Modelling the Long Range Transport of Toxic Substances to the Great Lakes: 10-Years of Progress and Next Steps

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LRT Challenge

- Assess atmospheric inputs of strategy substances to the Great Lakes. The aim of this effort is to evaluate and report jointly on the contribution and significance of long-range transport of strategy substances from world-wide sources. If ongoing long-range sources are confirmed, work within international frameworks to reduce releases of such substances.

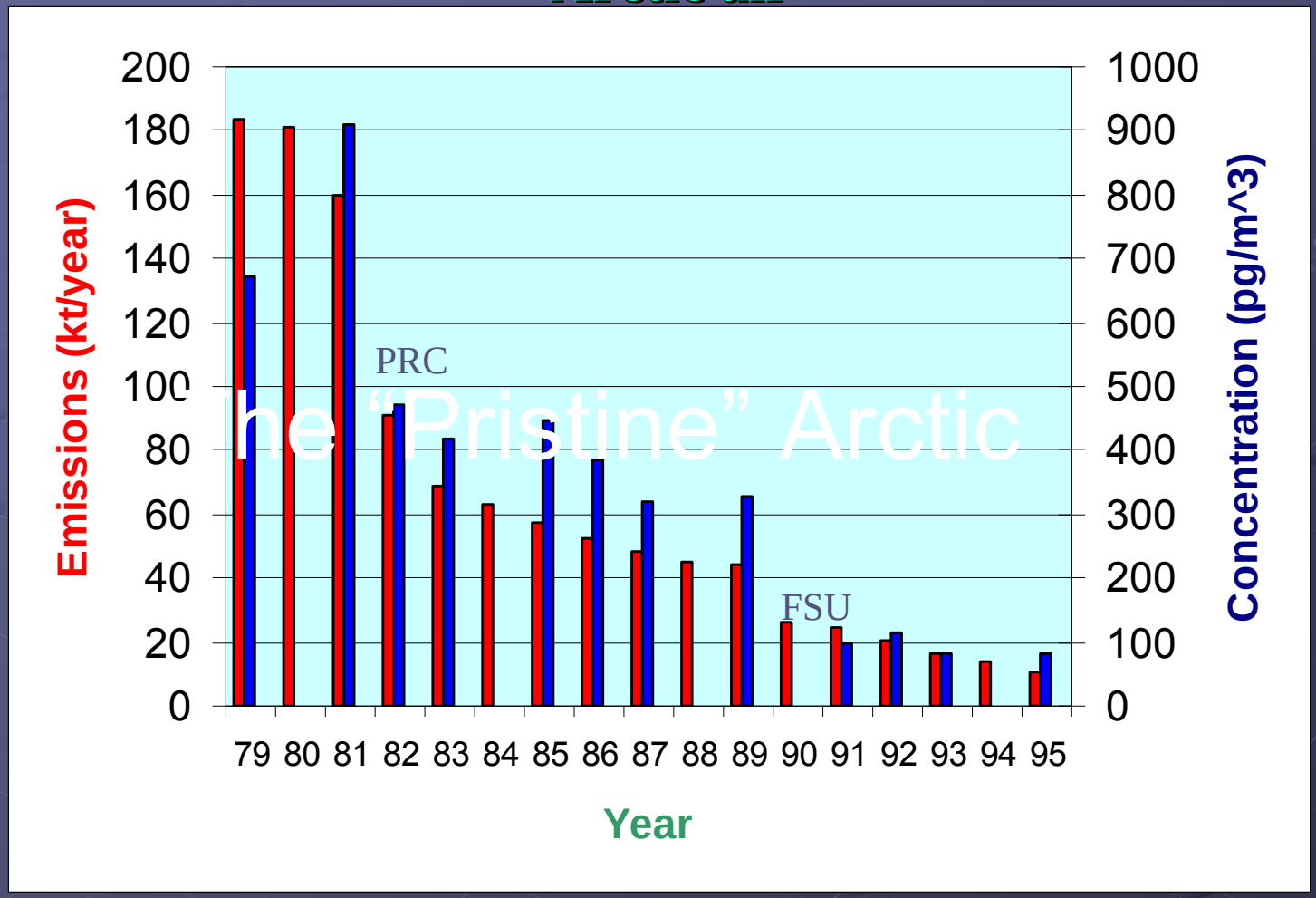
Questions to Answer

- How do we know that LRT affects the GL region?
- What substances have we modelled and what can we say about them?
- How good are our capabilities in Regional and/or Global modelling of LRT?
- How has modelling helped - in our understanding and in policy-making?
- Where do we go from here?

Does LRT affect the GL region?

α-HCH Story: Pathways

Global emissions of α-HCH and its concentrations in Arctic air



Source: Li et al., 1998, 2000

What substances have we modelled and what can we say about them?

- α-HCH, Lindane (pesticides),
- Toxaphene (pesticide),
- Endosulfan (CUP), DDT
- HCB (Industrial, pesticides, …),

- PCB (Commercial chemical)

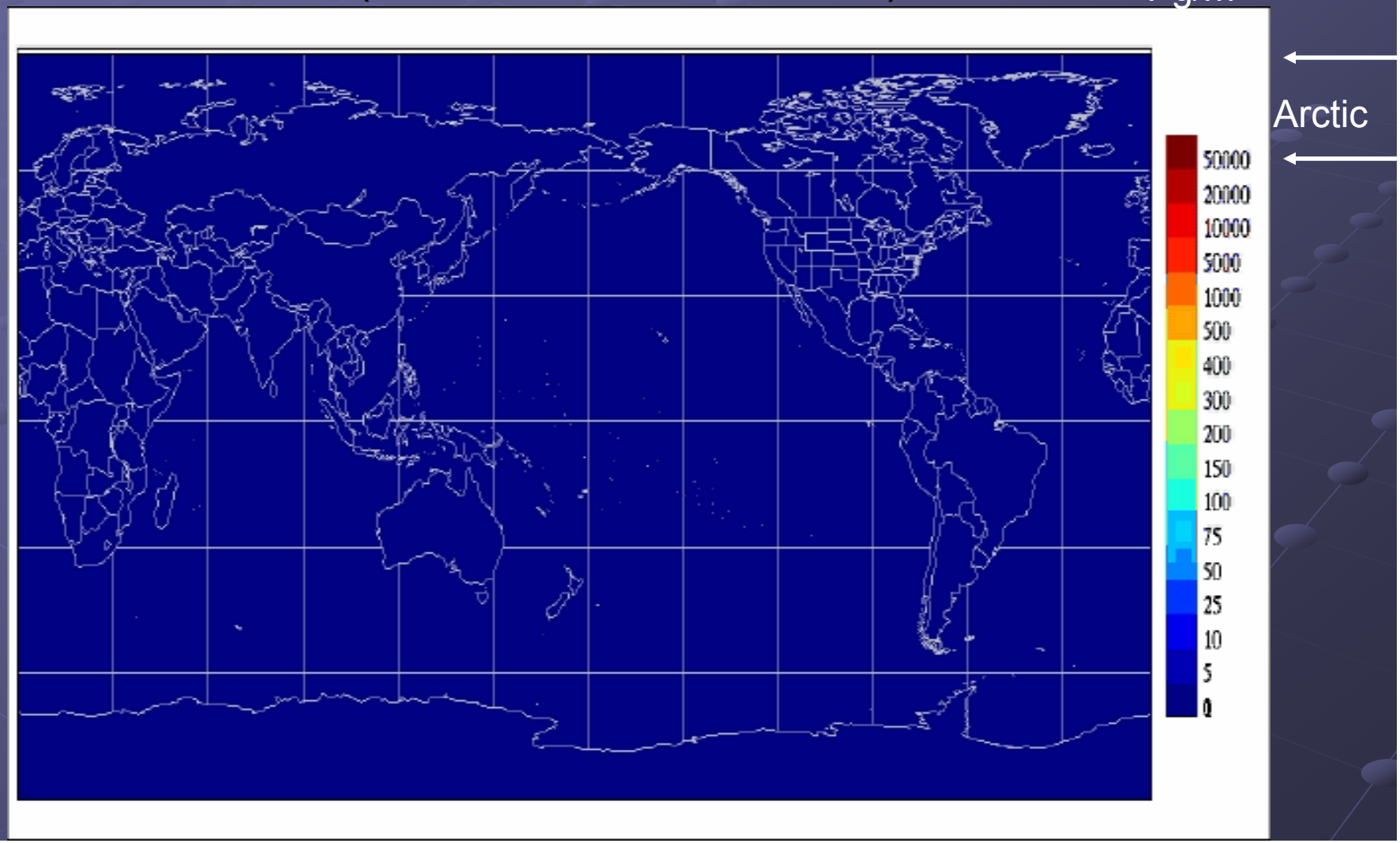
- Hg (Electricity generation),

The late 1990s

Multi-compartment Environmental DIagnostics and Assessment (MEDIA)

A Global model for α-HCH

(Jan 1993 to June 1994)



Global model for α-HCH Multi-compartment Environmental Diagnostics and Assessment (MEDIA)

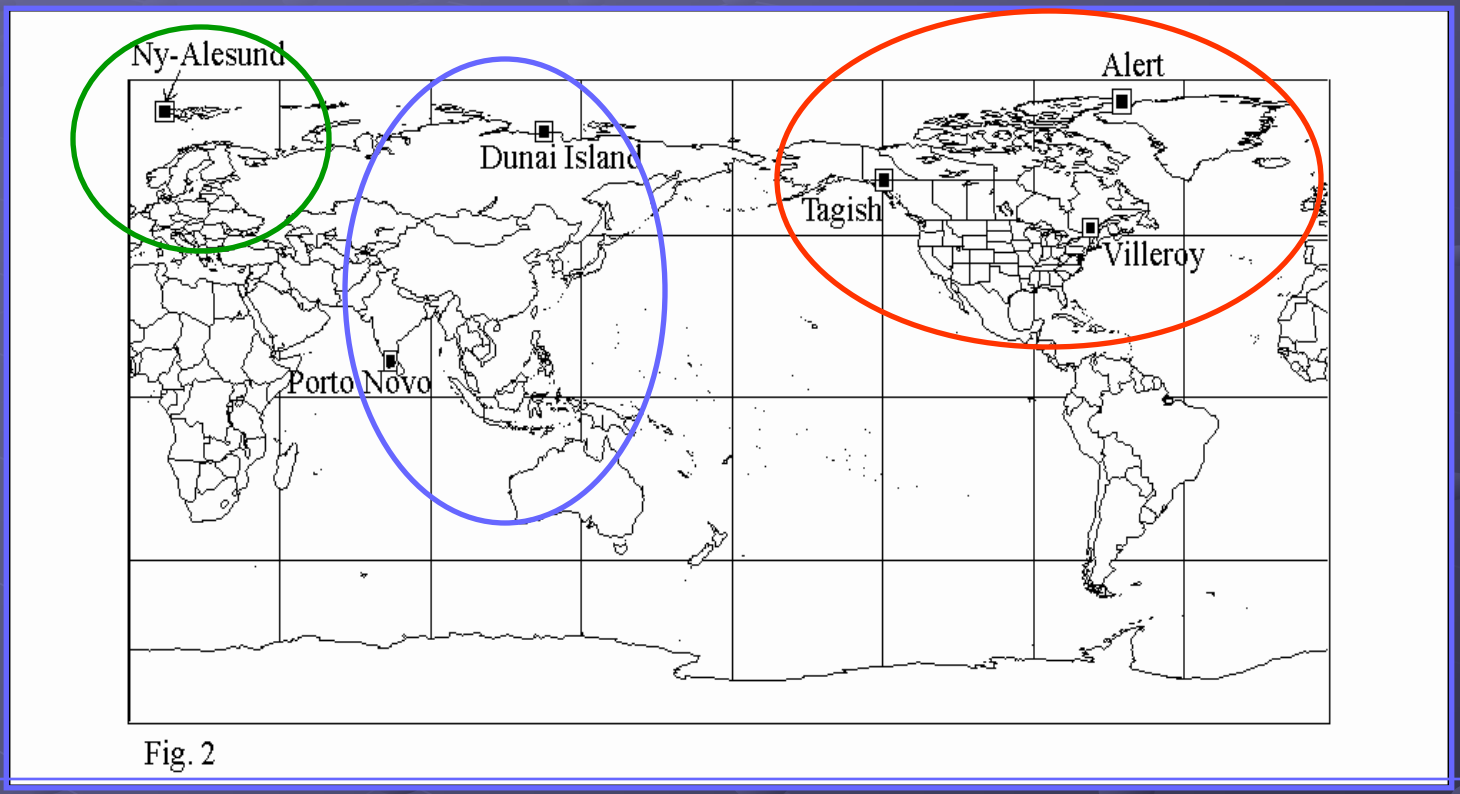
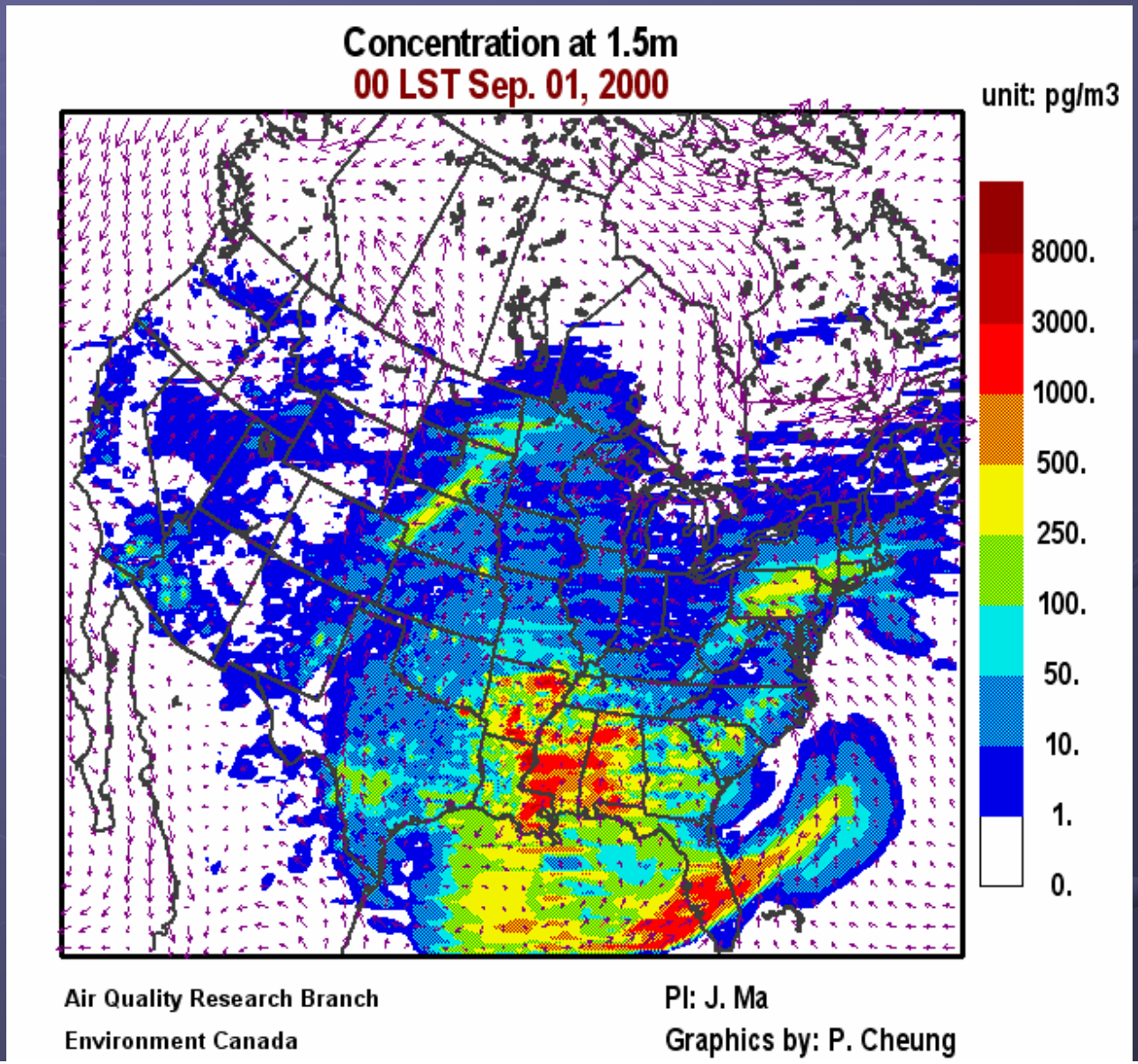


Fig. 2

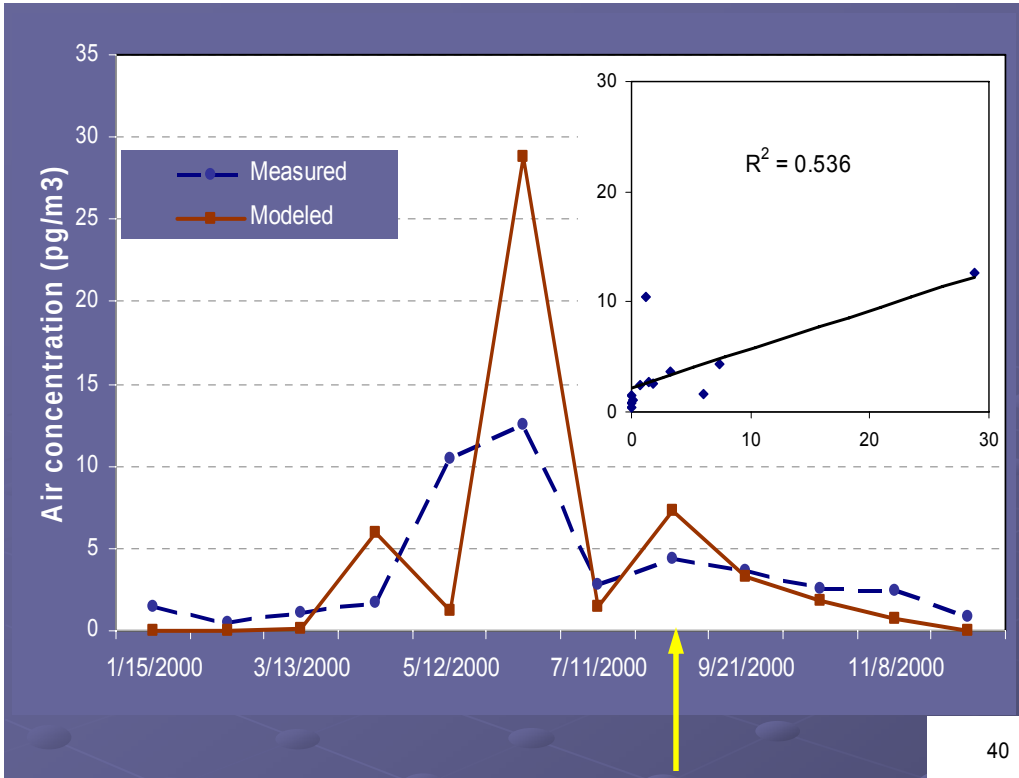
- Model Evaluation: Model is able to capture both trends and short term components in the observed time series

The early 2000s

LRT of Lindane and Toxaphene
Canadian Model for the Environmental Transport of Oragnochlorine Pesticides (CanMETOP)

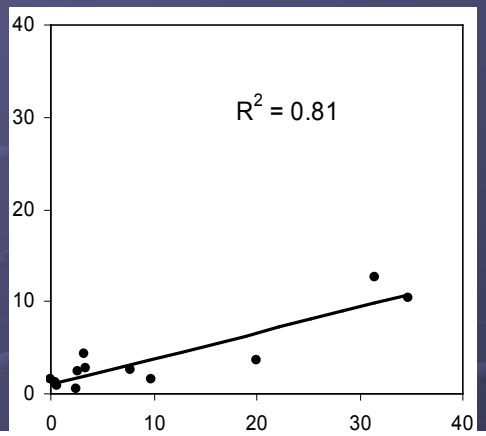


Model Evaluation with IADN data



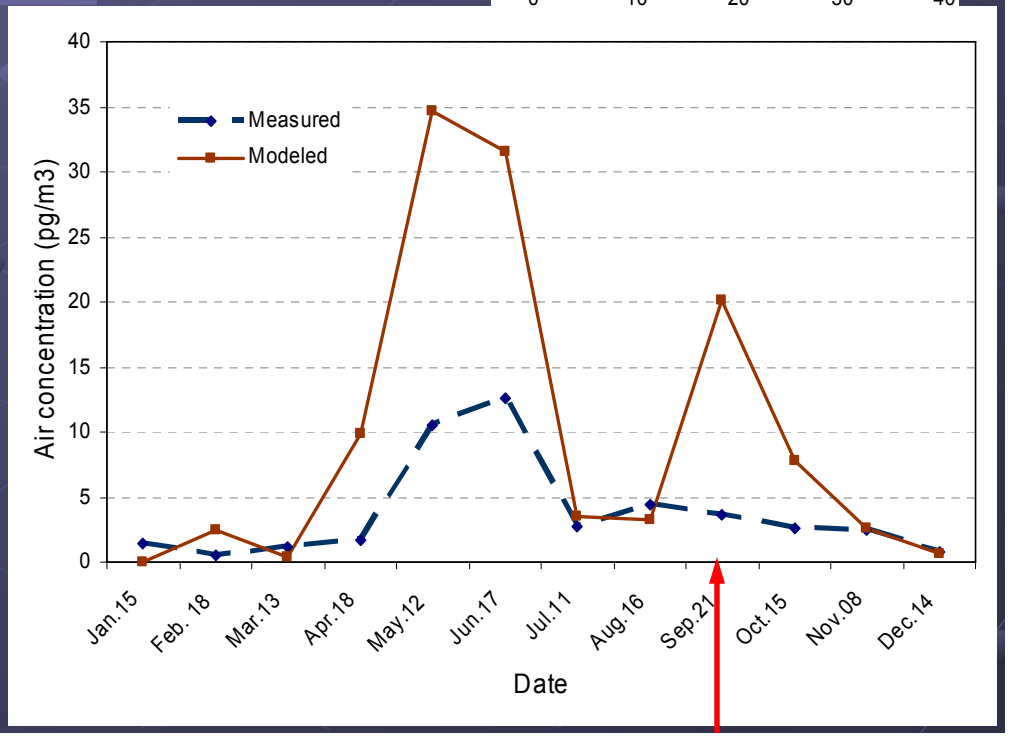
Daily

Unit: pg m^{-3}



3 days

Comparison between modeled and measured air concentration at Point Petre (Lake Ontario)

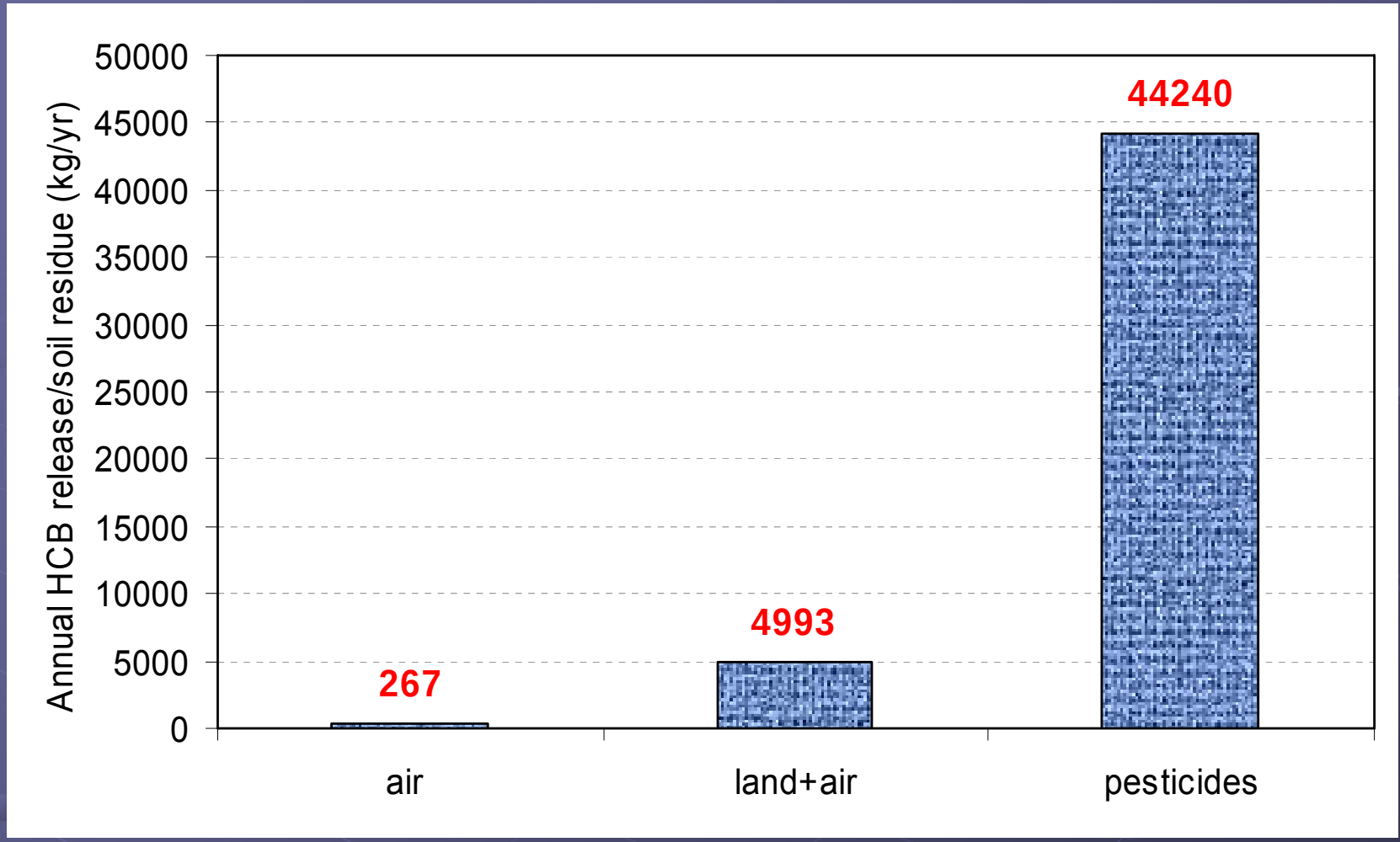


Mean concentration (pg m^{-3}) in June 2000:

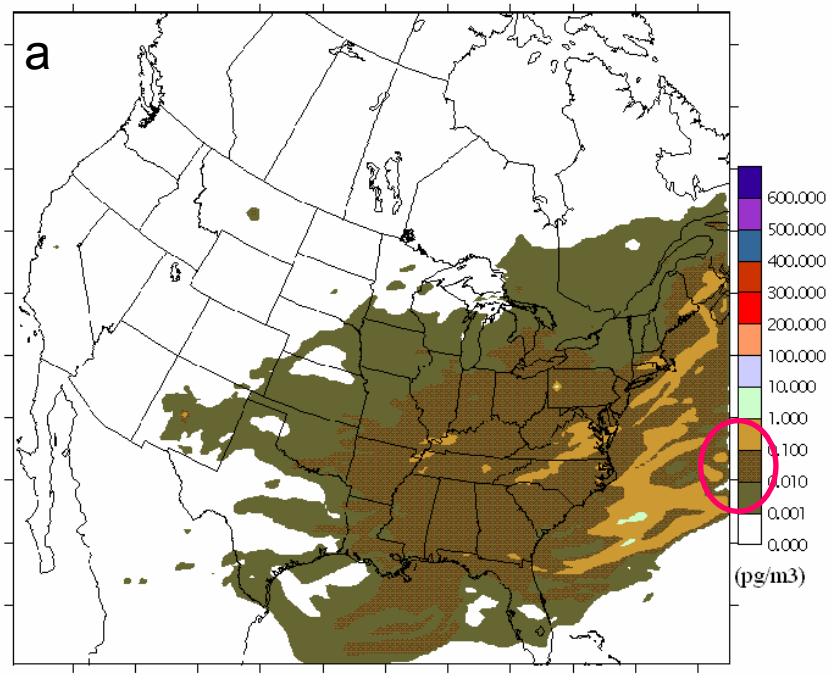
- **Lake Ontario (ship): 25±20**
- **Model: 15 (averaged over Lake Ontario)**
- **Point Petre: ~10**

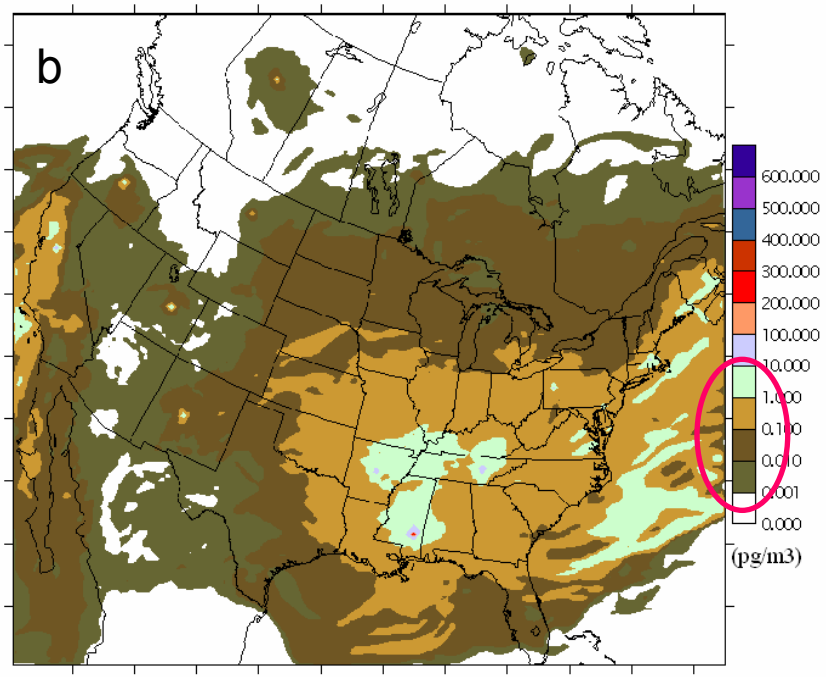
2006 – 2007

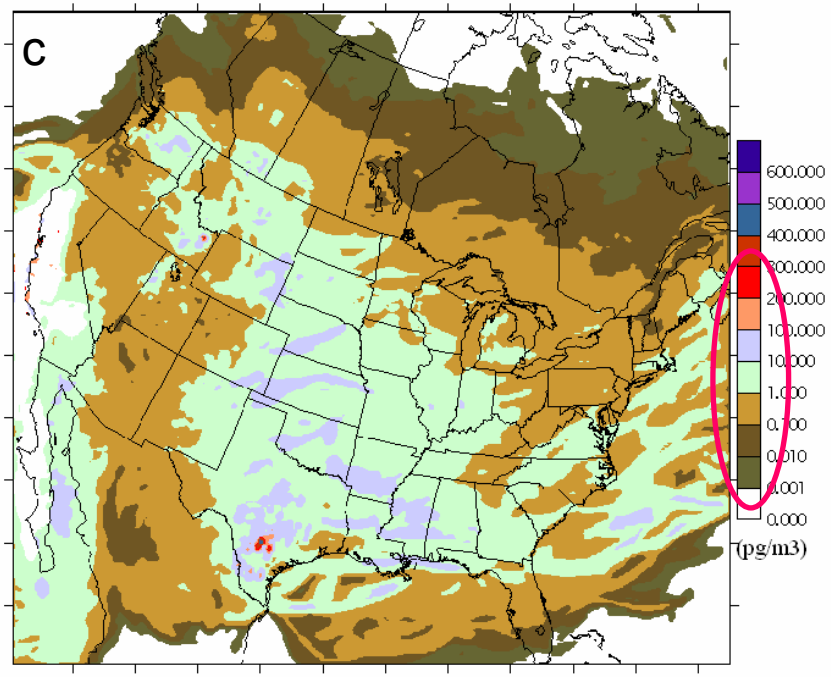
HCB



Annual air/land release of HCB in the US from USEPA Toxics Release Inventory (TRI) database and estimated HCB residue in soil in the US in 2001 from historical pesticides application (as a fungicide, atrazine, dacthal, lindane, Penta-chloro-nitro-benzene…)





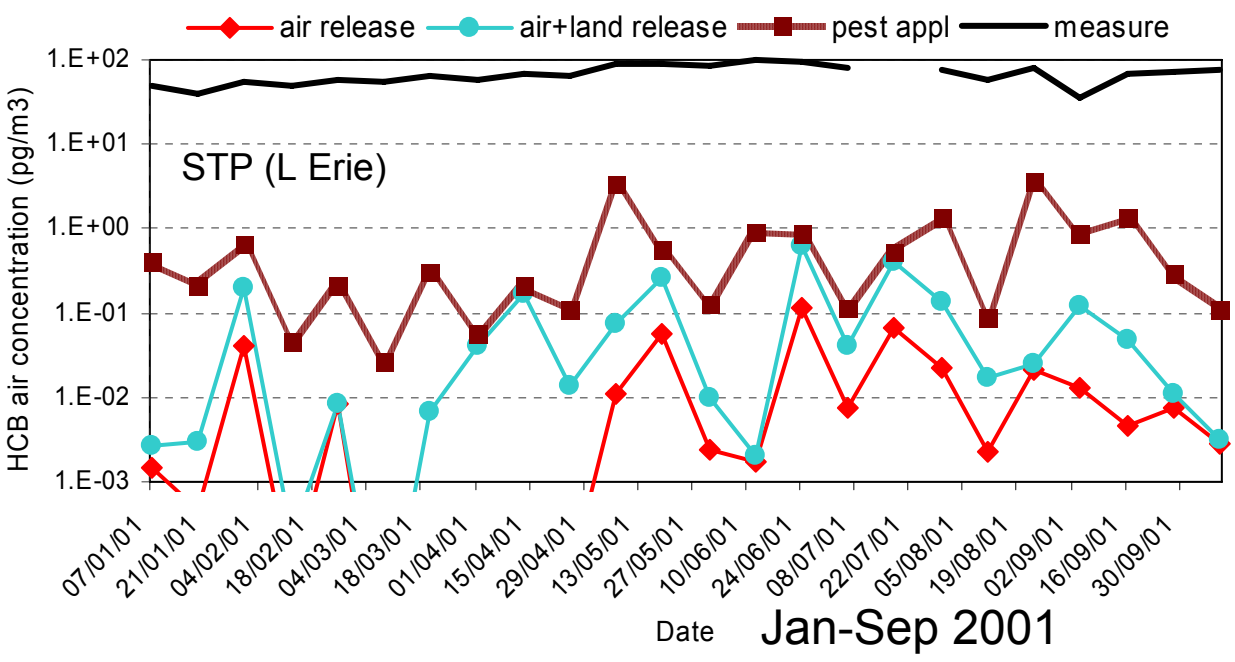


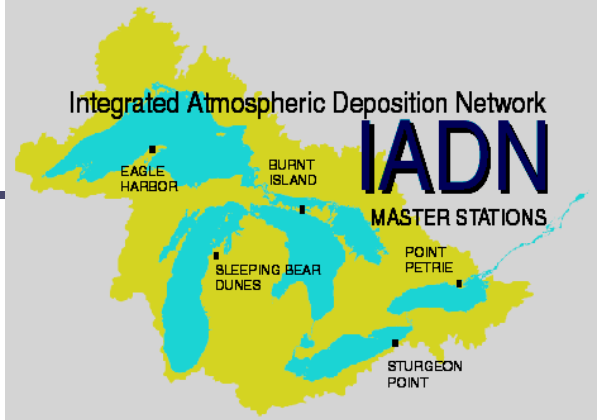
Modeled HCB air concentration at 1.5 m averaged over summer 2001.

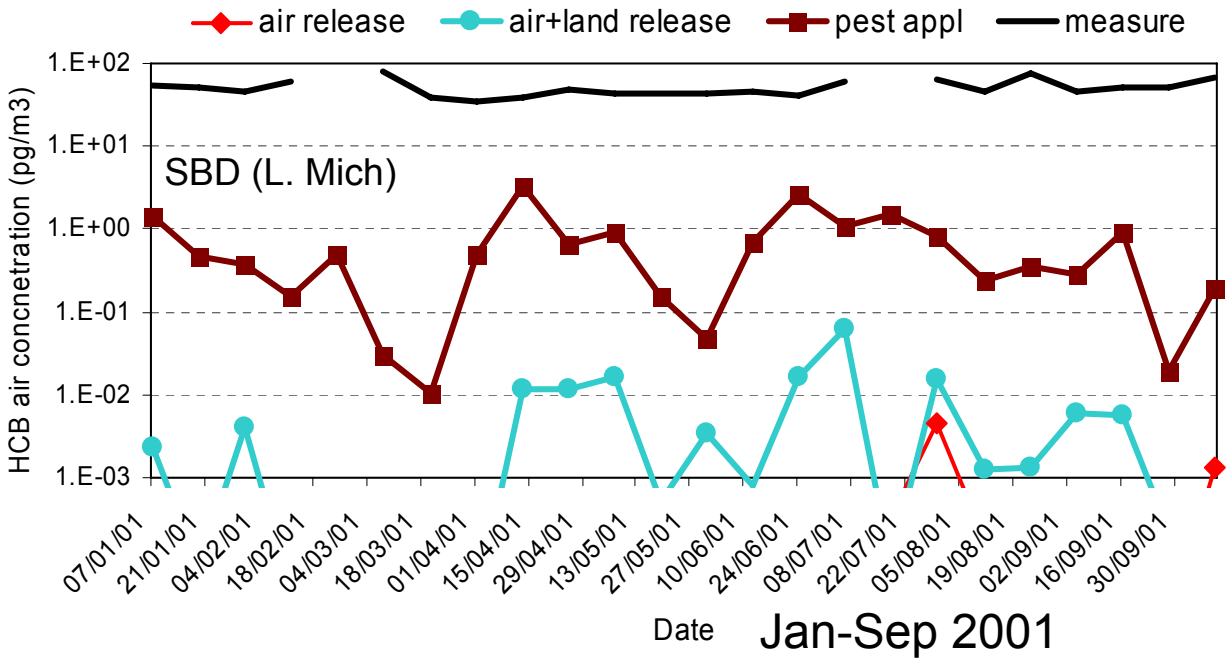
a. **TRI air release**
b. **TRI air and land release**
c. **Soil residues from historical pesticides application**

24 km x 24 km resolution, meteorological data from GEM

LRT HCB


air release
air+land release
pest appl
measure
STP (L Erie)
HCB air concentration (pg/m3)
1.E+02
1.E+01
1.E+00
1.E-01
1.E-02
1.E-03
07/01/01
21/01/01
04/02/01
18/02/01
04/03/01
18/03/01
01/04/01
15/04/01
29/04/01
13/05/01
27/05/01
10/06/01
24/06/01
08/07/01
22/07/01
05/08/01
19/08/01
02/09/01
16/09/01
30/09/01
Date
Jan-Sep 2001


Integrated Atmospheric Deposition Network
IADN
MASTER STATIONS
EAGLE HARBOR
BURNT ISLAND
SLEEPING BEAR DUNES
POINT PETRIE
STURGEON POINT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Date
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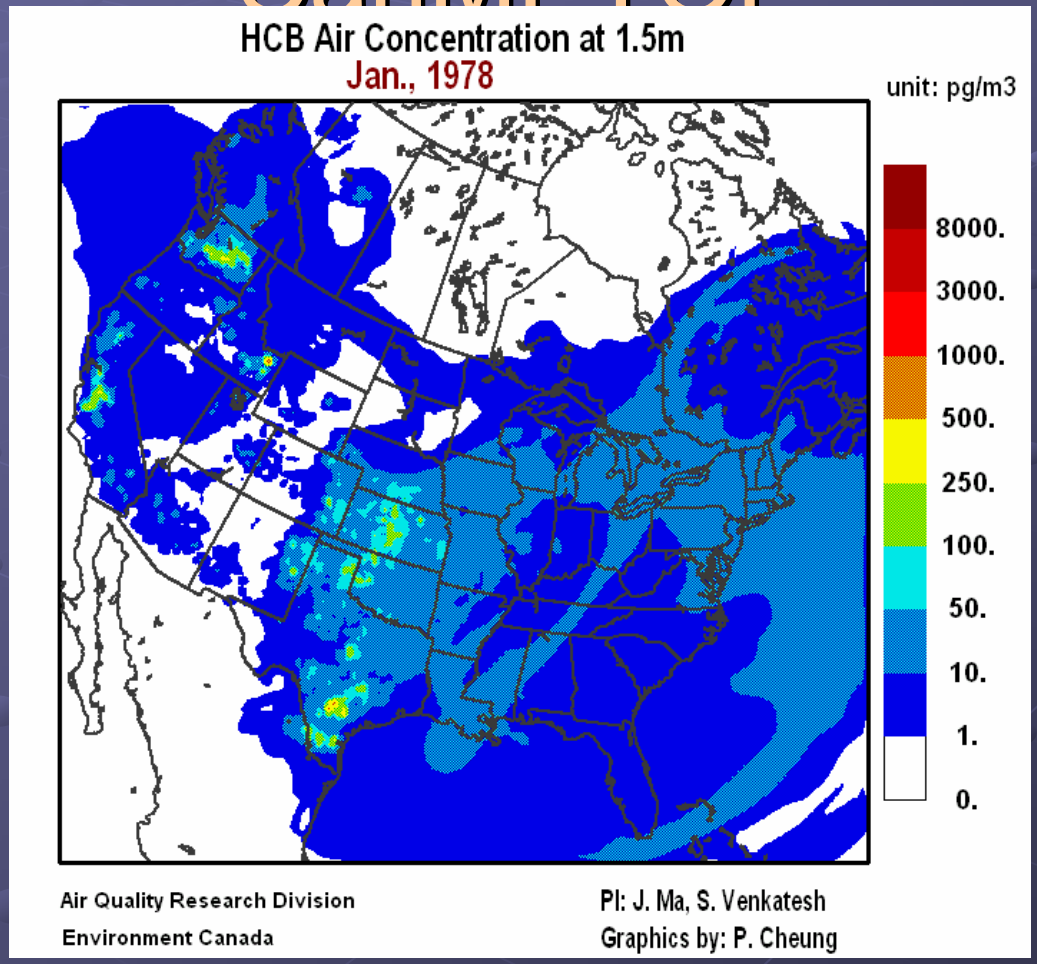
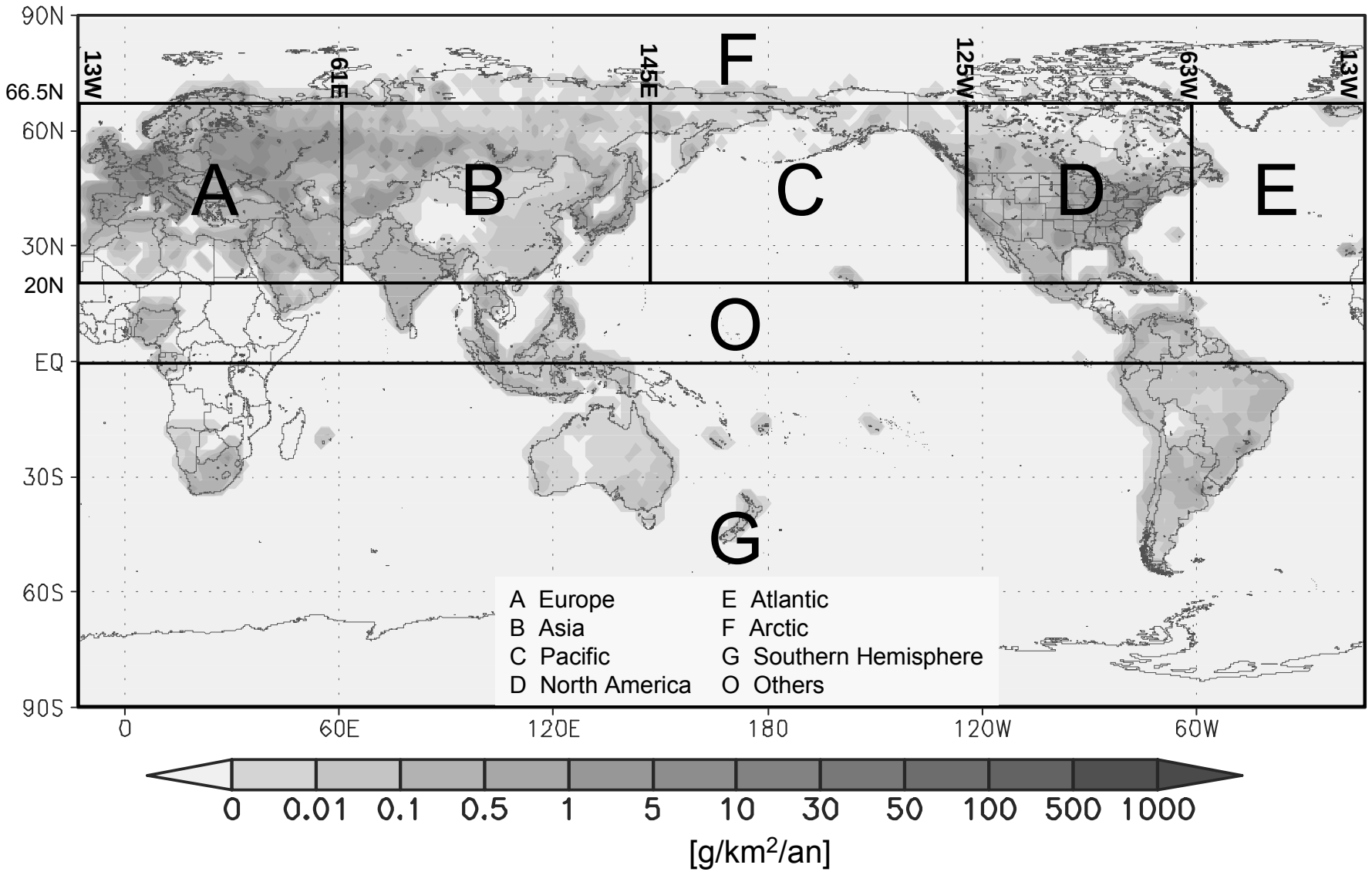
LRT of HCB
20-year Simulations using CanMETOP

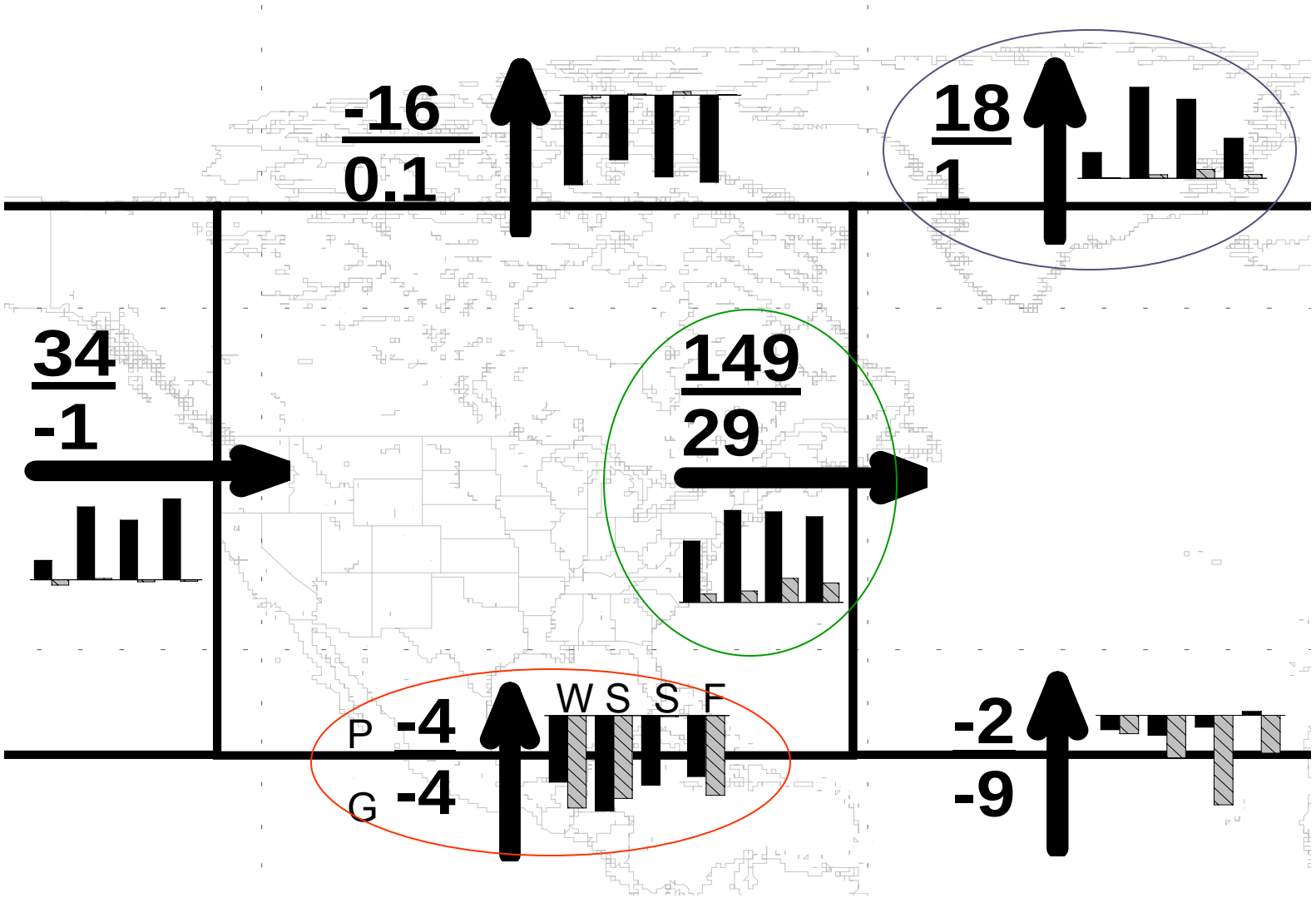


PCB – Global Transport

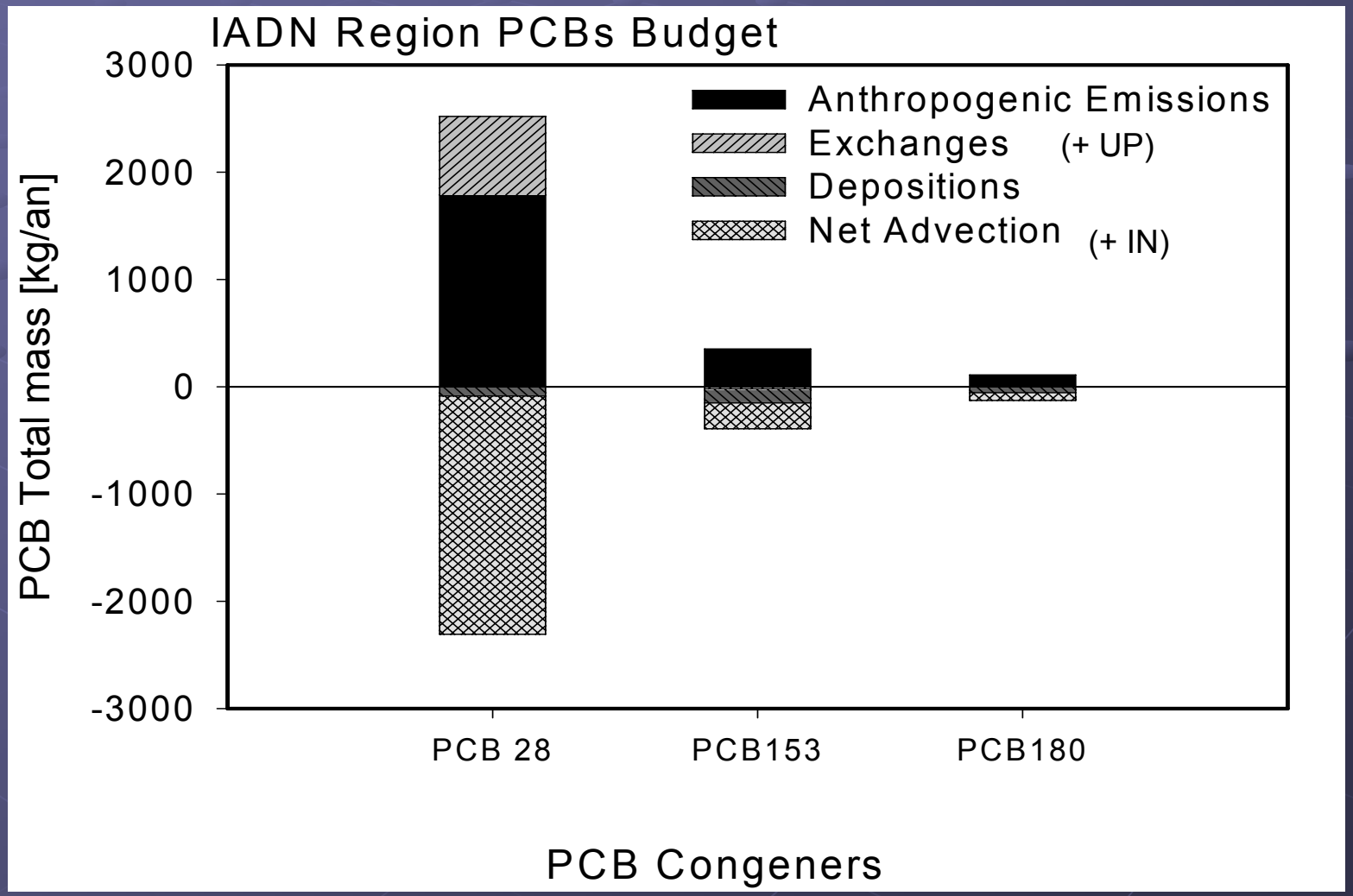
GEM/POPs Global Transport of PCBs - Emissions



Inter-continental transports of PCB180 for North America

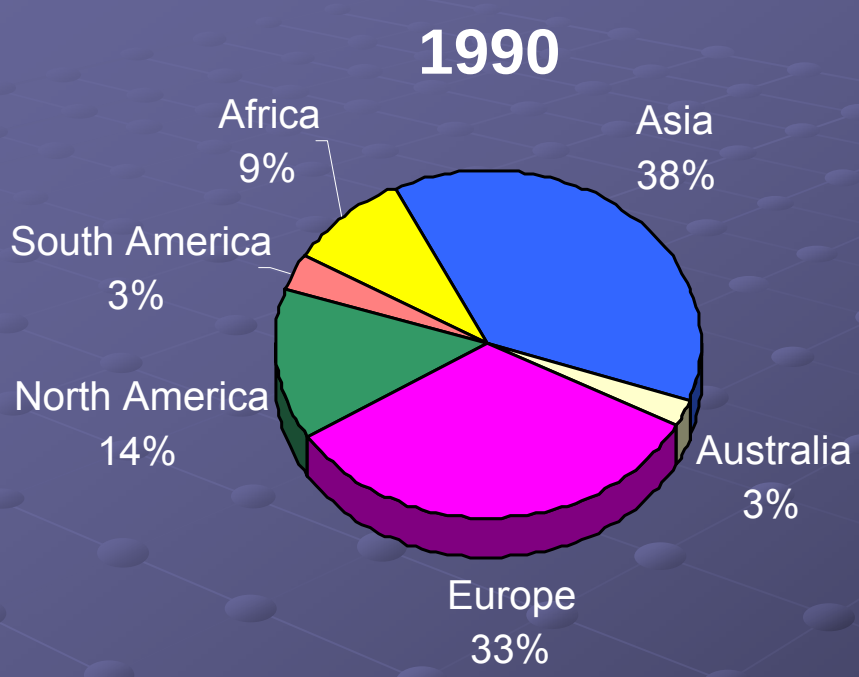


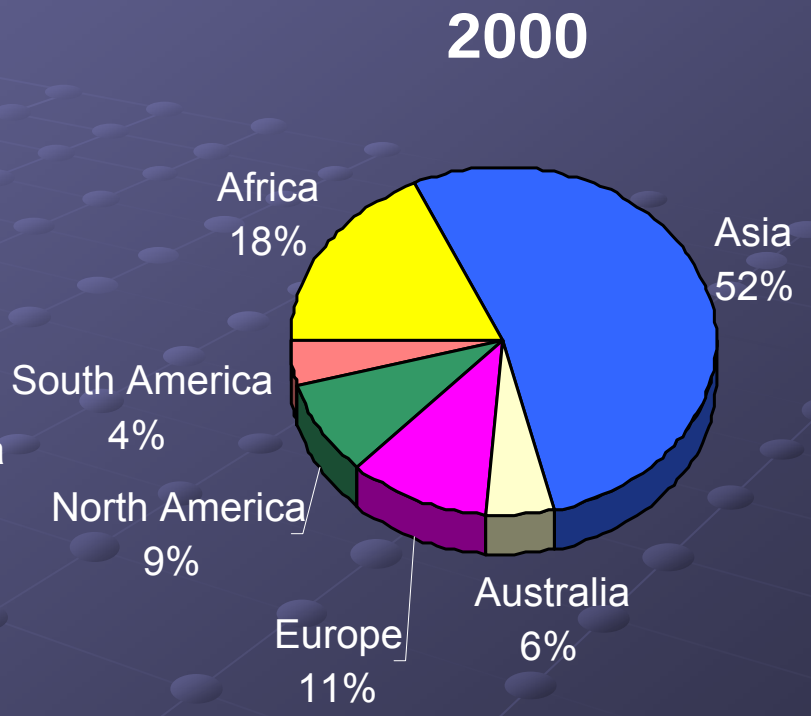
PCB budget for Great Lakes region (76W-90W, 40N-48N)



Mercury – Global Transport

Anthropogenic Air Emissions of Mercury: Distribution by Region in 1990 and 2000





Total: 1,881 metric tons/yr

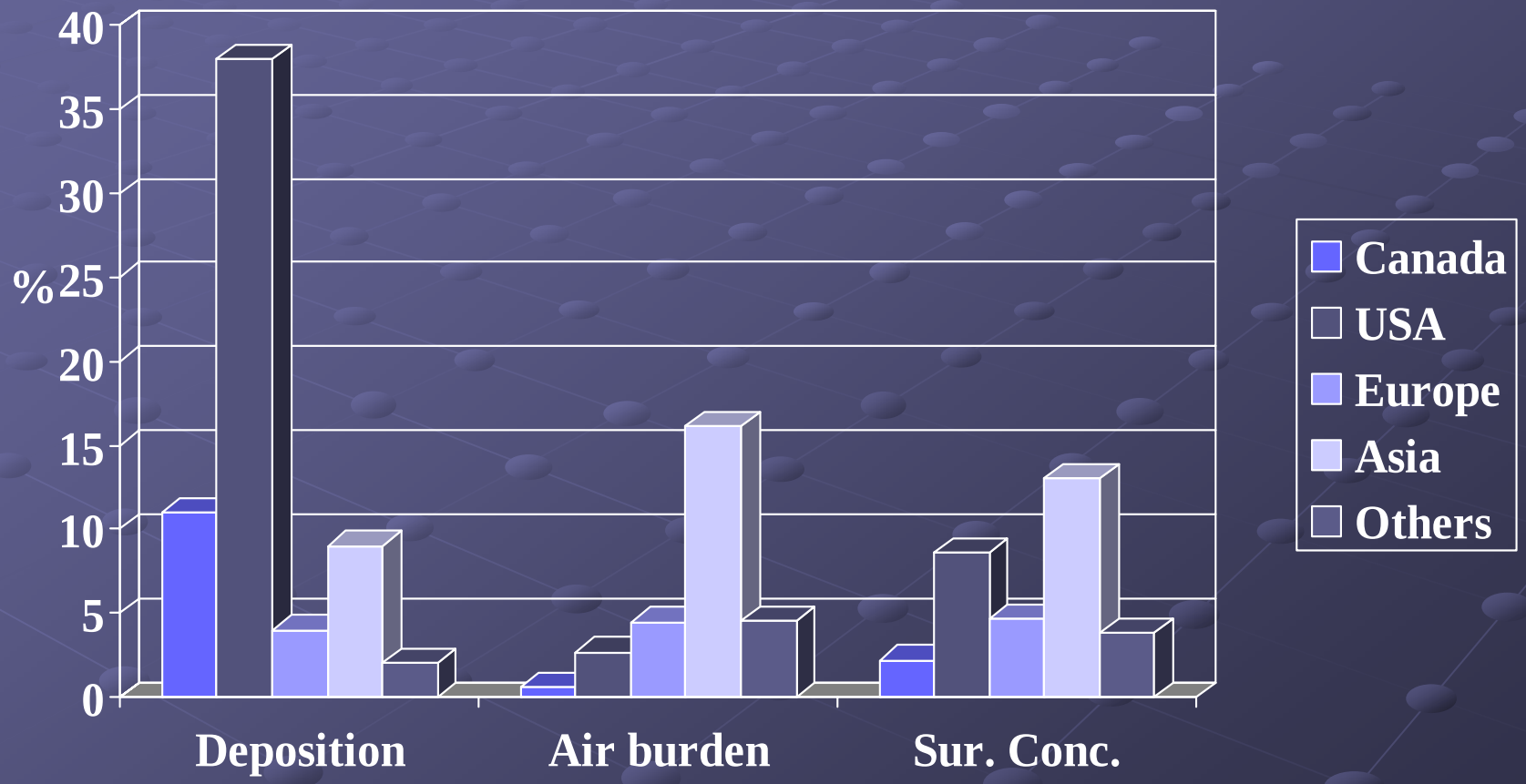
Total: 2,269 metric tons/yr

Asia and Africa account for about 70% of global emissions and show steady, significant increases due to industrialization.

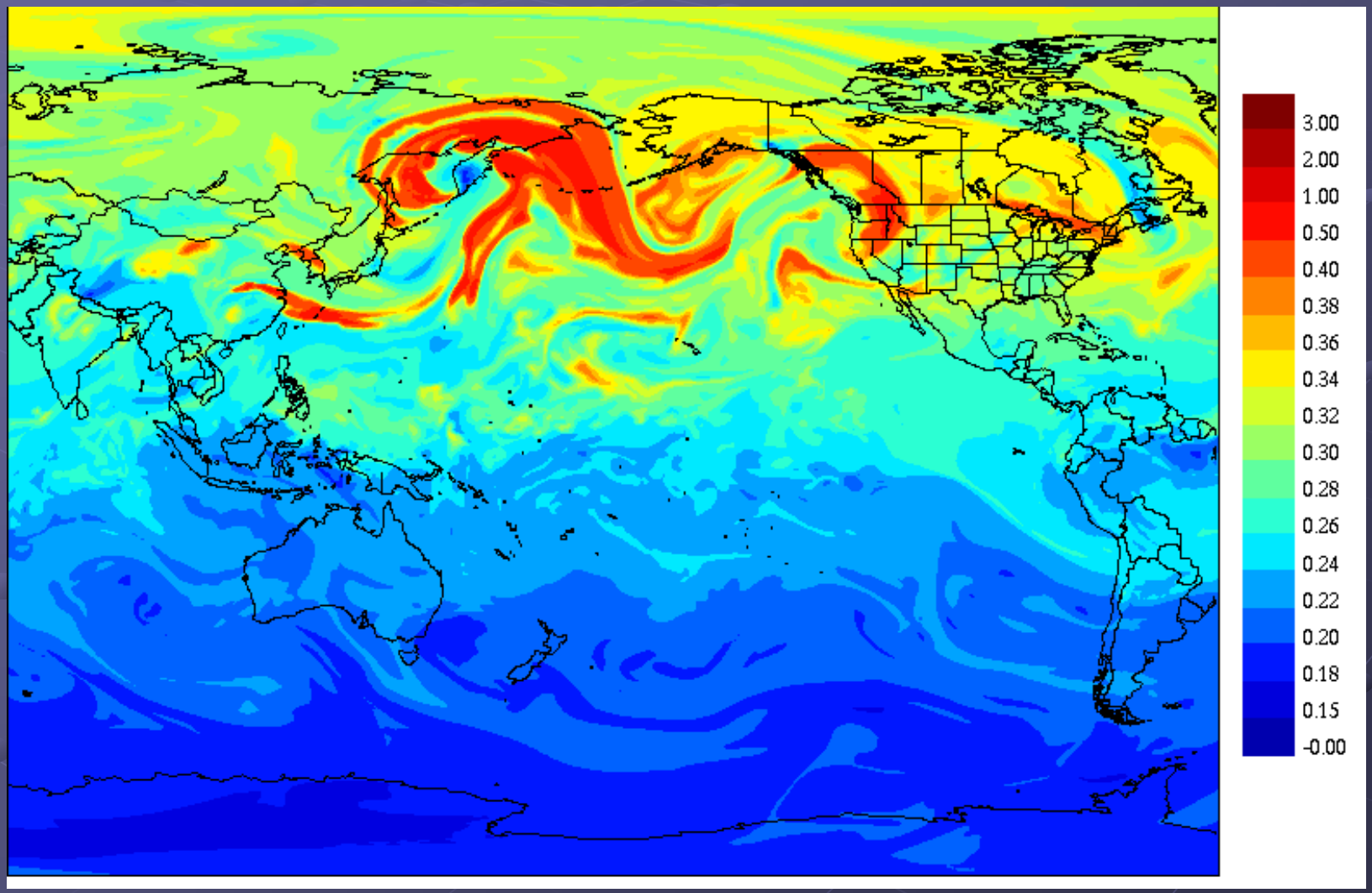
Based on Pacyna, J., Munthe J., Presentation at Workshop on Mercury: Brussels, March 29-30, 2004

Slide courtesy Grace Howland, Air Pollution Prevention Directorate, Environment Canada

Annual average contributions to the Great Lakes from 1995 Anthropogenic emissions

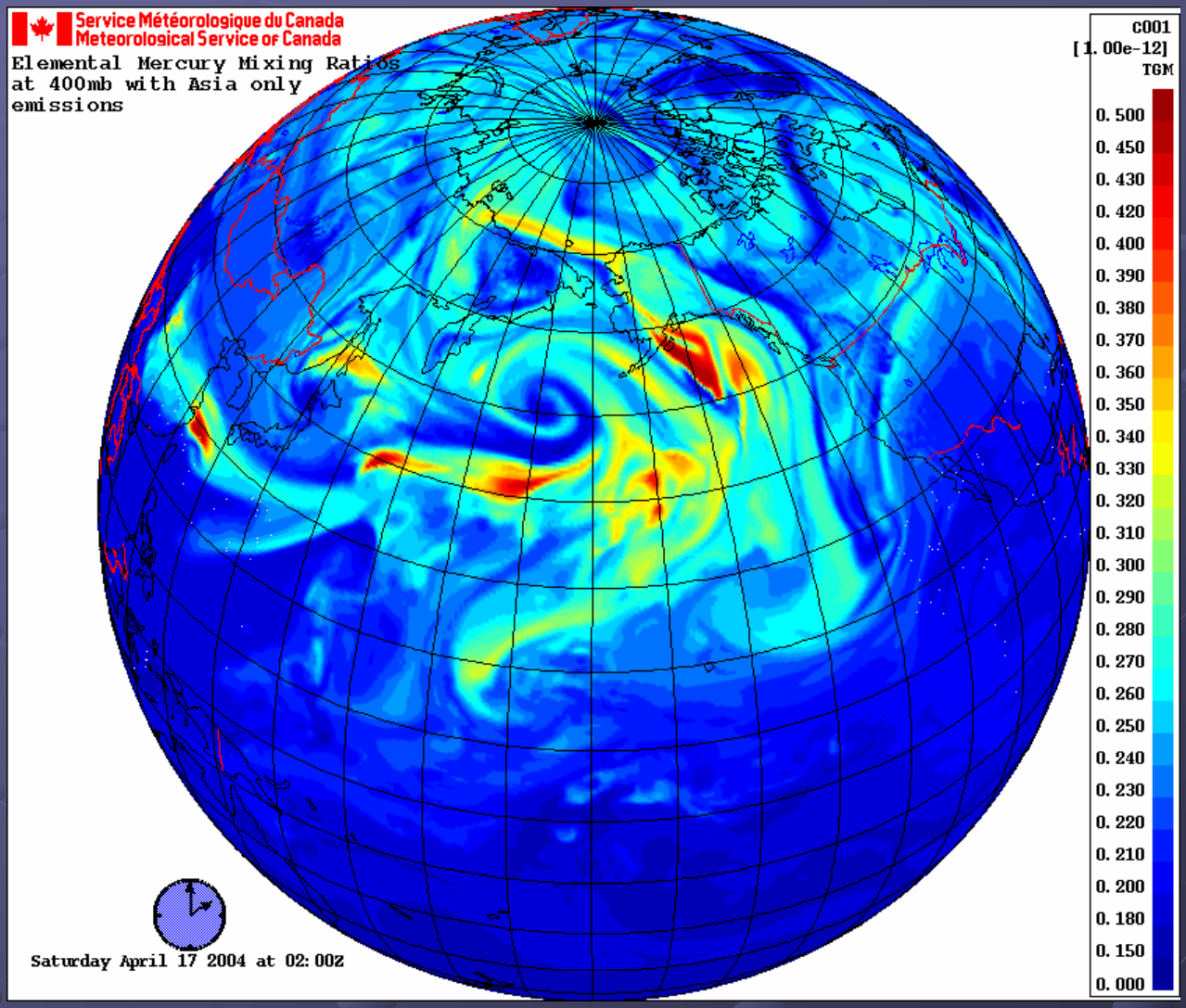


GRAHM air concentrations of mercury (ng/m3) at 00Z on April 25, 2004 at 500mb showing an episode of Asian outflow of mercury reaching N. America and which was observed at Mt. Bachelor in central Oregon



Mercury Episode Animation

(00Z on April 25, 2004 at 500mb)



Where do we go from here?

- Enhanced global inventories and modelling
  - Lindane, PCB
  - Greater focus on CUPs
  - International model inter-comparisons
    - Hg, POPs (global, NA)
- What Questions do the policy-makers want answered?
- Work within Int'l frameworks

Canada-USA-China Joint Lindane Project

- Financially supported by
  - Environment Canada
  - US EPA
  - The North America Commission for Environmental Cooperation (CEC)
  - Harbin Institute of Technology, China
    - (Peking University, China)

LRT Challenge – Status (2007)

- Assess atmospheric inputs of strategy substances to the Great Lakes. The aim of this effort is to evaluate and report jointly on the contribution and significance of long-range transport of strategy substances from world-wide sources. If ongoing long-range sources are confirmed, work within international frameworks to reduce releases of such substances.