CONTINUED OZONE-SONDE AND SURFACE OZONE MEASUREMENTS AT TRINIDAD HEAD, CA

2020

FINAL REPORT
CONTRACT NO. 18RD031

PREPARED FOR:

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RESEARCH DIVISION
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Research Division

Contract Final Progress Report

Contract Information

Title:	Continued Ozone-Sonde and Surface Ozone Measurements at Trinidad Head, CA
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Organization:	Humboldt State University
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Project Description:

Continuous Ozone-Sonde measurements from Trinidad Head will help California's Air Resources Board (ARB) track the magnitude and temporal variations in baseline ozone concentrations entering California. The data are also critically important for evaluating and improving the boundary conditions generated from the global transport models used in ARB's ozone SIP modeling.

Project Description and Timeline:

Historical Ozone-Sonde data from Trinidad Head, CA (THD) have shown that baseline concentrations may exceed 50 ppb, and increasing industrialization in Asia may lead to increased baseline ozone concentrations entering California from the west and northwest. Continuous Ozone-Sonde measurements from THD help the California Air Resources board (ARB) track the magnitude and temporal variations in baseline ozone concentrations entering California. The data are also critically important for evaluating and improving boundary conditions generated from the global transport models used in ARB's ozone SIP modeling.

This project's original goal was to continue weekly atmospheric Ozone-Sonde measurements at Trinidad Head, CA from March 01, 2019 through February 29, 2020. This included 52 weekly balloon launches from the Telonicher Marine Lab facility adjacent to THD, and 52 weeks of hourly surface ozone measurements on Trinidad Head proper using a TEI instrument supplied and maintained by NOAA.

At the start of the 4th quarter of the project (Jan 2020), it became clear that renewed funding for launches after February 2020 would not be readily available from ARB. In addition, the PI would not be able to obtain external funding from other sources for several more months. In light of this, ARB decided to switch to bi-weekly launches to extend the longevity of the dataset and avoid a large temporal gap in data collection. A no-cost extension was awarded to the project to launch balloons every 2-weeks until funds were exhausted sometime in the following quarter (Apr-Jun 2020).

Shortly thereafter in early March 2020, the CoVid-19 crisis was continuing in China and heightening in the states. Dr. Jim Butler, Director of Global Monitoring at NOAA ERSL reached out to ARB requesting increased frequency of balloon launches at THD. He expressed NOAA's interest in identifingy, at a higher temporal resolution, any changes in ozone concentration that might result from the reduction in industrial output and emissions as China dealt with the CoVid-19 crisis. ARB acceded to this request and PI Abell restarted weekly launches in mid-March – with the understanding that extra expenses would be covered with funds from NOAA. PI Abell worked with Dr. Butler late in that quarter to secure funding for the extra salary and expenses associated with the increased launch frequency.

By the end of the 5th quarter (Apr-Jun 2020), the project had launched 59 balloons and collected 37 weeks of surface ozone data. At this time an agreement had been drafted with NOAA ESRL's Global Monitoring Division to take over support of the weekly launches and surface ozone monitoring. Finalizing that agreement with NOAA proved to take time and so launches were continued under the ARB project through July and into the second week of August. By grant end 66 balloons had been launched and 44 weeks of surface

ozone data collected. Please review the last quarterly report for more details on what NOAA supported during these periods.

Site Description:

Trinidad Head Observatory (THD) is located at 41.0541° N 124.151° W at on a point jutting into the Pacific Ocean along the remote northern coast of California. It lies about 40 km (25 miles) north of Eureka, California, the main regional population center. The coastal climate is dominated by maritime influences, with moderate year-round temperatures and moderate-to-high humidity. To the immediate west of Trinidad Head is the unobstructed ocean. To the east, the coastal range is dominated by redwood forests. The town of Trinidad represents the primary community in the immediate vicinity and supports about 400 year-round residents. The Telonicher Marine Laboratory (TML), a satellite facility of Humboldt State University (HSU), is also located in Trinidad, CA.
NOAA established an atmospheric baseline observatory at Trinidad Head in 2002. Because of its relatively remote coastal location and prevailing maritime airflow, the site provides scientists with an opportunity to observe and monitor both regional and global atmospheric conditions reasonably free from local influences.

An instrument trailer was installed in April 2002 allowing measurements of aerosols, surface ozone, radiation, and flask sampling for halocarbons and carbon cycle gases. Bi-weekly airborne vertical profile measurements provide a continuous baseline of pollution and climate forcing agents in air entering the U.S. Co-located with the Trinidad Head Observatory, the Scripps Institution of Oceanography has operated two in situ instruments, one as part of the Advanced Global Atmospheric Gases Experiment (AGAGE), for measuring changes in atmospheric conditions.

In summer of June 2017, the NOAA Trinidad Head Atmospheric Baseline Observatory was downgraded from its status as a full “Observatory” to a “Sampling Site”. The downgrade followed a Global Monitoring Division-wide evaluation of scientific goals and network capabilities that resulted in realignment to best meet NOAA’s mission and the nation’s scientific needs. In the wake of the downgrade most long-term projects and infrastructure were removed from the site. However, three research projects remained at THD: 1) Weekly Ozone-Sonde launches which are conducted by HSU and supported by ARB; 2) surface ozone monitoring instrumentation which is maintained by HSU and supported by ARB but owned and data-managed by SIO and NOAA; 3) halocarbons flask sampling capabilities which are operated by AGAGE independenlty of HSU or ARB.

Standard Operating Procedures for Ozone Measurement Instruments

The Ozone-Sonde is a lightweight, balloon-borne instrument that is mated to a conventional meteorological radiosonde. As the balloon carrying the instrument package ascends through the atmosphere, the Ozone-Sonde telemeters to a ground receiving station information on ozone and standard meteorological quantities such as pressure, temperature and humidity. The balloon will typically ascend to altitudes of about 115,000 feet (35 km) before bursting, due to the reduced pressure.
An Ozone-Sonde consists of a Teflon air pump and electrochemical ozone sensor interfaced to a meteorological radiosonde. The small piston pump bubbles ambient air into the sensor cell containing 3 milliliters of 1% potassium iodide solution. The reaction of ozone and iodide generates an electrical signal proportional to the amount of ozone. The radiosonde measures air temperature, pressure, and relative humidity, and transmits the data back to a ground receiving station at the HSU TML during the balloon ascent, generally lasting about two hours.

Total column ozone (given in Dobson Units) is calculated by integrating the ozone partial pressure profile up to the balloon burst altitude and adding a residual amount, based on climatological ozone tables to account for ozone above the balloon burst altitude.

Surface Ozone Equipment and Techniques:

Surface Ozone measurements are made by Thermo Scientific Model 49 C and one or two BTechnologies Model 205 ozone monitors. These instruments are dual cell UV photometers which function on the absorption of UV light by ozone at 254nm and relating the UV absorption to the ozone concentration, following the Beer-Lambert law. Sample air is pulled through a particle filter and into the instrument cells. Sample air enters one detection cell and “zero air” (charcoal scrubber removes all ozone in the sample) enters through the other cell. The ozone concentration is calculated from the UV light intensities detected from the two cells comparing the difference in the two cells. The instrument alternates the two cells to ensure that there is not a bias in one of the detection cells. The data are continuously collected at one minute intervals and averaged to one-hour values for research and reporting to open data centers. The instruments are routinely calibrated to the NIST-traceable standard held at the NOAA David Skaggs Research Center in Boulder, Colorado.

Data Management:

All atmospheric data collected at Trinidad Head, including this project, are available on the NOAA Earth System Research Laboratory, Global Monitoring Division website at:

https://esrl.noaa.gov/gmd/dv/data/index.php?site=THD

THD Ozone-Sonde data is available at:

https://esrl.noaa.gov/gmd/dv/data/index.php?category=Ozone&parameter_name=Ozone&type=Balloon&site=THD

Vertical plots of the data are available at:

https://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=THD&program=ozwv&type=vp

THD Surface Ozone data are available at:

https://www.esrl.noaa.gov/gmd/dv/data/index.php?category=Ozone&site=THD&type=Insitu

Summary of Data Collection:

This project was originally scheduled to start March 1, 2020 but due to delays in receiving funding from ARB and in activating that funding on Humboldt State's end, balloon launches were not weekly in the first two months. Once funding was activated, supplies were ordered and student employees were appointed to the project. During this period launches could only be conducted at non-regular intervals through April. Surplus launch equipment was utilized during this period to conduct launches roughly every two weeks. From that point onward launches were primarily weekly with some exceptions due to launch equipment delivery delays or winter holidays. For further detail on the nature of the delays please consult the prior quarterly reports.

Surface ozone measurements were sparse in the first several months of the project. Prior to the start of the grant the instrument was malfunctioning. Replacement parts had been requested from NOAA but were not received until May 2019 well into the first project quarter. After install roughly two weeks of surface data was collected, but then the laptop computer interfaced to the TEI instrument ailed. Despite repeated requests NOAA was unable to provide a replacement until October 2019. Once installed the surface ozone instrument collected data every week until end of grant.

The following table contains a summary of ozone launches starting March 11, 2019 and ending August 14, 2020. Included in the table are the launch number for this project, the launch ID, the date of launch, the ozone file name on store at the GMD website noted above, and any comments.

#	ID	Date (yy/mm/dd)	Ozone launch file link	Comments
1	TH1185	19/03/11	th1185_2019_03_11_19.l100	2 out of 4 launches missed in March due to funding activation delays
2	TH1186	19/03/21	th1186_2019_03_21_17.l100	
3	TH1187	19/04/15	th1187_2019_04_15_18.l100	2 out of 4 launches missed in April due to equipment delivery delays
4	TH1188	19/04/22	th1188_2019_04_22_18.l100	
5	TH1189	19/05/06	th1189_2019_05_06_18.l100	
6	TH1190	19/05/13	th1190_2019_05_13_19.l100	
7	TH1191	19/05/20	th1191_2019_05_20_19.l100	
8	TH1192	19/05/27	th1192_2019_05_27_20.l100	Mislabeled as 190627 in launch log
9	TH1193	19/06/10	th1193_2019_06_10_19.l100	
10	TH1194	19/06/17	th1194_2019_06_17_18.l100	
11	TH1195	19/06/24	th1195_2019_06_24_19.l100	
12	TH1196	19/07/01	th1196_2019_07_01_18.l100	
13	TH1197	19/07/08	th1197_2019_07_08_18.l100	
14	TH1198	19/07/15	th1198_2019_07_15_18.l100	
15	TH1199	19/07/24	th1199_2019_07_24_18.l100	
16	TH1200	19/07/30	th1200_2019_07_30_18.l100	
17	TH1201	19/08/05	th1201_2019_08_05_18.l100	
18	TH1202	19/08/12	th1202_2019_08_12_18.l100	
19	TH1203	19/08/19	th1203_2019_08_19_18.l100	
20	TH1204	19/08/26	th1204_2019_08_26_18.l100	
21	TH1205	19/09/03	th1205_2019_09_03_18.l100	
22	TH1206	19/09/09	th1206_2019_09_09_17.l100	
23	TH1207	19/09/16	th1207_2019_09_16_16.l100	
24	TH1208	19/09/23	th1208_2019_09_23_17.l100	Ozonesonde failed midflight @ 2.8km
25	TH1209	19/09/30	th1209_2019_09_30_16.l100	
26	TH1210	19/10/07	th1210_2019_10_07_17.l100	
27	TH1211	19/10/15	th1211_2019_10_15_18.l100	
28	TH1212	19/10/22	th1212_2019_10_22_18.l100	
29	TH1213	19/10/31	th1213_2019_10_31_17.l100	
30	TH1214	19/11/08	th1214_2019_11_05_19.l100	
31	TH1215	19/11/12	th1215_2019_11_12_18.l100	
32	TH1216	19/11/22	th1216_2019_11_22_18.l100	1 launch missed in November due to Thanksgiving holiday schedule
33	TH1217	19/12/02	th1217_2019_12_02_17.l100	1 launch missed in December due to winter holiday schedule
34	TH1218	19/12/17	th1218_2019_12_17_19.l100	Ozonesonde failed midflight @ 2.5km
35	TH1219	19/12/26	th1219_2019_12_26_18.l100	
36	TH1220	20/01/02	th1220_2020_01_02_18.l100	
37	TH1221	20/01/09	th1221_2020_01_09_19.l100	
38	TH1222	20/01/13	th1222_2020_01_13_19.l100	
39	TH1223	20/01/23	th1223_2020_01_23_19.l100	
40	TH1224	20/01/30	th1224_2020_01_30_18.l100	

#	ID	Date (yy/mm/dd)	Ozone launch file link	Comments
41	TH1225	20/02/06	th1225_2020_02_06_19.l100	Bi-weekly launches were requested by ARB and initiated this week
42	TH1226	20/02/13	th1226_2020_02_13_19.l100	
43	TH1227	20/02/24	th1227_2020_02_24_19.l100	
44	TH1228	20/03/12	th1228_2020_03_12_18.l100	Weekly launches were re-initiated at ARB and NOAA's request
45	TH1229	20/03/20	th1229_2020_03_19_17.l100	
46	TH1230	20/03/26	th1230_2020_03_26_18.l100	
47	TH1231	20/04/03	th1231_2020_04_03_16.l100	
48	TH1232	20/04/11	th1232_2020_04_11_18.l100	
49	TH1233	20/04/17	th1233_2020_04_17_18.l100	
50	TH1234	20/04/24	th1234_2020_04_24_18.l100	
51	TH1235	20/05/01	th1235_2020_05_01_19.l100	
52	TH1236	20/05/08	th1236_2020_05_08_18.l100	
53	TH1237	20/05/15	th1237_2020_05_15_18.l100	
54	TH1238	20/05/22	th1238_2020_05_22_18.l100	
55	TH1239	20/05/28	th1239_2020_05_28_17.l100	
56	TH1240	20/06/05	th1240_2020_06_05_17.l100	
57	TH1241	20/06/12	th1241_2020_06_12_17.l100	
58	TH1242	20/06/19	th1242_2020_06_19_17.l100	
59	TH1243	20/06/26	th1243_2020_06_26_18.l100	
60	TH1244	20/07/03	th1244_2020_07_03_16.l100	
61	TH1245	20/07/10	th1245_2020_07_10_17.l100	
62	TH1246	20/07/17	th1246_2020_07_17_17.l100	
63	TH1247	20/07/24	th1247_2020_07_24_18.l100	
64	TH1248	20/07/31	th1248_2020_07_31_17.l100	
65	TH1249	20/08/06	th1249_2020_08_06_17.l100	
66	TH1250	20/08/14	th1250_2020_08_14_18.l100	

Launch Logs:

The hand-written launch logs have been provided in a digital format. This file: THDOzoneMonitoring_LaunchLogs_Mar2019Aug2020.pdf has been sent to ARB via email along with the digital copy of this final report.

Report Preparation:

This final report was prepared by PI Jeffrey Abell to the best of his knowledge using data from the past quarterly reports for this project, the aforementioned launch logs, and atmospheric data from the NOAA Global Monitoring Division's atmospheric data server.