Confidence and key uncertainties in black carbon emissions & radiative impacts

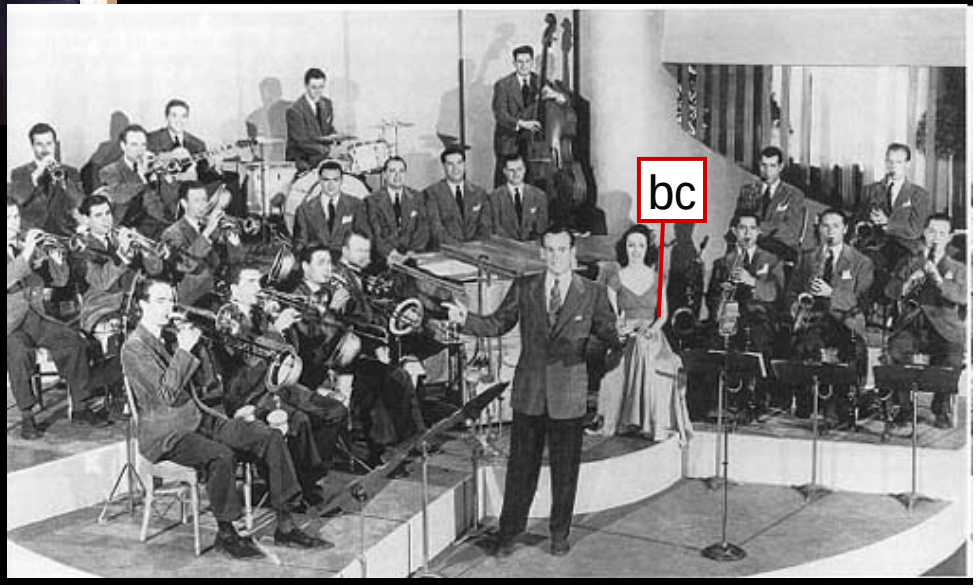
& measurements & co-emitted particles & gases & optical properties & vertical distributions & future emissions &…

Tami C. Bond

Department of Civil & Environmental Engineering

University of Illinois at Urbana-Champaign

U.S. Environmental Protection Agency, SLCF Workshop
North Carolina, USA
March 3, 2010

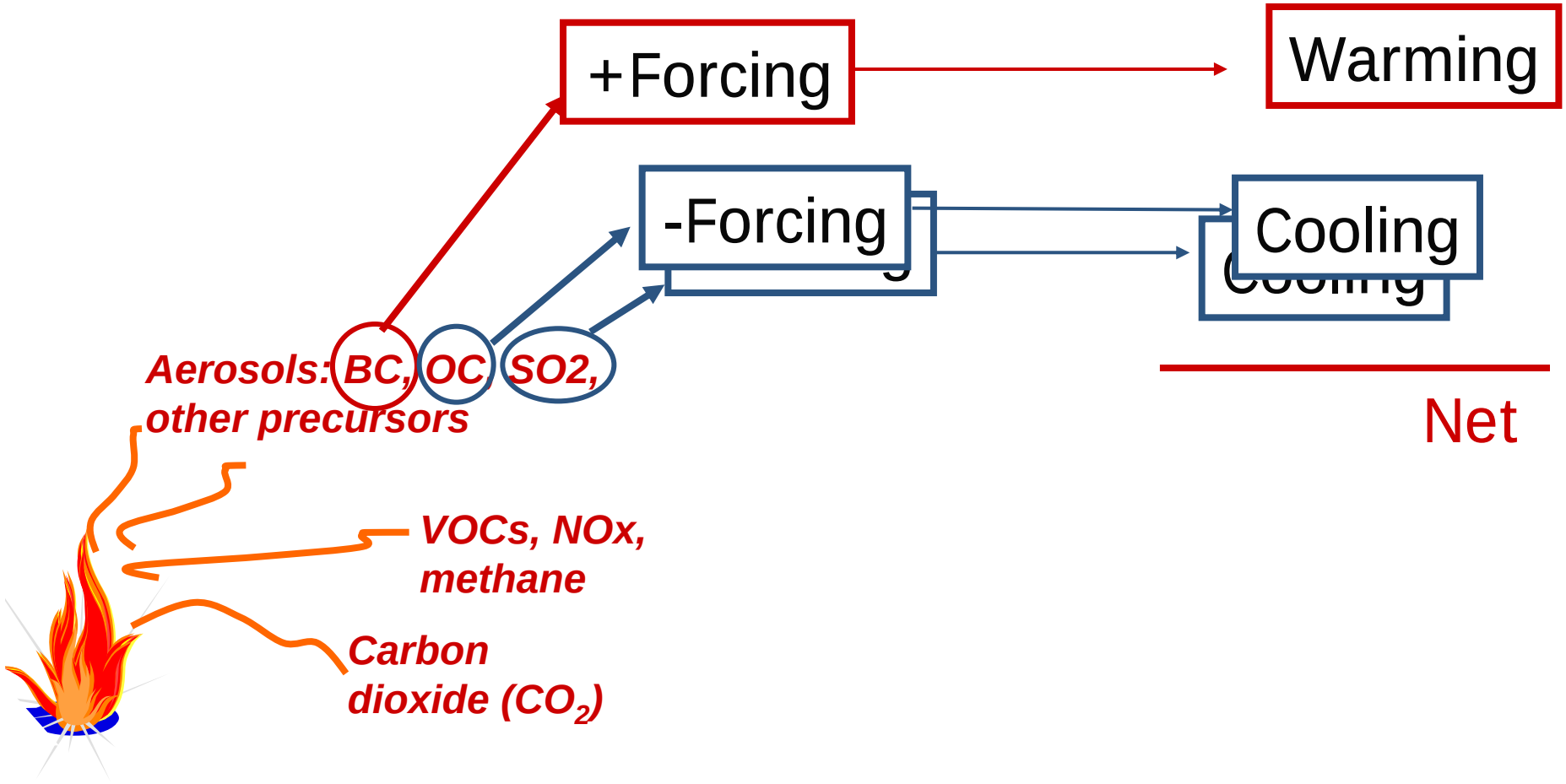


Climate

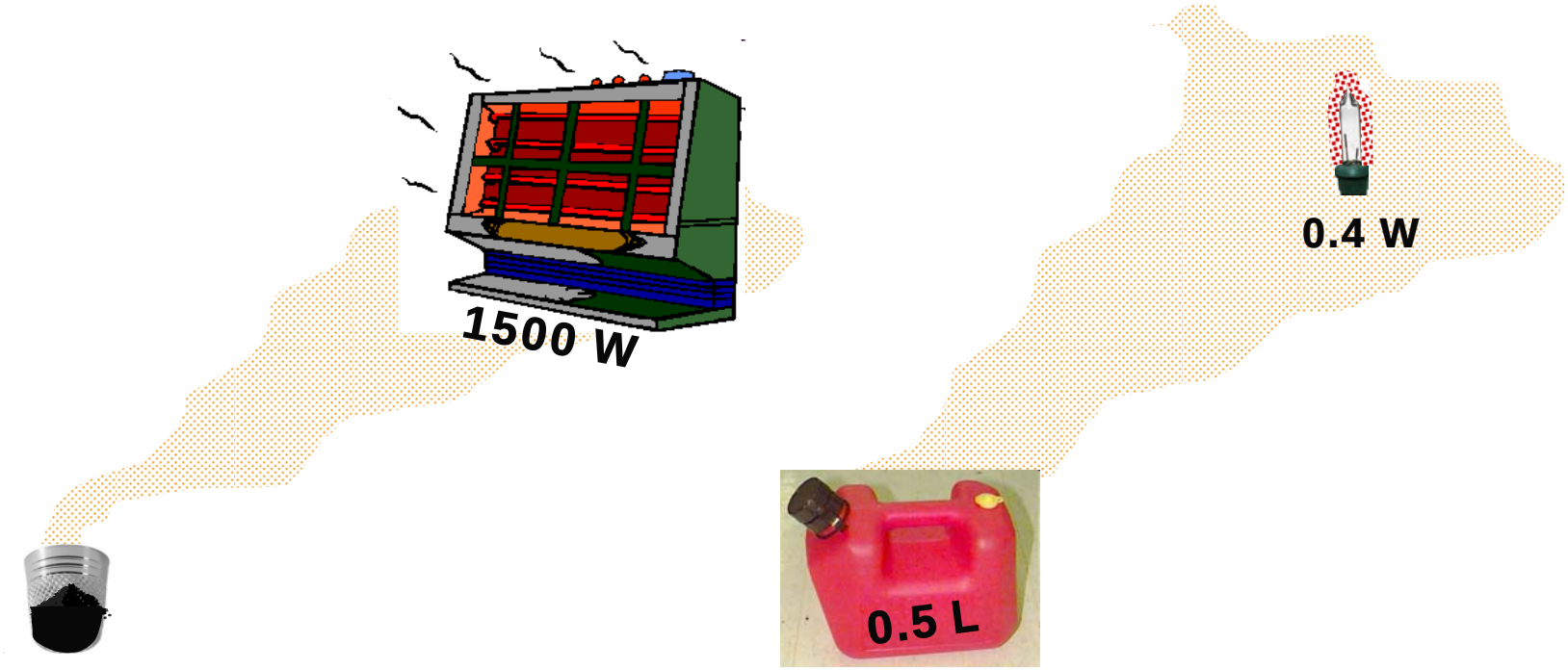
Health

Air Quality

Source-to-Impact measures



Strong absorption of BC causes powerful, immediate warming.



1 gram BC emitted =
small heater in atmosphere for 1 week
1 kg CO_2 emitted =
1 small bulb for 100 years

Black Carbon Sources

Black carbon is created ~~only~~ 99.99% in flame

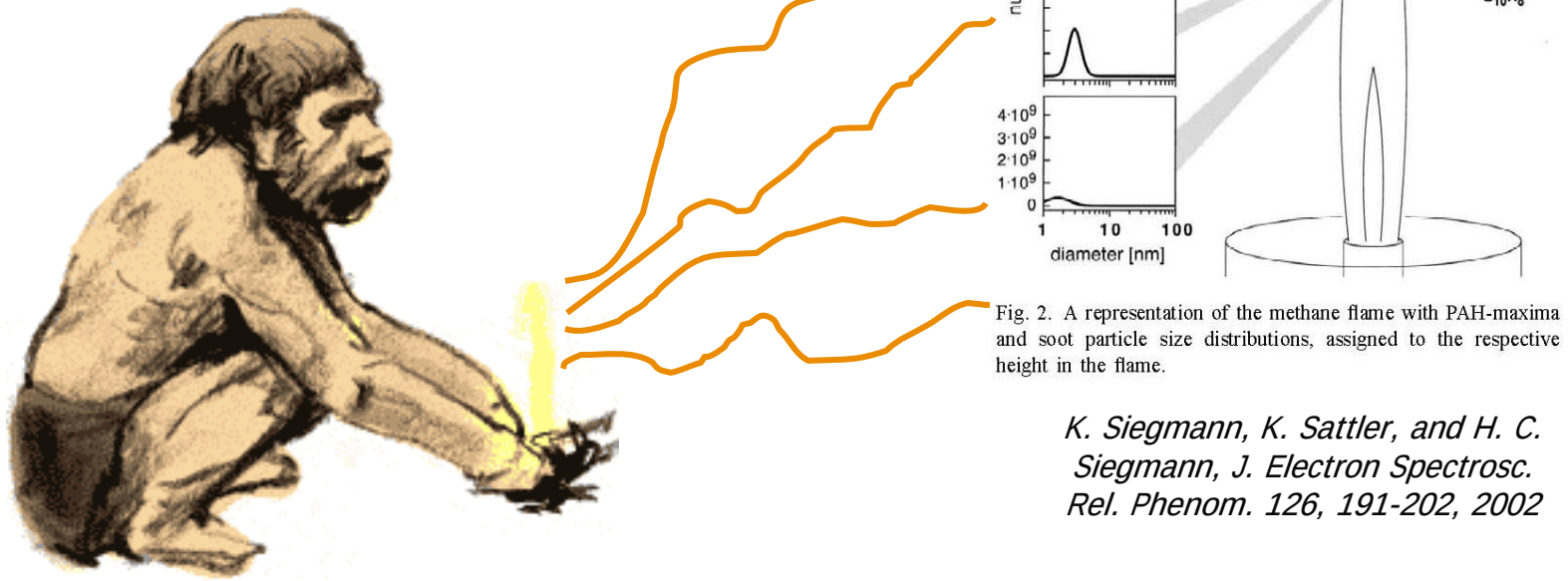
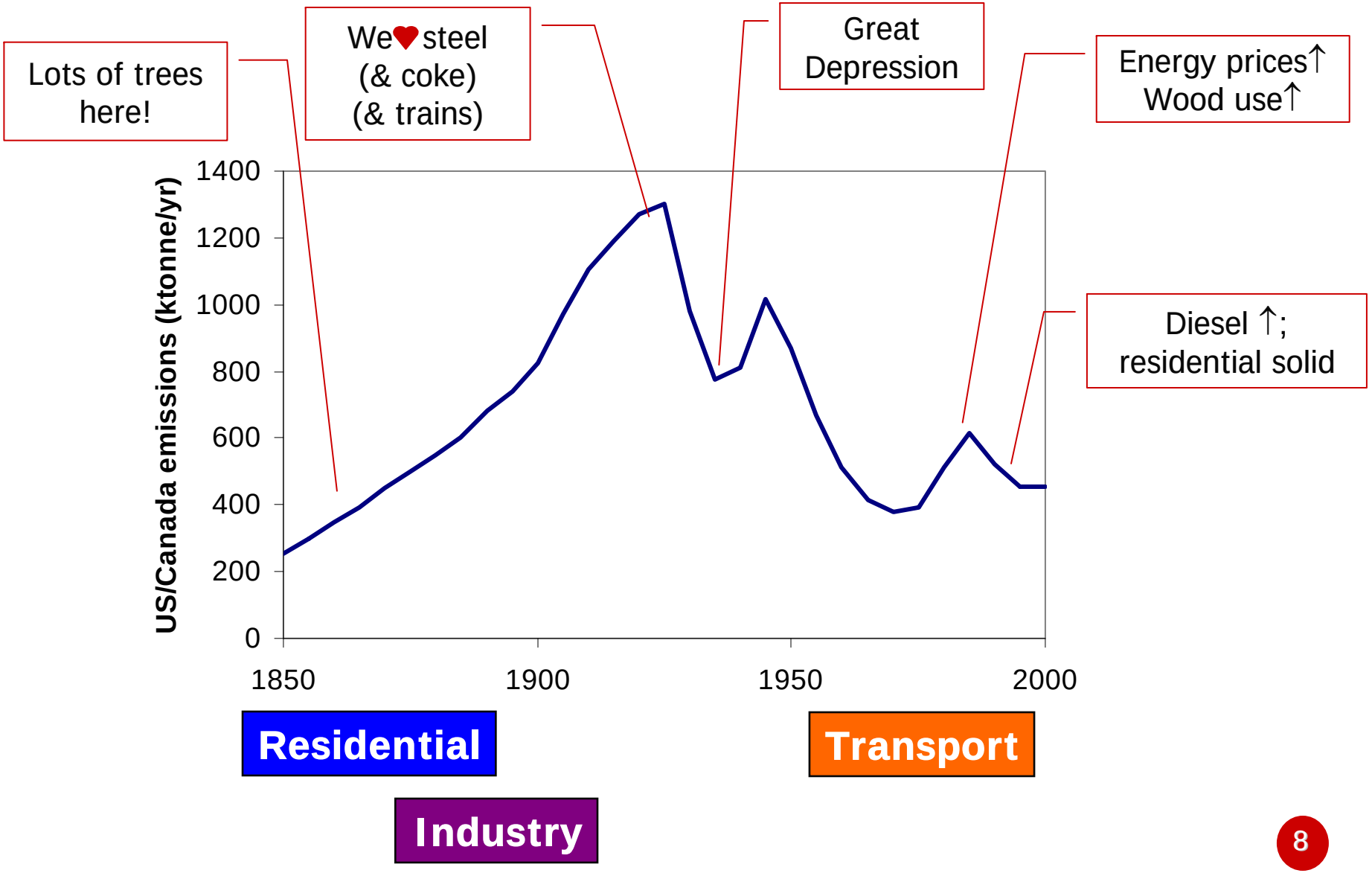


Fig. 2. A representation of the methane flame with PAH-maxima and soot particle size distributions, assigned to the respective height in the flame.

K. Siegmann, K. Sattler, and H. C. Siegmann, J. Electron Spectrosc. Rel. Phenom. 126, 191-202, 2002

Historical BC lessons

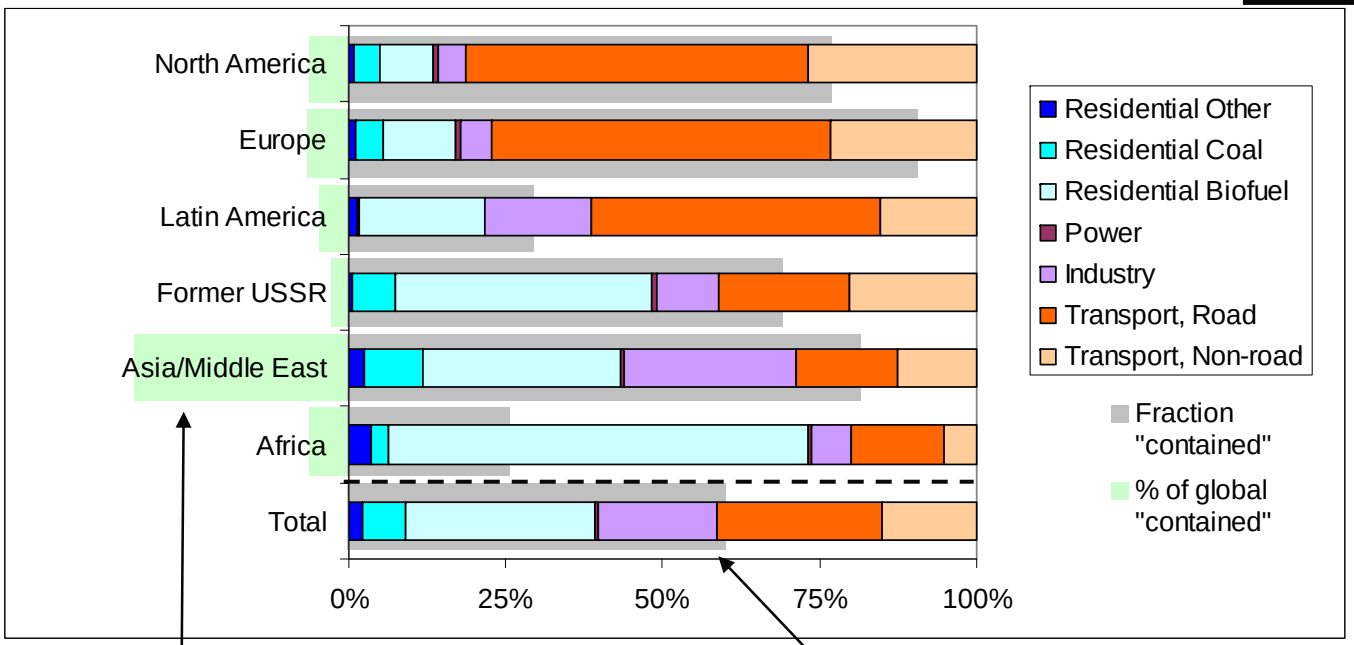


Source mix differs by region

Residential → **Industry** → **Transport**

d e v e l o p m e n t

Colored bars indicate relative contribution to global total.

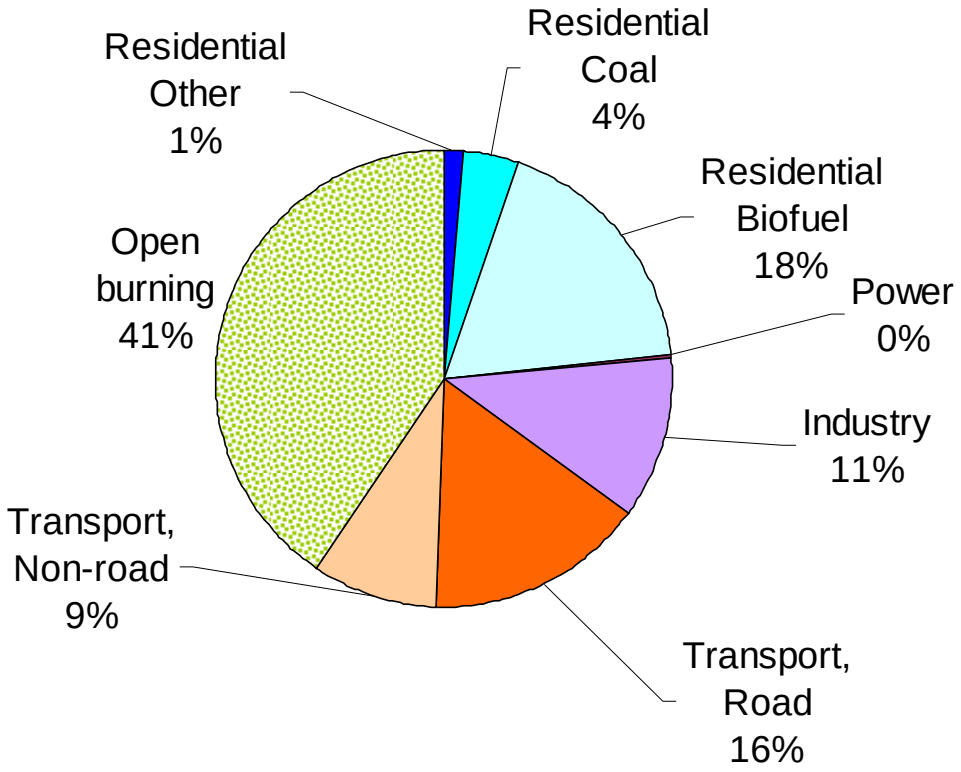


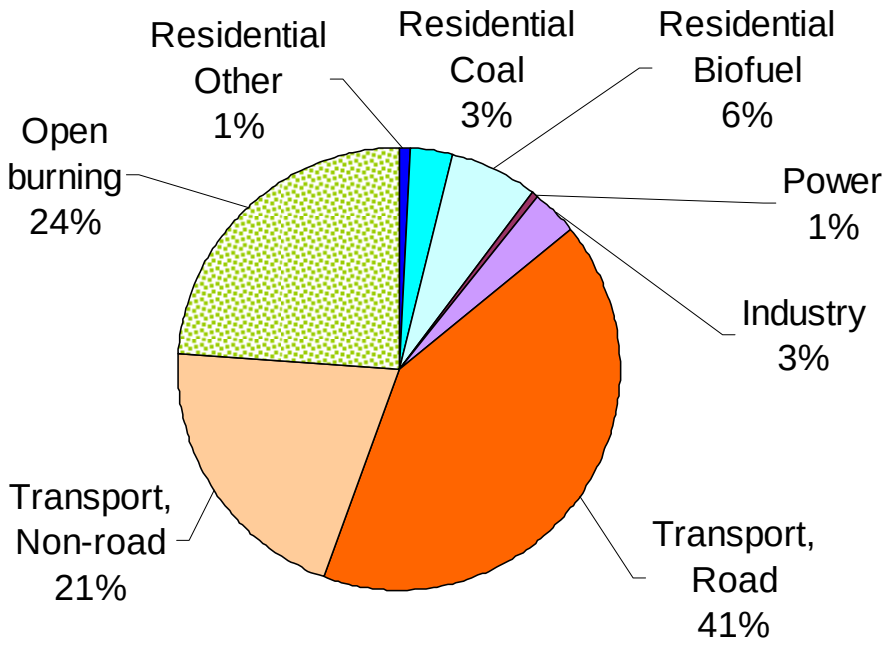
(Bond et al. 2004 JGR)

Green bars indicate relative contribution to global total.

Gray bars show how much comes from energy-related combustion.

Global & N American sources of BC





Global

North America

Year 2000 estimates (Bond et al., GBC 2007 + van der Werf, 2006 + updates for IPCC AR5)

Bottom-up inventory needs & major uncertainties

- Open biomass (forest+savanna) will *always* be uncertain

Gaps: Small fractions or small sources (stats please!)

- Activity: Vehicle superemitters
- Activity & Profiles: Residential wood
- A&P: Small industrial sources
- A&P: Crop burning, esp near ice
- A&P: Flaring

Connections: Inventory links from state-national-global levels

- Must retain flexibility & research nature

Straight talk about uncertainties

- Bottom-up inventory uncertainty = x2
  - Some sectors x5
  - If activity uncertain → Sign is known, magnitude isn't
  - If profile uncertain → ΔClimate forcing may be wrong
  - Measurements contribute (BC/OC division)
- Global model analysis (*Koch et al.*, ACP, 2009)
  - Surface predictions *close* to models
    - But only available in certain regions (US-Europe)
  - Column absorption *higher* than models
    - Probably affected by aerosol mixing = absorption ↑
  - Large underpredictions in *open biomass burning regions*

Major BC sources of interest

AKA: bands with a loud frontman

ktonne/yr, 2000

Bounding-BC

tease

"Bounding the Role of Black Carbon in Climate"

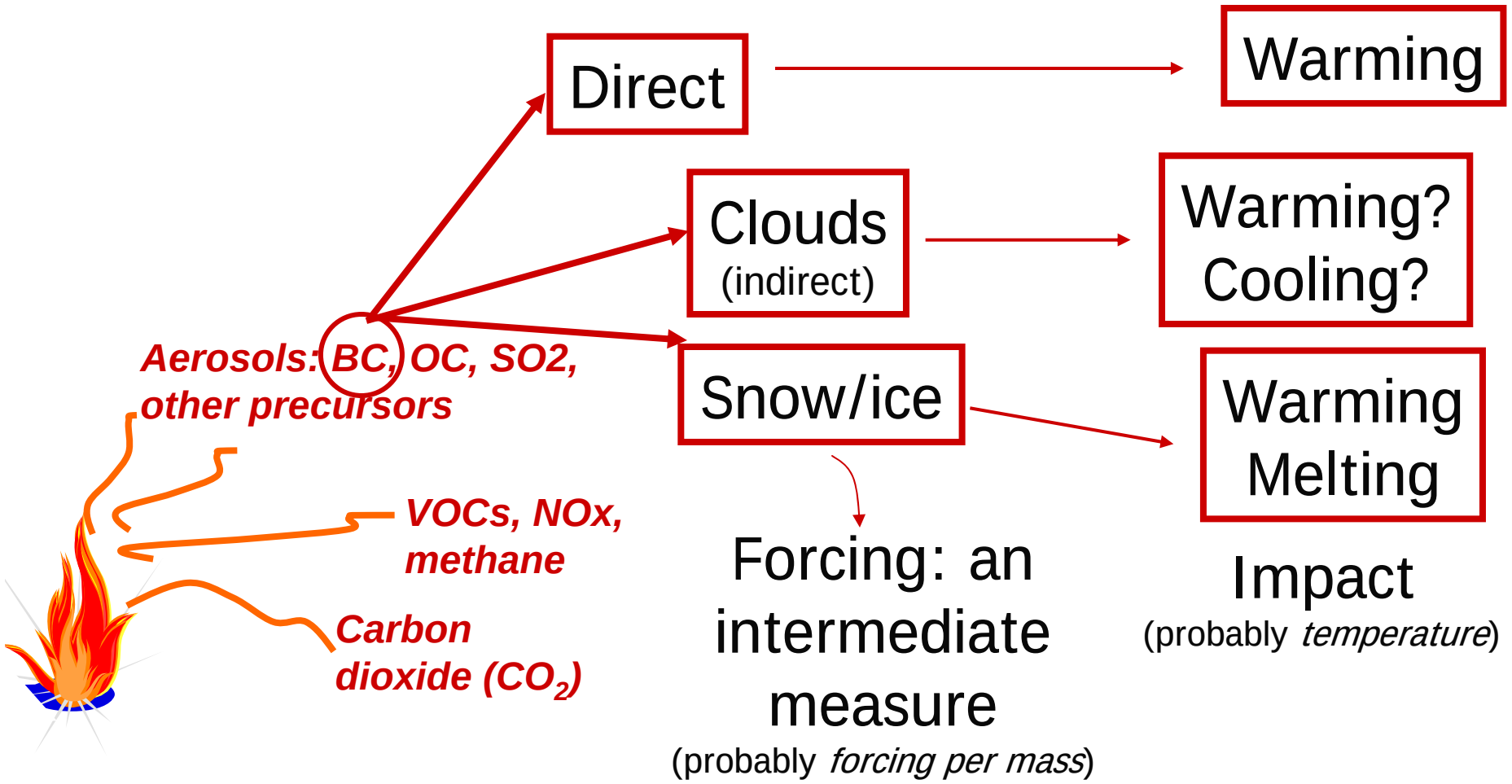
Conceived Jan 2009

Due Jun 2010

Bounding-BC major goals

- Provide best current estimate for radiative forcing by black carbon
  - identify causes of disagreement
- Connect individual sources to climate impacts
  - account for co-emitted short-lived pollutants

Bounding-BC Source-to-Impact measures



Bounding-BC: BC+OC+SO_2

Someday: All emitted species

THANK YOU!!

Questions?

yark@illinois.edu