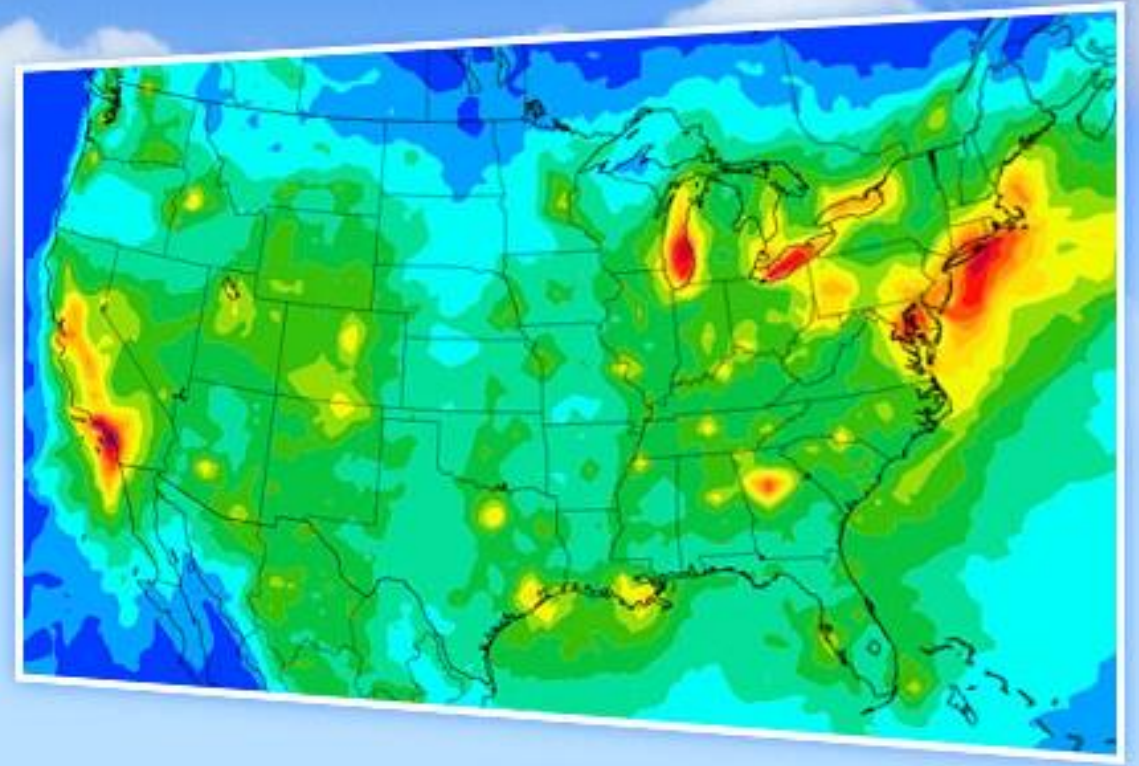


CAMx

Ozone
Particulates
Toxics



New Features and Updates in CAMx Version 7

Chris Emery, Gary Wilson, Greg Yarwood, Ralph Morris
2020 CMAS Virtual Conference, October 26-30, 2020

RAMBOLL



CAMx DEVELOPMENT TEAM

- Continuous development from 1995 (v1.13) to 2020 (v7) by a consistent team
- Guiding principals
 - Open software
 - Science alternatives
 - Efficiency is important
 - Probing tools create deeper understanding
 - Flexibility: provide options rather than "system"
 - Listen to what our clients needs

* Thanks to Dr. Bonyoung Koo for significant contributions (now at SF BAAQMD)



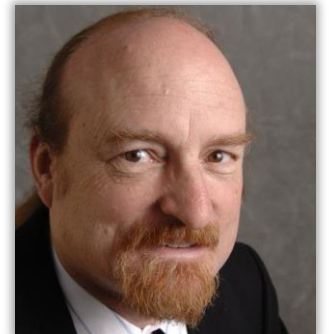
Chris Emery
meteorologist
model architect & algorithms



Gary Wilson
mathematician
code integrity & client support



Dr. Greg Yarwood
chemist
science & probing tools



Ralph Morris
mathematician
applications & vision



CAMx v7 INPUT/OUTPUT

Network Common Data Form ([NetCDF](#))

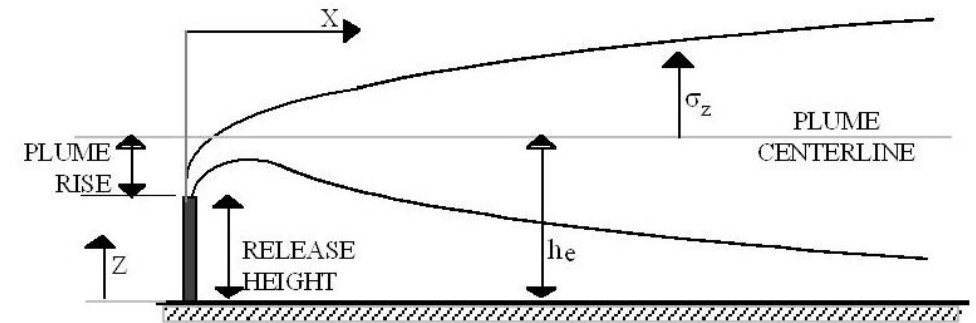
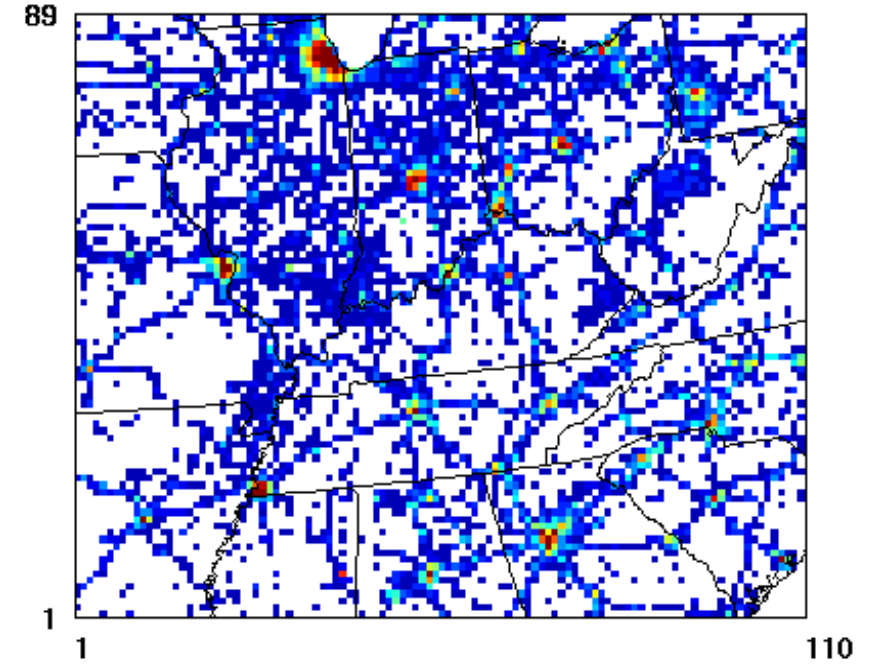
- Applied to meteorology, gridded and point emissions, IC/BC and gridded output
- NetCDF4 uses HDF5 data compression: no need for external manipulation!
 - NetCDF3 “classic” can be used, but does not support compression
 - Set netCDF version and compressed/uncompressed output with Makefile command option
- Uncompressed CAMx netCDF I/O is compatible with [Models-3 I/O-API](#) convention
- Inputs: CAMx allows mix of netCDF and traditional Fortran binary formats
- Outputs: Select netCDF or Fortran binary format using CAMx Control File namelist
- Ramboll is converting widely used support tools to netCDF4
 - Some in Fortran, some in Python



CAMx v7 INPUT/OUTPUT

Emission Updates

- Gridded surface emissions
 - Multiple input files (e.g., by sector)
 - Any mix of netCDF or traditional Fortran binary
- New gridded 3-D emissions
 - Aircraft, wildfire, lightning, etc.
 - Multiple input files (e.g., by sector)
 - NetCDF only: compression recommended and effective!
- Elevated point emissions
 - Multiple inputs file (e.g., by sector)
 - Any mix of netCDF or traditional Fortran binary



CAMx v7 INPUT/OUTPUT

Probing Tool Updates

- Emission inputs
 - Multiple input files by tracked sector
 - Any mix of netCDF or traditional Fortran binary
- Gridded output
 - Select netCDF or traditional Fortran binary
 - New 3-D output option for SAT tracers
 - Supports 1-way nested SAT applications by providing nested grid IC/BC (new processor)

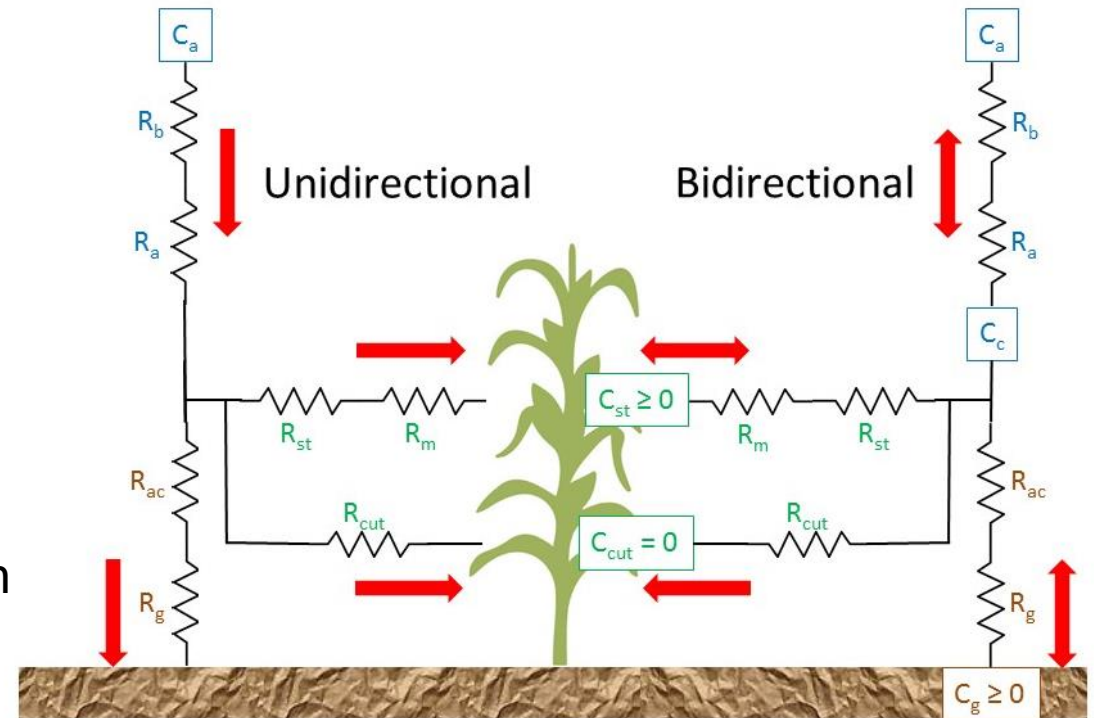
NOTE: SAT emission files now used BOTH for SAT and the CORE MODEL. No longer essential to provide consistent point source lists for all SAT point source files.

NOTE: DDM and RTRAC input point source emission files can now include stack lists that are unique and differ from the CORE MODEL. No longer necessary to provide consistent point source lists for all DDM, RTRAC and core model point source files.



BIDIRECTIONAL AMMONIA DEPOSITION/EMISSION

- Optional “BiDi” algorithm of Zhang et al. (2010)
 - Part of CAMx Zhang dry-deposition scheme
- NH_3 “emission potentials” from vegetation and ground (Whaley et al., 2018)
 - Assigned as constants by land cover
 - “Compensation points” are calculated from emission potentials, temperature, LAI, pathway resistances, and snow cover
- Switch from deposition to emission occurs when NH_3 concentration is below compensation point



CHEMISTRY UPDATES

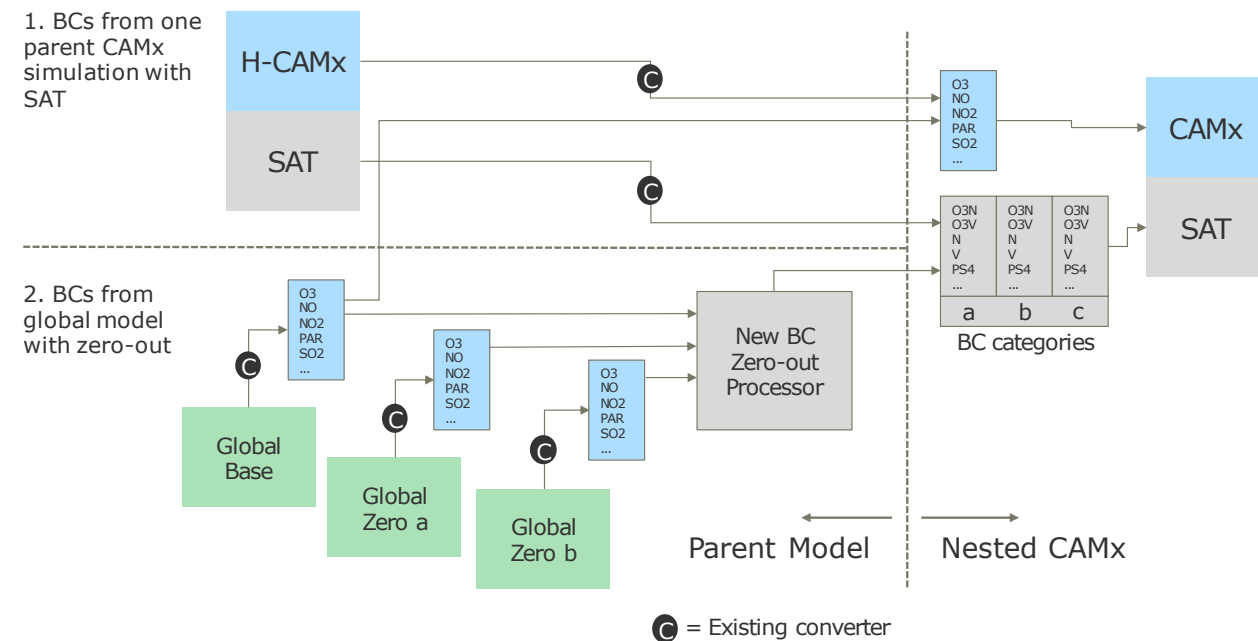
- SOA updates
 - Updated terpene SOA yields for RO_2 autoxidation (more non-volatile SOA, less total SOA)
 - Reduced SOA photolysis rate (more SOA)
 - Deactivated polymerization of anthropogenic SOA (less SOA)
- Oceanic dimethyl sulfide (DMS) chemistry
 - Added to CB6r4 gas-phase mechanism and PSAT, oxidizes to form SO_2 (ultimately SO_4)
 - OCEANIC emission preprocessor updated to generate DMS
- Additional explicit elemental species (optional)
 - Eight new primary $\text{PM}_{2.5}$ species (Fe, Mg, Mn, Ca, K, Al, Si, Ti) – consistent with CMAQ AERO6
 - PSAT includes each as explicit tracers (not yet implemented in PM-DDM)



PROBING TOOL UPDATES

Source Apportionment Technology (SAT)

- New 3-D tracer output
 - Supports 1-way grid nesting via boundary conditions for SAT tracers
 - SAT tracers from outside the nest are separate from tracers emitted within the nest
- Updated BNDEXTR processor supports CAMx-to-CAMx 1-way SAT nesting
- New SAICBC processor supports global model-to-CAMx SAT nesting
 - Global source apportionment from global model “zero-out” runs



PROBING TOOL UPDATES

Decoupled Direct Method (DDM)

- PM-DDM is reactivated for the CF aerosol treatment (SOAP, RADM-AQ, ISORROPIA)
 - Tied into core-model PM updates implemented in CAMx v6.4
 - VBS and EQSAM options not yet supported
- New chemical rate term sensitivities
- DDM sensitivities can be calculated on sub-domains instead of whole grids
- Larger Probing Tool applications
 - Array dimensions changed from single- to double-precision integers
 - Greatly expands the available Probing Tool space over species, sectors, regions



COMING SOON IN v7.1

- Simplify “buffer cells” for nested-grid met & emission input files
 - Buffer cells are optional for gridded emission inputs – maintains backwards compatibility
 - CAMx will diagnose whether they are present during model startup
 - WRFCAMx automatically adds buffer cells when user sets a nested grid flag
 - Simplifies specifying nested grid dimensions for WRFCAMx
- Enable plume distribution override for netCDF point source files
 - Supports fire emissions processing at EPA – updated binary-to-NCF point source converter
- Carbon Bond v6, release 5 (CB6r5)
 - Updated 47 reaction rates and added one new reaction (see Ross Beardsley’s presentation)
- Updated NH₃ emission potentials for bidi scheme



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THANK YOU QUESTIONS?

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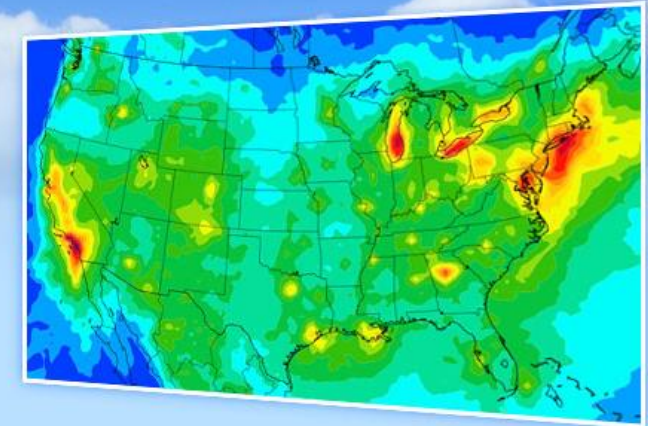
CAMx Ozone
Particulates
Toxics

Comprehensive Air Quality Model with Extensions

A multi-scale photochemical modeling
system for gas and particulate air
pollution

Version 7.00 posted May 31, 2020

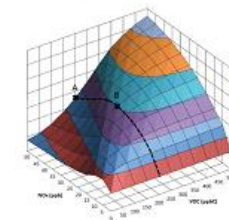
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Why CAMx

- Simulate air quality over many geographic scales
- Treat a variety of inert and chemically active pollutants – photochemical gases, particulates, mercury and toxics
- Conduct source attribution, sensitivity, and process analyses
- Apply distributed- and shared-memory parallelization

CAMx In Action...



Overview presentation of
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