Surface Aerosol Measurements at Lamont, Oklahoma

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Climate research at the Environmental Measurements Laboratory (EML) is now primarily directed to the first Atmospheric Radiation Measurement (ARM) Cloud and Radiation Testbed (CART) site in Lamont, Oklahoma. The U.S. Department of Energy (DOE) has established the CART site in order to characterize empirically radiative processes in the earth's atmosphere with improved resolution and accuracy. This information will improve the predictive capability of global climate models.

The scientific community recognizes that atmospheric aerosols can play an important role in climate change. The aerosol effect could be comparable in magnitude, but opposite (e.g., cooling) to the heating caused by the increasing atmospheric concentration of carbon dioxide.

In December of 1992 the ARM Aerosol Working Group prepared the document "Priority Recommendations for Aerosol Measurements in the ARM program." A series of experiments was described to answer questions on the direct and indirect radiative effects of aerosols. The objectives of each of the "Direct Radiative Forcing" priority experiments are reproduced here.

- Priority 1 Experiment

"Compare direct and diffuse spectral shortwave surface radiative fluxes to those predicted by a model such as LOWTRAN to establish the errors and uncertainties in using a "climatologically-averaged" description of aerosols by air mass type (rural, urban, marine, desert) included in such models."

- Priority 2 Experiment

"Determine the errors and uncertainties in predicting surface radiative fluxes by a radiative transfer code that takes explicit cognizance of the aerosol scattering and absorptive properties."

- Priority 3 Experiment

"Determine the error and uncertainties in the aerosol optical properties computed from measured chemical compositions and microphysical properties of aerosols."

By the end of winter 1994, the aerosol equipment should be operational at the site and provide data that can be used in the above three priority experiments.

Aerosol radiative models, such as "LOWTRAN 7," require characterization of surface aerosols and air masses to choose the most representative conditions for radiation calculations. To properly specify the correct input to this model, EML is using instruments at the CART site, housed in a dedicated trailer, to measure the following aerosol characteristics:

1. particle concentration (TSI, Inc. condensation nuclei counter)
2. optical scattering coefficient (MRI integrating nephelometer, on loan from PNL, to be replaced by a Radiance Research nephelometer in late spring 1993)
3. optical absorption coefficient (filter technique)
4. aerosol size distribution (PMS Inc. Passive cavity aerosol spectrometer probe Model PCASP-X).

In addition, the ozone concentration will be measured using an ultra-violet photometric analyzer (Dasibi Environmental Corp. Model 1008 RS). All instruments except the Radiance Research nephelometer and the optical absorption instrument are at EML for testing and evaluation before installation in Lamont, Oklahoma.

A special aerosol sampling manifold (Figure 1) has been designed at EML and will be built at the site before the equipment is installed in the aerosol trailer. The manifold

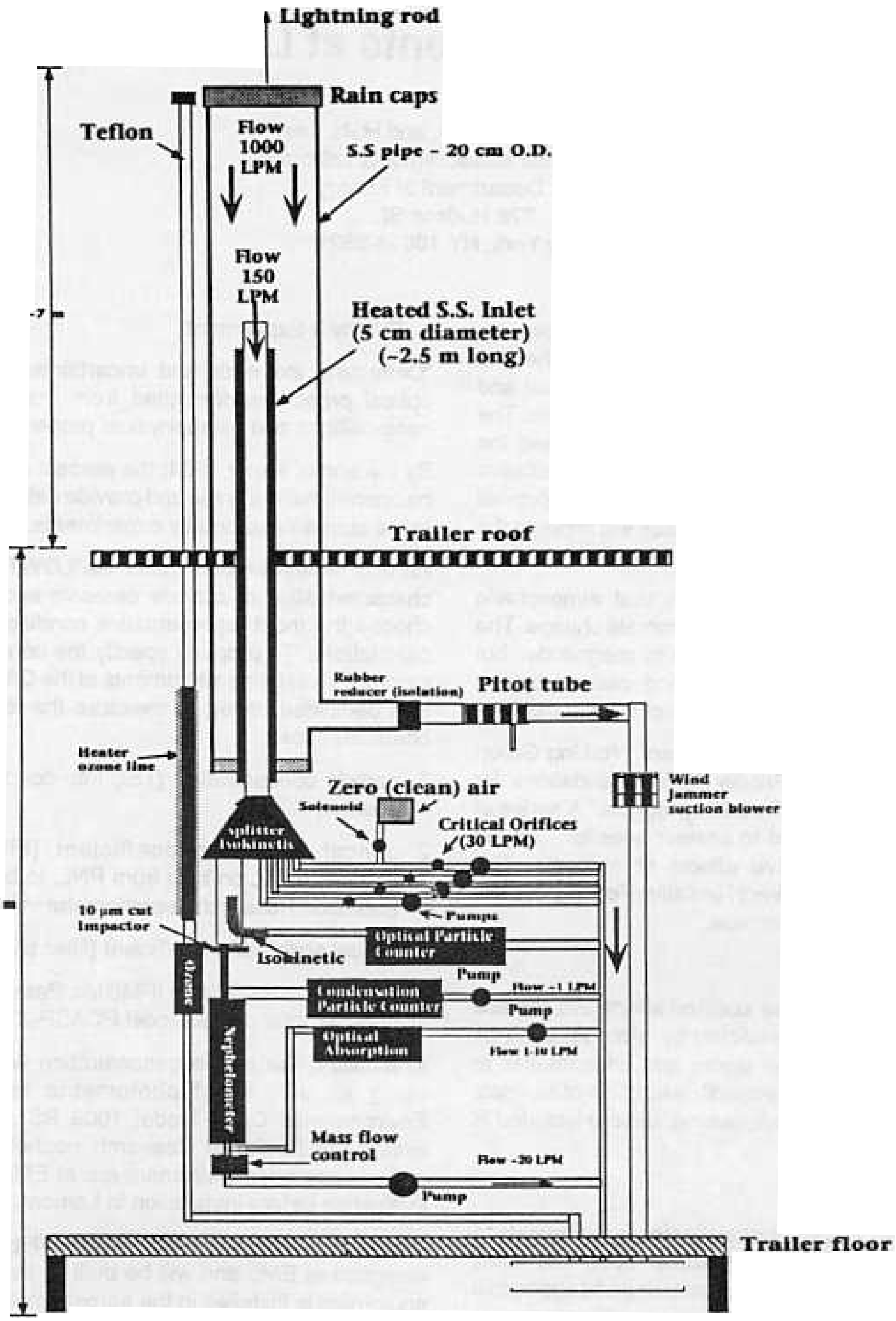

Figure 1. Preliminary design of the aerosol trailer at Lamont, Oklahoma.

will provide dried aerosol to the instruments and will be limited to sizes below 10 μm using an impactor designed at the University of Washington.

The interfacing of these instruments (hardware and software) to the main computer is being done by Richard Eagan of Argonne National Laboratory. A field data ingestor (FDI), located in the aerosol trailer, will interrogate and control instruments via RS-232 serial interface ports. In addition, the FDI will sample analog signals and perform control functions.

The size distribution and composition of aerosols measured at a specific location depend on the origin and the trajectory of the air mass passing over the site. Backward air mass trajectory analysis can be used to help characterize an air mass, but is not sufficient to qualitatively identify the aerosol composition of the air mass at the site. Additional analyses must be performed along the trajectory to understand how the original air mass has or has not been modified. Height analysis, precipitation events, the vertical temperature structure of the atmosphere, the relative humidity field, and other physical parameters are important to classify the air mass after it has traveled a few days. To this end, EML has developed a three-dimensional air mass trajectory model for the CART site. This model is discussed in the paper given by Hsi-Na Lee and Robert Leifer (this Proceedings).