Long-Range Transport of Toxic Substances to the Great Lakes

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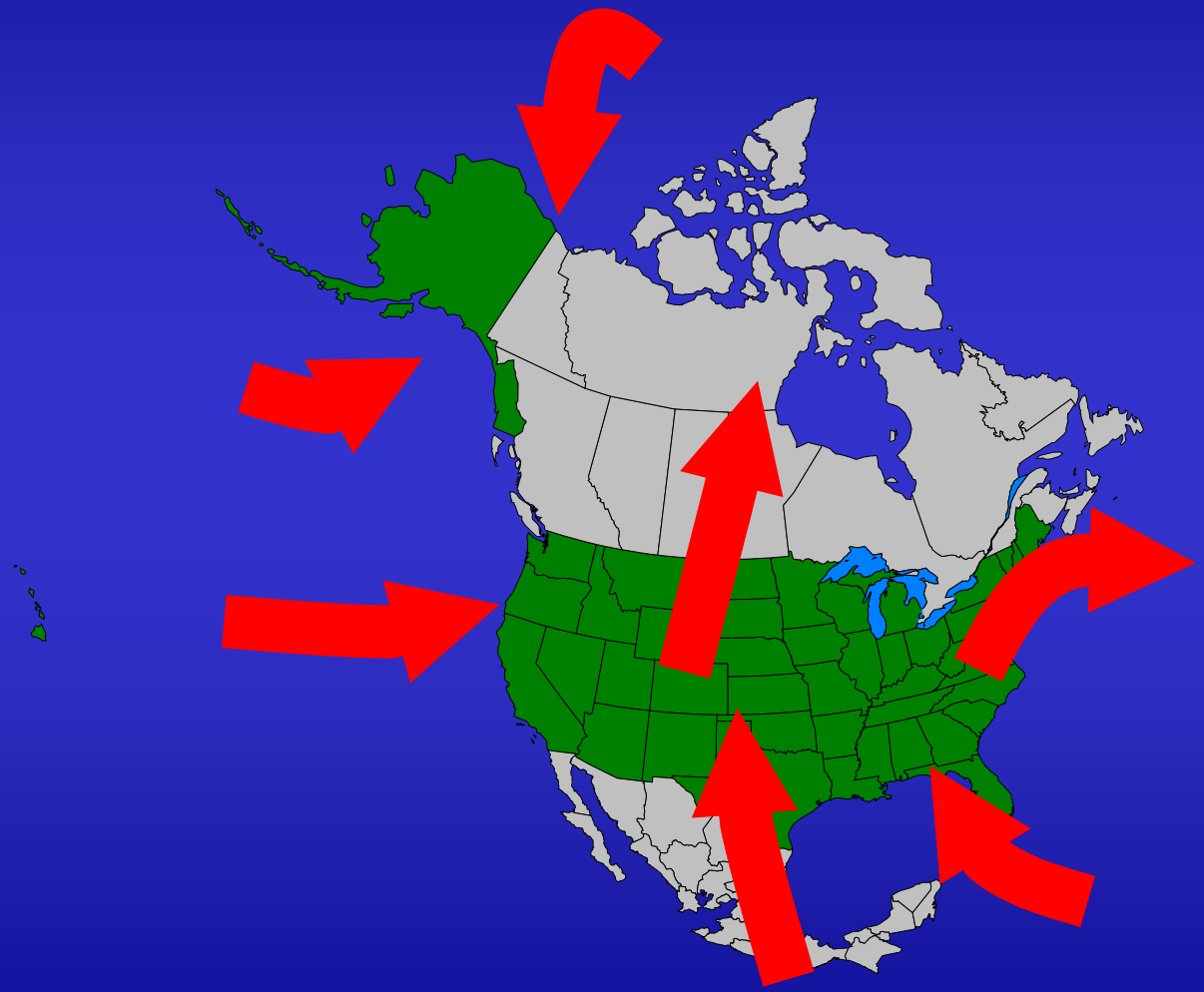
Contaminants that Cause Fish Advisories in Canada and the United States

Long-Range Transport 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 worldwide sources. If ongoing long-range sources are confirmed, work within international frameworks to reduce releases of such substances."

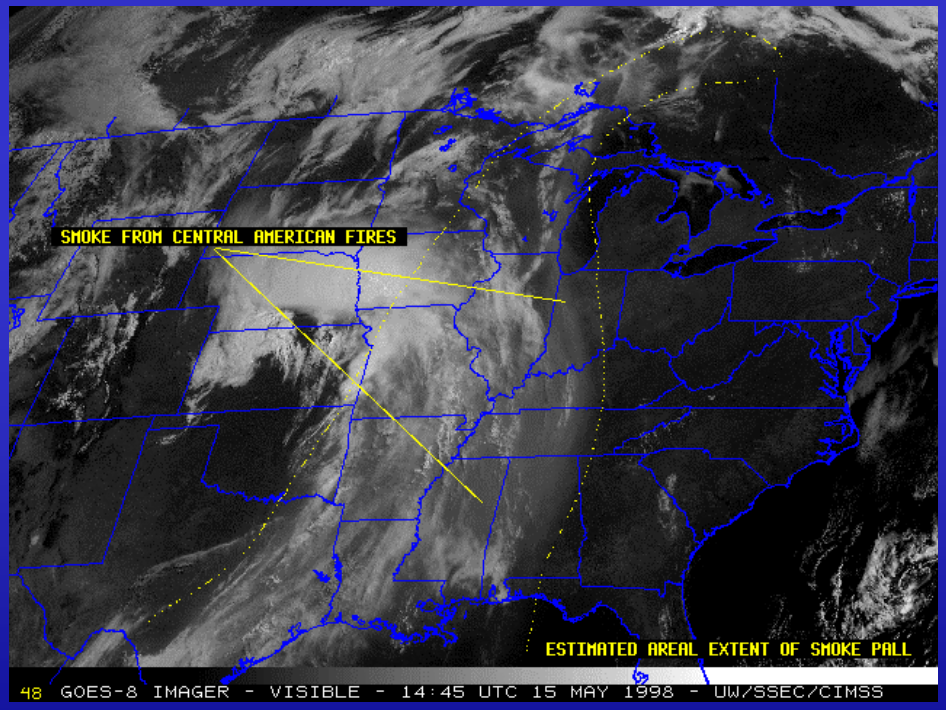
What have we learned about Long-Range Transport?



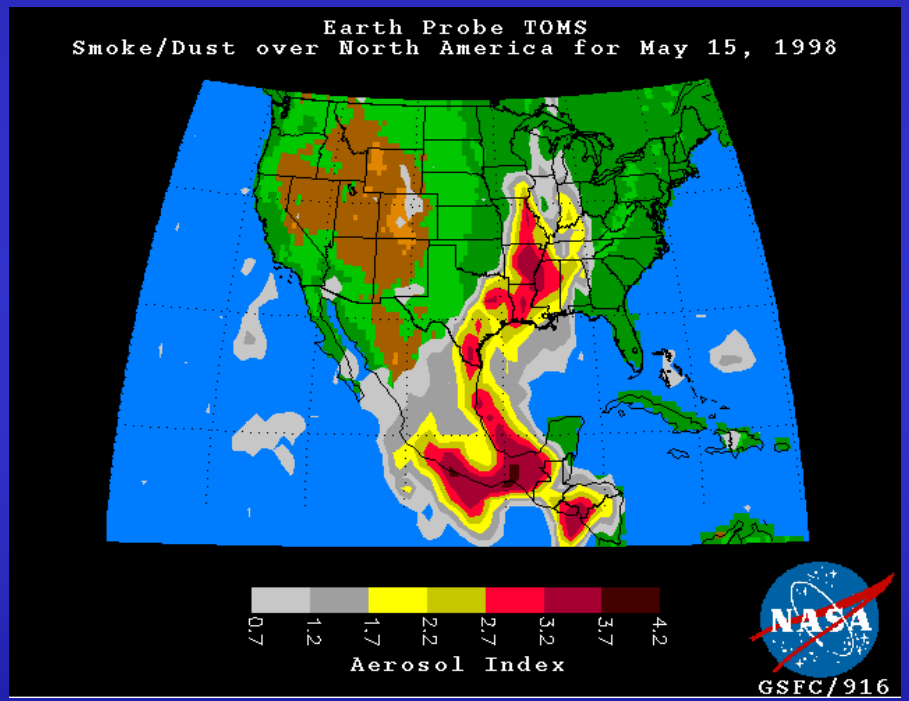
What do we know?

Imports from Central America

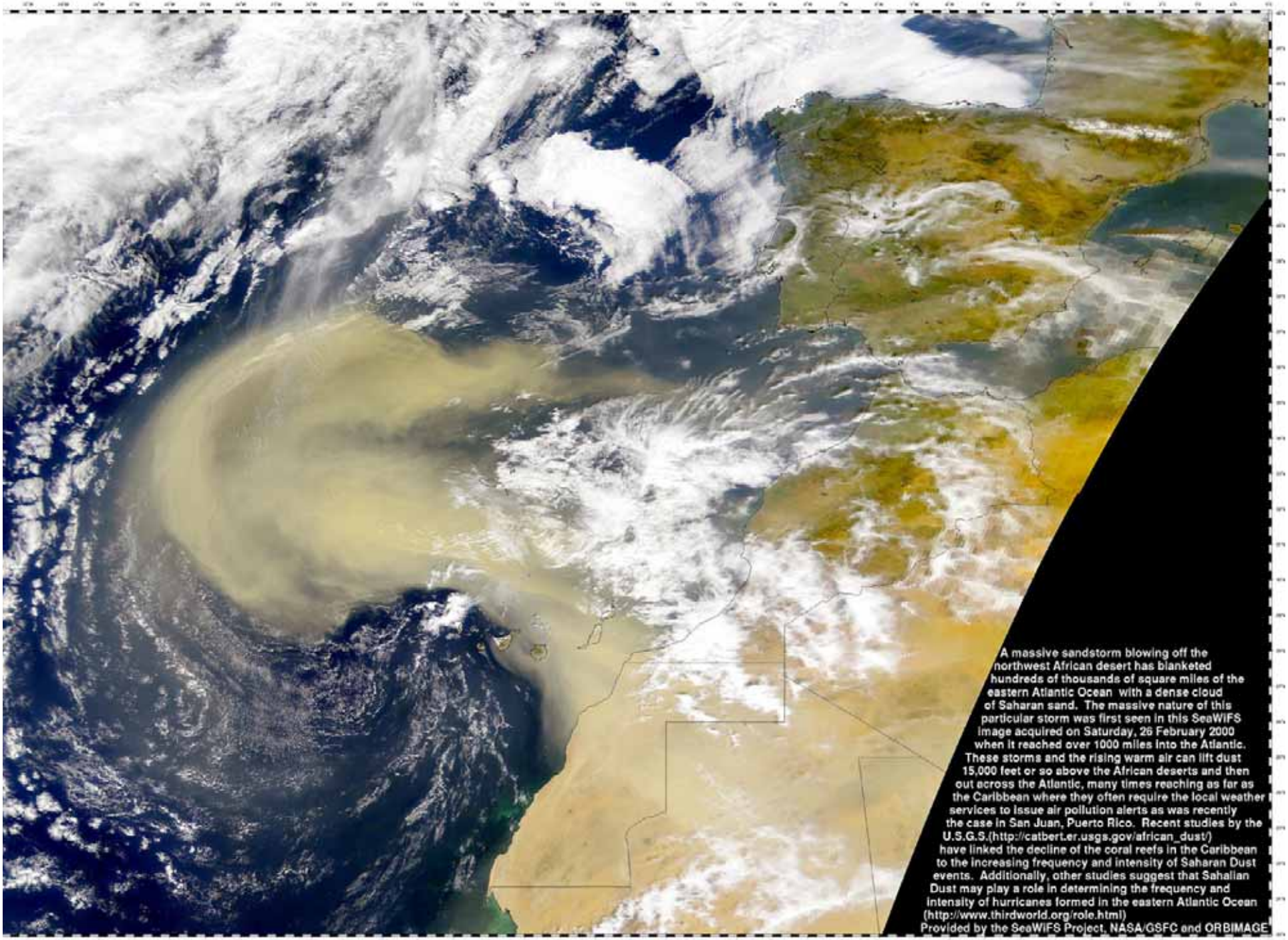
Flows from Central America carry smoke, as well as other pollutants, including pesticides. Pesticide use per acre in Central America exceeds the US by a factor of 10.



GOES-8 Satellite Image, CIMSS Univ of Wisconsin



In May 1998, fires in Central America create a smoke plume across the central U.S.

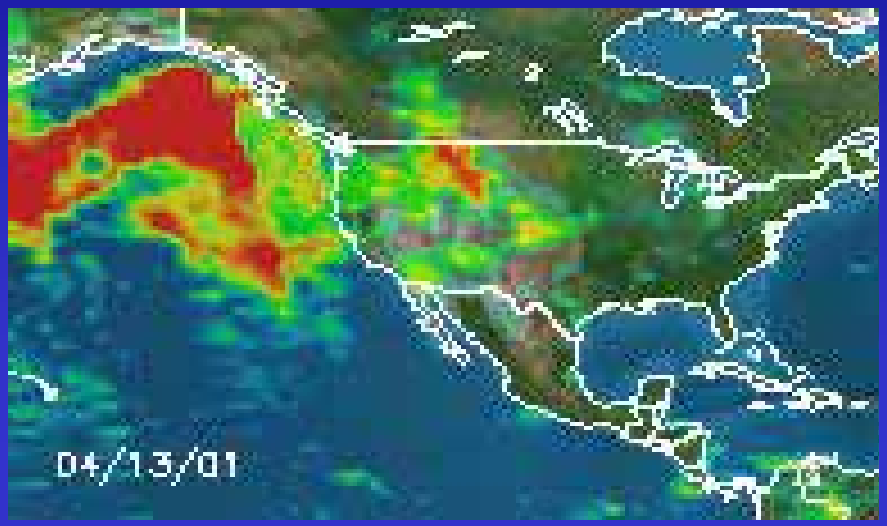


A massive sandstorm blowing off the northwest African desert has blanketed hundreds of thousands of square miles of the eastern Atlantic Ocean with a dense cloud of Saharan sand. The massive nature of this particular storm was first seen in this SeaWiFS image acquired on Saturday, 26 February 2000 when it reached over 1000 miles into the Atlantic. These storms and the rising warm air can lift dust 15,000 feet or so above the African deserts and then out across the Atlantic, many times reaching as far as the Caribbean where they often require the local weather services to issue air pollution alerts as was recently the case in San Juan, Puerto Rico. Recent studies by the U.S.G.S.(http://catbert.er.usgs.gov/african_dust/) have linked the decline of the coral reefs in the Caribbean to the increasing frequency and intensity of Saharan Dust events. Additionally, other studies suggest that Sahalian Dust may play a role in determining the frequency and intensity of hurricanes formed in the eastern Atlantic Ocean (http://www.thirdworld.org/role.html)

Provided by the SeaWiFS Project, NASA/GSFC and ORBIMAGE

What do we know?

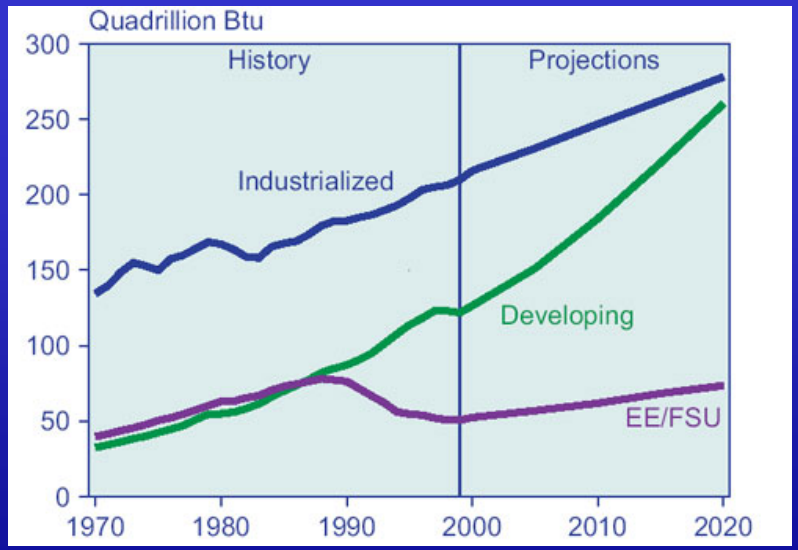
Imports from Asia



[Aerosol Index, NASA TOMS]

Dust from Chinese Deserts, fossil fuel emissions, and other pollutants travel across the Pacific and impact the Western U.S.

Emissions in Asia are expected to grow with further economic development, offsetting emissions decreases in the United States.

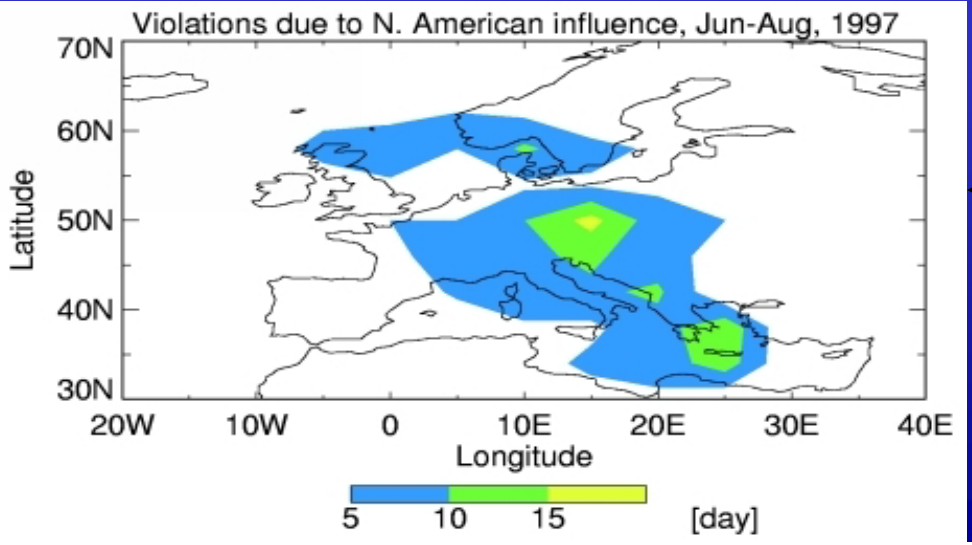


World Energy Use [EIA, 2002]

What do we know?

Exports to Europe

The U.S. exports ozone precursors, mercury, and other pollutants to the North Atlantic. The impact on attainment of European policy objectives may be significant.



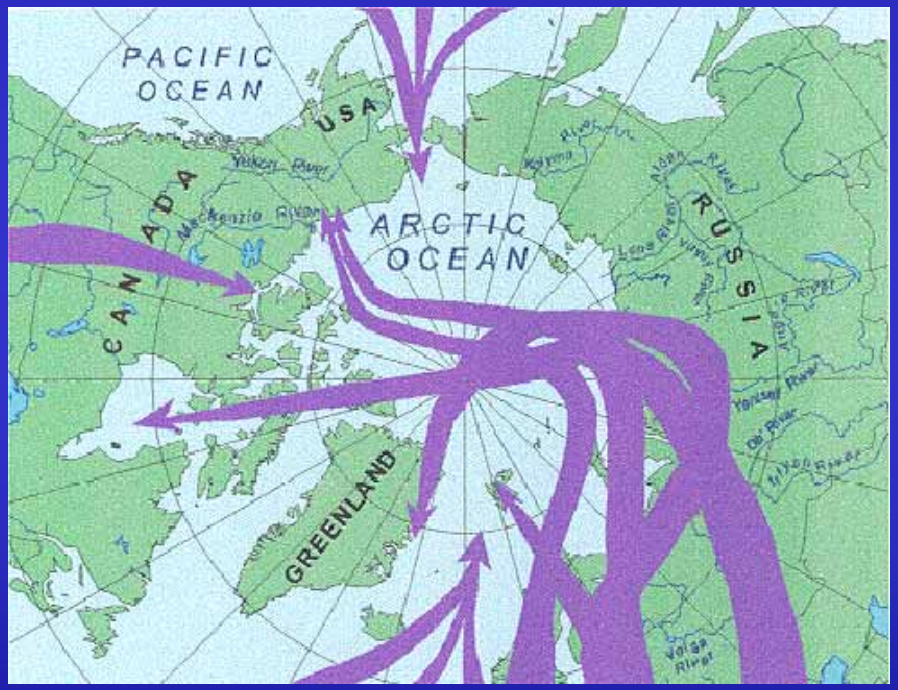
Days predicted to exceed the EU ozone standard that would not exceed the standard in the absence of North American emissions.

[Li et al., 2001]

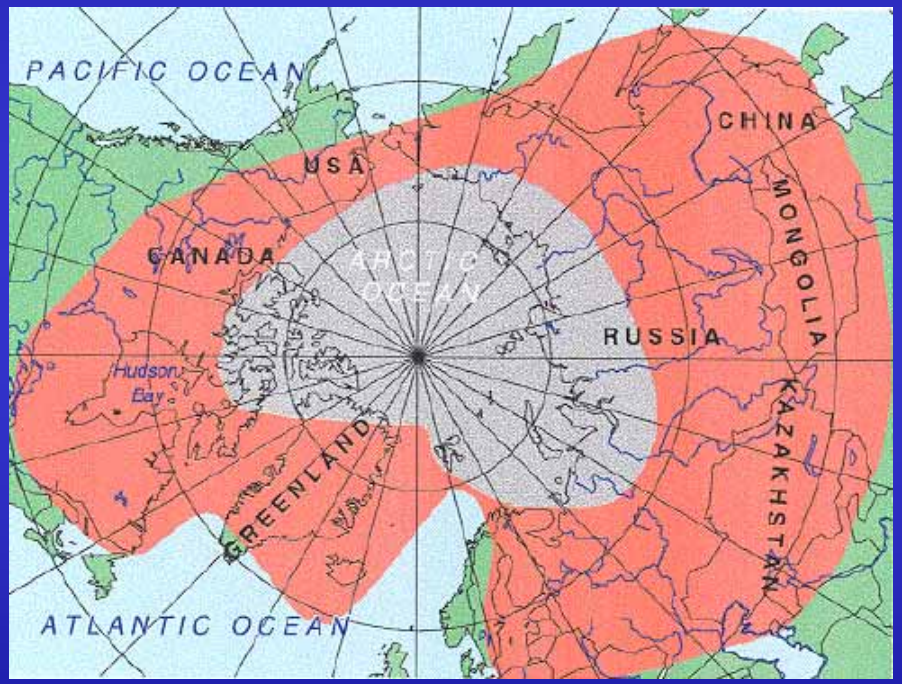
What do we know?

Imports to Alaska & Arctic

Mercury, POPs, and other pollutants are carried into the Arctic, and trapped by circulation patterns



Air Transport Pathways

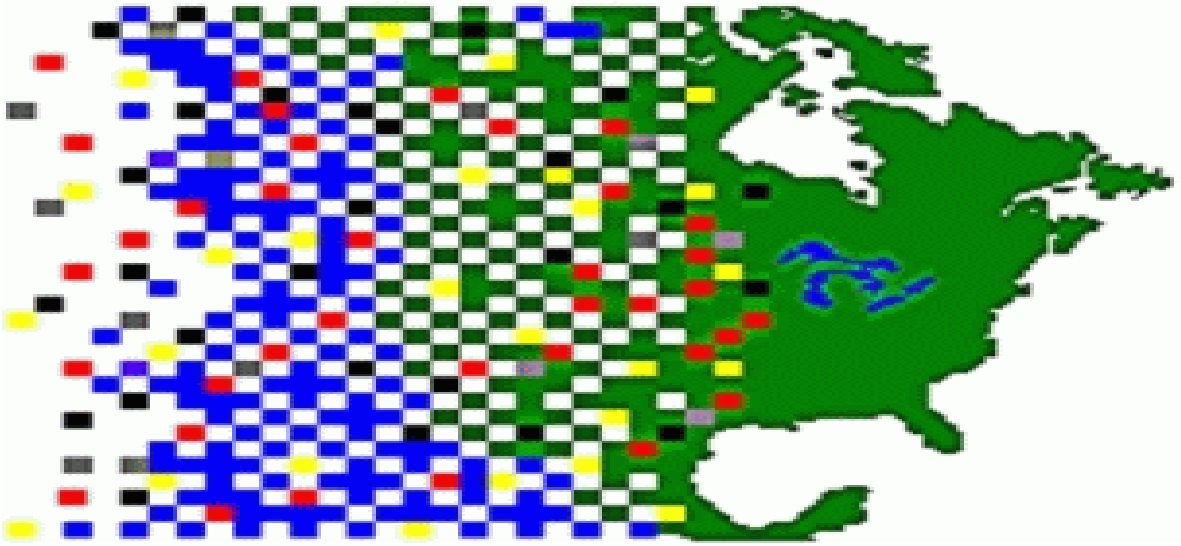


Arctic Air Mass In Summer and Winter

[Crane & Galasso, 1999]

Long Range Transport Workshop 2003

Ann Arbor, Michigan USA



Great Lakes Binational Toxics Strategy

International Joint Commission

Commission For Environmental Cooperation

United States Environmental Protection Agency

Environment Canada

Great Lakes Binational Toxics Strategy

Long Range Transport Workshop 2003

September 16th & 17th, 2003

Campus Inn, Ann Arbor, Michigan USA

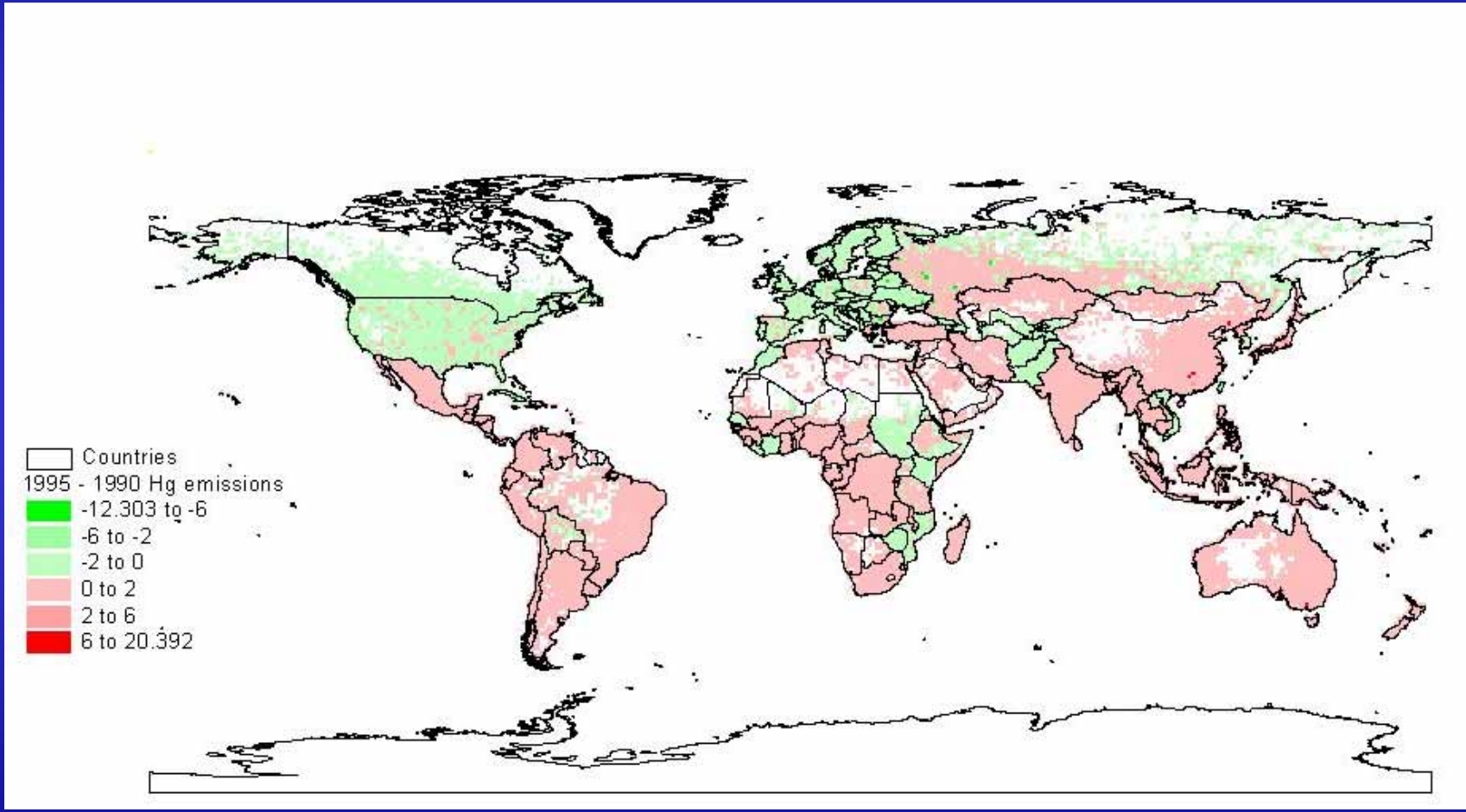
LRT Workshop: Goals & Objectives

- Review recent scientific research
  - Background paper developed by Global Change Strategies International – Ottawa
  - Several distinguished North American and European scientists
- Identify critical knowledge gaps
- Provide recommendations on future activities necessary to adequately address long-range transport.
- Communicate and share workshop products

Emissions Inventory Actions

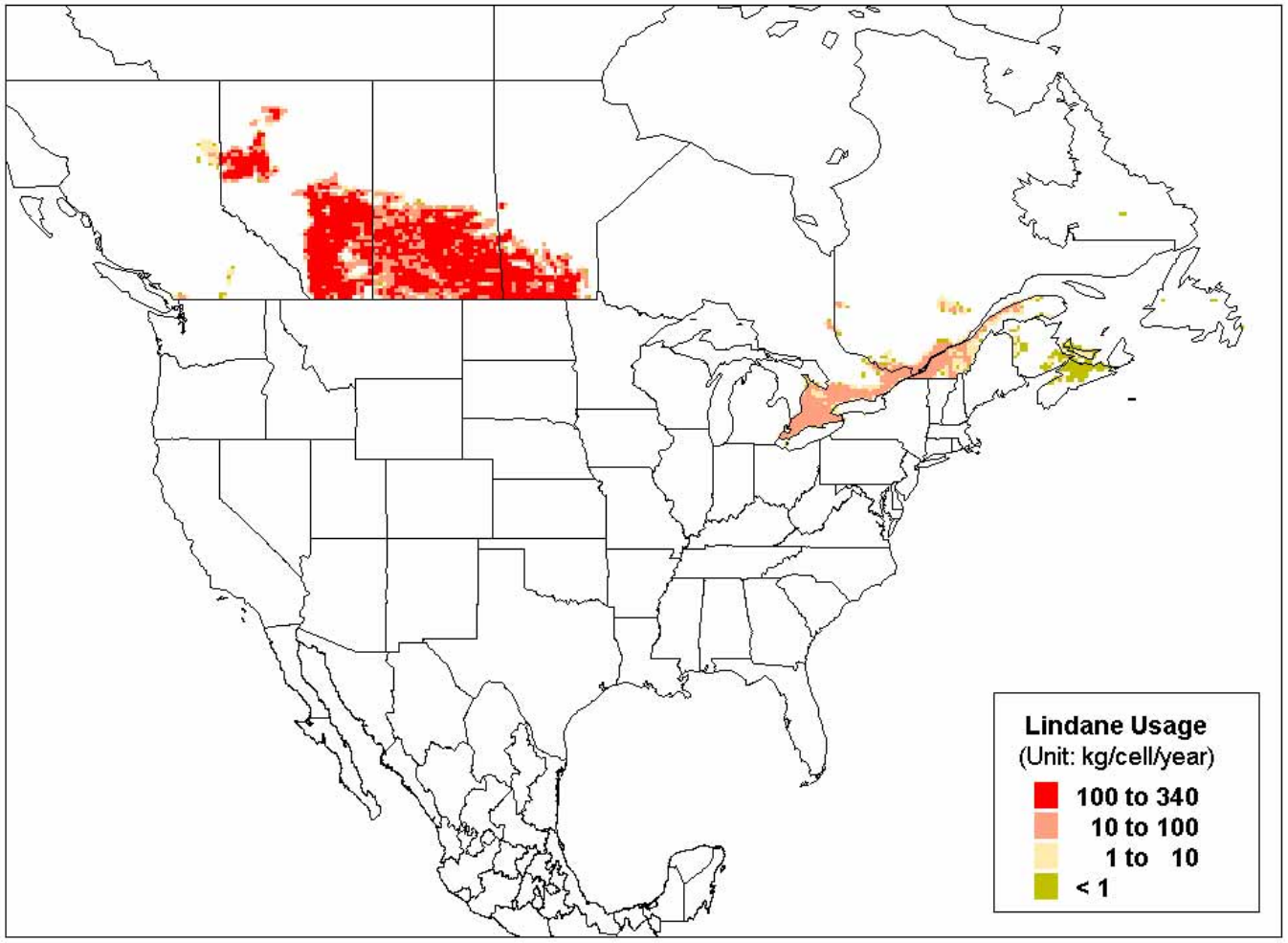
- Priority on North American PBTs
  - Local efforts are still VERY important (PCBs, Hg)
  - Authority is needed
- Improve transparency and access
- Improve review and accountability
- N.A./Global pesticide use and emissions
- Poorly characterized sources
  - Open burning (developing countries)
  - Residues in soil (re-emissions)
  - Mercury (speciation, mmHg)
- Aid developing countries

Comparison of anthropogenic emissions of total mercury in 1995 and 1990 (legend shows difference in emissions, in tonnes, per grid cell between 1990 and 1995, green shades indicating reductions, red shades indicating increases)



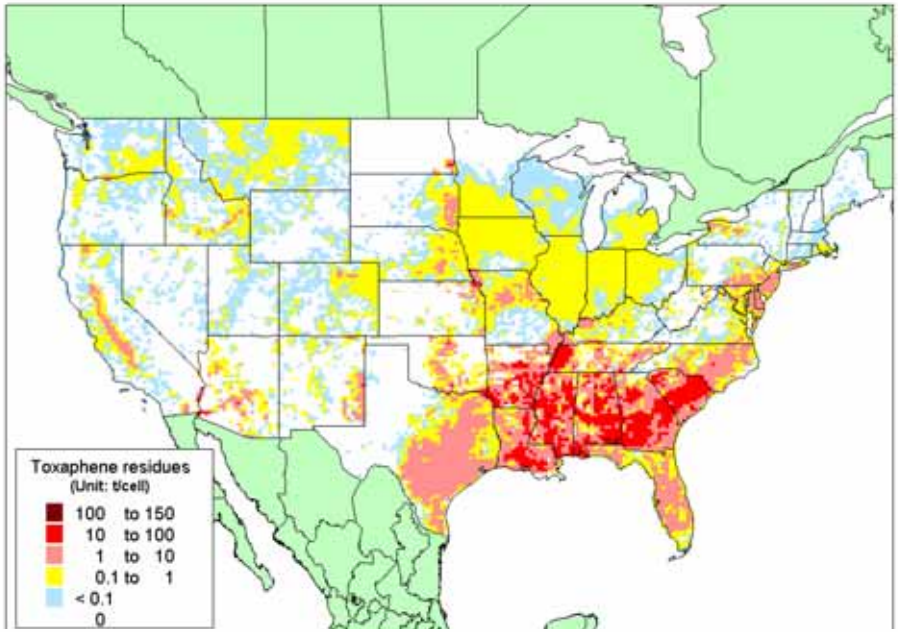
Pacyna and Pacyna 2002

Usage Inventories: Gridded Lindane Usage in Canada for 2000, Total: 500 t

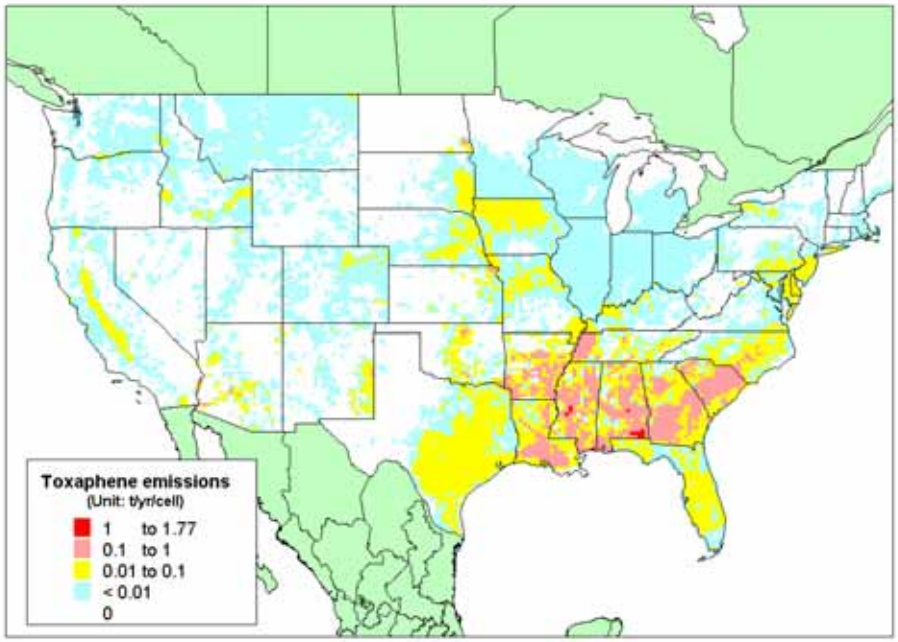


Source: Li et al., 2002

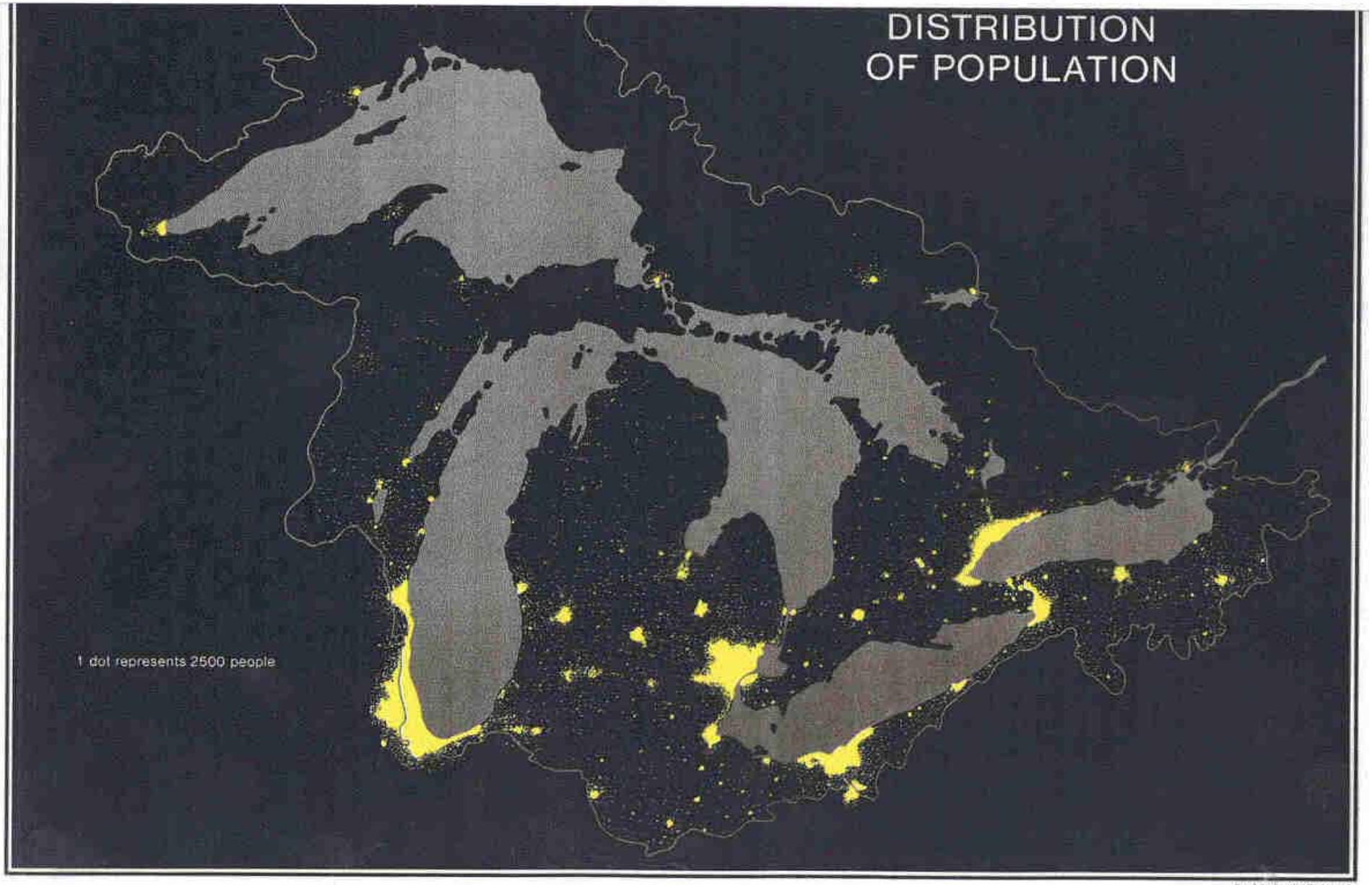
Residue Inventories: Gridded Toxaphene residues in soil in 2000 Total: 30 kt



Emission: Gridded Toxaphene emissions in 2000, Total: 360 t



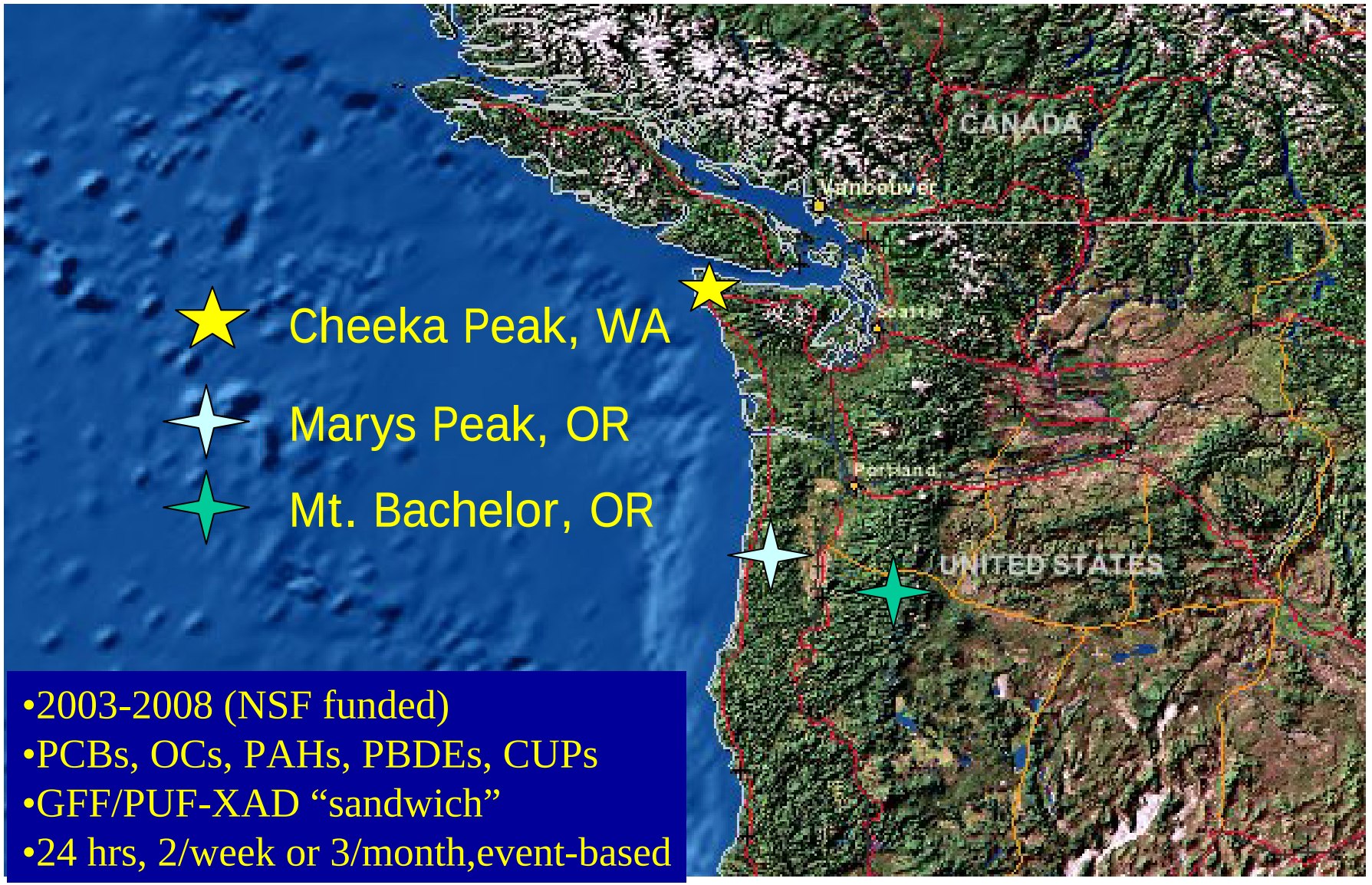
Source: Li et al., 2001b


DISTRIBUTION
OF POPULATION
1 dot represents 2500 people

Monitoring Actions

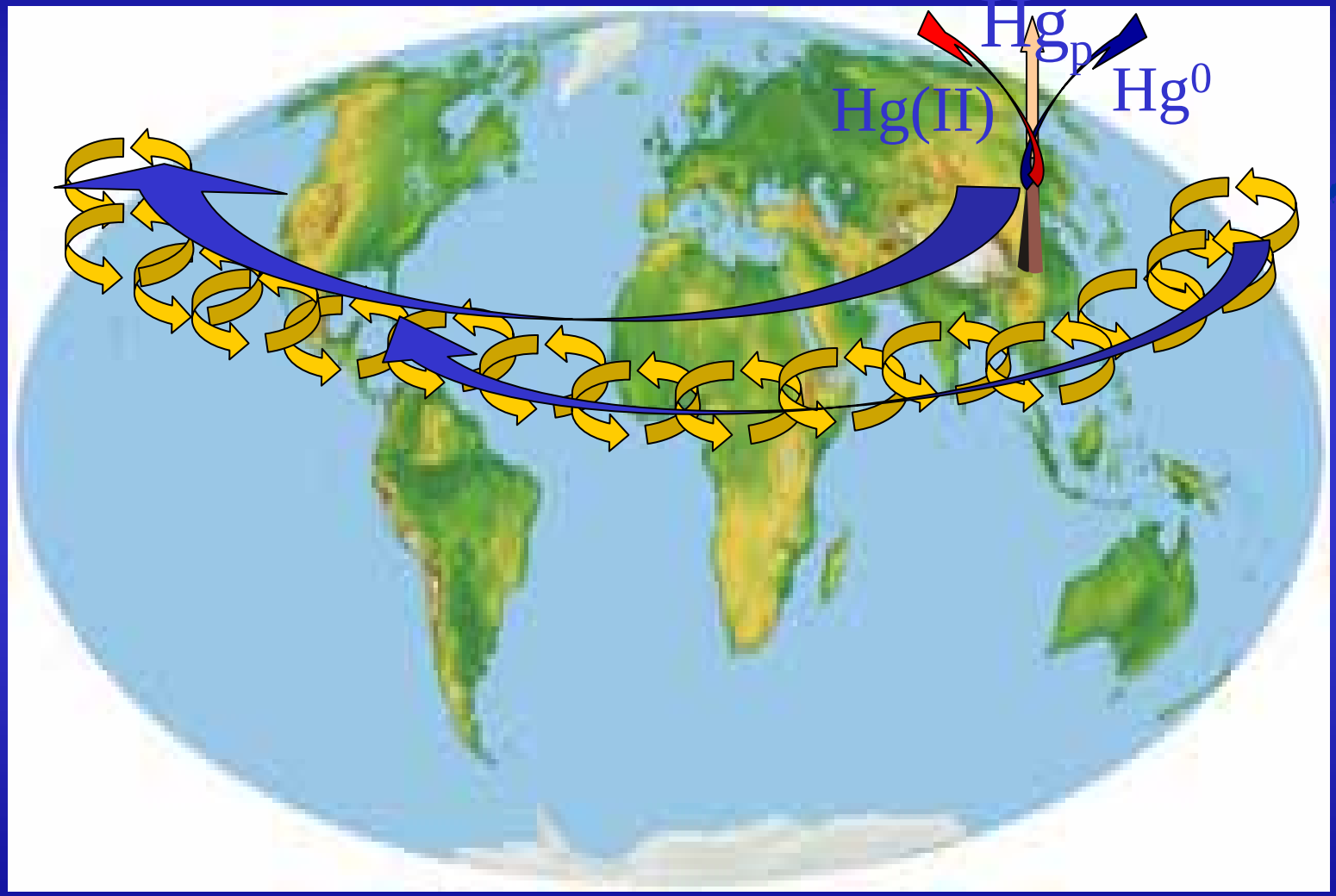
- Inter-network comparisons
- Improve Data Analysis
- Passive Sampling
- Sentinel sites
  - Trans-Pacific transport
  - Other transport pathways
- Utilize new monitoring methods
  - Highly intensive sampling studies
  - Emerging PBTs
- Mercury
  - Dry deposition
  - Throughfall, plant up-take, & litterfall
- IADN

Pacific Northwest Network of Air Monitoring Stations, US



- 2003-2008 (NSF funded)
- PCBs, OCs, PAHs, PBDEs, CUPs
- GFF/PUF-XAD “sandwich”
- 24 hrs, 2/week or 3/month,event-based

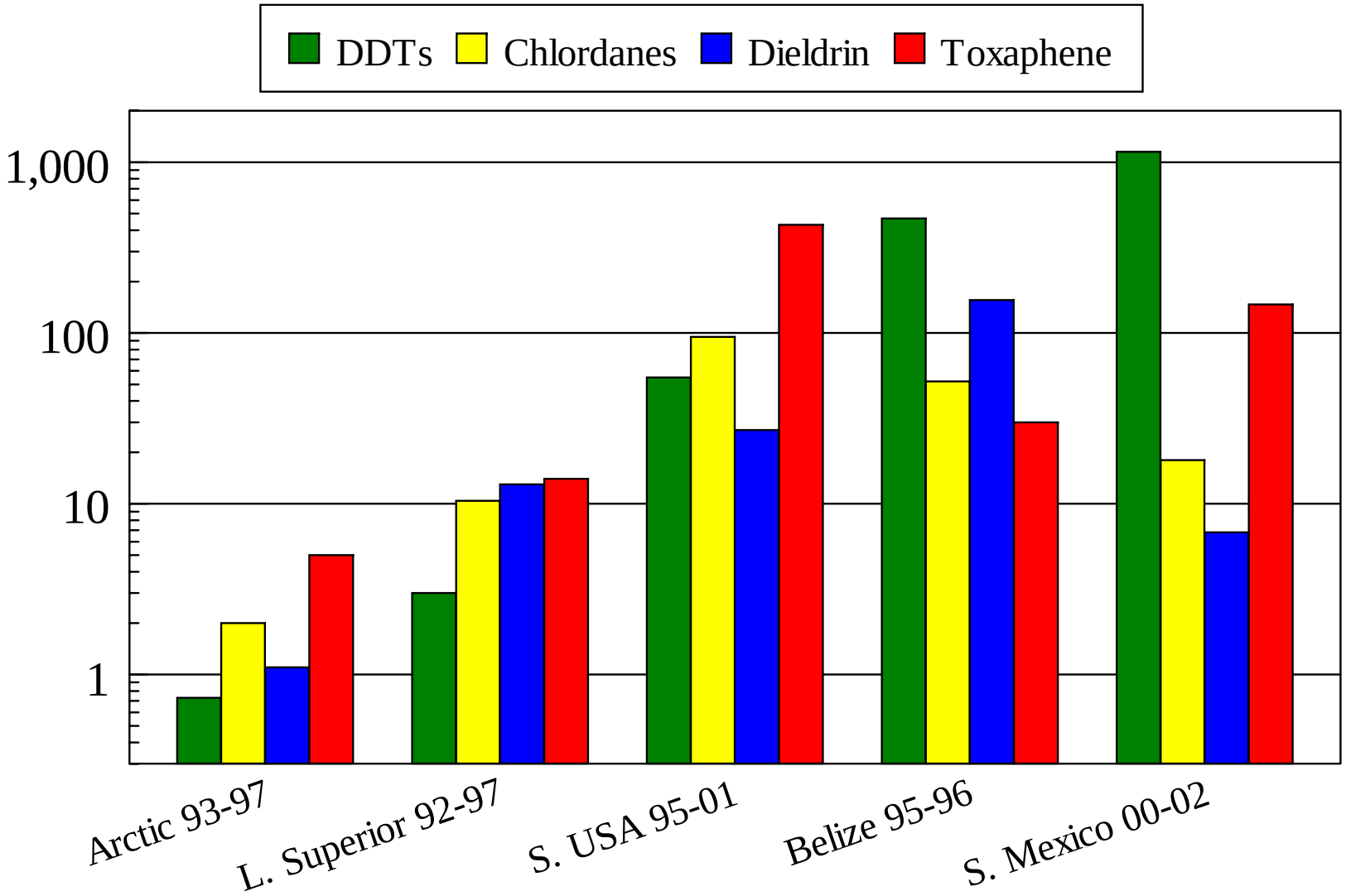
Global Atmospheric Mercury Cycle ?



Rapid Oxidation, Deposition, Evasion ?

Courtesy of Matt Landis

OC Pesticides in Ambient Air of Source and Receptor Regions, pg/m^3

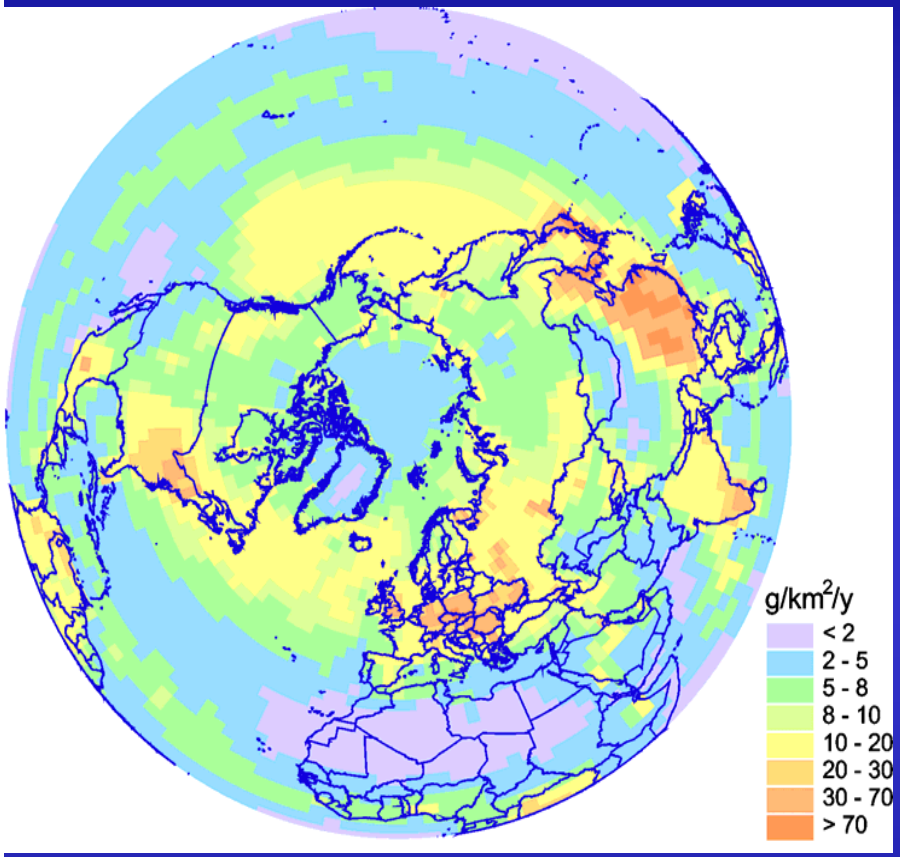


Arithmetic means for Arctic and L. Superior; geometric means for S. USA, Belize and S. Mexico. The latter data include Tapachula and the mountain site.

Modeling Actions

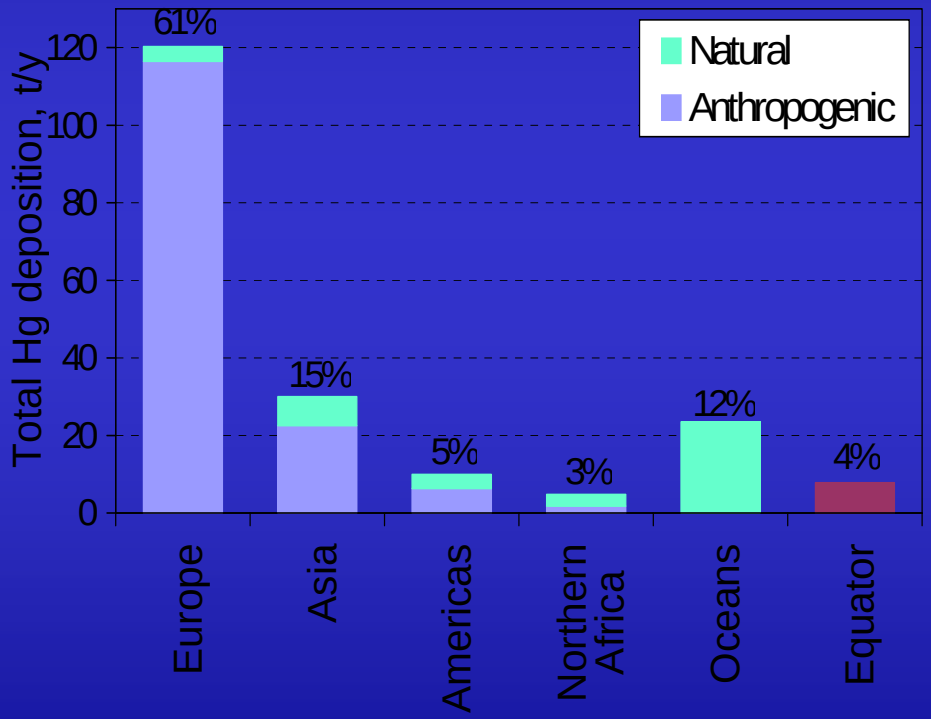
- Improve reliability of modeled estimates
  - EMEP Hg and POPs model inter-comparison studies
  - Great Lakes case study??
  - Use models of varying levels of complexity and scale
- Utilize new and improved POPs models
  - Fugacity-based (accounts for “grasshopping”)
- Knowledge Gaps
  - Chemical Kinetics (Hg, ozone, SO2, halides)
  - Emissions (natural, speciation, re-emission)
  - Chemical composition of RGM
  - Dry Deposition Velocities (including EGM)
  - Troposphere/Stratosphere Exchange
  - Volatilization Processes over Different Surfaces
  - Convective Transport

Modeling results



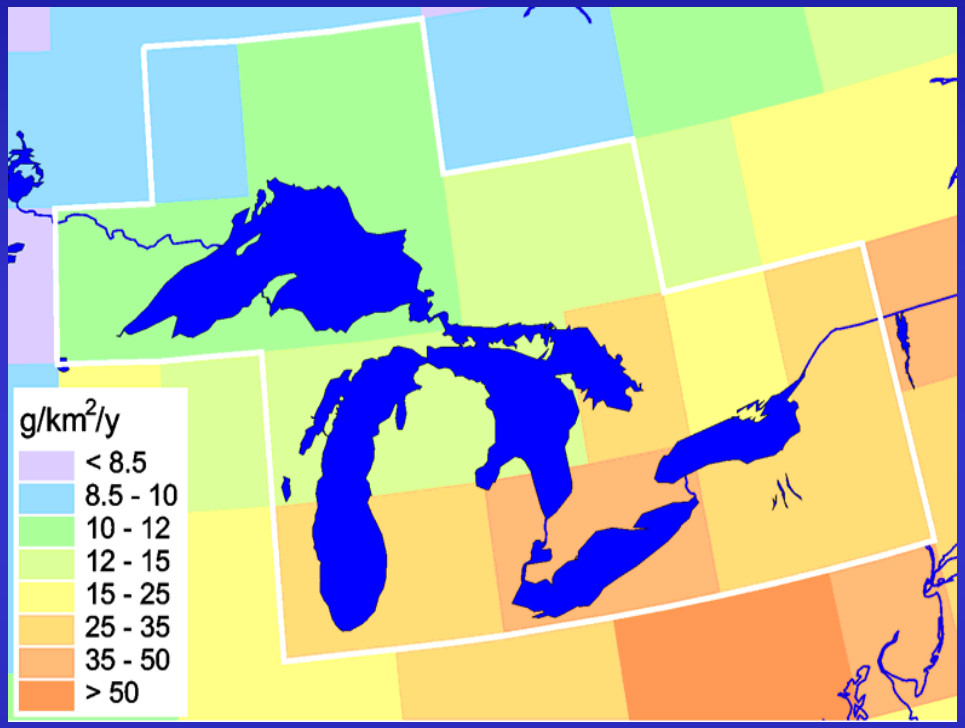
Annual deposition density of Hg in the Northern Hemisphere

Europe: contributions of global sources to deposition



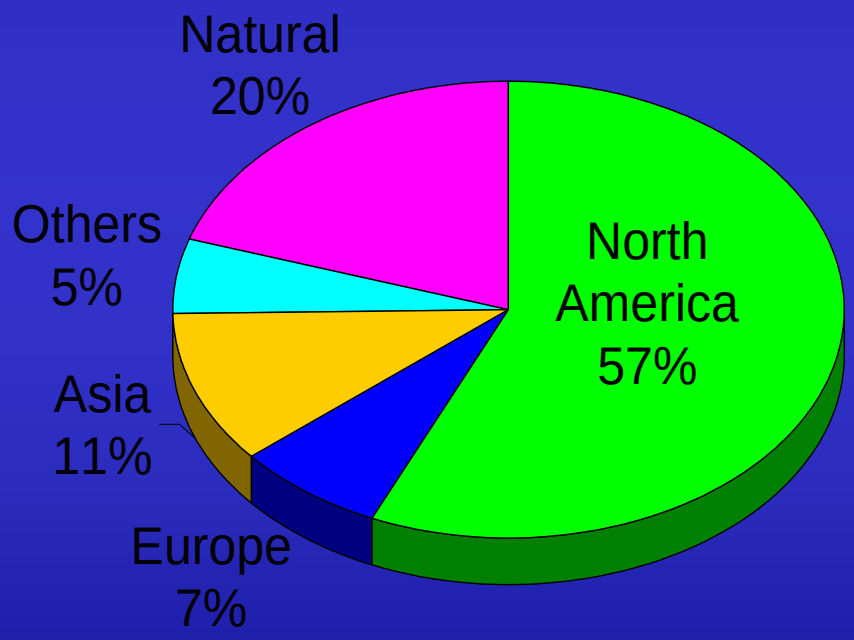
EMEP/MSC-E

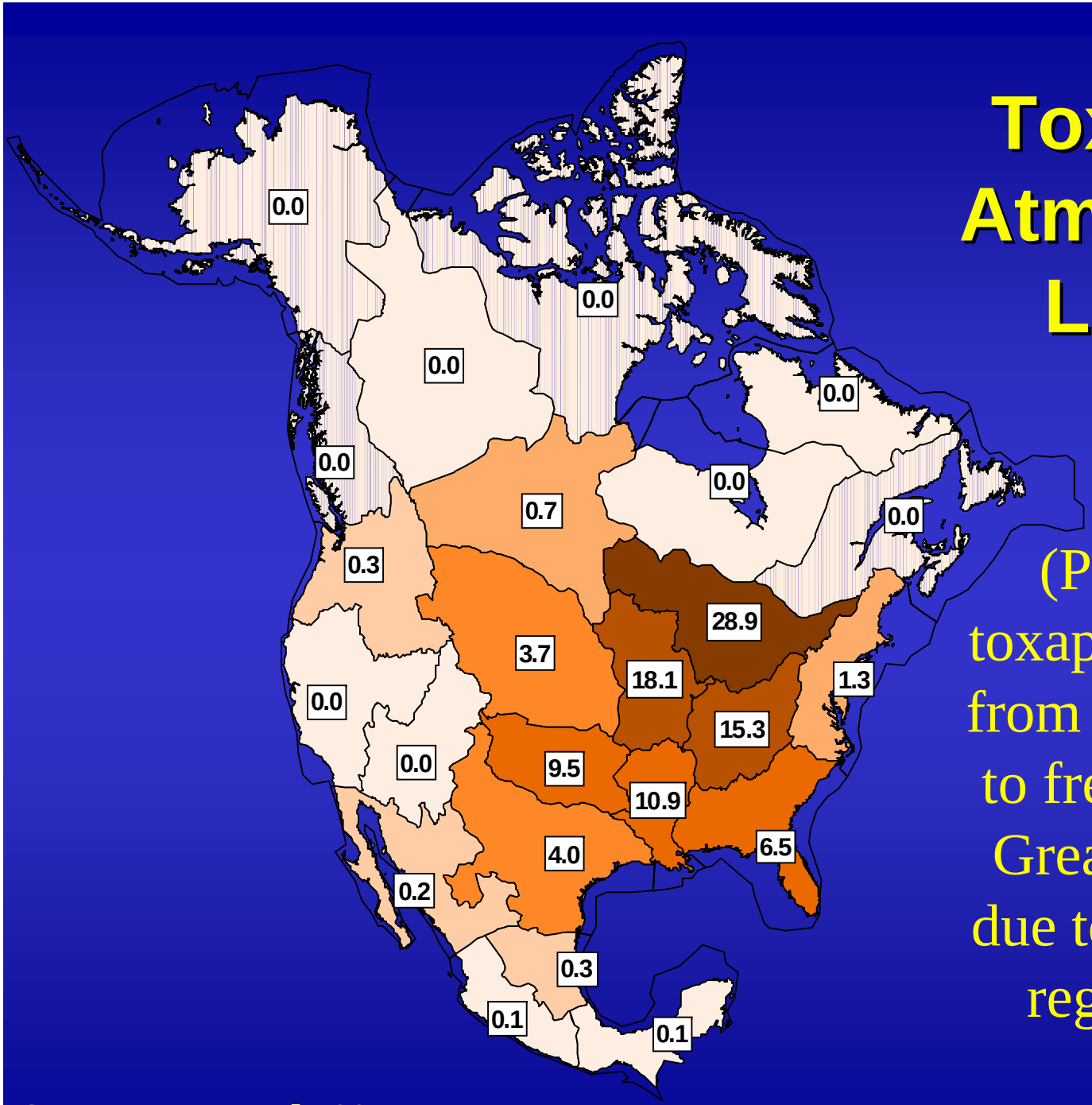
Modeling results



Mercury total depositions over the Great Lakes region

<u>Great Lakes:</u> contributions of global sources to deposition





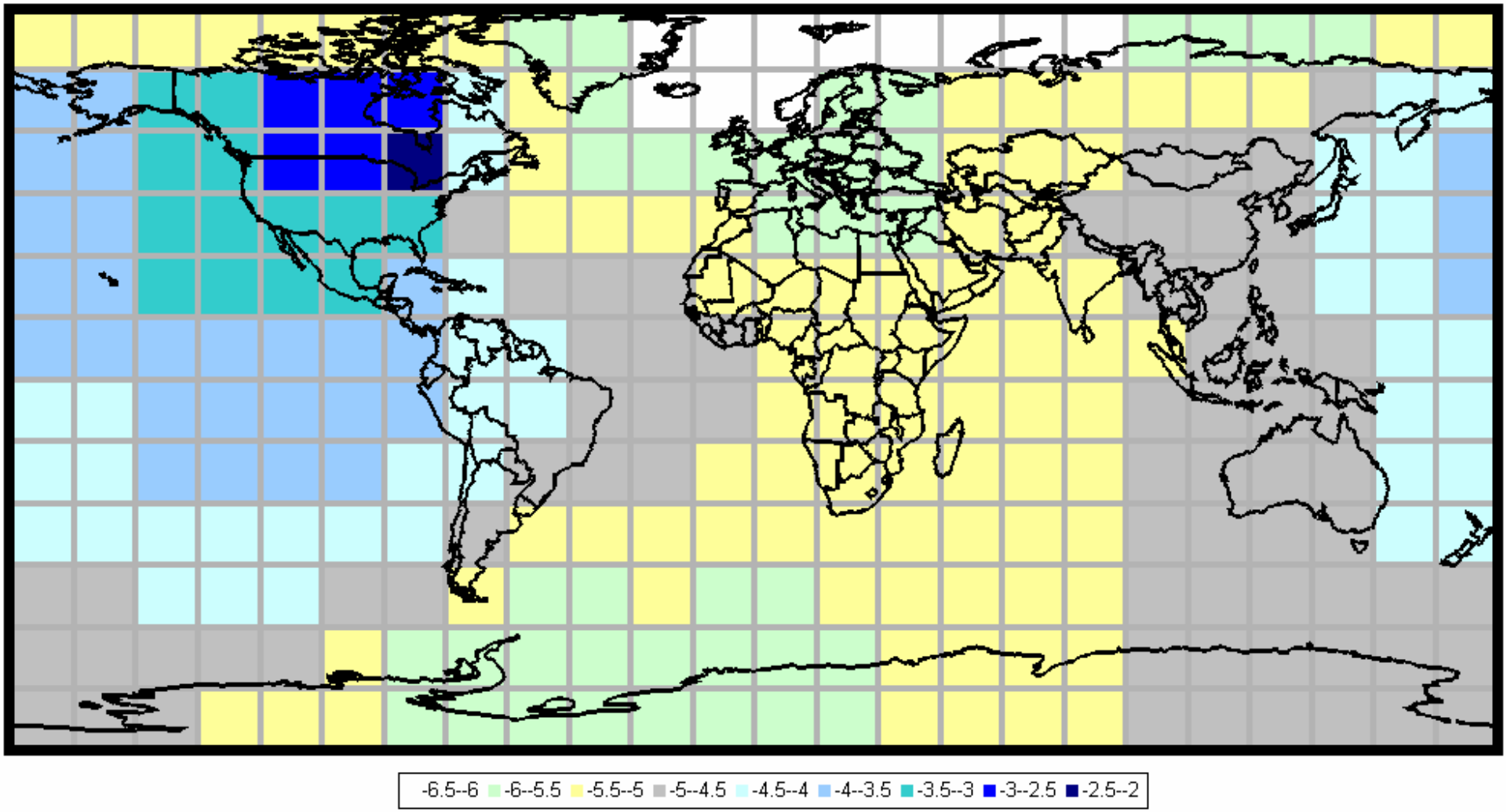
Toxaphene Atmospheric Loading

(Percentage of toxaphene deposited from the atmosphere to freshwater in the Great Lakes Basin due to usage in each region of North America)

Source: MacLeod 2003

Global-Scale PCB GLTE

Each color gradiation represents a ½ order of magnitude difference in transfer efficiency



Next Steps

- Draft “Ann Arbor Statement”
- 28 sets of comments received
- North American inter-comparison of mercury and POPs models
- Fugacity modeling for GLTBS substances
- Form national and international partnerships for monitoring networks
  - Sentinel sites - Mauna Loa and Alaska
- Workshop final report – March 2004
- **http://www.delta-institute.org/lrtworkshop/_main.html**

Special Thanks to:

Planning Committee:

S. Venkatesh	*Environment Canada (Canadian co-chair)*
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Vic Shantora	*Commission for Environmental Cooperation*
John McDonald	*International Joint Commission*
Nicholas Schneider	*International Joint Commission*
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Tim Watkins	*U.S. EPA*
Marilyn Engle	*U.S. EPA*
Stan Durkee	*U.S. EPA*
Angela Bandemehr	*U.S. EPA*
Melissa Hulting	*U.S. EPA*
Tim Brown	*Delta Institute*
T.J. Holsen	*Delta Institute*
Abby Jarka	*Delta Institute*