Case studies of CO and NO_2 as indicators of anthropogenic CO_2: Germany vs. India

Julia Marshall — CEOS AC-VC-14 — May 4, 2018 — College Park, MD

use of Satellite Measurements of Auxiliary Reactive Trace gases for fossil fuel CARBon dioxide emission estimation

Project team:
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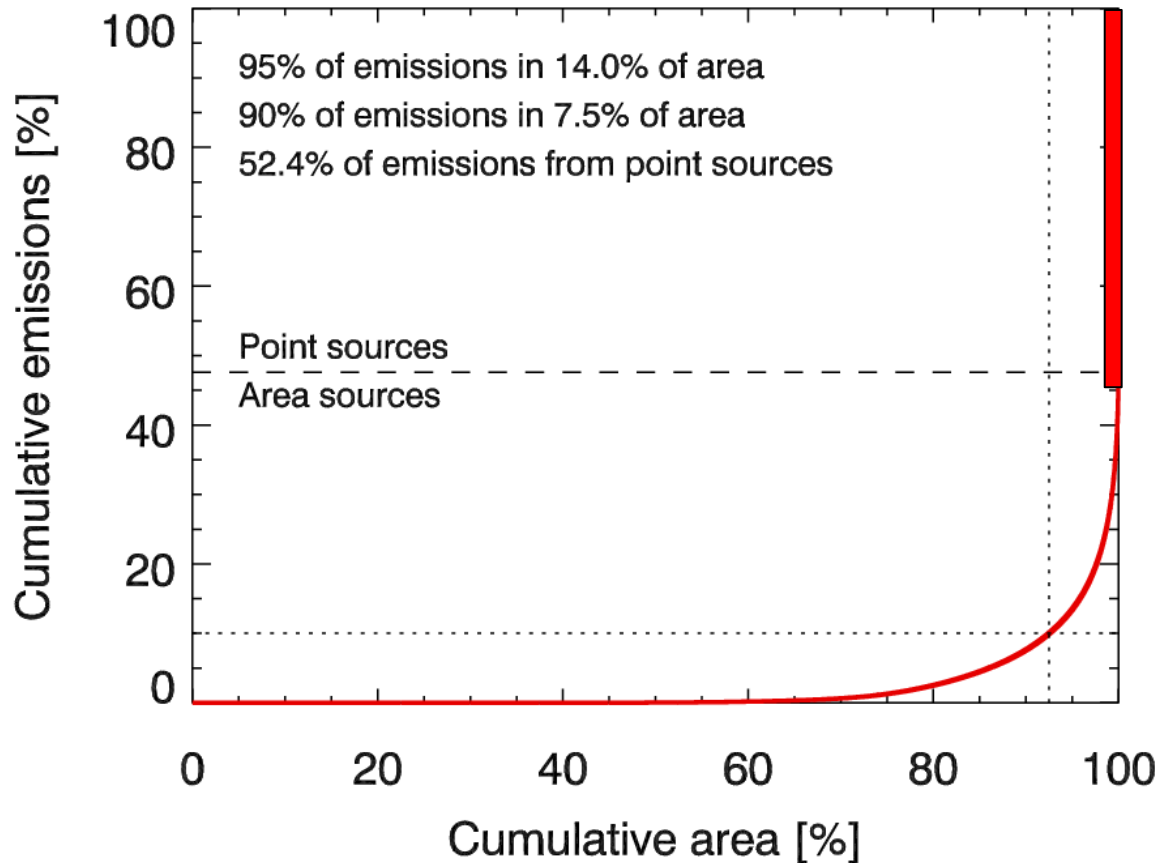Julia Marshall (MPI-BGC)

External Experts:
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The goals of SMARTCARB:

- Assess potential benefit of CO and NO_2 observations to quantify CO_2 emissions from satellite observations of city and power plant plumes

- Assist in the definition of Sentinel-7 mission requirements

Why point sources?

Cumulative CO_2 emissions vs. cumulative area over Europe, based on TNO/MACC-III inventory

95% of emissions in 14.0% of area
90% of emissions in 7.5% of area
52.4% of emissions from point sources
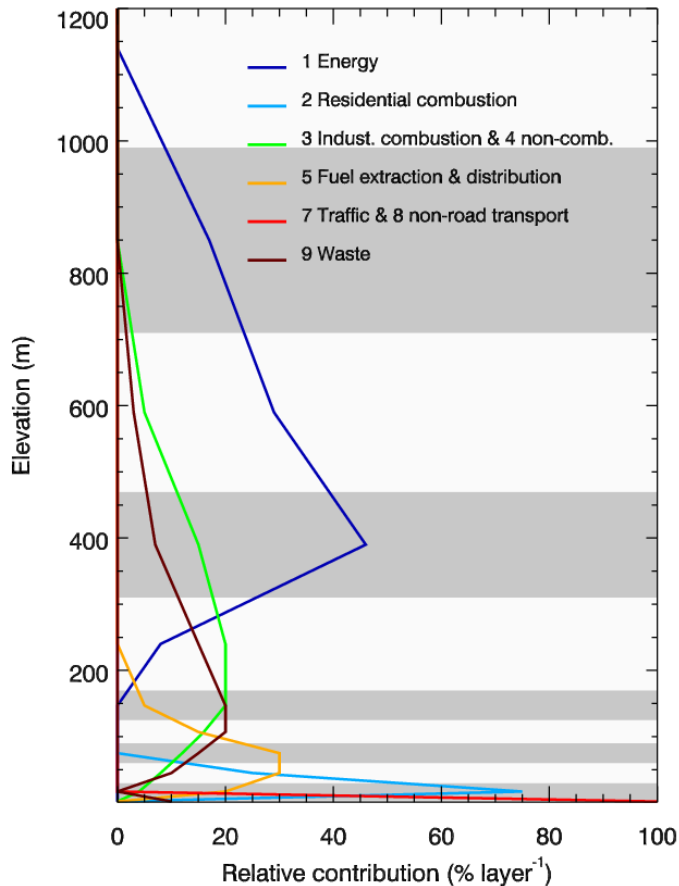
Point sources
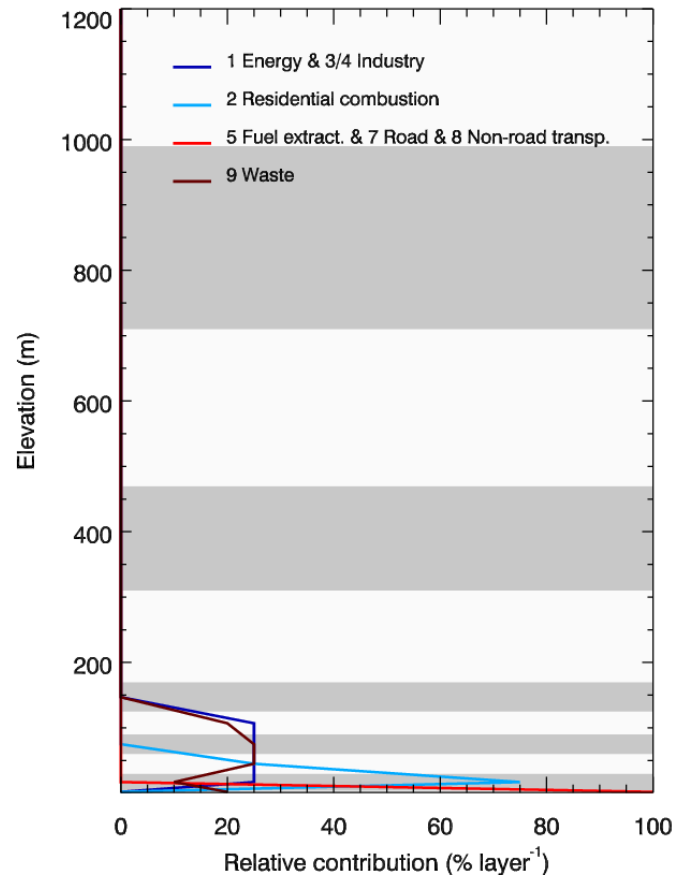Area sources

CO_2 emissions concentrated on a small area:

- 90% emitted over less
  than 8% of area of Europe
- 52% from point sources, primarily power plants

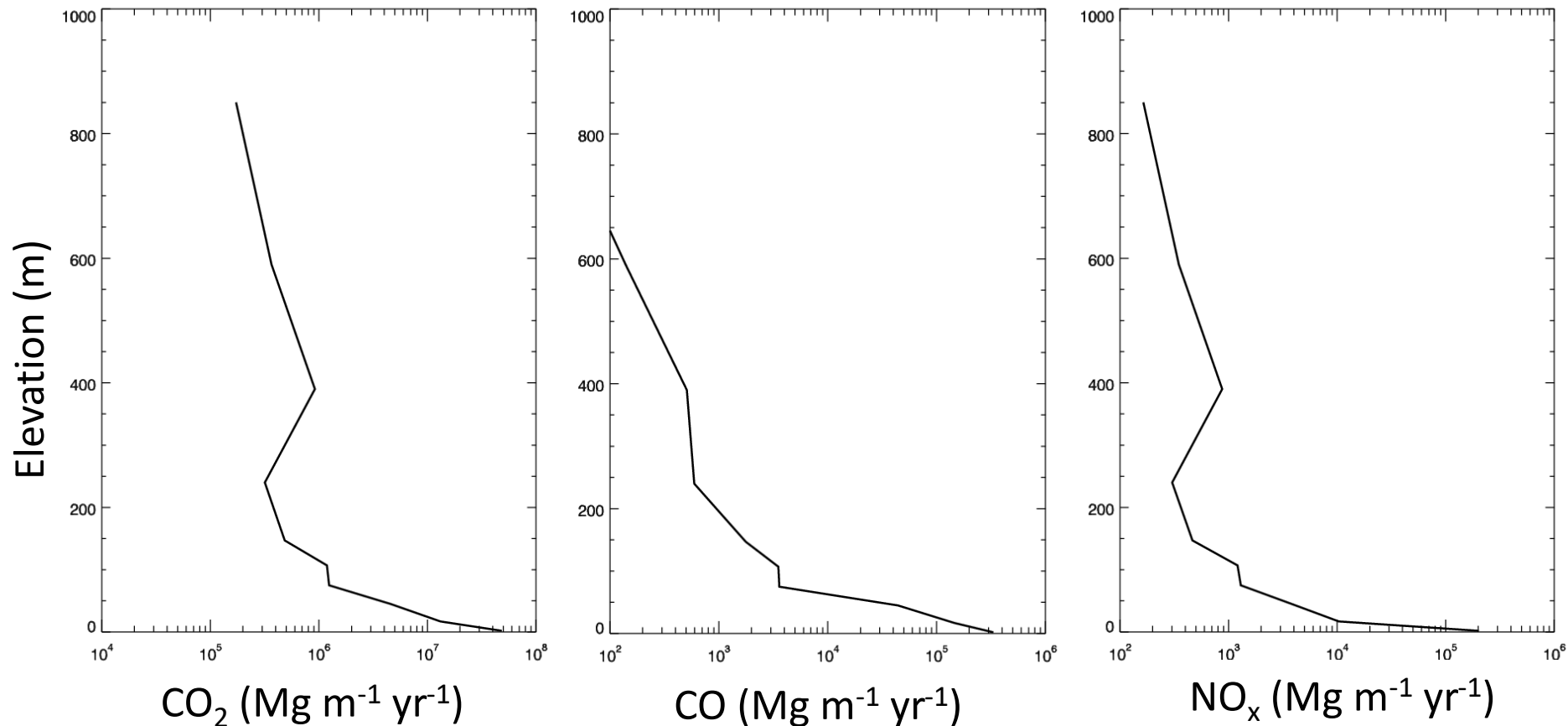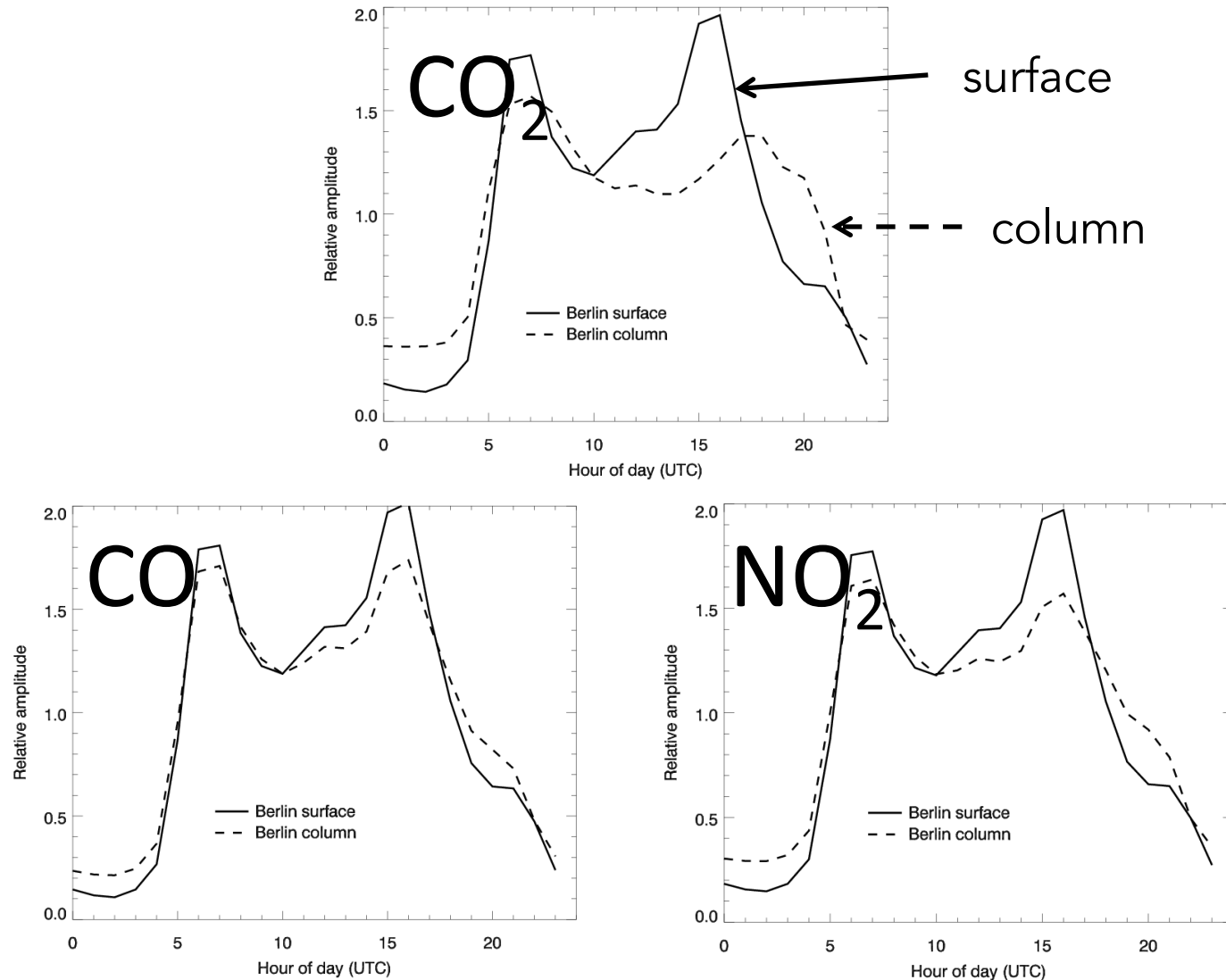# Different source categories are assigned different typical vertical profiles
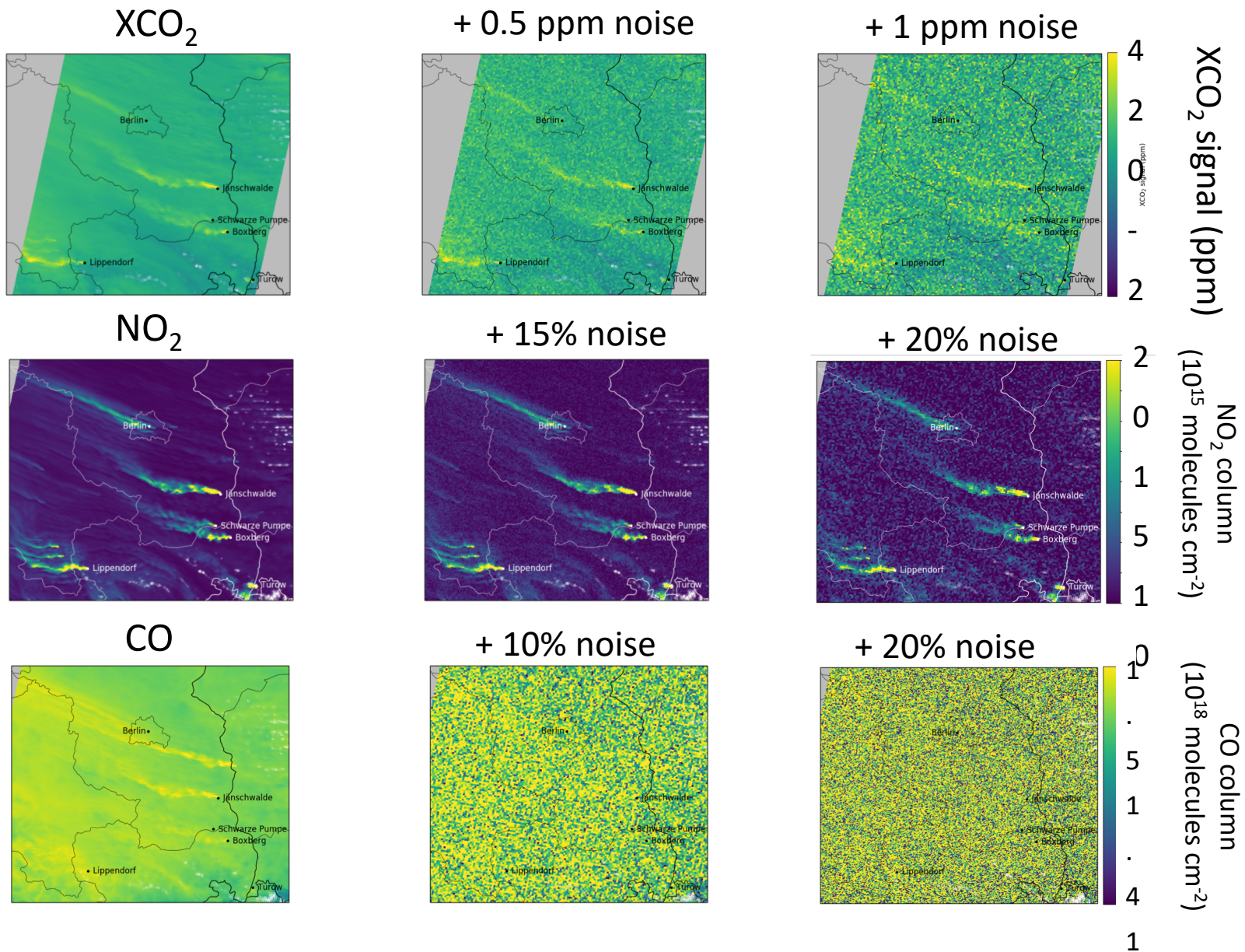
Point sources

Area sources

Around Berlin, vertical distribution of emissions more similar for NO_2 & CO_2 than for CO & CO_2

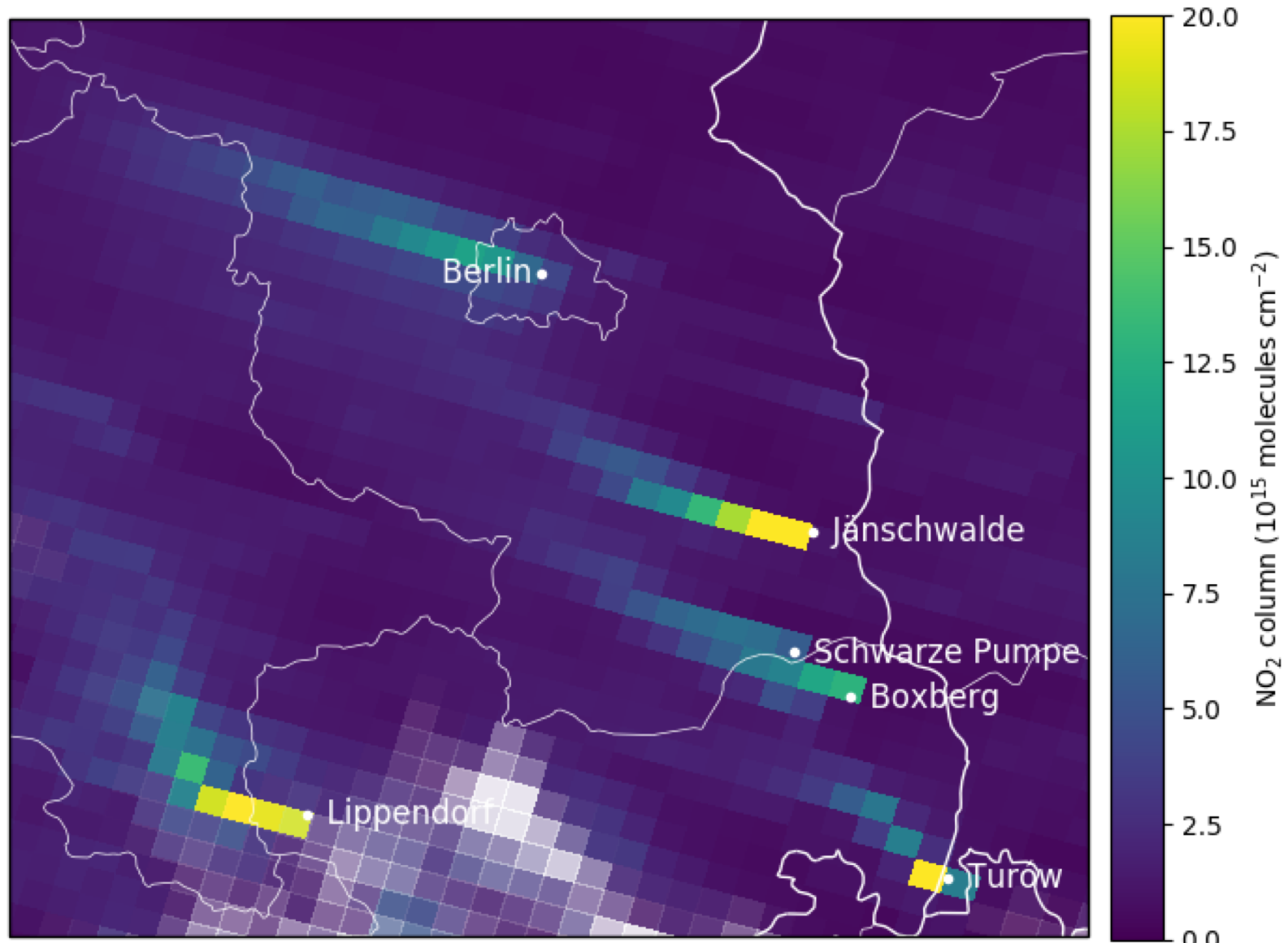# Different source categories assigned different temporal profiles (monthly, weekly, daily cycles)

Results

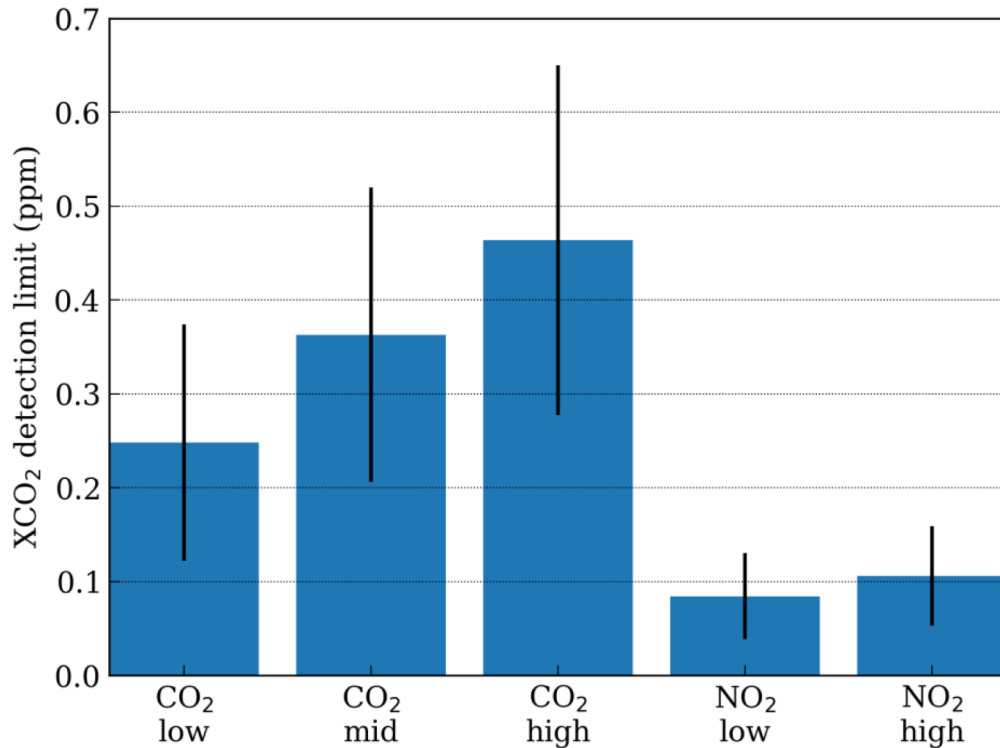# Sentinel-7, 1 x 1 km² vs. Sentinel-5, 7 x 7 km²

What this means for plume identification

- detection limit for a plume is about half the single-sounding precision

- detection limit using NO_2 for detecting the CO_2 plume is about 0.1 ppm

In this report we focus on the CO_2 emissions arising from anthropogenic activities, which constitute an addition of exogenous carbon in the climate system. We define "fossil CO_2 emissions" as the sum of CO_2 emissions from fossil fuel combustion, process CO_2 emissions from cement production, process CO_2 emissions from metal (ferrous and non-ferrous) production, and the CO_2 emissions from urea production, urea application and agricultural lime. Emissions from the combustion of biofuel (carbon neutral over one year) and from large-scale biomass burning (forest fires, peat fires) are not included.
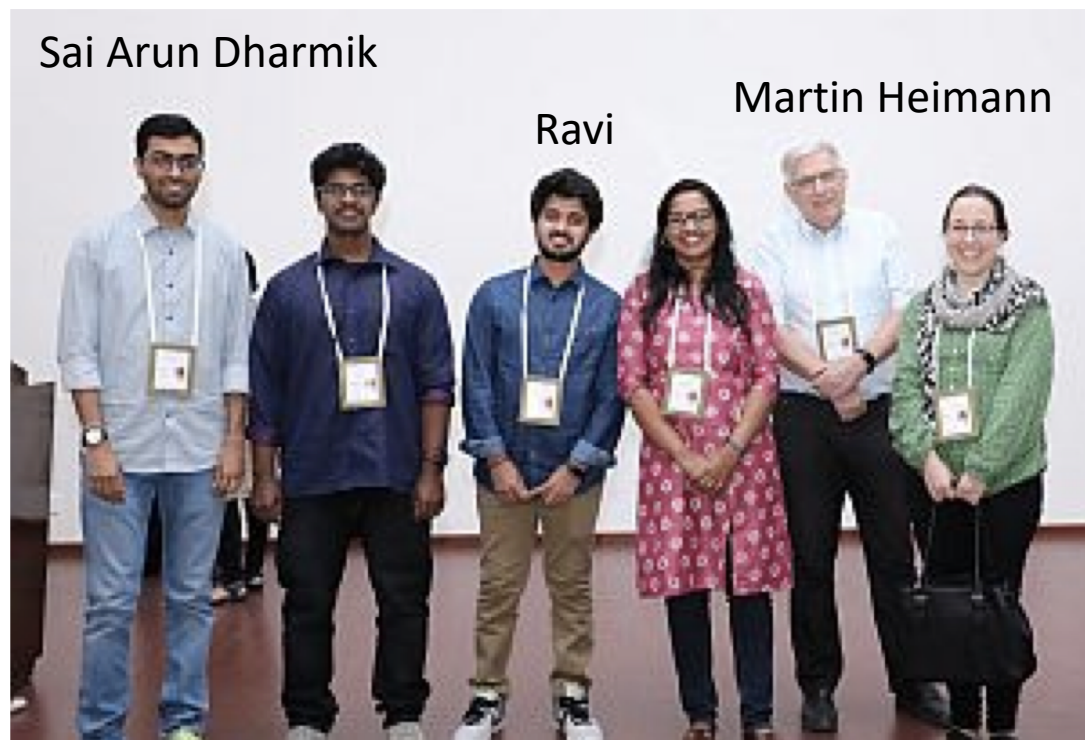
Observing System to Monitor Fossil

CO_2 emissions

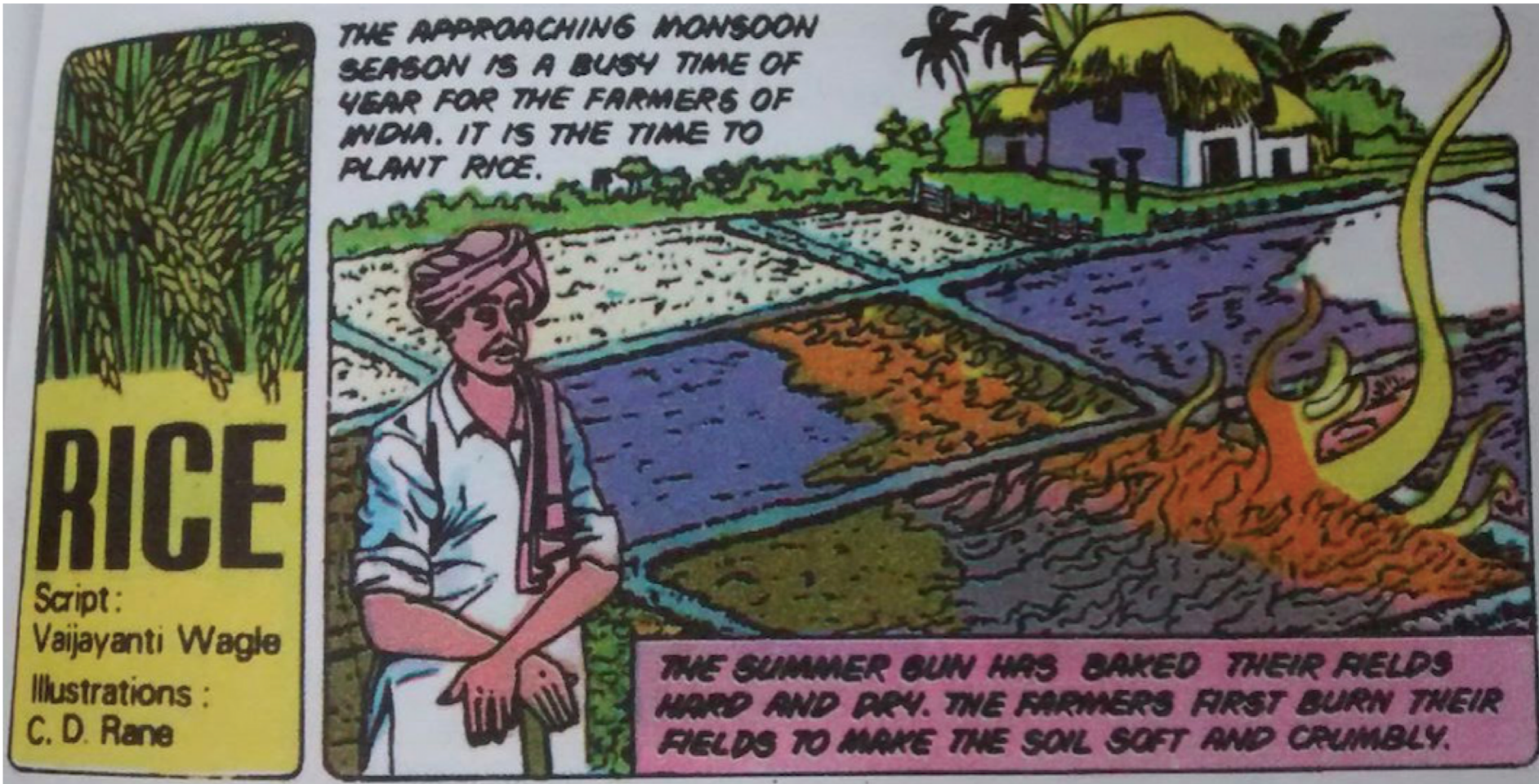Final Report from the expert group

CO_2

A contrasting case: India
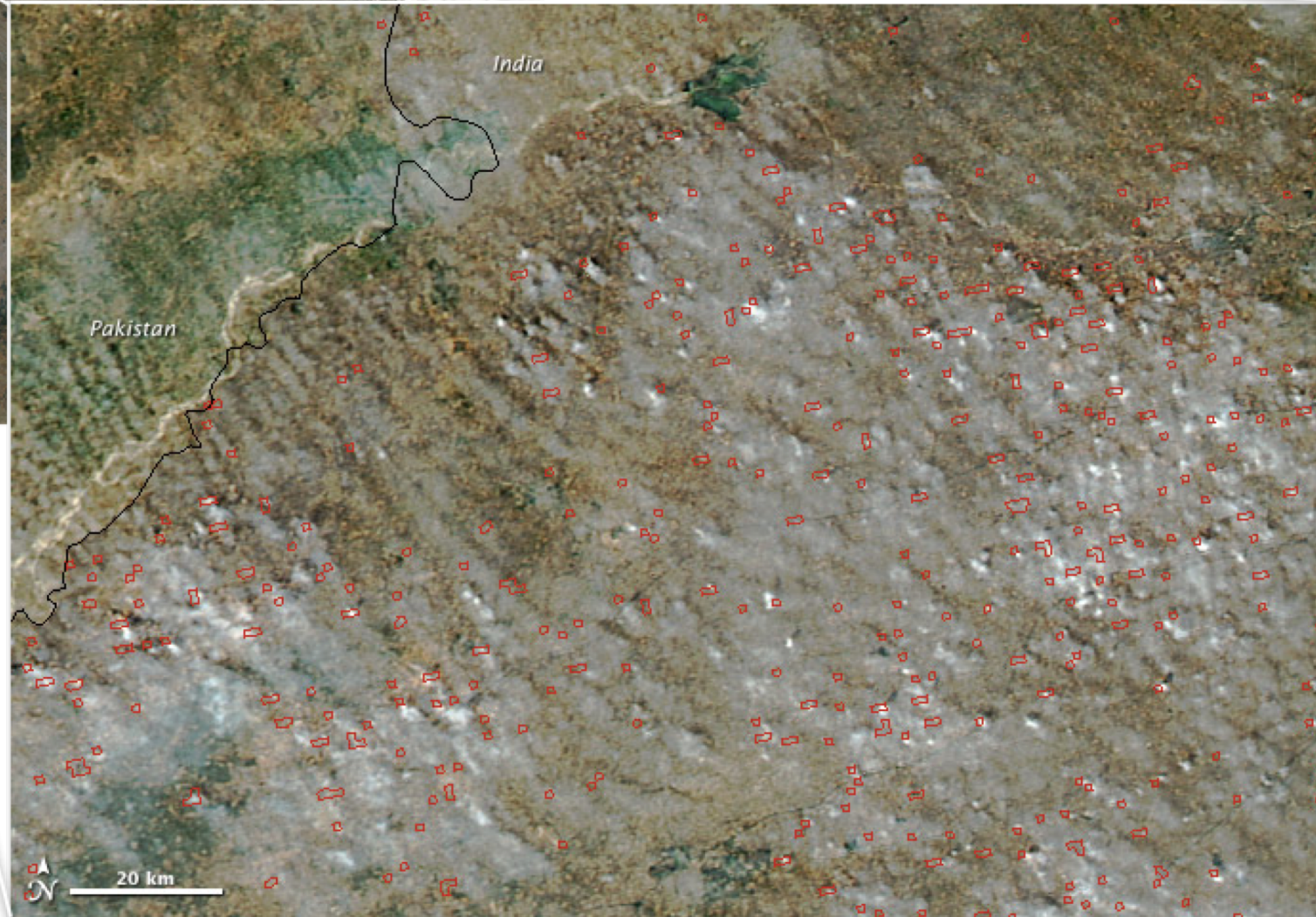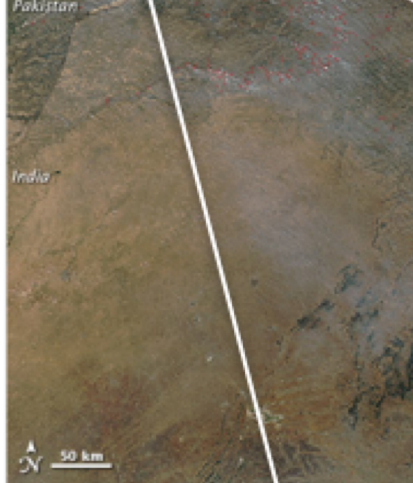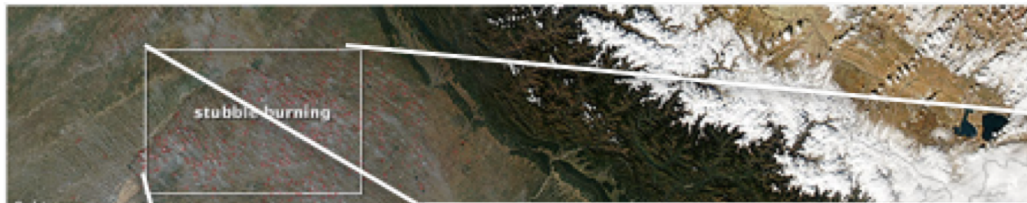

Sai Arun Dharmik
Ravi
Martin Heimann
Yadu S
Dhanyalekshmi Pillai

Max Planck Institute
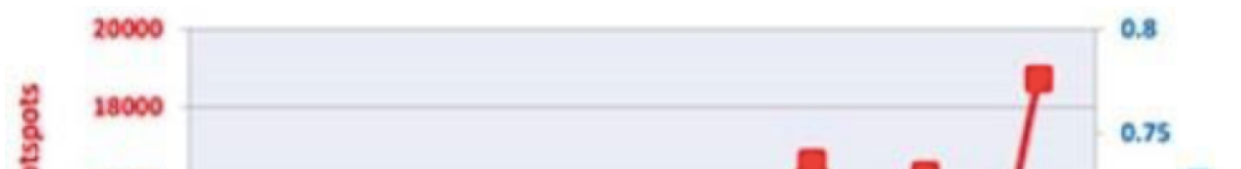for Biogeochemistry

Agricultural burning is a major part of the CO (and CO_2) budget

From MODIS imagery:

Increasing signal over time, despite government efforts to stop it

ENVIRONMENT   MARCH 7, 2018 / 6:05 PM / 4 DAYS AGO

## India approves plan to stop farmers burning crop residues

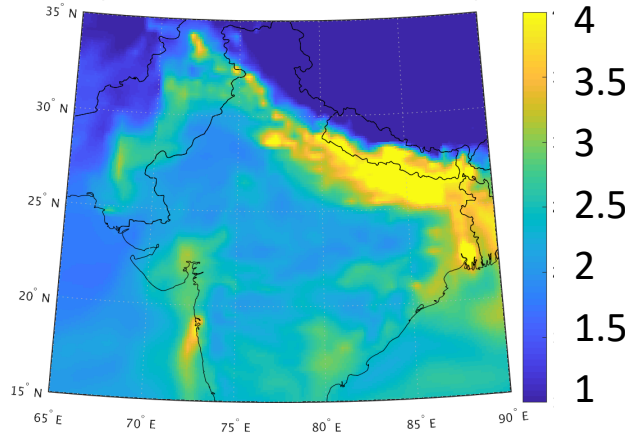Reuters Staff   2 MIN READ

NEW DELHI (Reuters) - India said on Wednesday it would spend 11.52 billion Indian rupees ($177.61 million) over two years on agricultural mechanization to reduce crop residue burning and bring pollution levels down in and around its capital New Delhi.

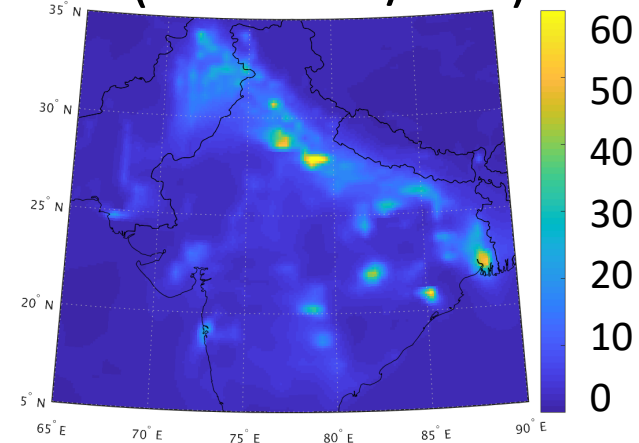# Anthropogenic signal (EDGAR + GFAS): November 29, 2017

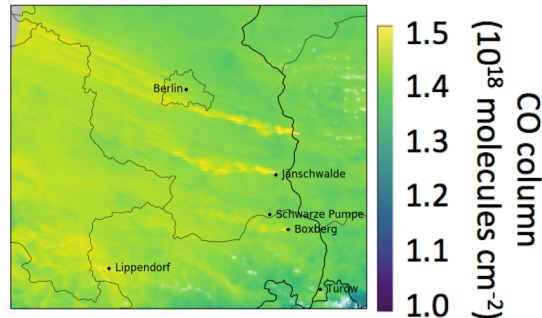XCO$_2$ (ppm)
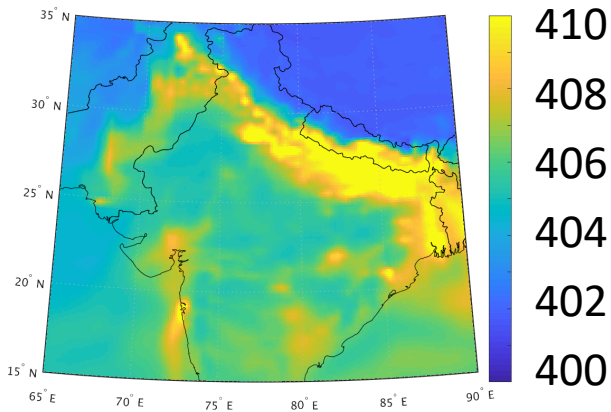
CO column (10^{18} mol./cm^2)

NO$_2$ column (10^{15} mol./cm^2)

CO

Compare:

Conclusions

- If the goal is the isolation of fossil signals alone, NO_2 is the way to go (but may not work as well for e.g. gas-powered power plants)
- Very useful for flagging CO_2 plumes for point source attribution, reducing wind uncertainties
- CO provides information about lower-efficiency combustion and biomass burning
- Analysis of all three simultaneously can facilitate process separation in different regions

The effect of different NO$_x$ decay times

No decay   24 h   12 h   4 h   2 h