NASA DEVELOP National Program

**2020 Fall Project Proposal**

**Idaho – Pocatello**

**Southern Idaho Health & Air Quality**

*Monitoring Fire Smoke Production and Spread by Monitoring Atmospheric Mixing Heights Post-Wildfire Through the use of NASA Earth Observations*

**Project Overview**

***Project Synopsis*:** While wildfires have a direct impact on the landscape and infrastructure, there is a long-lasting effect of smoke that is often overlooked. Smoke from large wildfires has a strong potential to travel thousands of miles from its source, affecting air quality and causing risk to human health on a very broad scale. The project proposes to work with the NOAA National Weather Service, National Park Service, & Bureau of Land Management to create a validation and tracking tool for monitoring smoke plumes from large fire events. It will use CALIPSO CALIOP, Suomi NPP VIIRS, and Terra and Aqua MODIS data to track aerosol content and movement throughout the atmosphere and monitor fire events to create a library of predictive variables for more aggressive smoke-producing wildfire events. Monitoring ground cover type of the fire, along with smoke production and movement, will allow the DEVELOP team to create a catalog of variables to better validate and predict smoke events during fire seasons.

***Community Concern:*** Wildfires have increased in frequency across the US since 1950. Fires across the United States cause not only damage to landscapes and infrastructure but can also have long-term effects on human health due to smoke and ash spreading for potentially thousands of miles from a fire source. The National Weather Service attempts to monitor these smoke and ash plumes mixing heights in the atmosphere and predict where they might travel. Past fires are used as an analog for predicting smoke expulsion from future fires. Better understanding and validation of aerosol mixing and travel patterns will allow project partners to better allocate resources to manage public notices and air quality warnings.

***Source of Project Idea:*** This was identified as a potential project idea during a meeting between local partners and the Idaho State University GIS Training and Research Center (GIS TRec). Heath Hockenberry from the NWS then reached out to the Idaho – Pocatello DEVELOP team to propose the project idea.

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

***Study Location:*** Southern ID

***Study Period:*** 2000 – 2020 (May – September)

***Advisors:*** Keith Weber (Idaho State University GIS TReC), Dr. Travis Toth (NASA Langley Research Center), Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **NOAA, National Weather Service** | Heath Hockenberry, Fire Weather Program Manager; Robyn Heffernan, Predictive Services Meteorologist | End User | No |
| **National Park Service, Fire Management Program Center** | Mark Fitch, Smoke Management Specialist | End User | No |
| **Bureau of Land Management, National Interagency Fire Center** | Dave Mueller, Hazardous Fuels Reduction Program | End User | No |

***End User Overview***

***End User’s Current Decision-Making Process:***The end users of this project currently make smoke pollution decisions based on a reactive analysis of how fires burn and the direction the smoke takes from the fire source. Atmospheric and smoke variables are acquired from ground-based weather stations, where the data are then interpolated to make decisions based on aerosol dispersion. The partners’ current goal is to validate past fires to see if these reactionary predictions are effective from *in situ* measurement sites.

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

*NOAA, National Weather Service* – This partner uses NASA Earth observations (EO) to inform decision making using validation methods to measure smoke predictions. The agency uses EOs minimally to observe smoke distribution but does not use EOs to predict or research further implications of smoke distribution. This project will build the partner's capacity to use EOs as a tool to monitor smoke dispersion and to couple these data with *in situ* data to have more robust smoke monitoring methods.

*National Park Service, Fire Management Program Center* – This partner uses NASA and ESA EOs in a predictive and responsive fashion to administer smoke warnings to urban areas near fire centers. This project will increase the partner’s capacity to use EOs for warning and response validation.

*Bureau of Land Management, National Interagency Fire Center* – This partner uses NASA EOs in a responsive manner to analyze fire patterns. This project will help the agency to use EOs in a research manner to monitor a wider variety of fire and smoke variables.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will have a biweekly teleconference with the project partners. They will use these meetings to provide updates and discuss project goals.

***Transition Plan*:** The Idaho DEVELOP team will conduct a virtual handoff and closeout at the end of the term with the partners. The partners will receive all of the final maps and a tutorial for the methods of the project from the DEVELOP team for implementation during the next fire season. No software release will be required by the team.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **CALIPSO CALIOP** | Lvl 2 5 km Aerosol Profile, Vertical Feature Mask | This EO will be used to analyze levels of fire-related aerosols in the atmosphere, and the height, following wildfires. |
| **Terra MODIS** | Lvl 2 MOD04 AOD, Lvl 3 MOD08 AOD, and Lvl 2 MCD19A2 AOD, MCD14DL Active Fire | These data will be used to analyze levels of fire-related aerosols in the atmosphere, and the height, following wildfires using Multi-Angle Implementation of Atmospheric Correction (MAIAC) calculations. |
| **Aqua MODIS** | Lvl 2 MYD04 AOD, Lvl 3 MYD08 AOD, and Lvl 2 MCD19A2 AOD, MCD14DL Active Fire  | These data will be used to analyze levels of fire-related aerosols in the atmosphere, and the height, following wildfires. |
| **Suomi NPP VIIRS** | AERDB\_L2\_VIIRS\_SNPP AOT, VNP14IMGTDL\_NRT Active Fire  | This EO will be used to analyze levels of fire-related aerosols in the atmosphere, and the height, following wildfires. |

***Ancillary Datasets:***

* LANDFIRE – Preexisting landcover types for fire analysis and smoke dispersion
* National Landcover Dataset (NLCD) – Landcover types for pre- and post-fire conditions
* NASA Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) – NASA reanalysis data with aerosol and planetary boundary height estimates

***Software & Scripting:***

* Python and/or R – MODIS, VIIRS, and MERRA-2 data processing
* ArcGIS Pro – Vector data manipulation
* IDRISI TerrSet – Raster manipulation
* Harris ENVI – Raster Manipulation

**Decision Support Tool & End Product Overview**

***End Products:***

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| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Smoke Distribution Validation Maps** | These maps will be used by the partners to monitor past smoke plume migration from large fire events to better understand variables leading to smoke expulsion and will validate current methods of smoke predictions. | This will use CALIPSO data to track aerosol activity in the lower atmosphere and use VIIRS and MODIS data to analyze variables contributing to fire type. | I |
| **Smoke Mixing Height Tutorial** | This tutorial will allow the partners to recreate these methods during the next fire season and beyond.  | This tutorial will involve how to acquire, use, and analyze CALIPSO, VIIRS, and MODIS data to track smoke mixing height and aerosol dispersion across the US. | I |

***End User Benefit*:** The National Weather Service, National Park Service, and Bureau of Land Management will be able to use the products created by the DEVELOP team to better allocate resources to deal with air quality warnings due to smoke and be better prepared to give go or no-go calls to areas with high human density due to air quality concerns. These products will give the partners strong validation methods for their current models of smoke prediction and allow them to better allocate resources in the future.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Fall 2020

***Related DEVELOP Work:***

2020 Summer (ARC) – Pacific Northwest Health & Air Quality: Utilizing NASA Earth Observations to Analyze Air Quality Impacts from Wildfires in the Pacific Northwest

2020 Spring (MSFC) – Washington Health & Air Quality: Quantifying Air Quality and Air Pollution Sources Impacting the Health of Puget Sound Residents Through the Use of NASA and ESA Earth Observations

2019 Fall (LaRC) – Central America Health & Air Quality: Assessing Air Quality Parameters Using NASA Earth Observations of Fire Events in Central America

**References:**

M. Fang & W. Huang (1998) Technical note - Tracking the Indonesian forest fire using NOAA/AVHRR images. *International Journal of Remote Sensing, 19(3)*, 387-390, DOI: 10.1080/014311698216044

Reid, J. S., Prins, E. M., Westphal, D. L., Schmidt, C. C., Richardson, K. A., Christopher, S. A., ... & Hoffman, J. P. (2004). Real‐time monitoring of South American smoke particle emissions and transport using a coupled remote sensing/box‐model approach. *Geophysical Research Letters*, *31*(6).

Reisen, F., Duran, S. M., Flannigan, M., Elliott, C., & Rideout, K. (2015). Wildfire smoke and public health risk. *International Journal of Wildland Fire*, *24*(8), 1029. doi: 10.1071/wf15034