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THE STATE UNIVERSITY OF NEW JERSEY

Southern Oxidant and Aerosol Study SOAS

Annmarie G. Carlton

Southern **O**xidant and **A**erosol **S**tudy

‘grass roots’ campaign based on SOS studies of the 1990s

NOAA’s commitment to fly the P3 for SENEX was an important impetus

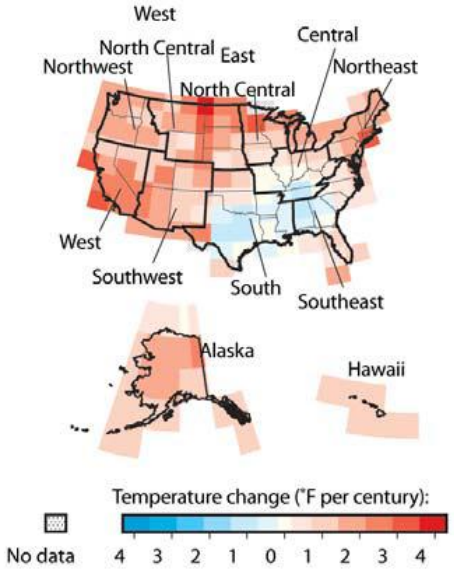
NSF/ATM funded an OFAP request: hours on C130, towers, ~100 release sondes and $4.5 million in individual investigator proposals

EPA RFA ~$4million in STAR grants and held the RFA earlier

EPRI science and logistics partner

One of my personal favorite SOAS facts:

> ***EPA*** funded a ***university*** scientist to fly an instrument on ***NOAA***’s plane



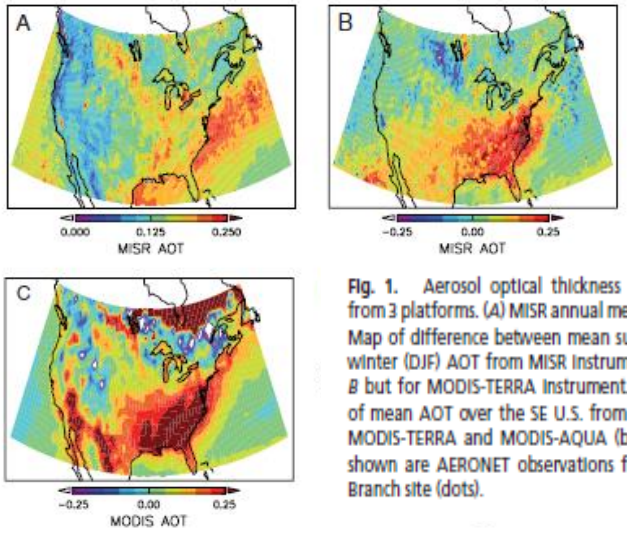
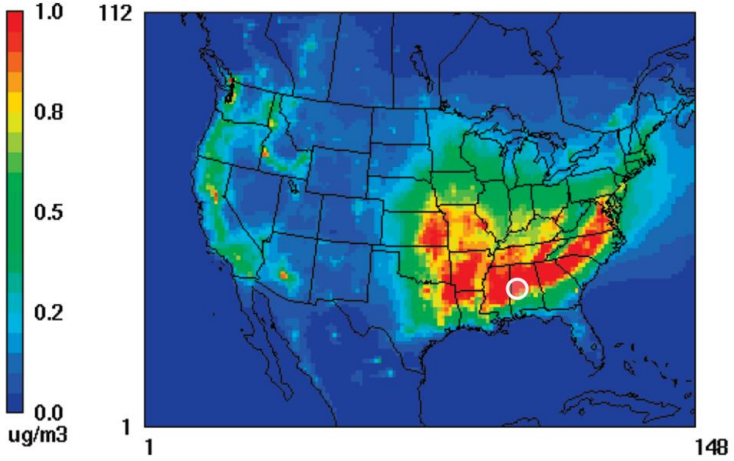


Fig. 1. Aerosol optical thickness (AOT) observed from 3 platforms. (*A*) MISR annual mean AOT map. (*B*) Map of difference between mean summer (JJA) and winter (DJF) AOT from MISR instrument. (*C*) same as *B* but for MODIS-TERRA instrument. (*D*) Time series of mean AOT over the SE U.S. from MISR (red line), MODIS-TERRA and MODIS-AQUA (black lines). Also shown are AERONET observations from the Walker Branch site (dots).

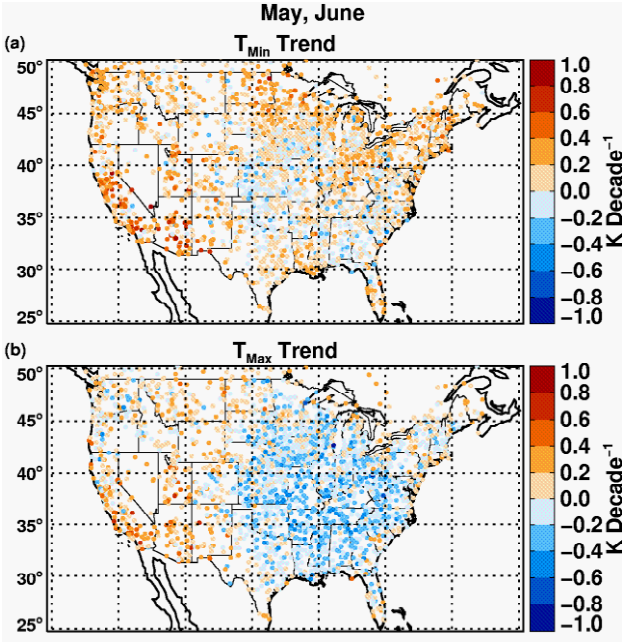
Goldstein et al., PNAS 2010

EPA with data courtesy of NOAA

Enhancement in biogenic SOA due to controllable emissions



Carlton et al., ES&T 2010



Portmann et al., PNAS 2010

SOS Reminders


+

= O_3

SOUTHERN OXIDANTS STUDY

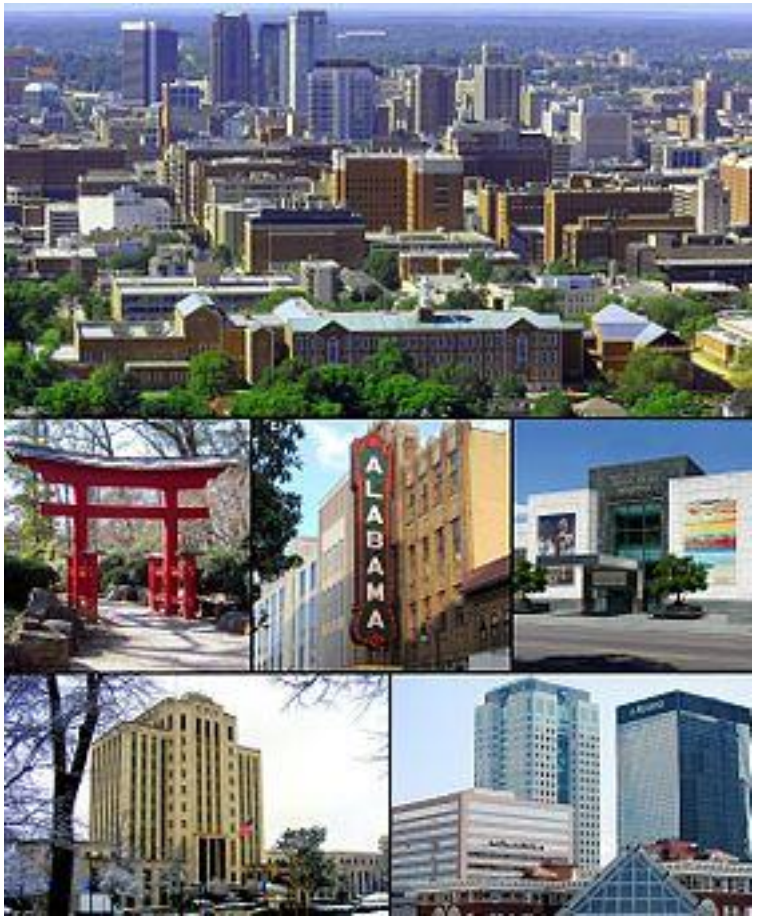
Overwhelming majority of organic compounds in the atmosphere come from the biosphere. Biogenic hydrocarbons interact with anthropogenic pollution to form pollutants ozone, even resulting in non-attainment.

Last time our community converged on the Southeast U.S. AQ management redefined for O_3

- As late as 1988: literature describing how VOC controls are not working for Atlanta O_3
- Ideas about NO_x-limited and VOC-limited
- Isoprene is 3% by mass of Atlanta's VOC inventory, but >30% of the reactivity

How will your contributions to SOAS redefine air quality?

Smog over Birmingham, TSP ~700 μg m^{-3}. EPA's first implementation of the CAA's "emergency powers" provision. (The Birmingham News file/Dave Battle)



40 years later EPA proposed that Birmingham be certified as having attaining the NAAQS.

Great Smoky Mountain National Park

Photo courtesy of CIRA

CAA is most successful US bill **EVER**
Benefit to cost ratio is $40:$1, 2nd place bill is $2:$1

Credit: Chester Higgins, Jr. 1973

http://magictouchimaging.com/gwbridge.html

SOAS
Southern Oxidant & Aerosol Study

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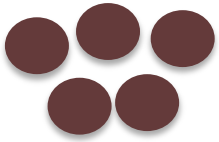
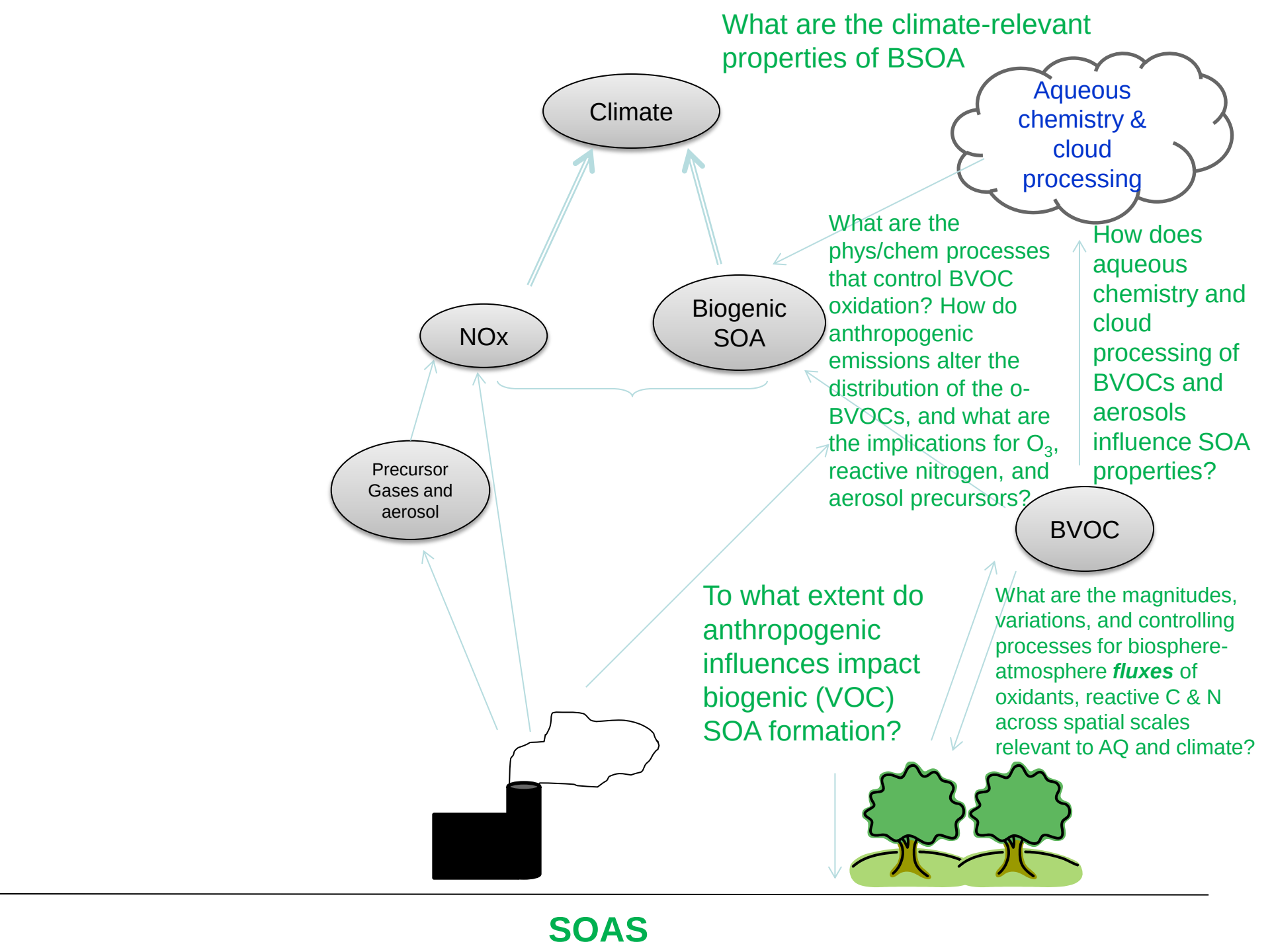
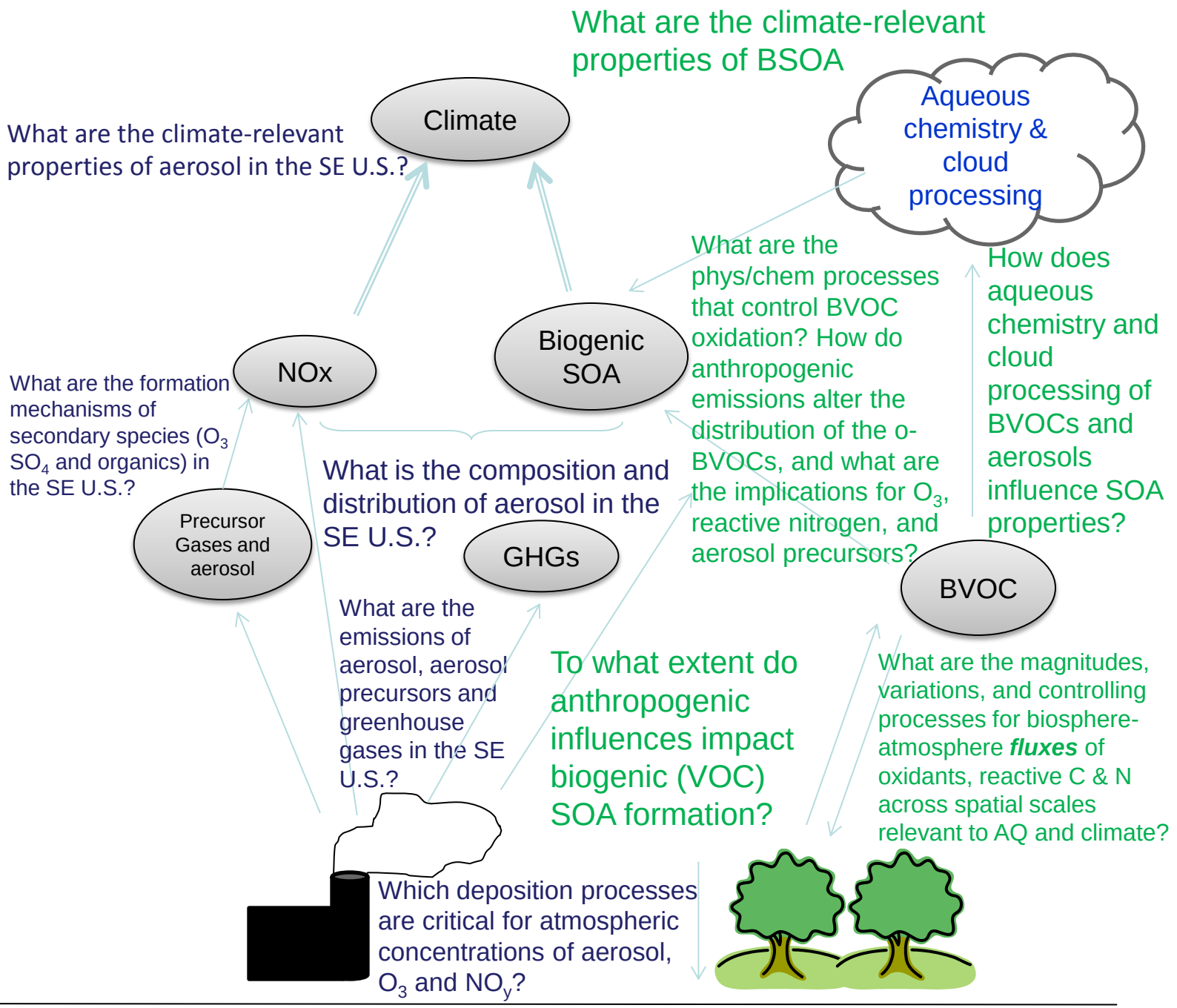


Emissions from the biosphere interact with emissions from human activity to form particulate matter. Anthropogenic pollution facilitates biogenic **SOA** formation (Weber et al., 2007; Surratt et al., 2007; Lane et al., 2009; Jimenez and de Gouw, 2009; Carlton et al. 2010; Spracklen et al., 2011; Shilling et al., 2013). Motivation behind SO**A**S in 2013.

Additionally: IMPROVE, STN, SEARCH, satellites


What are the climate-relevant properties of BSOA
Climate
Aqueous chemistry & cloud processing
What are the phys/chem processes that control BVOC oxidation? How do anthropogenic emissions alter the distribution of the o-BVOCs, and what are the implications for O_3, reactive nitrogen, and aerosol precursors?
How does aqueous chemistry and cloud processing of BVOCs and aerosols influence SOA properties?
NOx
Biogenic SOA
Precursor Gases and aerosol
BVOC
To what extent do anthropogenic influences impact biogenic (VOC) SOA formation?
What are the magnitudes, variations, and controlling processes for biosphere-atmosphere ***fluxes*** of oxidants, reactive C & N across spatial scales relevant to AQ and climate?
SOAS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Which deposition processes are critical for atmospheric concentrations of aerosol, O_3 and NO_y?

Investigate HONO dark formation/nighttime accumulation and morning-hour photolytic decay in the PBL and in the FT.

What are the climate-relevant properties of BSOA

Climate

Aqueous chemistry & cloud processing

What are the climate-relevant properties of aerosol in the SE U.S.?

pNO3

Quantify p-NO_3 as daytime HONO source and a re-NOx-ification pathway in the troposphere.

Examine HONO production from photo-enhanced heterogeneous NO_x reactions in urban/industrial plumes.

What are the phys/chem processes that control BVOC oxidation? How do anthropogenic emissions alter the distribution of the o-BVOCs, and what are the implications for O_3, reactive nitrogen, and aerosol precursors?

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Precursor Gases and aerosol

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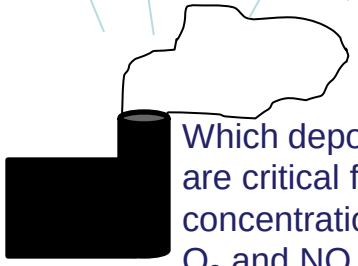

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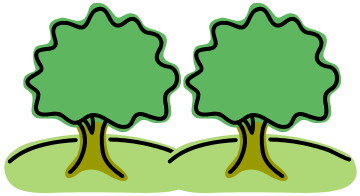

TROPHONO SENEX SOAS

Investigate HONO dark formation/nighttime accumulation and morning-hour photolytic decay in the PBL and in the FT.

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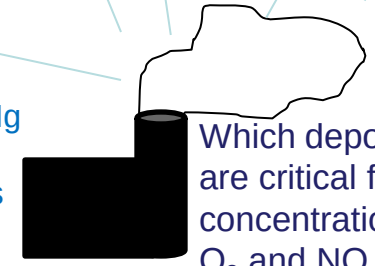
Hg^0

Hg^{2+}

Quantify distribution & chemical transformations of speciated Hg in the troposphere.

Constrain emissions of Hg from major source regions in the US.



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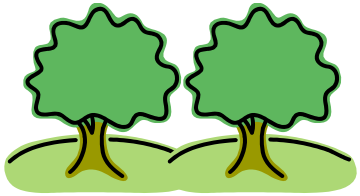
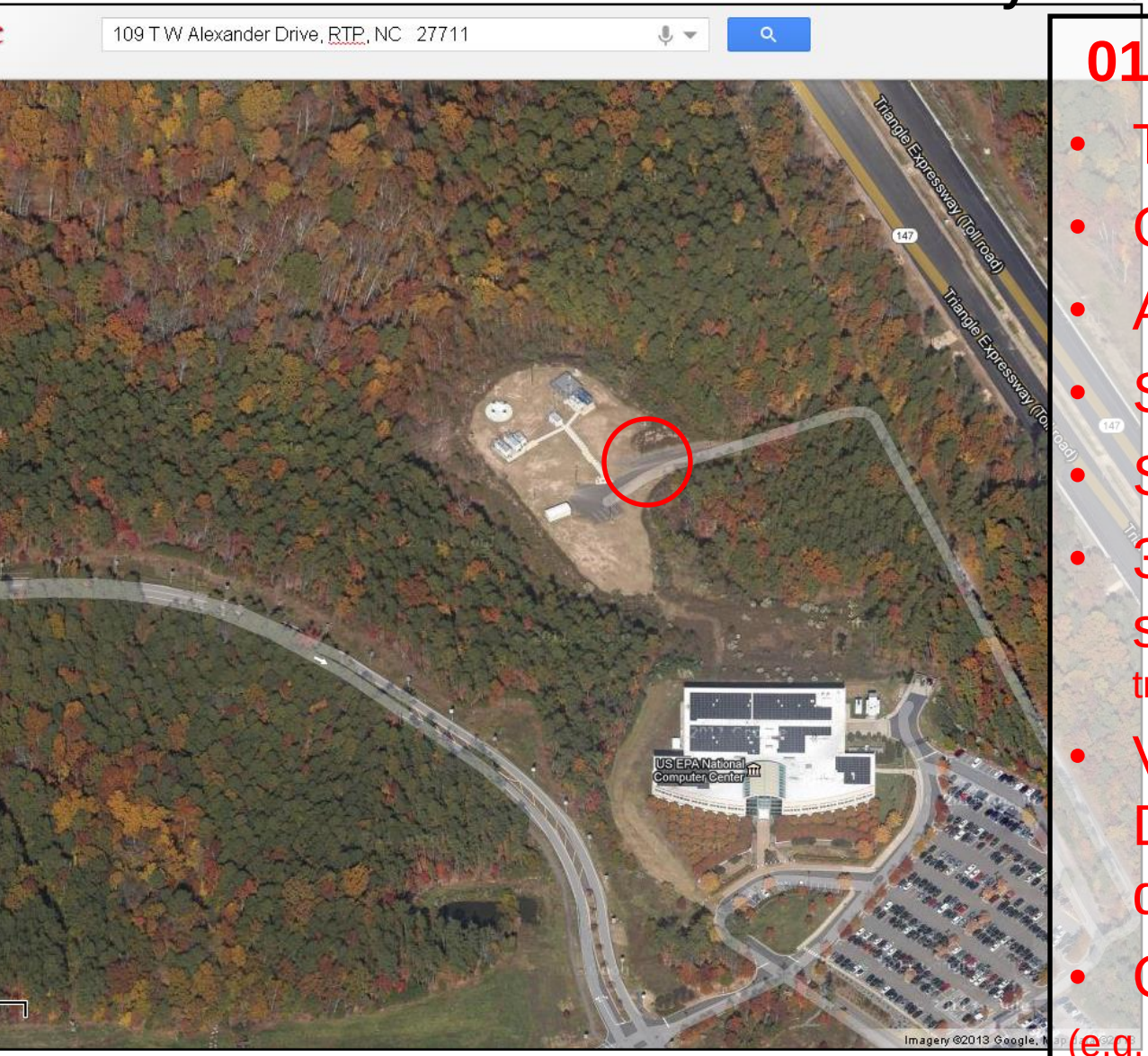


NAAMEX+ **TROPHONO**+ **SENEX**+ **SOAS** = Southeast Atmosphere Studies (**SAS**)

SOAS - RTP

Dates: 01 June - 15 July 2013

SOAS Southern Oxidant & Aerosol Study



01 June - 15 July 2013

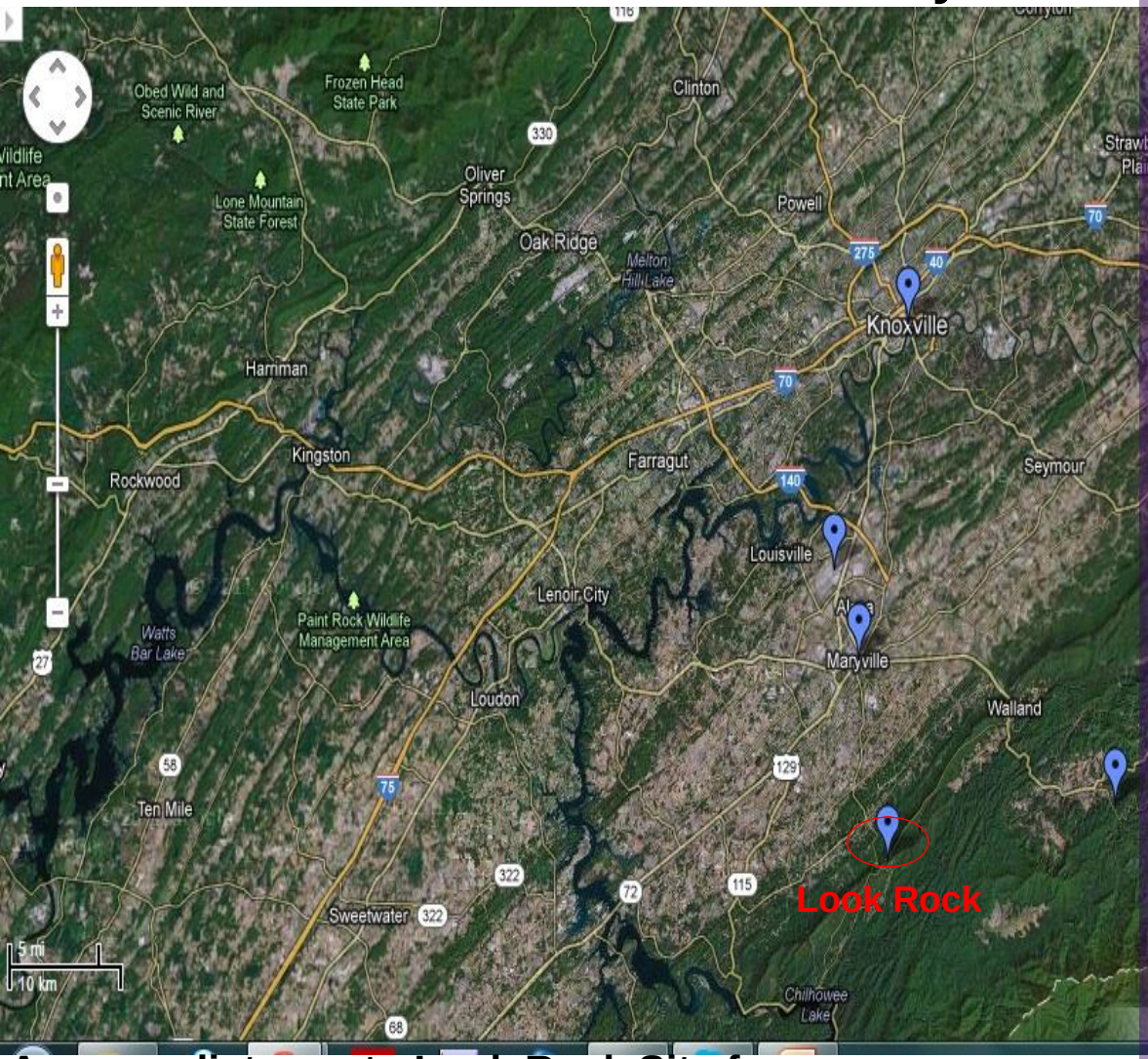
- TD-HR-ToF AMS
- CIMS
- AIM
- Sunset OC/EC; SMPS
- SP2 & PASS
- 3 x Hi-Vol filter samplers SOA tracers, POA tracers & ^{14}C
- VOC canisters & DNPH tubes twice daily; PAN hourly
- Criteria Gases… plus (e.g. NO_2 by CRDS; NO_x by FRM & FEM)

Slide courtesy of J. Offenberg

SOAS - Look Rock Site, TN

Dates: 01 June - 15 July 2013

SOAS Southern Oxidant & Aerosol Study



- **Aerodyne Acetate CIMS**
- **Aerodyne ACSM**
- **Aerodyne HR-TOF-AMS & SP2**
- **Low-Vol $PM_{2.5}$/PM_1 Filter Samplers**
  - FTIR; XRF
- **3 x High-Vol $PM_{2.5}$ Filter Samplers**
  - SOA Tracers by GC/MS & LC/ESI-HR-MS
- **3 x SMPS w/ CPCs**
- **Sunset OC/EC; TEOM**
- **Thermodenuder**
- **Cavity ringdown/photoacoustic spectrometer (CRD-PAS)**
- **CIMS for N_2O_5 reactivity**
- **CCN**
- **EPA NCore Site**
  - Criteria (e.g., NO_x, O_3, etc.) & particle data (e.g., BC, $PM_{2.5}$, etc.)
- **Continuous Meteorology**
- **Possibly PTR-MS**

Average distance to Look Rock Site from:

- **Maryville, TN = 12.3 mi**
- **Knoxville McGhee Tyson Airport = 17.4 mi**
- **Knoxville, TN = 30.9 mi**

Collaborators: TVA, EPRI & NPS

Slide courtesy of J. Surratt

SOAS – Brent, AL

Dates: 01 June - 15 July 2013

SOAS
Southern Oxidant & Aerosol Study

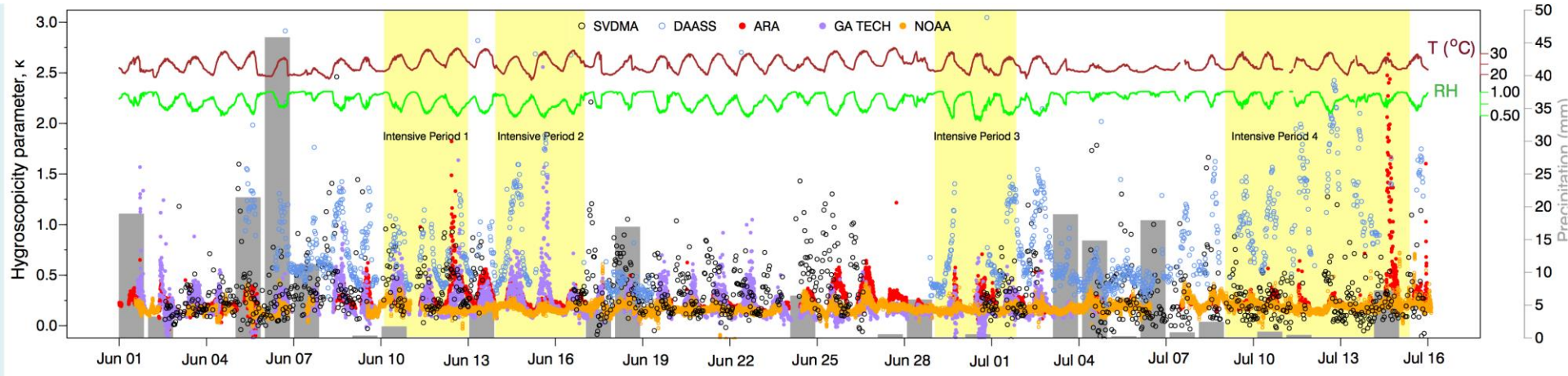
Brent, AL Site Details

PM sampler garden

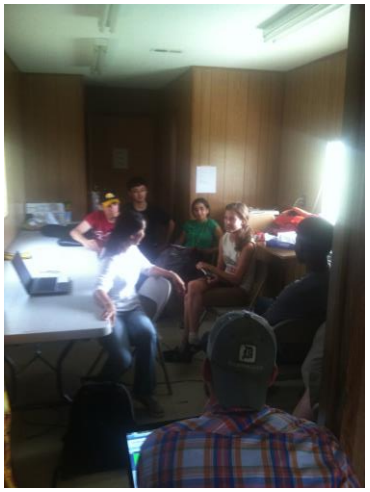
The most complete characterization of the atmosphere that I've been involved with
© Bill Brune (as recalled by Sherri Hunt)

Brent, Alabama

- Centreville: 85 measurements/instruments ***reported*** on the FTP
- AABC: soil moisture radiation, fluxes every day
- at steady state we had 60 graduate students, 20 postdocs and 10 undergrads
- weekly science meetings
- Coordinated instrument intercomparisons the last 2 weeks of the campaign (1000s points over just 6 weeks)



CBS Birmingham covered the open house



6 Science meetings at Saw Meal

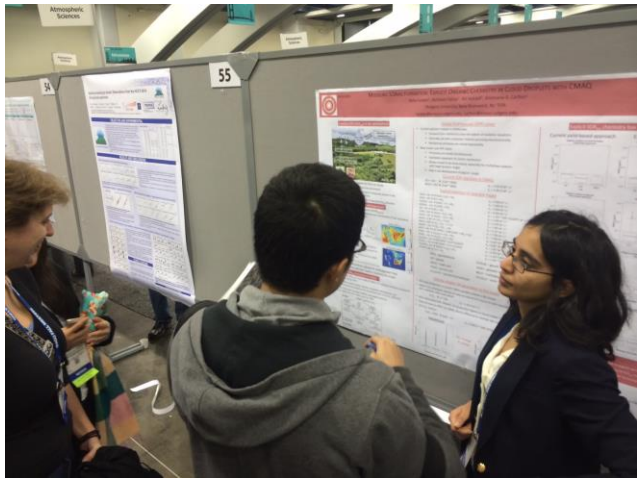
Postdoc led cross-trailer planning meeting

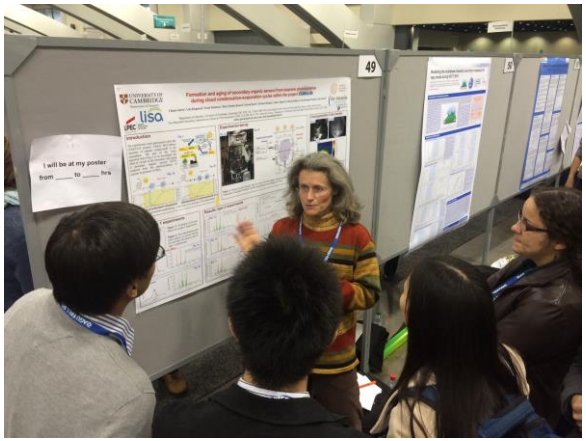
Tour: history & species composition of Talladega

NCAR assistance with soil temperature thermistor calibration

AGU Session: Air Quality and Climate in the Southeast US Dec. 2013

- 80 submissions, 5 sessions in 2013
- Poster Session: peer STEM education at its best
- Special Symposium October 2014 at AAAR
  - Includes concurrent studies: Discover AQ and SEACR^{4}S





Some SOAS highlights from AGU

There was a lot of water → inlets that worked fine the lab collect water at 30°C and 80% RH

Liquid water present in every aerosol sample

- Maximum mass concentration > 70 μg m^{-3}

More than 90% of SOAS organic particle mass is water-soluble

AMS-measured IEPOX tracers linked with sulfate

- Other indicators of biogenically-derived SOA do not

Aerosol is acidic (pH ~1)

Particle phase oxalate is not observed in Centreville, but oxalic acid forms in controlled experiments with ambient Centreville water-soluble gases.

Future Directions and Mission

- Are we still asking the most critical and open important science questions?
- What are high level questions we can answer with our robust data set?
- What are the important scientific details can we “finally figure out” and “nail down”?
- How do we ensure we get the most out of this very rich data set?
- How do we impact future the development of ***effective*** air quality management strategies?

Acknowledgements

NCAR's EOL
ARA, in particular Karsten Bauman
City of Brent, AL

SOAS2013.rutgers.edu