



Radiative forcing from aerosols: A real field experiment to test global model predictions

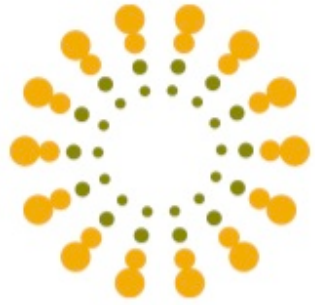
V. Ramanathan, I.H. Rehman, N. Ramanathan & K. Balakrishnan

***World Climate Research Program Open Science Conference
Session B9: Radiative Forcing of Climate and Chemistry-Climate Interactions***

**October 26, 2011, 14.30 to 15.00
Denver, Colorado**

***Providing Clean Cooking and Lighting Technologies
Documenting their impacts on Air pollution &
Climate***





project surya
Fighting Climate Change Now

3.6 Billion Rely on Biomass Fuel



Project Surya on the Web: www.projectsurya.org

UNEP's Project ABCs Findings

>500,000 deaths from ABCs

Millions of Tons of crop damages

Biomass burning is 60% of Aerosols

November 14 2006

NASA-MODIS

Deposition of BC on Snow
Melting of Glaciers

Intense Atmospheric Solar Heating:
Melting of Glaciers;
Disruption of Monsoon

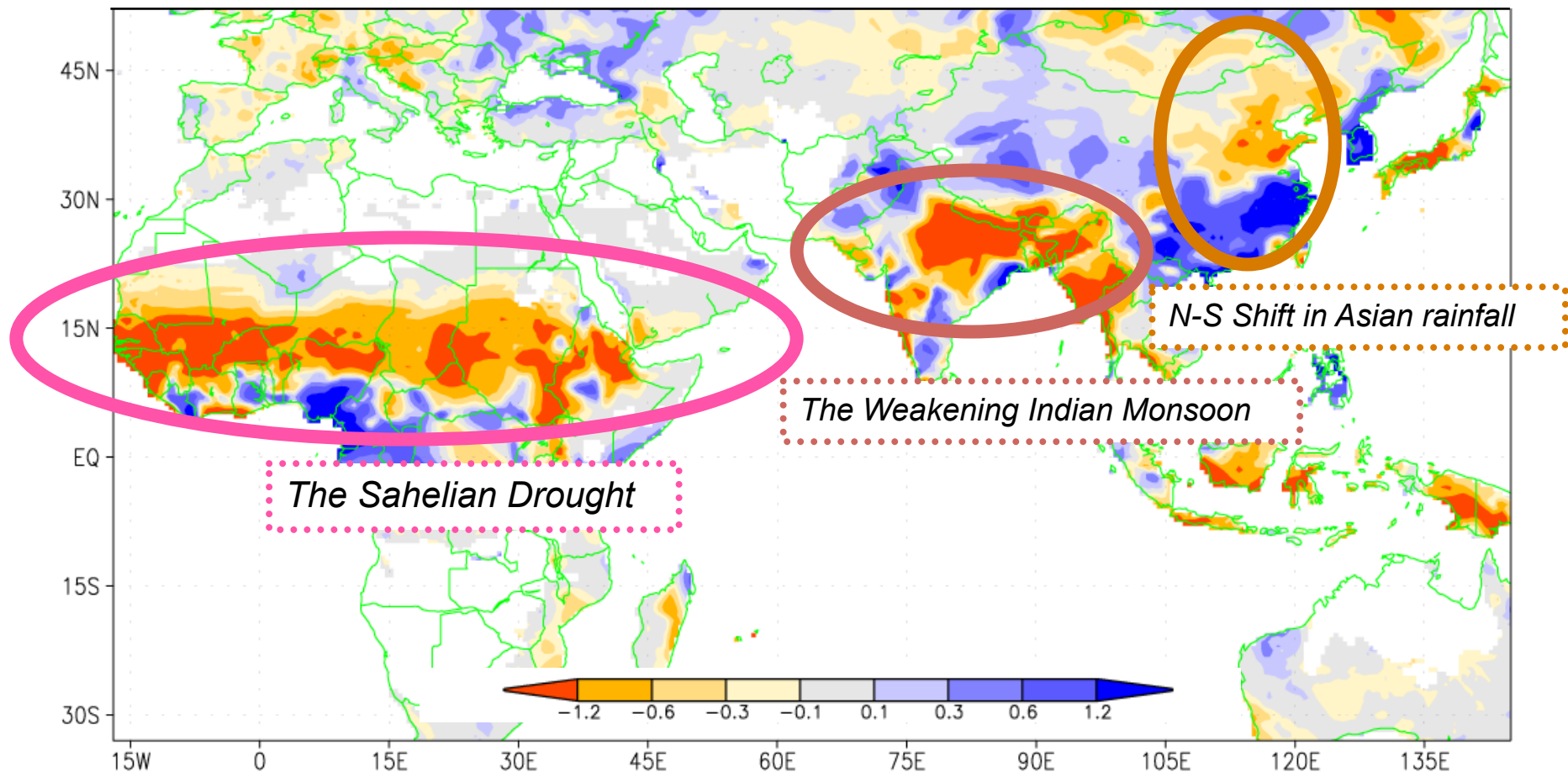
Dimming of Surface:
Decreasing evaporation;
Decrease SST gradient
Decreasing Monsoon Rainfall

Ramanathan 2007

December 21 2001

Major Rainfall Shifts during the last 50 Years

Observed Trends in Summer Rainfall: 1950 to 2002





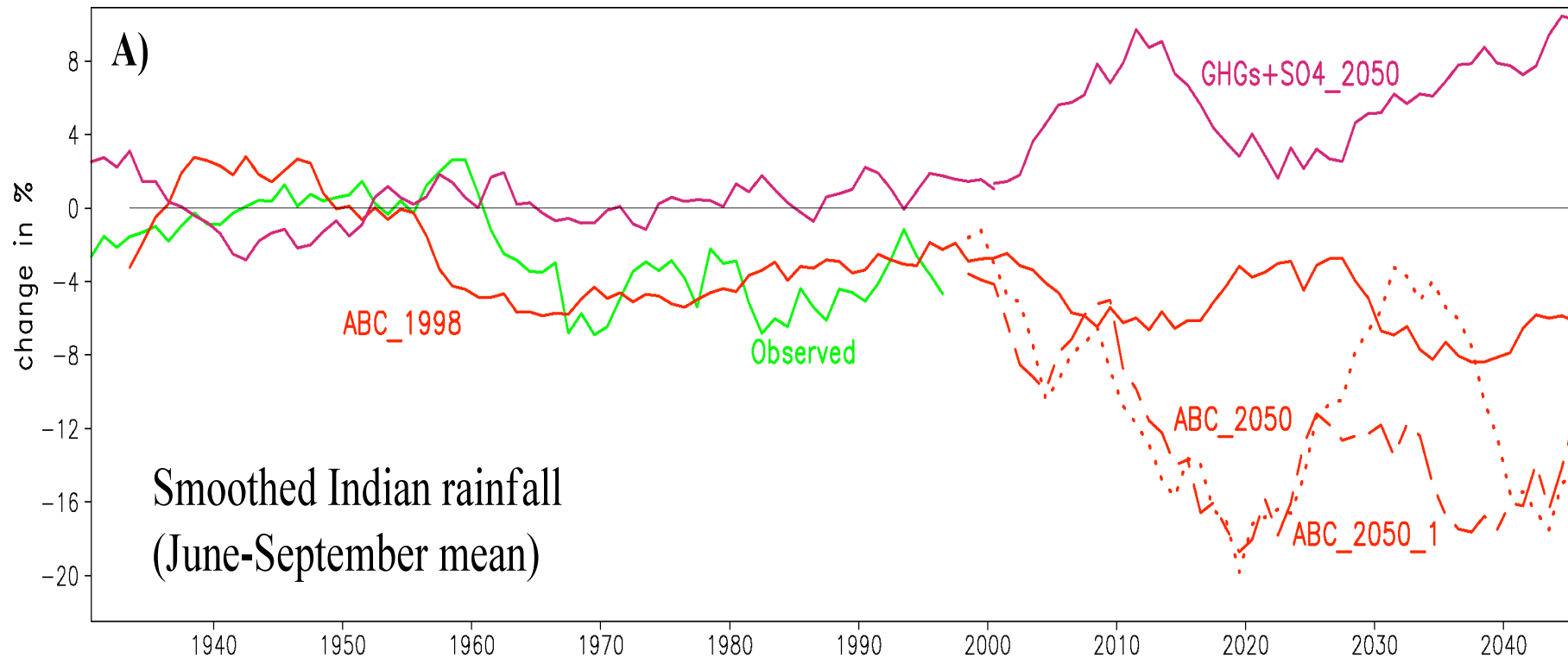
Atmospheric brown clouds: Impacts on South Asian climate and hydrological cycle

PNAS, 2005

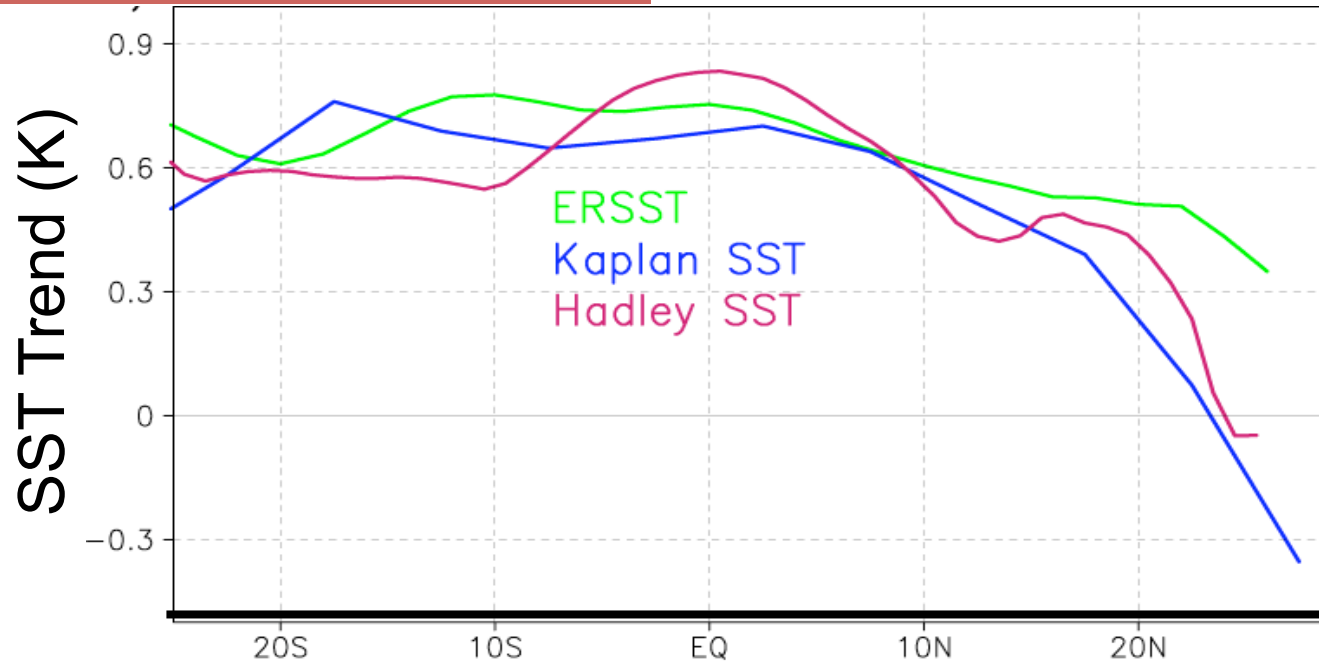
V. Ramanathan^{*†}, C. Chung^{*}, D. Kim^{*}, T. Bettge[‡], L. Buja[‡], J. T. Kiehl[‡], W. M. Washington[‡], Q. Fu[§], D. R. Sikka[¶], and M. Wild[‡]

Coupled Ocean-Atmosphere NCAR Model Study

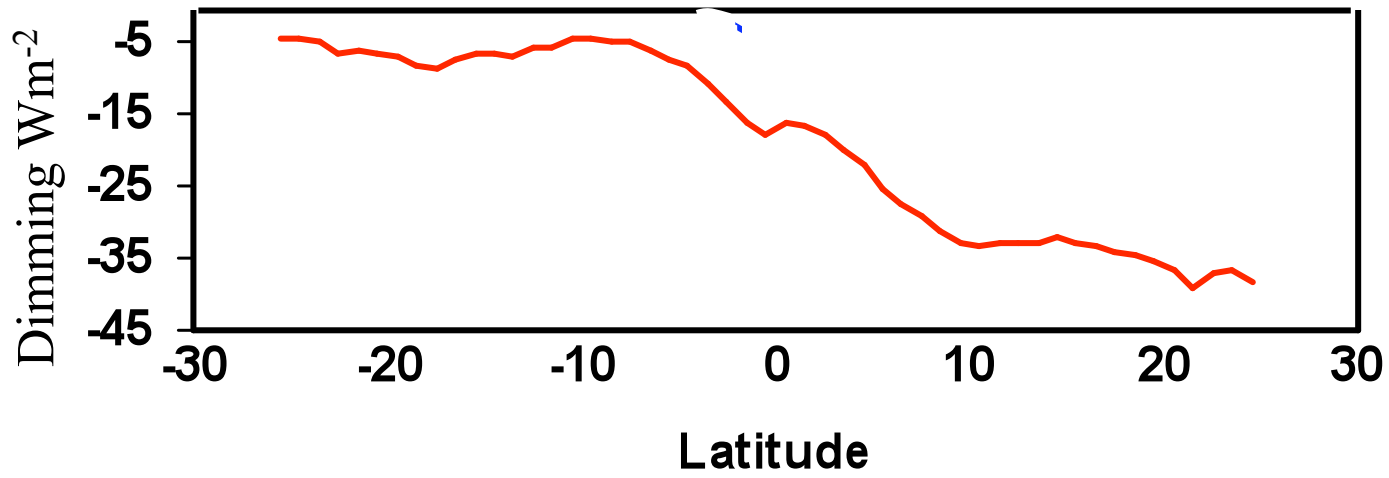
Changes in Summer Monsoon Rainfall averaged over India



Indian Ocean Observations



Observed SST Trend
1951 to 2002
Chung &
Ramanathan
J Clim, 2006



INDOEX Observed
Dimming '96 to '99
Ramanathan et al
2001

Atmospheric brown clouds: Impacts on South Asian climate and hydrological cycle

V. Ramanathan^{*†}, C. Chung^{*}, D. Kim^{*}, T. Bettge[‡], L. Buja[‡], J. T. Kiehl[‡], W. M. Washington[‡], Q. Fu[§], D. R. Sikka[¶], and M. Wild^{||}

^{*}Scripps Institution of Oceanography, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0221; [†]National Center for Atmospheric Research, Boulder, CO 80307; [‡]University of Washington, Box 351640, Seattle, WA 98195-1640; [§]40 Mausam Vihar, New Delhi, 110 051, India; and ^{||}Swiss Federal Institute of Technology, Winterthurerstrasse, 190 CH-8057 Zurich, Switzerland

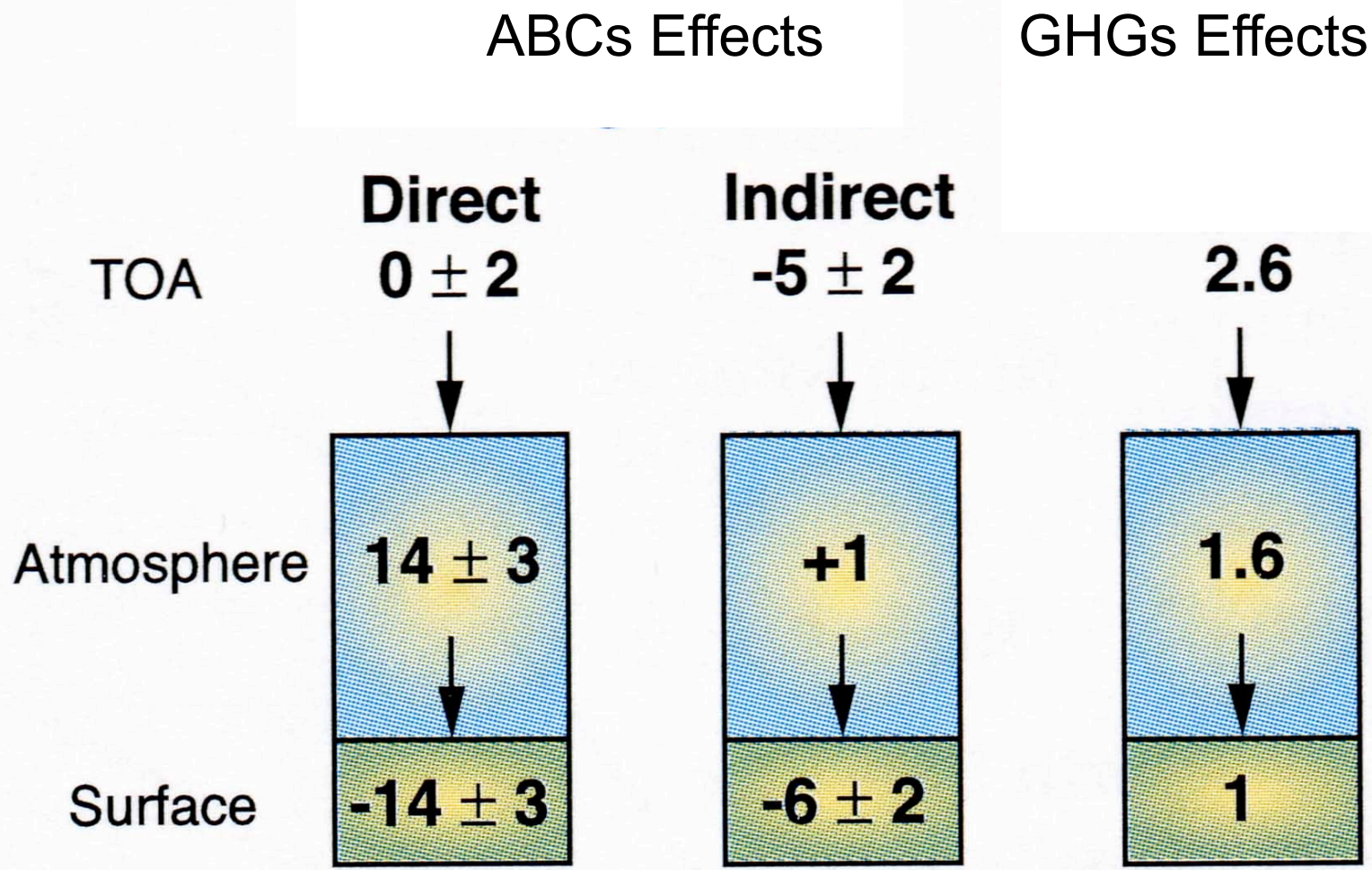
This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected on April 30, 2002.

Contributed by V. Ramanathan, January 25, 2005

From Methods Section, P. 5327:

The ABC forcing for the South Asian region and the tropical Indian Ocean was determined for 1999 from satellite, aircraft, and surface observations during the Indian Ocean experiment (14) and subsequently extended to the 1995–1999 period (6). For the dry season from October to May, the 1995–1999 Indian Ocean experiment data for ABC forcing was incorporated in the PCM. For the wet season from June to September, observational data were not available, and we adopted the aerosol assimilation model of Chin *et al.* (17), which matches Indian Ocean experiment results for the March to May period. **We include both the direct and the indirect forcing (see ref. 14 for details) of the aerosols.** Details of the aerosol forcing as adopted in the PCM are given in ref. 10, and pertinent details from ref. 10 also are summarized in *Supporting Text*, which is published as supporting information on the PNAS web site.

ABCs and GHGs: Impact on Regional Radiation Budget



**Tropical Indian Ocean: INDOEX
(Preindustrial to 1996-1999; January to April)**

Surya-Pilot Phase – Jagdishpur B lock





project surya



photo credit: Adam Ferguson, VII Network

Major findings from the Pilot Phase of Project Surya

Black carbon emissions from biomass and fossil fuels in rural India

I.H. Rehman, T. Ahmed, P.S. Praveen, A. Kar, and V. Ramanathan
Atmos. Chem. Phys. Discuss., 11, 10845–10874, 2011



A cellphone based system for large-scale monitoring of black carbon

N. Ramanathan, M. Lukac, T. Ahmed, A. Kar, P.S. Praveen, T. Honles, I. Leong, I.H. Rehman, J. Schauer, and V. Ramanathan
Accepted, Atmos. Environ., 2011



photo credit: Adam Ferguson, VII Network

Real-time assessment of Black Carbon pollution in Indian households due to traditional and improved biomass cookstoves

A. Kar, I.H. Rehman, J. Burney, P.S. Praveen, R. Suresh, L. Singh, V.K. Singh, T. Ahmed, N. Ramanathan, and V. Ramanathan
Submitted to Environ. Sci. Technol., 2011

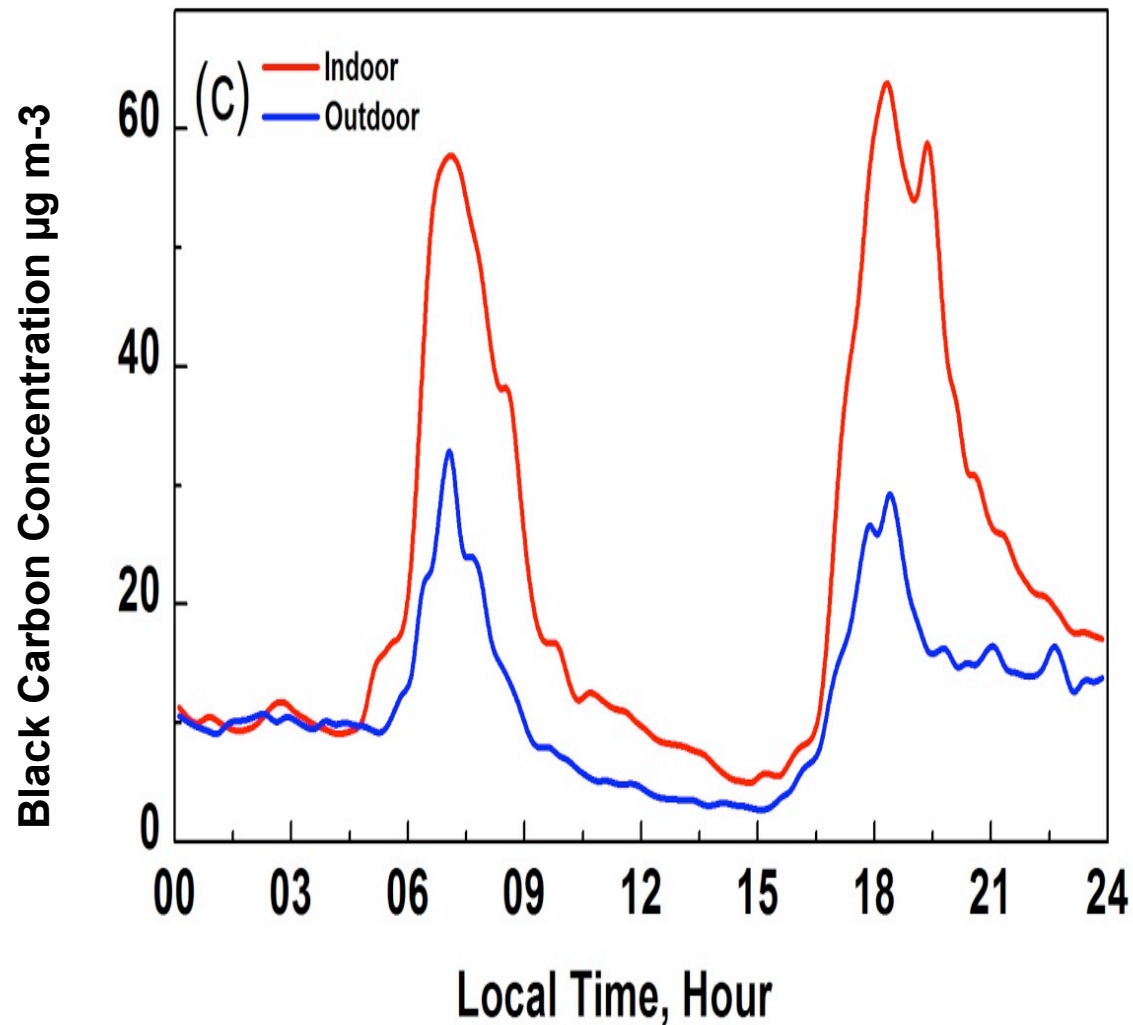
Link between local scale BC emissions and large scale atmospheric solar absorption

P.S. Praveen, T. Ahmed, A. Kar, I.H. Rehman, V. Ramanathan
Submitted to Atmos. Chem. Phys. Discuss., 2011

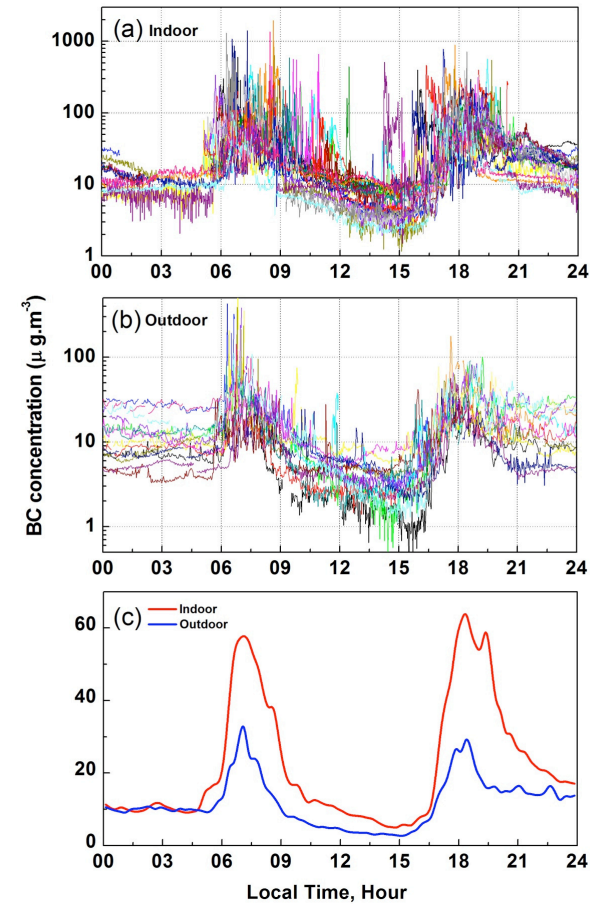
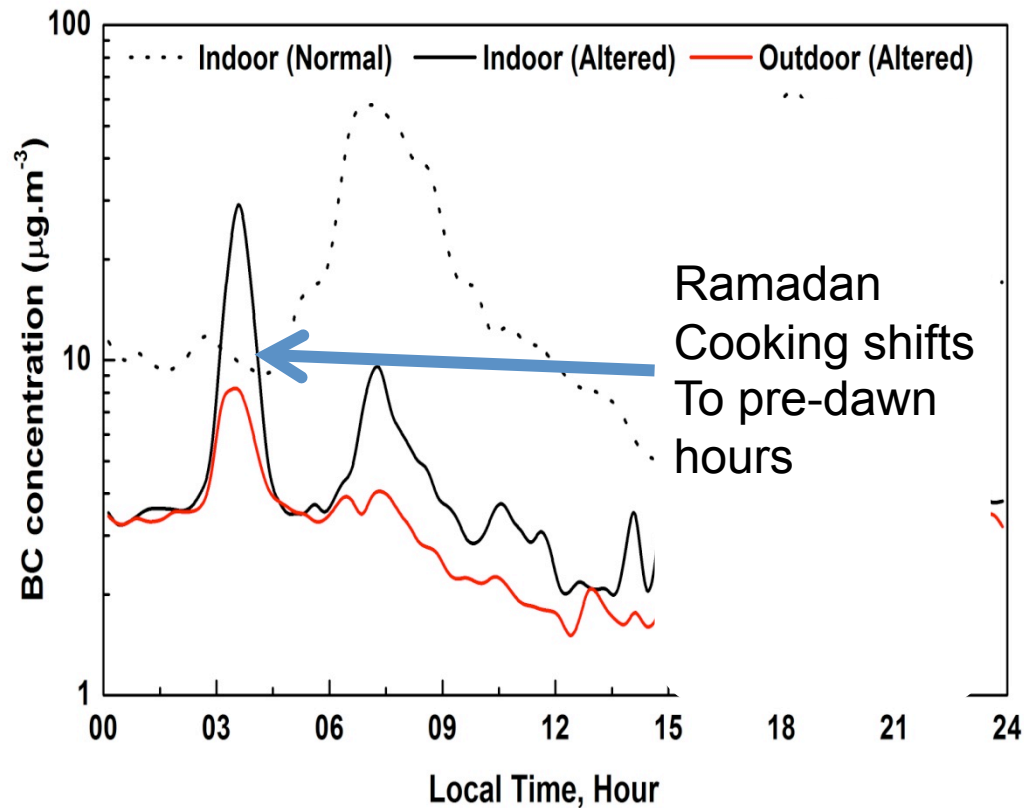


With funding from United Nations Environment Programme (UNEP), National Science Foundation (NSF), Swedish International Development Cooperation Agency (SIDA, Sweden), QUALCOMM Incorporated (USA), The G. Unger Vetelsen Foundation (USA), and private donors (Dr. E. Frieman, Dr. D. Zaelke)

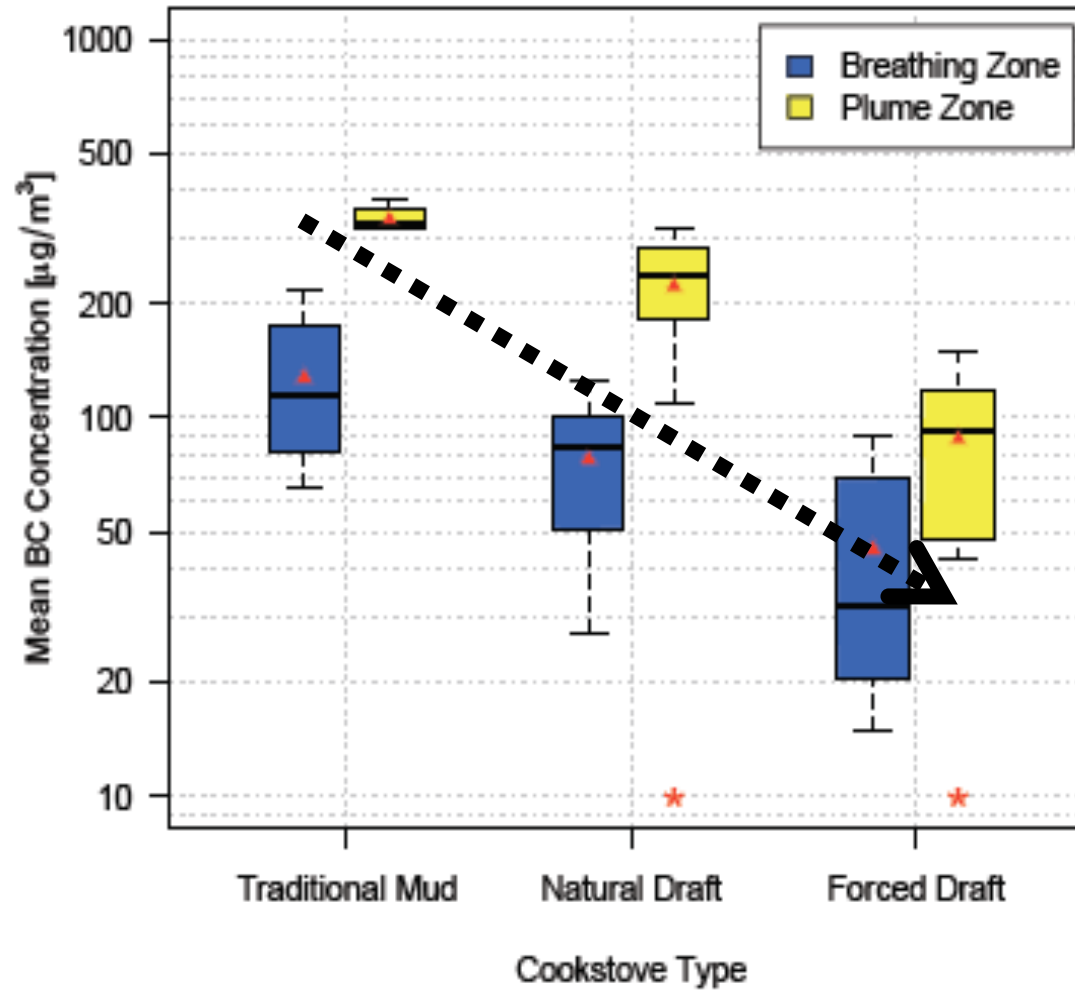
Baseline monitoring : BC Indoor concentrations drive outdoor concentrations



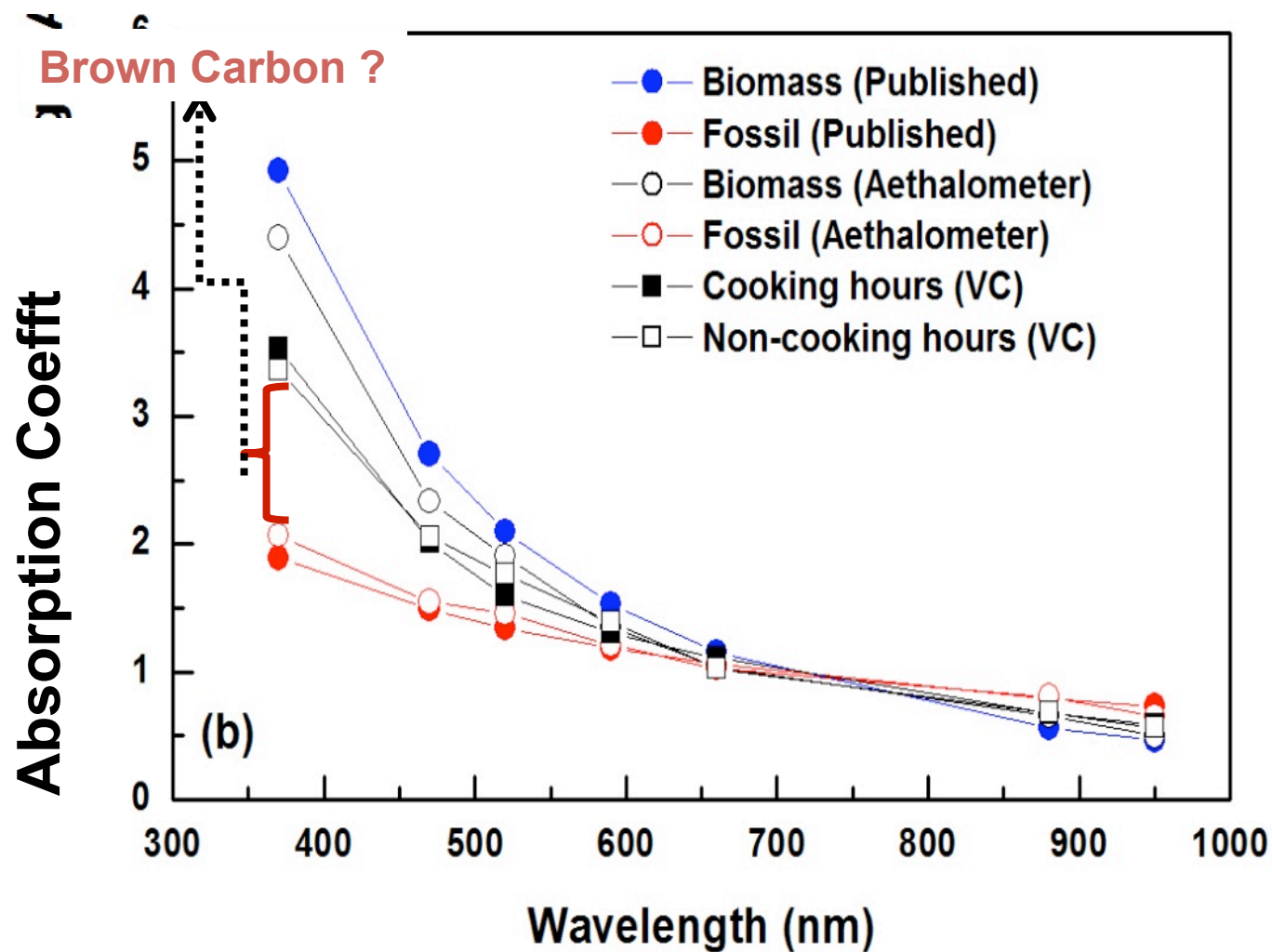
Baseline monitoring : Cooking a major source of high BC Concentrations



Forced draft better than natural draft

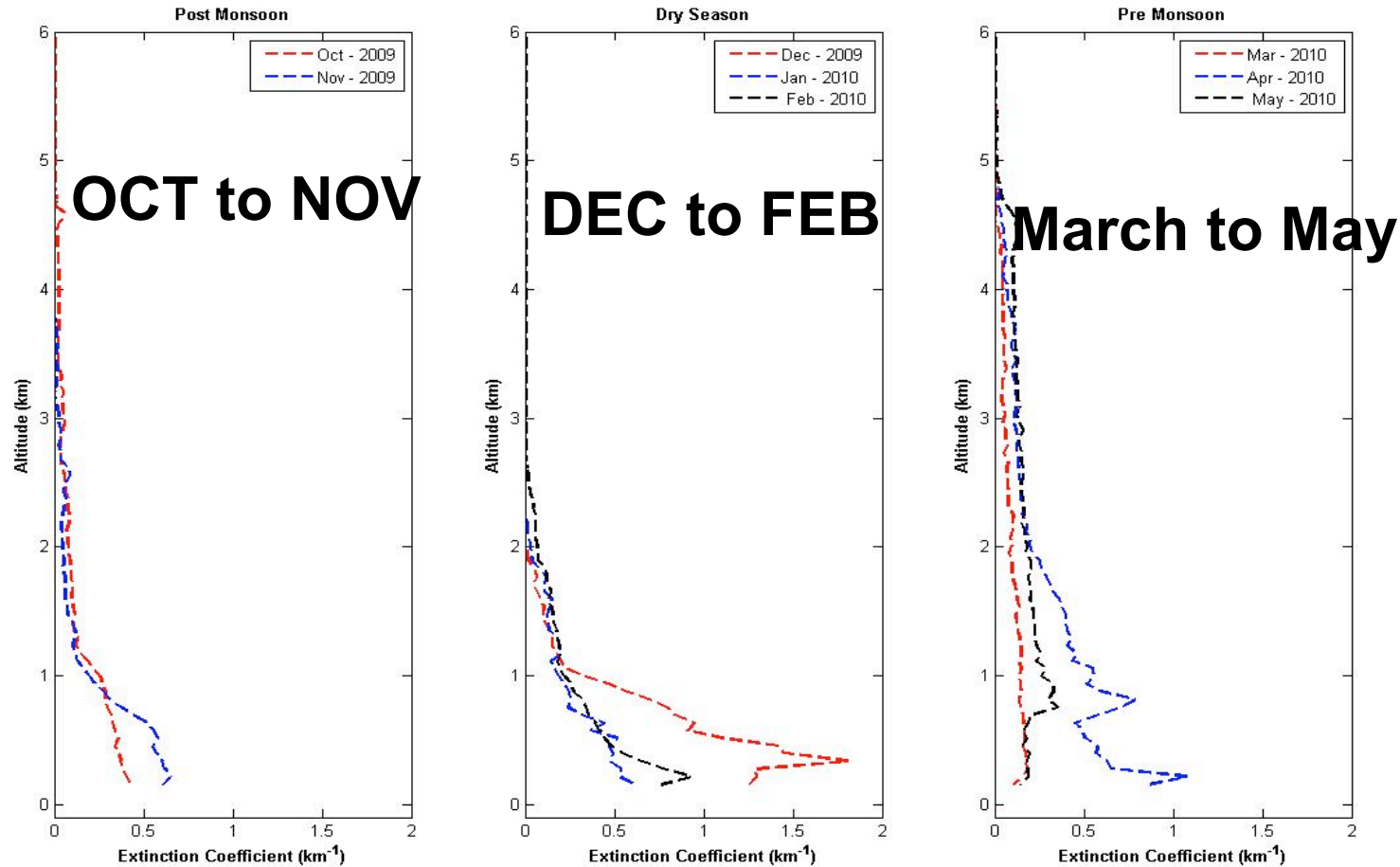


Detection of Brown Carbon Absorption

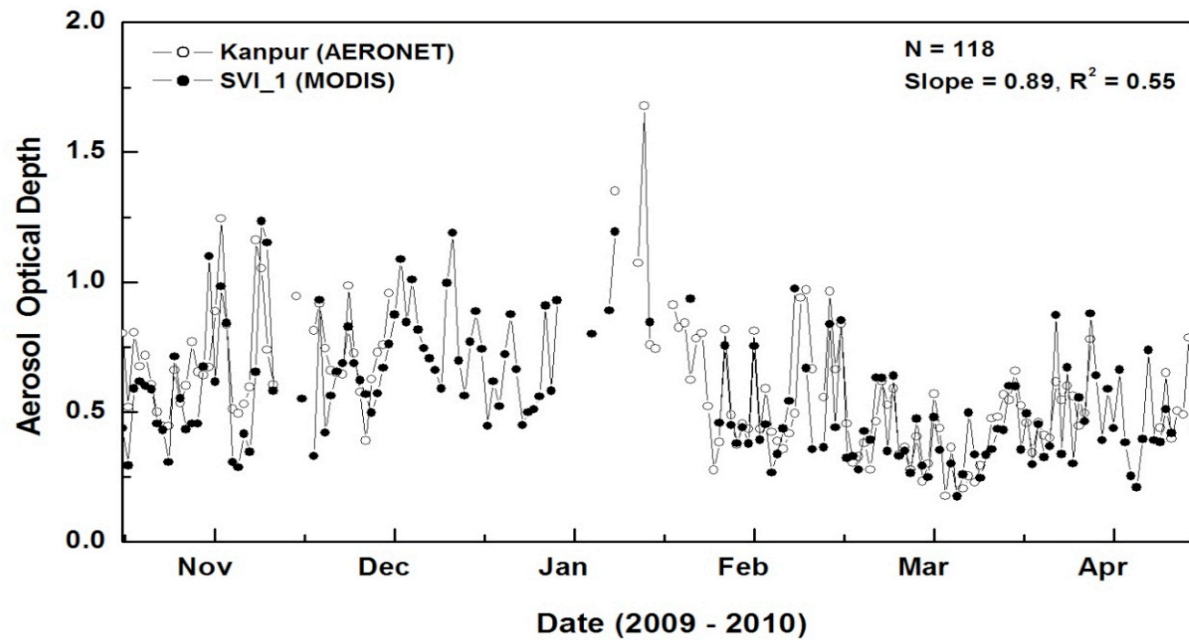


How Deep Does the Soot aerosols Penetrate?

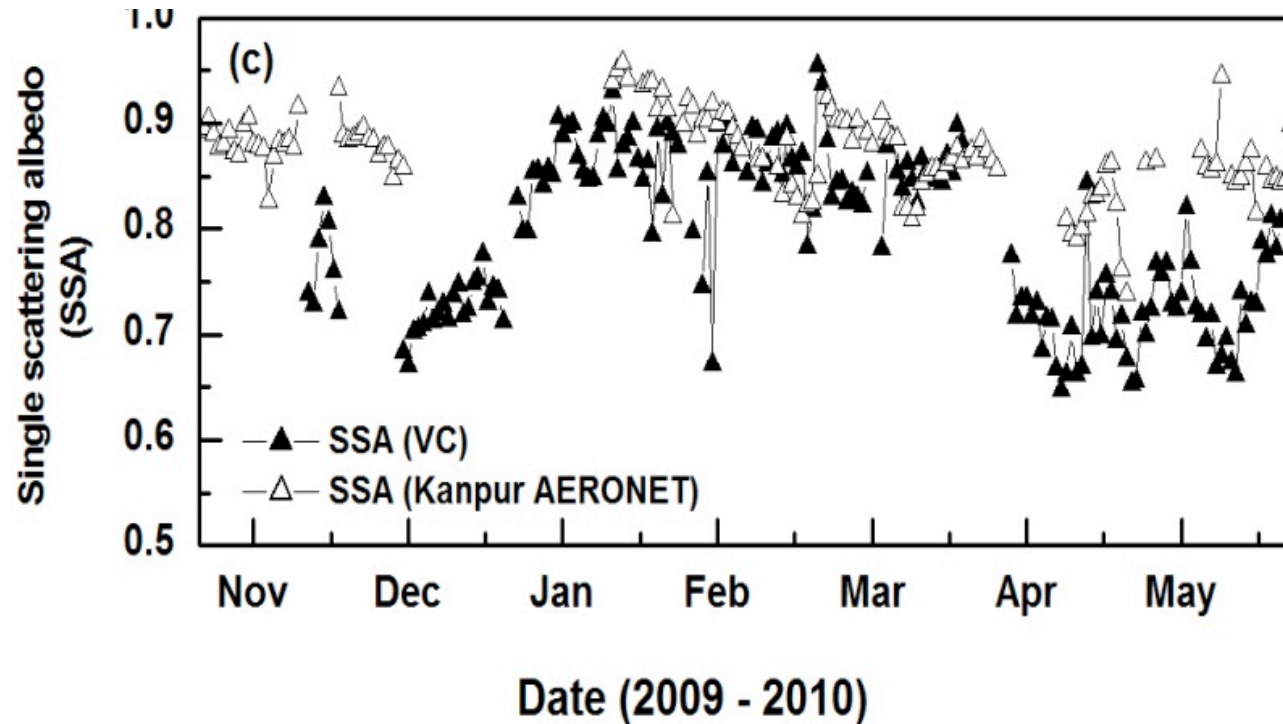
NASA-CALIPSO Data



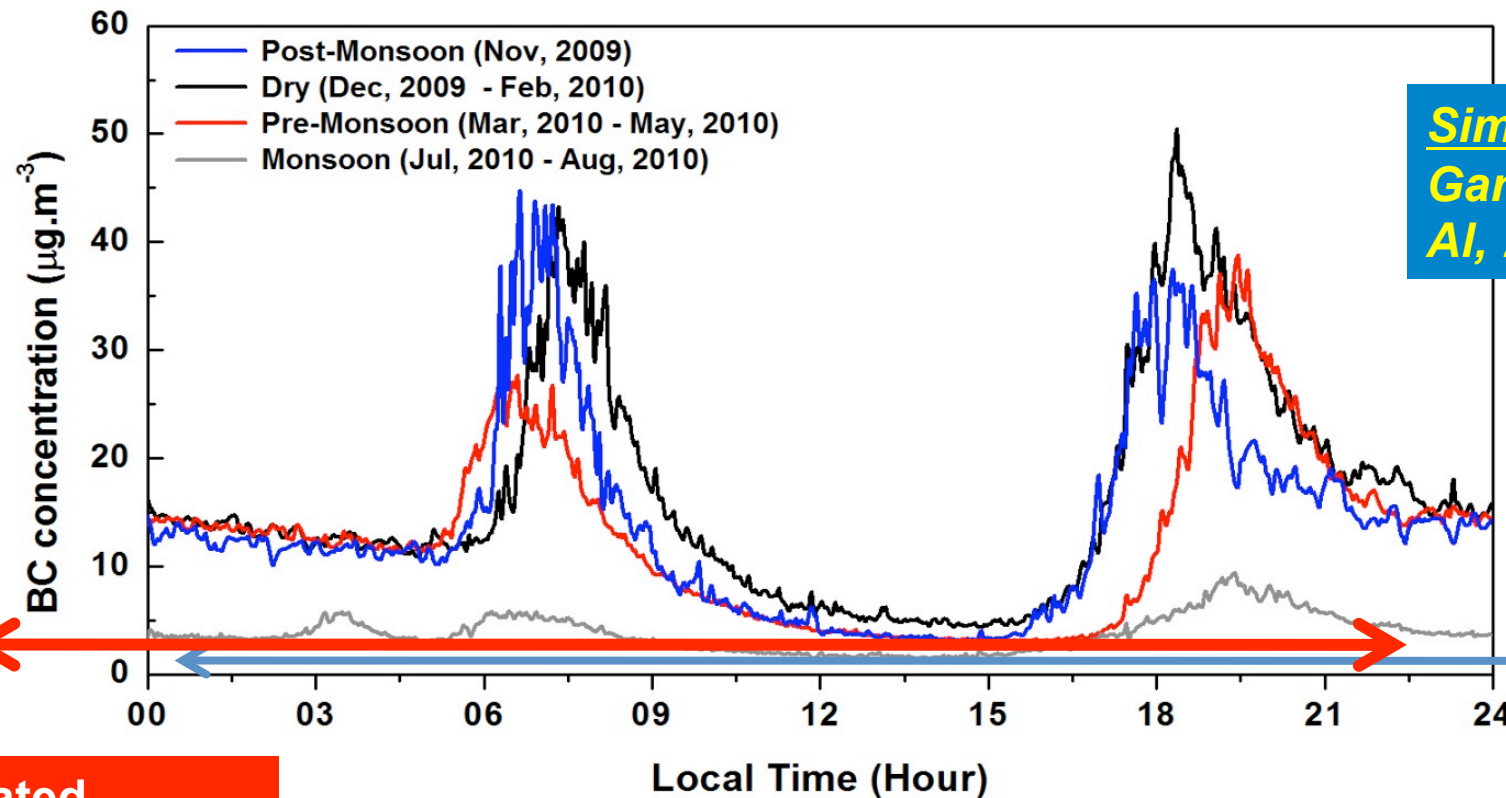
Monthly mean LIDAR extinction profiles (532 nm) from CALIPSO for the grid (26–27N and 80–82E) for post-monsoon, dry and pre-monsoon seasons, respectively. SVI_1 is located within this grid.



***Relevance to
Larger
Scale***



Seasonal Variation in BC Concentrations: Comparison with Climate Models



*Simulated
Ganguly et
Al, 2010*

**Simulated
Menon et al, 2010**

Diurnal variation of seasonal mean BC concentration at SVI_1 village centre (VC).

Over S. Asia, the simulated BC is a factor of 3 to 10 Lower

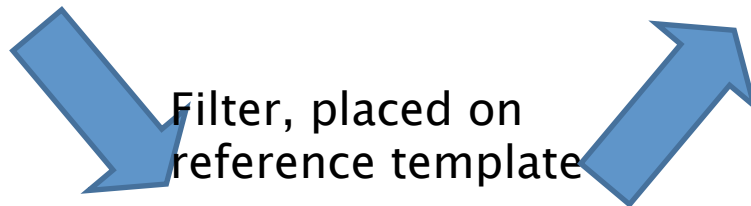
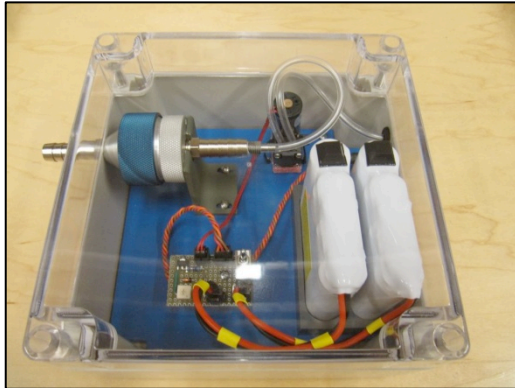
Retrieving the composition and concentration of aerosols over the Indo-Gangetic basin using CALIOP and AERONET data

Dilip Ganguly,^{1,2} P. Ginoux,¹ V. Ramaswamy,^{1,2} D. M. Winker,³ B. N. Holben,⁴ and S. N. Tripathi⁵

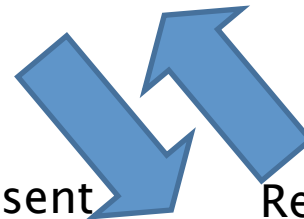
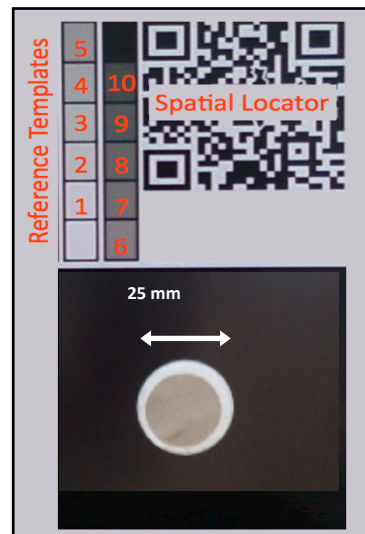
Month	Year	Black Carbon		Column	
		Surface		Minz	AM2
		Minz	AM2	Minz	AM2
<i>Gandhi College</i>					
JAN	2007	5.6 ± 0.5	0.6	4.7 ± 0.4	0.8
APR	2007	3.5 ± 0.4	0.6	9.5 ± 1.6	1.3
SEP	2006	3.1 ± 0.3	0.7	9.1 ± 0.9	1.2
NOV	2006	7.1 ± 0.8	0.8	7.2 ± 0.8	1.1
DEC	2006	6.8 ± 0.5	0.7	9.3 ± 0.7	0.9
<i>Kanpur</i>					
MAR	2007	2.5 ± 0.3	0.43	3.8 ± 0.5	0.6
APR	2007	2.5 ± 0.3	0.53	4.3 ± 0.5	1
SEP	2006	1.8 ± 0.2	0.7	2.8 ± 0.3	1.2
OCT	2006	2.9 ± 0.3	0.7	4.1 ± 0.4	1.1
DEC	2007	5.5 ± 0.5	0.57	4.8 ± 0.4	0.7

Monitoring Stove BC Emissions Using Mobile Phones

Micro-Pump and Filter



Filter, placed on reference template



Picture sent to server



Results sent back via SMS

Innovations

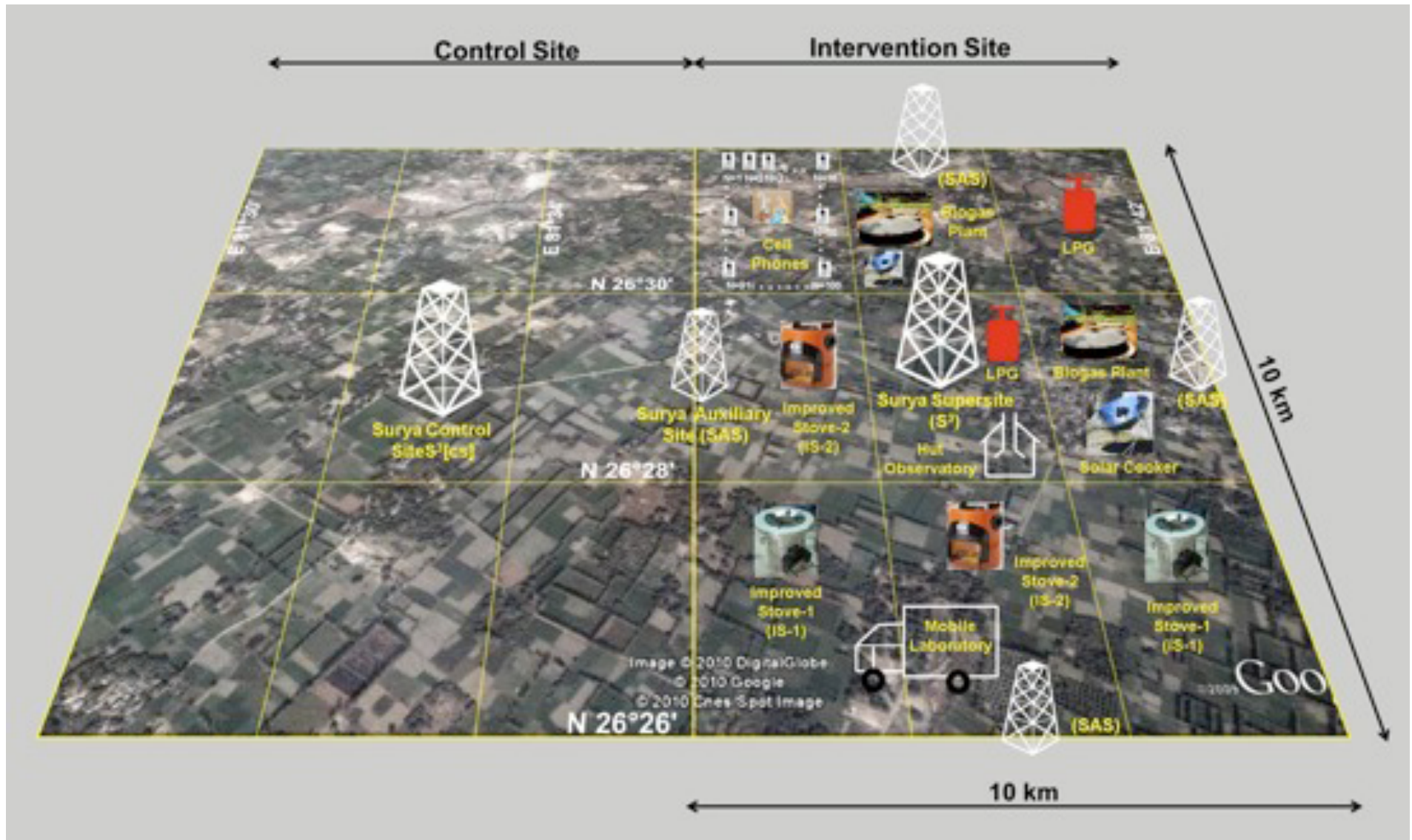
- \$500 per unit, ultra low power.
- Low-tech: works with **any** camera cellphone.
- Real-time reporting.



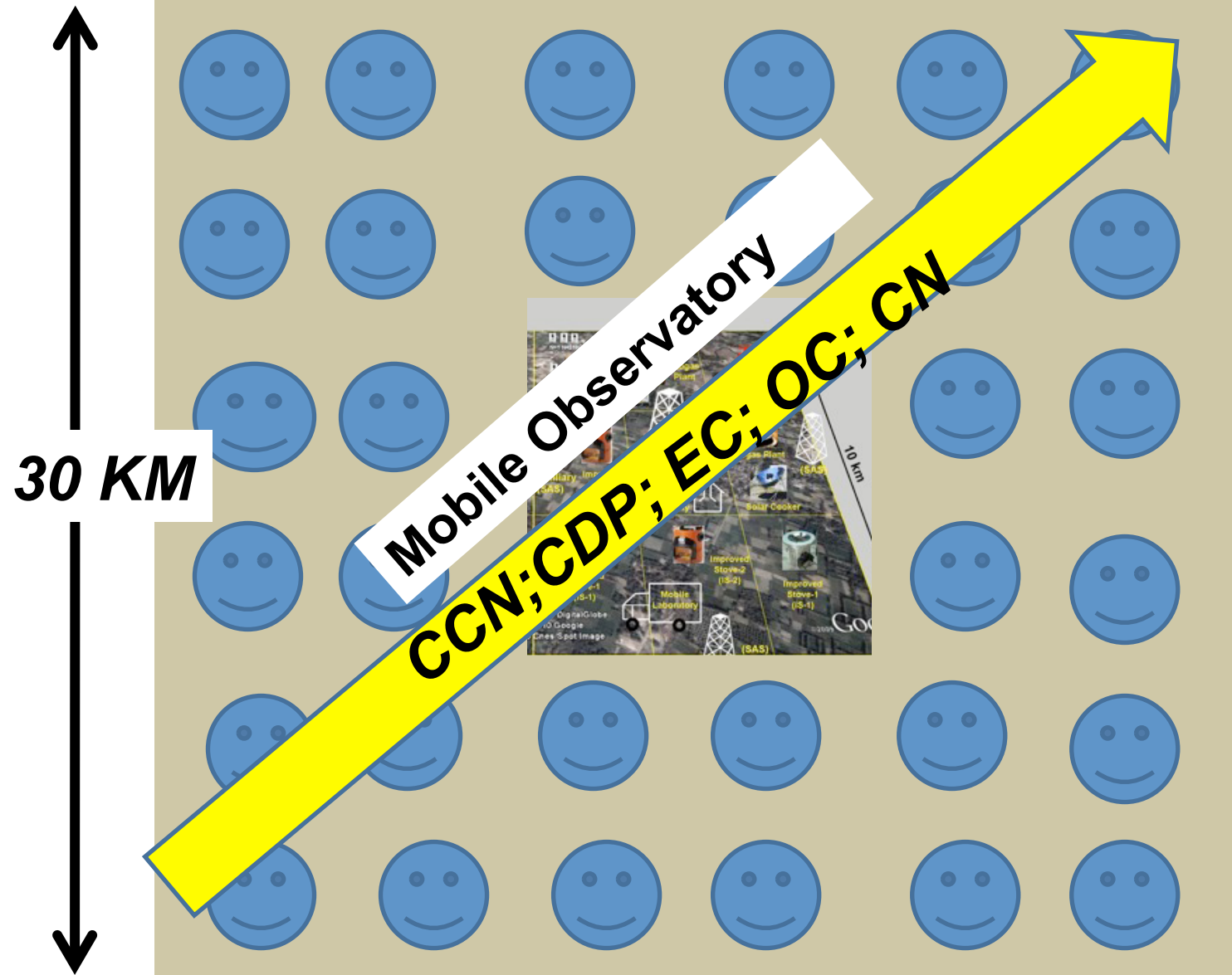
N Ramanathan, et al,
Atm Environment,
2011

Demonstration Phase: Creating a Black Carbon Hole

100 Sq km area; Population >50,000



BC-Cloud Interactions Detection



Mimicking Satellite Foot prints



Fundamental Climate Change Science Questions:

1) What is the Net Heating Effect of Black Carbon and Organic Carbon Emitted by Solid Fuel Cooking ?

2) What is the Role of BC-OC interactions within Clouds:

Burning off of Low Clouds

Nucleation of more Cloud Drops

Suppression of Rainfall

3) What is the Mitigation Potential of Biomass cooking?

a) BC/OC

b) Methane and CO emission: Ozone

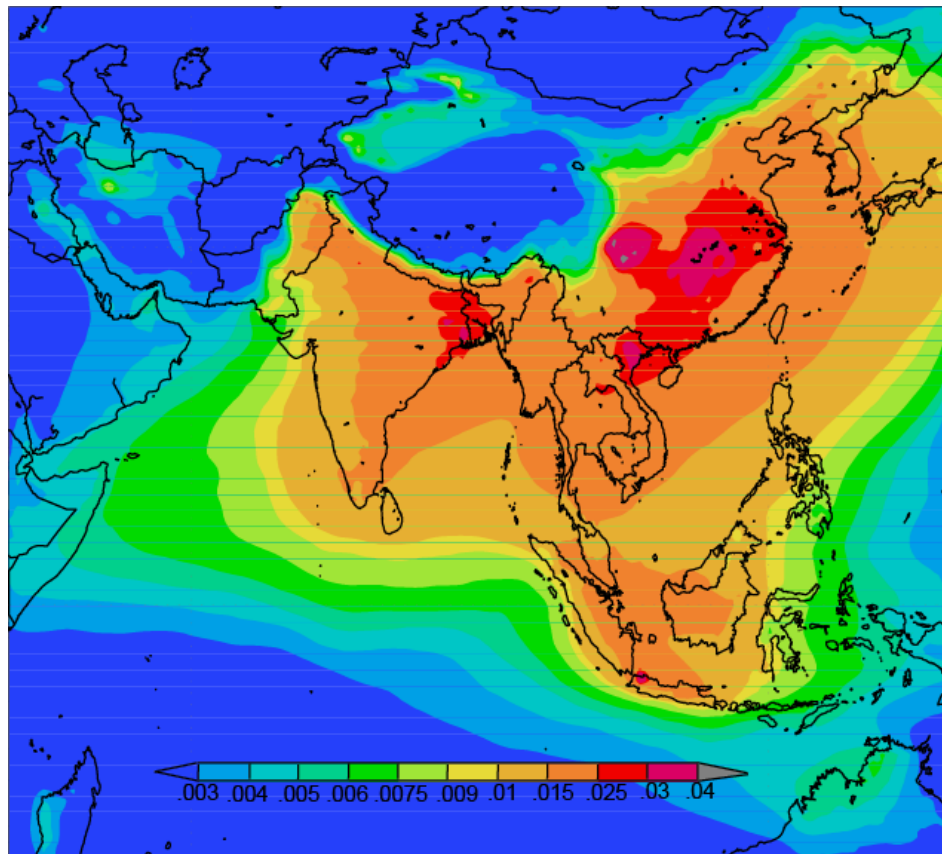
c) CO₂ emission through deforestation

***Simulate the Experiment and Validate Climate Model parameterizations
run at few km scales***

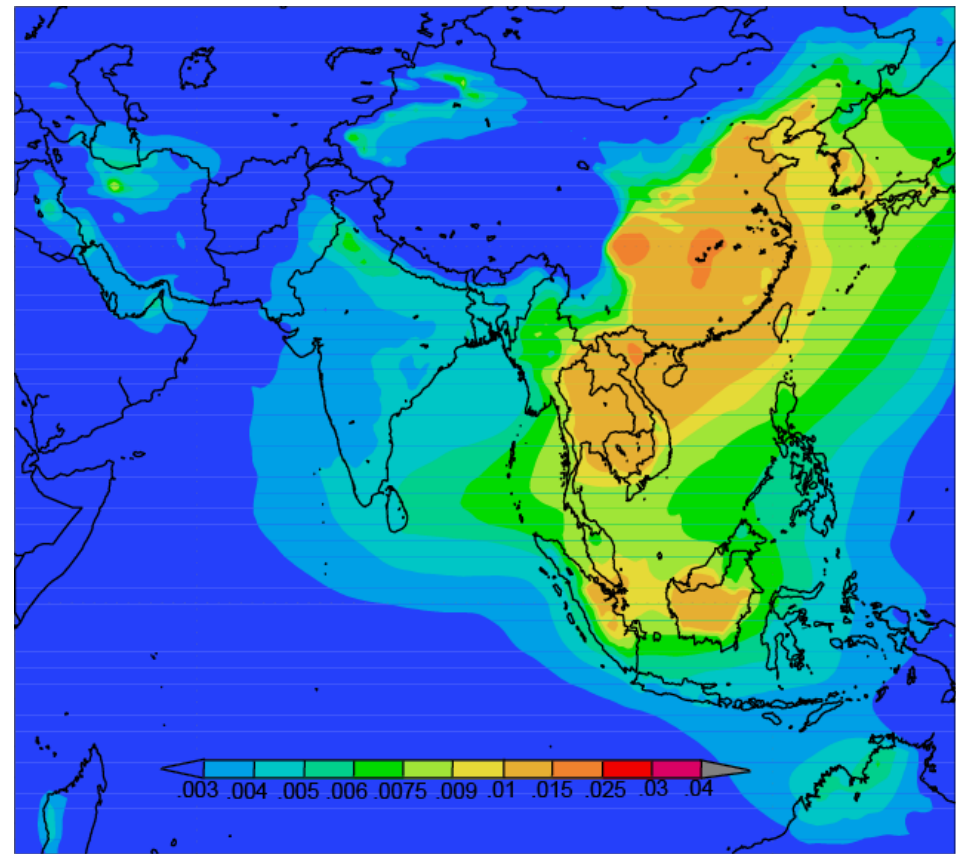
Eliminating Cooking Smoke can have dramatic Impact on Air Pollution & Climate

Ramanathan and Carmichael, 2008

2000 to 2005, as is



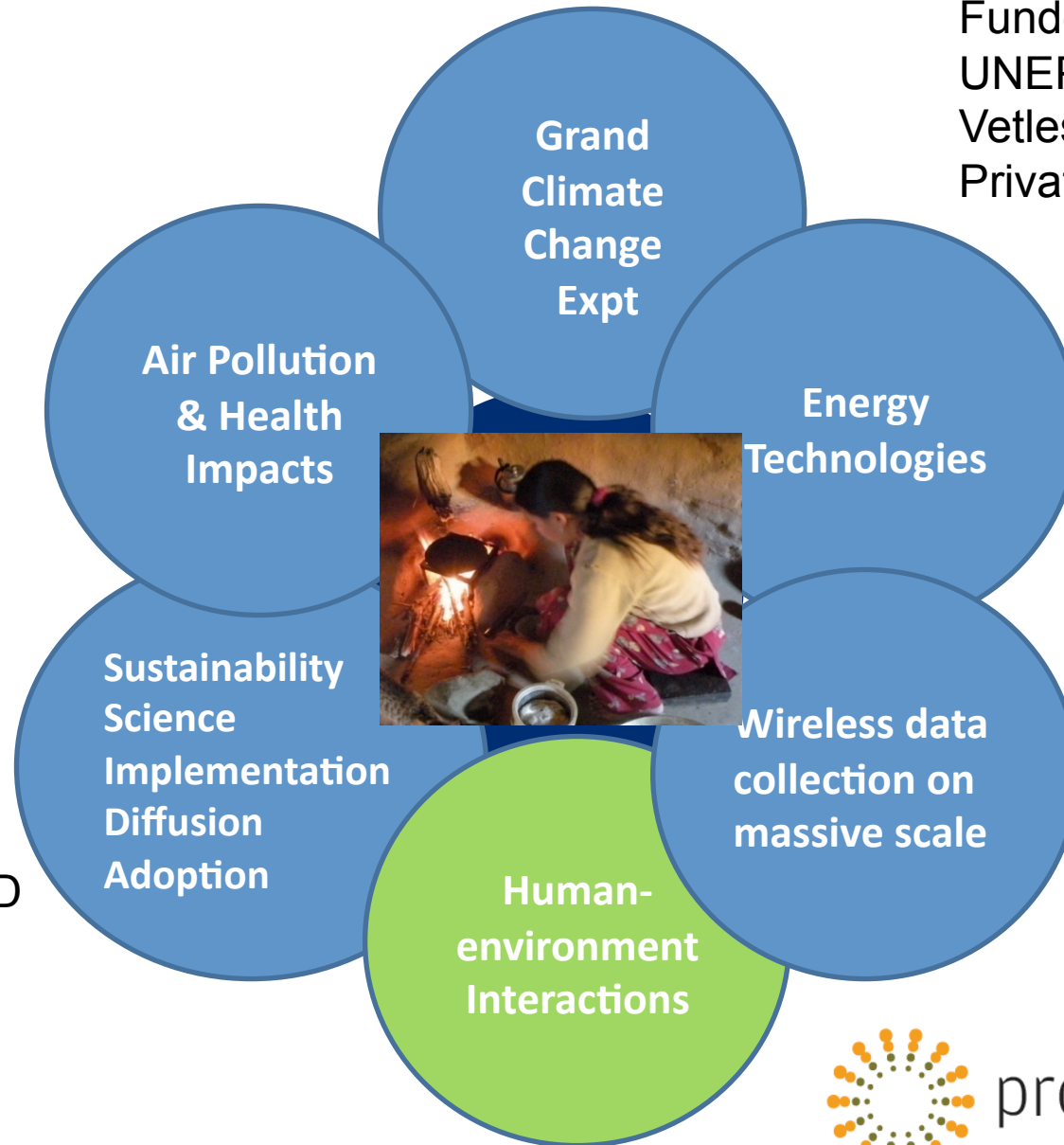
2000-2005 Without BC from Cooking



Simulated Column Black Carbon

Interdisciplinary Nature of Project Surya

Funded By:
UNEP; NSF; SIDA;
Vetlesen Foundation
Private Donors



Partners:
Scripps; UCSD
TERI(India)
UCLA;
SRU (India)