MODELLING THE AIR POLLUTION TRANSPORT FROM THE SÃO PAULO METROPOLIS TO NEAR AND MIDDLE DISTANCE PLACES

Kerr S.A.[1], Biemann N.[1], Anfossi D.[2], Trini Castelli S.[2], Carvalho J.[3]

(1) Universidade de São Paulo, Instituto de Física, São Paulo, SP, Brazil

(2) CNR, Istituto di Scienze dell'Atmosfera e del Clima - Torino, Italy

(3) Universidade Luterana do Brasil, Faculdade de Engenharia Ambiental, Canoas, RS, Brazil

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São Paulo metropolis is a mega-city (17 million inhabitants) experiencing intense air pollution problems.

The environmental control agency of São Paulo State, estimates that the local atmosphere receives an annual load of 2.6 Mt of urban air pollutants, 96% of this being generated by vehicles, specially by cars (52%).

This work is part of a larger project developed by several research groups, since 1998, studying in depth the local meteorology and its association with air pollution problems in the metropolitan area.

The aim of our specific research was to evaluate the transport of pollutants from São Paulo to near and middle distance areas.

In the metropolis neighbourhoods, there are other populous cities, besides crops and biological reserves that could receive significant loads of air pollution.

During the days 11, 12 and 13 of August 2000 intense measurement of meteorological parameters and of several air pollutants were performed.

These days were selected for the present analysis. In this work only CO was evaluated.

The first part of the work consisted in making operative at the São Paulo University Group, leaded by Prof. Kerr, the modelling system RMS (including the post-processing and graphics facilities) developed at the CNR-ISAC/TO

Then the first series of simulation have been carried on.

We are presenting here the preliminary results of the simulation performed.

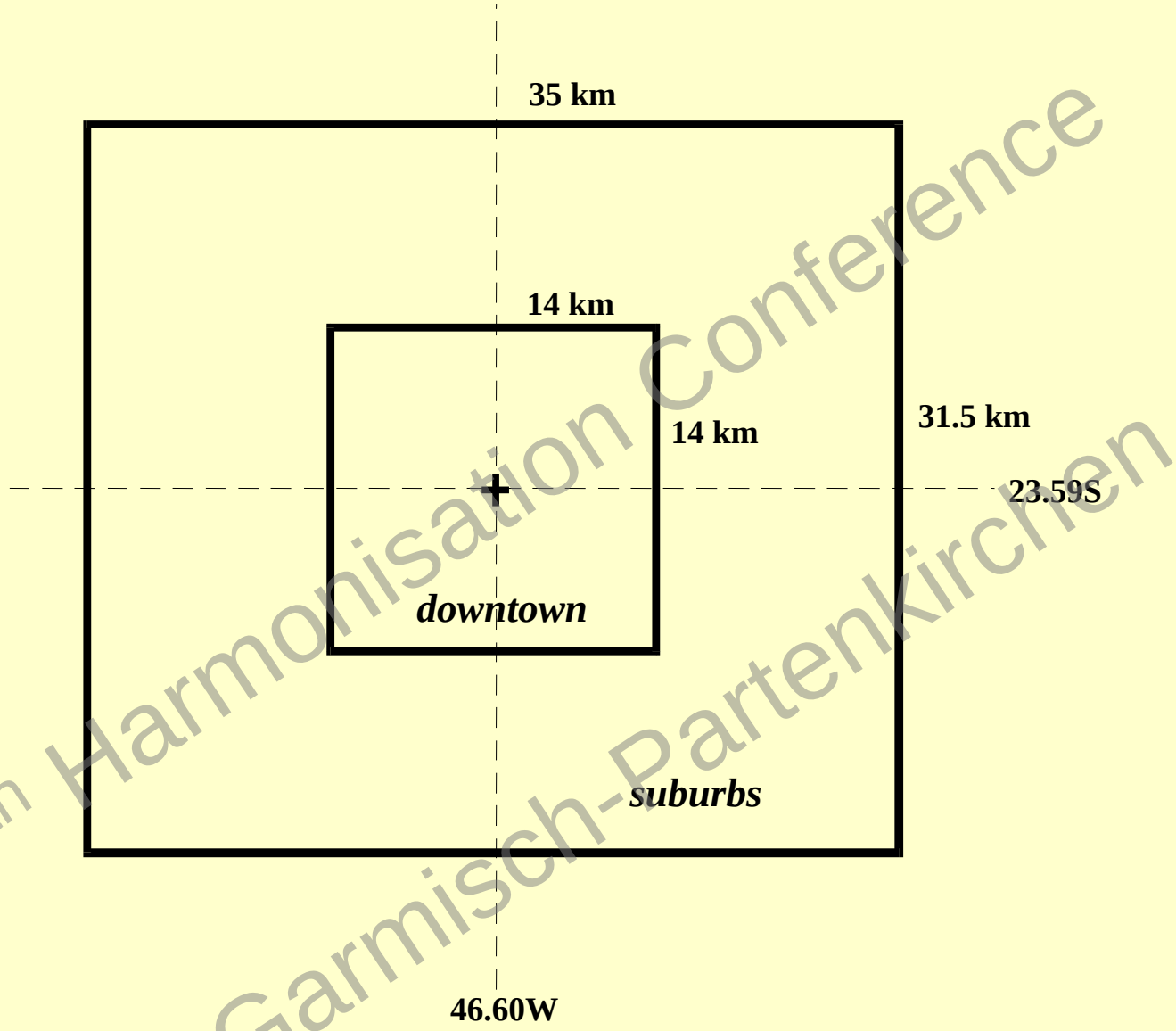
CO Emission from the São Paulo megacity

The CETESB inventory for 2000 estimates a total CO emission of 1.66×10^6 t/y and 1.62×10^6 t/y coming from traffic (98%).

As a first approximation we started considering all the São Paulo megacity as an area source divided in two sub-areas:

centre of the town - 14 x 14 km^2

suburbs - 35 km (E-W) x 31.5 km (N-S)



Structure of the CO source areas over São Paulo

Freitas (2003) estimated that emission ratio between these two areas is 3.6 .

Defining:

$M_c =$ CO traffic emission in the central area

$M_p =$ CO traffic emission in the suburban area

This means

$M_c = 3.27 \times 10^{12}$ mg/d

and

$M_p = 1.17 \times 10^{12}$ mg/d

SIMULATION OPTIONS

CO emission was uniformly distributed in each area.

The emission height was set to 0.45 m above ground to simulate the car height of emission.

The emission areas follow the topography.

Our modelling system allows considering the emission as a function of time (during the day, during the week, etc.). However, in this preliminary study this option was not used.

To carry out the simulations, the integrated modeling system ***RMS*** (RAMS-MIRS-SPRAY) was used

RMS modelling system
is based on a combination of :

meteorological model → RAMS

(Regional Atmospheric Modeling System

Pielke et al., 1992)

interface and parameterisation code → MIRS

(Method for Interfacing RAMS and SPRAY

Trini Castelli and Anfossi, 1997, Trini Castelli, 2000)

Lagrangian stochastic dispersion model → SPRAY

(Tinarelli et al., 2000, Ferrero et al. 2001a).

RMS MODEL SYSTEM (RAMS-MIRS-SPRAY)

RAMS

Fields of - WIND, TEMPERATURE, T.K.E., K (3 D)

TOPOGRAPHY, SURFACE FLUXES (2 D)

MIRS

Fields of - WIND, K, SKEWNESS/KURTOSIS, T_L (3 D)

TOPOGRAPHY, PBL height (2 D)

SPRAY

Fields of - PARTICLE POSITIONS

G. L. CONCENTRATION

Two nested grids were used

grid-1: 450 x 450 km^2 18 km horizontal resolution

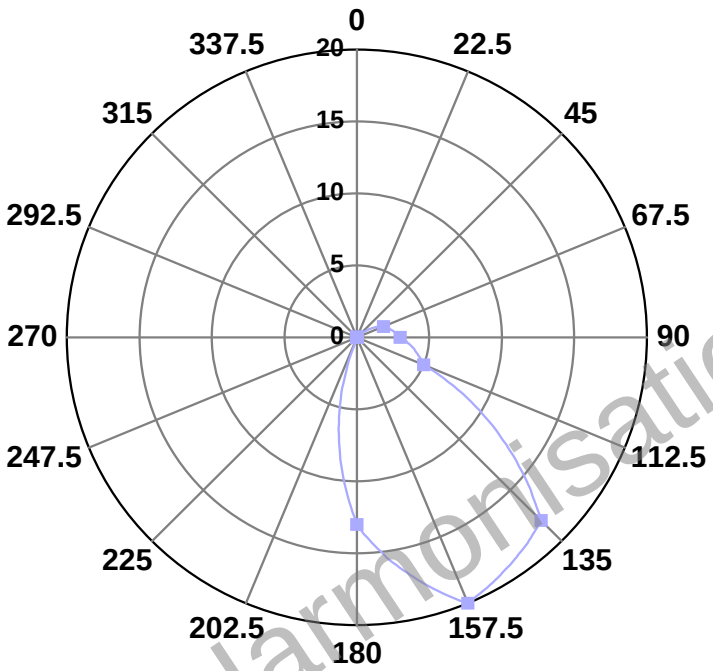
grid-2: 184.5 x 184.5 km^2 4.5 km horizontal resolution

Grid 2 represents the area of interest, including main urban areas within 90 km from São Paulo megacity, such as:

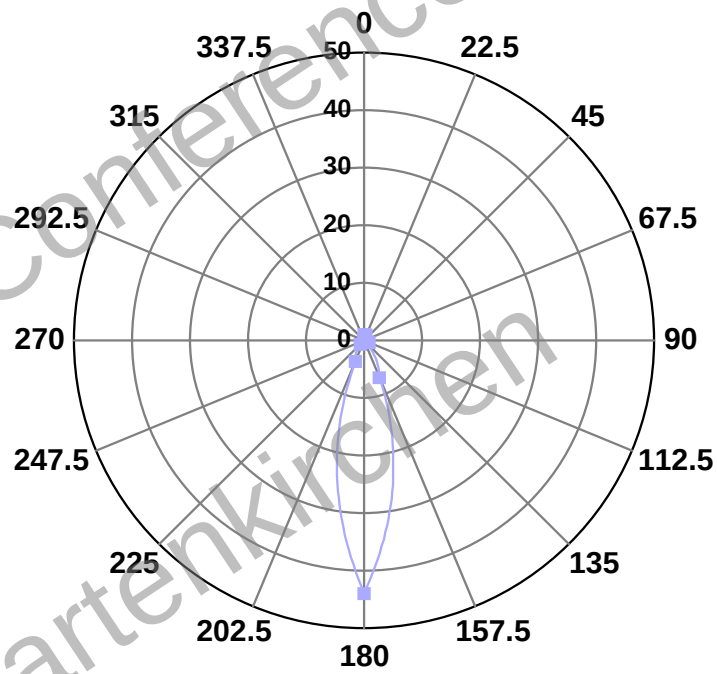
São José dos Campos, Campinas, Sorocaba,

Metropolitan Region of Baixada Santista.

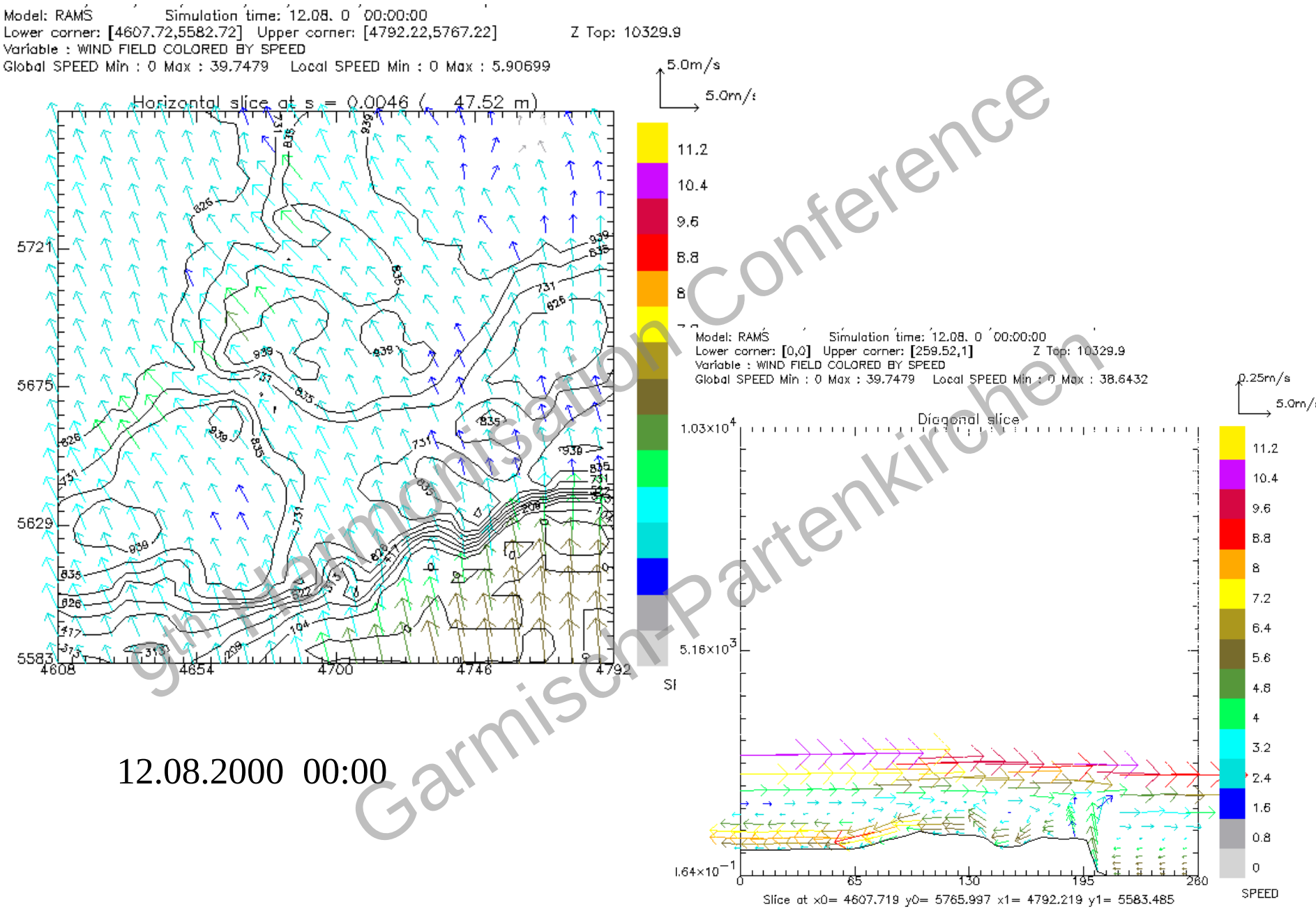
Meteorological data from CPTEC at 00, 06, 18 e 24 GMT



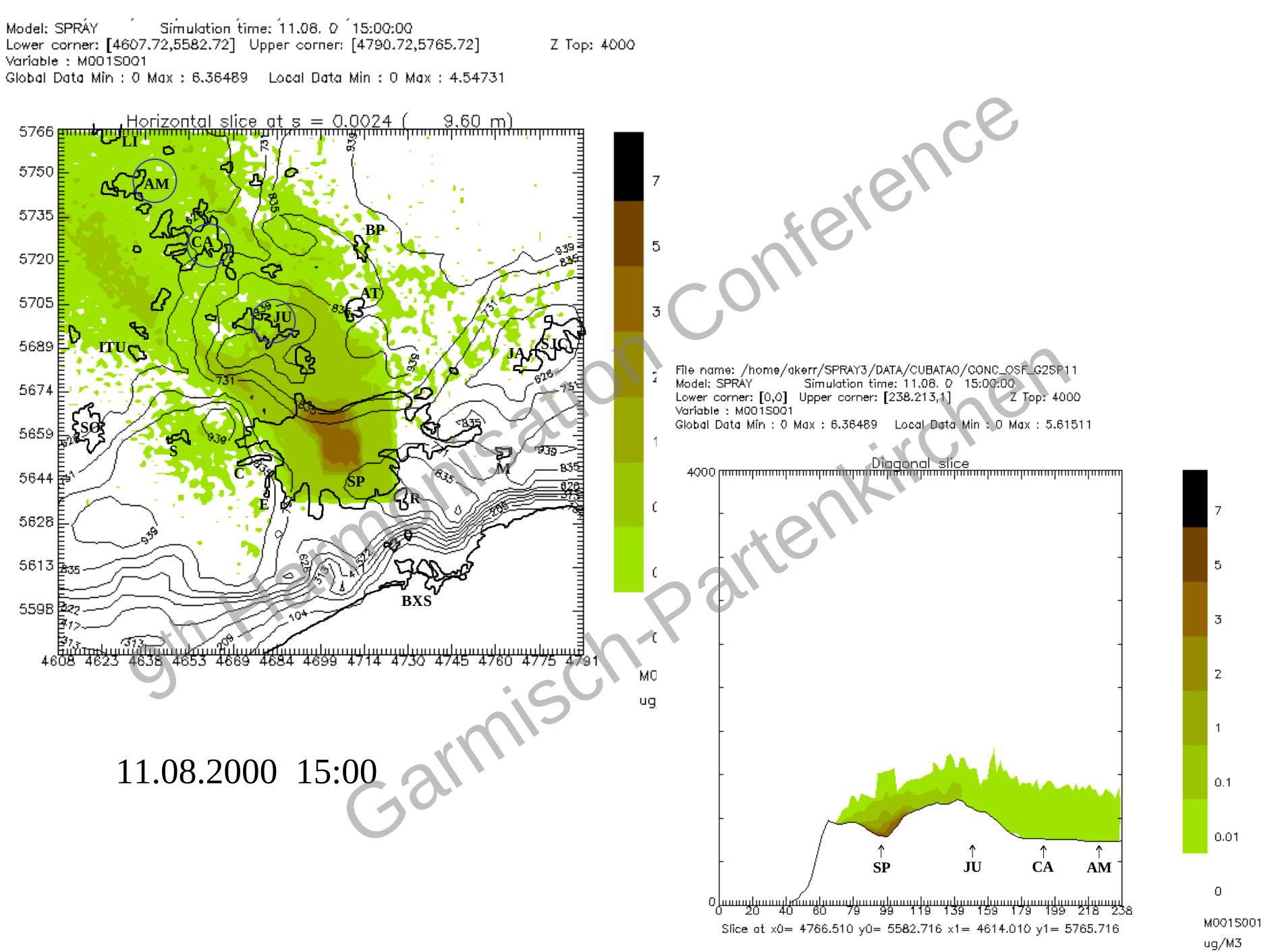
Wind rose at Pedro II (RMSP)



Wind rose at Paulinia



12.08.2000 00:00



11.08.2000 15:00

Model: SPRAY Simulation time: 11.08. 0 24:00:00
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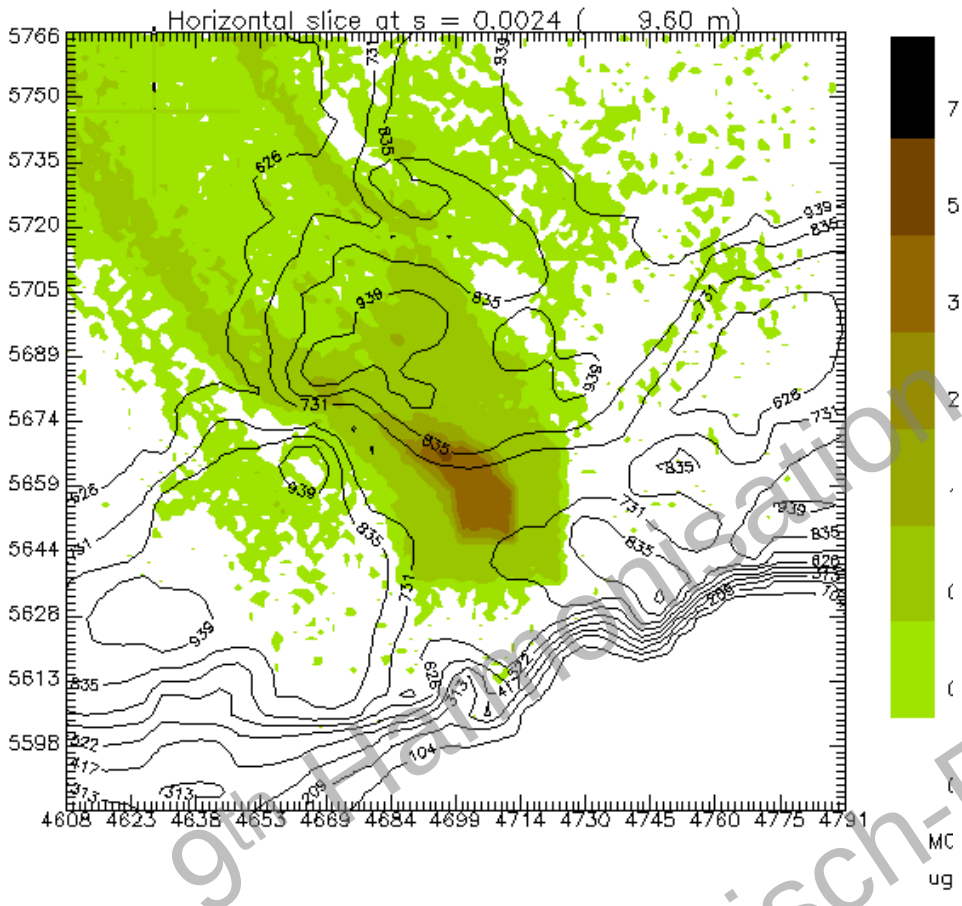

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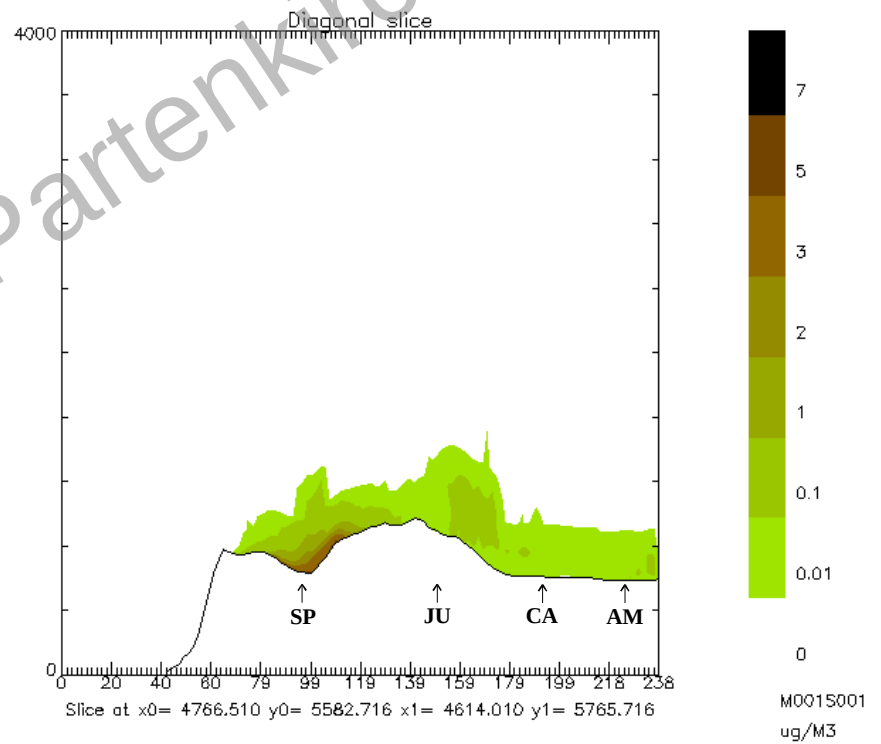

12.08.2000 00:00

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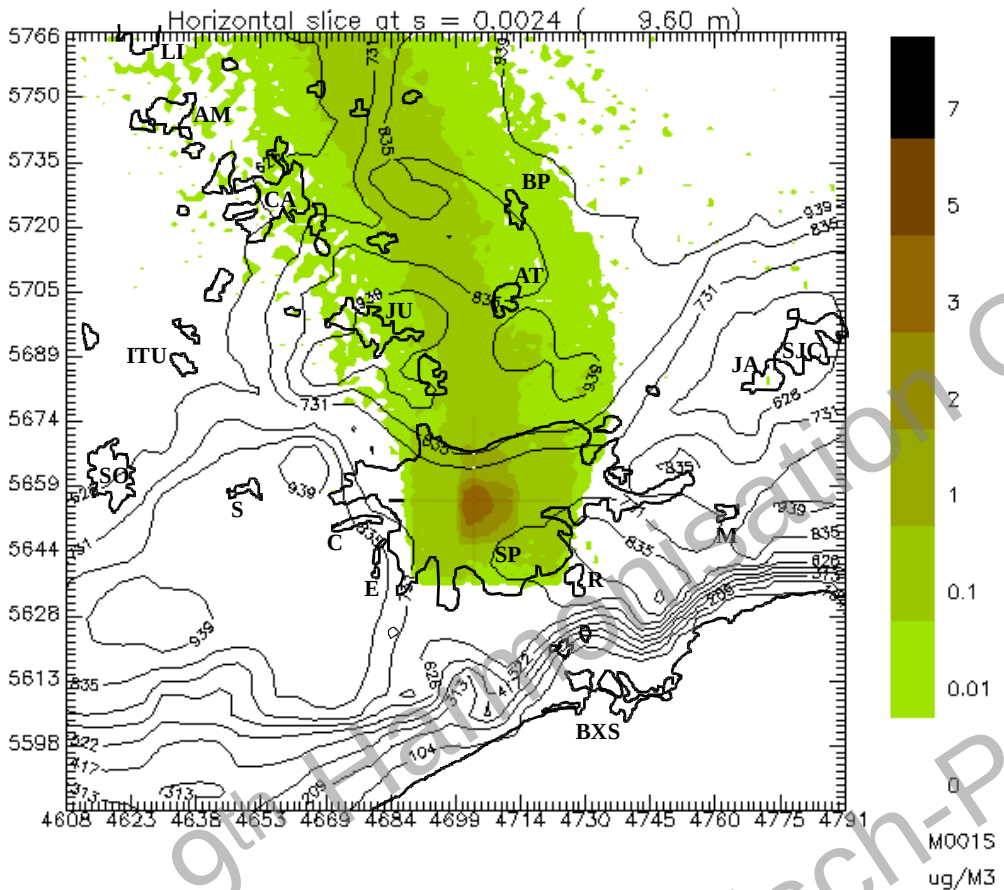

13.08.2000 03:00

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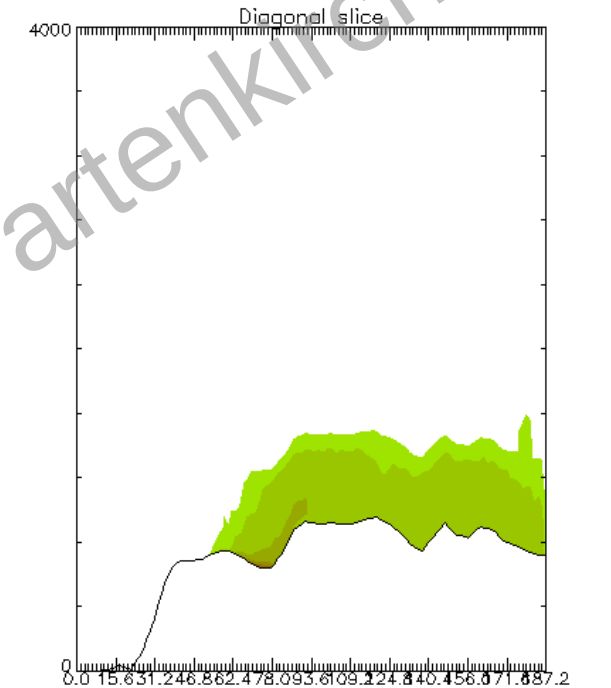

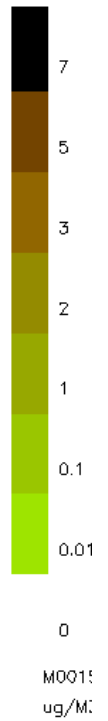

Table 2. Estimated Concentrations for CO

Date (UTC)	Time (UTC)	Time (Local)	Estimated Concentration (mg/m^3)			
			RMSP (SP-Maximum)	Jundiaí (JU)	Campinas (CA)	Americana (AM)
11/08/2000	15	12	6.36	0.04	0.04	0.014
	18	15	6.42	0.067	0.005	0.051
	21	18	7.71	0.04	0.06	0.060
	24	21	6.71	0.16	0.04	0.030
12/08/2000	03	00	6.61	0.12	0.058	0.080
	06	03	7.47	0.05	0.047	0.150
	09	06	6.41	0.34	0.12	0.280
	12	09	6.10	0.23	0.07	0.140
	15	12	6.24	0.039	0.0017	0.008

highest measured values 1 - 5.5 0.25 - 2.7

average " " 2.82 0.96

local emissions not considered

Thus, these preliminary simulated results are of the same order of magnitude of those measured, even if this simulation is only preliminary

Concluding remarks

The case study. Simulations of the dispersion of 4.44×10^{12} mg/day of CO emitted by the 6.5 million vehicles fleet, in the RMSP on 11, 12 and 13 august 2000, over an area of 184.5X184.5 km² around São Paulo mega-city.

General features and results. Most frequent wind direction in the period of simulation over São Paulo: SE wind → Jundiaí, Campinas and Americana layed along the central axis of dispersion receiving significant CO loads.
Simulated concentrations were higher at Jundiaí, followed by Americana: a topographic injection of airflow acted diluting the pollutant over Campinas, then slowing down before arriving to Americana.

The crop fields downstream the RMSP in the S and SE line are more intensely affected by the mega-city emissions.

The comparison between simulated CO concentrations and measurements available at São Paulo in field campaigns showed that our results are reliable.

Further developments and improvements: using a more refined land-use definition, increasing the spatial resolution of the CO source and the time dependence of the source emissions.