ConCEPT – Consolidated Community Emissions Processing Tool
An Open-Source Tool for the Emissions Modeling Community

Cyndi Loomis
James G. Wilkinson
Alpine Geophysics, LLC

John Haasbeek
Alison Pollack
ENVIRON Corporation

Mark Janssen
LADCO
CONCEPT
Introduction

- The new CONCEPT (CONsolidated Community Emissions Processing Tool) Emissions Processor is now available for use by the emissions modeling community.

- Developed as joint project between Alpine Geophysics, LLC and ENVIIRON Corporation, with Midwest RPO and joint RPO funding, the CONCEPT model combines the best attributes of current emissions modeling systems into an open source model.
CONCEPT

Goals

- Open Source
  - Public domain software
    - POSTgres, POSTGis, perl
  - GPL Compliant
  - Users encouraged to customize and share
  - Code and documentation available at: conceptmodel.org
CONCEPT
Goals

- Transparent
  - Database Structure easy to understand
  - Self-documenting tables and naming conventions
  - Extremely well documented code
CONCEPT

Goals

- Quality Control
  - Multiple levels of QA analysis
  - Interim products maintained to facilitate QA
  - Easy review of calculation procedures and assumptions
  - Multiple debug and report levels
CONCEPT Overview

- NEI Format Compatible
- RPO Data Exchange Protocol Compatible
- CAMx and CMAQ
- CBIV, SAPRC, PM speciation
- Multiple map projections
CONCEPT
Area Source Model

- Temporal Allocation
  - NEI format for temporal definition
  - Selects most appropriate record for modeling episode
  - Accounts for timezone shift
CONCEPT
Area Source Model

- Speciation
  - Pollutant-to-pollutant conversion
  - Lumped profile application
  - Mechanism independent

- Spatial Allocation
  - Surrogates applied at Country, state, county, tribal and/or SCC level
CONCEPT
Area Source Model

- Tribal Emissions
  - Explicitly coded to accept tribal emissions independently of any state or county identifiers
  - Extracts and corrects double counted emissions when both tribal-level and county-level are reported.
  - Spatial allocation includes tribal spatial overlays for correct spatial distribution
**CONCEPT**

**Point Source Model**

- Hourly CEM data
  - NEI format for hourly emissions
  - CEM-specific formats for hourly data
    - emissions
    - stack parameters
  - Currently replacement only
CONCEPT
Point Source Model

- Spatial Validity of Point Data
  - Uses grid overlay to assign stack locations
  - Validates stack location
CONCEPT

Point Source Model

- Validity of Stack Parameter data
  - Recalculates missing or invalid values
  - Supplies default values
  - Database maintain flags of all default values
  - QA reporting
**CONCEPT**

**On-Road Motor Vehicle Source Model**

- Combines MOBILE6 emission factors with link-based or county-level activity data.
- Maintain maximum flexibility while minimizing run times.
  - On the link
  - Off the link
  - Temperatures
  - Speed
CONCEPT

On-Road Motor Vehicle Source Model

- Transportation Demand Model Transformation Tool (T3) for Network (link-based) activity data
- RPO format for county-level activity data
- Inputs:
  - VMT
  - trips
  - volumes
  - network capacity
  - speeds
  - network definitions
  - speed adjustments
  - meteorological data
CONCEPT
On-Road Motor Vehicle Source Model

- MOBILE6 Run for each Combination of:
  - Representative County
  - Min/Max temperature
  - Calendar year
  - Season
  - Roadway Type
  - Speed Bin
CONCEPT
On-Road Motor Vehicle Source Model

- Speed Bins and Temperature Tolerance are User Defined
- Runs made for Freeway and Arterial
- Speed hardcoded in MOBILE6 for Freeway Ramps and Local Roads
- Emission Factors for Ramps/Locals taken from Freeway or Arterial runs with same Parameters
CONCEPT
On-Road Motor Vehicle Source Model

- Custom MOBILE6 Version
  - New DATABASE GROUPS command
  - MOBILE6 Vehicle Types Collapsed to MOBILE5 Types
  - Vehicle Ages Collapsed
- Pollutants – Currently HC CO NOX
- HC expressed As TOG
- All Emission Modes
CONCEPT
On-Road Motor Vehicle Source Model

- Temporal Allocation
  - Selects closest activity match for episode
  - Apply profiles by states, county, roadway type, year, month, day of week
  - Applies time-weight allocation to partial hourly values.
  - Temporal adjustments applied to
    - VMT
    - volume
    - capacity
    - trip counts
CONCEPT
On-Road Motor Vehicle Source Model

- **Speeds**
  - Average speeds
  - Hourly distributed speeds

- **Speed Adjustment**
  - Adjusts speeds using volume delay functions
    - Bureau of Public Road (BPR) curves
    - Detail tables
  - Can vary by network link, speed, volume-capacity
CONCEPT

On-Road Motor Vehicle Source Model

\[ S_a = \text{MAX} \left( S_{cg}, \frac{S_{ff}}{1 + [A \times VCR_{adj}^B]} \right) \]

where:

- \( S_a \) = actual link speed (mph)
- \( S_{ff} \) = reported link free flow speed (mph)
- \( S_{cg} \) = reported link congested speed (mph)
- \( S_{cg} \) = 0 if not reported
- \( VCR_{adj} \) = adjusted volume-capacity ratio
- \( VCR_{adj} = \text{MIN}(VCR, VCR_{cap}) \)
- \( VCR_{cap} \) = cap value on volume-capacity ratio
- \( VCR_{cap} = \infty \) if not reported
- \( VCR \) = reported volume-capacity ratio
- \( A, B \) = curve calibration coefficients
- \( A, B \sim \text{curve number, } S_{ff} \)
CONCEPT
Non-Road Motor Vehicle Source Model

- EPA’s NONROAD Model Used to Calculate Emissions
  - County level
  - Standard Temperature
  - User may supply local activity data
  - By episode month
CONCEPT Enhancements

- Applies gridded, hourly temperature adjustments
- Weekend/weekday adjustments
- NH3 emissions estimation based on fuel consumption and fuel type
**CONCEPT**

**Biogenic Source Model**

- Mimics BIOME3 Processing
  - BEIS2
  - BEIS3
  - GLOBEIS canopy model
- Based on SMOKE-BEIS3 (v0.9) Foundation Data
  - BELD3 datasets
- Includes Projection and Extraction Methodology for the BELD3 data
CONCEPT
Spatial Allocation Tools

- POSTGis Based
  - Fully integrated into CONCEPT system
- Grid Development
- Develops Spatial Surrogates
- Overlays Point Source Locations
CONCEPT
Spatial Allocation Tools

- **Input Options**
  - Lambert conformal
  - geographic
  - stereographic
  - UTM

- **Output Options**
  - Lambert
  - UTM
CONCEPT
Spatial Allocation Tools

- Grid Extraction Utility
  - Extract sub-grid regions
  - Aggregates cells to larger grids
  - CONCEPT includes the National RPO domain at 4k.
**CONCEPT**

**Speciation Development Tools**

- Supports Update of Speciation Profiles
  - Input of revised chemical profile data
  - Creates new lumped speciation factors.
CONCEPT
Forecasting Tools

- Creates Grown and/or Controlled Files
  - Multiple level application hierarchy
  - NEI format output
  - Extensive reporting and QA
  - Control cost estimates
CONCEPT
Upcoming Developments

- Incorporation of Process Based NH3 model
- CEM tool
- QA and Reporting Enhancements
- Graphics Reporting and Analysis Package
- EmisView