
# *Perspective from Mexico*

## *Air Quality Forecasting Program*

Potomac, MD US
November 28 — December 1, 2011

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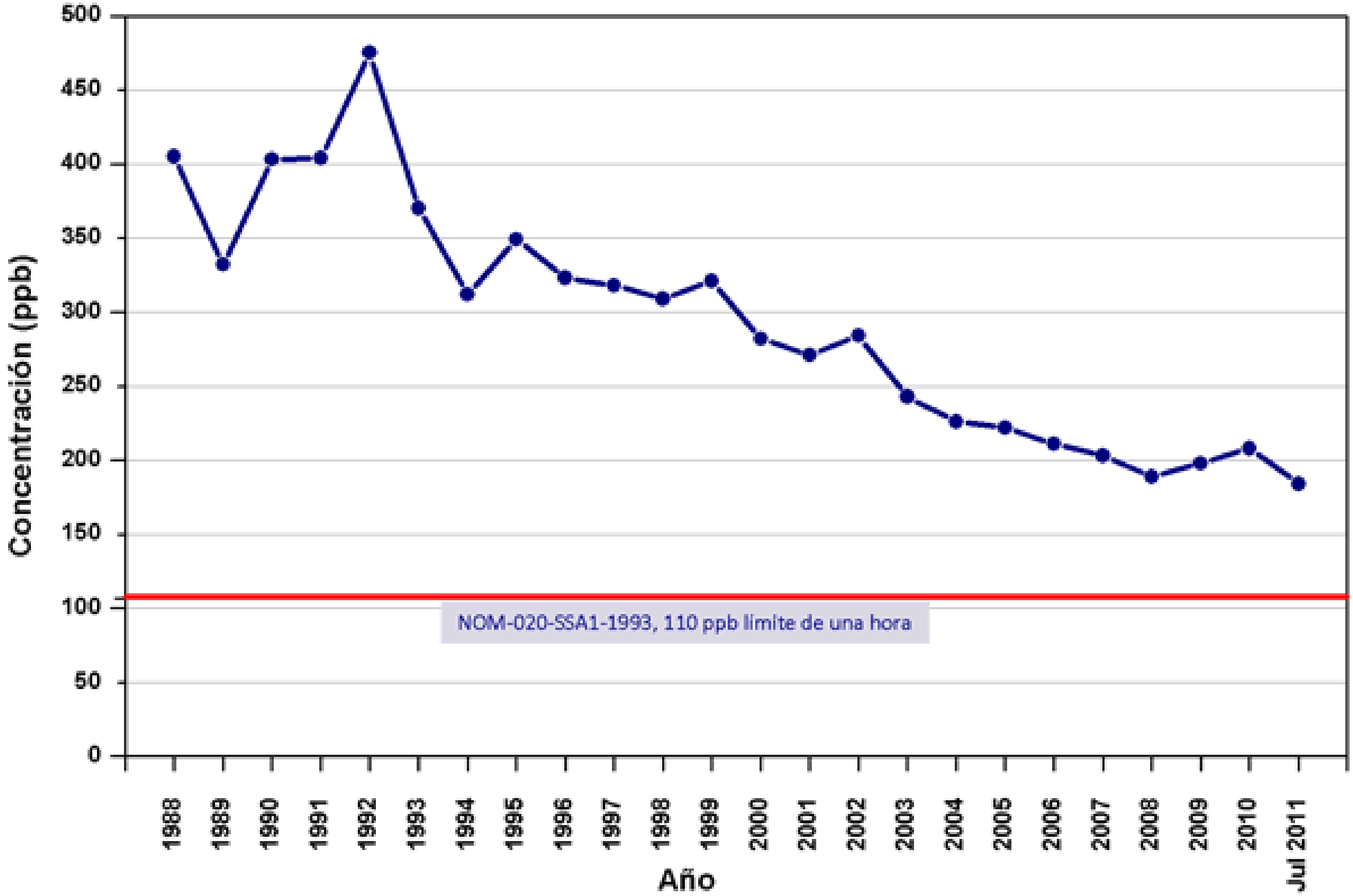
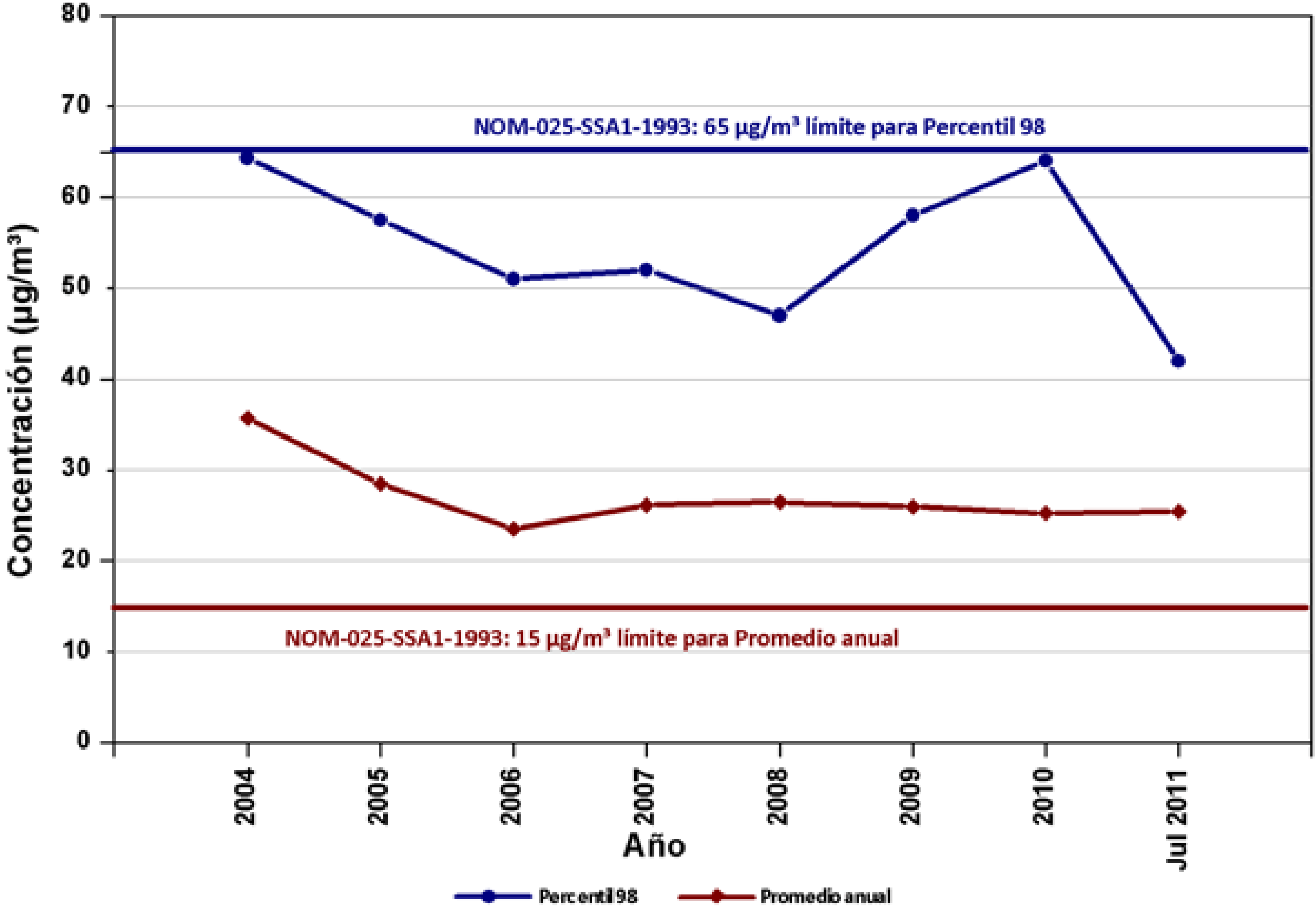
# Topics

- Pollution in MCMA
- Importance of Air quality forecast
- Methods
- Learned lessons
- Future work

# The Pollution Problem in MCMA: $O_3$



# $PM_{2.5}$



NOM-025-SSA1-1993: 65 µg/m³ límite para Percentil 98
NOM-025-SSA1-1993: 15 µg/m³ límite para Promedio anual
Concentración (µg/m³)
80
70
60
50
40
30
20
10
0
2004
2005
2006
2007
2008
2009
2010
Jul 2011
Año
Percentil 98
Promedio anual

# Air Quality Forecast Importance

- In Mexico City Metropolitan Area (MCMA) the ozone levels have exceeded the standard (110 ppb) on 50% of the days in 2010. The programs to prevent the environmental contingencies are applied after the people have been exposed to high ozone levels.
- An air quality forecast it is necessary in order to reduce exposure to ozone and other air pollutants

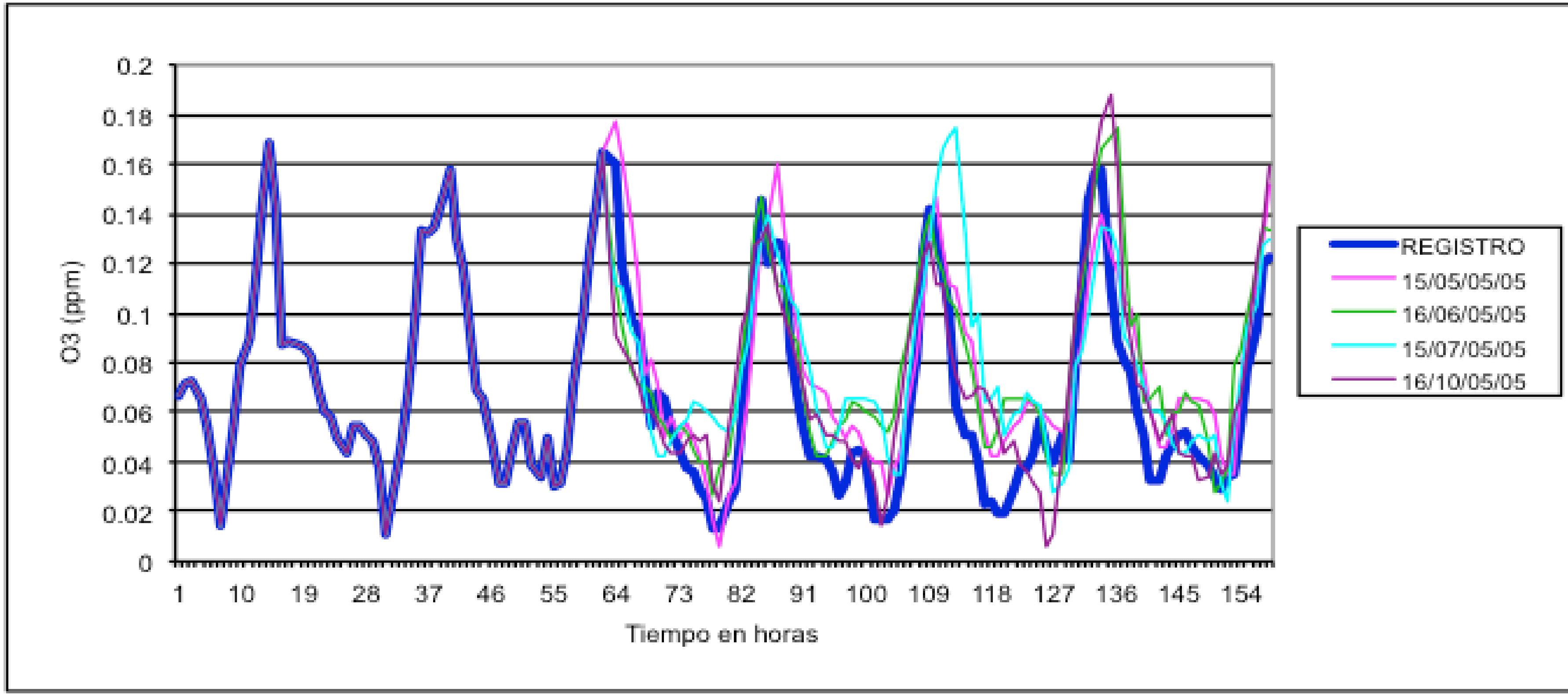
# Methods used for Air Quality Forecast

- Statistical (SMA)
- Analog (SMA)
- Numerical modeling (CCA-UNAM)

# Analog Forecast Technique

- Requiring the forecaster to remember a previous weather event which is expected to be mimicked by an upcoming event.
- Also called as pattern recognition

# Analogues Identification




Registro y análogos de la serie de tiempo de ozono (Periodo actual 63-86, Periodo futuro 87-158) Source: Pérez Sesma (Personal comunication)

# SMA Forecast

- Información calidad del aire
- IMECA
- Contaminantes tóxicos
- Índice UV
- Pronóstico de calidad del aire
- Mosaicos
- Indicadores de la calidad del aire
- Contingencias ambientales
- Incrementos extraordinarios
- Campañas de monitoreo

## Pronóstico de ozono

Hoy

**FECHA DE VALIDEZ:** 2011-09-22

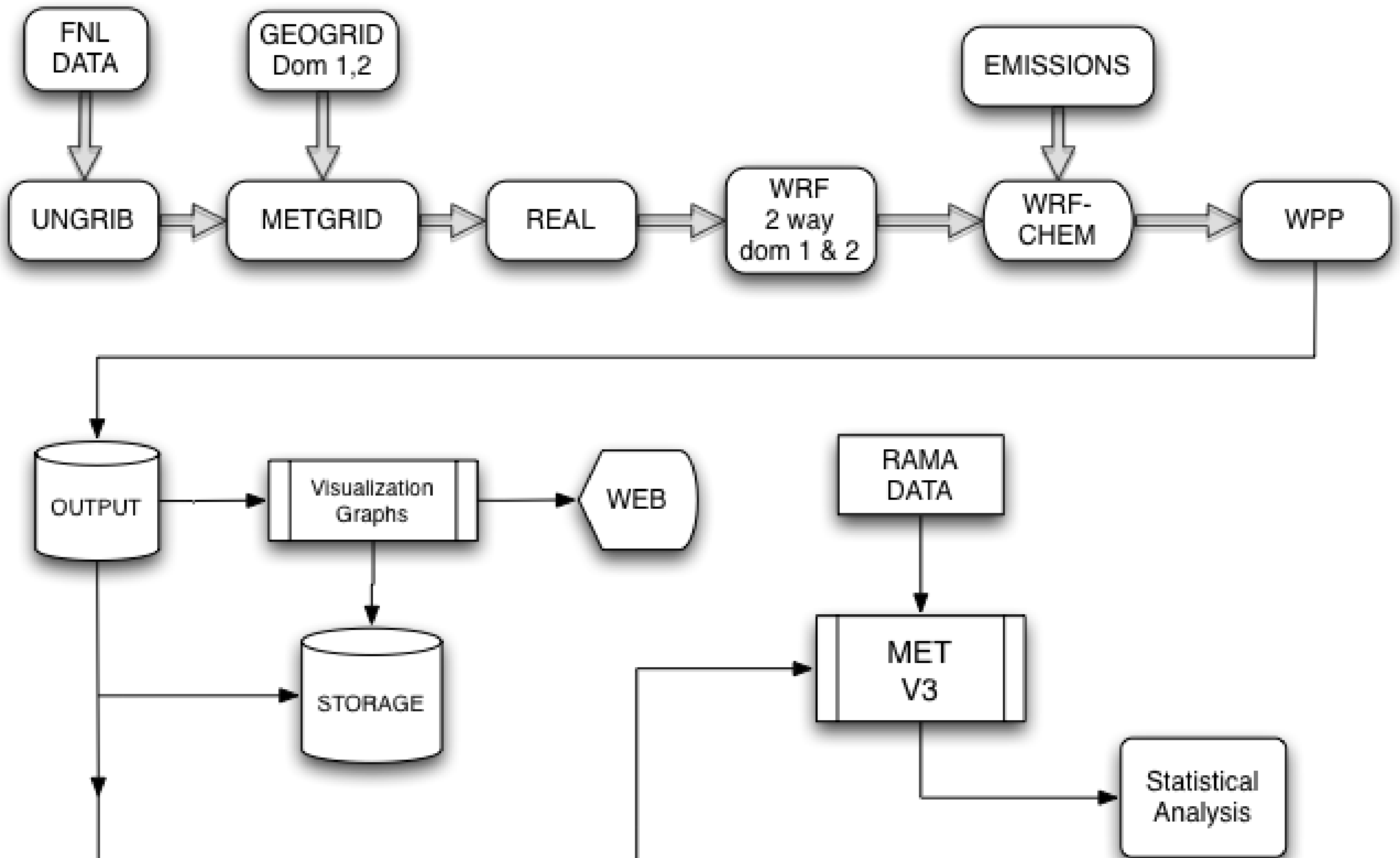
**FECHA DE ELABORACIÓN:** 2011-09-22

| HORAS | CALIDAD DEL AIRE | RIESGOS |
|---|---|---|
| 7 - 12 | Buena<br>1 - 50 | |
| 13 - 17 | Regular<br>51 - 80 | Las personas que son excepcionalmente sensibles al ozono y las partículas suspendidas pueden experimentar molestias en vías respiratorias. |
| 18 - 21 | Buena<br>1 - 50 | |

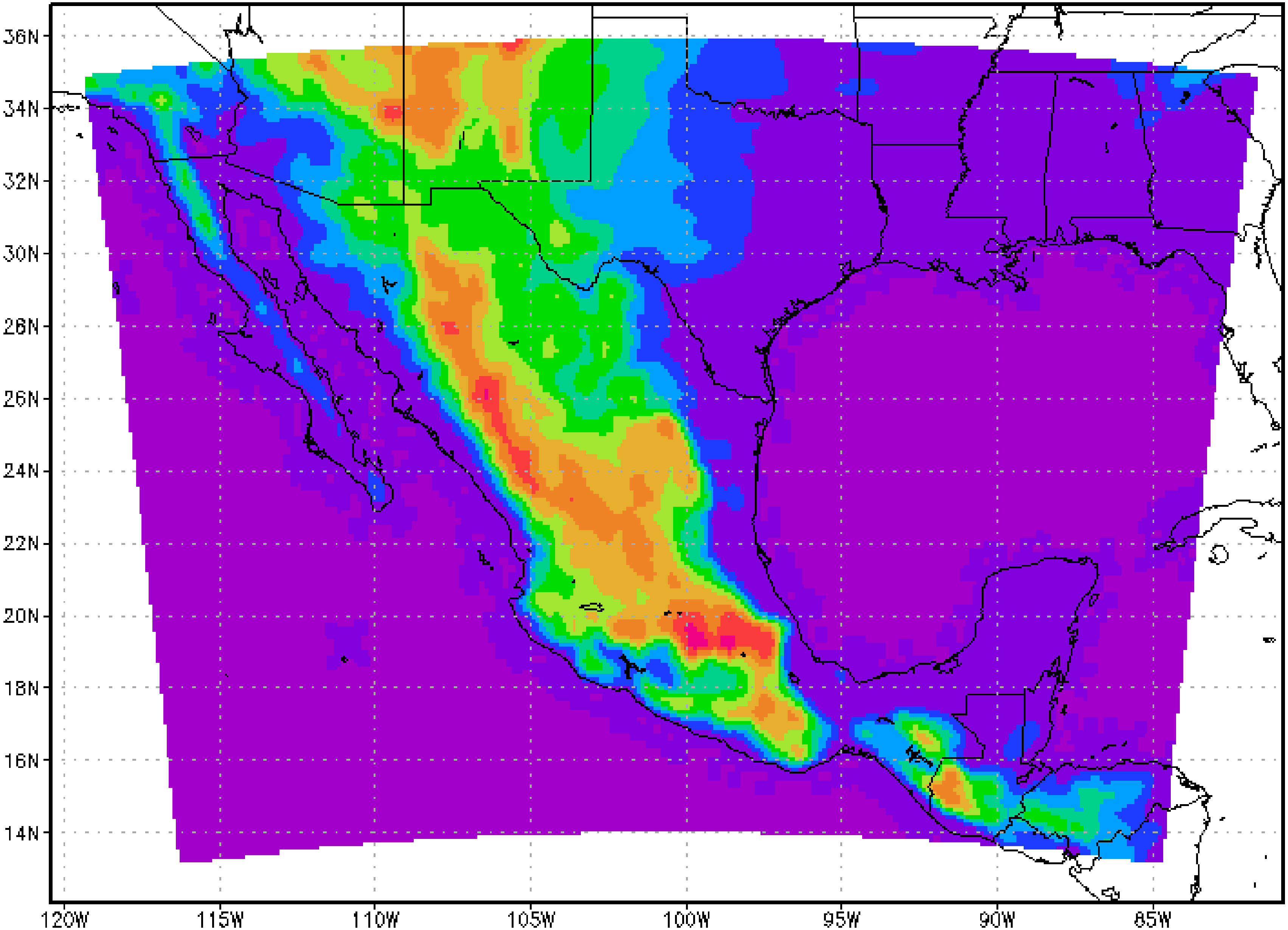
Volver

Los datos presentados en esta sección son preliminares
y podrían sufrir modificaciones durante las siguientes etapas de validación.

# Use of WRF-Chem with METv3 evaluation code



# Air Quality Forecast Domain



# AQ forecast web page

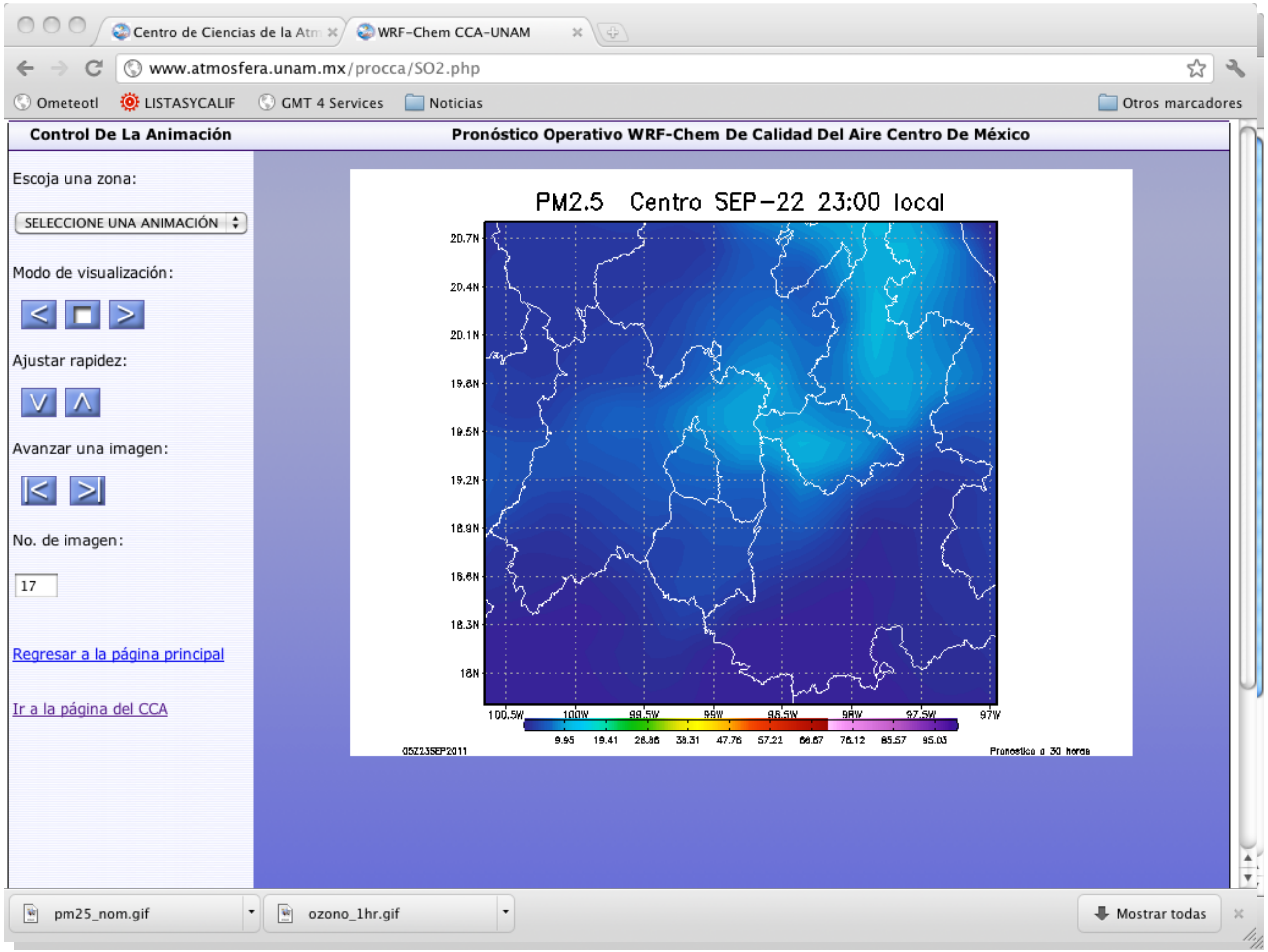
National Level:

Ozone

Central Mexico:

Ozone

$PM_{2.5}$




http://www.atmosfera.unam.mx/procca/Ozono.php

# Forecast Evaluation

Standard deviation

$$\sigma_p = \sqrt{\frac{\sum(p_i - \bar{p})^2}{n}} \qquad \sigma_o = \sqrt{\frac{\sum(o_i - \bar{o})^2}{n}}$$

Root Mean Square Difference

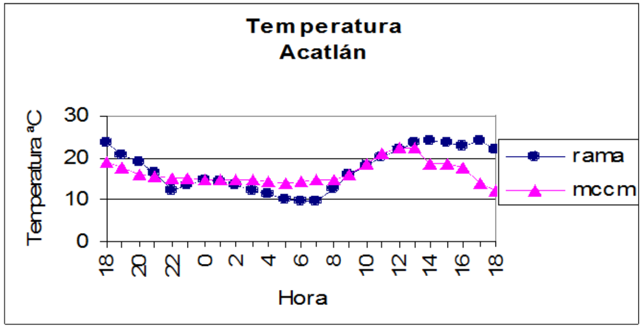
$$RMSD = \sqrt{\frac{\sum_{i=1}^{n}(o_i - p_i)^2}{n}}$$

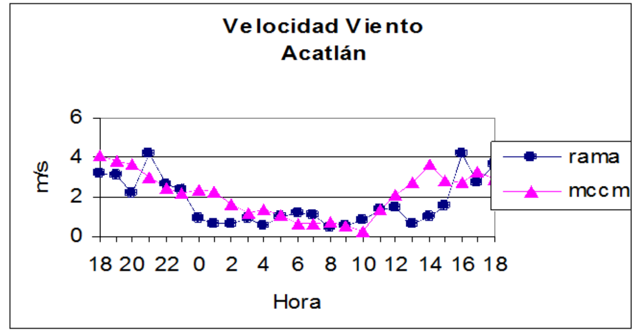
$$RMSD_s = \sqrt{\frac{\sum_{i=1}^{n}(\hat{p}_i - o_i)^2}{n}} \qquad RMSD_u = \sqrt{\frac{\sum_{i=1}^{n}(\hat{p}_i - p_i)^2}{n}}$$

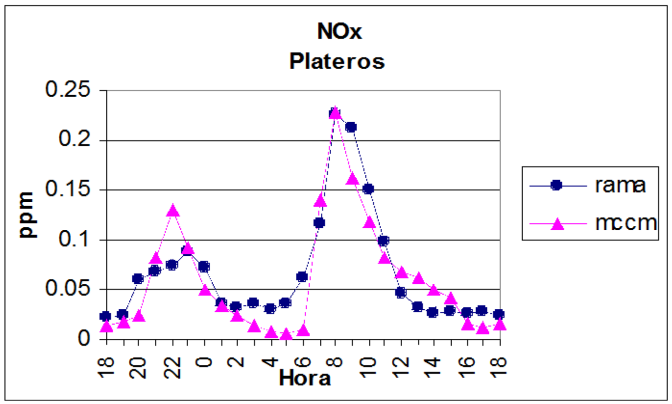
$$\hat{p} = a + b \cdot o_i$$

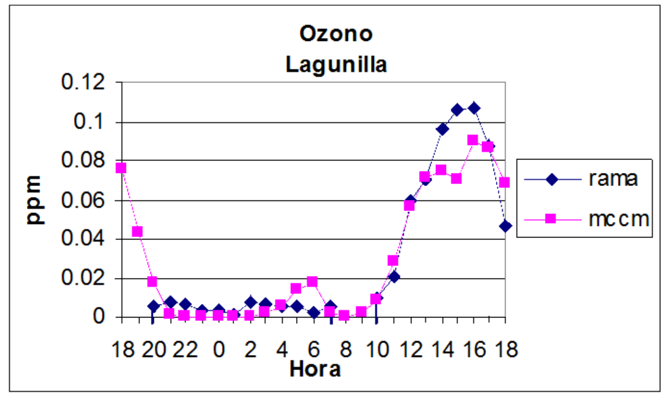
The performance of the model is considered to be high if $\sigma_p \approx \sigma_o$, while RMSD< $\sigma_o$
(Pielke, 1984)

Willmott *et al*. 1981




$$\mathrm{I}_c = 1 - \frac{\sum (p_i - o_i)^2}{\sum (|p_i - \bar{o}| + |o_i - \bar{o}|)^2}$$

Index of Agreement

$$N_{ge} = \frac{1}{N} \sum_{i=1}^{N} \frac{|p_i - o_i|}{o_i}$$

Net gross error

Normalized Bias

$$N_b = \frac{1}{N} \sum_{i=1}^{N} \frac{p_i - o_i}{o_i}$$

$(-)$*Subestimación*

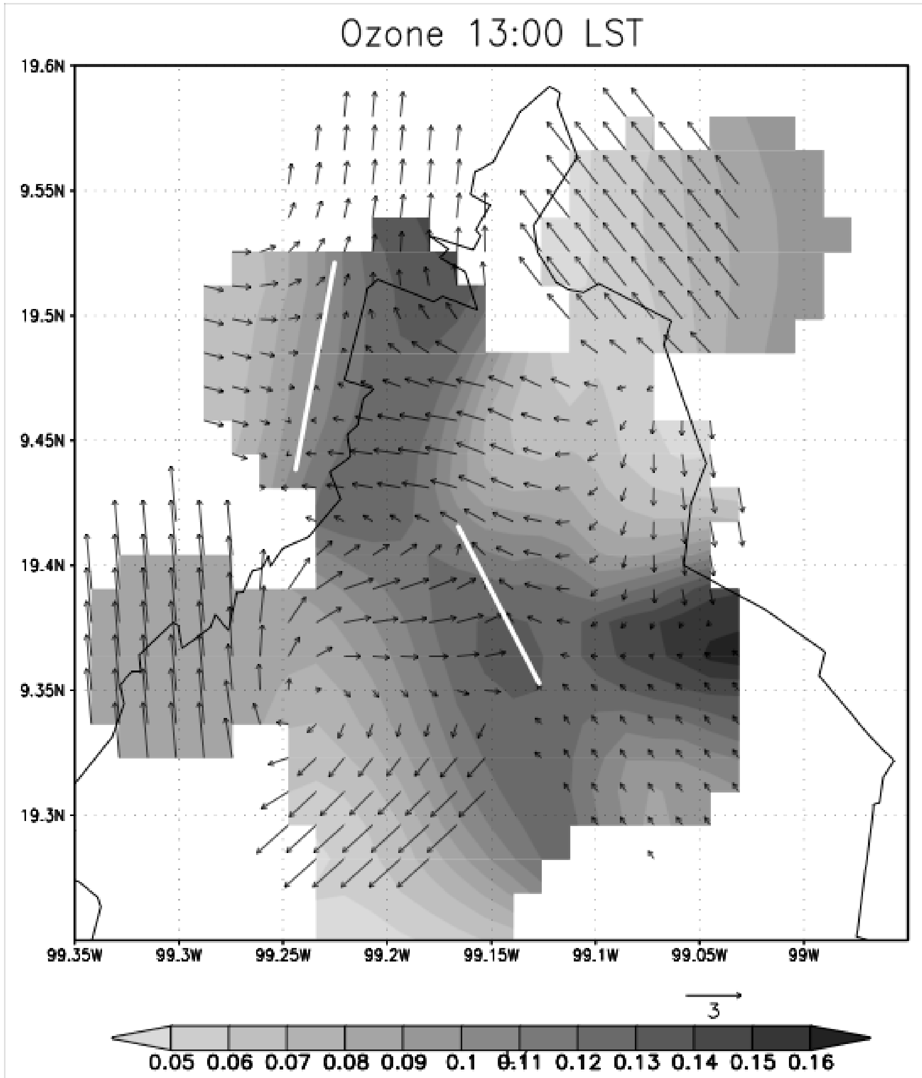
$(+)$*Sobreesimación*

# Learned Lessons

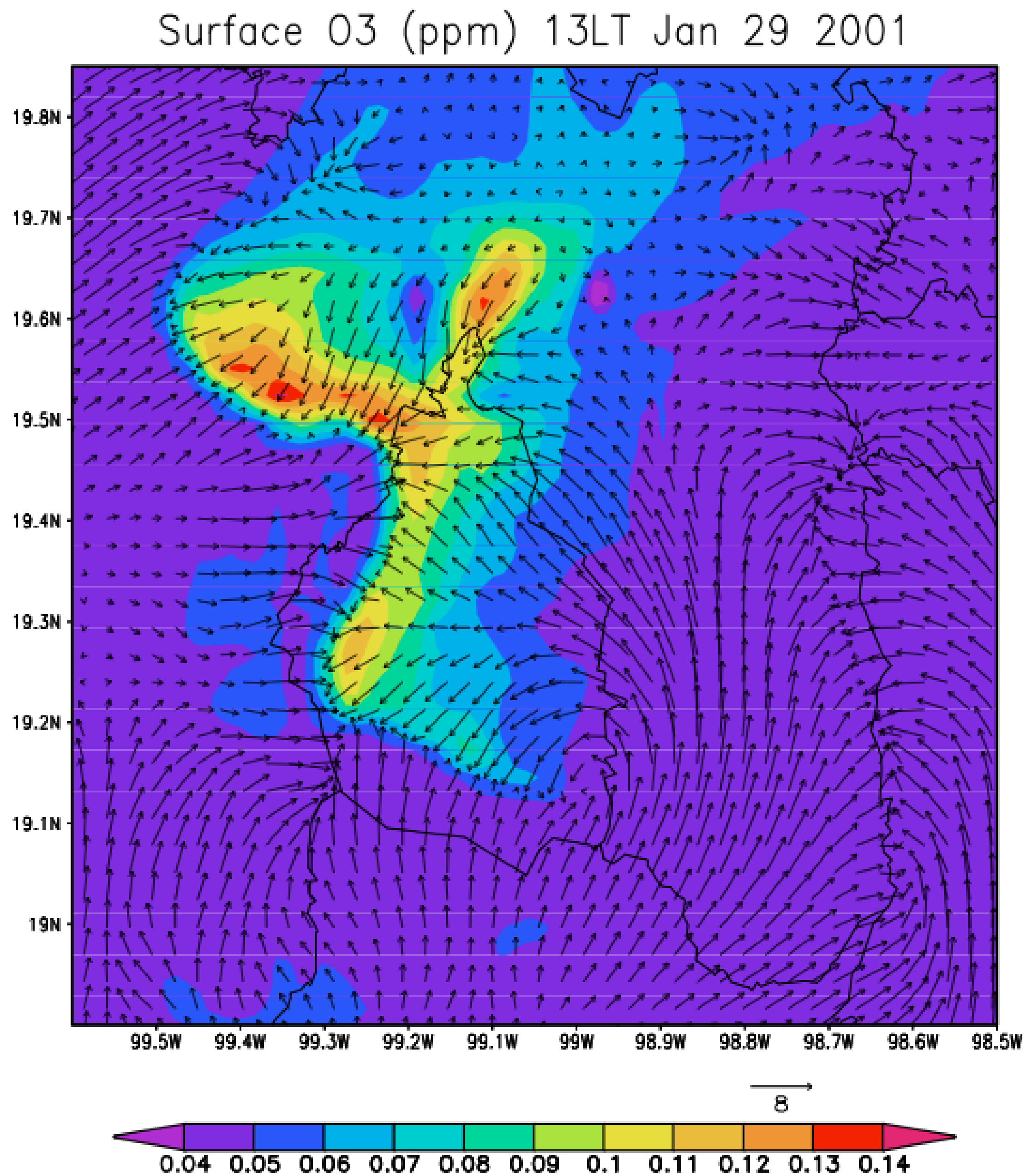
- Meteorological aspects
  - Confluences
  - Fumigation
- Influence in A.Q from
  - Large point sources (i.e. Tula´s Energy Sector, Popocatepetl volcano)
  - Area sources (i.e. bare soil lands, Toluca city)
  - Forest-City interaction
- Chemical Mechanism

# METEOROLOGICAL ASPECTS

# Measured distribution of surface Ozone and wind vectors (SIMAT)
# 13:00 LST January 29th, 2001

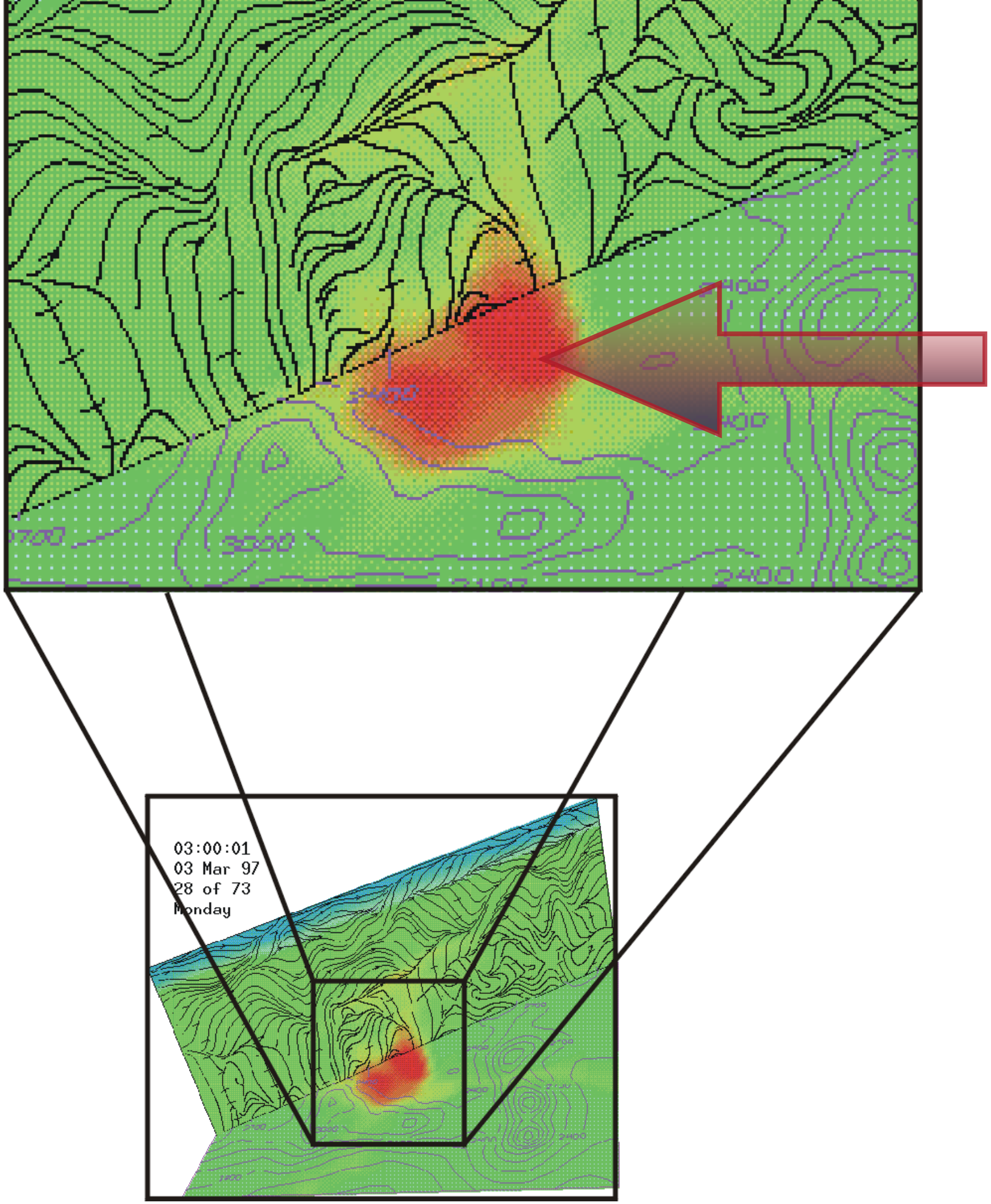



Confluences



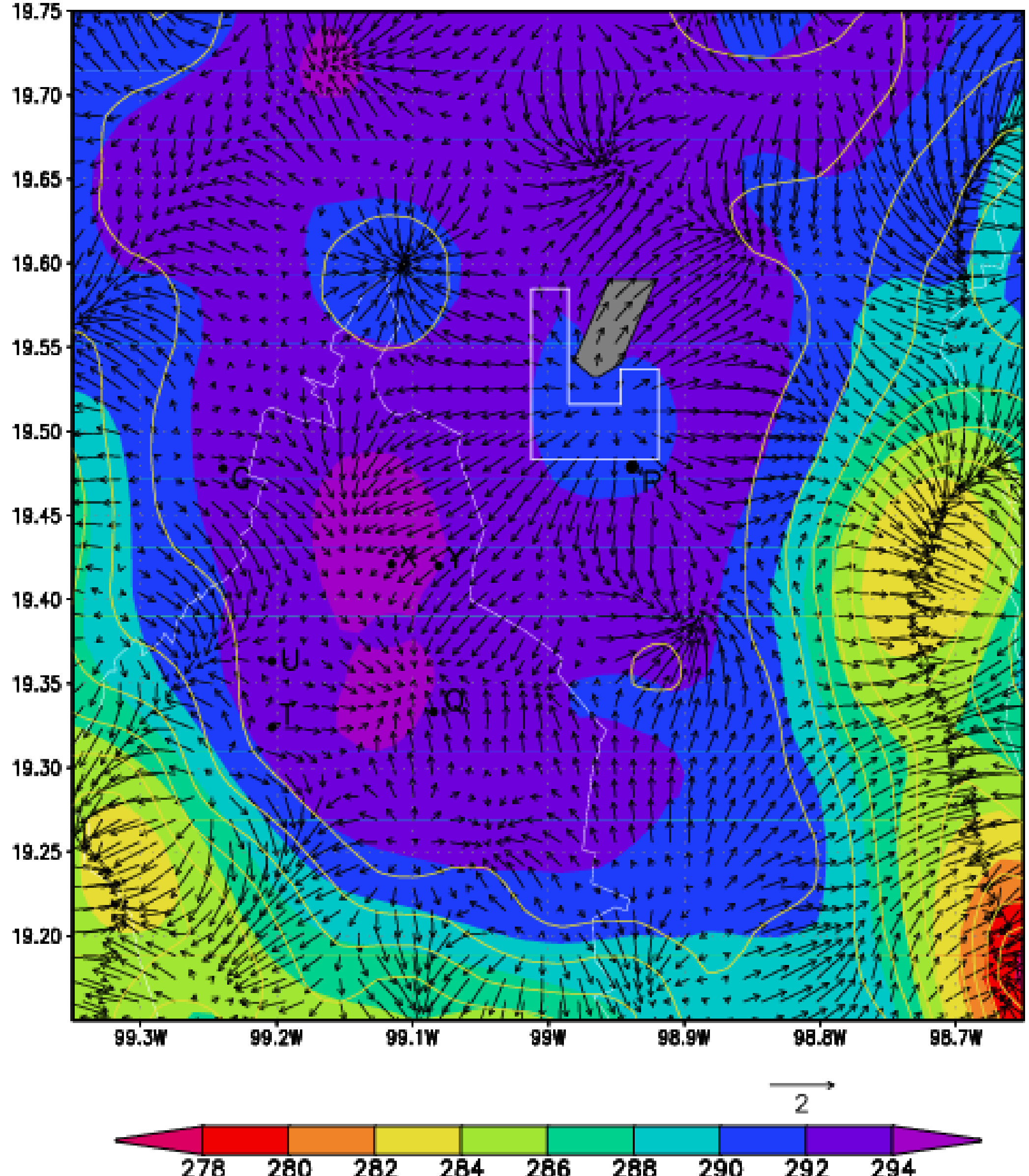

Locally Induced Surface Air Confluence By Complex Terrain and its Effect on Air Pollution in the Valley of Mexico", Aron D. Jazcilevich, Agustín R. García, Ernesto Caetano, Atmospheric Environment, 39, pp. 5481-5489, 2005

Pollutants vertical Fugation MCMA




"A study of air flow patterns affecting pollutant concentrations in the Central Region of México", Aron D. Jazcilevich, Agustín García, L.Gerardo Ruiz-Suárez, *Atmospheric Environment*, 37, pp. 183-193, 2003

# Land Use Change
# airport+lake (Feb26, 1997)

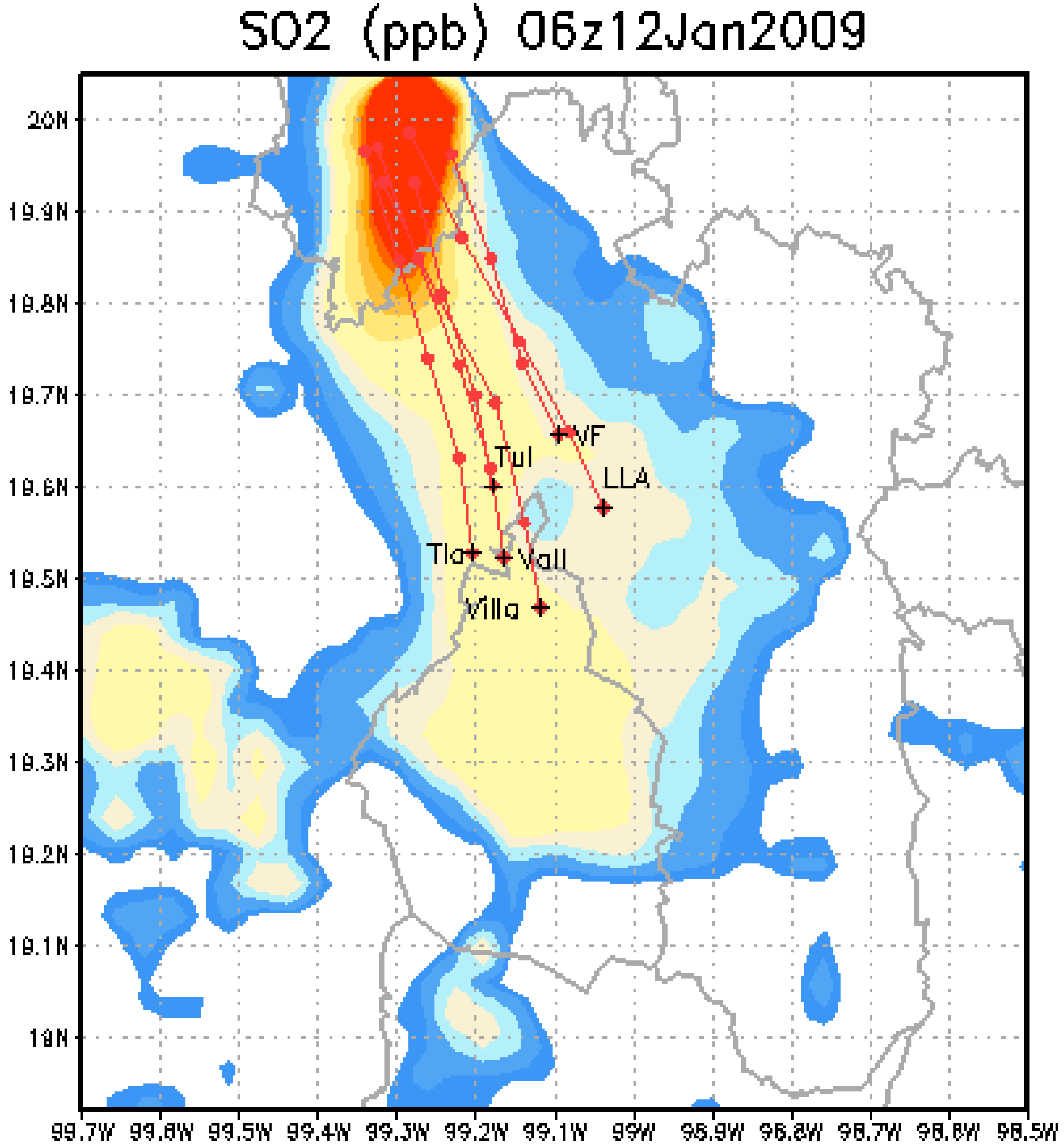



Land-Lake breeze influence

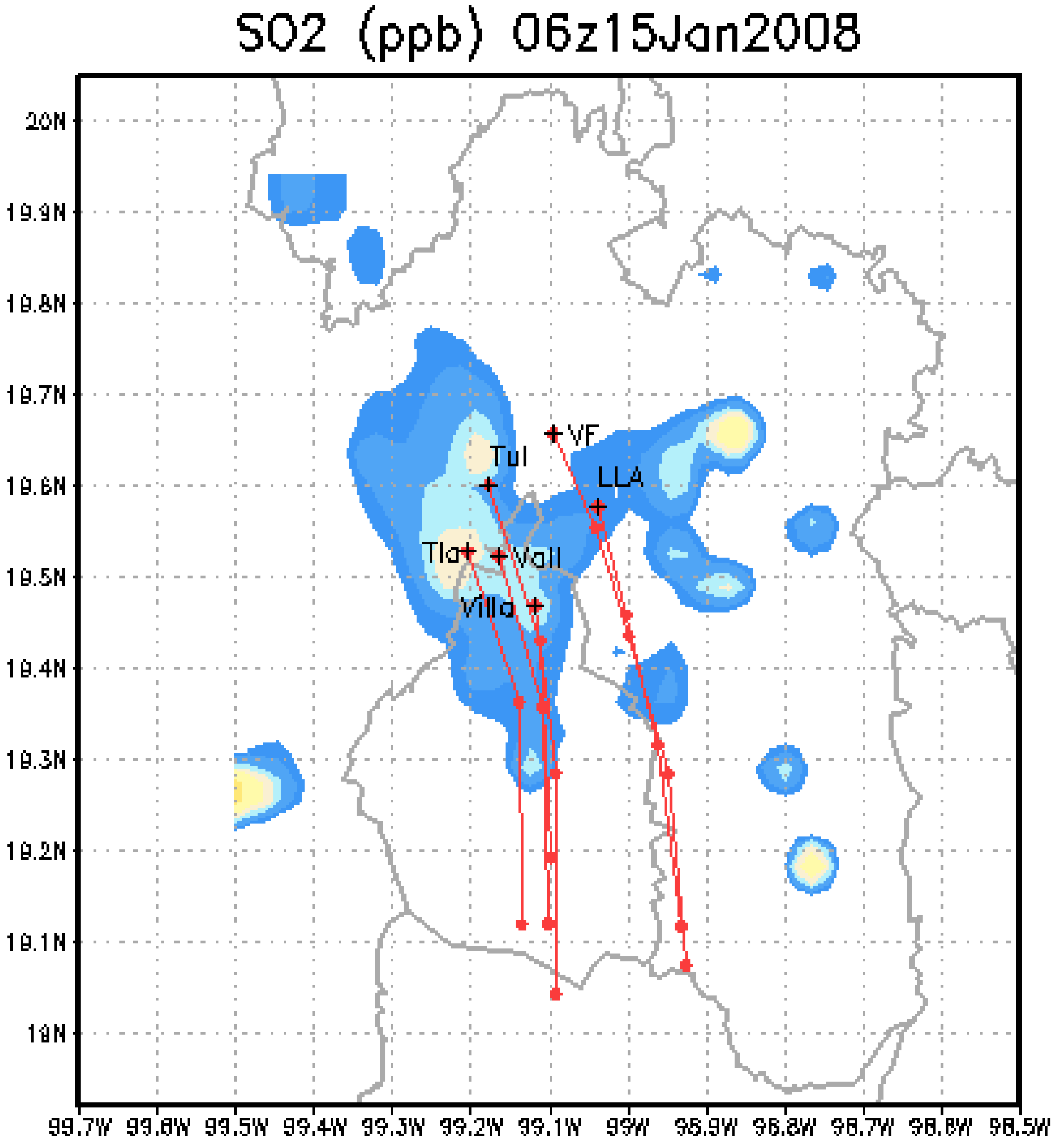
Emissions Identification

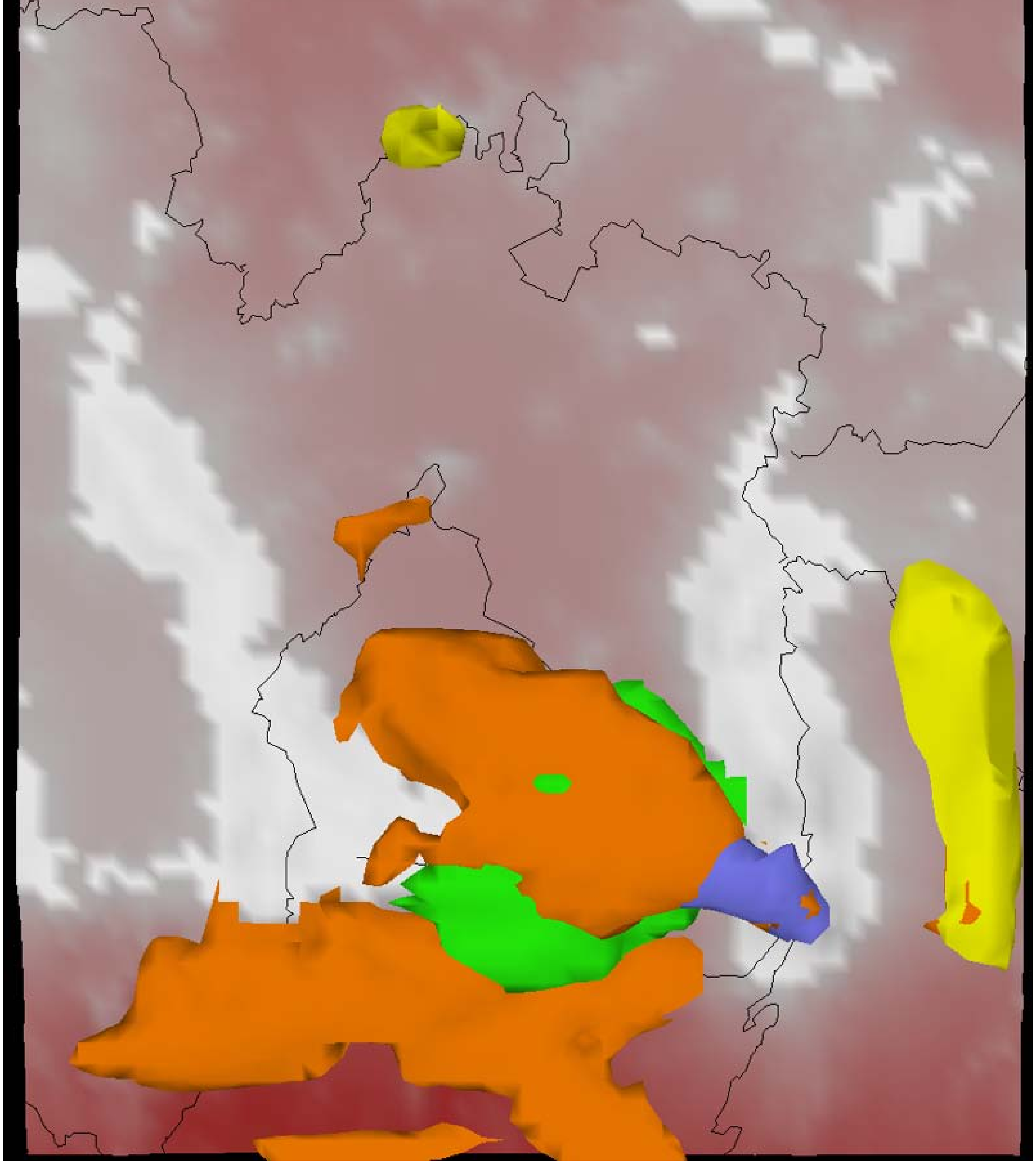
# LARGE POINT SOURCES

Backtrajectories
From Tula region

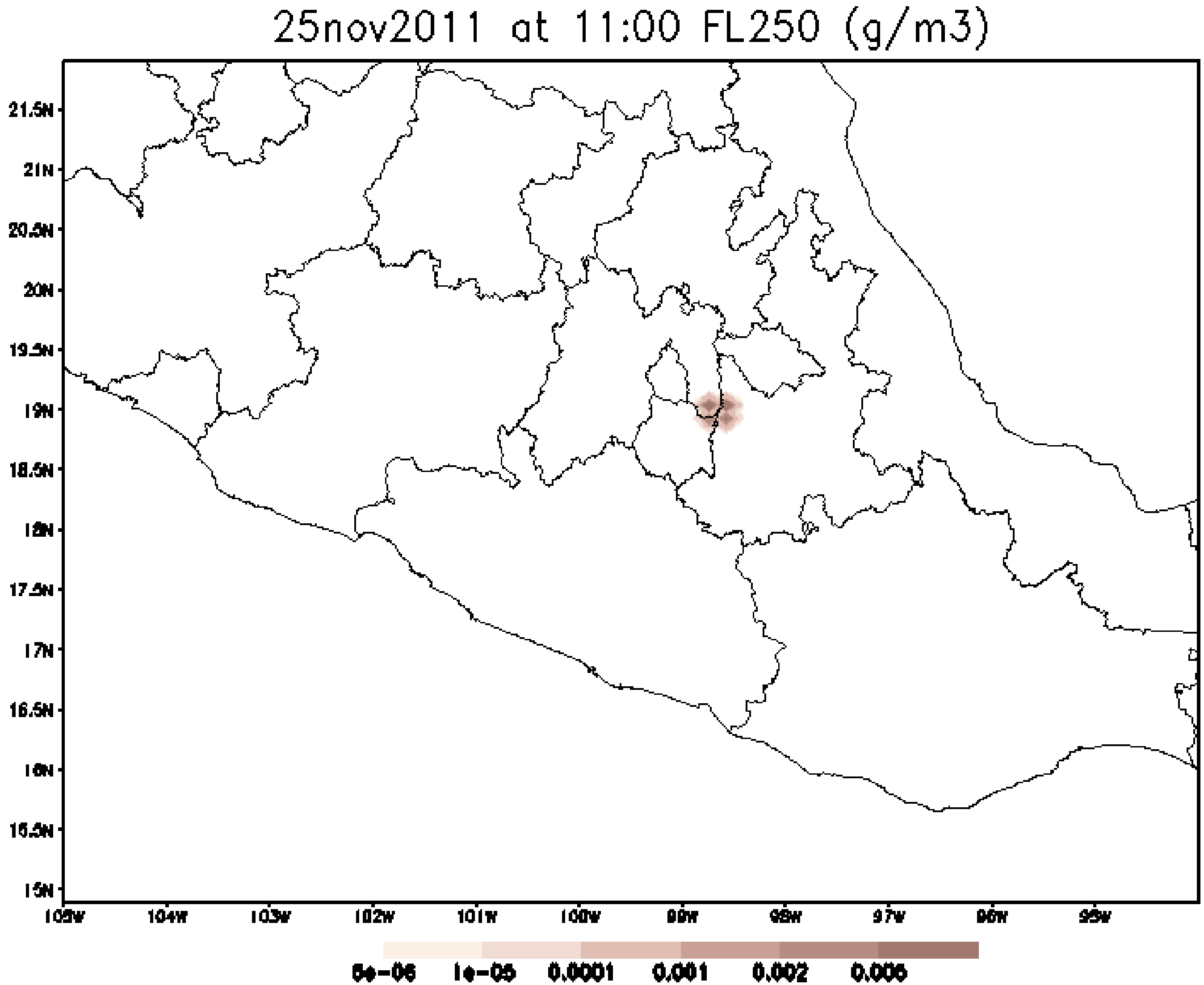


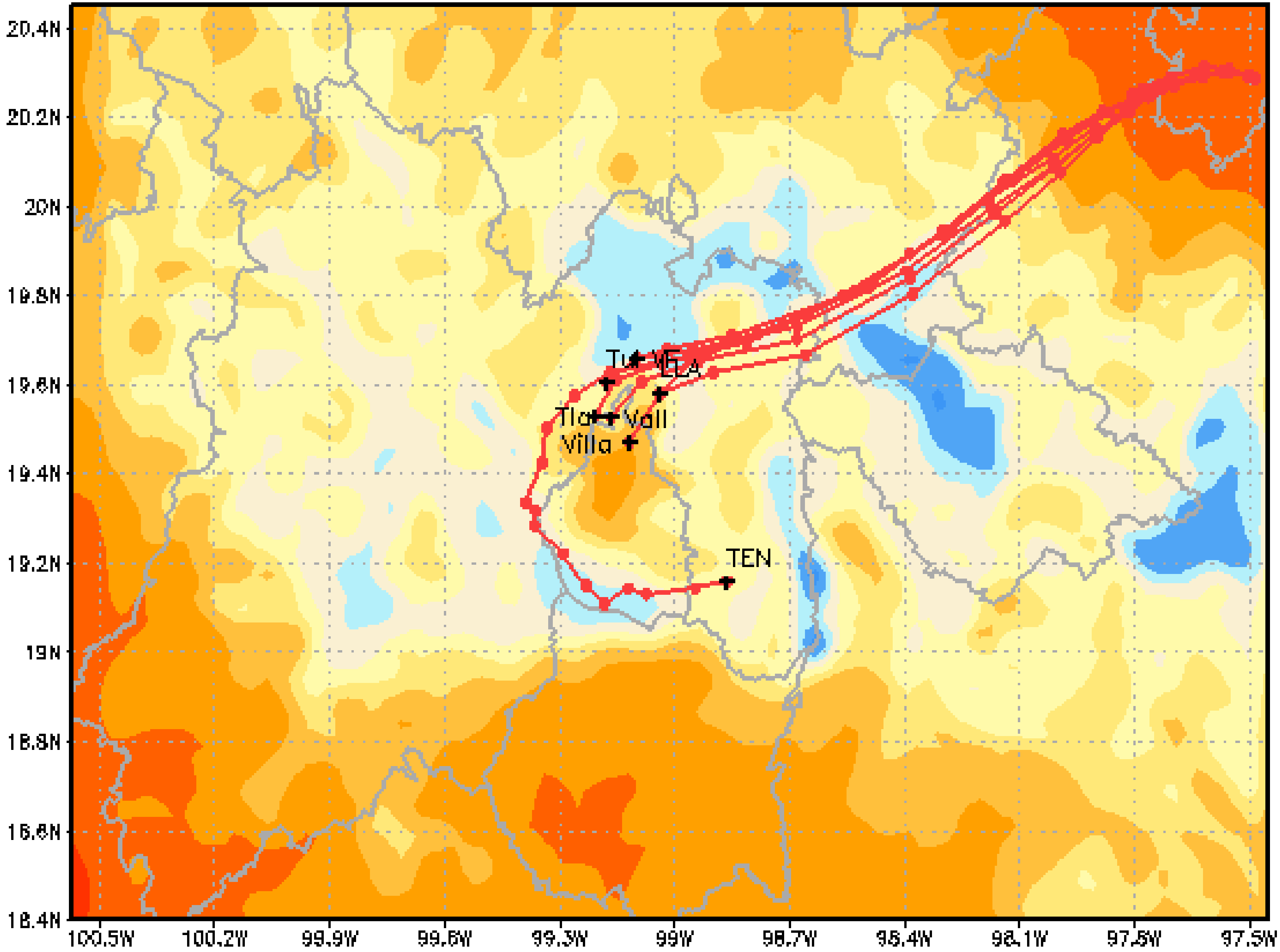
Bactrajectories
From Volcano influence





# Ash Forecast



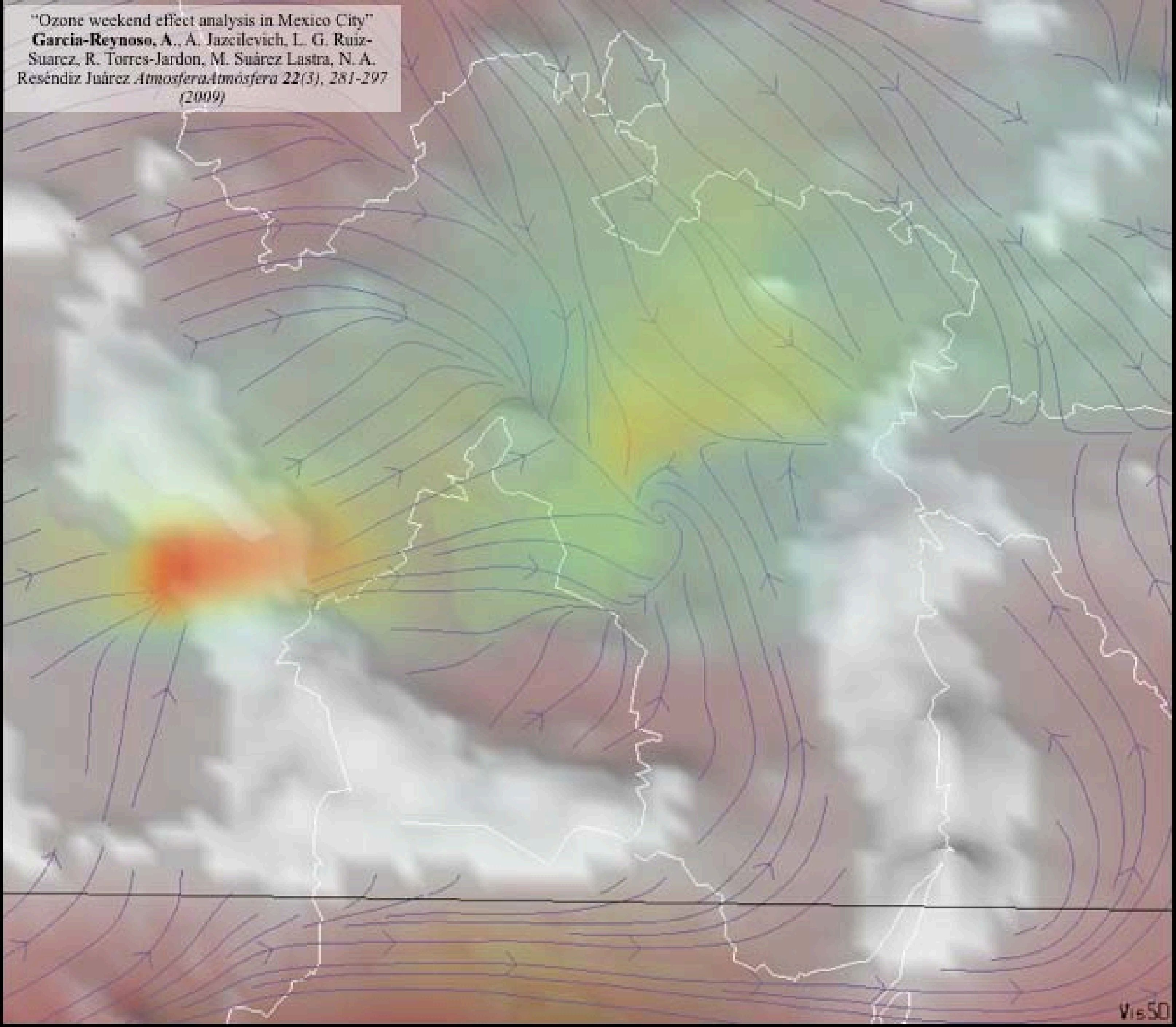


20.4N
20.2N
20N
19.8N
19.6N
19.4N
19.2N
19N
18.8N
18.6N
18.4N
100.5W
100.2W
99.9W
99.6W
99.3W
99W
98.7W
98.4W
98.1W
97.8W
97.5W
TEN
Villa
Vall

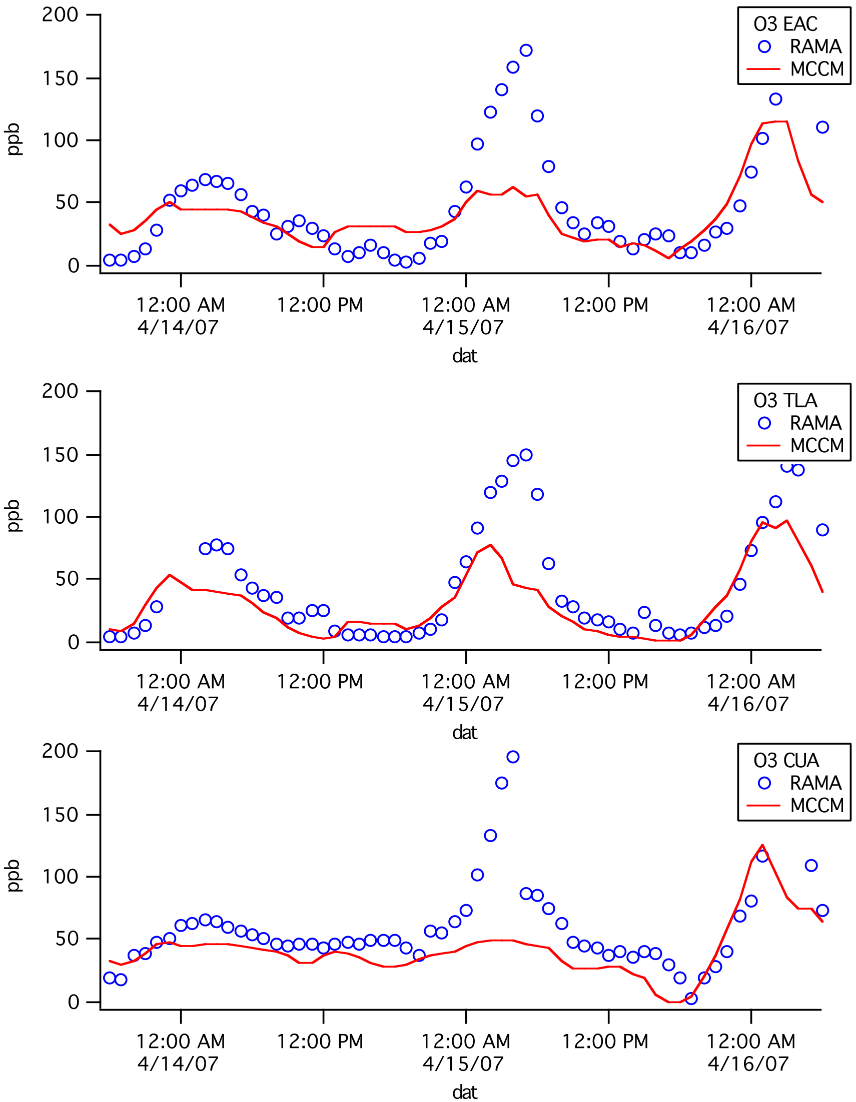
Emissions Identification

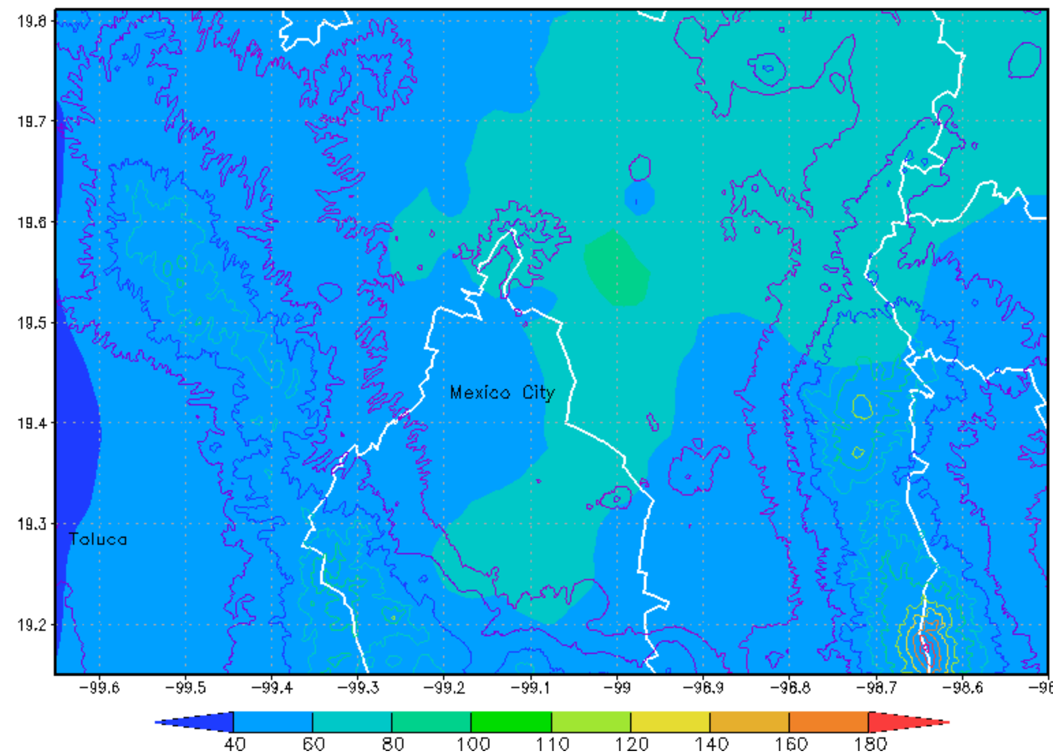
# AREA SOURCES

"Ozone weekend effect analysis in Mexico City"
**Garcia-Reynoso, A.**, A. Jazcilevich, L. G. Ruiz-Suarez, R. Torres-Jardon, M. Suárez Lastra, N. A. Reséndiz Juárez *AtmosferaAtmósfera* **22**(3), 281-297 (2009)

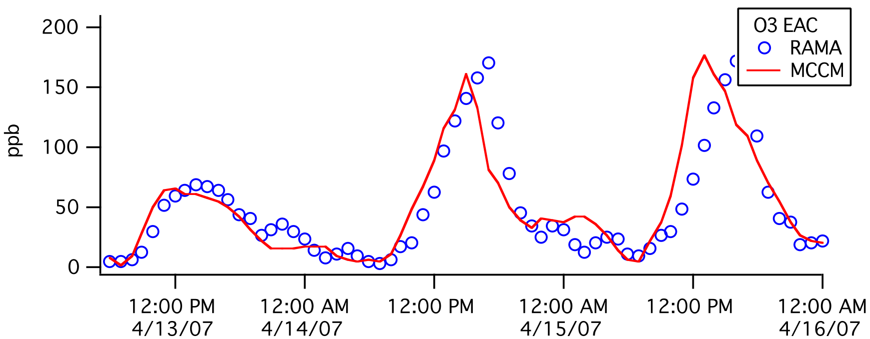


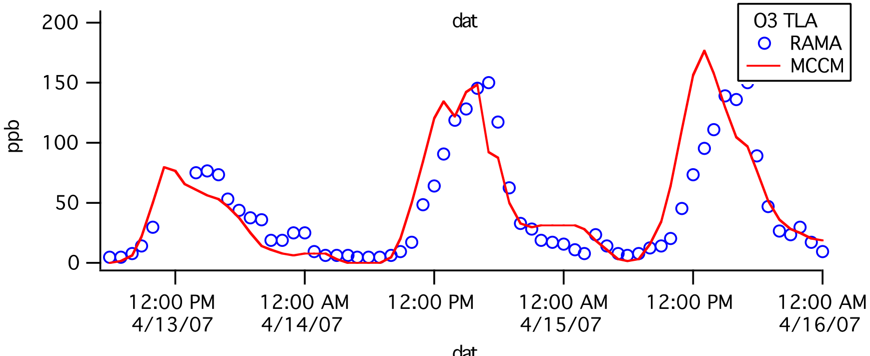
# Emissions MCMA

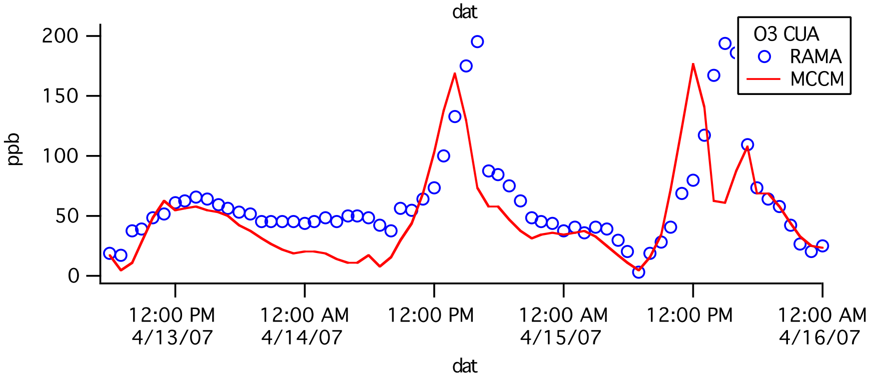


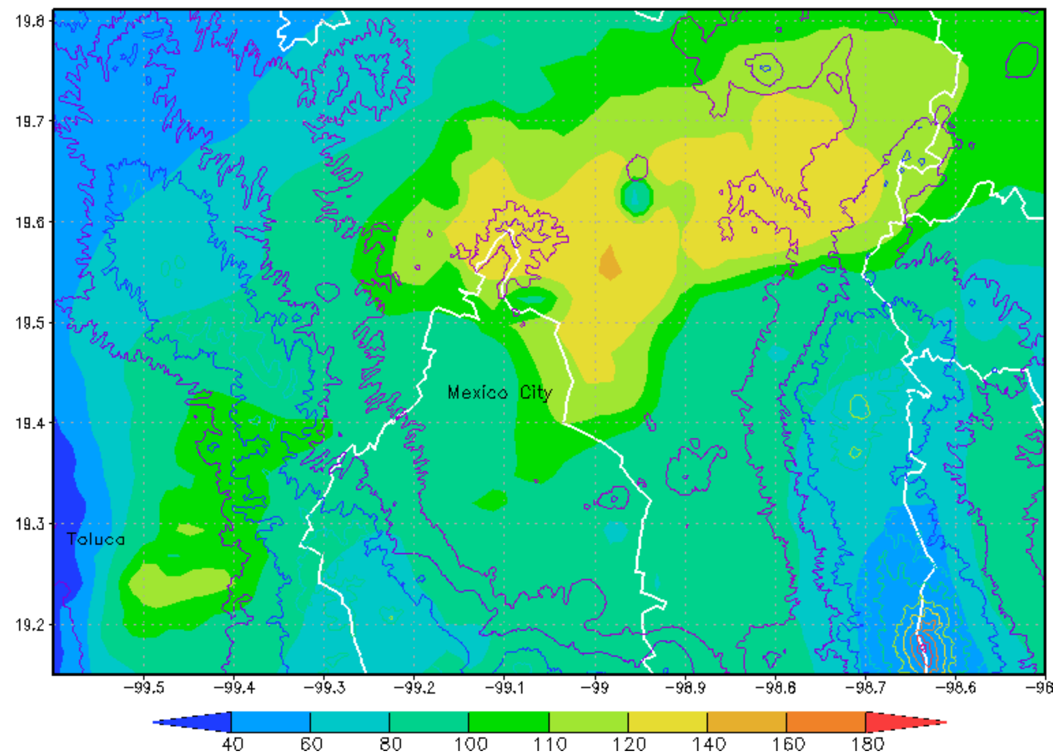



# Emissions MCMA + Toluca

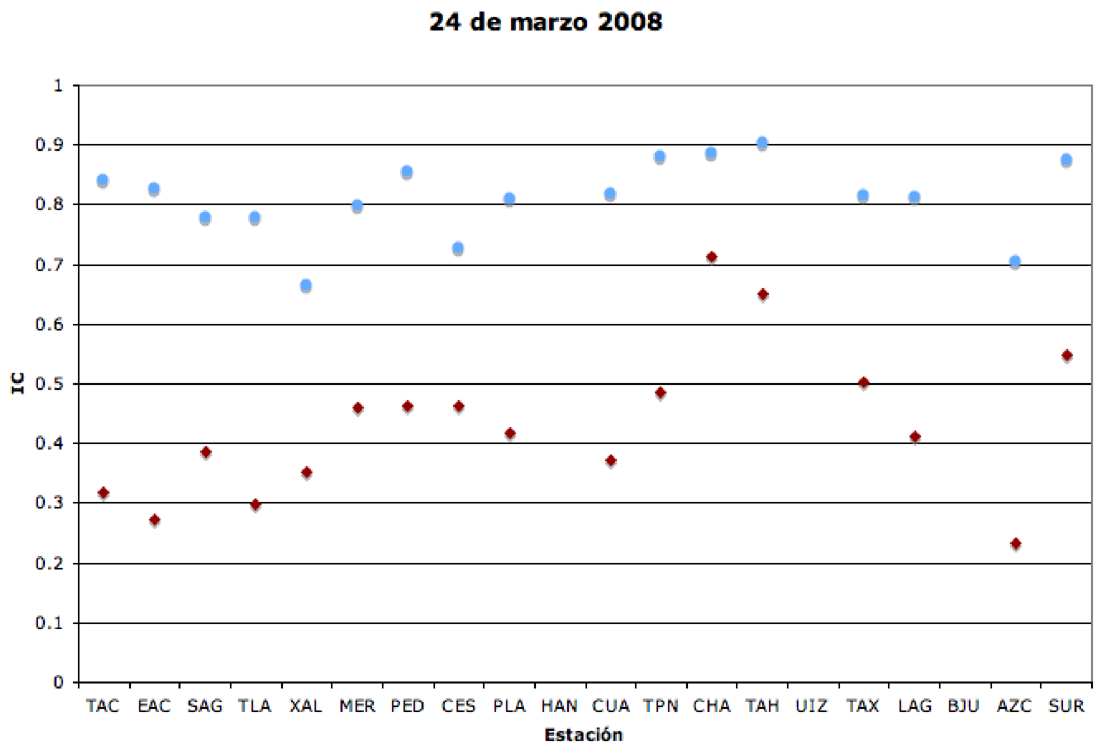


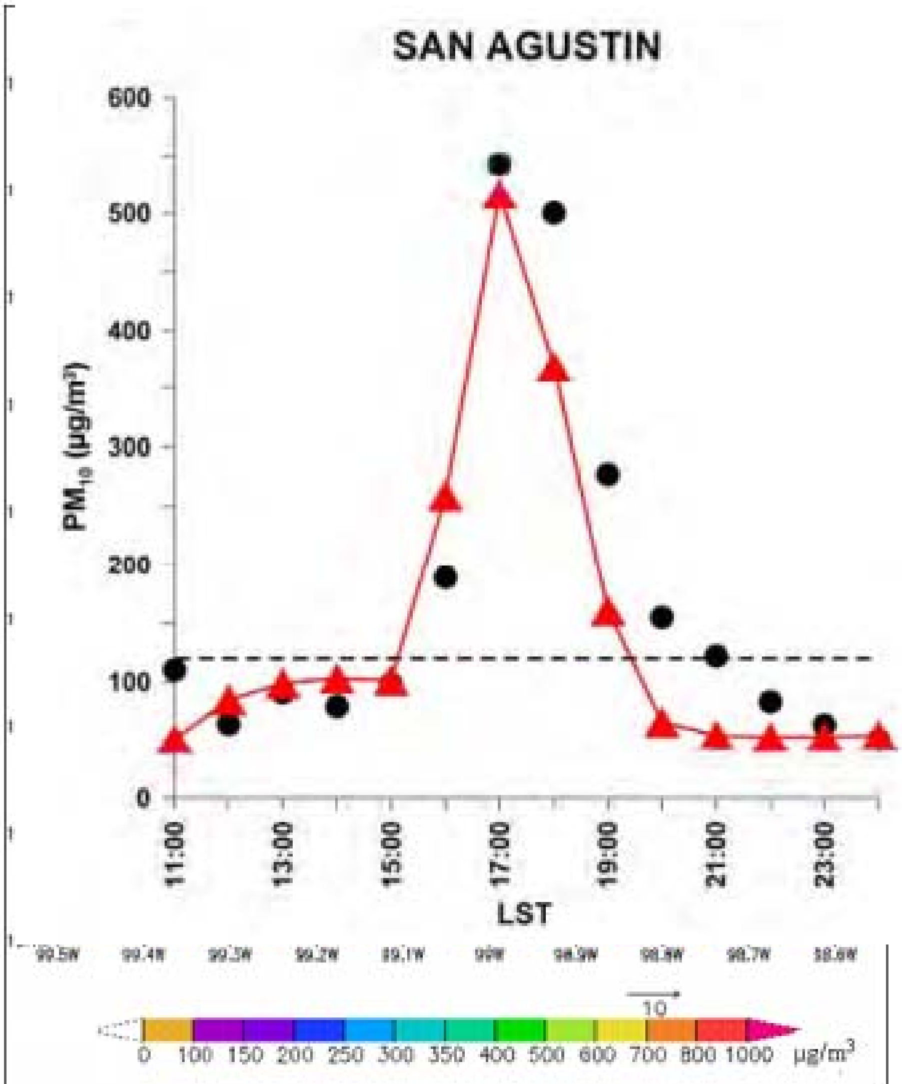



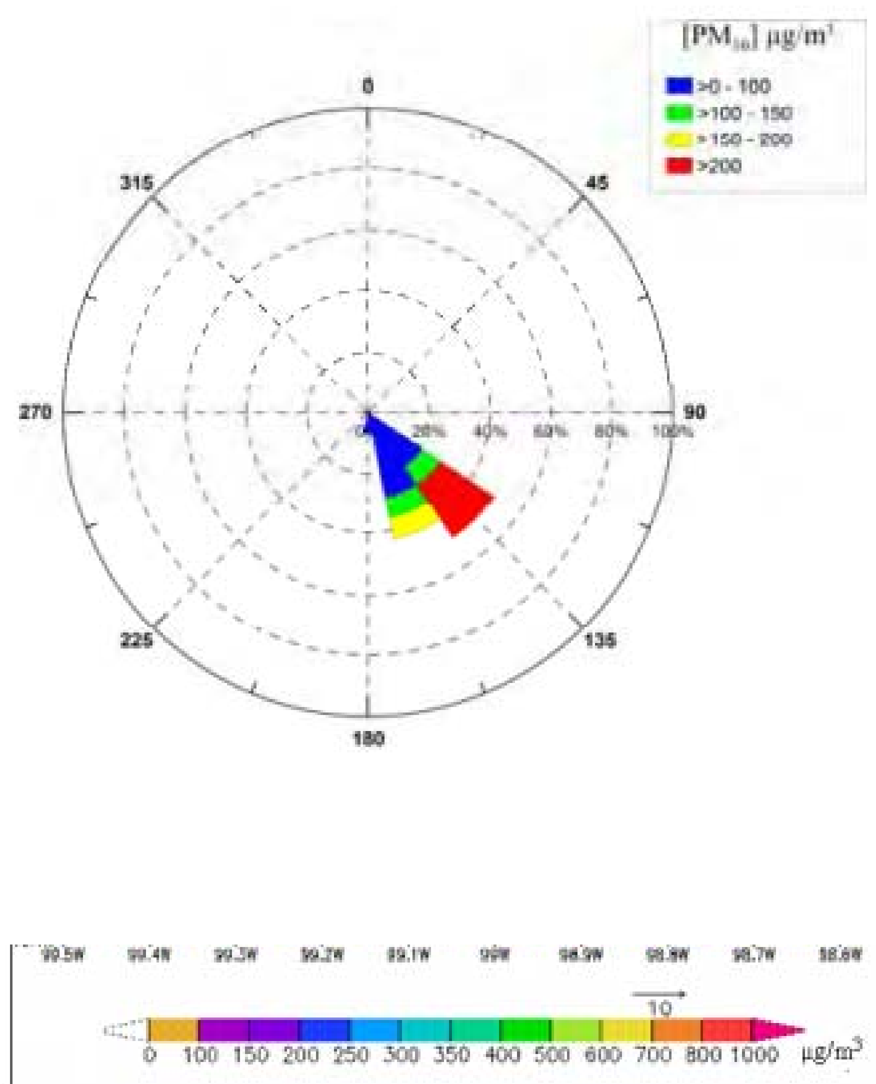
# Ic improvement




| Estaciones | Índice de Concordancia | |
|---|---|---|
| | Anterior | Nuevo |
| TAC | 0.318 | 0.840 |
| EAC | 0.271 | 0.826 |
| SAG | 0.387 | 0.778 |
| TLA | 0.300 | 0.779 |
| XAL | 0.353 | 0.665 |
| MER | 0.459 | 0.798 |
| PED | 0.464 | 0.855 |
| CES | 0.464 | 0.727 |
| PLA | 0.417 | 0.810 |
| CUA | 0.371 | 0.819 |
| TPN | 0.486 | 0.881 |
| CHA | 0.713 | 0.887 |
| TAH | 0.652 | 0.902 |
| TAX | 0.504 | 0.815 |
| LAG | 0.411 | 0.813 |
| AZC | 0.233 | 0.703 |
| SUR | 0.547 | 0.874 |
| Promedio | 0.432 | 0.810 |

# Soil dust emissions

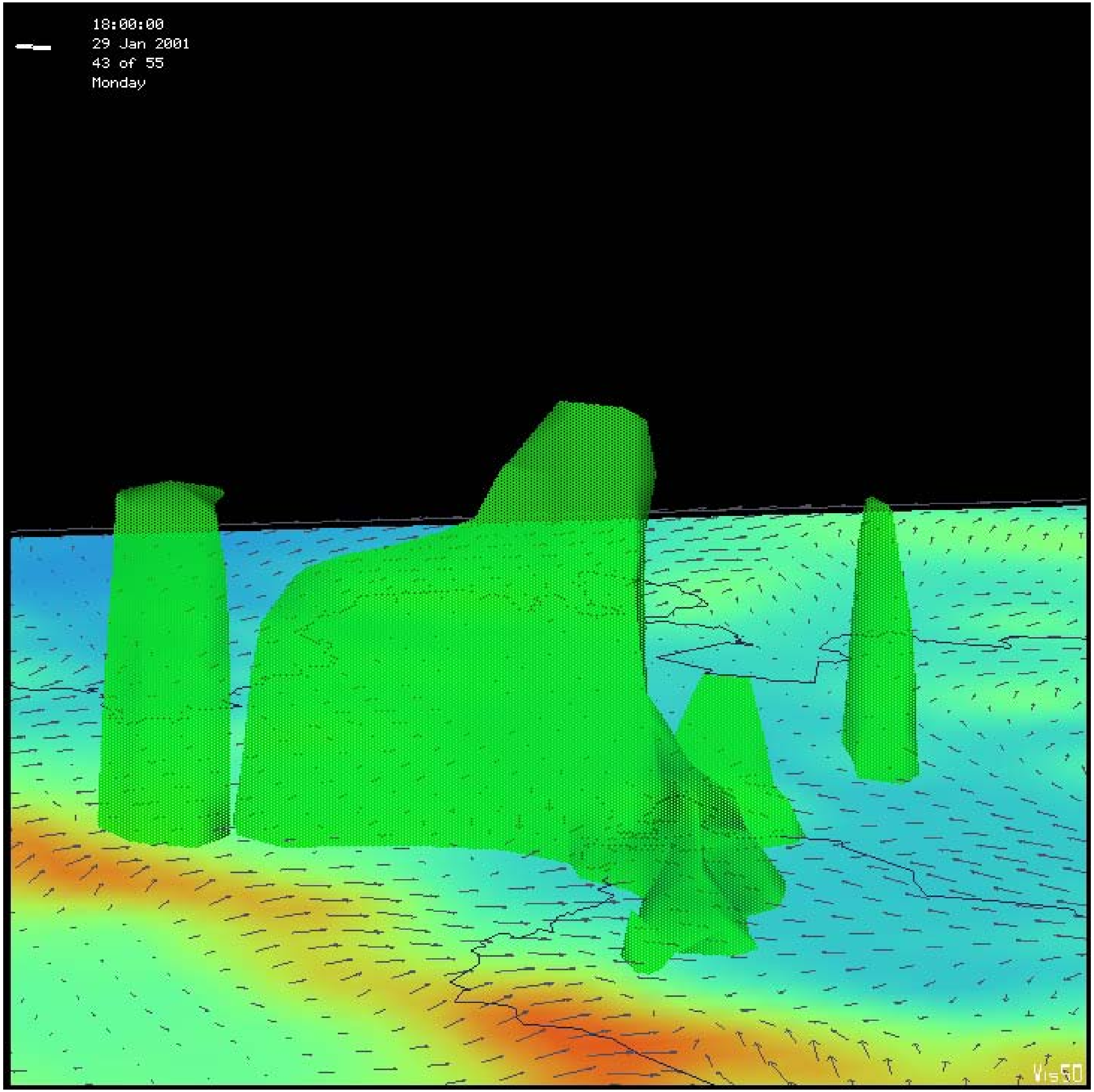


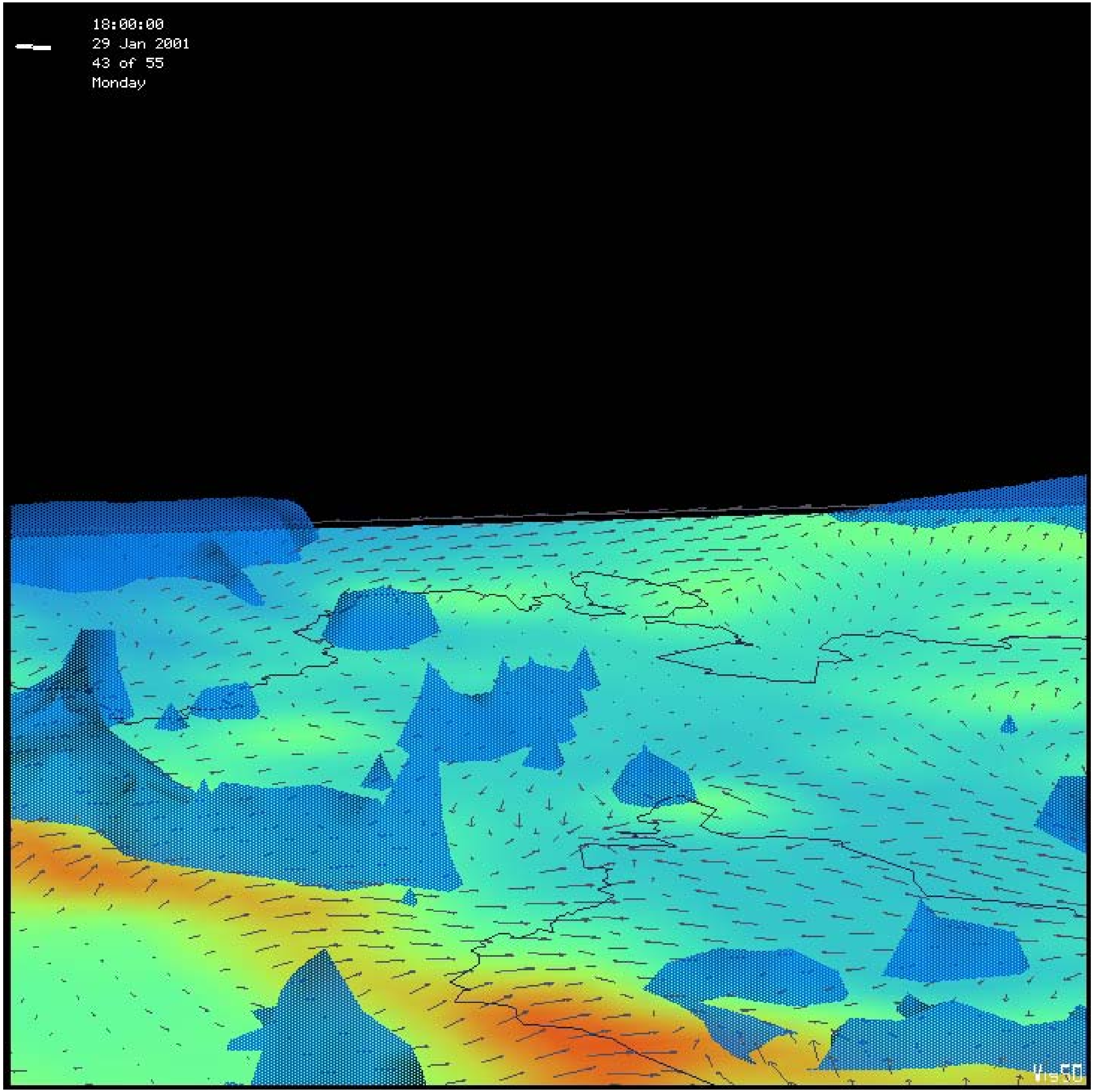
Emissions Identification

# FOREST – CITY INTERACTION

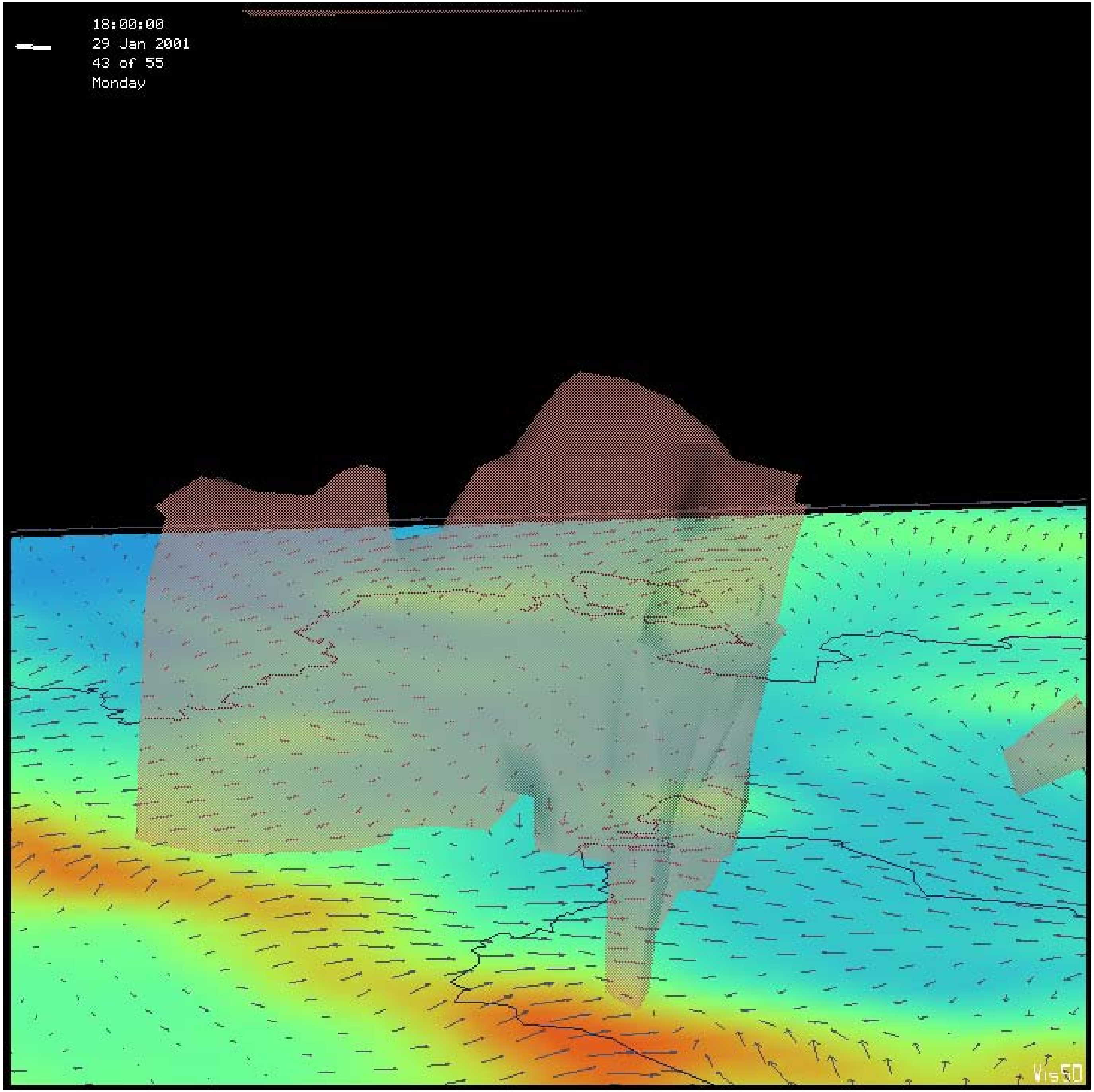
NOx

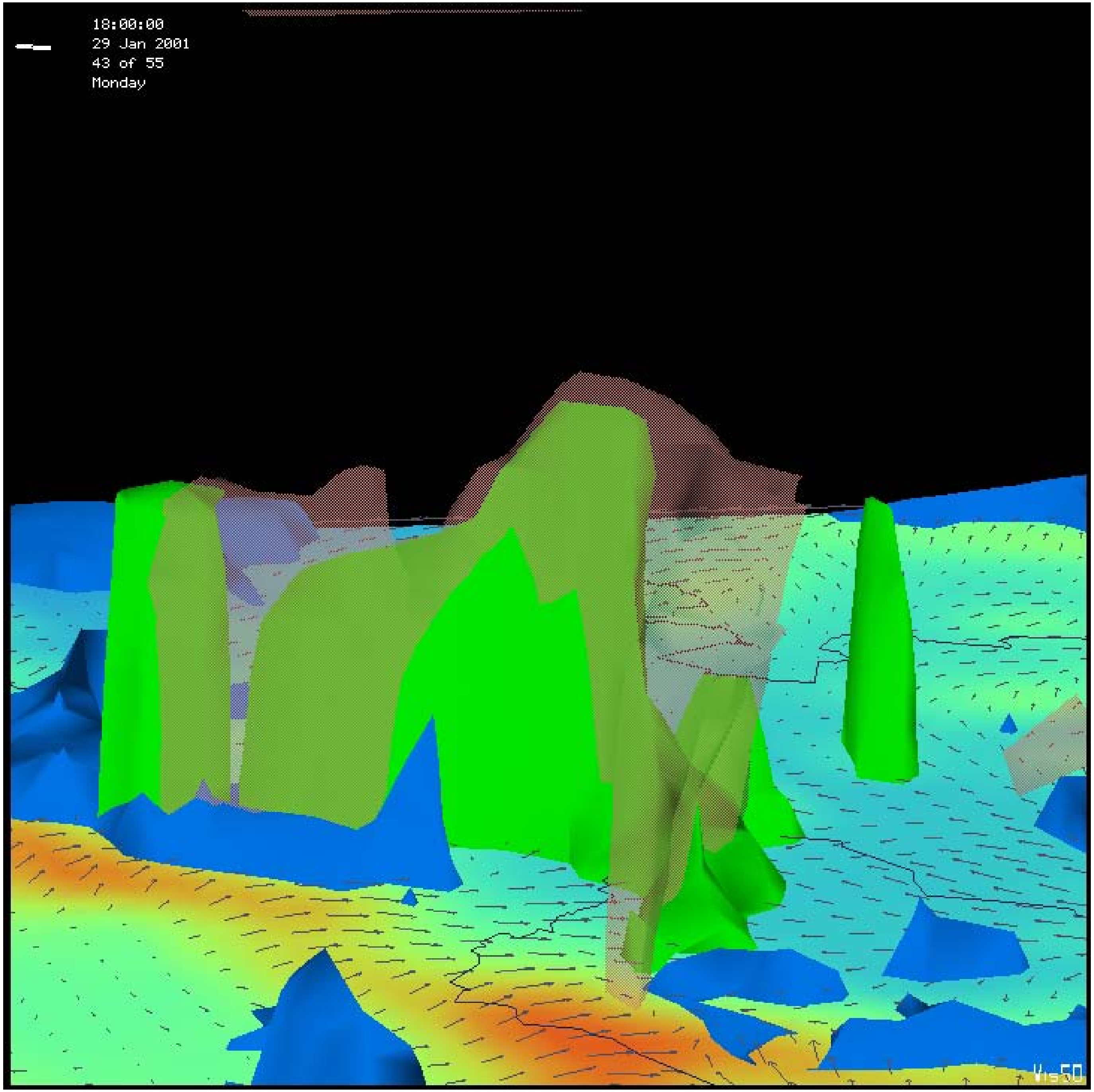


Isopreno



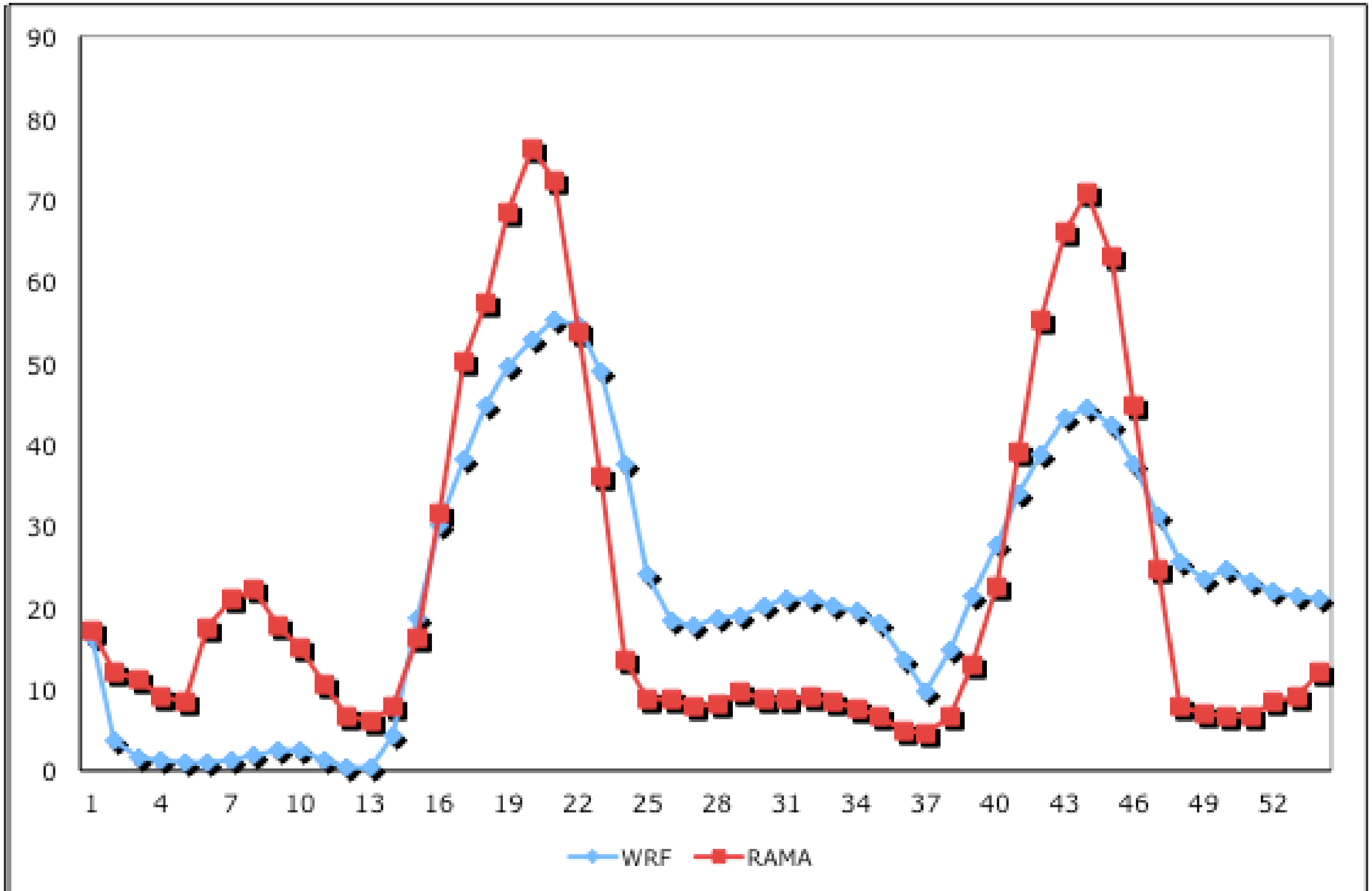
Ozono





18:00:00
29 Jan 2001
43 of 55
Monday
Vis5D

# Chemical Mechanism



# FUTURE WORK

# To Do

- Combining 2 or more forecast
- Nesting domains
- Updating emissions inventories
- Fire emissions during fires season
- Web page with performance results