The air quality trade-offs of wildfire and prescribed burning smoke

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Background



Source: https://www.charlottestories.com/dozens-wildfires-now-spreading-across-north-carolina/

- In November 2016, severe wildfires occurred in the Southern Appalachian Mountains, likely due to severe drought conditions¹.
- In North Carolina, 26 major wildfires
 burned more than 62,000 acres².
- Drought conditions in this region are also projected to become more frequent in future years³.
- The degree to which prescribed fire may reduce the air quality impacts of wildfire is poorly understood.

- 1. Konrad et al. (2018), The Southeastern Drought and Wildfires of 2016
- 2. NCFS (2017), Biennial report
- 3. Mitchell et al. (2014), Future climate and fire interactions in the SE US

Objective

Investigate the air quality trade-offs between wildfire and prescribed fire smoke by simulating historical and hypothetical scenarios using BlueSky Pipeline and WRF-CMAQ.

2016 Western North Carolina wildfires



https://www.google.com/imgres?imgurl=https%3A%2F%2Fwildfiretoday.com%2Fwp-content%2Fuploads%2F2016%2F11%2FFiresInSouth_11-14-2016.jpg&imgrefurl=https%3A%2F%2Fwildfiretoday.com%2F2016%2F14%2Fmaps-of-five-wildfires-in-georgia-and-north-carolina%2F&tbnid=2nz1MBrq1pniPM&vet=12ahUKEwj7r9SKrN7oAhXyWDABHdCXBjgQMygAegUIARCjAQ.i&docid=dP6jXpFvo9DkHM&w=900&h=452&q=NC%202016%20wildfire%20map&ved=2ahUKEwj7r9SKrN7oAhXyWDABHdCXBjgQMygAegUIARCjAQ.i%docid=dP6jXpFvo9DkHM&w=900&h=452&q=NC%202016%2Fublc%2Fwp-content%2Fwp-cont

Historical scenario

CASE A: Air quality impact of PR and CK wildfires

Hypothetical scenarios

□ CASE B: Air quality impact of posttreatment PR and CK wildfires

CASE C:

Air quality impact of **hypothetical prescribed fires**

How to analyze the air quality impacts?



How to differentiate the fire emissions under these scenarios?

Impact of PR and CK wildfires (CASE A)

Fuel loading at parks

Fuel consumption & emissions
by wildfires

Fuel consumption

Fuel loading after wildfire



Impact of post-treatment PR and CK wildfires (CASE B)

Fuel loading after prescribed fire



Fuel consumption & emission by post-treatment wildfire

Fuel consumption

Fuel loading after post-treatment wildfire



Impact of hypothetical prescribed fires (CASE C)



Fuel consumption & emissions by prescribed fires



Fuel consumption

Fuel loading after prescribed fire



Modeling wildland fire smoke

Air Quality Model	: CMAQ v5.2.1
Meteorology Model	: WRF v4.1
Gas-phase Chemistry	: cb06_nvPOA
Aerosol Chemistry	: AERO6
Resolution	: 4km X 4km
Domain	: 612km x 948km covering NC
Emission	: 2016 beta emission inventory
Fire Emission	: BlueSky Pipeline
Simulation Period	: Jan 01 to Dec 31, 2016



Base case simulation

Background emissions (EGUs, oil and gas, commercial marine vessels, other area sources, prescribed fires, agricultural fires and wildfires)

Model Simulations with CMAQ



How to analyze trade-offs between prescribed fire and wildfire smoke ?

Impact of PR and CK wildfires (CASE A) Impact of post-treatment PR and CK wildfires (CASE B)



Fuel loading after prescribed fire Air quality impact by post-treatment wildf res

VS

CASE A - CASE B Air quality "benefit" of prescribed fires

Impact of hypothetical prescribed fires (CASE C)



Satellite Imagery and 24-hr average ΔPM_{2.5} from PR and CK fires (CASE A)

11/10/2016



11/12/2016

11/16/2016





Hypothetical prescribed fires (500 acres each) on different days (CASE C)



Annual aggregated impacts under different scenarios



The hypothetical wildfires have reduced air quality impacts.

Aggregated air quality benefits of prescribed fires are much higher than their own air quality impacts.

Temporal variation of impacts under different scenarios



Favored and affected population at different PM levels



Summary

□ Simulated concentrations are **consistent with the satellite images**.

- □ Air quality benefits of prescribed fires are higher than their air pollution impacts for the case study.
- The population benefiting from reduced wildfire pollution is larger than the population affected by prescribed fire smoke in the case study.

Limitations:

- □ Results are for **PR and CK fuel beds**.
- **Q** Results depend on the **selection of** hypothetical prescribed fire **burn dates**.
- **Q** Results will depend on the **actual burn area after fuel reduction**.

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Thanks

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Supplementary Slides

Model performance evaluation



Above 80% of the sites meet the air quality modeling target* for both NME and NMB.

Overall, NME and
 NMB of all sites meet
 benchmark model
 performance goals*.