

“JICA Clean City Initiative (JCCI) International Seminar”

2023/2/2 11:00–12:30

Science and Technology in Japan and International Cooperation

12:20~11:50

**From the experience of the International Joint Research on Atmospheric Environment
(SARTEPS) between Japan and Mexico**

**Representative Director,
Institute of Integrated Atmospheric Environment (IIAE)
Professor Emeritus, Ehime University**

Shinji Wakamatsu

Based on the experience of the International Joint Research on atmospheric environment quality (SARTEPS) between Japan and Mexico, case studies of science and technology in Japan and international cooperation will be introduced.

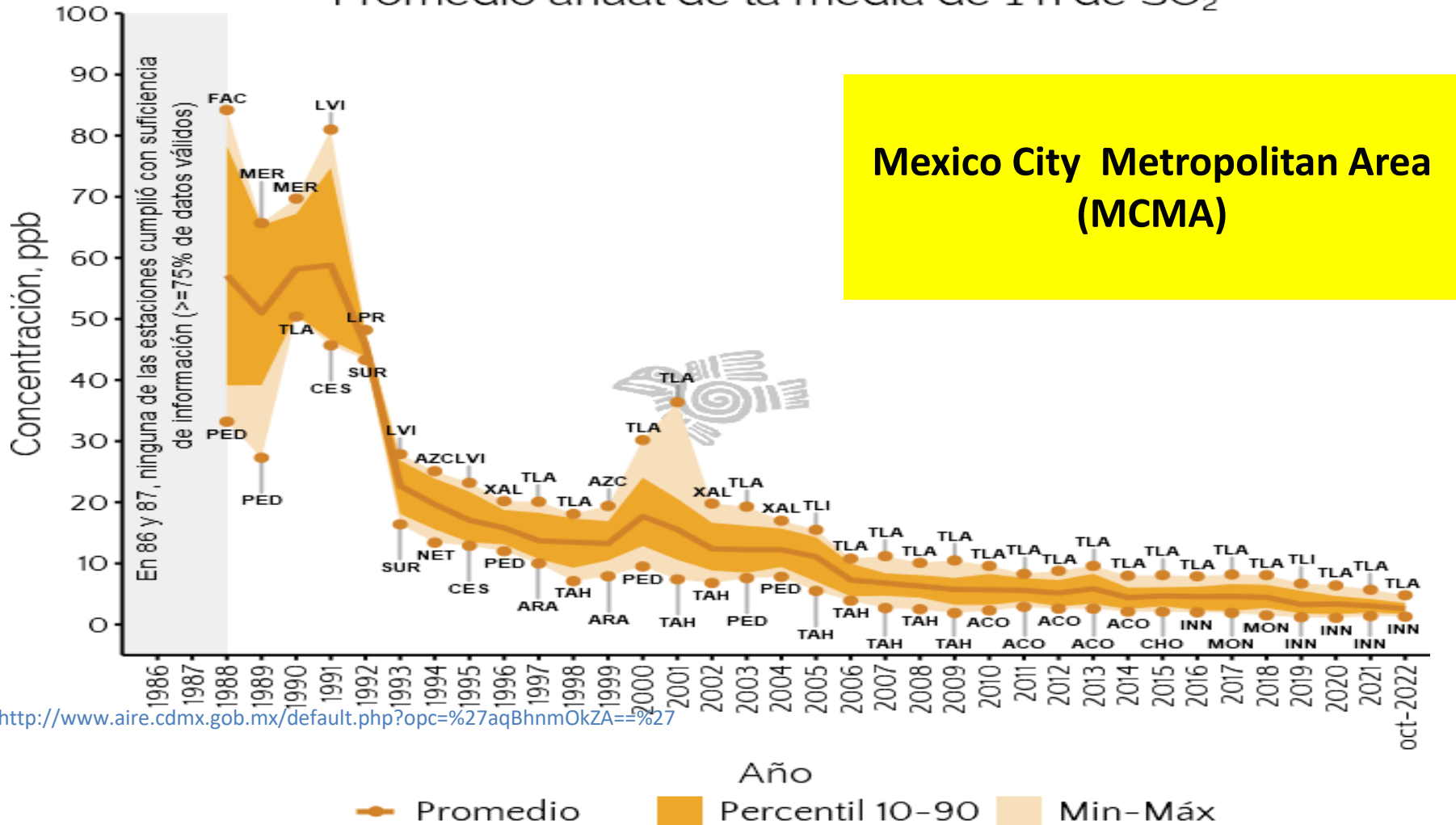


**Por solicitud de la Agencia de Cooperación
Internacional del Japón (JICA).**

13 de enero del 2023

SO₂ - 1h mean annual average

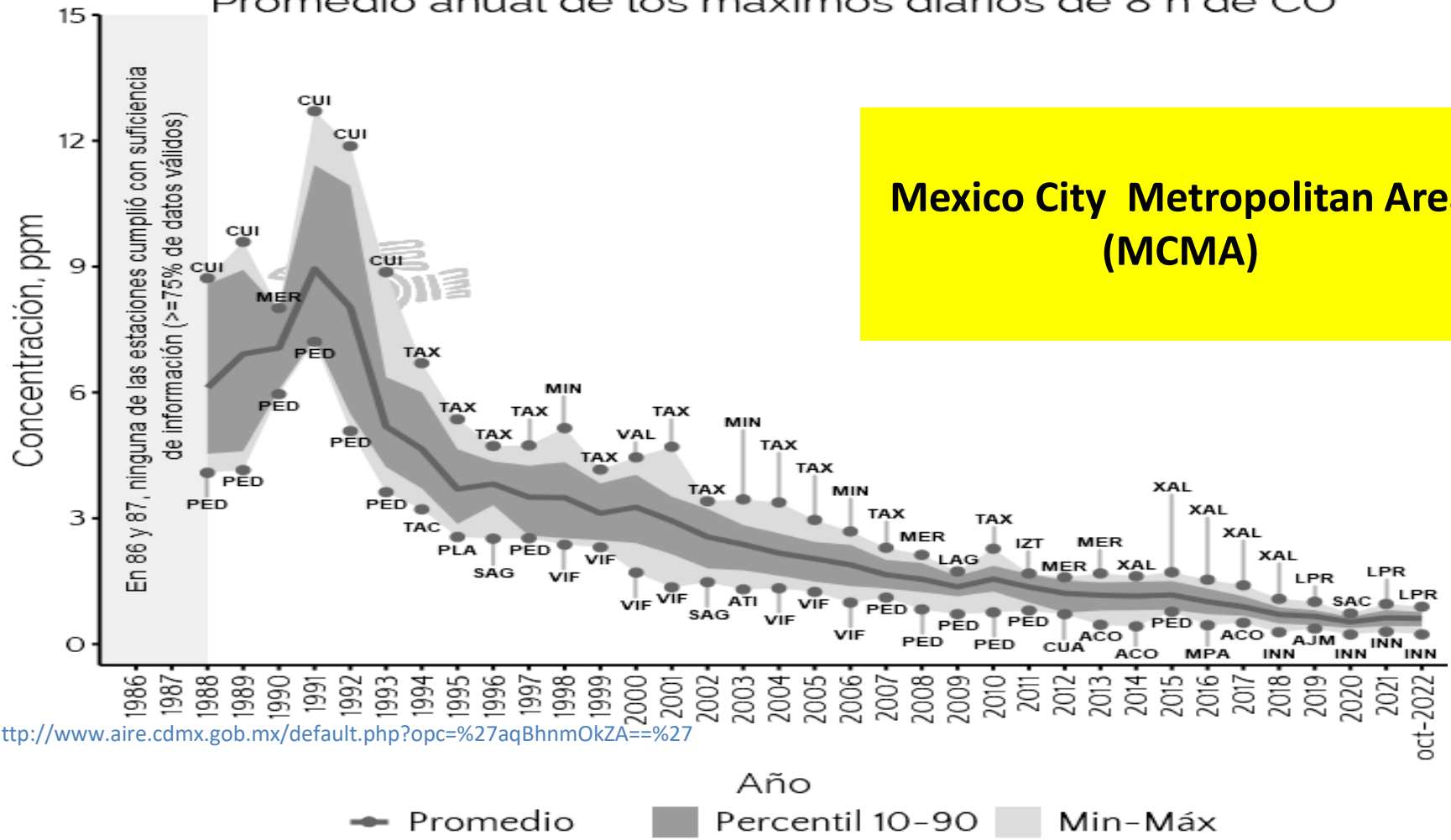
Promedio anual de la media de 1 h de SO₂



<http://www.aire.cdmx.gob.mx/default.php?opc=%27aqBhnmOkZA==%27>

CO - Annual average of the 8 h daily maximum

Promedio anual de los máximos diarios de 8 h de CO



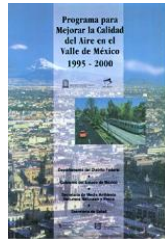
<http://www.aire.cdmx.gob.mx/default.php?opc=%27aqBhnmOkZA==%27>

Air pollution-abatement measures in Mexico

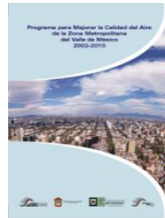
1980
1982: Federal Law of Environmental Protection

1988: General Law of Ecological Equilibrium and Environmental Protection

1990
PICCA 1990-1995*
1994 NAFTA (NAAEC)**
PROAIRE 1995-2000



2000
2000 SEMARNAT
PROAIRE 2002-2010



2010
PROAIRE 2011-2020



Supporting project from Japan to Mexico

1986 – 1988: Development survey on measures of Air pollution in Mexico City (JICA)

1990 – 1992: Development survey on air pollution controlling plan from stationary sources (JICA)

1993 – 1995: Development survey on introduction of combustion controlling technology related to air pollution abatement measures in Mexico. (JICA)

1995 – 2002 : CENICA Project / Phase I, Phase II / (JICA)

1996, 1997: Study on photochemical air pollution formation mechanism (Individually important international joint research between two countries) Leader: Shinji Wakamatsu (JST/NIES)

2005 – 2008: Supporting project for strengthening nation wide air pollution monitoring system (JICA)

2011 – 2015: Formation mechanism of Ozone , VOCs, and PM2.5 and countermeasure scenarios

Leader: Shinji Wakamatsu (JST-JICA/Ehime University)
SATREPS Project

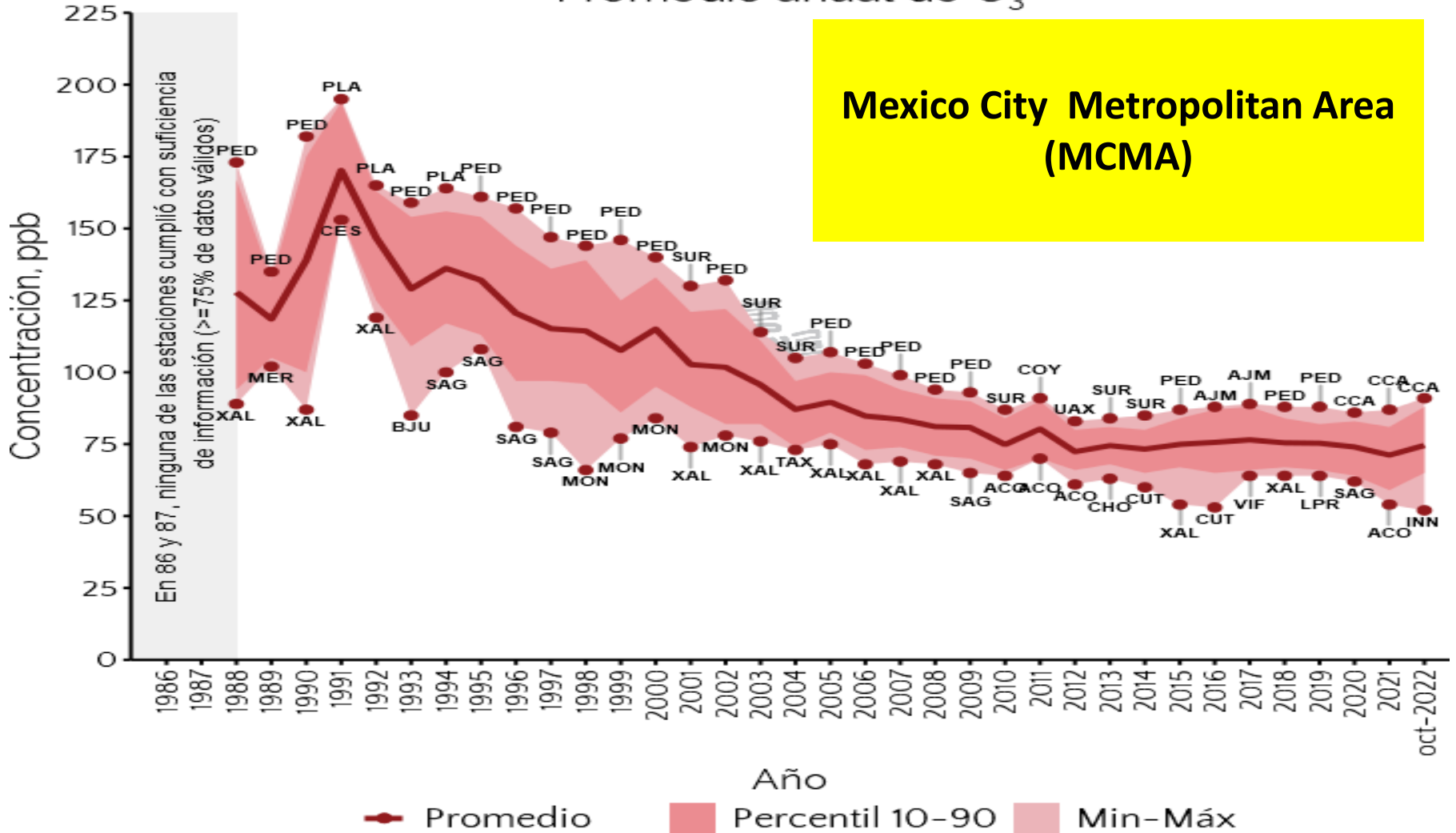
*Comprehensive Program Against Air Pollution ,Mexico City's official air pollution control plan for 1990-1995

** North American Agreement on Environmental Cooperation

O₃ - annual average

Promedio anual de O₃

Mexico City Metropolitan Area (MCMA)



Mexico City Metropolitan Area (MCMA)

Guadalajara Metropolitan Area (GMA)

Monterrey Metropolitan Area (MMA)

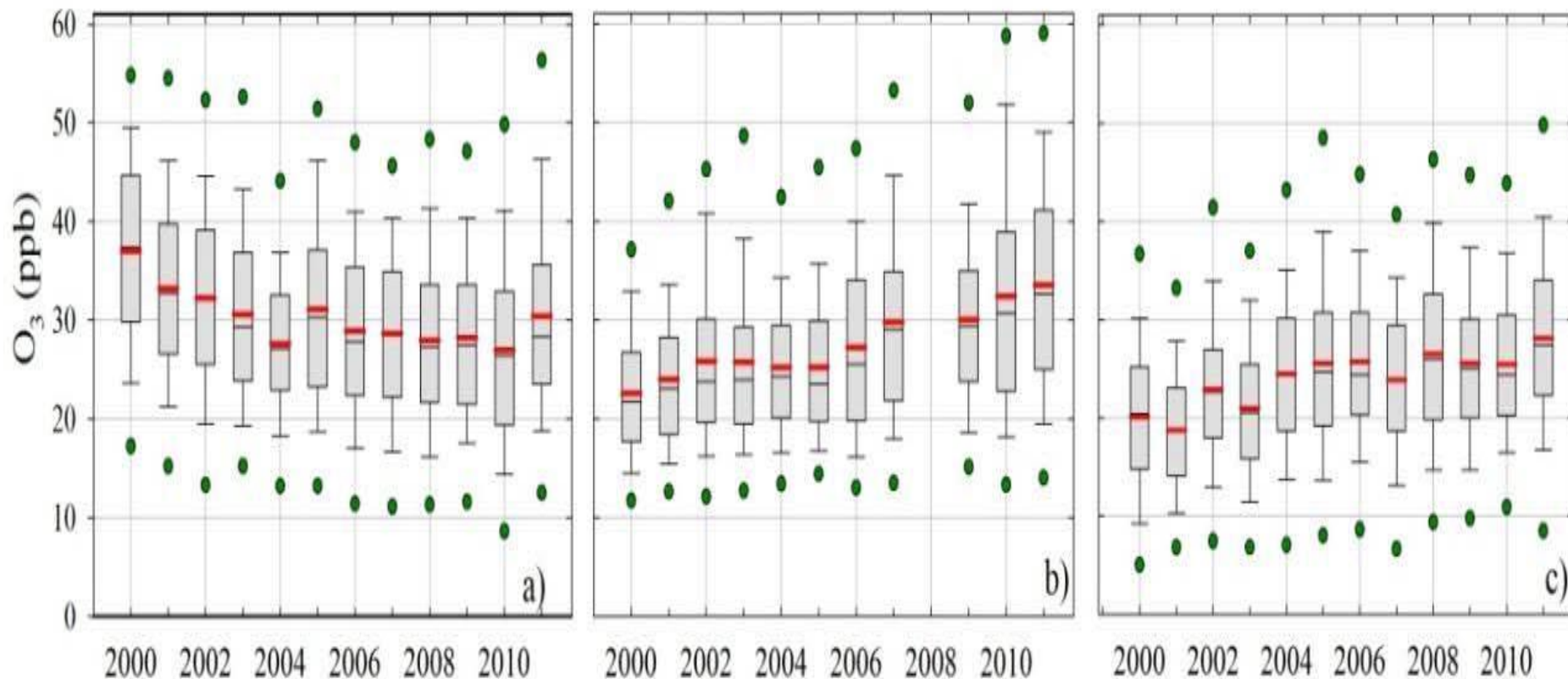


Fig. , Trends of annual statistics of O₃ concentration in (a) MCMA, (b)GMA, and (c) MMA.

The panels show the annual mean (thick line), median(thin line), 2nd and 98th percentiles (green circles), 10th and 90th percentiles (whiskers), and 25th and 75th percentiles (gray boxes) of the daily averaged concentrations (Benitez-Garcia 2015).



"International Science and Technology Cooperation for Global Issues"

SATREPS

Environment and Energy (Environmental Field)

International joint research project with Mexico

"Elucidation of Ozone, VOCs, and PM2.5 Formation Mechanisms and Proposal of Countermeasure Scenarios"

Five years joint research, 2011~2015

**Mexican Environment and Climate Change Agency
INECC(National Institute of Ecology and Climate Change)**



(Originally INE: Mexican National Center for Environmental Research and Training (CENICA))

**National University Corporation , Ehime University
Laboratory of Atmospheric Environmental Science**



AESRL (Atmospheric Environmental Sciences Research Laboratory)

- June 1, 2010~ Signed interim JST contract
- RD signed on September 6, 2010
- November 4, 2010: JICA contract signed
- Signed MOU on December 17, 2010



SATREPS 『地球規模課題対応国際科学技術協力』
キックオフ・公開シンポジウム
『オゾン、VOCs、PM_{2.5}生成機構の解明と
対策シナリオ提言共同研究プロジェクト』

SATREPS "Science and technology research partnership for sustainable development"
"on mechanism of ozone, VOCs and PM_{2.5} and proposal of countermeasure scenarios"

SATREPS (地球規模課題対応国際科学技術協力)
~ジョイント国際セミナー~
主催: 愛媛大学 共催: 国立環境研究所
メキシコ・中国・日本における
光化学オゾン、VOC、PM_{2.5}の生成機構解明研究
Joint Seminar on Formation Mechanism of Photochemical Ozone,
VOCs and PM_{2.5} in Mexico, China and Japan.

2011-4-21
13:30 受付開始
14:00~14:05 開会
14:05~14:10 挨拶
愛媛大学長 柳澤康信
第一部
14:10~14:20 JSTからの説明
科学技術振興機構(JST)国際科学技術部
高橋昭男
14:20~14:30 JICAからの説明
国際協力機構(JICA)地球環境部 今吉萌子
特別講演
14:30~15:30
『日本のODA、技術支援から
技術交流・共同研究へ』
国際協力専門員 山本敬子

日時: 2012年3月26日(月) 午後1時~5時
Date/Time: 26 March 2012, 1 pm ~ 5 pm
* 場所: 愛媛大学 城北キャンパス 校友会館2階サロ
Venue: Ehime University Alumni Association Hall 2F salon
* 形式: 公開 Open to public
* 用語: 英語 Official language: English

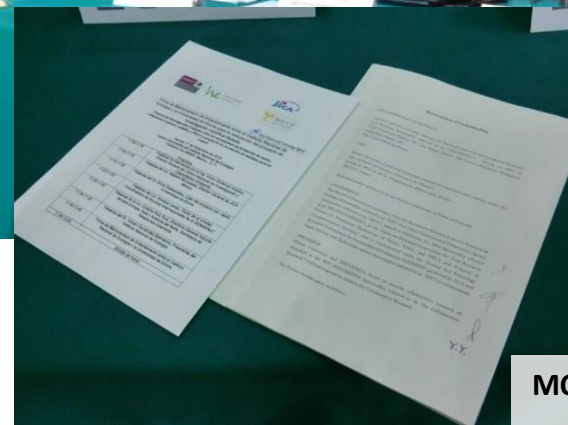
プログラム Program
13:00-13:15 開会: 主旨説明 愛媛大学 若松伸司
Opening remarks Shinji Wakamatsu (Ehime University)
13:15-13:30 SATREPS研究プロジェクトについて 高橋昭男(科学技術振興機構(JST)国際科学技術部)
Outline of JST research project Akiyo Takahashi (JST)
13:30-15:10(100 min) 第一部 地球規模課題対応国際科学技術協力 (SATREPS) ・メキシコとの共同研究
Part I SATREPS (Science and Technology Research Partnership for Sustainable Development)
議長: 愛媛大学 若松伸司 Chair: Shinji Wakamatsu (Ehime University)
メキシコの大気汚染状況: CENICA大気部門部長 アマリス カルデナス
Current Situation of Air Pollution in Mexico and VOC Research in CENICA
Beatriz Cárdenas (National Center for Environmental Research and Training)
メキシコ市における大気汚染状況: メキシコ市(GDF)大気モニタリング部部長 アルマンド レタマ
Current Situation of Air Pollution in DF and VOC monitoring: Armando Retama (Government of Federal District Mexico city)
メキシコと日本における粒子(PM)観測連携: 大阪府立大学 溝畑部
Observation of particulate matter in Mexico and Japan: Akira Mizohata (Osaka Prefecture University)
メキシコにおける気象観測状況: SMN(メキシコ気象局)上空大気測定チーム監督 ビクトール ラモス
Current Situation of Meteorological Observation Technique in Mexico and Japan: Isao Kanda (Ehime University)

15:10-15:30(20 min) 休憩と意見交換(ポスター発表)
15:30-17:10(100 min) 第二部 NSFC-JST 環境協働国際科学
アジアオゾンセンターとオゾンとPM_{2.5}との
Part II NSFC-JST Major Internati
Study on Formation Mechanism of Ozone a
議長: 国立環境研究所 大原利真 C
2010年6月の北京観測キャンペーンの解説: 清華大学 許
Analysis of Beijing field campaign in June 2010: Jingyu Xu (Tsinghua
北京と東京における微小粒子の¹⁴C測定: 国立環境研究所
Radiocarbon (¹⁴C) measurements in fine particles at Beijing and To
東京におけるECとOCの発生源別組成-観測とシミュ
Source apportionment of EC and OC in Tokyo and Beijing: Compar
Yu Mino (National Institute for Environmental Studies, Japan)
北京におけるオゾンとPM_{2.5}汚染の数値解析: 清華大学 許
Numerical analysis of ozone and PM_{2.5} pollution in Beijing: Bin Zh
北京の大気質改善のための高濃度PM_{2.5}条件下での光化学反応に
金属ナノ粒子触媒を用いた高濃度PM_{2.5}の光化学反応への影響: 清
Study of photochemical reaction under high PM_{2.5} concentration to im
Effects of metallic sulfate seeded aerosols on photochemical reacti

第55回大気環境学会年会併催公開国際シンポジウム
The 55th Annual Meeting of Japan Society for Atmospheric Environment
Open International Symposium
『オゾン、VOC、PM_{2.5}の生成機構解明と
対策シナリオ』
Formation Mechanism of Ozone, VOCs,
and PM_{2.5}, and Countermeasure Scenarios

日時: 2014年9月18日(木)15時50分~18時00分
受付開始 15時00分~
場所: 愛媛大学城北キャンパス 南加記念ホール
講演言語: 英語(英日同時通訳)
Date/Time: 18 September 2014 / 15:50~18:00
Doors open at 15:00
Venue: Ehime University, Nanka Memorial Hall
Official Language: English

プログラム Program
産長: 大原 利真(国立環境研究所)、神田 勲(愛媛大学)
Chairs: Toshimasa Ohara (National Institute for Environmental Studies)
Isao Kanda (Ehime University)
15:50 - 開会挨拶 若松 伸司(愛媛大学)
Opening Remark Shinji Wakamatsu (Ehime University)
16:00 - ビクトル・パラモ 博士(メキシコ、国立環境気候変動局)、SATREPS(JST/JICA)
Dr. Victor Paramo
(Mexico, National Institute of Ecology and Climate Change), SATREPS(JST/JICA)
『メキシコにおけるオゾン、VOC、PM_{2.5}の生成機構解明と対策シナリオ』



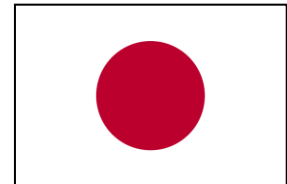
MOU signature

- April 21, 2011 Ehime University Kick-off Symposium
- March 26/29, 2012 Ehime University/AIST International Symposium (Tsinghua University, China, CENICA, Mexico)
- September 18, 2014 Ehime University The 55th Annual Meeting of the Japan Society for Atmospheric Environment International Symposium (Japan, Korea, China, Mexico)
- November 2015 ASAAQ13 Kobe (3SATREPS)
- February 20, 2016 SATREPS Joint Workshop 21st SATREPS Joint Symposium

Research Objectives

To elucidate the dynamics of photochemical ozone and atmospheric particulates, mainly in Japan and Mexico, and to understand the common aspects and region-specific characteristics between the two countries.

Based on this, we will clarify the production mechanism of Ozone, VOC (volatile organic compound), and PM2.5 (particles with a particle diameter of 2.5 microns or less) in Mexico. We will comprehensively analyze and evaluate the results obtained from monitoring and modeling and human exposure evaluation data, and propose scenarios for Co-benefit air pollution control in model cities and model areas to the Mexican Ministry of the Environment and local governments.



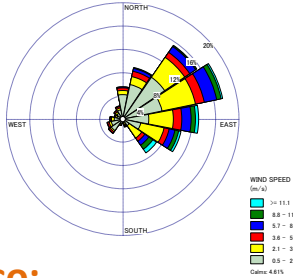
Capacity to study formation mechanism of Ozone, VOCs, and PM2.5 and to develop proposal of co-benefits countermeasure scenario based on key scientific findings are enhanced.

Mexico City is considered as a megacity due to its high population density, whereas Guadalajara and Monterrey are considered urban areas.

Monterrey, Nuevo Leon

25° 40'17" N 100°18'31"W

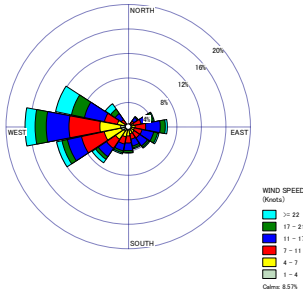
500 m



Guadalajara, Jalisco:

20° 40'35" N 103°20'32"W

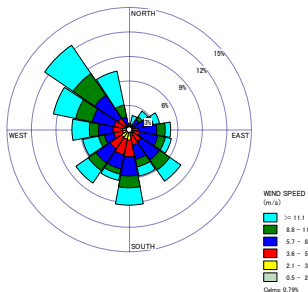
1540 m

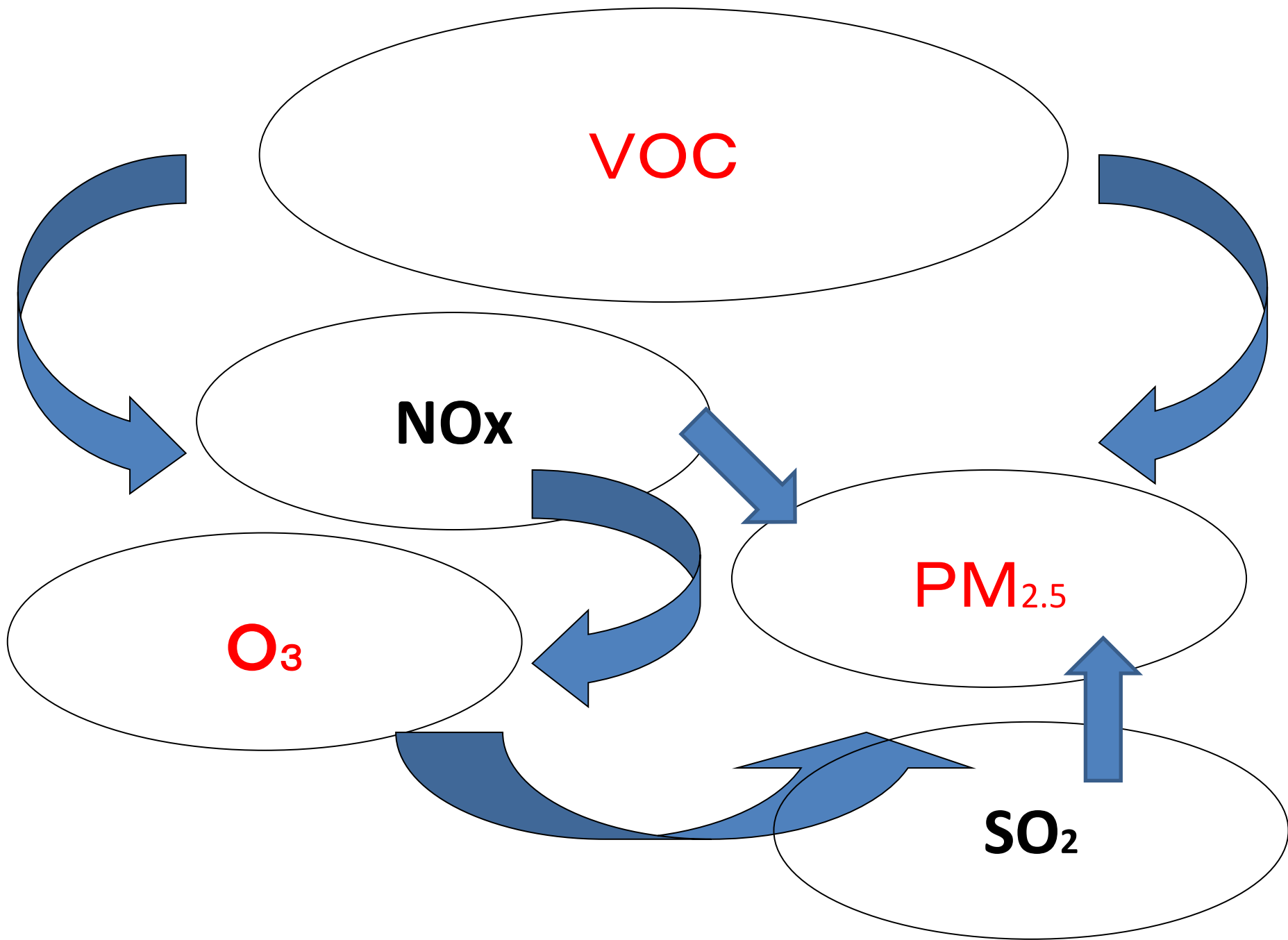


Mexico City

19° 29'52" N 99°7'37"W

2240 m





VOC

NOx

O₃

PM_{2.5}

SO₂

WG1 (O₃)

WG3 (PM_{2.5})

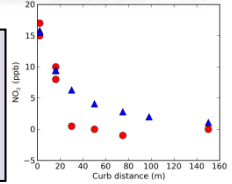
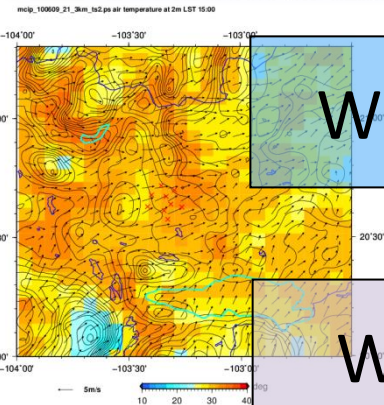
WG2 (VOCs)

WG4
(Personal Exposure,
Roadside Air Pollution)

WG5 (Monitoring, Emission, Modeling)

WG6 (Co-beneficial Countermeasures)

< roadside-urban-regional-global >



WG1 Ozone Research

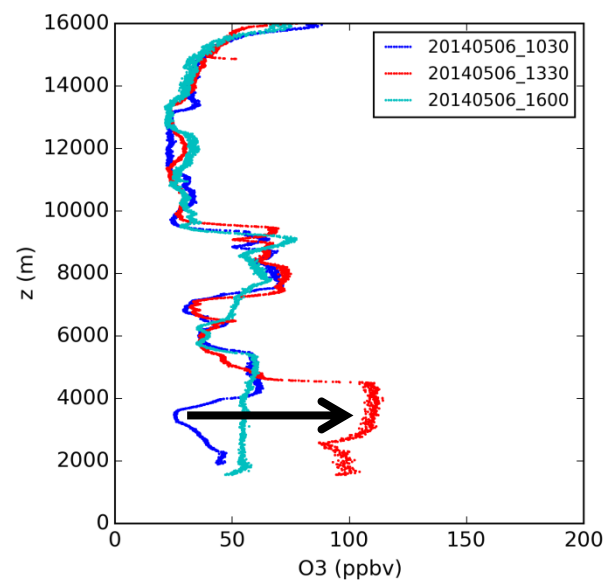
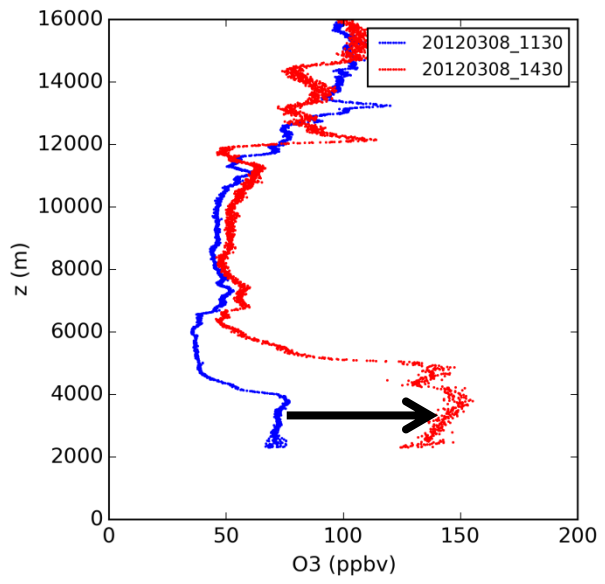
Understanding the three-dimensional distribution of ozone and weather from the ground to an altitude of 10 km or more

Ozone sonde observation

Mexico City (SMN) 6 + 12 launches



Guadalajara (SMN) 5 + 9 launches



Sonde observation

Mexico City, Meteorological Department rooftop



Guadalajara Meteorological Bureau



Simultaneous comparative observations

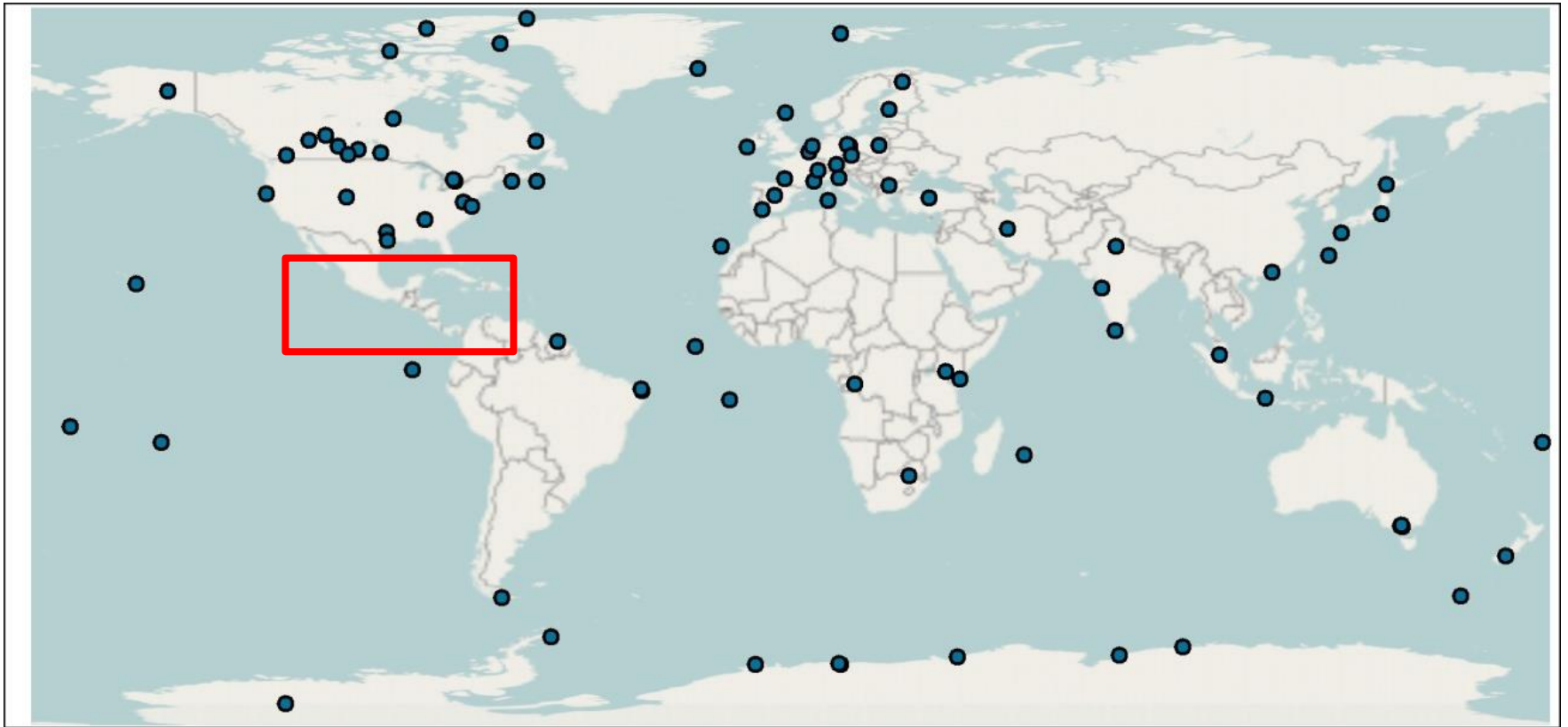


Mexican Meteorological Office



Preparation of observation manuals
in English and Spanish

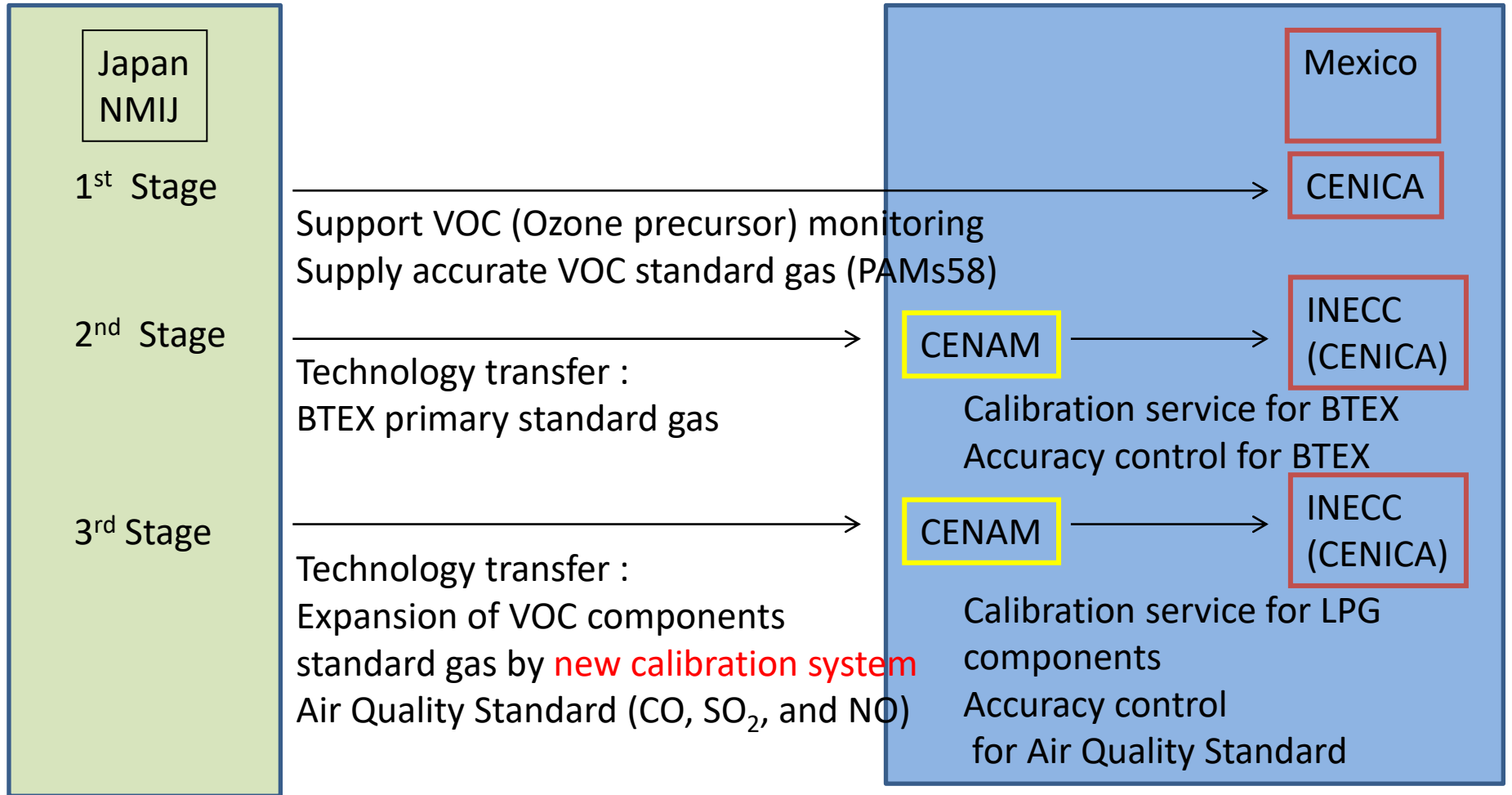
Central America is a blank zone for ozone sonde observation



Ozone Sonde Stations where data have been reported to the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) since 2010-1-1 or more for more than 2 years

Application to the World Bank for Periodic Observations

Check standard gas supply and quality control in Mexico through VOC monitoring
Realizing the need for unified quality control, including environmental standard items
Technology transfer to CENAM and proposal to build the same system
as CENICA-INECC cooperation between U.S. EPA-NIST
Technology transfer to CENAM for autonomous and sustainable development
after completion of the project (including new systems)



New calibration system : GC-FID system

Informe de Análisis

MEZCLA DE GASES DE CALIBRACIÓN DE BTEX EN NITRÓGENO

Clave única de identificación del Informe de Análisis: CNM-IA-630-001/2014
 No. de Servicio: 630-141068
 Nombre del cliente: Instituto Nacional de Ecología y Cambio Climático
 Dirección del cliente: Av. San Rafael Atlixco No. 186 Col. Vicentina, C.P. 09340, Iztapalapa, México, D.F.

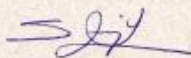
Analito	Número CAS	Fración de cantidad de sustancia $\mu\text{mol/mol}$		Incertidumbre Expandida $\mu\text{mol/mol}$
Benceno	71-43-2	1.028	±	0.013
Tolueno	108-88-3	1.031	±	0.012
Etilbenceno	100-41-4	0.9943	±	0.0094
o-Xileno	95-47-6	0.980	±	0.010
m-Xileno	108-38-3	1.0079	±	0.0081
p-Xileno	106-42-3	0.980	±	0.010

Emitido por:



Q.F.B. Francisco Rangel Murillo
Metrólogo

Aprobado por:



Q. en A. Guadalupe Judith Sáinz Uribe
Coordinador Científico

Calibration certificate issued by CENAM (copy)

Technical training at Japan launched a proofreading service. After returning to Japan,

*Equivalent to JCSS standard gas in Japan

The following is the expansion uncertainty of JCSS standard gas

Benzene: 1.0%

Toluene: 1.0%

o-Xylene: 1.5%

m-Xylene: 2.0%

Ethylbenzene: 2.0%

Note: JCSS standard gas does not contain p-xylene

Table 1 Major PM_{2.5} mass composition contribution in the atmosphere of the metropolis in Mexico (ug/m³)

Site	PM _{2.5}	POM	EC	(NH ₄) ₂ SO ₄	NH ₄ NO ₃	Crustal	Biomass	NH ₄ Cl	Sea salt
: MexicoCity	41.2	13.4 (33 %)	5.2 (13 %)	6.9 (17 %)	3.0 (7 %)	11.5 (28 %)	0.5 (1 %)	0.3 (1 %)	0.4 (1 %)
: Monterrey	29.5	8.5	2.0	5.0	3.2	6.6	0.3	0.6	0.6
		(29 %)	(7 %)	(17 %)	(11 %)	(22 %)	(1 %)	(2 %)	(2 %)
: Guadalajar	17.7	5.5	1.7	3.4	0.7	4.3	0.2	0.2	0.1
		(31 %)	(10 %)	(19 %)	(4 %)	(24 %)	(1 %)	(1 %)	(1 %)

Results of Source Category Analysis

(ug/m³)

	:Osaka	:Merced	:Guadarajara
PM _{2.5}	17.0	30.5	24.3
(NH ₄) ₂ SO ₄	6.8	5.8	2.8
POM=1.8OC	5.2	6.5	7.1
Crustal	1.8	5.6	5.6
EC	1.0	2.9	1.3
Biomass	0.2	0.1	0.3
Sea Salt	0.2	0.3	0.5
NH ₄ NO ₃	1.2	1.1	0.6
NH ₄ Cl	0.1	0.2	0.0
Unknown	0.5	7.9	6.2

WG3

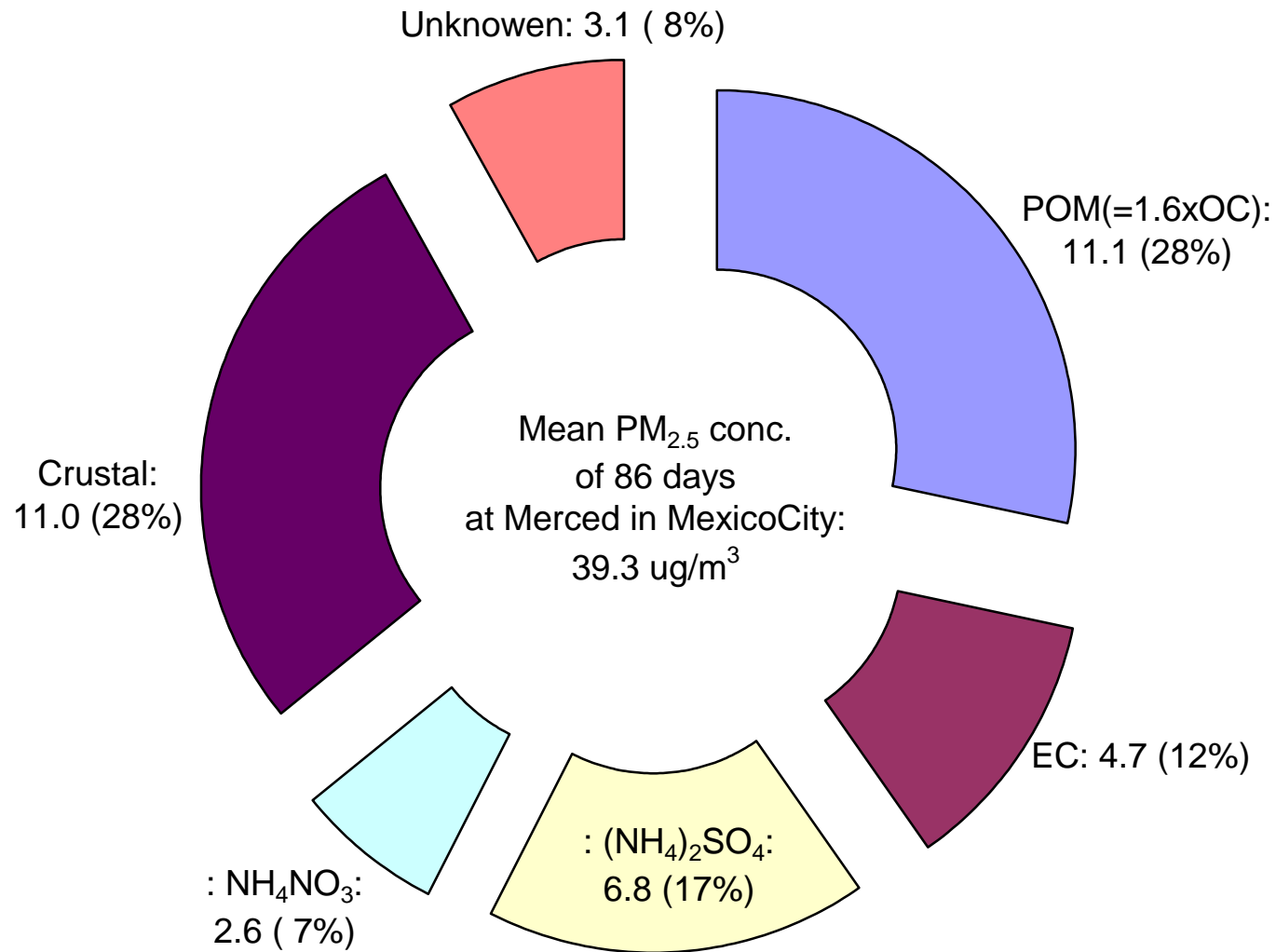
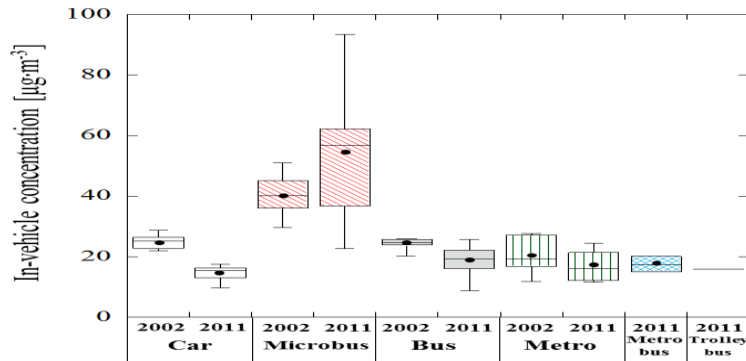


Figure Mean concentration of main constituent concentrations in PM_{2.5} observed from Sept 2011 to Oct. 2013 in Mexico City.

(a) Formaldehyde



(b) Acetaldehyde

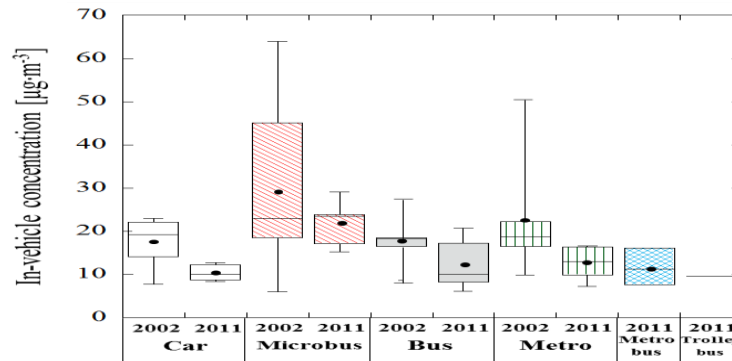


Fig. In-vehicle concentrations for each commuting mode in 2002 and 2011. Each solid bar shows the maximum value, upper quartile, median, lower quartile, and minimum value. The circle represents the mean value.

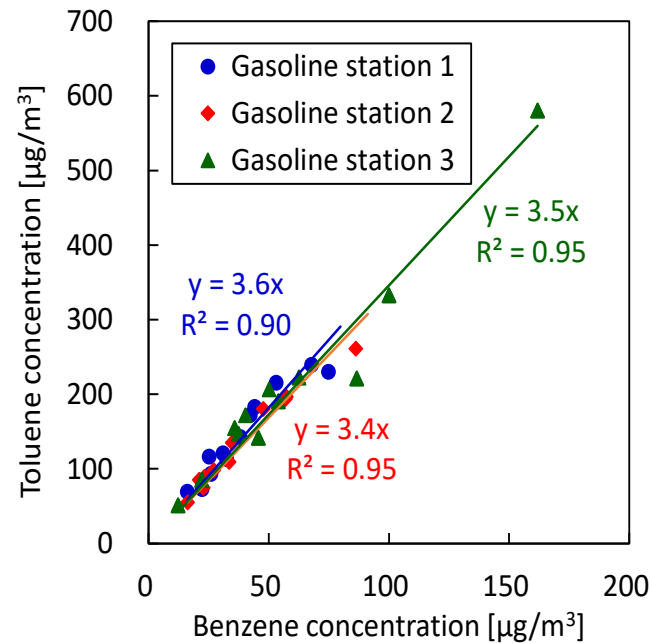
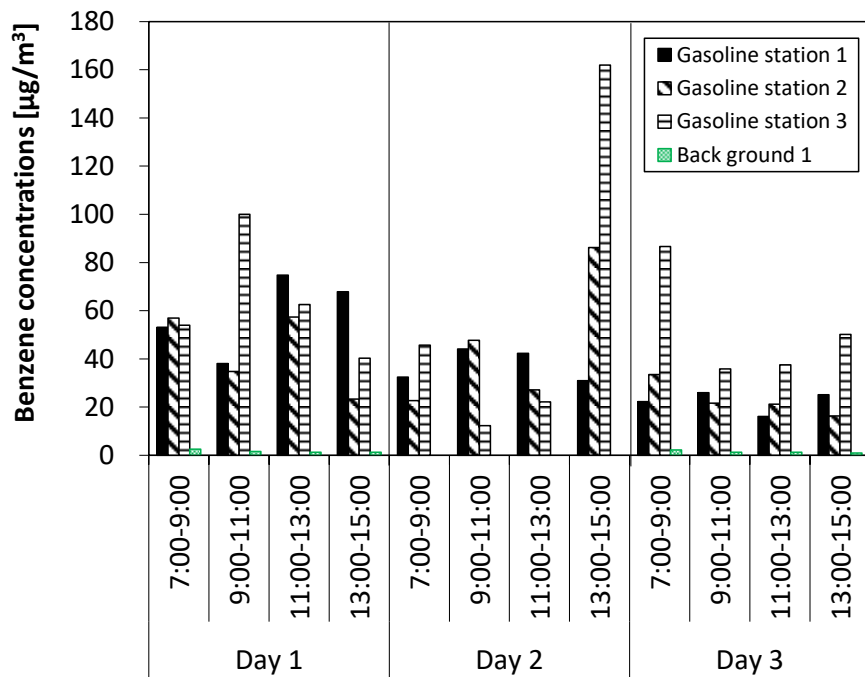


Fig. Occupational exposure and back ground atmospheric levels of benzene, toluene, and formaldehyde.

Creating a Model User Community

WG5



Title: National Pollutant Source Inventory Modeling Seminar

Date & Time: November 22, 2012 10:00~17:40

Place: SEMARNAT Conference Room 35F Conference Room

Participants: SEMARNAT, INE, GDF, IMP, CENICA, public health institute, local consultant Japan, people in total



サルミエント氏



フランシスコ氏



ルイス先生



ガルシア先生



若松教授



斎藤WG5

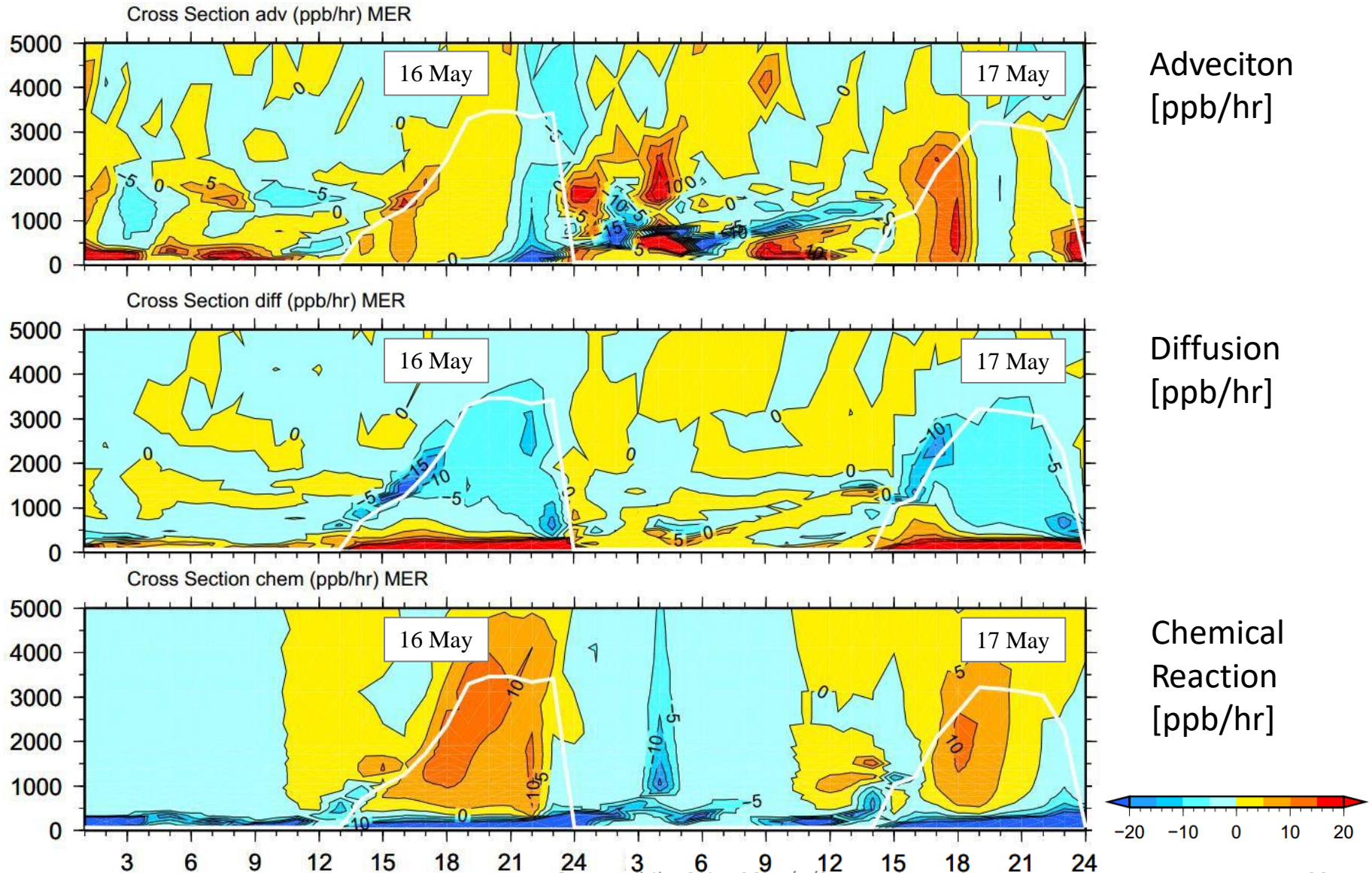
UNAM: National Autonomous University of Mexico

JST/JICA

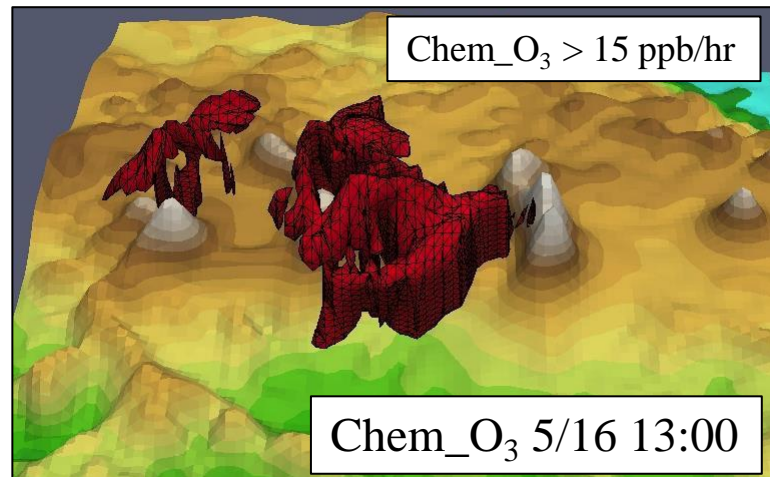
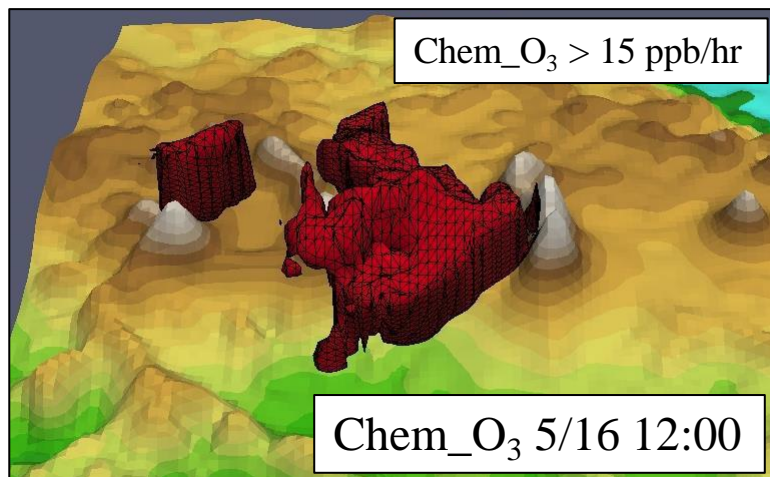
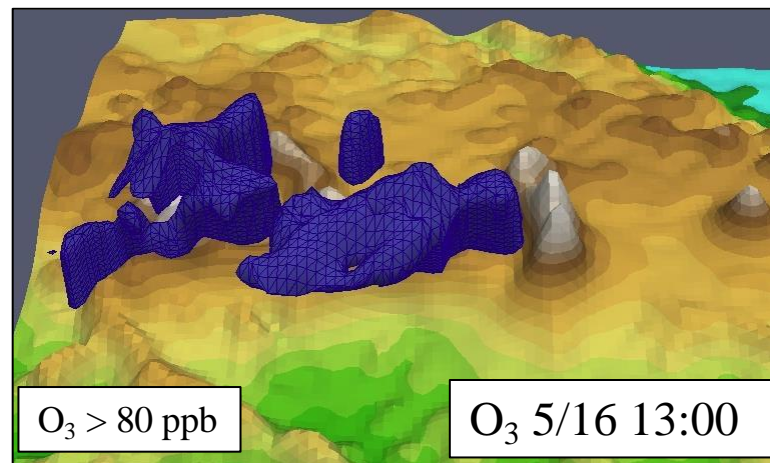
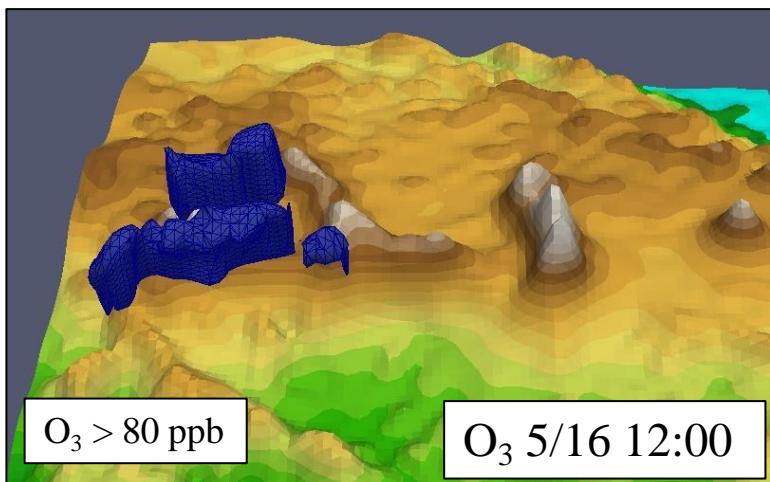
GDF: Mexico City

Vertical Cross Section of Adv., Diff. and Chemical terms

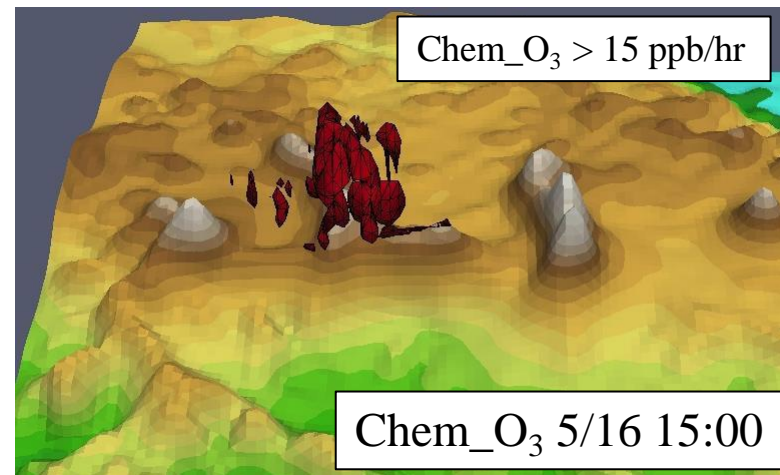
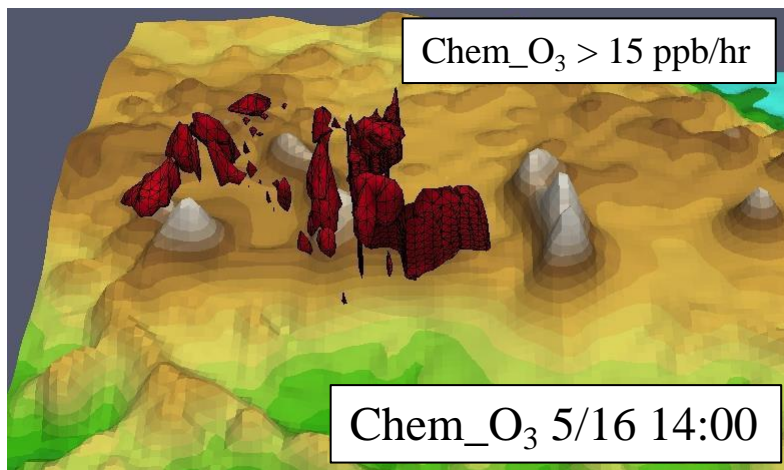
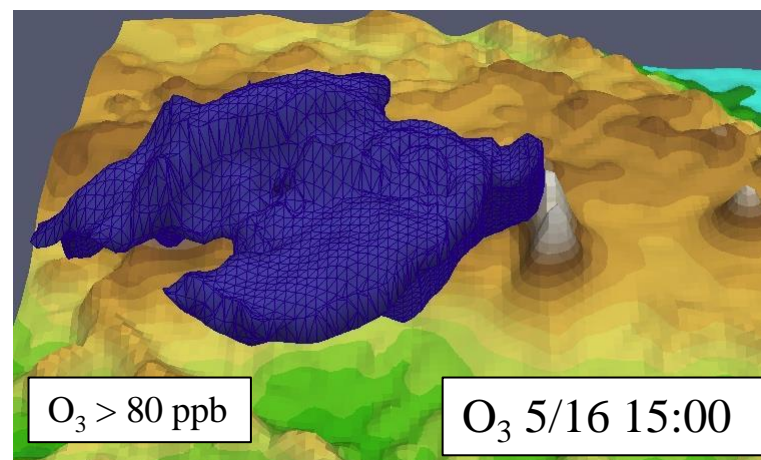
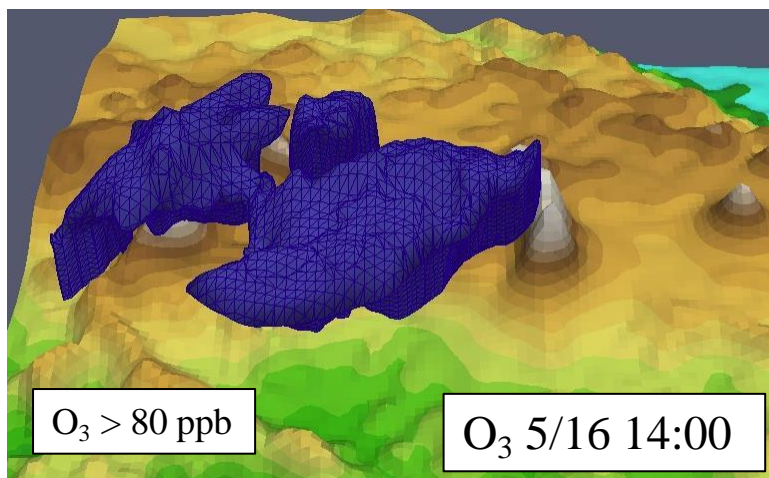
WG5



Ozone and Chemical Production Plumes



Ozone and Chemical Production Plumes

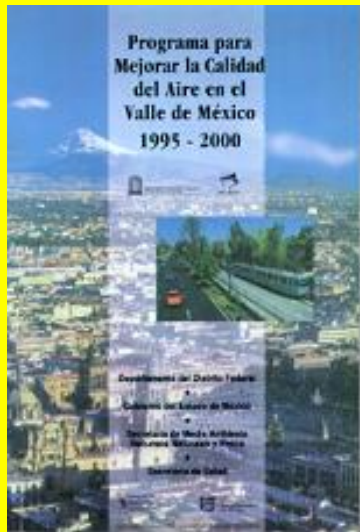


Recommendations (11 items)

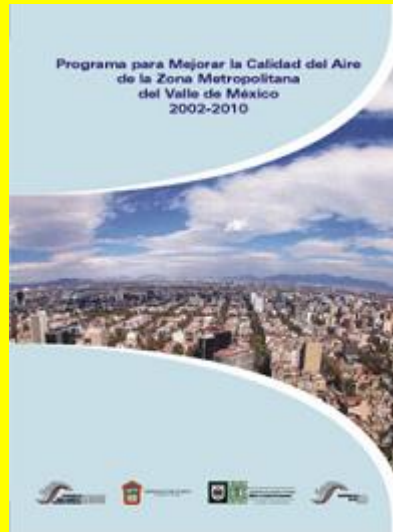
WG6

- 1. Countermeasures against sources of VOCs, which contribute to ozone generation**
- 2. Countermeasures against the source of airborne particulate matter (Focusing mainly on BC in PM2.5)**
- 3. Prevention of gasoline vapor emissions**
- 4. Ensuring the accuracy of monitoring data**
- 5. Strengthening and disseminating the vehicle inspection system**
- 6. Tightening of motorcycle exhaust gas regulations**
- 7. Reduction of sulfur content in vehicle fuels**
- 8. Promotion of solar thermal utilization**
- 9. Measures against soot in brick factories**
- 10. Regulation of Federal Jurisdictional Companies**
- 11. Construction of a low-carbon mobility system**

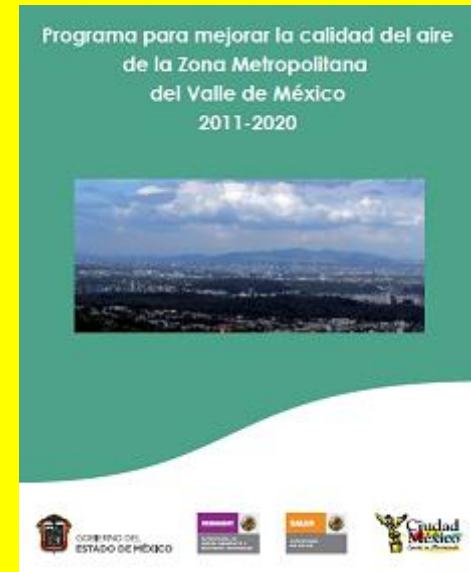
Mexico Metropolitan Area



1995 — 2000



2002 — 2010



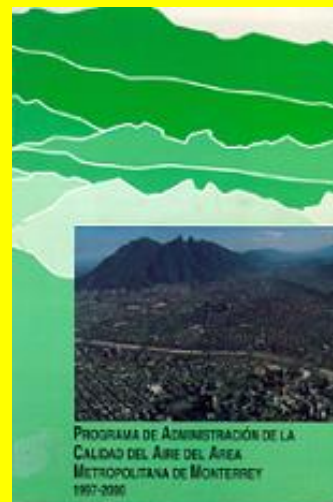
2011 — 2020

Guadalajara Metropolitan Area



2011 — 2020

Monterrey Metropolitan Area



1997 — 2000



2008 — 2012

Development of young Mexican human resources



Government Scholarship International Students(Global Framework)



17 Oct 2011

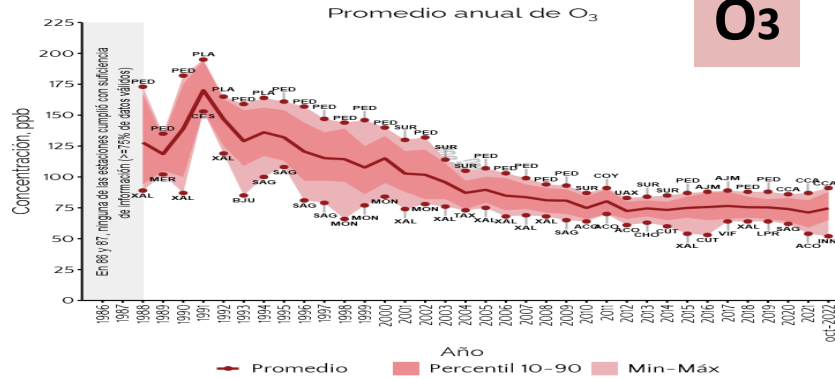
Entrance Ceremony of the United Graduate School of Agricultural Science, Ehime University

Dissertation Theme

"Distribution of Photochemical Air Pollutants in Mexico and Research on its generation mechanism"

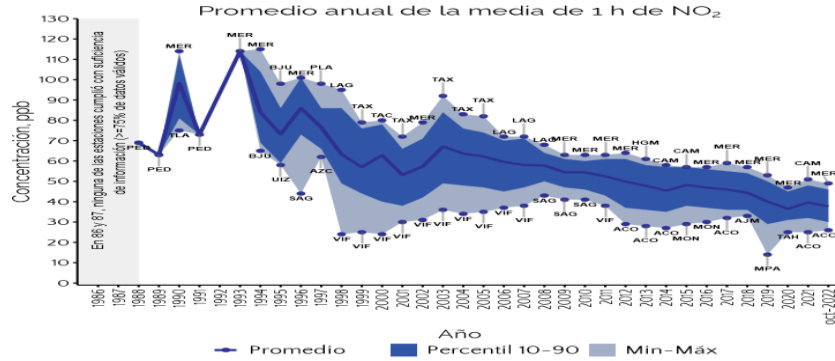


O₃

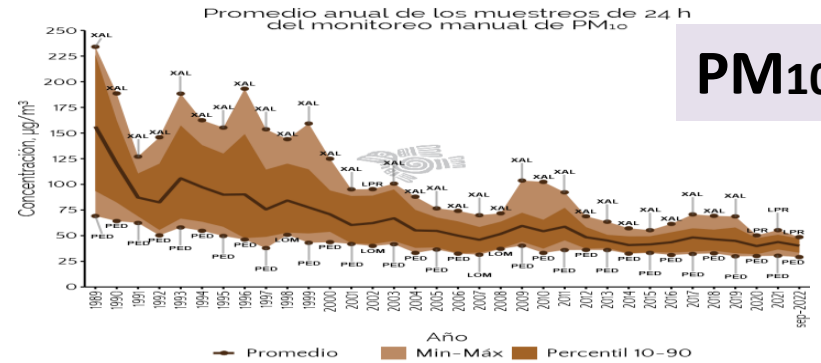


Mexico City Metropolitan Area (MCMA)

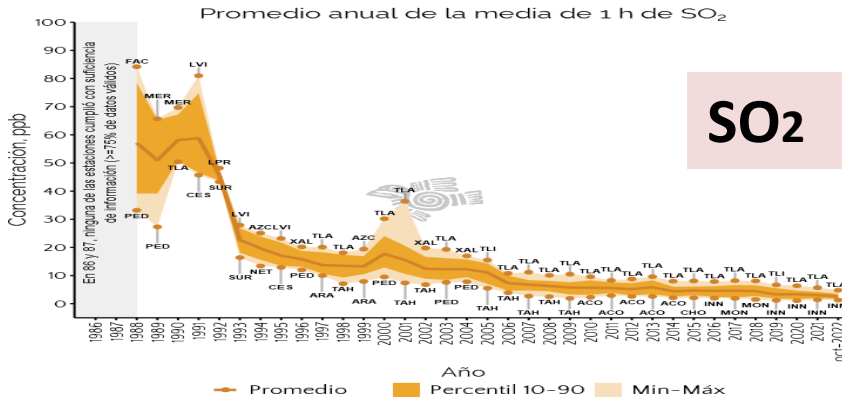
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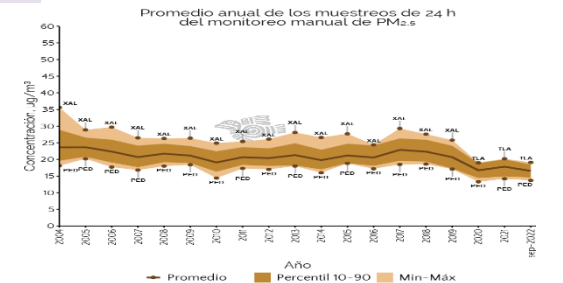
PM₁₀



SO₂

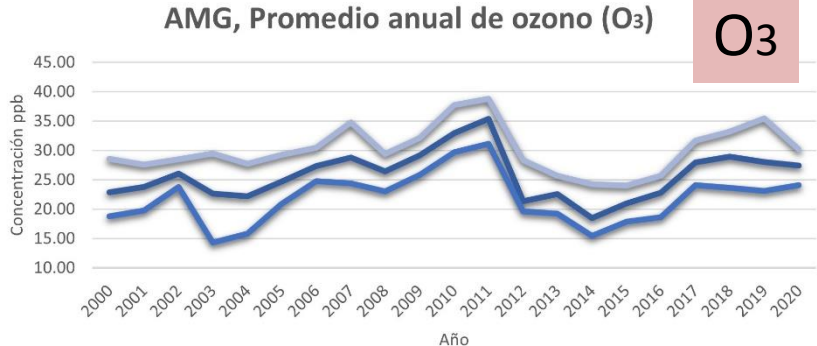


PM_{2.5}

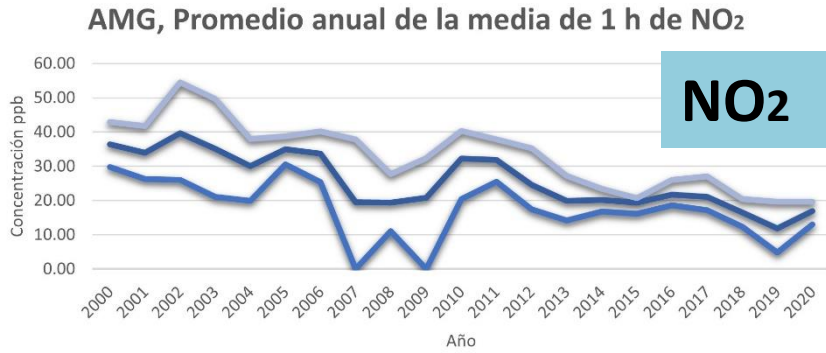


Guadalajara Metropolitan Area (GMA)

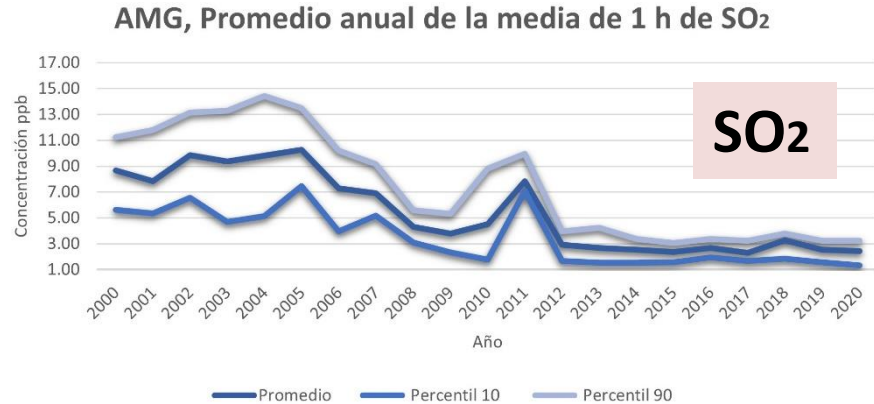
O₃



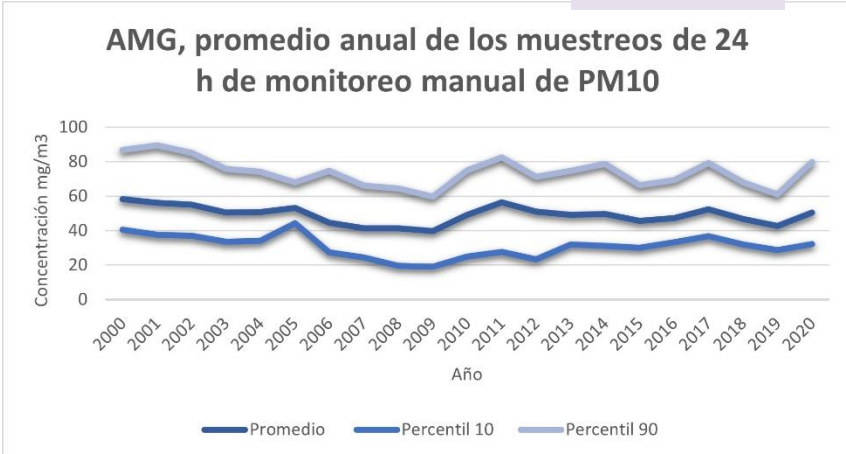
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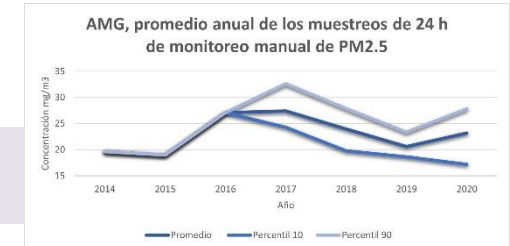
SO₂



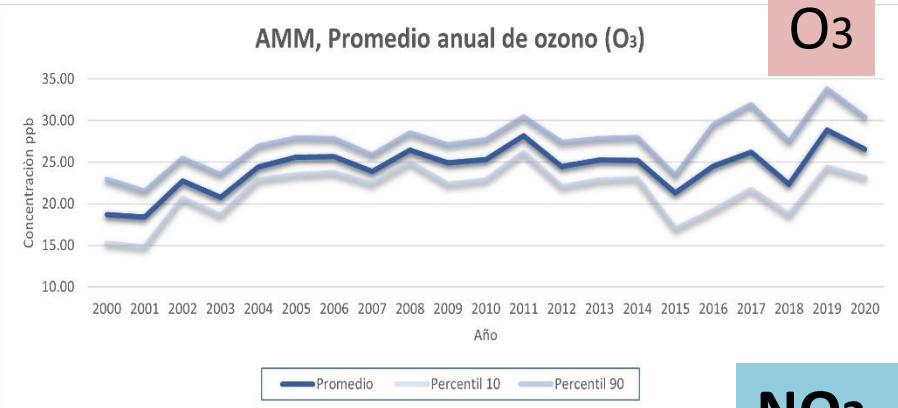
PM₁₀



PM_{2.5}

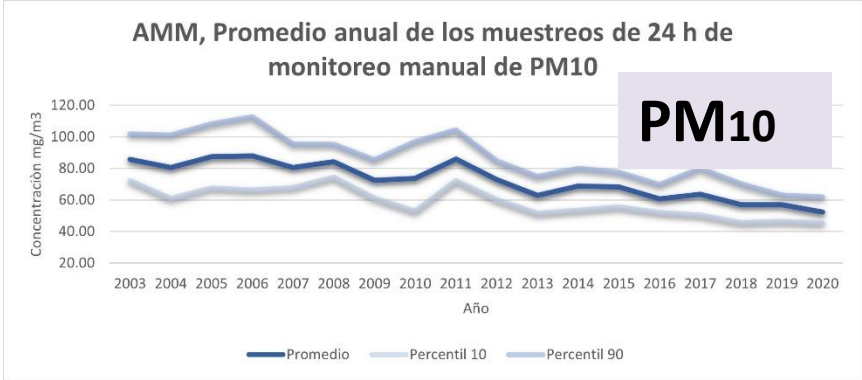
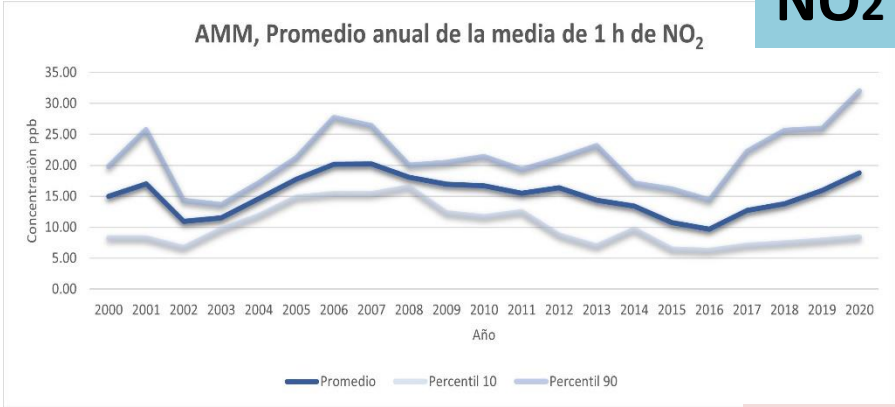


O₃

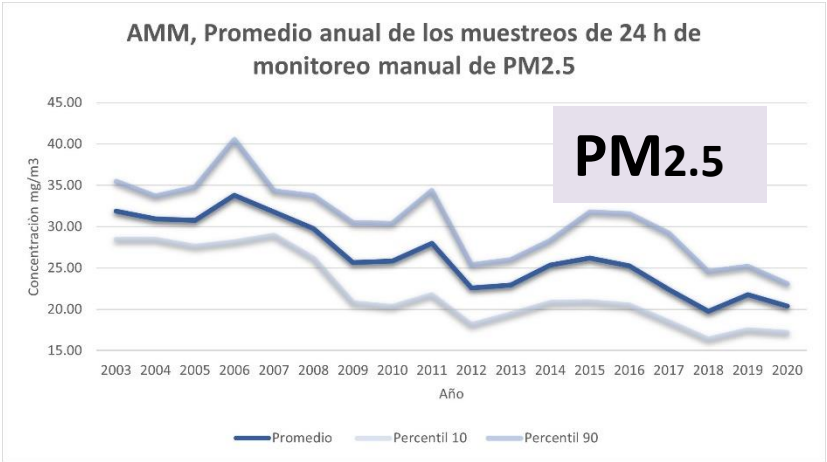
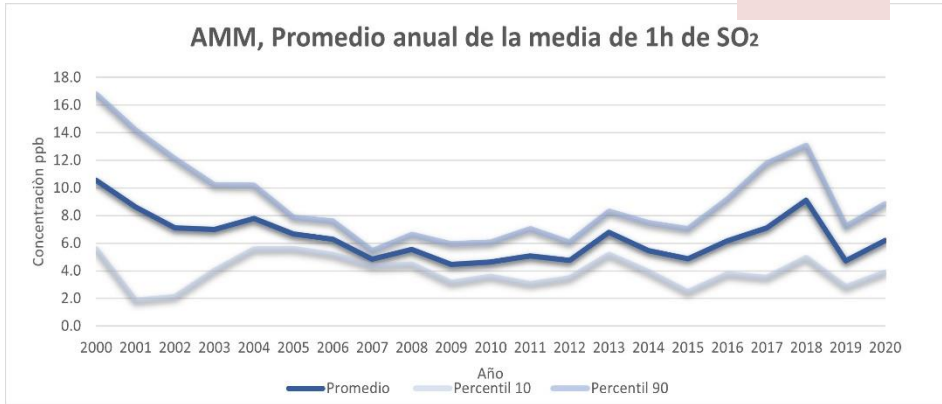


Monterrey Metropolitan Area (MMA)

NO₂



SO₂



Lessons learned and suggestions

By conducting joint research using the same measurement and same analytical methods, quantitatively comparable scientific knowledge was obtained, and policy recommendations based on these findings were made.

Cross-regional comparative studies have been conducted in each region. It was extremely useful in promoting effective co-beneficial air pollution control.

The technologies and scientific results that have been transferred to Mexico through environmental support and joint research are being used not only in Mexico but also in air pollution monitoring and air pollution countermeasures in the Caribbean.

Support for continuous post-confirmation after the project is completed.

Publications - JICA Ogata Research Institute

https://www.jica.go.jp/jica-ri/ja/publication/workingpaper/wp_145.html

JICA-RI Working Paper No. 145, Page 1-41, March 2017

**A Comparative Study of Urban Air Quality in Megacities in Mexico and Japan:
Based on Japan-Mexico Joint Research Project on Formation Mechanism of Ozone,
VOCs and PM2.5,
and Proposal of Countermeasure Scenario**

**Shinji Wakamatsu, Isao Kanda, Yukiyo Okazaki, Masahiko Saito, Mitsuhiro
Yamamoto, Takuro Watanabe, Tsuneaki Maeda and Akira Mizohata**