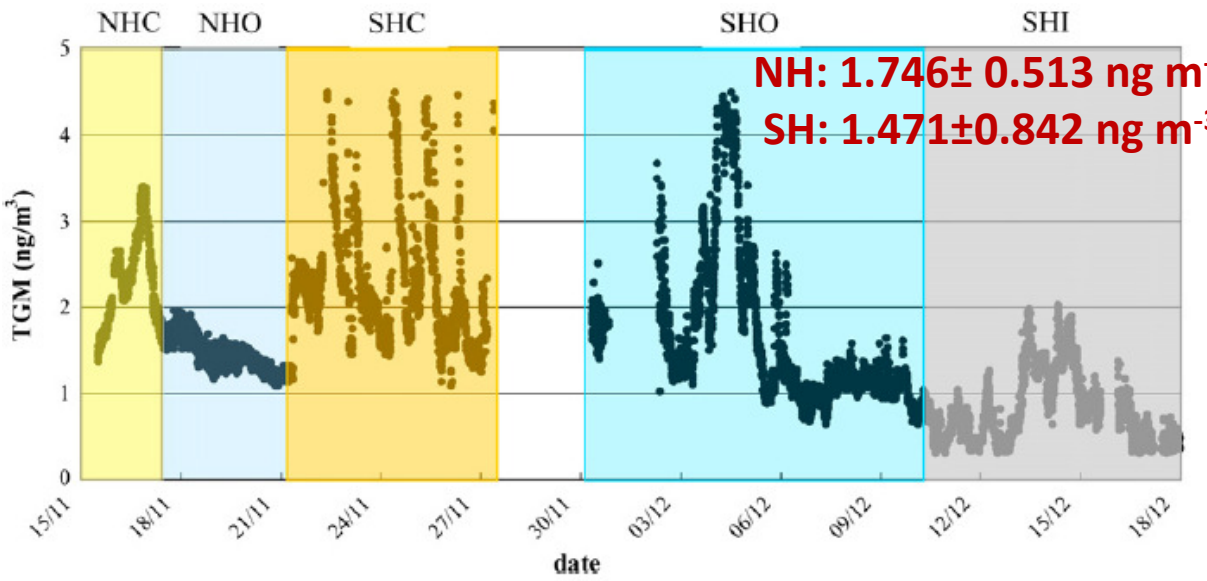
Increasing TGM from SH to NH, indicating anthropogenic influence

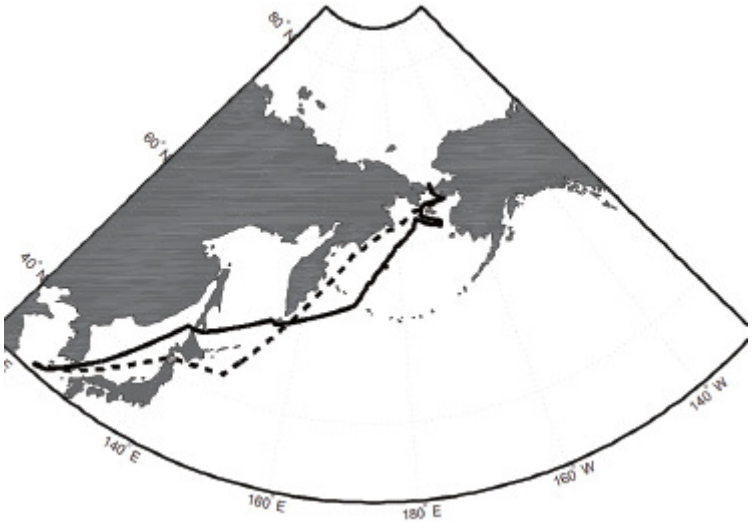
Slemr and Langer, 1992, Nature

Anthropogenic influence on the coasts

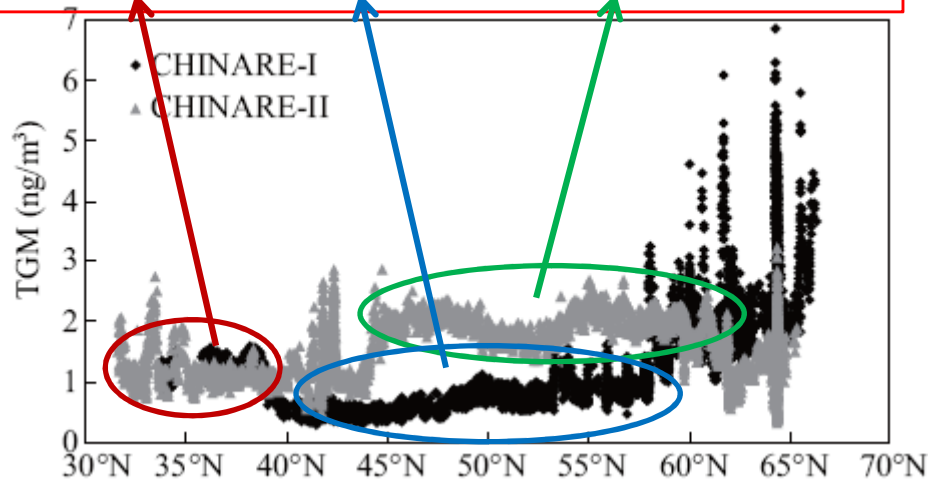


Xia et al., 2010, AE



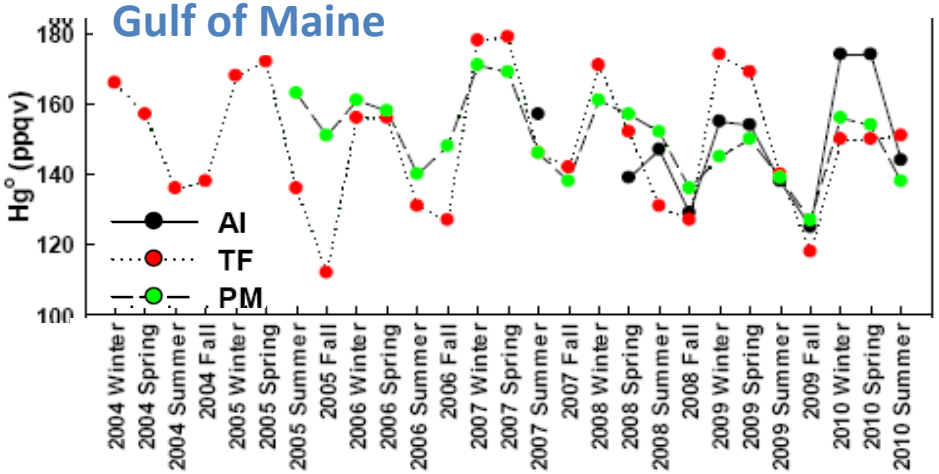


Anthropogenic; oxidation; volcanic emissions



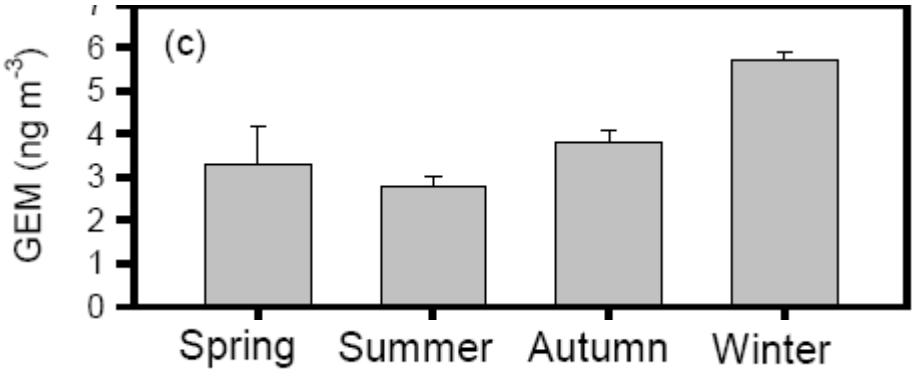
Kang&Xie et al., 2011, AE

Gulf of Maine



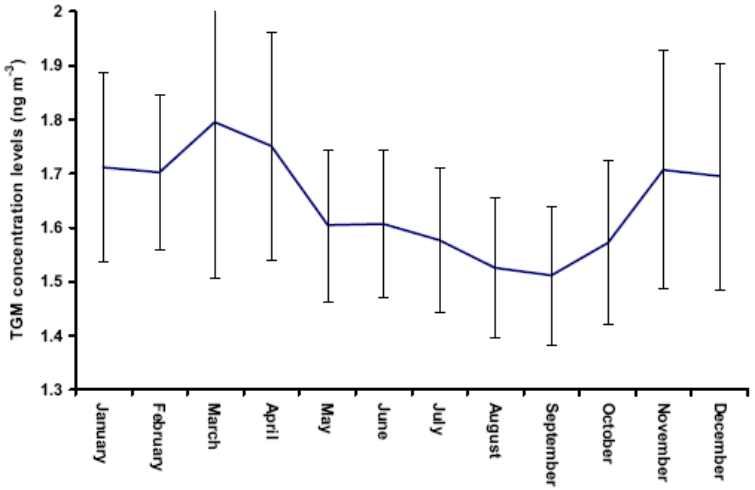
(Mao and Talbot, 2012, acp)

South China Sea – East Asian Monsoon



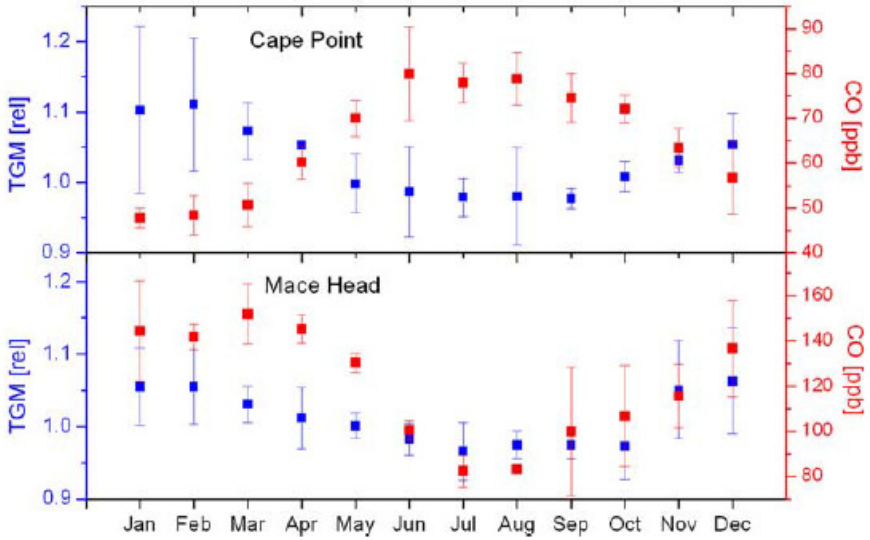
Tseng et al., 2012, acp

Mace head: 1996 - 2009



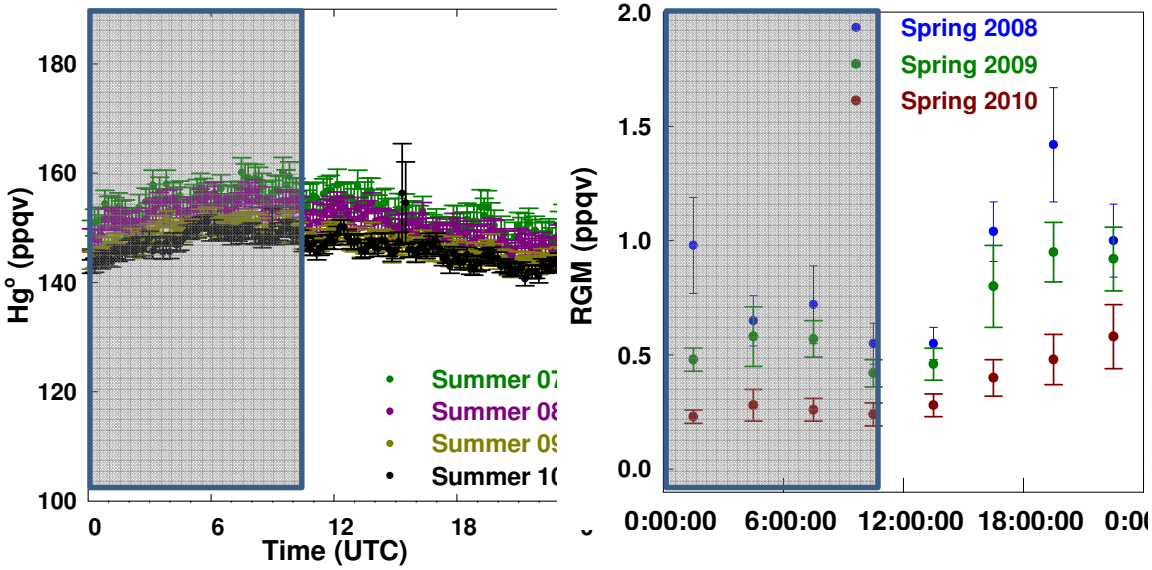
Ebinghaus et al., 2011, AE

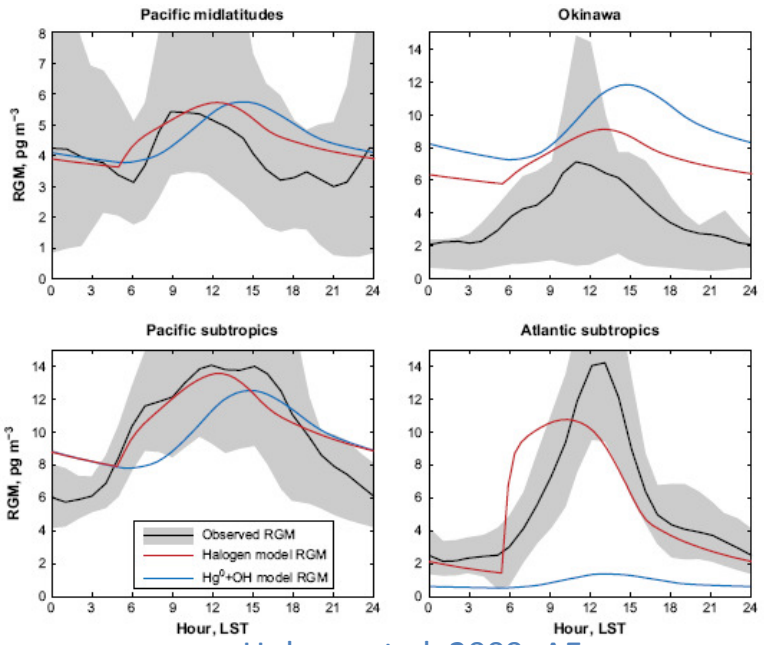
Annual max in summer – emissions?



Slemr et al., 2008,GRL

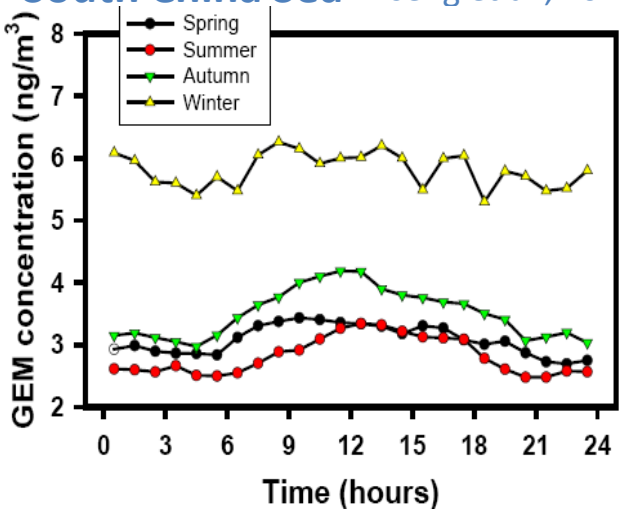
Gulf of Maine (Mao and Talbot, 2012, acp)

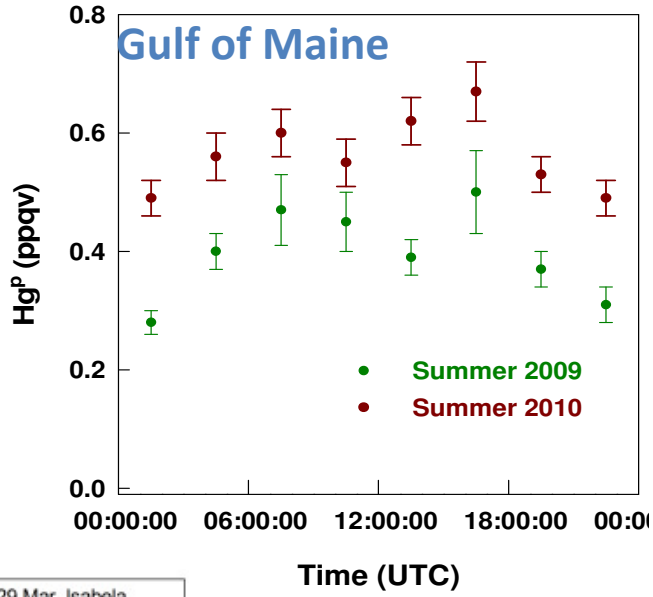




Holmes et al, 2009, AE

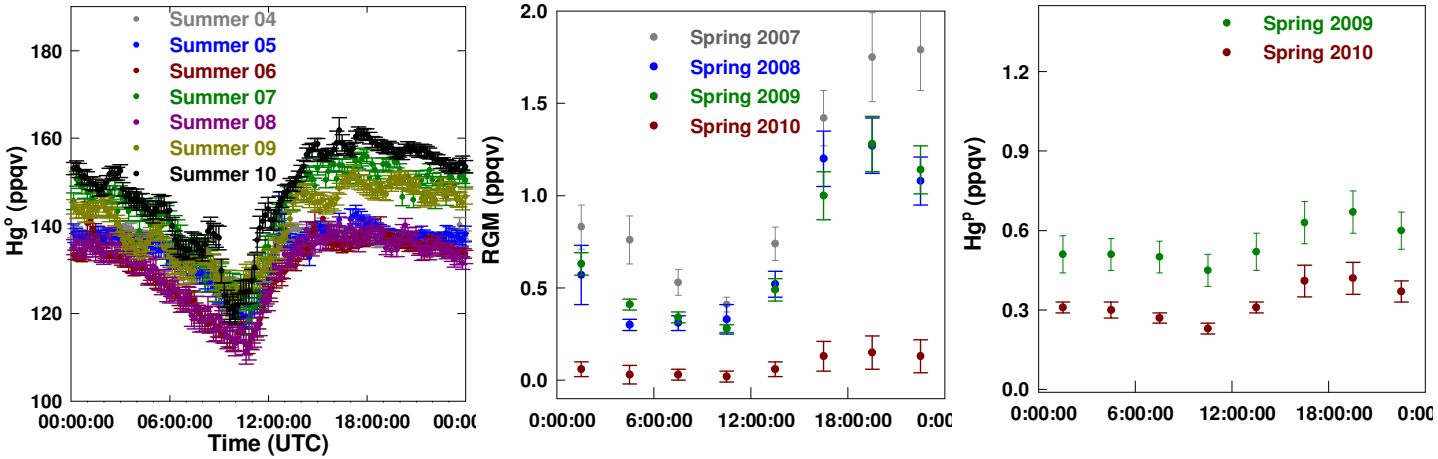
South China Sea Tseng et al., 2012



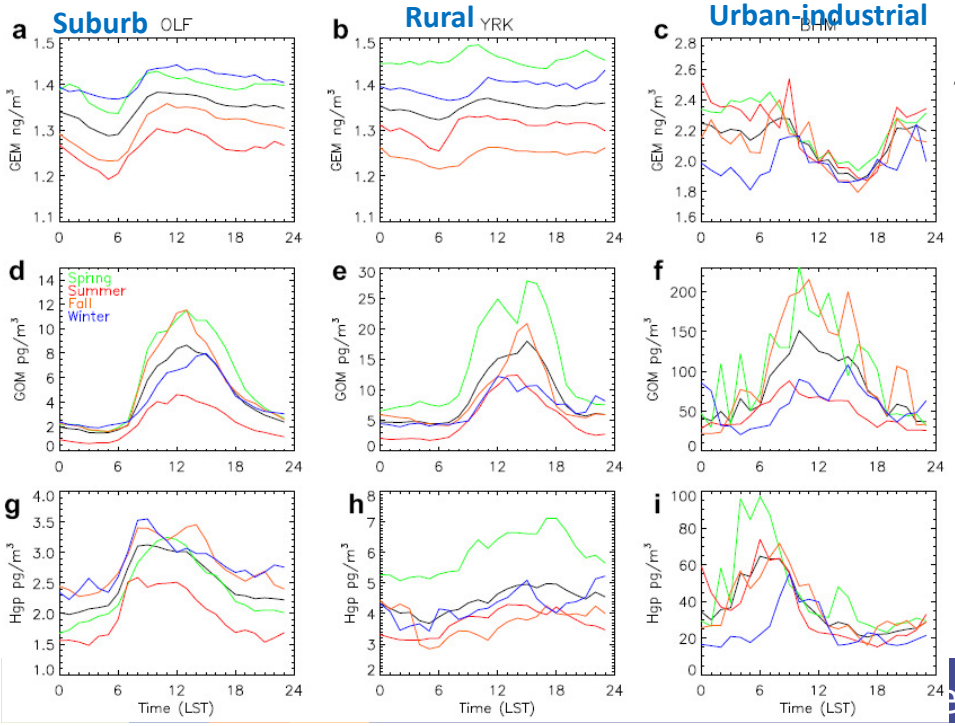


Urban, Suburban, Rural, Remote

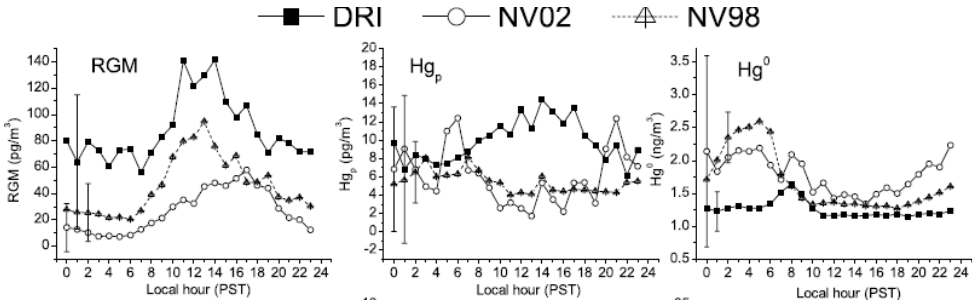
Northeastern US rural (Mao and Talbot, 2012, acp)



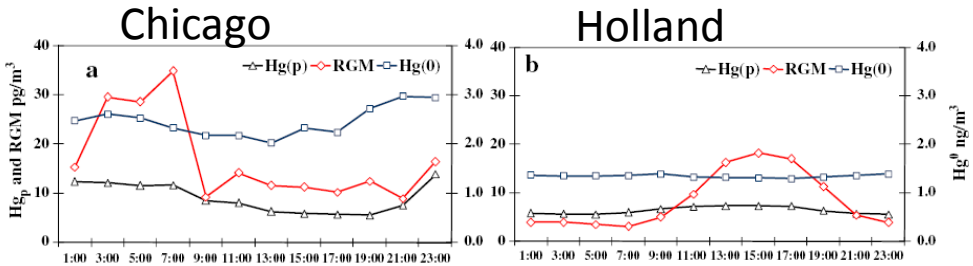
Southeast US: 2005 - 2008 Nair et al., 2011, AE



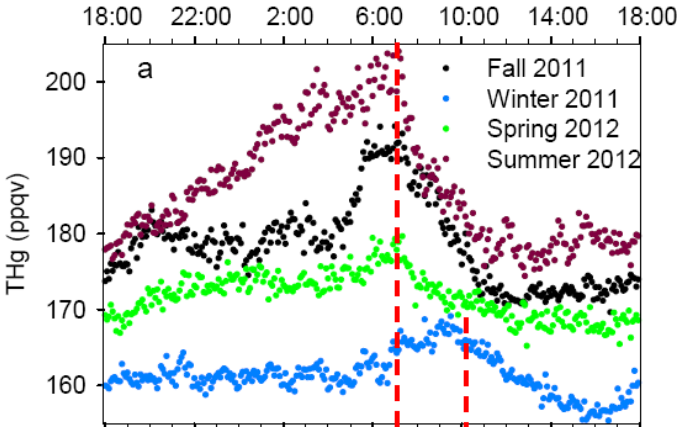
Western US: Jun – Aug 2007 Weiss-Penzias et al., 2009, JGR



Great Lakes: Jul – Nov 2007 Gratz et al., 2013, STOTEN

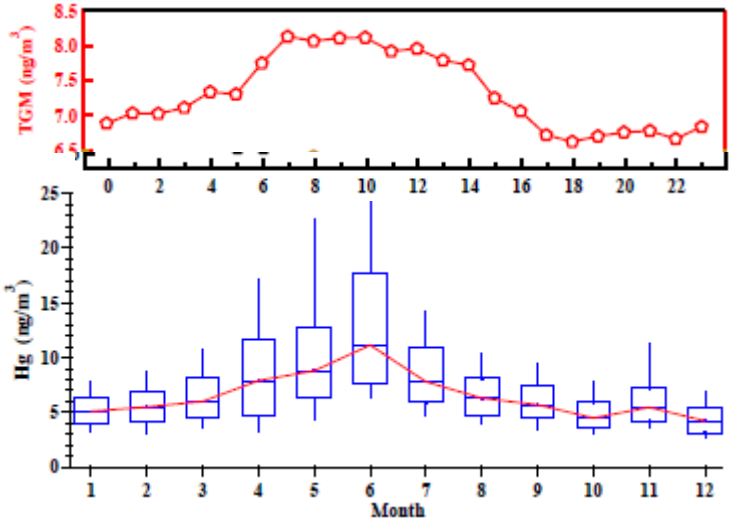


Houston, TX Lan et al., 2014, Atmos.



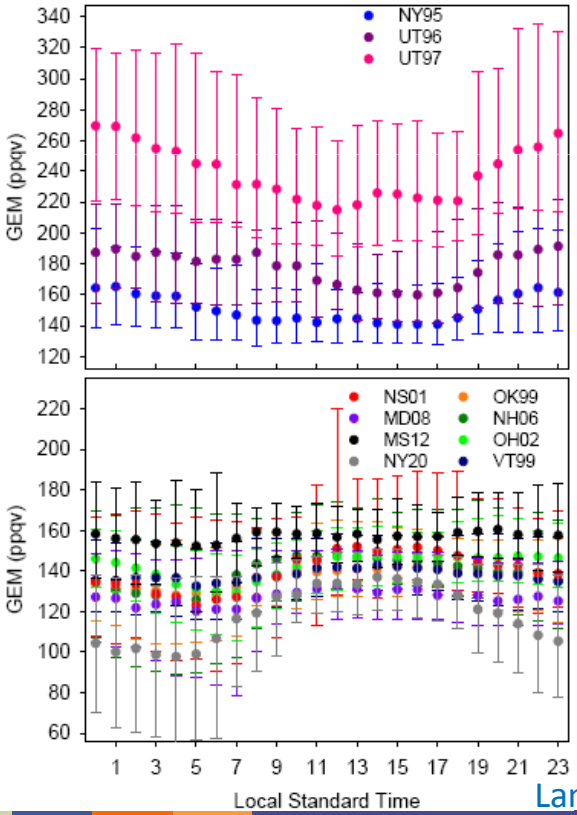
Nanjing, China

Zhu et al., 2012, acp



US

Summer 2009

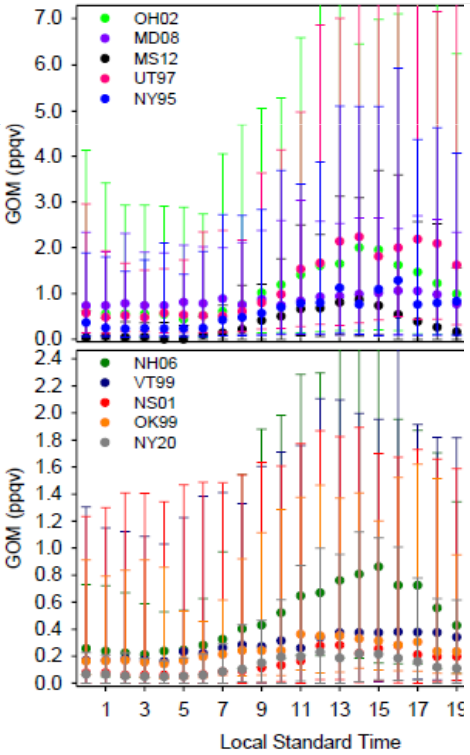


Urban

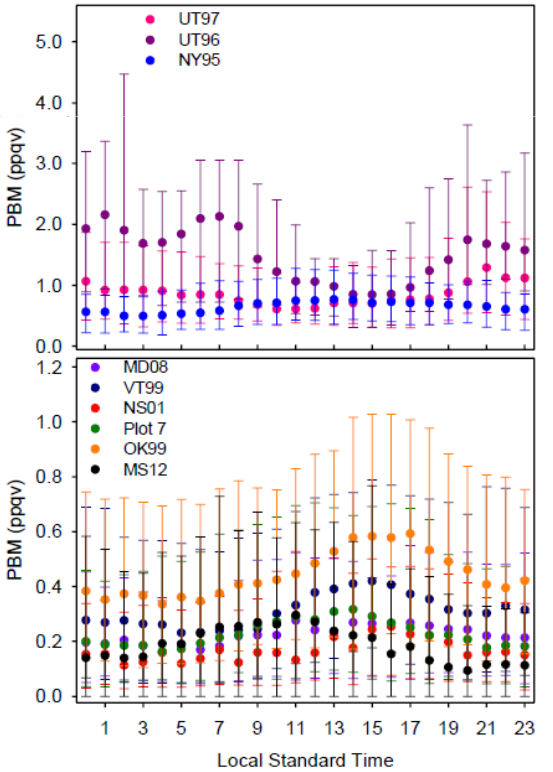
Sub-urban

Rural

Spring 2009



Summer 2009



Lan et al., 2012, acp

CAMNet: 1995 - 2005

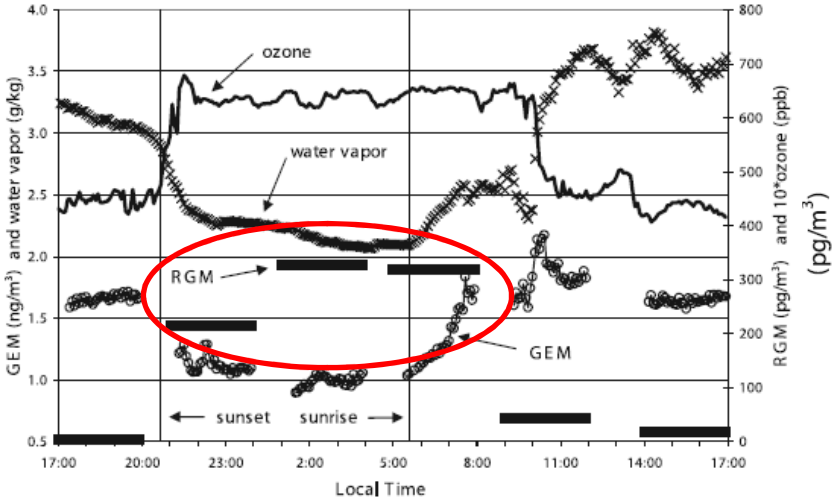
Temme et al., 2007, AE

	Minimum median, month	Maximum median, month
Station		
Alert	MAY	JUL
Kejimkujik	SEP	FEB
St. Andrews	SEP	FEB
St. Anicet	SEP	MAR
Point Petre	OCT	FEB
Egbert	AUG/SEP	FEB
Burnt Island	SEP	FEB
Bratt's Lake	SEP	MAR/APR
Esther	SEP	MAR
Fort Chipewyan	SEP	FEB
Reifel Island	OCT	FEB
Category		
RURAL-WEST (Median RFL, EST, FCH, BRL)	OCT	MAR
RURAL-EAST (Median KEJ, STA)	SEP	FEB
RURAL-AFFECTED (Median WBZ, PPT, EGB)	SEP	FEB
RURAL-CENTRAL (BNT)	SEP	FEB
ALL (Median all)	SEP	FEB

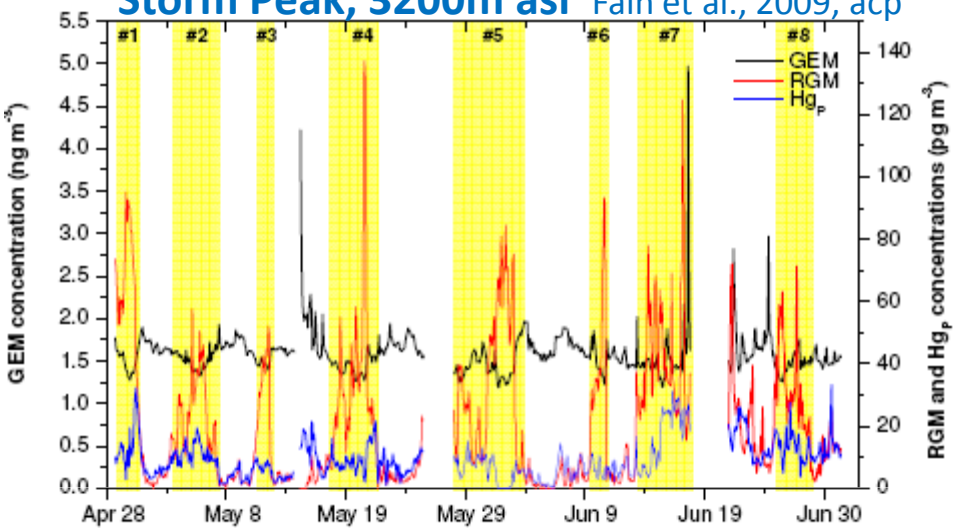
The largest declines of 17% and 13% over the study period in Montreal, Toronto, respectively, driven by local to regional emission changes

High elevation, High altitudes

Mt. Bachelor 2700 m asl Swartzendruber et al. (2006, JGR)

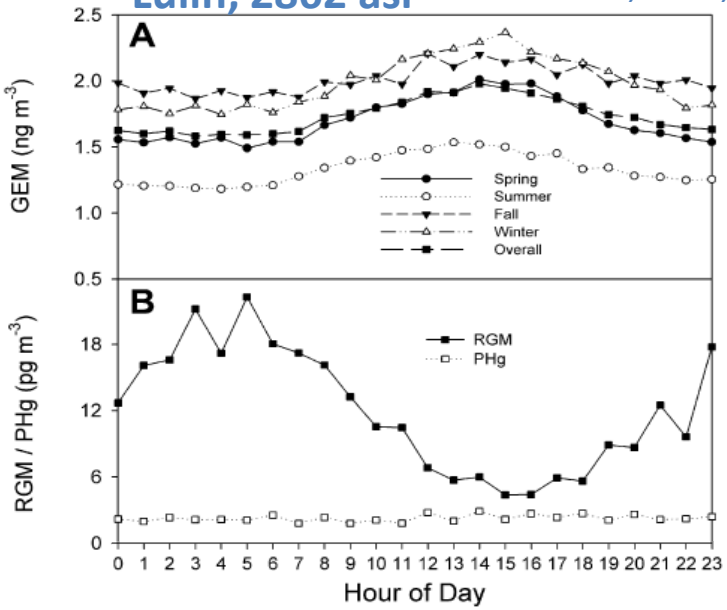


Storm Peak, 3200m asl Fain et al., 2009, acp

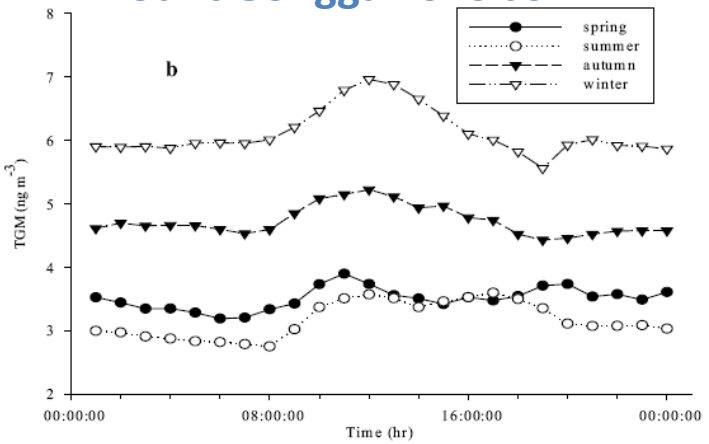


GEM: 1.6 ngm^{-3}, RGM: 20 pgm^{-3} Hg^{p}: 9 pgm^{-3}

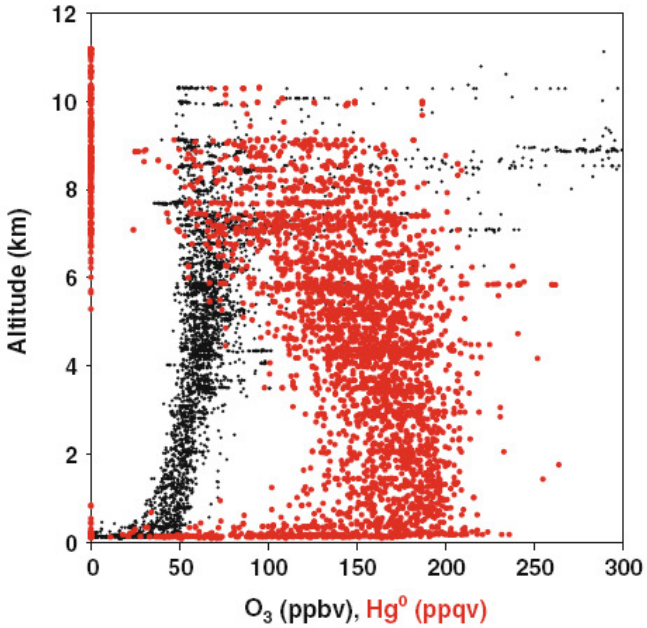
Lulin, 2862 asl Sheu et al., 2010, AE



Mount Gongga 1640 asl

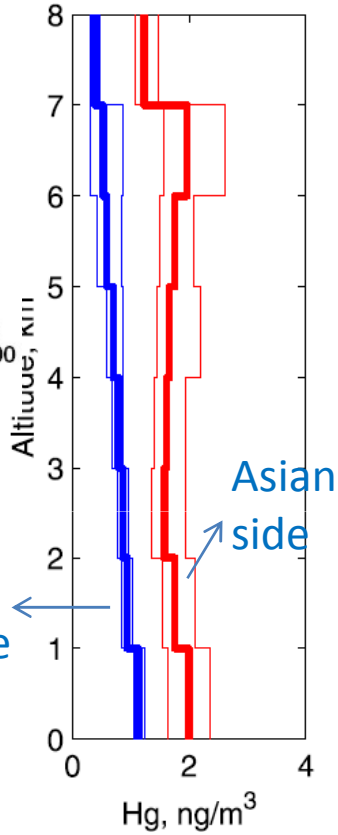


Zhu et al., 2008, J. Mt. Sci.



Springtime Arctic

Mao et al., 2011

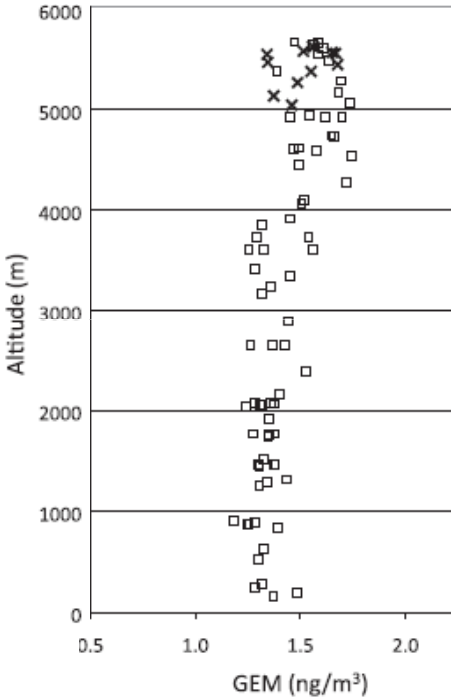


Asian side

CA side

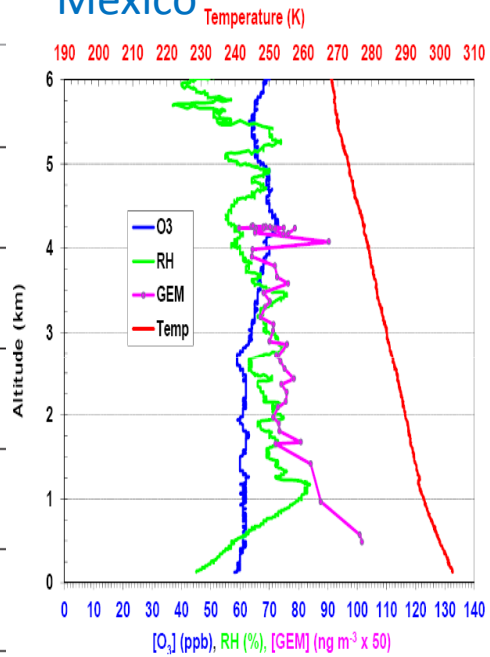
Radke et al., 2007

Pacific Northwest



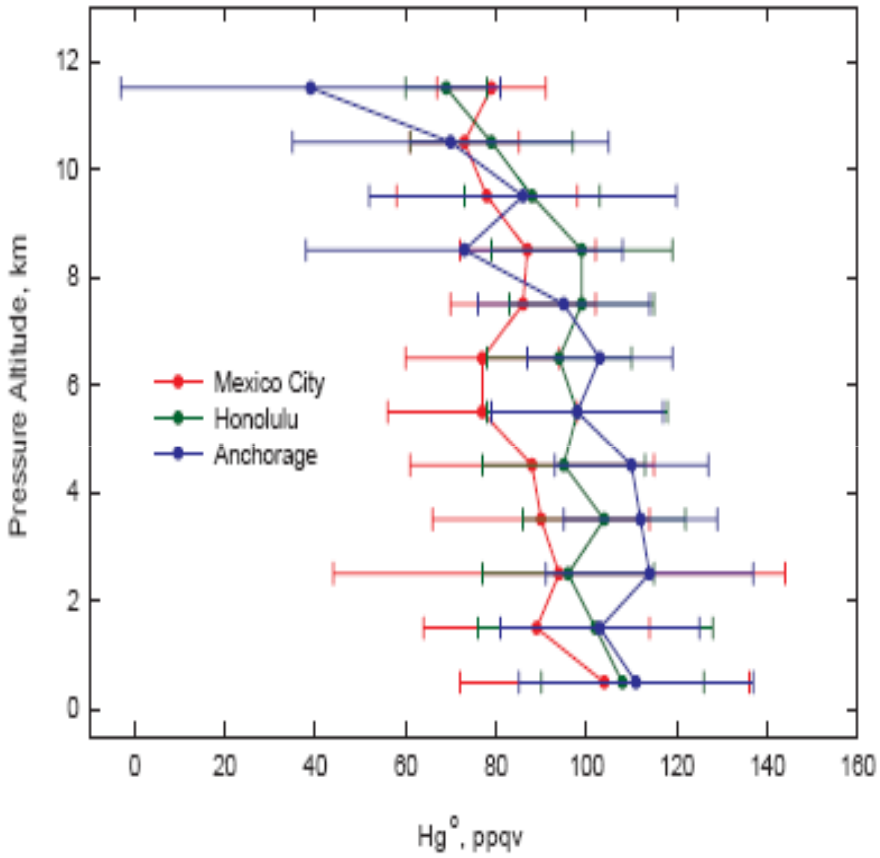
Swartzendruber et al., 2008

Grand Bay Intensive, North of Gulf of Mexico



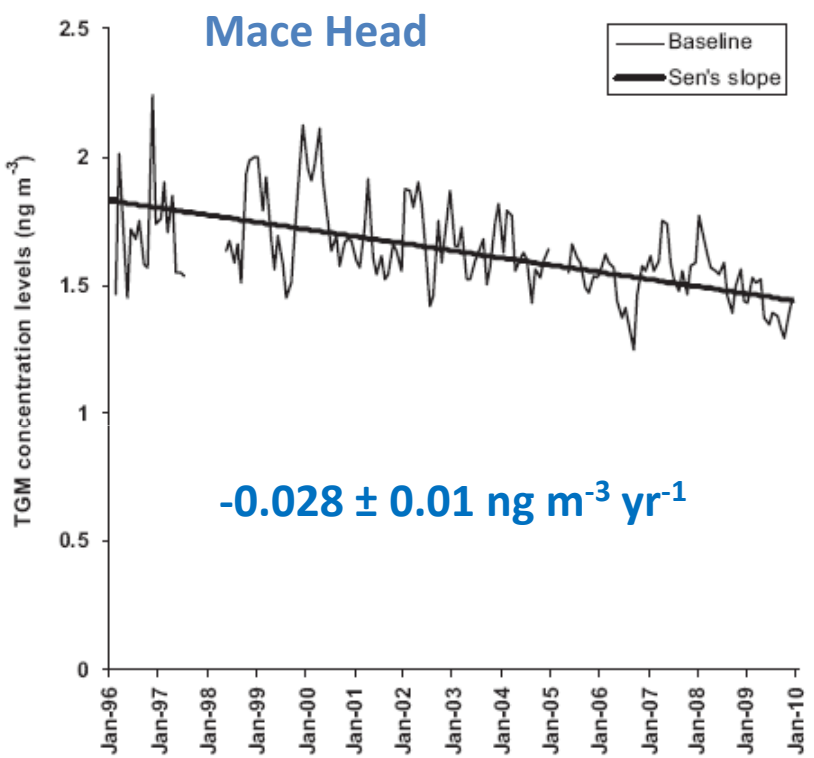
Ren et al., 2014, Atmos.

Latitudinal Variation

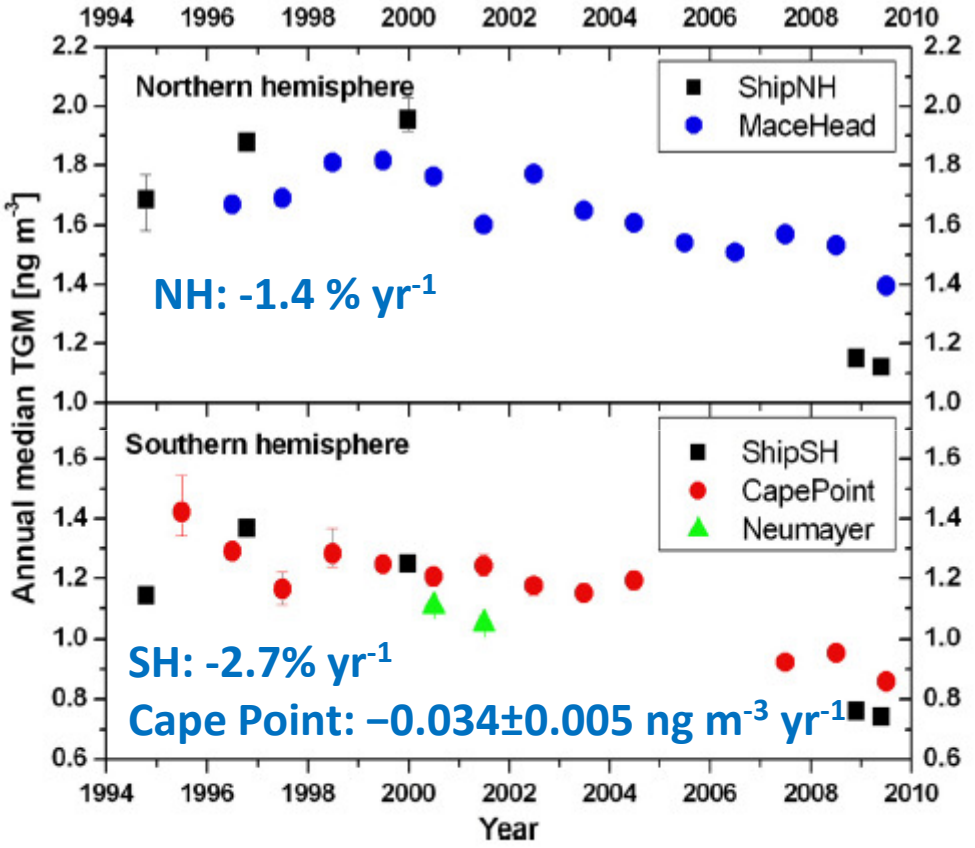


Talbot et al., 2008, acp

Long-term Trends



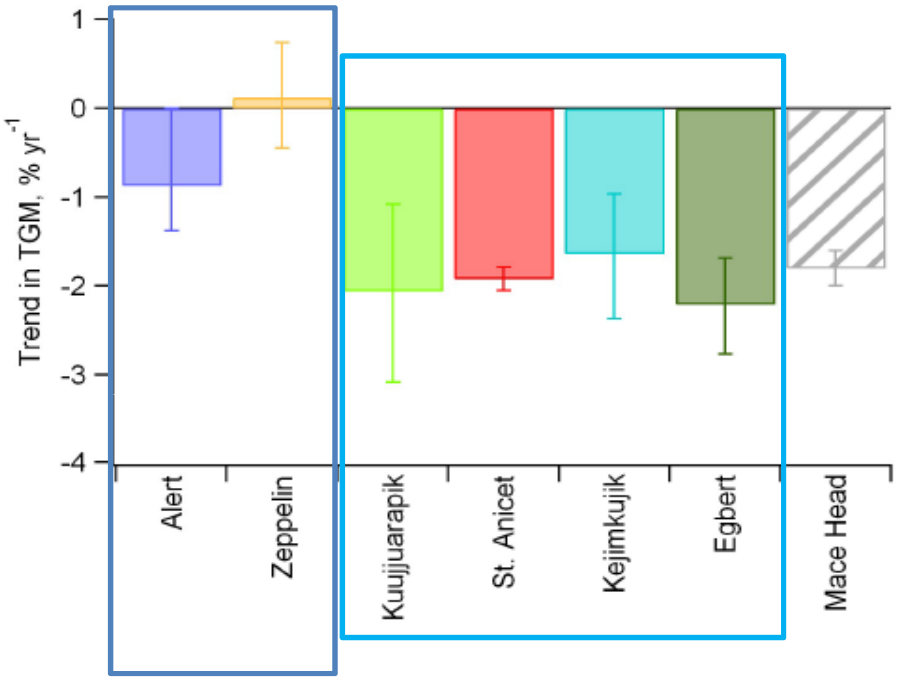
Ebinghaus et al., 2011, AE



Decreased legacy emissions?

Slemr et al., 2011, ACP

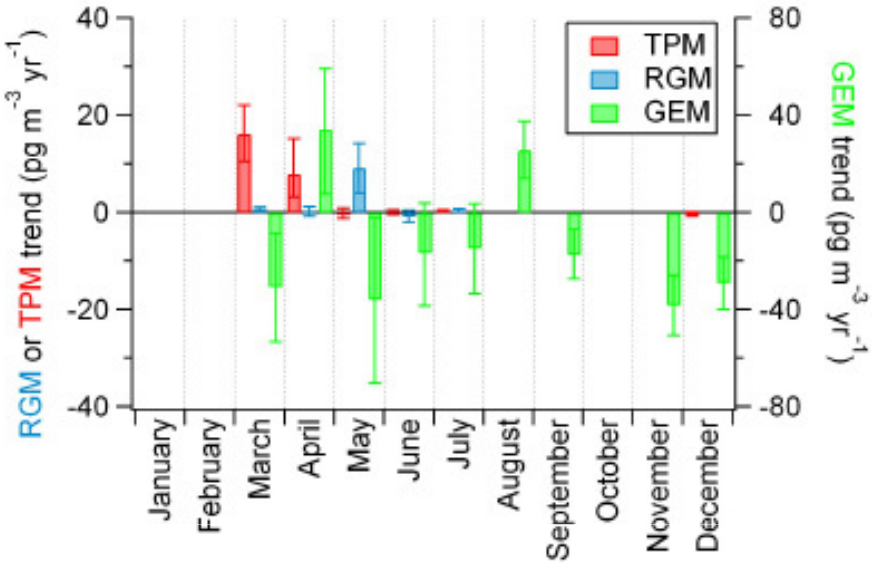
Trends in TGM at all sites for 2000–2009 and Mace Head, Ireland for 1996–2009.



Arctic

Midlatitudes
Sub-Arctic

Alert, 2002 - 2009

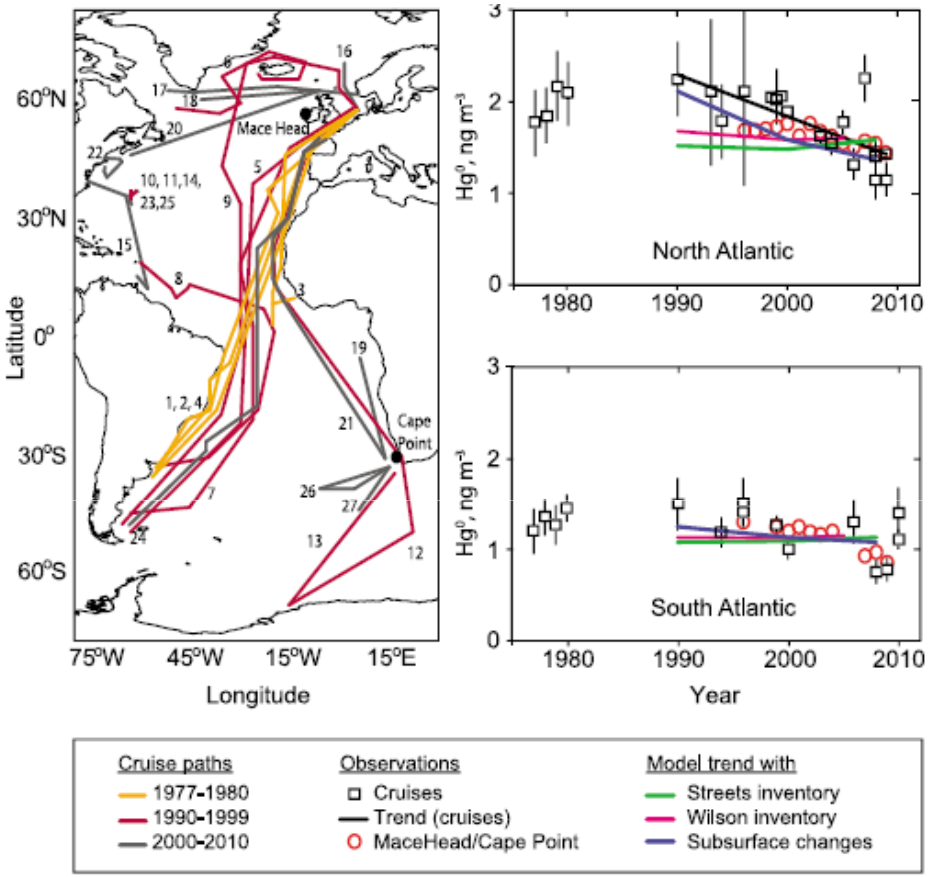


Increased RGM in Arctic May,
Increased TPM in Arctic spring

← Increased oxidation

Cole et al., 2013, acp

Decline of Hg^0 over the NA Ocean



"Caused by decreasing Hg inputs from rivers and wastewater and by changes in the oxidant chemistry of the atmospheric marine boundary layer"

Soerensen et al., 2012, GRL

Need to Know:

- Global distribution of Hg^0, RGM, and Hg^P
- The processes controlling spatiotemporal variabilities in speciated Hg in different environments
- Long term trends in Hg^0 – causes?