Transport and possible climate impacts of aerosols from biomass burning from the Amazon to the Bolivian Andes.
(A new GAW/CHC station)

Rubén Mamani-Paco

M. Andrade, F. Velarde, D. Biggeman, F. Zaratti, C.I. Moreno

Instituto de Investigaciones Físicas
Universidad Mayor de San Andrés

Laboratorio de Física de la Atmósfera

Abstract

The transport of aerosols from biomass burning was studied using a MOUDI impactor to collect atmospheric particles differentiated by size. Particles collected were less than 10 microns in cut-off diameter. Samples were taken at the source and at the Chacaltaya Mountain research station during seasons of influence and non-influence of plumes from the Amazon region. A marker of biomass burning such as K was identified in particles sampled under pollutant plumes. Back trajectory models were run to estimate air mass transport from the Amazon to the sampling site. We concluded that there is evidence of aerosol transport from biomass burning and that this transport influences local atmospheric radiative effects which might affect glacier retreat in the tropical Andes.

Keywords: aerosols, climate change, Andes, biomass burning.

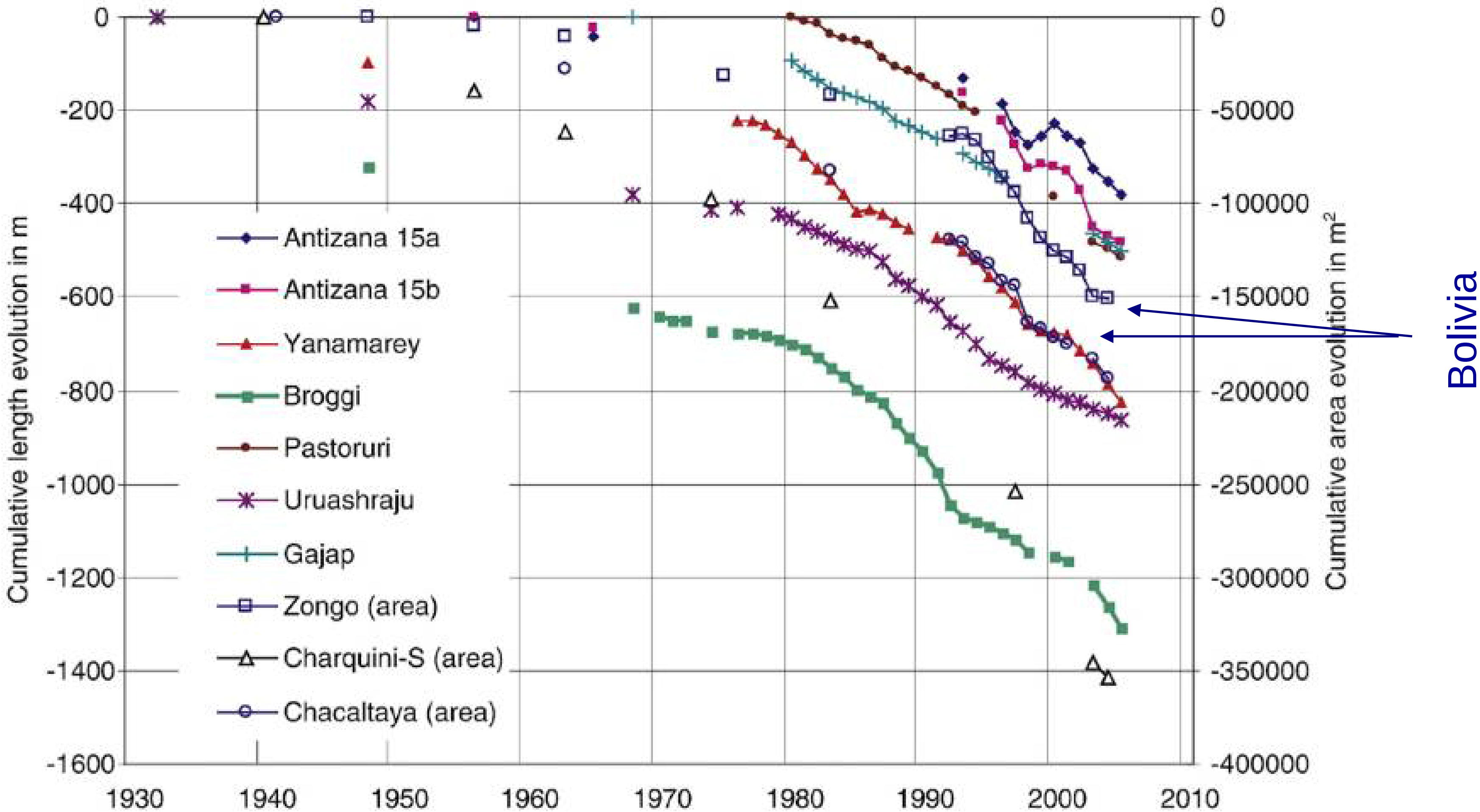
Introduction

- Absorbing aerosols contribute to changes in optical properties of snow and ice by changing their albedo.

Introduction

- Recent studies (Lau et al., 2010) suggest that at least part of the observed warming in the Himalayas could be due to aerosols transported from sources located far from the region.

Glacier retreat in the Andean region

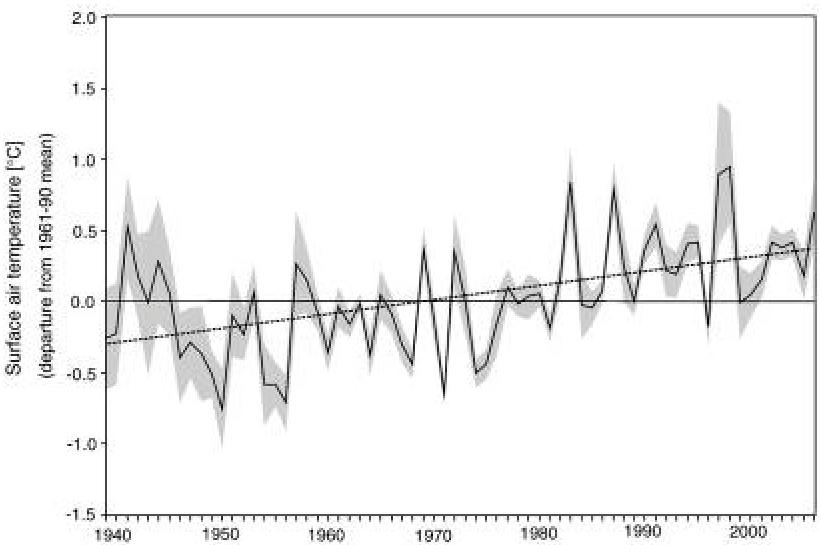


(Vuille et al., 2008)

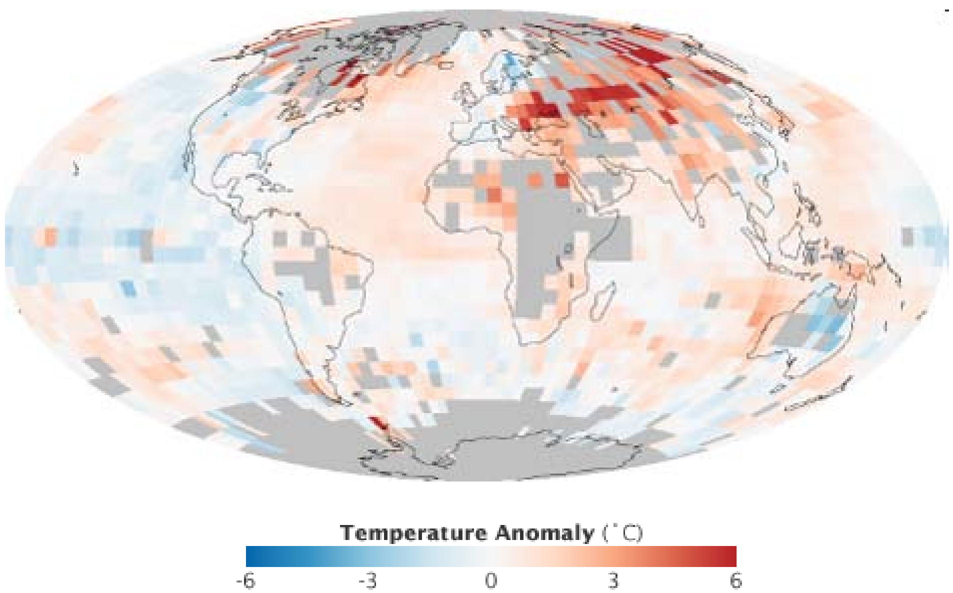
Temperature trends

- Temperature trends in the region (~0.10º C/decade), however, do not seem to account for the rapid retreat of the last two decades

Temperature anomalies



(Vuille et al., 2008)



Earth Observatory 2011 with data from Hadley Centre

Smoke transport over the Andes

- Smoke transport over the Bolivian Andes has been observed during the dry season (typically July to September)

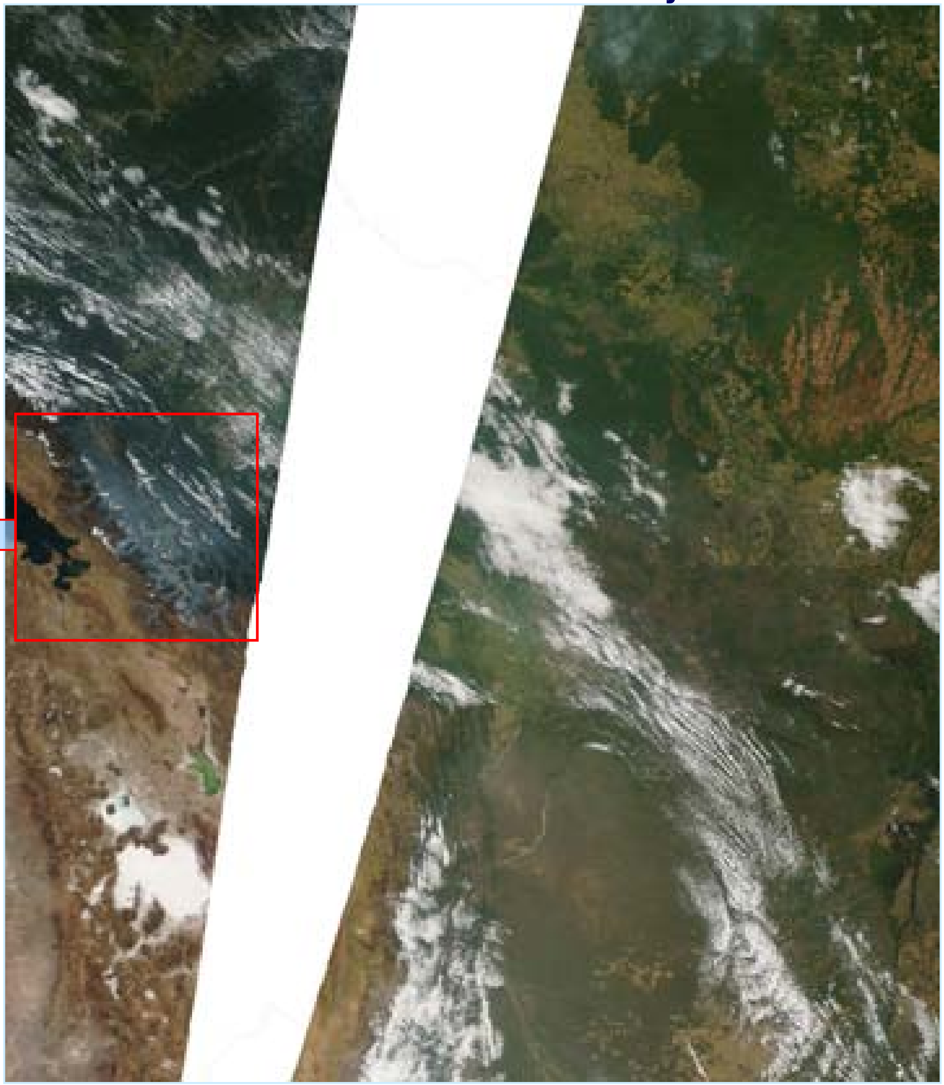
Smoke transport over the Andes, Apolobamba

(Tarquino-PMI, 2010-2011)

Evidence of aerosol transport to the city of La Paz

23 de julio, 2006

Smoke transport to La Paz

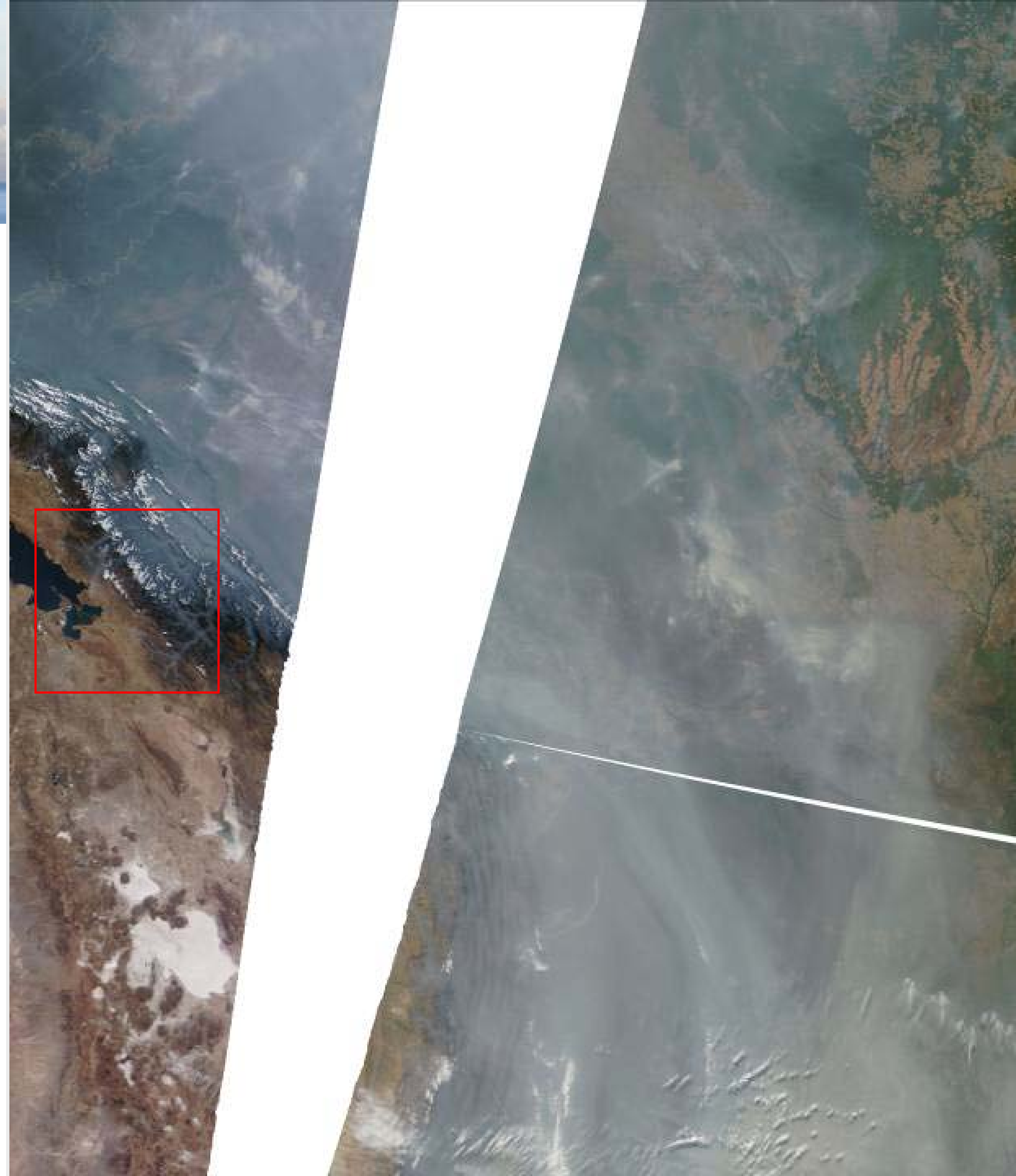


From MODIS on-board of Terra

Goals of this study

- To characterize the aerosol particles arriving to Chacaltaya.

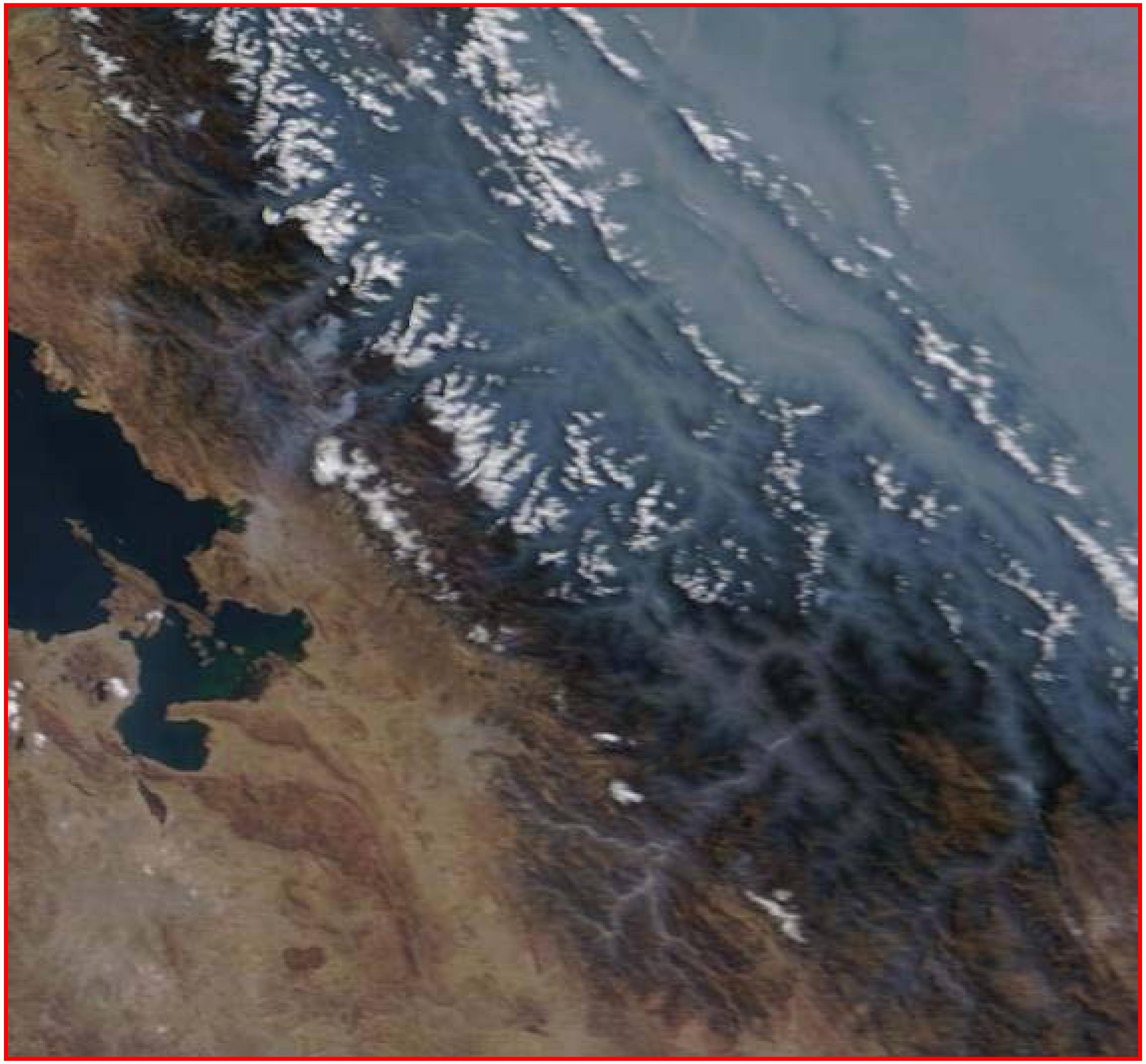
Smoke over Bolivia



August 19, 2010

From MODIS on-board of Terra

Smoke transported to the Altiplano

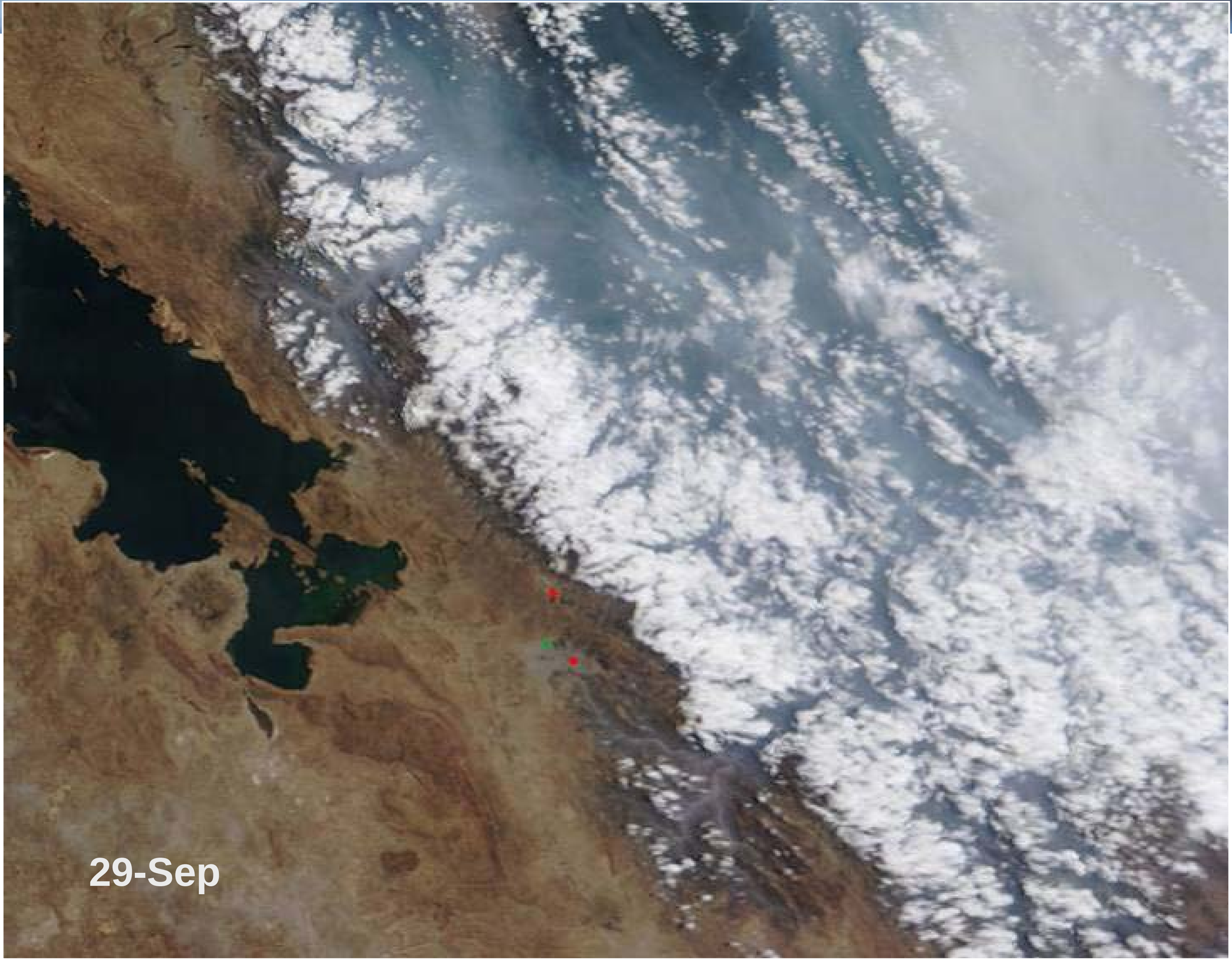


August 19, 2010

Measurements in 2010

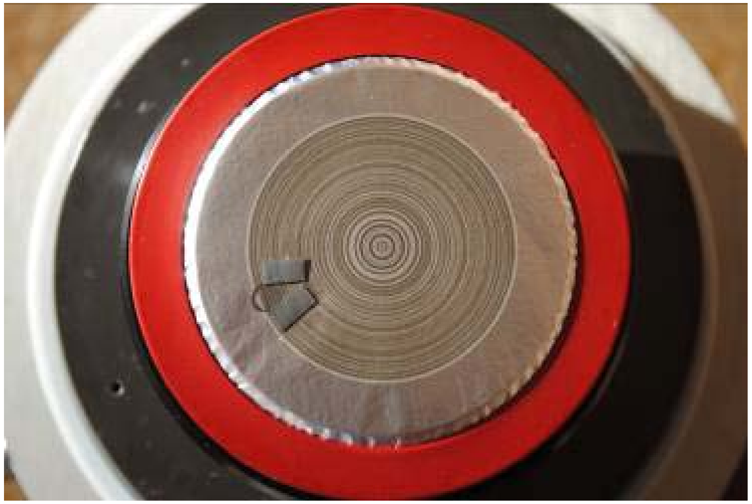
Sampling sites

Satellite imagery



Measurements in Chacaltaya (5200 masl)

Measurements at the LFA (3400 masl)



Going near the source…

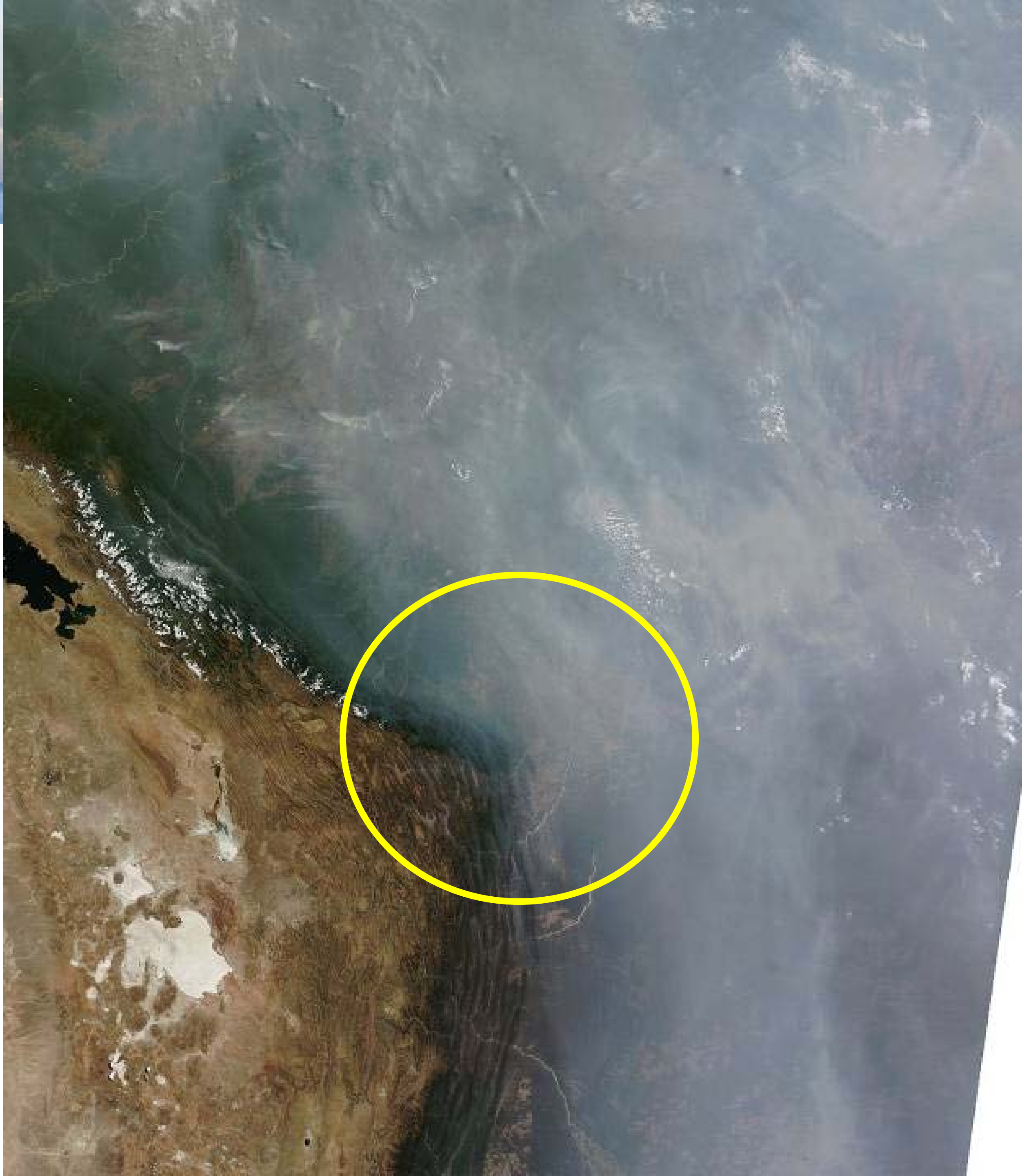
Santa Cruz

A lot of smoke…

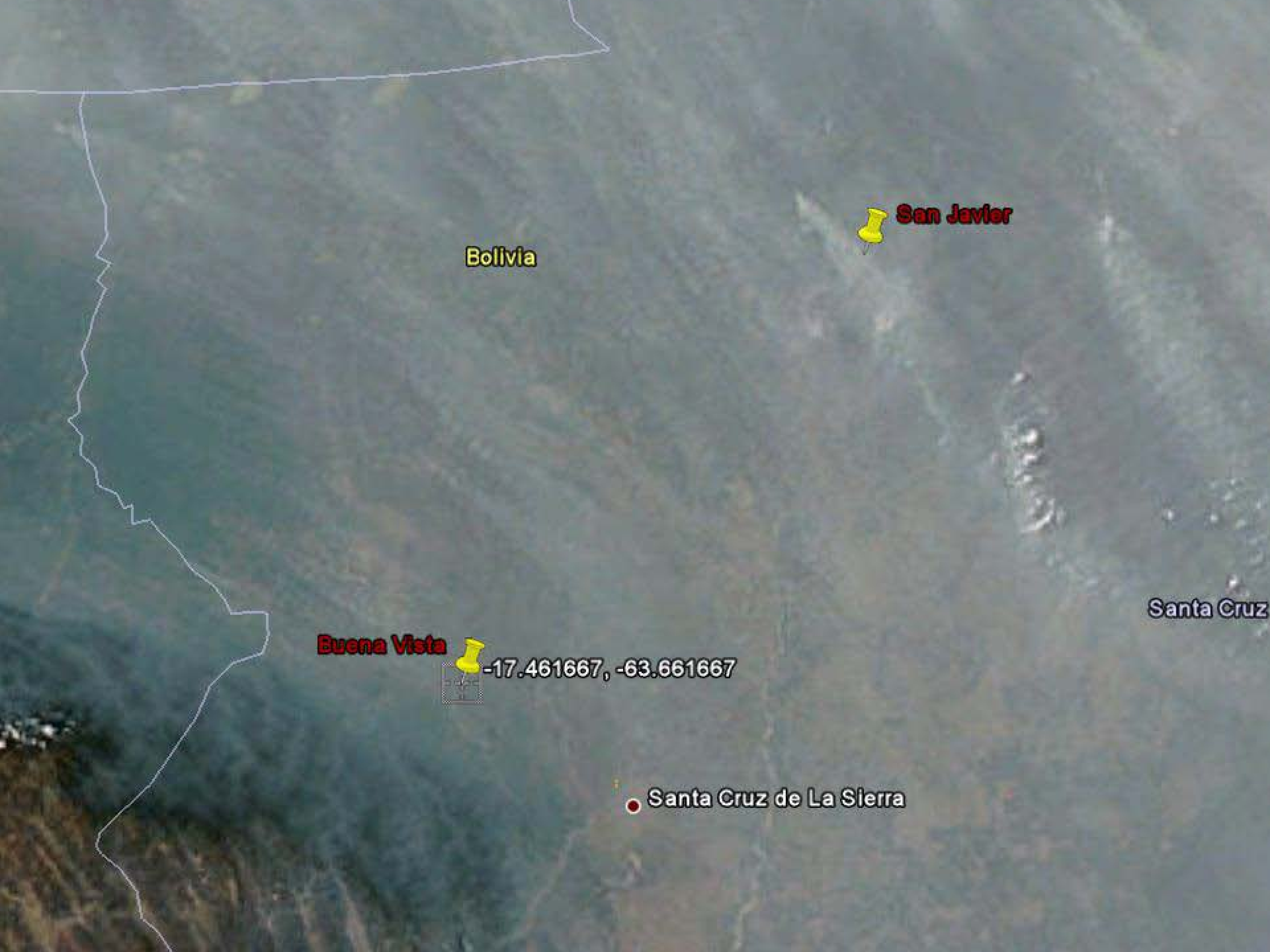
Sta. Cruz - 2

… and a lot of dust too.

Sept. 10, 2010



MODIS on board Terra


San Javier
Bolivia
Santa Cruz
Buena Vista
-17.461667, -63.661667
Santa Cruz de La Sierra

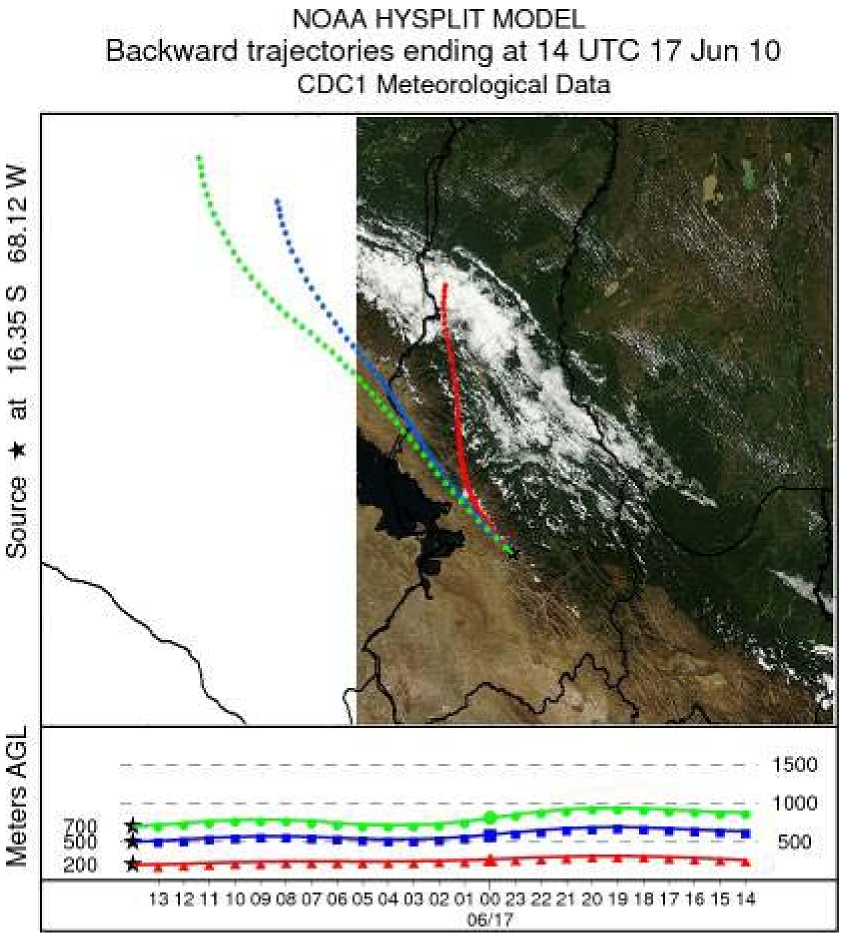
San Javier

Mass measurements

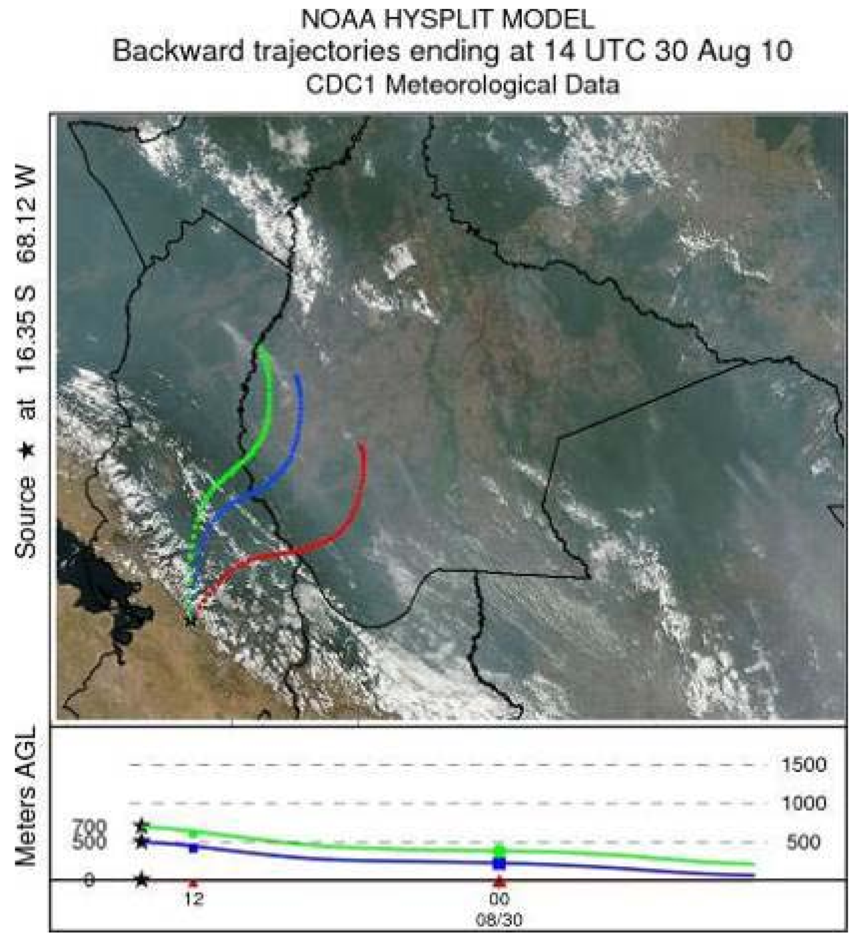
Site	Period (2010)	Conditions	Sampling Time	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)
Chacaltaya	June	Clean	5d,3h,50m	6.6 ± 0.1	19.2 ± 0.2
Chacaltaya	August	Smoky	4d,3h,30m	9.4 ± 0.1	16.3 ± 0.1
San Javier	September	Smoky	5h,10m	58 ± 1	72 ± 1

Backtrajectories

Clean conditions

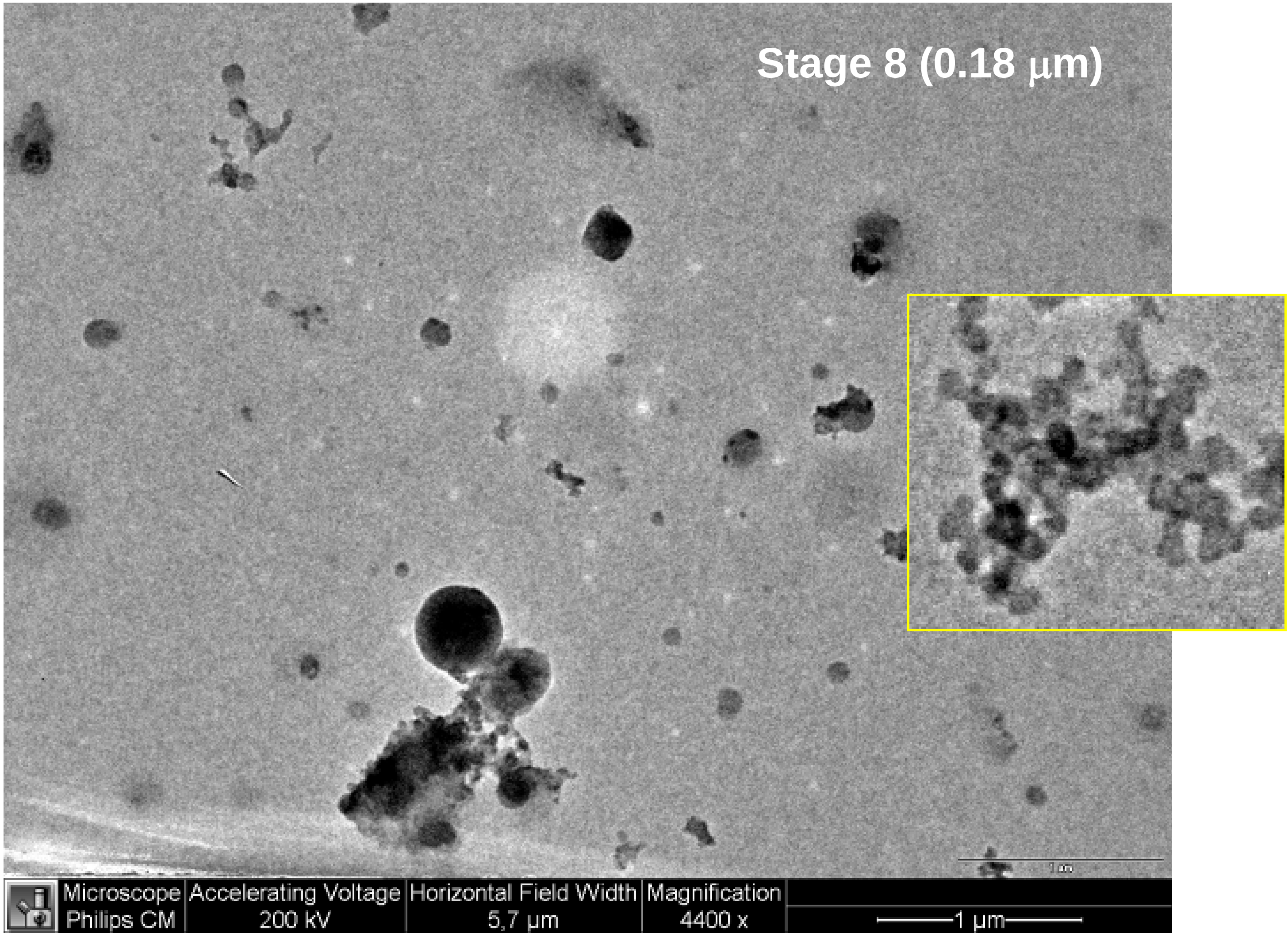


Smoky conditions



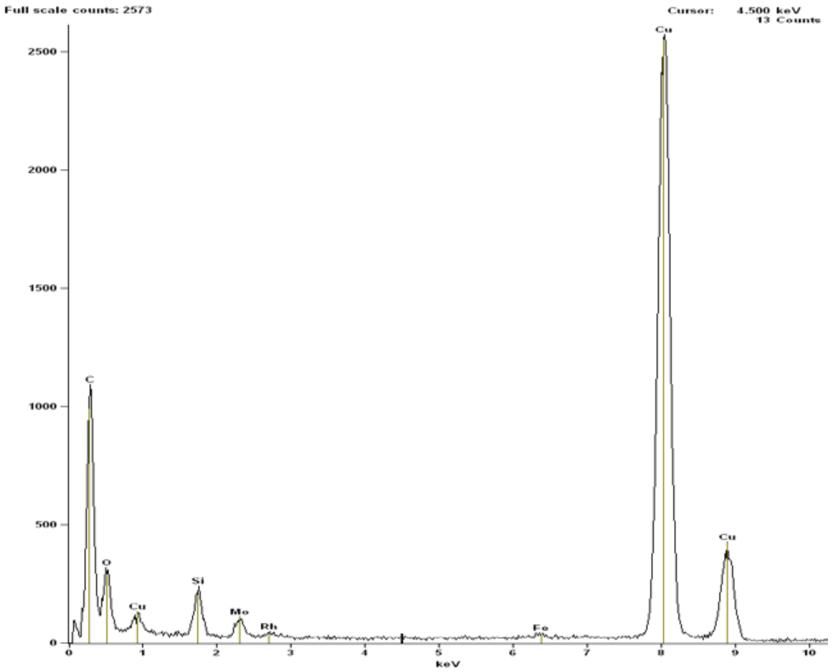
Images with an electronic microscope

Chacaltaya, smoky conditions (August)



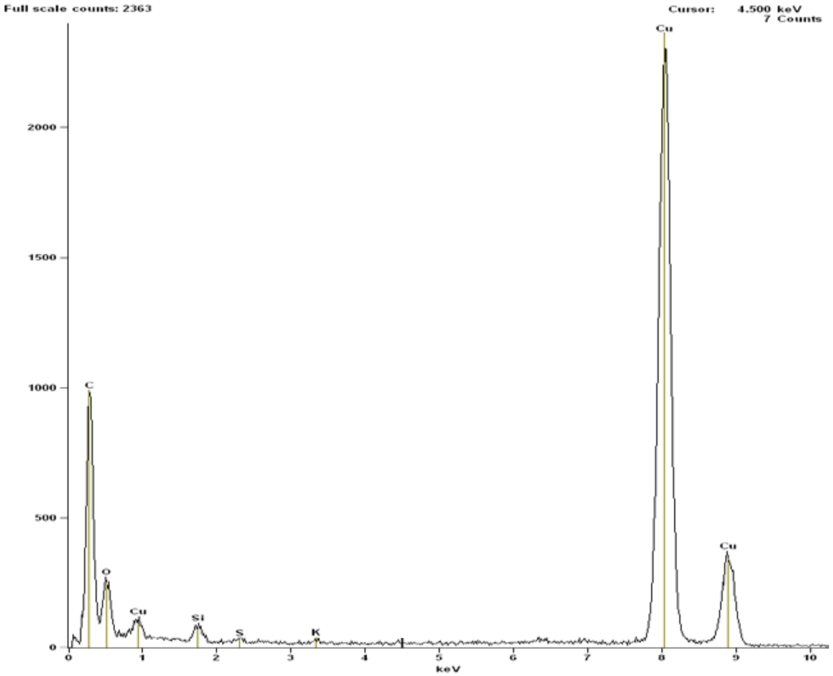
Analysis of grids

Clean conditions



Element Line	Element Wt.%	Wt.% Error
C K	56.70	+/-0.66
O K	28.49	+/-1.99
Si K	5.56	+/-0.18
Cu K	5.41	+/-0.05
Mo L	3.32	+/-0.22
Rh L	0.49	+/-0.12
Fe K	0.03	+/-0.01

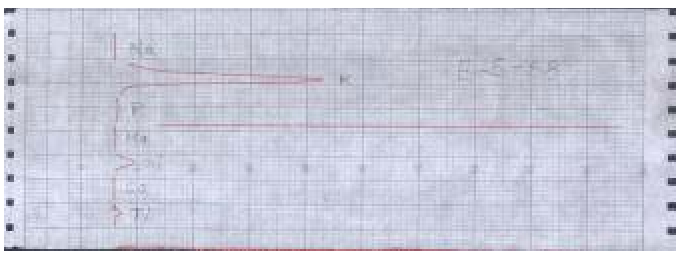
Smoky conditions

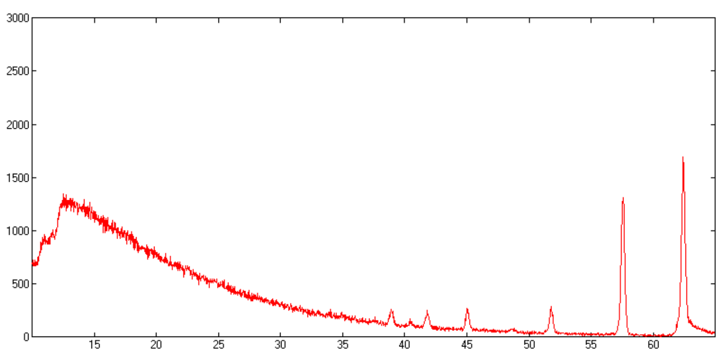


Element Line	Element Wt.%	Wt.% Error
C K	55.31	+/-0.67
O K	39.02	+/-1.67
Si K	2.11	+/-0.13
Cu K	3.29	+/-0.03
S K	0.20	+/-0.03
K K	0.07	+/-0.01

Analysis of grids

X-ray diffraction
X-ray fluorescence





Etapa 8 **(0.18 µm)**

Elemento/lugar	Chac_SI	Chac_CI	San Javier	Buena Vista	Blanco
			Rejillas TEM		
Ti	0	0	0	0	0
Ca	0	0	0	0	0
Si	2	2	1	3	2
Mg	0	0	0	0	0
P	0	0	0	0	0
K	0	3	2.5	2.5	0
Na	0	0	0	0	0

Etapa 7 **(0.32 µm)**

Elemento/lugar	Chac_SI	Chac_CI	San Javier	Buena Vista	Blanco
Ti	0	0	0	1	0
Ca	0	0	0	0	0
Si	2	2	2	2.5	2
Mg	0	0	0	0	0
P	0	0	0	0	0
K	0	11	12	5	0
Na	0	0	0	0	0

Etapa 6 **(0.56 µm)**

Elemento/lugar	Chac_SI	Chac_CI	San Javier	Buena Vista	Blanco
Ti	0	1	0	1	0
Ca	0	0	0	0	0
Si	2	4	2.5	2.5	2
Mg	0	0	0	0	0
P	0	0	0	0	0
K	0	8.5	2.5	2	0
Na	0	0	0	0	0

Etapa 5 **(1 µm)**

Elemento/lugar	Chac_SI	Chac_CI	San Javier	Buena Vista	Blanco
Ti	0	1	1	1.5	0
Ca	0	0	0	0	0
Si	2	3	2.5	3	2
Mg	0	0	0	0	0
P	0	0	0	0	0
K	1	1	0	0	0
Na	0	0	0	0	0

Etapa 4 **(1.8 µm)**

Elemento/lugar	Chac_SI	Chac_CI	San Javier	Buena Vista	Blanco
Ti	1.5	0.5	1	0.5	0
Ca	0	0	0	0	0
Si	4	5.5	4	2	2
Mg	0	0	0	0	0
P	0	0	0	0	0
K	1.5	1.5	0	0	0
Na	0	0	0	0	0

Results/Discussion

- Satellite imagery as well as ground measurements clearly show transport of smoke (and associated particles) to the Andes.

- Despite their elevation, measurements at Chacaltaya (5200 masl) show a significant concentration (in mass) of particles.

Results/Discussion - 2

-In the particle samples found in Chacaltaya under the influence of smoke we found presence of Potassium, K which is a typical marker for biomass burning.

-Particles in the smaller sizes showed higher mass concentrations of carbonaceous particles.

-More studies needed to assess other physical and chemical parameters due to the influence of particles and contaminants coming from biomass burning, urban pollution and area sources.

New Questions

-Carbonaceous particles are observed during the rainy season in Chacaltaya (not biomass burning). Probably they are originated in the near urban area.

-Need to study transport of air pollutants influenced by regional meteorological conditions and the Andes Mountains.

A new Global Atmospheric Watch, GAW/CHC Station

A new GAW/CHC station

Cosmic Ray Lab

Chacaltaya
GAW-WMO Regional Station

Aerosol Chemistry, GHG gases, physical properties of particles

A consortium of institutions has installed different air pollution monitoring instruments. Operations started in December 2011

The phase of calibration and initial measurements is ending. Measurements have started on a regular schedule.

Chacaltaya

Global Atmospheric Watch (GAW-WMO) Regional station

Laboratorio de Física de la Atmósfera

Joint efforts of an international consortium

- LFA-UMSA (La Paz, Bolivia)
- LGGE/PSI (Grenoble, France)
- TROPOS (Leipzig, Germany)
- ISAC/EvK2CNR (Italy)
- MISU (Stockholm,Sweden)
- Goddard Space Flight Center NASA (Greenbelt, USA).
- PSI (Villigen, Switzerland).
- IRD (France).

Summit AWS: 5380 masl

Observatory: 5240 masl

Long: 16º21' S

Lat: 68º08' W

Aerosols & Climate

- Aerosol & albedo of glaciers.
- Aerosol & radiative properties of the atmosphere
- Aerosol & rainy season onset
- Urban aerosol & health effects
- Water availability influences

So far, aerosol has been sparsely studied in this region.

Few stations are available:

- Brasil: Manaus (GAW), Sao Paulo (AEROCON),…
- Argentina: Ushuaia (GAW)
- Chile, Venezuela --> Few-year campaigns

Particle counting and size distribution (SMPS + CPC)
10 nm to 500 nm

Neutral Cluster and Air Ion Spectrometer (NAIS)
0.5 nm to 40 nm

Absorption coefficient of particles or “Black Carbon”)

Scattering & Backscattering coefficient of particles (Nephelometer)

CO_2 CO O_3
Gases concentration (Li-COR based)

Automatic Weather Station (AWS)

Campbell AWS

5380 masl (150 m above the station)

Wind, P, T, precipitation, RH, Short and Long wave radiation (incident)

High Volume Particle Filter Sampling

Quartz filter sampling for soluble ions, levoglucosan and BC analysis

PM_{10}, $PM_{2.5}$

Internship Possibilities

-Contact Information:

-Dr. Francesco Zaratti. Laboratorio de Fisica de la Atmosfera, LFA-UMSA.

Email: fzaratti@umsa.bo

-Dr. Marcos Andrade. Laboratorio de Fisica de la Atmosfera,LFA-UMSA.

Email: mandrade@atmos.umd.edu

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Vielen Dank!

Muchas Gracias!

Thank You!

Jikisinkama!

ILLAMPU view from the Island of the Sun

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