

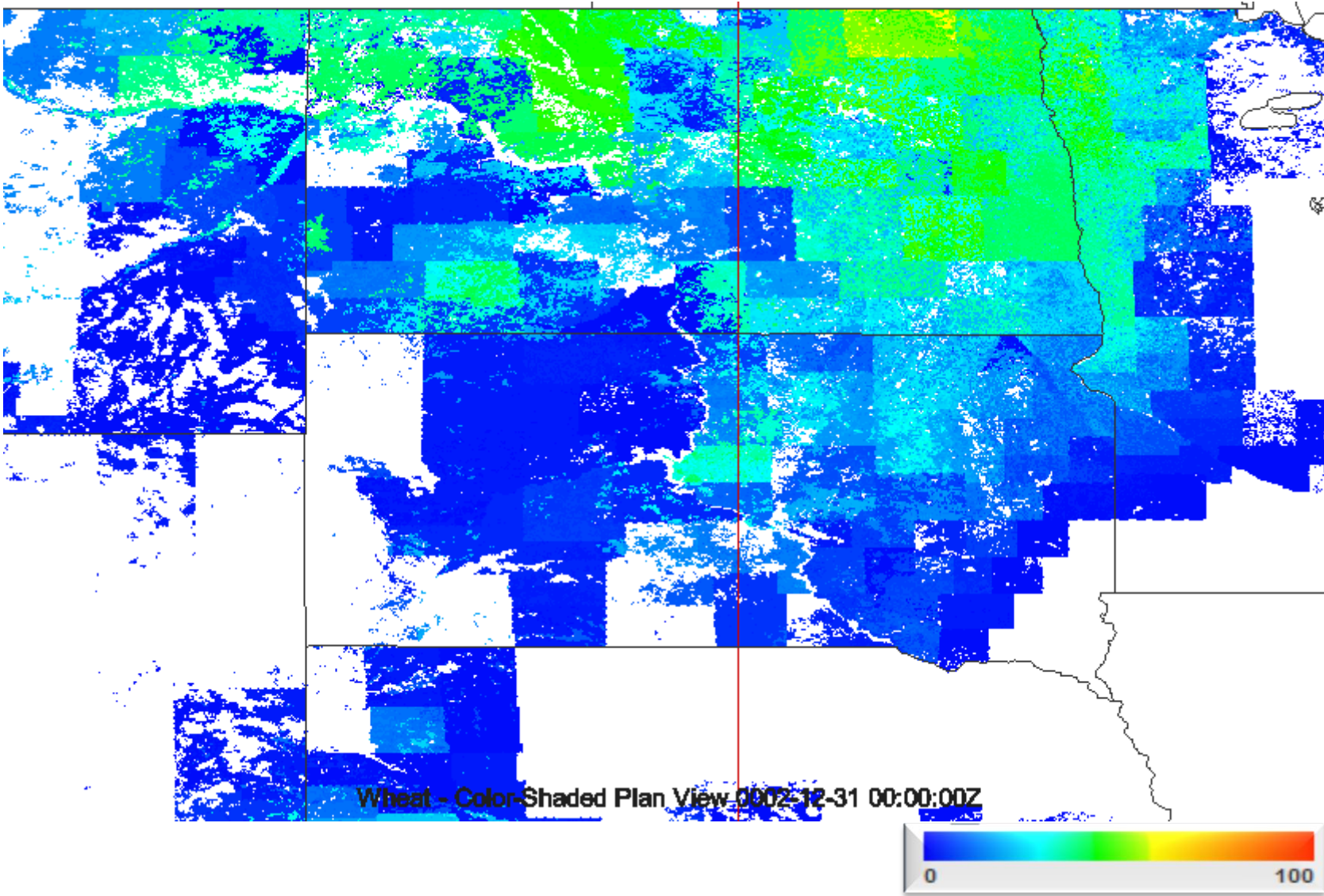
Investigation of Crop Harvesting as a Source of Climatically Important Aerosols

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Objective

To provide an initial estimate of the climatic importance of aerosols from harvesting activities on the regional climate of the Northern Plain States by using field measurements made between 16-18 August 2007, and the Weather Research and Forecasting-Chemistry model.

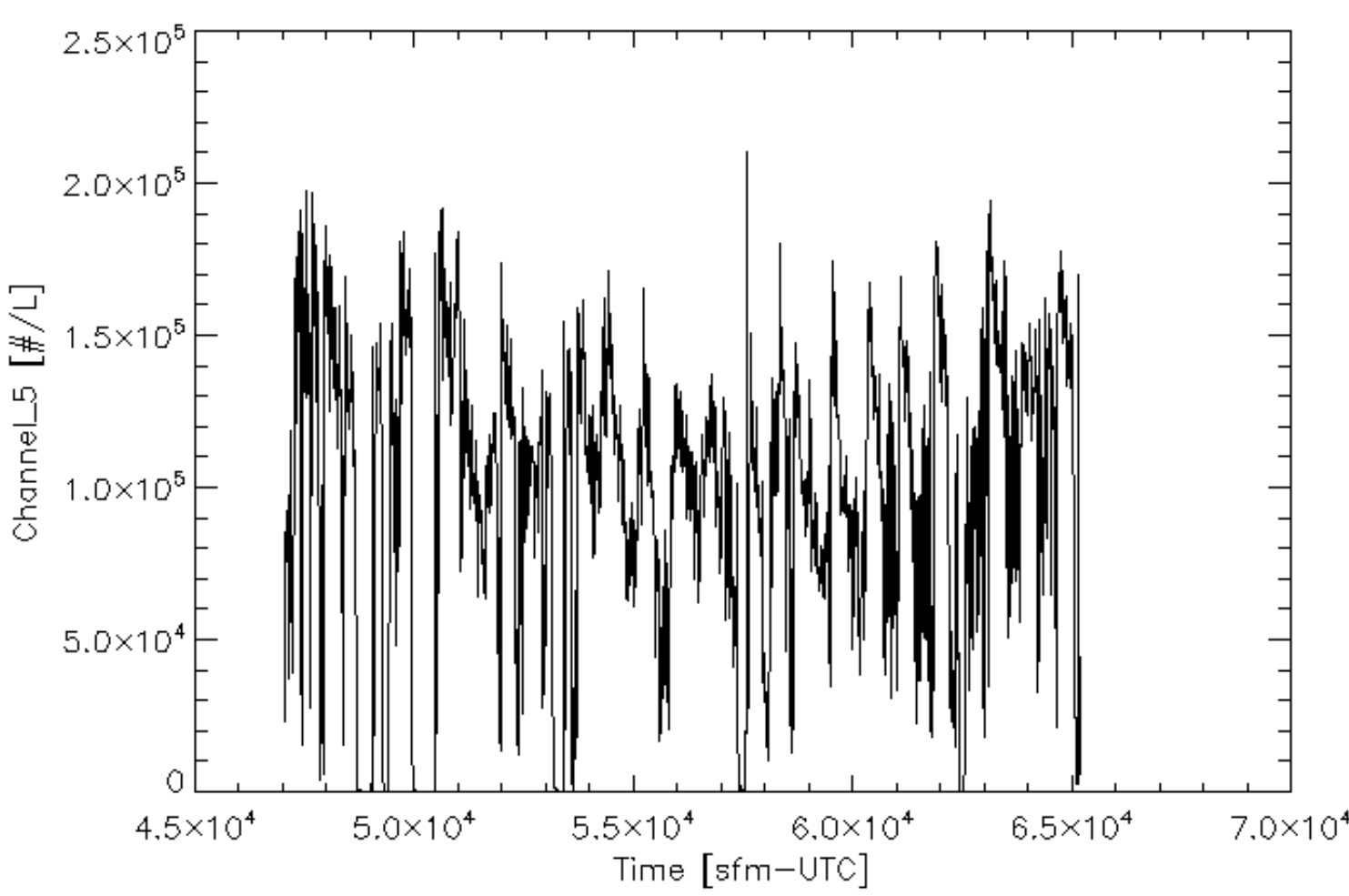
Crop Aerosol Emissions



This image portrays, on a 0.15° by 0.15° grid, the percentages of land used to grow wheat crops in the Northern Plains States. Zero percentage shows up as white on the map. [EPA 2009]



Image (left) showing the plume produced by a combine while harvesting wheat in North Dakota. Image (right) showing the exit of the chopper chute on the bullet rotor combine used for sampling with the six-channel particle counter. The rear-facing inlet samples aerosol concentrations at center of the airflow just outside the exit of the chute.



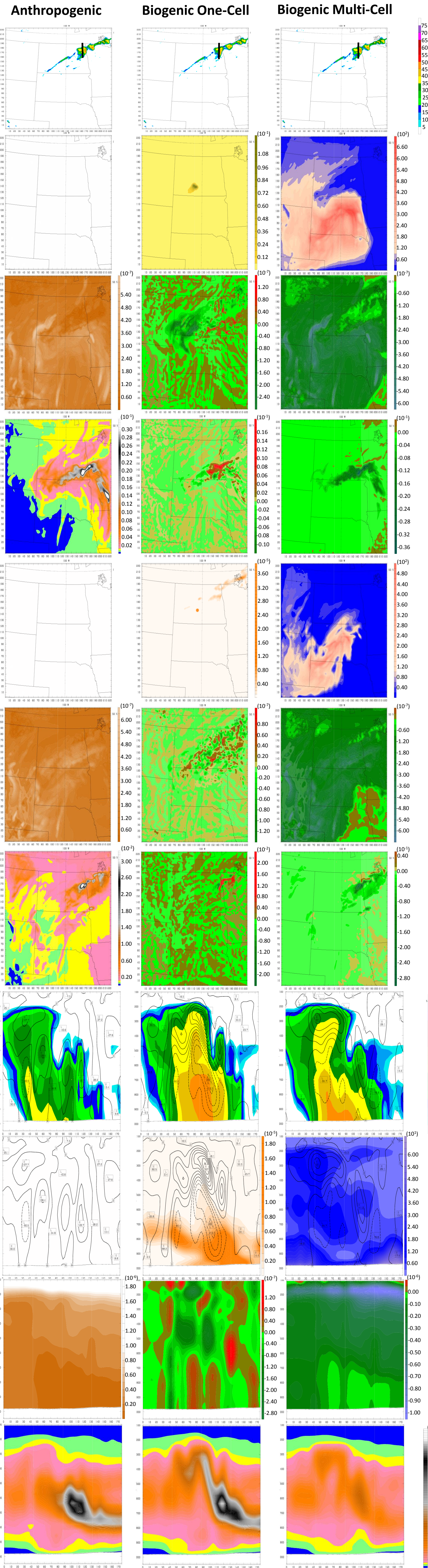
Example of data collected from particle counter. Particulate matter (PM = 2.5µm) measurements during the harvest on 18 August 2007. The data is from 47027 to 65201 seconds from midnight-UTC or 13:03:03–18:06:41UTC.

Center radius of particle (m)	.875X10 ⁻⁷
Volume of particle (m ³)	2.81X10 ⁻¹⁸
Length combine chute (m)	0.178
Width combine chute (m)	1.397
Particle velocity (m/s)	24
Duration (s)	3600
Area (m ²)	68796.6
Total Wheat Farmland in ND (m ²)	3.2X10 ¹⁰
Density (kg/m ³)	681
1 mol of Isoprene (g)	68.12
Emission Rate (moles/km ² /hr)	2.69X10 ⁶

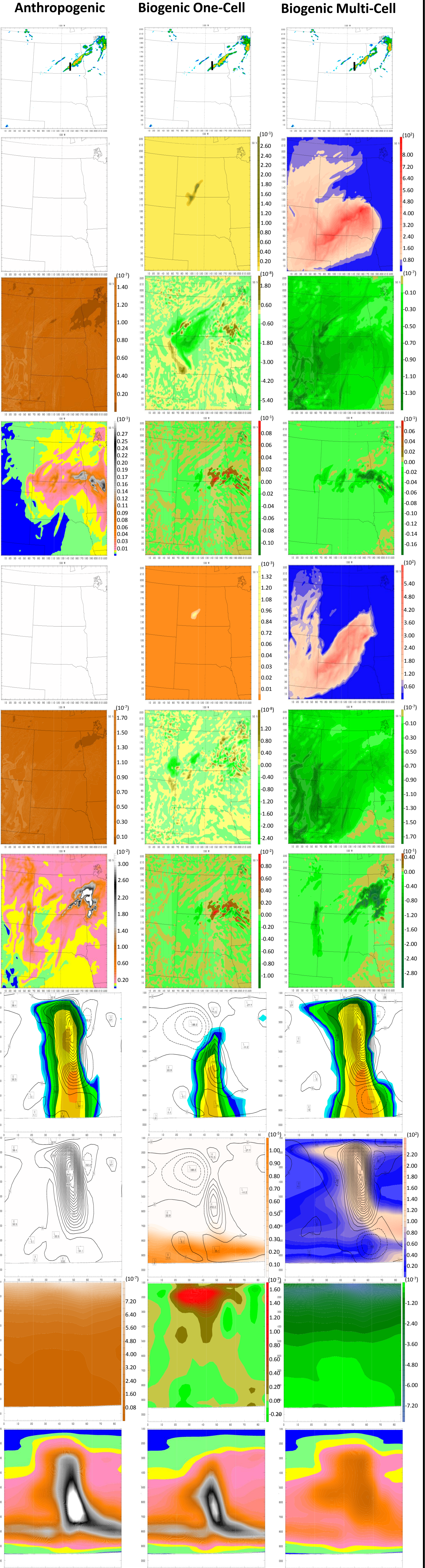
Assumed values used for calculating emission rate.

Selected Simulation Results

21 Hr Forecast



24 Hr Forecast



Plan View

30 Ft AGL

Radar reflectivity (dBz)

850 mb

Isoprene Concentration (ppmv)

OH Concentration (ppmv)

Optical Thickness

700 mb

Isoprene Concentration (ppmv)

OH Concentration (ppmv)

Optical Thickness

Cross Sections

Radar reflectivity (dBz) and Vertical Velocity (cm/s)

Isoprene Concentration (ppmv) and Vertical Velocity (cm/s)

OH Concentration (ppmv)

Optical Thickness

Experimental Design

All simulations start with a idealized profile for the chemistry.

Anthropogenic: uses the 2005 Environmental Protection Agency National Emission Inventory (NEI) database that covers the United States at 4km horizontal resolution [EPA 2008].

Biogenic One Cell: uses NEI database along with isoprene emits out of one grid point located near Harvey, North Dakota (47.58781°, -99.56165°).

Biogenic Multiple Cell: uses NEI database along with isoprene emits out of all grid cells that are west of 97.00o west longitude in the domain.

Model Configuration

WRF-Chem version	Version 3.1
Domains horizontal resolutions	5 km
Domains horizontal grids dimensions	224×224 for d01
Number of vertical levels	29 for every domain
Lateral boundary conditions	NARR
Initial conditions	NARR (cold start)
Long wave radiation	RRTM
Shortwave radiation	Goddard
Surface layer	Monin-Obukhov
Land-surface model	Noah LSM
Planetary boundary layer scheme	Yonsei University
Microphysics	Ferrier
Cumulus parameterization	Kain-Fritsch
Chemical mechanism	RADM2 (Chang et al)
Aerosols mechanism	MADE : Akermann et al 1998 SORGAM : Schell et al., 2001
Photolysis	Madronich, 1987
Dry deposition	Weseley, 1989
Biogenic Emissions	Online using reference fields and modified online. Not active for anthropogenic simulation.
Anthropogenic emissions	Emissions are speciation for RADM2/SORGAM
Dust option, Sea salt emissions, DMS emissions	Not active
Emissions anthropogenic input frequency	60 minutes

Future Work

The Isoprene gas emitted during the biogenic simulations causes a localized decrease of OH in those locations. The gas produced by the combination of Isoprene and OH may play a role in the decrease in optical depth and storm structure. Use different input method for biogenic simulation for aerosols along with using a binning microphysical scheme (Lin et al.).

References

EPA (Environmental Protection Agency) (2008), National Emission Inventory database for Criteria and hazardous Air Pollutants, <http://www.epa.gov/air/data/neidb.html> November 6 2008) viewed 4/11/09
EPA (Environmental Protection Agency) (2009), Biogenic Emissions Inventory System (BEIS) Modeling, <http://www.epa.gov/AMD/biogen.html> (March 5 2009) viewed 4/11/09
Grell, G. A., S. E. Peckham, R. Schmitz, S. A. McKeen, G. Frost, W. C. Skamarock and B. Eder, 2005: Fully coupled “online” chemistry within the WRF model, *Atmos. Environ.*, **39**, 6957–6975.
Skamarock, W. C, et. al., 2008: A Description of the Advanced Research WRF Version 3. NCAR Technical Note, NCAR/TN–475+STR.