

Wildland Fires: Towards Improved Understanding and Forecasting of Air Quality Impacts Summary of Day 1

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on behalf of the planning committee

Where are we now?

- Fire regimes are changing, affecting emissions, air quality and health
- Questions being addressed: what happens when the fire burns? What is emitted? How do those emissions change and what impacts do they have downwind?
- Began discussing interactions between fire smoke and health

Themes

- When will it be smoky, and when will the smoke go away?
- It's not what we have learned, but what we are learning
- Are we narrowing the uncertainties or realizing that the uncertainties are larger than we thought?
- Opportunities for synergy between atmospheric scientists and health scientists

Key takeaways

- Many pollutants (“Lots and lots of different compounds”)
 - Primary pollutants: PM, CO, NO₂, PAHs, VOCs
 - Secondary pollutants: PM, ozone
- Strong links between climate, weather, wildfire, air quality, health
- Range of health outcomes: respiratory, new evidence for cardiovascular, potentially also birth outcomes, mental health, metabolic outcomes, cognitive decline, child neurological development, decreased lung function, health of pregnant mothers, diabetes, mortality, could be risk factor for COVID-19
- Complexity at each step: fire → plume → chemistry/transport → exposure → health
- Importance of engaging with public health officials (public and occupational) and public education (e.g. avoiding exposure, early warning, changing resistance to prescribed burns)

Challenges with air quality forecasting

- Many challenges with modeling smoke transport/chemistry given plume complexity, behavior, and size.
- Scale issues - moving from plume scale → regional/global models
- Boundary layer dynamics, interactions with plumes and smoke transport
- Plume rise and vertical distribution might be the biggest challenge
- Opportunities from integrating information from multiple sources: lab studies, field campaigns, ground/aircraft monitoring, satellite observations, modeling (global, regional, plume, fire behavior, etc.). Each has an important role.

We are learning better air quality forecasting

Forecast models have different scopes, scales, uses, and challenges:

- **Fine scale** for fire spread (e.g. WRF-SFIRE): fire management and first responders needs hi-res meteorology and fire behaviour
- **Regional transport** models (e.g. HRRR-Smoke): detailed meteorology, PM emissions, no chemistry needs good FRP
- **Regional chemical transport** models (e.g. WRF-Chem): detailed AQ with PM and ozone needs chemical mechanisms and detailed EF
- **Global** models (e.g. RAQMS): global transport needs simplified chemical mechanisms

New data and resources available:

- **FIREX-AQ, WE-CAN, FASMEE, etc:** high quality detailed measurements for some/many fires, fire behaviour, new EF, updated chemical mechanisms, etc
- **Improved/future satellite capabilities:** e.g. GOES 5-min FRP or TEMPO NO2

Connections with health

- New evidence supporting cardiovascular effect of wildfire smoke, in addition to the respiratory effects previously recognized
- We have agency. Humans start the vast majority of wildfires, especially those that threaten homes.
- Smoke doesn't exist in isolation - Importance of the quality of the air that the smoke is mixing into - urban/rural
- Currently no common exposure definition or data sources

For further discussion

Improving air quality forecasts for regulatory assessments, health effects research:

- High spatial/vertical resolution, over complex terrain, with full chemistry
- Integrating multiple exposure sources: ground, aircraft, and satellite measurements (geostationary and polar orbiting), modeling (plume scale → regional/global CTMs)
- Many uncertainties and lots of variability: missing small wildfires, fire regime characterization, emissions, chemistry, plume rise/dynamics, vertical mixing, etc. Which are most important for air quality forecasting? For understanding health effects?

For further discussion (cont.)

- When we think of smoke, we think of $PM_{2.5}$ - based on health studies. But are we only exploring health effects for the pollutants we measure?
- Spatial/temporal questions: Modeling specific fires vs all fires over a broad region; short-term vs repeated exposure over years
- Prescribed burning vs. wildfires: plume dynamics, emissions, air quality, health
- Role of citizen science? What information can be provided to/from the public?
- Avenues and funding mechanisms for enabling air quality and health communities to meet, talk, and solve problems together