National Atmospheric Deposition Program

2014 Annual Meeting and Scientific Symposium
The Global Connection of Air and Water
Indianapolis, Indiana
October 21-24, 2014

Chronology of acid rain in Mexico City and the Gulf of Mexico.

Rodolfo Sosa E., Humberto Bravo A., Ana Luisa Alarcón J., Maria del Carmen Torres B., Pablo Sánchez A., Mónica Jaimes P., Elías Granados H., Rocio Bautista B.
Sección de Contaminación Ambiental, Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México. Circuito Exterior, C.U., México, D.F., C.P. 04510

Centro de Ciencias de la Atmósfera, UNAM.

Sampling Acid Deposition Network in Mexico

SCA CCA UNAM – SAMPLING STATIONS

1. Tajín, Veracruz.
2. El Morro, Veracruz.
3. San Juan de Ulúa, Veracruz.
4. Instituto de Ingeniería, UV.
5. Villahermosa, Tabasco.
6. Palenque, Chiapas.
7. Campeche, Campeche.
8. Tulum, Quintana Roo.
9. Monterrey, Nuevo León.
10. Tijuana, Baja California.
11. Montecillos, Estado de México.
12. Ciudad Universitaria, México City.

Stations by Atmospheric Netwoork of the Government of México City

WET AND DRY DEPOSITION SAMPLING PROTOCOL

SCA CCA UNAM LABORATORY

MATERIAL PREPARATION

REDDA-SIMAT LABORATORY

TRANSFER MATERIAL SAMPLING SITE

SAMPLE COLLECTION

MEASUREMENT OF FIELD PARAMETERS

TRANSFER TO LABORATORY REDDA

MEASUREMENT AND STORAGE OF THE SAMPLE

CUSTODY AND TRANSFER TO THE SCA-CCA-LABORATORY

MATERIAL PREPARATION

SAMPLES ANALYSIS

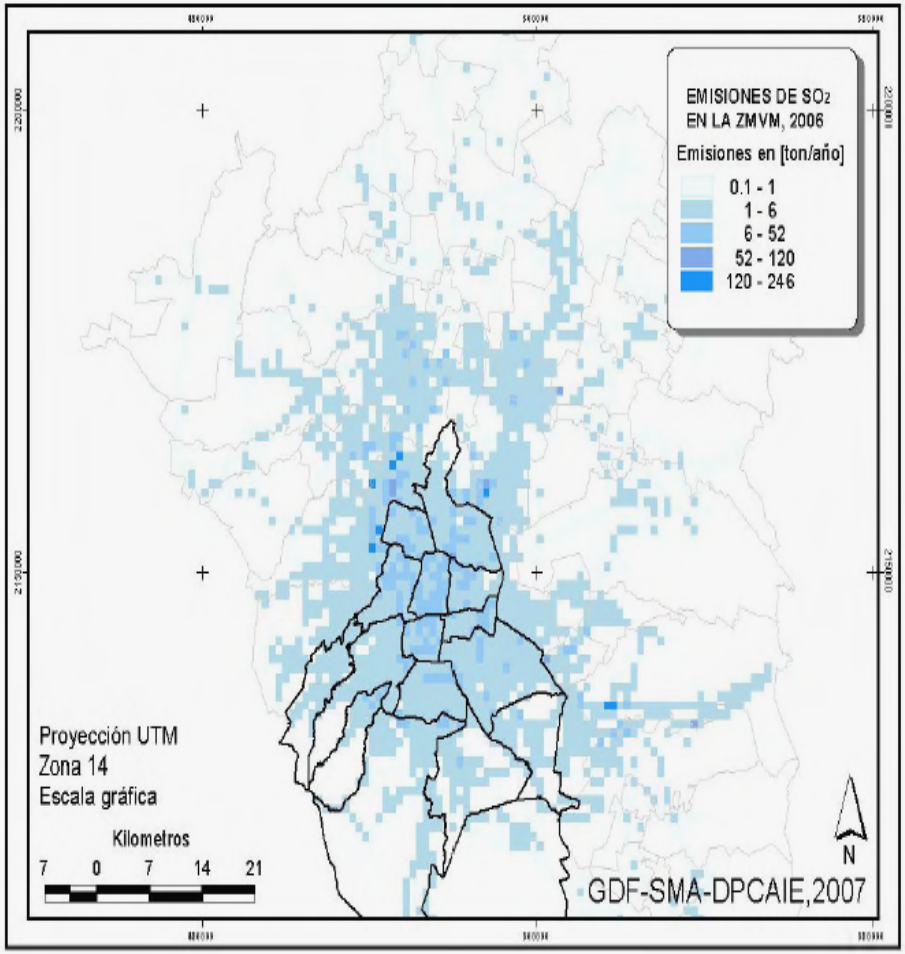
Wet deposition sampling and analysis

The collection of rainfall took place daily, at the Gulf of Mexico, to facilitate a more accurate temporal resolution for wet deposition.

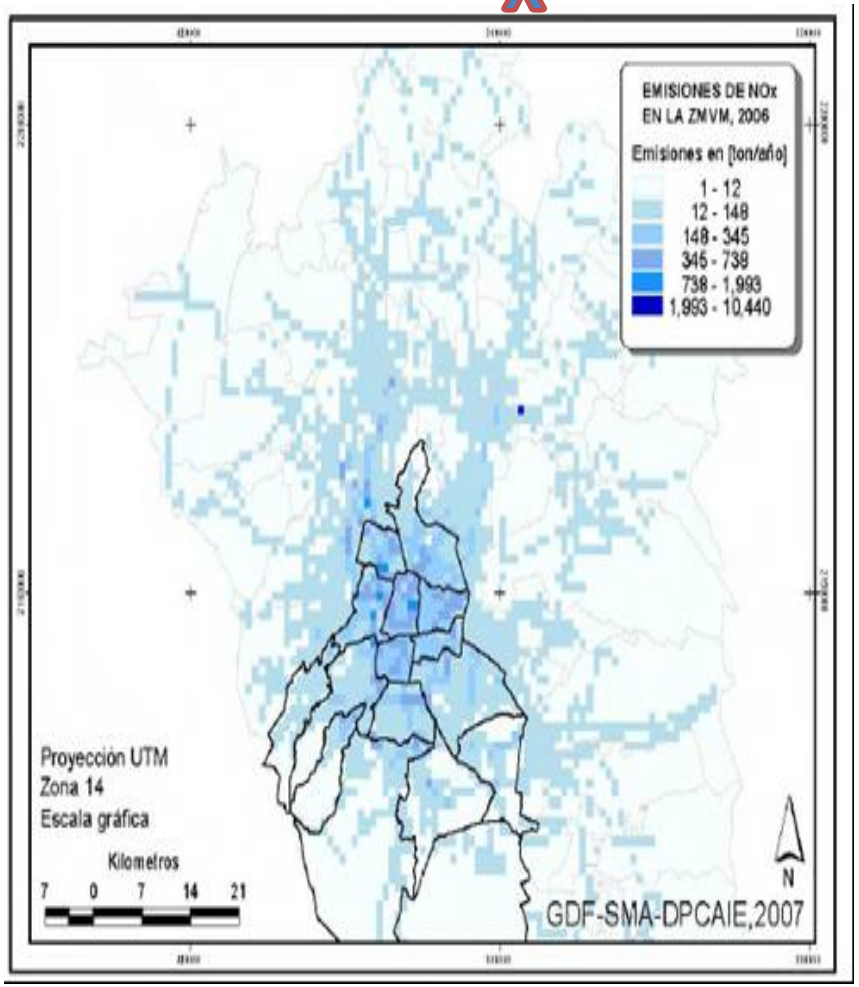
In the MCMA the collection is weekly. Chemical analysis for each sample of rain was to determine the following parameters: pH, conductivity, cations (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) and anions concentration (Cl^-, NO_3^-, SO_4^{2-}) by means of High Performance Liquid Chromatography (HPLC). These analytical methods are in line with the US-EPA protocols.

Emissions at the MCMA

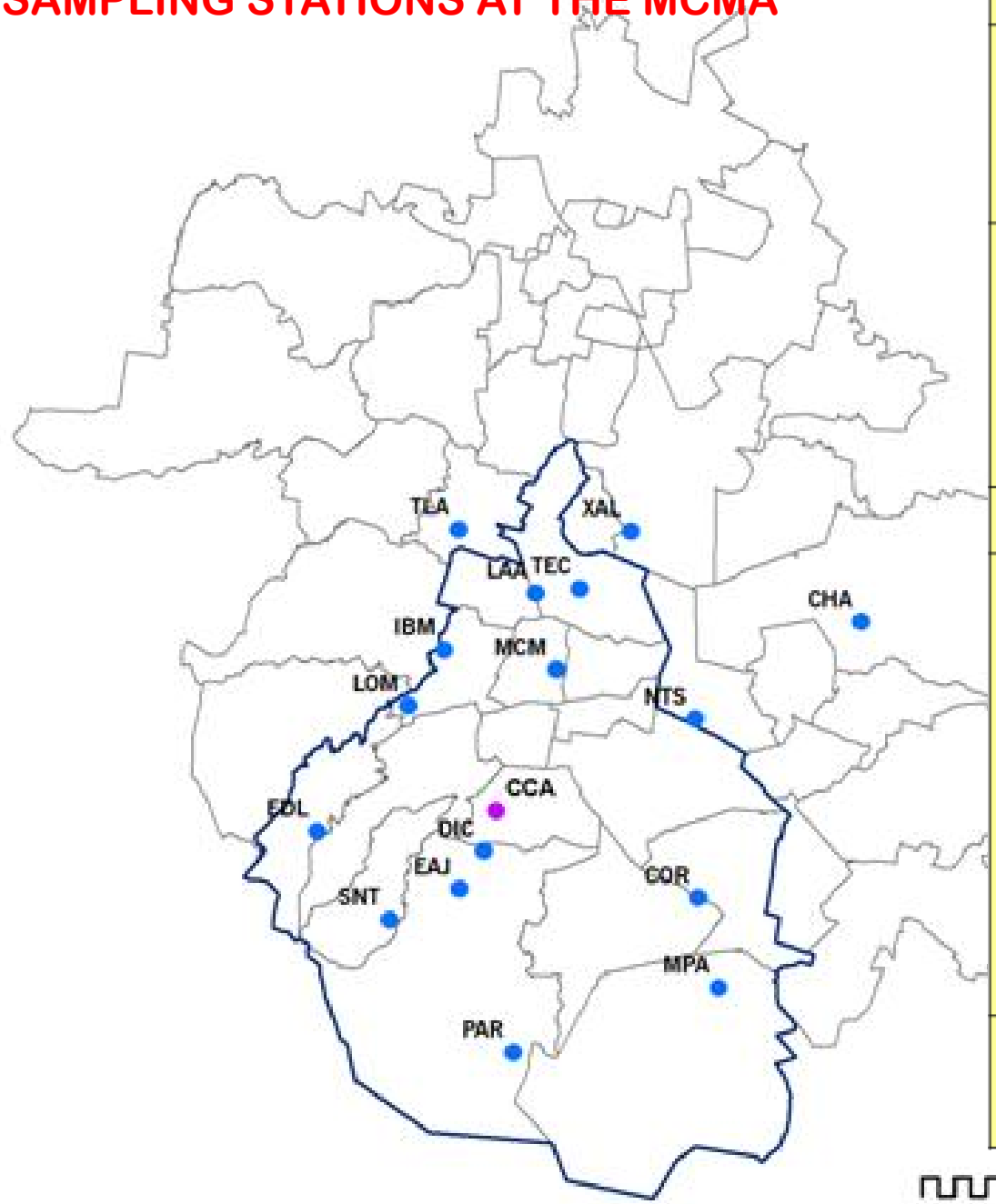
SO_2



NO_x



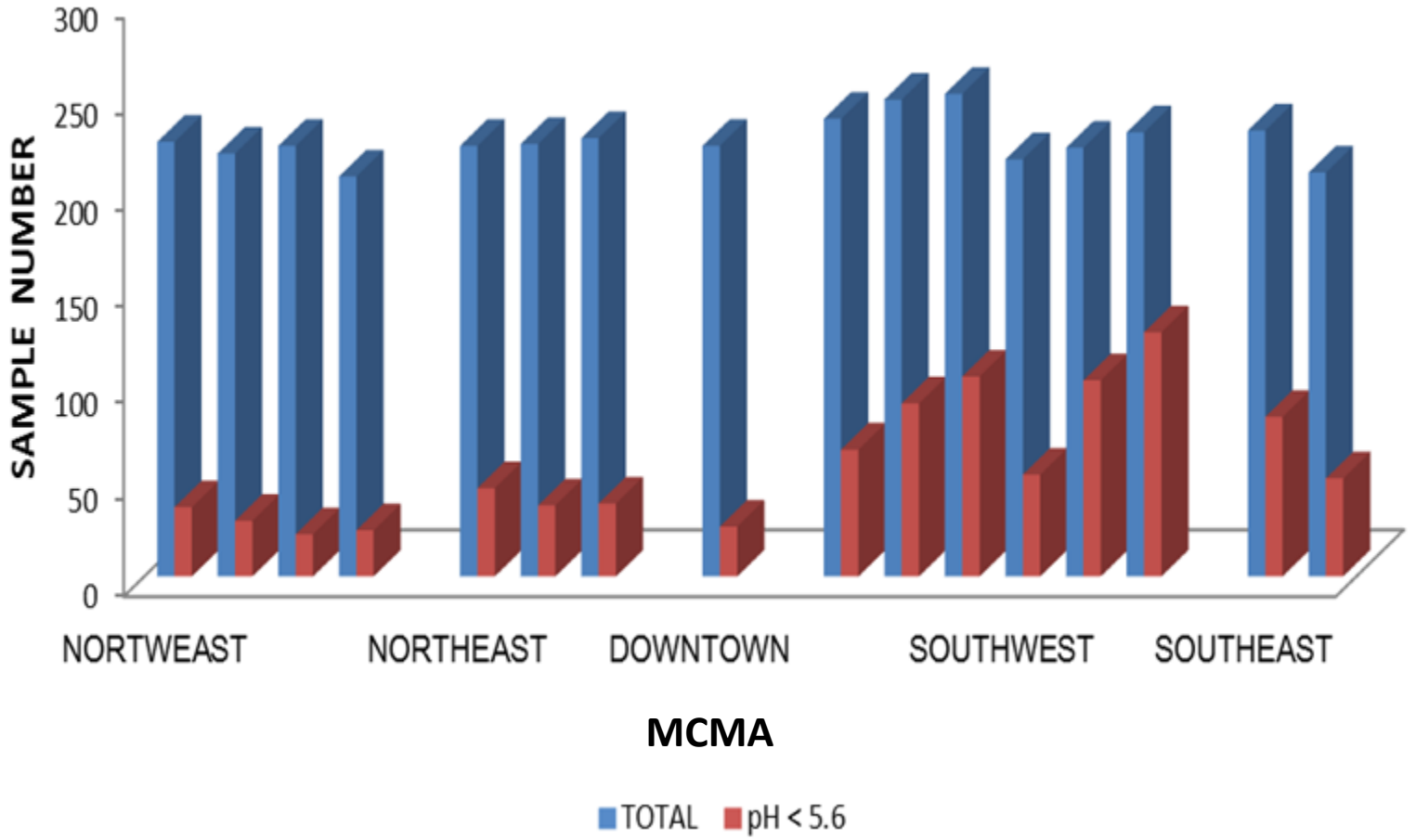
SAMPLING STATIONS AT THE MCMA



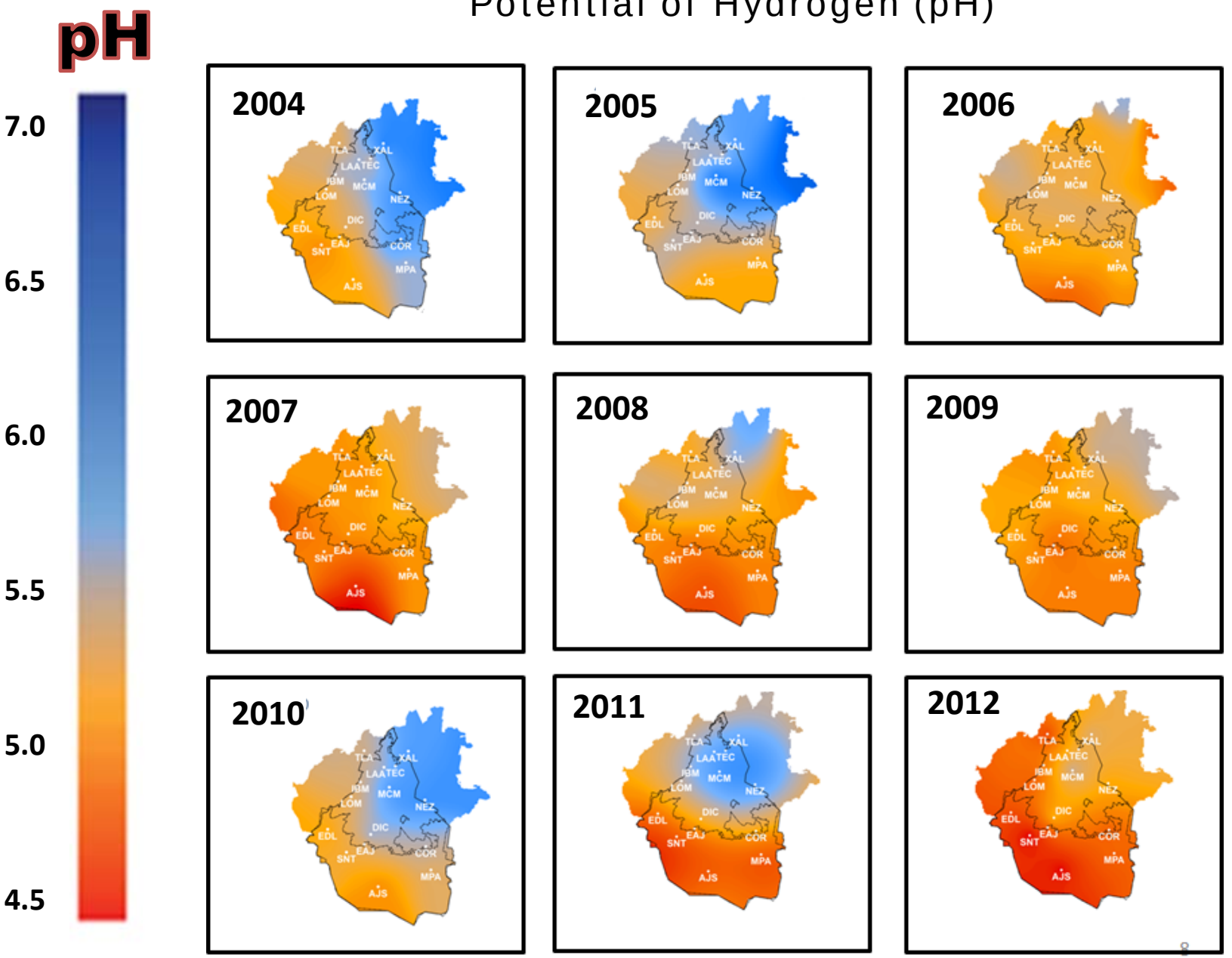
ZONE		NAME	KEY
NORTHWEST		IBM Legaria	IBM
		Lab. Análisis Ambiental	LAA
		Tlalnepantla	TLA
NORTHEAST		Chapingo	CHA
		Nezahualcoyotl Sur	NTS
		Cerro del Tepeyac	TEC
		Xalostoc	XAL
DOWNTOWN		Museo de la Cd. de Mexico	MCM
SOUTH WEST		Diconsa	DIC
		Ecoguardas Ajusco	EAJ
		Ex convento Desierto de los Leones	EDL
		Lomas	LOM
		Parres	PAR
		San Nicolás Totoalpan	SNT
		SCA-CCA-UNAM	CCA
SOUTH EAST		Corena	COR
		Milpa Alta	MPA

México City Metropolitan Area (MCMA)

Total Number and Acidic Samples Number

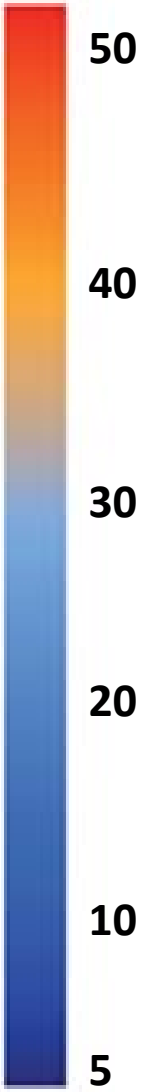


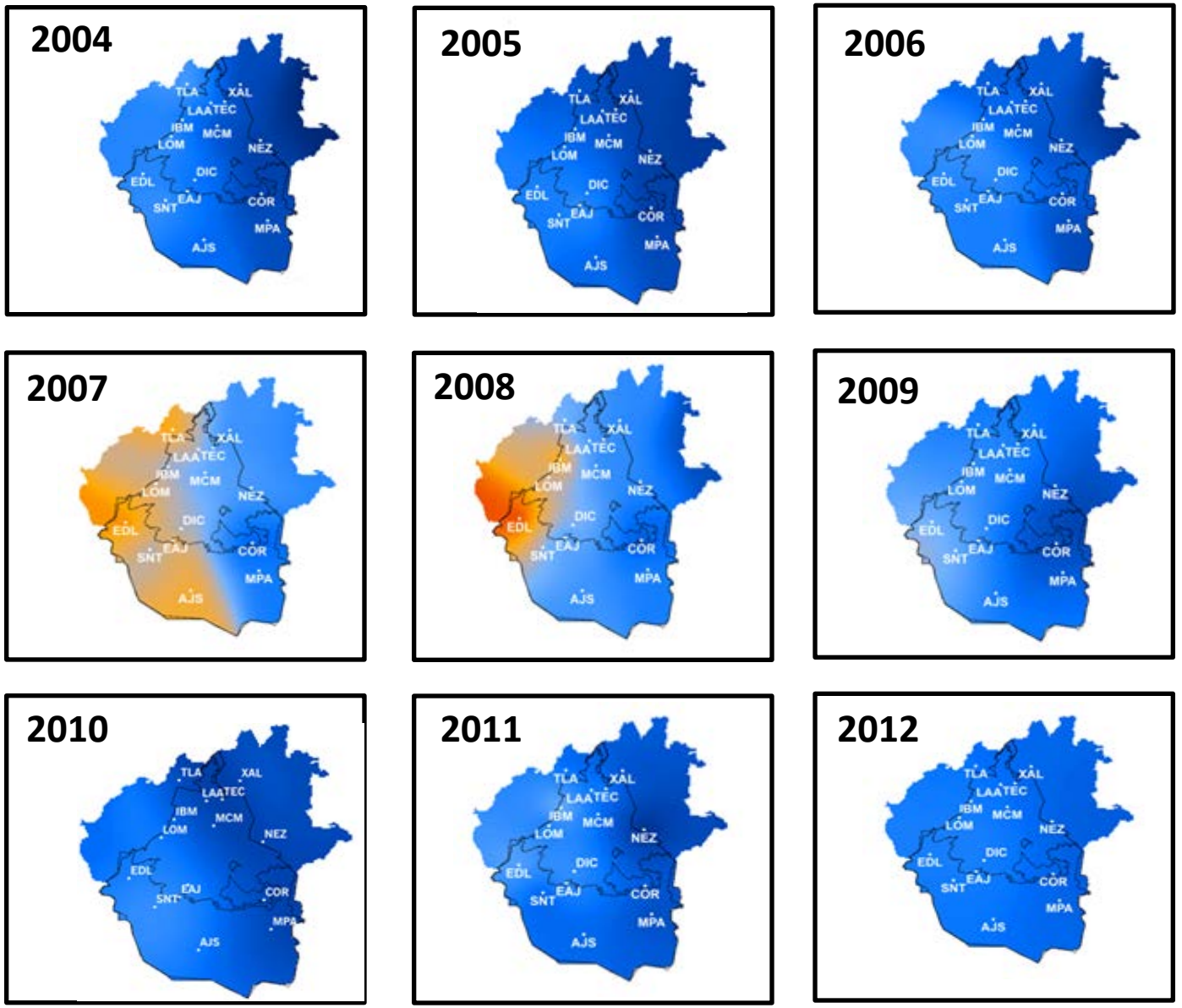
Potential of Hydrogen (pH)



Nitrate (NO_3^-)

Total Deposition (kg/ha)

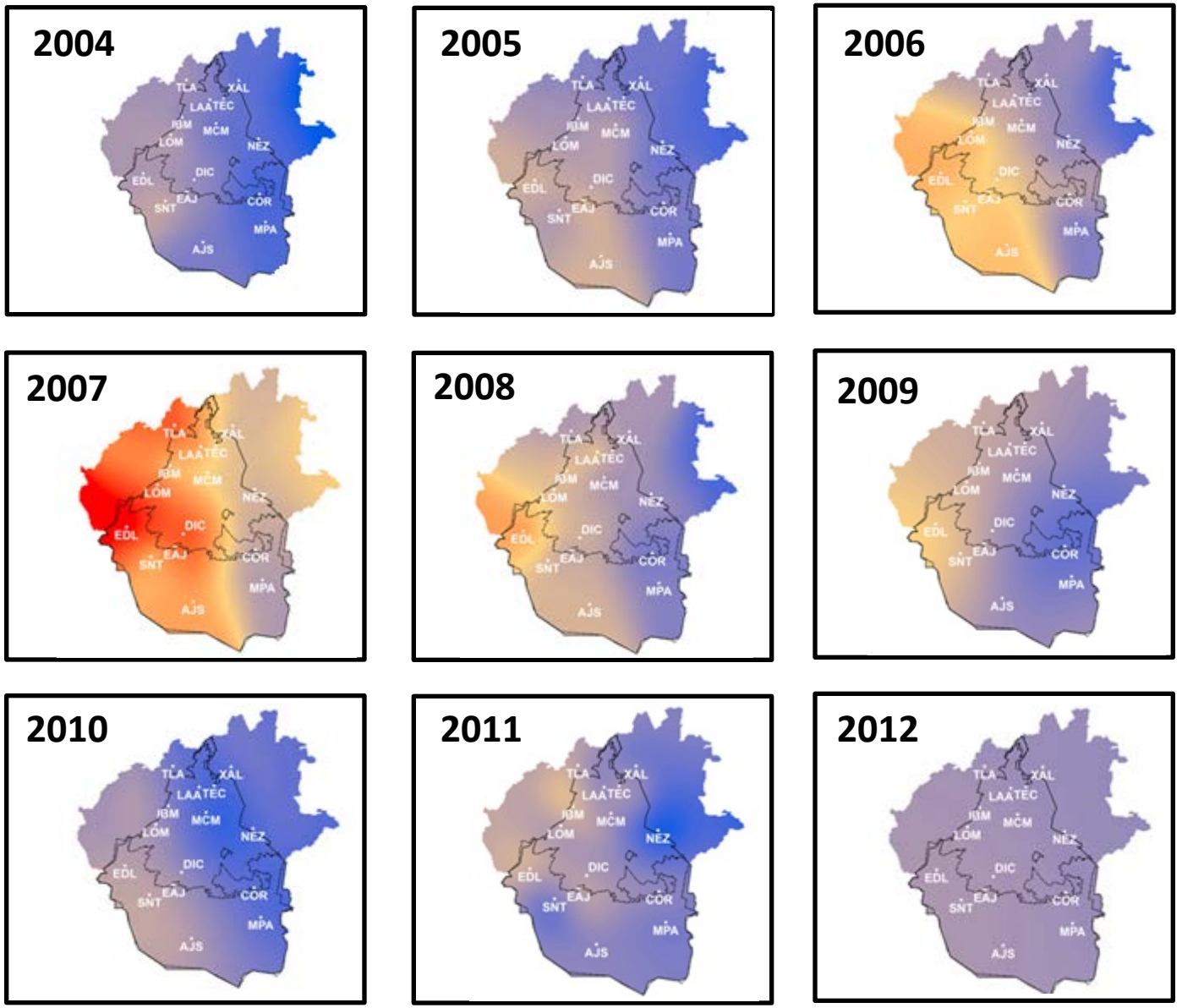




Sistema de Monitoreo Atmosférico (SIMAT), GDF

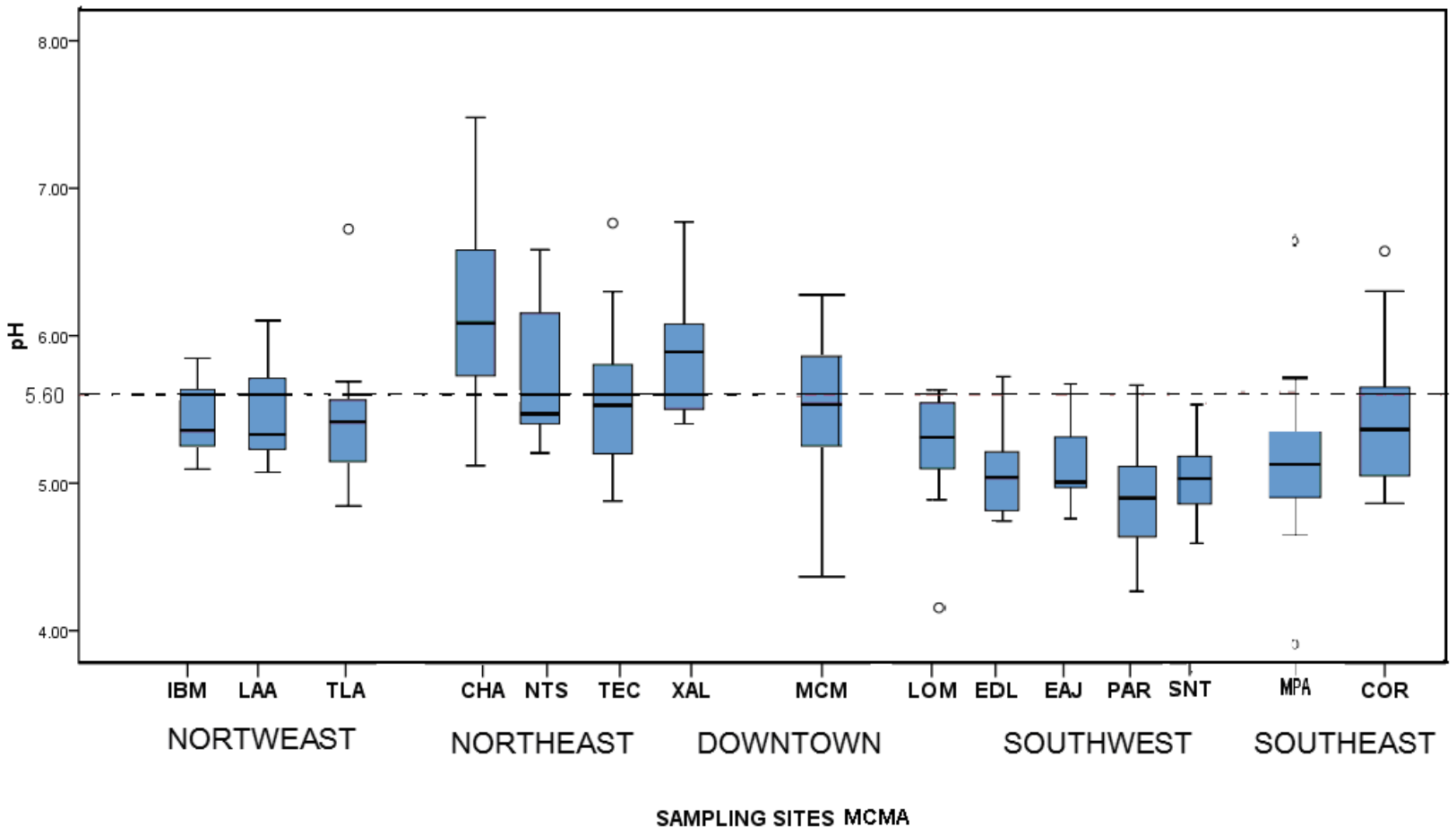
Sulfate (SO_4^{-2})

Total Deposition (kg/ha)

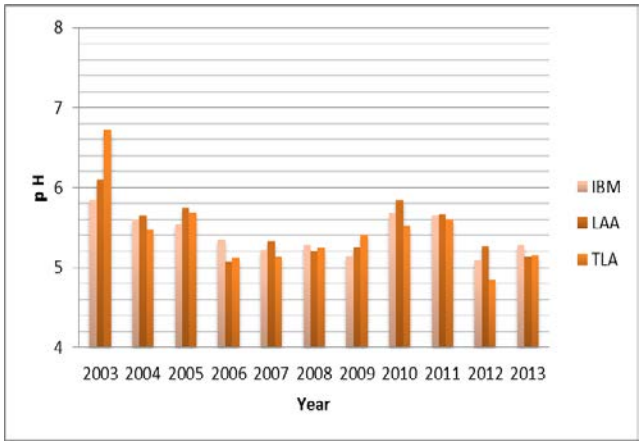


Sistema de Monitoreo Atmosférico (SIMAT), GDF

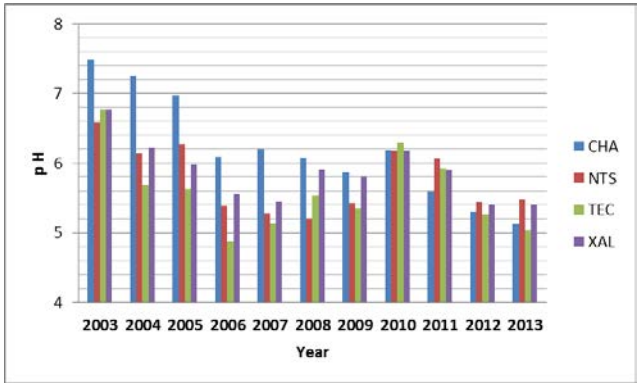
Box plots for the pH values measured at the MCMA



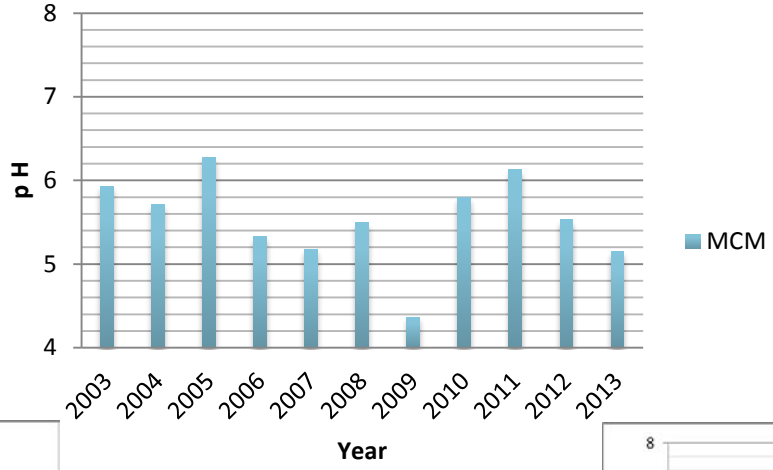
NW



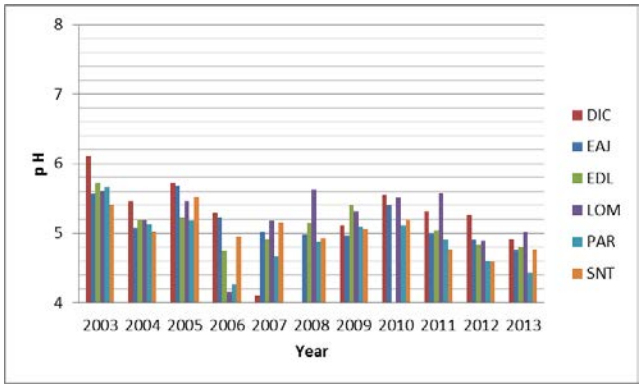
NE



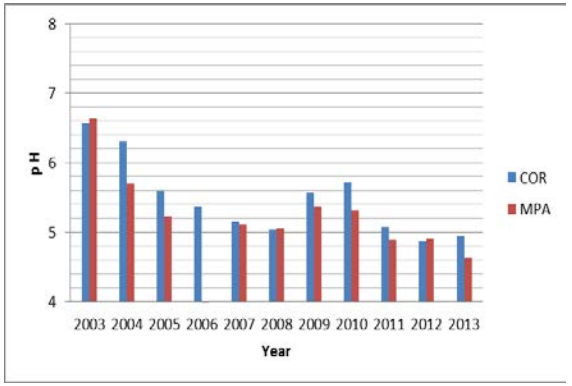
Downtown



SW



SE



Conclusions

In the southwest MCMA is having a greater impact by acid rain, corresponding to the station Parres the lower pH values found.

The Northeastern area presents higher pH values (Chapingo).

The highest levels (concentrations and deposition) of sulphate and nitrate is in the West of the MCMA.

Most sampling stations showed the following behavior: from 2003 to 2008 a decrease in pH, from 2008 to 2010 an increase and finally a decrease from 2010 to 2013.

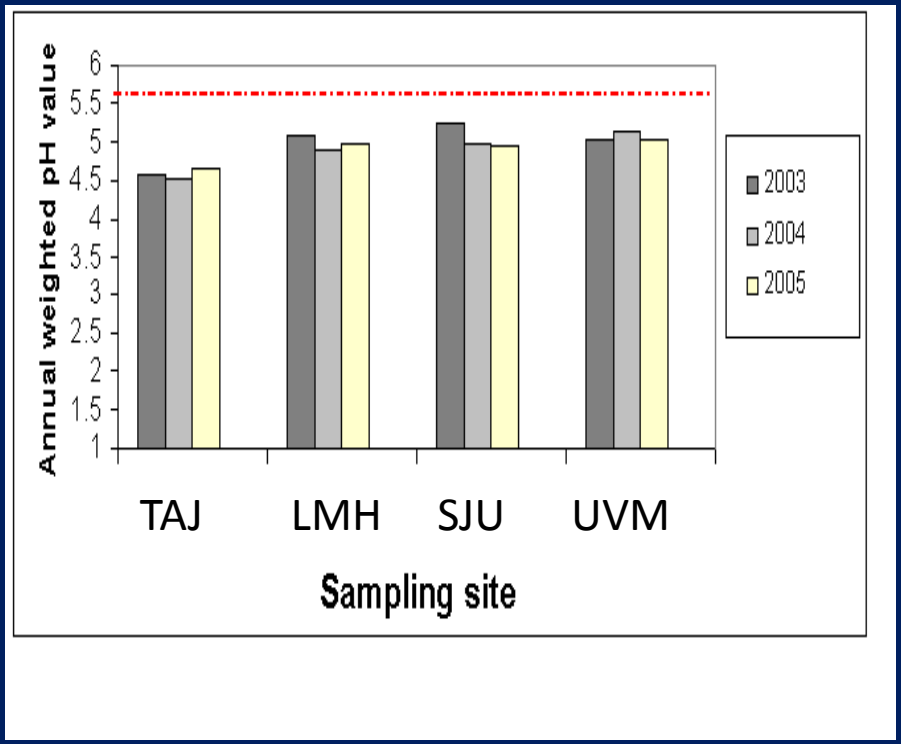
Gulf of Mexico

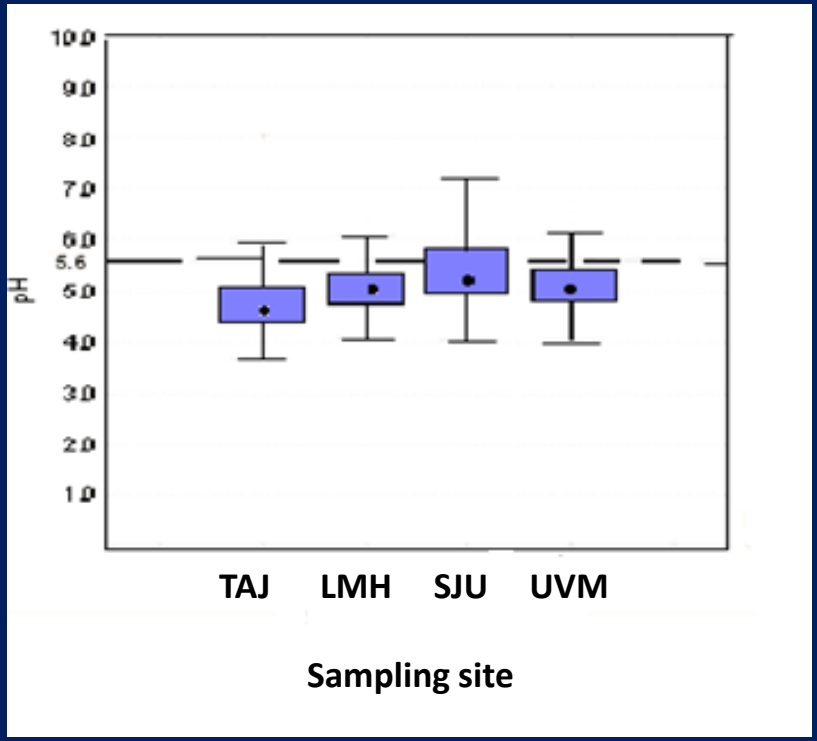
The commercial activities on the coast of the Gulf of Mexico are of great importance for this study (extraction processing and distribution of hydrocarbons, sea port activities, industrial, agricultural, fisheries and tourism) that make this area a potential source of air pollution.

From 2003 to 2005 the complete annual information has been continuously studied at the four sites: 1) The Archaeological Zone of El Tajín (TAJ); 2) the Instituto de Ecología, La Mancha (LMH); 3) The Fortress of San Juan de Ulúa (SJU) in the Port of Veracruz and 4) Universidad Veracruzana, Campus Mocambo (UVM).

Fortress of San Juan de Ulúa (SJU) in the Port of Veracruz.

pH values for the four sampling sites in the coast of the Gulf of Mexico

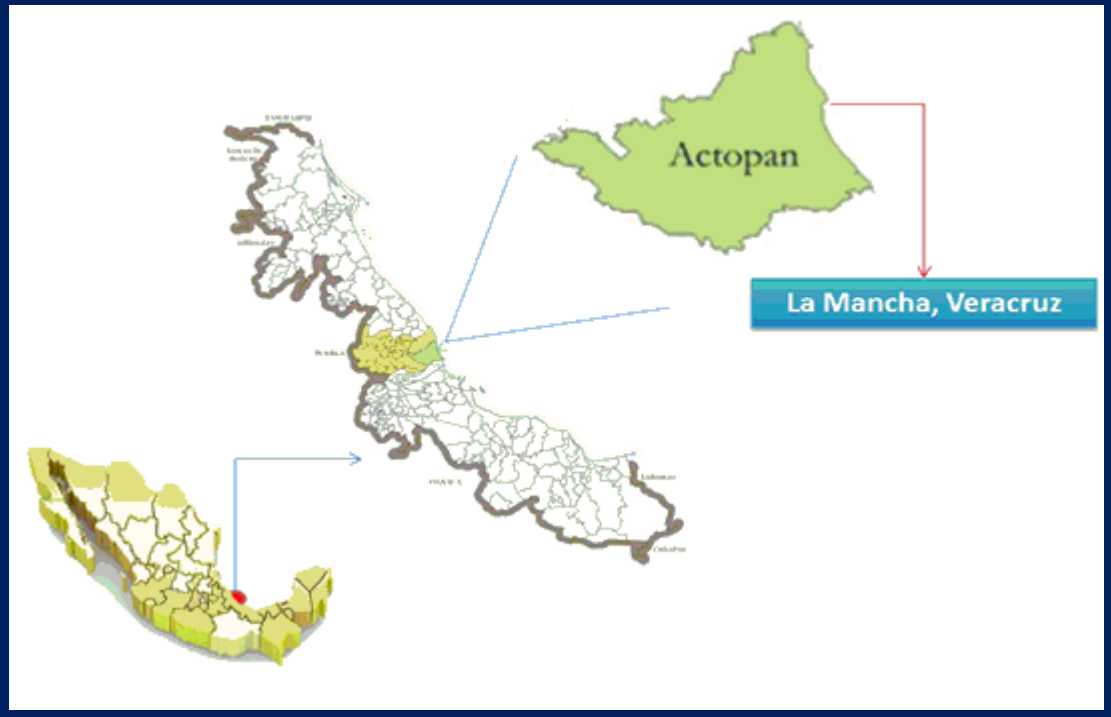




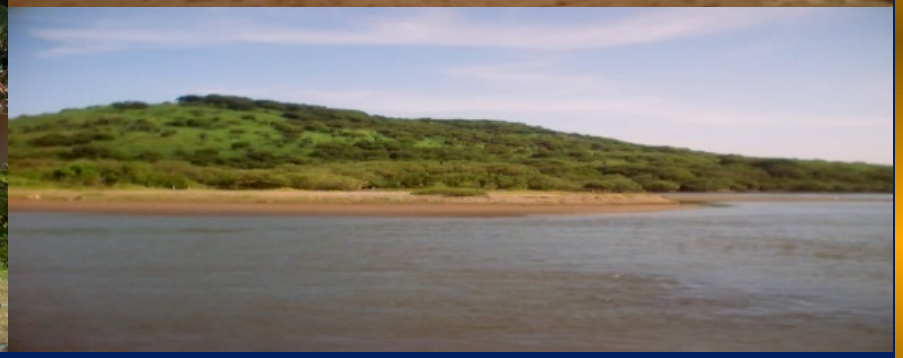
Sampling site location

Sampling site	Location	Geographical Coordinates
Instituto de Ecología. A.C., at the Morro de la Mancha.	The sampling site is located in climatological station, located on the Coast of the Gulf of Mexico	Lat. 19º35´ 21.6¨N Long. 96º22´49.7´´W Altitude 2 m.a.s.l.

"La Mancha", Veracruz, Mexico.



Since 2003, La Mancha is still working under a strict quality assurance and quality control protocol, which makes this station a prototype for the studies in atmospheric deposition on the Coast of the Gulf of Mexico.



Samples Number

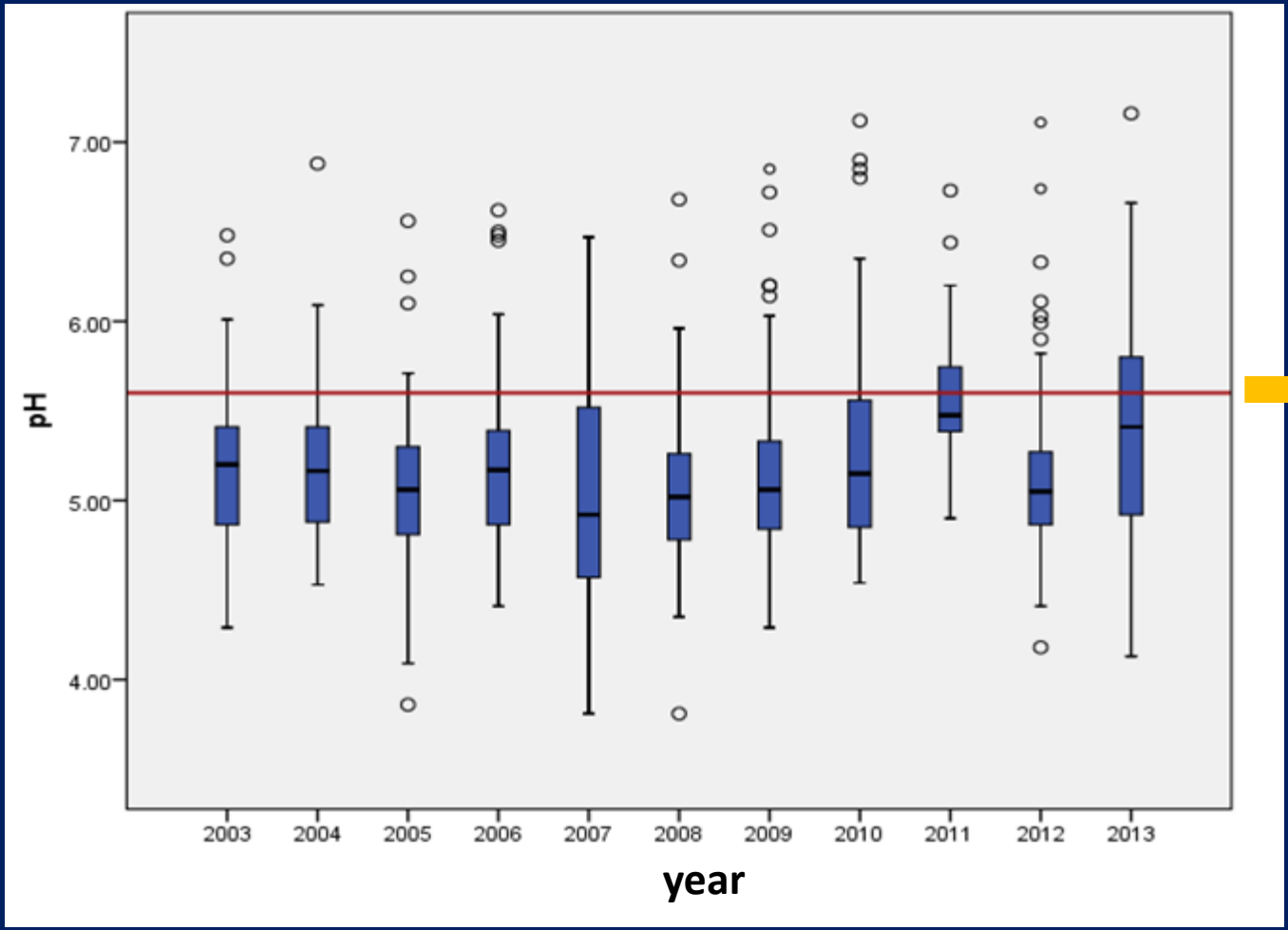
During the period of study (2003 to 2013) a total of 689 samples were collected in La Mancha station and analyzed at the SCA-CCA-UNAM laboratory.

Samples Number by year at La Mancha station

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011*	2012	2013	Total
Number	71	56	73	52	53	71	70	72	28	69	74	689

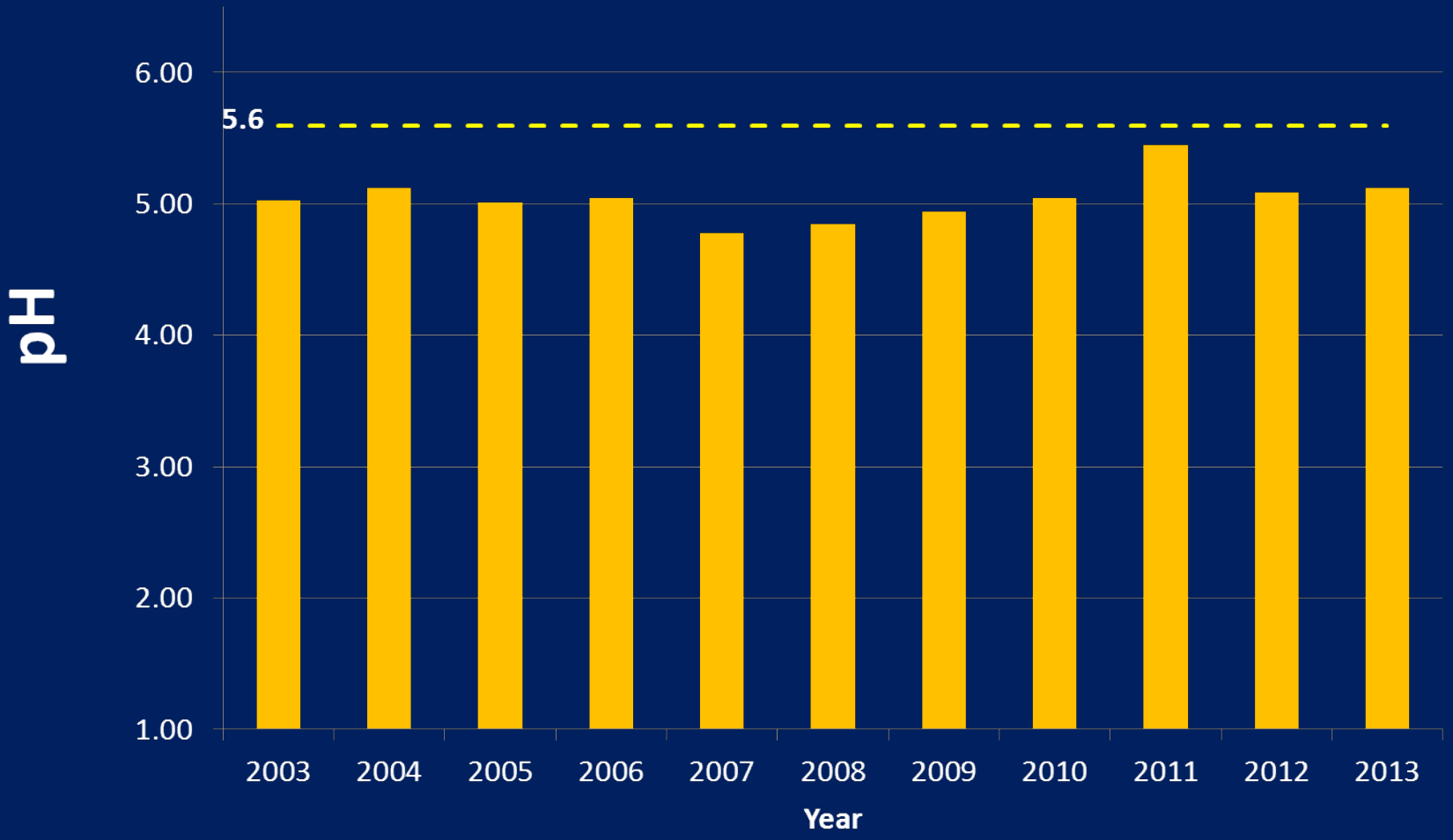
*Lost samples (from August to December).

Box plots for the pH values measured at “La Mancha” station.



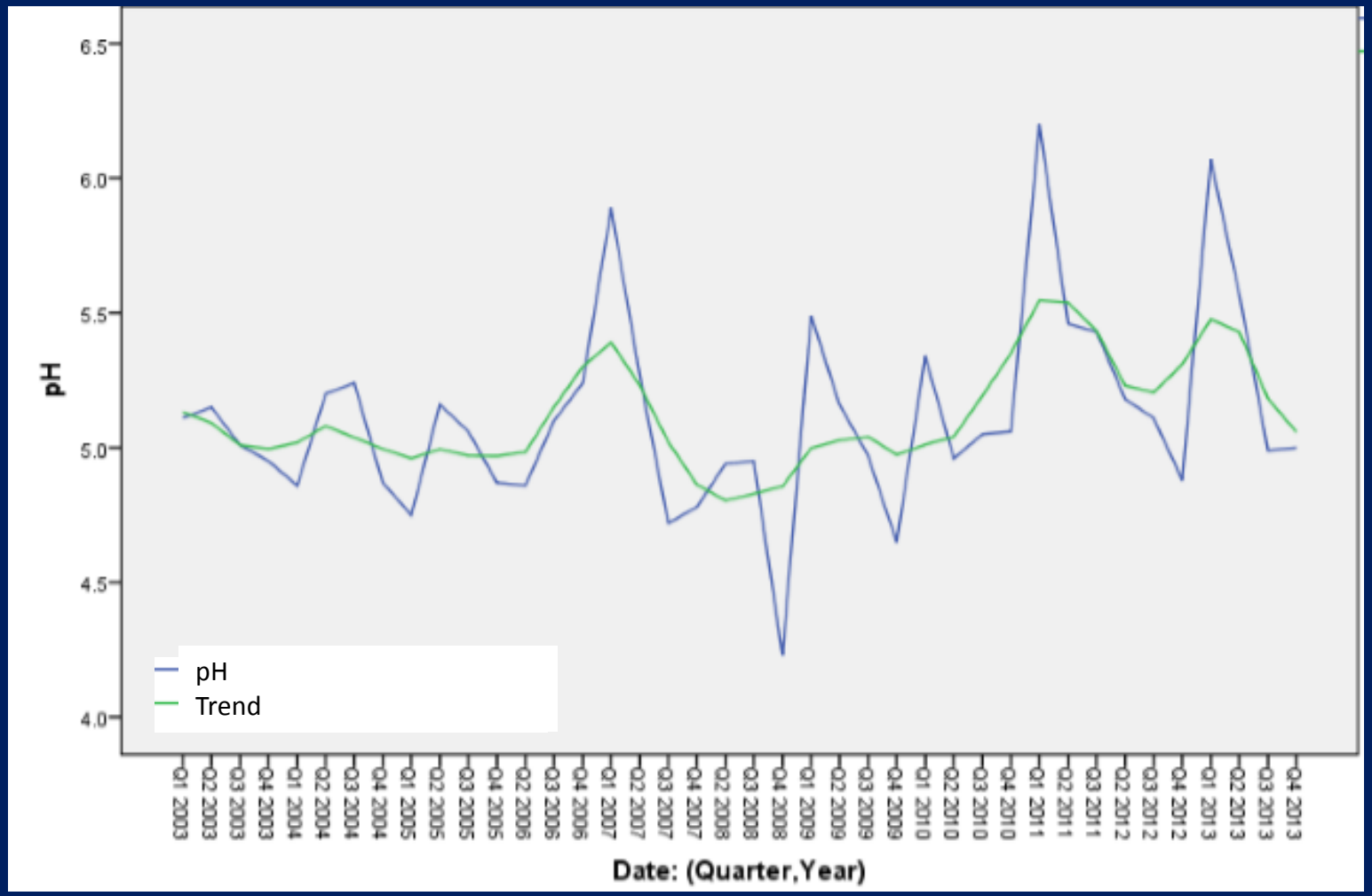
pH = 5.6
The pH of the rain in a clean atmosphere

Volume Weighted Mean pH values at La Mancha station.

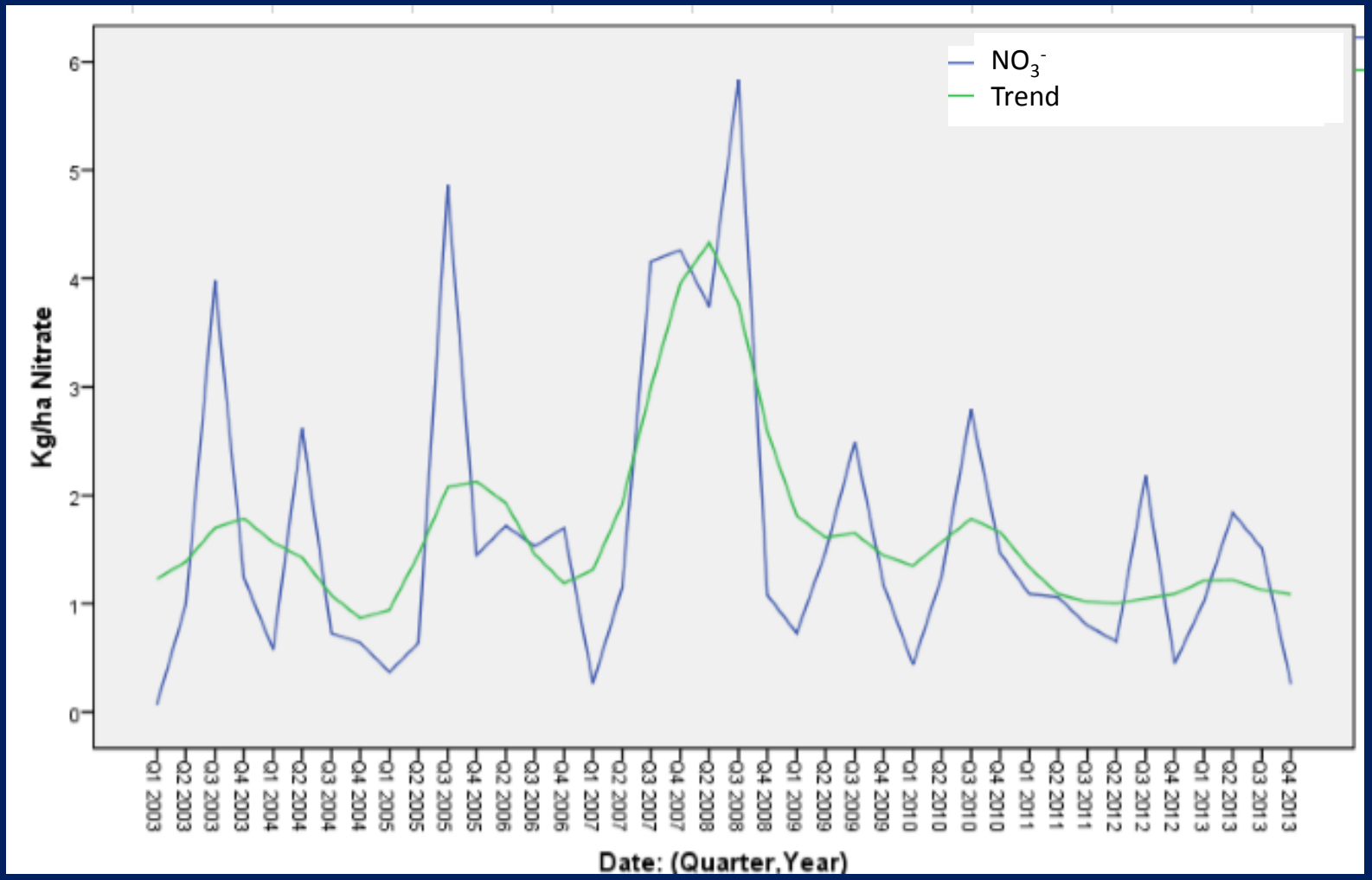


Centro de Ciencias de la Atmósfera, UNAM.

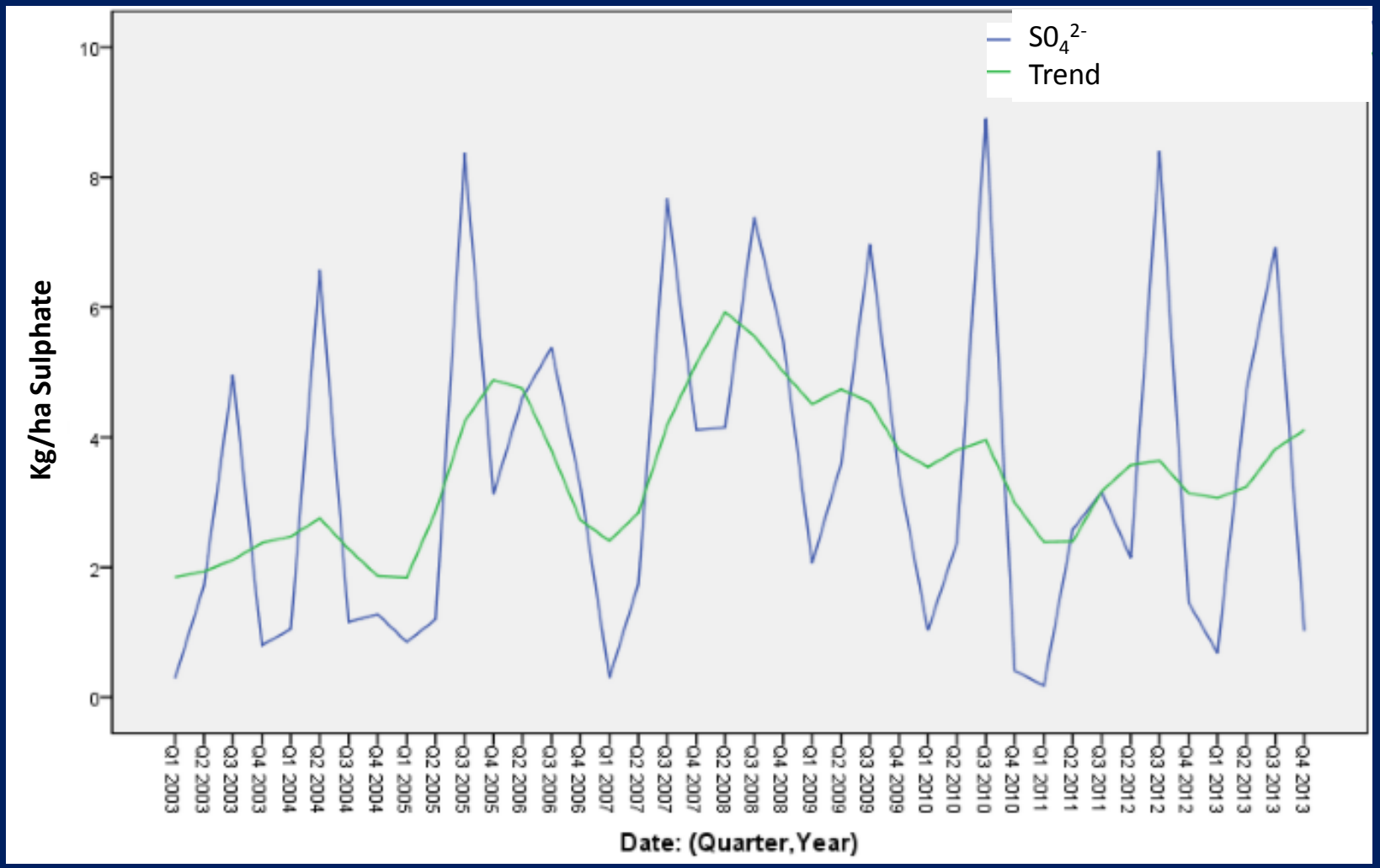
Monthly percentile 50 for pH at La Mancha station, 2003-2013.



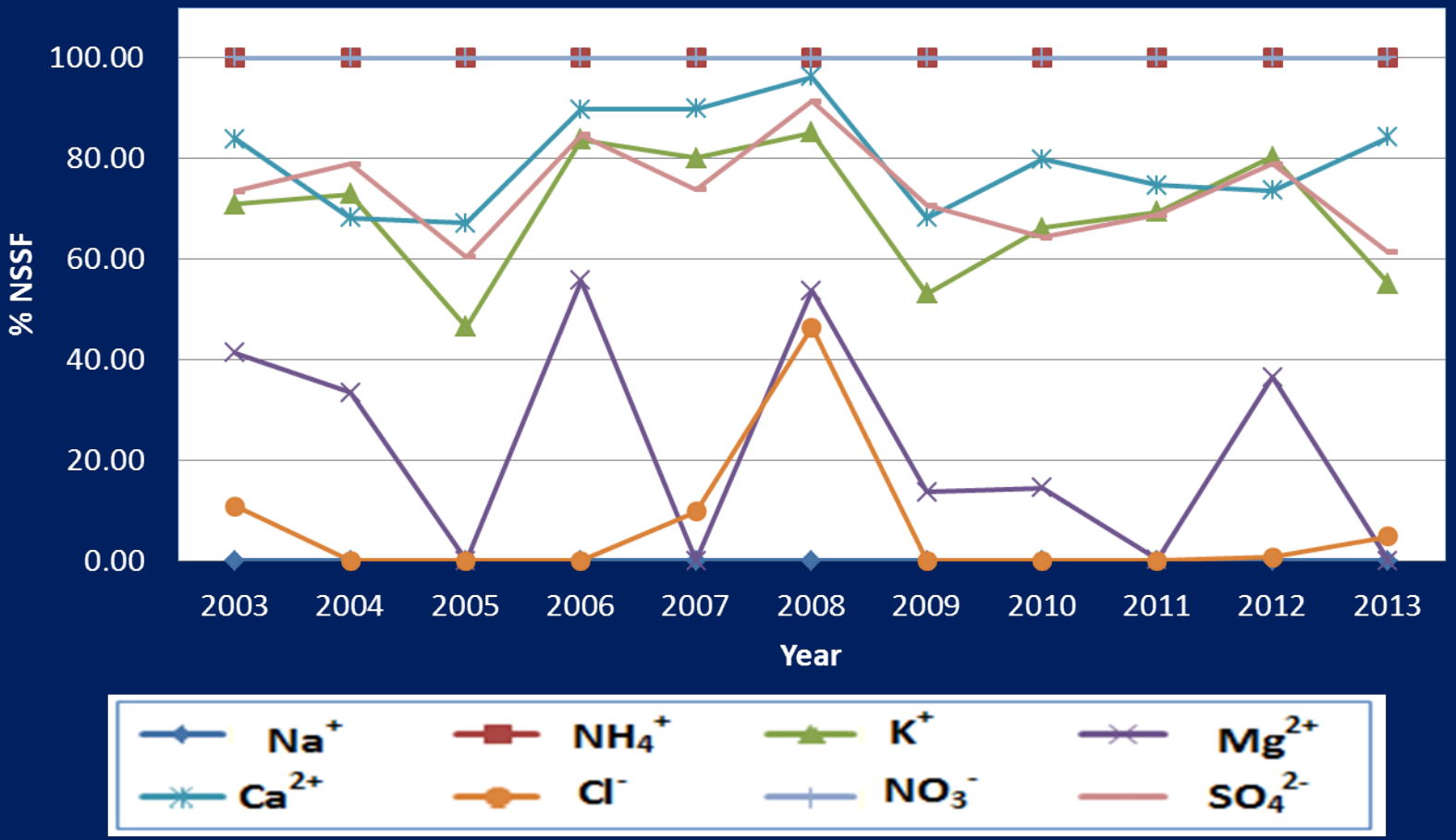
Monthly mean NO_3^- deposition at La Mancha station, 2003-2013.



Monthly mean SO_4^{2-} deposition at La Mancha station, 2003-2013.

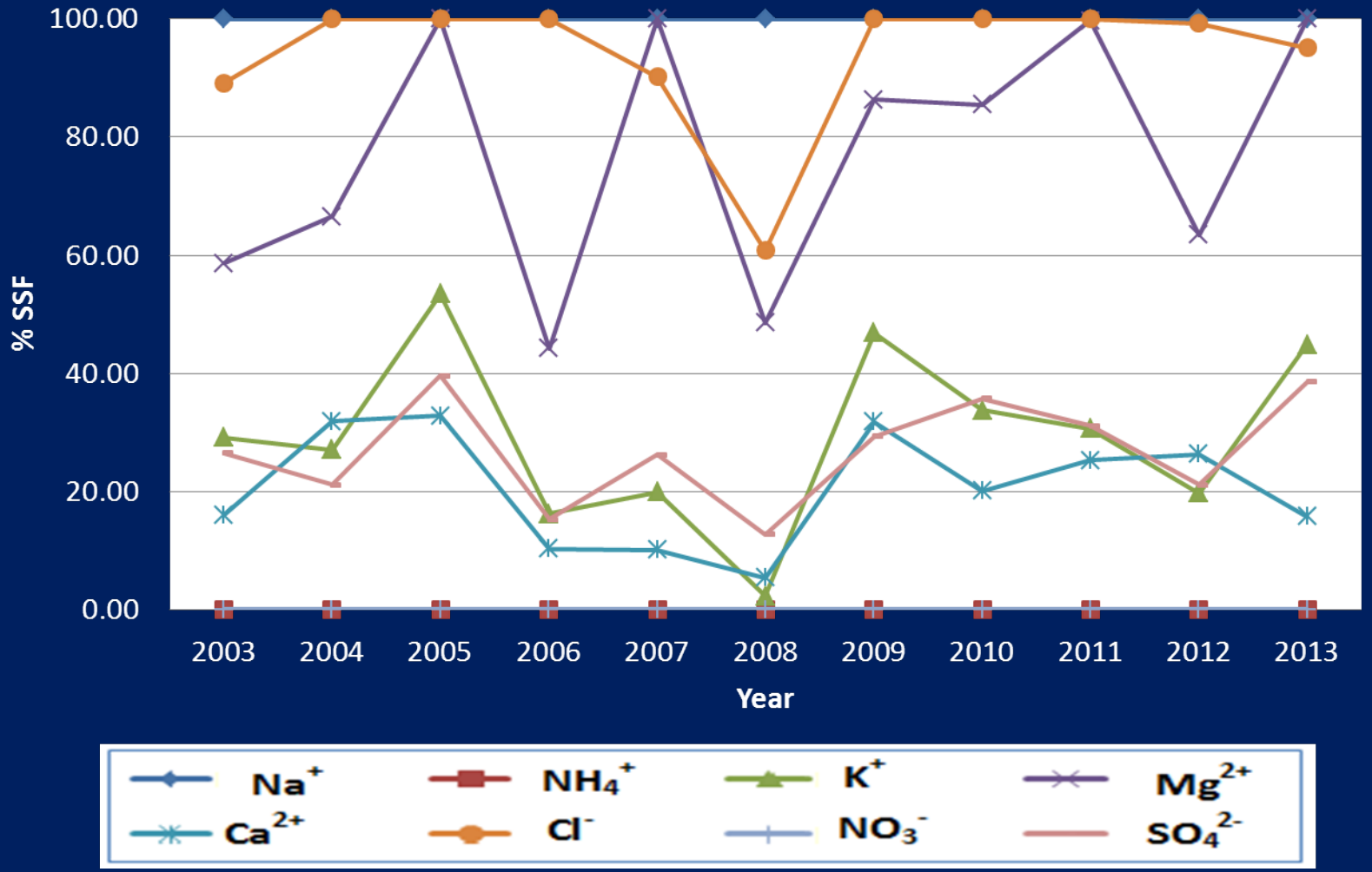


% NSSF anions and cations in La Mancha, Veracruz (2003-2013)



Centro de Ciencias de la Atmósfera, UNAM.

% SSF anions and cations in La Mancha, Veracruz (2003-2013)



Centro de Ciencias de la Atmósfera, UNAM.

Conclusions and recommendations

Volume Weighted Mean pH value (pH= 4.99) registered at La Mancha atmospheric deposition sampling station from 2003 to 2013, showed clearly the presence of the acid rain phenomena.

The results of the weighted values mean of pH indicated that wet deposition collected at La Mancha during the period 2003-2013 was acidic. In the statistical analysis of consecutive years of pH at this site, did not show significant variations over a period of eleven years of study.

Conclusions and recommendations

Sulfate ion concentration was higher than the concentration of nitrate ion, suggesting that the formation of acid rain was mainly to the formation and transport of sulfur dioxide in the region of La Mancha.

National Atmospheric Deposition Program

Aknowledgments

Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT-UNAM)

SCA CCA UNAM:
Verónica Néquiz Castillo, M. en I. Mónica Antúnez Arguelles, M. en I. Gilberto Fuentes Garcia, Cecilia Vargas, Ma. de los Ángeles López Portillo, Roberto Galicia Morales

Gobierno de Distrito Federal:
Quim. Armando Retama Hernández, M. en I. Olivia Rivera Hernández, Ing. Alejandro Campos Diaz, Ing. Miguel Sánchez, Raúl Amador Calderón, Jorge Rodas Rivera, Antonio Silva Hernández

Instituto de Ecología A.C.:
Dr. Jorge López Portillo; Enrique López Barradas

Instituto Nacional de Antropología e Historia:
Dr. Jurgen Brugerman†, Alejandro Santes. Ing. Daniel Goeritz, Arq. Jacinto Chacha, Arq. Nahum Noguera, M.en I. José Hernández Téllez, Biol. María del Pilar Ponce, LAE. Humberto Bravo Witt

Universidad Veracruzana:
Ing. Arturo Gomez

Centro de Ciencias de la Atmósfera, UNAM.

THANK YOU