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 Plains 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]

Example of data collected from particle counter. Particulate matter (PM = 2.5 μm) measurements during the harvest on 18 August 2007. The data is from 47027 to 65201 seconds from midnight-UTC on 13.03.03-18.06.41UTC.

Plan View

30 Ft AGL
Radar reflectivity (dBZ)

850 mb
Isoprene Concentration (ppmw)

OH Concentration (ppmw)

Optical Thickness

Cross Sections

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

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

OH Concentration (ppmw)

Optical Thickness

Selected Simulation Results

21 Hr Forecast

Anthropogenic

Biogenic One-Cell

Biogenic Multi-Cell

24 Hr Forecast

Anthropogenic

Biogenic One-Cell

Biogenic Multi-Cell

Experimental Design

All simulations start with an 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 (47.5878°, -99.5616°).

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

Model Configuration

WRF-Chem version

Version 3.1

Domains horizontal resolutions

5 km

Domains horizontal grids dimensions

224x224 for 001

Number of vertical levels

29 for every domain

Lateral boundary conditions

NARR

Initial conditions

NARR (cold start)

Long wave radiation

RTM

Shortwave radiation

Goddard

Surface layer

Monin-Obukhov

Land-surface model

Noah LSM

Planetary boundary layer scheme

Yonsei University

Microphysics

Ferrier

Cumulus parameterization

Kain-Fritch

Chemical mechanism

RADM2 (Chang et al)

Aerosols mechanism

MADE: Akerman et al 1998
SORGAM: Schell et al., 2001

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


