Contribution of Tula`s industrial emissions to the Mexico City urban plume

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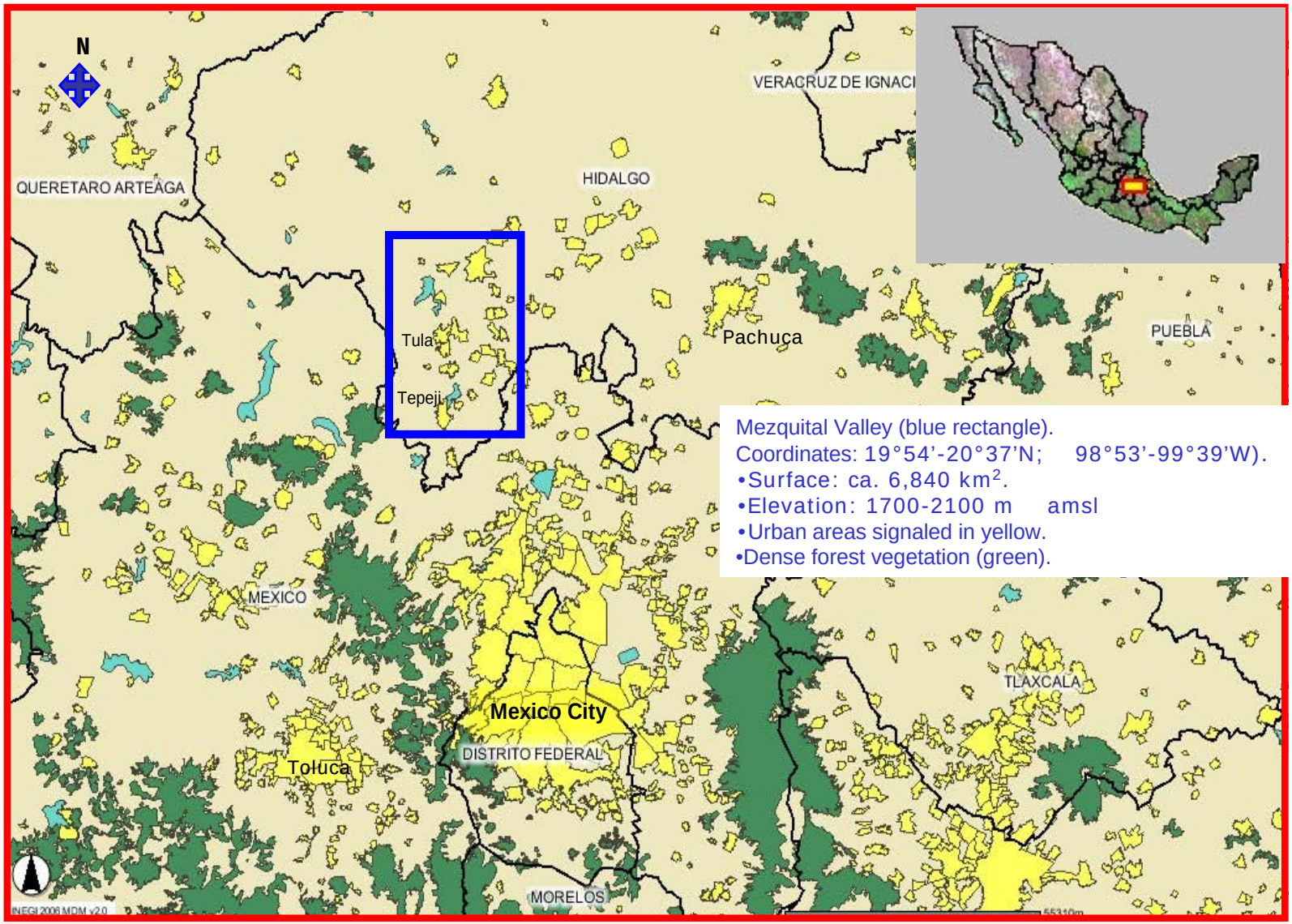
Instituto Mexicano del Petroleo

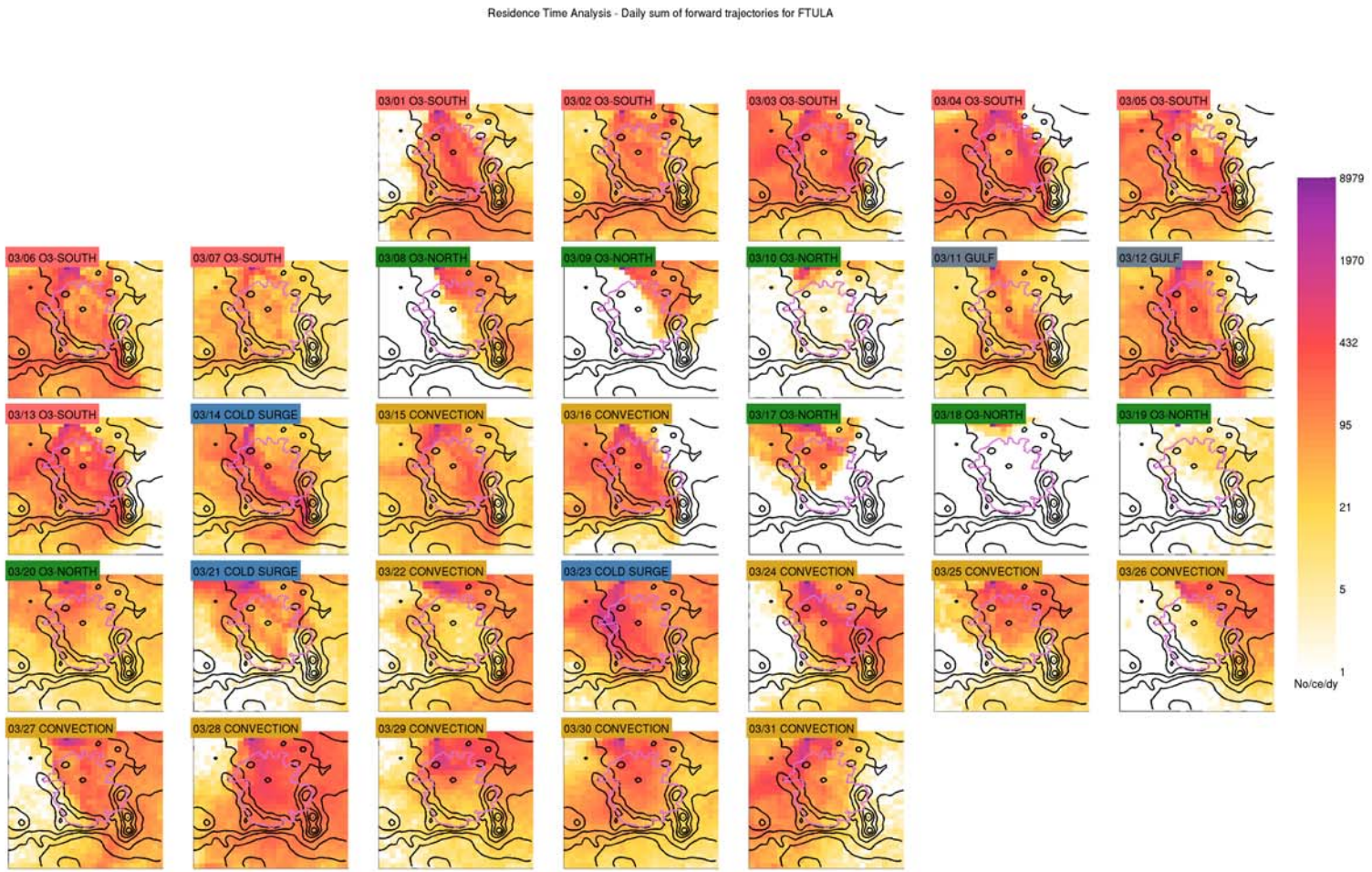
EGU: Vienna, Austria

April 18, 2007



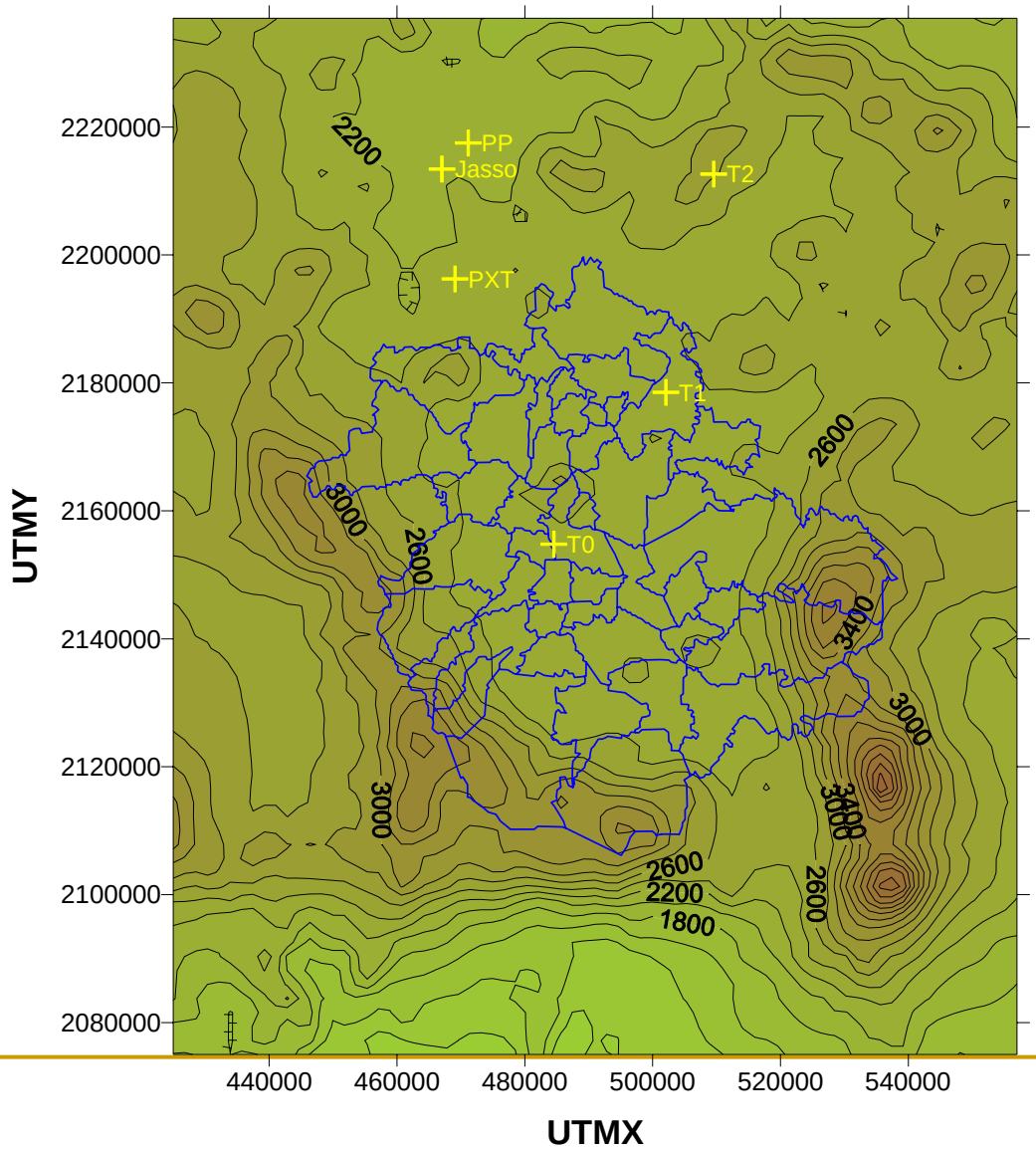
Mezquital Valley (blue rectangle).
Coordinates: 19°54'-20°37'N; 98°53'-99°39'W).
- Surface: ca. 6,840 km^2.
- Elevation: 1700-2100 m amsl
- Urban areas signaled in yellow.
- Dense forest vegetation (green).

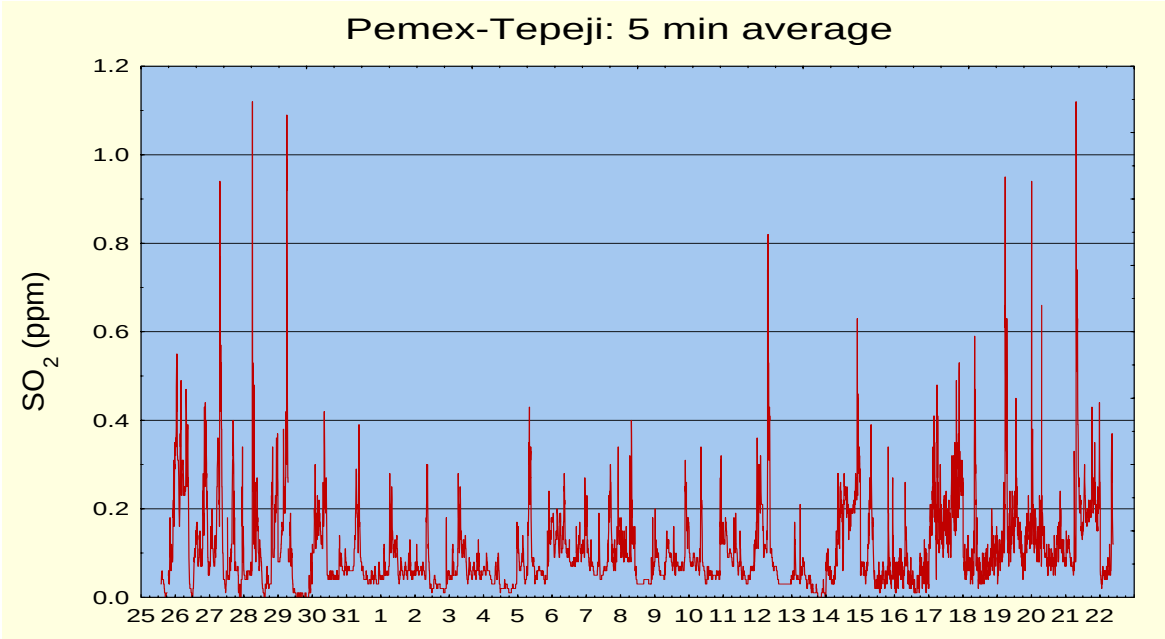
Residence Time analysis: Daily sum of all forward trajectories from Tula

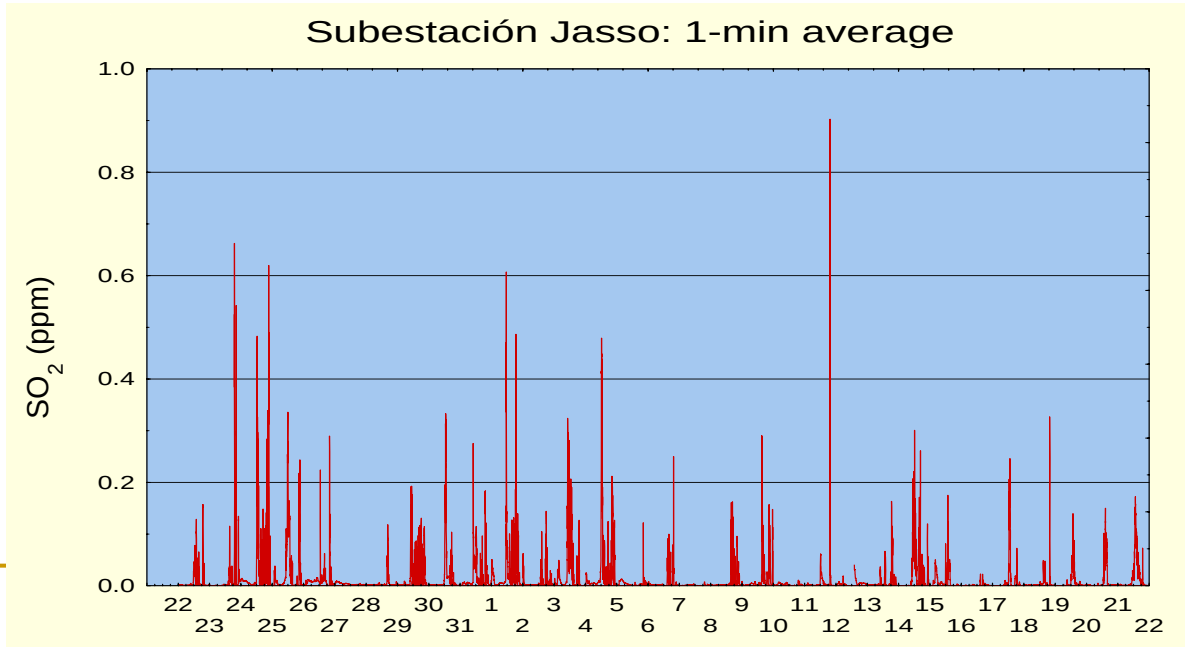


from B. de Foy et al

Monitoring sites location

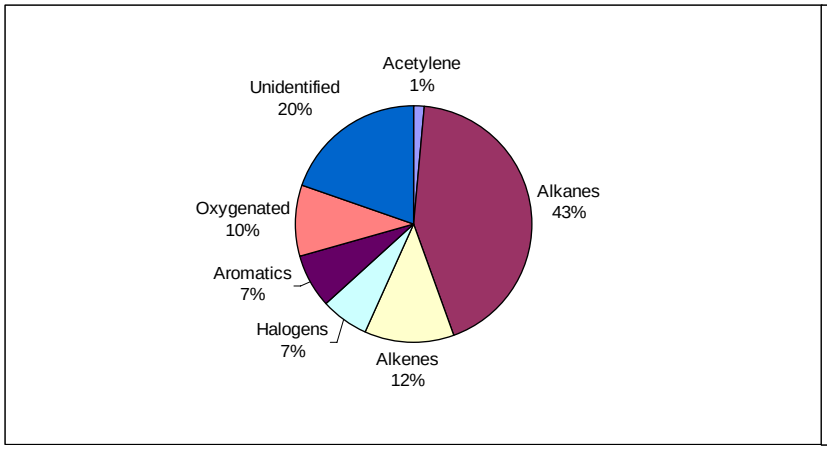



Pemex-Tepeji: 5 min average
SO2 (ppm)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

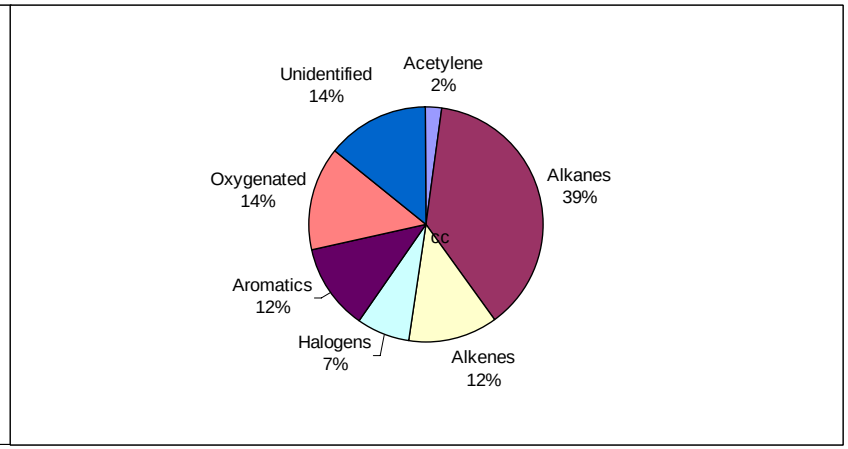

Subestación Jasso: 1-min average
SO2 (ppm)
1.0
0.8
0.6
0.4
0.2
0.0
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

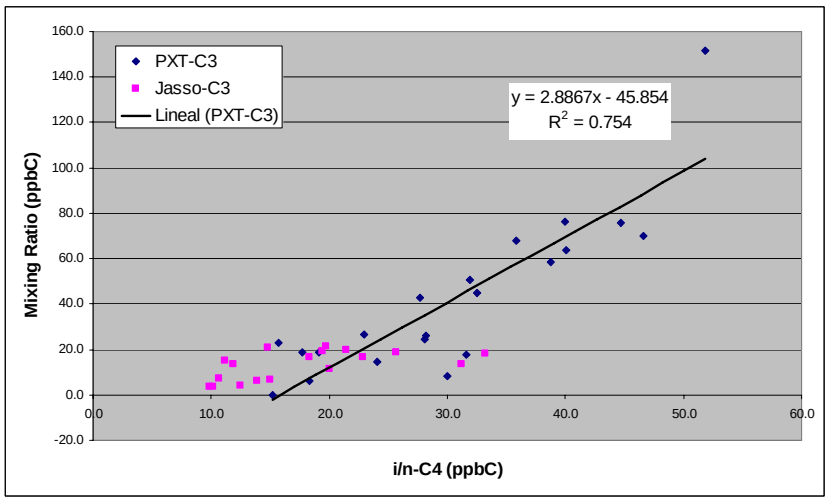
VOC chemical composition (ppbC)

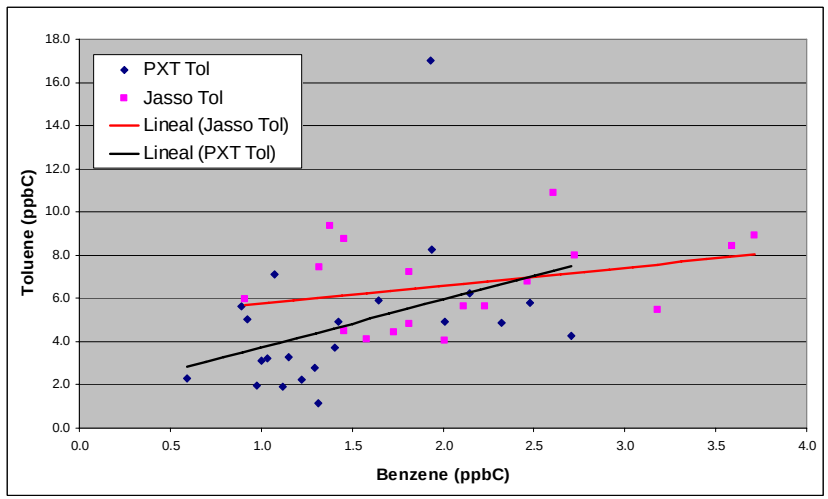
PXT
Average concentration 313.6 ppbC



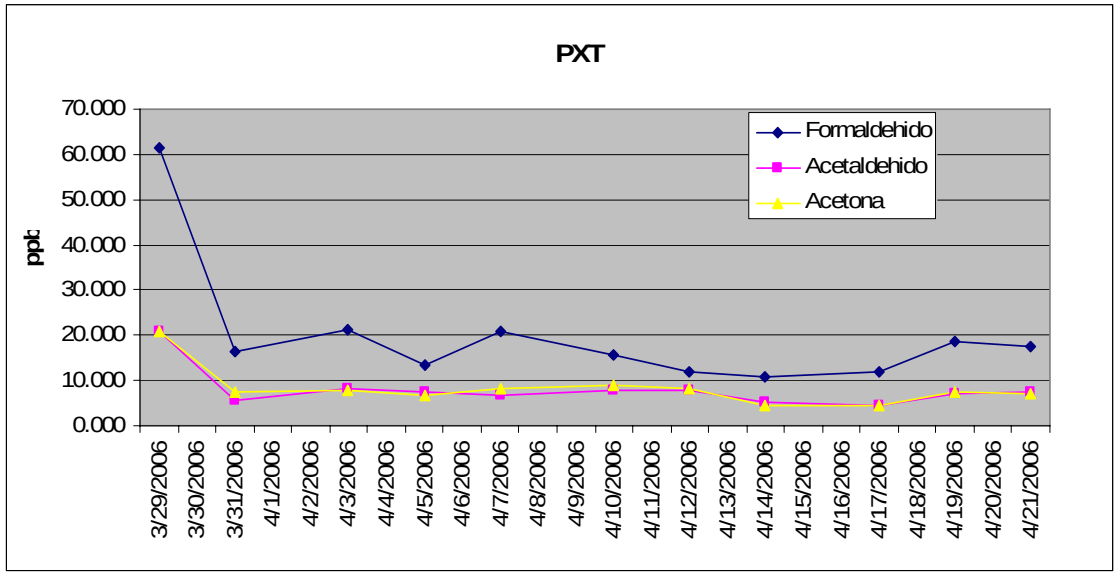
Jasso
Average concentration 260.3 ppbC







Carbonyls


PXT
ppb
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
Formaldehido
Acetaldehido
Acetona
3/29/2006
3/30/2006
3/31/2006
4/1/2006
4/2/2006
4/3/2006
4/4/2006
4/5/2006
4/6/2006
4/7/2006
4/8/2006
4/9/2006
4/10/2006
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4/12/2006
4/13/2006
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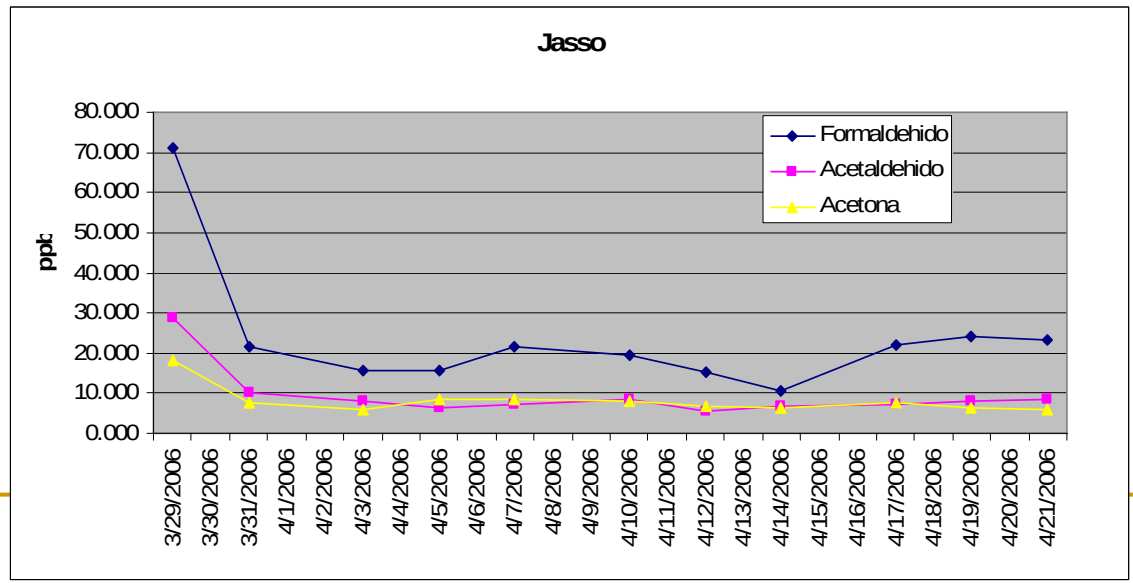
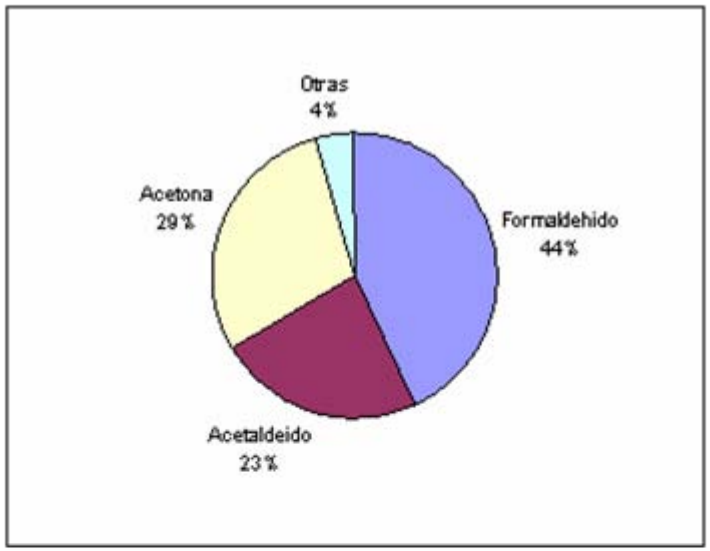
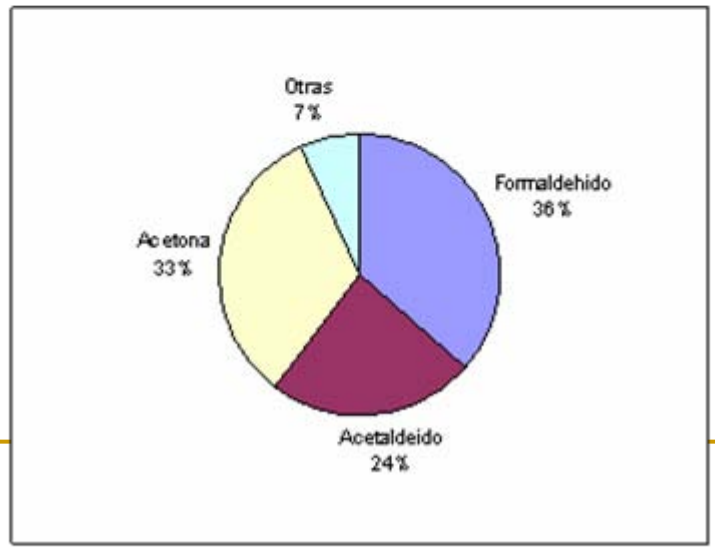
4/20/2006
4/21/2006


Jasso
ppb
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
Formaldehido
Acetaldehido
Acetona
3/29/2006
3/30/2006
3/31/2006
4/1/2006
4/2/2006
4/3/2006
4/4/2006
4/5/2006
4/6/2006
4/7/2006
4/8/2006
4/9/2006
4/10/2006
4/11/2006
4/12/2006
4/13/2006
4/14/2006
4/15/2006
4/16/2006
4/17/2006
4/18/2006
4/19/2006
4/20/2006
4/21/2006

Carbonyls concentration (μg/m^3)

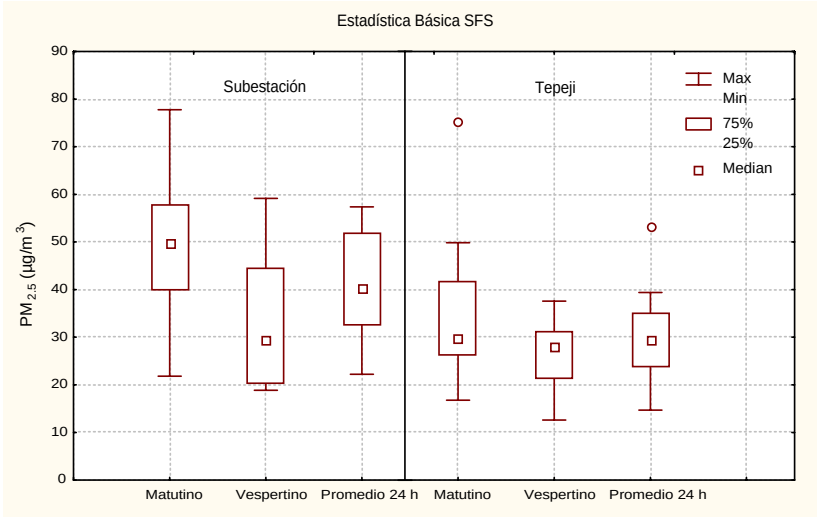


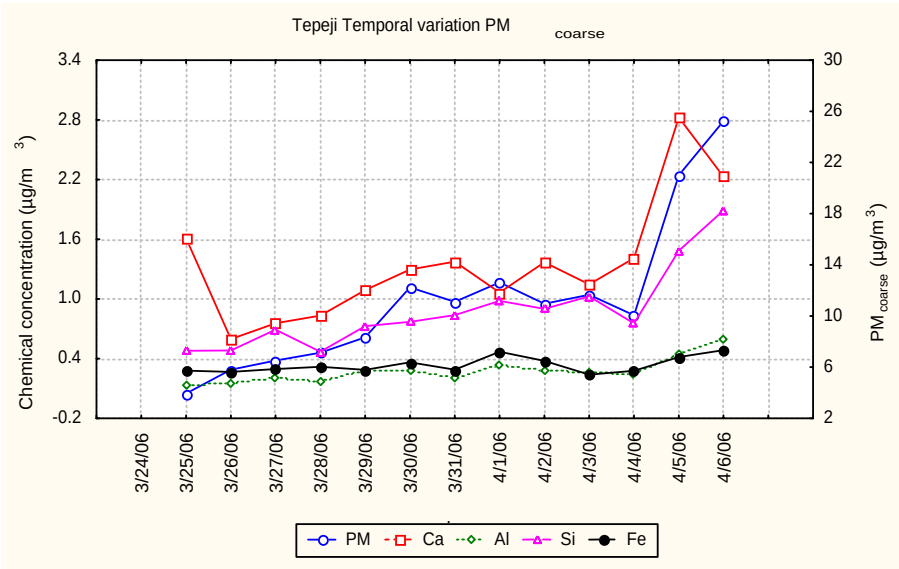
Jasso: Total average concentration: 63.5 μg/m^3

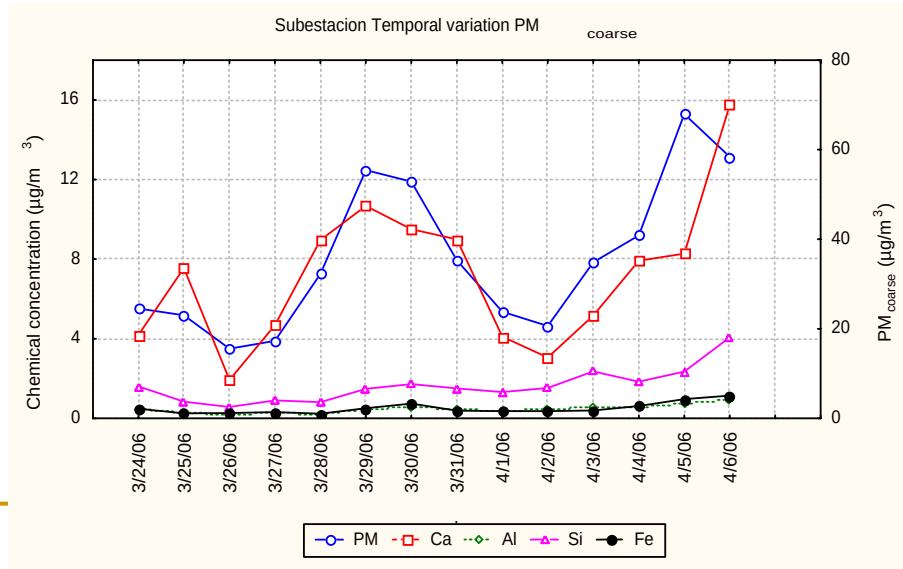


PXT: Total average concentration: 70.2 μg/m^3

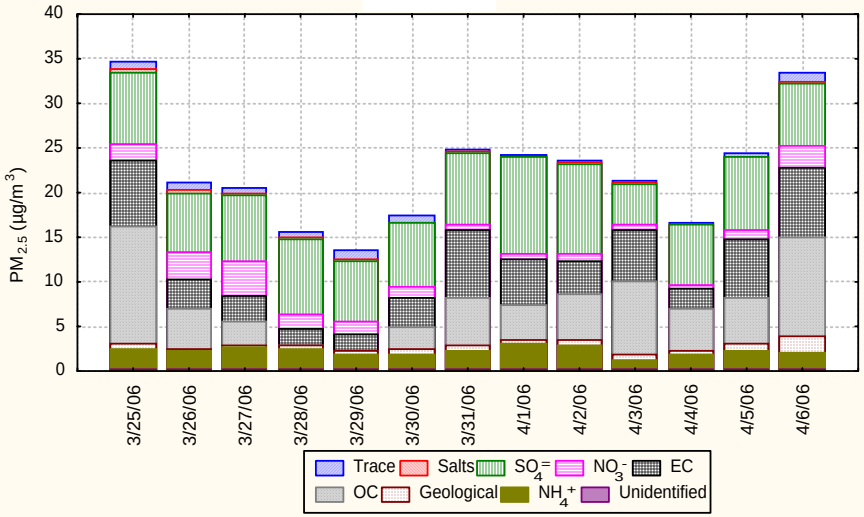
PM Chemical composition



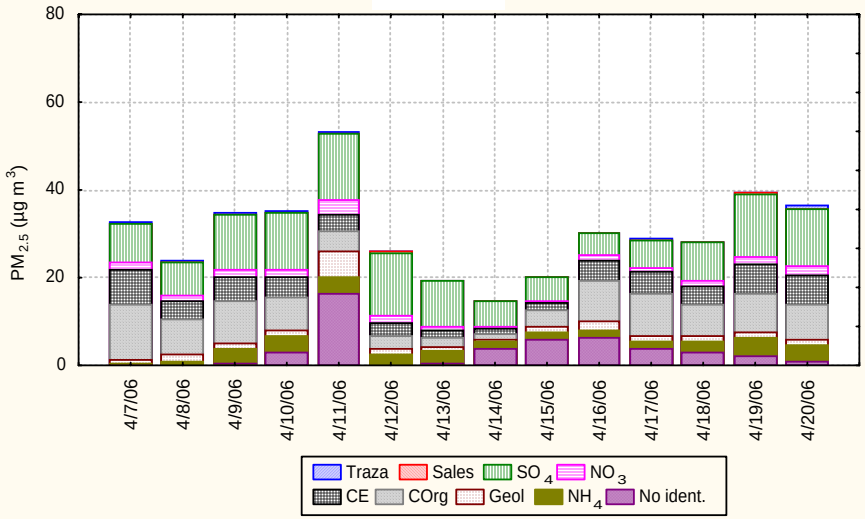




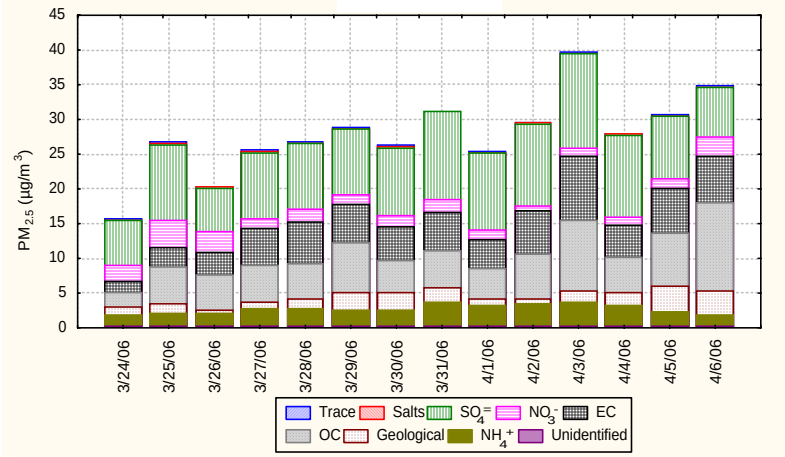
PXT



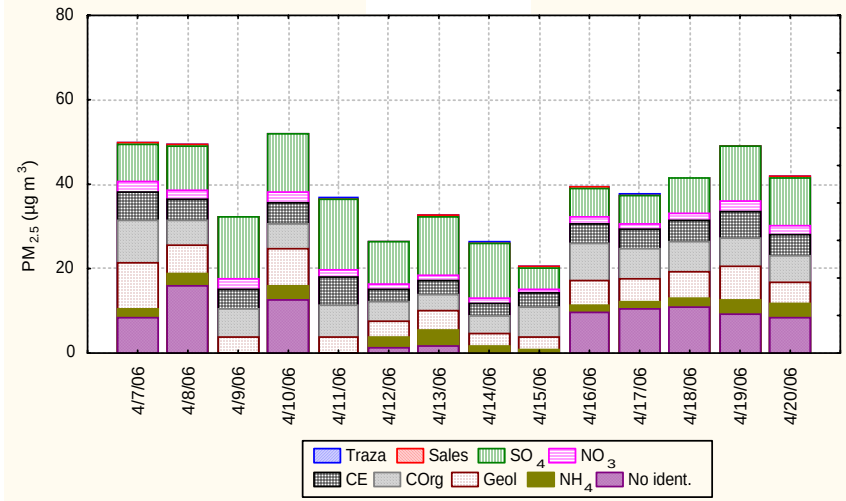
PXT



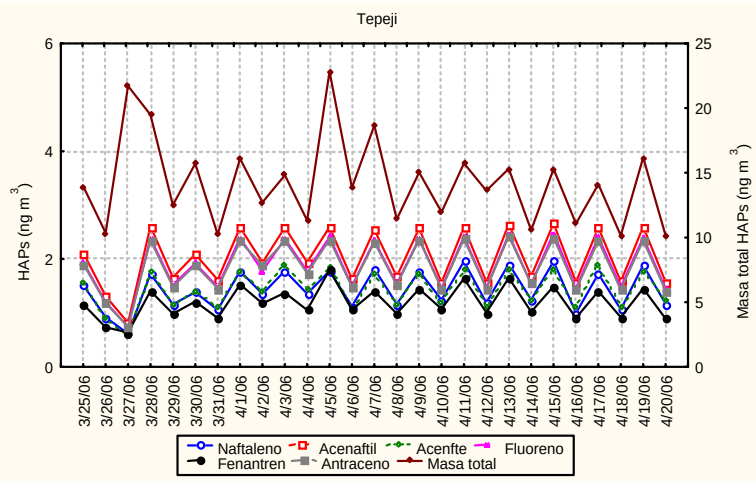
Jasso

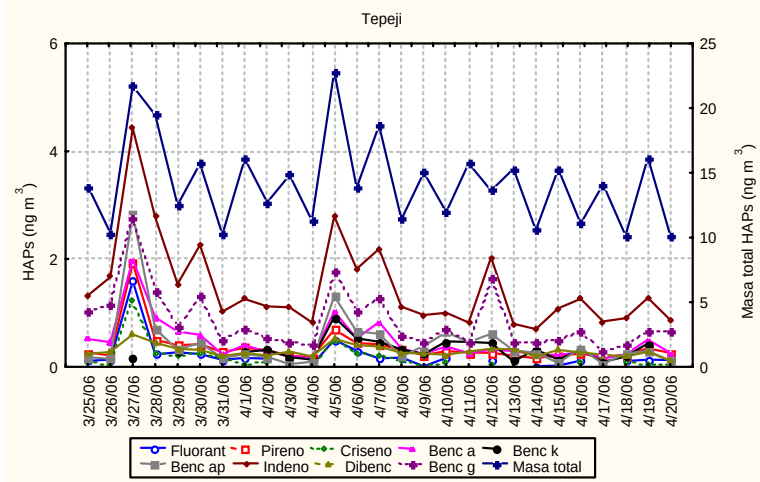


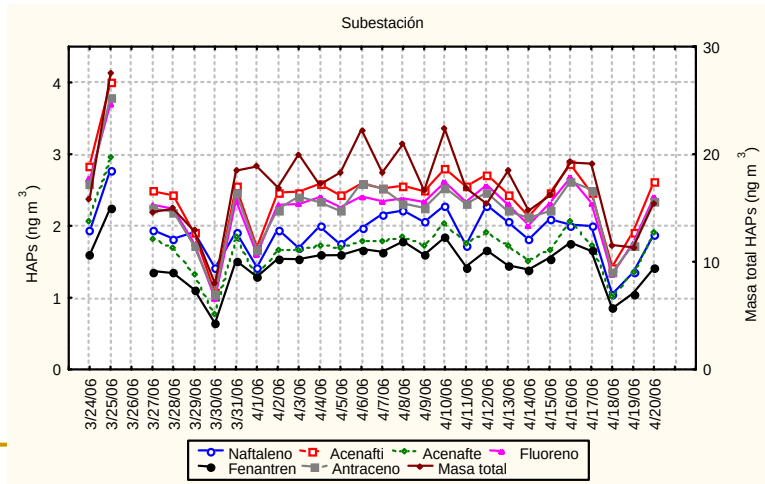
Jasso

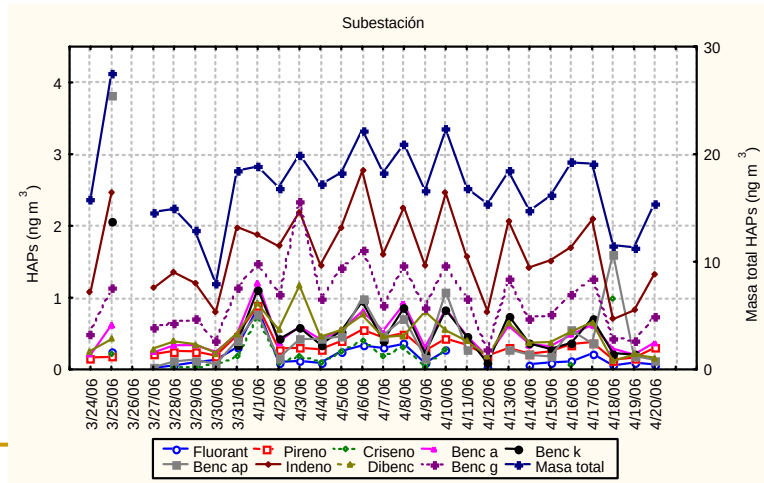


PAH´s concentration on $PM_{2.5}$ @Tula 24 Marzo-20 April, 2006.

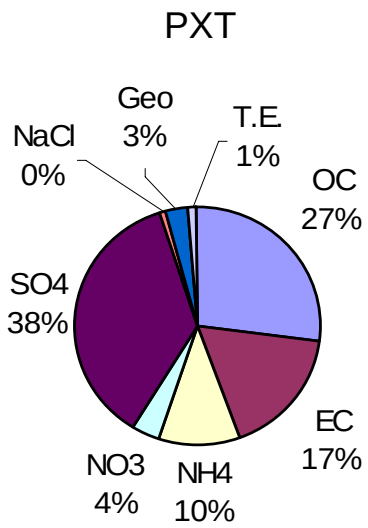


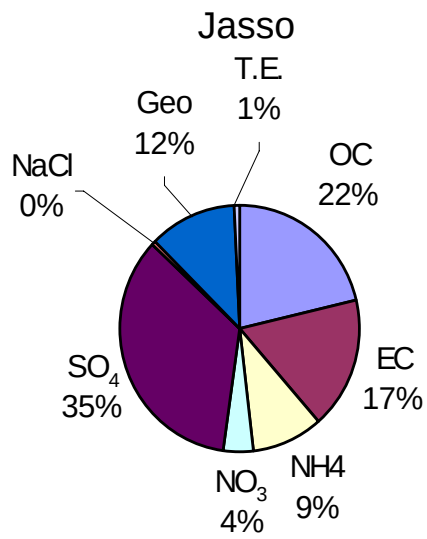


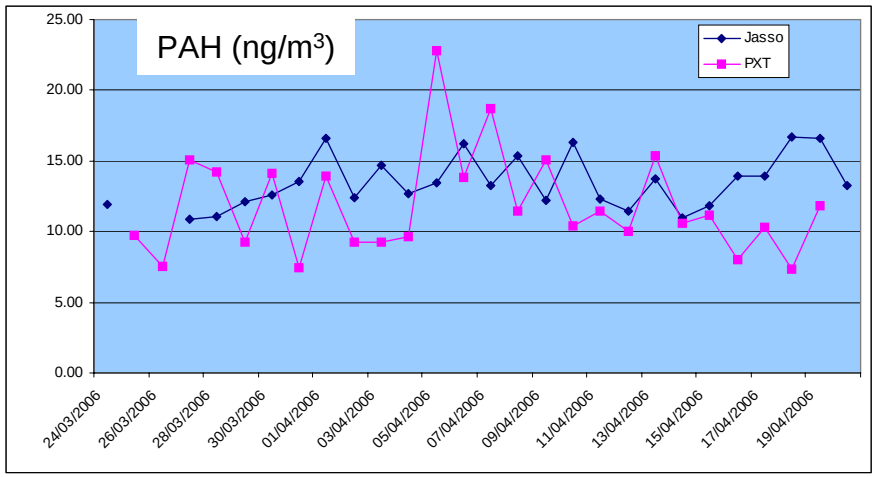




$PM_{2.5}$ chemical composition

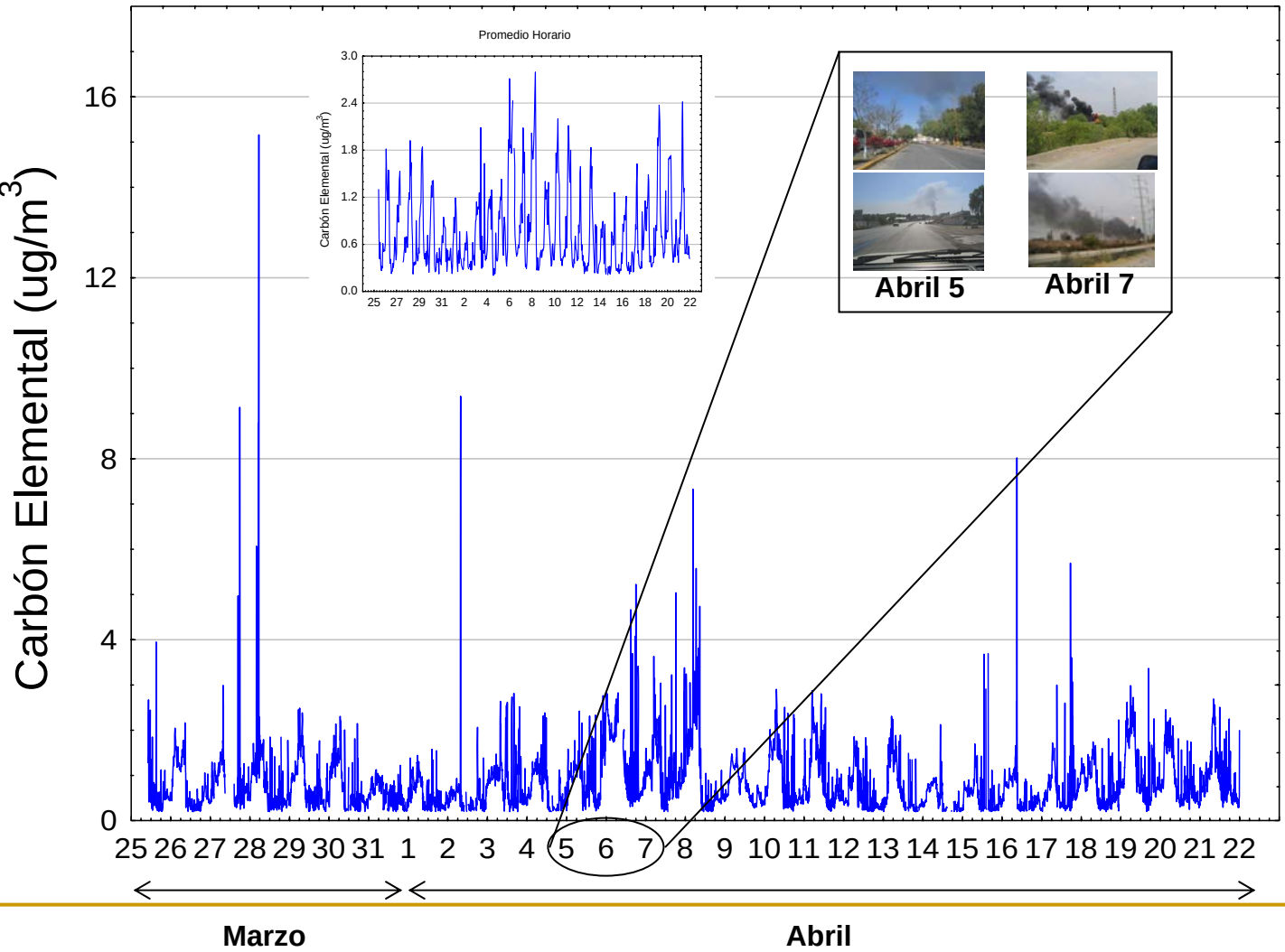




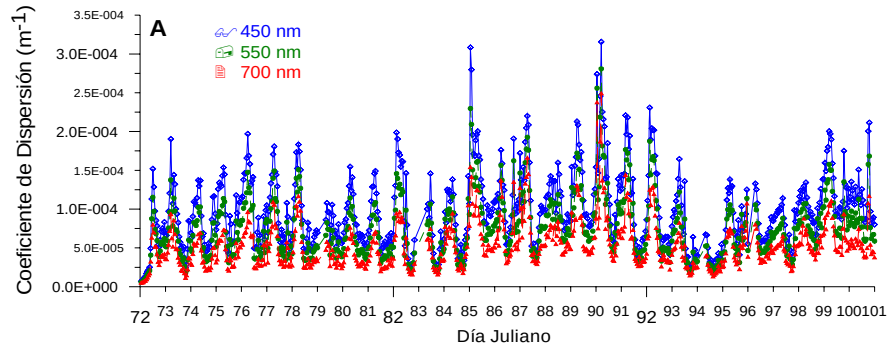


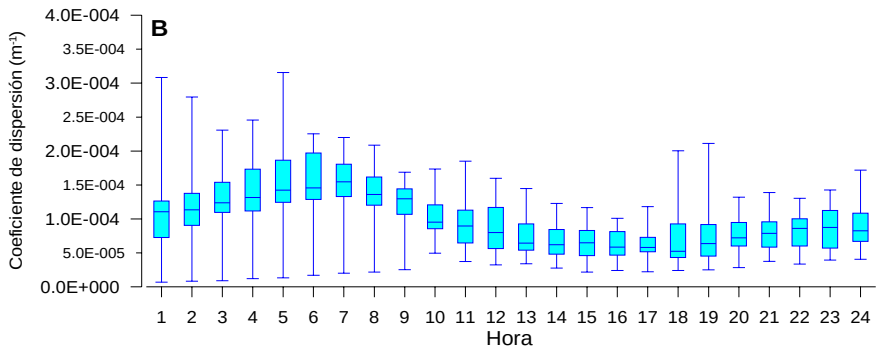
Caracterización de partículas ultrafinas

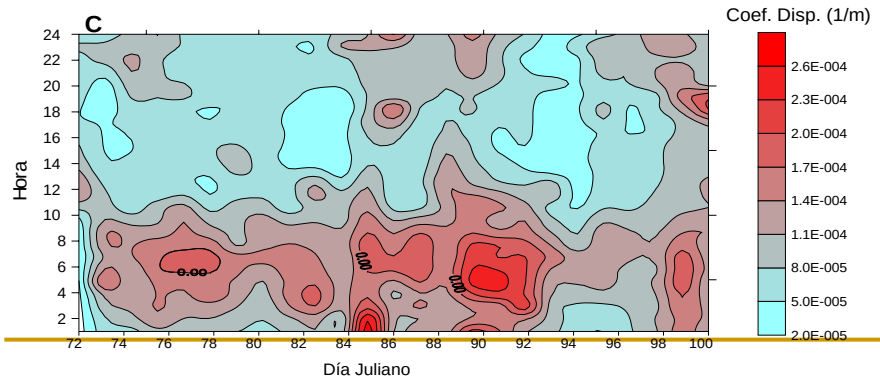
Subestación Jasso

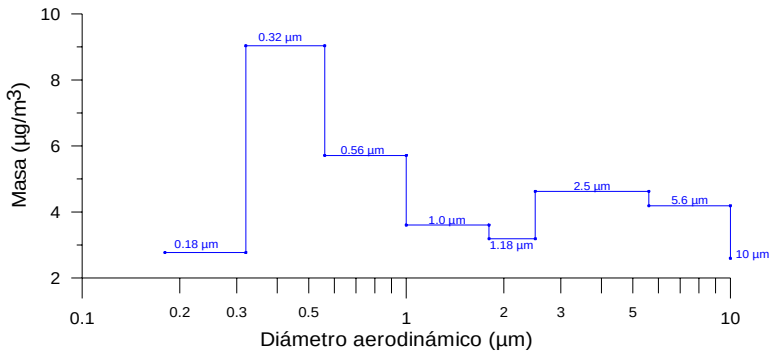


Caracterización de partículas ultrafinas









Distribución promedio de masa de partículas finas y gruesas

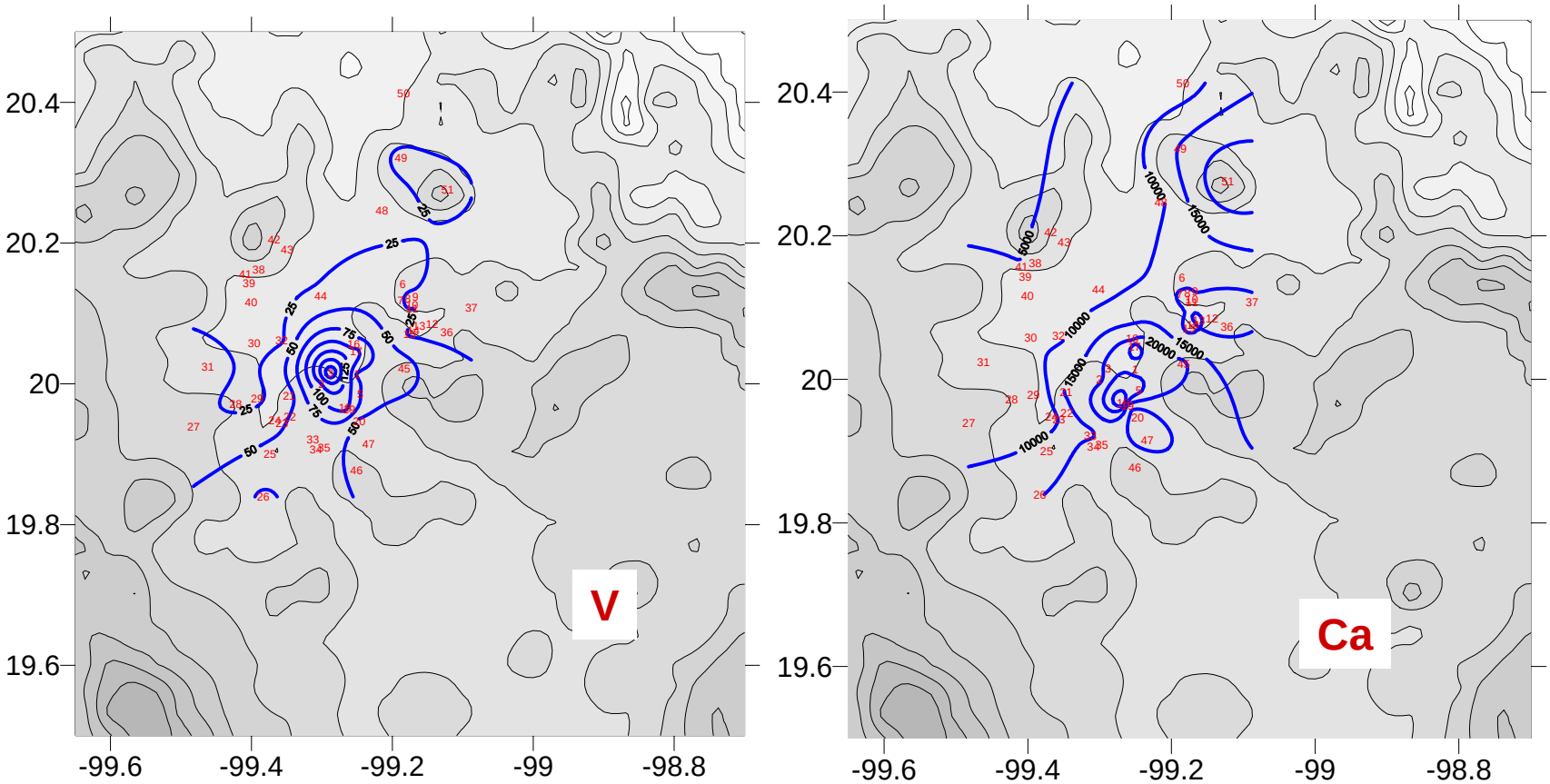
Biomonitoring around Tula, Hidalgo

Biomonitor: the epiphytic “ball moss” (*Tillandsia recurvata*)

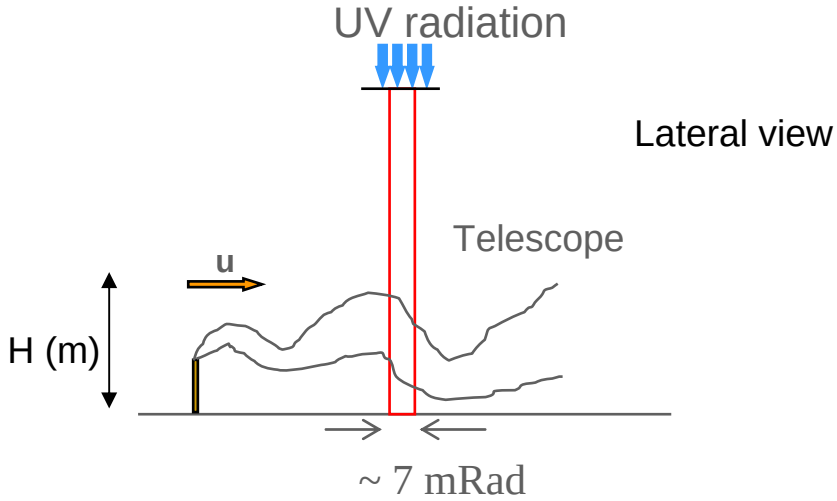
- **Biomonitoring network:** 50 sites; three composite samples per site (from mezquite trees).
- **Sampling period:** late spring-early summer (2006).
- **Sample preparation**: manual cleaning, grinding and microwave acid digestion (HNO_3-HCl-H_2O_2-HF).
- **Chemical analysis**: ICP-AES, method EPA 6010C.
- **Data analysis**: mapping, univariate and multivariate (Cluster and PCA).

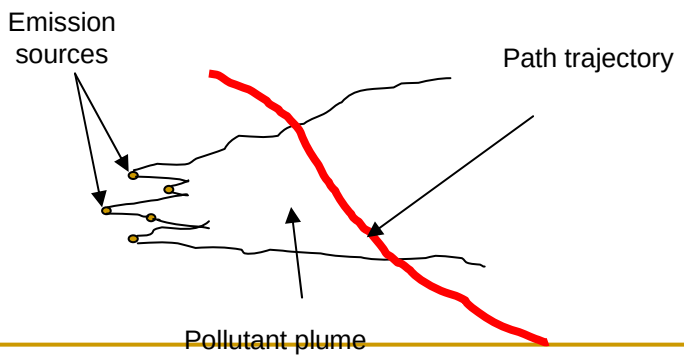
A. Zambrano & G. Sosa, IMP, 2006-7

Metal spatial distribution



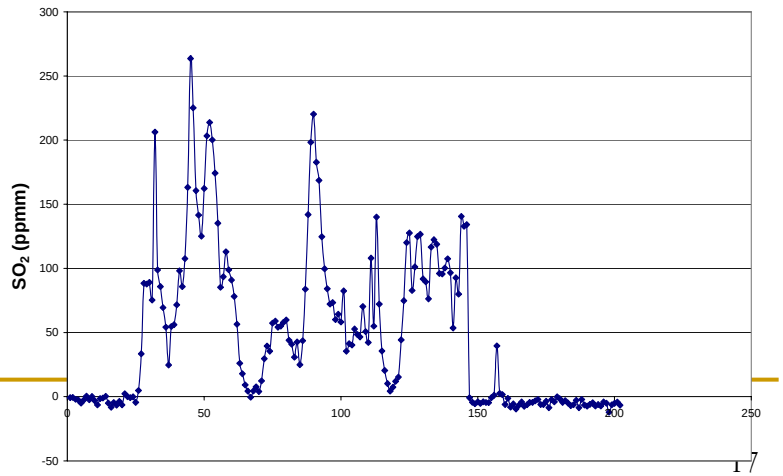
Column Integrated SO_2 concentration Mini-DOAS system



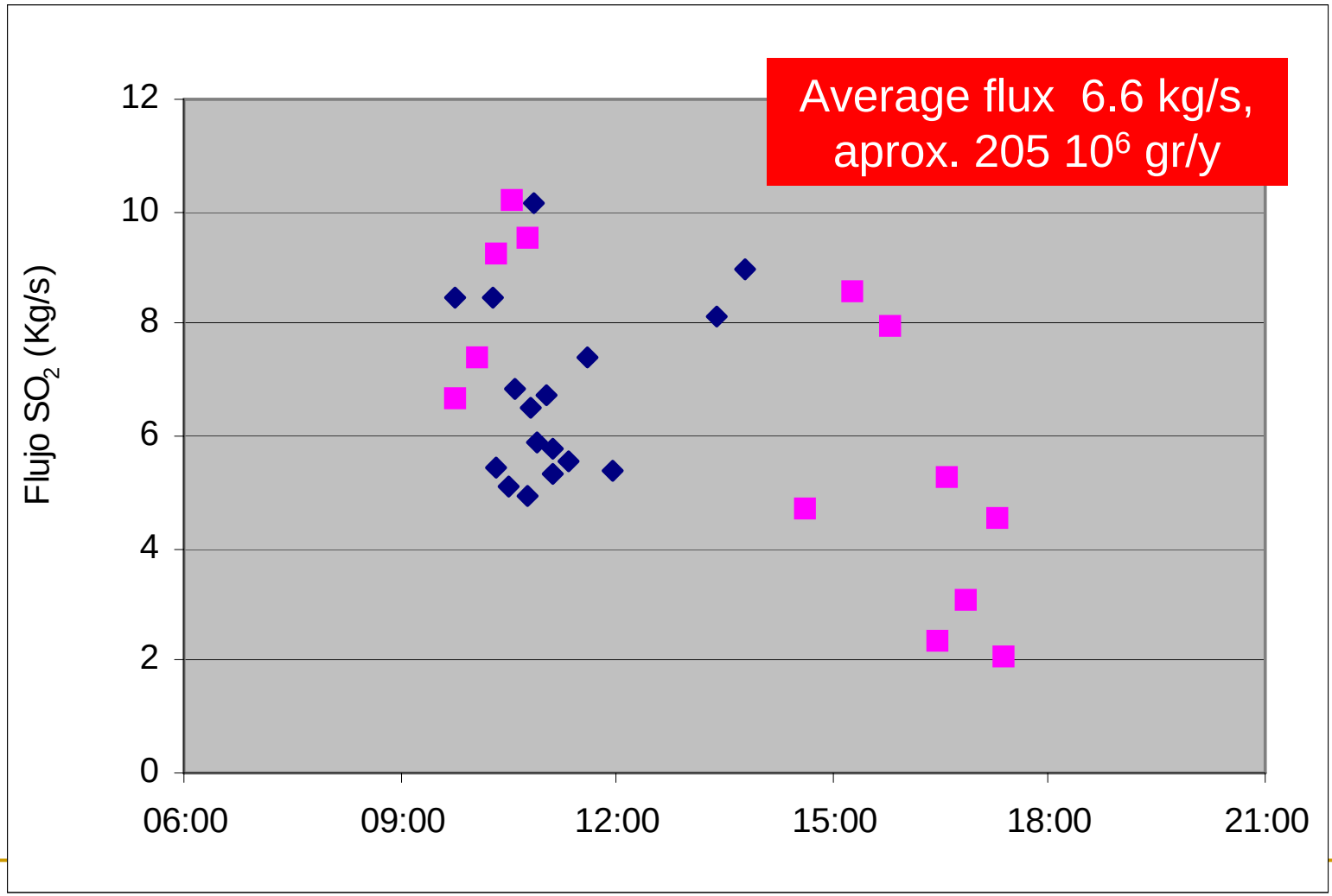


View from above

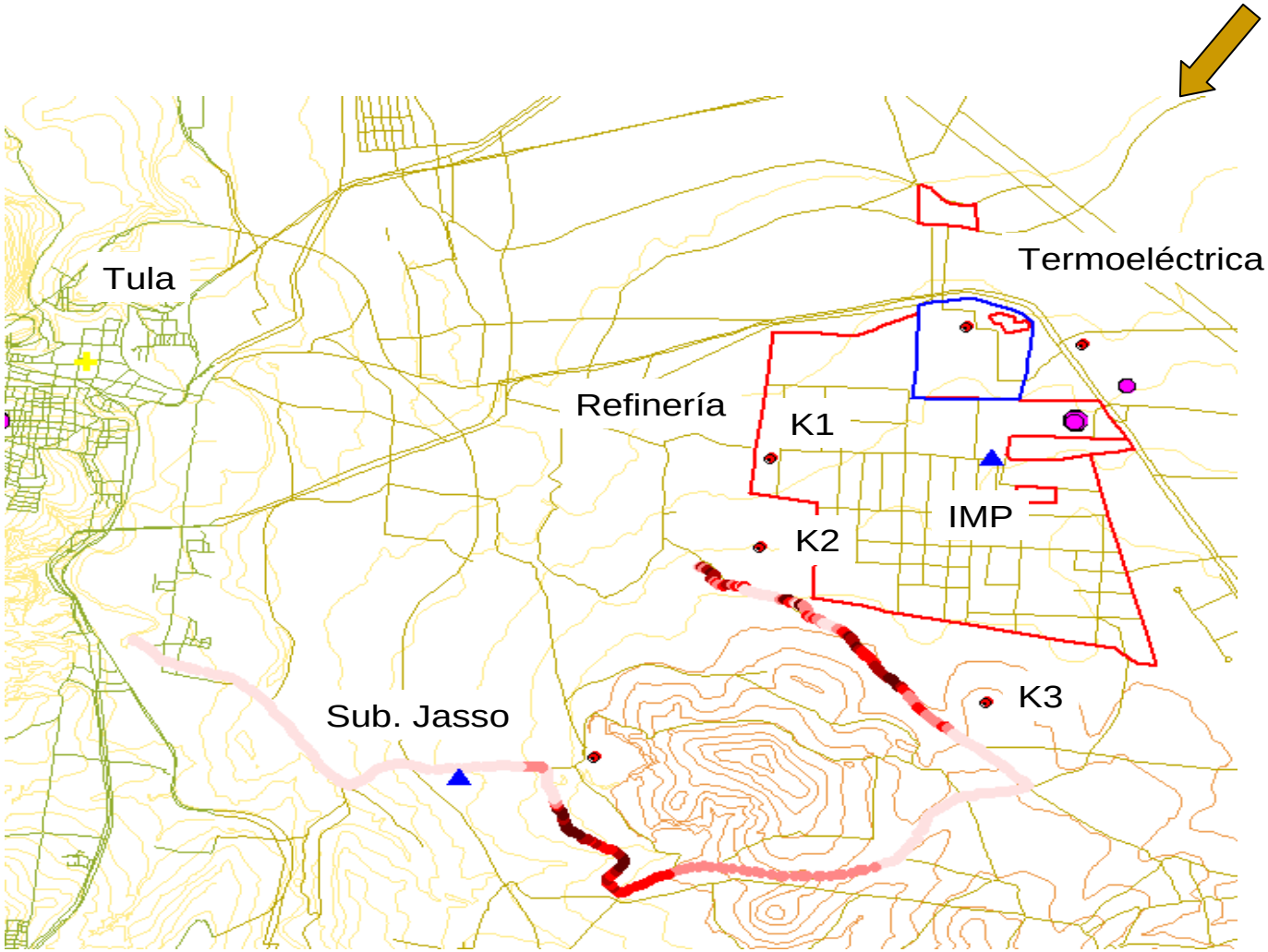
Transversal plume concentration



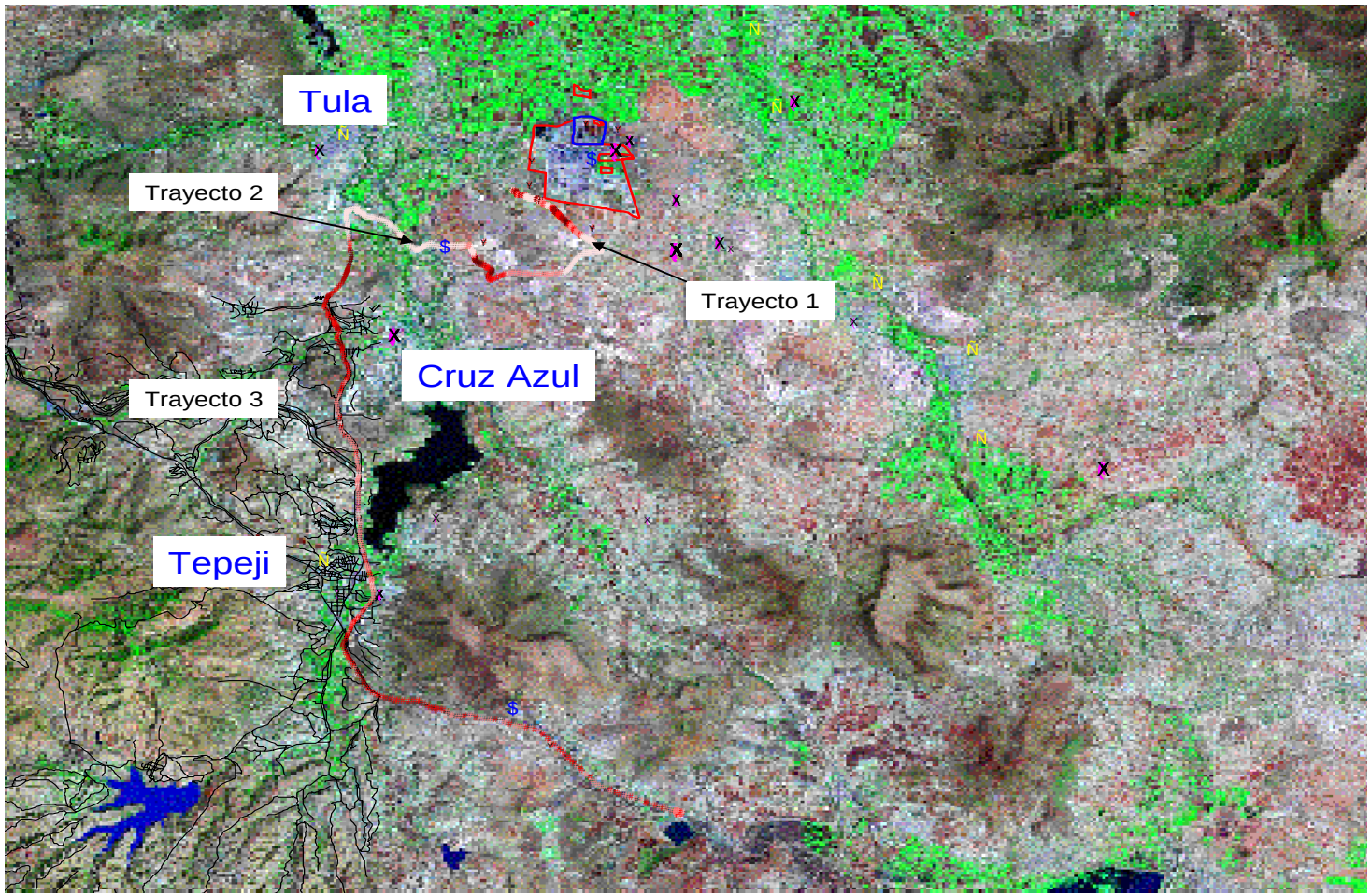
SO_2 flux emission (kg/s) at Tula industrial area



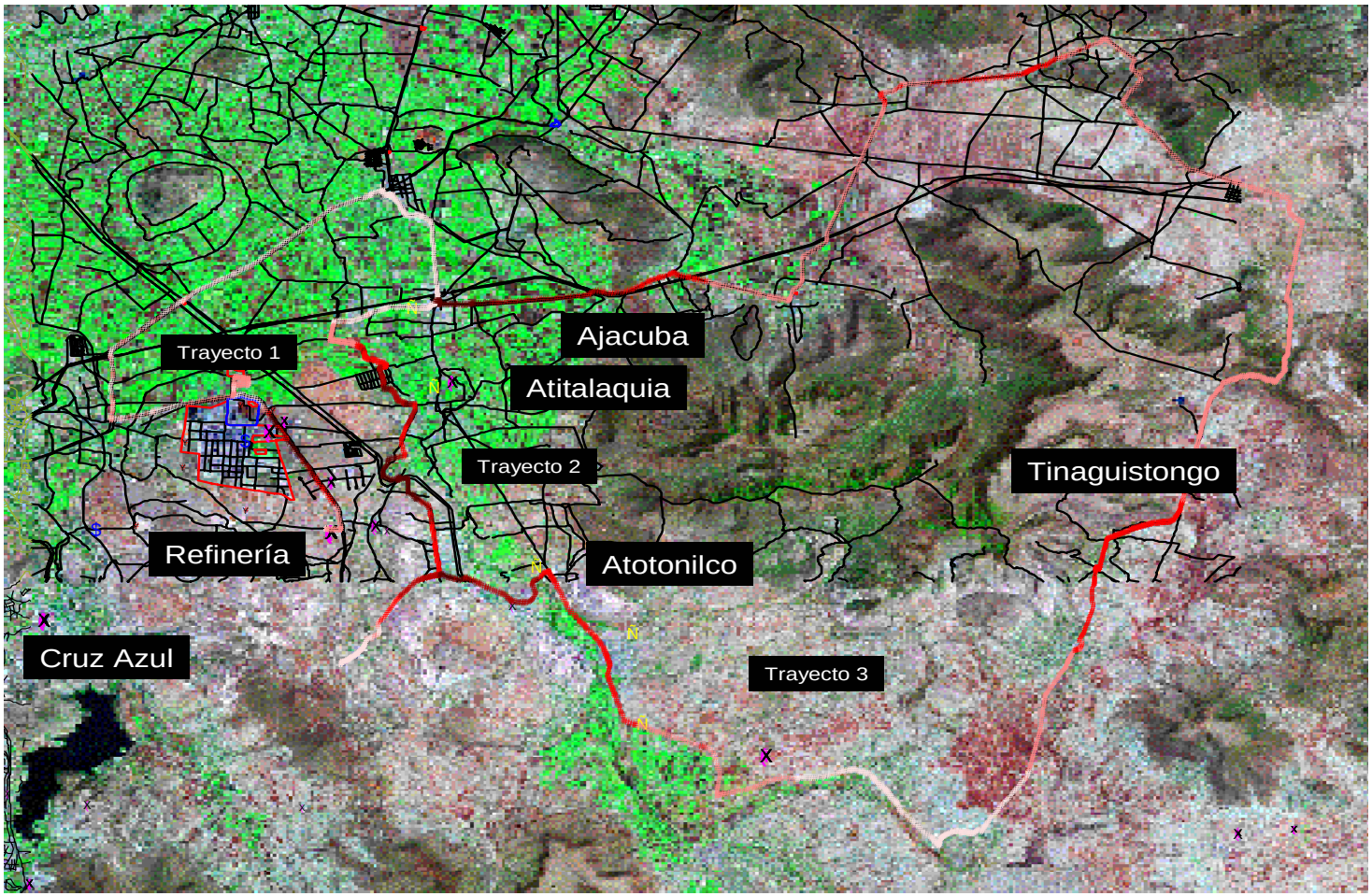
SO_2 plume tracking: April 4th, 2006



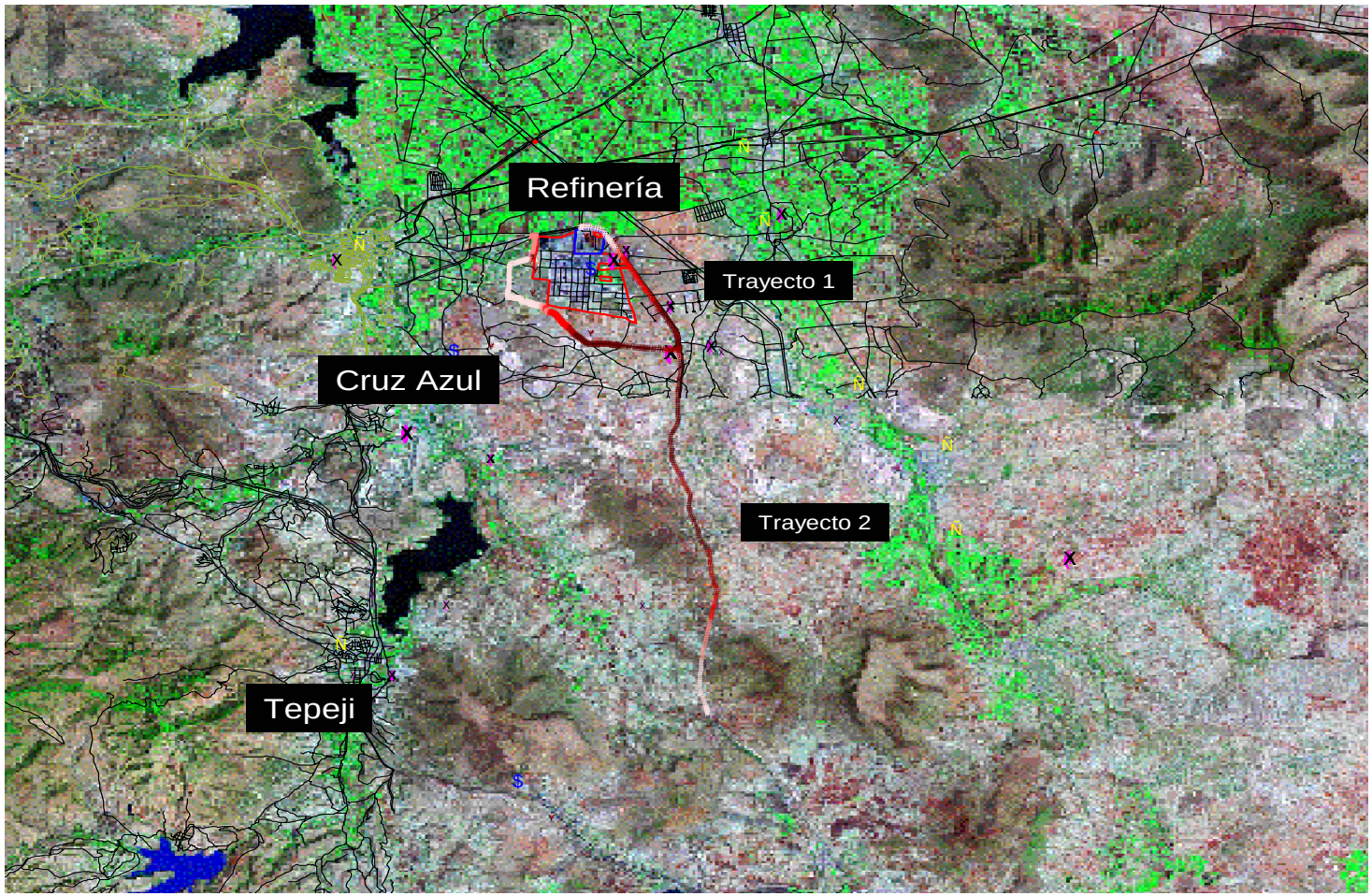
Seguimiento pluma SO_2: Abril 4



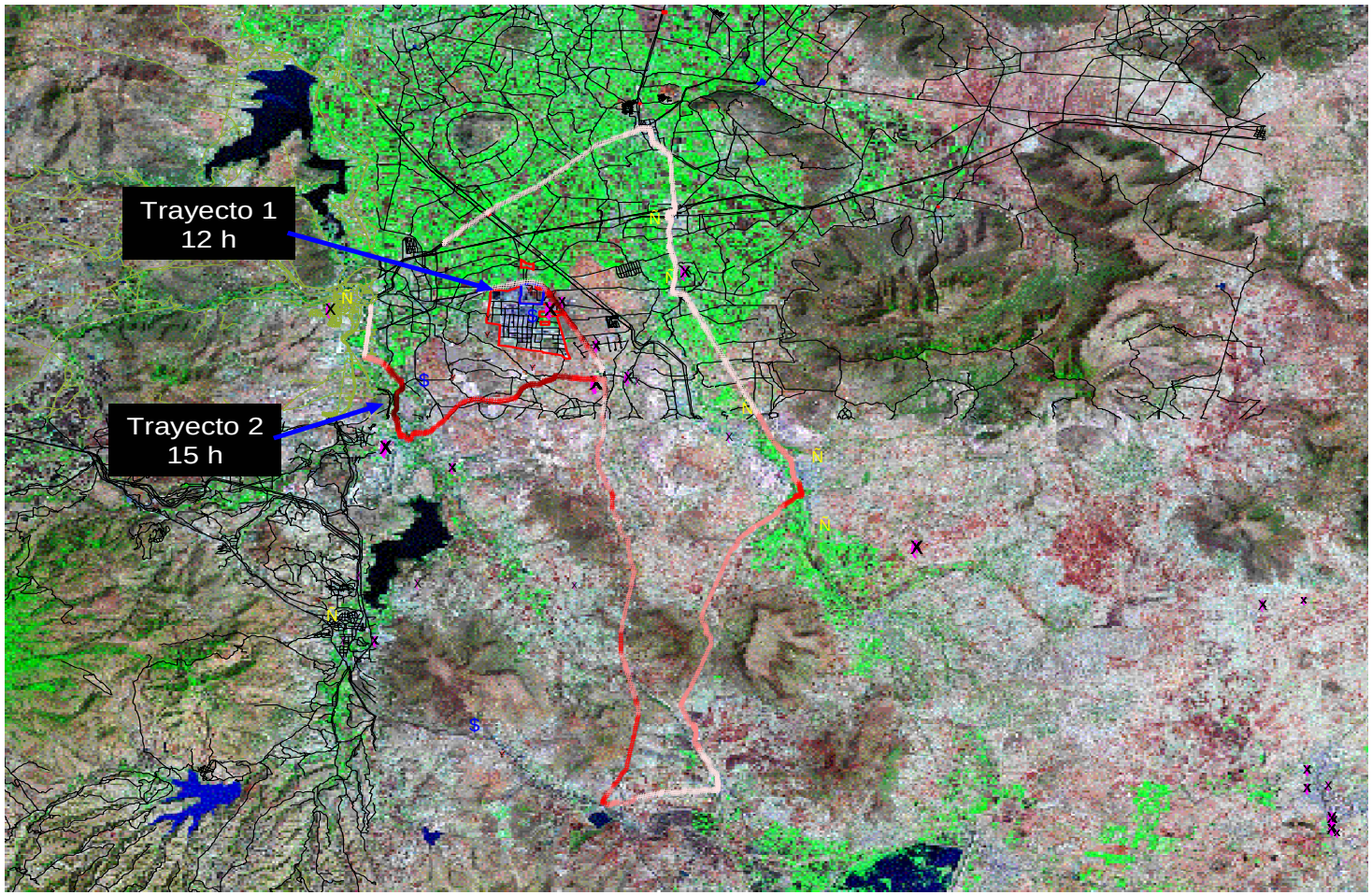
Seguimiento pluma SO_2: Abril 7



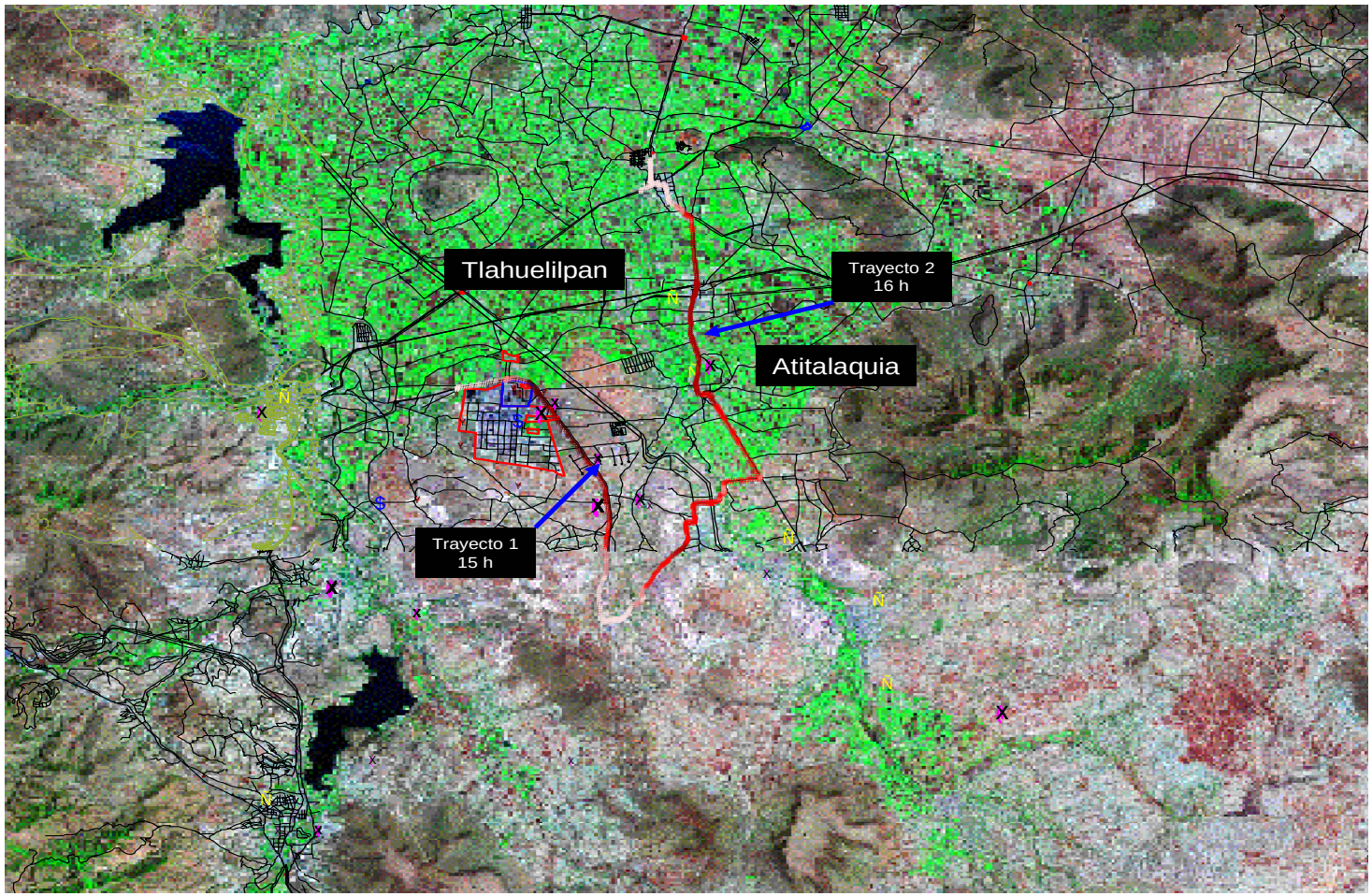
Seguimiento pluma SO_2: Abril 15



Seguimiento pluma SO_2: Abril 16



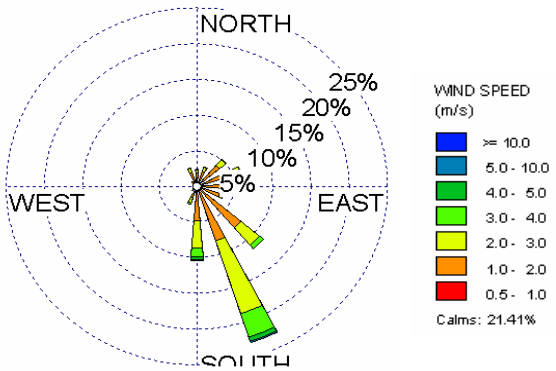
Seguimiento pluma SO2: Abril 17



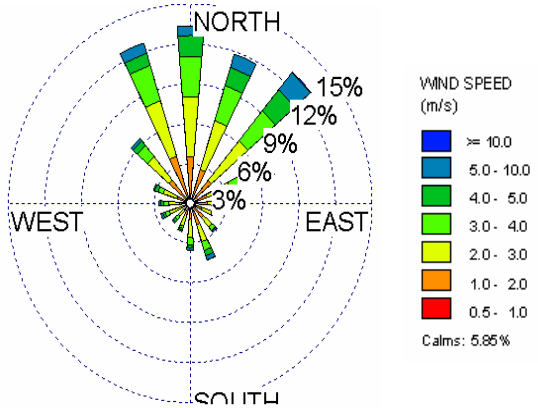
Conclusions

- The SO_2 emissions in Tula region represent 87% of the total emission in the extended Metropolitan Area (DF, Mexico State and Hidalgo State)
- The total flux of SO_2 measured in the Tula region is 6.6 kg/s (aprox. 200 T/y)
- The total VOC concentration at Tula region is below 0.5 ppbC. Formaldehyde concentration was close to that measured in Mexico City (16 to 20 ppb)
- The Sulfate concentration in the PM2.5 particle fraction represent almost 40% of the total mass. Total PAHs average concentration were 15 ng/m^3.

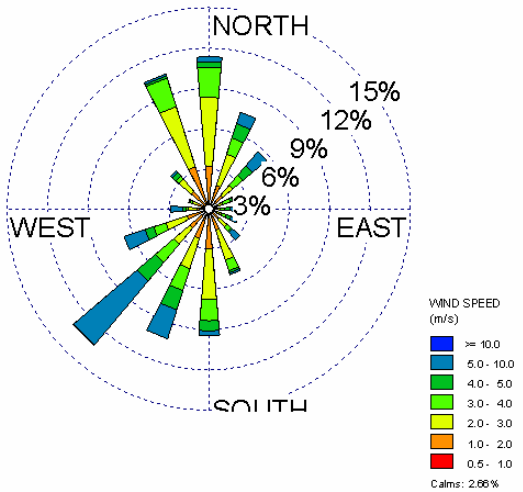
IMP-Tula



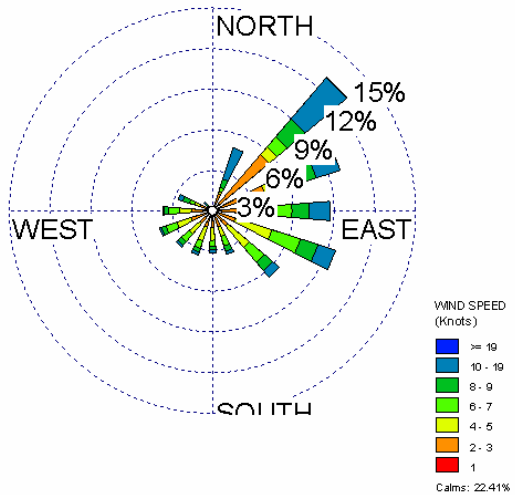
0-9 h



10-22 h

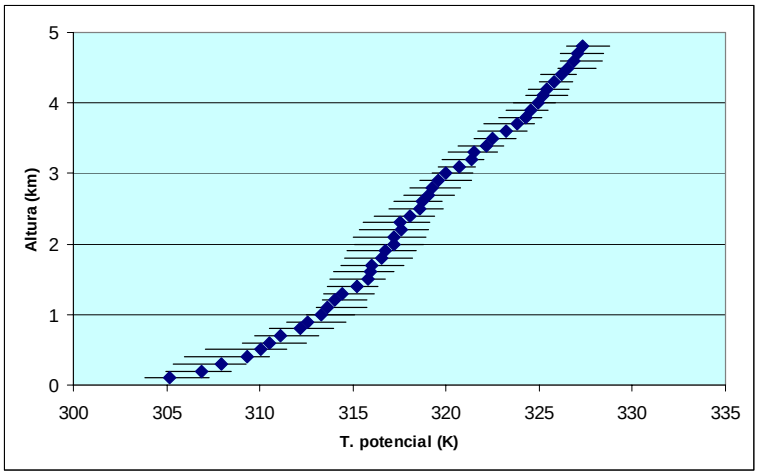


Sub Jasso: Promedio 24 h

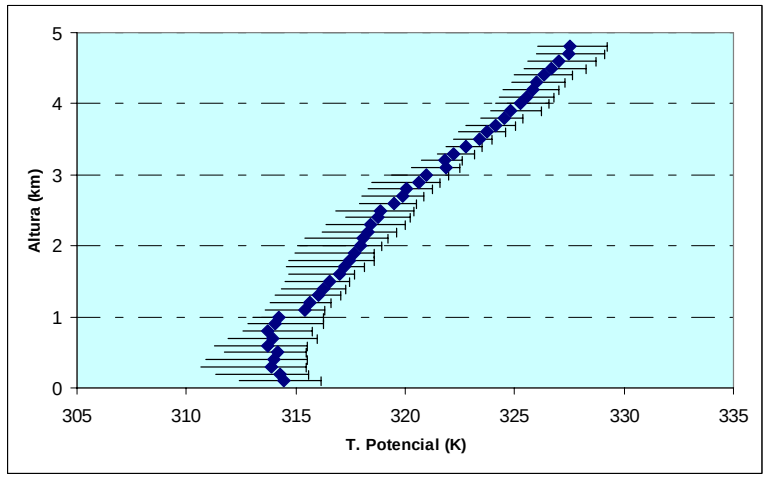


Pemex-Tepej: Promedio 24 h

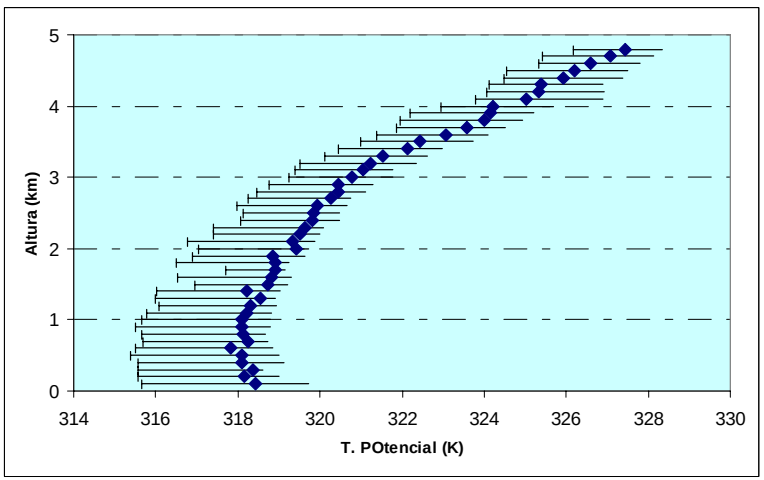
Average Potential Tem (K)



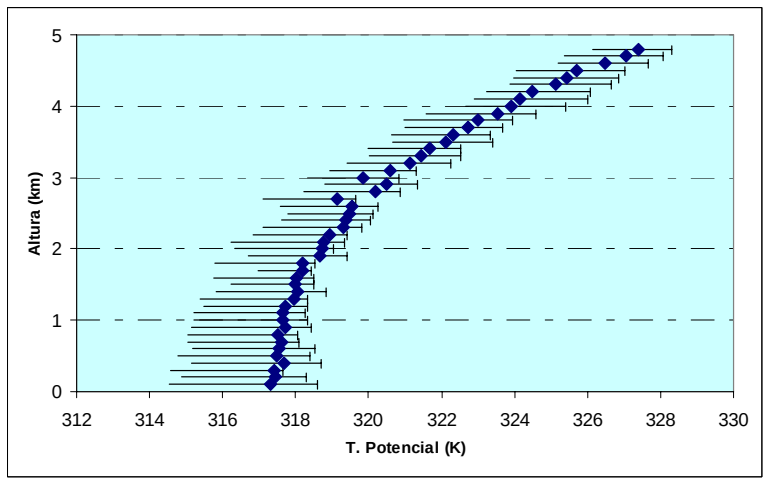
8 h



12 h

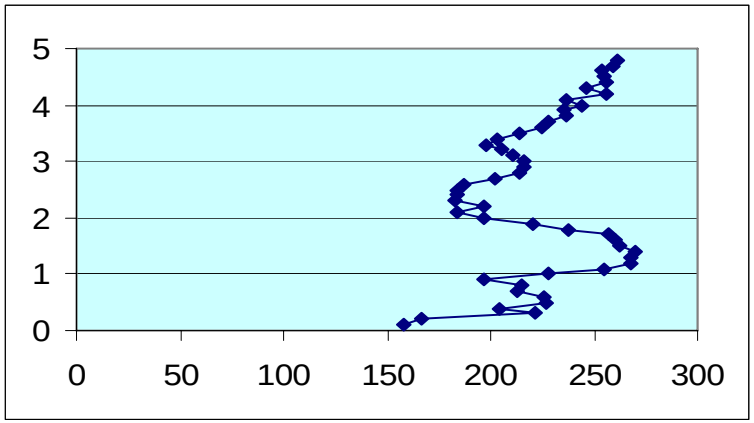


15 h



18 h

Average WD profile



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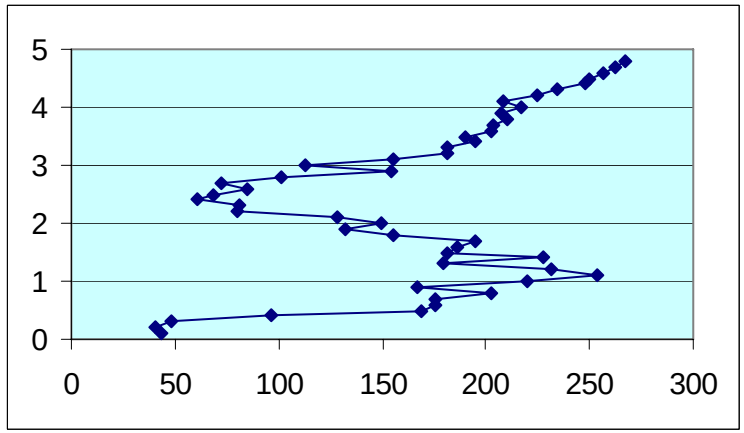

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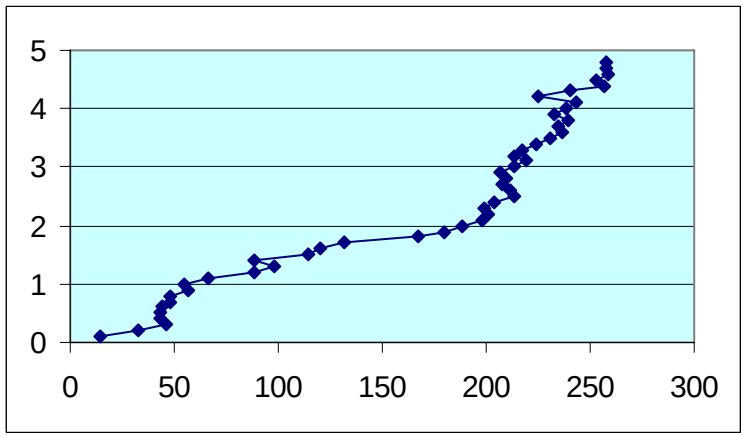

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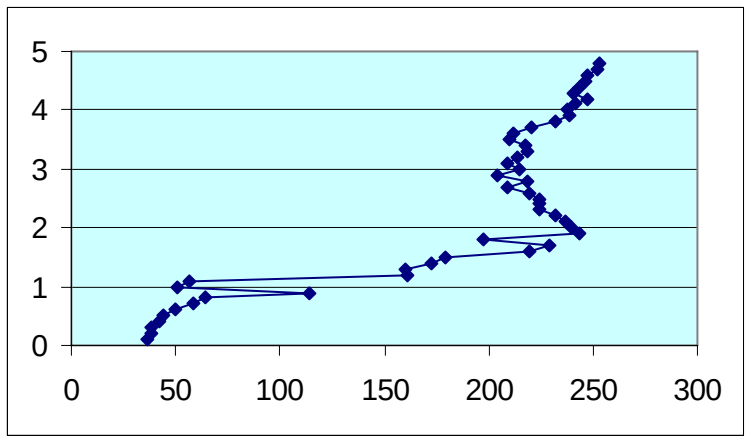

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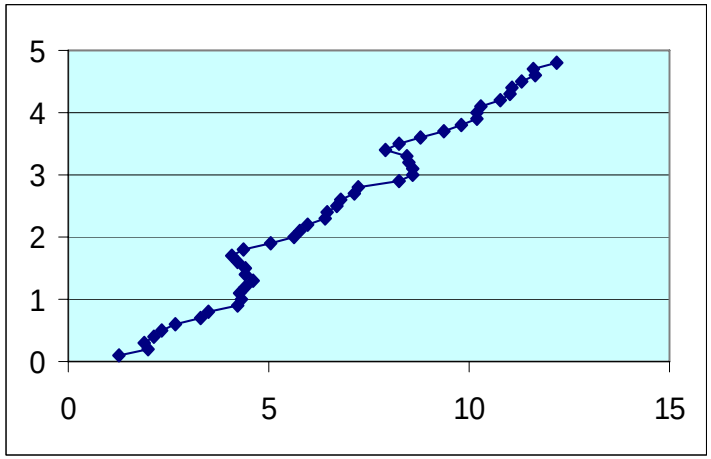
Average WV prfile (m/s)



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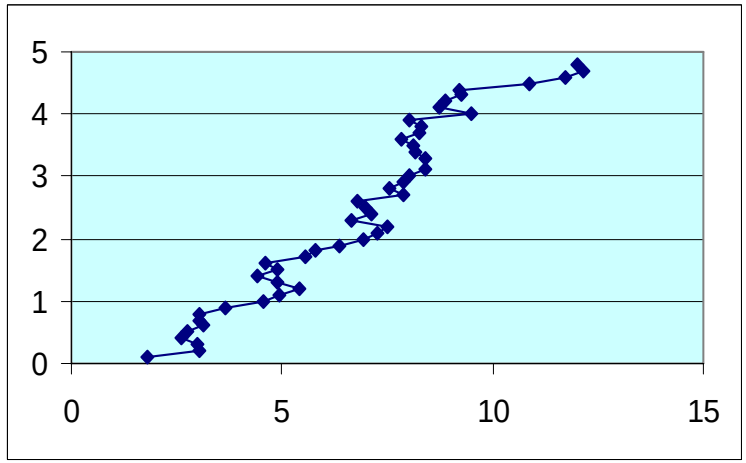

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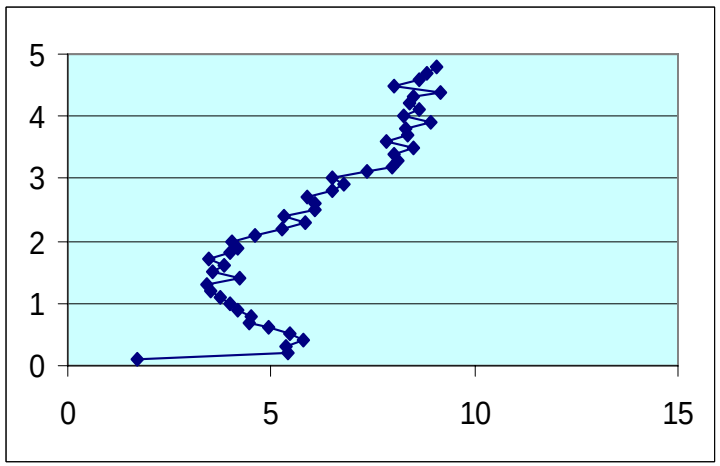

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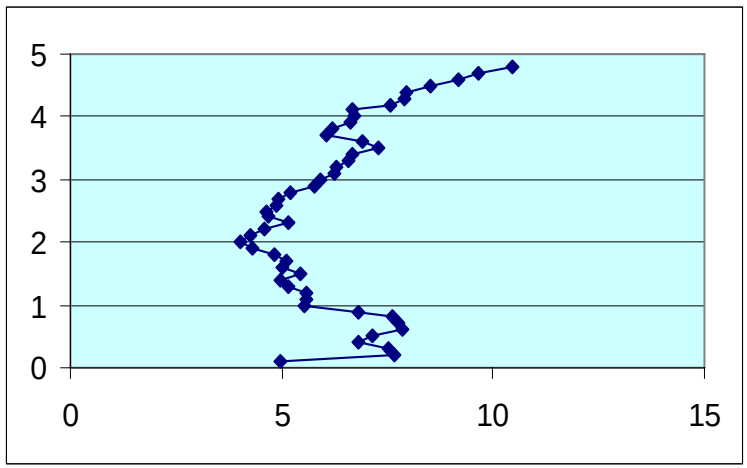
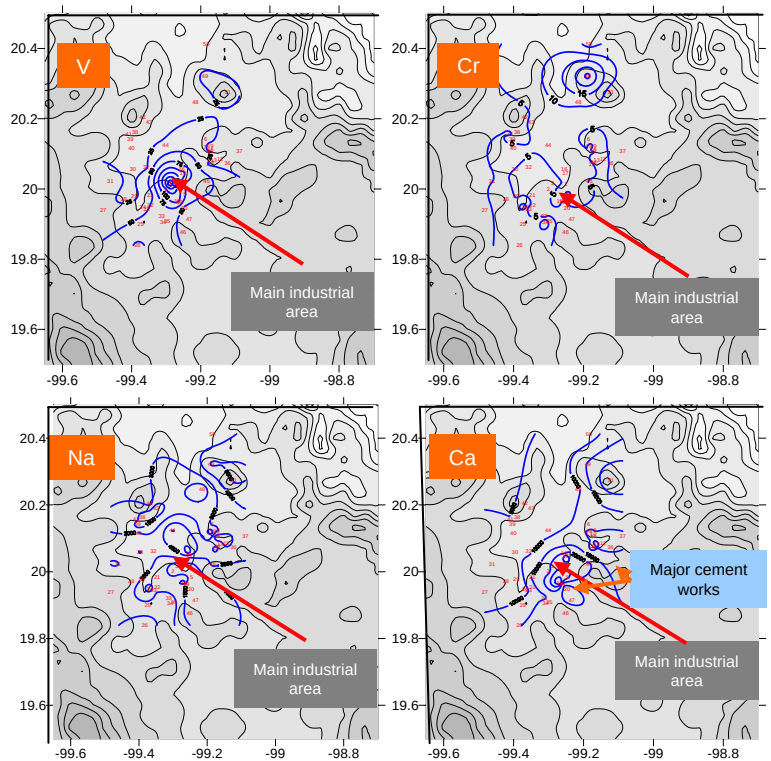


18 h

Preliminary conclusions

At the present level of data reduction:

- Regional mean contents of some toxic elements in the biomonitor (e.g., Cr, Ni, Pb and V) were 4-85 times higher than measured in similar studies at other world regions.
- The levels of toxic elements, except for Cr and Pb, were higher at sites near to- and downwind from the main industrial area.
- The local industrial sources had a higher relative importance for toxic particle emissions than agricultural sources.
- Since *T. recurvata* captured the relative spatial deposition patterns of metals, it can be considered a good biomonitoring tool.



Spatial distibution of some elements in *T. recurvata* at Mezquital Valley, México.

A. Zambrano & G. Sosa, IMP, 2006-7

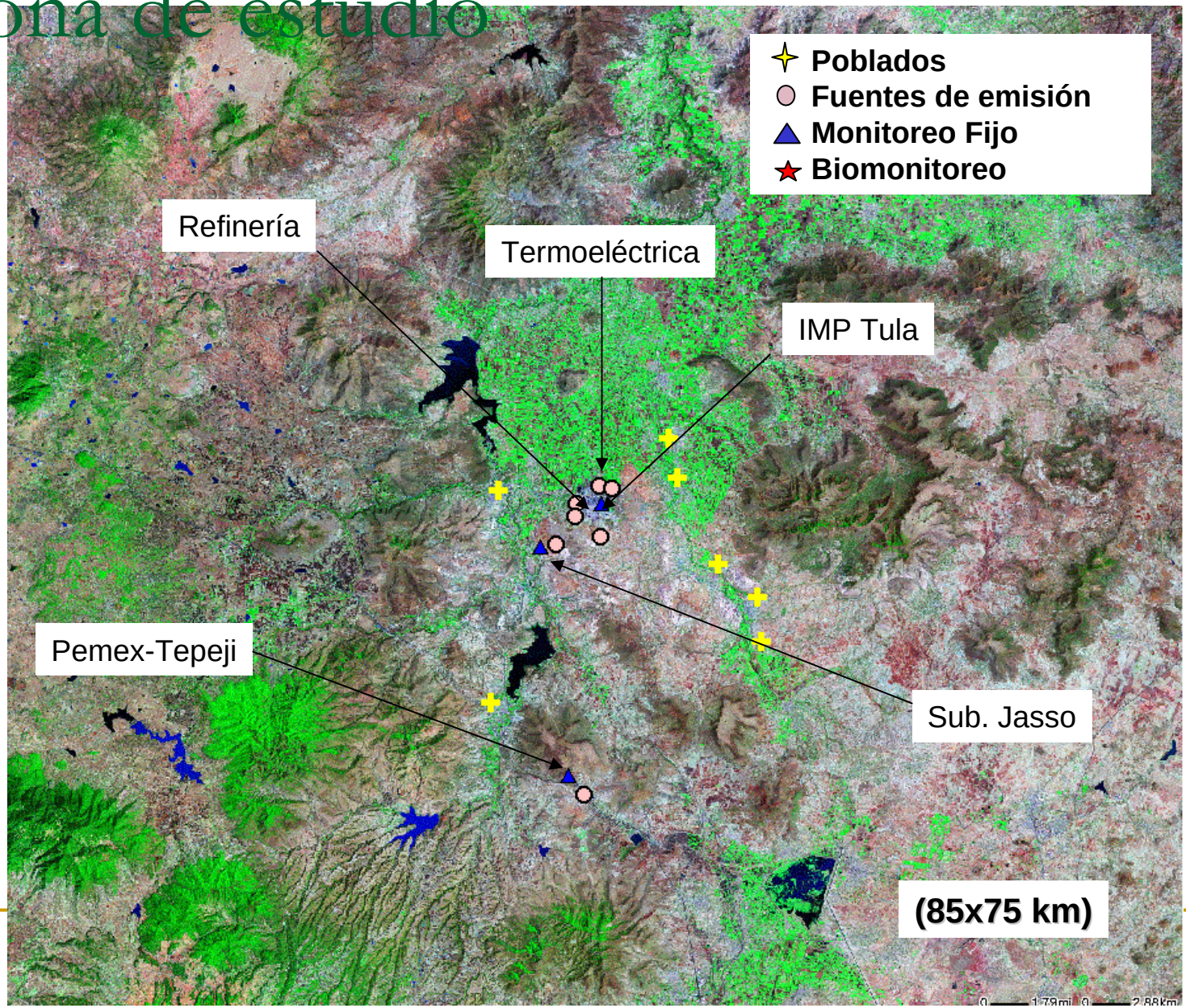
Field measurements
March 18 – April 22th, 2007

VOC & Carbonyls	Two Sites	12 h
PM10/PM2.5	Two Sites	12, 24 h
Elemental carbon	One Site	5’
Size Part. Dist.	One Site	15’
Opt. parameters	One Site	1’
Criteria pollutants	Two Sites	1’
Radiosondes	One Site	4 daily
Biomonitoring		
Colmn. Integrated SO_2	Mobile	

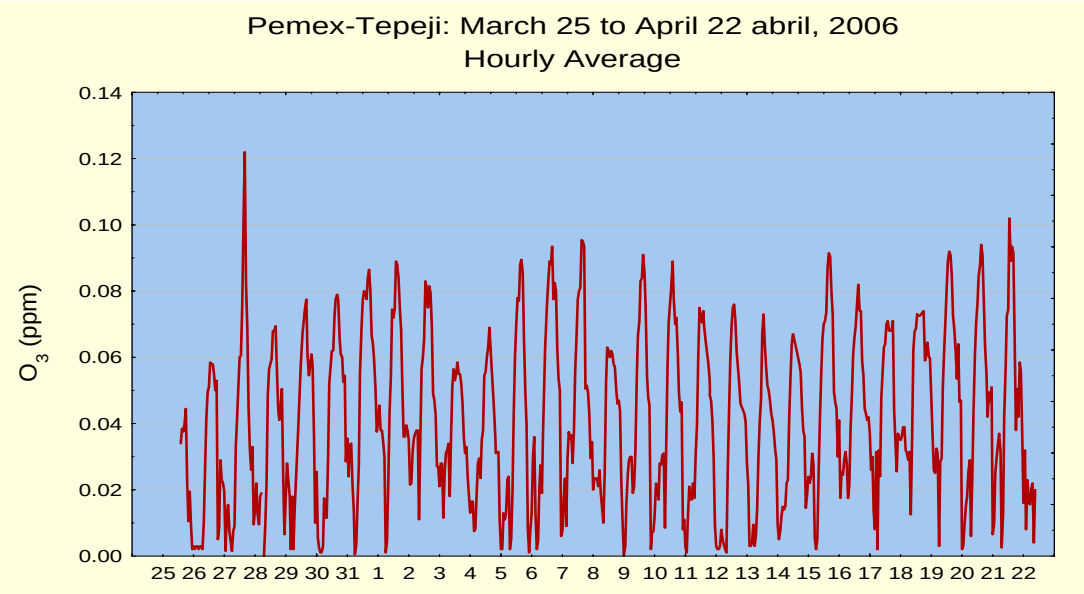
Biomonitoring

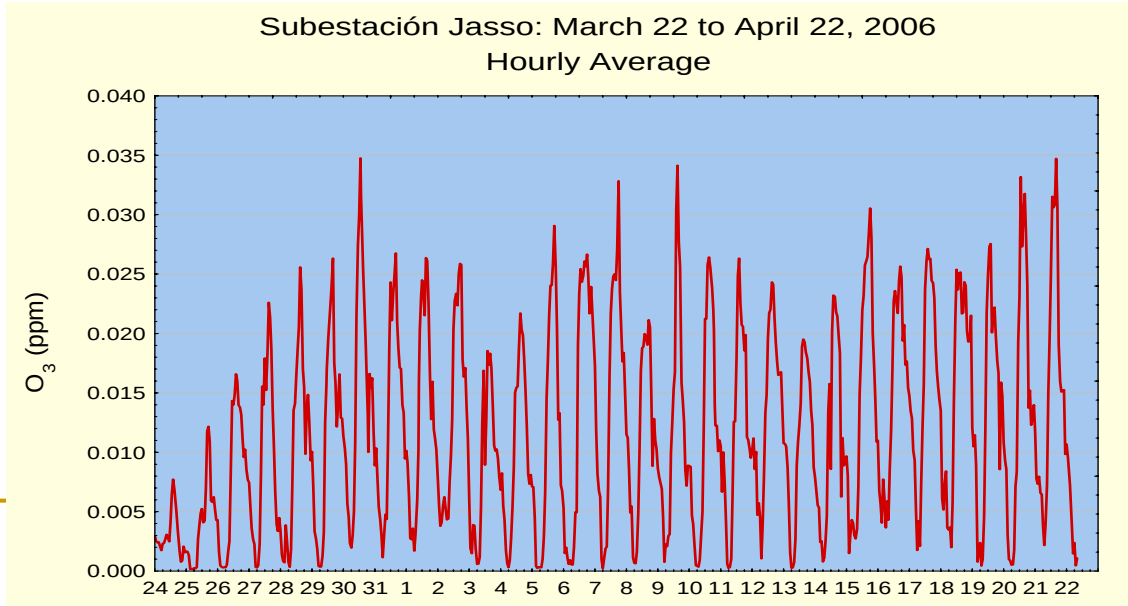
Trace metal analysis according to EPA 610C method (Ag, Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Ni, P, Pb, Sb, Se, Sr, Ti, V y Zn).

Zona de estudio

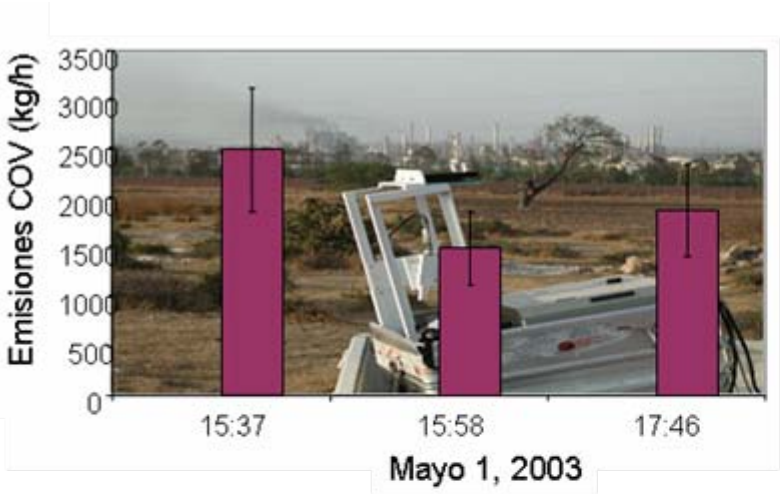


Caracterización de la calidad del aire

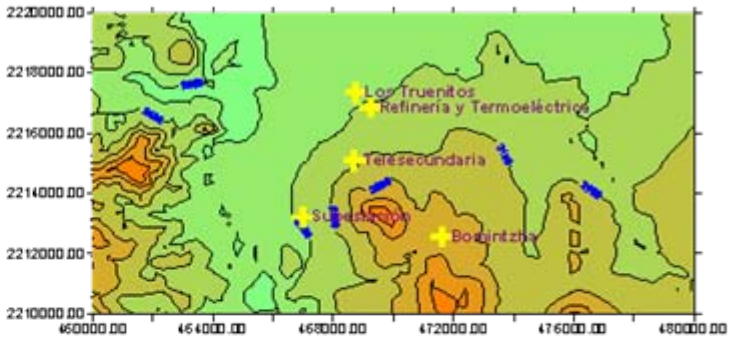


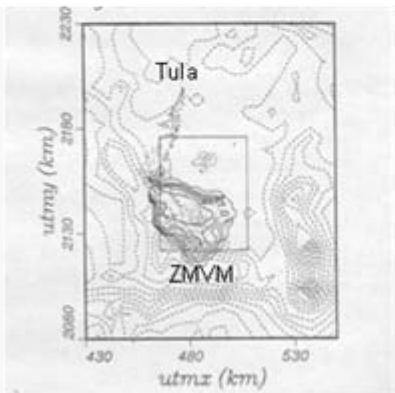


Estudios de previos en Tula



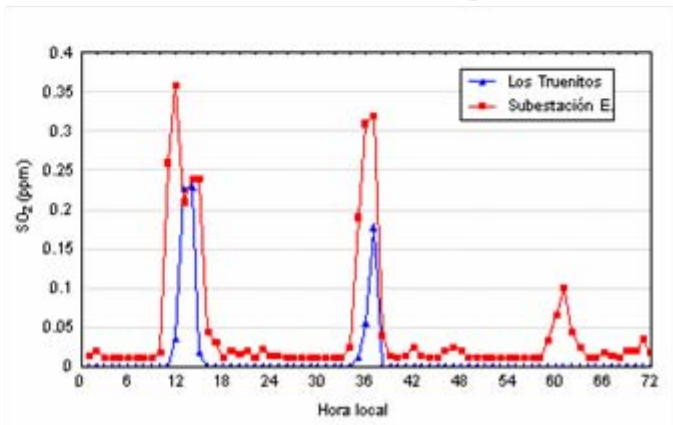
Sitios de monitoreo continuo de SO_2: 1997-2000



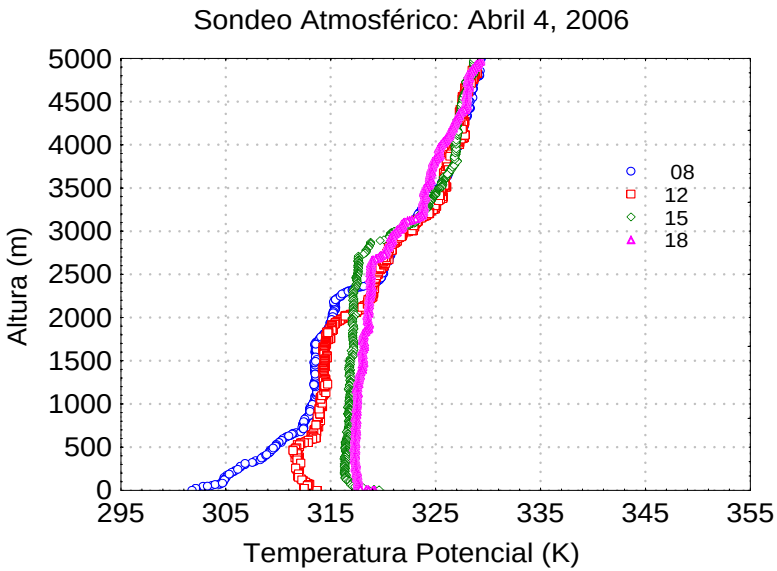


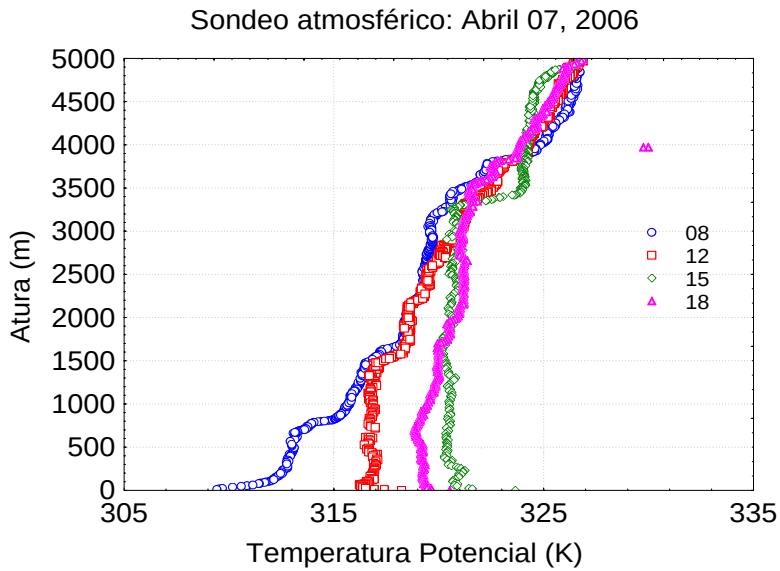
Trasporte de SO_2 de Tula a la ZMVM
Modelado con HOTMA-RAPTAD (EGCA, 1993)

Concentración continua de SO_2: 1997-200

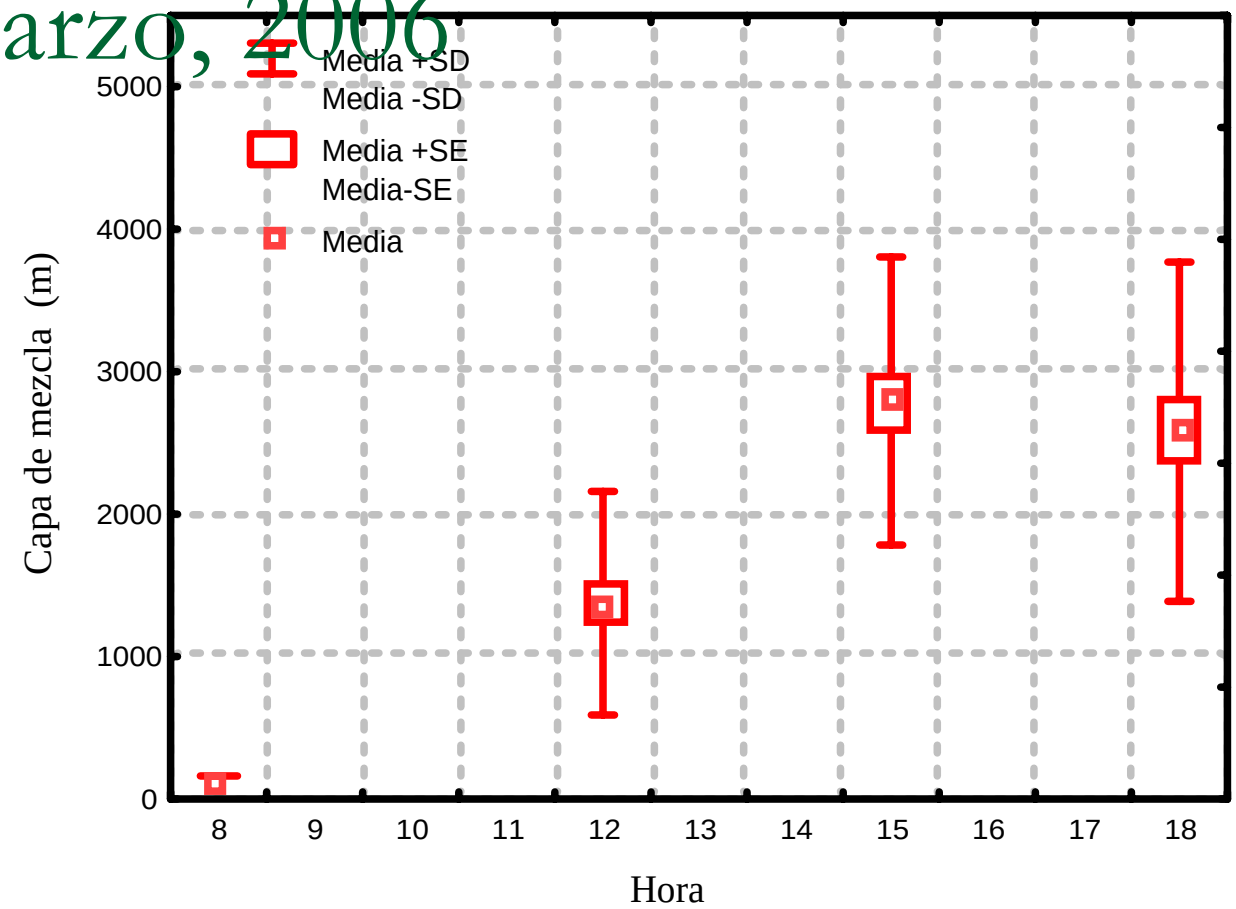


Radiosondeo atmosférico (IMP-Tula): Abril 04, 2006





Condiciones meteorológicas Abril-Marzo, 2006



Altura de la capa de mezcla promedio en Tula. Hgo. durante marzo-abril de 2006.