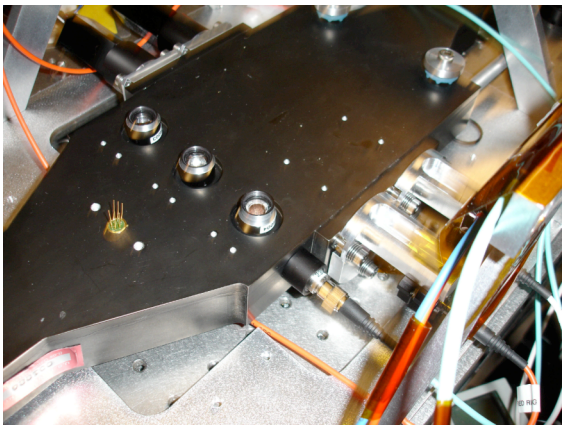
Aerosol Optical Property Measurement on Uninhabited Aerial Systems

This project is a collaboration between NASA's Aerosol Lab and Los Gatos Research, Inc. Its objective is the development of a unique instrument capable of measuring aerosol radiative properties from an Uninhabited Aerial System (UAS, formerly known as UAV). The instrument will be capable of measuring extinction and scattering coefficients at 2 wavelengths, and obtaining absorption coefficient, single scattering albedo, and asymmetry parameter at these wavelengths, and NO_2 concentration..

It is well known that aerosols have a profound effect on regional and global climate, however, there still exist large uncertainties in the measurement of key aerosol radiative properties, such as absorption and single scattering albedo and their distribution in the atmosphere. These effects are felt directly, through direct scattering and absorption of solar radiation and indirectly by modifying cloud properties and precipitation. Single scattering albedo, the ratio of scattering to extinction, is an important metric for aerosol radiative effects and an important input into global climate models.

Photograph of the flow cell. Air enters the cell from top right, is expanded to fill the cell through a laminar inlet, is probed by the laser beams, and exits at below left.



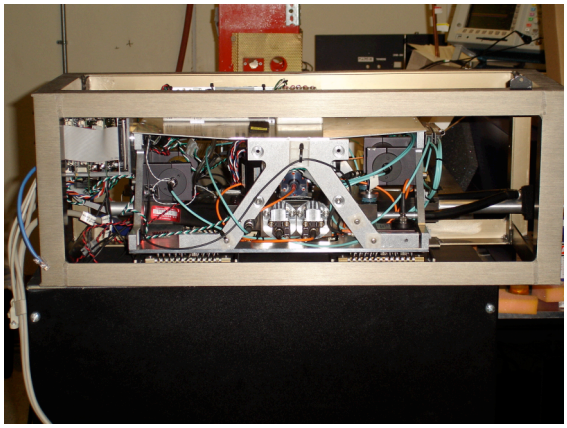


Photo of the instrument in the lab at Los Gatos Research, Inc. The instrument cage is 10" x 10" x 19" and weighs about 20 lbs.

Features of the Instrument

The instrument design is based on Cadenza [Strawa et al., 2003; Strawa et al., 2006]. It uses off-axis cavity ring-down (OA-CRD) to measure the aerosol extinction coefficient at wavelengths of 675 nm and 410 nm, and simultaneously measure the total and forward and back scattering coefficient at both wavelengths using a reciprical nephelometer [Mulholland and Bryner, 1994] concept. All measurements are made in the same optical and flow cell at exactly the same conditions with a temporal resolution of about 1 sec. Absorption coefficient is obtained from the difference of measured extinction and scattering within the instrument and single scattering albedo from their ratio.

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Applications

This instrument will be very useful in determining the vertical distribution of aerosol optical properties that are critical to accurate climate modeling. It can be mounted in a pod and carried under the wing of larger UAS or manned aircraft or it can be carried in the fuselage of smaller UAS. Its small size, light weight and excellent response time (1 sec.) make it ideal for these applications.

The instrument is sensitive enough to make measurements in the mid troposphere where aerosol extinction coefficients can be below 0.1 Mm^{-1}.

The instrument is portable and can be used in ground sites, such as the Caldecott tunnel (described on another page) to measure the emission factor from cars and trucks.

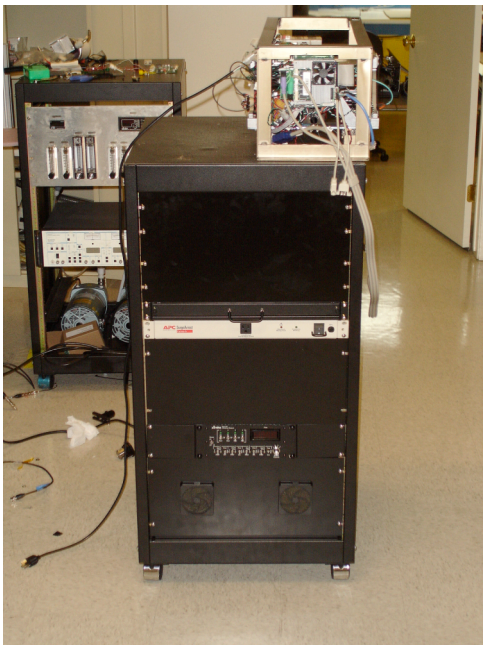
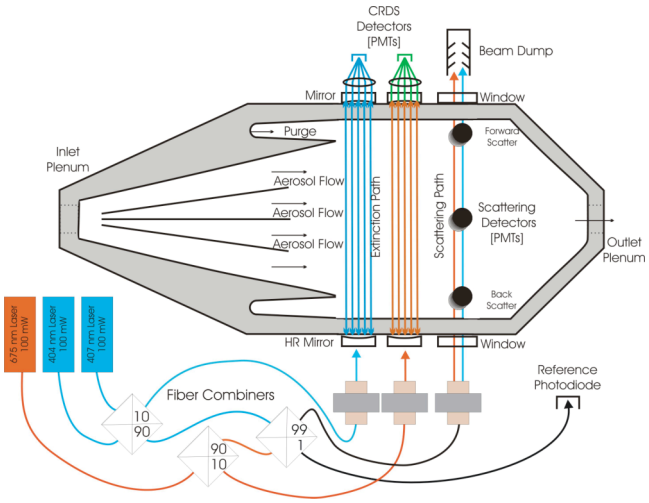


Photo of the ground support station.



Schematic of the instrument.

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