

# NASA DEVELOP National Program

## 2019 Fall Project Proposal

### Virginia – Langley

#### Central America Health & Air Quality

*Assessing Air Quality Parameters Using NASA Earth Observations of Fire Events in Central America*

### Project Overview

**Project Synopsis:** During the dry season, the air quality of Central American countries is heavily influenced by the increased occurrence of fires. These fires release plumes of aerosols into the atmosphere, which can be harmful to the environment and to human health. In partnership with El Salvador's Ministerio de Medio Ambiente y Recursos Naturales (MARN), this project aims to use aerosol optical depth (AOD) measurements and fire detection products from MODIS, VIIRS, and CALIPSO to establish a baseline air quality index, identify fire events from 2000-2019, and map the effects of these events on air quality throughout the region. By providing the end-user with maps of AOD, a geodatabase of fire events, and a method for generating these maps, the end users will be able to monitor air quality throughout the entire region and better understand the impacts of biomass burning and wildfires.

**Community Concern:** Central America's dry season, which peaks annually from March – May, is accompanied by an increase in anthropogenic fires, such as biomass burning, and naturally occurring wildfires. Smoke plumes from these fires severely degrade the air quality in the region by contributing to a higher concentration of PM<sub>2.5</sub>, a pollutant that can cause significant health problems such as lung disease, asthma, and heart problems. These fine particles, also known as aerosols, play a key role in the global climate system. High concentrations of fine particulate matter can contribute to the acidification of nearby water bodies, deplete nutrients in the soil, and damage sensitive crops and forest systems. Particulate matter can also stain or damage man-made objects of cultural significance, such as monuments or statues.

**Source of Project Idea:** This project supports the NASA-SICA Joint Statement for Activities in Applied Science Research and Earth Observations for Societal Benefit.

**National Application Areas Addressed:** Health & Air Quality, Disasters

**Study Location:** Central America

**Study Period:** 2000 – 2019

**Advisors:** Dr. Kenton Ross (NASA Langley Research Center); Dr. Travis Toth (NASA Langley Research Center)

### Partner Overview

#### Partner Organization:

Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?
Ministerio de Medio Ambiente y Recursos Naturales (MARN) (El Salvador)	Telma Chávez, Remote Sensing Specialist	End User	No
Ministerio de Medio Ambiente y Recursos Naturales (MARN) (Guatemala)	Kenset Rosales, Coordinator, Environmental Information and Climate Change Unit	End User	No

### End-User Overview

**End User's Current Decision-Making Process:** MARN currently has a well-established air quality monitoring system for the metropolitan area of San Salvador, which consists of a network of three monitoring stations located throughout the city. These stations gather *in situ* measurements of PM<sub>2.5</sub> each day, and MARN releases weekly air quality reports using a previously established classification system, the Central American Index of Air Quality (ICCA). This index rates air quality based on a six-tiered scale from 'Dangerous' to 'Good.' This information is available to the public on the MARN website.

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

*Ministerio de Medio Ambiente y Recursos Naturales* – MARN El Salvador currently generates air quality reports based on *in situ* measurements, and does not use NASA Earth Observations.

**Project Communication & Transition Overview**

**In-Term Communication Plan:** The team will have biweekly teleconferences with partners to provide updates on project methodologies and analyses throughout the term. The Project Lead will be the primary point of contact for in-term communications with project partners. Steve Padgett-Vasquez will be the primary POC for any translation needs throughout the term.

**Transition Plan:** A handoff will be conducted via webinar at the end of the term via Skype or Webex. End-users will receive a package with access to the final products via NASA Large File Transfer (LFT). The team will present their results and conclusions and answer any questions the end-user has at this time.

**Earth Observations Overview**

**Earth Observations:**

Platform & Sensor	Parameters	Use
Aqua MODIS	Aerosol Optical Depth, Active Fire Product	MODIS derived fire products will be used to identify the source anthropogenic fire events, and Aerosol Optical Depth will act as an air quality indicator.
Terra MODIS	Aerosol Optical Depth, Active Fire Product	MODIS derived fire products will be used to identify the source anthropogenic fire events, and Aerosol Optical Depth will act as an air quality indicator.
Suomi NPP VIIRS	Aerosol Optical Thickness, Active Fire Product	VIIRS derived fire products will be used to identify the source anthropogenic fire events, and Aerosol Optical Thickness will act as an air quality indicator.
NOAA-20 VIIRS	Aerosol Optical Thickness, Active Fire Product	VIIRS derived fire products will be used to identify the source anthropogenic fire events, and Aerosol Optical Thickness will act as an air quality indicator.
CALIPSO CALIOP	Aerosol Profiles and Layers	CALIPSO products will be used for validation of MODIS and VIIRS air quality products.

**Ancillary Datasets:**

- European Commission Joint Research Centre Global Wildfire Information System (GWIS) – Obtain harmonized fire information such as active fires, burnt areas, and fire emission information
- *In situ* measurements of PM<sub>2.5</sub> – Relate AOD to PM<sub>2.5</sub> for this geographic area

**Software & Scripting:**

- ENVI – Image processing

- R – Calculate annual average baseline values for air quality indicators; convert AOD to PM<sub>2.5</sub>
- Esri ArcGIS – Generate maps for baseline and fire event air quality indicators; create a geodatabase of anthropogenic and natural fire events

## Decision Support Tool & End Product Overview

### End Products:

End Product	Partner Use	Datasets & Analyses	Software Release Category
<b>Baseline Annual Air Quality Indicator Maps</b>	Baseline air quality maps will help the end-user understand the spatial distribution of aerosols between rural and urban areas, and will provide a reference point to study air quality following fire events.	MODIS AOD and VIIRS AOT will be averaged throughout the year to provide baseline maps for each year from 2010-2019, with validation from CALIPSO.	N/A
<b>Geodatabase of Anthropogenic and Natural Fire Events</b>	The partners will use this information to understand the differing impacts of anthropogenic and naturally occurring fires on air quality, and to relate changes in air quality to different specific events.	MODIS and VIIRS active fire products will be used to map fires across the region and distinguish between anthropogenic and naturally-occurring fires. This information will be supplemented with data from GWIS.	N/A
<b>Air Quality Indicator Maps of Anthropogenic and Natural Fire Events</b>	These maps will provide the end-user with a better understanding of the spatial impacts of fire events on air quality, and can be used in conjunction with current air quality monitoring tools to monitor air quality across the country.	MODIS AOD and VIIRS AOT will be mapped for the entire region in the aftermath of selected fire events of interest, with validation from CALIPSO.	N/A
<b>PM<sub>2.5</sub> Maps of Anthropogenic and Natural Fire Events</b>	These maps will be compatible with the end-user's current air quality monitoring classification, which will allow partners to disseminate this information in the same index as their current monitoring station data.	An algorithm that relates AOD and AOT with PM <sub>2.5</sub> will be generated and applied to aerosol maps.	N/A
<b>Tutorial of Methods</b>	This document will provide end-users with the information required to continue these analyses independently and continue tracking fire events and air quality throughout the region.	N/A	N/A

**End-User Benefit:** The maps generated from this project will provide baseline air quality information for the entire region, which will help end-users identify areas experiencing lower than average air quality in the wake of fire events. The geodatabase of fire events will help the partners distinguish wildfires from biomass burning events, and identify the source of fires that negatively impact air quality. By including a tutorial of methods, the end-user will be able to continue to ingest NASA Earth Observation data and record future fire

events, which will allow the partners to study a larger geographic area and provide more extensive air quality information to the public.

## **Project Timeline & Previous Related Work**

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**Project Timeline:** 1 Term: 2019 Fall

### **Related DEVELOP Work:**

2018 Fall (LaRC) – Intermountain West Health & Air Quality II: Monitoring Regional Air Quality to Address Air Pollution in National Parks Through the Application of NASA Earth Observations

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

2016 Spring (GSFC) – Gulf of Mexico Health & Air Quality: Utilizing NASA Earth Observations to Manage Air Quality and Pollutants over the Gulf of Mexico

## **Notes & References:**

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**Notes:** The team may wish to investigate alternative data sources, such as Sentinel-5 TROPOMI. *In situ* PM<sub>2.5</sub> data may be acquired from AERONET sites in the region or datasets available through the partners. The team may also wish to explore additional air quality indicators that are not currently included in this proposal, such as NO<sub>2</sub> and SO<sub>2</sub>.

### **References:**

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Health and Environmental Effects of Particulate Matter (PM). *United States Environmental Protection Agency*. Retrieved from <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>

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Wang, J., Christopher, S., Nair, U. S., Reid, J., Prins, E. M., Szykman, J. M. and Hand, J. L. (2006). Mesoscale modeling of Central American smoke transport to the United States: 1. “Top-down” assessment of emission strength and diurnal variation impacts. *Journal of Geophysical Research*, 111, D05S17. doi:10.1029/2005JD006416