# Understanding atmospheric processes and mitigation of air pollution in the Himalayan region through new Nepal Emissions Inventory (NEEMI)

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South Asia is a global air pollution hotspot: Multitudes of implications

Regional atmospheric haze over South Asia
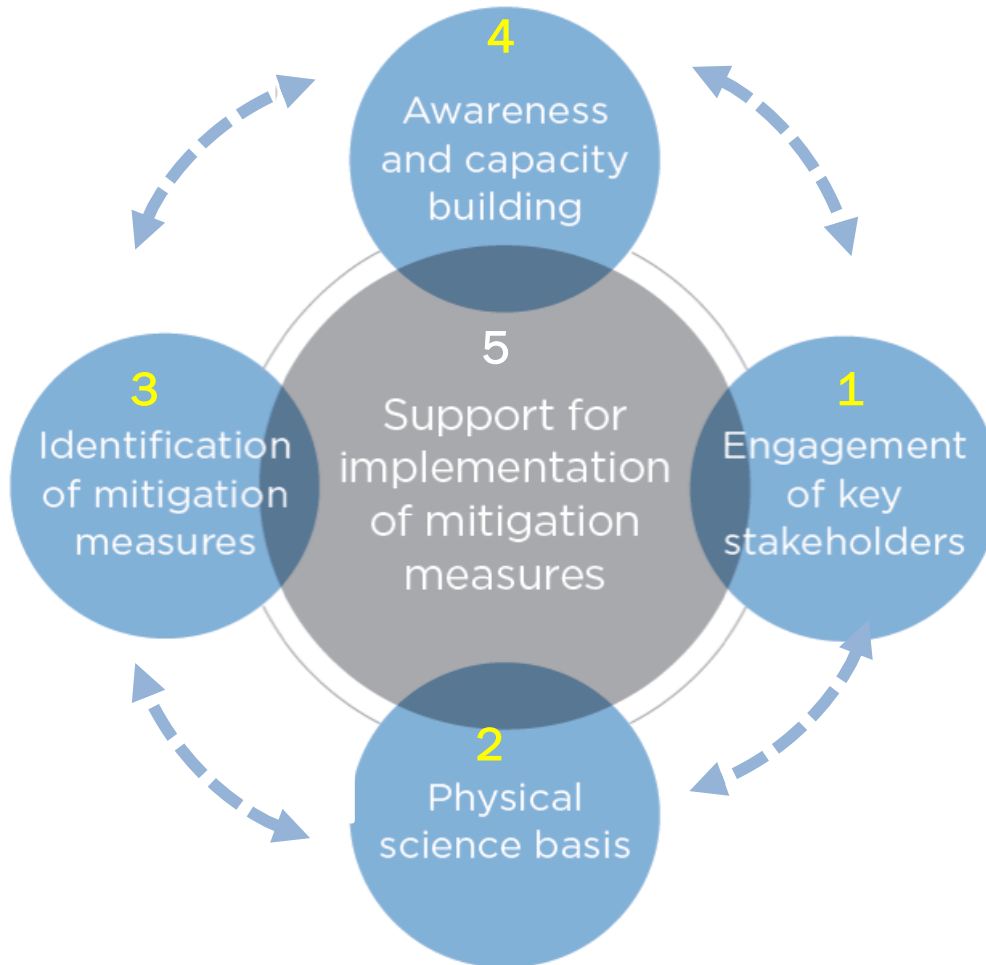

3 Jan 2016

https://eoimages.gsfc.nasa.gov/images/
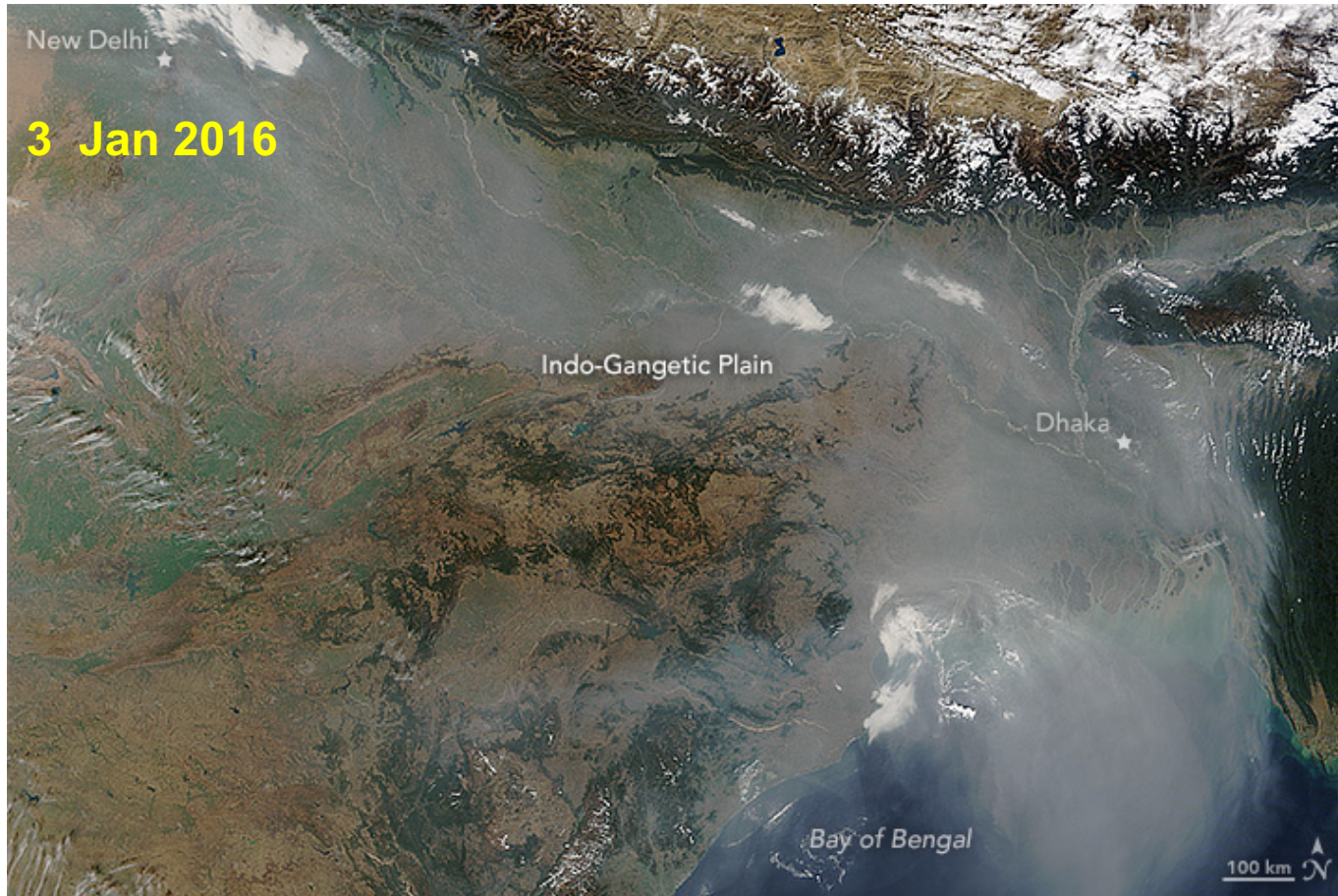
- Model simulations are unable to properly characterize it (one of the likely reasons is that the emissions are underestamated).

Sustainable Atmosphere for the Kathmandu Valley (SusKat)

Systematic study of air pollution in the Himalayan region, with focus on Nepal (2012 – till date)

SusKat approach

SusKat-ABC international air pollution measurement campaign in Nepal

The campaign was adopted by UNEP's project ABC

Measurement Period:
- Intensive campaign: Dec 2012- Feb 2013
- Extended campaign: Until June 2013
- Long term measurements (limited): till 2018

Objectives:
- Characterization of physical/chemical characteristics
- Source attributions

Participation: 40+ scientists (18 groups from 9 countries)

2nd largest international air pollution measurement campaign ever conducted in South Asia (after INDOEX in 1999)
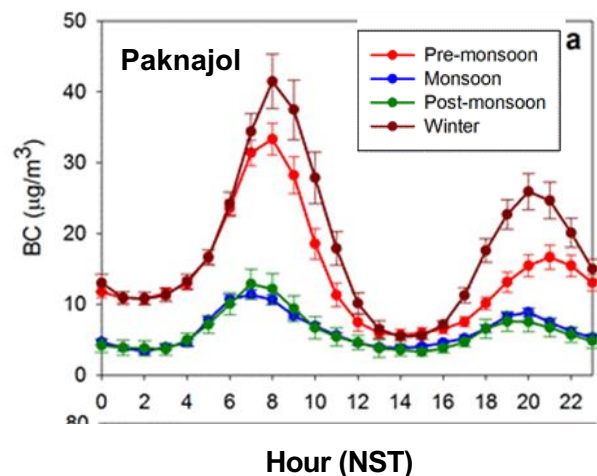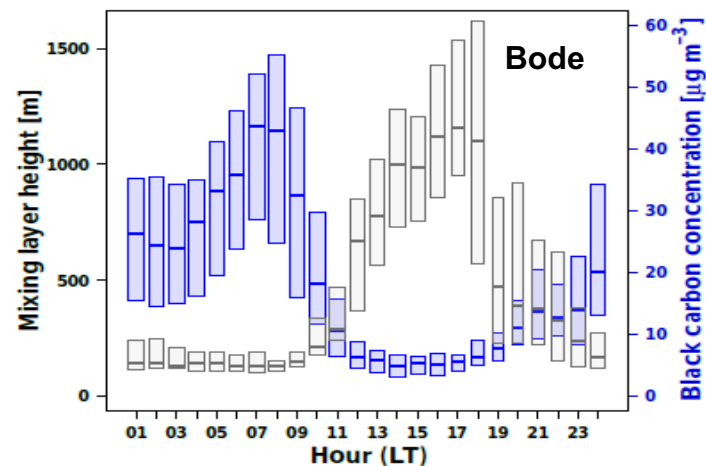
Outputs:
- Comprehensive dataset for the Himalayan Foothill region
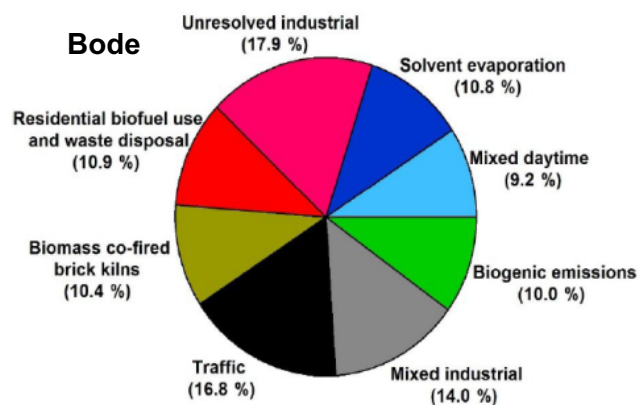- 40+ journal papers, with a special issue in ACP (18 papers)

SusKat-ABC and follow up campaigns:
Robust characterization of particulate and gaseous pollutants, with new information
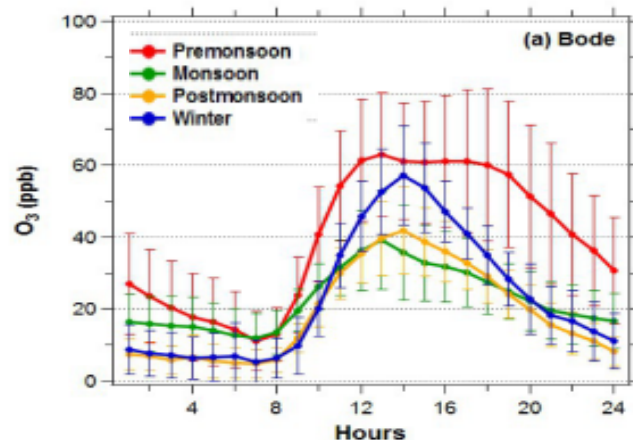

BC seasonal variation
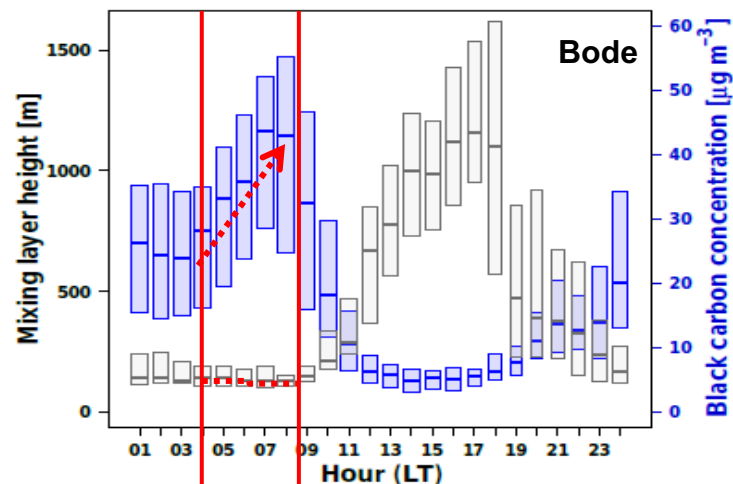

Diurnal variation of MLH and BC

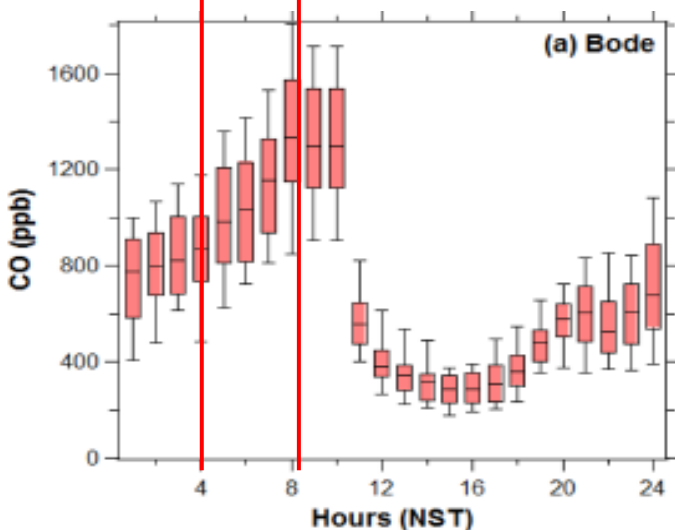**NMVOC source attribution**

O3 seasonal variation

 Putero et al, 2015   Sarkar et al, 2017   Mues et al, 2017   Mahata et al, 2018

Characterization of emissions of particulate and gaseous pollutants

Kathmandu Valley

BC HTAP v2.2+Traffic+brick production

BC fluxes (ng/m²/sec)

Mues et al:	**217**
EDGAR HTAP:	39

CO fluxes (ug/m²/sec)

Mahata et al:	**4.9**
EDGAR HTAP:	2.1
REAS:	0.7

Mues et al, 2017   Mahata et al, 2018   Zhong et al, 2019

NEpal EMissions Inventory (NEEMI)
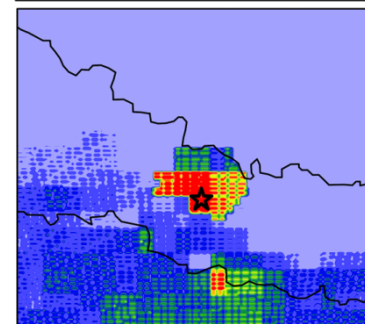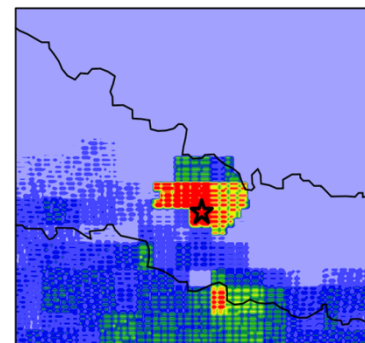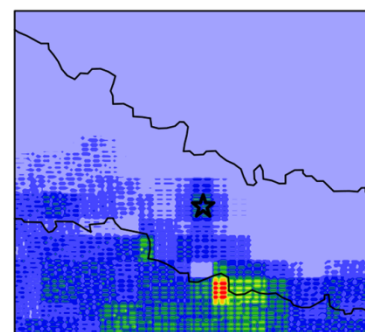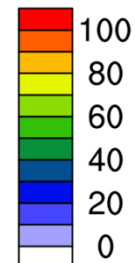
Major Technology-based sources:

Traditional cookstoves

Vehicles

Brick & other industries

Major open burning and fugitive sources:

Forest fire and agro-residue burning

Garbage burning

Agro-residue burning
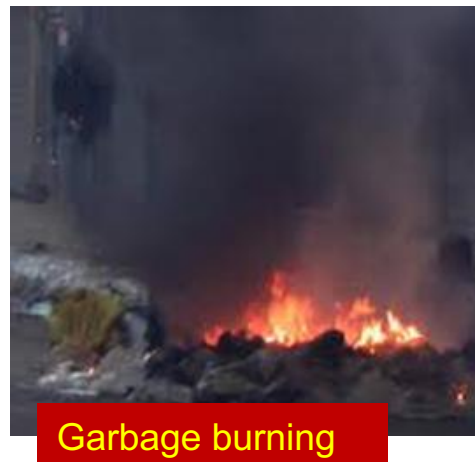
NEEMI: Emission inventory for 2001-2016
(high resolution: 1 km x 1km, monthly)

IASS POTSDAM

NEEMI-Tech

Sectors	Activities and pollutants
Residential	Cooking, Lighting, Water heating and Space heating
Industry	Point sources including brick and area sources
Commercial	Institutions, banks, hospitals, offices, DG gensets
Transport	2Wheelers, cars, vans, jeeps, buses, mini-buses, trucks, mini-trucks & others; aviation
Agriculture	Diesel irrigation pumps, tractors, threshers,

NEEMI-Open

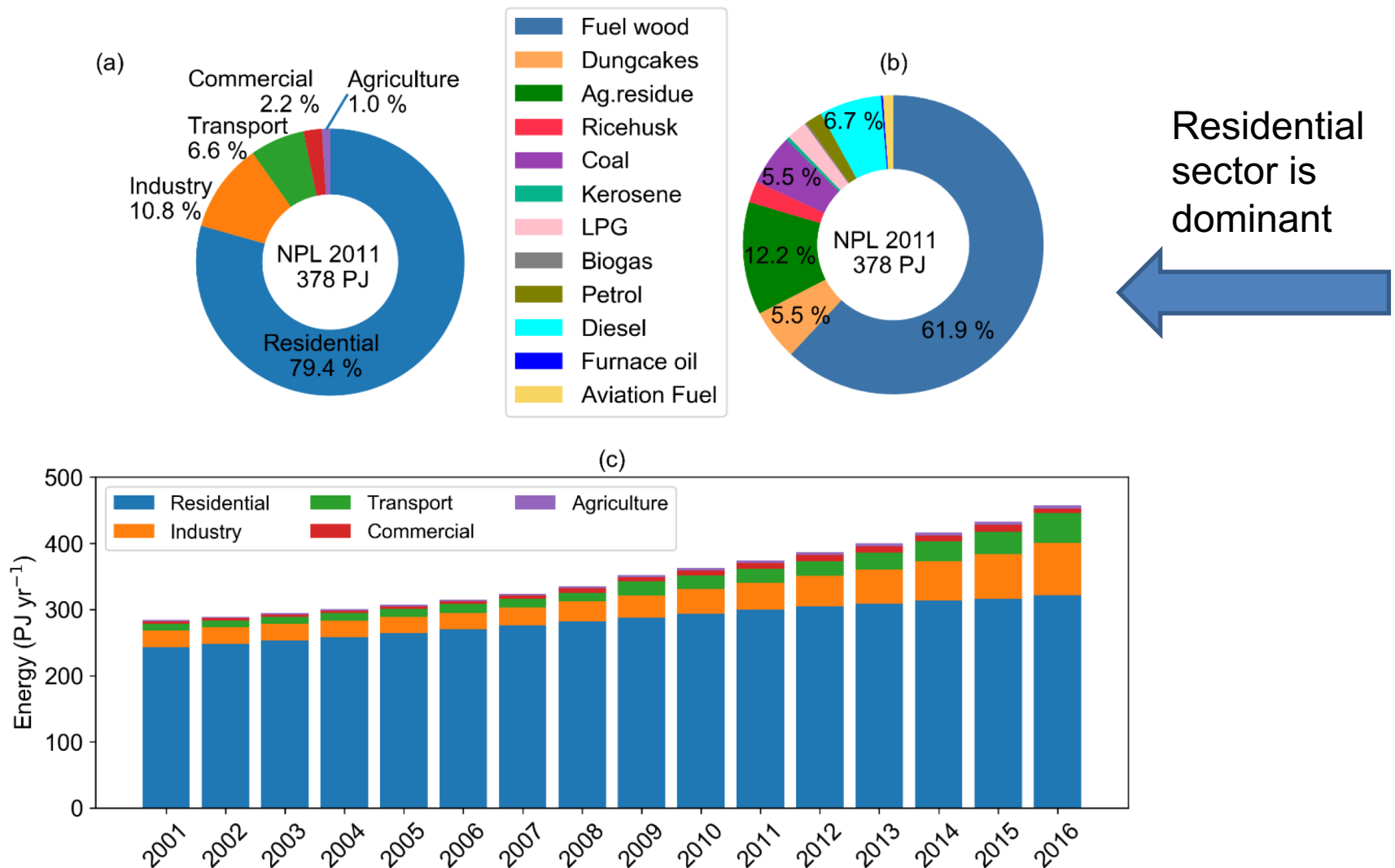| Sectors	Activities and pollutants
Solid waste	Solid waste burning
	Landfills, waste water (CH4)
Forest fires	Forest fires
Fugitive	Industrial processes, road dust etc.
Agriculture	Agricultural field burning
	Enteric fermentation, livestock manure, Paddy fields (CH4), Soil/fertilizer use (NH3)

Pollutants: PM10, PM2.5, BC, OC, SO2, NOX, CO, NMVOC, CO2, CH4, N2O

National sectoral energy consumption in Nepal during 2001-2016

Residential sector is dominant
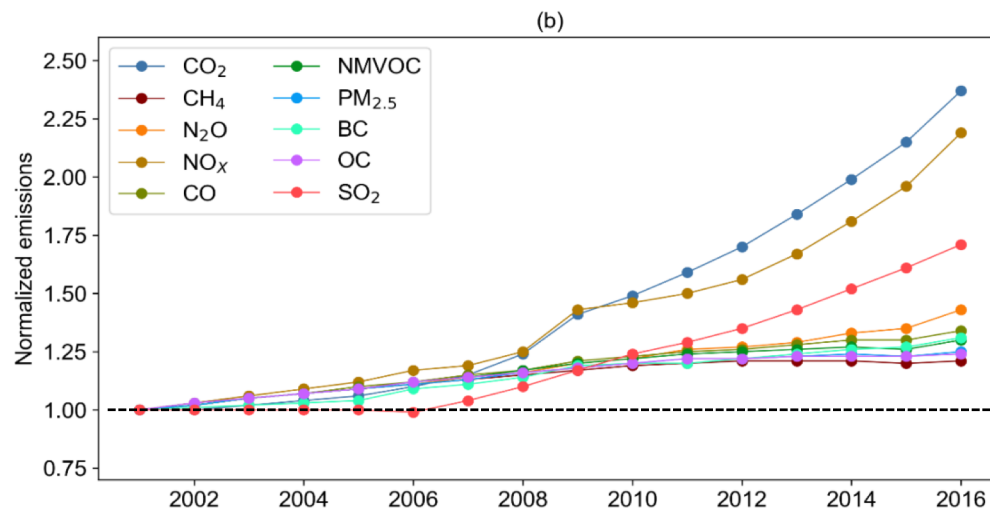
Sadavarte et al., 2019

Nepal emissions inventory: Technology-linked emissions (NEEMI-Tech) during 2001-2016
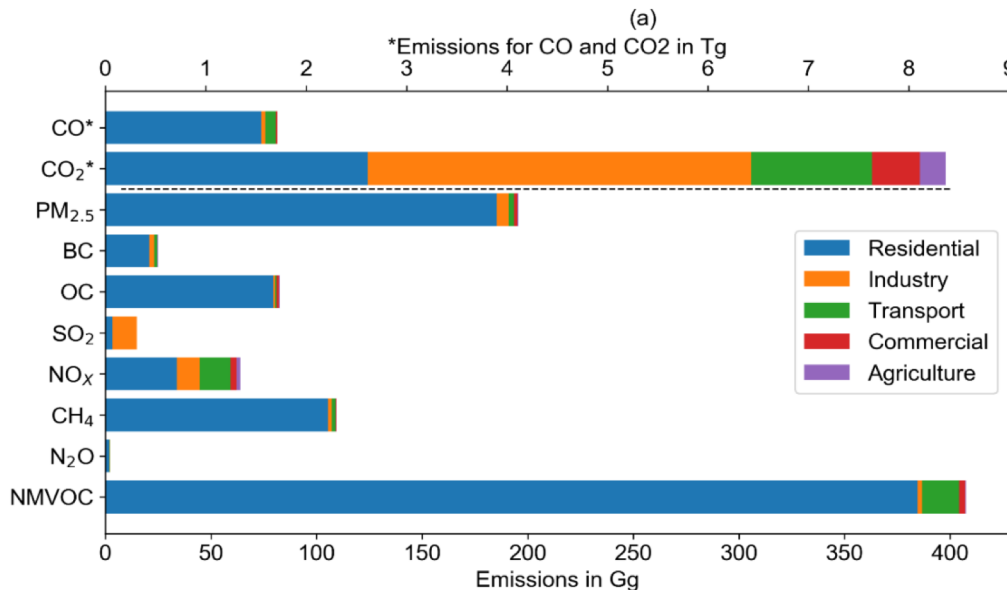
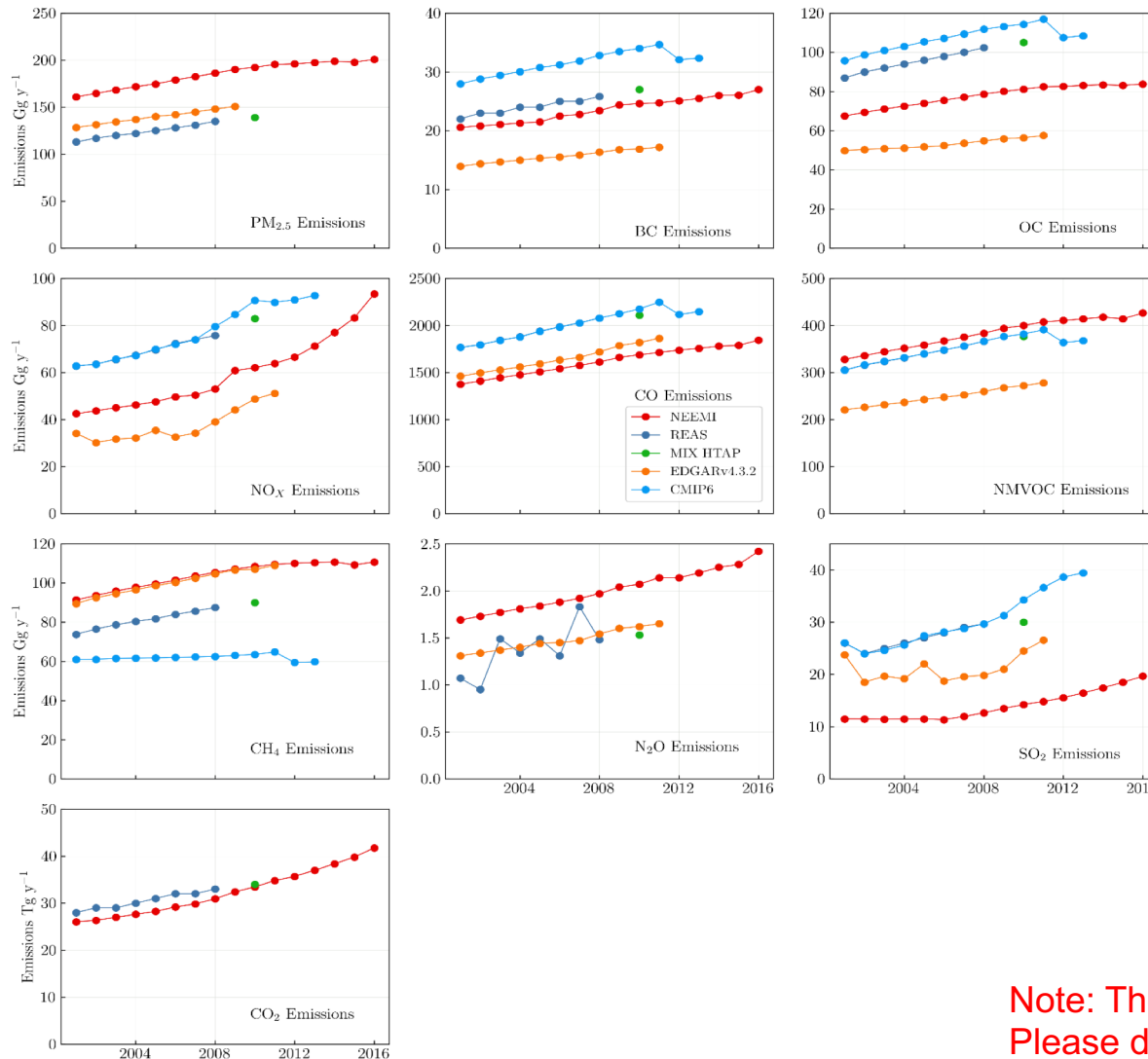**Most of the Emissions factors are taken from**

Nepal Ambient Monitoring and Source Testing Experiment (NAMaSTE) 2015

Stockwell et al., 2016, Jayaratne et al., 2018, Goetz et al, 2018

Several fold increase in emissions over 15 years
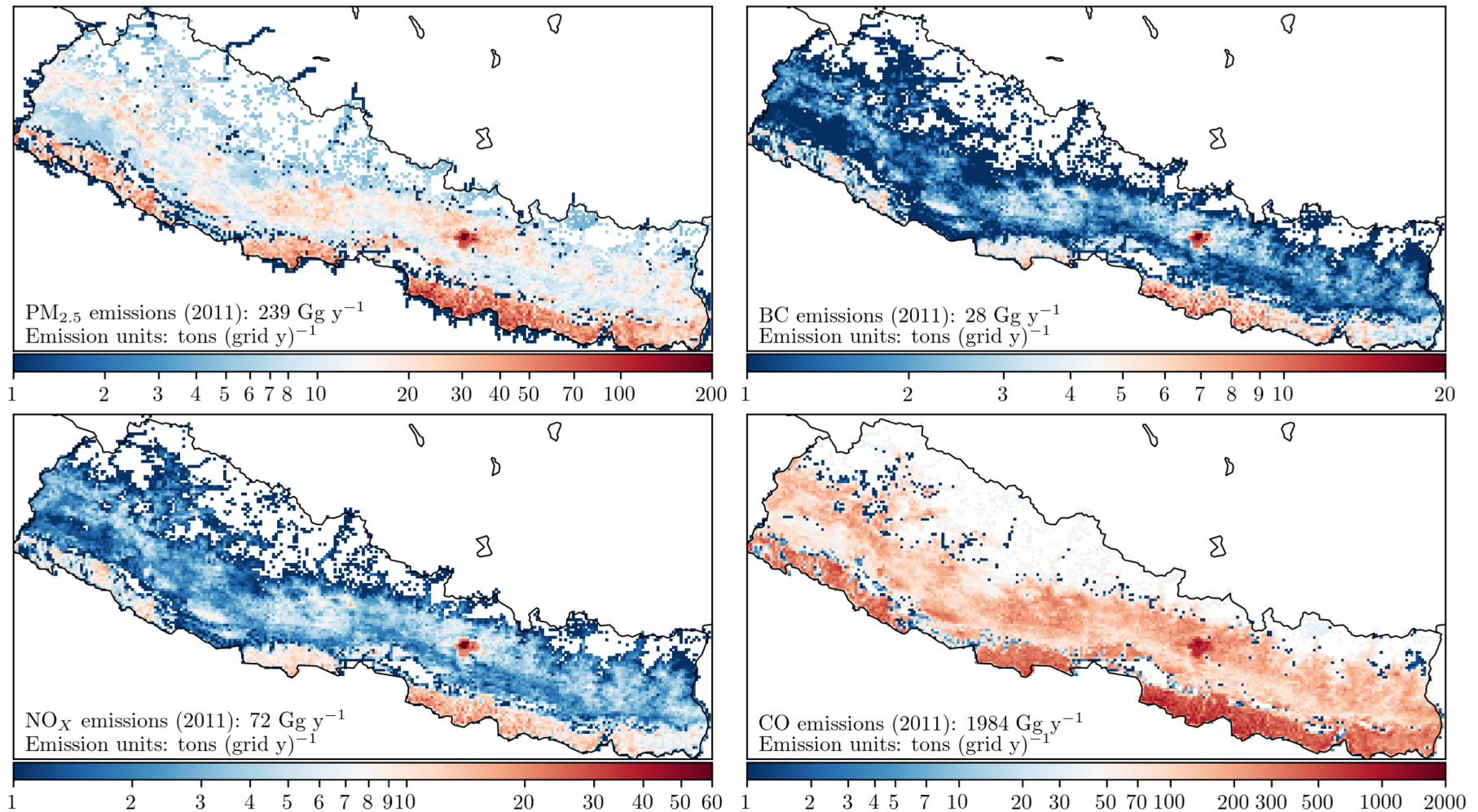
Sadavarte et al., 2019

Kathmandu Valley

BC fluxes (ng/m²/sec)

Mues et al: **217**
EDGAR HTAP: 39
NEEMI-Tech: **157**

Note: These numbers are being finalized.
Please don't cite, don't quote.

Sadavarte et al., 2019

PM$_{2.5}$ emissions (2011): 239 Gg y^{-1}
Emission units: tons (grid y)$^{-1}$

BC emissions (2011): 28 Gg y^{-1}
Emission units: tons (grid y)$^{-1}$

NO$_X$ emissions (2011): 72 Gg y^{-1}
Emission units: tons (grid y)$^{-1}$

CO emissions (2011): 1984 Gg y^{-1}
Emission units: tons (grid y)$^{-1}$

Note: These estimates are being finalized. Please don't cite, don't quote.

Sadavarte et al., 2019

Future direction
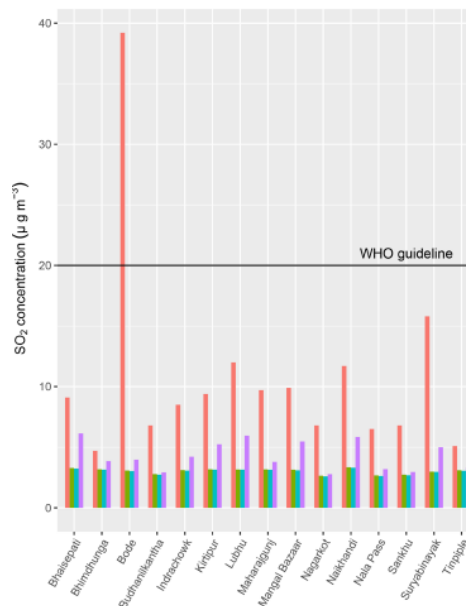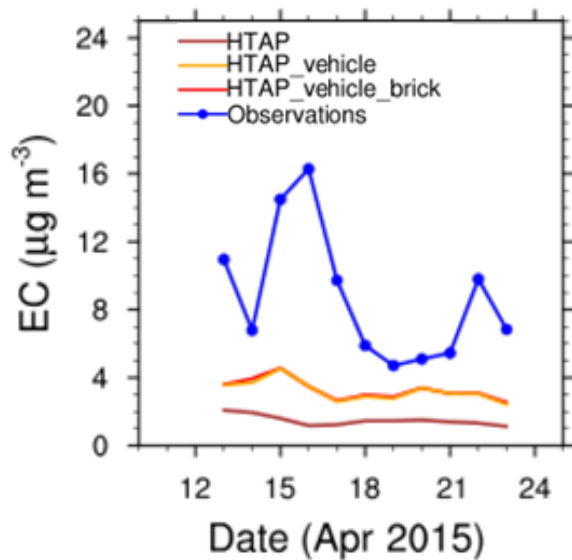
Zhong et al., 2019

Model simulations still underestimate observed BC, SO$_2$ and other species.

Next Step:

NEEMI-Tech
+
NEEMI-Open
} **+ WRF-Chem** ➡ **Understanding**
1. **Processes**
2. **Mitigation options**

Thank You

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