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Boulder, Colorado

Development Update for MMIF, the Mesoscale Model Interface Program

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What does MMIF do?

MM5
WRF

MMIF

CALPUFF
AERMOD
SCICHEM

Mesoscale Model Interface Program (MMIF)

- The Mesoscale Model Interface (MMIF) beta program that converts MM5/WRF output for CALPUFF, AERMOD, and SCICHEM
- Prototype by Bret Anderson
- Continued development by ENVIRON
- Major versions in 2009 and 2011
- Minor versions in 2012
- On-going EPA support

MMIF Philosphy

- As close to “pass-through” as possible

Don’t mess with the MET!

- Diagnose missing parameters
- FORTRAN 90, allocatable arrays, well-documented code
- Multi-platform: Linux/Unix or Windows environment

No Horizontal Interpolation

- Uses MM5/WRF projection and grid resolution
- Support for projections common to both MM5/WRF and CALPUFF
  - Lambert Conformal Conic (LCC)
  - Polar Stereographic (PS)
  - Equatorial Mercator (EM)
- Can process subset of MM5/WRF domain
  - Specify the lower-left and upper-right corners using
    - I, J index
      - Negative numbers = trim from edge
    - Latitude, longitude
    - Projected coordinates (km)

Vertical Coordinates

- Dispersion models typically use fewer layers than MET models
- MM5/WRF: pressure-based vertical coordinate
- CALPUFF/AERMOD/SCICHEM: height-based vertical coordinate

Vertical Interpolation

- Option 1: Layer Aggregation
  - Mass (pressure) weighted, but…
  - MM5 layers variable in space
  - WRF layers variable in space and time
  - Causes ~5% error
- Option 2: Layer Interpolation
  - Specify (or diagnose) Layer Heights (ZFACE)
    - Option: Use MM5/WRF heights
  - Mass (pressure) weighted
  - Conserves vertical integral of inputs

Planetary Boundary Layer Depth

- Options to re-diagnose or pass-through PBL depth
- MM5/WRF “snap” PBL depth to nearest layer
- MMIF uses a critical Richardson Number approach
- Interpolates to 1/20th of the MM5/WRF layer
- Requires “sane” output for CALPUFF and SCICHEM

Flexpart v6.2
Vogelezang and Holtslag (1996)
Gryning and Batchvarova (2003)

CALPUFF

- Creates CALMET.DAT v5.8 or v6.x format file
- Creates CALMET.AUX (cloud liquid water) file
  - For CALPUFF v6.x
- Two options for defining PG stability
  - SRDT
  - Golder (1972)
- If found, use MM5/WRF LAI, L and z_0
  - Not found: Use look-up tables
- If found, use MM5/WRF U_{10}, V_{10}, T_{10}, q_2
  - Not found: Calculate
- Creates Useful Info file, specifying the grid

AERMOD

- One MM5/WRF grid cell: no interpolation
- Three modes:
  - AERMOD: create SFC and PFL files directly
  - AERMET: create ONSITE and UPPERAIR (FSL) data
  - AERCOARE: create input data file
- Creates AERMET and AERCOARE control files and batch files
- Create Useful Info file (AERMOD's ME block)

SCICHEM

- Uses SCICHEM's MEDOC format
  - ASCII or Binary (optional)
- Creates a receptor sample location file
  - X,Y,Z of all points in the output sub-domain
- Creates Useful Info file
  - The required details that would be a pain to calculate

Testing and Evaluation

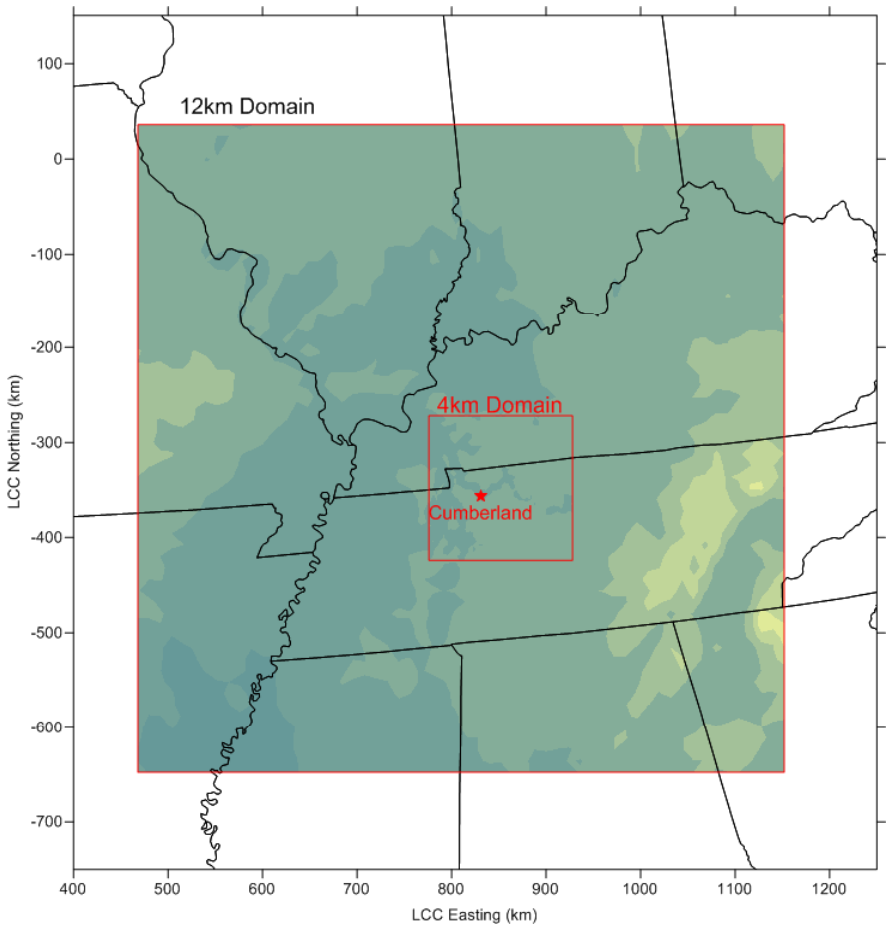
- Comprehensive testing of MMIF tool done against tracer release field studies (Bret Anderson and ENVIRON)
- CALMET+CALPUFF and MMIF+CALPUFF compared for tracer experiments ETEX, CAPTEX, and GP80
- Plume placement generally comparable or better when using MMIF for these tracer experiments
- Final Report "Documentation of CALPUFF and Other Long Range Transport Models using Tracer Test Field Experiment Data" (ENVIRON, February 2012)

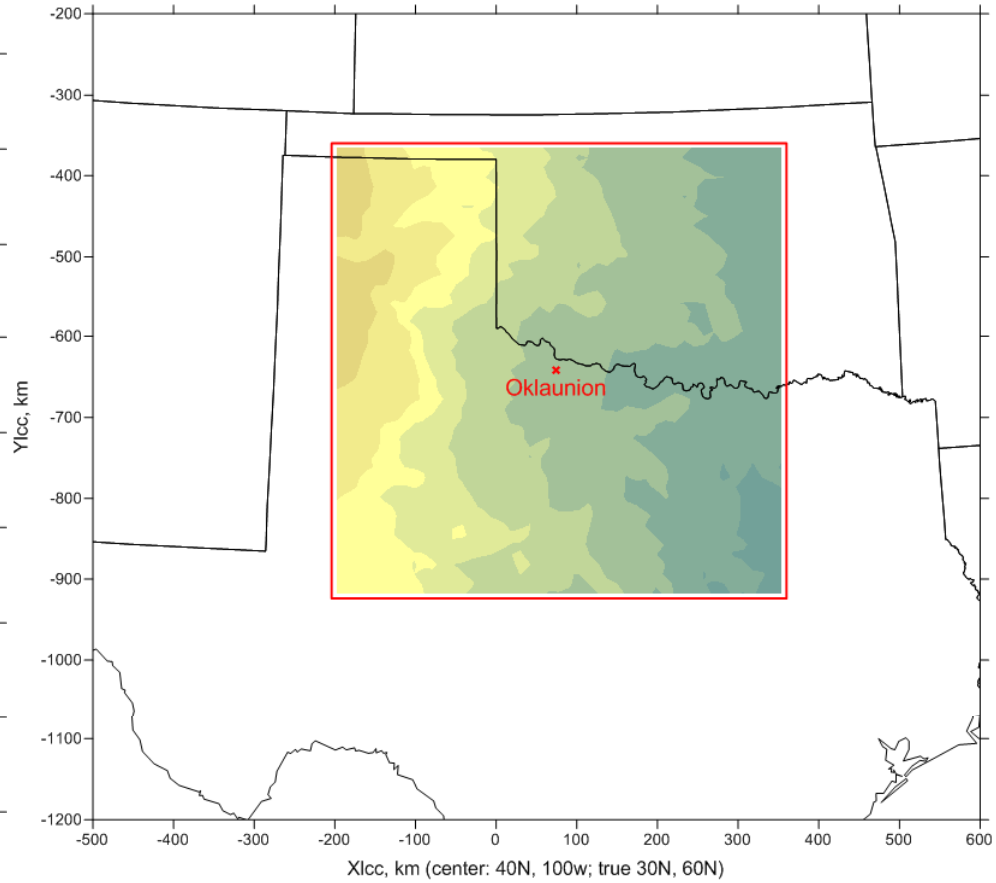
  http://www.epa.gov/ttn/scram/reports/LRT_Tracer_Final_Feb13_2012.pdf

Testing and Evaluation

- MMIF used to drive SCICHEM and CALPUFF
  - 1999 TVA (Cumberland) plume study
  - 2006 TexAQS (Olkaunion) plume study
- Five variants
  - CALMET+CALPUFF, v5.8 and v6.4 (in progress)
  - MMIF+CALPUFF, v5.8 and v6.4 (in progress)
  - MMIF+SCHICHEM
- MMIF+SCICHEM Plume placement consistent with real MET+SCICHEM
- Plume placement using MMIF+SCICHEM also consistent with CMAQ (MCIP) and CAMx (wrfcamx)

TVA (Cumberland) and TexAQS (Oklaunion) Plume Evaluations





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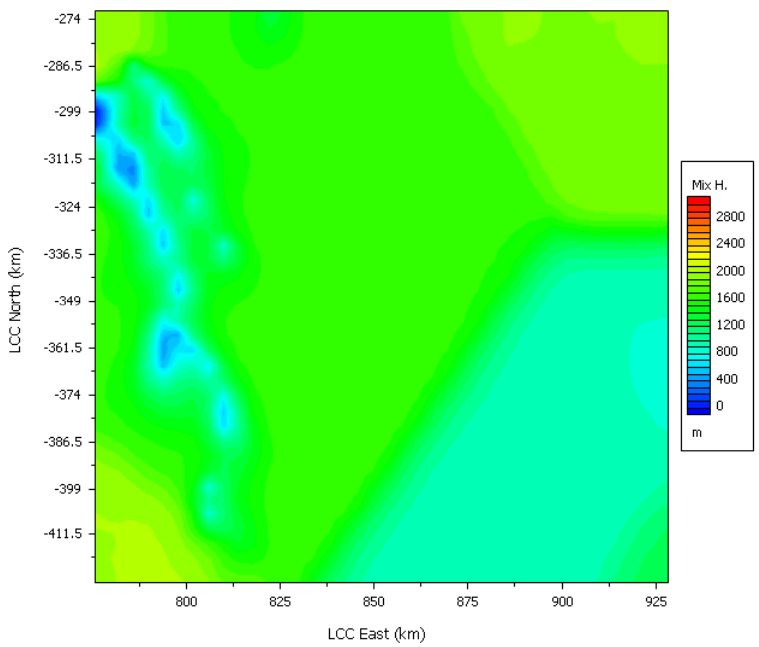
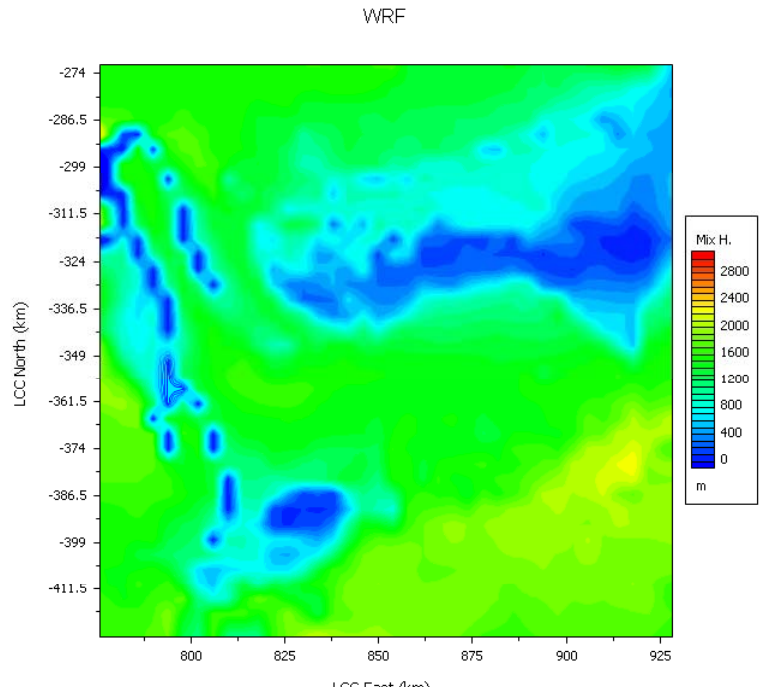
3:00 PM PBL Ht Cumberland

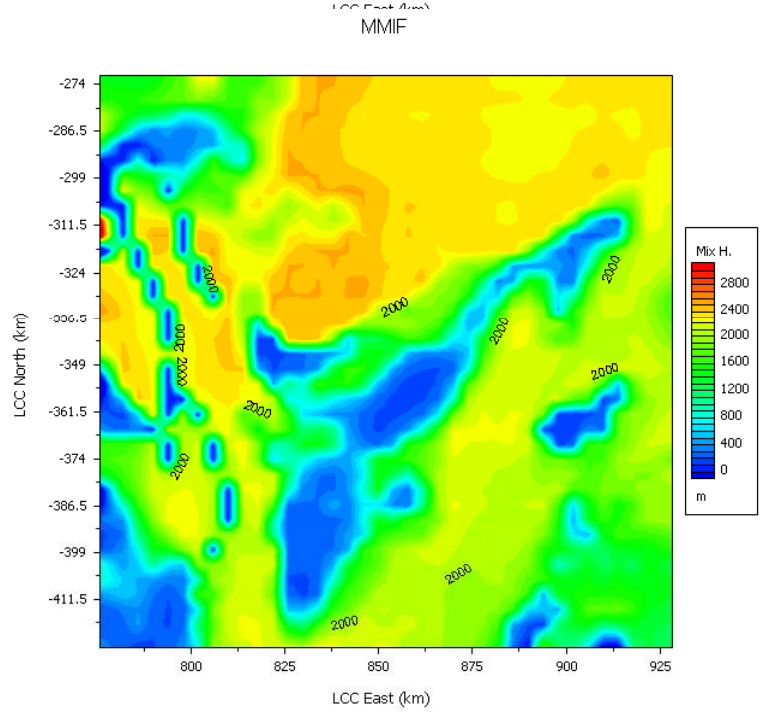
CALMET v5.8



WRF

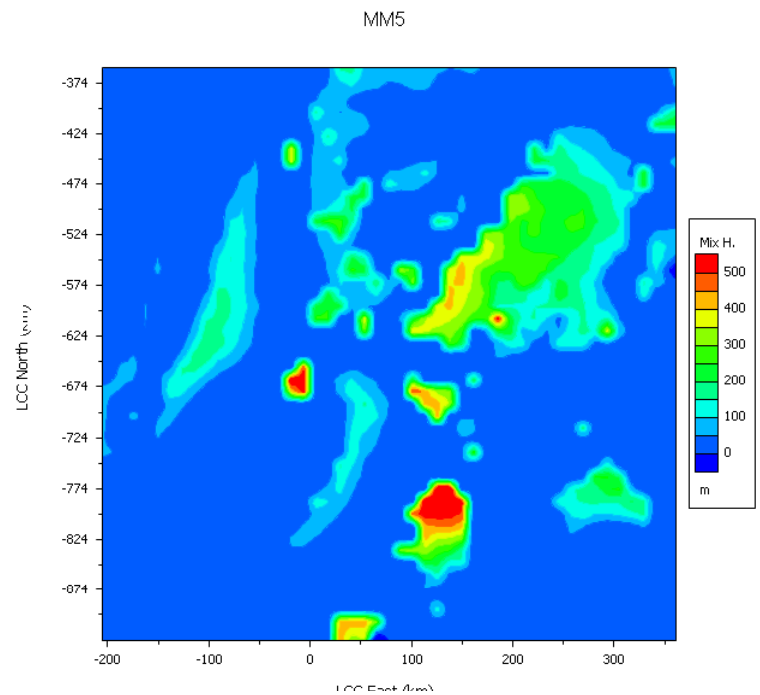


MMIF

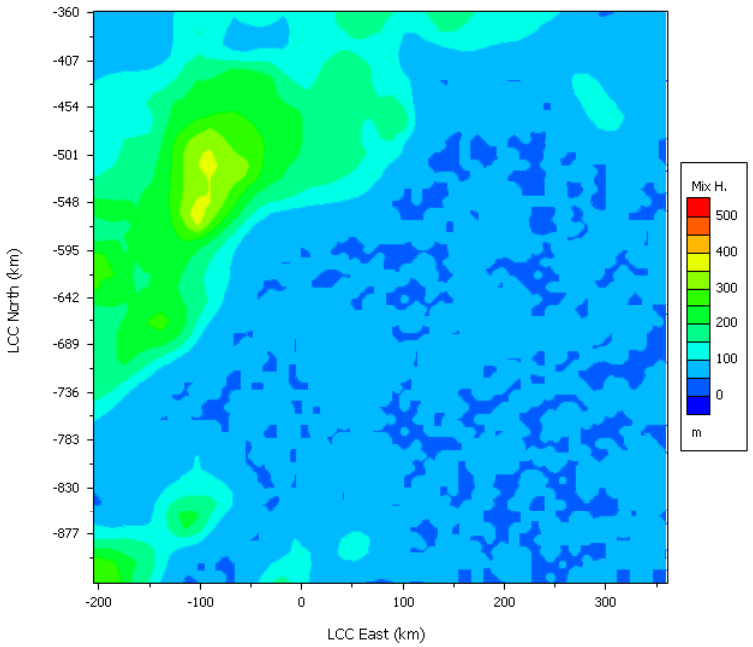


6:00 AM PBL Ht Oklaunion

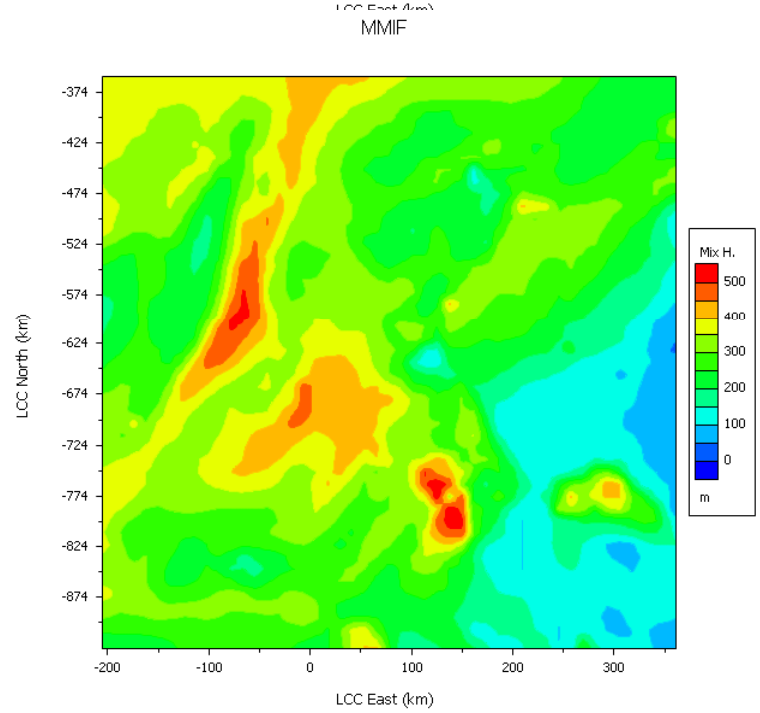
MM5



CALMET v5.8

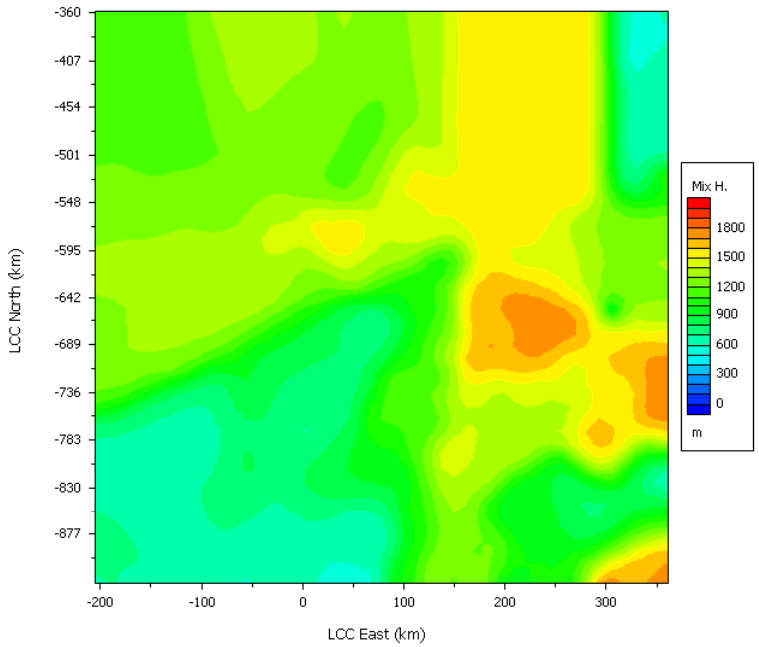


MMIF

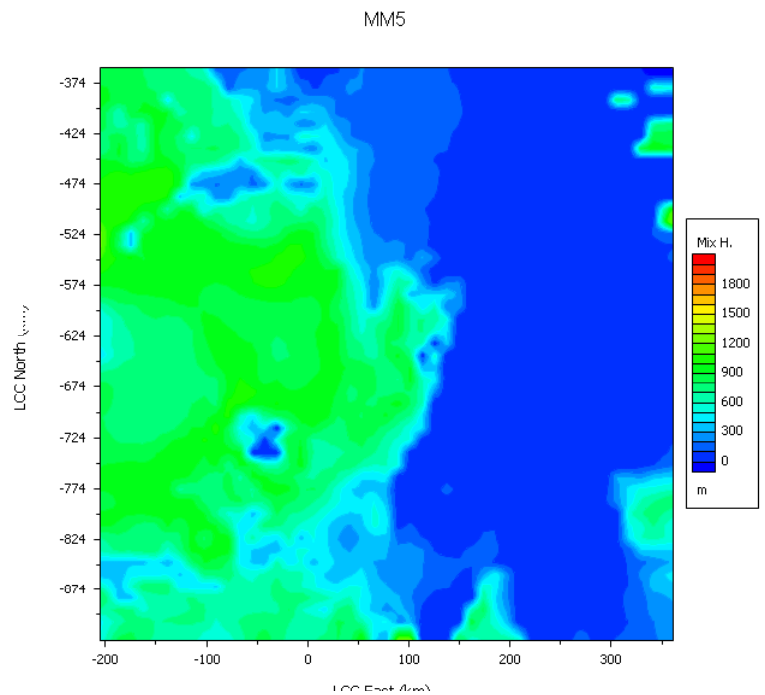


3:00 PM PBL Ht Oklaunion

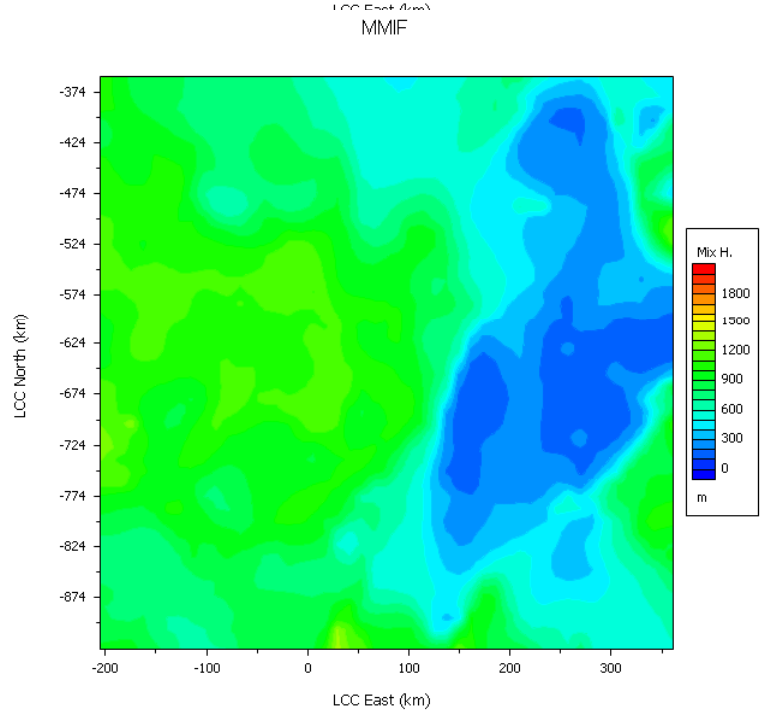
CALMET v5.8



MM5

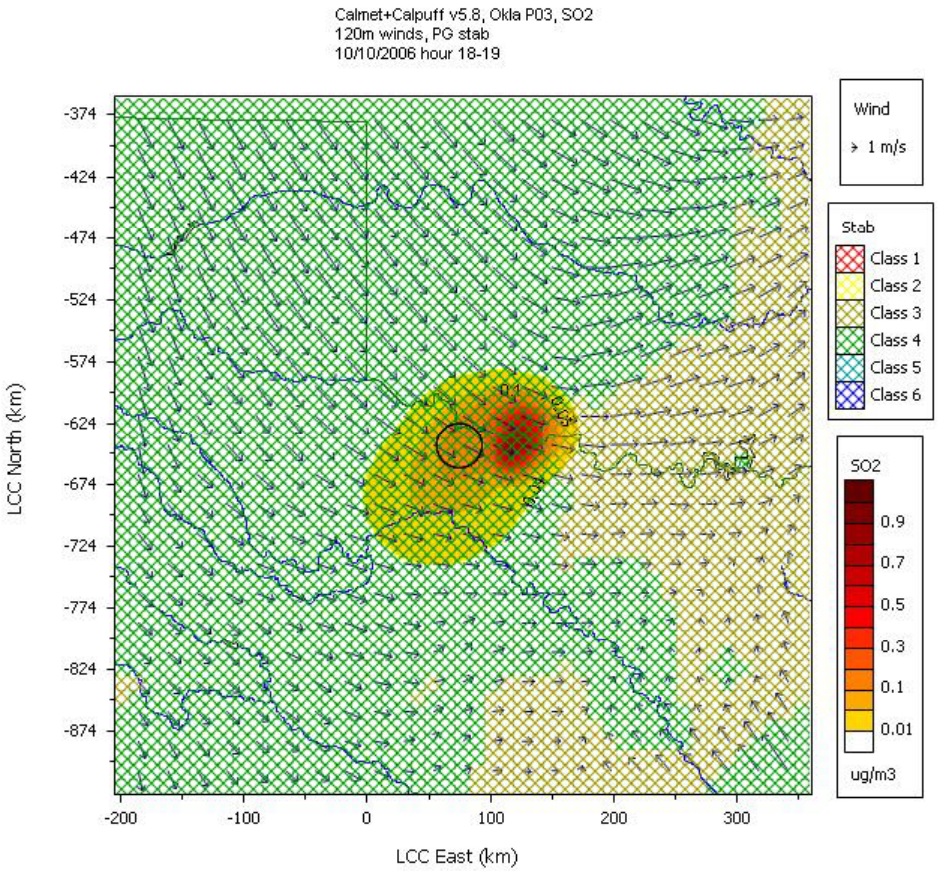


MMIF

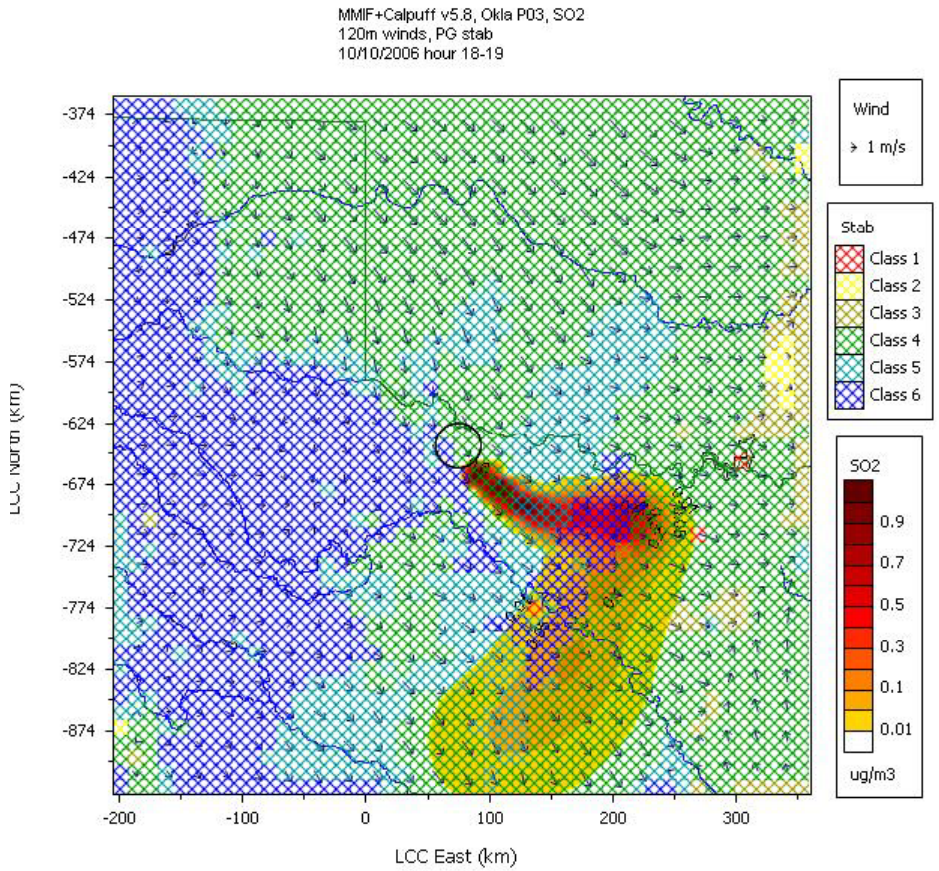


CALMET vs. MMIF Plumes

CALMET v5.8



MMIF



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Issues

- Cloud cover identification (for AERMOD modes) produces only 0 or 10/10^{ths}, nothing in between.
  - Inherited from MM5AERMOD code
- AERMOD's convective and mechanical mixing heights both set to PBL height.
- FSL output doesn't interpolate to mandatory levels.
- WRF now has an option **`prec_acc_dt`** to output HOURLY rather than accumulated precipitation rates. MMIF assumes accumulated.

Discussion?

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