A research plan for a new environmental chamber facility

Combined US/German Ozone/Fine Particle Science and Environemtal Chamber Workshop

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Background

Mexico's rapid economic growth, combined with modernization and industrialization has intensified the city's air pollution problem

Actions the government has taken to reverse the degradation of the atmosphere have included

- Improving the quality of fuels
- Restructure public transportation and vehicular emission control
- Modernize production methods
- Emission control from industry services and power plants
- Reforestation of the Mexico City basin
- Research, education, and communication

Despite stringent government measures to reverse the trend the air pollution problem is still persistent

Mexico City Standpoint

Why is air pollution more complex than originally thought?

- More than ½ of Mexico's industry is located in an urban area of 1,050 km^2
- More than *1/5* of the nation's population resides in the Mexico City basin driving 3/5 the national's automobile fleet
- The city dwellers consume 150 times the national average for energy per unit area

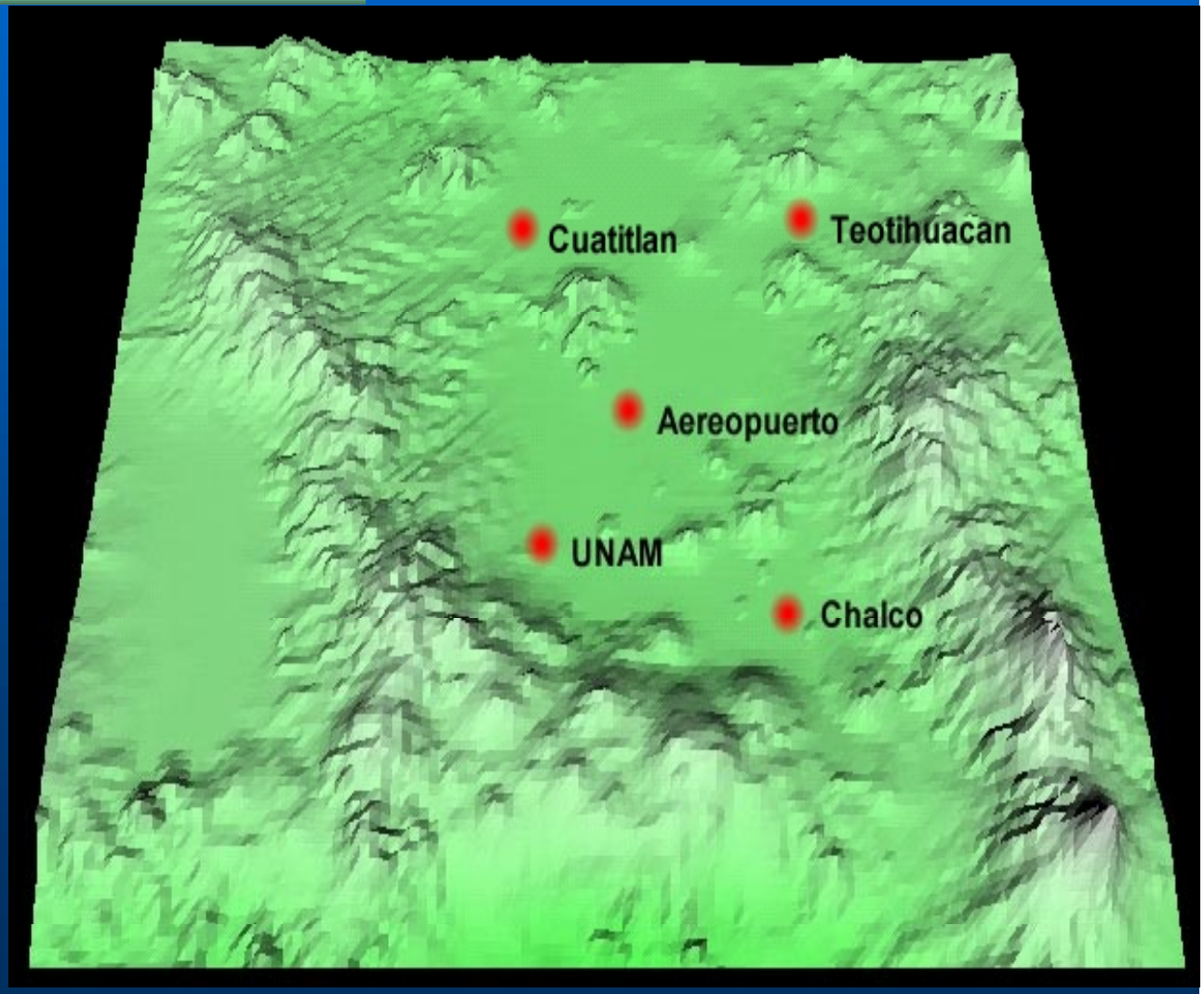
What factors exacerbate Mexico City environmental problem?

- The Valley of Mexico basin lies at a tropical latitude of 19^o N and an altitude of more than 2,200 meters with 25% thinner air than at low altitude
- The city is nearly surrounded by mountains reaching 1200 meters and more above the city

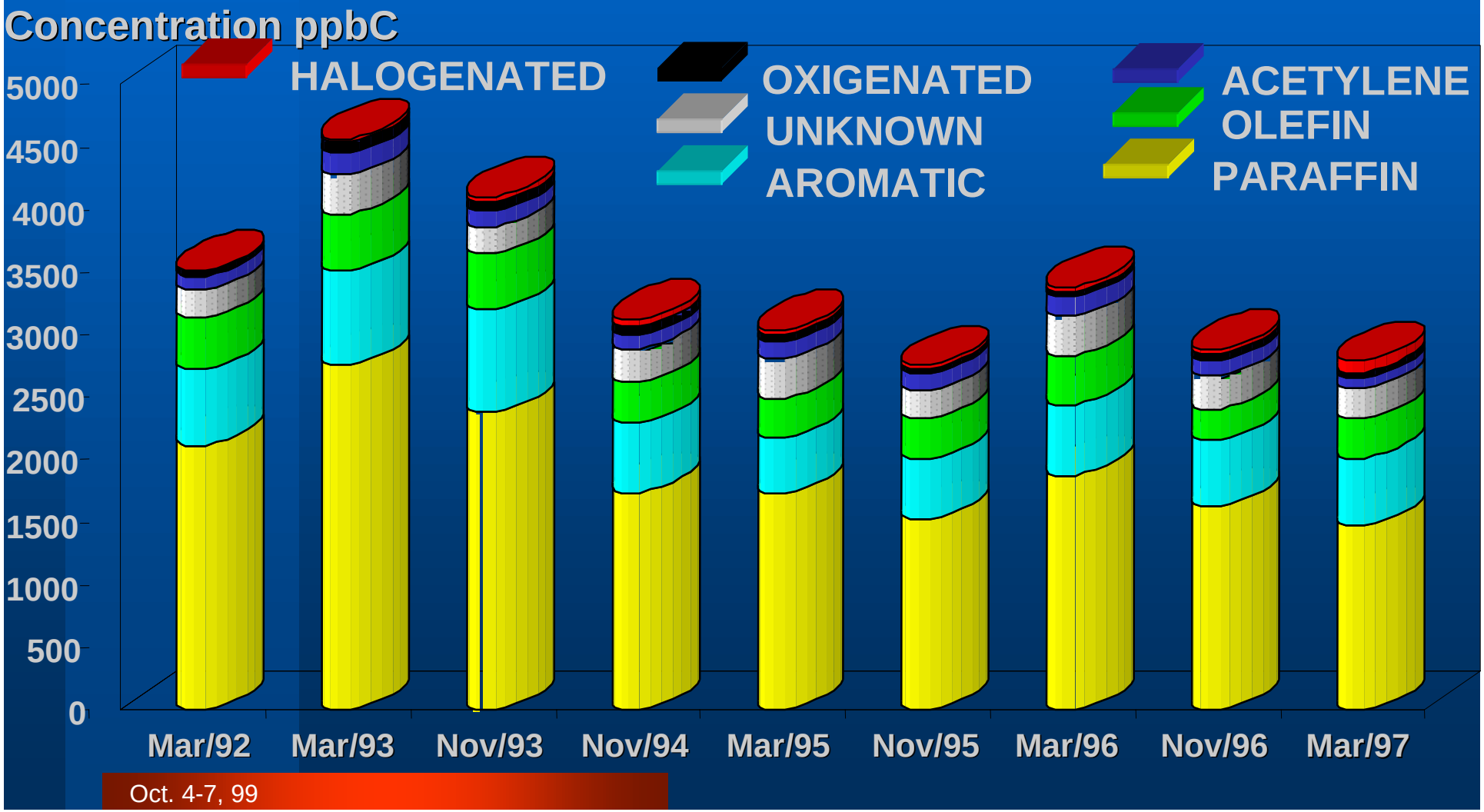
The combined human activity with geography gives rise to ozone concentrations that exceed air quality standards in Mexico City more than 300 days per year

The Mexico City Basin

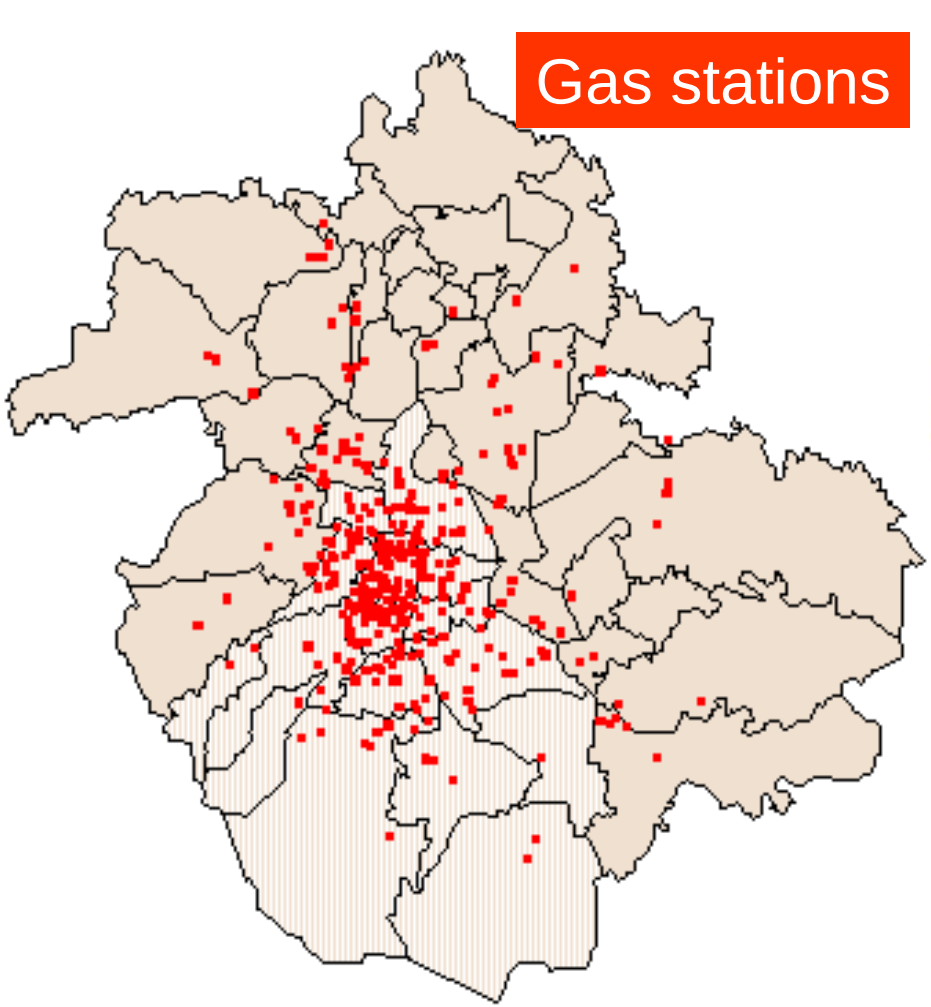
* Altitude 2240 m
* Latitude 19 °N
* City area ≅ 1000 km2
* 18 million inhabitants
* 3’500,000 vehicles
* 300,000 industrial facilities
* Transportation represents 75% of total emissions

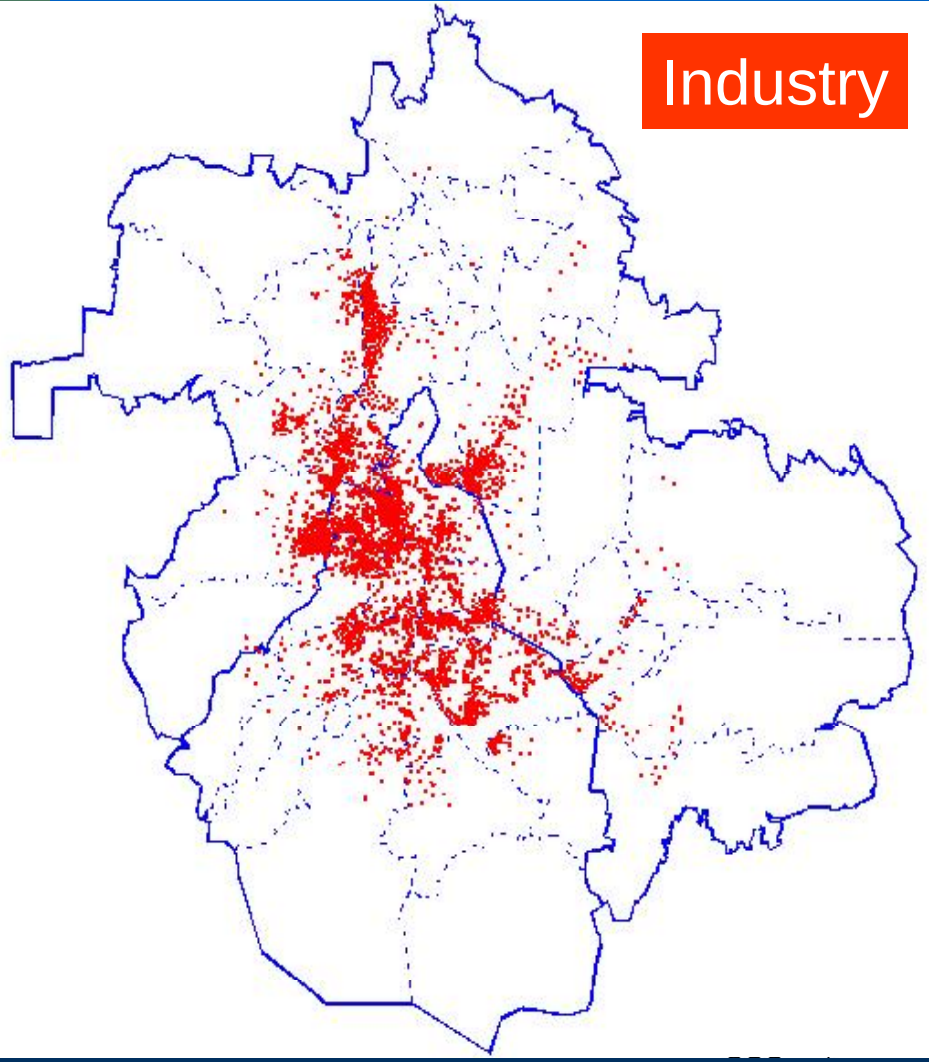


MCMA VOC for the 1992-1997 period



Georeferenced Stationary Source Emissions





A proposed alternative

Based on environmental considerations a new energy policy that promotes the use of Natural GAS (NG) as substitute of heavy fuel oil in the electric and industrial sector, gasoline and diesel in transportation, and as supplement to LPG in the residential sector is to come into effect in the near future

The introduction of NG into the MCMA as a major source of fossil fuel energy is expected to have a significant impact on the atmosphere due to:

- An atmospheric profile emission change as a result of the projected consumption of NG in the city including its distribution and transportation
- Modified green house emissions along with potential fugitive emissions of NG

Objective

To acquire scientific knowledge by devising scientific methodologies and experimental techniques to assess the still prevalent high concentrations of fine particles and ozone formation in the MCMA

The project is formulated under a modular structure with interconnections among the modules that integrate the network :

- To use the latest technology that´s available to create a new environmental chamber facility
- To collaborate with international researches in order to develop and apply state-of-the-art tools to better characterize the ozone forming potential
- To improve the quality of the emission inventory
- To develop tools to assist decision makers in evaluating air quality improvement strategies

Module I: Emission Inventory

Major Activities:

- ✓ Measument of emission factors of the most significant emission sources
- ✓ Improvement of an existing emission inventory for hydrocarbons and fine particles
- ✓ Selection of a regional domain to include forested areas, agricultural activities and metropolitan areas outside the Mexico City basin that are located within a radious of approximately 200 km
- ✓ Receptor models to determine the origin and distribution of particles, volatile organic compounds (VOC)
- ✓ Receptor models to aid in both the identification of new sources and finding the relative contributions of the different VOC into the airshed of these sources

Module II: Transport and formation of ozone and fine particles (1)

Methodology:

A two-step approach is proposed to carry out the objectives of Module II

Step 1 (Experimental phase):

- ✓ To study the chemical basis for ozone and aerosol formation, and apply a methodology for quantifying differences among the most important VOCs and their impacts on ozone and secondary particles
- ✓ Evaluation of atmospheric impacts of vehicle emissions
  - ➢ Development of a reactivity scale (or multiple scales) that reflects primarily the effect of the VOC on ozone formation rates for Mexico City
  - ➢ Assessment of the uncertainty range of the reactivity scales
- ✓ To provide the necessary data to develop and test chemical mechanisms for those VOC's that might have the largest impact for NOx-limited atmospheres such as Mexico City
- ✓ Identification of the reaction paths in which ozone precursors participate in the formation of secondary organic particles from condensation of low vapor pressure compounds

Module II: Transport and formation of ozone and fine particles (2)

Step 2 (Modeling and simulation):

- ✓ Prediction of both the main features of synoptic flow patterns and the interaction of surface winds with vertical winds in a region of complex terrain (RAMS & MM5)
- ✓ Incorporation of developed chemical mechanisms of phase 1 into an Eulerian airshed model that can be used for regulatory purposes and as a tool for assessing reactivity (ozone impacts of VOCs)
  - ➵ and assessing realistic representation of scenarios for new fuels or vehicle technology
- ✓ Prediction of the effects transport and formation of ozone and aerosols, by time of day and area of the city, that implementing various strategies would have on air pollution

Módulo III: Control strategies and technical options

Major activities:

Modules I and II provide input to feed Module III

- ✓ Evaluation of effects of changing fuel and vehicle technology on ground-level ozone impacts
  - ➢ Conducting scenario-specific assessments
  - ➢ Developing general VOC reactivity scales
- ✓ Implementation of control strategies to reduce the concentrations of the damaging photo-oxidant pollutants and aerosols during episodes to the critical levels, and use these strategies to keep them under control under the acceptable levels

Cost optimization of energy systems as a function of technological options and emission restriction, and feasibility of futures demands (NG and LPG).

- ✓ Technical and economical evaluation of environmental impacts associated to distribution and usage of NG and LPG
- ✓ Abatement of the ozone and secondary particle concentrations to the acceptable levels at as a low price as possible

Final comments

- The IMP researchers are seeking to achieve a better understanding of Mexico City meteorology, air pollution, and atmospheric dynamics by
  - Using advanced meteorology prediction models featuring non-hydrostatics dynamics, four-dimensional data assimilation and nested grids
  - by a joint effort between international and Mexican scientists conducting experiments with new methods and techniques on environmental chambers
    - and establishing uncertainties of multiple reactivity scales which are more valuable to decision-makers,
  - by developing more accurate reaction mechanism for airshed models with laboratory and environmental chamber data
    - and determining the extent to which their use gives different impact answers,
  - by implementing atmospheric control measures that efficiently reduce the rampant air pollution in the MCMA, which has become a high priority