NCAR

Socio-Economic Impact Assessment of "Chemical Data Assimilation and Analog-Based Uncertainty Quantification to Improve Decision-making in Public Health and Air Quality

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Overview

- **Motivation**: The modeling enhancements NCAR is undertaking is improving air quality forecasts, which in turn will increase individuals' ability to respond appropriately to protect themselves from poor ambient air quality (see talk 6B).
- **Research Questions:**
  - What are the potential health-related benefits of these improvements?
  - How can warnings be improved to better achieve these benefits?

Overview

Initial Findings (see March 13, 2018 presentation)

- Air quality authorities base their forecasts on several sources, including satellite and radar imagery as well as modelling results and personal experience.
- Until the modelling improvements are fully implemented, it will be difficult to estimate the extent to which they will be used to improve these forecasts.
- Little is known about the potential health benefits that could accrue from improved forecasts.

Implications

- Focus on estimating the health improvements associated with perfect forecasts; identify the factors that most significantly influence these benefits.
- Combine the results of this analysis with the literature on responses to air quality warnings and on effective risk communication, to identify ways to improve adherence to the warnings and hence achievement of these benefits.

Overview

Current status

- Refining health impacts model to incorporate new data and test the effects of differing assumptions.
- Integrating model results into recommendations for improving air quality warnings.
- Requested no cost extension to allow time to (a) further refine the model; (b) consult with national, regional, and local air quality authorities about the feasibility and usefulness of our recommendations; and (c) take into account upcoming changes in EPA's warnings, which were rolled out as part of their AirNow website last week.

Potential Health Benefits of Air Quality Warnings

Context

- Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) is required to develop a national air quality monitoring system and uniform air quality index (AQI).
- The AQI is calculated for each pollutant, then the highest AQI for an individual pollutant is reported as the overall index value for that day.
- The AQI is calibrated so that a value of 100 generally corresponds to the daily National Ambient Air Quality Standard (NAAQS) for that pollutant, as determined by EPA regulations.
- An AQI value at or below 100 is generally considered satisfactory; higher levels are of increasing concern first for sensitive populations and then for the general population.

Potential Health Benefits of Air Quality Warnings

Context

- Based on forecasted pollutant concentrations, national, state, and local air quality authorities issue warnings urging residents to stay indoors or take other precautions when pollutant levels exceed specified thresholds.
- We examine the health benefits that could be achieved if forecasts were always accurate and if individuals adhered to the recommendations.
- We develop a model to estimate these impacts and illustrate the results using data from three U.S. locations.

Potential Health Benefits of Air Quality Warnings

Context

Air Quality Guide for Particle Pollution

Harmful particle pollution is one of our nation's most common air pollutants. Use the chart below to help reduce your exposure and protect your health. For your local air quality forecast, visit www.airnow.gov

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good (0-50)	It's a great day to be active outside.	
Moderate (51-100)	Some people who may be unusually sensitive to particle pollution.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups (101-150)	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
Unhealthy (151-200)	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling. **Everyone else:** *Reduce* prolonged or heavy exertion. Take more breaks during outdoor activities.
Very Unhealthy (201-300)	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
Hazardous (301-500)	**Everyone**	**Everyone:** *Avoid all* physical activity outdoors. **Sensitive groups**: Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

Potential Health Benefits of Air Quality Warnings

Context

Air Quality Guide for Ozone

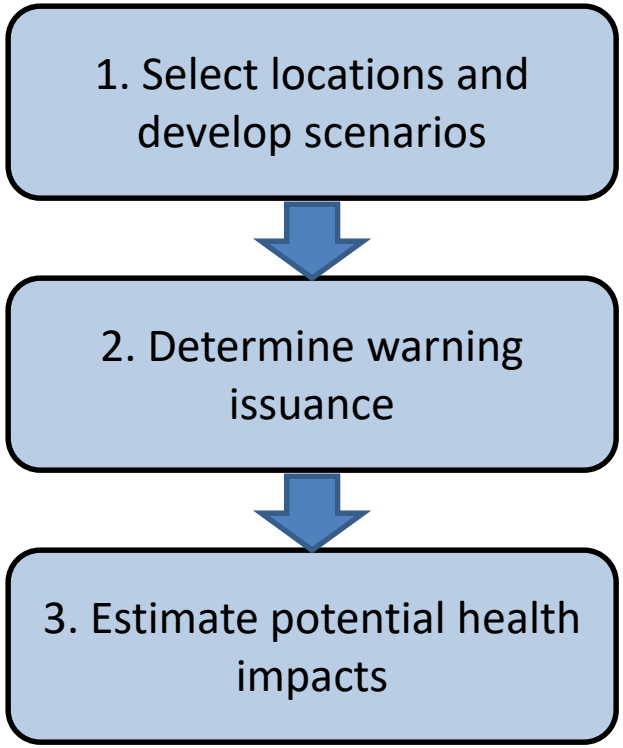
Ground-level ozone is one of our nation's most common air pollutants. Use the chart below to help reduce your exposure and protect your health. For your local air quality, visit www.airnow.gov

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good (0-50)	It's a great day to be active outside.	
Moderate (51-100)	Some people who may be unusually sensitive to ozone.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy outdoor exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups (101-150)	Sensitive groups include **people with lung disease such as asthma, older adults, children and teenagers, and people who are active outdoors.**	**Sensitive groups:** *Reduce* prolonged or heavy outdoor exertion. Take more breaks, do less intense activities. Watch for symptoms such as coughing or shortness of breath. Schedule outdoor activities in the morning when ozone is lower. **People with asthma** should follow their asthma action plans and keep quick- relief medicine handy.
Unhealthy (151-200)	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy outdoor exertion. Schedule outdoor activities in the morning when ozone is lower. Consider moving activities indoors. **People with asthma**, keep quick-relief medicine handy. **Everyone else:** *Reduce* prolonged or heavy outdoor exertion. Take more breaks, do less intense activities. Schedule outdoor activities in the morning when ozone is lower.
Very Unhealthy (201-300)	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **People with asthma**, keep quick-relief medicine handy. **Everyone else:** *Avoid* prolonged or heavy outdoor exertion. Schedule outdoor activities in the morning when ozone is lower. Consider moving activities indoors.
Hazardous (301-500)	**Everyone**	**Everyone:** *Avoid all* physical activity outdoors.

Note: If you don't have an air conditioner, staying inside with the windows closed may be dangerous in extremely hot weather. In these cases, seek alternative shelter.

Potential Health Benefits of Air Quality Warnings

Model overview



Potential Health Benefits of Air Quality Warnings

1. Select locations and develop scenarios

- Three locations: Denver, Los Angeles, Pittsburgh:
  - include relatively large populations;
  - issue air quality warnings; and
  - provide examples of differing warning practices, climates, and air pollution sources and patterns.

Potential Health Benefits of Air Quality Warnings

1. Select locations and develop scenarios

- Rely on hourly monitor readings for fine particles ($PM_{2.5}$) and ozone over four year period (2013-2017).
- Three scenarios:
  - Maximum, mean, and minimum concentrations for each location, based on readings for each hour across four years.

Potential Health Benefits of Air Quality Warnings

2. Determine warning issuance

- Use EPA approach to determine AQI values for each hour in each location, under each scenario.
- Identify warning days where:
  - AQI > 100 for $PM_{2.5}$ or ozone;
  - AQI > 150 for $PM_{2.5}$ or ozone.

Potential Health Benefits of Air Quality Warnings

3. Estimate potential health impacts

- Focus on premature mortality for individuals age 65 and over.
  - Dominates benefit estimates for most air pollution policies.
- Estimate concentration-response relationships using epidemiological studies by Lepeule et al. (2012) for $PM_{2.5}$ and Zanobetti and Schwartz (2008) for ozone.
  - Highly precise exposure assessment.
  - Long time periods for follow-up; capture full impact.

Potential Health Benefits of Air Quality Warnings

3. Estimate potential health impacts

- For each warning day under each scenario, calculate the change in mortality risk associated with spending an additional hour indoors.
  - One hour change is consistent with data on the amount of time individuals spend outdoors and with research on responses to warnings.
- Focus on daytime hour with highest monitor reading, compare monitored concentration to range of potential indoor concentrations given research on infiltration rates.
  - Infiltration highly dependent on building characteristics and occupant behavior; may reach 100 percent.
- Value benefits using default estimates applied by Federal agencies.
- Estimate net benefits of adhering to warnings by comparing value of health benefits to estimates of value of time spent in preferred activities.

Implications for Improving Responses

- Health impact assessment results have several implications for achieving health benefits; e.g., draw attention to building characteristics and occupant behaviors that affect indoor exposures.
- Combine with previous research on responses to warnings and on effective risk communication to develop policy recommendations.

Thank You!