CONVENTIONAL EMISSIONS INVENTORIES: MAXIMIZING STRENGTHS AND MINIMIZING VULNERABILITIES

G. M. Hidy

Envair/Aerochem

Placitas, NM

Conventional Emissions Inventories

- Development of inventories follows established practice
- Built on 1970s “bottom up” method—product of emission rate x process input rate or activity x emissions control factor
- Data acquisition by “small” geo-political area (county), aggregated to state, national …
- For some sources (e.g. mobile sources) emissions models developed
- Some applications—requirements for space and time resolution, and uncertainty estimate

Use of Emissions Inventories

- **Variety of applications**
  - **Level 1. Source specific for permitting and compliance**
  - **Level 2. Urban are for local, state regional or provincial planning or tracking**
  - **Level 3. Industry-wide for specific processes or hardware characterization, emission controls or technology trends**
  - **Level 4. Country-wide for national and international issues**
  - **Level 5. Support for air quality modeling evaluating response to emissions and their changes in the future.**

<u>Level 5 is generally most demanding</u>

Emissions of Interest

- Criteria Pollutants—CO, SO_2, NO_x, O_3, and PM (PM_{10} and $PM_{2.5}$)
- Natural emissions (S compounds NO_x, VOC)
- For O_3 –special requirements for short duration NO_x estimates and VOC (non-methane)
- For PM—special requirements for primary PM sources, combined with precursors for PM formation (SO_2, NO_x, $>C_7$ VOC)
- Spatial and temporal specifications, and long term history and projections

CONVENTIONAL INVENTORIES

- Annual emissions inventories perhaps best documented
- National inventories for Canada, Mexico and the United States are useful for coarse comparisons between countries
- Certain commonalities by pollutant—elements of combustion, major industries and electricity production; fugitive emissions
- Urban emissions give somewhat more differentiation
  - Differentiation is important locally and regionally to "optimize" emission control strategies

CONVENTIONAL INVENTORIES

- **Emissions history is increasingly important**
- **Documentation of historical changes have become a significant factor with increased interest in estimating the response to change.**
- **Emissions projections are increasingly important for quantitative analyses of future air quality conditions—planning for attainment strategies depend on these estimates.**
- **North American countries give attention to the past and future emissions patterns, both nationally and regionally, but the reliability of estimates are questionable.**

CONFIDENCE LEVEL AND UNCERTAINTIES

- The debates continue about the quality and reliability of emissions estimates. To many these estimates are the "Achilles Heel" of air quality management practice.
- A variety of methods have been used to verify the reliability of inventories, including QC/QA of input data, increased source testing, and comparisons with ambient observations.
- One method has been formalized—source apportionment through receptor modeling.
- Another "formal" method—merging detailed emissions estimation with ambient data and modeling derived from Cass' work.
- (With some exceptions) uncertainty estimates are qualitative.
  - An example—NARSTO (2003) attempt for PM.

Qualitative Estimates of Uncertainty—e.g. Gases

Pollu-tant	Source	Method	Canada	U.S.	Mexico
SO2	Elec. Util.	CEM/AP-42	H	H	H
	Transportation	MOBILE/NR	M	M	L
	Industrial	AP-42	M	M	NA
	Natural (Reduced S)	Literature	L	L	L
NOx	Elec. Util.	CEM/AP-42	M-H	H	M
	Transportation	MOBILE/NR	H	H	M
	Industrial	AP-42	M	M	L
	Natural	BEIS	M	M	L

Qualitative Uncertainty Estimates—e.g. PM

Pollut-ant	Source	Method	Canada	U.S.	Mexico
PM10	Elec. Util.	AP-4.	M	M	M
	Transportation	MOBILE/NR	M	M	L
	Industrial	AP-42	M	M	L
	Natural	AP-42/Lit.	L	L	L
PM2.5	Elec. Util.	AP-42	M-L	M-L	NA
	Transportation	MOBILE/NR	L	M	NA
	Industrial	AP-42	L	L	NA
	Natural	AP-42/Lit.	L	L	NA

INTERPRETAION OF UNCERTAINTIES —e.g. PM

- **Conventional estimation issues; the source-ambient air interface.**
- **Improvements in conventional methods focuses on PM2.5 data, speciated VOCs and NH3**
  - **Natural emissions are also important**
  - **Large stationary sources improved through continued source testing and wider use of CEMs**
  - **Mobile sources in real conditions continue to be a concern; more on activity patterns, age and condition of "fleet".**
  - **Area sources, especially fugitive emissions, are concern for models because of linkages to meteorological and surface conditions.**

INTERPRETATION OF UNCERTAINTIES --e.g. PM

- **Source-ambient interface involves changes in emissions immediately on release.**
  - **Recent work notes the importance of a transition regime for combustion sources, especially for ultrafine particles, for improving dust emissions, and for modeling reversible fluxes at the ground interface (e.g. NOx and NH3)**
- **Speciation by source a major requirement to facilitate comparisons with ambient air observations.**

HOW WELL DO THE EMISSIONS SERVE THE USERS?

- **Level 1. Source Specific—Annual emissions generally reasonable for anthropogenic component in the US and Canada, except for the future projections. Mexico needs to continue its development of urban and area inventories to be comparable with Mexico City.**
- **Level 2. Urban area—Fugitive and area sources are generally weak for most cities, especially for Canada and Mexico.**
- **Level 3. Industry-wide –For the US satisfactory for stationary sources, but real world limitations for transportation. Canadian and Mexican data for industrial sources limited access and uncertain quality.**
- **Level 4. Country-wide—The US and Canadian emissions are generally satisfactory for national surveillance needs, except for projections; need more frequent emissions reports for tracking progress.**
- **Level 5. Models—As models become more sophisticated, the requirements for emissions models continue to be more stringent.**

WHERE DO WE GO FROM HERE?

- **Playing to Strengths**
  - **We have identified essentially all categories**
  - **Annual inventories serve many requirements by gov't and stakeholders for applications.**
  - **Source testing and process engineering have provided a useful base for estimation.**
- **Minimizing Weaknesses**
  - **A need for establishing "specifications" for each level—Are we there yet for most levels??**
  - **Air quality modeling also needs specifications.**
  - **Level of uncertainty and reliability vs. specifications to establish the basis for focusing on emissions as the "Achilles' Heel"**
  - **Issues at the source-ambient air interface need to be dealt with on a microscale.**
  - **On a macroscale, Canadian and Mexican rural or regional emissions and ambient air quality need to be determined to a "level of confidence".**
- **Importance of Innovative Ideas**
  - **Key—how do new ideas and methods fit into an established framework, or do we need a 'new framework"?**