State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 10-10

February 25, 2010

Agenda Item No.: 10-2-1

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 2698-266, entitled "Improving Regional Biogenic Volatile Organic Compound (VOC) Emission Estimates Using an Airborne PTR MS Eddy Flux Measurement System," has been submitted by the University of California, Berkeley;

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

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

> Proposal Number 2698-266 entitled "Improving Regional Biogenic VOC Emission Estimates Using an Airborne PTR MS Eddy Flux Measurement System," submitted by University of California Berkeley, for a total amount not to exceed $400,000.

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

> Proposal Number 2698-266 entitled "Improving Regional Biogenic VOC Emission Estimates Using an Airborne PTR MS Eddy Flux Measurement System," submitted by University of California Berkeley, for a total amount not to exceed $400,000.

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 $400,000.

I hereby certify that the above is a true and correct copy of Resolution 10-10, as adopted by the Air Resources Board.

Sandra Bannerman, Clerk of the Board

ATTACHMENT A

Improving Regional Biogenic VOC Emission Estimates Using an Airborne PTR MS Eddy Flux Measurement System

Background

California has countless native and "exotic" plants and diverse ecosystems from coastal chaparral to Alpine conifers and from high desert to flat inland farmland. Speed of urbanization and changes to established land use in California's modern history have also been significant. Cognizant of these particularities, staff, with help from the California and national academia, developed the Biogenic Emission Inventory through Geographic Information Systems (BEIGIS) simulation platform to project isoprene, terpene, and methyl butenol emission inventories specific to California. Input databases to BEIGIS are specific to California, but independent evaluation of BEIGIS predictions has relied on ground-based flux data from one site, the Blodgett Forest Research Station.

Moderate Resolution Imaging Spectro-radiometer (MODIS) leaf biomass input to BEIGIS produce significant additional isoprene emissions from oak savanna in California. The United States Environmental Protection Agency's Model of Emissions of Gases and Aerosols from Nature (MEGAN) simulations confirmed these increased oak biogenic volatile organic carbon (BVOC) emissions. Yet, for oak savanna there are no ground level flux measurements and no grid scale regional data. Without regional biogenic VOC measurements, there is no validation tool to confirm a new version of BEIGIS simulations.

Developing new or modified land cover databases may account for part of these increased emissions. Use of newer versions of MODIS may also be helpful. Nevertheless, we have no regional concentration or flux database to evaluate simulation output, to understand whether these uncertainties are issues of scaling from leaf/needle emissions to branch/canopy and finally to grid scale, or are these issues of new land cover and leaf mass databases.

Objective

The proposal is intended to provide BVOC concentration and flux data on a regional basis (in California) necessary to evaluate our current emission inventory simulations and to improve land use cover databases for these simulations.

Methods

Simulation Improvements: The principal investigators (PIs) will assist staff in combining all available sources of input data such as the National Land Cover Dataset (NLCD), the output of a UC Berkeley GIS and species identification project, and existing BEIGIS and MEGAN land cover and leaf biomass data for the most up-to-date and state-of-the-

science California input data. With the enhanced database, staff will conduct BEIGIS and MEGAN simulations and in concert with the PIs and other selected members of national and California academia would choose 12 regions for airborne VOC flux measurements. Staff, PIs, and experts in meteorological aeronautics will plan specific flight patterns during the first year of the project.

Field Measurements: Using the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) Twin Otter airplane, the PIs will measure VOC eddy fluxes to quantify regional BVOC emissions during summer 2011. Using an airborne Proton Transfer Reaction Mass Spectrometer-Eddy Covariance (PTRMS-EC) flux system, the PIs will measure isoprene and total terpene emissions. They will further speciate monoterpenes using gas chromatography with mass spectrometer and flame ionization detector (GC-MS/FID) and estimate emissions using a tracer flux ratio technique. Area emissions will be characterized over triangular pathways, resulting in emission measurements with a spatial resolution of ~ 1 km^2. Using a line source sampling strategy, oak woodland emissions will be characterized. Because oak landscapes are expected to be major emission sources of isoprene and dominant contributors to reactive BVOC emissions in California, oak landscapes with low, moderate, and high leaf area index will be targeted.

New Validated Simulation Platform: With the help of PIs and interested academia, staff will use these inputs and validation data as the basis for a new validated BVOC simulation platform at Air Resources Board (ARB or Board).

Expected Results
With this contract's data and this contractor's contribution, ARB expects to build a new biogenic VOC regionally validated version of the BEIGIS simulation platform.

Significance to the Board
Federal and state laws require ARB to produce compliance demonstrations through the SIP process for ozone and PM. As VOC emissions from power plants, stationary sources, mobile sources, and industrial activities have been reduced significantly, the impact of biogenic VOC emissions for ozone and PM formation has increased. Accurate BVOC emission inventories are a critical requirement of the SIP process. This project supports the essential task of producing an accurate BVOC emission inventory.

Contractor:
University of California, Berkeley

Contract Period:
36 months

Principal Investigator (PI):
Professor Allen Goldstein and Dr. Alex Guenther

Contract Amount:

$400,000

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:
Professor Goldstein has contributed to development of BEIGIS through research projects "Whole Ecosystem Measurements of Biogenic Hydrocarbon Emissions: Impacts on Ozone and Aerosol Formation," and "Flux Measurements of Biogenic Precursors to Ozone and Particulate Matter in the Central Valley." Professor Goldstein has contributed results of numerous other biogenic emissions research work funded by others in the last decade.

Prior Research Division Funding to University of California, Berkeley:

Year	2008	2007	2006
Funding	$1,169,448	$1,372,484	$1,607,398

BUDGETSUMMARY

The Regents of the University of California, Berkeley

Improving Regional VOC Emission Estimates Using an Airborne PTRMS Eddy Flux Measurement System

DIRECT COSTS AND BENEFITS				
1.	Labor and Employee Fringe Benefits	$	141,583	
2.	Subcontractors	$	189,442[1]	
3.	Equipment	$	0	
4.	Travel and Subsistence	$	31,000	
5.	Electronic Data Processing	$	0	
6.	Reproduction/Publication	$	4,000	
7.	Mail and Phone	$	0	
8.	Supplies	$	10,287	
9.	Analyses	$	0	
10.	Miscellaneous	$	0	
	Total Direct Costs			$376,312
INDIRECT COSTS				
1.	Overhead	$	23,688	
2.	General and Administrative Expenses	$	0	
3.	Other Indirect Costs	$	0	
4.	Fee or Profit	$	0	
	Total Indirect Costs			$23,688
TOTAL PROJECT COSTS				**$400,000**

[1] The two subcontractors are bringing specialized intellectual resources, sampling platforms, and analytical capabilities that are indispensable to this effort, namely: providing aircraft, pilots, and flight time for regional measurements of biogenic emissions; and offering expertise and analytical support for regional biogenic measurements.

SUBCONTRACTORS' BUDGET SUMMARY

Naval Postgraduate School (Center for Interdisciplinary Remotely Piloted Aircraft Studies)

Description of subcontractor's responsibility: Provide aircraft, pilots, and flight time for regional measurements of biogenic emissions.

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 70,130[2]	
2.	Subcontractors	$ 0	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 0	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 0	
7.	Mail and Phone	$ 0	
8.	Supplies	$ 1,000	
9.	Analyses	$ 0	
10.	Miscellaneous (Aircraft Maintenance & Op)	$ 54,000[3]	
	Total Direct Costs		$125,130
INDIRECT COSTS			
1.	Overhead	$ 24,312	
2.	General and Administrative Expenses	$ 0	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$24,312
TOTAL PROJECT COSTS			**$149,442**

[2] Pilot and scientist labor constitutes more than 50% of the subcontractor's direct costs. Without their contribution the regional measurement campaign cannot occur.

[3] Twin Otter airplane is one of the most versatile and robust measurement platforms and its operations and maintenance costs are quite low compared to other airplanes for this type of application; on a per hour basis, these operation and maintenance costs are considered a bargain.

SUBCONTRACTORS' BUDGET SUMMARY

University Corporation for Atmospheric Research

Description of subcontractor's responsibility: Provide scientists and equipment for regional biogenic measurements.

DIRECT COSTS AND BENEFITS				
1.	Labor and Employee Fringe Benefits	$	0	
2.	Subcontractors	$	0	
3.	Equipment (HF Generator – PTR MS Comp)	$	24,000[3]	
4.	Travel and Subsistence	$	0	
5.	Electronic Data Processing	$	0	
6.	Reproduction/Publication	$	0	
7.	Mail and Phone	$	0	
8.	Supplies	$	10,500	
9.	Analyses	$	0	
10.	Miscellaneous	$	0	
	Total Direct Costs			$34,500
INDIRECT COSTS				
1.	Overhead	$	5,500	
2.	General and Administrative Expenses	$		
3.	Other Indirect Costs	$		
4.	Fee or Profit	$		
	Total Indirect Costs			$5,500
TOTAL PROJECT COSTS				**$40,000**

[3] Equipment here is 60% of the contract amount but is a critical component of the PTR-MS (Proton Transfer Reaction Mass Spectrometry worth $200,000) without which the airplane PTRMS would not function and the study could not occur.