

Carbonaceous Aerosol and Radiative Effects Study (CARES)

DOE ASP Field Campaign in 2010

Rahul Zaveri, Will Shaw, Dan Cziczo
Pacific Northwest National Laboratory

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Collaborators (Partial List)

PNNL

M.L. Alexander, J.C. Barnard, L.K. Berg, E.G. Chapman, R.C. Easter, J.D. Fast, W.I. Gustafson, J.M. Hubbe, A. Laskin, L.-Y. Leung, M. Pekour, J. Shilling, C. Song, X.-Y. Yu, and A. Zelenyuk

BNL

P.H. Daum, L.I. Kleinman, P.H. Daum, Y.-N. Lee, G. Sennum, S.R. Springston, J. Wang

Other Institutions (listed in alphabetical order of the institution name)

Timothy B. Onasch, Scott C. Herndon, Douglas R. Worsnop, **Aerodyne Research, Inc.**

Eileen McCauley, Ajith Kaduwela, **California Air Resources Board**

W. Patrick Arnott, **Desert Research Institute/University of Nevada, Reno**

Manvendra Dubey, **Los Alamos National Laboratory**

Claudio Mazzoleni, **Michigan Technological University, Houghton**

Chris Hostetler, Rich Ferrare, **NASA Langley**

David Parrish, Tom Ryerson, **NOAA, Boulder**

Jon Thompson, **Texas Tech University, Lubbock**

Jeff Gaffney and Nancy Marley, **University of Arkansas, Little Rock**

Kimberly A. Prather, **University of California, San Diego**

Tom Jobson, **Washington State University, Pullman**

DOE ASP and CARES Objectives

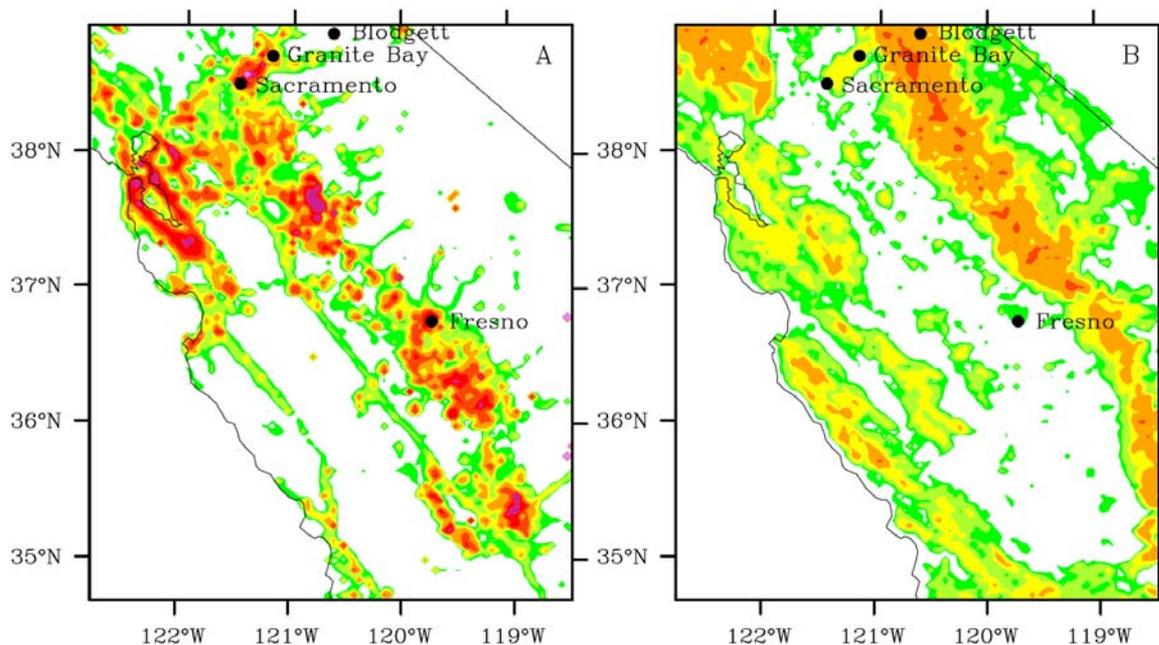
- ▶ Evaluate, improve, and validate models of aerosol formation, aging, and their climate-relevant properties, with particular emphasis on:
 - Anthropogenic and biogenic secondary organic aerosol (SOA)
 - Aerosol mixing states
 - Optical and CCN activation properties
 - Biomass burning aerosols (as opportunity arises)

Focus on Sacramento Plume / Central Valley

VOC Emissions [Steiner et al., 2007]

Anthropogenic VOC

Biogenic VOC

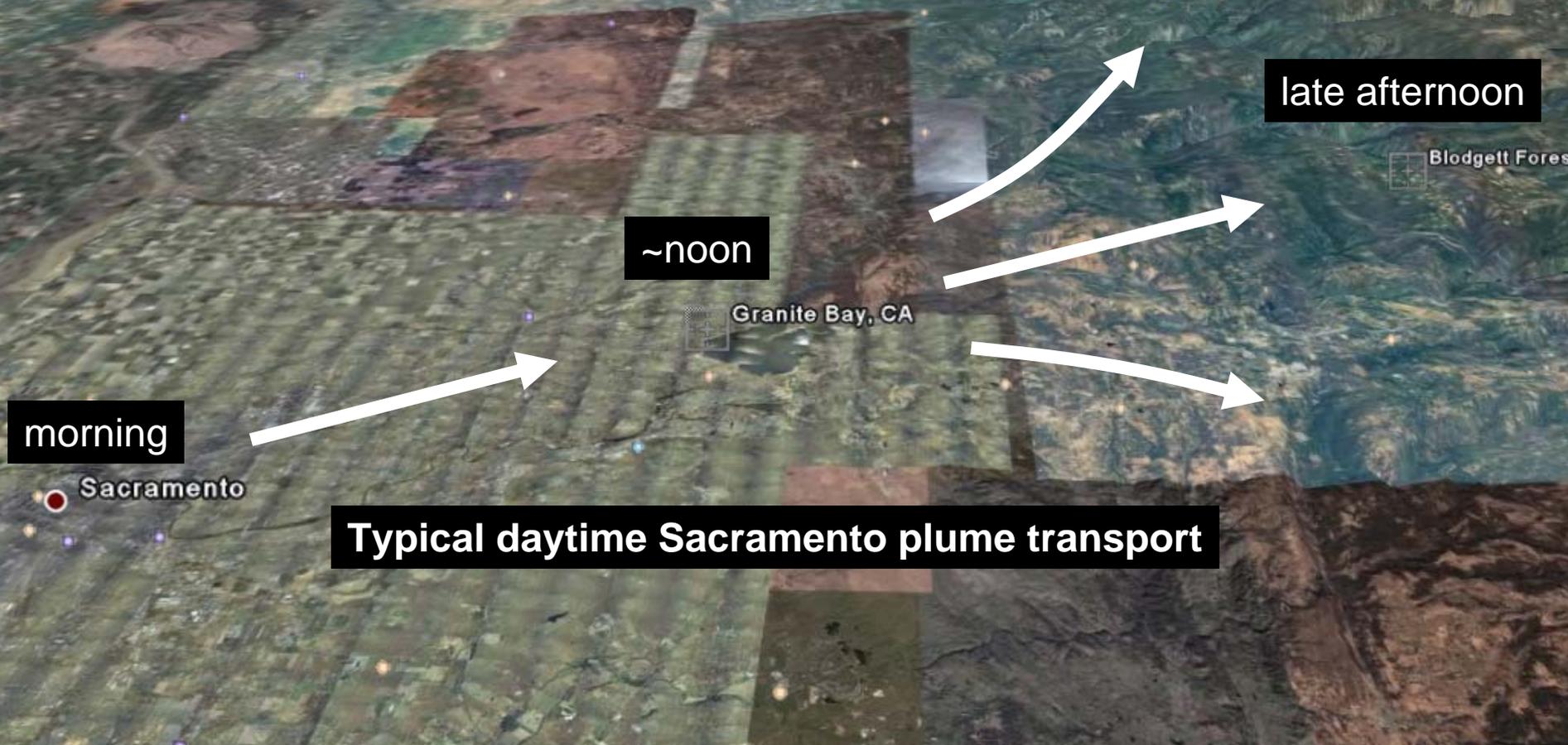


mol s^{-1}



Sacramento-Blodgett Forest Corridor

Somewhat regular meteorology expected in Summer



morning

~noon

late afternoon

Typical daytime Sacramento plume transport

Sacramento

Granite Bay, CA

Blodgett Forest



Scientific and Logistical Motivations

- ▶ Clear skies and highly regular wind patterns in summer
- ▶ Convenient to deploy ground sites and aircraft
- ▶ Detailed CARB emissions inventory (a big plus for modeling!)
- ▶ Great opportunity for ASP to collaborate with NOAA, CARB, and other participants
- ▶ Several previous ground-based studies at this location provide a good foundation for an intensive ASP field project in 2010

[e.g., Dillon et al., 2002; Murphy et al., 2006; Steiner et al., 2007; BEARPEX 2006-2007]

CARES Logistics

- ▶ Where: Sacramento / Central Valley, California
- ▶ When: June 2010
- ▶ Measurements Platforms
 - DOE G-1 aircraft
 - NASA B-200 aircraft (HSRL)
 - T0 Ground Site in Sacramento urban area
 - T1 Ground Site downwind of Sacramento (Possibly at “Cool”)
 - Aerodyne Mobile Lab (pending ASP support)
- ▶ Aircraft Base
 - Mather Airport
 - Full-service FBO, 24-hour air traffic control, 11,300 feet runway.

Coordinated Flight Plans & Collaborations

- ▶ Coordinated flights of **G-1** and **B-200** upwind, within, and downwind of Sacramento
 - Stacked patterns
- ▶ Coordinated flights of **G-1**, **B-200**, and **WP-3** as opportunity arises during **June 1 – 15**.
 - Wing-tip intercomparisons
 - Race track pattern
- ▶ Possible coordination of G-1 flights over other CalNex ground sites, especially during **June 15 – 30**.
- ▶ Possible coordination with **CIRPAS Twin Otter**
- ▶ Welcome additional collaborations and support for the CARES ground sites

DOE G-1 Aircraft Measurements

► Platform

- Gulfstream 159, N701BN
- Nominal flight altitude: 25 kft (7.6 km)
- Useful load: ~4000 lb
- Sampling speed: 195 knots (100 m/s)
- Mission duration: ~4 hours
- Science flight hours: ~70 h
- Based in Sacramento (Mather Field)



G-1 Administered by PNNL's Airborne Facility and Programs Office

► Basic Instruments

- total temperature
 - static pressure
 - gust-probe differential pressures
 - platform position/velocity/attitude
 - dew-point temperature
 - aerosol spectrum, 0.1-3 μm (PCASP)
 - particle count, $>7\text{nm}$ (CPC)
 - particle count, $>3\text{nm}$ (uCPC)
 - particle light scattering (nephelometer)
 - particle absorption (PSAP)
 - isokinetic aerosol inlet
- static temperature
 - potential temperature
 - winds

DOE G-1 Aircraft Measurements

Potential CARES Instruments

- Aerosol Mass Spectrometer (AMS)
- SPLAT/ATOFMS
- Single Particle Soot Photometer (SP2)
- PILS (Water Soluble Organic Carbon, WSOC)
- TSEMS/FIMS, PCASP
- PTRMS
- NO_x , NO_y , O_3 , SO_2 , NH_3 , CO , VOC (canisters)
- Nephelometer, PSAP, Photo-acoustic
- Aerosol samplers (TRAC, DRUM and others) for
 - microprobe/microscopy analysis
 - high-resolution MS analysis of oligomer constituents in OA
- Radiation (down-welling and up-welling, spectrally resolved)



Not all instruments listed here will simultaneously fit on the G-1!

NASA B-200 Deployment for CARES 2010



► Platform

- NASA Langley King Air B-200
- Nominal flight altitude: 28 kft (~ 9 km)
- Science flight hours: ~70 h
- Aircraft speed: 200-220 knots
- Aircraft duration: 4-5 hours
- Based in Sacramento with DOE G-1



► Instruments

- High Spectral Resolution Lidar
 - Digital Camera
 - Research Scanning Polarimeter
- Ferrare/Hostetler
NASA Langley
(possible) Cairns
NASA/GISS

► Objectives

- Support DOE G-1 operations (reconnaissance and real-time direction)
- Characterize the vertical and horizontal distribution of aerosols and aerosol optical properties
- Provide the vertical context for G-1 and ground in situ measurements
- Infer aerosol type and apportion optical depth by type
- Investigation of new active + passive (lidar + radiometer) aerosol retrieval techniques
- Characterize the PBL height and distribution of aerosols within and above PBL
- Assess aerosol model transport simulations
- CALIPSO/CALIOP & GLORY/APS Validation

NASA Langley Airborne High Spectral Resolution Lidar (HSRL)



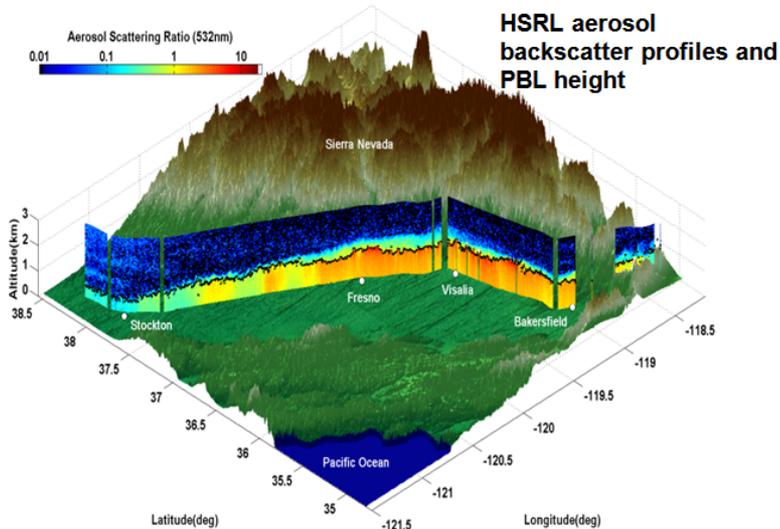
HSRL Technique (Hair et al., AO, 2008):

- Relies on spectral separation of aerosol and molecular backscatter in lidar receiver
- Independently measures aerosol backscatter, extinction, and optical thickness
- Internally calibrated
- Provides **intensive** aerosol parameter to help determine aerosol type

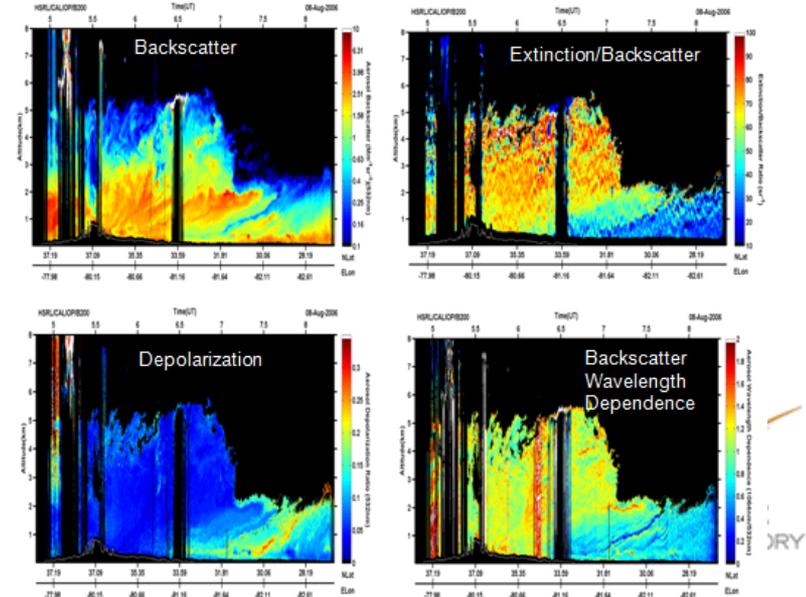
HSRL Aerosol Data Products:

- Scattering ratio (532 nm)
- Backscatter coefficient (532, 1064 nm)
- Extinction Coefficient (532 nm)
- **Backscatter Wavelength Dependence (532/1064 nm)**
- **Extinction/Backscatter Ratio ("lidar ratio") (532 nm)**
- **Depolarization (532, 1064 nm)**

February 15, 2007 Flight over San Joaquin Valley



August 8, 2006 CALIPSO Validation Flight



(Tentative) NASA GISS Research Scanning Polarimeter (RSP): Possible Deployment for CARES



Measurements

- Total and linearly polarized reflectance in nine spectral channels
- 152 viewing angle samples over 120 deg angular range

Derived parameters

- Aerosols
 - optical depth
 - location and width of both modes of bimodal size distribution
 - refractive index
 - estimates of size and amount of accumulation mode aerosols above clouds
- Clouds
 - optical depth
 - effective radius, variance
 - liquid water path
 - cloud drop number concentration

Ground Measurements at T0 / T1

Tentative List

- Aerosol Mass Spectrometer (AMS)
- SPLAT II
- Single Particle Soot Photometer (SP2)
- PILS (Water Soluble Organic Carbon, WSOC)
- SMPS
- PTRMS, GC-MS for SVOCs and VOCs in urban air
- EC/OC Analyzer
- NO_x, NO_y, O₃, SO₂, NH₃, CO, VOC (canisters)
- Nephelometer, PSAP, cavity ring-down, Photo Acoustic Soot Spectrometer
- CCN counter, Humidified-TDMA, Volatility-TDMA
- UV-MFRSR, Rotating Shadowband Spectrometer (RSS)
- Trace gas photolysis rates.
- Aerosol samplers (TRAC, DRUM and others) for
 - microprobe/microscopy analysis
 - radiocarbon analysis (¹³C, ¹⁴C), and
 - high-resolution MS analysis of oligomer constituents in OA
- Meteorological measurements, including profilers, sodars, and radiosondes

Aerodyne Mobile Laboratory

Pending ASP Support

- Aerosol Mass Spectrometer (AMS) with the black carbon detection module (SP2)
- Scanning Mobility Particle Sizer (SMPS)
- Multi-angle absorption photometer (MAAP)
- CAPS-extinction and SSA instruments
- Gas Chromatogram, originally based on TO-14 method targeting aromatics and semi-volatiles
- QC-TILDAS – HCHO/HCOOH and NH₃
- PTR-MS
- NO, NO₂ (direct TILDAS), NO_y, O₃, CO, CO₂
- Eppley uv, atmospheric temperature, pressure, wind direction, wind speed, relative humidity

