**NASA DEVELOP National Program**

**Spring 2016 Project Proposal**

**NASA Goddard Space Flight Center**

**Gulf of Mexico Health & Air Quality**

Utilizing NASA Earth Observations to Manage Air Quality and Pollutants over the Gulf of Mexico

**Project Overview**

***Objective:*** This project aims to map airborne pollutants across the Gulf of Mexico (GOM), complete a time series analysis of pollutants in the region, correlate these pollutants to primary emission sources, and see how they compare with *in situ* data. Using NASA Earth observations, this project would create a methodology for the Bureau of Ocean Energy Management (BOEM) to monitor atmospheric plumes in the GOM to address future environmental concerns.

***Community Concern:*** BOEM assesses the potential onshore air quality impacts from petroleum resources at the outer continental shelf of the GOM. BOEM alone does not have the technology or the network monitoring records to address interconnected environmental concerns and scientific questions. As satellite data provides coverage and long-term (15+ years) record of metrics related to air quality in the region, BOEM is especially interested in utilizing NASA satellite imagery and data processing techniques that are relevant to BOEM’s needs of monitoring air quality in the GOM. These data will help answer questions pertaining to the fate of plumes from outer continental shelf sources, the impacts of these plumes on onshore ozone and particulate matter concentrations, and the primary emission sources compared with BOEM inventories.

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

***Study Location:*** Coastal and outer continental shelf under the United States jurisdiction over the Gulf of Mexico

***Study Period:*** January2000 – December 2015

***Advisor(s):*** Dr. Robert Levy (NASA GSFC), Dr. Pawan Gupta (NASA GSFC)

***Source of Project Idea:*** Dr. Jose Hernandez from BOEM reached out to ARSET after attending a training in Atlanta, GA (August 2015) for management of airborne pollutants in the GOM. At this point, the GSFC center lead, Sean McCartney, received an email from Dr. Robert Levy (ARSET/GESTAR/USRA) and Dr. Pawan Gupta (ARSET/GESTAR/USRA) requesting a collaboration between DEVELOP and BOEM.

**Partner Overview**

***Partner Organization(s):***

BOEM (End-User, POC: Dr. Jose Hernandez, Physical Scientist)

ARSET/GESTAR/USRA (Collaborator, POC: Dr. Pawan Gupta, Research Scientist)

***End-User Current Decision Making Process:***

To make a decision regarding air quality, offshore facility operators must include air emission information when they submit exploratory, development, and production plans. BOEM applies laws presented in the 30 Code for Federal Regulations 550.302 through 304, and, in general, follows the National Ambient Air Quality Standards (criteria pollutants) defined by U.S. EPA. If the projected emissions are below the onshore thresholds, the plan is exempt from further review and approved. Otherwise, operators have to apply the best available control technologies or emission offsets to limit the emissions. When a facility is not exempt, the operator has to use an approved model to determine whether the emissions impact the onshore ambient concentrations. In practice, operators run the air quality models using their average emission data. BOEM has not used satellite data before and seeks a methodology to support their emission inventories and operator information models.

***NASA Earth Observations Capacity:***

Bureau of Ocean Energy Management (BOEM) – In the past BOEM used interagency collaborations to exploit remote sensing in multidisciplinary projects. However, this is the first attempt to explore satellite information to manage and regulate offshore emission sources for air quality. BOEM does not have the infrastructure or a complete understanding of remote sensing, but has a goal to collect the best historical and existing data from satellite missions.

***Collaborator & Boundary Organization Support:***

Dr. Pawan Gupta/ARSET/ GESTAR/USRA is the collaborator on this project.

Dr. Gupta will support the project through bi-weekly email exchanges with the DEVELOP team targeting sensors and methodologies most appropriate in monitoring and managing atmospheric pollutants in the Gulf of Mexico. Dr. Gupta made first contact with the end-user and has years of experience focusing on retrieval of particulate matter air quality from satellite observations.

***Communication Plan & Transition Approach:***

Communication between all partners involved with the project will be primarily through weekly email exchanges and bi-weekly conference calls. The transition of all decision support tools to the end-user will be through email or large file transfer depending on the size of the files. The methodology will be incorporated into BOEM’s monitoring of pollutants within one year of obtaining tools and all other deliverables.

***End-User Benefit:***

Deliverables from this project are requested to enhance activities related to monitoring air quality and supporting operator information models. BOEM is requesting the monthly and annual regional analyses to be performed on the years 2000 to 2015, focusing on the years 2000, 2005, 2008, 2011, and 2014 for comparison with previous emissions inventories. Also, BOEM will benefit from the comparison of available pollutant (e.g. ozone, particulate matter) concentration profiles derived from remote sensing, with those from NOAA flights during the Deep Water Horizon Oil Spill (April 20, 2010). This validation is very important for quality assurance of final deliverables.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Aura** | Ozone Monitoring Instrument (OMI) | NO2, SO2, Ozone |
| **Aqua/Terra** | Moderate Resolution Imaging Spectroradiometer (MODIS) | Aerosols |
| **Terra** | Measurements Of Pollution In The Troposphere (MOPITT) | CO |
| **Suomi-NPP** | Ozone Mapping Profiler Suite (OMPS) | Ozone |
| **OCO-2** | Orbiting Carbon Observatory 2 - Instrument | CO2 |
| **CALIPSO** | Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) | Vertical Aerosol Profiles |

***NASA Earth Observations Use:***

OMI – Sensor onboard the Aura platform will be used to monitor concentrations of nitrogen dioxide, particulate matter or aerosols, and sulfur dioxide along coastal and offshore waters in the Gulf of Mexico.

MODIS – Sensor onboard the Aqua/Terra platforms will be used to monitor the ambient aerosol optical thickness over the GOM showing periods of controlled burns related to the Deepwater Horizon explosion in April 20, 2010.

MOPITT – Sensor onboard the Terra platform will be used to analyze the transport and sinks of CO and its effects in the lower atmosphere in the GOM.

OMPS – Sensor onboard the Suomi-NPP platform will be used to monitor airborne pollutants along coastal and offshore waters in the Gulf of Mexico.

OCO-2 – Sensor onboard the OCO-2 platform will be used to study CO2 concentrations along coastal and offshore waters in the Gulf of Mexico.

CALIOP – Sensor onboard the CALIPSO platform will be used to study vertical aerosol profiles along coastal and offshore waters in the Gulf of Mexico.

***Ancillary Datasets:***

Emission inventories collected on 2000, 2005, 2008, 2011, and 2014 – BOEM

**Decision Support Tool & End-Product Overview**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Time Series Analysis: Monthly and annual maps of pollutants at spatial resolution depending on satellites products, automated using scripts to allow for continued input of data for updated results | Comparison with BOEM’s emissions inventories; obtain background pollutant concentrations; and validation of petroleum operator modeling input data | Incoming reports from emission inventories and other agencies |
| Methodology to analyze concentration profiles of pollutants related to the Deepwater Horizon Oil Spill | Decision support and allocation of resources for regional evaluation of future emission scenarios and potential disaster events | Incoming data from other agencies |

*Time Series Analysis of Monthly/Annual Pollutants* – The team will import datasets from the six platforms (OMI, MODIS, MOPITT, OMPS, OCO-2, CALIOP) determining their relationship to pollutants in the Gulf of Mexico, providing a complete time series of airborne pollutants from 2000 - 2015. Python scripts will be created to automate this process for inputs to update results post-2015.

*Methodology to Analyze Concentration Profiles of Pollutants –* A best practices methodology will be conceived using raw datasets obtained from all six platforms (OMI, MODIS, MOPITT, OMPS, OCO-2, CALIOP) allowing BOEM to effectively monitor and allocate resources in the GOM when potential disasters occur in the future.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2016

***Previous Related DEVELOP Work:***

2010 Fall (Langley) – Gulf of Mexico Health and Air Quality: CALIPSO Decision Support for Gulf of Mexico Air Quality Relating to the Deepwater Horizon Oil Spill

2010 Fall (Stennis) - Gulf of Mexico Health and Air Quality: Aura Decision Support for Gulf of Mexico Air Quality Relating to the Deepwater Horizon Oil Spill

2010 Fall (Mobile) – Alabama Ecological Forecasting: Utilizing Remote Sensing Products for Monitoring Anthropogenic Sand Dune Movement on Dauphin Island, AL.

**Project Needs/Requests**

***Participants Requested:*** 4

***Software & Scripting:***

ENVI/IDL – Raster Manipulation/Analysis, Image Processing

ArcGIS – Raster/Vector Manipulation/Analysis, Image Enhancement & Map Creation of airborne pollutants from the six platforms

R – Statistical analysis and modeling of airborne pollutants from the six platforms

Python – Software integration