**EXHIBIT A**

**SCOPE OF WORK**

☒ Contract ☐ Grant

Does this project include Research (as defined in the UTC)? ☒ Yes ☐ No

**PI Name:** Alex Guenther

**Project Title:** Improving estimates of CO2 and CH4 emissions from southern California coastal wetlands and BVOC emission estimates from all California landscapes

## Project Summary/Abstract

This research contract aims to quantify greenhouse gases (GHGs) from southern California coastal wetlands and biogenic volatile organic compound (BVOC) fluxes from all California landscapes to support climate adaptation and air quality mitigation strategies to create safer, sustainable environments. California inventories of GHGs and BVOCs have major uncertainties, primarily due to the limited availability of measurements characterizing different California landscapes. The improvement and assessment of GHG and BVOC emission estimates will be advanced through five (5) main activities. First, the University of California, Irvine (UCI or Contractor) will measure BVOC emission rates for selected California urban and agricultural vegetation at both emission model standard conditions (30°C) and heat wave conditions (40°C). Second, the Contractor will compile fine-resolution California landcover datasets for driving BVOC emissions from all California landscapes, including all Model of Emissions of Gases and Aerosols from Nature (MEGAN) model landcover inputs: Leaf Area Index (LAI), growth form fractions, vegetation type, and vegetation composition. Third, the Contractor will develop a chemical speciation mapping scheme for the MEGAN model to translate detailed biogenic chemical species to the lumped chemical groups utilized in the latest Statewide Air Pollution Research Center 2022 (SAPRC22) and the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) chemical mechanisms for regional air quality modeling. Fourth, the Contractor will measure carbon dioxide ($CO_2$) and methane ($CH_4$) fluxes over a representative Southern California coastal saltwater wetland (marsh) for two years using eddy covariance (EC) towers. Finally, the Contractor will measure soil carbon accretion rates in several Southern California coastal wetlands for which data does not exist. These five (5) activities are described in greater detail below in the background section. These datasets will characterize GHG and BVOC fluxes and carbon stocks and stock changes of GHG flux to improve inputs to air quality and climate models. GHG data from Southern California saltwater wetlands are understudied, and the new data acquired from this contract will improve the California Air Resources Board's (CARB) carbon inventory. Research on BVOCs, key contributors to ozone and fine particles, will include all Californian landscapes and will support strategies to meet air quality standards.

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**If Third-Party Confidential Information is to be provided by the State:**

☐ Performance of the Scope of Work is anticipated to involve use of third-party Confidential Information and is subject to the terms of this Agreement; ***OR***

☐ A separate CNDA between the University and third-party is required by the third-party and is incorporated in this Agreement as Exhibit A7.

# Scope of Work

## Background

Carbon GHGs fluxes and BVOCs emissions are essential inputs to the modelling tools used to characterize and identify climate and air quality benefits, such as green space and recreation. These data provide insights that guide efforts to equitably assess and distribute climate benefits. This contract will also address gaps in understanding how climate change may affect GHG fluxes and BVOC emissions. This contract highlights Southern California saltwater wetlands, which are understudied and experience unique anthropogenic stressors. This contract will improve CARB's carbon inventory, specifically assessing soil carbon stocks and stock changes, as well as carbon GHG fluxes in Southern California wetlands, and inform wetland restoration projects. Research on BVOCs, key contributors to air pollutants, supports strategies to meet air quality standards, directly benefiting priority communities.

Observations obtained for this project, such as soil core carbon samples and leaf enclosure BVOC samples, include measurements that quantify key variables in Net Ecosystem Carbon Balance (NECB) and BVOC emission inventory procedures. An additional research activity is a long-term (2 years) whole ecosystem flux study in a Southern Californian saltwater wetland that will be used to assess model estimates of GHG emissions. Although wetlands cover only 3% of the global land surface area, they sequester a disproportionately large amount of blue carbon; however, they could also contribute to GHG emissions. The balance between sequestration and emissions can be particularly sensitive to climate change. This contract will result in datasets serving GHG accounting needs and may provide additional insights into their controlling processes.

This research project can also benefit priority communities by providing crucial information to inform strategies for adapting to climate change, particularly through improved coastal resilience and additional knowledge on the impact of BVOC sources on their community's air quality. This contract will also provide information relevant to designing safer and more sustainable living and recreational environments, especially for communities vulnerable to extreme weather events like storm surges, groundwater emergence, heat waves, and droughts. By better understanding saltwater wetland NECB, carbon sequestration potential in wetland soils, and BVOCs, California can better assess the ecosystem function, health, and resilience of saltwater wetlands and other landscapes.

Finally, to effectively track, evaluate, and publicly report on the multi-benefits to humans and nature of a saltwater wetland, the Contractor will follow CARB’s multi-pronged approach involving specific metrics, community engagement strategies, and transparent reporting mechanisms. This will ensure that the research outcomes demonstrably benefit the public, particularly communities disproportionately affected by environmental issues.

### Greenhouse gas fluxes from saltwater wetlands

The Natural and Working Lands (NWL) Carbon Inventory is geospatially and temporally explicit, utilizes input datasets that are updated regularly, and allows continual inventory improvements as science advances and new data becomes available. Historically, the NWL Carbon Inventory had limited capacity to quantify carbon stocks and GHG emissions in wetland ecosystems.

Including all wetlands in the NWL Carbon Inventory was challenged by the difficulty of accurately mapping wetland extent and type over time, modeling complex GHG and carbon stock changes, assessing the effects of management and restoration, and understanding the impacts of disturbance and sea level rise on ecosystem function and carbon cycling.

Ongoing efforts by CARB to improve emission estimates include collecting high-quality and high-temporal-resolution data, mapping, and improving modeling resources in wetland ecosystems. The NWL Carbon Inventory quantifies GHG emissions of CO2 and CH4 along with soil organic carbon (SOC) stocks over time. CARB relies on significant field data, including eddy covariance tower flux measurements and dated soil core data, to accurately quantify Greenhouse Gas (GHG) emissions and carbon stocks. This data is crucial for informing and validating upscaling models. For wetlands, almost all flux towers are in northern California, concentrated within the San Joaquin Bay Delta (The Delta). In fact, the Delta has the most flux towers in any landscape in California. A large data gap exists in Southern California's vast coastal saline wetlands. These systems and the environmental conditions (climate and vegetation) are sufficiently different from those of northern California and the Delta, so using that data to estimate or model emissions in southern California is not scientifically sufficient. For this reason, the Contractor will focus on data collection and analysis on Southern California's coastal saltwater wetlands.

Wetlands are an important land category that influences California's carbon stocks and GHG emissions. Currently, the NWL Carbon inventory can only model wetlands in the San Joaquin Delta due to data limitations in other wetland ecosystems of the state. The Contractor will address data gaps by measuring CO2 and CH4 fluxes for at least two years, and soil carbon accretion/subsidence rates over the past century, in a Southern California saltwater wetland using eddy covariance and dated soil cores. These efforts will provide the Contractor with data to refine the Carbon Inventory for California. Findings from this contract will refine the NWL Carbon Inventory, enhance scenario modeling, and broaden wetland types included in climate planning. The results will support future Scoping Plan updates, improve coastal wetland carbon inventory estimates, and help meet Assembly Bill 1757's implementation and tracking of nature-based solutions targets, specifically as they relate to the restoration of coastal tidal wetlands by providing baseline data on carbon stocks and fluxes from these systems. This contract will also support integrating coastal saltwater wetland management and restoration into state climate planning, advancing California's climate targets while delivering co-benefits such as flood protection, shoreline stabilization, pollution reduction, and wildlife habitat conservation.

**Previous experience measuring long-term GHG fluxes from saltwater wetlands using eddy covariance and soil carbon accretion/subsidence rates**

The Biogeochemistry lab at the University of California, Santa Cruz (UCSC), led by Dr. Adina Paytan (Co-PI), manages the only coastal tidal eddy covariance network in California outside the San Francisco Bay and Delta. This includes five fully instrumented towers installed and operating at different marsh types (natural, restored, drowned mudflat, impounded, and a managed wetland for water treatment) (Figure 1). The data from these towers and associated ancillary data are deposited in the AmeriFlux system following Quality Assurance/Quality Control (QA/QC) and gap filling. In addition, soil cores are collected and dated, and carbon accumulation is determined at all sites. Porewater and surface water parameters are also monitored. For more details, see the project website https://wetlands.ucsc.edu/ and the outreach information video that describes the motivation for the work conducted https://www.youtube.com/watch?v=_SVkI0mAtBA.


**Figure 1a**: Elkhorn Slough a comparable, existing installation in Monterey Bay, California (top left), and location of study sites within Elkhorn Slough (red stars). Images from Google Earth Pro. Moro Cojo Castroville is located just south of Elkhorn Slough and shown on the top left insert in red.

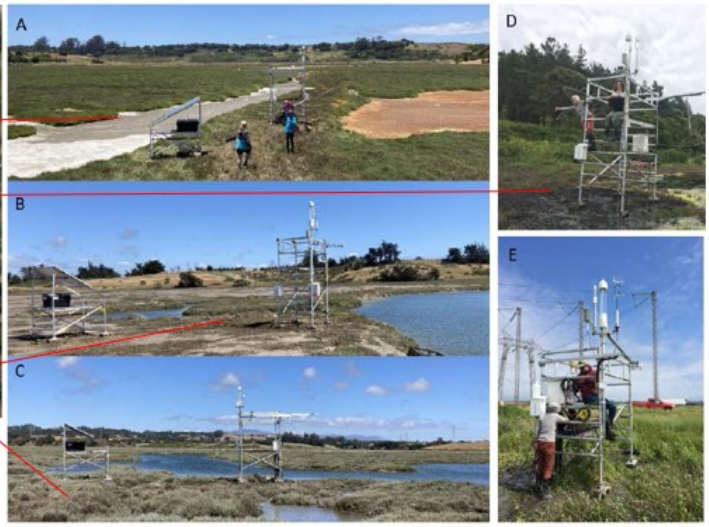


**Figure 1b**: Display of eddy covariance towers next to which instruments for water monitoring data are installed comparable to work proposed here. Elkhorn Slough: (A) Porter Marsh, (B) Hester Marsh, (C) Yampah Marsh, (D) North Marsh, (E) Moro Cojo Castroville.

**Biogenic VOC emissions from Californian landscapes**

In addition to GHGs, terrestrial landscapes also emit biogenic volatile organic compounds (BVOCs) into the atmosphere, which play important roles in the formation of ozone (O3) and secondary components of fine particulate matter (PM2.5). BVOC emissions are naturally occurring and not currently regulated, but they can significantly affect atmospheric chemistry and air quality.

BVOC emissions are dominated by plant foliage, although other emission sources exist. Foliar BVOC emissions are primarily functions of the leaf mass, plant-specific emission factors, temperature, and light conditions. Caltrans recently finalized a literature review on biogenic emissions and their potential air quality impacts (Caltrans 2024). This report's database consisted of common plant species, their emissions by terpene classes, O3 formation potential, and secondary organic aerosol formation potential. The report indicates that many of the emission factors used to model BVOCs are based on decades-old studies. A broader update of the available literature and published BVOC emission rate data was recommended, which is necessary to expand the quantitative analysis and the number of different types of plants. In addition, BVOC emission factors for many dominant Californian species are based on limited measurements, and most of those data do not fully represent the conditions that plants typically experience.
California's biogenic emissions inventory is based on estimates from the Model of Emissions of Gases and Aerosols from Nature (MEGAN). The MEGAN model (Guenther et al. 2012) estimates the emissions of hundreds of BVOCs with a flexible horizontal resolution ranging from meters to hundreds of kilometers. The currently used MEGAN landcover inputs for California are based on global satellite data products that are reasonable for global modeling but have biases for specific locations.

For instance, the current leaf area index (LAI) input was produced from the Moderate Resolution Imaging Spectroradiometer (MODIS) MCD15A2H[1] product, which is missing information on urban areas. Similarly, urban areas' growth form fractions and tree composition are not based on measurements.

[1] MCD15A2H is a specific MODIS data product that stands for: MCD signifies that this is a combined product derived from observations from both the Terra and Aqua MODIS sensors; 15: refers to the MODIS product number 15, which relates to vegetation properties; and A2H: designates a specific product within the MOD15 family; and the "H" indicates it's a 500-meter (m) resolution dataset.

Recently, MEGAN has been updated to accept high-resolution, user-specified vegetation data to improve biogenic emission estimates (Guenther et al. in preparation). Estimates based on these updated inputs differed from values estimated using the global default MEGAN land cover by about a factor of two, on average, and by more than a factor of three in some urban landscapes. Figure 2 shows that even at 30-m resolution, landcover datasets tend to underestimate tree cover in urban areas. In summary, the estimates of BVOC emissions can be substantially improved with fine resolution, location, and time-specific landcover data as well as updated emission factors.

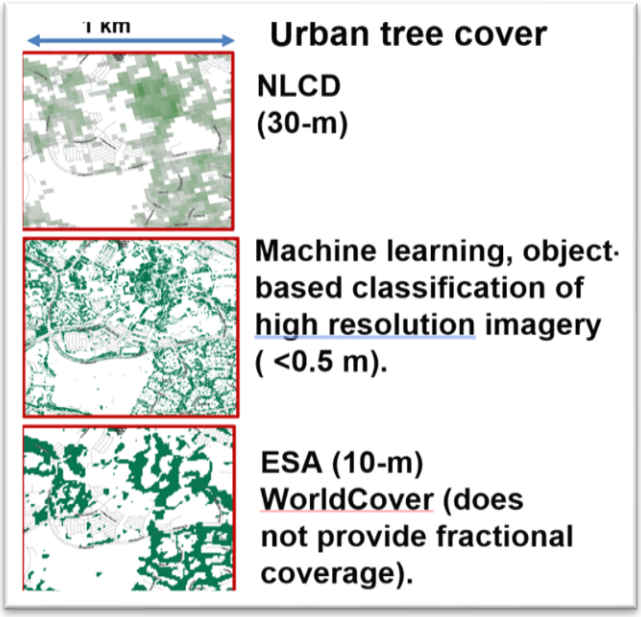


*Figure 2.* Urban tree cover fractions were estimated for a 1km x 1km area using three approaches: NLCD based on 30-m LANDSAT data (used for current California MEGAN simulations), Machine learning object-based classification based on high-resolution NAIP imagery, and ESA WORLDCOVER based on 10-m resolution. The tree cover estimated using machine learning, object-based classification of 0.6-m imagery, is ~50% higher than the estimate based on 30-m data and a factor of two higher than estimates based on 1 $km^2$ resolution satellite data.

The MEGAN model calculates emissions of about 200 chemical species and maps them to common chemical schemes. This is accomplished using tables that relate the emission of a specific chemical species to its equivalent chemical categories in various atmospheric chemistry schemes. MEGAN currently includes many commonly used chemical schemes, but has not been updated to include some of the most recently developed chemical schemes.

Improved CARB capabilities for incorporating accurate biogenic emissions into air quality models will be achieved through five objectives: (1) Updated MEGAN emission factors for selected California urban and agricultural plant species based on literature data and more accurate and representative emission factors measurements made for this project, (2) updated Leaf Area Index (LAI) distributions for all California landscapes based on field measurements and fine resolution (10-m) and coarser resolution (300-m) satellite data, (3) updated growth form fractions (tree, shrub, etc.) for all California landscapes based on satellite datasets and random location observations with fine resolution (0.6-m) imagery, (4) updated ecosystem vegetation types and plant species composition for all California landscapes based on landcover data generated for this contract, (5) development of chemical speciation mapping files for converting MEGAN output emission files into the format required for the SAPRC22 and the CRACMM chemical mechanisms used by CARB. The expected outcome is an improved capability for predicting and mitigating regional air pollutants.

**Previous UCI experience measuring BVOC emission factors and compiling landcover inputs and chemical scheme mapping for BVOC emission models**

The UCI team, led by Guenther (PI), has been developing BVOC emission models (e.g., Lamb et al. 1987, Guenther et al. 1995, Guenther et al. 2012) and conducting measurements to parameterize and assess these models (e.g., Guenther et al. 1991, Nagalingam et al. 2024) for more than 40 years. This includes the development of the two most widely used BVOC emission models, with a supporting role in the development

of the Biogenic Emission Inventory System (BEIS) (Pierce et al. 1994) and the lead role for MEGAN (Guenther et al. 2012). UCI has recently updated MEGAN2.1 to MEGAN3, which accepts high-resolution, user-specified vegetation data to improve biogenic emission estimates in urban and agricultural areas. This includes the development and application of new MEGAN3 landcover characterization and measurement approaches, which have been used to improve BVOC emission estimates in Texas, Utah, Southern California, and the San Francisco Bay Area, supported by Texas Council on Environmental Quality (TCEQ), Utah Division of Air Quality, South Coast Air Quality Management District, and Bay Area Air Quality Management District agencies, respectively. The new estimates differ from MEGAN2.1 and BEIS emission estimates by about a factor of two, on average, and by more than a factor of three in some urban landscapes. These differences are attributable to improvements in the land cover and emission factor inputs in the new version. MEGAN3 development provides a better understanding of BVOC emissions and has enabled more effective and accurate approaches for quantifying and implementing improved landcover inputs and BVOC emission enclosure measurements. The enhanced transparency of the approach has also facilitated the identification of the remaining BVOC estimation issues and uncertainties. This includes using LAI field measurements to calibrate and assess 10-meter satellite LAI data for selected California landscapes and using these results to bridge the field observations to the 300-m satellite LAI data. These recent studies have also demonstrated the effectiveness and accuracy of machine-learning, object-based characterization of vegetation cover types (e.g., trees, grass, shrubs, crops) using ultra-fine resolution (e.g., 30 to 60 cm) imagery coupled with observations at random locations. In addition, an urban tree species composition database for BVOC emission modeling has been compiled to quantify zip-code average tree species composition for all major California cities. However, recent UCI studies have revealed that the species composition of backyard (private) trees differs from street and parks (public) trees, indicating the need to quantify this difference. These studies have also shown the need to characterize “super-emitters” and stress emission responses of dominant vegetation. UCI and collaborators have also developed an approach for implementing the major chemical schemes into MEGAN output capabilities. The current version of MEGAN includes ten chemical mechanism schemes, but it does not include two currently used by CARB: SAPRC22 and CRACMM.

**Project objectives**

This contract's overall goal is to improve NECB estimates from a saline coastal wetland in Southern California and BVOC emissions from Californian landscapes into the atmosphere. The objectives include measuring CO2 and CH4 fluxes and soil carbon accretion/subsidence rates in a Southern California saltwater wetland using eddy co-variance and dated soil cores to fill critical data gaps in the NWL Carbon Inventory. The data will provide a basis for CARB's subsequent modeling efforts. The Contractor will measure species-specific BVOC emissions to better quantify emission factors for dominant California plant species. Biogenic emission estimates will also be improved by developing improved landcover products to better estimate the Leaf Area Index distributions, growth form fractions, and plant species composition variables that drive BVOC emission models. Finally, the Contractor will develop chemical speciation mapping files to translate detailed biogenic chemical species to the lumped chemical groups utilized in the latest SAPRC22 and CRACMM chemical mechanisms for regional air quality modeling.

The Contractor will address the following questions:

- Which plant species dominate California urban and agricultural BVOC emissions and their contributions to ozone and SOA formation potentials? How do their relative contributions differ during heat waves compared to the MEGAN emission model standard conditions of 30°C?
- What major uncertainties are associated with California BVOC emission estimates, and how can those uncertainties be reduced?
- What are the magnitude and variability of CO2 and CH4 fluxes from a southern California saltwater wetland ecosystem over two years of sampling at 30-minute temporal resolution?
- How do these GHG fluxes and the NECB at the Southern California monitored wetland compare to those in Northern California, and what controls the differences observed?

**Data, Communication, and Documentation Standards**

The general requirements for data, products, and analyses produced during this project are listed below. Task 5 “Deliverables and Final report” provides more details.

- All data products require validation and/or uncertainty analysis.
- Field protocols will be documented for non-scientific technicians.
- Raw data and a full processing workflow (including QA/QC, gap-filling, partitioning, and plotting) will be delivered to CARB.
- All code and analyses will be documented for independent use and re-analysis by CARB without contractor support.
- Reports will be public-ready, clearly presenting methods, results, and conclusions, meeting WCAG 2.0 AA and equitable language standards.
- CARB will guide the project through regular consultation with the PI and team.
- Workflows will be in R or Python unless CARB specifies otherwise.
- All methods and dependencies will be open source, with GPL v.3-equivalent licensing.
- Remote sensing workflows will process raw data without non-replicable tools.

**Project Tasks**

**Task 1: Develop a detailed measurement and model development plan**

In consultation with CARB staff, the Contractor will select a saline wetland in Southern California and design field campaigns to measure CO2 and CH4 fluxes for two years using eddy covariance and stratified SOC accumulation rates using dated soil core samples from Southern California coastal wetlands. In addition, the contractor will design field campaigns to measure LAI of some representative Californian landscapes, selected in consultation with CARB, using plant canopy analyzers and a Normalized Difference Vegetation Index (NDVI; measures the difference between near-infrared (NIR) and red light reflectance to assess vegetation health) sensors, and BVOC emission factors and heat stress responses of dominant California urban and agricultural plant species using enclosure measurement techniques. A field measurement plan will be developed by the Contractor that clearly defines the sampling and deployment strategy and how this strategy addresses the objectives of the research.

The GHG measurement plan developed by the Contractor will address how this contract will fill spatial, temporal, and biogeographic gaps in the current data record for California wetlands, focusing on vulnerable communities. In this project, the SOC sampling task will target understudied sites within Southern California's coastal wetland systems based on an assessment of currently available SOC data found in the Smithsonian's Coastal Carbon Atlas (https://shiny.si.edu/coastal_carbon_atlas/). The soil sampling plan will also address whether this contract will incorporate diverse wetland types, including data disaggregated by socioeconomic factors to provide a more comprehensive understanding of wetland ecosystems and their interactions with human communities.

Alongside GHGs, terrestrial vegetation also emits BVOCs into the atmosphere. The plan for BVOC enclosure measurements will identify agricultural and urban plant species that are either known to be dominant California BVOCs emission sources or that are highly uncertain and potentially important. The Contractor will select species to target with emission factor measurements after a literature review and in consultation with CARB scientists. UCI will address how to quantify emission factors for dominant California species under variable conditions, including heat stress. The plan will also prioritize observations required to assess the MEGAN BVOC emission model with the RECAP aircraft flux measurements (Pfannerstill et al. 2023).

The plan for LAI field measurements will identify the landscapes that will be investigated and describe how these field observations will be used to calibrate 10-m Sentinel 2 and Sentinel 3 300-m satellite LAI data. The Contractor will collaborate with CARB's staff to determine the sites for LAI field measurements.

The plan will address the field LAI measurement techniques that will be used and how the data will be used to assess and calibrate satellite LAI data. The plan will also describe the approaches that will be used to develop other land-cover inputs for the MEGAN model.

The Contractor will develop a planned soil core sampling map, including sampling within the eddy co-variance tower footprint. Sampling of SOC at other sites will represent understudied sites within Southern California's coastal wetland systems, based on unsampled or under-sampled areas in the Smithsonian's Coastal Carbon Atlas. The results of this research project, along with its unique database, will provide a basis for CARB's subsequent modeling efforts and improve the accuracy and predictive capability of wetland models in California.

The Contractor will document access agreements, permits, or land holdings that will facilitate planned sampling. Access agreements and permits will be valid for the duration of the contract. Any facilities required for sample processing will be shown to be operational and available.

Task 1 Deliverable
The Contractor will describe the research plan in an interim report with more substance on the research design. This will include a more developed literature review, refined research questions, finalized methodology, and any adjustments made to the initial research plan. The report will include a detailed description of the CO2 and CH4 eddy covariance flux tower site, a list of targeted SOC measurement sites, a list of targeted plant species for BVOC emission factor measurements, a list of LAI field measurement sites, along with a description of the sampling methodology and protocols. The interim report will provide an update on the research design before fully launching the data collection and data analysis phase.

**Task 2: Initiate measurements and model input data compilation, Site Characterization for GHG Instrument Installation/Deployment**

In consultation with CARB, the Contractor will perform a rigorous site characterization process for the eddy flux tower installation and the SOC sampling sites. This will include a thorough review of the following criteria prior to installation:

- **Site Safety:** Site selection should clearly define the risks experienced by researchers and by deployed equipment. This should include an assessment of any potential flooding, including extreme tide events at tidal sites, and how these events will be mitigated for the safety of the sampling team and the protection of sampling equipment.
- **Ecosystem types**: Based on research objectives and current knowledge gaps, identify the appropriate wetland ecosystem types for SOC sampling.
- **Site accessibility**: Ensure the sites are accessible for installation, maintenance, and data collection. This assessment should also factor in challenges associated with sampling locations and the availability of supporting infrastructure.
- **Meteorological conditions**: Assess prevailing wind patterns, stability conditions, and potential disturbances that could affect the EC flux tower measurements. This assessment should include the anticipated tower footprint based on prevailing meteorological conditions.
- **Vegetation characteristics**: Document plant species composition, canopy structure, and phenology in the flux tower footprint.
- **Priority Communities**: Priority communities, as identified by Calenviroscreen (https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf), adjacent to proposed sampling locations, will be identified. The Contractor will also identify any

possible detrimental effects on the health or ecosystem services available to surrounding priority communities.

**Sampling Strategy: Operation and Maintenance Plan During Sampling Period**

The Contractor will install and operate an eddy co-variance tower for at least two years. The installation will allow for continuous, long-term measurements of $CO_2$ fluxes, $CH_4$ fluxes, and meteorological conditions with a time resolution of half an hour. Prior to and during the sampling period, the Contractor will work with CARB staff on the following:

- Tower Installation: An appropriate tower height for the site will be selected, and all instrumentation will be installed securely at the site. The installation will be safely above the potential flooding level.
- Sensor Selection: The Contractor will collaborate closely with CARB to obtain instruments and tools that will be used during the field campaign and will also demonstrate the efficacy of both the instruments and the methods prior to the field campaign to optimize deployment and sampling strategies. This includes building and powering a secure tower, suitable sensors, and supporting instrumentation for measuring:
    - Data logging and recording system: A datalogger with appropriate sampling frequency to capture rapid fluctuations in gas concentrations and wind velocity, and a camera
    - Meteorological Conditions: Sensors will include air temperature, relative humidity, salinity, incoming PAR, incoming total radiation, net radiation, soil temperature, precipitation, water table depth, and water temperature.
    - Wind speed and direction: A sonic anemometer suitable for eddy covariance measurements
    - Gas concentration: Analyzers for $CO_2$ and $CH_4$ suitable for eddy covariance measurements
    - Networking Devices: A cell modem or other networking device that will provide constant internet access to the tower. This access will allow CARB or the Contractor to assess the status of each of the tower's sensors.
    - Power Systems: Mainline power will be available at the eddy covariance flux tower site of sufficient capacity to support the installation, given typical site conditions and power requirements.
    - Safety: The Contractor will develop a plan to optimize the security and stability of the tower and sensors to both natural and human threats. The plan will include responses if the tower and/or sensors are lost.

Soil core sampling will collect at least the upper 30cm of soil, stratified at 1cm depths, dated, and quantified for soil organic carbon and organic matter across each stratification bin. Sampling methods will enable accurate quantification of SOC and dating at various depths across the soil profile.

To improve the BVOC emission factor inputs for California's dominant vegetation, the Contractor will develop a plan for accessing the targeted California plant species for BVOC enclosure measurements. The Contractor will also develop reliable sample collection techniques to quantify BVOC emission factors for target species under optimal conditions and under heat stress conditions.

Task 2 Deliverable

For Task 2, key elements of interim deliverables include documenting field experiments sampling protocol, minimizing researcher bias, ensuring researchers are adequately trained in the sampling protocol, minimizing subjective interpretation, systematically recording data, and continuously analyzing observations within the natural context of the field setting. The interim report will include information about choosing appropriate data collection tools, such as field notes, audio/video recordings, or checklists, to capture observations accurately. The report will also include high-quality pictures of the field site and instrumentation that CARB can publish for this project's research website. The Contractor will provide preliminary BVOC emission rates of targeted species under optimal conditions and heat stress conditions. The Contractor will compile observations and compare them to data from the scientific literature. The comparison will quantify and assess the differences

between estimates based on the new observational data and the emission factors based on data compiled from the literature review.

**Task 3: GHG Data collection, BVOC model input compilation, QA/QC, and archiving**

CO2 and CH4 flux measurements using eddy co-variance will follow the procedures developed for Task 2, including the following key components:

- Pre-deployment checks: Conduct thorough pre-deployment checks of all sensors and instruments to ensure proper functioning.
- Calibration procedures: Regularly calibrate gas analyzers and other sensors according to manufacturer guidelines.
- Data collection: Record continuous measurements of CO2 and CH4 concentrations, wind speed, and direction at 10 Hz or higher frequency. Record continuous measurements of meteorological conditions with at least 30-minute frequency.
- Data Offloading and Handoff: Raw data will be offloaded, processed, and provided to CARB within 2 weeks of collection (recurring every two weeks).
- Data Cleaning: Data Products should be cleaned using standardized practices. Cleaning will follow procedures well established in the literature.
- For QA/QC, the Contractor will screen and assess flux data quality monthly. QA/QC procedure will adhere to standards established in peer-reviewed eddy co-variance tower literature. Data quality should be marked using a tiered data masking column; no data will be permanently removed between collection and handoff to CARB.
- For the collection of Soil Cores, sampling locations will be in understudied coastal wetlands with insufficient representation in the Smithsonian Coastal Carbon Atlas (CCA (https://shiny.si.edu/coastal_carbon_atlas/). This sampling will occur in Southern California coastal wetlands and will include multiple samples within the eddy co-variance sampling footprint. The soil core collection method will be compatible with the current samples with the CCA. This includes, but is not limited to:
    - Sampling at Multiple Depths: Soil cores will be processed in such a way as to segment the core across multiple depths. Segmentation will have sufficient resolution to accurately detect accretion and subsidence rates.
    - Dating: Cores will be dated across sampling depth to provide detailed information on carbon accretion rates over time.
    - SOC: Processing will quantify SOC across depth. All samples will be processed using the same methodology at the same laboratory.

For the BVOC Task, the Contractor will conduct precise emission measurements of a comprehensive suite of BVOC chemical species representing both optimal and heat stress conditions. The Contractor will compile a 30-m growth form (tree, shrub, herbaceous, crop) map for California for a specific year, selected by CARB staff, that is calibrated and assessed using random location observations and machine learning, object-based classification of fine-resolution (0.3-m or 0.6-m) The National Agriculture Imagery Program (NAIP) imagery. The Contractor will assess the growth form fractions in the San Joaquin Valley, the South Coast, the Bay Area, and the Sacramento urban areas. The Contractor will also integrate field LAI measurements with fine-resolution (10-m) satellite data to generate and assess a 10-day, 300-m resolution LAI dataset of California Leaf Area Index (LAI) formatted for MEGAN model input for the specific year selected by CARB staff. The Contractor will focus on urban and agricultural land cover but will develop MEGAN data inputs for all California landscapes, including updated vegetation type and species composition data. The Contractor will also use ground survey datasets to improve quantitative estimates of plant species composition for California urban, agricultural, and rural landscapes. For agricultural landscapes, this will be based on Cropscape cropland data (https://nassgeodata.gmu.edu/CropScape/). These data are available for any individual year from 1997 to 2024.

The Forest Inventory Analysis data (https://research.fs.usda.gov/programs/fia) will be integrated with LANDFIRE data (https://landfire.gov/) for other rural landscapes. LANDFIRE data are available for 2001, 2014, 2016, 2022, 2023, and 2024. Urban tree species composition will be based on the Urban Forest Ecosystems California urban tree inventory (https://ufei.calpoly.edu/). These data are based on shared street tree inventory data from California's largest tree companies and do not represent any specific year.

Task 3 Deliverable
For Task 3, the key element of interim deliverables includes regular delivery of collected data. QA/QC'd eddy co-variance and soil core data will be provided regularly. At the onset of collection, additional time will be provided for CARB to review the first collections and ensure the data fulfills CARB's needs. The Contractor will work with CARB staff to make necessary changes to the data collection process, QA/QC methods, data format, and to address any other concerns expressed by CARB staff.

Eddy Covariance data will be offloaded, processed, cleaned, and provided to CARB alongside a monthly report containing graphics of the collected data. The Contractor will work with CARB to identify the required information. This process is anticipated to be automated.

The Contractor will provide updated emission rates of BVOCs for plant species based on field measurements and the available literature. The Contractor will also provide updated growth form inputs for California for a specific year specified by CARB staff, LAI inputs for the same year, and updated vegetation type and species composition files that are representative of the same year. In consultation with CARB, the Contractor will provide all files in a format that can be used in the MEGAN model.

**Task 4: Data Analysis**
For Eddy Covariance data collection, the Contractor will assess annual/monthly dynamics and annual/monthly budgets of greenhouse gases, identify primary drivers of greenhouse gas fluxes (primarily as they differ from other wetlands in the state), and partition net ecosystem exchange. Partitioning should use the most appropriate, scientifically supported partitioning scheme to separate gross primary productivity and ecosystem respiration from the sampled net ecosystem exchange. Identifying primary drivers should distinguish between the primary drivers of CO2 exchange and CH4 exchange. All analyses will be provided to CARB as either a written report or as a presentation to staff. The Contractor will work closely with CARB staff to evaluate the delivered data/products and implement feedback.

For soil cores, the Contractor will assess differences in accretion and subsidence rates from the collected soil cores compared to publicly available data in the coastal carbon atlas (https://shiny.si.edu/coastal_carbon_atlas/). This analysis should focus on potential drivers of these differences, including interactions with surrounding lands and anthropogenic drivers. All analyses will be provided to CARB as either a written report or a presentation to staff. The Contractor will work closely with CARB staff to evaluate the delivered data/products and implement feedback.

The Contractor will assess the MEGAN growth form input data compared to iTree (canopy.itree.org) observations and fine-resolution, machine learning, object-based classifications. The Contractor will validate satellite LAI estimates using ground measurement data. The Contractor will generate annual emission estimates for a specific year, chosen by CARB staff, based on the updated inputs. The Contractor will also evaluate the emission estimates using the CARB-funded aircraft flux campaigns from 2011 (CABERNET) and 2021 (RECAP-CA). The Contractor will work closely with CARB scientists to train them to be able to reproduce the growth form, LAI, and speciation composition data. The Contractor will also work closely with CARB staff to evaluate the delivered data/products and receive feedback.

Task 4 Deliverable
For Task 4, key elements of interim deliverables include propagated uncertainty for all data, detailed documentation on the methodology for all implemented analyses, draft analyses for CARB feedback, and all

processing pipelines or code used for analyses. The Contractor will work with CARB staff to identify the required level of detail and format for interim deliverables.

The Contractor will specify the range of uncertainty for all data provided. In consultation with CARB staff, the BVOC inputs will be in a format that can be implemented into the MEGAN biogenic model. The Contractor will also provide emission rates of targeted species under optimal and heat stress conditions and a detailed description of the methodology used to generate growth form inputs from high-resolution land cover products. The Contractor will also provide a detailed description of the methodology to generate the leaf area index from year-specific satellite products to estimate the LAI for other years. This will also include a detailed description of the methodology for generating vegetation type and species composition input files for future years. The Contractor will submit the updated code for the biogenic model, including SAPRC22 and CARCMM mechanism speciation mapping files.

**Task 5: Final Data, Data Publication, Tower Removal, Draft Final Report and Final Report**
The Contractor will provide CARB with all data developed through this project (Task 5.1). In consultation with CARB, the contractor will publish the data generated through this project (Tasks 5.2 and 5.5) and remove the eddy covariance tower and all related infrastructure (Task 5.3). The Contractor will submit the draft report (Task 5.4) in a format compliant with the Americans with Disabilities Act. The Contractor will submit a draft final report to CARB six (6) months prior to the agreement end date. The results of the project will be presented to CARB staff (Task 5.5). The primary deliverable (Task 5.6) will be a final report describing the background, experimental and analytical methods, and results. The final report will be amended based on CARB comments and submitted to CARB before the end date of the agreement. In the final report, the Contractor will also include a one-page Public Outreach Document that will use clear and accessible language to communicate this work to the public.

Task 5 Deliverables
The Contractor will provide CARB with all data developed through this project. The Contractor will publish the data generated from this contract and remove the eddy covariance tower and all related infrastructure associated with this contract. The Contractor will submit the draft report in compliance with the Americans with Disabilities Act (ADA). . The Contractor will submit a draft final report to CARB six (6) months prior to the agreement end date. The results of the project will be presented to CARB staff at a Technical Seminar . The primary deliverable will be a Final report describing the background, experimental and analytical methods, and results from this contract... In the Final report, the Contractor will also include a one-page Public Outreach Document that will use clear and ADA compliant language to communicate this work to the public.

**Project Schedule**
Task 1 (T1): Develop a detailed measurement and model development plan
Task 2 (T2): Initiate measurements and model input data compilation, Site Characterization for GHG Instrument Installation/Deployment
Task 3 (T3): GHG Data collection, BVOC model input compilation, QA/QC, and archiving
Task 4 (T4): Data analysis
Task 5 (T5): Final Data, Data Publication, Tower Removal, Draft Final Report, and Final Report

**Table 1**

| | Year 1 | | | | Year 2 | | | | Year 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | | | | | | | | | | | | |
| T2 | | | | | | | | | | | | |
| T3 | | | | | | | | | | | | |
| T4 | | | | | | | | | | | | |
| T5 | | | | | | | | | | | | |
| | m.p | p | m.p | p | m.p | p | m.p | p | m,p | p | m.p.d | f |

m = meeting with CARB staff
p= quarterly progress report
d= deliver final draft report
f= deliver final report

**Meetings**

A. Initial meeting. Before work on the contract begins, the Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

B. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with CARB's Contract Project Manager at quarterly intervals to discuss the progress of the project. This meeting may be conducted by phone.

C. Technical Seminar. The Contractor will present the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.

**UCI Earth System Science (ESS) Facilities available for this project**
The Guenther laboratory (2,800 sq ft), in the basement of Croul Hall on the UC Irvine campus, includes plant growth chambers with temperature, light, and humidity control for conducting emission factor measurements. Office space adjacent to the lab includes computers outfitted with ARCGIS, various data analysis software (Python, R, IGOR), and the latest version of Microsoft Office. In addition, the lab has software for improved data acquisition and analysis, including DAQ Factory, which facilitates instrument operation and maintenance. Equipment in that lab available for this project includes the following:
**Enclosure systems:** LICOR 6400 photosynthesis/transpiration enclosure systems and three custom glass cuvette gas exchange enclosure systems with temperature and light control designed to measure highly reactive monoterpenes and sesquiterpenes.
**Offline GCs for VOC analysis***:* thermal-desorption (Markes Ultra/Unity) gas chromatograph (Agilent 7890b) equipped with time-of-flight mass spectrometer (Markes BenchTOF-SeV) and flame ionization detector (TD-GC-FID/TOFMS). The ToF-MS, compared to the quadrupole MS used for most previous BVOC studies, has better sensitivity (< 1 ppt detection limit), chromatographic separation, and deconvolution of co-eluting compounds due to higher scan rates, mass resolution, and accuracy. The system is highly inert with a heated transfer line and suitable for analyzing SVOCs. The unique select-eV technology provides simultaneous measurements with conventional electron ionization (-70 eV) and much softer ionization, down to -10 eV, without loss of sensitivity to aid in detecting molecular ions. In addition, the labs have a portable GC system fitted with a vacuum UV detector (VUV analytics VGA 100) and another GC system configured with a chiral column for analyzing monoterpene enantiomers. Three other portable GC-QMS systems (Inficon HAPSITE ER) and two portable GC-PIDs are also available. The Contractor also have access to an offline liquid chromatograph high-resolution orbitrap mass spectrometer (LC-OMS, Q Extractive Plus, ThermoScientific) for measuring semi-volatile BVOC.
**Continuous trace gas measurement systems:** An on-line proton transfer reaction time-of-flight mass spectrometer (PTR-TOFMS, Ionicon 1000 Ultra) with fast response (10 Hz) suitable for BVOC eddy covariance measurements and stress studies. Li7000 high precision $CO_2$ and $H_2O$ infrared gas analyzers (IRGAs) suitable for eddy covariance measurements. RM Young model 81000 and Campbell Scientific CSAT3 3D ultrasonic anemometers. Relaxed eddy accumulation (REA) systems for collecting BVOC “up” and “down” samples for off-line analysis.
In addition, a 1000 sq ft high bay storage area next to Croul Hall is available for storing shipping containers and field equipment. Expertise in instrumentation in the UCI Instrumental Development Facility, within the UCI ESS department, is available for developing and repairing electronics, communications, plumbing, and other components. This facility has extensive experience supporting BVOC enclosure measurements. In addition, the UCI School of Physical Sciences has outstanding professional mechanical and electrical facilities.

**UCSC Facilities available for this project**
**Laboratories**: Paytan Biogeochemistry, Institute of Marine Sciences Analytical Facility, Keck Mass Spectrometry Facility, Department of Earth & Planetary Sciences Core Equipment. The Contractor also has access to the BioMed facility, which provides flexible laboratories for researchers.

**Major Equipment:** Full chemistry preparation laboratory with hoods, ovens, centrifuges, and chemical storage facilities. Shimadzu GC-14A gas chromatograph with FID for methane analysis and all needed sample collection and processing equipment. LiCor - $CH_4$, $CO_2$ and $N_2O$ analyzer and soil gas chambers, YSI hand-held probe for temperature, salinity, conductivity, pH, turbidity, and oxygen (Yellowsprings). **IMS Lab**: LaChat Quick Chem 8000 spectrophotometric flow injection analytical system, DOC (Shimadzu TOC-5000A), DIC coulometer, Alk titration system, XRD, XRF, SEM, Ion-microprobe, ICP-OES, GC-MS. **Keck Lab**: Gas ratio mass spectrometer for C and H isotopes in methane, Finnegan TIMS, Neptune MC ICP-MS, Element HR ICP-MS, **E&PS Equipment**: Coring supplies, well points, data loggers, pumps, push cores, piezometers, pressure transducers, GPS units, batteries, filters, columns, and shipping coolers.

**Other Resources:** The Department of Earth and Planetary Sciences at UCSC has an Administrative Support Associate as well as Technical Staff and Instrument Engineers available to help support the project. UCSC’s Office of Sponsored Projects is available to provide ongoing post-award support for grant activities and

management, assist PIs, and support Departmental Administrators with day-to-day operations of grant administration management, and provide tools and training for post-award management. The UCSC's Office of Information Technology maintains UCSC servers and institution-funded Google Drive backup options and is available to provide ongoing data management assistance. The Department of Earth and Planetary Sciences at UCSC has fleet vehicles that can be rented on a daily basis at $0.85/mile.

**Project Management Plan**

This team includes experts on BVOC emission factor measurements (Guenther), BVOC landcover inputs and MEGAN model development (Guenther), $CO_2$ and $CH_4$ eddy covariance measurements in a saltwater wetland (Paytan), and soil core analysis (Paytan).

Alex Guenther (PI), a UCI professor, will have overall responsibility for coordinating all aspects of this project. Professor Guenther has over 40 years of experience in measuring and modeling biogeochemical trace gas fluxes and is the lead developer of the MEGAN model. The Contractor will supervise two postdoctoral scientists working on the BVOC component of this project (one focused on emission measurements and the other on landcover inputs). Adina Paytan (co-PI), a UCSC Professor, will supervise two graduate students, one focused on the eddy covariance data and the other on the soil data, and a field technician who will service the towers on a regular basis.

**References**


- Caltrans, Volatile Organic Compound Emissions from Plant Species Used by Caltrans and an Analysis of Their Potential Air Quality Impacts, CTAQ-TM-24-435.03.03, 2024.
- Guenther, A., P. Zimmerman and M. Wildermuth, Natural volatile organic compound emission rate estimates for U.S. woodland landscapes. *Atmos. Environ., 28***,**1197-1210, 1994.
- Guenther, A., C. N. Hewitt, D. Erickson, R. Fall, C. Geron, T. Graedel, P. Harley, L. Klinger, M. Lerdau, W. McKay, T. Pierce, B. Scholes, R. Steinbrecher, R. Tallamraju, J. Taylor and P. Zimmerman, A global model of natural volatile organic compound emissions, *J. Geophys. Res., 100*, 8873-8892, 1995.
- Guenther, A. B., X. Jiang, C. L. Heald, T. Sakulyanontvittaya, T. Duhl, L. K. Emmons, and X. Wang, "The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions," Geosci. Model Dev. **5** (6), 1471-1492, 2012.
- Guenther et al. (in preparation) Estimating urban to global biogenic volatile organic compound emissions with the Model of Emissions of Gases and Aerosol from Nature version 3.3 (MEGAN3.3).
- Lamb, B., A. Guenther, D. Gay and H. Westberg, A national inventory of biogenic hydrocarbon emissions, *Atmos. Environ.*, *21,* 1695-1705, 1987.
- Pfannerstill E.et al., Comparison between Spatially Resolved Airborne Flux Measurements and Emission Inventories of Volatile Organic Compounds in Los Angeles, Environ. Sci. Technol. doi: 10.1021/acs.est.3c03162, 2023.

**EXHIBIT A1**

**DELIVERABLES**

| Deliverable | Description | Due Date |
|---|---|---|
| Racial equity/implicit bias training | The Principal Investigator and key personnel must demonstrate that they have taken, or will take, cultural competency training, implicit bias training, or racial equity training, whichever is administered at their institution. Training certificates or certificates of completion completed within one (1) year prior to the agreement start date will be accepted. If the training has not been completed within one (1) year prior to the agreement start date. In that case, the Principal Investigator and key personnel must demonstrate that they have scheduled the training within 30 days of the agreement start date and shall complete the training within 90 days of the agreement start date. | Within 90 days of the agreement start date. |
| Initial Meeting | The Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin. | Month 1 |
| Task 1.3 Site Sampling | In consultation with CARB staff, the Contractor will provide an electronic document and a map of planned sampling locations for eddy covariance, dated soil core, BVOC, LAI, heat stress response, and any other planned sampling. Provide written documentation specifying the number and location of sites to be sampled for each portion of the project. Where appropriate, planning documentation will highlight how this design constitutes a representative sampling design and how it captures the variation and management history of major wetland types. This map must highlight land ownership, define the required permits/approvals, and identify any restoration projects that occurred between 2001 and the present for each sampling point. If possible, the contractor will identify potential restoration that may occur during or immediately following this project at each point. Mapping products must be provided in a digital format compatible with ESRI ArcGIS Pro as either a raster or shapefile. | Month 2 |

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| Task 2.1 - Site Characterization | In consultation with CARB, the Contractor will provide a detailed, written site characterization document for the planned eddy covariance tower installation. This will include a thorough review of the following criteria prior to installation: (1) Site Safety: Site selection should clearly define the risks experienced by researchers and by deployed equipment. This should include an assessment of any potential flooding, including extreme tide events at tidal sites, and how these events will be mitigated for the safety of the sampling team and the protection of sampling equipment; (2) Ecosystem types: Based on research objectives and current knowledge gaps, identify the appropriate wetland ecosystem types for dated soil core sampling; (3) Site accessibility: Ensure the sites are accessible for installation, maintenance, and data collection. This assessment should also factor in challenges associated with instrument availability, sampling locations and the availability of supporting infrastructure; (4) Meteorological conditions: Assess prevailing wind patterns, stability conditions, and potential disturbances that could affect the EC flux tower measurements. This assessment should include the anticipated tower footprint based on prevailing meteorological conditions; (5) Vegetation characteristics: Document plant species composition, canopy structure, and phenology in the flux tower footprint; (6) Priority communities, as identified by Calenviroscreen (https://oehha.ca.gov/media/downloads/calenviroscreen/report/Calenviroscreen/report/calenviroscreen40reportf2021.pdf), adjacent to proposed sampling locations will be identified. The Contractor will also identify any possible benefits and/or detrimental effects to the health or ecosystem services available to surrounding priority communities resulting from this project. Provide a draft document for CARB review, and after review, provide a final document incorporating CARB comments. | Month 6 |
| Task 2.2 - Tower Installation | In consultation with CARB, the Contractor will install and operate an eddy co-variance tower in the designated sampling location. The installation will be appropriate for eddy covariance sampling. It will allow for continuous, long-term measurements of CO2 fluxes, CH4 fluxes, and meteorological conditions with a time resolution of half an hour. Prior to and during the sampling period, the Contractor will work with CARB staff on the following: (1) Tower installation: An appropriate tower height for the site will be selected, and all available instrumentation will be installed securely at the site. The installation will be safely above the potential flooding level and be constructed in such a way as to be constantly accessible and to prevent damage to the tower or instrumentation during the deployment period. (2) Sensor Selection: The Contractor will collaborate closely with CARB to obtain instruments and tools that will be used during the field campaign. Deployed instrumentation must undergo pre-deployment checks and be | Month 6 |

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| | calibrated to accurately measure CO2 Concentration, CH4 concentration, wind speed and direction, air temperature, relative humidity, salinity, incoming PAR, incoming total radiation, net radiation, soil temperature, precipitation, water table depth, and water temperature. The installation will include all infrastructure and devices needed for constant remote monitoring and diagnosis of the system. This includes: (1) Data logging and recording system; (2) Networking Devices; (3) Power Systems; (4) any required safety equipment. Installation will include comprehensive pictures of the installation process and the final tower. The contractor will initiate and maintain a system diagram, detailing the wiring, mounting, programming, and other details required for operation of the tower. This documentation will be provided to CARB following installation and updated as changes occur. | |
| Task 2.3 - BVOC Model Input Data | Provide a written document detailing a plan for improvements to the BVOC emission factor inputs for the dominant vegetation in California and a plan for accessing the targeted California plant species for BVOC enclosure measurements. The Contractor will develop reliable sample collection techniques to quantify BVOC emission factors for target species under optimal conditions and also under heat stress conditions. | Month 6 |
| Task 3.1 - Eddy Covariance Progress Report and Maintenance Log 1 | In consultation with CARB, the Contractor will provide a written progress report and an up-to-date log of maintenance, calibration, and any other changes to the tower since installation. This will include a documented calibration of each gas analyzer using methods specified by the instrument manufacturer at least annually. Logs of maintenance will include the date(s) of initial issue (if applicable), date(s) of maintenance or repair, issue(s) addressed, and whether the maintenance/repair was successful. The progress report will synthesize work to date and incorporate plots of all data collected to date. The progress report will also include recent photos of the tower. | Month 18 |
| Task 3.2 - Eddy Covariance Progress Report and Maintenance Log 2 | In consultation with CARB, the Contractor will provide a written progress report and an up-to-date log of maintenance, calibration, and any other changes to the tower since installation. This will include a documented calibration of each gas analyzer using methods specified by the instrument manufacturer at least annually. Logs of maintenance will include the date(s) of initial issue (if applicable), date(s) of maintenance or repair, issue(s) addressed, and whether the maintenance/repair was successful. The progress report will synthesize work to date and incorporate plots of all data collected to date. The progress report will also include recent photos of the tower. | Month 10 |
| Task 3.3 - Eddy Covariance Data Offloading and Handoff (ongoing) | The Contractor will offload, process, QA/QC, and submit eddy covariance tower data to CARB within 2 weeks of collection (recurring every two weeks). Data will be provided as both raw collected files and a processed CSV file with a temporal | Recurring every 2-4 weeks from the date of installation until |

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| | resolution of 1/2 hour. Data will include all collected meteorological and flux tower data values. QA/QC procedure will adhere to standards established in peer-reviewed eddy covariance tower literature. Data quality should be marked using a tiered data masking column; no data will be permanently removed between collection and handoff to CARB. The Contractor will be responsive to CARB on questions related to the data provided and will act quickly to address issues with the installation if identified in the data. If requested by CARB staff, the Contractor will modify the provided data structure or content and replicate those edits for all future handoffs. | the end of the data collection period |
| Task 3.4 - Dated Soil Core Sampling | The Contractor will provide a progress report and all data to date related to the collection and processing of dated soil cores. These soil cores will be collected and processed to facilitate: (1) Sampling at Multiple Depths: Soil cores will be processed in such a way as to segment the core across multiple depths. Segmentation will have sufficient resolution to accurately detect accretion and subsidence rates (at most 1cm resolution); (2) Dating: Cores will be dated across sampling depth to provide detailed information on carbon accretion rates over time; (3) SOC and SOM: Processing will quantify soil organic carbon and soil organic matter across depth. All samples will be processed using the same methodology at the same laboratory. This report will include recent photos of the sampling and processing of soil cores | Month 24 |
| Task 3.5 - BVOC Sampling | The Contractor will conduct precise emission measurements of a comprehensive suite of BVOC chemical species representing both optimal and heat stress conditions. The Contractor will compile a 30-m growth form (tree, shrub, herbaceous, crop) map for California for a specific year chosen by CARB staff that is calibrated and assessed using random location observations and machine learning, object-based classification of fine-resolution (0.3-m to 0.6m) imagery. The Contractor will assess the growth form fractions in the San Joaquin Valley, the South Coast, the Bay Area, and the Sacramento urban areas. The Contractor will also integrate field measurements with fine-resolution (10-m) satellite data to calibrate and assess 300-m satellite data to generate California Leaf Area Index (LAI) MEGAN model input for a specific year chosen by CARB staff. The Contractor will focus on urban and agricultural land cover but will develop MEGAN data inputs for all California landscapes, including updated vegetation type and species composition data. The Contractor will also use ground survey datasets to improve quantitative estimates of plant species composition for California urban, agricultural, and rural landscapes | Month 24 |
| Task 4.1 - Eddy Covariance Data Analysis | Provide either a written report or a presentation to CARB staff detailing annual/monthly dynamics and annual/monthly budgets of greenhouse gases, primary drivers of greenhouse gas fluxes (especially as they differ from other wetlands in the state), and partitioned net ecosystem exchange. Partitioning | Month 32 |

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| | should use the most appropriate, scientifically supported partitioning scheme to separate gross primary productivity and ecosystem respiration from the sampled net ecosystem exchange. Identification of primary drivers should distinguish between the primary drivers of CO2 exchange and CH4 exchange. The Contractor will work closely with CARB staff to evaluate the delivered data/products and implement feedback. | |
| Task 4.2 - Dated Soil Core Analysis | Provide either a written report or a presentation to CARB staff detailing differences in accretion and subsidence rates from the collected soil cores compared to publicly available data in the coastal carbon atlas (https://shiny.si.edu/coastal_carbon_atlas/). This analysis should focus on potential drivers of these differences, including interactions with surrounding lands and anthropogenic drivers. The Contractor will work closely with CARB staff to evaluate the delivered data/products and implement feedback. | Month 32 |
| Task 4.3 - BVOC Analysis | Provide either a written report or a presentation to CARB staff detailing the MEGAN growth form input data by comparison to iTree (canopy.itree.org) observations and fine-resolution, machine learning, object-based classifications. The Contractor will validate satellite LAI estimates using ground measurement data. The Contractor will generate annual emission estimates for a specific year, selected by CARB staff, based on the updated inputs. The Contractor will also evaluate the emission estimates using the CARB-funded aircraft flux campaigns from 2011 (CABERNET) and 2021 (RECAP-CA). The Contractor will work closely with CARB scientists to train them to be able to reproduce the growth form, LAI, and speciation composition data. The Contractor will also work closely with CARB staff to evaluate the delivered data/products and receive feedback. | Month 32 |
| Progress Reports & Meetings | Quarterly progress reports and meetings throughout the agreement term, to coincide with work completed in quarterly invoices. | Quarterly |
| Task 5.1 - Final Data Handoff | The Contractor will demonstrate the final products with an uncertainty analysis. All data developed through this project will be provided to CARB with appropriate meta-data and documentation. The Contractor will provide a tutorial for running the workflows that generated this data to ensure that CARB staff will have the ability to replicate the deliverables. The Contractor will ensure that all methods execute tasks correctly and will work with CARB staff to ensure that workflows can be reproduced using the computational resources available to CARB staff. Data will be provided in a clean, easily understandable state with sufficient documentation for understandability and transferability (as outlined in the RFP Data, Communication, and Documentation Standards). | Month 34 |
| Task 5.2 - Data Publication | In consultation with CARB, the Contractor will publish all generated eddy covariance tower data and all dated soil core data to public repositories. Eddy covariance data should be | Month 35 |

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| | published to the Ameriflux website (https://ameriflux.lbl.gov/) or a comparable, permanent repository. The soil core data should be published to the Smithsonian's Coastal Carbon Atlas webtool (https://shiny.si.edu/coastal_carbon_atlas/). If either of these repositories is no longer operational or no longer accepts new data, the Contractor will work with CARB staff to identify an appropriate substitute. | |
| Task 5.3 – Tower Removal | In consultation with CARB, the Contractor will remove the eddy covariance tower installation and all related infrastructure. The site will be restored to a state comparable to the condition prior to installation. All equipment, including all equipment purchased through this contract, will be delivered to an address in Sacramento, CA provided by CARB. The Contractor will ensure the instrumentation is not damaged in transport. | Month 35 |
| Task 5.4 Draft Final Report | Draft version of the Final Report detailing the purpose and scope of the work undertaken, the work performed, the results obtained, and conclusions, and a Public Outreach Document and an Equity Implications Section. The Draft Final Report shall be copy-edited before being sent to CARB for review, and the Principal Investigator shall attest that the Final Report has been reviewed and approved.<br><br>The Draft Final Report must be submitted in accordance with the requirements outlined in Exhibit A1, Section 2 – Research Final Report Format. | Six (6) months prior to the agreement end date. |
| Task 5.5 Data | Provide CARB with data compilations produced in the performance of this Agreement by the Principal Investigator or the University's project personnel. | Two (2) weeks prior to the agreement end date. |
| Task 5.5 Technical Seminar | Presentation of the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte. The Technical Seminar slides shall be submitted in an ADA-compliant format. CARB's standard for ADA compliance requires that the submitted document adhere to WCAG 2.1 AA (https://www.w3.org/TR/WCAG21/) and Federal Section 508 (https://www.section508.gov/). | On or before the agreement end date. |
| **The following Deliverables are subject to paragraph 19. Copyrights, paragraph B of Exhibit C** | | |
| Task 5.6 Final Report | Written record of the project and its results. The Final Report must be submitted in accordance with the requirements outlined in Exhibit A1, Section 2 – Research Final Report Format. | Two (2) weeks prior to the agreement end date. |

**1. Reports and Data Compilations**

A. With respect to each invoice period University shall submit, to the CARB Contract Project Manager, one (1) electronic copy of the progress report. When emailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report must accompany a related invoice covering the same billing period. Each progress report will begin with the following disclaimer:

*The statements and conclusions in this report are those of the University and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products*.

B. Each progress report will also include:

1. A brief summary of the status of the project, including whether the project is on schedule. If the project is behind schedule, the progress report must contain an explanation of reasons and how the University plans to resume the schedule.

2. A brief narrative account of project tasks completed or partially completed since the last progress report.

3. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved.

4. A brief discussion of work planned, by project task, before the next progress report. and

5. A graph or table showing percent of work completion for each task.

C. Six (6) months prior to Agreement expiration date, University will deliver to CARB an electronic copy of the draft final report in both PDF and Microsoft Word formats. The draft final report will conform to Exhibit A1, Section 2 – Research Final Report Format.

D. Within forty-five (45) days of receipt of CARB's comments, University will deliver to CARB's Contract Project Manager an electronic copy of the final report incorporating all reasonable alterations and additions. Within two (2) weeks of receipt of the revised report, CARB will verify that all CARB comments have been addressed. Upon acceptance of the amended final report approved by CARB in accordance to Exhibit A1, Section 2 – Research Final Report Format, University will within two (2) weeks, deliver to CARB an electronic copy of the final report in both PDF and Microsoft Word formats.

E. As specified in Exhibit A1, Section 2, Final Report will be submitted in an Americans with Disabilities Act compliant Format.

F. Together with the final report, University will deliver a set of all data compilations as specified in Exhibit A1 – Schedule of Deliverables.

G. University's obligation under this Agreement shall be deemed discharged only upon submittal to CARB of an acceptable final report in accordance to Exhibit A1, Section 2 – Research Final Report Format, all required data compilations, and any other project deliverables.

**2. Research Final Report Format**

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. The CARB's Research Screening Committee (RSC) reviews all draft final reports, paying special attention to the Abstract and Executive Summary. If the RSC finds that the Report does not fulfill the requirements stated in this Exhibit, the RSC may not recommend release, and final payment for

the work completed may be withheld. This Exhibit outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the Contractor shall submit a copy of the Report in PDF format and in a word-processing format, preferably in Word – Version 6.0 or later. The electronic copy file name shall contain the CARB contract number, the words "Final Report", and the date the report was submitted.

*Accessibility.* Contractor must ensure that the Final Report complies with Web Content Accessibility Guidelines 2.0, levels A and AA, and otherwise meets the accessibility requirements set forth in California Government Code Sections 7405 and 11135, Section 202 of the federal Americans with Disabilities Act (42 U.S.C. § 12132), and Section 508 of the federal Rehabilitation Act (29 U.S.C. § 794d) and the regulations promulgated thereunder (36 C.F.R. Parts 1193 and 1194) (collectively, the "Accessibility Requirements"). For any report provided in PDF format, Contractor shall also provide an electronic version in the original electronic format (for example, Microsoft Word or Adobe InDesign). CARB may request documentation from the Contractor of compliance with the Accessibility Requirements and may perform testing to verify compliance. Contractor must bring into compliance, at no cost to CARB, any report by Contractor or its subcontractors not meeting the Accessibility Requirements. If Contractor fails to bring its or its subcontractors' report into compliance with the Accessibility Requirements within five (5) business days of written notice from CARB, or within the time frame specified by CARB in its notice, Contractor will be responsible for all costs incurred by CARB in bringing Contractor's or its subcontractors' report into compliance with the Accessibility Requirements. Contractor agrees to respond to and resolve any complaint brought to its attention regarding accessibility of deliverables provided under this Contract for a period of one year following delivery of the final deliverable under this Contract.

Deviations from the Accessibility Requirements are permitted only by written consent by CARB.

*Watermark.* Each page of the draft Report must include a watermark stating "DRAFT." The revised report should not include any watermarks.

Title. The title of the Report should exactly duplicate the title of the contract. However, minor changes to the title may be approved provided the new title does not deviate from the old title. These minor changes must be approved in writing by the contract manager. Significant changes to the title would require a formal amendment.

*Page size.* All pages should be standard size (8 ½" x 11") to allow for photo-reproduction.

*Corporate identification.* Do not include corporate identification on any page of the Final Report, except the title page.

*Unit notation.* Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

*Section order.* The Report should contain the following sections, in the order listed below:

Title page
Disclaimer
Acknowledgment (1)
Acknowledgment (2)
Table of Contents

List of Figures
List of Tables
Abstract
Public Outreach Document
Executive Summary
Equity Implications Section
Body of Report
References
List of inventions reported and copyrighted materials produced
Glossary of Terms, Abbreviations, and Symbols
Appendices

*Page numbering.* Beginning with the body of the Report, pages shall be numbered consecutively beginning with “1”, including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.

*Title page.* The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date, and this statement:
"Prepared for the California Air Resources Board and the California Environmental Protection Agency"

*Disclaimer.* A page dedicated to this statement must follow the Title Page:

> The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

*Acknowledgment (1).* Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

> This Report was submitted in fulfillment of [CARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

*Acknowledgment (2).* Health reports should include an acknowledgment to the late Dr. Friedman. Reports should include the following paragraph:

> This project is funded under the CARB’s Dr. William F. Friedman Health Research Program. During Dr. Friedman’s tenure on the Board, he played a major role in guiding CARB’s health research program. His commitment to the citizens of California was evident through his personal and professional interest in the Board’s health research, especially in studies related to children’s health. The Board is sincerely grateful for all of Dr. Friedman’s personal and professional contributions to the State of California.

*Attestation.* A page dedicated to this attestation statement must follow the Acknowledgement(s). The Principal Investigator (PI) must digitally sign below the following statement:

> The Final Report for CARB Agreement No. [contract number] titled “[Enter project title]” has been copy-edited for grammar, style, and format and is reviewed and approved by the Principal Investigator (PI), [title and name of PI] of [Contractor Name]. The signature below attests that the PI has completed a thorough review of this Final Report and approves it for

submission to the California Air Resources Board.

PI Signature
Date

*Table of Contents.* This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

*List of Figures.* This list is optional if there are fewer than five illustrations.

*List of Tables.* This list is optional if there are fewer than five tables.

*Abstract.* The abstract should tell the reader, in nontechnical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozonesonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors.

*Public Outreach Document.* The public outreach document is a one-page document that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. CARB will be translating the document into other languages. This document must adhere to the following guidelines:

- Single space, limited to one-page or about 500 words.
- Use narrative form and active voice.
- Incorporate a graphic that is easy to interpret and captures the results' central message.
- Avoid jargon and technical terms. Use a style and vocabulary level comparable to that of sixth grade reading level.
- The document should contain a title and the following five sections: Issue/s, Main Question, Key Research Findings, Conclusion/s, and More Information. Guidance on how to write these sections is described below.

  TITLE: Adopt a short, non-technical title to make the topic clear and concise. The title will likely differ from the original title of the contract.

  ISSUE/S: In one to two paragraphs, describe why the project was needed. In this section, identify the problem leading to this study and what the study was set to accomplish to help address the problem. Reference any history that is relevant, such as a regulation, legislation, program, law, or other. Without going into detail and disclosing the research findings, mention the methods used in the study and how they informed the

results.

MAIN QUESTION: Present a concise central research question driving this project.

KEY RESEARCH FINDING/S: This section covers the key research findings. List key points and or findings.

CONCLUSION/S: In one to two paragraphs, discuss how the results could be used. Mention its relevance to policies, rules, regulations, legislations, or CARB programs. Include suggestions for next steps, additional research, or other actions.

MORE INFORMATION: In two to three short sentences provide specifics about the study. This section should include the full title of the study, sponsor, authors, and where the full report can be found (the final report will be posted on the CARB website). In addition to a direct contact to gain more information (author and CARB contract manager).

*Executive Summary.* The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level accessible to the general audience. Assume the audience is being exposed to the subject for the first time.

Do not list contract tasks in lieu of discussing the methodology. Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

Avoid the temptation to lump separate topics together in one sentence to cut down on length.

The Executive Summary should contain four sections: Background, Objectives and Methods, Results, and Conclusions, described below.

THE BACKGROUND SECTION.
For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

THE OBJECTIVES AND METHODS SECTION. At the beginning of the Objectives and Methods section, state the research objectives as described in the contract. Include a short, one or two sentences, overview of what was done in general for this research.

The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed if it is important in interpreting the results. The findings should not be mentioned in the Objectives and Methods section.

THE RESULTS SECTION. The Results section should be a single paragraph in which the main findings are cited, and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

THE CONCLUSIONS SECTION. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

*Equity Implication Section.* The equity implications section should summarize how the research results inform disparate impacts of policies, regulations, or programs on priority communities. [5] This section should summarize how sociodemographic factors were examined in this research. Given the data used or collected, which populations are excluded or overrepresented? How were relevant communities engaged in the research effort, and/or how were existing data gaps identified and ground-truthed during the research project? If ground-truthed data were found to not accurately reflect the lived experiences of community members, what future research projects could address this disconnect? The research results should inform existing or future CARB programs, and the equity implications section should discuss how the research results may inform programs to close disparities in health outcomes, pollutant exposure, or climate adaptation, etc., for priority communities. This section should be limited to a maximum of two (2) pages, single-spaced, and shall include the following sections.

HISTORICAL ANALYSIS. Provide an overview of the inequities and disparities observed in the existing data or data gathered during the research and how it ties to historic policies. For example, what is the root-cause of the disparity being experienced

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[5] Priority communities here encompasses various terms CARB uses such as priority populations[2], communities of concern[3], protected classes[4], or disadvantaged communities[5].
[2] Priority Populations — California Climate Investments
[3] Referenced from the California Public Utilities Commission Environmental and Social Justice Plan an effort resulting from California's Capitol Collaborative on Race & Equity.
[4] Protected Classes | California State Senate
[5] SB-535-Designation-Final.pdf (ca.gov) ; California Climate Investments to Benefit Disadvantaged Communities | CalEPA; CalEnviroScreen 4.0 | OEHHA

by the community or population central to this research?

MATERIALS AND METHODS. Describe how this research project examines racial equity. Some methods can include but are not limited to: examining the potential for existing data to address racial inequalities, ground-truthing existing data, engaging priority communities, assessments for racial and ethnic subgroups in the development of data and approaches, identifying data gaps and filling those gaps.

RESULTS AND DISCUSSION. Describe how the results improve our understanding of the equity issues identified or interventions to address those inequalities.

*Body of Report.* The body of the Report should contain the details of the research, divided into the following sections:[6]

INTRODUCTION. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study.

Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

MATERIALS AND METHODS. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work. Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology.

Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project.

RESULTS. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures, and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

DISCUSSION. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings?

Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

SUMMARY AND CONCLUSIONS. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or overinterpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

[6] Note that if the research employs multiple distinct methods, analyses, etc., the final report can include separate materials/methods, results, and discussion sections to allow for coherent discussion of each set of analyses and findings. However, the executive summary and conclusions sections should synthesize the collective findings of the entire study.

RECOMMENDATIONS. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

*References.* Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

*List of inventions reported and publications produced.* If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles, authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

*Glossary of terms, abbreviations, and symbols.* When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO2)]. Symbols listed in the table and figure legends need not be listed in the Glossary.

*Appendices.* Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document.

The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at “1”.

**3. Other Deliverables**

A. Contractor must ensure that all products and services submitted, uploaded, or otherwise provided by the Contractor and/or its subcontractors under this Agreement, including but not limited to data, software, plans, drawings, specifications, reports, operating manuals, notes, and other written or graphic work prepared in the course of performance of this Contract (collectively, the “Work”), comply with Web Content Accessibility Guidelines 2.0, levels A and AA, and otherwise meet the accessibility requirements set forth in California Government Code Sections 7405 and 11135, Section 202 of the federal Americans with Disabilities Act (42 U.S.C. § 12132), and Section 508 of the federal Rehabilitation Act (29 U.S.C. § 794d) and the regulations promulgated thereunder (36 C.F.R. Parts 1193 and 1194) (collectively, the “Accessibility Requirements”). For any Work provided in PDF format, Contractor shall also provide an electronic version in the original electronic format (for example, Microsoft Word or Adobe InDesign). CARB may request documentation from the Contractor of compliance with the Accessibility Requirements and may perform testing to verify compliance. Contractor must bring into compliance, at no cost to CARB, any Work by Contractor or its subcontractors not meeting the Accessibility Requirements. If Contractor fails to bring its or its subcontractors’ Work into compliance with the Accessibility Requirements within five (5) business days of written notice from CARB, or within the time frame specified by CARB in its notice, Contractor will be responsible for all costs incurred by CARB in bringing Contractor’s or its subcontractors’ Work into compliance with the Accessibility Requirements. Contractor agrees to respond to and resolve any

complaint brought to its attention regarding accessibility of deliverables provided under this Contract for a period of one year following delivery of the final deliverable under this Contract.

Deviations from the Accessibility Requirements are permitted only by written consent by CARB.

**EXHIBIT A2**

**KEY PERSONNEL**

| | | |
|---|---|---|
| **Principal Investigator (PI):** | | |
| Guenther, Alex | UCI | PI |
| **Co-PI – if applicable:** | | |
| Paytan, Adina | UCSC | Co-PI |

**EXHIBIT A3**

**AUTHORIZED REPRESENTATIVES**

| **State Agency Contacts**<br><br>Agency Name: **CARB** | **University Contacts**<br><br>University Name: **UCI** |
|---|---|
| ***Contract Project Manager (Technical)***<br><br>Name: Nehzat Motallebi<br>Address: Research Division<br>1001 I Street, 7th Floor<br>Sacramento, CA 95814<br><br>Telephone: (279) 208-7220<br>Email: nehzat.motallebi@arb.ca.gov | ***Principal Investigator (PI)***<br><br>Name: Alex Guenther<br>Address: University of California, Irvine<br>Earth System Science<br>3325 Croul Hall<br>Irvine, CA 92697<br><br>Telephone: (949) 824-7320<br>Email: alex.guenther@uci.edu<br><br>Designees to certify invoices under Section 14 of Exhibit C on behalf of PI: |
| ***Authorized Official (contract officer)***<br><br>Name: Alice Kindarara, Branch Chief<br>Address: Acquisitions Branch<br>1001 I Street, 20th Floor<br>Sacramento, CA 95814<br>alice.kindarara@arb.ca.gov<br><br>***Send notices to (if different):***<br><br>Name: Mariah Figueroa<br>Address: Research Division<br>1001 I Street, 7th Floor<br>Sacramento, CA 95814<br><br>Telephone: (279) 208-7882<br>Email: mariah.figueroa@arb.ca.gov | ***Authorized Official***<br><br>Name: Erika Blossom<br>Senior Contract & Grant Officer<br>Address: Sponsor Projects Administration<br>324 Aldrich Hall<br>Irvine, CA 92697<br><br>***Send notices to (if different):***<br><br>Telephone: (949) 824-2237<br>Fax: (949) 824-2094<br>Email: Erika.Blossom@uci.edu |

| | |
|---|---|
| ***Administrative Contact***<br><br>Name: Mariah Figueroa<br>Address: Research Division<br>1001 I Street, 7th Floor<br>Sacramento, CA 95814<br><br>Telephone: (279) 208-7882<br>Email: mariah.figueroa@arb.ca.gov | ***Administrative Contact***<br><br>Name: Julissa Terriquez<br>Sr. Contracts & Grants Analyst<br>Address: UCI Physical Sciences, Dean's Office<br>162 Rowland Hall<br>Irvine, CA 92697<br><br>Telephone: (949) 824-1068<br>Email: jterriqu@uci.edu |
| ***Financial Contact/Accounting***<br><br>Name: Accounts Payable<br>Address: P.O. Box 1436<br>Sacramento, CA 95814<br><br>Email: AccountsPayable@arb.ca.gov<br><br>**Send courtesy copy to:** rd.invoices@arb.ca.gov | ***Authorized Financial Contact/Invoicing***<br><br>Name: Griselda Duran<br>Accounting & Operations Manager<br>Address: Contracts & Grants Accounting<br>228 Aldrich Hall<br>Irvine, CA 92697<br><br>Telephone: (949) 824-6828<br>Email: griseld@uci.edu<br><br>Designees for invoice certification in accordance with Exhibit C – University Terms and Conditions, Section 14 on behalf of the Financial Contact:<br>1.<br>2. |

## EXHIBIT A4

## USE OF INTELLECTUAL PROPERTY & DATA

A. State: Preexisting Intellectual Property (IP)/Data to be provided to the University from the State or a third party for use in the performance in the Scope of Work.

☒ None or ☐ List:

B. University: Restrictions in Preexisting IP/Data included in Deliverables identified in Exhibit A1, Deliverables.

☒ None or ☐ List:

C. Anticipated restrictions on use of Project Data.
If the University PI anticipates that any of the Project Data generated during the performance of the Scope of Work will have a restriction on use (such as subject identifying information in a data set), then list all such anticipated restrictions below. If there are no restrictions anticipated in the Project Data, then check “none” in this section.

☒ None or ☐ List:

**EXHIBIT A5**

**RÉSUMÉ / BIOSKETCH**


## Alex B. Guenther

Professor, Department of Earth System Science
3200 Croul Hall, University of California, Irvine, CA 92697-3100, USA


**Education:**

1989 Ph.D., Engineering Science, Washington State University, Pullman WA
1986 M.S., Environmental Engineering, Washington State University, Pullman WA
1984 B.S., Biology with minor in Computer Science, University of Puget Sound, Tacoma WA

**Appointments:**

2015-present Professor, Dept. of Earth System Science, U. of California, Irvine, CA 92697
2013-2015 Laboratory Fellow, Atmospheric Sciences and Global Change Division, Pacific Northwest National Laboratory, Richland WA 99352
2004-2013 Senior Scientist and Section Head, Atmospheric Chemistry Division, National Center for Atmospheric Research (NCAR), Boulder, Colorado
1990-2004 Scientist I, II, III, Atmos. Chemistry Division, NCAR, Boulder, Colorado
1989-1990 Visiting Fellow (post-doctoral), Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado

**Selected Awards:**

- 2023 Research.com Environmental Sciences Leader Award
- 2022 Fellow of the American Association for the Advancement of Science (AAAS)
- 2015 Fellow of the American Geophysical Union (AGU)
- 2014 Essential Science Indicators Highly Cited Researcher (Thomson Reuters)
- 2012 UCAR Outstanding Publication Award
- 2011 Yoram J. Kaufman Award for Unselfish Cooperation in Research (AGU)

**Significant Activities:**

- Lead developer of the Model of Emissions of Gases and Aerosols from Nature (MEGAN) community model: 2000-present.
- Principal Investigator or Co-PI for NSF, NASA, NOAA, EPA, DOE, USDA, NIER (Korea), TCEQ (Texas), ARB, BAAQMD, and SCAQMD (California) funded projects
- Editorial Board member: Elementa (2013 – present), Frontiers in Forests and Global Change (2018-present), PeerJ (2017-present), Atmos. Chem. and Physics (2001-21), Geo. Model Dev. (2014-19), Atmos. Envir. (2000-12), J. Geophys. Res. (1998-2000), Tree Phys. (1997-2000)
- Contributing author: IPCC assessment; IGBP-IGAC integration and synthesis
- Int. Geosphere Biosphere Program (IGBP): Co-chair of integrated Land Ecosystem Atmosphere Processes Study (iLEAPS), 2010-2015; Co-chair of Global Emissions Inventory Activity (GEIA), 2003-2010, Science Steering Committee member: 2011-2015.

**Relevant publications (out of >400 publications, H index = 119; Total Citations > 60000)**


- Wang, H., Welch, A.M., Nagalingam, S., Leong, C., Czimczik, C.I., Tang, J., Seco, R., Rinnan, R., Vettikkat, L., Schobesberger, S., Holst, T., Brijesh, S., Sheesley, R.J., Barsanti, K.C., & Guenther, A.B. High temperature sensitivity of Arctic isoprene emissions explained by sedges. Nature Communications, 15, 6144, doi:10.1038/s41467-024-49960-0, 2024.

- Perraud, V., Blake, D.R., Wingen, L.M., Barletta, B., Bauer, P.S., Campos, J., Ezell, M.J., Guenther, A.B., Johnson, K.N., Lee, M., Meinardi, S., Patterson, J., Saltzman, E.S., Thomas, A.E., Smith, J.N., & Finlayson-Pitts, B.J. Unrecognized volatile and semi-volatile organic compounds from brake wear. Environmental science. Processes & impacts, doi: 10.1039/D4EM00024B, 2024.
- Wang, Hui, Allison M. Welch, Sanjeevi Nagalingam, Christopher Leong, Pitchayawee Kittitananuvong, Kelley Claire Barsanti, Rebecca J. Sheesley, Claudia I. Czimczik and Alex B. Guenther. "Arctic Heatwaves Could Significantly Influence the Isoprene Emissions From Shrubs." Geophysical Research Letters, 51, 2, 10.1029/2023GL107599, 2024.
- Wang, Peng, Yanli Zhang, Haixing Gong, Hongliang Zhang, Alex Guenther, Jianqiang Zeng, Tao Wang and Xinming Wang. "Updating Biogenic Volatile Organic Compound (BVOC) Emissions with Locally Measured Emission Factors in South China and the Effect on Modeled Ozone and Secondary Organic Aerosol Production." Journal of Geophysical Research: Atmospheres 128, 128, 24, 10.1029/2023JD039928, 2023.
- Nagalingam, Sanjeevi, Roger Seco, Saewung Kim and Alex B. Guenther. "Heat stress strongly induces monoterpene emissions in some plants with specialized terpenoid storage structures." Agricultural and Forest Meteorology, 333, 109400, 10.1016/j.agrformet.2023.109400, 2023.
- DiMaria, Christian A., Dylan B. A. Jones, Helen M. Worden, A. Anthony Bloom, Kevin W. Bowman, Trissevgeni Stavrakou, Kazuyuki Miyazaki, John Worden, Alex B. Guenther, Chinmoy Sarkar, Roger Seco, Jeong-Hoo Park, Júlio Tóta, Eliane Gomes Alves and Valerio Ferracci. "Optimizing the Isoprene Emission Model MEGAN With Satellite and Ground-Based Observational Constraints." Journal of Geophysical Research: Atmospheres 128, 10.1029/2022JD037822, 2023.
- Vettikkat, Lejish, Pasi P.J. Miettinen, Angela Buchholz, Pekka A. Rantala, Hao Yu, Simon Schallhart, Tuukka Petäjä, Roger Seco, Elisa Männistö, Markku Kulmala, Eeva-Stiina Tuittila, Alex B. Guenther and Siegfried Schobesberger. "High emission rates and strong temperature response make boreal wetlands a large source of isoprene and terpenes." Atmospheric Chemistry and Physics, 23, 2683-2698, 10.5194/acp-23-2683-2023, 2023.
- Wang, Hui, Xincheng Lu, Roger Seco, Trissevgeni Stavrakou, Thomas G. Karl, Xiaoyan Jiang, Lianhong Gu and Alex B. Guenther. "Modeling Isoprene Emission Response to Drought and Heatwaves Within MEGAN Using Evapotranspiration Data and by Coupling With the Community Land Model." Journal of Advances in Modeling Earth Systems 14, e2022MS003174, 10.1029/2022MS003174, 2022.
- Wang, Yuxuan, Nan Lin, Wei Li, Alex B. Guenther, Joey C. Y. Lam, Amos P. K. Tai, Mark J. Potosnak and Roger Seco. "Satellite-derived constraints on the effect of drought stress on biogenic isoprene emissions in the southeastern US." Atmospheric Chemistry and Physics, 22, 14189-14208, 10.5194/acp-22-14189-2022, 2022.
- Seco, Roger, Thomas Holst, Cleo L. Davie-Martin, Tihomir Simin, Alex B. Guenther, Norbert Pirk, Janne Rinne and Riikka Rinnan. "Strong isoprene emission response to temperature in tundra vegetation." Proceedings of the National Academy of Sciences of the United States of America, 119, 38, e2118014119, 10.1073/pnas.2118014119, 2022.
- Sanjeevi Nagalingam, Roger Seco, Kirill Musaev, Chhandak Basu, Saewung Kim, Alex Guenther; Impact of heat stress on foliar biogenic volatile organic compound emission and gene expression in tomato (Solanum lycopersicum) seedlings. Elementa: Science of the Anthropocene, 10 (1): 00096. 10.1525/elementa.2021.00096, 2022.
- Gu, S., **A. Guenther**, and C. Faiola, Effects of Anthropogenic and Biogenic Volatile Organic Compounds on Los Angeles Air Quality. **Environmental Science & Technology**. 55 (18), 12191-12201, DOI: 10.1021/acs.est.1c01481, **2021**.
- Fu, D., Millet, D.B., Wells, K.C., Payne, V., Yu, S. and **Guenther, A.** Direct retrieval of isoprene from satellite-based infrared measurements. ***Nature Communications***, 10, 3811. doi.org/10.1038/s41467-019-11835-0, **2019**.
- **Guenther, A**., X. Jiang, C. Heald, T. Sakulyanontvittaya, T. Duhl, L. Emmons & X. Wang. The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions, ***Geophysical Model Development***, *5*, 1471-1492, **2012**.

**BIOGRAPHICAL AND BIBLIOGRAPHIC INFORMATION**
**ADINA PAYTAN**

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**EDUCATION**

1996 Ph.D. Oceanography, Scripps Institution of Oceanography
1989 M.S. Earth Sciences Oceanography, Hebrew University, Jerusalem
1987 M.S. Science Education, Weizmann Institute of Science, Rehovot
1985 B.S. Geology and Biology, Hebrew University, Jerusalem

**PROFESSIONAL EXPERIENCE**

2023-Present Distinguished Professor, Earth and Planetary Sciences, UCSC
2009-2023 Research Scientist, Institute of Marine Sciences, UCSC
2007-present Adjunct Scientist, Monterey Bay Aquarium Research Institute
2007-2009 Associate Research Scientist, Institute of Marine Sciences, UCSC
1999-2007 Assistant Professor, Geological & Environmental Sciences, Stanford University

**SELECT HONORS AND AWARDS**

2025 ASLO - Tommy and Yvette Edmondson Distinguished Service Award
2022 Vernadsky Medal, EGU for Exceptional Contributions to Biogeosciences
2020 Fulbright Fellow - Portugal
2019 A.G. Huntsman Award for Excellence in the Marine Sciences
2018 Fellow – American Geophysical Union
2018 Endowed Biogeochemistry Lecturer – Geochemical Society
2017 Fellow – Association of the Sciences of Limnology and Oceanography (ASLO)
2017 Keynote Speaker – Inaugural Dorothy Hill Women in Earth Science Symposium
2016 Women in Science and Engineering (WiSE) Award - UCSC
2015 Dansgaard Award, AGU mid-career Paleoceanography Award
2014-15 Lady Davis Fellowship, Hebrew University
2014 Fellow - Geochemical Society and European Association of Geochemistry
2013 Rachel Carson Lecture AGU
2013 Excellence in Research Award - Petersen Foundation
2011 COSEE Scientist Making an Impact
2009 Mildred Mathias Award as the outstanding proposal in the natural sciences
2008 Distinguished Lecturer - Consortium for Ocean Leadership
2007 Ellen Weaver Award for Support of Women in Science
2006 Aldo Leopold Leadership Fellow
2005 NSF CAREER Award
2005 GSA Ingerson Lecture
2004 AGU Oceanography Section Early Career Award
2002 NASA New Investigator Program in Earth Science Award
2000-01 Terman Fellowship, Stanford University
1990 Gerson Meerbaum Foundation for Oceanography Award

**MEMBERSHIPS IN PROFESSIONAL AND SCHOLARLY ORGANIZATIONS**

American Geophysical Union, American Society of Limnology and Oceanography
American Geochemical Society, American Association for Advancement of Science
American Women in Science, Association for Women Geoscientists

**RESEARCH SUPPORT**

Since 1999 PI or co-PI on research grants totaling >$23 million in funding to support research and education activities (NSF, NASA, NOAA, Sea Grant, USDA, ACS, NATO, US-AID, Belmont Forum and more).

**CURRENT AND PAST ADVISEES**

20 Post Doctoral Fellows, 31 Ph.D. students and 21 M.S. students

**RECENT PROFESSIONAL ACTIVITIES**

| | |
|---|---|
| 2025-Present | Editorial Committee Annual Review of Marine Science |
| 2023-Present | Academic Advisory Board, Inst. Earth Sciences, Academia Sinica, Taiwan |
| 2023-Present | AGU Ocean Science, Fellow award committee |
| 2022-Present | EGU Award Vernadsky Medal Committee |
| 2022-Present | Editor Geo-Health |
| 2020-Present | Advisor Instituto LAMIR Universidade Federal do Paraná - UFPR |
| 2022-2024 | AGU Ocean Science Fellows Committee |
| 2020-2022 | Science Innovation Award Committee, EAG |
| 2020-2022 | AGU Fellows Selection Committee |
| 2020-2024 | AAAS Section Election Nomination Committee |
| 2018-Present | European Research Council – Advance Proposals Evaluator |
| 2016-Present | European Research Council – Consolidator Proposals Evaluator |
| 2015-2022 | Editor $G^3$ |
| 2019-2023 | Editor Marine Geology |
| 2019-Present | Editorial Board - Marine Chemistry |
| 2019-2024 | Co-Director Urbino Summer School in Paleoceanography |
| 2018-Present | Coordinator – LOREX Limnology and Oceanography Research Exchange |
| 2018-2025 | GEOMAR Kiel – External Science Advisory Board member |

**SELECT RELEVANT PUBLICATIONS**

Out of >340 publications, H-index 87, I-10 Index 265, >24,000 citations (Google Scholar).
Papers can be found at https://paytanlab.sites.ucsc.edu/publications/
* Indicates student or postdoc supervised by Paytan


*Brereton A, Z Mekonnen, B Arora, W Riley, K Yuan, Y *Xu, Y Zhang, Q Zhu, **A. Paytan** Development of a Model Framework for Terrestrial Carbon Flux Prediction: the Regional Carbon and Climate Analytics Tool (RCCAT) Applied to Non-tidal Wetlands. 2024, EGUsphere 2025, 1-28

Wei S, **Paytan A**, Chu X, Zhang X, Song W, Wang X, Li P, Han G. Vegetation Types Shift Physiological and Phenological Controls on Carbon Sink Strength in a Coastal Zone. Global Change Biology. 2025 January 24; 31(1). DOI: 10.1111/gcb.70029

Jones S, *Arias-Ortiz A, Baldocchi D, *Eagle M, Friess D, Gore C, Noe G, Nolte S, Oikawa P, **Paytan A**, Raw J, Roberts B, Rogers K, Schutte C, Stagg C, Thorne K, Ward E, Windham-Myers L, Yando E. When and where can coastal wetland restoration increase carbon sequestration as a natural climate solution? Cambridge Prisms: Coastal Futures. 2024 October 11; 2. DOI: 10.1017/cft.2024.14

*Arias-Ortiz A, Oikawa P, Carlin J, Masqué P, Shahan J, Kanneg S, **Paytan A**, Baldocchi D. Tidal and Nontidal Marsh Restoration: A Trade-Off Between Carbon Sequestration, Methane Emissions, and Soil Accretion. Journal of Geophysical Research: Biogeosciences. 2021 November 23; 126(12): DOI:10.1029/2021JG006573

*Richardson, C. M., Fackrell, J. K., Kraus, T. E. C., Young, M. B., & **Paytan, A**. 2020. Lateral carbon exports from drained peatlands: An understudied carbon pathway in the Sacramento-San Joaquin Delta, California. *Journal of Geophysical Research*: Biogeosciences,125, e2020JG005883.

*Richardson, C. M, Fackrell, J. K, Kraus, T. E, Young, M., and **Paytan, A**. 2022. Nutrient and Trace Element Contributions from Drained Islands in the Sacramento–San Joaquin Delta, California. *San Francisco Estuary and Watershed Science*, 20(2)

*Richardson, M. Young, **A. Paytan**. 2023. Paired Synoptic and Long-Term Monitoring Datasets Reveal Decadal Shifts in Suspended Sediment Supply and Particulate Organic Matter Sources in a River-Estuarine System. *Estuaries and Coasts*. https://doi.org/10.1007/s12237-022-01160-z.

*Chuang, P.-C., *Young, M.B., Dale, A.W., Miller, L.G., Herrera-Silveira, J.A. and **A. Paytan** (2017), **A. Paytan**. (2017) Methane fluxes from tropical coastal lagoons surrounded by mangroves, Yucatan, Mexico. Journal of Geophysical Research: Biogeosciences, 122,

*Chuang P-C., M. B. *Young, A. W. Dale, L. G. Miller, J. A. Herrera-Silveira and **A. Paytan**. (2016) Methane and sulfate dynamics in sediments from mangrove-dominated tropical coastal lagoons, Yucatán, Mexico. Biogeosciences, 13, 2981–3001.

*Black, F. J., **A. Paytan**, K. L. Knee, N. De Sieyes, P. Ganguli, E. Gray, A. R. Felgal. 2009. Submarine Groundwater Discharge of Total Mercury and Monomethylmercury to Central California Coastal Waters. Environmental Science & Technology 43 (15): 5652-5659.

Paytan, A., *AL. Lecher, *N. Dimova, KJ. Sparrow, F. G-T Kodovska, *J. Murray, S. Tulaczyk, and J.D. Kessler (2015) Methane transport from the active layer to lakes in the Arctic using Toolik Lake, Alaska, as a case study. PNAS. doi/10.1073/pnas.1417392112

*Lecher, A.L., *P.C. Chuang, M. Singleton, **A. Paytan**. (2017) Sources of methane to an arctic lake in Alaska: An isotopic investigation, JGR: Biogeosciences, 122.

*Wankel, SD, A. C. Mosier, C. M. Hansel, **A. Paytan**, and C. A. Francis. 2011. Spatial Variability in Nitrification Rates and Ammonia-Oxidizing Microbial Communities in the Agriculturally Impacted Elkhorn Slough Estuary, California. Applied and Environmental Microbiology 77(1): 269–280, DOI/10.1128/AEM.01318-10

*Breier, J. A., N., Nidzieko, S. Monismith, W. Moore, and **A. Paytan**. 2009. Groundwater and surface water exchange in Elkhorn Slough, California: a coupled geochemical and hydrodynamic approach. *Limnology and Oceanography*. 54(6), 2009, 1964–1980.

*Wankel, S. D., C. Kendall, and **A. Paytan**. 2009. Using nitrate dual isotopic composition ($\delta^{15}$N and $\delta^{18}$O) as a tool for exploring sources and cycling of nitrate in an estuarine system: Elkhorn Slough, California. Journal of Geophysical Research 114: G01011.

*McLaughlin, K., B.J. Cade-Menun and **A. Paytan**. 2006. The oxygen isotopic composition of phosphate in Elkhorn Slough, California: A tracer for phosphate sources. Estuarine, Coastal and Shelf Science 70: 499-506.

*Gonneea, M.E., **A. Paytan,** and J.A. Herrera-Silviera. 2004. Tracing Organic matter sources and carbon burial in mangrove sediments over the past 160 years. Estuarine, Coastal & Shelf Sci. 61: 211-227.

Monismith, S., Jones, N., Bela, M., NidziekoDe. N., **A. Paytan**, *Misra, G. and *Street, J. 2005. Hydrodynamics and sediment dynamics in Elkhorn Slough: A report to Monterey Bay Sanctuary Foundation.

**Select Recent Relevant Conference Abstracts**

*Khan A, *D Baker-Berry, **A Paytan**. Carbon Speciation and Concentration in California Salt Marsh Surface Waters Under Varied Land Use History and Management Regimes. Goldschmidt 2025 Conference.

**A Paytan** AmeriFlux US-EKN Elkhorn Slough North Marsh. 2025. Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA (United States).

**A Paytan** AmeriFlux AmeriFlux US-EKH Elkhorn Slough Hester Marsh. 2025. Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA (United States).

*Ganey TM, M Adloff, A Ridgwell, SL Clegg, SK Turner, A Paytan, M Hain. 2024. Ion content and carbon speciation set ocean carbon and alkalinity inventories for balanced budgets. Goldschmidt 2024 Conference.

*Arias Ortiz A, DJ Szutu, JG Verfaillie, T Wang, R Shortt, **A Paytan**, ... Carbon Biogeochemical Cycling in Tidal Wetlands: Exploring Lateral Carbon Exchange and Sequestration Potential. AGU Fall Meeting Abstracts 2023, B54A-06

*Brereton A, ZA Mekonnen, B Arora, DD Baldocchi, JD Moulton, .. **A Paytan.** Evaluating Coastal Wetland Carbon Sequestration Potential: An Ecosystem Modelling Study. AGU Fall Meeting Abstracts 2023 (765), GC51L-0765

*Agrawal R, J *Jabuka, *A Arias Ortiz, **A Paytan**. 2023. Monitoring of lateral carbon export in tidal wetlands-Examples from Elkhorn Slough. AGU Fall Meeting Abstracts 2023, ED07-07

*Xu Y, Y Zhang, JD Moulton, **A Paytan.** Investigate the Impacts of Coastal Wetland Restoration on Surface and Subsurface Hydrology and Freshwater-saltwater Interaction. AGU Fall Meeting Abstracts 2023 (2145), EP33D-2145

*Galindo-Eguiarte V, *SM Pit, *A Arias Ortiz, **A Paytan** Carbon and Nitrogen content and Stable isotope analysis for Elkhorn Slough sediments. AGU Fall Meeting Abstracts 2023 (1811), B51E-1811

**EXHIBIT A6**

**CURRENT & PENDING SUPPORT**

| **PI: Alex Guenther** | | | | | |
|---|---|---|---|---|---|
| **Status** | **Award #** | **Source** | **Project Title** | **Start Date** | **End Date** |
| Active | 25RD001 | CARB | Improving estimates of CO2 and CH4 emissions from southern California coastal wetlands and BVOC emission estimates from all California landscapes | 11/1/2025 | 10/31/2028 |
| Active | | NOAA | Understanding the growing contribution of temperature-dependent VOC emissions to U.S. urban air pollution | 9/2025 | 8/2028 |
| Active | | NSF | Atmospheric Aerosol Formation in the California Desert | 4/2025 | 3/2028 |
| Active | | NASA | Investigate the influence of temperature-dependent emissions and processes on air quality during heatwaves | 2/2025 | 1/2028 |
| Active | AGS-2347370 | NSF | Biogenic VOC emissions from managed landscapes and their contribution to atmospheric ozone and aerosol | 2/2024 | 1/2027 |
| Active | 2024.001 | BAAQMD | BAAQMD biogenic VOC emissions and air quality modeling | 1/2024 | 9/2025 |
| Active | AGS-2327825 | NSF | Non-tailpipe Emissions: The Next Frontier in Vehicle Contributions to Air Quality and Climate Change | 1/2024 | 12/2025 |
| Active | 22-EARTH22-0135 | NASA | Using new generation satellite observations to investigate the influence of drought and heatwave on isoprene emission | 9/2023 | 8/2026 |
| Active | | DOE | Observational Constraints on Biogenic VOC Interactions with Ecosystem Stress and Climate in the Southeastern U.S. | 4/2025 | 3/2028 |

**Co-PI: Adina Paytan**

| Status | Award # | Source | Project Title | Start Date | End Date |
|---|---|---|---|---|---|
| Active | 25RD001 | CARB | Improving estimates of CO2 and CH4 emissions from southern California coastal wetlands and BVOC emission estimates from all California landscapes | 11/1/2025 | 10/31/2028 |
| Active | | NSF | LOREX ME | 9/2025 | 8/2028 |
| Pending | | DOE | Linking Microbial Subsurface Processes to Carbon and Nitrogen Dynamics in Coastal Wetlands | 1/2026 | 12/2028 |
| Active | 2325493 | NSF | Collaborative Research: GEOPaths: IN: DIG IT (Data in Geosciences in Teaching) | 9/2023 | 8/2026 |
| Active | L22CR4529 | UCOP | Collaborative Research: Coastal Wetland Restoration a Nature Based Decarbonization Multi-Benefit Climate Mitigation Solution | 4/2022 | 4/2026 |
| Active | Q2196005 | CDFW | High frequency water quality monitoring of agricultural drainage in the Sacramento-San Joaquin Delta | 10/2021 | 9/2026 |
| Active | OISE 1831075 | NSF | IRES Track III - International Research Engagement for Graduate Level Professional Development: Limnology and Oceanography Research Exchange (LOREX) On no-cost extension | 3/2018 | 2/2026 |

**EXHIBIT A7**

**THIRD PARTY CONFIDENTIAL INFORMATION**

**CONFIDENTIAL NONDISCLOSURE AGREEMENT**

*Exhibit A7 is not applicable for this Agreement.*

**EXHIBIT B2**

**SUBAWARDEE BUDGET(S)**

*Use Exhibit B2 subawardee budget template for each subrecipient.*

**EXHIBIT B3**

**INVOICE ELEMENTS**

In accordance with Section 14 of Exhibit C – Payment and Invoicing, the invoice, summary report and/or transaction/payroll ledger shall be certified by the University's Financial Contact and the PI (or their respective designees).

**Invoicing frequency**

☒ Quarterly ☐ Monthly

**Invoicing signature format**

☐ Ink ☒ Facsimile/Electronic Approval

**Summary Invoice – includes either on the invoice or in a separate summary document – by approved budget category (Exhibit B) – expenditures for the invoice period, approved budget, cumulative expenditures and budget balance available[1]**

- Personnel
- Equipment
- Travel
- Subawardee – Consultants
- Subawardee – Subcontract/Subrecipients
- Materials & Supplies
- Other Direct Costs
    - TOTAL DIRECT COSTS (if available from system)
- Indirect Costs
    - TOTAL

**Detailed transaction ledger and/or payroll ledger for the invoice period [2]**

- University Fund OR Agency Award # (to connect to invoice summary)
- Invoice/Report Period (matching invoice summary)
- GL Account/Object Code
- Doc Type (or subledger reference)
- Transaction Reference#
- Transaction Description, Vendor and/or Employee Name
- Transaction Posting Date
- Time Worked
- Transaction Amount

[1] If this information is not on the invoice or summary attachment, it may be included in a detailed transaction ledger.

[2] For salaries and wages, these elements are anticipated to be included in the detailed transaction ledger. If all elements are not contained in the transaction ledger, then a separate payroll ledger may be provided with the required elements.

## EXHIBIT D

## ADDITIONAL REQUIREMENTS ASSOCIATED WITH FUNDING SOURCES

**University to Complete:**

Research and Development (R&D) means all research activities, both basic and applied, and all development activities that are performed by non-Federal entities. The term research also includes activities involving the training of individuals in research techniques where such activities utilize the same facilities as other R&D activities and where such activities are not included in the instruction function.

This award ☑ does ☐ does not support Research & Development.

## EXHIBIT E

## SPECIAL CONDITIONS FOR SECURITY OF CONFIDENTIAL INFORMATION

*Exhibit E is not applicable for this Agreement.*

**EXHIBIT F**

**ACCESS TO STATE FACILITIES OR COMPUTING RESOURCES**

*Exhibit F is not applicable for this Agreement.*

# EXHIBIT G

# NEGOTIATED ALTERNATE UTC TERMS

**I. Exhibit C, UTC – 220 Section 14 – Payment & Invoicing is hereby amended to incorporate the following:**

**Add Item 6 to Section 14. A. to read as follows:**

6) CARB shall withhold payment equal to 10 percent after the Contractor has been compensated for 90 percent of the total agreement amount. The 10 percent shall be withheld until completion of all work and submission to CARB by the University of a final report approved by CARB in accordance with Exhibit A1, Schedule of Deliverables, Section 2. It is the University's responsibility to submit one (1) original and one (1) copy of the final invoice.

**Amend Section 14. C.2 – Invoicing to read as follows:**

2) Invoices shall be submitted in arrears not more frequently ~~than monthly and not less frequently~~ than quarterly to the State Financial Contact, identified in Exhibit A3. Invoices may be submitted electronically by email. If submitted electronically, invoice must include the following certification for State certification to the State Controller's Office, in compliance with SAM 8422.1
This bill has been checked against our records and found to be the original one presented for payment and has not been paid. We have recorded this payment so as to prevent later duplicate payment.

Signed: _____
State Agency Accounting Officer

**Add Item E: to Section 14, to read as follows:**

E. Advance Payment

1) Nothing herein contained shall preclude advance payments pursuant to Title 2, Division 3, Part 1, Chapter 3, Article 1 of the Government Code of the State of California.

2) Upon termination or completion of this Agreement, Contractor shall refund any excess funds to the CARB. Contractor will reconcile total Agreement costs to total payments received in advance and any remaining advance will be refunded to the CARB's Accounting Office. In the event the Agreement is terminated, total project costs incurred prior to the effective date of termination (including close-out costs) will be reconciled to total project payments received in advance and any remaining advance will be refunded to the CARB. In either event Contractor shall return any balance due to CARB within sixty (60) days, of expiration or earlier termination.

**II. Exhibit C, UTC – 220 Section 15 – Prior Approval Requirements and Budget Flexibility is hereby amended to incorporate the following:**

**Amend Section 15. B – Budget Flexibility to read as follows:**

B. Budget Flexibility

Budget revisions between identified budget categories in cost reimbursement agreements that are within the total Agreement amount, comply with the Prior Approval Requirements, above and do not change the Scope of Work or substitute Key Personnel, as defined in this Agreement, are allowed as described below:

1) Up to 10% ~~of each annual budget amount or $10,000, whichever is less~~, is allowed with approval of the State's Contract Project Manager, or as otherwise agreed to by the Parties and documented on Exhibit B.

2) Exceeding 10% ~~or $10,000, whichever is less,~~ of the last approved budget require the State's Contract Project Manager's prior approval and may require a formal amendment to this Agreement. The University will submit a revised budget to the State for approval. Budget transfers that would cause any portion of the funds to be used for purposes other than those consistent with the original intent of this Agreement are not allowed.

**III. Add the following sections to the UTC-220 to incorporate additional required provisions:**

**Add Section 31 to read as follows:**

**31. GenAI Disclosure Obligations:**

A. The following terms are in addition to the defined terms and shall apply to the Contract:

1) "Generative AI (GenAI)" means an artificial intelligence system that can generate derived synthetic content, including text, images, video, and audio that emulates the structure and characteristics of the system's training data. (Gov. Code § 11549.64.)

B. Contractor shall immediately notify the State in writing if it: (1) intends to provide GenAI as a deliverable to the State; or (2), intends to utilize GenAI, including GenAI from third parties, to complete all or a portion of any deliverable that materially impacts: (i) functionality of a State system, (ii) risk to the State, or (iii) Contract performance. For avoidance of doubt, the term "materially impacts" shall have the meaning set forth in State Administrative Manual (SAM) § 4986.2 Definitions for GenAI.

C. Notification shall be provided to the State designee identified in this Contract.

D. At the direction of the State, Contractor shall discontinue the provision to the State of any previously unreported GenAI that results in a material impact to the functionality of the System, risk to the State, or Contract performance, as determined by the State.

E. If the use of previously undisclosed GenAI is approved by the State, then Contractor will update the Deliverable description, and the Parties will amend the Contract accordingly, which may include incorporating the GenAI Special Provisions into the Contract, at no additional cost to the State.

F. The State, at its sole discretion, may consider Contractor's failure to disclose or discontinue the provision or use of GenAI as described above, to constitute a material breach of Contract when such failure results in a material impact to the functionality of the System, risk to the State, or Contract performance. The State is entitled to seek any and all remedies available to it under law

as a result of such breach, including but not limited to termination of the contract.

**Add Section 32 to read as follows:**

**32.Health and Safety**

Contractors are required to, at their own expense, comply with all applicable health and safety laws and regulations. Upon notice, Contractors are also required to comply with the state agency's specific health and safety requirements and policies.
Contractors agree to include in any subcontract related to performance of this Agreement, a requirement that the subcontractor comply with all applicable health and safety laws and regulations, and upon notice, the state agency's specific health and safety requirements and policies.

**Add Section 33 to read as follows:**

**33. Executive Order N-6-22 – Russia Sanctions**

On March 4, 2022, Governor Gavin Newsom issued Executive Order N-6-22 (the EO) regarding Economic Sanctions against Russia and Russian entities and individuals. "Economic Sanctions" refers to sanctions imposed by the U.S. government in response to Russia's actions in Ukraine, as well as any sanctions imposed under state law. The EO directs state agencies to terminate contracts with, and to refrain from entering any new contracts with, individuals or entities that are determined to be a target of Economic Sanctions. Accordingly, should the State determine Contractor is a target of Economic Sanctions or is conducting prohibited transactions with sanctioned individuals or entities, that shall be grounds for termination of this agreement. The State shall provide Contractor advance written notice of such termination, allowing Contractor at least 30 calendar days to provide a written response. Termination shall be at the sole discretion of the State.