**Take Home Message**

- NASA Goddard’s Earth Observing System Composition Forecast (GEOS-CF) model produces global forecasts of atmospheric pollutants such as O₃, NO₂, PM₂.⁵ in near-real time. The project demonstrates one of the model applications for inferring estimated health impacts during severe air quality events.
- In the study we evaluated how the change in PM₂.⁵ level concentration impacts an individual’s respiratory and cardiovascular health as well as their daily activities.
- This work demonstrates that NASA’s observations and models are now detailed enough to assess the impact of wildfires on air quality and human health.
- Based upon the estimated health impact results from BenMAP we can make the broad assumption that individual’s (i.e. children and the elderly) respiratory and cardiovascular health was greatly affected due to the 2017 wildfire events in Washington and California.

**Methods**

GEOS-CF simulated PM₂.⁵ applied to a human health assessment model - BenMAP (The Environmental Benefits Mapping and Analysis Program, version 1.4.8), estimates the impact on adverse respiratory health conditions due to PM₂.⁵ exposure from wildfires.

**Background Information**

**Health Impact Results**

**Figure 1:** BenMAP calculates the health impact estimate based upon the change in pollutant concentration and exposed population, which refers to the number of individuals impacted by the change in pollutant concentrations.

**Figure 2:** The GEOS-FF weather model combined with the detailed chemistry from GEOS-Chem produces the PM₂.⁵ exposure maps, which is able to provide a 5 day forecast for various chemical species across the globe. GEOS-CF includes NO₂ and O₃ and the same type of study can be extended to these constituents.

**Figure 3:** PM₂.⁵ concentrations simulated by GEOS-CF agree well with independent observations (i.e. openAQ) for the August 2017 Seattle, Washington wildfires. GEOS-CF uses satellite observations to constrain fire emissions (i.e. GFED-the Quick Fire emissions dataset).

In this study we evaluated how the change in PM₂.⁵ level concentration impacts an individual’s respiratory and cardiovascular health as well as their daily activities.

**Figure 4:** The bar graphs above show that the 2017 Washington state wildfires produce the highest health impact estimates for each health endpoint (i.e. asthma exacerbation, work loss days, and minor restrictive activity days) compared to the California wildfire events.

**Figure 5:** (a) displays the August's monthly average GEOS-CF model PM₂.⁵ concentrations values throughout the Northern California area (b) and (c) the county distribution for the cough symptom (a) and the county distribution for the October's monthly average GEOS-CF model PM₂.⁵ concentrations values throughout the Northern California area (c) displays the December’s monthly average GEOS-CF model PM₂.⁵ concentrations values.

**Table 1:** The epidemiological studies described in the table were used in the health impact function to estimate which health endpoints produced the largest health impact estimate due to the change in PM₂.⁵ model concentrations.

**Table 2:** The wildfire event scenario dates evaluates the PM₂.⁵ levels prior to and during the wildfires and the background scenario evaluates the PM₂.⁵ levels after the wildfire. The delta represents the change in GEOS-CF PM₂.⁵ model concentrations between the baseline and background scenario. The largest delta value was calculated for the Washington wildfire event.

**Table 3:** The chart above shows the percentage of the total amount of individuals impacted by the specific health impact during a severe wildfire event based upon the BenMAP health impact estimate results.

**Conclusion**

- GEOS-CF can be used to perform analysis and predictions for PM₂.⁵ concentrations during severe air quality events (i.e. wildfires).
- According to BenMAP results it can be assumed that the 2017 wildfire events in Washington did impact individual’s respiratory health and daily activities.
- The simulated change in PM₂.⁵ from the wildfires was likely not large enough to impact severe-outcome health endpoints such as emergency room visits, hospital admissions, and mortality.
- The health impact results showed a minimal effect on individual’s cardiovascular health.

**Future Work**

- Evaluate severe air quality events across the globe (i.e. India) using the GEOS-CF model.
- Observe the resulting health impact estimates due to the 2018 wildfire events.

**Figure 6:** (a) displays the October’s monthly average GEOS-CF model PM₂.⁵ concentrations values throughout the Northern California area (b) and (c) the county distribution for the minor restrictive activity days health impact estimates and the corresponding exposed population density of the areas in Northern California. BenMAP’s health impact estimate results from their wildfire scenario in the San Francisco Bay Area.

**Figure 7:** (a) displays the October’s monthly average GEOS-CF model PM₂.⁵ concentrations values throughout the Northern California area; (b) and (c) the county distribution for the minor restrictive activity days health impact estimates and the corresponding exposed population density of the areas in Northern California. Source: BenMAP health impact estimate results from their wildfire scenario in the San Francisco Bay Area.