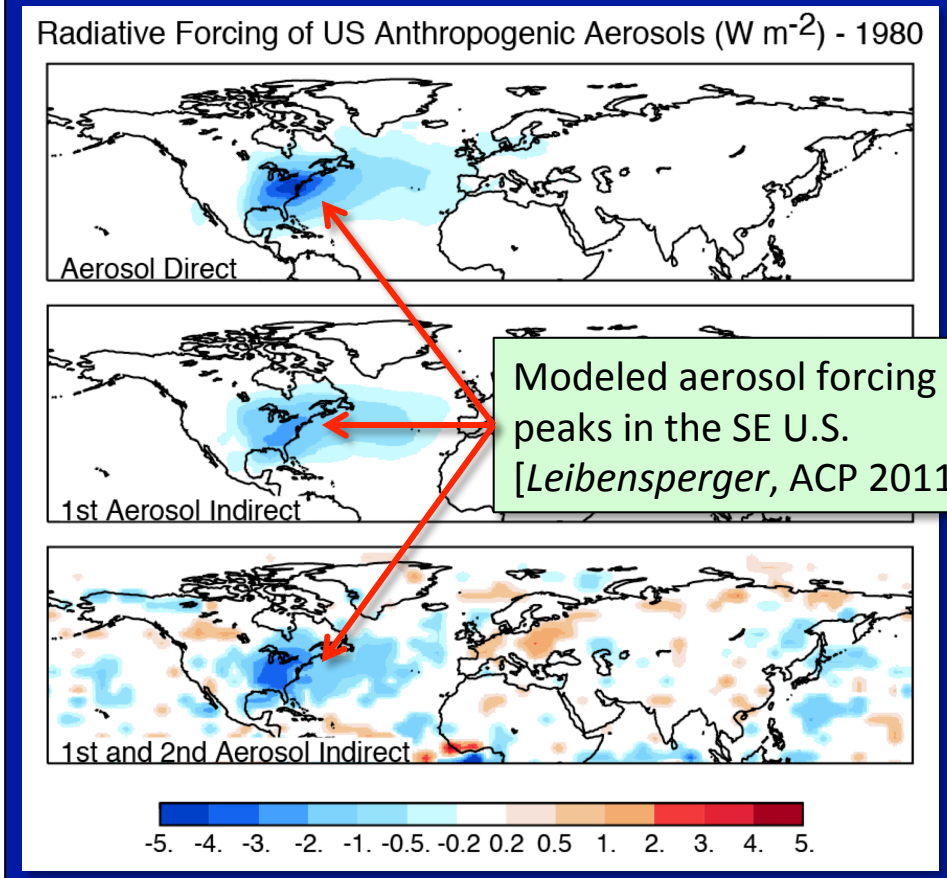
Southeast Nexus (SENEX)

Studying the Interactions Between Natural and Anthropogenic Emissions at the Nexus of Air Quality and Climate Change



Modeled aerosol forcing peaks in the SE U.S. [*Leibensperger*, ACP 2011]

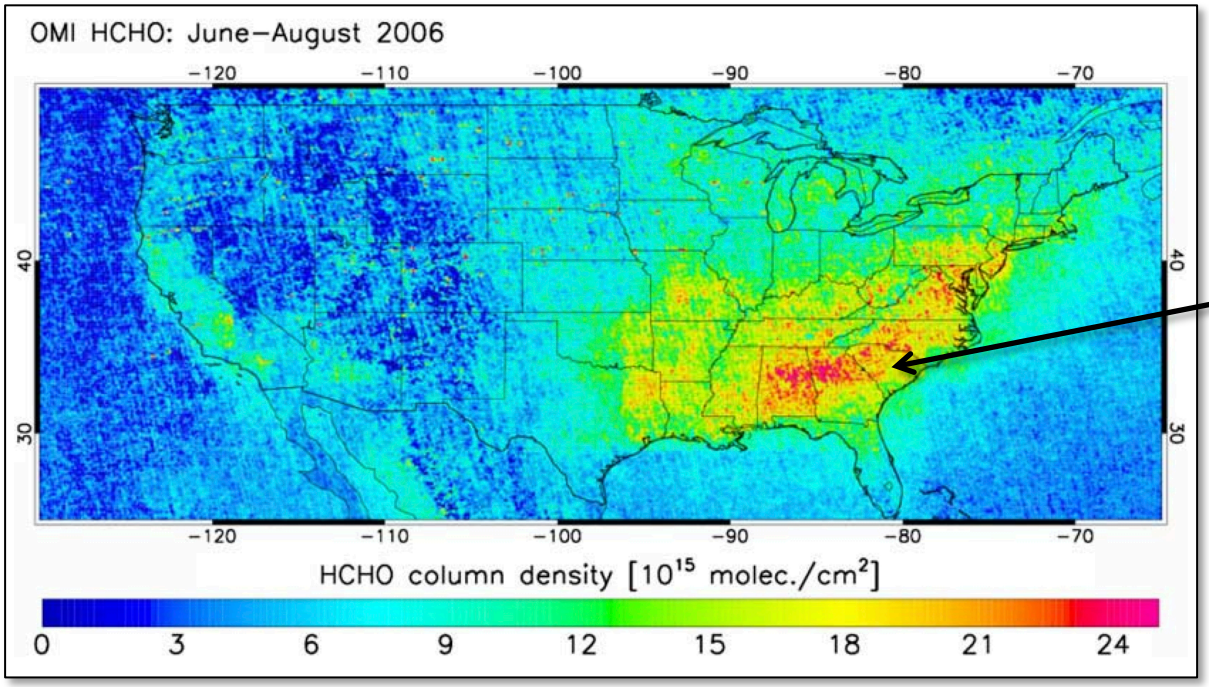
- Southeast U.S. has high anthropogenic and biogenic emissions, humidity, and photochemistry
- How do the emissions react to form aerosol and oxidants?
- What are the climate-relevant properties of the aerosol?

A NOAA Field Study in the Southeast U.S. in Summer 2013

Scientific Motivation

Southeast U.S.:

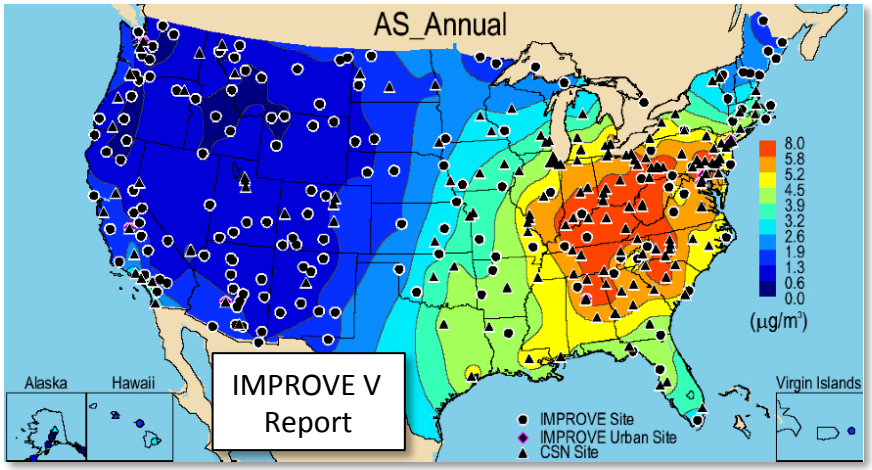
- Many secondary pollutants and radiative forcings are higher than elsewhere in the Nation



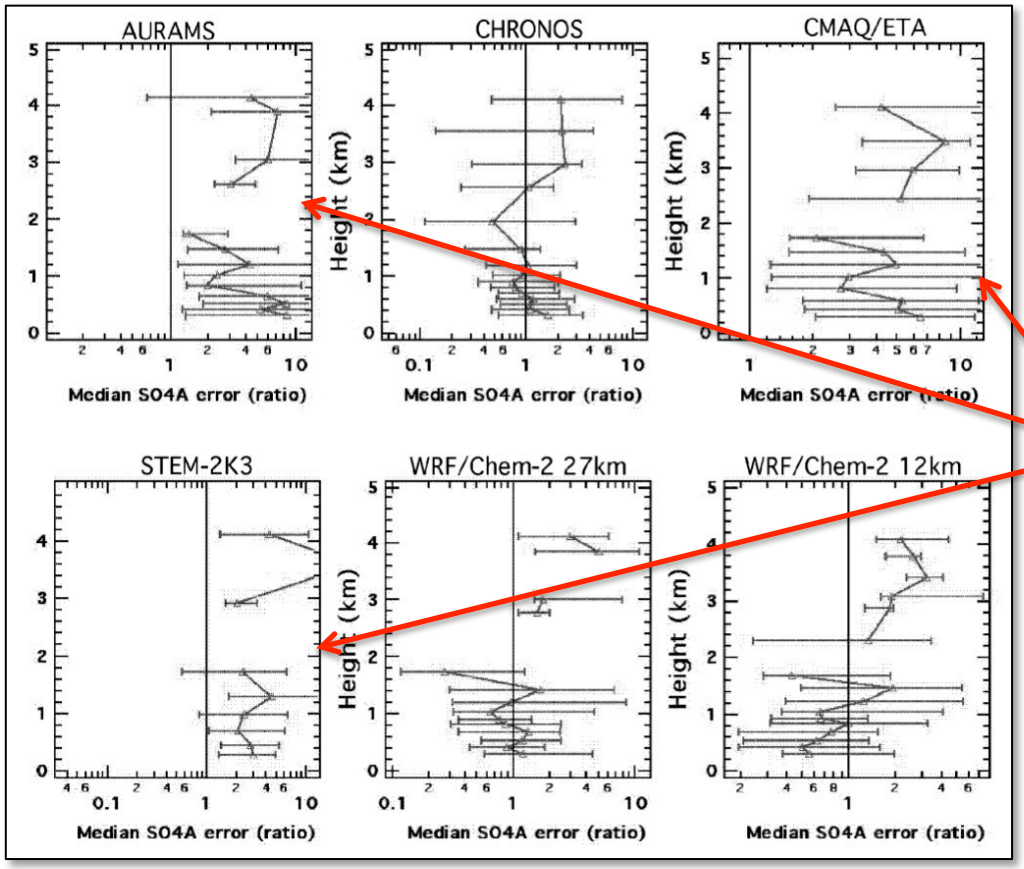
OMI HCHO column peaks in summer SE U.S. [*Millet, 2008*]

How do anthropogenic and biogenic emissions interact and affect air quality and climate?

Sulfate Aerosol

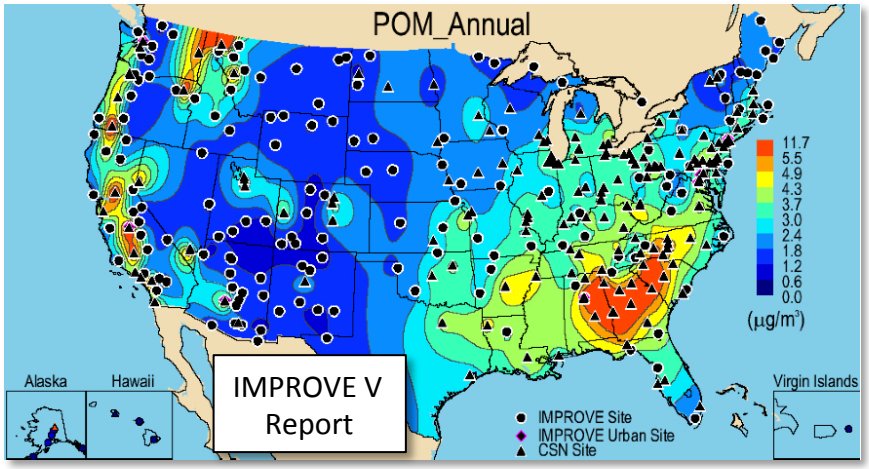


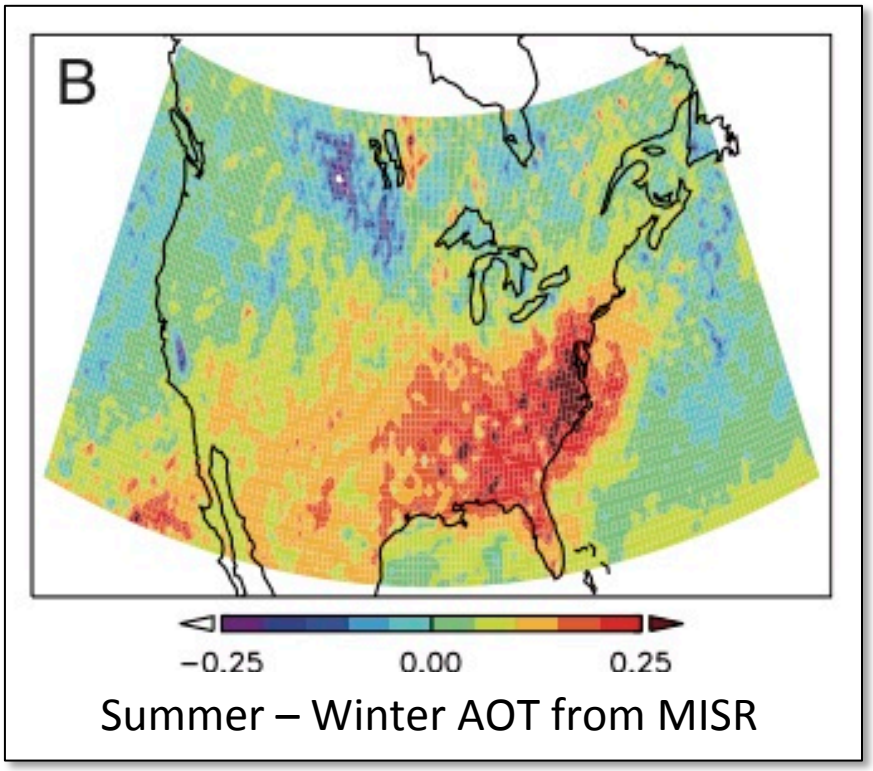
- Sulfate still represents a major fraction of submicron aerosol in the East and Southeast
- Formation in gas phase vs. clouds poorly understood



Models that include cloud oxidation overestimate sulfate [*McKeen*, 2007]

Organic Aerosol

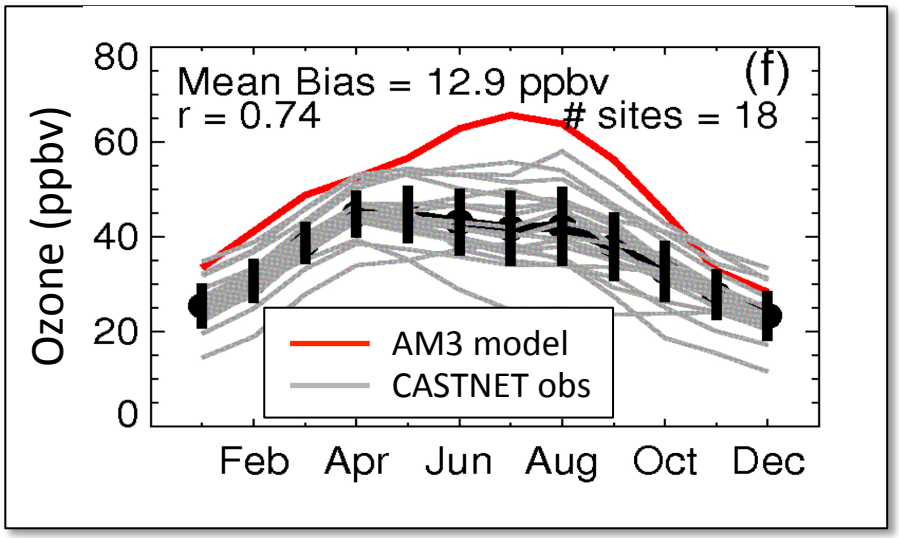




Goldstein [2009]

- Observations show highest organics in Southeast
- Satellite AOT shows strong seasonal cycle: biogenic SOA? (But: IMPROVE shows larger cycle for sulfate)
- Role of aqueous-phase processing?
- Role of nighttime oxidation of biogenic VOCs?
- What fraction of SOA is controllable?

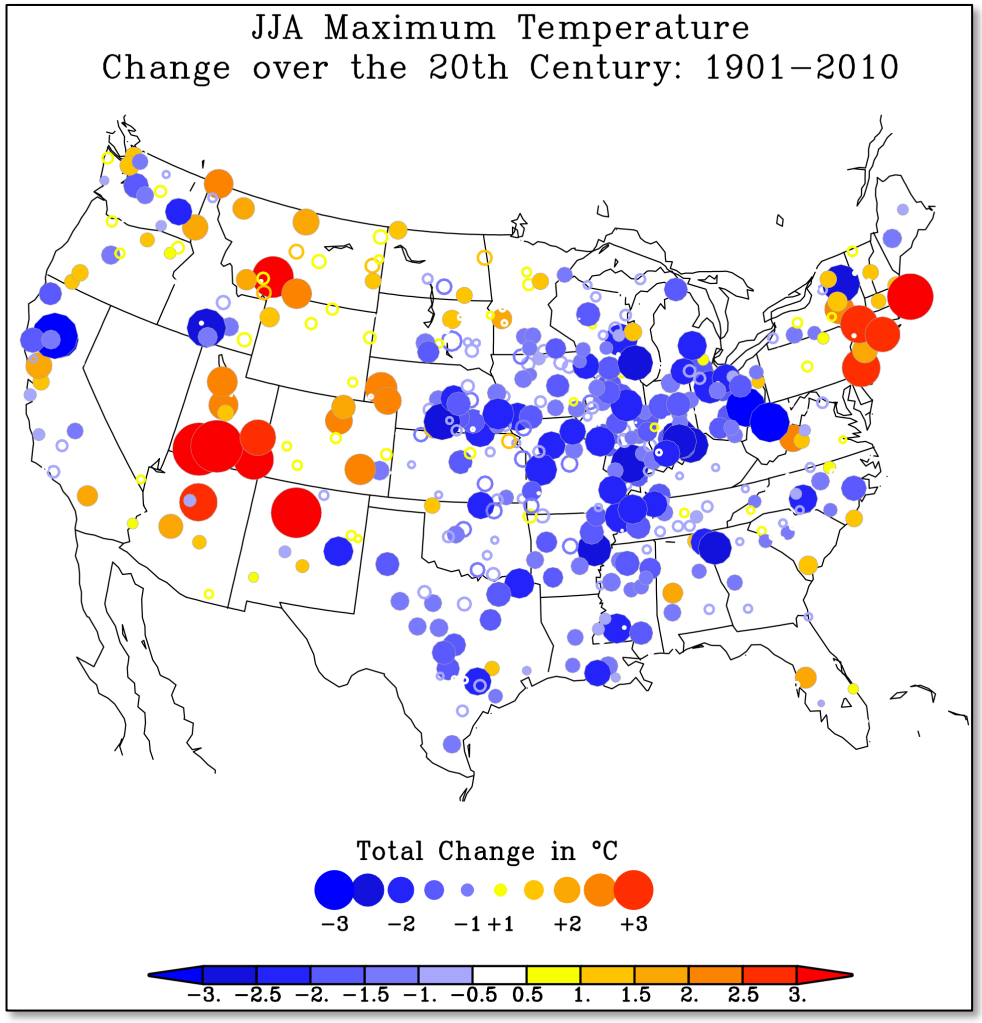
Tropospheric Ozone



Fiore [2009]

- Many models are biased high in the Summertime SE U.S.
- Yield and fate of isoprene nitrates?
- Nighttime chemistry and removal of NO_x?
- Difficulty in modeling the structure of the nighttime boundary layer?

Part of the motivation: Regional Climate Change and its causes



NOAA Science Challenge Workshop [2011]

- Eastern U.S. has not warmed since 1950 and has received more precipitation [*Portmann*, PNAS 2009]
- Connection with aerosol distribution?
- SENEX contribution:
  1. Describe and improve understanding of aerosol distribution
  2. Describe climate-relevant properties of aerosol

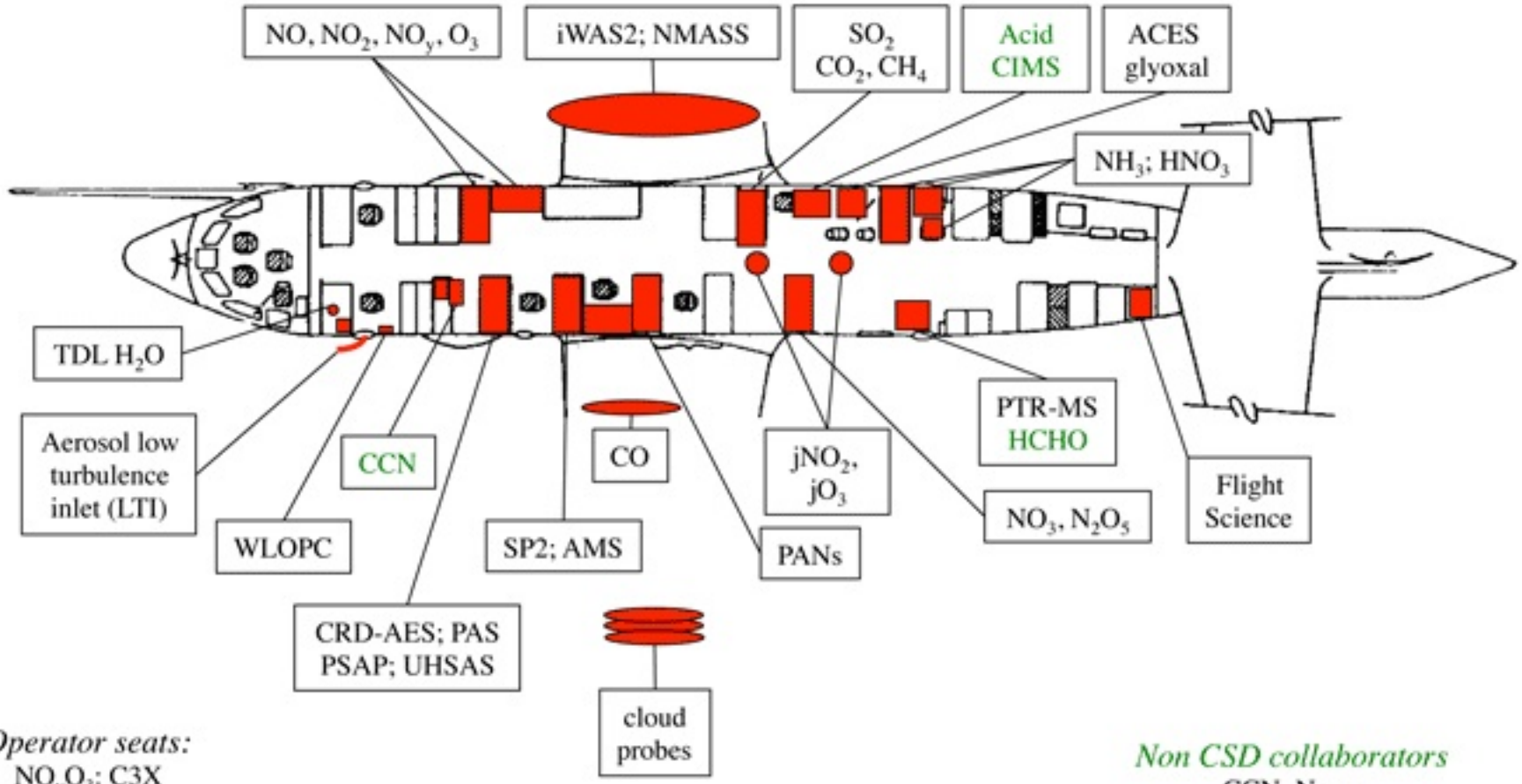
Main Science Questions

1. What are the emissions of aerosol, aerosol precursors and greenhouse gases in the SE U.S.?
2. What is the composition and distribution of aerosol in the SE U.S.?
3. What are the formation mechanisms of secondary species (ozone, sulfate and organics) in the SE U.S.?
4. Which deposition processes are critical for determining atmospheric concentrations of aerosol, ozone and NOy?
5. What are the climate-relevant properties of aerosol in the SE U.S.?

More details in White Paper: www.esrl.noaa.gov/csd/projects/senex/whitepaper.pdf

NOAA WP-3D Instrument Payload

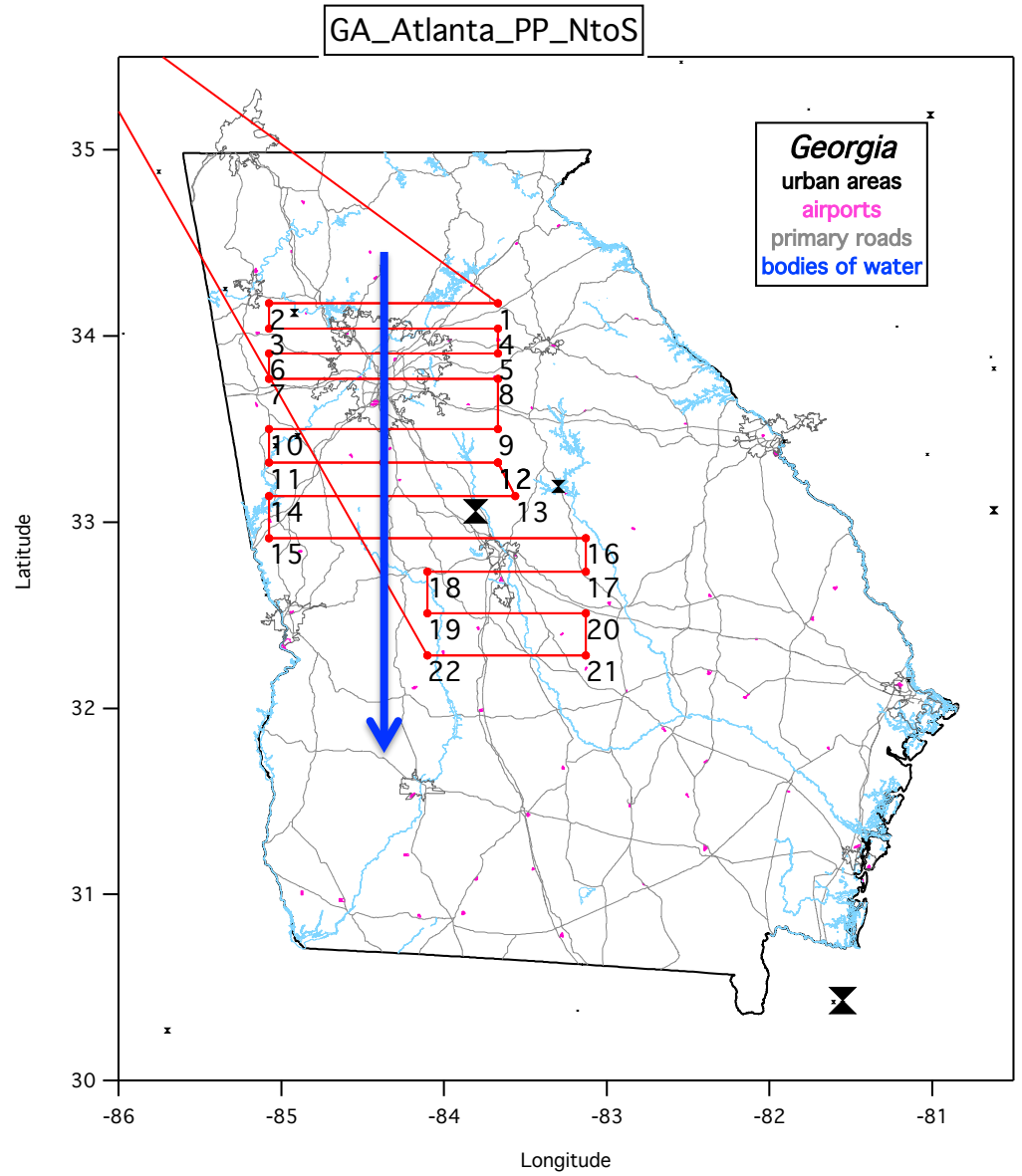
Operated out of Smyrna regional airport
110 flight hours, June 1 – July 15



Operator seats:
NO_yO_3: C3X
CRDS: Sta. 2
AMS: Sta. 3
CIMS: Galley
rotating: Galley

Non CSD collaborators
CCN: Nenes
HCHO: Hanisco/Keutsch
Acid CIMS: Thornton

Flight Plans: O_3-SOA Formation in Clear Air

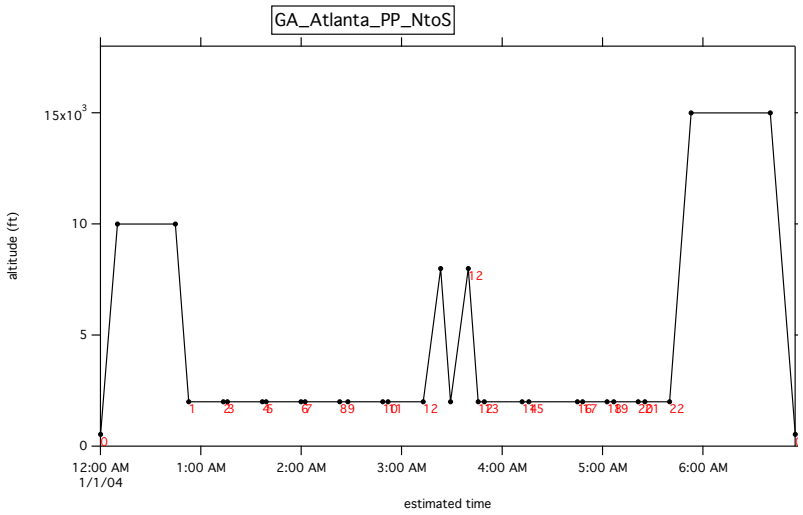


Oxidants & aerosol formation in:

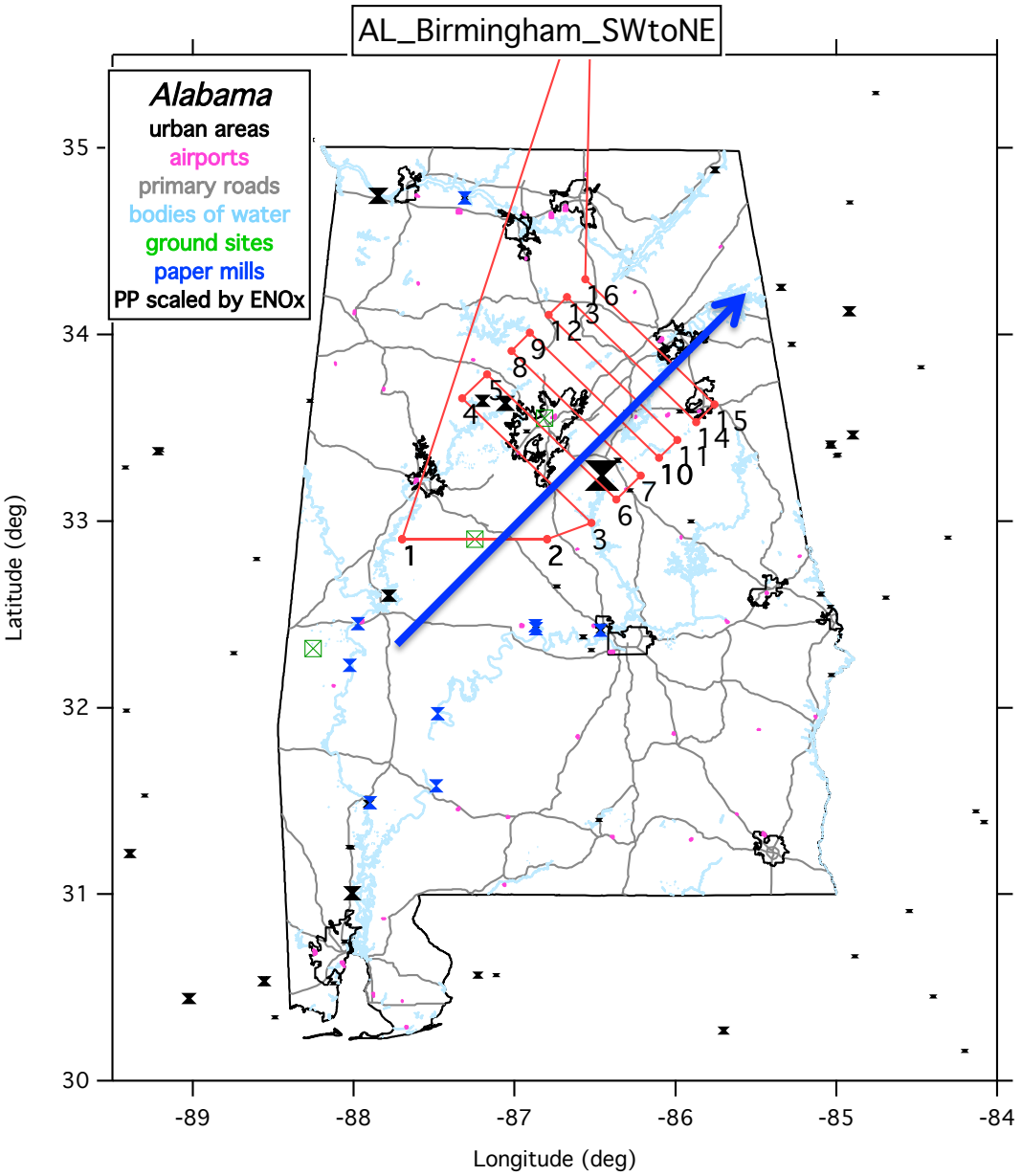
- Urban plumes: NOx, SO_2, POA, BC and anthropogenic VOCs
- Power plant plumes: NOx, SO_2, no POA, no anthropogenic VOCs

With high and low biogenic VOCs

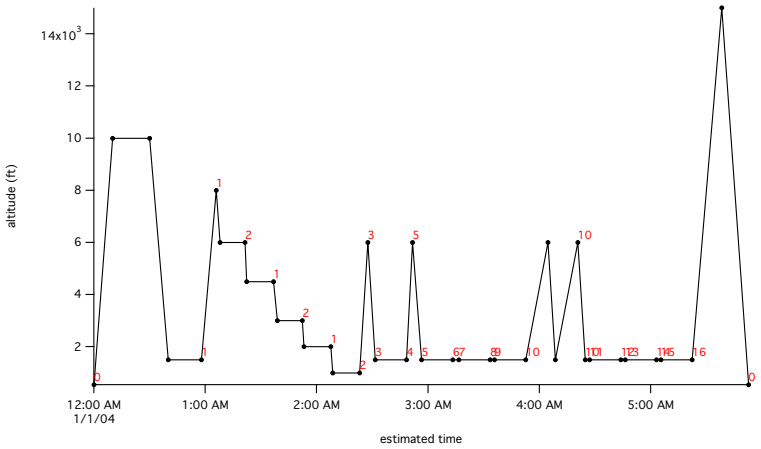
Cities: Atlanta, St. Louis, Nashville, Birmingham, Indianapolis



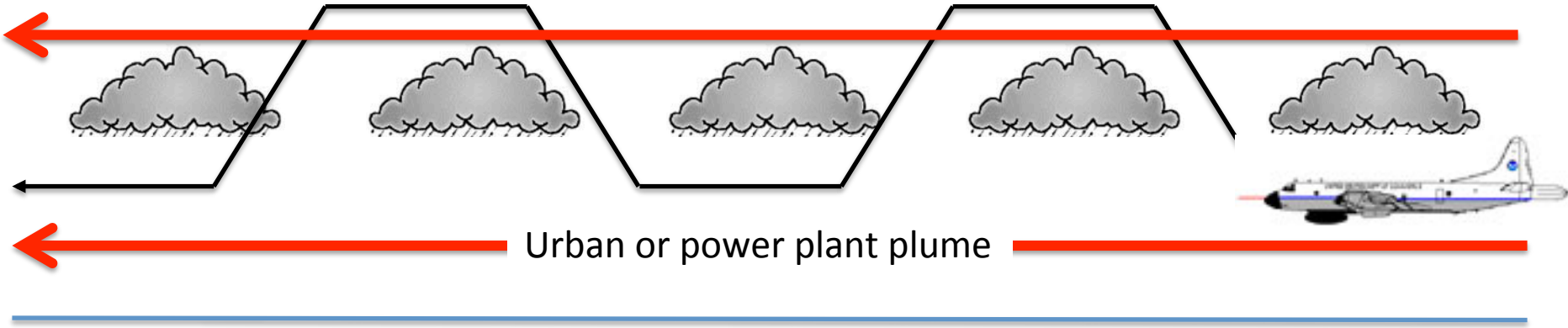
Flight Plans: O_3-SOA Formation in Clear Air



Example of a Birmingham flight including overpass of the Centreville site



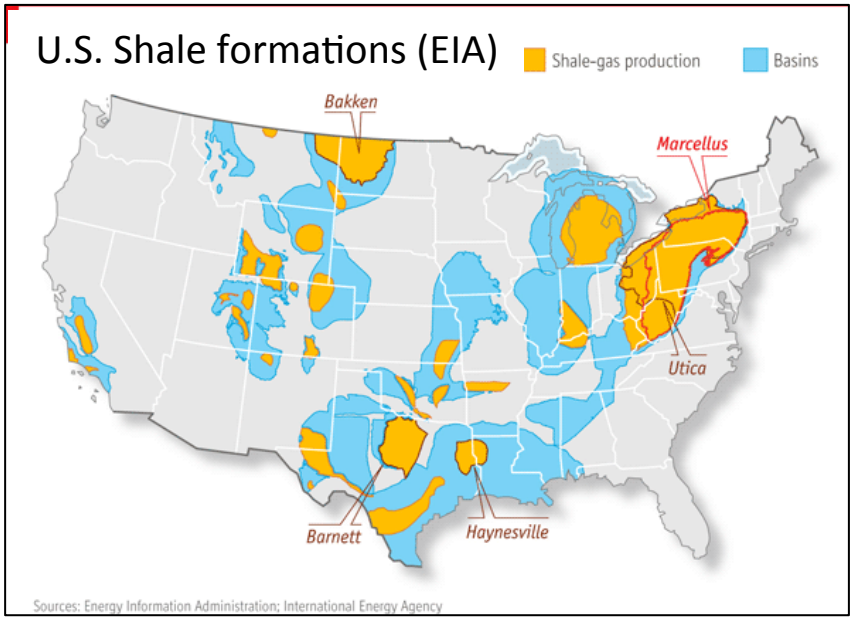
Flight Plans: SOA & Sulfate Formation in Clouds

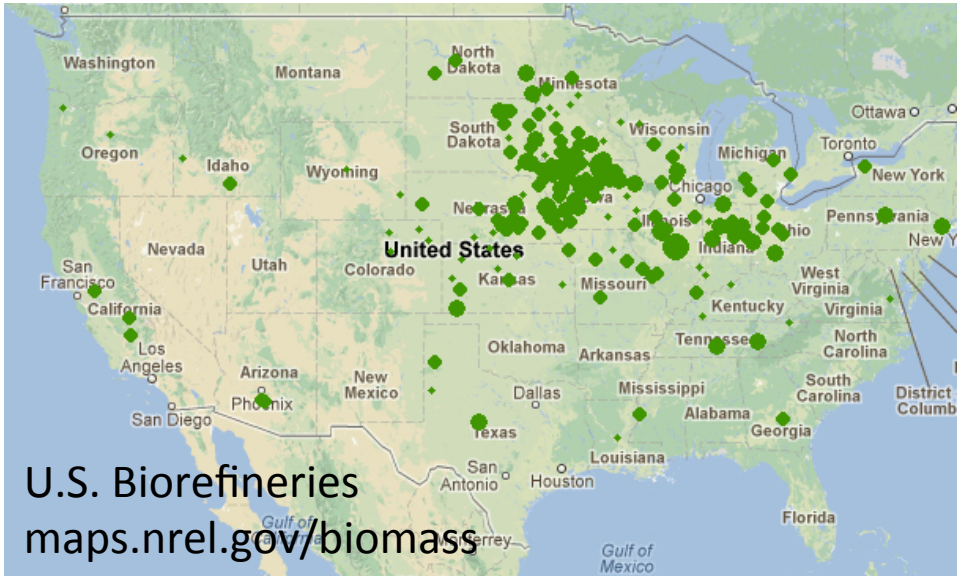


- Compare chemical evolution of plume above and below clouds
- Identify and quantify cloud-modified formation of sulfate, organics, others above cloud
- Successfully done during 1 flight in TexAQS 2006; will be looking for opportunities during SENEX

Flight Plans: Other Goals

1. Nighttime chemistry and SOA formation
2. Regular overpasses of Centreville site
3. Inter-comparison flights with C-130
4. Emissions from natural gas production in Haynesville Shale
5. Emissions from biofuel refineries (Archer Daniels Midland, Decatur, IL)

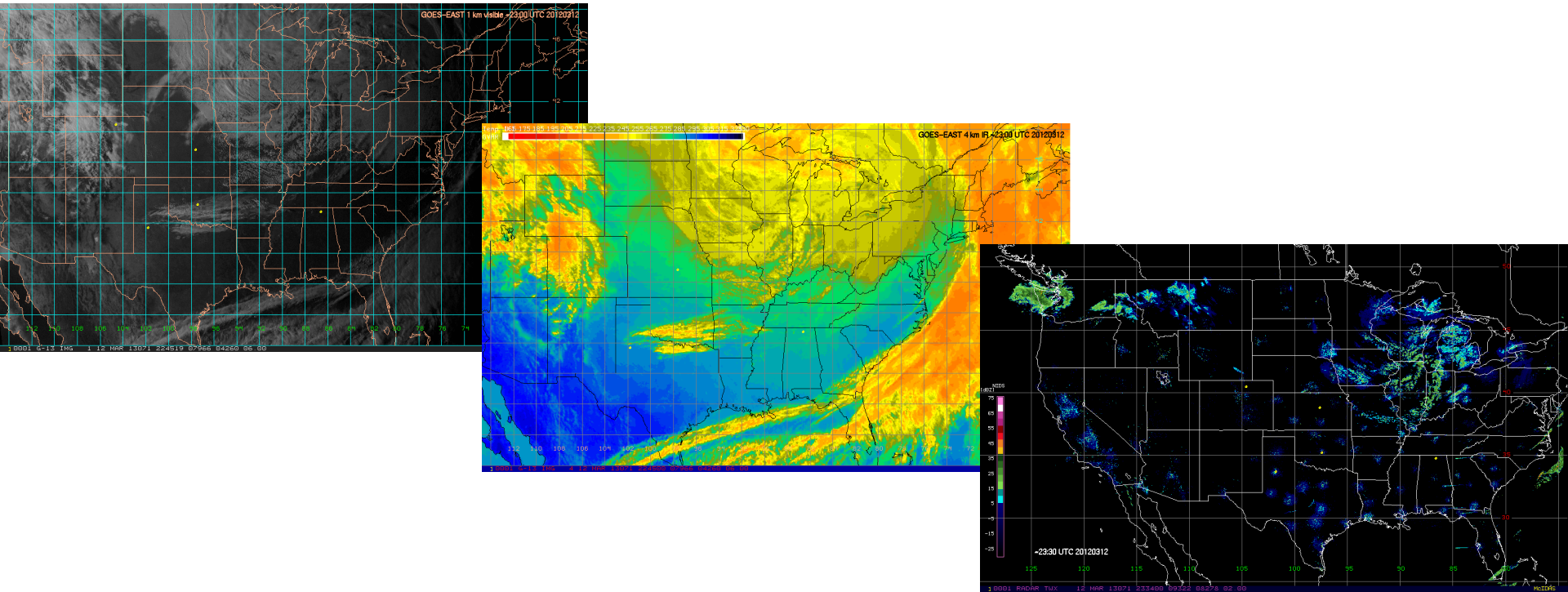




Forecast, Imagery and Modeling

1. GOES visible and IR: every 15 min, archived for the entire study period, U.S. and sub-regions
2. Composite radar - base reflectivity

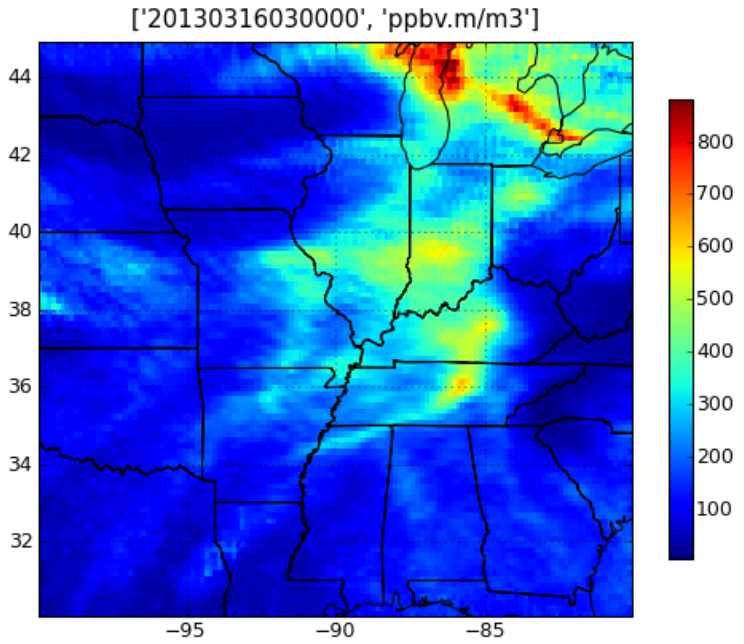
Examples for DC3 (Owen Cooper):
www.esrl.noaa.gov/csd/groups/csd4/metproducts/2012dc3/



Forecast, Imagery and Modeling

3. Flexpart forecasts (biomass burning, anthropogenic, perhaps simplified biogenic)
4. Flexpart analyses: time series and footprints for WP-3D flight tracks and ground sites

Forecast site already up (Jerome Brioude):
www.esrl.noaa.gov/csd/groups/csd4/forecasts/senex/



North-American CO
Forecast for March 16, 2013
Column CO
Transport time of 10 days

Forecast, Imagery and Modeling

5. WRF-Chem model output: not forecasts (Stu McKeen and Ravan Ahmadov)
6. GFDL AM3 model: output along WP-3D flight tracks and for ground sites (Larry Horowitz, Jingqiu Mao)
7. Emissions: Map viewer (Greg Frost)
8. Real time NOAA WP-3D data on top of various imagery and model forecasts

Synergies with SOAS

SOAS and SENEX were designed in close communication:

1. Interaction of anthropogenic and biogenic emissions to form oxidants and aerosol
2. Implications for climate

Are important science goals for both campaigns

Synergies between platforms:

1. SOAS ground sites: 24/7 measurements, high chemical detail
2. SOAS C-130: biogenic emissions
3. NOAA WP-3D: process-oriented studies, regional and vertical perspective to ground sites
4. Data inter-comparisons between platforms are needed

Synergies with NAAMEX

1. Air mass characterization

Coordinate on forecasted transport events

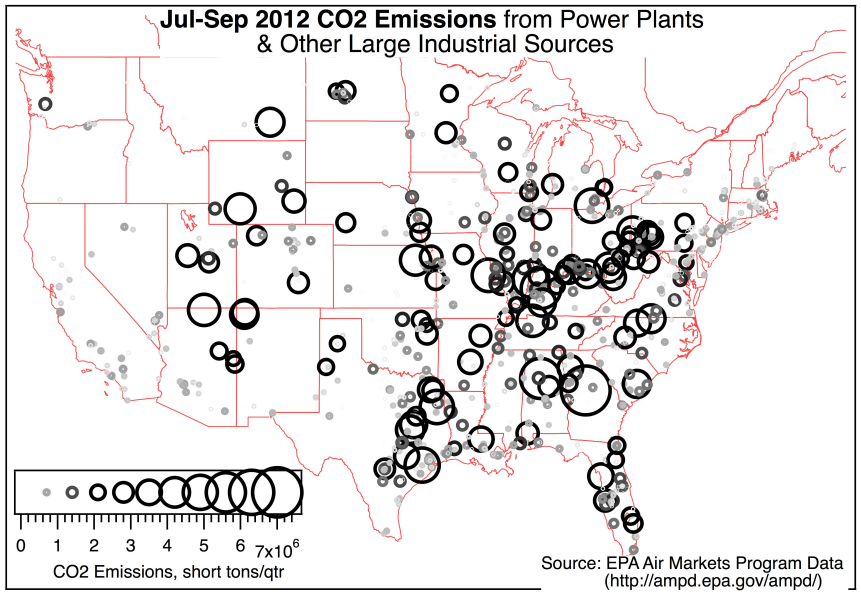
NOAA WP-3D measurements complement C-130

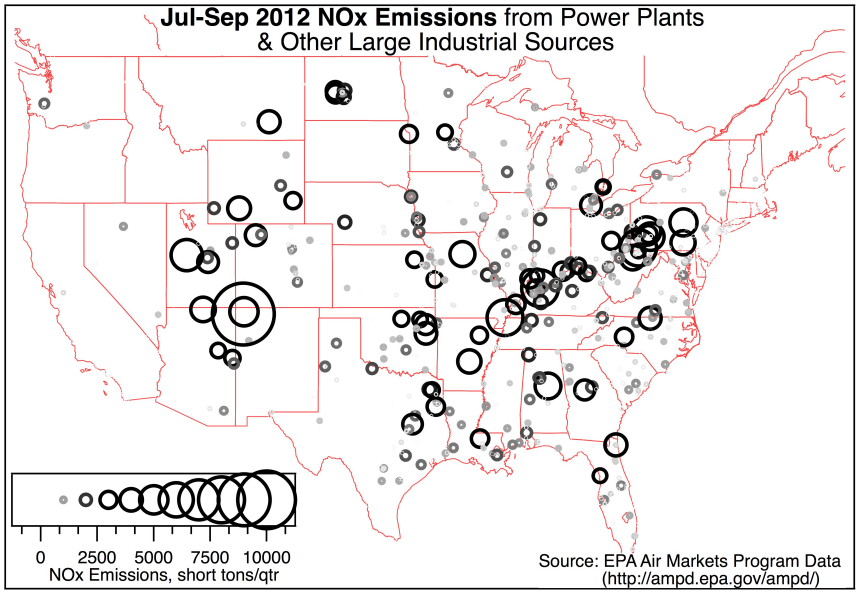
NOx, NOy, VOCs, aerosol: air mass origin and history

2. Power plant emissions

Coordinate on which plants to target (CEMS data)

More complete characterization of emissions





Synergies with TROPHONO

Relevant Measurements Onboard the NOAA WP-3D:

NO, NO2, NOy	chemi-luminescence	Ryerson
Nitrate	AMS	Middlebrook
HONO (?)	CIMS	Thornton
PANs	I^- CIMS	Roberts
Alkyl nitrates	iWAS2	Gilman
HNO3	CIMS	Neuman
NO3, N2O5	CRD	Brown

Share data

Coordinate on flight plans

Perform inter-comparison flight

Questions?