State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 11-8

February 24, 2011

Agenda Item No.: 11-1-1

WHEREAS, the Air Resources Board (ARB or Board) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2712-269, entitled "Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California," has been submitted by the University of California, Davis;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2712-269 entitled "Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California," submitted by the University of California, Davis, for a total amount not to exceed $155,000.

NOW, THEREFORE, BE IT RESOLVED that ARB, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

> Proposal Number 2712-269 entitled "Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California," submitted by the University of California, Davis, for a total amount not to exceed $155,000.

BE IT FURTHER RESOLVED that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $155,000.

I hereby certify that the above is a true and correct copy of Resolution 11-8, as adopted by the Air Resources Board.

Mary Alice Morency, Clerk of the Board

ATTACHMENT A

"Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California"

Background

Aerosols are ubiquitous in the atmosphere and directly affect human health, climate, and deposition to ecosystems and crops. Organic aerosols (OA) typically account for 30-80 percent of the total submicron particle mass fraction worldwide. Despite this importance, OA represent a challenge to characterize and model due to the thousands of distinct compounds with vastly different properties (such as oxidation degree, volatility, and hygroscopicity) which comprise it. To help address these issues in the characterization of OA, rapid progress has been made in instrumentation to characterize aerosols. Among these developments, Aerodyne Aerosol Mass Spectrometers (AMS) are unique in providing real-time, quantitative, and size-resolved information on submicron non-refractory aerosol chemistry. The High Resolution-Time-of-Flight-AMS (HR-ToF-AMS) is further able to determine the elemental ratios and oxidation degrees of organic species within OA. Recently, Dr. Qi Zhang, the Principal Investigator for the current proposal, acquired one of the most comprehensive AMS data sets for Northern California as part of the Department of Energy (DOE)-funded CARES field campaign in 2010. This data set includes measurements from a HR-ToF-AMS and a Scanning Mobility Particle Sizer (SMPS) at a site in Cool, California (which is downwind of urban Sacramento). The Atmospheric Science Program of DOE funded the deployment of the instruments at Cool and only the initial analysis of the dataset for size-resolved chemical composition and temporal variations of sulfate, nitrate, ammonium, chloride and total organics.

Objective

The proposed research has several objectives:

1. Analyze the high resolution mass spectrometer (HRMS) data that was collected in Northern California as part of CARES to determine ratios of elements (carbon, oxygen, nitrogen, hydrogen) and the temporal and temperature-dependent variation of the bulk composition of OA.
2. Perform multivariate analysis of the HRMS data to determine components of OA and their associations with distinct sources, physicochemical properties, and atmospheric processes.
3. Conduct focused case studies of SOA formation and new particle formation and growth processes utilizing the HRMS data in conjunction with concurrent measurements of gaseous precursors and meteorology.

Methods

Source contributions and possible atmospheric transformations will be inferred from species in HRMS that can be used as tracers for sources and processes. Elemental ratios of hydrogen, oxygen and nitrogen in OA will be determined directly from HRMS spectra; these provide insight into sources and evolution processes. For example, the ratio of oxygen to carbon has been identified as an indicator for aerosol aging and photochemical processing.

Multivariate analysis of HRMS data will also be conducted. In previous studies, these methods proved effective in reducing the number of variables to a few chemically unique components and distilling essential information about OA properties, sources and processes. The enhanced chemical resolution of HRMS allows separation of major ion types and reduces ambiguity in Positive Matrix Factorization (PMF) solutions, yielding more easily interpretable OA components. Comprehensive analyses of these components, size distributions, temporal and diurnal variation patterns, and correlations with tracer compounds from the CARES datasets will be carried out to illuminate relationships between OA components and distinct sources, physicochemical properties and atmospheric processes.

SOA formation and new particle formation will be investigated through focused case studies of the CARES datasets. The Cool site is dominated by biogenic VOC emissions with urban components transported daily from the Sacramento plume. Utilizing measurements of physical properties of aerosols, gaseous trace species and meteorological variables, the researchers will identify different dominant aerosol contribution scenarios (e.g. primary source vs. secondary formation; urban vs. biogenic) to study photochemical processing and aging of OA under different emissions and processing regimes.

Expected Results

The primary expected result of the proposed research is an improved characterization of the sources and atmospheric processing of OA in the Sacramento and foothills region. Advanced statistical analyses will be carried out on data collected with HR-ToF-AMS and other instruments during the DOE-funded Carbonaceous Aerosols and Radiative Effects Study (CARES). These studies will provide information on source strengths of primary organic aerosols (POA), mechanisms leading to secondary organic aerosol (SOA) formation, and photochemical processing of organic aerosols and gaseous organic precursors in Northern California. The resulting data will lead to improvements in regional air quality models used to predict the efficacy of various emissions control programs.

Significance to the Board

Organic aerosol represents a major mass fraction of fine particles in California, yet the ability of current air quality models to simulate ambient organic aerosol concentrations is limited by a weak characterization of organic aerosol sources, formation mechanisms, and evolution processes. This simplified modeling restricts the ability of California to meet the United States Environmental Protection Agency's current PM2.5 standards, which requires that the State's planning and implementation strategies are informed by accurate partitioning models of primary PM as well as improved models of secondary aerosol formation processes and transport dynamics. ARB's Strategic Plan for Research identified the investigation of the composition, sources and processing of organic aerosols as a major area for research. The proposed research will make a direct contribution to this area by providing insights into the relative source strength of primary organic aerosol, the mechanisms leading to formation of secondary organic aerosol, and the photochemical processing of organic aerosol species in Northern California. Further, the integration and comparison of these findings with those from CalNex will substantially improve the understanding of the state-wide aerosol pollution

problem in California and have broad and significant application within regional air quality models.

Contractor:
University of California, Davis

Contract Period:
24 months

Principal Investigator (PI):
Qi Zhang, Ph.D.

Contract Amount:
$155,000

Basis for Indirect Cost Rate:
The State and the UC system have agreed to a ten percent indirect cost rate.

Past Experience with this Principal Investigator:
Dr. Zhang has an extensive background in aerosol measurements and is widely recognized as a leader in AMS analysis. Staff has not had previous contract experience with this researcher, but staff is confident that Dr. Zhang's work will provide new and important information that will directly aid development of climate change and air pollution mitigation strategies.

Prior Research Division Funding to the University of California, Davis:

Year	2009	2008	2007
Funding	$1,588,387	$1,419,135	$ 773,346

BUDGET SUMMARY

Contractor: University of California, Davis

"Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California"

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 129,959	
2.	Subcontractors	$ 0	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 2,000	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 150	
7.	Mail and Phone	$ 150	
8.	Supplies	$ 1,500	
9.	Analyses	$ 0	
10.	Miscellaneous	$ 7,150	
	Total Direct Costs		$ 140,909
INDIRECT COSTS			
1.	Overhead	$ 14,091	
2.	General and Administrative Expenses	$ 0	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$ 14,091
TOTAL PROJECT COSTS			**$ 155,000**