Utilizing NASA Earth Observations to Analyze Air Quality Impacts from Wildfires in the Pacific Northwest

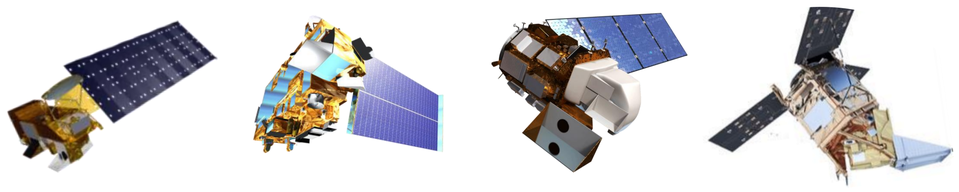
Abstract

The Pacific Northwest region of the United States and Canada, specifically Oregon, Washington, and Southern British Columbia, has become more vulnerable to intense wildfire regimes due to years of fire suppression and climatic changes. Smoke from fires exposes communities to hazardous aerosols and pollutants known to trigger asthma symptoms and exacerbate other respiratory and cardiovascular diseases. The NASA DEVELOP Pacific Northwest Health & Air Quality team, in partnership with The Nature Conservancy's Washington Chapter and the Puget Sound Clean Air Agency, investigated the impacts of wildfire smoke on air quality from 2008 to 2020 using NASA Earth observations. To explore the various dimensions of smoke and its relation to air quality, the team looked at the vertical extent of smoke plumes and the resulting changes in air quality. The team evaluated the potential relationship between plume height of wildfire smoke and fire radiative power using the Moderate Resolution Imaging Spectroradiometer aboard the Aqua and Terra satellites and Multi-angle Imaging SpectroRadiometer (MISR) aboard Terra with the MISR INteractive eXplorer (MINX). The team determined that there was no regional relationship between fire radiative power and smoke plume height. To investigate changes in air quality resulting from wildfire smoke, the team utilized data from NASA's Fire Information for Resource Management System, from the European Space Agency's Sentinel-5P (Precursor) Tropospheric Monitoring Instrument, and true color imagery from Landsat-8 Operational Land Imager. The team created a Google Earth Engine-based (GEE) web toolto visualize changes in pollutants (carbon monoxide, formaldehyde, nitrogen dioxide) and aerosol optical depth. Results of case study fires analyzed in the GEE tool showed varying increases in pollutant concentrations when compared to a baseline map. The end products provided the partners with tools to quantify plume height using MINX and to visualize recent air quality patterns relating to variations in wildfire extent and severity in the Pacific Northwest.

Objectives

- **Evaluate** how wildfire smoke impacts air quality in the Pacific Northwest
- **Create** a web-based tool in Google Earth Engine to visualize changes in air quality and the distribution via selected pollutants and aerosols due to fire events
- **Develop** a methodology and tutorial to assess smoke plume height
- **Provide** air quality information for locations with limited access to ground-based air quality sensors

Earth Observations



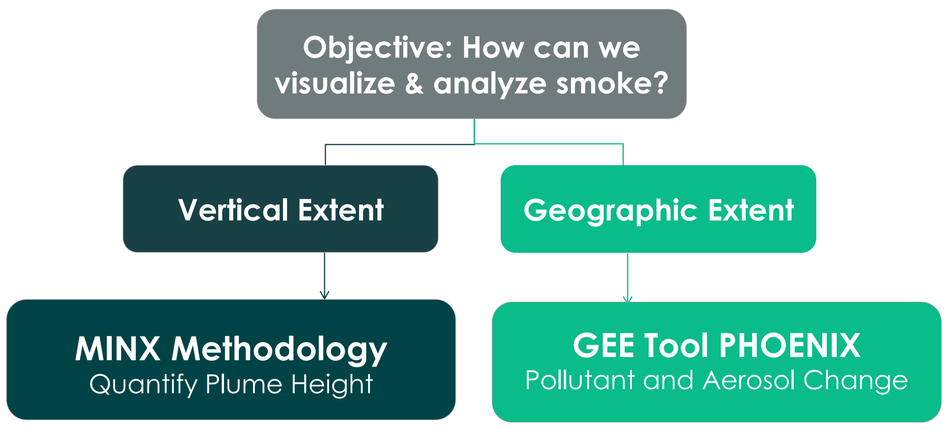
Aqua
MODIS

Terra
MODIS & MISR

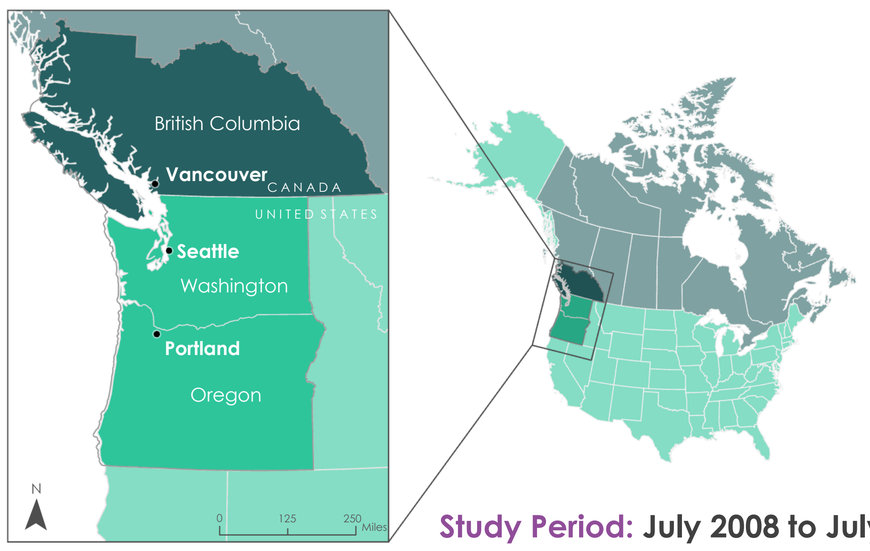
LANDSAT 8
OLI

Sentinel-5P
TROPOMI

Methodology



Study Area: The Pacific Northwest



Study Period: July 2008 to July 2020

Results

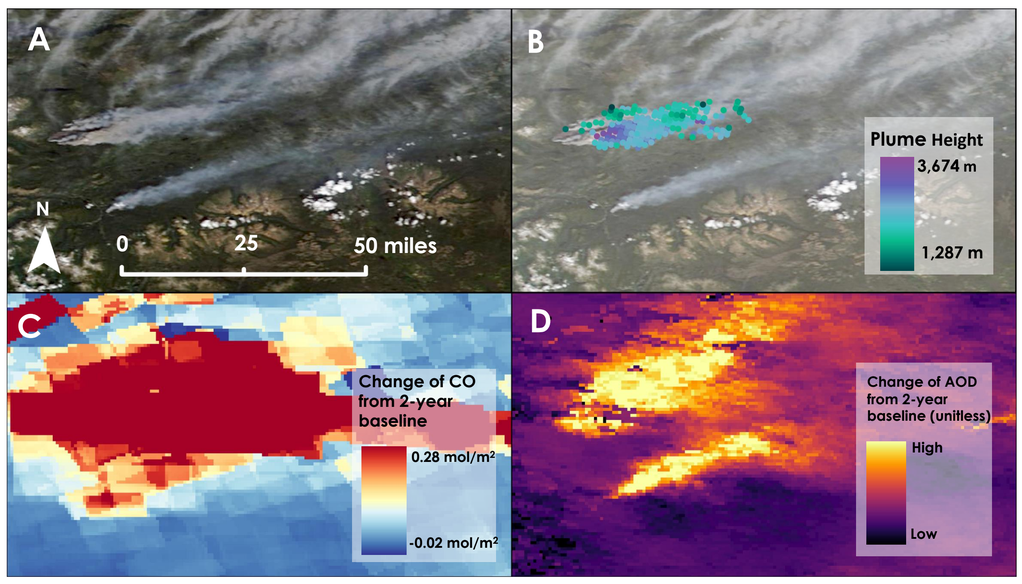
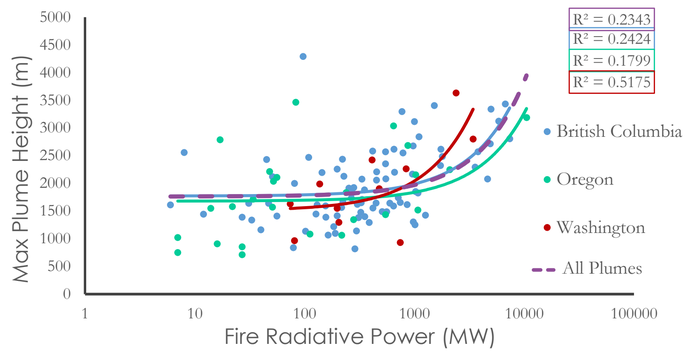


Figure 1: A wildfire event in British Columbia on August 6, 2018 displayed as a true color image (A), with plume height values in MINX (B), the resulting carbon monoxide (CO) increase from the PHOENIX GEE tool (C), and the increase in Aerosol Optical Depth (AOD) also derived from the GEE tool (D).

Figure 2. Fire Radiative Power and Max Plume Height in the Pacific Northwest

Figure 2: Plumes in the Pacific Northwest region plotted in total and by region with their maximum height in meters (m), and fire radiative power in megawatts (MW). The R^2 values show no statistically significant correlation between the two variables, even when analyzed by location. Plume height and fire radiative power data was derived from MISR in MINX.



Conclusions

- Satellite data can successfully visualize pollutant distribution and changing air quality levels over remote regions that lack ground monitoring stations.
- Changes in air quality surrounding a plume can be detected by looking at AOD and carbon monoxide using the PHOENIX tool.
- There is no regional, statistical correlation between fire radiative power and plume height.

Project Partners

- The Nature Conservancy, Washington Chapter
- Puget Sound Clean Air Agency

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DEVELOP

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