TESSCORN

AERODYNE MOBILE LABORATORY

A large and increasing fraction of the planet's population lives in megacities, especially in the developing world. These large metropolitan areas generally have very high levels of both gaseous and particulate air pollutants that have severe impacts on human health, ecosystem viability, and climate on local, regional, and even continental scales. Urban/industrial air quality problems are characterized by complex emissions patterns and rapidly changing pollutant and pollutant precursor concentrations. Emissions fluxes and ambient pollutant concentration distributions are generally poorly characterized for large urban areas even in developed nations. Much less is known about pollutant sources and concentration patterns in the faster growing megacities of the developing world.

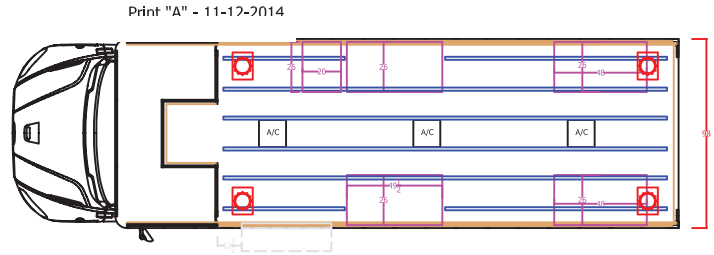
Air quality studies are typically conducted by periodically sampling air at a small number of fixed sites providing limited understanding of pollutant sources, down-wind chemical transformations and limited ability to extrapolate pollutants to areas far from the measurement location. One way to address these limitations is with the use of a ground based mobile laboratory.

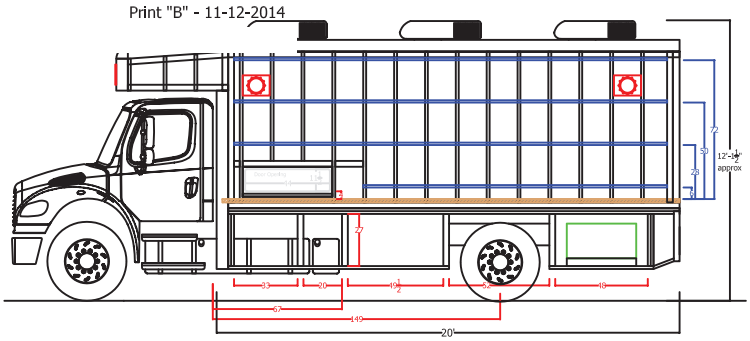
The Aerodyne Mobile Laboratory (AML) is a customized vehicle equipped with fast response instruments and high resolution sampling systems capable of characterizing both gaseous and fine particulate emissions and distributions in urban atmospheres and is capable of measuring while moving.

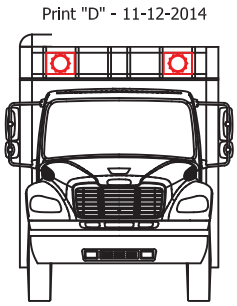
The vehicle based mobile laboratory is equipped with on-board power sources (two 12 kW generators) sufficient to run instruments and air conditioning to handle the instrumental and solar heat load. A dual gas and PM sampling system is used to distribute the ambient air to the instruments and has significant relative velocity for gas and particle instruments for the fast response instruments to provide adequate spatial resolution at higher speeds.

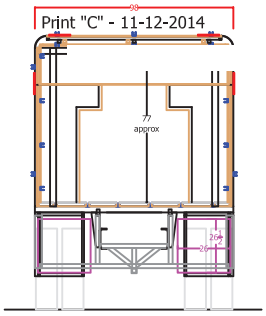
AERODYNE MOBILE LABORATORY INSTRUMENTS

INSTRUMENT / METHOD	MEASUREMENT	TYPE
Tunable Infrared Laser Direct Absorption Spectroscopy (TILDAS)	CO, HCN, HCHO, C2H6, NO, NO2, H2O, CH4, C2H2, N2O, HCOOH, NH3	Gas Phase
Non-dispersive infrared	CO2	Gas Phase
UV absorption	O3	Gas Phase
Vocus-Proton Transfer Reaction (PTR) Mass Spectrometer	Oxygenated and nitrogen-containing volatile organic compounds, including aromatics	Gas Phase
High-Resolution Aerosol Mass Spectrometer (AMS)	Particulate matter size and composition	Aerosol
Multiwavelength Photoacoustic Spectrometer/Nephelometer	Quantification of particulate matter optical characteristics of smoke and brown-carbon particulate matter	Aerosol
SMPS w/ CPC, DMS 500, DMT, UHSAS, APS, Optical Particle Spectrometer	Aerosol Size Distribution	Aerosol Microphysics
3-wavelength CAPS	3-λ Extinction	Aerosol Optics
Nephelometer	3-λ Scattering	Aerosol Optics
Aethalometer	7-λ Absorption	Aerosol Optics
Photoacoustic Extinctiometer (PAX)	Absorption/ Scattering coefficient	Aerosol Optics
Tricolor Absorption Photometer (TAP)	3-λ Absorption Photometer	Aerosol Optics
ARI dPAS-3, ARI dPASS, DMT PASS-3	3-λ Photo-Acoustic Spectrometers	Aerosol Optics
DMT SP2	Black Carbon Mass and Size	Aerosol Composition and Mass
Cooper Xact 625i, Sunset labs	EC/OC, multi-metal fence line monitoring	Aerosol Composition and Mass
Dekati Mass Monitor DePS	Real-time particle mass, number and LDSA concentration values	Aerosol Composition and Mass
Sun Photometer	Atmospheric Optical Depth	Atmospheric Structure and Meteorology
Ceilometer	Vertical structure of the atmosphere	Atmospheric Structure and Meteorology
	Global positioning system, wind, and other meteorological parameters	
Spectral Radiometer	Quantification of sunlight available to initiate atmospheric chemistry	Radiation









A variety of trace gaseous pollutants can be quantified in real time with a dual tunable infrared laser differential absorption spectroscopy (TILDAS) instrument utilizing infrared diode lasers including NO, NO2, HONO, CO, N2O, CH4, C2H6, SO2, and H2CO. The AML has fast response capabilities to monitor mobile air toxics: acetaldehyde (CH3CHO) and benzene (C6H6) using proton transfer reaction mass spectrometer (Vocus PTR-MS), formaldehyde using an ARI TILDAS instrument, and the organics on diesel PM using the ARI AMS.

Measurement applications

AML is designed for two fundamentally different measurement approaches: stationary measurements and mobile measurements while driving. Both types of measurements allow a broad variety of applications to address various scientific questions, which often cannot or are much harder to be addressed using "classical" approaches.

Mobile measurements types

Chasing measurements: Mobile sources, like passenger vehicles, trucks or buses, can be sampled over extended time intervals by chasing the emitters with the mobile laboratory. This allows measurement of their emissions under different ambient or operation conditions, like various engine loads under real-world driving conditions.

Mapping measurements:

Measurements of the ambient air while the mobile laboratory is driving provide information on pollutant concentrations along the driving track. If the complete measurement trip is completed before ambient conditions change significantly, these measurements reflect the spatial distribution of pollutants, and under favorable conditions allow the generation of pollutant maps. Other applications of mobile measurements are the investigation of pollutant distributions in the vicinity of major industrial sources or in residential areas within urban environments, and the analysis of spatial structures of large emission plumes, e.g., from whole urban agglomerations like megacities.

Instrumentation

- Aerosol physical and chemical measurements
- Trace gas monitoring and meteorological parameters

The major focus of the mobile laboratory is the investigation of the ambient aerosol. Physical aerosol parameters that are measured include particle number concentration of particles larger than 2.5 nm diameter and particle mass concentrations for the PM1, PM2.5, and PM10 size fractions. While the focus of the measurements is on aerosol properties, also several trace gases and meteorological parameters are determined.


Aerodyne Mobile Laboratory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