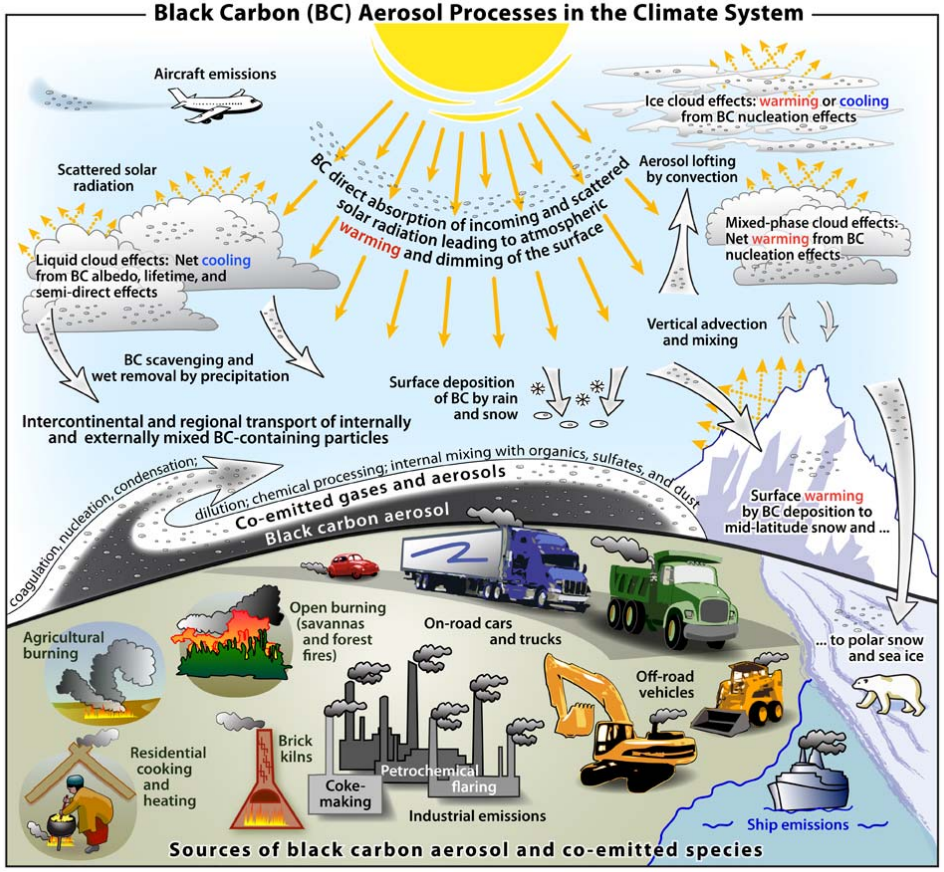
Constraining black carbon in the climate system

Joshua Schwarz

CSD spearheads black carbon research focused on HIGH IMPACT topics with large uncertainties and high stakes



Bond et al., 2013 – 286 citations

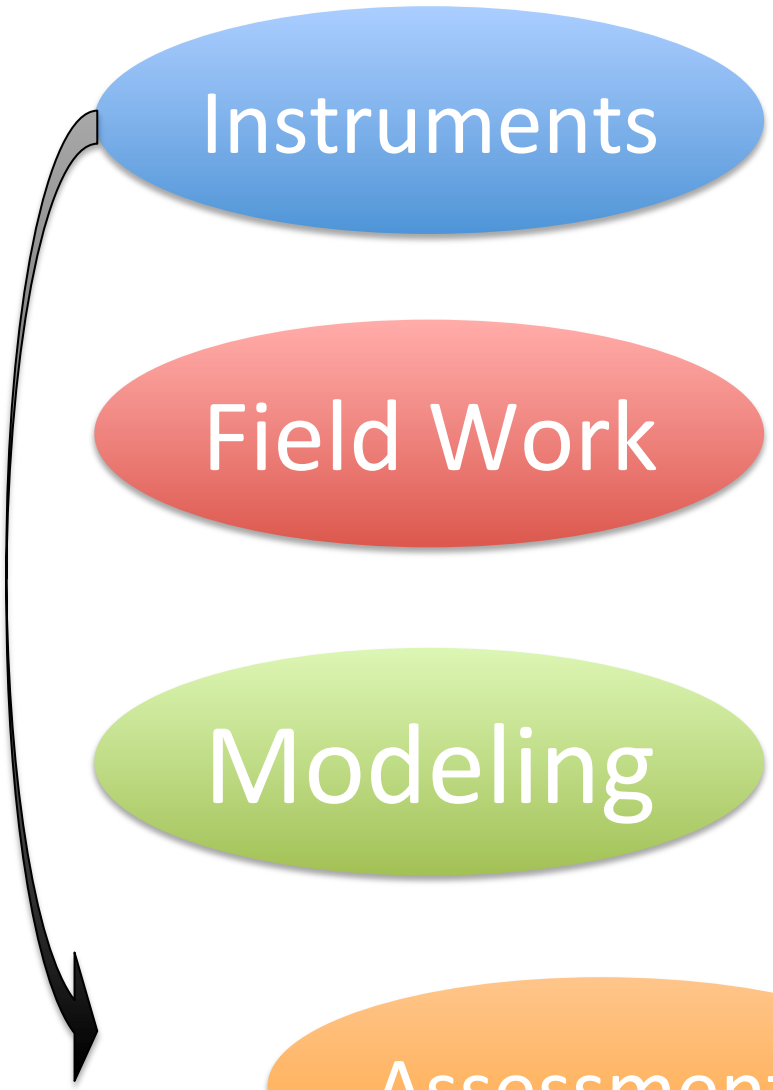
HIGH STAKES

- Major short-lived forcer
- Large anthropogenic sources
- Dramatic heath impacts
- Impacts on hydrological cycle
  -> Focus for policy action

LARGE UNCERTAINTIES

- Sources
- Abundance
- Optical properties/evolution
- Climate relevant processes

CSD Research Foci



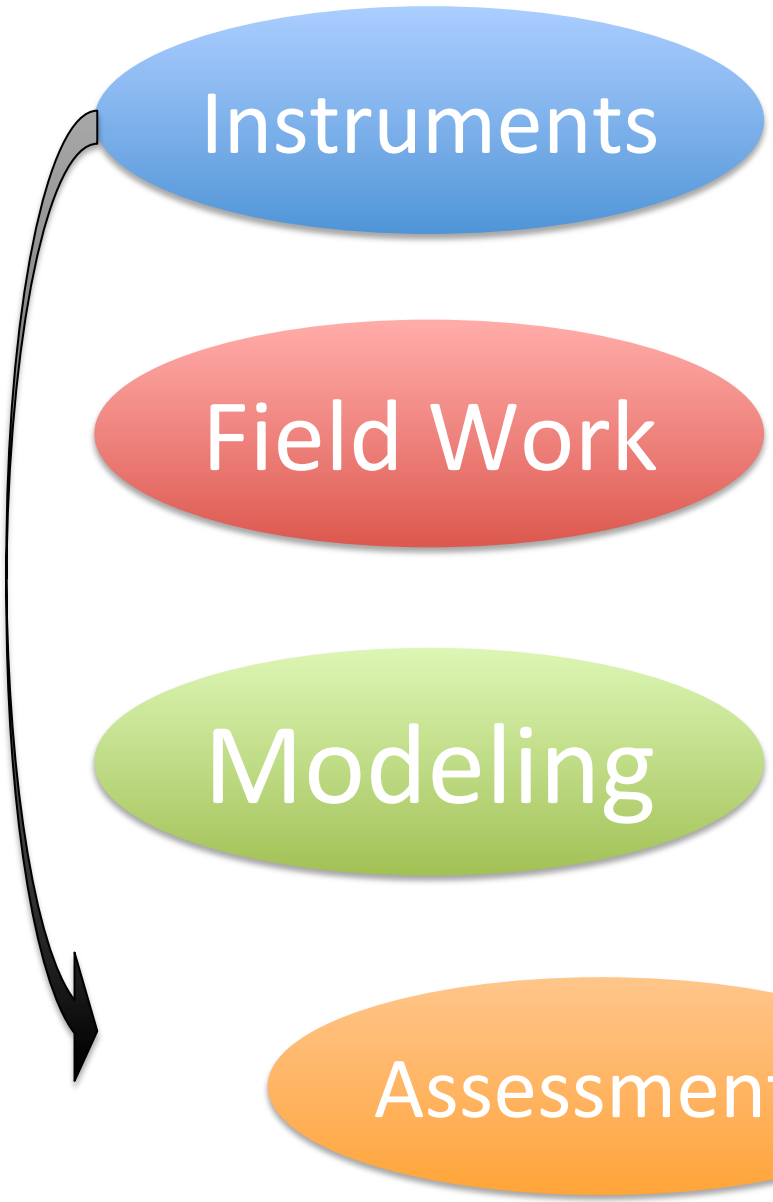
- Photo-acoustic spectrometry
- Laser-induced incandescence
  - Single-particle soot photometer (SP2)
  - BC in snow/ice
- Calibration materials

- BC abundance: Remote, source regions
- Emissions: shipping, marine fuels, flaring
- BC microphysics: size distributions, aging, coagulation, hygroscopicity
- BC in cryosphere, removal processes, aging

- Topdown/bottom up inventories
- Regional and global model comparisons
- Optical properties/data analysis

- IPCC AR5
- Bond et al., "Bounding BC" 2013
- Baumgardner et al, 2012, "Recommendations for Reference Materials"

CSD Research Foci



- Photo-acoustic spectrometry
- Laser-induced incandescence
  - Single-particle soot photometer (SP2)
  - BC in snow/ice
- Calibration materials

- BC abundance: Remote, source regions
- Emissions: shipping, marine fuels, flaring
- BC microphysics: size distributions, aging, coagulation, hygroscopicity
- BC in cryosphere, removal processes, aging

- Topdown/bottom up inventories
- Regional and global model comparisons
- Optical properties/data analysis

- IPCC AR5
- Bond et al., "Bounding BC" 2013
- Baumgardner et al, 2012, "Recommendations for Reference Materials"

BC in the remote compared to global models

MEASUREMENTS:

HIAPER Pole-to-Pole Observations (HIPPO) Campaign: NSF GV

- Five 3-week flight series over 3 years
- 67S to 85N latitudes over Pacific
- ~750 vertical profiles of BC with SP2

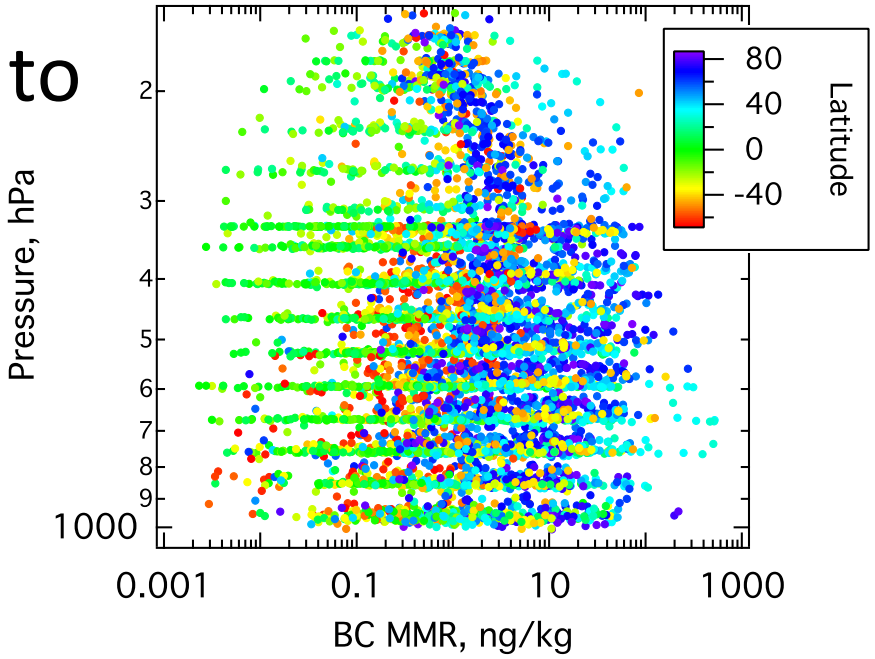
MODELING:

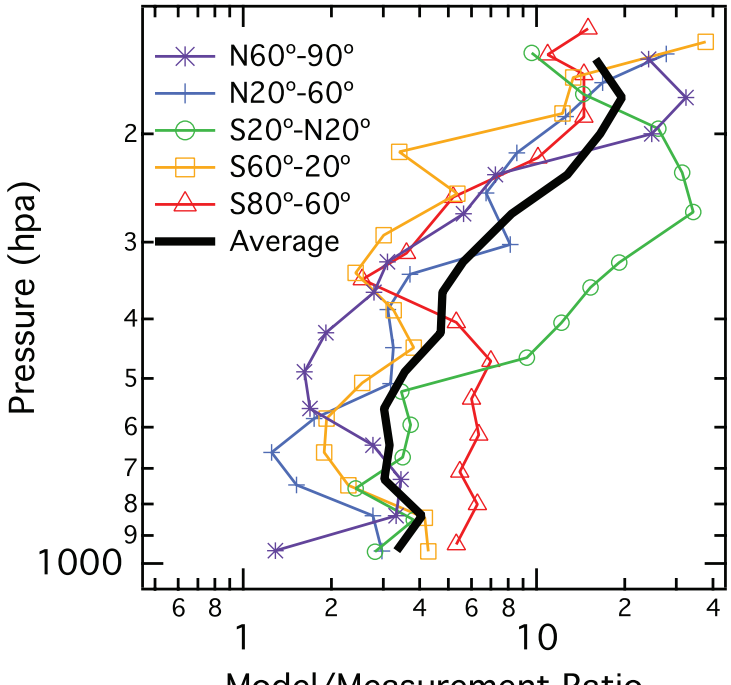
- AeroCom: initiative to enable model and measurement comparisons of aerosol deliverables.
- 16 global models participate

RESULT:

AeroCom biased high by 3X on average, 4X in column load, and 17X over 250 hPa

Global model estimates of BC forcing are being reduced in response to this work





Schwarz et al., *GRL*, 2010 & 2013 – 68 citations

BC in the Cryosphere

INSTRUMENTATION

- Nebulizer characterized for size dependent efficiency
- SP2 configured to allow quantification of "giant BC"

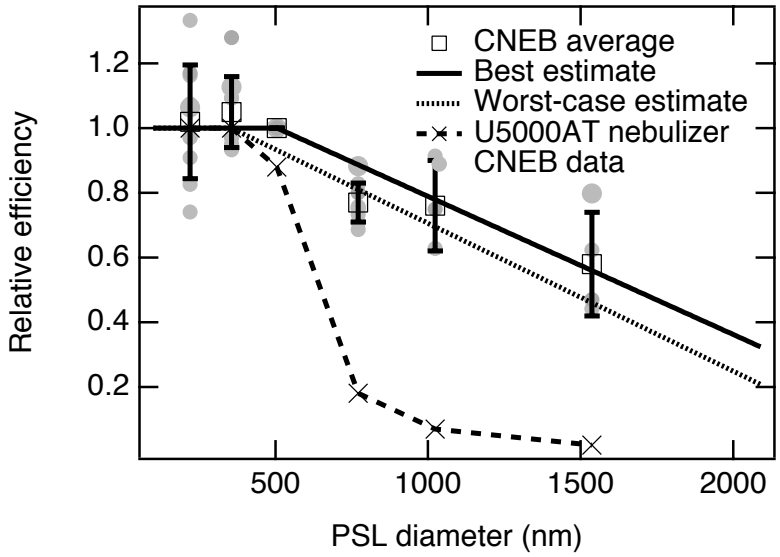
FIELD WORK

- Snow samples from semi-rural and rural Colorado
- Aged and fresh snow

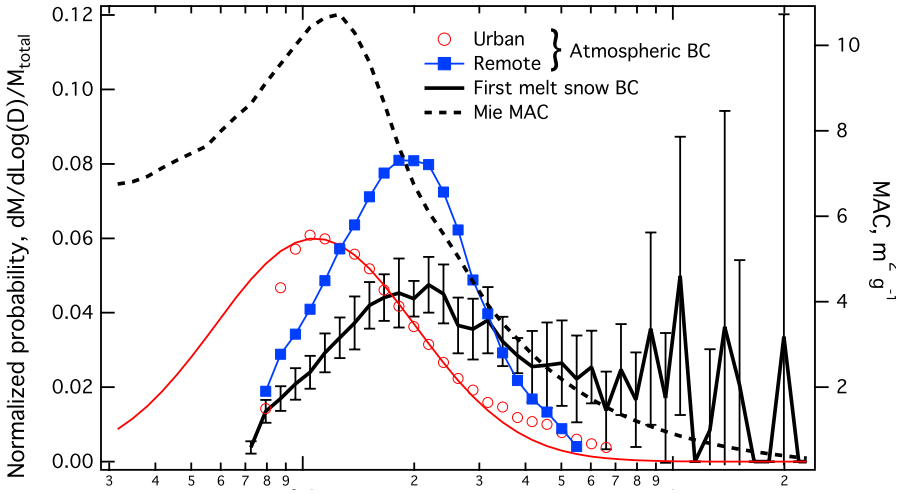
RESULTS

- BC in snow shifted to larger size
- Giant BC observed in most samples
- Mass absorption efficiency can be decreased 40% - a dominant uncertainty in BC snow-albedo forcing

CSD is unearthing new mechanisms and processes affecting BC snow albedo forcing.



Schwarz et al., *AMT.,* 2012
16 citations



Diameter, µm
Schwarz et al., *Sci. Rep.,* 2013
14 citations

Future

AIRBORNE CAMPAIGNS

- Atmospheric Tomography Experiment– NASA DC8, 2016 – 2020
- Fire Influence on Regional and Global Environments (FIREX) – NOAA P-3 – 2018
- Observations of Fire's Impact on the Southeast

Atlantic Region - NSF C130 2017

- KORUS - NASA DC8 - 2016
- GO-AHEAD – NOAA Balloon/UAV

GROUND/LABORATORY CAMPAIGNS

BC Aging and Removal/Deposition in Snow – BARDS 2015

Storm Peak Ice Nucleation Study – 2015

FIREX Fire Lab Study – 2017