**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**California – Ames**

**California Health & Air Quality**

*Measuring California Air Quality and Greenhouse Gas Quantities through the Use of Earth Observations to Assess the Effectiveness of Policy Initiatives and Public Health Trends Over Time*

**Project Overview**

***Project Synopsis*:** California is the leading state in the US when it comes to policy initiatives aimed at reducing heat-trapping gases and limiting carbon pollution. This project will focus on short-lived hydrofluorocarbon concentrations on a seasonal basis though the analysis of atmospheric particulate matter (PM2.5) and Aerosol Optical Depth (AOD), whose reduction is a co-benefit of air quality policies like California’s AB 32. AOD measurements will enhance the overall understanding of aerosol pollutants through California over time and provide greater insight into seasonal pollutants, such as the increase in AOD during a high fire season due to the increase in smoke. Data derived from Terra Moderate Resolution Imaging Spectroradiometer (MODIS), Merra-2, and CALIPSO will be averaged over three-year intervals from 2000 to present, at three different points in time to account for climatic variability between years. These data will be examined and compared with the Statewide GHG Emissions Inventory Program to better understand the influence of climate related policy initiatives.

***Community Concern:*** The findings provided by the World Health Organization from 2013 ranked air pollution as the 4th highest risk factor for death globally. As of 2016, there are 39.35 million people living in California, all of whom are affected by air quality, depending on location. Poor air quality can diminish an individual’s quality of life and result in diseases such as asthma, respiratory illnesses, and heart-related complications. Moreover, anthropogenically-derived GHG emissions are leading to increased warming globally, causing numerous environmental impacts such as sea level rise. This adverse impact could lead to the displacement of coastal businesses and residences, damage marine ecosystems, and reduce fresh water availability from snowpack. California is at risk of experiencing all of these issues, therefore, it is striving to find innovative solutions to reduce heat-trapping gases.

***Source of Project Idea:*** This project originated when Madeline Brozen, Associate Director of UCLA Institute of Transportation Studies, and DEVELOP alumni, reached out to Lauren Childs-Gleason in early August 2017 to assess the potential for a project collaboration.

***National Application Area Addressed:*** Health & Air Quality

***Study Location:*** California

***Study Period:*** March 2000 to October 2017

***Advisor:*** Dr. Juan Torres-Pérez (Bay Area Environmental Research Institute)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **California Air Resources Board** | Steve Cliff, Deputy Executive Officer  | End User | No |
| **University of California, Los Angeles, Institute of Transportation Studies** | Madeline Brozen, Associate Director  | Collaborator | Yes |
| **NASA Earth Exchange (NEX)** | Ramakrishna Nemani, Senior Earth Scientist | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:*** CARB uses two different emission reporting programs to record criteria pollutant and GHG emissions for large State facilities. These data are collected and visualized through the use of the CARB Pollution Mapping Tool and are entirely vector based. CARB uses CalEnviroScreen data which compiles 19 indicators to characterize pollution burdened populations throughout California. CARB is able to uses these data to track and measure compliance with environmental laws.

***End User’s Capacity to Use NASA Earth Observations:***

*California Air Resources Board* – CARB primarily uses excel data on GHG and criteria pollutants that is reported by state facilities to assess benchmarks set by environmental laws. California’s 2006 Global Warming Solutions Act, known as AB 32, as to reducing Greenhouse Gases (GHG) emission across the state to 1990 levels by 2020 and then 40% below that by 2030. Currently they use 40 ground stations located throughout California to monitor air quality.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*University of California, Los Angeles, Institute of Transportation Studies* – This collaborator will support the team through advising and attendance on partner calls. During the development of this project, Madeline Brozen provided valuable resources on what policy initiatives California has in place, aided in resource gathering, and acted as a knowledgeable source on the topic of California air quality measurements. She has also helped facilitate the connection between DEVELOP and our end user.

*NASA Earth Exchange* – Dr. Nemani expressed his interest in collaborating with NASA DEVELOP by providing access to the NEX facilities and data. NEX already ingests all the MODIS datasets, this collaboration will allow participants to gain experience programing and processing large datasets on a supercomputer. Ultimately, this process will increase our ability to process large datasets quickly increasing the amount of information we can provide our partners. The NEX team will advise on data available through NEX and processing.

***Dissemination by Boundary Organization*:**

*University of California, Los Angeles, Institute of Transportation Studies* – The UCLA Institute of Transportation Studies (UC ITS) is a part of a UC-wide Institute of Transportation Studies with campuses at Davis, Irvine, Berkeley and UCLA. Madeline Brozen from the UCLA branch works closely with individuals from the other schools allowing for decimation of project results and methodologies to the greater UC ITS network.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** During the research term, the team will have bi-weekly teleconferences with CARB and UCLA Institute of Transportation Studies. The team will also have the opportunity for in-person meetings with the NEX team. The main POC for this communication will be Jenna Williams, the current Center Lead at NASA Ames Research Center.

***Transition Plan*:** A formal end-user handoff will take place at the end of the research term in the form of a WebEx teleconference. Results will be sent via NASA’s Large File Transfer (LFT). This project is not likely to require software release.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **CALIPSO CALIOP** | Aerosol Profile  | An aerosol profile will be used to look over facilities that are required to report under the AB 32 to demonstrate how Earth observation data can provide visual understanding of unseen particulates. The VOCAL tool will be used to visualize and assess this data. |
| **Terra MODIS** | Aerosol Optical Depth | Monthly reports of MOD04\_L2 Collection 6 product, and will be seasonally-averaged for the three study periods to understand impacts of AB 32 over time. |

***Ancillary Datasets:***

California Emissions Inventory Development and Reporting System (CEIDARS) – analyze emissions data, reported by large state facilities that is used to develop air quality management plans.

CalEnviroScreen 3.0 Data – validation of areas with high levels of pollution at census track level; this dataset measures the ‘cumulative impacts’ different socioeconomic factors (poverty, race and ethnicity, and education) in addition to health reports for respiratory illnesses such as asthma.

CARB Pollution Mapping Tool – visualize and download GHG and criteria pollutants data that is reported from large California facilities; these data are what is used to determine if benchmarks for GHG reduction is being achieved.

NASA Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) Modeled Aerosol Optical Depth – understand AOD on a seasonal basis

***Modeling:***

Visualization of CALIPSO (VOCAL) (POC: Jordan Vaa, NASA DEVELOP)

***Software & Scripting:***

TerrSet – Processing imagery from Earth observations

Esri ArcGIS – Vector-based analysis

Python 3.4 – Script to extract AOD from MODIS and calculate PM2.5 data

Python 2.7 – Utilize the OSGEO4W shell to access GDAL Python module

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Aerosol Optical Depth Seasonal Analysis** | This product will provide geographical concentration visualizations of where aerosols are concentrated over time and how they change by season and year. It will help partners identify hot spots that continually have high concentrations of aerosols so that they can target areas for reduction to help meet 2030 and 2050 metrics and monitor population health more closely.  | Look at MODIS AOD and MERRA-2 to determine the mean of AOD for each season and average that over three years at 3 different points in time. This data will be grouped by air districts and act as the basis for the surface particulate matter seasonal concentration product. | I |
| **Surface Particulate Matter Seasonal Concentration Analysis** | This product will provide our partners with a way to see how seasonal changes affect the amount of PM in the air. This will allow CARB to see what times of year they may want to be focusing on for air quality in regard to human health.  | Using a modified version of the AOD and calculate PM2.5 python script to derive PM2.5 from the above product results. Overlaying industry sector and demographic data this will be compared with CalEnviroScreen 3.0 population vulnerability data.  | I |
| **VOCAL Facility Analysis** | This product will give partners a vertical profile of the particulate matter that is being produced by the facilities that report under AB 32. | Average monthly Level 3 CALPISO data on a seasonal basis for the study periods and compare to self-reporting results from CEIDARS. | I |

***End-User Benefit*:** This project will provide the end user with another way to visualize and assess GHG reduction targets. It will enhance their understanding of how NASA Earth observations can be used in conjunction with their already established GHG reporting mechanisms. These data provide a more robust and more frequent analyses of GHG levels and if desired, can be a way to inform CARB about GHG amounts independent of the California GHG Emission Inventory.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2018

***Related DEVELOP Work:***

2017 Summer (JPL) – California Health and Air Quality: Identifying Methane Emissions Patterns from Dairy Farms Using Aircraft Remote Sensing Observations and Image Classifications

2017 Fall (LaRC) – Shenandoah Health & Air Quality II: Monitoring Air Quality in Shenandoah National Park to Address National Park Service Initiatives Using NASA Earth Observations

2016 Summer (NCEI) – Coastal US Health & Air Quality: Understanding the Temporal and Spatial Variation of Air Quality to Support the Use of NASA Earth Observations

2016 Summer 2016 (ARC) – San Francisco Bay Health & Air Quality: Using Satellite, Aircraft, and Ground-Based Observations to Monitor Methane and Improve a Greenhouse Gas Inventory Network for the San Francisco Bay Area

2015 Summer (LaRC) – CALIPSO Cross-Cutting: Developing software to further assist researchers in the tracking and identifying of aerosols in the Earth’s atmosphere through CALIPSO data

**Notes & References:**

***Notes*:**

CalEnvioScreen 3.0 data download - <https://oehha.ca.gov/calenviroscreen/maps-data/download-data>

CalEnvioScreen 3.0 data visualizer - <https://oehha.maps.arcgis.com/apps/webappviewer/index.html?id=4560cfbce7c745c299b2d0cbb07044f5>

CARB Pollution Mapping Tool - <https://www.arb.ca.gov/ei/tools/pollution_map/>

LAADS Web – download MOD04\_L3 data - <https://ladsweb.modaps.eosdis.nasa.gov/>

AOD to PM2.5 Python Script - <https://arset.gsfc.nasa.gov/airquality/python-scripts-aerosol-data-sets-merra-modis-and-omi>

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CALIPSO – Data Availability Site - <https://www-calipso.larc.nasa.gov/tools/data_avail/index.php?d=2017>