Use of CAMx for BART and PSD Class I Visibility Analyses

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Introduction

- For the subject to BART assessment, EPA BART Guidelines state that “You can use CALPUFF, or another EPA approved model, to predict the visibility impacts from a single source at a Class I area” (EPA, 2005). For the visibility improvement determination, EPA BART Guidelines state “Use CALPUFF, or other appropriate dispersion model to determine the visibility improvement expected at a Class I area from the potential BART control technology applied to the source” (EPA, 2005). For the subject to BART modeling, cumulative modeling may also be conducted to show that no source in a State is subject to BART.
- This cumulative BART exemption modeling may be done “on a pollutant by pollutant basis or for all visibility-impairing pollutants to determine if emissions from these sources contribute to visibility impairment” (EPA, 2005). BART Guidelines suggest using California Puff Model (CALPUFF) or a photochemical grid model to perform the cumulative group exemption modeling, but notes “if you wish to use a grid model, you should consult with the appropriate EPA Regional Office to develop an appropriate modeling protocol” (EPA, 2005).

Introduction

- PSD Class I visibility impact analysis procedures vary little when compared to BART. Minor differences between BART and FLAG procedures likely to be similar with FLAG 2007.
- Proposed FLAG 2007 modeling procedures likely to adopt many of the procedures established for BART modeling (EPA, 2005). Final procedures to be determined by FLM's.
  - Monthly f(RH) rather than hourly RH (switch from method 2 to method 6 in CALPOST)
  - 98th percentile impact

Concerns Regarding Use of Photochemical Grid Models (PGM) for Single Source Analyses

- (1) PGMs can only resolve the dynamics and chemistry of a point source plume to the grid resolution specified and use of a high resolution grid (e.g., 100 m to 1 km) to resolve a plume would require extensive model inputs and model run times; and
- (2) to assess the impacts of a source two runs have to be performed, a base case with the source and a zero-out case where the emissions of the source are eliminated. As PGM runs are already more costly than a source-oriented plume model, like CALPUFF, the need to do multiple zero-out runs to assess the individual impacts of multiple sources is quite costly. Recent

CAMx Advances for Single Source Analyses

- PM Source Apportionment Technology (PSAT) that allows the separate tracking of individual source PM impacts so that the individual impacts from many different sources can be obtained cost-effectively in one run; ozone can also be tracked for single sources by dumping reactive tracers for ozone.

- Threading of the PSAT PM source apportionment through the full-chemistry PiG module so that the early plume chemistry and plume dynamics can be tracked by the subgrid-scale PiG module until the plume size is commensurate with the grid resolution when the plume can be adequately simulated by the grid model;

Issues With CALPUFF

- GAQM, Appendix A.4 states “CALPUFF is appropriate for long range transport (source-receptor distances of 50 to several hundred kilometers).”
- Distance to Class I Areas in EPA Region 7, except for Missouri, usually exceed 300 kilometers, beyond the regulatory accepted distance.
- Studies by IDNR (Johnson, 2006) showed that CALPUFF behavior beyond 450 km becomes erratic, with linear increases in concentration beyond 450 km.

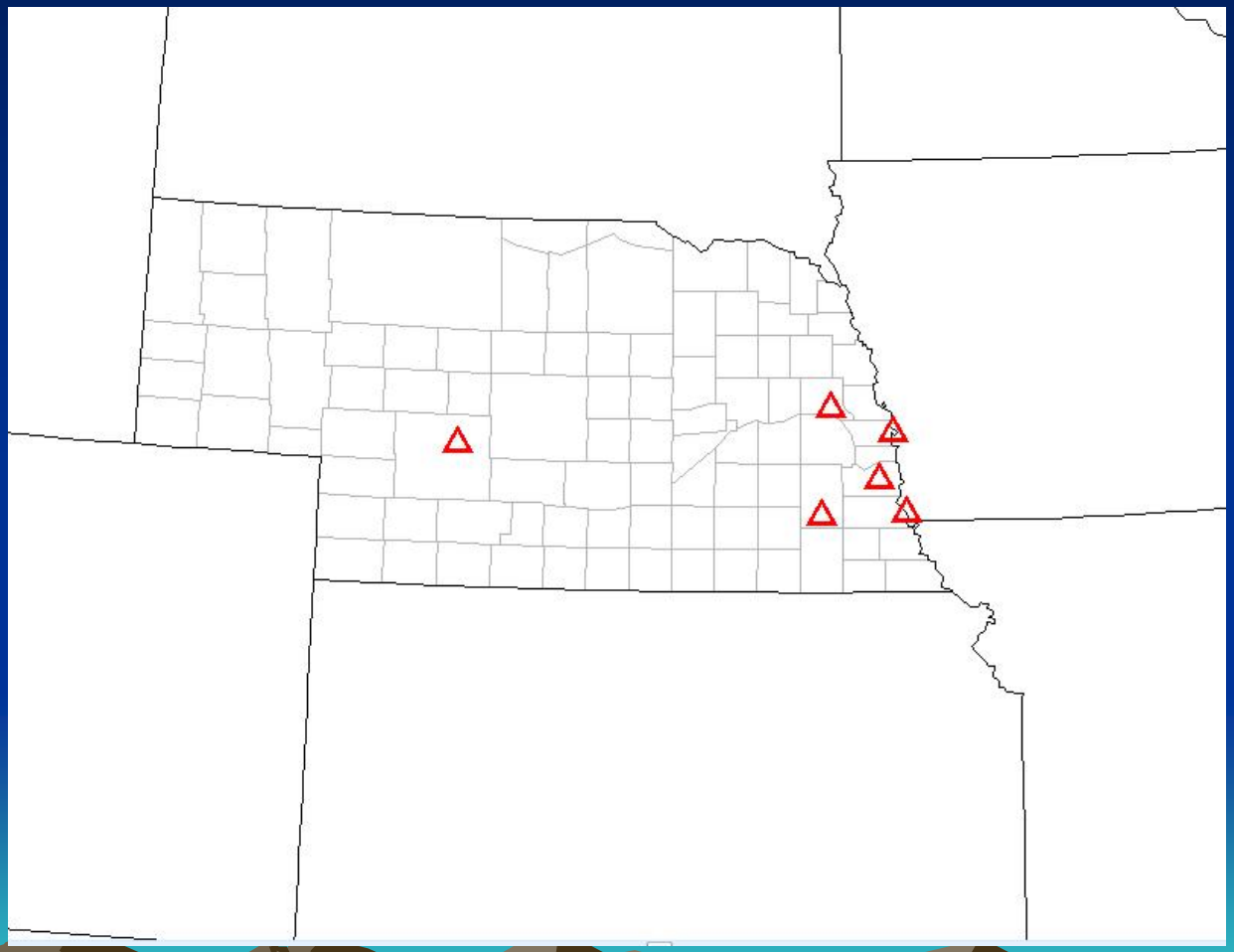
Questions Regarding the Use of CALPUFF Beyond 300km

- Does the impact of a source stop at 300 km?
- Do we not conduct PSD Class I analyses because the distance of the source-receptor relationship is beyond the effective range of the Appendix A model for LRT?

Areas CAMx Used for BART Style Analyses

- Texas (Initial screening w/ grouped sources and optional single source refined)
- Arkansas (PSAT cumulative modeling)
- Iowa (brute force)
- MRPO (PSAT)
- Nebraska/EPA R7 (PSAT initial screening for single sources)

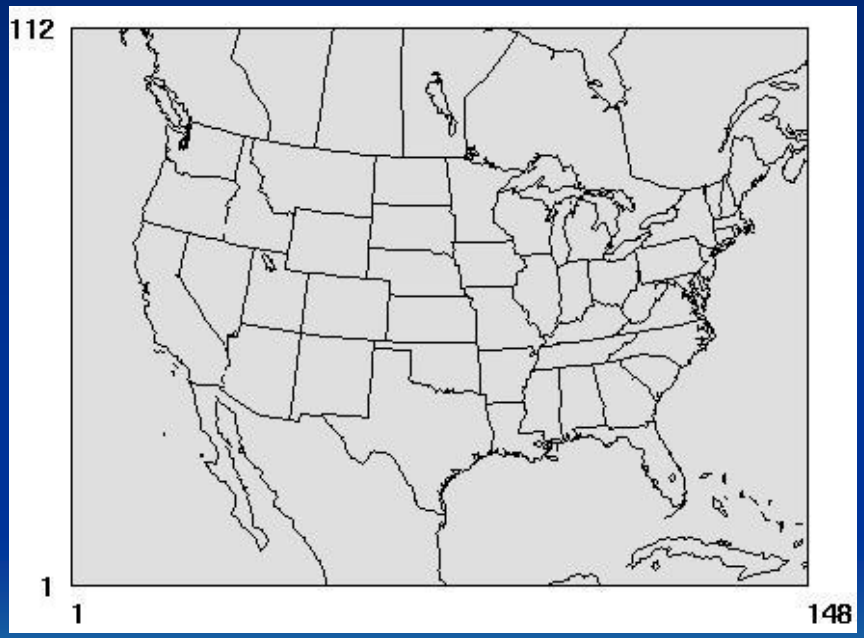
CAMx Sources Modeled for Nebraska Analysis



Emissions Inventory Processing for BART

- CENRAP Base02f inventory used for study
- Environ PIGSET_BART program modified by Region 7 to modify stack and emission parameters of sources to reflect BART 24 hour maximum actual conditions and flag source(s) for Plume-In-Grid (PiG) treatment and PSAT override.
- For new sources (PSD), Environ ADDPT program to add new point sources to existing CAMx point source files. Updated by Region 7 for use with CAMx Chemical Mechanism 4 (CB4 + aerosol and SOA).

CAMx Modeling Domain



- CENRAP 36 km grid used
  - 148 x 112
  - 19 vertical layers
  - LCC:
    - CLAT: 40° N Lat
    - CLON: 97° W Lon
    - TLAT1: 33° N Lat
    - TLAT2: 45° N Lat

CAMx Options Used

- Probing Tool: Particulate Source Apportionment (PSAT)
- Plume-in-Grid: GREASD PiG
- Flexinest: Optional 12 km or 4 km imposed on modeling grid to limit initial dispersion of PiG puffs
- Species Classes: Treated for sulfate, nitrate, and primary particulate

Computational Logistics

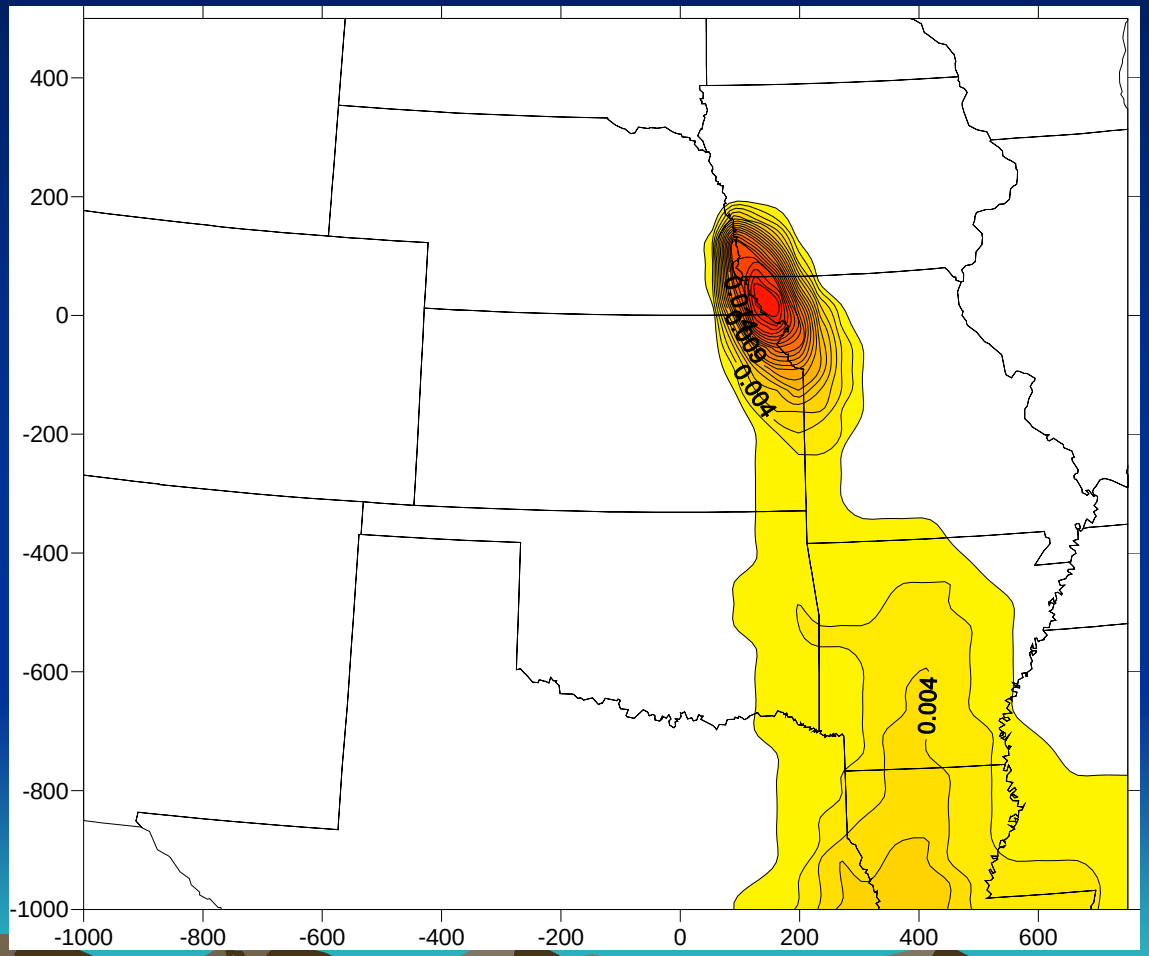
- Annual CAMx run with 15 days of spinup per calendar quarter.
- Each calendar quarter run on a separate compute node of Region 7 cluster (105 days).
  - 2 x 2.8 GHz XEON CPUs, 2 GB RAM
- With 7 source regions (single sources) and 2 source groups (point and area), average of 3 hours per simulation day or 8 simulation days per CPU day.
- 105/8 = 13.125 days for calendar quarter to complete. Run sequentially, it would require 47.5 days to complete.
- Multiple CPU environment is essential.

Post-processing Options

- Two options available for post-processing for visibility impacts:

1. Ranktrac/calc_Bext – reads CAMx SA binaries and extracts impacts at user selected grid cells and computes delta-DV impacts
2. recep2Bextin/calc_Bext – reads ASCII receptor files output by CAMx, reformats, and computes delta-DV impacts

Single Source Impact Snapshot



Sample Comparison of Impacts

YEAR	DAY	BOWA1		BADL1	
		CALPUFF	CAMx	CALPUFF	CAMx
2002	70	0.0030	0.0727	0.0000	0.0928
2002	71	0.1890	0.3396	0.0000	0.0307
2002	72	0.3050	0.5923	0.0000	0.0207
2002	73	0.0000	0.3081	0.0000	0.4058
2002	74	0.0000	0.1629	0.0000	0.4182
2002	75	0.0000	0.1056	0.0000	0.1274
2002	76	0.0000	0.0945	0.0000	0.2413
2002	77	0.0130	0.0455	0.0000	0.1969
2002	78	0.3150	0.0369	0.0060	0.2678
2002	79	0.0920	0.0198	0.0000	0.0878
2002	80	0.0020	0.0042	0.0000	0.0179
2002	81	0.0000	0.0011	0.0000	0.0162
2002	82	0.0000	0.0021	0.0000	0.0641
2002	83	0.0000	0.0002	0.0000	0.1357
2002	84	0.0000	0.0002	0.0130	0.0163
2002	85	0.0000	0.0000	0.0340	0.1221
2002	86	0.0000	0.0008	0.0030	0.0892
2002	87	0.0480	0.0378	0.0000	0.0028

PGM (CAMx) Role in PSD

- Near term proposal:
  - Complete bug fixes and freeze current version of CALPUFF. Focus future development on PGM's
  - Promote PGM's use for PSD Class I Analyses for distances beyond 300 km, allowing for seamless set of tools for Class I analysis (CALPUFF less than 300 km, CAMx greater than 300 km).
- Long term proposal:
  - Focus IWAQM Workgroup efforts upon use of PGM's at all distances (replacement for CALPUFF for distances less than 300 km), working towards Phase III guidance.
  - Presentation of concept for 9th Modeling Conference