

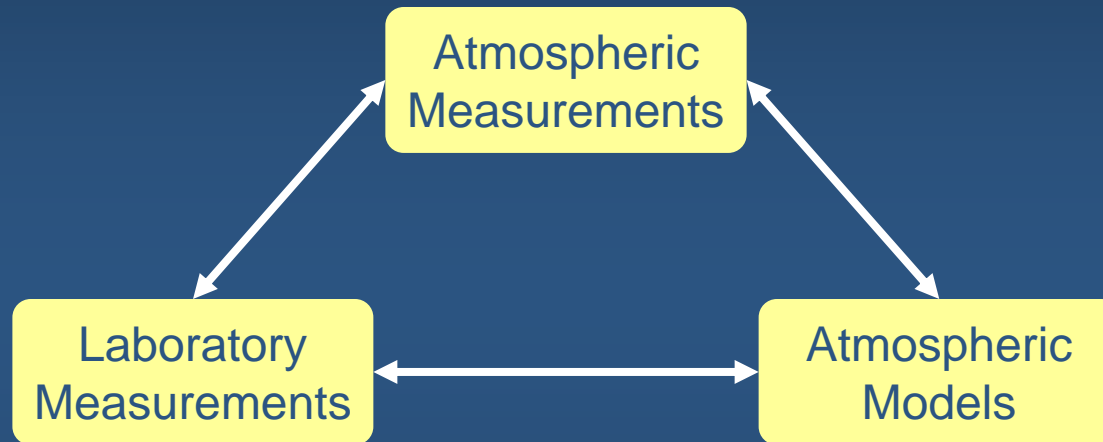
Aerosol Sources, Sinks, Distributions, and Processes

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1. Defining the issues
2. Research on a range of scales
 - Plume scale
 - Regional scale
 - Intercontinental scale
3. Future directions

Overall Goal: Develop fundamental understanding of aerosol processes to aid model development for air quality forecasting and climate diagnostics and forecasting. Our approach makes use of three complementary efforts:

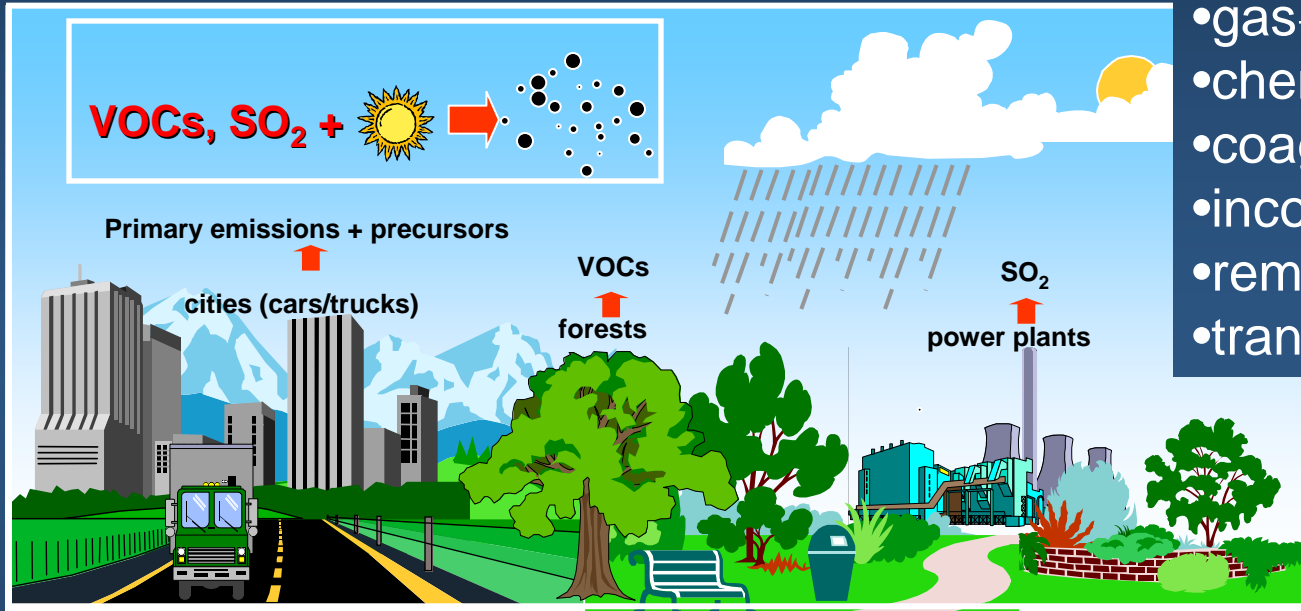


Collaborations:

- GSD, PSD, CSD, GFDL & NESDIS on forecasting & diagnostic models
- GMD, PSD, CSD & PMEL on measurements

Secondary (produced in atmosphere) sources of particles:

- vehicles (organics, nitrates)
- industry (sulfate, organics, nitrates, ammonium)
- plants (organics)
- agriculture (ammonium, nitrate)



Atmospheric processes:

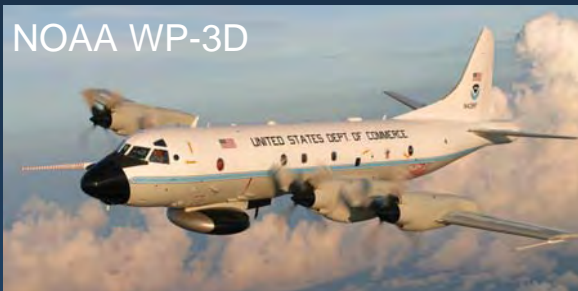
- gas \rightarrow particle conversion
- chemical reactions
- coagulation
- incorporation into clouds
- removal by precipitation
- transport

Primary (directly emitted) sources of particles:

- vehicles (soot, organics)
- industry (soot, sulfate, organics, metals)
- construction & agriculture (soot, soil)
- sea-spray (salt)
- fires (soot and organics)

Tools for Field Measurements

NOAA WP-3D



GMD Observatories



Temporary Ground Sites



NOAA Ron Brown



NOAA Twin Otter



➤ In-situ Measurements

Aerosol size distributions

Aerosol composition (single particle & bulk)

Aerosol optical properties

➤ Remote Measurements

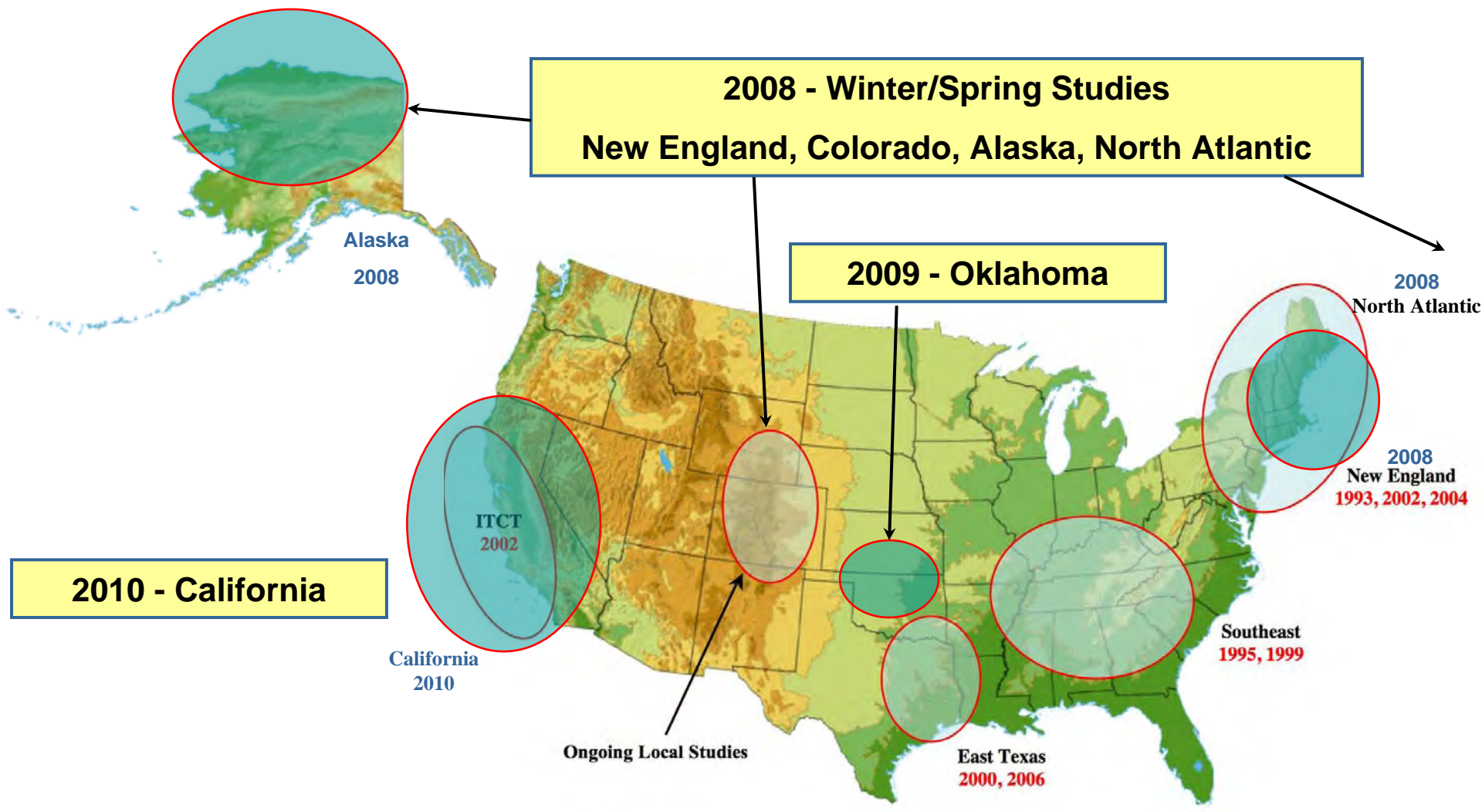
Vertical profiles of aerosol backscatter (lidar)

Spatial distribution of wind (Doppler lidar, profilers)

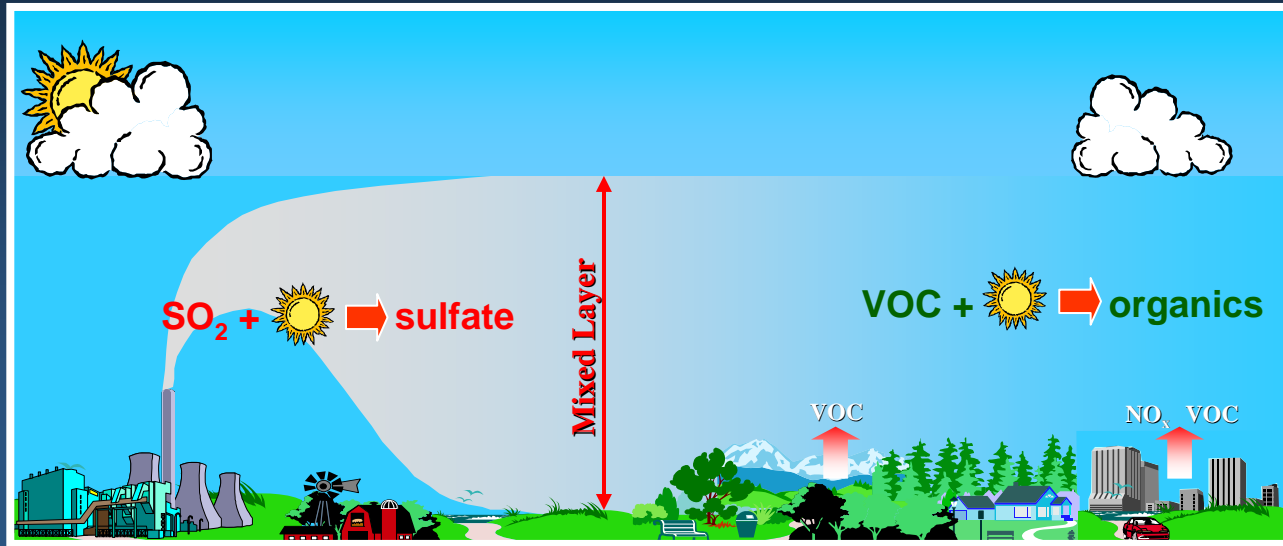
Radiometric measurements (optical depth, etc.)



Aerosol Process Studies for Air Quality and Climate



Plume-scale processes (meters to ~100 km)



➤ Key investigations

- Emission studies & inventories
- Nucleation of new particles
- Conversion of gases to particle mass
- Interaction with clouds
- Changes in aerosol optical properties
- Comparison with plume-scale & air quality models

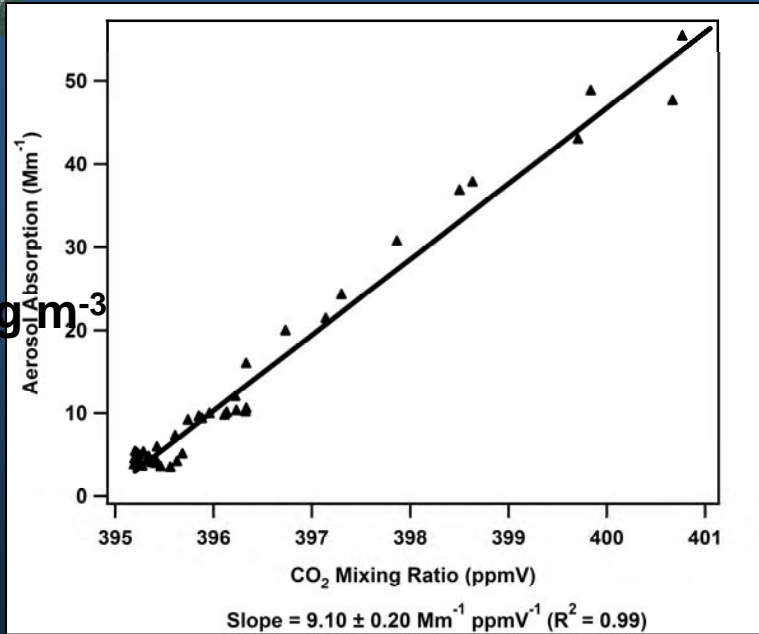
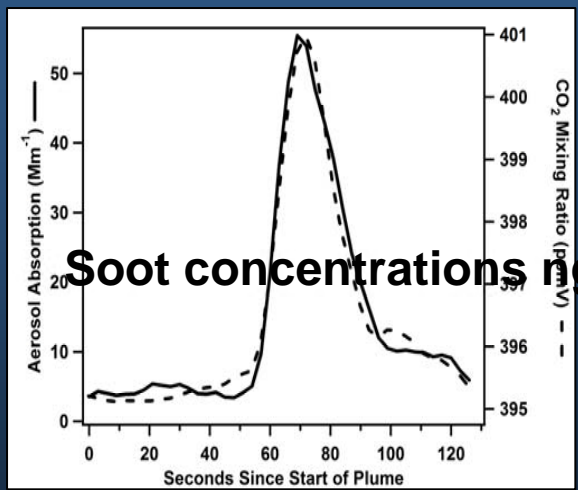
Emissions of light-absorbing carbon from ships ... from single ship emissions to global effects



Photo by Steve Ringman, The Seattle Times

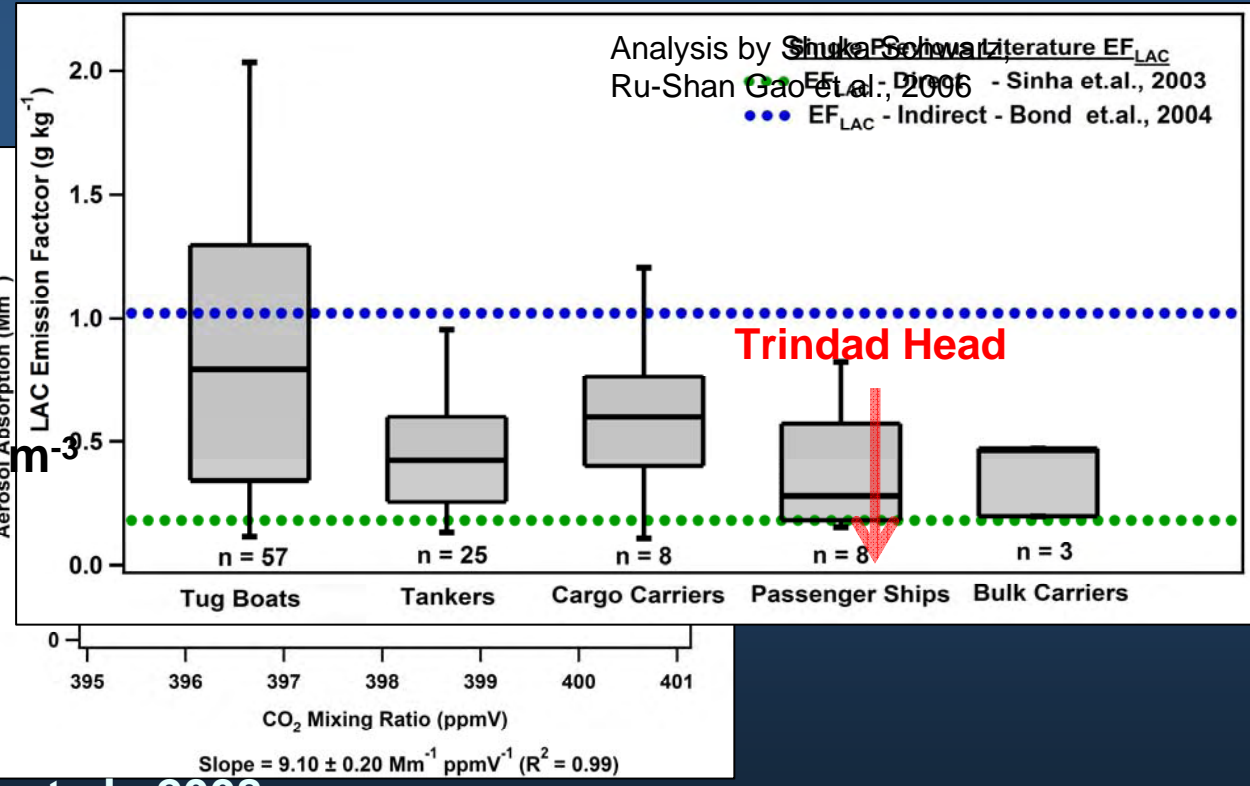
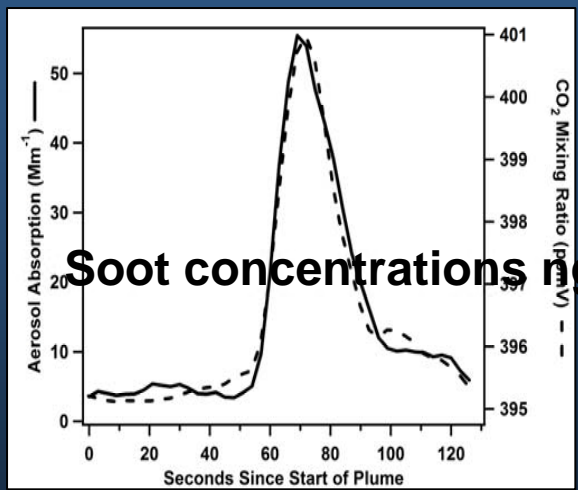
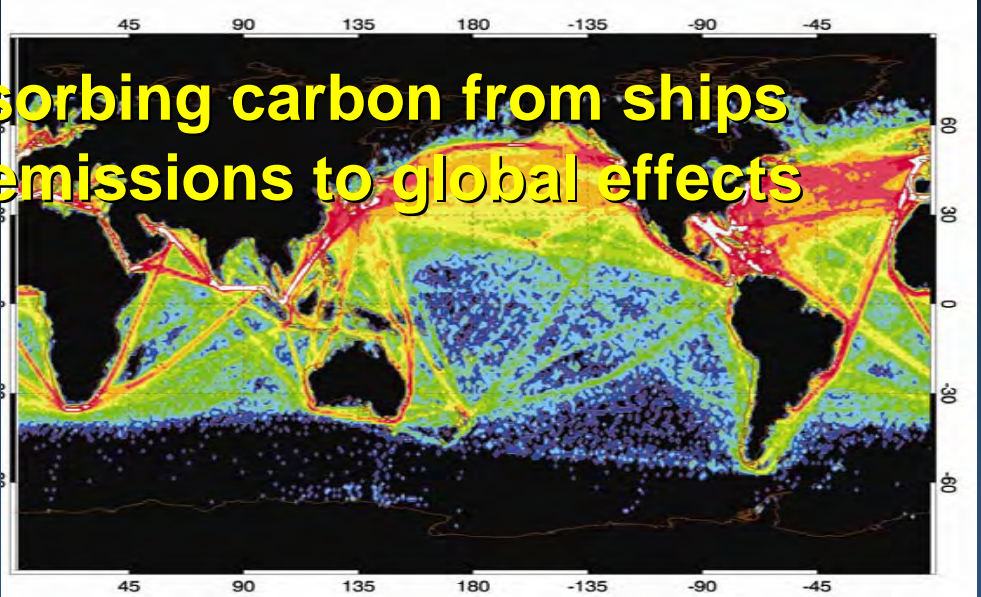


NOAA Ron Brown



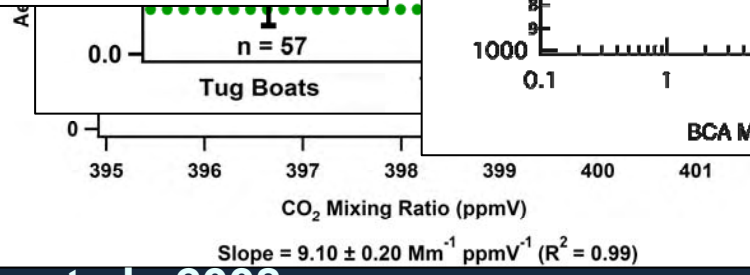
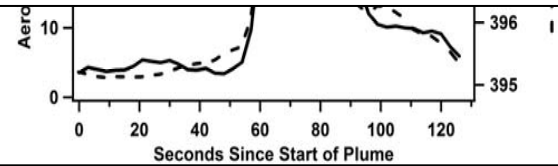
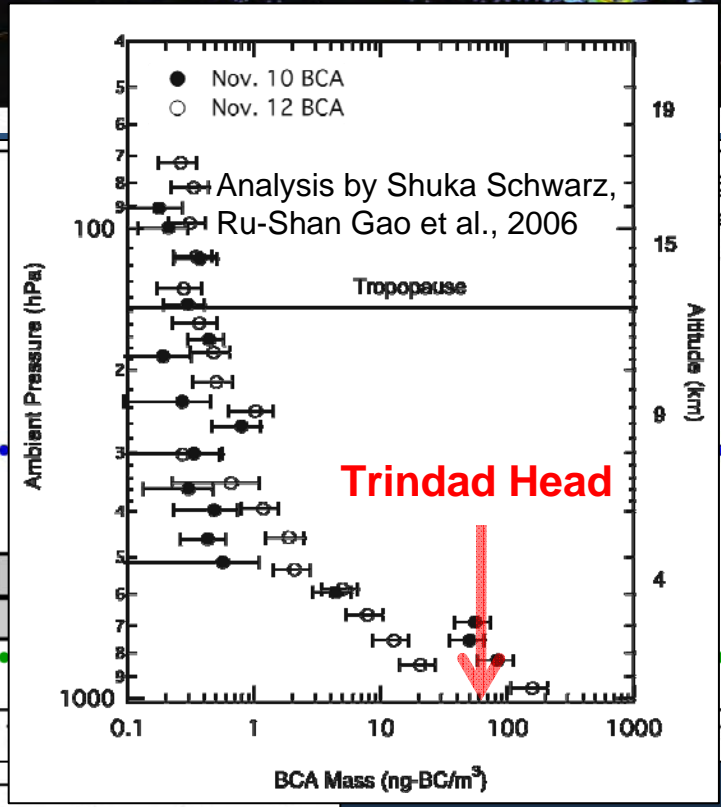
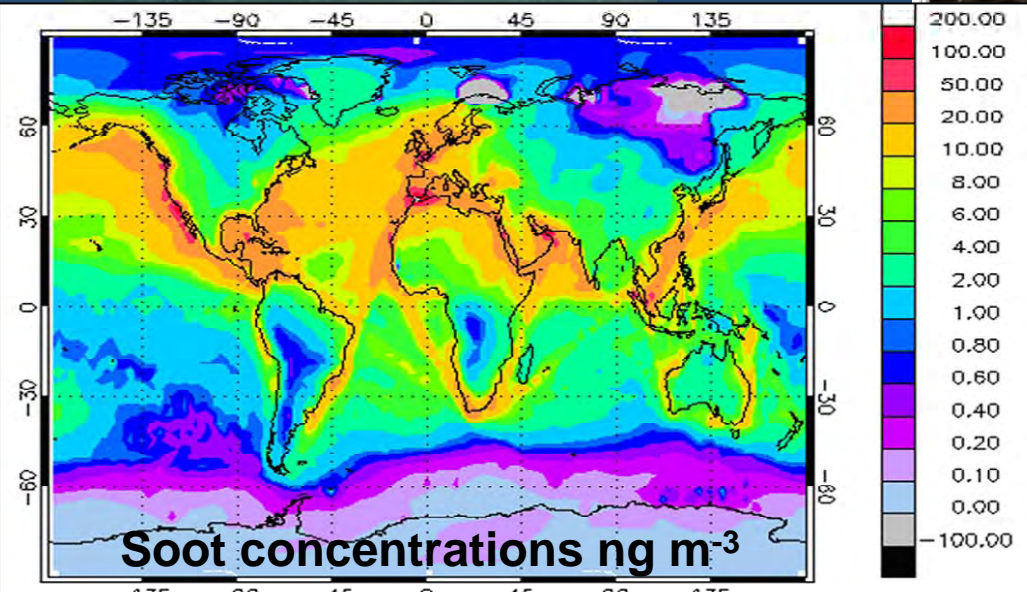
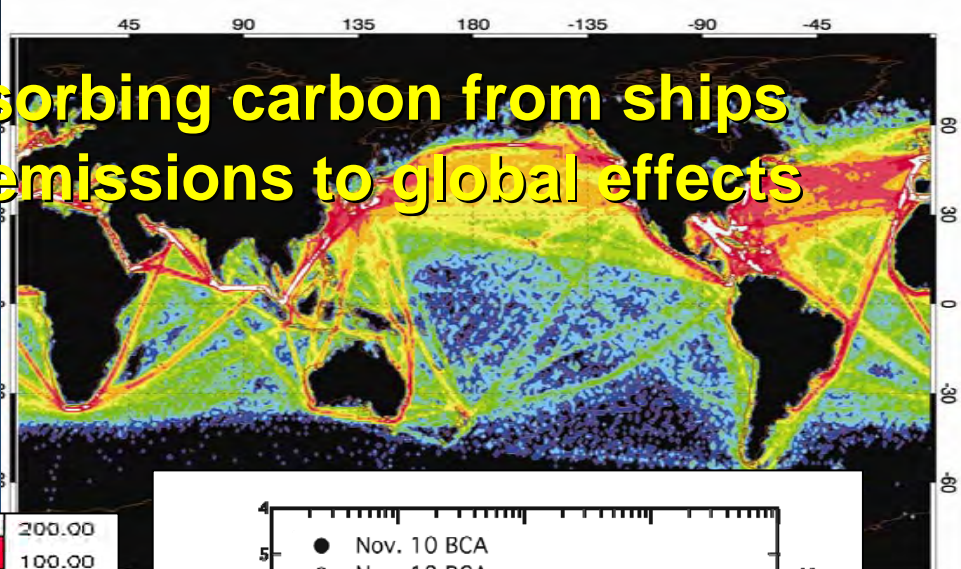
Analysis by Dan Lack,
Brian Lerner, Claire Granier et al., 2008

Emissions of light-absorbing carbon from ships . . . from single ship emissions to global effects



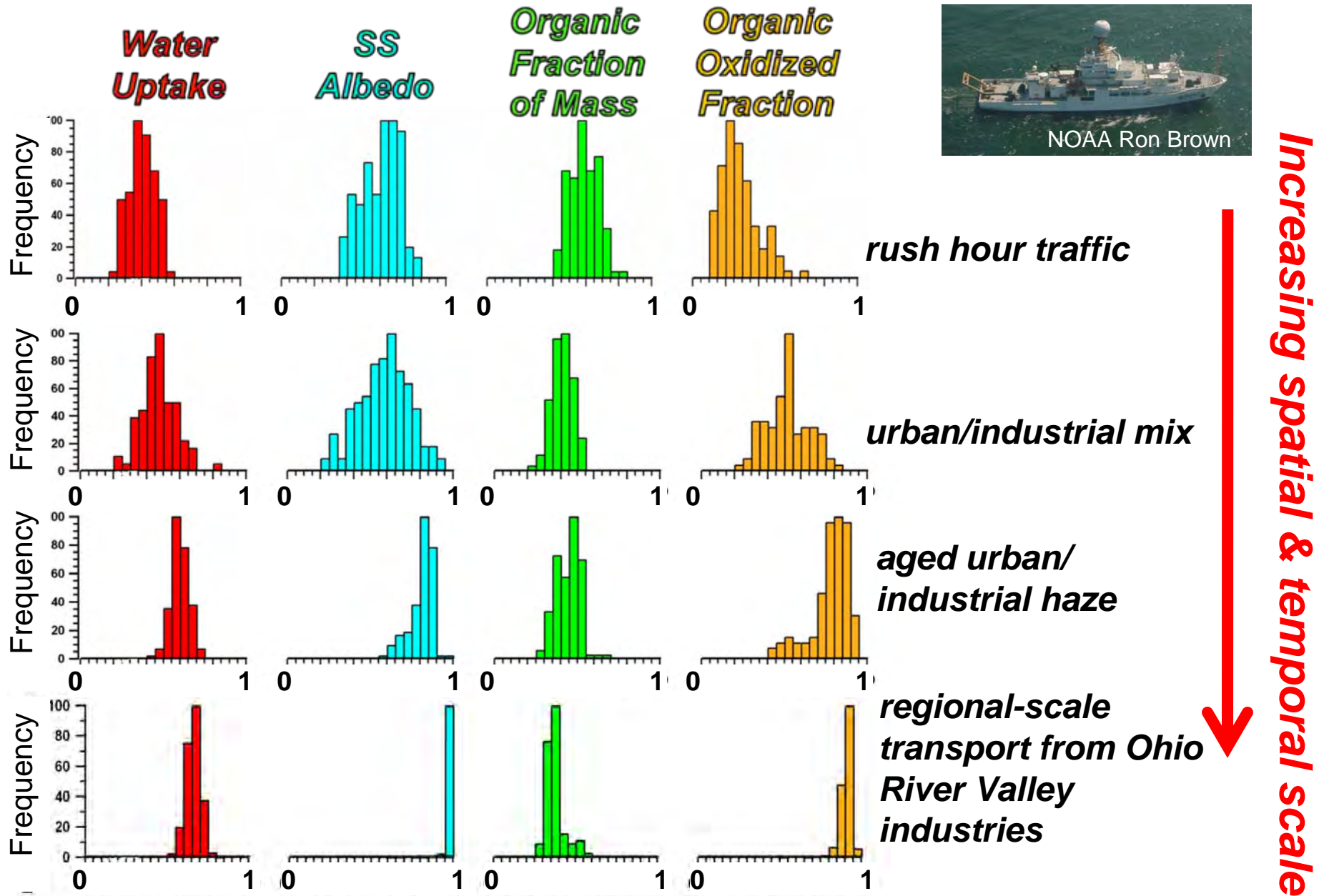
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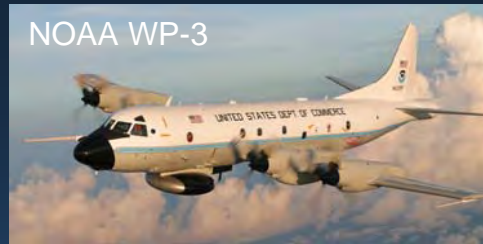
Plume & Regional Scale Processing Effects on Optical Properties in Houston



Increasing spatial & temporal scale

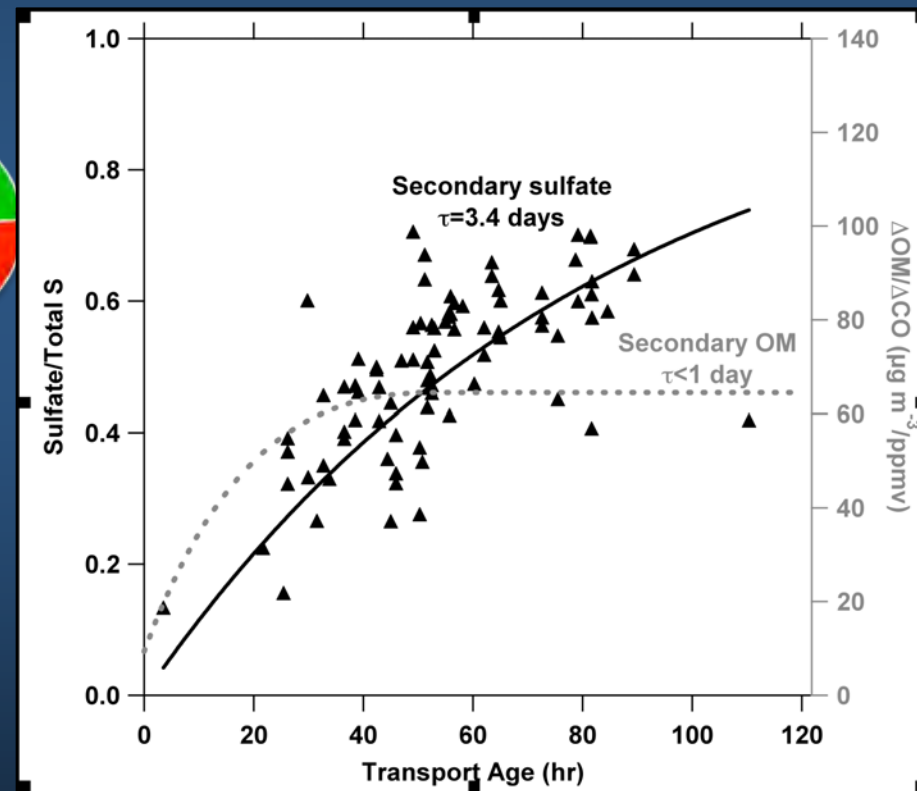
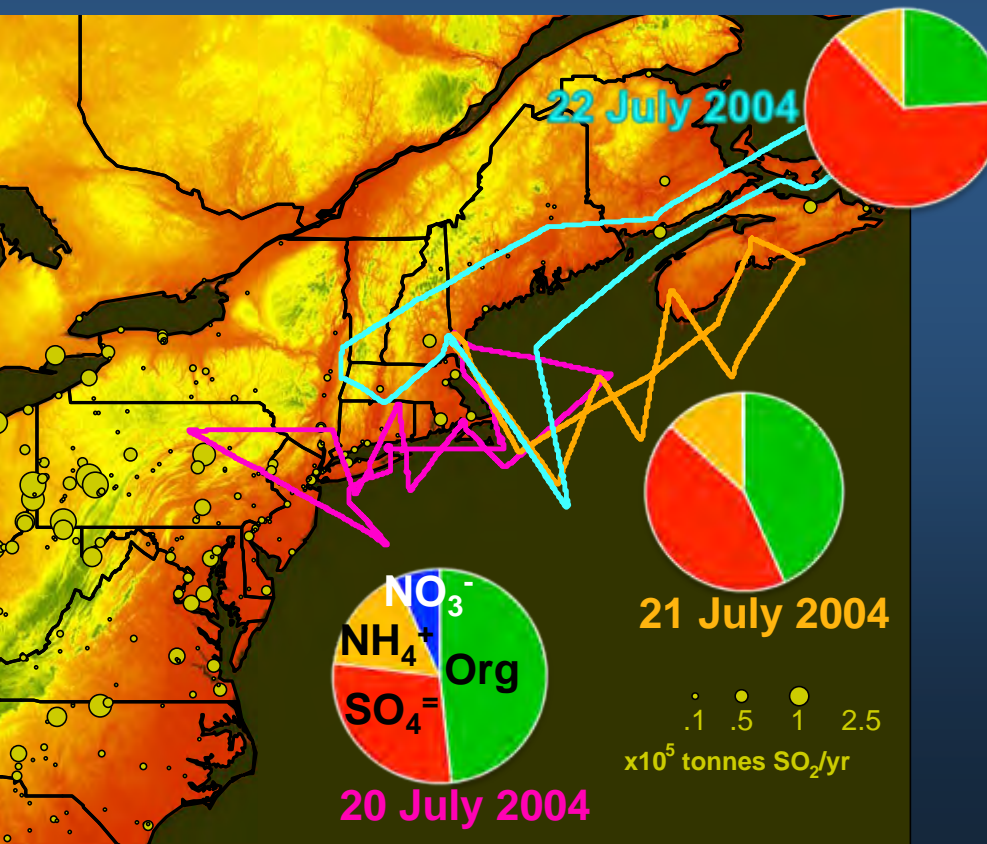
Work by Paola Massoli, Dan Lack, Trish Quinn, et al.

Aerosol Transport & Evolution over Regional Scales (~100-2000 km)



Particle composition evolves over a period of days in summertime. . .

- Secondary organic aerosol forms first from urban/biogenic precursors with $\tau \sim 1$ day
- Sulfate forms more slowly from industrial emissions with $\tau \sim 3-4$ days



Analysis by Chuck Brock,
Joost de Gouw et al., 2008

Recent Progress in Aerosol Processes Research

Emissions and plume scale

- Soot emissions & "young" optical properties
- Formation of secondary organic aerosol & sulfate

Regional scale

- Continuing chemical and optical evolution-increasing influence of sulfate
- Comparison of observations with air quality models

Intercontinental scale

- Observations of the transport of particles to the Arctic
- Processes during transport from Eurasia toward N. America
- Processes during transport from N. American sources toward Europe

Future Directions: Aerosol Processes Research

- 1) Source of secondary organic aerosol mass in different environments—anthropogenic vs. biogenic; primary vs. secondary**
- 2) Improve parameterizations of aerosol optical properties and cloud nucleating properties as a function of source type and atmospheric processing**
- 3) Effect of clouds on aerosol properties**
- 4) Sources of aerosol particles and precursors in California—differences from other regions studied, air quality and climate implications**