

# Development of an "Open" Emissions Model

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# History Of Emissions Processors/Models

- EPS – Made in 1980's (Fortran)
  - Basic Functions of emissions processors
- EMS/ GEMAP Early 1990's (SAS)
  - Advanced functions including Biogenic and Mobile Models.
- SMOKE written in Mid 1990's (Fortran)
  - Sparse Matrix Speeds processing up

# What Do Emissions Modelers DO?

- Spend most of our time integrating new data into our models.
- Identifying problematic data
- Fixing anomalous data
- Reformatting data
- Understanding sources and quality of data
- A small fraction of our time is spent on execution

# What do emissions models do?

- Mostly Database Manipulation
  - Merge the area source inventory with an SCC temporal profile table.
- Generally not calculation intensive
  - Exception Mobile6
- Fairly simple calculations if you can understand the data sources

# Problems with Existing Models - EMS

- Troublesome
  - SAS is very costly(\$18,000+) in small organizations
  - Intermediate file retention slows it down
  - Lack of good documentation
- Good
  - Intermediate file retention allows deeper understanding of data sources
  - Algorithms/processing/data are transparent

# Problems with Existing Models- SMOKE

- Troublesome
  - Written in Fortran, No Database
  - Sparse Matrix makes it a black box to many
  - Difficult to understand intermediate data
- Good
  - ┌ Fortran is common in modeling circles
  - ┌ Code is Public
  - ┌ Computational efficiency

# What Emissions Modelers Need In An Emissions Model?

- Need to easy access to intermediate data sets.
- Need to make it easy to implement new data
  - Visualization tools
  - Comprehensive flexible diagnostic tools
  - Need to be able to trace a single record completely through the entire process.
- We need to run it on any number of Linux machines we chose without limits
- Process 4-5 times faster than photochemical model (problem for MOBILE6)

# Practical Attributes Of A New Emissions Model

- Code/Language is easy to understand
- Written in robust database program
- Language is GPL – No Licensing/No Owner
- Intermediate files retained when needed
- Data can be traced to source
- Some computational efficiency (Mobile6)
- Comprehensive QA tools
- Direct interface with MM5 for meteorology
- Output common chemistries to common transport models

# Open Emissions Model - CONCEPT

- Use RPO Data Exchange Protocol
  - Base on NIF3.0 format
  - Extensions for Spatial, Temporal, Link Networks
- Include Point and Area models with updated temporalization to fit NIF
- Biogenics model is an SQL version of BEIS3 for data transparency
- Speciation to handle SAPRC, CB-IV, HG and output to CAMX or CMAQ – No Fixed Species
- Growth and control will compute strategy costs and interpolate/extrapolate growth/control.

# CONCEPT - On Road

- Mobile model based on Mobile6
  - Built in components to read directly from common Travel Demand Models
  - Link based processing at high spatial resolution where needed
  - Lower temperature resolution (county) for large domains
- Processing speed most important to improve

# Nonroad Model

- LADCO will be funding the inclusion of EPA's Nonroad model into CONCEPT.
  - Use Grid Specific, hour specific temperatures to calculate emissions
  - LADCO funding inclusion of NH<sub>3</sub> into EPA's Nonroad model
- Input is EPA Nonroad model inputs not emissions estimates.

# Spatial Allocation

- Built on GRASS GIS and MIMS spatial allocator (Not ARC/INFO)
- GIS work is only done when new grids are developed
- Build surrogates from continental super domain surrogates.
- Process census, TIGER lines, land use, road network links, points
- GRASS has links to SQL so access intermediate data sets can be tied back to geo-spatial data easily .

# Spatial processing outside US

- 10 Digit Spatial ID that includes country, state/province, county/census division, and Jurisdiction/tribal codes.
- Other countries are not just wayward states of the US. (Canada ≠ US State ID 75)
- Model is truly global while also ready for high spatial resolution!
- Working on getting early users from Hong Kong, Australia, Canada, and EU.

# Community Development Model

- Built with the community in mind:
  - Minimized alternate programming languages
    - PostgreSQL, PERL, GRASS for GIS.
- Extensive internal/external documentation
- Code is to be GPL so nobody owns it
- Promote the development of new model components by third parties
  - ┆ NH3 Model
  - ┆ Electric utility day specific/temperature model
  - ┆ QA Tools should come from community (EIIIP)

# Community of Developers

- A community is not a common set of financial contributors
- Judge a community model by:
  - The number of community based improvements that make it into the public release
  - The frequency of updates/improvements.
  - The hurdles an individual must cross before they get their work implemented.

# Open Emissions Model – Systems Attributes

- Written In Postgres SQL
  - Publicly available, industrial strength database, SQL compliant, ACID compliant, client/server model, allows multiple concurrent sessions
- Built to run on LINUX (Redhat/Fedora)
- Binary Datasets not SAS/Fortran ASCII files which reduces I/O.

# In CONCEPT and not currently in SMOKE and EMS

- Will read in NEIv3.0 format (IDA converter not required)
- Developed using PostgreSQL database
- Next Generation growth and control model will be an integral part of CONCEPT
- Simple Cost and interpolation model in Growth/Control
- 2 part spatial surrogate development tool integrated
- Excellent community driven QA tools
- Process based ammonia model
- Build Lumped Speciation on the fly
- EPA's NONROAD model will be built in CONCEPT
- Multiple processing engines for Mobile6
- Direct integration with travel demand models

# Open Emissions Model

- Regional Planning Organizations Fund Development 2/3 LADCO and 1/3 other RPO's
- Contract Signed with Alpine Geophysics/UC Riverside/Environ
- QA Tool written by EIIP (CEP, AG, ENVIRON?)
  - Fall 2004
- Schedule:
  - Beta Point/Area/Speciation July 1<sup>st</sup> 2004
  - Beta Biogenics/Spatial Allocation September 2004
  - Beta Mobile/Nonroad/ December 2004
  - Beta Ammonia December 2005
  - Final Draft of model April 1<sup>st</sup> 2005