

Addressing Science and Policy Needs with Community Emissions Efforts

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CIERA

Community Initiative for Emissions Research and Applications

The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect the views of NOAA or the Department of Commerce.

Acknowledgements



Global Emissions Initiative

<http://www.geiacenter.org/>



Leonor Tarrasón (*Chair*), Gregory Frost (*Chair*), Beatriz Cardenas, Hugo Denier van der Gon, Claire Granier (*Past Chair*), Alex Guenther (*Past Chair*), Greet Janssens-Maenhout, Johannes Kaiser, Terry Keating, Zbigniew Klimont, Jean-Francois Lamarque, Catherine Liousse, Paulette Middleton (*Network Manager*), Slobodan Nickovic, Toshimasa Ohara, Martin Schultz, Ute Skiba, John van Aardenne, Yuxuan Wang

Emissions of atmospheric Compounds & Compilation of Ancillary Data

Claire Granier, Catherine Liousse, Sabine Darras, Aude Mieville, Vincent Pignot

<http://ether.ipsl.jussieu.fr/eccad>



Community Initiative for Emissions Research and Applications



<http://ciera-air.org/>

Gregory Frost, Stefan Falke, Claire Granier, Ann Keane, Terry Keating, Jean-François Lamarque, Megan Melamed, Paulette Middleton, Gabrielle Pétron, Steven Smith



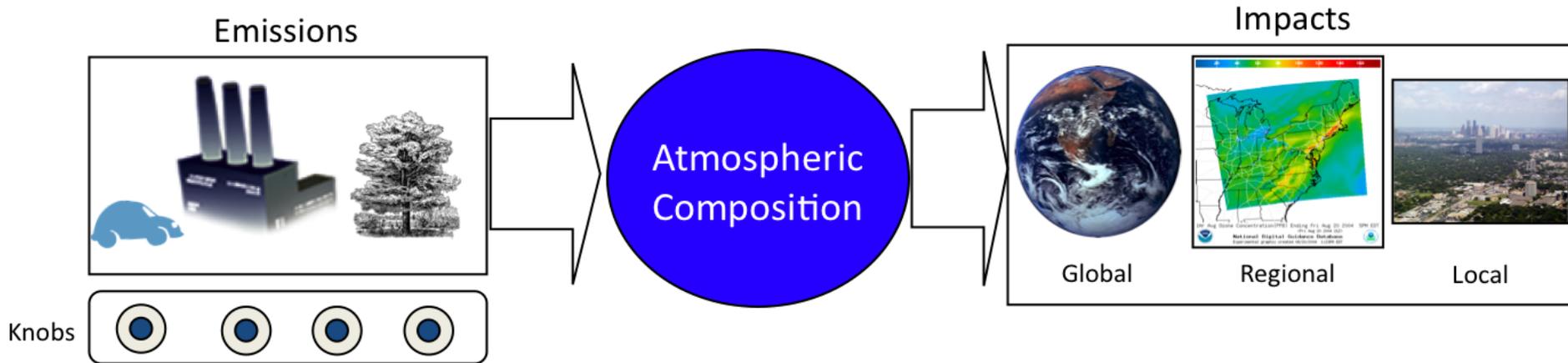
Outline

- Emissions information challenges
 - Global and regional examples
- Emissions evaluations and approaches
 - Examples of top-down evaluations
- Overview of community emissions efforts
 - GEIA
 - ECCAD
 - CIERA



Motivation for Understanding Emissions

Actions and decisions about the atmosphere focus on emissions



Quantitative emission information is needed for:

- Accounting for the past
- Observing and calculating the present
- Predicting and projecting the future
- Taking action on emissions
- Making choices: Which “knob” to turn? Is one better than the other?

➤ **Do current emissions data meet our needs?**

➤ **How can these data be improved while maximizing sparse resources?**

Emissions Information Challenges

Many emissions data requirements are common to air quality and climate research, regulation, & policy

- Transparency
- Accuracy
- Uncertainty
- Consistency
- Timeliness

At the same time, there are many issues and needs associated with emissions data

Complexity

- Spatial/temporal scales
- Source types
- Interdisciplinary

Development

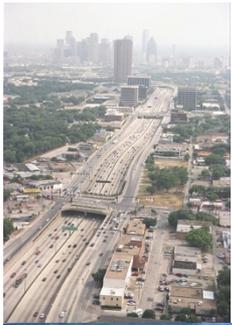
- Inconsistencies
- Timeliness
- Traceability

Analysis

- Evaluations
- Uncertainties
- Impacts

Communication

- Data access and sharing
- Literature access
- Producer – user feedbacks



Bottom-up Inventory Methodology

Inventories are an amalgam of calculations and measurements

Total mass emissions of compound X

$$E_X = \sum_S [EF_{X,S} \cdot A_S \cdot (1 - CE_{X,S})]$$

Sum up all sources S

Emissions factor = mass of compound X emitted by source S per unit activity; “representative” measm’ts or estimated

Activity of source S, e.g., amount of fuel burned, vehicle miles driven, etc.; measured or estimated

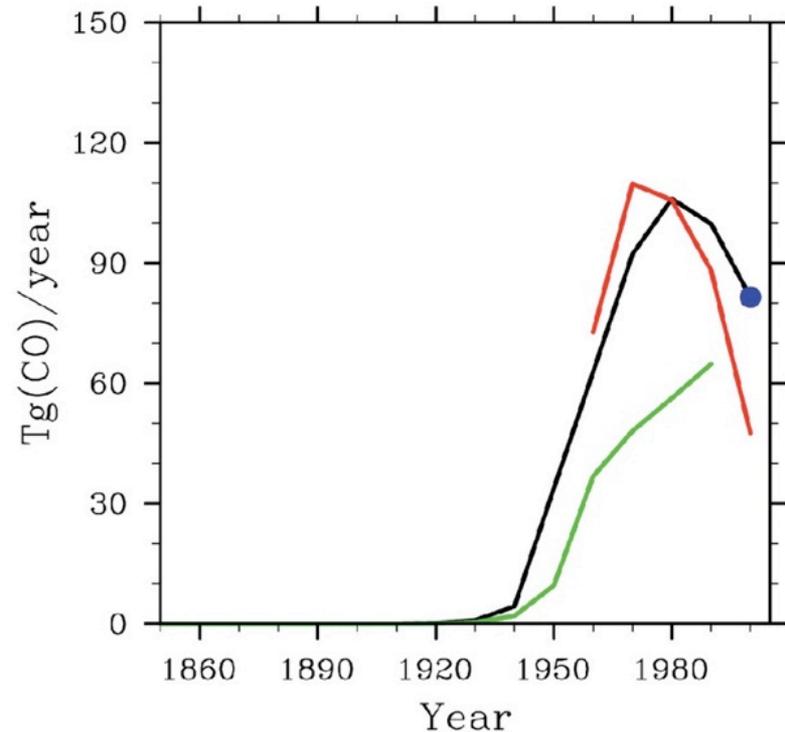
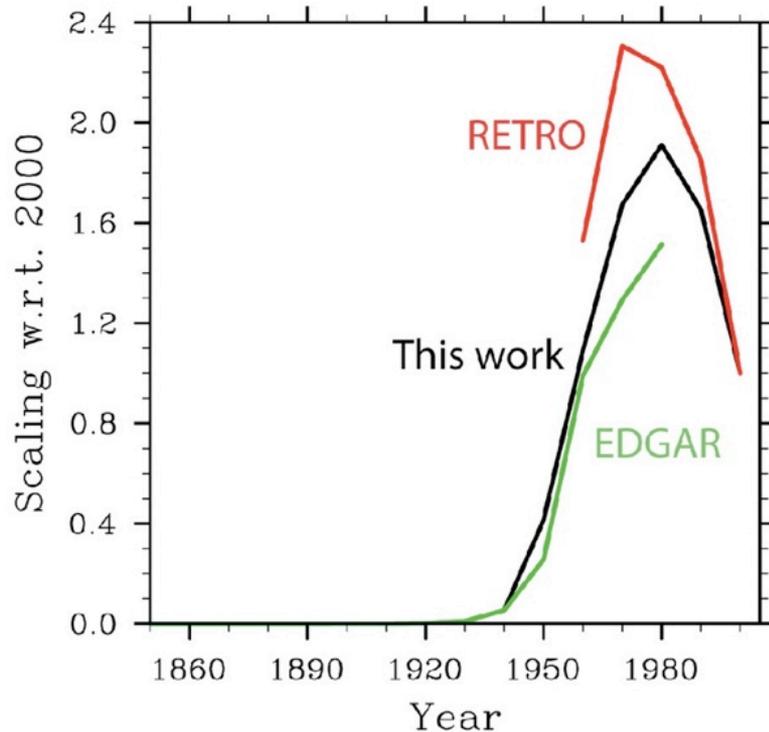
Effectiveness of control measures for cmpd X at source S; estimated or “representative” measm’ts

Above calculation carried out over a particular geographic region (usually national scale, or state/county) for a specific time period (usually annual or monthly)

Additional steps usually needed to use inventory in modeling or analysis

- **Spatial Allocation:** gridding, spatial scaling
- **Temporal Variability:** between and subdivisions of inventory periods
- **Temporal Extrapolation:** projections, scenarios
- **Speciation:** VOCs, PM, ...

Inconsistencies in Global Inventories



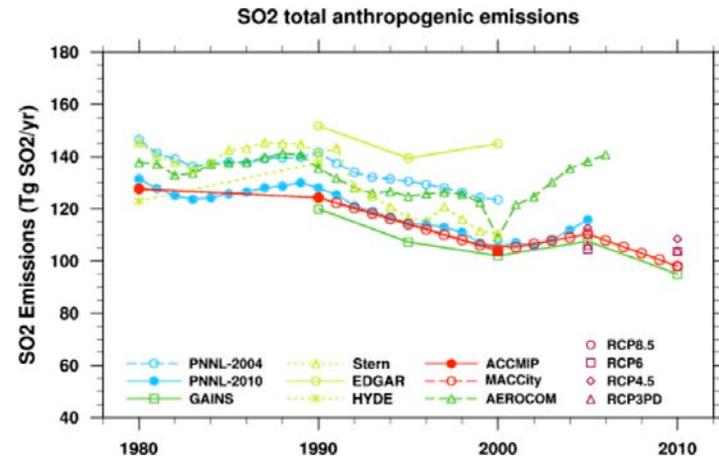
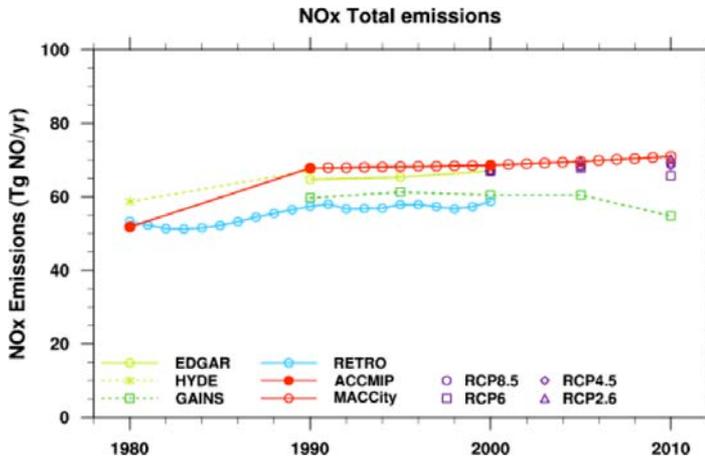
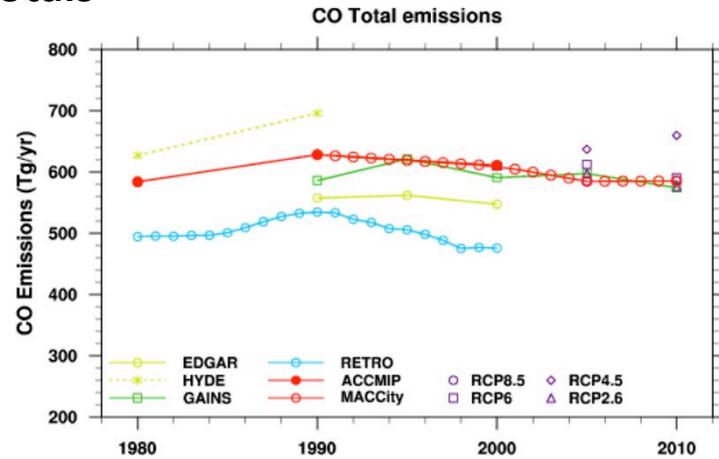
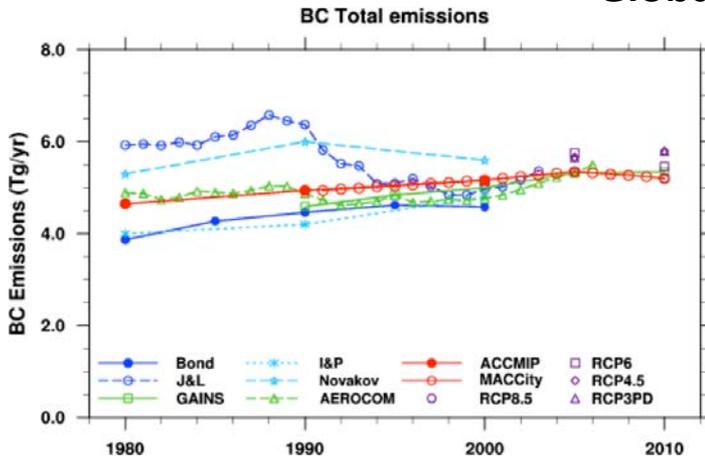
ACCMIP Emissions for IPCC AR5

- IPCC 5th Assessment work in progress
- Needed consistent 1850-2000 inventory
- 2000: Scenarios begin
- Different initial inventories give different emissions estimates
- Reconciliation necessary

Global Inventory Comparisons

Global inventories developed around the world show large differences for most pollutants (*see previous talk*)

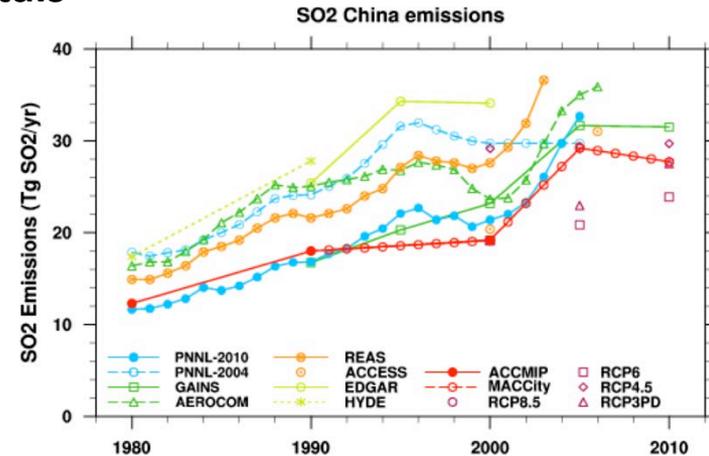
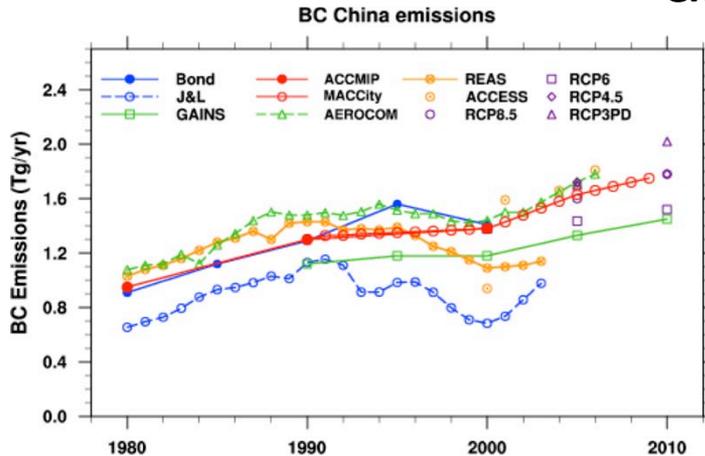
Global Totals



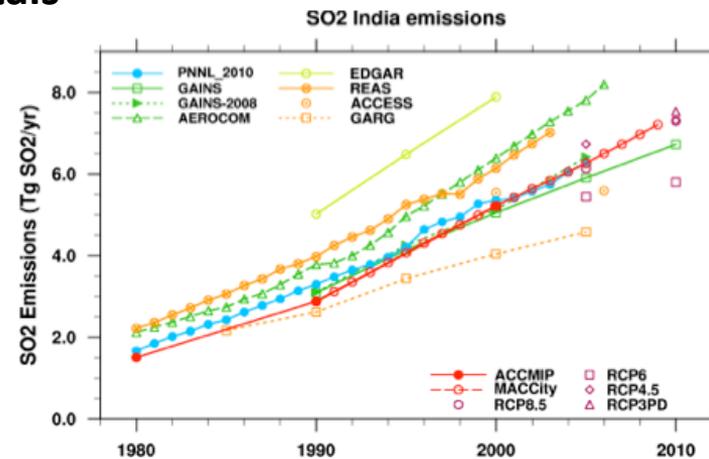
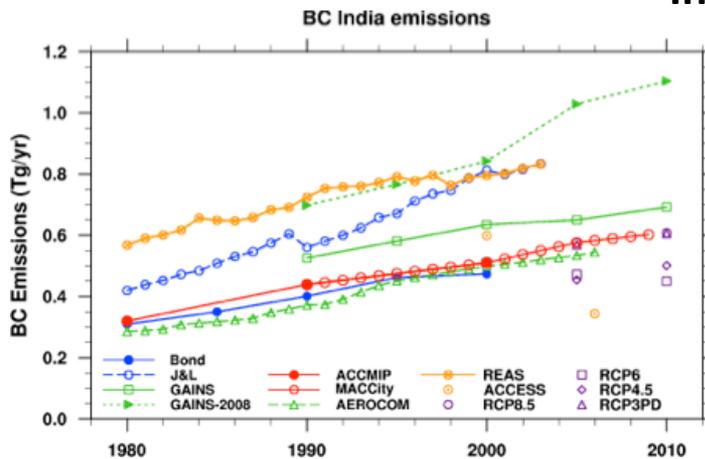
Regional Inventory Comparisons

Regional inventories show even larger differences for some pollutants
(see previous talk)

China Totals



India Totals



Emissions Evaluations and Approaches

Inventories

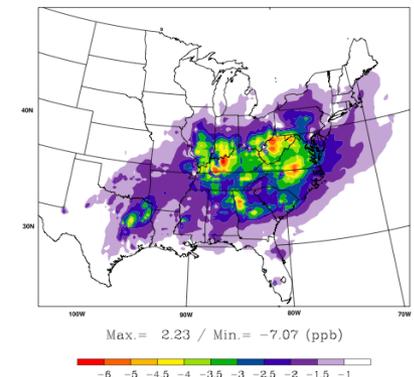
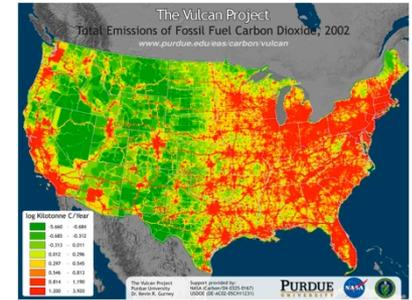
- Consistent inventories for all pollutants relevant to air quality and climate more common
- Alternative hybrid inventory methods now available

Inventories + Observations

- Combination of observing platforms provide data useful for emissions evaluations
- Evaluate inventories using observations
 - Relative and absolute fluxes of pollutants
 - Spatial distributions of emissions
 - Temporal variability
 - Speciation

Inventories + Observations + Models

- Direct and inverse models aid emissions evaluations
- Models needed to understand AQ/climate impacts of emissions changes and feedbacks

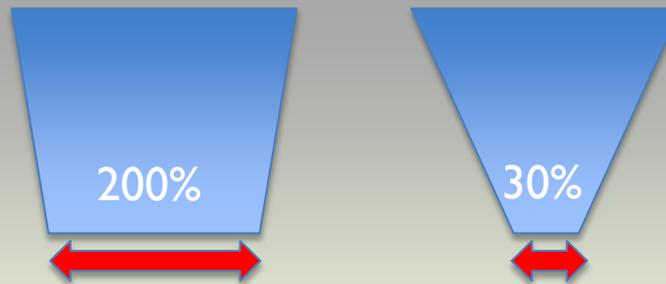


Top-Down vs. Bottom-Up Emissions Approaches

Top-Down

Research atmospheric measurements and modeling

- Sector specific
- Time specific
- Speciated
- Regional or global scales
- **Wide range of uncertainties**

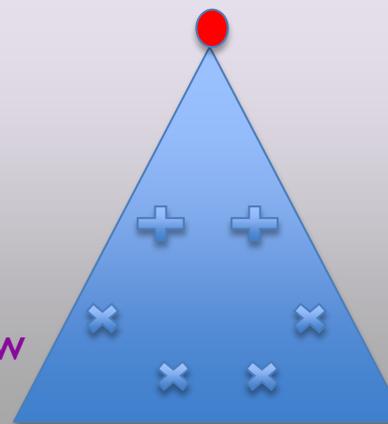


Relies on high quality atmospheric measurements of trace gas enhancements and measurements or modeling of the atmosphere mixing and wind characteristics

Bottom-Up

Regulatory or research emissions inventories

- Sector specific/process specific
- Time specific
- Not always speciated (total VOCs)
- Regional or global scales
- **Uncertainty estimates usually non-existent or low**
- **Rarely up-to-date**



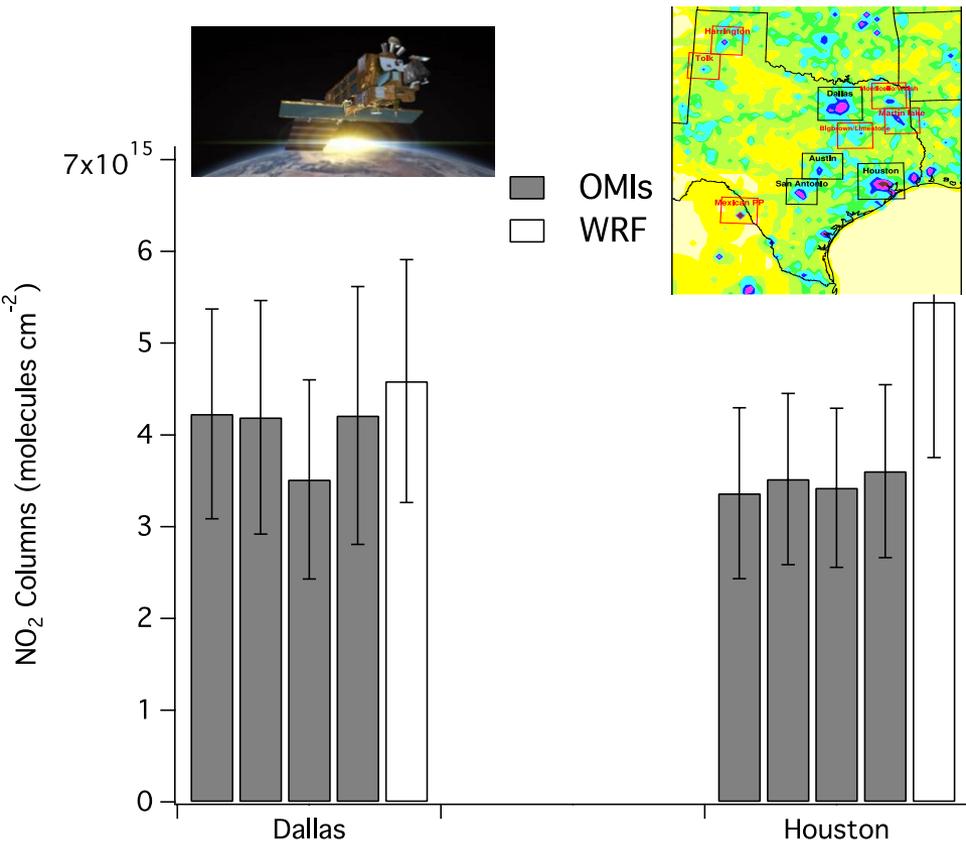
Relies on high quality activity data (routine and non routine), emissions factors, estimates of control effectiveness

Inventories Evaluated by Satellite and Aircraft Data

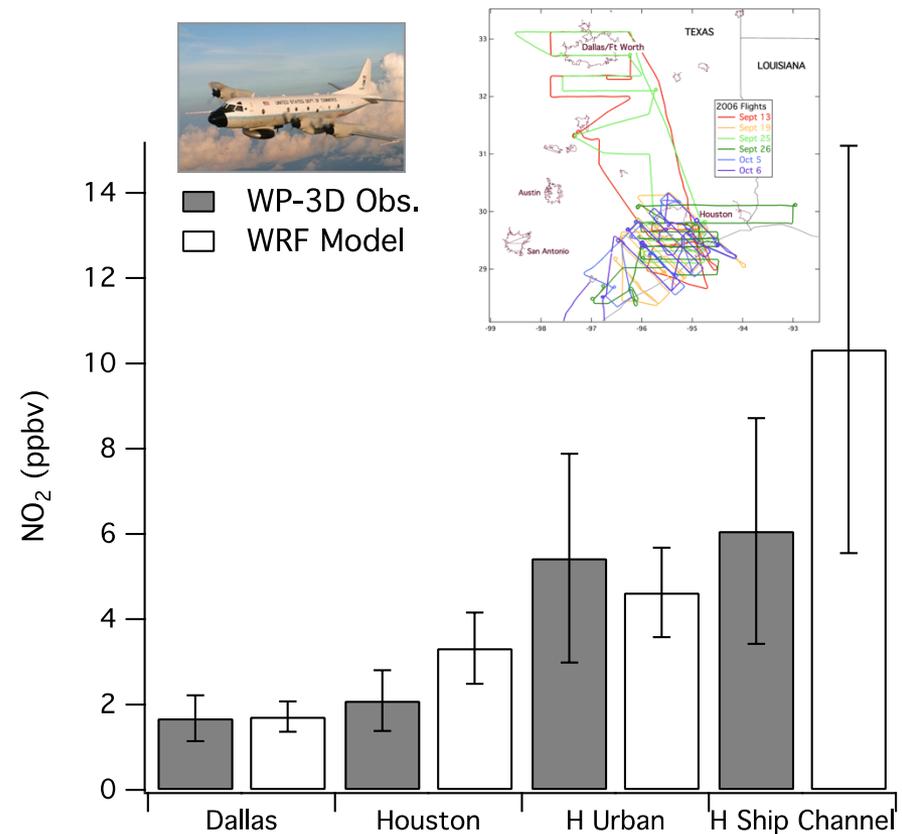
Dallas & Houston NO_x emissions

- Observations consistent with NEI urban NO_x emissions when onroad sources dominate
- Top-down analysis highlights NEI biases in industrial point & in-port shipping sources

Satellite (OMIs) vs. Model (WRF/Chem) NO_2



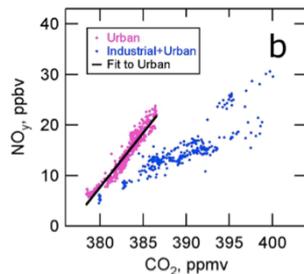
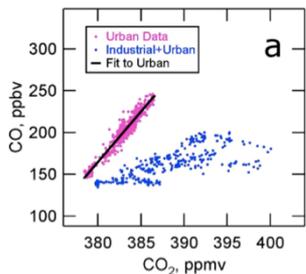
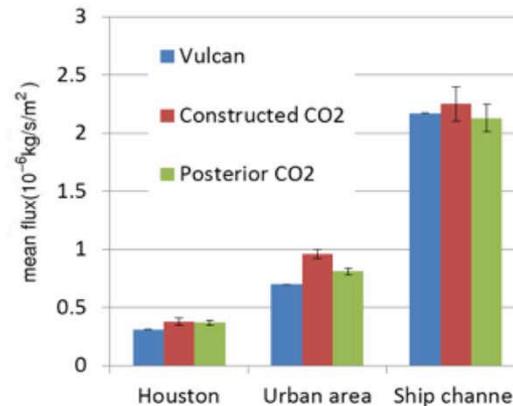
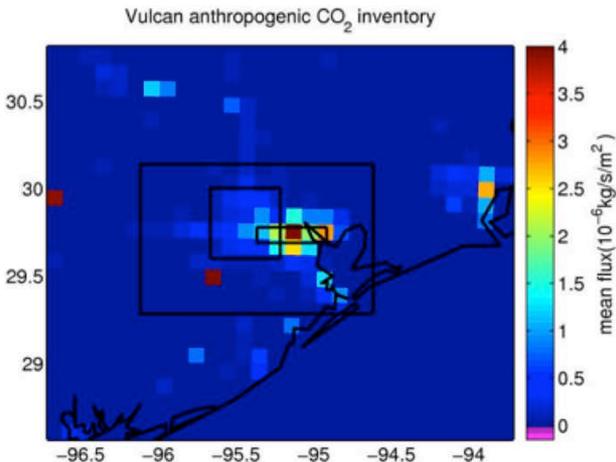
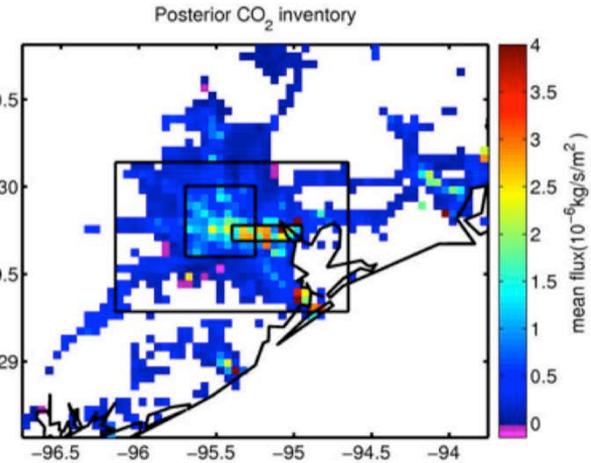
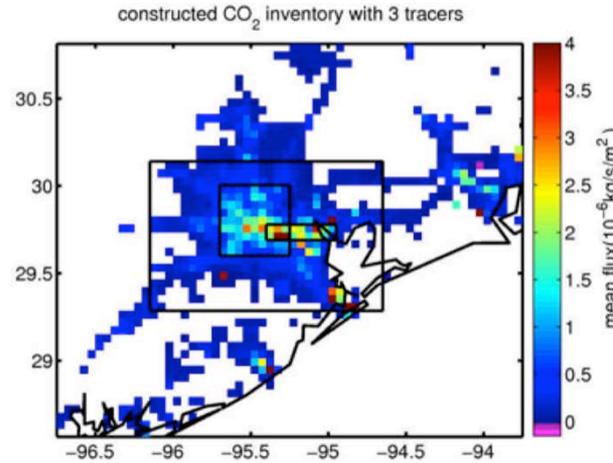
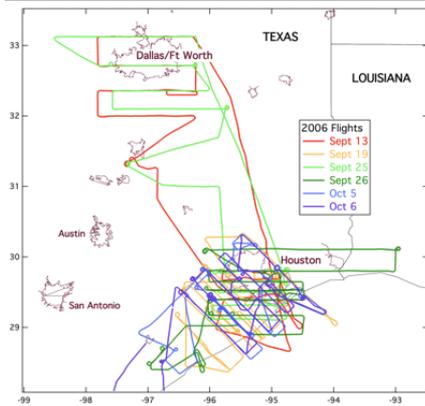
Aircraft (WP-3D) vs. Model (WRF/Chem) NO_2



Inverse Modeling of Emissions Using Aircraft Data

Houston fossil-fuel CO₂ emissions calculated without a prior

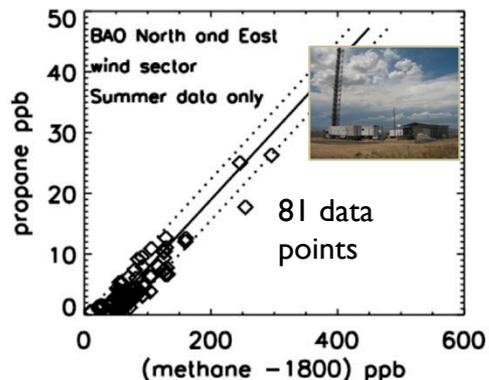
Inverse modeling using correlated observations of combustion tracers (CO, NO_x, SO₂, CO₂) allows estimate of CO₂ emissions without the use of an explicit CO₂ inventory



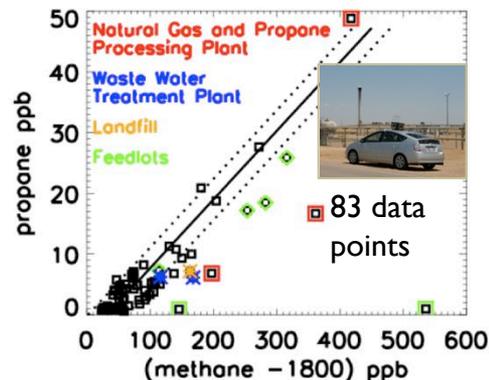
Emissions Inferred from Tower and Mobile Sampling

Inferred natural gas CH₄ leak rates in Colorado

BAO N&E winds



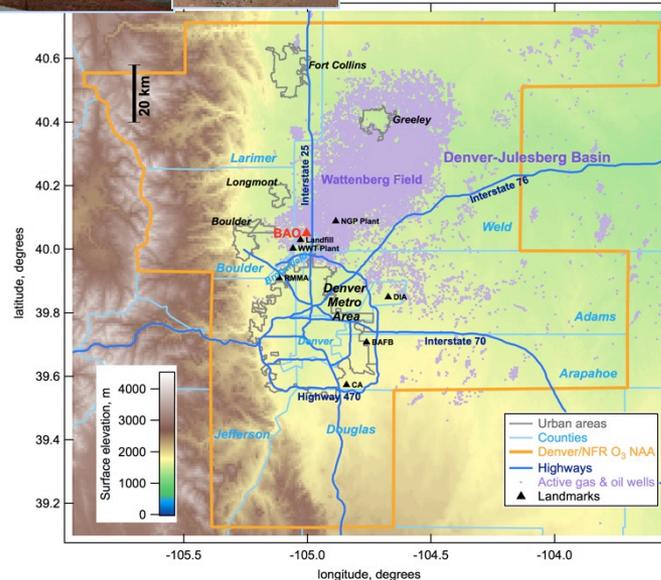
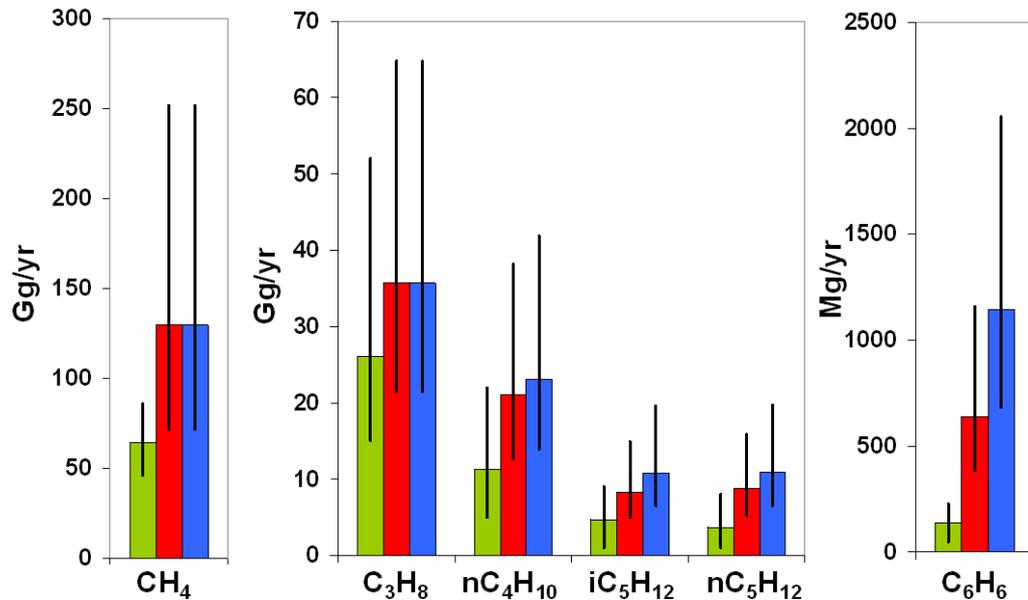
Mobile Lab



Atmospheric observations point to inventory underestimates of hydrocarbon leakage from production in Colorado oil & natural gas basin

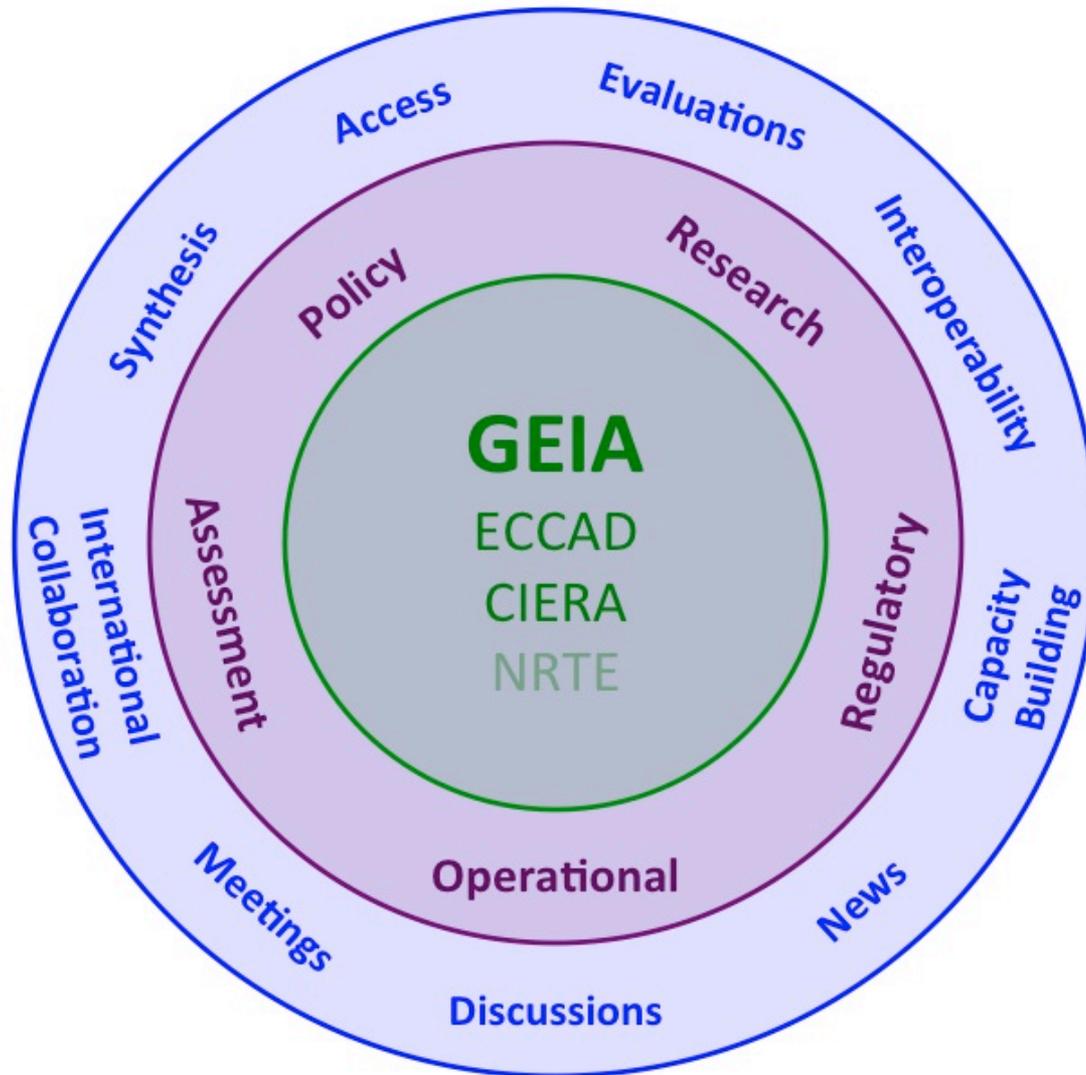


■ Bottom-up ■ BAO- Top-Down ■ Mobile Lab-Top-Down



Pétron et al., JGR, 2012

GEIA Communities & Functions



Bringing together people, data and tools to create the highest quality information on global exchange processes

Global Emissions Initiative

IGBP/IGAC/iLEAPS/AIMES initiative

Mission since 1990

- Quantify anthropogenic emissions & natural exchanges of trace gases & aerosols
- Facilitate use of this information by research, assessment, & policy communities

Ongoing Activities

- Provide consistent access to global and regional emission inventories
- Organize meetings & schools for inventory developers and users
- Facilitate emissions data evaluations and assessments
- Prepare state-of-the-science emissions summaries
- Support international scientific projects

New Directions

Demonstrate potential of improving inventories

- Promote interoperability of datasets & tools
- Make use of near-real-time observations

Funding: NASA, EU programs

Current chairs: Greg Frost, Leonor Tarrasón

Past chairs: Claire Granier, Alex Guenther

Network manager: Paulette Middleton

Steering Committee: Newly formed in 2012

GEIA Network



~1300 data developers and users

GEIA Steering Committee, 2012-2014

Leonor Tarrasón (<i>Chair</i>)	NILU, Norway
Gregory Frost (<i>Chair</i>)	NOAA & Univ Colorado, USA
Beatriz Cardenas	INE, Mexico
Hugo Denier van der Gon	TNO, The Netherlands
Claire Granier (<i>Past Chair</i>)	CNRS & UPMC, France
Alex Guenther (<i>Past Chair</i>)	NCAR, USA
Greet Janssens-Maenhout	JRC, Italy
Johannes Kaiser	ECMWF, UK
Terry Keating	EPA, USA
Zbigniew Klimont	IIASA, Austria
Jean-Francois Lamarque	NCAR, USA
Catherine Liousse	Laboratoire d'Aérodologie, France
Paulette Middleton (<i>Network Manager</i>)	Panorama Pathways, USA
Slobodan Nickovic	WMO, Switzerland
Toshimasa Ohara	NIES, Japan
Martin Schultz	FZ Jülich, Germany
Ute Skiba	CEH, UK
John van Aardenne	EEA, Denmark
Yuxuan Wang	Tsinghua University, China

Emissions of chemical Compounds & Compilation of Ancillary Data

GEIA's new interactive emissions data portal

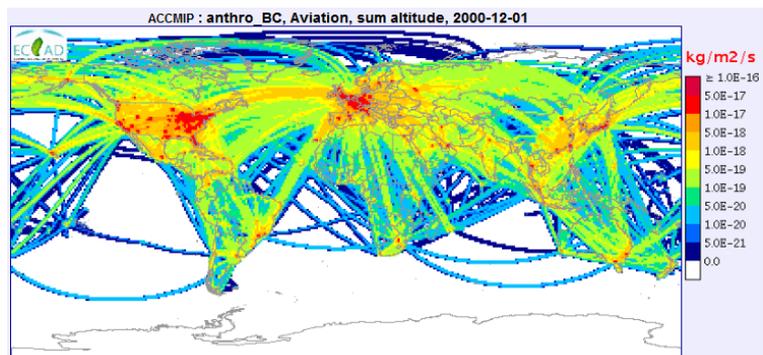
Consistent access to GEIA's inventories and ancillary data

with easy-to-use tools

Supports EU science & forecasting projects

Funding: French National Center for Space Studies

PIs: Claire Granier, Cathy Liousse

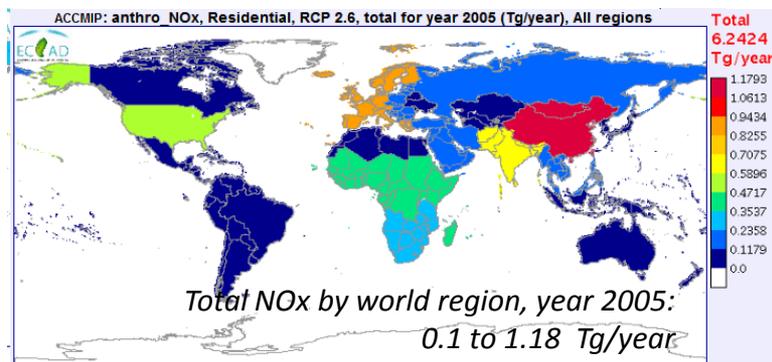
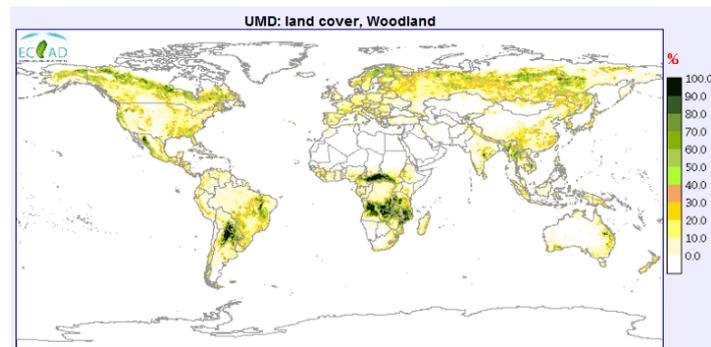


Emissions Inventories

Relational database with all inventories previously in GEIA and most recent global and regional inventories

Ancillary Data

Access to ancillary data used to construct emissions inventories: population, vegetation, & fire data



Interactive Graphical Tools

Online maps, time series, and data analysis

ECCAD Datasets



THE ECCAD - GEIA DATABASE

LOGIN

Enter
[Not yet registered?](#)

Emissions of atmospheric Compounds & Compilation of Ancillary Data

Data Catalogue
Data Visualization
Emission Calculation

Emissions Inventories

■ Anthropogenic
■ Biomass burning
■ Natural

GLOBAL INVENTORIES	REGIONAL INVENTORIES
<ul style="list-style-type: none"> ■ ACCMIP RCPs EDGARv4.2 EDGARv3.2FT2000 RETRO ■ MACCity Assamoi-Liousse Junker-Liousse HYDE1.3 Andres_CO2 AMAP_Mercury ■ GFASv1.0 GFED3 GFED2 GICC AMMABB ■ MEGANv2 MEGANv2-CH3OH ■ POET <p style="text-align: center; color: gray;"><i>Developed for ongoing projects</i></p> <ul style="list-style-type: none"> ■ IS4FIRES ■ GUESS-ES 	<ul style="list-style-type: none"> ■ TNO-MACC (Europe) EMEP (Europe) SAFAR-India (India) REAS (Asia) <p style="text-align: center; color: gray;"><i>Developed for ongoing projects</i></p> <ul style="list-style-type: none"> ■ ChArMEx (Mediterranean)

Ancillary Datasets

LAND COVER	FIRES	POPULATION	GEOGRAPHICAL INFORMATION
<ul style="list-style-type: none"> ■ UMD CLM3 GLC2000 	<ul style="list-style-type: none"> ■ WFA GEOLAND GBA2000 	<ul style="list-style-type: none"> ■ GPW3_Population 	<ul style="list-style-type: none"> ■ GPW3 Region_IMAGE2.4 Pixel_Area

Home

Data Catalogue ▶

Data Visualization ▶

Emission Calcul. ▶

Project Users ▶

Partners











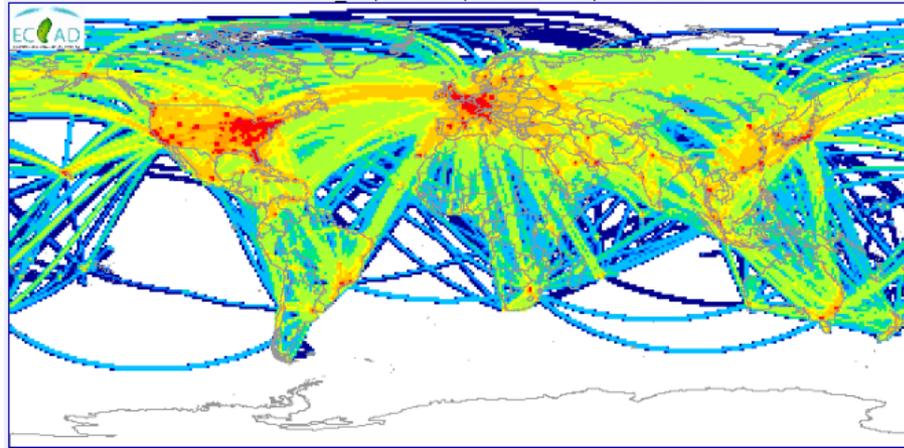
This site is developed and tested with Firefox and Chrome

ECCAD v6.2.2 ©2006-2012 CNRS/SEDOO

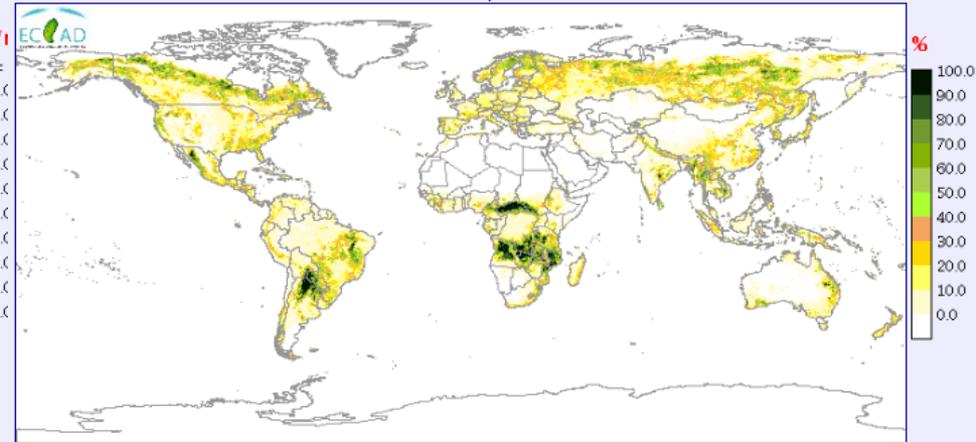
<http://ether.ipsl.jussieu.fr/eccad>

ECCAD Maps & Tools

ACCMIP : anthro BC, Aviation, sum altitude, 2000-12-01



UMD: land cover, Woodland

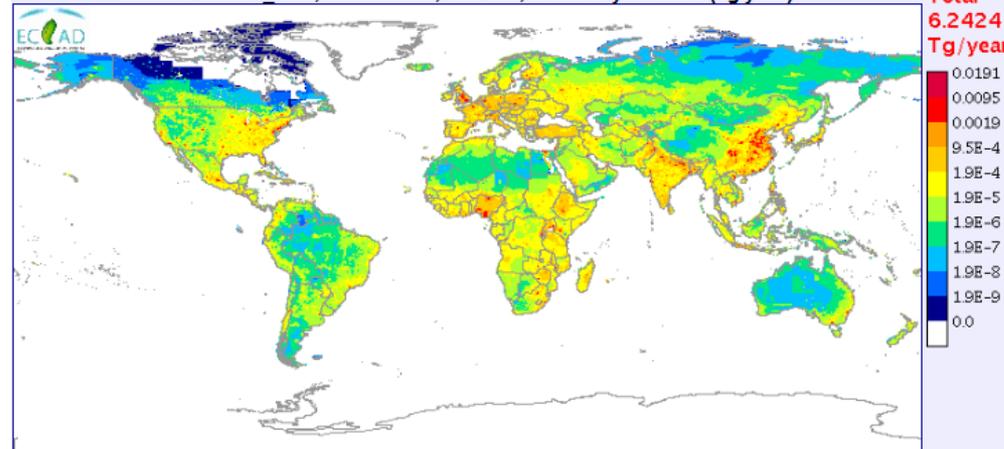


Global Totals

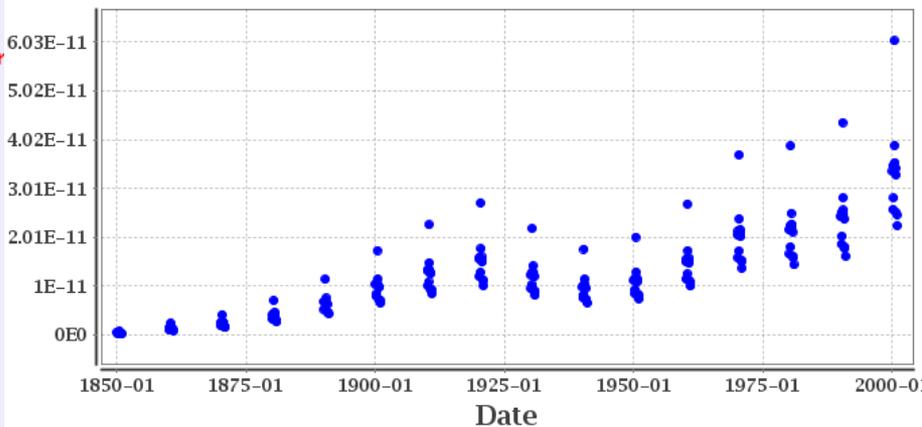
NO_x, Residential, year 2005: 6.24 Tg/year

NO_x, ships, 1850 to 2000, over strait of Gibraltar

ACCMIP: anthro NO_x, Residential, RCP 2.6, total for year 2005 (Tg/year)



anthro_NO_x, Ships : ACCMIP



Temporal profile at 35.75 / -5.75 from 1850-01-01 to 2000-12-31

Community Initiative for Emissions Research and Applications

Holistic community effort to improve emissions information

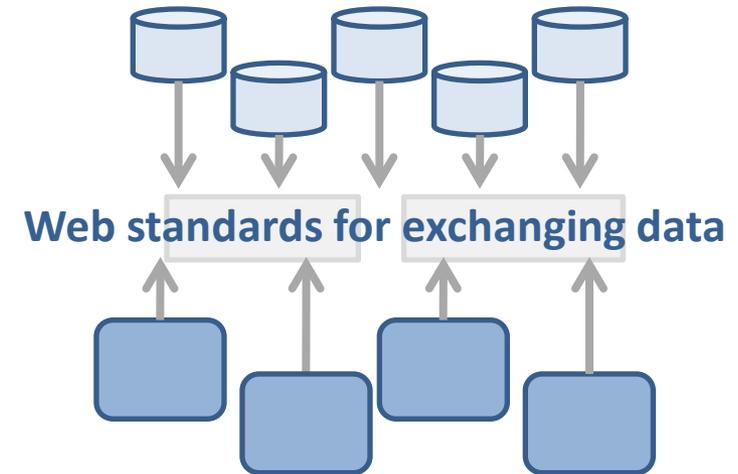
GEIA's new emissions collaboration space

- Developing interoperability
- Facilitating evaluations
- Innovating in communication
- Community developed and driven

Emissions information resources

- Sharing analyses
- Blogs and web forums
- Emissions bibliography
- Emissions lexicon

Distributed Emissions Data System Inventories, observations, model output



Standardized tools to visualize, analyze data

Support: EPA, NOAA, ESIP

Working Group: Greg Frost, Stefan Falke, Claire Granier, Ann Keane, Terry Keating, Jean-François Lamarque, Megan Melamed, Paulette Middleton, Gabrielle Pétron, Steven Smith

CIERA - Using Emissions Web Services

Standardized web service access to emissions data allow them to be used in online tools

EDGAR HTAP Source Data		
	ASCII	NetCDF
Sulfur Dioxide	2000	2000
	2001	2001
	2002	2002
	2003	2003
	2004	2004
	2005	2005

Web page for data file download

Each web link is a call to a web service, dynamically creating and accessing the netCDF file

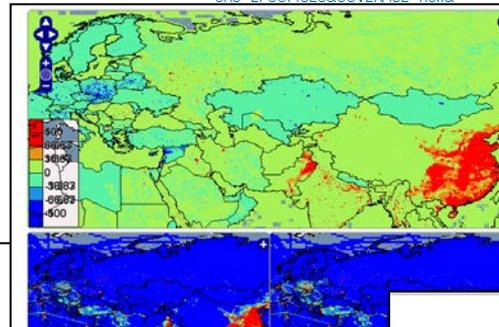
EDGAR-HTAP Data Browser			
View	Edit	Outline	Track
Select values for the filters available to format the EDGAR-HTAP data.			
Parameter:	NOx		
Year:	2001		
Sector:	Total		
Format:	CSV		
Area:	<input checked="" type="radio"/> Preset <input type="radio"/> Custom		
	World		
<input type="button" value="Get Data"/>			

Web form for data access

Form input is used to create web service call for data

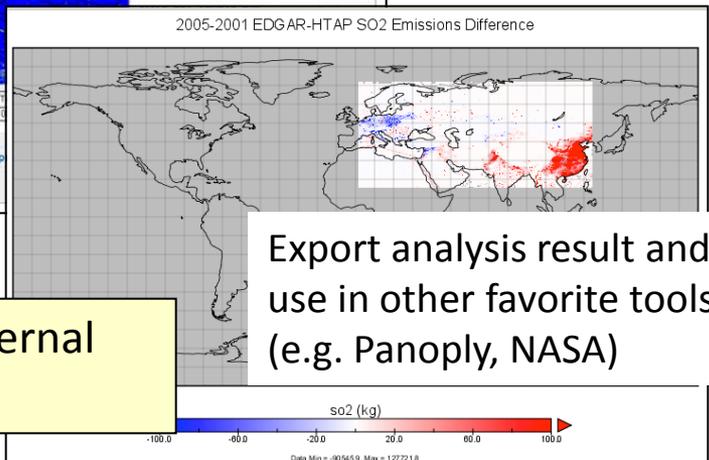
Request Url:(Toggle)
http://webapps.datafed.net/cov_345072.ogc?SERVICE=WCS&REQUEST=GetCoverage&VERSION=1.0.0&CRS=EPSG:4326&COVERAGE=nox&

Application controls make calls to web services for maps and data



Emissions Co
In the maps, select the datasets to compare. Set your comparison expression and calculate the results to be shown in the map to the left. More info
Expression: []
Scale: 100 100
Resolution: use coarser
<input type="button" value="Calculate"/> <input type="button" value="Export"/> <input type="button" value="Save Analysis"/>
<input type="button" value="Options"/> <input type="button" value="Open Analysis"/> <input type="button" value="Help"/>

Web application for visualization, analysis



Export analysis result and use in other favorite tools (e.g. Panoply, NASA)

Export to external application

Air Quality Community of Practice

Practice http://wiki.esipfed.org/index.php/GEO_AQ_CoP

Log in

page discussion view source history

GEO AQ CoP



GROUP ON EARTH OBSERVATIONS

Air Quality Community of Practice



The GEO AQ CoP is a self-organized voluntary group that fosters the application of Earth observations to air quality management and science. Its participants and its main beneficiaries are members of national and international science teams, data portals and decision support activities. CoP activities include sharing tools and best practices and facilitation of standards-based networking of air quality data systems using GEOSS data sharing principles.

News

- 2011-08-26: [Solta workshop](#) ended. Meeting notes can be found as edits of the [Agenda](#). Wiki pages about to be re-organized to facilitate finding of information.
- 2011-07-12: Data Network and Analysis Tools - HTAP & AQCoP
- 2011-06-26: [File:Solta AQNetwork 2011 Registration.doc](#) distributed
- 2011-06-21: [Solta 2011 Workshop Venue](#) described
- 2011-06-13: [Multiple versions of data - Discussion](#)
- 2011-05-12: [Workshop on AQ Data Networking, Announced, Pdf](#)

GEO AQ CoP Activities

- [Air Quality Data Network](#)
- [Community WCS server development](#)
- [AQ Community Catalog](#)
- [DataSpaces](#)
- [AQ Data Network Workshop, Solta, Aug. 2011](#)
- [CoP Reports to GEO User Interface Comm.](#)
- [AQ_CoP General Descriptions](#)
- [AQ_CoP Objectives](#)



navigation

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search

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toolbox

- What links here
- Related changes
- Special pages
- Printable version
- Permanent link
- Browse properties

Constituent Communities of AQ CoP

Data Portals
Science Teams
Decision Support
Facilitators

CoP General

Resources

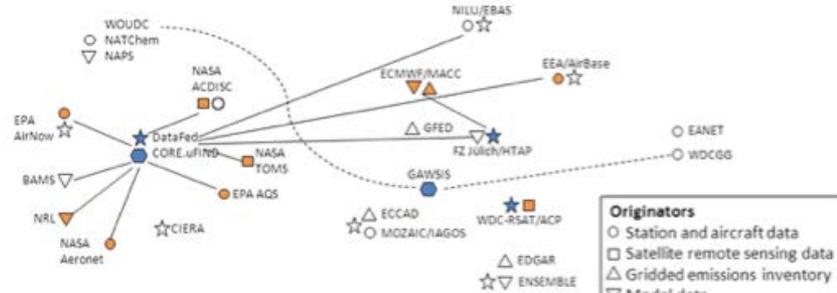
- [Tools and Methods](#)
- [DataSpaces](#) | [AQ Community Catalog](#)
- [CoP Resources](#)



CIERA is part of AQ CoP, an international community of data providers working on

- Common data structures
- Data standards & conventions
- Standardized tools

Network Status



- Originators**
- Station and aircraft data
 - Satellite remote sensing data
 - △ Gridded emissions inventory
 - ▽ Model data
- WCS distributors**
- ★ Active
 - ☆ Under development
- Other**
- WMS or WMS services
 - Catalogs
 - near realtime (max. 1 day)
 - delayed mode

Note: this graphics is still under development!

[Access catalogue](#)

GEIA Strategic Planning

GEIA is formulating a strategic plan for the next 5+ years, based on feedback from our 2012 GEIA Conference Town Hall and Steering Committee meetings.

Proposed GEIA focus areas:

1. Cross-regional Collaboration

- Building stronger links to emerging nations

2. Links to Regulatory Community

- Working closer with regulatory community to establish priority needs
- Determining how science community can better help meet those needs

3. Capacity Building

- Synthesizing the science and what it means
- Recommending best practices
- Providing access to relevant data
- Exposing new techniques
- Facilitating evaluations and assessments

4. Interoperability of Databases

- Improving access to inventories, observations, and models

Take-Home Messages

- High quality emissions information is critical to understanding the atmosphere and making good decisions about how to manage it
- Bottom-up methodologies are integral to these efforts, but there are challenges associated with these complex datasets
- Top-down methods based on observations and modeling provide alternative approaches to understanding emissions
- Community emissions efforts seek to bring together people, data and tools to provide the best information on emissions
- The research and regulatory communities need to work together for these emissions efforts to succeed
 - *Please contact the GEIA, ECCAD, & CIERA teams!*

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