



# On understanding and addressing Air Pollution in Northern South Asia

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C4M Pune, India 1-3 May 2013

- ➔ Background
- ➔ SusKat\*: An end-to-end project
- ➔ Expectations

\*SusKat: Sustainable Atmosphere for the Kathmandu Valley

# Acknowledgement



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Prof. V. Ramanathan (UCSD), Prof. T. Nakajima (U. Tokyo), Prof. S.C. Yoon (SNU), Prof. A. Jayaraman (NARL), Prof. S. Fuzzi (CNR), M. Lawrence (IASS), S. Shrestha (UNEP)



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Many more.....

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- Prof. O. Gustafsson (SU), C. Bosch (SU), A. Anderson (SU)

- Prof. S.C. Yoon (SNU), Dr. S.W. Kim (SNU), Dr. J.H. Kim (SNU)
- Dr. J.S. Park (NIER), ....



- **Background**
- SusKat: An end-to-end project
- Expectations

## Regional Air Pollution in northern South Asia



24 March 2001



Birth of Project ABC of UNEP

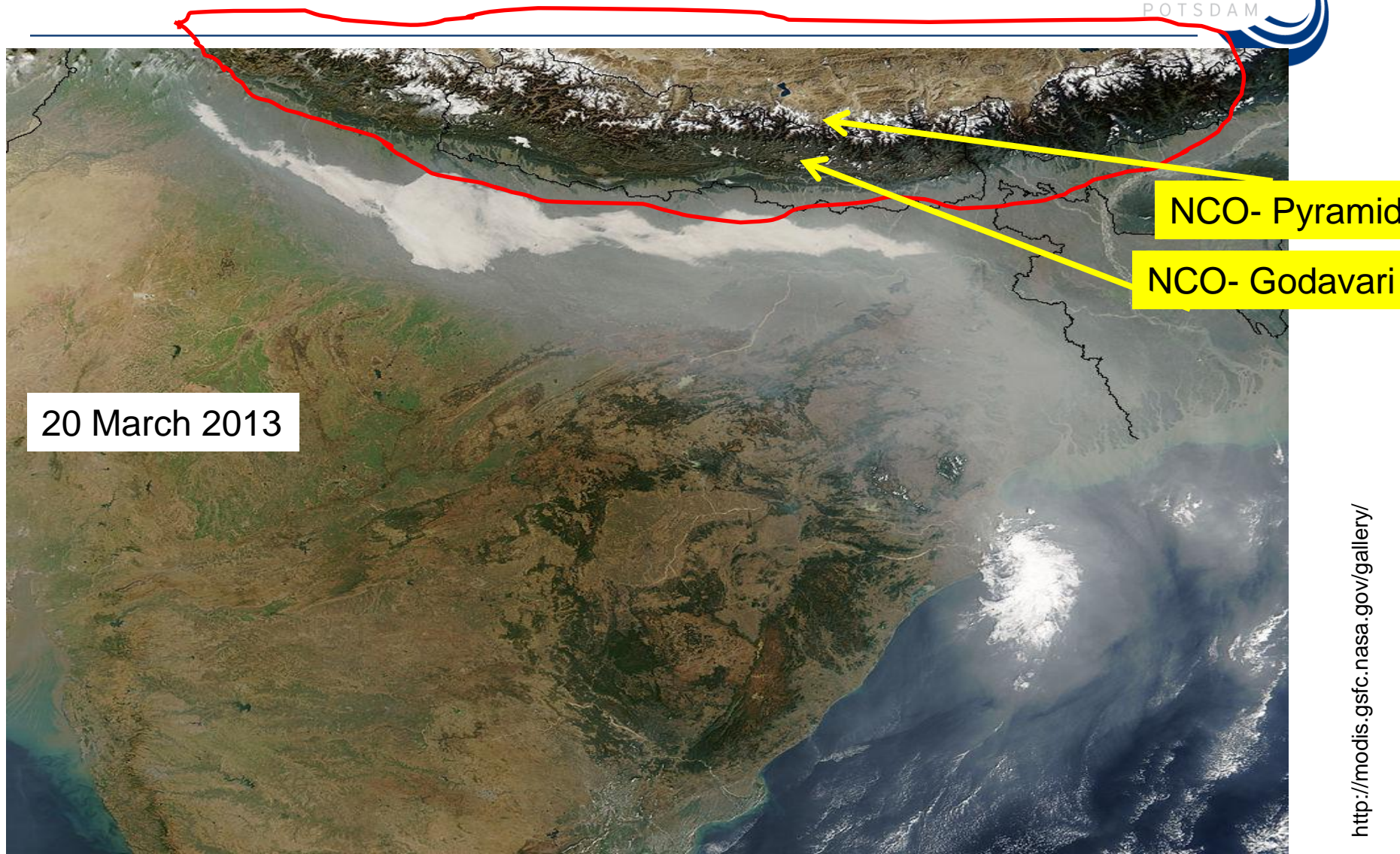


23 March 2001



# Regional Air Pollution in South Asia

IASS  
POTSDAM

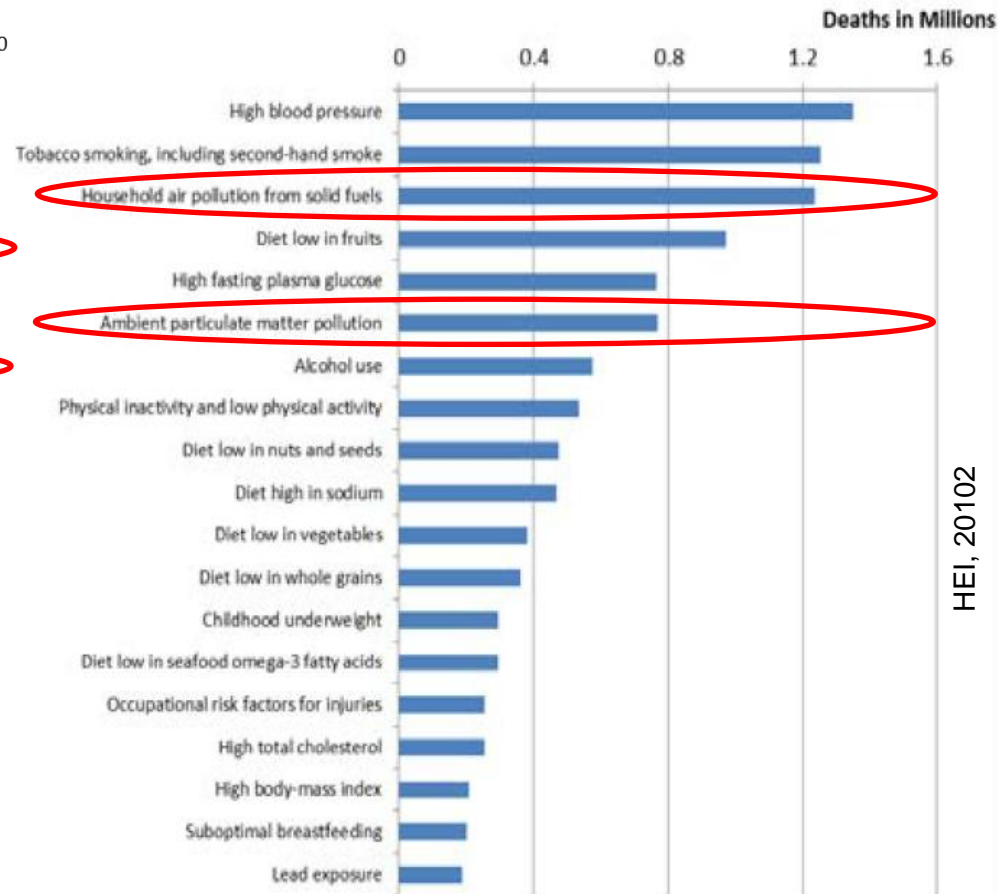
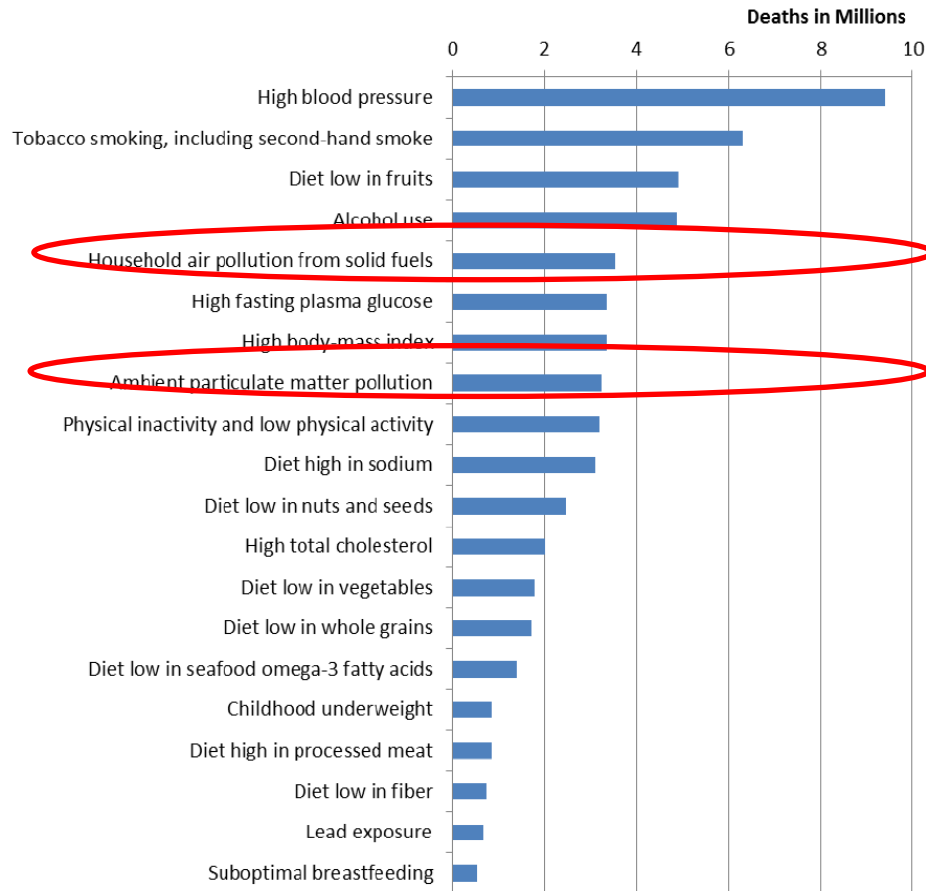


<http://modis.gsfc.nasa.gov/gallery/>

Northern South Asia: Still one of the least sampled regions of the world

# Air Pollution and Health in South Asia

## Deaths attributable to 20 leading risks in 2010



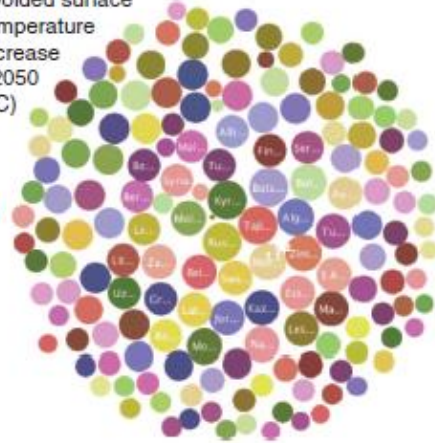
Our understanding of air pollution in the region has changed significantly.



# Multiple Benefits of Air Pollution (e.g. SLCP) Mitigation

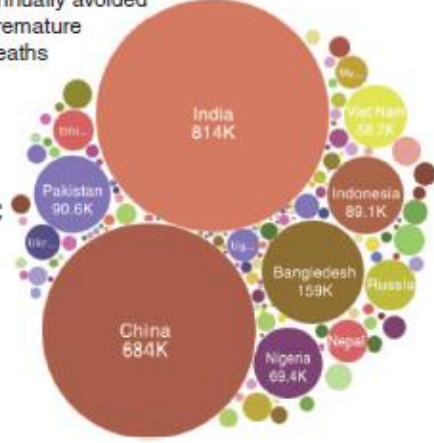
Avoided surface temperature increase ~2050 (°C)

A



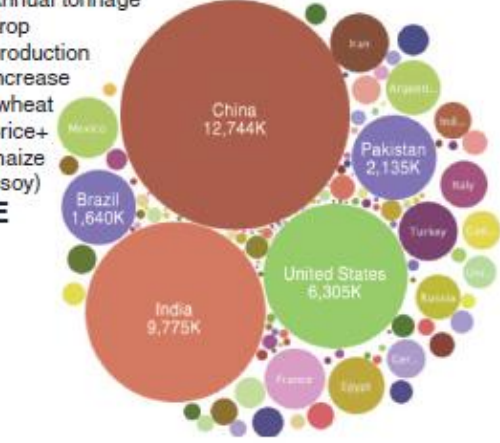
Annually avoided premature deaths

C



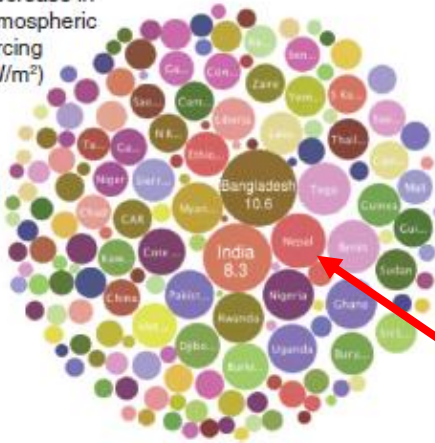
Annual tonnage crop production increase (wheat +rice+ maize +soy)

E



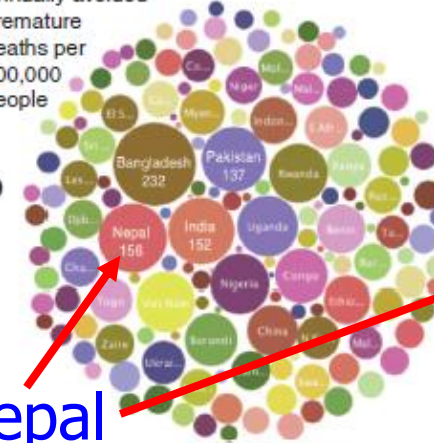
Decrease in atmospheric forcing (W/m<sup>2</sup>)

B



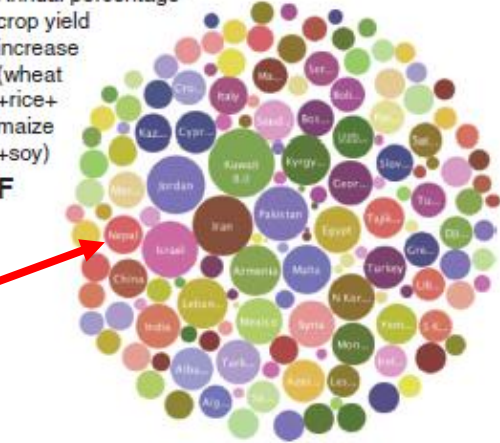
Annually avoided premature deaths per 100,000 people

D



Annual percentage crop yield increase (wheat +rice+ maize +soy)

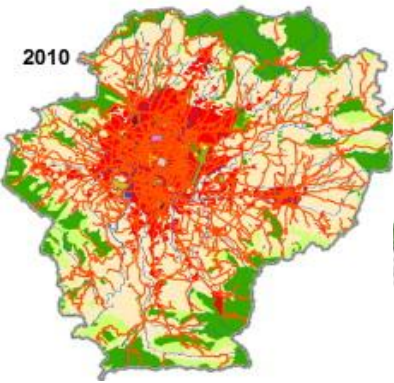
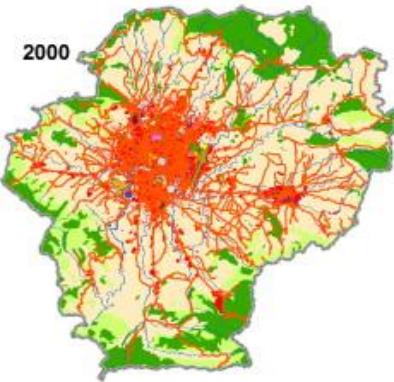
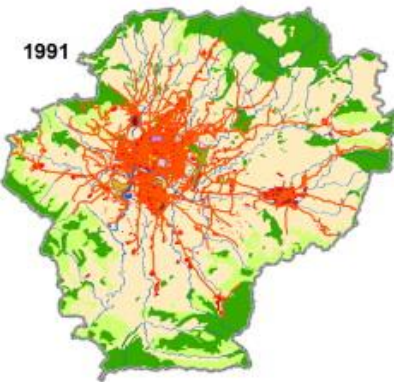
F



Nepal

- Nepal can get substantial benefits from SLCP mitigation
- Air pollution is a significant threat to Nepal's development goals

# Why Kathmandu Valley?



• Population (3 million )	~12 % of Nepal total
• Land (50km x 40 km)	1.5% of Nepal
• Vehicles (0.5 million)	~ 50% of Nepal
• Coal	40% of Nepal
• Petrol	66% of Nepal
• Diesel	35% of Nepal
• Kerosene	50% of Nepal
• LPG	55% of Nepal (50% of total residential use)

## Land use



ICIMOD, RUA, 2013

# Why Kathmandu Valley?



**Supermitter**



**Traffic Congestion**



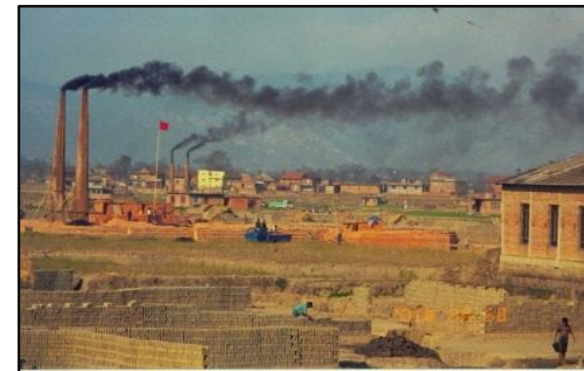
**Poorly maintained roads**



**Public Strikes**



**Meteorology**



**Brick Kilns**



**Garbage burning**



**Haze**



**Forest fire**

- 
- Background
  - ➔ • **SusKat: “end-to-end” project**
    - Scientific Basis
    - Mitigation Options
    - Engagement
    - Implementation of Mitigation
  - Expectations

1

## Scientific basis

Science



Observation

Emissions

Atmospheric Modeling

Impacts



Air quality

Climate

Health

Crops

Social

2

## Mitigation Options

Mitigation Options



Tech., financial, Legal...

Mitigation Potential



Impacts, cost/benefits...

3

## Engagement

Scientific Community



Research/Training/MSc/PhD/Postdoc

Policy Community



Science-policy interactions

Action Community



Private sector/media/ Outreach

4

## Implementation of Measures

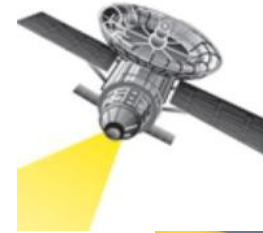


Demonstration

Scaling up

## SusKat-ABC Campaign in Nepal (Dec 2012- Jun 2013)

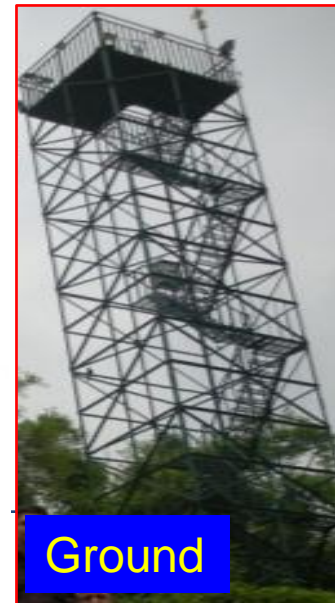
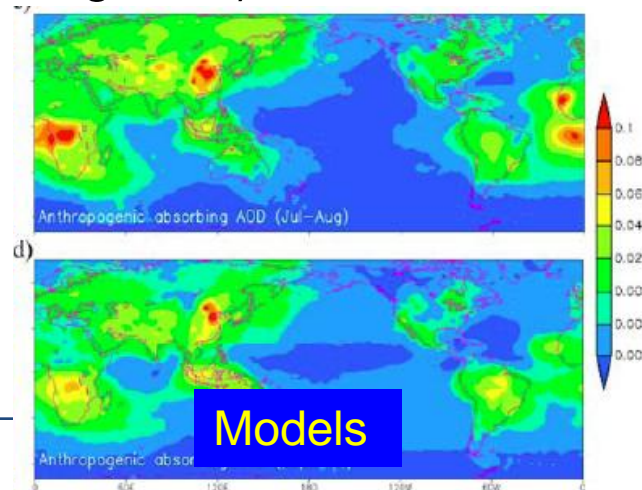
- 40+ Scientists
- 18 Research Groups
- 9 Countries
- 160+ instruments/sensors  
(Aerosol/Gas/Meteorology)
- **23 sites** (1 Supersite, 5 Satellite site, 2 regional sites, and other collaborating sites)



Space

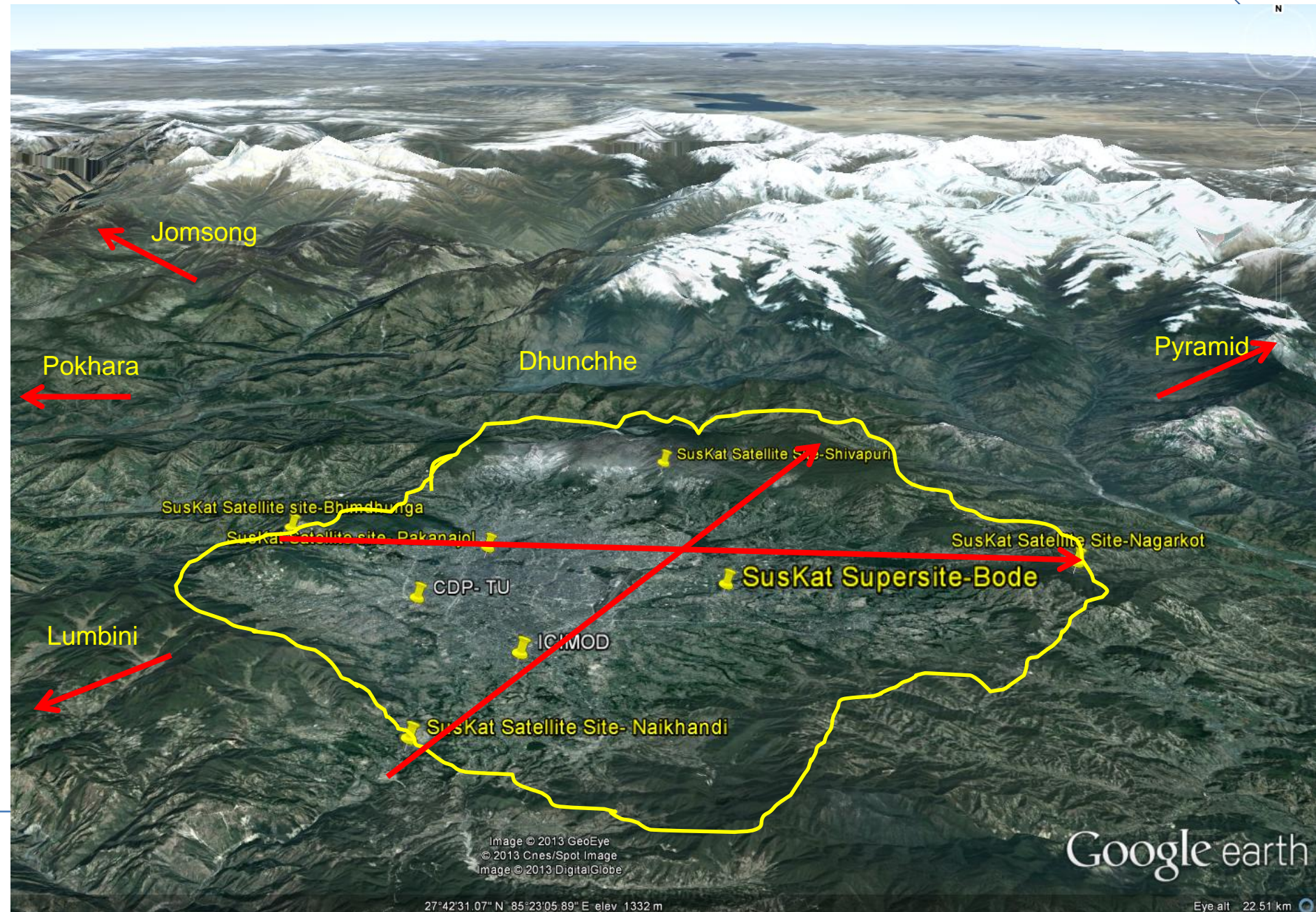


Air

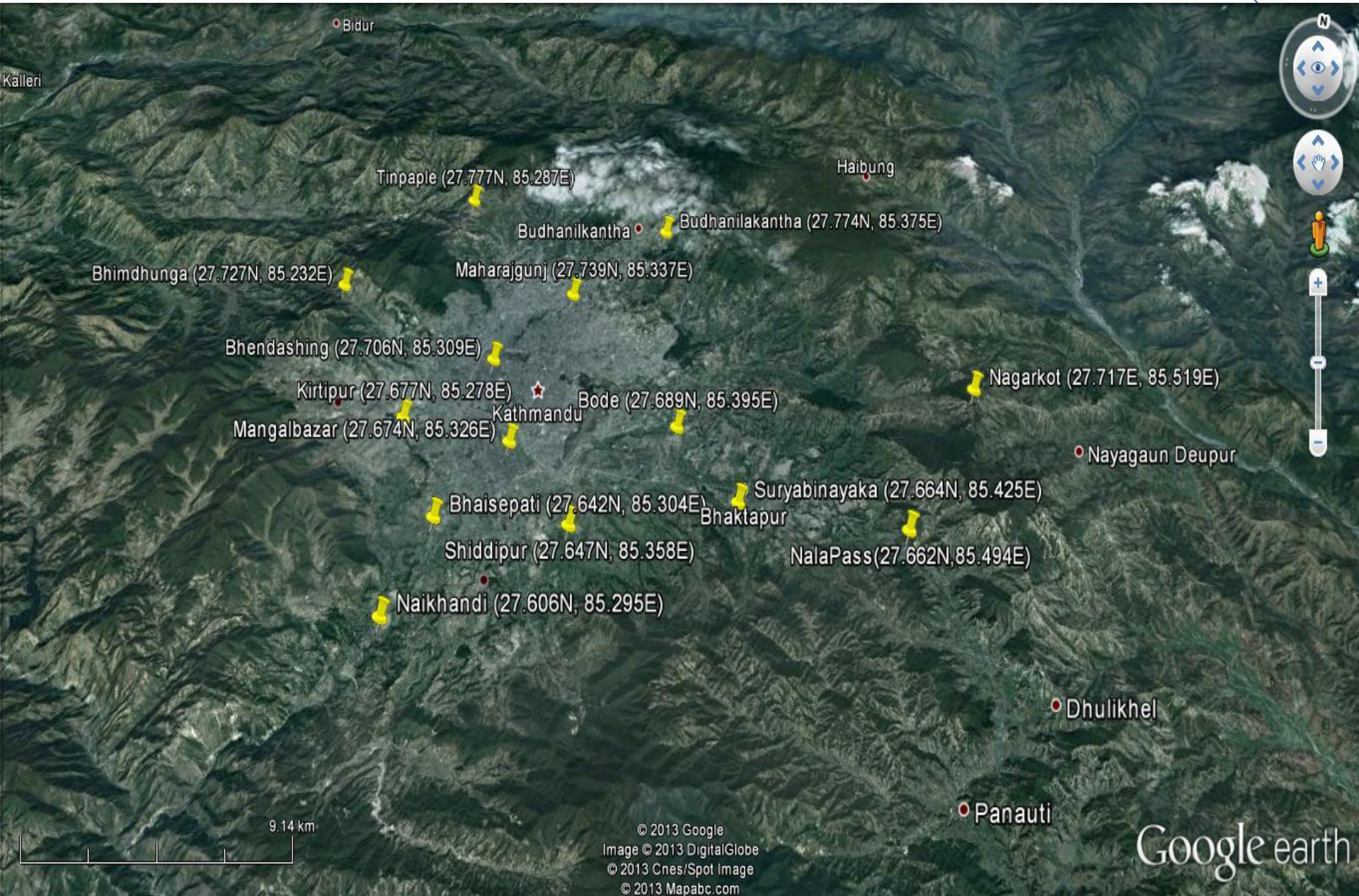


Ground

# SusKat-ABC Field Campaign ground sites



# SusKat-ABC Field Campaign passive sampling sites





# Instrumentation: Supersite-Bode

SN	Instrument	Parameter	Institute
1	Aethelometer AE31	BC	SNU, Korea
2	COSMOS	BC	SNU, Korea
3	Aethelometer AE31	BC	IOE TU, Nepal
4	Aethalometer AE33	BC	IASS, Germany
5	OPS	Number size distributions (coarse)	IASS, Germany
6	OPS	Number size distributions (coarse)	UVA, USA
7	APS	Number size distributions (coarse)	NIER, Korea
8	SMPS	Number size distributions (fine)	NIER, Korea
9	NanoSMPS	Number size distributions (fine)	IASS, Germany*
10	GRIM Dust Monitor	PM10 mass conc.	IASS, Germany
11	Dustrak	PM1/PM2.5/PM10 mass conc.	UVA, USA
12	UCPC	Total Particle Conc.	SNU, Korea
13	Handheld CPC	Total Particle Conc.	IASS, Germany
14	Nephelometer	Particle scattering	SNU, Korea
15	Aeronet Sunphotometer	AOD	NASA, USA
16	Microtops Sunphotometer	AOD	IOE, TU
17	Ceilometer	Aerosol vertical profile, PBL, Cloud height	U. Mainz, Germany
18	PM10 filter sampler	PM10 composition (ions, EC/OC)	NIER, Korea
19	Cascade Impactor	Size-segregated PM composition	SNU, Korea

# Instrumentation: Supersite-Bode



SN	Instrument	Parameter	Institute
20	Horiba O3 monitor	O3 conc.	AIERS, India
21	Teledyne CO monitor	CO conc	AIERS, India
22	2BTech O3 monitor	O3conc	UVA, USA/
23	2B Tech NOx monitor	NO, NO2 conc	ICIMOD, Nepal
24	Thermo CO monitor	CO conc	UVA, USA
25	Thermo O3 monitor	O3 conc	UVA, USA
26	Thermo CO monitor	CO conc	IASS, Germany*
27	Thermo O3 monitor	O3 conc	IASS, Germany
28	Gas Canisters	CO, CH4 and light HCs	AIRES/PRL, India
29	Ionicon PTR TOF MS	Speciated VOCs	IASS, Germany IISER , India
30	PICARRO gas monitor	CO, CH4, H2O , CO2	ICIMOD, Nepal
31	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany

SN	Instrument	Parameter	Institute
32	AWS	T, RH, WS, WD, Precip., Global Radiation	IASS, Germany
33	AWS	T, RH, WS, WD, P, Precip., Global Radiation	UVA, USA
34	SODAR	3D wind profile	CDP, TU

SP2 and LIDAR failed before running.

# Satellite-Bhimdhunga, Shivapuri and Naikhandi

SN	Instrument	Parameter	Institute
1	Aethelometer AE31	BC	IOE TU, Nepal
2	2BTech O3 monitor	O3 conc	AIRES, India
3	Microtops Sunphotometers	AOD, O3 column	ICIMOD, Nepal
4	Thermo CO monitor	CO conc	UVA, USA
5	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany
6	AWS	T, RH, WS, WD, P, Precip., Global Radiation	UVA, USA
7	SODAR	3D wind profile	CDP, TU

SN	Instrument	Parameter	Institute
1	Aethelometer AE33	BC	IOE TU, Nepal
2	2BTech O3 monitor	O3 conc	UVA, USA
3	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany
4	AWS	T, RH, WS, WD, P, Precip., Global Radiation	UVA, USA

SN	Instrument	Parameter	Institute
1	Aethelometer AE31	BC	AIRES, India
2	DUSTRAK	PM1/PM2.5/PM10 mass conc	UVA, USA
3	2BTech O3 monitor	O3 conc	UVA, USA
4	Thermo CO monitor	CO conc	UVA, USA
5	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany
6	AWS	T, RH, WS, WD, P, Precip., Global Radiation	UVA, USA

# Satellite- Pakanajol

SN	Instrument	Parameter	Institute
1	MAAP	BC	Ev-K2-CNR, Italy
2	PM monitor	PM1/PM2.5/PM10 mass conc	Ev-K2-CNR, Italy
3	O3 monitor	O3 conc	Ev-K2-CNR, Italy
4	CO monitor	CO conc	Ev-K2-CNR, Italy
5	PM filters	PM composition	Ev-K2-CNR, Italy
6	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany
7	AWS	T, RH, WS, WD, P, Precip., Global Radiation	Ev-K2-CNR, Italy

# Satellite- Nagarkot

SN	Instrument	Parameter	Institute
1	<a href="#">Aethalometer AE51</a>	BC	<a href="#">UVA, USA/ICIMOD</a>
2	<a href="#">Aethalometer AE33</a>	BC	<a href="#">AIRES, India</a>
3	OPS	PM1/PM2.5/PM10 mass conc	UVA, USA/ICIMOD
4	Thermo O3 monitor	O3 conc	Ev-K2-CNR, Italy
5	Thermo CO monitor	CO conc	Ev-K2-CNR, Italy
6	Passive samplers	NOx, SO2, O3 and NH3	IASS, Germany
7	AWS	T, RH, WS, WD, P, Precip., Global Radiation	RTS, Nepal

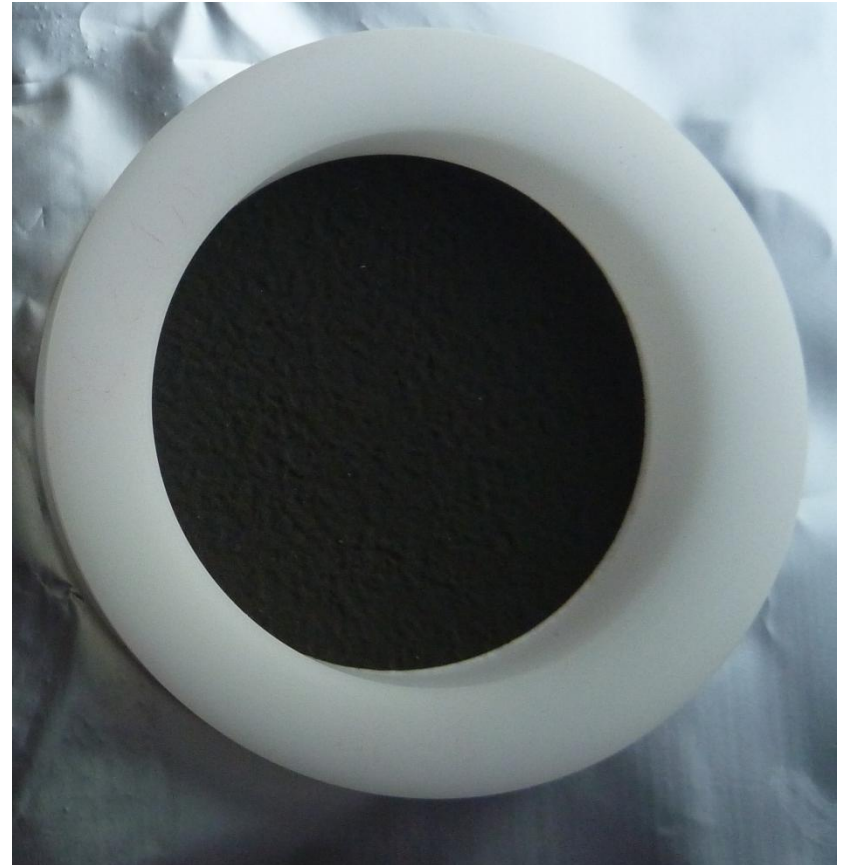
## Regional - Lumbini

SN	Instrument	Parameter	Institute
1	Aeronet Sunpotometer	AOD	NASA, USA
2	Microtops Sunpotometer	AOD	UVA, USA
3	PM monitor	PM10 , PM2.5, PM1 mass conc	IASS, Germany
4	PM filters	PM composition	ITP CAS, China
5	Magee Aethalometer	BC conc	ARIES, India
6	TSI OPS	Particle Number distribution	IASS, Germany
7	CO monitor	CO conc.	IASS, Germany
8	O3 monitor	O3 conc.	IASS, Germany
9	AWS	T, RH, WS, WD, Precip., Global Radiation	IASS, Germany

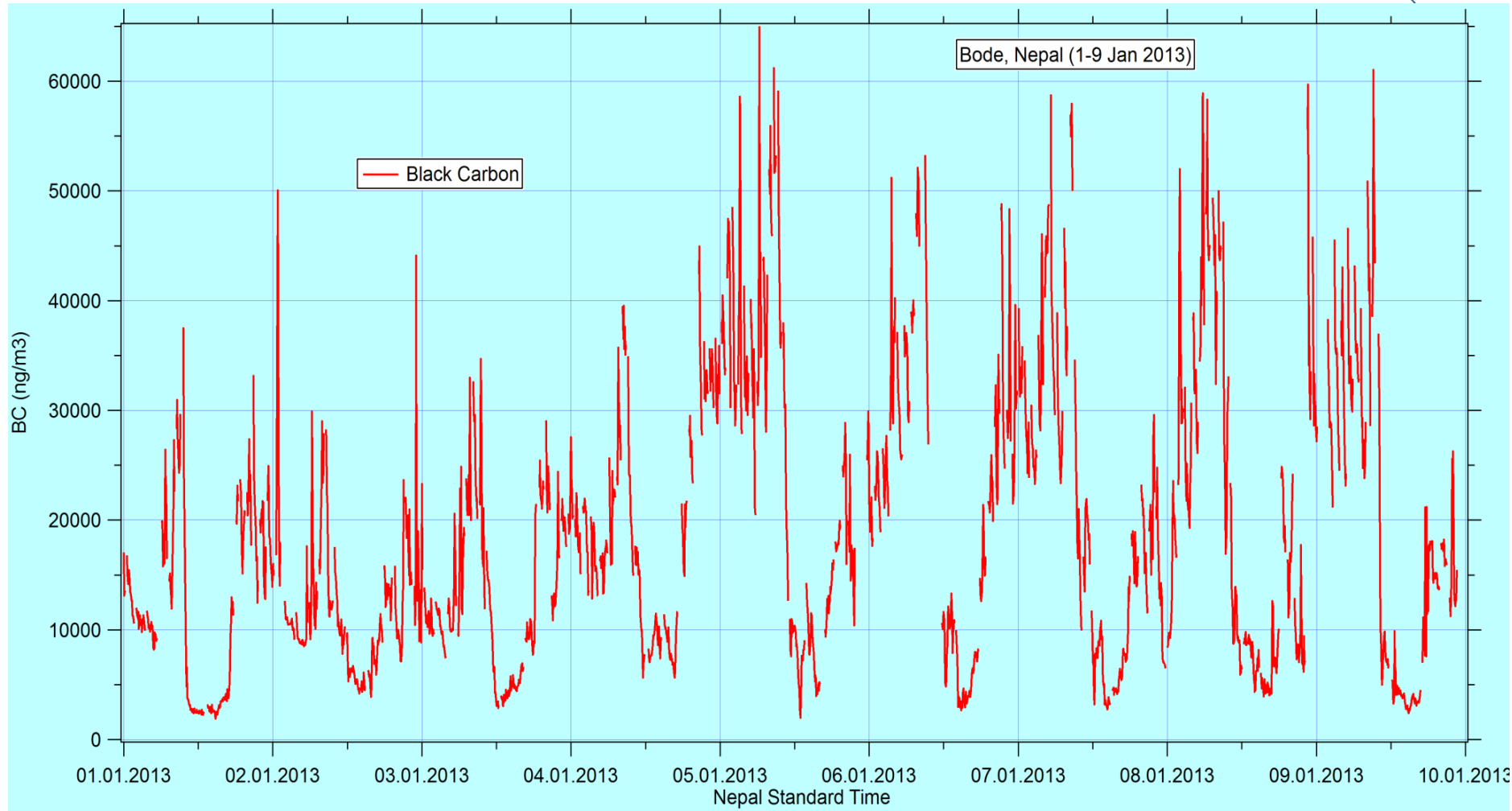
## Regional - Pokhara

SN	Instrument	Parameter	Institute
1	Aeronet Sunpotometer	AOD	NASA, USA
2	PM filters	PM composition	ITP CAS, China
3	AWS	T, RH, WS, WD, Precip., Global Radiation	UVA, USA



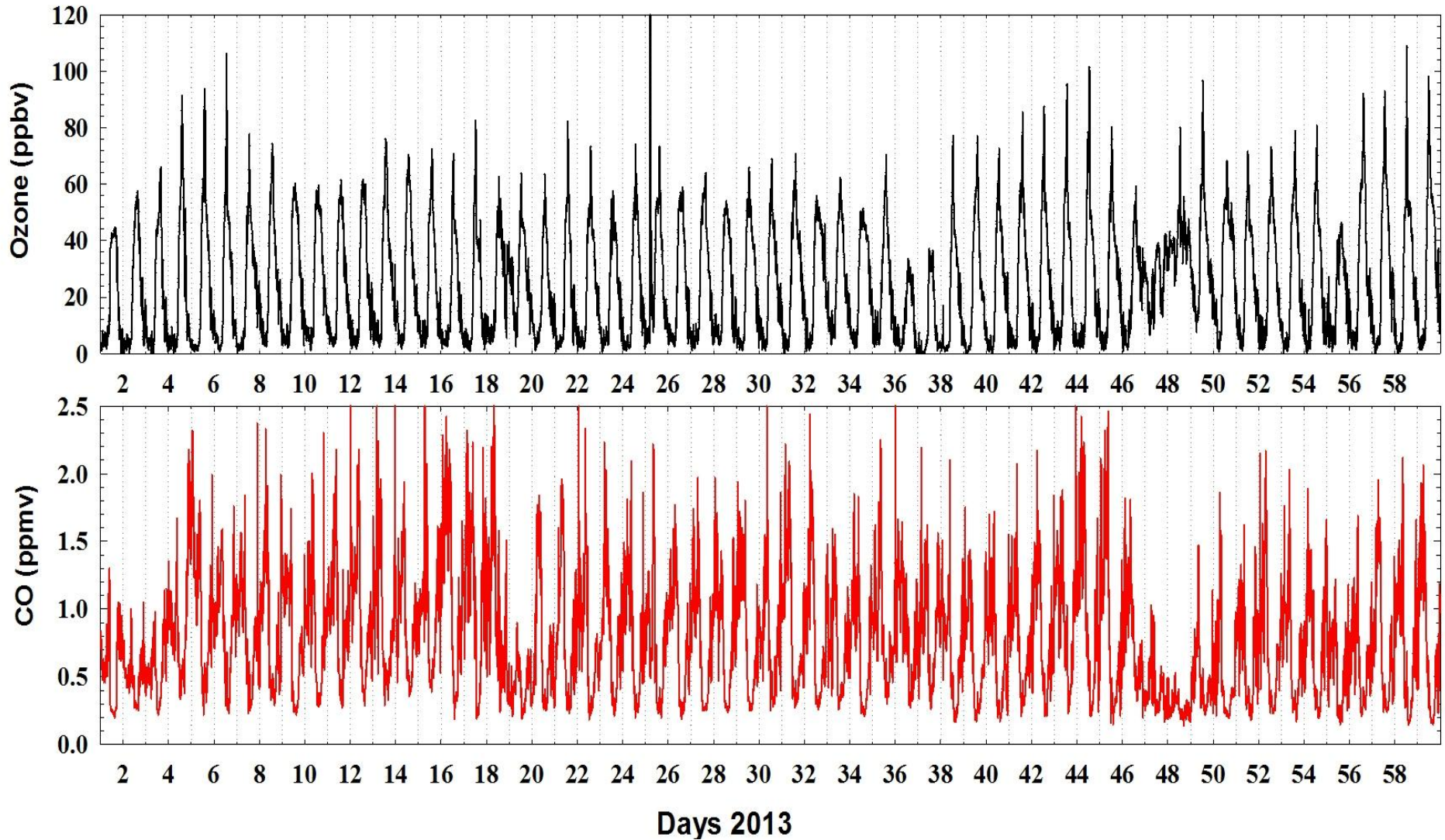


PM10 filter sampling at Bode: Filter before sampling and after 24h sampling



- BC is monitored simultaneously at 7 sites in the Valley and in Lumbini
- Some sites have now time series for over a year



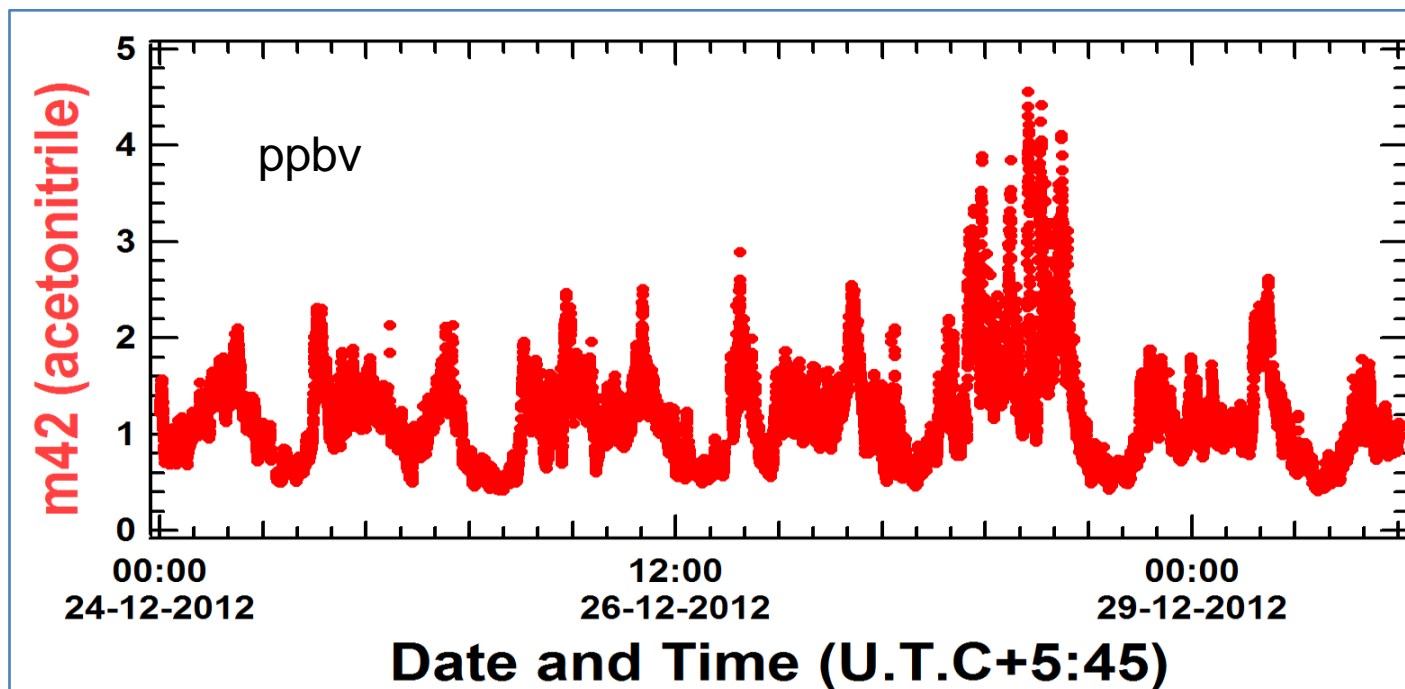


- CO and O3 are simultaneously monitored at 6 sites in the Valley – 8 months data

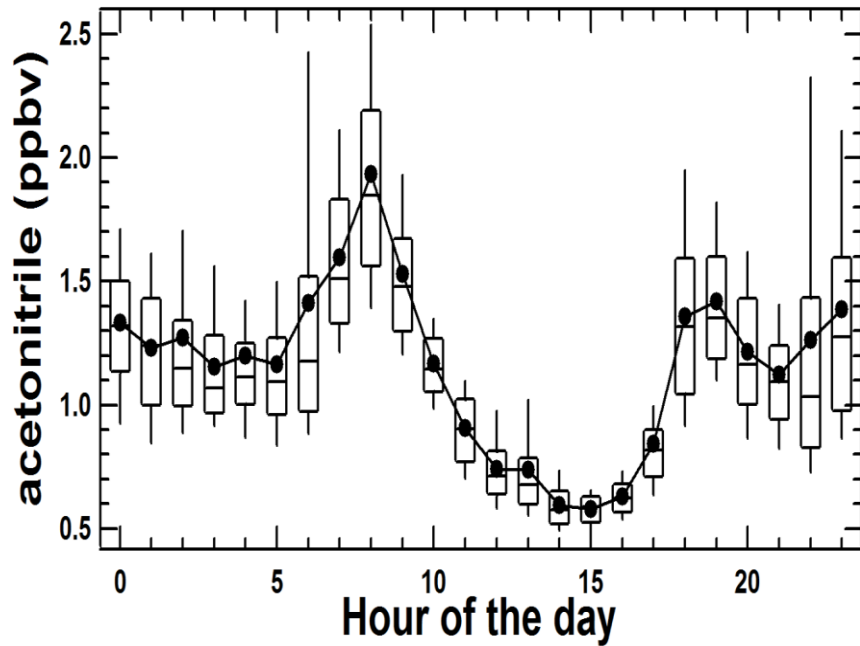
# 1<sup>st</sup> PTR TOF MS measurement in South Asia



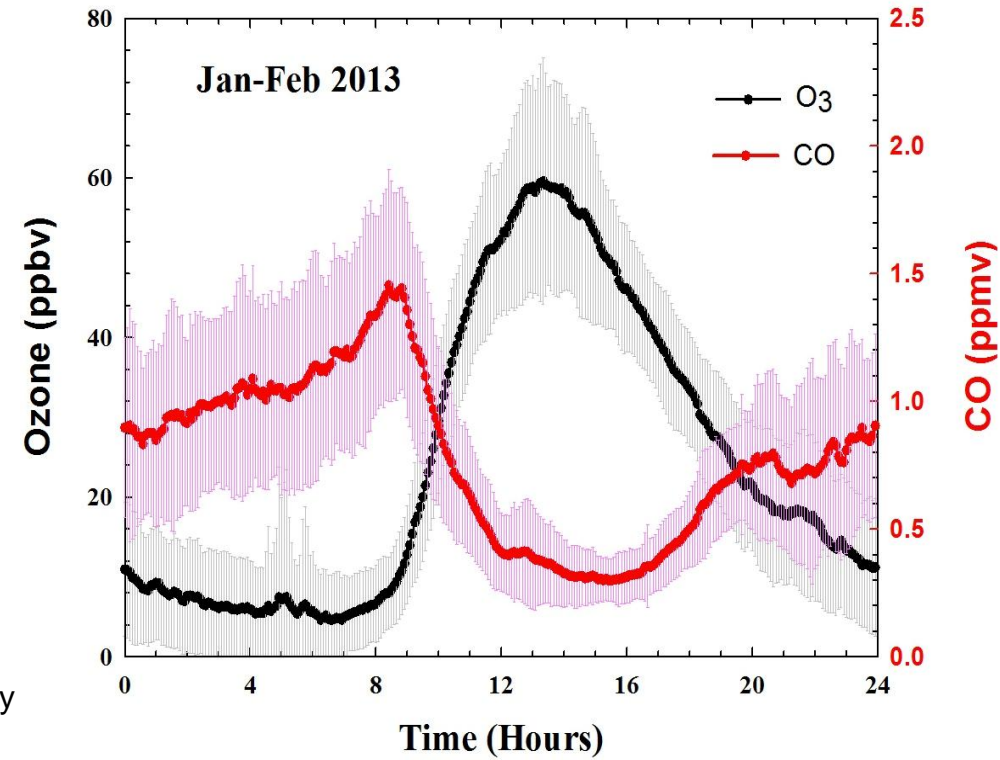
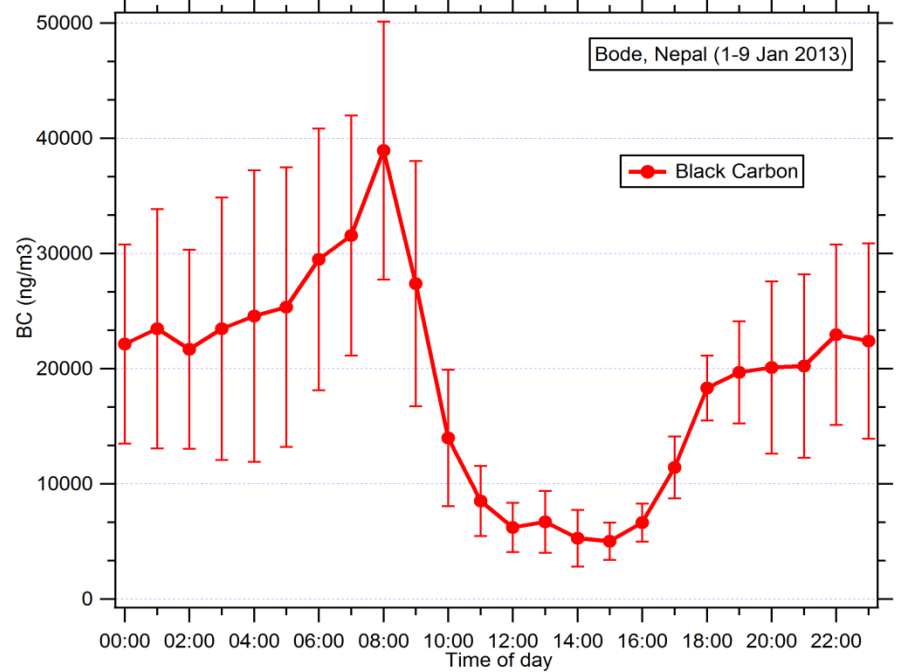
**Supersite: Bode**



# Supersite: Bode



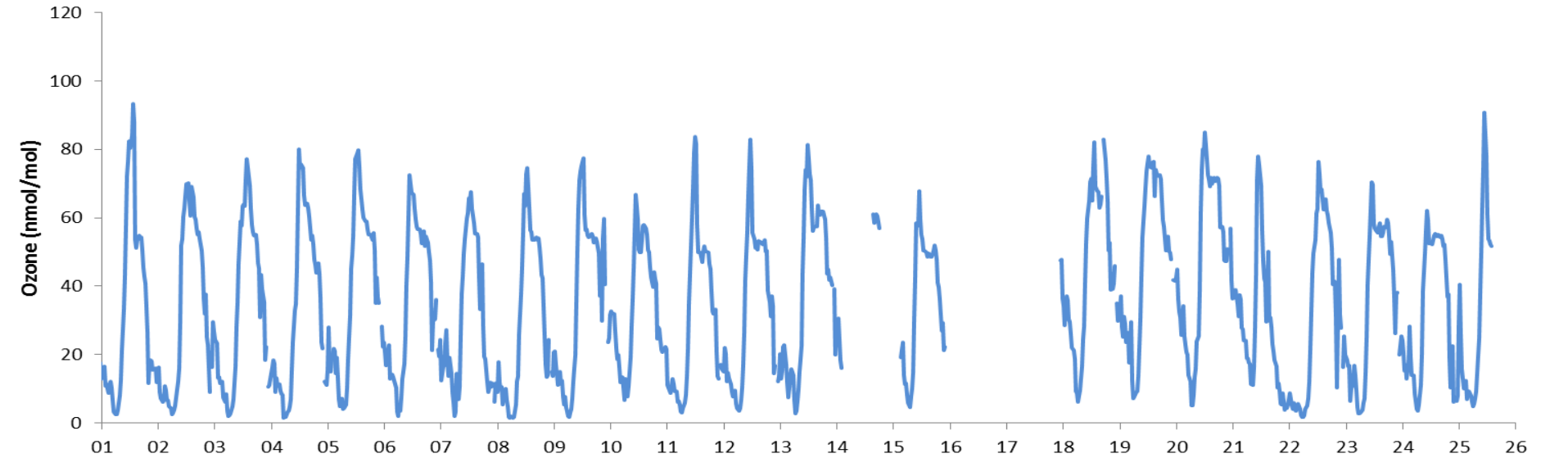
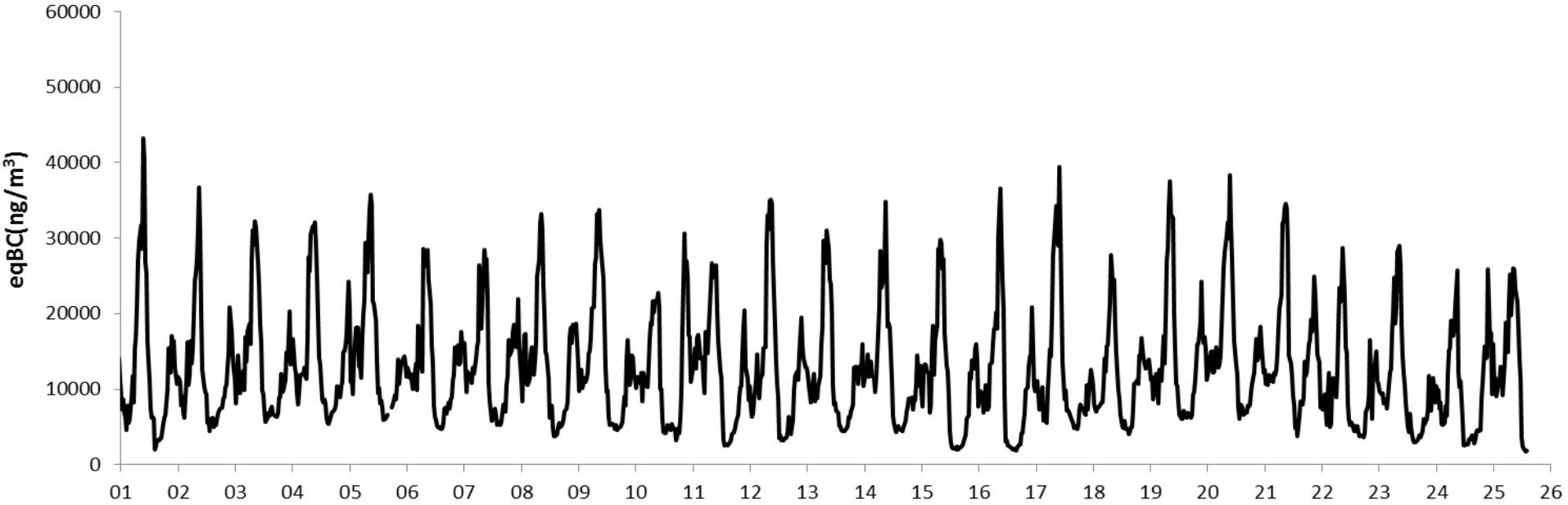
Acetonitrile - a marker for biomass burning



Courtesy:  
Sangwoo and Dipesh; Manish and Piyush; Vinayak and Chinmoy

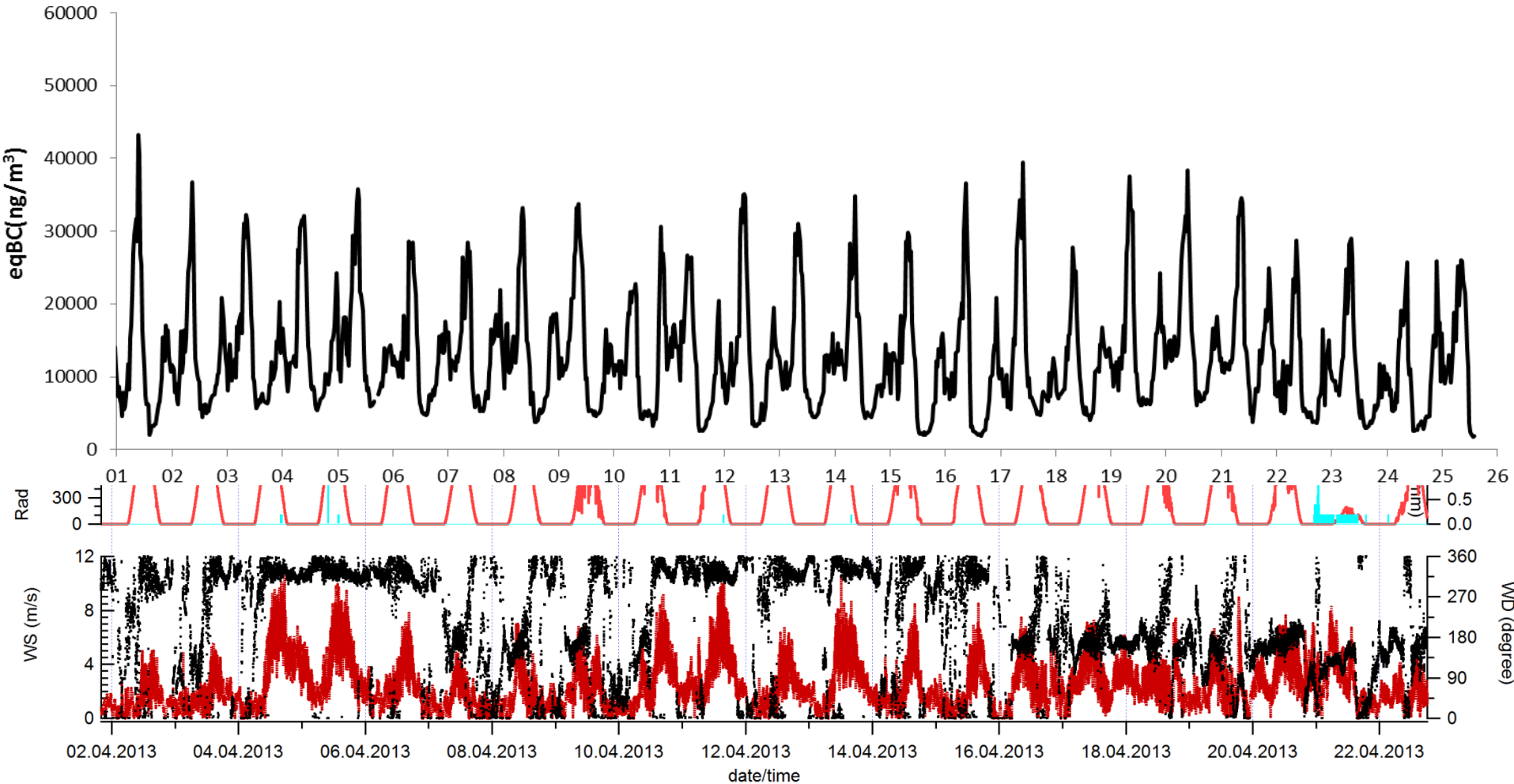
# Satellite site: Pakanajol (city Center)

Feb 2013



Courtesy: P. Bonasoni

# Regional site Supersite: Lumbini



# Mitigation Options

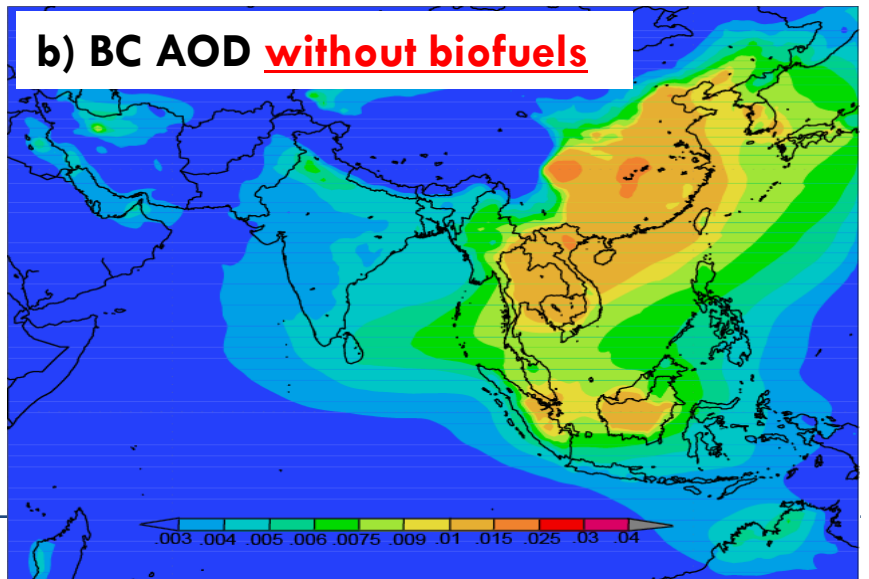
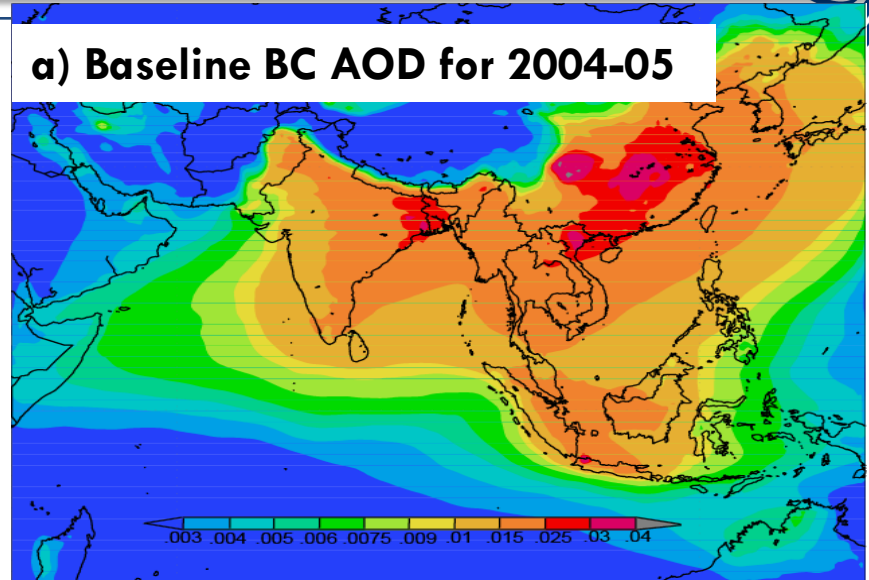
## Identification and Evaluation of mitigation potential of mitigation measures



Traditional cookstoves



Improved Cookstove





Science-Policy Seminar on Short-lived Climate-forcing Pollutants, 22 Nov 2012, Kathmandu



Joint Secretary -MoEST



Former Minister- MoEST



Movie Actors



Media





Experts

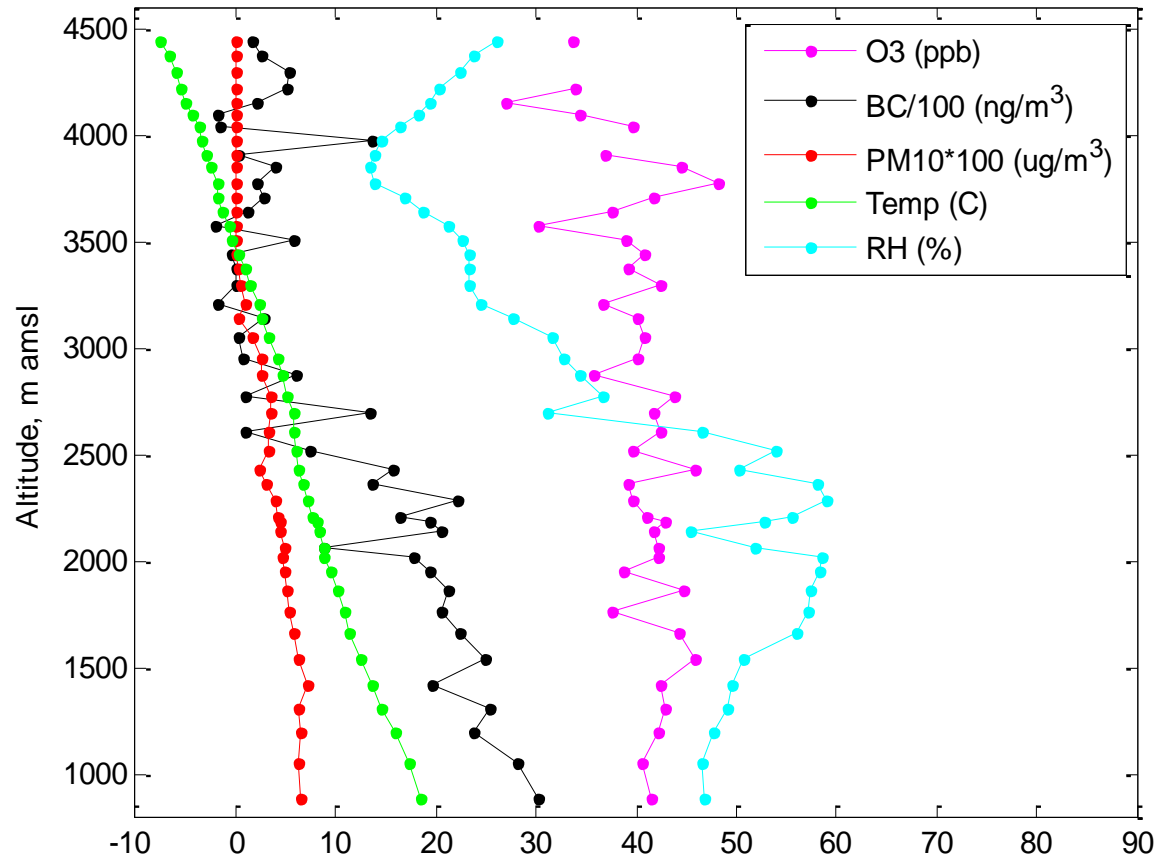
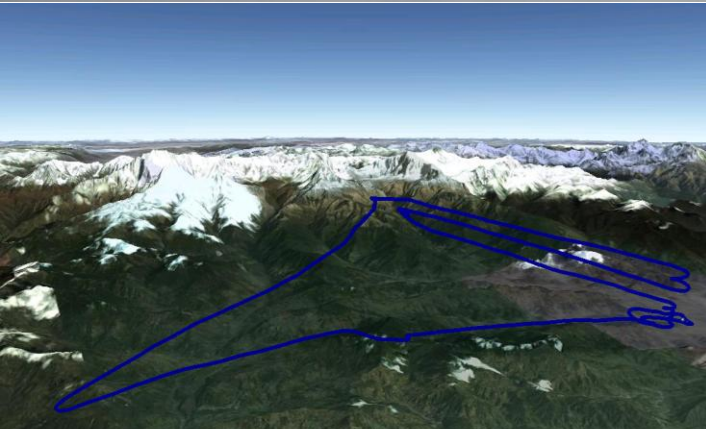


Spiritual Leader (Civil Society)

Upcoming:



# Aerial sampling using ultralight aircrafts (300-400 h)- Fall/Winter (IASS, ICIMOD, KIT)



Jan 8, 2011. Afternoon

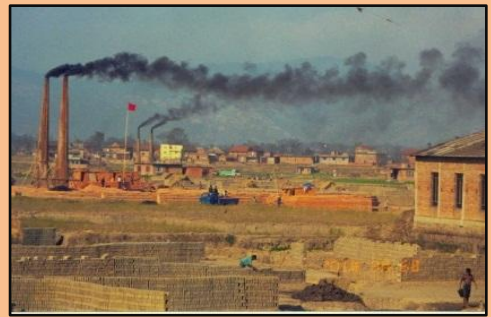
Slide: A. Panday

# Implementation of Mitigation Options

## Pilot demonstration of select measures



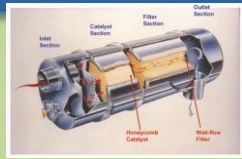
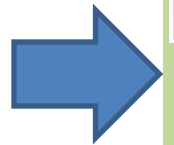
Superemitting vehicle



Traditional brick kiln



Traditional cookstoves



DPF



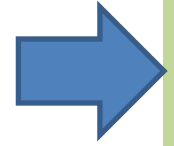
CNG engine



Retrofit



Upgrade



Hoffman brick kiln



Switch



Improved cookstoves



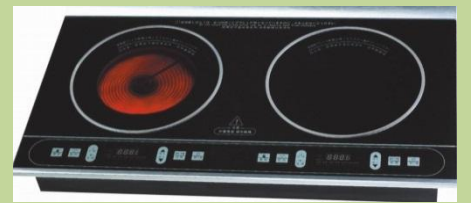
CNG



Biogas plants



Solar cooker



Electric cooker

# Scaling up, Scaling up, Scaling up ... if the opportunity exists at the IASS to continue on

Scaling-up of mitigation measures in Nepal and lessons learned from it  
(scaling up in selected sources and sectors)



Possible implementation of mitigation in other regions  
(in other parts of Nepal or other regions with similar condition)

- 
- Background
  - SusKat: An end-to-end project
  - **Expectations**



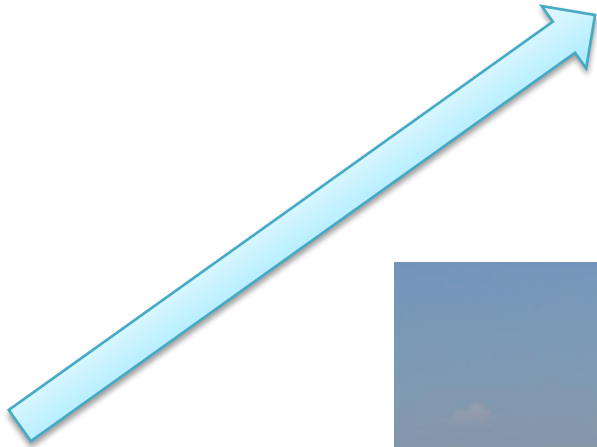
➤ A substantially improved database of local air pollution

➤ Objective and balanced science-based assessment of the causes and impacts of air pollution in the Kathmandu valley and the surrounding region .

➤ Identification of and later demonstration of selected mitigation measures and strategies that

- are based on sound science,
- are politically viable, cost-effective & realizable in a step-wise way,
- have a potential for scaling up to larger levels and
- that have a potential for application to other regions.

➤ Scientific publications



AOD = 0.05



AOD = 0.5



AOD = 1.5

# Thank You



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