**Delaware Basin Health & Air Quality**

*Analysis of Air Pollutants Collected from Ground and Space Instruments Around the Guadalupe Mountains and Carlsbad Caverns National Parks*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

The Delaware Basin Air Quality project addressed effects from air pollution emissions in the Carlsbad Caverns and Guadalupe Mountain National Parks by creating seasonal maps of nitrogen dioxide from 2010 to 2021. Pairing data from publicly available natural gas plant emissions with Earth observations, the team utilized information from OMI and TROPOMI sensors to characterize moderate-to-fine resolution concentrations of these primary pollutants, which contribute to the burden of climate degradation through the formation of ozone and particulate matter.

***Abstract:***

Nitrogen dioxide (NO2) is a precursor for secondary air pollutants, which are associated with decreased visibility, and decreased ecosystem and respiratory health. NO2 is a growing threat to national parks within the Delaware Basin where nearby oil and gas activity contributes to deteriorating park conditions, implying adverse effects on the local tourism economy and public health. To demonstrate spatial and temporal patterns of air pollution in the parks, we examined average monthly, seasonal, and annual tropospheric column concentrations of NO2 in Carlsbad Caverns (CAVE) and Guadalupe Mountain (GUMO) National Parks. We used both the NASA Ozone Monitoring Instrument (OMI) and the European Space Agency (ESA) Tropospheric Monitoring Instrument (TROPOMI) to map NO2 tropospheric column densities. Using ground-based emissions values from the Environmental Protection Agency National Emissions Inventory (NEI) for two nearby natural gas processing plants (Indian Basin Gas Plant, South Carlsbad Plant), we extrapolated monthly trends from these point sources and compared seasonal emissions levels with the measurements recorded by OMI and TROPOMI. The NEI data show an 8% increase in flaring from 2013–2021. OMI measured a 38.3% NO2 increase over the Delaware Basin, 15.29% increase over CAVE, and 4.26% decrease over GUMO from 2011–2018. TROPOMI measured a -1% NO2 change over the Delaware Basin, 3% over CAVE, and 7% over GUMO from 2018–2020. The analysis indicates a positive correlation between emissions from fossil fuel exploration and NO2 concentrations above CAVE and GUMO. This information will inform National Park Service air quality monitoring and policy efforts to ensure compliance with the Clean Air Act.

***Key Terms:*** air quality, nitrogen dioxide, visibility, OMI, TROPOMI, national parks

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

***Study Location:*** Carlsbad Caverns National Park, Carlsbad, NM; Guadalupe Mountains National Park, Salt Flat, TX

***Study Period:*** May, 2010 – May, 2021

***Community Concerns:***

* Visitors to both parks are experiencing decreased visibility and air quality within the parks, which negatively impact the park experience.
* Negative park experiences from an unhealthy ecosystem will have an adverse effect on park attendance, harming the local tourism industry.
* Decreased visibility and air quality also contribute to acute respiratory problems among visitors and staff.
* Nitrogen dioxide (NO2) deposition increases acidity of water and alters soil chemistry, both resulting in worsened ecosystem health and biodiversity.

***Project Objectives:***

* Evaluate key relationships between pollution sources and air quality within Carlsbad Caverns (CAVE) and Guadalupe Mountains (GUMO)
* Produce monthly maps of NO2 over CAVE and GUMO to assist with park management policy surrounding air quality and visibility
* Validate satellite retrievals with *in situ* ground measurements to increase the credibility of satellite data to serve as an effective proxy for ground measurements of aerosol concentration

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service,**  **Intermountain Region** | Lisa Devore, Air Quality Specialist | End User | No |
| **National Park Service, Carlsbad Caverns National Park** | Erin Lynch, Physical Scientist | End User | No |
| **National Park Service, Guadalupe Mountains National Park** | Mike Medrano, Resource Stewardship and Science Manager | End User | No |

***Decision-Making Practices & Policies:***

Our partner’s focus is poor air quality and visibility over CAVE and GUMO. Currently, the NPS is abiding by the Clean Air Act, which was passed in 1970 with a mission to ensure clean air across the United States. By including data from the Interagency Monitoring Protection of Visual Environments (IMPROVE) and low-cost air monitors (PurpleAir), the NPS addresses air quality and visibility concerns for certain sections of the parks in compliance with the Clean Air Act. However, these monitors are not centralized and there are large gaps in monitor coverage. Therefore, utilizing satellite data will allow for a better spatial look at air quality and visibility issues throughout both parks.

**Earth Observations & End Products Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Sentinel 5p TROPOMI** | NO2 | For mapping recent monthly peaks in NO2 over the target region. |
| **Aura OMI** | NO2 | For mapping historic seasonal and annual peaks in NO2 the target region. |

***Ancillary Datasets:***

* New Mexico Environment Department Air Quality Ground Sensors – Validate EOs of NO2 from TROPOMI/OMI
* Information Handling Services Well Dataset – Visualize locations of oil and gas exploration

***Software & Scripting:***

* Python 3.9.7– Create maps and gifs of EOs
* IDL 8.8.1– Regridding and oversampling of NO2 satellite data
* Esri ArcGIS Pro 2.9.1 – Overlay of NO2 observations and national park boundaries
* Esri ArcGIS Online 2.9.2 – Produce StoryMap

***End Product:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **PDF of NO2 Overlay Maps** | Sentinel 5p TROPOMI and Aura OMI | Partners will use these maps to identify sources of pollution and work with local, state, and federal governments to improve the air quality of their park. | N/A |
| **Zip files of NO2 GIS rasters** | Sentinel 5p TROPOMI and Aura OMI | Partners will be able to perform additional analysis and add any layers from other research projects. | N/A |

***Product Benefit to End User:***

The partner organizations will be able to use the products created by the DEVELOP team to better understand the intensity and sources of atmospheric pollution. This information will assist future NPS policy on air quality and will allow the NPS to inform the public of ongoing air quality issues within the Delaware Basin region. In addition, the NPS will be able to improve the placement of any air quality monitoring stations to better measure pollution, and will be able to communicate to the public of the degrading air quality in the local community.

***Project Continuation Plan:***

The second term of the project will incorporate vegetation and precipitation variables as a means of understanding their correlation with pollution trends. They will explore the question: “Are the spatial and temporal trends of NDVI and precipitation correlated with the spatial and temporal trends in nitrogen column amounts over CAVE and GUMO?” The inclusion of these trends in the analysis will enhance the NPS’ understanding of how local pollution sources are impacting ecosystems and scenic resources in and around the parks.

**References**

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