Examining the Influence of *in-situ* Aircraft Emissions with CMAQ

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Motivation

- Like any mobile combustion source, aircraft emit NO_x, HC, CO, as well as CO_2, H_2O, SO_2, and PM.

- Unlike surface based mobile combustion sources, aircraft emissions are three-dimensional. These emissions fill the troposphere.

- What is the effect of these emissions on tropospheric chemistry and on photolysis?

Emission Inventory

- The inventory of emissions from *scheduled* aircraft operations was prepared for NASA by Boeing for the year 1999.

- This inventory is global and has a horizontal resolution of one latitude degree by one longitude degree and a vertical resolution of one kilometer. Emitted species are NOx, HC, and CO.

- We have done CMAQ calculations with this inventory by assuming a PM (soot) emission rate based upon a fleet average ratio of soot mass to fuel use.
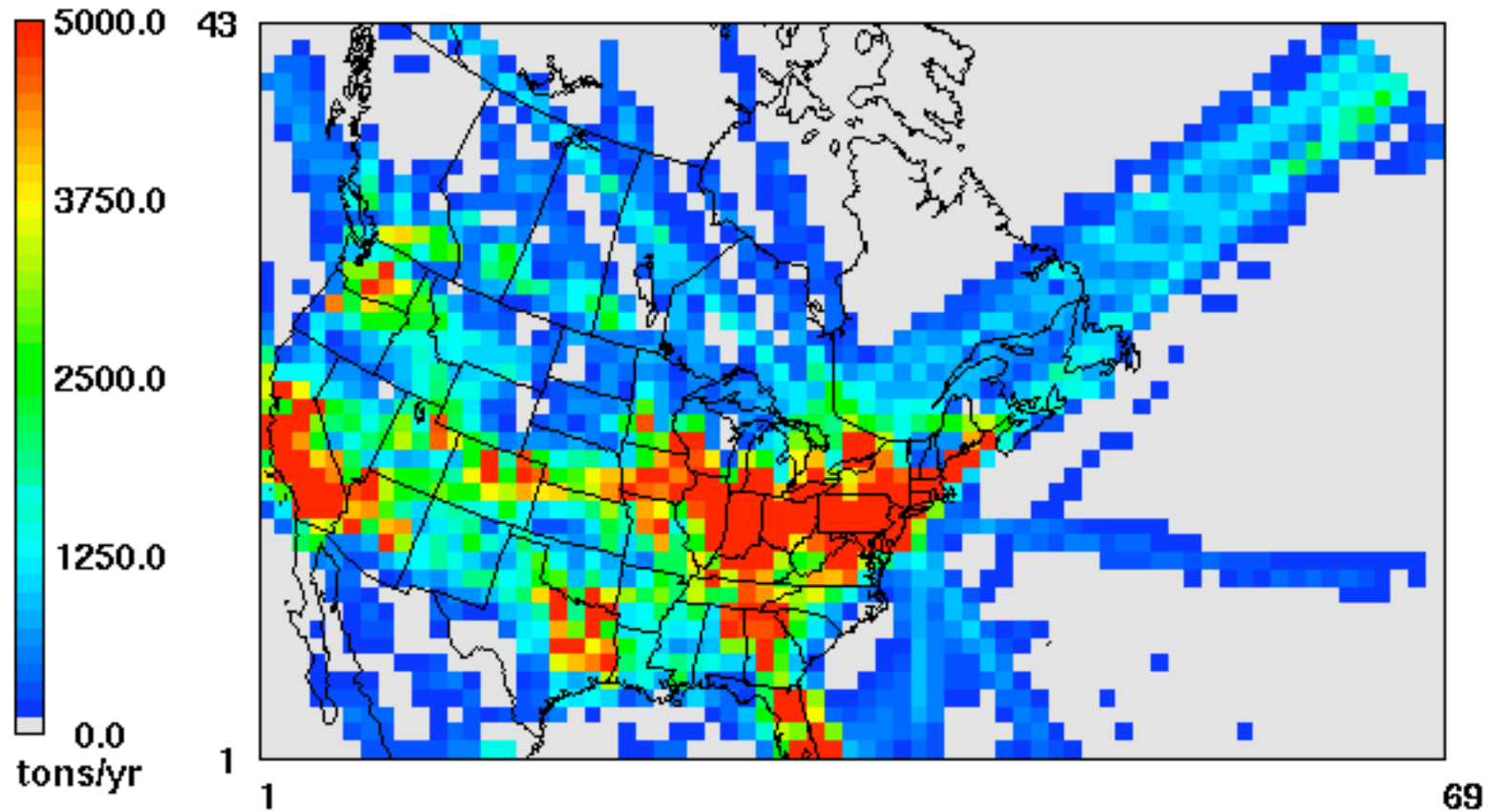
Boeing 1999 Aircraft Fuel Use

0−1 km Altitude Band
108 km NASA
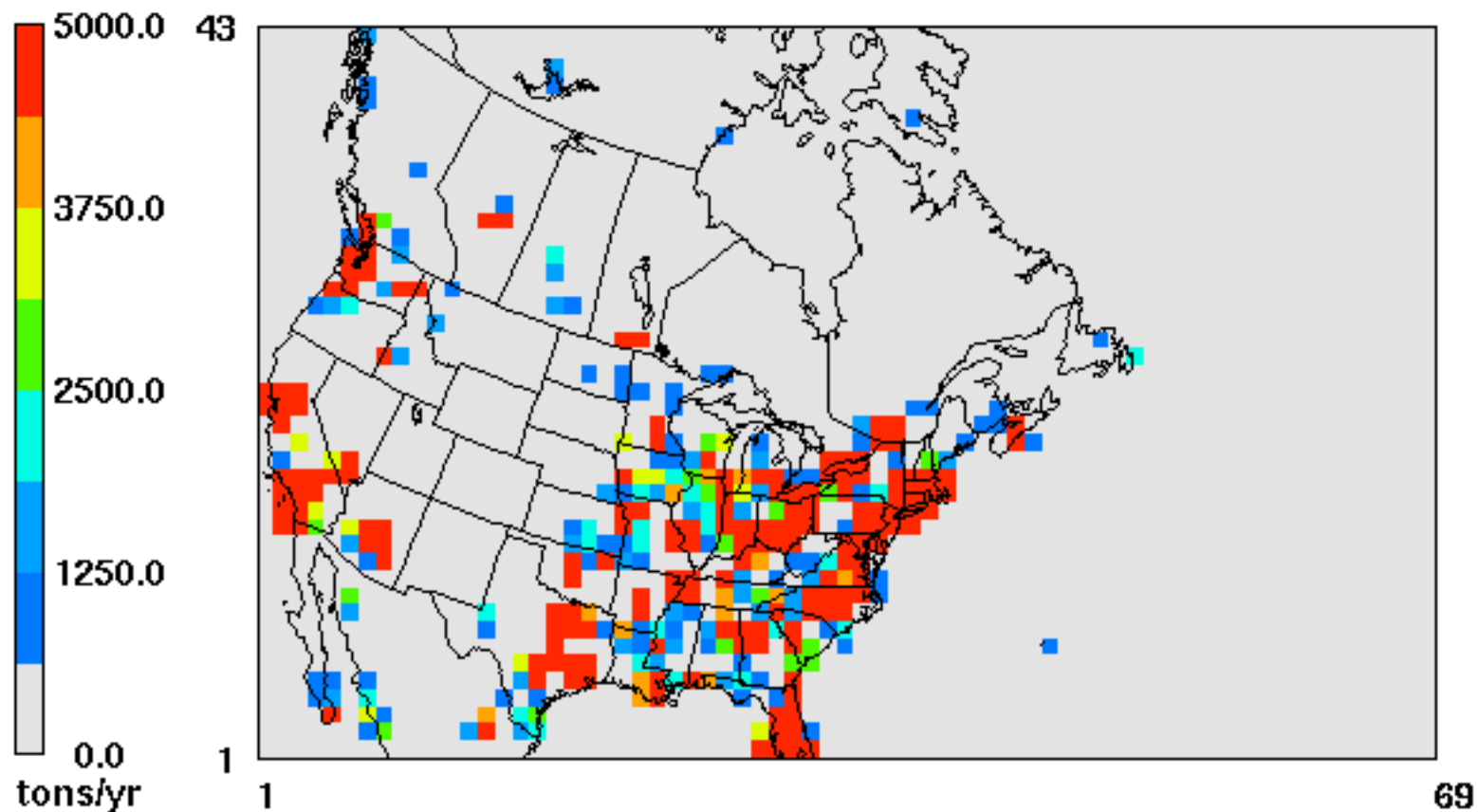
January 1,0 0:00:00
Min= 0.0 at (1,1), Max=341952.9 at (28,16)
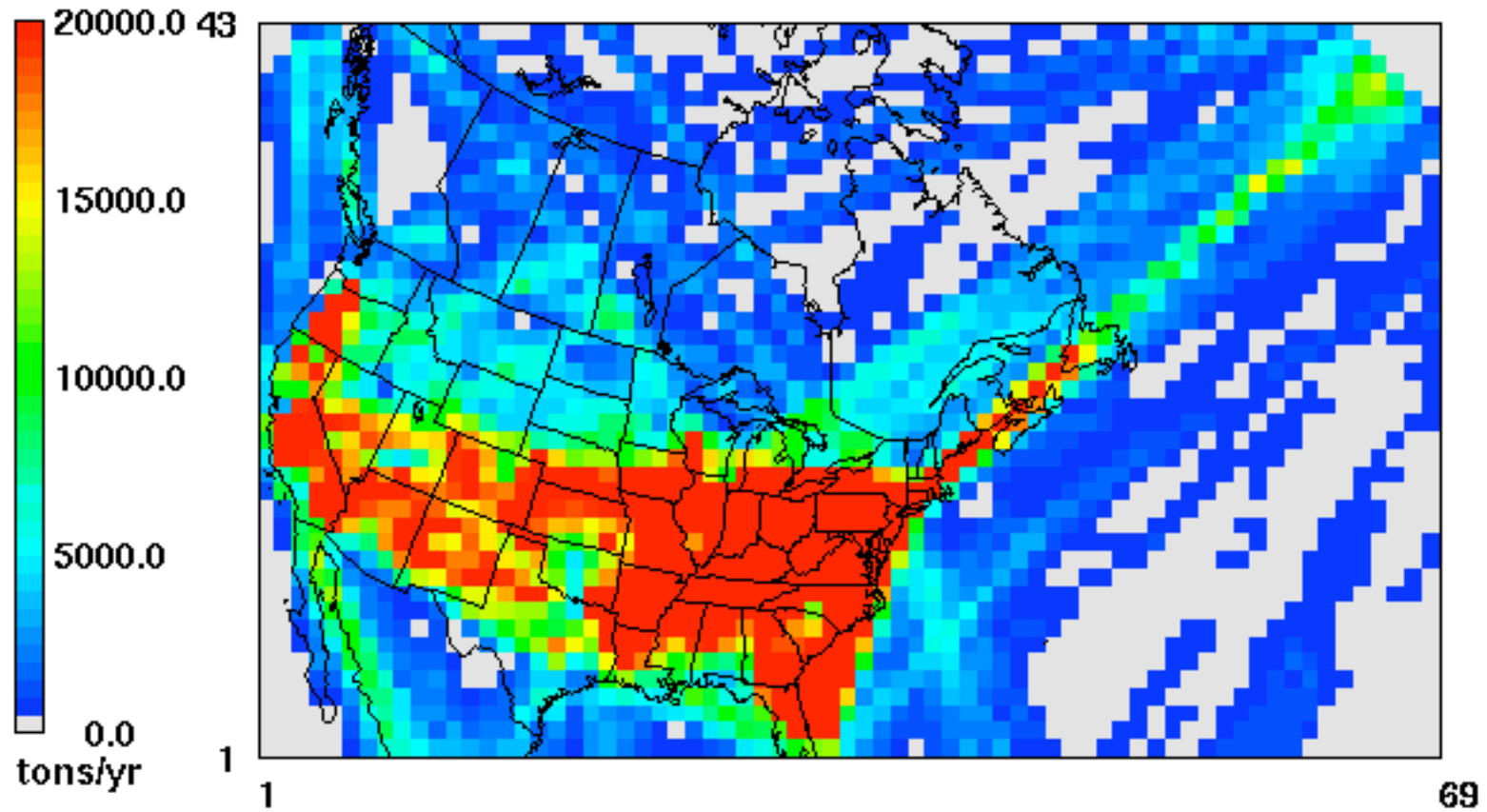
Boeing 1999 Aircraft Fuel Use

9–10 km Altitude Band
108 km NASA

5000.0   43

3750.0

2500.0

1250.0

0.0
tons/yr   1

1   69

January 1,0 0:00:00
Min= 0.0 at (1,1), Max=22139.6 at (39,16)

Boeing 1999 Aircraft Fuel Use

10-11 km Altitude Band
108 km NASA

January 1,0 0:00:00
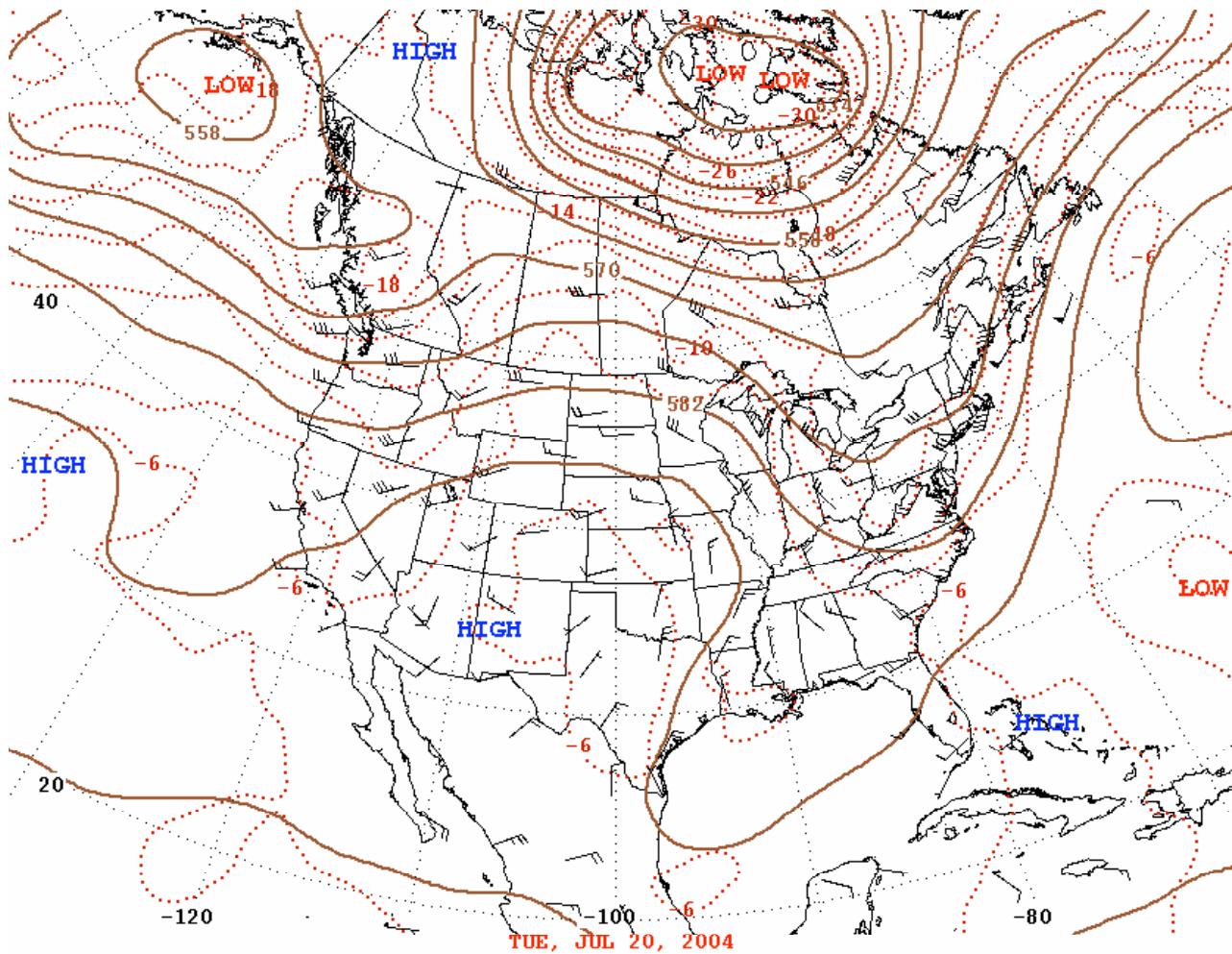Min= 0.0 at (1,1), Max=62382.5 at (30,16)

CMAQ Calculations

- Date Shown: July 20, 2004
- Ozone and EC differences: at 2 altitudes
- Layer 26: 9.3 km
- Layer 27: 10.2. km
- Horizontal Grid Resolution: 108 km

Weather Situation

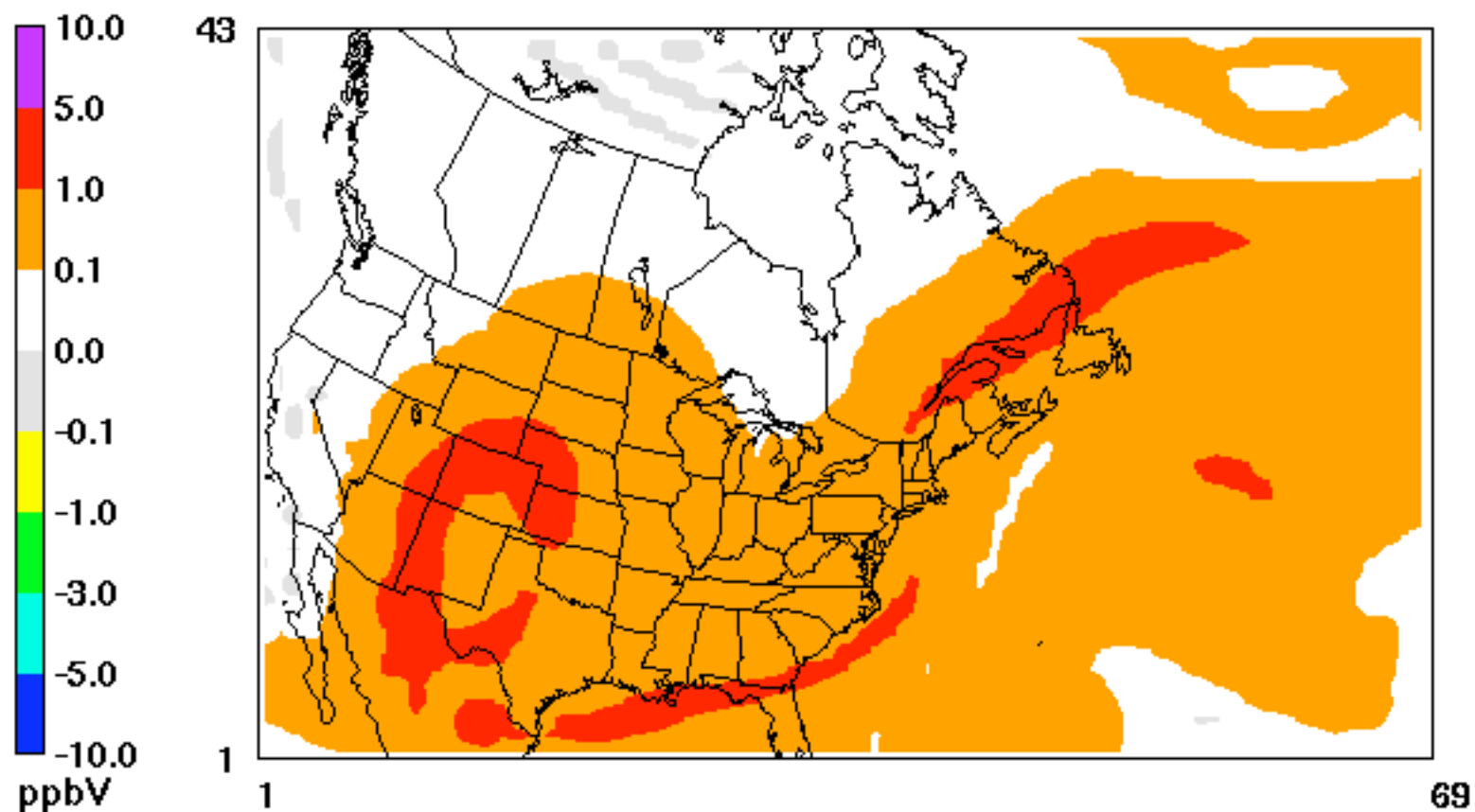- There is a trough over the eastern US and a ridge over the western US.

TUE, JUL 20, 2004
500-Millibar Height Contours at 7:00 A.M. E.S.T.

O3 DailyAverage Abs Diff

Layer26 saprc99_ace - saprc99_no_ace
INTEX2004 Simulation with CMAQ 4.5 (SAPRC99)

10.0
5.0
1.0
0.1
0.0
-0.1
-1.0
-3.0
-5.0
-10.0
ppbV

43

1

1

69

July 20,2004 0:00:00
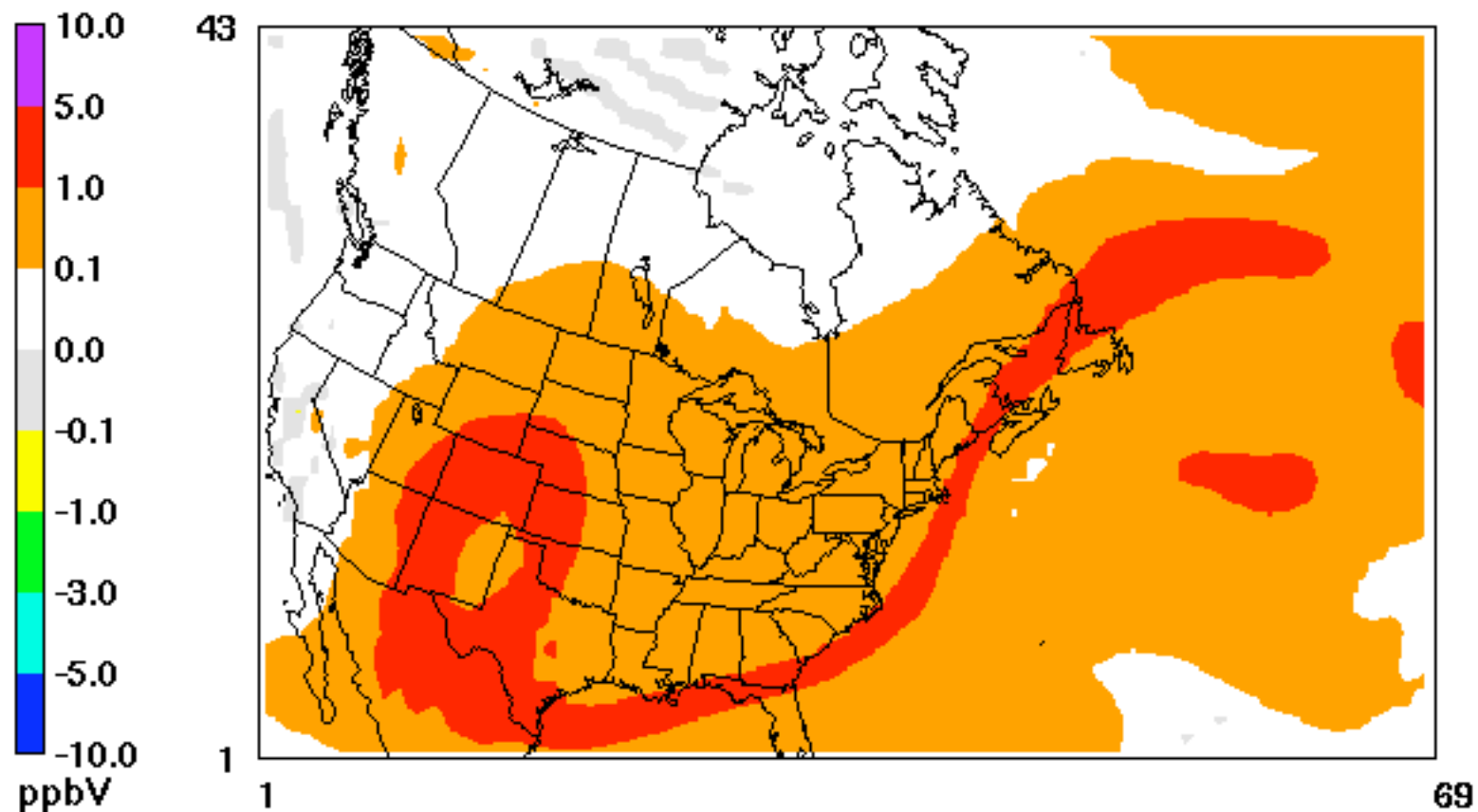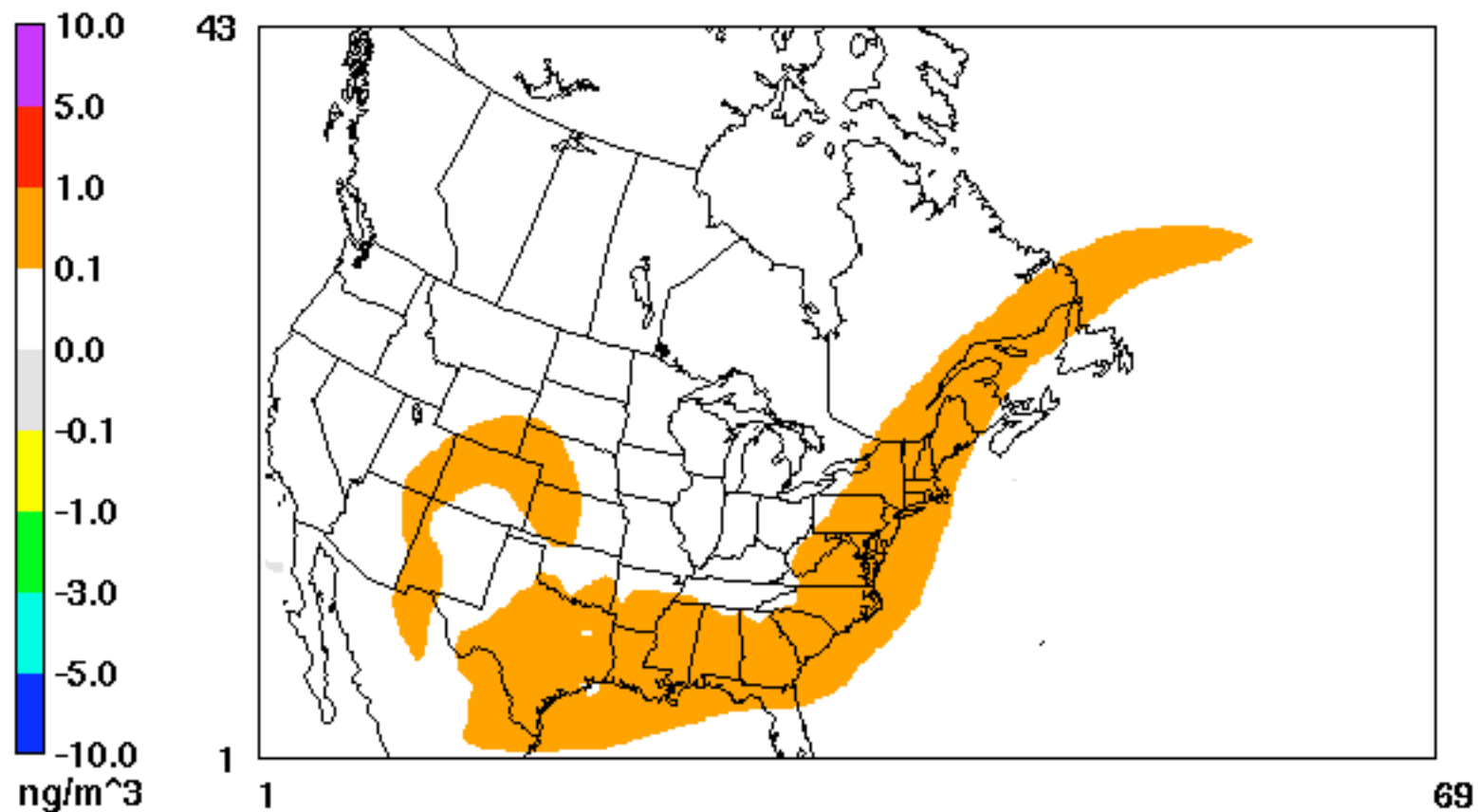Min=-0.0 at (4,22), Max=2.0 at (12,17)

O3 DailyAverage Abs Diff

Layer27 saprc99_ace - saprc99_no_ace
INTEX2004 Simulation with CMAQ 4.5 (SAPRC99)

July 20,2004 0:00:00
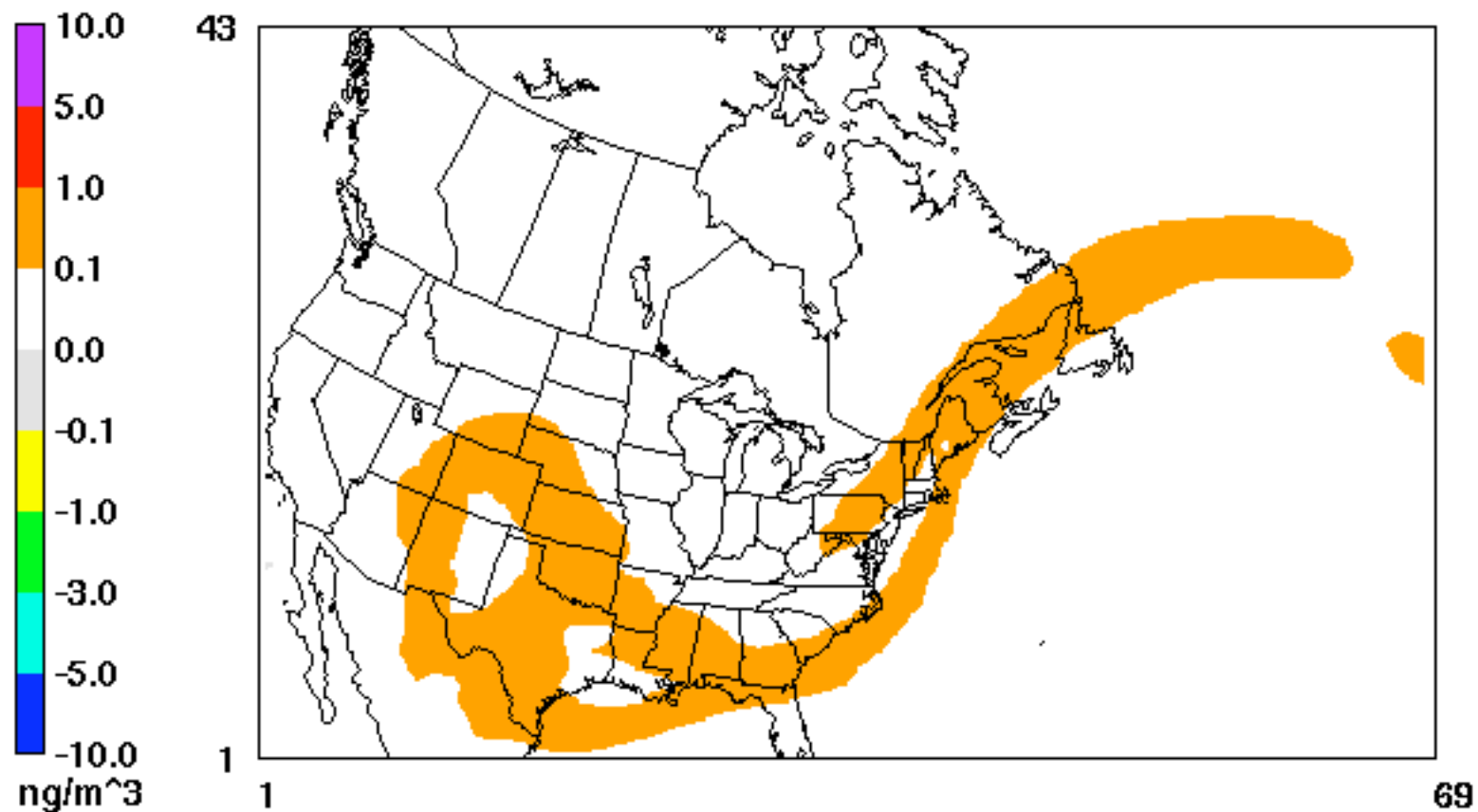Min=-0.1 at (3,21), Max=2.5 at (16,18)

EC Aerosol DailyAverage Abs Diff

Layer26 saprc99_ace - saprc99_no_ace
INTEX2004 Simulation with CMAQ 4.5 (SAPRC99)

July 20,2004 0:00:00
Min=-0.0 at (45,17), Max=0.2 at (37,16)

EC Aerosol DailyAverage Abs Diff

Layer27 saprc99_ace - saprc99_no_ace
INTEX2004 Simulation with CMAQ 4.5 (SAPRC99)

July 20,2004 0:00:00
Min=-0.0 at (1,12), Max=0.2 at (12,17)

AERO2K Inventory

- Newer Emissions for civil aviation for the year 2002 from European Commission project AERO2k

- Global inventory of NO_x, HC, CO, CO_2, H_2O, soot mass, particle number.

- Horizontal resolution is one latitude degree by one longitude degree. Vertical resolution is 150 meters.

- We have done one-dimensional column modeling of the effect on photolysis rates using this inventory.

- We *strongly* recommend that this inventory be available for CMAQ

Effect of Aircraft Emissions on Photolysis

- Column model version the new online photolysis module calculates the photolysis rates over two airport locations (PHL and ATL).

Effect of Aircraft Soot Emissions on JNO2

With ACFT

No ACFT

ATL->

<-PHL

<-ATL

PHL->

Altitude [m]

JNO2 [1 / sec]