Draft PROPOSAL

*Performing Ozonesonde Measurements at Northern California’s Coast*

Principle Investigator:

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**Abstract**

This proposed research is to collect upper air ozone data at two potential sites (e.g., Bodega Bay and Moss landing) on the California coast to support the State Implementation Plan (SIP) air quality modeling for the State. The goal of this project is to measure vertical snapshots of ozone concentrations on a near daily basis, for four months from the late spring to summer in 2016. Approximately 200 GRAW DFM-09 radiosondes with electrochemical concentration cell (ECC) will be employed in this project. The quality assurance (QA) and quality control (QC) for ozonesondes will follow the standard operation procedures from sounding manufacturer. In order to determine precision, accuracy and response of the ozonesondes as a function of altitude, and ozone level, special attention will be focused on in-flight performance, particularly for the ECC-sonde responses. Real time data will be collected and share with the ARB researchers. The Air Resources Board (ARB) as well as the scientific community will benefit from a complete characterization of ozone that acts as the baseline for California’s ozone air quality. This knowledge is necessary for the design of effective SIP to attain the current and future National Ambient Air Quality Standards (NAAQS) for ozone.

**1. Project Objectives**

Understanding tropospheric ozone (O3) variability in the West Coast of the United States remains an active area of research with air quality and forecast. Because health effects research has consistently led to more stringent ambient air quality standards (AAQS) for ozone, California must continue to achieve significant new reductions in ozone precursor emissions. In the past, there have been limited, episodic campaigns of instrumented aircraft flights sponsored by federal, state, and regional groups (e.g., the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), the San Joaquin Valley Air Pollution Control District, and the ARB) as well as weekly ozonesonde launches on the north coast of the State (i.e., Trinidad Head) to investigate ozone events and processes. While these measurements have provided some information of ozone aloft, these isolated efforts do not provide sufficient information to fully understand the spatial and temporal variations in baseline ozone concentrations entering California (including separate contributions from difference sources such as lofted regional emissions, long-range transport, and stratospheric intrusion).

Modeling exercises focused on the contributions of long-range transport and the stratosphere to ozone in the western United States (including California) have been conducted. But, those photochemical models rely on atmospheric boundary conditions specified by coarse resolution global models that have not performed well historically in California due to its complex terrain and meteorology. To better understand the contributions of the external pollution sources and atmospheric processes to high surface ozone concentrations in the State, a routine monitoring program is needed to document incoming layers of ozone aloft from the Pacific Ocean.

Ozone soundings serve to integrate models, aircraft and ground-based measurements for better interpretation of atmospheric pollution. A well-designed network of ozonesonde stations will answer questions not possible with short campaigns or current remote sensing (e.g., satellite) technology. One of the main purposes of this project is to help the modeling group at ARB to validate and improve the atmospheric boundary conditions used in the ozone modeling. The proposed ozonesonde launching domain covers the northern California. The selection of this study area reflects the regional nature of long-range transported ozone aloft at California’s coast, and a need to include all of the major flow features that affect air quality in central California. The proposed field measurement will be conducted in the last spring to summer of 2016. The overarching goals of this project are to:

1. conduct vertical snapshots of ozone to evaluate and improve air quality models for representing regional-scale ozone episodes in California to meet the regulatory requirements for the state and federal ozone standards; and
2. determine the contributions of long-range transport and locally generated ozone in coastal areas.

The data and information collected in this project will help to validate and improve the atmospheric boundary conditions used in the ozone SIP modeling. This research project is a necessary first step toward understanding the difficult policy relevant question of what is the contribution of Pacific long-range transported ozone to surface sites in the state.

**2. Technical Plan**

An ozonesonde is a collection of instruments that measure ozone concentrations, temperature, relative humidity, wind speed and direction. The instruments are mounted in a lightweight Styrofoam container, then tied to a helium-filled weather balloon and launched into the sky. The instruments collect data from just above ground level to about two-to-three kilometers above the earth’s surface and transmit it back to the ground-based scientists. The ozonesondes require clearance from the Federal Aviation Commission before their release. They can be released during the pre-dawn, late afternoon, early evening or late night hours.

To better quantify the magnitude, and the spatial and temporal variations in baseline ozone concentrations entering California, particularly on high ozone days in the SJV, ozonesondes would be launched 6 times a week during the late spring and summer from two coastal sites. During the summer of 2016 (May 15-September 15), there will be nearly daily launches (200 total) at the two sites (Bodega Bay and Moss landing) with planned launches at 1200 UTC. Potential tasks will include but not limited to:

1. Review and synthesize the available data and modeling results to identify any critical gaps that can be filled with an ozonesonde deployment.
2. Launch ozonesondes from two coastal sites once a day to collect the vertical profiles of ozone concentrations. The data will be processed and fully screened and validated for quality assurance and quality control. Draft data will be submitted to ARB on a monthly basis. The full QAed data base will be submitted to ARB at the end of the deployment.
3. Prepare and submit a final report to ARB for approval.

**3. Project schedule**

This project will be completed in 36 months from the start date. This schedule allows 30 months for the completion of all work through delivery of a draft final report; the last 6 months are for ARB review of the draft final report and the delivery of a revised final report and data files to ARB.

**4. Project Management Plan**

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| --- | --- | --- | --- |
| **Role** | **Name** | **Commitment**  **(% of FTE)** | **Area of Expertise/Participation** |
| PI | Dr. Sen Chiao | 4.17 | Management  (Ozonesonde data QA/QC) |
| Co-PI | Dr. Craig Clements | 4.17 | Technical support  (Ozonesonde launching) |
|  | One graduate student | 50 | M.S. Degree Research  Ozonesondes preparation and launching Data Analysis and collecting) |
|  | Three undergraduate students | 50 | Ozonesondes preparation and launching |

Project management products include:

* Quarterly progress reports and conference calls;
* Draft final report;
* All data and analyses generated through the course of this project;
* Additional deliverables to be determined in consultation with ARB staff;
* Final report and research seminar in Sacramento;
* Peer-reviewed publication(s), as appropriate.

**5. The Estimated Cost**

The estimated budget for this project is $426,900 including total personnel and fringe ($149,095), 200 ozonesondes and ground systems ($208,800), travel ($20,000), material and supplied ($4,000), and the facility and administration rate is 26% ($45,005).

Biographic Sketch

**Sen Chiao**

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**(a) Professional Preparation**

B.S. Atmospheric Science, Chinese Culture University, Taiwan, 1994

M.S. Atmospheric Physics, National Central University, Taiwan, 1996

Ph.D. Marine, Earth and Atmospheric Sciences, North Carolina State University, 2003

Postdoctoral School of Engineering and Applied Sciences, Harvard University, 2003-2004

**(b) Appointments**

2014 – present Associate Professor of Meteorology, San José State University

2011 – 2014 Assistant Professor of Meteorology, San José State University

2011 – present Adjunct Associate Professor of Meteorology, Florida Institute of Technology

2010 – June Visiting Professor, National Central University, Taiwan

2010 – 2011 Associate Professor of Meteorology, Florida Institute of Technology

2005 – 2010 Assistant Professor of Meteorology, Florida Institute of Technology

2008 summer Visiting Professor, NCAR/ASP/RAL

2004 – 2005 Research Associate, NOAA Center for Atmospheric Sciences, Howard University

2003 – 2004 Postdoctoral Fellow, Harvard University, School of Engineering and Applied Sciences

1999 – 2002 Graduate Research Assistant, North Carolina State University

2000 – 2002 Graduate Teaching Assistant, North Carolina State University

1998 – 1999 Graduate Research Assistant, University of Hawaii at Manoa

**(c) Products**

**i. Five Publications Related to Proposed Topic**

Eiserloh, A. J, and S. **Chiao**, 2014: Modeling studies of landfalling atmospheric rivers and orographic

precipitation over northern California, Meteorology and Atmospheric Physics, doi:10.1007/s00703-014-

0350-4.

**Chiao**, S., and R. Dumais, 2013: Investigations of a down-valley flow event during T-REX 2006, Meteorology and Atmospheric Physics, 122, 75-90. doi: 10.1007/s00703-013-0279-z.

Whitehall, K., S. **Chiao**, M. Mayers-Als, 2013: Numerical Investigations of Convective Initiation in Barbados, *Advances in Meteorology*, doi:10.1155/2013/630263.

Jury, M., and **S. Chiao**, 2013: Leeside boundary layer confluence and afternoon thunderstorms over Mayaguez, Puerto Rico. *J. Appl. Meteor. Climatol.*, 52, 429-454.

Pelissero, J., and S. **Chiao**, 2013: The Impacts of Extratropical Reintensification on North Atlantic Shipping Routes*,* Met. Apps. doi: 10.1002/met.1410.

**ii. Five Additional Publications**

**Chiao**, S., and M. Jury, 2015: Southern Caribbean Hurricane Regional Observations and WRF Model

Simulations, Earth Interactions, in review.

Centeno, D., and S. **Chiao**, 2014: The footprints of Saharan Air Layer and lightning on the formation of tropical depressions over the Eastern Atlantic ocean, Meteorology and Atmospheric Physics, 10.1007/s00703-014-0343-3.

Jury, M., and S. **Chiao**, 2014: Representation of Ethiopian wet spells in global and nested models, Advances in Meteorology, doi:10.1155/2014/237374.

**Chiao, S.,** and G. Jenkins, 2010: Numerical investigations on the formation of tropical storm Debby during NAMMA-06. *Wea and Forecasting*, 25, 866-884.

Tompkins, C., and S. **Chiao**, 2012: Modeling Studies of Impacts from the Guinea Highlands in Relation to Tropical Cyclogenesis Along the West African Coast. Meteorology and Atmospheric Physics, in press. DOI: 10.1007/s00703-011-0167-3

**(d) Synergistic Activities**

2013 – present: Unidata Users Committee, UCAR, Boulder, CO.

2013 Oct: NSF EarthCube Domain End-User Workshop at George Mason University, Fairfax, VA.

2013 July: Unidata Software Training Workshop, UCAR/Unidata, Boulder, CO.

2013 June: Geoscience and the 21th Century Workforce workshop, NSF/InTeGrate, Penn State

2013 March: Convener of the 2013 Unidata Regional Workshop, San Jose State University

**(e) Collaborators and Other Affiliations**

**i**. **Collaborators (past 48 months)**

Stan Czyzyk, NWS/WFO/Las Vegas

Robert Dumais, The US Army Research Laboratory

Gregory Jenkins, Howard University

Mark Jury, University of Puerto Rico at Mayaguez

Margate Mayers-Als, Caribbean Institute for Meteorology and Hydrology

Jonathan Pelissero, Applied Weather Technology

Andre Pattantyus, University of Hawaii at Manoa

Ashley Takeuchi, Covance, Inc.

C. Forbes Tompkins, World Research Institute

Kim Whitehall, Howard University

Total number of collaborators: 10

**ii. Graduate Advisor and Postdoctoral Sponsor**

Duane E. Stevens and David Chen, University of Hawaii at Manoa

Yuh-Lang Lin, North Carolina A&T

Michael Kaplan, Desert Research Institute

Ana Barros, Duke University

Everette Joseph, SUNY Albany

Total number of graduate advisors and postdoctoral sponsors: 6

**iii. Thesis Advisor and Postgraduate-Scholar Sponsor (last five years)**

Amy Ip (Meteorology, M.S. in progress)

Steven Boring (Meteorology, M.S. in progress)

Angela Reside (Meteorology, M.S., in progress)

Rie Onodera (Meteorology, M.S., in progress)

Dany Tran (Meteorology, M.S., in progress)

Diana Centeno (Meteorology, M.S., May 2014)

Arthur J. Eiserloh (Meteorology, M.S., May 2014)

Kim Whitehall (Postgraduate-Scholar Sponsor, 2010-2011; Ph.D. candidate at Howard University)

Travis Washington (Meteorology, M.S., Summer 2011; Ph.D. candidate at Howard University)

Keren I. Rosado (Meteorology, M.S., Fall 2011; Ph.D. candidate at Howard University)

William Ulrich (Meteorology, M.S., May 2011; NWS/Key West)

Andre K. Pattantyus (Meteorology, M.S., July 2010; Ph.D. candidate at U. Hawaii Manoa)

C. Forbes Tompkins (Meteorology, M.S., May 2010; World Resources Institute)

Total number of advisees from 2010 to 2015: 13 M.S. students and one postgraduate scholar.