Quantifying uncertainties of the global mercury cycle using the GEOS-Chem model and observations

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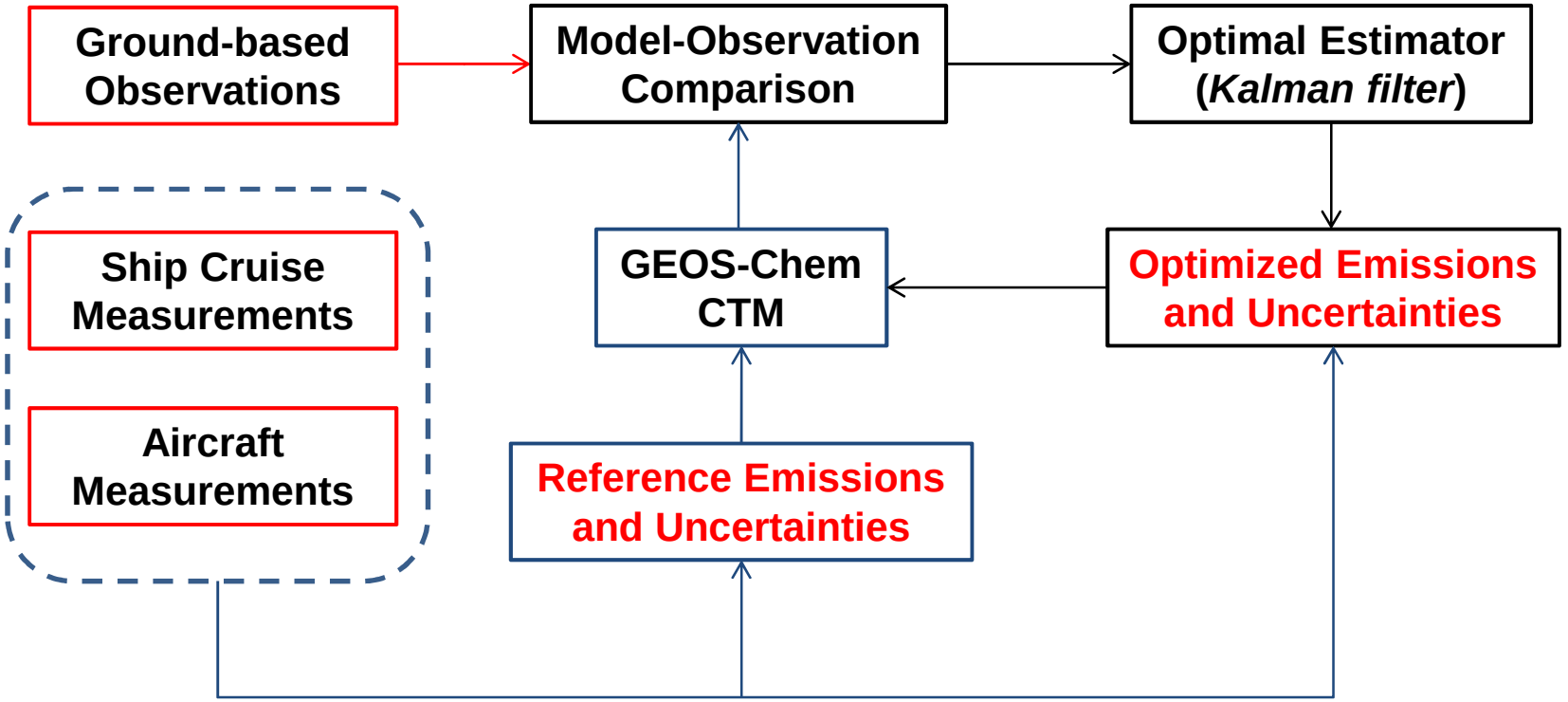
Mercury emission fluxes to the atmosphere

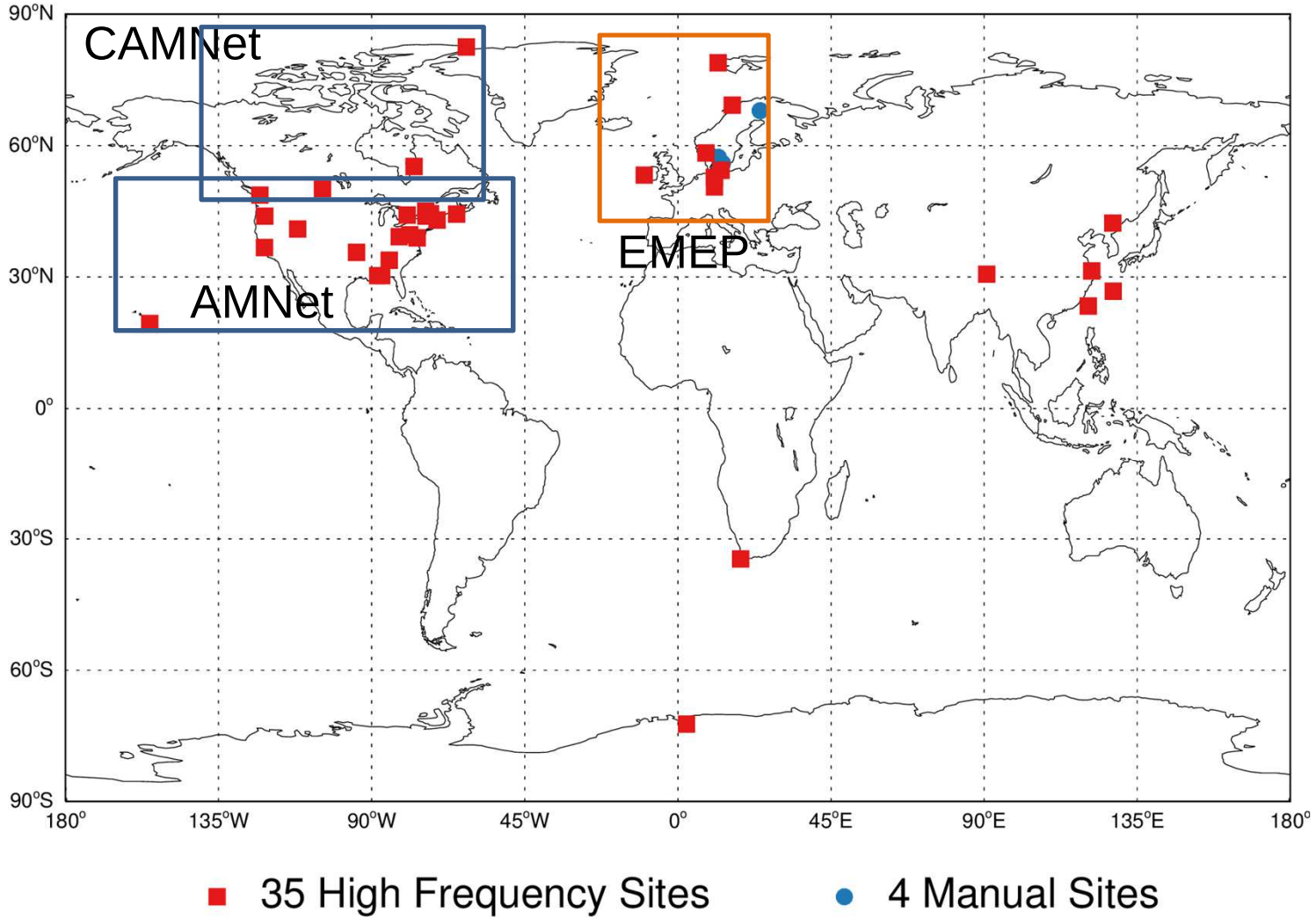
Mercury Source	Range Mg a^{-1}	Reference
Ocean	782 – 5282	Hedgecock et al., 2006 ; Mason and Sheu, 2002 ; Sunderland and Mason, 2007
Terrestrial	863–3806	Mason, 2009
Anthropogenic	1010-4070	UNEP, Global Mercury Assessment 2013
Biomass burning	200-1330	Brunke et al., 2001; Friedli et al., 2008; Holmes et al., 2010
Total	4400-7000	Selin et al., 2007

Inverse modeling method



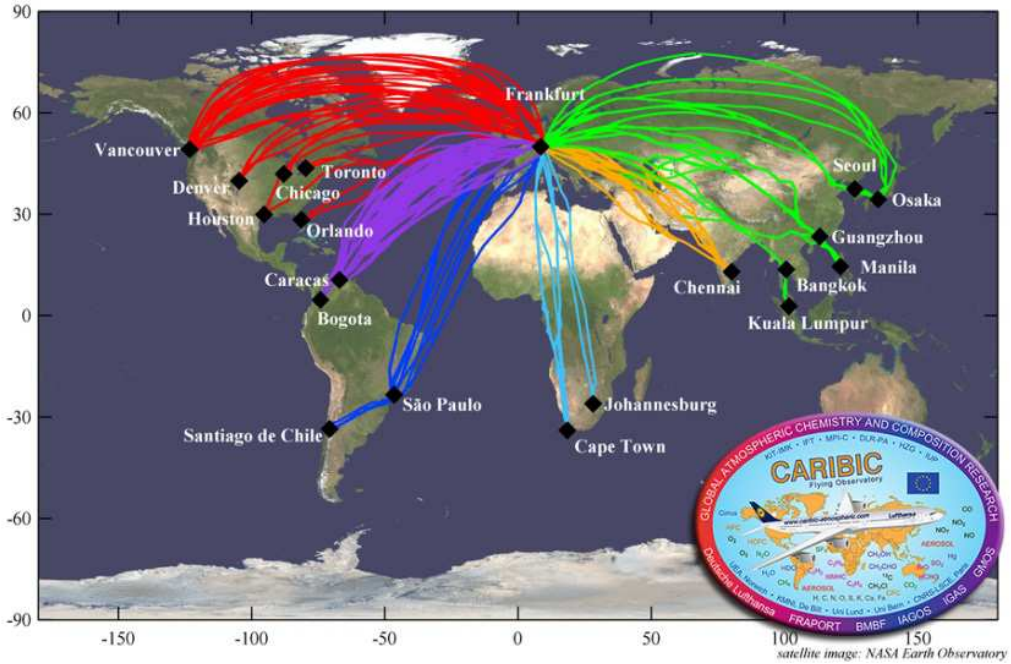
Question: *Can we use observations to quantify the emission sources of atmospheric mercury through inverse modeling?*

Ground-based observations (2009-2011)



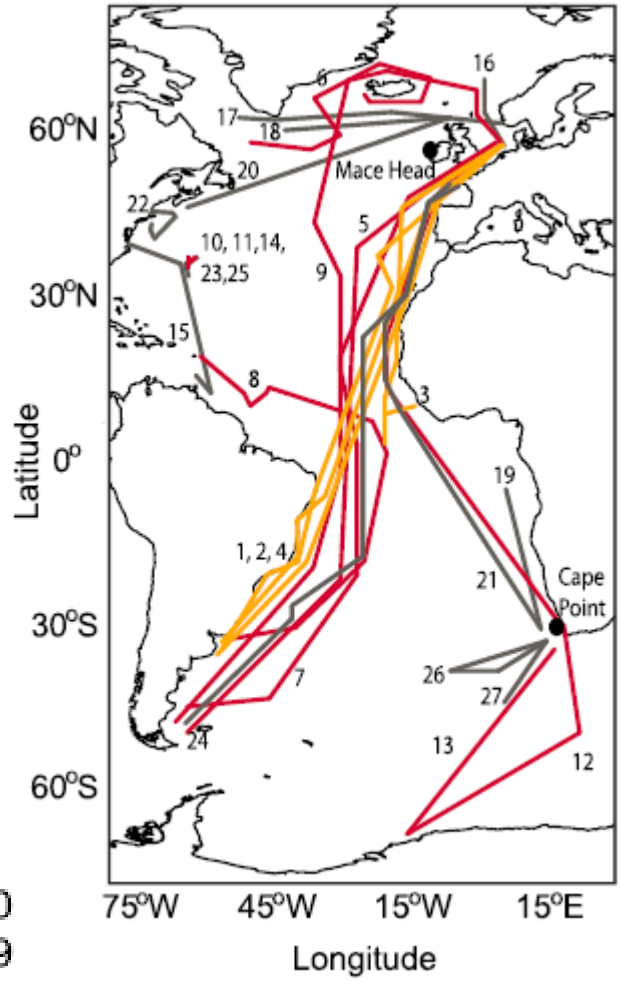
http://www.emep.int/;
http://www.on.ec.gc.ca/natchem/Login/Login.aspx;
http://nadp.sws.uiuc.edu/amn/

Ship cruise and aircraft measurements



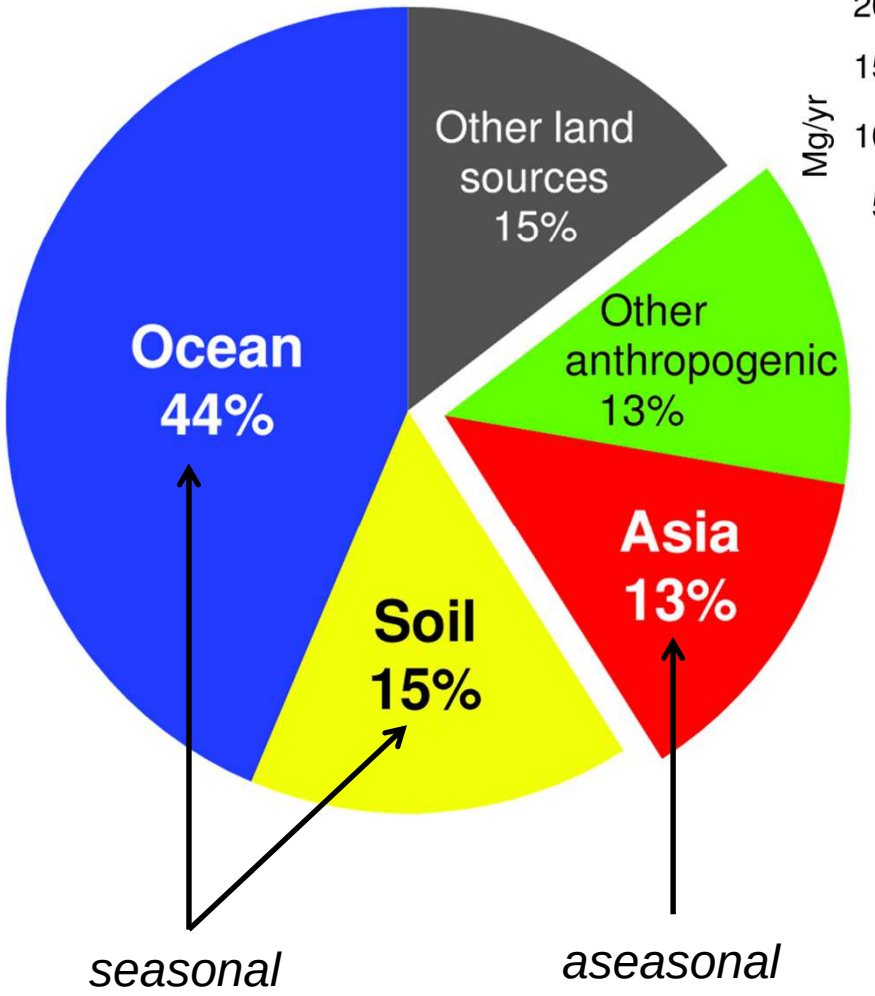
CARIBIC (Dec 2004-): Civil Aircraft for Regular Investigation of the Atmosphere Based on an Instrument Container

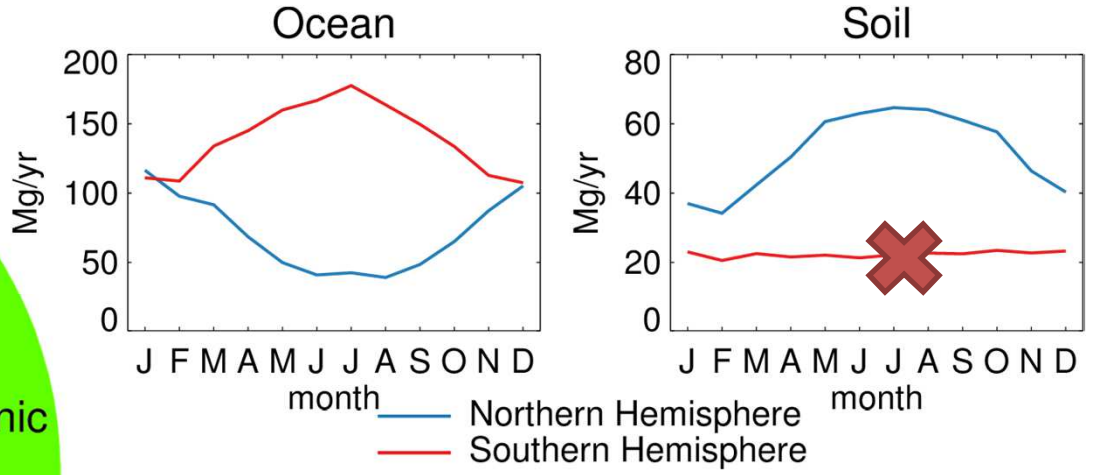
http://www.caribic-atmospheric.com



Soerensen et al., 2012

Reference atmospheric mercury emissions

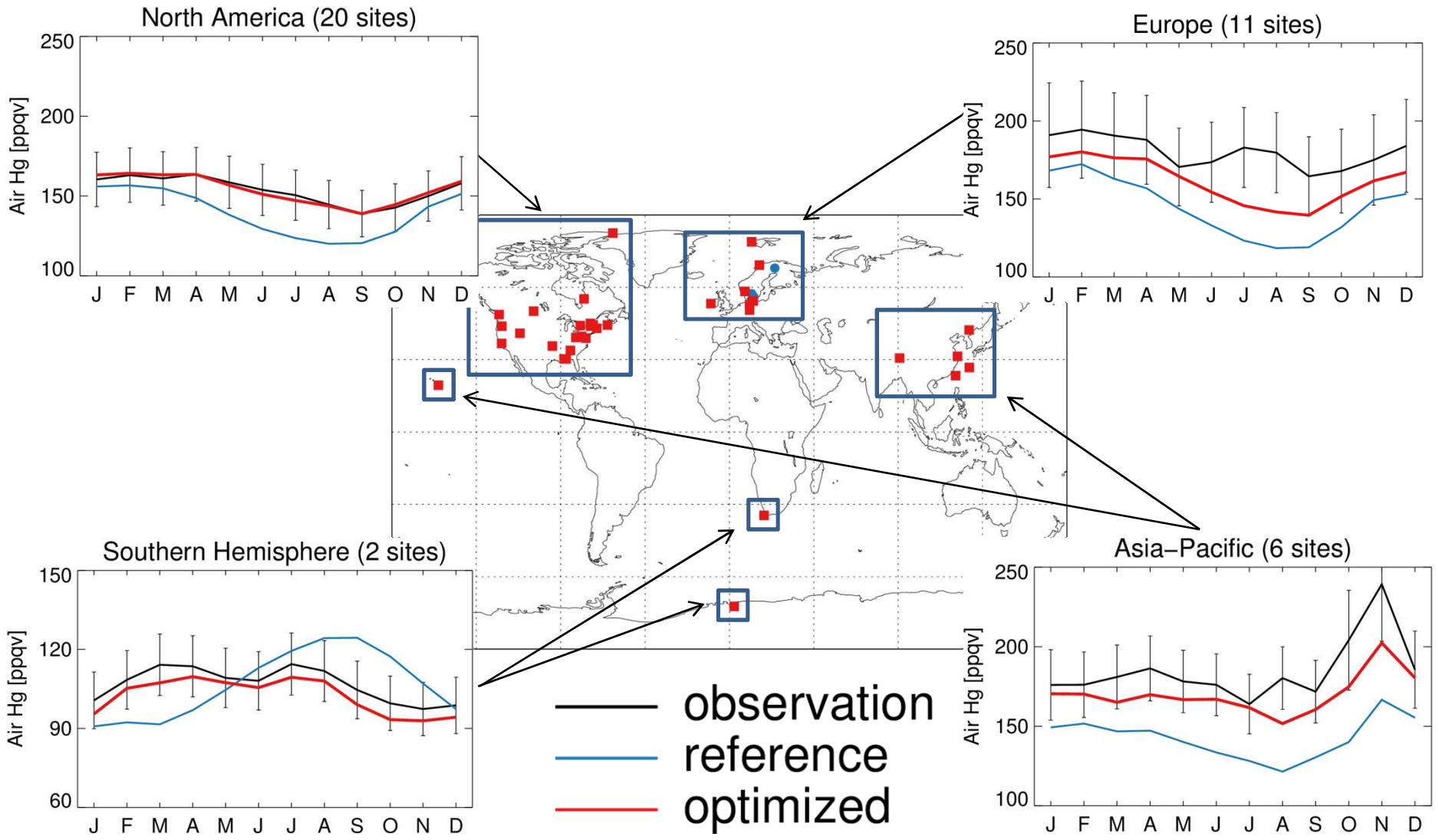




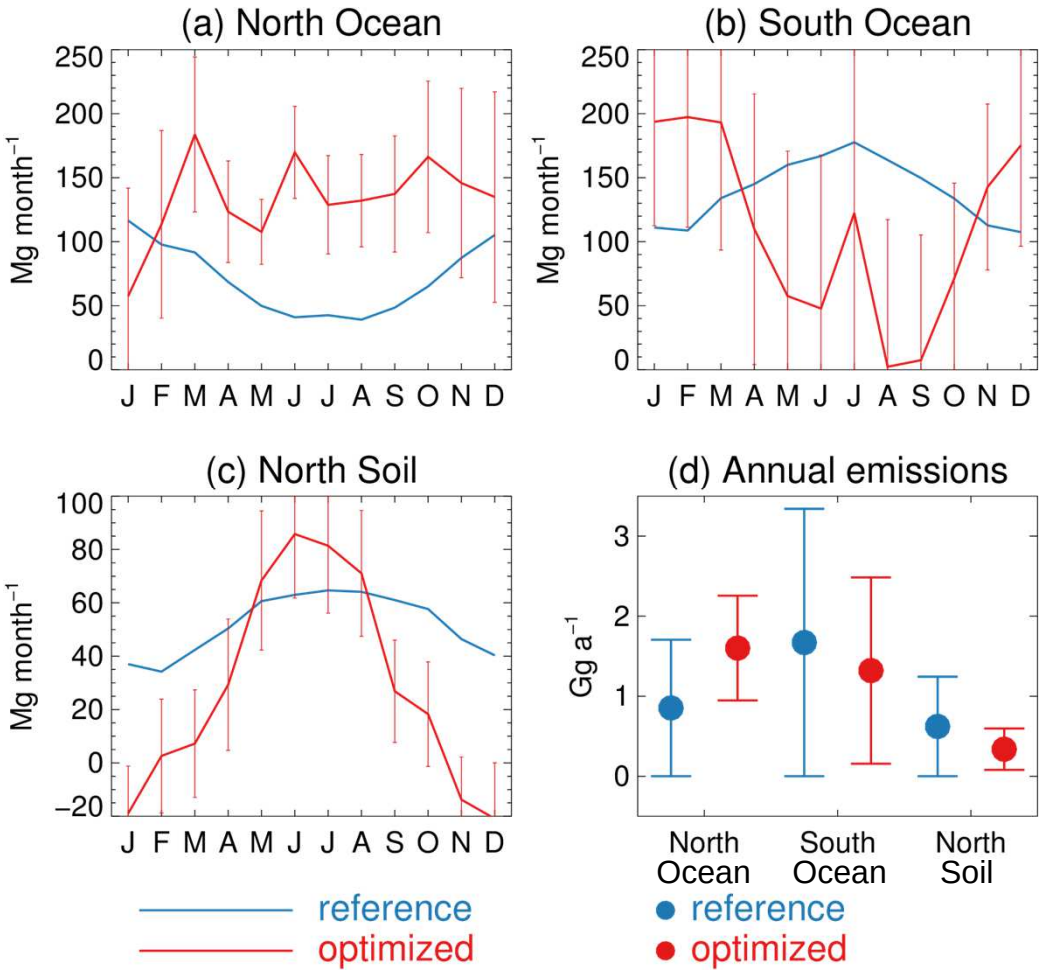
Emissions by source/region	Reference uncertainty (%)
North Ocean	100
South Ocean	100
North Soil	100
Asia	100

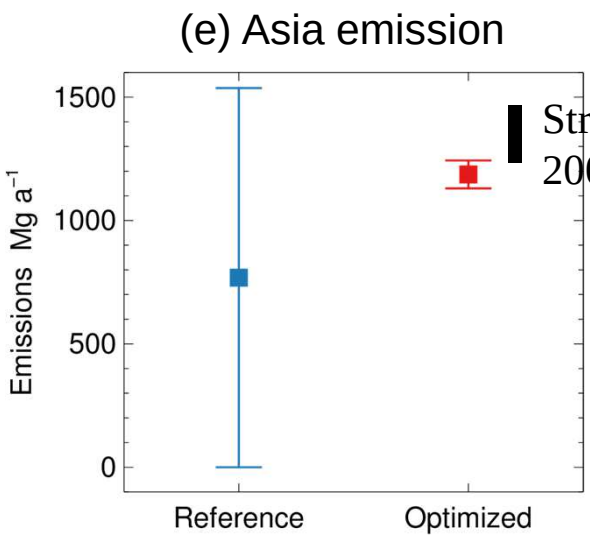
GEOS-Chem version 9-01-03
2^{o}x2.5^{o} horizontal resolution, 47 vertical layers
Emission inventory 2010v1 from UNEP, 2013
Time period: 2009-2011

Model-Observation comparison



Optimized emissions

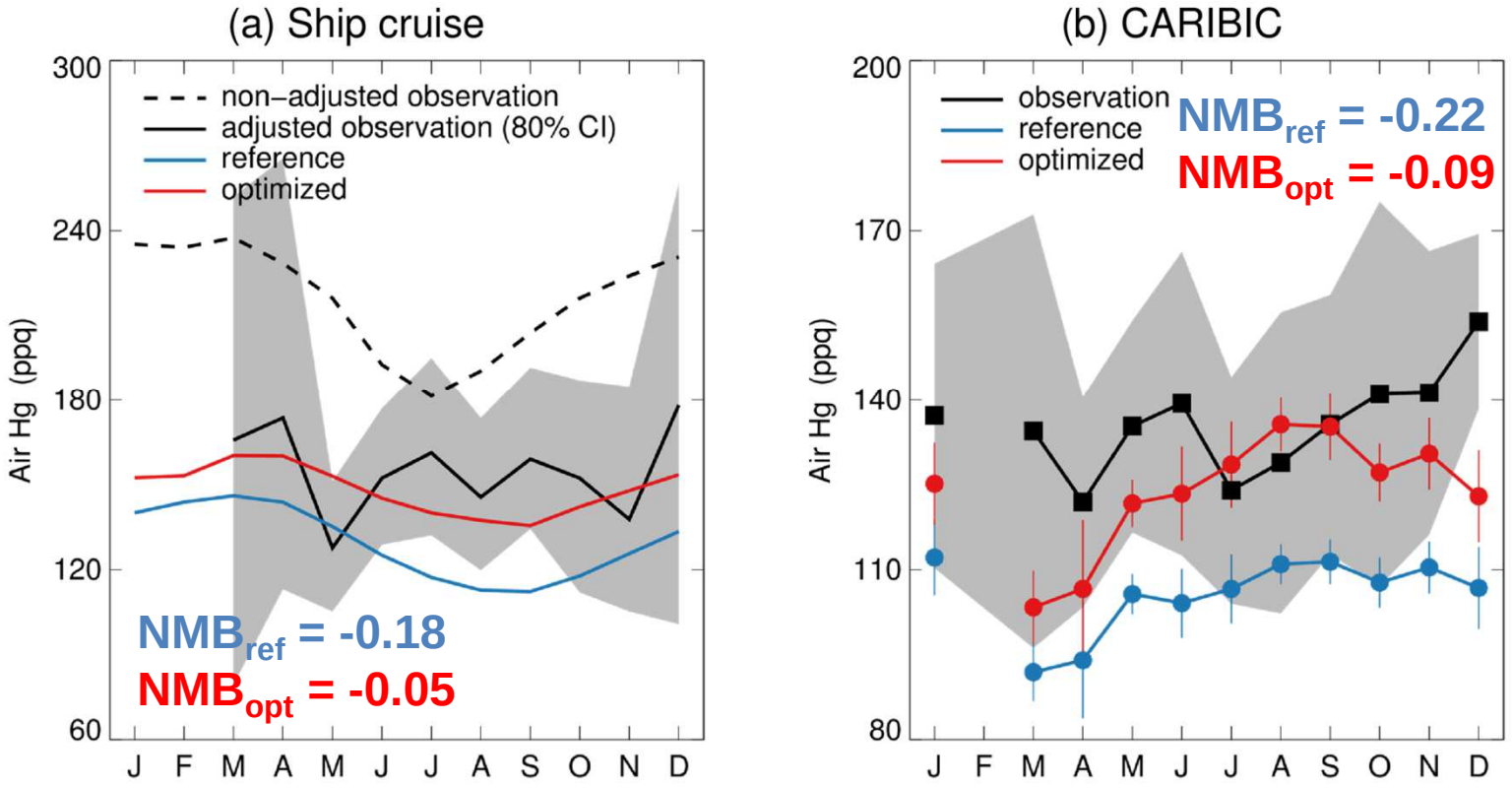




- The optimized Asia emission was ~ 54% higher than the reference, similar to that by Strode et al. (2008).

- The average uncertainties are reduced from 100% to ~ 64%.
- Significant changes in the seasonality of ocean and soil emissions.

Independent tests of the inversion



- The North Atlantic Ocean region was selected for both data sets.
- Independent data sets from ship cruise and aircraft measurements were better reproduced using optimized emissions.

Ship cruise data source: Soerensen et al., 2010a; Soerensen et al., 2012

Acknowledgment

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AMNet (Atmospheric Mercury Network)
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Thanks for your attention!

Any questions?