Emissions Metadata Needs

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Presentation Overview

Emissions Data Definitions and Uses
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Emissions Information Definitions

Emissions = Inputs of constituents to the atmosphere

Inventory = Quantitative compilation of emissions

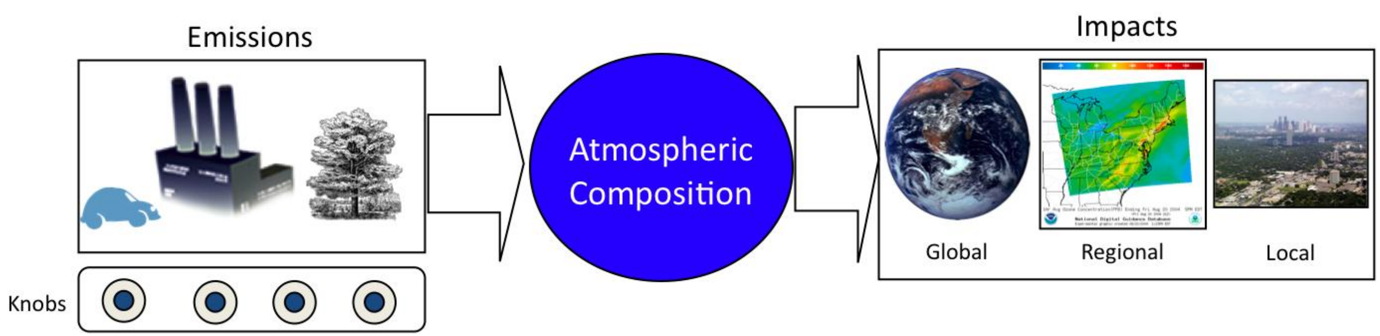
Uses of Emissions Information

Scientific Research

- Emissions affect atmospheric composition
- Impacts of atmospheric composition and its changes: air quality, climate change
- Inventories are input for atmospheric models
- Observations provide constraints on emissions inventories

Policy & Regulatory

- Inventories are regulatory and policy instruments
- Quantifying air quality and climate change
- Understanding impacts of changing emissions
- Actions and decisions about the atmosphere focus on emissions



Emissions Data Providers

"Official" emissions information

- Originates from government regulatory/environmental agencies, often in partnership with private sector

Examples:

UN, IEA

USEPA, USDOE, EMEP, Env. Canada, national environmental ministries

Regional or local environmental agencies

Research emissions information

- Official emissions information often not sufficient for scientific purposes
- Datasets for a variety of scientific purposes are produced by government agencies, academic institutions, and private sector

Examples:

JRC

NASA, USDOE, NOAA, USFS

ACCMIP, HTAP, AQMEII

Emissions Data Distributors

Data providers often provide their data through public portals

- Official distribution points for emissions data
- Data provided can have limitations: access, formats, traceability, timeliness
- Users may need to access several providers for completeness

Data clearinghouses seek to overcome some of these issues

- Aggregate emissions data sets
- Standardize data formats
- Supply data manipulation tools
- Facilitate objective evaluations
- *Examples:*

  GEIA - **G**lobal **E**missions **I**niti**A**tive
  http://www.geiacenter.org/

  ECCAD - **E**missions of atmospheric **C**ompounds & **C**ompilation of **A**ncillary **D**ata
  http://eccad.sedoo.fr

  CIERA - **C**ommunity **I**nitiative for **E**missions **R**esearch and **A**pplications
  http://ciera-air.org/

Inventory Methodology

Inventories are an amalgam of calculations and measurements

Total mass emissions of compound X

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

Sum up all sources S

Emissions factor = mass of compound X emitted by source S per unit activity

Activity of source S, e.g., amount of fuel burned

Effectiveness of control measures for cmpd X at source S

Accumulate over specific geographic region
Calculate for specific time period
To use inventory in modeling or analysis, may need…

- Spatial allocation
- Temporal variability
- Temporal extrapolation
- Speciation

Emissions Data Dimensions

Dimensions common to earth science data

- Space
- Time
- Data Parameter

Additional dimensions specific to emissions data

- Pollutant
- Source Specification
- Source Aggregation

Emissions Data Considerations – Space

Domain

- Global, regional, local
- 2-D (surface) or 3-D (elevated sources)

Resolution

- Points: Large anthropogenic sources, volcanoes
- Line: Motor vehicles, aircraft, ships
- Area: National, state, county
- Gridded: Coarse (degrees) - fine (km), various projections & grids

Aggregation

- Inconsistent boundary & region definitions

Completeness

- Need to balance domain, resolution

Emissions Data Considerations – Time

Extent

- Days -> years -> decades -> centuries

Resolution

- Hourly -> daily -> monthly -> seasonal -> annual -> decadal

Reference

- Time standard: local vs UT?
- Time stamp: beginning or middle of interval
- Emissions data = accumulated totals for a time period: appropriate time stamp?

Existence

- Time variable may be missing in data/metadata

Emissions Data Considerations – Pollutant

Many possible pollutants

- Trace gases: e.g., CO, NOx, SO_2, VOC, CO_2, …
- Particulates: e.g., dust, PM2.5, BC, OC, sulfate, …
- Other species: CFCs, POPs, allergens (pollen)

Pollutants are application dependent

- AQ and climate species traditionally kept separate

Naming

- Many different names in common use
- Need comprehensive "dictionary"

Speciation

- Use of aggregated & specific pollutant categories: e.g., total VOC *vs.* methane, ethane, propane, …
- Speciation schemes are developer dependent
- General need for speciation cross-walks

Emissions Data Considerations – Source Specification

Type

- Anthropogenic – fossil fuel combustion, human & economic activity
- Biogenic – natural systems (vegetation, dust)
- Mixed - fires

Granularity

- Sector
  - Economic sector level is most commonly used
    e.g., mobile sources, industry, energy production
  - Difficult to connect sector categories between inventories
- Process
  - Detailed description of specific emissions process
    e.g., electricity generation with lignite coal using specific boiler + controls
  - Requires lots of information on emission factors and activities
  - Can aggregate process level information to produce sectors
  - But only used & reported in some inventories

Completeness

- Not all inventories include all categories
- Difficulty comparing different inventory emissions totals
- Difficulty understanding detailed differences between inventories

Emissions Data Considerations – Source Aggregation

Point

- Larger sources often treated individually in many inventories
  - E.g., power plants, factories, cement producers, …
  - Volcanoes: total emissions/eruption

Area

- Most other sources quantified over specific geographic region
  - County, state, nation, world
  - E.g., transport, residential, agriculture, etc.

Gridded

- Need to allocate point/area data to grids for modeling and analysis
- Use spatial proxies to convert point/area data to gridded data
  - E.g., population, road networks, etc.
- Spatial proxies are inconsistent between developers
- Lack of information on proxies for some sectors and regions

Emissions Data Considerations – Data Parameters

Methodologies

- Different approaches used by different developers
- Sector and pollutant dependent calculations
- Is it appropriate to compare estimates from different methods?

Units for emissions data

- Metric vs. other systems: e.g., tonnes vs. short tons or pounds
- Conversion of mass to number (molecular weight) for aggregated species

Multiple values

- Version control

Other Emissions Data Considerations

Documentation

- How emissions were estimated is as important as data themselves!
- Must be captured in metadata
- Inventory development information can be difficult to find

Accessibility

- Differences between providers
- Many data formats
- Public *vs.* proprietary data

Communication between regulatory and scientific community

- Different needs and cultures
- Two-way feedbacks difficult

Evaluation and assessment

- Objective evaluations using observations/models
- Check reliability of methodologies
- Need expert assessments of inventories

Some Closing Thoughts

- Emissions data have unique dimensions and considerations when compared with other earth science data
- There is a lack of consistency in many attributes of emissions data because of different developers, methodologies, and applications for these data sets
- Emissions metadata are not generally compliant with metadata standards for other types of earth science data
- Web services approaches for handling emissions data exist, but are still dataset specific in some cases
- More generic approaches to linking emissions data sets are needed
- Need to learn from other communities working with air quality metadata
- Need to link with other communities developing/using emissions, such as climate modeling groups, satellite observations, assessment/future scenarios, health, etc.