The Climate-Air Quality Continuum and the Global Emissions Inventory Activity (GEIA)

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Overview of Presentation

- Overview of GEIA

- Spatial continuum, data needs and new techniques

- GEIA Foundations -- Achievements, Organization

- New GEIA Initiatives

GEIA--

- Has been developing and distributing state-of-the-art global inventories and information since 1990

- Is a cross-cutting activity of International Global Atmospheric Chemistry Program

- Maintains communication through GEIA Center at <www.geiacenter.org>

GEIA Organization

- **Convenors: Jos Olivier and Derek Cunnold**

- **GEIA Center Director: Paulette Middleton**

- **International Coordinating Committee: Olivier, Cunnold, Middleton, Carmen Benkovitz, Gregg Marland, Ann McMillan, Jozef Pacyna, Trevor Scholtz**

Contact: Paulette@rand.org for general information and
Check geiacenter.org for specific data base contacts

GEIA Principals

GEIA has been seeking to provide:

- **Data on 1x1 degree grid worldwide and country by country**

- **Data evaluation, inter-comparisons and updates**

- **Sectoral, seasonal and historical information for inventories**

But more is needed in order to address the continuum...

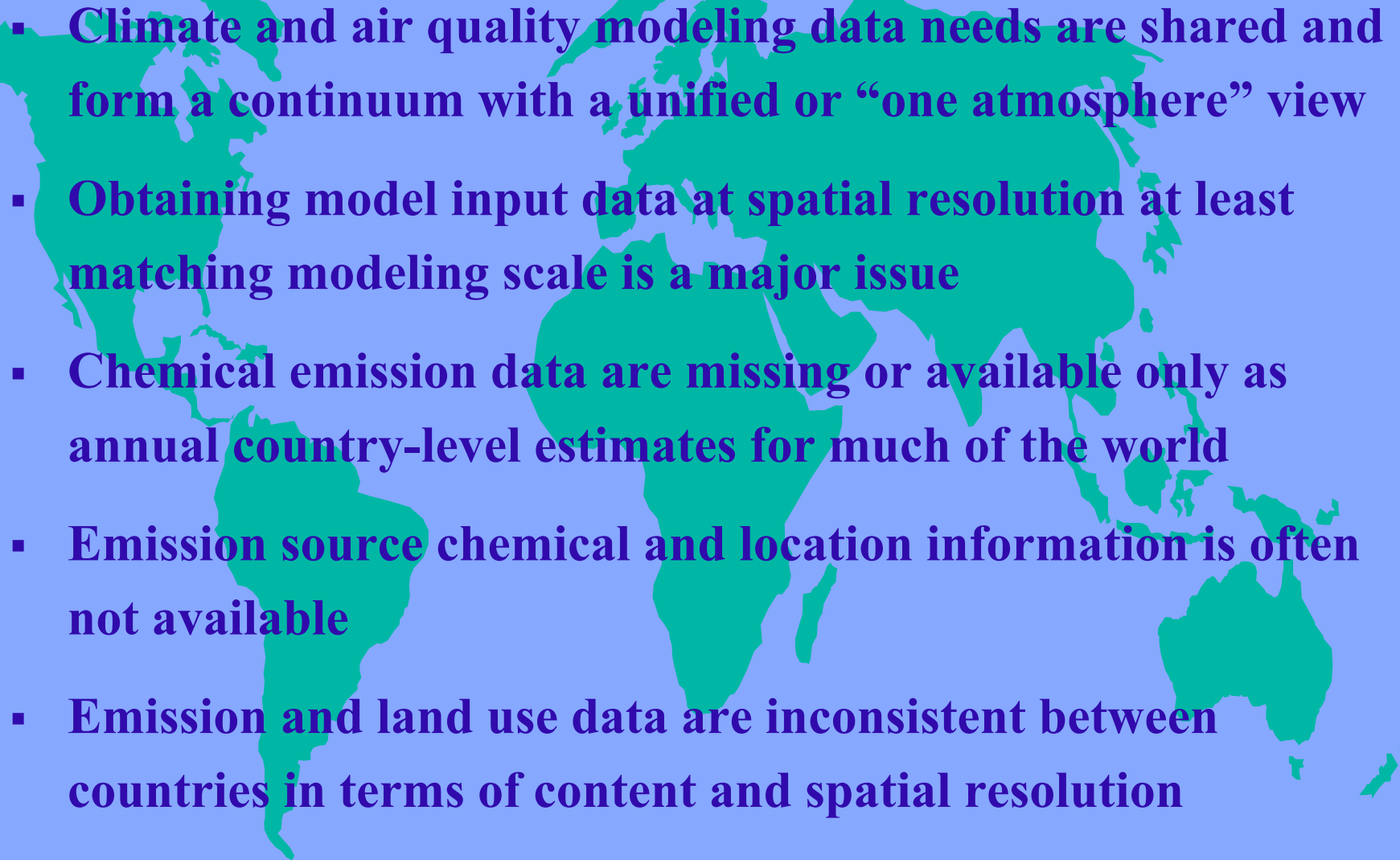# Historical Global Climate and Regional Air Quality Model Differences

- **Traditional scale resolution differences between climate and air quality modeling are shrinking**

- **Climate modeling performed at global or hemispherical scale until the use of regional models in recent years**

- **Previously, relatively long-lived species were included in climate models, and short-lived species in air quality models**

Why a Modeling Scale Overlap?

- **Both climate and air quality chemical transport models need more detailed spatial and chemical data to improve performance**

- **Improved computational capability makes increased spatial resolution feasible**

- **Improved model chemistry blurs the distinctions between climate and air quality transport models (one atmosphere)**

- **GIM seeks improvement and comparison of chemical transport models**

Consolidated Model Data Needs

- **Climate and air quality modeling data needs are shared and form a continuum with a unified or "one atmosphere" view**

- **Obtaining model input data at spatial resolution at least matching modeling scale is a major issue**

- **Chemical emission data are missing or available only as annual country-level estimates for much of the world**

- **Emission source chemical and location information is often not available**

- **Emission and land use data are inconsistent between countries in terms of content and spatial resolution**

- **Emission data uncertainties are generally unknown**

Consolidated Model Data Needs (2)

- **Data consistency**

  - **Data content and methodological basis of data varies**

- **Uncertainties in Data**

  - **Uncertainties of emission inventory data have not been quantified**

- **Historical emission data and projection needs**

  - **Consistent historical and projected emission data for the world**

  - **Consistent and valid projection methods for emission data and land use are needed**

Some Newer Alternative Emission Estimation Methods

- **Satellite based emission data**

  - **Currently limited by horizontal resolution, limited ability to distinguish chemical species near the surface, and interference by water and carbon dioxide spectra**

  - **Longer-term promise**

  - **Initial assistance likely with model output verification**

  - **New sensors will be much improved**

    - **Tropospheric Emission Spectrometer (TES) in 2004**

    - **5km horizontal resolution**

    - **Detects Ozone, Carbon Monoxide, Methane, Nitric acid, Nitrous oxide..**

Some Newer Alternative Emission Estimation Methods (2)

- **Inverse Modeling of Emissions**

  - **Model output concentrations compared to monitored values of chemical concentrations**

  - **Emission adjustments estimated using a reverse statistical modeling technique to normalize the difference between modeled and observed chemical concentrations**

  - **Inverse modeling method may be improved as satellite data enhance traditional air quality monitor data**

The Challenge for GEIA

- **GEIA is the established international forum for consistent model-oriented data bases of emission inventories and related variables**

- **GEIA plans to expand its initiatives to address the need for higher quality and more spatially resolved emission data**

Building on GEIA's Achievements to Better Address the Continuum Challenge

- Core of dedicated participants

- 25 projects with completed inventories for most

- GEIA communication hub <geiacenter.org>

- 12 international planning workshops

- Growing user community (over 500 on the e-mail network)

- Expanded links to related data base and modeling efforts

- Enhanced QA and updating protocols for new information

Data Status

Available

- Ammonia (A)
- Black Carbon (A)
- Carbon Dioxide (A)
- Carbon Monoxide (A)
- Chlorofluorocarbons (A)
- Lead (A)
- Mercury
- Methane (N)
- Sulfur and Nitrogen Oxides (A)
- Nitrous Oxide
- Reactive Chlorine Emissions (A&N)
- Volatile Organic Compounds (A&N)
- Aircraft Emission
- Lightening
- Nitrogen Oxides in Soils (A)
- Sulfur from Volcanoes (N)
- Population
- Cropland

In Progress

- Dimethylsulfide (N)
- Organochlorines (A)
- Radionuclides (N)
- Methane (A)
- Primary Particles (A&N)
- CFC (new)
- HCFC
- HFC/PFG/SF6

- International Shipping
- Biomass Burning (A & N)

GEIA Projects and Directors

Compounds

Ammonia (A)	Lee (UK)
Black Carbon (A)	Dignon (USA)
Carbon Dioxide (A)	Marland (USA)
Carbon Monoxide (A)	Visschedijk (The Netherlands)
CFC	Cunnold (USA)
CFC (new) *In Progress*	McCulloch (UK), Olivier (The Netherlands)
HCFC (*HCFC-22 Available)*	McCulloch (UK)
HFC/PFC/SF6 *In Progress*	McCulloch (UK)
Dimethylsulfide *In Progress*	Tarrason (Norway)
Heavy Metals	Pacyna (Norway)
Nitrous Oxide	Kroeze (The Netherlands), Mosier (USA)
Methane (N)	Matthews (USA), Roulet (Canada)
Methane (A) Preliminary	Olivier (The Netherlands)
Organochlorides *In progress*	Scholtz (Canada)
Primary Particles *In progress*	Benkovitz (USA)
Radionuclides *In Progress*	Kritz (USA)
Reactive Chlorine Emissions	Keene (USA)
Sulfur and Nitrogen Oxides (A)	Benkovitz (USA), Scholtz (Canada)
Volatile Organic Compounds (N)	Guenther (USA), Hewitt (UK)
Volatile Organic Compounds (A)	Visschedijk (The Netherlands)

**Source Specific Emissions**

Aircraft	Wuebbles, Baughcum (USA)
Biomass Burning *In Progress*	Goldammer (Germany), Levine (USA), Stocks (Canada)
International Shipping *In Progress*	Corbett (USA)
Lightning	Price (Israel)
Nitrogen Oxides in Soils	Levy,Yienger (USA)
Sulfur from Volcanoes	Andres (USA)

Other Data

Population	Li (Canada)
Cropland	Li (Canada)

Note: A=Anthropogenic   N=Natural

Example of Multiple Modeling Scales and Domains
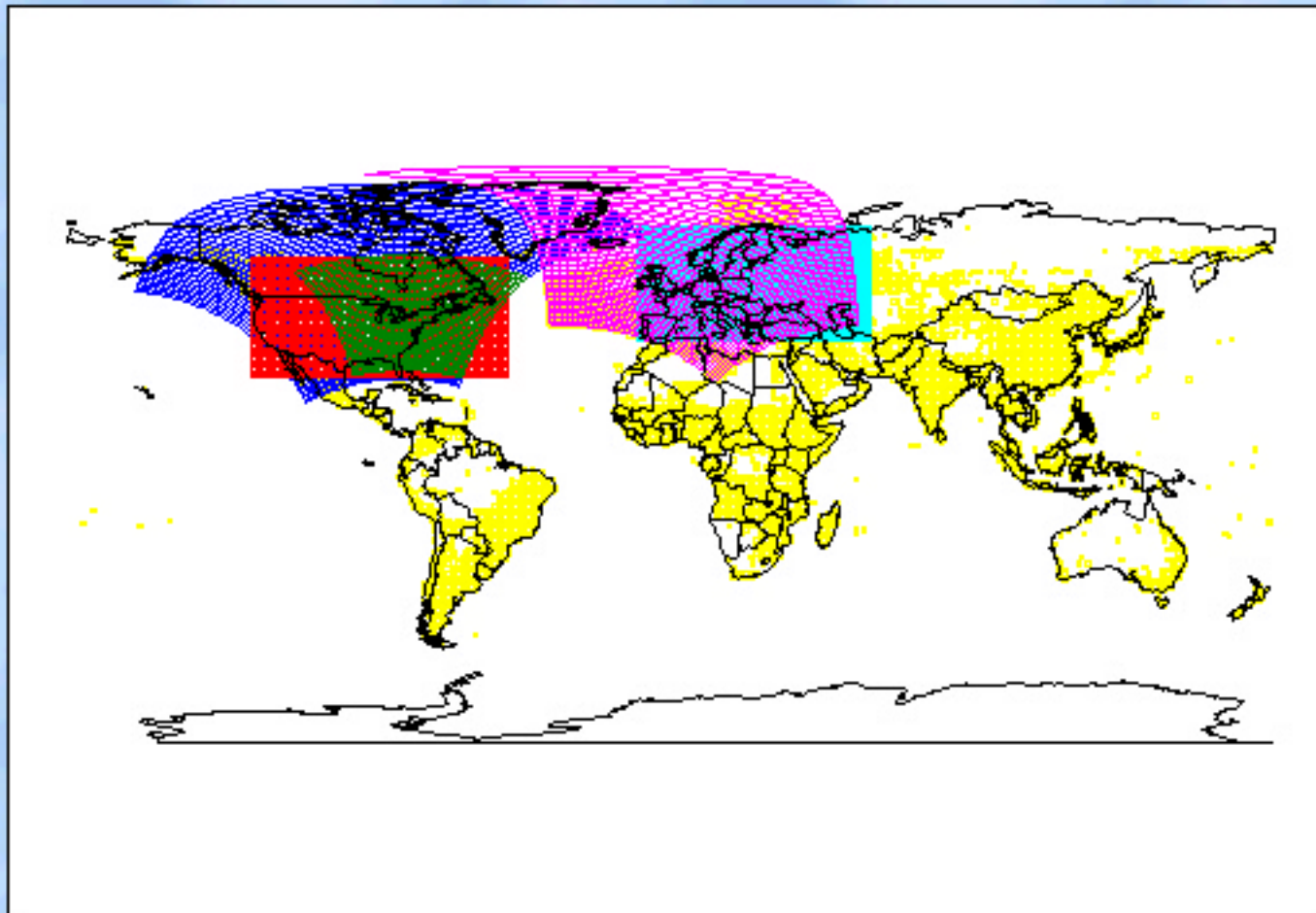
Environment Canada North American Polarstereographic Grid
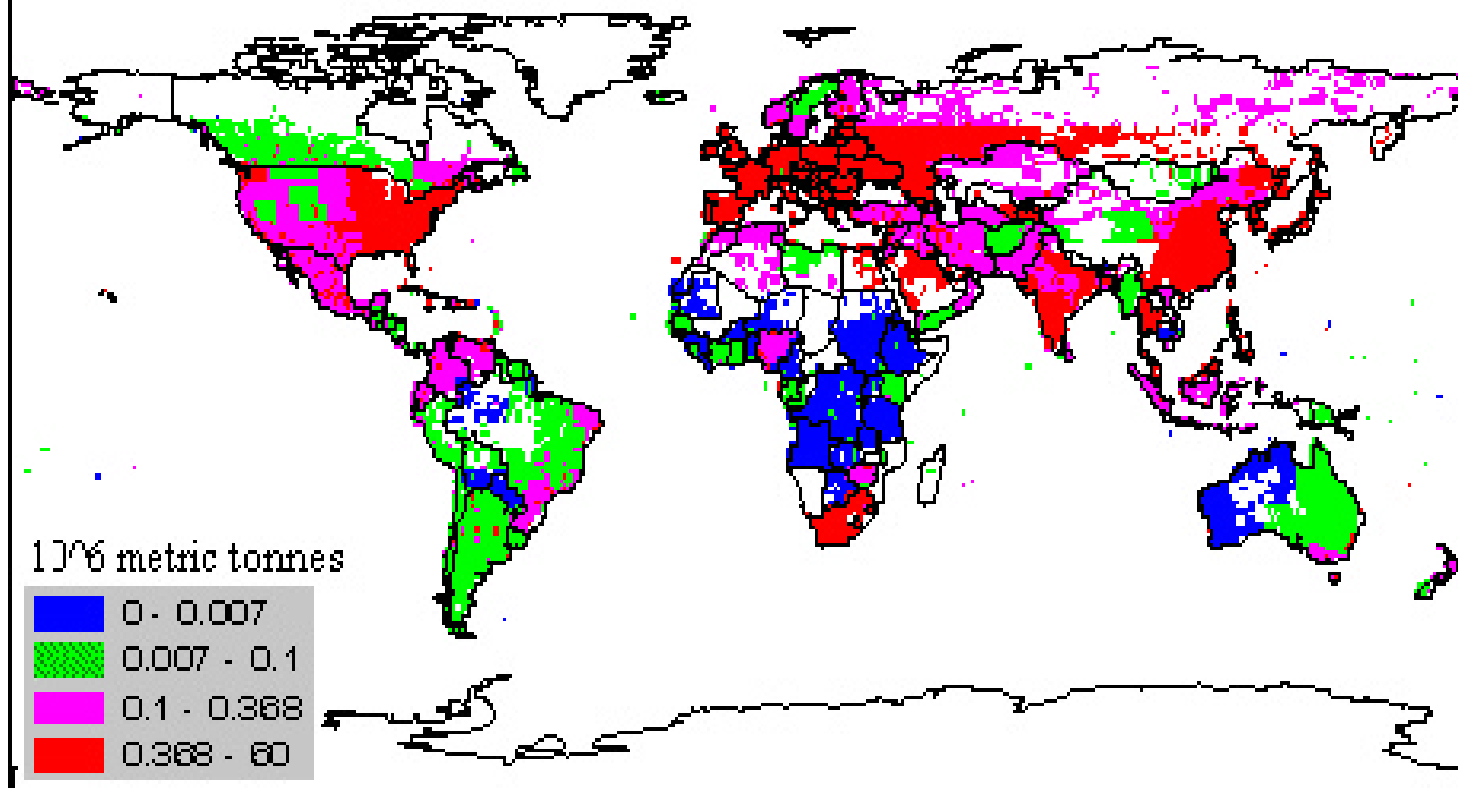
National Acid Precipitation Assessment Program (NAPAP)

Canadian Acid Deposition and Oxidants Model (ADOM)

EMEP

LOTOS Grid

GEIA CO2 Inventory

1990 Annual CO2

10^6 metric tonnes

- 0 - 0.007
- 0.007 - 0.1
- 0.1 - 0.368
- 0.368 - 60

GEIA QA

- **International teams are developing data and updates**

- **Peer review is required for each GEIA inventory**

- **Consistency checks are done for data transferred to the web site**

- **User comments on data are relayed to project directors**

- **Guidelines for checking data are provided**

- **Teams are being formed to review new emissions information***

- **Work with modelers is helping improve GEIA contributions***

* Ongoing improvements

New Initiatives (2001 & Beyond)*

- **Interact more closely with modelers**

- **Expand emission information provided by GEIA**

*GEIA is seeking to increase the awareness, development
and exchange of versatile data systems and plans
in order to provide more useful information for studies of
Global change and related issues such as air quality.

GEIA Plans to Provide:

- References to non-GEIA data with descriptive comments

- Underlying data sets & algorithms used to derive emissions

- Clear definitions of emissions data and starting points for modeling

- Long term historical and future trends of emissions

- Information on seasonality of emissions

- References to key scenarios for future emissions

- More precise labeling of inventories

Please send your suggestions and comments to Paulette@rand.org

GEIA Plans to Enhance Collaboration With GIM and Others

- Hold joint meetings with GIM and other groups

- Produce state of emission science summaries

- Develop strategies for improving emissions data

- Summarize GEIA and non-GEIA data differences

Working together with researchers
Around the world to develop
Improved assessments of
Global Change and

Related Concerns