Carbonaceous Aerosol and Radiative Effects Study (CARES)

DOE ASP Field Campaign in 2010

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Collaborators (Partial List)

PNNL

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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
Sacramento-Blodgett Forest Corridor

Somewhat regular meteorology expected in Summer

Typical daytime Sacramento plume transport

- Morning
- Noon
- Late afternoon
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)

**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, >7nm (CPC)
- particle count, >3nm (uCPC)
- particle light scattering (nephelometer)
- particle absorption (PSAP)
- isokinetic aerosol inlet

G-1 Administered by PNNL’s Airborne Facility and Programs Office
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\textsubscript{x}, NO\textsubscript{y}, O\textsubscript{3}, SO\textsubscript{2}, NH\textsubscript{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
**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

**Measurements**

- Total and linearly polarized reflectance in nine spectral channels
- 152 viewing angle samples over 120 deg angular range
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$_y$, O$_3$, SO$_2$, NH$_3$, 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 ($^{13}$C, $^{14}$C), and
  - high-resolution MS analysis of oligomer constituents in OA
- Meteorological measurements, including profilers, sodars, and radiosondes
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), NOₓ, O₃, CO, CO₂
- Eppley uv, atmospheric temperature, pressure, wind direction, wind speed, relative humidity